Electronic Supplementary Information

Synergistic Diselenide/Guanidine Catalyzed Dehydrophosphorylation of 2-Nitrobenzhydrols to Access C-Stereogenic Phosphinates

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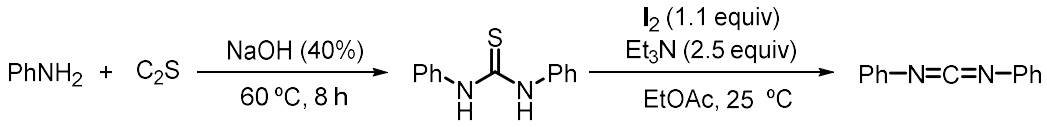
Table of Contents

1. General Information

Thin-layer chromatography (TLC) was performed using 60 mesh silica gel plates visualized with short-wavelength UV light (254 nm). Silica gel 60 (230-400 mesh) was used for column chromatography. ^{1}H and ^{13}C NMR spectra were recorded using $CDCl_3$ solvent on a Bruker advance III 400 spectrometer (400 MHz for ^{1}H, 162 MHz for ^{31}P and 101 MHz for ^{13}C), on a Bruker advance III 600 spectrometer (600 MHz for ^{1}H, 243 MHz for ^{31}P and 151 MHz for ^{13}C). ^{1}H and ^{13}C NMR spectra were recorded on a Bruker advance III 400 spectrometer in $CDCl_3$ with TMS as internal standard. Chemical shifts (δ) were measured in ppm relative to TMS $\delta = 0$ for ^{1}H in $CDCl_3$, or to $CDCl_3$ $\delta = 77.2$ for ^{13}C as internal tandard.^{31}P and ^{19}F NMR were recorded on the same instrument. Data are reported as follows: Chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), Coupling constants are reported in Hertz (Hz). Mass data were measured with Thermo Scientific DSQ II mass spectrometer. Low resolution mass spectroscopic (LRMS) and mass spectra were measured using Bruker micro TOF-Q II mass spectrometer and Thermo Scientific DSII mass spectrometer. The enantiomeric excess (ee) of the products was determined by chiral HPLC (Thermo Scientific UltiMate 3000) using Daicel CHIRALCEL® columns and Daicel CHIRALPAK® columns (internal diameter 4.6 mm, column length 250 mm, particle size 3 μm). The starting materials were purchased from Aldrich, Across Organics, J&K Chemicals or TCI and used without further purification. Solvents were dried and purified according to the procedure from "Purification of Laboratory Chemicals book". Reaction solvent 2-chlorotoluene (Macklin, 97%) was used as received. Molecular sieve was activated at 500 ºC for 5 h and stored in room temperature under N_2 atmosphere.

2. General Procedures for the Synthesis of Guanidine Catalysts

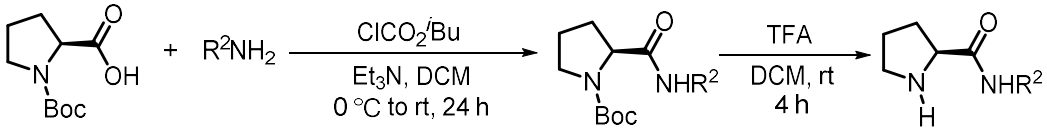
2.1 General procedure for the synthesis of carbodiimide according to the literature procedure[1]



In a round-bottomed flask (500 mL) equipped with a magnetic stirrer, 5.52 mL of a solution of NaOH (40%) was added with stirring at room temperature to amines (50 mmol) and CS_2 (3.91mL, 65 mmol). The mixture was stirred at 60 ℃ heated in an oil bath for 8 h, then cooled at room temperature. A precipitate formed after the addition of 10 mL of water. The precipitate was filtered, washed with 20 mL water and dried to give thiourea. The solid product was scraped off the walls of the mortar affording thiourea quantitatively.

According to the literature, iodine (44 mmol, 1.1 equiv) was added to a solution of thiourea (40 mmol) and triethylamine (100 mmol, 2.5 equiv) in EtOAc (100 mL) for 30 min with well stirring. According to the TLC test, the precipitate was filtered after appropriate time and washed with EtOAc (3×40 mL) and the solvents were evaporated. The crude mixture was purified by column chromatography using hexane as the eluent to give the carbodiimide.

2.2 General Procedure for the Preparation of *L*-Proline-Derived Amides[2]

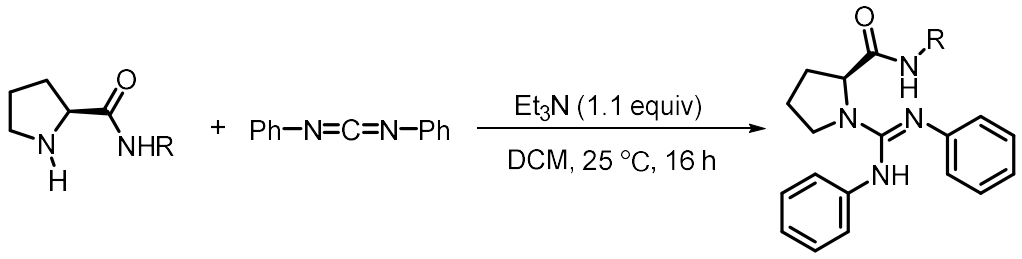


N-Boc-L-proline (10 mmol) was dissolved in dry DCM (40 mL) and treated with triethylamine (15 mmol, 1.5 equiv). The reaction mixture was cooled to 0 °C and isopropyl chloroformate (15 mmol, 1.5 equiv) was then added dropwise over 15 min. After the mixture had been stirred for another 30 min, an amine (11 mmol, 1.1 equiv) was added over 15 min. The resulting solution was stirred at 0 °C for 1 h and at room temperature for another 24 h. According to the TLC test, it was filtered through a Celite pad and the solvents were evaporated. Column chromatography on silica gel gave the desired amides.

N-Boc- L-Proline-Derived Amides (5 mmol) was dissolved in dry CH_2Cl_2 (10 mL) and was treated with TFA (50 mmol, 10 equiv) at 25 °C. After 4 h, the solvent was removed by rotary evaporation. The residue was dissolved in CH_2Cl_2 (20 mL)

and water (10 mL) was added. The mixture was neutralized with NaOH (5 M) until pH 11~12, and then it was extracted with CH_2Cl_2 (3 × 30 mL). The combined organic layers were dried over Na_2SO_4 and concentrated by rotary evaporation to afford amino amide.

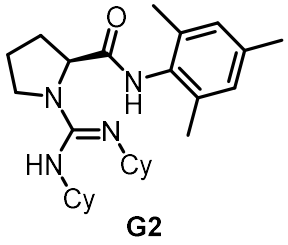
2.3 General procedure for the synthesis of guanidine catalyst[3]



In a dry tube was charged with the amide (2 mmol, 1.0 equiv), Carbodiimide (2 mmol, 1 equiv) and Et_3N (2.2 mmol, 1.1 equiv) in DCM (20 mL), stirring at room temperature for 12 h. After completion, the reaction was concentrated under reduced pressure. The desired aryl substituted guanidine catalyst was purified by flash column chromatography.

Note: **G1** were known compounds.[4]

Identification data for Guanidine Catalysts **G2**-**G12**.



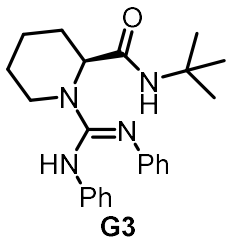
G2

Prepared according to **General Procedure**. Purification via silica gel column chromatography (dichloromethane/methanol = 40:1 to 30:1) afforded **G2** as white solid

^{1}H NMR (400 MHz, Chloroform-*d*) δ 9.51 (s, 1H), 7.16 (s, 1H), 6.77 (s, 2H), 6.00 – 5.95 (m, 1H), 3.80 (q, *J* = 8.39, 7.82 Hz, 1H), 3.42 (t, *J* = 7.53 Hz, 1H), 3.28 – 3.02 (m, 3H), 2.62 – 2.47 (m, 1H), 2.17 (d, *J* = 8.47 Hz, 9H), 1.98 – 1.92 (m, 2H), 1.88 – 1.79 (m, 2H), 1.78 – 1.66 (m, 4H), 1.66 – 1.56 (m, 2H), 1.56 – 1.39 (m, 4H), 1.38 – 1.24 (m, 2H), 1.24 – 1.09 (m, 3H), 1.09 – 0.96 (m,3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 170.1, 155.3, 136.4, 134.6, 131.2, 128.9, 61.0, 55.3, 51.3, 34.3, 32.9, 31.8, 25.5, 25.3, 24.8, 20.9, 18.9, 18.4.

HRMS Calculated for $C_{27}H_{42}N_4O$ $[M+H]^+$: 439.3431, found: 439.3431.



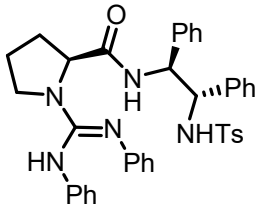
G3

Prepared according to **General Procedure**. Purification via silica gel column chromatography (dichloromethane/methanol = 40:1 to 30:1) afforded **G3** as white solid

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.26 (s, 1H), 7.39 – 7.14 (m, 4H), 7.08 – 6.80 (m, 6H), 5.52 (s, 1H), 4.59 (s, 1H), 3.55 (d, *J* = 13.3 Hz, 1H), 2.86 (t, *J* = 12.6 Hz, 1H), 2.29 – 2.12 (m, 1H), 1.82 – 1.72 (m, 1H), 1.58 – 1.50 (m, 1H), 1.46 – 1.18 (m, 12H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 171.4, 152.8, 129.5, 123.4, 122.4, 120.2, 57.0, 51.0, 44.9, 29.1, 25.7, 24.3, 21.0.

HRMS Calculated for $C_{23}H_{30}N_4O$ $[M+H]^+$: 379.2492, found: 379.2490.



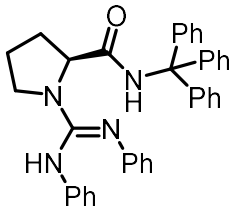
G4

Prepared according to **General Procedure**. Purification via silica gel column chromatography (dichloromethane/methanol = 40:1 to 30:1) afforded **G4** as white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.26 (d, *J* = 8.0 Hz, 1H), 7.40 (d, *J* = 8.0 Hz, 2H), 7.12 (t, *J* = 7.7 Hz, 4H), 7.07 – 6.85 (m, 14H), 6.69 (d, *J* = 7.8 Hz, 4H), 5.22 (t, *J* = 8.6 Hz, 1H), 4.67 (d, *J* = 9.0 Hz, 2H), 3.37 – 3.07 (m, 2H), 2.35 – 2.30 (m, 4H), 2.10 – 1.95 (m, 1H), 1.95 – 1.76 (m, 2H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 174.0, 150.3, 142.7, 138.4, 138.2, 137.7, 129.4, 129.3, 128.7, 128.1, 127.8, 127.6, 127.4, 126.9, 122.8, 121.2, 64.0, 61.0, 59.0, 48.8, 28.4, 24.9, 21.6.

HRMS Calculated for $C_{39}H_{39}N_5O_3S$ $[M+H]^+$: 658.2846, found: 658.2844.



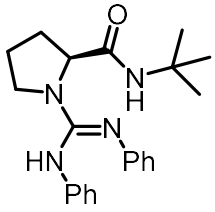
G5

Prepared according to **General Procedure**. Purification via silica gel column chromatography (dichloromethane/methanol = 50:1 to 40:1) afforded **G5** as white solid

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.60 (s, 1H), 7.22 – 7.12 (m, 20H), 6.93 (t, *J* = 7.4 Hz, 2H), 6.77 (s, 4H), 4.90 (t, *J* = 7.0 Hz, 1H), 3.32 – 3.18 (m, 1H), 3.16 – 3.08 (m, 1H), 2.28 – 2.16 (m, 1H), 2.09 – 1.97 (m, 1H), 1.91 – 1.69 (m, 2H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 170.8, 150.3, 144.9, 129.4, 128.9, 127.9, 126.9, 122.6, 70.4, 61.9, 49.1, 28.4, 25.0.

HRMS Calculated for $C_{37}H_{34}N_4O$ $[M+H]^+$: 551.2805, found: 551.2803.



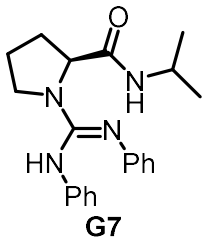
G6

Prepared according to **General Procedure**. Purification via silica gel column chromatography (dichloromethane/methanol = 50:1 to 40:1) afforded **G6** as white solid

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.23 (t, *J* = 7.7 Hz, 4H), 7.14 (s, 1H), 7.04 – 6.80 (m, 6H), 5.58 (s, 1H), 4.65 (t, *J* = 6.7 Hz, 1H), 3.38 – 3.24 (m, 1H), 3.21 – 3.10 (m, 1H), 2.37 – 2.29(m, 1H), 2.02 – 1.88 (m, 2H), 1.82 – 1.72 (m, 1H), 1.32 (s, 9H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 171.4, 150.1, 129.5, 122.6, 61.3, 50.9, 48.9, 28.9, 27.9, 25.0.

HRMS Calculated for $C_{22}H_{28}N_4O$ $[M+H]^+$: 365.2336, found: 365.2336.



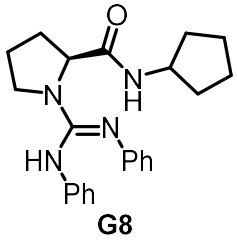
G7

Prepared according to General Procedure. Purification via silica gel column chromatography (dichloromethane/methanol = 50:1 to 40:1) afforded **G7** as white solid

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.44 (s, 1H), 7.17 (t, *J* = 7.7 Hz, 4H), 7.03 (d, *J* = 7.8 Hz, 4H), 6.94 (t, *J* = 7.4 Hz, 2H), 4.99 (t, *J* = 7.4 Hz, 1H), 4.05 – 3.88 (m, 1H), 3.17 (q, *J* = 8.7 Hz, 1H), 3.03 (s, 1H), 2.23 – 2.03 (m, 2H), 1.95 – 1.84 (m, 1H), 1.83 – 1.71 (m, 1H), 1.10 (d, *J* = 6.6 Hz, 3H), 0.97 (d, *J* = 6.5 Hz, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 171.0, 150.4, 129.3, 123.4, 121.3, 61.8, 49.6, 41.6, 29.3, 25.1, 22.7, 22.6.

HRMS Calculated for $C_{21}H_{26}N_4O$ $[M+H]^+$: 351.2179, found: 351.2174.



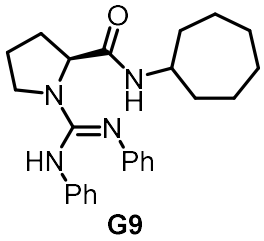
G8

Prepared according to General Procedure. Purification via silica gel column chromatography (dichloromethane/methanol = 50:1 to 40:1) afforded **G8** as white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.35 – 7.13 (m, 5H), 7.07 – 6.81 (m, 6H), 5.43 (s, 1H), 4.69 (t, *J* = 6.8 Hz, 1H), 4.28 – 4.08 (m, 1H), 3.36 – 3.08 (m, 2H), 2.39 – 2.23 (m, 1H), 2.05 – 1.87 (m, 5H), 1.66 – 1.45 (m, 4H), 1.43 – 1.30 (m, 2H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 171.9, 150.1, 129.5, 122.7, 121.0, 61.0, 51.2, 48.9, 33.4, 33.1, 28.4, 24.9, 23.8 (d, *J* = 2.5 Hz).

HRMS Calculated for $C_{23}H_{28}N_4O$ $[M+H]^+$: 377.2336, found: 377.2338.



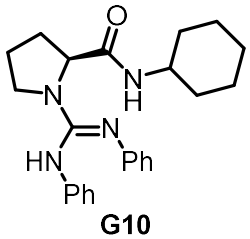
G9

Prepared according to **General Procedure**. Purification via silica gel column chromatography (dichloromethane/methanol = 50:1 to 40:1) afforded **G9** as white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.39 – 7.14 (m, 5H), 7.09 – 6.88 (m, 6H), 5.99 (s, 1H), 4.80 (t, *J* = 7.17 Hz, 1H), 4.00 – 3.80 (m, 1H), 3.33 – 2.87 (m, 2H), 2.28 – 2.02 (m, 2H), 2.00 – 1.68 (m, 4H), 1.69 – 1.27 (m, 10H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 170.9, 150.2, 129.4, 123.0, 121.1, 61.6, 50.6, 49.3, 35.0 (d, *J* = 2.5 Hz), 29.1, 28.2 (d, *J* = 5.1 Hz), 25.1, 24.2, 24.1.

HRMS Calculated for $C_{25}H_{32}N_4O$ $[M+H]^+$: 405.2649, found: 405.2644.



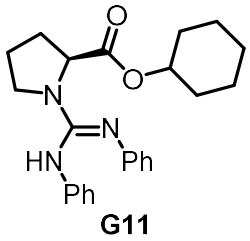
G10

Prepared according to **General Procedure**. Purification via silica gel column chromatography (dichloromethane/methanol = 50:1 to 40:1) afforded **G10** as white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.22 (t, *J* = 7.7 Hz, 4H), 7.12 (d, *J* = 8.3 Hz, 1H), 6.99 – 6.88 (m, 6H), 5.01 (s, 1H), 4.69 (dd, *J* = 7.7, 5.9 Hz, 1H), 3.81 – 3.69 (m, 1H), 3.29 – 3.13 (m, 2H), 2.35 – 2.22 (m, 1H), 2.09 – 1.97 (m, 1H), 1.95 – 1.74 (m, 4H), 1.71 – 1.60 (m, 2H), 1.59 – 1.49(m, 1H), 1.38 – 1.24 (m, 2H), 1.19 – 1.02 (m, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 171.4, 150.2, 129.5, 122.8, 121.1, 61.2, 49.0, 48.2, 33.2, 33.1, 28.7, 25.7, 25.0, 24.9 (d, *J* = 2.3 Hz).

HRMS Calculated for $C_{24}H_{30}N_4O$ $[M+H]^+$: 391.2492, found: 391.2487.



G11

Prepared according to **General Procedure**. Purification via silica gel column chromatography (dichloromethane/methanol = 50:1 to 40:1) afforded **G11** as white solid.

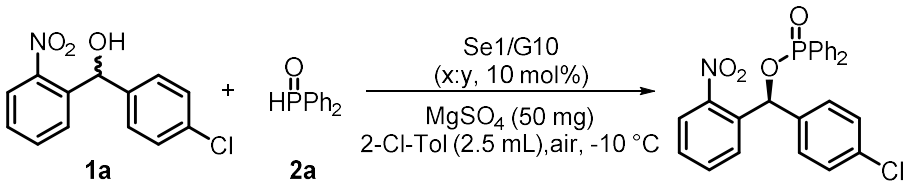
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.32 – 7.10 (m, 4H), 7.08 – 6.57 (m, 6H), 5.63 (s, 1H), 4.92 – 4.74 (m, 1H), 4.73 – 4.50 (m, 1H), 3.45 – 3.17 (m, 2H), 2.36 – 2.19 (m, 1H), 1.97 – 1.80 (m, 5H), 1.78 – 1.66 (m, 2H), 1.55 – 1.40 (m, 3H), 1.39 – 1.20 (m, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 173.2, 148.7, 129.3, 122.2, 73.3, 60.5, 48.2, 31.7 (d, J = 6.6 Hz), 30.1, 25.5, 24.9, 23.8 (d, J = 7.3 Hz).

HRMS Calculated for $C_{24}H_{29}N_3O_2$ $[M+H]^+$: 392.2333, found: 392.2333.

3. Optimization of the reaction conditions

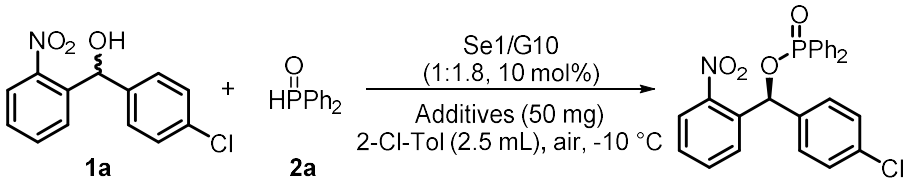
Table S1: Optimization of the amount of **Se1** and **G10** catalyst[a]



Entry	x:y (mol%)	Yield[b] (%)	e.r.[c]
1	1:0.8	45	96:4
2	1:1.0	58	96:4
3	1:1.1	58	96:4
4	1:1.2	59	95.5:4.5
5	1:1.4	58	95.5:4.5
6	1:1.6	67	95.5:4.5
7	1:1.8	71	95:5
8	1:2.0	64	95:5
9	1:3.0	67	95.5:4.5
10	1:4.0	69	95.5:4.5

[a]Reaction conditions: **1a** (0.25 mmol), **2a** (0.1 mmol), Se1 (10 mol%), G10 (10y mol %), $MgSO_4$ (50 mg) in 2.5 mL solvent at -10 °C under Air. [b]Isolated yield (based on 2a). [c]Enantiomeric ratios (e.r.) were determined by HPLC analysis.

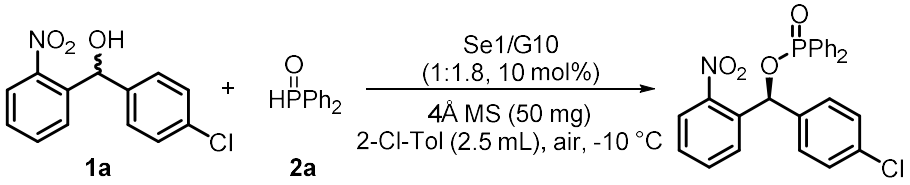
Table S2: Optimization of the additives[a]



Entry	Additives (50 mg)	Yield[b] (%)	e.r.[c]
1	--	63	95:5
2	$MgSO_4$	71	95:5
3	$NaSO_4$	62	95:5
4	3Å MS	28	87:13
5	4Å MS	86	95:5
6	5Å MS	41	93:7

[a]Reaction conditions: **1a** (0.25 mmol), **2a** (0.1 mmol), Se1 (10 mol%), G10 (18 mol %), Additives (50 mg) in 2.5 mL solvent at -10 °C under Air. [b]Isolated yield (based on 2a). [c]Enantiomeric ratios (e.r.) were determined by HPLC analysis.

Table S3: Optimization of the substrate ratio[a]

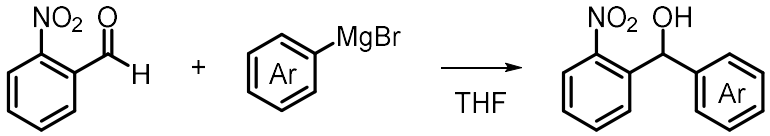


Entry	1a:2a	Yield[b] (%)	e.r.[c]	Remaining 1a[d]	Conv. [%]	*s*
1	1:1	48	90:10	38%, 80:20 e.r.	43	16
2	2:1	71	94:6	57%, 69:31 e.r.	30	24
3	2.5:1	86	95:5	61%, 65:35 e.r.	25	25
4	3:1	85	96:4	--		

[a]Reaction conditions: **2a** (0.1 mmol), Se1 (10 mol%), G10 (18 mol %) in 2.5 mL solvent at -10 °C under Air. [b]Isolated yield (based on 2a). [c]Enantiomeric ratios (e.r.) were determined by HPLC analysis. [d]Isolated yield and Enantiomeric ratios (e.r.) of remaining 1a. For the kinetic resolution, selectivity factors (*s*) were calculated according to Kagan's equation: $s = \ln((1-C)(1-ee_s))/\ln((1-C)(1+ee_s))$, wherein the C is conversion of the reaction, ee_s is the enantiomeric excess of the remaining substrate. Conversions (C) were calculated by the following equation: $C = ee_s/(ee_p+ee_s)$.

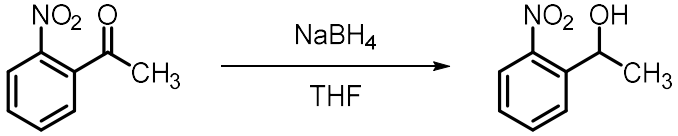
4. General Procedures for the Synthesis of 2-nitrobenzhydrols substrates

General procedure A[5]: Synthesis of **1a-1o, 1s**.



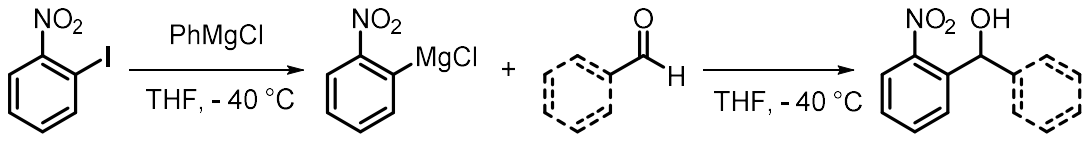
To a solution of 2-nitrobenzaldehyde (1.51 g, 10 mmol) in anhydrous THF (20 mL) was added phenylmagnesium bromide or a close derivative (15 mL, 1.0 M solution in THF) dropwise at -78°C. The mixture was then stirred at -78°C for 1 hour under an argon atmosphere. After being warmed to room temperature, saturated NH_4Cl solution (5 mL) was added dropwise to quench the reaction. The solvent was removed under reduced pressure and the residue was extracted with ethyl acetate (20 mL × 3). The combined organic layers was then washed with brine (20 mL) and dried over anhydrous Na_2SO_4. The solvent was removed under reduced pressure and the residue was purified by column chromatography (petroleum ether/EtOAc = 10:1-5:1) to give **1a-1o, 1s.**

General procedure B[6]: Synthesis of **1p**.



A 100 mL reaction flask was charged with 2-Nitroacetophenone (825 mg, 5 mmol) and THF (20 mL). The mixture was stirred at 0 °C for 5 min, then $NaBH_4$ (378 mg, 10 mmol) was added in 10 min slowly. Then the temperature returned to room temperature. When TLC monitoring showed that the raw material was consumed completely, the reaction was quenched by addition of water (20 mL) and extracted with diethyl ether (3 x 10 mL). The organic layer was dried over Na_2SO_4. The combined ether extracts were concentrated under reduced pressure and the residue was purified by flash column chromatography on silica gel (petroleum ether/EtOAc = 10:1) to give **1p.**

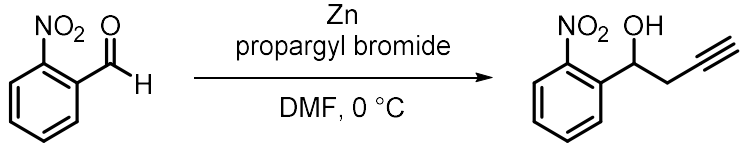
General procedure C[7]: Synthesis of **1q-1r, 1u-1z, 5a-5c**.



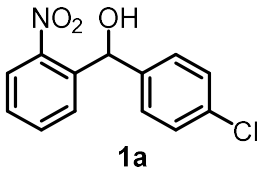
A solution of 2-iodo-nitrobenzene (1.51 g, 10 mmol) in THF (10 mL) was cooled to -40 °C and a solution of phenylmagnesium chloride (1 M in THF, 1.1 eq.) was added dropwise. After stirring for 30 min at -40 °C, the aldehyde (1.0 eq.) was added. Then, the reaction mixture was continuously stirred at -40 °C until complete conversion

(checked by TLC). The reaction was quenched with a saturated solution of NH_4Cl (5 mL) and diluted with water (5 mL). The aqueous phase was extracted with ethyl acetate (three times) and the combined organic layers were washed with brine, dried, and concentrated under reduced pressure. The residue was purified by column chromatography (petroleum ether/EtOAc = 10:1-5:1) to give the desired product **1q-1r, 1u-1z, 5a-5c.**

General procedure D[8]: Synthesis of **1t**.



To stirred suspension of activated zinc dust (1.7 g, 26.6 mmol, 2 equiv.) in DMF (30 mL) at 0 °C, propargyl bromide (2.4 g, 19.9 mmol, 1.5 equiv.) was added dropwise. The mixture was stirred for 1 h at the same temperature. Then, a solution of 2-nitrobenzaldehyde (2.0 g, 13.3 mmol) in DMF (6 mL) was transferred to the reaction flask. After 2.5 h, full conversion of the aldehyde was observed (checked by TLC) and the reaction was quenched with a saturated solution of NH_4Cl (20 mL). The aqueous phase was extracted with ethyl acetate (three times) and the combined organic layers were washed with brine, dried, and concentrated under reduced pressure. The residue was purified by column chromatography (petroleum ether/EtOAc =5:1) to give the desired product **1t**.



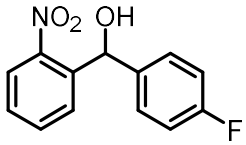
1a

Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1a** as yellow solid (83% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.91 (d, *J* = 8.2 Hz, 1H), 7.71 – 7.57 (m, 2H), 7.44 (t, *J* = 7.8 Hz, 1H), 7.31 – 7.16 (m, 4H), 6.34 (s, 1H), 3.19 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-d) δ 148.3, 140.1, 138.2, 133.9, 133.8, 129.4, 128.9, 128.8, 128.4, 124.9, 70.9.

HRMS Calculated for $C_{13}H_{10}ClNO_3$ $[M+Na]^+$: 286.0241, found: 286.0240.



1b

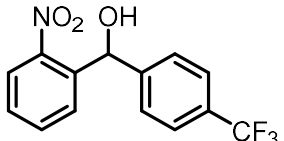
Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1b** as yellow solid (87% yield)

^{1}H NMR (400 MHz, Chloroform-d) δ 7.91 (d, J = 8.2 Hz, 1H), 7.71 (d, J = 7.9 Hz, 1H), 7.66 – 7.59 (m, 1H), 7.50 – 7.40 (m, 1H), 7.28 (dd, *J* = 7.5, 4.4 Hz, 2H), 7.07 – 6.92 (m, 2H), 6.37 (s, 1H), 3.05 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 163.7, 161.2, 148.4, 138.5, 137.5 (d, *J* = 3.2 Hz), 133.7, 129.3, 128.9, 128.8 (d, *J* = 2.4 Hz), 124.9, 115.7, 115.5, 71.0.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -114.02.

HRMS Calculated for $C_{13}H_{10}FNO_3$ $[M+Na]^+$: 270.0537, found: 270.0534.



1c

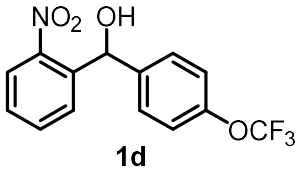
Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1c** as yellow oil (81% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.94 (d, *J* = 8.2 Hz, 1H), 7.68 – 7.61 (m, 2H), 7.58 (d, *J* = 8.1 Hz, 2H), 7.51 – 7.39 (m, 3H), 6.43 (s, 1H), 3.36 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 148.3, 145.5, 137.9, 133.9, 130.2 (q, *J* = 32.4 Hz), 129.6, 129.1, 127.3, 125.6 (q, *J* = 3.8 Hz), 125.0, 124.1 (q, *J* = 272.1 Hz), 70.9.

^{19}F NMR (376 MHz, Chloroform-d) δ -62.55.

HRMS Calculated for $C_{14}H_{10}F_3NO_3$ $[M+Na]^+$: 320.0505, found: 320.0504.



1d

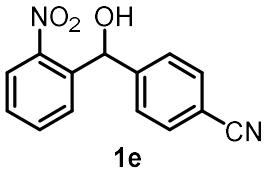
Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1d** as yellow oil (78% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.93 (d, *J* = 8.2 Hz, 1H), 7.70 (d, *J* = 8.0 Hz, 1H), 7.66 – 7.59 (m, 1H), 7.50 – 7.41 (m, 1H), 7.35 (d, *J* = 6.5 Hz, 2H), 7.16 (d, *J* = 8.3 Hz, 2H), 6.40 (s, 1H), 3.24 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 148.9 (q, *J* = 1.9 Hz), 148.3, 140.3, 138.2, 133.8, 129.4, 128.9, 128.5, 124.9, 121.0, 120.5 (q, *J* = 257.4 Hz), 70.8.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -57.84.

HRMS Calculated for $C_{14}H_{10}F_3NO_4$ $[M+ Na]^+$: 336.0454, found: 336.0456.



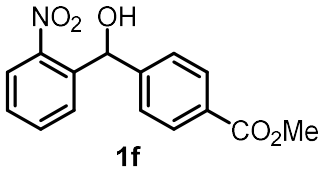
1e

Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1e** as yellow oil (86% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.90 (d, *J* = 8.3 Hz, 1H), 7.68 (d, *J* = 8.2 Hz, 1H), 7.65 – 7.59 (m, 1H), 7.53 (d, *J* = 6.5 Hz, 2H), 7.48 – 7.39 (m, 3H), 6.40 (s, 1H), 3.93 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.9, 147.1, 137.5, 133.8, 132.2, 129.3, 128.9, 127.6, 124.7, 118.6, 111.1, 70.3.

HRMS Calculated for $C_{14}H_{10}N_2O_3$ $[M+Na]^+$: 277.0584, found: 277.0583.



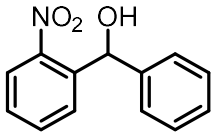
1f

Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1f** as yellow oil (75% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.94 – 7.83 (m, 3H), 7.70 (d, *J* = 8.0 Hz, 1H), 7.59 (t, *J* = 7.6 Hz, 1H), 7.45 – 7.39 (m, 1H), 7.36 (d, *J* = 8.3 Hz, 2H), 6.42 (s, 1H), 3.99 (s, 1H), 3.84 (s, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 167.0, 148.1, 146.8, 138.0, 133.6, 129.7, 129.4, 128.7, 126.9, 124.7, 70.7, 52.2.

HRMS Calculated for $C_{15}H_{13}NO_5$ $[M+Na]^+$: 310.0686, found: 310.0686.



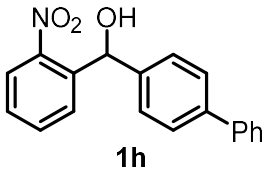
1g

Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1g** as yellow solid (93% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.89 (d, *J* = 8.1 Hz, 1H), 7.72 (d, *J* = 7.9 Hz, 1H), 7.60 (t, *J* = 7.6 Hz, 1H), 7.41 (t, *J* = 7.8 Hz, 1H), 7.35 – 7.22 (m, 5H), 6.38 (s, 1H), 3.03 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 148.4, 141.6, 138.5, 133.5, 129.5, 128.7, 128.6, 128.1, 127.0, 124.8, 71.5.

HRMS Calculated for $C_{13}H_{11}NO_3$ $[M+Na]^+$: 252.0631, found: 252.0634.



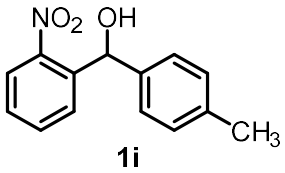
1h

Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1h** as yellow solid (88% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.91 (d, *J* = 8.1 Hz, 1H), 7.77 (d, *J* = 7.9 Hz, 1H), 7.61 (t, *J* = 7.6 Hz, 1H), 7.54 (t, *J* = 6.3 Hz, 4H), 7.46 – 7.28 (m, 6H), 6.44 (s, 1H), 3.00 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 148.4, 141.0, 140.7, 140.7, 138.6, 133.7, 129.5, 128.9, 128.7, 127.6, 127.5, 127.4, 127.2, 124.9, 71.4.

HRMS Calculated for $C_{19}H_{15}NO_3$ $[M+Na]^+$: 328.0944, found: 328.0941.



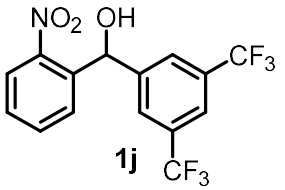
1i

Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1i** as yellow oil (76% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.89 (d, *J* = 8.5 Hz, 1H), 7.78 (d, *J* = 7.9 Hz, 1H), 7.67 – 7.55 (m, 1H), 7.46 – 7.38 (m, 1H), 7.18 (d, *J* = 8.2 Hz, 2H), 7.12 (d, *J* = 8.1 Hz, 2H), 6.34 (s, 1H), 3.18 (s, 1H), 2.33 (s, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 148.2, 138.7, 138.7, 137.8, 133.4, 129.3, 129.2, 128.3, 127.0, 124.7, 71.3, 21.2.

HRMS Calculated for $C_{14}H_{13}NO_3$ $[M+Na]^+$: 266.0788, found: 266.0785.



1j

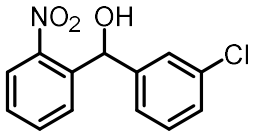
Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1j** as yellow solid (85% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.02 (d, *J* = 8.1 Hz, 1H), 7.86 (s, 2H), 7.82 (s, 1H), 7.69 (t, *J* = 7.5 Hz, 1H), 7.59 (d, *J* = 7.9 Hz, 1H), 7.54 (t, *J* = 7.7 Hz, 1H), 6.50 (s, 1H), 3.11 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 148.5, 144.2, 137.3, 134.4, 132.0 (q, *J* = 33.5 Hz), 129.8, 129.7, 127.2 (d, *J* = 4.2 Hz), 125.3, 124.8 (q), 122.6 – 121.6 (m), 70.5.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -62.87 .

HRMS Calculated for $C_{15}H_9F_6NO_3$ $[M+Na]^+$: 388.0379, found: 388.0376.



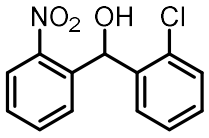
1k

Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1k** as yellow oil (85% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.94 (d, *J* = 9.7 Hz, 1H), 7.72 – 7.58 (m, 2H), 7.51 – 7.42 (m, 1H), 7.33 (s, 1H), 7.29 – 7.22 (m, 2H), 7.21 – 7.16 (m, 1H), 6.35 (s, 1H), 3.46 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 148.1, 143.6, 137.9, 134.5, 133.8, 129.9, 129.5, 128.9, 128.2, 127.1, 125.2, 124.9, 70.8.

HRMS Calculated for $C_{13}H_{10}ClNO_3$ $[M+Na]^+$: 286.0241, found: 286.0240.



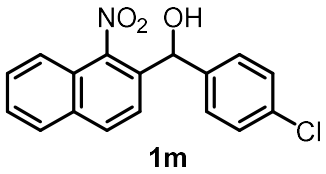
1l

Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1l** as white solid (87% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.98 (d, *J* = 8.1 Hz, 1H), 7.62 – 7.50 (m, 2H), 7.47 (t, *J* = 7.3 Hz, 1H), 7.42 – 7.33 (m, 2H), 7.32 – 7.24 (m, 2H), 6.64 (s, 1H), 3.27 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 149.0, 138.9, 137.2, 133.7, 133.0, 129.8, 129.6, 129.4, 128.9, 128.1, 127.2, 124.9, 68.4.

HRMS Calculated for $C_{13}H_{10}ClNO_3$ $[M+Na]^+$: 286.0241, found: 286.0242.



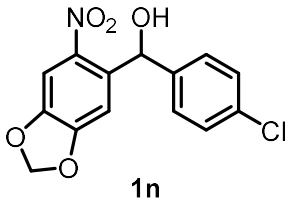
1m

Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1m** as yellow solid (89% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.90 – 7.79 (m, 2H), 7.70 (d, *J* = 8.2 Hz, 1H), 7.64 – 7.53 (m, 2H), 7.46 (d, *J* = 8.7 Hz, 1H), 7.36 – 7.21 (m, 4H), 6.01 (s, 1H), 3.02 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 146.6, 139.8, 133.9, 133.3, 132.4, 131.5, 129.0, 128.8, 128.2, 127.9, 127.8, 124.2, 124.1, 121.9, 70.5.

HRMS Calculated for $C_{17}H_{12}ClNO_3$ $[M+Na]^+$:336.0398, found: 336.0398.



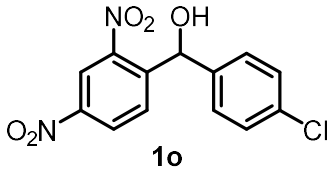
1n

Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1n** as yellow solid (68% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.44 (s, 1H), 7.30 – 7.17 (m, 4H), 7.08 (s, 1H), 6.33 (s, 1H), 6.09 (dd, *J* = 8.0, 1.2 Hz, 2H), 3.32 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 152.4, 147.4, 142.0, 140.2, 136.0, 133.7, 128.7, 128.3, 108.1, 105.6, 103.3, 70.6.

HRMS Calculated for $C_{14}H_{10}ClNO_5$ $[M+Na]^+$: 330.0140, found: 330.0136.



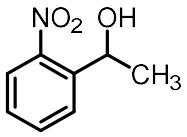
1o

Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1o** as yellow oil (78% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.75 (d, *J* = 2.3 Hz, 1H), 8.48 (dd, *J* = 8.7, 2.4 Hz, 1H), 8.12 (d, *J* = 8.7 Hz, 1H), 7.33 – 7.20 (m, 4H), 6.53 (s, 1H), 2.96 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.9, 147.3, 144.7, 139.0, 134.8, 130.6, 129.3, 128.7, 127.7, 120.5, 70.7.

HRMS Calculated for $C_{13}H_9ClN_2O_5$ $[M+Na]^+$:331.0092, found: 331.0090.



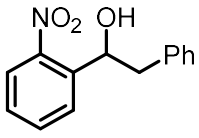
1p

Prepared according to **General Procedure B**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 10:1 v/v) afforded **1p** as yellow oil (95% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.75 (d, *J* = 8.6 Hz, 1H), 7.69 (d, *J* = 8.0 Hz, 1H), 7.53 (t, *J* = 7.7 Hz, 1H), 7.31 (t, *J* = 7.8 Hz, 1H), 5.26 (q, *J* = 6.3 Hz, 1H), 3.76 (s, 1H), 1.40 (d, *J* = 6.4 Hz, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.4, 141.1, 133.6, 127.9, 127.4, 124.1, 65.2, 24.3.

HRMS Calculated for $C_8H_9NO_3$ $[M+Na]^+$: 190.0475, found: 190.0475.



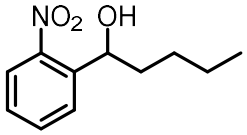
1q

Prepared according to **General Procedure C**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1q** as yellow solid (90% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.96 (d, *J* = 8.2 Hz, 1H), 7.87 (d, *J* = 7.9 Hz, 1H), 7.65 (t, *J* = 7.6 Hz, 1H), 7.43 (t, *J* = 7.8 Hz, 1H), 7.37 – 7.31 (m, 4H), 7.30 – 7.23 (m, 1H), 5.46 (d, *J* = 9.4 Hz, 1H), 3.26 (dd, *J* = 13.7, 2.9 Hz, 1H), 2.80 (dd, *J* = 13.7, 9.3 Hz, 1H), 2.24 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.7, 139.7, 138.0, 133.8, 129.7, 128.8, 128.3, 128.3, 127.1, 124.6, 70.8, 45.4.

HRMS Calculated for $C_{14}H_{13}NO_3$ $[M+Na]^+$:266.0788, found: 266.0788.



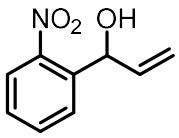
1r

Prepared according to **General Procedure C**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1r** as yellow solid (85% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.86 (d, *J* = 8.1 Hz, 1H), 7.77 (d, *J* = 7.8 Hz, 1H), 7.61 (t, *J* = 7.6 Hz, 1H), 7.39 (t, *J* = 7.8 Hz, 1H), 5.20 (dd, *J* = 8.3, 4.0 Hz, 1H), 2.53 (s, 1H), 1.85 – 1.64 (m, 2H), 1.55 – 1.27 (m, 4H), 0.89 (t, *J* = 7.0 Hz, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 148.0, 140.4, 133.6, 128.2, 128.1, 124.4, 69.5, 38.1, 28.4, 22.6, 14.1.

HRMS Calculated for $C_{11}H_{15}NO_3$ $[M+Na]^+$: 232.0944, found: 232.0946.



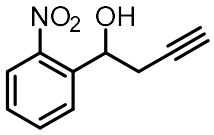
1s

Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1s** as yellow oil (93% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.84 (d, *J* = 8.2 Hz, 1H), 7.71 (d, *J* = 7.9 Hz, 1H), 7.59 (t, *J* = 7.6 Hz, 1H), 7.39 (t, *J* = 7.8 Hz, 1H), 6.00 (ddd, *J* = 16.6, 10.5, 5.3 Hz, 1H), 5.72 (d, *J* = 5.4 Hz, 1H), 5.32 (d, *J* = 17.2 Hz, 1H), 5.17 (d, *J* = 10.5 Hz, 1H), 3.28 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 148.1, 138.1, 137.6, 133.6, 128.8, 128.5, 124.5, 116.1, 69.8.

HRMS Calculated for $C_9H_9NO_3$ $[M+Na]^+$: 202.0475, found: 202.0472.



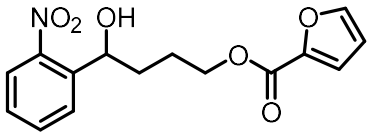
1t

Prepared according to **General Procedure D**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 5:1 v/v) afforded **1t** as brown solid (80% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.93 (d, *J* = 8.2 Hz, 1H), 7.87 (d, *J* = 7.9 Hz, 1H), 7.66 (t, *J* = 7.7 Hz, 1H), 7.45 (t, *J* = 7.8 Hz, 1H), 5.48 – 5.40 (m, 1H), 3.00 – 2.83 (m, 2H), 2.71 – 2.61 (m, 1H), 2.09 (t, *J* = 2.6 Hz, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.8, 137.9, 133.7, 128.8, 128.4, 124.6, 79.9, 71.9, 67.5, 28.6.

HRMS Calculated for $C_{10}H_9NO_3$ $[M+Na]^+$:214.0475, found: 214.0476.



1u

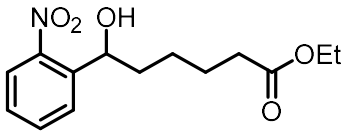
Prepared according to **General Procedure C**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1u** as yellow solid (70% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.90 (d, *J* = 8.2 Hz, 1H), 7.82 (d, *J* = 7.9 Hz, 1H), 7.63 (t, *J* = 7.6 Hz, 1H), 7.55 (s, 1H), 7.41 (t, *J* = 7.8 Hz, 1H), 7.16 (d, *J* = 3.5 Hz,

1H), 6.49 (d, *J* = 3.5 Hz, 1H), 5.31 (d, *J* = 8.5 Hz, 1H), 4.36 (t, *J* = 6.1 Hz, 2H), 2.71 (s, 1H), 2.09 – 1.77 (m, 4H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 159.0, 147.9, 146.5, 144.8, 140.2, 133.7, 128.3, 128.2, 124.6, 118.1, 112.0, 69.1, 64.8, 34.7, 25.7.

HRMS Calculated for $C_{15}H_{15}NO_6$ $[M+Na]^+$:328.0792, found: 328.0792.



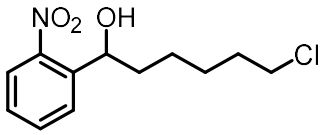
1v

Prepared according to **General Procedure C**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 10:1 v/v) afforded **1v** as yellow oil (85% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.80 (d, *J* = 8.2 Hz, 1H), 7.73 (d, *J* = 8.0 Hz, 1H), 7.55 (t, *J* = 7.7 Hz, 1H), 7.33 (t, *J* = 7.7 Hz, 1H), 5.15 (dd, *J* = 8.6, 3.6 Hz, 1H), 4.01 (q, *J* = 7.1 Hz, 2H), 3.36 (s, 1H), 2.22 (t, *J* = 7.3 Hz, 2H), 1.78 – 1.68 (m, 1H), 1.67 – 1.46 (m, 4H), 1.45 – 1.33 (m, 1H), 1.16 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 174.0, 147.6, 140.7, 133.4, 128.0, 127.9, 124.2, 68.8, 60.3, 38.0, 34.1, 25.6, 24.5, 14.2.

HRMS Calculated for $C_{14}H_{19}NO_5$ $[M+Na]^+$:304.1155, found: 304.1149.



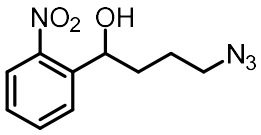
1w

Prepared according to **General Procedure C**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 15:1 v/v) afforded **1w** as yellow oil (80% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.87 (d, *J* = 8.2 Hz, 1H), 7.77 (d, *J* = 7.9 Hz, 1H), 7.62 (t, *J* = 7.7 Hz, 1H), 7.40 (t, *J* = 7.8 Hz, 1H), 5.20 (dt, *J* = 8.3, 3.5 Hz, 1H), 3.51 (td, *J* = 6.7, 2.3 Hz, 2H), 2.62 (s, 1H), 1.85 – 1.66 (m, 4H), 1.61 – 1.38 (m, 4H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.9, 140.4, 133.6, 128.2, 128.1, 124.4, 69.3, 45.1, 38.1, 32.6, 26.6, 25.5.

HRMS Calculated for $C_{12}H_{16}ClNO_3$ $[M+Na]^+$:280.0711, found: 280.0711.



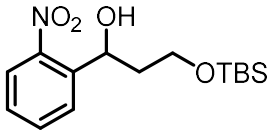
1x

Prepared according to **General Procedure C**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 10:1 v/v) afforded **1x** as green oil (85% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.89 (d, *J* = 8.2 Hz, 1H), 7.79 (d, *J* = 7.9 Hz, 1H), 7.64 (t, *J* = 7.6 Hz, 1H), 7.41 (t, *J* = 7.8 Hz, 1H), 5.23 (dd, *J* = 7.5, 3.4 Hz, 1H), 3.34 (t, *J* = 6.0 Hz, 2H), 2.70 (s, 1H), 1.94 – 1.68 (m, 4H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.7, 140.1, 133.8, 128.4, 128.0, 124.6, 69.0, 51.3, 35.4, 25.8.

HRMS Calculated for $C_{10}H_{12}N_4O_3$ $[M+Na]^+$:259.0802, found: 259.0801.



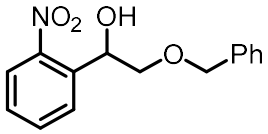
1y

Prepared according to **General Procedure C**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1y** as yellow oil (89% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.94 – 7.83 (m, 2H), 7.60 (t, *J* = 7.6 Hz, 1H), 7.35 (t, *J* = 7.8 Hz, 1H), 5.43 (d, *J* = 8.5 Hz, 1H), 4.43 (s, 1H), 4.00 – 3.83 (m, 2H), 2.09 – 2.01 (m, 1H), 1.91 – 1.79 (m, 1H), 0.91 (s, 9H), 0.09 (d, *J* = 3.5 Hz, 6H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.4, 140.2, 133.5, 128.4, 127.9, 124.3, 70.0, 62.9, 39.9, 25.9, 18.2, -5.5 (d, *J* = 2.2 Hz).

HRMS Calculated for $C_{15}H_{25}NO_4Si$ $[M+Na]^+$:334.1445, found: 334.1444.



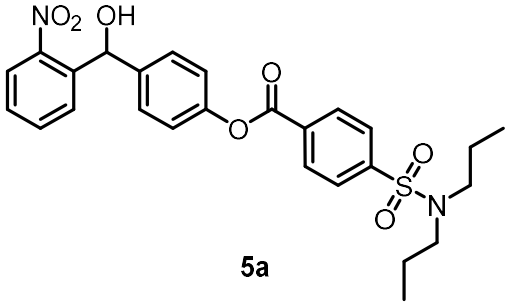
1z

Prepared according to **General Procedure C**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **1z** as yellow solid (75% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.91 (d, *J* = 8.2 Hz, 1H), 7.85 (d, *J* = 7.9 Hz, 1H), 7.65 – 7.57 (m, 1H), 7.44 – 7.36 (m, 1H), 7.36 – 7.24 (m, 5H), 5.50 (d, *J* = 7.7 Hz, 1H), 4.59 (q, *J* = 11.9 Hz, 2H), 3.84 (dd, *J* = 10.0, 3.1 Hz, 1H), 3.49 (dd, *J* = 10.0, 7.8 Hz, 1H), 3.40 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 148.0, 137.7, 136.1, 133.6, 128.9, 128.6, 128.5, 128.0, 127.9, 124.5, 74.5, 73.2, 68.3.

HRMS Calculated for $C_{15}H_{15}NO_4$ $[M+Na]^+$:296.0893, found: 296.0898.



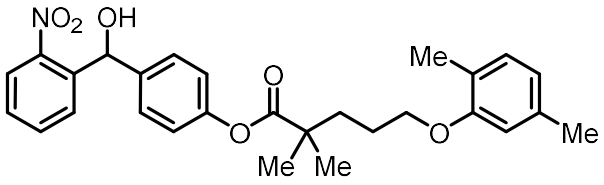
5a

Prepared according to **General Procedure C**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **5a** as white solid (88% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.25 (d, *J* = 6.5 Hz, 2H), 7.88 (d, *J* = 8.2 Hz, 3H), 7.76 (d, *J* = 7.9 Hz, 1H), 7.60 (t, *J* = 7.6 Hz, 1H), 7.44 – 7.33 (m, 3H), 7.14 (d, *J* = 8.2 Hz, 2H), 6.40 (s, 1H), 3.62 (s, 1H), 3.14 – 3.04 (m, 4H), 1.53 (m, 4H), 0.85 (t, *J* = 7.4 Hz, 6H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 163.8, 150.0, 148.0, 144.8, 139.9, 138.5, 133.6, 132.7, 130.8, 129.2, 128.5, 128.3, 127.1, 124.6, 121.5, 70.5, 49.9, 21.9, 11.2.

HRMS Calculated for $C_{26}H_{28}N_2O_7S$ $[M+Na]^+$: 535.1509, found: 535.1507.



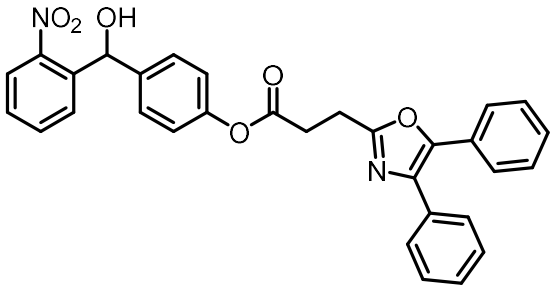
5b

Prepared according to **General Procedure C**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **5b** as yellow oil (90% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.93 (d, *J* = 8.1 Hz, 1H), 7.72 (d, *J* = 7.9 Hz, 1H), 7.69 – 7.58 (m, 1H), 7.44 (t, *J* = 7.7 Hz, 1H), 7.41 – 7.30 (m, 2H), 7.02 (dd, *J* = 8.3, 2.6 Hz, 3H), 6.74 – 6.62 (m, 2H), 6.40 (s, 1H), 4.00 (t, *J* = 5.3 Hz, 2H), 3.19 (s, 1H), 2.33 (s, 3H), 2.20 (s, 3H), 1.96 – 1.83 (m, 4H), 1.39 (s, 6H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 176.5, 156.9, 150.6, 148.3, 139.2, 138.5, 136.6, 133.6, 130.5, 129.4, 128.6, 128.2, 124.8, 123.7, 121.7, 120.9, 112.1, 70.8, 67.8, 42.5, 37.2, 25.3, 25.2, 21.5, 15.9.

HRMS Calculated for $C_{28}H_{31}NO_6$ $[M+Na]^+$: 500.2044, found: 500.2041.



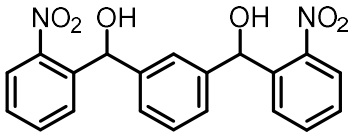
5c

Prepared according to **General Procedure C**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **5c** as yellow oil (86% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.88 (d, *J* = 8.1 Hz, 1H), 7.73 (d, *J* = 7.8 Hz, 1H), 7.67 – 7.51 (m, 5H), 7.43 – 7.27 (m, 9H), 7.05 (d, *J* = 8.2 Hz, 2H), 6.37 (s, 1H), 4.07 (s, 1H), 3.25 (t, *J* = 7.3 Hz, 2H), 3.12 (t, *J* = 7.3 Hz, 2H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 170.6, 161.6, 150.0, 148.1, 145.6, 139.7, 138.6, 135.0, 133.5, 132.2, 129.2, 128.8, 128.7, 128.6, 128.6, 128.4, 128.2, 128.2, 127.9, 126.5, 124.6, 121.5, 70.3, 31.2, 23.4.

HRMS Calculated for $C_{31}H_{24}N_2O_6$ [M+Na]$^+$: 543.1527, found: 543.1521.



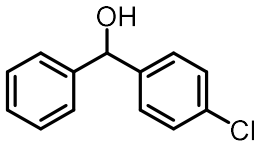
11

Prepared according to **General Procedure C**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 5:1 v/v) afforded **11** as yellow solid (90% yield)

^{1}H NMR (400 MHz, Methanol-d_4) δ 7.82 (d, J = 6.6 Hz, 2H), 7.76 (d, J = 8.5 Hz, 2H), 7.63 (t, J = 7.6 Hz, 2H), 7.43 (t, J = 7.8 Hz, 2H), 7.29 – 7.15 (m, 4H), 6.35 (s, 2H).

^{13}C NMR (101 MHz, Methanol-d_4) δ 149.8, 144.2, 140.1, 134.0, 129.9, 129.4, 129.3, 127.6, 127.2, 125.2, 71.4.

HRMS Calculated for $C_{20}H_{16}N_2O_6$ [M+Na]$^+$: 403.0901, found: 403.0900.



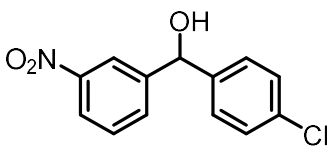
13

Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **13** as yellow oil (80% yield)

^{1}H NMR (400 MHz, Chloroform-d) δ 7.40 – 7.26 (m, 9H), 5.75 (s, 1H), 2.59 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-d) δ 143.5, 142.3, 133.4, 128.8, 128.7, 128.0, 128.0, 126.7, 75.7.

HRMS Calculated for $C_{13}H_{11}ClO$ [M+Na]$^+$:241.0391, found: 241.0391.



15

Prepared according to **General Procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 8:1 v/v) afforded **15** as yellow oil (80% yield)

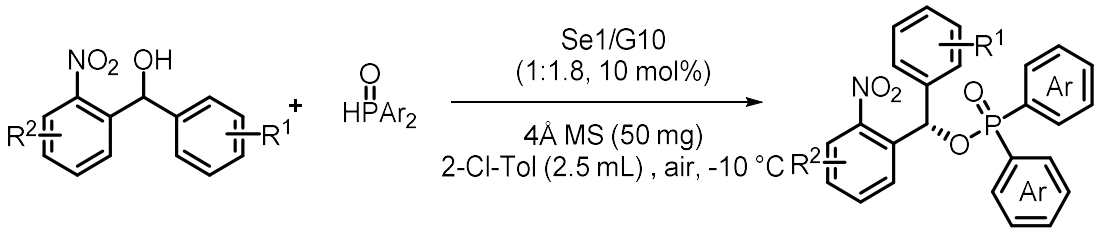
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.18 (s, 1H), 8.03 (d, *J* = 8.4 Hz, 1H), 7.60 (d, *J* = 7.7 Hz, 1H), 7.43 (t, *J* = 7.9 Hz, 1H), 7.33 – 7.16 (m, 4H), 5.81 (s, 1H), 2.95 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 148.4, 145.5, 141.3, 134.2, 132.6, 129.6, 129.1, 128.1, 122.7, 121.3, 74.7.

HRMS Calculated for $C_{13}H_{10}ClNO_3$ $[M+Na]^+$: 286.0241, found: 286.0243.

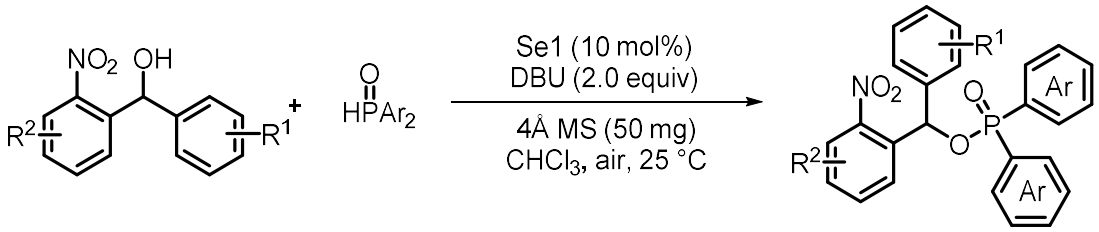
5. General Procedures for the Dehydrogenative Phosphinoylation

General procedure A



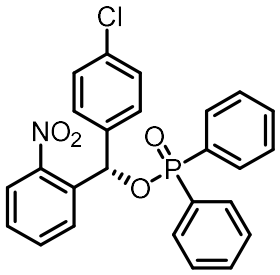
In a 20 ml Schlenk tube containing a magnetic stir bar, phosphine oxide substrate (0.1 mmol), 2-nitrobenzhydrol substrate (0.25 mmol), electrophilic diaryldiselenide catalyst **Se1** (10 mol %), chiral guanidine organocatalyst **G10**(18 mol %), 4Å MS (50 mg) and 2.5 mL 2-Cl-Tol were added sequentially under ambient air. The reaction tube was sealed in air and the mixture was stirred at –10 ℃ until the phosphine oxide substrate was judged to be consumed as indicated by TLC analysis. The resulting reaction mixture was purified by flash chromatography on silica gel (Petroleum ether to Petroleum ether/ Ethyl acetate, 2:1) to afford the chiral product.

General procedure B



In a 20 ml Schlenk tube containing a magnetic stir bar, phosphine oxide substrate (0.15 mmol), 2-nitrobenzhydrol substrate (0.1 mmol), electrophilic diaryldiselenide catalyst **Se1** (10 mol %), DBU (2.0 equiv), 4Å MS (50 mg) and 1.0 mL $CHCl_3$ were added sequentially under ambient air. The reaction tube was sealed in air and the mixture was stirred at 25 ℃ for 24 h. The reaction mixture was purified by flash chromatography on silica gel (Petroleum ether to Petroleum ether/ Ethyl acetate, 2:1) to afford the racemic product.

6. Characterization Data of Products



3aa, (96 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **3aa** as white solid (86% yield, 95:5 e.r.).

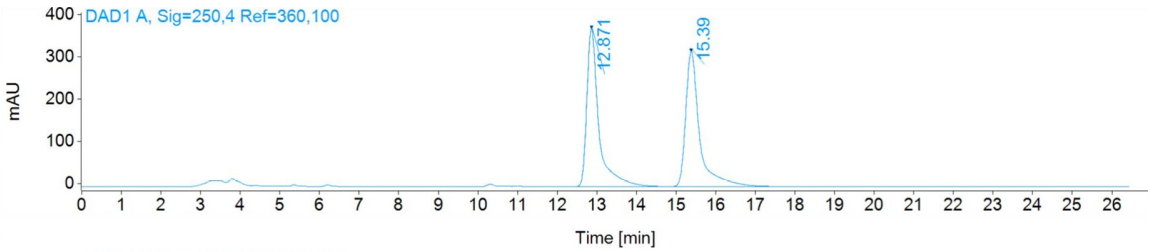
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.01 (d, *J* = 8.0 Hz, 1H), 7.91 (d, *J* = 8.2 Hz, 1H), 7.76 – 7.63 (m, 5H), 7.56 – 7.42 (m, 3H), 7.41 – 7.31 (m, 4H), 7.22 – 7.12 (m, 5H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.1, 137.5 (d, *J* = 4.4 Hz), 135.9 (d, *J* = 3.8 Hz), 134.4, 133.8, 132.5 (t, *J* = 3.1 Hz), 131.9, 131.8, 131.7, 131.6, 131.5, 131.4, 130.3, 130.1, 129.4, 129.0 (d, *J* = 7.9 Hz), 128.7 (d, *J* = 2.4 Hz), 128.5, 125.0, 73.2 (d, *J* = 4.7 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 32.96.

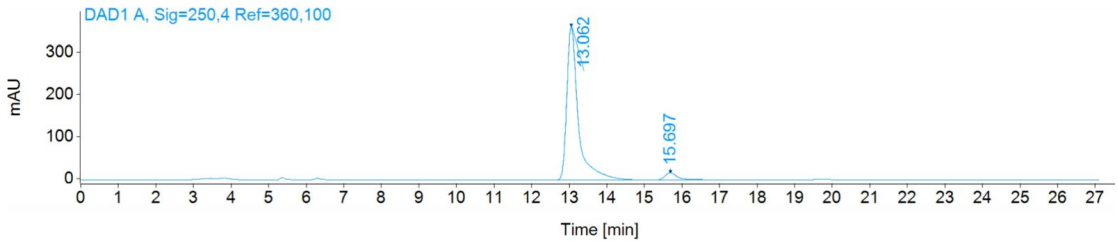
HRMS calculated for $C_{25}H_{19}ClNO_4P$ $[M+Na]^+$: 486.0632; found: 486.0632.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 70:30, 1.0 mL/min, 250 nm, t (major) = 13.062 min, t (minor) = 15.697 min.



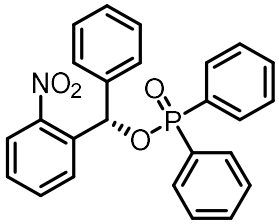
Signal: DAD1 A, Sig=250,4 Ref=360,100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
12.871	374.54340	0.59	0.2682	7859.00830	50.26
15.390	319.74677	0.62	0.3067	7778.76416	49.74



Signal: DAD1 A, Sig=250,4 Ref=360,100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
13.062	363.65161	0.56	0.2741	7699.87451	95.07
15.697	16.96522	0.69	0.3200	399.51550	4.93



3ga, (6 d)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **3ga** as white solid (60% yield, 95:5 e.r.).

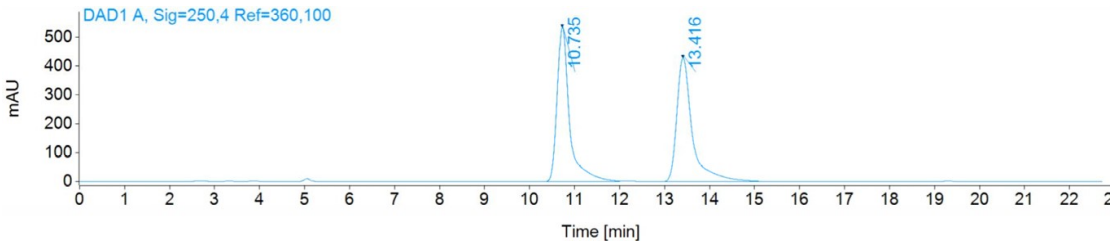
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.03 (d, *J* = 8.0 Hz, 1H), 7.89 (d, *J* = 8.3 Hz, 1H), 7.77 – 7.62 (m, 5H), 7.52 – 7.44 (m, 2H), 7.44 – 7.32 (m, 5H), 7.28 – 7.19 (m, 6H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.1, 138.8 (d, *J* = 4.5 Hz), 136.2 (d, *J* = 3.6 Hz), 133.5, 132.3 (dd, *J* = 5.5, 2.8 Hz), 131.9, 131.9, 131.8, 131.5, 131.4, 130.5, 130.1, 129.1, 128.7, 128.5 (d, *J* = 1.2 Hz), 128.4 (t, *J* = 2.7 Hz), 127.9, 124.8, 73.7 (d, *J* = 4.8 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 32.68.

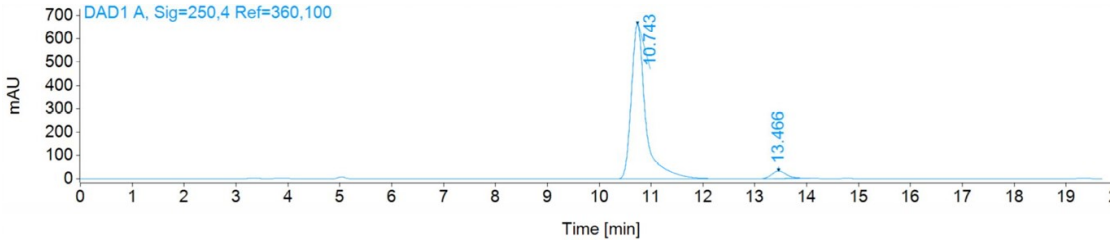
HRMS calculated for $C_{25}H_{20}NO_4P$ $[M+Na]^+$: 452.1022; found: 452.1026.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 70:30, 1.0 mL/min, 250 nm, t (major) = 10.743 min, t (minor) = 13.466 min.



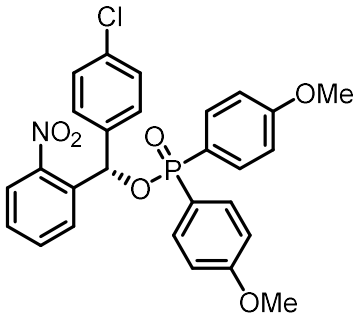
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
10.735	536.93066	0.66	0.2558	10366.58496	50.01
13.416	429.52734	0.60	0.3171	10364.25293	49.99



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
10.743	663.17865	0.70	0.2556	12818.55273	95.10
13.466	32.82909	0.80	0.3000	659.82794	4.90



3ab, (96 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **3ab** as yellow oil (61% yield, 88:12 e.r.).

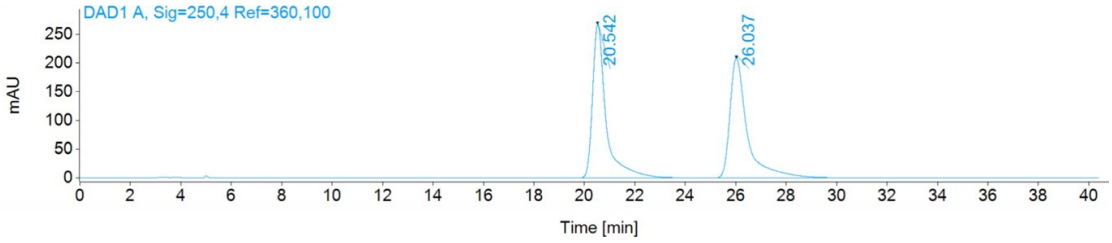
^{1}H NMR (600 MHz, Chloroform-*d*) δ 8.00 (d, *J* = 7.9 Hz, 1H), 7.91 (d, *J* = 8.2 Hz, 1H), 7.67 (t, *J* = 7.7 Hz, 1H), 7.63 – 7.55 (m, 4H), 7.43 (t, *J* = 7.8 Hz, 1H), 7.21 – 7.13 (m, 4H), 7.09 (d, *J* = 10.1 Hz, 1H), 6.88 (d, *J* = 8.7 Hz, 2H), 6.84 (d, *J* = 8.8 Hz, 2H), 3.82 (s, 3H), 3.80 (s, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 162.8 (dd, *J* = 13.3, 3.0 Hz), 147.1, 137.8 (d, *J* = 4.4 Hz), 136.2 (d, *J* = 3.8 Hz), 134.3, 133.8 (d, *J* = 8.0 Hz), 133.7, 133.4 (d, *J* = 11.6 Hz), 129.4, 129.1, 128.9, 128.6, 125.0, 123.0, 122.7, 122.1, 121.8, 114.1 (dd, *J* = 14.2, 1.9 Hz), 72.9 (d, *J* = 4.5 Hz), 55.4 (d, *J* = 2.8 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 33.80.

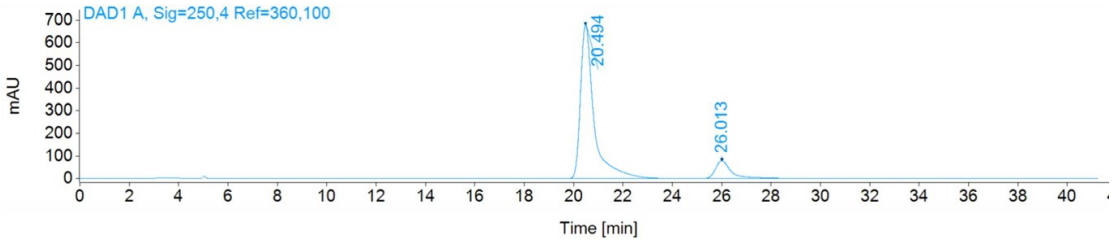
HRMS calculated for $C_{27}H_{23}ClNO_6P$ $[M+Na]^+$: 546.0844; found: 546.0850.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 60:40, 1.0 mL/min, 250 nm, t (major) = 20.494 min, t (minor) = 26.013 min.



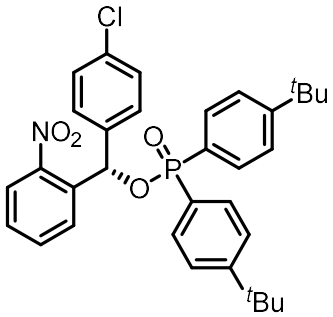
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
20.542	268.17197	0.55	0.4765	9986.44336	49.94
26.037	208.93925	0.52	0.6156	10008.56641	50.06



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
20.494	679.08832	0.53	0.4923	25945.95117	88.12
26.013	77.87365	0.61	0.5933	3497.20166	11.88



3ac, (7 d)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **3ac** as white solid (87% yield, 87.5:12.5 e.r.).

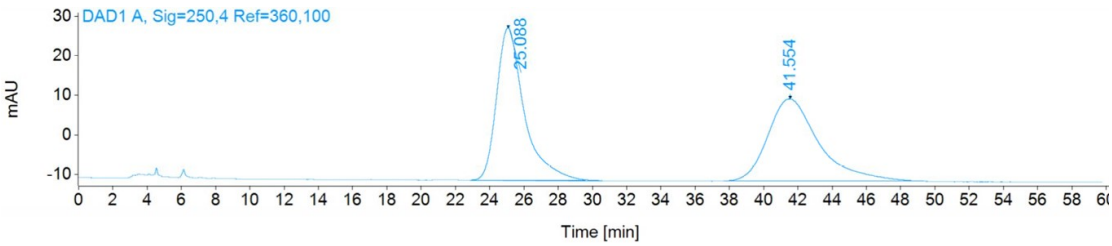
^{1}H NMR (600 MHz, Chloroform-*d*) δ 8.02 (d, *J* = 7.9 Hz, 1H), 7.90 (d, *J* = 8.2 Hz, 1H), 7.68 (t, *J* = 7.7 Hz, 1H), 7.65 – 7.55 (m, 4H), 7.46 – 7.41 (m, 1H), 7.40 – 7.33 (m, 4H), 7.20 – 7.10 (m, 5H), 1.31 (s, 9H), 1.29 (s, 9H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 156.1 (d, *J* = 2.8 Hz), 156.0 (d, *J* = 2.8 Hz), 147.2, 137.7 (d, *J* = 3.9 Hz), 136.3 (d, *J* = 4.1 Hz), 134.3, 133.8, 131.8 (d, *J* = 10.7 Hz), 131.5 (d, *J* = 10.8 Hz), 129.6, 129.2, 128.9, 128.6, 128.4, 128.1, 127.5, 127.2, 125.6 (dd, *J* = 13.4, 6.8 Hz), 125.0, 72.9 (d, *J* = 4.4 Hz), 35.2 (d, *J* = 5.4 Hz), 31.2 (d, *J* = 9.9 Hz), .

^{31}P NMR (243 MHz, Chloroform-*d*) δ 33.43.

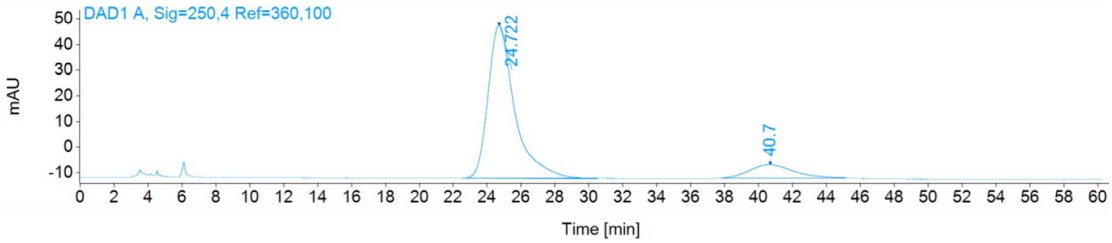
HRMS calculated for $C_{33}H_{35}ClNO_4P$ $[M+Na]^+$: 598.1884; found: 598.1883.

Chiral HPLC: CHIRALPANK IG-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 24.722 min, t (minor) = 40.700 min.



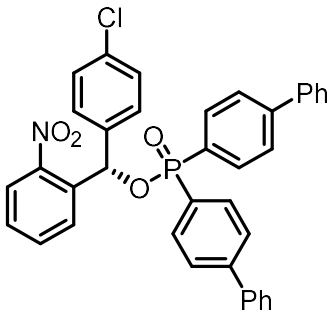
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
25.088	38.56578	0.65	1.5733	4329.89990	50.13
41.554	20.80877	0.74	2.9600	4307.91455	49.87



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
24.722	59.75696	0.65	1.5200	6502.18555	87.45
40.700	5.22913	0.83	2.7000	932.88165	12.55



3ad, (96 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **3ad** as yellow oil (97% yield, 86:14 e.r.).

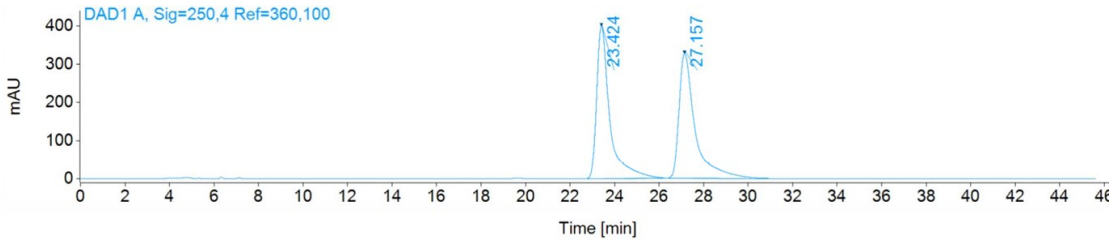
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.06 (d, *J* = 7.9 Hz, 1H), 7.91 – 7.73 (m, 5H), 7.67 (t, *J* = 7.6 Hz, 1H), 7.64 – 7.50 (m, 8H), 7.46 – 7.31 (m, 7H), 7.30 – 7.23 (m, 3H), 7.19 (d, *J* = 8.3 Hz, 2H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.1, 145.3 (dd, *J* = 6.2, 2.9 Hz), 139.7 (d, *J* = 2.8 Hz), 137.5 (d, *J* = 4.2 Hz), 135.8 (d, *J* = 4.0 Hz), 134.3, 133.8, 132.4, 132.3, 132.0, 131.9, 130.2, 129.9, 129.4, 129.0, 128.8, 128.6, 128.3 (d, *J* = 2.5 Hz), 127.4 – 127.0 (m), 124.9, 73.1 (d, *J* = 4.4 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 33.11.

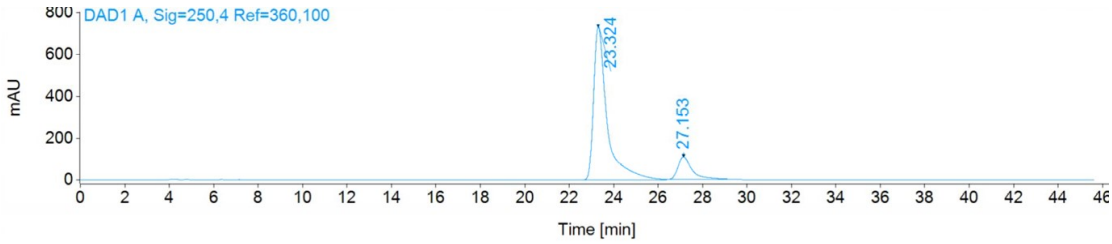
HRMS calculated for $C_{37}H_{27}ClNO_4P$ $[M+Na]^+$: 638.1258; found: 638.1247.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 60:40, 0.8 mL/min, 250 nm, t (major) = 23.324 min, t (minor) = 27.153 min.



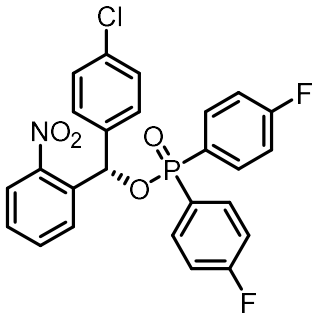
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
23.424	400.51428	0.55	0.5344	16504.66602	49.99
27.157	327.16382	0.50	0.6552	16510.92188	50.01



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
23.324	729.45032	0.52	0.5436	30722.88477	86.31
27.153	106.28284	0.59	0.6267	4873.07373	13.69



3ae, (48 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **3ae** as yellow oil (72% yield, 97:3 e.r.).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.94 (t, *J* = 7.8 Hz, 2H), 7.74 – 7.62 (m, 5H), 7.50 – 7.43 (m, 1H), 7.23 – 7.14 (m, 5H), 7.12 – 7.02 (m, 4H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.7 (dd, *J* = 8.0, 3.6 Hz), 164.2 (dd, *J* = 7.8, 3.5 Hz), 147.2, 137.2 (d, *J* = 4.3 Hz), 135.5 (d, *J* = 4.0 Hz), 134.7, 134.6, 134.5 (d, *J* =

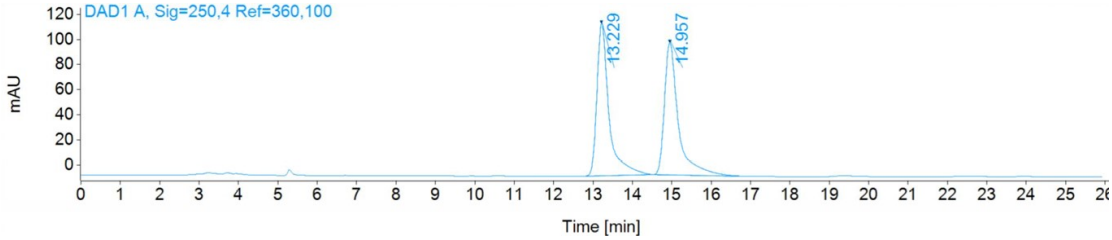
2.9 Hz), 134.4, 134.2, 134.1 (d, J = 3.0 Hz), 134.0, 133.8, 129.4, 129.3, 128.9, 128.8, 127.7 (d, J = 3.5 Hz), 127.4 (d, J = 3.3 Hz), 126.2 (d, J = 3.6 Hz), 126.0 (d, J = 3.3 Hz), 125.2, 116.2 (dd, J = 21.5, 14.6 Hz), 73.5 (d, J = 4.4 Hz), .

^{31}P NMR (162 MHz, Chloroform-*d*) δ 31.07.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -105.05, -105.14.

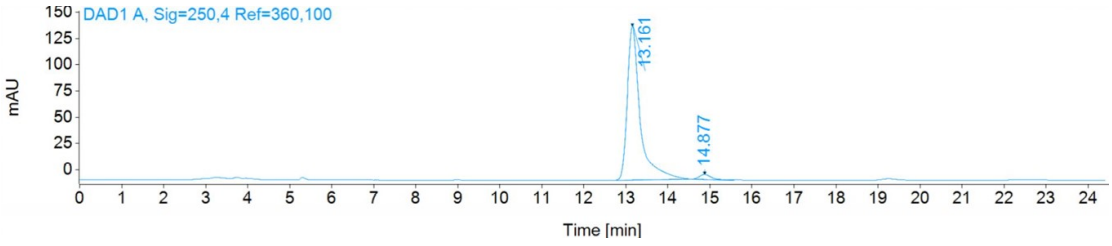
HRMS calculated for $C_{25}H_{17}ClF_2NO_4P$ $[M+Na]^+$: 522.0444; found: 522.0445.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 70:30, 1.0 mL/min, 250 nm, t (major) = 13.161 min, t (minor) = 14.877 min.



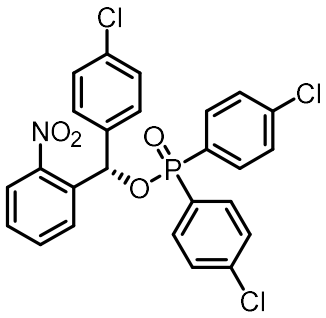
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
13.229	121.54553	0.63	0.2800	2590.95044	49.99
14.957	105.39276	0.59	0.3233	2591.57715	50.01



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
13.161	146.37325	0.62	0.2767	3119.04492	97.07
14.877	4.69001	0.71	0.2900	94.30394	2.93



3af, (48 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **3af** as yellow oil (89% yield, 96:4 e.r.).

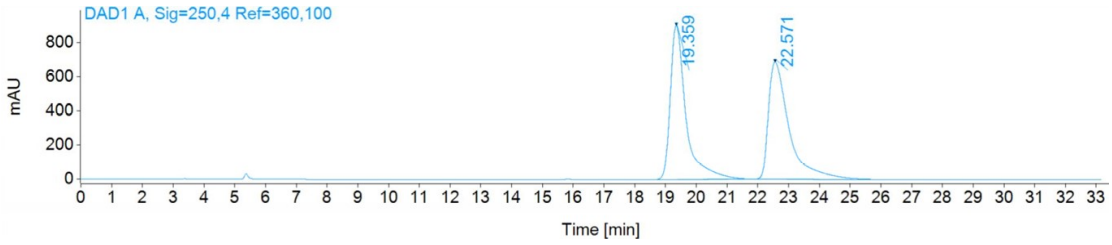
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.94 (d, *J* = 8.0 Hz, 2H), 7.68 (t, *J* = 7.7 Hz, 1H), 7.64 – 7.53 (m, 4H), 7.47 (t, *J* = 7.8 Hz, 1H), 7.41 – 7.30 (m, 4H), 7.24 – 7.09 (m, 5H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.2, 139.5 (dd, *J* = 6.7, 3.6 Hz), 137.0 (d, *J* = 4.4 Hz), 135.4 (d, *J* = 4.1 Hz), 134.7, 133.8, 133.3, 133.2, 132.9, 132.8, 129.9, 129.7, 129.4, 129.3, 129.2 (d, *J* = 2.5 Hz), 129.1 (d, *J* = 2.4 Hz), 128.8 (d, *J* = 3.3 Hz), 128.5, 128.3, 125.2, 73.6 (d, *J* = 4.5 Hz), .

^{31}P NMR (162 MHz, Chloroform-*d*) δ 31.00.

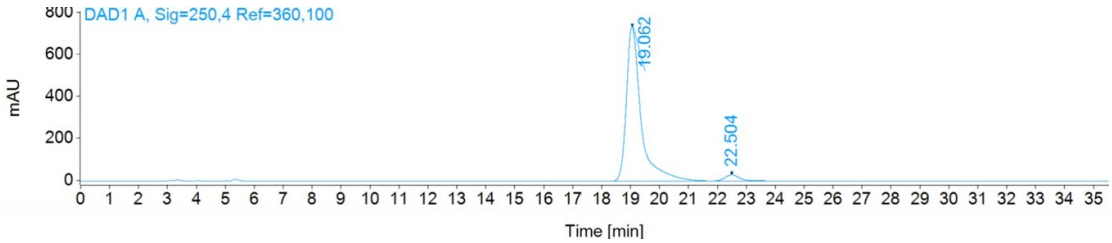
HRMS calculated for $C_{25}H_{17}Cl_3NO_4P$ $[M+Na]^+$: 553.9853; found: 553.9856.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 70:30, 1.0 mL/min, 250 nm, t (major) = 19.062 min, t (minor) = 22.504 min.



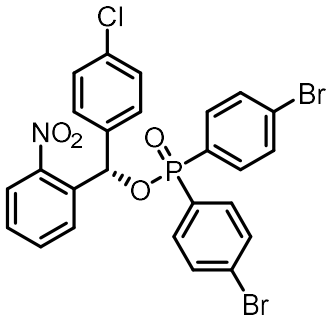
Signal: DAD1 A, Sig=250,4 Ref=360,100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
19.359	902.31616	0.58	0.4711	31983.12305	49.85
22.571	684.82190	0.44	0.6409	32180.47461	50.15



Signal: DAD1 A, Sig=250,4 Ref=360,100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
19.062	737.43176	0.60	0.4612	26036.93555	96.19
22.504	29.10803	0.78	0.5133	1030.47742	3.81



3ag, (48 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **3ag** as white solid (95% yield, 96.5:3.5 e.r.).

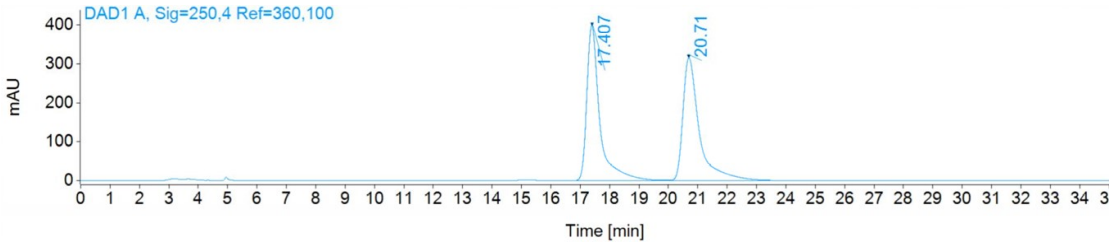
^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.93 (dd, *J* = 8.0, 3.9 Hz, 2H), 7.68 (t, *J* = 7.7 Hz, 1H), 7.58 – 7.45 (m, 9H), 7.24 – 7.11 (m, 5H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 147.1, 137.0 (d, *J* = 4.1 Hz), 135.3 (d, *J* = 4.1 Hz), 134.8, 133.8, 133.3 (d, *J* = 11.0 Hz), 132.9 (d, *J* = 11.2 Hz), 132.1 (d, *J* = 3.5 Hz), 132.0 (d, *J* = 3.7 Hz), 130.1, 129.9, 129.4, 129.3, 129.2, 129.0, 128.8, 128.1 (dd, *J* = 8.2, 3.7 Hz), 125.2, 73.7 (d, *J* = 4.4 Hz).

^{31}P NMR (243 MHz, Chloroform-*d*) δ 31.30.

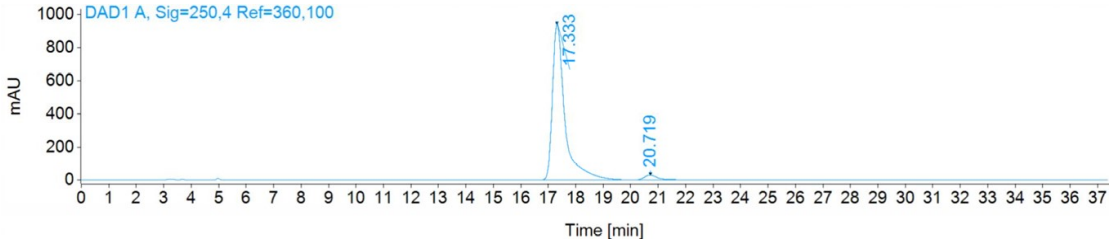
HRMS calculated for $C_{25}H_{17}Br_2ClNO_4P$ $[M+Na]^+$: 641.8843; found: 641.8842.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 60:40, 1.0 mL/min, 250 nm, t (major) = 17.333 min, t (minor) = 20.719 min.



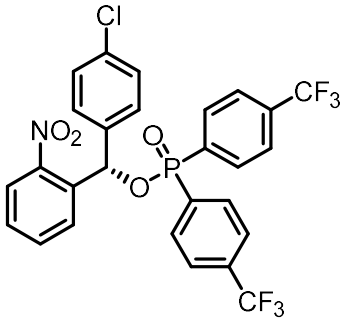
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
17.407	398.21198	0.56	0.4014	12252.43555	50.00
20.710	315.58948	0.51	0.5133	12250.56055	50.00



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
17.333	938.02075	0.57	0.4138	29618.23633	96.53
20.719	30.18687	0.67	0.4800	1064.89319	3.47



3ah, (96 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **3ah** as yellow solid (80% yield, 95:5 e.r.).

^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.95 (td, *J* = 7.9, 1.4 Hz, 2H), 7.86 – 7.77 (m, 4H), 7.70 (t, *J* = 7.7 Hz, 1H), 7.66 (d, *J* = 7.1 Hz, 4H), 7.52 – 7.47 (m, 1H), 7.25 (d, *J* = 9.5 Hz, 1H), 7.22 – 7.14 (m, 4H).

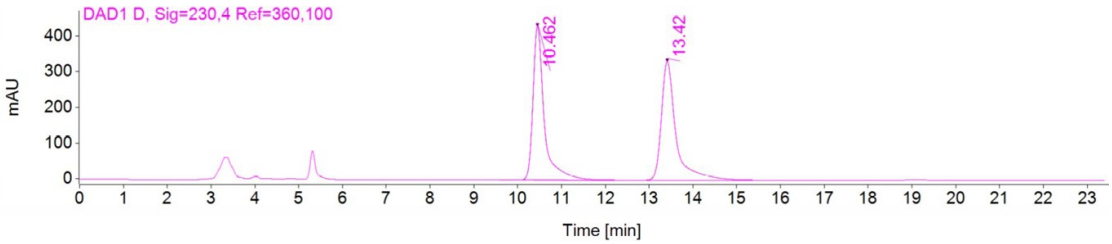
^{13}C NMR (151 MHz, Chloroform-*d*) δ 147.3, 136.7 (d, *J* = 4.0 Hz), 135.1 (d, *J* = 3.6 Hz), 135.3 – 133.9 (m), 133.9, 132.5, 132.4, 132.1, 132.0, 129.5, 129.5, 128.9, 128.7, 125.8 (ddt, *J* = 16.9, 13.1, 3.6 Hz), 125.4, 126.4 – 120.6 (m), 74.2 (d, *J* = 4.4 Hz).

^{31}P NMR (243 MHz, Chloroform-*d*) δ 28.98.

^{19}F NMR (565 MHz, Chloroform-*d*) δ -63.33, -63.40.

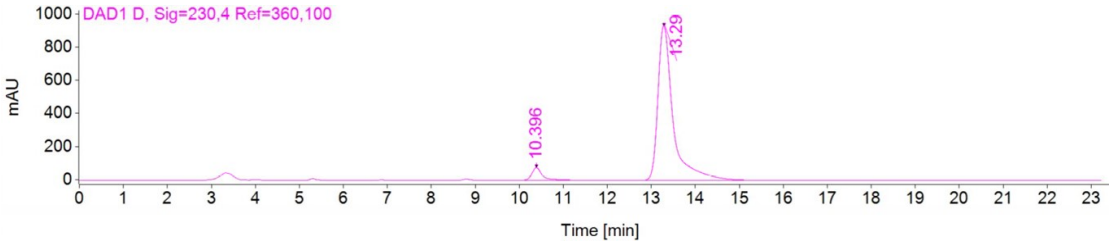
HRMS calculated for $C_{27}H_{17}ClF_6NO_4P$ $[M+Na]^+$: 622.0380; found: 622.0382.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 70:30, 1.0 mL/min, 230 nm, t (major) = 13.290 min, t (minor) = 10.396 min.



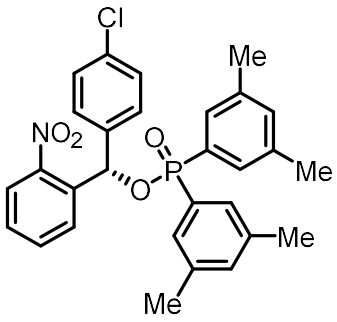
Signal: DAD1 D, Sig=230, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
10.462	430.78400	0.60	0.2294	7671.66943	50.00
13.420	332.18887	0.59	0.2948	7670.20850	50.00



Signal: DAD1 D, Sig=230, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
10.396	76.29285	0.74	0.2233	1266.94482	5.31
13.290	932.87054	0.60	0.3124	22574.13672	94.69



3aj, (72 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **3aj** as yellow oil (89% yield, 96:4 e.r.).

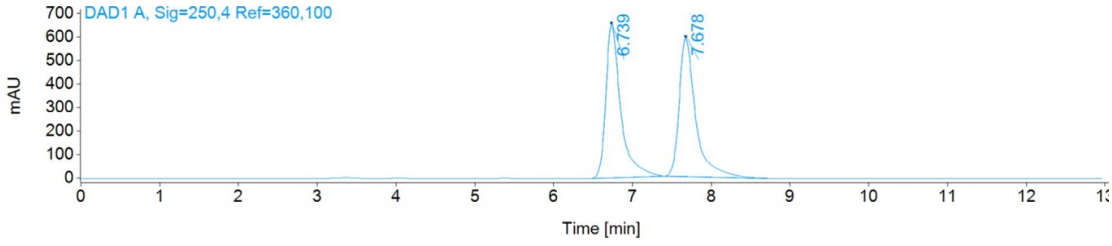
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.04 (d, *J* = 8.0 Hz, 1H), 7.92 (d, *J* = 8.3 Hz, 1H), 7.70 (t, *J* = 7.7 Hz, 1H), 7.45 (t, *J* = 7.8 Hz, 1H), 7.31 – 7.22 (m, 4H), 7.22 – 7.15 (m, 4H), 7.13 (s, 1H), 7.12 – 7.06 (m, 2H), 2.28 (s, 6H), 2.25 (s, 6H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.2, 138.4 (d, *J* = 3.2 Hz), 138.3 (d, *J* = 3.2 Hz), 137.7 (d, *J* = 4.2 Hz), 136.2 (d, *J* = 3.9 Hz), 134.4, 134.2 (d, *J* = 3.0 Hz), 133.7, 131.5, 131.2, 130.1, 129.9, 129.7, 129.6, 129.5, 129.2, 129.1, 129.0, 128.6, 124.9, 73.1 (d, *J* = 4.7 Hz), 21.3.

^{31}P NMR (162 MHz, Chloroform-*d*) δ 34.62.

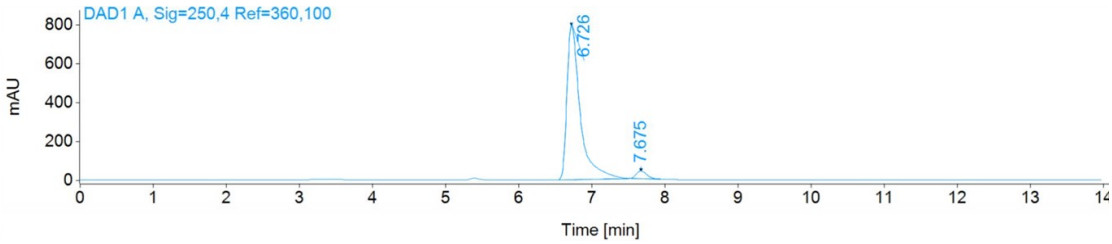
HRMS calculated for $C_{29}H_{27}ClNO_4P$ $[M+Na]^+$: 542.1258; found: 542.1266.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 70:30, 1.0 mL/min, 250 nm, t (major) = 6.726 min, t (minor) = 7.675 min.



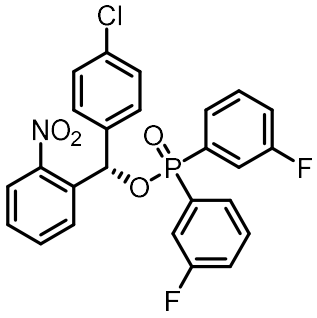
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
6.739	651.69366	0.61	0.1819	8582.91602	50.04
7.678	587.94983	0.60	0.2000	8569.08594	49.96



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
6.726	796.31323	0.51	0.1733	10053.80859	96.11
7.675	40.41802	0.78	0.1567	406.55328	3.89



3ak, (72 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **3ak** as yellow oil (86% yield, 95:5 e.r.).

^{1}H NMR (600 MHz, Chloroform-*d*) δ 8.01 – 7.92 (m, 2H), 7.74 – 7.70 (m, 1H), 7.51 – 7.44 (m, 3H), 7.42 – 7.37 (m, 2H), 7.37 – 7.31 (m, 2H), 7.25 – 7.15 (m, 7H).

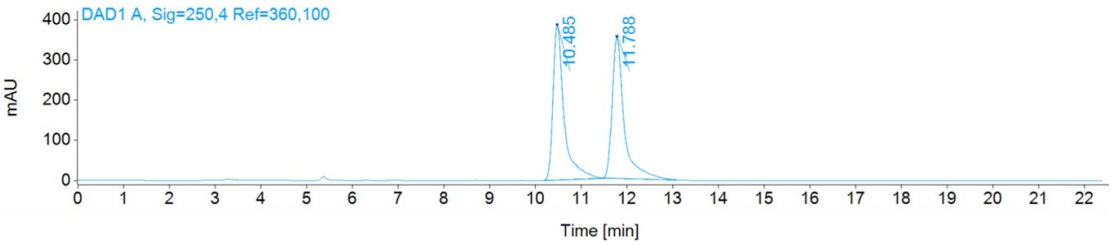
^{13}C NMR (151 MHz, Chloroform-*d*) δ 163.4 (dd, *J* = 19.0, 2.1 Hz), 161.7 (dd, *J* = 19.1, 2.1 Hz), 147.2, 137.0 (d, *J* = 4.3 Hz), 135.4 (d, *J* = 4.3 Hz), 134.9, 133.9, 133.6 (d, *J* = 5.7 Hz), 133.4 (d, *J* = 5.6 Hz), 132.7 (d, *J* = 5.9 Hz), 132.5 (d, *J* = 5.8 Hz), 130.9 (ddd, *J* = 15.6, 10.6, 7.5 Hz), 129.5, 129.4, 128.9, 128.8, 127.7 (dd, *J* = 9.8, 3.3 Hz), 127.4 (dd, *J* = 9.8, 3.3 Hz), 125.3, 120.2 (t, *J* = 2.4 Hz), 120.0 (t, *J* = 2.4 Hz), 118.7 (dd, *J* = 22.4, 11.3 Hz), 118.4 (dd, *J* = 22.4, 11.3 Hz), 73.9 (d, *J* = 4.6 Hz).

^{31}P NMR (243 MHz, Chloroform-*d*) δ 29.42.

^{19}F NMR (565 MHz, Chloroform-*d*) δ -110.53 (p, *J* = 7.7 Hz), -110.61 (p, *J* = 8.0 Hz).

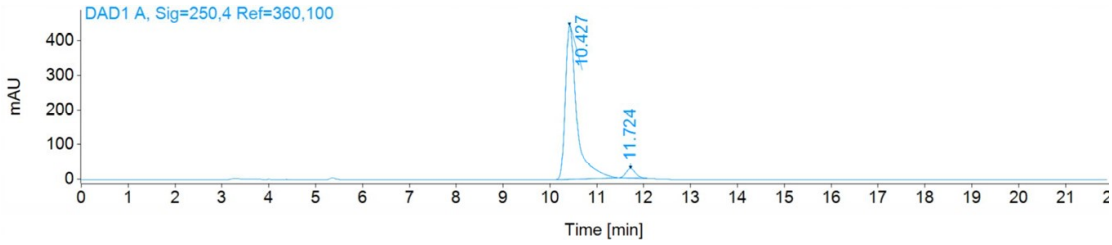
HRMS calculated for $C_{25}H_{17}ClF_2NO_4P$ $[M+Na]^+$: 522.0444; found: 522.0449.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 70:30, 1.0 mL/min, 250 nm, t (major) = 10.427 min, t (minor) = 11.724 min.



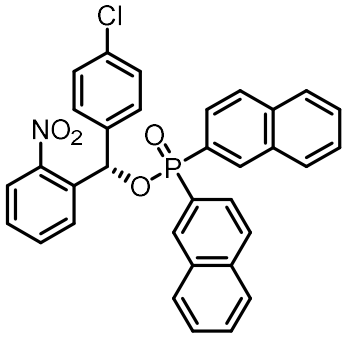
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
10.485	382.57526	0.59	0.2271	6452.42285	50.05
11.788	349.10190	0.61	0.2464	6438.86719	49.95



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
10.427	444.93283	0.58	0.2239	7550.45996	95.03
11.724	27.64625	0.82	0.2222	394.52252	4.97



3al, (72 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **3al** as yellow oil (89% yield, 96:4 e.r.).

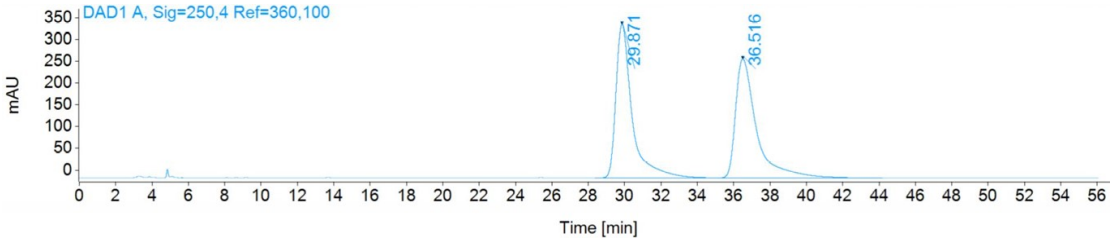
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.41 (s, 1H), 8.38 (s, 1H), 8.11 (d, *J* = 8.0 Hz, 1H), 7.92 – 7.79 (m, 7H), 7.73 – 7.63 (m, 3H), 7.63 – 7.50 (m, 4H), 7.42 (t, *J* = 7.8 Hz, 1H), 7.31 (d, *J* = 9.8 Hz, 1H), 7.25 – 7.13 (m, 4H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 147.1, 137.5 (d, *J* = 4.3 Hz), 135.9 (d, *J* = 3.9 Hz), 135.0 (dd, *J* = 6.0, 2.5 Hz), 134.5, 134.3 (d, *J* = 10.0 Hz), 133.9 (d, *J* = 10.3 Hz), 133.8, 132.5 (d, *J* = 2.4 Hz), 132.4 (d, *J* = 2.6 Hz), 129.6, 129.1, 129.0 (d, *J* = 14.0 Hz), 128.7, 128.7 – 128.5 (m), 128.4, 127.9 (d, *J* = 5.4 Hz), 127.8, 127.5, 127.2 (d, *J* = 7.6 Hz), 126.4 (d, *J* = 11.0 Hz), 126.0 (d, *J* = 10.7 Hz), 125.1, 73.6 (d, *J* = 4.5 Hz), .

^{31}P NMR (243 MHz, Chloroform-*d*) δ 33.57.

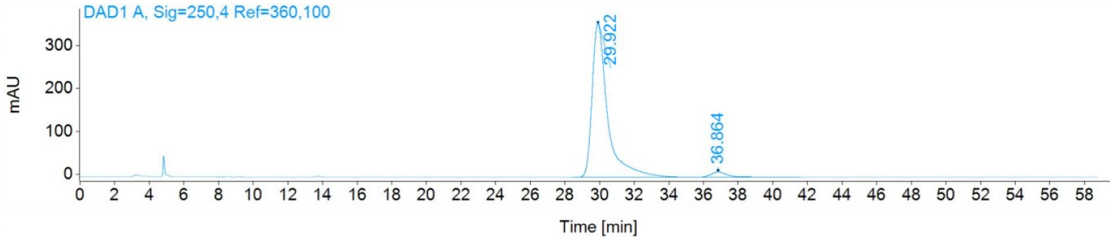
HRMS calculated for $C_{33}H_{23}ClNO_4P$ $[M+Na]^+$: 586.0945; found: 586.0943.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 29.922 min, t (minor) = 36.864 min.



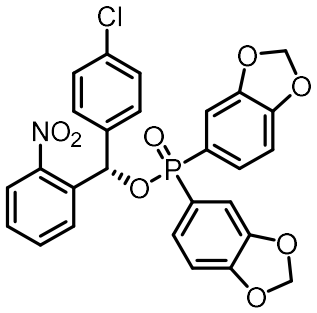
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
29.871	353.42972	0.54	0.8200	21895.94531	50.00
36.516	273.58426	0.47	1.0667	21895.67578	50.00



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
29.922	358.97888	0.54	0.8200	22356.22266	96.25
36.864	12.25000	0.64	0.9667	871.20013	3.75



3am, (7 d)

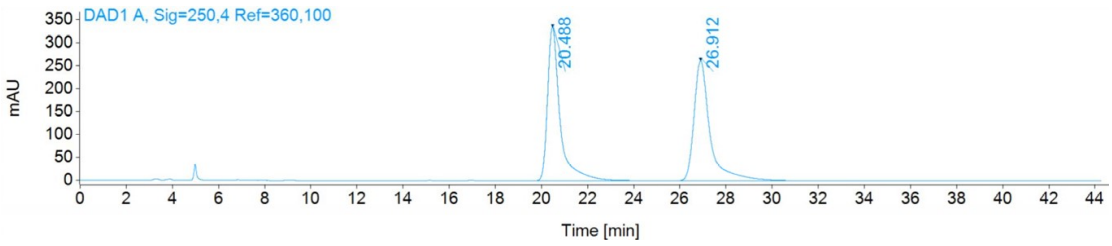
Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **3am** as yellow oil (47% yield, 92:8 e.r.).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.99 (d, *J* = 8.0 Hz, 1H), 7.94 (d, *J* = 8.2 Hz, 1H), 7.71 (t, *J* = 7.6 Hz, 1H), 7.47 (t, *J* = 7.8 Hz, 1H), 7.31 – 7.22 (m, 2H), 7.21 – 7.19 (m, 4H), 7.11 (d, *J* = 9.9 Hz, 1H), 7.06 – 6.95 (m, 2H), 6.85 – 6.75 (m, 2H), 6.00 (s, 2H), 5.98 (s, 2H).
^{13}C NMR (101 MHz, Chloroform-*d*) δ 151.3 (t, *J* = 3.3 Hz), 148.0 (dd, *J* = 20.2, 4.4 Hz), 147.2, 137.5 (d, *J* = 4.2 Hz), 136.0 (d, *J* = 4.2 Hz), 134.4, 133.8, 129.4, 129.0 (d, *J* = 9.3 Hz), 128.7, 127.6 (d, *J* = 11.3 Hz), 127.2 (d, *J* = 11.5 Hz), 125.0, 124.9, 124.6, 123.4, 123.2, 110.9 (dd, *J* = 32.4, 13.0 Hz), 108.8 (dd, *J* = 16.6, 5.1 Hz), 101.8 (d, *J* = 4.0 Hz), 73.1 (d, *J* = 4.5 Hz).

^{31}P NMR (243 MHz, Chloroform-*d*) δ 32.74.

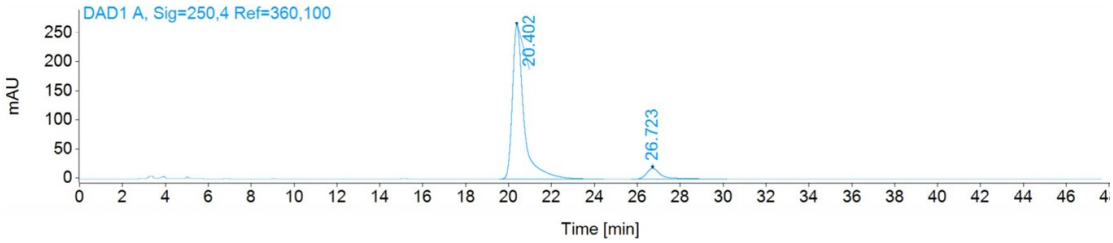
HRMS calculated for $C_{27}H_{19}ClNO_8P$ $[M+Na]^+$: 574.0429; found: 574.0439.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 60:40, 1.0 mL/min, 250 nm, t (major) = 20.402 min, t (minor) = 26.723 min.



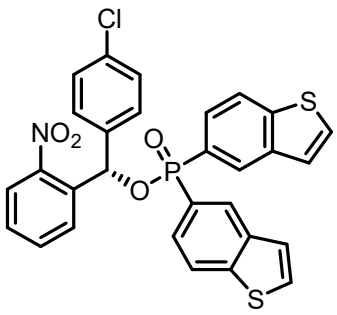
Signal: DAD1 A, Sig=250,4 Ref=360,100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
20.488	334.90961	0.56	0.5000	12650.75000	49.94
26.912	261.49316	0.62	0.6400	12679.43066	50.06



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
20.402	265.09003	0.57	0.4879	9851.58496	91.84
26.723	18.59689	0.61	0.6200	875.17102	8.16



3an, (96 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **3an** as yellow oil (90% yield, 97:3 e.r.).

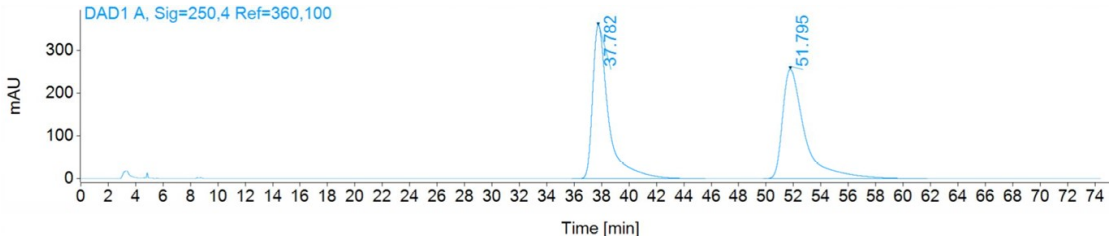
^{1}H NMR (600 MHz, Chloroform-*d*) δ 8.17 (s, 1H), 8.14 (s, 1H), 7.96 (d, *J* = 7.9 Hz, 1H), 7.83 – 7.73 (m, 3H), 7.57 (t, *J* = 7.7 Hz, 1H), 7.54 – 7.48 (m, 2H), 7.44 – 7.37 (m, 2H), 7.31 (t, *J* = 7.8 Hz, 1H), 7.23 (dd, *J* = 9.9, 5.5 Hz, 2H), 7.17 – 7.13 (m, 1H), 7.09 (q, *J* = 8.5 Hz, 4H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 147.1, 143.8 (dd, *J* = 9.6, 2.9 Hz), 139.3 (d, *J* = 15.2 Hz), 137.6 (d, *J* = 4.3 Hz), 136.0 (d, *J* = 3.7 Hz), 134.5, 133.8, 129.6, 129.0, 128.7, 128.3 (d, *J* = 11.1 Hz), 128.1 (d, *J* = 8.9 Hz), 127.9 (d, *J* = 11.3 Hz), 127.4, 127.0, 126.4, 126.2 (d, *J* = 12.0 Hz), 126.1, 125.8 (d, *J* = 11.6 Hz), 125.0, 124.2, 123.0 (d, *J* = 14.4 Hz), 73.4 (d, *J* = 4.4 Hz), .

^{31}P NMR (243 MHz, Chloroform-*d*) δ 34.77.

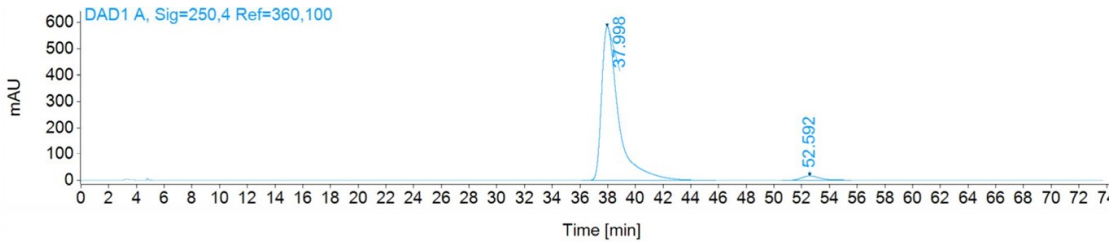
HRMS calculated for $C_{29}H_{19}ClNO_4PS_2$ $[M+Na]^+$: 598.0074; found: 598.0081.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 37.998 min, t (minor) = 52.592 min.



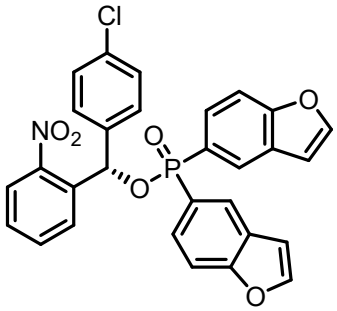
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
37.782	359.21069	0.50	1.0645	28824.73633	49.89
51.795	255.68021	0.48	1.5098	28947.41211	50.11



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
37.998	583.85345	0.46	1.1341	49451.70313	96.97
52.592	16.67286	0.72	1.3533	1543.31006	3.03



3ao, (5 d)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **3ao** as yellow oil (57% yield, 98:2 e.r.).

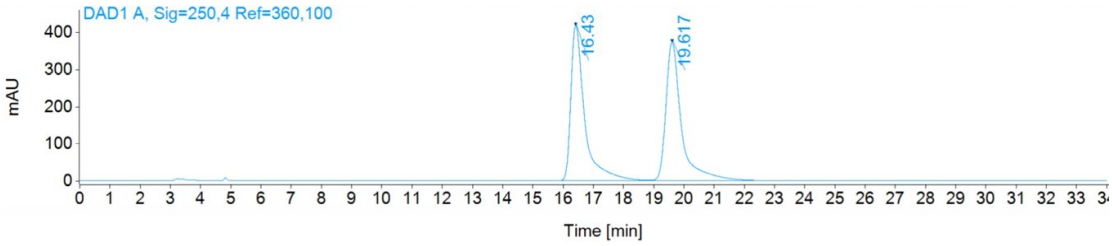
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.09 – 7.99 (m, 3H), 7.89 (d, *J* = 8.2 Hz, 1H), 7.72 – 7.58 (m, 5H), 7.55 – 7.41 (m, 3H), 7.22 – 7.14 (m, 5H), 6.77 (d, *J* = 7.3 Hz, 2H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 157.1 (dd, *J* = 7.5, 3.0 Hz), 147.2, 146.5 (d, *J* = 5.9 Hz), 137.7 (d, *J* = 4.5 Hz), 136.1 (d, *J* = 3.7 Hz), 134.5, 133.8, 129.5, 129.1 (d, *J* = 7.0 Hz), 128.7, 127.9 (d, *J* = 4.4 Hz), 127.7, 127.4 (d, *J* = 12.4 Hz), 126.4 (d, *J* = 12.1 Hz), 126.1 (d, *J* = 12.0 Hz), 126.0, 125.0, 124.6, 112.0 (d, *J* = 15.0 Hz), 107.0, 73.3 (d, *J* = 4.6 Hz), .

^{31}P NMR (243 MHz, Chloroform-*d*) δ 34.86.

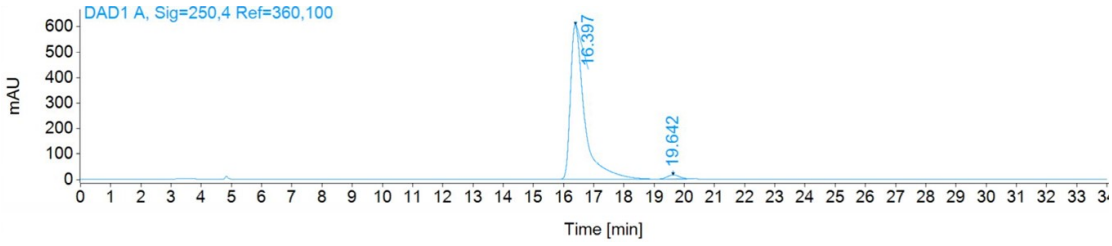
HRMS calculated for $C_{29}H_{19}ClNO_6P$ $[M+Na]^+$: 566.0531; found: 566.0528.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 16.397 min, t (minor) = 19.642 min.



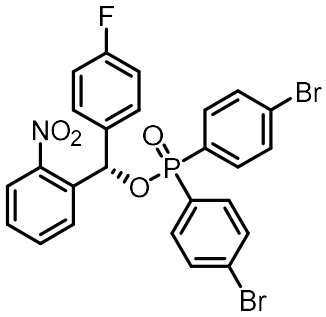
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
16.430	419.29193	0.49	0.4205	13339.37109	49.83
19.617	373.66223	0.58	0.4725	13429.55762	50.17



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
16.397	607.03278	0.46	0.4310	19786.27148	97.64
19.642	16.49512	0.91	0.4533	478.32672	2.36



4bg, (72 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4bg** as yellow oil (78% yield, 95:5 e.r.).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.94 (t, *J* = 8.5 Hz, 2H), 7.66 (t, *J* = 7.5 Hz, 1H), 7.56 – 7.43 (m, 9H), 7.25 – 7.16 (m, 3H), 6.91 (t, *J* = 8.5 Hz, 2H).

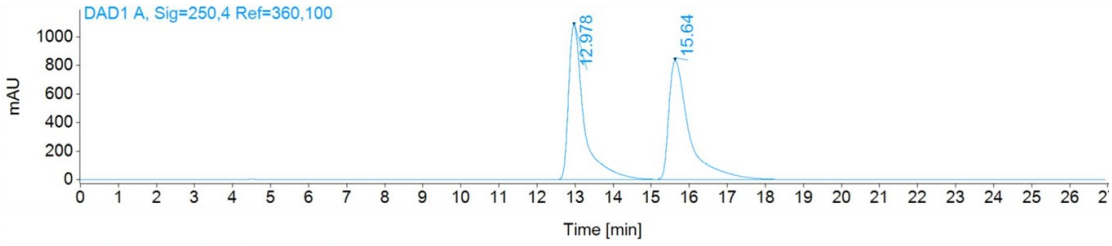
^{13}C NMR (101 MHz, Chloroform-*d*) δ 163.9, 161.5, 147.1, 135.6 (d, *J* = 4.3 Hz), 134.4 (t, *J* = 3.7 Hz), 133.8, 133.4, 133.2, 133.0, 132.9, 132.1 (dd, *J* = 13.8, 5.3 Hz), 130.5, 130.2, 130.1, 130.0, 129.2, 129.1, 128.8, 128.6, 128.1 (t, *J* = 3.5 Hz), 125.2, 115.7, 115.5, 73.7 (d, *J* = 4.6 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 31.12.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -112.47.

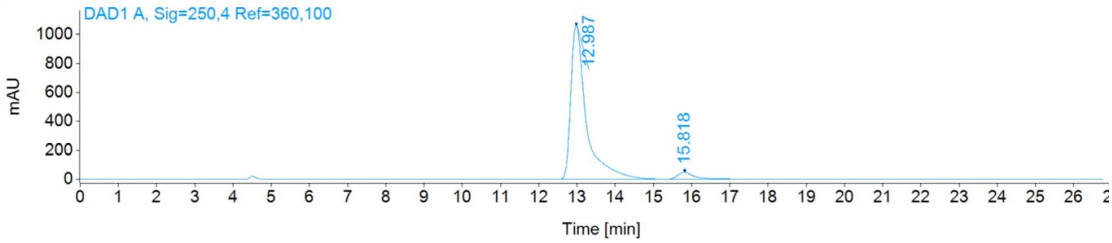
HRMS calculated for $C_{25}H_{17}Br_2FNO_4P$ $[M+Na]^+$: 625.9138; found: 625.9141.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 12.987 min, t (minor) = 15.818 min.



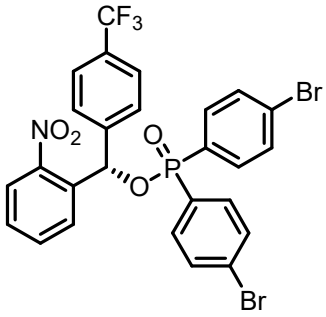
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
12.978	1083.27356	0.47	0.3593	30727.82813	49.84
15.640	831.34332	0.44	0.4838	30922.01172	50.16



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
12.987	1064.03870	0.47	0.3584	30099.42188	95.37
15.818	47.59143	0.62	0.4067	1460.31238	4.63



4cg, (72 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4cg** as yellow oil (93% yield, 97:3 e.r.).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.99 – 7.90 (m, 2H), 7.70 (t, *J* = 7.7 Hz, 1H), 7.55 – 7.46 (m, 11H), 7.39 (d, *J* = 8.1 Hz, 2H), 7.25 (d, *J* = 9.7 Hz, 1H).

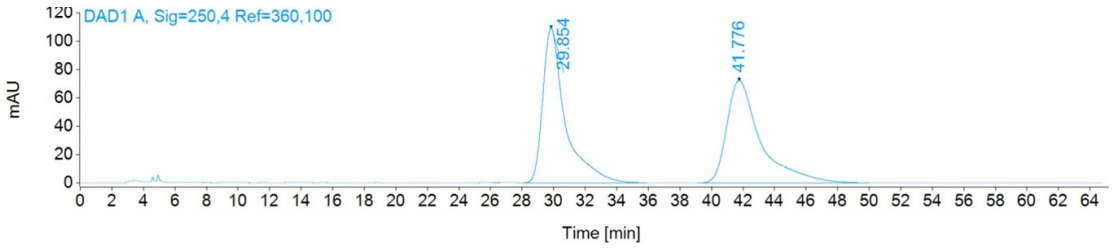
^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.2, 142.4 (d, *J* = 4.0 Hz), 135.0 (d, *J* = 4.2 Hz), 134.0, 133.2 (d, *J* = 11.1 Hz), 132.9 (d, *J* = 11.3 Hz), 132.2 (d, *J* = 3.0 Hz), 132.1 (d, *J* = 2.9 Hz), 130.8 (q, *J* = 32.6 Hz), 130.2, 130.0, 129.5, 129.0, 128.8, 128.6, 128.4 – 128.1 (m), 125.6 (q, *J* = 3.7 Hz), 125.3, 123.9 (q, *J* = 272.2 Hz), 73.5 (d, *J* = 4.4 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 31.60.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -62.70.

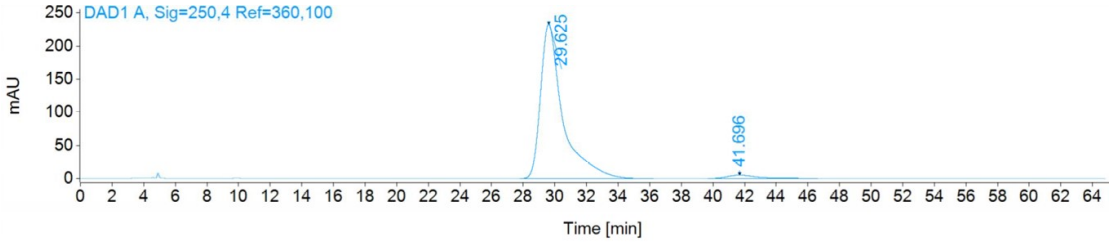
HRMS calculated for $C_{26}H_{17}Br_2F_3NO_4P$ $[M+Na]^+$: 675.9106; found: 675.9109.

Chiral HPLC: CHIRALPANK IG-3, Hexane/^{i}PrOH = 60:40, 1.0 mL/min, 250 nm, t (major) = 29.625 min, t (minor) = 41.696 min.



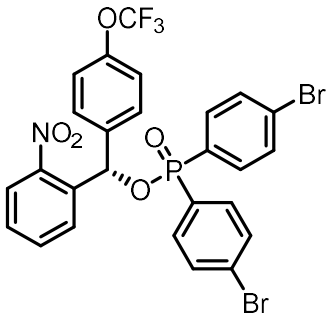
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
29.854	109.34227	0.53	1.2715	10788.73633	50.04
41.776	72.25780	0.52	1.9533	10769.65723	49.96



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
29.625	232.63477	0.51	1.2576	22643.25195	97.01
41.696	5.28521	0.62	1.8267	697.44110	2.99



4dg, (72 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4dg** as yellow oil (94% yield, 96:4 e.r.).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.99 – 7.92 (m, 2H), 7.71 (t, *J* = 7.7 Hz, 1H), 7.56 – 7.46 (m, 9H), 7.32 – 7.27 (m, 2H), 7.23 (d, *J* = 9.6 Hz, 1H), 7.07 (d, *J* = 8.3 Hz, 2H).

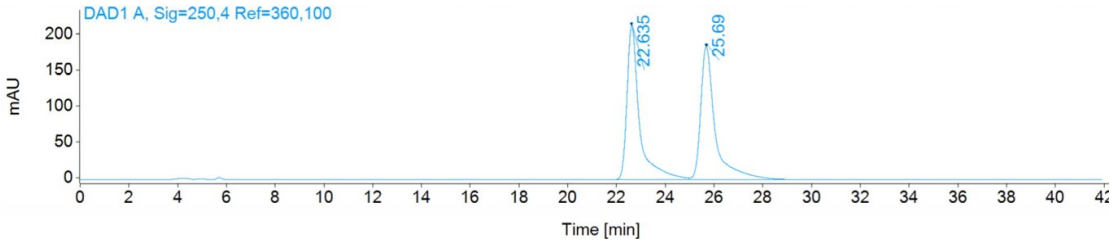
^{13}C NMR (101 MHz, Chloroform-*d*) δ 149.3 (d, *J* = 1.9 Hz), 147.2, 137.1 (d, *J* = 4.1 Hz), 135.4 (d, *J* = 4.3 Hz), 133.9, 133.3 (d, *J* = 11.2 Hz), 132.9 (d, *J* = 11.3 Hz), 132.2 (d, *J* = 5.8 Hz), 132.1 (d, *J* = 5.8 Hz), 130.4, 130.1, 129.7, 129.4, 129.0, 128.8, 128.7, 128.2 (dd, *J* = 5.6, 3.7 Hz), 125.3, 121.0, 120.5 (q, *J* = 257.9 Hz), 73.5 (d, *J* = 4.6 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 31.37.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -57.79.

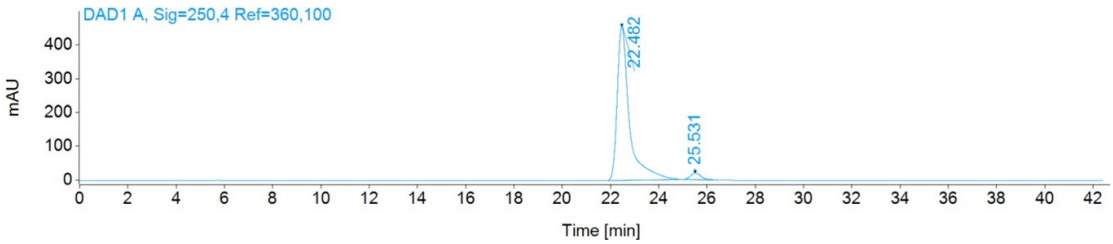
HRMS calculated for $C_{26}H_{17}Br_2F_3NO_5P$ $[M+Na]^+$: 691.9055; found: 691.9050

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 70:30, 0.8 mL/min, 250 nm, t (major) = 22.482 min, t (minor) = 25.531 min.



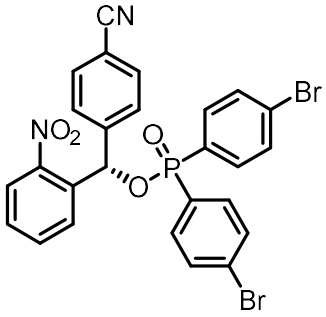
Signal: DAD1 A, Sig=250,4 Ref=360,100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
22.635	215.54704	0.54	0.4467	7738.65674	50.03
25.690	185.71217	0.53	0.5200	7730.74561	49.97



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
22.482	456.14484	0.56	0.4508	16055.30469	96.38
25.531	19.51276	0.81	0.4721	603.18689	3.62



4eg, (72 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4eg** as yellow solid (97% yield, 98:2 e.r.).

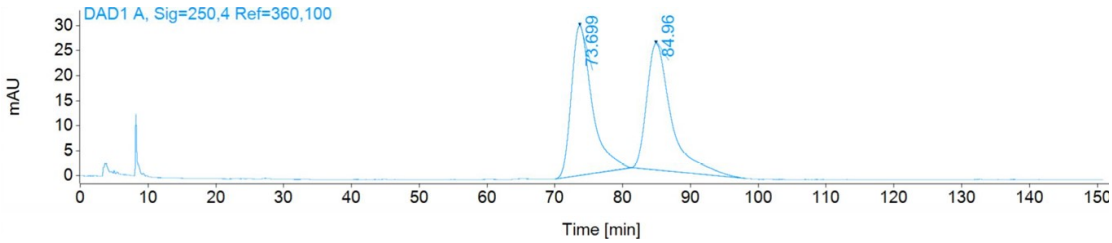
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.96 (d, *J* = 8.2 Hz, 1H), 7.86 (d, *J* = 7.9 Hz, 1H), 7.70 (t, *J* = 7.6 Hz, 1H), 7.60 – 7.44 (m, 11H), 7.41 (d, *J* = 8.0 Hz, 2H), 7.20 (d, *J* = 9.9 Hz, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.2, 143.6 (d, *J* = 4.4 Hz), 134.6 (d, *J* = 3.9 Hz), 134.1, 133.0 (dd, *J* = 20.9, 11.2 Hz), 132.5, 132.3 (d, *J* = 5.2 Hz), 132.1 (d, *J* = 5.2 Hz), 129.9 (d, *J* = 1.8 Hz), 129.8, 129.1, 128.5, 128.3 (dd, *J* = 8.7, 3.7 Hz), 125.3, 118.3, 112.5, 73.2 (d, *J* = 4.4 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 31.99.

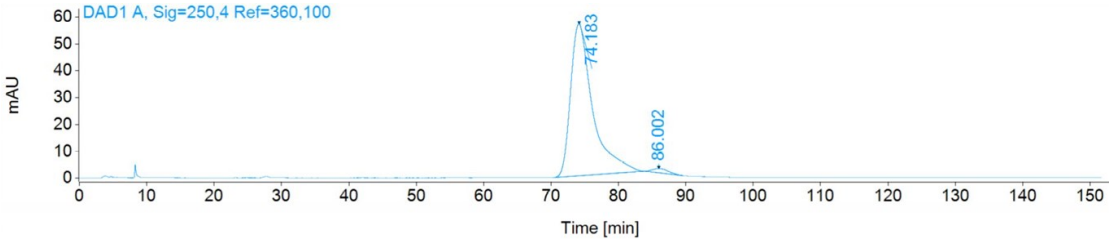
HRMS calculated for $C_{26}H_{17}Br_2N_2O_4P$ $[M+Na]^+$: 632.9178; found: 632.9185.

Chiral HPLC: CHIRALPANK IG-3, Hexane/^{i}PrOH = 50:50, 0.9 mL/min, 250 nm, t (major) = 74.183 min, t (minor) = 86.002 min.



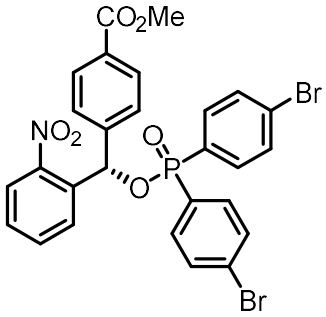
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
73.699	29.89277	0.65	3.0733	6359.86719	49.97
84.960	25.28820	0.58	3.4333	6368.58594	50.03



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
74.183	56.46062	0.56	3.1533	12889.67188	97.98
86.002	1.59856	0.57	2.6467	266.37463	2.02



4fg, (48 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4fg** as yellow solid (89% yield, 96:4 e.r.).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.97 – 7.88 (m, 4H), 7.67 (t, *J* = 7.6 Hz, 1H), 7.56 – 7.44 (m, 9H), 7.33 (d, *J* = 8.3 Hz, 2H), 7.24 (d, *J* = 9.8 Hz, 1H), 3.88 (s, 3H).

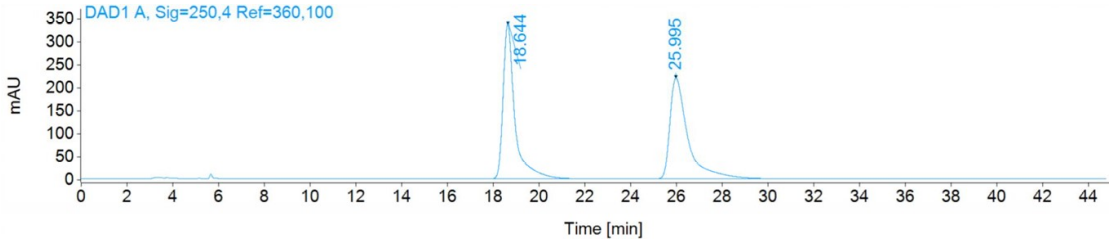
^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.5, 147.3, 143.2 (d, *J* = 4.5 Hz), 135.2 (d, *J* = 3.7 Hz), 133.9, 133.3, 133.2, 133.0, 132.9, 132.2, 132.1, 130.4, 130.3, 130.0, 129.9,

129.4, 129.1, 128.9, 128.6, 128.2 (dd, J = 8.2, 3.7 Hz), 127.8, 125.2, 73.7 (d, J = 4.5 Hz), 52.3.

^{31}P NMR (162 MHz, Chloroform-*d*) δ 31.50.

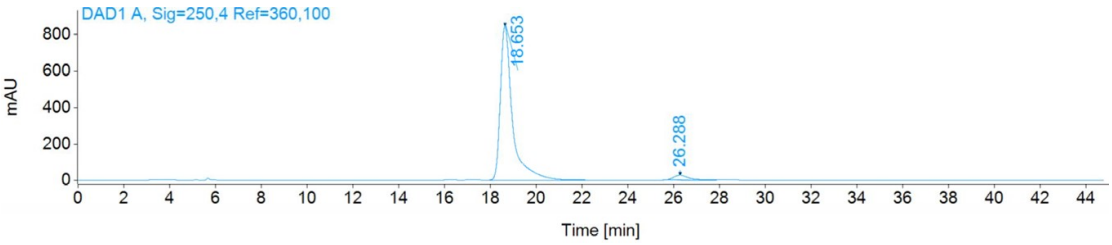
HRMS calculated for $C_{27}H_{20}Br_2NO_6P$ $[M+Na]^+$: 665.9287; found: 665.9287.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 18.653 min, t (minor) = 26.288 min.



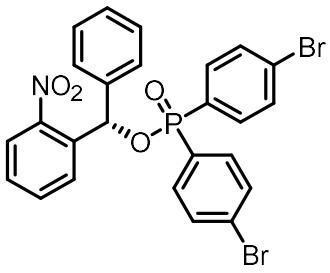
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
18.644	336.35135	0.57	0.4713	11998.33496	49.96
25.995	219.14365	0.45	0.7372	12019.63086	50.04



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
18.653	847.88544	0.54	0.4814	30972.94141	96.10
26.288	26.25086	0.65	0.6733	1256.84412	3.90



4gg, (48 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4gg** as yellow oil (60% yield, 95.5:4.5 e.r.).

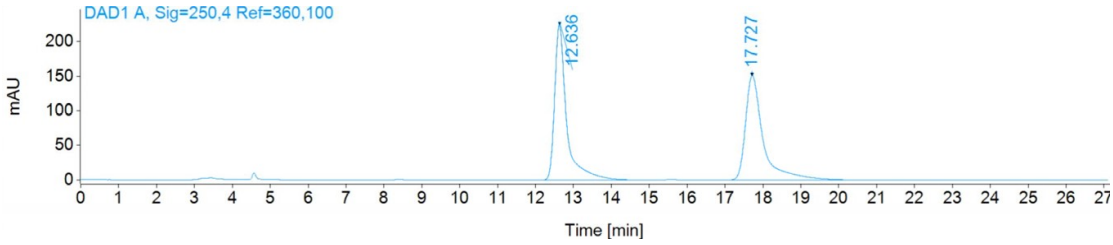
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.00 – 7.90 (m, 2H), 7.67 (t, *J* = 7.7 Hz, 1H), 7.58 – 7.43 (m, 9H), 7.27 – 7.20 (m, 6H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.3, 138.4 (d, *J* = 4.4 Hz), 135.9 (d, *J* = 4.0 Hz), 133.7, 133.4 (d, *J* = 11.2 Hz), 133.0 (d, *J* = 11.2 Hz), 132.1 (d, *J* = 5.8 Hz), 132.0 (d, *J* = 5.8 Hz), 130.7, 130.3, 129.3, 129.1, 128.9, 128.8, 128.7, 128.0, 125.1, 74.4 (d, *J* = 4.7 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 30.95.

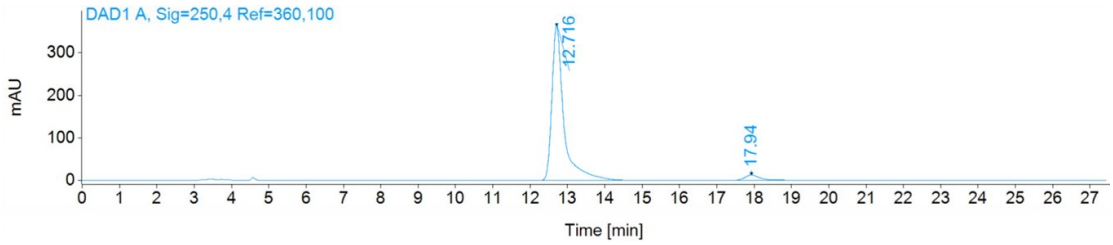
HRMS calculated for $C_{25}H_{18}Br_2NO_4P$ $[M+Na]^+$: 607.9232; found: 607.9226.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 12.716 min, t (minor) = 17.940 min.



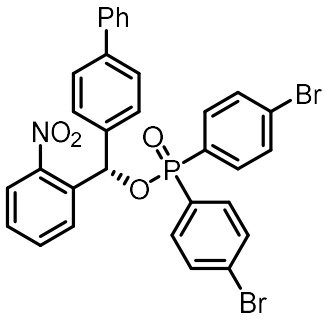
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
12.636	224.39552	0.57	0.2828	4917.93750	49.99
17.727	151.01794	0.55	0.4219	4919.37695	50.01



Signal: DAD1 A, Sig=250,4 Ref=360,100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
12.716	363.07733	0.57	0.2870	8106.77539	95.53
17.940	12.35531	0.71	0.4167	379.32526	4.47



4hg, (48 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4hg** as yellow solid (62% yield, 93:7 e.r.).

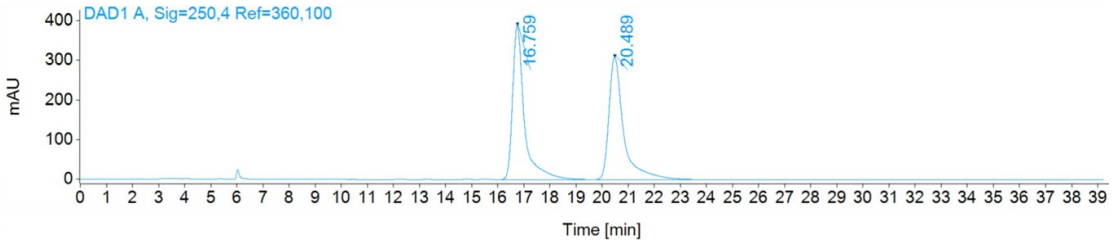
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.04 (d, *J* = 8.0 Hz, 1H), 7.97 (d, *J* = 8.2 Hz, 1H), 7.71 (t, *J* = 7.7 Hz, 1H), 7.62 – 7.50 (m, 10H), 7.49 – 7.39 (m, 5H), 7.37 – 7.28 (m, 4H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.2, 141.7, 140.3, 137.2 (d, *J* = 4.1 Hz), 135.8 (d, *J* = 4.4 Hz), 133.8, 133.5, 133.3, 133.0, 132.9, 132.1, 132.0 (d, *J* = 2.9 Hz), 131.9, 130.7, 130.3, 129.3, 129.1, 128.9, 128.8, 128.6, 127.9 (t, *J* = 3.5 Hz), 127.7, 127.3, 127.2, 125.2, 74.3 (d, *J* = 4.6 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 30.95.

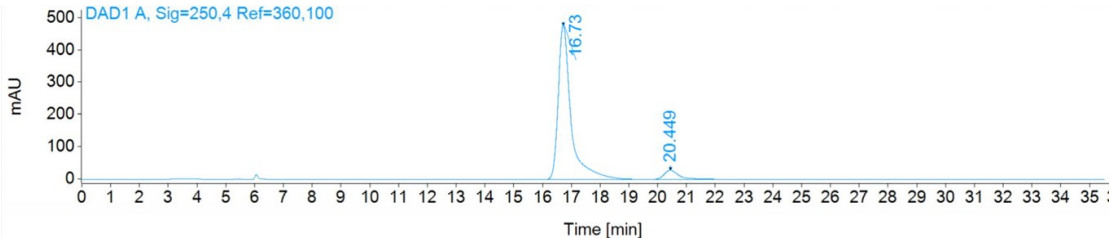
HRMS calculated for $C_{31}H_{22}Br_2NO_4P$ $[M+Na]^+$: 683.9545; found: 683.9544.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 16.730 min, t (minor) = 20.449 min.



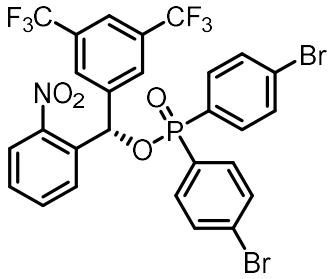
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
16.759	389.37549	0.58	0.4050	12147.94336	50.09
20.489	309.09122	0.56	0.5133	12105.16992	49.91



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
16.730	477.82043	0.57	0.4005	14782.44727	93.14
20.449	28.54311	0.59	0.4933	1089.18066	6.86



4jg, (48 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4jg** as yellow solid (96% yield, 92:8 e.r.).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.04 (d, *J* = 8.2 Hz, 1H), 7.96 (d, *J* = 7.8 Hz, 1H), 7.80 – 7.73 (m, 2H), 7.70 (s, 2H), 7.60 – 7.45 (m, 9H), 7.31 (d, *J* = 9.6 Hz, 1H).

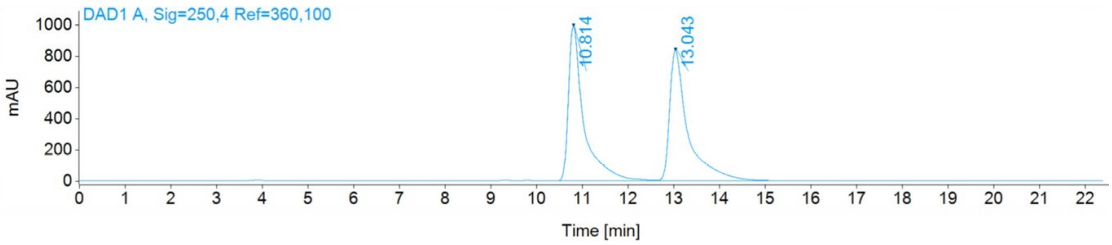
^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.1, 141.3 (d, *J* = 4.0 Hz), 134.4, 134.2 (d, *J* = 4.4 Hz), 133.1 (d, *J* = 11.3 Hz), 132.8 (d, *J* = 11.4 Hz), 132.3, 132.2, 132.1 (q, *J* = 33.6 Hz), 130.1, 129.9, 129.6, 128.9, 128.6, 128.5 (d, *J* = 2.2 Hz), 128.4 (d, *J* = 3.7 Hz), 128.3, 128.2 (d, *J* = 3.9 Hz), 125.6, 123.0 (q, *J* = 273.1 Hz), 123.1 – 122.4 (m), 73.0 (d, *J* = 4.3 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 32.31.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -62.88.

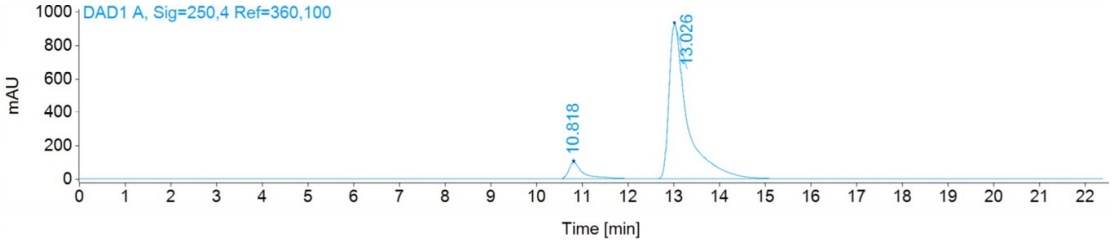
HRMS calculated for $C_{27}H_{16}Br_2F_6NO_4P$ $[M+Na]^+$: 743.8980; found: 743.8987

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 70:30, 1.0 mL/min, 250 nm, t (major) = 13.026 min, t (minor) = 10.818 min.



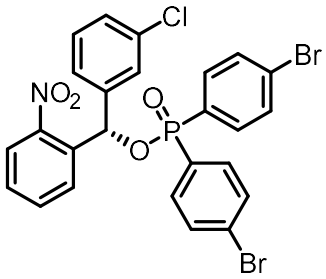
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
10.814	989.71130	0.42	0.2848	23176.20117	49.84
13.043	835.47223	0.40	0.3383	23327.92969	50.16



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
10.818	97.82305	0.44	0.2739	2232.00732	7.90
13.026	926.32727	0.39	0.3393	26012.20703	92.10



4kg, (72 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4kg** as white solid (93% yield, 96.5:3.5 e.r.).

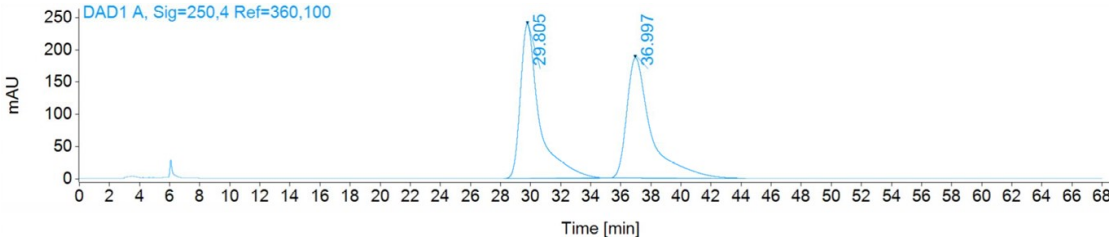
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.94 (t, *J* = 8.5 Hz, 2H), 7.69 (t, *J* = 7.7 Hz, 1H), 7.57 – 7.44 (m, 9H), 7.23 – 7.11 (m, 5H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.1, 140.4 (d, *J* = 4.3 Hz), 135.1 (d, *J* = 4.1 Hz), 134.5, 133.9, 133.3 (d, *J* = 11.2 Hz), 132.9 (d, *J* = 11.2 Hz), 132.1 (d, *J* = 3.8 Hz), 132.0 (d, *J* = 3.7 Hz), 130.3, 130.0, 129.9, 129.4, 128.9, 128.9 (d, *J* = 2.1 Hz), 128.6, 128.2 (d, *J* = 3.7 Hz), 128.1 (d, *J* = 3.7 Hz), 128.0, 126.3, 125.2, 73.5 (d, *J* = 4.4 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 31.33.

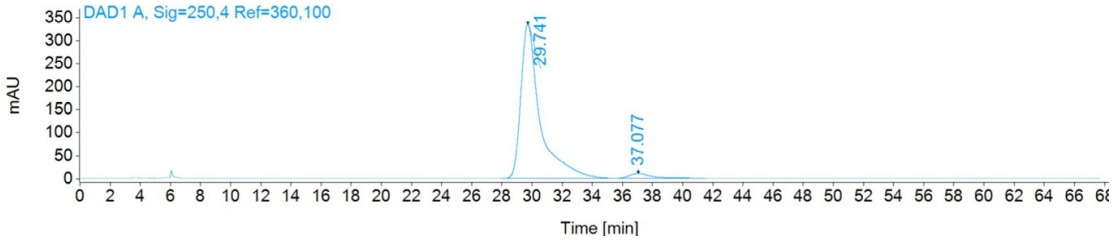
HRMS calculated for $C_{25}H_{17}Br_2ClNO_4P$ $[M+Na]^+$: 641.8843; found: 641.8847

Chiral HPLC: CHIRALPANK IG-3, Hexane/^{i}PrOH = 60:40, 1.0 mL/min, 250 nm, t (major) = 29.741 min, t (minor) = 37.077 min.



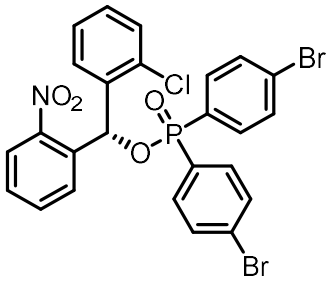
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
29.805	239.49466	0.51	1.1144	21113.37500	50.15
36.997	186.77194	0.50	1.4383	20985.16602	49.85



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
29.741	335.70392	0.51	1.1116	29565.84180	96.53
37.077	10.58000	0.65	1.3733	1063.76367	3.47



4lg, (72 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4lg** as yellow oil (30% yield, 74:26 e.r.).

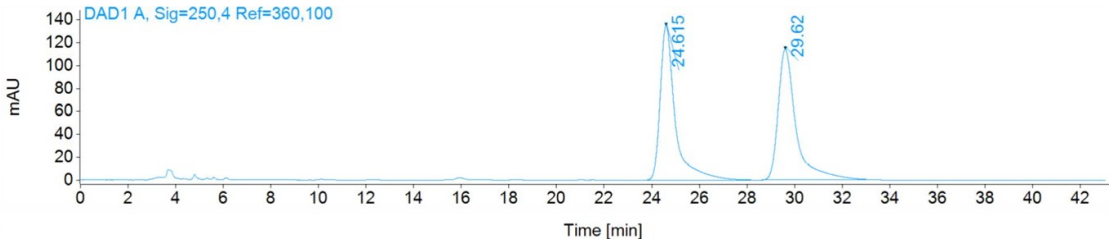
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.95 (d, *J* = 8.1 Hz, 1H), 7.83 (d, *J* = 8.0 Hz, 1H), 7.65 – 7.44 (m, 11H), 7.33 – 7.16 (m, 4H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.4, 136.3 (d, *J* = 4.7 Hz), 134.4 (d, *J* = 4.0 Hz), 133.9, 133.4, 133.3 (d, *J* = 4.1 Hz), 133.1, 132.9, 132.1, 132.0 (d, *J* = 1.6 Hz), 131.9, 131.0, 130.5, 130.2 (d, *J* = 5.2 Hz), 130.0, 129.6, 129.4 (d, *J* = 1.8 Hz), 129.1, 127.9 (dd, *J* = 6.1, 3.7 Hz), 127.1, 125.3, 72.2 (d, *J* = 5.1 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 30.67.

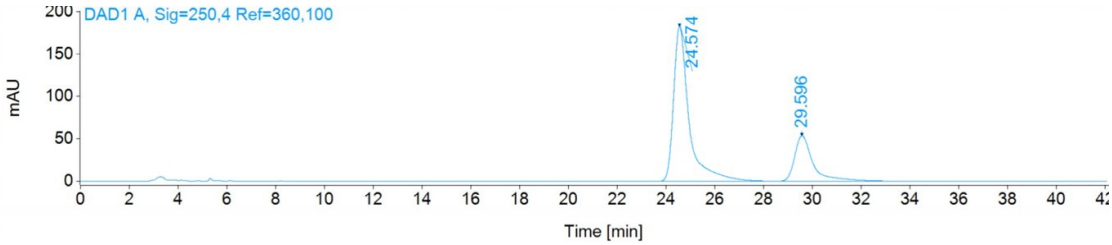
HRMS calculated for $C_{25}H_{17}Br_2ClNO_4P$ $[M+Na]^+$: 641.8843; found: 641.8848

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 60:40, 1.0 mL/min, 250 nm, t (major) = 24.574 min, t (minor) = 29.596 min.



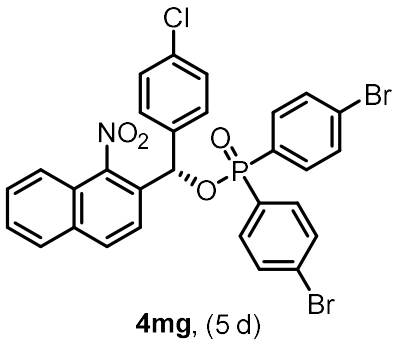
Signal: DAD1 A, Sig=250,4 Ref=360,100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
24.615	135.16255	0.61	0.5753	5935.90137	49.85
29.620	114.22001	0.62	0.6966	5972.25195	50.15



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
24.574	183.05682	0.56	0.5757	8067.83545	73.99
29.596	53.98558	0.59	0.6867	2836.85181	26.01



4mg, (5 d)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4mg** as yellow oil (89% yield, 90:10 e.r.).

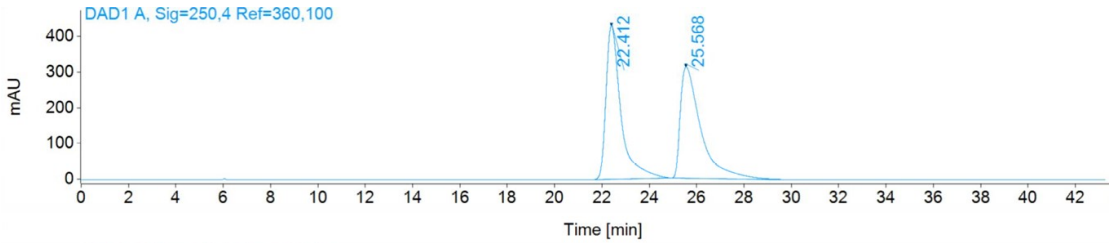
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.94 (d, *J* = 8.7 Hz, 1H), 7.88 (d, *J* = 8.3 Hz, 1H), 7.74 – 7.66 (m, 1H), 7.65 – 7.55 (m, 7H), 7.54 – 7.45 (m, 2H), 7.44 – 7.37 (m, 2H), 7.33 (d, *J* = 8.4 Hz, 2H), 7.26 (d, *J* = 8.5 Hz, 2H), 6.68 (d, *J* = 9.4 Hz, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 146.2, 137.2 (d, *J* = 4.5 Hz), 134.9, 133.6, 133.2 (dd, *J* = 11.3, 7.2 Hz), 132.3, 132.1 (d, *J* = 6.1 Hz), 131.9, 131.6, 130.3, 129.8, 129.4, 129.2 (d, *J* = 4.0 Hz), 129.0, 128.9, 128.6, 128.4 (d, *J* = 6.8 Hz), 128.2 (d, *J* = 3.8 Hz), 124.3, 124.0, 122.2, 73.8 (d, *J* = 4.9 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 31.81.

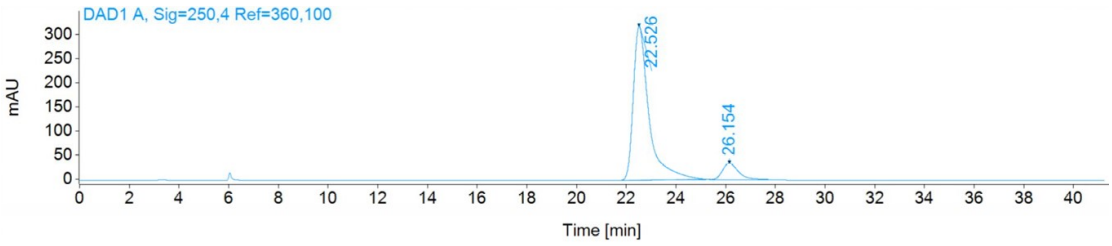
HRMS calculated for $C_{29}H_{19}Br_2ClNO_4P$ $[M+Na]^+$: 691.8999; found: 691.8995

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 22.526 min, t (minor) = 26.154 min.



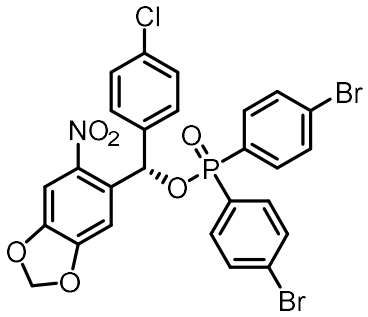
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
22.412	430.82199	0.54	0.5960	18856.54297	50.05
25.568	312.23434	0.38	0.8400	18820.82813	49.95



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
22.526	319.41724	0.56	0.5878	13997.33301	90.17
26.154	33.81031	0.68	0.6533	1526.43335	9.83



4ng, (96 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4ng** as yellow solid (76% yield, 87:13 e.r.).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.61 – 7.48 (m, 8H), 7.47 (s, 1H), 7.26 – 7.14 (m, 6H), 6.13 (d, *J* = 4.9 Hz, 2H).

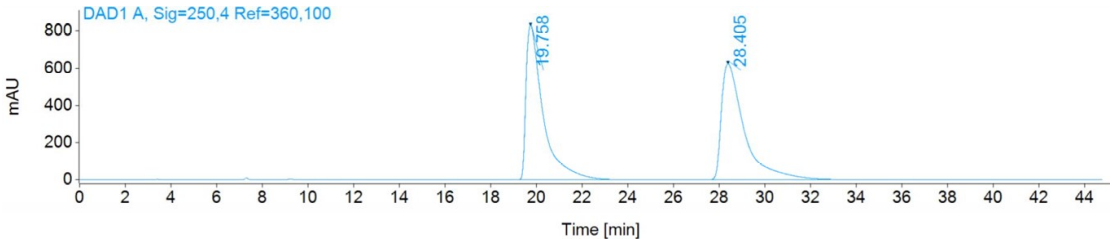
^{13}C NMR (101 MHz, Chloroform-*d*) δ 152.5, 148.0, 141.6, 137.2 (d, *J* = 4.9 Hz), 134.8, 133.4 (d, *J* = 11.2 Hz), 133.0 (d, *J* = 11.2 Hz), 132.6 (d, *J* = 3.6 Hz), 132.3 (d, *J*

= 2.2 Hz), 132.1 (d, *J* = 2.2 Hz), 130.5, 130.1, 129.2, 129.1, 128.9, 128.7, 128.3 (d, *J* = 3.8 Hz), 128.1 (d, *J* = 3.7 Hz), 107.7, 105.8, 103.5, 73.7 (d, *J* = 4.5 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 31.22.

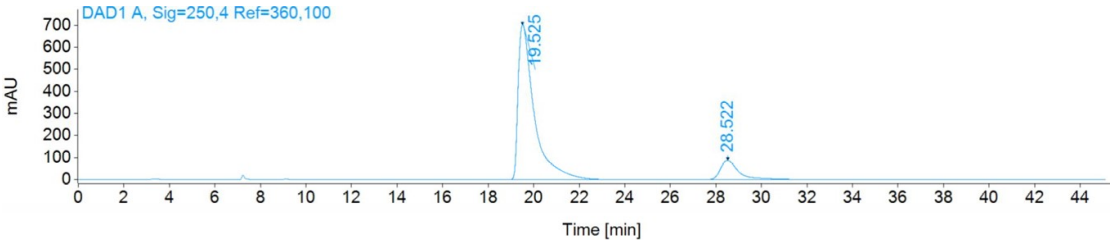
HRMS calculated for $C_{26}H_{17}Br_2ClNO_6P$ $[M+Na]^+$: 685.8741; found: 685.8747

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 19.525 min, t (minor) = 28.522 min.



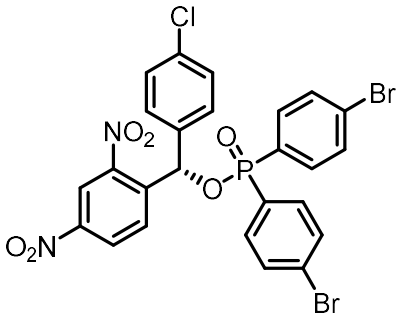
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
19.758	831.09479	0.32	0.6966	43076.16016	49.94
28.405	623.32471	0.39	0.9444	43177.16016	50.06



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
19.525	703.56793	0.34	0.6576	34628.25781	87.31
28.522	87.78710	0.54	0.7467	5033.46777	12.69



4og, (96 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4og** as white solid (90% yield, 97:3 e.r.).

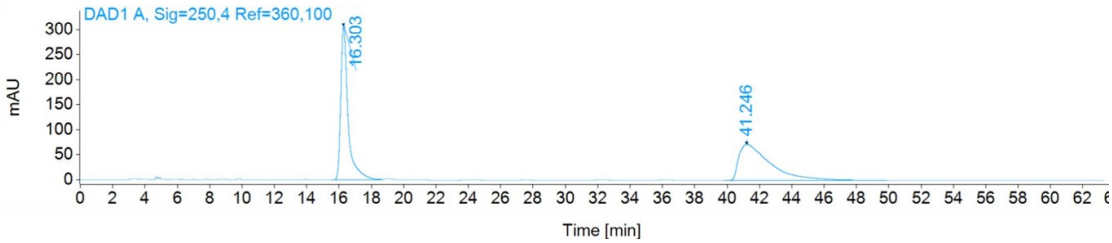
^{1}H NMR (600 MHz, Chloroform-*d*) δ 8.82 (d, *J* = 2.4 Hz, 1H), 8.52 (dd, *J* = 8.7, 2.4 Hz, 1H), 8.21 (d, *J* = 8.7 Hz, 1H), 7.64 – 7.53 (m, 6H), 7.52 – 7.46 (m, 2H), 7.28 – 7.20 (m, 3H), 7.12 (d, *J* = 8.4 Hz, 2H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 147.7, 147.2, 141.9 (d, *J* = 3.8 Hz), 135.7, 135.6 (d, *J* = 4.5 Hz), 133.4 (d, *J* = 11.2 Hz), 132.8 (d, *J* = 11.3 Hz), 132.5, 132.4, 132.3, 130.3, 129.9, 129.4, 129.3, 129.2, 129.0, 128.6 (dd, *J* = 8.5, 3.6 Hz), 128.3, 127.9, 120.9, 73.4 (d, *J* = 4.5 Hz).

^{31}P NMR (243 MHz, Chloroform-*d*) δ 32.61.

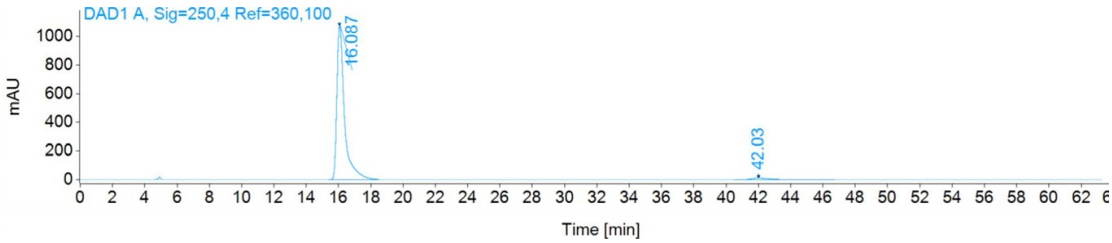
HRMS calculated for $C_{25}H_{16}Br_2ClN_2O_6P$ $[M+Na]^+$: 686.8693; found: 686.8695

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 16.087 min, t (minor) = 42.030 min.



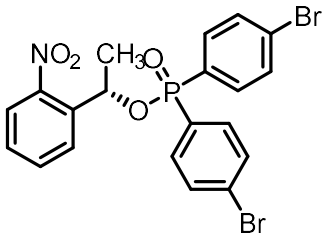
Signal: DAD1 A, Sig=250,4 Ref=360,100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
16.303	308.01559	0.56	0.4154	9752.32422	49.95
41.246	71.61162	0.32	1.9600	9771.56445	50.05



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
16.087	1075.28223	0.50	0.4378	35318.02734	96.93
42.030	12.28425	0.50	1.2667	1117.43433	3.07



4pg, (72 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4pg** as yellow oil (84% yield, 89:11 e.r.).

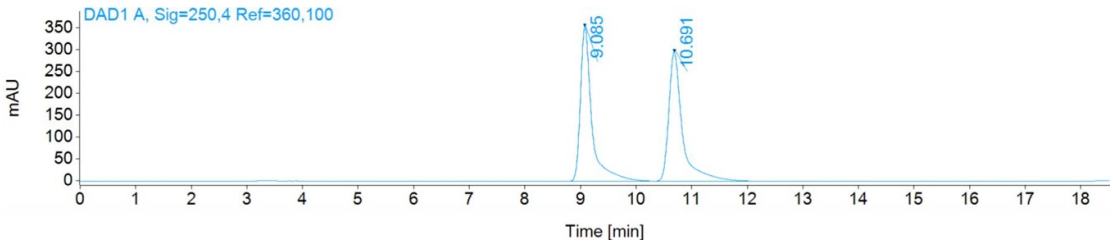
^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.89 (d, *J* = 8.2 Hz, 1H), 7.81 (d, *J* = 7.9 Hz, 1H), 7.70 – 7.61 (m, 5H), 7.51 – 7.42 (m, 5H), 6.11 – 6.03 (m, 1H), 1.74 (d, *J* = 6.3 Hz, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 147.0, 138.0 (d, *J* = 4.3 Hz), 133.9, 133.1 (dd, *J* = 14.6, 11.1 Hz), 132.2 (dd, *J* = 24.4, 13.8 Hz), 130.7, 130.2, 129.7, 129.3, 128.9, 128.1 (d, *J* = 6.5 Hz), 128.0 (d, *J* = 3.4 Hz), 124.7, 70.6 (d, *J* = 4.6 Hz), 25.2 (d, *J* = 4.0 Hz).

^{31}P NMR (243 MHz, Chloroform-*d*) δ 29.93.

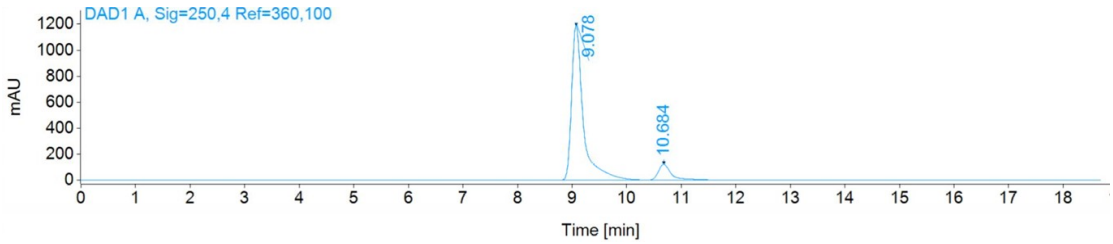
HRMS calculated for $C_{20}H_{16}Br_2NO_4P$ $[M+Na]^+$: 545.9076; found: 545.9082

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 60:40, 1.0 mL/min, 250 nm, t (major) = 9.078 min, t (minor) = 10.684 min.



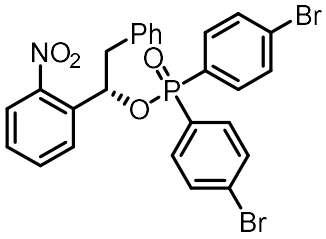
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
9.085	354.04932	0.57	0.1849	5086.42383	50.07
10.691	295.40427	0.58	0.2210	5072.13574	49.93



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
9.078	1189.04089	0.54	0.1935	17849.48438	89.36
10.684	122.18594	0.58	0.2183	2124.66016	10.64



4qg, (6 d)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4qg** as yellow oil (43% yield, 80:20 e.r.).

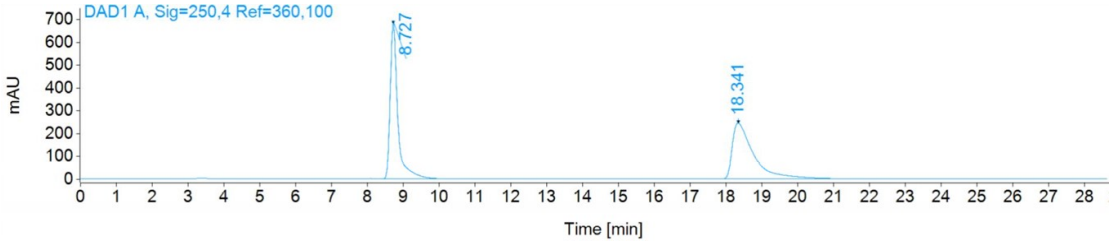
^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.98 (d, *J* = 8.2 Hz, 1H), 7.77 (d, *J* = 7.9 Hz, 1H), 7.62 (t, *J* = 7.7 Hz, 1H), 7.57 – 7.40 (m, 5H), 7.40 – 7.20 (m, 7H), 7.03 (dd, *J* = 12.0, 8.0 Hz, 2H), 6.07 (t, *J* = 8.7 Hz, 1H), 3.37 (d, *J* = 14.1 Hz, 1H), 3.09 (dd, *J* = 14.1, 9.0 Hz, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 146.8, 136.9, 136.8, 133.8, 133.1 (dd, *J* = 32.6, 11.0 Hz), 131.9 (dd, *J* = 13.7, 3.8 Hz), 130.6, 130.0, 129.7, 129.1, 129.0, 128.9, 128.8, 128.2, 127.8 (d, *J* = 3.6 Hz), 127.7 (d, *J* = 3.6 Hz), 127.3, 124.8, 75.1 (d, *J* = 5.9 Hz), 44.8 (d, *J* = 7.0 Hz).

^{31}P NMR (243 MHz, Chloroform-*d*) δ 30.15.

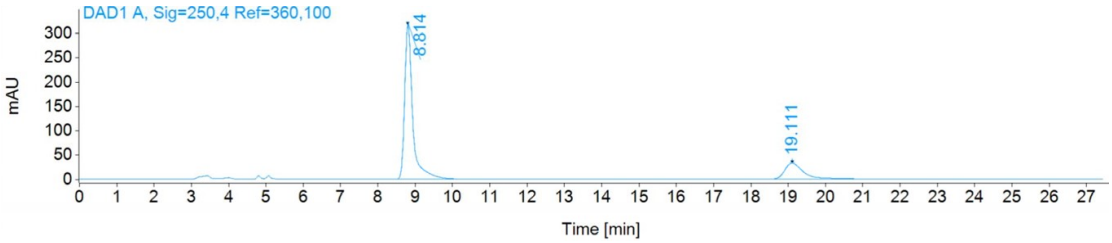
HRMS calculated for $C_{26}H_{20}Br_2NO_4P$ $[M+Na]^+$: 621.9389; found: 621.9395.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 8.814 min, t (minor) = 19.111 min.



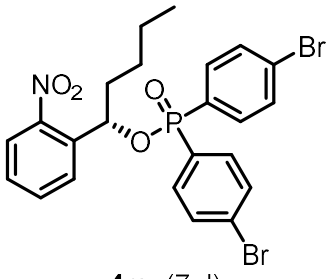
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
8.727	682.06555	0.59	0.1977	10101.56250	49.85
18.341	245.25912	0.36	0.5677	10163.20703	50.15



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
8.814	318.20721	0.61	0.1997	4763.97754	80.25
19.111	32.87038	0.60	0.5021	1172.48059	19.75



4rg, (7 d)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4rg** as yellow oil (60% yield, 93:7 e.r.).

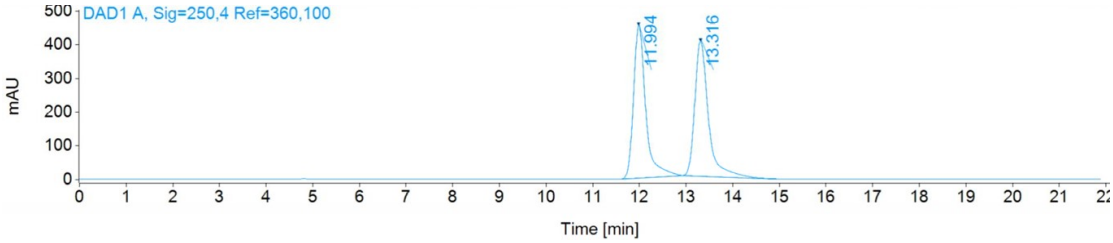
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.81 (d, *J* = 8.2 Hz, 1H), 7.72 (d, *J* = 7.8 Hz, 1H), 7.68 – 7.55 (m, 5H), 7.45 – 7.33 (m, 5H), 5.98 – 5.85 (m, 1H), 2.08 – 1.88 (m, 2H), 1.50 – 1.24 (m, 4H), 0.83 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.2, 136.9 (d, *J* = 2.5 Hz), 133.4, 133.1 (dd, *J* = 11.1, 9.1 Hz), 132.0 (dd, *J* = 26.9, 13.7 Hz), 130.6, 130.3, 129.2, 128.9, 128.7, 128.6, 128.0 (d, *J* = 3.7 Hz), 127.8 (d, *J* = 3.7 Hz), 124.5, 73.3 (d, *J* = 5.4 Hz), 38.0 (d, *J* = 5.1 Hz), 27.5, 22.3, 14.0.

^{31}P NMR (162 MHz, Chloroform-*d*) δ 29.65.

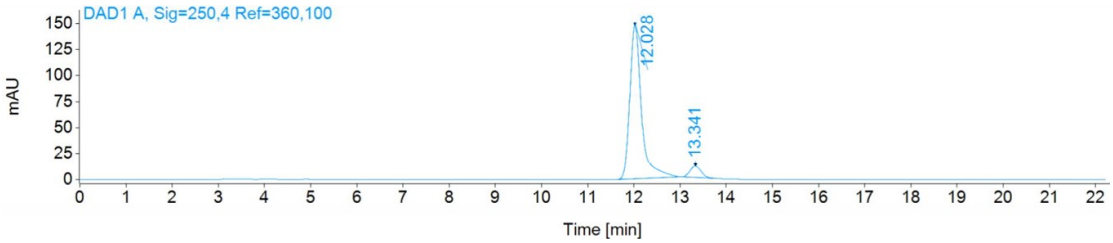
HRMS calculated for $C_{23}H_{22}Br_2NO_4P$ $[M+Na]^+$: 587.9545; found: 587.9555.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 70:30, 1.0 mL/min, 250 nm, t (major) = 12.028 min, t (minor) = 13.341 min.



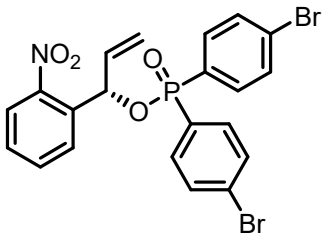
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
11.994	454.44861	0.73	0.2586	8252.29688	50.16
13.316	402.06842	0.69	0.2867	8198.11230	49.84



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
12.028	147.31400	0.74	0.2482	2597.13208	93.32
13.341	10.99129	0.88	0.2689	186.03473	6.68



4sg, (96 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4sg** as yellow oil (86% yield, 95:5 e.r.).

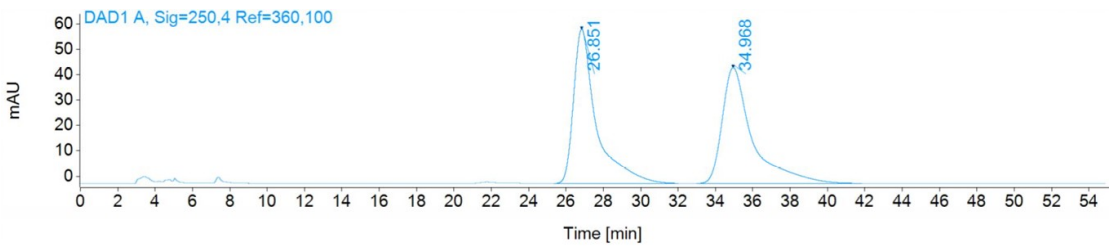
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.89 (d, *J* = 8.2 Hz, 1H), 7.76 (d, *J* = 8.0 Hz, 1H), 7.70 – 7.59 (m, 5H), 7.55 – 7.48 (m, 4H), 7.47 – 7.41 (m, 1H), 6.50 (dd, *J* = 9.2, 5.8 Hz, 1H), 6.08 (ddd, *J* = 16.5, 10.4, 5.7 Hz, 1H), 5.31 (d, *J* = 17.1 Hz, 1H), 5.24 (d, *J* = 10.4 Hz, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.4, 135.6 (d, *J* = 4.7 Hz), 134.8 (d, *J* = 4.0 Hz), 133.7, 133.2 (dd, *J* = 30.9, 11.1 Hz), 132.1 (dd, *J* = 13.8, 11.6 Hz), 130.5 (d, *J* = 2.6 Hz), 129.2, 129.1 (d, *J* = 2.2 Hz), 128.9, 128.1 (d, *J* = 3.7 Hz), 128.0 (d, *J* = 3.7 Hz), 124.8, 118.5, 73.4 (d, *J* = 4.7 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 30.74.

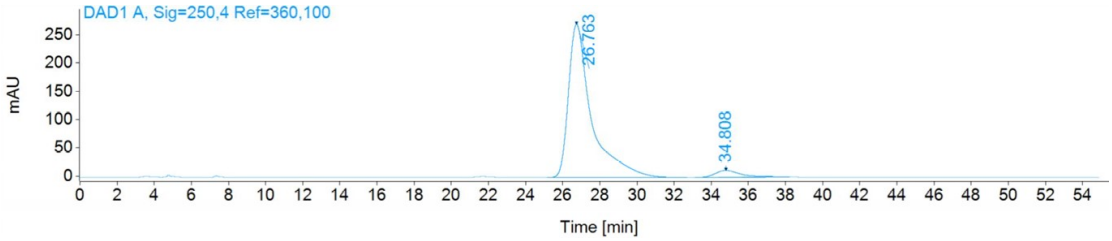
HRMS calculated for $C_{21}H_{16}Br_2NO_4P$ $[M+Na]^+$: 557.9076; found: 557.9079

Chiral HPLC: CHIRALPANK IG-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 26.763 min, t (minor) = 34.808 min.



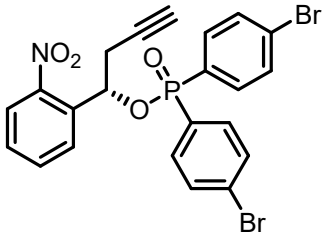
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
26.851	60.68423	0.53	1.0600	5130.71289	50.10
34.968	45.56147	0.52	1.4267	5110.54004	49.90



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
26.763	271.28909	0.49	1.0800	23320.14453	95.04
34.808	12.27379	0.66	1.3867	1216.43787	4.96



4tg, (6 d)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4tg** as yellow oil (70% yield, 94:6 e.r.).

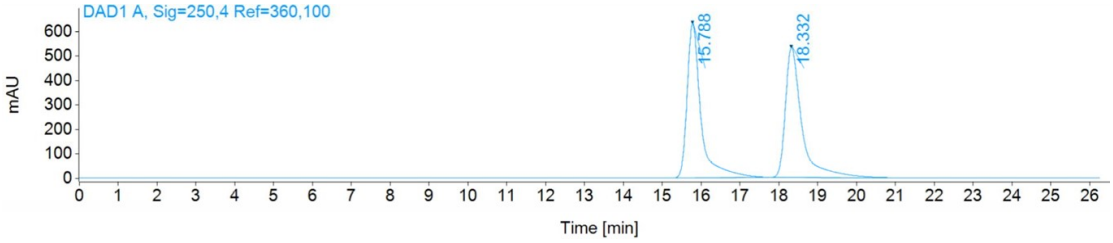
^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.94 (d, *J* = 8.3 Hz, 1H), 7.87 (d, *J* = 7.9 Hz, 1H), 7.70 (dd, *J* = 12.0, 8.3 Hz, 2H), 7.67 – 7.59 (m, 3H), 7.57 – 7.48 (m, 4H), 7.46 (t, *J* = 7.8 Hz, 1H), 6.13 (dt, *J* = 9.8, 5.2 Hz, 1H), 3.04 – 2.91 (m, 2H), 2.03 (t, *J* = 2.7 Hz, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 147.0, 134.7 (d, *J* = 3.3 Hz), 133.5, 133.2 (dd, *J* = 38.6, 11.1 Hz), 132.1 (dd, *J* = 20.8, 13.8 Hz), 130.0, 129.9, 129.4, 129.3, 129.1, 129.0, 128.2 (d, *J* = 3.6 Hz), 128.1 (d, *J* = 3.5 Hz), 124.8, 78.5, 72.4, 70.5 (d, *J* = 4.8 Hz), 28.3 (d, *J* = 4.8 Hz).

^{31}P NMR (243 MHz, Chloroform-*d*) δ 30.77.

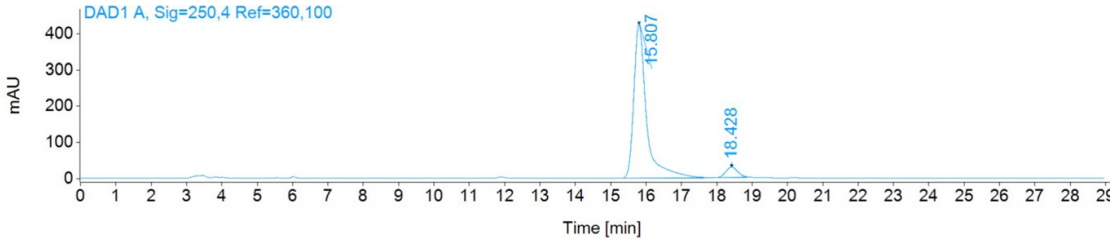
HRMS calculated for $C_{22}H_{16}Br_2NO_4P$ $[M+Na]^+$: 569.9076; found: 569.9080.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 70:30, 1.0 mL/min, 250 nm, t (major) = 15.807 min, t (minor) = 18.428 min.



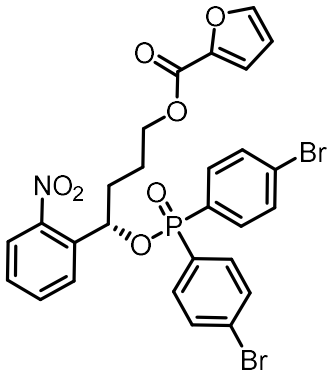
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
15.788	632.93488	0.63	0.3291	15719.82910	49.92
18.332	532.47034	0.56	0.3957	15772.35840	50.08



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
15.807	426.46790	0.64	0.3291	10657.70996	93.93
18.428	29.08853	0.91	0.3733	688.29462	6.07



4ug, (6 d)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4ug** as yellow oil (38% yield, 81:19 e.r.).

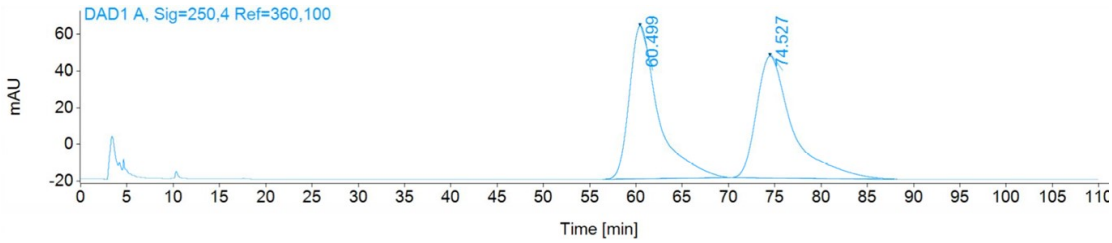
^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.83 (d, *J* = 8.2 Hz, 1H), 7.73 (d, *J* = 7.9 Hz, 1H), 7.68 – 7.57 (m, 5H), 7.55 (s, 1H), 7.45 – 7.31 (m, 5H), 7.14 (d, *J* = 3.6 Hz, 1H), 6.48 (d, *J* = 3.6 Hz, 1H), 5.97 (dt, *J* = 9.8, 6.1 Hz, 1H), 4.30 (t, *J* = 6.4 Hz, 2H), 2.13 (q, *J* = 7.2, 6.8 Hz, 2H), 2.03 – 1.96 (m, 1H),1.93 – 1.85 (m, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 158.8, 147.2, 146.5, 144.7, 136.3 (d, *J* = 2.6 Hz), 133.6, 133.1 (dd, *J* = 11.1, 6.5 Hz), 132.1 (dd, *J* = 48.2, 13.8 Hz), 130.1, 129.7, 129.2, 129.0, 128.8, 128.6, 128.2 (d, *J* = 3.7 Hz), 127.9 (d, *J* = 3.7 Hz), 124.6, 118.1, 112.0, 72.8 (d, *J* = 5.2 Hz), 64.2, 34.7 (d, *J* = 4.8 Hz), 25.0.

^{31}P NMR (243 MHz, Chloroform-*d*) δ 30.25.

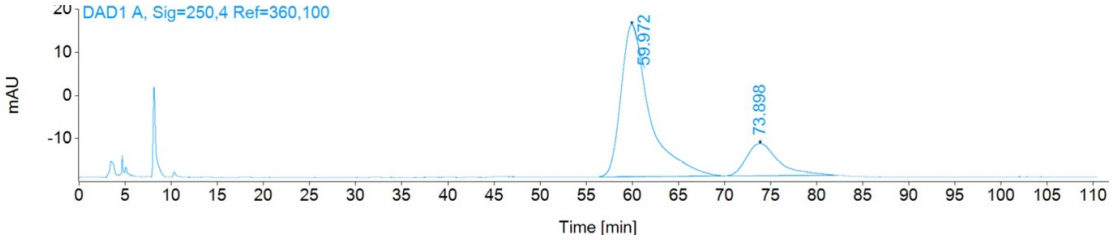
HRMS calculated for $C_{27}H_{22}Br_2NO_7P$ $[M+Na]^+$: 683.9393; found: 683.9392.

Chiral HPLC: CHIRALPANK IG-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 59.972 min, t (minor) = 73.898 min.



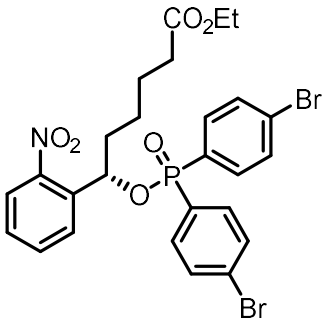
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
60.499	83.16423	0.58	2.9067	18091.40039	50.13
74.527	66.37389	0.58	3.6067	17995.81836	49.87



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
59.972	35.34995	0.58	2.8533	7574.44385	80.71
73.898	7.47764	0.70	3.4400	1810.52612	19.29



4vg, (96 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4vg** as yellow oil (48% yield, 93:7 e.r.).

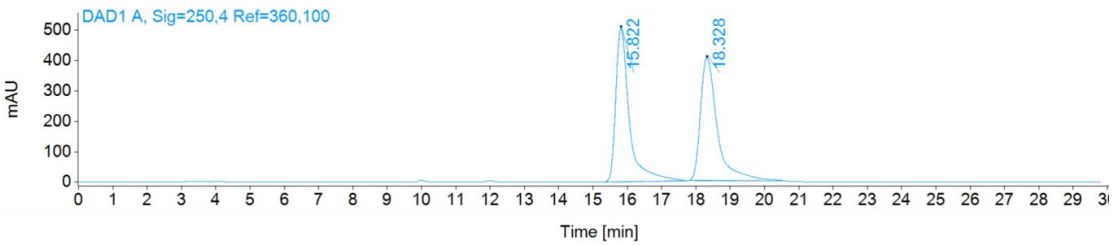
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.81 (d, *J* = 8.2 Hz, 1H), 7.71 (d, *J* = 7.9 Hz, 1H), 7.68 – 7.55 (m, 5H), 7.46 – 7.31 (m, 5H), 5.91 (ddd, *J* = 9.3, 7.6, 4.5 Hz, 1H), 4.08 (q, *J* = 7.1 Hz, 2H), 2.25 (t, *J* = 7.3 Hz, 2H), 2.08 – 1.91 (m, 2H), 1.65 – 1.48 (m, 3H), 1.47 – 1.38 (m, 1H), 1.20 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 173.5, 147.2, 136.7 (d, *J* = 2.6 Hz), 133.5, 133.1 (dd, *J* = 11.1, 7.9 Hz), 132.0 (dd, *J* = 29.7, 13.7 Hz), 130.5, 130.2, 129.1, 128.9, 128.8, 128.6, 128.0 (d, *J* = 3.7 Hz), 127.8 (d, *J* = 3.6 Hz), 124.5, 73.1 (d, *J* = 5.3 Hz), 60.4, 38.0 (d, *J* = 5.0 Hz), 34.1, 25.0, 24.5, 14.4.

^{31}P NMR (162 MHz, Chloroform-*d*) δ 29.85.

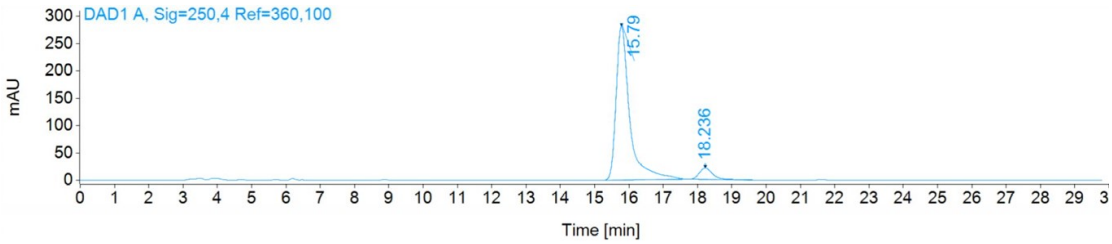
HRMS calculated for $C_{26}H_{26}Br_2NO_6P$ $[M+Na]^+$: 659.9757; found: 659.9761.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 70:30, 1.0 mL/min, 250 nm, t (major) = 15.790 min, t (minor) = 18.236 min.



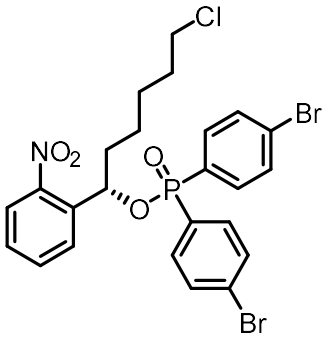
Signal: DAD1 A, Sig=250,4 Ref=360,100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
15.822	505.56039	0.58	0.3705	13912.54102	50.05
18.328	403.09723	0.58	0.4800	13885.12109	49.95



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
15.790	281.85397	0.60	0.3673	7778.13916	93.08
18.236	20.86193	0.74	0.4033	578.54297	6.92



4wg, (5 d)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4wg** as yellow oil (65% yield, 91:9 e.r.).

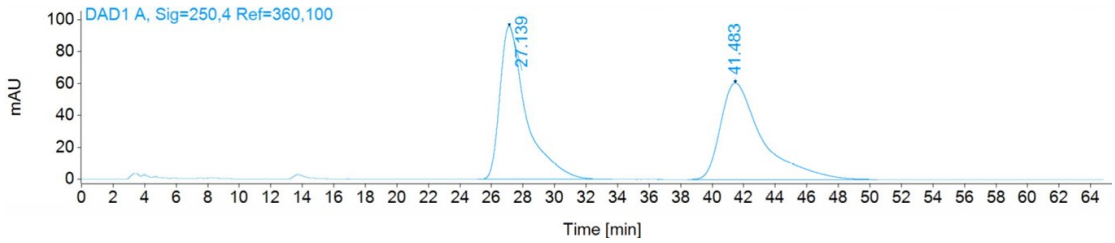
^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.82 (d, *J* = 8.1 Hz, 1H), 7.72 (d, *J* = 7.9 Hz, 1H), 7.68 – 7.57 (m, 5H), 7.44 – 7.33 (m, 5H), 5.92 (td, *J* = 8.4, 4.3 Hz, 1H), 3.48 (t, *J* = 6.7 Hz, 2H), 2.07 – 1.93 (m, 2H), 1.77 – 1.69 (m, 2H), 1.57 – 1.49 (m, 1H), 1.47 – 1.39 (m, 3H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 147.3, 136.8 (d, *J* = 2.6 Hz), 133.5, 133.1 (dd, *J* = 11.0, 7.0 Hz), 132.1 (dd, *J* = 43.6, 13.7 Hz), 130.4, 130.0, 129.4, 129.1, 128.9, 128.6, 128.1 (d, *J* = 3.6 Hz), 127.9 (d, *J* = 3.5 Hz), 124.6, 73.2 (d, *J* = 5.3 Hz), 45.0, 38.2 (d, *J* = 4.9 Hz), 32.5, 26.5, 24.8.

^{31}P NMR (243 MHz, Chloroform-*d*) δ 29.87.

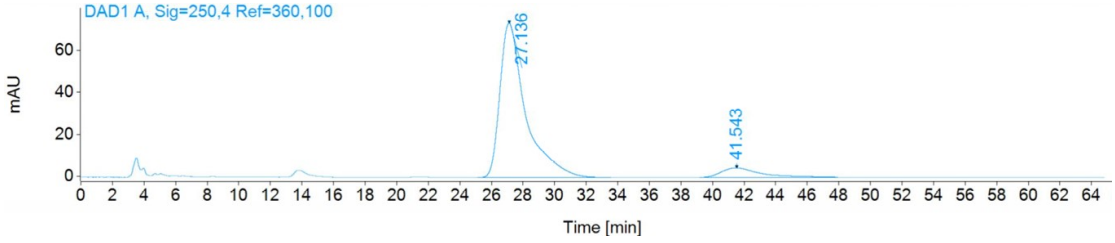
HRMS calculated for $C_{24}H_{23}Br_2ClNO_4P$ $[M+Na]^+$: 635.9312; found: 635.9321.

Chiral HPLC: CHIRALPANK IG-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 27.136 min, t (minor) = 41.543 min.



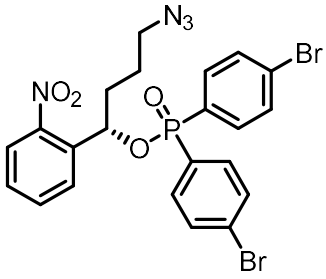
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
27.139	95.87359	0.50	1.5379	11085.37500	49.97
41.483	60.37452	0.51	2.4667	11100.90430	50.03



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
27.136	73.28944	0.51	1.4933	8262.79980	91.40
41.543	4.51014	0.61	2.3867	777.78607	8.60



4xg, (5 d)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4xg** as yellow oil (57% yield, 85:15 e.r.).

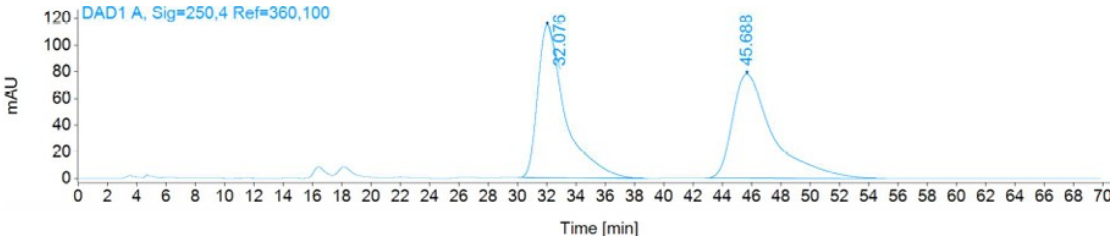
^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.84 (d, *J* = 8.1 Hz, 1H), 7.73 (d, *J* = 7.9 Hz, 1H), 7.68 – 7.58 (m, 5H), 7.44 – 7.33 (m, 5H), 5.95 – 5.90 (m, 1H), 3.36 – 3.28 (m, 2H), 2.15 – 2.03 (m, 2H), 1.87 – 1.79 (m, 1H), 1.77 – 1.70 (m, 1H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 147.2, 136.4 (d, *J* = 2.6 Hz), 133.7, 133.1, 133.0, 132.3 (d, *J* = 13.8 Hz), 132.0 (d, *J* = 13.7 Hz), 130.1, 129.7, 129.2, 129.1, 128.8, 128.7, 128.5, 128.2 (d, *J* = 3.7 Hz), 128.0 (d, *J* = 3.7 Hz), 126.6, 124.7, 72.6 (d, *J* = 5.2 Hz), 50.9, 35.5 (d, *J* = 4.8 Hz), 25.1.

^{31}P NMR (243 MHz, Chloroform-*d*) δ 30.34.

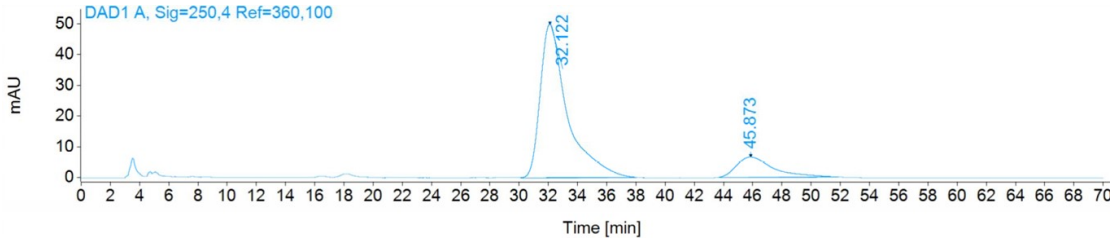
HRMS calculated for $C_{22}H_{19}Br_2N_4O_4P$ $[M+H]^+$: 592.9583; found: 592.9575.

Chiral HPLC: CHIRALPANK IG-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 32.122 min, t (minor) = 45.873 min.



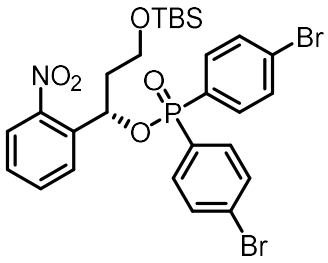
Signal: DAD1 A, Sig=250,4 Ref=360,100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
32.076	114.73779	0.51	1.7200	14814.45703	49.87
45.688	78.04938	0.52	2.5588	14891.03711	50.13



Signal: DAD1 A, Sig=250,4 Ref=360,100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
32.122	49.84225	0.53	1.7082	6408.39844	84.78
45.873	6.56401	0.58	2.4733	1150.49768	15.22



4yg, (96 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4yg** as yellow oil (62% yield, 96:4 e.r.).

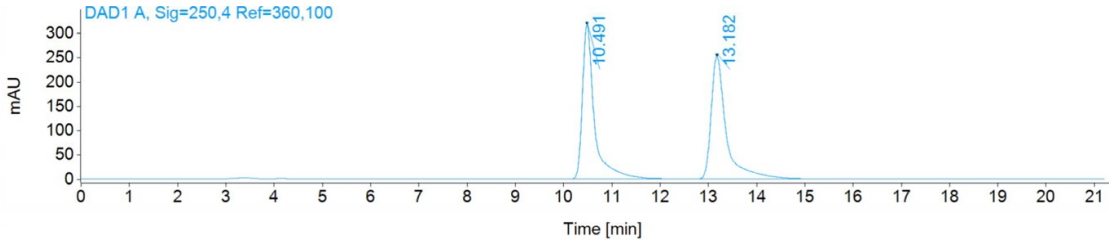
^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.82 (d, *J* = 8.2 Hz, 1H), 7.72 (d, *J* = 7.9 Hz, 1H), 7.66 – 7.55 (m, 5H), 7.49 – 7.36 (m, 5H), 6.05 – 6.01 (m, 1H), 3.79 – 3.75 (m, 1H), 3.72 – 3.69 (m, 1H), 2.29 – 2.16 (m, 2H), 0.83 (s, 9H), -0.01 (d, *J* = 2.2 Hz, 6H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 147.5, 136.4 (d, *J* = 2.6 Hz), 133.3 (d, *J* = 4.0 Hz), 133.2, 133.1, 132.2 (d, *J* = 14.0 Hz), 132.0 (d, *J* = 13.8 Hz), 130.4 (d, *J* = 13.1 Hz), 129.4 (d, *J* = 10.8 Hz), 129.0, 128.9, 128.0 (d, *J* = 3.7 Hz), 127.9 (d, *J* = 3.5 Hz), 124.5, 71.5 (d, *J* = 5.4 Hz), 59.4, 41.4 (d, *J* = 5.3 Hz), 26.0, 18.4, -5.3.

^{31}P NMR (243 MHz, Chloroform-*d*) δ 29.67.

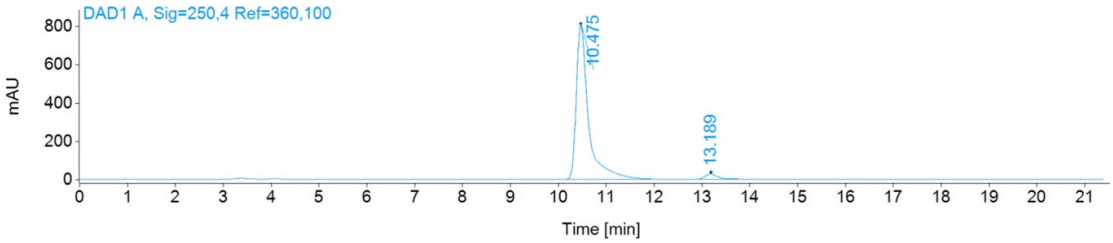
HRMS calculated for $C_{27}H_{32}Br_2NO_5PSi$ $[M+Na]^+$: 690.0046; found: 690.0045.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 80:20, 1.0 mL/min, 250 nm, t (major) = 10.475 min, t (minor) = 13.189 min.



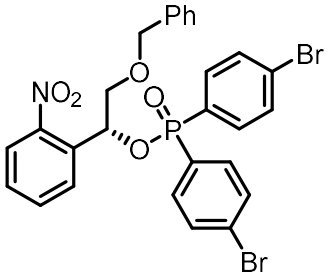
Signal: DAD1 A, Sig=250,4 Ref=360,100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
10.491	317.73050	0.54	0.2225	5530.05371	49.99
13.182	252.54202	0.54	0.2810	5532.01465	50.01



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
10.475	806.58417	0.51	0.2291	14392.90527	95.85
13.189	28.16203	0.56	0.2807	622.74310	4.15



4zg, (96 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **4zg** as white solid (60% yield, 92:8 e.r.).

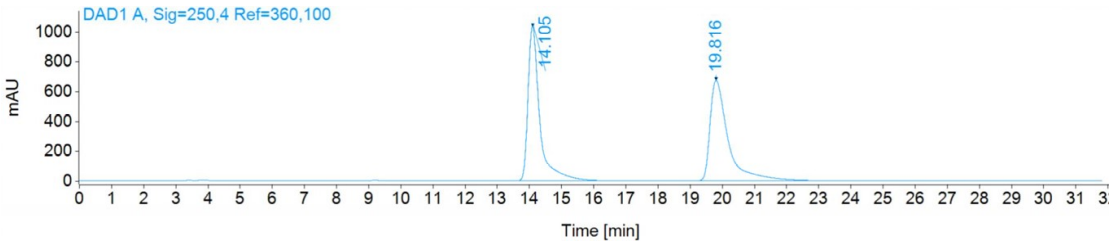
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.86 (d, *J* = 8.2 Hz, 1H), 7.74 (d, *J* = 7.9 Hz, 1H), 7.59 (dd, *J* = 12.0, 8.1 Hz, 2H), 7.56 – 7.31 (m, 8H), 7.27 – 7.09 (m, 5H), 6.19 – 6.13 (m, 1H), 4.41 (q, *J* = 11.9 Hz, 2H), 3.86 – 3.68 (m, 2H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.1, 137.6, 133.6 (d, *J* = 3.4 Hz), 133.5, 133.0, 132.9, 132.0 (d, *J* = 3.5 Hz), 131.9 (d, *J* = 3.4 Hz), 130.9, 130.1, 129.5, 129.4, 129.2, 128.7, 128.4, 128.0 (d, *J* = 3.8 Hz), 127.8 (d, *J* = 7.7 Hz), 127.7, 124.8, 73.3 (d, *J* = 5.4 Hz), 72.9, 72.4 (d, *J* = 5.4 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 30.95.

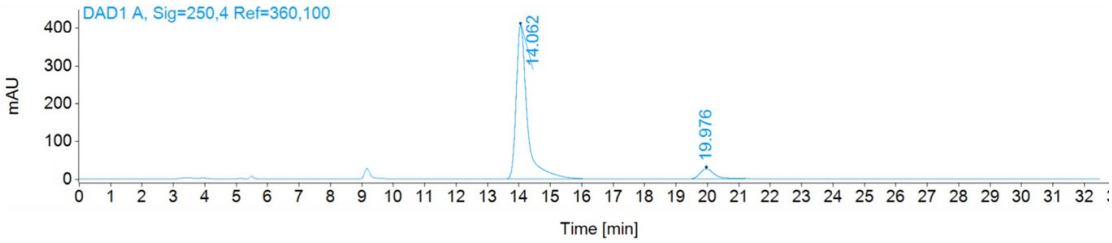
HRMS calculated for $C_{27}H_{22}Br_2NO_5P$ $[M+H]^+$: 629.9675; found: 629.9672.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 60:40, 1.0 mL/min, 250 nm, t (major) = 14.062min, t (minor) = 19.976 min.



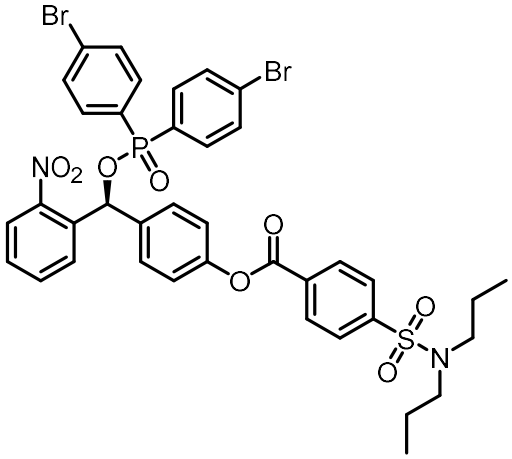
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
14.105	1036.85754	0.54	0.3370	26307.51367	50.05
19.816	674.19293	0.48	0.5256	26253.23633	49.95



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
14.062	407.68576	0.59	0.3247	9990.44238	92.13
19.976	26.80913	0.75	0.4733	853.39221	7.87



6ag, (36 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **6ag** as yellow oil (70% yield, 91:9 e.r.).

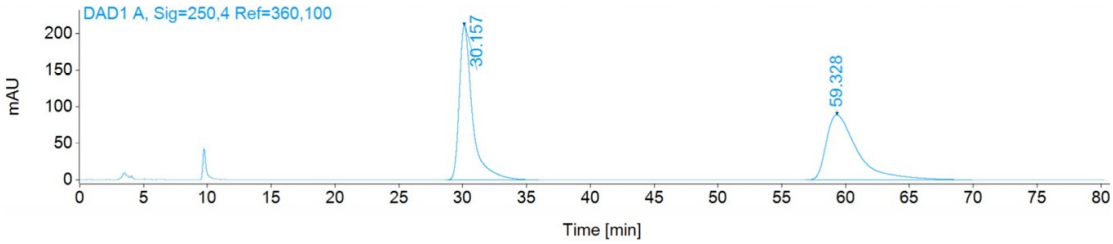
^{1}H NMR (600 MHz, Chloroform-*d*) δ 8.30 (d, *J* = 8.1 Hz, 2H), δ 7.98 (d, *J* = 8.1 Hz, 2H), 7.94 (d, *J* = 8.1 Hz, 2H), 7.71 (t, *J* = 7.7 Hz, 1H), 7.62 – 7.47 (m, 9H), 7.33 (d, *J* = 8.2 Hz, 2H), 7.26 (d, *J* = 9.6 Hz, 1H), 7.12 (d, *J* = 8.2 Hz, 2H), 3.13 (t, *J* = 7.7 Hz, 4H), 1.60 – 1.53 (m, 4H), 0.88 (t, *J* = 7.4 Hz, 6H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 163.7, 150.8, 147.2, 145.2, 136.5 (d, *J* = 4.4 Hz), 135.6 (d, *J* = 3.9 Hz), 133.9, 133.4 (d, *J* = 11.1 Hz), 133.0 (d, *J* = 11.1 Hz), 132.7, 132.2 (dd, *J* = 13.9, 4.1 Hz), 131.0, 130.2, 129.9, 129.4, 129.3, 129.0, 128.9, 128.1 (dd, *J* = 8.7, 3.7 Hz), 127.3, 125.2, 121.8, 73.8 (d, *J* = 4.4 Hz), 50.1, 22.1, 11.3.

^{31}P NMR (243 MHz, Chloroform-*d*) δ 31.34.

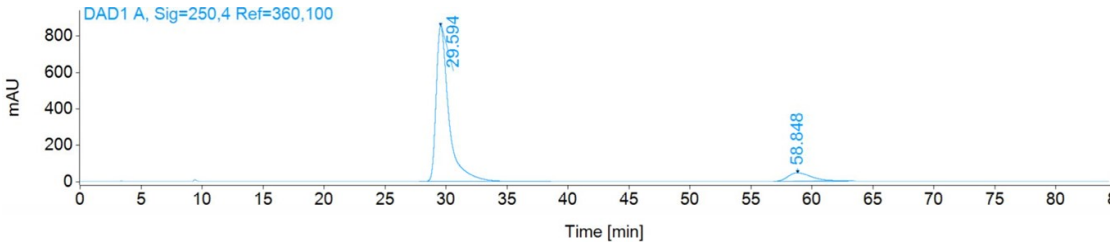
HRMS calculated for $C_{38}H_{35}Br_2N_2O_8PS$ $[M+Na]^+$: 891.0111; found: 891.0104.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 29.594 min, t (minor) = 58.848 min.



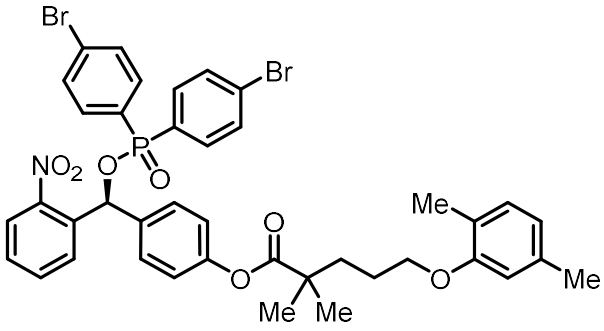
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
30.157	210.79700	0.56	0.9665	15067.46191	50.06
59.328	88.79691	0.46	2.3774	15030.54199	49.94



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
29.594	855.77350	0.54	0.9777	61368.61328	90.61
58.848	46.53423	0.63	2.0733	6358.86035	9.39



6bg, (48 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **6bg** as yellow oil (83% yield, 96:4 e.r.).

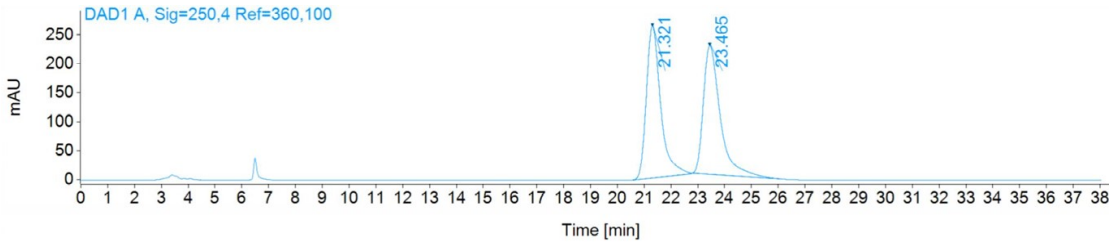
^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.97 (t, *J* = 7.5 Hz, 2H), 7.69 (t, *J* = 7.6 Hz, 1H), 7.59 – 7.45 (m, 9H), 7.24 (d, *J* = 8.6 Hz, 3H), 7.00 (d, *J* = 7.4 Hz, 1H), 6.93 (d, *J* = 8.4 Hz, 2H), 6.66 (d, *J* = 7.5 Hz, 1H), 6.63 (s, 1H), 3.98 (t, *J* = 5.3 Hz, 2H), 2.30 (s, 3H), 2.17 (s, 3H), 1.90 – 1.82 (m, 4H), 1.36 (s, 6H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 176.1, 156.9, 151.2, 147.2, 136.6, 135.8 (d, *J* = 4.4 Hz), 135.7 (d, *J* = 3.8 Hz), 133.8, 133.4 (d, *J* = 11.3 Hz), 132.9 (d, *J* = 11.1 Hz), 132.1 (dd, *J* = 13.9, 3.5 Hz), 130.5, 130.4, 129.9, 129.5, 129.2, 129.0, 128.8, 128.0 (dd, *J* = 10.7, 3.6 Hz), 125.2, 123.7, 121.7, 120.9, 112.0, 73.8 (d, *J* = 4.6 Hz), 67.8, 42.6, 37.2, 25.4, 25.2 (d, *J* = 2.4 Hz), 21.5, 15.9.

^{31}P NMR (243 MHz, Chloroform-*d*) δ 31.10.

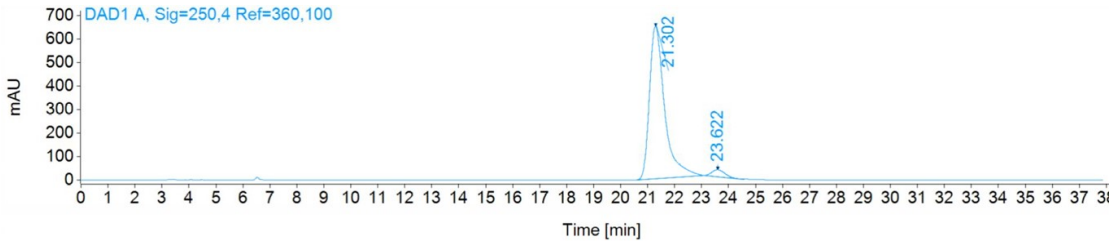
HRMS calculated for $C_{40}H_{38}Br_2NO_7P$ $[M+Na]^+$: 856.0645; found: 856.0647.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 70:30, 1.0 mL/min, 250 nm, t (major) = 21.302 min, t (minor) = 23.622 min.



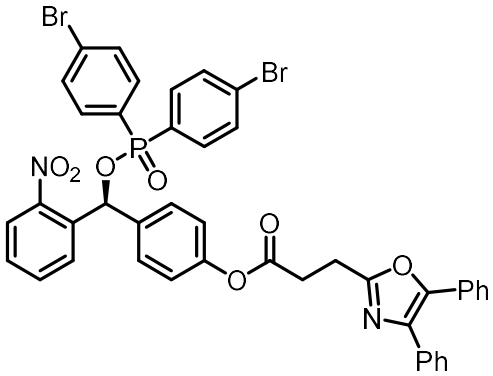
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
21.321	262.72467	0.71	0.5436	9742.36328	50.10
23.465	222.57057	0.60	0.6267	9703.20996	49.90



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
21.302	649.69427	0.63	0.5604	25319.54492	96.19
23.622	30.01838	0.75	0.5333	1002.88483	3.81



6cg, (48 h)

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **6cg** as yellow oil (92% yield, 95:5 e.r.).

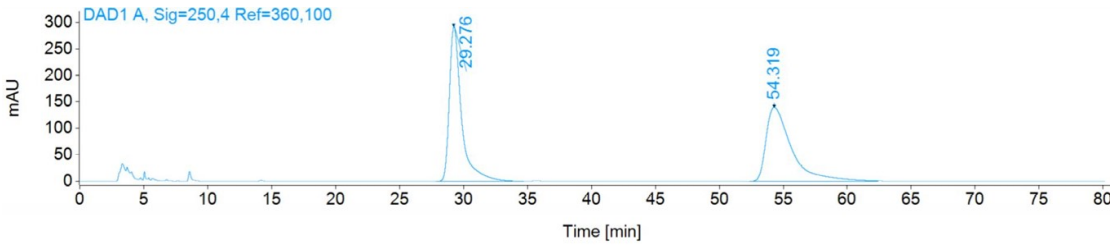
^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.95 (dd, *J* = 8.1, 5.1 Hz, 2H), 7.70 – 7.61 (m, 3H), 7.61 – 7.43 (m, 11H), 7.39 – 7.29 (m, 6H), 7.27 – 7.18 (m, 3H), 7.00 (d, *J* = 8.2 Hz, 2H), 3.28 (t, *J* = 7.3 Hz, 2H), 3.15 (t, *J* = 7.3 Hz, 2H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 170.5, 161.5, 150.8, 147.2, 145.7, 136.1 (d, *J* = 4.4 Hz), 135.7 (d, *J* = 3.8 Hz), 135.3, 133.8, 133.4 (d, *J* = 11.3 Hz), 132.9 (d, *J* = 11.2 Hz), 132.5, 132.1 (dd, *J* = 13.8, 5.4 Hz), 130.3, 129.8, 129.4, 129.2 (d, *J* = 3.8 Hz), 129.0, 128.9 (d, *J* = 8.1 Hz), 128.8, 128.7 (d, *J* = 3.7 Hz), 128.2, 128.1 (d, *J* = 3.8 Hz), 128.0, 126.6, 125.2, 121.8, 73.7 (d, *J* = 4.5 Hz), 31.3, 23.6.

^{31}P NMR (243 MHz, Chloroform-*d*) δ 31.22.

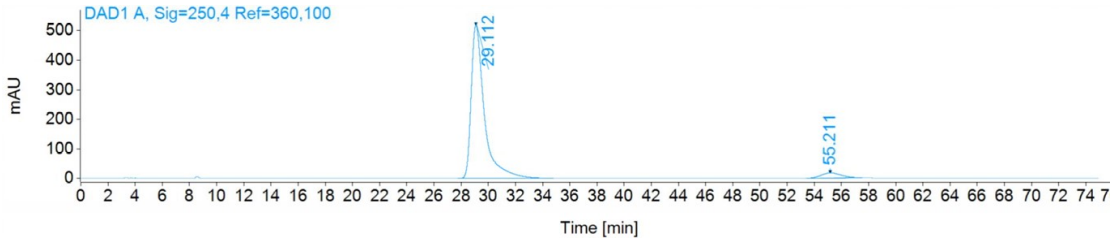
HRMS calculated for $C_{43}H_{31}Br_2N_2O_7P$ $[M+Na]^+$: 899.0128; found: 899.0129.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 50:50, 1.0 mL/min, 250 nm, t (major) = 29.112 min, t (minor) = 55.211 min.



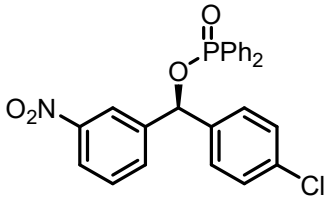
Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
29.276	291.84921	0.54	0.8941	19283.88477	49.99
54.319	139.44131	0.46	1.9335	19288.97266	50.01



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
29.112	517.93665	0.51	0.9106	34721.77734	94.97
55.211	17.48868	0.82	1.6600	1840.06982	5.03



16

Prepared according to **general procedure A**. Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 2:1) afforded **16** as white solid (24% yield, 74:26 e.r.).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.14 (t, *J* = 2.0 Hz, 1H), 8.08 (ddd, *J* = 8.2, 2.3, 1.0 Hz, 1H), 7.79 – 7.65 (m, 5H), 7.53 – 7.42 (m, 3H), 7.42 – 7.33 (m, 4H), 7.28 – 7.21 (m, 4H), 6.56 (d, *J* = 9.8 Hz, 1H).

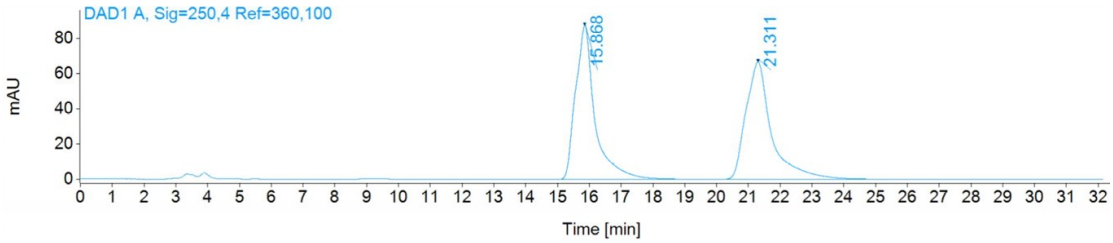
^{13}C NMR (101 MHz, Chloroform-*d*) δ 148.2, 142.5 (d, *J* = 4.0 Hz), 138.0 (d, *J* = 4.3 Hz), 134.5, 133.1, 132.5 (dd, *J* = 2.8, 1.4 Hz), 131.7, 131.6 (d, *J* = 6.9 Hz), 131.5,

131.4, 130.3, 130.1, 129.6, 129.0, 128.6 (d, J = 1.8 Hz), 128.5, 128.5 (d, J = 1.8 Hz), 123.1, 121.9, 76.5 (d, J = 5.3 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 33.64.

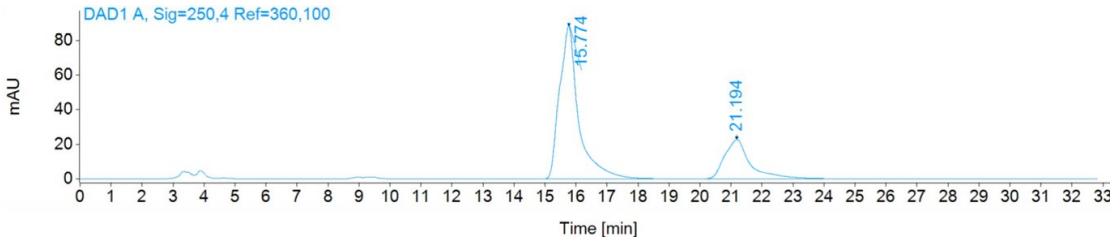
HRMS calculated for $C_{25}H_{19}ClNO_4P$ $[M+Na]^+$: 486.0632; found: 486.0632.

Chiral HPLC: CHIRALPANK IA-3, Hexane/^{i}PrOH = 70:30, 1.0 mL/min, 250 nm, t (major) = 15.774 min, t (minor) = 21.194 min.



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
15.868	87.23787	0.85	0.5870	3692.80396	49.83
21.311	66.38634	0.79	0.7719	3717.94043	50.17

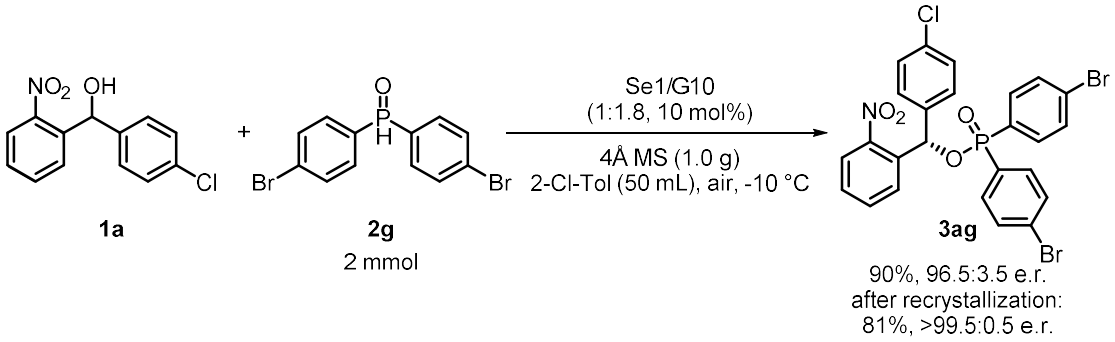


Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
15.774	88.56779	0.82	0.5972	3775.81348	74.21
21.194	22.80388	0.79	0.7867	1311.88489	25.79

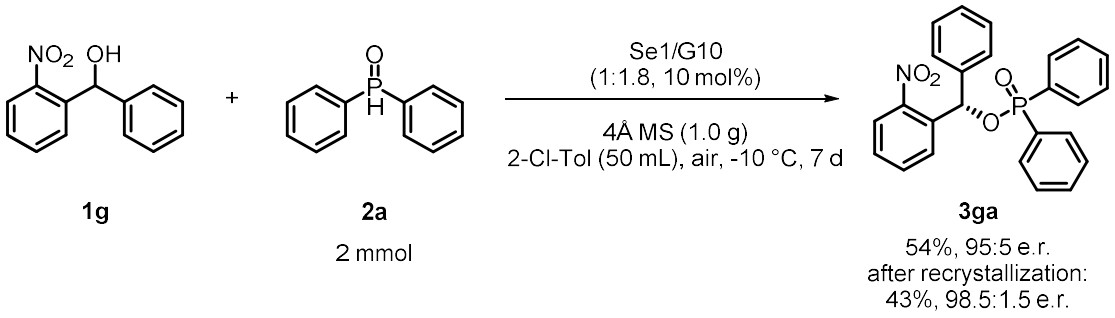
7. Synthetic Transformations and Applications

Scale-up reaction of 3ag



In a 100 ml Schlenk tube containing a magnetic stir bar, phosphine oxide substrate **2g** (2 mmol), 2-nitrobenzhydrols substrate **1a** (5 mmol), electrophilic diaryldiselenide catalysts **Se1** (10 mol %), chiral guanidine organocatalyst **G10**(18 mol %), 4Å MS (1.0 g) and 50 mL 2-Cl-Tol were added sequentially under ambient air. The reaction tube was sealed in air and the mixture was stirred at – 10 ℃ for 3d. The reaction mixture was purified by flash chromatography on silica gel (Petroleum ether to Petroleum ether/ Ethyl acetate, 2:1) to afford the product **3ag** (90%, 96.5:3.5 e.r.). The enantiomeric ratio (> 99.5:0.5 e.r.) was further improved by recrystallization (Completely dissolved in hot ethyl acetate, then cooled at room temperature and let stand for 48 hours).

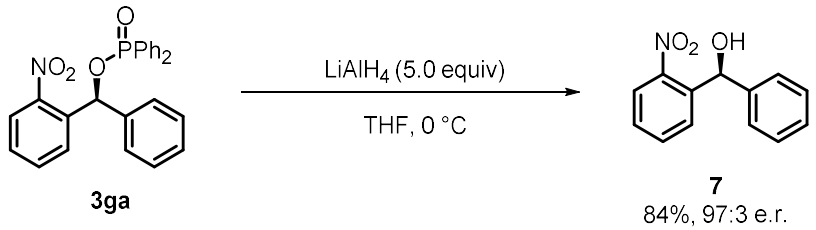
Scale-up reaction of 3ga



In a 100 ml Schlenk tube containing a magnetic stir bar, phosphine oxide substrate **2a** (2 mmol), 2-nitrobenzhydrols substrate **1g** (5 mmol), electrophilic diaryldiselenide catalysts **Se1** (10 mol %), chiral guanidine organocatalyst **G10** (18 mol %), 4Å MS (1.0 g) and 50 mL 2-Cl-Tol were added sequentially under ambient air. The reaction tube was sealed in air and the mixture was stirred at – 10 ℃ for 7d. The reaction mixture was purified by flash chromatography on silica gel (Petroleum ether to Petroleum ether/ Ethyl acetate, 2:1) to afford the product **3ag** (54%, 95:5 e.r.). The enantiomeric ratio (98.5:1.5 e.r.) was further improved by recrystallization

(Completely dissolved in hot ethyl acetate, then cooled at room temperature and let stand for 48 hours).

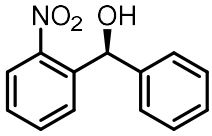
Preparation of 7[9].



3ga

7
84%, 97:3 e.r.

At 0 °C, to a solution of (S)-**3ga** (0.429g, 1 mmol, 97.5:1.5 e.r.) in dry THF (10.0 mL) was added $LiAlH_4$ (0.189g, 5 mmol), and the resulting reaction mixture was stirred at 0 °C for 12 h and then quenched by slow addition of H_2O. The reaction mixture was diluted with EtOAc (20 mL), washed with brine (3 x 10 mL). The organic layer was dried over Na_2SO_4, and concentrated in vacuo by rotary evaporation. The residue was purified by flash chromatography on silica gel (eluting with petroleum ether/EtOAc (v/v): 10:1→5:1) to afford the product **7**.



7

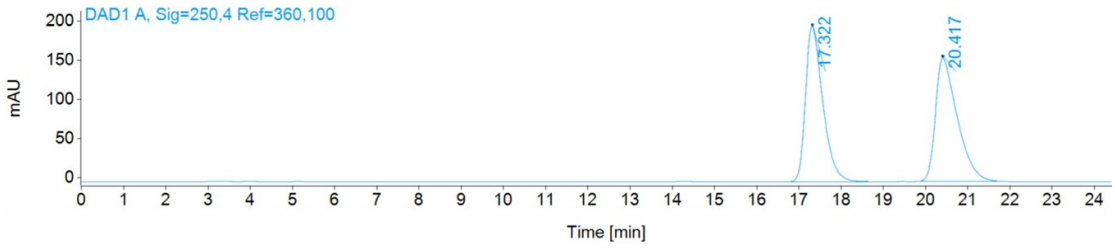
Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 10:1→5:1) afforded **7** as yellow oil (84% yield, 97:3 e.r.).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.89 (d, *J* = 8.1 Hz, 1H), 7.72 (d, *J* = 7.9 Hz, 1H), 7.60 (t, *J* = 7.6 Hz, 1H), 7.41 (t, *J* = 7.8 Hz, 1H), 7.35 – 7.22 (m, 5H), 6.38 (s, 1H), 3.03 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 148.4, 141.6, 138.5, 133.5, 129.5, 128.7, 128.6, 128.1, 127.0, 124.8, 71.5.

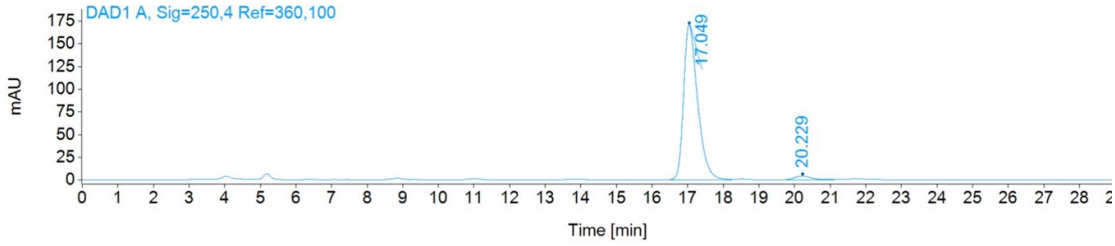
HRMS calculated for $C_{13}H_{11}NO_3$ $[M+Na]^+$: 252.0631; found: 252.0634.

Chiral HPLC: CHIRALCEL OJ-H, Hexane/^{i}PrOH = 80:20, 1.0 mL/min, 250 nm, t (major) = 17.049 min, t (minor) = 20.229 min.



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

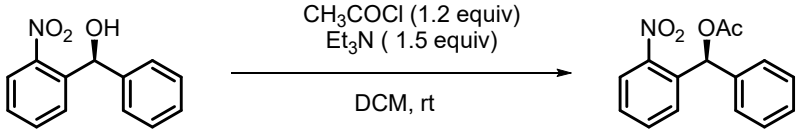
RT [min]	Height	Symm.	Width (50%)	Area	Area%
17.322	198.56145	0.59	0.4267	5652.06396	49.87
20.417	157.95447	0.49	0.5333	5681.00293	50.13



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

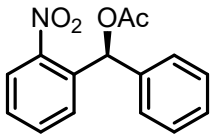
RT [min]	Height	Symm.	Width (50%)	Area	Area%
17.049	171.06801	0.62	0.4108	4686.48926	97.05
20.229	4.20459	0.73	0.4900	142.65118	2.95

Preparation of 8[10].



7 **8**
87%, 97:3 e.r.

(2-nitrophenyl)(phenyl)methanol **7** (23 mg, 0.1 mmol) and acetyl chloride (9 uL, 0.12 mmol) were dissolved in dry dichloromethane (1 mL) and Et_3N (21 uL, 0.15 mmol) was added by syringe under argon. The resulting reaction mixture was stirred at room temperature for 8 h and subsequently ethyl acetate (10 mL) was added, washed with brine (3 x 5 mL). The organic layer was dried over Na_2SO_4, and concentrated in vacuo by rotary evaporation. The residue was purified by flash chromatography on silica gel (eluting with petroleum ether/EtOAc (v/v), 5:1) to afford the product **8**.



8

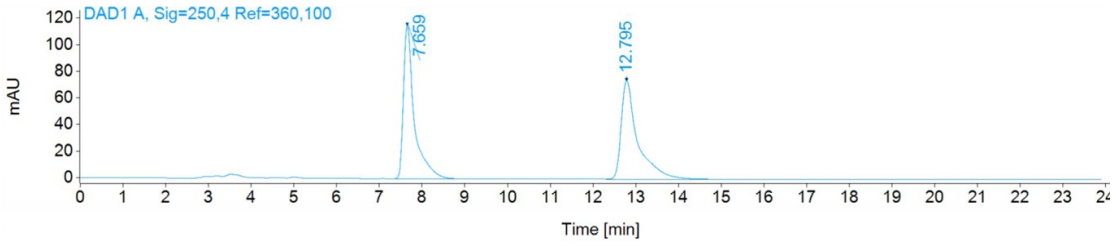
Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 5:1) afforded **8** as yellow oil (87% yield, 97:3 e.r.).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.97 (d, *J* = 8.3 Hz, 1H), 7.69 – 7.61 (m, 2H), 7.51 (s, 1H), 7.47 (ddd, *J* = 8.6, 6.5, 2.4 Hz, 1H), 7.41 – 7.28 (m, 5H), 2.14 (s, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 169.7, 148.4, 138.3, 135.5, 133.5, 128.9, 128.8, 128.7, 128.6, 127.9, 125.0, 72.5, 21.2.

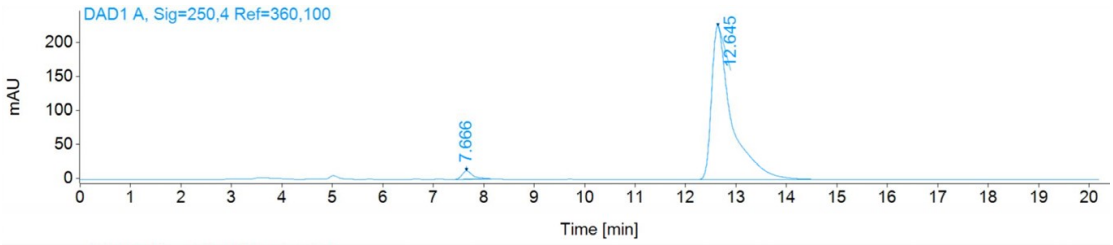
HRMS calculated for $C_{15}H_{13}NO_4$ $[M+Na]^+$: 294.0737; found: 294.0733.

Chiral HPLC: CHIRALCEL OD-H, Hexane/^{i}PrOH = 90:10, 1.0 mL/min, 250 nm, t (major) = 12.645 min, t (minor) = 7.666 min.



Signal: DAD1 A, Sig=250,4 Ref=360,100

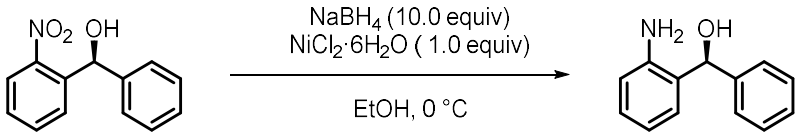
RT [min]	Height	Symm.	Width (50%)	Area	Area%
7.659	115.42640	0.49	0.2185	2003.85156	50.10
12.795	74.22081	0.44	0.3207	1995.73975	49.90



Signal: DAD1 A, Sig=250,4 Ref=360,100

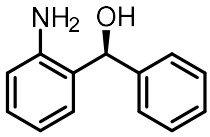
RT [min]	Height	Symm.	Width (50%)	Area	Area%
7.666	12.40543	0.64	0.2067	184.42120	2.87
12.645	226.30304	0.39	0.3322	6243.64160	97.13

Preparation of 9[11].



7 9
95%, 97:3 e.r.

To a stirred solution of (2-nitrophenyl)(phenyl)methanol **7** (23 mg, 0.1 mmol) and $NiCl_2 \cdot 6H_2O$ (23.8 mg, 0.1 mmol) in EtOH was added $NaBH_4$ (38 mg, 1 mmol) at 0 °C. The reaction was stirred at 0 °C for 2 h and then quenched by slow addition of H_2O. The solution was extracted with EtOAc twice, dried with Na_2SO_4 and concentrated in vacuo by rotary evaporation. The residue was purified by flash chromatography on silica gel (eluting with petroleum ether/EtOAc (v/v), 3:1) to afford the product **9**.



9

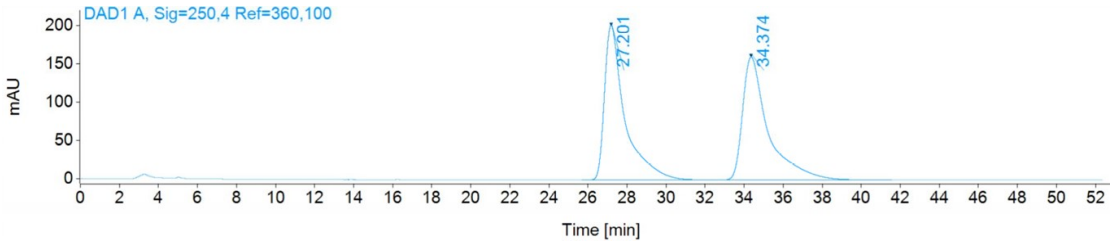
Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 3:1) afforded **9** as yellow oil (95% yield, 97:3 e.r.).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.43 – 7.28 (m, 5H), 7.14 (td, *J* = 7.6, 1.6 Hz, 1H), 7.02 (d, *J* = 7.6 Hz, 1H), 6.80 – 6.71 (m, 1H), 6.66 (d, *J* = 8.0 Hz, 1H), 5.82 (s, 1H), 3.58 (s, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 144.9, 142.0, 129.1, 128.8, 128.6, 127.7, 126.7, 118.5, 117.1, 75.0.

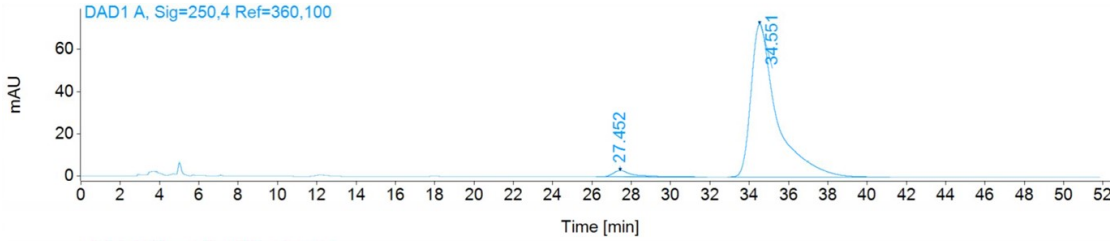
HRMS calculated for $C_{13}H_{13}NO$ $[M+Na]^+$: 222.0889; found: 222.0882.

Chiral HPLC: CHIRALCEL OD-H, Hexane/^{i}PrOH = 90:10, 1.0 mL/min, 250 nm, t (major) = 34.551 min, t (minor) = 27.452 min.



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

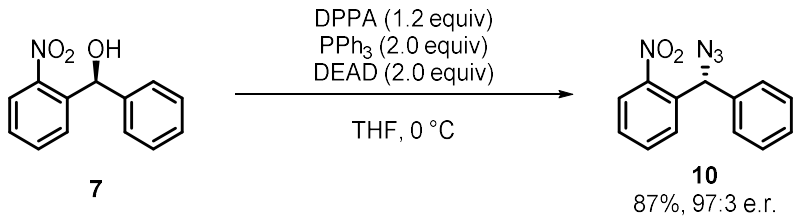
RT [min]	Height	Symm.	Width (50%)	Area	Area%
27.201	202.10347	0.43	0.9200	14621.28711	50.01
34.374	160.83974	0.45	1.1533	14616.89648	49.99



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
27.452	2.93700	0.51	0.8867	210.91586	3.11
34.551	72.40003	0.46	1.1467	6565.17920	96.89

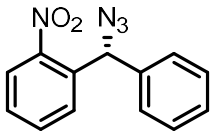
Preparation of 10[12].



7 **10**
87%, 97:3 e.r.

In a reaction tube containing a magnetic stir bar was charged with (2-nitrophenyl)(phenyl)methanol **7** (23 mg, 0.1 mmol) and PPh_3 (53 mg, 0.2 mmol). The reaction tube was evacuated and backfilled with argon and this process repeated three times. Anhydrous THF (1 mL) was added and the mixture was cooled to 0°C

whereupon diethyl azodicarboxylate (31 uL, 0.2 mmol)was added dropwise. Then diphenyl phosphoryl azide (26 uL, 0.12 mmol) was added by a similar way. The reaction tube was slowly warmed to room temperature and stirred overnight. The reaction mixture was concentrated in vacuo, the residue was purified by flash chromatography on silica gel (eluting with petroleum ether/EtOAc (v/v), 10:1) to afford the product **10**.



10

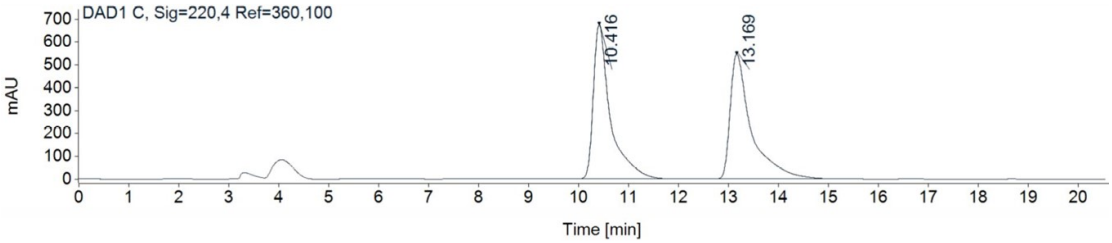
Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) afforded **10** as yellow oil (87% yield, 97:3 e.r.).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.95 (d, *J* = 8.1 Hz, 1H), 7.77 (d, *J* = 7.9 Hz, 1H), 7.66 (t, *J* = 7.6 Hz, 1H), 7.49 – 7.44 (m, 1H), 7.38 – 7.29 (m, 3H), 7.28 – 7.22 (m, 2H), 6.53 (s, 1H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 148.2, 137.8, 134.6, 133.6, 129.6, 129.1, 129.0, 128.7, 127.9, 125.2, 63.6.

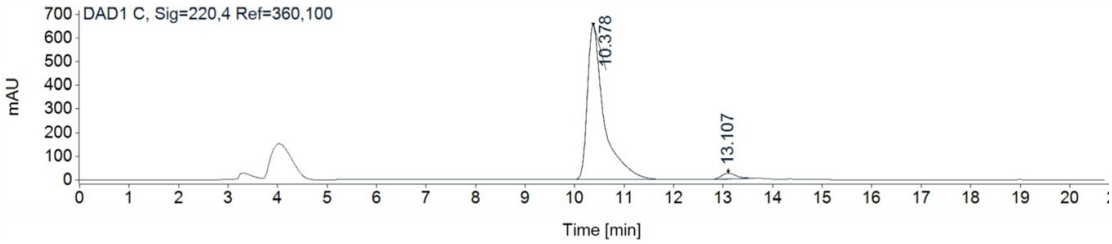
HRMS calculated for $C_{13}H_{10}N_4O_2$ $[M+Na]^+$: 277.0696; found: 277.0698.

Chiral HPLC: CHIRALCEL OD-H, Hexane/^{i}PrOH = 99:1, 1.0 mL/min, 220 nm, t (major) = 10.378 min, t (minor) = 13.107 min.



Signal: DAD1 C, Sig=220,4 Ref=360,100

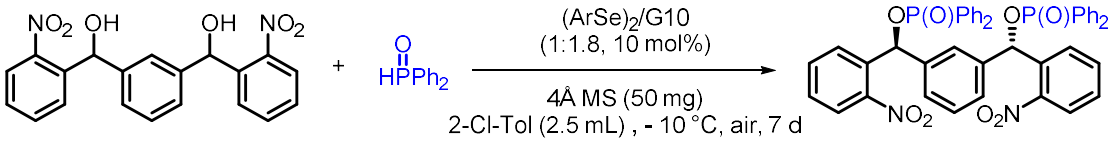
RT [min]	Height	Symm.	Width (50%)	Area	Area%
10.416	674.89050	0.46	0.3023	15935.03125	50.07
13.169	545.26691	0.44	0.3681	15890.66016	49.93



Signal: DAD1 C, Sig=220, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
10.378	650.98059	0.46	0.2988	15235.21094	96.67
13.107	24.86446	0.84	0.3267	524.22656	3.33

Preparation of 12.

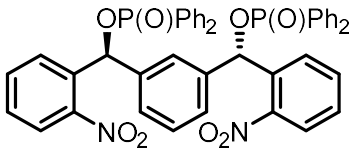


11, 1.0 eq
dl + *meso*
(mixture of three isomers)
92:8

2a, 2.2 eq

12
36%, >99.5:0.5 e.r.

In a reaction tube containing a magnetic stir bar, phosphine oxide substrates (0.22 mmol), 2-nitrobenzhydrols substrates **11** (0.1 mmol), electrophilic diaryldiselenide catalysts (10 mol %), chiral guanidine organocatalyst (18 mol %), 4Å MS (50 mg) and 2.5 mL 2-Cl-Tol were added. The tube was sealed and the mixture was stirred at –10 °C for 7d. The crude mixture was concentrated under reduced pressure and the residue was purified by flash chromatography on silica gel (Petroleum ether to Petroleum ether/ Ethyl acetate, 1:1) to afford the product **12**.



12

Purification via silica gel column chromatography (petroleum ether/ethyl acetate = 1:1) afforded **12** as yellow oil (36% yield, >99.5:0.5 e.r.).

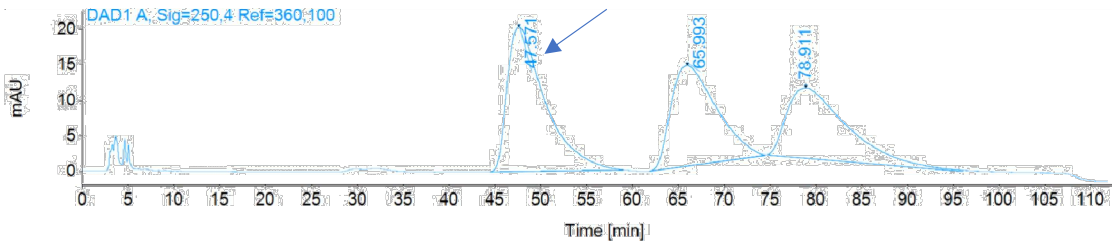
^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.93 (d, *J* = 7.9 Hz, 1H), 7.90 – 7.88 (m, 1H), 7.85 (d, *J* = 8.2 Hz, 1H), 7.71 – 7.63 (m, 7H), 7.62 – 7.53 (m, 3H), 7.50 – 7.27 (m, 14H), 7.25 – 7.20 (m, 2H), 7.18 – 7.05 (m, 5H).

^{13}C NMR (151 MHz, Chloroform-*d*) δ 147.1 (d, *J* = 4.2 Hz), 139.4 (d, *J* = 5.1 Hz), 139.3 (d, *J* = 4.6 Hz), 136.2 (d, *J* = 3.4 Hz), 136.1 (d, *J* = 3.1 Hz), 133.8, 133.7, 132.6 (d, *J* = 2.7 Hz), 132.4 (dd, *J* = 6.6, 2.7 Hz), 131.9 (d, *J* = 10.4 Hz), 131.8 (d, *J* = 10.5 Hz), 131.7, 131.6 (d, *J* = 6.5 Hz), 131.5 (d, *J* = 6.6 Hz), 131.1 (d, *J* = 6.1 Hz), 130.7 (d, *J* = 11.9 Hz), 130.2 (d, *J* = 6.6 Hz), 129.3 (d, *J* = 3.8 Hz), 128.9, 128.7 (d, *J* = 3.5 Hz), 128.6, 128.5 (d, *J* = 3.5 Hz), 128.4, 128.0, 127.9, 127.0, 126.7, 124.8 (d, *J* = 9.3 Hz), 73.3 (d, *J* = 4.7 Hz), . meso-12

^{31}P NMR (162 MHz, Chloroform-*d*) δ 32.79.

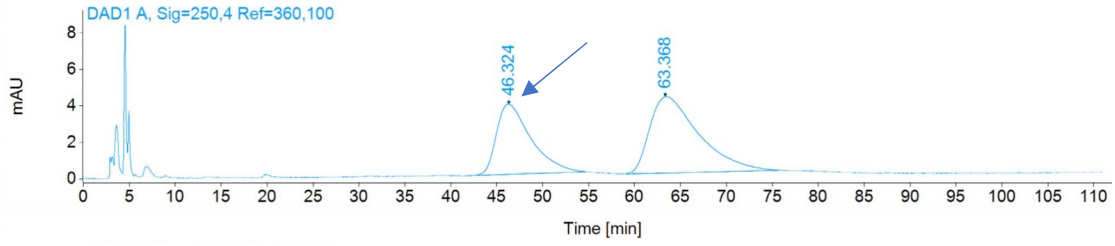
HRMS calculated for $C_{44}H_{34}N_2O_8P_2$ $[M+Na]^+$: 803.1683; found: 803.1676.

Chiral HPLC: CHIRALCEL OD-H, Hexane/^{i}PrOH = 90:10, 1.0 mL/min, 250 nm, t (major) = 63.368 min, t (minor) = 78.911 min.



Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
47.571	20.41672	0.42	4.2067	5863.62012	38.35
65.993	14.19374	0.56	5.7067	4855.75195	31.75
78.911	9.92288	0.44	6.6200	4572.24365	29.90

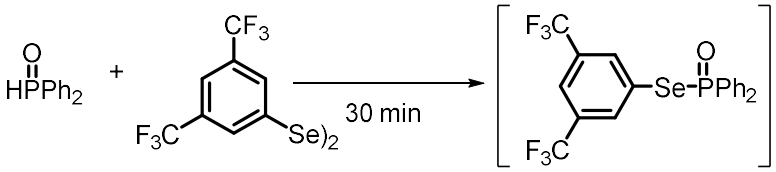


Signal: DAD1 A, Sig=250, 4 Ref=360, 100

RT [min]	Height	Symm.	Width (50%)	Area	Area%
46.324	3.86900	0.53	3.9467	1012.93335	39.41
63.368	4.20033	0.45	5.6267	1557.20813	60.59

8. Mechanistic studies.

8.1. ^{1}P NMR, ^{77}Se NMR and HRMS studies of Int-A



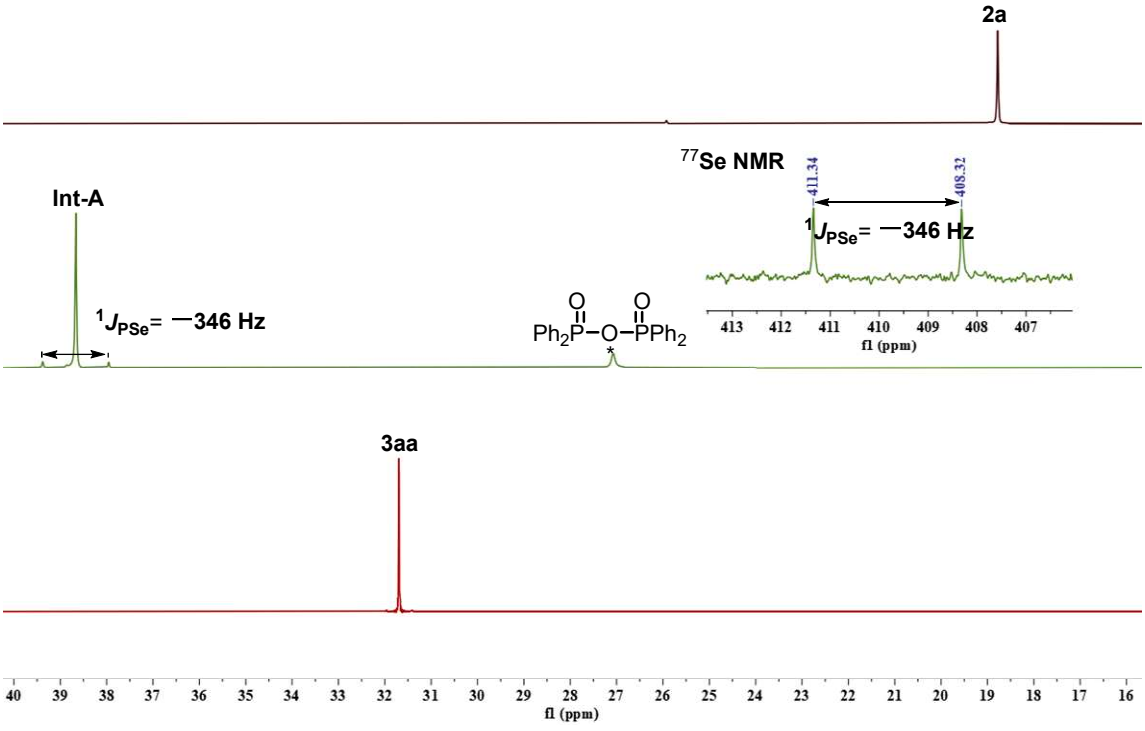
2a **Se1** **Int-A**

Exact Mass ([M+H]$^{+}$): 494.9846

Found: 494.9838

Procedure: In a dry test tube, **2a** (10.1 mg, 0.050 mmol) and **Se1** (29.3 mg, 0.050 mmol) were added. Then, C_6D_5Cl (500 µL) was added and the reaction was stirred for 30 min at 25 °C. The solution was then monitored by ^{31}P NMR, ^{77}Se NMR and HRMS.

^{31}P NMR



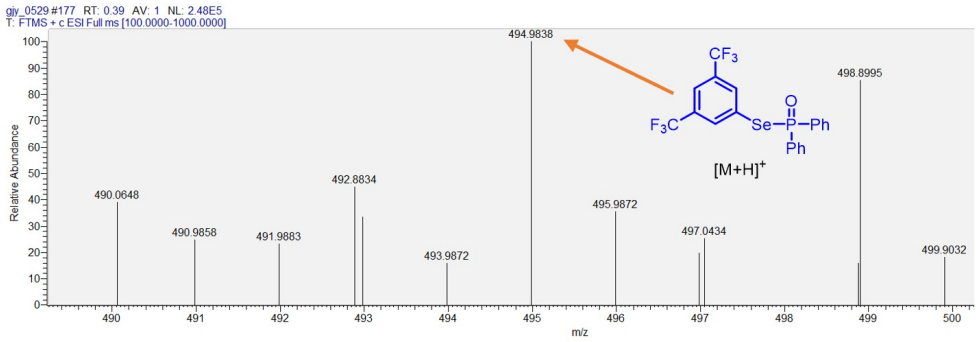
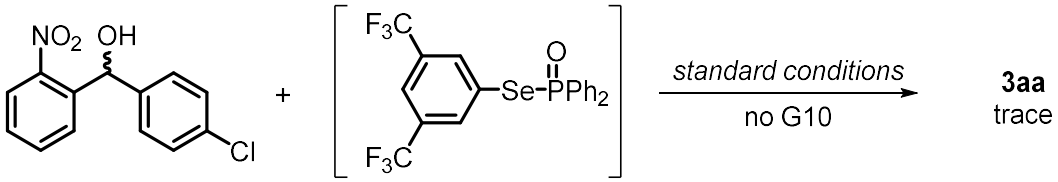


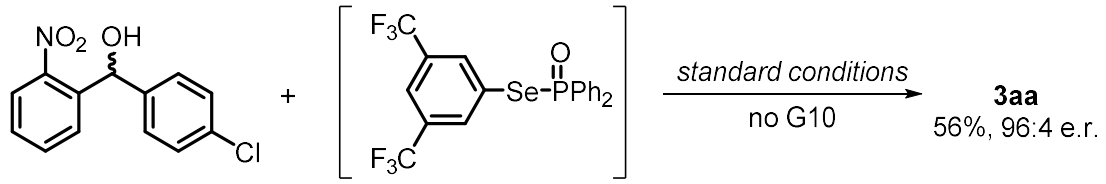
Figure S4. The ^{31}P NMR, ^{77}Se NMR and HRMS of Int-A

8.2. Control experiment



1a **Int-A**

In a reaction tube containing a magnetic stir bar, **2a** (20.2 mg, 0.1 mmol) and **Se1** (58.6 mg, 0.1 mmol) were added. Then, 2.5 mL of 2-Cl-Tol was added and the reaction was stirred for 30 min at –10 ℃. **1a** (65.8 mg, 0.25 mmol) and 4Å MS (50 mg) were then added. The tube was sealed and the mixture was stirred at –10 ℃ for 96 h.

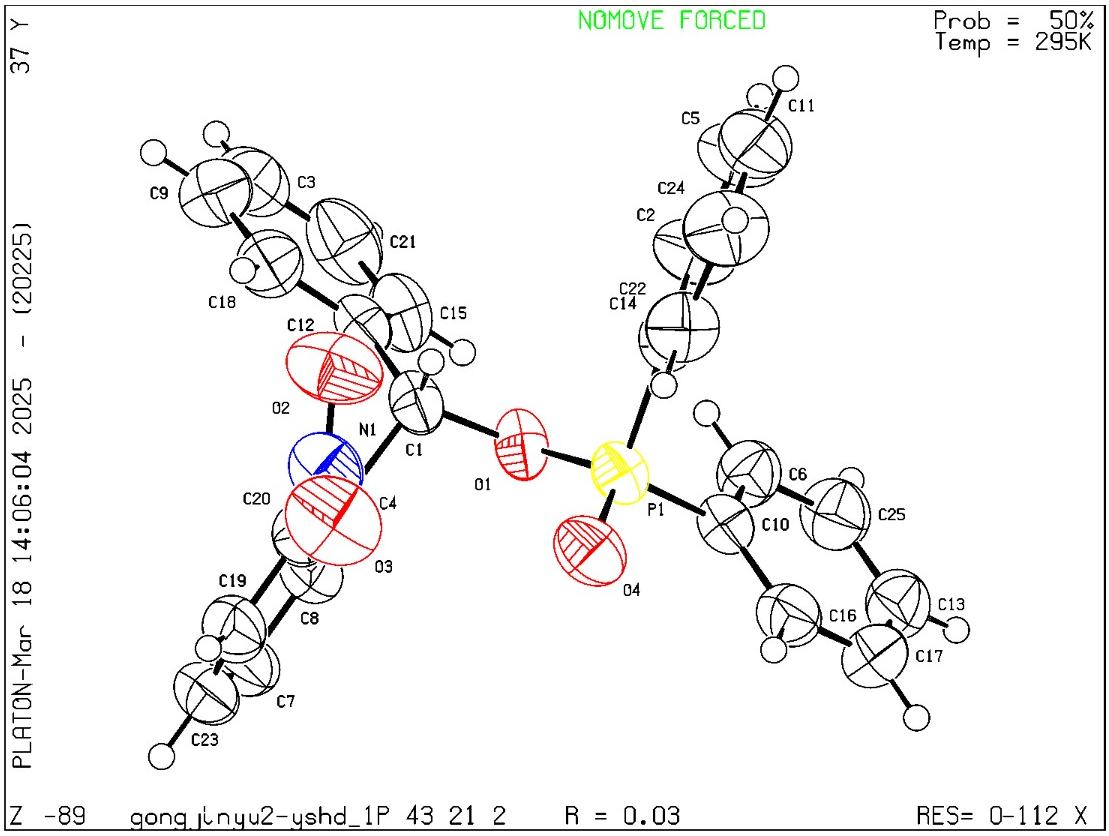


1a **Int-A**

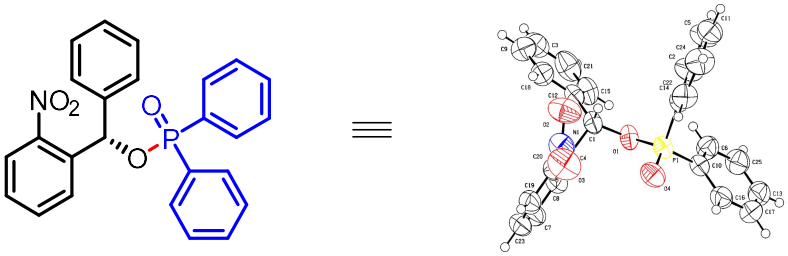
In a reaction tube containing a magnetic stir bar, **2a** (20.2 mg, 0.1 mmol) and **Se1** (58.6 mg, 0.1 mmol) were added. Then, 2.5 mL of 2-Cl-Tol was added and the reaction was stirred for 30 min at –10 ℃. **1a** (65.8 mg, 0.25 mmol), **G10** (7.0 mg, 18 mol%) and 4Å MS (50 mg) were then added. The tube was sealed and the mixture was stirred at –10 ℃ for 96 h. The reaction mixture was purified by flash chromatography on silica gel (Petroleum ether to Petroleum ether/Ethyl acetate, 2:1) to afford the desired product **3aa** in 96:4 e.r., 56% yield.

9. X-ray Crystallographic Data of compound 3ga

X-ray Crystallographic Data for **3ga**



(with 50% ellipsoid contour probability levels)



3ga **CCDC: 2426084**

Table S5. Crystal data and structure refinement for 3ga

Single crystals of $C_{25}H_{20}NO_4P$ (**3ga**) were collected. A suitable crystal was selected and collected on a SuperNova, Dual, Cu at zero, Eos diffractometer. The crystal was kept at 295.22 K during data collection. Using Olex2, the structure was solved with the ShelXS structure solution program using Direct Methods and refined with the ShelXL refinement package using Least Squares minimisation. Refined structure and crystallographic parameters are summarized in Table S5. CCDC 2426084 contains the supplementary crystallographic data for **3ga**. The crystallographic data of the

compound can be obtained free of charge from The Cambridge Crystallographic Data Centre via http://www.ccdc.cam.ac.uk/data_request/cif.

Compound	**3ga**
Empirical formula	$C_{25}H_{20}NO_4P$
Formula weight	429.39
Temperature/K	295.22(10)
Crystal system	tetragonal
Space group	$P4_32_12$
a/Å	10.33330(10)
b/Å	10.33330(10)
c/Å	39.8477(5)
α/°	90
β/°	90
γ/°	90
Volume/Å^3	4254.82(10)
Z	8
ρcalcg/cm^3	1.341
μ/mm^{-1}	1.416
F(000)	1792.0
Crystal size/mm^3	0.12 × 0.09 × 0.06
Radiation	Cu Kα (λ = 1.54184)
2Θ range for data collection/°	8.84 to 152.408
Index ranges	$-12 \leq h \leq 12$, $-11 \leq k \leq 12$, $-44 \leq l \leq 50$
Reflections collected	24608
Independent reflections	4340 [R_{int} = 0.0404, R_{sigma} = 0.0216]
Data/restraints/parameters	4340/0/280
Goodness-of-fit on F^2	1.047
Final R indexes [I>=2σ (I)]	R_1 = 0.0339, wR_2 = 0.0923
Final R indexes [all data]	R_1 = 0.0370, wR_2 = 0.0945
Largest diff. peak/hole / e Å^{-3}	0.15/-0.16
Flack parameter	0.013(9)

10. Computational studies

10.1. Computational Details

Geometry optimizations were performed using the M06-2X functional[13] in combination with the 6-31G(d,p) basis set,[14] as implemented in the Gaussian 16 software package.[15] Frequency calculations were carried out at the same level of theory to confirm the nature of each stationary point. The single-point energy calculations were conducted using the same functional but with the higher-precision Def2-TZVP basis set[16] to improve the accuracy of the computed energies. All calculations were performed at 263.15 K, with o-chlorotoluene as the solvent, consistent with the experimental conditions that yielded the highest product yield and enantioselectivity. Solvent effects were evaluated using the SMD implicit solvation model.[17, 18] Dispersion interactions within the system were accounted for using the DFT-D3 correction method developed by Grimme. [19] Optimized molecular structures were visualized using GaussView 6.0 [20] and CYLview 1.0b. [21] All optimized catalyst, reactants and complexes were confirmed as true minima with no imaginary frequencies and full convergence. Each transition state exhibited one and only one imaginary frequency, and its validity was further confirmed by intrinsic reaction coordinate (IRC) analysis,[22, 23] ensuring that it correctly connects the corresponding reactants and products.

10.2. Optimized geometries.

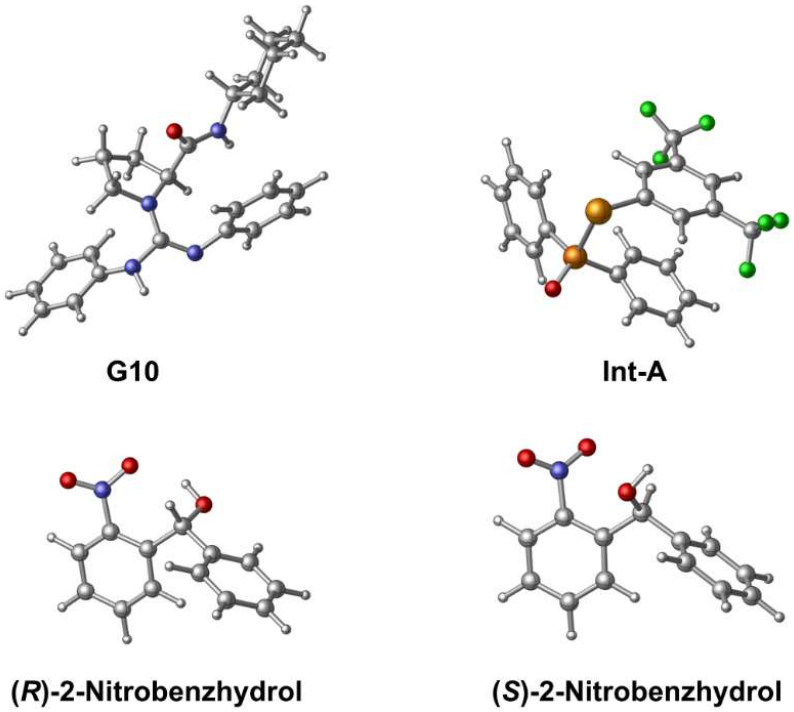


Fig. S1 Optimized geometries of catalyst and reactants

10.2.1 The exploration and elimination of the stepwise mechanism

If following the stepwise reaction mechanism, the alcohol hydroxyl group first undergoes hydroxyl proton transfer to form an alkoxide ion, and then the alkoxide ion undergoes a nucleophilic reaction. We successfully identified the hydrogen transfer transition state for the double hydrogen-bond mode (**TS-*R*-HPT** and **TS-*S*-HPT**). However, during the optimization of the product (**INT-*R*-HPT** and **INT-*S*-HPT**), we observed that the hydrogen proton returned to the alkoxide ion, as shown in **Fig. S2** of the Electronic Supplementary Information. Consequently, we ruled out the stepwise mechanism.

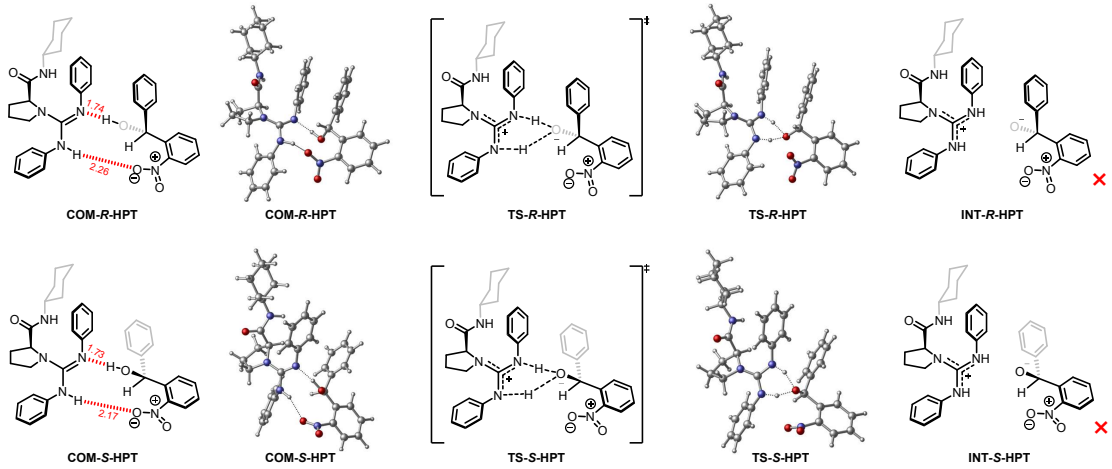


Fig. S2 Structural optimization diagrams of complexes and transition states under the mechanism of stepwise process

10.2.2 Exploration of the concerted mechanism

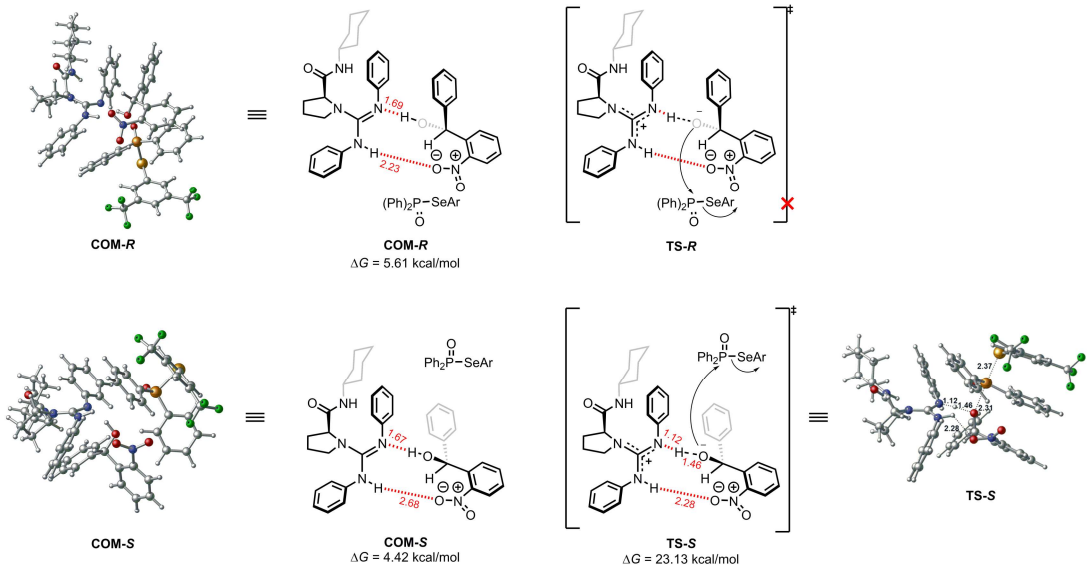


Fig. S3 Structural optimization diagrams of complexes and transition states under the concerted

mechanism process

(*S*)-2-Nitrobenzhydrol (**(*R*)-2-Nitrobenzhydrol)**), along with **G10** and **Int-A**, absorbs 4.42 (5.61) kcal·mol^{-1} energy to form **COM-*S*** (**COM-*R***). Among them, the length of the O-H···N hydrogen bond is 1.67 (1.69) Å, and the length of the N-H···O bond is 2.68(2.23) Å. Subsequently, **COM-*S*** absorbed 18.71 kcal·mol^{-1} energy to form **TS-*S***. The hydrogen bond length between N and H (O-H···N) has decreased from 1.67 Å to 1.12 Å, and the hydrogen bond length formed by the nitro group (N-H···O) has also decreased from 2.68 Å to 2.28 Å. The distance between the oxygen anion and the phosphorus atom is 2.31 Å, and the selenium anion departs when it is 2.37 Å away from the phosphorus atom. The independent gradient model based on Hirshfeld partition (IGMH) analysis[24] of **TS-*S*** was shown in **Fig. S4**.

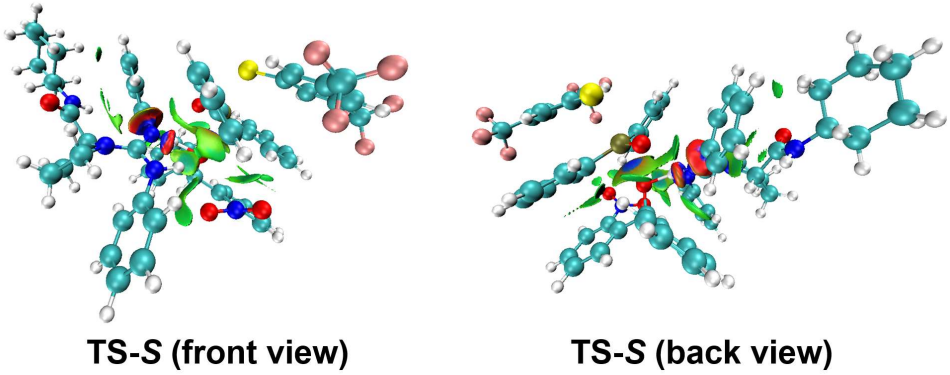


Fig. S4 IGMH plots for the front and back views for the transition state **TS-*S***. The blue, green and red surfaces represent the strong interaction, weak interaction and steric effect, respectively.

10.3. Calculated Gibbs free energy correction (GFEC), energy (*E*) and Gibbs free energy (*G*) of all optimized structures.

	GFEC/a.u	*E*/a.u.	*G*/a.u.	Δ*G*/(kcal•mol^{-1})	vis of TS (cm^{-1})
G10	0.463862	-1226.857878	-1226.394016		
(*R*)-2-Nitrobenzhydrol	0.185058	-782.332572	-782.147514		
(*S*)-2-Nitrobenzhydrol	0.18432	-782.330553	-782.146233		
COM-*R*-HPT	0.673701				
COM-*S*-HPT	0.672251				
TS-*R*-HPT	0.670198				-262.82
TS-*S*-HPT	0.666096				-377.95
COM-*R*	0.936978	-6196.54489	-6195.607912	5.61	
COM-*S*	0.938514	-6196.547033	-6195.608519	4.42	
TS-*S*	0.936814	-6196.515528	-6195.578714	23.13	-171.65

Since we excluded the stepwise reaction mechanism, we did not perform single-point energy calculations for the following structure: **COM-*R*-HPT**, **COM-*S*-HPT**, **TS-*R*-HPT**, **TS-*S*-HPT**.

10.4. Cartesian coordinates

G10

C	4.32528100	-1.26624300	1.33420800
C	3.43958200	-1.09962300	0.10018800
C	4.11085300	-0.18897900	-0.93056700
C	5.47751400	-0.74897600	-1.33054600
C	6.37697100	-0.91871300	-0.10390200
C	5.70623400	-1.80267800	0.95036700
H	3.45013000	-0.08512800	-1.79650700
H	3.28878700	-2.08171100	-0.36974200
H	4.43276500	-0.28429700	1.81849800
H	3.83685900	-1.93381600	2.05294200
H	5.34198200	-1.72396700	-1.81818100
H	5.95237400	-0.09095400	-2.06542500
H	7.34385800	-1.34400700	-0.39256600
H	6.57893400	0.06952100	0.33132400
H	5.59408800	-2.81870400	0.54920400
H	6.33579900	-1.88126000	1.84249600
H	4.23489800	0.80600500	-0.48565800
N	2.12134900	-0.63041900	0.51332700
H	2.01973500	-0.20231300	1.42414600
C	1.02568300	-0.81026700	-0.25675900
O	1.07686400	-1.21771600	-1.41223900
C	-0.31236000	-0.66927700	0.47599300
C	-0.77419700	-2.09557000	0.84350200
H	-0.22219200	-0.01752600	1.34713100
C	-1.88656200	-1.33250700	-1.20932100
C	-1.45417700	-2.60158400	-0.44082000
H	-1.48818200	-2.03193100	1.66914000
H	0.05755700	-2.72719100	1.16532100
H	-2.96557700	-1.27585900	-1.33992600
H	-1.40729200	-1.29312800	-2.19003100
H	-2.31071300	-3.23948900	-0.21175900
H	-0.74907300	-3.17516900	-1.04350500
N	-1.39585300	-0.21731100	-0.38535600
C	-1.97326800	1.01757000	-0.27903500
N	-3.31047100	1.11155000	-0.67252200
H	-3.55488200	2.07382900	-0.87289600
N	-1.41904200	2.10706500	0.13461200
C	-0.03367600	2.30339500	0.18030400
C	0.56450000	2.69429100	1.38827900
C	0.76048600	2.25331600	-0.97633300

C	1.91649700	3.01917500	1.44019500
H	-0.05599900	2.74657700	2.27831900
C	2.10696000	2.59800900	-0.92033400
H	0.30940800	1.95632900	-1.91819400
C	2.69490600	2.98214600	0.28400800
H	2.35911900	3.31965100	2.38552300
H	2.70294500	2.56356400	-1.82771200
H	3.74544800	3.25318100	0.31962400
C	-4.38841500	0.33931300	-0.19811400
C	-5.65217200	0.58497000	-0.75082300
C	-4.25770600	-0.64475900	0.78806800
C	-6.75894700	-0.13847200	-0.32515100
H	-5.75279100	1.34571700	-1.51995000
C	-5.37123200	-1.37526000	1.19488700
H	-3.29046400	-0.83317900	1.24011600
C	-6.62665900	-1.12966100	0.64640900
H	-7.73009400	0.06972400	-0.76341900
H	-5.25053900	-2.13685200	1.95937500
H	-7.49024300	-1.69978500	0.97157500

(*R*)-2-Nitrobenzhydrol

C	1.12211700	2.63312800	-0.54964600
C	0.25441100	1.54527100	-0.53806200
C	0.69198700	0.25763600	-0.21854800
C	2.05358600	0.13193000	0.08771500
C	2.93539200	1.20817200	0.11486400
C	2.46463200	2.47017600	-0.21687500
H	0.74306400	3.61530000	-0.81214300
H	-0.79456000	1.69499900	-0.77069600
H	3.97266300	1.03998000	0.37850200
H	3.14196700	3.31684200	-0.21629200
N	2.64435400	-1.17683000	0.39172600
O	2.19287900	-2.16663800	-0.17325100
O	3.57516200	-1.21520100	1.17177700
C	-0.28338600	-0.92756300	-0.23188900
H	0.00371600	-1.61225300	0.57640000
C	-1.70976600	-0.49178300	0.03342300
C	-2.66135500	-0.47404400	-0.98458500
C	-2.07204600	-0.08325700	1.31969000
C	-3.96323700	-0.05024300	-0.71750900
H	-2.37764500	-0.79903500	-1.97930000
C	-3.36965000	0.34009000	1.58522100
H	-1.33043000	-0.09758700	2.11527700
C	-4.32000400	0.35845000	0.56419000
H	-4.69943100	-0.04161800	-1.51542700
H	-3.64157500	0.65170700	2.58888000
H	-5.33402300	0.68632600	0.77019700
O	-0.22983700	-1.58429900	-1.47892700
H	0.64405600	-1.99553600	-1.52220600

(*S*)-2-Nitrobenzhydrol

C	-1.08417100	2.72896300	-0.02553400
C	-0.20739300	1.64967000	0.08470000
C	-0.67308100	0.33717500	0.14065000
C	-2.06091700	0.16627100	0.06874400
C	-2.95127500	1.21995100	-0.07430600
C	-2.45532500	2.51906200	-0.11106600
H	-0.68553100	3.73747000	-0.05917100
H	0.86107000	1.83164600	0.11832100
H	-4.01316900	1.01447100	-0.14378900
H	-3.13903200	3.35507300	-0.20804400
N	-2.66555000	-1.17074500	0.17366100
O	-2.23134200	-1.93114100	1.02025100
O	-3.60497700	-1.41921000	-0.55946700
C	0.26070200	-0.86791100	0.19268700
H	0.09512000	-1.37484600	1.15104000
C	1.72599400	-0.49253700	0.09746600
C	2.46157400	-0.24388000	1.25690700
C	2.34083600	-0.36006100	-1.14837300
C	3.79779800	0.14057800	1.17393500
H	1.98309300	-0.35148600	2.22758900
C	3.67829300	0.01857600	-1.23212100
H	1.76282200	-0.56272800	-2.04465300
C	4.40810900	0.27232300	-0.07191300
H	4.36333400	0.33099300	2.08071900
H	4.15185300	0.11698700	-2.20403900
H	5.45050500	0.56768200	-0.13838100
O	-0.14516700	-1.70219000	-0.88219600
H	0.23381000	-2.57879600	-0.73458400

Int-A

P	1.99849800	-1.64451300	-0.18820600
O	2.63641200	-2.98773300	-0.33630800
C	0.69977800	-1.57793300	1.06173800
C	0.34856500	-0.39394300	1.71769200
C	-0.04252500	-2.74447600	1.26964100
C	-0.75172100	-0.37723300	2.57039500
H	0.92018200	0.51594800	1.55629000
C	-1.13789300	-2.72316400	2.12724400
H	0.24239900	-3.65759700	0.75447200
C	-1.49608500	-1.53876500	2.76999500
H	-1.02973100	0.54578900	3.06982400
H	-1.71840500	-3.62594400	2.28686600
H	-2.36074300	-1.52125300	3.42605000
C	3.13315900	-0.27625600	0.17776900
C	3.42171000	0.74144200	-0.73431400
C	3.76734200	-0.29671800	1.42756000
C	4.33910300	1.73425700	-0.39738000
H	2.93027300	0.74836700	-1.70211600
C	4.68024100	0.69821500	1.75823900
H	3.54367200	-1.08533100	2.14149700
C	4.96512000	1.71405100	0.84582900
H	4.56223500	2.52316700	-1.10816000
H	5.16836300	0.68251700	2.72712600
H	5.67681400	2.49093300	1.10645600
Se	0.95647000	-1.08775900	-2.12279600
C	-0.46781800	-0.06627700	-1.37018000
C	-1.67438100	-0.70059400	-1.08750700
C	-0.28891600	1.27684500	-1.04894000
C	-2.69469800	0.01249000	-0.46377600
H	-1.80353000	-1.75073000	-1.33215500
C	-1.31095700	1.96338500	-0.40109200
H	0.65264900	1.77301200	-1.26307600
C	-2.52028500	1.34329800	-0.10323800
H	-3.31011500	1.88572700	0.40411900
C	-3.98278000	-0.70134400	-0.16458500
C	-1.04861400	3.35599200	0.09287400
F	-0.23454900	4.03495900	-0.72622000
F	-2.17515900	4.06681200	0.22979000
F	-0.45274000	3.32926600	1.29949400
F	-4.57171800	-1.14145300	-1.28715900
F	-4.86168400	0.08629800	0.46758900

F	-3.78113800	-1.77931400	0.60913100

COM-*R*-HPT

C	6.09147900	-3.52168800	-0.36255800
C	4.73631300	-3.20696800	-0.26207700
C	4.27885100	-1.89634400	-0.38829500
C	5.26132200	-0.92106800	-0.60209900
C	6.61841100	-1.20200700	-0.67623300
C	7.03683500	-2.52325100	-0.56634400
H	6.40579300	-4.55574200	-0.26601600
H	4.01888900	-3.99717900	-0.07167400
H	7.32374500	-0.39342700	-0.82892200
H	8.09176500	-2.76371600	-0.63653800
N	4.89593300	0.48925700	-0.78692000
O	5.61663000	1.33056400	-0.28558600
O	3.92035000	0.74739500	-1.47669700
C	2.81387900	-1.50919800	-0.19521900
H	2.46100300	-1.06927300	-1.13927700
C	1.91361100	-2.69459400	0.10113800
C	1.46529800	-3.50060900	-0.94827500
C	1.50561000	-2.97790100	1.40335400
C	0.62389700	-4.58049900	-0.69900400
H	1.77552000	-3.27360800	-1.96613600
C	0.64725400	-4.04733700	1.65225600
H	1.84587500	-2.34087100	2.21387600
C	0.20879500	-4.85305900	0.60423500
H	0.27928600	-5.19967100	-1.52166700
H	0.31650900	-4.24740900	2.66693200
H	-0.46294500	-5.68331800	0.79969500
O	2.80425200	-0.54435600	0.83439900
H	1.85572200	-0.25993800	0.95264300
C	-6.60906500	0.12088800	0.55662700
C	-5.43631300	0.07022600	-0.42162700
C	-5.26238100	-1.33867300	-0.99202200
C	-6.54849300	-1.80389300	-1.67791300
C	-7.73067500	-1.76126500	-0.70690900
C	-7.89959500	-0.36222800	-0.10943700
H	-4.41496100	-1.33835300	-1.68450100
H	-5.63912500	0.74908000	-1.26142500
H	-6.37449800	-0.52506900	1.41548400
H	-6.72840400	1.14125800	0.93793100
H	-6.75985500	-1.14924500	-2.53431900
H	-6.41681300	-2.81472900	-2.07719500
H	-8.65241600	-2.06960400	-1.21125300

H	-7.55400000	-2.48004100	0.10487900
H	-8.17160200	0.33960600	-0.90892900
H	-8.71948400	-0.35067700	0.61582400
H	-5.01443400	-2.01856800	-0.16710200
N	-4.23402500	0.57296400	0.23472200
H	-4.19892600	0.58389600	1.24557600
C	-3.21685600	1.12041200	-0.46686400
O	-3.13989400	1.07296700	-1.68887600
C	-2.25599500	1.98450900	0.35865000
C	-2.78114800	3.43263200	0.30029800
H	-2.16098900	1.61244900	1.38047100
C	-0.98754200	3.14204700	-1.33329100
C	-2.28971000	3.92499200	-1.06866600
H	-2.32375600	4.00553100	1.11191400
H	-3.86675700	3.48263800	0.41301700
H	-0.11137800	3.78692800	-1.28520400
H	-1.01277000	2.64657500	-2.30627600
H	-2.11658800	5.00279900	-1.07424700
H	-3.02569900	3.68845900	-1.83818300
N	-0.94779400	2.12503100	-0.26531600
C	0.16873100	1.45320900	0.12087700
N	1.38613400	2.05367200	-0.20163600
H	2.15037600	1.38342700	-0.22585100
N	0.23242600	0.32049100	0.75116800
C	-0.82944600	-0.59410000	0.90329800
C	-1.33702600	-0.84299900	2.18531500
C	-1.27081800	-1.38224600	-0.16696500
C	-2.28011500	-1.84610500	2.39077900
H	-0.96905500	-0.24503000	3.01438100
C	-2.19779400	-2.39756400	0.04906500
H	-0.86464900	-1.20770600	-1.15859000
C	-2.70937900	-2.63427100	1.32456900
H	-2.66426100	-2.02426600	3.39091600
H	-2.51783900	-3.01247300	-0.78698100
H	-3.42882600	-3.43119500	1.48566800
C	1.79736600	3.34235500	0.20050200
C	3.09861300	3.73641100	-0.13988100
C	0.98609600	4.22446700	0.92359600
C	3.57076100	4.98805400	0.23300700
H	3.73495100	3.04425500	-0.68287500
C	1.46875300	5.48155500	1.27956500
H	-0.01544300	3.92891300	1.21527000

C	2.75871600	5.87524500	0.93845700
H	4.58437400	5.27068500	-0.03433000
H	0.82411900	6.15269700	1.83907700
H	3.12868600	6.85464500	1.22244600

COM-*S*-HPT

C	-6.06325200	-1.06280500	1.15001300
C	-5.52925500	0.07849800	0.28545400
C	-5.97250800	-0.09134300	-1.17023400
C	-7.49896100	-0.15129000	-1.25877500
C	-8.04840200	-1.29354000	-0.40100500
C	-7.58744500	-1.15931200	1.05233600
H	-5.56645900	0.73120100	-1.76601300
H	-5.94163000	1.02991300	0.65018400
H	-5.60941600	-2.00192900	0.79943900
H	-5.75012700	-0.91709900	2.18993500
H	-7.92187200	0.80047600	-0.90927500
H	-7.80998800	-0.27192000	-2.30147400
H	-9.14212400	-1.31846200	-0.44871700
H	-7.68826500	-2.24955600	-0.80538100
H	-8.02939000	-0.25289100	1.48708300
H	-7.94577600	-2.00452900	1.64872900
H	-5.54763100	-1.02576200	-1.55482000
N	-4.08217500	0.16649500	0.44895100
H	-3.57473500	-0.64574000	0.77900200
C	-3.39549000	1.28025800	0.12044000
O	-3.90399800	2.23810800	-0.45489800
C	-1.97052600	1.37032000	0.67316600
C	-1.96075500	2.49440900	1.73324300
H	-1.63476700	0.41270300	1.07520800
C	-1.13419300	3.32252900	-0.43081700
C	-1.69761800	3.78367100	0.93109500
H	-1.14876200	2.30559000	2.43937400
H	-2.89578400	2.52673700	2.29744800
H	-0.17661200	3.77876900	-0.67328800
H	-1.84341800	3.54357400	-1.23118000
H	-0.98525300	4.42665200	1.45305000
H	-2.62190000	4.34166400	0.77917500
N	-1.00868200	1.86233800	-0.31153600
C	0.04964300	1.11114500	-0.73568800
N	1.24237300	1.77773800	-0.96853500
H	1.91375800	1.24058700	-1.51274000
N	0.03935800	-0.17420300	-0.92040400
C	-1.13265400	-0.93659000	-1.07170100
C	-1.37254500	-1.99528000	-0.18465700
C	-1.99549400	-0.74981100	-2.15942100
C	-2.45284100	-2.85129200	-0.38363600

H	-0.69404400	-2.13522700	0.65293000
C	-3.06490200	-1.61689900	-2.35847000
H	-1.80810200	0.06160000	-2.85585500
C	-3.30152100	-2.67001200	-1.47557400
H	-2.62055700	-3.67000800	0.31050300
H	-3.71920500	-1.46734400	-3.21220300
H	-4.13611000	-3.34488300	-1.63982400
C	1.82554800	2.66336500	-0.02554400
C	2.70743300	3.64601800	-0.48158900
C	1.54629000	2.56362400	1.34005600
C	3.29697100	4.52298300	0.42260900
H	2.92408300	3.70671900	-1.54331000
C	2.12172400	3.46143400	2.23621800
H	0.88850100	1.77630000	1.69663000
C	2.99846900	4.44373600	1.78235900
H	3.98462600	5.28038500	0.05990300
H	1.89310300	3.37975100	3.29454500
H	3.45051400	5.13845300	2.48244800
C	6.44925300	-2.46228400	0.85260100
C	5.08755600	-2.17251500	0.93698300
C	4.46750400	-1.31618500	0.02825600
C	5.28812100	-0.77107200	-0.96527100
C	6.63617000	-1.07095500	-1.09539700
C	7.22560500	-1.92187800	-0.16640700
H	6.89795000	-3.12905600	1.58158400
H	4.49050000	-2.63169100	1.71740300
H	7.20645900	-0.62851800	-1.90431500
H	8.28133800	-2.15718000	-0.24279300
N	4.75554900	0.20502600	-1.92479300
O	5.06934900	0.08224600	-3.09179500
O	4.08085400	1.12231200	-1.48320600
C	2.96971900	-1.03317800	0.04422100
H	2.83273000	0.00623600	0.38586100
C	2.19846700	-1.93675500	0.98915700
C	1.76030300	-1.46940000	2.22779000
C	1.89863900	-3.24642600	0.60561700
C	1.02901400	-2.29964600	3.07747100
H	1.99183700	-0.44854400	2.52408500
C	1.17454800	-4.07876600	1.45395300
H	2.22447900	-3.59473600	-0.37003700
C	0.73559100	-3.60601200	2.69152600
H	0.68723700	-1.92553200	4.03773300

H	0.94345700	-5.09432900	1.14731600
H	0.16519500	-4.25320600	3.35056300
O	2.51897600	-1.18502700	-1.28241100
H	1.56049200	-0.91451300	-1.25848600

TS-*R*-HPT

C	6.07304500	-3.45031900	0.23235900
C	4.72908500	-3.12368900	0.04529000
C	4.32350000	-1.82121700	-0.24661000
C	5.34967400	-0.87349500	-0.33221400
C	6.69040600	-1.15969700	-0.12316700
C	7.05784200	-2.47219400	0.15533400
H	6.34533200	-4.47767400	0.45249400
H	3.97682800	-3.89938900	0.13949400
H	7.42454700	-0.36491200	-0.19255100
H	8.10191900	-2.72144200	0.30918100
N	5.04546000	0.51443900	-0.70010200
O	5.62218600	1.40382800	-0.10256400
O	4.27728300	0.69795800	-1.63165400
C	2.85117900	-1.37779600	-0.32101200
H	2.68512900	-0.99310500	-1.34218900
C	1.91309400	-2.56932900	-0.16468100
C	1.49918500	-3.29882300	-1.28133900
C	1.45743300	-2.94949100	1.09831000
C	0.63392400	-4.38156000	-1.14207800
H	1.85225300	-3.00674800	-2.26819000
C	0.58431800	-4.02597800	1.24180100
H	1.78164400	-2.37453900	1.96205200
C	0.16930600	-4.74391200	0.12148800
H	0.31215800	-4.93444700	-2.01968300
H	0.22244000	-4.30147000	2.22814000
H	-0.51789100	-5.57732700	0.23179800
O	2.65196300	-0.39716800	0.64232300
H	1.10823700	-0.31536400	0.93681700
C	-6.45567800	-0.10273300	0.97781200
C	-5.49742200	0.25374100	-0.15743600
C	-5.43944700	-0.87282200	-1.19229500
C	-6.83548000	-1.15540200	-1.75132300
C	-7.80771100	-1.51763100	-0.62619500
C	-7.85238300	-0.41702500	0.43667400
H	-4.73686400	-0.59579200	-1.98377300
H	-5.86252400	1.15669100	-0.66674400
H	-6.05671200	-0.98272900	1.50416900
H	-6.49679000	0.72008500	1.70028000
H	-7.20439400	-0.26426300	-2.27703100
H	-6.78741300	-1.96166700	-2.49024900
H	-8.81101400	-1.69441500	-1.02751200

H	-7.48000200	-2.45618300	-0.15849700
H	-8.27435200	0.49424500	-0.00739300
H	-8.51384100	-0.70469100	1.26006700
H	-5.05203200	-1.77420600	-0.70260000
N	-4.19240800	0.59254200	0.40307500
H	-3.97249300	0.29435800	1.34490200
C	-3.28944700	1.31562300	-0.29065800
O	-3.42565400	1.60262500	-1.47517600
C	-2.15850200	1.92784200	0.54117800
C	-2.47181400	3.42785400	0.72302100
H	-2.03138900	1.41014800	1.49273900
C	-0.91416300	3.09351500	-1.14940200
C	-1.93497000	4.08956800	-0.55999200
H	-1.93432400	3.79047500	1.60297500
H	-3.53848300	3.60239300	0.88234700
H	0.07518500	3.52471300	-1.27685200
H	-1.26258900	2.70267900	-2.10628700
H	-1.46472700	5.04957700	-0.33665700
H	-2.74054500	4.25682000	-1.27541800
N	-0.88826100	1.97783200	-0.18556600
C	0.20528900	1.27230700	0.15932900
N	1.46285700	1.70478800	-0.06838000
H	2.18656800	0.86535600	0.12687300
N	0.11602200	0.07851500	0.76564200
C	-0.98218300	-0.82676500	0.72955400
C	-1.54320800	-1.23567900	1.94103500
C	-1.41855000	-1.38723800	-0.47146700
C	-2.53738200	-2.21037600	1.95387300
H	-1.17683400	-0.79453900	2.86351800
C	-2.40668500	-2.36715000	-0.45056400
H	-0.96469500	-1.07653700	-1.40730400
C	-2.96463900	-2.78337500	0.75742300
H	-2.96477000	-2.53274800	2.89829800
H	-2.73426300	-2.81457400	-1.38384600
H	-3.72950300	-3.55403200	0.76495300
C	1.89051200	3.03911700	0.13285700
C	3.04105400	3.47418900	-0.53047600
C	1.23581400	3.91338500	1.01121900
C	3.51925900	4.76505300	-0.32514700
H	3.56113000	2.78576200	-1.18697700
C	1.71041100	5.20794100	1.19373100
H	0.35805500	3.57822400	1.55505200

C	2.85406300	5.64297400	0.52693100
H	4.41864500	5.08460600	-0.84249500
H	1.18849500	5.87412600	1.87412900
H	3.22559700	6.65129600	0.67688200

TS-*S*-HPT

C	-6.38306800	-0.64474500	1.31456900
C	-5.65743400	0.07458800	0.17840400
C	-5.94960000	-0.59507600	-1.16590200
C	-7.45577000	-0.62863400	-1.43302800
C	-8.19446900	-1.34994600	-0.30334400
C	-7.88946300	-0.70522900	1.05092500
H	-5.41453200	-0.05668300	-1.95401700
H	-6.01626200	1.11172900	0.12165000
H	-5.98187600	-1.66601300	1.39183100
H	-6.17617200	-0.13886100	2.26432700
H	-7.83260100	0.40004700	-1.51322200
H	-7.65568100	-1.11456000	-2.39339100
H	-9.27379900	-1.34687400	-0.48766500
H	-7.87641600	-2.40118600	-0.28105600
H	-8.29396600	0.31555000	1.06254200
H	-8.38635600	-1.25302500	1.85793500
H	-5.55508600	-1.61866400	-1.13628200
N	-4.23148800	0.14343100	0.48316200
H	-3.85388000	-0.47984600	1.18476100
C	-3.43324800	1.08783700	-0.06033200
O	-3.79124700	1.82770200	-0.96977300
C	-2.10426900	1.30374700	0.66822500
C	-2.28015200	2.51751600	1.60586000
H	-1.79244200	0.40301500	1.20040000
C	-1.22597900	3.20026500	-0.50505900
C	-2.04013400	3.73462400	0.69405000
H	-1.52008200	2.46366300	2.38929800
H	-3.26306000	2.52411800	2.08318100
H	-0.27532100	3.71012700	-0.63572800
H	-1.80301700	3.27816100	-1.42752700
H	-1.49643500	4.51995800	1.22325300
H	-2.98662500	4.14683000	0.34184100
N	-1.03262800	1.76868500	-0.21420700
C	0.10141800	1.05690600	-0.41132500
N	1.32420700	1.59917900	-0.52790100
H	2.08588400	0.78023400	-0.73286800
N	0.06041700	-0.28336800	-0.47861000
C	-1.05484300	-1.08586300	-0.82475200
C	-1.29922800	-2.21764500	-0.04367100
C	-1.84496400	-0.82214700	-1.94615500
C	-2.31990600	-3.09667400	-0.39309200

H	-0.67318200	-2.39726500	0.82634000
C	-2.86596500	-1.70475400	-2.28559400
H	-1.65520400	0.06179400	-2.54639300
C	-3.10244600	-2.84455300	-1.51812700
H	-2.49678100	-3.98112700	0.21130600
H	-3.47640500	-1.50251500	-3.16010800
H	-3.89476700	-3.53199600	-1.79735300
C	1.70770000	2.81005700	0.10357100
C	2.48602500	3.72727800	-0.60547100
C	1.34334500	3.08768200	1.42476300
C	2.87283500	4.92104200	-0.00511900
H	2.78647900	3.48388400	-1.61890200
C	1.72271700	4.28987300	2.01524600
H	0.76714200	2.35753000	1.98575300
C	2.48468700	5.21259700	1.30169700
H	3.47749100	5.62862700	-0.56355400
H	1.43036900	4.49911300	3.03975200
H	2.78210900	6.14823300	1.76388900
C	6.56575000	-2.80692000	0.29558000
C	5.26153700	-2.45111100	0.63970200
C	4.64403200	-1.31959900	0.10399600
C	5.41851300	-0.56833400	-0.78421300
C	6.70384600	-0.91462900	-1.17393500
C	7.28774300	-2.04924100	-0.62011300
H	7.01016200	-3.69361400	0.73624900
H	4.70435500	-3.07797600	1.32780400
H	7.23288000	-0.29125300	-1.88627200
H	8.29590400	-2.33235600	-0.90208900
N	4.91113700	0.70250600	-1.31468800
O	5.04472200	0.92042400	-2.50452600
O	4.45253000	1.49728900	-0.51297300
C	3.17682800	-0.94183700	0.36678500
H	3.18732800	-0.11781400	1.10732100
C	2.42284000	-2.10774400	0.99923900
C	2.02713300	-2.09177300	2.33536600
C	2.09901300	-3.21640100	0.20851300
C	1.32917900	-3.17119800	2.88226000
H	2.26694200	-1.22895200	2.95265000
C	1.41369600	-4.29767700	0.75138600
H	2.38913000	-3.21151700	-0.83869900
C	1.02689600	-4.27812500	2.09330000
H	1.02526100	-3.14615000	3.92450500

H	1.17166800	-5.15359100	0.12840200
H	0.48953100	-5.12037100	2.51841600
O	2.58143800	-0.55635200	-0.82777200
H	1.05750100	-0.68087400	-0.60743900

COM-*R*

C	-2.39143700	-3.67872900	3.82163900
C	-1.20864300	-3.35451900	3.15706300
C	-0.73824800	-2.04419200	3.09293400
C	-1.54757400	-1.07446400	3.70429300
C	-2.74471200	-1.36623000	4.34601600
C	-3.16333700	-2.68921500	4.41892700
H	-2.71418700	-4.71443400	3.85562000
H	-0.63989200	-4.13815900	2.66933700
H	-3.32064900	-0.56346300	4.79101000
H	-4.08511900	-2.93747200	4.93322000
N	-1.15801600	0.34101000	3.72358100
O	-2.04434200	1.17377600	3.64665000
O	0.02260600	0.61961900	3.86696400
C	0.51325800	-1.66161100	2.30199600
H	1.18212200	-1.12174100	2.98491300
C	1.29646300	-2.85945200	1.79497800
C	2.03413900	-3.62484000	2.70318000
C	1.32867100	-3.18390800	0.44071300
C	2.77507800	-4.71872800	2.26773800
H	2.02409300	-3.36006000	3.75869600
C	2.07303800	-4.28071300	0.00448400
H	0.80202000	-2.55620600	-0.27298100
C	2.79312400	-5.05167000	0.91299900
H	3.34445800	-5.30581100	2.98193600
H	2.10238200	-4.51841000	-1.05502500
H	3.37627500	-5.90033500	0.56847600
O	0.06086800	-0.79802000	1.28212300
H	0.86079000	-0.42998000	0.79744700
C	7.89942100	-0.35500000	-3.00831200
C	7.70489100	0.12616600	-1.57089400
C	8.14951000	-0.94995000	-0.57636900
C	9.61523900	-1.32000000	-0.81346500
C	9.82621800	-1.80858600	-2.24847100
C	9.35313600	-0.76166900	-3.25987700
H	7.98523200	-0.58600000	0.44183500
H	8.33055300	1.01401800	-1.40071700
H	7.23837400	-1.21887300	-3.17425400
H	7.59111400	0.43089100	-3.70682600
H	10.24770200	-0.44005600	-0.63288700
H	9.92889800	-2.08717100	-0.09813500
H	10.88009100	-2.05056100	-2.42163200

H	9.25598500	-2.73580400	-2.39751300
H	9.99009400	0.12921700	-3.17890900
H	9.46259900	-1.13816800	-4.28199600
H	7.52172700	-1.83641100	-0.72073600
N	6.32191200	0.55689500	-1.39497900
H	5.61487400	0.21074000	-2.03242400
C	5.94790500	1.35137300	-0.37074800
O	6.69811700	1.65088900	0.55375300
C	4.58799000	2.03978800	-0.53007400
C	4.87598400	3.53884700	-0.77013300
H	4.00237100	1.58937100	-1.33248900
C	4.35338800	3.10670900	1.59624200
C	5.00131700	4.13784500	0.64556500
H	4.03215900	3.97533700	-1.31104700
H	5.77282100	3.68850800	-1.37578700
H	3.57838400	3.53579400	2.22716800
H	5.11215800	2.64520100	2.23124300
H	4.49278800	5.10303700	0.70744300
H	6.04821700	4.28062100	0.91402400
N	3.80412700	2.07672700	0.70233600
C	2.61641700	1.42113900	0.84920500
N	1.65155900	1.99884100	1.65616100
H	0.94881300	1.33620500	1.97216400
N	2.30975500	0.28027700	0.30438100
C	3.26500900	-0.62573700	-0.19601300
C	3.16552900	-1.05131900	-1.52685200
C	4.20889100	-1.22870800	0.64645800
C	4.01155300	-2.04631000	-2.01159300
H	2.38426600	-0.62416100	-2.14761100
C	5.03286000	-2.23830400	0.16154000
H	4.26804800	-0.92278600	1.68704500
C	4.94623700	-2.64755800	-1.16930100
H	3.92057600	-2.37058500	-3.04442900
H	5.74546400	-2.71168500	0.83067300
H	5.59139900	-3.43825400	-1.54109700
C	1.24577600	3.34782300	1.69657400
C	0.40569100	3.74173500	2.74527200
C	1.61587600	4.28637400	0.72829700
C	-0.04482100	5.05452500	2.82411100
H	0.09301400	3.00129700	3.47533300
C	1.17469200	5.60309300	0.82832300
H	2.23363800	3.98415000	-0.10941400

C	0.34469200	5.99862600	1.87456300
H	-0.70083300	5.34090500	3.64052400
H	1.47653600	6.31962400	0.07006800
H	0.00158900	7.02539400	1.94621500
P	-1.37493600	-0.75931200	-1.47202000
O	-0.05510100	-1.31164300	-1.91236000
C	-2.36402100	-1.90130700	-0.47934000
C	-3.52665800	-1.55052300	0.21721800
C	-1.97747400	-3.24466600	-0.55016900
C	-4.27863600	-2.53542400	0.85323300
H	-3.86082400	-0.51833600	0.25581800
C	-2.73689200	-4.22476500	0.07999200
H	-1.08715100	-3.51379600	-1.10936700
C	-3.88708300	-3.87035400	0.78237600
H	-5.17724200	-2.25652100	1.39323000
H	-2.42968300	-5.26403200	0.02069600
H	-4.48096900	-4.63489800	1.27391200
C	-1.39809000	0.92607300	-0.80844200
C	-1.00335300	1.94492300	-1.68666900
C	-1.88442200	1.25222100	0.45971600
C	-1.13345000	3.27684400	-1.31116500
H	-0.64196200	1.69384500	-2.68004400
C	-2.04283000	2.58980700	0.81801800
H	-2.14084900	0.46899500	1.16276500
C	-1.68131900	3.59975500	-0.06951200
H	-0.82348300	4.06384500	-1.99130800
H	-2.43756800	2.83680400	1.79766000
H	-1.80217800	4.64004200	0.21689000
Se	-2.60837400	-0.48252200	-3.36821900
C	-4.22740700	0.07659000	-2.52540500
C	-5.25386100	-0.84778800	-2.34323900
C	-4.37002400	1.38065300	-2.05303600
C	-6.41425600	-0.46356900	-1.67659700
H	-5.13441900	-1.86424500	-2.70410200
C	-5.52453400	1.73752200	-1.36426900
H	-3.57754300	2.10706700	-2.20073700
C	-6.55603500	0.82371800	-1.16953600
H	-7.45774900	1.11322500	-0.63918300
C	-7.49325900	-1.47693200	-1.42244000
C	-5.63697100	3.10940300	-0.76200700
F	-4.83189800	3.99321000	-1.36532800
F	-6.88980400	3.58267500	-0.83923400

F	-5.30721600	3.10172800	0.54048800
F	-7.51044700	-2.43640900	-2.35607800
F	-8.70914600	-0.91232500	-1.39663300
F	-7.32693100	-2.08914500	-0.23663300

COM-*S*

C	7.57621800	-1.77004600	-1.43734800
C	6.82832800	-2.03004700	-0.12833800
C	6.33071500	-3.47498600	-0.05415900
C	7.48013000	-4.46614700	-0.24823600
C	8.21399700	-4.20995800	-1.56597400
C	8.71926600	-2.76733100	-1.63551100
H	5.83554100	-3.62786000	0.90907200
H	7.50402000	-1.85303600	0.71829000
H	6.86154100	-1.86558400	-2.26904100
H	7.94994300	-0.73998000	-1.44644100
H	8.18965600	-4.36286000	0.58409100
H	7.09894400	-5.49185000	-0.21365000
H	9.04864000	-4.90929700	-1.68132000
H	7.52566800	-4.39135100	-2.40263900
H	9.47059900	-2.61093900	-0.84998000
H	9.21603100	-2.57869100	-2.59267600
H	5.57070200	-3.62049300	-0.83429000
N	5.74726800	-1.06348500	-0.00095100
H	5.30035000	-0.73021200	-0.84722600
C	5.33199300	-0.56008600	1.18192800
O	5.72363500	-0.95362600	2.27505900
C	4.47562800	0.69805200	1.03660100
C	5.41039200	1.89516800	1.31836300
H	4.01427800	0.74243700	0.04509100
C	4.01667100	1.42737200	3.28875800
C	5.35213900	2.06621700	2.84644700
H	5.02432000	2.77819000	0.80428900
H	6.42238600	1.71394500	0.94689900
H	3.33547300	2.14567600	3.74471200
H	4.19449300	0.61491600	3.99861200
H	5.40215500	3.11969900	3.13060300
H	6.18341700	1.54119000	3.31829200
N	3.44599600	0.86807400	2.05727500
C	2.12163100	0.78674200	1.73539100
N	1.23716400	1.70208500	2.26679300
H	0.27123000	1.40347900	2.16977000
N	1.59958000	-0.08177500	0.91447400
C	2.11678300	-1.36442400	0.68244600
C	1.74834900	-1.99610700	-0.51419300
C	2.81385500	-2.11149200	1.64610800
C	2.08132600	-3.32341200	-0.75663700

H	1.13338300	-1.45069400	-1.22325600
C	3.13604800	-3.44196600	1.40097000
H	3.09970700	-1.65212900	2.58628700
C	2.78039600	-4.05691500	0.20090200
H	1.74531600	-3.78866500	-1.67753600
H	3.66628400	-4.00500700	2.16391500
H	3.03239100	-5.09762800	0.02255200
C	1.42408200	3.07542600	2.51949000
C	0.52334500	3.71246000	3.37796600
C	2.44119300	3.81787300	1.91392600
C	0.64583900	5.07382100	3.62968000
H	-0.27156800	3.13156600	3.83720700
C	2.56902200	5.17642500	2.18885800
H	3.11501100	3.32884300	1.21949700
C	1.67426700	5.81230000	3.04595900
H	-0.06348200	5.55808600	4.29332000
H	3.36667500	5.74057800	1.71473000
H	1.77240300	6.87270400	3.25236400
C	-0.31195200	4.46444700	-4.09150800
C	0.53349900	3.70483200	-3.28117800
C	0.11505900	3.22135000	-2.04294400
C	-1.20189600	3.52336200	-1.67038300
C	-2.07164000	4.25030200	-2.47055400
C	-1.61576500	4.73613000	-3.69209000
H	0.05183600	4.83057800	-5.04600900
H	1.53679200	3.47426700	-3.62292400
H	-3.08443500	4.43090800	-2.12978300
H	-2.27866000	5.31787300	-4.32290600
N	-1.74297000	3.09189000	-0.37127000
O	-2.91444000	2.75223200	-0.33975800
O	-1.02241400	3.15128400	0.60895700
C	0.97075900	2.30665100	-1.17415200
H	1.13008400	2.82278800	-0.21699400
C	2.34651200	2.01349900	-1.75058300
C	3.38598800	2.93346900	-1.58089600
C	2.60275600	0.81504500	-2.41602600
C	4.66826000	2.64807500	-2.04502100
H	3.18609700	3.87577500	-1.07372300
C	3.88801900	0.52027200	-2.87029600
H	1.79143500	0.11126800	-2.56381100
C	4.92652100	1.43164300	-2.67749000
H	5.46869800	3.36750800	-1.90084400

H	4.07670300	-0.42349900	-3.37429000
H	5.92819600	1.20118400	-3.02780400
O	0.20019300	1.14675100	-0.98172200
H	0.60386300	0.62645200	-0.22348800
P	-2.06871400	-2.34326000	-1.59865100
O	-0.95775300	-3.22735700	-2.07071500
C	-1.75082900	-1.49922400	-0.03364200
C	-2.25328000	-0.22901900	0.25604900
C	-1.10908900	-2.24594700	0.96328300
C	-2.12390500	0.29118000	1.54368300
H	-2.75820200	0.35479500	-0.50717900
C	-0.98697100	-1.72655500	2.24680600
H	-0.70688100	-3.22743700	0.72572200
C	-1.50335000	-0.46261900	2.53918400
H	-2.51268900	1.28302500	1.75277400
H	-0.49065900	-2.30589800	3.01883400
H	-1.42461500	-0.06832200	3.54867200
C	-2.64387000	-1.11223100	-2.80328900
C	-3.81378600	-1.28153400	-3.54985100
C	-1.82154500	-0.00163000	-3.03224000
C	-4.15997000	-0.34172500	-4.51737300
H	-4.44946500	-2.14209800	-3.36605000
C	-2.17956100	0.93745900	-3.99515800
H	-0.92485600	0.15663500	-2.43732500
C	-3.34687800	0.76797300	-4.73761600
H	-5.06905100	-0.47562100	-5.09472800
H	-1.54419000	1.80342100	-4.16016700
H	-3.62499400	1.50326300	-5.48637700
Se	-3.89275900	-3.61177200	-1.12997200
C	-4.69196200	-2.39209400	0.10193100
C	-4.40769900	-2.53203400	1.46116800
C	-5.46963500	-1.33147800	-0.34669800
C	-4.87219400	-1.57861000	2.35612600
H	-3.79062200	-3.35633600	1.80098500
C	-5.92804300	-0.38487400	0.56930900
H	-5.68863600	-1.21659600	-1.40348900
C	-5.62951800	-0.49263000	1.91999500
H	-5.96964300	0.26085600	2.62313200
C	-4.54345600	-1.68056000	3.81786400
C	-6.66317300	0.82044100	0.05751600
F	-7.46439500	0.51244300	-0.97358400
F	-7.42431000	1.38457000	1.00595000

F	-5.81380500	1.76284600	-0.37873500
F	-5.60880400	-2.05837800	4.54329400
F	-4.14663600	-0.49530800	4.31090100
F	-3.56696700	-2.56353900	4.05909500

TS-*S*

C	7.95032877	-1.86943782	-1.45541688
C	7.35583650	-1.68567325	-0.05968956
C	6.99994892	-3.04024560	0.55950698
C	8.24083904	-3.93337269	0.62858397
C	8.84800606	-4.13016541	-0.76253530
C	9.17602065	-2.78438192	-1.41351928
H	6.56488892	-2.87882992	1.54974379
H	8.10361200	-1.20905226	0.59024220
H	7.17870092	-2.31273323	-2.10251812
H	8.21072600	-0.89276868	-1.87857960
H	8.98727048	-3.46998712	1.28810216
H	7.98221398	-4.89966181	1.07330136
H	9.74842766	-4.75053375	-0.70474149
H	8.12793383	-4.66856589	-1.39386499
H	9.96893127	-2.28972454	-0.83691307
H	9.56464800	-2.93184725	-2.42618614
H	6.23912333	-3.51995962	-0.06657606
N	6.22885761	-0.76098818	-0.14211504
H	5.79644894	-0.59658375	-1.04302569
C	5.73215978	-0.14395828	0.94801437
O	6.08143057	-0.41514780	2.09310071
C	4.83862428	1.06958421	0.67192811
C	5.61042033	2.32354726	1.13673086
H	4.53906192	1.12275014	-0.37603157
C	4.05532440	1.55875751	2.88119149
C	5.30374661	2.43495140	2.64382322
H	5.22242196	3.19054802	0.59659114
H	6.67845374	2.24213299	0.92287169
H	3.24784781	2.08249163	3.38612184
H	4.31524706	0.66759509	3.45413373
H	5.11389445	3.47293954	2.92531903
H	6.13525875	2.05853780	3.23970524
N	3.65117100	1.11933976	1.53376608
C	2.39836149	1.11281695	1.03313082
N	1.41459665	1.87153956	1.57904879
H	0.48039952	1.67366647	1.20664734
N	2.05871525	0.37844873	-0.01905608
C	2.76400590	-0.77102275	-0.46882819
C	3.13116771	-0.84129068	-1.81221591
C	3.01051062	-1.84551729	0.38605369
C	3.72176787	-1.99910926	-2.30911841

H	2.92832821	0.00763645	-2.45707075
C	3.59620540	-3.00233357	-0.11937743
H	2.72532901	-1.77938831	1.43156074
C	3.94713711	-3.08639313	-1.46572596
H	3.98955207	-2.05491227	-3.36009296
H	3.77717089	-3.84281370	0.54351468
H	4.39532161	-3.99558217	-1.85511992
C	1.60092636	3.15513433	2.16733320
C	0.86669112	3.47587544	3.30857534
C	2.47409657	4.08747776	1.60806504
C	1.01798372	4.72684259	3.89657983
H	0.18628587	2.73721013	3.72053569
C	2.63477059	5.33138479	2.21361475
H	3.01821212	3.84101227	0.70123065
C	1.90915144	5.65400771	3.35786747
H	0.44317177	4.97507241	4.78291156
H	3.31963772	6.05306127	1.77957878
H	2.03223498	6.62577838	3.82446344
C	-2.92466482	3.67415800	-3.66924769
C	-1.74359780	3.03879728	-3.28820442
C	-1.37875734	2.88410938	-1.94815674
C	-2.30343612	3.38654352	-1.01993835
C	-3.49134010	4.01697781	-1.37029982
C	-3.79839085	4.18086497	-2.71376220
H	-3.15687416	3.77134933	-4.72502238
H	-1.08304087	2.65966886	-4.05865826
H	-4.15646504	4.36792533	-0.58981170
H	-4.71383395	4.68361448	-3.00541513
N	-2.09180048	3.23773891	0.42197210
O	-3.07101322	2.97557146	1.10673286
O	-0.97514880	3.39685089	0.88023747
C	-0.07034240	2.19858335	-1.51445637
H	0.45798977	2.96262747	-0.91747399
C	0.85588255	1.90452983	-2.69068603
C	2.00340351	2.67851824	-2.87696609
C	0.60308316	0.85781282	-3.58141767
C	2.88041623	2.42062074	-3.93117040
H	2.21208379	3.49401127	-2.18764772
C	1.46735820	0.60307050	-4.64223036
H	-0.26902364	0.23538872	-3.42836764
C	2.61130690	1.38215057	-4.81965892
H	3.76934626	3.03126467	-4.05788595

H	1.25443299	-0.21372441	-5.32527719
H	3.28876853	1.17835809	-5.64328636
O	-0.30780108	1.09261678	-0.68858939
H	1.03517213	0.59688447	-0.41844178
P	-1.09784383	-1.06554165	-0.87612313
O	0.11114225	-1.44325036	-1.67182645
C	-0.93772220	-0.88957984	0.93646160
C	-1.53145232	0.10679017	1.71030702
C	-0.20029858	-1.90019170	1.56769384
C	-1.42640003	0.07610340	3.10114805
H	-2.06949355	0.91703049	1.24251195
C	-0.06235311	-1.90573187	2.95211920
H	0.24304296	-2.69375016	0.97355505
C	-0.68994384	-0.92689365	3.72413835
H	-1.92438213	0.84213637	3.68727513
H	0.52109125	-2.68646561	3.43009301
H	-0.60560435	-0.95023687	4.80600377
C	-2.50969280	-0.31709477	-1.74002951
C	-2.64232742	-0.71256542	-3.07794999
C	-3.50402586	0.46411048	-1.15469707
C	-3.73759158	-0.29988840	-3.82687723
H	-1.88955783	-1.35897988	-3.52179234
C	-4.61068327	0.86252246	-1.90502662
H	-3.45227037	0.75567389	-0.11232045
C	-4.72851098	0.48733274	-3.23913396
H	-3.82525971	-0.60458178	-4.86486135
H	-5.38426437	1.45982118	-1.43319247
H	-5.59333198	0.79741875	-3.81738435
Se	-2.12054978	-3.19537367	-0.75450130
C	-3.68041463	-2.65482437	0.19461682
C	-3.65619647	-2.52113764	1.58302570
C	-4.83799007	-2.31462969	-0.50761269
C	-4.77223722	-2.02668330	2.25228392
H	-2.75900059	-2.78059726	2.13648324
C	-5.94753661	-1.83135662	0.17703478
H	-4.85105811	-2.39580332	-1.59009135
C	-5.92656182	-1.67701546	1.56021971
H	-6.79247842	-1.28565397	2.08650138
C	-4.71347529	-1.78890230	3.73307335
C	-7.17767781	-1.40237361	-0.56758830
F	-7.08585275	-1.62818476	-1.88367383
F	-8.27491715	-2.03949788	-0.12609580

F	-7.41551356	-0.08761171	-0.40578722
F	-5.85371179	-2.15360336	4.34155362
F	-4.53058050	-0.48695524	4.01691189
F	-3.71289249	-2.46014189	4.31836758

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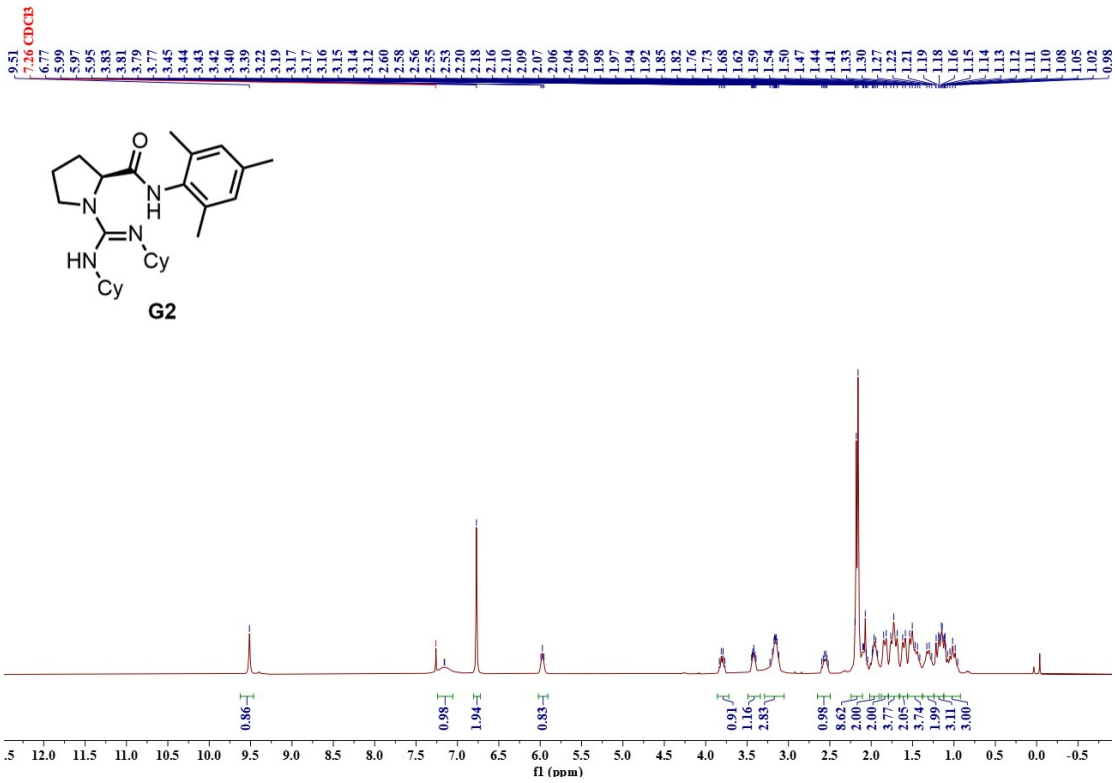
12. Copies of NMR Spectra

^{1}H NMR (400 MHz, $CDCl_3$) spectrum for G2



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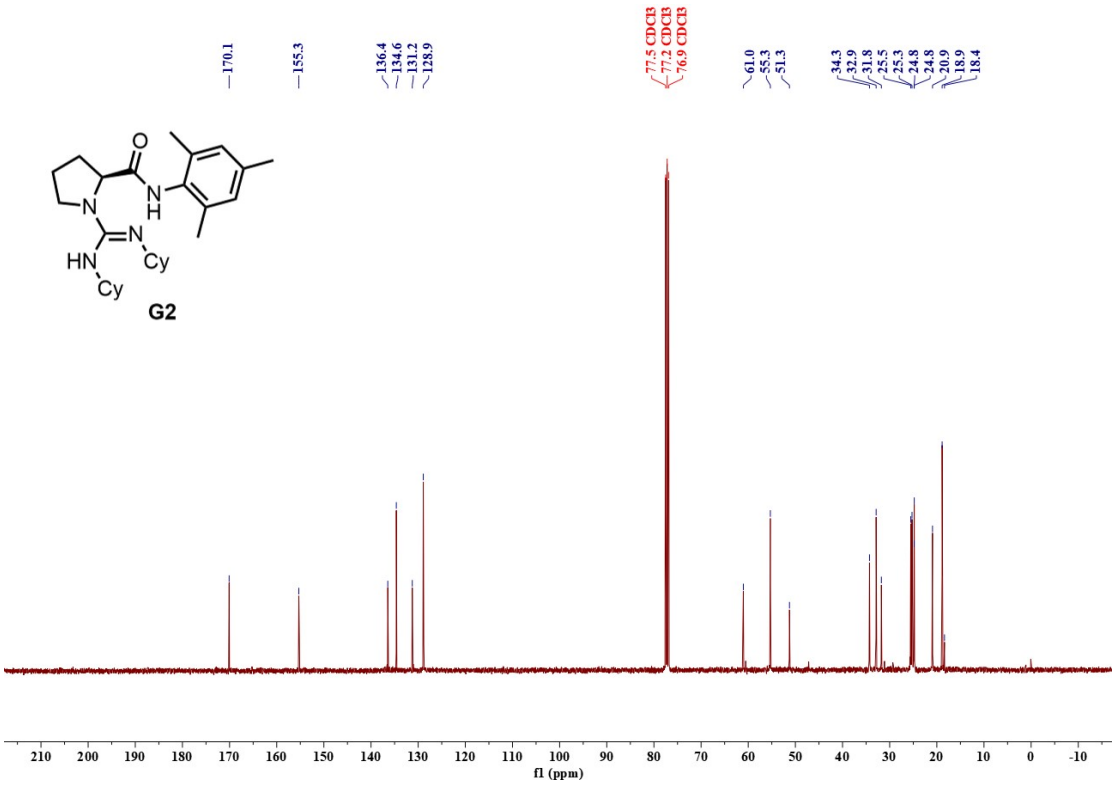

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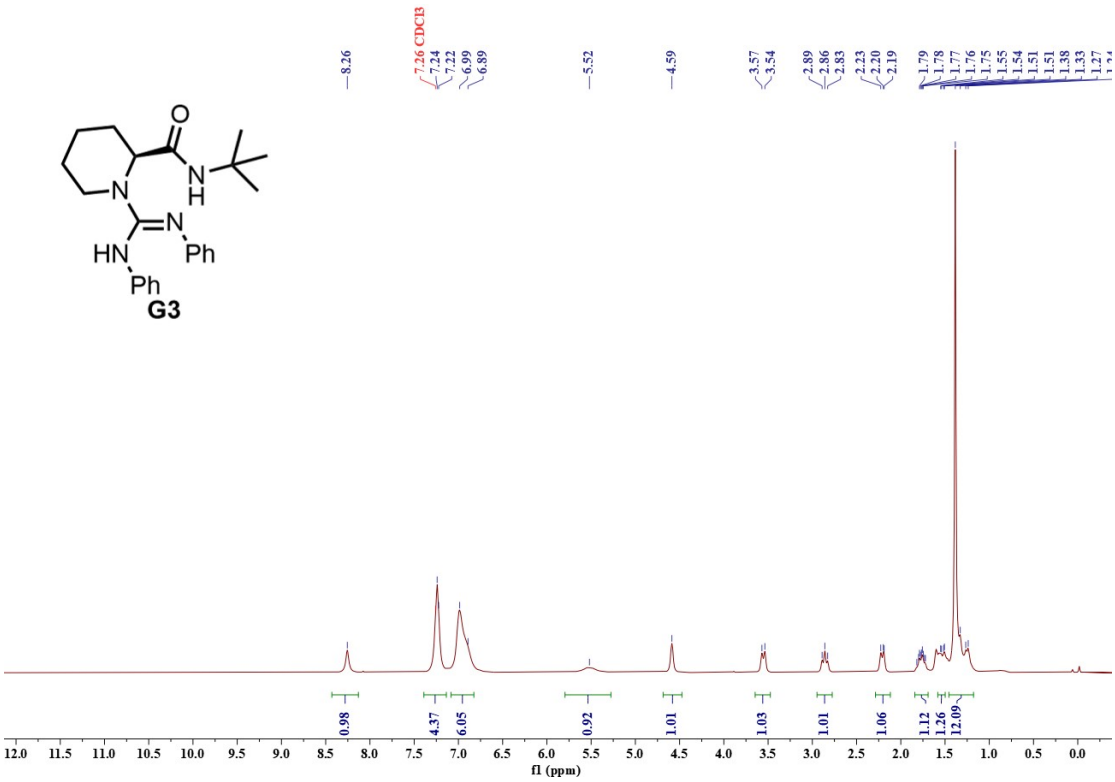

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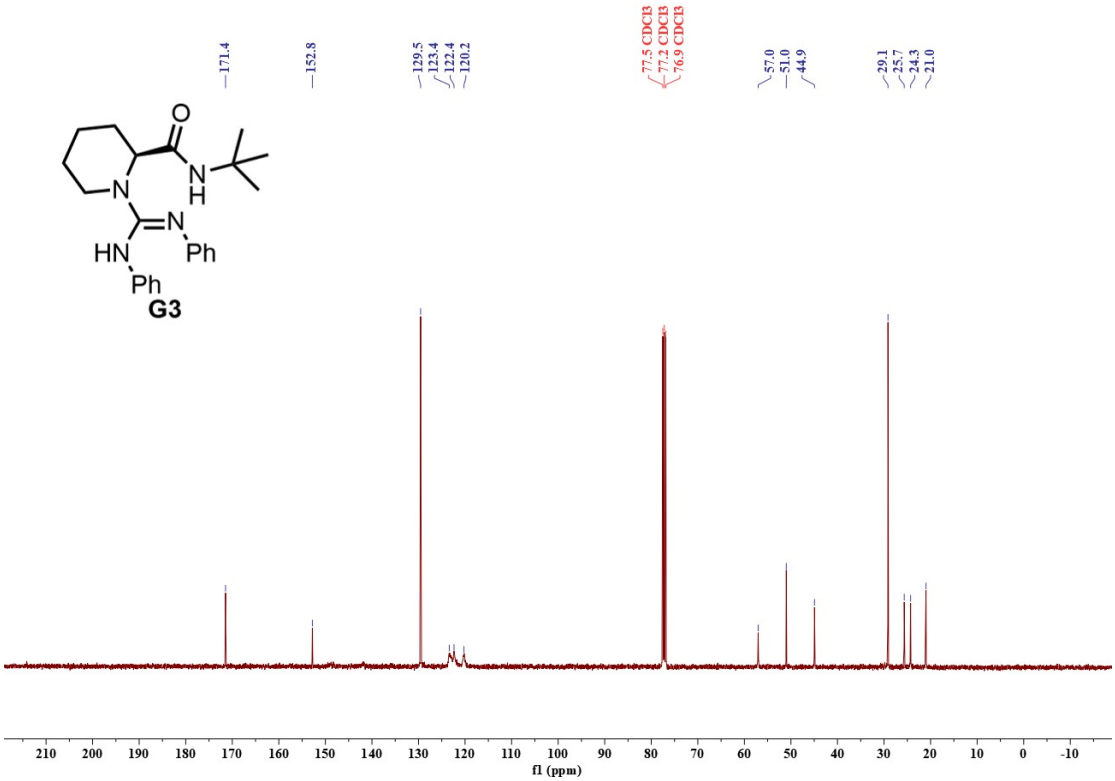

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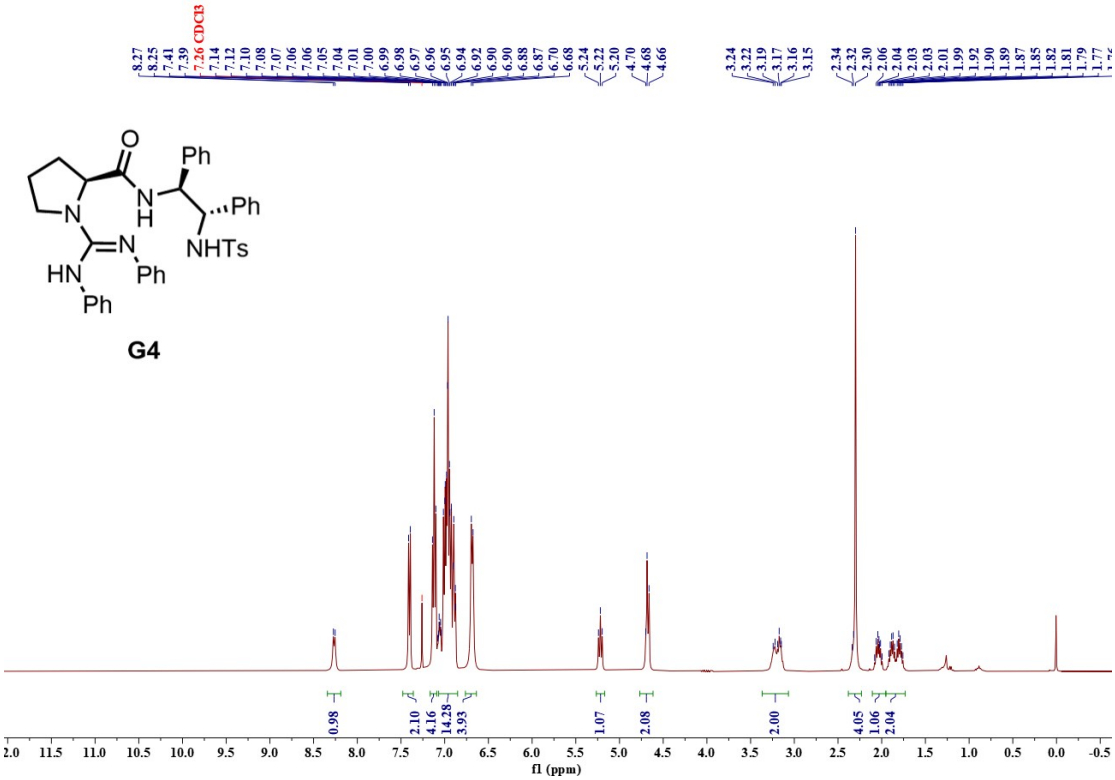

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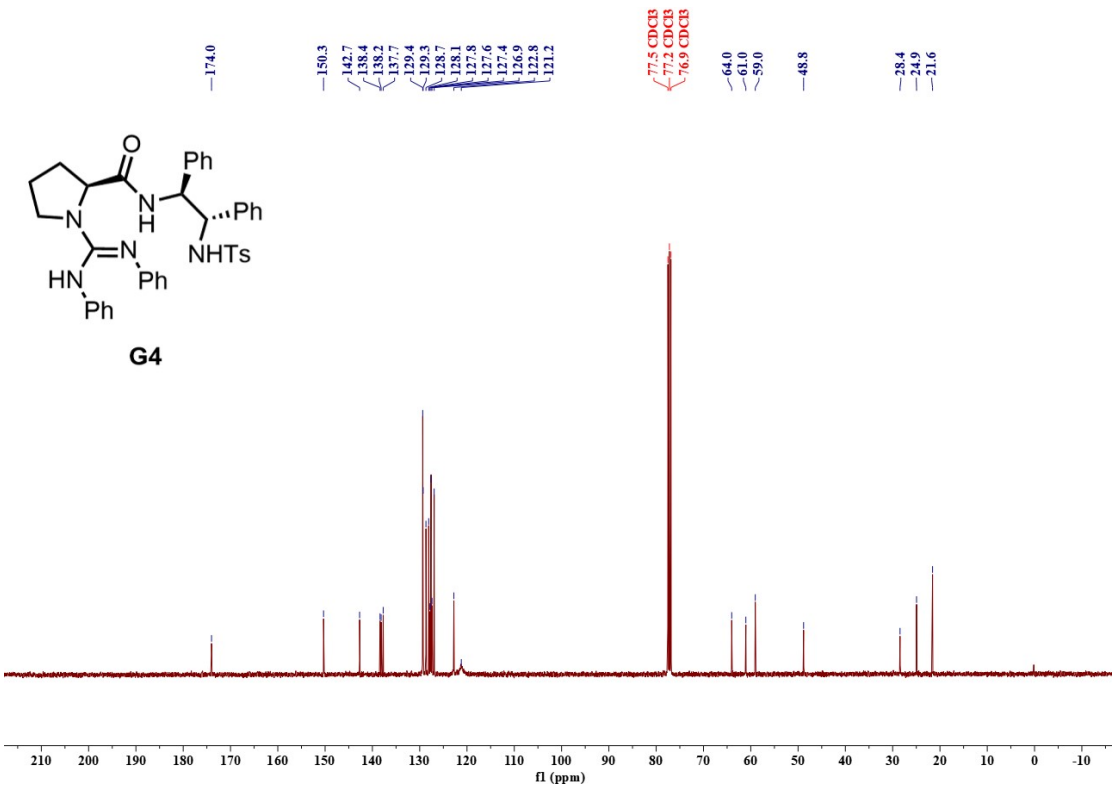

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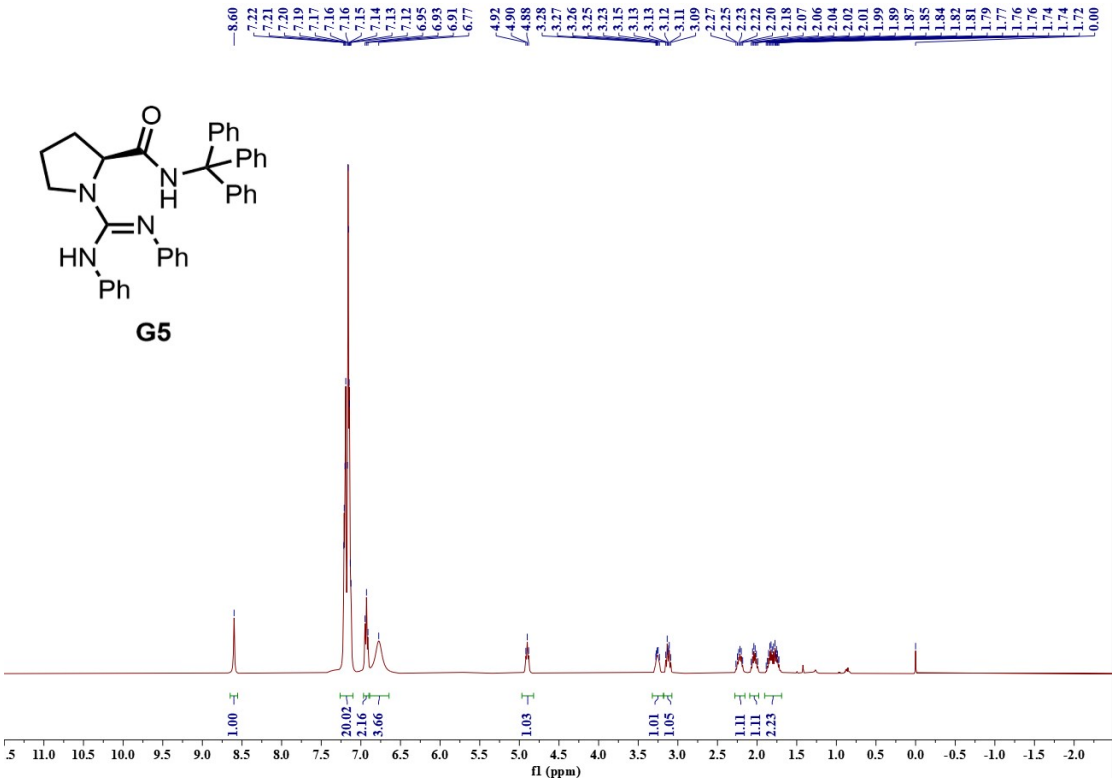

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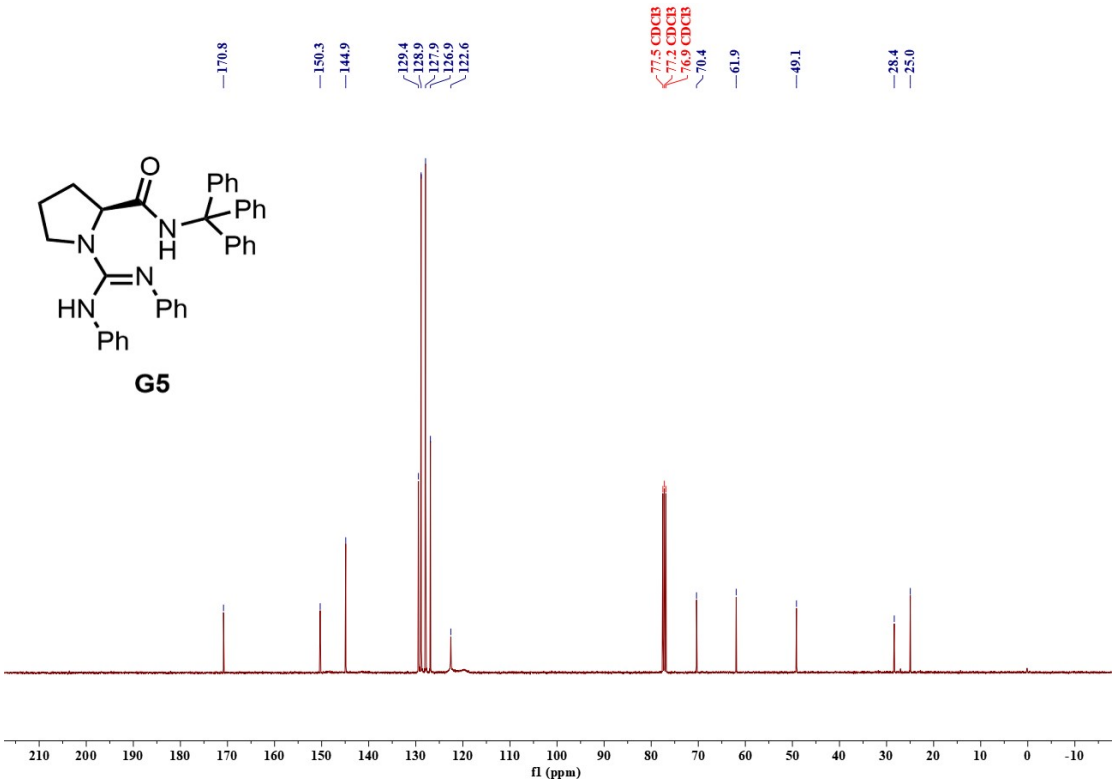
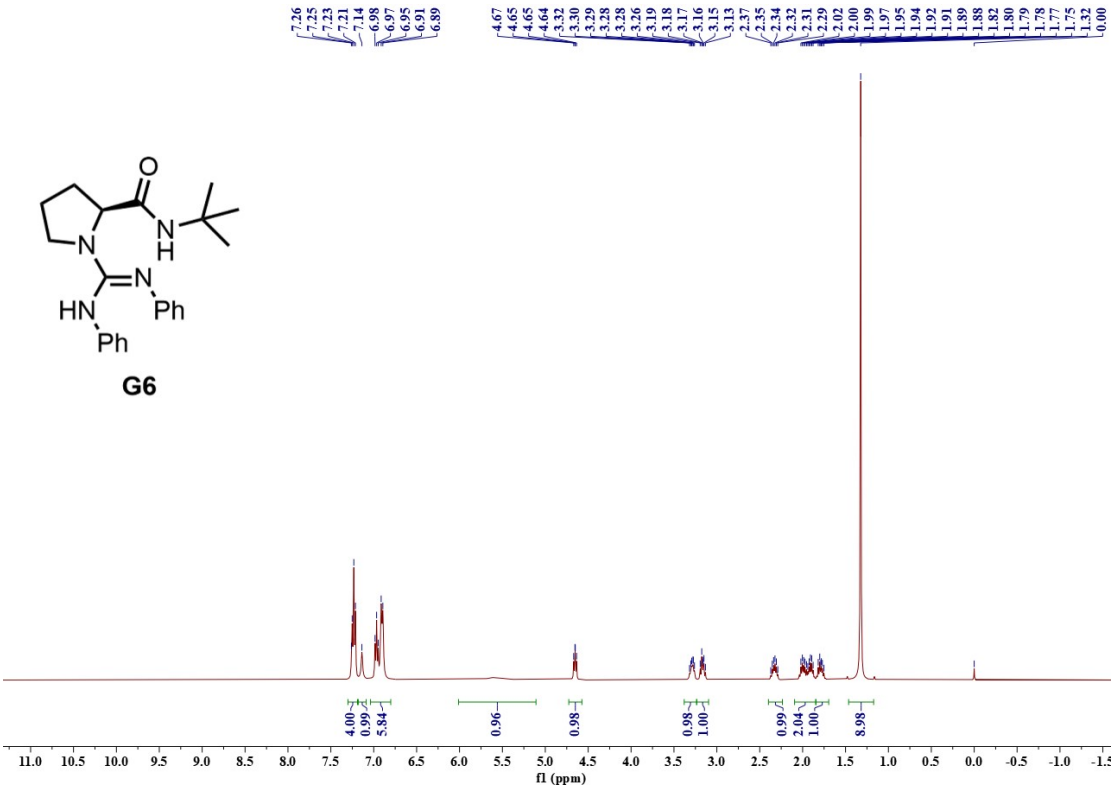


H NMR (400 MHz, $CDCl_3$) spectrum for G6



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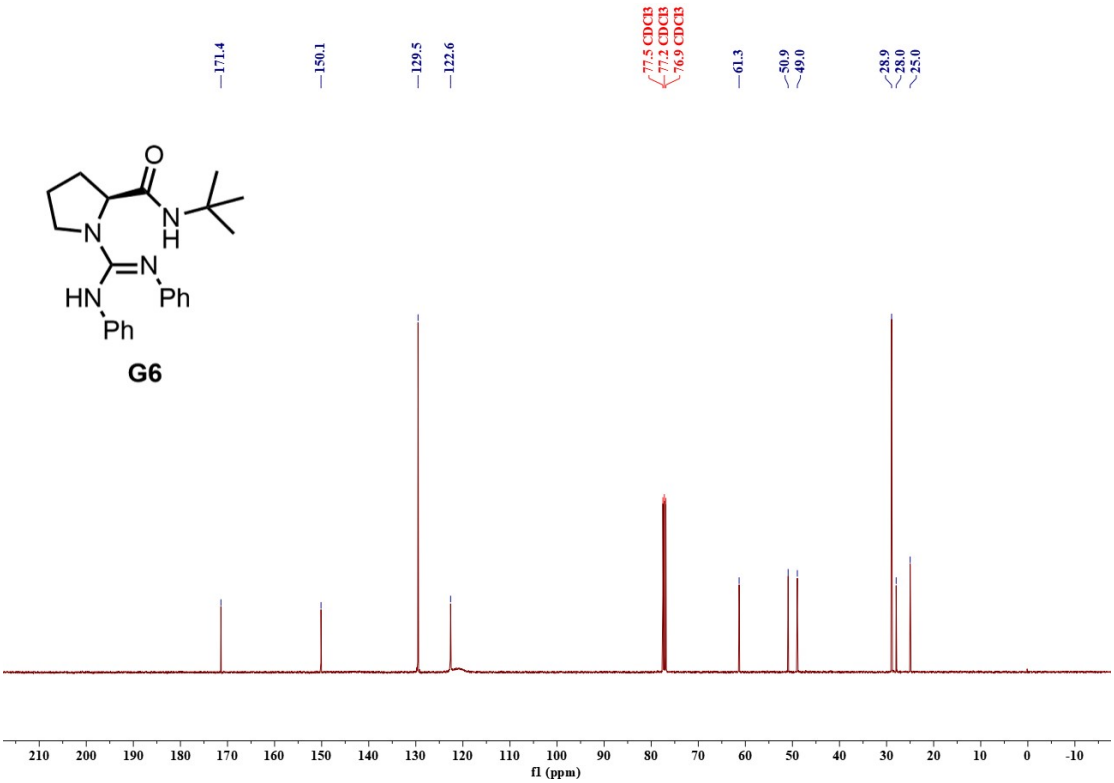

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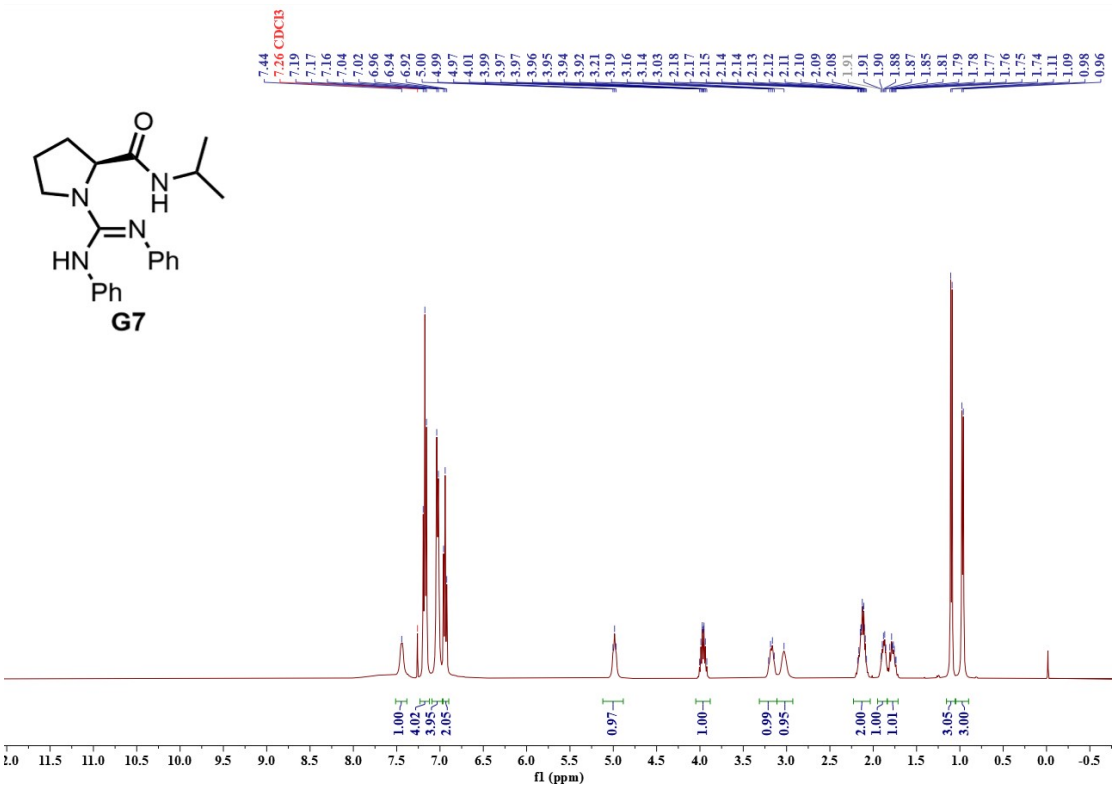

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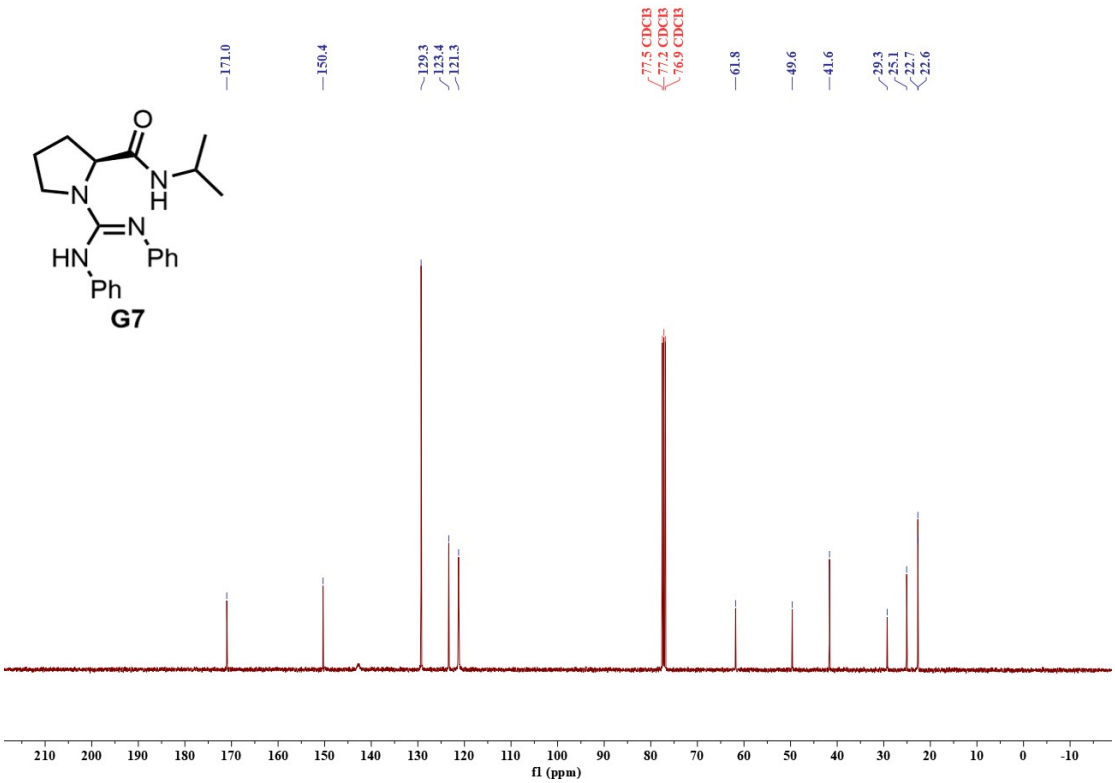

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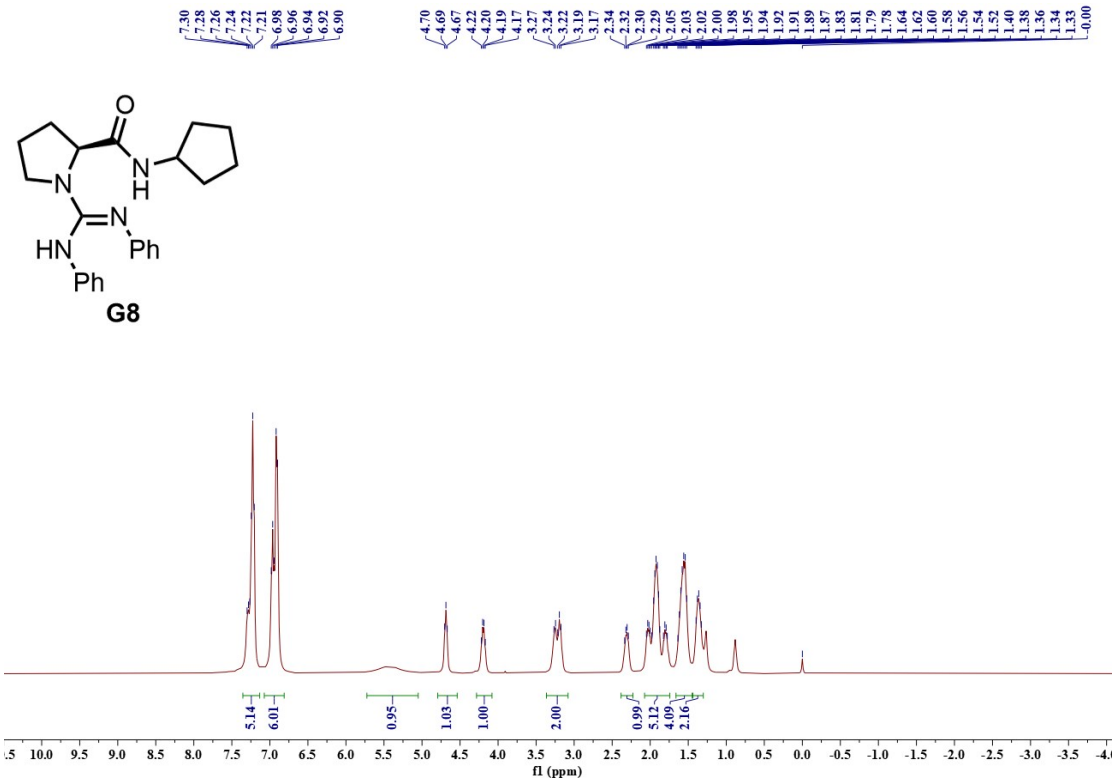

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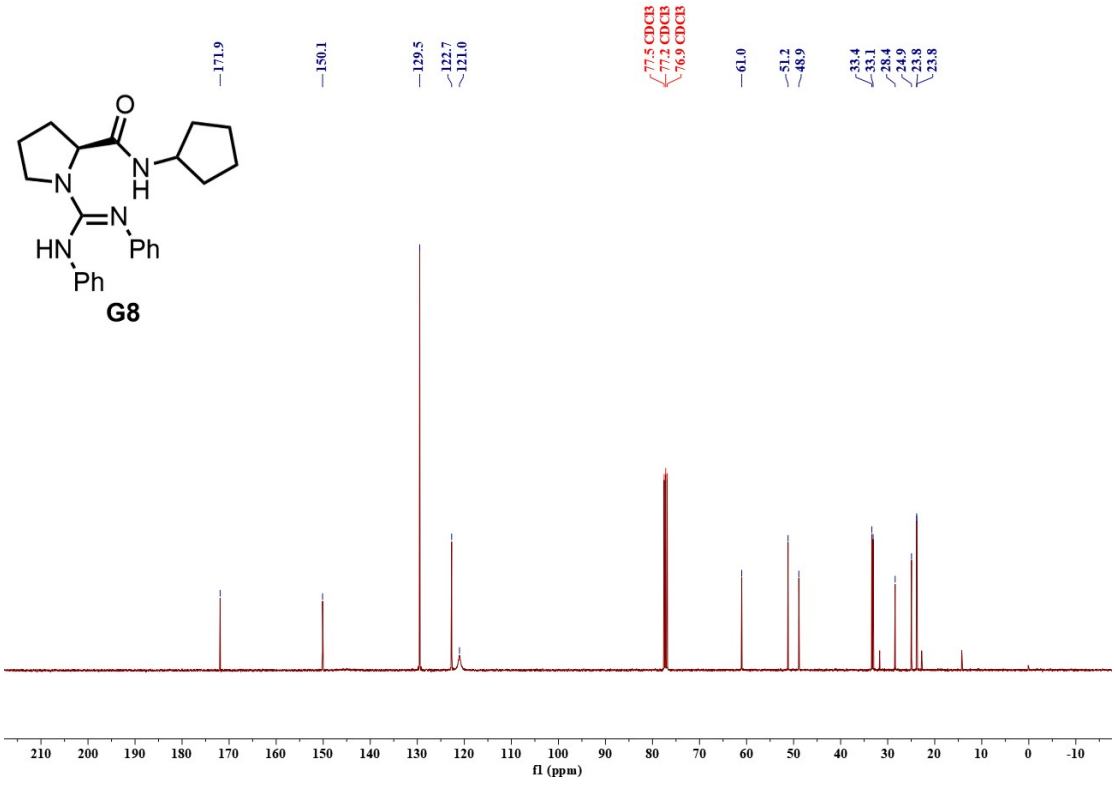

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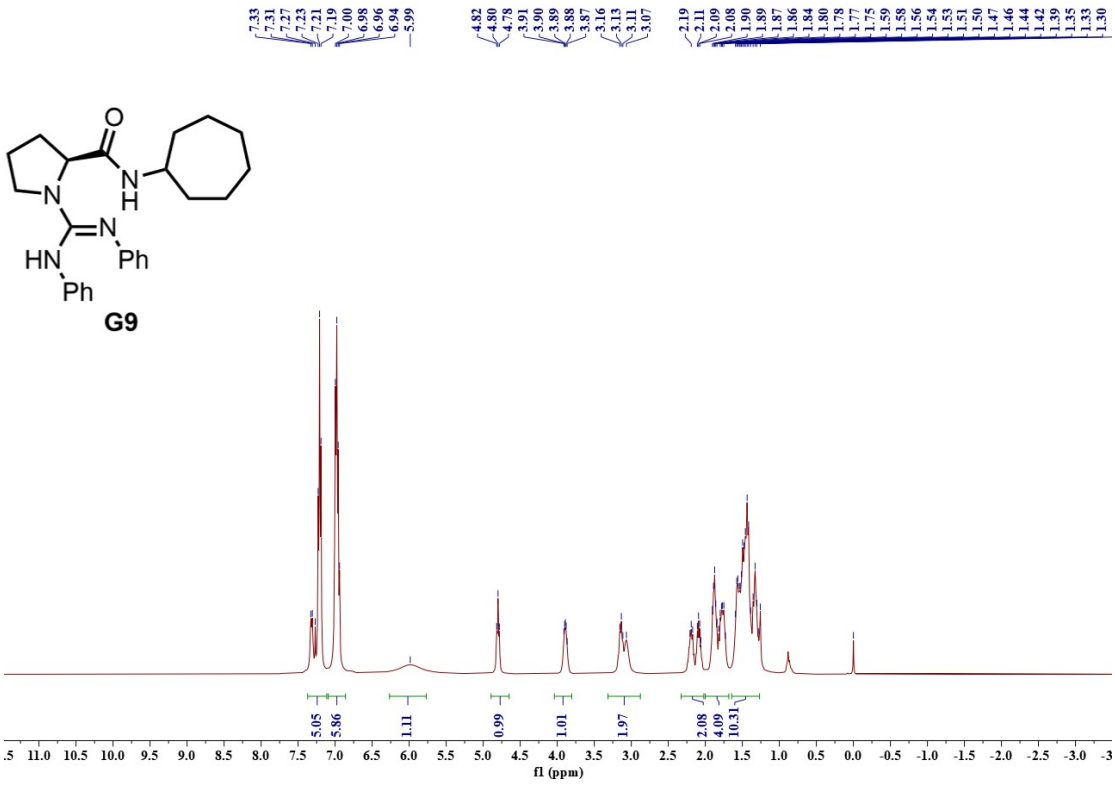

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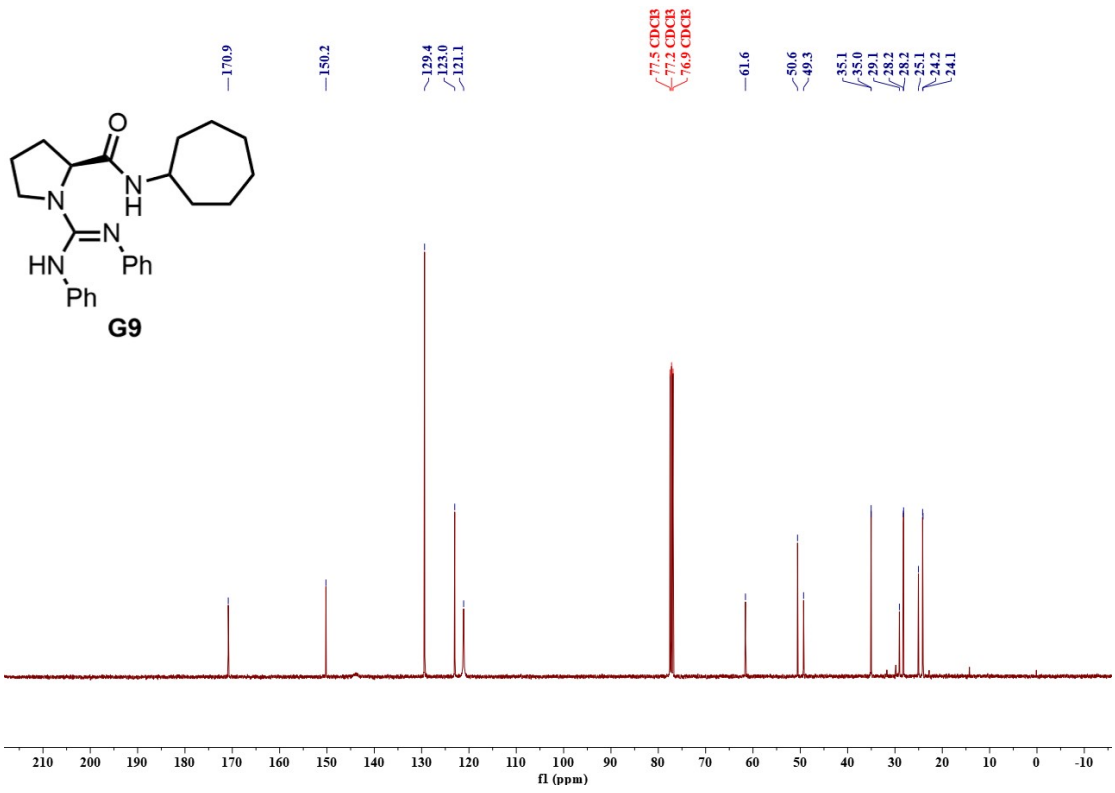

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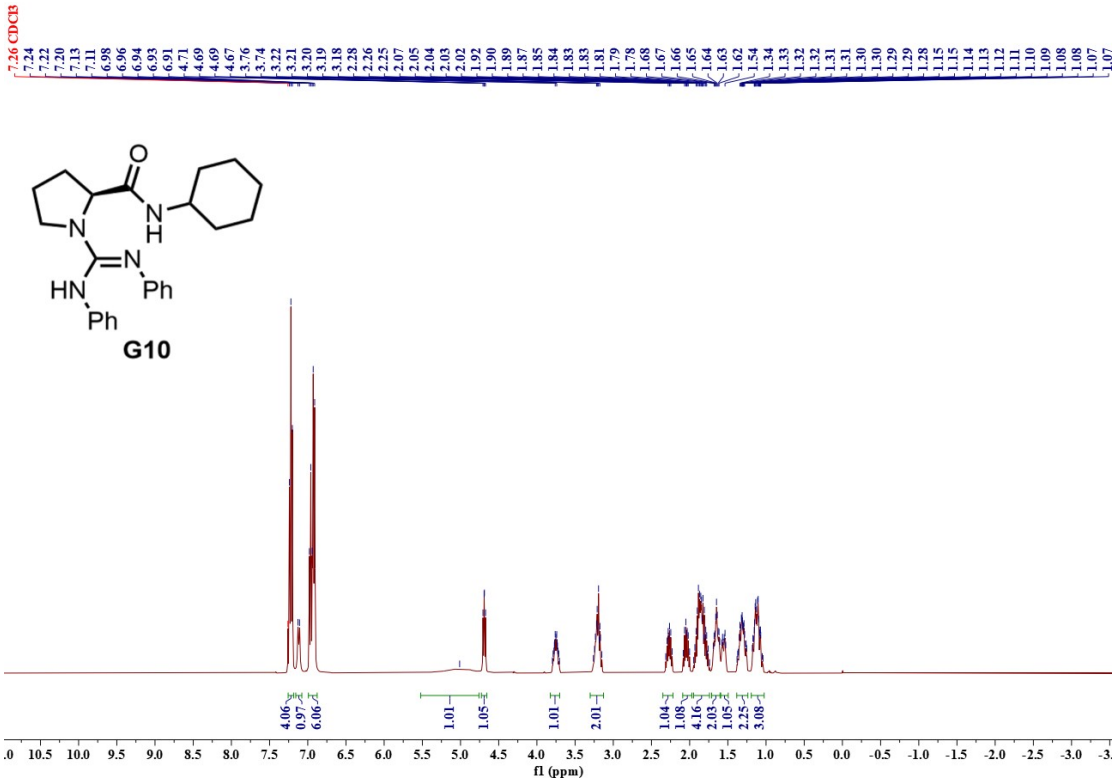

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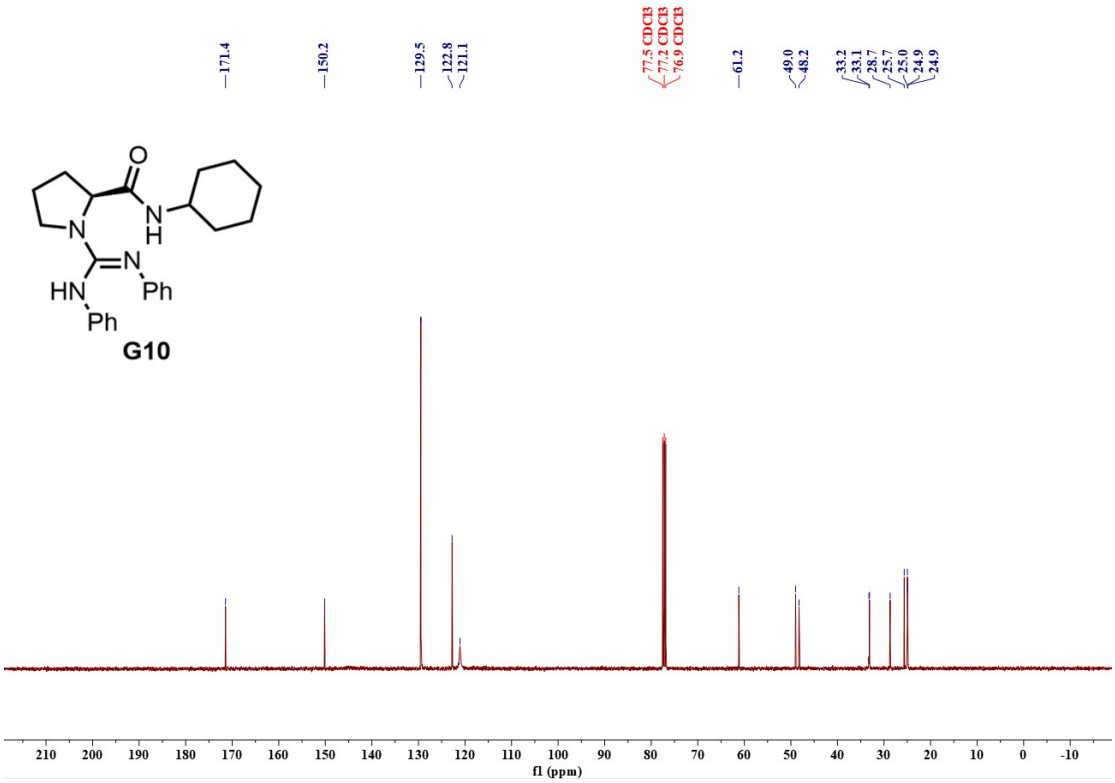

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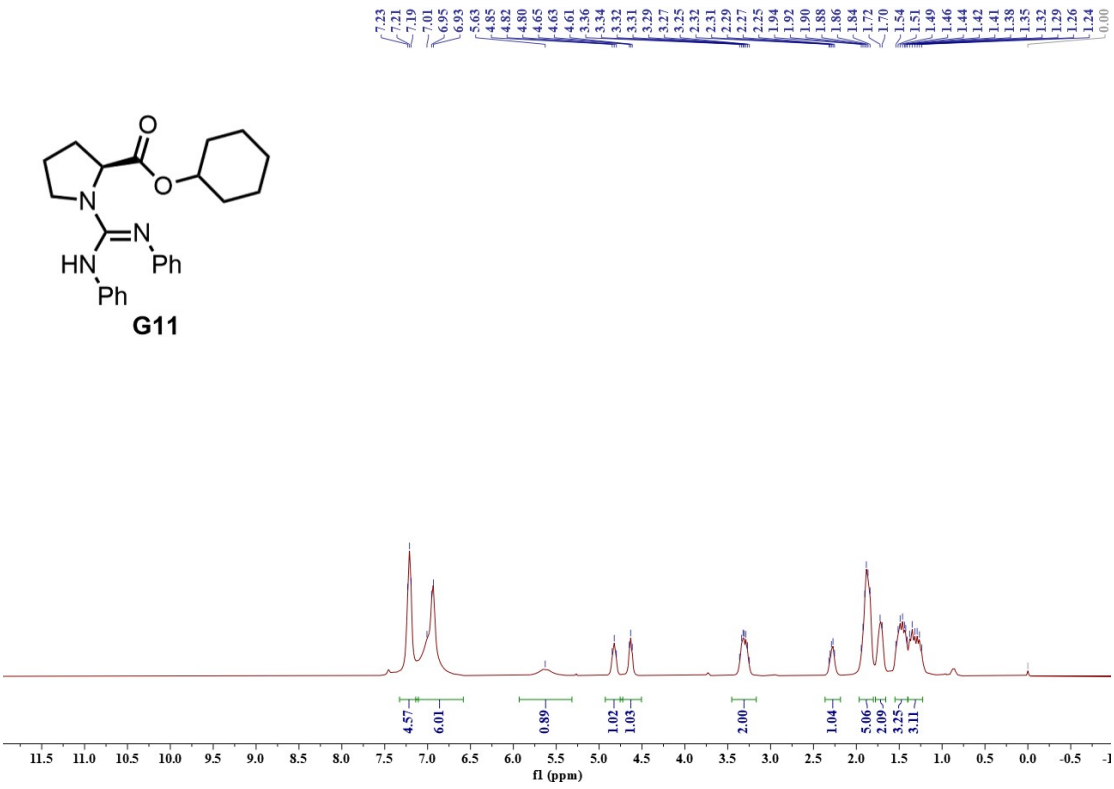

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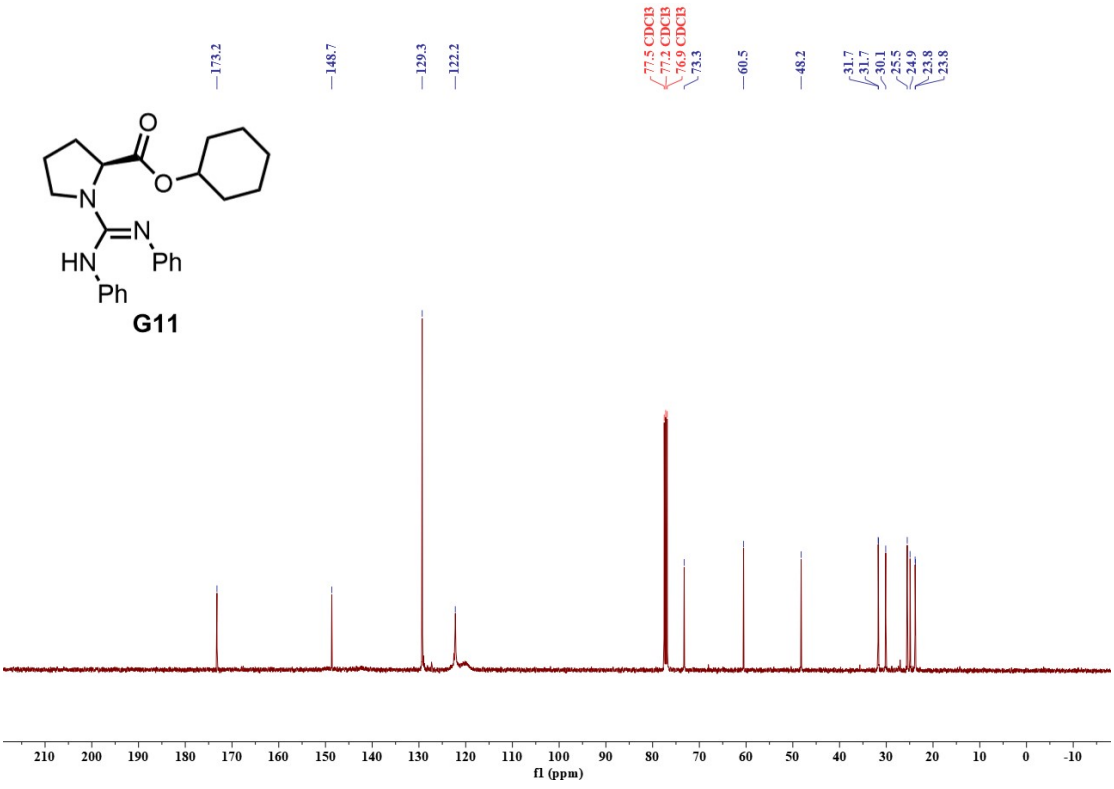
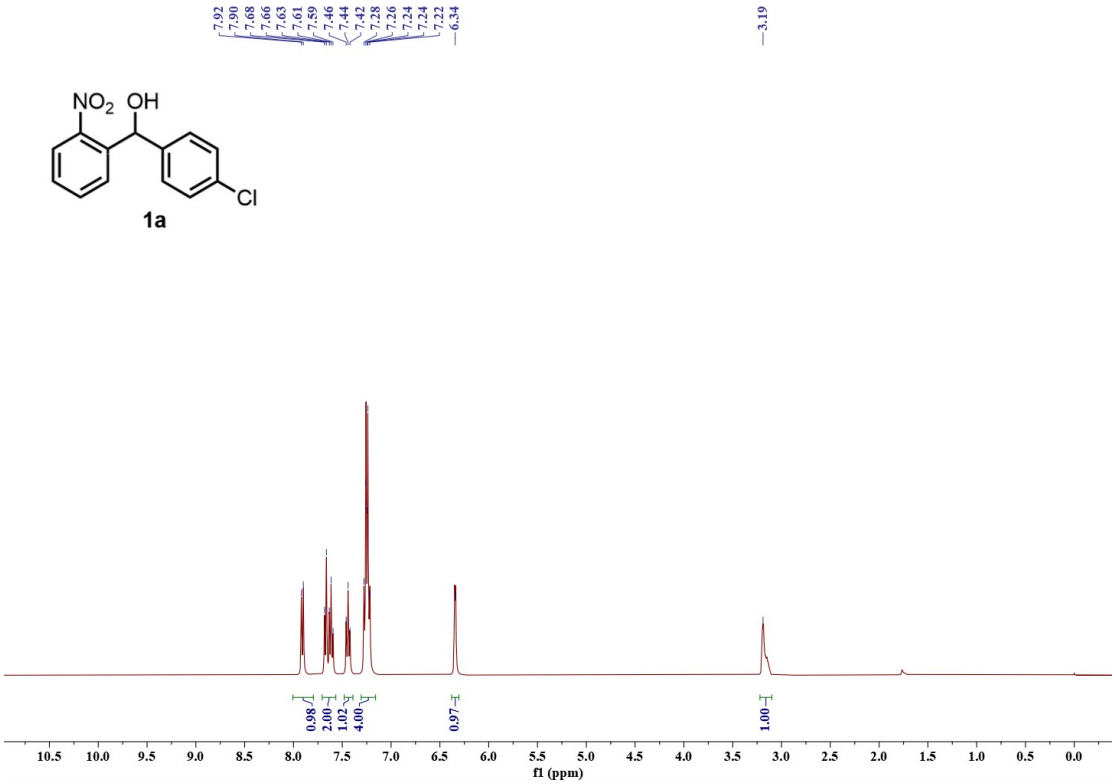


^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1a



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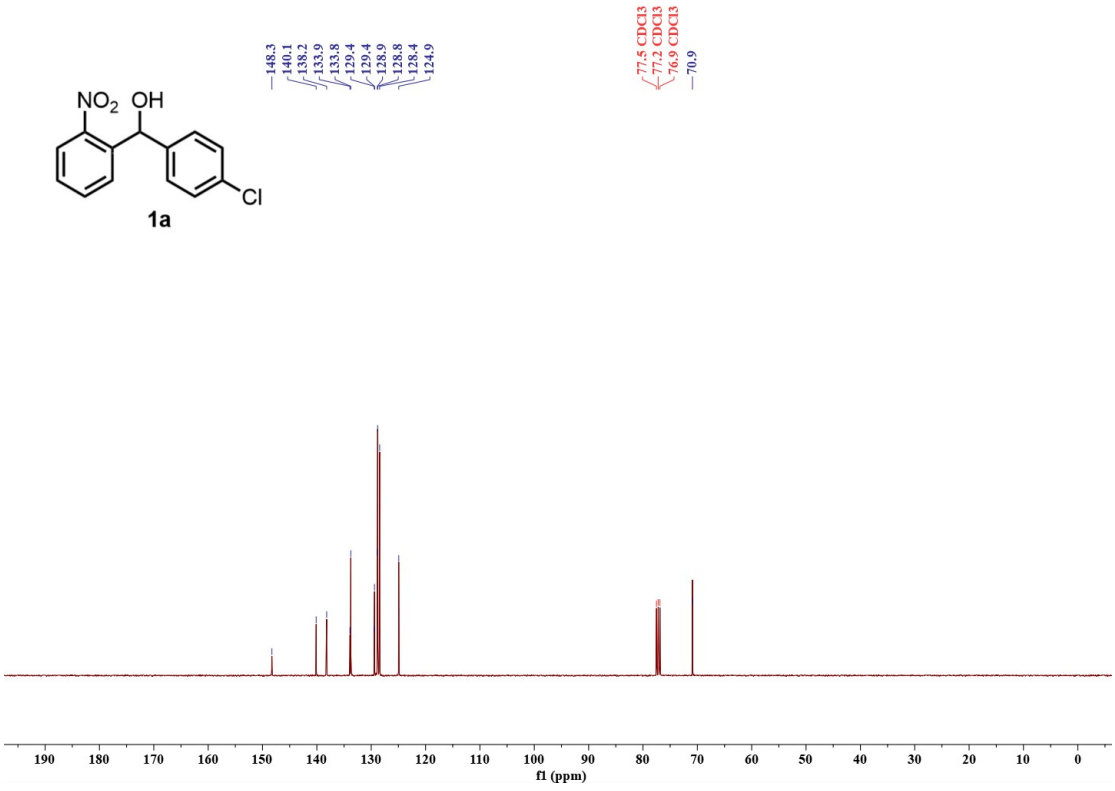
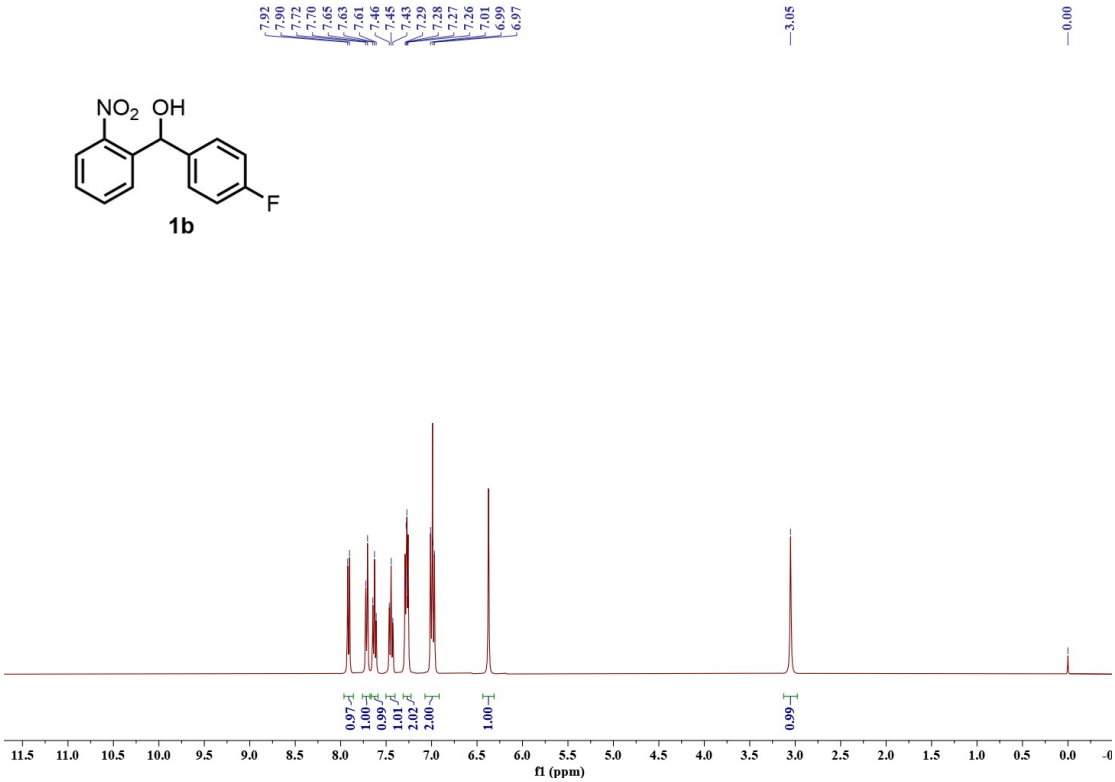


^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1b



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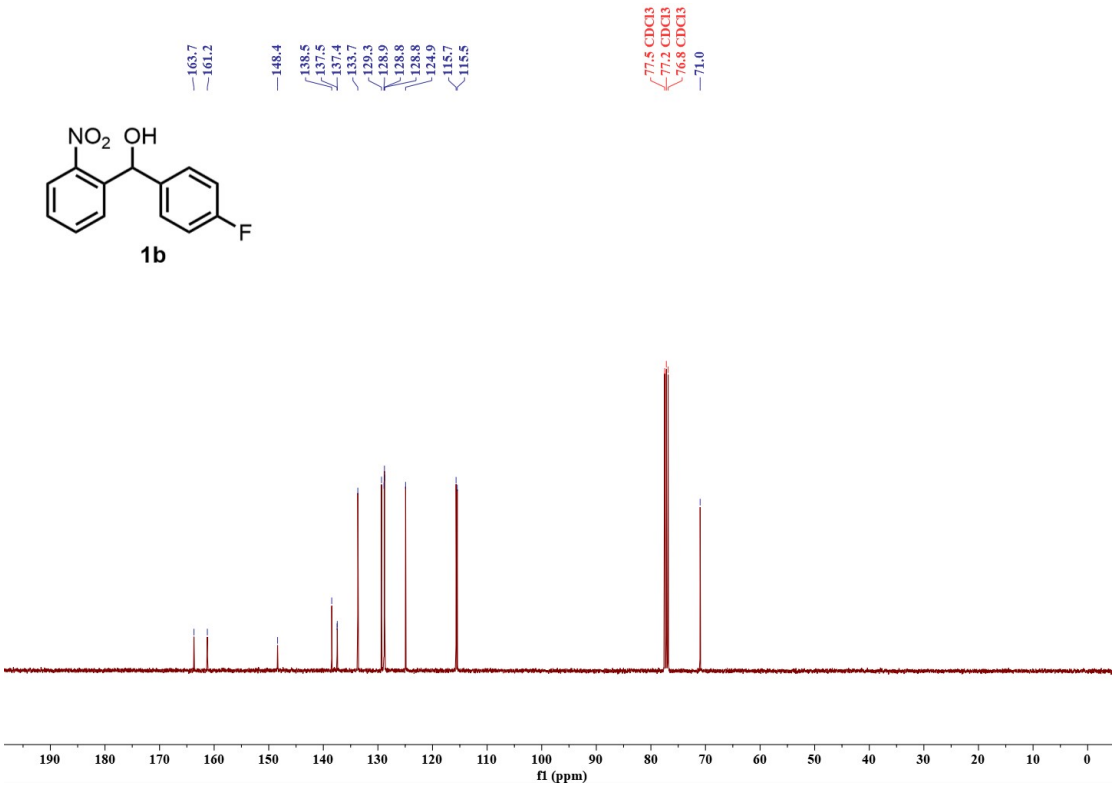
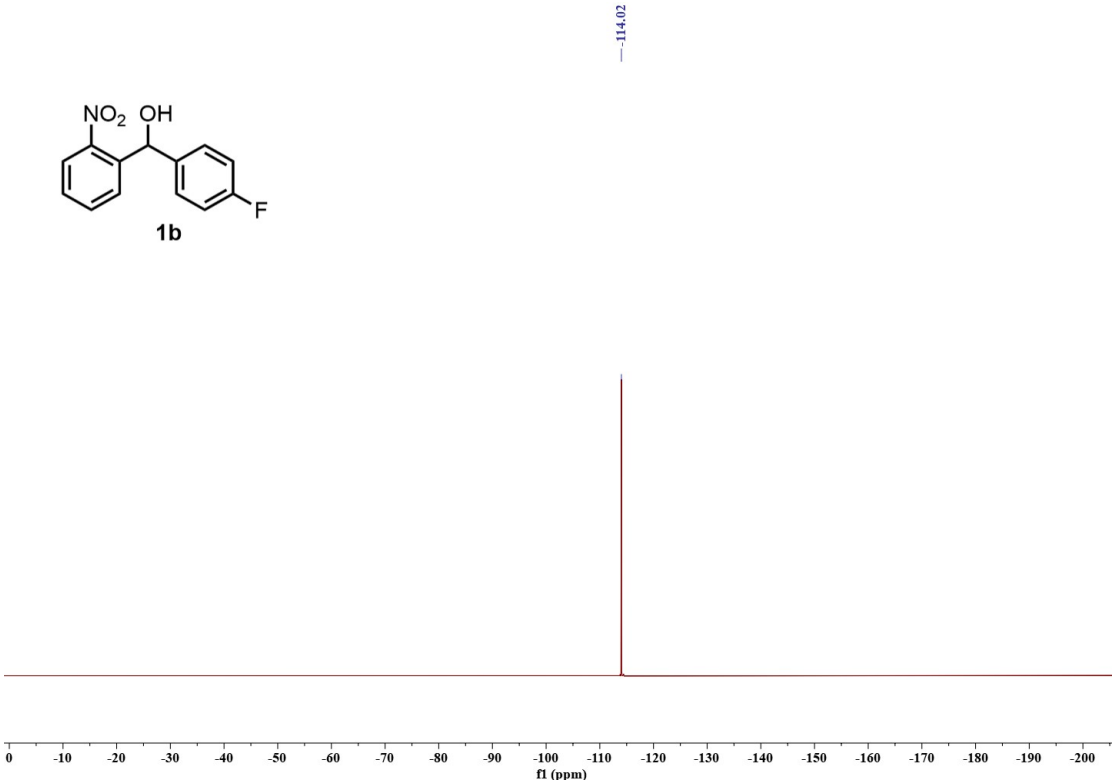


^{19}F NMR (376 MHz, $CDCl_3$) spectrum for 1b

1b



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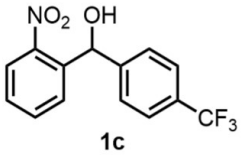
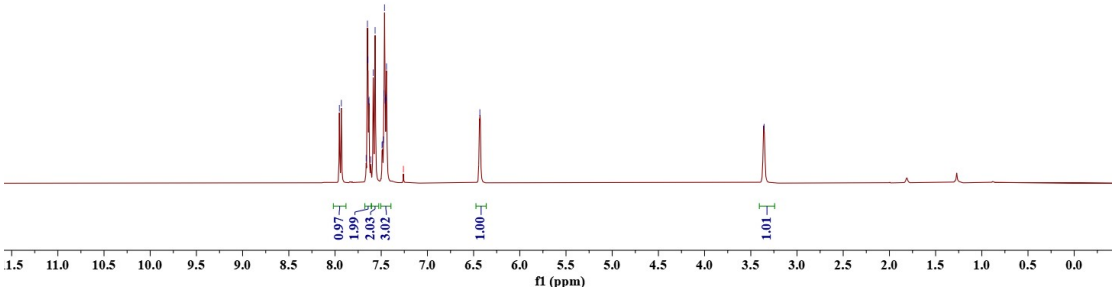


1c



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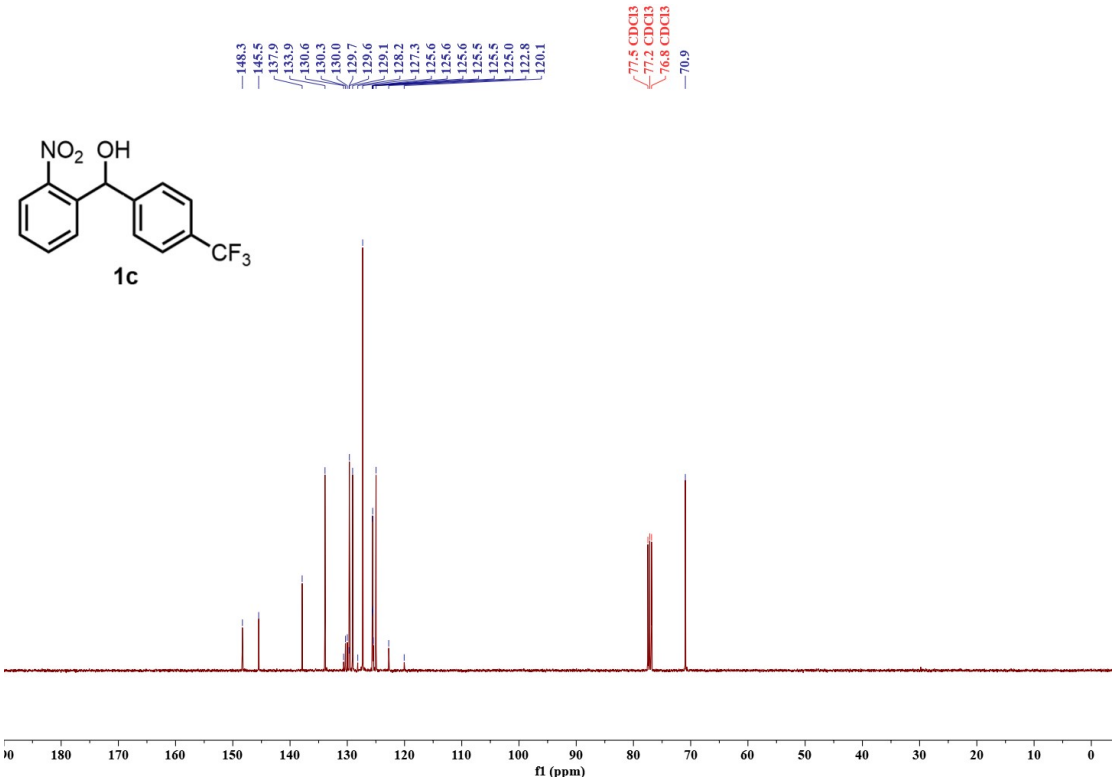

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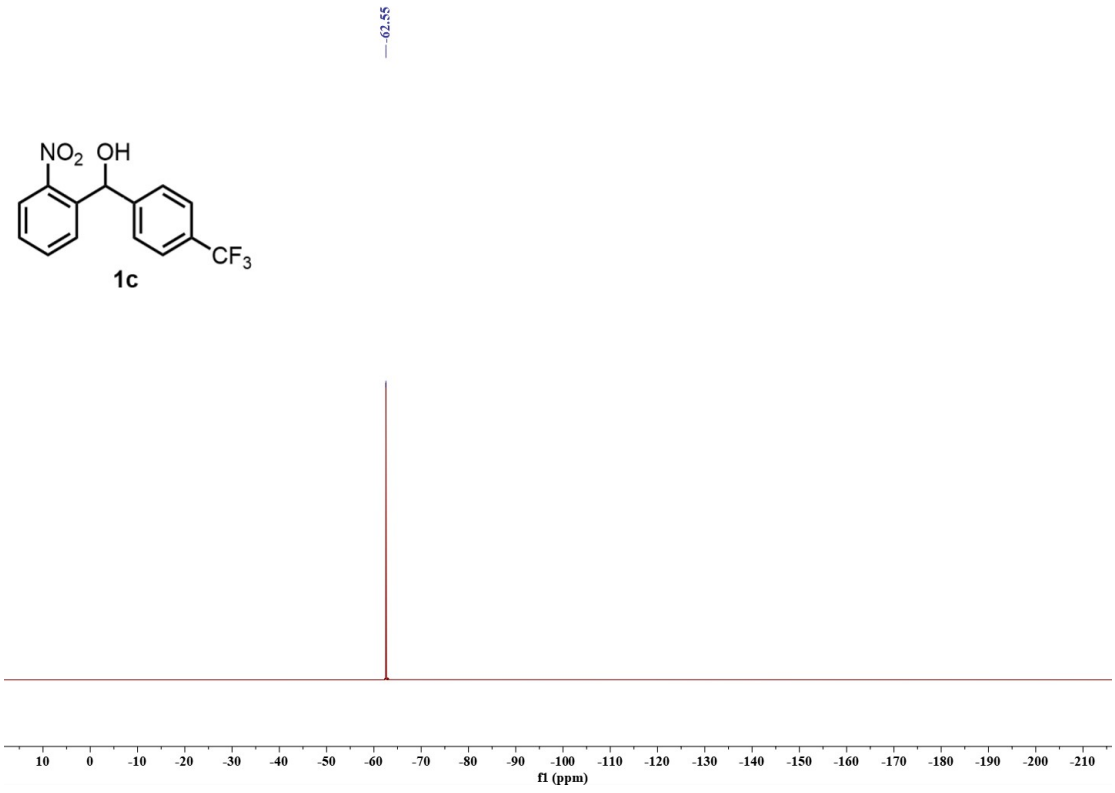

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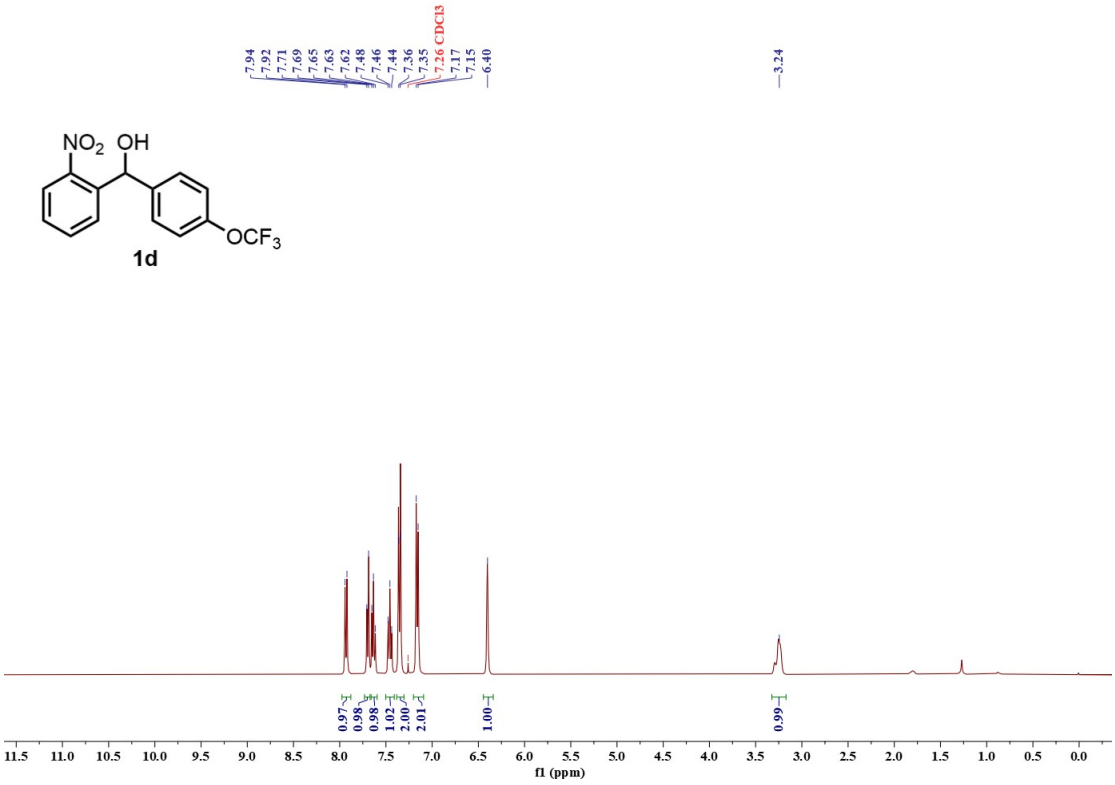

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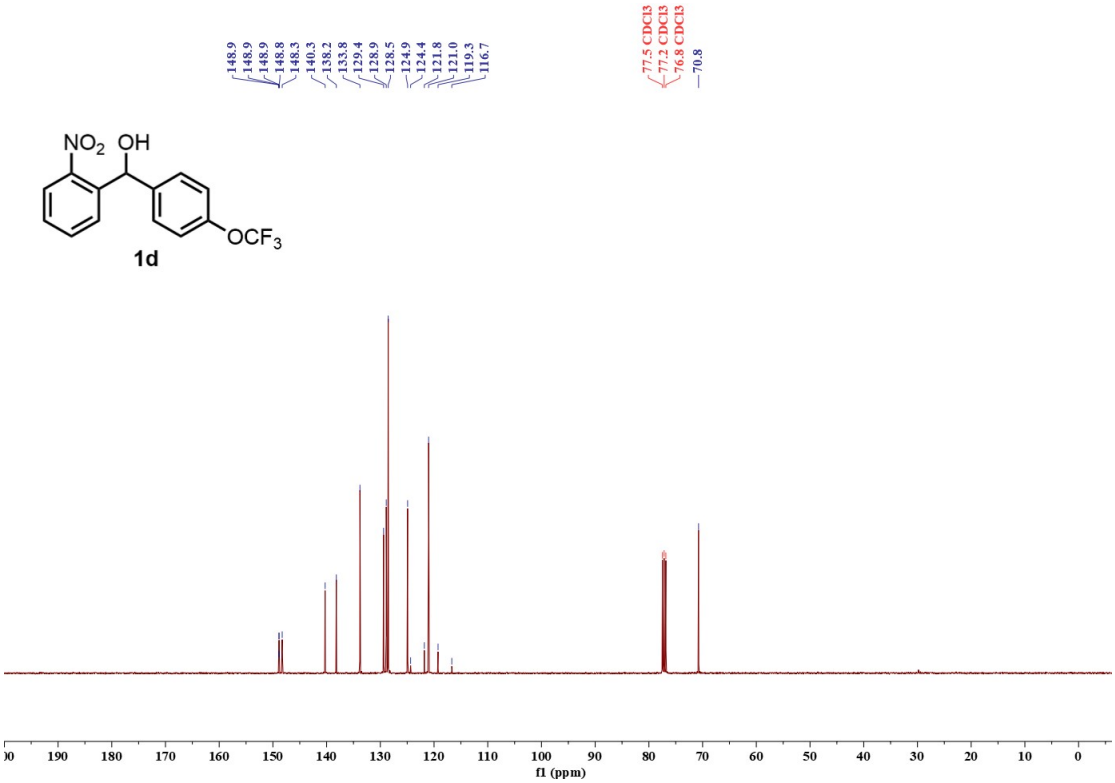

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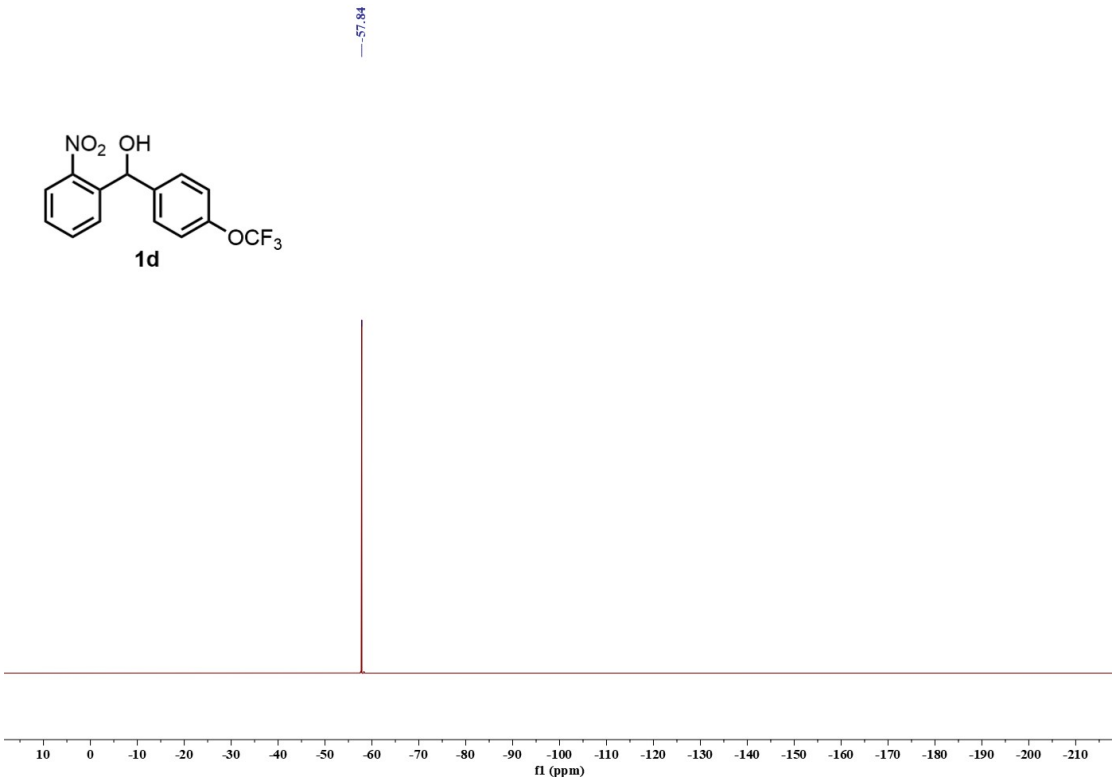

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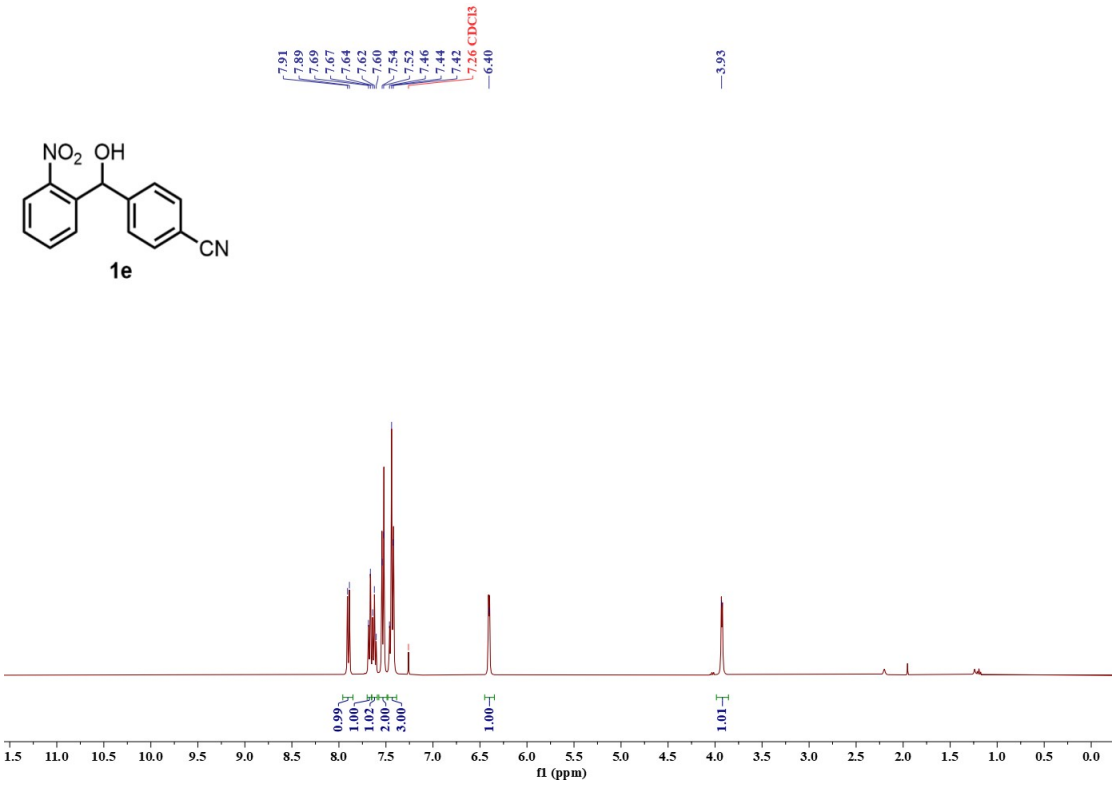

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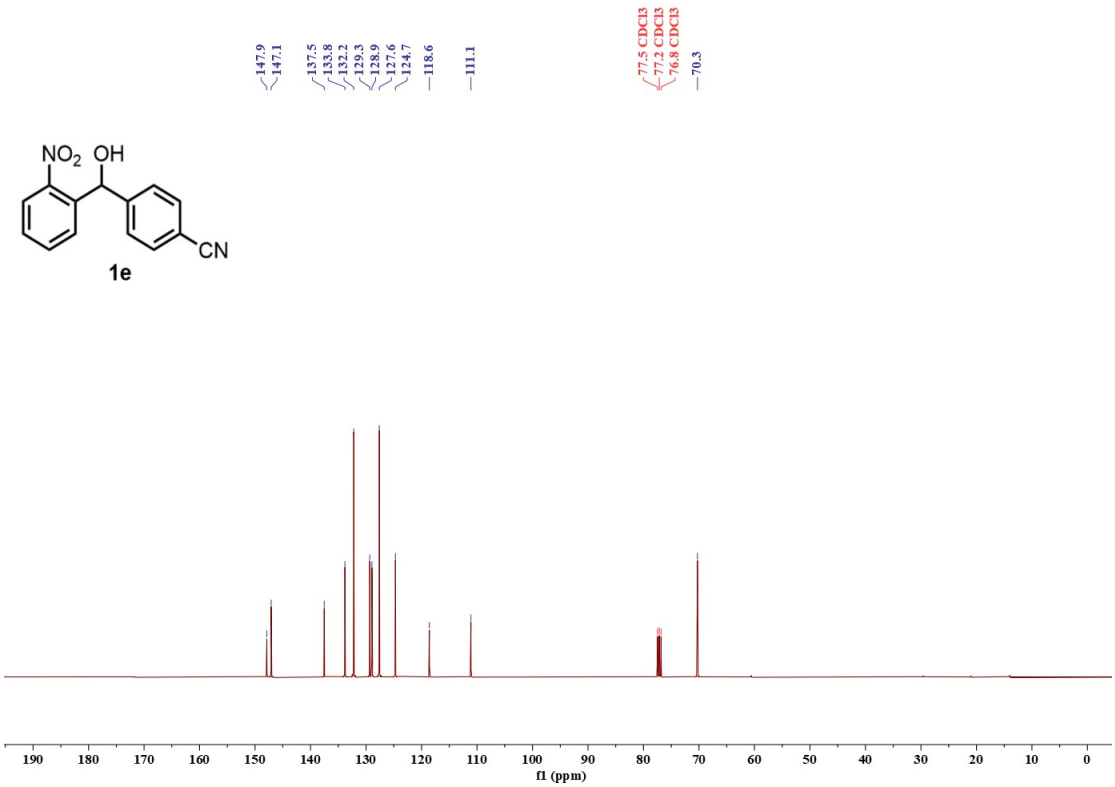

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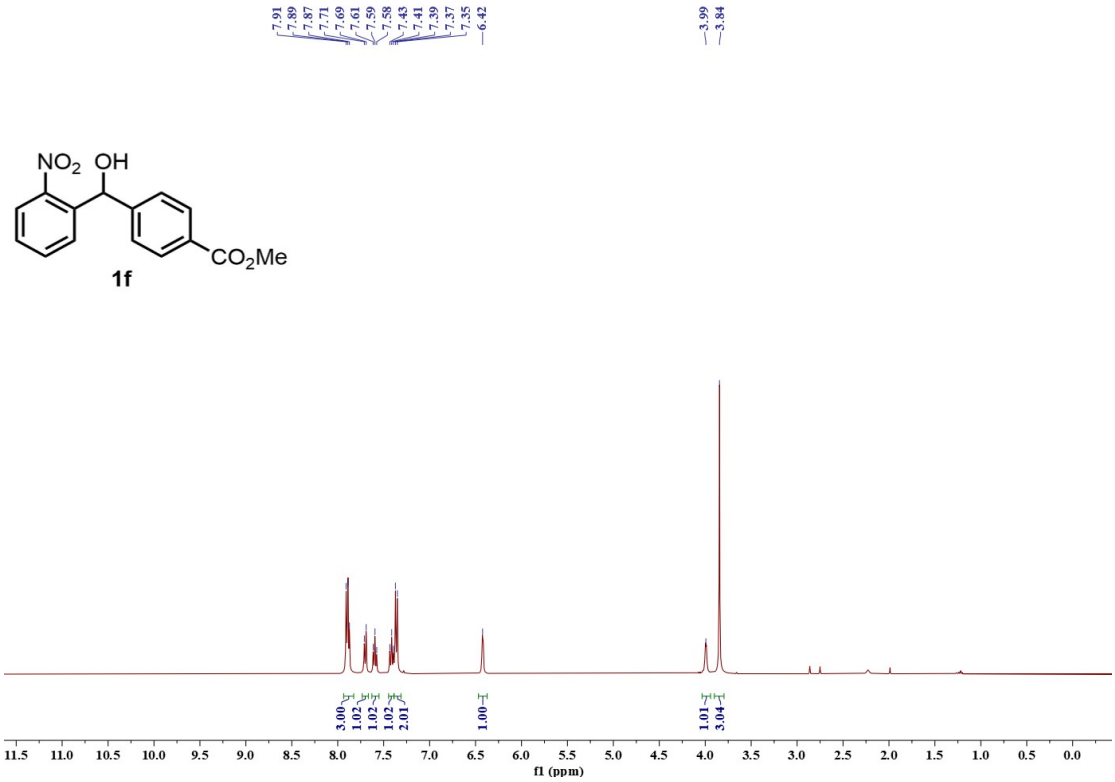

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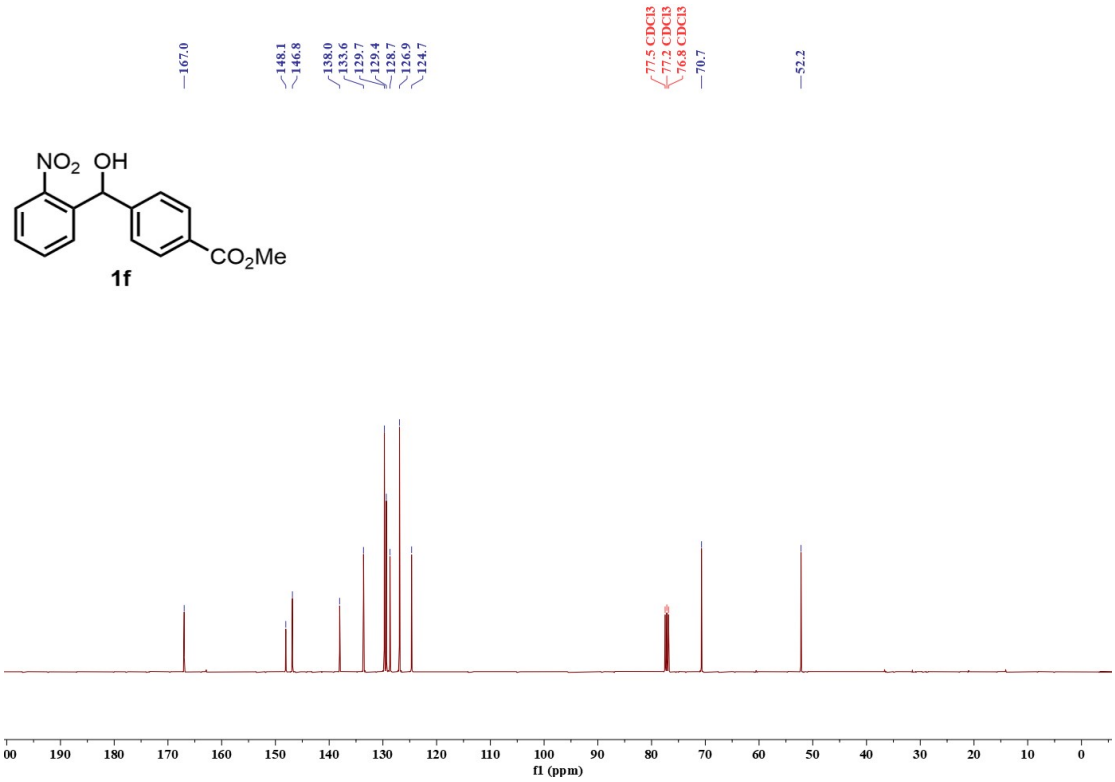

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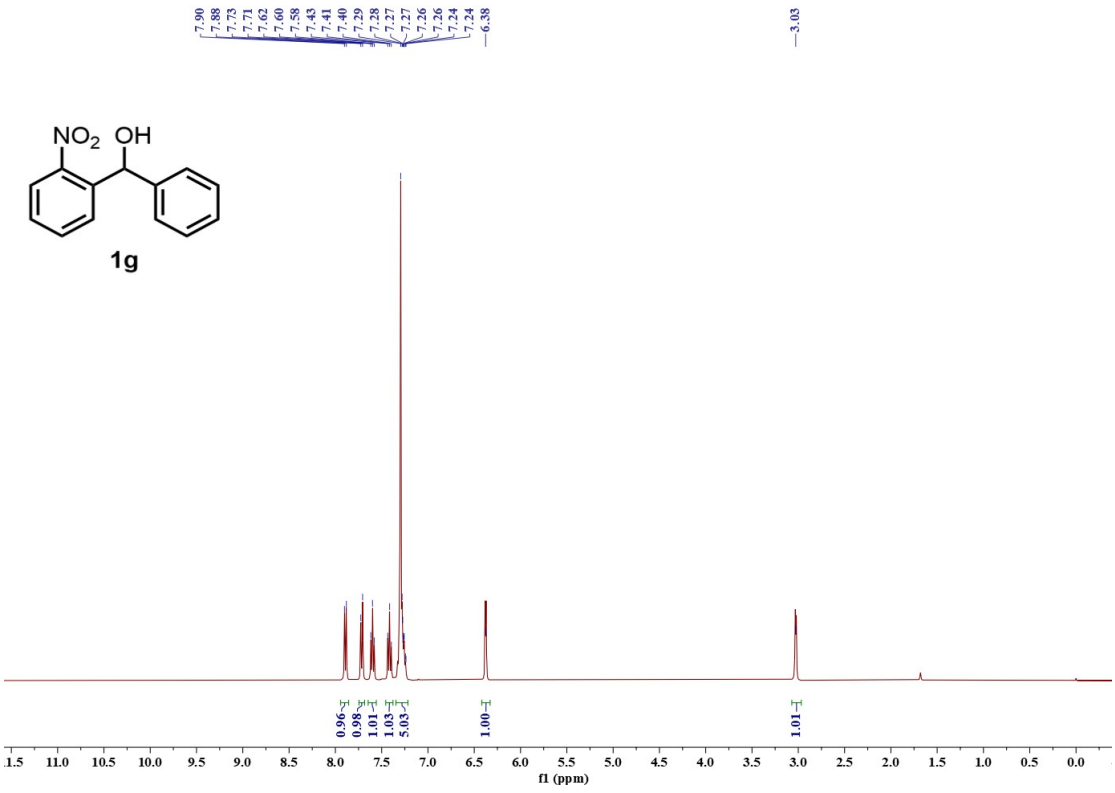

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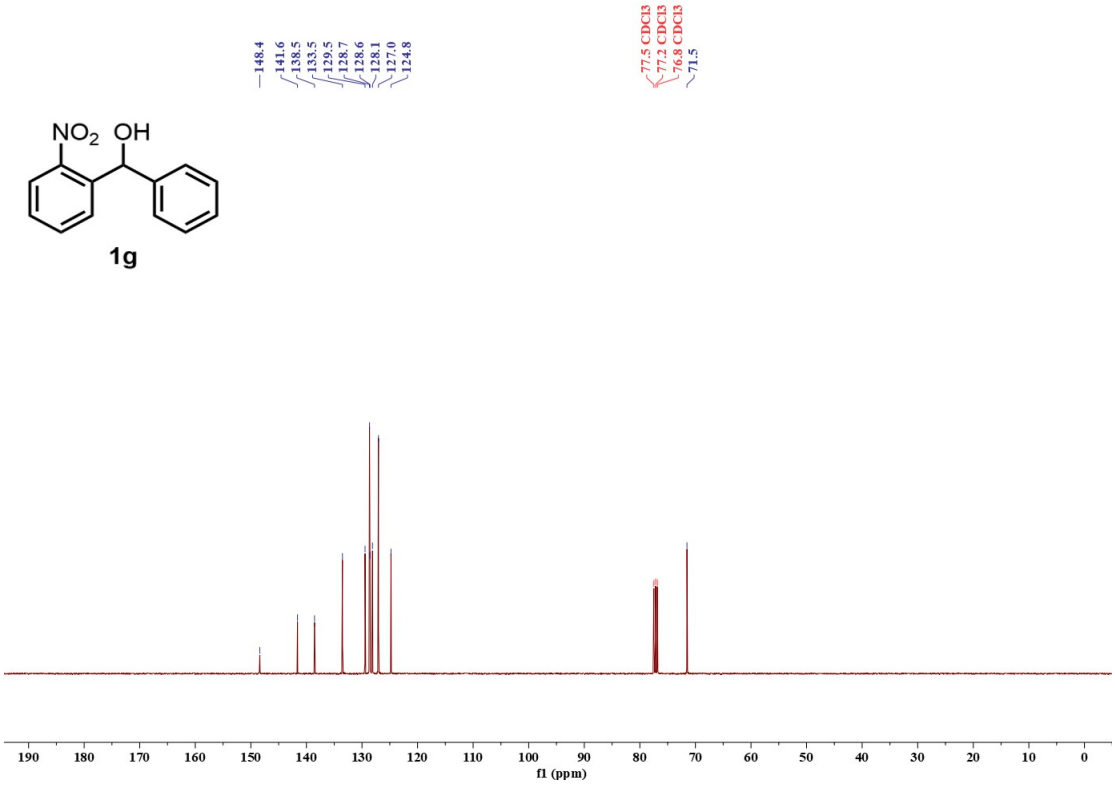

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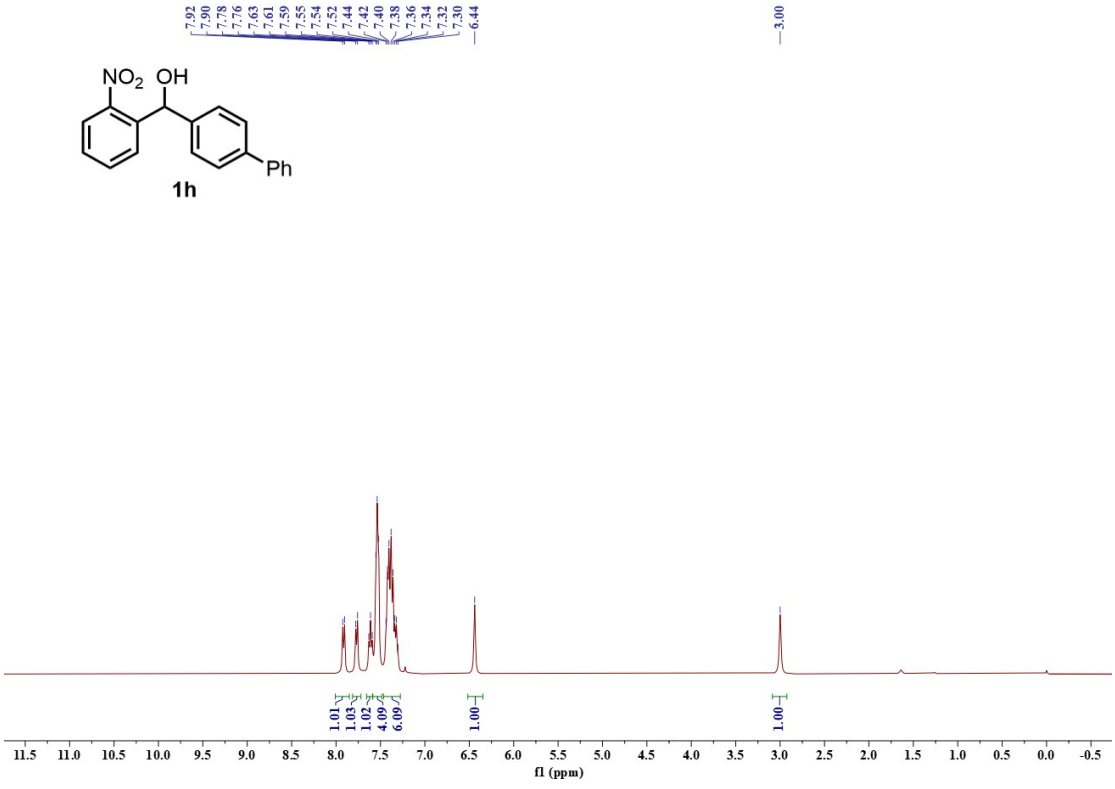

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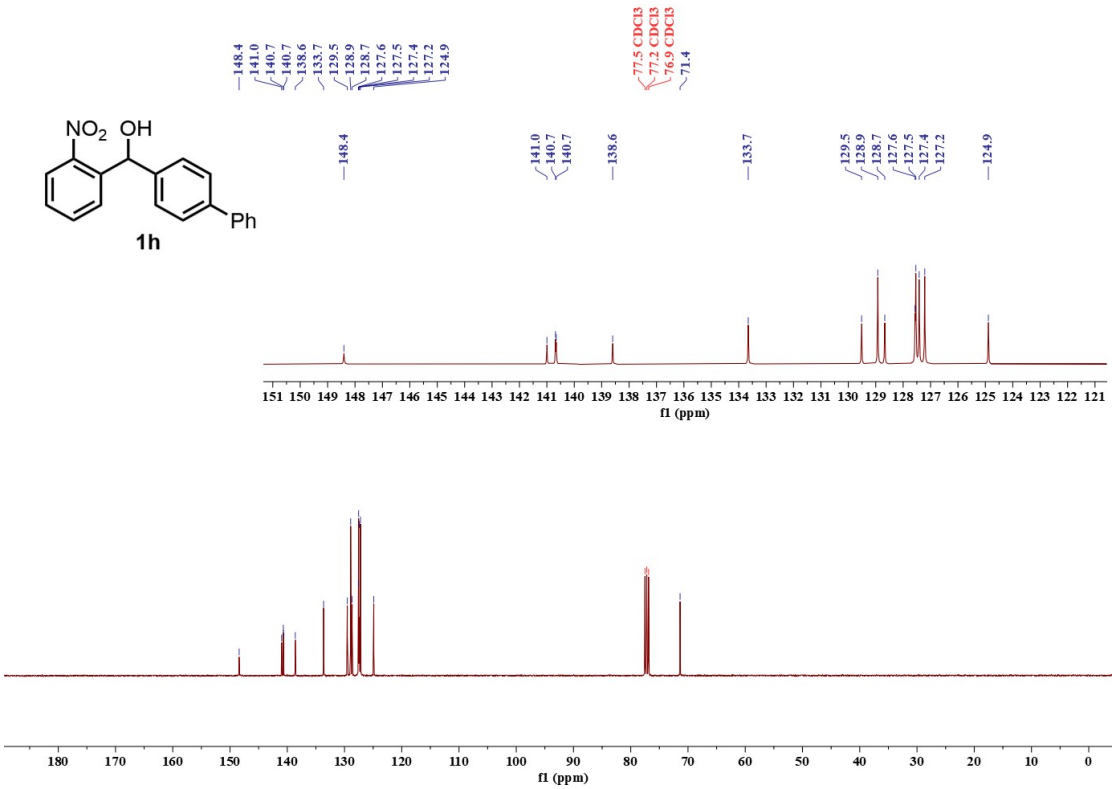

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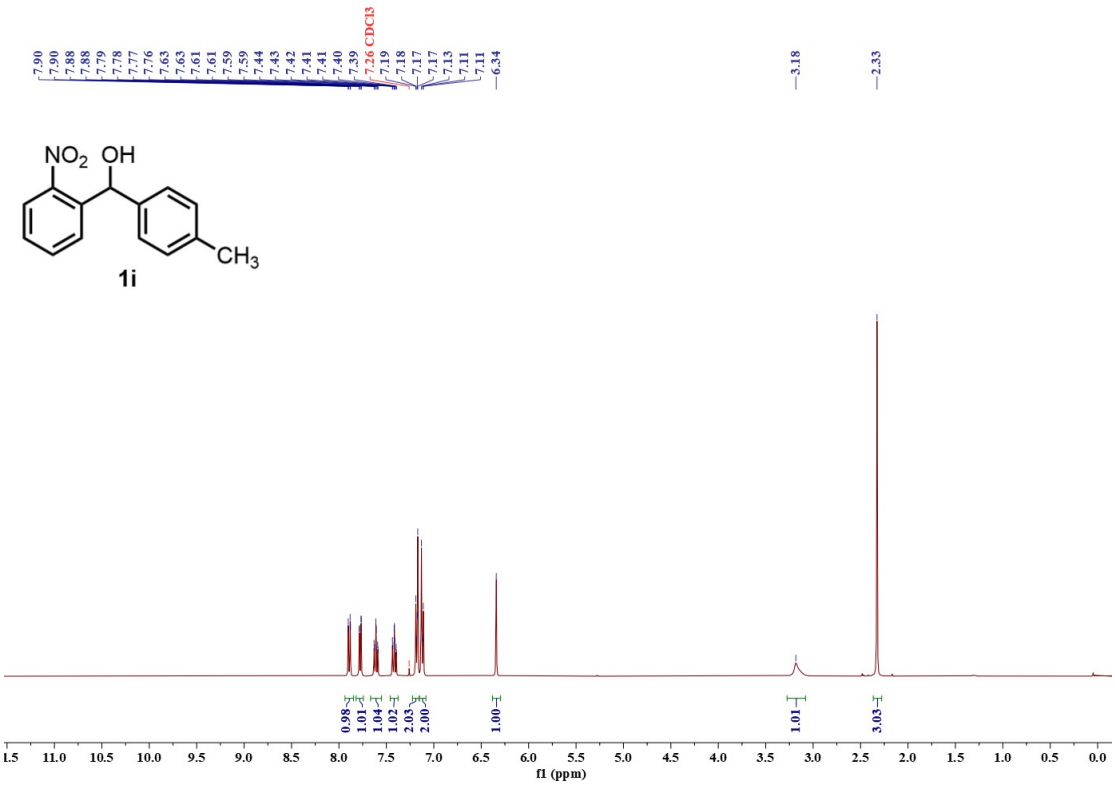

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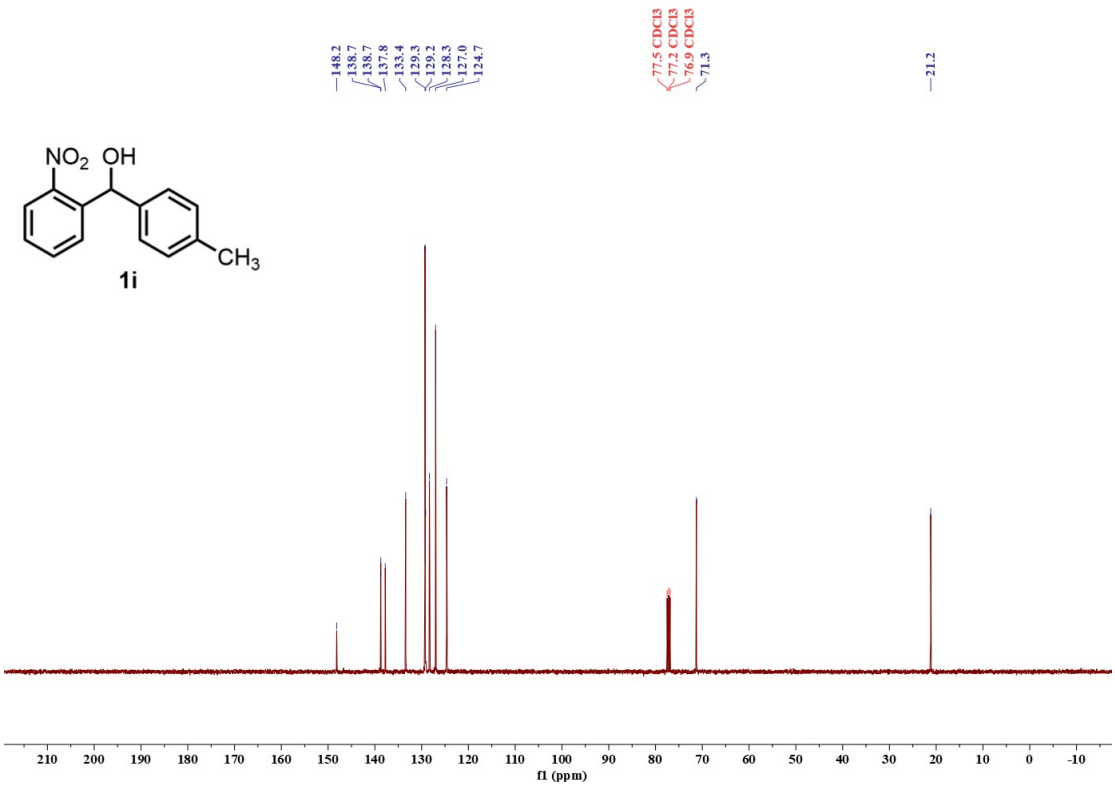
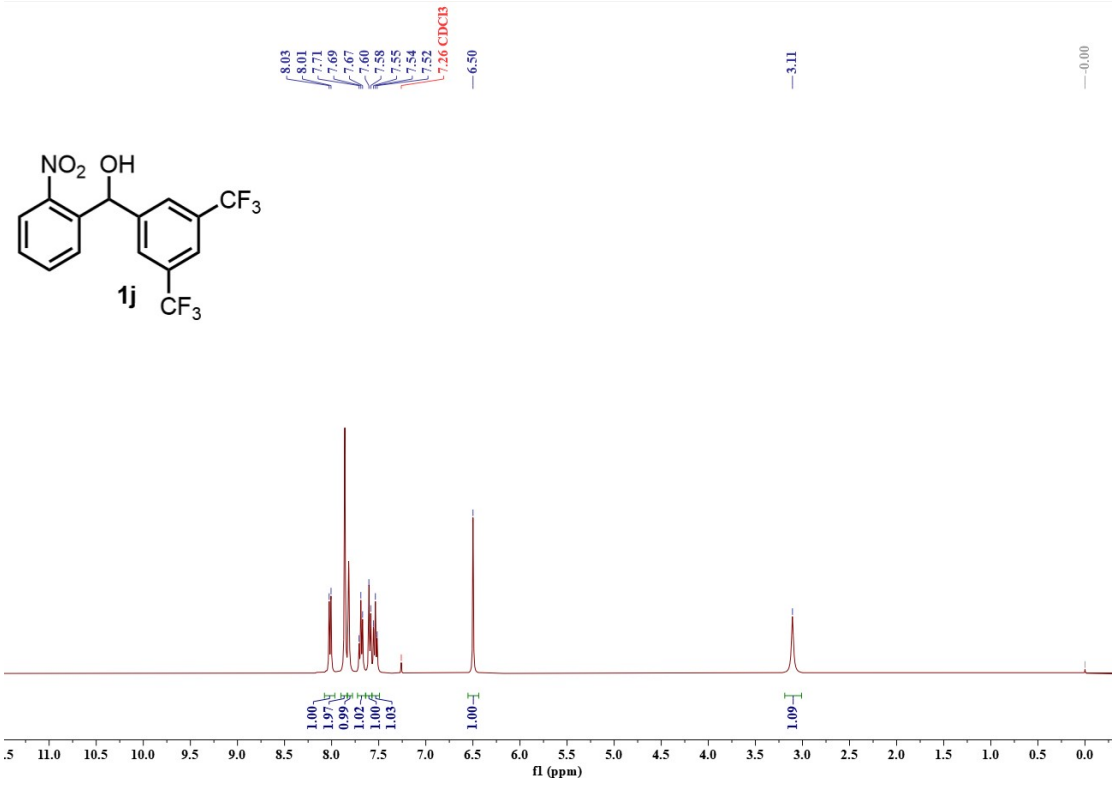
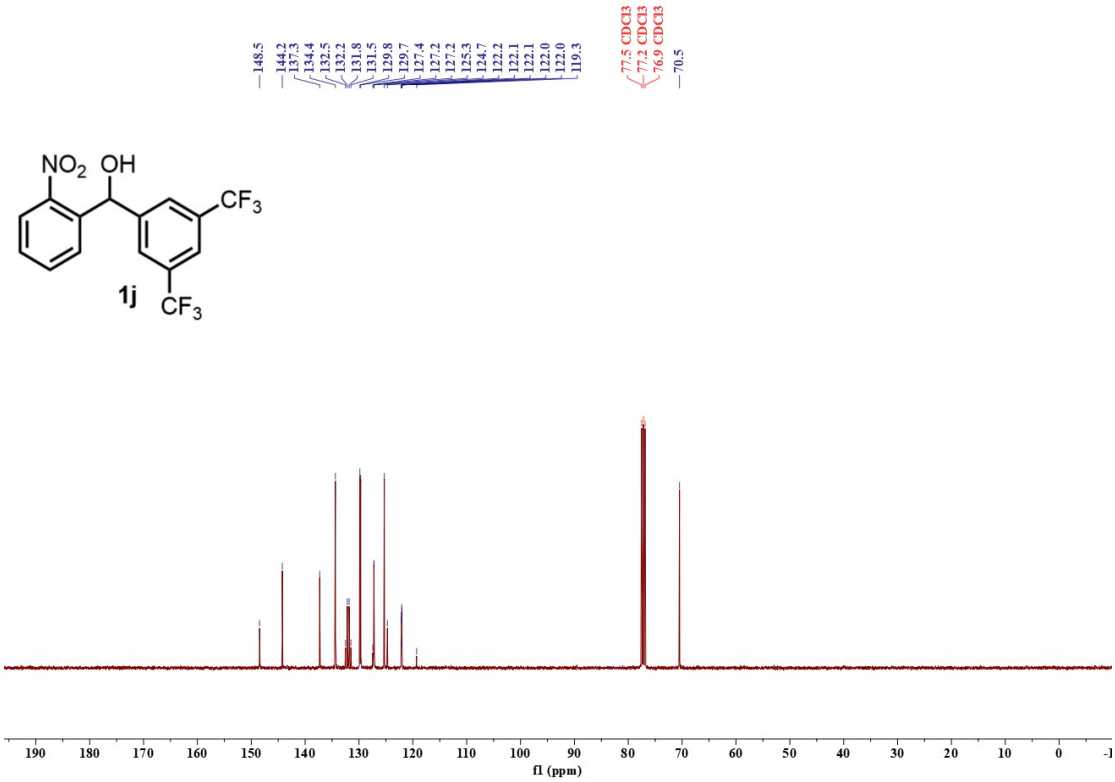


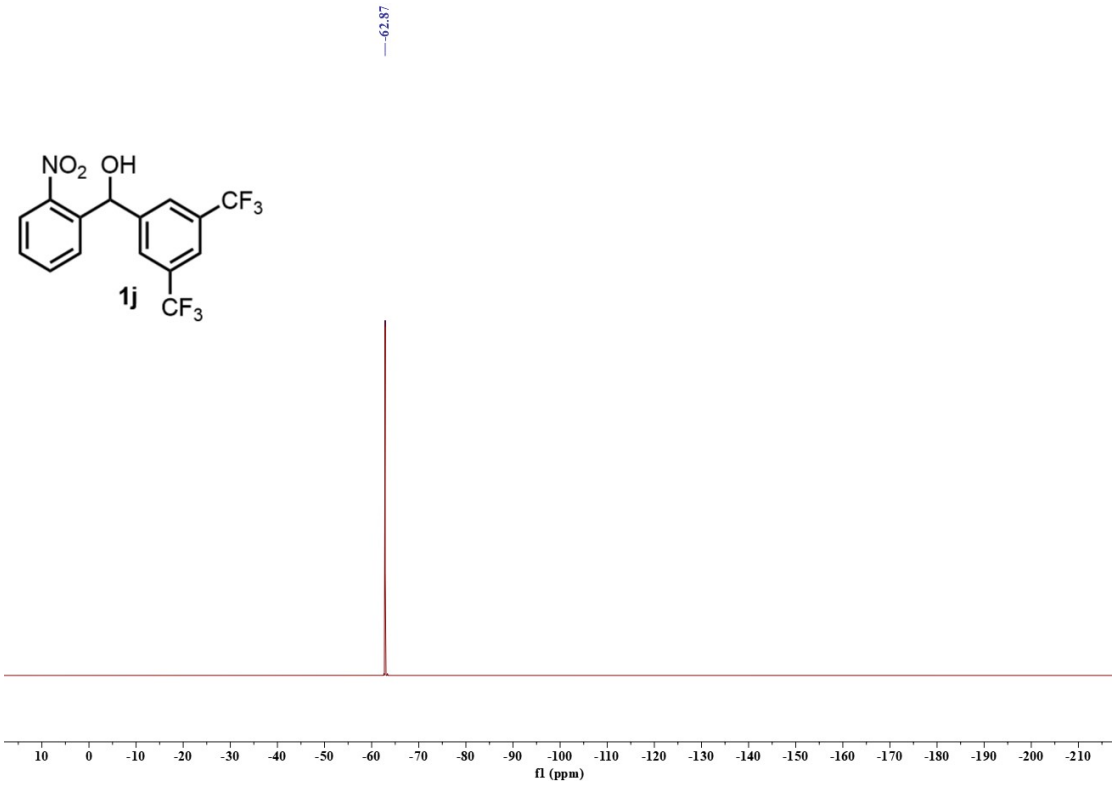
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1j



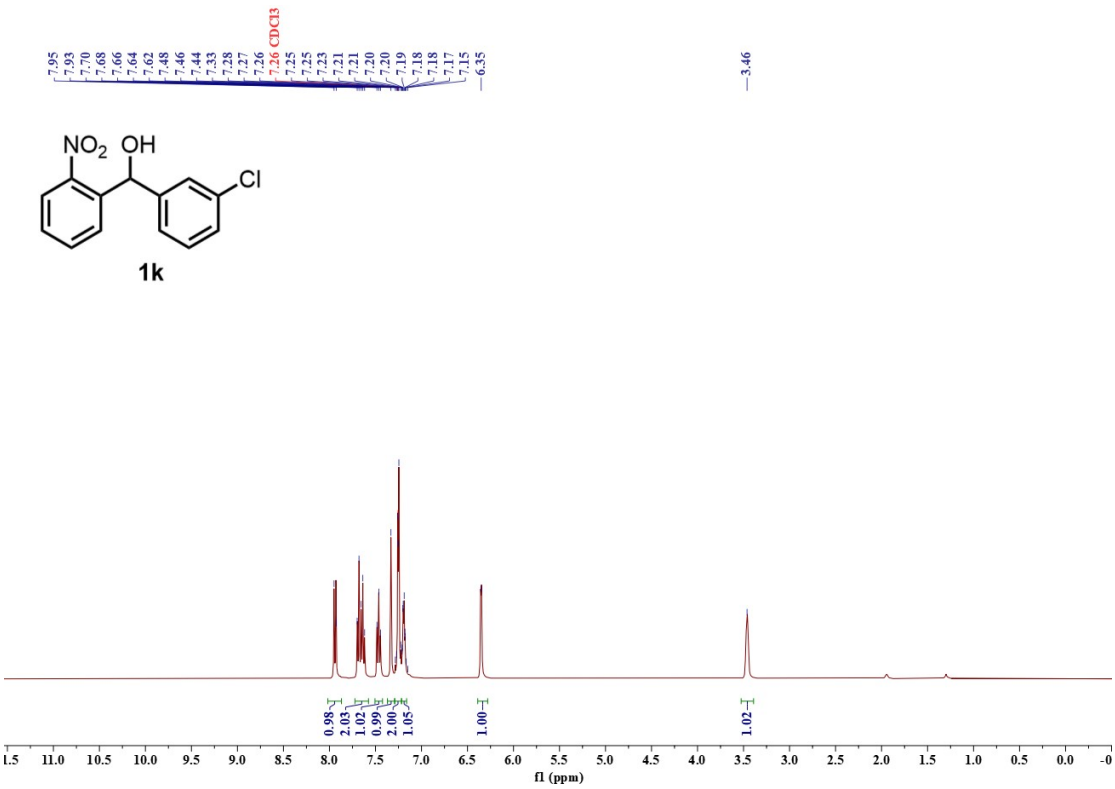
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1j



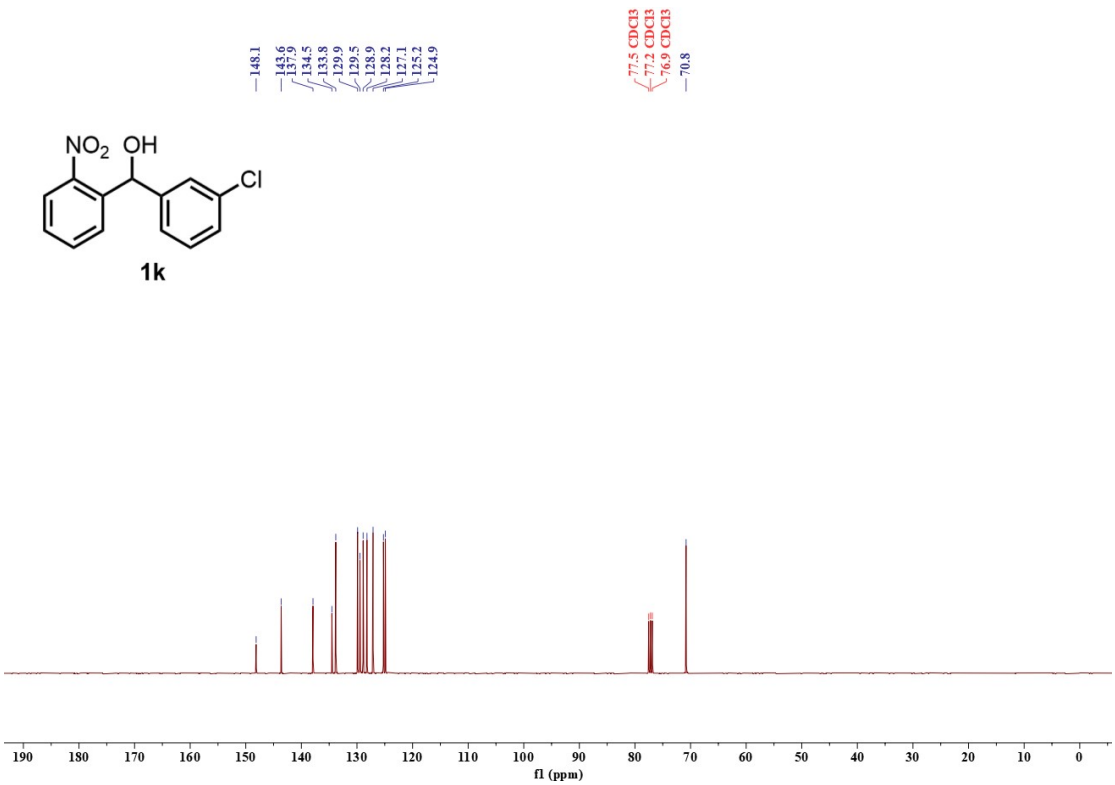
^{19}F NMR (376 MHz, $CDCl_3$) spectrum for 1j



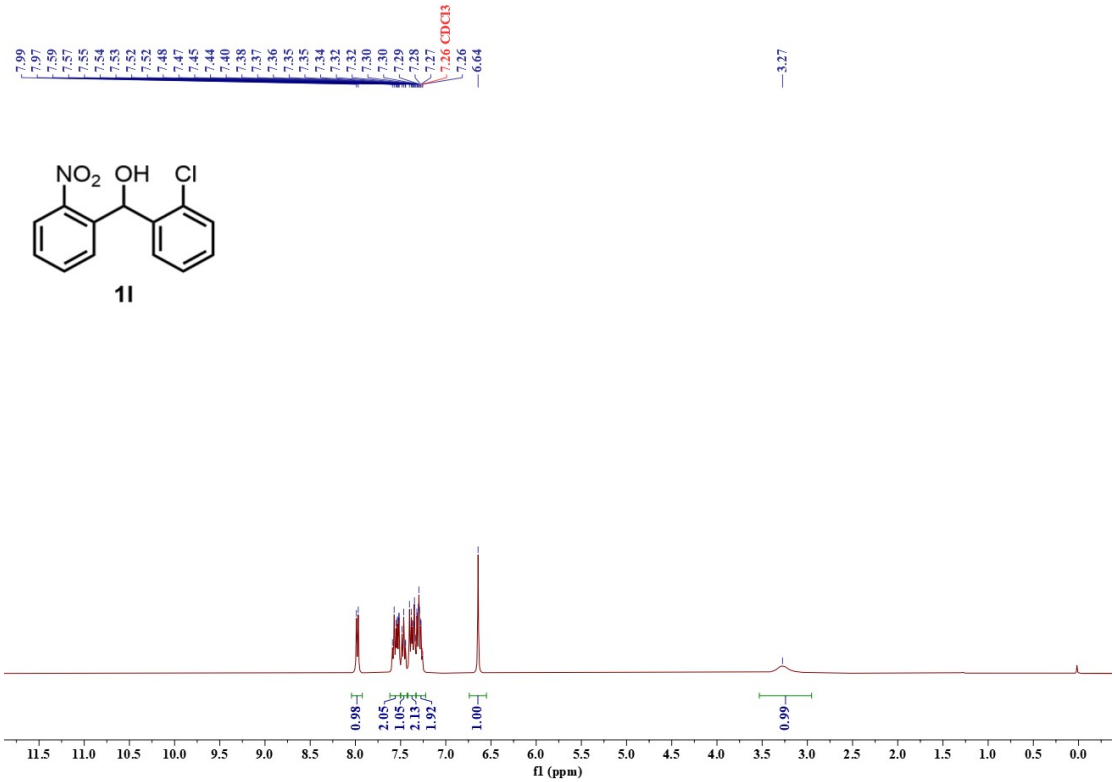
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1k



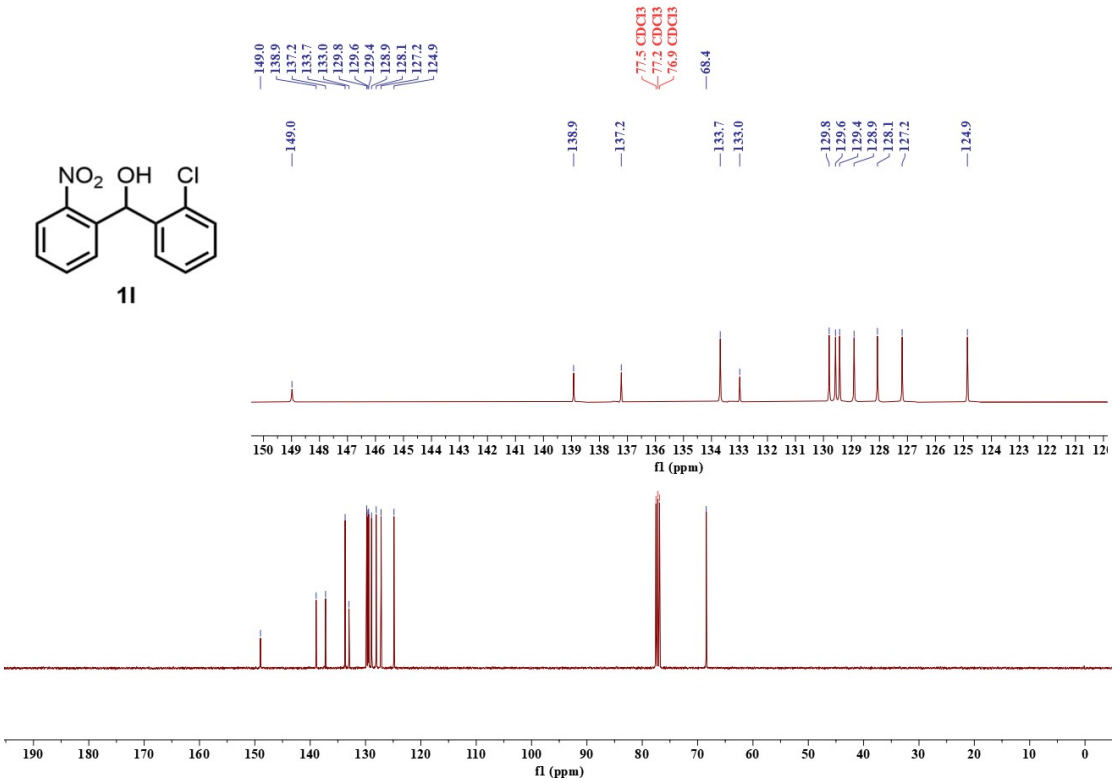
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1k



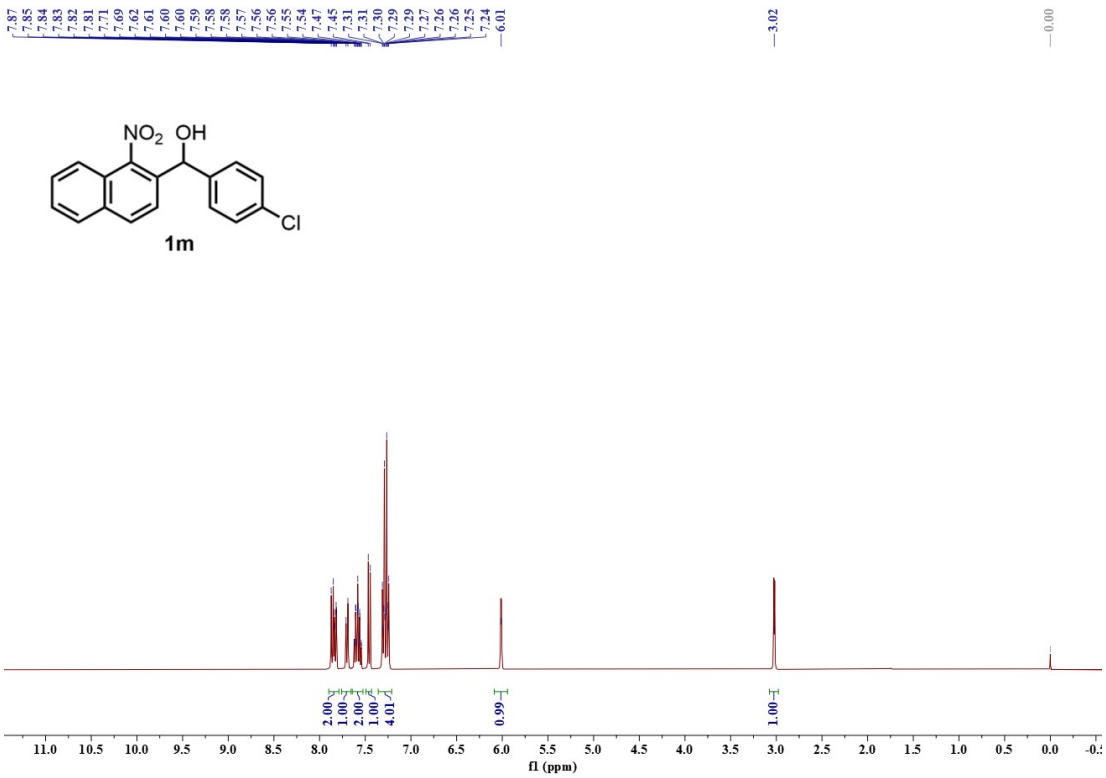
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1l



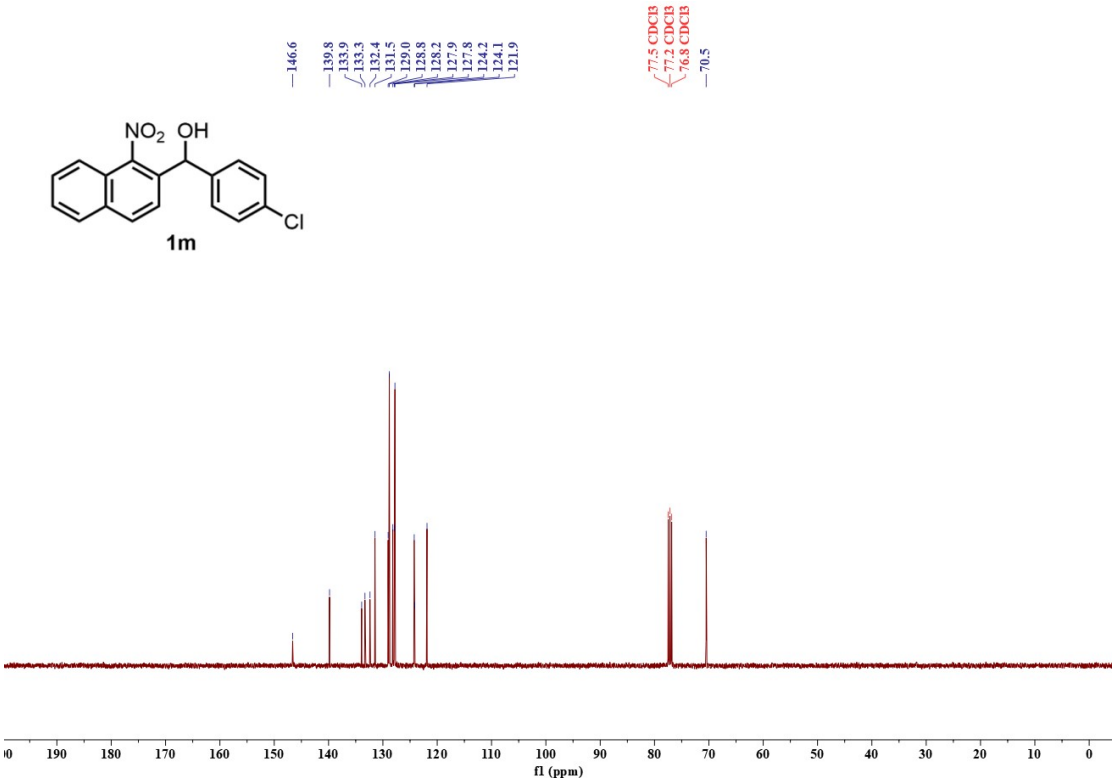
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1l



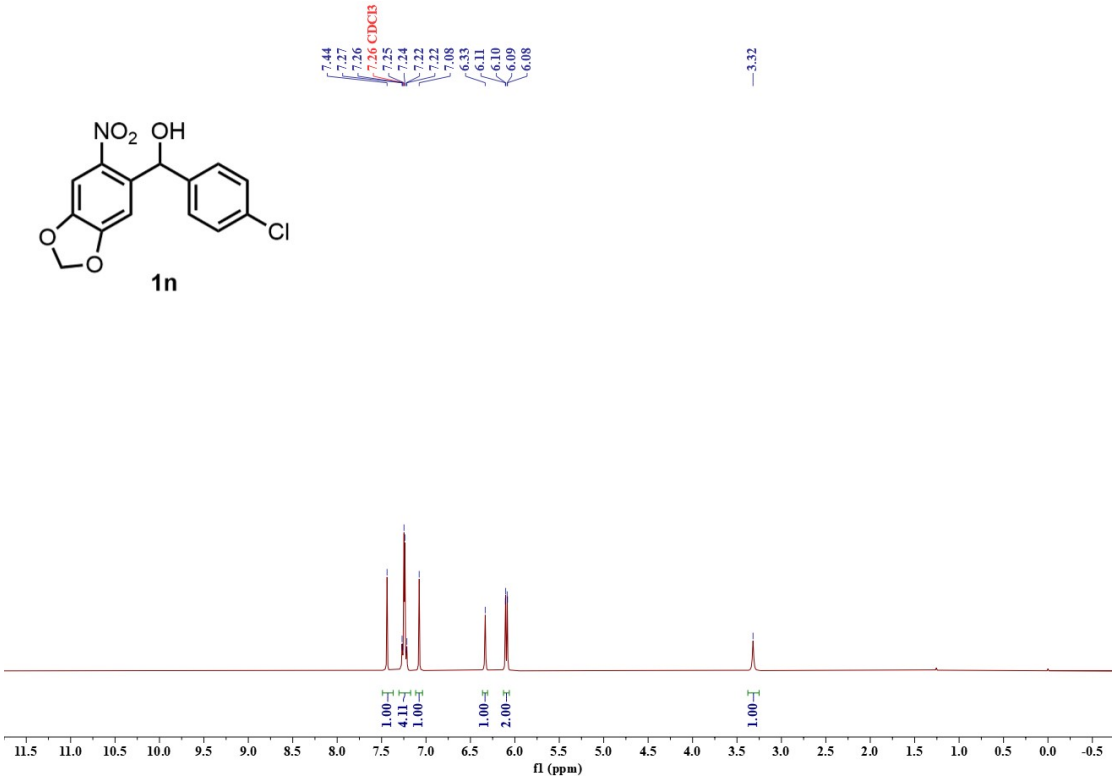
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1m



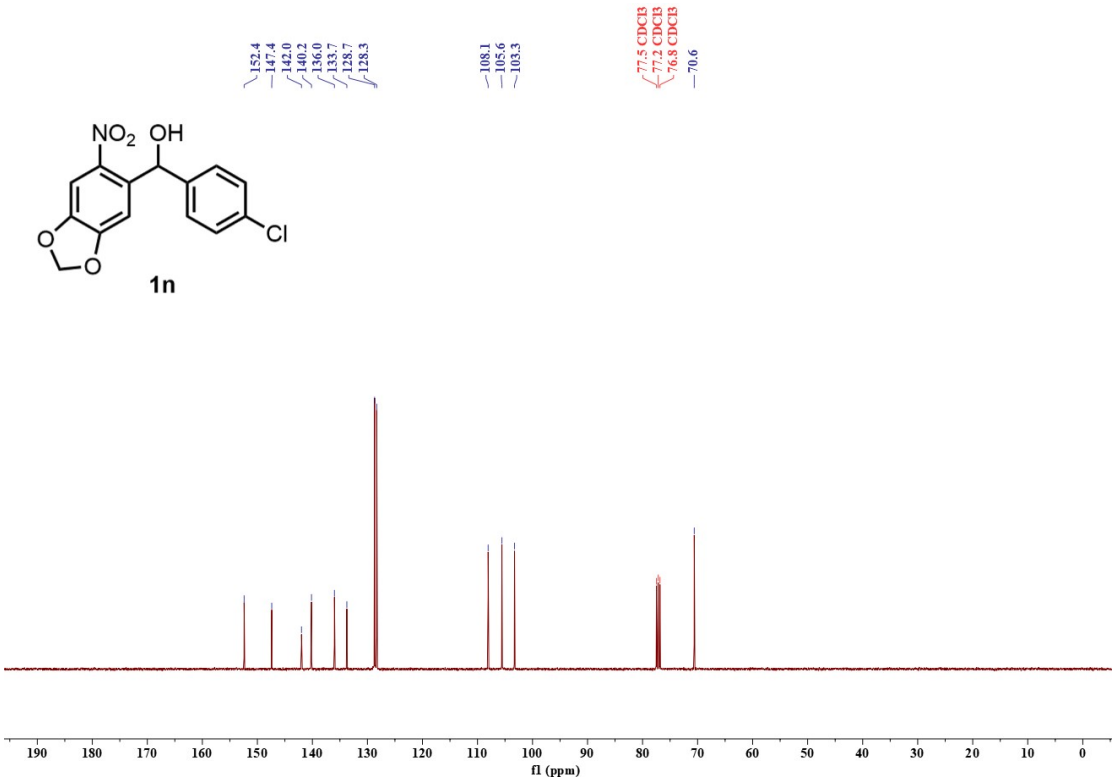
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1m



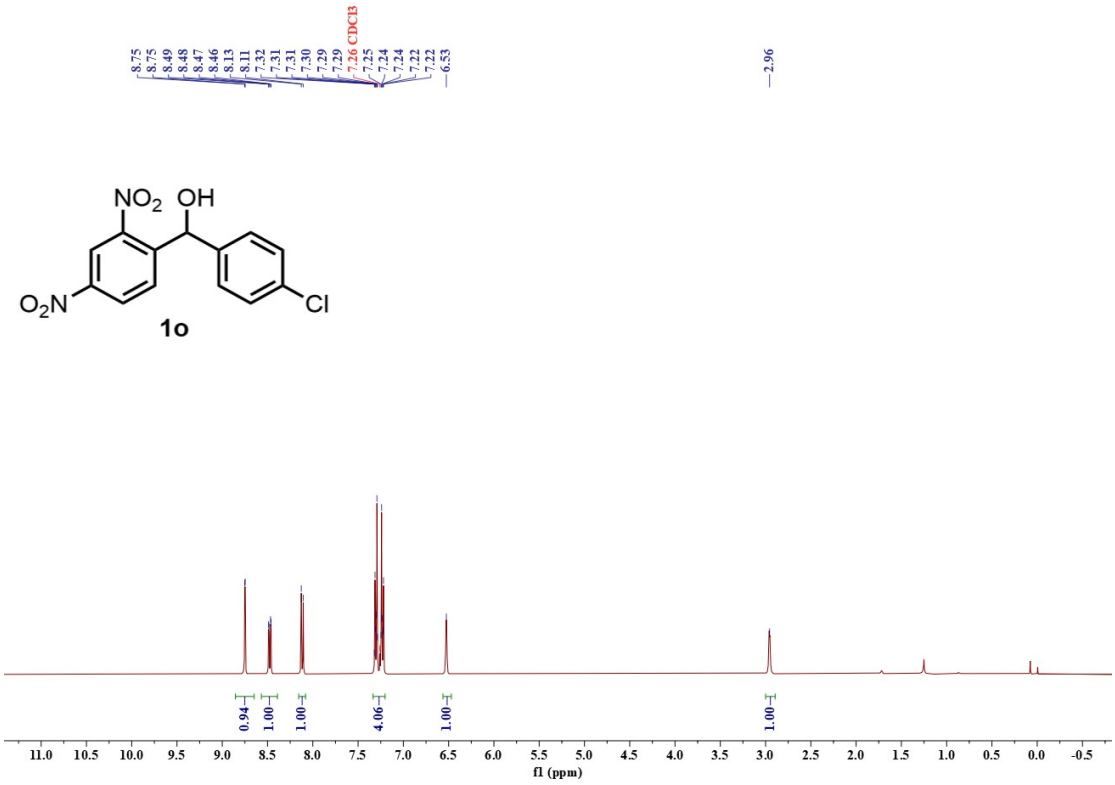
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1n



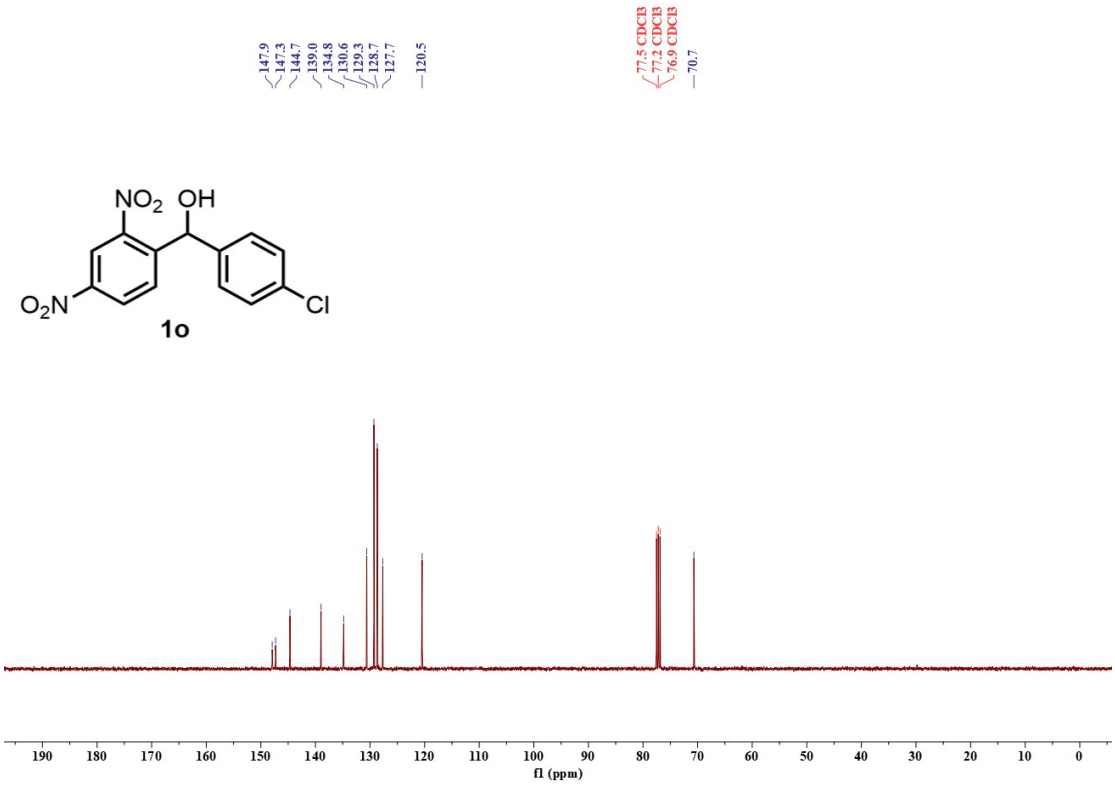
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1n



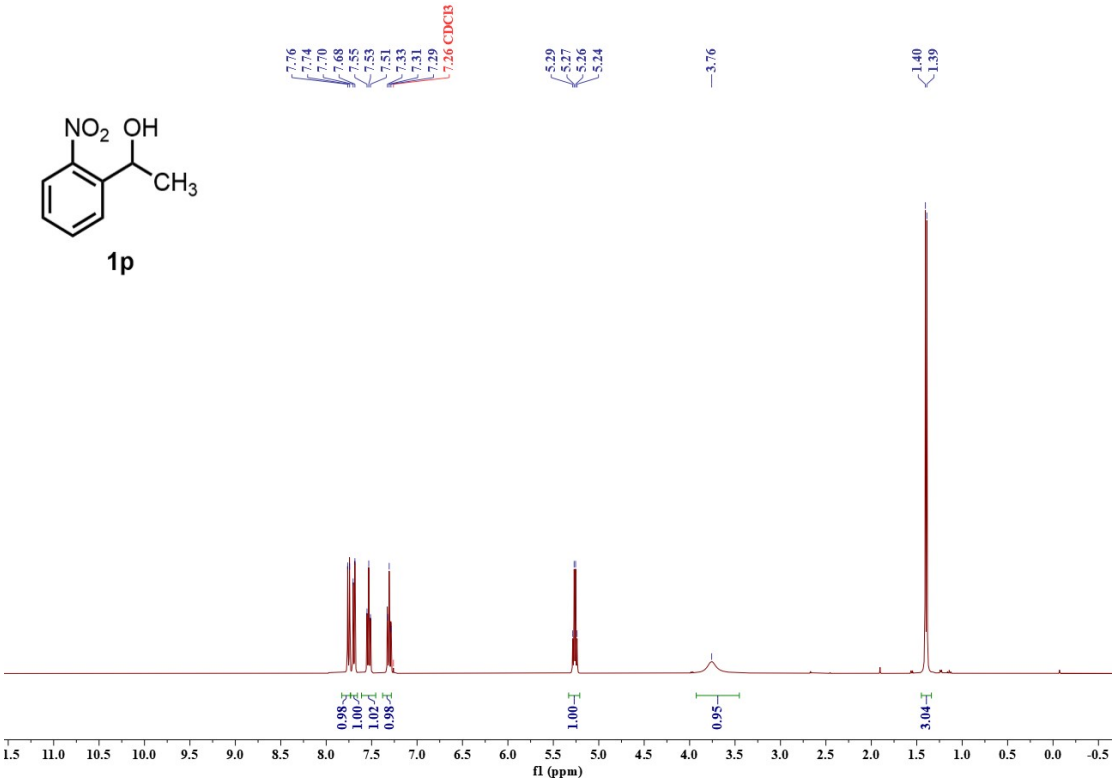
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1o



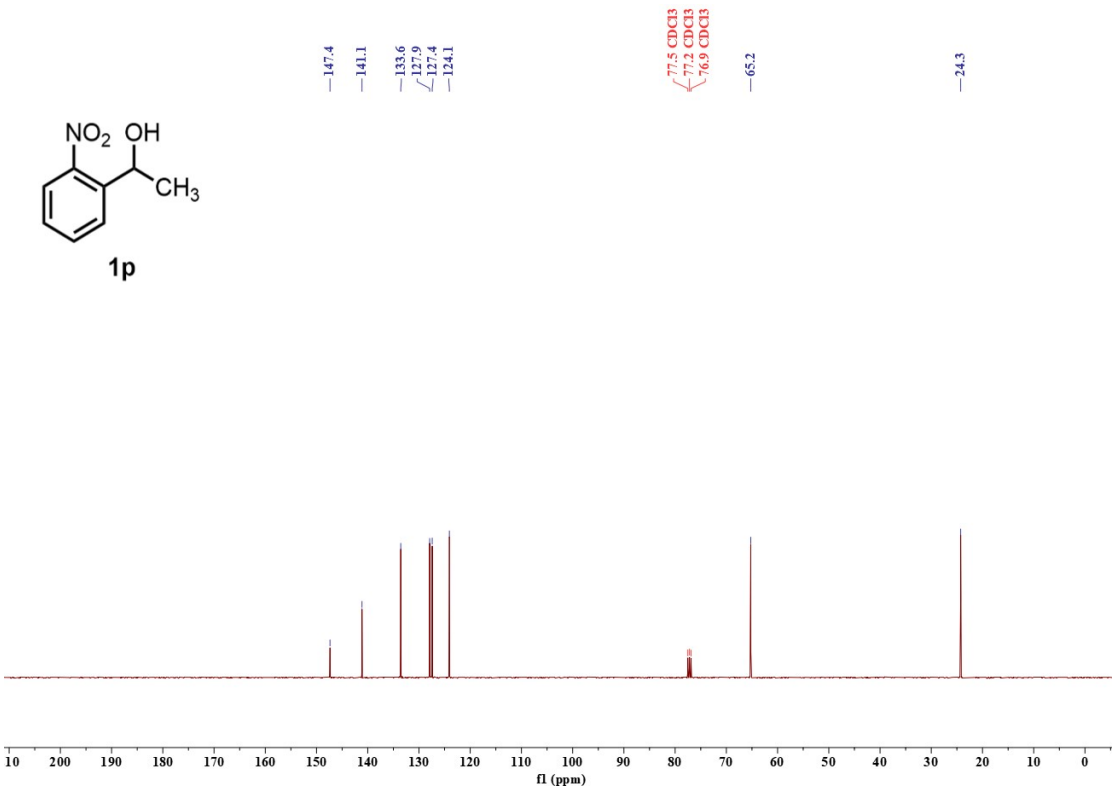
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1o



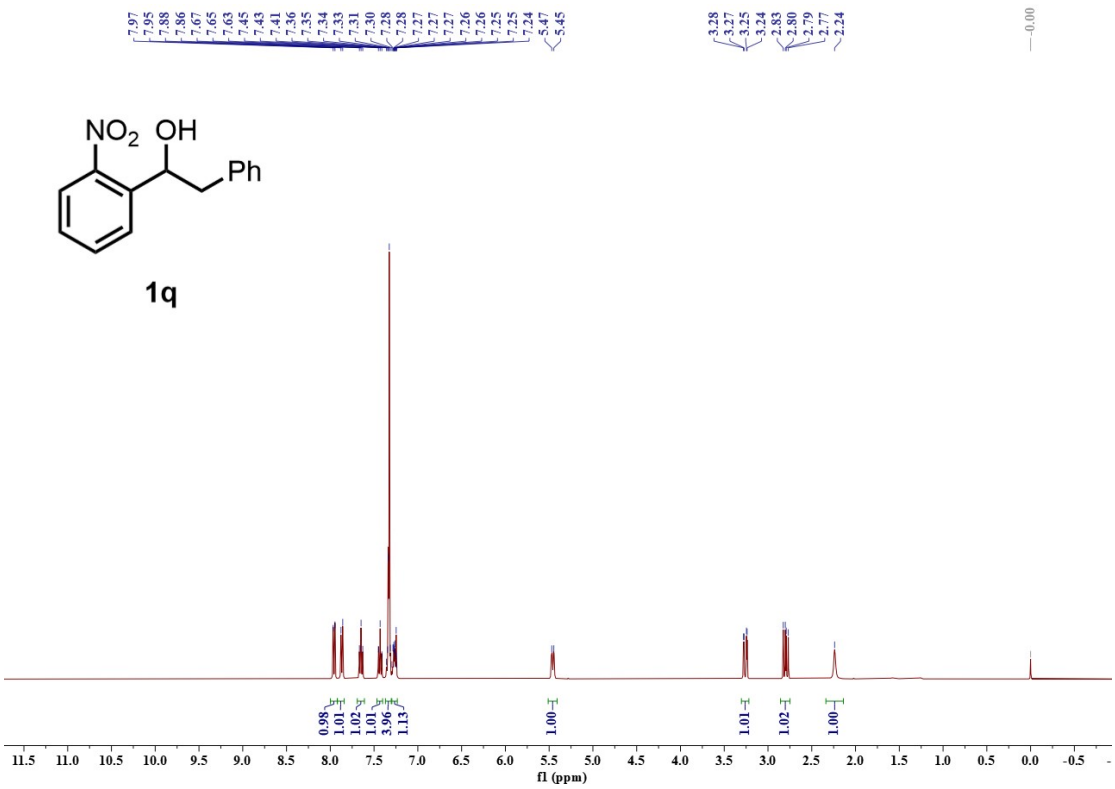
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1p



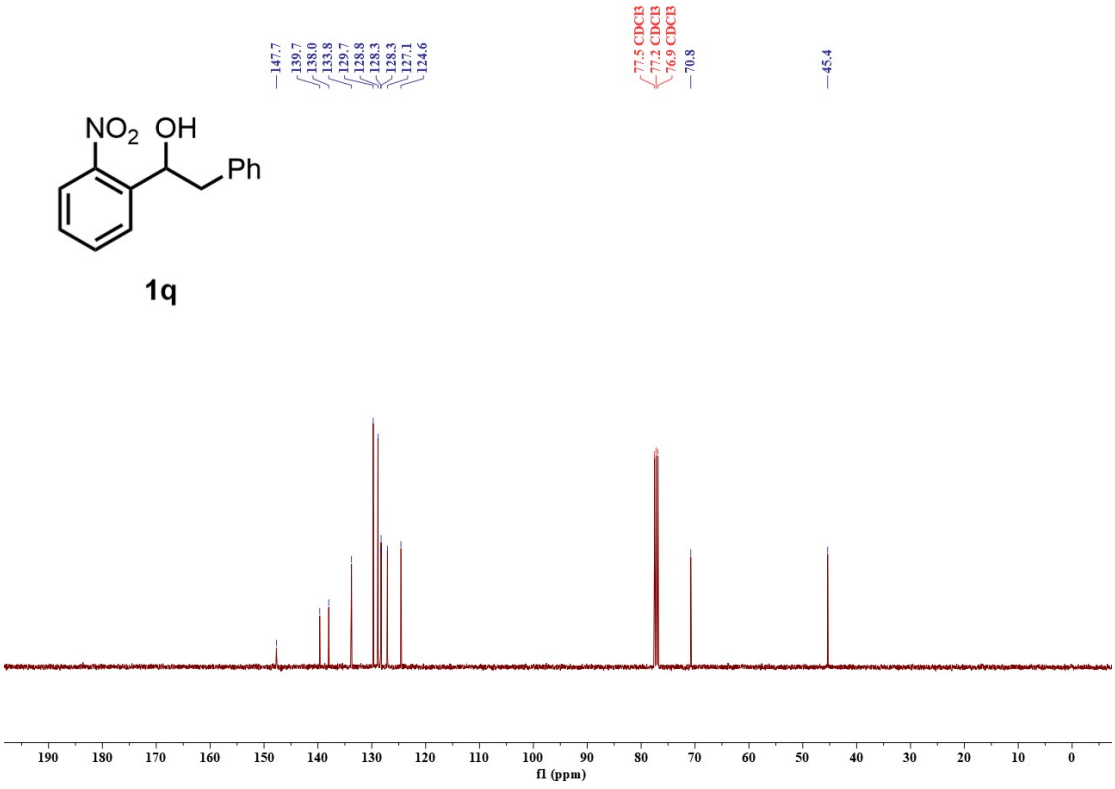
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1p



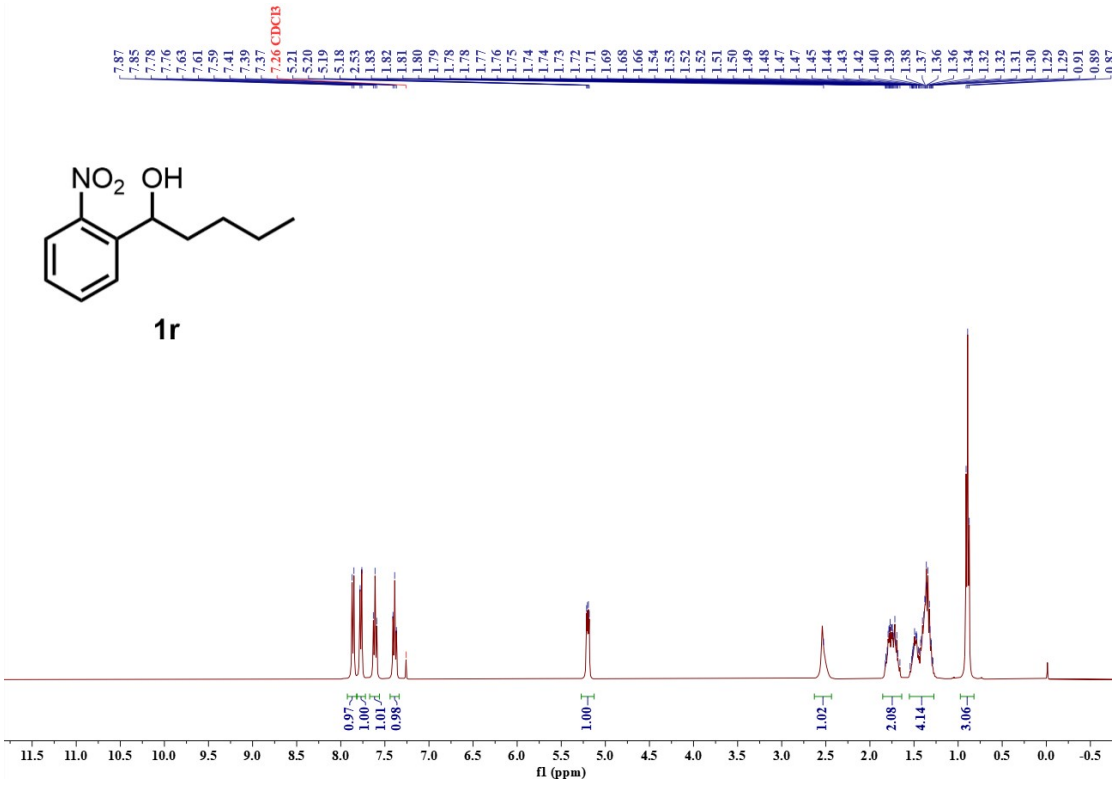
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1q



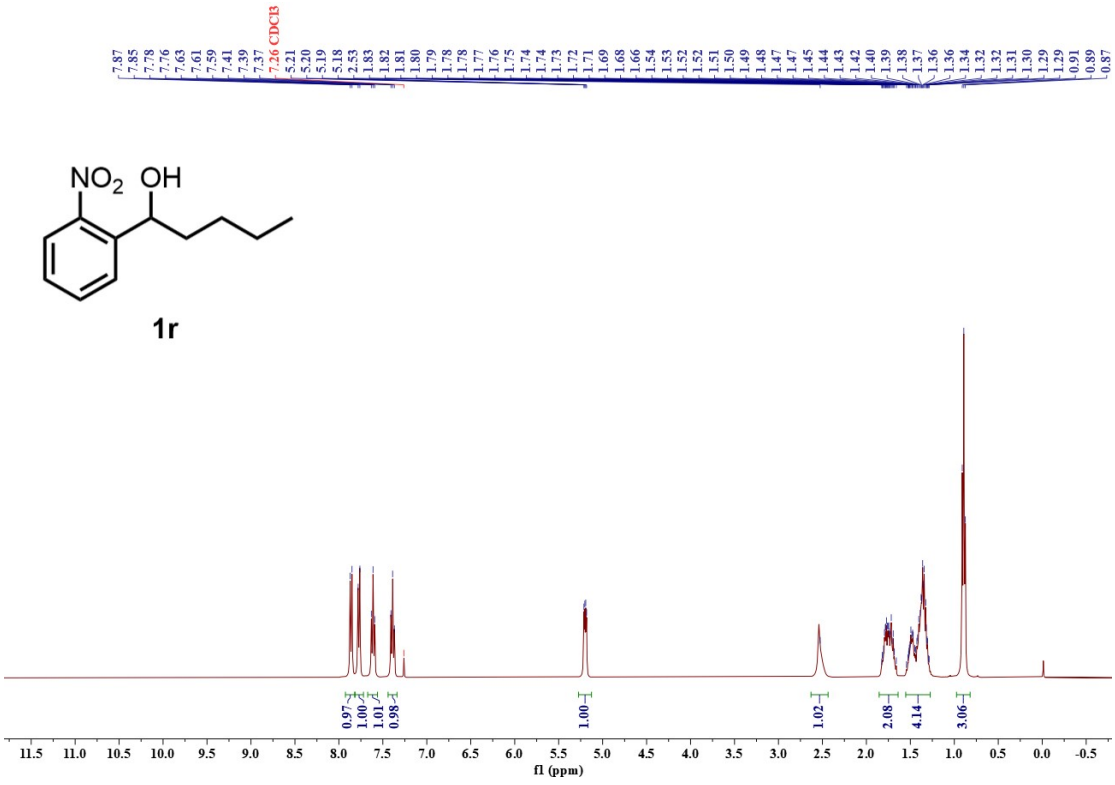
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1q



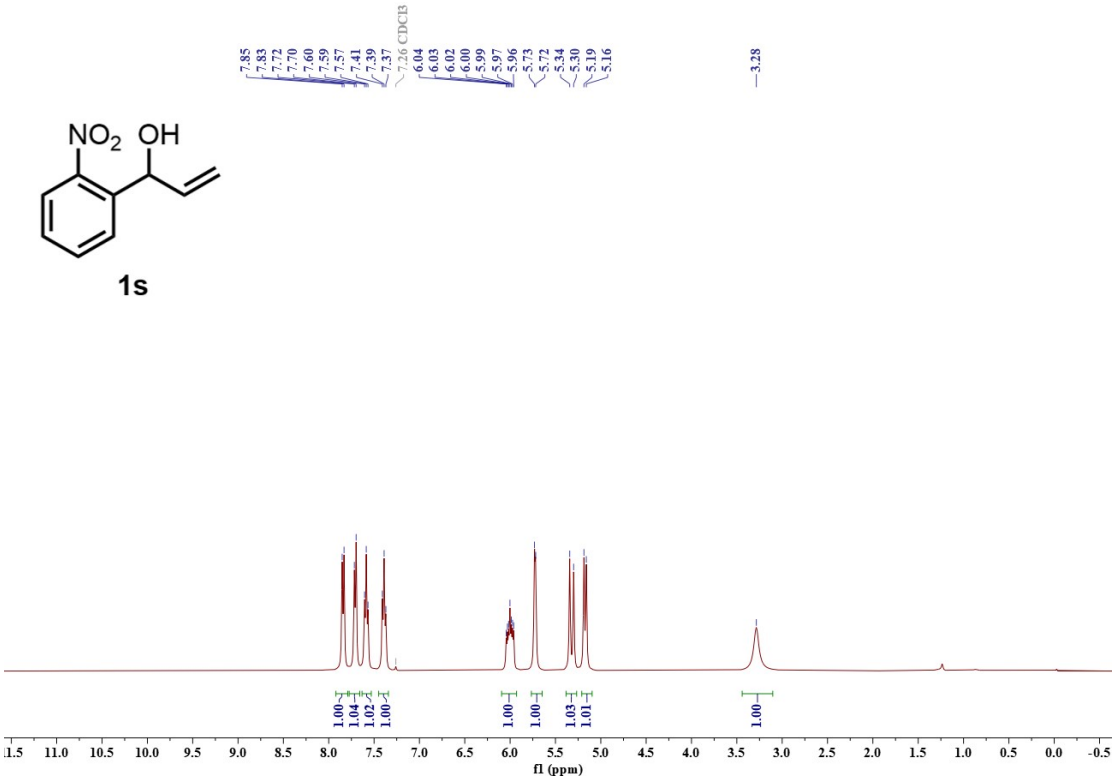
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1r



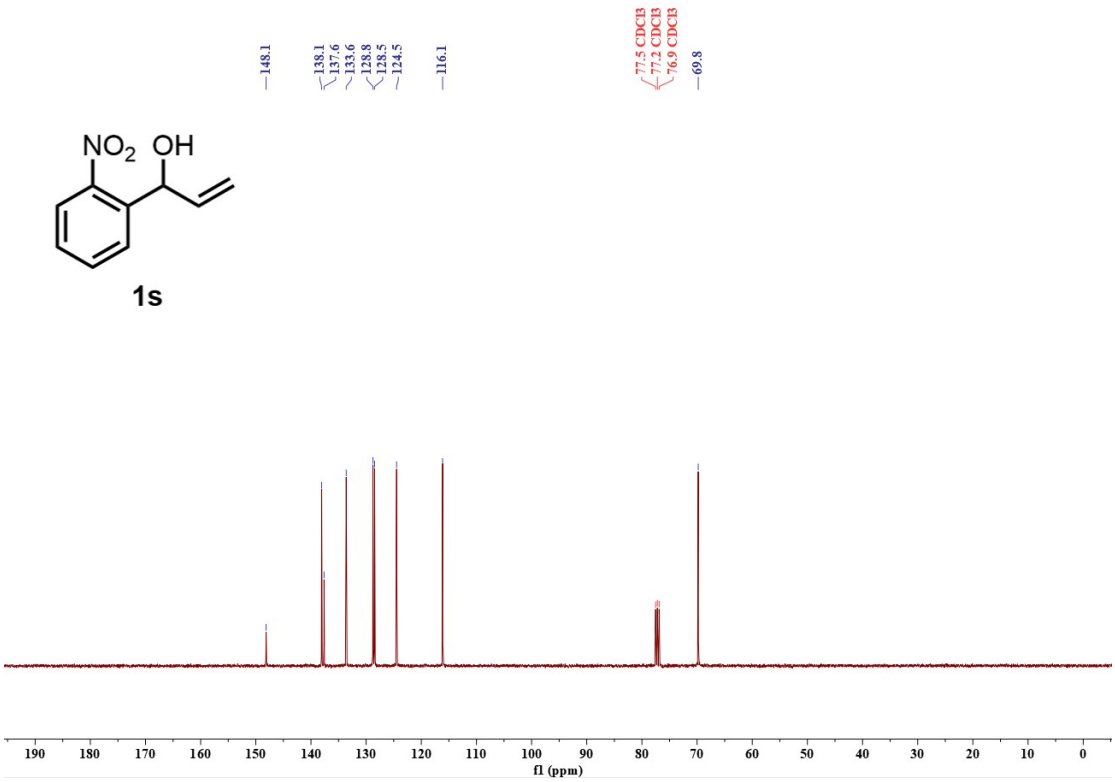
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1r



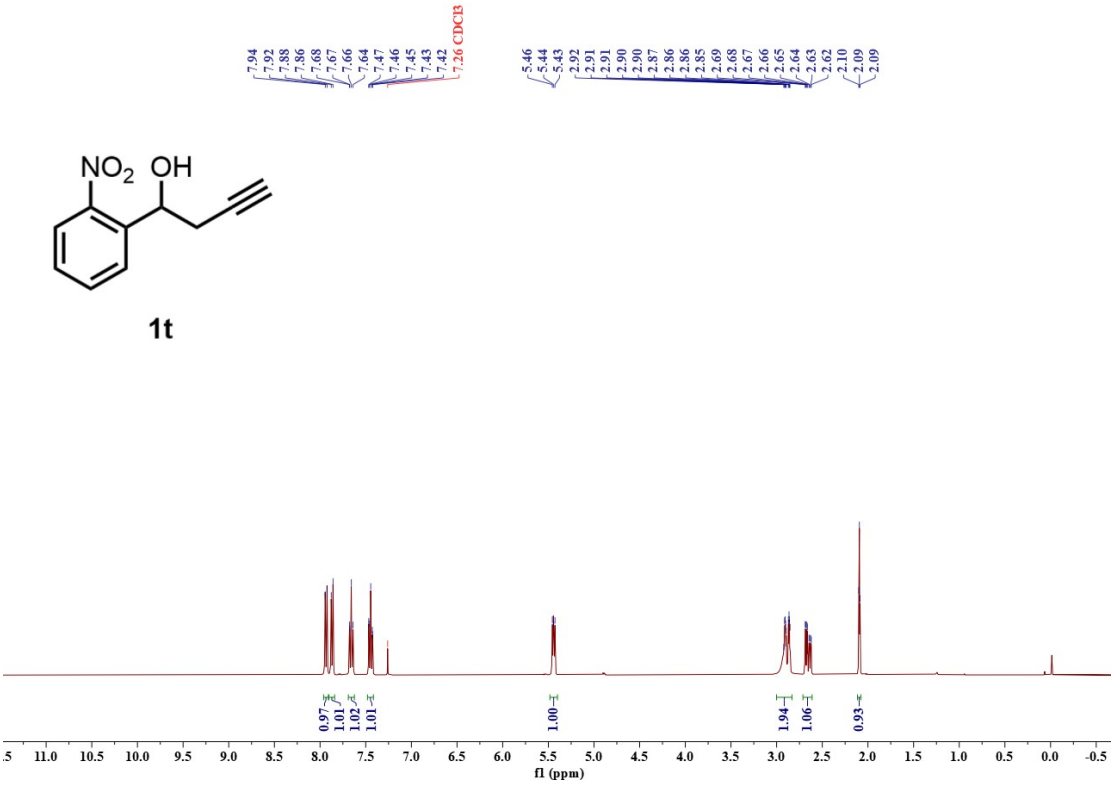
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1s



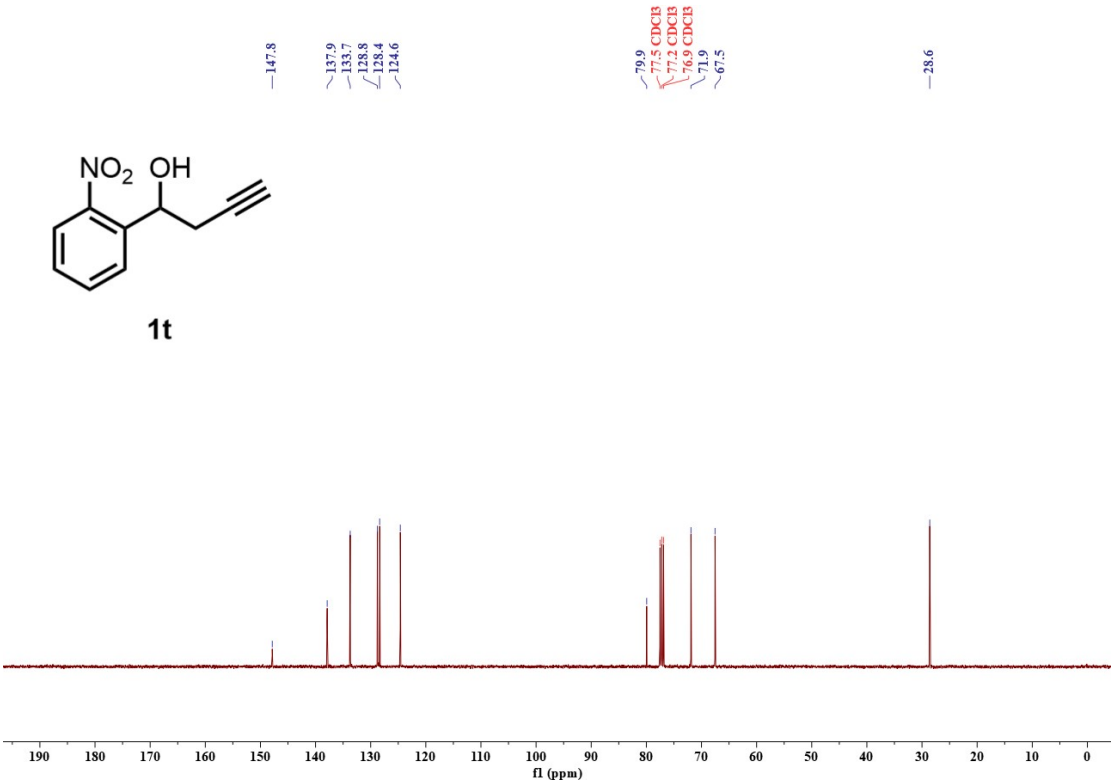
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1s



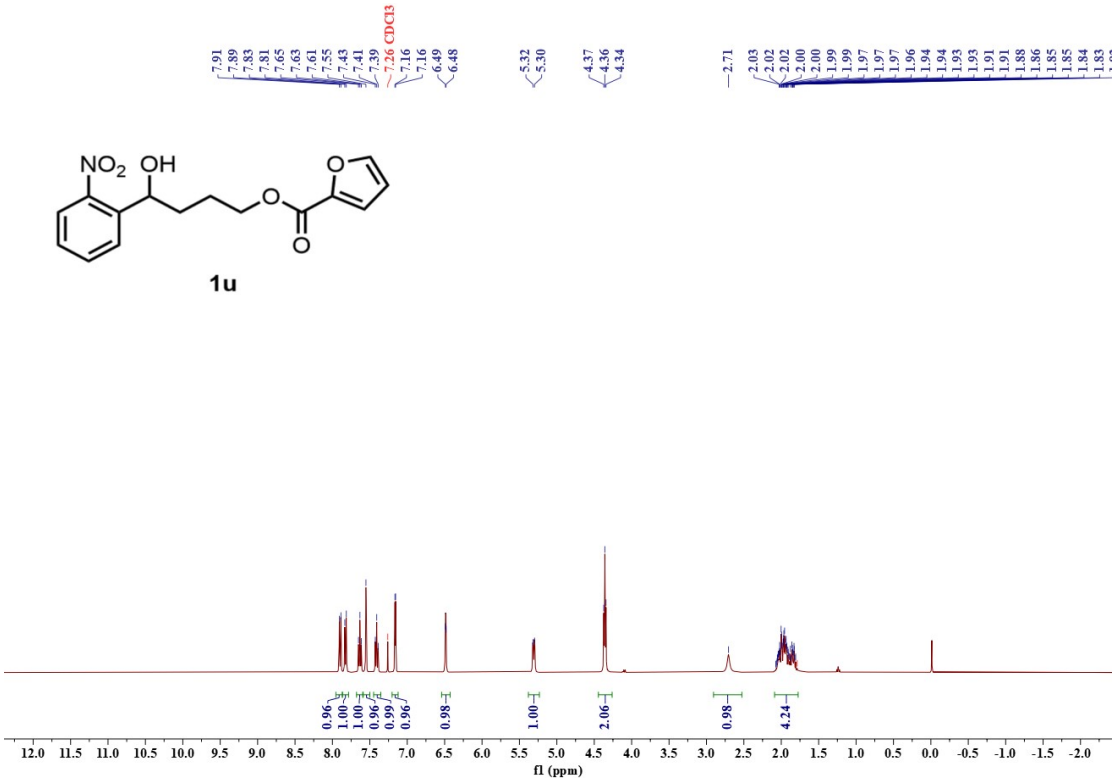
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1t



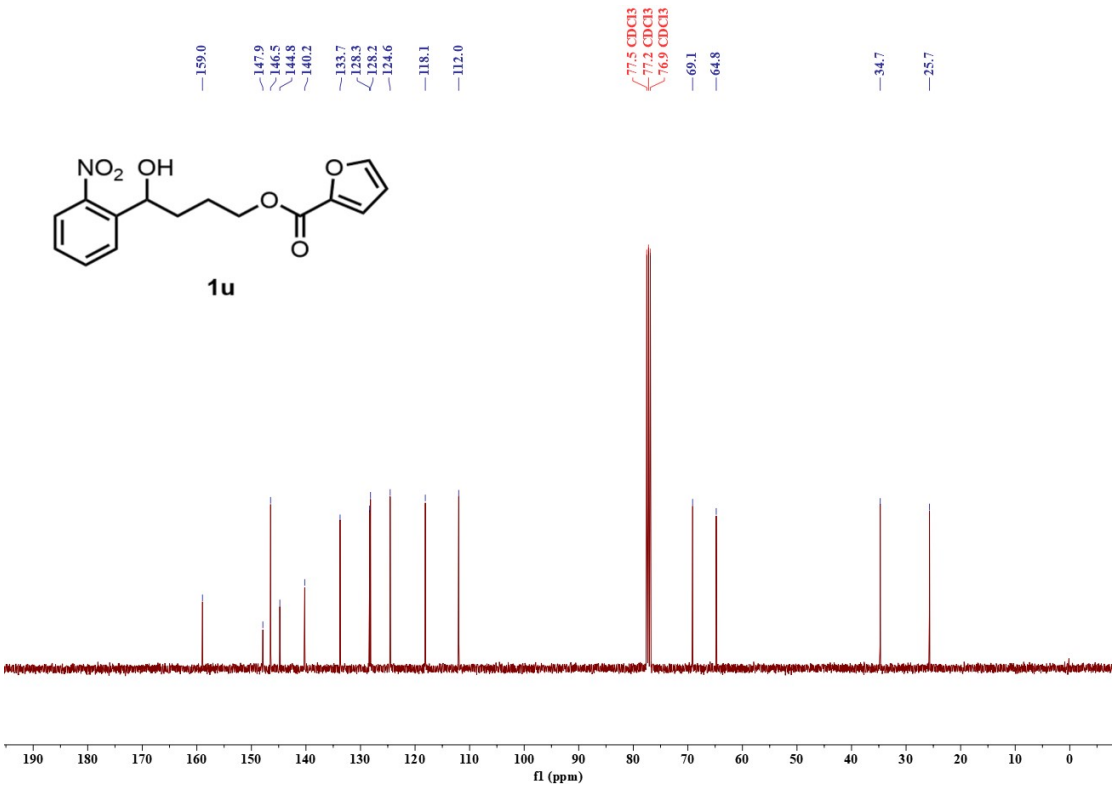
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1t



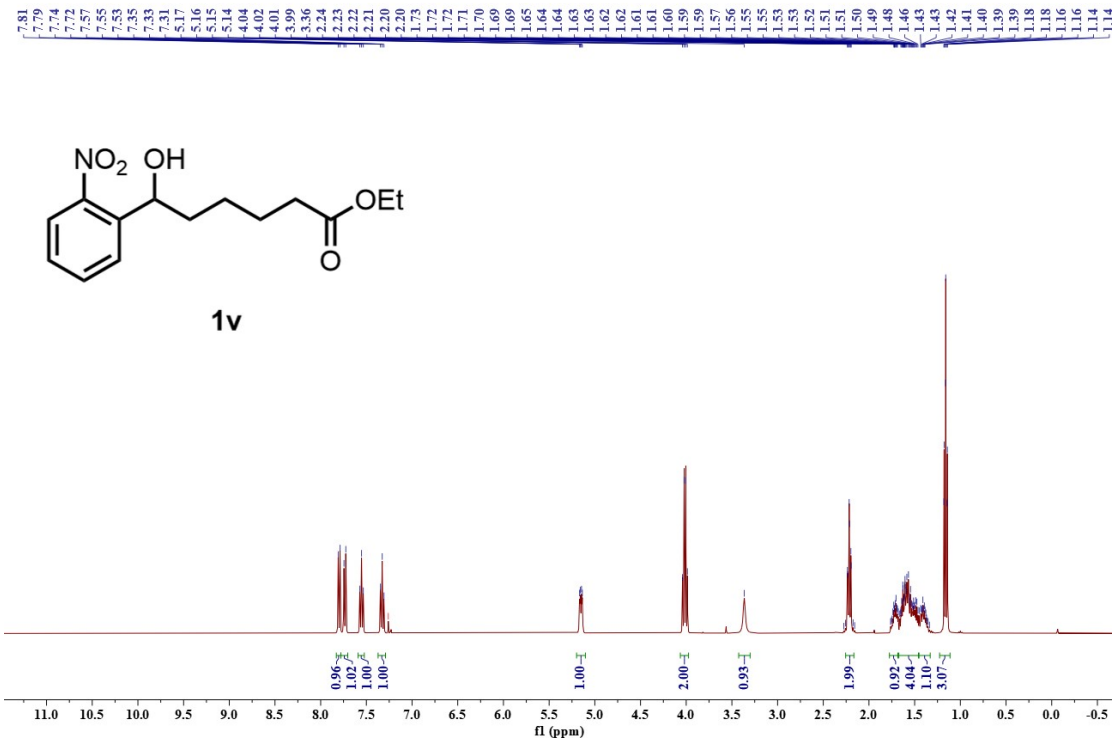
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1u



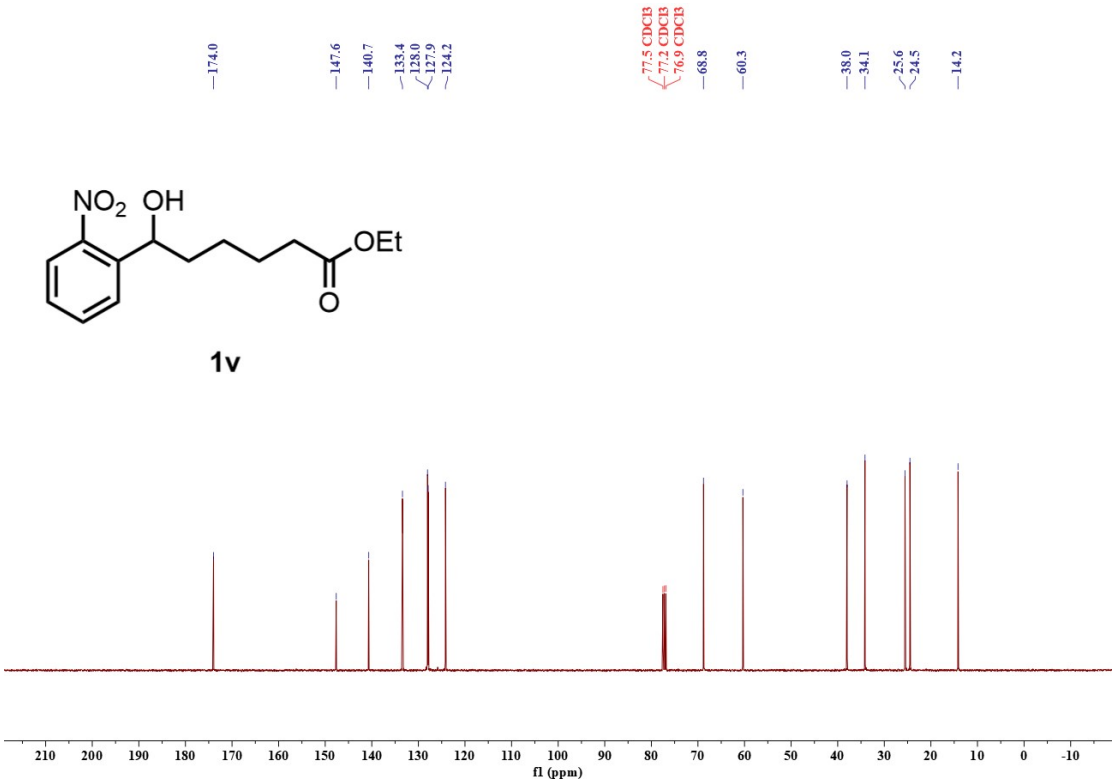
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1u



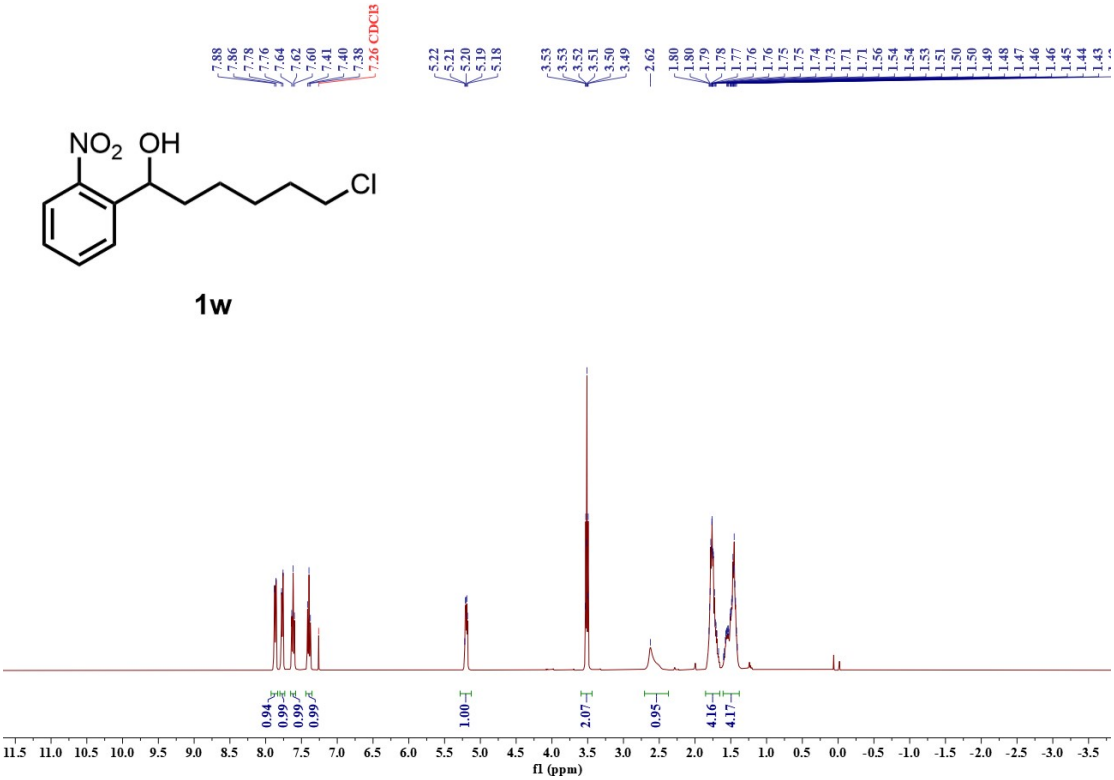
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1v



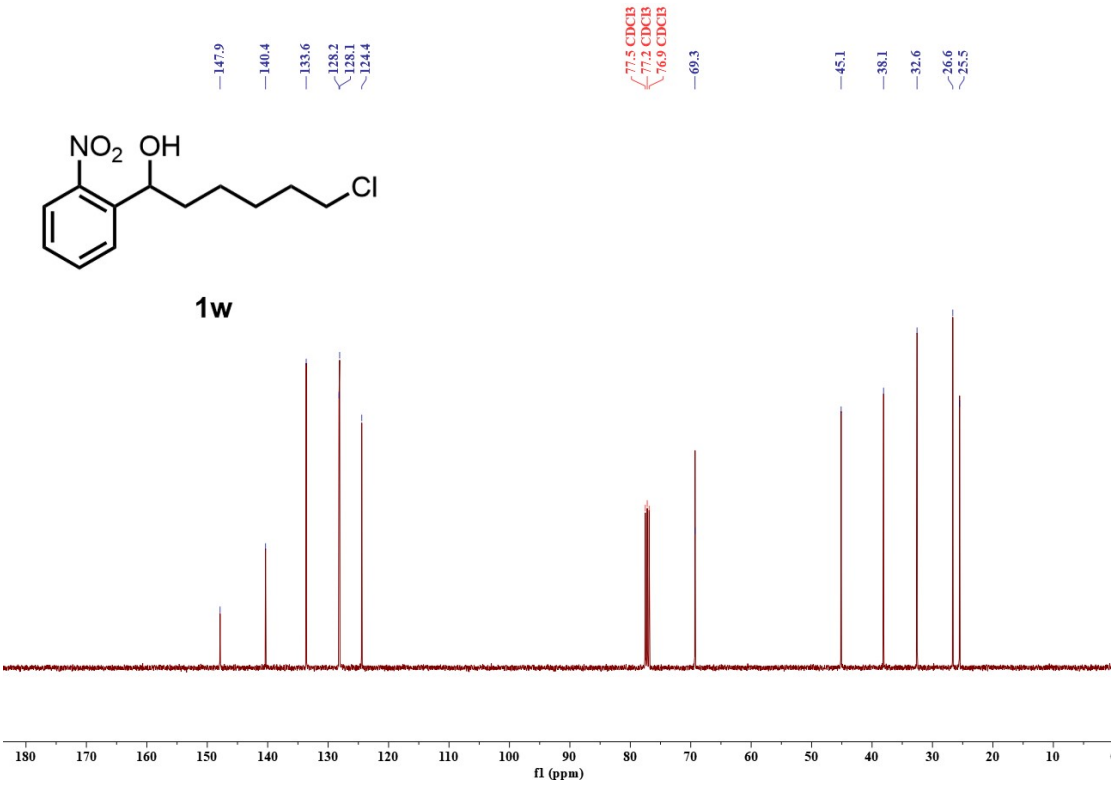
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1v



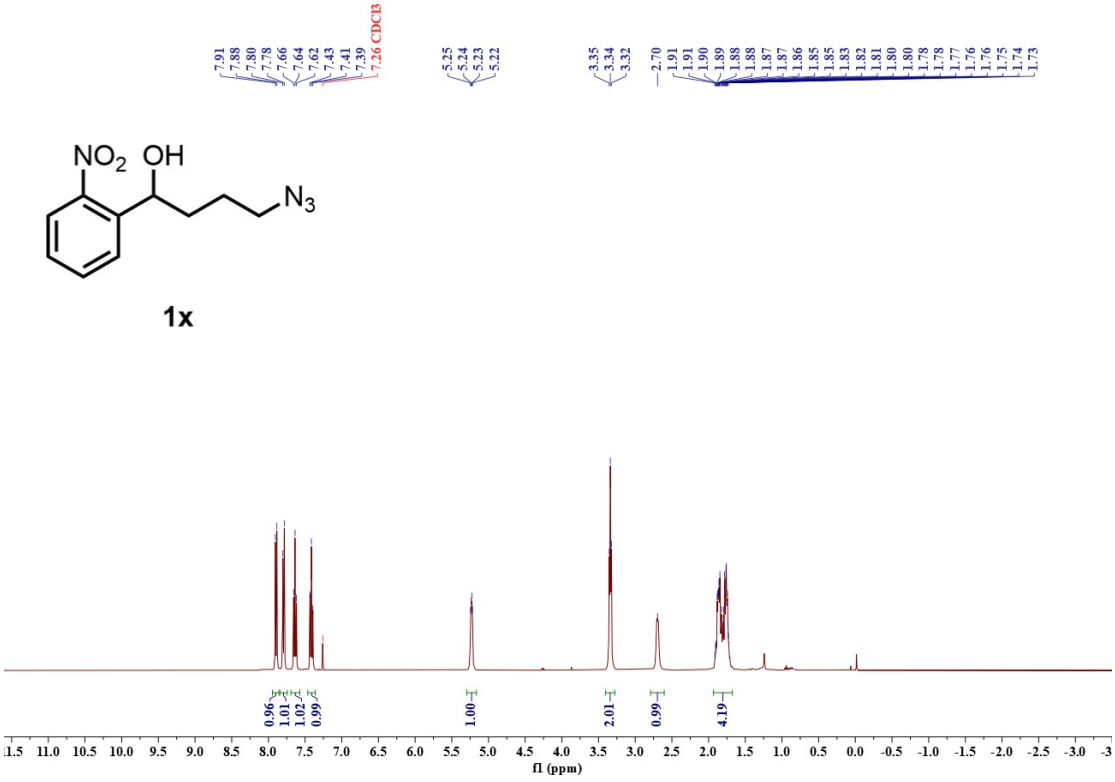
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1w



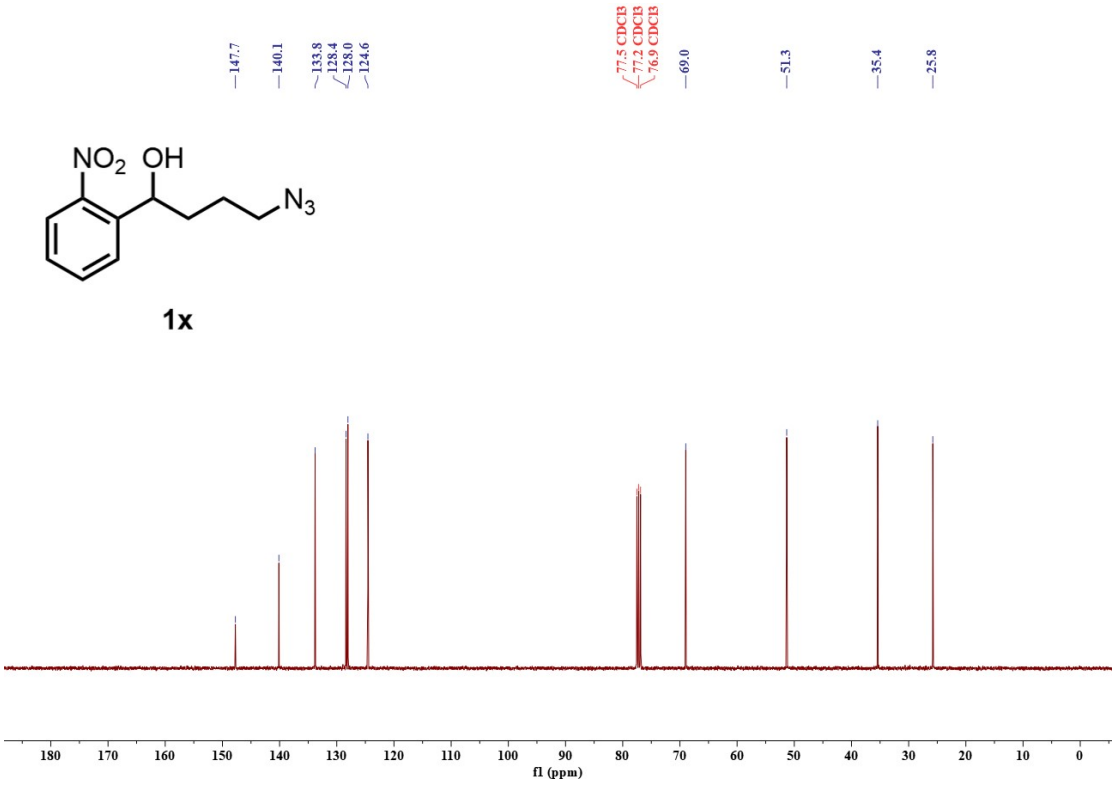
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1w



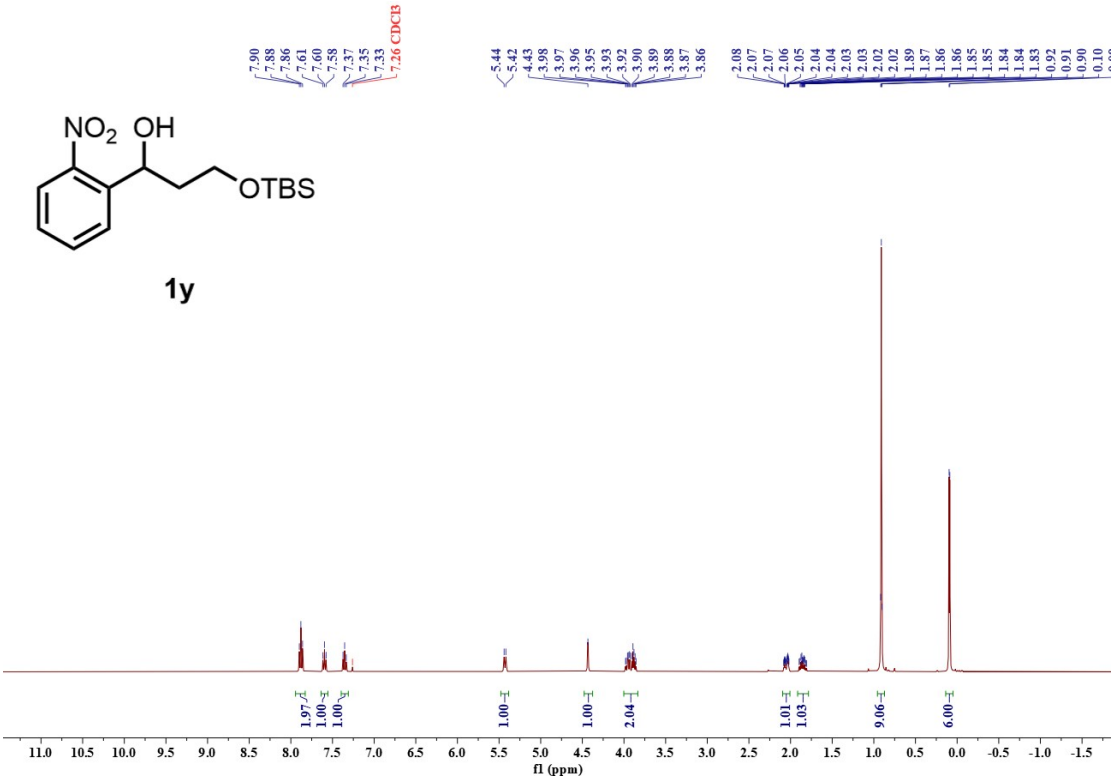
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1x



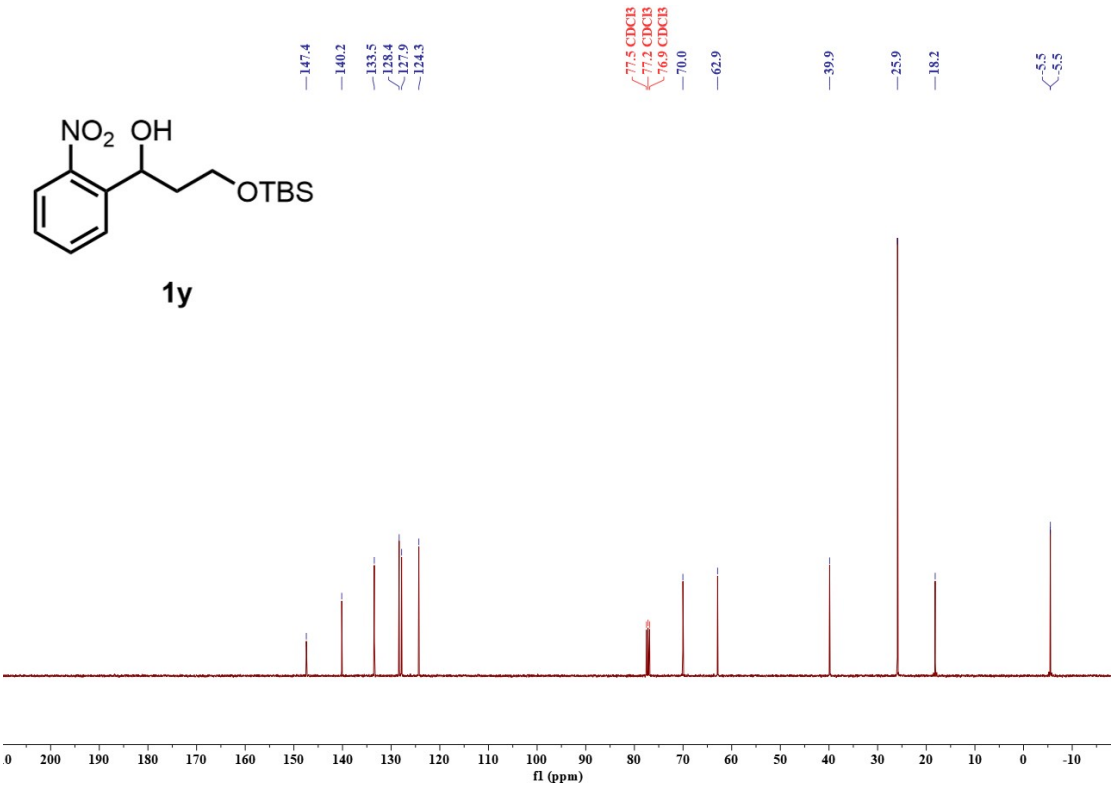
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1x



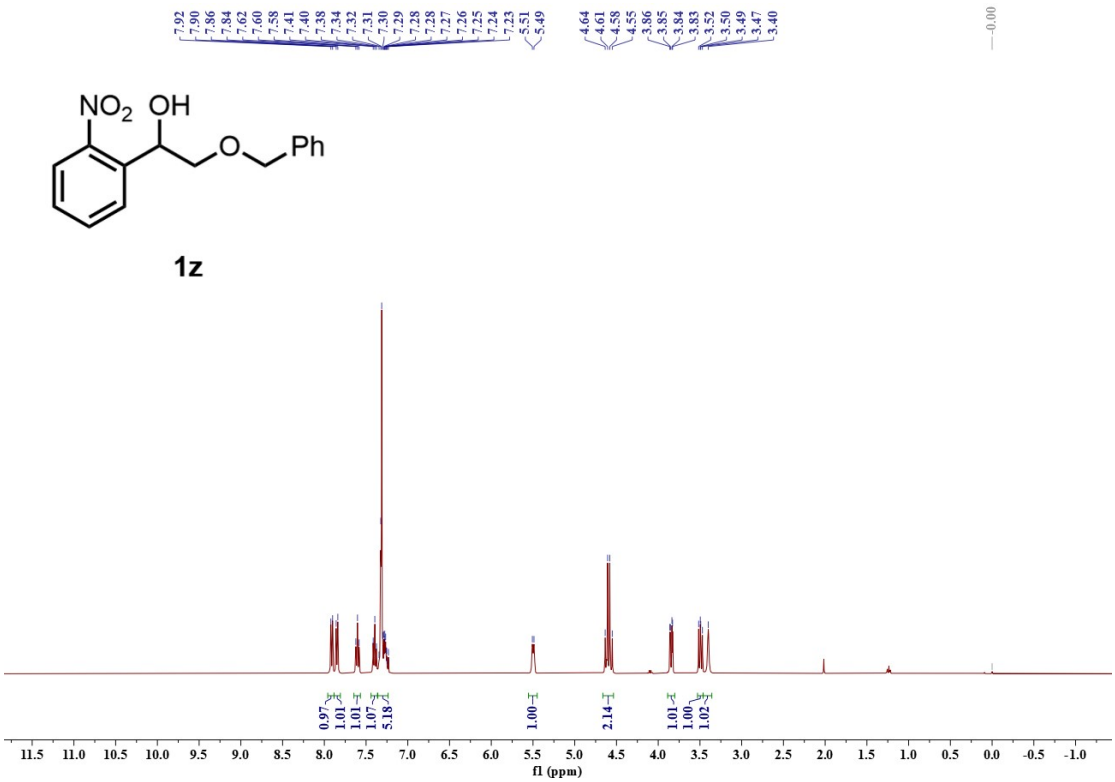
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1y



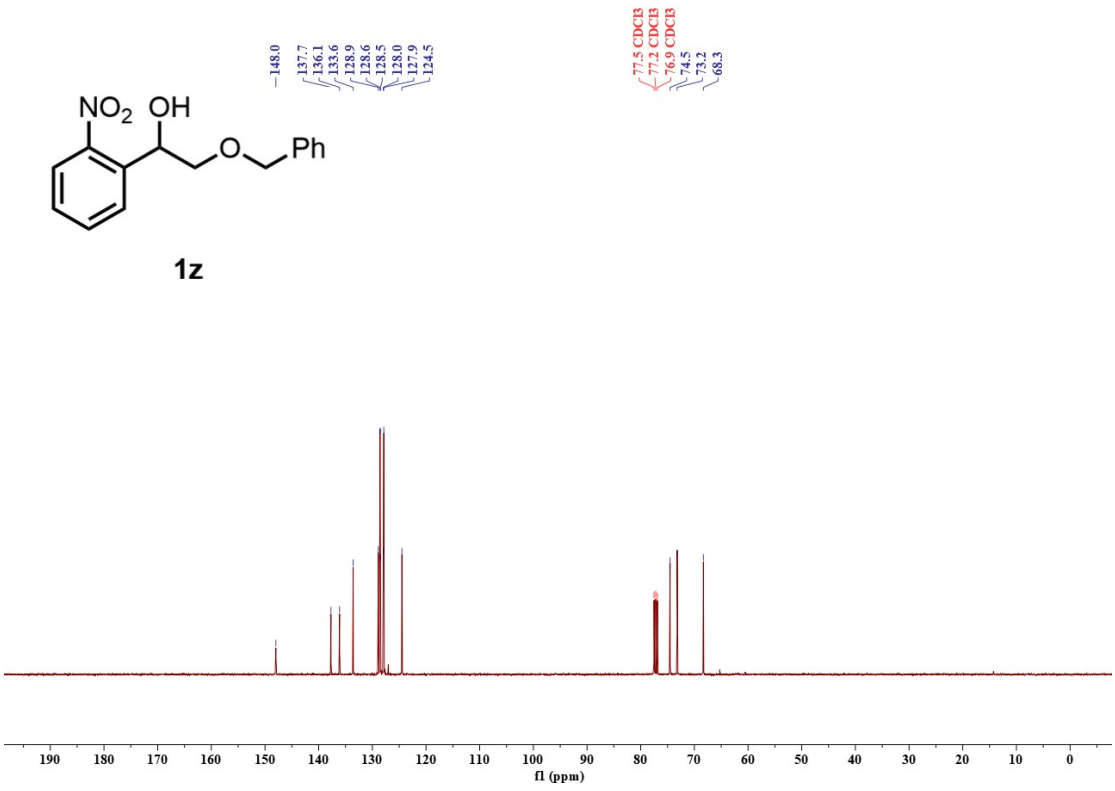
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1y



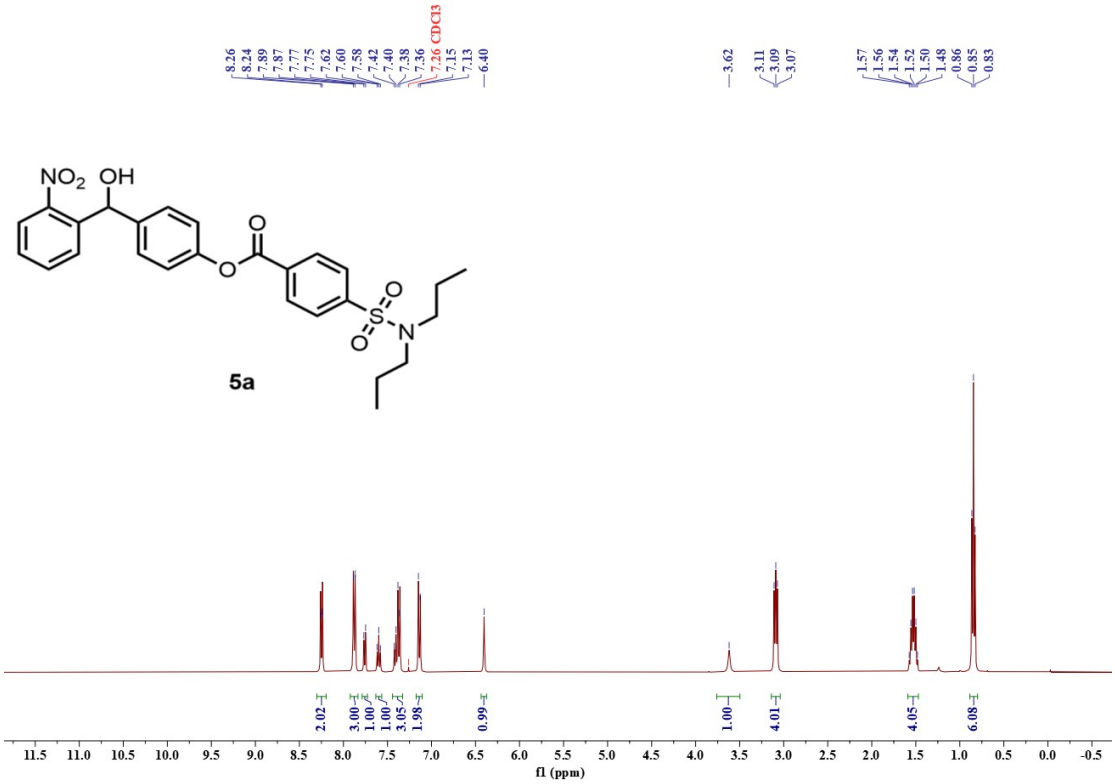
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 1z



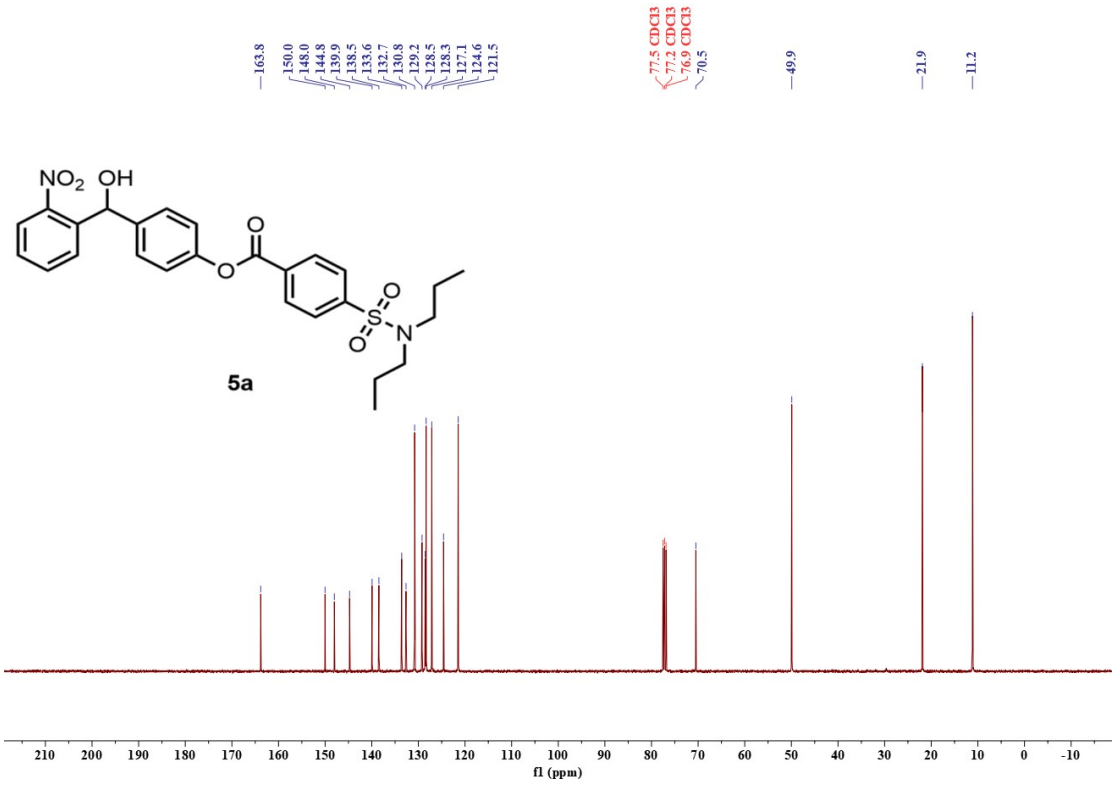
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 1z



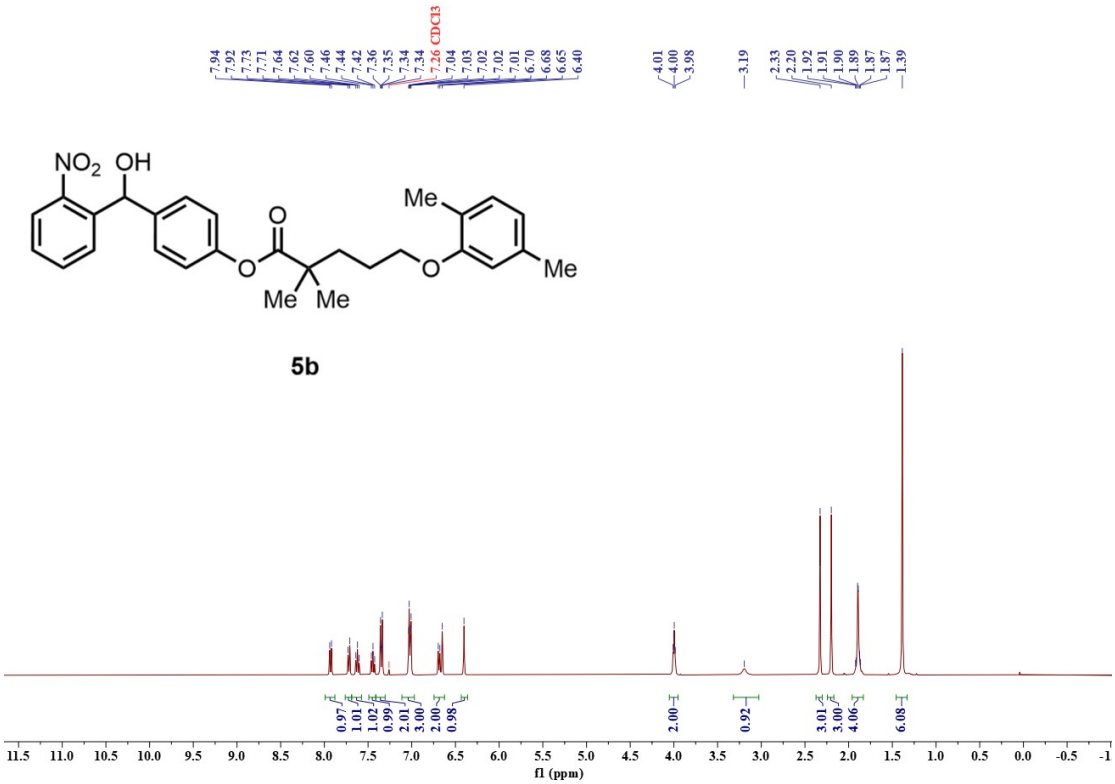
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 5a



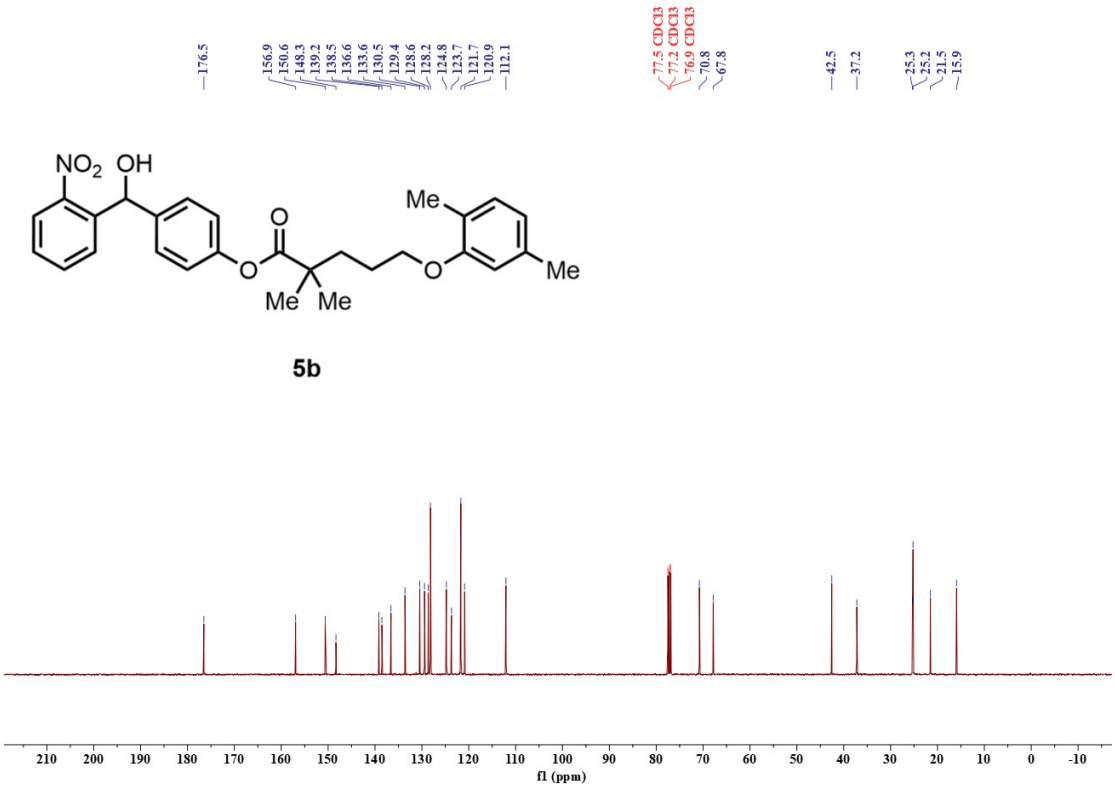
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 5a



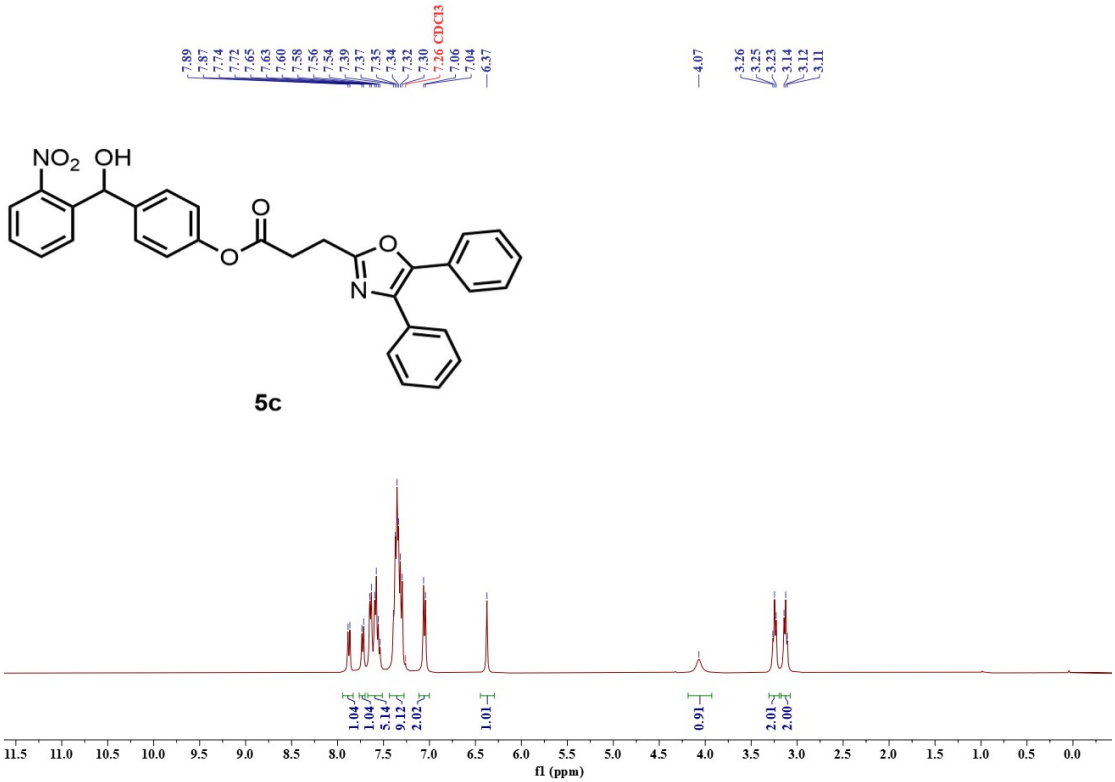
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 5b



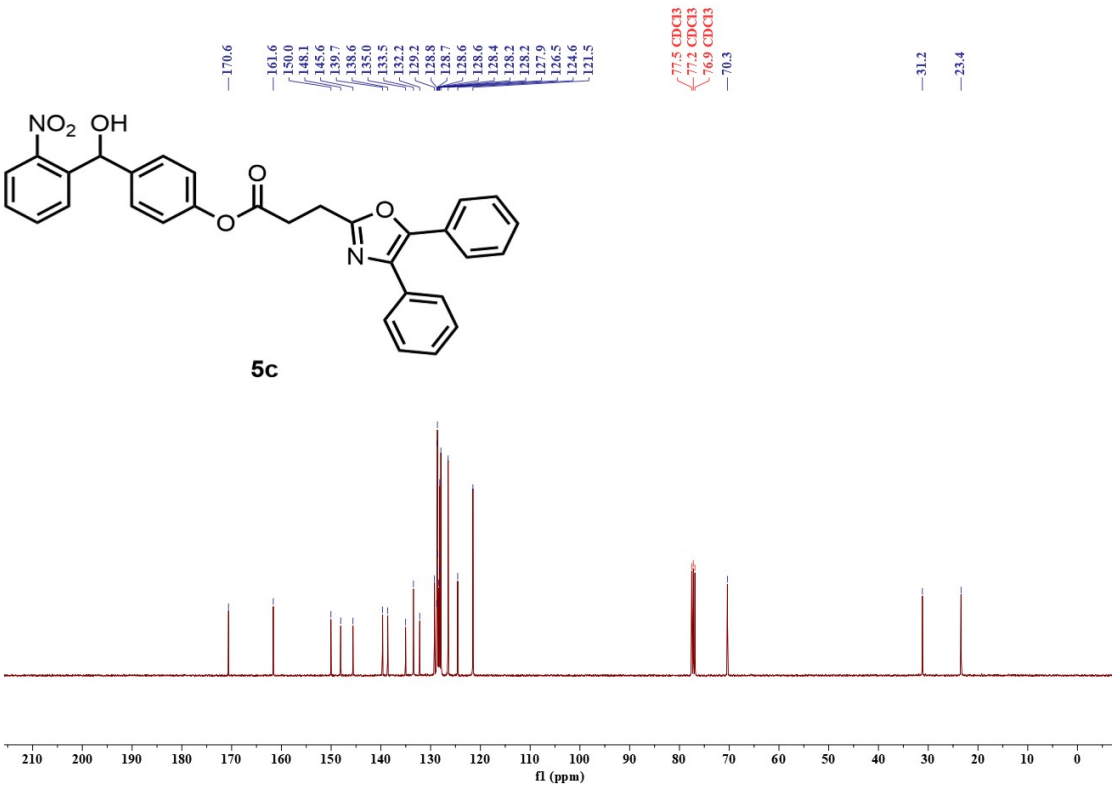
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 5b



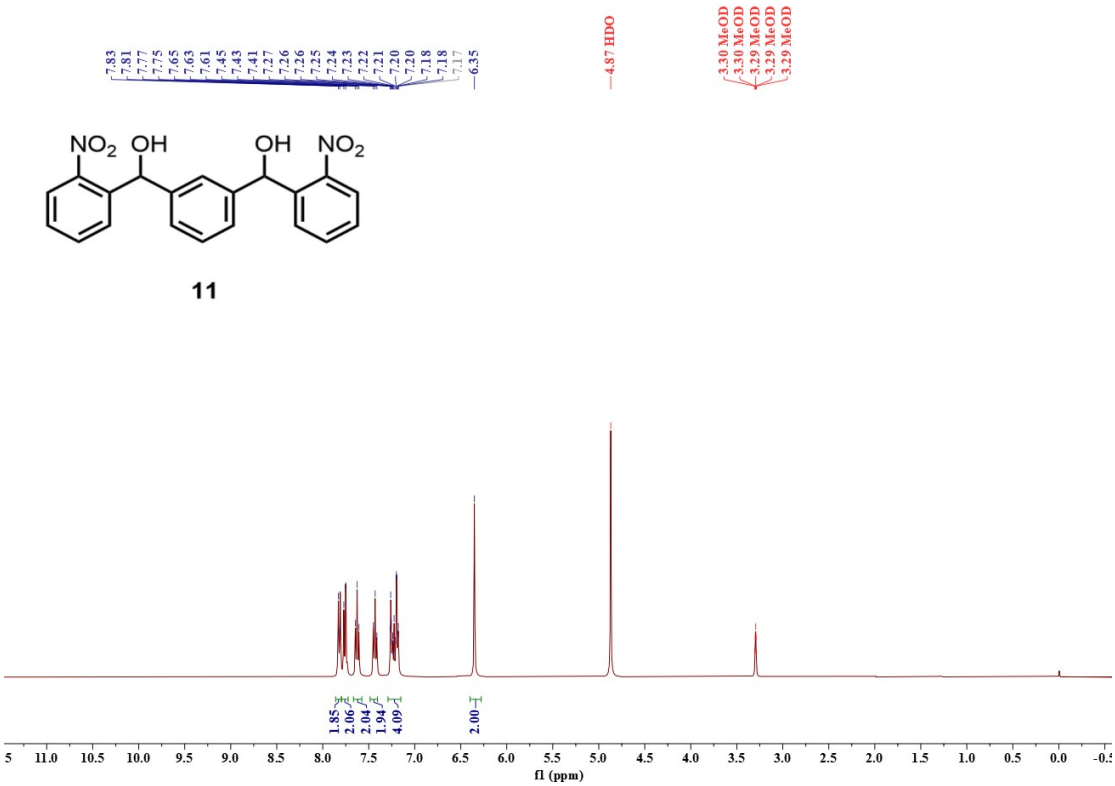
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 5c



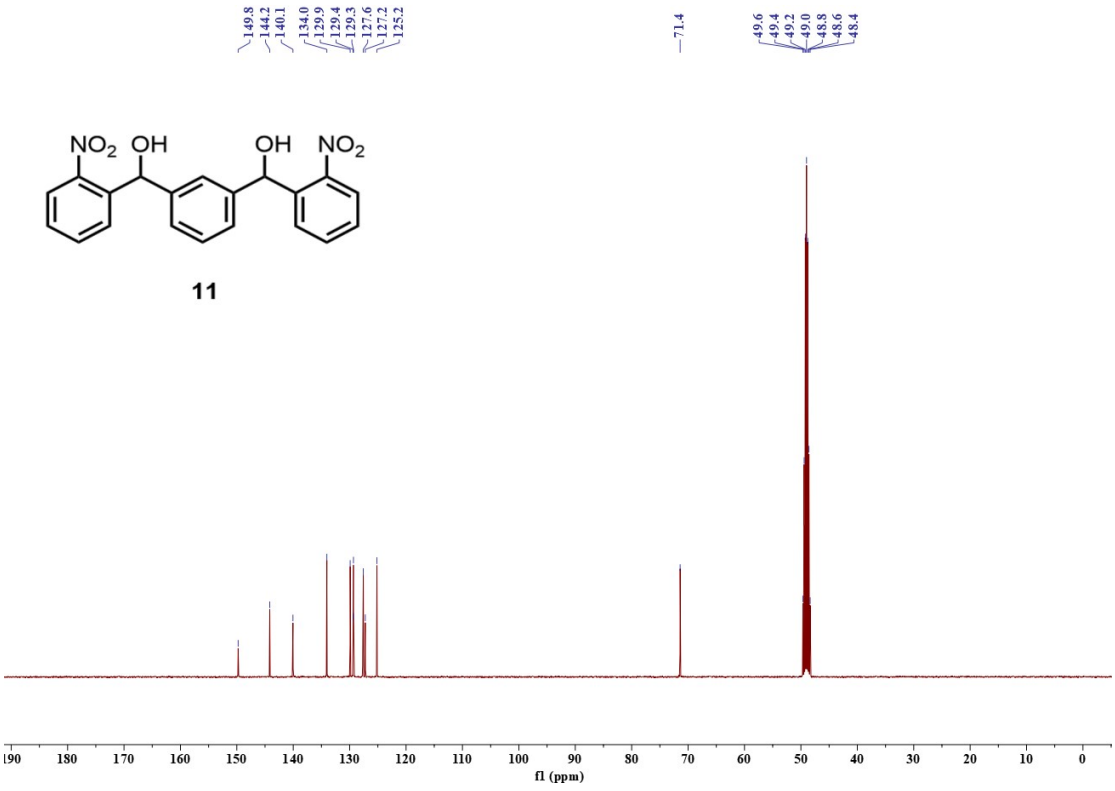
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 5c



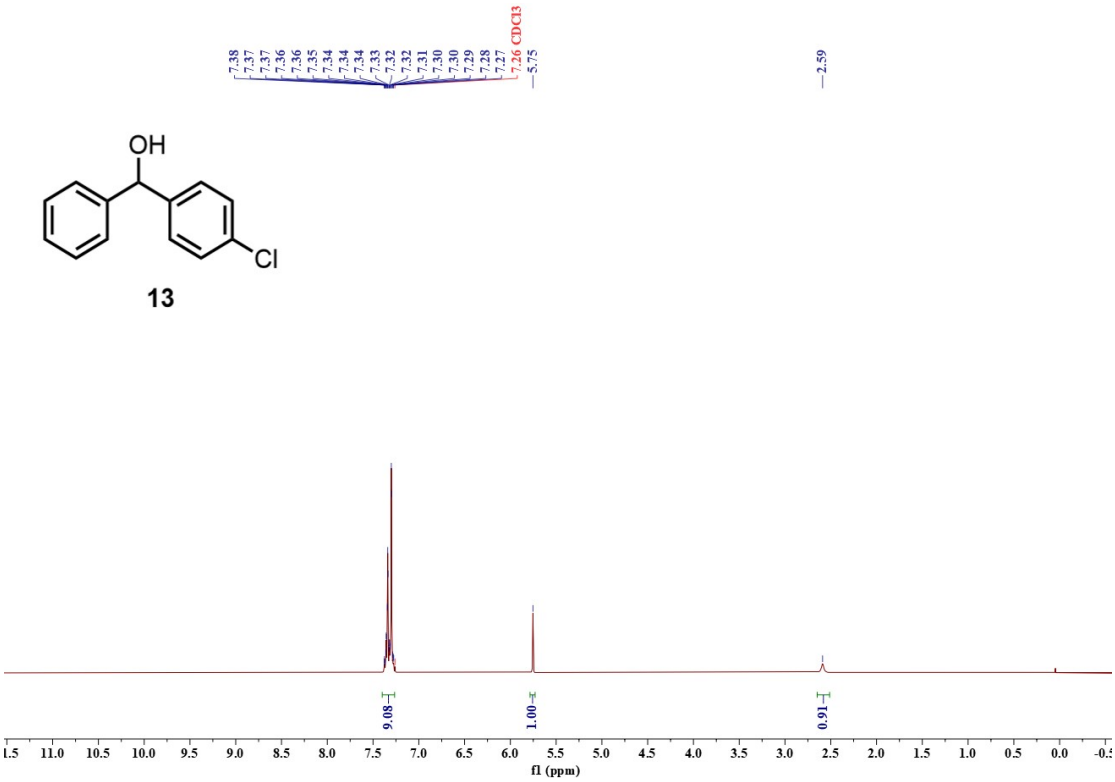
^{1}H NMR (400 MHz, CD_3OD) spectrum for 11



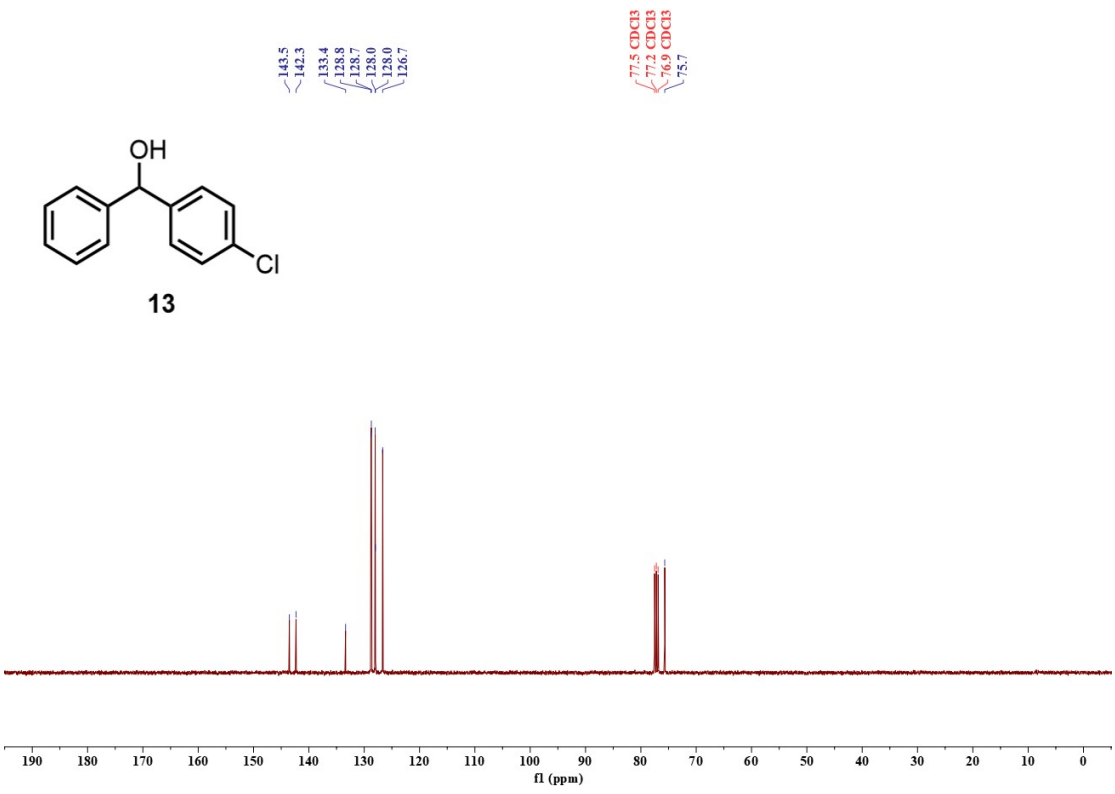
^{13}C NMR (101 MHz, CD_3OD) spectrum for 11



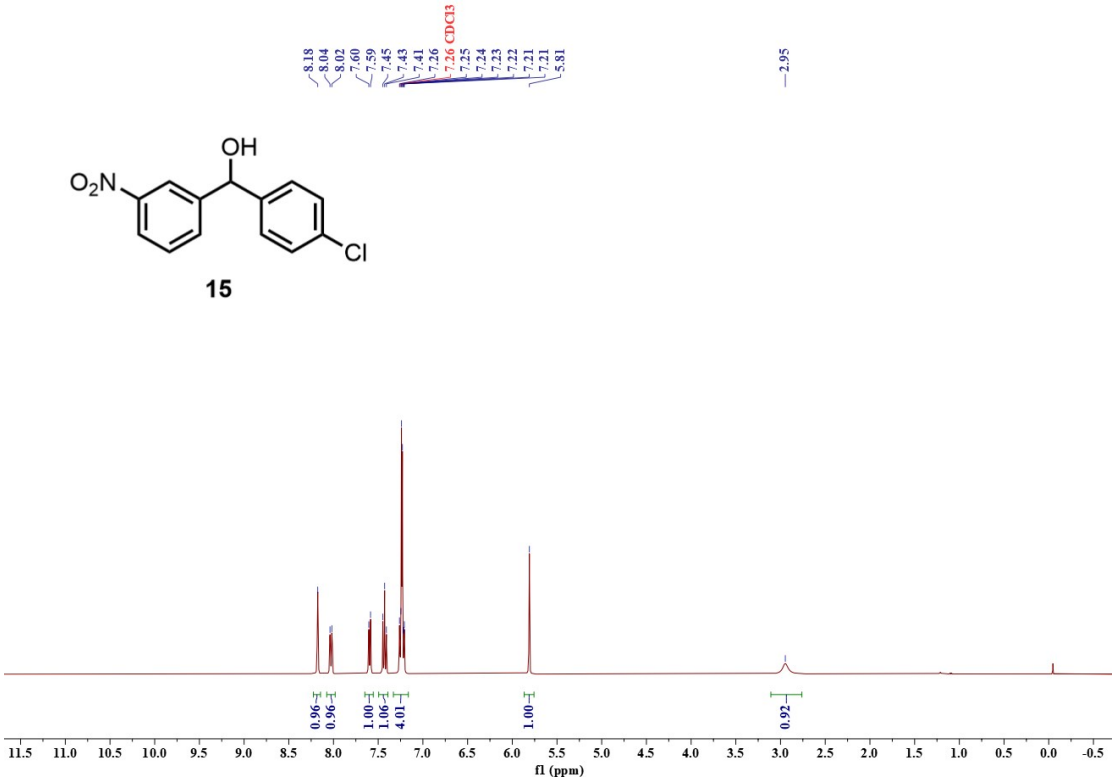
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 13



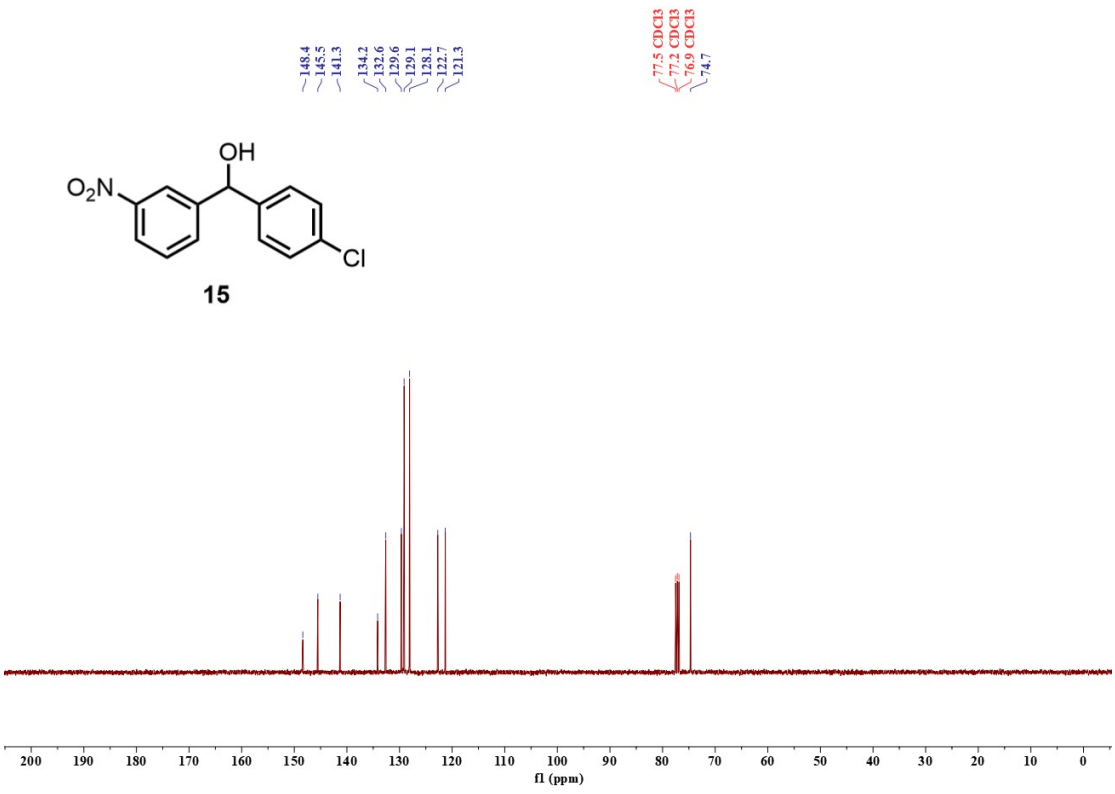
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 13



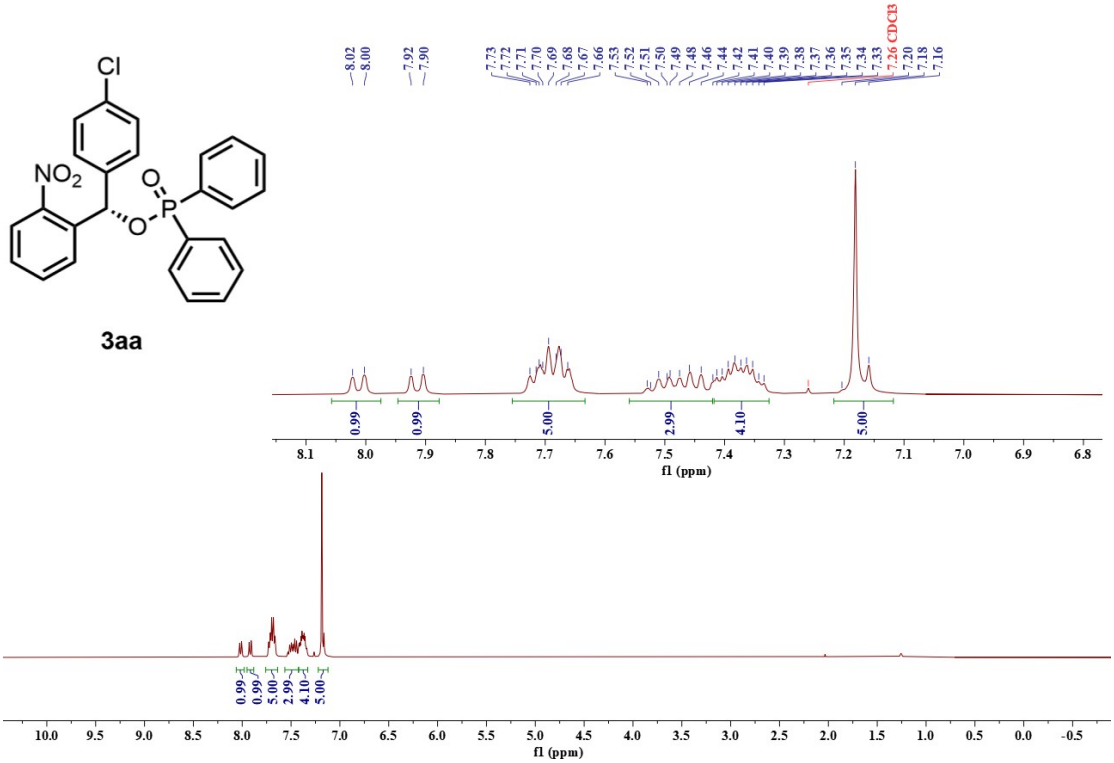
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 15



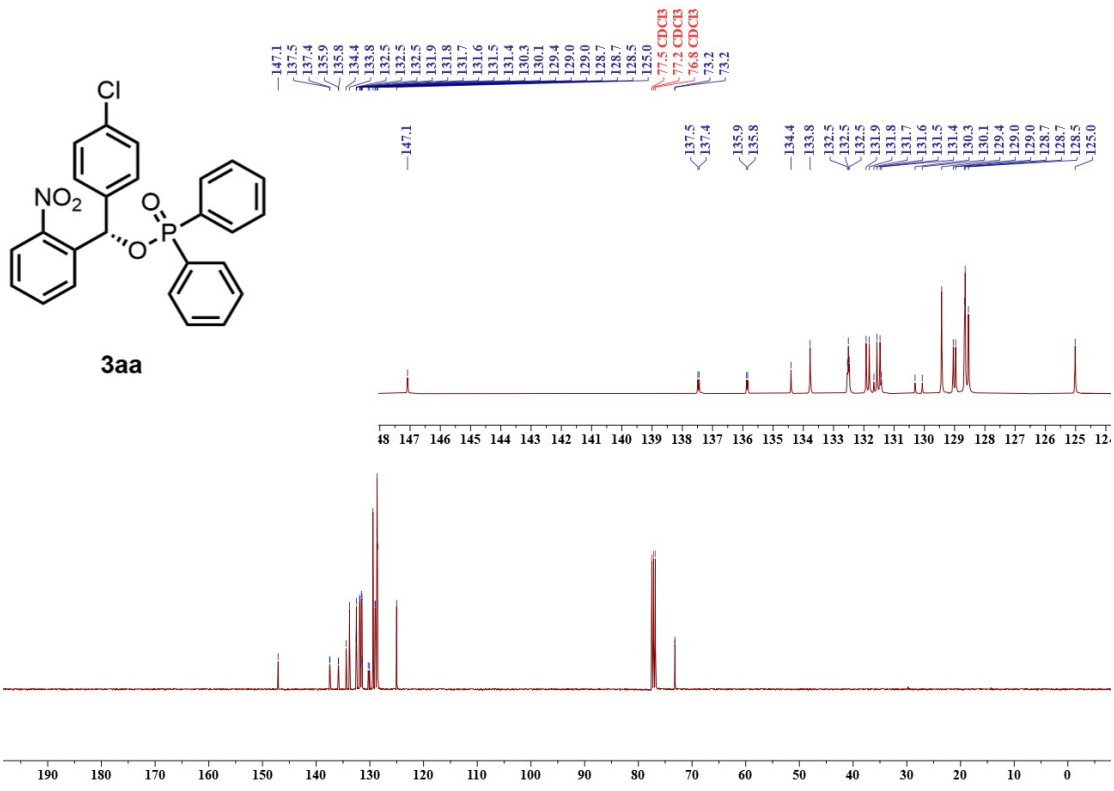
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 15



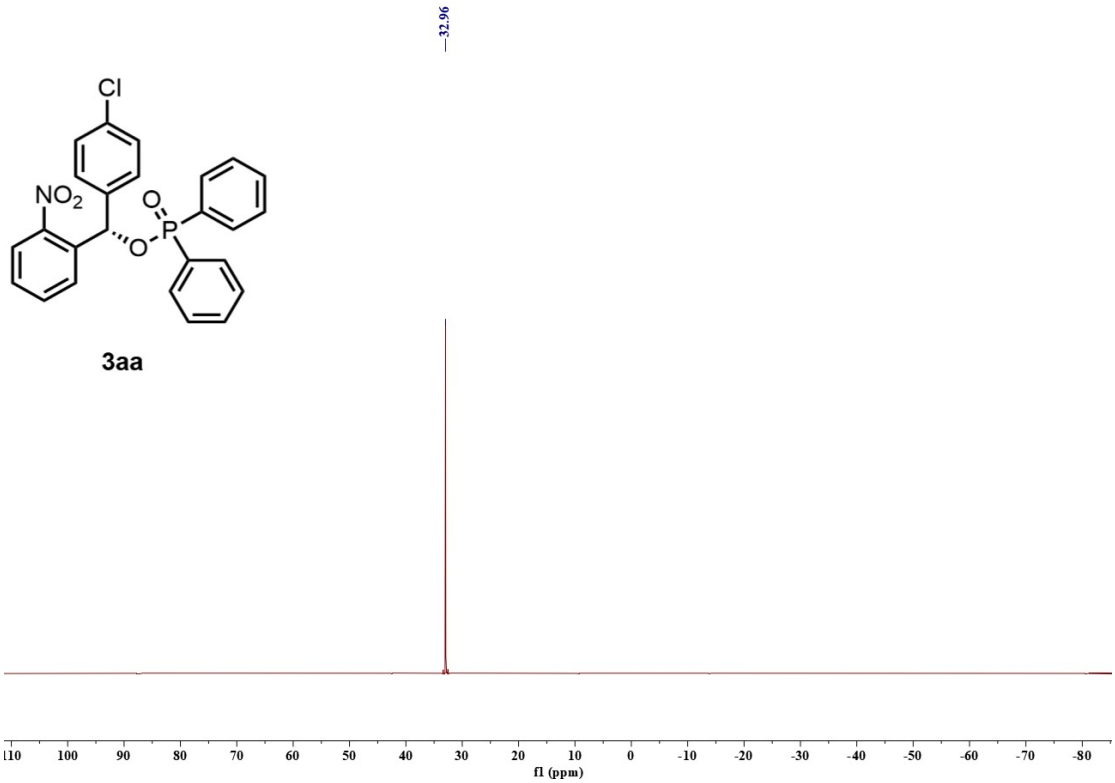
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 3aa



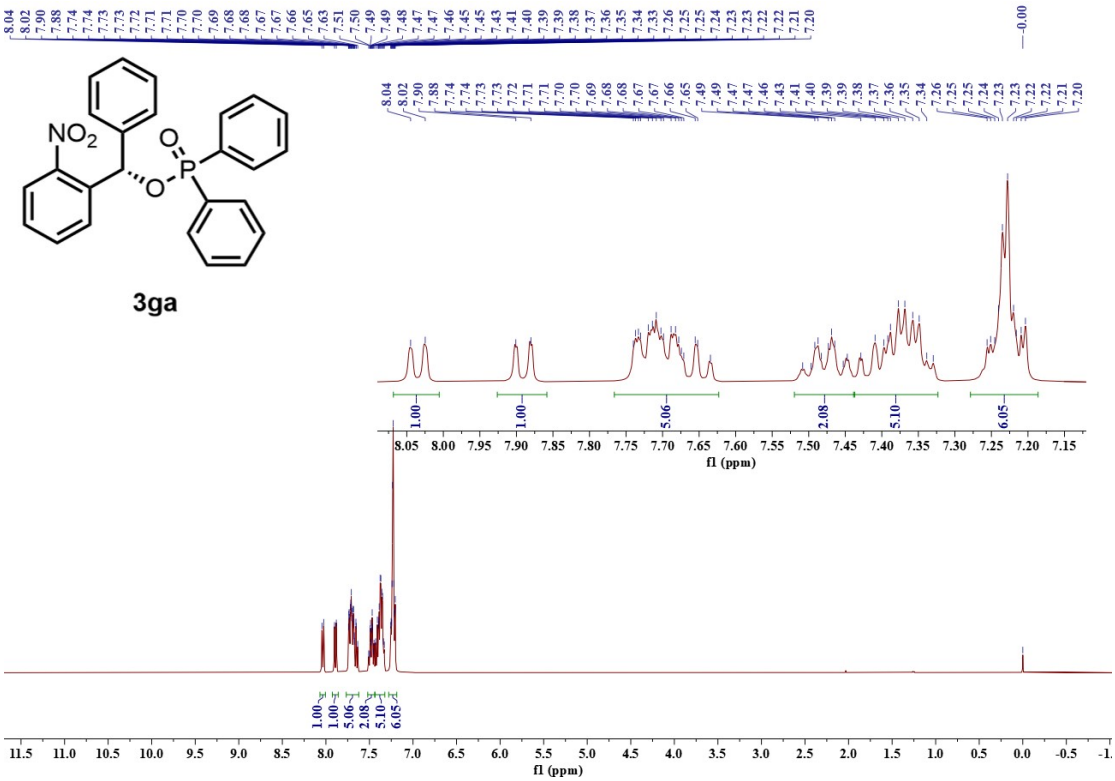
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 3aa



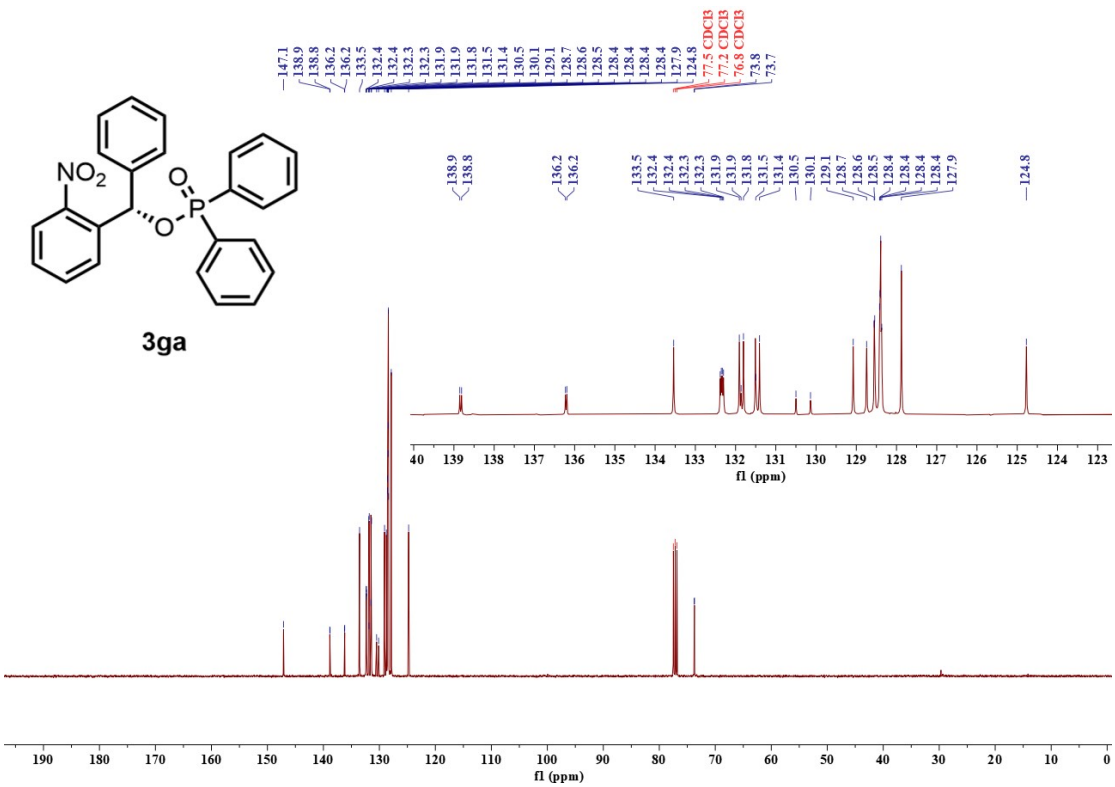
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 3aa



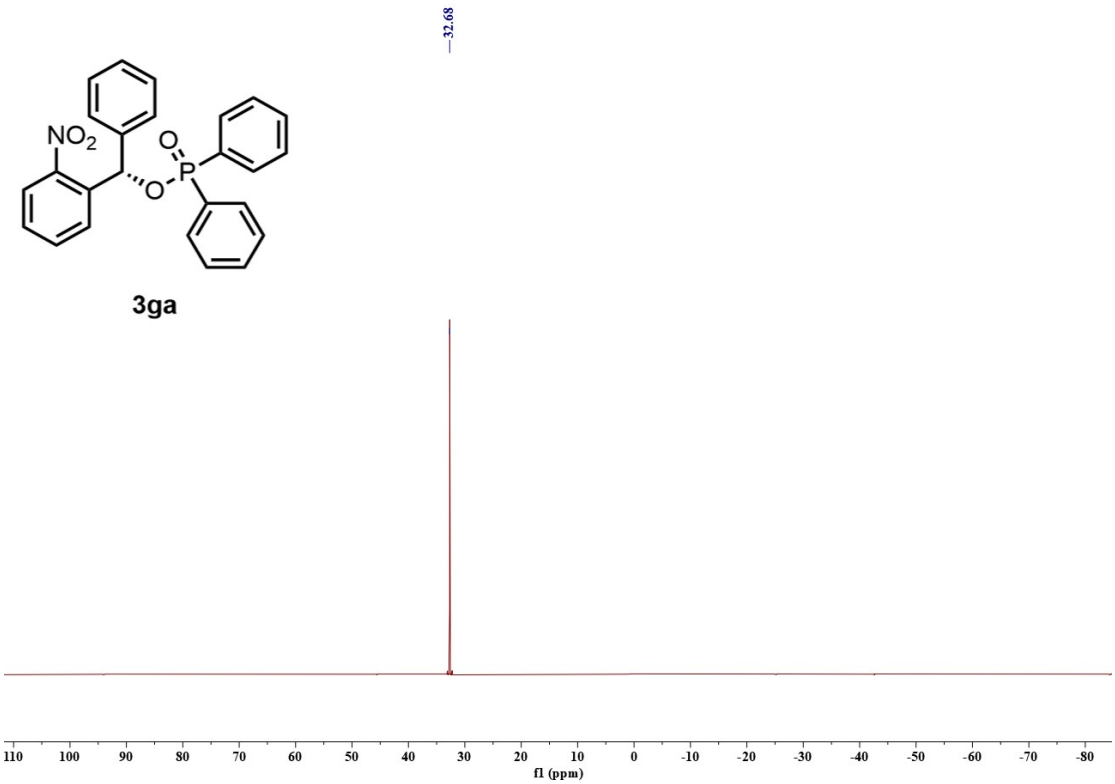
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 3ga



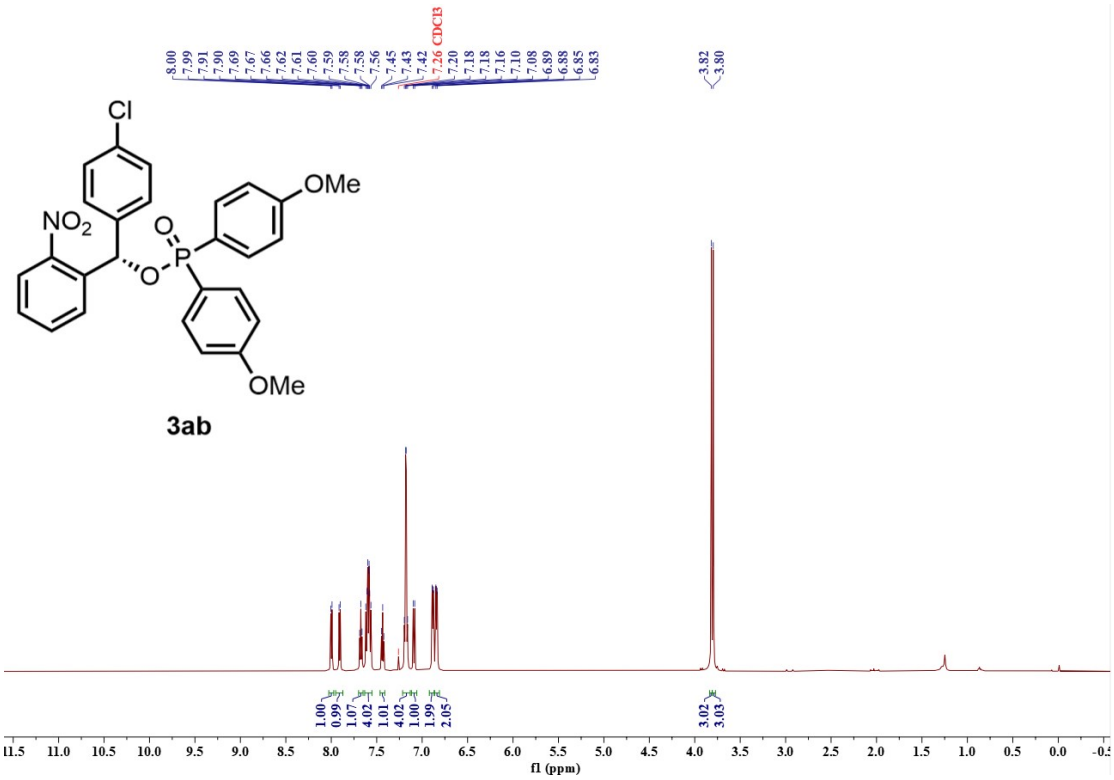
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 3ga



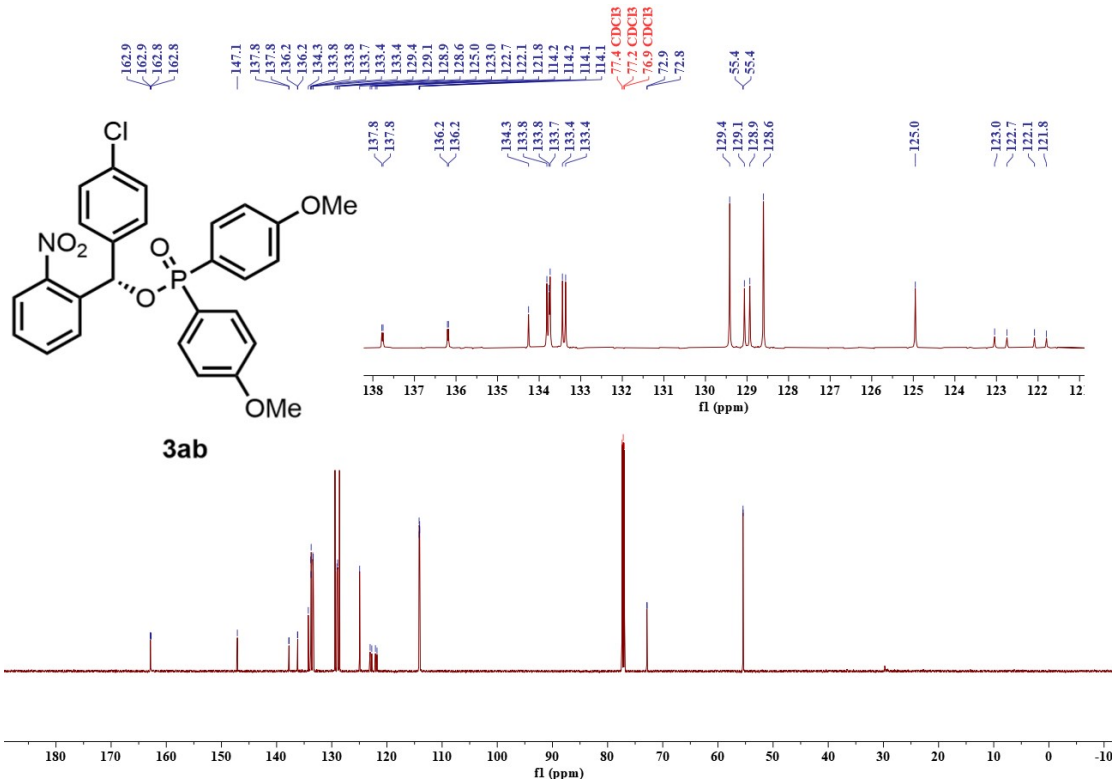
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 3ga



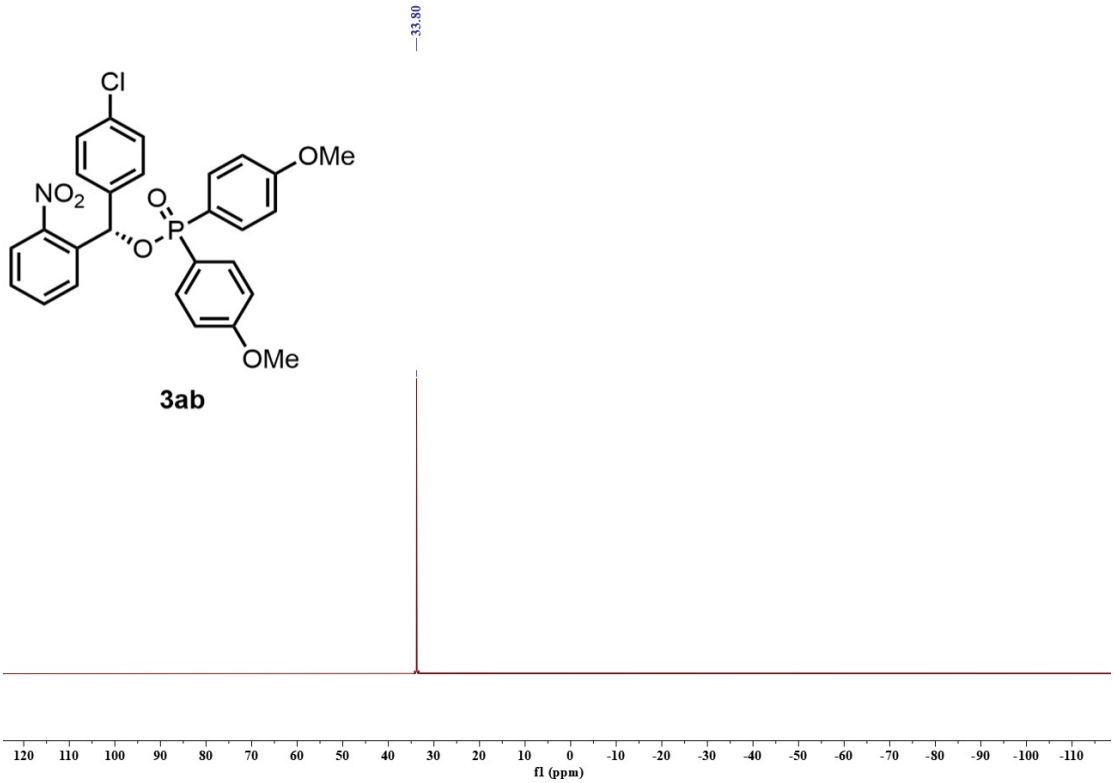
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 3ab



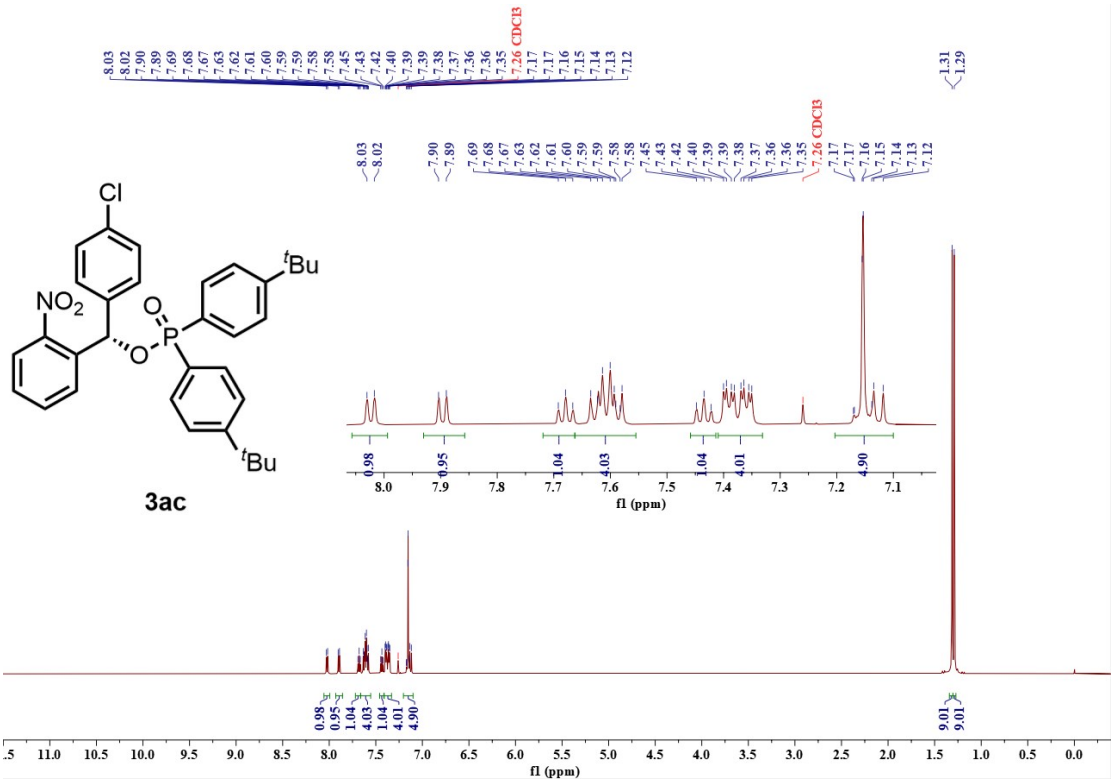
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 3ab



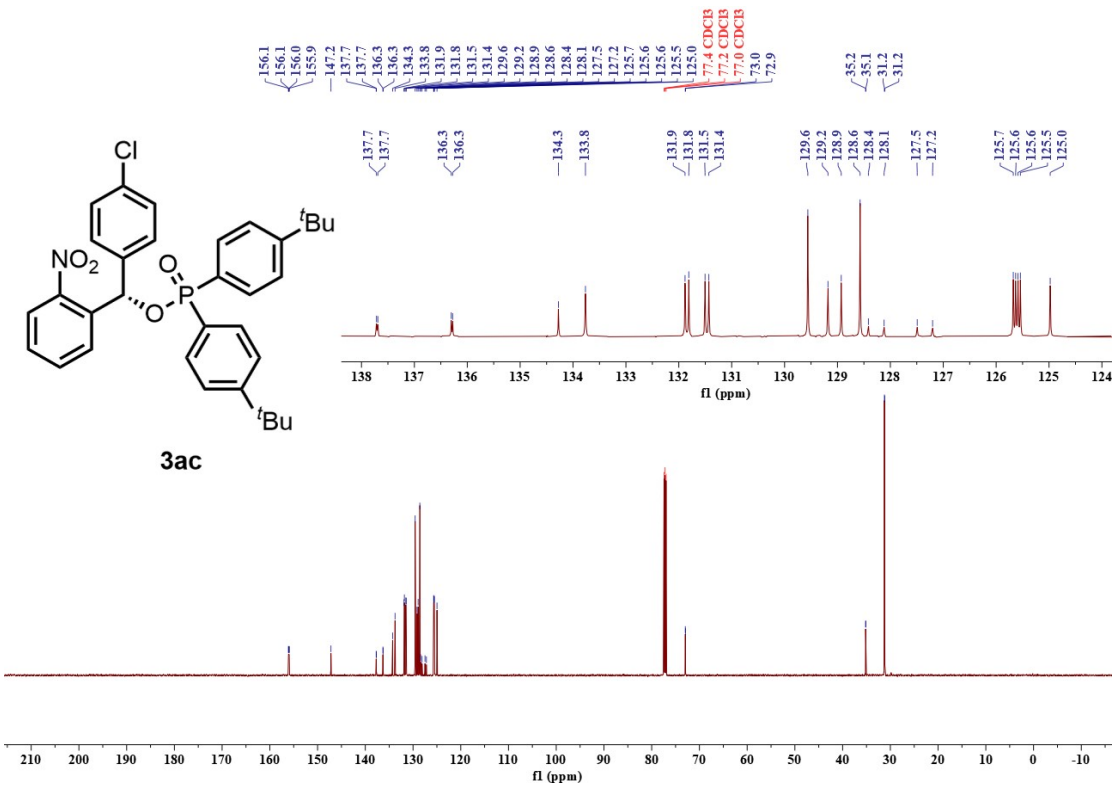
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 3ab



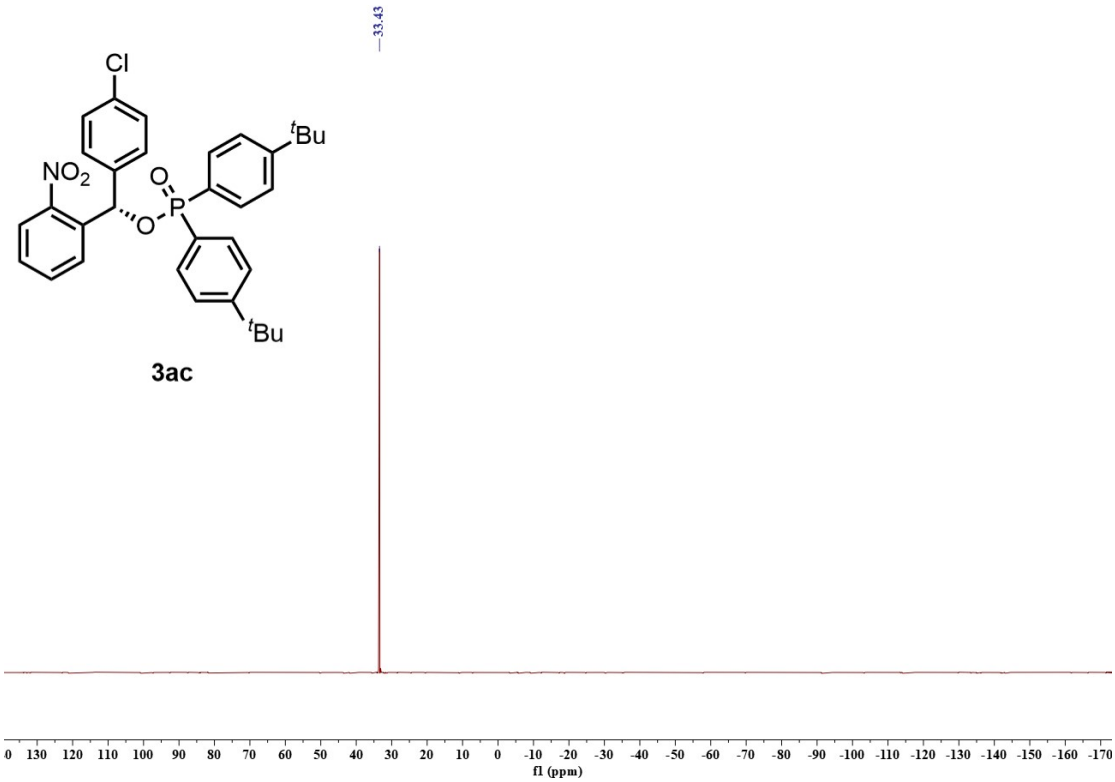
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 3ac



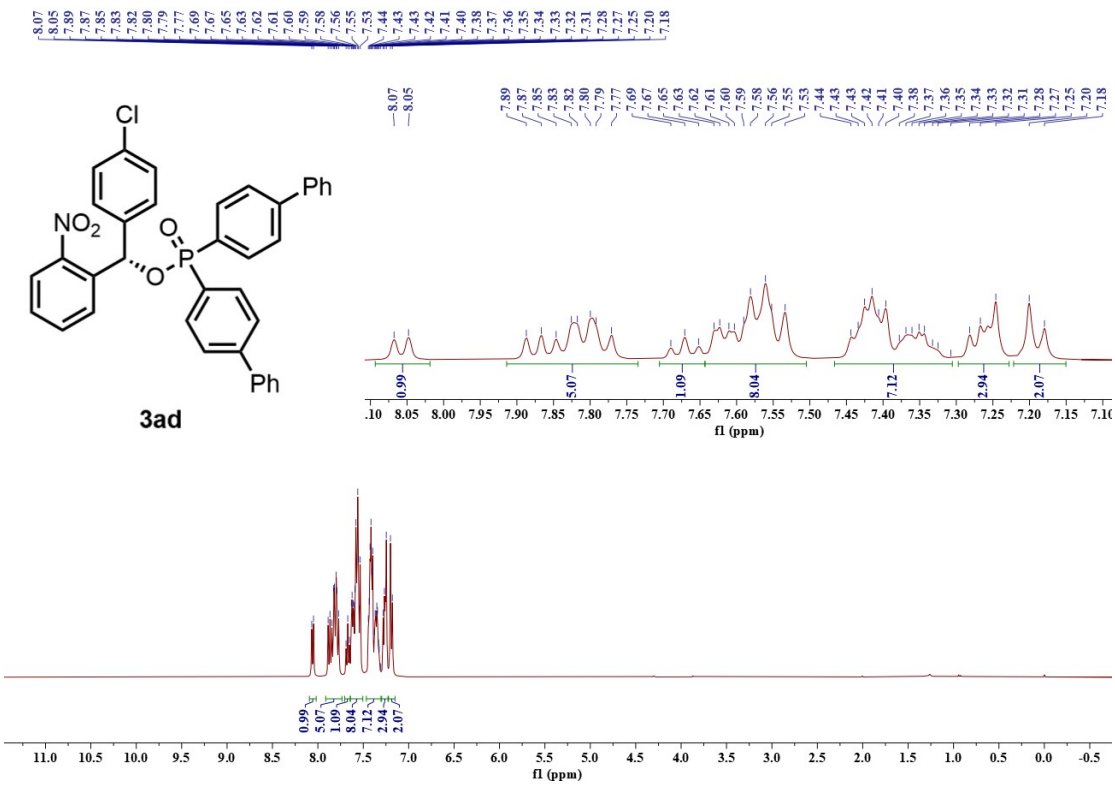
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 3ac



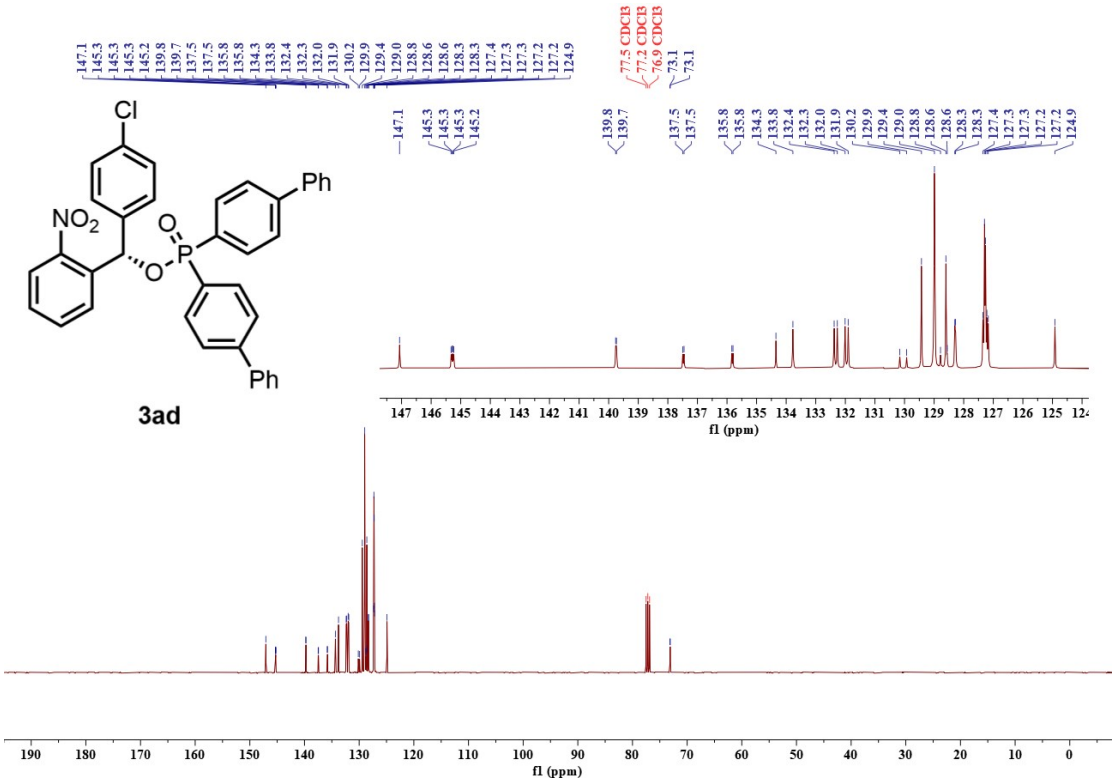
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 3ac



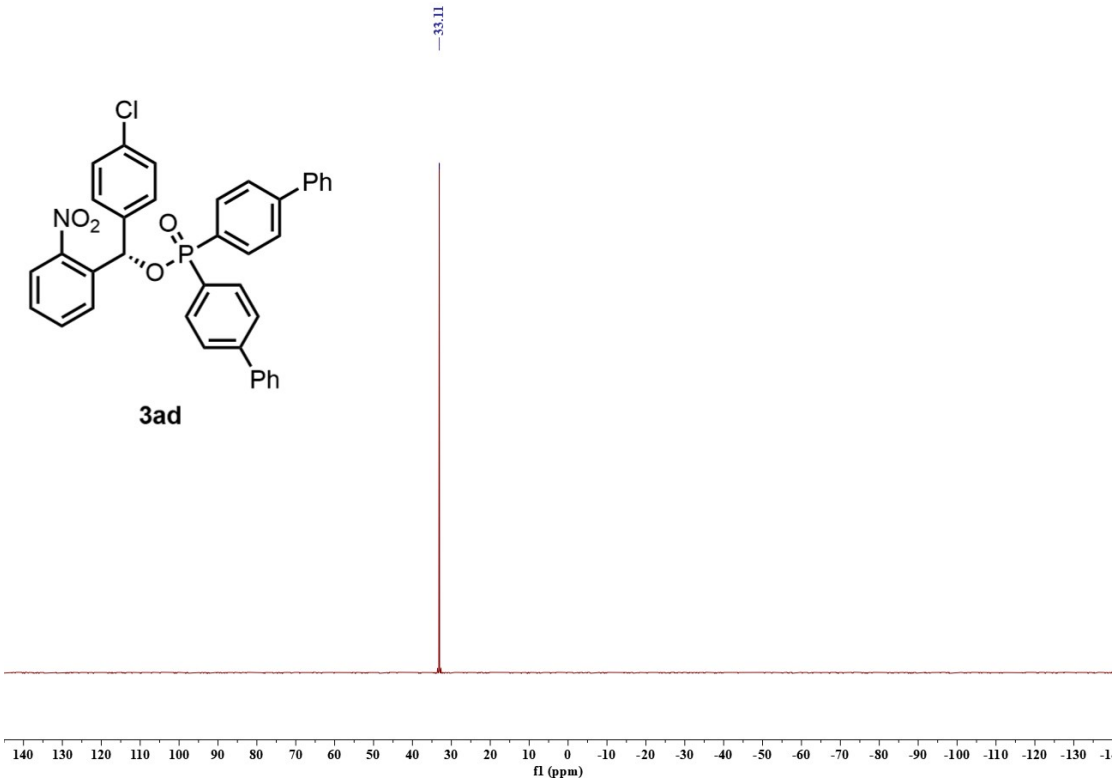
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 3ad



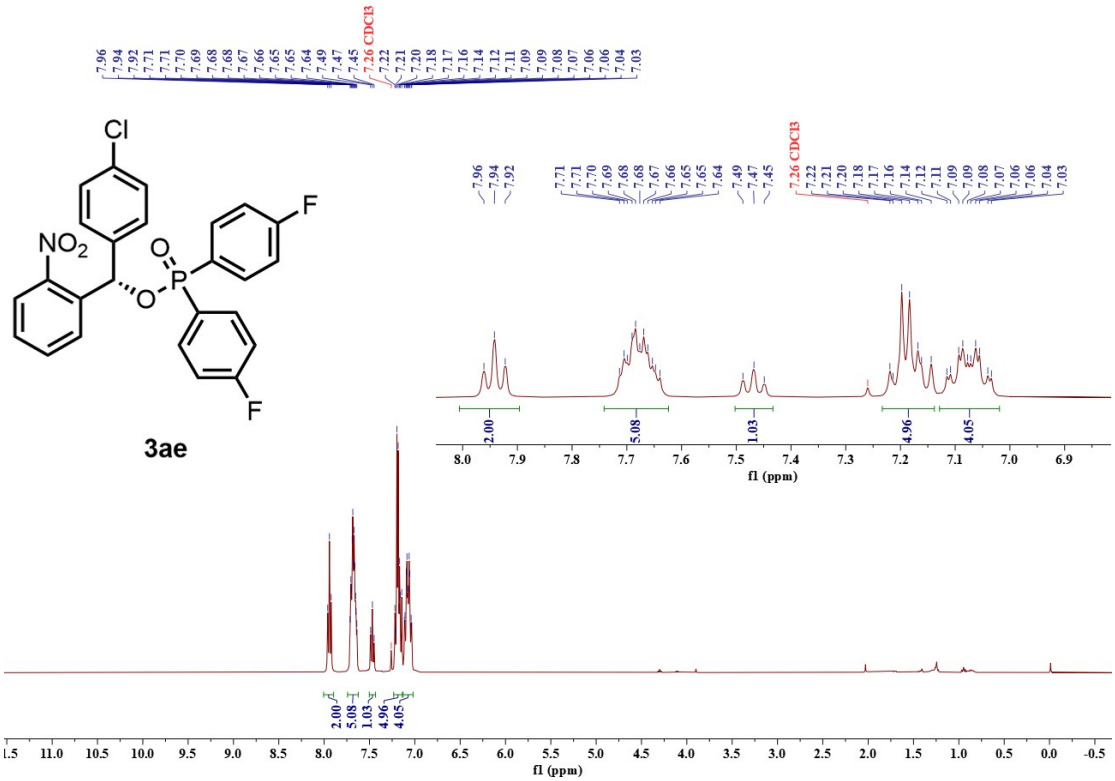
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 3ad



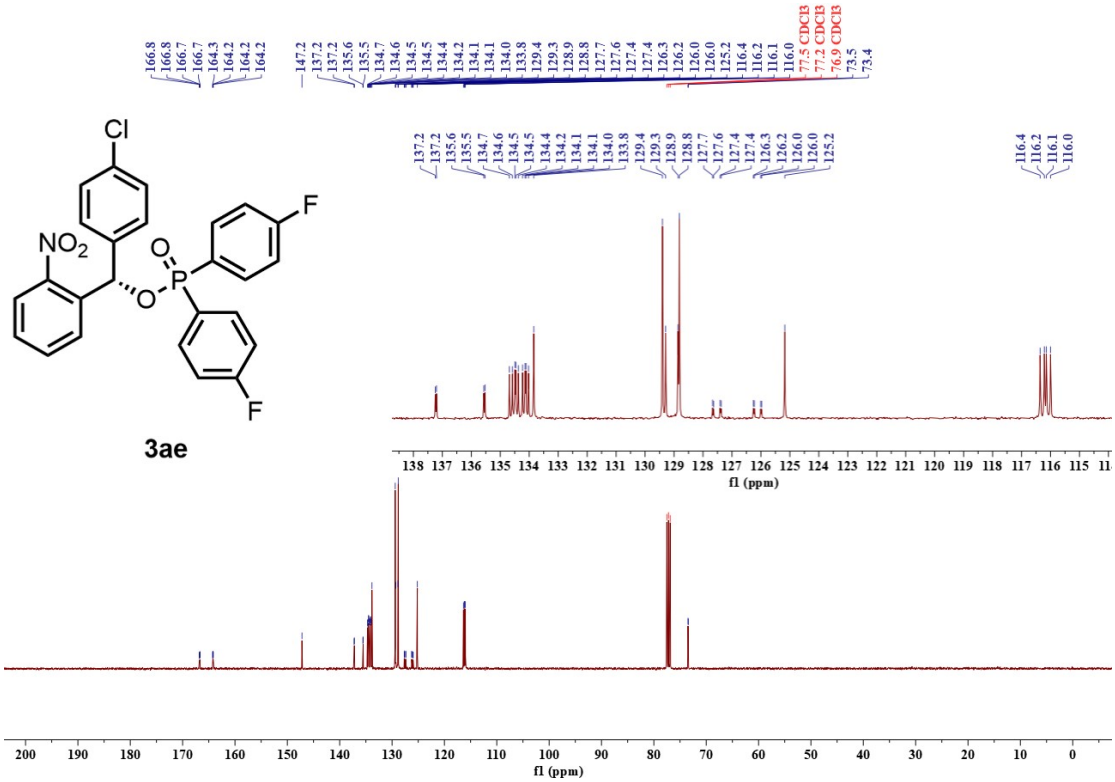
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 3ad



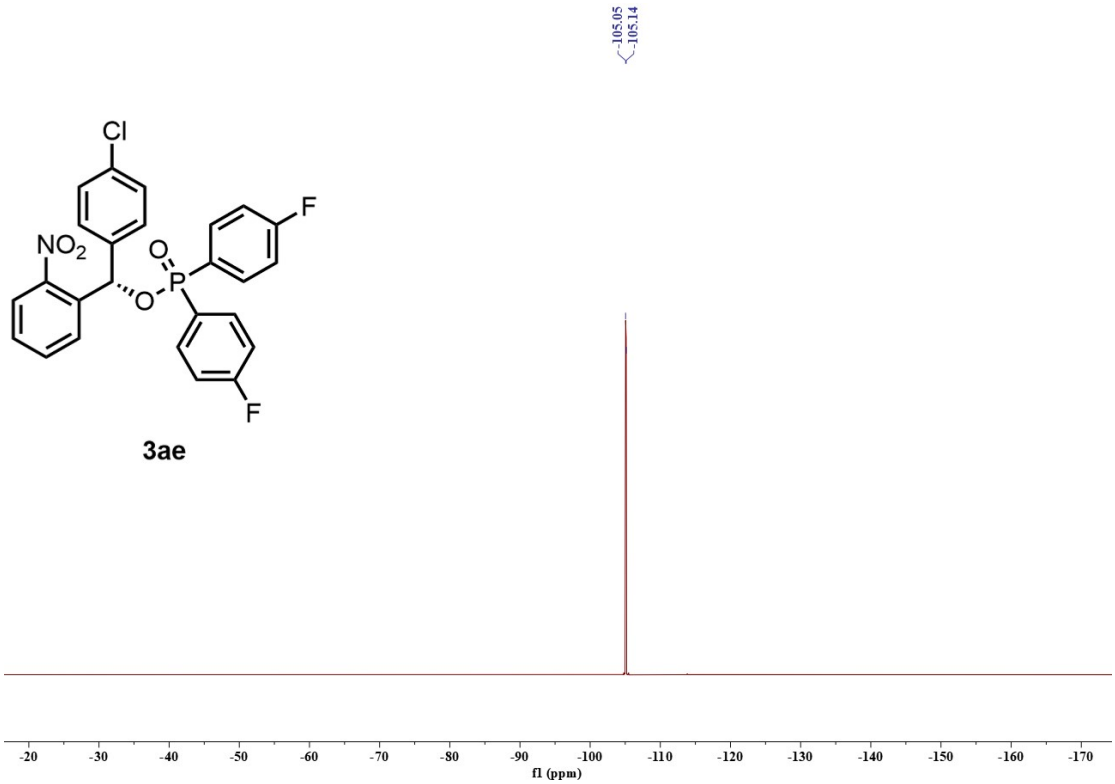
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 3ae



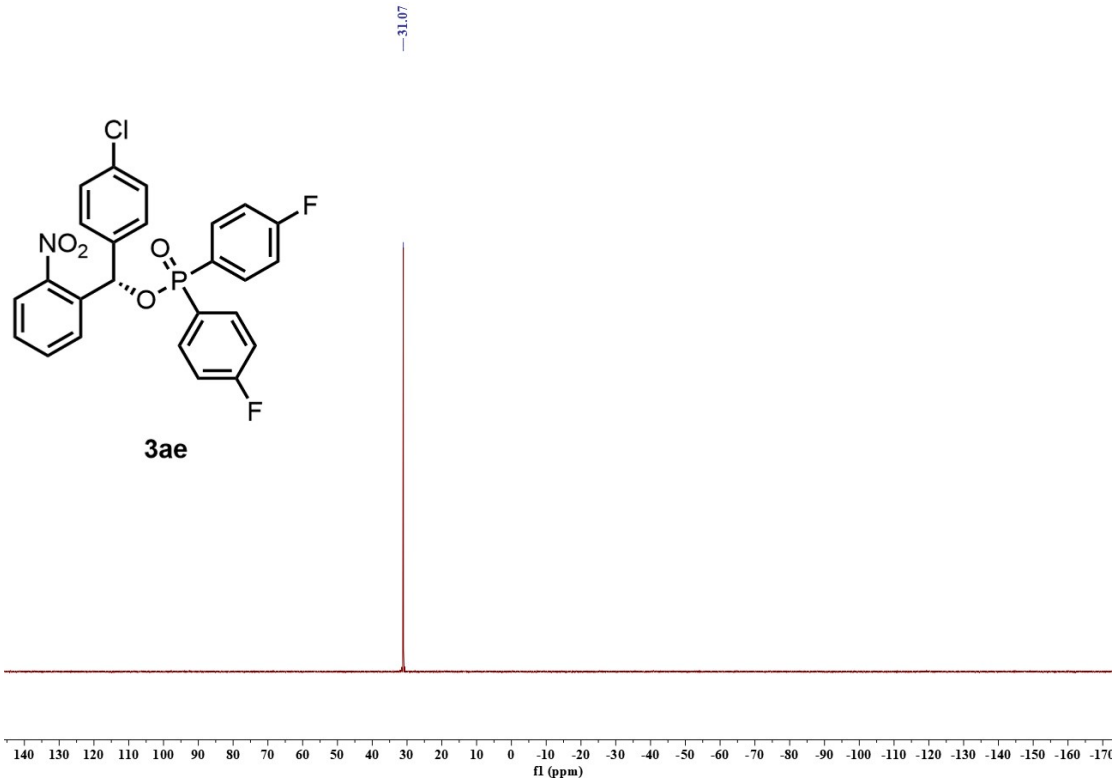
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 3ae



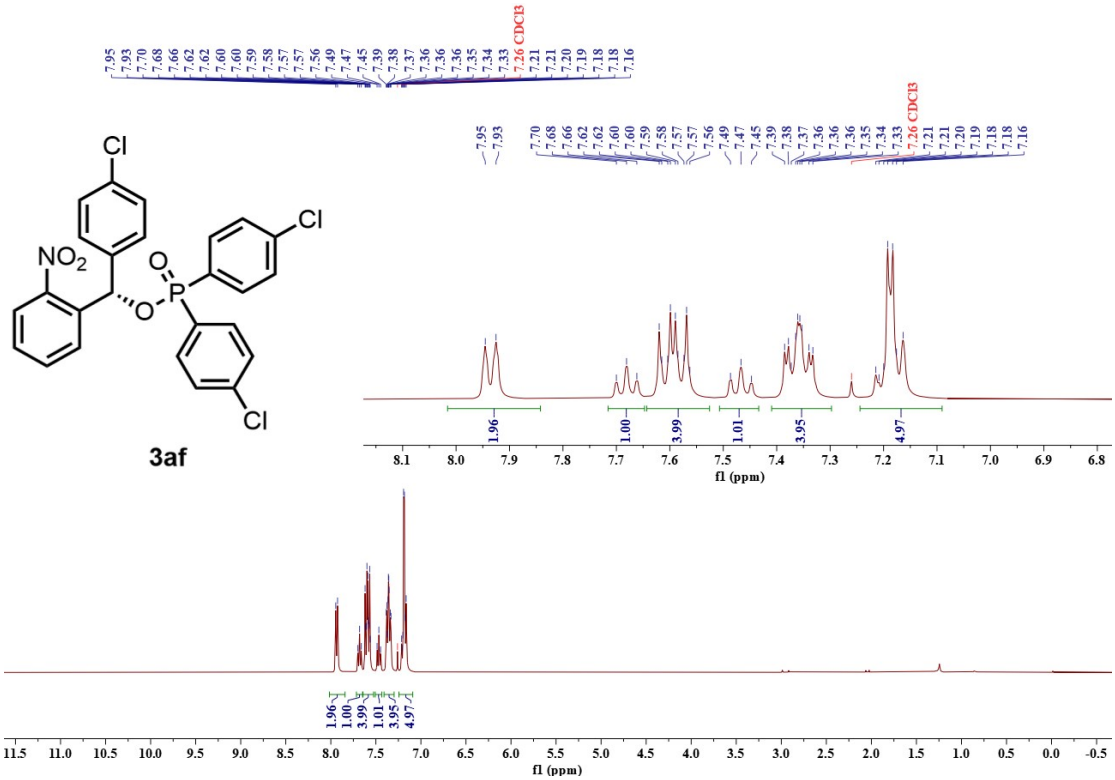
^{19}F NMR (376 MHz, $CDCl_3$) spectrum for 3ae



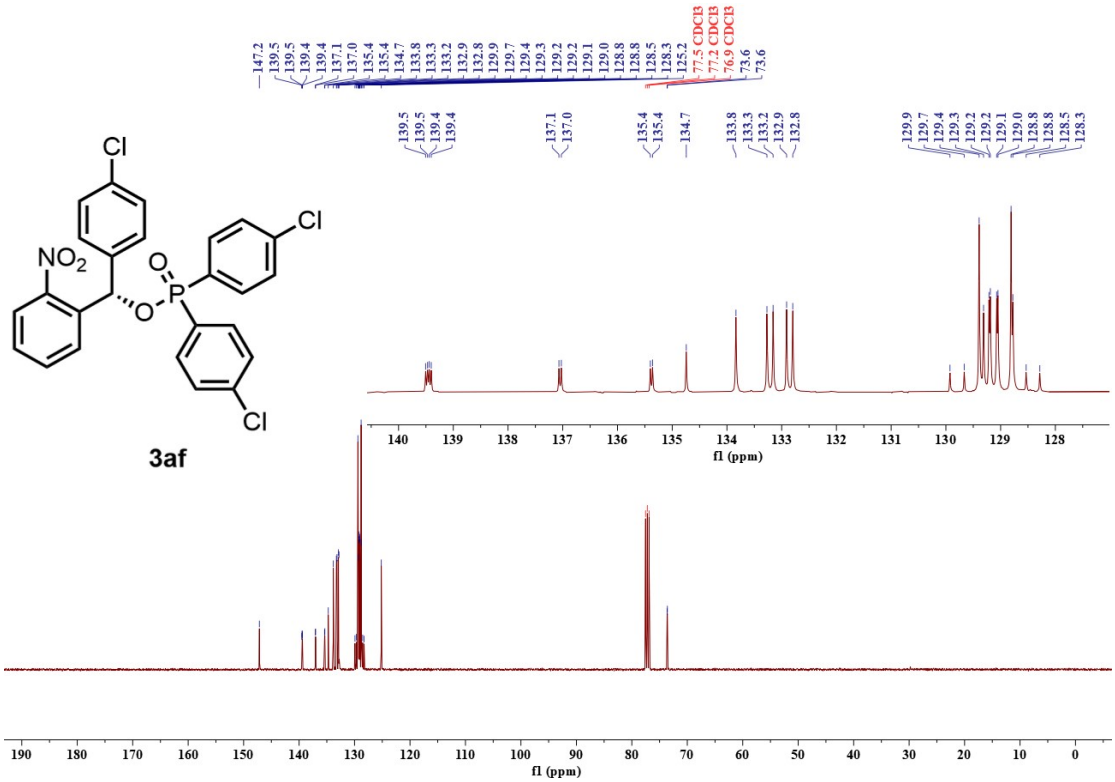
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 3ae



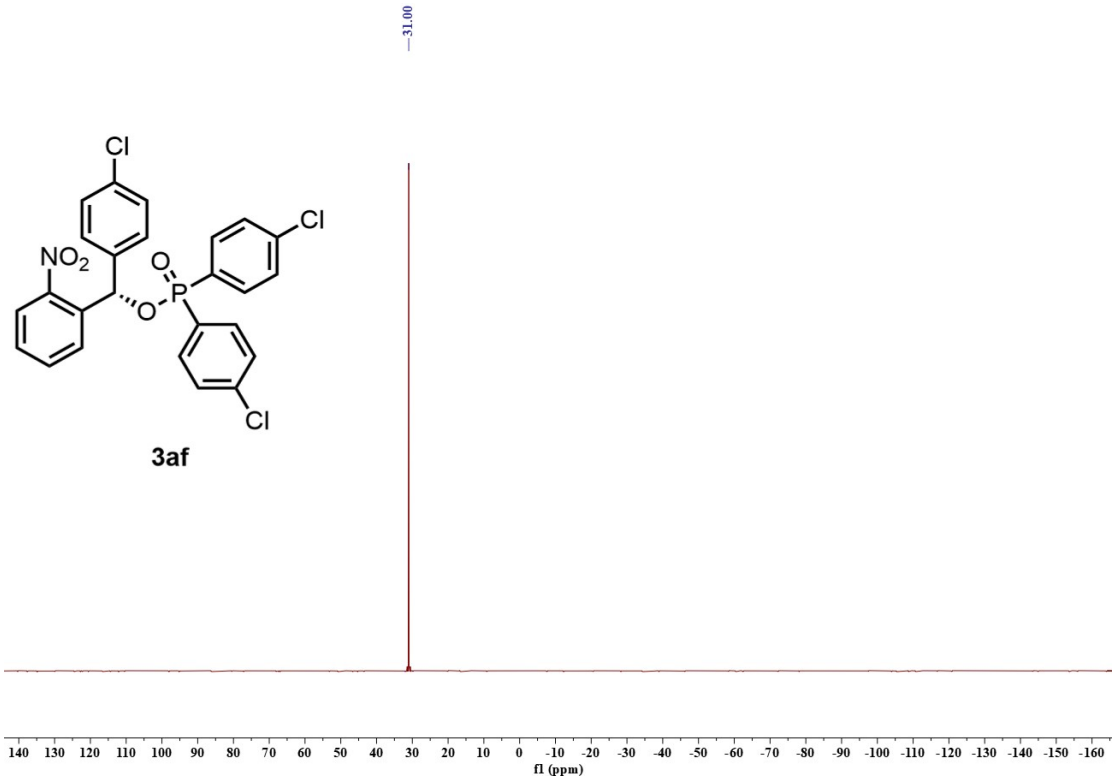
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 3af



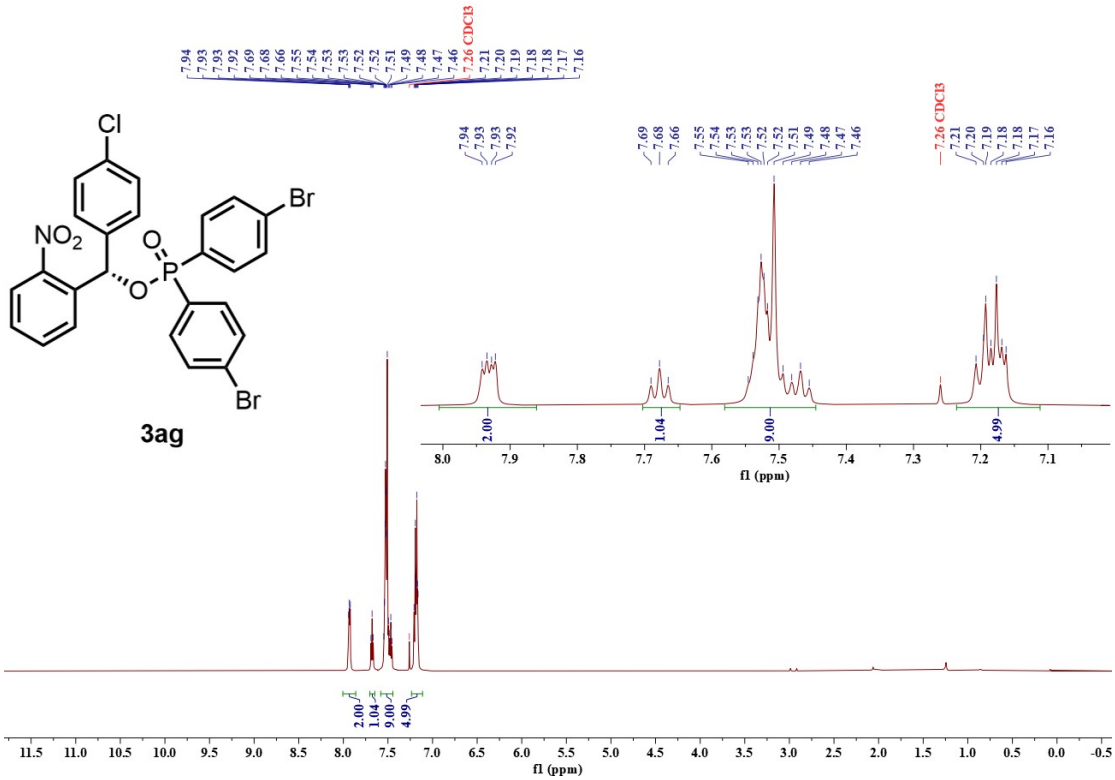
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 3af



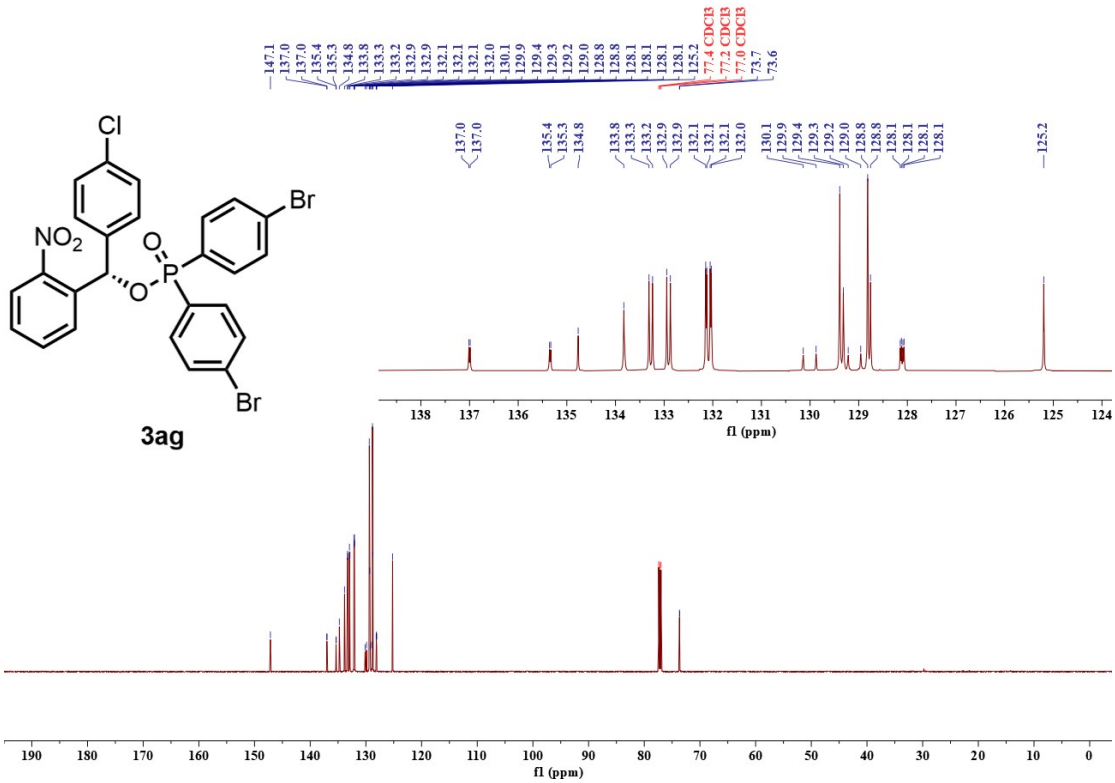
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 3af



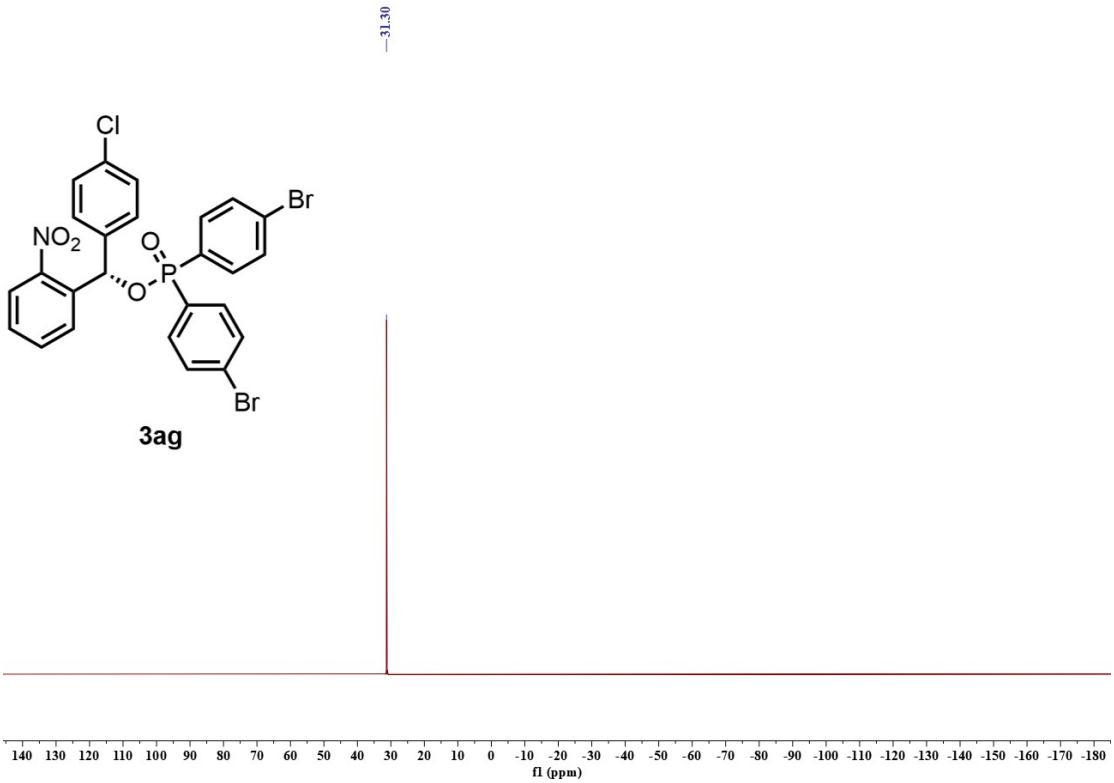
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 3ag



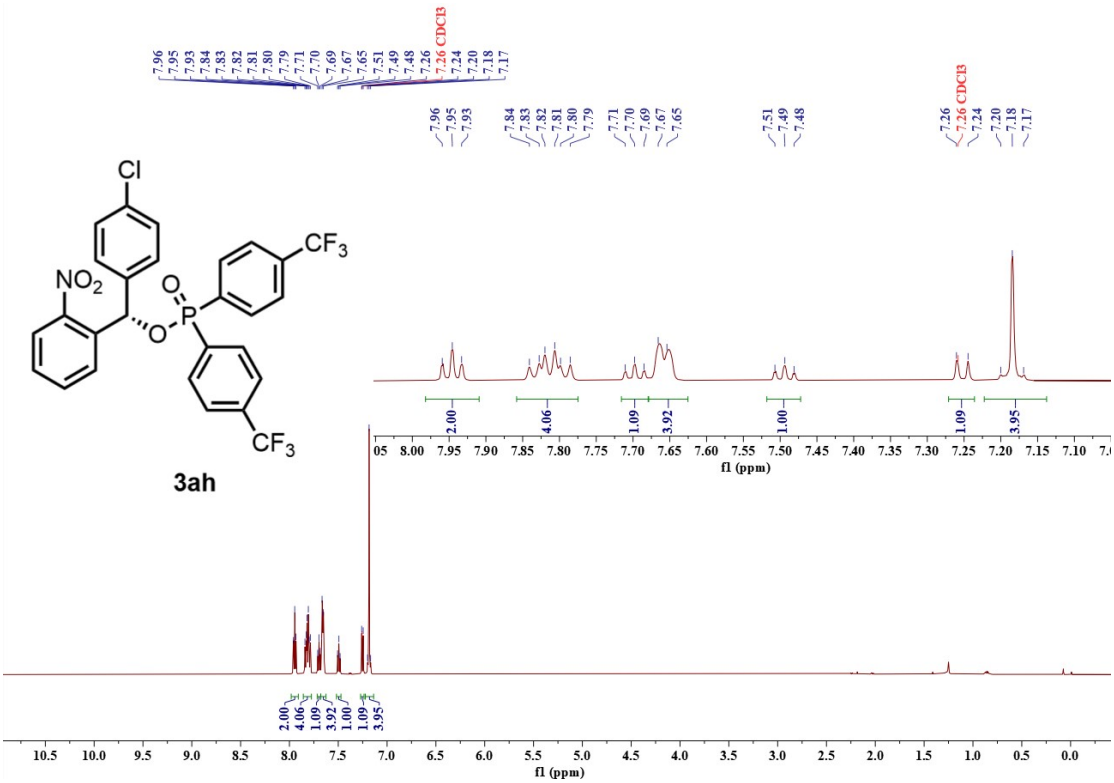
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 3ag



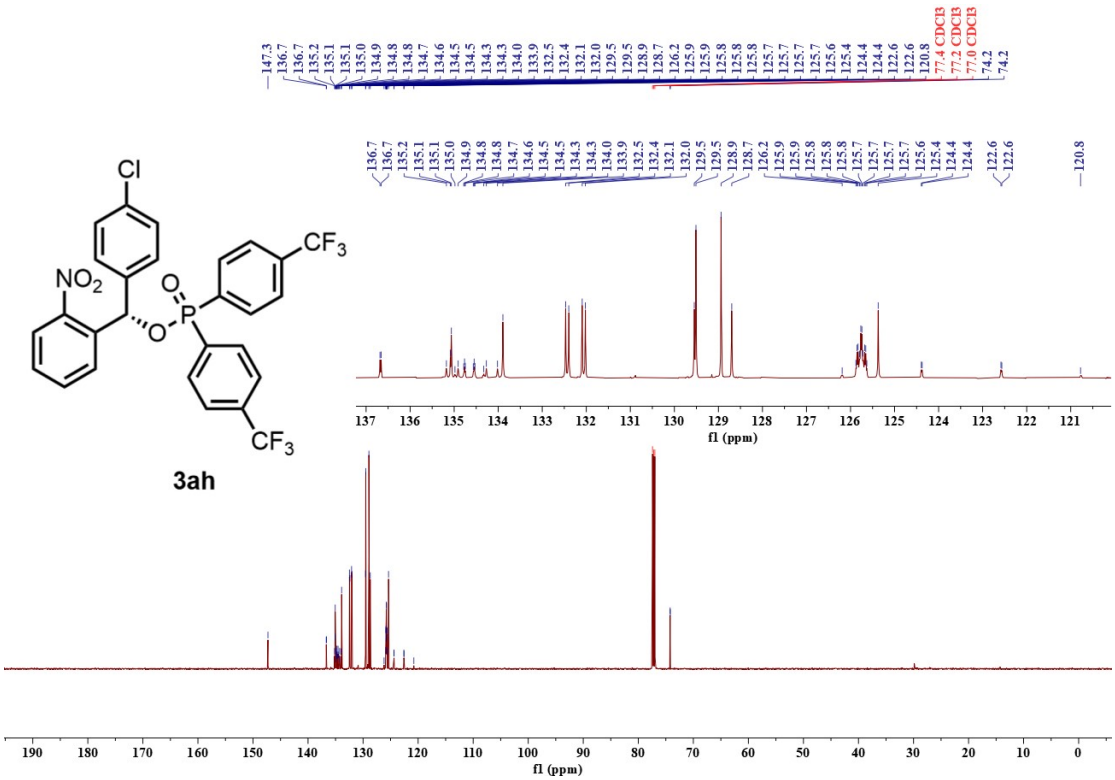
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 3ag



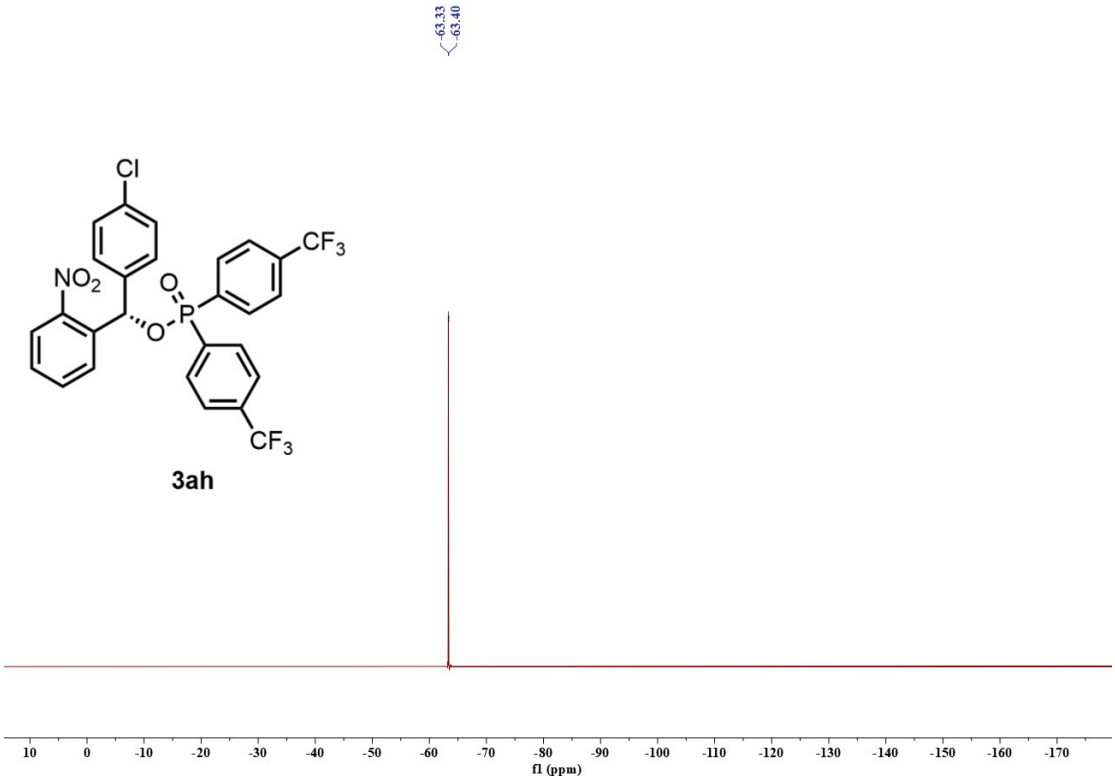
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 3ah



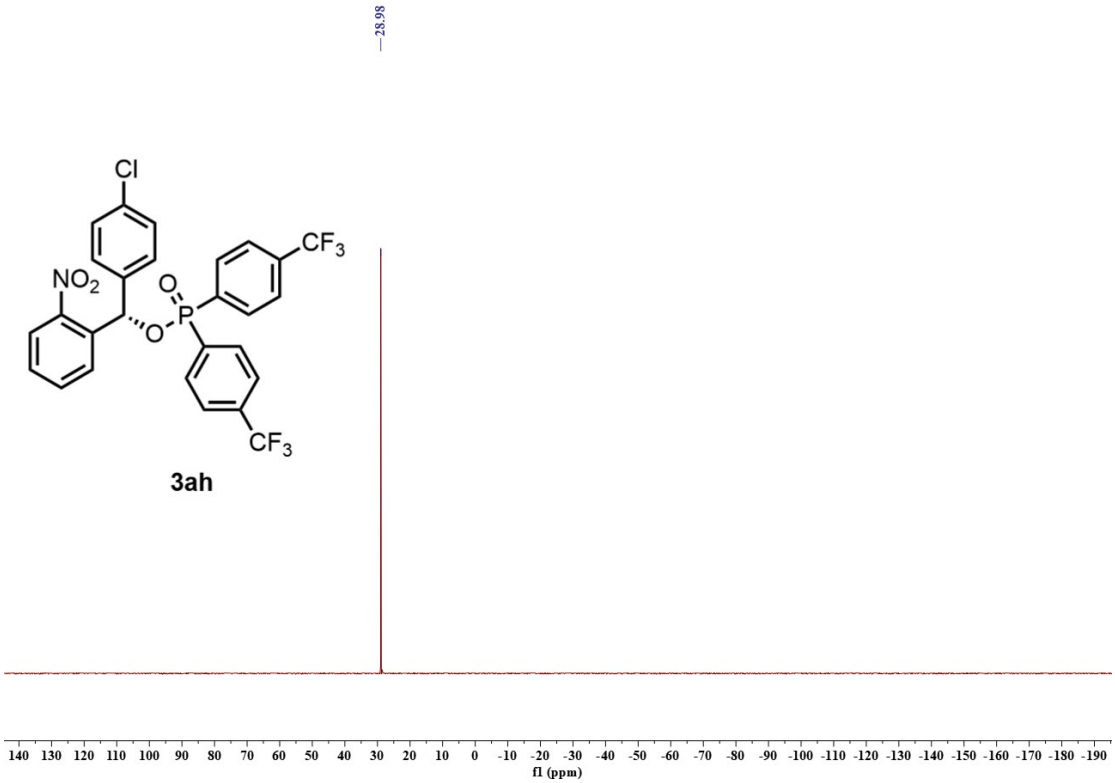
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 3ah



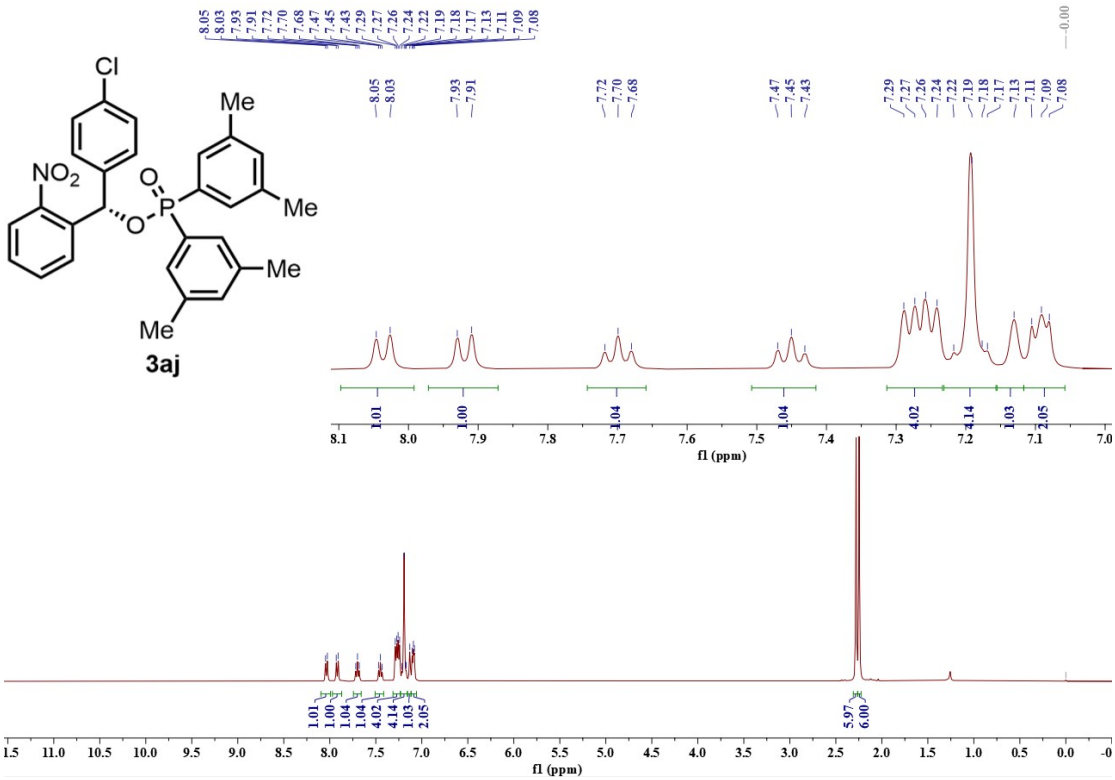
^{19}F NMR (565 MHz, $CDCl_3$) spectrum for 3ah



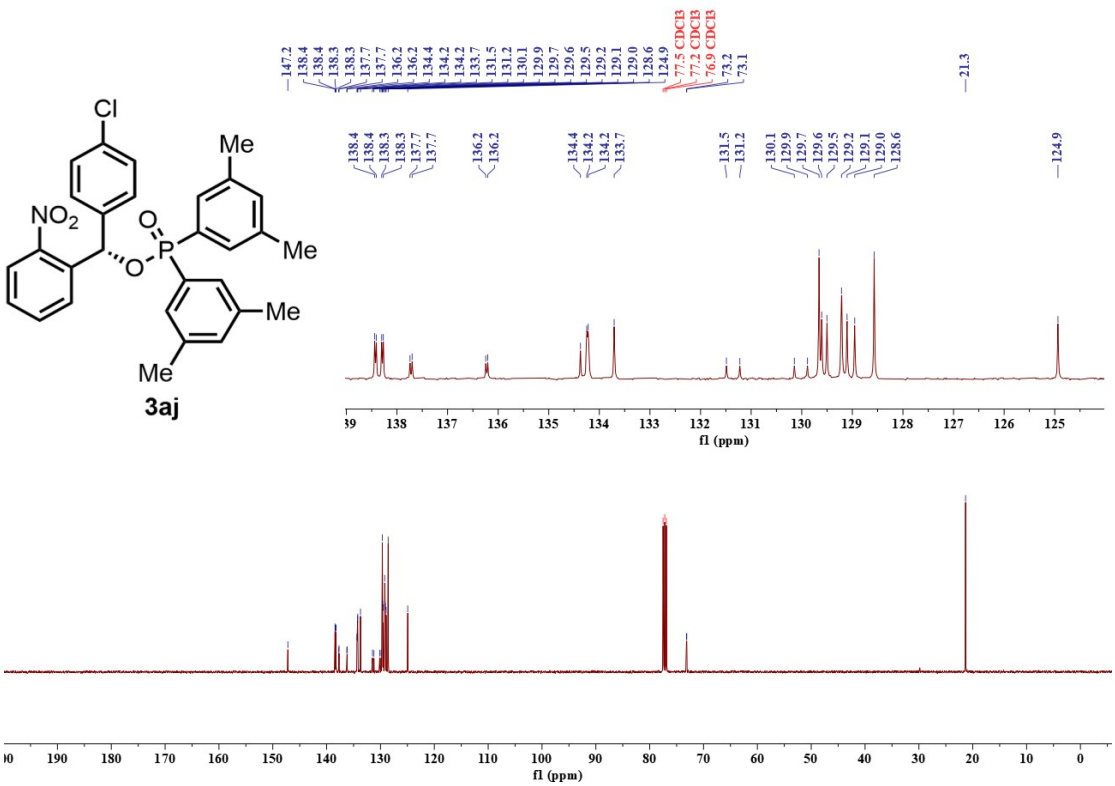
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 3ah



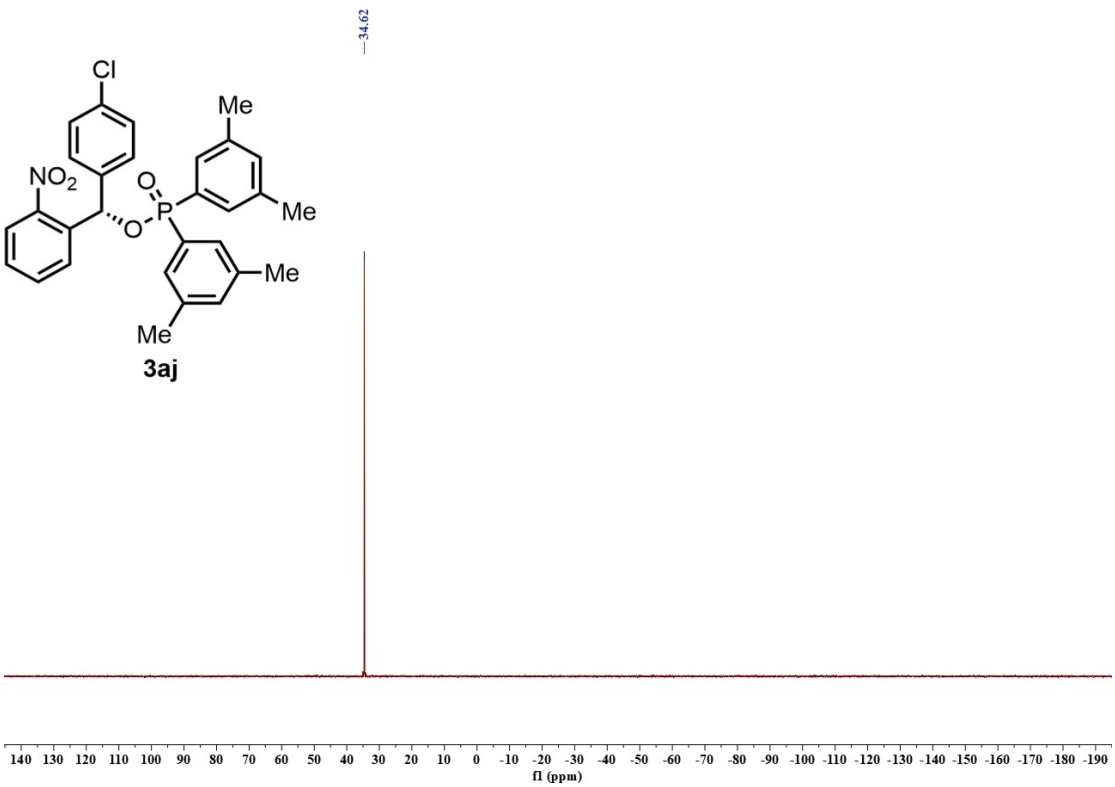
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 3aj



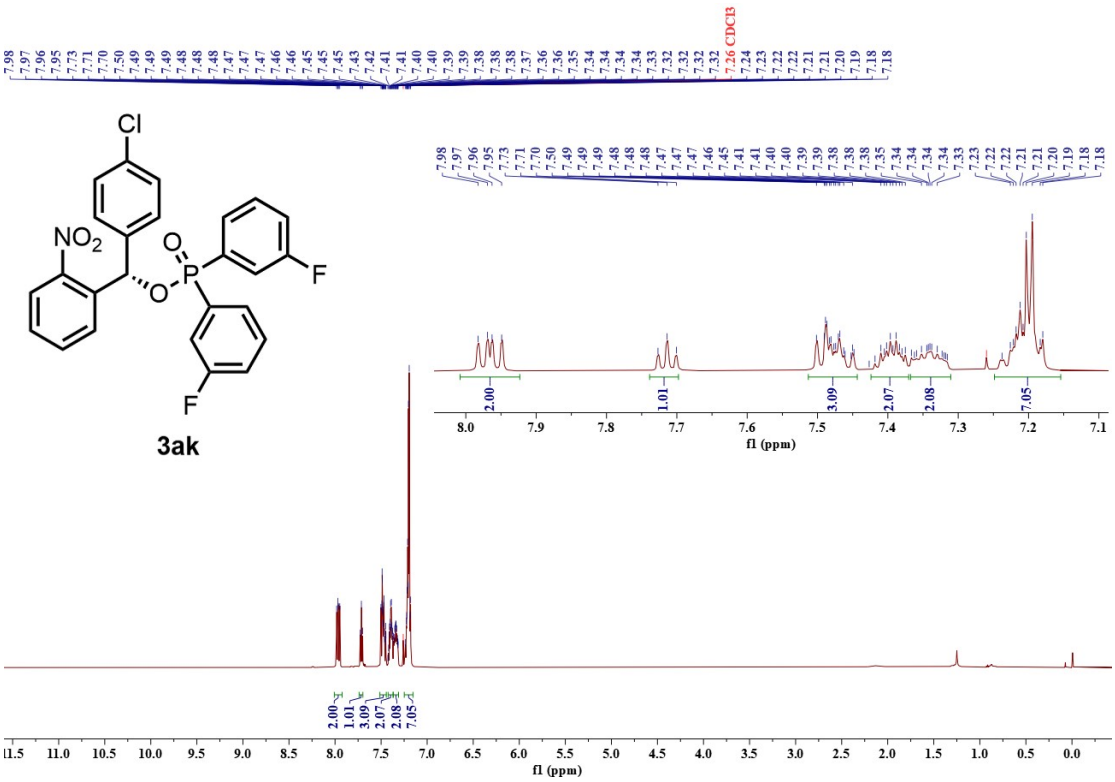
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 3aj



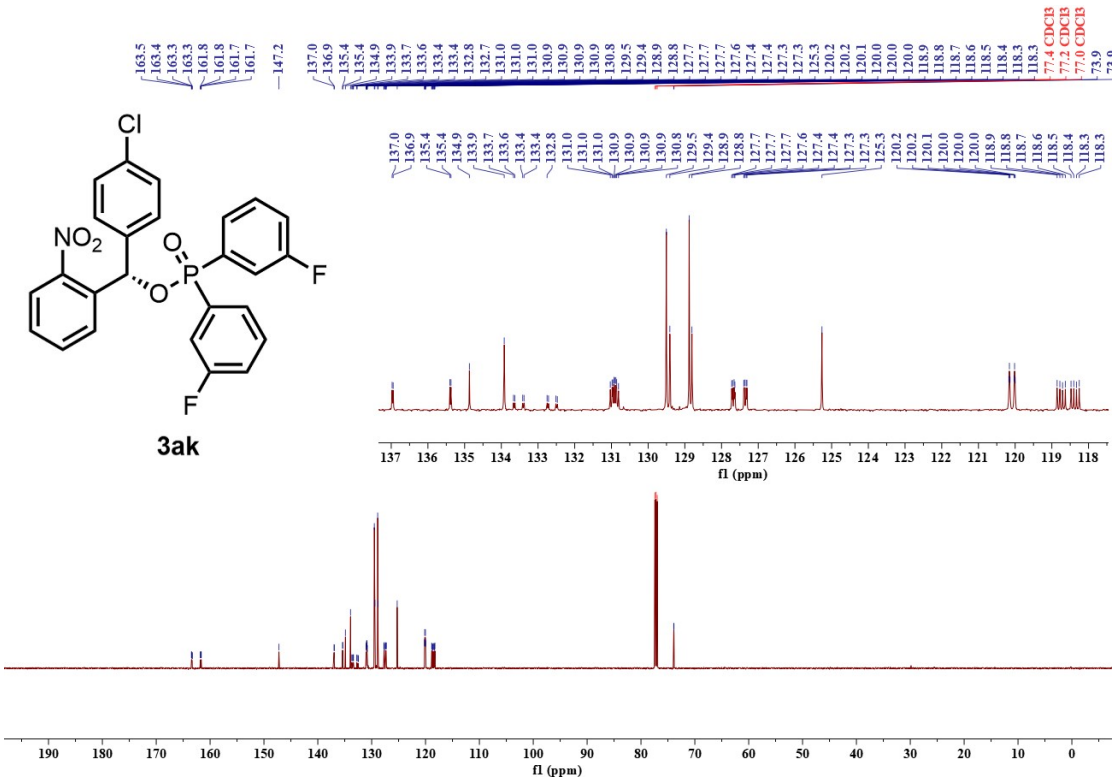
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 3aj



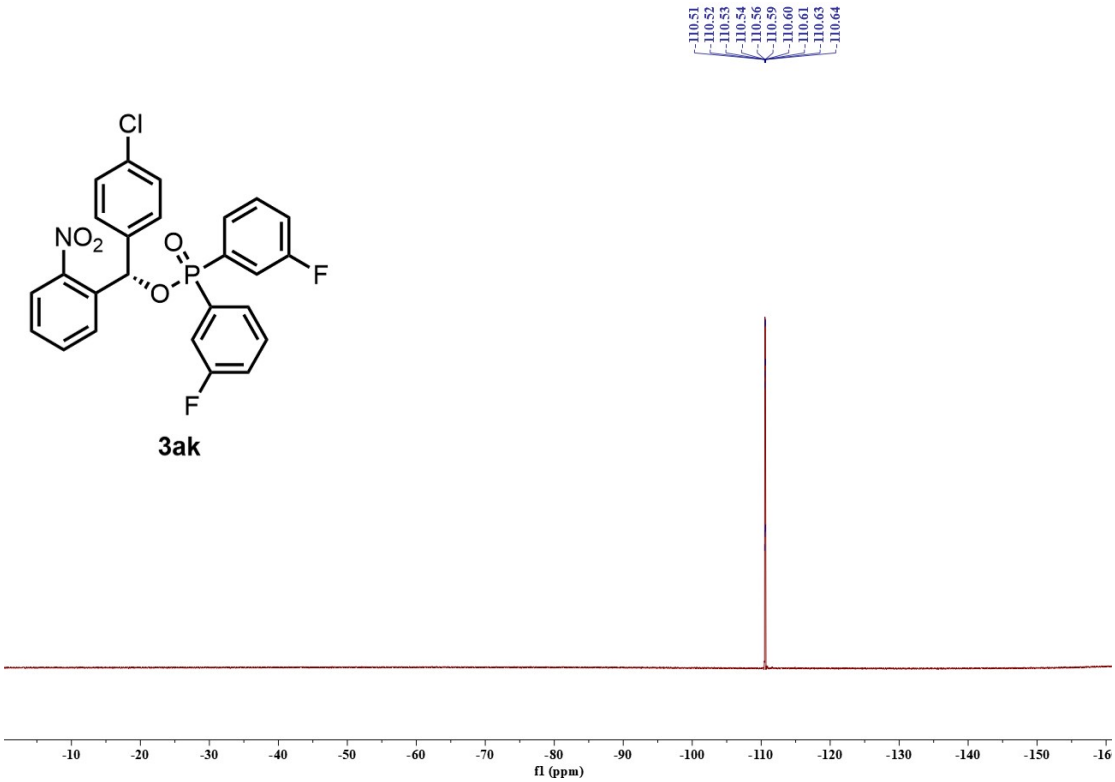
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 3ak



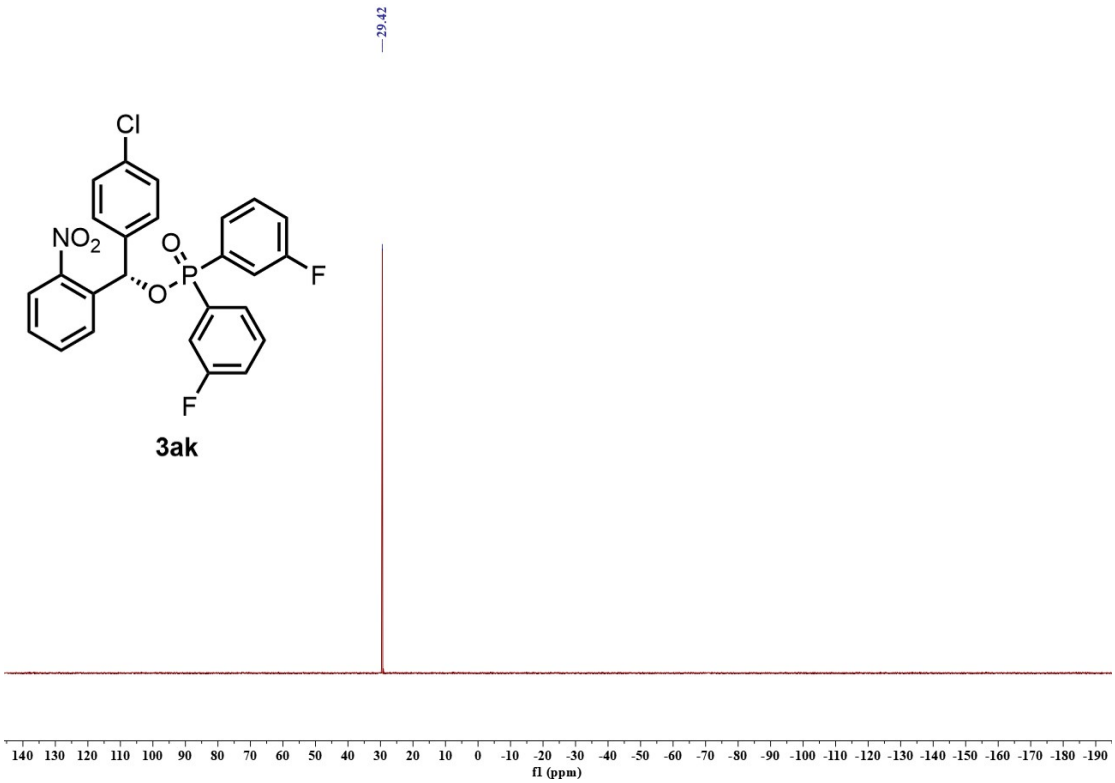
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 3ak



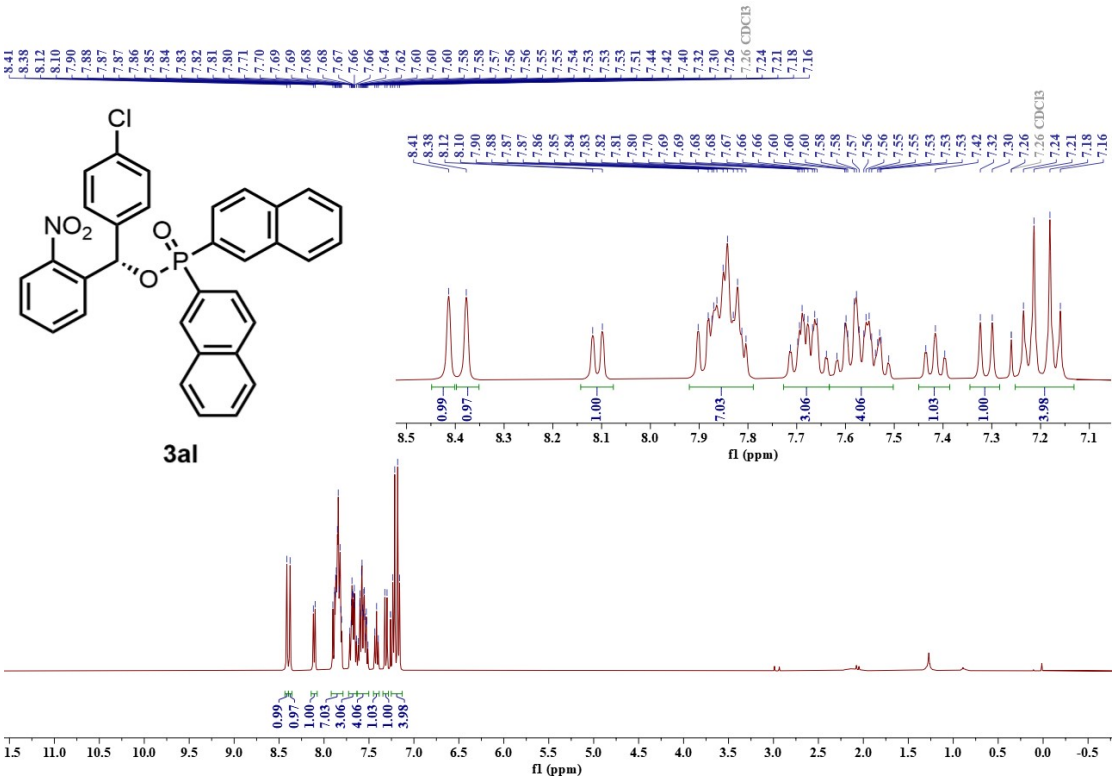
^{19}F NMR (565 MHz, $CDCl_3$) spectrum for 3ak



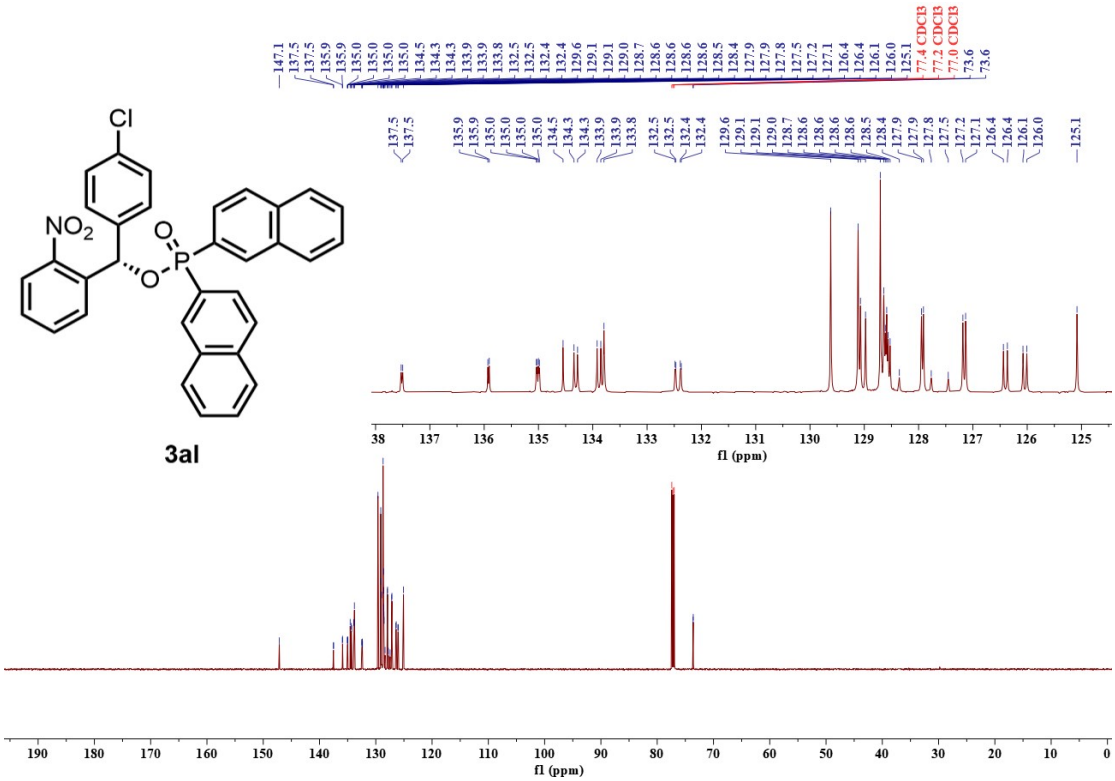
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 3ak



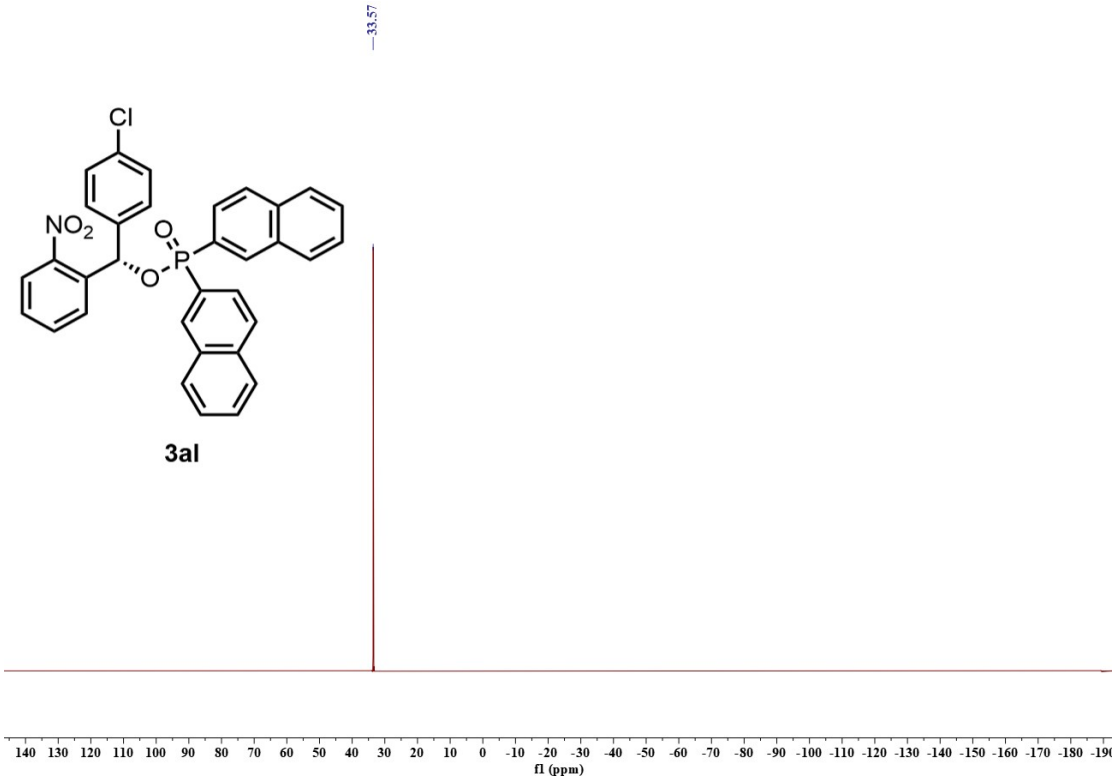
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 3al



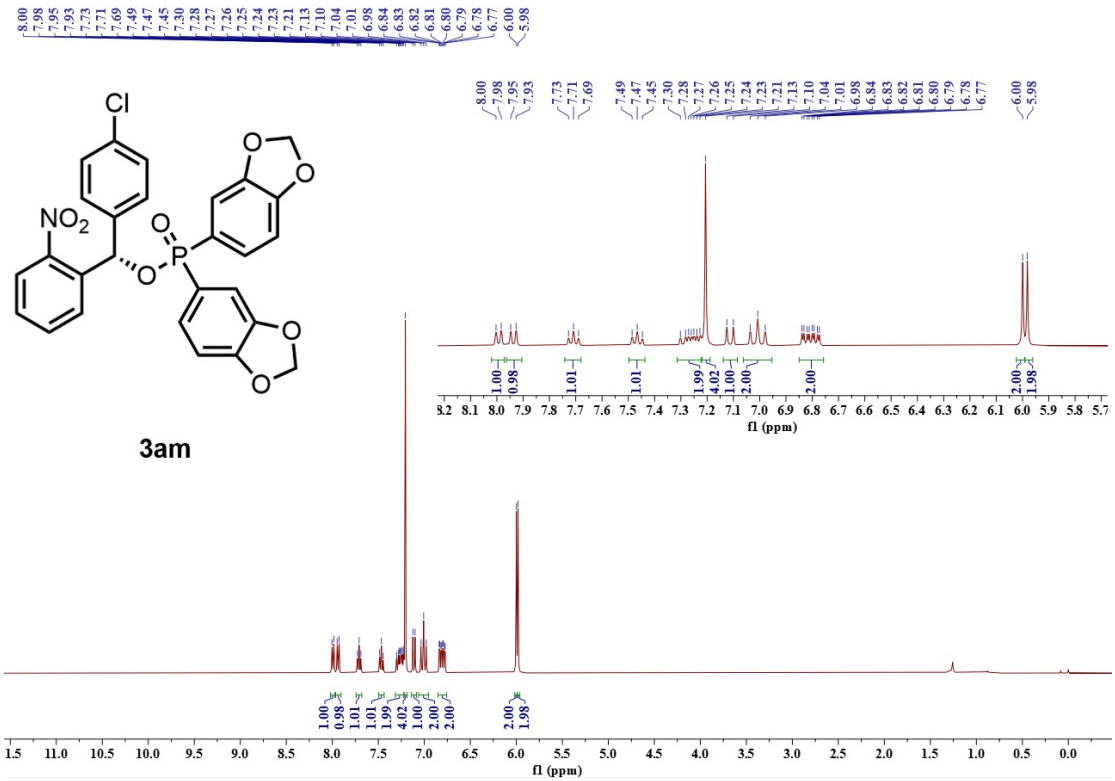
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 3al



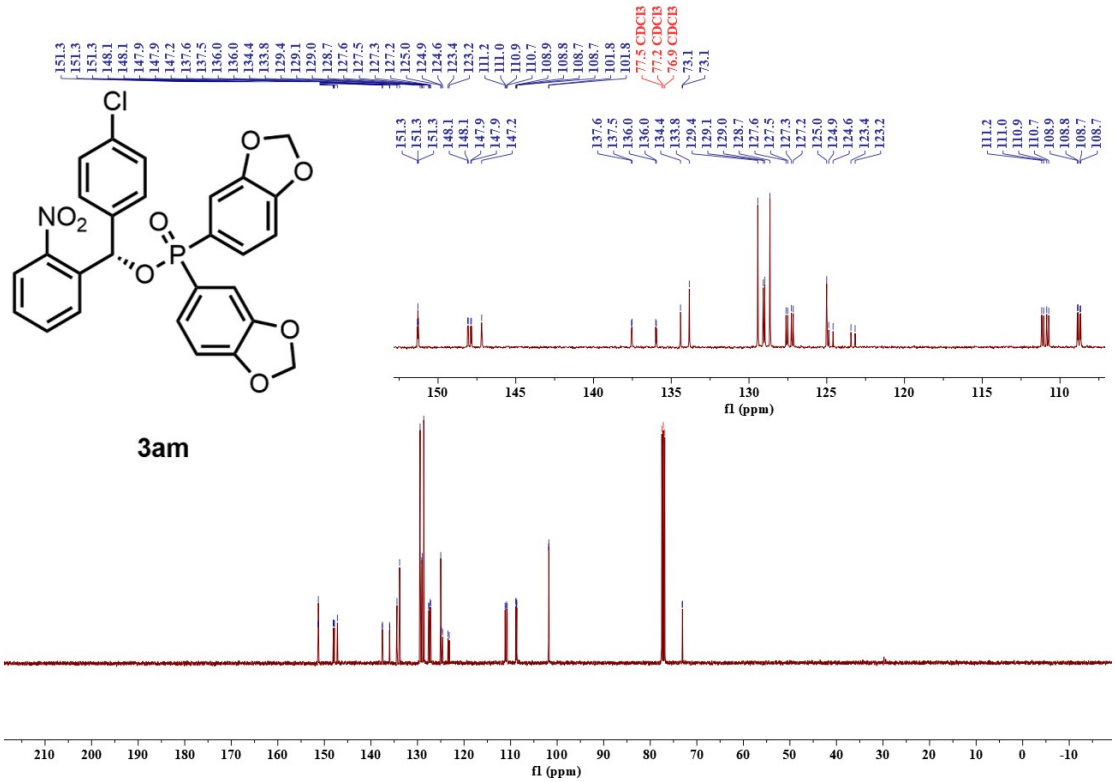
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 3al



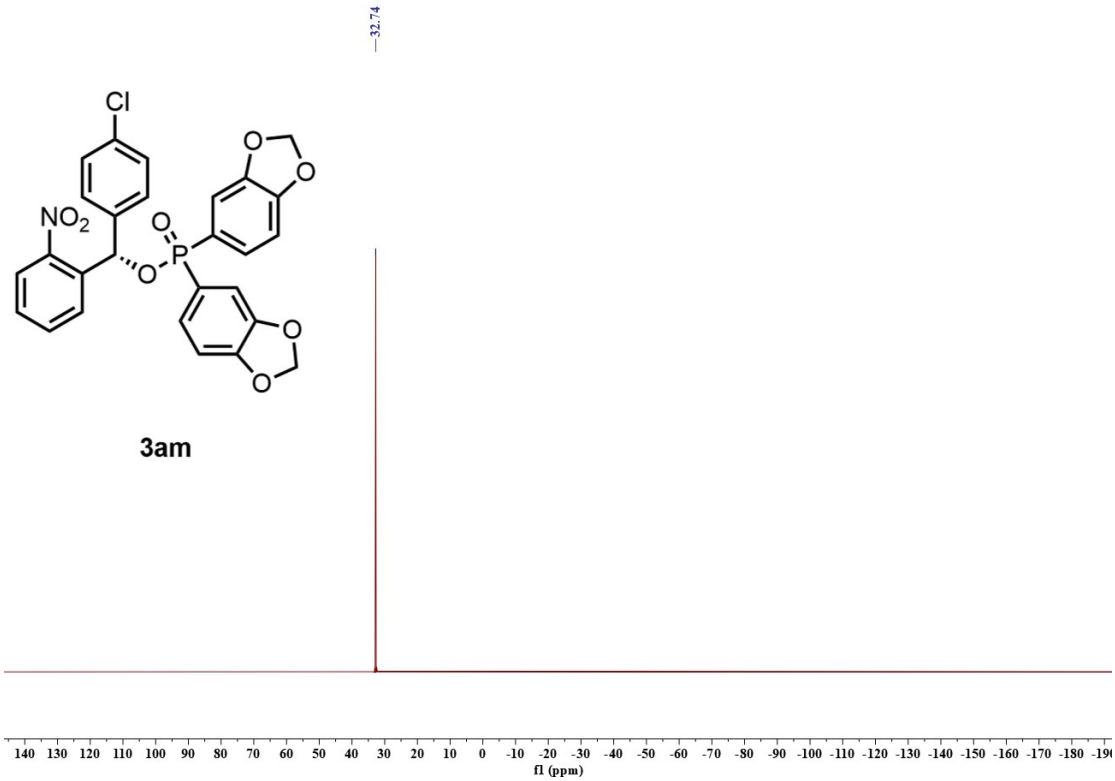
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 3am



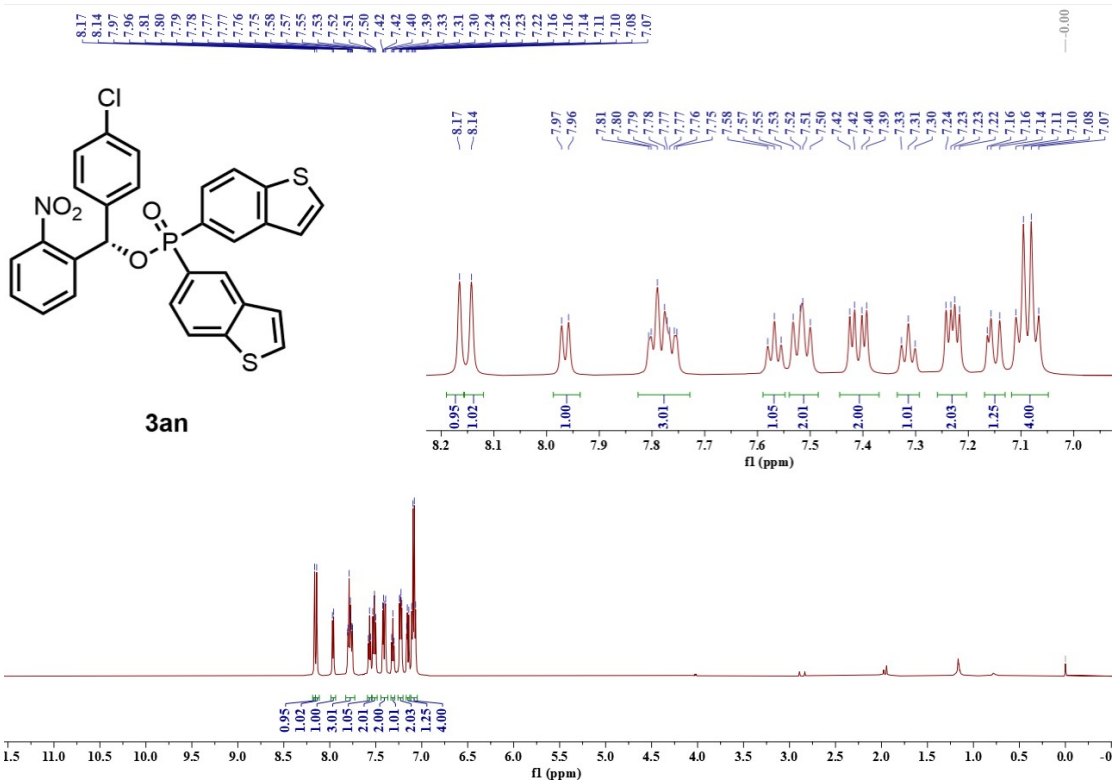
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 3am



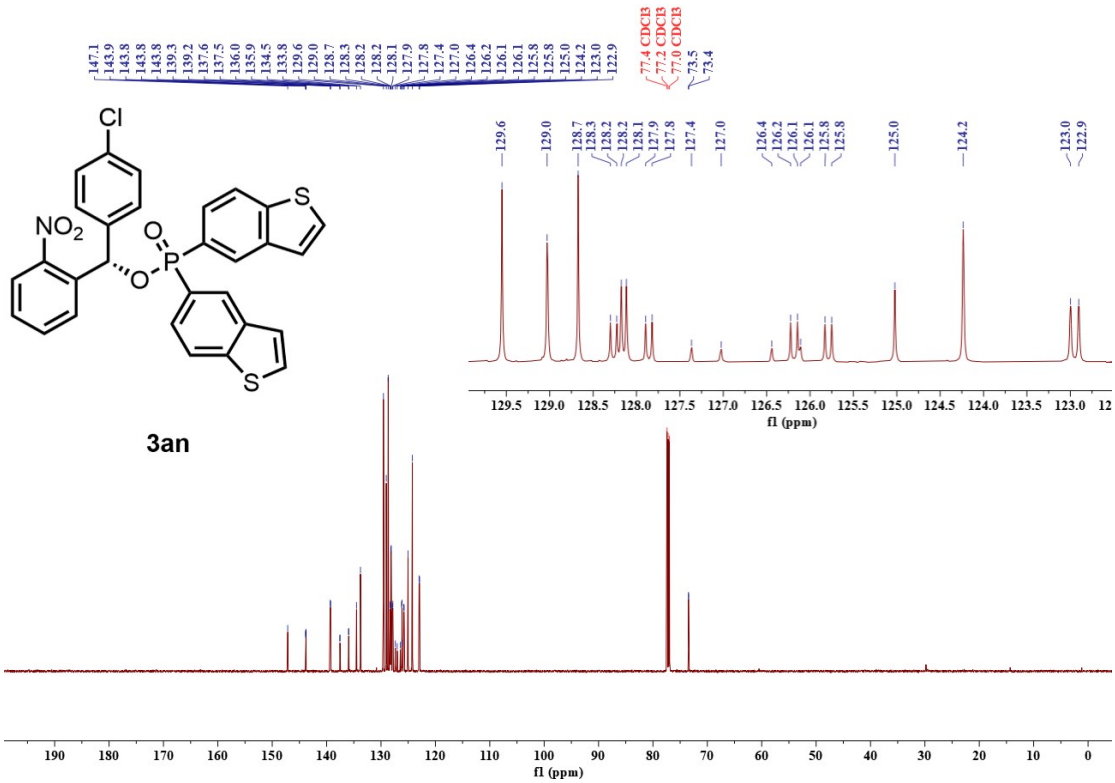
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 3am



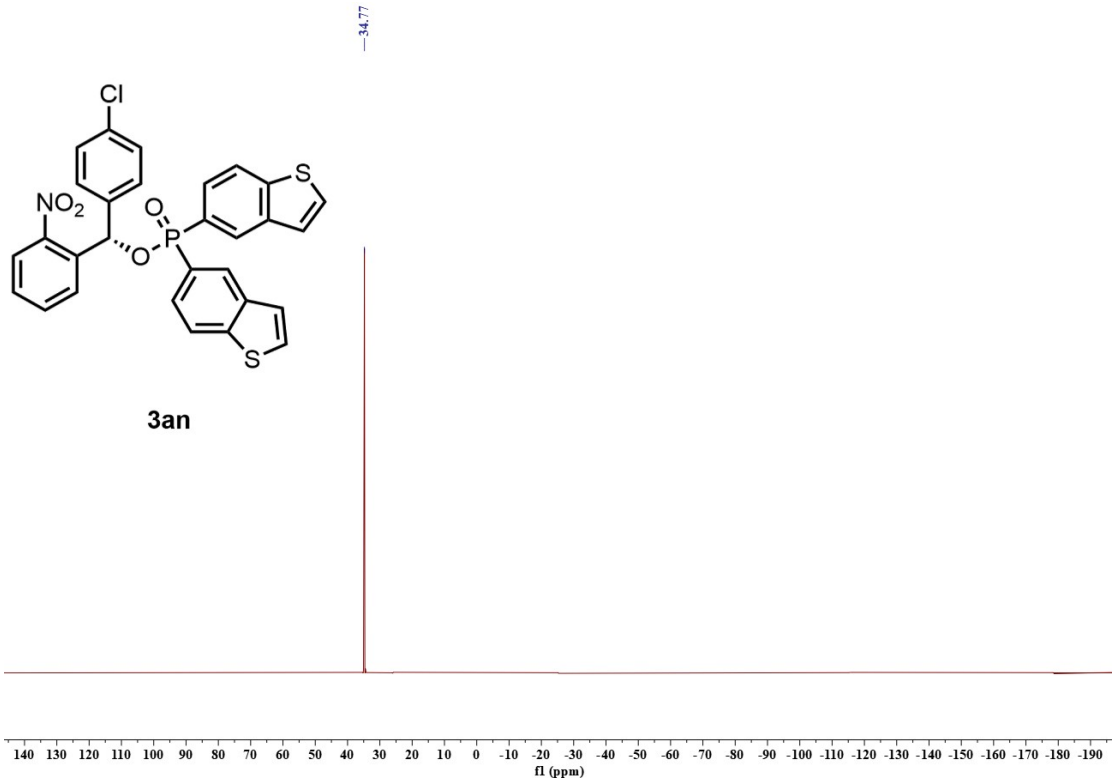
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 3an



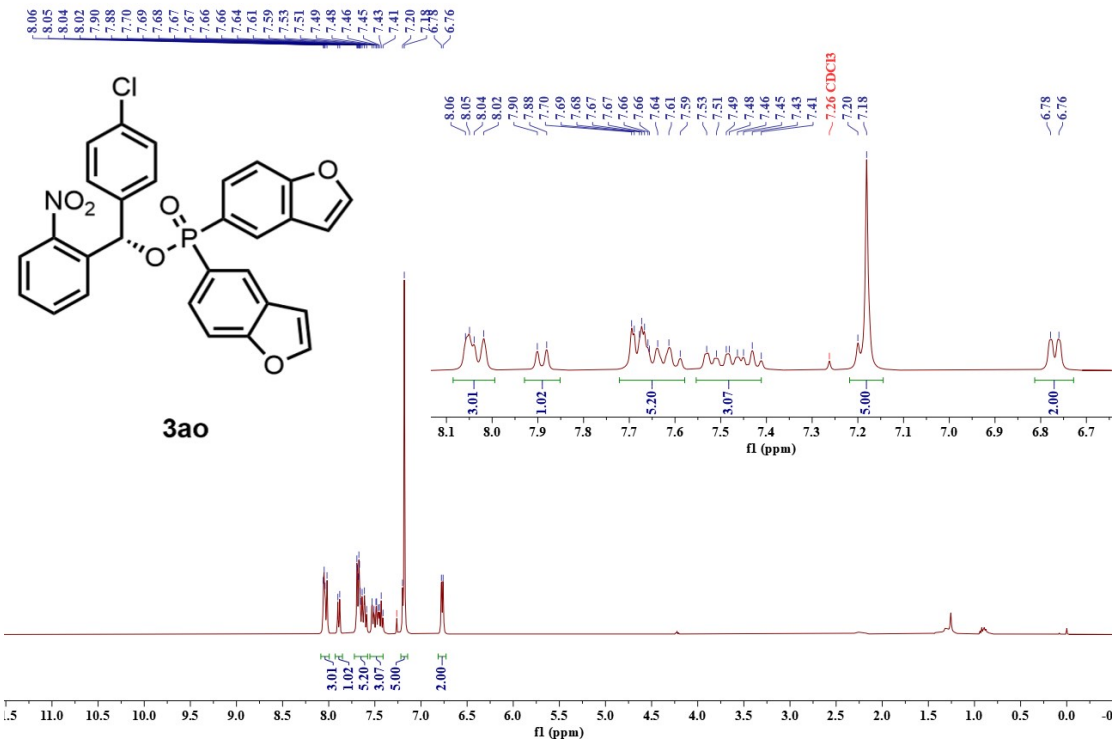
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 3an



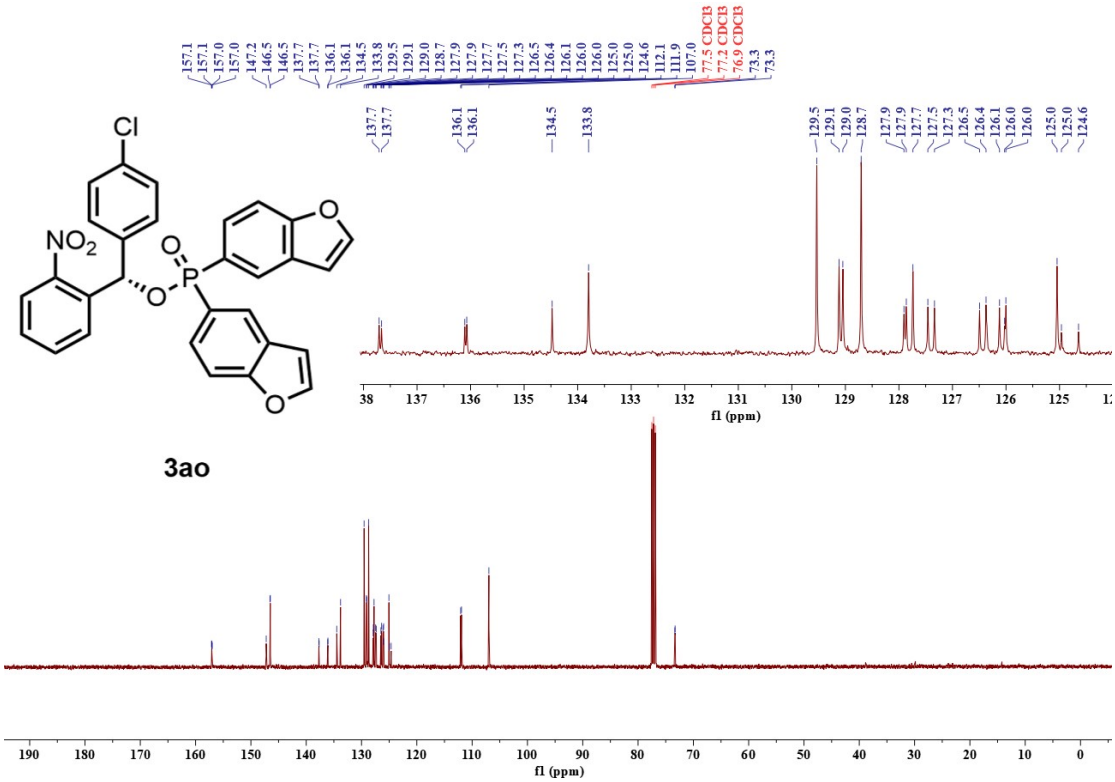
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 3an



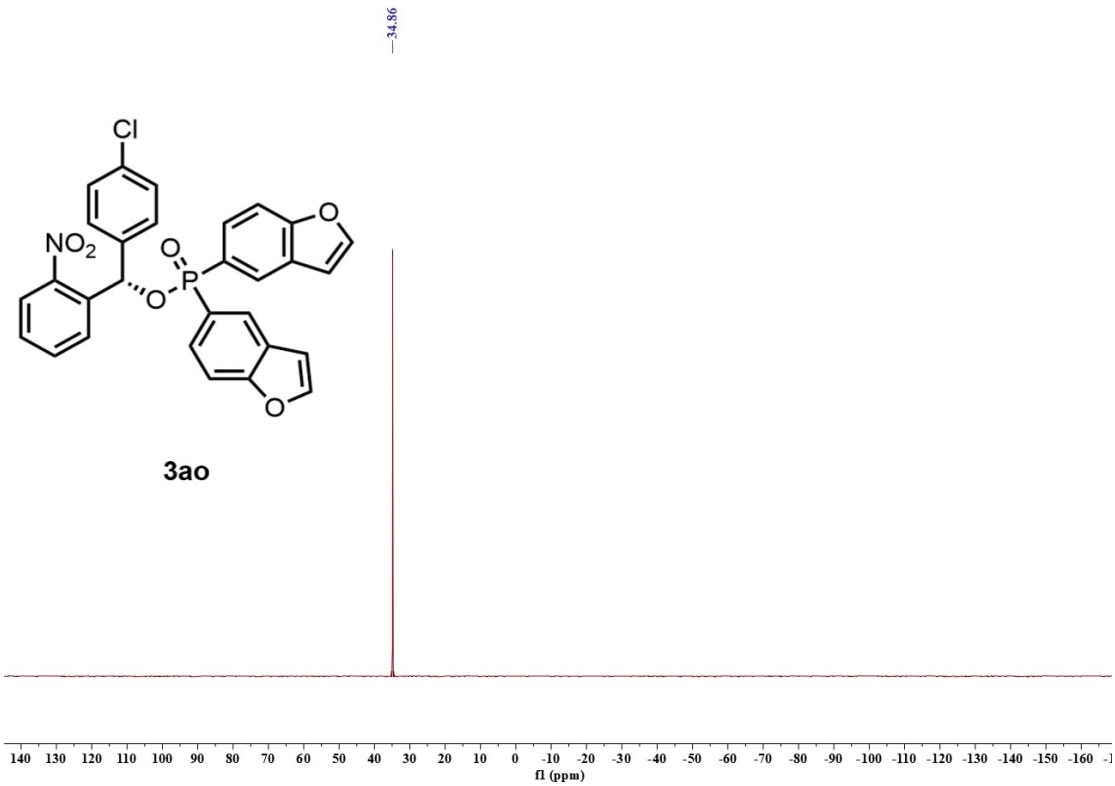
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 3ao



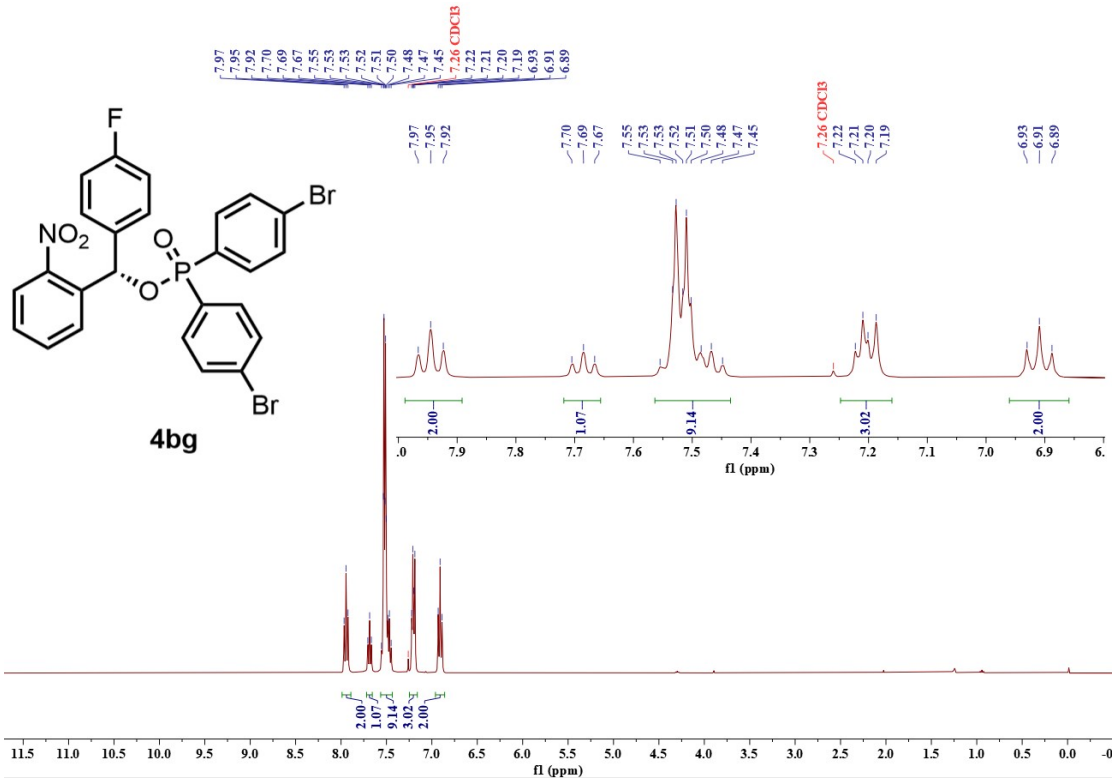
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 3ao



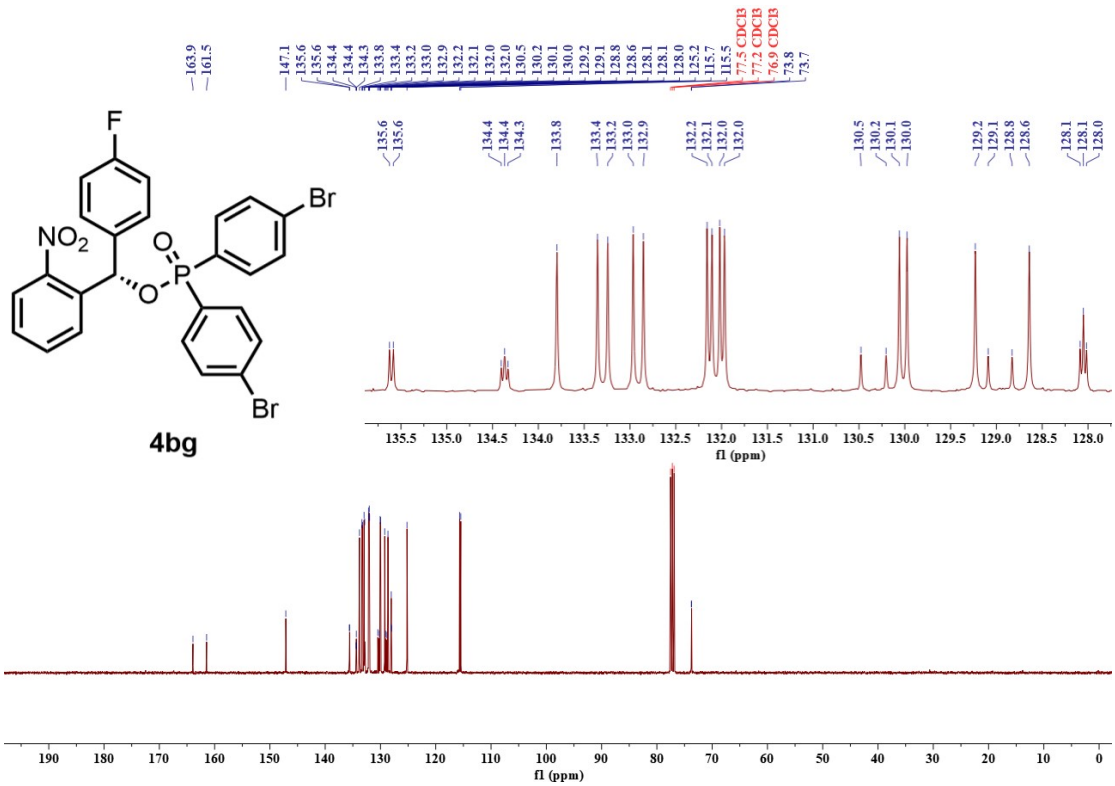
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 3ao



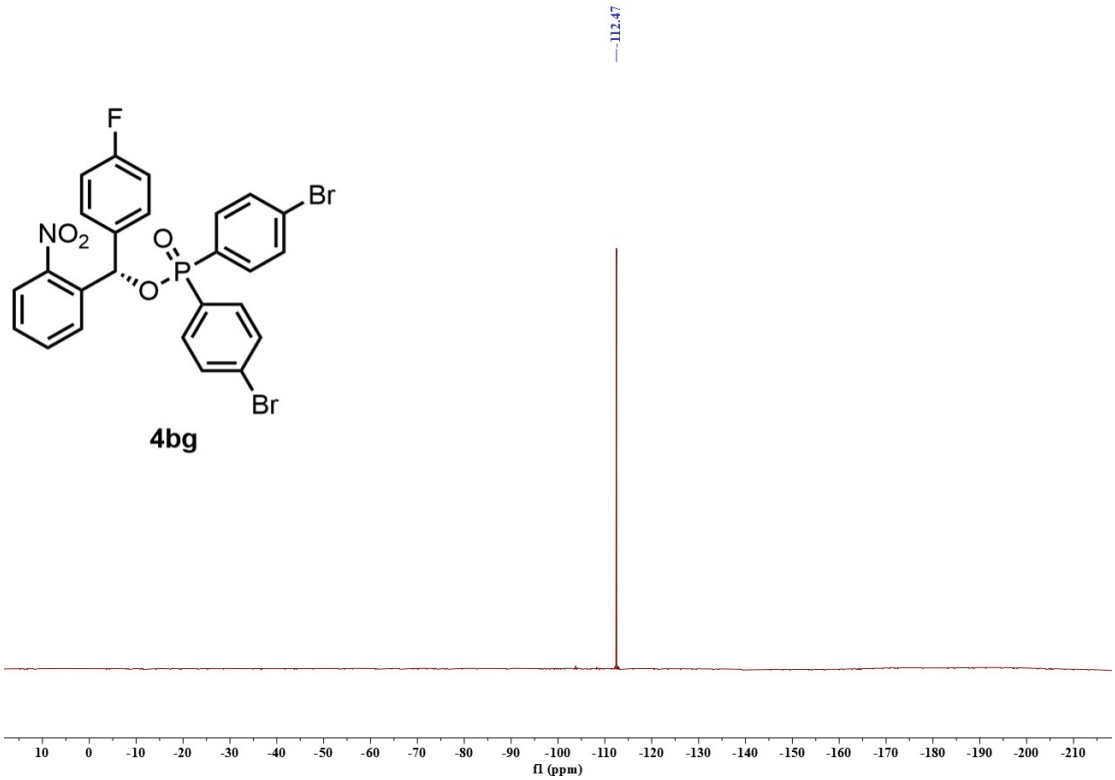
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4bg



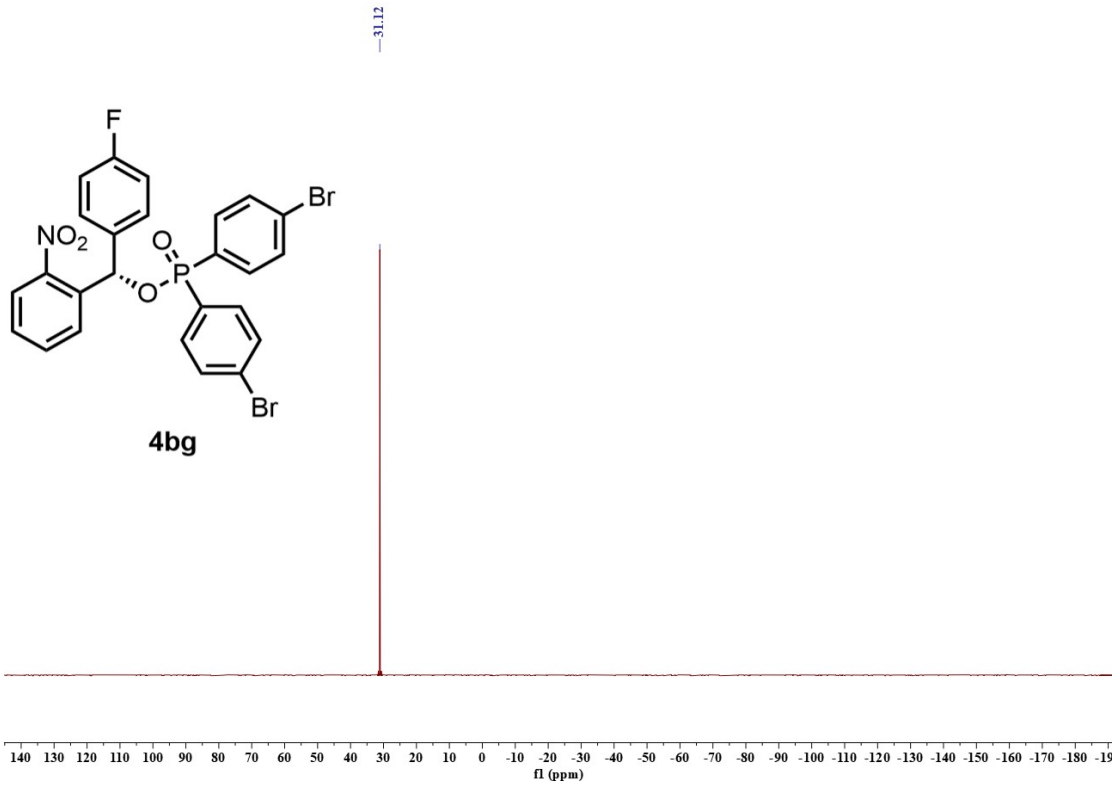
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 4bg



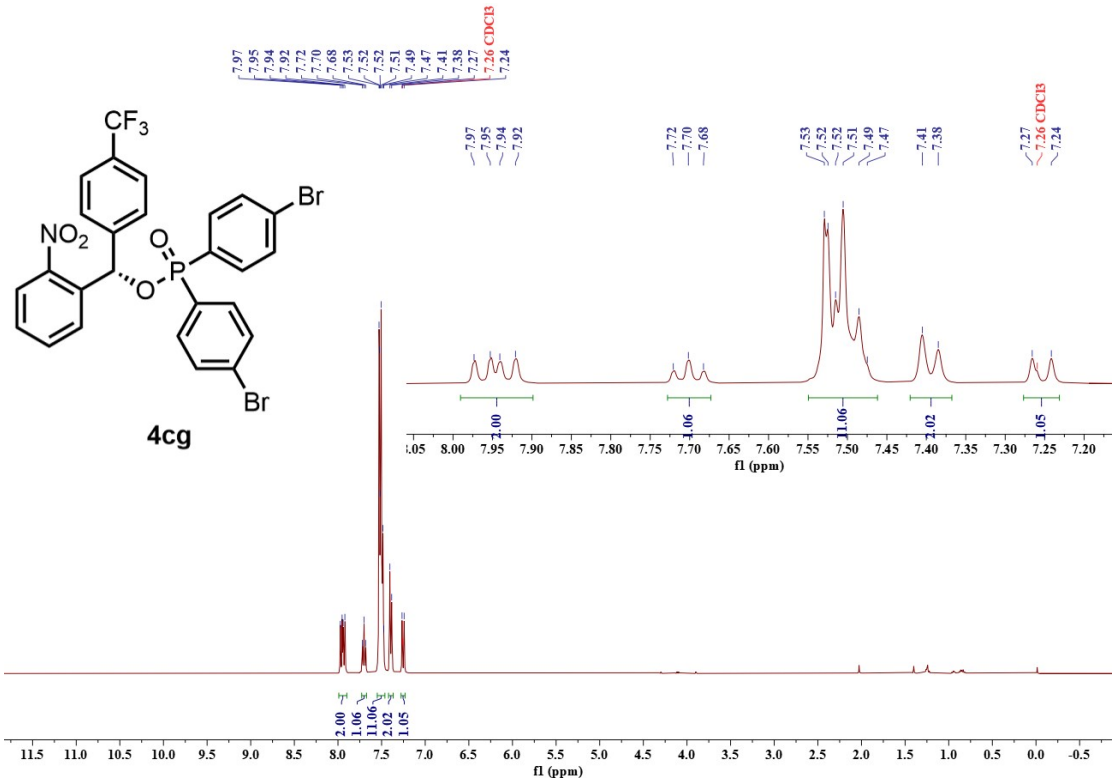
^{19}F NMR (376 MHz, $CDCl_3$) spectrum for 4bg



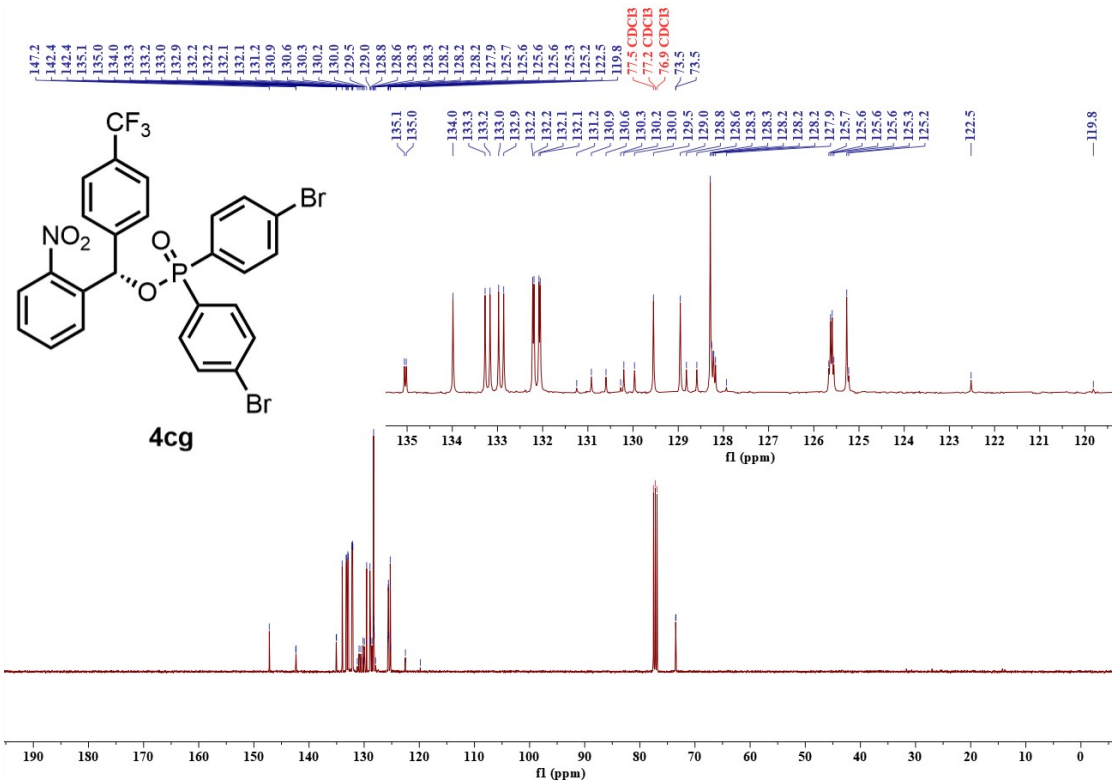
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4bg



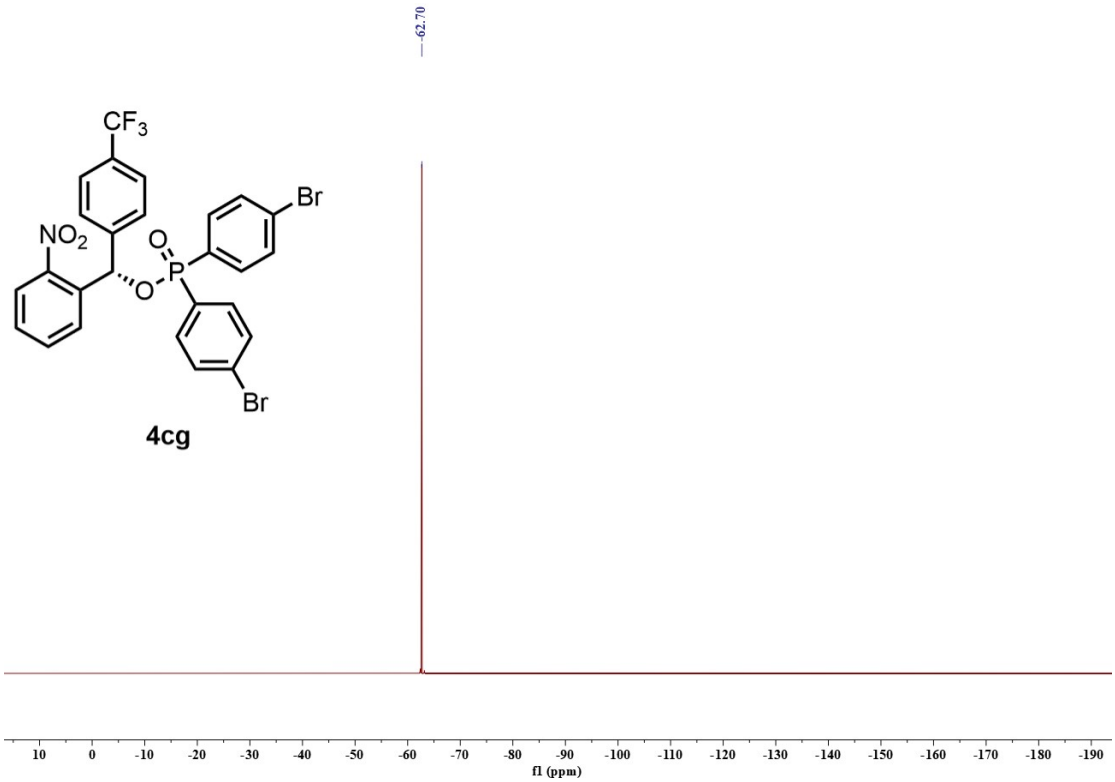
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4cg



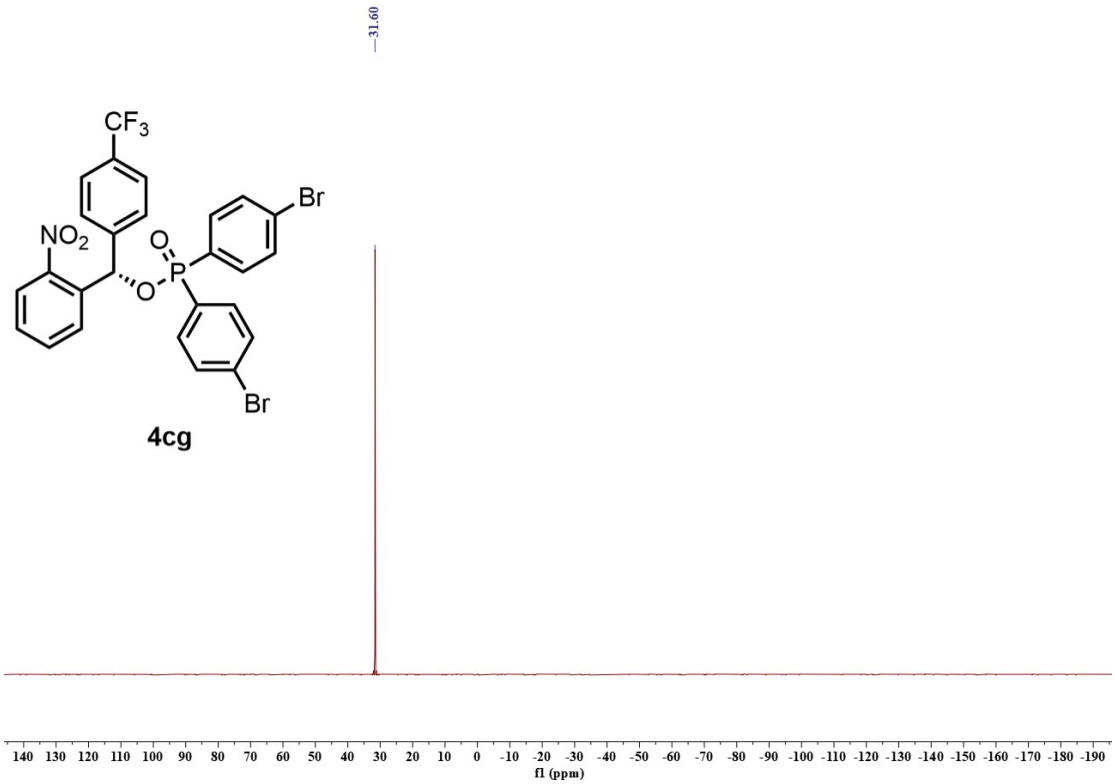
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 4cg



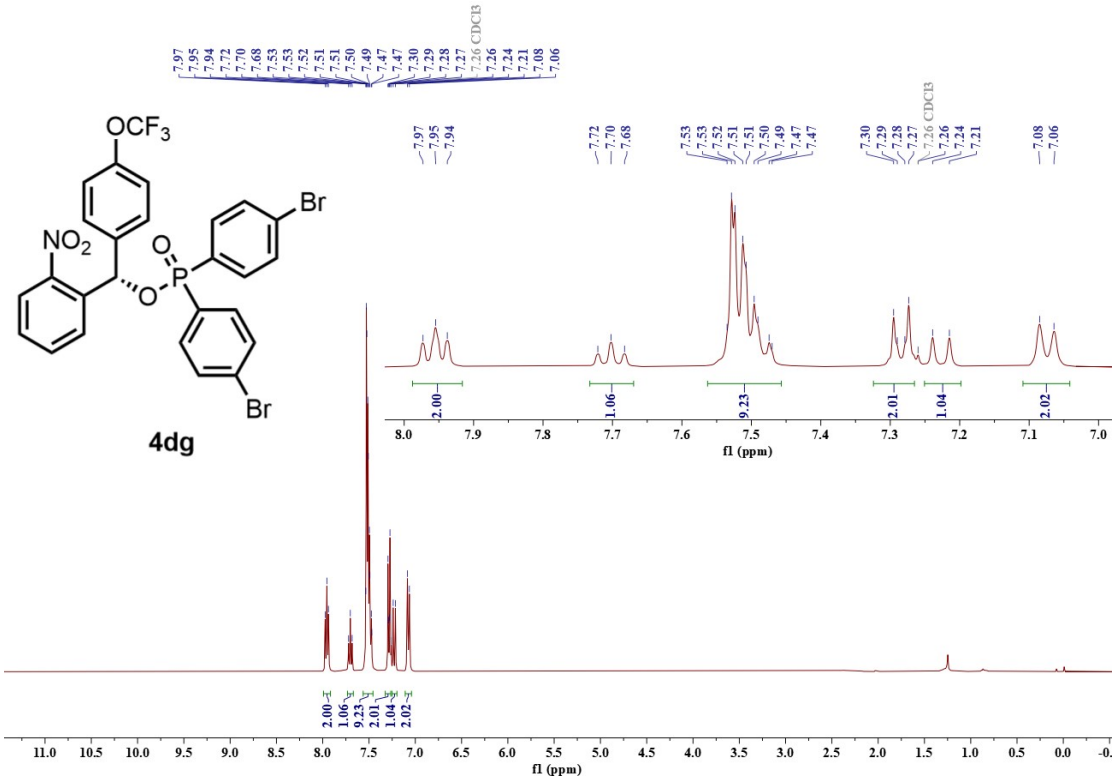
^{19}F NMR (376 MHz, $CDCl_3$) spectrum for 4cg



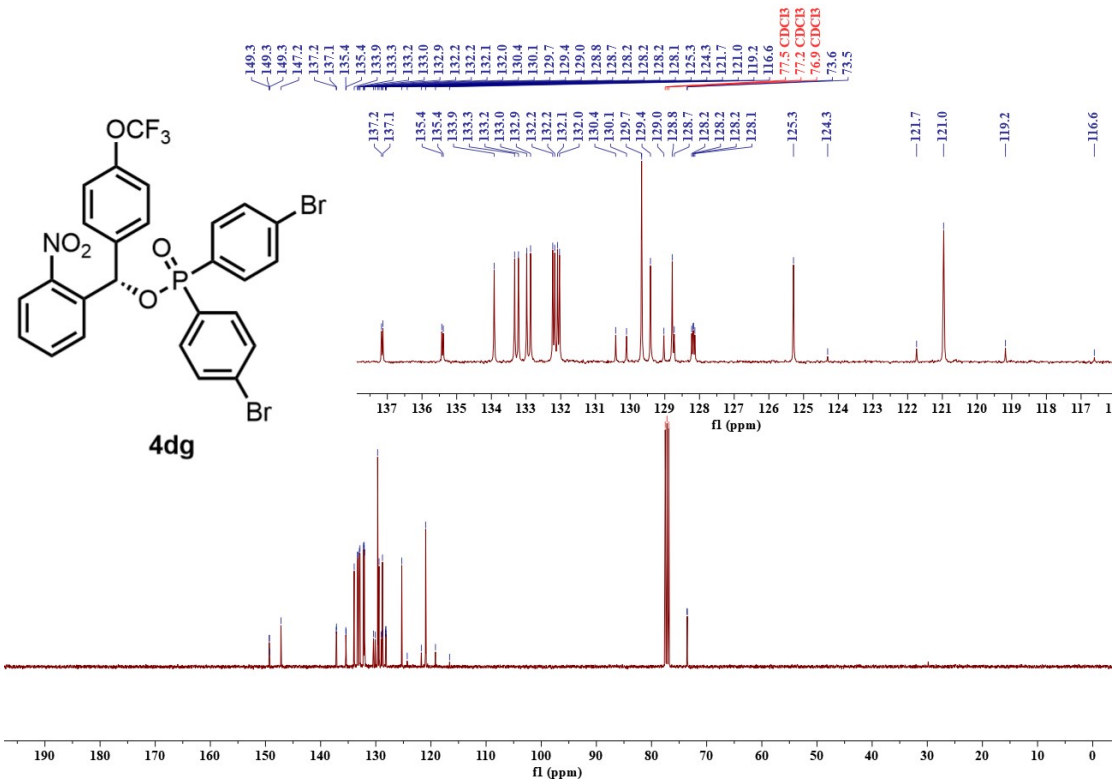
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4cg



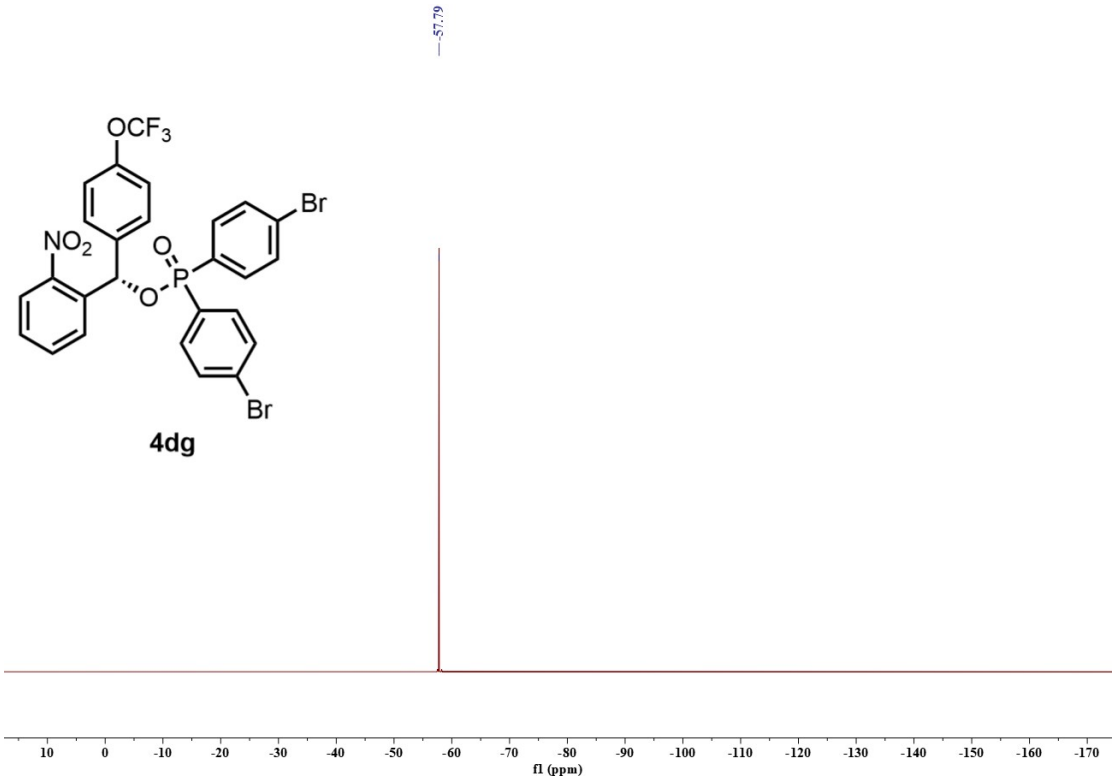
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4dg



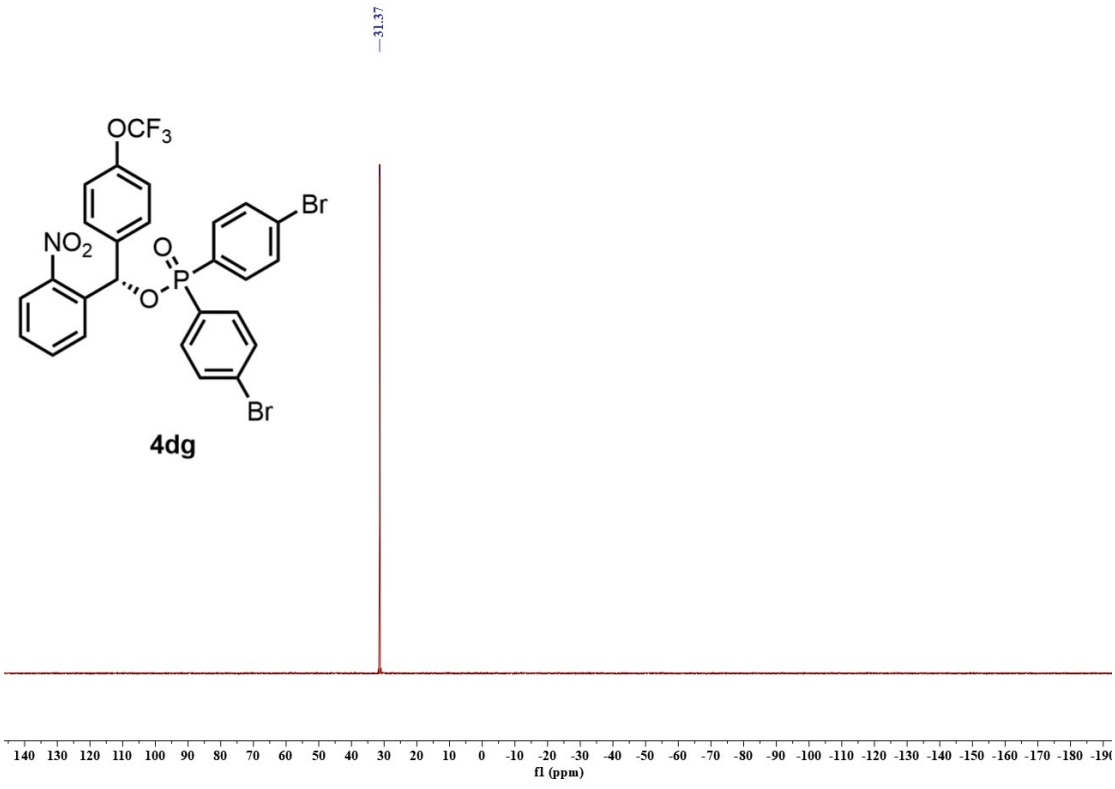
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 4dg



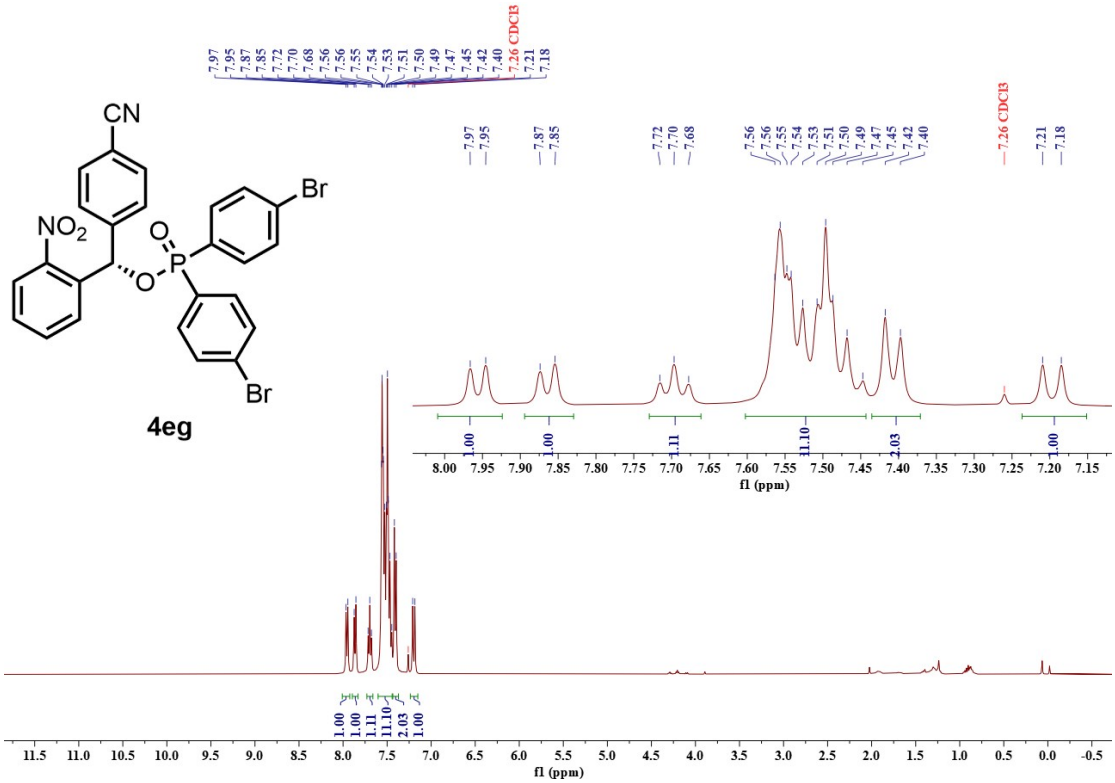
^{19}F NMR (376 MHz, $CDCl_3$) spectrum for 4dg



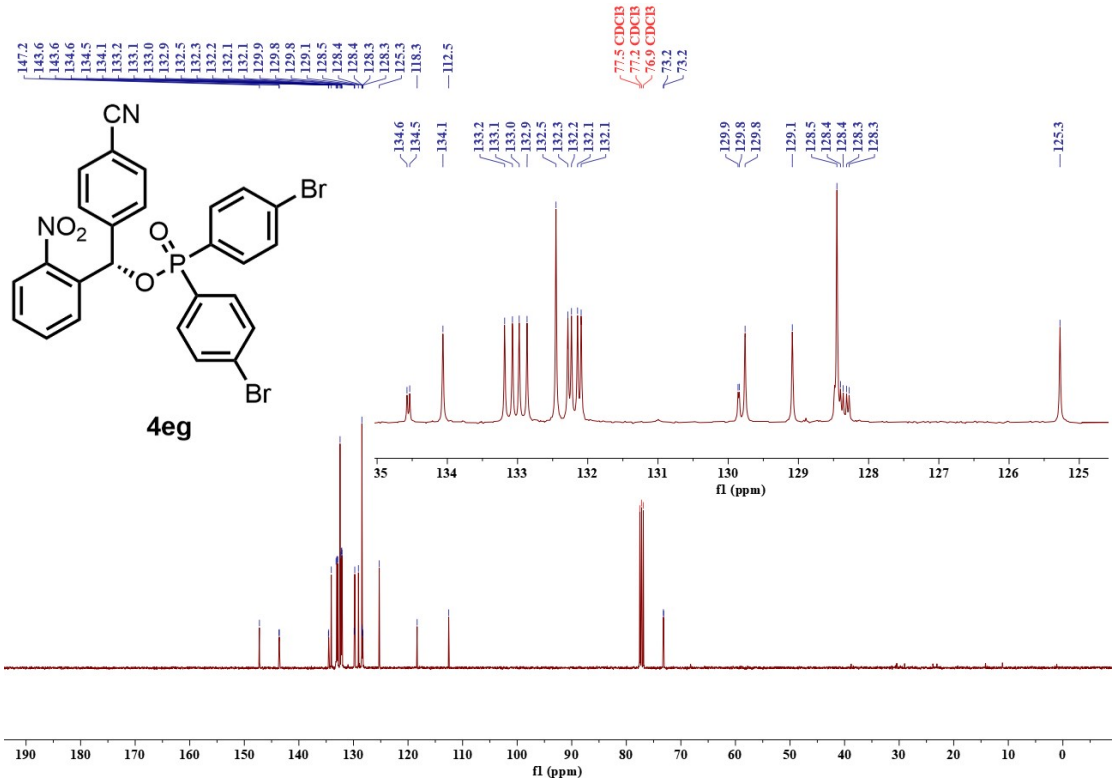
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4dg



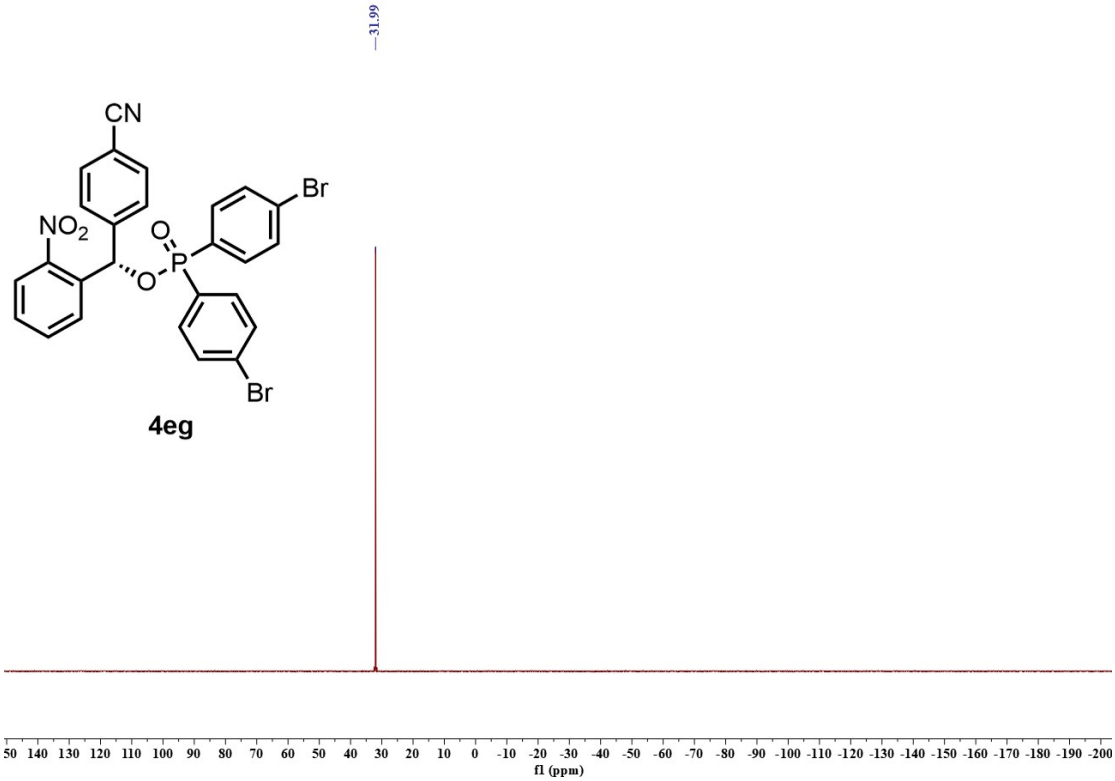
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4eg



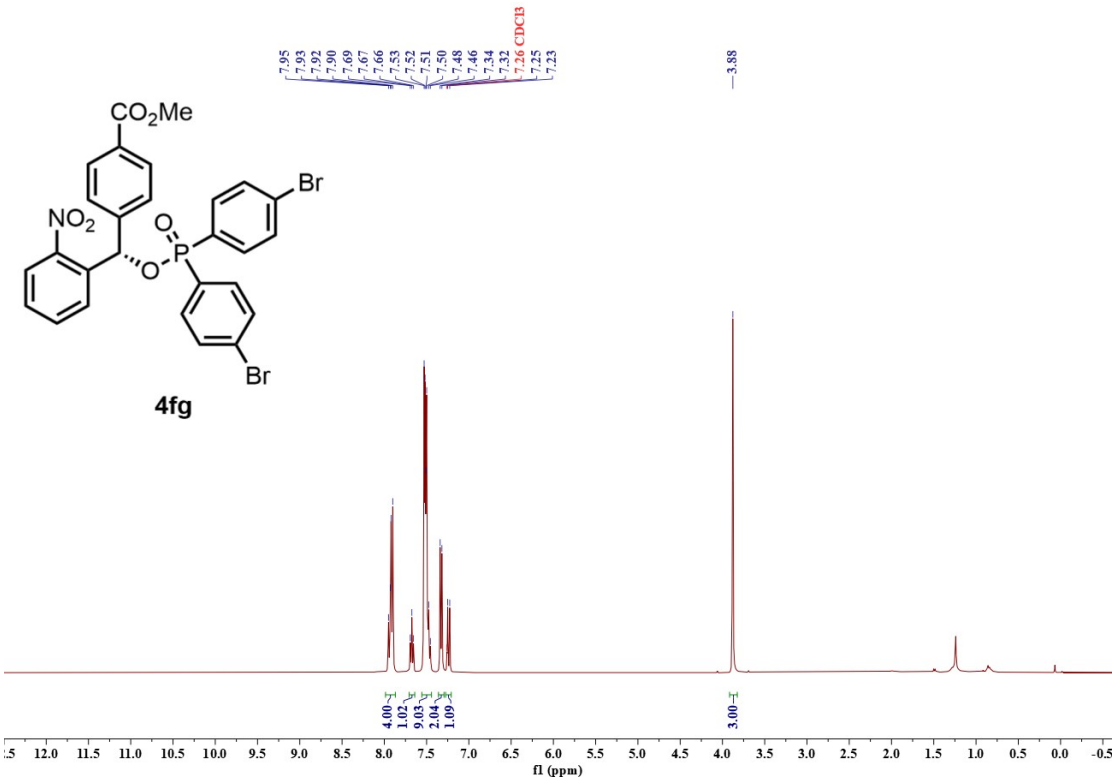
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 4eg



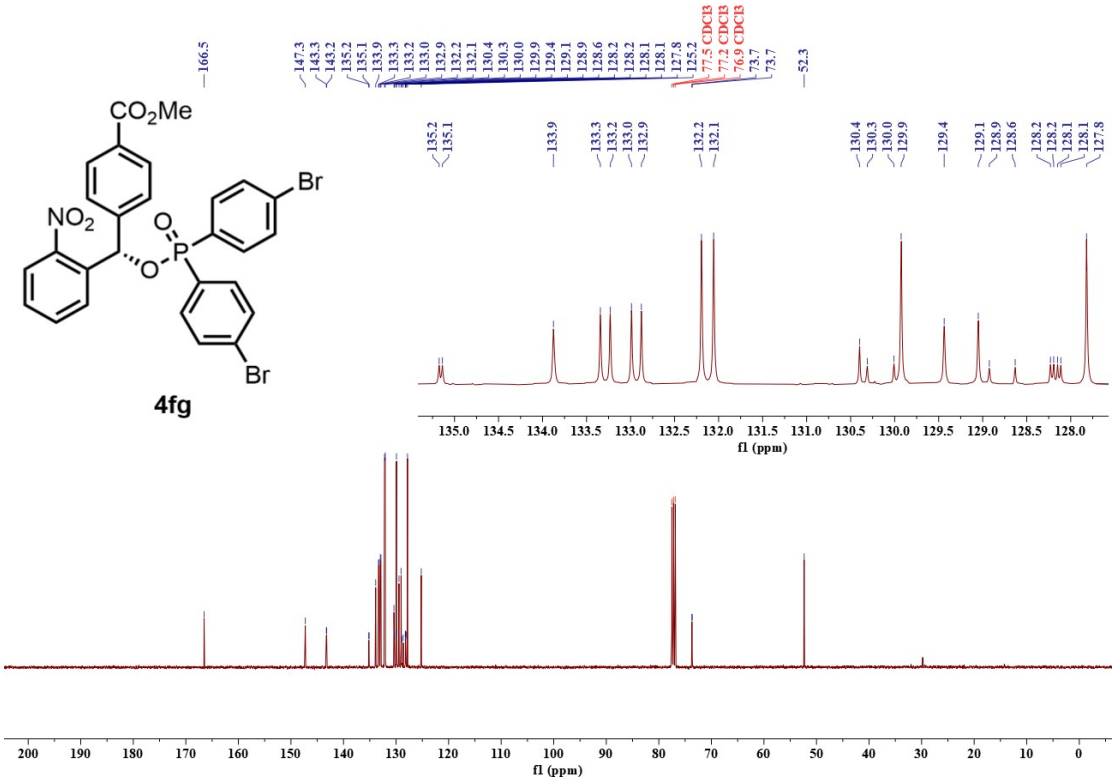
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4eg



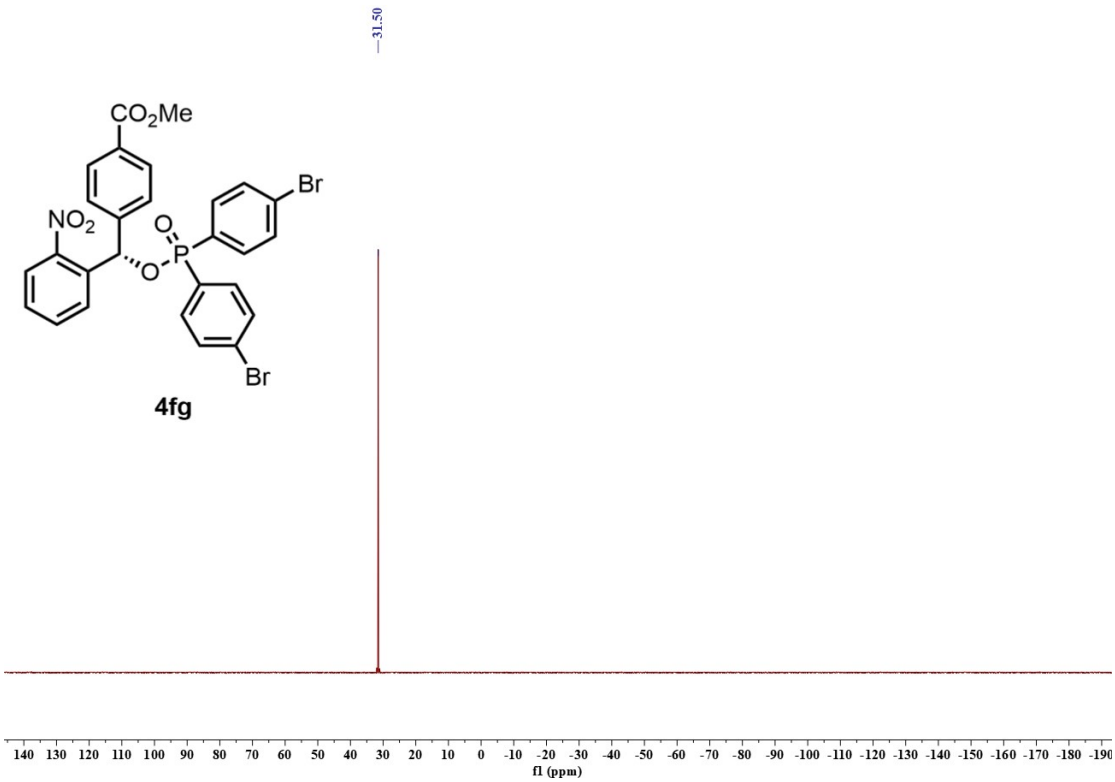
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4fg



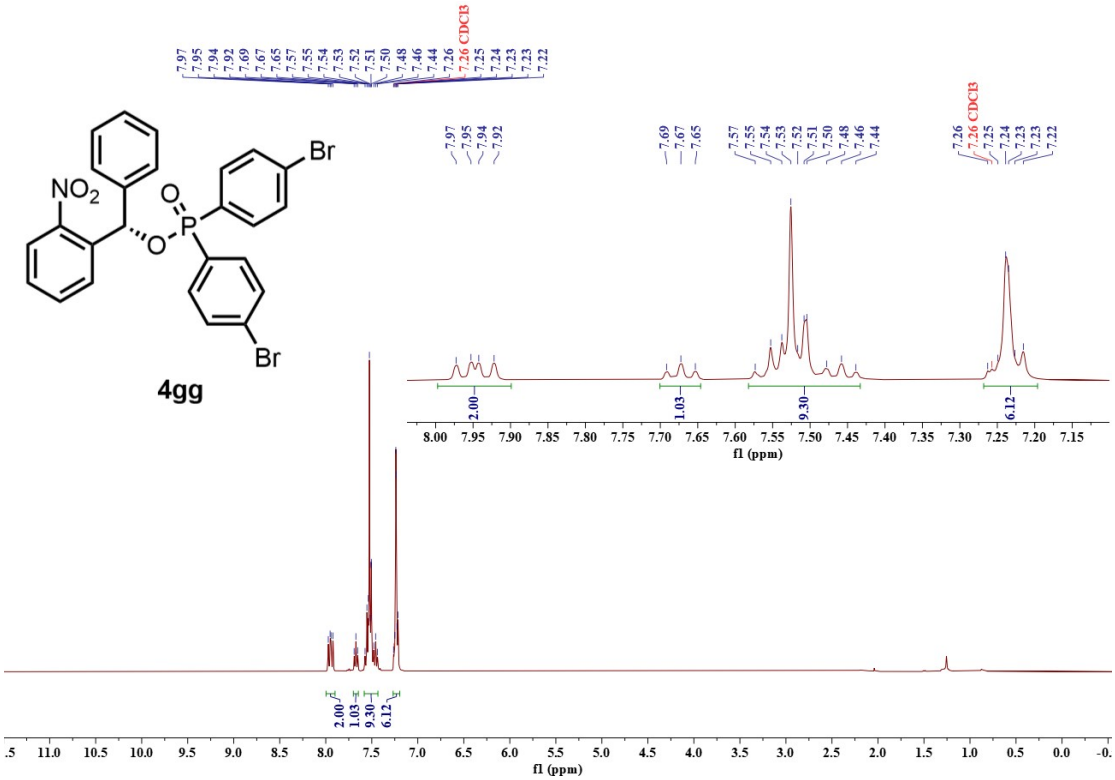
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 4fg



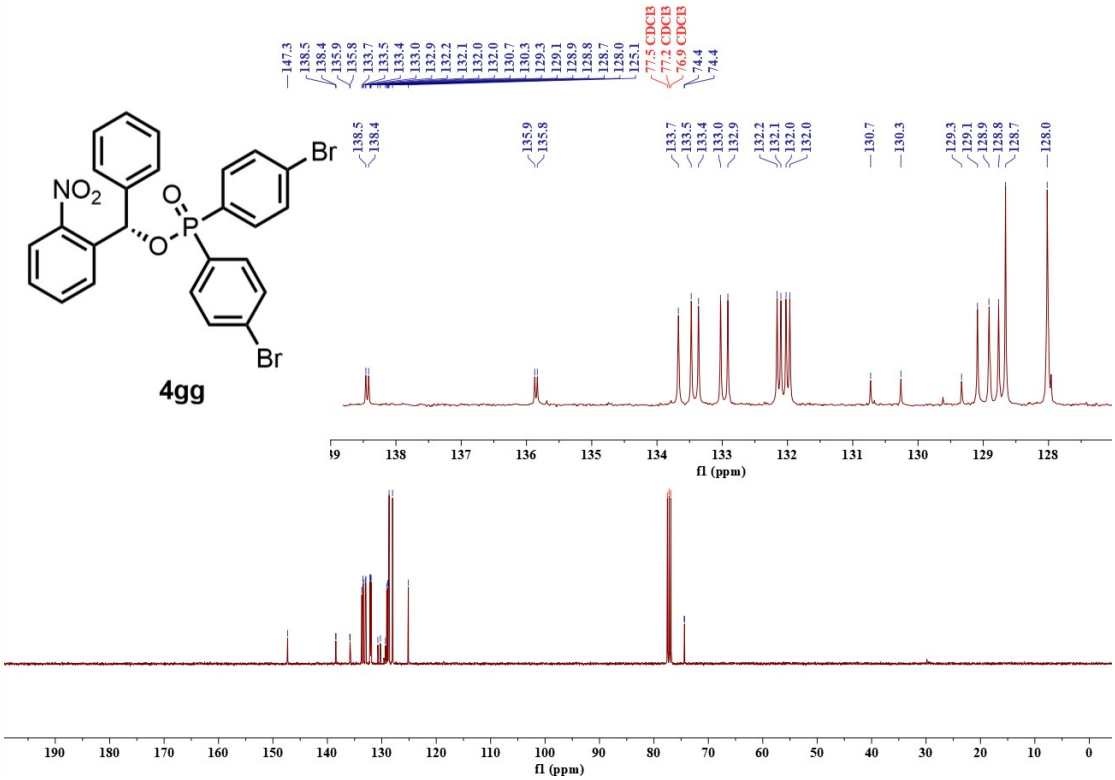
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4fg



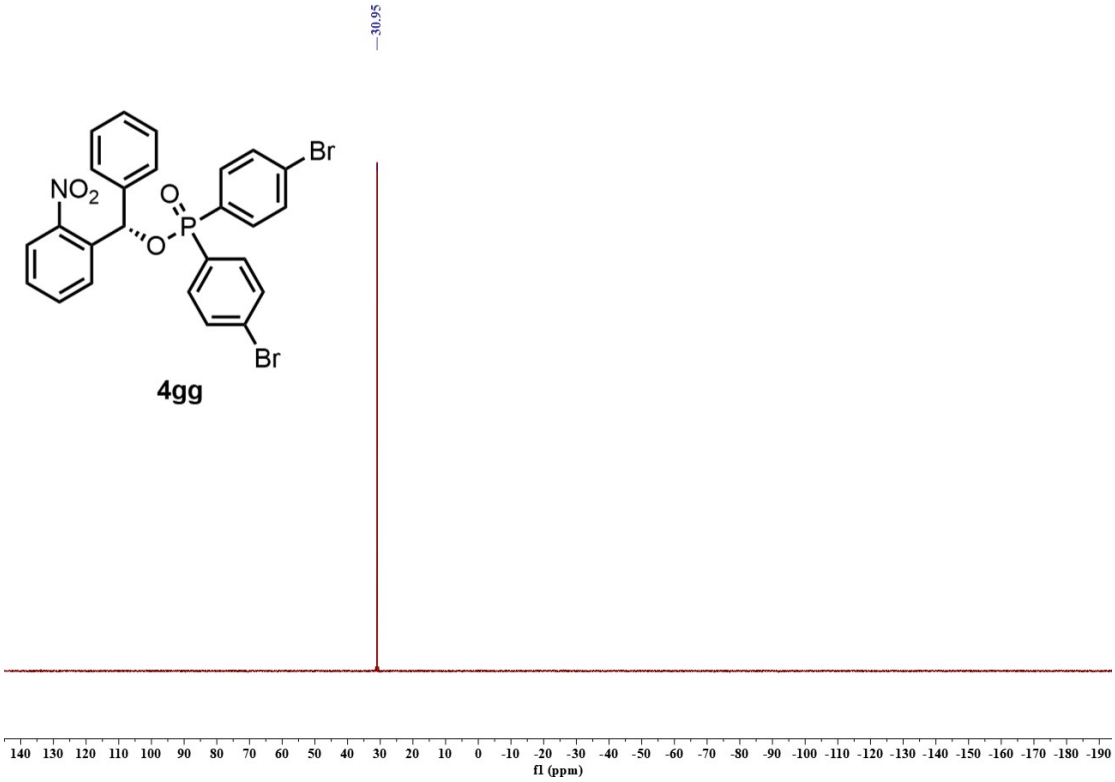
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4gg



^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 4gg



^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4gg



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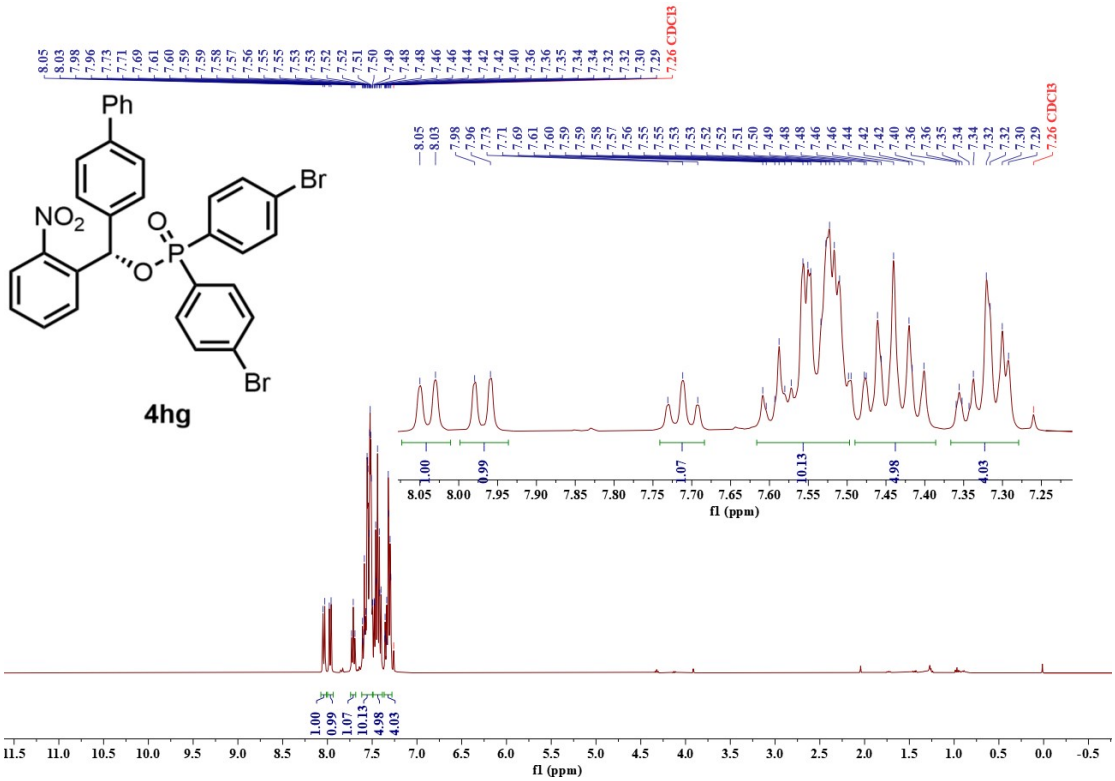

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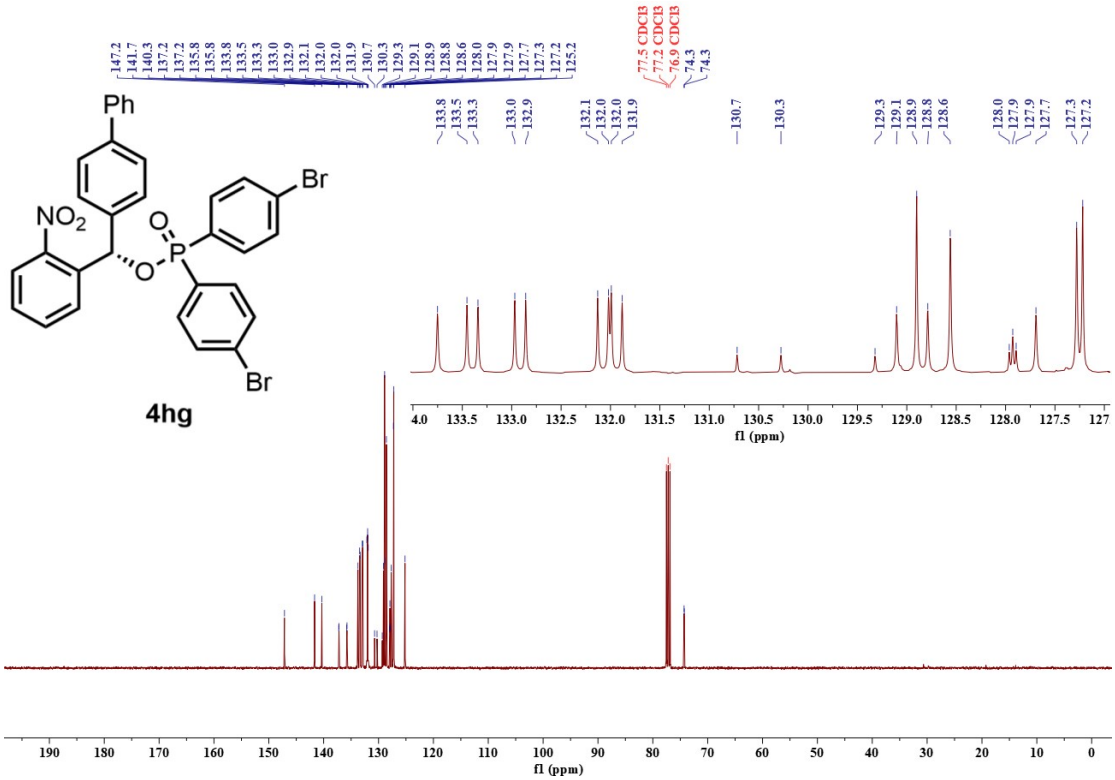
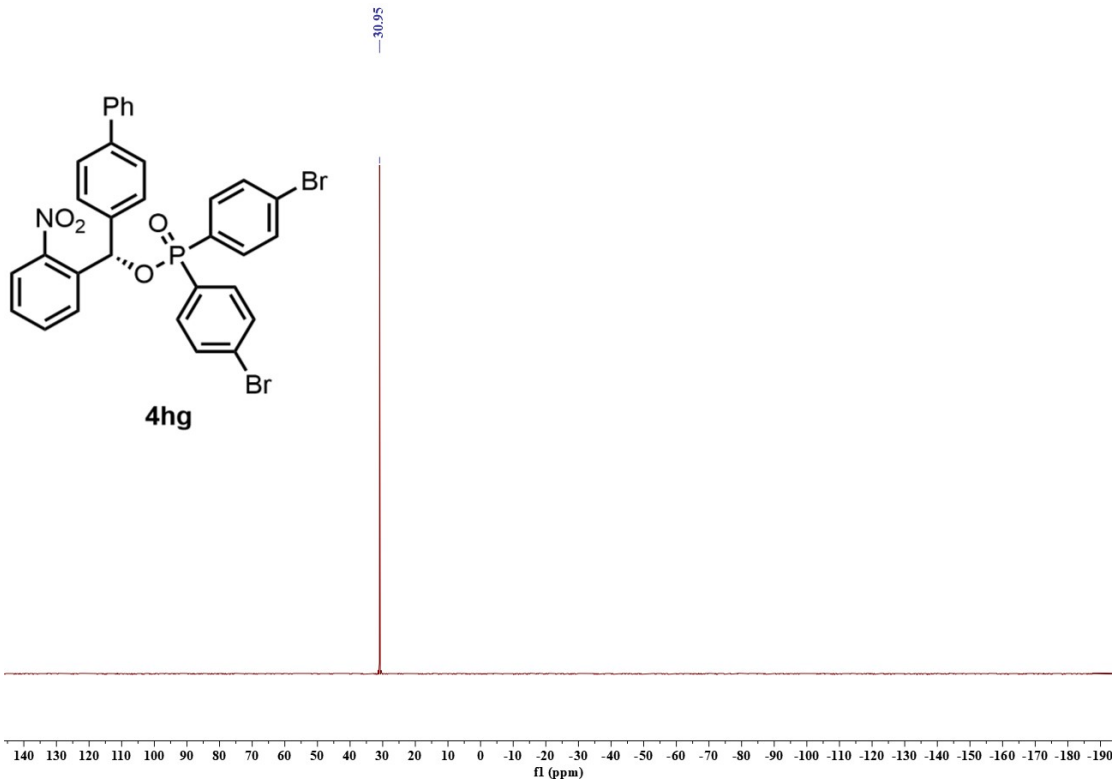
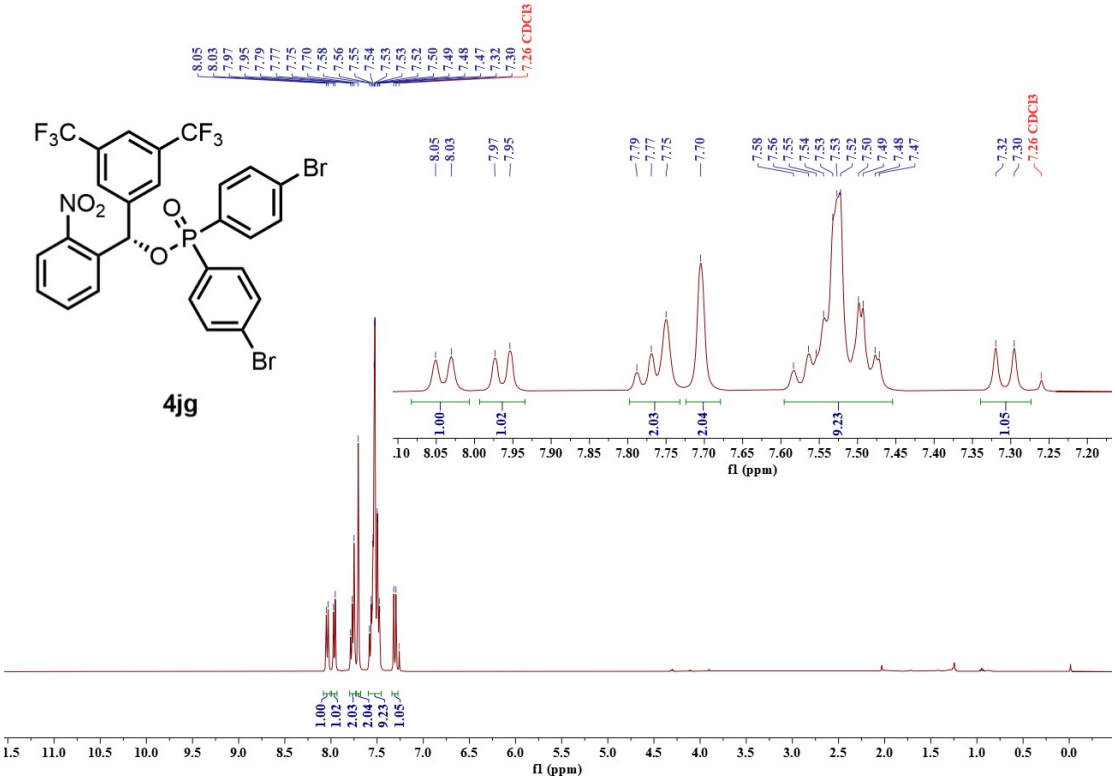


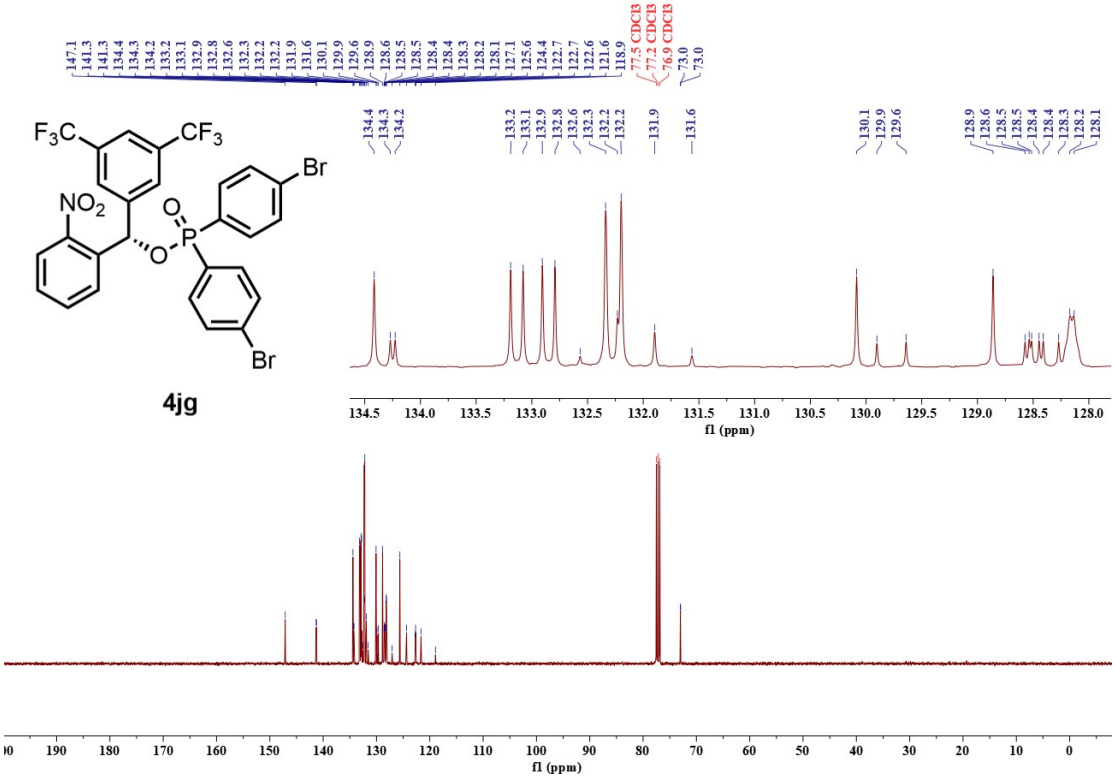
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4hg



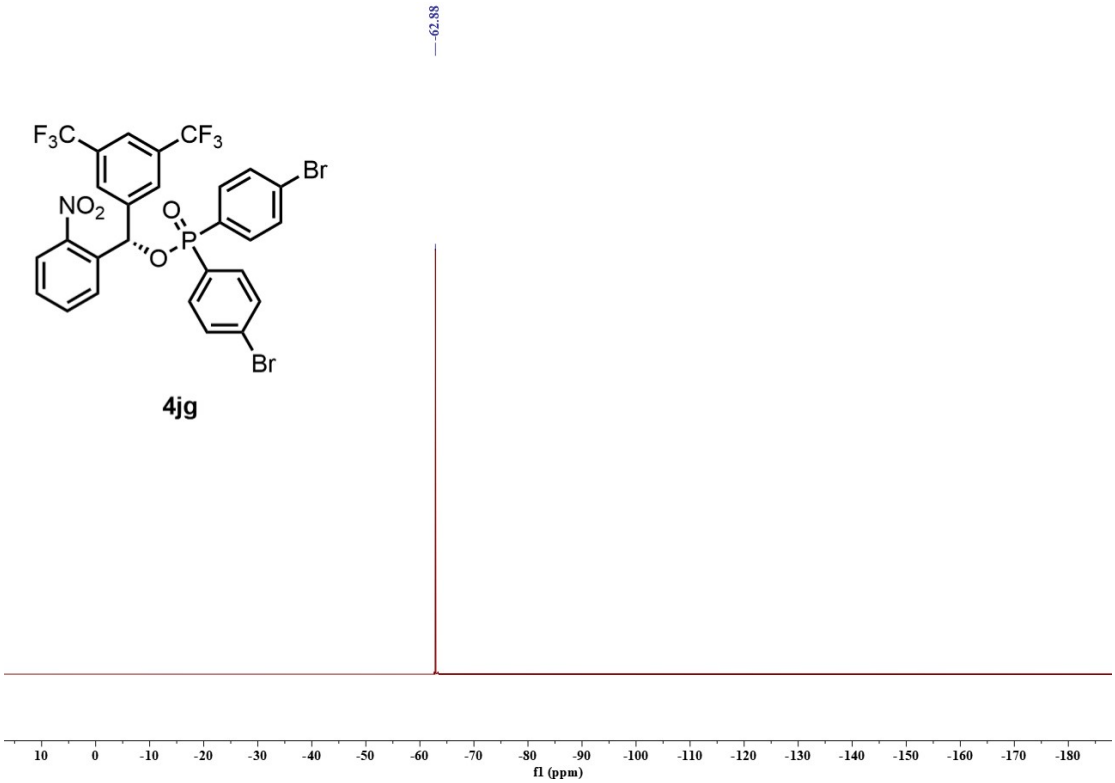
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4jg



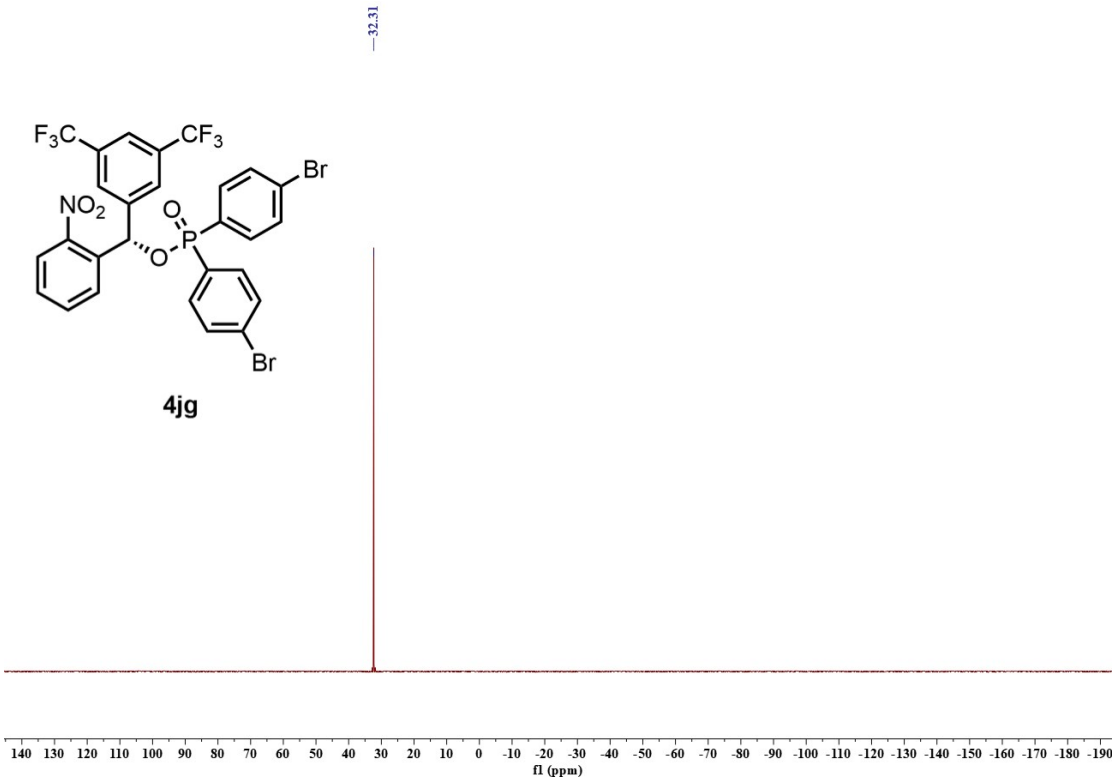
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 4jg



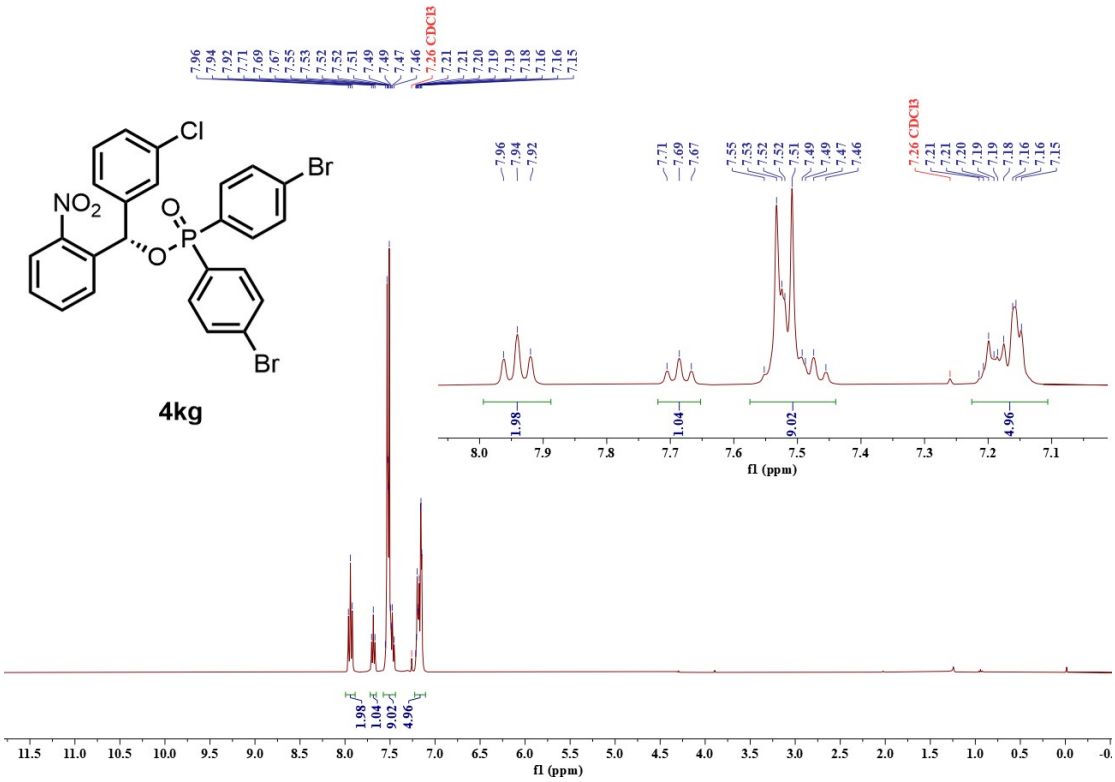
^{19}F NMR (376 MHz, $CDCl_3$) spectrum for 4jg



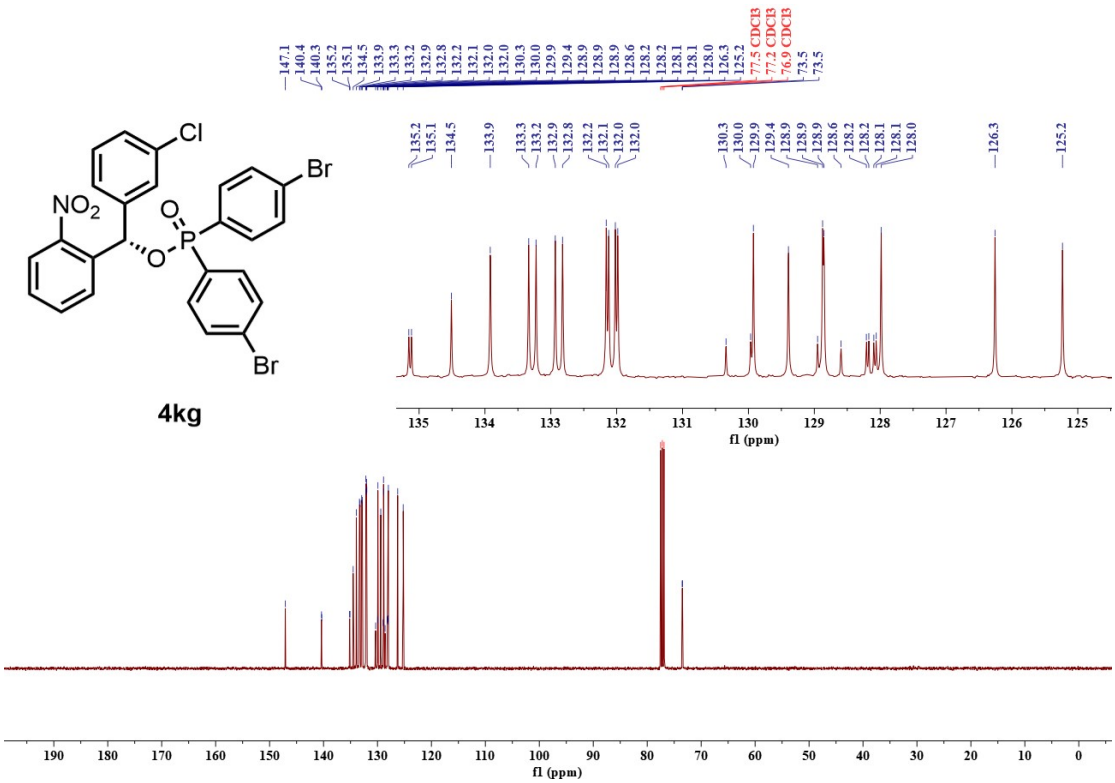
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4jg



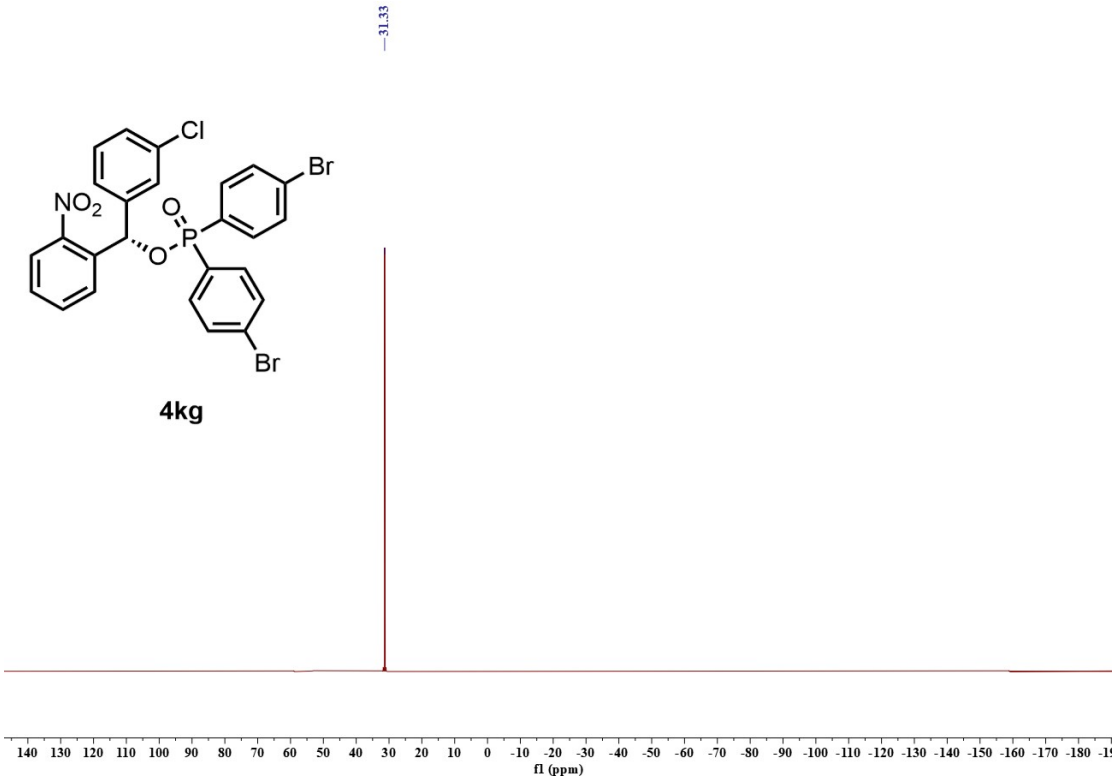
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4kg



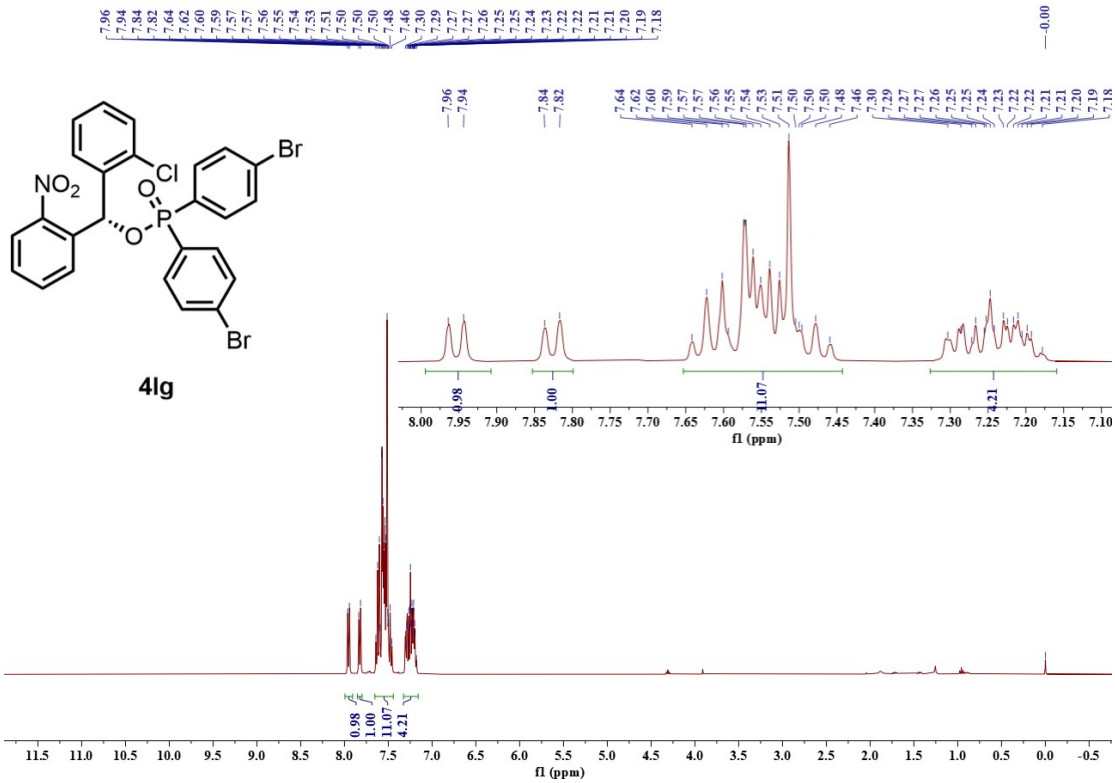
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 4kg



^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4kg



^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4lg



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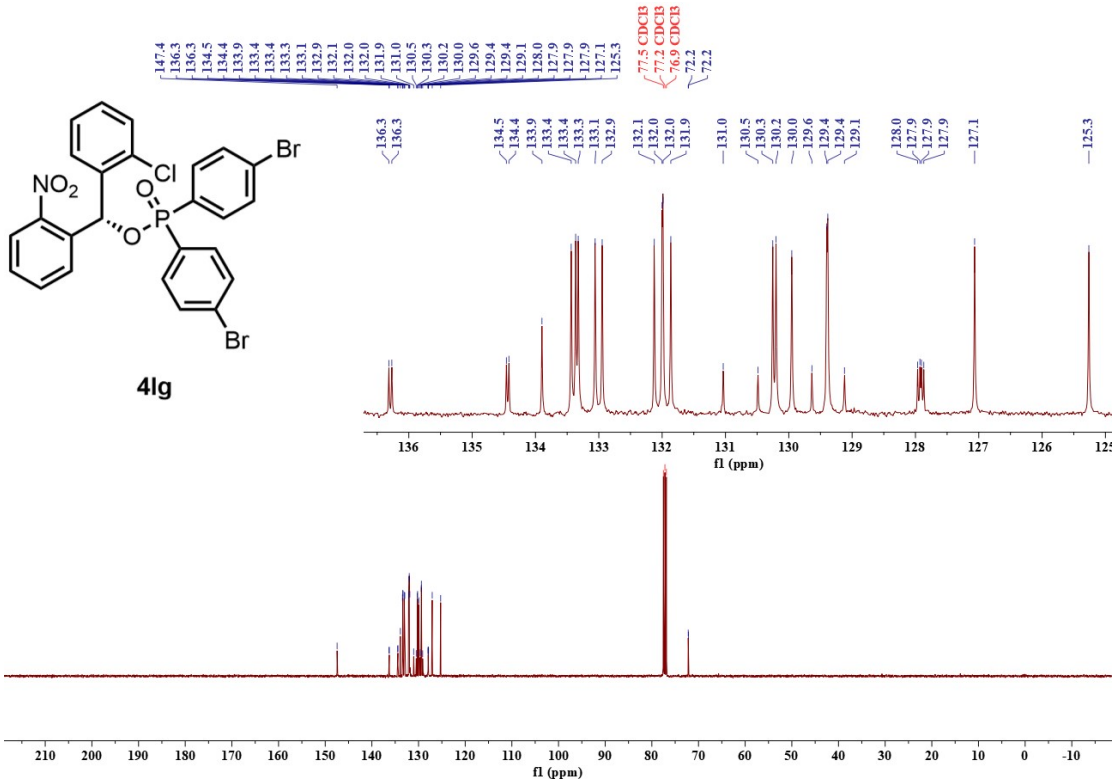
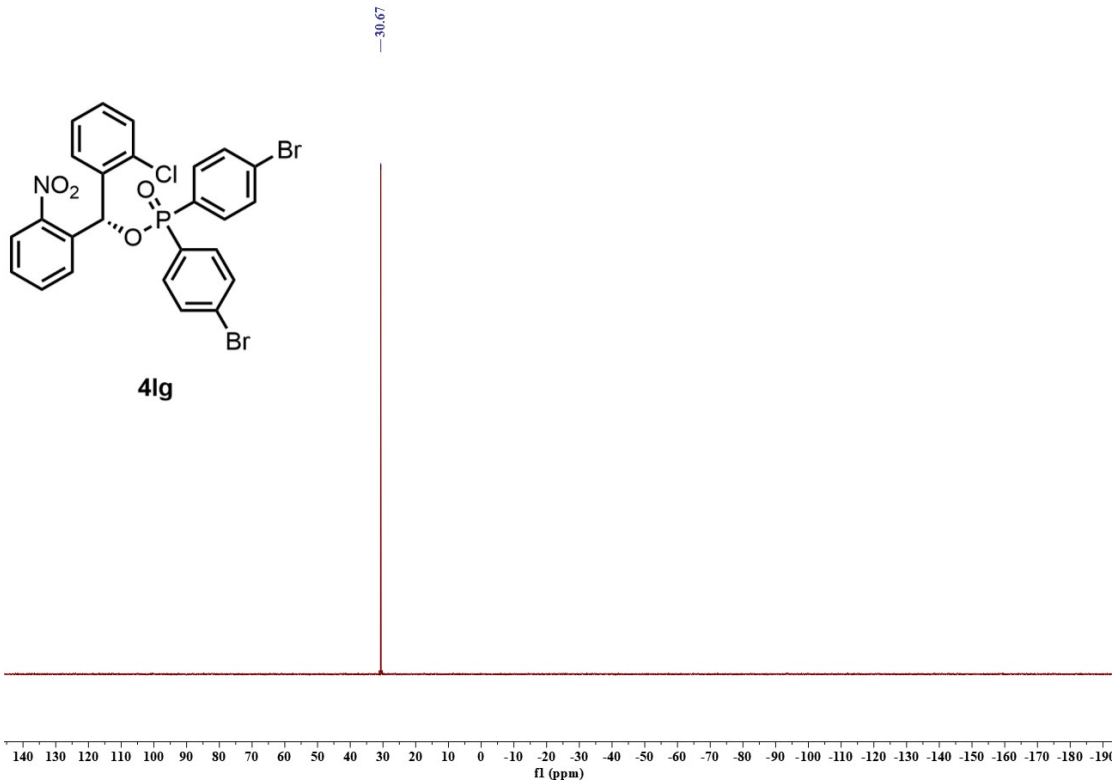
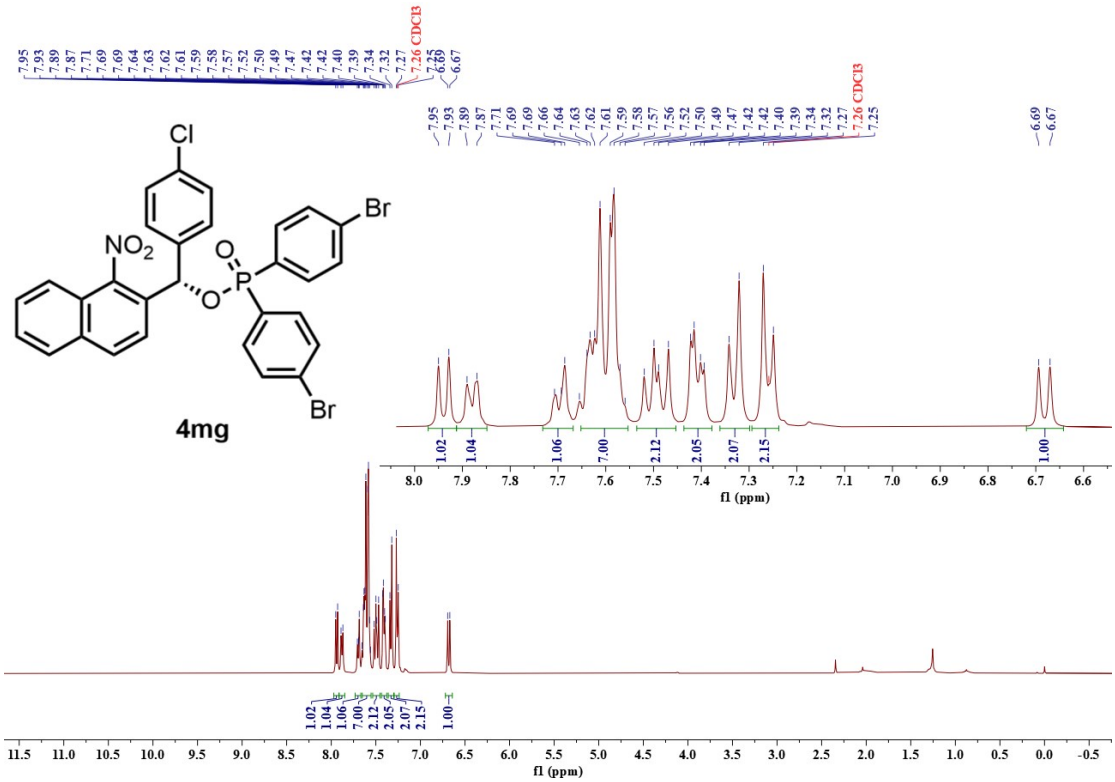


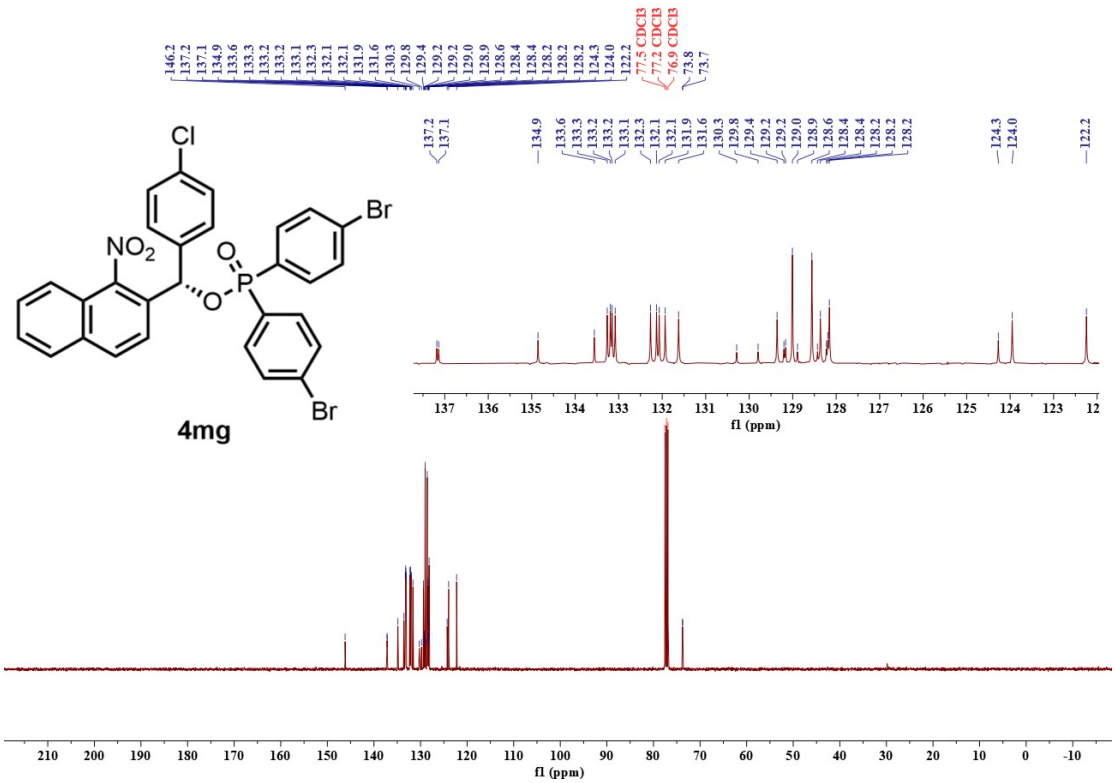
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4lg



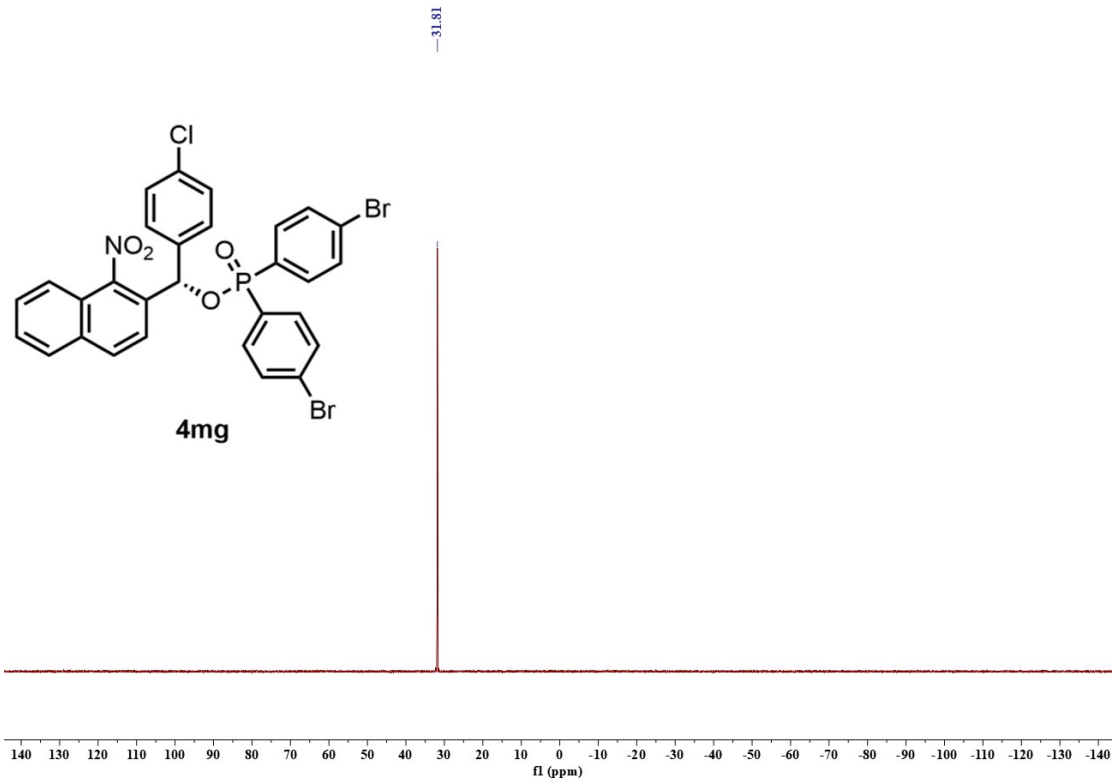
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4mg



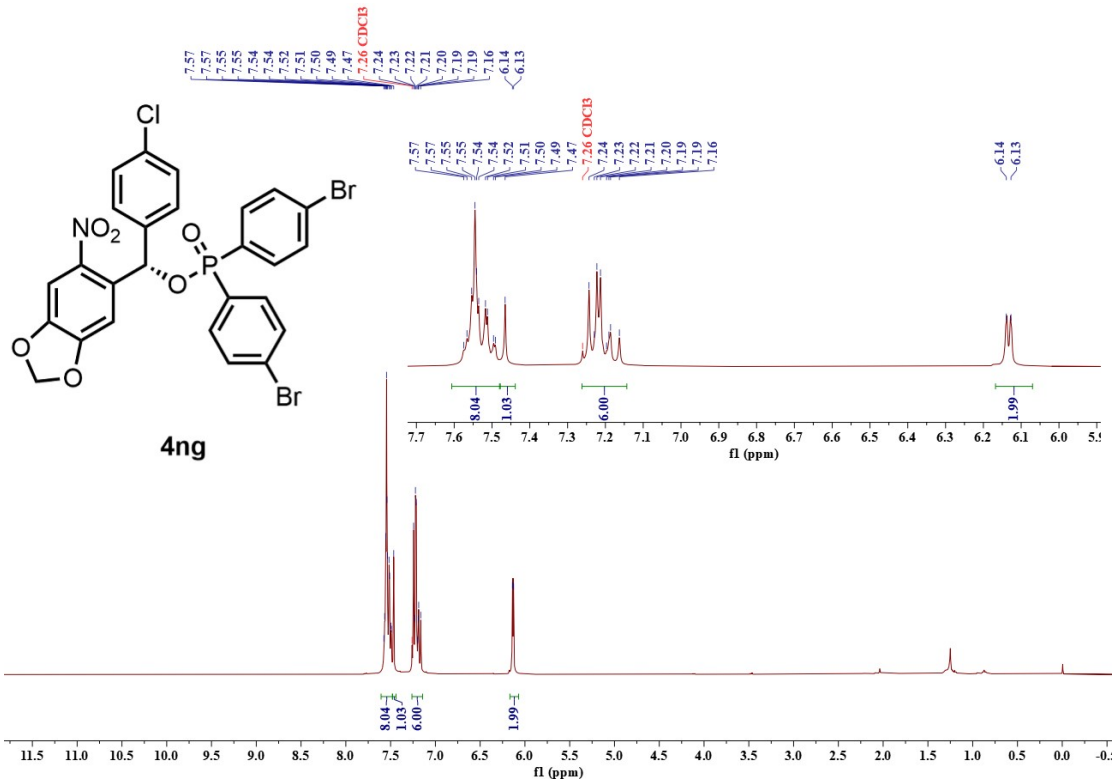
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 4mg



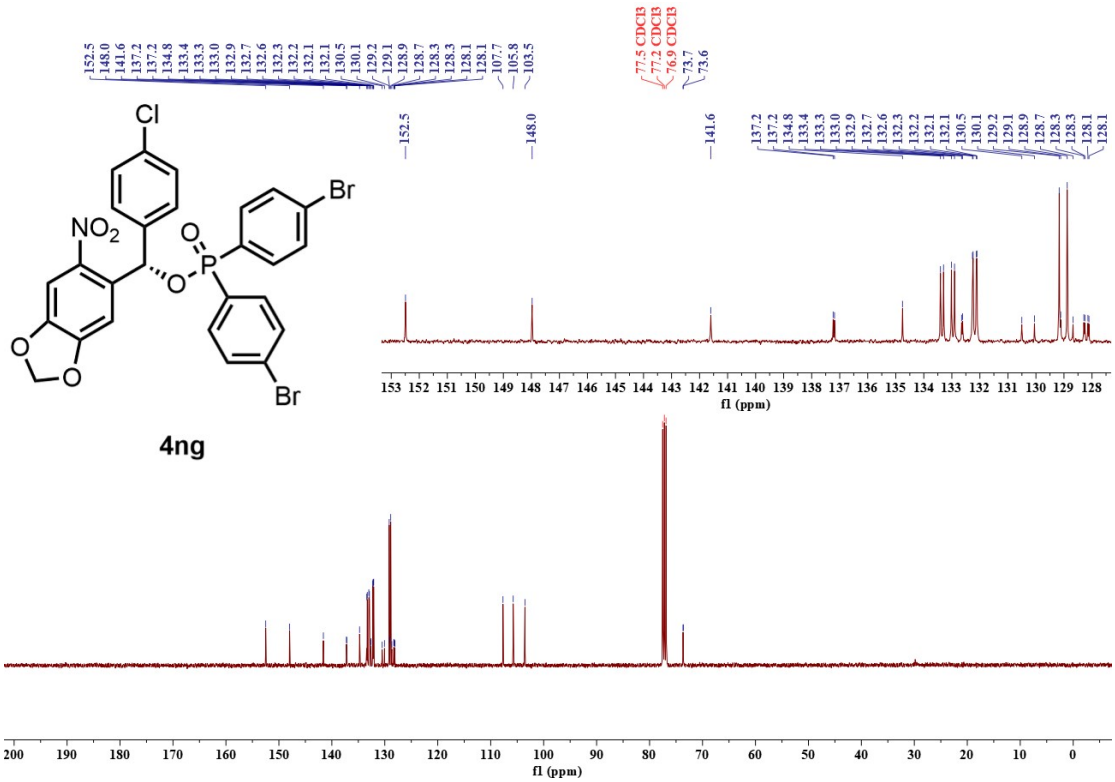
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4mg



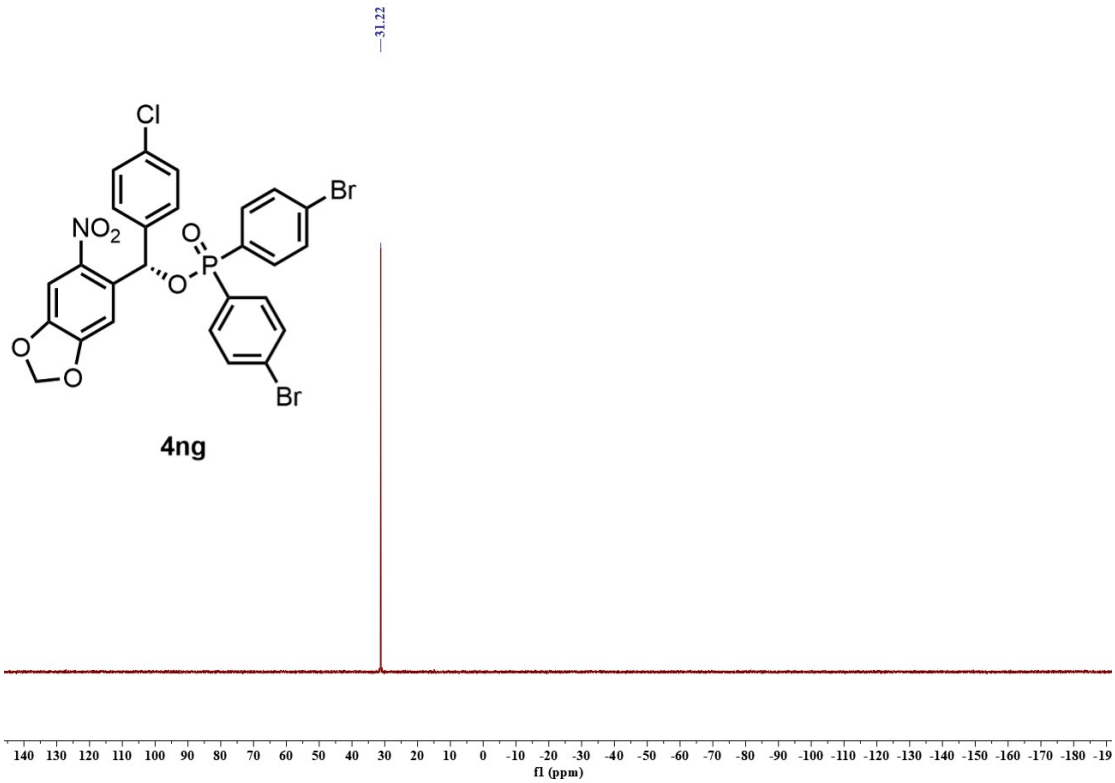
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4ng



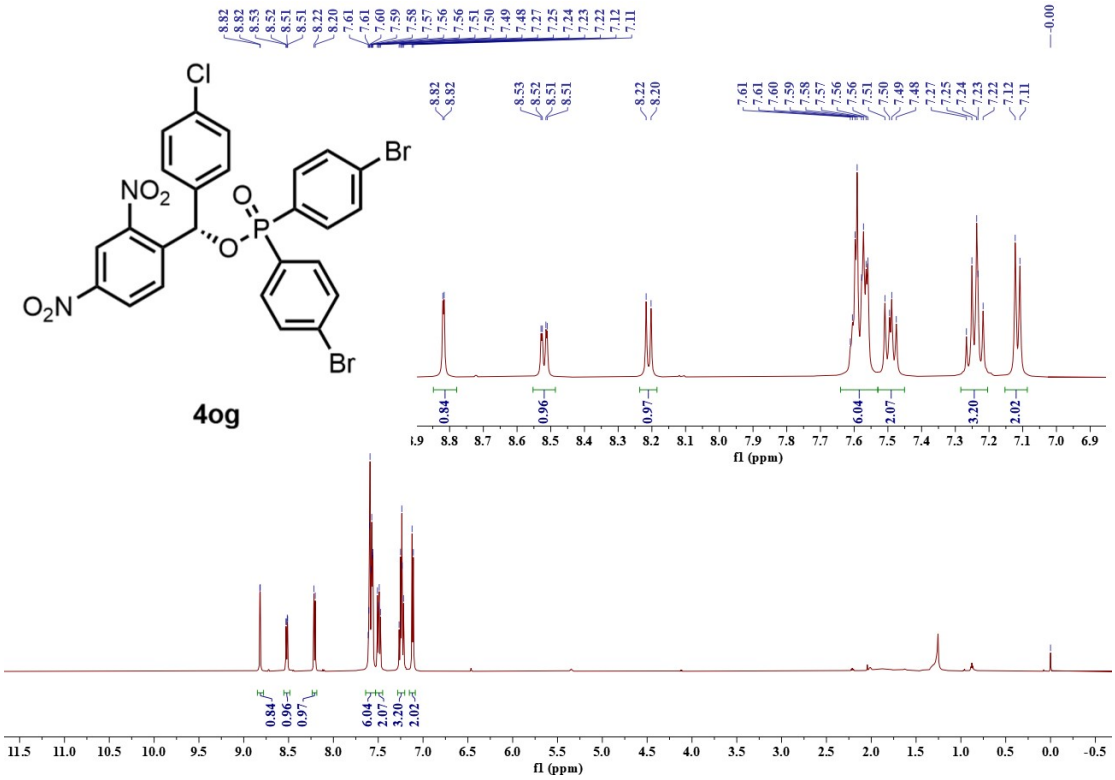
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 4ng



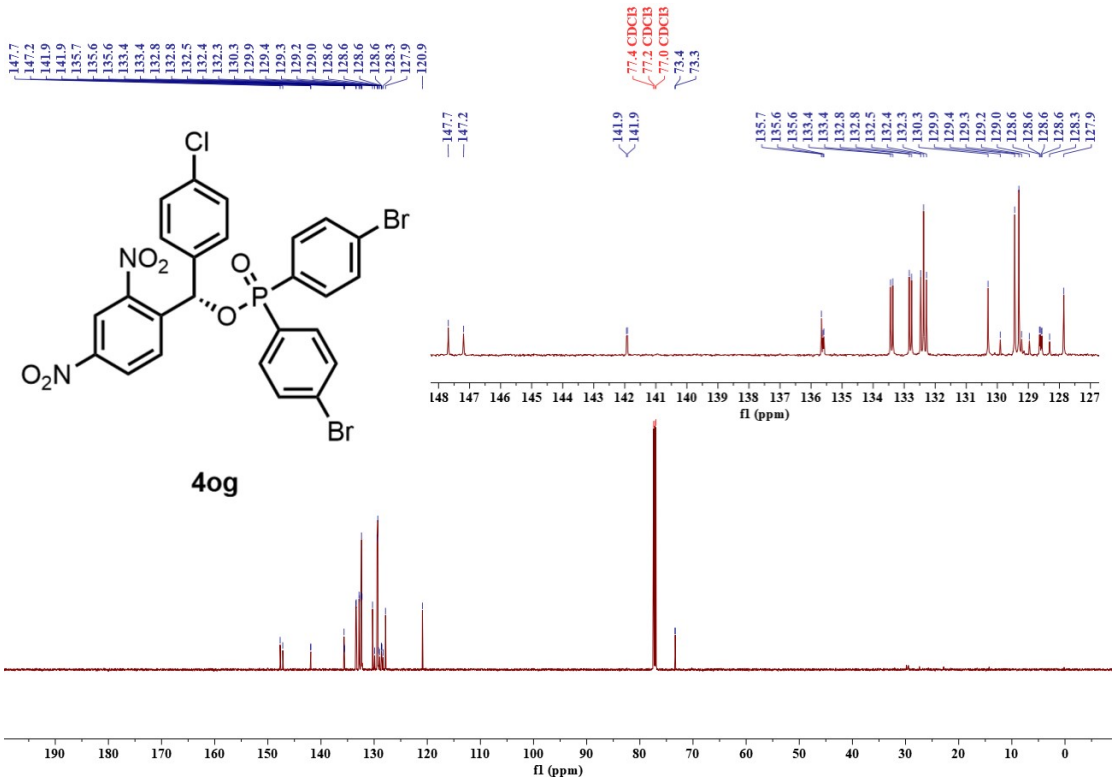
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4ng



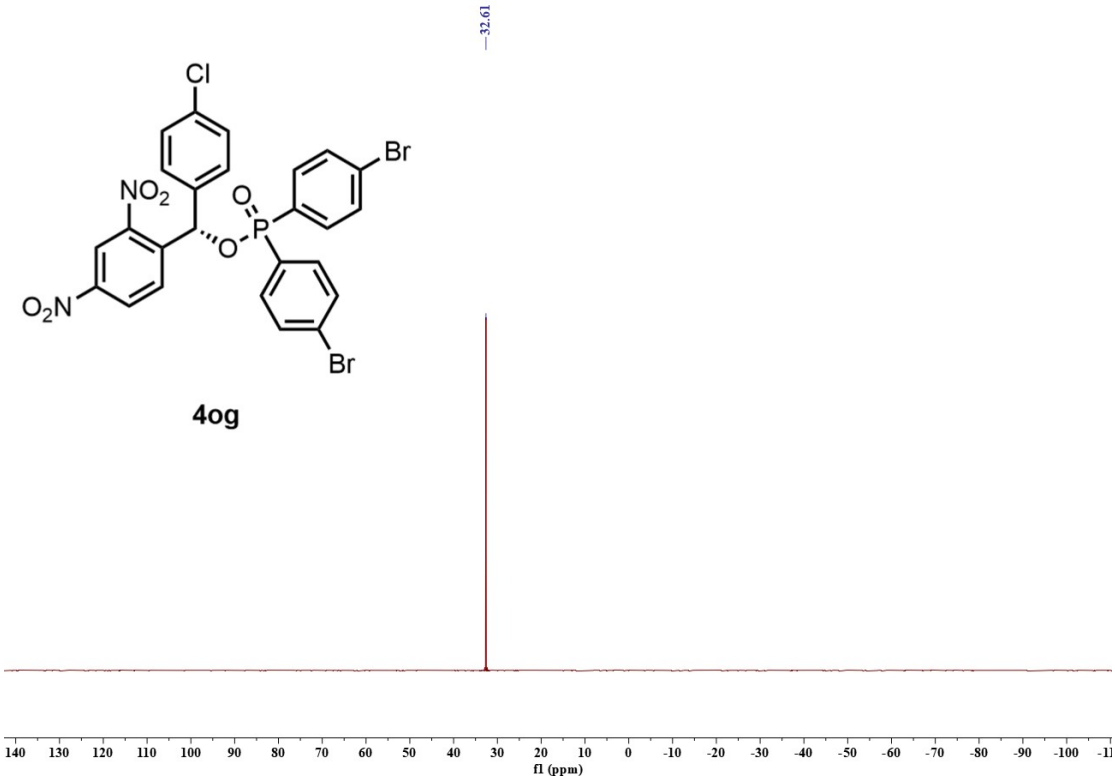
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4og



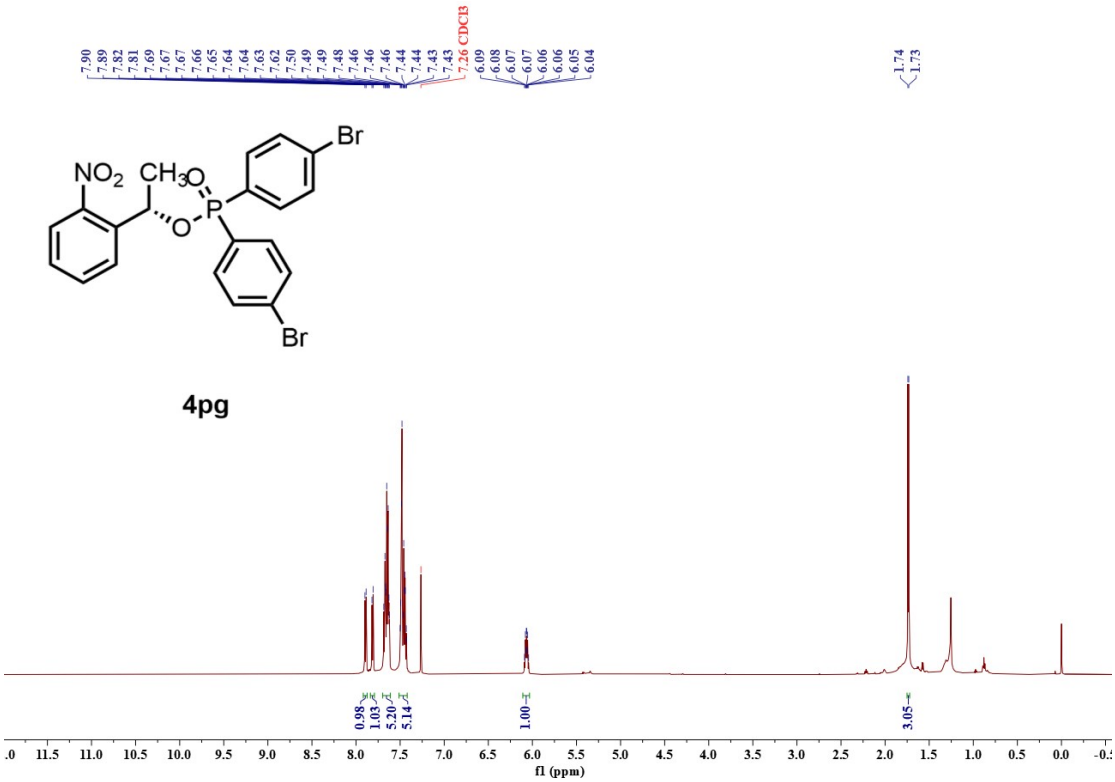
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 4og



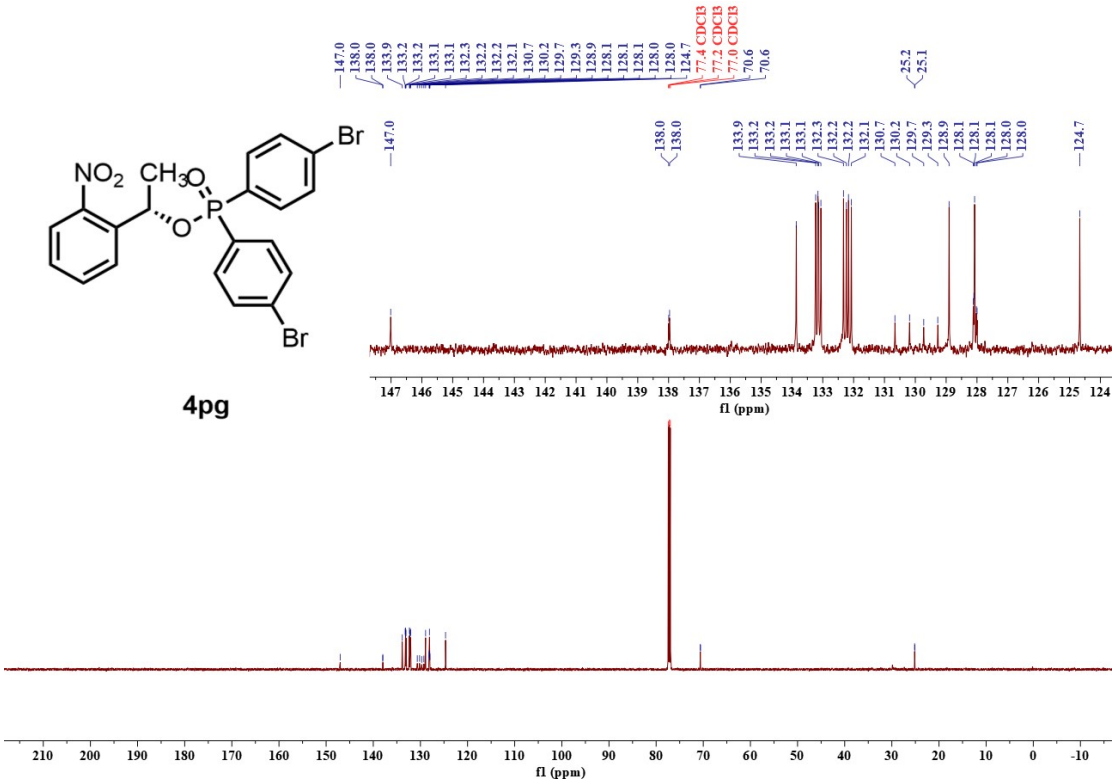
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4og



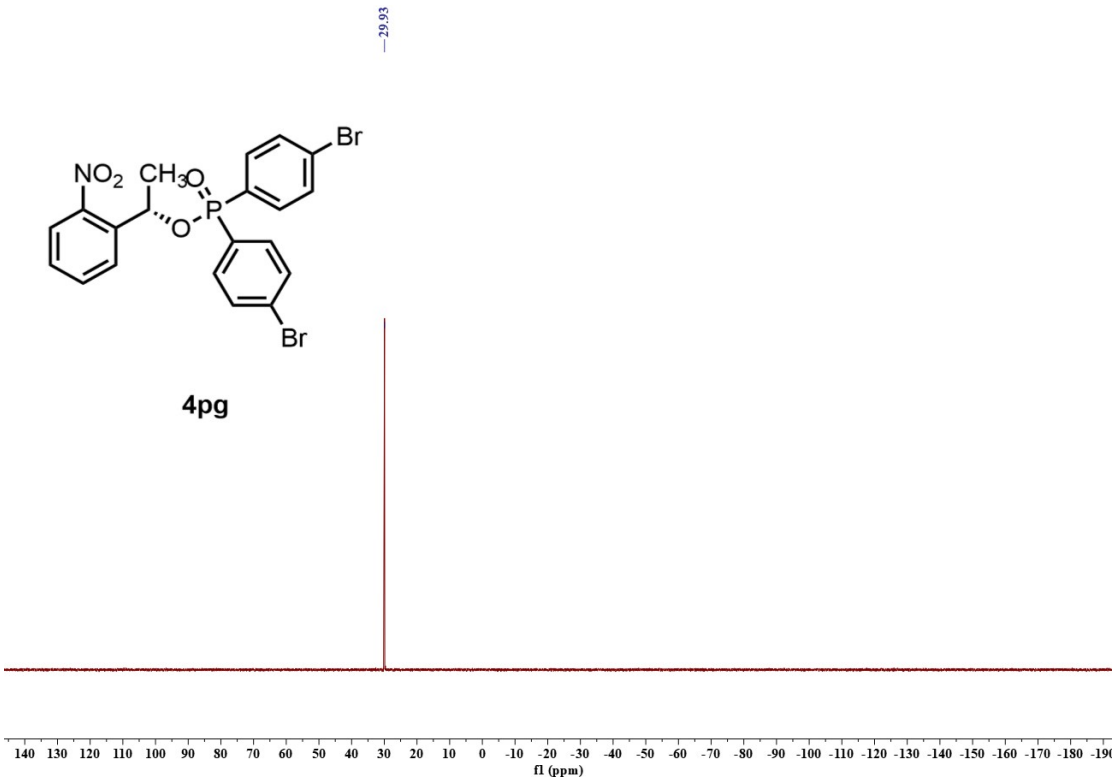
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 4pg



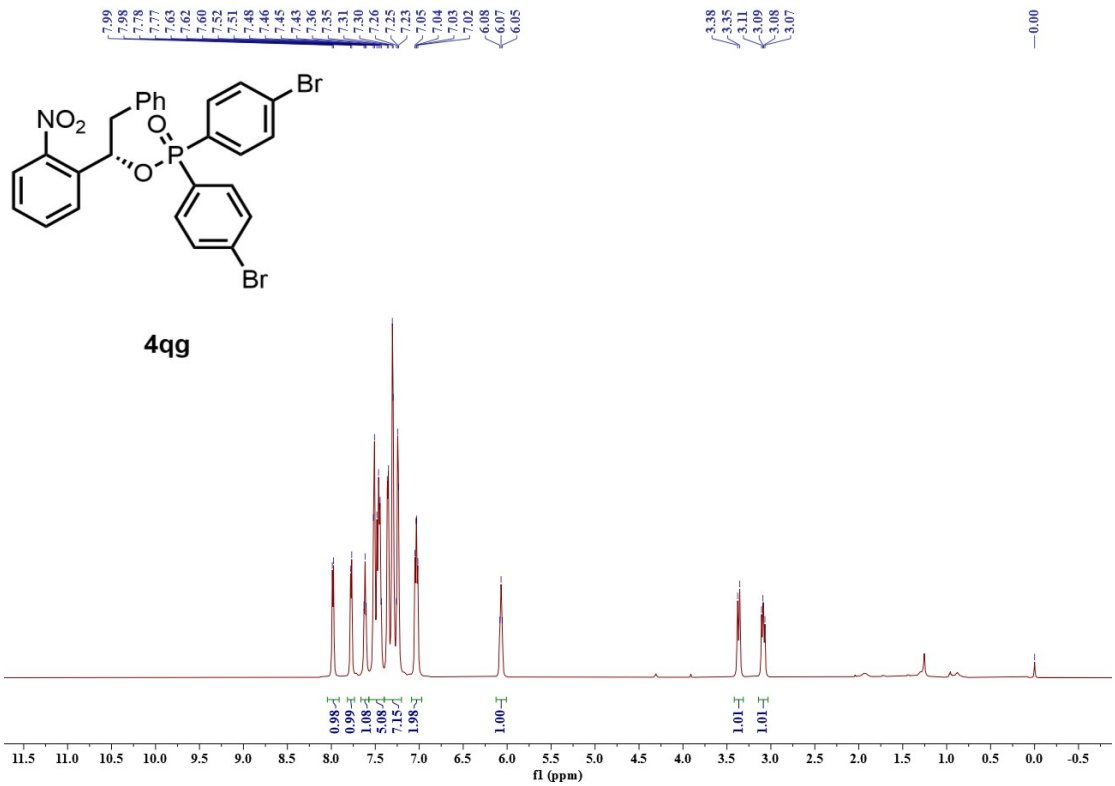
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 4pg



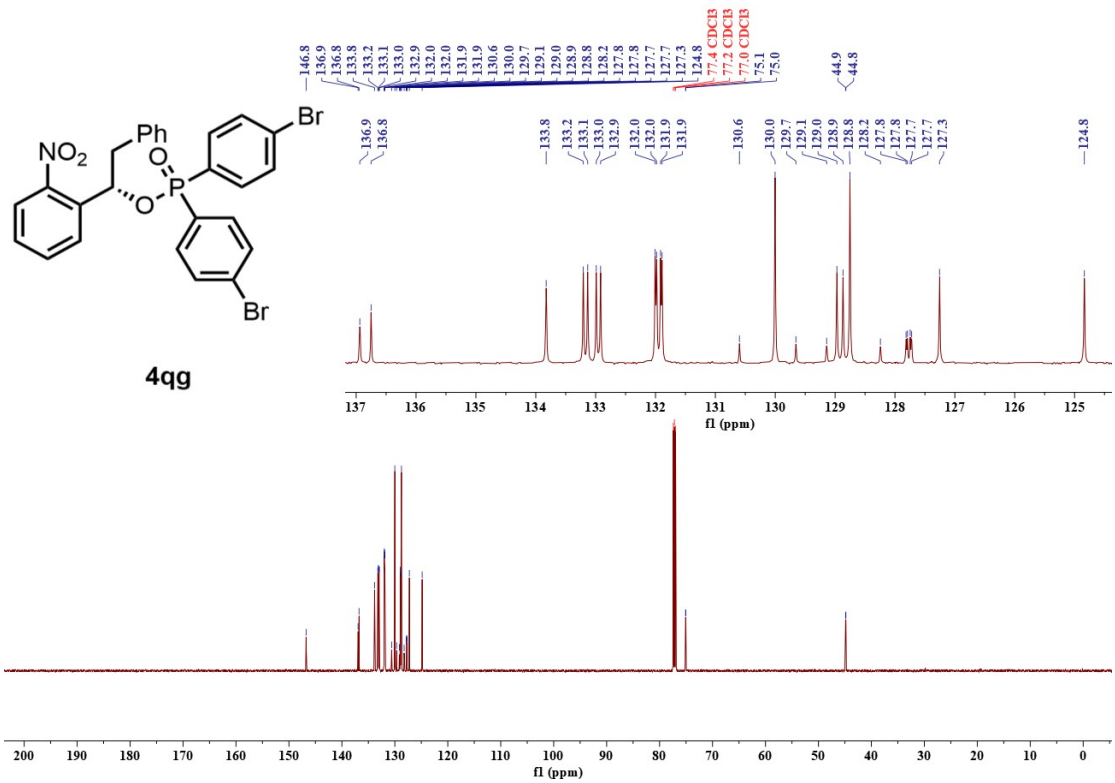
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 4pg



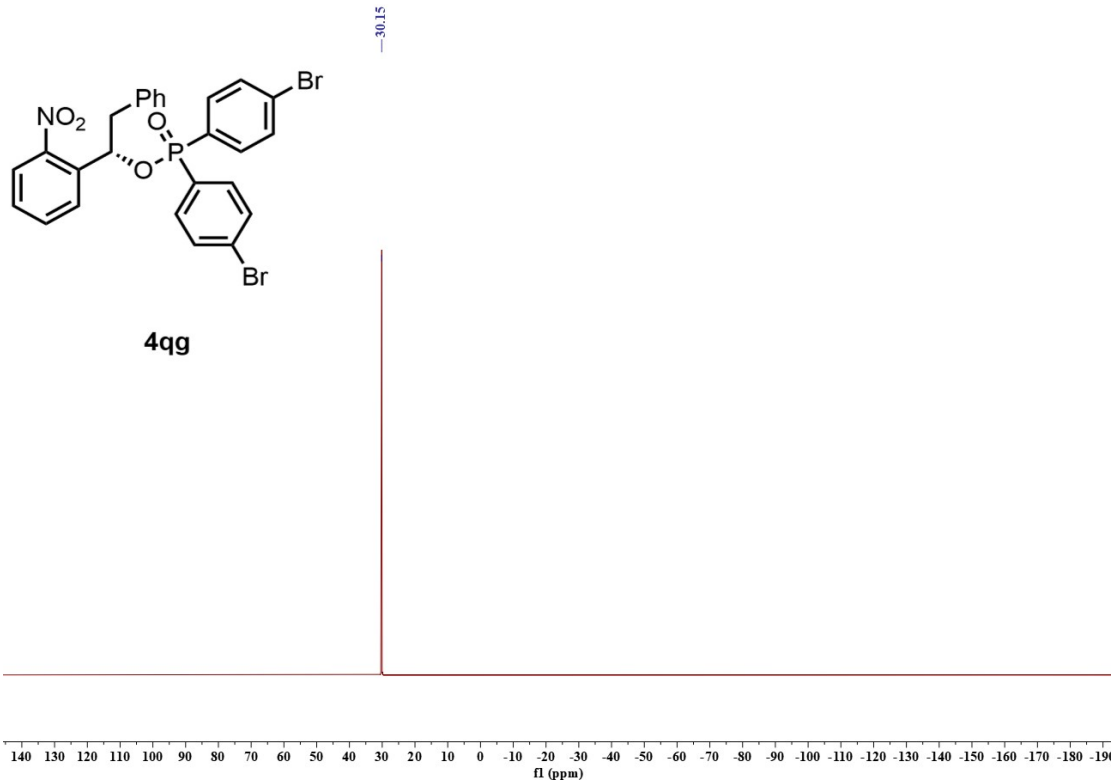
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 4qg



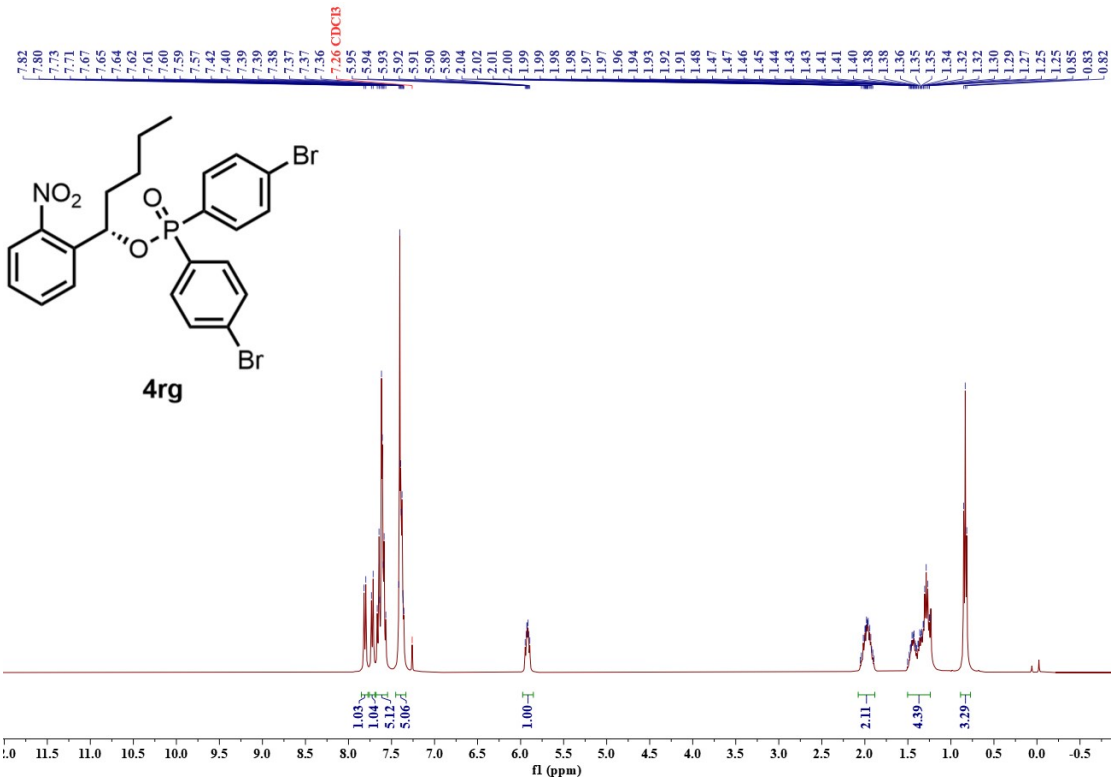
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 4qg



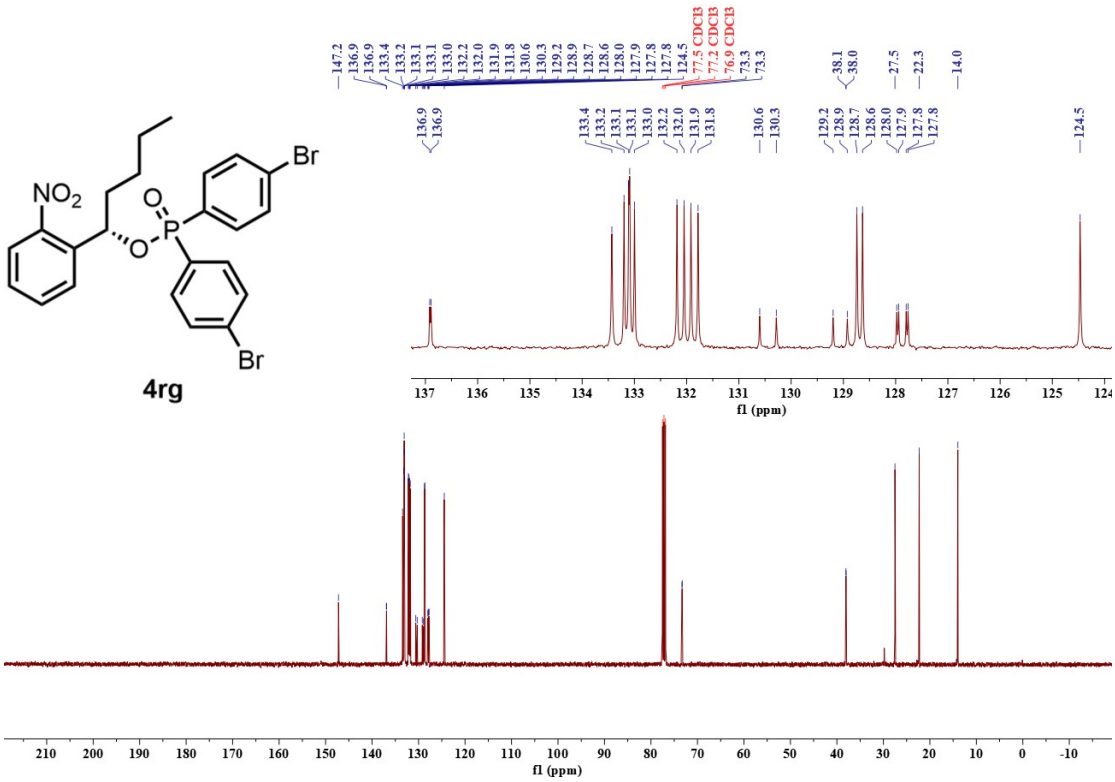
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 4qg



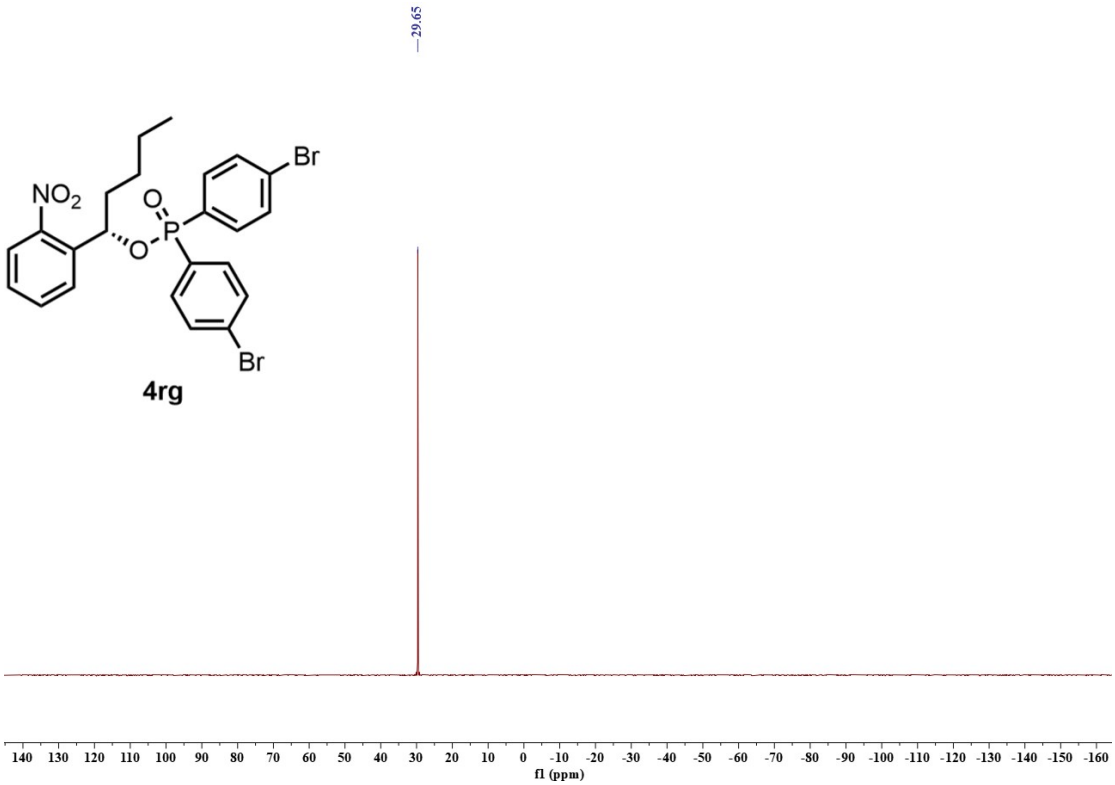
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4rg



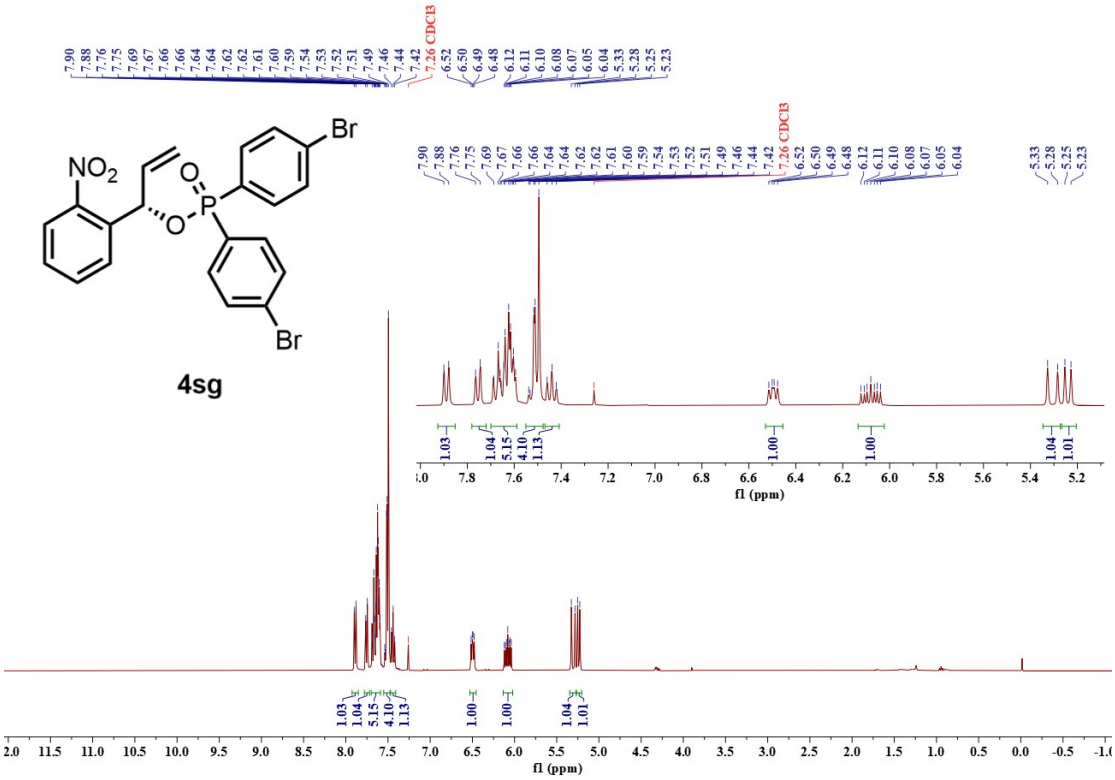
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 4rg



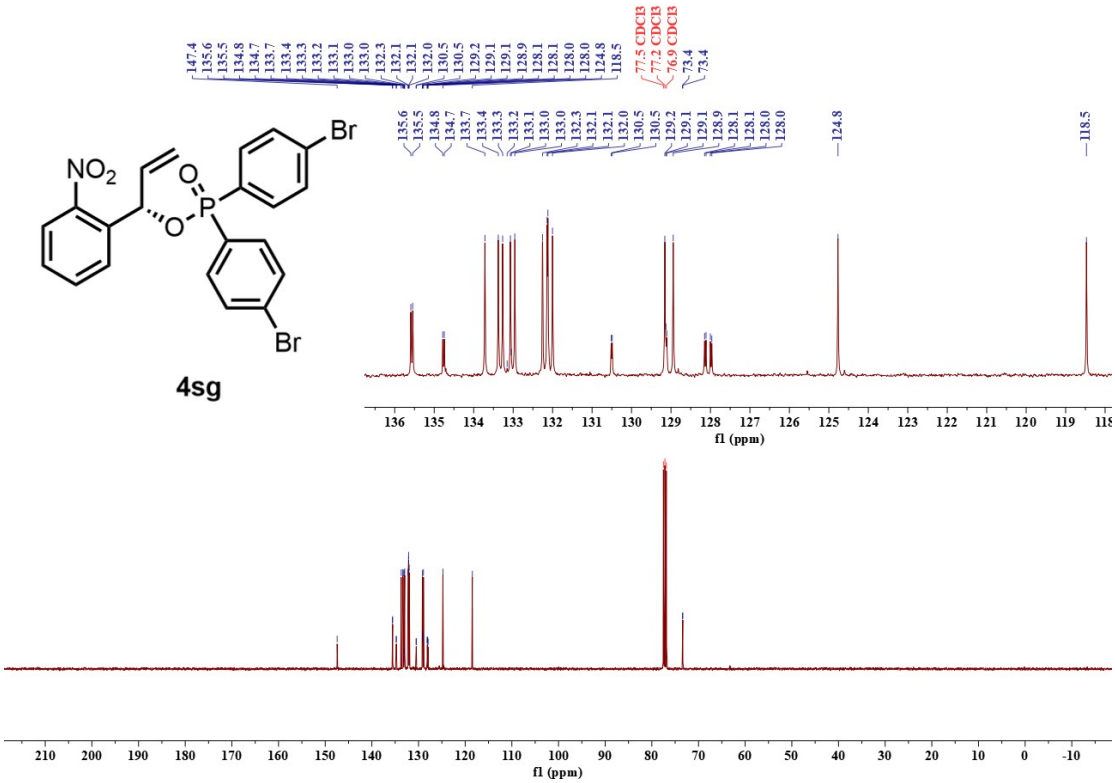
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4rg



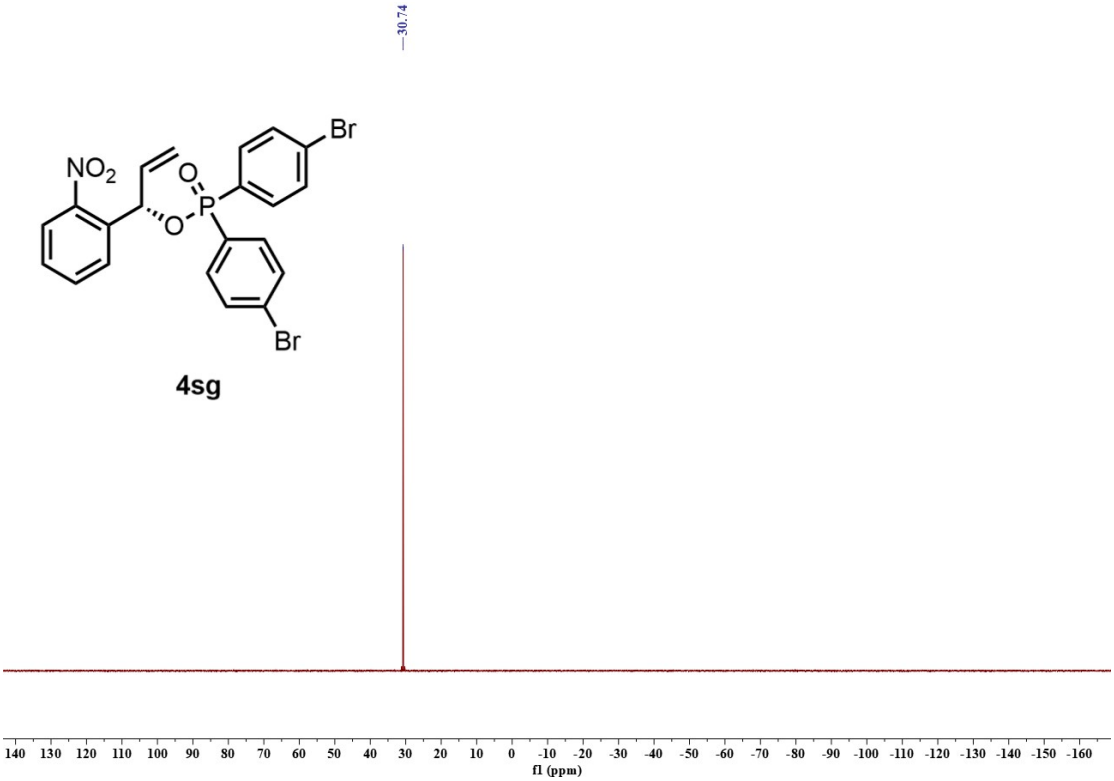
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4sg



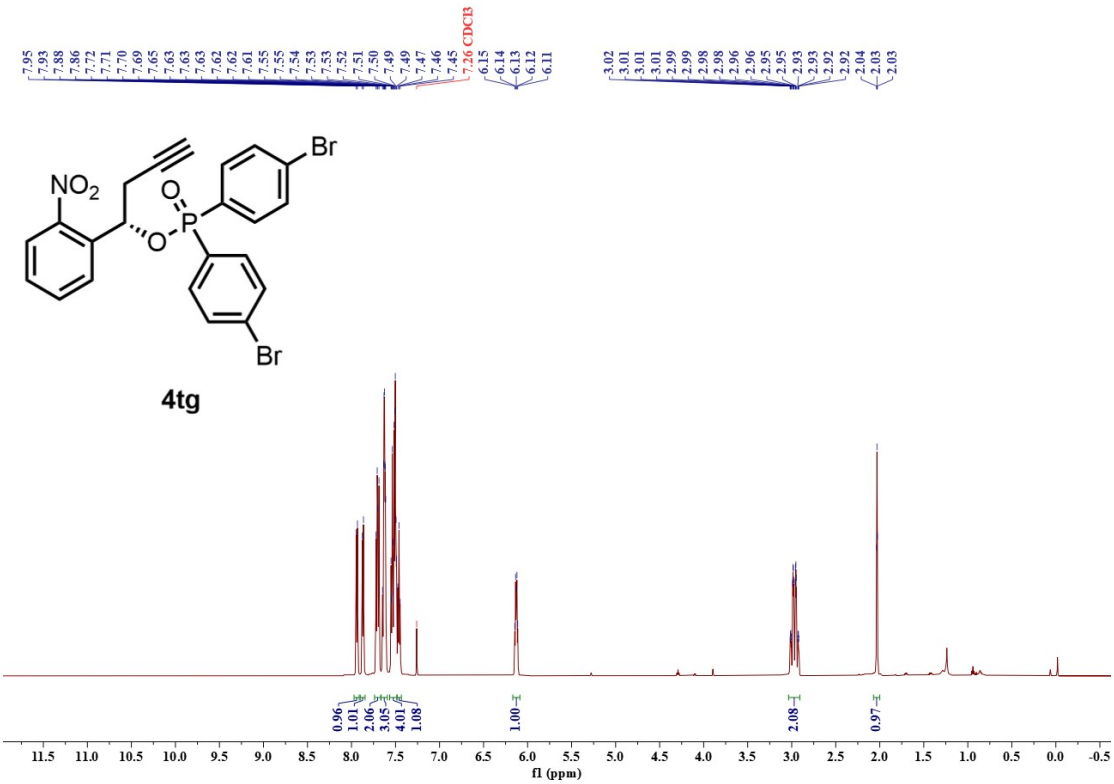
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 4sg



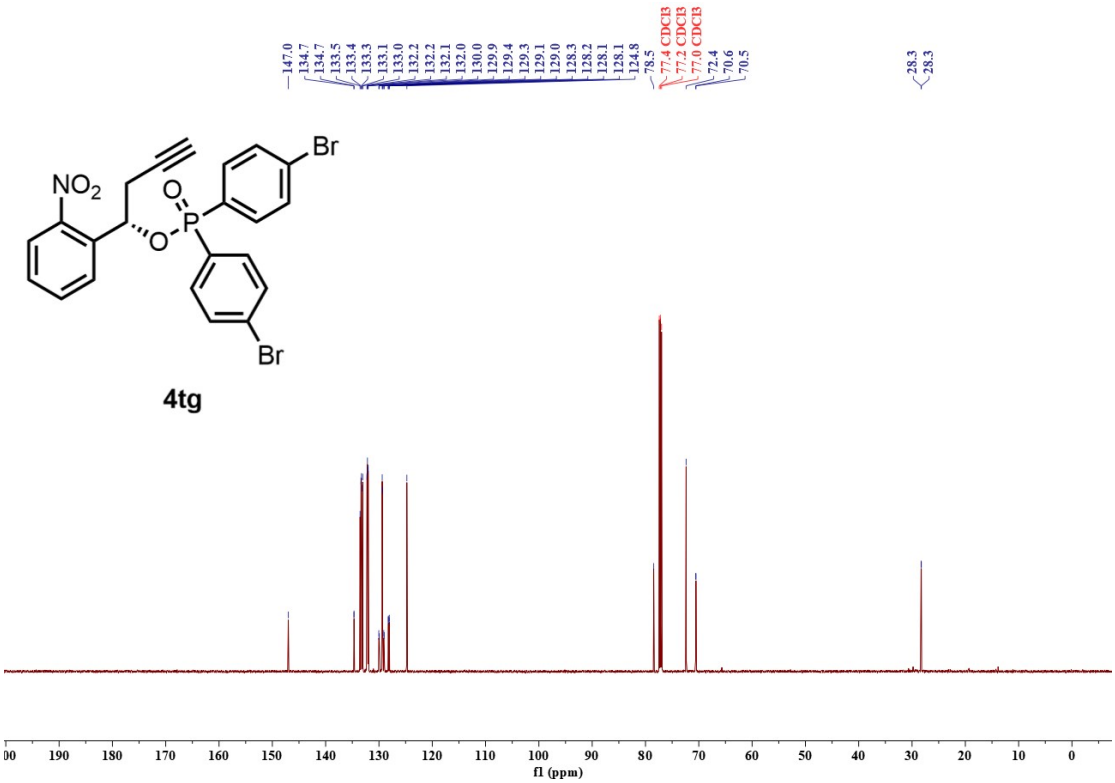
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4sg



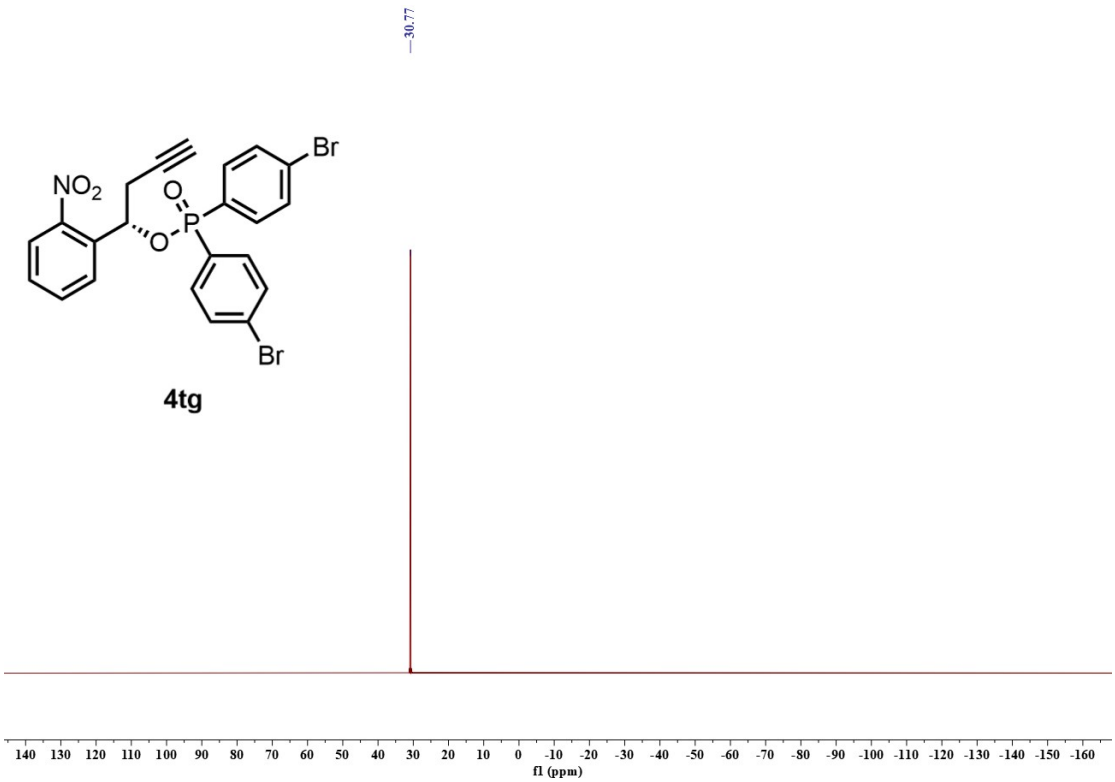
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 4tg



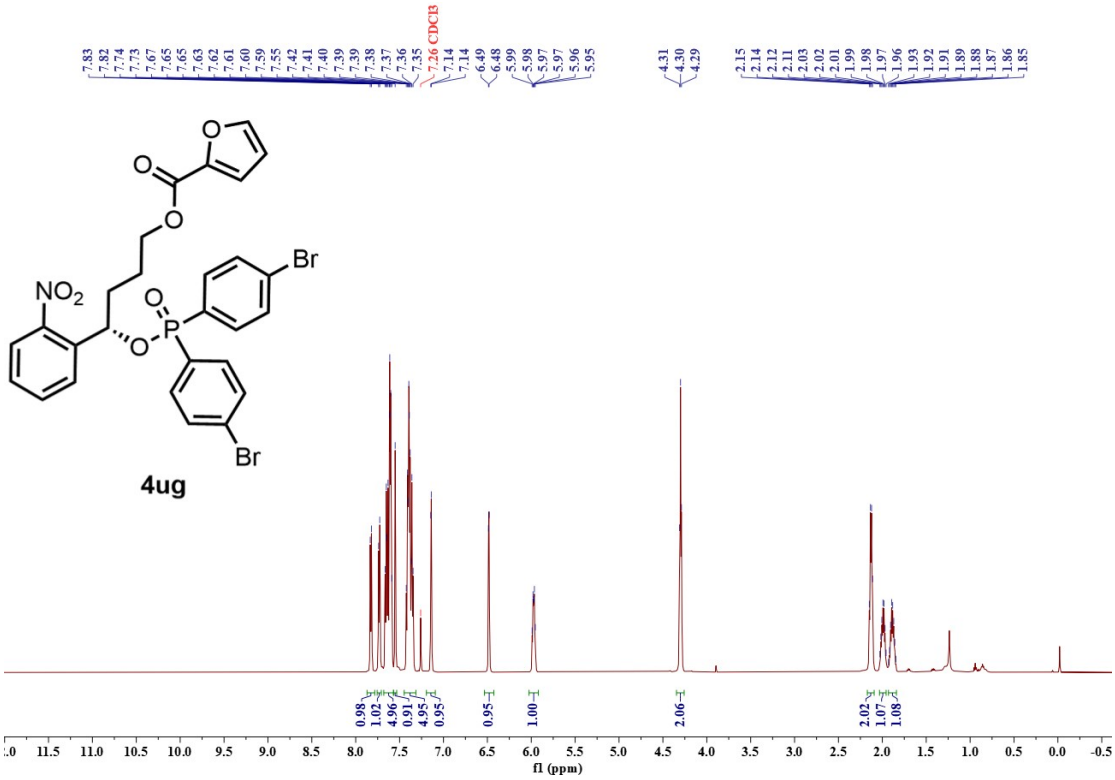
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 4tg



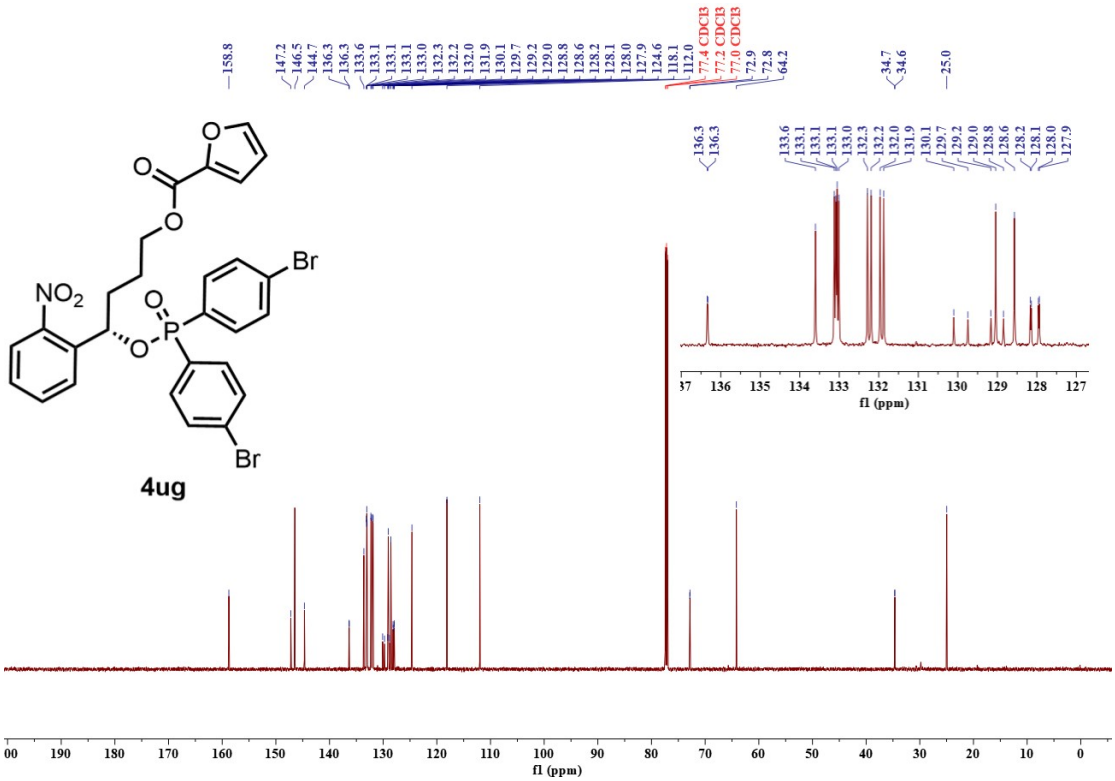
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 4tg



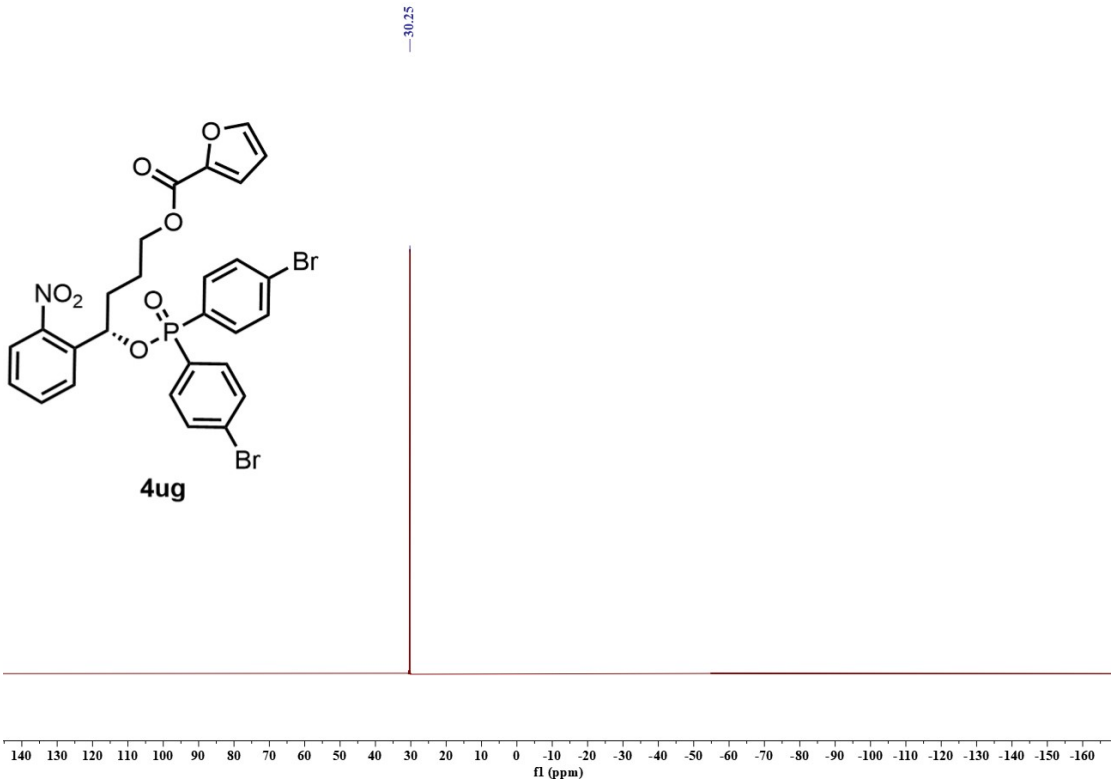
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 4ug



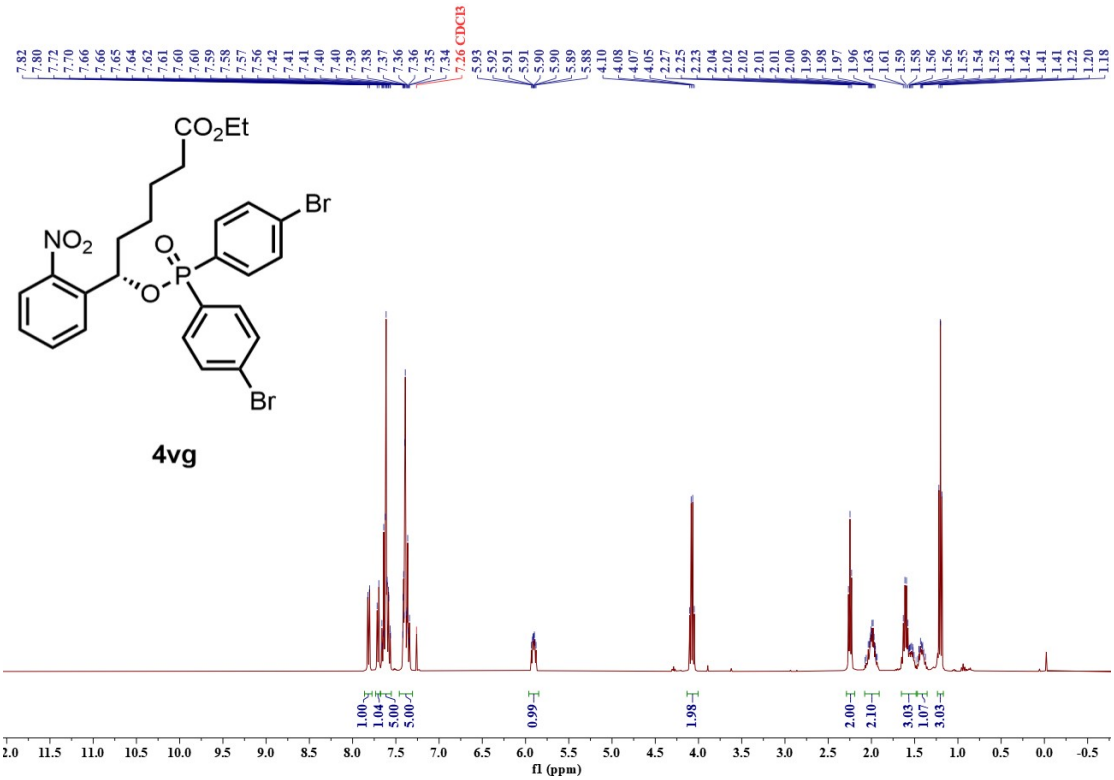
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 4ug



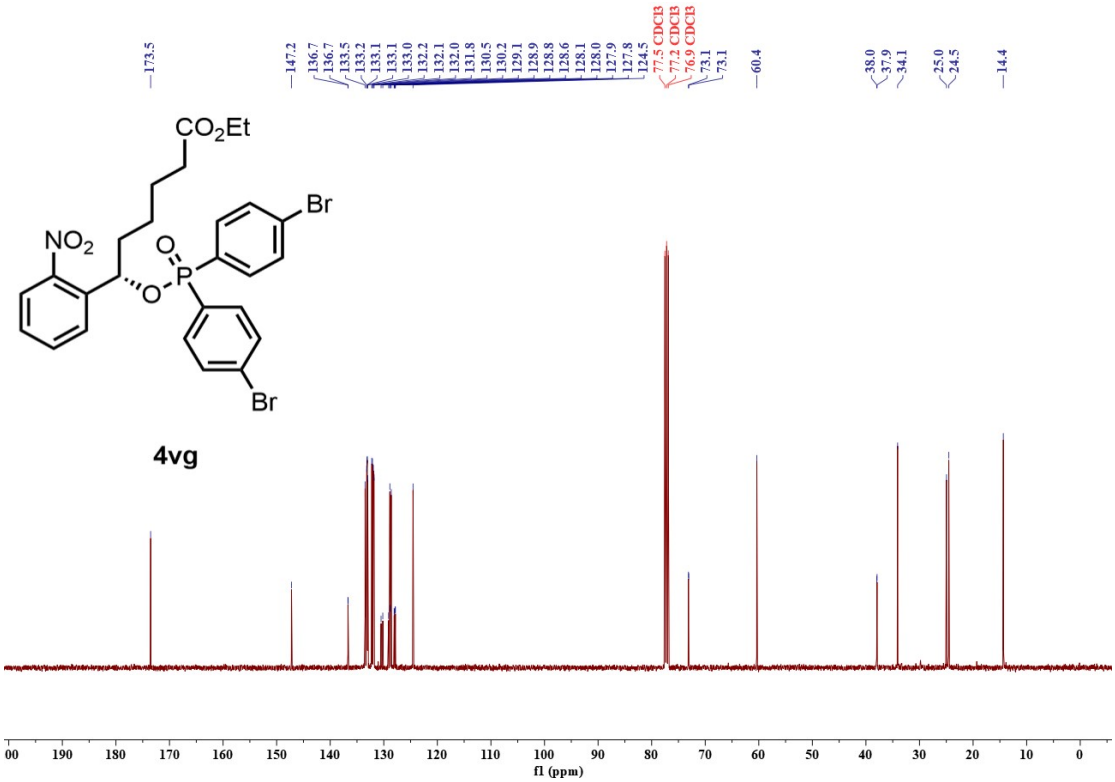
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 4ug



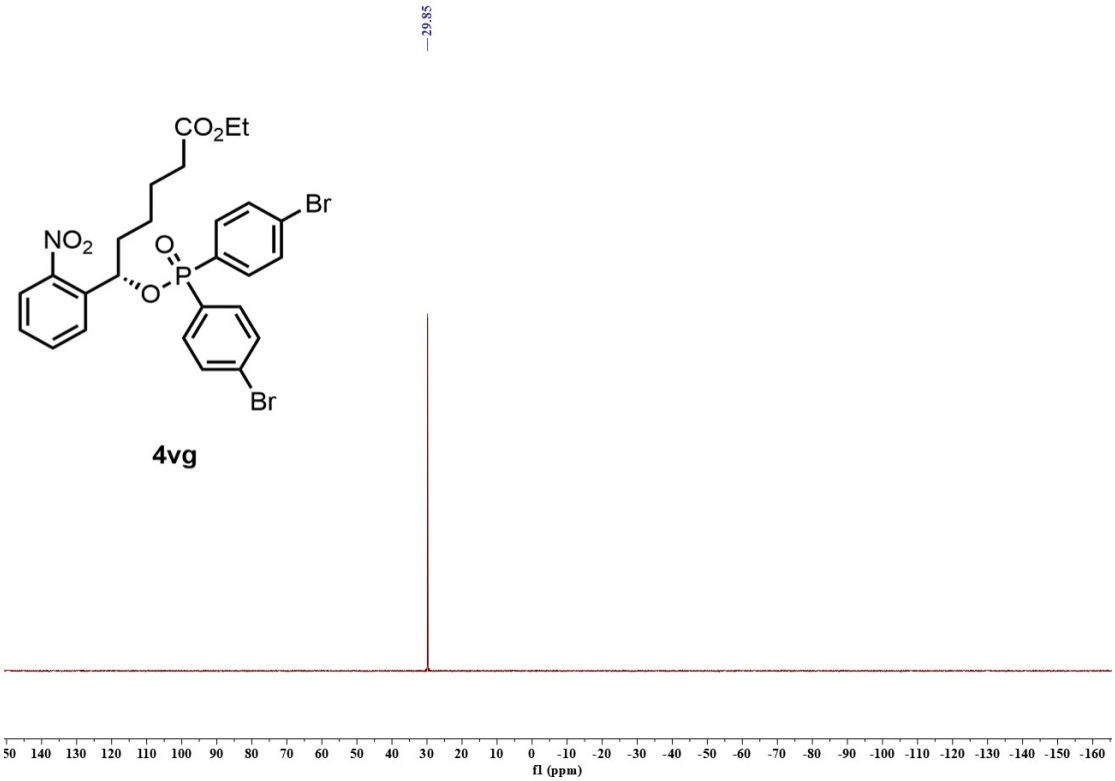
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4vg



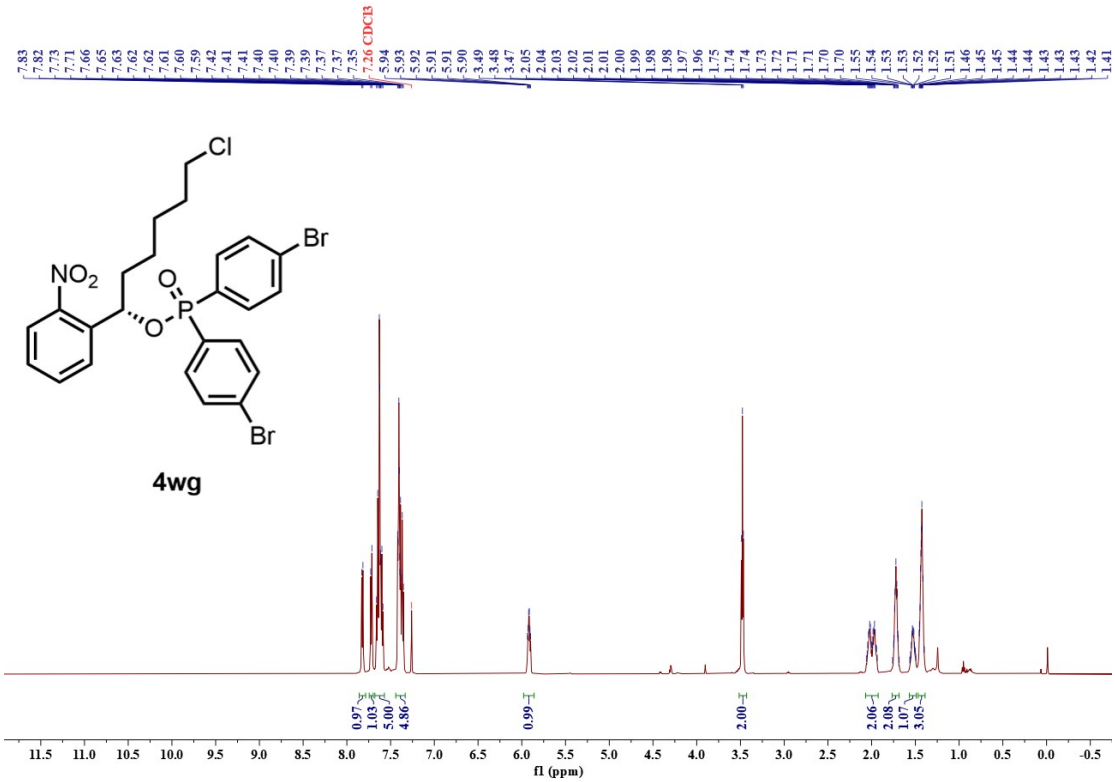
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 4vg



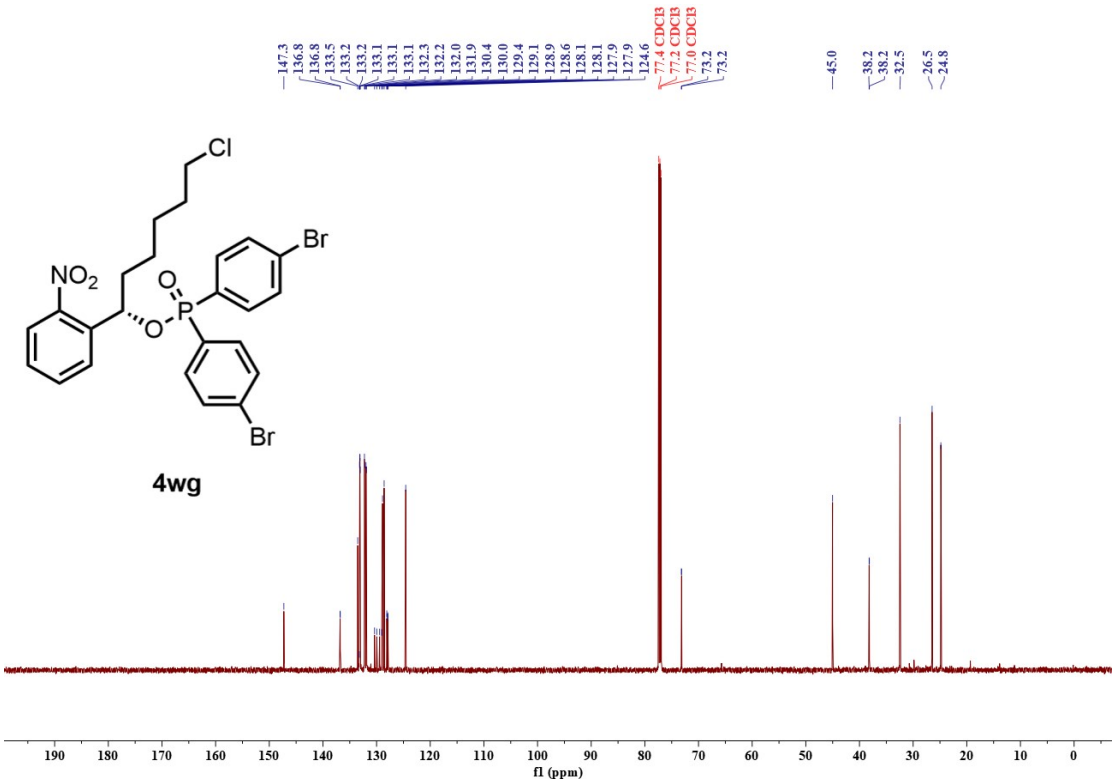
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4vg



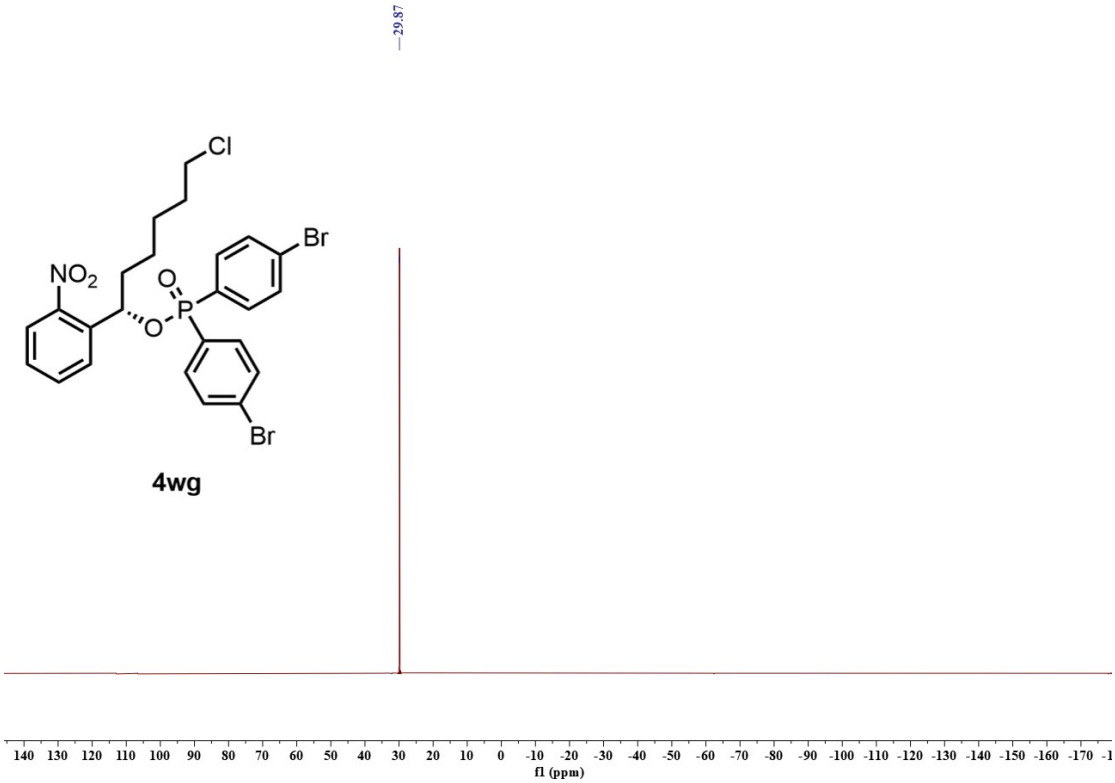
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 4wg



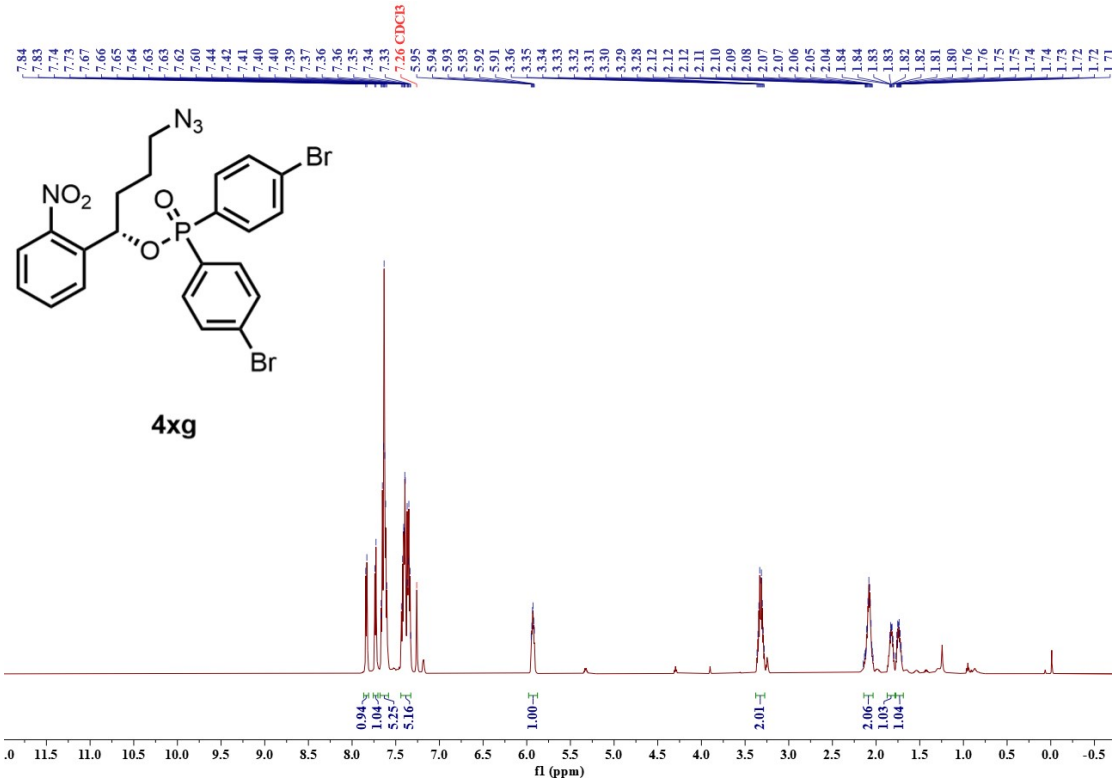
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 4wg



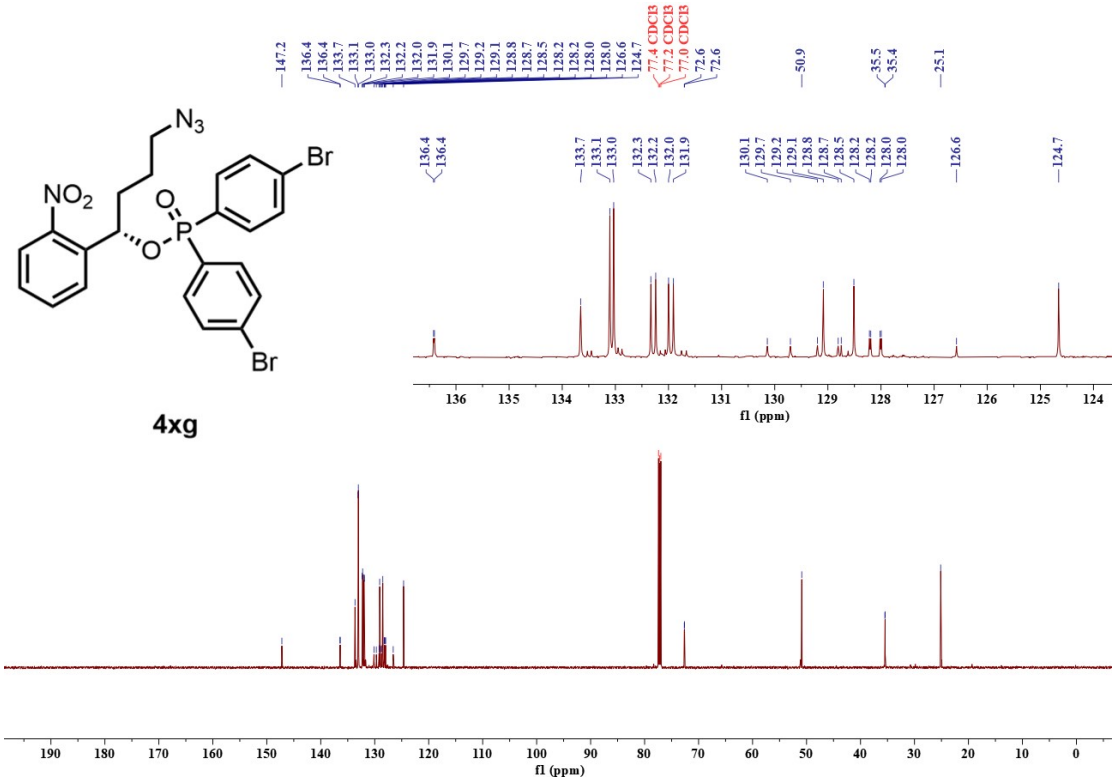
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 4wg



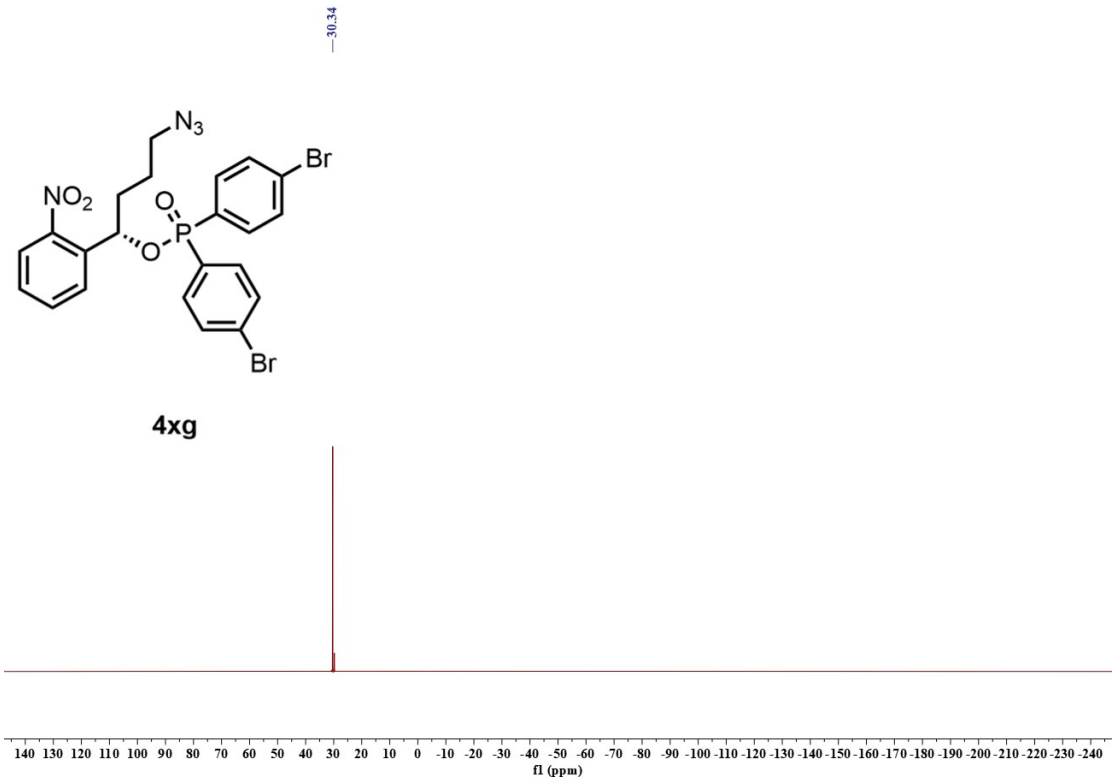
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 4xg



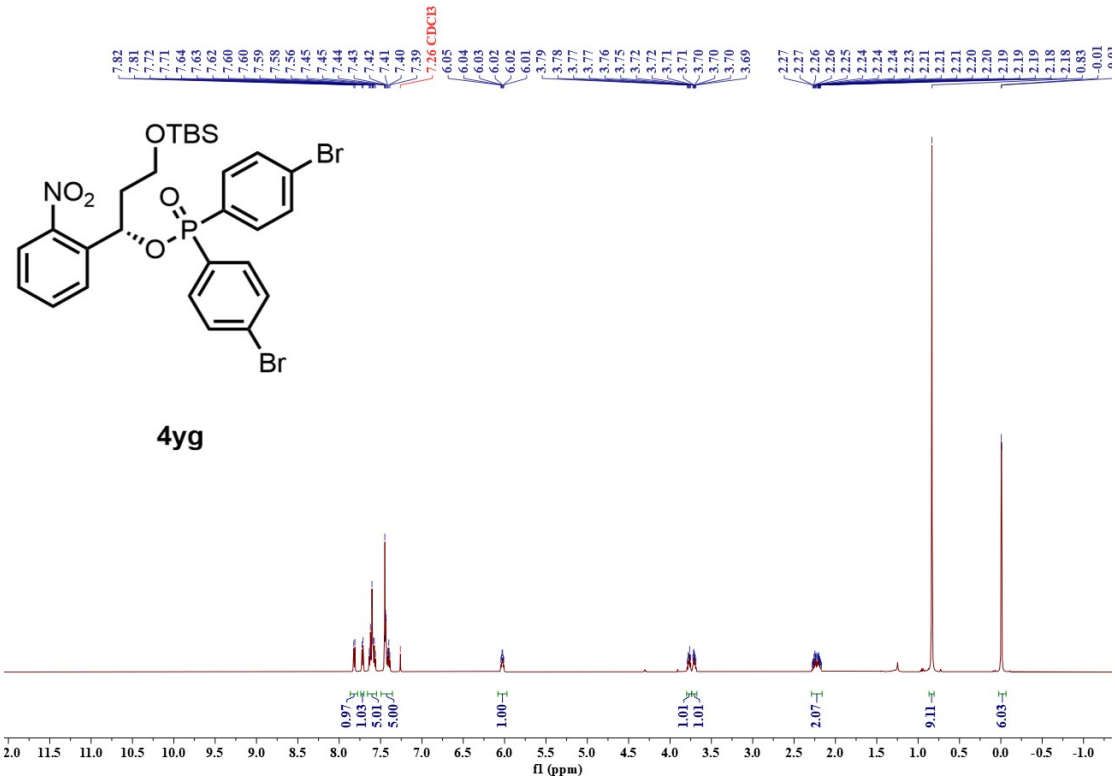
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 4xg



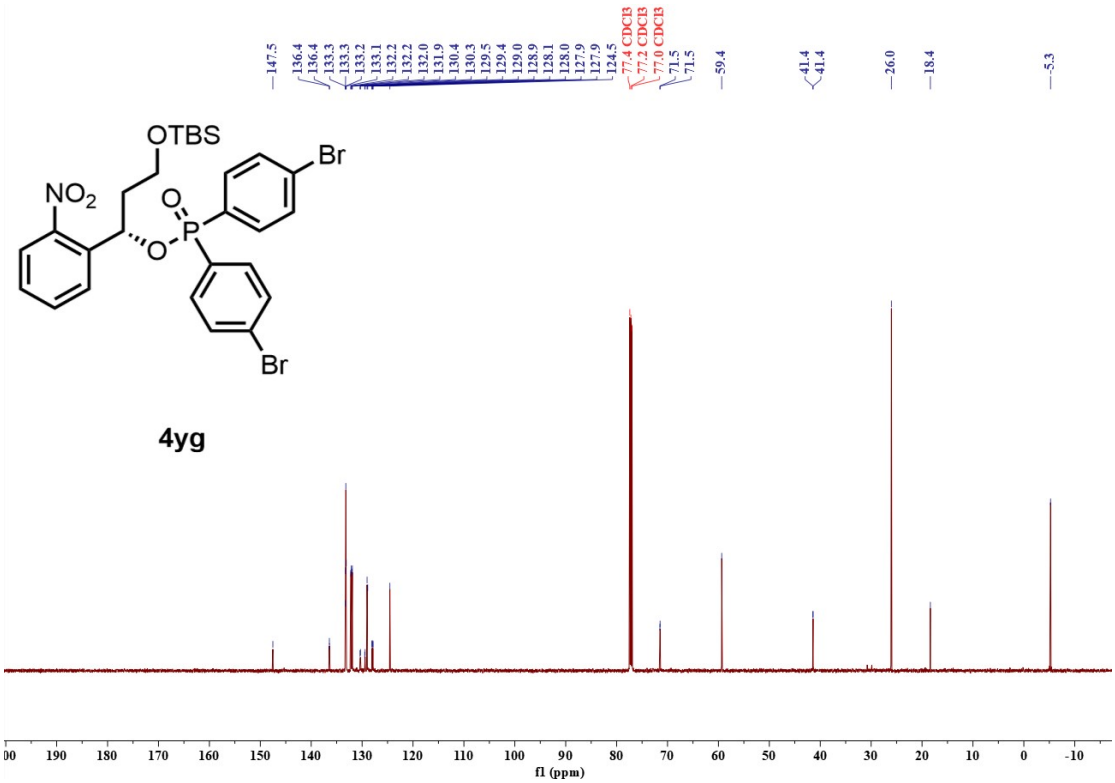
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 4xg



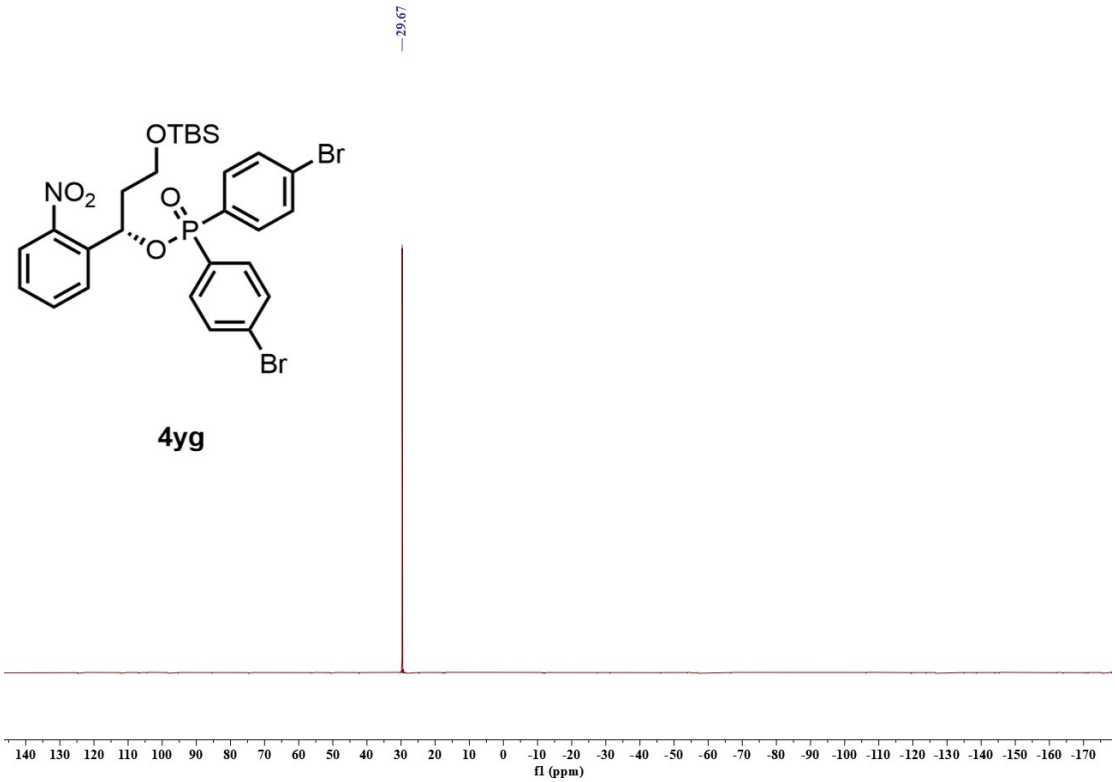
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 4yg



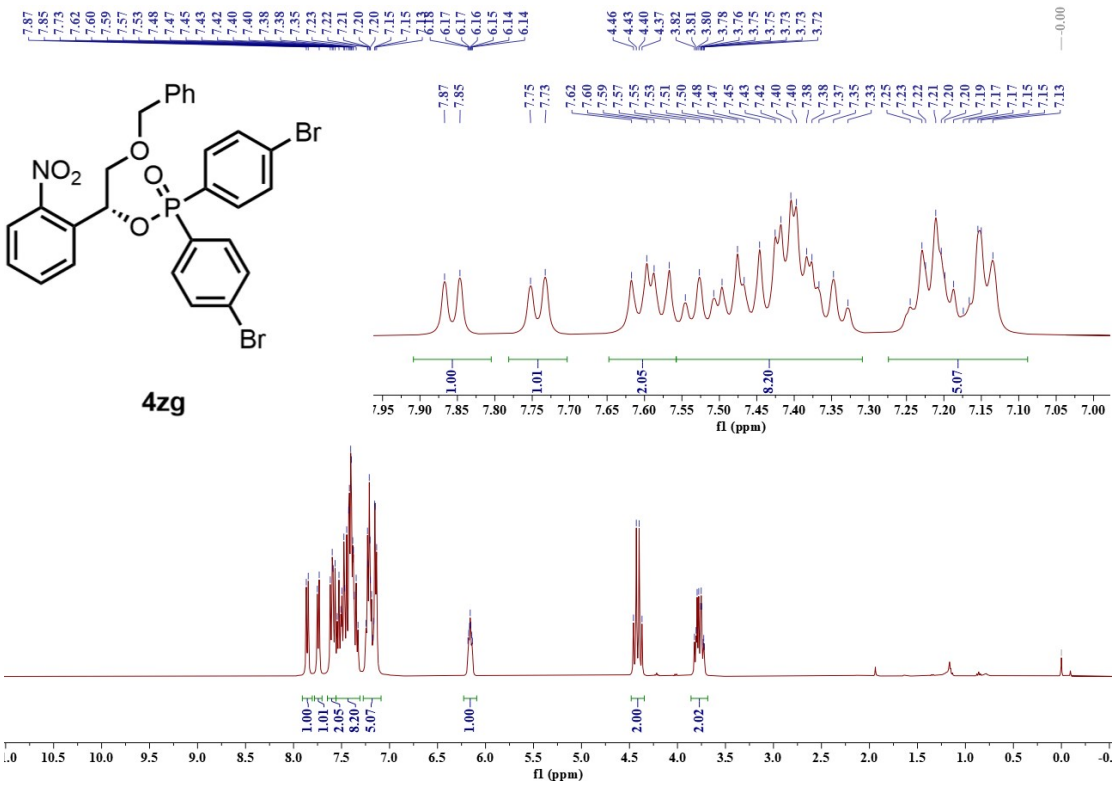
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 4yg



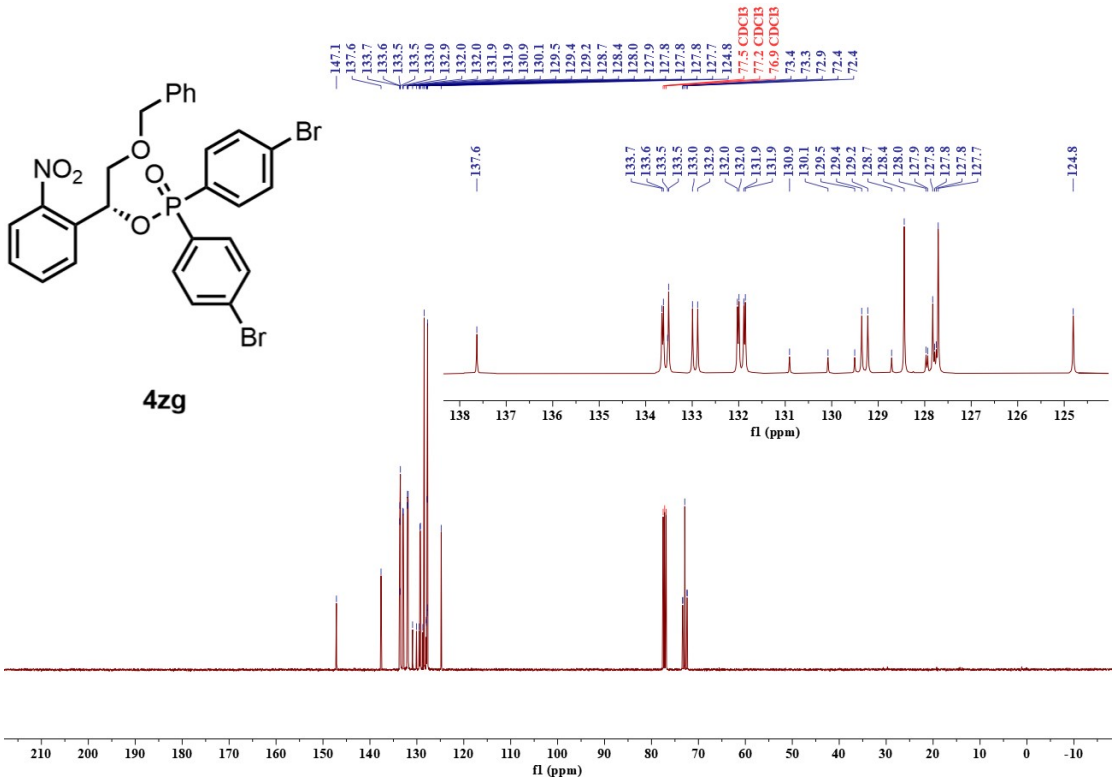
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 4yg



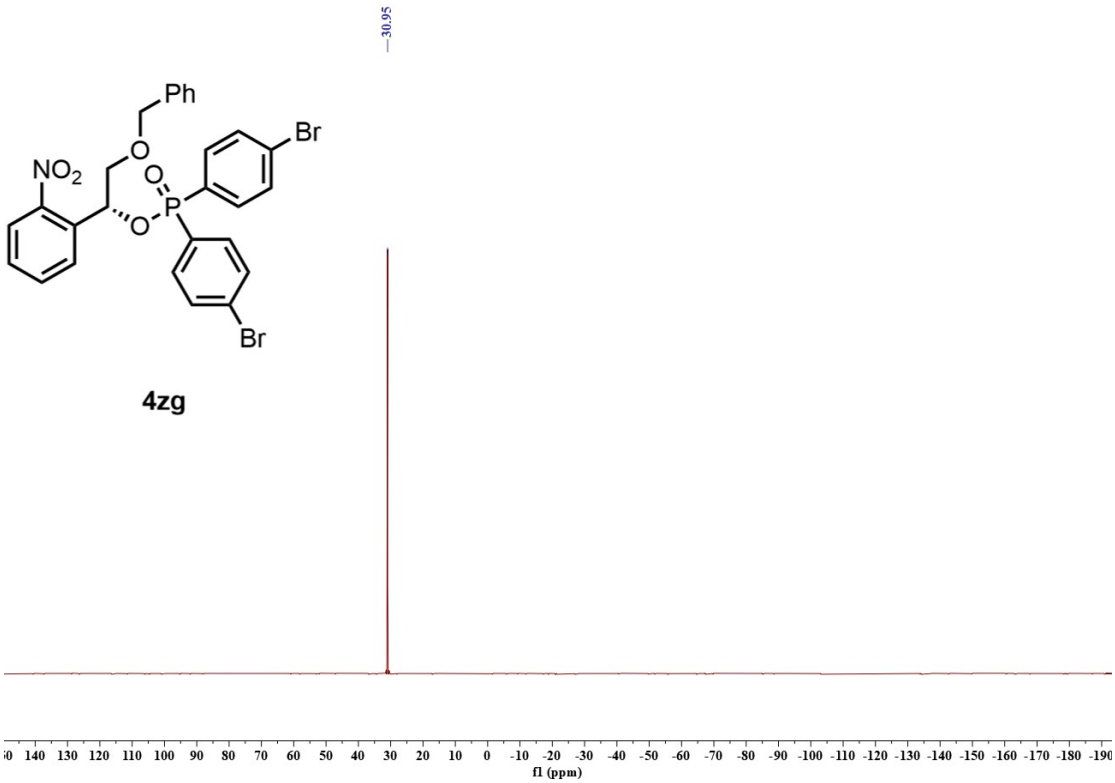
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4zg



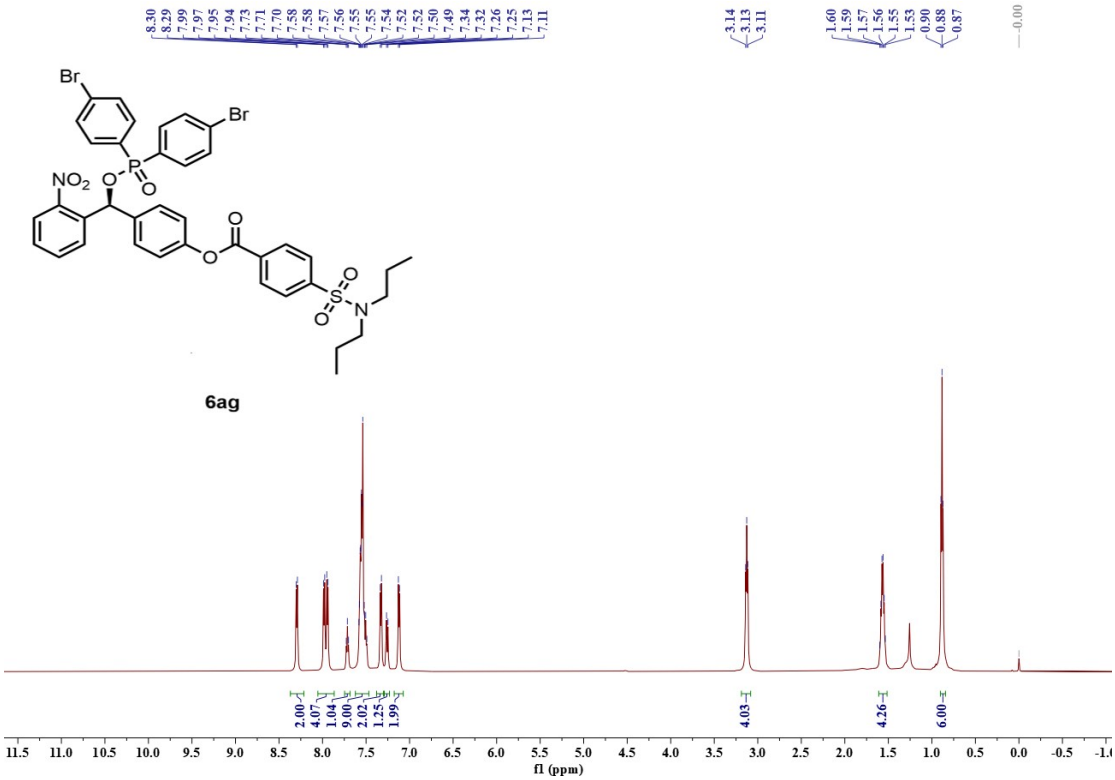
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 4zg



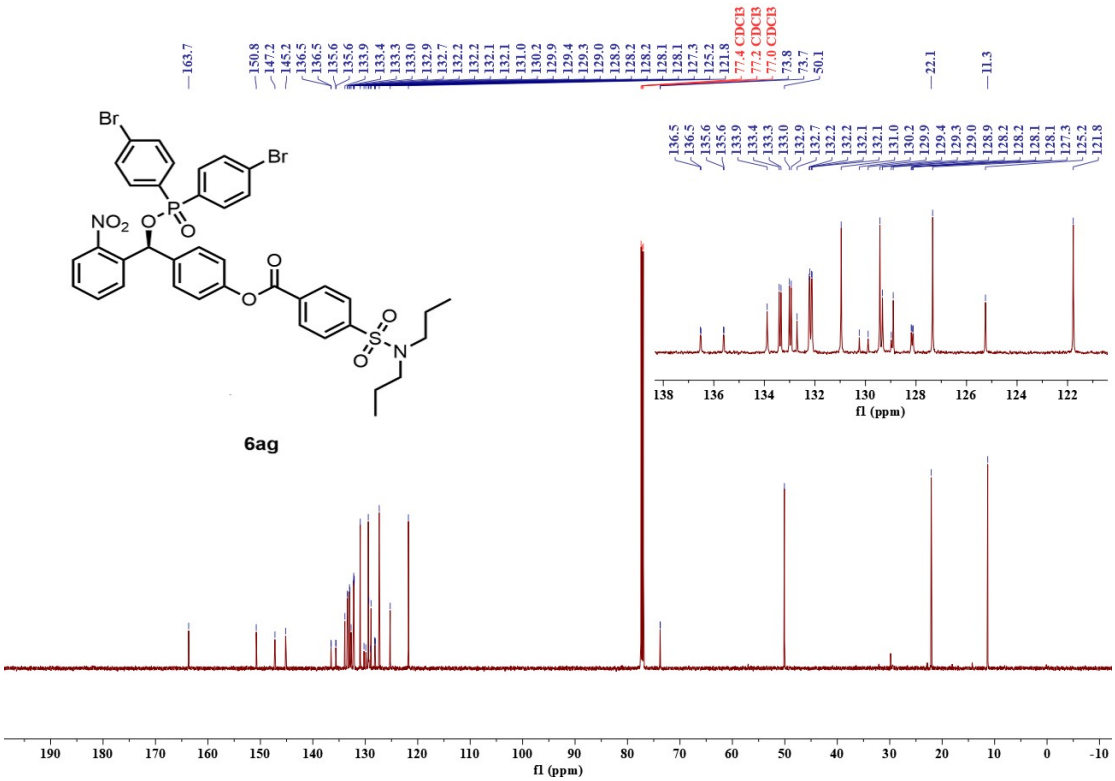
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 4zg



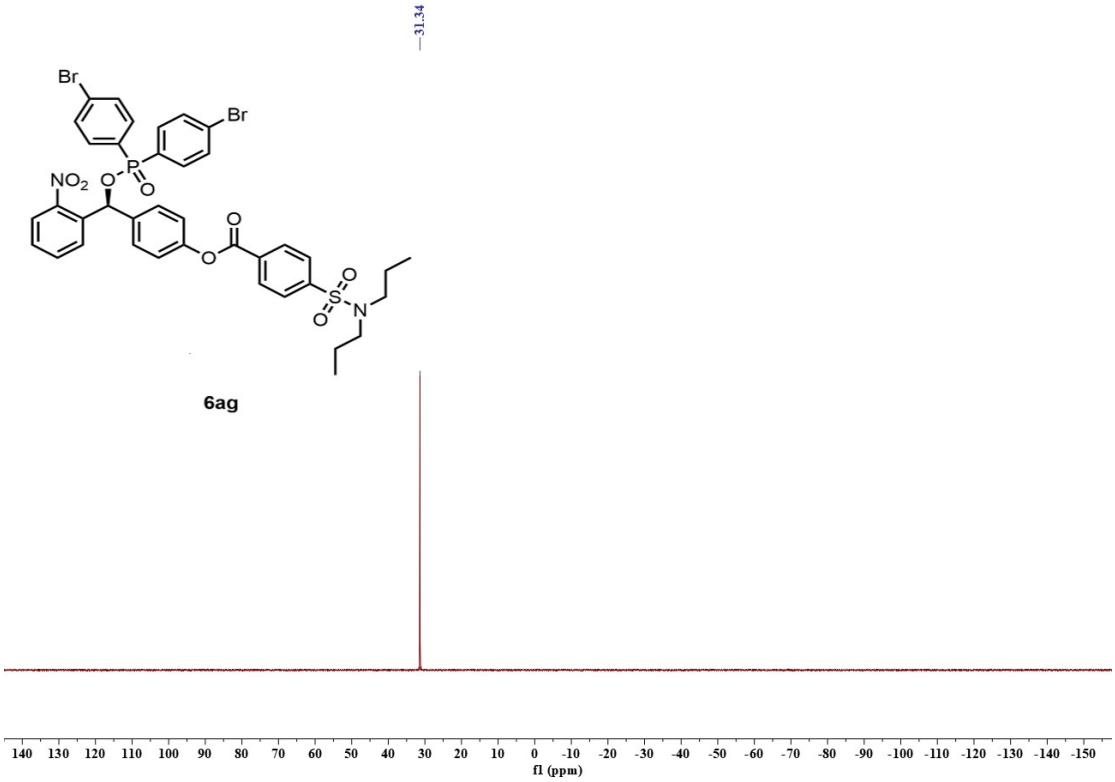
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 6ag



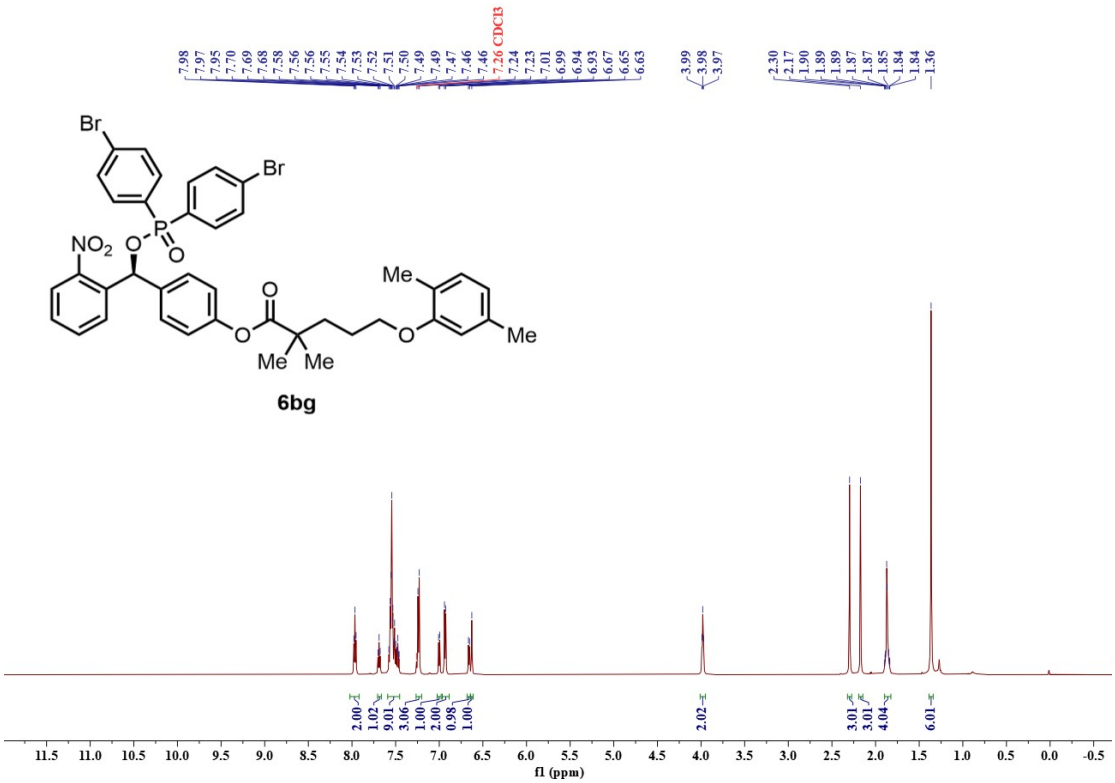
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 6ag



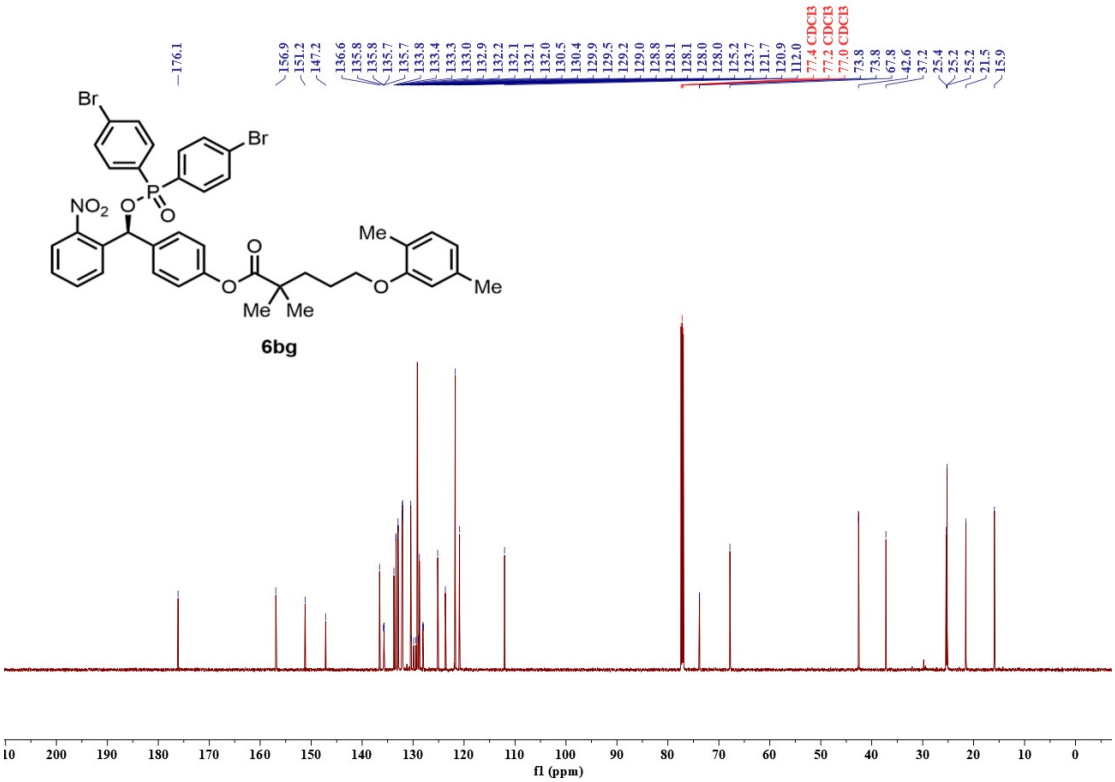
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 6ag



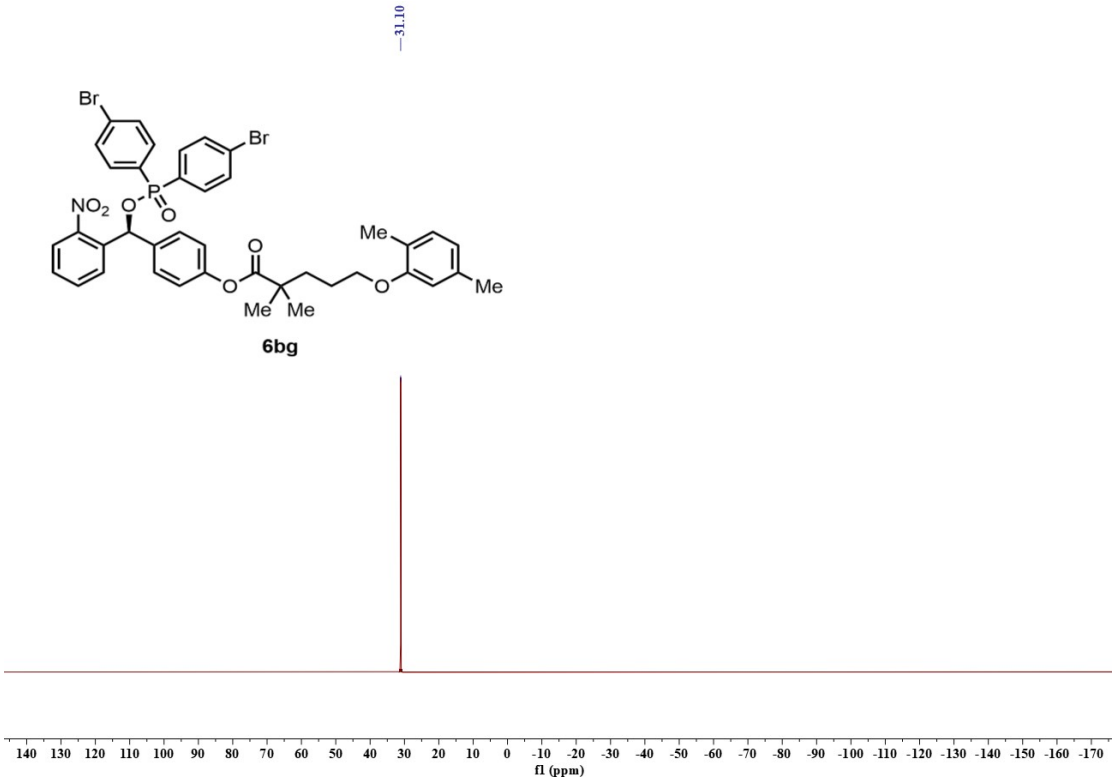
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 6bg



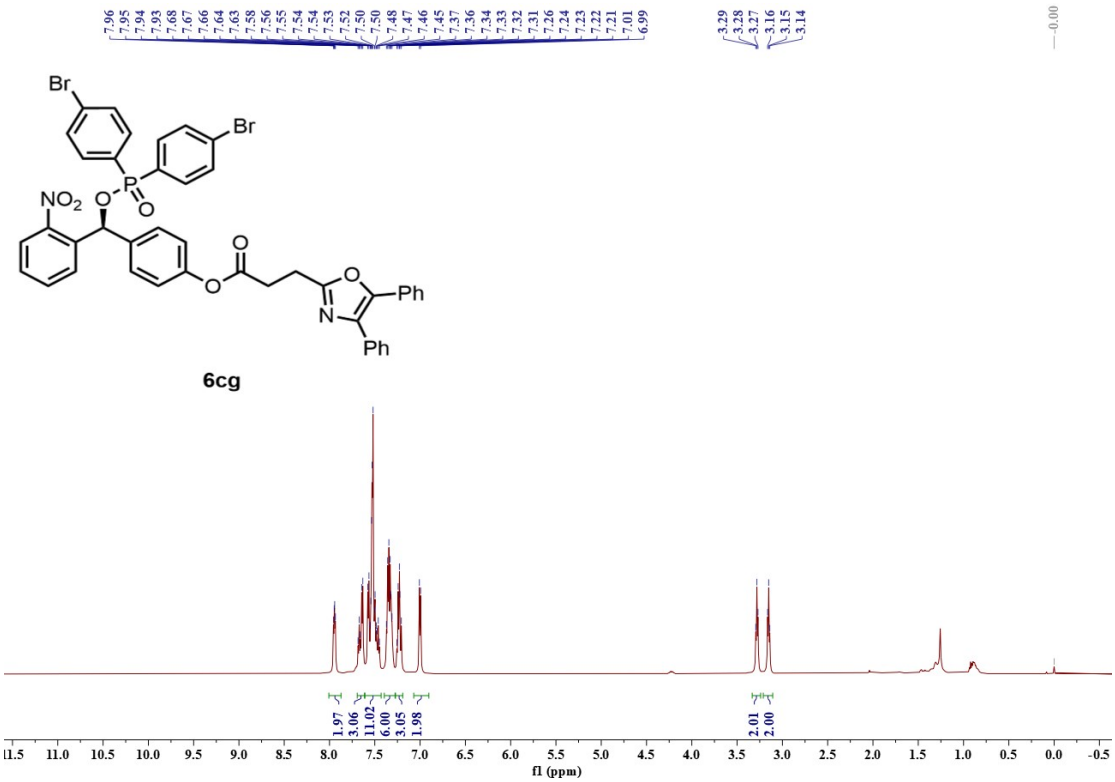
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 6bg



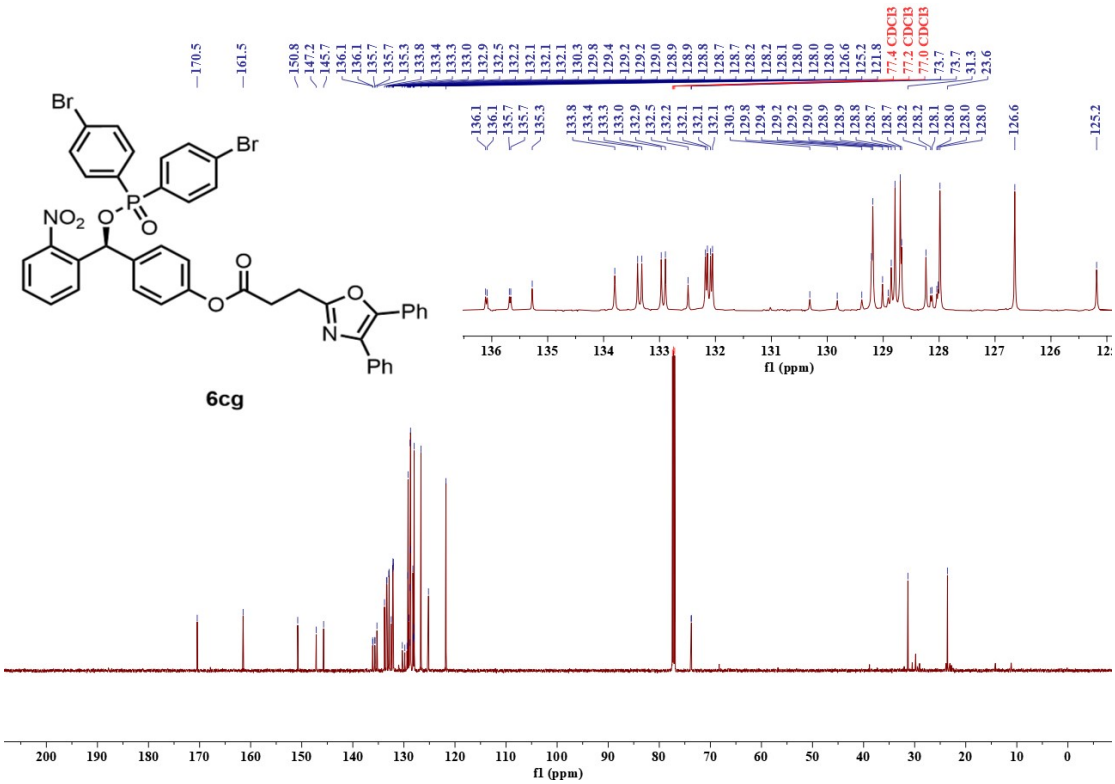
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 6bg



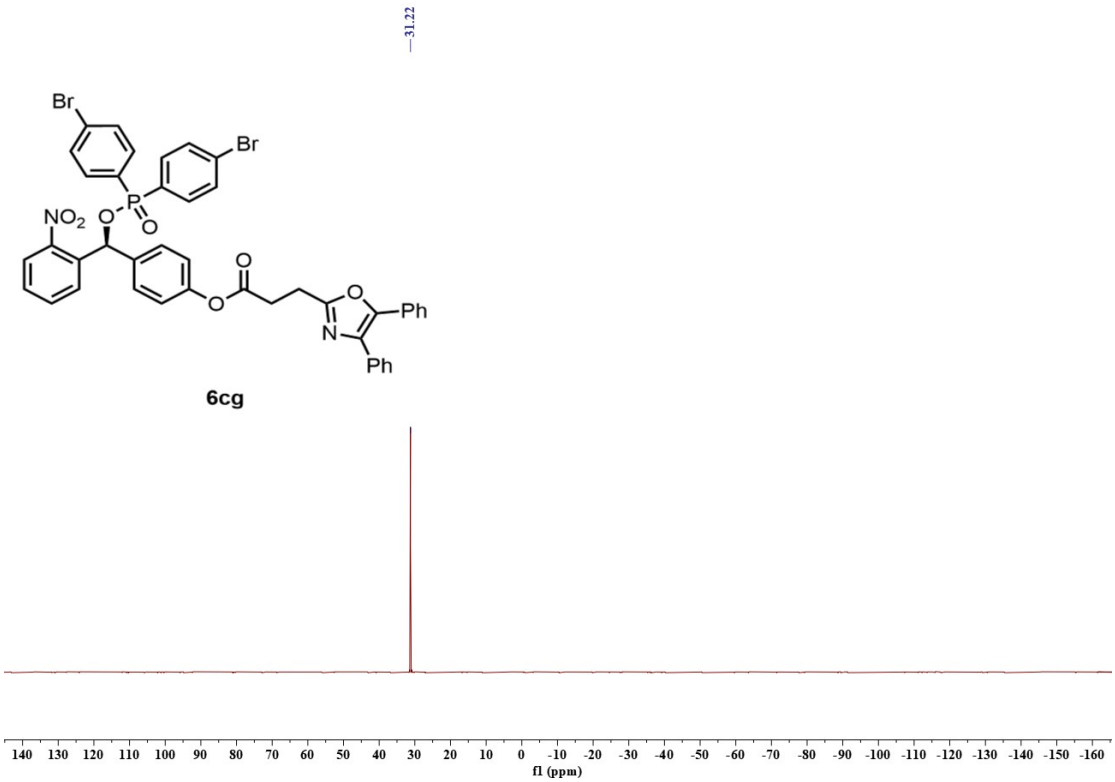
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 6cg



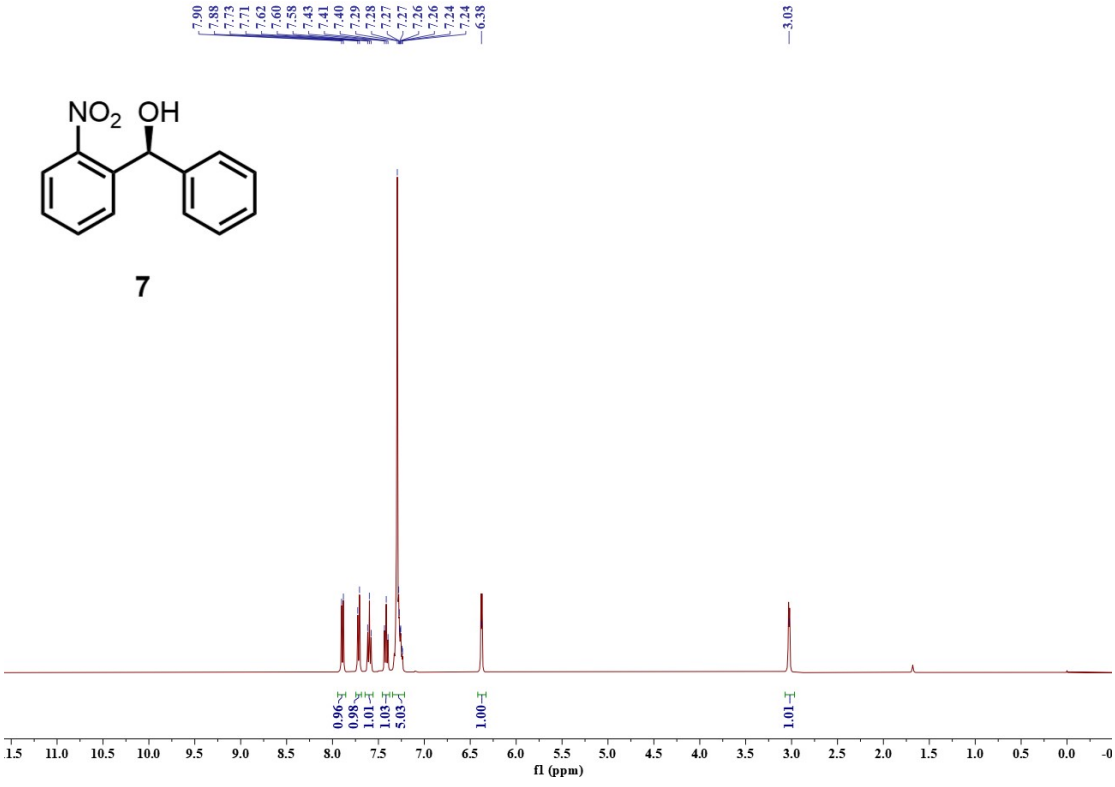
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 6cg



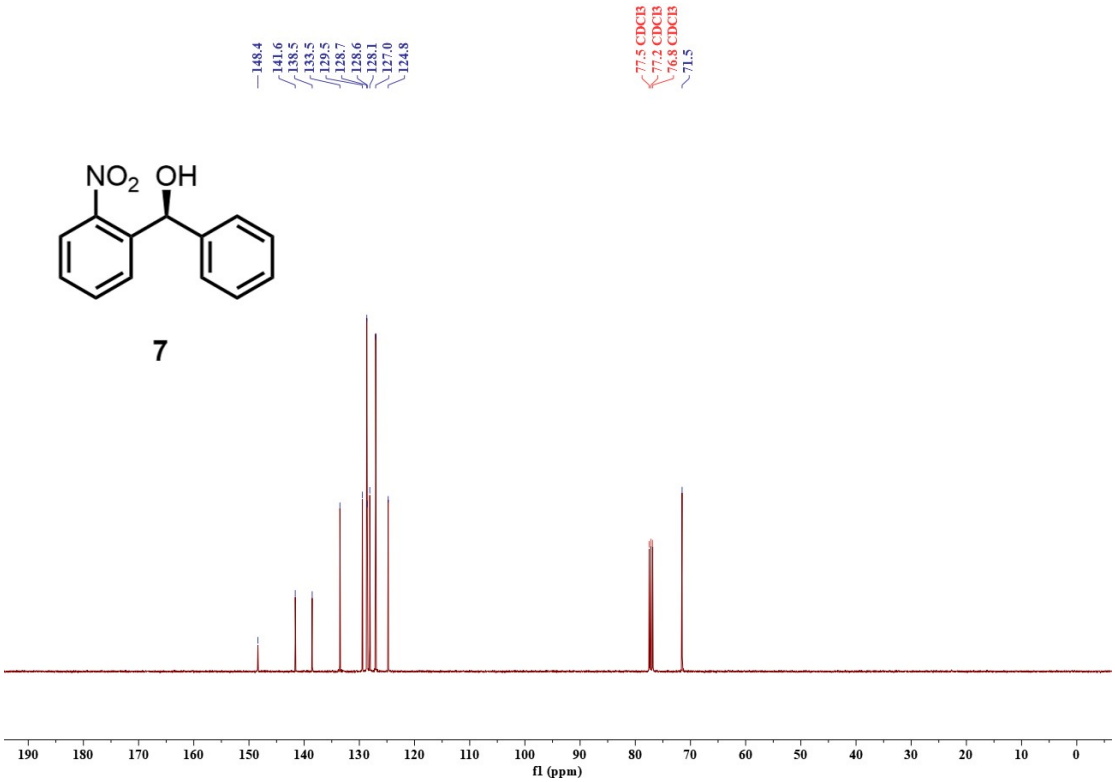
^{31}P NMR (243MHz, $CDCl_3$) spectrum for 6cg



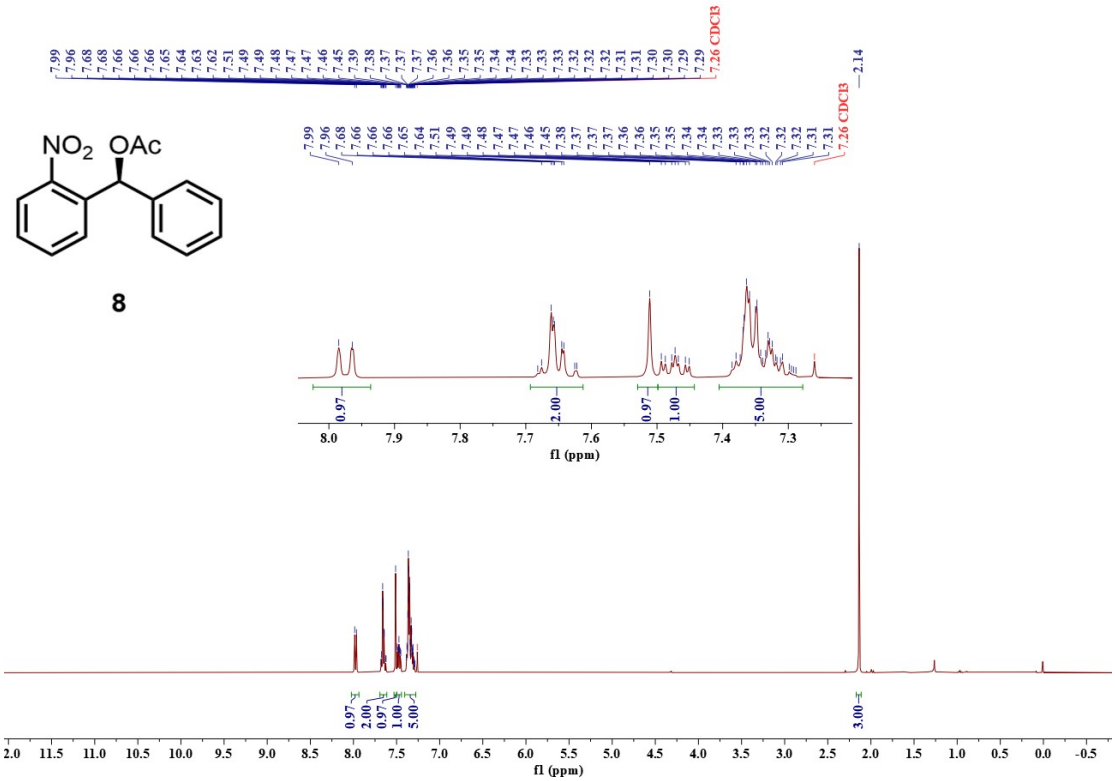
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 7



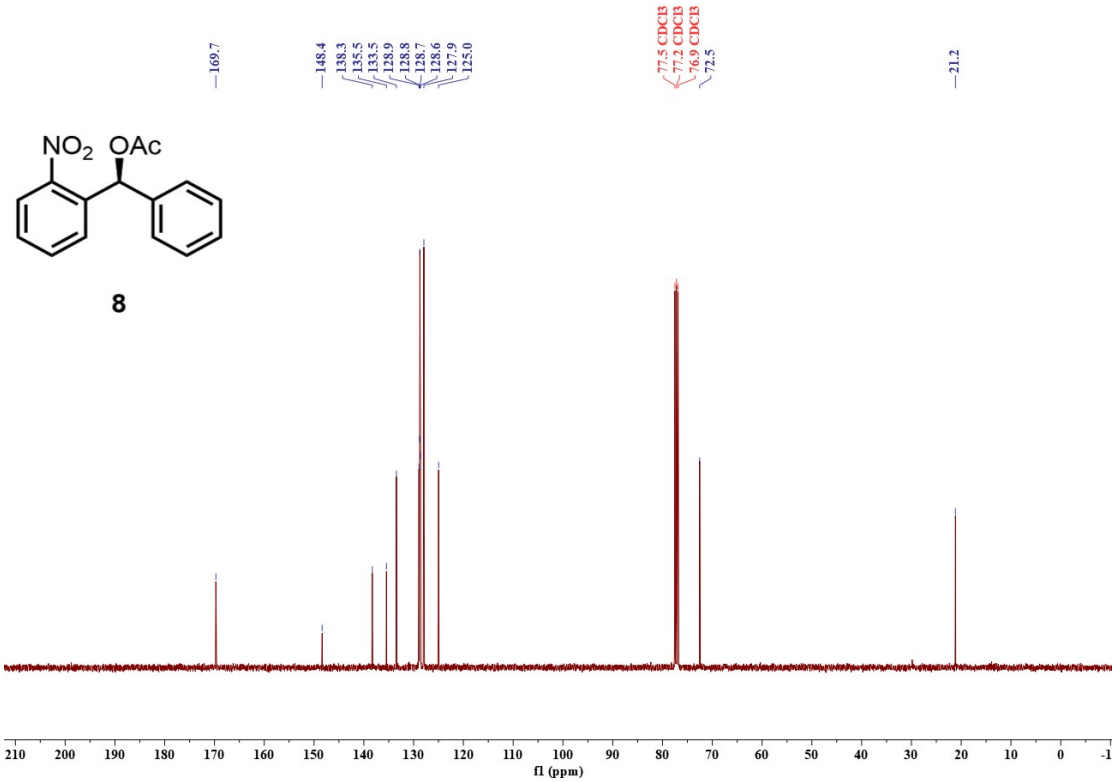
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 7



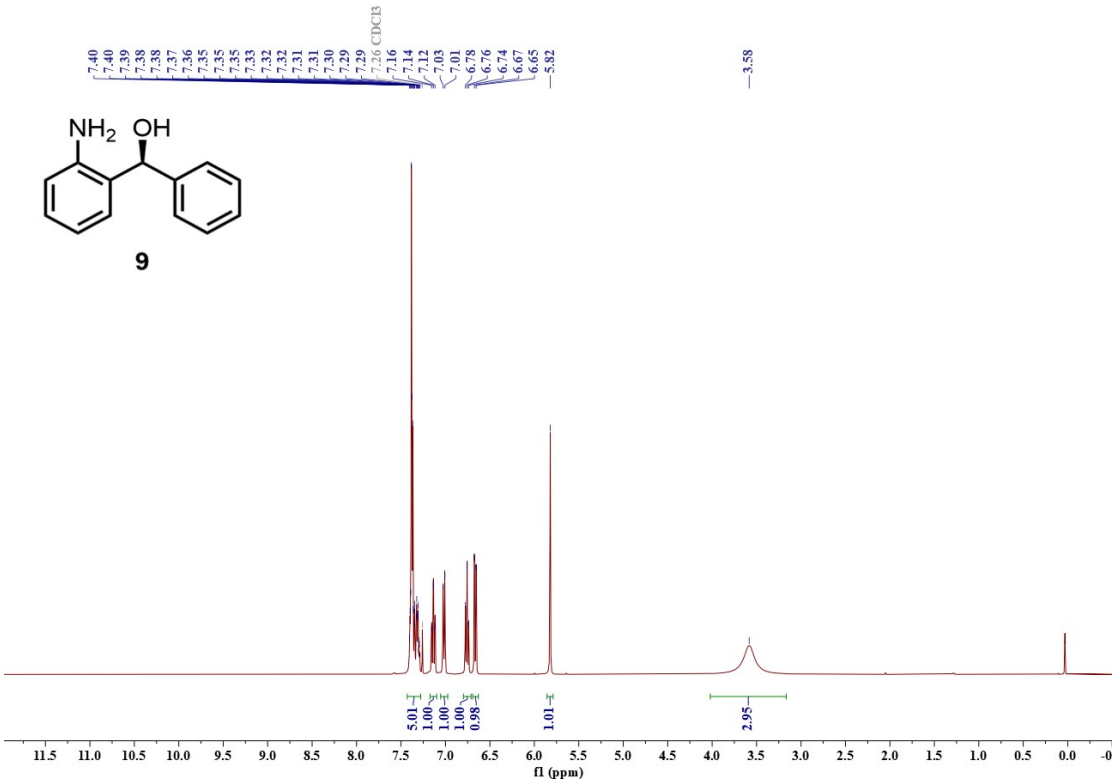
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 8



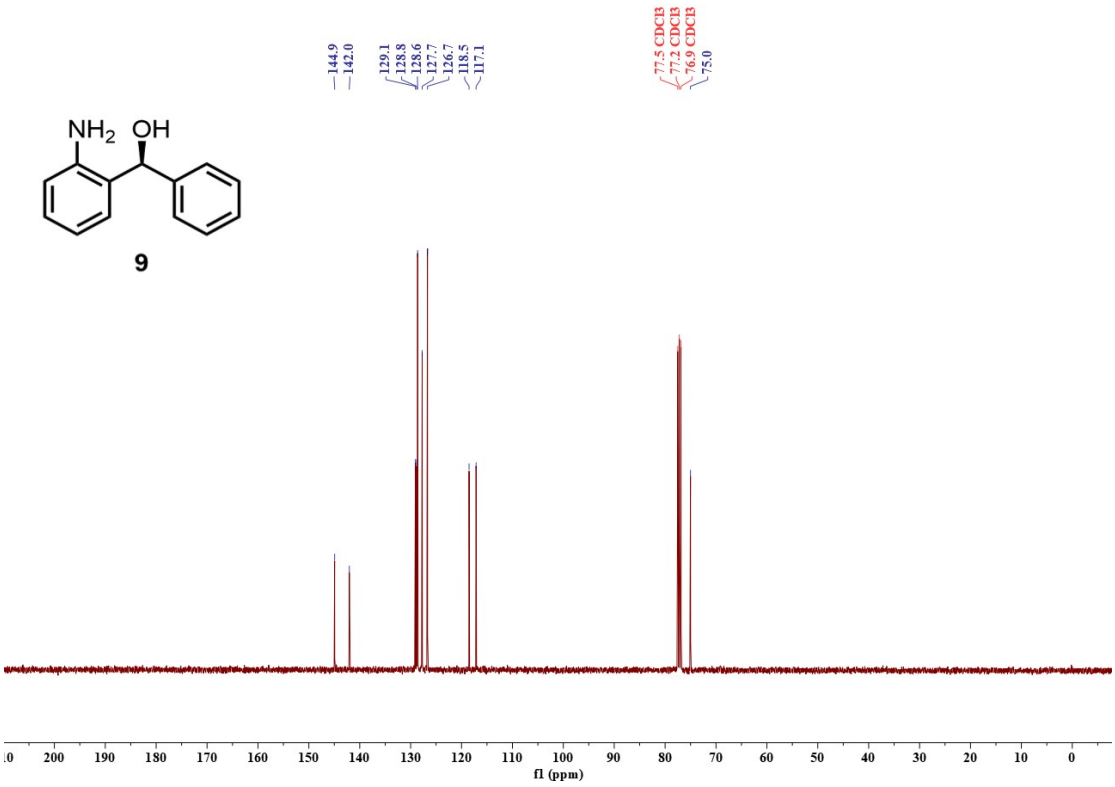
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 8



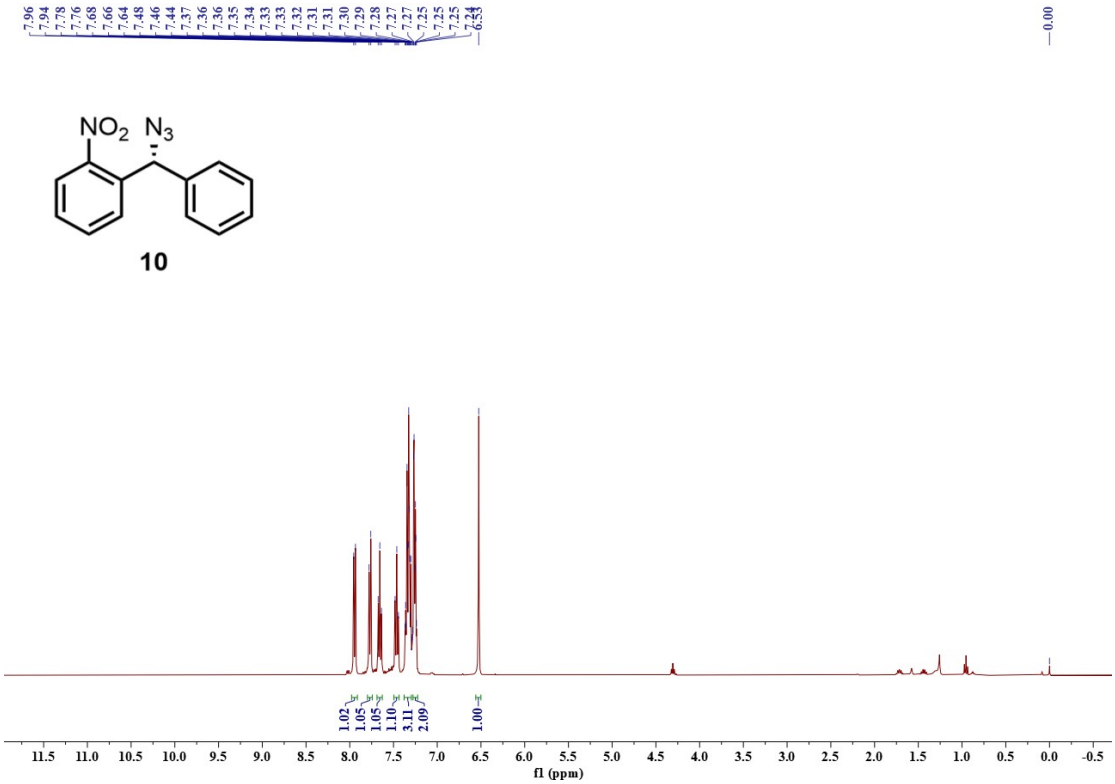
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 9



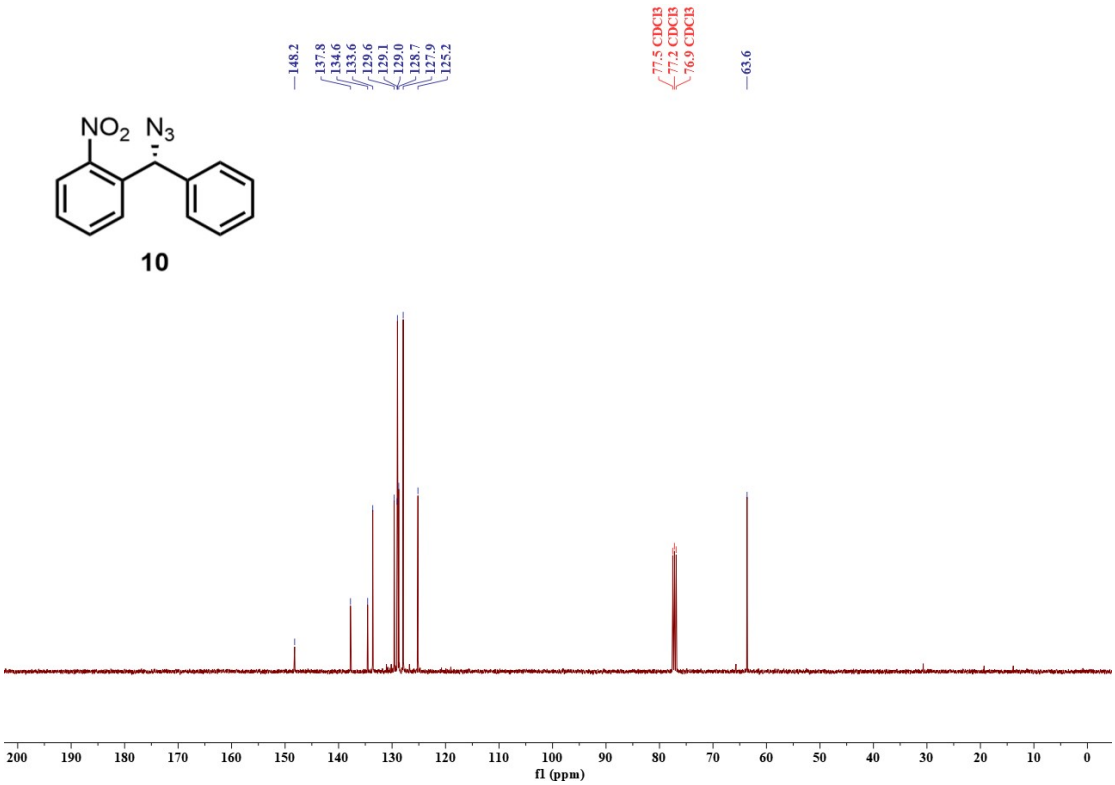
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 9



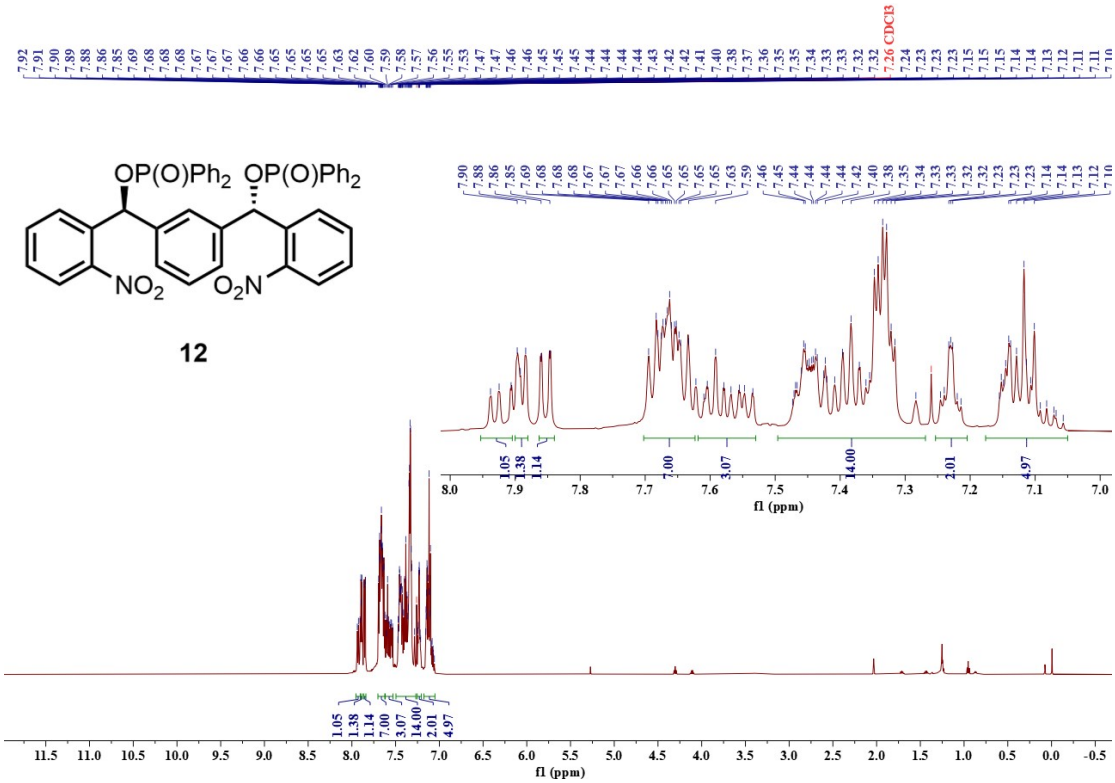
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 10



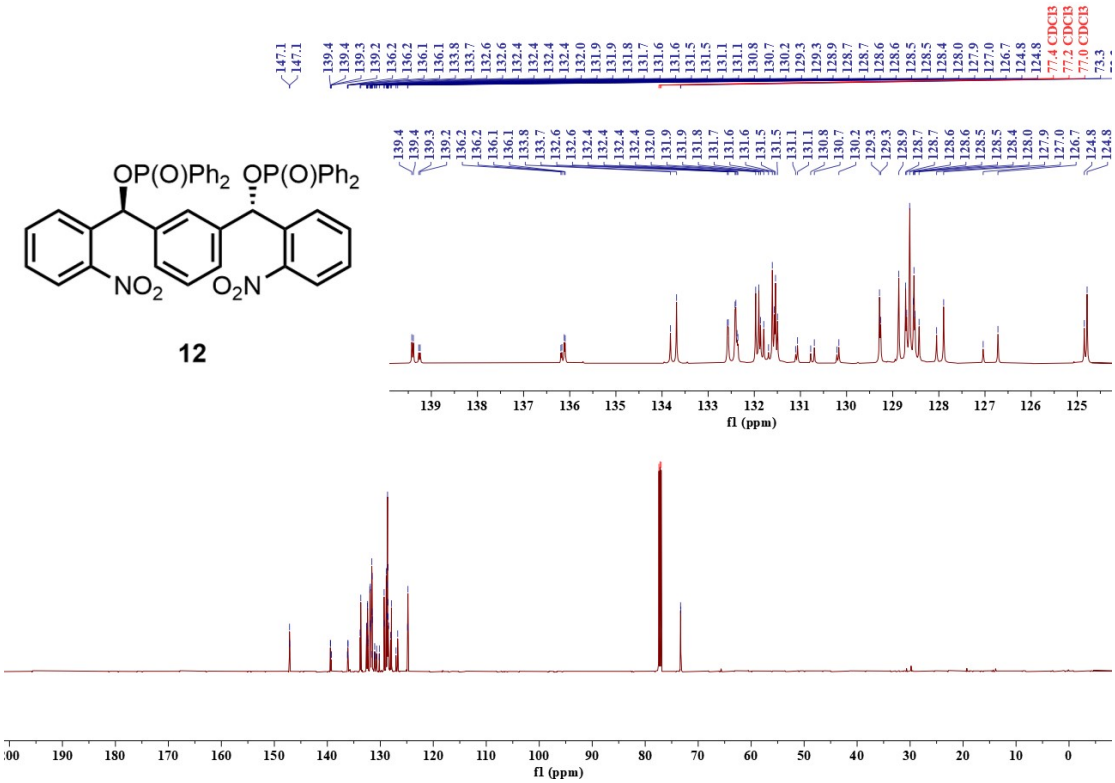
^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 10



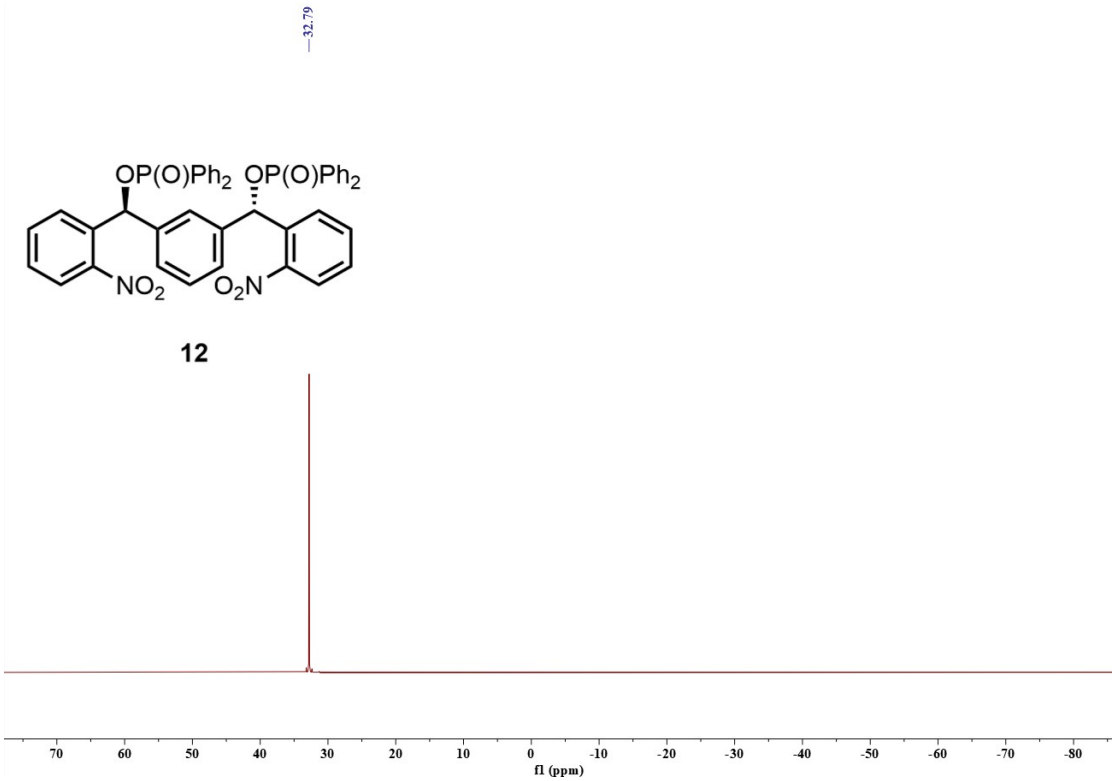
^{1}H NMR (600 MHz, $CDCl_3$) spectrum for 12



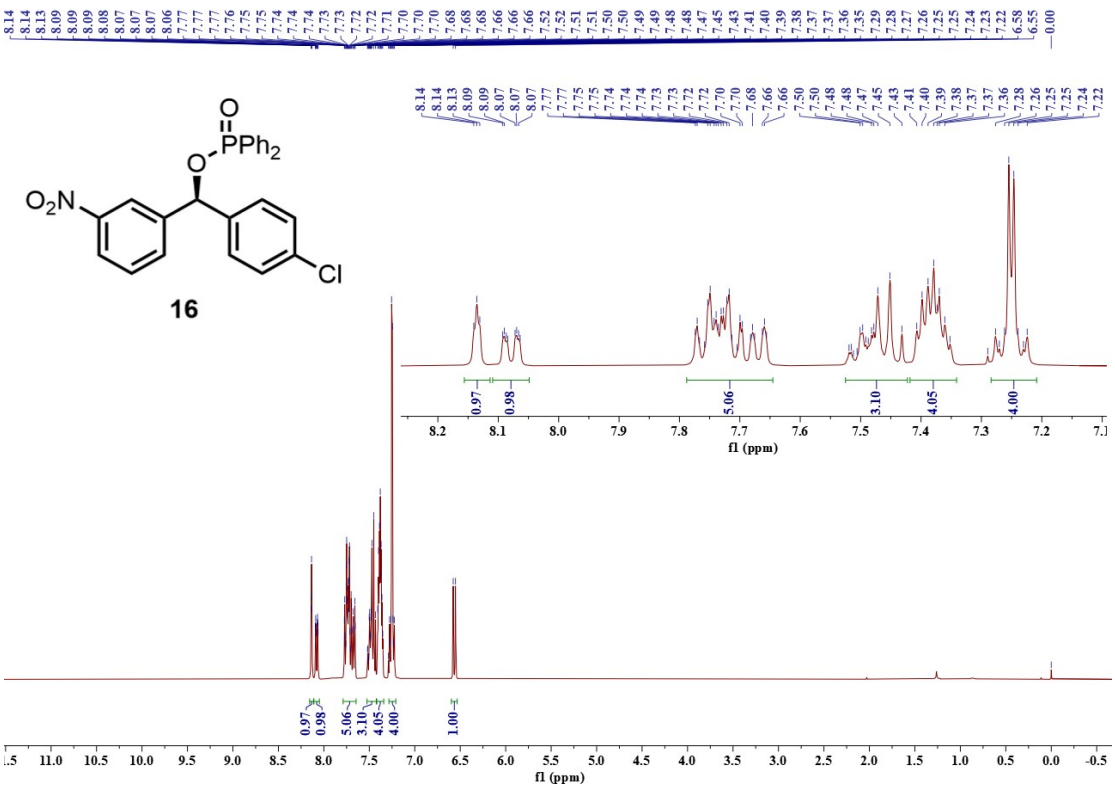
^{13}C NMR (151 MHz, $CDCl_3$) spectrum for 12



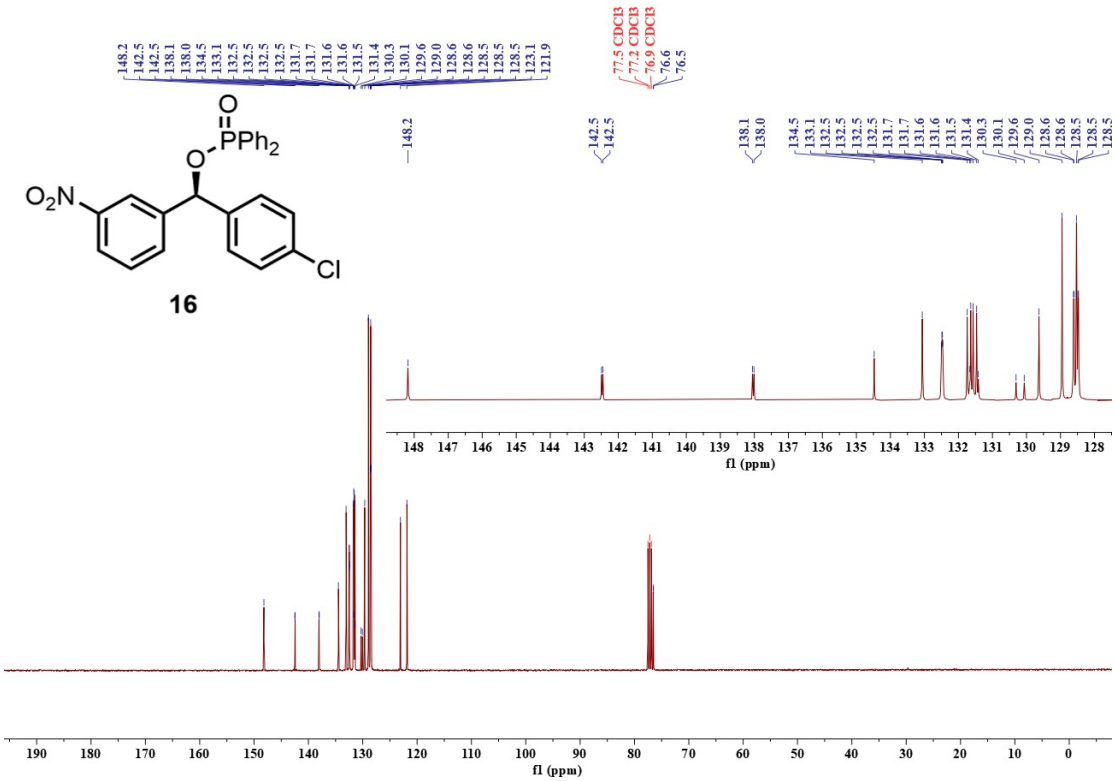
^{31}P NMR (162MHz, $CDCl_3$) spectrum for 12



^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 16



^{13}C NMR (101 MHz, $CDCl_3$) spectrum for 16



^{31}P NMR (162MHz, $CDCl_3$) spectrum for 16