Copper-Catalyzed Synthesis of Alkynylphosphine Derivatives: Unprecedented Use of Nucleophilic Phosphorus compounds

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Supporting Information

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(I) General remarks

Toluene and THF were purified by an Innovative Technology Pure Solv. Device (activated alumina column containing a copper catalyst and molecular sieves) and degassed. Chromatographic purifications were conducted using Merck silica gel Si 60 (40-63 µm) and TLC were performed on silica gel 60-F_{254} plates (0.1 mm) with UV or $KMnO_4$ detection. ^{1}H, ^{13}C, ^{31}P NMR spectra were recorded on a BRUKER AVANCE III 400 or 500 spectrometer. ^{11}B NMR spectrum was obtained on a 500 spectrometer. ^{1}H and ^{13}C NMR chemical shifts are reported in ppm using the residual peak of chloroform-*d* (7.26 and 77.16 ppm) or tetrahydrofurane-d_8 (3.58 and 67.40 ppm) as internal standard. ^{31}P and ^{11}B NMR chemical shifts are reported relative to respectively H_3PO_4 (85%) and $BF_3.Et_2O$ used as eternal references. Coupling constants are reported in Hertz (Hz). Abbreviations are used as follows: s = singulet, d = doublet, t = triplet, quint = quintuplet, sext = sextuplet, m = multiplet, br = broad. High Resolution Mass Spectrometry was performed on a Varian MAT 311 spectrometer. IR spectra were recorded on Spectrum One Perkin Elmer spectrometer and only the strongest or structurally most important peaks are listed.

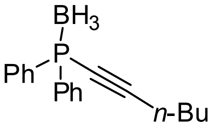
(II) Synthesis of alkynylphosphines **3**

(a) General procedure

In a Schlenk tube, flushed with nitrogen, copper iodide (14.3 mg, 0.075 mmol, 10 mol%), 1,10-phenanthroline (13.5 mg, 0.075 mmol, 10 mol%) and degassed dry toluene (2 mL) were introduced. After 20 min of stirring at rt, phosphine-borane **1** (0.75 mmol, 1 equiv.), K_2CO_3 (207 mg, 1.5 mmol, 2 equiv.) or K_3PO_4 (318 mg, 1.5 mmol, 2 equiv.), degassed dry toluene (7 mL) and a solution of 1-bromoalkyne **2** (0.75 mmol, 1 equiv.) in toluene (3 mL) were successively added. The reaction mixture was flushed with nitrogen prior to thermal heating at 40 °C or 60 °C overnight or until complete conversion of **1** (see Table 2). After cooling to rt, the reaction mixture was filtered over celite with toluene as the eluent. The filtrate was concentrated under reduced pressure and the residue was purified by silica gel column chromatography with pentane/toluene as the eluent.

(b) Characterization data

Hex-1-ynyldiphenylphosphine borane (3a)



$C_{18}H_{22}BP$
M = 280.16 g.mol^{-1}
colorless oil
R_f = 0.35 (pentane/toluene: 6/4)

Yield: 74% (155 mg).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82–7.76 (m, 4 H), 7.50–7.41 (m, 6 H), 2.47 (td, $^{4}J_{HP}$ = 3.2 Hz, $^{3}J_{HH}$ = 7.2 Hz, 2 H), 1.63 (quint, $^{3}J_{HH}$ = 7.2 Hz, 2 H), 1.46 (sext, $^{3}J_{HH}$ = 7.2 Hz, 2 H), 0.94 (t, $^{3}J_{HH}$ = 7.3 Hz, 3 H), 1.70–0.60 (m, 3 H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 132.0 (d, $^{2}J_{CP}$ = 11.0 Hz), 131.5 (d, $^{4}J_{CP}$ = 2.5 Hz), 129.9 (d, $^{1}J_{CP}$ = 63.7 Hz), 128.9 (d, $^{3}J_{CP}$ = 10.9 Hz), 112.9 (d, $^{2}J_{CP}$ = 17.2 Hz), 70.0 (d, $^{1}J_{CP}$ = 113.9 Hz), 30.0 (d, $^{4}J_{CP}$ = 1.4 Hz), 22.1, 20.0 (d, $^{3}J_{CP}$ = 2.4 Hz), 13.6.

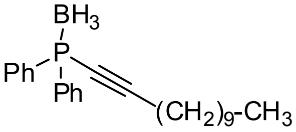
^{31}P NMR (162 MHz, $CDCl_3$) δ 4.4–4.0 (m).

^{11}B NMR (160 MHz, $CDCl_3$) δ −35.0 to −40.0 (m).

IR (neat): 2387, 2196, 1437, 1106, 1054, 732, 691 cm^{-1}.

HRMS (ESI) Calcd for $C_{18}H_{22}BNaP$ $[M+Na]^+$: 303.1449. Found: 303.1448.

Dodec-1-ynyldiphenylphosphine borane (3b)



$C_{24}H_{34}BP$
M = 364.25 g.mol^{-1}
colorless oil
R_f = 0.38 (pentane/toluene: 6/4)

Yield: 69% (189 mg).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81–7.76 (m, 4 H), 7.50–7.41 (m, 6 H), 2.46 (td, $^{4}J_{HP}$ = 3.2 Hz, $^{3}J_{HH}$ = 7.2 Hz, 2 H), 1.64 (quint, $^{3}J_{HH}$ = 7.2 Hz, 2 H), 1.44–1.26 (m, 14 H), 0.88 (t, $^{3}J_{HH}$ = 6.8 Hz, 3 H), 1.50–0.70 (m, 3 H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 132.0 (d, $^{2}J_{CP}$ = 11.1 Hz), 131.5 (d, $^{4}J_{CP}$ = 2.5 Hz), 129.9 (d, $^{1}J_{CP}$ = 63.7 Hz), 128.9 (d, $^{3}J_{CP}$ = 10.9 Hz), 113.0 (d, $^{2}J_{CP}$ = 17.3 Hz), 70.1 (d, $^{1}J_{CP}$ = 113.8 Hz), 32.0, 29.7, 29.6, 29.4, 29.1, 29.0, 28.0, 22.8, 20.3 (d, $^{3}J_{CP}$ = 2.4 Hz), 14.3.

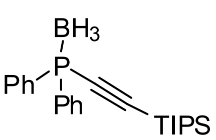
^{31}P NMR (162 MHz, $CDCl_3$) δ 4.1–3.8 (m).

^{11}B NMR (160 MHz, $CDCl_3$) δ −35.0 to −39.0 (m).

IR (neat): 2924, 2854, 2390, 2197, 1437, 1107, 1054, 733, 690 cm^{-1}.

HRMS (ESI) Calcd for $C_{24}H_{34}BNaP$ $[M+Na]^+$: 387.2389 Found: 387.2387.

(Triisopropylsilyl)ethynyldiphenylphosphine borane (3c)



$C_{23}H_{34}BPSi$
M = 380.23 g.mol^{-1}
colorless oil
R_f = 0.35 (pentane/toluene: 6/4)

Yield: 55% (157 mg, containing 10% of free phosphine).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84–7.79 (m, 4 H), 7.51–7.42 (m, 6 H), 1.20–1.10 (m, 21 H), 1.70–0.70 (m, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 132.0 (d, $^2J_{CP}$ = 11.0 Hz), 131.5 (d, $^4J_{CP}$ = 2.5 Hz), 129.5 (d, $^1J_{CP}$ = 62.9 Hz), 129.0 (d, $^3J_{CP}$ = 10.9 Hz), 117.3 (d, $^2J_{CP}$ = 7.2 Hz), 97.3 (d, $^1J_{CP}$ = 93.4 Hz), 18.7, 11.2.

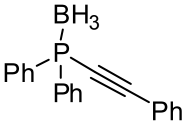
^{31}P NMR (162 MHz, $CDCl_3$) δ 5.0–4.7 (m).

^{11}B NMR (160 MHz, $CDCl_3$) δ –35.0 to –39.0 (m).

IR (neat): 2945, 2866, 2393, 2346, 1462, 1437, 1103, 1057, 997, 882, 797, 733, 682 cm^{-1}.

HRMS (ESI) Calcd for $C_{23}H_{34}BNaSiP$ $[M+Na]^+$: 403.2158. Found: 403.2160.

(Phenyl)ethynyldiphenylphosphine borane (3d)



$C_{20}H_{18}BP$
M = 300.12 g.mol^{-1}
colorless oil
R_f = 0.34 (pentane/toluene: 6/4)

Yield: 69% (148 mg).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89–7.84 (m, 4 H), 7.61–7.59 (m, 2 H), 7.54–7.36 (m, 9 H), 1.80–0.80 (m, 3 H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 132.6 (d, $^4J_{CP}$ = 1.5 Hz), 132.1 (d, $^2J_{CP}$ = 11.1 Hz), 131.7 (d, $^4J_{CP}$ = 2.5 Hz), 130.6, 129.4 (d, $^1J_{CP}$ = 63.5 Hz), 129.1 (d, $^3J_{CP}$ = 11.0 Hz), 128.7, 120.7 (d, $^3J_{CP}$ = 3.2 Hz), 108.8 (d, $^2J_{CP}$ = 16.8 Hz), 78.8 (d, $^1J_{CP}$ = 108.6 Hz).

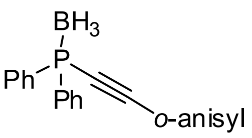
^{31}P NMR (162 MHz, $CDCl_3$) δ 5.0–4.7 (m).

^{11}B NMR (160 MHz, $CDCl_3$) δ –34.0 to –39.0 (m).

IR (neat): 2388, 2177, 1489, 1437, 1105, 1053, 854, 732, 686 cm^{-1}.

HRMS (ESI) Calcd for $C_{20}H_{18}BNaP$ $[M+Na]^+$: 323.1137. Found: 323.1133.

(*o*-anisyl)ethynyldiphenylphosphine borane (3e)



$C_{21}H_{20}BOP$
M = 330.13 g.mol^{-1}
colorless oil
R$_f$ = 0.34 (pentane/toluene: 4/6)

Yield: 59% (146 mg).

^{1}H NMR (400 MHz, CDCl$_3$) δ 7.96–7.90 (m, 4 H), 7.54–7.38 (m, 8 H), 6.97–6.91 (m, 2 H), 3.92 (s, 3 H), 1.77–0.77 (m, 3 H).

^{13}C NMR (100 MHz, CDCl$_3$) δ 161.6 (d, $^4J_{CP}$ = 1.1 Hz), 134.1 (d, $^4J_{CP}$ = 1.6 Hz), 132.2 (d, $^2J_{CP}$ = 11.2 Hz), 132.1, 131.5 (d, $^4J_{CP}$ = 2.5 Hz), 129.9 (d, $^1J_{CP}$ = 63.4 Hz), 128.9 (d, $^3J_{CP}$ = 10.9 Hz), 120.6, 111.0, 110.2 (d, $^3J_{CP}$ = 3.2 Hz), 106.0 (d, $^2J_{CP}$ = 17.6 Hz), 82.4 (d, $^1J_{CP}$ = 111.4 Hz), 56.0.

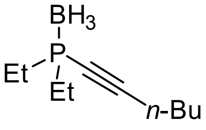
^{31}P NMR (162 MHz, CDCl$_3$) δ 4.8–4.6 (m).

^{11}B NMR (160 MHz, CDCl$_3$) δ –36.0 to –41.0 (m).

IR (neat): 2376, 2176, 1489, 1436, 1258, 1106, 1053, 1021, 867, 732, 690 cm^{-1}.

HRMS (ESI) Calcd for $C_{21}H_{20}OBNaP$ [M+Na]$^+$: 353.1242. Found: 353.1245.

Diethylhex-1-ynylphosphine borane (3f)



$C_{10}H_{22}BP$
M = 184.16 g.mol^{-1}
colorless oil
R$_f$ = 0.40 (pentane/toluene: 6/4)

Yield: 60% (106 mg), obtained from **1b** (100 mg, 0.96 mmol).

^{1}H NMR (400 MHz, CDCl$_3$) δ 2.34 (td, $^3J_{HH}$ = 7.2 Hz, $^4J_{HP}$ = 3.3 Hz, 2 H), 1.82–1.65 (m, 4 H), 1.55 (quint, $^3J_{HH}$ = 6.8 Hz, 2 H), 1.41 (sext, $^3J_{HH}$ = 7.0 Hz, 2 H), 1.20 (dt, $^3J_{HP}$ = 17.6 Hz, $^3J_{HH}$ = 7.6 Hz, 6 H), 0.92 (t, $^3J_{HH}$ = 7.2 Hz, 3 H), 0.96–0.12 (m, 3 H).

^{13}C NMR (100 MHz, CDCl$_3$) δ 110.1 (d, $^2J_{CP}$ = 12.6 Hz), 69.9 (d, $^1J_{CP}$ = 95.5 Hz), 30.1 (d, $^4J_{CP}$ = 1.5 Hz), 22.0, 19.7 (d, $^3J_{CP}$ = 2.3 Hz), 19.0 (d, $^1J_{CP}$ = 41.0 Hz), 13.6, 7.4 (d, $^2J_{CP}$ = 3.5 Hz).

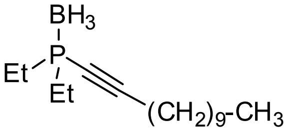
^{31}P NMR (162 MHz, CDCl$_3$) δ 8.8 (q, $^1J_{PB}$ = 58.9 Hz).

^{11}B NMR (160 MHz, CDCl$_3$) δ –39.2 (dq, $^1J_{BH}$ = 96.0 Hz, $^1J_{BP}$ = 58.9 Hz).

IR (neat): 2961, 2937, 2390, 2197, 1457, 1067, 1045, 1034, 1020, 777, 760 cm^{-1}.

HRMS (ESI) Calcd for $C_{10}H_{22}BNaP$ [M+Na]$^+$: 207.1450. Found: 207.1459.

Dodec-1-ynyldiethylphosphine borane (3g)



$C_{16}H_{34}BP$
M = 268.25 g.mol^{-1}
colorless oil
R$_f$ = 0.40 (pentane/toluene: 6/4)

Yield: 58% (149 mg), obtained from **1b** (100 mg, 0.96 mmol).

^{1}H NMR (400 MHz, $CDCl_3$) δ 2.32 (td, $^4J_{HP}$ = 3.2 Hz, $^3J_{HH}$ = 6.8 Hz, 2 H), 1.82–1.64 (m, 4 H), 1.54 (quint, $^3J_{HH}$ = 7.2 Hz, 2 H), 1.41–1.24 (m, 14 H), 1.19 (dt, $^3J_{HP}$ = 17.5 Hz, $^3J_{HH}$ = 7.6 Hz, 6 H), 0.87 (t, $^3J_{HH}$ = 7.2 Hz, 3 H), 0.90–0.10 (m, 3 H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 110.1 (d, $^2J_{CP}$ = 12.7 Hz), 69.9 (d, $^1J_{CP}$ = 95.4 Hz), 32.0, 29.6, 29.5, 29.4, 29.1, 28.8, 28.0 (d, $^4J_{CP}$ = 1.4 Hz), 22.8, 19.9 (d, $^3J_{CP}$ = 2.3 Hz), 19.0 (d, $^1J_{CP}$ = 41 Hz), 14.2, 7.3 (d, $^2J_{CP}$ = 3.5 Hz).

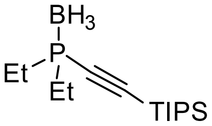
^{31}P NMR (162 MHz, $CDCl_3$) δ 9.3–8.2 (m).

^{11}B NMR (160 MHz, $CDCl_3$) δ –39.2 (dq, $^1J_{BH}$ = 96.5 Hz, $^1J_{BP}$ = 58.7 Hz).

IR (neat): 2924, 2854, 2379, 2196, 1457, 1066, 1045, 1019, 777, 760 cm^{-1}.

HRMS (ESI) Calcd for $C_{16}H_{34}BNaP$ $[M+Na]^+$: 291.2389. Found: 291.2390.

Diethyl(triisopropylsilyl)ethynylphosphine borane (3h)



$C_{15}H_{34}BPSi$
M = 284.23 g.mol^{-1}
colorless oil
R$_f$ = 0.35 (pentane/toluene: 6/4)

Yield: 58% (158 mg), obtained from **1b** (100 mg, 0.96 mmol).

^{1}H NMR (400 MHz, $CDCl_3$) δ 1.79–1.68 (m, 4 H), 1.24 (dt, $^3J_{HP}$ = 17.2 Hz, $^3J_{HH}$ = 7.6 Hz, 6 H), 1.11–1.07 (m, 21 H), 0.95–0.24 (m, 3 H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 114.0 (d, $^2J_{CP}$ = 3.6 Hz), 97.8 (d, $^1J_{CP}$ = 76.6 Hz), 19.0 (d, $^1J_{CP}$ = 40.1 Hz), 18.6, 11.1, 7.4 (d, $^2J_{CP}$ = 3.7 Hz).

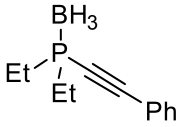
^{31}P NMR (162 MHz, $CDCl_3$) δ 10.1–9.7 (m).

^{11}B NMR (160 MHz, $CDCl_3$) δ –39.2 (dq, $^1J_{BH}$ = 95.8 Hz, $^1J_{BP}$ = 55.8 Hz).

IR (neat): 2943, 2867, 2379, 2346, 1461, 1065, 1036, 1019, 997, 882, 805 cm^{-1}.

HRMS (ESI) Calcd for $C_{15}H_{34}BNaSiP$ $[M+Na]^+$: 307.2158. Found: 307.2157.

Diethyl(phenyl)ethynylphosphine borane (3i)



$C_{12}H_{18}BP$
M = 204.12 g.mol^{-1}
colorless oil
R_f = 0.41 (pentane/toluene: 6/4)

Yield: 59% (115 mg), obtained from **1b** (100 mg, 0.96 mmol).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53–7.51 (m, 2 H), 7.42–7.33 (m, 3 H), 1.96–1.77 (m, 4 H), 1.29 (dt, $^3J_{HP}$ = 17.5 Hz, $^3J_{HH}$ = 7.6 Hz, 6 H), 1.10–0.20 (m, 3 H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 132.5 (d, $^4J_{CP}$ = 1.6 Hz), 130.2, 128.6, 120.9 (d, $^3J_{CP}$ = 3.1 Hz), 106.6 (d, $^2J_{CP}$ = 12.0 Hz), 79.0 (d, $^1J_{CP}$ = 89.9 Hz), 19.0 (d, $^1J_{CP}$ = 40.4 Hz), 7.5 (d, $^2J_{CP}$ = 3.5 Hz).

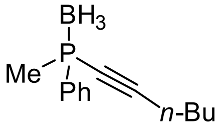
^{31}P NMR (162 MHz, $CDCl_3$) δ 10.4–10.0 (m).

^{11}B NMR (160 MHz, $CDCl_3$) δ –39.2 (dq, $^1J_{BH}$ = 96.7 Hz, $^1J_{PB}$ = 56.2 Hz).

IR (neat): 2379, 2336, 2178, 1489, 1065, 1034, 1020, 850, 755, 688 cm^{-1}.

HRMS (ESI) Calcd for $C_{12}H_{18}BNaP$ $[M+Na]^+$: 227.1137. Found: 227.1137.

Hex-1-ynylmethylphenylphosphine borane (3j)



$C_{13}H_{20}BP$
M = 218.14 g.mol^{-1}
colorless oil
R_f = 0.42 (pentane/toluene: 6/4)

Yield: 50% (82 mg).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86–7.81 (m, 2 H), 7.52–7.45 (m, 3 H), 2.39 (td, $^4J_{HP}$ = 3.2 Hz, $^3J_{HH}$ = 7.1 Hz, 2 H), 1.70 (d, $^2J_{HP}$ = 10.5 Hz, 3 H), 1.59 (quint, $^3J_{HH}$ = 7.0 Hz, 2 H), 1.43 (sext, $^3J_{HH}$ = 7.2 Hz, 2 H), 0.93 (t, $^3J_{HH}$ = 7.3 Hz, 3 H), 1.40–0.50 (m, 3 H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 131.6 (d, $^4J_{CP}$ = 2.5 Hz), 131.3 (d, $^2J_{CP}$ = 10.8 Hz), 129.9 (d, $^1J_{CP}$ = 62.8 Hz), 128.9 (d, $^3J_{CP}$ = 10.8 Hz), 110.9 (d, $^2J_{CP}$ = 16.4 Hz), 71.1 (d, $^1J_{CP}$ = 106.9 Hz), 29.9 (d, $^4J_{CP}$ = 1.5 Hz), 22.1, 19.8 (d, $^3J_{CP}$ = 2.4 Hz), 16.1 (d, $^1J_{CP}$ = 44 Hz), 13.6.

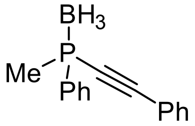
^{31}P NMR (162 MHz, $CDCl_3$) δ –4.4 to –4.9 (m).

^{11}B NMR (160 MHz, $CDCl_3$) δ –36.8 (dq, $^1J_{BH}$ = 96.7 Hz, $^1J_{PB}$ = 54.7 Hz).

IR (neat): 2379, 2354, 2197, 1438, 1110, 1058, 909, 894, 742, 691 cm^{-1}.

HRMS (ESI) Calcd for $C_{13}H_{20}BNaP$ $[M+Na]^+$: 241.1293. Found: 241.1293.

(Phenyl)ethynylmethylphenylphosphine borane (3k)



$C_{15}H_{16}BP$
M = 238.11 g.mol^{-1}
colorless oil
R_f = 0.40 (pentane/toluene: 6/4)

Yield: 52% (93 mg).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96–7.90 (m, 2 H), 7.57–7.34 (m, 8 H), 1.83 (d, $^2J_{HP}$ = 10.4 Hz, 3 H), 1.50–0.60 (m, 3 H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 132.4 (d, $^4J_{CP}$ = 1.7 Hz), 131.8 (d, $^4J_{CP}$ = 2.6 Hz), 131.4 (d, $^2J_{CP}$ = 10.9 Hz), 130.4, 129.2 (d, $^1J_{CP}$ = 62.5 Hz), 129.0 (d, $^3J_{CP}$ = 10.8 Hz), 128.6, 120.6 (d, $^3J_{CP}$ = 3.2 Hz), 107.0 (d, $^2J_{CP}$ = 15.9 Hz), 79.9 (d, $^1J_{CP}$ = 101.4 Hz), 15.7 (d, $^1J_{CP}$ = 43.8 Hz).

^{31}P NMR (162 MHz, $CDCl_3$) δ –3.5 to –3.9 (m).

^{11}B NMR (160 MHz, $CDCl_3$) δ –36.8 (dq, $^1J_{BH}$ = 95.9 Hz, $^1J_{PB}$ = 52.0 Hz).

IR (neat): 2373, 2178, 1488, 1437, 1110, 1057, 895, 741, 687 cm^{-1}.

HRMS (ESI) Calcd for $C_{15}H_{16}BNaP$ $[M+Na]^+$: 261.0980. Found: 261.0987.

(III) Formation of complex [$Ph_2P(BH_3)$Cuphen] and Reaction with 1-bromohexyne **2a**

In a Schlenk tube, flushed with nitrogen, diphenylphosphine-borane **1a** (60 mg, 0.30 mmol, 1 equiv.) in degassed dry THF (0.5 mL) was cooled to –78 °C. *n*-BuLi (0.130 mL, 0.33 mmol, 1.1 equiv., 2.5 M solution in hexane) was then slowly added and the mixture was stirred at this temperature for 20 min before allowing the temperature to reach 0 °C. The resulting solution of $Ph_2P(BH_3)Li$ (δ_p = –31.0 ppm) was slowly added to a suspension of CuI (57 mg, 0.30 mmol, 1 equiv.) in degassed dry toluene (1 mL) at 0 °C. After 20 min of stirring at 0 °C, a solution of 1,10-phenanthroline (54 mg, 0.30 mmol, 1 equiv.) in a mixture of degassed dry toluene (0.5 mL) and THF (0.3 mL) was added. The reaction medium turned red instantly, indicating the formation of [$Ph_2P(BH_3)$Cuphen] complex (δ_p = –22.0 ppm). After 20 min at 0 °C, a pre-cooled solution of 1-bromohexyne **2a** (70 mg, 0.43 mmol, 1.4 equiv.) in degassed dry toluene (0.5 mL) was slowly added and the reaction mixture was subsequently heated to 40 °C. After 2 hours, the spectrum showed the signal of the corresponding alkynylphosphine **3a** (δ_p = 5.0 ppm), alongside with a broad signal (δ_p = –33.1 to –35.7 ppm) assigned to [Ph_2PHCuXphen] complexes (X = I, Br) and a signal corresponding to **1a** (δ_p = 1.4 ppm), probably resulting from a partial hydrolysis of the copper phosphide [$Ph_2P(BH_3)Cu$phen].

NMR data for [$Ph_2P(BH_3)Cu$phen]:

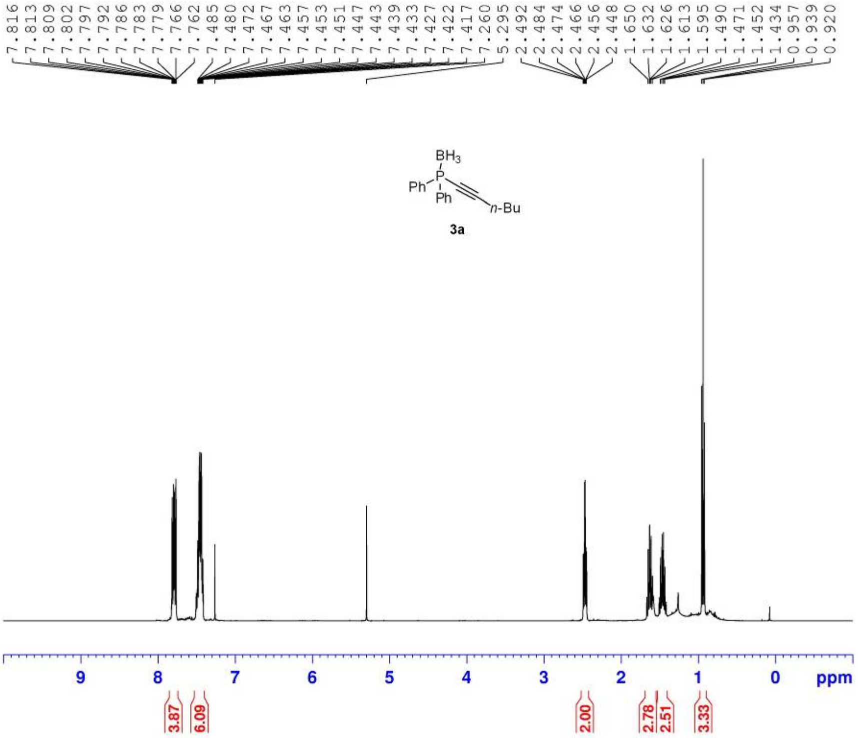
^{1}H NMR (500 MHz, THF–d_8) δ 8.80 (br, 2 H), 8.26 (br, 2 H), 7.64–7.57 (m, 8 H), 6.97 (br, 6 H), (signal of BH_3 is hidden in the base line).

^{13}C NMR (125 MHz, THF–d_8) δ 150.3, 144.3 (d br, $^1J_{CP}$ = 16.3 Hz), 144.0, 137.2 (br), 134.6 (br), 129.6, 127.6 (d br, $^3J_{CP}$ = 5.5 Hz), 127.3, 126.7, 125.3.

^{31}P NMR (202 MHz, THF–d_8) δ –21.8 (br).

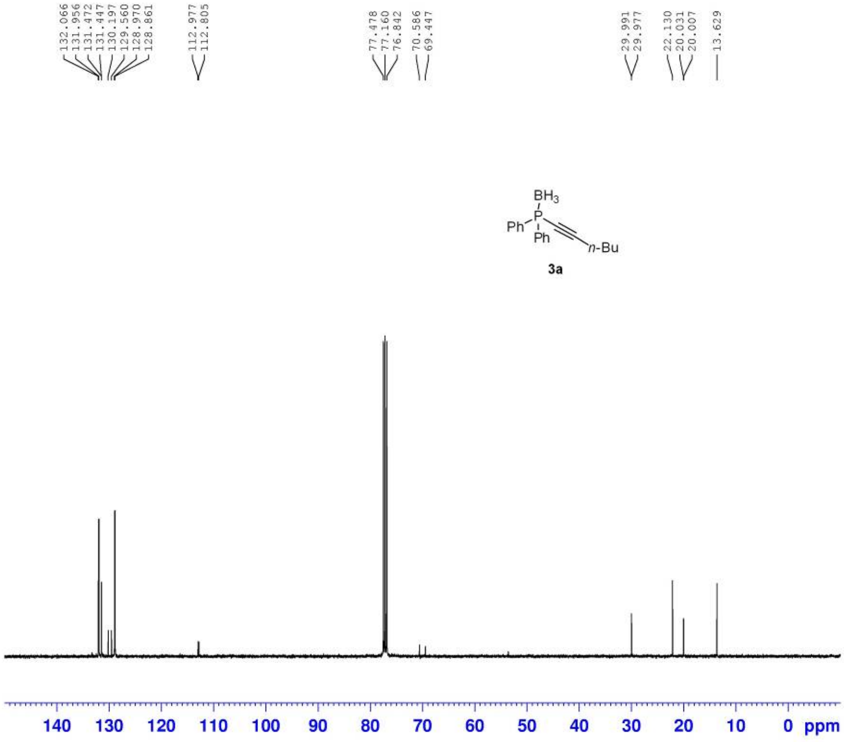
^{11}B NMR (160 MHz, THF–d_8) δ –31.0 (br).

(IV) NMR Spectra



```
NAME              eb108p2
EXPNO                  10
PROCNO                  1
Date_            20091113
Time                 6.07
INSTRUM             spect
PROBHD   5 mm QNP 1H/13
PULPROG              zg30
TD                  65536
SOLVENT             CDCl3
NS                     16
DS                      2
SWH              8223.685 Hz
FIDRES           0.125483 Hz
AQ              3.9846387 sec
RG                    161
DW                 60.800 usec
DE                   8.00 usec
TE                  295.0 K
D1             1.00000000 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                   1H
P1                  12.00 usec
PL1                 -1.00 dB
PL1W          15.25798988 W
SFO1          400.1324710 MHz
SI                  32768
SF            400.1300225 MHz
WDW                    EM
SSB                     0
LB                   0.30 Hz
GB                      0
PC                   1.00
```



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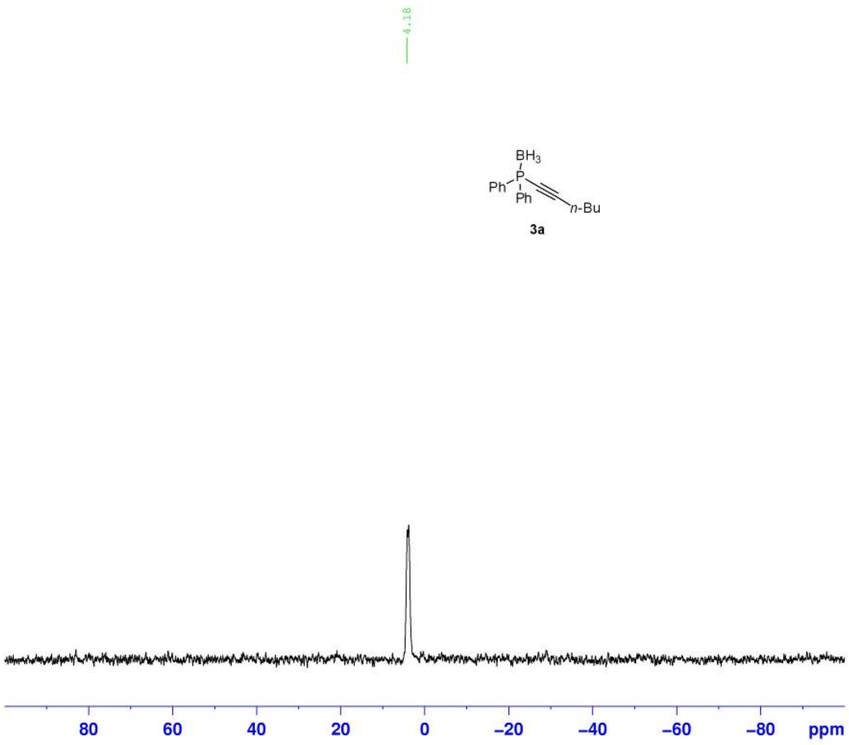
EXPNO                  20
PROCNO                  1
Date_            20091114
Time                 0.59
INSTRUM             spect
PROBHD   5 mm QNP 1H/13
PULPROG            zgpg30
TD                  65536
SOLVENT             CDCl3
NS                   1024
DS                      2
SWH             26041.666 Hz
FIDRES           0.397364 Hz
AQ              1.2583412 sec
RG                   2050
DW                 19.200 usec
DE                   8.00 usec
TE                  295.0 K
D1             3.00000000 sec
D11            0.03000000 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                  13C
P1                   8.30 usec
PL1                 -2.00 dB
PL1W          58.36251068 W
SFO1          100.6238364 MHz

======== CHANNEL f2 ========
CPDPRG2           waltz16
NUC2                   1H
PCPD2              100.00 usec
PL2                 -1.00 dB
PL12                17.42 dB
PL13                20.00 dB
PL2W          15.25798988 W
PL12W          0.21953173 W
PL13W          0.12119852 W
SFO2          400.1316005 MHz
SI                 131072
SF            100.6127596 MHz
WDW                    EM
SSB                     0
LB                   1.00 Hz
GB                      0
PC                   1.40
```

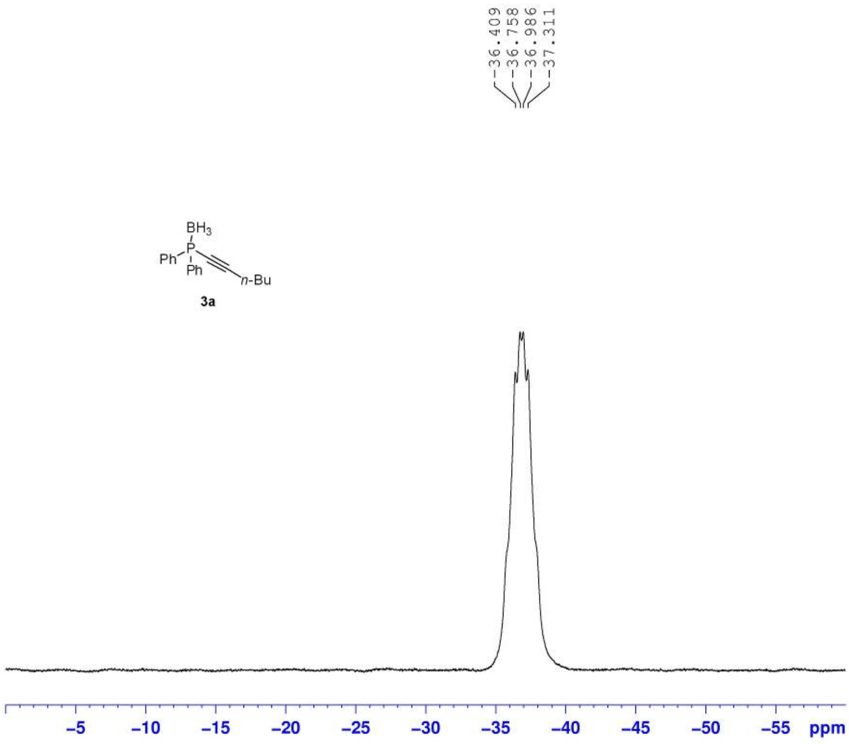


3a

```
NAME              eb117p2
EXPNO                  11
PROCNO                  1
Date_            20090907
Time                 4.05
INSTRUM             spect
PROBHD   5 mm QNP 1H/13
PULPROG            zgpg30
TD                  65536
SOLVENT             CDCl3
NS                     64
DS                      2
SWH             64102.563 Hz
FIDRES           0.978127 Hz
AQ              0.5112308 sec
RG                   2050
DW                  7.800 usec
DE                   8.00 usec
TE                  295.0 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                  31P
P1                   8.60 usec
PL1                  0.00 dB
PL1W          25.06862640 W
SFO1         161.9674942 MHz

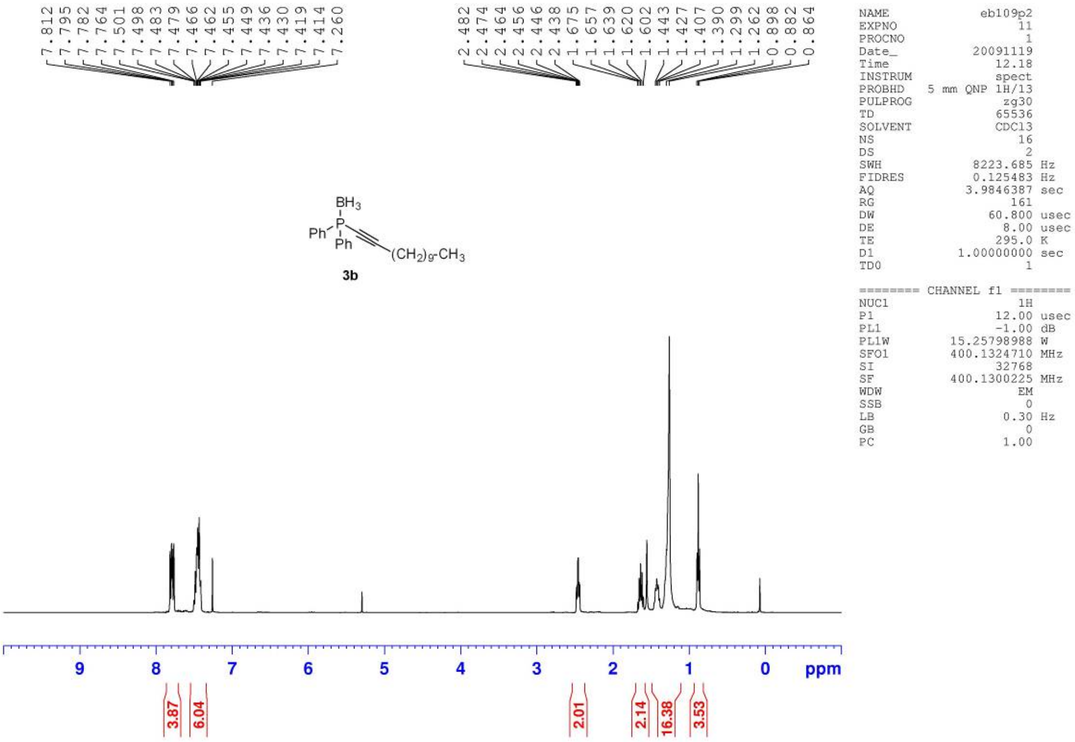
======== CHANNEL f2 ========
CPDPRG2           waltz16
NUC2                   1H
PCPD2              100.00 usec
PL2                 -1.00 dB
PL12                17.42 dB
PL13                20.00 dB
PL2W          15.25798988 W
PL12W          0.21953173 W
PL13W          0.12119852 W
SFO2         400.1316005 MHz
SI                  32768
SF           161.9755930 MHz
WDW                    EM
SSB                     0
LB                  15.00 Hz
GB                      0
PC                   1.40
```



3a

```
NAME          eb108p2-500
EXPNO                  10
PROCNO                  1
Date_            20091117
Time                20.01
INSTRUM             spect
PROBHD   5 mm PABBO BB-
PULPROG                zg
TD                  65536
SOLVENT             CDCl3
NS                    256
DS                      4
SWH             32051.281 Hz
FIDRES           0.489064 Hz
AQ              1.0224116 sec
RG                    362
DW                 15.600 usec
DE                   6.50 usec
TE                  295.0 K
D1             1.00000000 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                  11B
P1                   7.50 usec
PL1                  0.00 dB
PL1W          86.66007996 W
SFO1         160.4615792 MHz
SI                  32768
SF           160.4615790 MHz
WDW                    EM
SSB                     0
LB                   3.00 Hz
GB                      0
PC                   0.40
```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7.479
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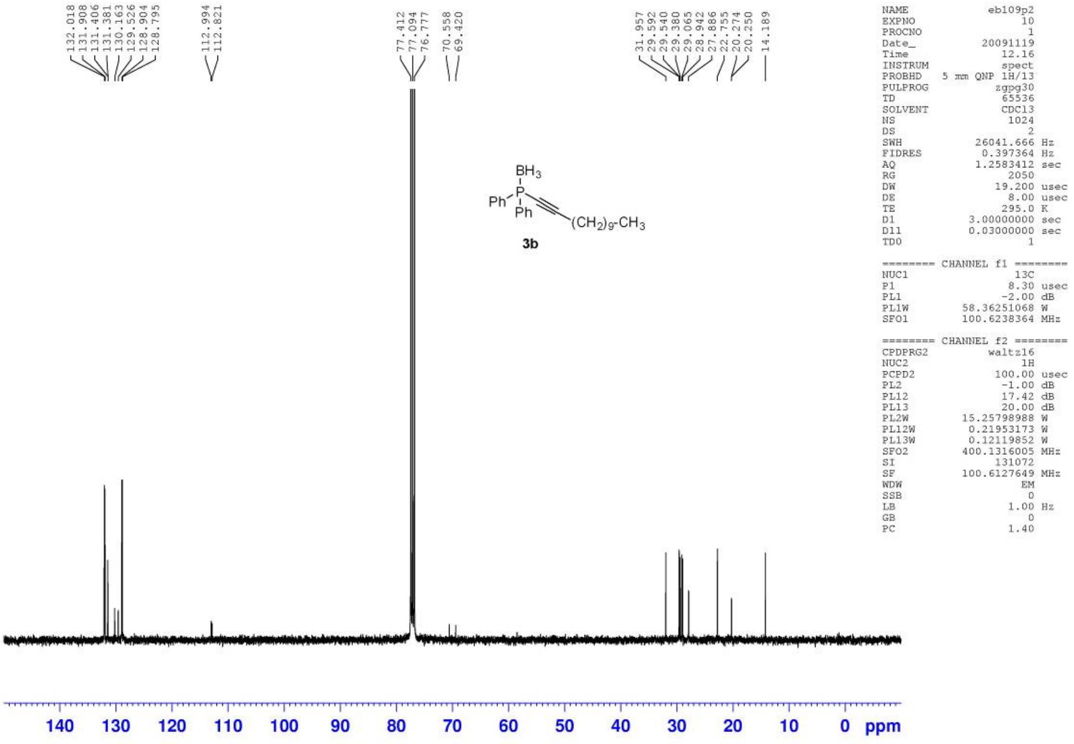
7.462
7.455
7.449
7.436
7.430
7.419
7.414
7.260
2.482
2.474
2.464
2.456
2.446
2.438
1.675
1.657
1.639
1.620
1.602
1.443
1.427
1.407
1.390
1.299
1.262
0.898
0.882
0.864
BH3
Ph
P
Ph
(CH2)9-CH3
3b
NAME eb109p2
EXPNO 11
PROCNO 1
Date_ 20091119
Time 12.18
INSTRUM spect
PROBHD 5 mm QNP 1H/13
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 161
DW 60.800 usec
DE 8.00 usec
TE 295.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 12.00 usec
PL1 -1.00 dB
PL1W 15.25798988 W
SFO1 400.1324710 MHz
SI 32768
SF 400.1300225 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
9
8
7
6
5
4
3
2
1
0
ppm
3.87
6.04
2.01
2.14
16.38
3.53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131.381
130.163
129.526
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128.795
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112.821
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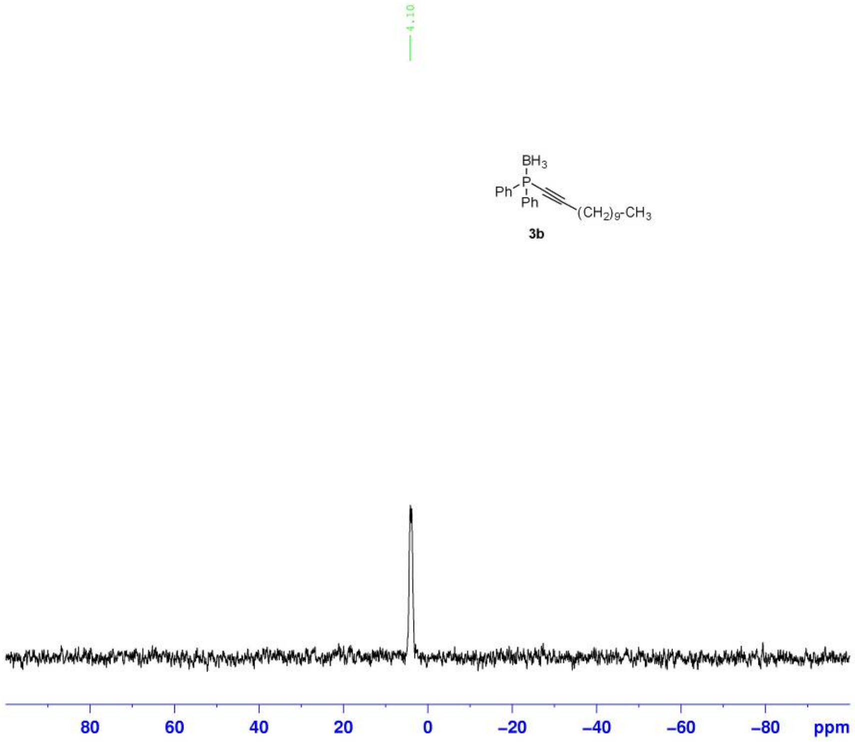
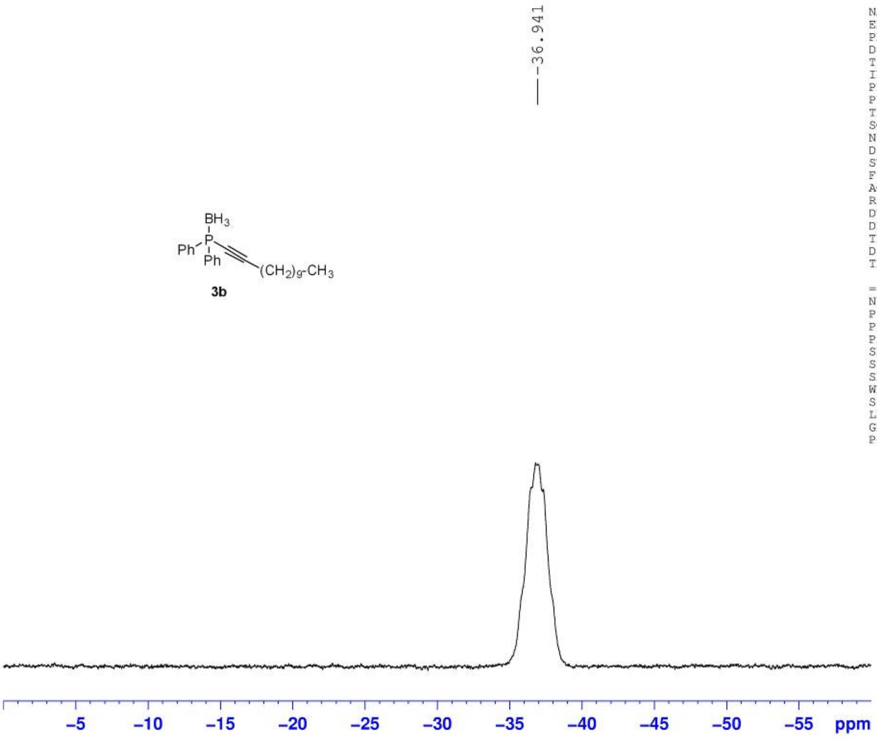
77.094
76.777
70.558
69.420
31.957
29.592
29.540
29.380
29.065
28.942
27.886
22.755
20.274
20.250
14.189
BH3
Ph
P
Ph
(CH2)9-CH3
3b
NAME eb109p2
EXPNO 10
PROCNO 1
Date_ 20091119
Time 12.16
INSTRUM spect
PROBHD 5 mm QNP 1H/13
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 1024
DS 2
SWH 26041.666 Hz
FIDRES 0.397364 Hz
AQ 1.2583412 sec
RG 2050
DW 19.200 usec
DE 8.00 usec
TE 295.0 K
D1 3.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 13C
P1 8.30 usec
PL1 -2.00 dB
PL1W 58.36251068 W
SFO1 100.6238364 MHz
======== CHANNEL f2 ========
CPDPRG2 waltz16
NUC2 1H
PCPD2 100.00 usec
PL2 -1.00 dB
PL12 17.42 dB
PL13 20.00 dB
PL2W 15.25798988 W
PL12W 0.21953173 W
PL13W 0.12119852 W
SFO2 400.1316005 MHz
SI 131072
SF 100.6127649 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm



```
NAME              eb099p2
EXPNO                  11
PROCNO                  1
Date_            20090617
Time                 8.54
INSTRUM             spect
PROBHD   5 mm QNP 1H/13
PULPROG            zgpg30
TD                  65536
SOLVENT             CDCl3
NS                     64
DS                      2
SWH             64102.563 Hz
FIDRES           0.978127 Hz
AQ              0.5112308 sec
RG                   2050
DW                  7.800 usec
DE                   8.00 usec
TE                  295.0 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                     1

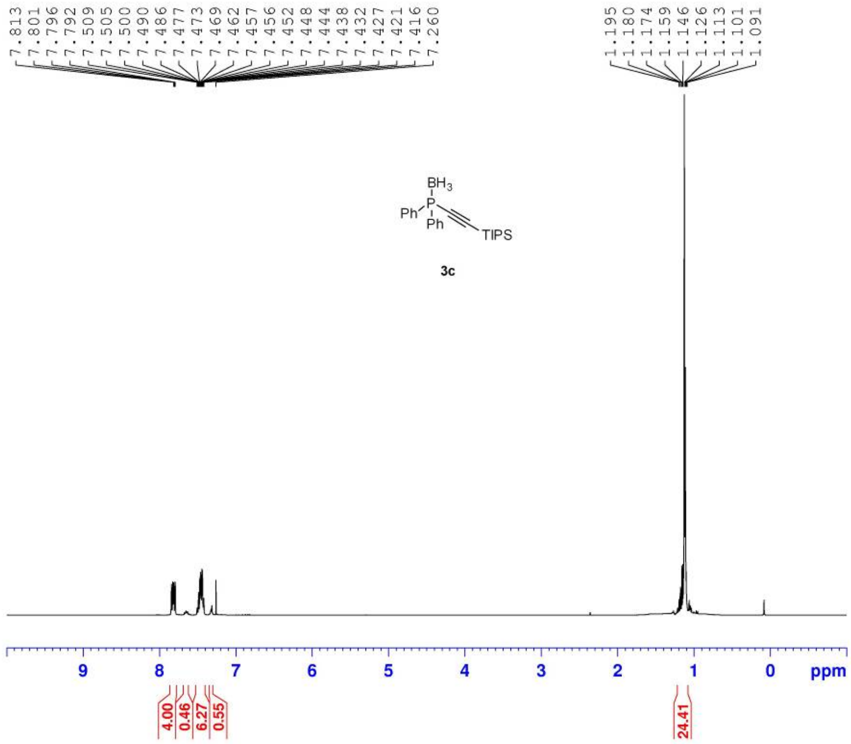
======== CHANNEL f1 ========
NUC1                  31P
P1                   8.60 usec
PL1                  0.00 dB
PL1W          25.06862640 W
SFO1         161.9674942 MHz

======== CHANNEL f2 ========
CPDPRG2           waltz16
NUC2                   1H
PCPD2              100.00 usec
PL2                 -1.00 dB
PL12                17.42 dB
PL13                20.00 dB
PL2W          15.25798988 W
PL12W          0.21953173 W
PL13W          0.12119852 W
SFO2         400.1316005 MHz
SI                  32768
SF           161.9755930 MHz
WDW                    EM
SSB                     0
LB                  15.00 Hz
GB                      0
PC                   1.40
```



```
NAME              eb109p2B
EXPNO                   10
PROCNO                   1
Date_             20091117
Time                 18.28
INSTRUM              spect
PROBHD   5 mm PABBO BB-
PULPROG                 zg
TD                   65536
SOLVENT              CDCl3
NS                     256
DS                       4
SWH              32051.281 Hz
FIDRES            0.489064 Hz
AQ               1.0224116 sec
RG                     362
DW                  15.600 usec
DE                    6.50 usec
TE                   295.0 K
D1              1.00000000 sec
TD0                      1

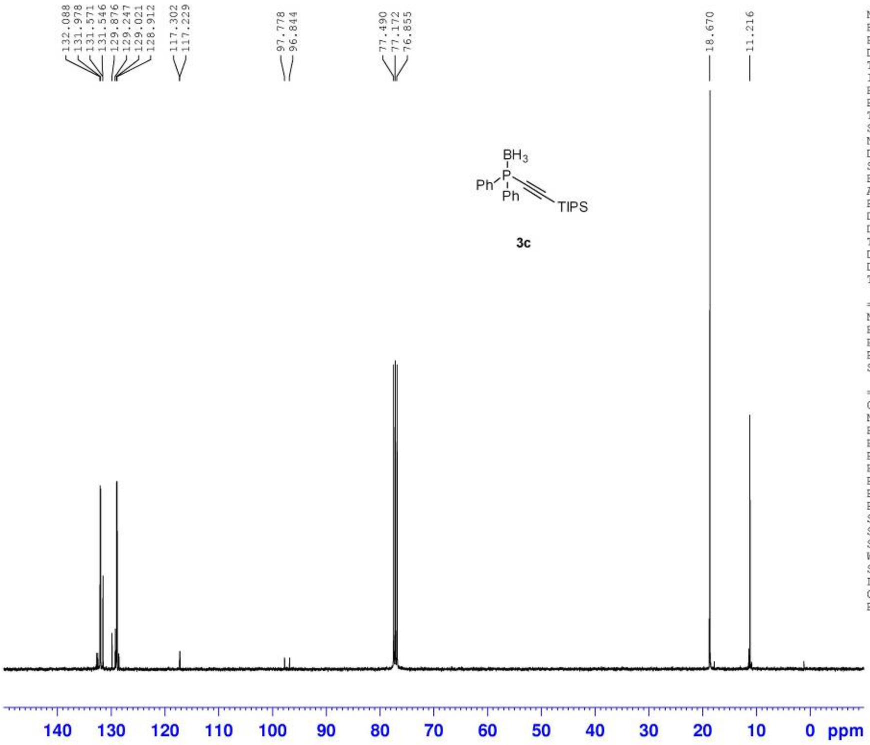
======== CHANNEL f1 ========
NUC1                   11B
P1                    7.50 usec
PL1                   0.00 dB
PL1W           86.66007996 W
SFO1          160.4615792 MHz
SI                   32768
SF            160.4615790 MHz
WDW                     EM
SSB                      0
LB                    4.00 Hz
GB                       0
PC                    0.20
```



3c

```
NAME            eb111p2
EXPNO                11
PROCNO                1
Date_          20091221
Time              21.13
INSTRUM           spect
PROBHD   5 mm QNP 1H/13
PULPROG            zg30
TD                65536
SOLVENT           CDCl3
NS                   16
DS                    2
SWH            8223.685 Hz
FIDRES         0.125483 Hz
AQ            3.9846387 sec
RG                 90.5
DW               60.800 usec
DE                 8.00 usec
TE                295.0 K
D1           1.00000000 sec
TD0                   1

======== CHANNEL f1 ========
NUC1                 1H
P1                12.00 usec
PL1               -1.00 dB
PL1W        15.25798988 W
SFO1        400.1324710 MHz
SI                32768
SF          400.1300215 MHz
WDW                  EM
SSB                   0
LB                 0.30 Hz
GB                    0
PC                 1.00
```

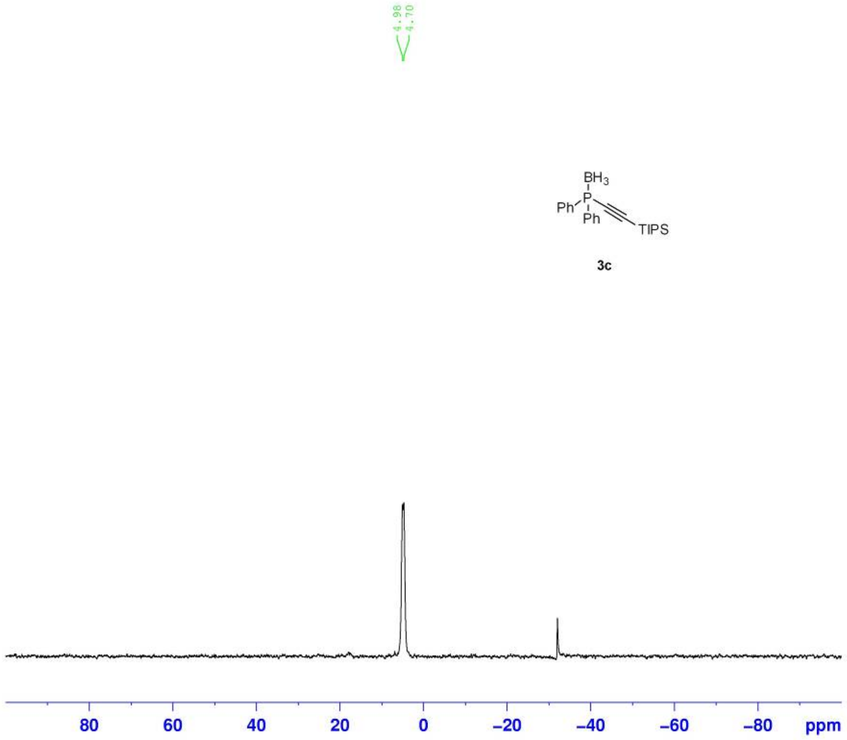


3c

```
NAME            eb111p2
EXPNO                10
PROCNO                1
Date_          20091221
Time              21.11
INSTRUM           spect
PROBHD   5 mm QNP 1H/13
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                 1024
DS                    2
SWH           26041.666 Hz
FIDRES         0.397364 Hz
AQ            1.2583412 sec
RG                 2050
DW               19.200 usec
DE                 8.00 usec
TE                295.0 K
D1           3.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
NUC1                13C
P1                 8.20 usec
PL1               -2.00 dB
PL1W        58.36251068 W
SFO1        100.6238364 MHz

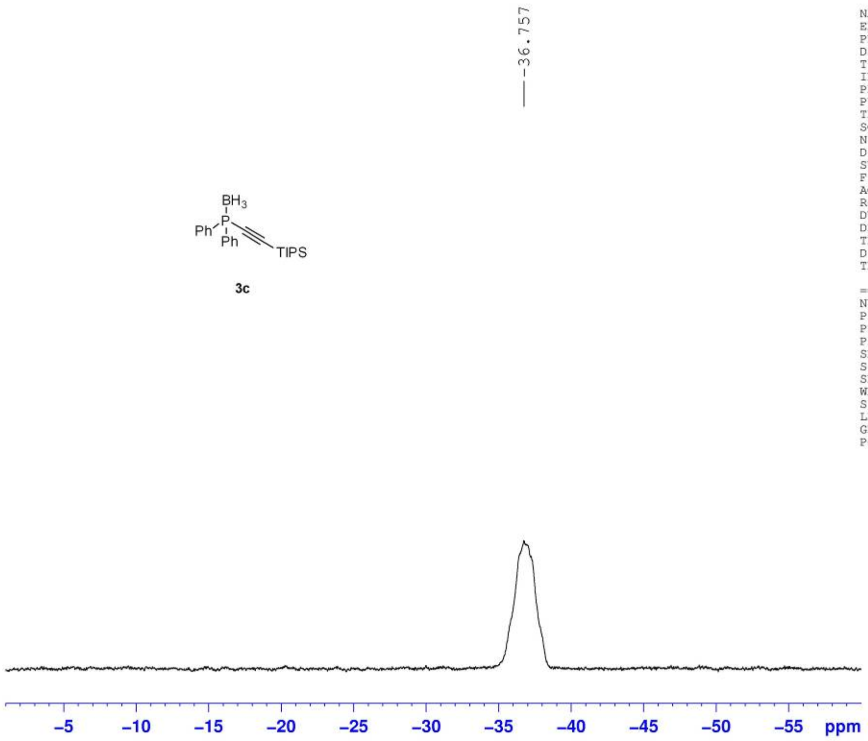
======== CHANNEL f2 ========
CPDPRG2         waltz16
NUC2                 1H
PCPD2            100.00 usec
PL2               -1.00 dB
PL12              17.42 dB
PL13              17.42 dB
PL2W        15.25798988 W
PL12W        0.21953173 W
PL13W        0.21953173 W
SFO2        400.1316005 MHz
SI               131072
SF          100.6127578 MHz
WDW                  EM
SSB                   0
LB                 1.00 Hz
GB                    0
PC                 1.40
```



```
NAME             eb111p2
EXPNO                 12
PROCNO                 1
Date_           20091221
Time               21.16
INSTRUM            spect
PROBHD   5 mm QNP 1H/13
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                    64
DS                     2
SWH            64102.563 Hz
FIDRES          0.978127 Hz
AQ             0.5112308 sec
RG                  2050
DW                 7.800 usec
DE                  8.00 usec
TE                 295.0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

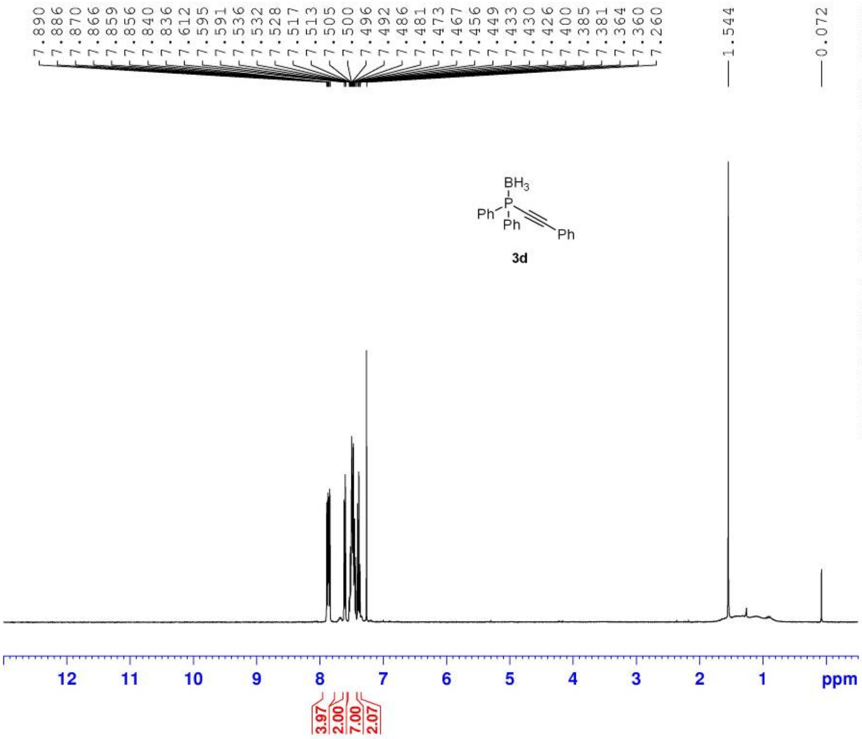
======== CHANNEL f1 ========
NUC1                 31P
P1                  8.60 usec
PL1                 0.00 dB
PL1W         25.06862640 W
SFO1         161.9674942 MHz

======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                  1H
PCPD2             100.00 usec
PL2                -1.00 dB
PL12               17.42 dB
PL13               17.42 dB
PL2W         15.25798988 W
PL12W         0.21953173 W
PL13W         0.21953173 W
SFO2         400.1316005 MHz
SI                 32768
SF           161.9755930 MHz
WDW                   EM
SSB                    0
LB                 15.00 Hz
GB                     0
PC                  1.40
```



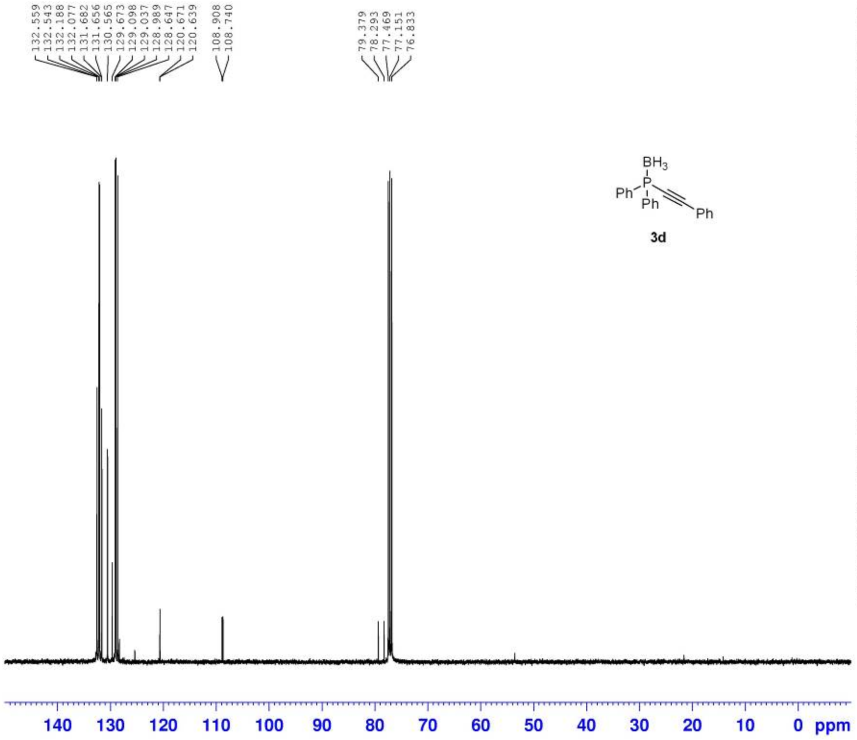
```
NAME             eb132pB
EXPNO                 10
PROCNO                 1
Date_           20091117
Time               19.38
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG               zg
TD                 65536
SOLVENT            CDCl3
NS                   256
DS                     4
SWH            32051.281 Hz
FIDRES          0.489064 Hz
AQ             1.0224116 sec
RG                   362
DW                15.600 usec
DE                  6.50 usec
TE                 295.0 K
D1            1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                 11B
P1                  7.50 usec
PL1                 0.00 dB
PL1W         86.66007996 W
SFO1         160.4615792 MHz
SI                 32768
SF           160.4615790 MHz
WDW                   EM
SSB                    0
LB                  4.00 Hz
GB                     0
PC                  0.10
```



```
NAME            eb71pbis
EXPNO                 20
PROCNO                 1
Date_           20100607
Time               17.00
INSTRUM            spect
PROBHD   5 mm QNP 1H/13
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    16
DS                     2
SWH             8223.685 Hz
FIDRES          0.125483 Hz
AQ             3.9846387 sec
RG                   456
DW                60.800 usec
DE                  8.00 usec
TE                 295.2 K
D1            1.00000000 sec
TD0                    1

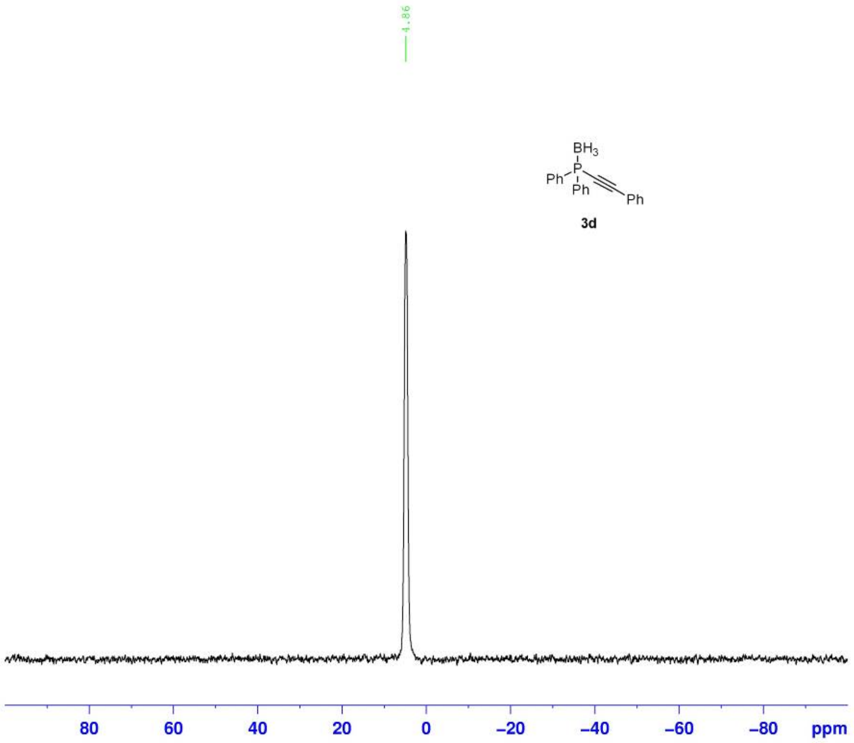
======== CHANNEL f1 ========
NUC1                  1H
P1                 12.00 usec
PL1                -1.00 dB
PL1W         15.25798988 W
SFO1         400.1324710 MHz
SI                 32768
SF           400.1300219 MHz
WDW                   EM
SSB                    0
LB                  0.30 Hz
GB                     0
PC                  1.00
```



```
NAME           eb71pbis2
EXPNO                 10
PROCNO                 1
Date_           20100608
Time               16.54
INSTRUM            spect
PROBHD   5 mm QNP 1H/13
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                  1024
DS                     2
SWH            26041.666 Hz
FIDRES          0.397364 Hz
AQ             1.2583412 sec
RG                  2050
DW                19.200 usec
DE                  8.00 usec
TE                 295.2 K
D1            3.00000000 sec
D11           0.03000000 sec
TD0                    1

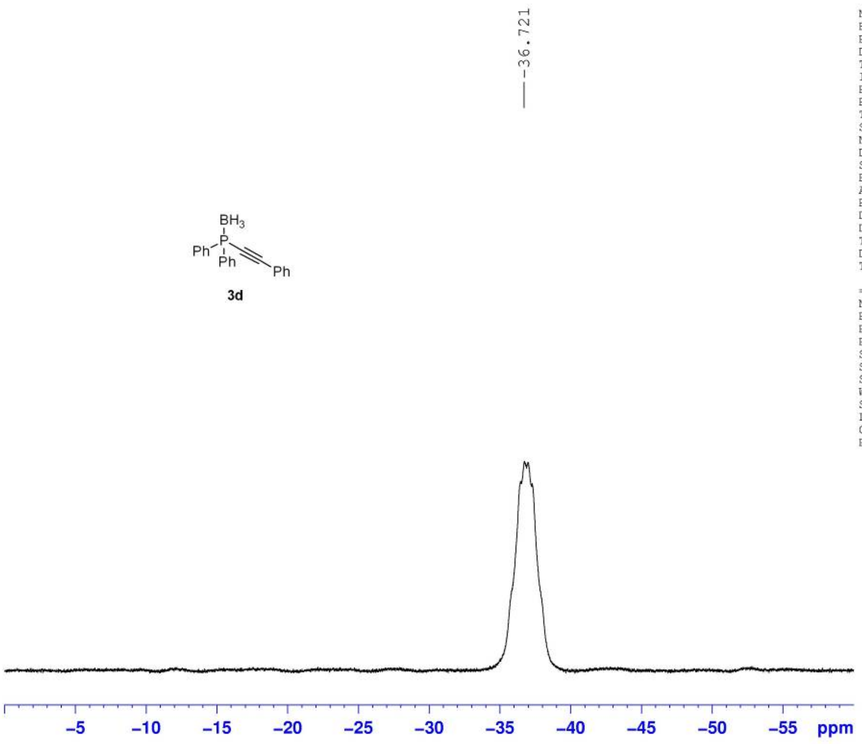
======== CHANNEL f1 ========
NUC1                 13C
P1                  8.20 usec
PL1                -2.00 dB
PL1W         58.36251068 W
SFO1         100.6238364 MHz

======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                  1H
PCPD2             100.00 usec
PL2                -1.00 dB
PL12               17.42 dB
PL13               17.42 dB
PL2W         15.25798988 W
PL12W         0.21953173 W
PL13W         0.21953173 W
SFO2         400.1316005 MHz
SI                131072
SF           100.6127640 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```



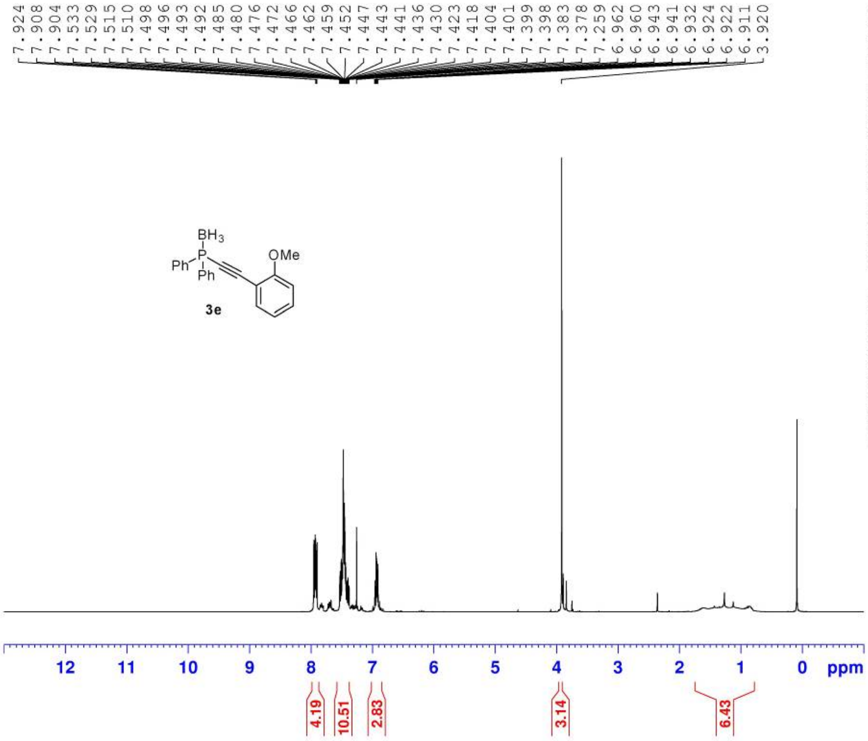
```
NAME           eb71pbis
EXPNO                12
PROCNO                1
Date_          20100604
Time               8.40
INSTRUM           spect
PROBHD   5 mm QNP 1H/13
PULPROG            zg30
TD                65536
SOLVENT           CDCl3
NS                   64
DS                    4
SWH           64102.563 Hz
FIDRES         0.978127 Hz
AQ            0.5112308 sec
RG                 2050
DW                7.800 usec
DE                 8.00 usec
TE                295.2 K
D1           2.00000000 sec
TD0                   1

======== CHANNEL f1 ========
NUC1                31P
P1                 8.60 usec
PL1                0.00 dB
PL1W        25.06862640 W
SFO1        161.9674942 MHz
SI                32768
SF          161.9755930 MHz
WDW                  EM
SSB                   0
LB                15.00 Hz
GB                    0
PC                 1.40
```



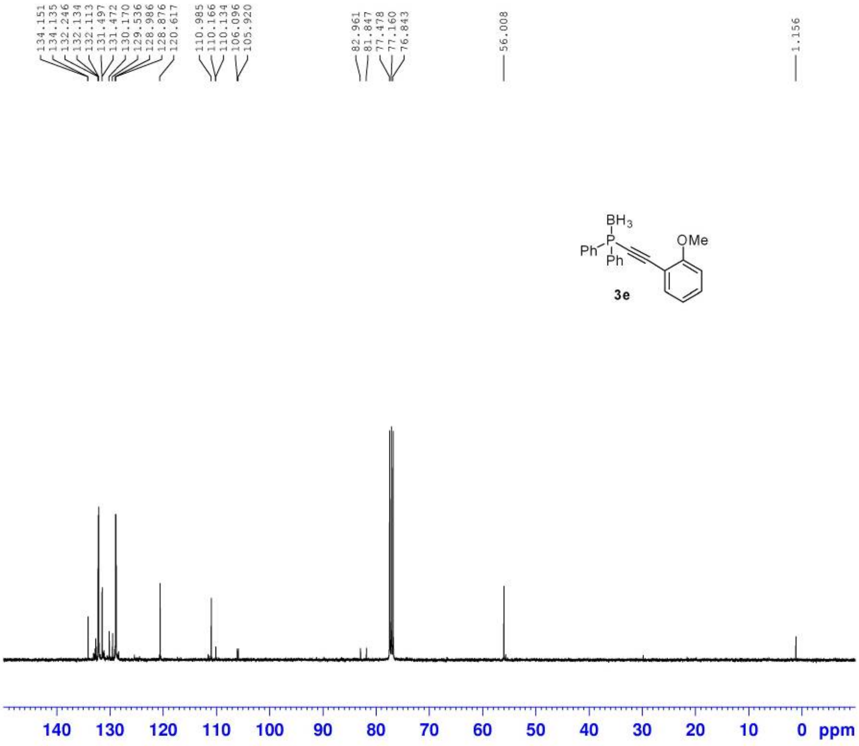
```
NAME          eb71pbisB
EXPNO                10
PROCNO                1
Date_          20100617
Time              17.46
INSTRUM           spect
PROBHD   5 mm PABBO BB-
PULPROG              zg
TD                65536
SOLVENT           CDCl3
NS                  256
DS                    4
SWH           32051.281 Hz
FIDRES         0.489064 Hz
AQ            1.0224116 sec
RG                  362
DW               15.600 usec
DE                 6.50 usec
TE                295.3 K
D1           1.00000000 sec
TD0                   1

======== CHANNEL f1 ========
NUC1                11B
P1                 7.50 usec
PL1                0.00 dB
PL1W        86.66007996 W
SFO1        160.4615792 MHz
SI                32768
SF          160.4615790 MHz
WDW                  EM
SSB                   0
LB                 1.00 Hz
GB                    0
PC                 1.40
```



```
NAME          ebcgf2bis
EXPNO                11
PROCNO                1
Date_          20100403
Time               2.53
INSTRUM           spect
PROBHD   5 mm QNP 1H/13
PULPROG            zg30
TD                65536
SOLVENT           CDCl3
NS                   16
DS                    2
SWH            8223.685 Hz
FIDRES         0.125483 Hz
AQ            3.9846387 sec
RG                  161
DW               60.800 usec
DE                 8.00 usec
TE                295.2 K
D1           1.00000000 sec
TD0                   1

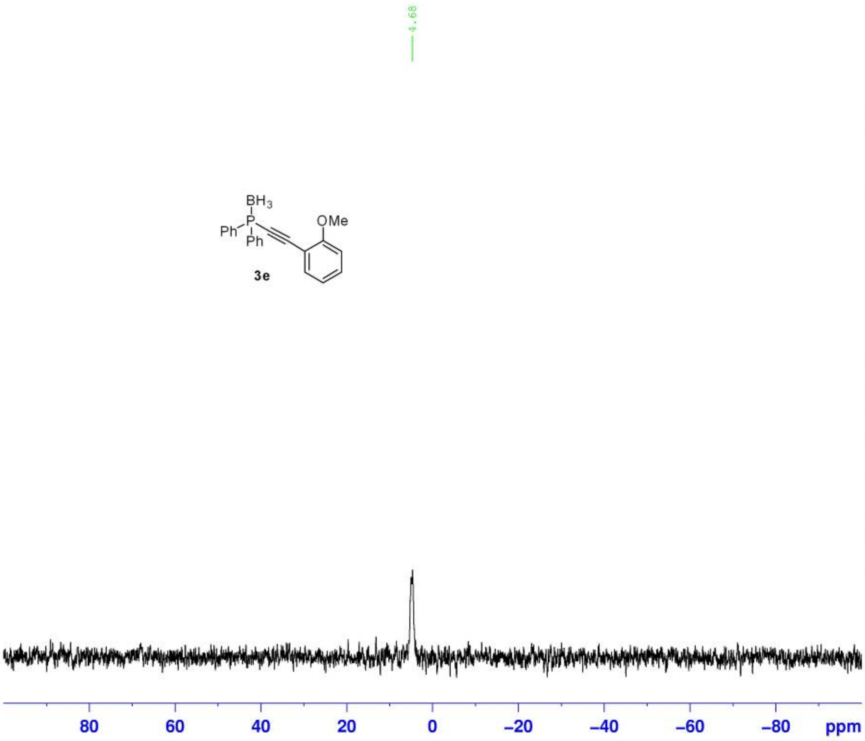
======== CHANNEL f1 ========
NUC1                 1H
P1                12.00 usec
PL1               -1.00 dB
PL1W        15.25798988 W
SFO1        400.1324710 MHz
SI                32768
SF          400.1300221 MHz
WDW                  EM
SSB                   0
LB                 0.30 Hz
GB                    0
PC                 1.00
```



```
NAME          ebcgf2bis
EXPNO                10
PROCNO                1
Date_          20100403
Time               2.52
INSTRUM           spect
PROBHD   5 mm QNP 1H/13
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                 1024
DS                    2
SWH           26041.666 Hz
FIDRES         0.397364 Hz
AQ            1.2583412 sec
RG                 2050
DW               19.200 usec
DE                 8.00 usec
TE                295.2 K
D1           3.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
NUC1                13C
P1                 8.20 usec
PL1               -2.00 dB
PL1W        58.36251068 W
SFO1        100.6238364 MHz

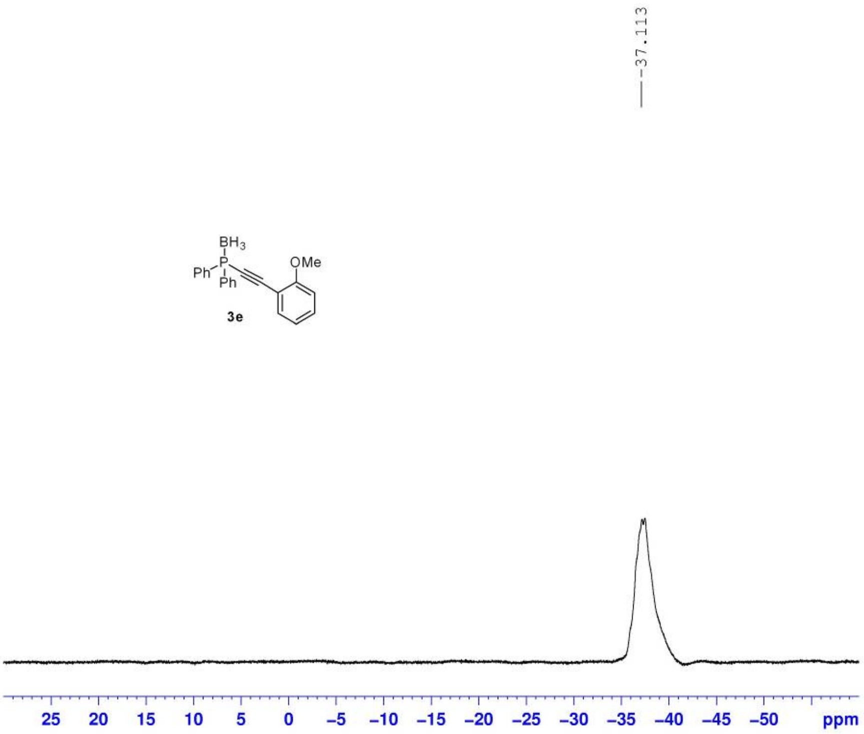
======== CHANNEL f2 ========
CPDPRG2         waltz16
NUC2                 1H
PCPD2            100.00 usec
PL2               -1.00 dB
PL12              17.42 dB
PL13              17.42 dB
PL2W        15.25798988 W
PL12W        0.21953173 W
PL13W        0.21953173 W
SFO2        400.1316005 MHz
SI               131072
SF          100.6127611 MHz
WDW                  EM
SSB                   0
LB                 1.00 Hz
GB                    0
PC                 1.40
```



```
NAME              EB212P3
EXPNO                  11
PROCNO                  1
Date_            20100427
Time                10.27
INSTRUM             spect
PROBHD   5 mm QNP 1H/13
PULPROG           zgpg30
TD                  65536
SOLVENT             CDCl3
NS                     64
DS                      2
SWH            64102.563 Hz
FIDRES          0.978127 Hz
AQ             0.5112308 sec
RG                   2050
DW                  7.800 usec
DE                   8.00 usec
TE                  295.2 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                     1

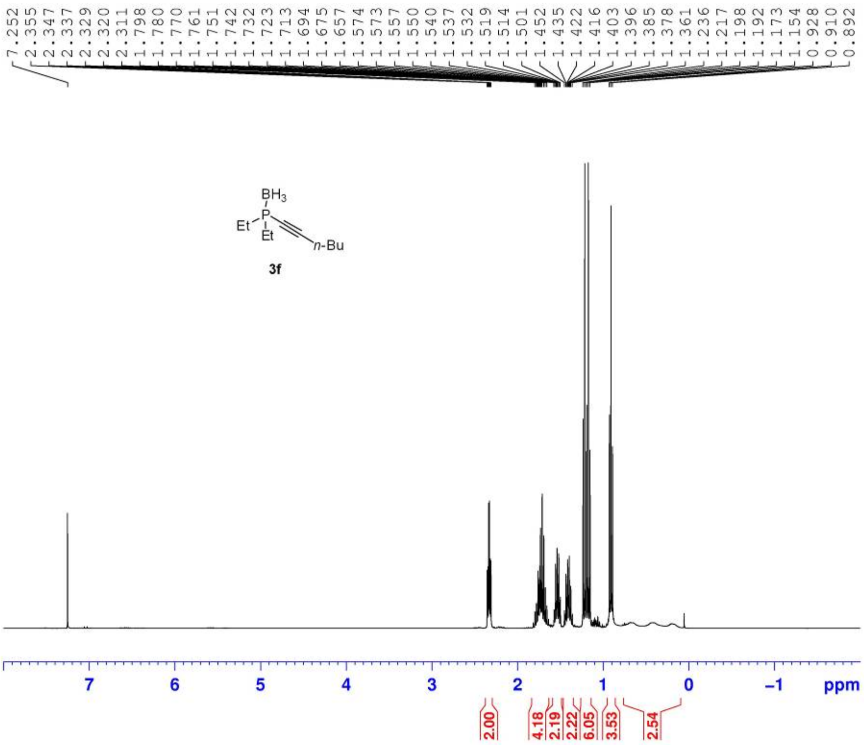
======== CHANNEL f1 ========
NUC1                  31P
P1                   8.60 usec
PL1                  0.00 dB
PL1W          25.06862640 W
SFO1         161.9674942 MHz

======== CHANNEL f2 ========
CPDPRG2           waltz16
NUC2                   1H
PCPD2              100.00 usec
PL2                 -1.00 dB
PL12                17.42 dB
PL13                17.42 dB
PL2W          15.25798988 W
PL12W          0.21953173 W
PL13W          0.21953173 W
SFO2         400.1316005 MHz
SI                  32768
SF           161.9755930 MHz
WDW                    EM
SSB                     0
LB                  10.00 Hz
GB                      0
PC                   1.40
```



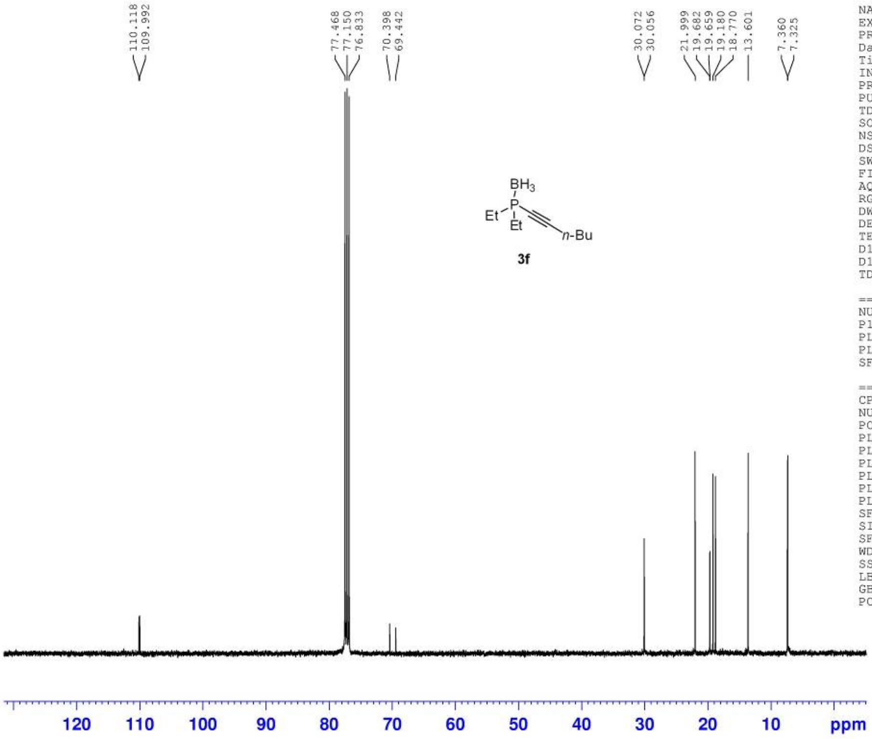
```
NAME           eb212pp6-9B
EXPNO                  10
PROCNO                  1
Date_            20100617
Time                18.10
INSTRUM             spect
PROBHD   5 mm PABBO BB-
PULPROG                zg
TD                  65536
SOLVENT             CDCl3
NS                    256
DS                      4
SWH            32051.281 Hz
FIDRES          0.489064 Hz
AQ             1.0224116 sec
RG                    362
DW                 15.600 usec
DE                   6.50 usec
TE                  295.6 K
D1             1.00000000 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                  11B
P1                   7.50 usec
PL1                  0.00 dB
PL1W          86.66007996 W
SFO1         160.4615792 MHz
SI                  32768
SF           160.4615790 MHz
WDW                    EM
SSB                     0
LB                   1.00 Hz
GB                      0
PC                   1.40
```



```
NAME           eb154p2
EXPNO               21
PROCNO               1
Date_         20091222
Time             16.45
INSTRUM          spect
PROBHD   5 mm QNP 1H/13
PULPROG           zg30
TD               65536
SOLVENT          CDCl3
NS                  16
DS                   2
SWH           8223.685 Hz
FIDRES        0.125483 Hz
AQ           3.9846387 sec
RG                 161
DW              60.800 usec
DE                8.00 usec
TE               295.0 K
D1          1.00000000 sec
TD0                  1

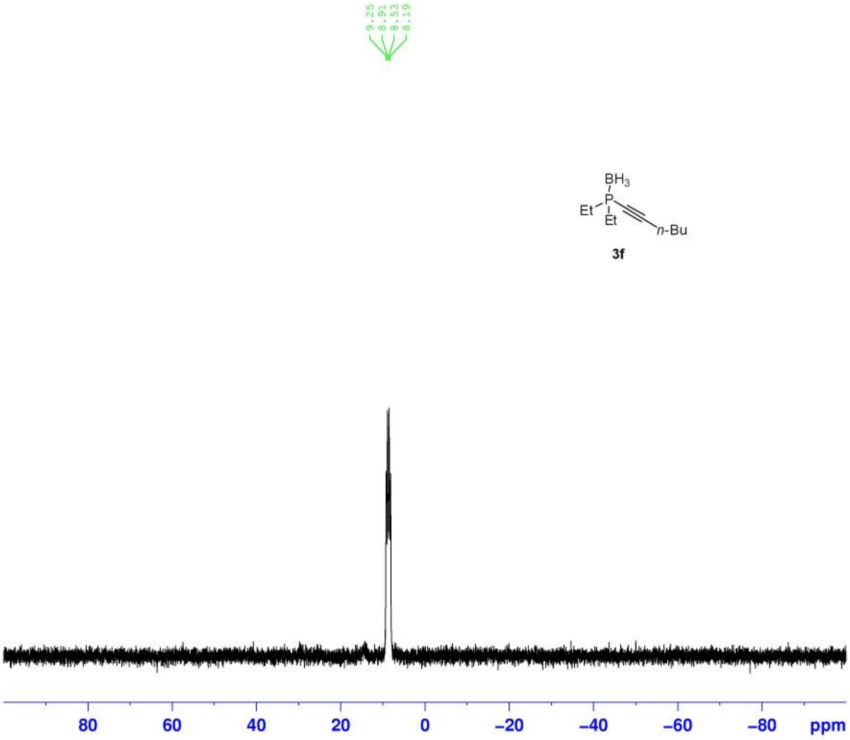
======== CHANNEL f1 ========
NUC1                1H
P1               12.00 usec
PL1              -1.00 dB
PL1W       15.25798988 W
SFO1       400.1324710 MHz
SI               32768
SF         400.1300247 MHz
WDW                 EM
SSB                  0
LB                0.30 Hz
GB                   0
PC                1.00
```



```
NAME           eb154p2
EXPNO               20
PROCNO               1
Date_         20091222
Time             16.43
INSTRUM          spect
PROBHD   5 mm QNP 1H/13
PULPROG         zgpg30
TD               65536
SOLVENT          CDCl3
NS                1024
DS                   2
SWH          26041.666 Hz
FIDRES        0.397364 Hz
AQ           1.2583412 sec
RG                2050
DW              19.200 usec
DE                8.00 usec
TE               295.0 K
D1          3.00000000 sec
D11         0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
NUC1               13C
P1                8.20 usec
PL1              -2.00 dB
PL1W       58.36251068 W
SFO1       100.6238364 MHz

======== CHANNEL f2 ========
CPDPRG2        waltz16
NUC2                1H
PCPD2           100.00 usec
PL2              -1.00 dB
PL12             17.42 dB
PL13             17.42 dB
PL2W       15.25798988 W
PL12W       0.21953173 W
PL13W       0.21953173 W
SFO2       400.1316005 MHz
SI              131072
SF         100.6127599 MHz
WDW                 EM
SSB                  0
LB                1.00 Hz
GB                   0
PC                1.40
```

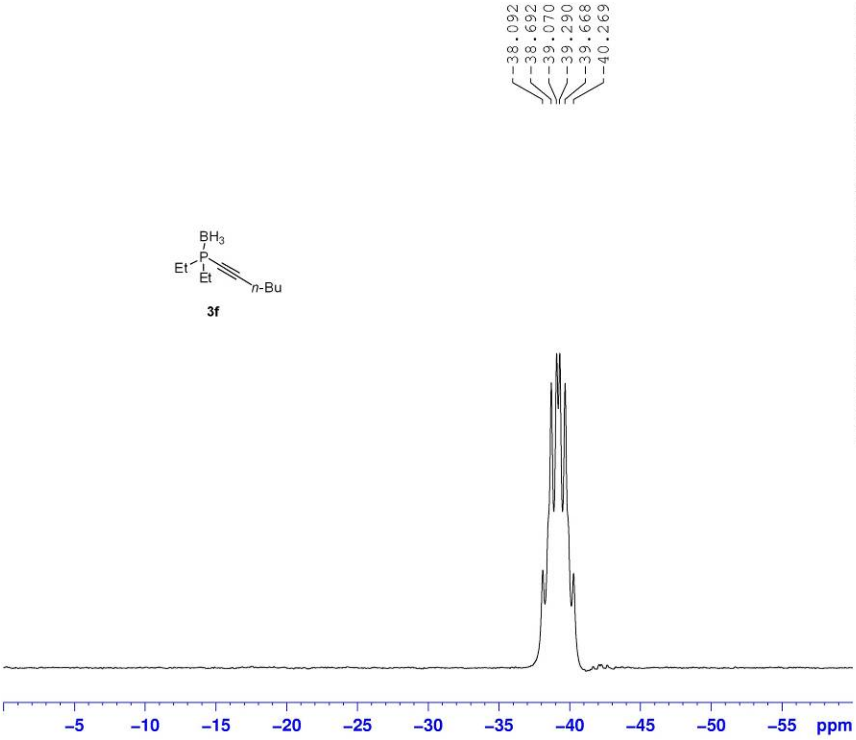


3f

```
NAME            eb154p2
EXPNO                22
PROCNO                1
Date_          20091222
Time              16.49
INSTRUM           spect
PROBHD   5 mm QNP 1H/13
PULPROG         zgpg30
TD                65536
SOLVENT           CDCl3
NS                   64
DS                    2
SWH           64102.563 Hz
FIDRES         0.978127 Hz
AQ            0.5112308 sec
RG                 2050
DW                7.800 usec
DE                 8.00 usec
TE                295.0 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
NUC1                31P
P1                 8.60 usec
PL1                0.00 dB
PL1W        25.06862640 W
SFO1        161.9674942 MHz

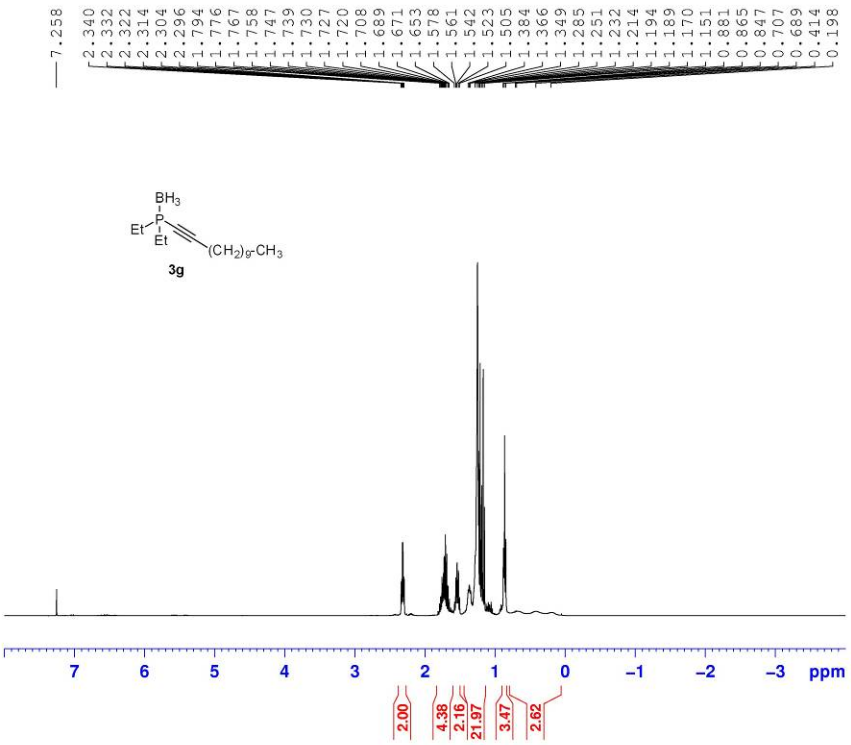
======== CHANNEL f2 ========
CPDPRG2         waltz16
NUC2                 1H
PCPD2            100.00 usec
PL2               -1.00 dB
PL12              17.42 dB
PL13              17.42 dB
PL2W        15.25798988 W
PL12W        0.21953173 W
PL13W        0.21953173 W
SFO2        400.1316005 MHz
SI                32768
SF          161.9755930 MHz
WDW                  EM
SSB                   0
LB                 1.00 Hz
GB                    0
PC                 1.40
```



3f

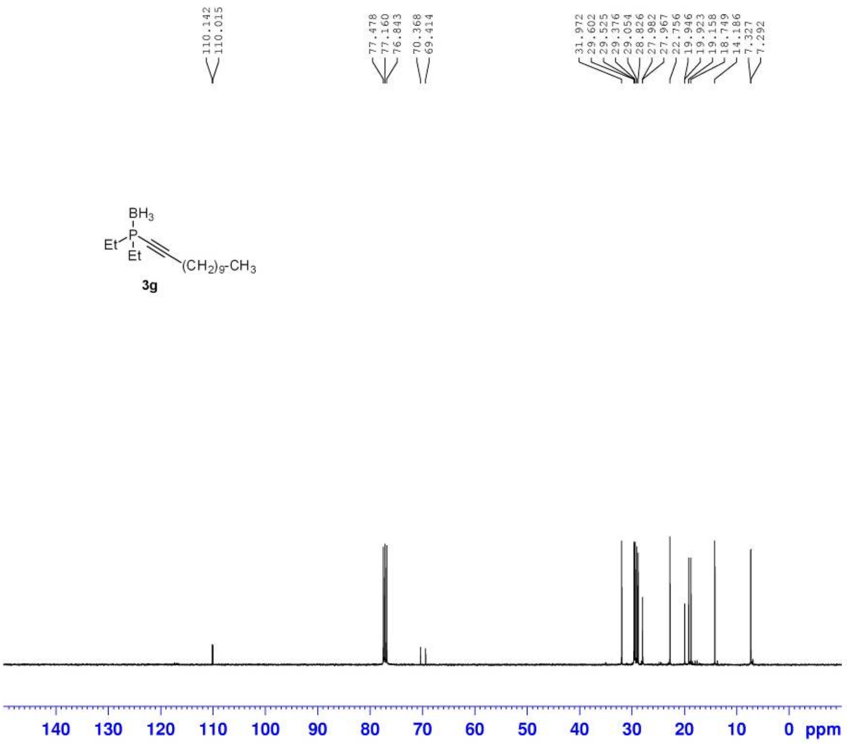
```
NAME           eb153p2B
EXPNO                10
PROCNO                1
Date_          20100625
Time              19.01
INSTRUM           spect
PROBHD   5 mm PABBO BB-
PULPROG              zg
TD                65536
SOLVENT           CDCl3
NS                  512
DS                    4
SWH           32051.281 Hz
FIDRES         0.489064 Hz
AQ            1.0224116 sec
RG                  362
DW               15.600 usec
DE                 6.50 usec
TE                295.2 K
D1           1.00000000 sec
TD0                   1

======== CHANNEL f1 ========
NUC1                11B
P1                 7.50 usec
PL1                0.00 dB
PL1W        86.66007996 W
SFO1        160.4615792 MHz
SI                32768
SF          160.4615790 MHz
WDW                  EM
SSB                   0
LB                10.00 Hz
GB                    0
PC                 1.40
```



```
NAME       EB149P2-02-04
EXPNO                 10
PROCNO                 1
Date_           20100402
Time                5.52
INSTRUM            spect
PROBHD   5 mm QNP 1H/13
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    16
DS                     2
SWH             8223.685 Hz
FIDRES          0.125483 Hz
AQ             3.9846387 sec
RG                  28.5
DW                60.800 usec
DE                  8.00 usec
TE                 295.2 K
D1            1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                  1H
P1                 12.00 usec
PL1                -1.00 dB
PL1W         15.25798988 W
SFO1         400.1324710 MHz
SI                 32768
SF           400.1300228 MHz
WDW                   EM
SSB                    0
LB                  0.30 Hz
GB                     0
PC                  1.00
```

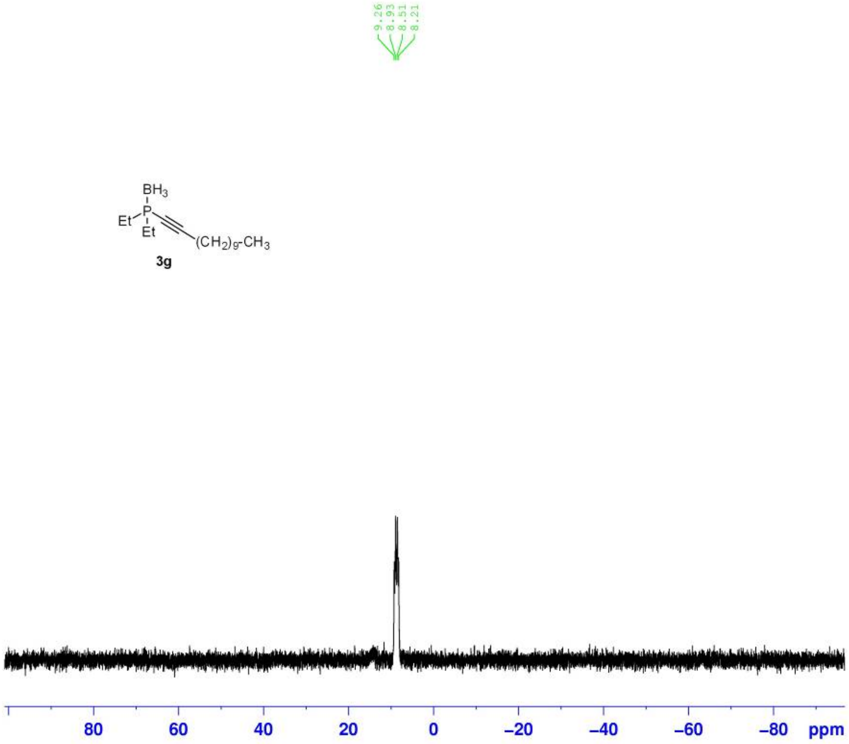


```
NAME       EB149P2-02-04
EXPNO                 20
PROCNO                 1
Date_           20100402
Time               12.33
INSTRUM            spect
PROBHD   5 mm QNP 1H/13
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                  1024
DS                     2
SWH            26041.666 Hz
FIDRES          0.397364 Hz
AQ             1.2583412 sec
RG                  2050
DW                19.200 usec
DE                  8.00 usec
TE                 295.2 K
D1            3.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                 13C
P1                  8.20 usec
PL1                -2.00 dB
PL1W         58.36251068 W
SFO1         100.6238364 MHz

======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                  1H
PCPD2             100.00 usec
PL2                -1.00 dB
PL12               17.42 dB
PL13               17.42 dB
PL2W         15.25798988 W
PL12W         0.21953173 W
PL13W         0.21953173 W
SFO2         400.1316005 MHz
SI                131072
SF           100.6127628 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```

3g

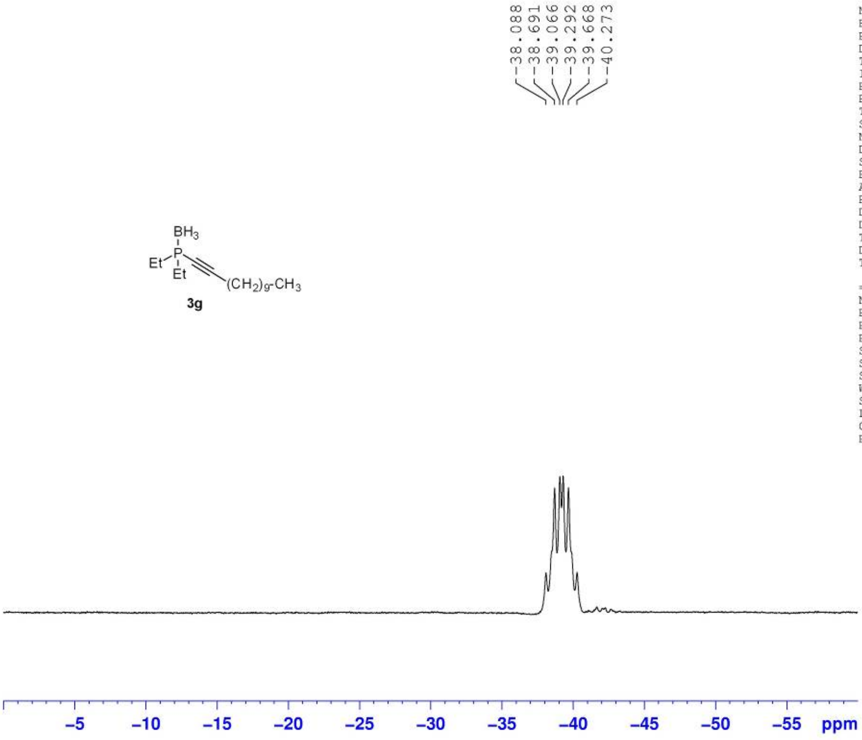


```
NAME             eb152p1
EXPNO                 42
PROCNO                 1
Date_           20091222
Time               12.41
INSTRUM            spect
PROBHD   5 mm QNP 1H/13
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                    64
DS                     2
SWH            64102.563 Hz
FIDRES          0.978127 Hz
AQ             0.5112308 sec
RG                  2050
DW                 7.800 usec
DE                  8.00 usec
TE                 295.0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                 31P
P1                  8.60 usec
PL1                 0.00 dB
PL1W         25.06862640 W
SFO1         161.9674942 MHz

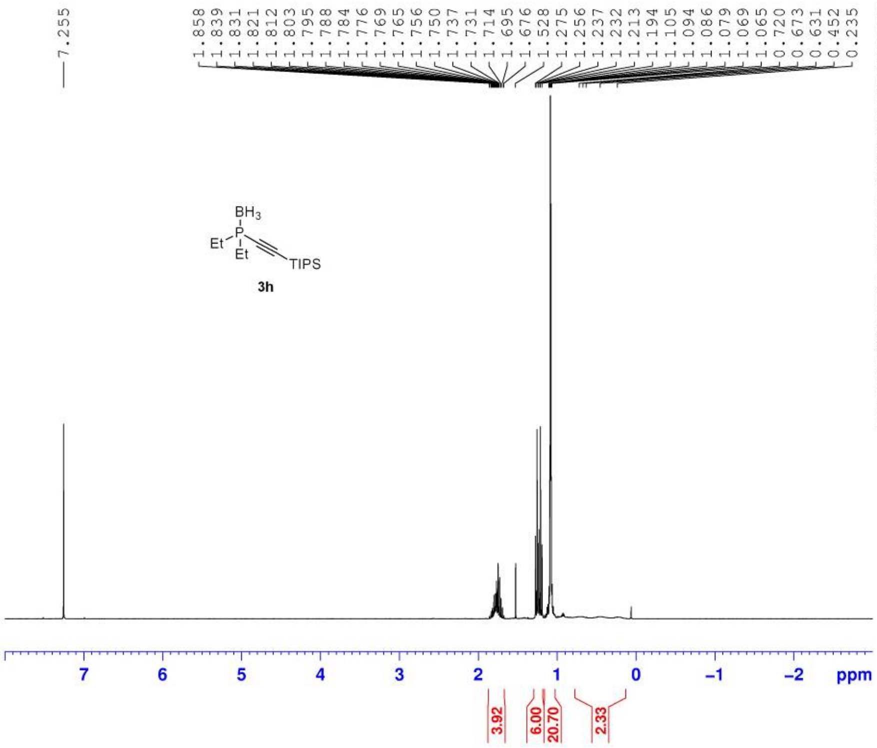
======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                  1H
PCPD2             100.00 usec
PL2                -1.00 dB
PL12               17.42 dB
PL13               17.42 dB
PL2W         15.25798988 W
PL12W         0.21953173 W
PL13W         0.21953173 W
SFO2         400.1316005 MHz
SI                 32768
SF           161.9755930 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```

3g



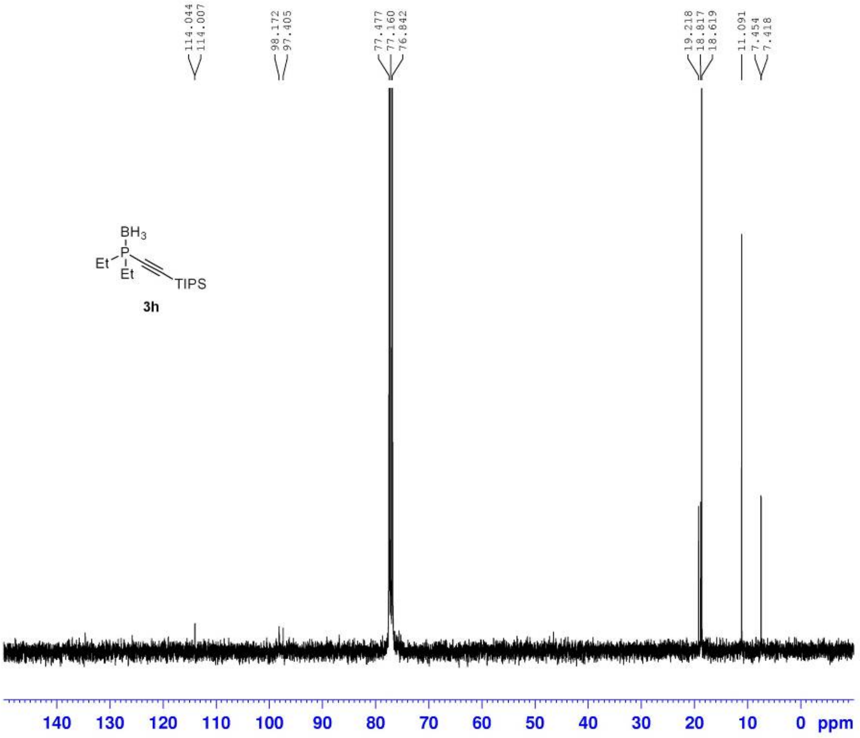
```
NAME             eb149p2B
EXPNO                  10
PROCNO                  1
Date_            20100625
Time                18.20
INSTRUM             spect
PROBHD   5 mm PABBO BB-
PULPROG                zg
TD                  65536
SOLVENT             CDCl3
NS                    512
DS                      4
SWH             32051.281 Hz
FIDRES           0.489064 Hz
AQ              1.0224116 sec
RG                    362
DW                 15.600 usec
DE                   6.50 usec
TE                  295.2 K
D1             1.00000000 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                  11B
P1                   7.50 usec
PL1                  0.00 dB
PL1W          86.66007996 W
SFO1          160.4615792 MHz
SI                  32768
SF            160.4615790 MHz
WDW                    EM
SSB                     0
LB                   3.00 Hz
GB                      0
PC                   0.50
```



```
NAME             eb145p
EXPNO                22
PROCNO                1
Date_          20091222
Time              15.26
INSTRUM           spect
PROBHD   5 mm QNP 1H/13
PULPROG            zg30
TD                65536
SOLVENT           CDCl3
NS                   16
DS                    2
SWH            8223.685 Hz
FIDRES         0.125483 Hz
AQ            3.9846387 sec
RG                  322
DW               60.800 usec
DE                 8.00 usec
TE                295.0 K
D1           1.00000000 sec
TD0                   1

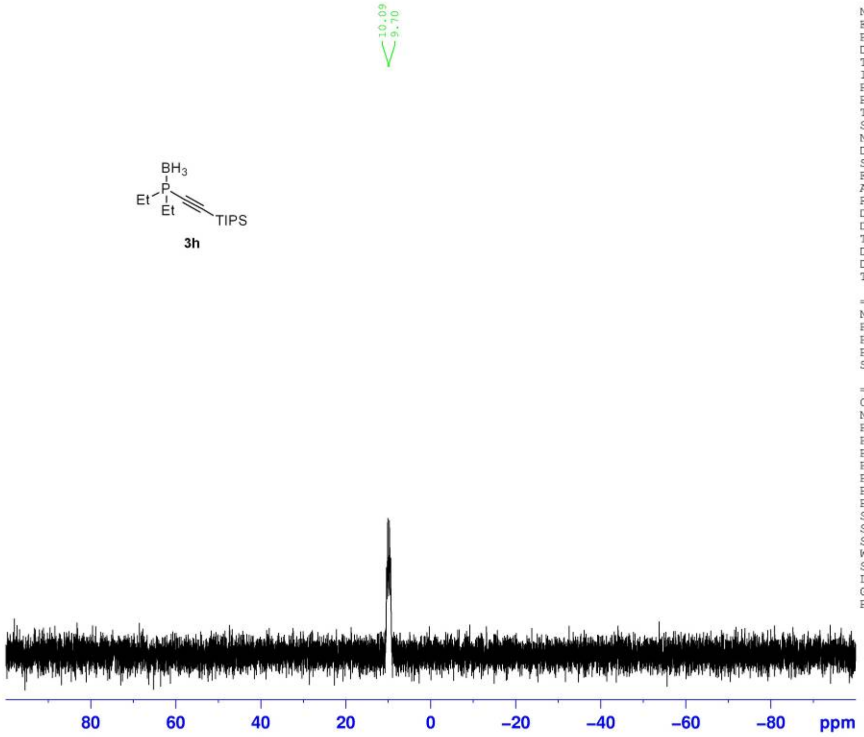
======== CHANNEL f1 ========
NUC1                 1H
P1                12.00 usec
PL1               -1.00 dB
PL1W        15.25798988 W
SFO1        400.1324710 MHz
SI                32768
SF          400.1300235 MHz
WDW                  EM
SSB                   0
LB                 0.30 Hz
GB                    0
PC                 1.00
```



```
NAME             eb145p
EXPNO                20
PROCNO                1
Date_          20091222
Time              15.21
INSTRUM           spect
PROBHD   5 mm QNP 1H/13
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                 1024
DS                    2
SWH           26041.666 Hz
FIDRES         0.397364 Hz
AQ            1.2583412 sec
RG                 2050
DW               19.200 usec
DE                 8.00 usec
TE                295.0 K
D1           3.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
NUC1                13C
P1                 8.20 usec
PL1               -2.00 dB
PL1W        58.36251068 W
SFO1        100.6238364 MHz

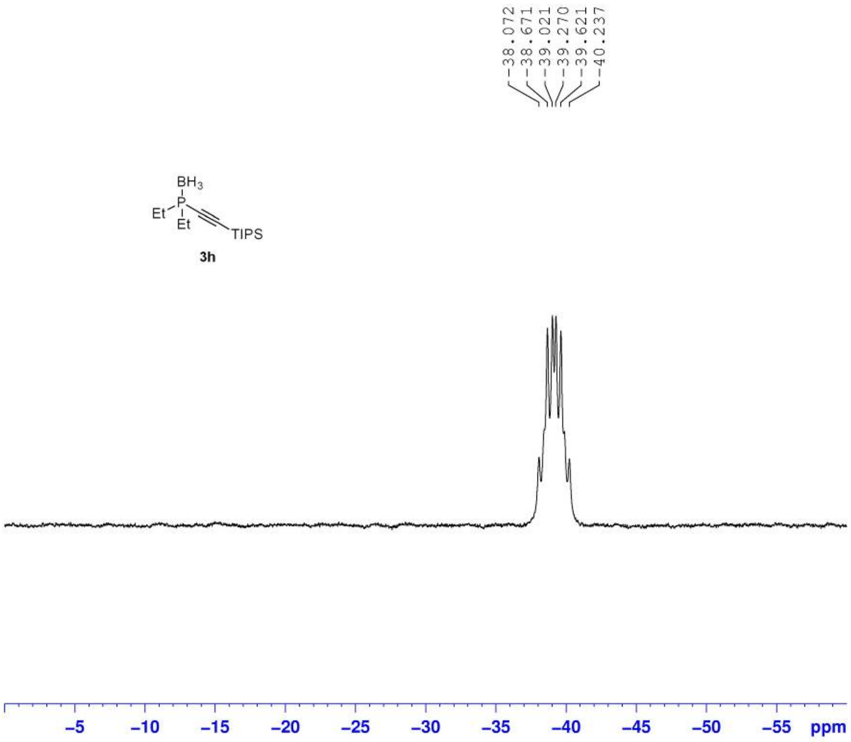
======== CHANNEL f2 ========
CPDPRG2         waltz16
NUC2                 1H
PCPD2            100.00 usec
PL2               -1.00 dB
PL12              17.42 dB
PL13              17.42 dB
PL2W        15.25798988 W
PL12W        0.21953173 W
PL13W        0.21953173 W
SFO2        400.1316005 MHz
SI               131072
SF          100.6127572 MHz
WDW                  EM
SSB                   0
LB                 1.00 Hz
GB                    0
PC                 1.40
```



```
NAME              eb145p
EXPNO                 21
PROCNO                 1
Date_           20091222
Time               15.24
INSTRUM            spect
PROBHD   5 mm QNP 1H/13
PULPROG          zgpg30
TD                 65536
SOLVENT            CDCl3
NS                    64
DS                     2
SWH            64102.563 Hz
FIDRES          0.978127 Hz
AQ             0.5112308 sec
RG                  2050
DW                 7.800 usec
DE                  8.00 usec
TE                 295.0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

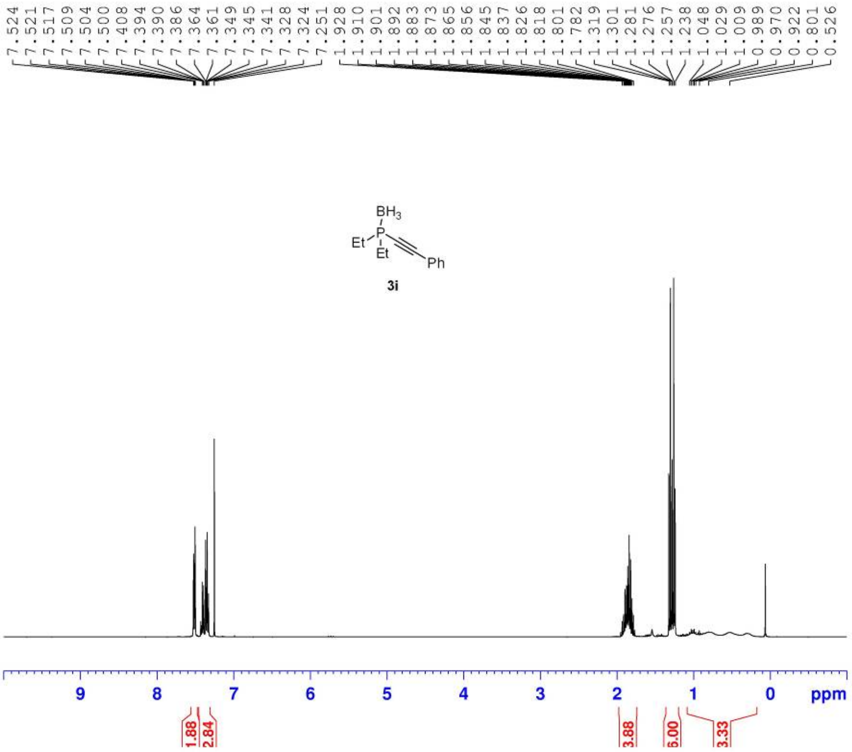
======== CHANNEL f1 ========
NUC1                 31P
P1                  8.60 usec
PL1                 0.00 dB
PL1W         25.06862640 W
SFO1         161.9674942 MHz

======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                  1H
PCPD2             100.00 usec
PL2                -1.00 dB
PL12               17.42 dB
PL13               17.42 dB
PL2W         15.25798988 W
PL12W         0.21953173 W
PL13W         0.21953173 W
SFO2         400.1316005 MHz
SI                 32768
SF           161.9755930 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```



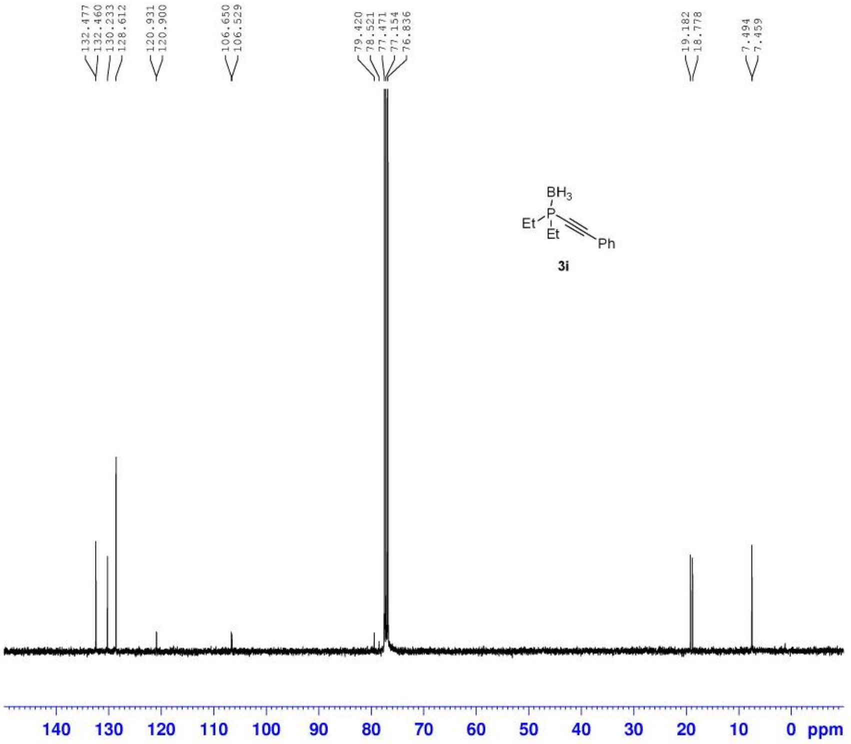
```
NAME             eb145pB
EXPNO                 10
PROCNO                 1
Date_           20091117
Time               19.15
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG               zg
TD                 65536
SOLVENT            CDCl3
NS                   256
DS                     4
SWH            32051.281 Hz
FIDRES          0.489064 Hz
AQ             1.0224116 sec
RG                   362
DW                15.600 usec
DE                  6.50 usec
TE                 295.0 K
D1            1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                 11B
P1                  7.50 usec
PL1                 0.00 dB
PL1W         86.66007996 W
SFO1         160.4615792 MHz
SI                 32768
SF           160.4615790 MHz
WDW                   EM
SSB                    0
LB                  3.00 Hz
GB                     0
PC                  0.40
```



```
NAME            eb144p
EXPNO               21
PROCNO               1
Date_         20091221
Time             22.35
INSTRUM          spect
PROBHD   5 mm QNP 1H/13
PULPROG           zg30
TD               65536
SOLVENT          CDCl3
NS                  16
DS                   2
SWH           8223.685 Hz
FIDRES        0.125483 Hz
AQ           3.9846387 sec
RG                 287
DW              60.800 usec
DE                8.00 usec
TE               295.0 K
D1          1.00000000 sec
TD0                  1

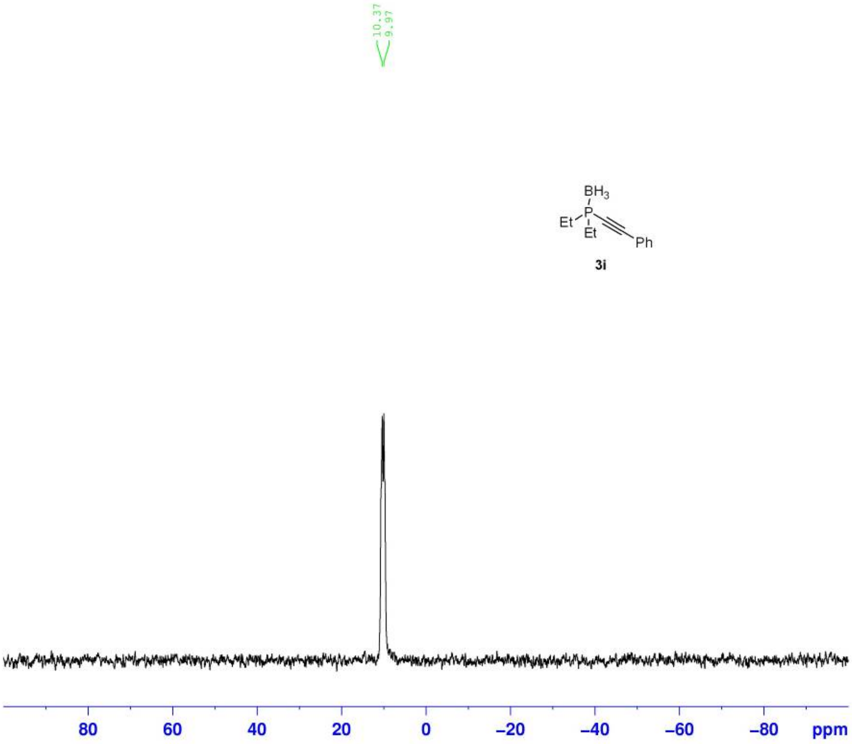
======== CHANNEL f1 ========
NUC1                1H
P1               12.00 usec
PL1              -1.00 dB
PL1W       15.25798988 W
SFO1       400.1324710 MHz
SI               32768
SF         400.1300251 MHz
WDW                 EM
SSB                  0
LB                0.30 Hz
GB                   0
PC                1.00
```



```
NAME            eb144p
EXPNO               20
PROCNO               1
Date_         20091221
Time             22.34
INSTRUM          spect
PROBHD   5 mm QNP 1H/13
PULPROG         zgpg30
TD               65536
SOLVENT          CDCl3
NS                1024
DS                   2
SWH          26041.666 Hz
FIDRES        0.397364 Hz
AQ           1.2583412 sec
RG                2050
DW              19.200 usec
DE                8.00 usec
TE               295.0 K
D1          3.00000000 sec
D11         0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
NUC1               13C
P1                8.20 usec
PL1              -2.00 dB
PL1W       58.36251068 W
SFO1       100.6238364 MHz

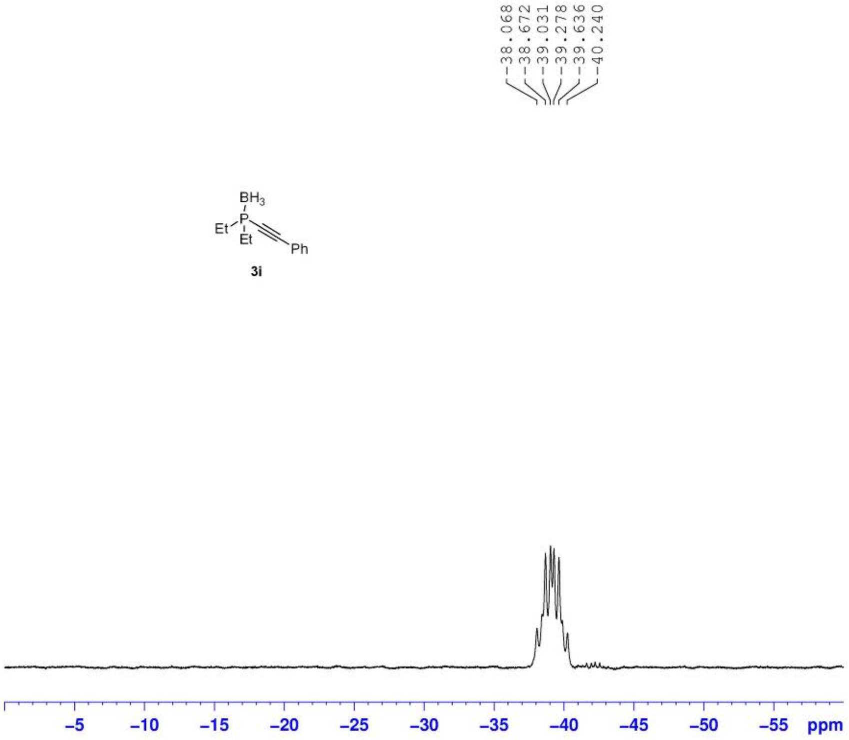
======== CHANNEL f2 ========
CPDPRG2        waltz16
NUC2                1H
PCPD2           100.00 usec
PL2              -1.00 dB
PL12             17.42 dB
PL13             17.42 dB
PL2W       15.25798988 W
PL12W       0.21953173 W
PL13W       0.21953173 W
SFO2       400.1316005 MHz
SI              131072
SF         100.6127585 MHz
WDW                 EM
SSB                  0
LB                1.00 Hz
GB                   0
PC                1.40
```



```
NAME              eb144p
EXPNO                 22
PROCNO                 1
Date_           20091221
Time               22.39
INSTRUM            spect
PROBHD   5 mm QNP 1H/13
PULPROG          zgpg30
TD                 65536
SOLVENT            CDCl3
NS                    64
DS                     2
SWH            64102.563 Hz
FIDRES          0.978127 Hz
AQ             0.5112308 sec
RG                  2050
DW                 7.800 usec
DE                  8.00 usec
TE                 295.0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

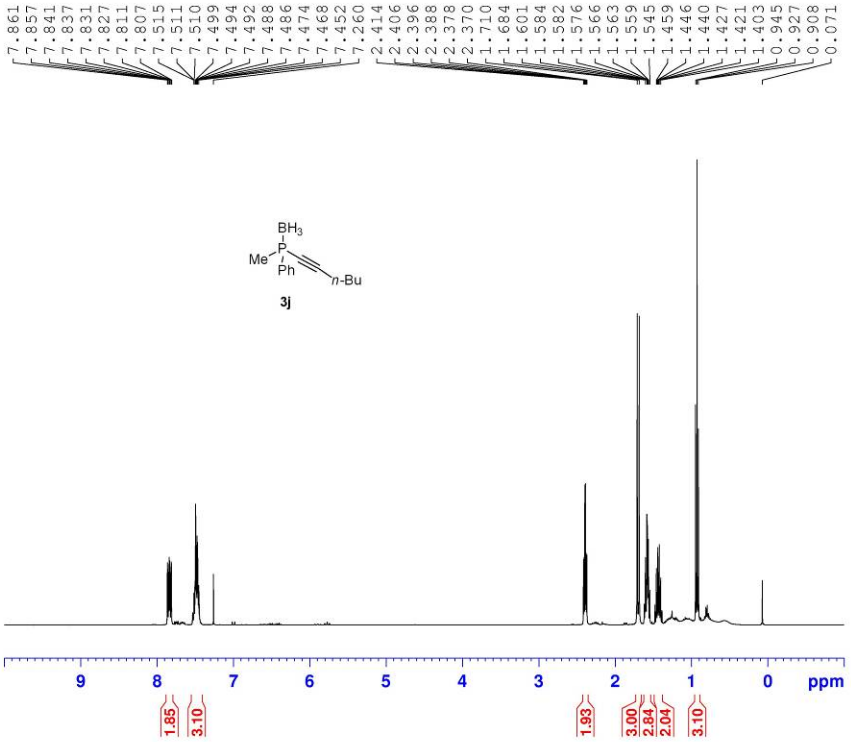
======== CHANNEL f1 ========
NUC1                 31P
P1                  8.60 usec
PL1                 0.00 dB
PL1W         25.06862640 W
SFO1         161.9674942 MHz

======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                  1H
PCPD2             100.00 usec
PL2                -1.00 dB
PL12               17.42 dB
PL13               17.42 dB
PL2W         15.25798988 W
PL12W         0.21953173 W
PL13W         0.21953173 W
SFO2         400.1316005 MHz
SI                 32768
SF           161.9755930 MHz
WDW                   EM
SSB                    0
LB                 15.00 Hz
GB                     0
PC                  1.40
```



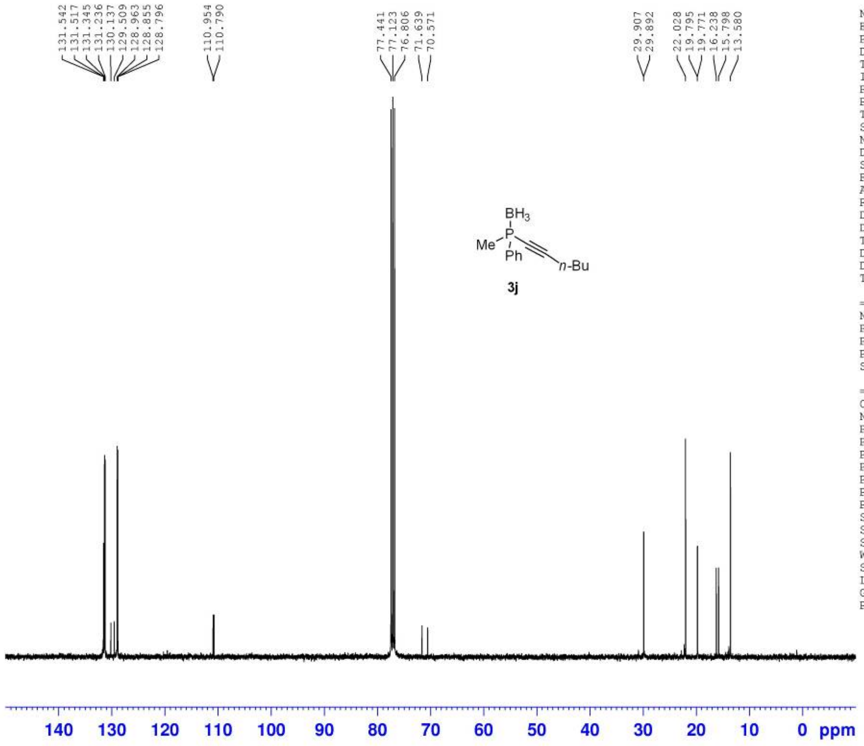
```
NAME             eb144pB
EXPNO                 10
PROCNO                 1
Date_           20091117
Time               20.48
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG               zg
TD                 65536
SOLVENT            CDCl3
NS                   256
DS                     4
SWH            32051.281 Hz
FIDRES          0.489064 Hz
AQ             1.0224116 sec
RG                   362
DW                15.600 usec
DE                  6.50 usec
TE                 295.0 K
D1            1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                 11B
P1                  7.50 usec
PL1                 0.00 dB
PL1W         86.66007996 W
SFO1         160.4615792 MHz
SI                 32768
SF           160.4615790 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```



```
NAME          cacg14p8H
EXPNO                10
PROCNO                1
Date_          20100610
Time              12.15
INSTRUM           spect
PROBHD   5 mm QNP 1H/13
PULPROG            zg30
TD                65536
SOLVENT           CDCl3
NS                   16
DS                    2
SWH            8223.685 Hz
FIDRES         0.125483 Hz
AQ            3.9846387 sec
RG                  161
DW               60.800 usec
DE                 8.00 usec
TE                295.2 K
D1           1.00000000 sec
TD0                   1

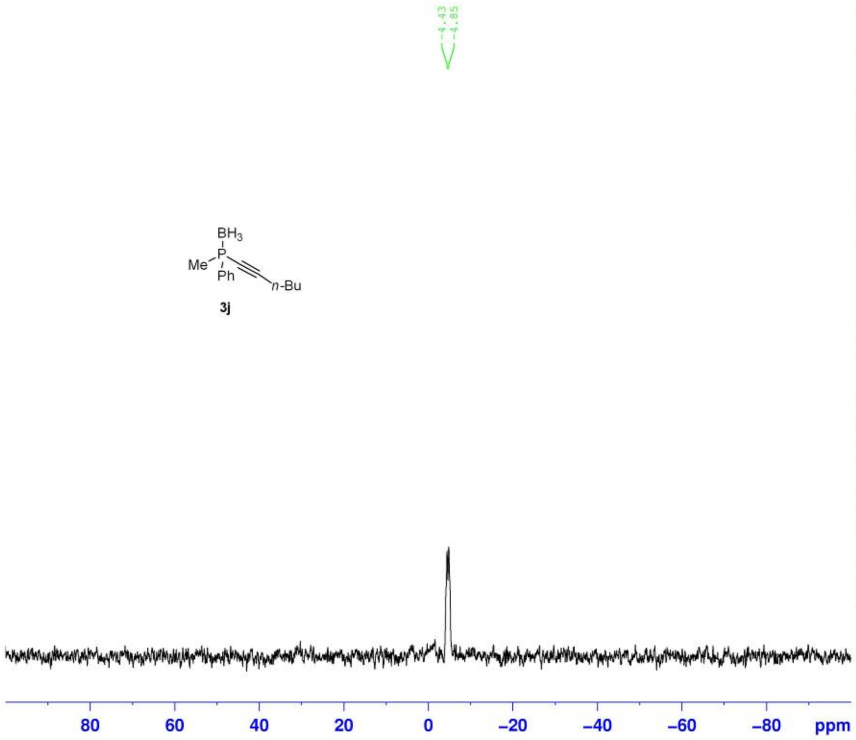
======== CHANNEL f1 ========
NUC1                 1H
P1                12.00 usec
PL1               -1.00 dB
PL1W        15.25798988 W
SFO1        400.1324710 MHz
SI                32768
SF          400.1300219 MHz
WDW                  EM
SSB                   0
LB                 0.30 Hz
GB                    0
PC                 1.00
```



```
NAME           CACG14p8
EXPNO                10
PROCNO                1
Date_          20100612
Time               8.52
INSTRUM           spect
PROBHD   5 mm QNP 1H/13
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                 1024
DS                    2
SWH           26041.666 Hz
FIDRES         0.397364 Hz
AQ            1.2583412 sec
RG                 2050
DW               19.200 usec
DE                 8.00 usec
TE                295.2 K
D1           3.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
NUC1                13C
P1                 8.20 usec
PL1               -2.00 dB
PL1W        58.36251068 W
SFO1        100.6238364 MHz

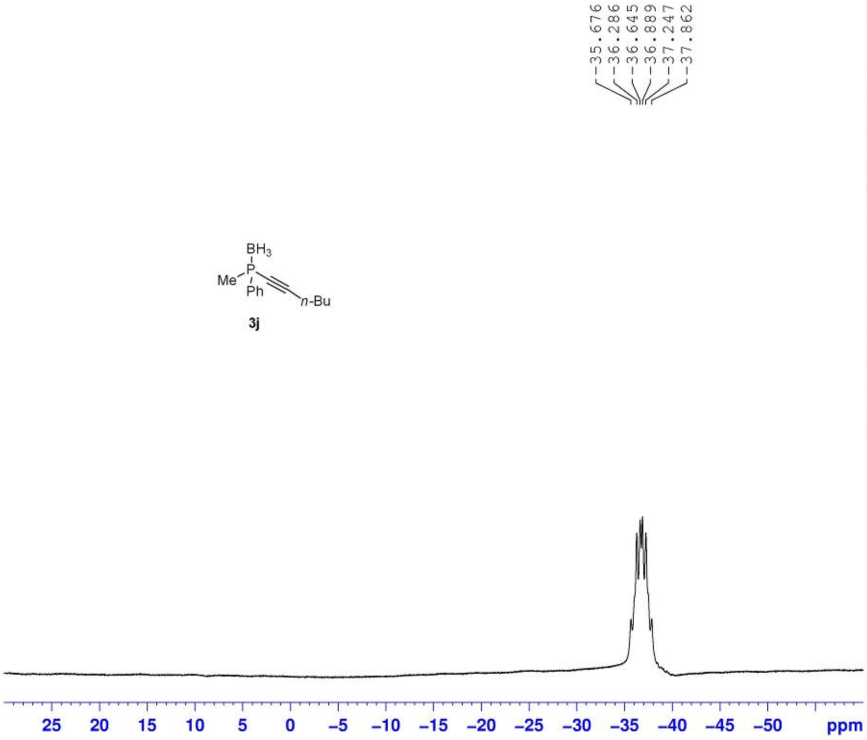
======== CHANNEL f2 ========
CPDPRG2         waltz16
NUC2                 1H
PCPD2            100.00 usec
PL2               -1.00 dB
PL12              17.42 dB
PL13              17.42 dB
PL2W        15.25798988 W
PL12W        0.21953173 W
PL13W        0.21953173 W
SFO2        400.1316005 MHz
SI               131072
SF          100.6127642 MHz
WDW                  EM
SSB                   0
LB                 1.00 Hz
GB                    0
PC                 1.40
```



```
NAME          EB190P1-02-04
EXPNO                    11
PROCNO                    1
Date_              20100402
Time                   6.03
INSTRUM               spect
PROBHD    5 mm QNP 1H/13
PULPROG             zgpg30
TD                    65536
SOLVENT               CDCl3
NS                       64
DS                        2
SWH           64102.563 Hz
FIDRES         0.978127 Hz
AQ            0.5112308 sec
RG                     2050
DW               7.800 usec
DE                8.00 usec
TE                  295.2 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                       1

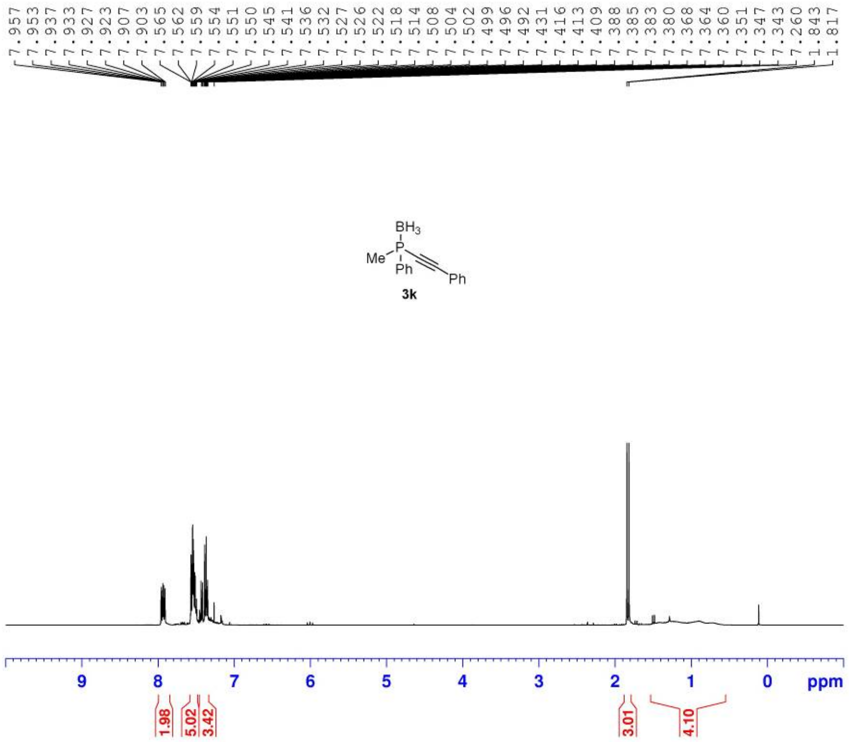
======== CHANNEL f1 ========
NUC1                    31P
P1                8.60 usec
PL1                 0.00 dB
PL1W        25.06862640 W
SFO1        161.9674942 MHz

======== CHANNEL f2 ========
CPDPRG2             waltz16
NUC2                     1H
PCPD2           100.00 usec
PL2                -1.00 dB
PL12               17.42 dB
PL13               17.42 dB
PL2W        15.25798988 W
PL12W        0.21953173 W
PL13W        0.21953173 W
SFO2        400.1316005 MHz
SI                    32768
SF          161.9755930 MHz
WDW                      EM
SSB                       0
LB                 15.00 Hz
GB                        0
PC                     1.40
```



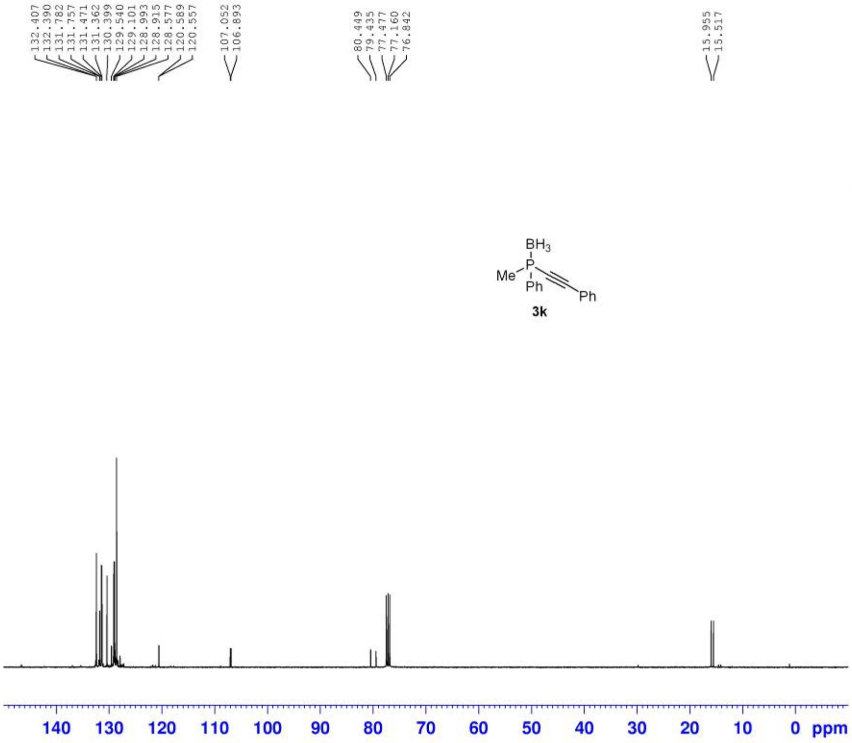
```
NAME              cacg14p8B
EXPNO                    10
PROCNO                    1
Date_              20100617
Time                  17.23
INSTRUM               spect
PROBHD    5 mm PABBO BB-
PULPROG                  zg
TD                    65536
SOLVENT               CDCl3
NS                      256
DS                        4
SWH           32051.281 Hz
FIDRES         0.489064 Hz
AQ            1.0224116 sec
RG                      362
DW              15.600 usec
DE                6.50 usec
TE                  295.4 K
D1           1.00000000 sec
TD0                       1

======== CHANNEL f1 ========
NUC1                    11B
P1                7.50 usec
PL1                 0.00 dB
PL1W        86.66007996 W
SFO1        160.4615792 MHz
SI                    32768
SF          160.4615790 MHz
WDW                      EM
SSB                       0
LB                  1.00 Hz
GB                        0
PC                     1.40
```



```
NAME             eb191p1
EXPNO                 21
PROCNO                 1
Date_           20100403
Time                1.31
INSTRUM            spect
PROBHD   5 mm QNP 1H/13
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    16
DS                     2
SWH             8223.685 Hz
FIDRES          0.125483 Hz
AQ             3.9846387 sec
RG                  50.8
DW                60.800 usec
DE                  8.00 usec
TE                 295.2 K
D1            1.00000000 sec
TD0                    1

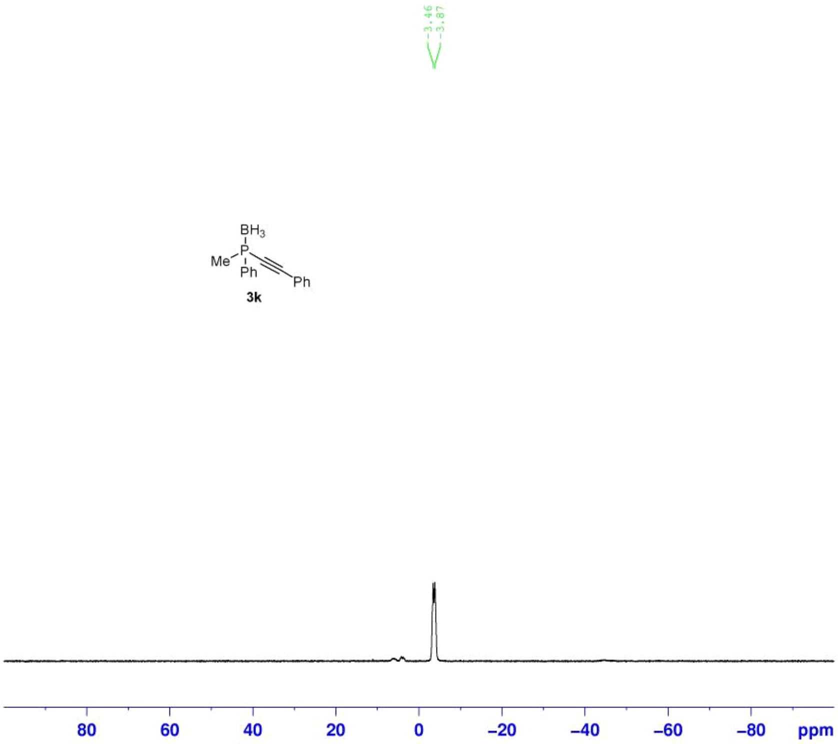
======== CHANNEL f1 ========
NUC1                  1H
P1                 12.00 usec
PL1                -1.00 dB
PL1W         15.25798988 W
SFO1         400.1324710 MHz
SI                 32768
SF           400.1300219 MHz
WDW                   EM
SSB                    0
LB                  0.30 Hz
GB                     0
PC                  1.00
```



```
NAME             eb191p1
EXPNO                 20
PROCNO                 1
Date_           20100403
Time                1.29
INSTRUM            spect
PROBHD   5 mm QNP 1H/13
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                  1024
DS                     2
SWH            26041.666 Hz
FIDRES          0.397364 Hz
AQ             1.2583412 sec
RG                  2050
DW                19.200 usec
DE                  8.00 usec
TE                 295.2 K
D1            3.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                 13C
P1                  8.20 usec
PL1                -2.00 dB
PL1W         58.36251068 W
SFO1         100.6238364 MHz

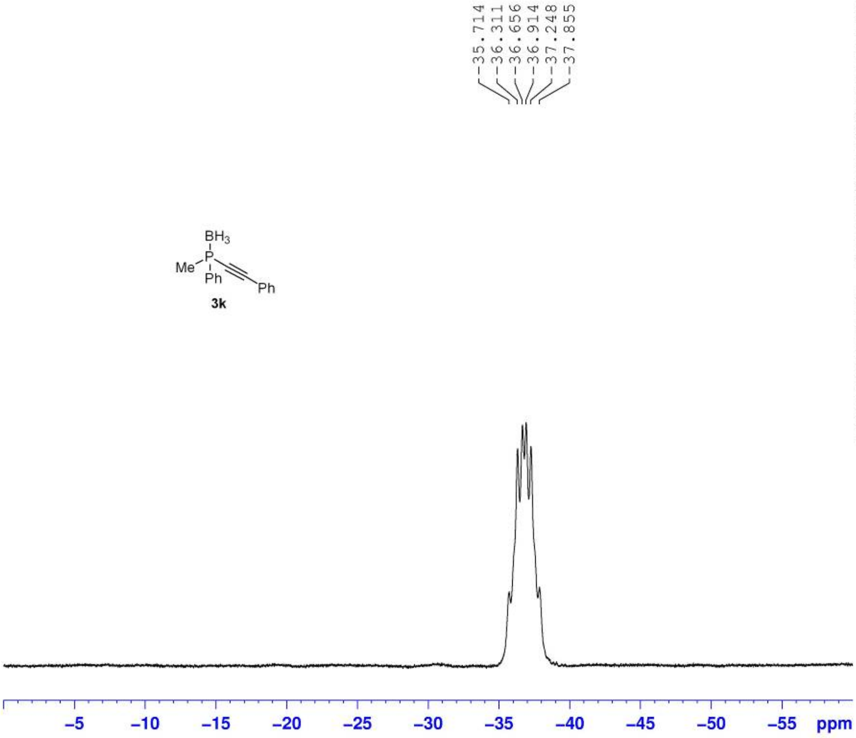
======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                  1H
PCPD2             100.00 usec
PL2                -1.00 dB
PL12               17.42 dB
PL13               17.42 dB
PL2W         15.25798988 W
PL12W         0.21953173 W
PL13W         0.21953173 W
SFO2         400.1316005 MHz
SI                131072
SF           100.6127705 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```



```
NAME              eb191p1
EXPNO                  22
PROCNO                  1
Date_            20100403
Time                 1.34
INSTRUM             spect
PROBHD   5 mm QNP 1H/13
PULPROG            zgpg30
TD                  65536
SOLVENT             CDCl3
NS                     64
DS                      2
SWH             64102.563 Hz
FIDRES           0.978127 Hz
AQ              0.5112308 sec
RG                   2050
DW                  7.800 usec
DE                   8.00 usec
TE                  295.2 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                     1

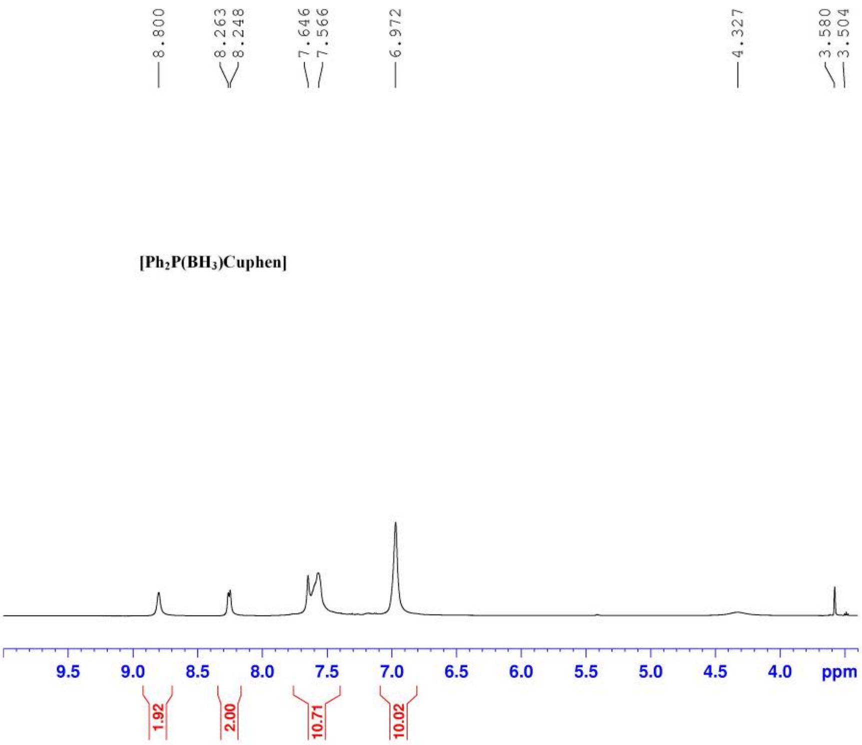
======== CHANNEL f1 ========
NUC1                  31P
P1                   8.60 usec
PL1                  0.00 dB
PL1W          25.06862640 W
SFO1          161.9674942 MHz

======== CHANNEL f2 ========
CPDPRG2           waltz16
NUC2                   1H
PCPD2              100.00 usec
PL2                 -1.00 dB
PL12                17.42 dB
PL13                17.42 dB
PL2W          15.25798988 W
PL12W          0.21953173 W
PL13W          0.21953173 W
SFO2          400.1316005 MHz
SI                  32768
SF            161.9755930 MHz
WDW                    EM
SSB                     0
LB                   1.00 Hz
GB                      0
PC                   1.40
```



```
NAME             eb191p1B
EXPNO                  10
PROCNO                  1
Date_            20100617
Time                16.59
INSTRUM             spect
PROBHD   5 mm PABBO BB-
PULPROG                zg
TD                  65536
SOLVENT             CDCl3
NS                    256
DS                      4
SWH             32051.281 Hz
FIDRES           0.489064 Hz
AQ              1.0224116 sec
RG                    362
DW                 15.600 usec
DE                   6.50 usec
TE                  295.5 K
D1             1.00000000 sec
TD0                     1

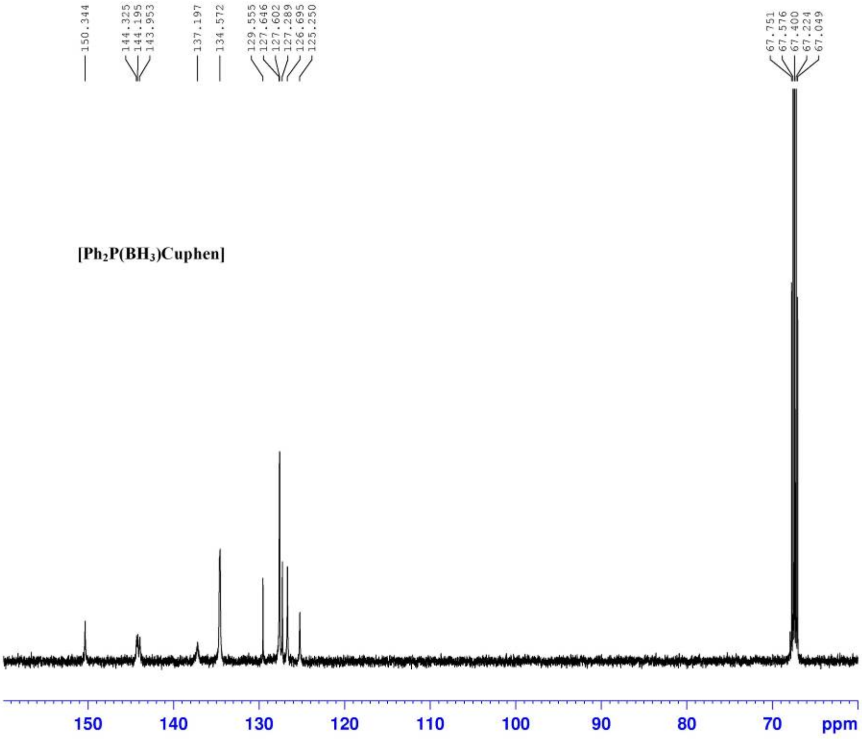
======== CHANNEL f1 ========
NUC1                  11B
P1                   7.50 usec
PL1                  0.00 dB
PL1W          86.66007996 W
SFO1          160.4615792 MHz
SI                  32768
SF            160.4615790 MHz
WDW                    EM
SSB                     0
LB                   1.00 Hz
GB                      0
PC                   1.40
```



[Ph$_2$P(BH$_3$)Cuphen]

```
NAME              eb251-P1
EXPNO                   11
PROCNO                   1
Date_             20100914
Time                 16.18
INSTRUM              spect
PROBHD   5 mm PABBO BB-
PULPROG               zg30
TD                   65536
SOLVENT                THF
NS                      16
DS                       2
SWH          10330.578 Hz
FIDRES        0.157632 Hz
AQ           3.1719923 sec
RG                    22.6
DW              48.400 usec
DE               12.01 usec
TE               272.8 K
D1          1.00000000 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                    1H
P1               14.70 usec
PL1               1.00 dB
PL1W       19.77305031 W
SFO1       500.1330885 MHz
SI                   32768
SF         500.1300058 MHz
WDW                     EM
SSB                      0
LB                0.30 Hz
GB                       0
PC                    1.00
```

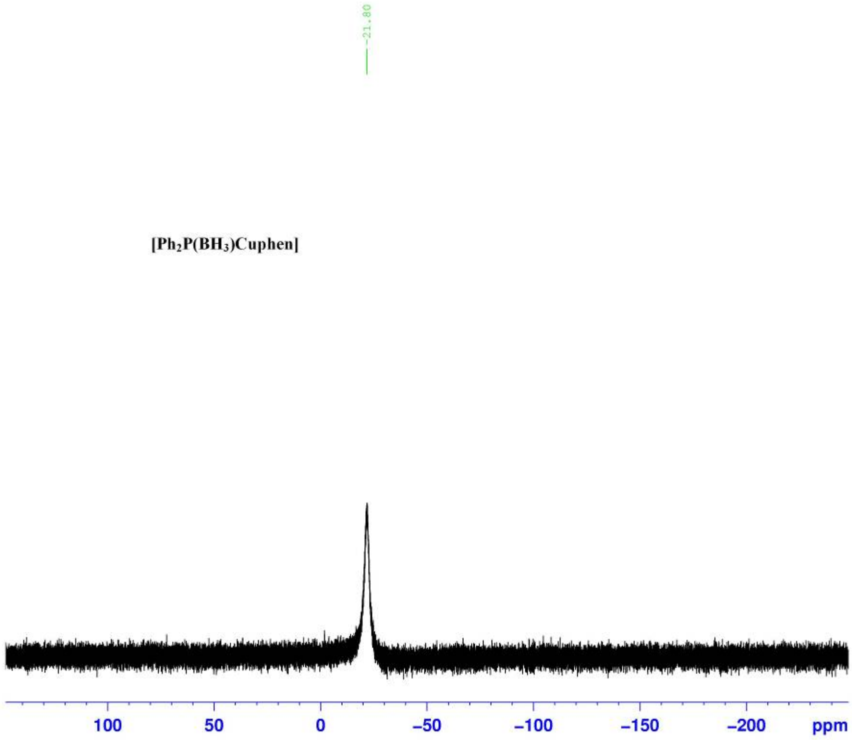


[Ph$_2$P(BH$_3$)Cuphen]

```
NAME              eb251-P1
EXPNO                   12
PROCNO                   1
Date_             20100914
Time                 16.36
INSTRUM              spect
PROBHD   5 mm PABBO BB-
PULPROG             zgpg30
TD                   65536
SOLVENT                THF
NS                     396
DS                       2
SWH          31250.000 Hz
FIDRES        0.476837 Hz
AQ           1.0486259 sec
RG                    2050
DW              16.000 usec
DE                8.00 usec
TE               273.3 K
D1          1.00000000 sec
D11         0.03000000 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                   13C
P1               10.50 usec
PL1               1.50 dB
PL1W       64.32036591 W
SFO1       125.7703648 MHz

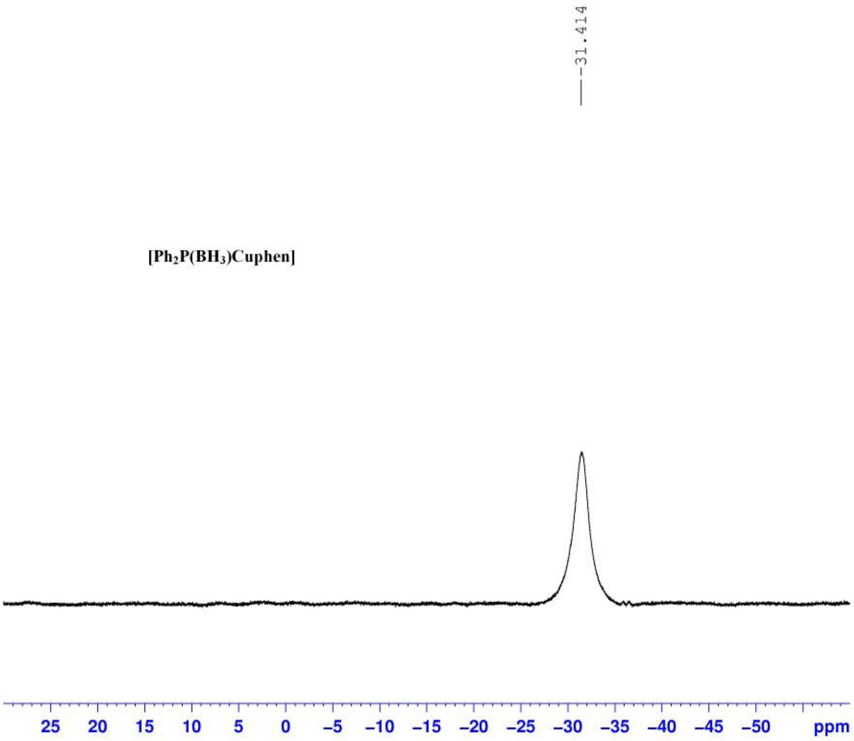
======== CHANNEL f2 ========
CPDPRG2            waltz16
NUC2                    1H
PCPD2            80.00 usec
PL2               1.90 dB
PL12             17.00 dB
PL13             17.00 dB
PL2W       16.07213783 W
PL12W       0.49667653 W
PL13W       0.49667653 W
SFO2       500.1316005 MHz
SI                  131072
SF         125.7576726 MHz
WDW                     EM
SSB                      0
LB                1.00 Hz
GB                       0
PC                    1.40
```



```
NAME            eb251-P1
EXPNO                 10
PROCNO                 1
Date_           20100914
Time               16.14
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG           zgpg30
TD                 65536
SOLVENT              THF
NS                    64
DS                     4
SWH            81521.742 Hz
FIDRES          1.243923 Hz
AQ             0.4020041 sec
RG                  2050
DW                 6.133 usec
DE                  6.50 usec
TE                 272.7 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                 31P
P1                 11.00 usec
PL1                 4.80 dB
PL1W         28.52949524 W
SFO1         202.4462121 MHz

======== CHANNEL f2 ========
CPDPRG2         waltz16
NUC2                  1H
PCPD2              80.00 usec
PL2                 1.90 dB
PL12               17.00 dB
PL13               17.00 dB
PL2W         16.07213783 W
PL12W         0.49667653 W
PL13W         0.49667653 W
SFO2         500.1325007 MHz
SI                131072
SF           202.4563350 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```



```
NAME            eb251-P1
EXPNO                 16
PROCNO                 1
Date_           20100914
Time               17.20
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG           zgpg30
TD                 65536
SOLVENT              THF
NS                   256
DS                     4
SWH            32051.281 Hz
FIDRES          0.489064 Hz
AQ             1.0224116 sec
RG                   362
DW                15.600 usec
DE                  6.50 usec
TE                 273.1 K
D1            1.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                 11B
P1                  7.50 usec
PL1                 0.00 dB
PL1W         86.66007996 W
SFO1         160.4615792 MHz

======== CHANNEL f2 ========
CPDPRG2         waltz16
NUC2                  1H
PCPD2             100.00 usec
PL2                 1.00 dB
PL12               18.00 dB
PL13               20.00 dB
PL2W         19.77305031 W
PL12W         0.39452422 W
PL13W         0.24892795 W
SFO2         500.1316005 MHz
SI                 32768
SF           160.4615790 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```