SUPPORTING INFORMATION

Palladium-Catalyzed α-Arylation of Benzylic Phosphine Oxides

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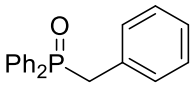
1. General Methods.

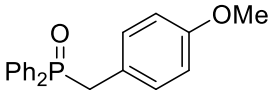
All cross coupling reactions were conducted under an inert atmosphere of dry nitrogen. Anhydrous CPME and dioxane were purchased from Sigma-Aldrich and used without further purification. Toluene and THF were dried through activated alumina columns. Unless otherwise stated, reagents were commercially available and used as received without further purification. Chemicals were purchased from Sigma-Aldrich, Acros, or Matrix Scientific and solvents were obtained from Fisher Scientific. Flash chromatography was performed with Silica gel (230–400 mesh, Silicycle). NMR spectra were obtained using a Brüker 500 MHz Fourier-transform NMR spectrometer. Chemical shifts are reported in units of parts per million (ppm) downfield from tetramethylsilane (TMS), and all coupling constants are reported in hertz. The infrared spectra were obtained with KBr plates using a Perkin-Elmer Spectrum 1600 Series spectrometer. High resolution mass spectrometry (HRMS) data were obtained on a Waters LC-TOF mass spectrometer (model LCT-XE Premier) using electrospray ionization (ESI) in positive or negative mode, depending on the analyte. Melting points were determined on a Unimelt Thomas-Hoover melting point apparatus and are uncorrected.

2. Preparation of the benzylic phosphine oxides

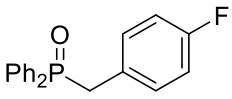
General Procedure for the synthesis of benzylic phosphine oxides: To a suspension of sodium hydride (95% in oil) (187 mg, 7.42 mmol) in THF (24 mL) at 0°C was added diphenylphosphine oxide (1 g, 4.95 mmol) under nitrogen. The mixture was stirred for 10 min. The benzyl bromide or chloride derivative (5.44 mmol) was then added and the mixture was stirred at room temperature for 5 h. Water was added (10 mL) to quench the reaction and the organic layer was extracted with ethyl acetate (40 mL) three times, dried over $MgSO_4$ and the volatile materials removed under reduced pressure. The crude product was purified by flash chromatography on silica gel to give the product as a solid.



Benzyldiphenylphosphine oxide 1a: The reaction was performed following the general procedure with benzyl chloride (0.63 mL, 5.44 mmol)**.** The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:hexanes = 90:10) to give the product (1.26 g, 90% yield) as a white solid. The spectroscopic data match the previously reported data.[1a,b]

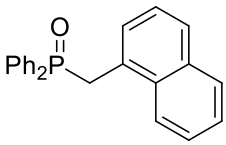


(4-Methoxybenzyl)diphenylphosphine oxide 1b: The reaction was performed following the general procedure with 1-(chloromethyl)-4-methoxybenzene (0.74 mL, 5.44 mmol)**.** The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 30:70 to EtOAc 100%) to give the product (1.29 g, 81% yield) as a withe solid. The spectroscopic data match the previously reported data.[1b]

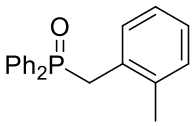


(4-Fluorobenzyl)diphenylphosphine oxide 1c: The reaction was performed following the general procedure with 1-(chloromethyl)-4-fluorobenzene (0.68 mL, 5.44 mmol)**.** The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 30:70 to EtOAc 100%) to give the product (1.40 g, 83% yield) as a yellow solid. The spectroscopic data match the previously reported data.[1b]

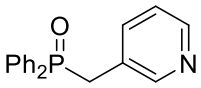
[1] (a) Miao, W.; Gao, Y.; Li, X.; Gao, Y.; Tang, G.; Zhao, Y. *Adv. Synth. Catal.* **2012**, *354*, 2659. (b) Wu, L.; Chen, Q.-Q.; Wu, L.; Zhang, X.; Zhou, A.-K. *Org. Biomol. Chem.* **2012**, *10*, 7859.



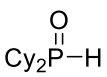
(Naphtalen-1-ylmethyl)diphenylphosphine oxide 1d: The reaction was performed following the general procedure with 1-(chloromethyl)naphtalene (0.81 mL, 5.44 mmol)**.** The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 30:70 to EtOAc 100%) to give the product (1.46 g, 86% yield) as a white solid. m.p. = 166–168 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.93 (d, *J* = 8.2 Hz, 1H), 7.76 (d, *J* = 7.8 Hz, 1H), 7.73 – 7.64 (m, 5H), 7.46 – 7.44 (m, 2H), 7.42 – 7.35 (m, 6H), 7.32 – 7.22 (m, 2H), 4.11 (d, *J* = 14.0 Hz, 2H) ppm ; ^{31}P{^{1}H} NMR (121 MHz, $CDCl_3$) : δ 29.42 (s) ppm ; ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$): 133.8, 132.5 (d, *J* = 4.3 Hz), 132.5 (d, *J* = 98.8 Hz), 131.8, 131.3 (d, *J* = 9.1 Hz), 128.7 (d, *J* = 6.0 Hz), 128.5 (d, *J* = 11.3 Hz), 127.8 (d, *J* = 8.3 Hz), 127.7 (d, *J* = 2.7 Hz), 125.9, 125.6, 125.2, 125.1, 124.3, 34.9 (d, *J* = 66.8 Hz) ppm; IR (thin film) : 3052, 2936, 1642, 1595, 1510, 1437, 1396, 1191, 1117, 1103, 797, 777, 742, 725, 695, 636, 595, 550, 521, 511, 486 cm^{-1}; HRMS calculated for $C_{23}H_{20}OP$ 343.1252, found 343.1256 $[M+H]^+$.



(2-Methylbenzyl)diphenylphosphine oxide 1e: The reaction was performed following the general procedure with 1-(chloromethyl)-2-methylbenzene (0.72 mL, 5.44 mmol)**.** The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 30:70 to EtOAc 100%) to give the product (1.07 g, 71% yield) as a withe solid. The spectroscopic data match the previously reported data.[2]



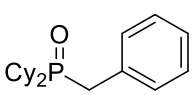
(Pyridine-3-ylmethyl)diphenylphosphine oxide 1f: The reaction was performed following the general procedure with 3-(chloromethyl)pyridine hydrochloride (812 mg, 5.44 mmol) and 2.5 equiv. of sodium hydride**.** The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:*i*PrOH = 95:5) to give the product (798 mg, 55% yield) as a pale yellow solid. m.p. = 212–214 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.38 (s, 1H), 8.19 (s, 1H), 7.82 – 7.55 (m, 5H), 7.58 – 7.38 (m, 6H), 7.12 (s, 1H), 3.59 (d, *J* = 13.3 Hz, 2H) ppm ; ^{31}P{^{1}H} NMR (300 MHz, $CDCl_3$) : δ 29.19 (s) ppm ; ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$): 150.5 (d, *J* = 6.0 Hz), 148.1, 137.5, 132.0 (d, *J* = 2.5 Hz), 131.6 (d, *J* = 100.2 Hz), 130.9 (d, *J* = 9.2 Hz), 128.6 (d, *J* = 11.8 Hz), 127.3 (d, *J* = 7.2 Hz), 123.2, 35.1 (d, *J* = 66.0 Hz) ppm; IR (thin film) : 3053, 2939, 2885, 1572, 1479, 1435, 1424, 1180, 1136, 1118, 1068, 1027, 850, 805, 734, 721, 714, 693, 600, 564, 528, 510, 503 cm^{-1}; HRMS calculated for C18H17NOP 294.1048, found 294.1046 $[M+H]^+$.



Dicyclohexylphosphine oxide: In a 2-necked flask under nitrogen was added cyclohexyl magnesium bromide 1M in THF (7.17 mL, 71.69 mmol). The solution was cooled to 0°C. A solution of diethylphosphite (2.8 mL, 21.72 mmol) in 7 mL of THF was added dropwise via syringe. The mixture was stirred for 15 min at 0°C, and then the bath was removed and the mixture stirred an additional 2 h at room temperature. Next, the reaction was cooled to 0 °C. HCl (1N, 54 mL) was added dropwise to quench the reaction. The organic layer was extracted with ethyl acetate (3 X 70 mL), dried over $MgSO_4$ and the volatile materials removed under reduced pressure. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:*i*PrOH = 90:10) to give

[2] Bew, S. P.; Brimage, R. A.; Hughes, D. L.; Legentil, L.; Sharma, S. V.; Wilson, M. A. *J. Org. Chem.* **2007**, *72*, 2655.

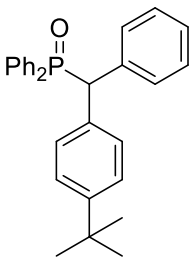
the product (2.8 g, 60% yield) as a withe solid. The spectroscopic data match the previously reported data.[3]



Benzyl dicyclohexylphosphine oxide 1g: To a suspension of sodium hydride 95% in oil (175 mg, 7.00 mmol) in THF (25 mL) at 0°C was added dicyclohexylphosphine oxide (1 g, 4.67 mmol) under nitrogen. The mixture was stirred for 10 min. Next, benzyl bromide (0.6 mL, 5.13 mmol) was added and the mixture was stirred at reflux for 6 h. Water (10 mL) was added to quench the reaction and the organic layer was extracted with ethyl acetate (3 X 30 mL), dried over $MgSO_4$ and evaporated under vacuum. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:*i*PrOH = 90:10) to give the product (795 mg, 56% yield) as a white solid. m.p. = 149–152 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.55 – 7.07 (m, 5H), 3.08 (d, *J* = 12.7 Hz, 2H), 2.12 – 1.57 (m, 12H), 1.46 – 0.98 (m, 10H) ppm ; ^{31}P{^{1}H} NMR (121 MHz, $CDCl_3$) : δ 48.19 (s) ppm ; ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$): 132.9 (d, *J* = 7.0 Hz), 129.7 (d, *J* = 4.9 Hz), 128.5 (d, *J* = 1.9 Hz), 126.5 (d, *J* = 2.3 Hz), 36.2 (d, *J* = 63.7 Hz), 32.1 (d, *J* = 55.6 Hz), 26.5 (d, *J* = 12.1 Hz), 26.5 (d, *J* = 12.1 Hz), 25.9 (d, *J* = 0.9 Hz), 25.7 (d, *J* = 12.8 Hz), 25.7 (d, *J* = 12.8 Hz) ppm; IR (thin film) : 3059, 3032, 2925, 2850, 1601, 1494, 1447, 1275, 1214, 1168, 1134, 1115, 917, 896, 889, 855, 774, 756, 733, 699, 525, 516 cm^{-1}; HRMS calculated for $C_{19}H_{30}OP$ 305.2034, found 305.2035 $[M+H]^+$.

3. Procedure and Characterization for Pd-Catalyzed Arylation of benzyldiphenylphosphine oxides

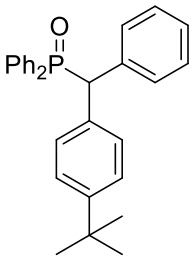
To an oven-dried microwave vial equipped with a stirbar was added $Pd(OAc)_2$ (2.2 mg, 0.01 mmol) and Xantphos (12 mg, 0.02 mmol) under a nitrogen atmosphere followed by 1.0 mL CPME. After the catalyst/ligand solution was stirred for 2 h at 24 °C, NaO*t*Bu (38 mg, 0.40 mmol, 2 equiv) or NaH (95% in oil) (10 mg, 0.40 mmol, 2 equiv) was added to the reaction vial followed by benzyldiphenylphosphine oxide (58 mg, 0.2 mmol, 1.0 equiv). The microwave vial was sealed and arylbromide (0.4 mmol, 2.0 equiv) was added by syringe under a nitrogen atmosphere. Note that if the aryl bromide was a solid, it was added to the reaction vial before the base. The reaction mixture was heated to 110 °C by oil bath and stirred for the expected period of time. The sealed vial was cooled to room temperature, opened to air, and the reaction mixture was passed through a short pad of silica gel. The pad was rinsed with 10:1 dichloromethane:methanol (10 mL). The solvent was removed under reduced pressure to yield a solid. The residue was purified by flash chromatography as outlined below.



((4-(*tert*-Butyl)phenyl)(phenyl)methyl)diphenylphosphine oxide 3a: The reaction was performed following the general procedure with **1a** (58 mg, 0.2 mmol), **2a** (69 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) in 2 mL of dry CPME. The mixture was then heated at 110°C for 16 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 5:95) to give the product (76 mg, 90% yield) as a white solid. R*f* = 0.7 (EtOAc:DCM = 10 : 90) ; m.p. = 295–297 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.65 – 7.55 (m, 4H), 7.51 (d, *J* = 8.1 Hz, 2H),

[3] Busacca, C. A.; Lorenz, J. C.; Grinberg, N.; Haddad, N.; Hrapchak, M.; Latli, B.; Lee, H.; Sabila, P.; Saha, A.; Sarvestani, M.; Shen, S.; Varsolona, R.; Wei, X.; Senanayake, C. H. *Org. Lett.* **2005**, 7, 4277-4280.

7.38 – 7.36 (m, 4H), 7.31– 7.28 (m, 4H), 7.19 – 7.10 (m, 5H), 4.71 (d, *J* = 9.0 Hz, 1H), 1.22 (s, 9H) ppm ; $^{31}P\{^{1}H\}$ NMR (121 MHz, $CDCl_3$) : δ 31.20 (s) ppm ; $^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$): δ 149.8, 137.6 (d, *J* = 4.4 Hz), 133.9 (d, *J* = 4.7 Hz), 132.8 (d, *J* = 98.1 Hz), 132.7 (d, *J* = 97.6 Hz), 131.5 (d, *J* = 8.9 Hz), 129.9 (d, *J* = 6.8 Hz), 129.5 (d, *J* = 6.5 Hz), 128.6, 128.2 (d, *J* = 4.9 Hz), 128.1 (d, *J* = 4.9 Hz), 126.9, 125.5, 53.2 (d, *J* = 66.1 Hz), 34.5, 31.4 ppm; IR (thin film): 3056, 2963, 1597, 1509, 1494, 1453, 1437, 1364, 1177, 1117, 1101, 1069, 1027, 747, 719, 695, 570 cm^{-1}; HRMS calculated for $C_{29}H_{30}OP$ 425.2034, found 425.2037 $[M+H]^+$.



((4-(*tert*-Butyl)phenyl)(phenyl)methyl)diphenylphosphine oxide 3a (1 g scale): To a two-necked round bottom flask equipped with a condenser under a nitrogen atmosphere was added $Pd(OAc)_2$ (38 mg, 0.17 mmol) and Xantphos (198 mg, 0.34 mmol) and the flask was purged again with 3 cycles of vacuum/nitrogen Then, 34 mL dry CPME were added via syringe. The catalyst/ligand solution was stirred for 2 h at room temperature. NaO*t*Bu (657 mg, 6.84 mmol) was then added to the reaction mixture followed by benzyl diphenylphosphine oxide (1 g, 3.42 mmol). 4-*tert*-Butyl bromobenzene (1.19 mL, 6.84 mmol) was added by syringe. The reaction was heated to 110 °C and stirred for 16 h under nitrogen. The reaction mixture was passed through a short pad of silica gel, and eluted with 10: 1 DCM : MeOH (150 mL). The solvent was removed under reduced pressure and the residue was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 5:95) to give the product (1.20 g, 83% yield) as a withe solid. The spectroscopic data match the above reported data.

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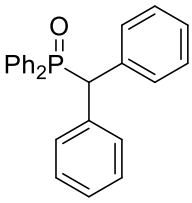
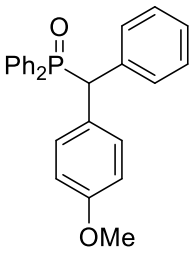
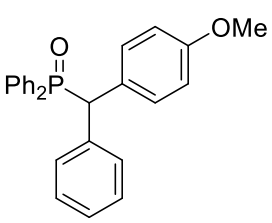


Benzydryldiphenylphosphine oxide 3b: The reaction was performed following the general procedure with **1a** (58 mg, 0.2 mmol), **2b** (42 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) in 2 mL CPME. The mixture was heated to 110°C for 16 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 5:95) to give the product (58 mg, 79% yield) as a white solid. R*f* = 0.5 (EtOAc:DCM= 10 : 90) ; m.p. = 314–315 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.67 – 7.57 (m, 4H), 7.49 (d, *J* = 7.1 Hz, 4H), 7.39 (m, 2H), 7.32 (m, 4H), 7.16 (m, 6H), 4.73 (d, *J* = 8.9 Hz, 1H) ppm ; $^{31}P\{^{1}H\}$ NMR (121 MHz, $CDCl_3$): δ 31.01 (s) ppm ; $^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$): δ 137.4 (d, *J* = 4.7 Hz), 132.7 (d, *J* = 98.1 Hz), 131.5 (d, *J* = 2.8 Hz), 131.5 (d, *J* = 8.7 Hz), 129.9 (d, *J* = 6.7 Hz), 128.6, 128.4 (d, *J* = 11.6 Hz), 127.1, 53.7 (d, *J* = 66.0 Hz) ppm; IR (thin film) : 3058, 3025, 2888, 1594, 1492, 1436, 1449, 1190, 1173, 1117, 1104, 1068, 843, 746, 731, 718, 701, 692, 552, 518 cm^{-1}; HRMS calculated for $C_{25}H_{22}OP$ 369.1408, found 369.1409 $[M+H]^+$.

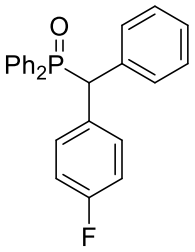


((4-Methoxyphenyl)(phenyl)methyl)diphenylphosphine oxide 3c: The reaction was performed following the general procedure with **1a** (58 mg, 0.2 mmol), **2c** (50 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) and 2 mL CPME. The mixture was heated at 110°C for 16 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 5:95) to give the product (73 mg, 91% yield) as a yellow solid. R*f* = 0.5 (EtOAc:DCM= 10 : 90) ; m.p. = 233–236 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.68 – 7.55 (m, 4H), 7.49 – 7.27 (m, 10H), 7.19 – 7.10 (m, 3H), 6.72 (d, *J* = 8.5 Hz, 2H), 4.72 (d, *J* = 9.0 Hz, 1H), 3.70 (s, 3H) ppm ; $^{31}P\{^{1}H\}$ NMR (121 MHz, $CDCl_3$): δ 31.13 (s)

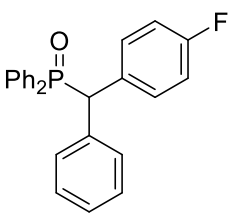
ppm ; $^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$): δ 158.4, 137.5 (d, *J* = 3.8 Hz), 132.5 (d, *J* = 98.1 Hz), 132.6 (d, *J* = 98.1 Hz), 131.3 (d, *J* = 3.4 Hz), 131.2 (d, *J* = 3.8 Hz), 130.8 (d, *J* = 7.5 Hz), 129.6 (d, *J* = 6.3 Hz), 129.2 (d, *J* = 5.0 Hz), 128.4, 128.2 (d, *J* = 11.3 Hz), 128.1 (d, *J* = 11.3 Hz), 126.8, 113.8, 55.1, 52.4 (d, *J* = 66.6 Hz) ppm; IR (thin film) : 3057, 2954, 2828, 2835, 1609, 1598, 1510, 1494, 1462, 1437, 1302, 1254, 1176, 1117, 1070, 1031, 863, 791, 721, 698, 553, 519 cm^{-1}; HRMS calculated for $C_{26}H_{24}O_2P$ 399.1514, found 399.1510 $[M+H]^+$.



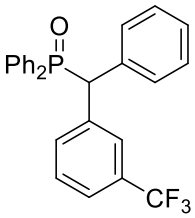
((4-Methoxyphenyl)(phenyl)methyl)diphenylphosphine oxide 3c: The reaction was performed following the general procedure with **1b** (64 mg, 0.2 mmol), **2b** (42 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) and 2 mL CPME. The mixture was heated to 110°C for 16 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 5:95) to give the product (70 mg, 87% yield) as a yellow solid. R*f* = 0.5 (EtOAc:DCM= 10 : 90). The spectroscopic data for **3c** match the above reported data.



((4-Fluorophenyl)(phenyl)methyl)diphenylphosphine oxide 3d: The reaction was performed following the general procedure with **1a** (58 mg, 0.2 mmol), **2d** (44 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) and 2 mL CPME. The mixture was heated to 110°C for 16 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 5:95) to give the product (64 mg, 83% yield) as a white solid. R*f* = 0.5 (EtOAc:DCM= 10 : 90); m.p. = 269–274 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.70 – 7.57 (m, 4H), 7.51 – 7.28 (m, 10H), 7.21 – 7.11 (m, 3H), 6.86 (t, *J* = 8.7 Hz, 2H), 4.72 (d, *J* = 9.0 Hz, 1H) ppm ; $^{31}P\{^{1}H\}$ NMR (121 MHz, $CDCl_3$): δ 31.07 (d, *J* = 2.7 Hz) ppm ; $^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$): δ 161.9 (d, *J* = 246.0 Hz), 137.1 (d, *J* = 4.4 Hz), 133.1 (d, *J* = 3.5 Hz), 133.1 (d, *J* = 3.5 Hz), 132.4 (d, *J* = 98.3 Hz), 132.3 (d, *J* = 98.5 Hz), 131.6 (d, *J* = 3.0 Hz), 131.6 (d, *J* = 3.2 Hz), 131.5 (d, *J* = 6.9 Hz), 131.4 (d, *J* = 3.3 Hz), 131.3 (d, *J* = 3.2 Hz), 129.8 (d, *J* = 6.7 Hz), 128.7 (s), 128.5 (d, *J* = 6.5 Hz), 128.4 (d, *J* = 6.5 Hz), 127.2 (s), 115.5 (d, *J* = 21.4 Hz), 52.7 (d, *J* = 66.0 Hz) ppm; IR (thin film) : 3057, 2888, 1604, 1506, 1436, 1228, 1175, 1158, 1117, 1104, 800, 720, 692, 562, 548, 505 cm^{-1}; HRMS calculated for $C_{25}H_{21}OPF$ 387.1314, found 387.1309 $[M+H]^+$.

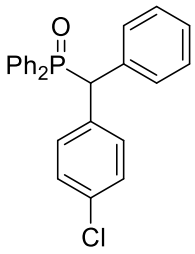


((4-Fluorophenyl)(phenyl)methyl)diphenylphosphine oxide 3d: The reaction was performed following the general procedure with **1c** (58 mg, 0.2 mmol), **2b** (42 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) and 2 mL CPME. The mixture was heated to 110°C for 16 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 5:95) to give the product (62 mg, 81% yield) as a white solid. R*f* = 0.5 (EtOAc:DCM= 10 : 90). The spectroscopic data match the above reported data.

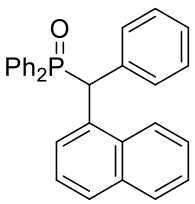


((3-Trifluorophenyl)(phenyl)methyl)diphenylphosphine oxide 3e: The reaction was performed following the general procedure with **1a** (58 mg, 0.2 mmol), **2e** (56 µL, 0.4 mmol), NaH (95% in oil, 10 mg, 0.4 mmol) and 2 mL CPME. The mixture was heated to 110°C for 16 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 5:95) to give the product (62 mg, 71% yield)

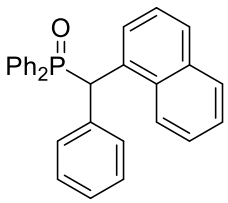
as a white solid. R*f* = 0.6 (EtOAc:DCM= 10 : 90) ; m.p. = 234–235 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.84 (d, *J* = 7.6 Hz, 1H), 7.70 – 7.63 (m, 2H), 7.59 (dt, *J* = 18.3, 7.9 Hz, 2H), 7.54 (d, *J* = 7.8 Hz, 2H), 7.48 (s, 1H), 7.44 – 7.35 (m, 3H), 7.37 – 7.26 (m, 5H), 7.18 (dt, *J* = 25.3, 7.1 Hz, 3H), 4.82 (d, *J* = 8.9 Hz, 1H) ppm ; ^{31}P{^{1}H} NMR (121 MHz, $CDCl_3$): δ 30.86 (s) ppm ; ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$): δ 138.2 (d, *J* = 4.7 Hz), 136.6 (d, *J* = 4.5 Hz), 133.3 (d, *J* = 5.1 Hz), 132.1 (d, *J* = 98.5 Hz), 132.0 (d, *J* = 99.0 Hz), 131.8 (d, *J* = 4.6 Hz), 131.8 (d, *J* = 4.6 Hz), 131.4 (d, *J* = 8.7 Hz), 131.3 (d, *J* = 8.7 Hz), 130.6 (q, *J* = 32.3 Hz), 129.9 (d, *J* = 6.8 Hz), 129.1 (s), 128.8 (s), 128.5 (d, *J* = 11.6 Hz), 127.4 (s), 126.7 (q, *J* = 3.7 Hz), 126.6 (q, *J* = 3.7 Hz), 124.0 (q, *J* = 272.4 Hz), 53.5 (d, *J* = 65.1 Hz) ppm; IR (thin film): 3058, 2923, 1592, 1493, 1437, 1447, 1329, 1167, 1120, 1096, 1075, 720, 698, 547, 519 cm^{-1}; HRMS calculated for $C_{26}H_{21}OPF_3$ 437.1282, found 437.1281 $[M+H]^+$.



((4-Chlorophenyl)(phenyl)methyl)diphenylphosphine oxide 3f: The reaction was performed following the general procedure with **1a** (58 mg, 0.2 mmol), **2f** (77 mg, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) and 2 mL CPME. The mixture was heated to 110°C for 16 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 5:95) to give the product (43 mg, 54% yield) as a white solid. R*f* = 0.6 (EtOAc:DCM = 10 : 90); m.p. = 243–245 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.71 – 7.55 (m, 4H), 7.51 – 7.27 (m, 10H), 7.22 – 7.10 (m, 5H), 4.72 (d, *J* = 8.9 Hz, 1H) ppm ; ^{31}P{^{1}H} NMR (121 MHz, $CDCl_3$): δ 30.79 (s) ppm ; ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$): 136.9 (d, *J* = 4.6 Hz), 136.0 (d, *J* = 4.7 Hz), 133.1 (d, *J* = 2.0 Hz), 132.4 (d, *J* = 98.2 Hz), 132.3 (d, *J* = 98.8 Hz), 131.7 (d, *J* = 2.7 Hz), 131.6 (d, *J* = 2.7 Hz), 131.4 (d, *J* = 8.6 Hz), 131.2 (d, *J* = 6.6 Hz), 129.8 (d, *J* = 6.6 Hz), 128.7 (d, *J* = 4.9 Hz), 128.5 (d, *J* = 11.6 Hz), 128.4 (d, *J* = 11.8 Hz), 127.2 (d, *J* = 1.3 Hz), 52.9 (d, *J* = 65.8 Hz); IR (thin film) : 3057, 2888, 1599, 1488, 1436, 1175, 1117, 1098, 1017, 870, 738, 721, 712, 693, 551, 529 cm^{-1}; HRMS calculated for $C_{25}H_{21}ClOP$ 403.1019, found 403.1017 $[M+H]^+$.

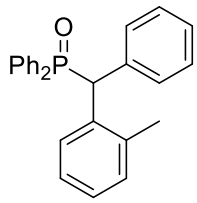


(Naphthalen-1-yl)(phenyl)methyl)diphenylphosphine oxide 3g: The reaction was performed following the general procedure with **1a** (58 mg, 0.2 mmol), **2g** (56 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) and 1 mL CPME. The mixture was heated to 110°C for 48 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 5:95) to give the product (43 mg, 51% yield) as a yellow solid. R*f* = 0.7 (EtOAc:DCM= 10 : 90) ; m.p. = 256–259 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.60 (d, *J* = 7.3 Hz, 1H), 8.04 (d, *J* = 8.3 Hz, 1H), 7.81 – 7.74 (m, 1H), 7.71 – 7.59 (m, 3H), 7.57 – 7.47 (m, 2H), 7.46 – 7.37 (m, 4H), 7.34 – 7.26 (m, 5H), 7.19 (td, *J* = 7.6, 2.9 Hz, 2H), 7.15 – 7.07 (m, 3H), 5.54 (d, *J* = 10.4 Hz, 1H) ppm ; ^{31}P{^{1}H} NMR (121 MHz, $CDCl_3$): δ 32.54 (s) ppm ; ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$): δ 135.7 (d, *J* = 5.7 Hz), 134.2, 133.7 (d, *J* = 2.7 Hz), 133.2 (d, *J* = 100.5 Hz), 132.6 (d, *J* = 97.2 Hz), 131.7 (d, *J* = 9.0 Hz), 131.5 (d, *J* = 3.6 Hz), 131.5 (d, *J* = 9.1 Hz), 131.2 (d, *J* = 8.6 Hz), 130.4 (d, *J* = 5.5 Hz), 129.3, 128.6 (d, *J* = 7.1 Hz), 128.5 (d, *J* = 11.5 Hz), 128.3 (d, *J* = 1.9 Hz), 128.2 (d, *J* = 11.5 Hz), 128.1, 127.0 (d, *J* = 2.3 Hz), 126.5, 125.8, 125.5, 122.7, 48.7 (d, *J* = 66.9 Hz) ppm; IR (thin film): 3054, 2924, 1597, 1492, 1437, 1402, 1169, 1116, 799, 776, 718, 697, 602, 560, 532, 519, 507 cm^{-1}; HRMS calculated for $C_{29}H_{24}OP$ 419.1565, found 419.1566 $[M+H]^+$.

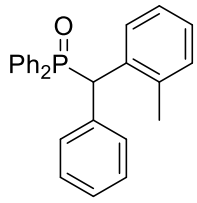


(Naphthalen-1-yl)(phenyl)methyl)diphenylphosphine oxide 3g: The reaction was performed following the general procedure with **1d** (68 mg, 0.2 mmol), **2b**

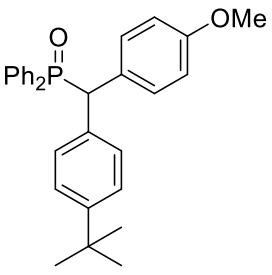
(42 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) and 2 mL CPME. The mixture was heated to 110°C for 16 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 5:95) to give the product (71 mg, 85% yield) as a yellow solid. R*f* = 0.7 (EtOAc:DCM= 10 : 90). The spectroscopic data match the above reported data.



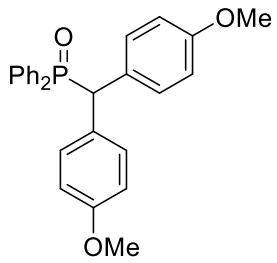
(Phenyl(*o*-tolyl)methyl)diphenylphosphine oxide 3h: The reaction was performed following the general procedure with **1a** (58 mg, 0.2 mmol), **2h** (48 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) and 1 mL CPME. The mixture was heated to 110°C for 48 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 5:95) to give the product (50 mg, 66% yield) as a yellow solid. R*f* = 0.7 (EtOAc:DCM= 10 : 90) ; m.p. = 208–211 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.27 (d, *J* = 7.8 Hz, 1H), 7.67 – 7.47 (m, 4H), 7.44 – 7.34 (m, 2H), 7.34 – 7.27 (m, 6H), 7.18 – 6.99 (m, 6H), 4.92 (d, *J* = 9.7 Hz, 1H), 2.17 (s, 3H) ppm ; ^{31}P{^{1}H} NMR (121 MHz, $CDCl_3$): δ 31.91 (s) ppm ; ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$): δ 136.2 (d, *J* = 3.5 Hz), 135.9 (t, *J* = 6.9 Hz), 132.8 (d, *J* = 97.3 Hz), 132.7 (d, *J* = 99.3 Hz), 131.6 (d, *J* = 2.7 Hz), 131.5 (d, *J* = 2.1 Hz), 131.5 (d, *J* = 8.8 Hz), 131.3 (d, *J* = 8.7 Hz), 130.4 (d, *J* = 6.4 Hz), 130.4 (d, *J* = 13.7 Hz), 128.4 (d, *J* = 11.4 Hz), 128.3 (d, *J* = 11.6 Hz), 127.0 (d, *J* = 36.1 Hz), 126.7 (d, *J* = 34.8 Hz), 48.9 (d, *J* = 66.9 Hz), 20.0 ppm; IR (thin film) : 3057, 3025, 2925, 1597, 1493, 1437, 1178, 1115, 1072, 753, 720, 699, 554, 516 cm^{-1}; HRMS calculated for $C_{26}H_{24}OP$ 383.1565, found 383.1559 $[M+H]^+$.



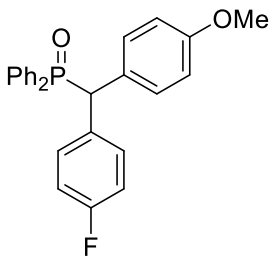
(Phenyl(*o*-tolyl)methyl)diphenylphosphine oxide 3h: The reaction was performed following the general procedure with **1e** (61 mg, 0.2 mmol), **2b** (42 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) and 2 mL CPME. The mixture was heated to 110°C for 16 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 5:95) to give the product (68 mg, 78% yield) as a yellow solid. R*f* = 0.7 (EtOAc:DCM= 10 : 90). The spectroscopic data match the above reported data.



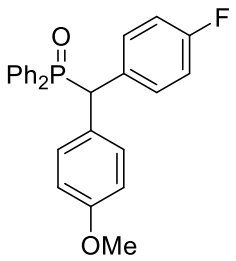
((4-(*tert*-Butyl)phenyl)(4-methoxyphenyl)methyl)diphenylphosphine oxide 3i: The reaction was performed following the general procedure with **1b** (64 mg, 0.2 mmol), **2a** (69 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) and 2 mL CPME. The mixture was heated to 110°C for 16 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 5:95) to give the product (77 mg, 85% yield) as a withe solid. R*f* = 0.6 (EtOAc:DCM = 10 : 90) ; m.p. = 268–271 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.69 – 7.53 (m, 4H), 7.47 – 7.26 (m, 10H), 7.18 (d, *J* = 8.4 Hz, 2H), 6.84 – 6.67 (m, 2H), 4.68 (d, *J* = 9.3 Hz, 1H), 3.69 (s, 3H), 1.21 (s, 9H) ppm ; ^{31}P{^{1}H} NMR (121 MHz, $CDCl_3$): δ 31.37 (s) ppm ; ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$): δ 158.3, 149.7, 134.2 (d, *J* = 4.5 Hz), 132.9 (d, *J* = 97.6 Hz), 132.8 (d, *J* = 97.6 Hz),), 131.5 (d, *J* = 4.2 Hz), 131.4 (d, *J* = 4.2 Hz), 131.4 (d, *J* = 3.3 Hz), 131.0 (d, *J* = 6.8 Hz), 129.6 (d, *J* = 4.6 Hz), 129.4 (d, *J* = 6.5 Hz), 128.3 (d, *J* = 11.9 Hz), 128.2 (d, *J* = 11.8 Hz),125.5, 114.0, 55.2, 52.2 (d, *J* = 66.6 Hz), 34.4, 31.4 ppm; IR (thin film): 3057, 2963, 2930, 2869, 1610, 1579, 1509, 1463, 1436, 1366, 1301, 1255, 1176, 1166, 1117, 1103, 1068, 1029, 872, 816, 725, 716, 693, 574, 532, 520 cm^{-1}; HRMS calculated for $C_{30}H_{32}O_2P$ 455.2140, found 455.2143 $[M+H]^+$.



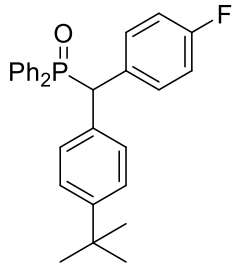
(Bis(4-methoxyphenyl)methyl)diphenylphosphine oxide 3j: The reaction was performed following the general procedure with **1b** (64 mg, 0.2 mmol), **2c** (50 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) and 1 mL CPME. The mixture was heated to 110°C for 48 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 10:90) to give the product (71 mg, 83% yield) as a white solid. R*f* = 0.3 (EtOAc:DCM = 10 : 90^{1}H); m.p. = 230–234 °C; NMR (500 MHz, $CDCl_3$): δ 7.72 – 7.54 (m, 4H), 7.44 – 7.26 (m, 10H), 6.71 (d, *J* = 8.5 Hz, 4H), 4.67 (d, *J* = 9.3 Hz, 1H), 3.69 (s, 6H) ppm ; $^{31}P\{^1H\}$ NMR (121 MHz, $CDCl_3$): δ 31.37 (s) ppm ; $^{13}C\{^1H\}$ NMR (125 MHz, $CDCl_3$): δ 158.5, 132.8 (d, *J* = 97.4 Hz), 131.4 (d, *J* = 3.7 Hz), 131.4 (d, *J* = 8.5 Hz), 130.8 (d, *J* = 6.7 Hz), 129.7 (d, *J* = 4.5 Hz), 128.3 (d, *J* = 11.5 Hz), 114.0, 55.2, 51.6 (d, *J* = 66.9 Hz) ppm; IR (thin film) : 3006, 3056, 2953, 2931, 2886, 2834, 1607, 1581, 1509, 1461, 1437, 1301, 1252, 1176, 1118, 1105, 1032, 815, 739, 718, 696, 555, 519 cm^{-1}; HRMS calculated for $C_{27}H_{25}O_3PNa$ 451.1439, found 451.1460 $[M+Na]^+$.



((4-Fluorophenyl)(4-methoxyphenyl)methyl)diphenylphosphine oxide 3k: The reaction was performed following the general procedure with **1b** (64 mg, 0.2 mmol), **2d** (44 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) and 1 mL CPME. The mixture was heated to 110°C for 48 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 10:90) to give the product (58 mg, 70% yield) as a yellow solid. Rf= 0.4 (EtOAc:DCM = 10 : 90) ; m.p. = 197–199 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.72 – 7.56 (m, 4H), 7.51 – 7.28 (m, 10H), 6.85 (t, *J* = 8.7 Hz, 2H), 6.72 (d, *J* = 8.7 Hz, 2H), 4.71 (d, *J* = 9.2 Hz, 1H), 3.69 (s, 3H) ppm ; $^{31}P\{^1H\}$ NMR (121 MHz, $CDCl_3$): δ 31.17 (d, *J* = 2.7 Hz) ppm ; $^{13}C\{^1H\}$ NMR (125 MHz, $CDCl_3$): δ 161.9 (d, *J* = 245.9 Hz), 158.6, 133.61 – 133.30 (m), 132.51 (d, *J* = 97.6 Hz), 132.42 (d, *J* = 98.2 Hz), 131.57 (d, *J* = 2.6 Hz), 131.43 – 131.23 (m), 130.82 (d, *J* = 6.8 Hz), 129.18 (d, *J* = 4.5 Hz), 128.38 (d, *J* = 11.6 Hz), 115.40 (d, *J* = 21.3 Hz), 114.08, 55.21, 51.68 (d, *J* = 66.6 Hz) ppm; IR (thin film): 3056, 2928, 2836, 1607, 1507, 1438, 1254, 1227, 1179, 1159, 1118, 1032, 721, 697, 555 cm^{-1}; HRMS calculated for $C_{26}H_{23}O_2PF$ 417.1420, found 417.1415 $[M+H]^+$.

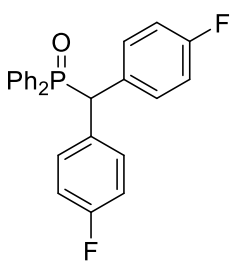


((4-Fluorophenyl)(4-methoxyphenyl)methyl)diphenylphosphine oxide 3k: The reaction was performed following the general procedure with **1c** (62 mg, 0.2 mmol), **2c** (50 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) and 2 mL CPME. The mixture was heated to 110°C for 16 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 10:90) to give the product (60 mg, 72% yield) as a yellow solid. R*f* = 0.4 (EtOAc:DCM = 10 : 90). The spectroscopic data match the above reported data.

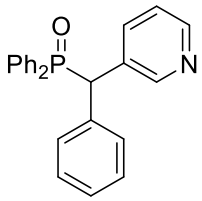


((4-(*tert*-Butyl)phenyl)(4-flurorophenyl)methyl)diphenylphosphine oxide 3l: The reaction was performed following the general procedure with **1c** (62 mg, 0.2 mmol), **2a** (69 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) and 2 mL CPME. The mixture was heated to 110°C for 16 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 5:95) to give the product (67 mg, 76% yield) as a yellow solid. R*f* = 0.7 (EtOAc:DCM = 10 : 90) ;

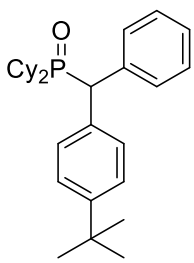
m.p. = 263–264 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.65 – 7.55 (m, 4H), 7.47 – 7.44 (m, 2H), 7.42 – 7.28 (m, 8H), 7.19 (d, *J* = 8.3 Hz, 2H), 6.86 (t, *J* = 8.7 Hz, 2H), 4.72 (d, *J* = 9.1 Hz, 1H), 1.22 (s, 9H) ppm ; ^{31}P{^{1}H} NMR (121 MHz, $CDCl_3$): δ 31.20 (d, *J* = 2.7 Hz) ppm ; ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$): δ 161.9 (d, *J* = 247.5 Hz), 149.9 (d, *J* = 1.8 Hz), 133.8 (d, *J* = 4.6 Hz), 133.4 (d, *J* = 3.5 Hz), 133.3 (d, *J* = 3.6 Hz), 132.4 (d, *J* = 97.5 Hz), 131.6 (m), 131.5 (d, *J* = 1.9 Hz), 131.4 (m), 131.4 (d, *J* = 2.7 Hz), 129.4 (d, *J* = 6.5 Hz), 128.3 (t, *J* = 11.4 Hz), 125.6, 115.4 (d, *J* = 21.3 Hz), 52.2 (d, *J* = 66.1 Hz), 34.4, 31.3 ppm; IR (thin film) : 3055, 2964, 2905, 1603, 1507, 1436, 1231, 1178, 1169, 1117, 1102, 1068, 1026, 878, 822, 736, 721, 704, 693, 572, 550, 528, 500 cm^{-1}; HRMS calculated for $C_{29}H_{29}OPF$ 443.1940, found 443.1945 $[M+H]^+$.



(Bis(4-fluorophenyl)methyl)diphenylphosphine oxide 3m: The reaction was performed following the general procedure with **1c** (62 mg, 0.2 mmol), **2d** (44 µL, 0.4 mmol), NaO*t*Bu (38 mg, 0.4 mmol) and 2 mL CPME. The mixture was heated to 110°C for 16 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:DCM = 10:90) to give the product (49 mg, 61% yield) as a yellow solid. R*f* = 0.6 (EtOAc:DCM = 10 : 90); m.p. = 252–254 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.63 – 7.59 (m, 4H), 7.48 – 7.29 (m, 10H), 6.88 (t, *J* = 8.6 Hz, 4H), 4.72 (d, *J* = 9.0 Hz, 1H) ppm ; ^{31}P{^{1}H} NMR (121 MHz, $CDCl_3$): δ 31.02 ppm ; ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$): δ 162.0 (d, *J* = 246.3 Hz), 133.0, 132.2 (d, *J* = 98.5 Hz), 131.7 (d, *J* = 2.6 Hz), 131.4 (d, *J* = 6.9 Hz), 131.3 (d, *J* = 8.5 Hz), 128.5 (d, *J* = 11.7 Hz), 115.6 (d, *J* = 21.4 Hz), 51.8 (d, *J* = 66.1 Hz) ppm; IR (thin film) : 3055, 2890, 1603, 1505, 1436, 1230, 1189, 1175, 1167, 1158, 1117, 1095, 1069, 880, 836, 787, 739, 717, 693, 553, 548, 509, 486 cm^{-1}; HRMS calculated for $C_{25}H_{20}OF_2P$ 405.1220, found 405.1221 $[M+H]^+$.

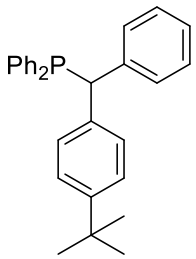


(Phenyl(pyridine-3-yl)methyl)diphenylphosphine oxide 3n: The reaction was performed following the general procedure with **1d** (65 mg, 0.2 mmol), **2b** (42 µL, 0.4 mmol), NaH 95% oil (15 mg, 0.4 mmol) and 2 mL CPME. The mixture was heated to 110°C for 32 h. The crude product was purified by flash chromatography on silica gel (eluted with EtOAc:*i*PrOH = 95:5) to give the product (55 mg, 75% yield) as a white solid. R*f* = 0.3 (EtOAc) ; m.p. = 313–315 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.39 (d, *J* = 13.7 Hz, 2H), 8.14 (d, *J* = 7.4 Hz, 1H), 7.75 – 7.60 (m, 4H), 7.52 (d, *J* = 7.6 Hz, 2H), 7.44 – 7.30 (m, 6H), 7.23 – 7.11 (m, 4H), 4.76 (d, *J* = 8.8 Hz, 1H) ppm ; ^{31}P{^{1}H} NMR (121 MHz, $CDCl_3$): δ 30.84 ppm ; ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$): δ 150.5 (d, *J* = 7.8 Hz), 148.3, 137.10 (d, *J* = 5.2 Hz), 136.4 (d, *J* = 4.5 Hz), 133.3, 131.9 (d, *J* = 98.4 Hz), 131.8 (d, *J* = 99.2 Hz), 131.8 (d, *J* = 2.5 Hz), 131.7 (d, *J* = 2.6 Hz), 131.3 (d, *J* = 8.8 Hz), 131.1 (d, *J* = 8.7 Hz), 129.7 (d, *J* = 6.6 Hz), 128.7, 128.5 (d, *J* = 11.7 Hz), 128.3 (d, *J* = 11.8 Hz), 127.3, 123.4, 50.8 (d, *J* = 65.3 Hz) ppm; IR (thin film) : 3054, 2886, 2396, 2355, 1570, 1493, 1477, 1452, 1436, 1420, 1175, 1118, 1101, 1069, 1027, 784, 735, 719, 693, 554, 520 cm^{-1}; HRMS calculated for C24H21NOP 370.1361, found 370.1352 $[M+H]^+$.



((4-(*tert*-Butyl)phenyl)(phenyl)methyl)dicyclohexylphosphine oxide 3o: The reaction was performed following the general procedure with **1g** (61 mg, 0.2 mmol), **2a** (69 µL, 0.4 mmol), NaH 95% oil (10 mg, 0.4 mmol) and 2 mL CPME. The mixture was heated to 110°C for 16 h. The crude product was purified by flash

chromatography on silica gel (eluted with EtOAc) to give the product (73 mg, 84% yield) as a white solid. R*f* = 0.6 (EtOAc) ; m.p. = 273–274 °C; ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.68 (d, *J* = 7.7 Hz, 2H), 7.55 (d, *J* = 7.9 Hz, 2H), 7.31 – 7.26 (m, 4H), 7.22 – 7.19 (m, 1H), 4.11 (d, *J* = 7.0 Hz, 1H), 1.90 (bs, 4H), 1.72-1.60 (m, 8H), 1.37 – 1.19 (m, 11H), 1.12 – 0.93 (m, 8H) ppm ; ^{31}P{^{1}H} NMR (121 MHz, $CDCl_3$): δ 49.27 ppm ; ^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$): δ 149.9, 139.2 (d, *J* = 4.3 Hz), 135.5 (d, *J* = 4.8 Hz), 129.6 (d, *J* = 6.0 Hz), 129.1 (d, *J* = 5.8 Hz), 128.8, 127.0, 125.7, 48.5 (d, *J* = 54.7 Hz), 38.3 (d, *J* = 60.8 Hz), 38.2 (d, *J* = 61.5 Hz), 34.5, 31.4, 27.3-26.9 (m), 26.5 (d, *J* = 34.9 Hz), 26.5 (d, *J* = 35.0 Hz), 26.2 ppm; IR (thin film) : 3042, 2928, 2853, 1597, 1509, 1494, 1446, 1363, 1269, 1232, 1149, 1123, 1023, 897, 869, 758, 740, 704, 577 cm^{-1}; HRMS calculated for $C_{29}H_{42}OP$ 437.2973, found 437.2972 $[M+H]^+$.



((4-(*tert*-Butyl)phenyl)(phenyl)methyl)diphenylphosphine 4a: In a solution of **1a** (30 mg, 0.07 mmol) in 1 mL dry benzene was added triethoxysilane (39 µL, 0.21 mmol) and titanium tetraisopropoxide (6 µL, 0.02 mmol) under nitrogen. The mixture was heated at 80 °C for 3.5 h until total consumption of the starting material (monitored by ^{31}P NMR). The crude product was purified by flash chromatography on silica gel under nitrogen (eluted with EtOAc:hexanes = 5:95) to give the product (26 mg, 91% yield) as a white solid. R*f* = 0.5 (EtOAc:hexanes = 1 : 10) ; m.p. = 165–168 °C; ^{1}H NMR (500 MHz, benzene d_6): δ 7.12 – 7.01 (m, 8H), 6.90 – 6.81 (m, 3H), 6.72 – 6.69 (m, 2H), 6.66 – 6.64 (m, 5H), 6.61 – 6.58 (m, 1H), 4.46 (d, *J* = 6.7 Hz, 1H), 0.83 (s, 9H) ppm ; ^{31}P{^{1}H} NMR (121 MHz, benzene d_6) : δ -3.37 (s) ppm ; ^{13}C{^{1}H} NMR (125 MHz, benzene d_6): δ 149.1, 142.7 (d, *J* = 11.1 Hz), 139.5 (d, *J* = 11.4 Hz), 138.4 (d, *J* = 15.5 Hz), 138.3 (d, *J* = 15.5 Hz), 134.2 (d, *J* = 18.8 Hz), 134.0 (d, *J* = 18.6 Hz), 129.5 (d, *J* = 9.5 Hz), 129.2 (d, *J* = 9.9 Hz), 128.7 (d, *J* = 6.0 Hz), 128.6 (d, *J* = 3.6 Hz), 128.3 (d, *J* = 7.3 Hz), 128.1 (d, *J* = 12.5 Hz), 128.0 (d, *J* = 11.2 Hz), 126.46 (d, *J* = 1.8 Hz), 125.70, 52.82 (d, *J* = 14.2 Hz), 34.33, 31.40ppm; IR (thin film): 3054, 2963, 1597, 1512, 1492, 1451, 1433, 1363, 1261, 1092, 1067, 1026, 807, 740, 694, 612 cm^{-1}; HRMS calculated for $C_{29}H_{30}P$ 409.2085, found 409.2076 $[M+H]^+$.

4. High-throughput Experimentation Screenings for Pd-Catalyzed Arylation of benzyldiphenylphosphine oxides

General Experimental Procedure:

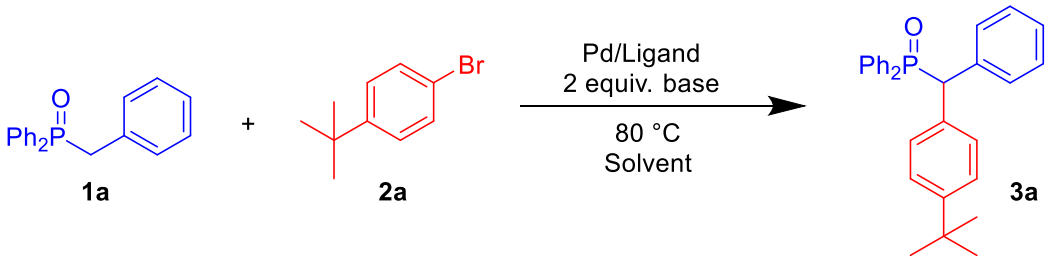
Set up:

Experiments were set inside a glovebox under a nitrogen atmosphere. A 96-well aluminum block containing 1 mL glass vials was predosed with $Pd(OAc)_2$ (1 µmol) or $Pd(dba)_2$ (1 µmol) and the two phosphine ligands: NiXantphos or N-(dicyclohexylphosphino)-2-2'-tolylindole (2 µmol) in THF. The solvent was removed to dryness using a GeneVac and 6 different bases (LiHMDS, NaHMDS, KHMDS, LiO*t*Bu, NaO*t*Bu, KO*t*Bu, 20 µmol) in THF were added to the ligand/catalyst mixture. The solvent was removed on the GeneVac and a parylene stir bar was then added to each reaction vial. Benzyldiphenylphosphine oxide (10 µmol/reaction) and 4-*tert*-butyl bromobenzene (20 µmol) were then dosed together into each reaction vial as a solution in 4 different solvents (CPME, dioxane, THF, toluene, 100 µL, 0.1 M). The 96-well plate was then sealed and stirred for 16 h at 80 °C.

Work up:

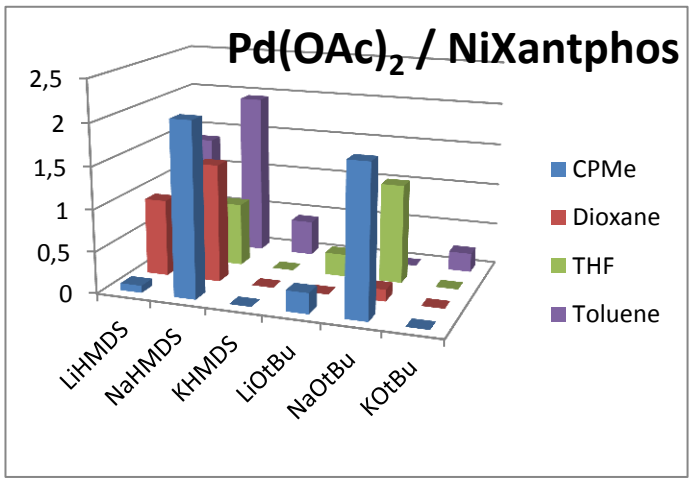
Upon opening the plate to air, 500 µL of a solution of 4,4'-di-methylbiphenyl (used as internal standard to measure HPLC yields) in acetonitrile (0. 002 mol/L) was added into each vial. The plate was covered again and the vials stirred for 10 min. to ensure good homogenization. Into a separate 96-well LC block was added 700 µL of acetonitrile, followed by 40 µL of the diluted reaction mixtures. The LC block was then sealed with a silicon-rubber storage mat and mounted on an automated HPLC instrument for analysis.

Bases and solvents screening with 2 palladium sources and 2 ligands



- **$Pd(OAc)_2$ / NiXantphos**

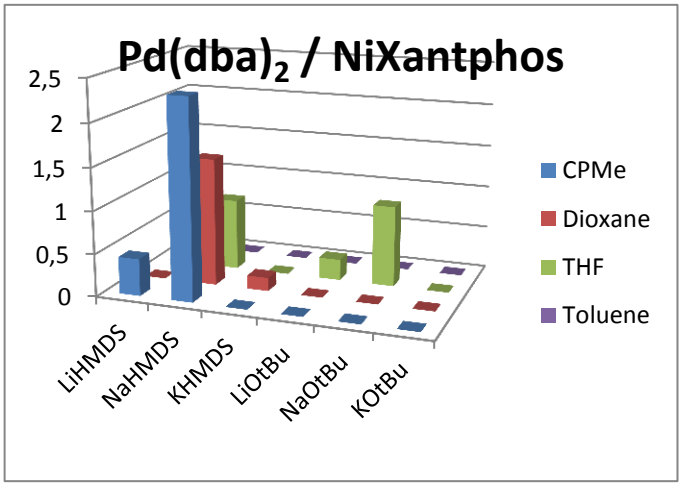
Solvent	Base	Prod/IS
CPMe	LiHMDS	0.09
CPMe	NaHMDS	2.08
CPMe	KHMDS	0
CPMe	LiO*t*Bu	0.25
CPMe	NaO*t*Bu	1.78
CPMe	KO*t*Bu	0
Dioxane	LiHMDS	0.92
Dioxane	NaHMDS	1.41
Dioxane	KHMDS	0
Dioxane	LiO*t*Bu	0
Dioxane	NaO*t*Bu	0.15
Dioxane	KO*t*Bu	0
THF	LiHMDS	0.22
THF	NaHMDS	0.76
THF	KHMDS	0
THF	LiO*t*Bu	0.27
THF	NaO*t*Bu	1.18
THF	KO*t*Bu	0
Toluene	LiHMDS	1.37
Toluene	NaHMDS	1.94
Toluene	KHMDS	0.42
Toluene	LiO*t*Bu	0
Toluene	NaO*t*Bu	0



Toluene	KO*t*Bu	0.23

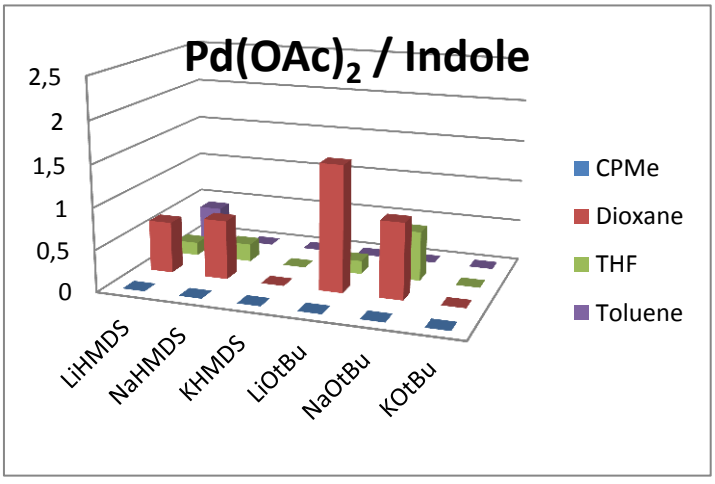
- **$Pd(dba)_2$ / NiXantphos**

Solvent	Base	Prod/IS
CPMe	LiHMDS	0.44
CPMe	NaHMDS	2.34
CPMe	KHMDS	0
CPMe	LiO*t*Bu	0
CPMe	NaO*t*Bu	0
CPMe	KO*t*Bu	0
Dioxane	LiHMDS	0
Dioxane	NaHMDS	1.49
Dioxane	KHMDS	0.16
Dioxane	LiO*t*Bu	0
Dioxane	NaO*t*Bu	0
Dioxane	KO*t*Bu	0
THF	LiHMDS	0
THF	NaHMDS	0.84
THF	KHMDS	0
THF	LiO*t*Bu	0.25
THF	NaO*t*Bu	0.95
THF	KO*t*Bu	0
Toluene	LiHMDS	0.53
Toluene	NaHMDS	0
Toluene	KHMDS	0
Toluene	LiO*t*Bu	0
Toluene	NaO*t*Bu	0
Toluene	KO*t*Bu	0



- **$Pd(OAc)_2$ / Indole ligand**

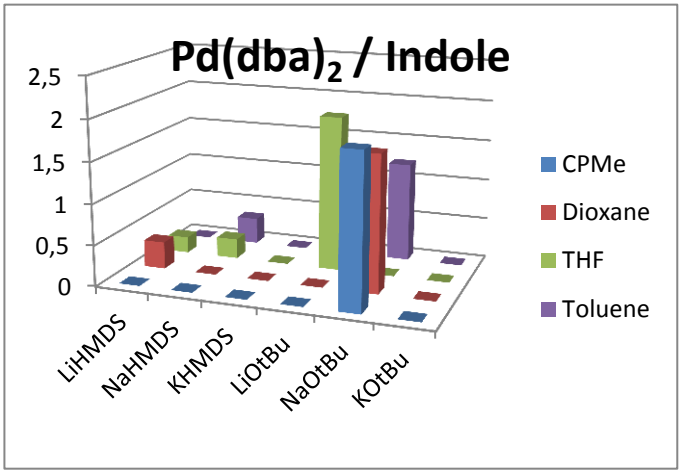
Solvent	Base	Prod/IS
CPMe	LiHMDS	0
CPMe	NaHMDS	0
CPMe	KHMDS	0
CPMe	LiO*t*Bu	0
CPMe	NaO*t*Bu	0
CPMe	KO*t*Bu	0
Dioxane	LiHMDS	0.62
Dioxane	NaHMDS	0.71
Dioxane	KHMDS	0
Dioxane	LiO*t*Bu	1.51
Dioxane	NaO*t*Bu	0.91
Dioxane	KO*t*Bu	0
THF	LiHMDS	0.16
THF	NaHMDS	0.21



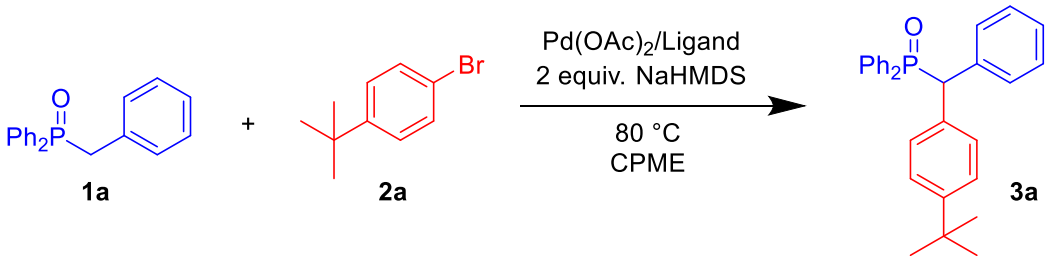
THF	KHMDS	0
THF	LiO*t*Bu	0.16
THF	NaO*t*Bu	0.59
THF	KO*t*Bu	0
Toluene	LiHMDS	0.41
Toluene	NaHMDS	0
Toluene	KHMDS	0
Toluene	LiO*t*Bu	0
Toluene	NaO*t*Bu	0
Toluene	KO*t*Bu	0

- **$Pd(dba)_2$ / Indole ligand**

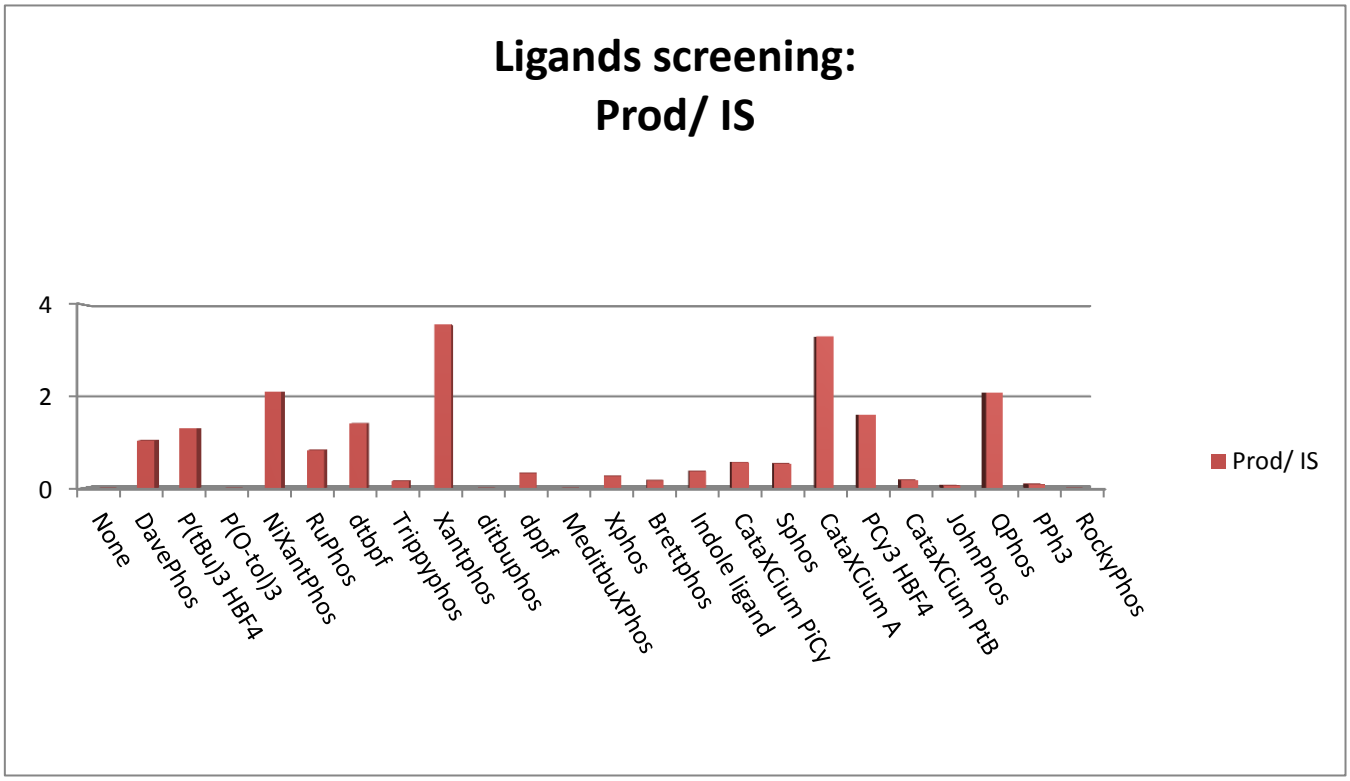
Solvent	Base	Prod/IS
CPMe	LiHMDS	0
CPMe	NaHMDS	0
CPMe	KHMDS	0
CPMe	LiO*t*Bu	0
CPMe	NaO*t*Bu	1.86
CPMe	KO*t*Bu	0
Dioxane	LiHMDS	0.33
Dioxane	NaHMDS	0
Dioxane	KHMDS	0
Dioxane	LiO*t*Bu	0
Dioxane	NaO*t*Bu	1.66
Dioxane	KO*t*Bu	0
THF	LiHMDS	0.20
THF	NaHMDS	0.24
THF	KHMDS	0
THF	LiO*t*Bu	1.90
THF	NaO*t*Bu	0
THF	KO*t*Bu	0
Toluene	LiHMDS	0
Toluene	NaHMDS	0.32
Toluene	KHMDS	0
Toluene	LiO*t*Bu	0
Toluene	NaO*t*Bu	1.22
Toluene	KO*t*Bu	0



Ligands screening

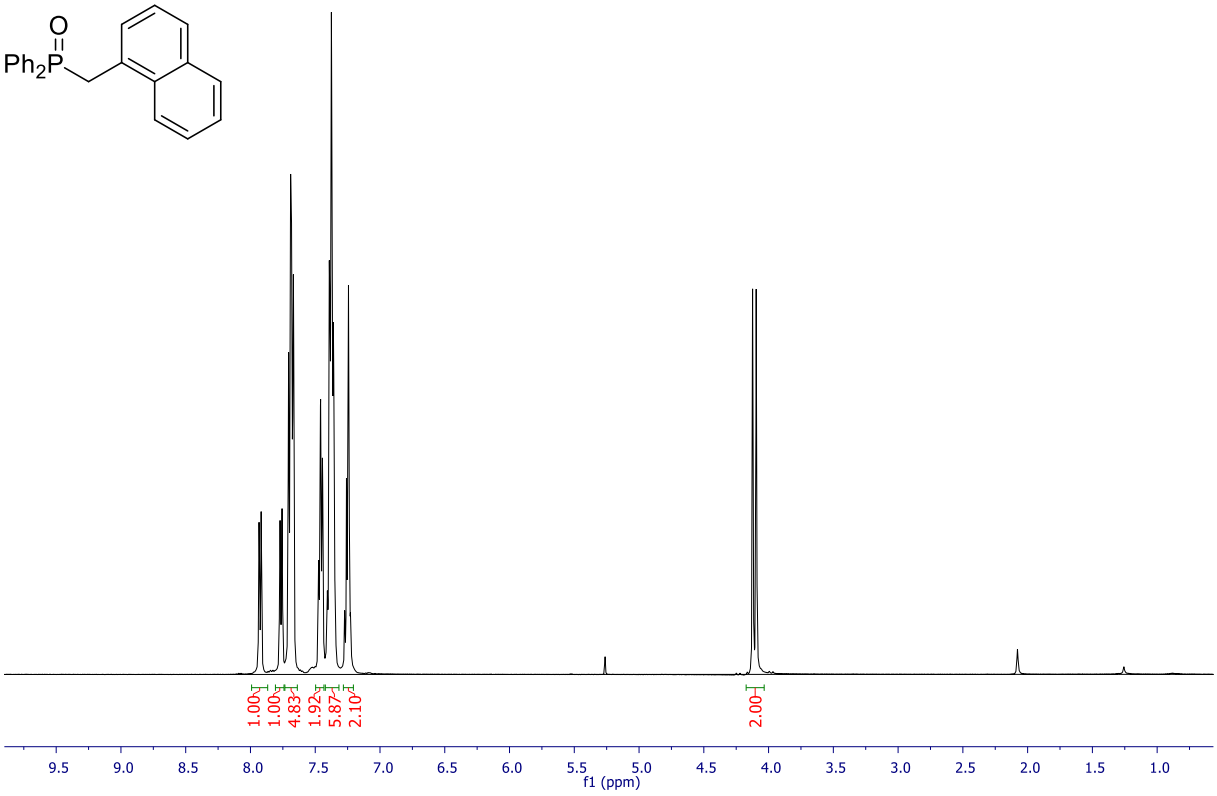


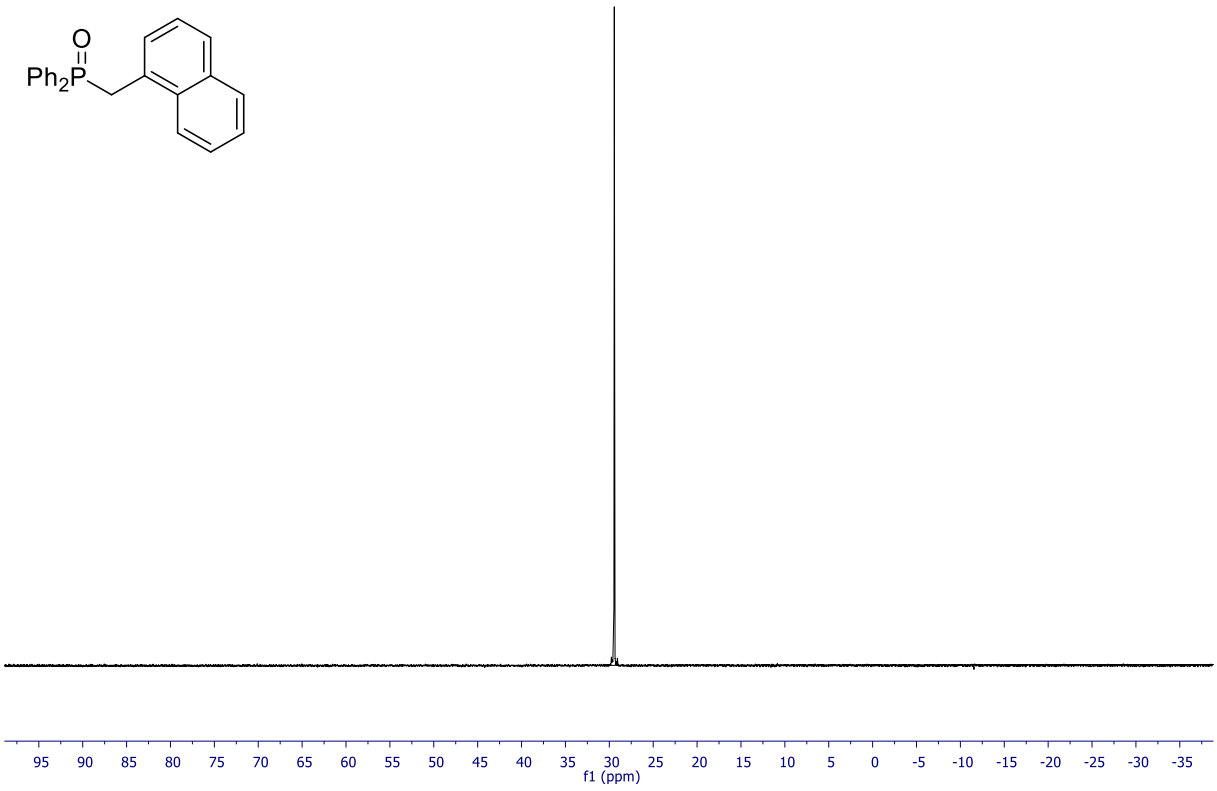
Ligand	Prod/IS
None	0
2-Dicyclohexylphosphino-2'-(*N*,*N*-dimethylamino)biphenyl (DavePhos)	1.04
$P(tBu)_3$ HBF_4	1.30
$P(O\text{-}tol)_3$	0
4,6-Bis(diphenylphosphino)phenoxazine (NiXantPhos)	2.11
2-Dicyclohexylphosphino-2',6'-di-i-propoxy-1,1'-biphenyl (RuPhos)	0.83
1,1'-Bis(di-*t*-butylphosphino)ferrocene (dtbpf)	1.42
1-[2-[Bis(*t*-butyl)phosphino]phenyl]-3,5-diphenyl-1H-pyrazole (Trippyphos)	0.16
9,9-Dimethyl-4,5-bis(diphenylphosphino)xanthene (Xantphos)	3.56
ditbuphos	0
1,1'-Bis(diphenylphosphino)ferrocene (dppf)	0.33
2-Di-*t*-butylphosphino-3,4,5,6-tetramethyl-2',4',6'-triisopropyl-1,1'-biphenyl (MeditbuXPhos)	0
2-Dicyclohexylphosphino-2',4',6'-tri-i-propyl-1,1'-biphenyl (Xphos)	0.26
Dicyclohexyl-[3,6-dimethoxy-2-(2,4,6-triisopropylphenyl)phenyl]phosphane (Brettphos)	0.17
N-(dicyclohexylphosphino)-2-2′-tolylindole (Indole ligand)	0.37
1-(2,4,6-Trimethylphenyl)-2-(dicyclohexylphosphino)imidazole (CataXCium PICy)	0.57
2-Dicyclohexylphosphino-2',6'-dimethoxy-1,1'-bipheny (lSphos)	0.53
Butyldi-1-adamantylphosphine (CataCXium A)	3.30
PCy_3 HBF_4	1.60
N-phenyl-2-(di-*t*-butylphosphino)pyrrole (CataXCium PtB)	0.17
2-(Di-*t*-butylphosphino)biphenyl (JohnPhos)	0.06
1,2,3,4,5-Pentaphenyl-1'-(di-*t*-butylphosphino)ferrocene (QPhos)	2.08
PPh_3	0.08
RockyPhos	0



5. NMR Spectra

(naphtalen-1-ylmethyl)diphenylphosphine oxide 1d





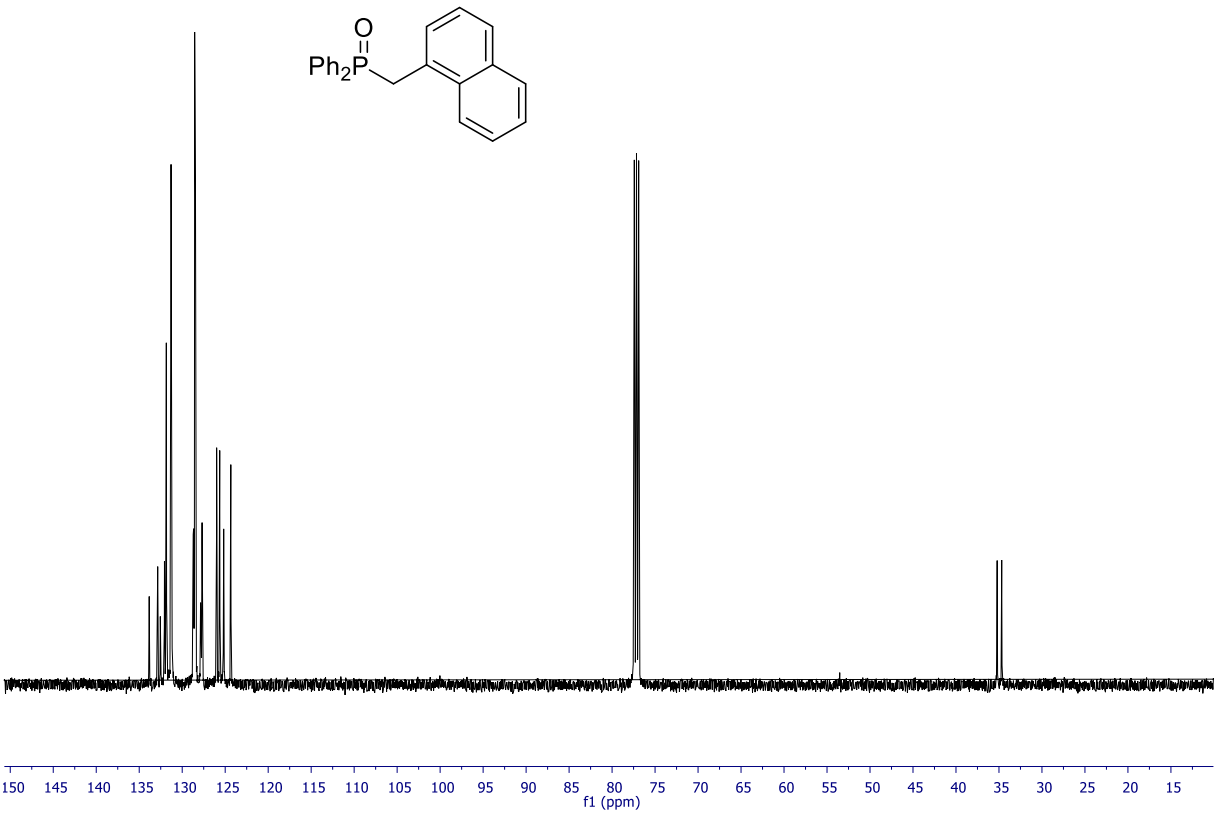
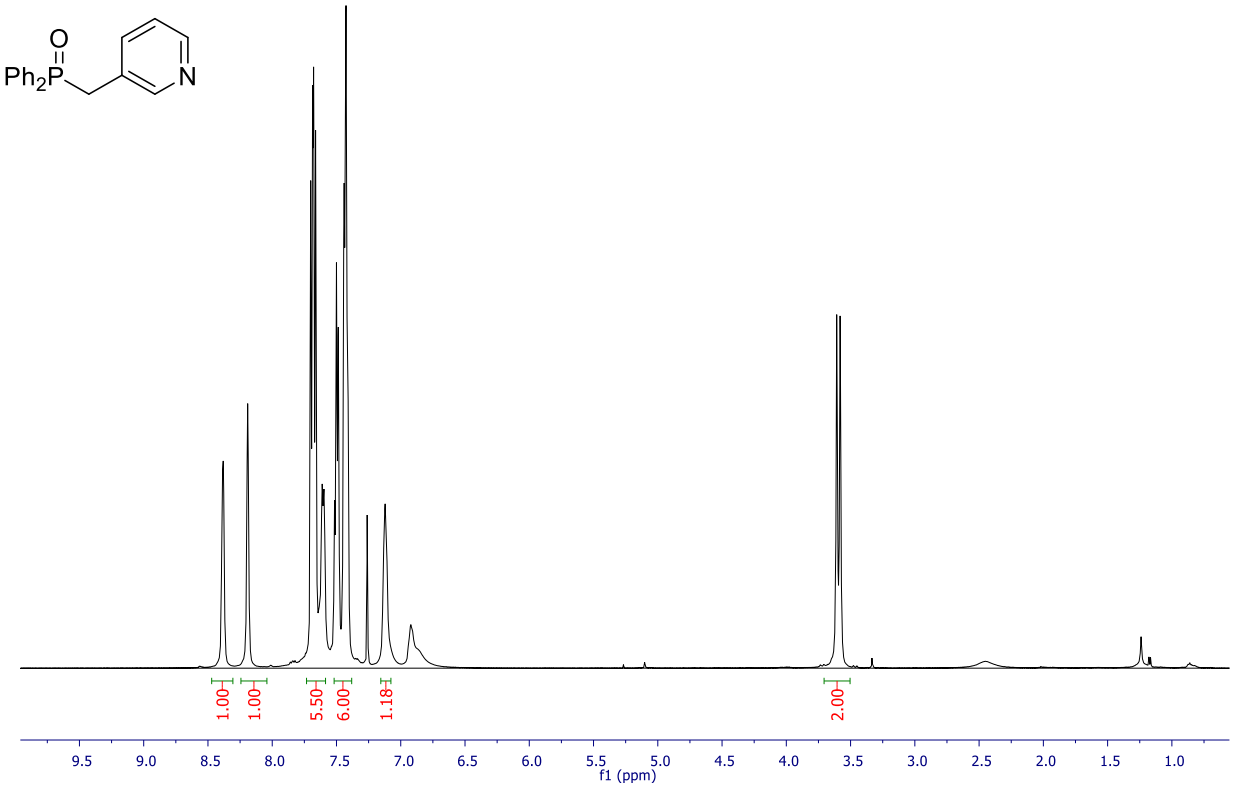
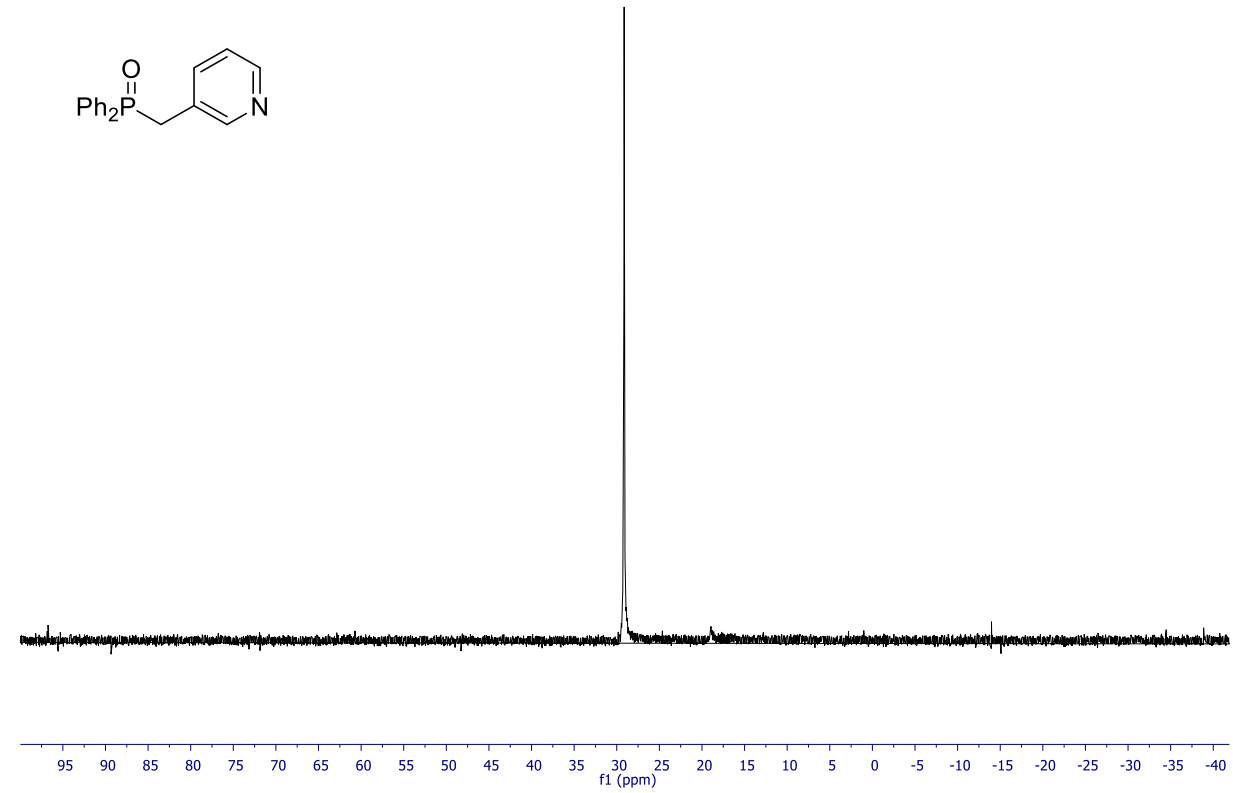


Figure S1. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 1d in $CDCl_3$.

(pyridine-3-ylmethyl)diphenylphosphine oxide 1f





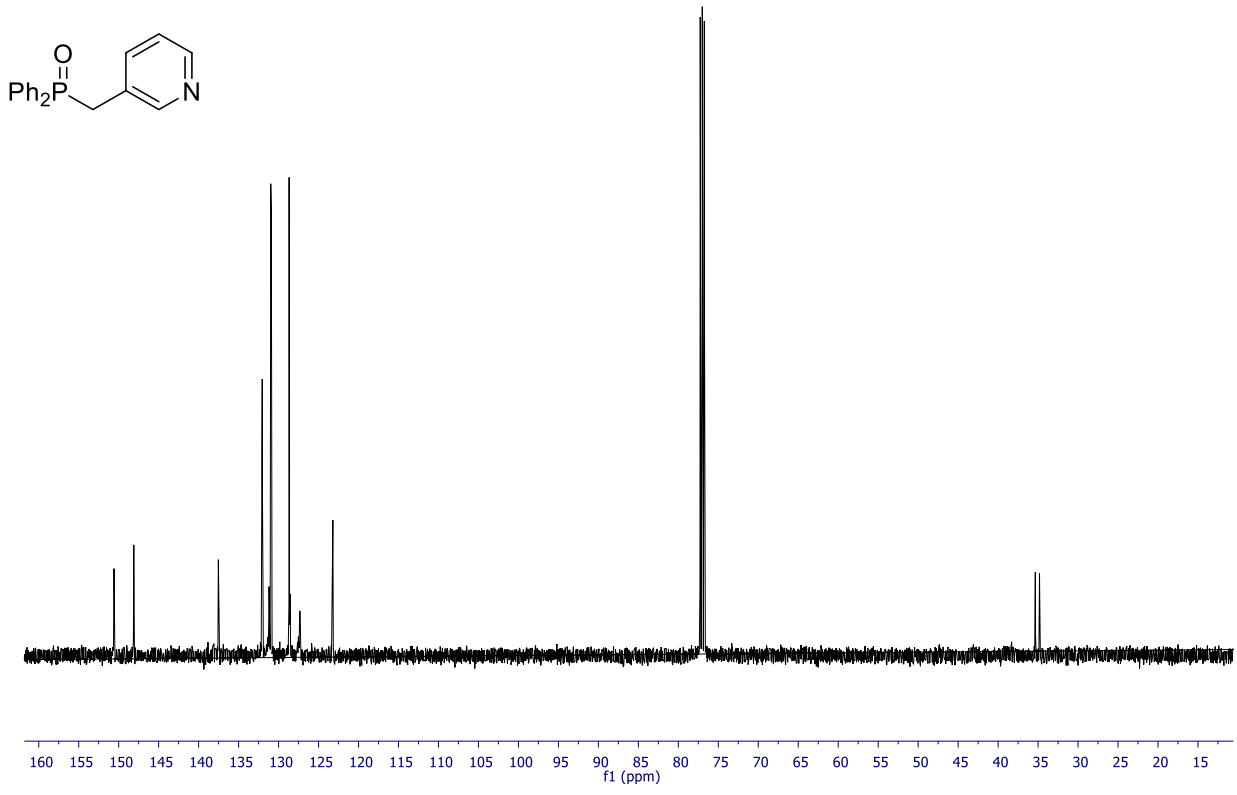
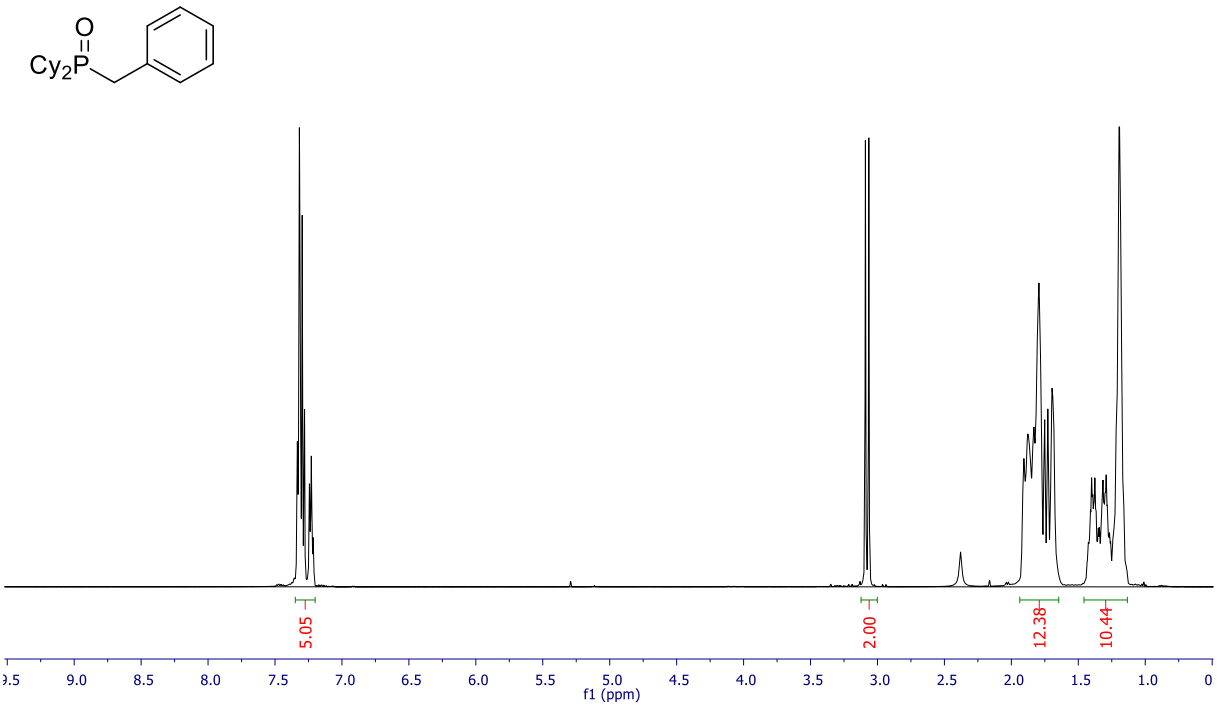
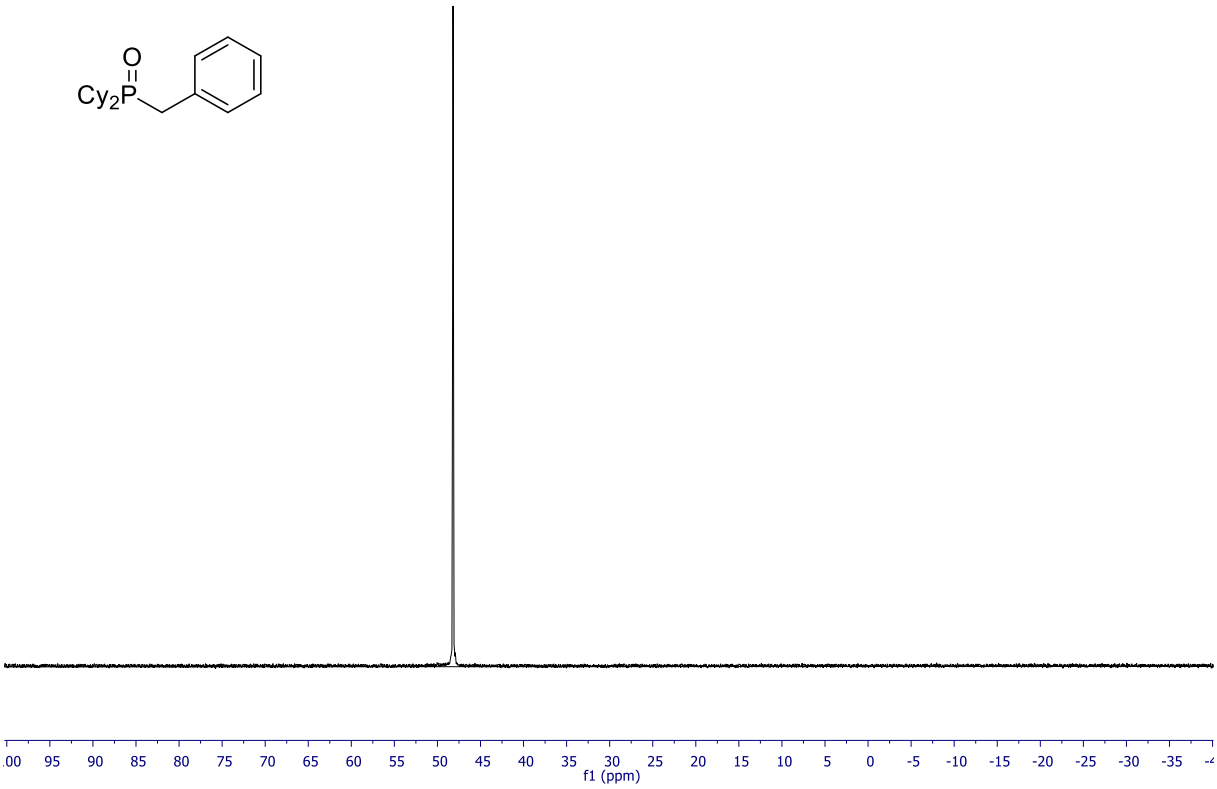


Figure S2. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 1f in $CDCl_3$.

benzyl dicyclohexylphosphine oxide 1g





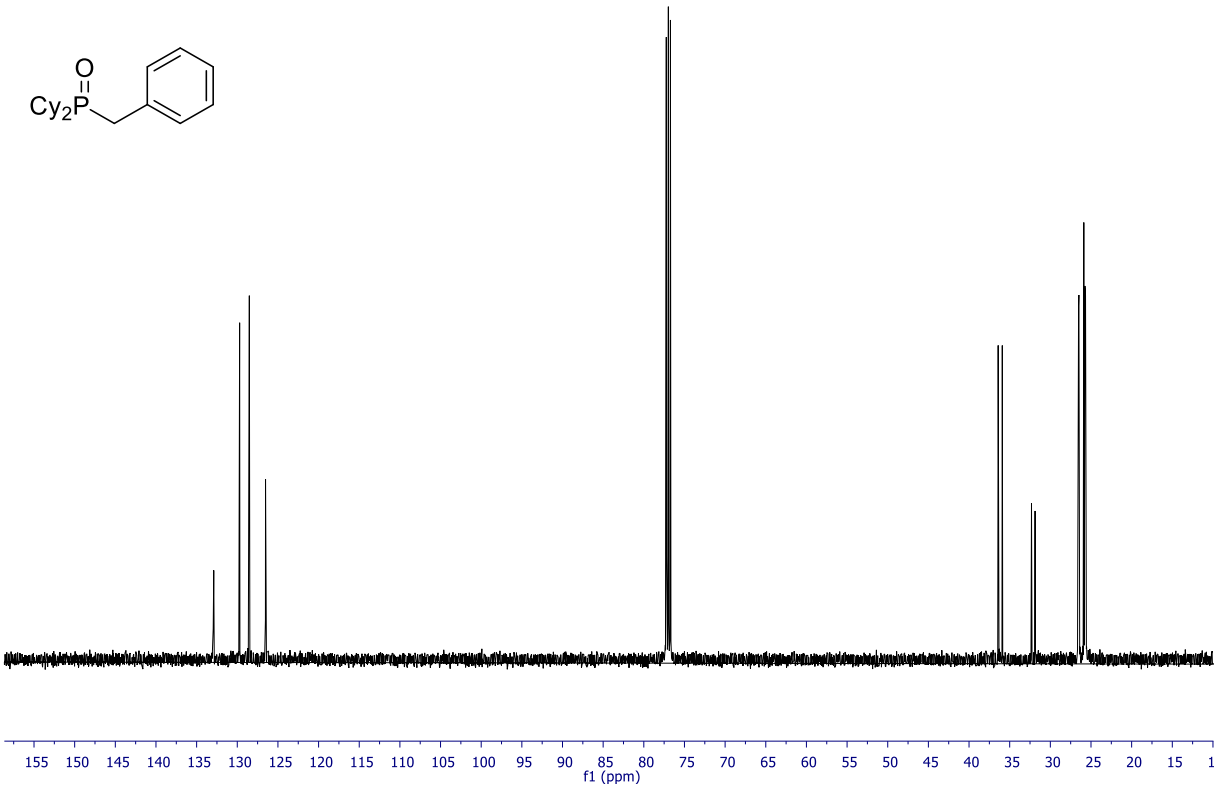
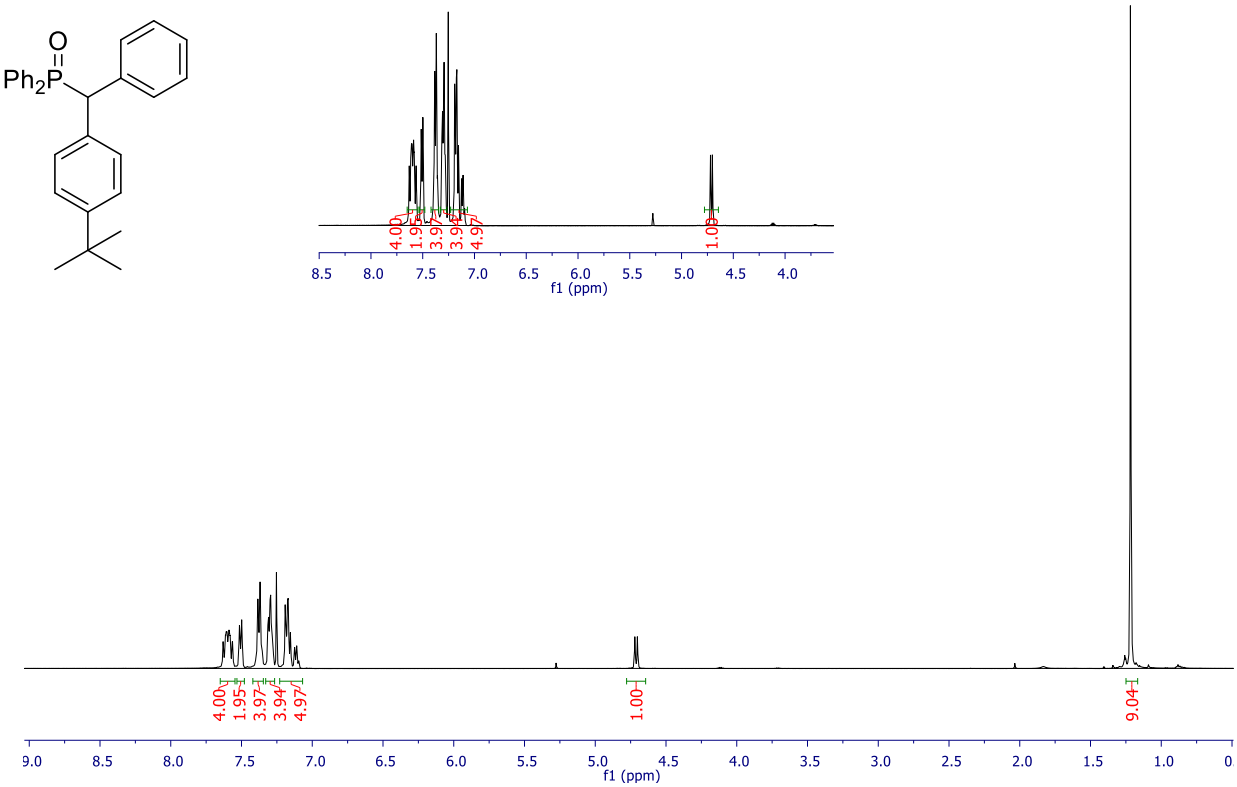
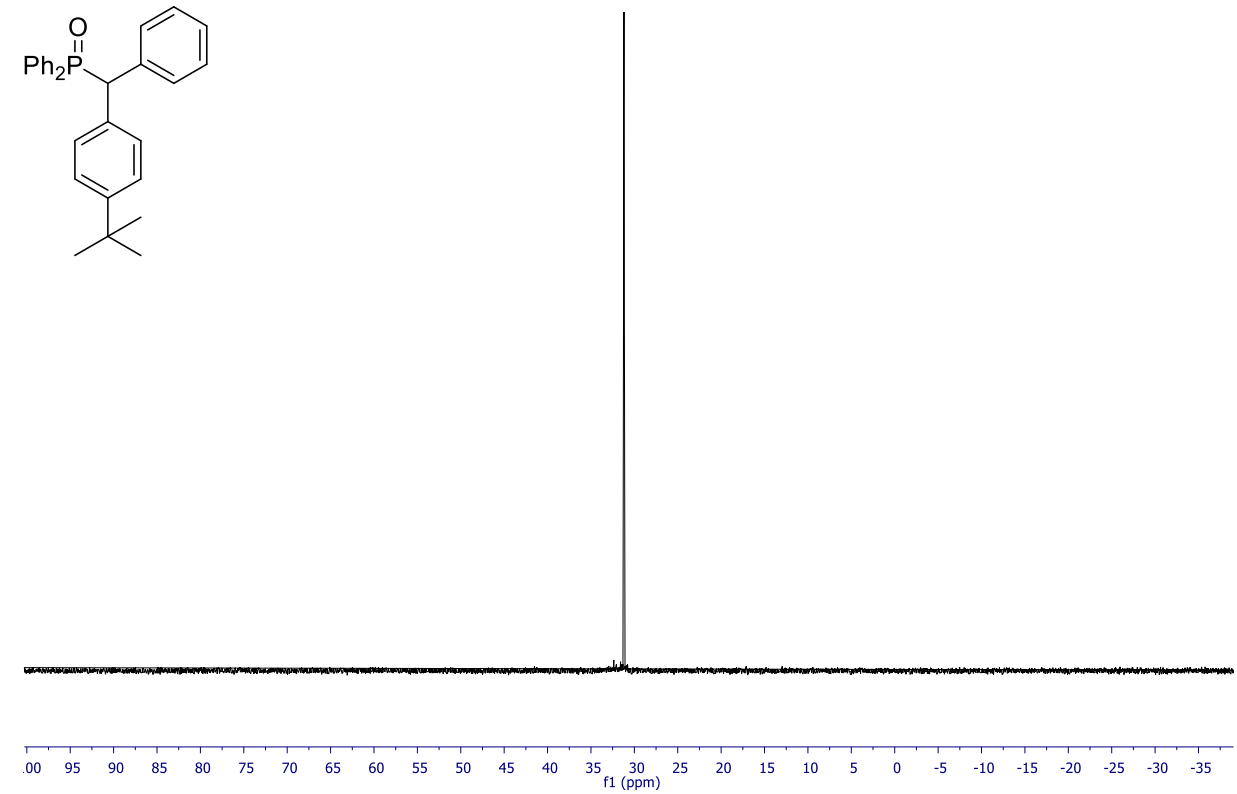


Figure S3. ^{1}H (500 MHz), $^{31}P\{^{1}H\}$ (121 MHz) and $^{13}C\{^{1}H\}$ (125 MHz) NMR spectra of 1g in $CDCl_3$.

((4-(tert-butyl)phenyl)(phenyl)methyl)diphenylphosphine oxide 3a





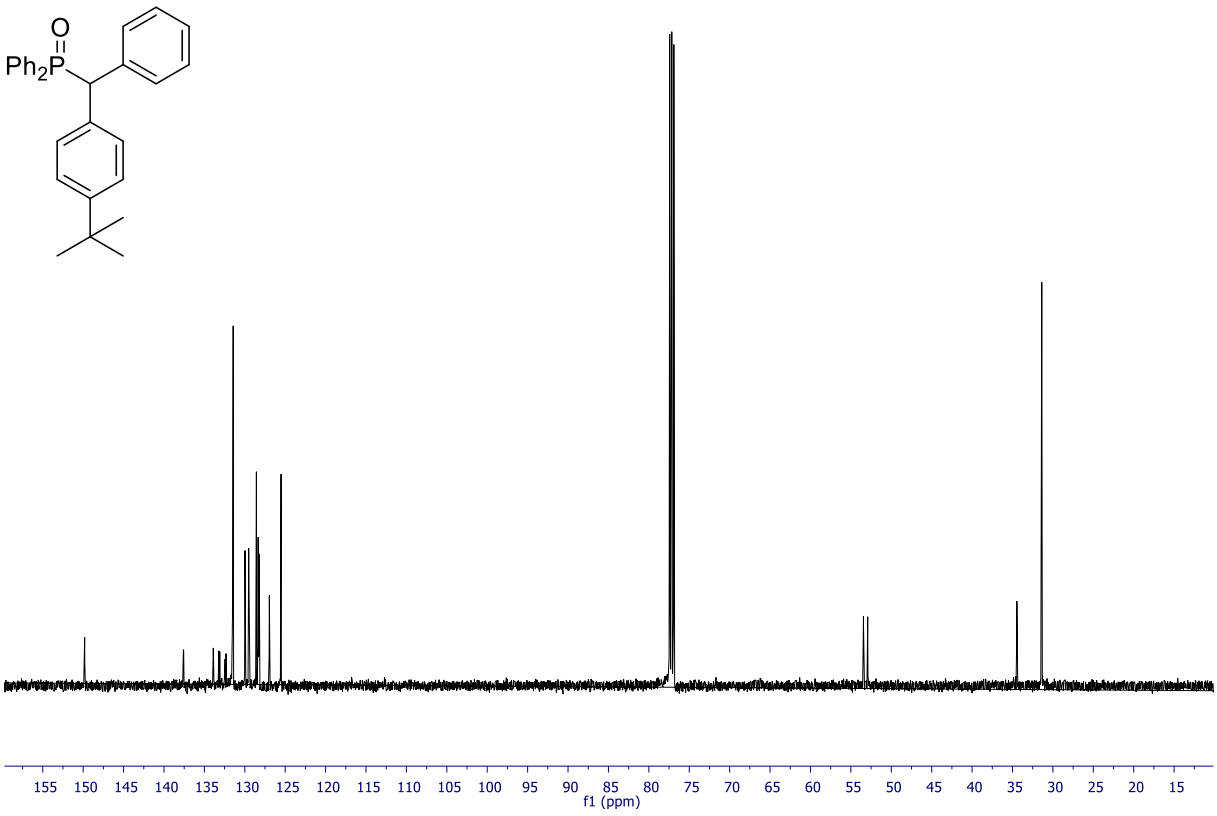
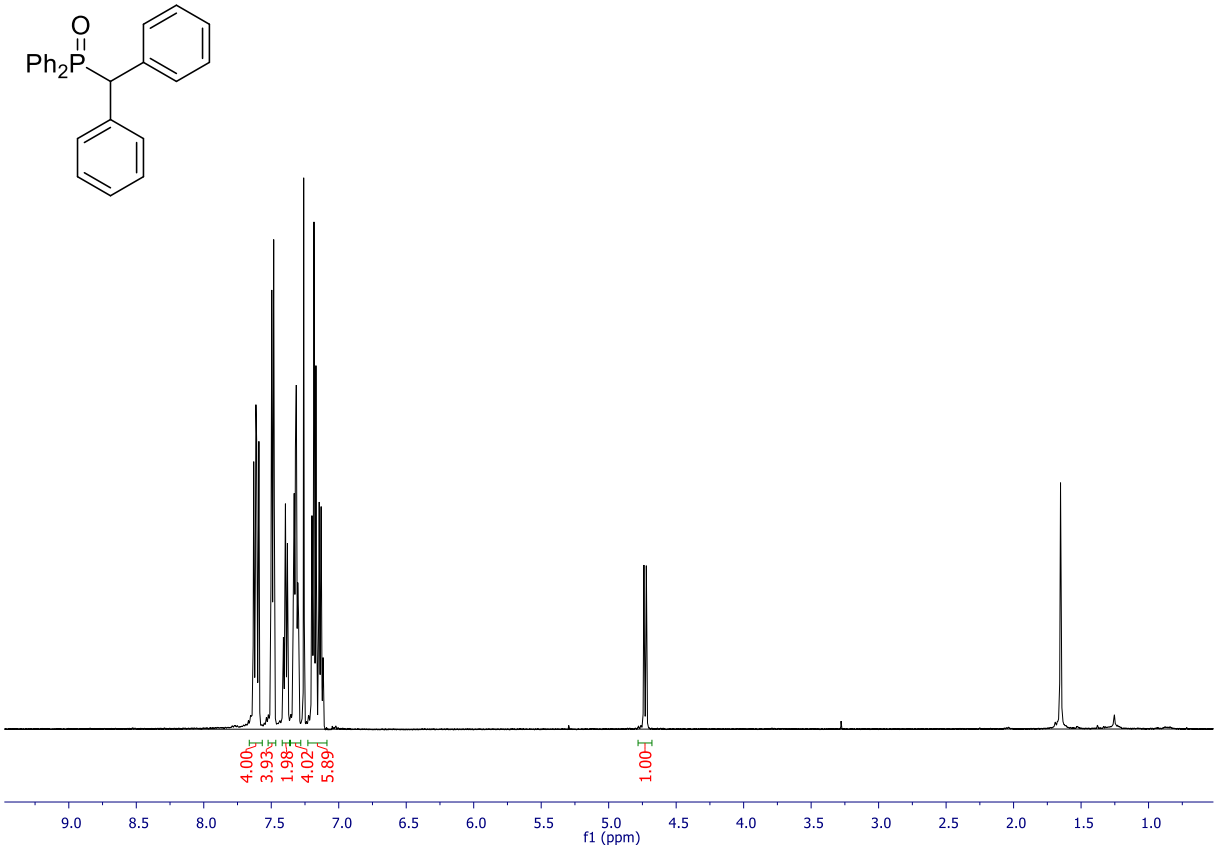
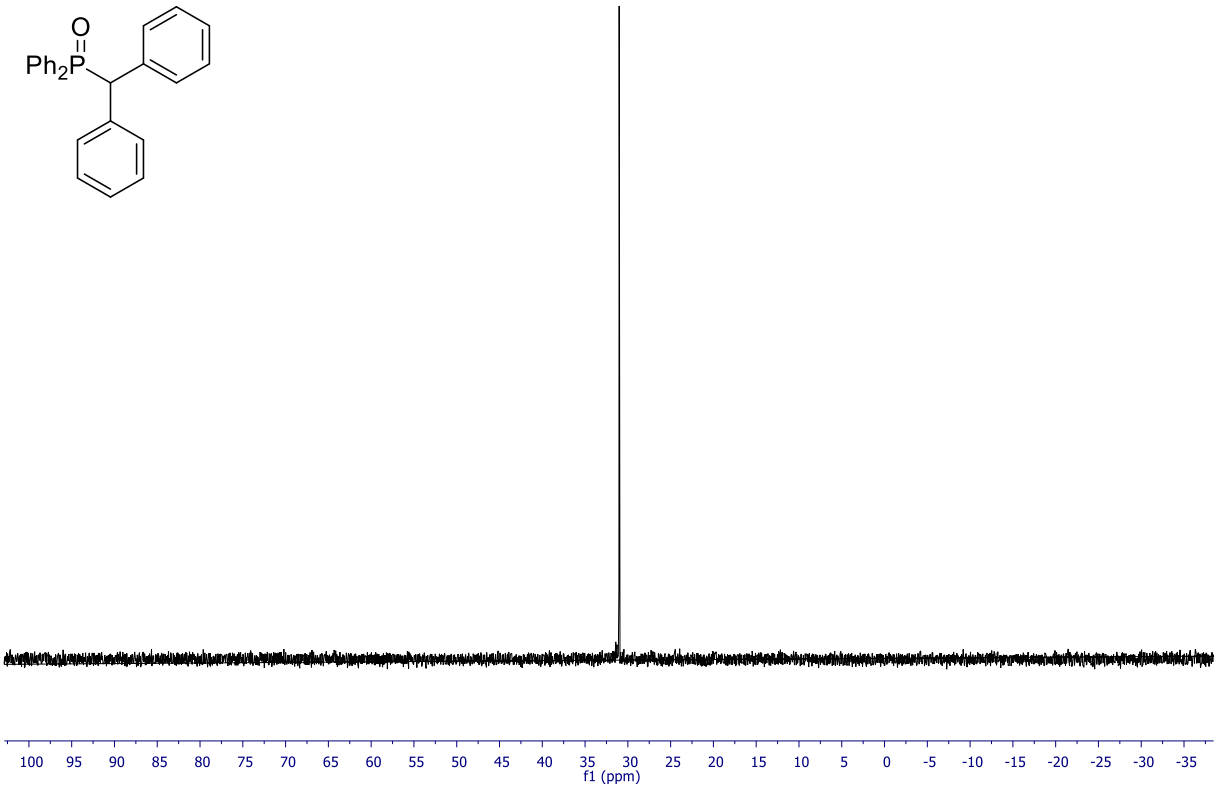


Figure S4. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 3a in $CDCl_3$.

benzydryldiphenylphosphine oxide 3b





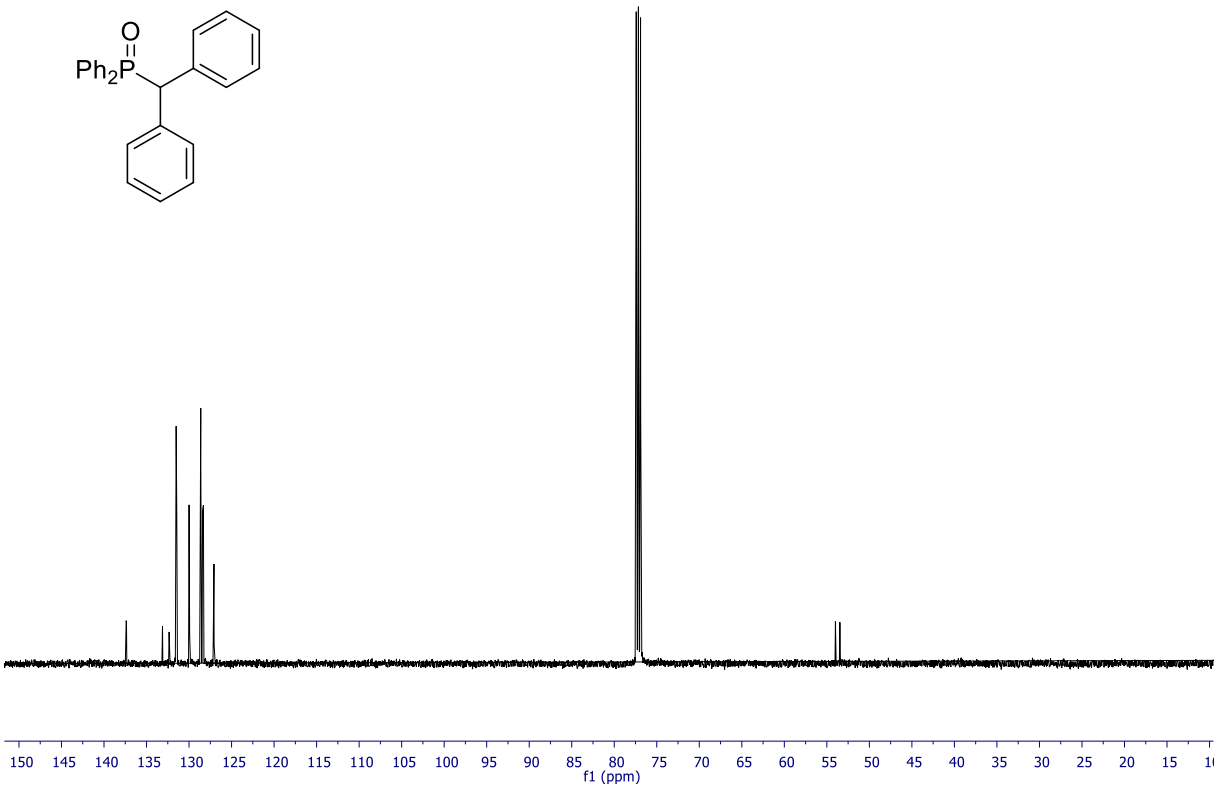
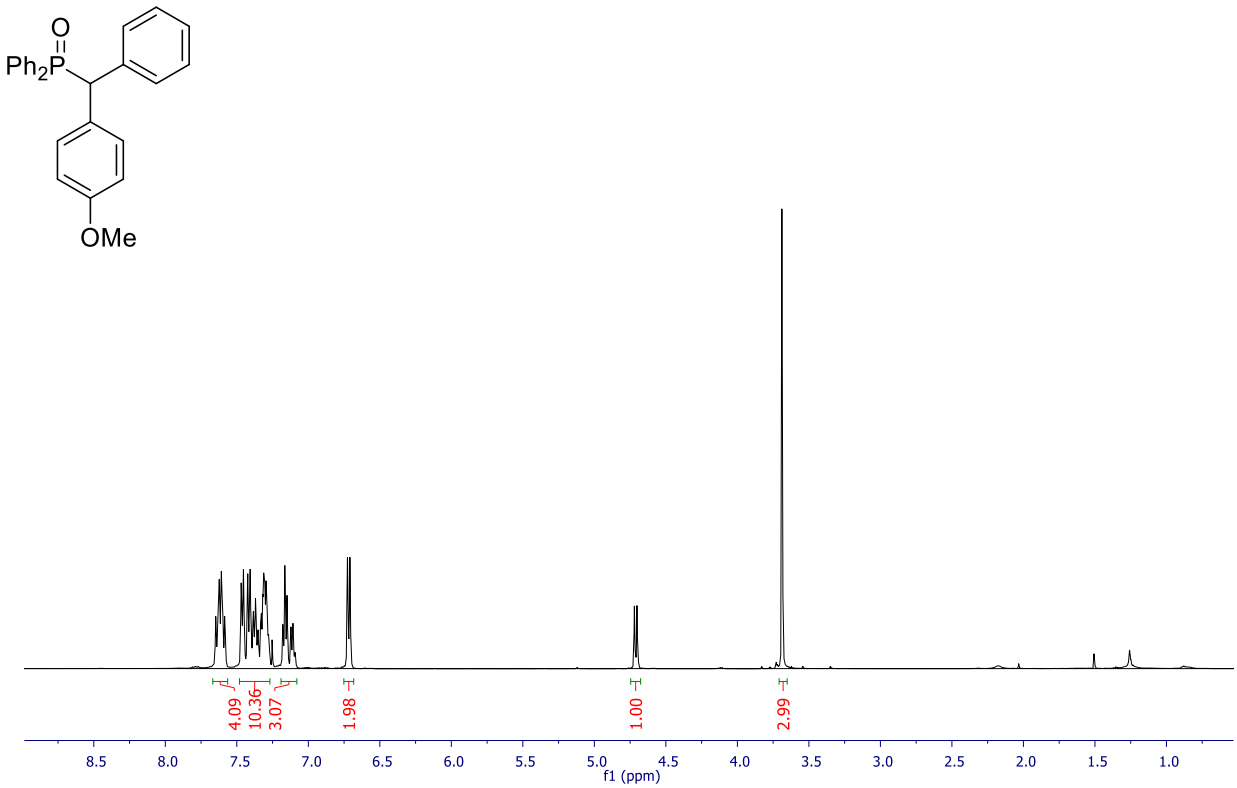
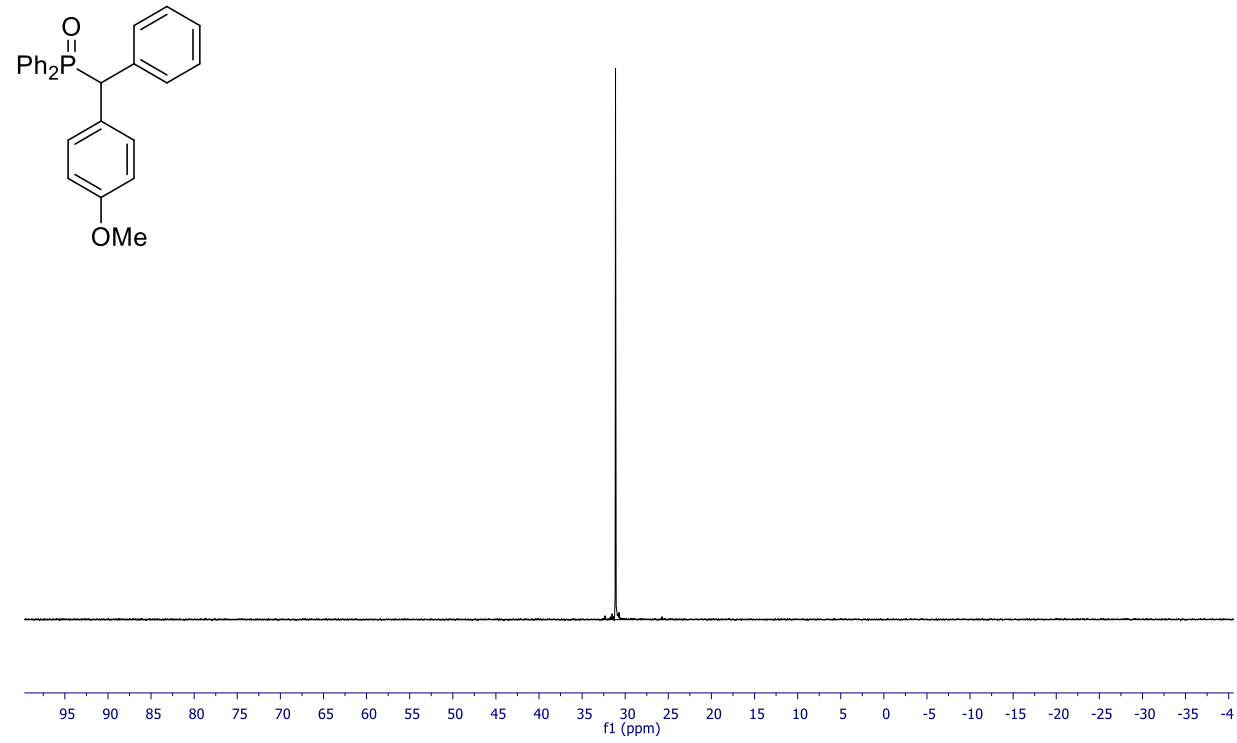


Figure S5. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 3b in $CDCl_3$.

((4methoxyphenyl)(phenyl)methyl)diphenylphosphine oxide 3c





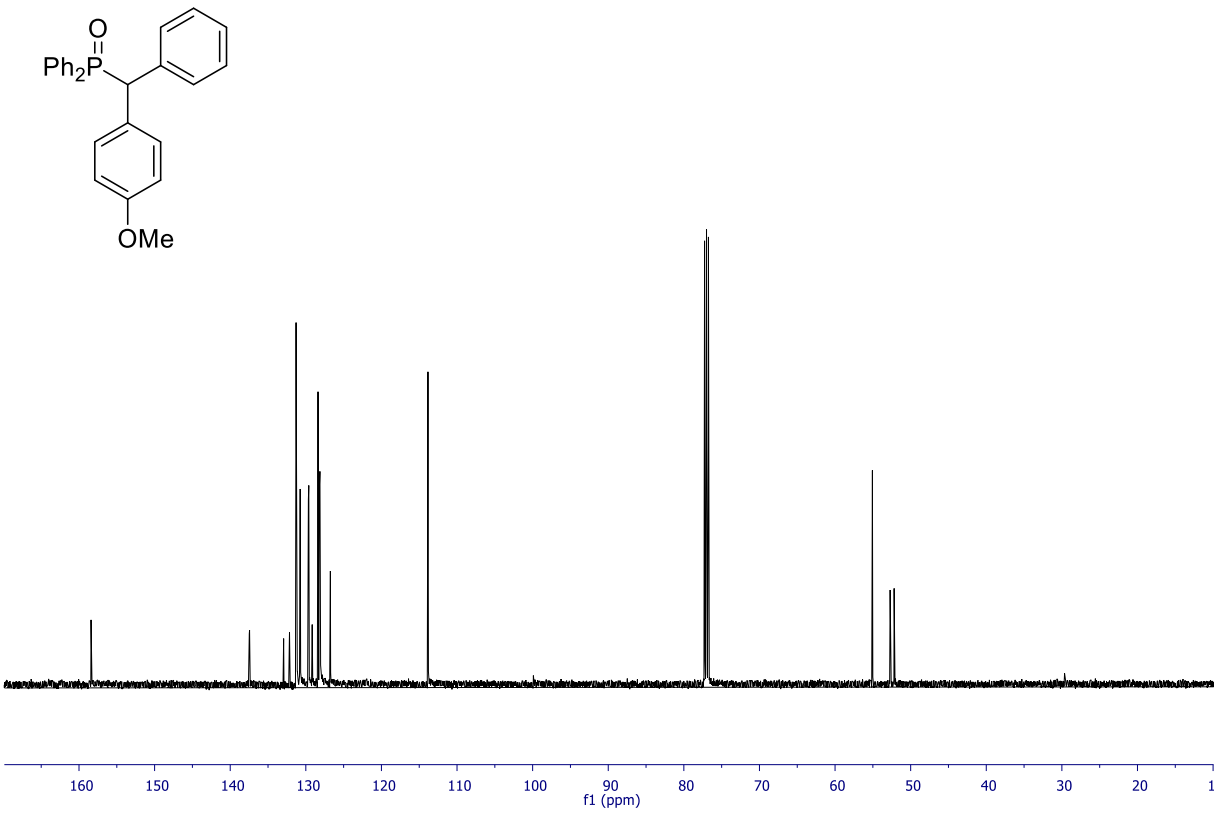
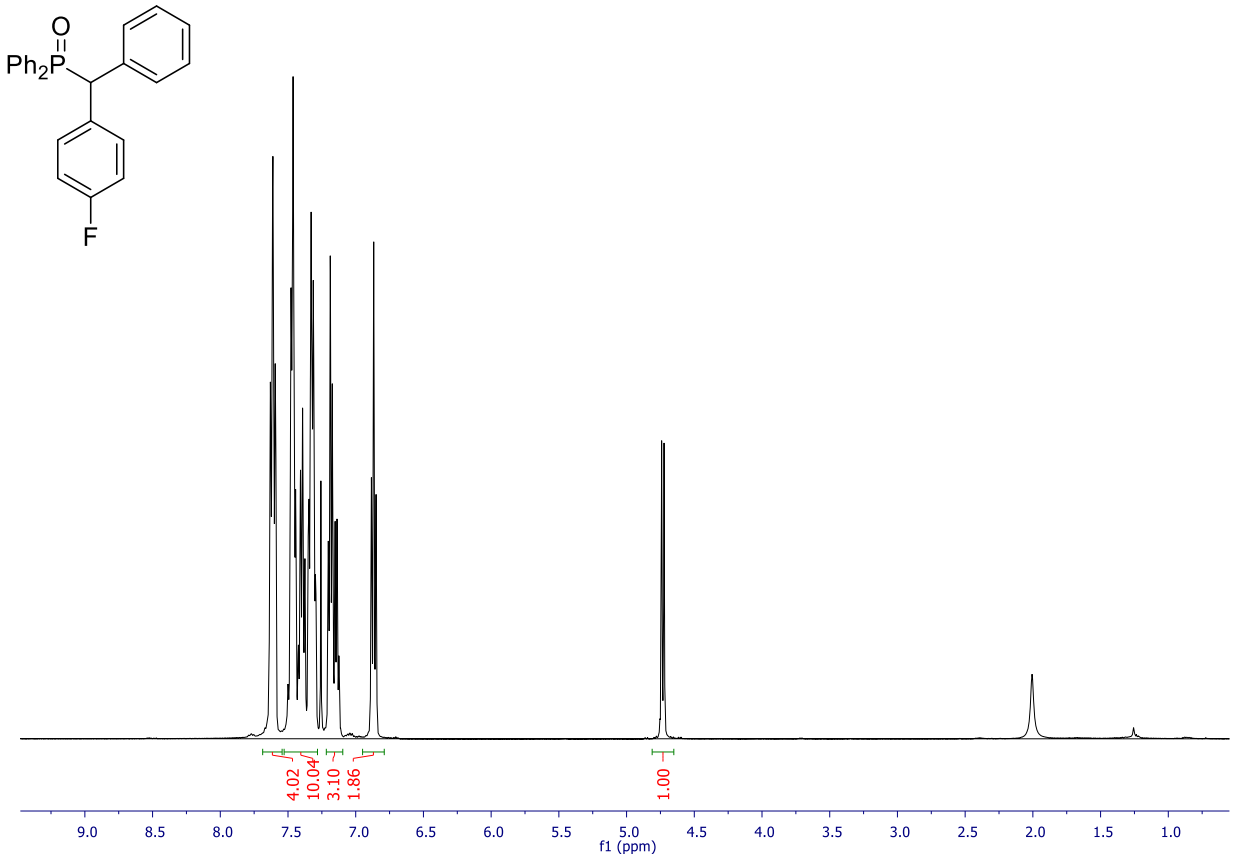
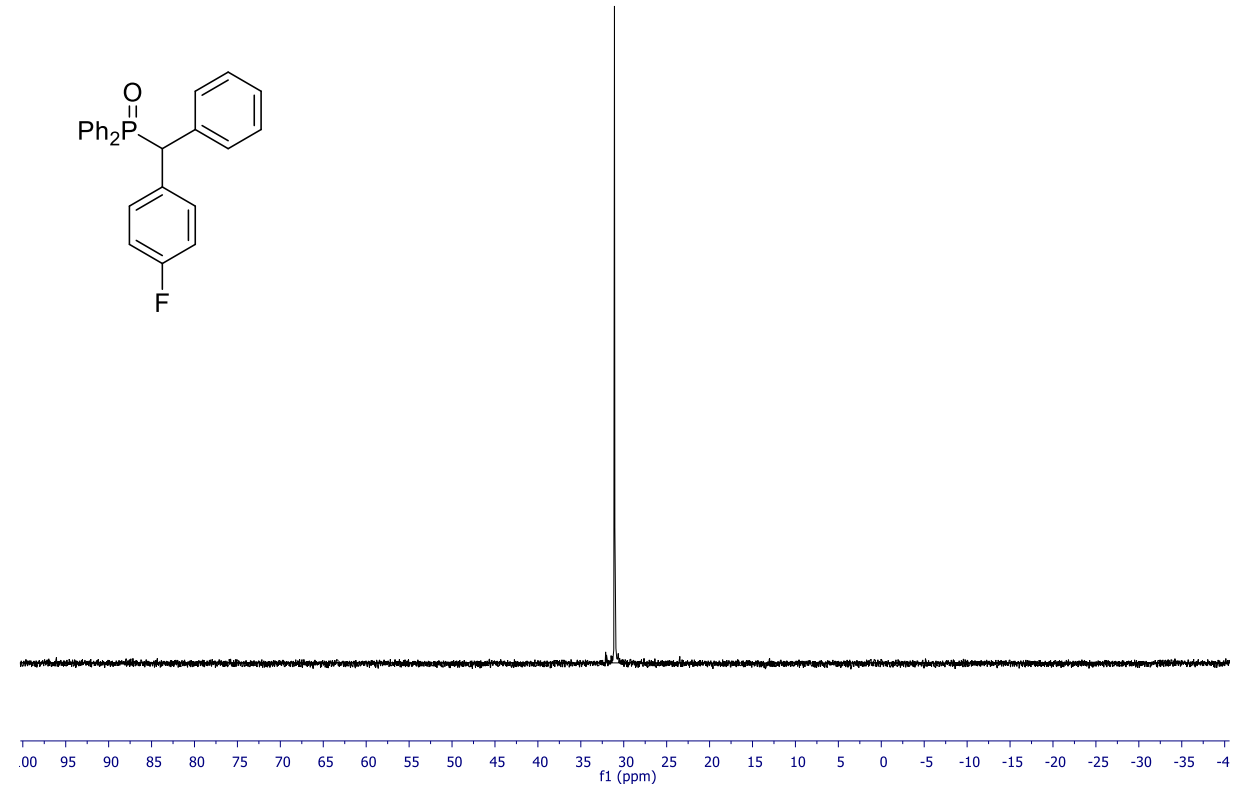


Figure S6. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 3c in $CDCl_3$.

((4-fluorophenyl)(phenyl)methyl)diphenylphosphine oxide 3d





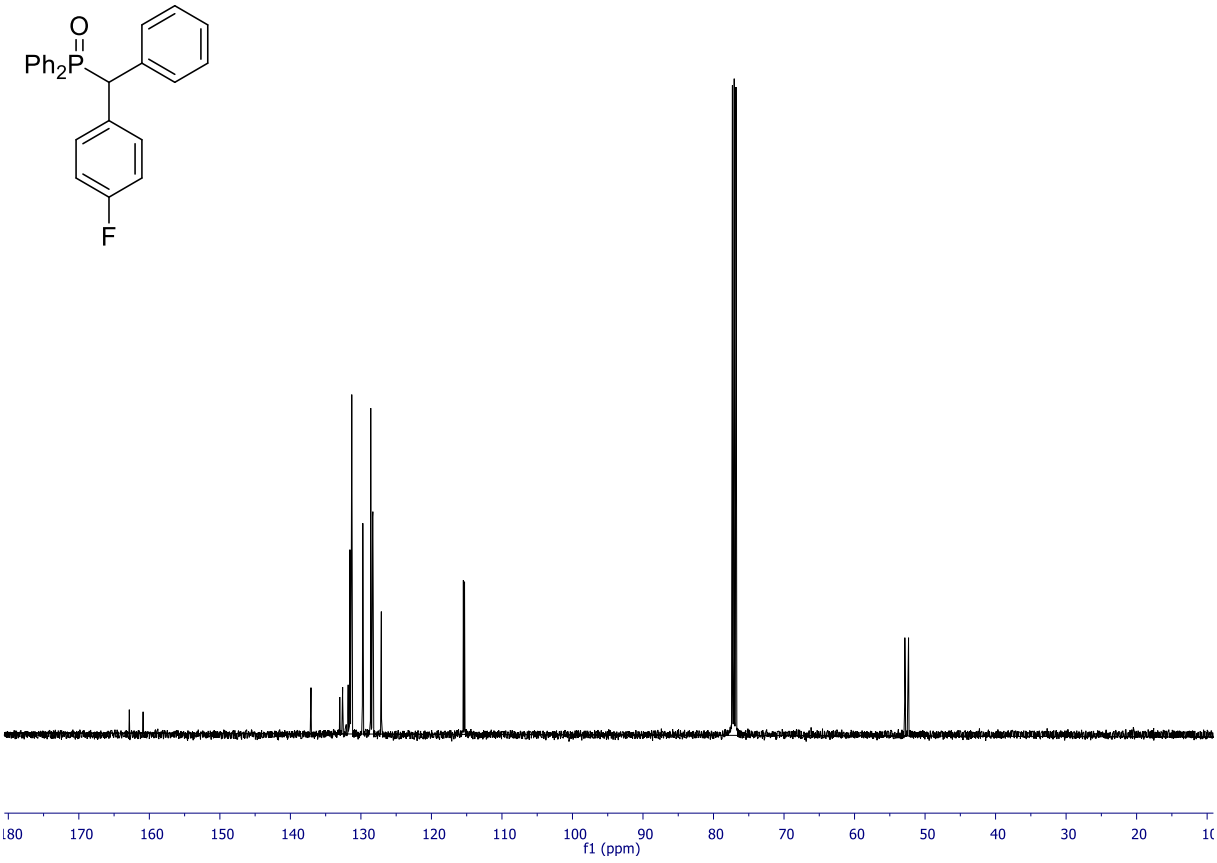
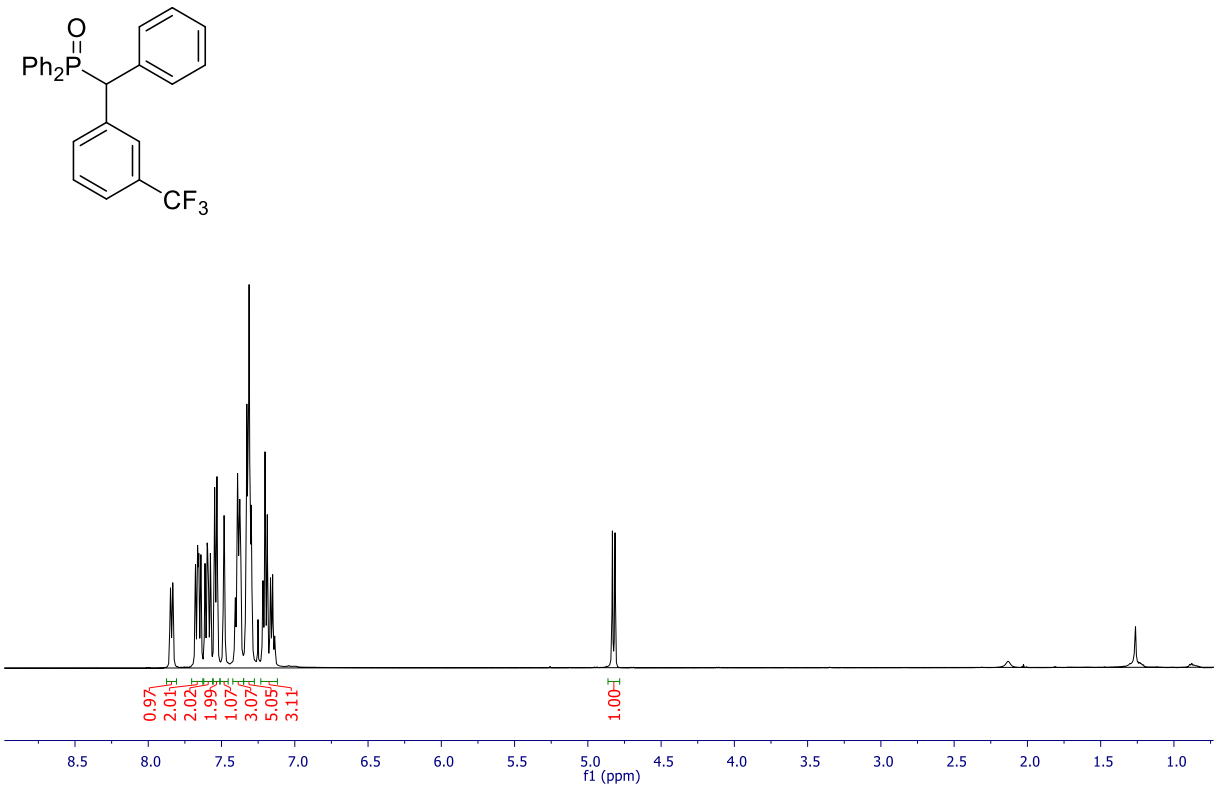
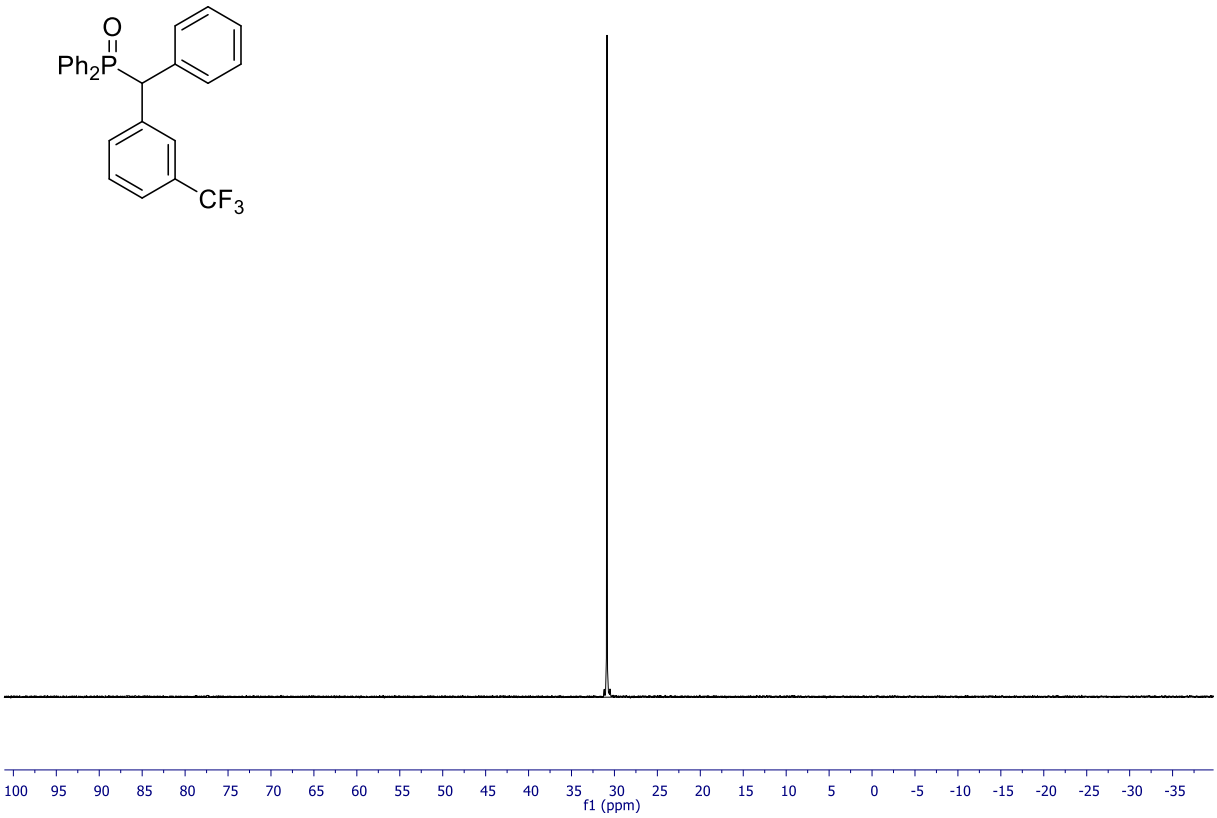


Figure S7. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 3d in $CDCl_3$.

((3-trifluorophenyl)(phenyl)methyl)diphenylphosphine oxide 3e





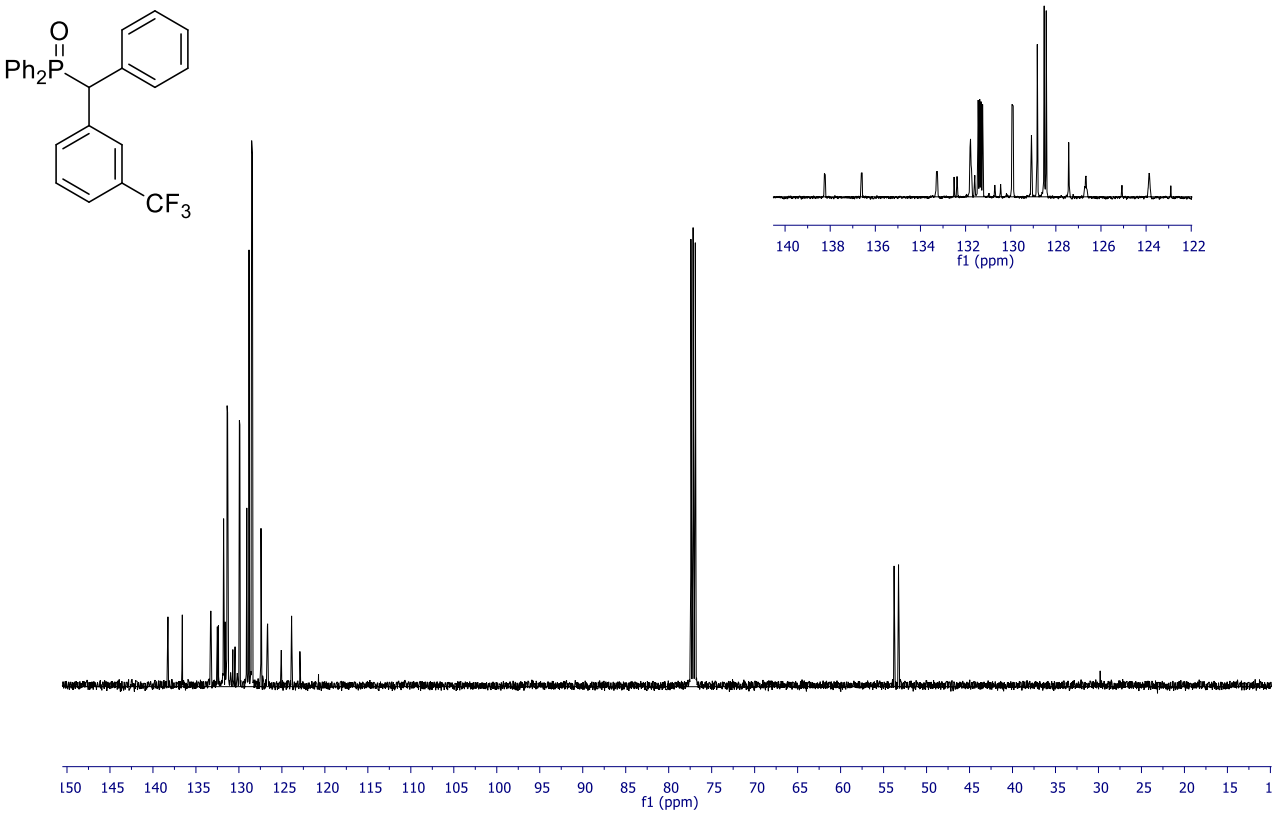
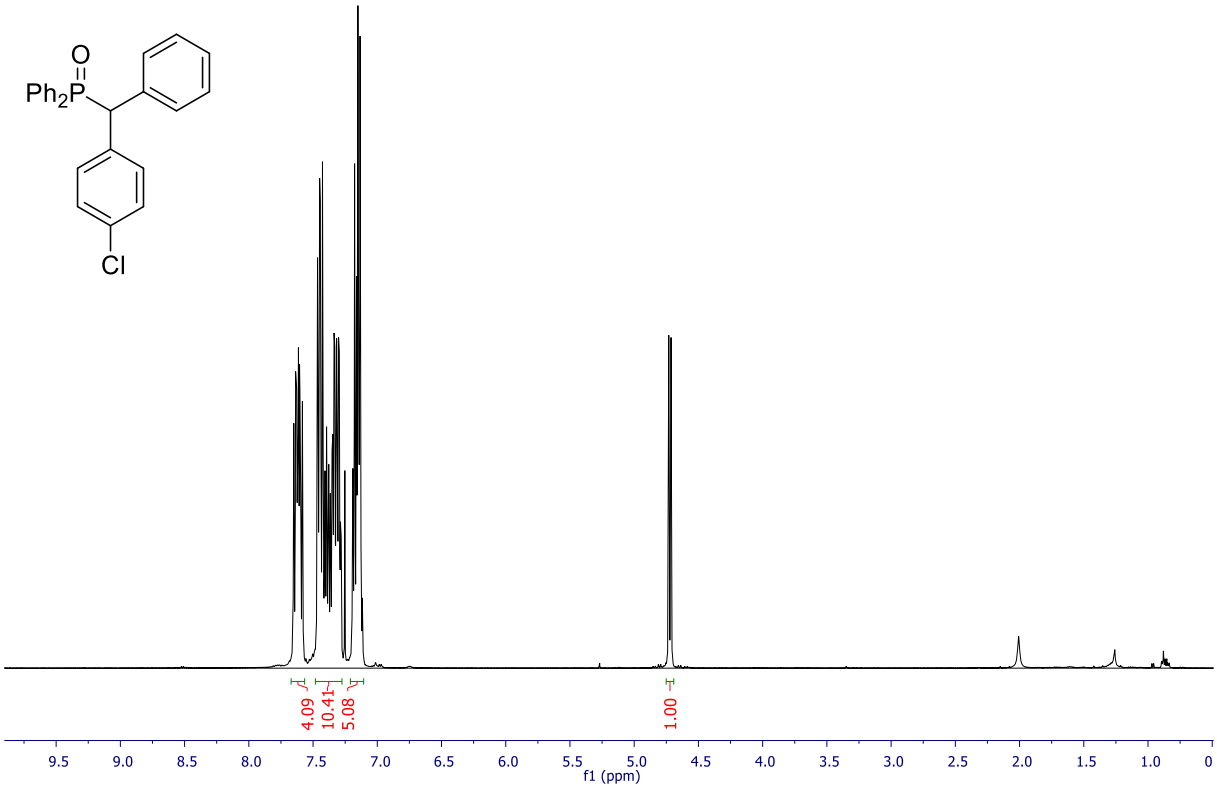
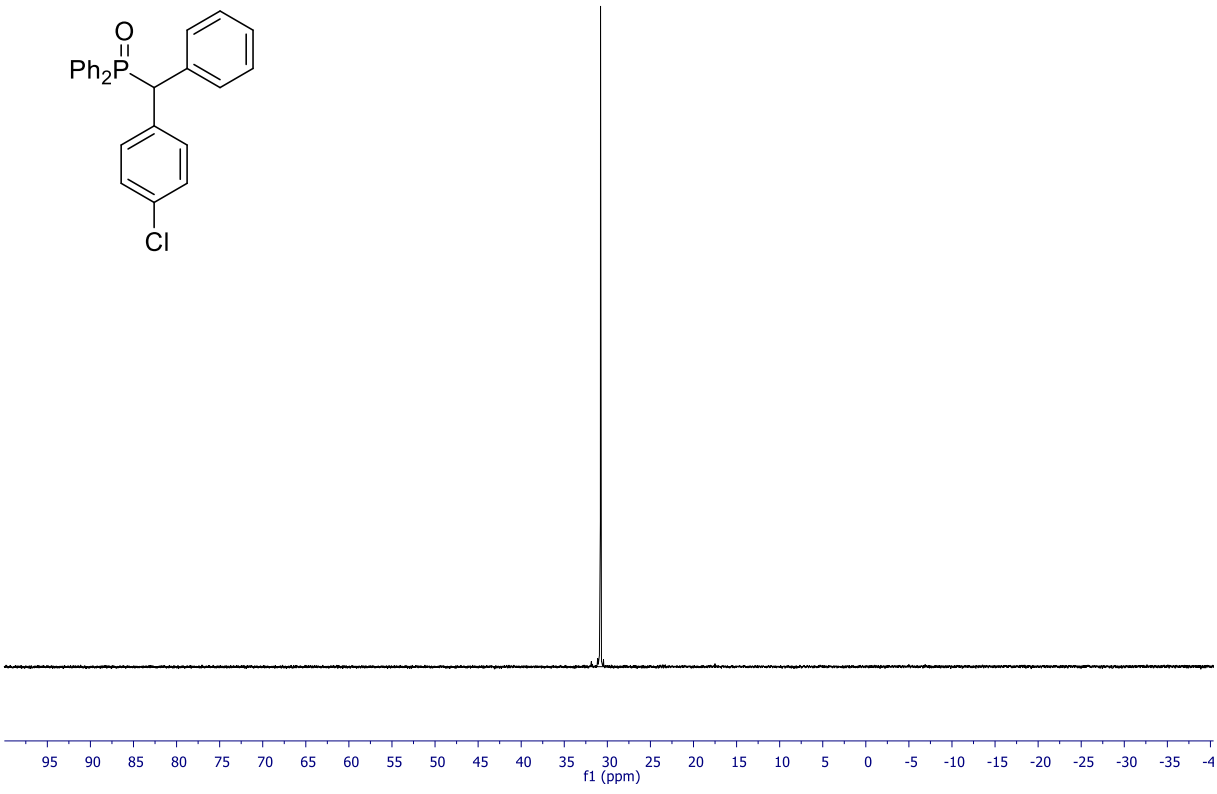


Figure S8. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 3e in $CDCl_3$.

((4chlorophenyl)(phenyl)methyl)diphenylphosphine oxide 3f





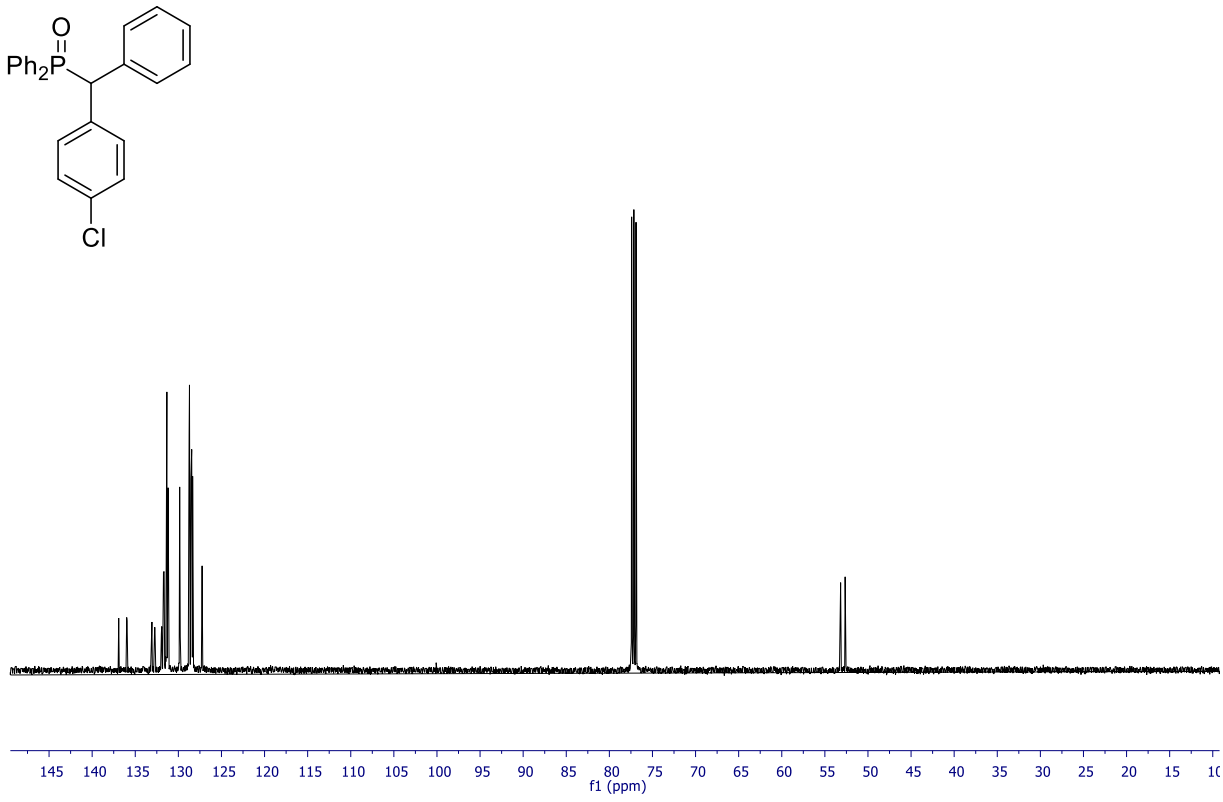
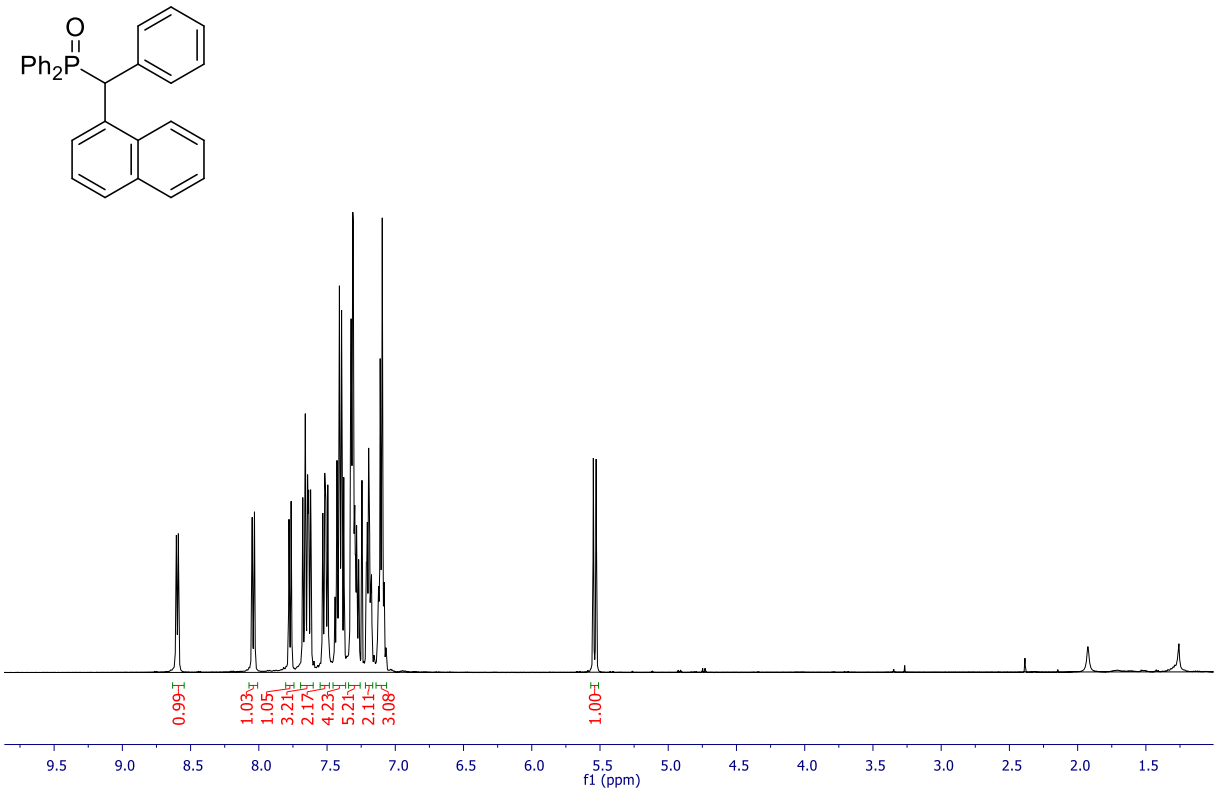
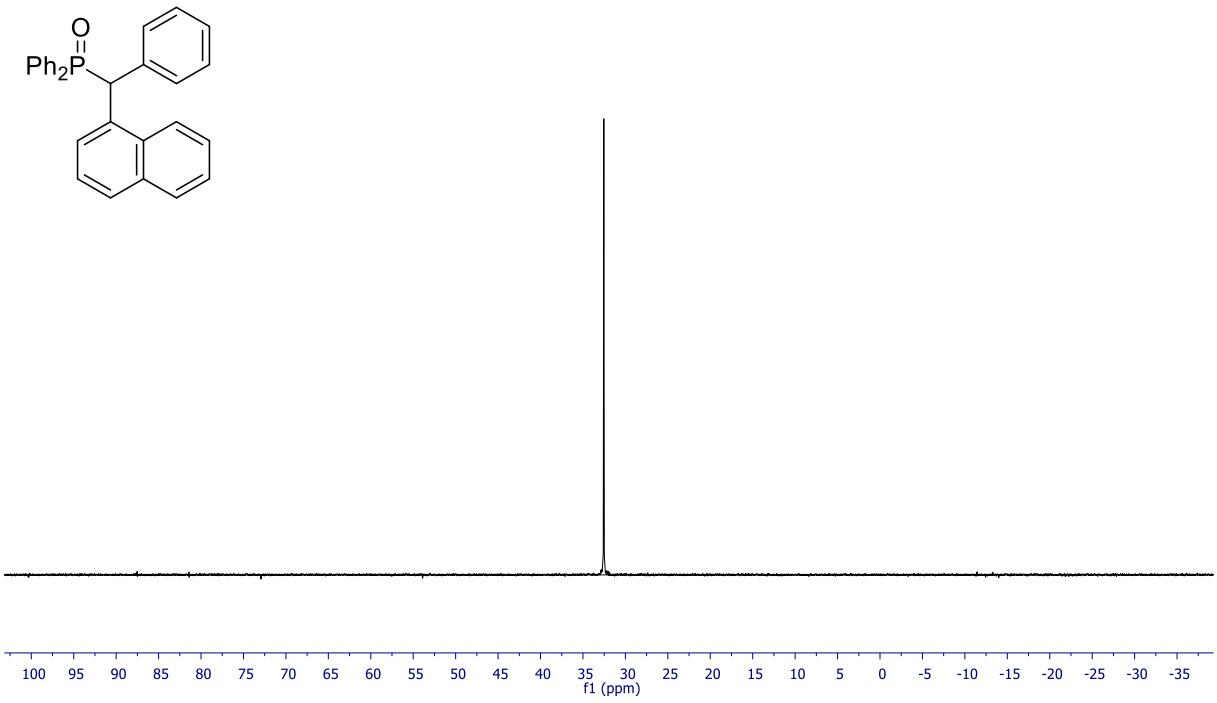


Figure S9. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 3f in $CDCl_3$.

(naphthalen-1-yl)(phenyl)methyl)diphenylphosphine oxide 3g





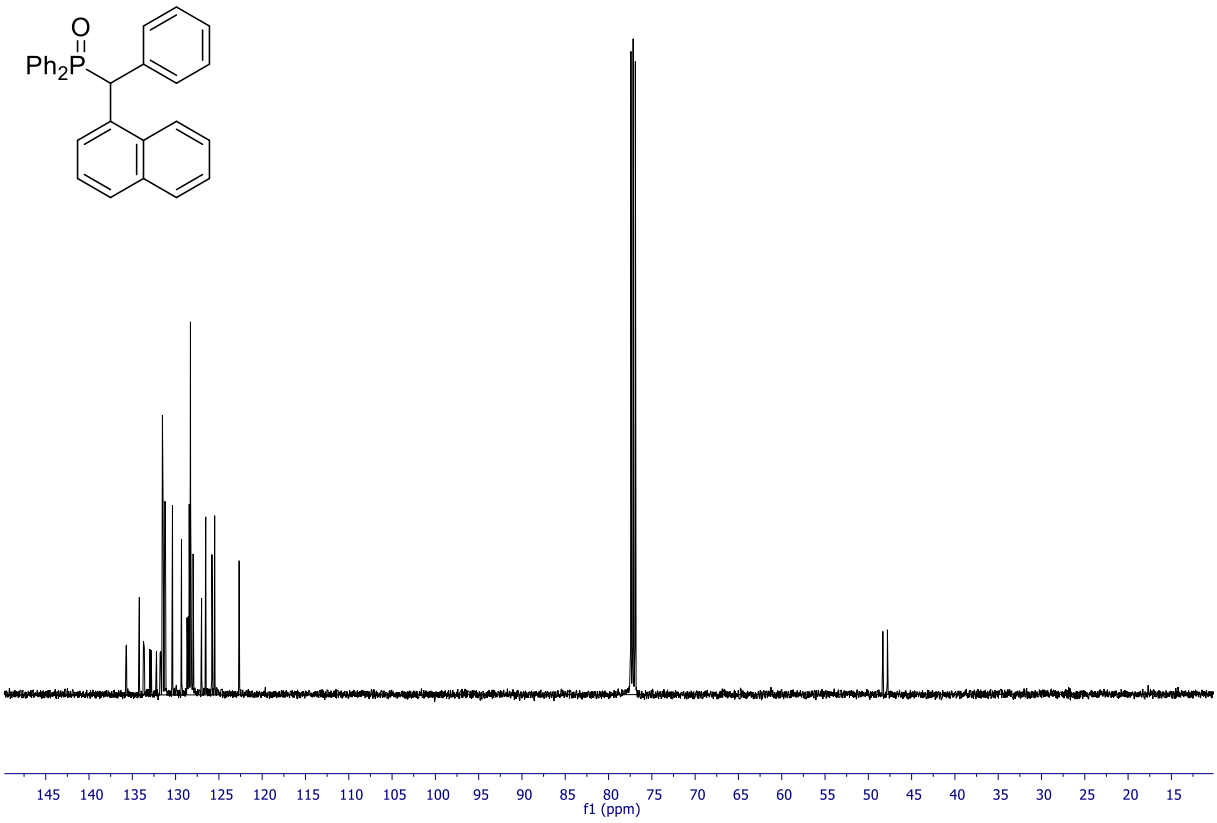
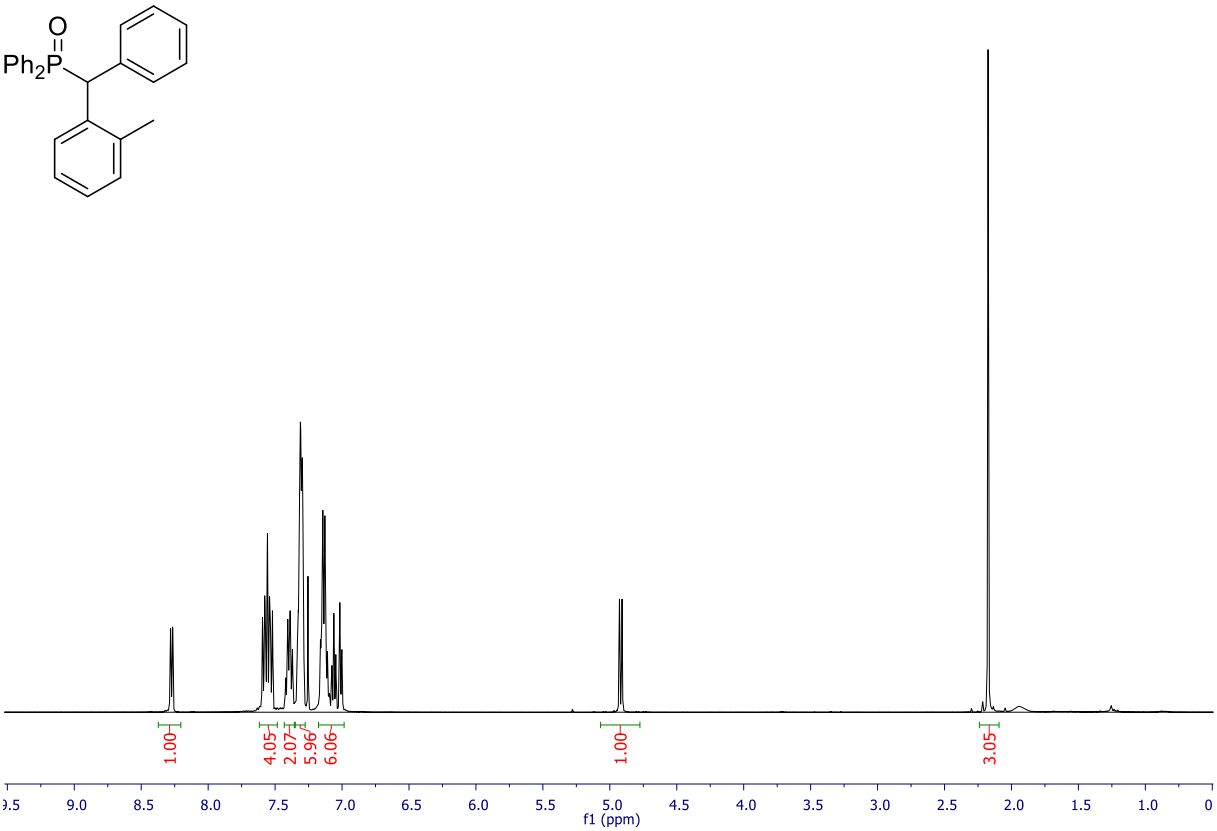
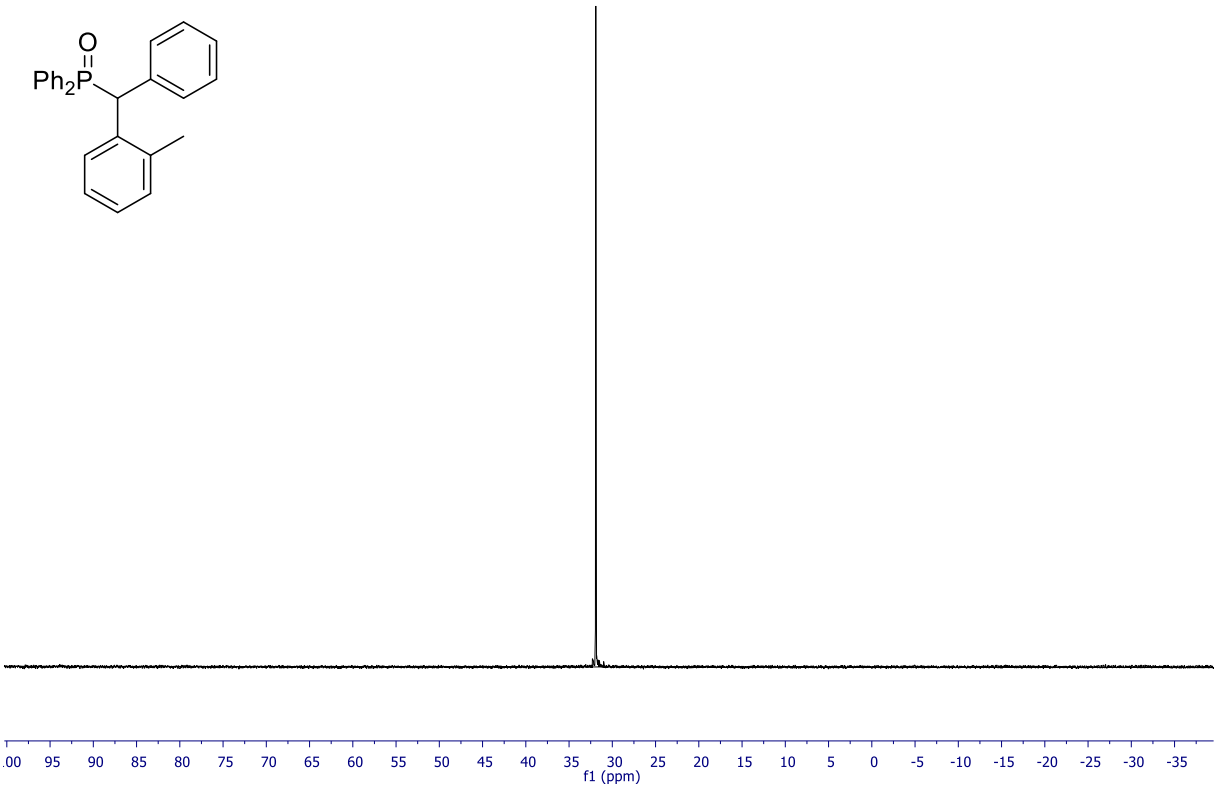


Figure S10. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 3g in $CDCl_3$.

(phenyl(*o*-tolyl)methyl)diphenylphosphine oxide 3h





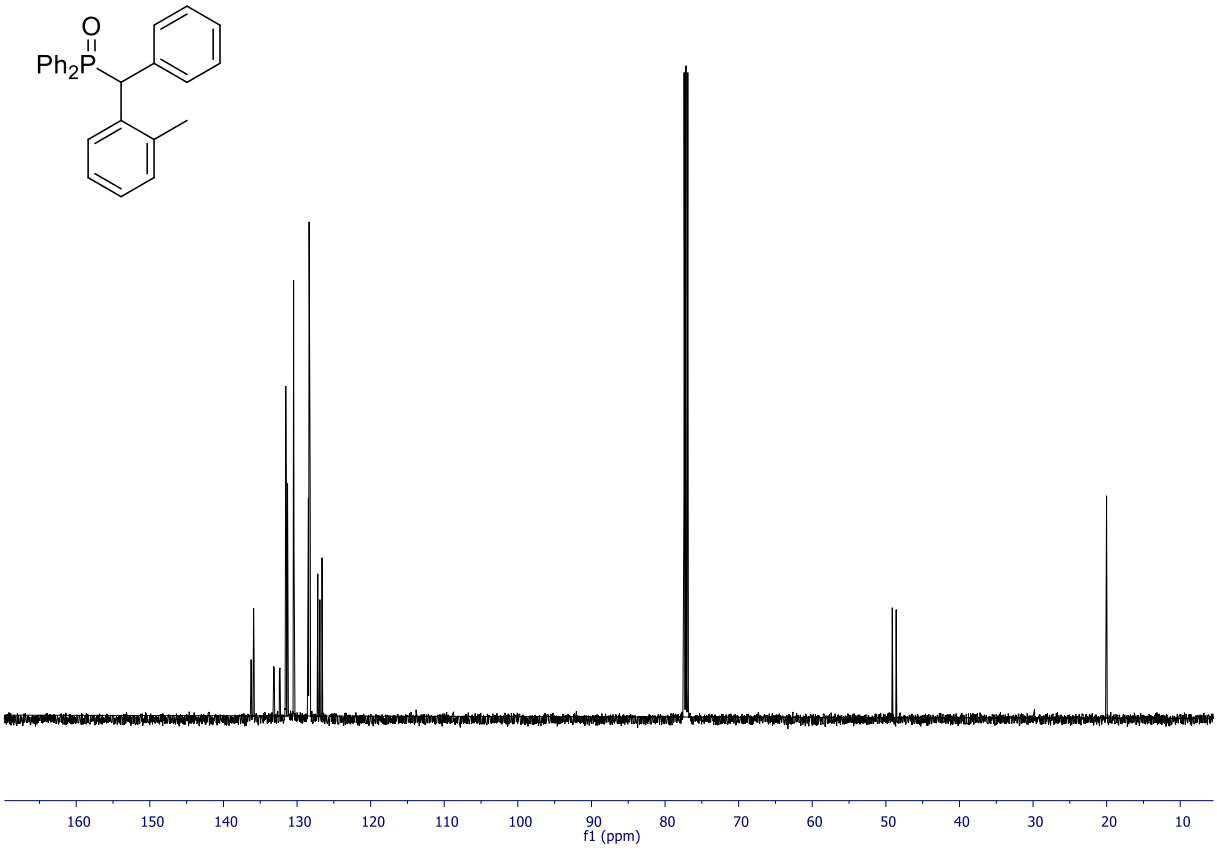
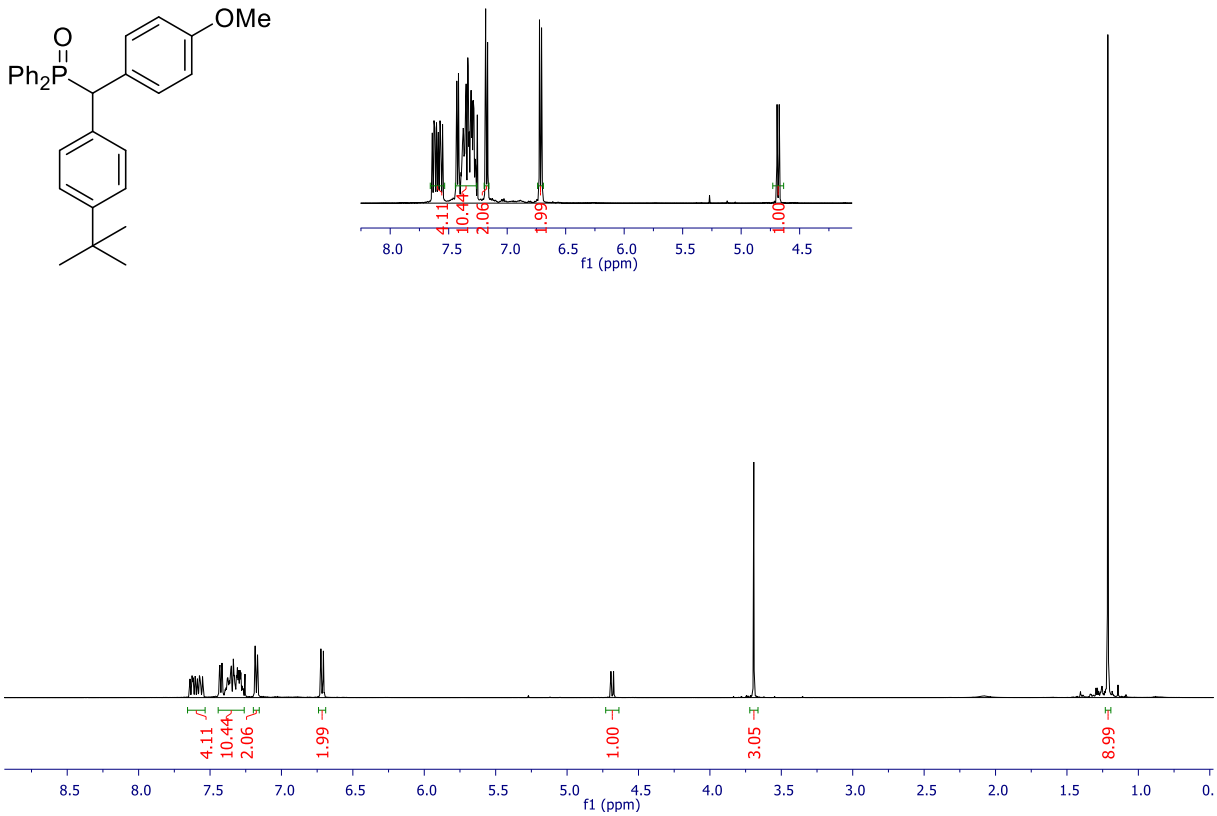
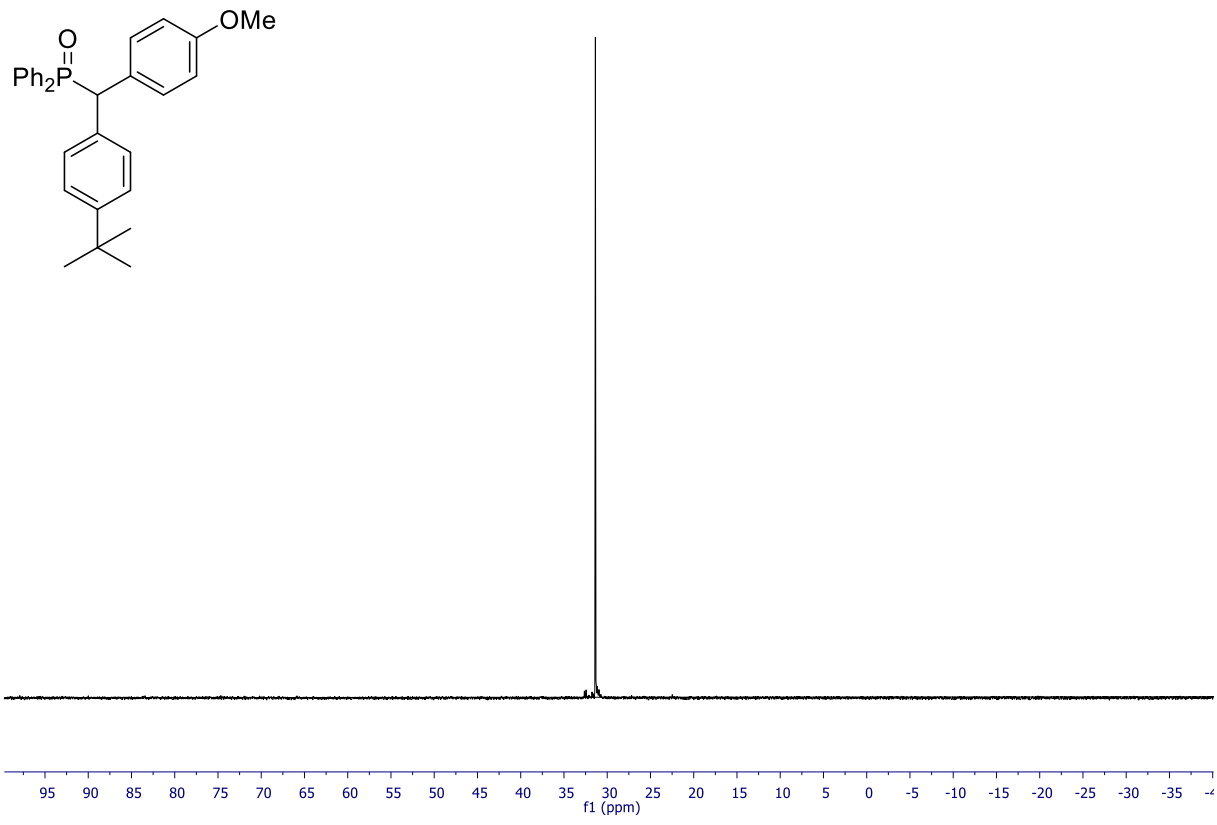


Figure S11. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 3h in $CDCl_3$.

((4-(tert-butyl)phenyl)(4-methoxyphenyl)methyl)diphenylphosphine oxide 3i





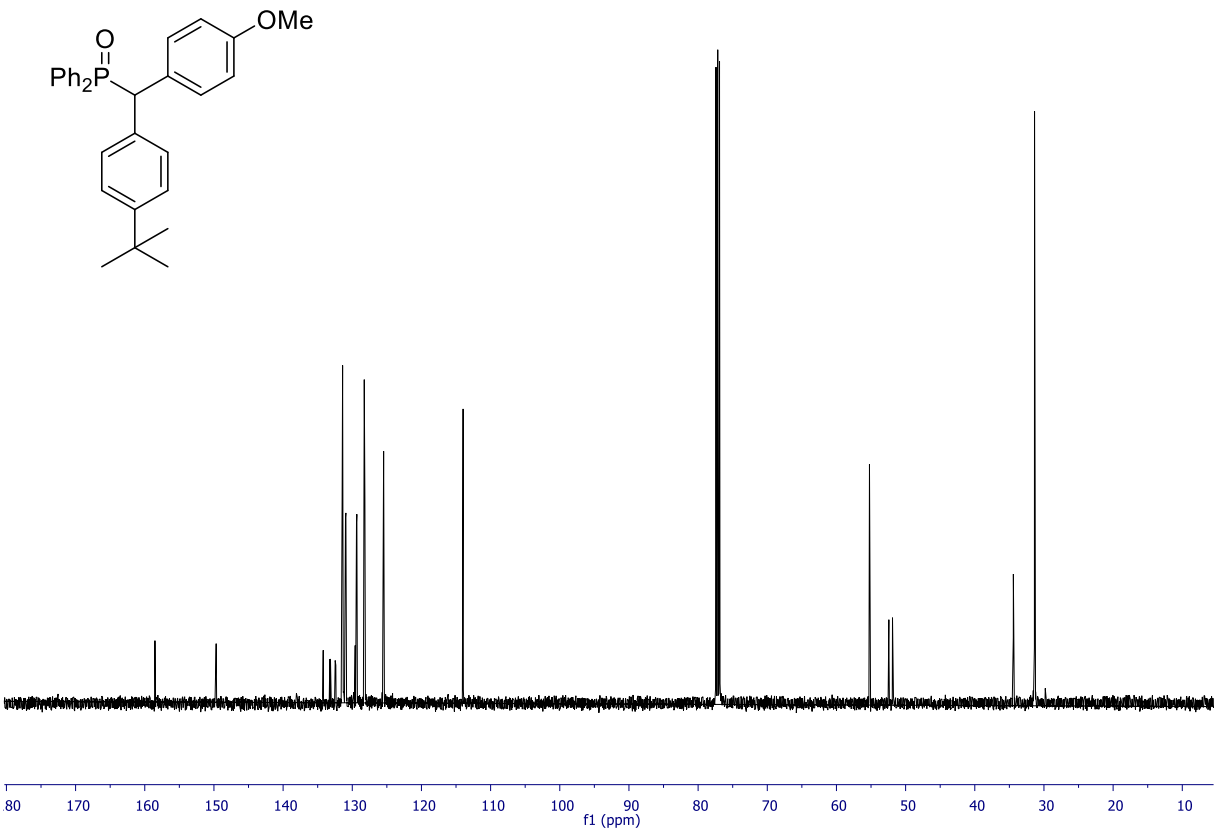
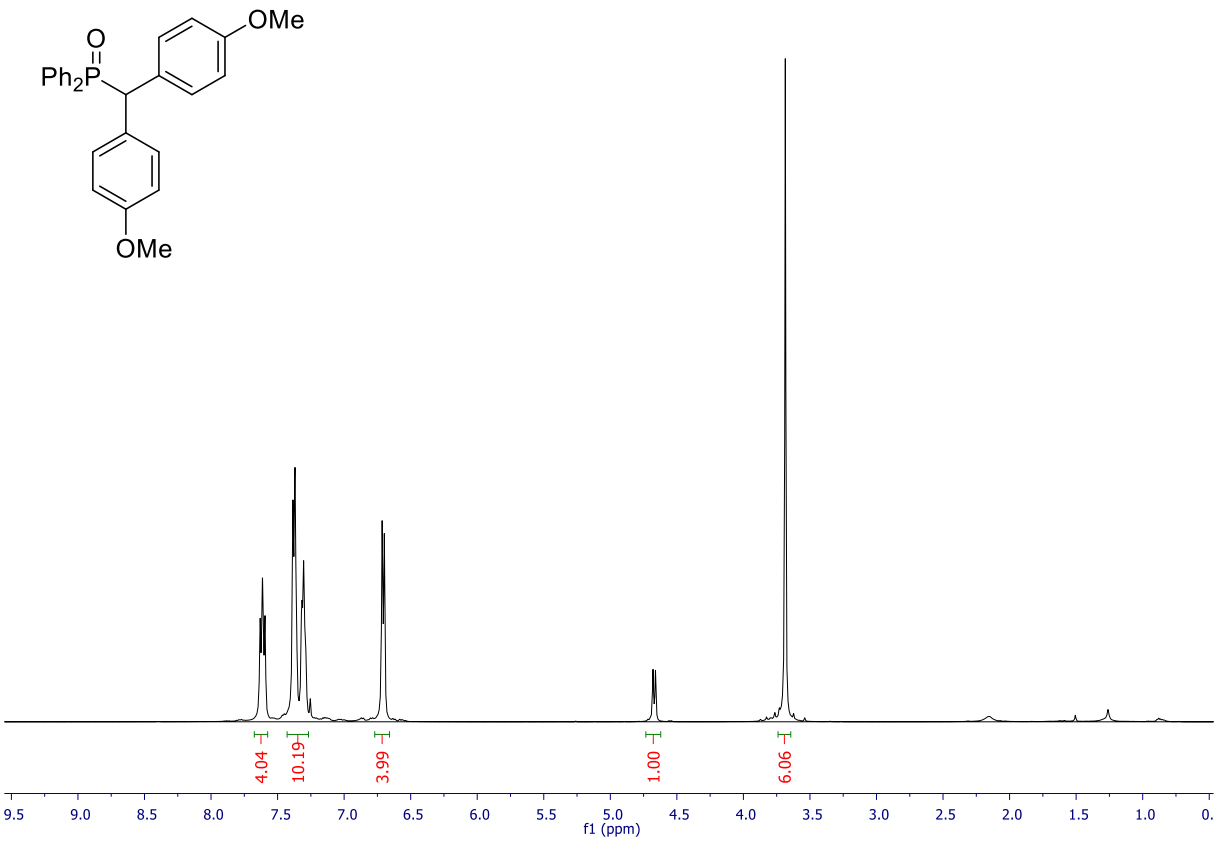
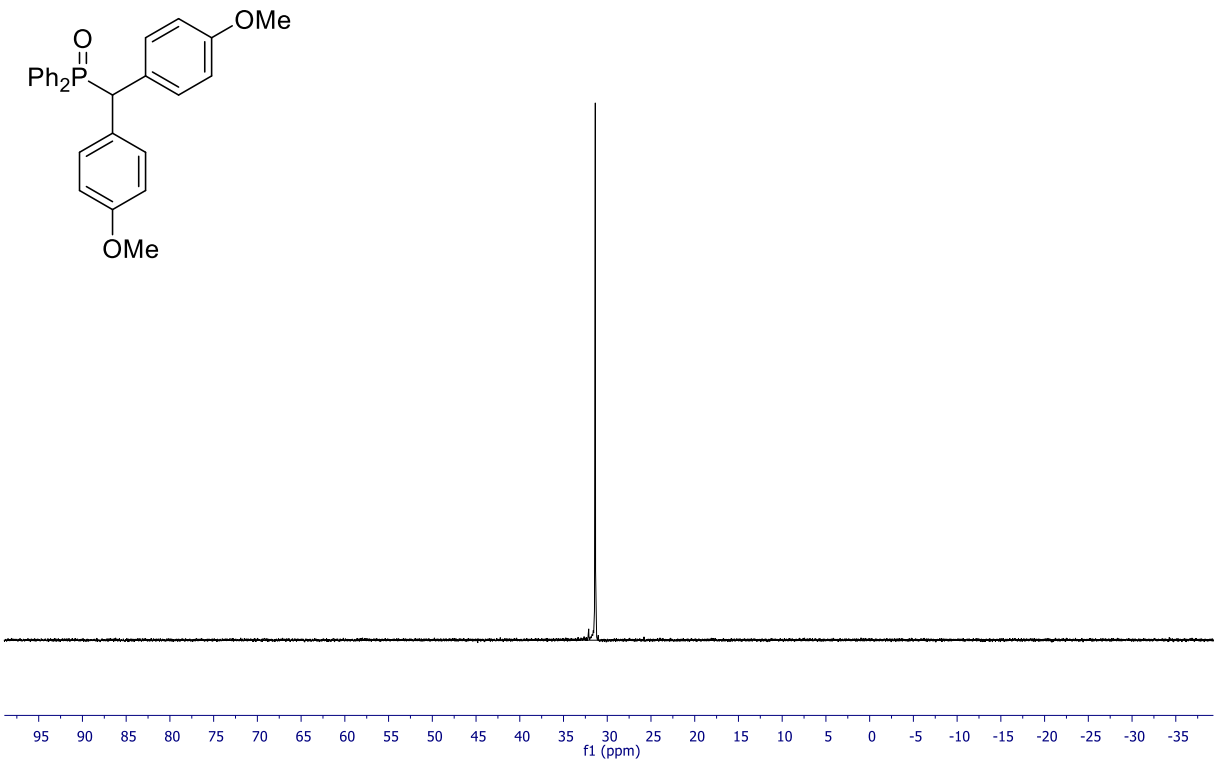


Figure S12. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 3i in $CDCl_3$.

(bis(4-methoxyphenyl)methyl)diphenylphosphine oxide 3j





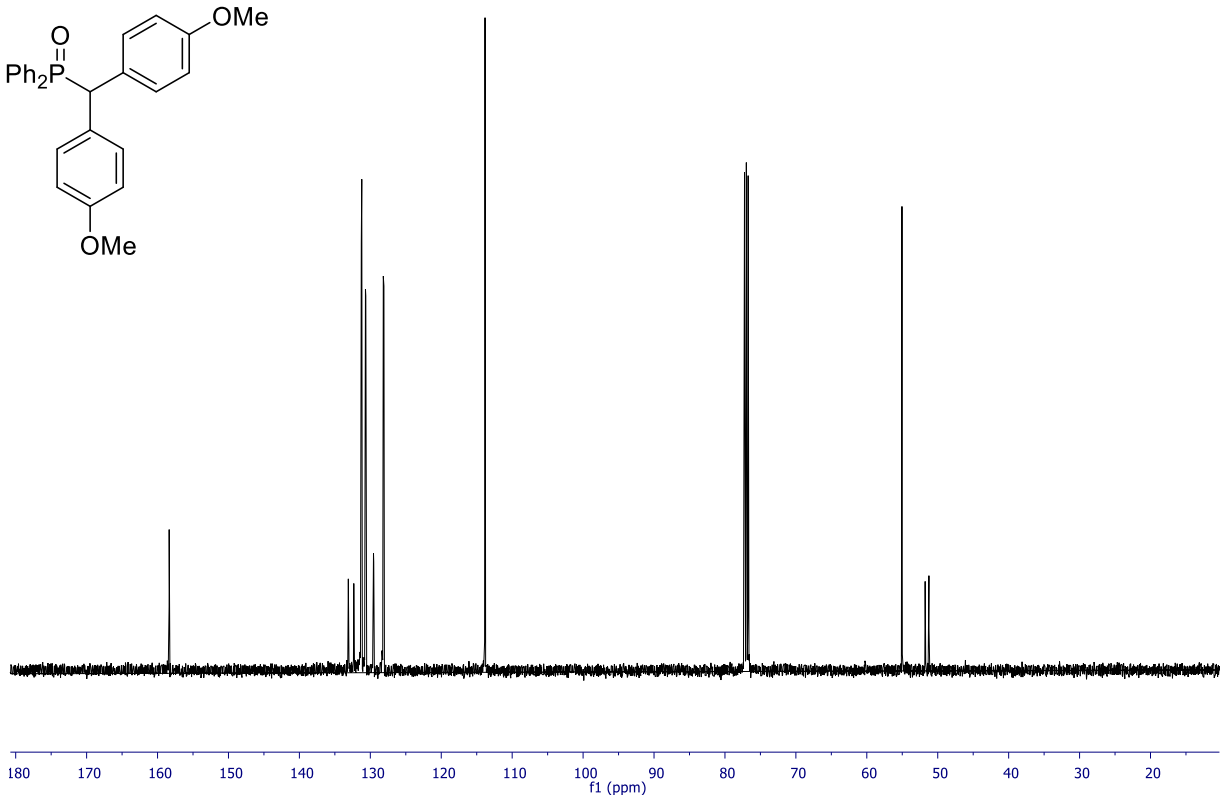
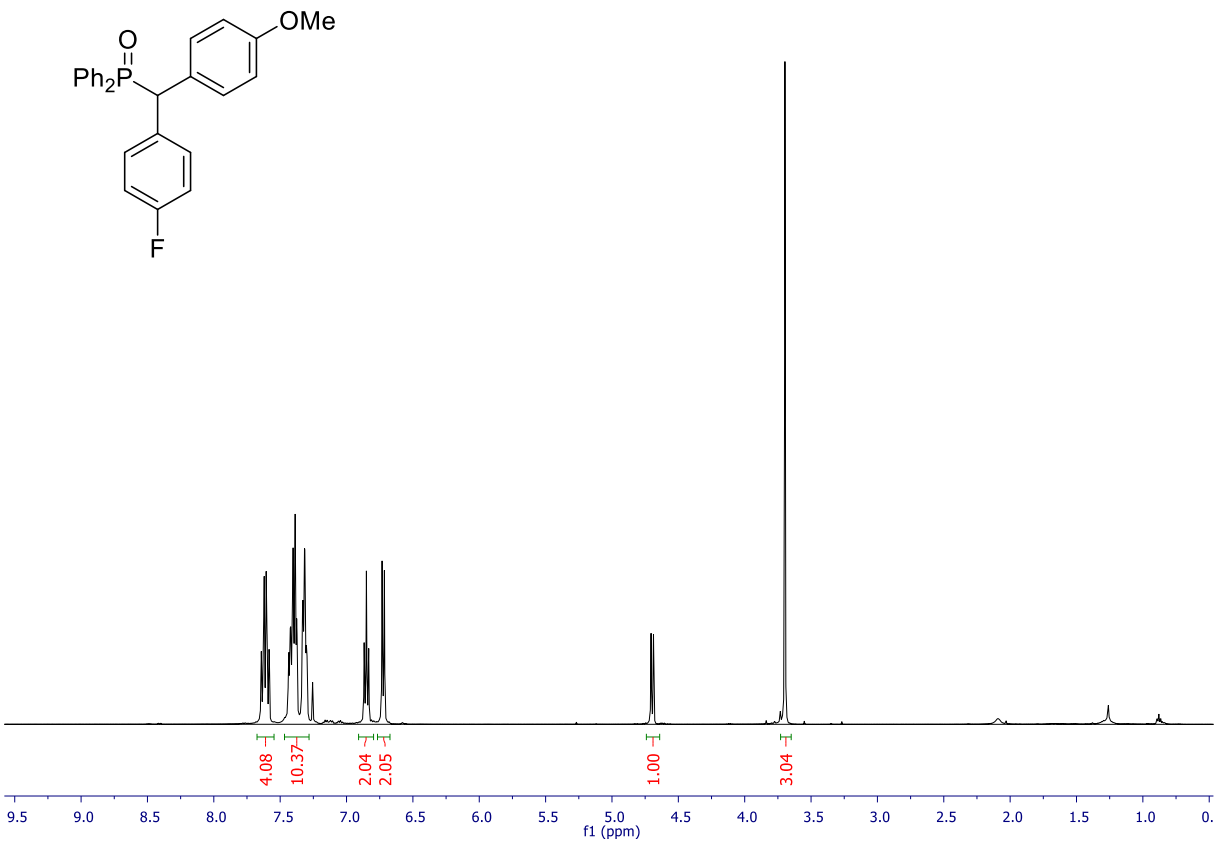
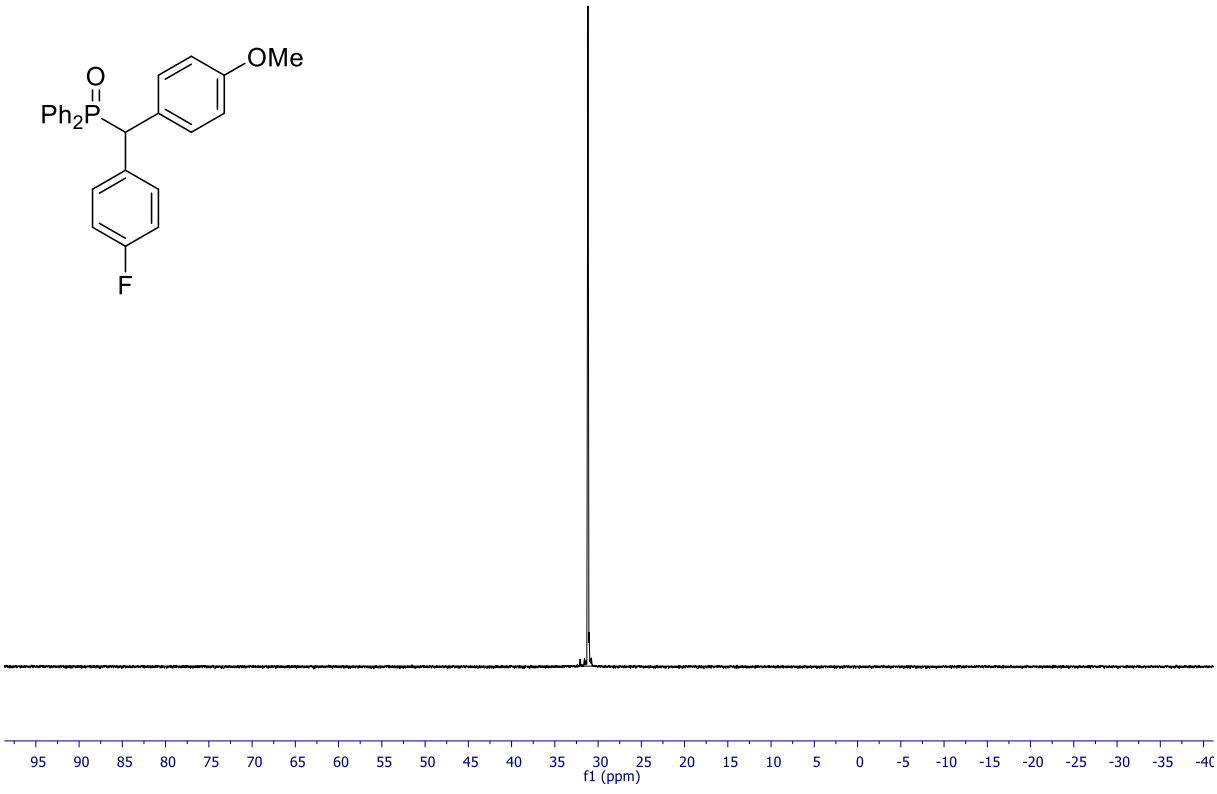


Figure S13. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 3j in $CDCl_3$.

((4-fluorophenyl)(4-methoxyphenyl)methyl)diphenylphosphine oxide 3k





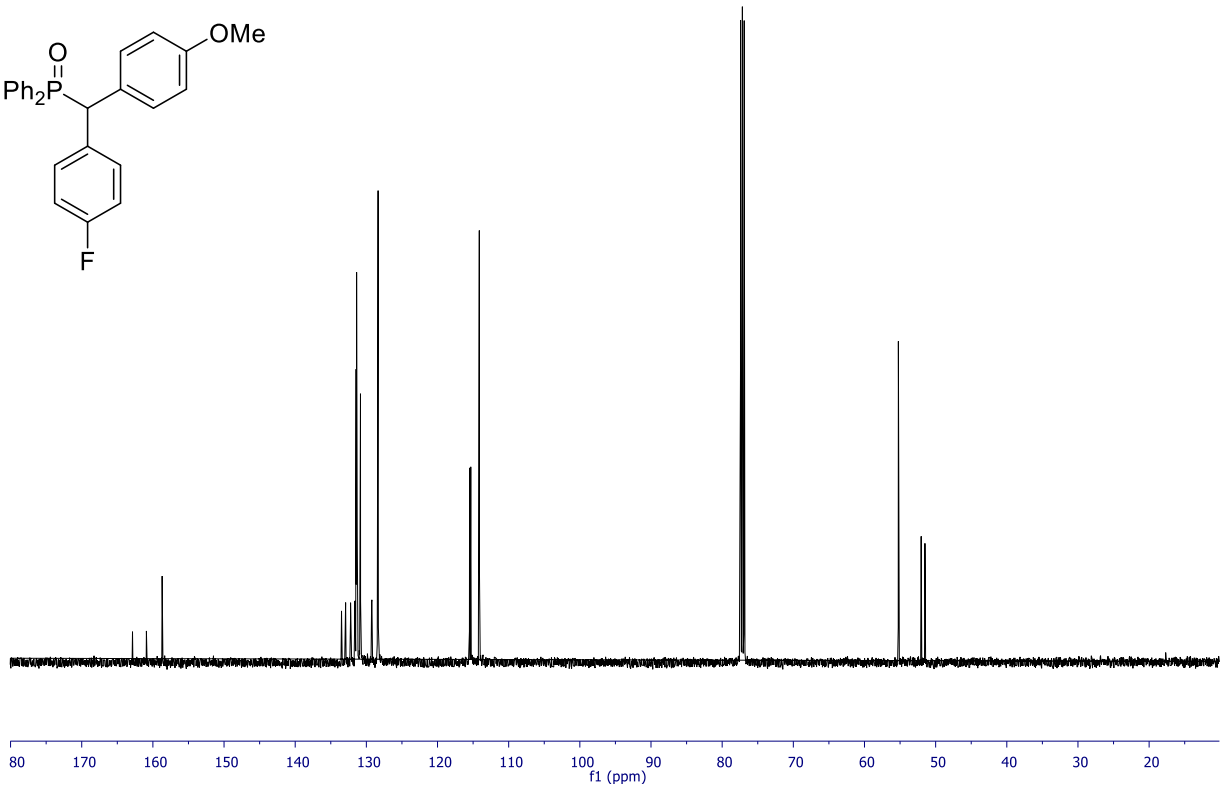
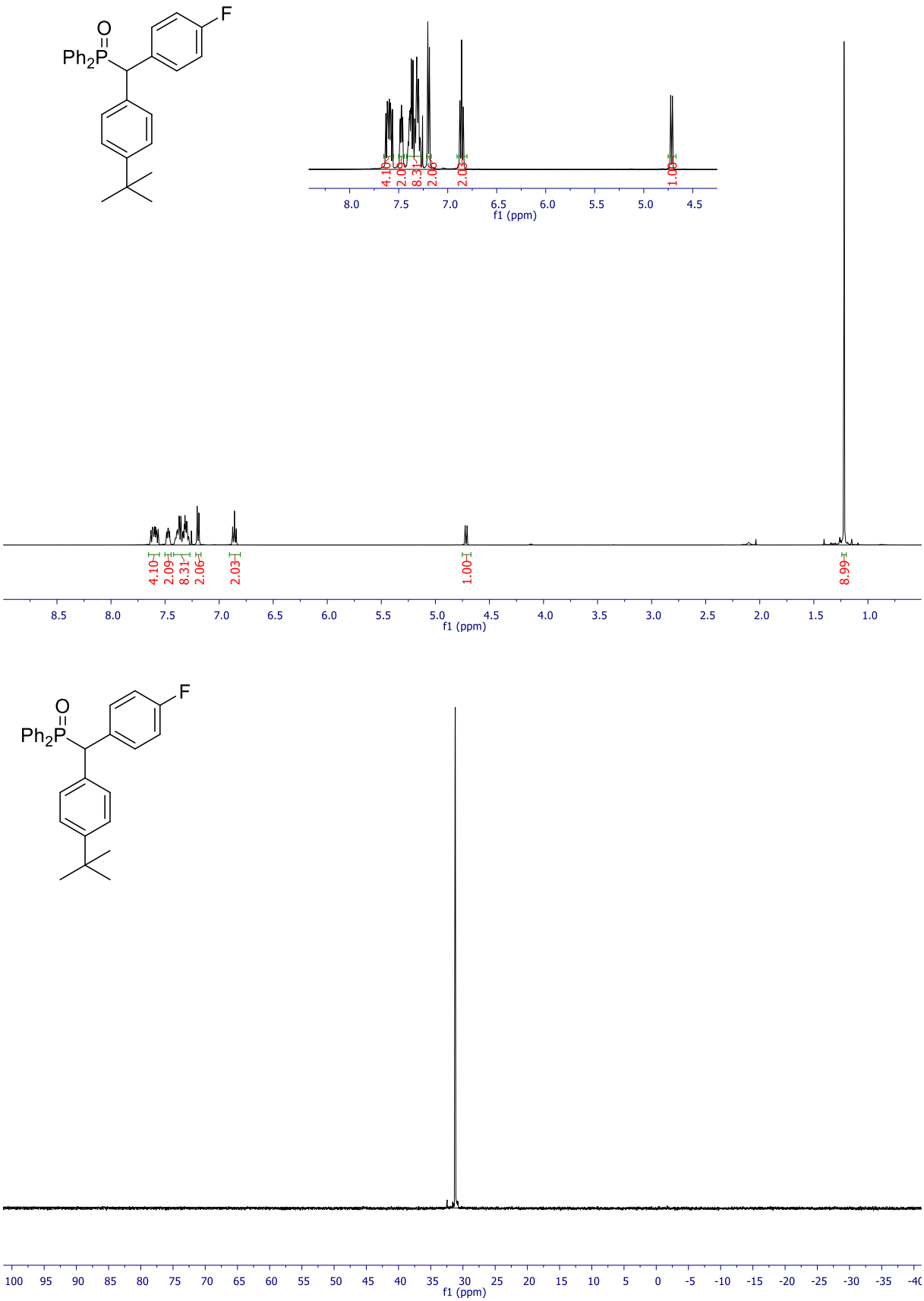


Figure S14. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 3k in $CDCl_3$.

((4-(tert-butyl)phenyl)(4-flurorophenyl)methyl)diphenylphosphine oxide 3l



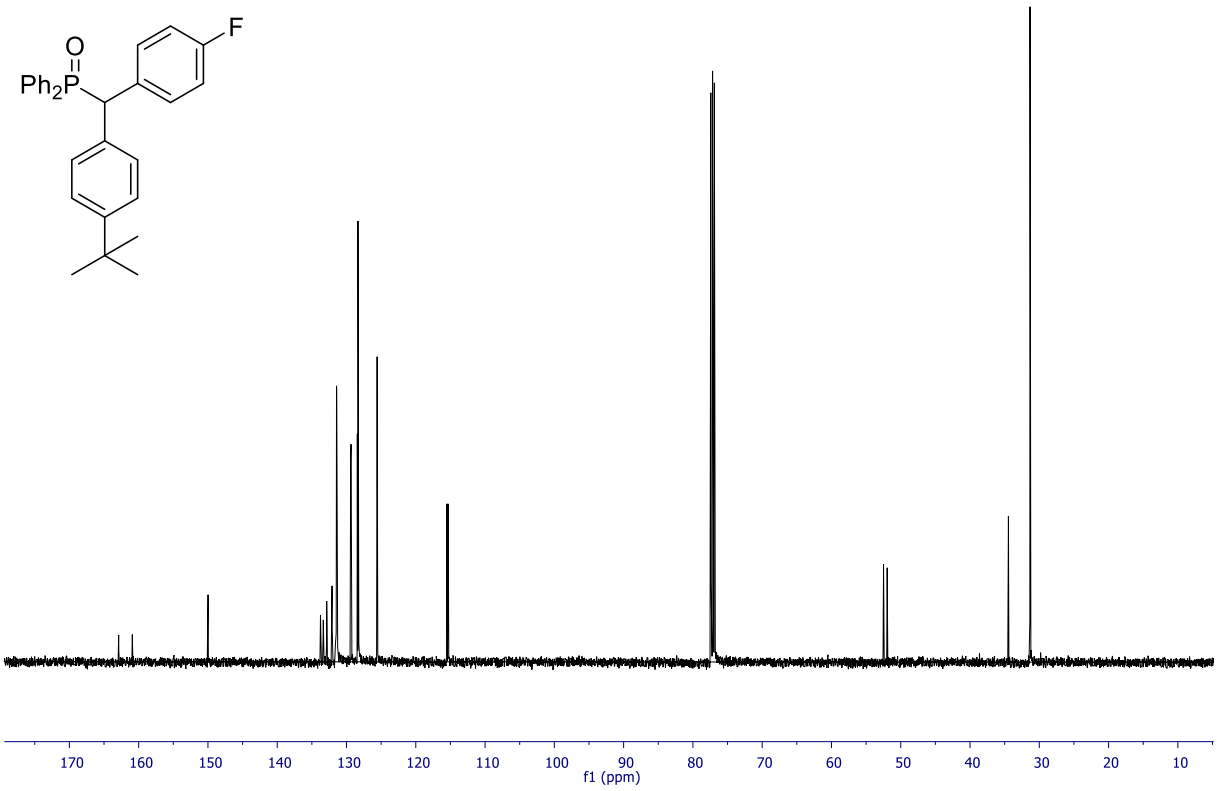
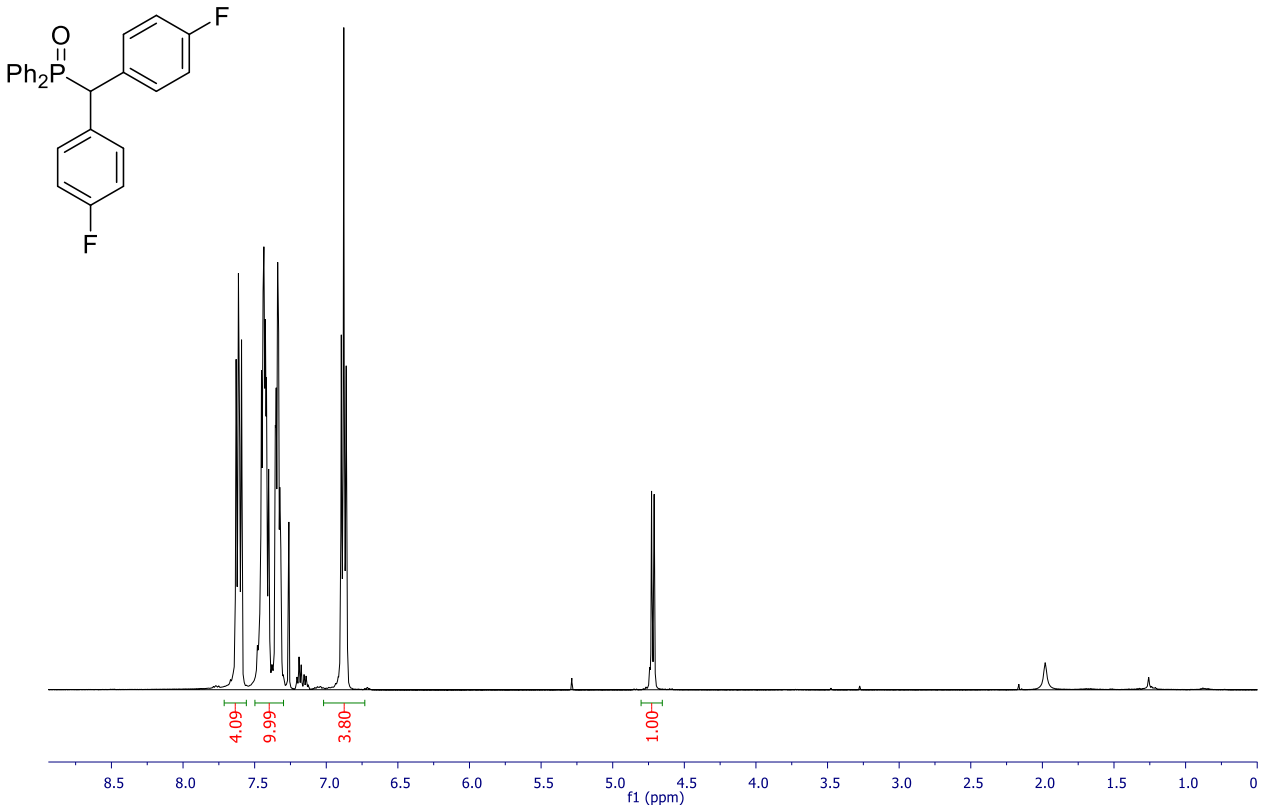
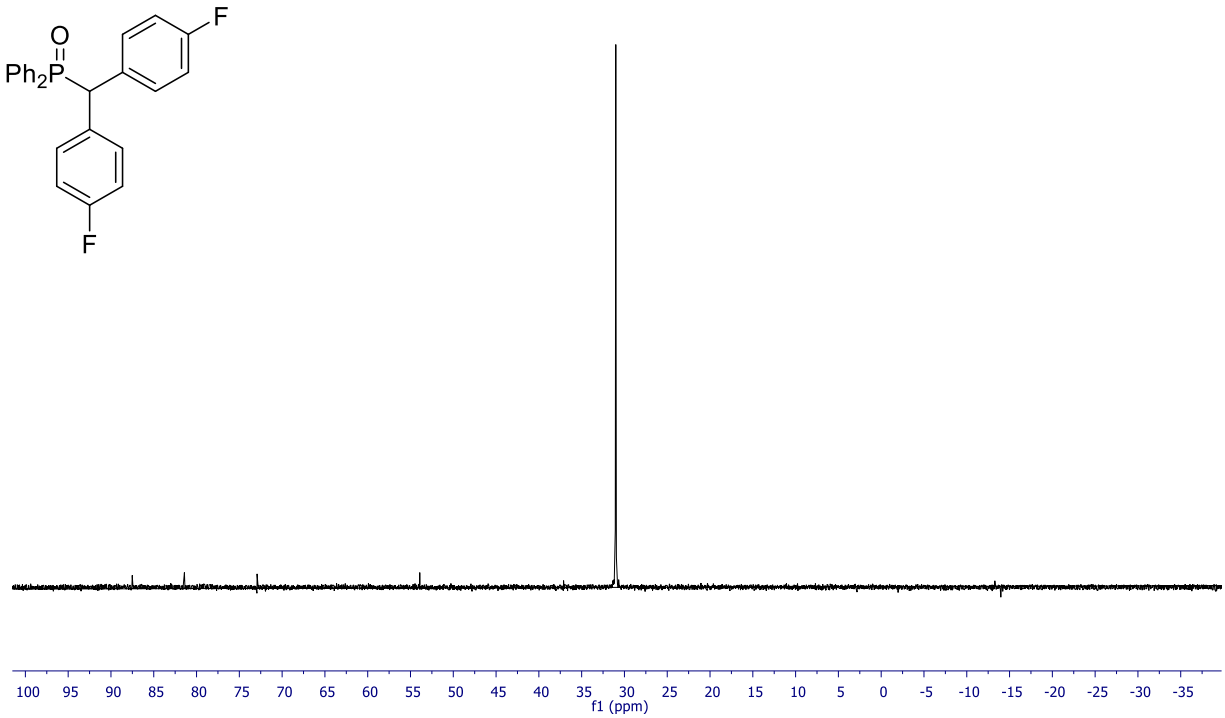


Figure S15. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 3l in $CDCl_3$.

(bis(4-fluorophenyl)methyl)diphenylphosphine oxide 3m





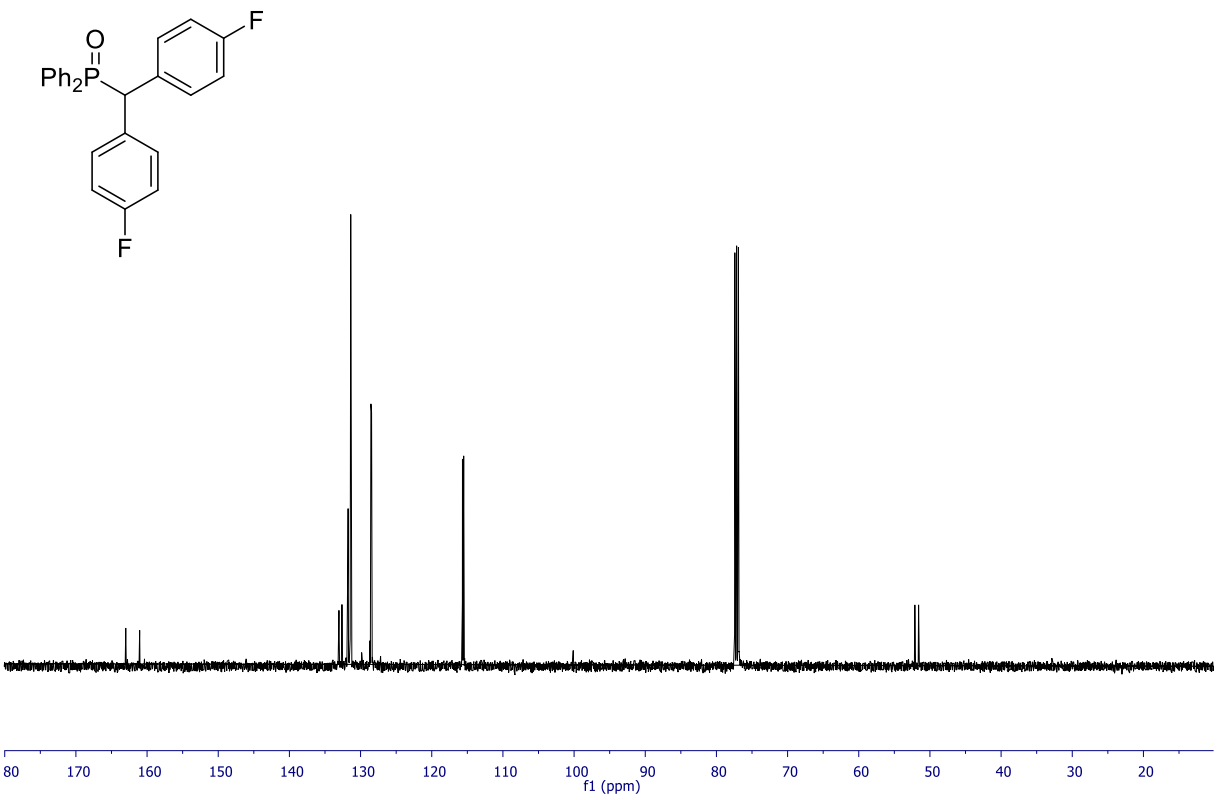
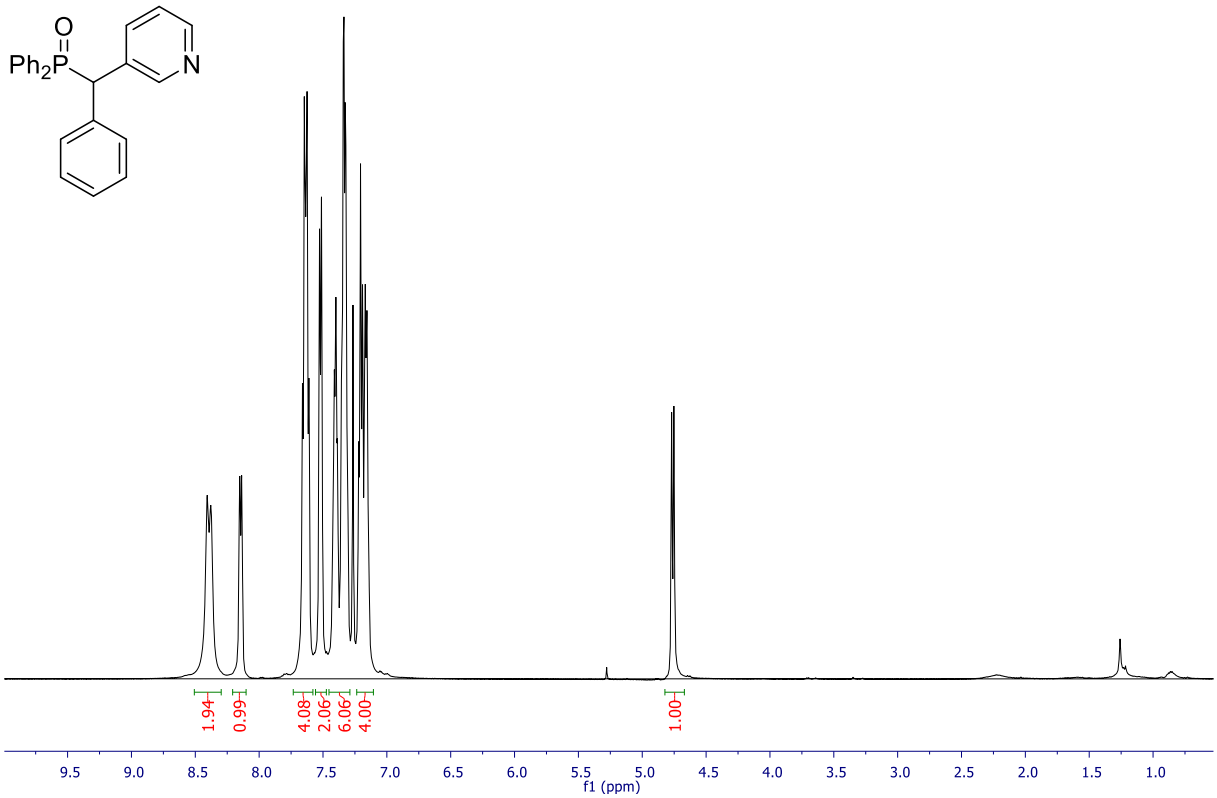
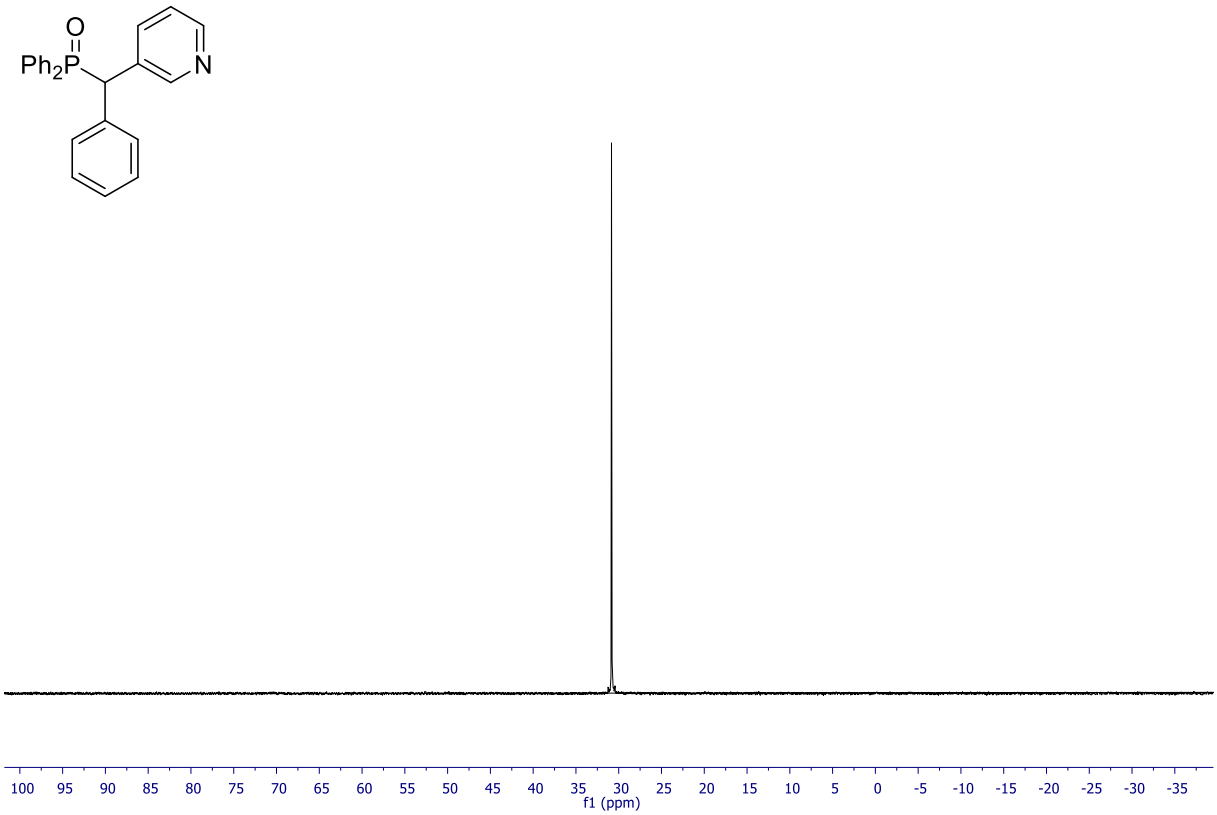


Figure S16. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 3m in $CDCl_3$.

(phenyl(pyridine-3-yl)methyl)diphenylphosphine oxide 3n





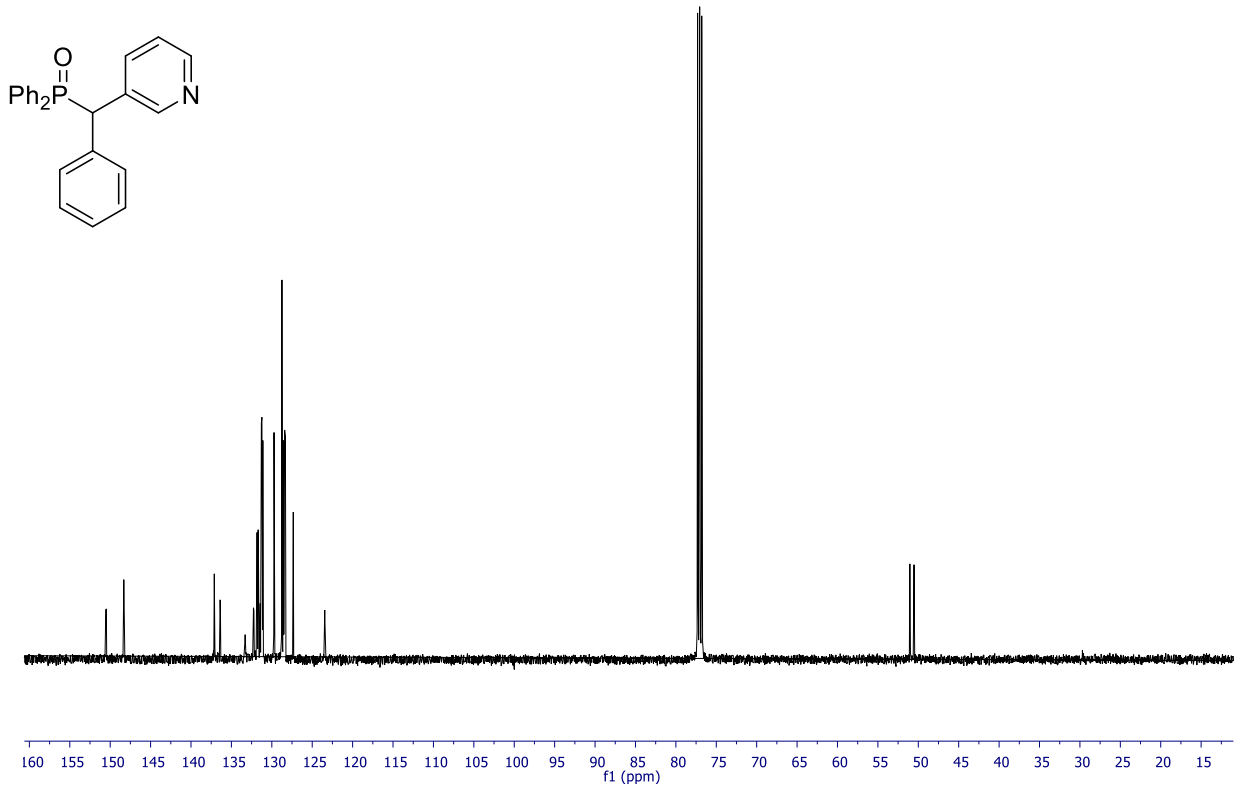
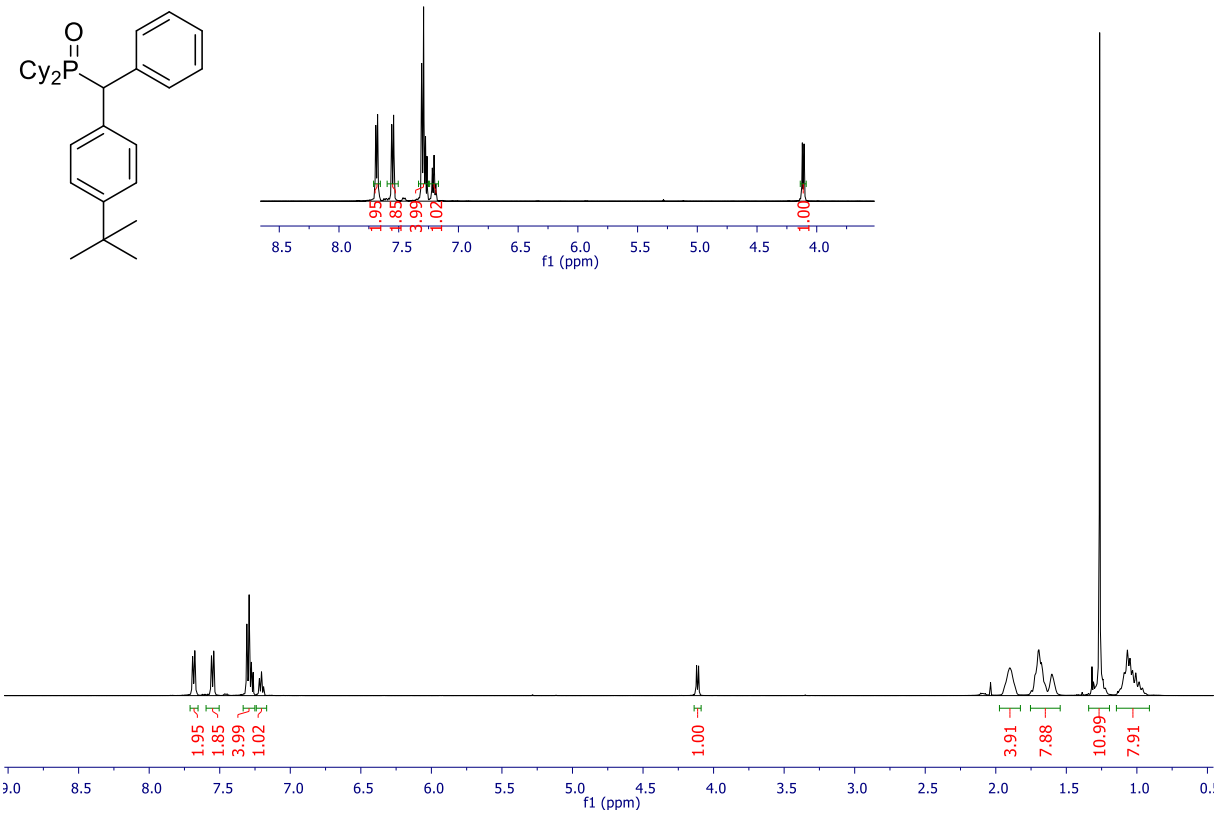
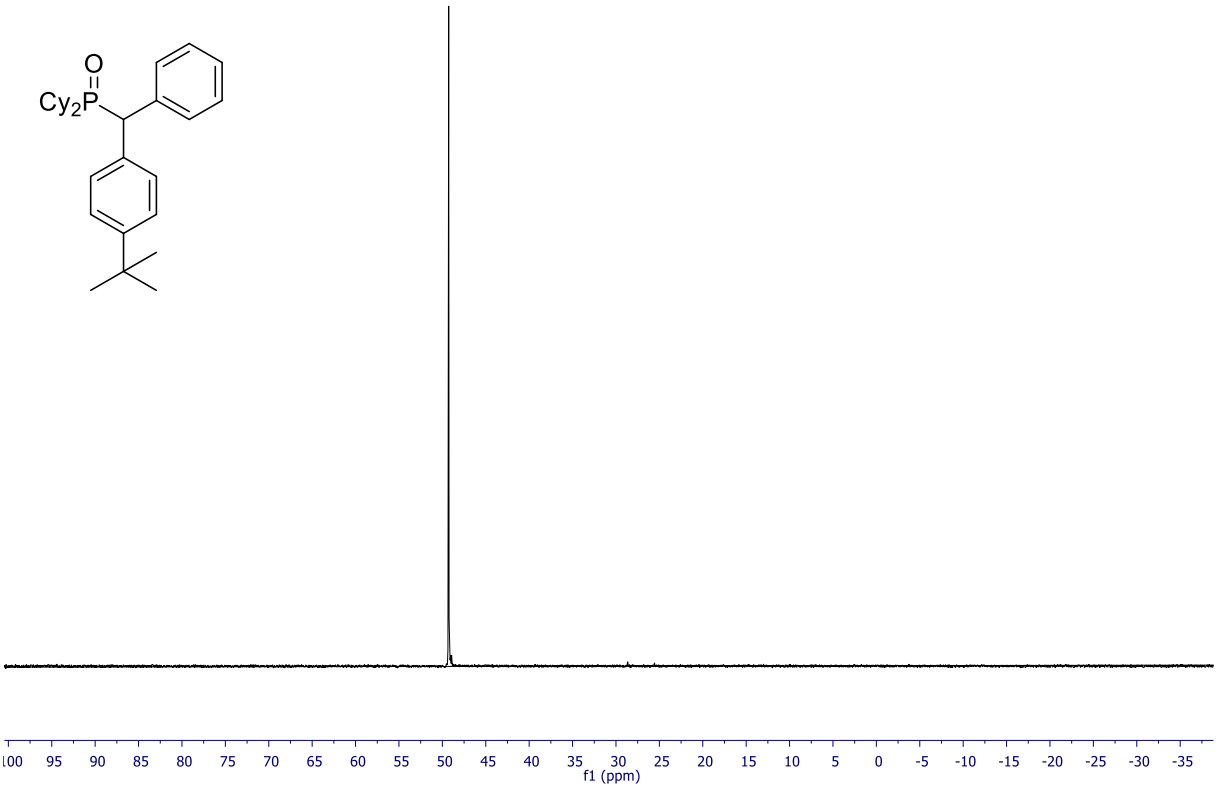


Figure S17. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 3n in $CDCl_3$.

((4-(tert-butyl)phenyl)(phenyl)methyl)dicyclohexylphosphine oxide 3o





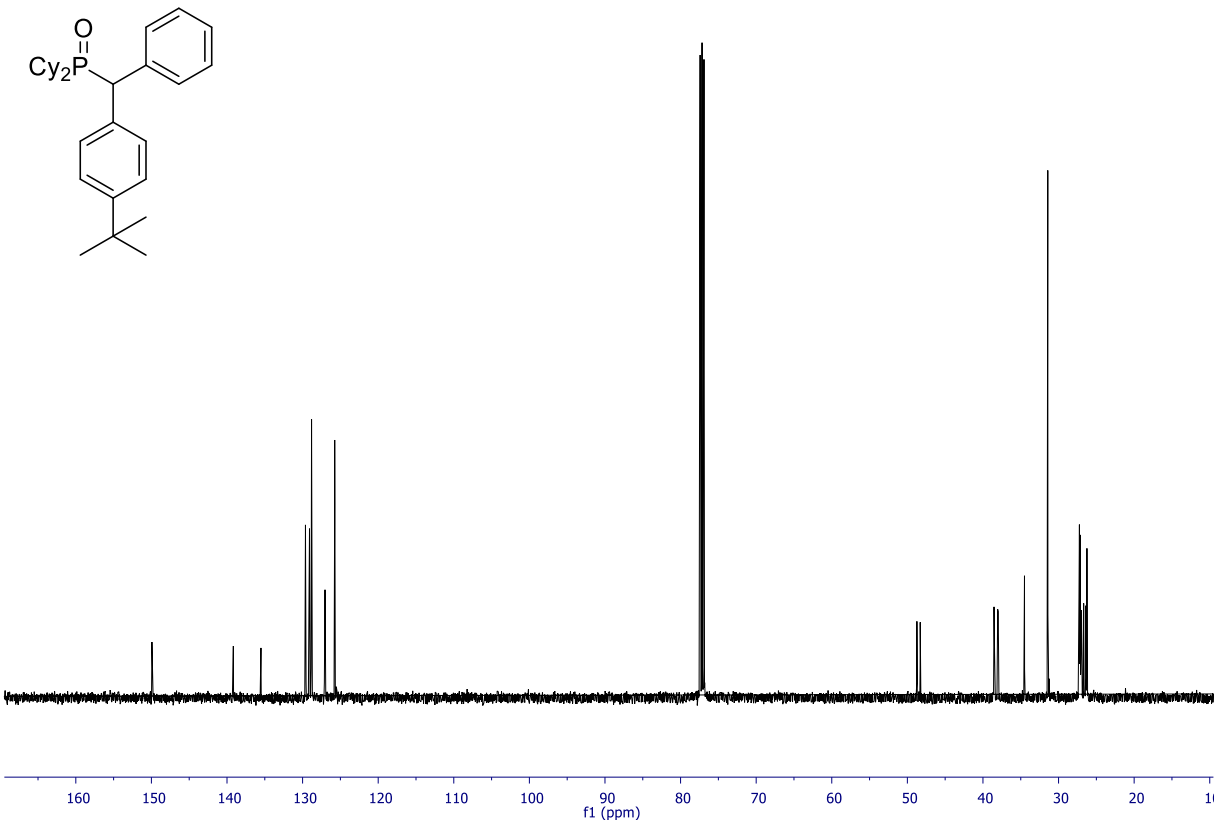
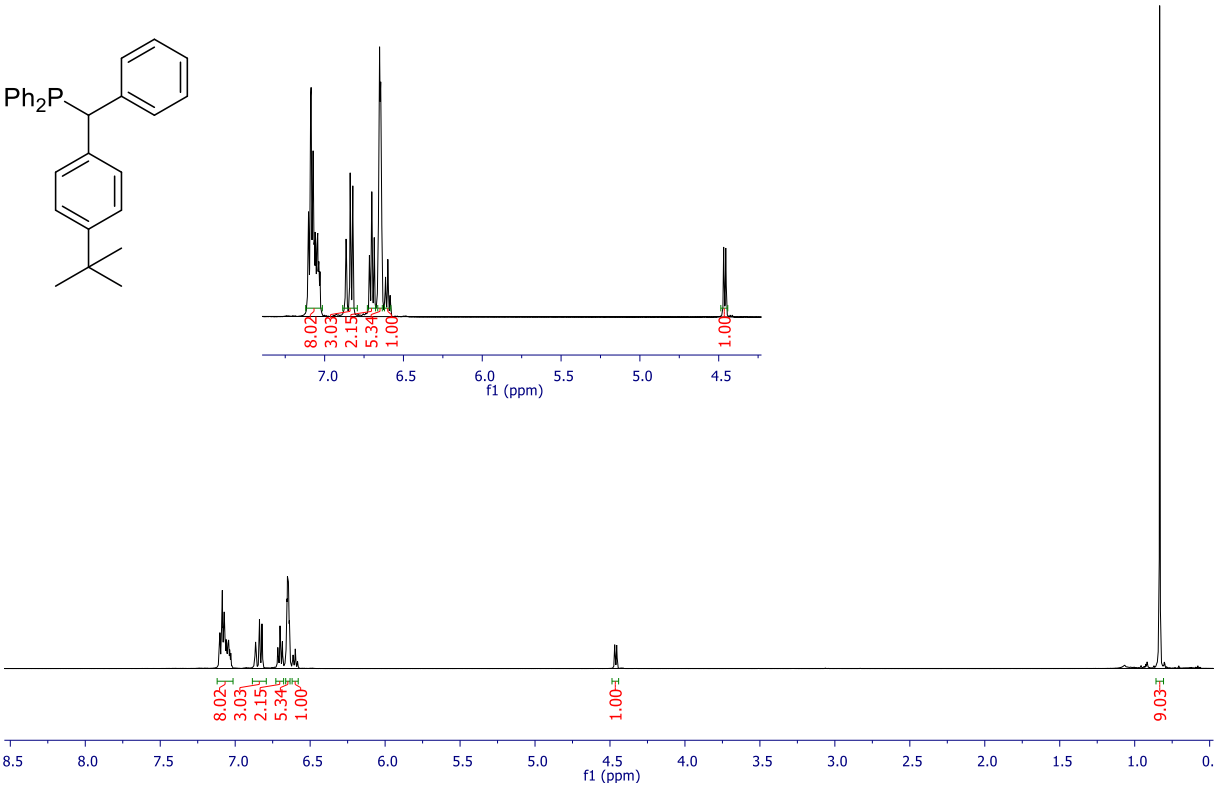
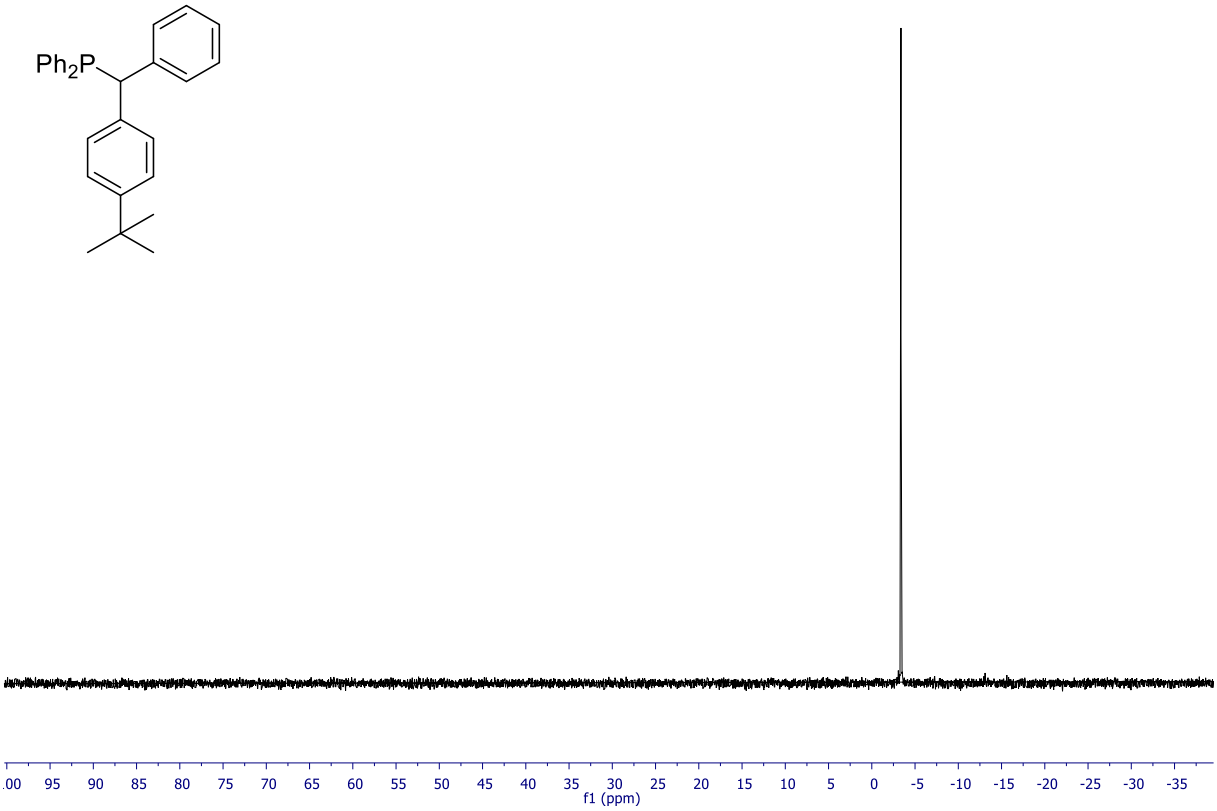


Figure S18. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 3o in $CDCl_3$.

((4-(tert-butyl)phenyl)(phenyl)methyl)diphenylphosphine 4a





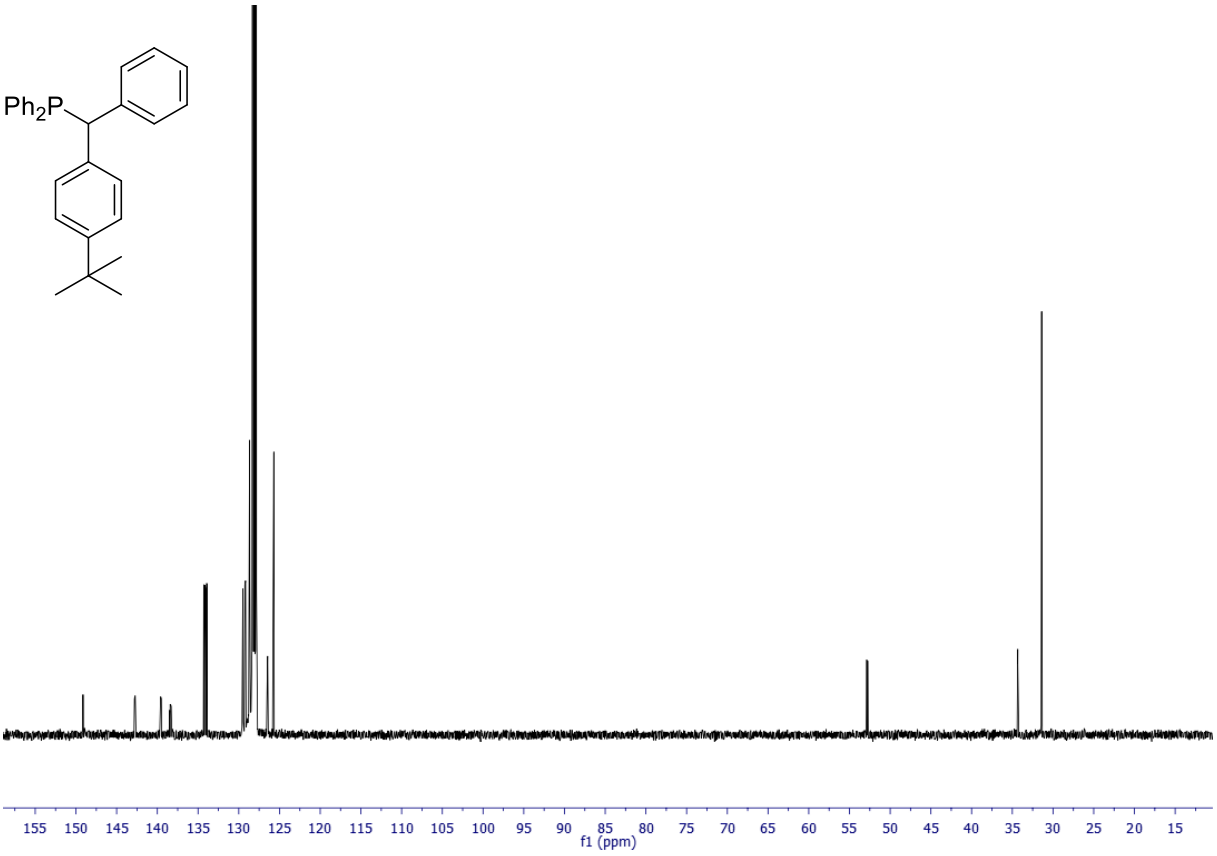


Figure S19. ^{1}H (500 MHz), ^{31}P{^{1}H} (121 MHz) and ^{13}C{^{1}H} (125 MHz) NMR spectra of 4a in benzene d_6.