Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Copper-Catalyzed Three-Component Phosphorylation-Peroxidation of Alkenes

Yan Chen, Yuanjin Chen, Shenglin Lu, Zhiping Li*

[a]*Department of Chemistry, Renmin University of China, Beijing 100872, China*

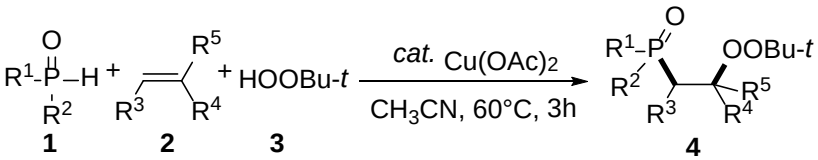
Email: zhipingli@ruc.edu.cn

Contents

1. General information

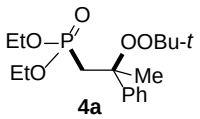
^{1}H NMR spectra were recorded on Bruker 400 MHz and 600 MHz spectrometer and the chemical shifts were reported in parts per million (δ) relative to internal standard TMS (0 ppm) for $CDCl_3$. The peak patterns are indicated as follows: s, singlet; d, doublet; dd, doublet of doublet; t, triplet; m, multiplet; q, quartet. The coupling constants, *J*, are reported in Hertz (Hz). ^{13}C NMR spectra were obtained at Bruker 100 MHz, 150 MHz and referenced to the internal solvent signals (central peak is 77.0 ppm in $CDCl_3$). ^{31}P NMR spectra were proton decoupled and recorded in $CDCl_3$ on 243 MHz NMR spectrometer. $CDCl_3$ was used as the NMR solvent. APEX II (Bruker Inc.) was used for ESI-MS and EI-MS. IR spectra were recorded by a Bruker Tensor 27 infrared spectrometer. Flash column chromatography was performed over silica gel 200-300. All reagents were weighed and handled in air at room temperature. All chemical reagents were purchased from Alfa, Acros, Aldrich, TCI, and J&K and used without further purification. The substrates **1b**[1], **2e**, **2i**[2], **2k**, **2o**[3] were prepared according to the reported literatures.

2. General procedure for synthesis of 4



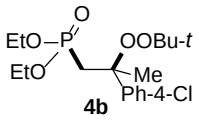
To a dry Schlenk tube were added phosphoryl compound **1** (2.5 mmol), alkene **2** (0.5 mmol), $Cu(OAc)_2$ (0.05 mmol), and anhydrous MeCN (5.0 mL) under N_2 atmosphere at room temperature. Subsequently, *tert*-butyl hydroperoxide **3** (5-6 M solution in decane, 2.5 mmol) was added to the mixture, and the resulting solution was stirred at 60 ^{o}C for 3 h. The resulting mixture was cooled to room temperature and the solvent was evaporated under vacuum. The residue was purified by flash column chromatography on silica gel (eluent: ethylacetate/ petroleum ether) to give the peroxide **4**.

3. Characterization of 4



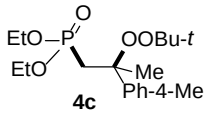
4a

Diethyl (2-(*tert*-butylperoxy)-2-phenylpropyl)phosphonate (4a): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 4) in 73% yield (126 mg); Colorless oil; IR (KBr): ν_{max} 2982, 1645, 1366, 1249, 1197, 1057, 1029, 963, 877, 762, 689 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.52-7.49 (m, 2H), 7.35-7.31 (m, 2H), 7.29-7.25 (m, 1H), 4.00-3.59 (m, 4H), 2.62 (dd, *J* = 18.8 Hz,15.2 Hz, 1H), 2.42 (dd, *J* = 15.2 Hz, 19.6 Hz, 1H), 1.91 (s, 3H), 1.23 (s, 9H), 1.20 (t, *J* = 7.2 Hz, 3H), 1.07 (t, *J* = 4.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.2 (d, *J* = 4.4 Hz), 127.8, 127.4, 126.3, 81.3, 79.2, 61.2, 61.1, 37.5 (d, *J* = 138.2 Hz), 26.6, 23.2, 16.2 (d, *J* = 6.5 Hz), 16.1 (d, *J* = 6.4 Hz); ^{31}P NMR (243 MHz, $CDCl_3$): δ 26.2; HRMS (ESI) calcd for $C_{17}H_{29}O_5PNa$ $(M+Na)^+$: 367.1645; found: 367.1640.



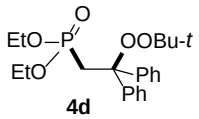
4b

Diethyl (2-(*tert*-butylperoxy)-2-(4-chlorophenyl)propyl)phosphonate (4b): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 4) in 53% yield (100.9 mg); Colorless oil; IR (KBr): ν_{max} 2982, 1646, 1491, 1395, 1249, 1197, 1029, 964, 877, 826, 747 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.37-7.35 (m, 2H),7,23-7.21(m,2H), 3.95-3.60 (m, 4H), 2.46 (dd, *J* = 15.2 Hz, 18.8 Hz, 1H), 2.29 (dd, *J* = 15.4 Hz, *J* = 19.6 Hz, 1H), 1.81 (s, 3H), 1.15 (t, *J* = 7.2 Hz, 3H), 1.14 (s, 9H), 1.02 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.8 (d, *J* = 4.4 Hz), 133.1, 127.9, 127.8, 80.8, 79.3, 61.3 (d, *J* = 5.8 Hz), 61.2 (d, *J* = 6.0 Hz), 37.4 (d, *J* = 138.8 Hz), 26.5, 23.3, 16.2 (d, *J* = 6.9 Hz), 16.0 (d, *J* = 6.35 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 25.6; HRMS (ESI) calcd for $C_{17}H_{28}ClO_5PNa$ $(M+Na)^+$: 401.1255; found: 401.1251.



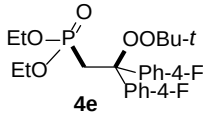
4c

Diethyl (2-(*tert*-butylperoxy)-2-(*p*-tolyl)propyl)phosphonate (4c): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0.4) in 40% yield (70.8 mg); Colorless oil; IR (KBr): ν_{max} 2982, 1649, 1514, 1455, 1366, 1249, 1197, 1029, 963, 878, 816, 747 cm^{-1} ;^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39-7.37 (m, 2H), 7.15-7.13 (m, 2H), 4.00-3.62 (m, 4H), 2.63 (dd, *J* = 15.2 Hz, *J* = 18.8 Hz, 1H), 2.41 (dd, *J* = 15.2 Hz, *J* = 19.6 Hz, 1H), 2.33 (s, 3H), 1.89 (s, 3H), 1.22 (s, 9H), 1.21 (t, *J* = 7.2 Hz, 3H), 1.08 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 140.1 (d, *J* = 4.4 Hz), 137.1, 128.4, 126.2, 81.1, 79.1, 61.2 (d, *J* = 6.0 Hz), 61.1 (d, *J* = 5.9 Hz), 37.4 (d, *J* = 138.0 Hz), 26.6, 23.2, 21.0, 16.2 (d, *J* = 6.4 Hz), 16.0 (d, *J* = 6.4 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 26.3; HRMS (ESI) calcd for $C_{18}H_{31}O_5PNa$ $(M+Na)^+$: 381.1801; found: 381.1795.



4d

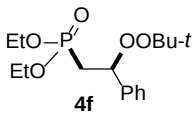
Diethyl (2-(*tert*-butylperoxy)-2,2-diphenylethyl)phosphonate (4d): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 4) in 73% yield (149 mg); Colorless oil; IR (KBr): ν_{max} 3062, 2981, 1646, 1493, 1449, 1391, 1364, 1245, 1197, 1029, 963, 882, 757, 699 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38-7.36 (m, 4H), 7.29-7.21 (m, 6H), 3.89-3.79 (m, 2H), 3.76-3.66 (m, 2H), 3.14 (d, *J* = 19.6 Hz, 2H), 1.11 (s, 9H) ,1.10 (t, *J* = 7.2 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.3 (d, *J* = 7.2 Hz), 127.6, 127.2, 127.1, 84.4, 79.5, 60.9, 60.9, 34.9 (d, *J* = 142.6 Hz), 26.5, 16.1, 16.0; ^{31}P NMR (243 MHz, $CDCl_3$) δ 26.1; HRMS (ESI) calcd for $C_{22}H_{31}O_5PNa$ $(M+Na)^+$: 429.1801; found: 429.1783.



4e

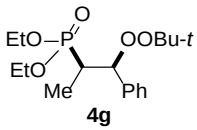
Diethyl (2-(*tert*-butylperoxy)-2,2-bis(4-fluorophenyl)ethyl)phosphonate (4e):

Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 3) in 64% yield (141 mg); Colorless oil; IR (KBr): ν_{max} 2982, 1605, 1500, 1392, 1232, 1196, 1029, 965, 836, 747 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.36-7.33 (m, 4H), 7.00-6.96 (m, 4H), 3.92-3.72 (m, 4H), 3.10 (d, J = 19.6 Hz, 2H), 1.13 (t, J = 7.2 Hz, 6H), 1.10 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.2, 160.7, 138.7, 129.7, 129.6, 114.2, 114.0, 84.0, 79.7, 61.2, 61.1, 35.4 (d, J = 142.5 Hz), 26.4, 16.1, 16.0; ^{31}P NMR (243 MHz, $CDCl_3$) δ 25.5; HRMS (ESI) calcd for $C_{22}H_{29}F_2O_5PNa$ $(M+Na)^+$: 465.1613; found: 465.1608.



4f

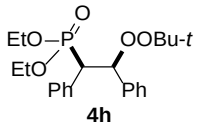
Diethyl (2-(*tert*-butylperoxy)-2-phenylethyl)phosphonate (4f): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0.3) in 69% yield (114 mg); Colorless oil; IR (KBr): ν_{max} 2981, 1645, 1454, 1391, 1364, 1255, 1197, 1026, 965, 877, 798, 960 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.39-7.31 (m, 5H), 5.23-5.17 (m, 1H), 4.05-3.78 (m, 4H), 2.71-2.61 (m, 1H),2.29-2.18 (m, 1H), 1.21 (s, 9H), 1.20 (t, J = 6.8 Hz, 3H), 1.16 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.4 (d, J = 6.1 Hz), 128.2, 128.1, 127.3, 80.9, 80.5, 61.4 (d, J = 5.9 Hz), 61.3 (d, J = 5.8 Hz), 31.3 (d, J = 138.3 Hz), 26.2, 16.1 ,16.0; ^{31}P NMR (243 MHz, $CDCl_3$) δ 26.5; HRMS (ESI) calcd for $C_{16}H_{27}O_5PNa$ $(M+Na)^+$: 353.1488; found: 353.1485.



4g

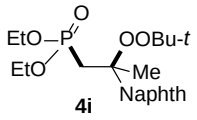
Diethyl (1-(*tert*-butylperoxy)-1-phenylpropan-2-yl)phosphonate (4g and 4g'): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 3) in 58% yield (99 mg); d.r. = 8:1; Colorless oil; IR (KBr): ν_{max} 2981, 1646, 1456, 1390, 1254, 1197, 1057, 962, 911, 751, 701 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.37-7.24 (m, 10H), 5.28-5.24 (m, 1H), 5.18-5.14 (m, 1H), 4.21-3.78 (m, 8H), 2.63-2.51 (m, 1H), 2.30-2.18 (m, 1H), 1.31-1.19 (m, 36H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 140.3 (d, J = 9.3 Hz), 127.8, 127.4, 127.1, 83.2, 80.5, 61.6 (d, J=6.1), 61.5

(d, J=4.9), 60.3, 38.0 (d, *J* = 139.6 Hz), 26.5, 16.3 (d, *J* = 3.8 Hz), 16.3 (d, *J* = 2.5 Hz), 8.9 (d, *J* = 4.3 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 30.0 ; HRMS (ESI) calcd for $C_{17}H_{29}O_5PNa$ $(M+Na)^+$: 367.1645; found: 367.1636.



4h

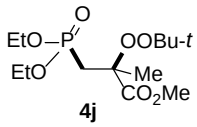
Diethyl (2-(*tert*-butylperoxy)-1,2-diphenylethyl)phosphonate (4h and 4h'): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0.5) in 62% yield (126 mg); d.r. = 3:1; IR (KBr): ν_{max} 3032, 2979, 2235, 1718, 1602, 1496, 1389, 1249, 1026, 879, 816, 757, 700, 647 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42-7.33 (m, 6H), 7.29-7.23 (m, 10H), 7.12-7.06 (m, 4H), 5.54-5.47 (m, 2H), 4.21-3.47 (m, 9H), 3.41-3-33 (m, 1H), 1.35 (t, *J* = 7.2 Hz, 3H), 1.24 (s, 9H), 1.01 (s, 9H), 1.01 (t, *J* = 8.4 Hz, 3H), 0.99 (t, *J* = 4.4 Hz, 3H), 0.94 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.9, 139.8, 139.0, 138.8, 133.5, 133.4, 133.3, 130.3, 130.2, 130.1, 130.0, 128.0, 127.9, 127.6, 127.5, 127.4, 127.3, 127.1, 127.0, 85.6, 84.3, 80.7, 80.5, 62.6 (d, *J* = 6.9 Hz), 61.6 (d,*J*=7.3), 61.3 (d,J=7.1), 51.4 (d, *J* = 138.4 Hz), 49.5 (d, *J* = 137.0 Hz), 26.4, 26.2, 16.3, 16.2, 16.0,15.9,15.9, 15.8; ^{31}P NMR (243 MHz, $CDCl_3$) δ 23.6, 25.3; HRMS (ESI) calcd for $C_{22}H_{31}O_5PNa$ $(M+Na)^+$: 429.1801; found: 429.1787.



4i

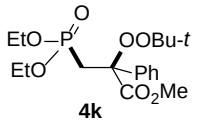
Diethyl (2-(*tert*-butylperoxy)-2-(naphthalen-1-yl)propyl)phosphonate (4i): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:2, R_f = 0.25) in 26% yield (52 mg); yellow oil; IR (KBr): ν_{max} 3051, 2981, 1602, 1509, 1448, 1366, 1249, 1197, 1020, 964, 878, 805, 779, 603 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.83-8.80 (m, 1H), 7.84-7.77 (m, 2H), 7.63-7.61 (m, 1H), 7.49-7.39 (m, 3H), 3.92-3.72 (m, 2H), 3.58-3.48 (m, 1H), 3.42-3.32 (m, 1H), 2.91 (dd, *J* = 15.2 Hz, *J* = 20.8 Hz, 1H), 2.81 (dd, *J* = 15.2 Hz, 19.2 Hz, 1H), 2.17 (s, 3H), 1.22 (s, 9H), 1.13 (t, *J*

= 7.2 Hz, 3H), 0.84 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.0 (d, *J* = 4.5 Hz), 134.5, 131.5, 129.2, 128.8, 126.9, 125.6, 125.3, 125.0, 124.7, 83.2, 79.1, 61.1 (d, *J* = 3.2 Hz), 61.1 (d, *J* = 3.2 Hz), 35.9 (d, *J* = 138.0 Hz), 26.7, 25.1, 16.1 (d, *J* = 6.5 Hz), 15.8 (d, *J* = 6.6 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 25.9; HRMS (ESI) calcd for $C_{21}H_{31}O_5PNa$ $(M+Na)^+$: 417.1801; found: 417.1794.



4j

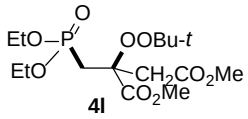
Methyl 2-(*tert*-butylperoxy)-3-(diethoxyphosphoryl)-2-methylpropanoate (4j): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:2, R_f = 0.25) in 55% yield (89.5 mg); Colorless oil; IR (KBr): ν_{max} 2983, 1748, 1644, 1455, 1367, 1248, 1197, 1108, 1020, 965, 879, 840, 747 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.14-4.06 (m, 4H), 3.75 (s, 3H), 2.56 (dd, *J* = 15.2 Hz, 19.2 Hz, 1H), 2.30 (dd, *J* = 15.2 Hz, 19.2 Hz, 1H), 1.64 (s, 3H), 1.32 (t, *J* = 7.04 Hz, 3H), 1.32 (t, *J* = 7.2 Hz, 3H), 1.20 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.7, 81.5, 80.1, 61.7 (d, *J* = 3.4 Hz), 61.7 (d, *J* = 3.9 Hz), 52.2, 32.4 (d, *J* = 140.8 Hz), 26.4, 20.7, 16.4, 16.3; ^{31}P NMR (243 MHz, $CDCl_3$) δ 25.4; HRMS (ESI) calcd for $C_{13}H_{27}O_7PNa$ $(M+Na)^+$: 349.1387; found: 349.1372.



4k

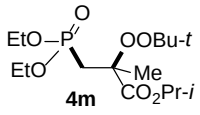
Methyl 2-(*tert*-butylperoxy)-3-(diethoxyphosphoryl)-2-phenylpropanoate (4k): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 4) in 75% yield (145 mg); Colorless oil; IR (KBr): ν_{max} 2982, 2375, 1742, 1646, 1541, 1455, 1392, 1297, 1029, 961, 746 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41-7.39 (m, 2H), 7.36-7.28 (m, 3H), 3.95-3.74 (m, 4H), 3.71 (s, 3H), 3.07 (dd, *J* = 16.0 Hz, *J* = 18 Hz, 1H), 2.96 (dd, *J* = 16.0 Hz, *J* = 18.8 Hz, 1H), 1.30 (s, 9H), 1.14 (t, *J* = 7.2 Hz, 3H), 1.11 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.5 (d, *J* = 15.7 Hz), 137.5 (d, *J* =4.4 Hz), 128.1, 128.0, 125.6, 84.8, 80.9, 61.2, 61.1, 52.5, 32.2 (d, *J* =

144.6 Hz), 26.6, 16.2 (d, J = 6.3 Hz),16.1 (d, J = 6.3 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 25.2; HRMS (ESI) calcd for $C_{18}H_{29}O_7PNa$ $(M+Na)^+$: 411.1543; found: 411.1535.



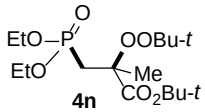
4l

Dimethyl 2-(*tert*-butylperoxy)-2-((diethoxyphosphoryl)methyl)succinate (4af): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:2, R_f = 0.25) in 68% yield (130 mg); Colorless oil; IR (KBr): ν_{max} 2985, 1746, 1646, 1541, 1392, 1260, 1026, 913, 749 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.13-4.05 (m, 4H), 3.76 (s, 3H), 3.68 (s, 3H), 3.32 (dd, J = 16.8 Hz, 15.6 Hz, 2H), 2.88 (dd, J = 15.6 Hz, J = 18.4 Hz, 1H), 2.67 (dd, J = 15.6 Hz, 19.6 Hz, 1H), 1.31 (t, J = 6.0 Hz, 3H), 1.31 (t, J = 7.2 Hz, 3H), 1.19 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.5, 170.3 (d, J = 12.1 Hz), 81.6, 80.5, 61.8, 61.7, 52.4, 51.5, 36.4, 28.8 (d, J = 140.3 Hz), 26.3, 16.3,16.2; ^{31}P NMR (243 MHz, $CDCl_3$) δ 25.0; HRMS (ESI) calcd for $C_{15}H_{29}O_9PNa$ $(M+Na)^+$: 407.1441; found: 407.1424.



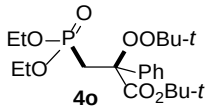
4m

Isopropyl 2-(*tert*-butylperoxy)-3-(diethoxyphosphoryl)-2-methylpropanoate (4m): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 4) in 72% yield (127 mg); Colorless oil; IR (KBr): ν_{max} 2982, 1740, 1459, 1369, 1252, 1193, 1104, 1020, 961, 882, 850, 755 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 5.09-5.00 (m, 1H), 4.14-4.07 (m, 4H), 2.56 (dd, J = 15.2 Hz, 19.2 Hz, 1H), 2.32 (dd, J = 15.2 Hz, 19.2 Hz, 3H), 1.62 (s, 3H), 1.32 (t, J = 7.2 Hz, 3H), 1.32 (t, J = 7.2 Hz, 3H), 1.28 (d, J = 3.2 Hz, 3H), 1.27 (d, J = 2.0 Hz, 3H), 1.21 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.8 (d, J = 9.0 Hz), 81.3, 79.8, 68.8, 61.6 (d, J = 5.4 Hz), 61.5 (d,J = 4.6 Hz), 32.0 (d, J = 141.0 Hz), 26.4, 21.6, 20.6, 16.3,16.3; ^{31}P NMR (243 MHz, $CDCl_3$) δ 25.9; HRMS (ESI) calcd for $C_{15}H_{31}O_7PNa$ $(M+Na)^+$: 377.1700; found: 377.1695.



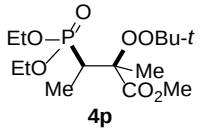
4n

***Tert*-butyl 2-(*tert*-butylperoxy)-3-(diethoxyphosphoryl)-2-methylpropanoate (4n):** Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0.3) in 75% yield (138 mg); Colorless oil; IR (KBr): ν_{max} 2981, 1738, 1643, 1368, 1257, 1162, 1029, 961, 749 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 4.15-4.07 (m, 4H), 2.52 (dd, *J* = 15.4 Hz, 19.2 Hz, 1H), 2.33 (dd, *J* = 15.4 Hz, *J* = 19.0 Hz, 1H), 1.58 (s, 3H), 1.48 (s, 9H), 1.32 (t, *J* = 7.2 Hz, 6H), 1.22 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.4 (d, *J* = 9.6 Hz), 81.7, 81.2, 79.7, 61.6, 61.5, 31.9 (d, *J* = 141.3 Hz), 27.8, 28.5, 20.7, 16.4, 16.3; ^{31}P NMR (243 MHz, $CDCl_3$) δ 26.5; HRMS (ESI) calcd for $C_{16}H_{33}O_7PNa$ $(M+Na)^+$: 391.1856; found: 391.1847.



4o

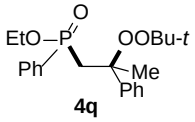
***Tert*-butyl 2-(*tert*-butylperoxy)-3-(diethoxyphosphoryl)-2-phenylpropanoate (4o):** Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0.5) in 63% yield (136 mg); Colorless oil; IR (KBr): ν_{max} 2980, 1730, 1451, 1392, 1253, 1161, 1030, 886, 847, 698 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.40-7.38 (m, 2H), 7.34-7.25 (m, 3H), 3.93-3.70 (m, 4H), 3.06 (dd, *J* = 16.0 Hz, *J* = 17.6 Hz, 1H), 2.92 (dd, *J* = 16.0 Hz, 18.8 Hz, 1H), 1.38 (s, 9H), 1.33 (s, 9H), 1.14-1.09 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.7 (d, *J* = 16.5 Hz), 138.1, 138.0, 127.7, 125.5, 84.9, 81.7, 80.5, 61.0 (d, *J* = 6.4 Hz), 60.9 (d, *J* = 6.4 Hz), 31.8 (d, *J* = 144.5 Hz), 27.6, 26.7, 16.1 (d, *J* = 5.6 Hz), 16.0 (d, *J* = 4.4 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 26.0; HRMS (ESI) calcd for $C_{21}H_{35}O_7PNa$ $(M+Na)^+$: 453.2013; found: 453.2004.



4p

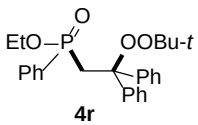
Methyl 2-(*tert*-butylperoxy)-3-(diethoxyphosphoryl)-2-methylbutanoate (4p and 4p'): Isolated by flash column chromatography (ethyl acetate/petroleum ether =

1:2, R_f = 0.25) in 52% yield (88.4 mg); d.r. = 8:1; Colorless oil; IR (KBr): ν_{max} 2984, 1748, 1646, 1456, 1390, 1265, 1138, 1024, 963, 791, 748 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 4.16-4.04 (m, 8H), 3.75 (s, 6H), 2.99-2.88 (m, 1H), 2.60-2.48 (m, 1H), 1.64 (s, 3H), 1.52 (s, 3H), 1.32-1.21 (m, 27H), 1.18 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.6, 83.1 (d, *J* = 6.5 Hz), 79.9, 61.9 (d, *J* = 6.6 Hz), 61.7 (d, *J* = 6.9 Hz), 51.9, 35.9 (d, *J* = 138.6 Hz), 26.3, 16.3, 16.3, 15.8, 8.5 (d, *J* = 5.8 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 28.5 ; HRMS (ESI) calcd for $C_{14}H_{29}O_7PNa$ $(M+Na)^+$: 363.1543; found: 363.1539.



4q

Ethyl (2-(*tert*-butylperoxy)-2-phenylpropyl)(phenyl)phosphinate (**4q and 4q'**): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 5) in 50% yield (95 mg); d.r. = 1:1; Colorless oil; IR (KBr): ν_{max} 3059, 2981, 1721, 1443, 1366, 1285, 1121, 1095, 1035, 950, 876, 756, 698 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.76-7.71 (m, 2H), 7.52-7.18 (m, 15H) , 7.04-7.02 (m, 3H), 3.98-3.89 (m, 1H), 3.80-3.63 (m, 2H), 3.61-3.51 (m, 1H), 2.85 (dd, *J* = 19.2 Hz, 15.2 Hz, 1H), 2.70 (dd, *J* = 11.6 Hz, 15.2 Hz, 1H), 2.61-2.51 (m, *2*H), 1.97 (s, 3H), 1.96 (s, 3H), 1.21 (t, *J* = 7.2 Hz, 3H), 1.20 (s, 9H), 1.02 (t, *J*=7.2,3H) ,1.01 (s,9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.4 (d, *J* = 6.6 Hz), 142.1, 131.8, 131.5, 131.3 (d, *J* = 10.8 Hz), 128.3 (d, *J* = 12.5 Hz), 127.9 (d, *J* = 12.5 Hz), 127.6 (d, *J* = 22.9 Hz), 127.2 (d, *J* = 18.2 Hz), 126.1 (d, *J* = 23.5 Hz), 81.9, 81.4 (d, *J* = 2.5 Hz), 79.0 (d, *J* = 4.1 Hz), 59.9 (d, *J* = 6.1), 59.8 (d, *J* = 6.2), 41.9 (d, *J* = 99.7 Hz), 40.9 (d, *J* = 98.8 Hz), 26.6, 26.3, 23.4, 23.3, 16.3 (d, *J* = 6.8 Hz), 16.0 (d, *J* = 6.7 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 38.7, 39.1; HRMS (ESI) calcd for $C_{21}H_{29}O_4PNa$ $(M+Na)^+$: 399.1696; found: 399.1680.

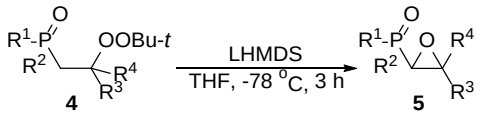


4r

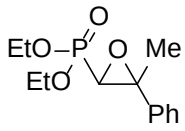
Ethyl (2-(*tert*-butylperoxy)-2,2-diphenylethyl)(phenyl)phosphinate (4r): Isolated

by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 5) in 51% yield (112 mg); Colorless oil; IR (KBr): ν_{max} 3059, 2980, 1595, 1445, 1390, 1231, 1197, 1037, 949, 880, 791, 754, 697 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.53-7.15 (m, 15H), 3.87-3.73 (m, 1H) , 3.66-3.56 (m, 1H), 3.35 (d, *J* = 16.4 Hz, 2H), 1.10 (t, *J* = 7.2 Hz, 3H), 0.93 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.4 (d, *J* = 6.4 Hz), 142.8 (d, *J* = 5.8 Hz), 132.8, 131.7, 131.6, 131.3, 128.0, 127.8, 127.7, 127.2, 84.8, 79.4, 59.8 (d, *J* = 5.9 Hz), 38.9 (d, *J*=101.0 Hz), 26.3, 16.1 (d, *J* = 6.8 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 39.0; HRMS (ESI) calcd for $C_{26}H_{31}O_4PNa$ $(M+Na)^+$: 461.1852; found: 461.1837.

4. Synthesis and characterization of **5**



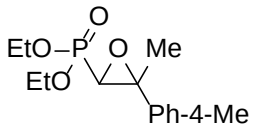
To a solution of the peroxide **4** (0.2 mmol) in THF (2.0 mL) under N_2 atmosphere, LHMDS (1.0 M in THF, 0.4 mL, 2 equiv) was added dropwise to the mixture at -78 ^oC and stirred for 3 h. Then NH_4Cl aq (5.0 mL) was added and the organic layer was separated. The aqueous layer was extracted with EtOAc (3 x 15 mL). The collected organic layers were dried over $MgSO_4$ and concentrated under reduced pressure to give the crude product. The residue was purified by flash column chromatography on silica gel using ethyl acetate/petroleum ether as eluent to give the epoxide **5**.



5a (major)

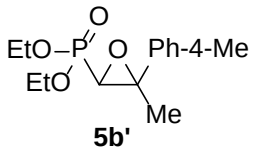
Diethyl ((2R,3R)-3-methyl-3-phenyloxiran-2-yl)phosphonate (5a major**):** Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:2, R_f = 0. 3) in 82% yield (44.5 mg); Colorless oil; IR (KBr): ν_{max} 2983, 1448, 1389, 1260, 1163, 1024, 968, 854, 789, 700 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.38-7.29 (m, 5H), 4.30-4.17 (m, 4H), 2.93 (d, *J* = 28.0 Hz, 1H), 1.97 (s, 3H), 1.40 (t, *J* = 7.2, 3H), 1.37 (t, *J* = 8.4

Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.0, 128.4, 127.8, 124.9, 62.8 (d, J = 6.2 Hz), 62.3 (d, J = 6.2 Hz), 61.9, 59.1 (d, J =196.0 Hz), 18.4, 16.4, 16.3; ^{31}P NMR (243 MHz, $CDCl_3$) δ 17.3; HRMS (ESI) calcd for $C_{13}H_{19}O_4PNa$ $(M+Na)^+$: 293.0913; found: 293.0908.



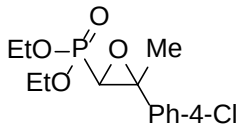
5b

Diethyl ((2R,3R)-3-methyl-3-(p-tolyl)oxiran-2-yl)phosphonate (5b): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 5) in 79% yield (45.2mg); Colorless oil; IR (KBr): ν_{max} 2983, 1515, 1448, 1372, 1260, 1164, 1022, 968, 798 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27-7.24 (m, 2H), 7.16-7.14 (m, 2H), 4.31-4.14 (m, 4H), 2.92 (d, J = 28.0 Hz, 1H), 2.34 (s, 3H), 1.95 (s, 3H), 1.39 (t, J = 7.2 Hz, 3H), 1.37 (t, J = 7.08, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.1, 137.6, 129.1, 124.9, 62.8 (d, J = 6.2 Hz), 62.3 (d, J = 6.1 Hz), 61.9, 59.2 (d, J = 195.5 Hz), 21.0, 18.5, 16.4, 16.3; ^{31}P NMR (243 MHz, $CDCl_3$) δ 17.5; HRMS (ESI) calcd for $C_{14}H_{21}O_4PNa$ $(M+Na)^+$: 307.1070; found: 307.1058.



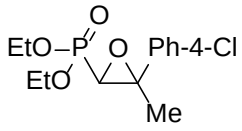
5b'

Diethyl ((2R,3S)-3-methyl-3-(p-tolyl)oxiran-2-yl)phosphonate (5b'): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 25) in 3% yield (1.6 mg); Colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35-7.33 (m, 2H), 7.16-7.14 (m, 2H), 4.04-3.89 (m, 2H), 3.80-3.70 (m, 1H), 3.47-3.37 (m, 1H), 3.19 (d, J = 28.0 Hz, 1H), 2.33 (s, 3H), 1.68 (d, J = 2.4 Hz, 3H), 1.23 (t, J = 7.2 Hz, 3H), 1.03 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 137.4, 135.0, 128.5, 126.3, 63.5, 62.1 (d, J = 5.8 Hz), 62.0 (d, J = 5.7 Hz), 58.4 (d, J = 210.4 Hz), 26.3, 21.1, 16.2 (d, J = 6.1 Hz), 16.1 (d, J = 5.6 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 16.7; HRMS (ESI) calcd for $C_{14}H_{21}O_4PNa$ $(M+Na)^+$: 307.1070; found: 307.1060.



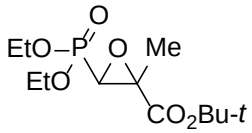
5c

Diethyl ((2R,3R)-3-(4-chlorophenyl)-3-methyloxiran-2-yl)phosphonate (5c): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0.4) in 67% yield (41mg); Colorless oil; IR (KBr): ν_{max} 2983, 1599, 1492, 1448, 1389, 1260, 1197, 1019, 969, 842, 620 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.33-7.28 (m, 4H), 4.29-4.18(m, 4H), 2.88 (d, J = 27.2 Hz, 1H), 1.95 (s, 3H), 1.40 (t, J = 7.2 Hz, 3H), 1.37 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.5, 133.7, 128.5, 126.4, 62.8 (d, J = 5.9 Hz), 62.3 (d, J = 5.9 Hz), 61.4, 59.1 (d, J = 196.1 Hz), 18.2, 16.3, 16.2; ^{31}P NMR (243 MHz, $CDCl_3$) δ 16.9; HRMS (ESI) calcd for $C_{13}H_{18}ClO_4PNa$ $(M+Na)^+$: 327.0523; found: 327.0518.



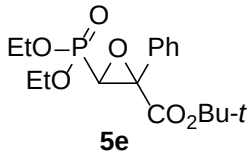
5c'

Diethyl ((2R,3S)-3-(4-chlorophenyl)-3-methyloxiran-2-yl)phosphonate (5c'): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0.25) in 7% yield (4.3 mg); Colorless oil; ^1H NMR (400 MHz, $CDCl_3$) δ 7.41-7.38 (m, 2H), 7.33-7.30 (m, 2H), 4.05-3.90 (m, 2H), 3.85-3.75 (m, 1H), 3.62-3.52 (m, 1H), 3.19 (d, J = 28.0 Hz, 1H), 1.68 (d, J = 2.4 Hz, 3H), 1.23 (t, J = 7.2 Hz, 3H), 1.07 (t, J = 7.2 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 136.6, 133.6, 128.1, 128.0, 63.0, 62.3 (d, J = 8.4Hz), 62.2 (d, J = 7.2 Hz), 58.3 (d, J = 201.3 Hz), 25.9, 16.2 (d, J = 5.9 Hz), 16.1 (d, J = 5.4 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 16.2; HRMS (ESI) calcd for $C_{13}H_{18}ClO_4PNa$ $(M+Na)^+$: 327.0523; found: 327.0521.



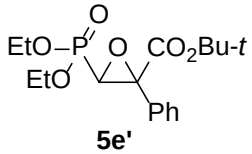
5d (major)

Tert-butyl (2R,3R)-3-(diethoxyphosphoryl)-2-methyloxirane-2-carboxylate (5d major**):** Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 4) in 70% yield (40.6 mg); Colorless oil; IR (KBr): ν_{max} 2982, 1733, 1453, 1393, 1261, 1154, 1023, 971, 847, 792, 750 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 4.24-4.16 (m, 4H), 3.25 (d, *J* = 28.0 Hz, 1H), 1.76 (s, 3H), 1.48 (s, 9H), 1.37 (t, *J* = 7.08 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.1, 82.8, 63.0 (d, *J* = 6.4 Hz), 62.6 (d, *J* = 6.16 Hz), 58.5, 54.4 (d, *J* = 200.3 Hz), 27.6, 16.3, 16.2, 13.9; ^{31}P NMR (243 MHz, $CDCl_3$) δ 16.0; HRMS (ESI) calcd for $C_{12}H_{23}O_6PNa$ $(M+Na)^+$: 317.1124; found: 317.1121.



5e

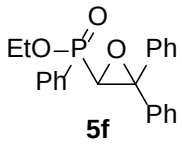
Tert-butyl (2R,3R)-3-(diethoxyphosphoryl)-2-phenyloxirane-2-carboxylate (5e): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 4) in 50% yield (35.4 mg); Colorless oil; IR (KBr): ν_{max} 2981, 1753, 1451, 1371, 1329, 1205, 1152, 1097, 839, 790, 698, 637 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.56-7.52 (m, 2H), 7.40-7.35 (m, 3H), 4.32-4.21 (m, 4H), 3.11 (d, *J* = 28.0 Hz, 1H), 1.53 (s, 9H), 1.39 (t, *J* = 7.2 Hz, 3H), 1.38 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.6, 134.4, 128.9, 128.5, 125.9, 83.3, 63.7, 63.4 (d, *J* = 5.8 Hz), 63.1 (d, *J* = 6.2 Hz), 58.1 (d, *J* = 197.7 Hz), 27.8, 16.4 (d, *J* = 4.6 Hz), 16.3 (d, *J* = 5.1 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 14.4; HRMS (ESI) calcd for $C_{17}H_{25}O_6PNa$ $(M+Na)^+$: 379.1281; found: 379.1273.



5e'

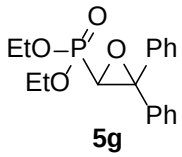
Tert-butyl (2S,3R)-3-(diethoxyphosphoryl)-2-phenyloxirane-2-carboxylate (5e'): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 5) in 32% yield (22.8mg); Colorless oil; ^1H NMR (400 MHz, $CDCl_3$) δ 7.56-7.54 (m,

2H), 7.38-7.31 (m, 3H), 4.07-3.97 (m, 2H), 3.76-3.67 (m, 1H), 3.61 (d, *J* = 29.2 Hz, 1H), 3.42-3.32 (m, 1H), 1.43 (s, 9H), 1.25 (t, *J* = 7.2 Hz, 3H), 1.00 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.7, 131.5, 128.4, 128.1, 127.4, 83.4, 62.5, 62.4, 60.9, 56.1 (d, *J* = 201.6 Hz), 27.6, 16.1 (d, *J* = 6.1 Hz), 15.9 (d, *J* = 5.7 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 13.7; HRMS (ESI) calcd for $C_{17}H_{25}O_6PNa$ $(M+Na)^+$: 379.1281; found: 379.1275.



5f

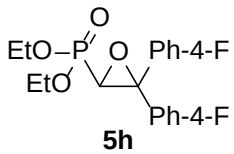
Ethyl (3,3-diphenyloxiran-2-yl)(phenyl)phosphinate (5f and 5f'): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 4) in 80% yield (58mg); d.r. = 1.7:1; IR (KBr): ν_{max} 3060, 2988, 2234, 1964, 1813, 1592, 1494, 1390, 1217, 1160, 1020, 959, 695, 637 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70-7.02 (m, 30H), 4.13-3.61 (m, 5H), 2.75 (d, *J* = 31.2 Hz, 1H), 1.29 (t, *J* = 7.2 Hz, 3H), 0.96 (t, *J* = 8.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.8, 139.6, 135.8, 134.4, 132.6, 132.5, 131.9, 131.5 (d, *J* = 9.87 Hz), 128.5, 128.4, 128.2, 128.20, 127.9, 127.88, 127.72, 127.57, 126.53, 126.22, 62.4 (d, *J* = 137.5 Hz), 62.3 (d, *J* = 142.6 Hz), 61.0, 60.9, 60.3, 16.4 (d, *J* = 6.3 Hz), 15.9(d, *J* = 6.1 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 34.4, 29.4; HRMS (ESI) calcd for $C_{22}H_{21}O_3PNa$ $(M+Na)^+$: 387.1121; found: 387.1109.



5g

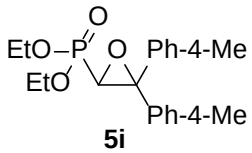
Diethyl (3,3-diphenyloxiran-2-yl)phosphonate (5g): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 4) in 68% yield (45mg); IR (KBr): ν_{max} 2983, 1448, 1389, 1264, 1162, 1026, 970, 757, 701, 638 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59-7.56 (m, 2H), 7.40-7.25 (m, 8H), 4.12-3.97 (m, 2H), 3.85-3.75 (m, 1H), 3.55-3.45 (m, 1H), 3.48 (d, *J* = 28.0 Hz, 1H), 1.24 (t, *J* = 7.2, 3H), 1.03 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.6, 136.0, 128.4, 128.2,

128.1, 127.9, 126.5, 66.3, 62.5 (d, *J* = 7.2 Hz), 62.4 (d, *J* = 7.0 Hz), 60.1 (d, *J* = 198.4 Hz), 16.2 (d, *J* = 6.1 Hz), 16.1 (d, *J* = 5.7 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 15.1; HRMS (ESI) calcd for $C_{18}H_{21}O_4PNa$ $(M+Na)^+$: 355.1070; found: 355.1059.



5h

Diethyl (3,3-bis(4-fluorophenyl)oxiran-2-yl)phosphonate (5h): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 3) in 70% yield (51.4 mg); IR (KBr): ν_{max} 3074, 2986, 1729, 1611, 1507, 1444, 1409, 1157, 1051, 836, 678 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55-7.51 (m, 2H), 7.28-7.23 (m, 2H), 7.11-7.06 (m, 2H), 7.02-6.96 (m, 2H), 4.13-3.98 (m, 2H), 3.91-3.81 (m, 1H), 3.71-3.61 (m, 1H), 3.44 (d, *J* = 28.0 Hz, 1H), 1.26 (t, *J* = 7.2 Hz, 3H), 1.09 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.6 (d, *J* = 245.8 Hz), 135.3, 131.8, 130.1, 130.0, 128.4, 128.3, 115.4 (d, *J* = 21.7 Hz), 115.0 (d, *J* = 21.5 Hz), 65.3, 62.6 (d, *J* = 6.9 Hz), 62.6 (d, *J* = 6.8 Hz), 60.2 (d, *J* = 198.3 Hz), 16.3 (d, *J* = 5.9 Hz), 16.1 (d, *J* = 5.6 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 14.7; HRMS (ESI) calcd for $C_{18}H_{19}F_2O_4PNa(M+Na)^+$: 391.0881; found: 391.0874.

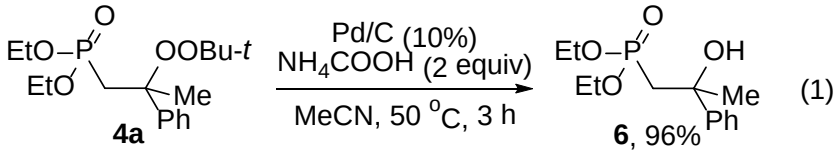


5i

Diethyl (3,3-di-*p*-tolyloxiran-2-yl)phosphonate (5i): Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 3) in 60% yield (43 mg); IR (KBr): ν_{max} 2984, 2361, 1655, 1609, 1511, 1213, 1025, 750 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46-7.44 (m, 2H), 7.38-7.35 (m, 2H), 7.13-7.07 (m, 4H), 4.84 (d, *J* = 8.8 Hz, 1H), 4.19-4.04 (m, 2H), 3.75-3.65 (m, 1H), 3.42-3.31 (m, 1H), 2.28 (s, 3H), 2.27 (s, 3H), 1.27 (t, *J* = 7.2 Hz, 3H),0.92(t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 140.6, 140.5, 136.7, 128.9, 128.6, 125.9, 125.8, 79.1, 72.3 (d, *J* = 159.2 Hz), 63.9 (d, *J* = 6.9), 61.8 (d, *J* = 7.3 Hz), 20.9, 20.8, 16.4 (d, *J* = 5.7 Hz), 15.7 (d, *J* = 6.1 Hz); ^{31}P NMR (243 MHz, $CDCl_3$) δ 23.2; HRMS (ESI) calcd for $C_{20}H_{26}O_4P(M+H)^+$:

361.1563; found: 361.1558.

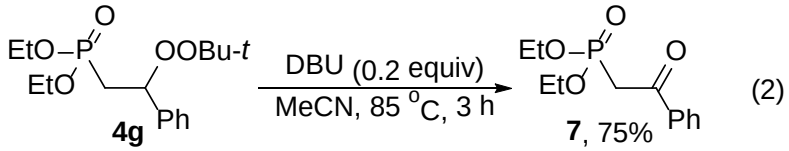
5. Synthesis and characterization of 6 and 7



(1)

To a solution of **4a** (0.2 mmol) and NH_4COOH (2 equiv) in CH_3CN (2 mL) under nitrogen at room temperature, then Pd/C (10%, 10 mol%) was added to the mixture under nitrogen at room temperature. The reaction mixture was stirred at 50°C for 3 h, then passed through celite. The celite was washed with diethyl ether, the eluent was chromatography concentrated in vacuo, and the residue was subjected to silica gel flash. **6** was obtained as a colorless oil in 96% yield.

Diethyl (2-hydroxy-2-phenylpropyl)phosphonate (6) [4] Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:3, R_f = 0.3) in 96% yield (52 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49-7.47 (m, 2H), 7.36-7.32 (m, 2H), 7.25-7.21 (m, 1H), 5.02 (s, 1H), 4.12-3.98 (m, 2H), 3.74-3.64 (m, 1H), 3.42-3.32 (m, 1H), 2.47 (dd, *J* = 15.6 Hz, *J* = 17.6 Hz, 1H), 2.34 (dd, *J* = 15.6 Hz, *J* = 16.8 Hz, 1H), 1.62 (d, *J* = 2.4 Hz, 3H), 1.31 (t, *J* = 7.2 Hz, 3H), 1.00 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.1 (d, *J* = 7.0 Hz), 128.0, 126.7, 124.7, 71.9 (d, *J* = 4.7 Hz), 61.7 (d, *J* = 6.4 Hz), 61.4 (d, *J* = 6.5 Hz), 39.6 (d, *J* = 134.8 Hz), 32.4 (d, *J* = 14.3 Hz), 16.3 (d, *J* = 6.2 Hz), 16.0 (d,*J* = 6.1 Hz).

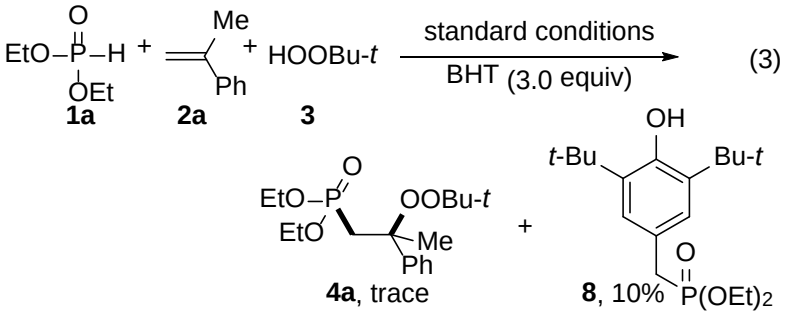


(2)

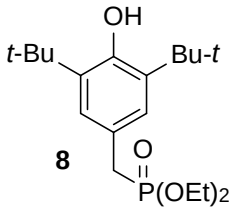
To a solution of **4g** (0.2 mmol) in MeCN (2 mL) under nitrogen at room temperature. Then DBU (0.04 mmol, 0.2 equiv) was added to the mixture under nitrogen at room temperature. The reaction stirred at85 °C for 3 h. Subsequently, the reaction solution was evaporated in vacuo at 25 °C, and the resulting residue was purified by flash column chromatography on silica gel using ethyl acetate/petroleum ether (1:1) as an eluent to give the desired product **7** in 75% combined yield.

Diethyl (2-oxo-2-phenylethyl)phosphonate 7[5] Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 25) in 75% yield (38.3 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03-8.01 (m, 2H), 7.61-7.57 (m, 1H), 7.61-7.57 (m, 1H), 7.50-7.46 (m, 2H), 4.18-4.10 (m, 4H), 3.64 (d, J = 22.8 Hz, 2H), 1.28 (t, J = 7.2 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.9 (d, J = 6.2 Hz), 136.4, 133.6, 128.9, 128.5, 62.6, 62.5, 38.4 (d, J = 129.2 Hz), 16.2, 16.1.

6.BHT-trapping experiment



To a dry Schlenk tube were added alpha-Methylstyrene **2a** (0.5 mmol), diethyl phosphite **1a** (2.5mmol), and $Cu(OAc)_2$ (0.05 mmol), BHT (1.5 mmol, 3 equiv), anhydrous CH_3CN (5.0 mL) at room temperature. Subsequently, *tert*-butyl hydroperoxide **3** (5-6M solution in decane, 2.5 mmol) was added to the mixture, and the resulting solution was stirred at 60 ^{o}C for 3 h. The resulting reaction solution was filtered through a pad of silica with ethyl acetate as eluent. The solvent was evaporated *in vacuo*. The formation of **8** in 0.08 mmol amount was determined by ^{1}H NMR using dibromomethane as an internal standard; 0.05 mmol amount of **8** was isolated by flash column chromatography on silica gel.



8

Diethyl (3,5-di-*tert*-butyl-4-hydroxybenzyl)phosphonate 8: Isolated by flash column chromatography (ethyl acetate/petroleum ether = 1:1, R_f = 0. 4) in 10% yield (17 mg); IR (KBr): ν_{max} 3360, 2957, 2873, 1658, 1436, 1393, 1222, 1162, 1056, 966,

888, 808, 768, 704, 634 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.08 (m, 2H), 5.13 (br, 1H), 4.04-3.97 (m, 4H),3.07(d, J = 21.0 Hz, 2H) 1.43 (s, 18H), 1.24 (t, *J* = 7.2 Hz, 6H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 152.7 (d, *J* = 3.5 Hz), 136.0, 126.4, 126.3, 61.9, 61.8, 34.3, 33.4 (d, *J* = 137.85 Hz), 30.3, 16.4, 16.3; ^{31}P NMR (243 MHz, $CDCl_3$) δ 27.4; HRMS (ESI) calcd for $C_{19}H_{33}O_4PNa$ $(M+Na)^+$: 379.2009; found: 379.1998.

7. References:

[1] L. Y. Kuo, D. C. Baker, A.K. Dortignacq, K. M. Dill, *Organometallics.,* 2013, **32**, 4759

For the spectroscopic properties, see:

K. E. Debruin, C. W. Tang, D. M. Johnson, R. L.Wilde, *J. Am. Chem. Soc.*, 1989, **111**, 5871.

[2] C. Chatalova-Sazepin, Q. Wang, G. M. Sammis, J. Zhu, *Angew. Chem. Int. Ed.*, 2015, **54**, 5443.

For spectroscopic data, see:

H. Namai, H. Ikeda, N. Kato, K. Mizuno, *J. Phys. Chem. A.*, 2007, **111**, 4436.

[3] S. Kawashima, K. Aikawa, K. Mikami , *Eur. J. Org. Chem.*, 2016, 3166.

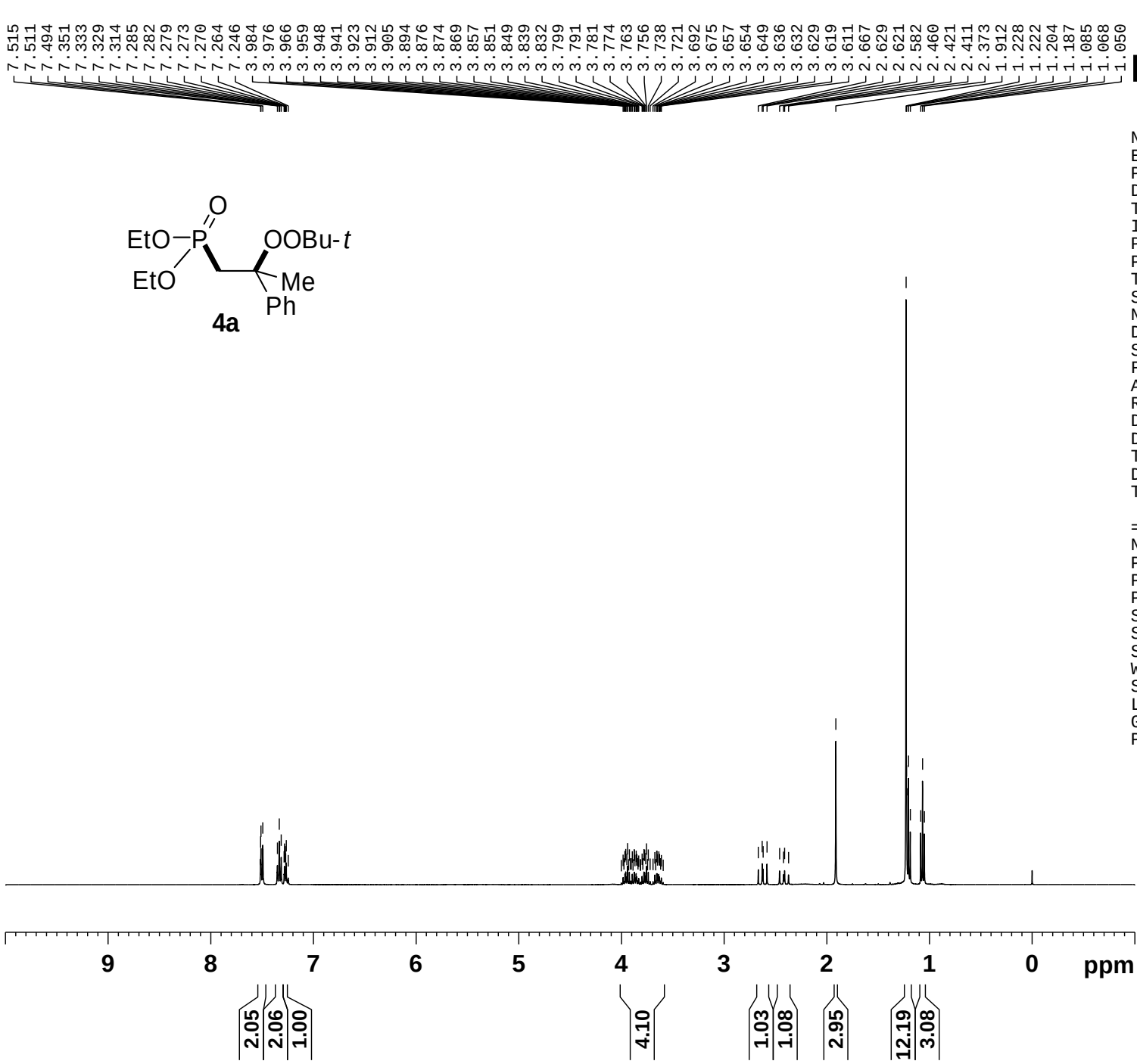
For spectroscopic data, see:

A. T. Biju, M. Padmanaban, N. E. Wurz, F. Glorius, *Angew. Chem. Int. Ed.*, 2011, **50**, 8412.

[4] T. Taniguchi, A. Idota, S. Yokoyama, H. Ishibashi, *Tetrahedron Lett.*, 2011, **52** ,4768.

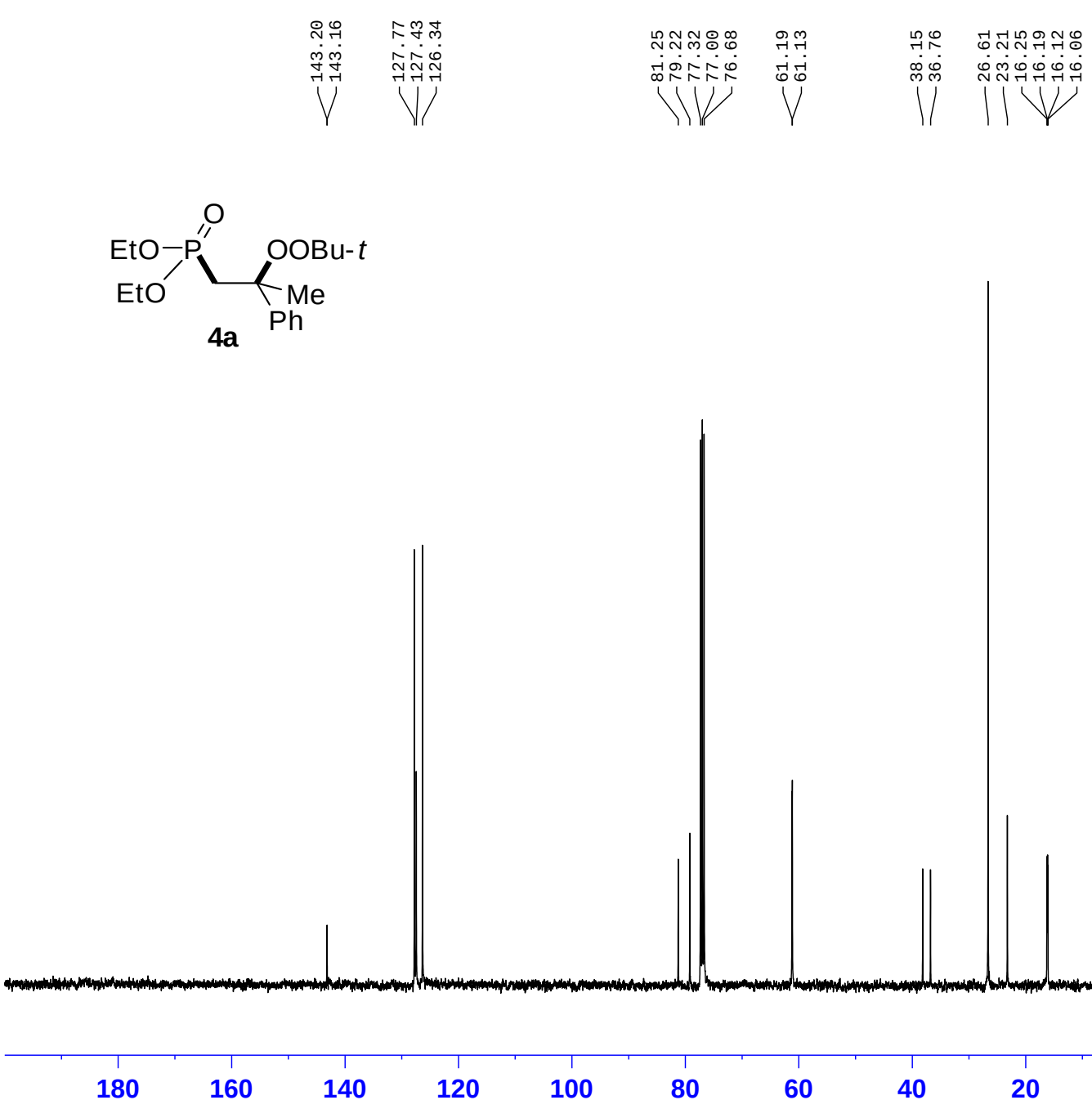
[5] W. Wei, J. Ji, *Angew. Chem., Int. Ed.*, 2011, **50**, 9097.

8. Copies of ^{1}H and ^{13}C, ^{31}P NMR spectra for all compounds



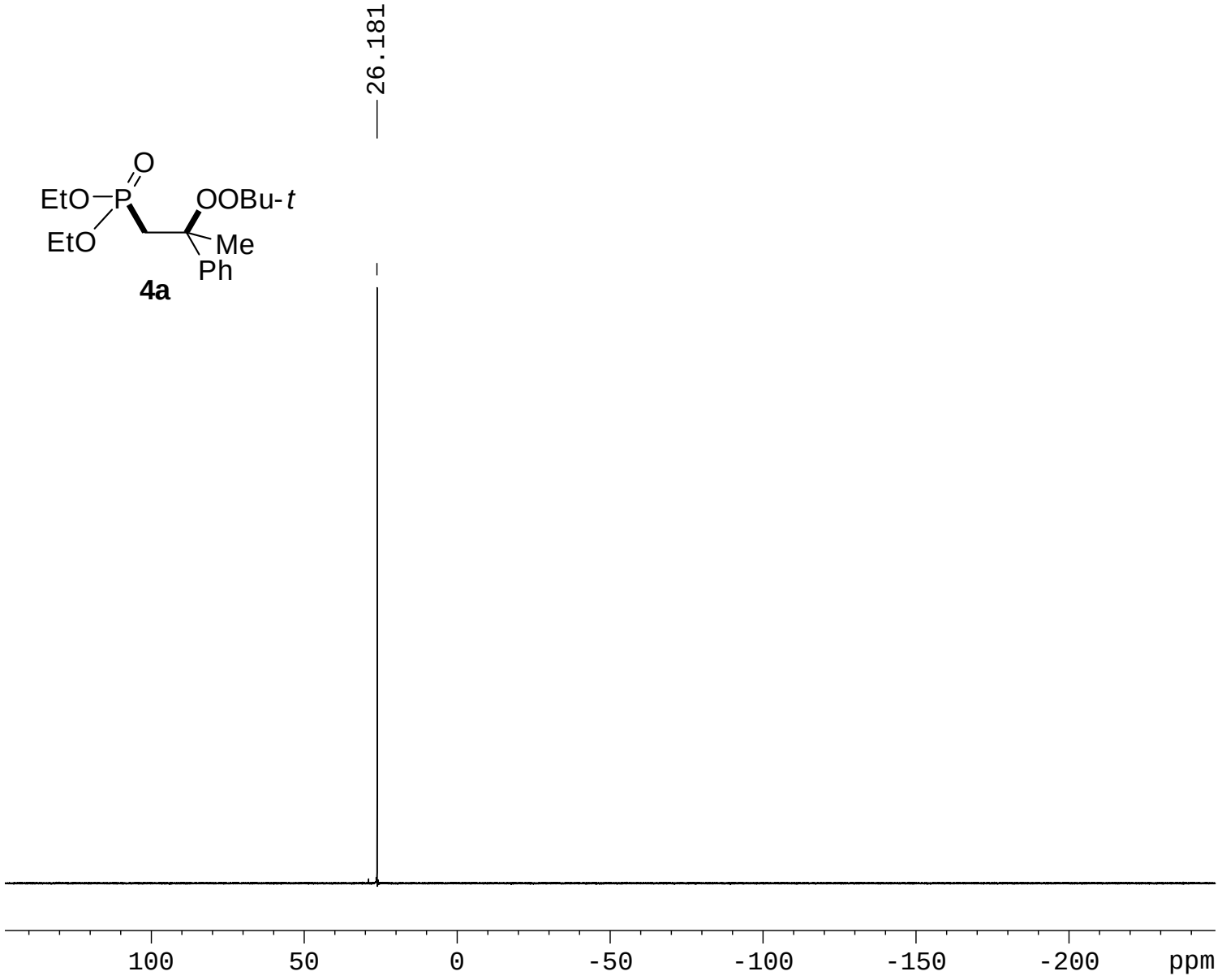
BRUKER

NAME	cy-20170328
EXPNO	1
PROCNO	1
Date_	20170328
Time	9.54
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	90.5
DW	78.200 usec
DE	6.50 usec
TE	292.3 K
D1	1.00000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1300046 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00

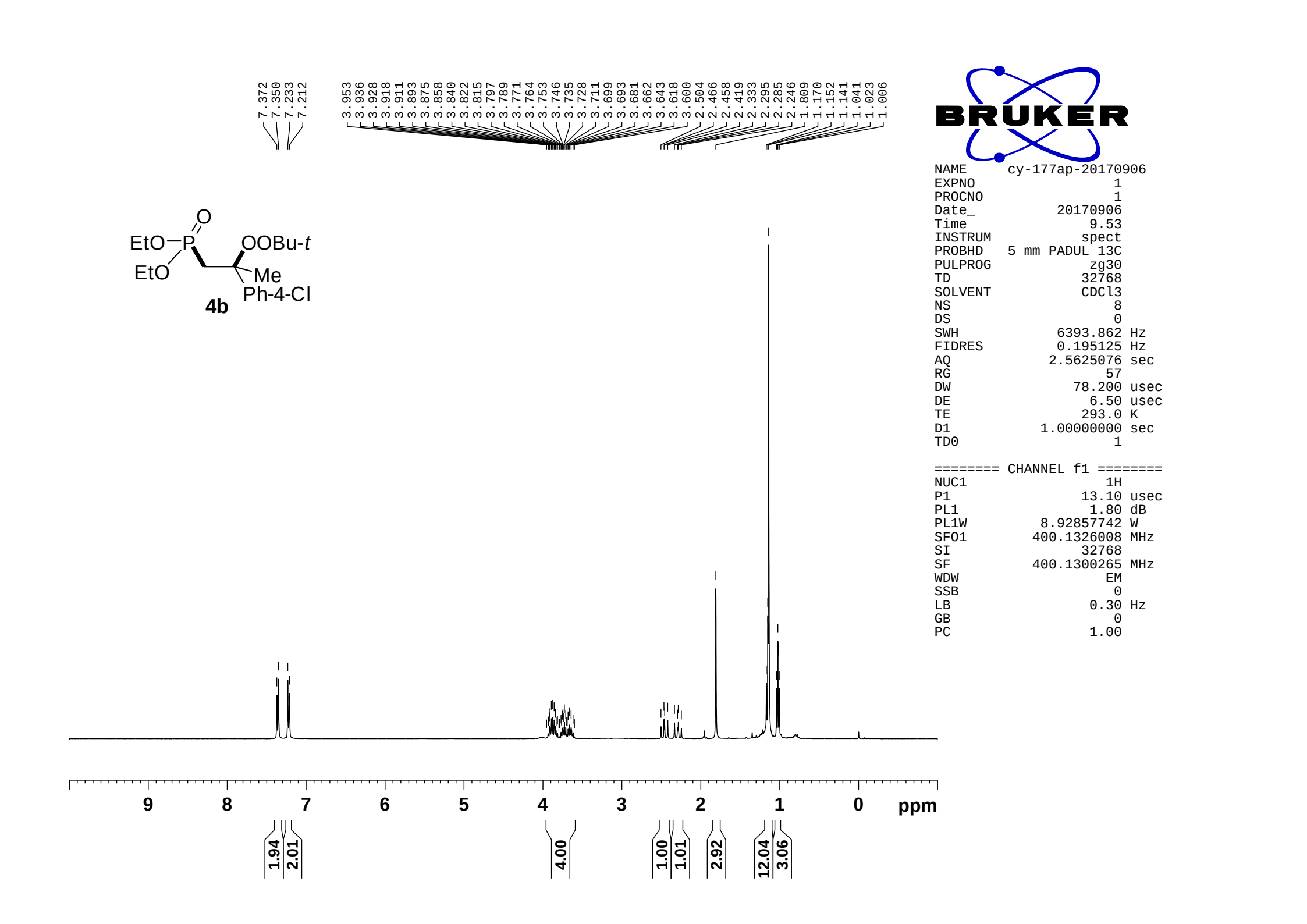


BRUKER

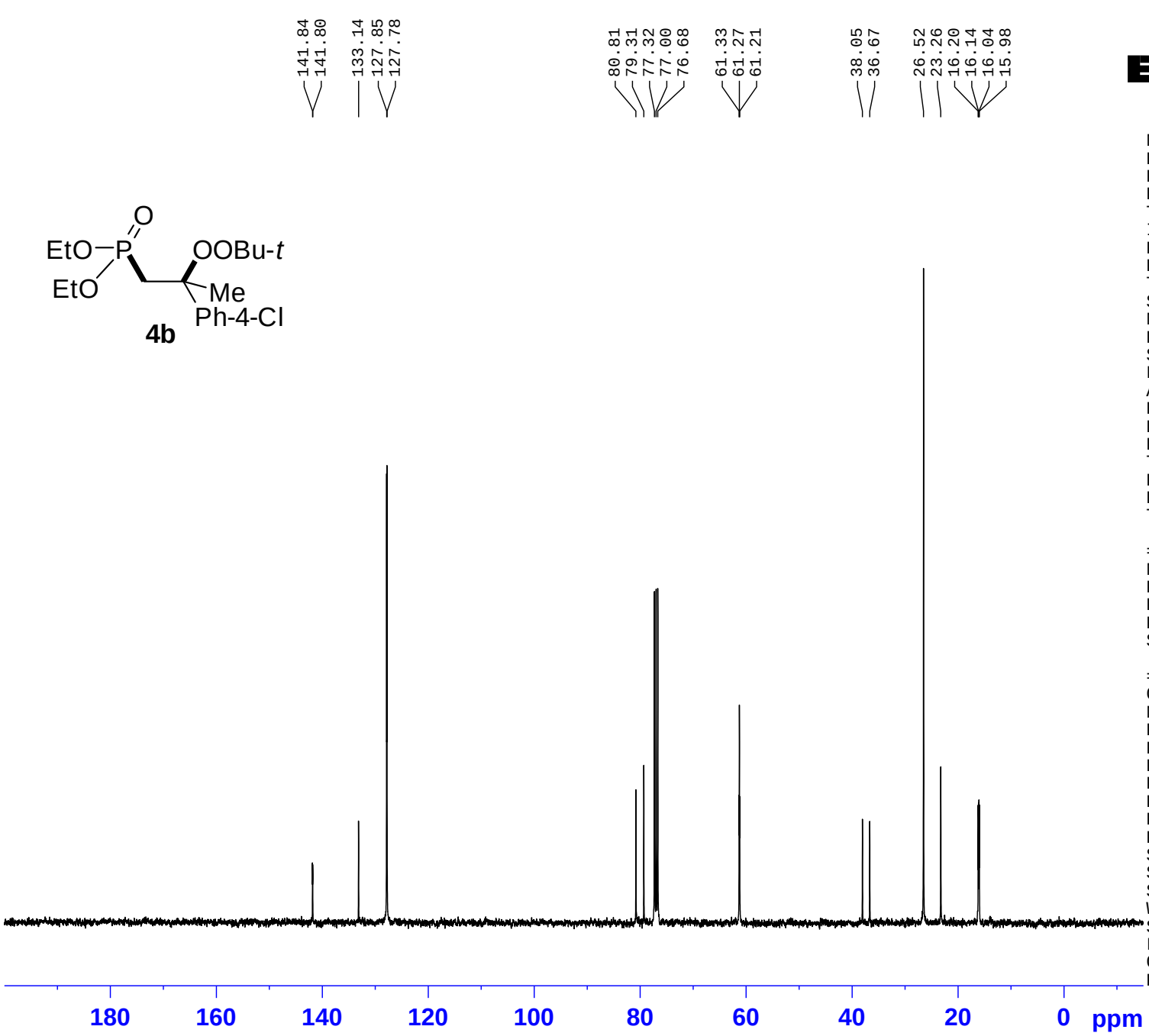
NAME	cy-20170328
EXPNO	2
PROCNO	1
Date_	20170328
Time	9.57
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	184
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	292.9 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127757 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40



NAME	cy-20170328p
EXPNO	3
PROCNO	1
Date_	20170329
Time	9.39
INSTRUM	spect
PROBHD	5 mm PABBO BB/
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	16
DS	4
SWH	96153.844 Hz
FIDRES	1.467191 Hz
AQ	0.3408372 sec
RG	190.02
DW	5.200 usec
DE	6.50 usec
TE	0.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
SFO1	242.9411216 MHz
NUC1	31P
P1	11.90 usec
SI	32768
SF	242.9532693 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40

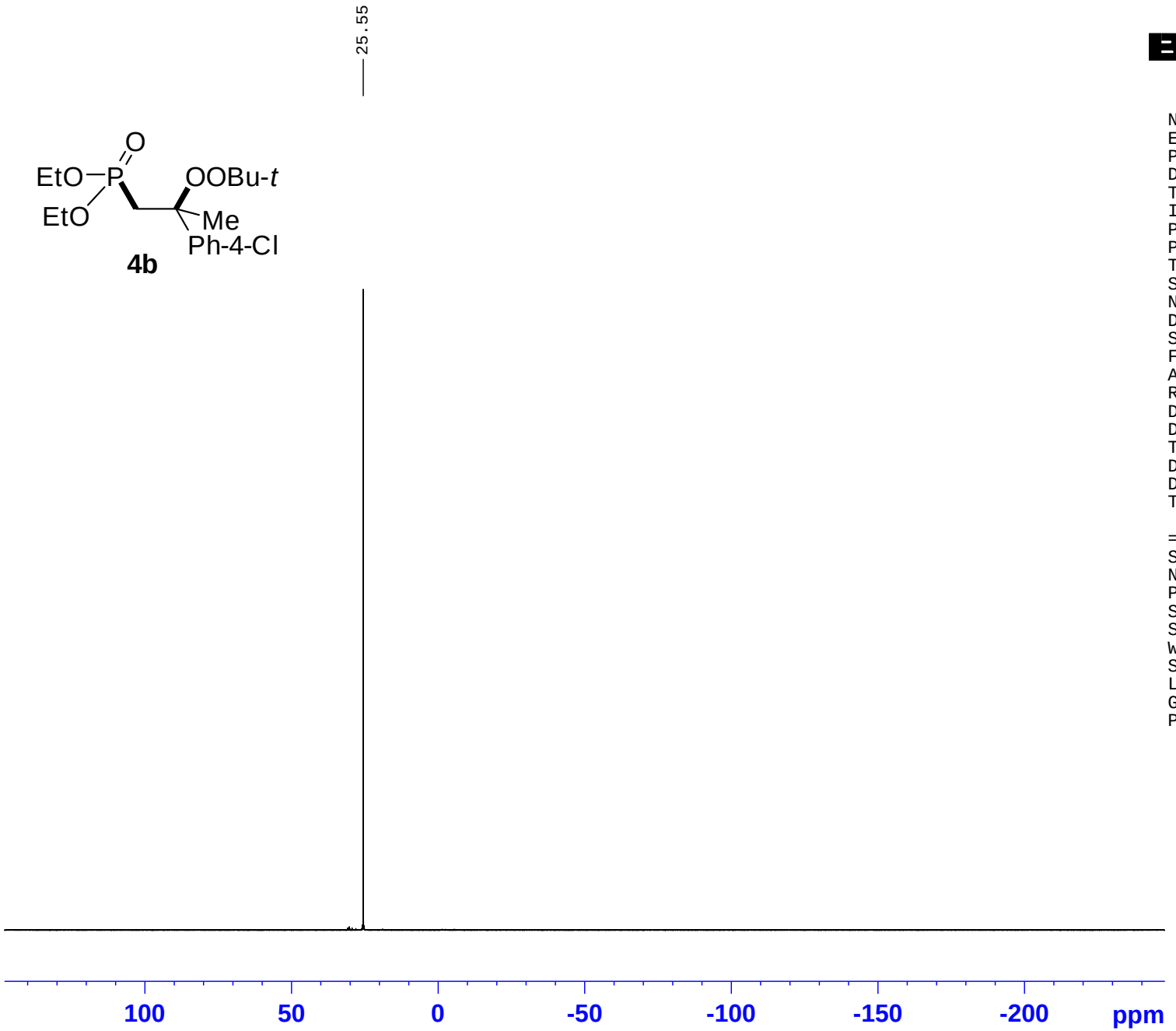



```
NAME      cy-177ap-20170906
EXPNO                    1
PROCNO                   1
Date_             20170906
Time                 9.53
INSTRUM             spect
PROBHD   5 mm PADUL 13C
PULPROG              zg30
TD                  32768
SOLVENT             CDCl3
NS                      8
DS                      0
SWH              6393.862 Hz
FIDRES           0.195125 Hz
AQ             2.5625076 sec
RG                     57
DW                78.200 usec
DE                 6.50 usec
TE                293.0 K
D1           1.00000000 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                   1H
P1                  13.10 usec
PL1                  1.80 dB
PL1W          8.92857742 W
SFO1         400.1326008 MHz
SI                  32768
SF           400.1300265 MHz
WDW                    EM
SSB                     0
LB                 0.30 Hz
GB                      0
PC                   1.00
```



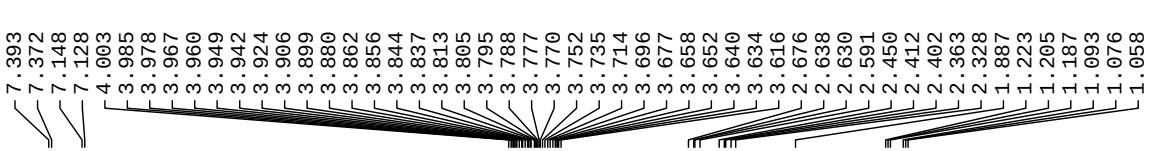
BRUKER

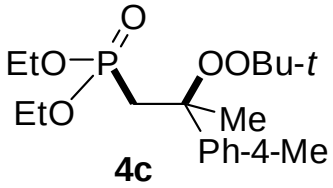
NAME	cy-177ap-20170906
EXPNO	2
PROCNO	1
Date_	20170906
Time	9.56
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	104
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	293.6 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127785 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40



BRUKER

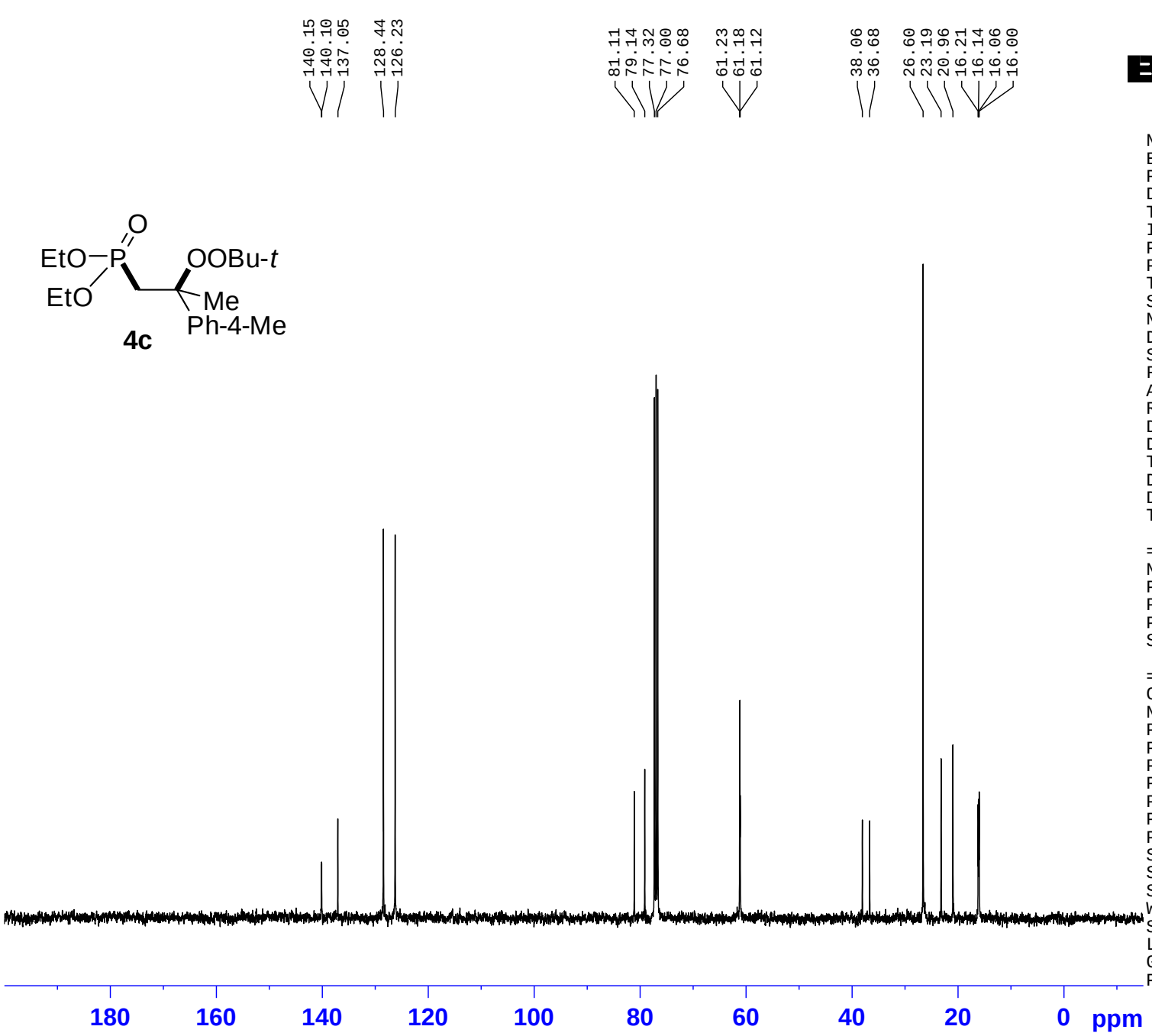
NAME	cy-177ap
EXPNO	3
PROCNO	1
Date_	20170913
Time	10.46
INSTRUM	spect
PROBHD	5 mm PABBO BB/
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	32
DS	4
SWH	96153.844 Hz
FIDRES	1.467191 Hz
AQ	0.3408372 sec
RG	190.02
DW	5.200 usec
DE	6.50 usec
TE	0.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
SFO1	242.9411216 MHz
NUC1	31P
P1	11.90 usec
SI	32768
SF	242.9532693 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40





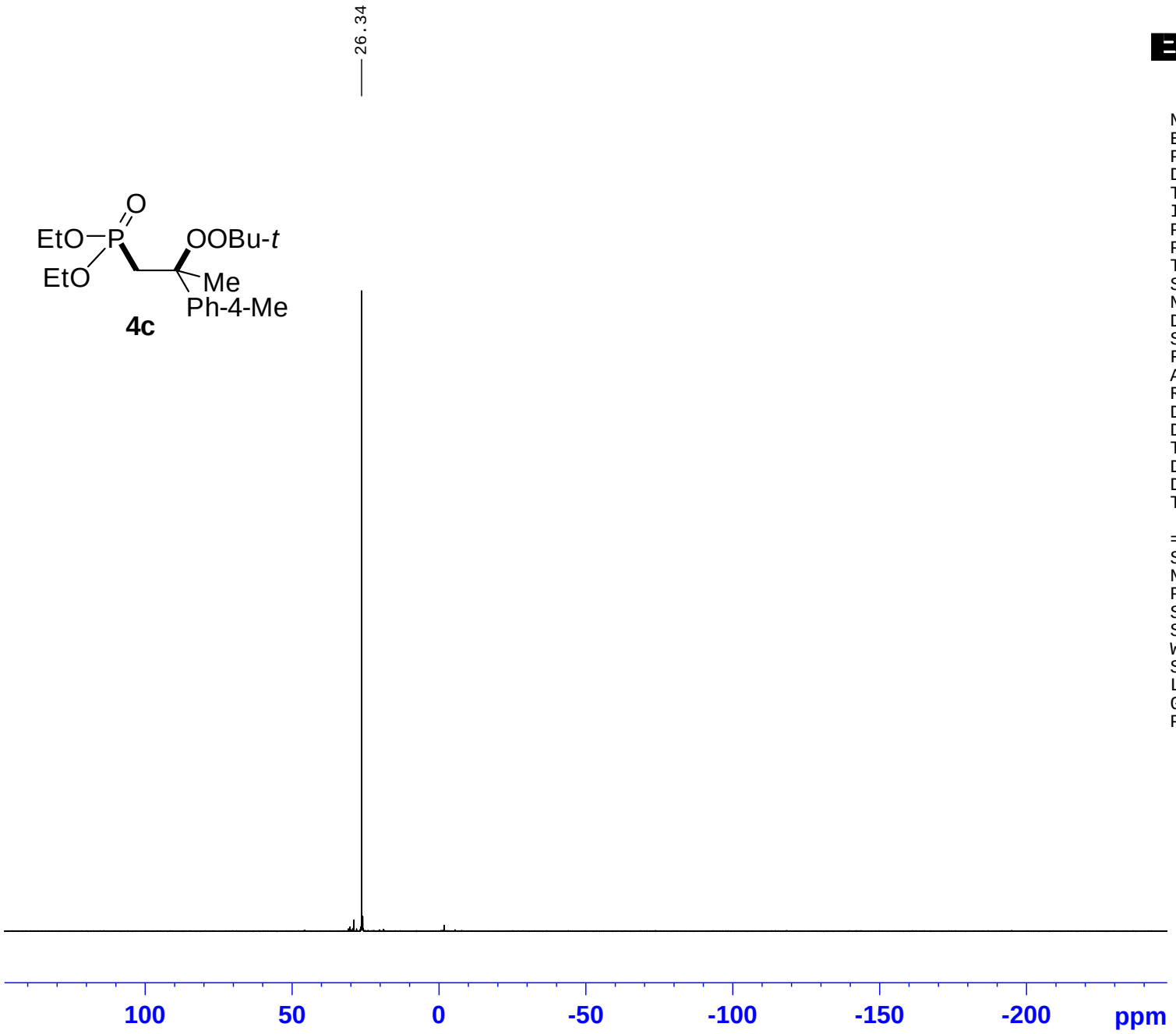
4c

```
NAME      cy-177bp-20170906
EXPNO                    1
PROCNO                   1
Date_             20170906
Time                 10.05
INSTRUM              spect
PROBHD   5 mm PADUL 13C
PULPROG               zg30
TD                   32768
SOLVENT              CDCl3
NS                       8
DS                       0
SWH               6393.862 Hz
FIDRES            0.195125 Hz
AQ               2.5625076 sec
RG                      57
DW                  78.200 usec
DE                   6.50 usec
TE                  293.0 K
D1             1.00000000 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                    1H
P1                   13.10 usec
PL1                   1.80 dB
PL1W          8.92857742 W
SFO1         400.1326008 MHz
SI                   32768
SF           400.1300045 MHz
WDW                     EM
SSB                      0
LB                    0.30 Hz
GB                       0
PC                    1.00
```



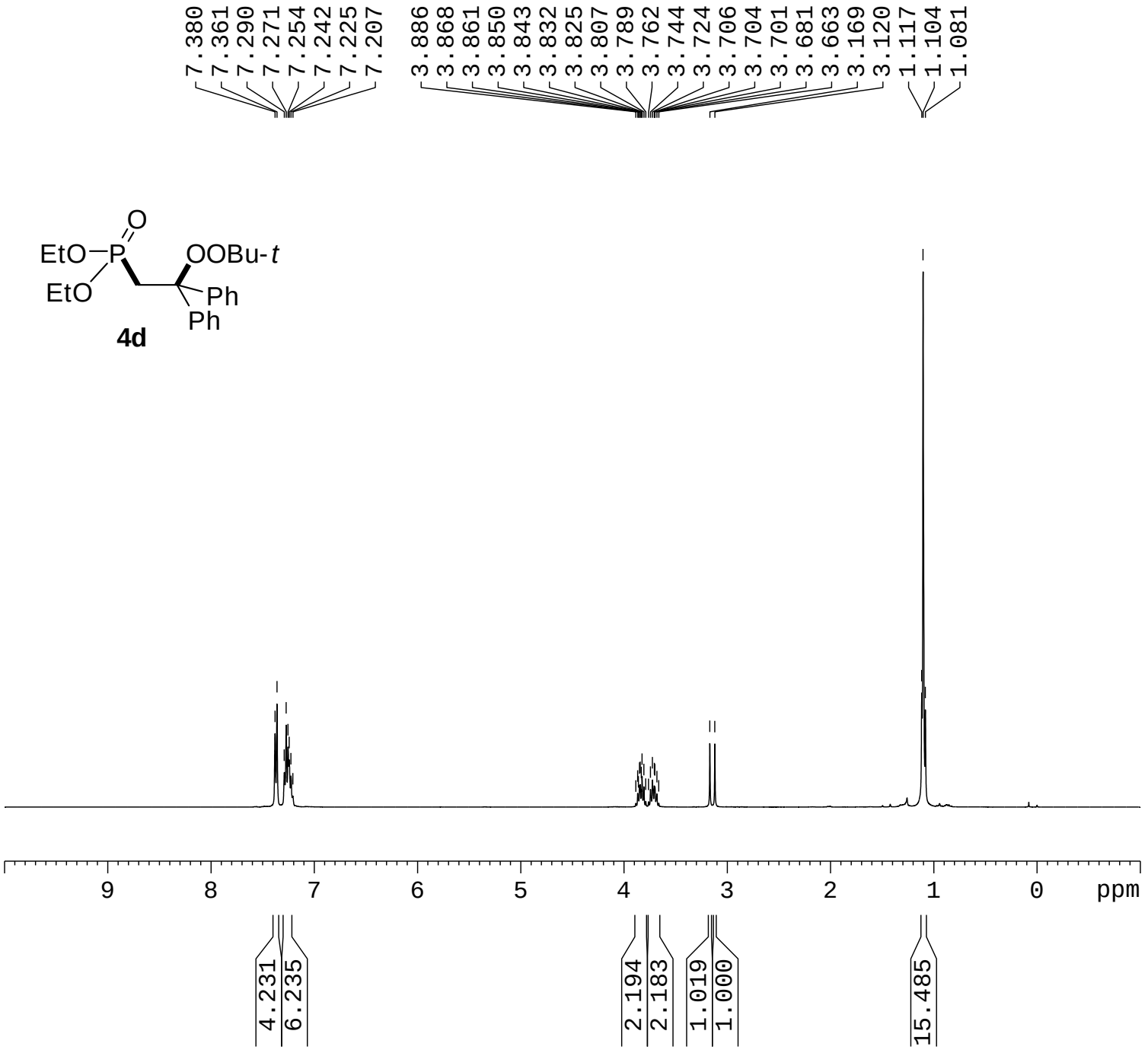
BRUKER

NAME	cy-177bp-20170906
EXPNO	2
PROCNO	1
Date_	20170906
Time	10.10
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	96
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	294.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127773 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40



BRUKER

NAME	cy-177bp
EXPNO	3
PROCNO	1
Date_	20170913
Time	10.41
INSTRUM	spect
PROBHD	5 mm PABBO BB/
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	32
DS	4
SWH	96153.844 Hz
FIDRES	1.467191 Hz
AQ	0.3408372 sec
RG	190.02
DW	5.200 usec
DE	6.50 usec
TE	0.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
SFO1	242.9411216 MHz
NUC1	31P
P1	11.90 usec
SI	32768
SF	242.9532693 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40

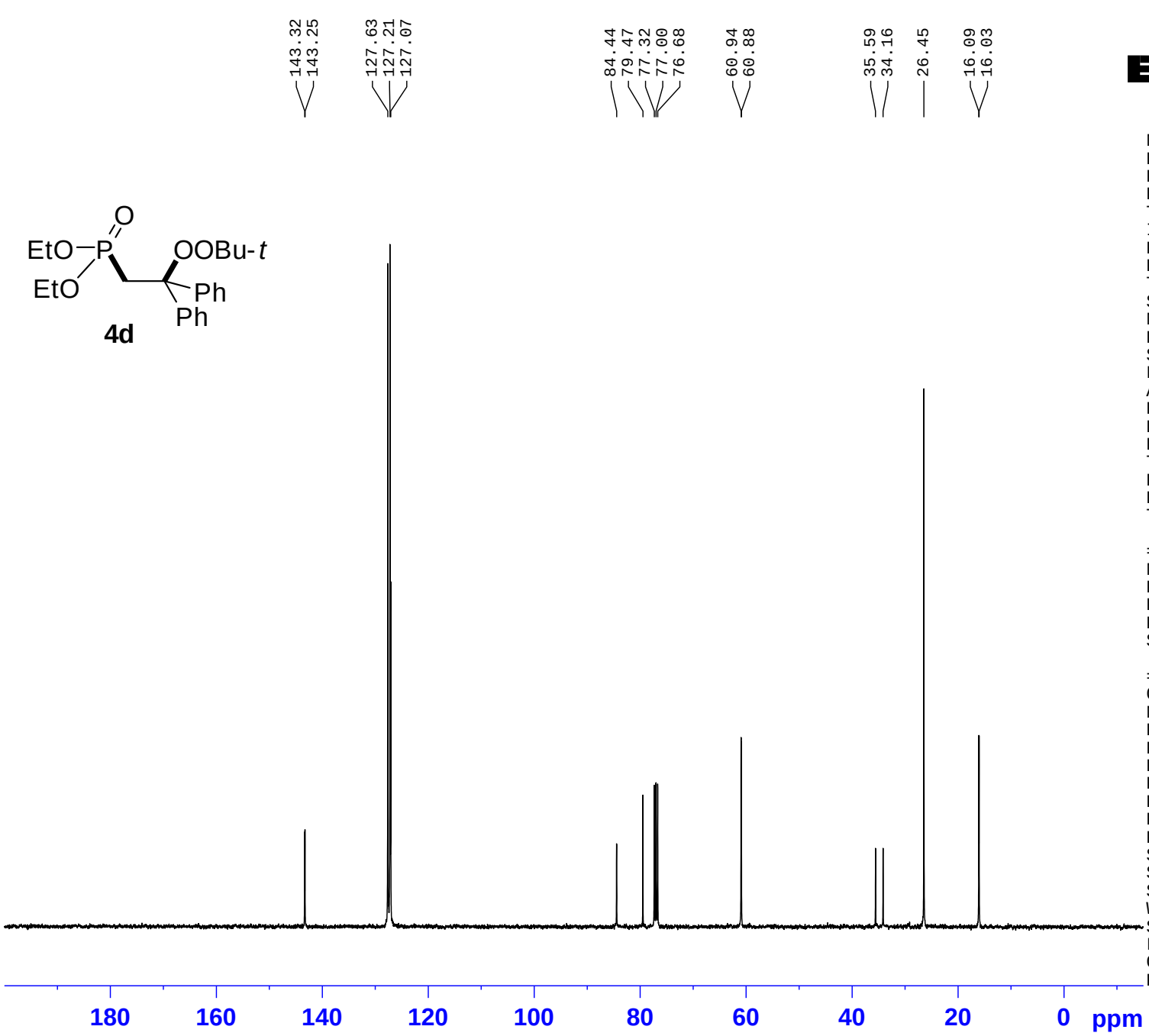


BRUKER

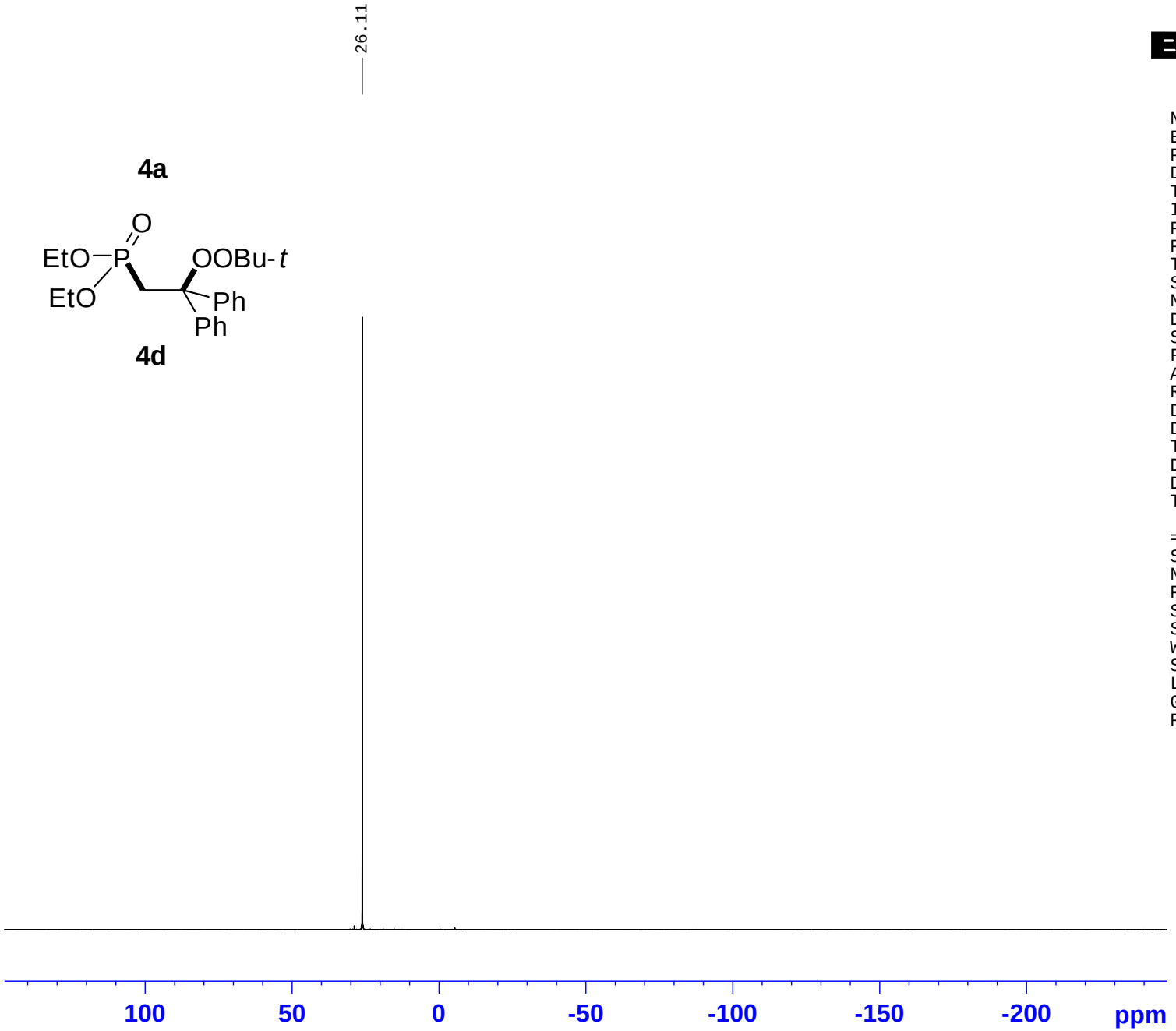
NAME	cy-99a1-20170330
EXPNO	1
PROCNO	1
Date_	20170330
Time	17.27
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	40.3
DW	78.200 usec
DE	6.50 usec
TE	292.8 K
D1	1.00000000 sec
TD0	1

======== CHANNEL f1 ========

NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1300052 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00

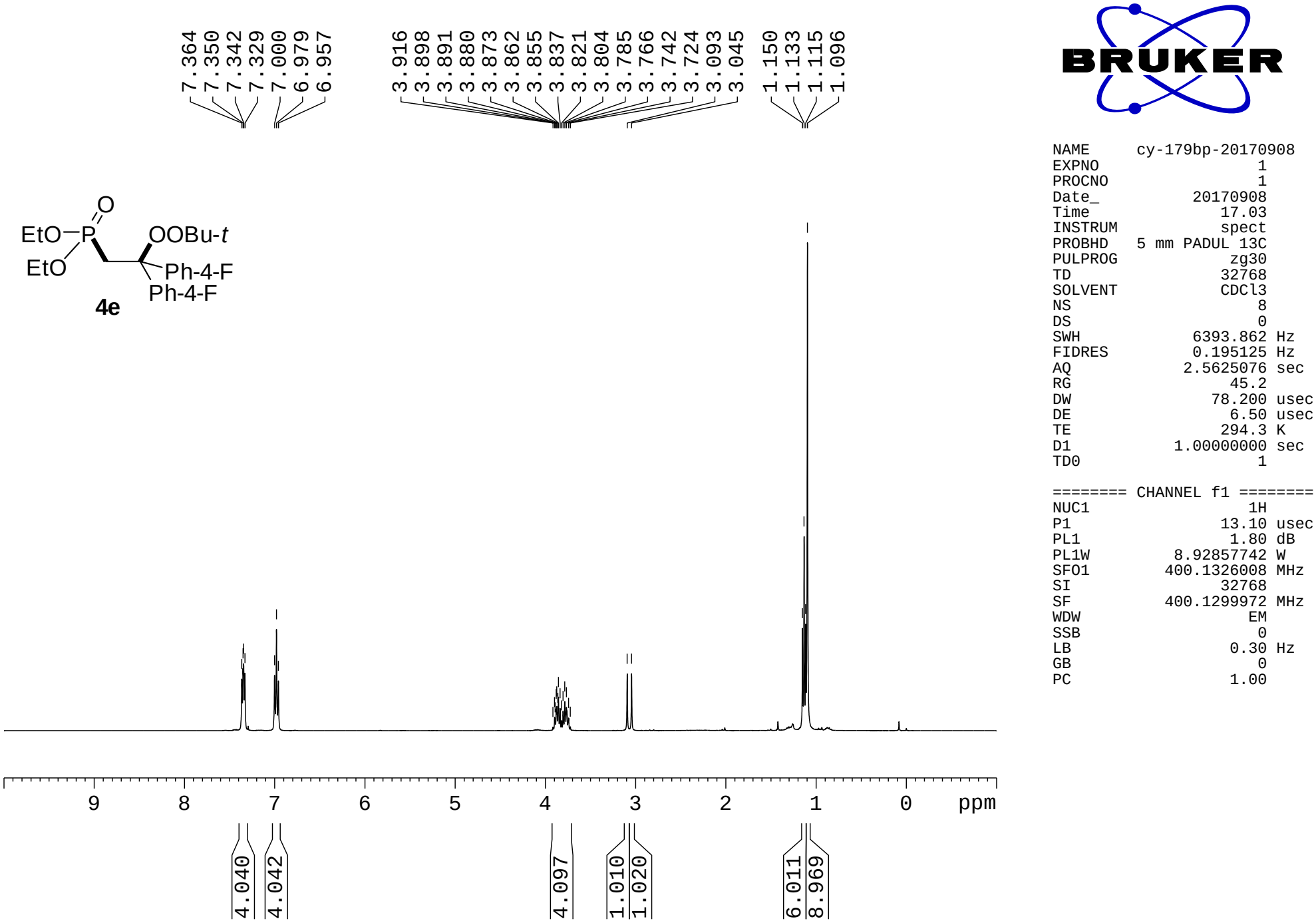



```
NAME      cy-99a1-20170330
EXPNO                    2
PROCNO                   1
Date_             20170330
Time                17.33
INSTRUM             spect
PROBHD   5 mm PADUL 13C
PULPROG             zgpg30
TD                   65536
SOLVENT              CDCl3
NS                     120
DS                       4
SWH              25252.525 Hz
FIDRES            0.385323 Hz
AQ               1.2976629 sec
RG                    2050
DW                  19.800 usec
DE                   8.00 usec
TE                  293.8 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                     10

======== CHANNEL f1 ========
NUC1                   13C
P1                  13.50 usec
PL1                  3.00 dB
PL1W          43.93649673 W
SFO1          100.6238364 MHz

======== CHANNEL f2 ========
CPDPRG2           waltz16
NUC2                   1H
PCPD2               80.00 usec
PL2                  1.80 dB
PL12                17.19 dB
PL13                18.46 dB
PL2W           8.92857742 W
PL12W          0.25809658 W
PL13W          0.19265592 W
SFO2          400.1316005 MHz
SI                  32768
SF            100.6127860 MHz
WDW                    EM
SSB                     0
LB                   3.00 Hz
GB                      0
PC                   1.40
```

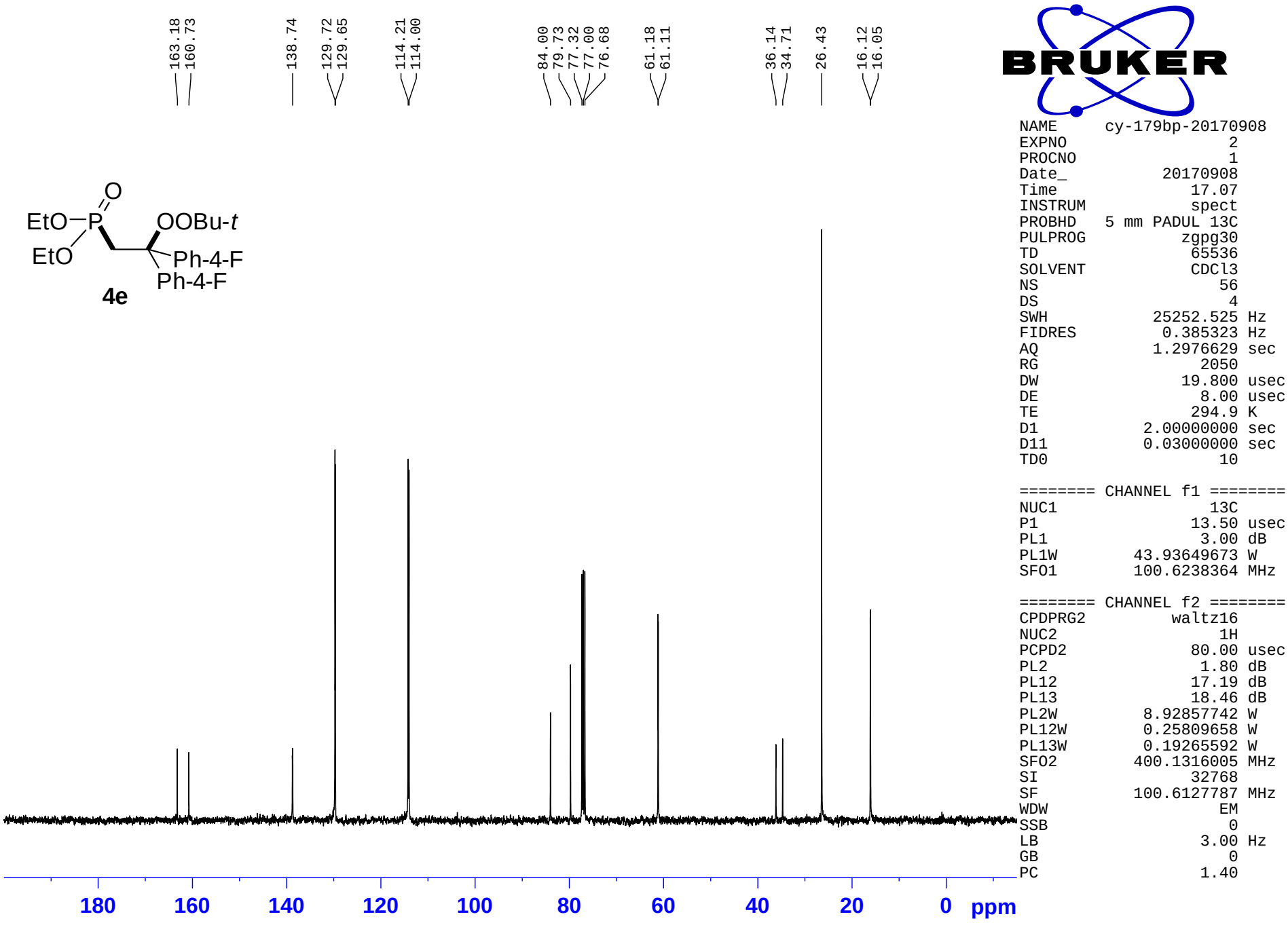


BRUKER

NAME	cy-99a1
EXPNO	3
PROCNO	1
Date_	20170426
Time	9.54
INSTRUM	spect
PROBHD	5 mm PABBO BB/
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	64
DS	4
SWH	96153.844 Hz
FIDRES	1.467191 Hz
AQ	0.3408372 sec
RG	190.02
DW	5.200 usec
DE	6.50 usec
TE	295.1 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
SFO1	242.9411216 MHz
NUC1	31P
P1	11.90 usec
SI	32768
SF	242.9532693 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40

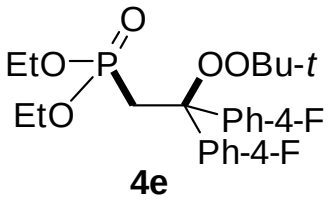



```
NAME      cy-179bp-20170908
EXPNO                    1
PROCNO                   1
Date_             20170908
Time                 17.03
INSTRUM              spect
PROBHD   5 mm PADUL 13C
PULPROG               zg30
TD                   32768
SOLVENT              CDCl3
NS                       8
DS                       0
SWH               6393.862 Hz
FIDRES            0.195125 Hz
AQ               2.5625076 sec
RG                    45.2
DW                  78.200 usec
DE                   6.50 usec
TE                  294.3 K
D1             1.00000000 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                    1H
P1                   13.10 usec
PL1                   1.80 dB
PL1W           8.92857742 W
SFO1          400.1326008 MHz
SI                   32768
SF            400.1299972 MHz
WDW                     EM
SSB                      0
LB                    0.30 Hz
GB                       0
PC                    1.00
```



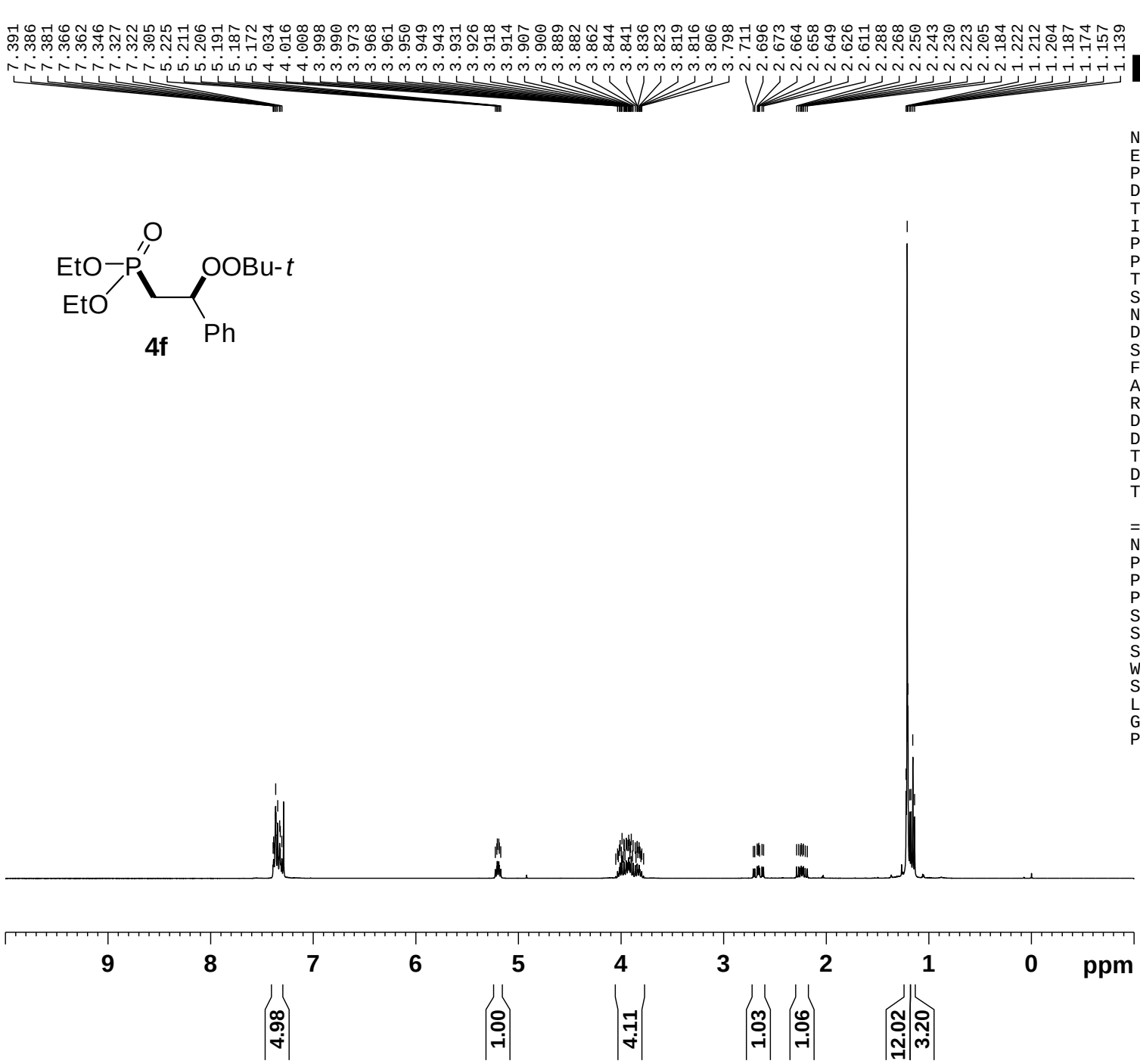
BRUKER

NAME	cy-179bp-20170908
EXPNO	2
PROCNO	1
Date_	20170908
Time	17.07
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	56
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	294.9 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127787 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40



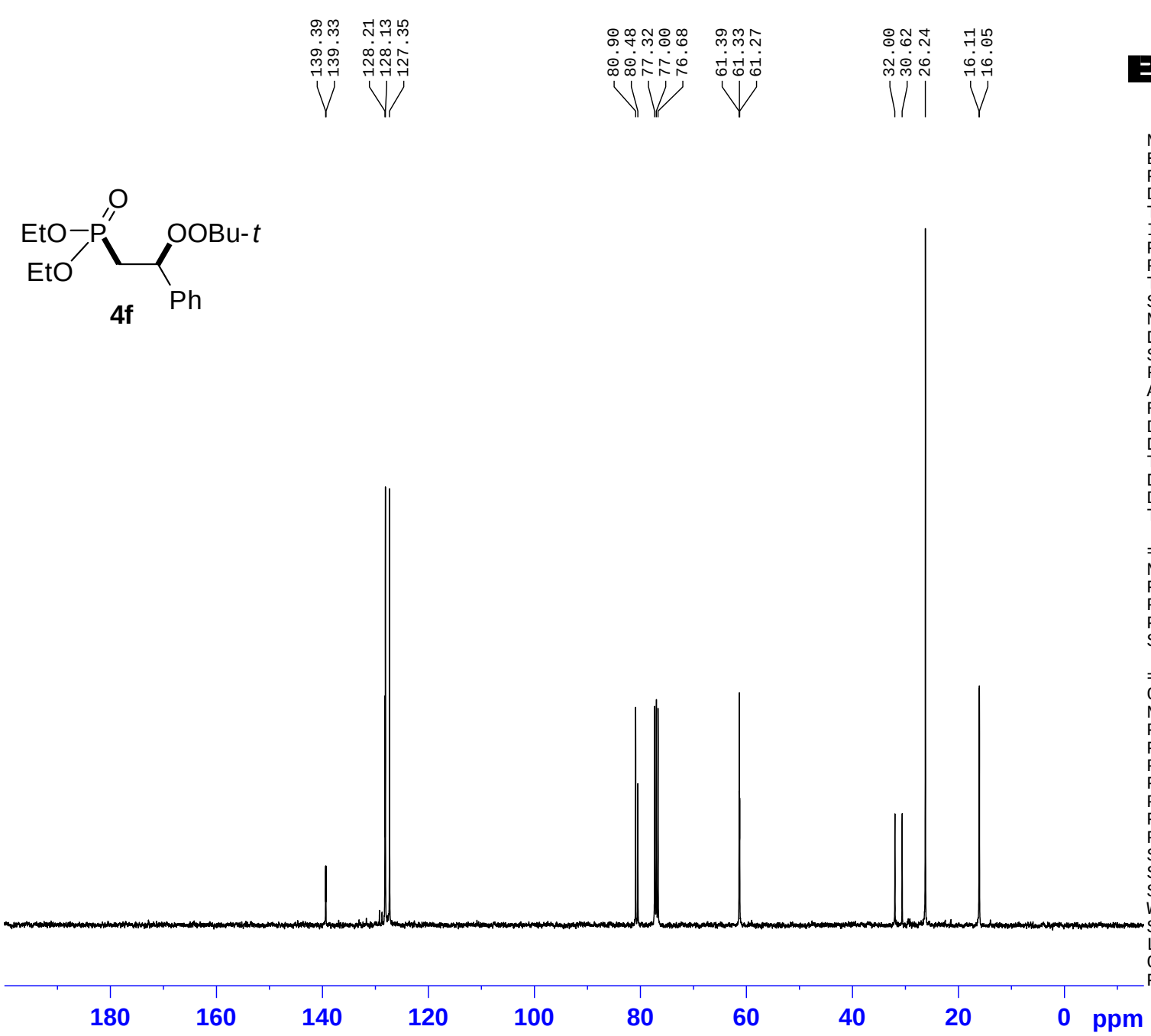
4e


```
NAME              cy-179bp
EXPNO                    3
PROCNO                   1
Date_             20170913
Time                 10.26
INSTRUM              spect
PROBHD   5 mm PABBO BB/
PULPROG             zgpg30
TD                   65536
SOLVENT              CDCl3
NS                      32
DS                       4
SWH              96153.844 Hz
FIDRES            1.467191 Hz
AQ                0.3408372 sec
RG                   190.02
DW                    5.200 usec
DE                    6.50 usec
TE                     0.0 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                      1

======== CHANNEL f1 ========
SFO1           242.9411216 MHz
NUC1                   31P
P1                   11.90 usec
SI                   32768
SF             242.9532693 MHz
WDW                     EM
SSB                      0
LB                    1.00 Hz
GB                       0
PC                    1.40
```



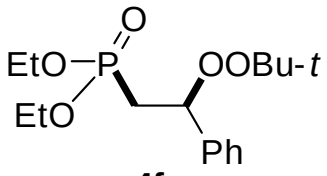
BRUKER

```
NAME        cy-114a1-20170422
EXPNO                      1
PROCNO                     1
Date_               20170422
Time                   19.58
INSTRUM                spect
PROBHD   5 mm PADUL 13C
PULPROG                 zg30
TD                     32768
SOLVENT                CDCl3
NS                         8
DS                         0
SWH                 6393.862 Hz
FIDRES              0.195125 Hz
AQ                2.5625076 sec
RG                        64
DW                   78.200 usec
DE                    6.50 usec
TE                    293.6 K
D1                1.00000000 sec
TD0                        1

======== CHANNEL f1 ========
NUC1                      1H
P1                     13.10 usec
PL1                     1.80 dB
PL1W             8.92857742 W
SFO1            400.1326008 MHz
SI                     32768
SF              400.1299981 MHz
WDW                       EM
SSB                        0
LB                     0.30 Hz
GB                         0
PC                     1.00
```



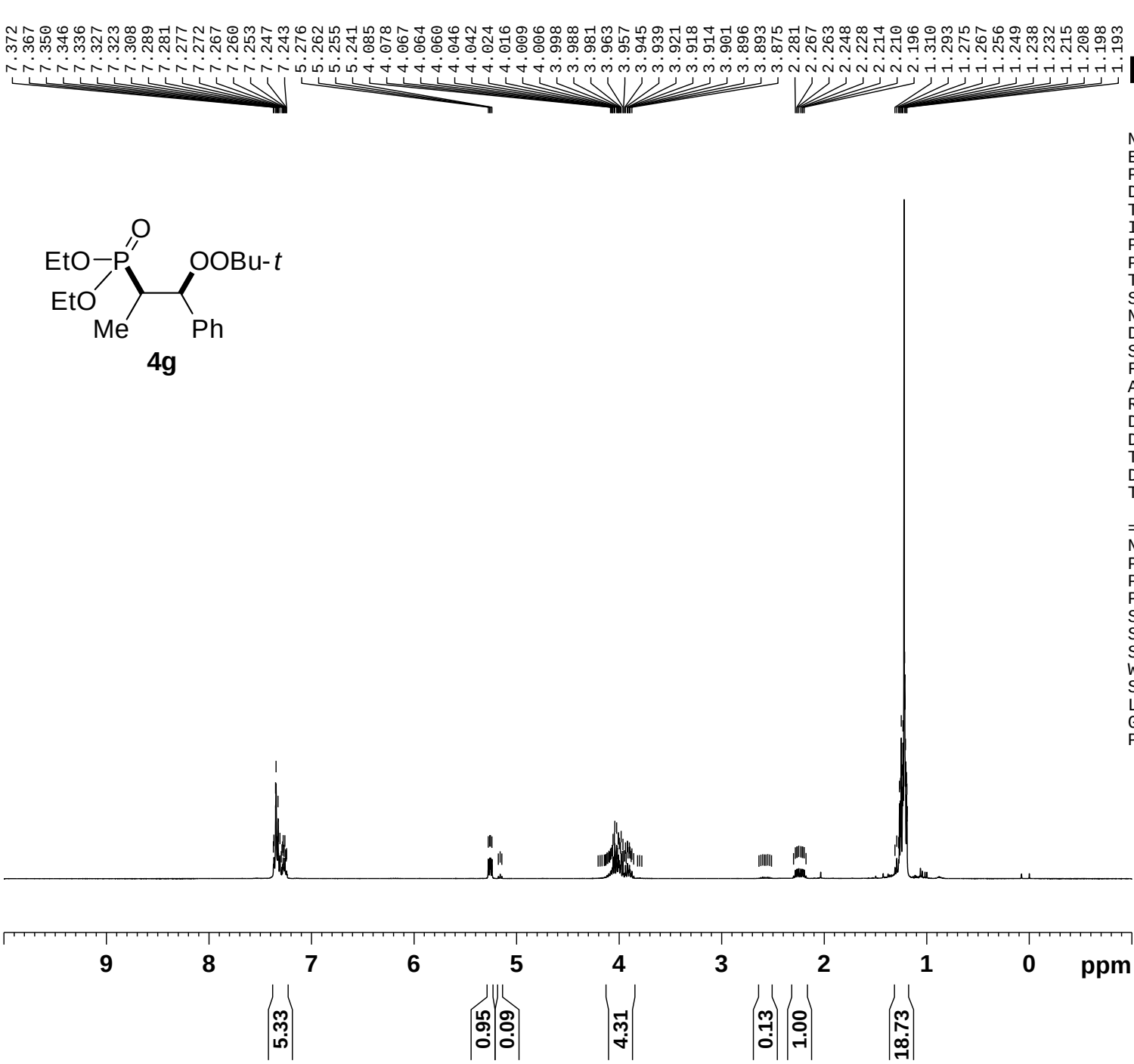
BRUKER

NAME	cy-96a-20170426
EXPNO	2
PROCNO	1
Date_	20170426
Time	18.43
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	128
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	294.3 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127820 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40



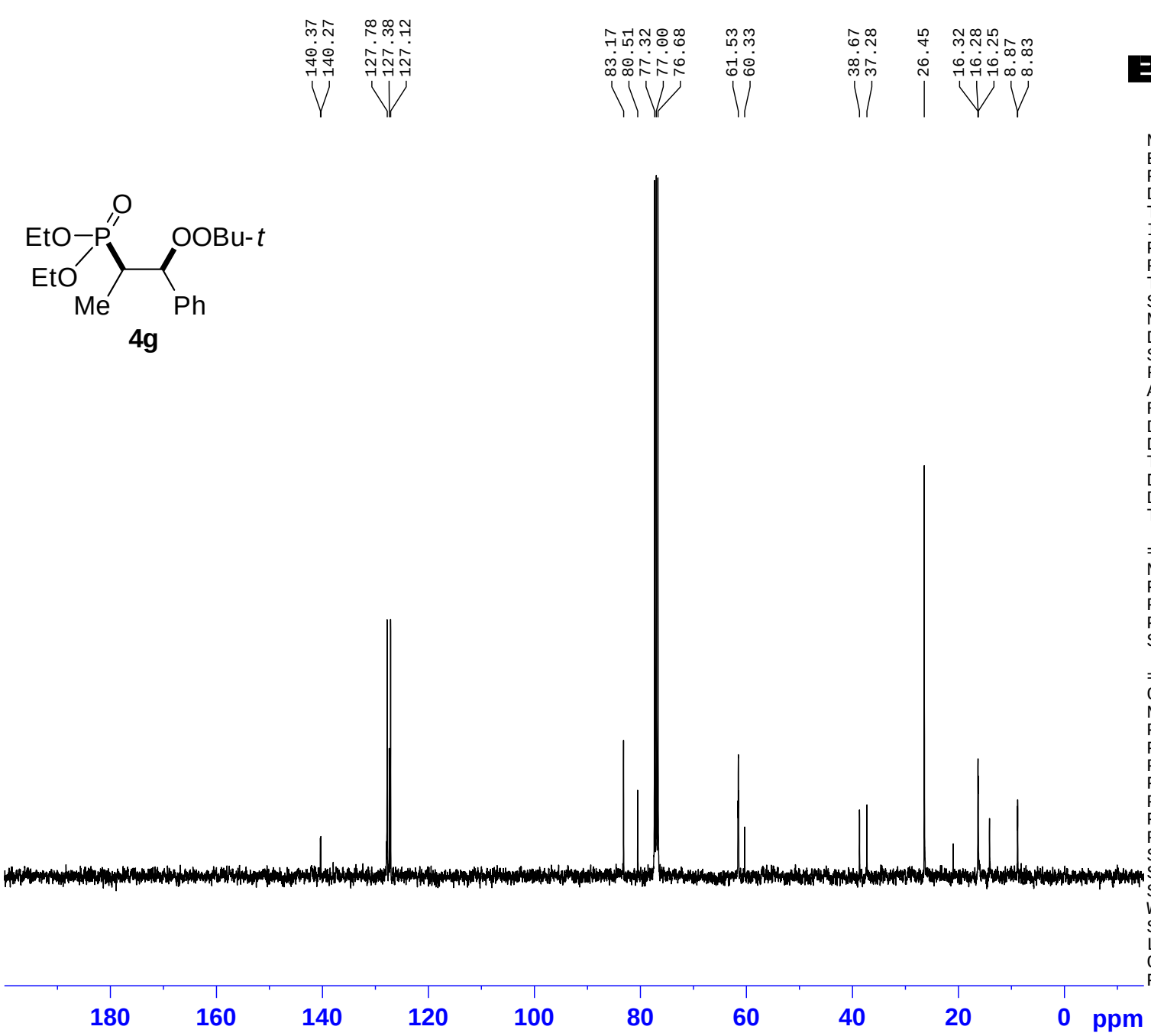
4f


```
NAME                cy-114a1
EXPNO                      3
PROCNO                     1
Date_               20170428
Time                   10.05
INSTRUM                spect
PROBHD   5 mm PABBO BB/
PULPROG                zgpg30
TD                      65536
SOLVENT                 CDCl3
NS                         32
DS                          4
SWH                 96153.844 Hz
FIDRES               1.467191 Hz
AQ                   0.3408372 sec
RG                      190.02
DW                       5.200 usec
DE                       6.50 usec
TE                      294.4 K
D1                  2.00000000 sec
D11                 0.03000000 sec
TD0                         1

======== CHANNEL f1 ========
SFO1               242.9411216 MHz
NUC1                       31P
P1                       11.90 usec
SI                      32768
SF                 242.9532692 MHz
WDW                        EM
SSB                         0
LB                       3.00 Hz
GB                          0
PC                       1.40
```



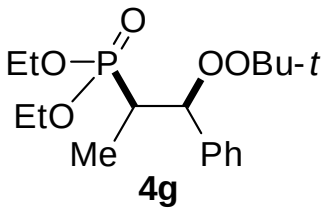
BRUKER

NAME	cy-142c-2-20170609
EXPNO	1
PROCNO	1
Date_	20170609
Time	17.31
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	50.8
DW	78.200 usec
DE	6.50 usec
TE	294.9 K
D1	1.00000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1299984 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00



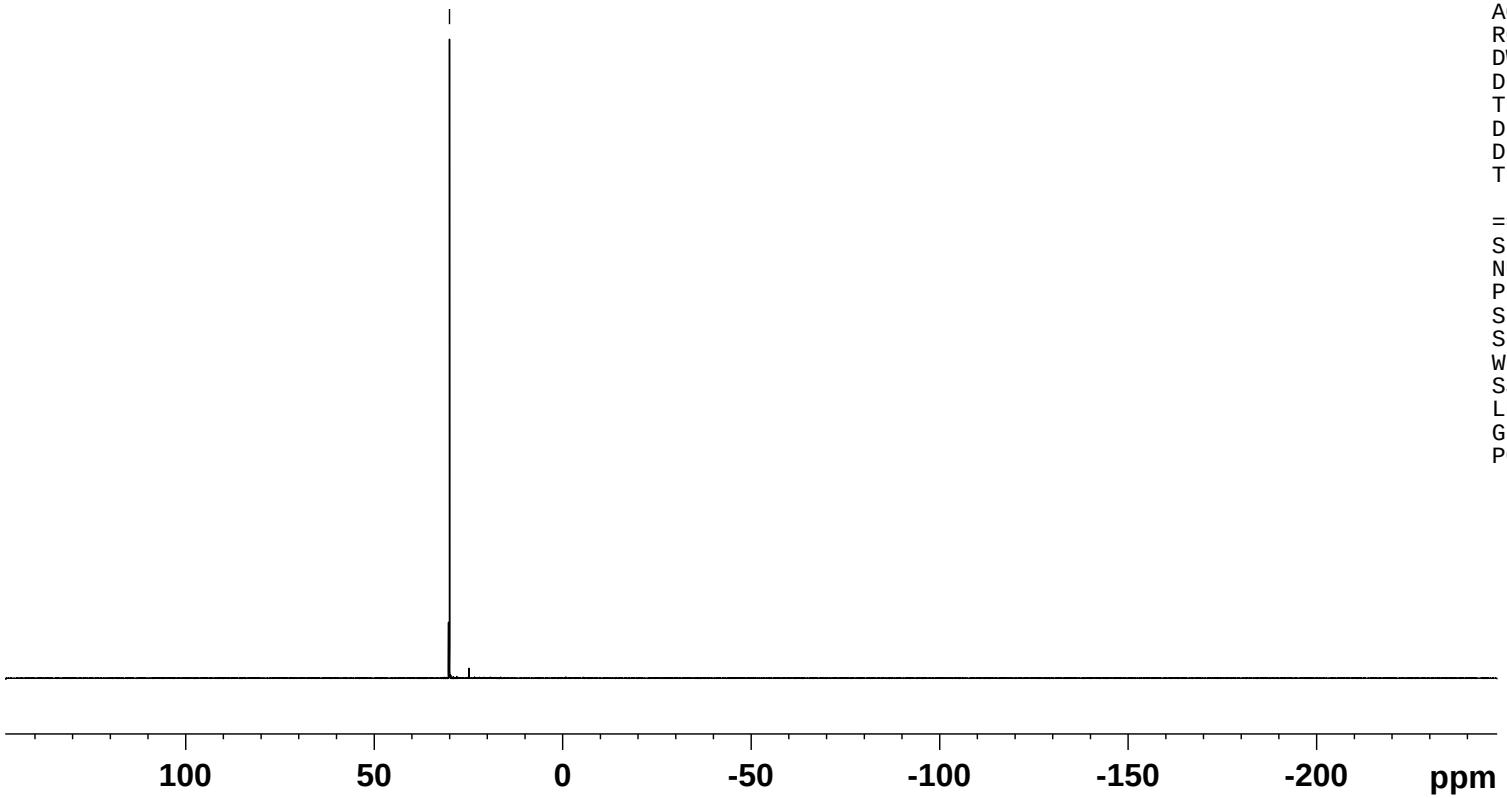
BRUKER

NAME	cy-63-2p-20161123
EXPNO	2
PROCNO	1
Date_	20161123
Time	10.14
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	88
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	297.4 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127734 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40

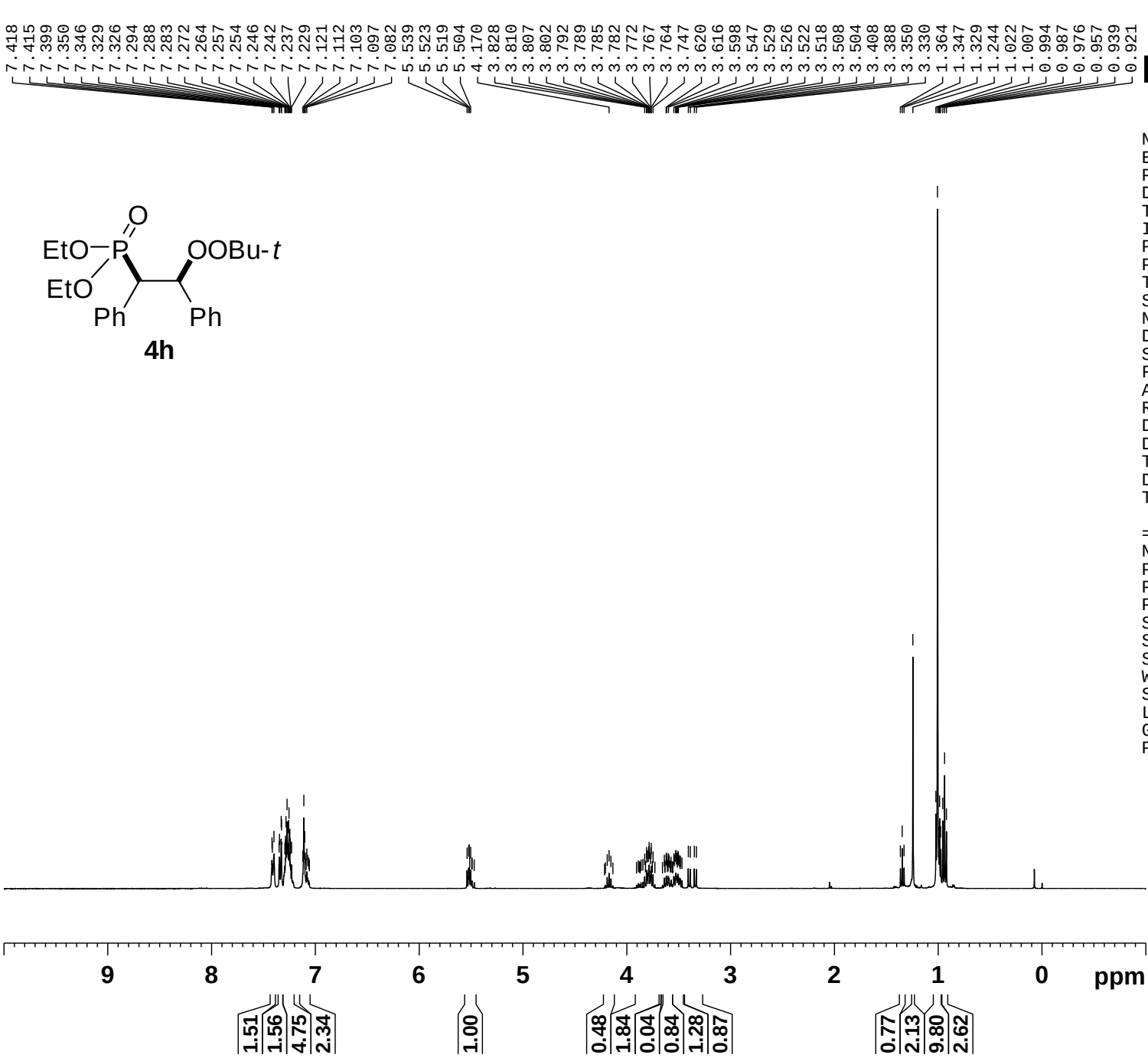


4g

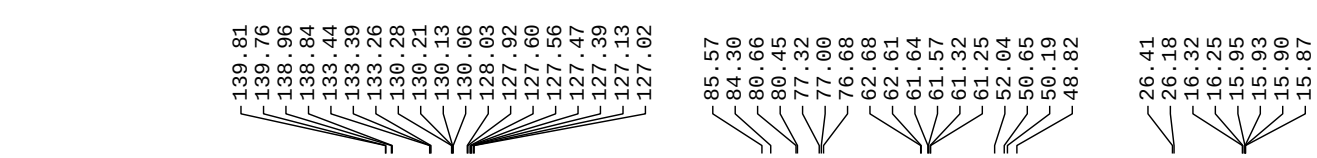
30.035

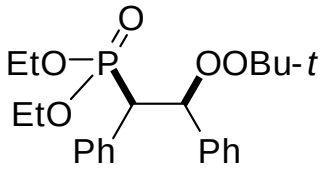



```
NAME            cy-142c-2
EXPNO                   3
PROCNO                  1
Date_            20170913
Time                10.31
INSTRUM             spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                    32
DS                     4
SWH             96153.844 Hz
FIDRES           1.467191 Hz
AQ               0.3408372 sec
RG                 190.02
DW                  5.200 usec
DE                  6.50 usec
TE                   0.0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          242.9411216 MHz
NUC1                  31P
P1                 11.90 usec
SI                 32768
SF            242.9532693 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```



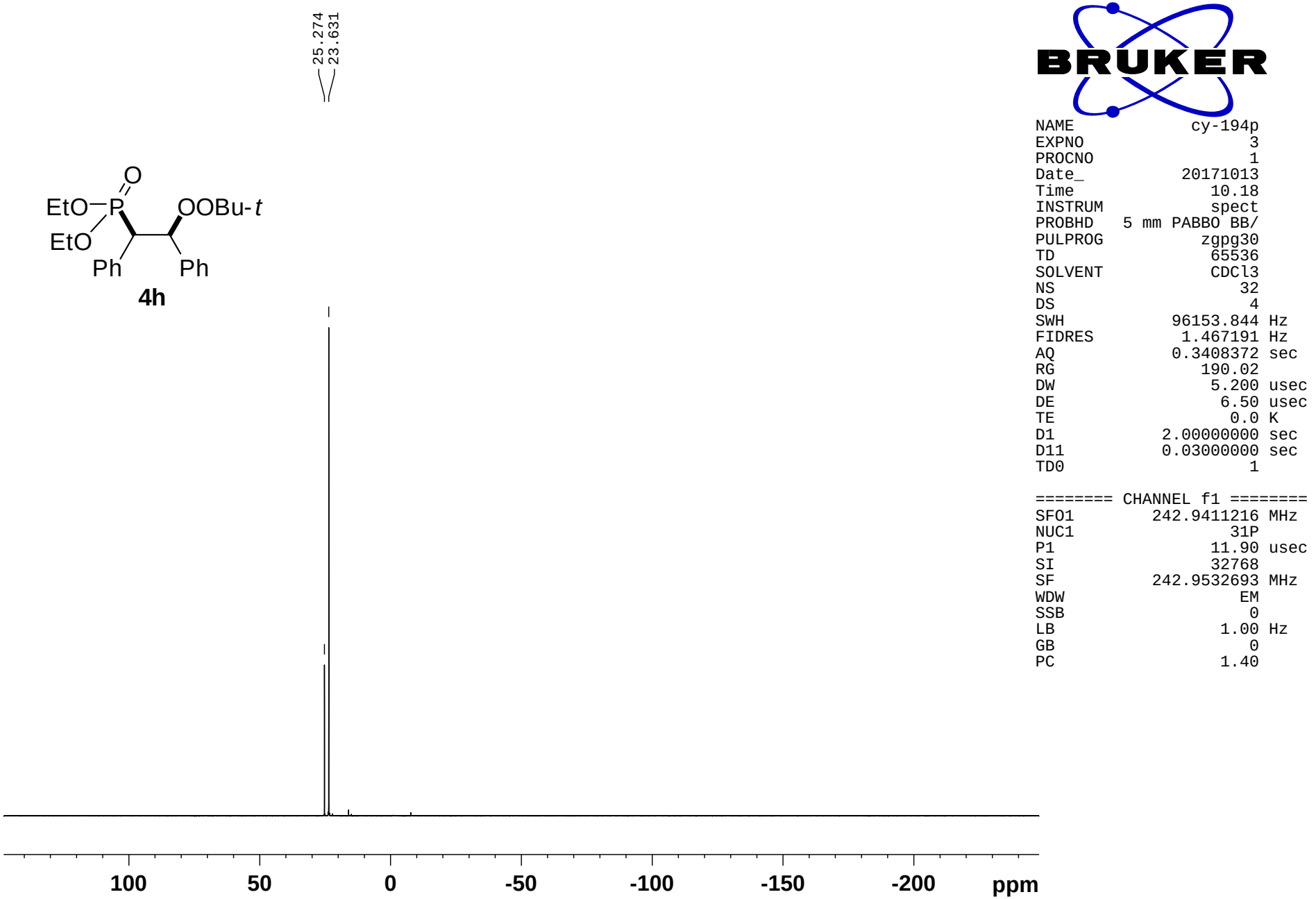

```
NAME      cy-194p-20171012
EXPNO                    1
PROCNO                   1
Date_             20171012
Time                 17.23
INSTRUM              spect
PROBHD   5 mm PADUL 13C
PULPROG               zg30
TD                   32768
SOLVENT              CDCl3
NS                       8
DS                       0
SWH               6393.862 Hz
FIDRES            0.195125 Hz
AQ               2.5625076 sec
RG                    50.8
DW                  78.200 usec
DE                   6.50 usec
TE                  293.9 K
D1             1.00000000 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                    1H
P1                   13.10 usec
PL1                   1.80 dB
PL1W           8.92857742 W
SFO1          400.1326008 MHz
SI                   32768
SF            400.1300049 MHz
WDW                     EM
SSB                      0
LB                    0.30 Hz
GB                       0
PC                    1.00
```



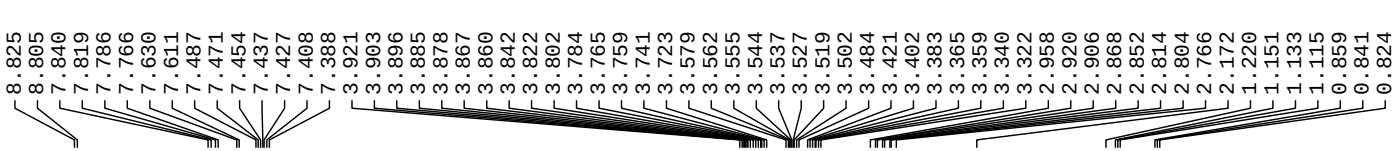


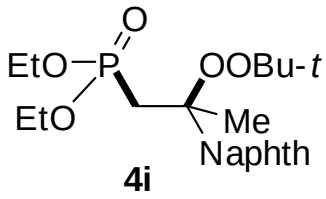
4h


```
NAME      cy-194p-20171012
EXPNO                    2
PROCNO                   1
Date_             20171012
Time                 17.28
INSTRUM              spect
PROBHD   5 mm PADUL 13C
PULPROG           zgpg30
TD                  65536
SOLVENT             CDCl3
NS                    152
DS                      4
SWH             25252.525 Hz
FIDRES          0.385323 Hz
AQ              1.2976629 sec
RG                   2050
DW                 19.800 usec
DE                  8.00 usec
TE                 294.7 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    10

======== CHANNEL f1 ========
NUC1                  13C
P1                 13.50 usec
PL1                 3.00 dB
PL1W         43.93649673 W
SFO1         100.6238364 MHz

======== CHANNEL f2 ========
CPDPRG2           waltz16
NUC2                  1H
PCPD2              80.00 usec
PL2                 1.80 dB
PL12                17.19 dB
PL13                18.46 dB
PL2W          8.92857742 W
PL12W         0.25809658 W
PL13W         0.19265592 W
SFO2         400.1316005 MHz
SI                 32768
SF           100.6127811 MHz
WDW                   EM
SSB                    0
LB                  3.00 Hz
GB                     0
PC                  1.40
```



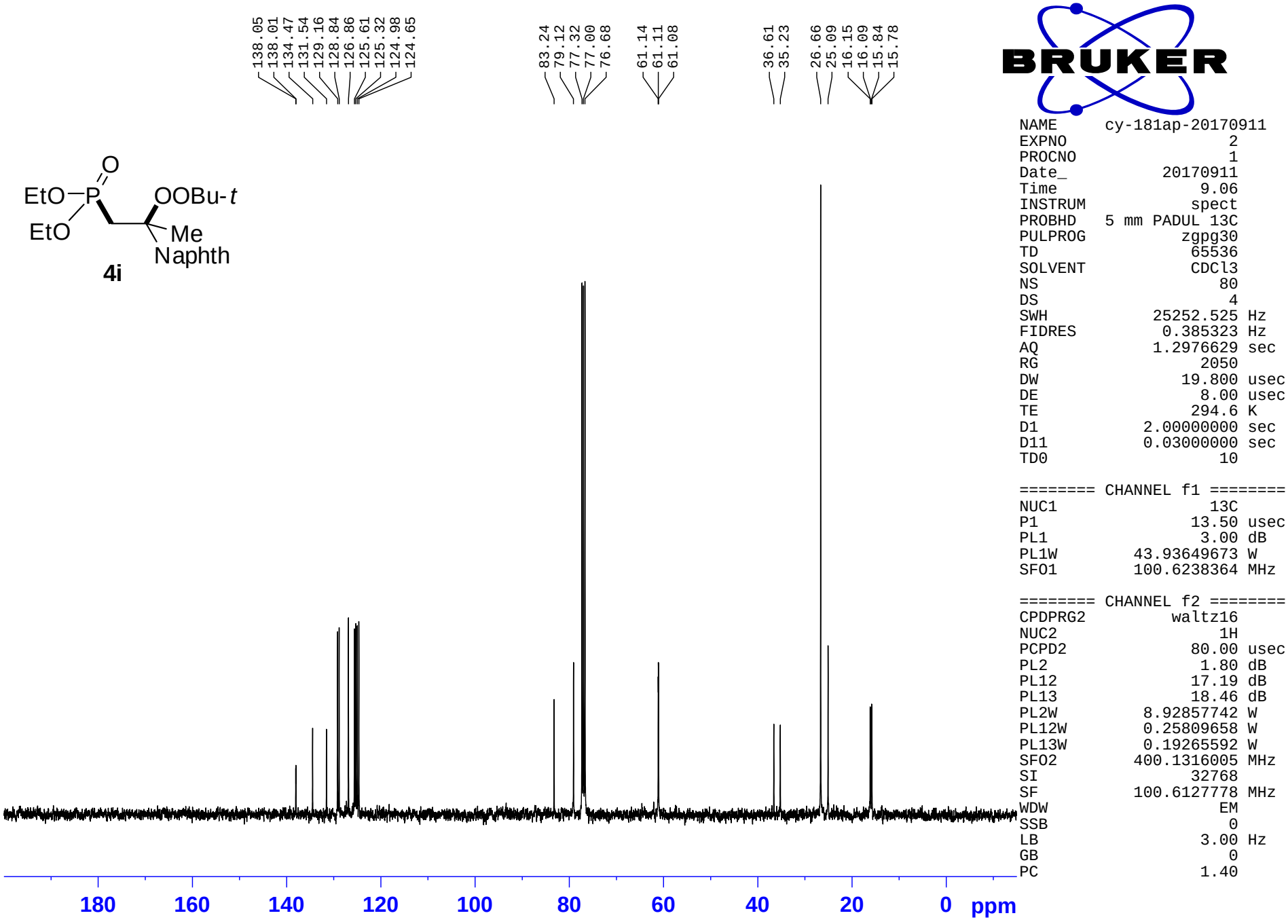
NAME	cy-194p
EXPNO	3
PROCNO	1
Date_	20171013
Time	10.18
INSTRUM	spect
PROBHD	5 mm PABBO BB/
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	32
DS	4
SWH	96153.844 Hz
FIDRES	1.467191 Hz
AQ	0.3408372 sec
RG	190.02
DW	5.200 usec
DE	6.50 usec
TE	0.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
SFO1	242.9411216 MHz
NUC1	31P
P1	11.90 usec
SI	32768
SF	242.9532693 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40



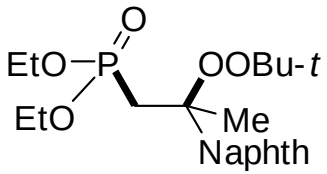


4i

```
NAME      cy-181ap-20170911
EXPNO                    1
PROCNO                   1
Date_             20170911
Time                 9.02
INSTRUM             spect
PROBHD   5 mm PADUL 13C
PULPROG               zg30
TD                   32768
SOLVENT              CDCl3
NS                       8
DS                       0
SWH               6393.862 Hz
FIDRES           0.195125 Hz
AQ              2.5625076 sec
RG                      57
DW                  78.200 usec
DE                   6.50 usec
TE                  294.0 K
D1             1.00000000 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                    1H
P1                   13.10 usec
PL1                   1.80 dB
PL1W          8.92857742 W
SFO1         400.1326008 MHz
SI                   32768
SF           400.1300095 MHz
WDW                     EM
SSB                      0
LB                   0.30 Hz
GB                       0
PC                   1.00
```

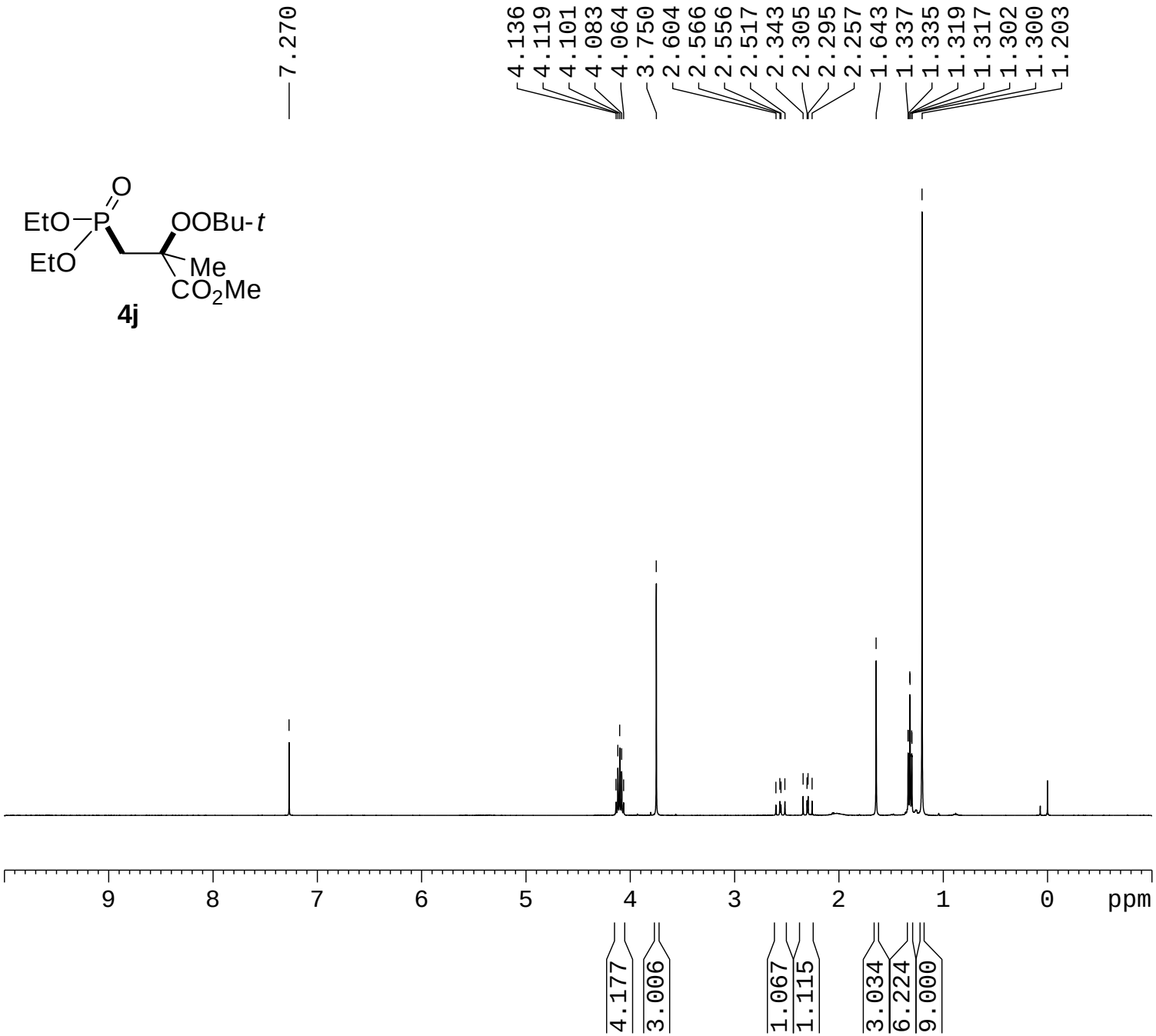



```
NAME      cy-181ap-20170911
EXPNO                    2
PROCNO                   1
Date_             20170911
Time                 9.06
INSTRUM             spect
PROBHD   5 mm PADUL 13C
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                    80
DS                     4
SWH            25252.525 Hz
FIDRES          0.385323 Hz
AQ             1.2976629 sec
RG                  2050
DW                19.800 usec
DE                 8.00 usec
TE                294.6 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   10

======== CHANNEL f1 ========
NUC1                 13C
P1                 13.50 usec
PL1                 3.00 dB
PL1W         43.93649673 W
SFO1         100.6238364 MHz

======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                 1H
PCPD2              80.00 usec
PL2                 1.80 dB
PL12               17.19 dB
PL13               18.46 dB
PL2W          8.92857742 W
PL12W         0.25809658 W
PL13W         0.19265592 W
SFO2         400.1316005 MHz
SI                 32768
SF           100.6127778 MHz
WDW                  EM
SSB                   0
LB                 3.00 Hz
GB                    0
PC                 1.40
```



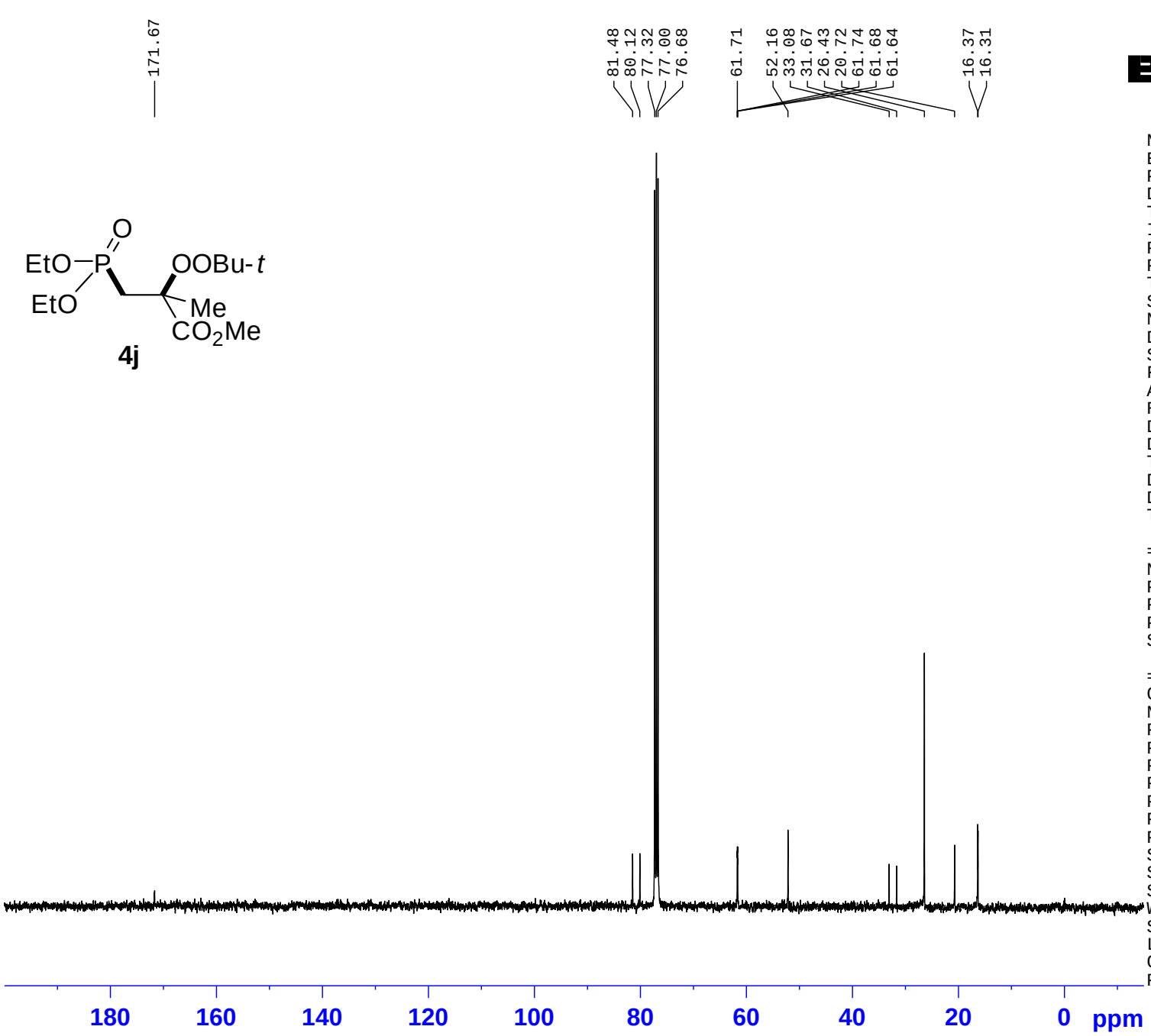
4i


```
NAME                cy-181ap
EXPNO                      3
PROCNO                     1
Date_               20170913
Time                   10.55
INSTRUM                spect
PROBHD   5 mm PABBO BB/
PULPROG                zgpg30
TD                      65536
SOLVENT                 CDCl3
NS                         32
DS                          4
SWH                 96153.844 Hz
FIDRES               1.467191 Hz
AQ                   0.3408372 sec
RG                      190.02
DW                       5.200 usec
DE                       6.50 usec
TE                        0.0 K
D1                 2.00000000 sec
D11                0.03000000 sec
TD0                        1

======== CHANNEL f1 ========
SFO1               242.9411216 MHz
NUC1                       31P
P1                      11.90 usec
SI                      32768
SF                 242.9532693 MHz
WDW                        EM
SSB                         0
LB                       1.00 Hz
GB                          0
PC                       1.40
```



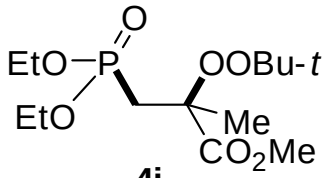
BRUKER

NAME	cy-25-20170426
EXPNO	1
PROCNO	1
Date_	20170426
Time	17.31
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	287
DW	78.200 usec
DE	6.50 usec
TE	293.3 K
D1	1.00000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1300058 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00



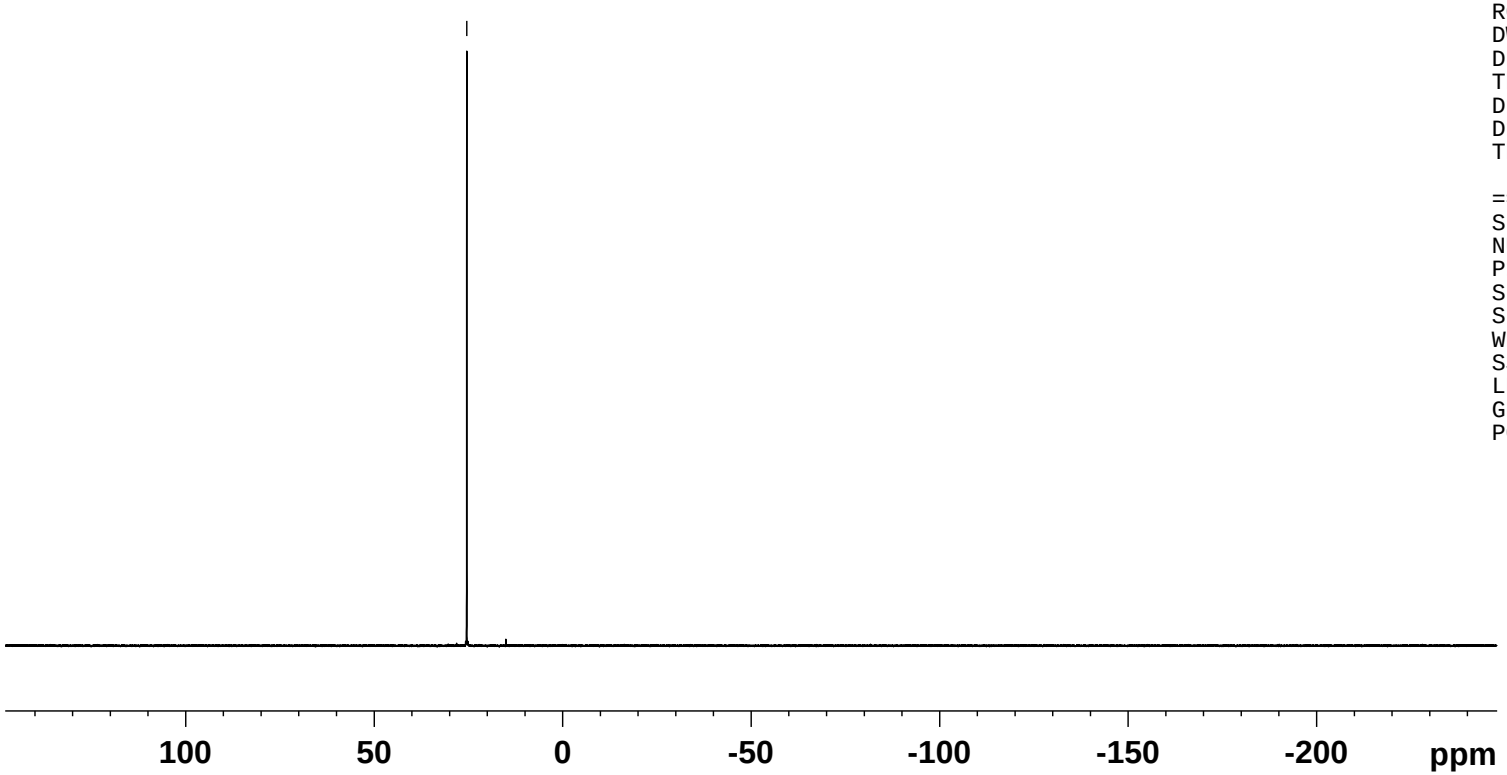
BRUKER

NAME	cy-25-20170426
EXPNO	2
PROCNO	1
Date_	20170426
Time	17.35
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	456
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	294.2 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127720 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40

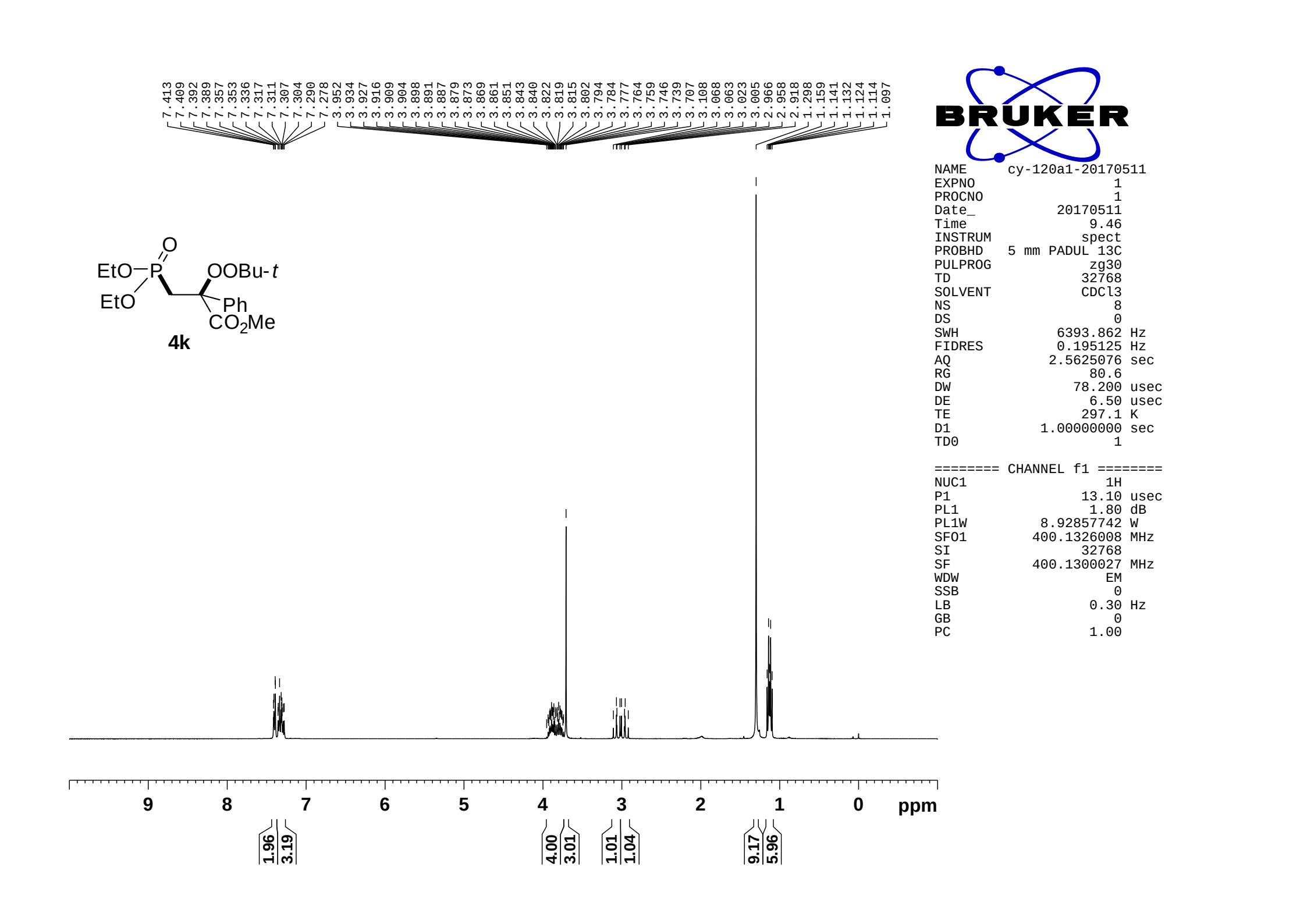


4j

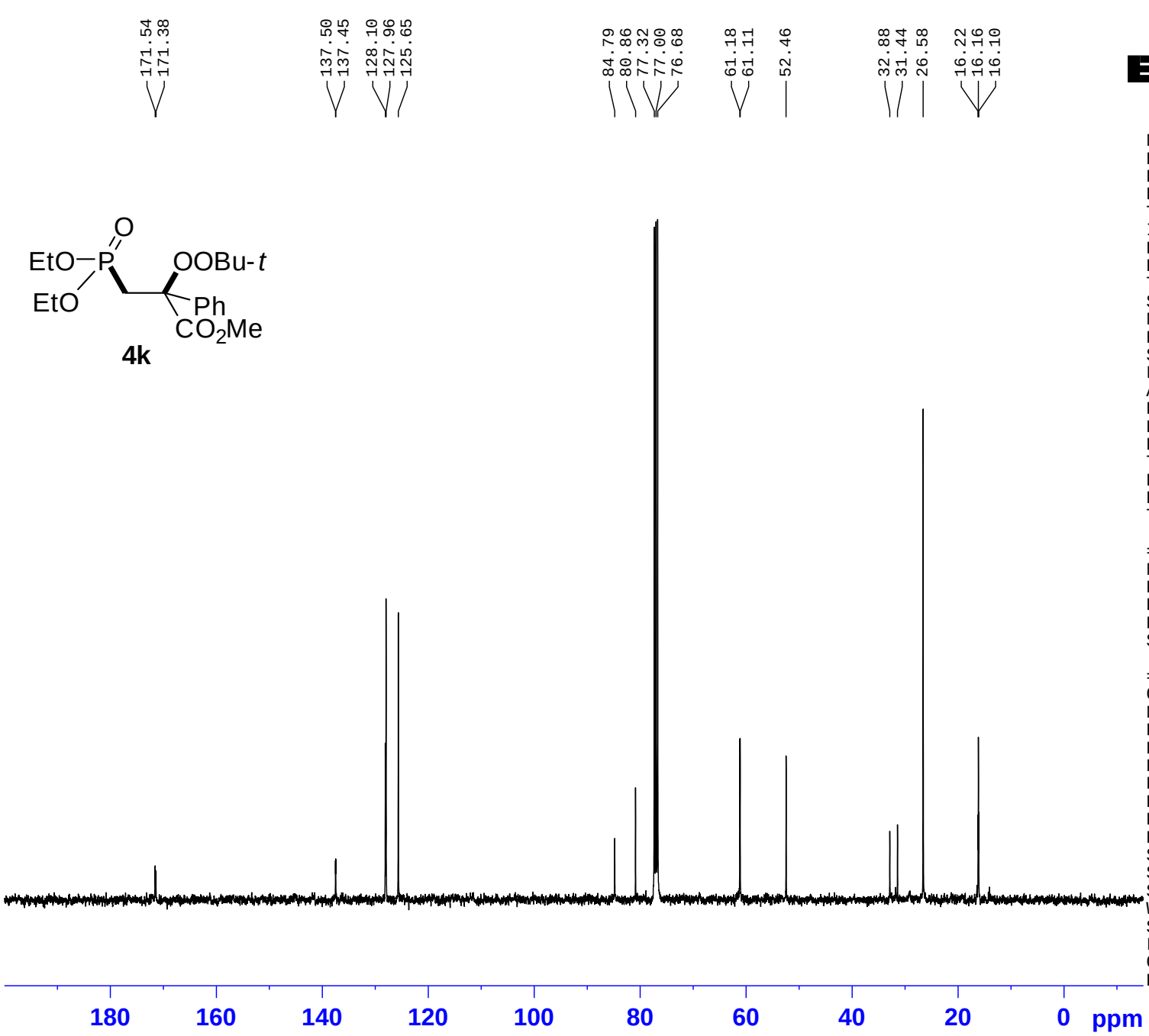
25.435




```
NAME                cy-25
EXPNO                  3
PROCNO                 1
Date_           20170426
Time                9.37
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                 65536
SOLVENT            CDCl3
NS                    40
DS                     4
SWH            96153.844 Hz
FIDRES          1.467191 Hz
AQ              0.3408372 sec
RG                 190.02
DW                  5.200 usec
DE                  6.50 usec
TE                 294.6 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         242.9411216 MHz
NUC1                31P
P1                 11.90 usec
SI                 32768
SF           242.9532693 MHz
WDW                   EM
SSB                    0
LB                  3.00 Hz
GB                     0
PC                  1.40
```

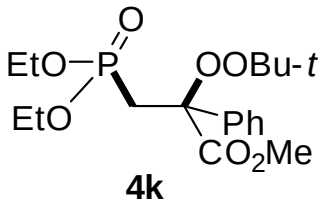



```
NAME      cy-120a1-20170511
EXPNO                    1
PROCNO                   1
Date_             20170511
Time                 9.46
INSTRUM             spect
PROBHD   5 mm PADUL 13C
PULPROG              zg30
TD                  32768
SOLVENT             CDCl3
NS                      8
DS                      0
SWH              6393.862 Hz
FIDRES           0.195125 Hz
AQ               2.5625076 sec
RG                   80.6
DW                 78.200 usec
DE                  6.50 usec
TE                 297.1 K
D1            1.00000000 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                   1H
P1                  13.10 usec
PL1                  1.80 dB
PL1W          8.92857742 W
SFO1         400.1326008 MHz
SI                  32768
SF           400.1300027 MHz
WDW                    EM
SSB                     0
LB                   0.30 Hz
GB                      0
PC                   1.00
```



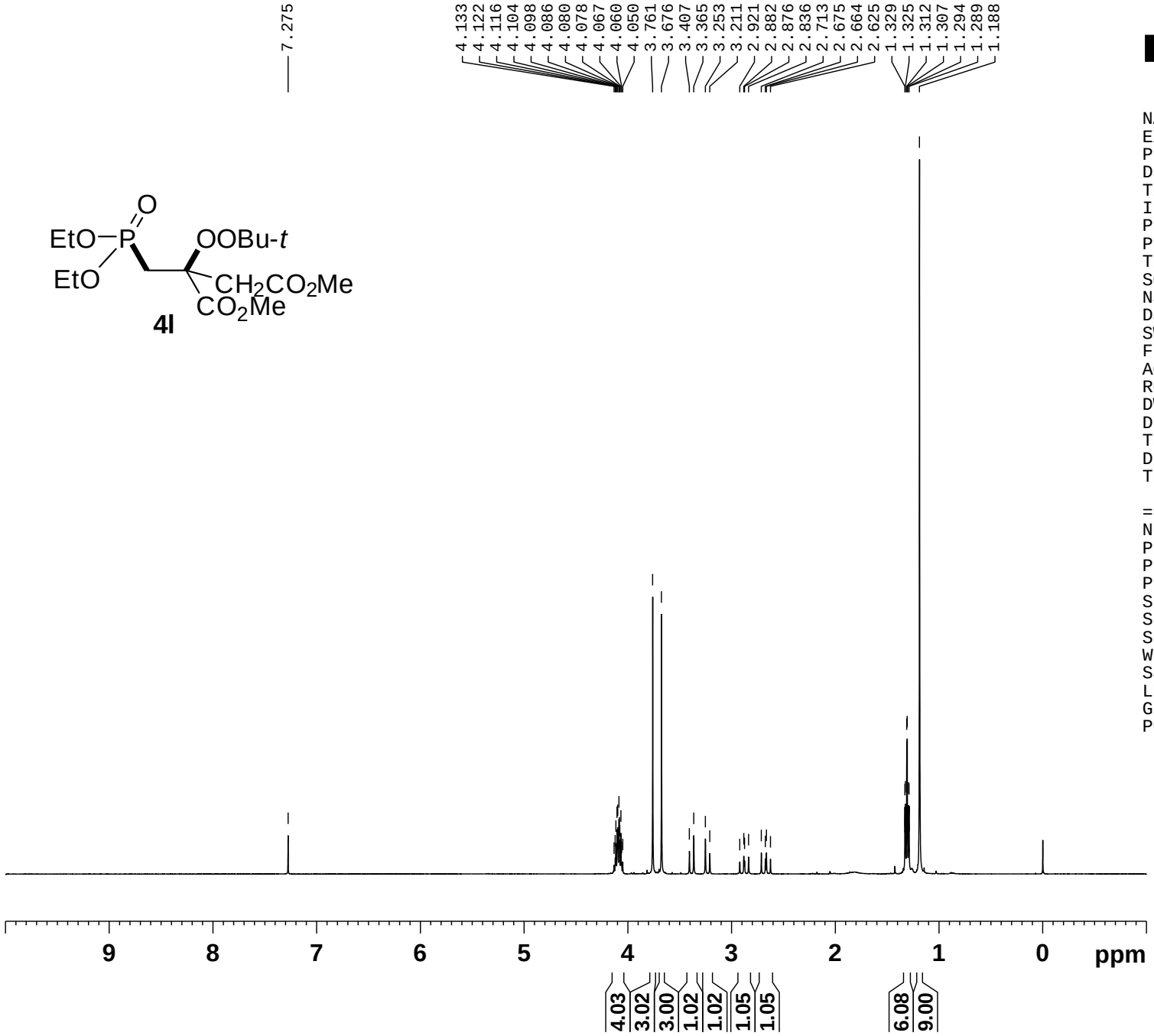
BRUKER

```
NAME      cy-182ap-20170912
EXPNO                    2
PROCNO                   1
Date_             20170912
Time                 16.41
INSTRUM              spect
PROBHD   5 mm PADUL 13C
PULPROG            zgpg30
TD                  65536
SOLVENT             CDCl3
NS                    280
DS                      4
SWH             25252.525 Hz
FIDRES          0.385323 Hz
AQ              1.2976629 sec
RG                   2050
DW                 19.800 usec
DE                  8.00 usec
TE                 295.3 K
D1              2.00000000 sec
D11             0.03000000 sec
TD0                    10

======== CHANNEL f1 ========
NUC1                  13C
P1                 13.50 usec
PL1                 3.00 dB
PL1W         43.93649673 W
SFO1         100.6238364 MHz

======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                  1H
PCPD2              80.00 usec
PL2                 1.80 dB
PL12               17.19 dB
PL13               18.46 dB
PL2W          8.92857742 W
PL12W         0.25809658 W
PL13W         0.19265592 W
SFO2         400.1316005 MHz
SI                 32768
SF           100.6127737 MHz
WDW                   EM
SSB                    0
LB                 3.00 Hz
GB                     0
PC                 1.40
```



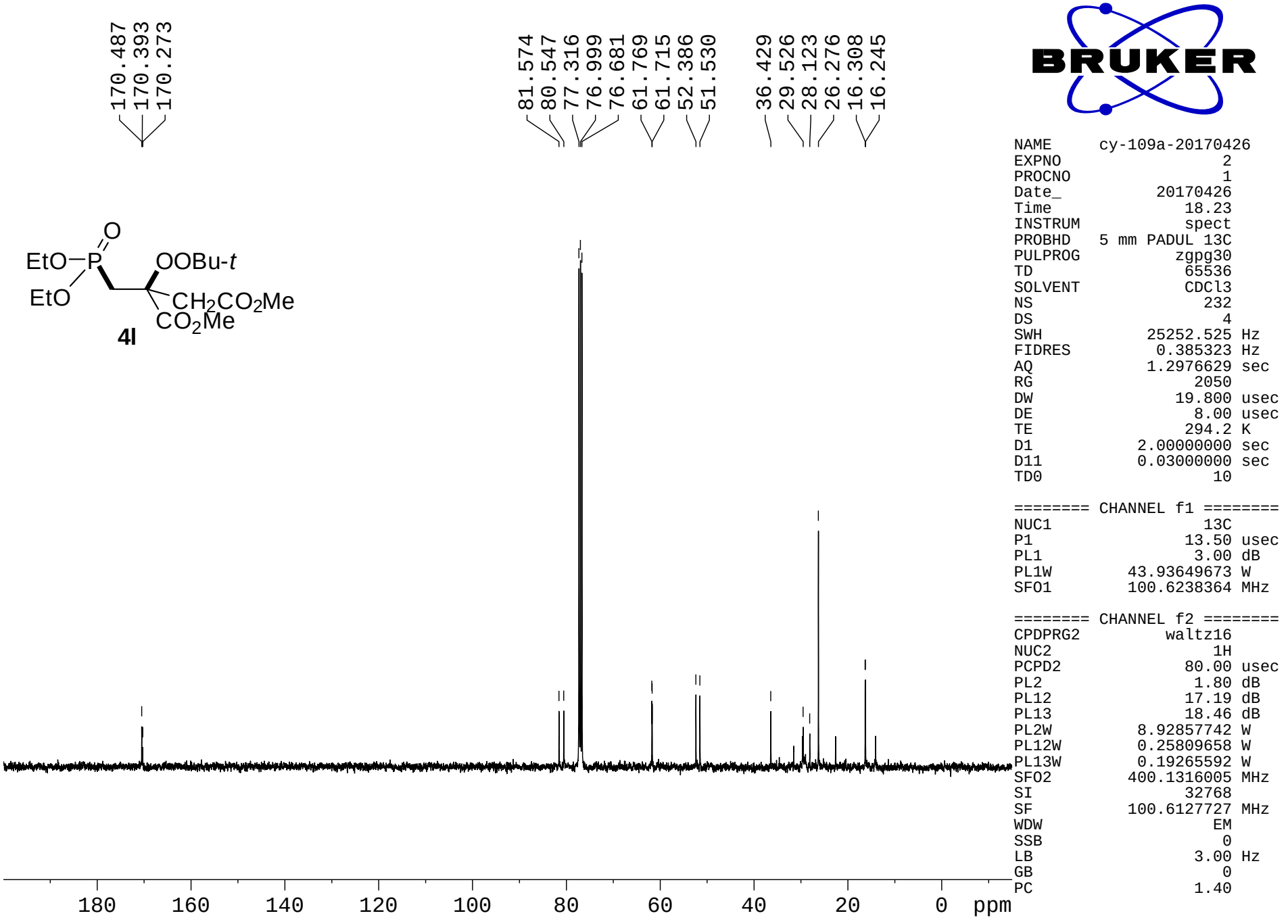
4k


```
NAME              cy-120a1
EXPNO                    3
PROCNO                   1
Date_             20170511
Time                 10.09
INSTRUM              spect
PROBHD   5 mm PABBO BB/
PULPROG             zgpg30
TD                   65536
SOLVENT              CDCl3
NS                      48
DS                       4
SWH              96153.844 Hz
FIDRES            1.467191 Hz
AQ               0.3408372 sec
RG                  190.02
DW                   5.200 usec
DE                   6.50 usec
TE                  299.3 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                      1

======== CHANNEL f1 ========
SFO1           242.9411216 MHz
NUC1                   31P
P1                   11.90 usec
SI                   32768
SF             242.9532693 MHz
WDW                     EM
SSB                      0
LB                    3.00 Hz
GB                       0
PC                    1.40
```



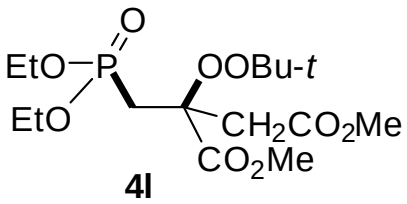
BRUKER

NAME	cy-148a-20170613
EXPNO	1
PROCNO	1
Date_	20170613
Time	8.51
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	144
DW	78.200 usec
DE	6.50 usec
TE	293.4 K
D1	1.00000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1300038 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00



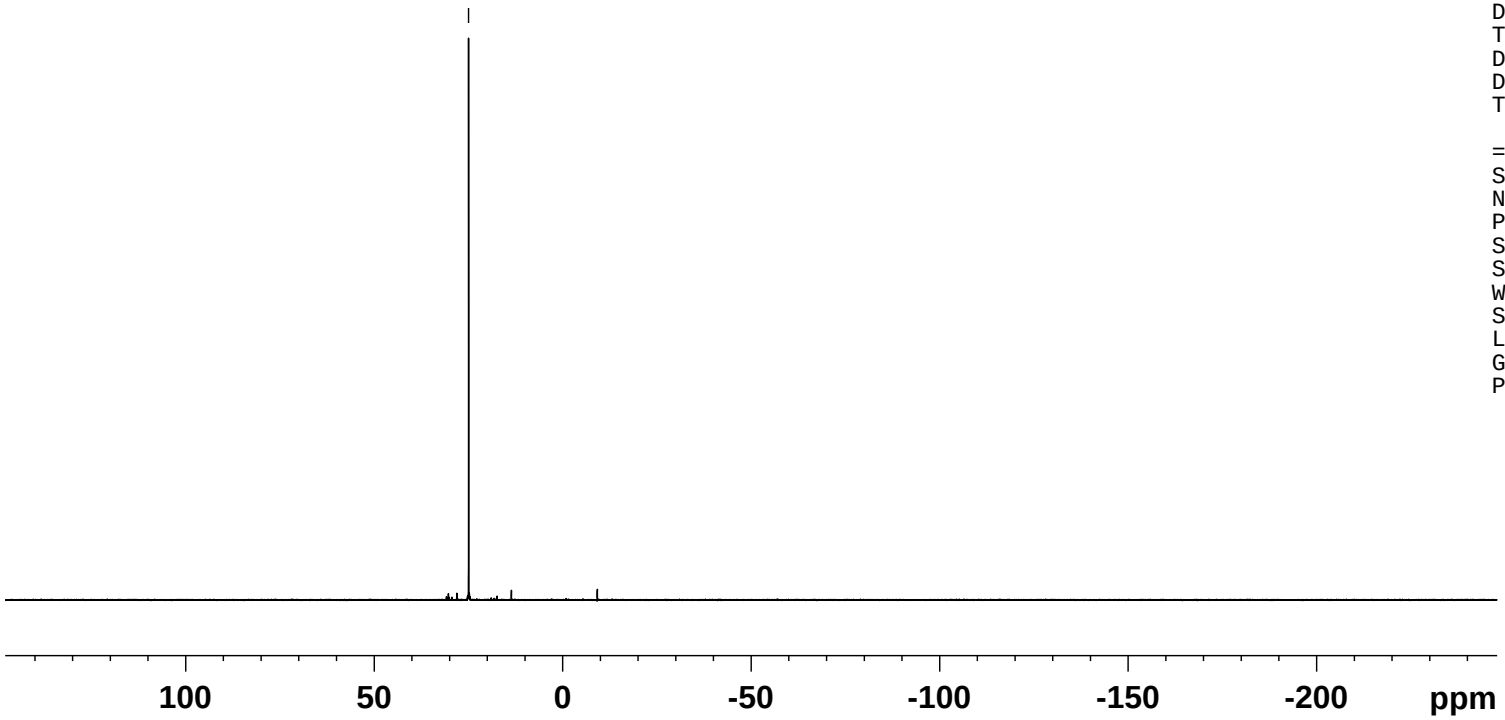
BRUKER

NAME	cy-109a-20170426
EXPNO	2
PROCNO	1
Date_	20170426
Time	18.23
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	232
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	294.2 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127727 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40

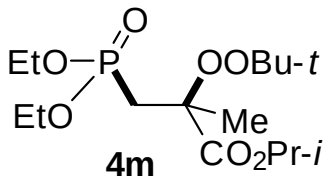


4l

24.974




```
NAME                cy-109a
EXPNO                     3
PROCNO                    1
Date_              20170426
Time                   9.47
INSTRUM               spect
PROBHD   5 mm PABBO BB/
PULPROG              zgpg30
TD                    65536
SOLVENT               CDCl3
NS                       32
DS                        4
SWH               96153.844 Hz
FIDRES             1.467191 Hz
AQ                 0.3408372 sec
RG                    190.02
DW                     5.200 usec
DE                     6.50 usec
TE                    294.7 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                       1

======== CHANNEL f1 ========
SFO1             242.9411216 MHz
NUC1                     31P
P1                     11.90 usec
SI                     32768
SF               242.9532693 MHz
WDW                       EM
SSB                        0
LB                      3.00 Hz
GB                         0
PC                      1.40
```

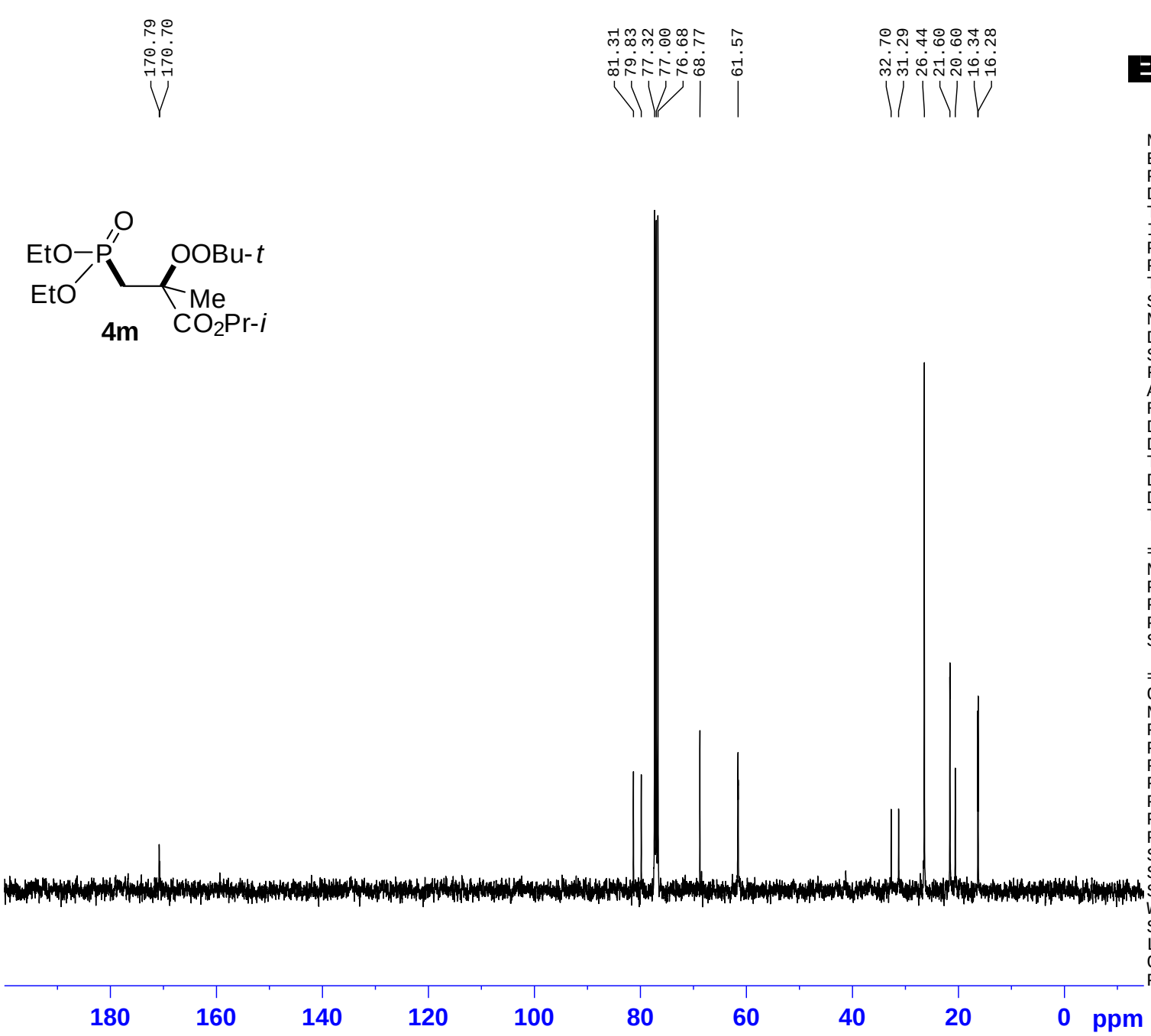


4m

7.288

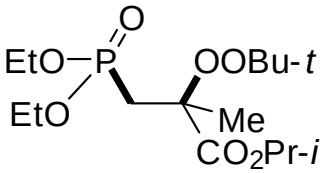
5.090 5.074 5.059 5.043 5.027 5.012 4.995 4.142 4.140 4.124 4.122 4.087 4.069 2.604 2.566 2.556 2.518 2.364 2.325 2.316 2.277 1.615 1.340 1.337 1.322 1.320 1.305 1.302 1.288 1.281 1.272 1.265 1.210


```
NAME      cy-191p-20170923
EXPNO                    1
PROCNO                   1
Date_             20170923
Time                 22.46
INSTRUM              spect
PROBHD   5 mm PADUL 13C
PULPROG               zg30
TD                   32768
SOLVENT              CDCl3
NS                       8
DS                       0
SWH               6393.862 Hz
FIDRES            0.195125 Hz
AQ               2.5625076 sec
RG                     101
DW                  78.200 usec
DE                   6.50 usec
TE                  293.8 K
D1             1.00000000 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                    1H
P1                   13.10 usec
PL1                   1.80 dB
PL1W          8.92857742 W
SFO1         400.1326008 MHz
SI                   32768
SF           400.1299986 MHz
WDW                     EM
SSB                      0
LB                    0.30 Hz
GB                       0
PC                    1.00
```



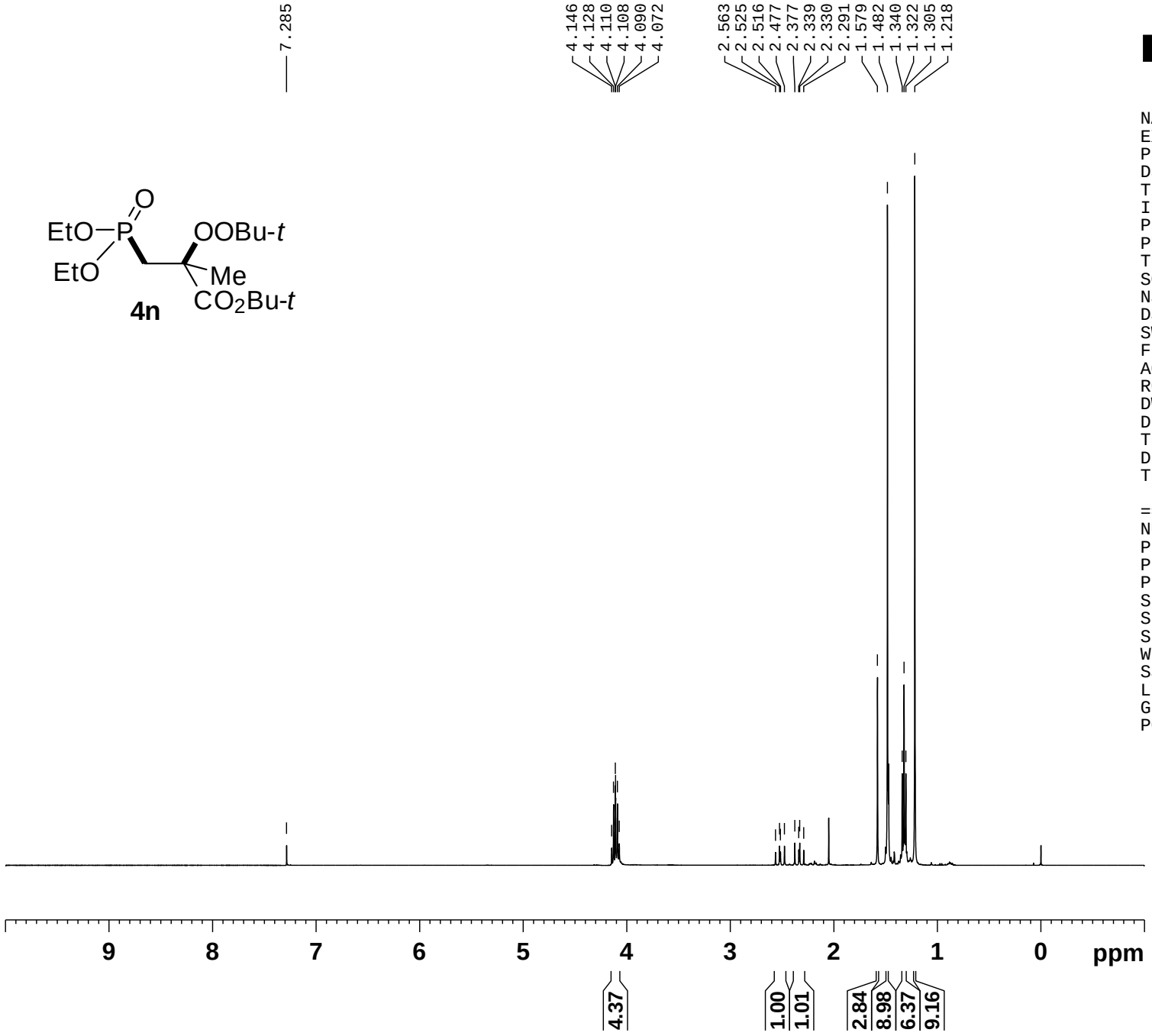
BRUKER

NAME	cy-191p-20170923
EXPNO	2
PROCNO	1
Date_	20170923
Time	22.49
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	40
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	294.5 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127736 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40

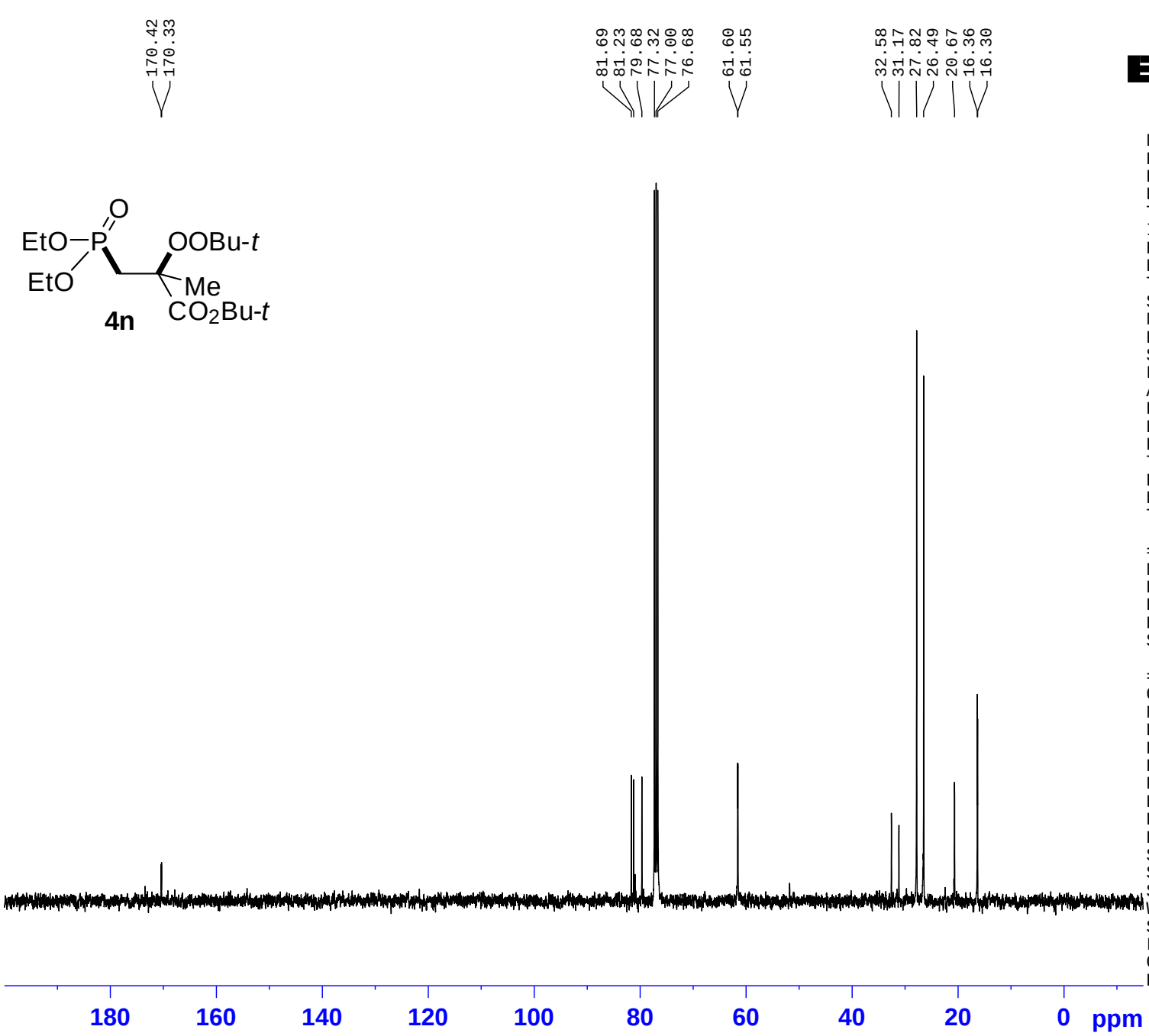


4m

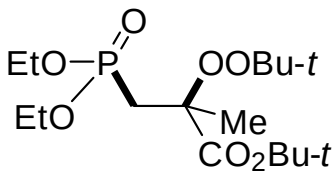

```
NAME            cy-191p-p
EXPNO                   3
PROCNO                  1
Date_            20171017
Time                9.59
INSTRUM             spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                    32
DS                     4
SWH             96153.844 Hz
FIDRES           1.467191 Hz
AQ               0.3408372 sec
RG                  190.02
DW                   5.200 usec
DE                   6.50 usec
TE                  296.0 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                     1

======== CHANNEL f1 ========
SFO1          242.9411216 MHz
NUC1                  31P
P1                  11.90 usec
SI                  32768
SF            242.9532693 MHz
WDW                    EM
SSB                     0
LB                   1.00 Hz
GB                      0
PC                   1.40
```



NAME	cy-186ap-20170916
EXPNO	1
PROCNO	1
Date_	20170916
Time	20.37
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	128
DW	78.200 usec
DE	6.50 usec
TE	294.3 K
D1	1.00000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1299997 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00

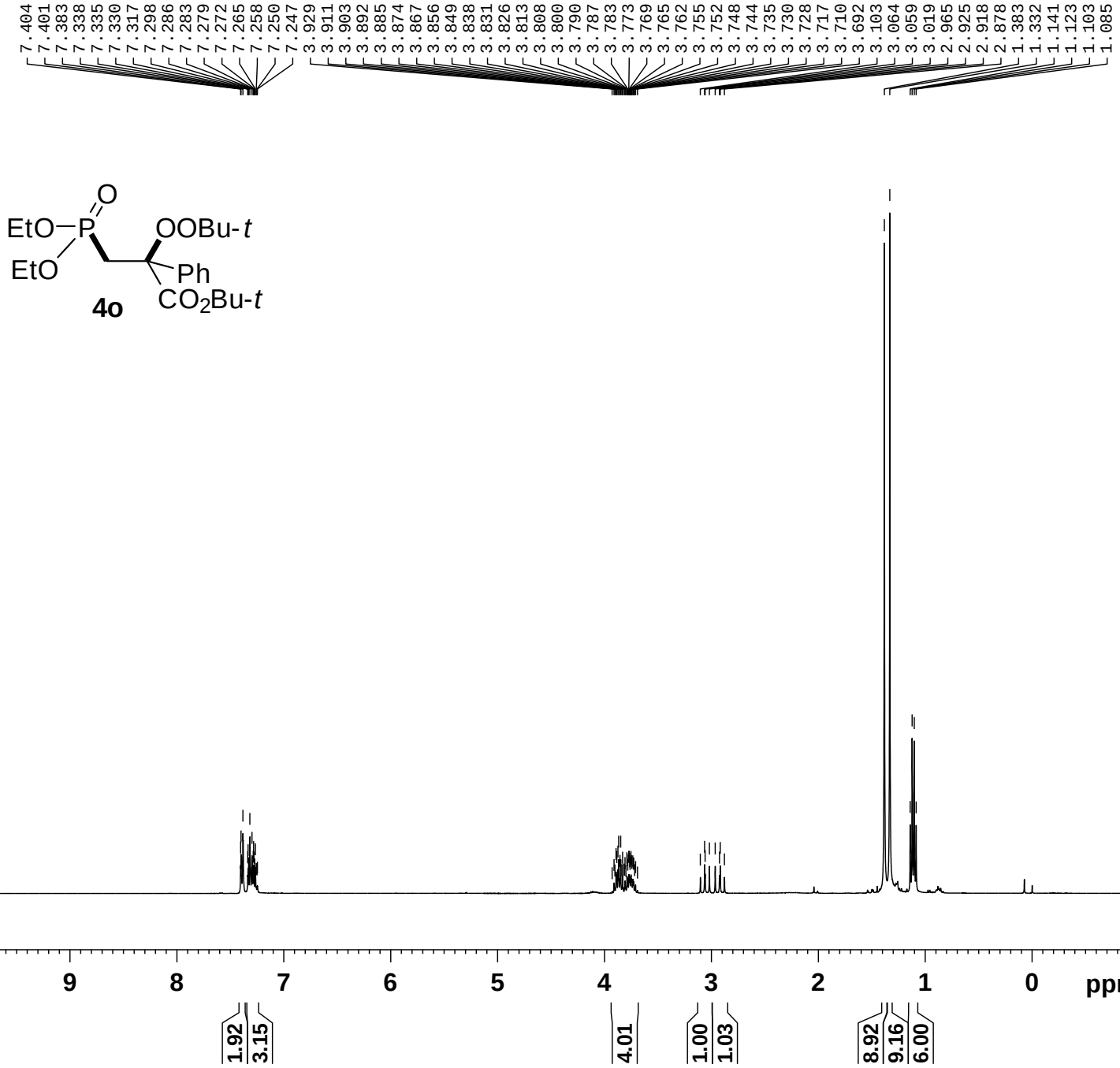



```
NAME      cy-186ap-20170916
EXPNO                    2
PROCNO                   1
Date_             20170916
Time                 20.40
INSTRUM              spect
PROBHD   5 mm PADUL 13C
PULPROG           zgpg30
TD                65536
SOLVENT           CDCl3
NS                  120
DS                    4
SWH           25252.525 Hz
FIDRES         0.385323 Hz
AQ            1.2976629 sec
RG                 2050
DW               19.800 usec
DE                8.00 usec
TE                295.0 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                  10

======== CHANNEL f1 ========
NUC1                13C
P1                13.50 usec
PL1                3.00 dB
PL1W        43.93649673 W
SFO1        100.6238364 MHz

======== CHANNEL f2 ========
CPDPRG2          waltz16
NUC2                1H
PCPD2            80.00 usec
PL2               1.80 dB
PL12              17.19 dB
PL13              18.46 dB
PL2W         8.92857742 W
PL12W        0.25809658 W
PL13W        0.19265592 W
SFO2        400.1316005 MHz
SI                32768
SF          100.6127732 MHz
WDW                  EM
SSB                   0
LB                 3.00 Hz
GB                    0
PC                 1.40
```

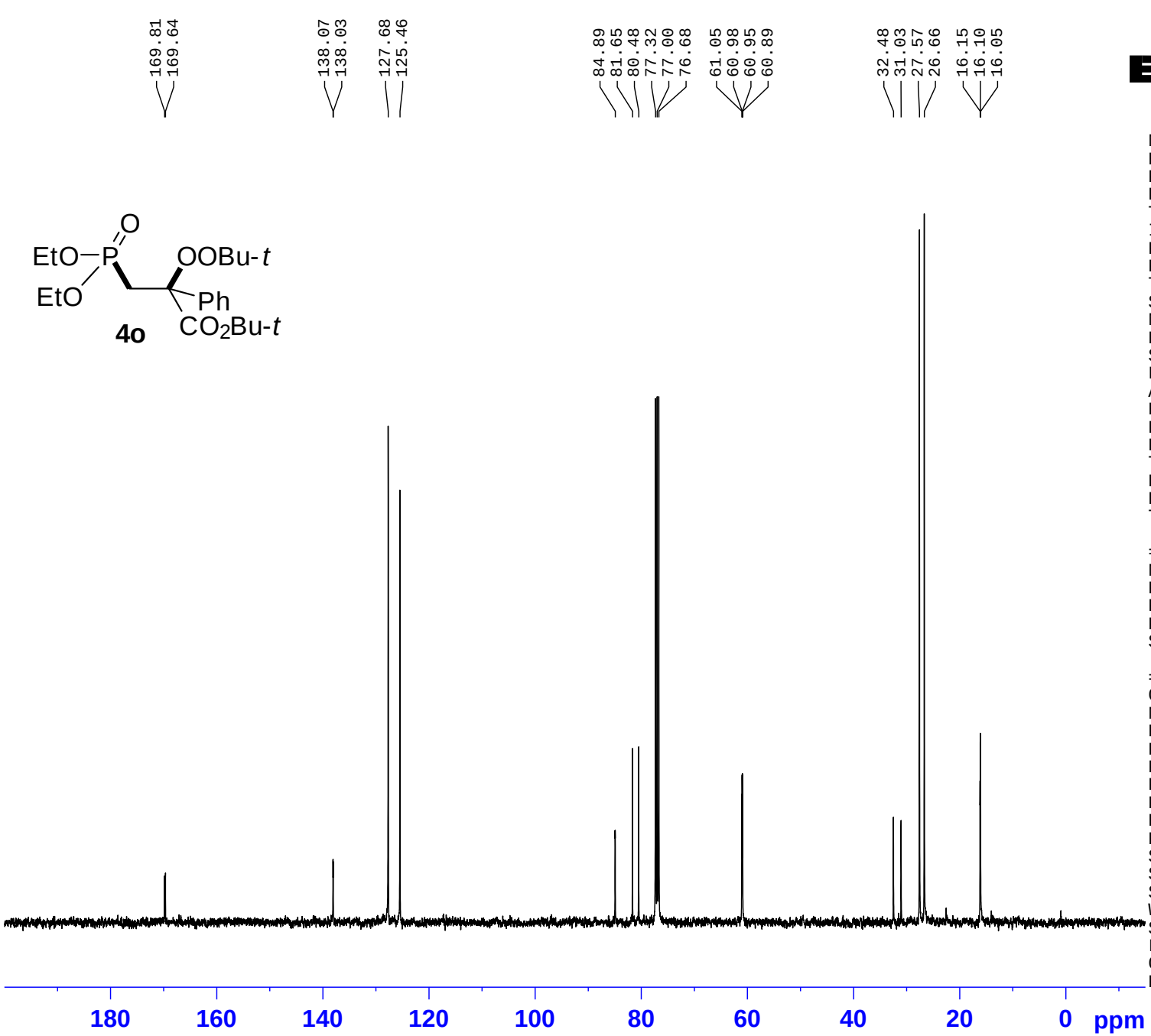


4n


```
NAME              cy-186ap
EXPNO                    3
PROCNO                   1
Date_             20170920
Time                 10.00
INSTRUM              spect
PROBHD   5 mm PABBO BB/
PULPROG             zgpg30
TD                   65536
SOLVENT              CDCl3
NS                      32
DS                       4
SWH              96153.844 Hz
FIDRES            1.467191 Hz
AQ                0.3408372 sec
RG                   190.02
DW                    5.200 usec
DE                    6.50 usec
TE                     0.0 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                      1

======== CHANNEL f1 ========
SFO1           242.9411216 MHz
NUC1                   31P
P1                   11.90 usec
SI                   32768
SF             242.9532693 MHz
WDW                     EM
SSB                      0
LB                    1.00 Hz
GB                       0
PC                    1.40
```

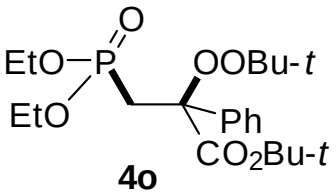



```
NAME      cy-208p-20171019
EXPNO                    1
PROCNO                   1
Date_             20171019
Time                 21.26
INSTRUM              spect
PROBHD   5 mm PADUL 13C
PULPROG               zg30
TD                   32768
SOLVENT              CDCl3
NS                       8
DS                       0
SWH               6393.862 Hz
FIDRES            0.195125 Hz
AQ               2.5625076 sec
RG                      57
DW                  78.200 usec
DE                   6.50 usec
TE                  294.6 K
D1             1.00000000 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                    1H
P1                   13.10 usec
PL1                   1.80 dB
PL1W          8.92857742 W
SFO1         400.1326008 MHz
SI                   32768
SF           400.1299958 MHz
WDW                     EM
SSB                      0
LB                    0.30 Hz
GB                       0
PC                    1.00
```



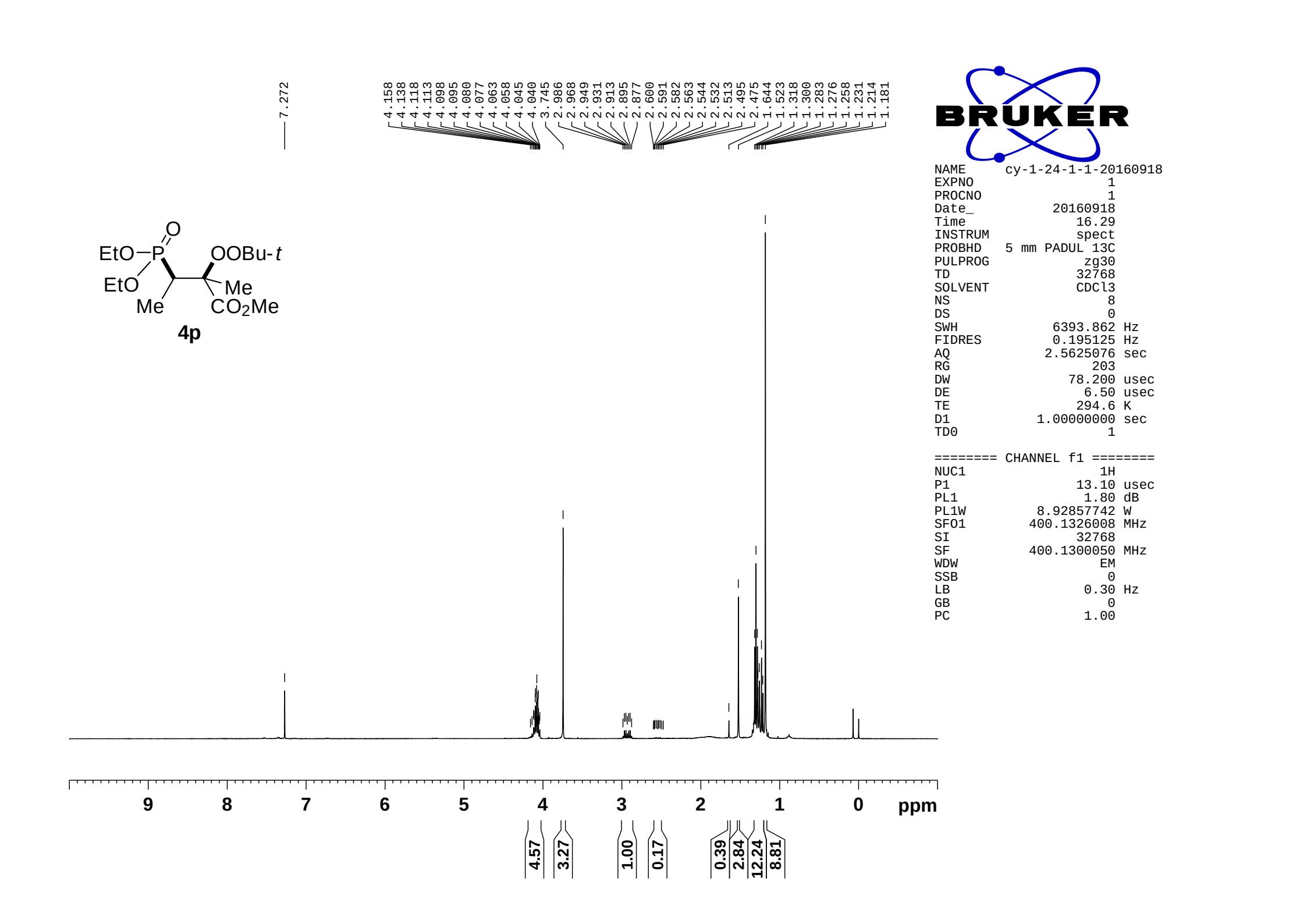
BRUKER

NAME	cy-208p-20171019
EXPNO	2
PROCNO	1
Date_	20171019
Time	21.29
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	96
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	295.2 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127772 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40



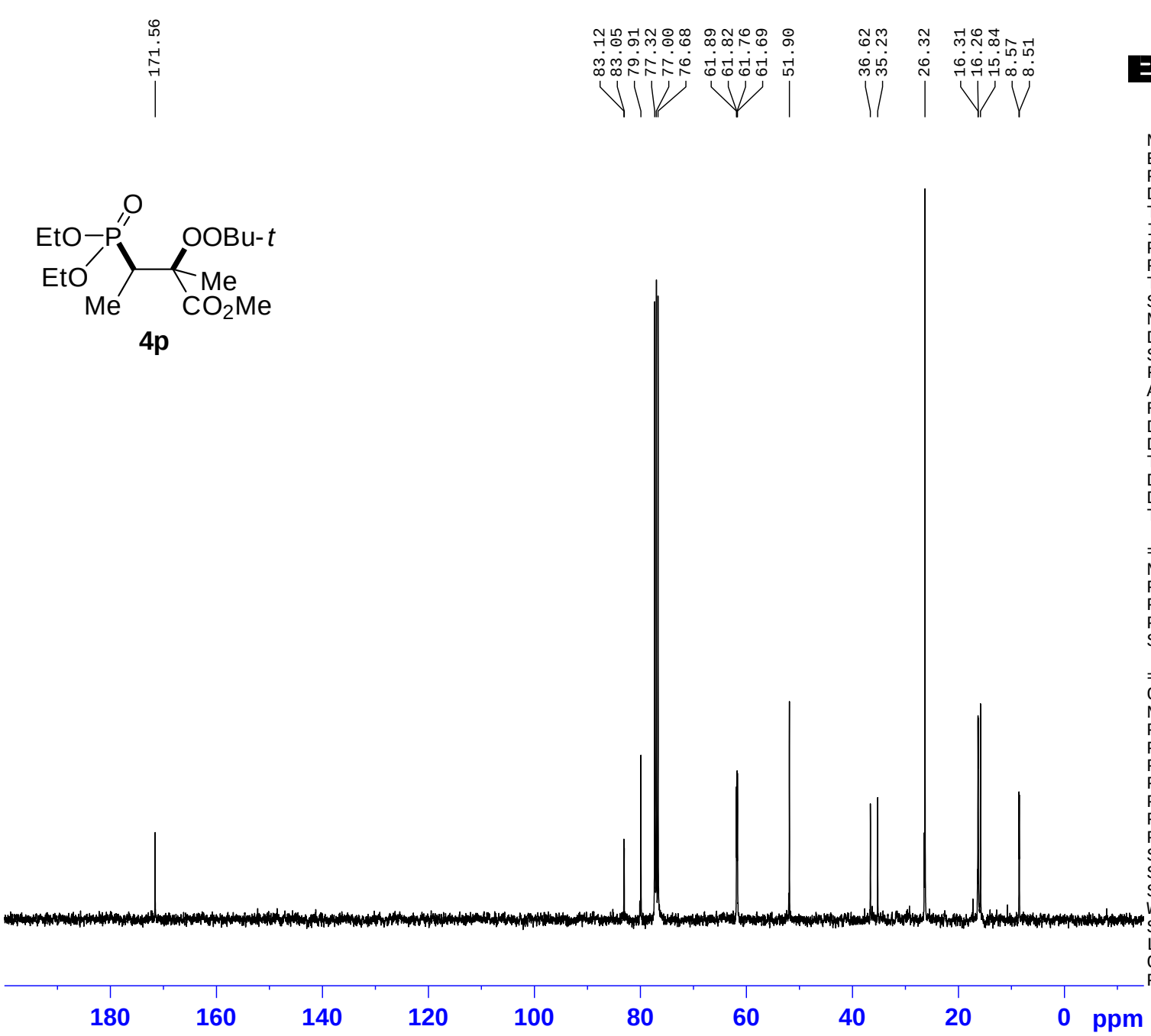
4o


```
NAME                cy-208p
EXPNO                     4
PROCNO                    1
Date_              20171024
Time                  14.44
INSTRUM               spect
PROBHD   5 mm PABBO BB/
PULPROG              zgpg30
TD                    65536
SOLVENT               CDCl3
NS                       32
DS                        4
SWH               96153.844 Hz
FIDRES             1.467191 Hz
AQ                 0.3408372 sec
RG                    190.02
DW                     5.200 usec
DE                     6.50 usec
TE                    296.5 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                       1

======== CHANNEL f1 ========
SFO1             242.9411216 MHz
NUC1                     31P
P1                     11.90 usec
SI                     32768
SF               242.9532693 MHz
WDW                      EM
SSB                       0
LB                     1.00 Hz
GB                        0
PC                     1.40
```



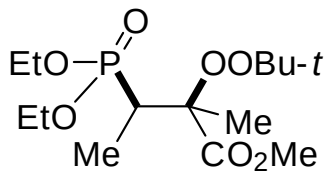
BRUKER

NAME	cy-1-24-1-1-20160918
EXPNO	1
PROCNO	1
Date_	20160918
Time	16.29
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	203
DW	78.200 usec
DE	6.50 usec
TE	294.6 K
D1	1.00000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1300050 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00



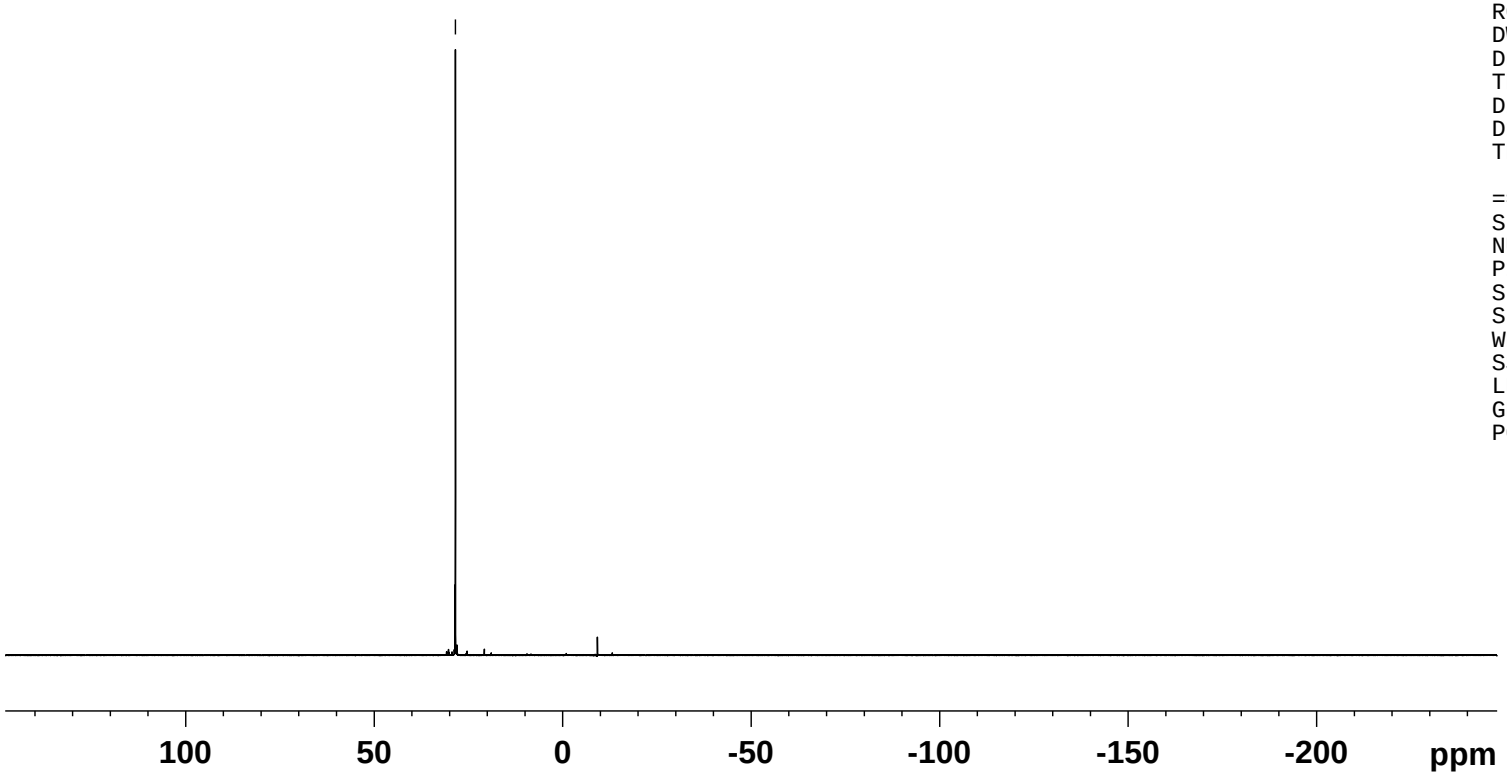
BRUKER

NAME	cy-108b1-20170428
EXPNO	2
PROCNO	1
Date_	20170428
Time	17.02
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	192
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	294.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127742 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40

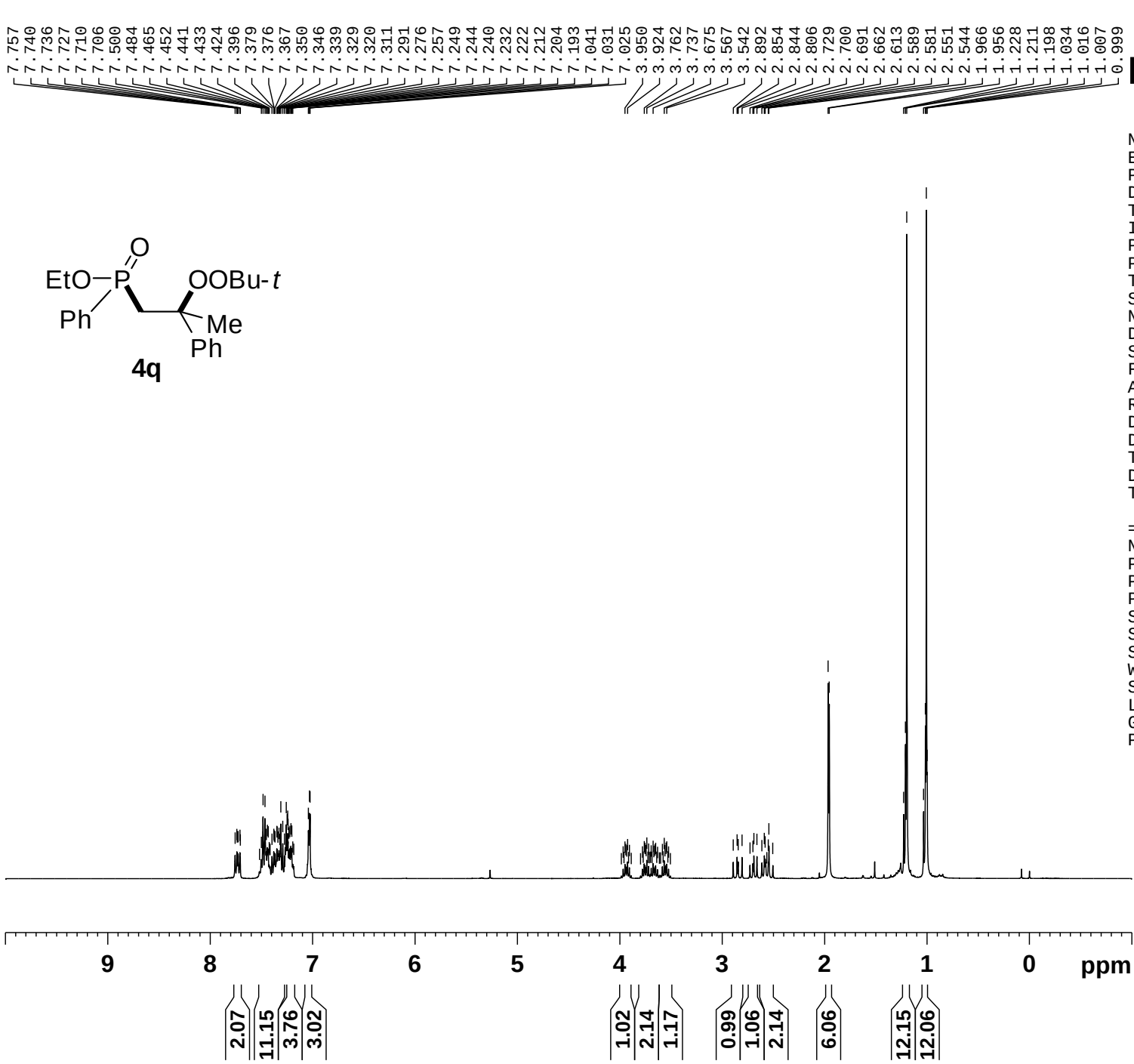


4p

28.469

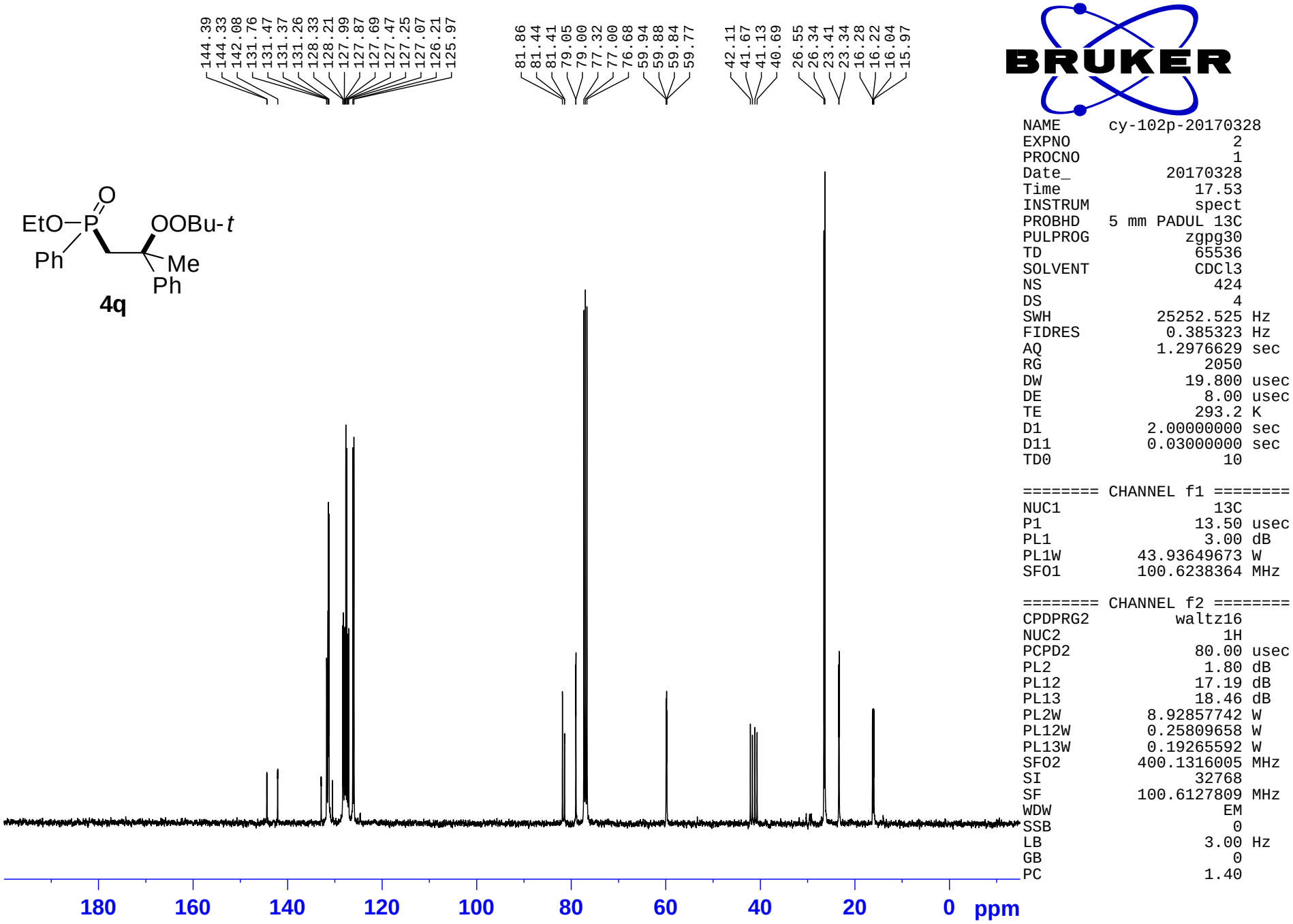



```
NAME              cy-108b1
EXPNO                    3
PROCNO                   1
Date_             20170428
Time                 10.00
INSTRUM              spect
PROBHD   5 mm PABBO BB/
PULPROG             zgpg30
TD                   65536
SOLVENT              CDCl3
NS                      32
DS                       4
SWH              96153.844 Hz
FIDRES            1.467191 Hz
AQ               0.3408372 sec
RG                  190.02
DW                   5.200 usec
DE                   6.50 usec
TE                  294.4 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                      1

======== CHANNEL f1 ========
SFO1          242.9411216 MHz
NUC1                   31P
P1                   11.90 usec
SI                   32768
SF            242.9532692 MHz
WDW                     EM
SSB                      0
LB                    3.00 Hz
GB                       0
PC                    1.40
```

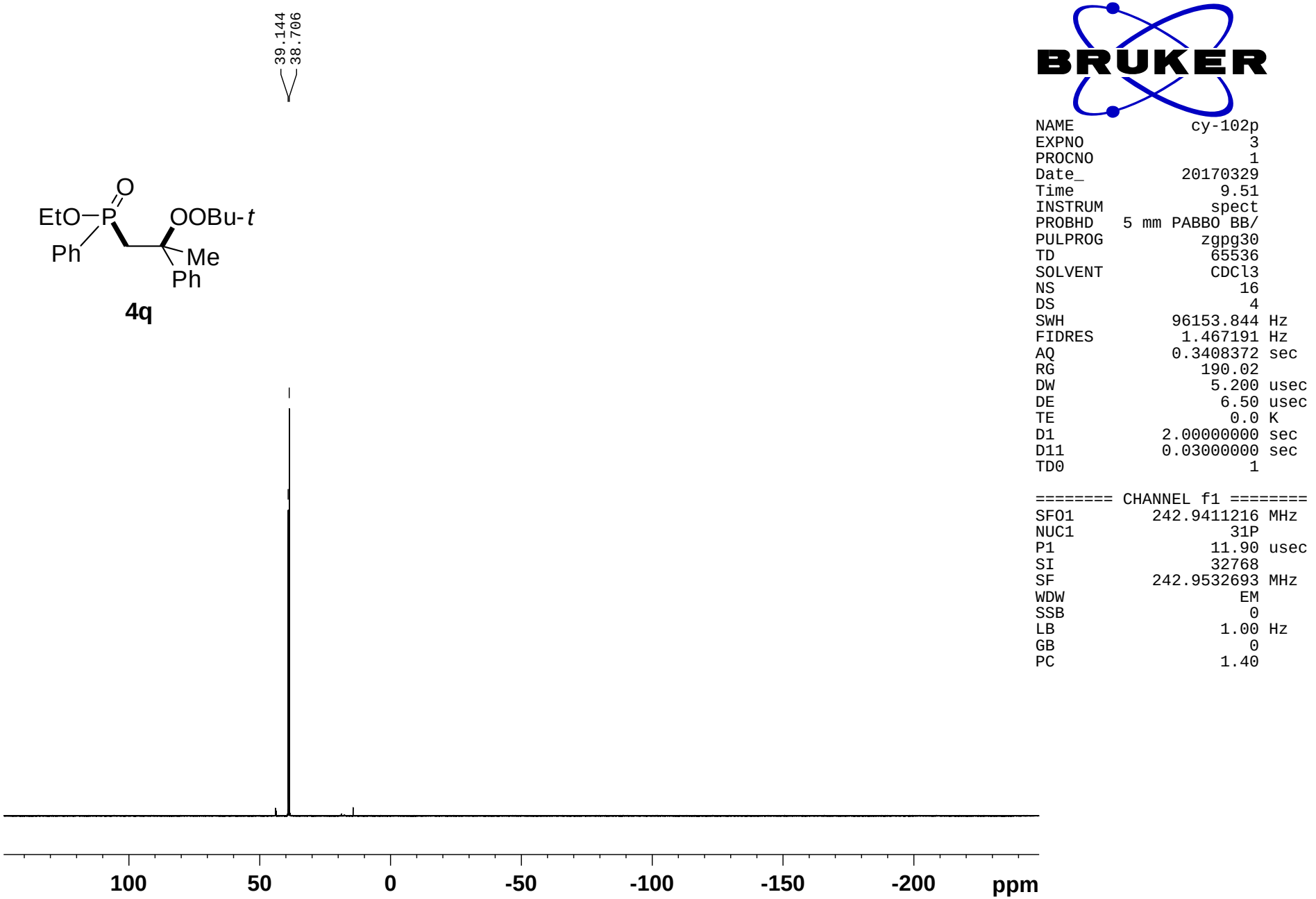


BRUKER

NAME	cy-102p-20170328
EXPNO	1
PROCNO	1
Date_	20170328
Time	17.50
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	57
DW	78.200 usec
DE	6.50 usec
TE	292.5 K
D1	1.00000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1300033 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00

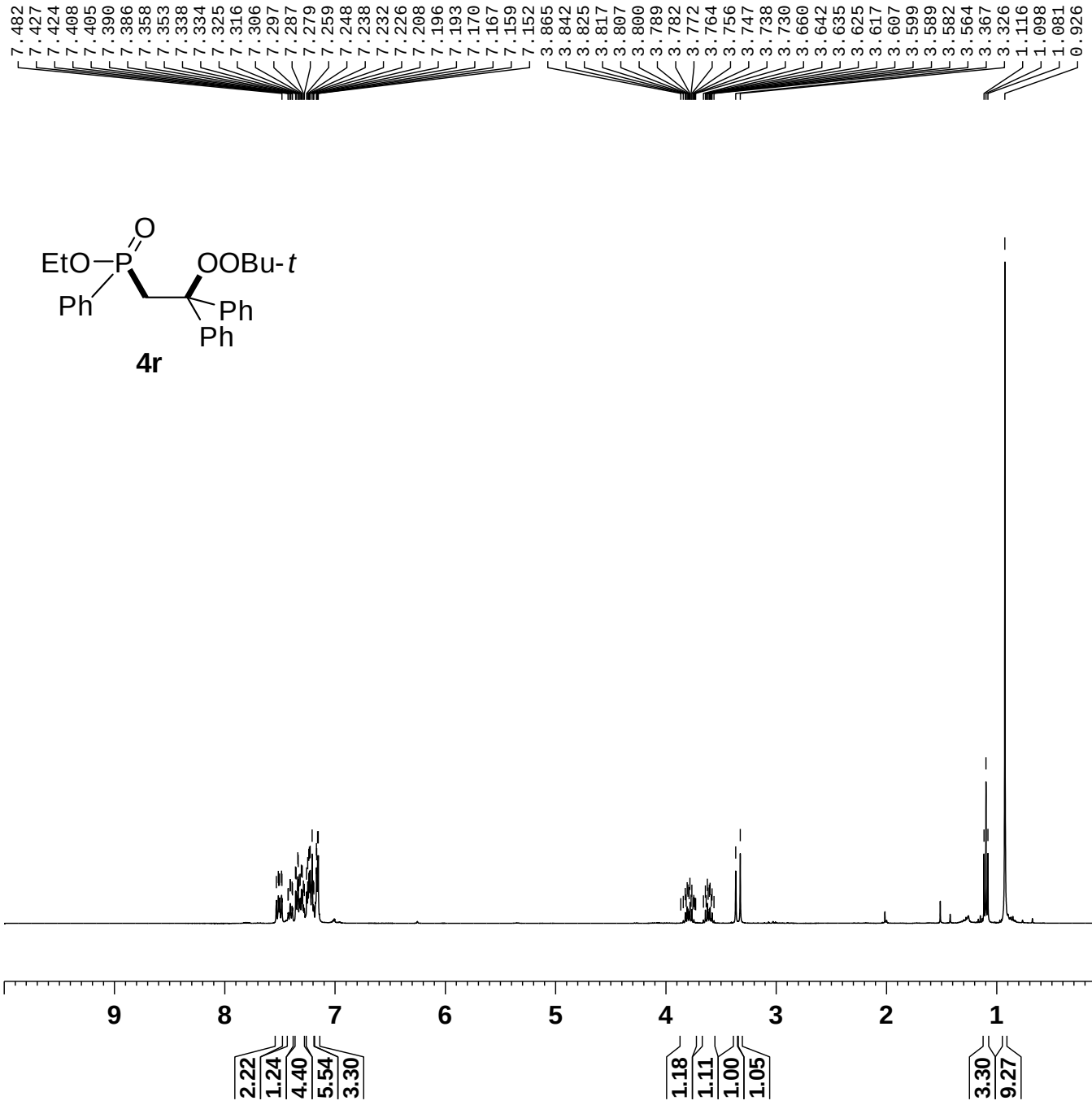



```
NAME      cy-102p-20170328
EXPNO                    2
PROCNO                   1
Date_             20170328
Time                 17.53
INSTRUM              spect
PROBHD   5 mm PADUL 13C
PULPROG             zgpg30
TD                   65536
SOLVENT              CDCl3
NS                     424
DS                       4
SWH              25252.525 Hz
FIDRES           0.385323 Hz
AQ               1.2976629 sec
RG                    2050
DW                  19.800 usec
DE                   8.00 usec
TE                  293.2 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                     10

======== CHANNEL f1 ========
NUC1                   13C
P1                   13.50 usec
PL1                   3.00 dB
PL1W          43.93649673 W
SFO1          100.6238364 MHz

======== CHANNEL f2 ========
CPDPRG2           waltz16
NUC2                   1H
PCPD2                80.00 usec
PL2                   1.80 dB
PL12                 17.19 dB
PL13                 18.46 dB
PL2W           8.92857742 W
PL12W          0.25809658 W
PL13W          0.19265592 W
SFO2          400.1316005 MHz
SI                    32768
SF            100.6127809 MHz
WDW                     EM
SSB                      0
LB                    3.00 Hz
GB                       0
PC                    1.40
```

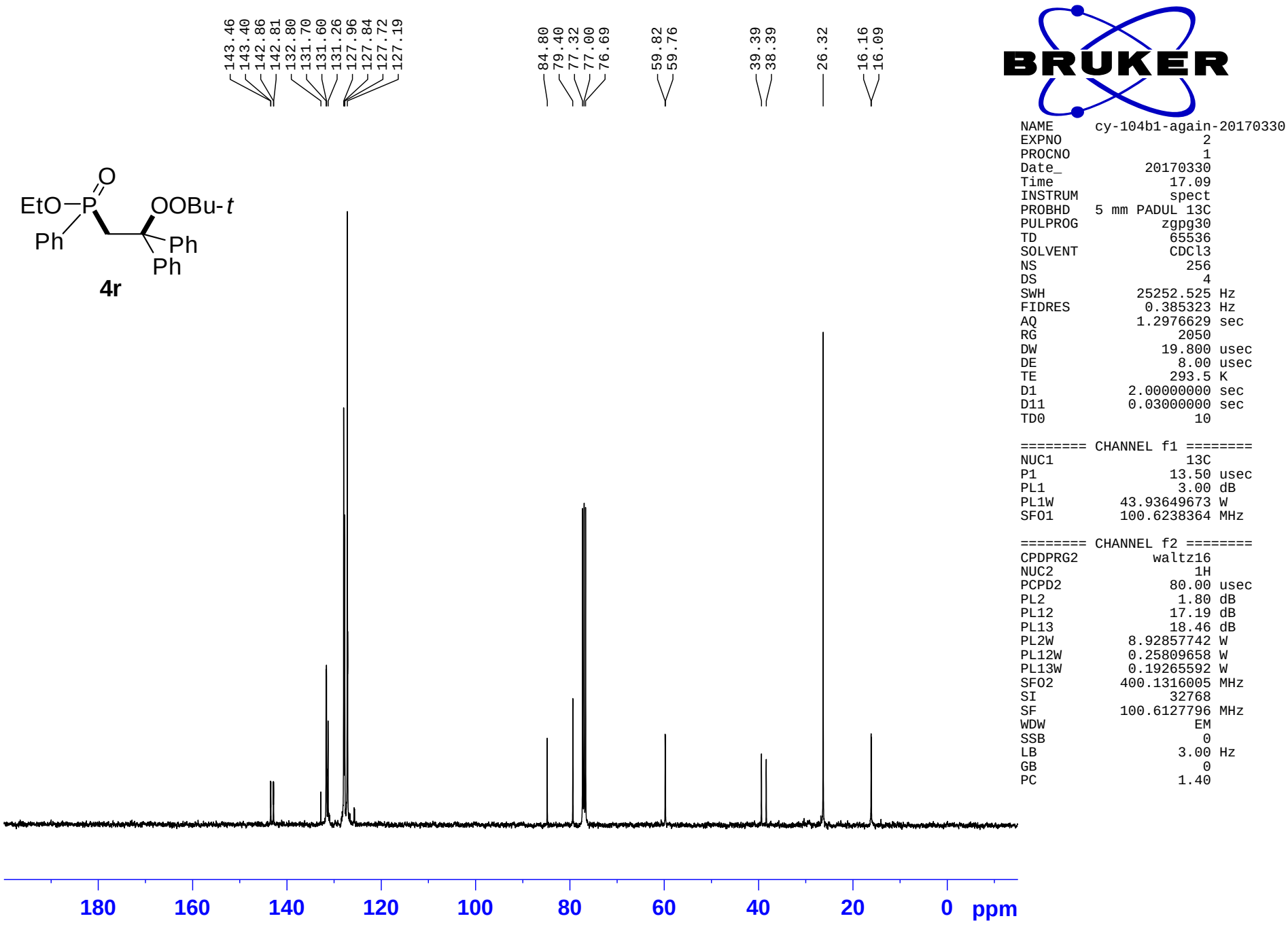


BRUKER

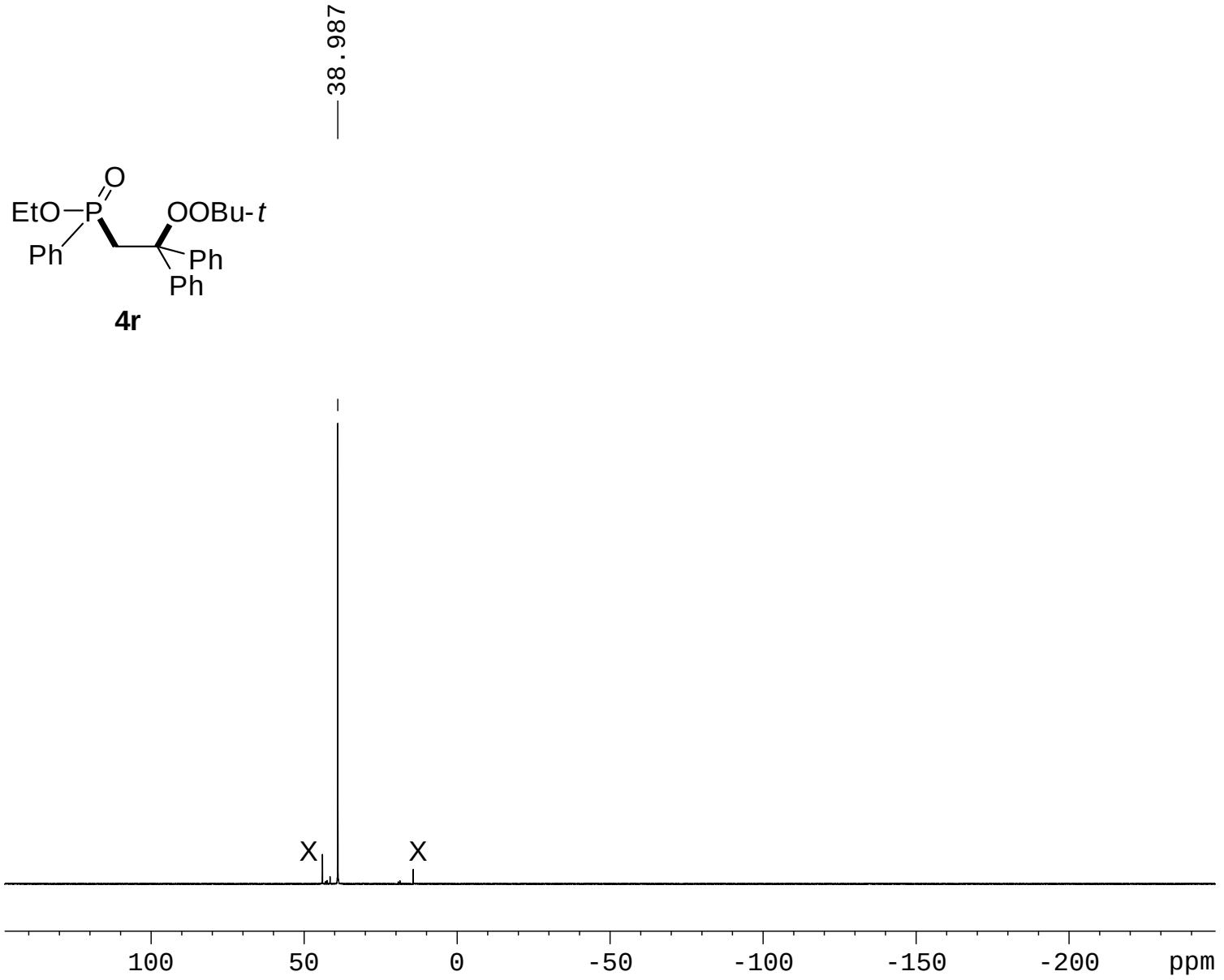
NAME	cy-102p
EXPNO	3
PROCNO	1
Date_	20170329
Time	9.51
INSTRUM	spect
PROBHD	5 mm PABBO BB/
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	16
DS	4
SWH	96153.844 Hz
FIDRES	1.467191 Hz
AQ	0.3408372 sec
RG	190.02
DW	5.200 usec
DE	6.50 usec
TE	0.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
SFO1	242.9411216 MHz
NUC1	31P
P1	11.90 usec
SI	32768
SF	242.9532693 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40




```
NAME      cy-104b1-again-20170330
EXPNO                  1
PROCNO                 1
Date_           20170330
Time               17.05
INSTRUM            spect
PROBHD   5 mm PADUL 13C
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                     8
DS                     0
SWH             6393.862 Hz
FIDRES          0.195125 Hz
AQ             2.5625076 sec
RG                  71.8
DW                78.200 usec
DE                 6.50 usec
TE                292.6 K
D1           1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                  1H
P1                 13.10 usec
PL1                 1.80 dB
PL1W          8.92857742 W
SFO1        400.1326008 MHz
SI                 32768
SF          400.1300101 MHz
WDW                   EM
SSB                    0
LB                  0.30 Hz
GB                     0
PC                  1.00
```

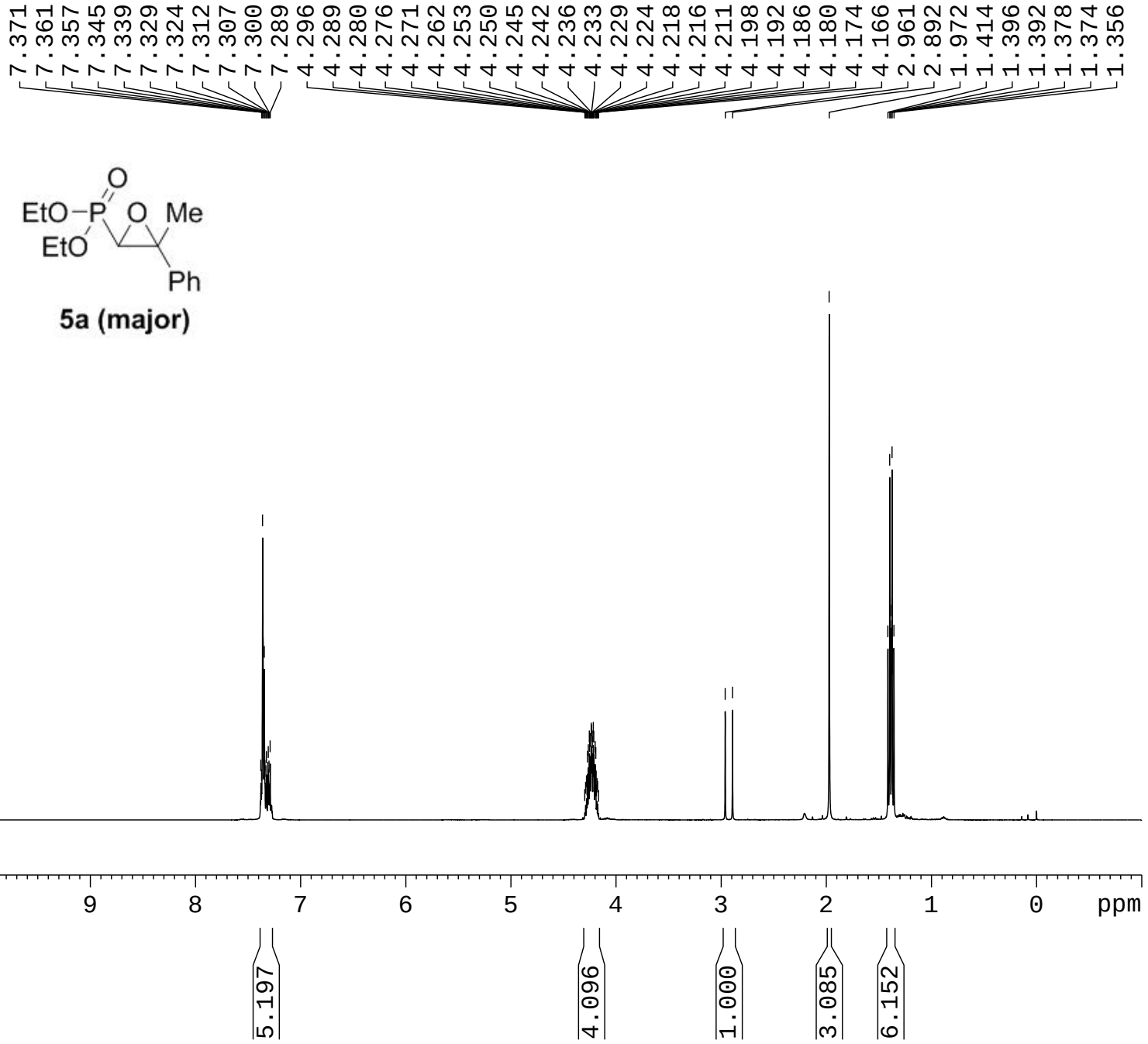



```
NAME      cy-104b1-again-20170330
EXPNO                          2
PROCNO                         1
Date_                   20170330
Time                       17.09
INSTRUM                    spect
PROBHD   5 mm PADUL 13C
PULPROG                   zgpg30
TD                         65536
SOLVENT                    CDCl3
NS                           256
DS                             4
SWH                    25252.525 Hz
FIDRES                 0.385323 Hz
AQ                     1.2976629 sec
RG                          2050
DW                        19.800 usec
DE                         8.00 usec
TE                        293.5 K
D1                    2.00000000 sec
D11                   0.03000000 sec
TD0                           10

======== CHANNEL f1 ========
NUC1                         13C
P1                        13.50 usec
PL1                        3.00 dB
PL1W                43.93649673 W
SFO1                100.6238364 MHz

======== CHANNEL f2 ========
CPDPRG2                 waltz16
NUC2                         1H
PCPD2                     80.00 usec
PL2                        1.80 dB
PL12                      17.19 dB
PL13                      18.46 dB
PL2W                 8.92857742 W
PL12W                0.25809658 W
PL13W                0.19265592 W
SFO2                400.1316005 MHz
SI                         32768
SF                  100.6127796 MHz
WDW                          EM
SSB                           0
LB                         3.00 Hz
GB                            0
PC                         1.40
```

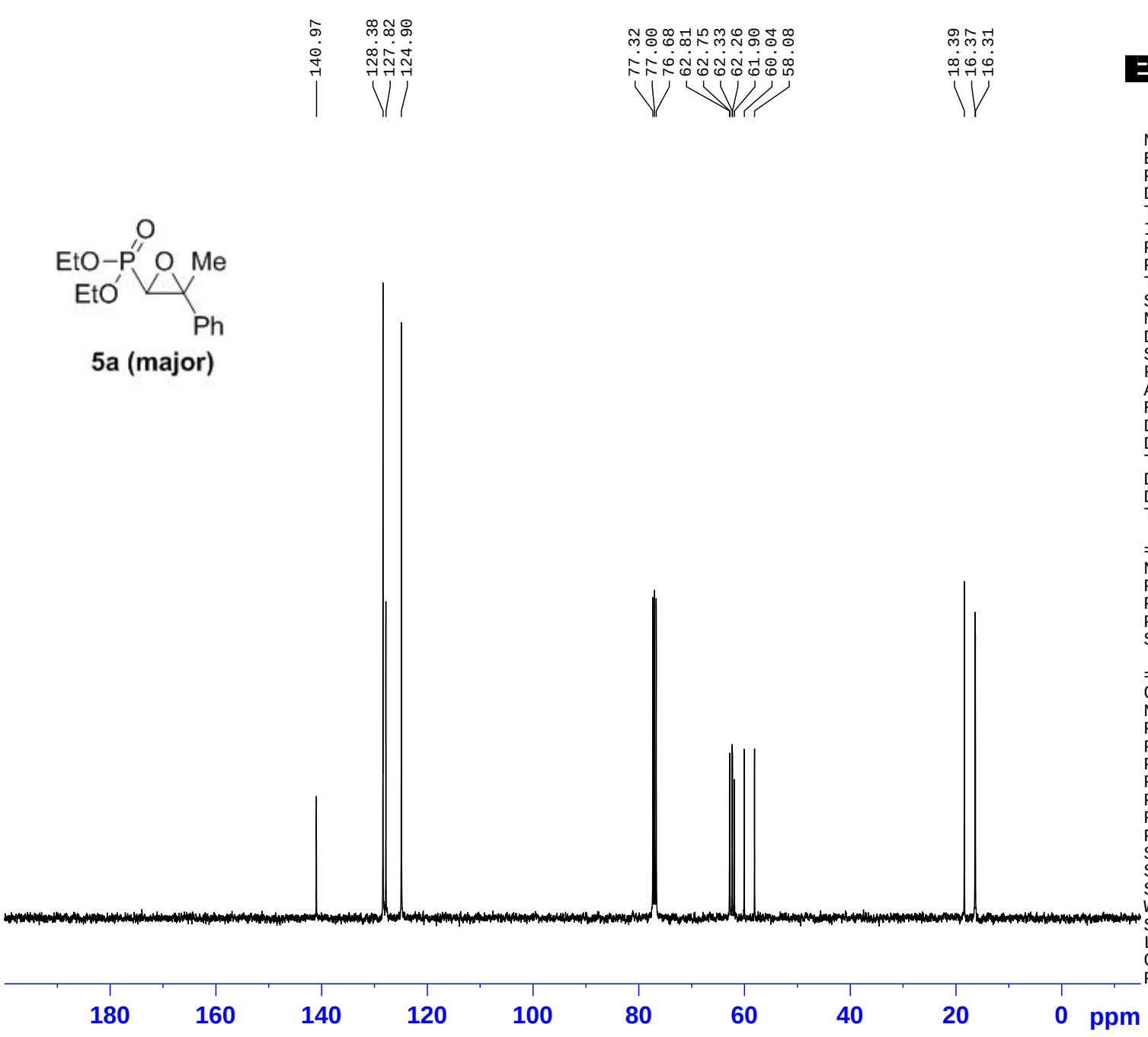


4r

NAME	cy-104b1
EXPNO	3
PROCNO	1
Date_	20170426
Time	9.42
INSTRUM	spect
PROBHD	5 mm PABBO BB/
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	40
DS	4
SWH	96153.844 Hz
FIDRES	1.467191 Hz
AQ	0.3408372 sec
RG	190.02
DW	5.200 usec
DE	6.50 usec
TE	294.6 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
SFO1	242.9411216 MHz
NUC1	31P
P1	11.90 usec
SI	32768
SF	242.9532693 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40

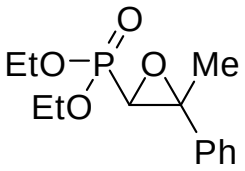


NAME	cy-213-1p-20171028
EXPNO	1
PROCNO	1
Date_	20171028
Time	20.34
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	64
DW	78.200 usec
DE	6.50 usec
TE	294.6 K
D1	1.00000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1299982 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00



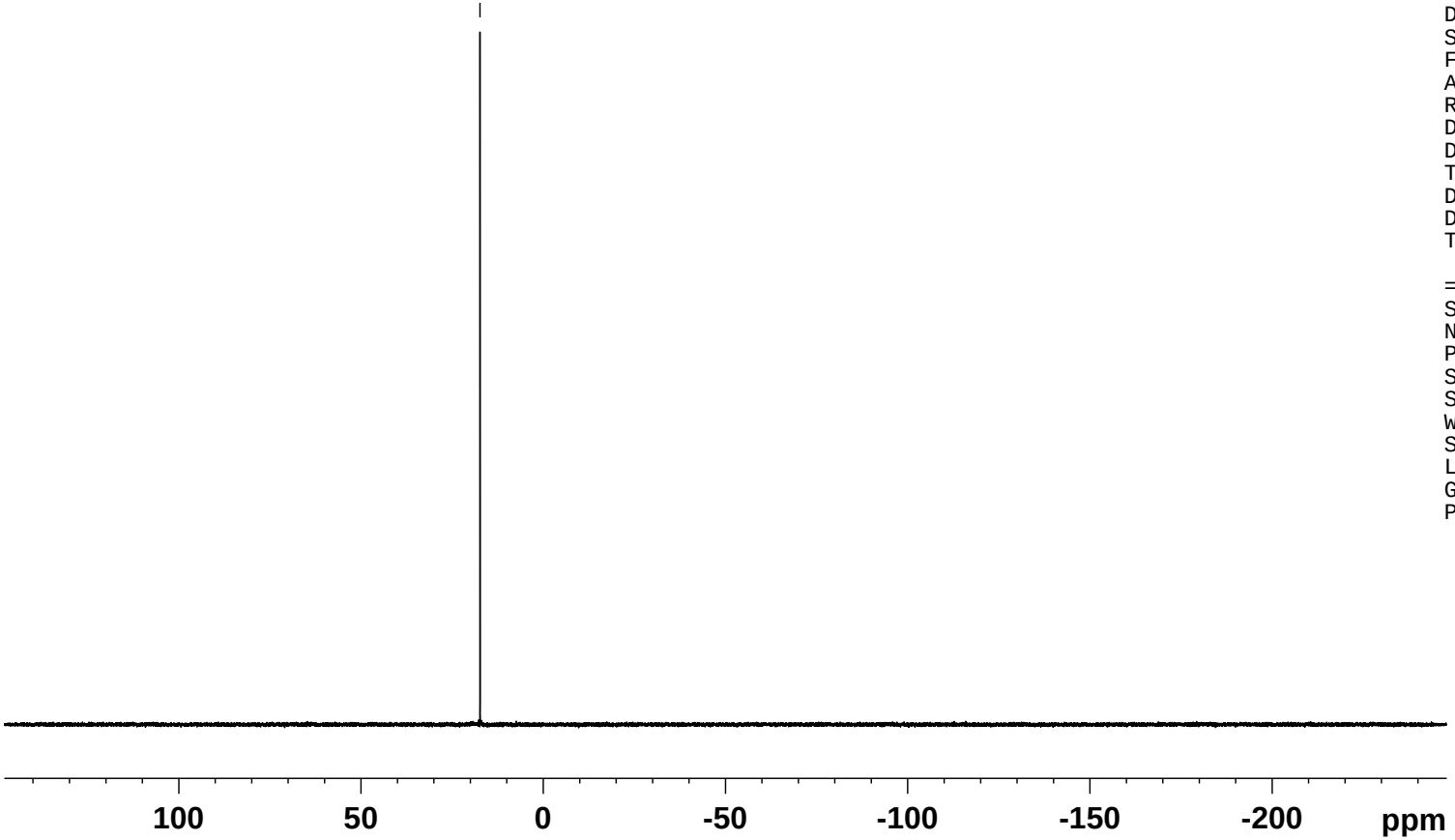
BRUKER

NAME	cy-213-1p-20171028
EXPNO	2
PROCNO	1
Date_	20171028
Time	20.41
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	80
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	295.8 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127818 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40

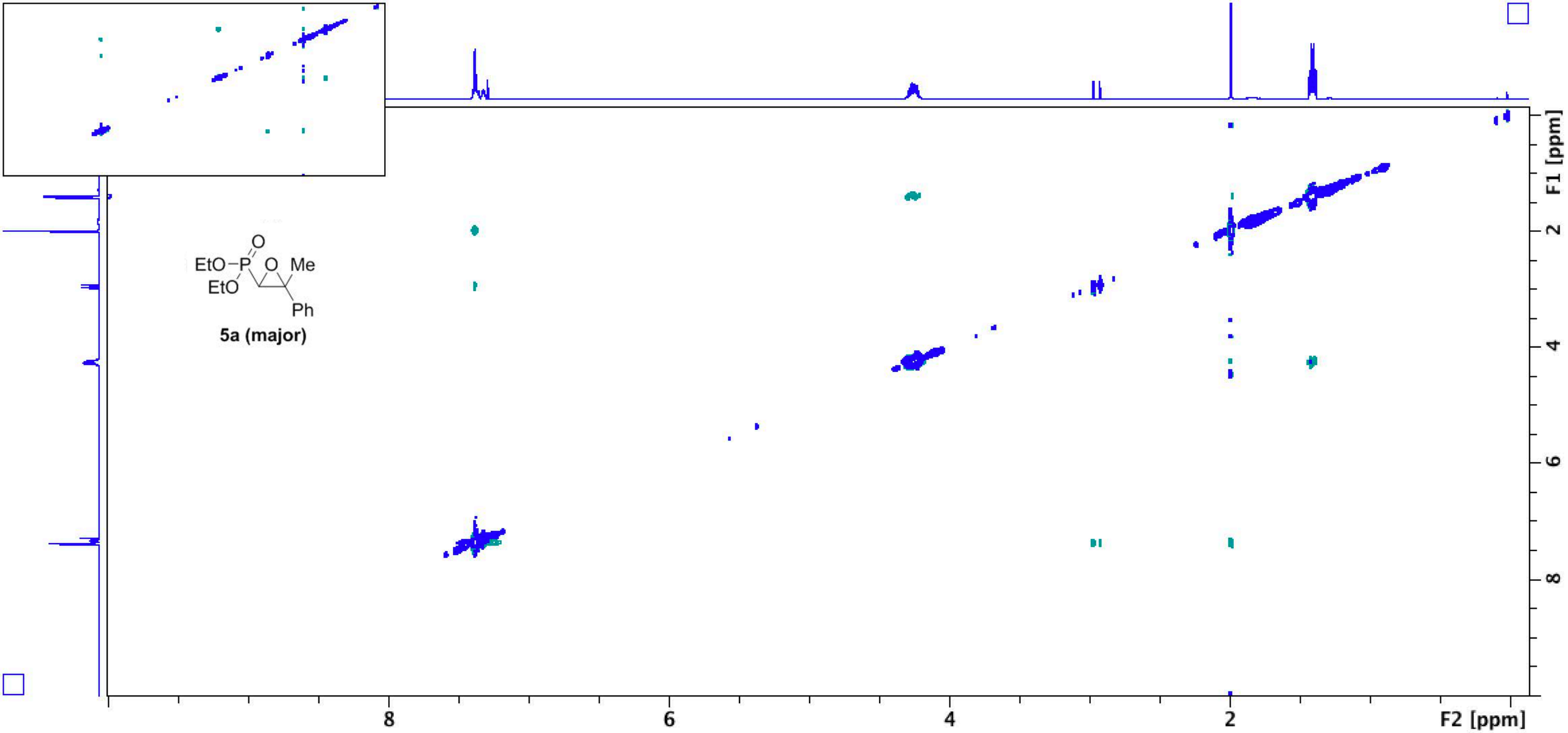


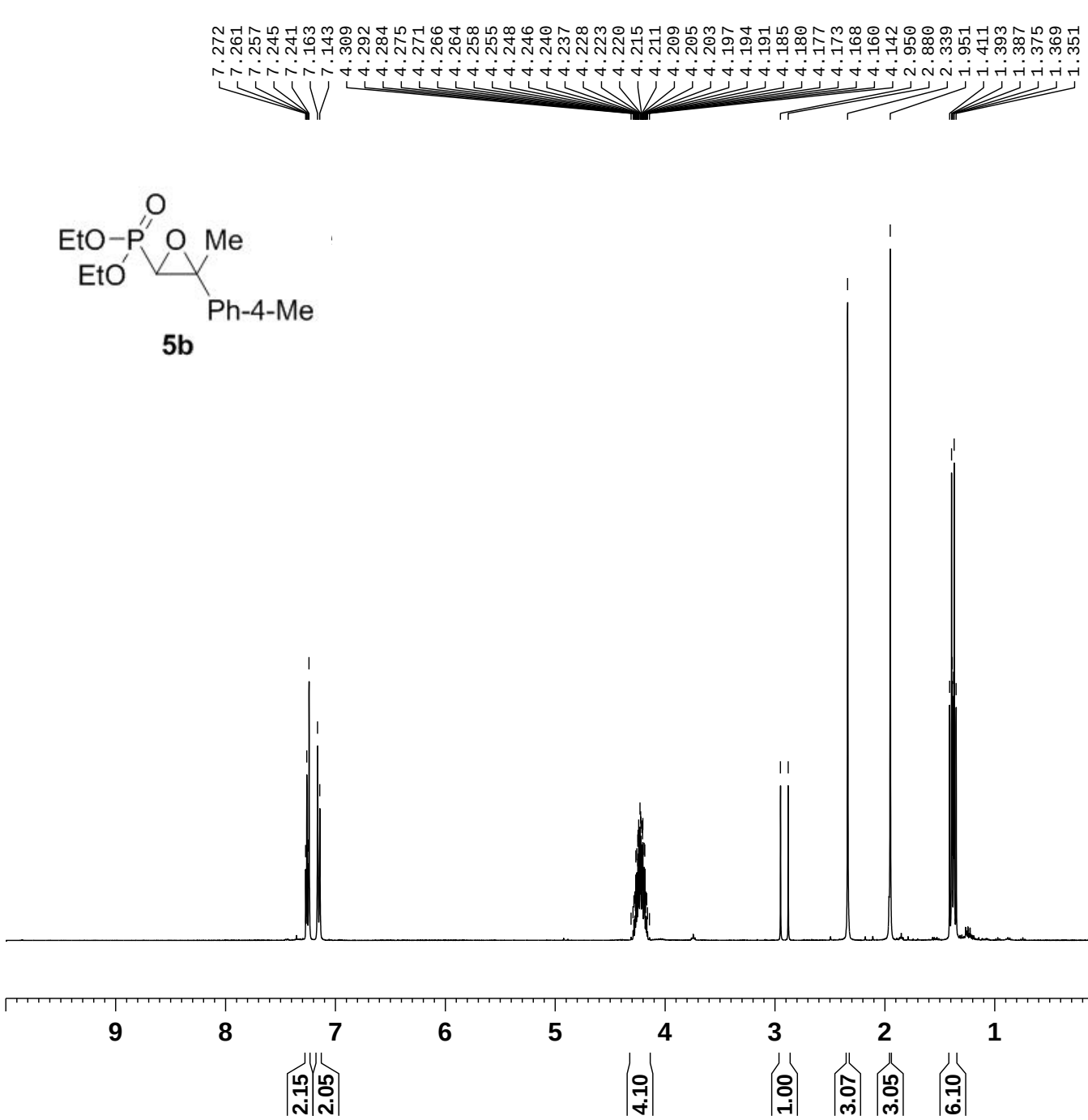
5a (major)

17.341

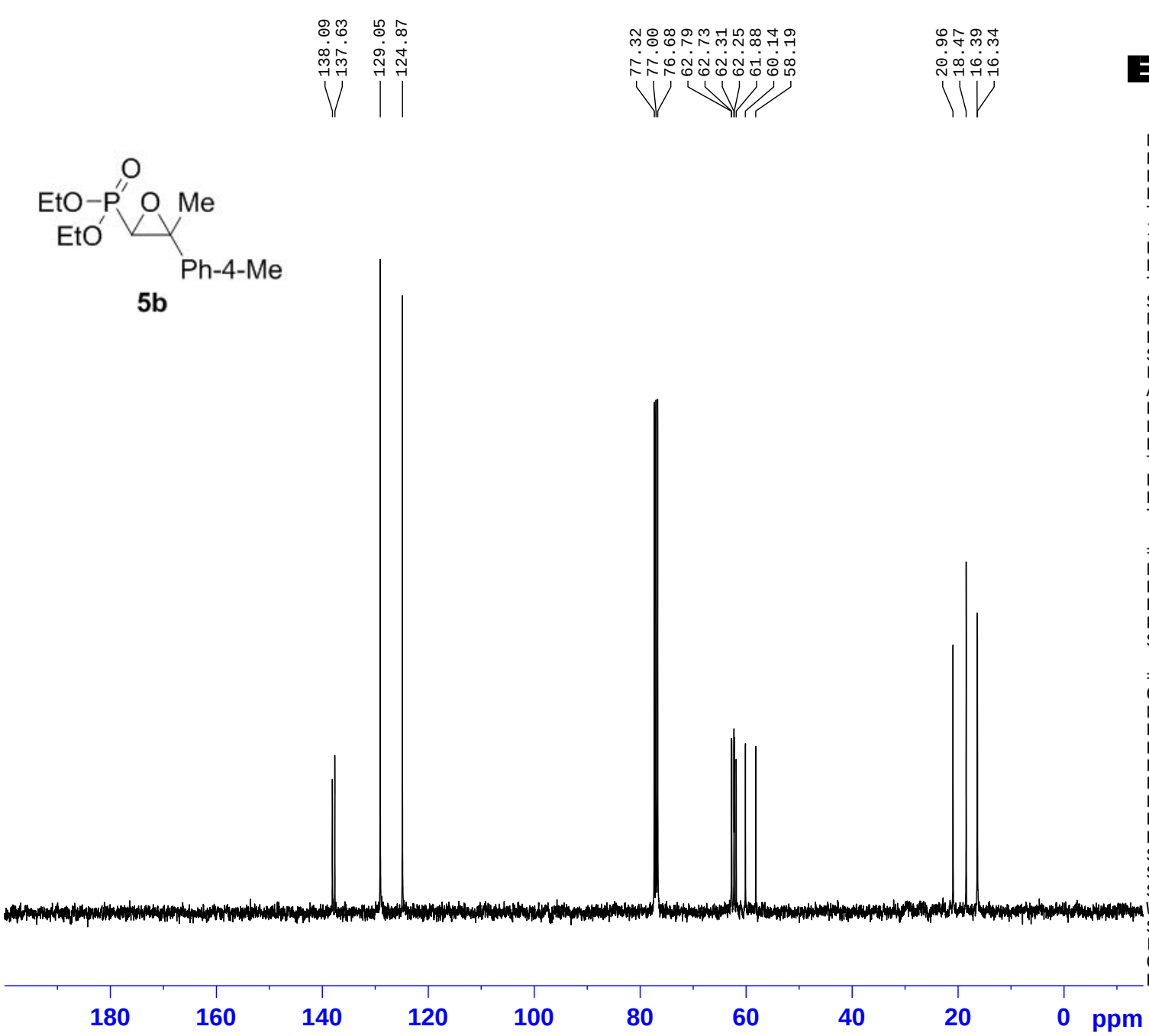



```
NAME          cy-68a-p1-p
EXPNO                   3
PROCNO                  1
Date_            20170109
Time                14.00
INSTRUM             spect
PROBHD   5 mm PABBO BB/
PULPROG            zgpg30
TD                  65536
SOLVENT             CDCl3
NS                     16
DS                      4
SWH             96153.844 Hz
FIDRES           1.467191 Hz
AQ              0.3408372 sec
RG                 190.02
DW                  5.200 usec
DE                  6.50 usec
TE                 306.3 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                     1

======== CHANNEL f1 ========
SFO1          242.9411216 MHz
NUC1                  31P
P1                 11.90 usec
SI                 32768
SF            242.9532693 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```


EtO
P
O
O
Me
EtO
Ph
5a (major)
F1 [ppm]
F2 [ppm]
2
4
6
8
8
6
4
2

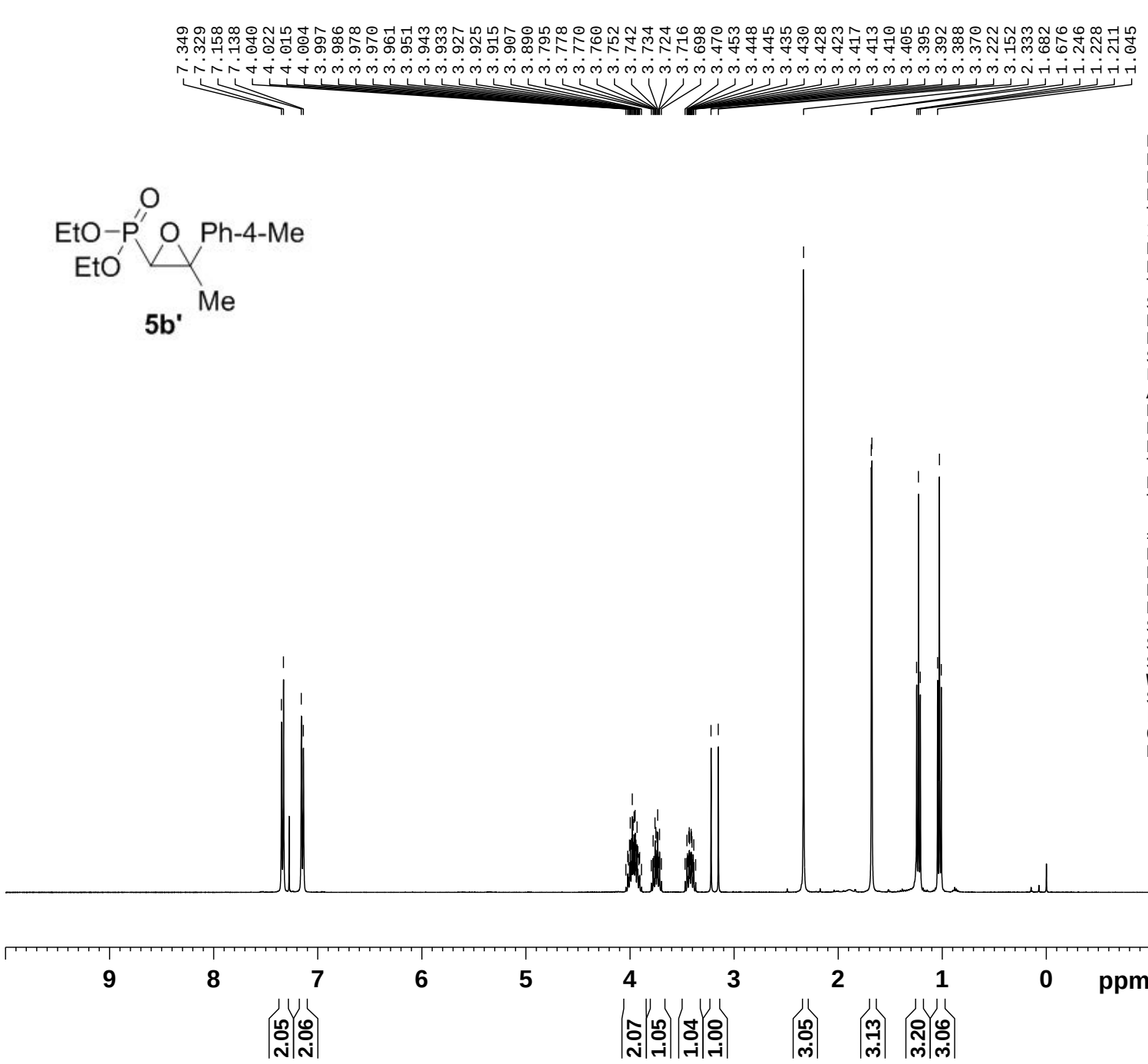



```
NAME      cyj-89ap-pure-20171030
EXPNO                  1
PROCNO                 1
Date_           20171030
Time               16.56
INSTRUM            spect
PROBHD   5 mm PADUL 13C
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                     8
DS                     0
SWH             6393.862 Hz
FIDRES          0.195125 Hz
AQ            2.5625076 sec
RG                   114
DW                78.200 usec
DE                 6.50 usec
TE                294.4 K
D1           1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                  1H
P1                13.10 usec
PL1                1.80 dB
PL1W         8.92857742 W
SFO1        400.1326008 MHz
SI                 32768
SF          400.1300052 MHz
WDW                   EM
SSB                    0
LB                0.30 Hz
GB                     0
PC                1.00
```



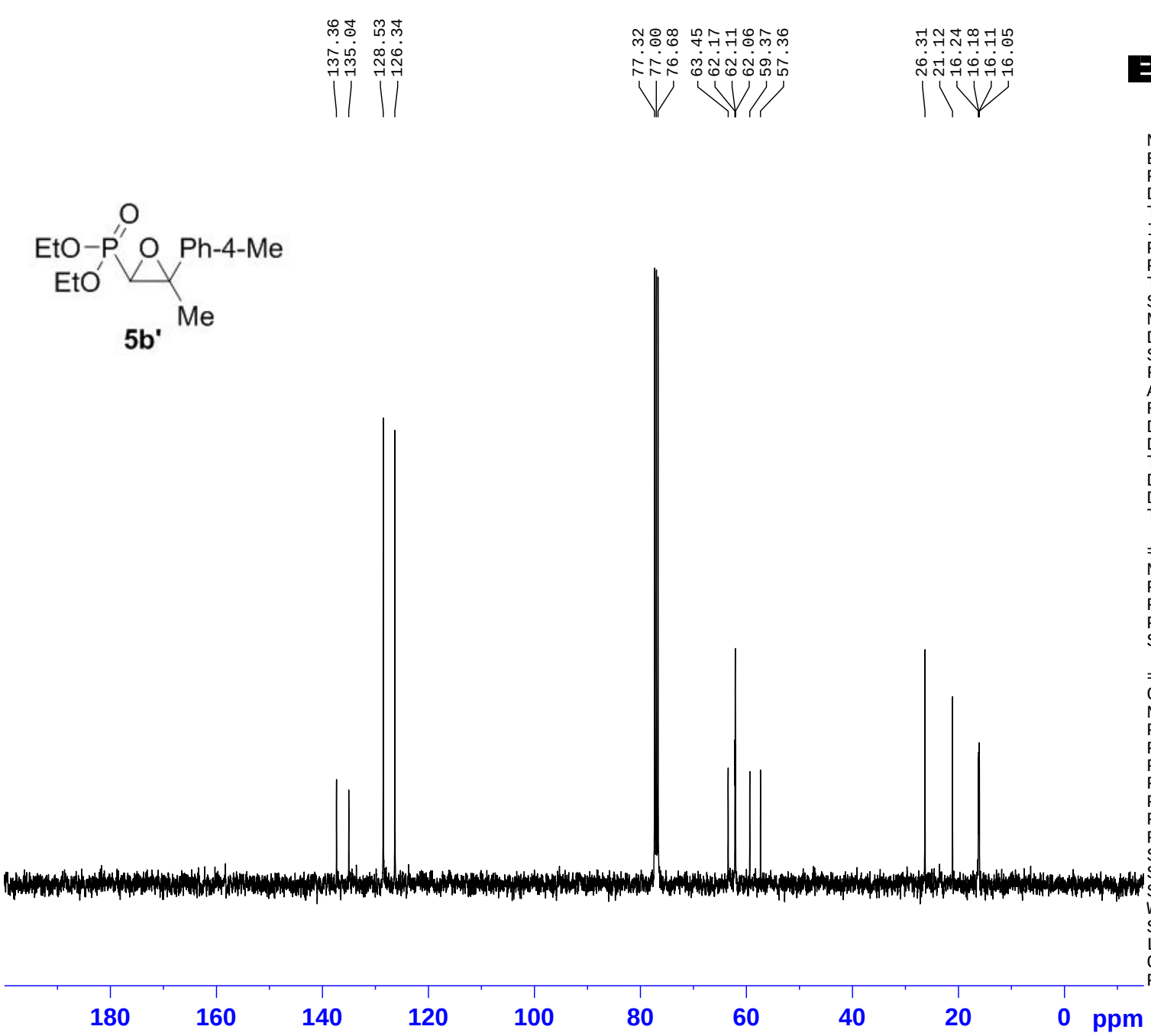
BRUKER

NAME	cy-25-ir-20171119
EXPNO	2
PROCNO	1
Date_	20171119
Time	11.12
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	56
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	298.2 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127791 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40



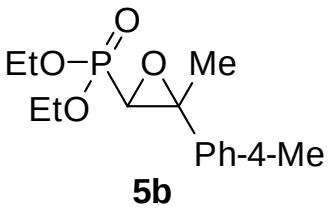
BRUKER

NAME	cyj94-2p-20171101
EXPNO	1
PROCNO	1
Date_	20171101
Time	18.15
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	128
DW	78.200 usec
DE	6.50 usec
TE	294.4 K
D1	1.00000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1300034 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00



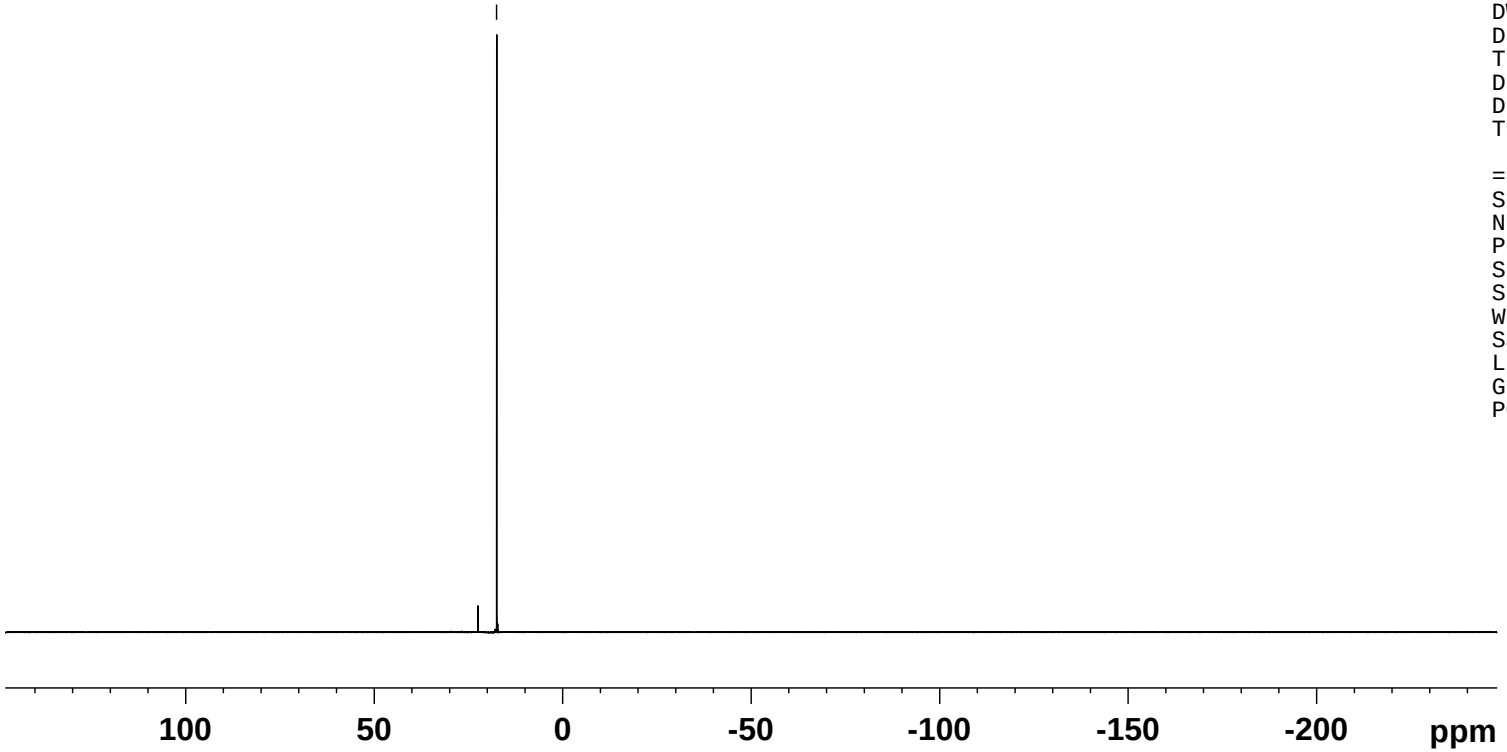
BRUKER

NAME	cyj94-2p-20171101
EXPNO	2
PROCNO	1
Date_	20171101
Time	18.19
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	40
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	295.4 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127758 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40



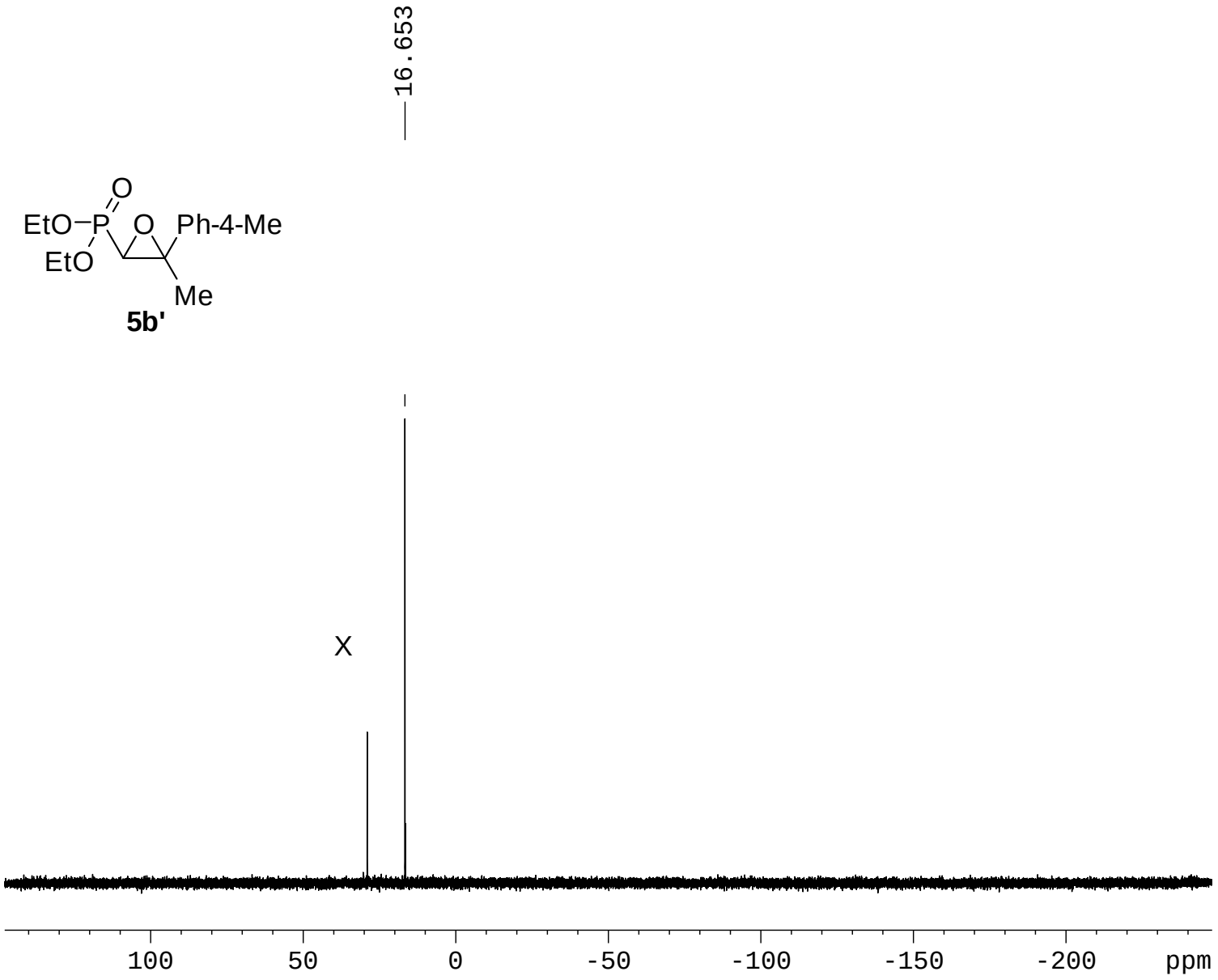
5b

17.534

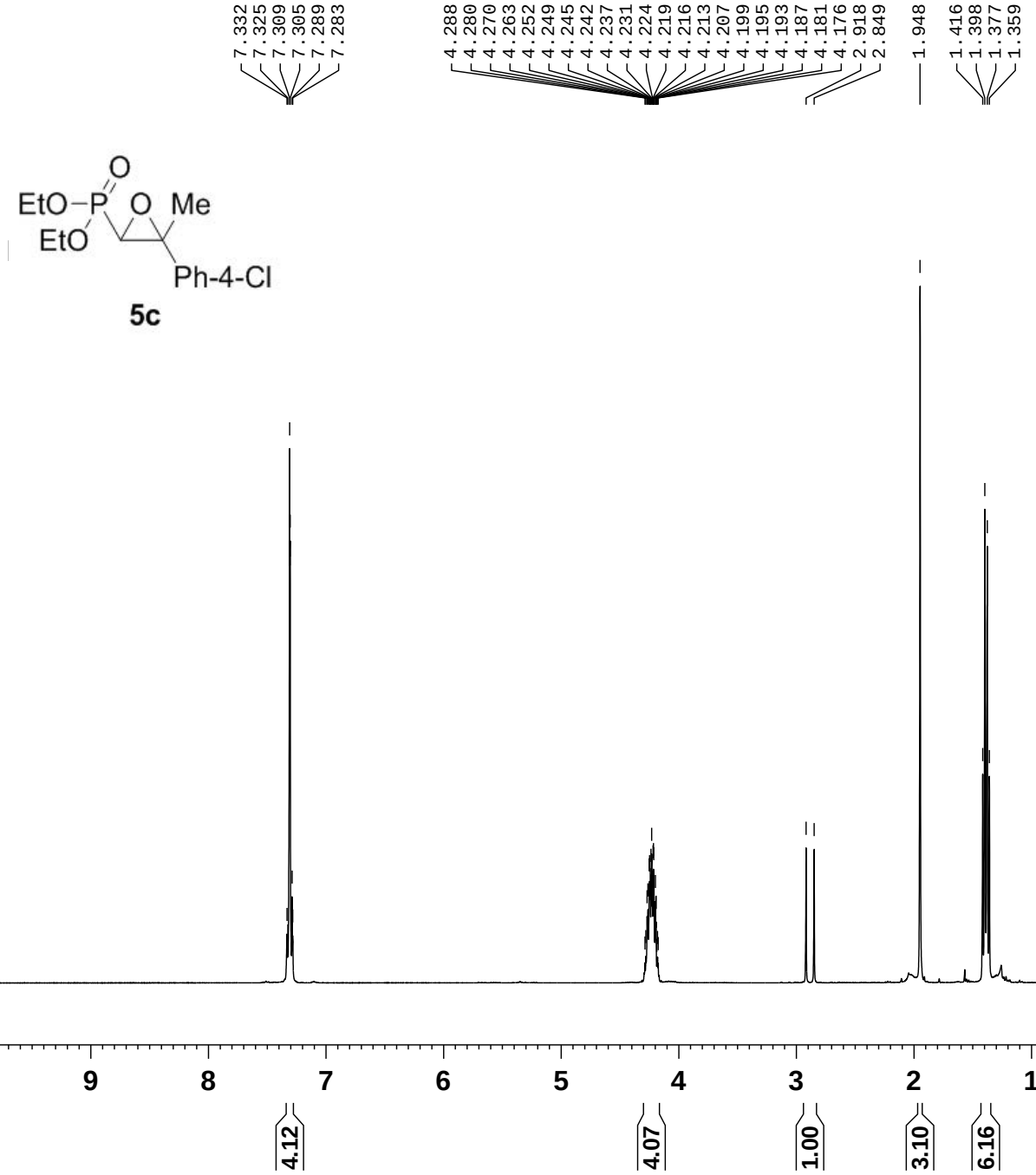


BRUKER

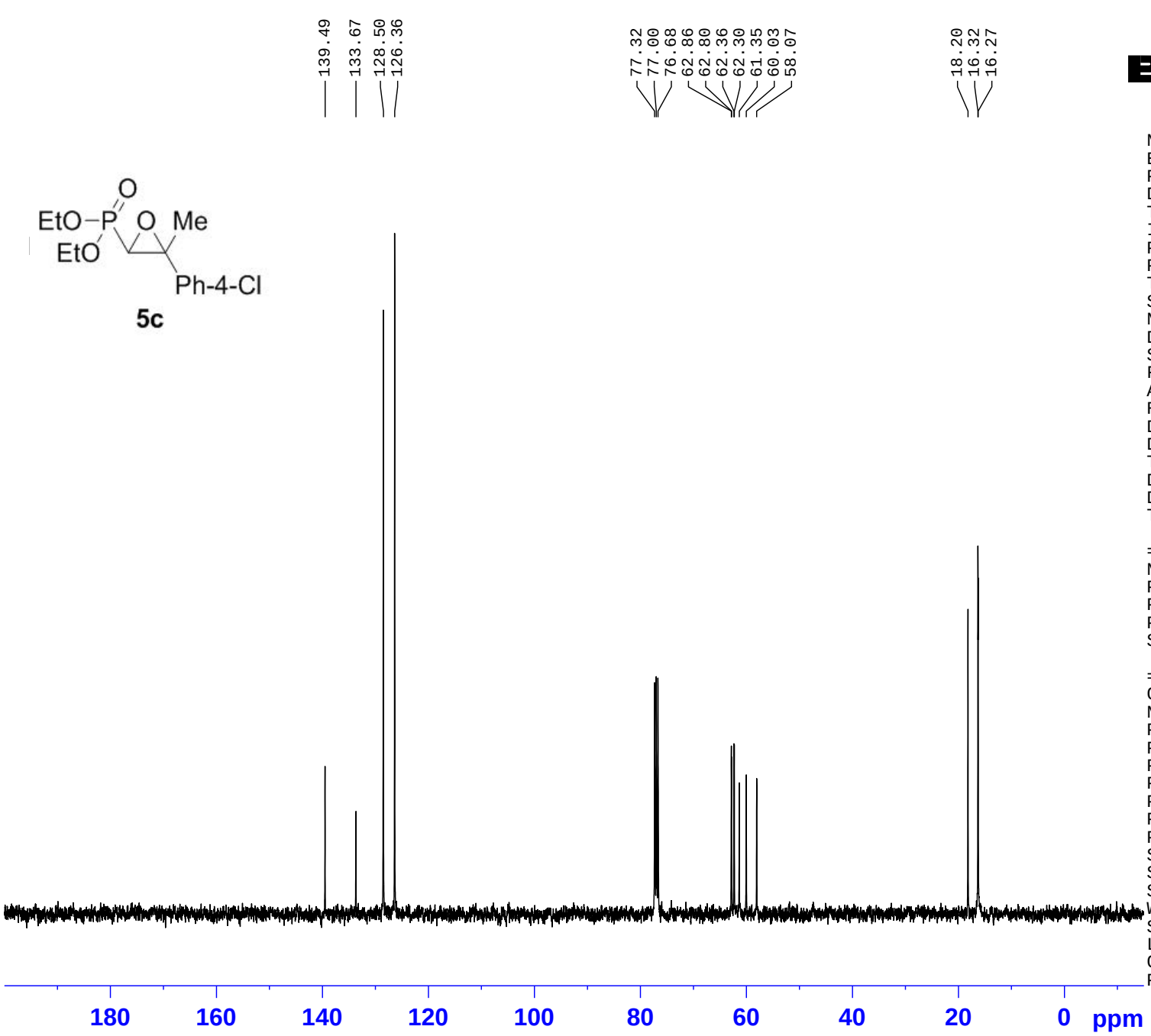
NAME	cy-187a-1p
EXPNO	3
PROCNO	1
Date_	20170920
Time	9.41
INSTRUM	spect
PROBHD	5 mm PABBO BB/
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	32
DS	4
SWH	96153.844 Hz
FIDRES	1.467191 Hz
AQ	0.3408372 sec
RG	190.02
DW	5.200 usec
DE	6.50 usec
TE	0.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
SFO1	242.9411216 MHz
NUC1	31P
P1	11.90 usec
SI	32768
SF	242.9532693 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40



NAME	cy-187a-2p
EXPNO	3
PROCNO	1
Date_	20171031
Time	9.47
INSTRUM	spect
PROBHD	5 mm PABBO BB/
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	64
DS	4
SWH	96153.844 Hz
FIDRES	1.467191 Hz
AQ	0.3408372 sec
RG	190.02
DW	5.200 usec
DE	6.50 usec
TE	0.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
SFO1	242.9411216 MHz
NUC1	31P
P1	11.90 usec
SI	32768
SF	242.9532693 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40

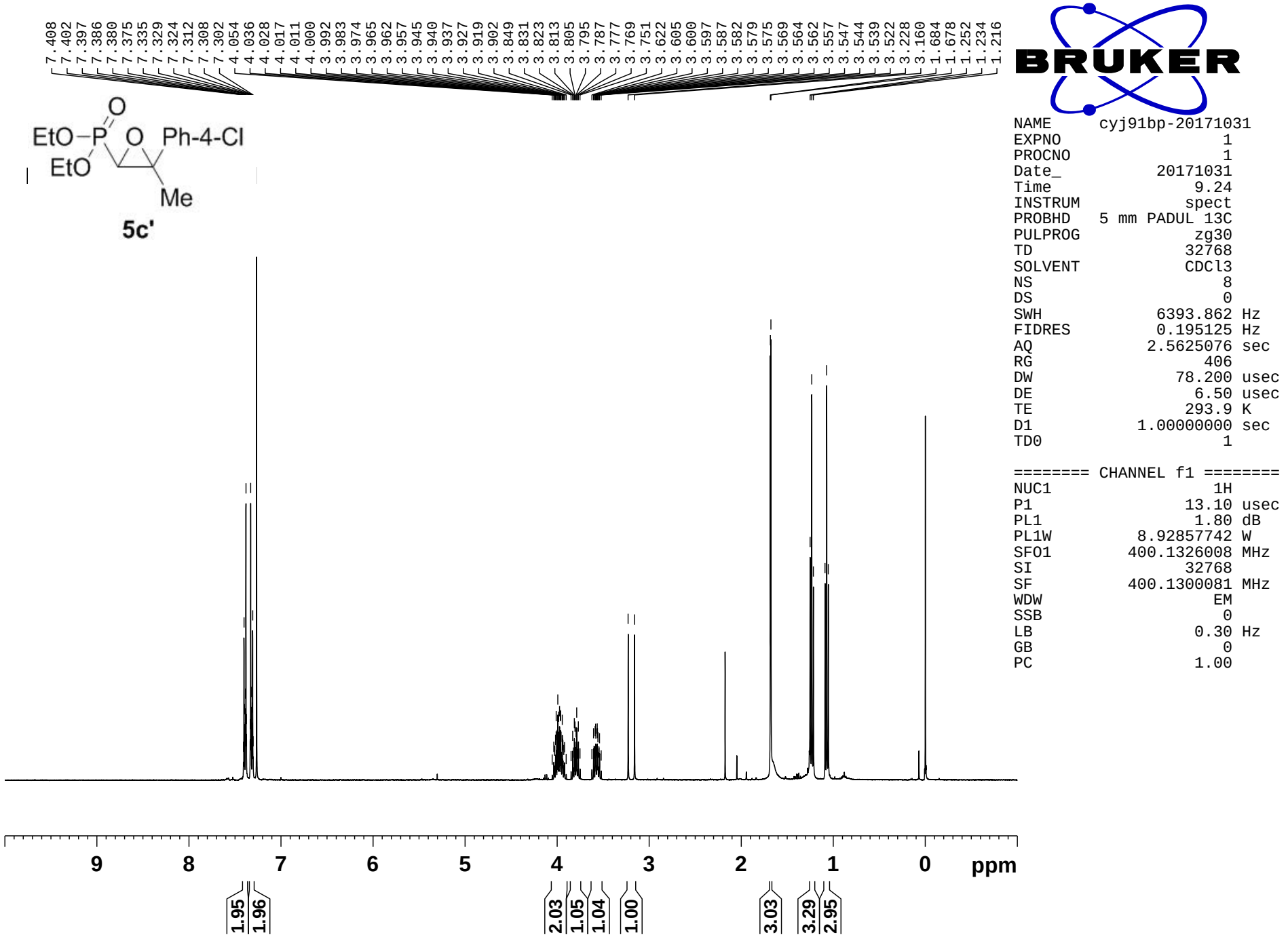


NAME	cy-187b-1p-20171012
EXPNO	1
PROCNO	1
Date_	20171012
Time	22.05
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	101
DW	78.200 usec
DE	6.50 usec
TE	293.6 K
D1	1.00000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1299983 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00

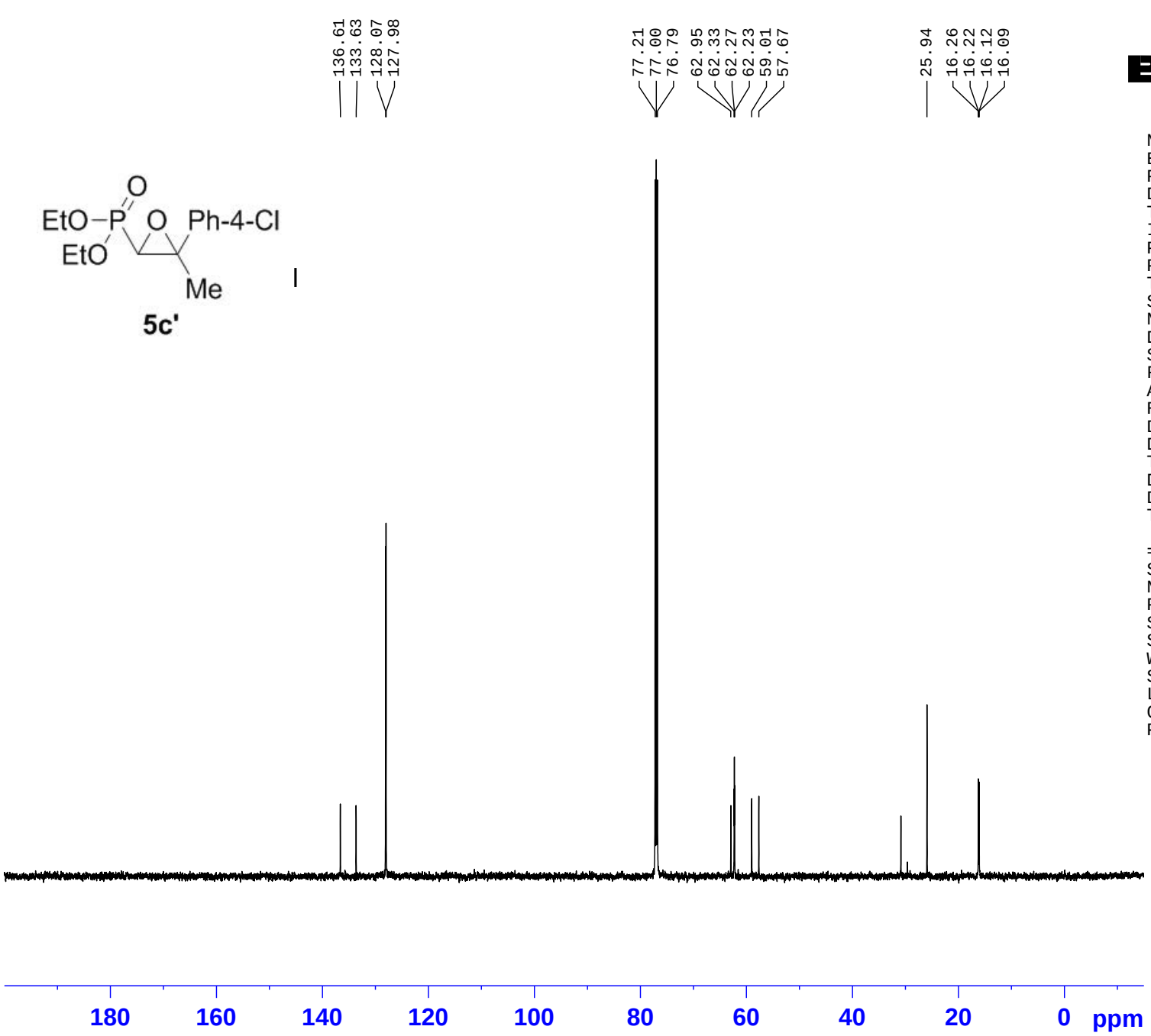


BRUKER

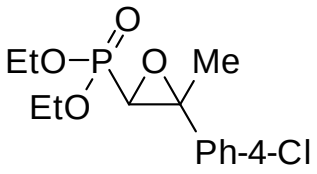
NAME	cyj91ap-c-20171031
EXPNO	2
PROCNO	1
Date_	20171031
Time	16.55
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	40
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	295.4 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127838 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40




```
NAME      cyj91bp-20171031
EXPNO                    1
PROCNO                   1
Date_             20171031
Time                 9.24
INSTRUM             spect
PROBHD   5 mm PADUL 13C
PULPROG               zg30
TD                   32768
SOLVENT              CDCl3
NS                       8
DS                       0
SWH               6393.862 Hz
FIDRES            0.195125 Hz
AQ               2.5625076 sec
RG                     406
DW                  78.200 usec
DE                   6.50 usec
TE                  293.9 K
D1             1.00000000 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                    1H
P1                   13.10 usec
PL1                   1.80 dB
PL1W           8.92857742 W
SFO1          400.1326008 MHz
SI                   32768
SF            400.1300081 MHz
WDW                     EM
SSB                      0
LB                    0.30 Hz
GB                       0
PC                    1.00
```

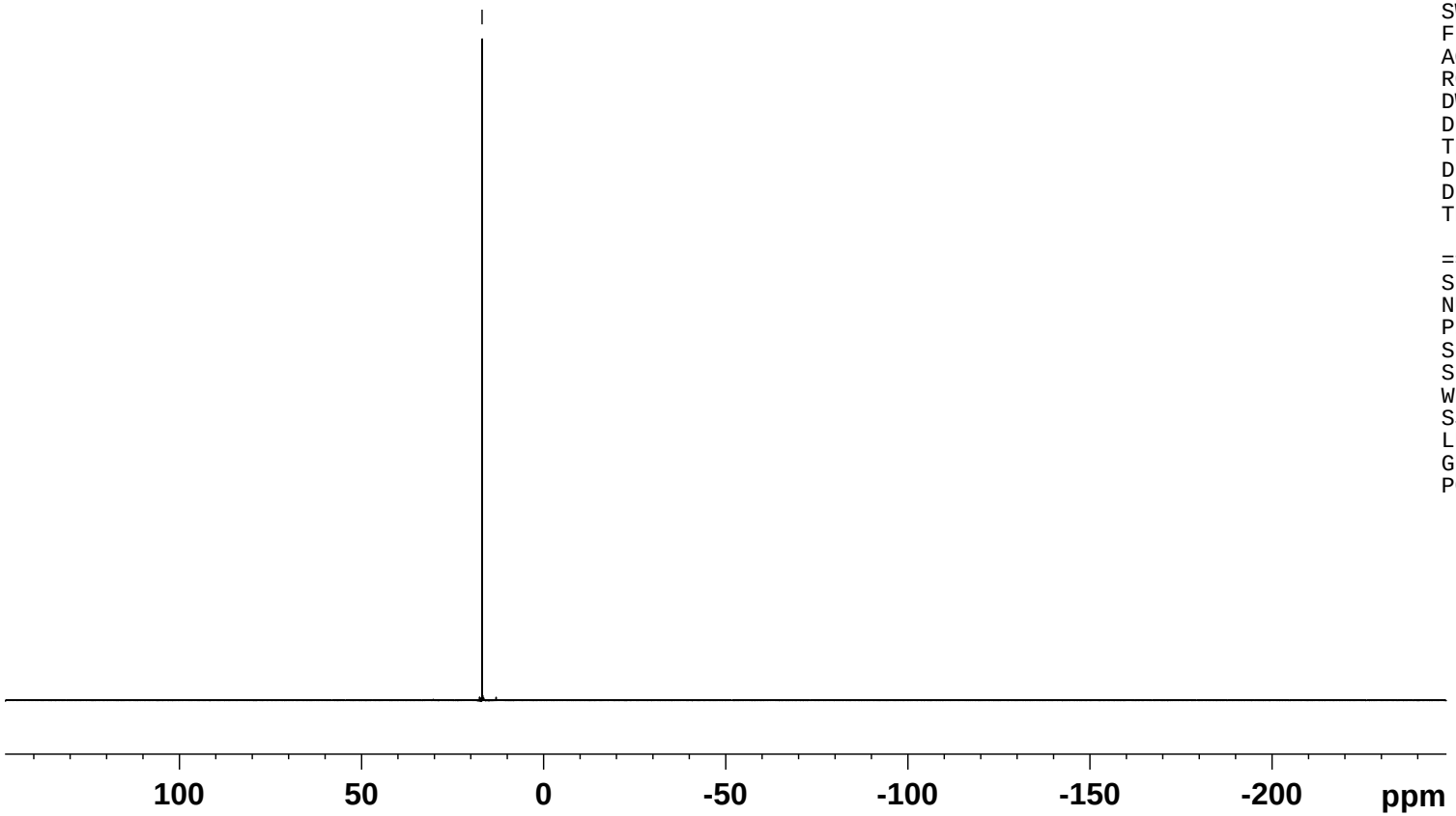


NAME	cyj91bp	
EXPNO	2	
PROCNO	1	
Date_	20171031	
Time	14.59	
INSTRUM	spect	
PROBHD	5 mm PABBO BB/	
PULPROG	zgpg30	
TD	65536	
SOLVENT	CDCl3	
NS	184	
DS	4	
SWH	37878.789	Hz
FIDRES	0.577984	Hz
AQ	0.8651252	sec
RG	190.02	
DW	13.200	usec
DE	6.50	usec
TE	297.2	K
D1	2.00000000	sec
D11	0.03000000	sec
TD0	3	
======== CHANNEL f1 ========		
SFO1	150.9294669	MHz
NUC1	13C	
P1	11.90	usec
SI	32768	
SF	150.9128729	MHz
WDW	EM	
SSB	0	
LB	3.00	Hz
GB	0	
PC	1.40	

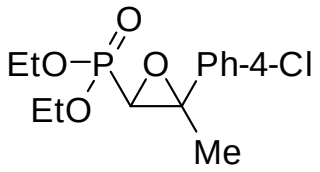


5c

16.894

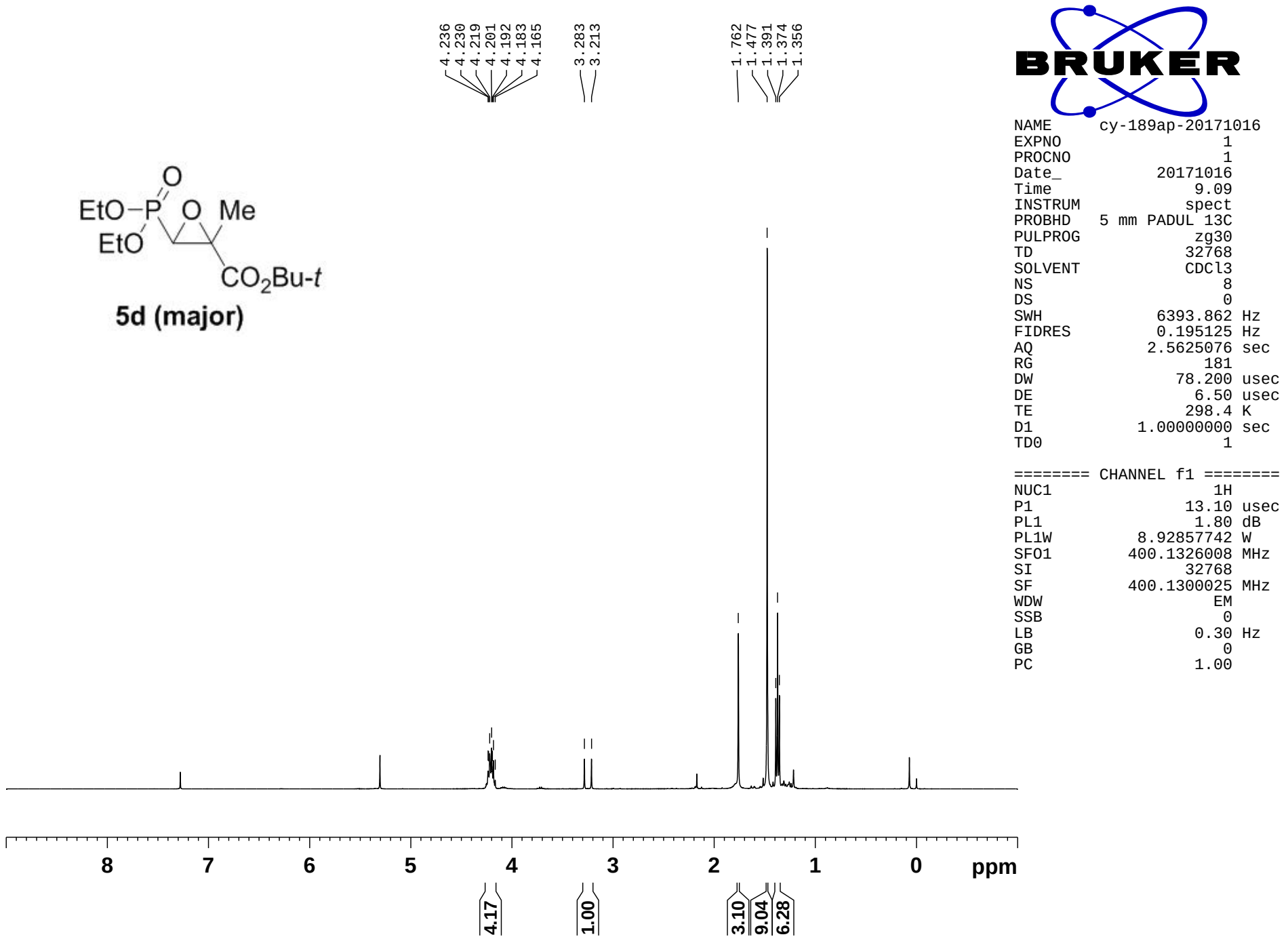



```
NAME          cy-187b-1p
EXPNO                  3
PROCNO                 1
Date_           20170920
Time               10.10
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                 65536
SOLVENT            CDCl3
NS                    32
DS                     4
SWH            96153.844 Hz
FIDRES          1.467191 Hz
AQ              0.3408372 sec
RG                190.02
DW                 5.200 usec
DE                 6.50 usec
TE                  0.0 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         242.9411216 MHz
NUC1                  31P
P1                 11.90 usec
SI                 32768
SF           242.9532693 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```

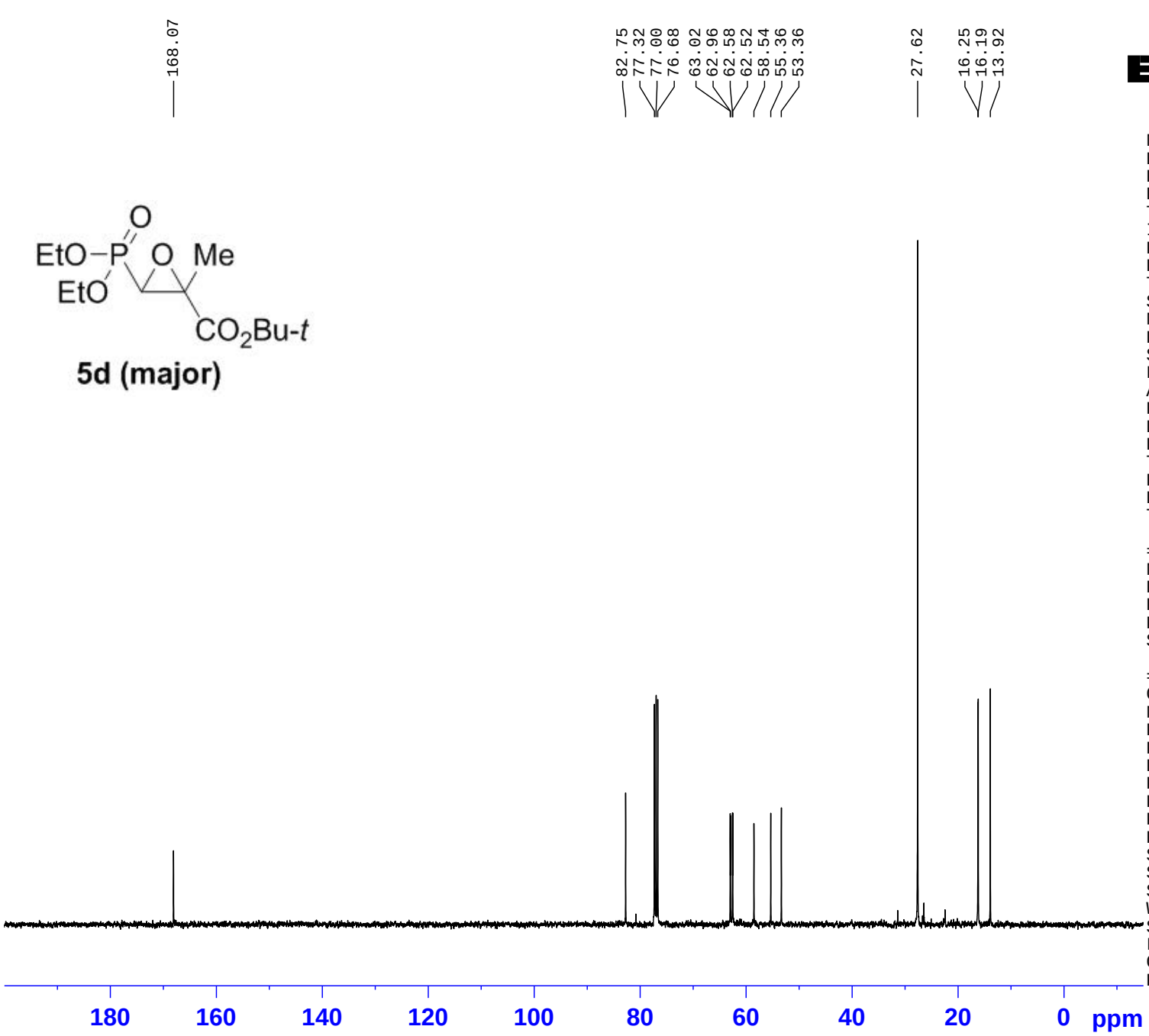


5c'


```
NAME                cyj91bp
EXPNO                     3
PROCNO                    1
Date_              20171031
Time                  14.53
INSTRUM               spect
PROBHD   5 mm PABBO BB/
PULPROG              zgpg30
TD                    65536
SOLVENT               CDCl3
NS                       64
DS                        4
SWH               96153.844 Hz
FIDRES             1.467191 Hz
AQ                 0.3408372 sec
RG                    190.02
DW                     5.200 usec
DE                     6.50 usec
TE                    297.0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                       1

======== CHANNEL f1 ========
SFO1             242.9411216 MHz
NUC1                     31P
P1                     11.90 usec
SI                     32768
SF               242.9532693 MHz
WDW                      EM
SSB                       0
LB                     1.00 Hz
GB                        0
PC                     1.40
```

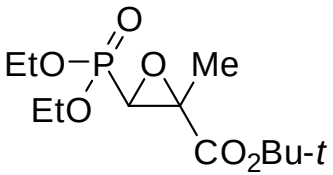



```
NAME      cy-189ap-20171016
EXPNO                    1
PROCNO                   1
Date_             20171016
Time                 9.09
INSTRUM             spect
PROBHD   5 mm PADUL 13C
PULPROG              zg30
TD                  32768
SOLVENT             CDCl3
NS                      8
DS                      0
SWH              6393.862 Hz
FIDRES           0.195125 Hz
AQ               2.5625076 sec
RG                    181
DW                 78.200 usec
DE                  6.50 usec
TE                 298.4 K
D1            1.00000000 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                   1H
P1                 13.10 usec
PL1                 1.80 dB
PL1W          8.92857742 W
SFO1         400.1326008 MHz
SI                  32768
SF           400.1300025 MHz
WDW                    EM
SSB                     0
LB                 0.30 Hz
GB                      0
PC                 1.00
```



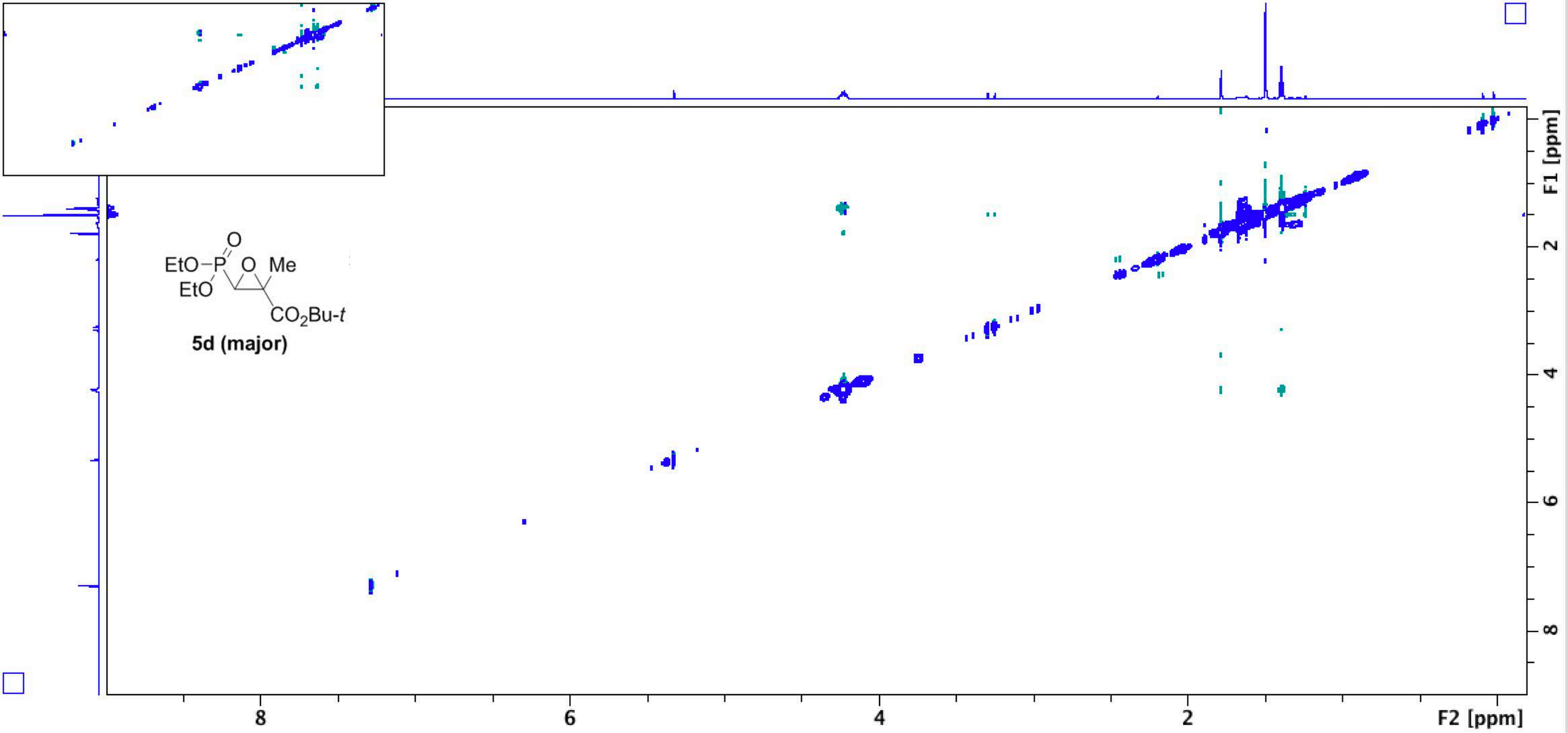
BRUKER

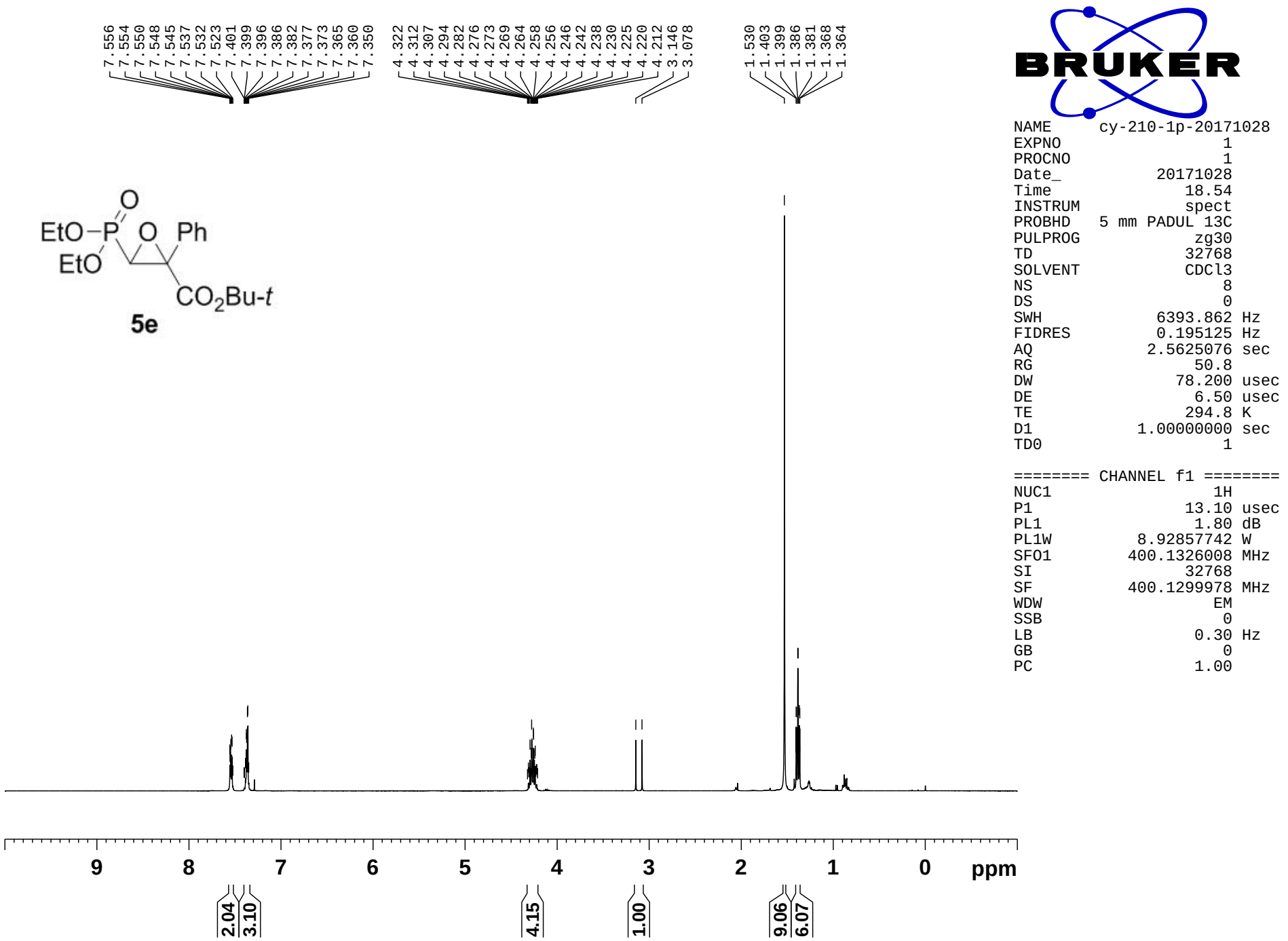
NAME	cy-214-2p-20171028
EXPNO	2
PROCNO	1
Date_	20171028
Time	21.05
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	80
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	295.6 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127804 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40



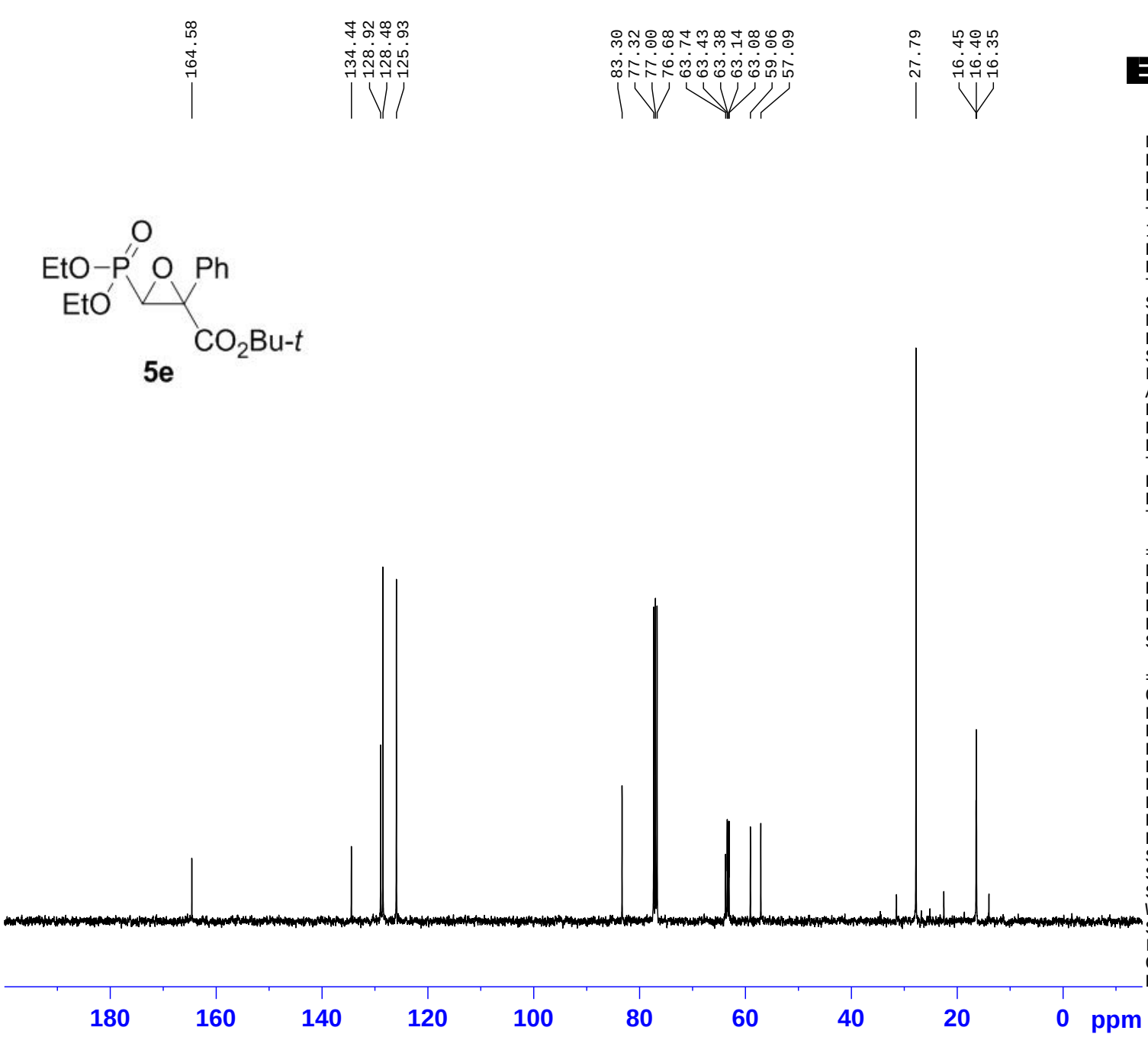
5d

NAME	cy-189a-p
EXPNO	4
PROCNO	1
Date_	20171017
Time	10.04
INSTRUM	spect
PROBHD	5 mm PABBO BB/
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	32
DS	4
SWH	96153.844 Hz
FIDRES	1.467191 Hz
AQ	0.3408372 sec
RG	190.02
DW	5.200 usec
DE	6.50 usec
TE	296.2 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
SFO1	242.9411216 MHz
NUC1	31P
P1	11.90 usec
SI	32768
SF	242.9532693 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40


EtO
P
O
O
Me
EtO
CO2Bu-t
5d (major)
F1 [ppm]
F2 [ppm]
2
4
6
8

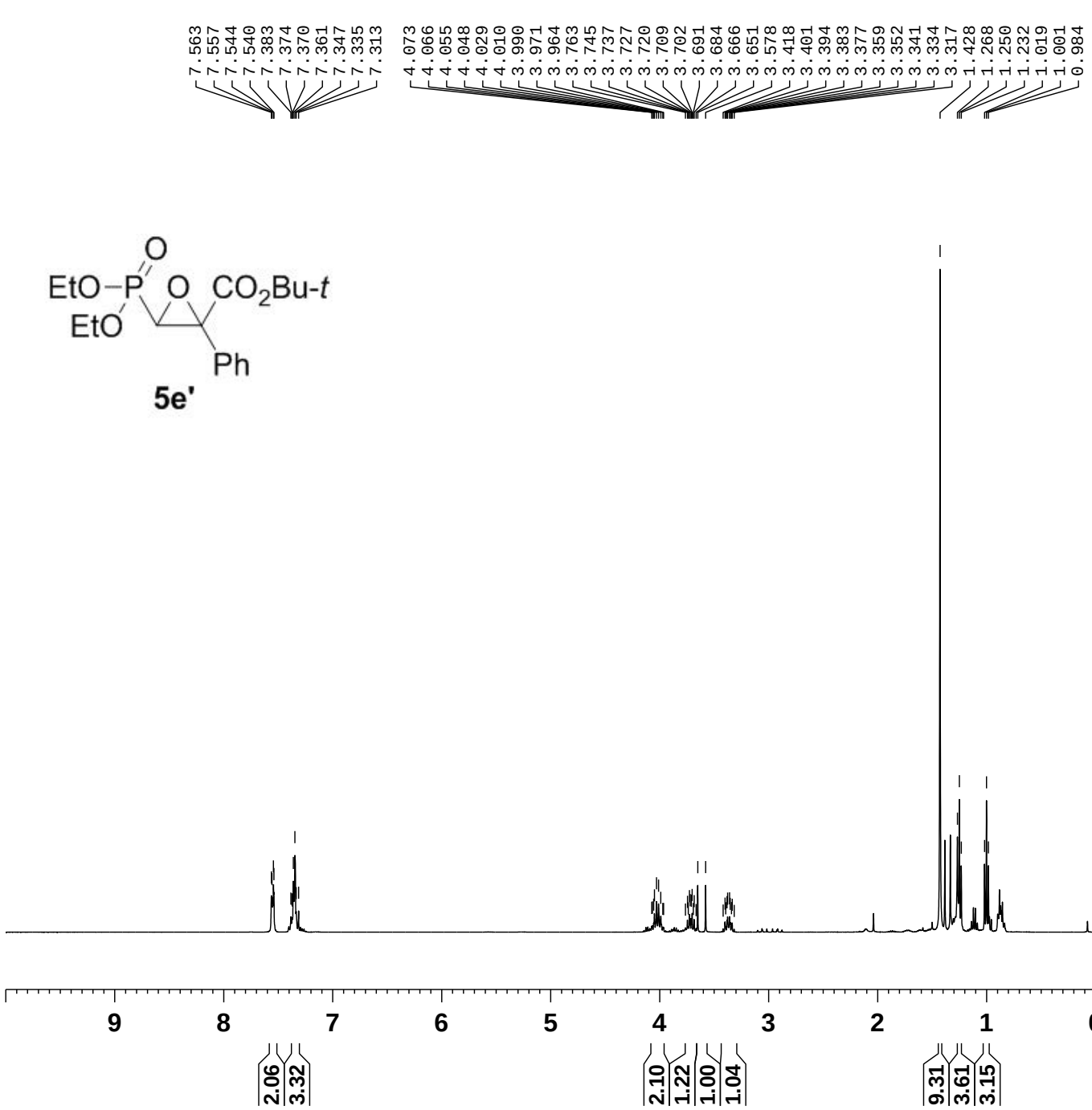



```
NAME      cy-210-1p-20171028
EXPNO                      1
PROCNO                     1
Date_               20171028
Time                   18.54
INSTRUM                spect
PROBHD   5 mm PADUL 13C
PULPROG                zg30
TD                    32768
SOLVENT               CDCl3
NS                        8
DS                        0
SWH                6393.862 Hz
FIDRES             0.195125 Hz
AQ                 2.5625076 sec
RG                      50.8
DW                    78.200 usec
DE                     6.50 usec
TE                    294.8 K
D1                1.00000000 sec
TD0                        1

======== CHANNEL f1 ========
NUC1                      1H
P1                     13.10 usec
PL1                     1.80 dB
PL1W            8.92857742 W
SFO1           400.1326008 MHz
SI                    32768
SF             400.1299978 MHz
WDW                      EM
SSB                       0
LB                     0.30 Hz
GB                        0
PC                     1.00
```

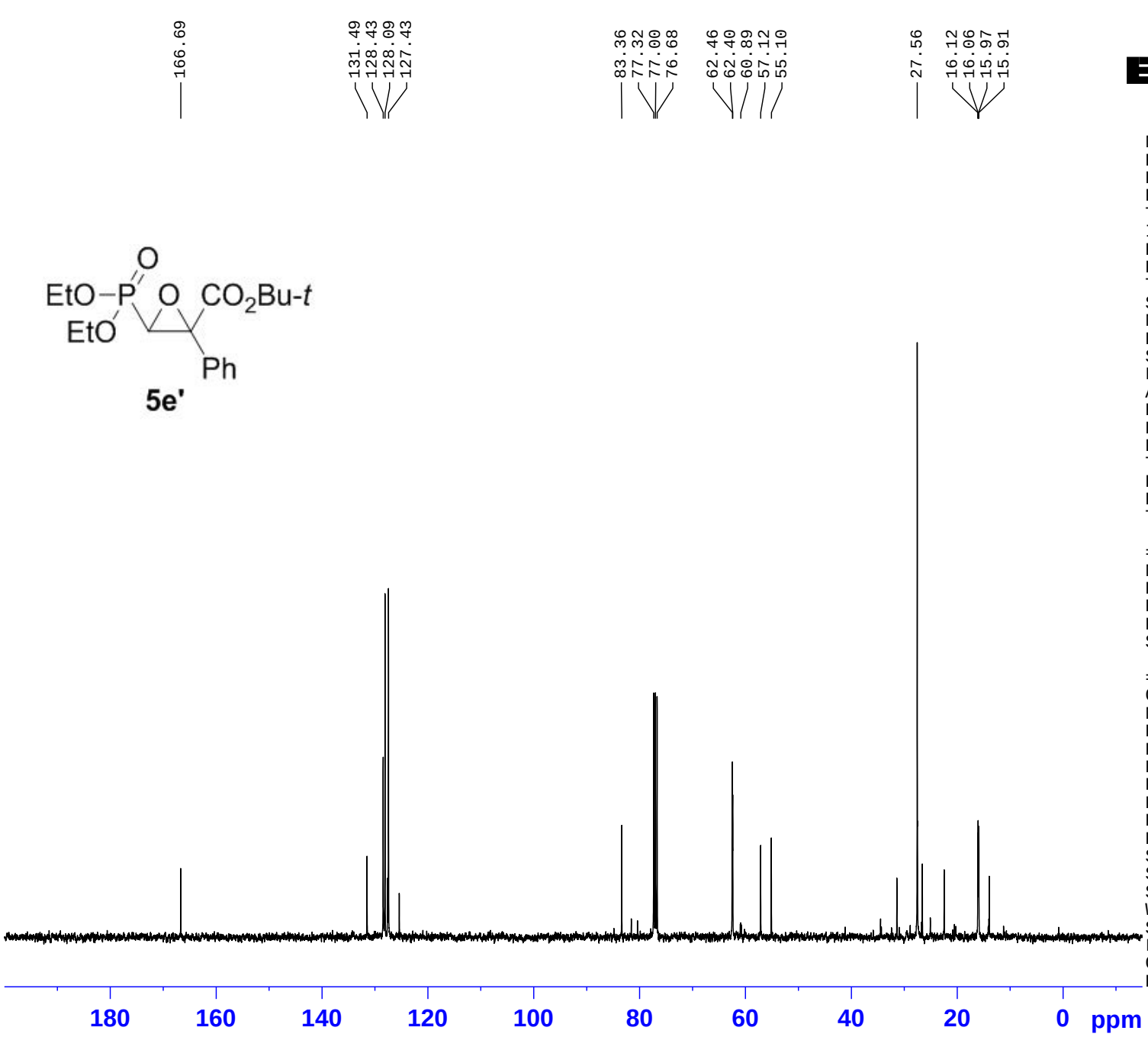


BRUKER

NAME	cy-210-1p-20171028
EXPNO	2
PROCNO	1
Date_	20171028
Time	18.58
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	56
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	295.5 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127788 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40

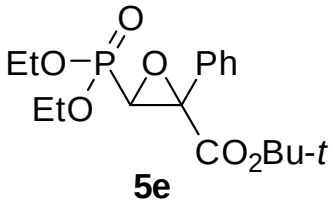



```
NAME      cy-210-2p-20171028
EXPNO                      1
PROCNO                     1
Date_               20171028
Time                   19.05
INSTRUM                spect
PROBHD   5 mm PADUL 13C
PULPROG                 zg30
TD                     32768
SOLVENT                CDCl3
NS                         8
DS                         0
SWH                 6393.862 Hz
FIDRES              0.195125 Hz
AQ                2.5625076 sec
RG                      50.8
DW                    78.200 usec
DE                     6.50 usec
TE                    294.7 K
D1                1.00000000 sec
TD0                        1

======== CHANNEL f1 ========
NUC1                      1H
P1                     13.10 usec
PL1                     1.80 dB
PL1W             8.92857742 W
SFO1           400.1326008 MHz
SI                     32768
SF             400.1299887 MHz
WDW                       EM
SSB                        0
LB                      0.30 Hz
GB                         0
PC                      1.00
```



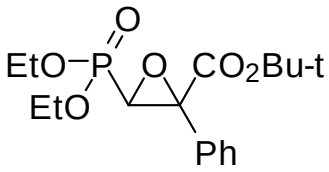
BRUKER

NAME	cy-210-2p-20171028
EXPNO	2
PROCNO	1
Date_	20171028
Time	19.13
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	48
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	295.6 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127821 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40



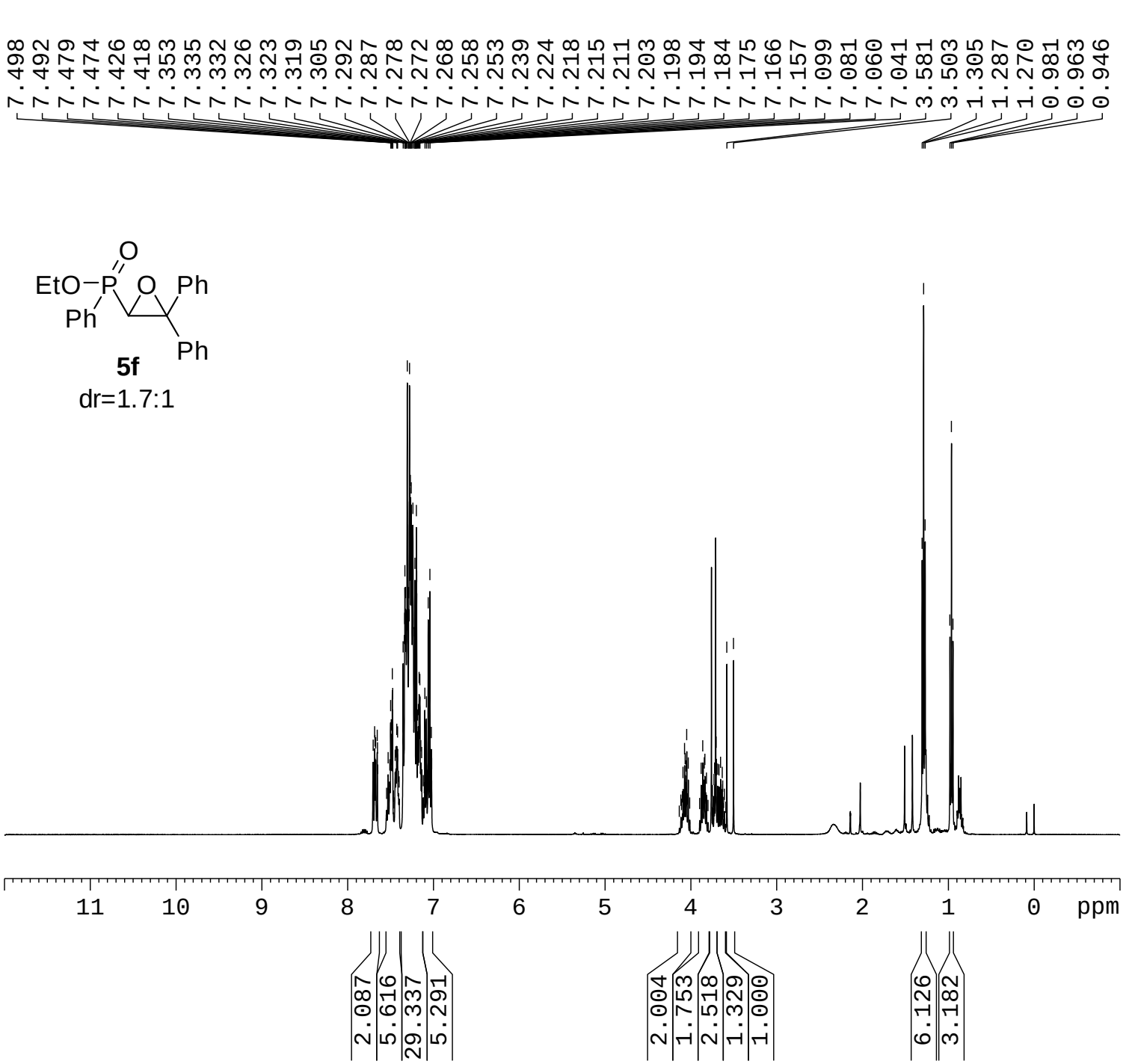
5e


```
NAME            cy-210-1p
EXPNO                   4
PROCNO                  1
Date_            20171024
Time                14.34
INSTRUM             spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                    32
DS                     4
SWH             96153.844 Hz
FIDRES           1.467191 Hz
AQ               0.3408372 sec
RG                  190.02
DW                   5.200 usec
DE                   6.50 usec
TE                  296.4 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          242.9411216 MHz
NUC1                  31P
P1                  11.90 usec
SI                  32768
SF            242.9532693 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```



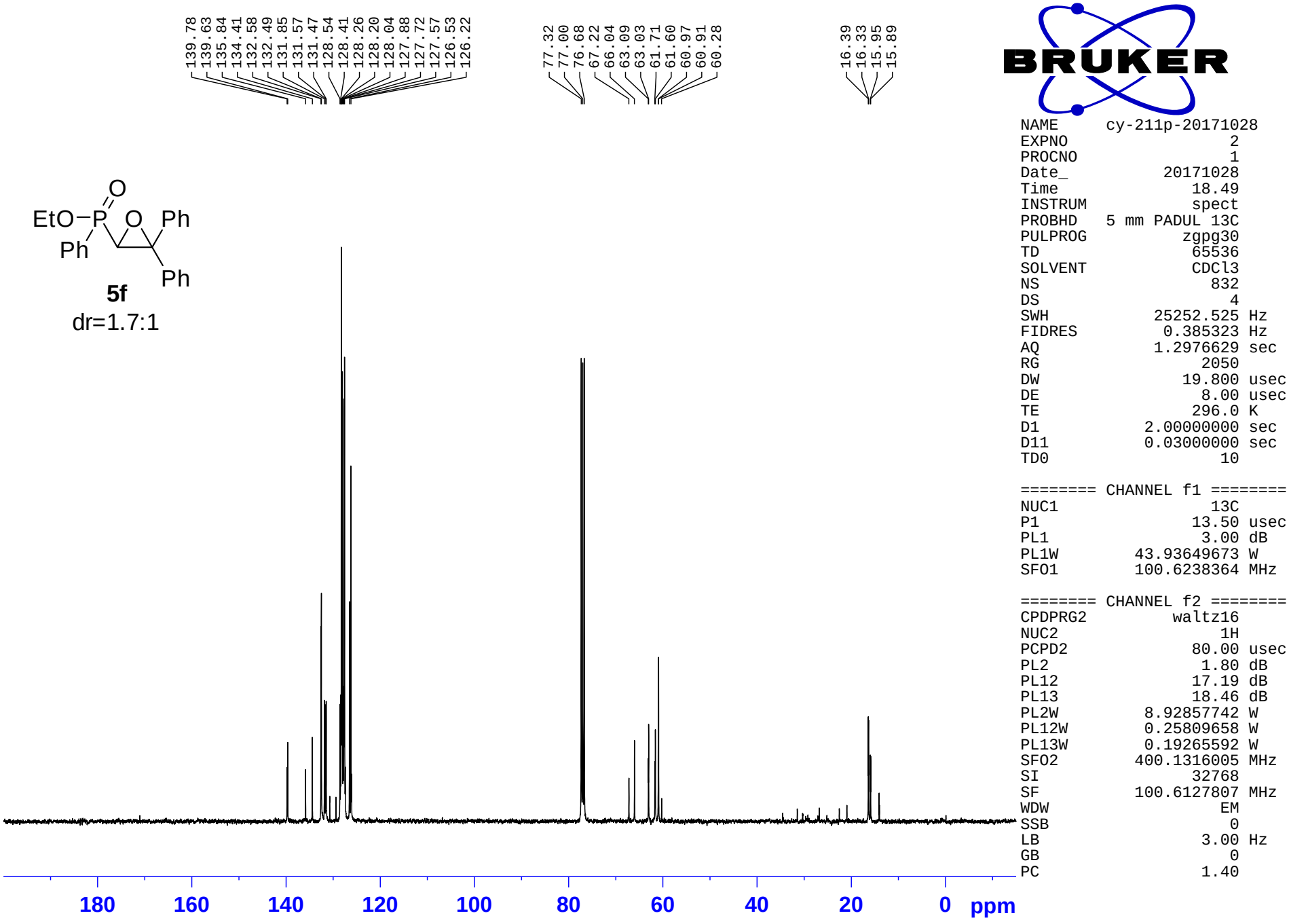
5e'


```
NAME            cy-210-2p
EXPNO                   4
PROCNO                  1
Date_            20171024
Time                14.39
INSTRUM             spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                    32
DS                     4
SWH             96153.844 Hz
FIDRES           1.467191 Hz
AQ               0.3408372 sec
RG                  190.02
DW                   5.200 usec
DE                   6.50 usec
TE                  296.5 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          242.9411216 MHz
NUC1                  31P
P1                  11.90 usec
SI                  32768
SF            242.9532693 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```



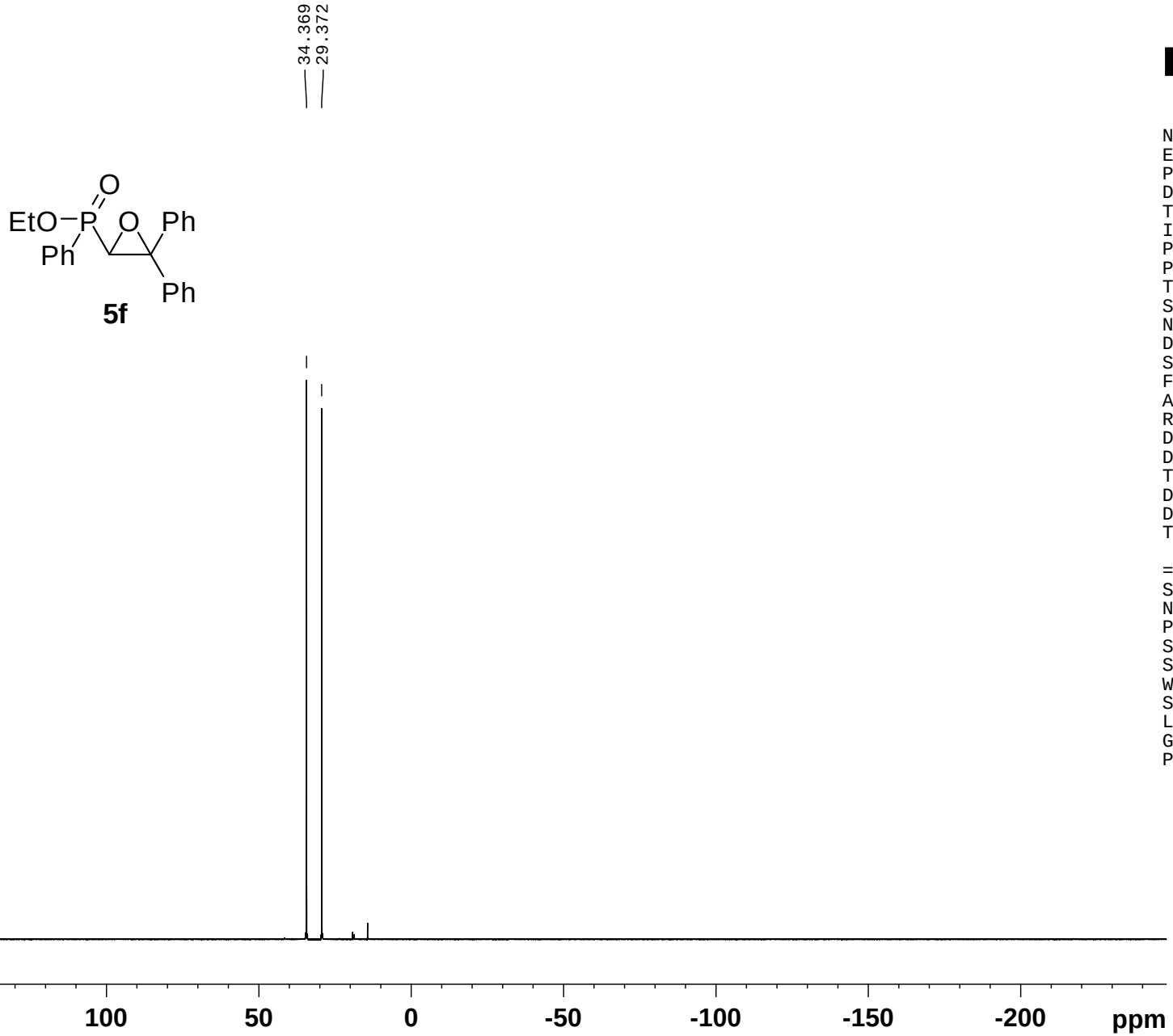
BRUKER

NAME	cy-211p-20171024
EXPNO	1
PROCNO	1
Date_	20171024
Time	9.56
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	50.8
DW	78.200 usec
DE	6.50 usec
TE	294.4 K
D1	1.00000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1300064 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00

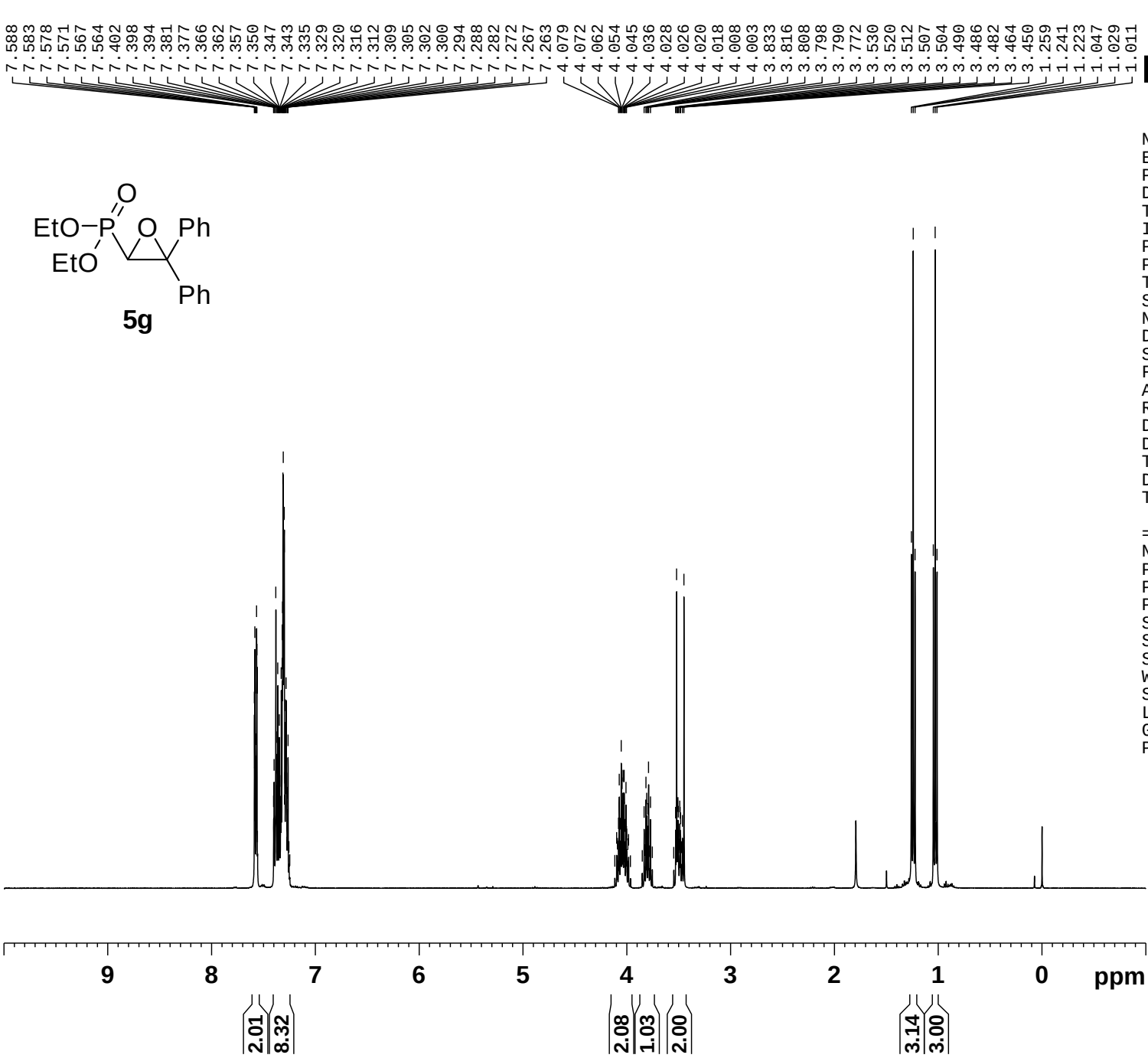


BRUKER

NAME	cy-211p-20171028
EXPNO	2
PROCNO	1
Date_	20171028
Time	18.49
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	832
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	296.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127807 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40

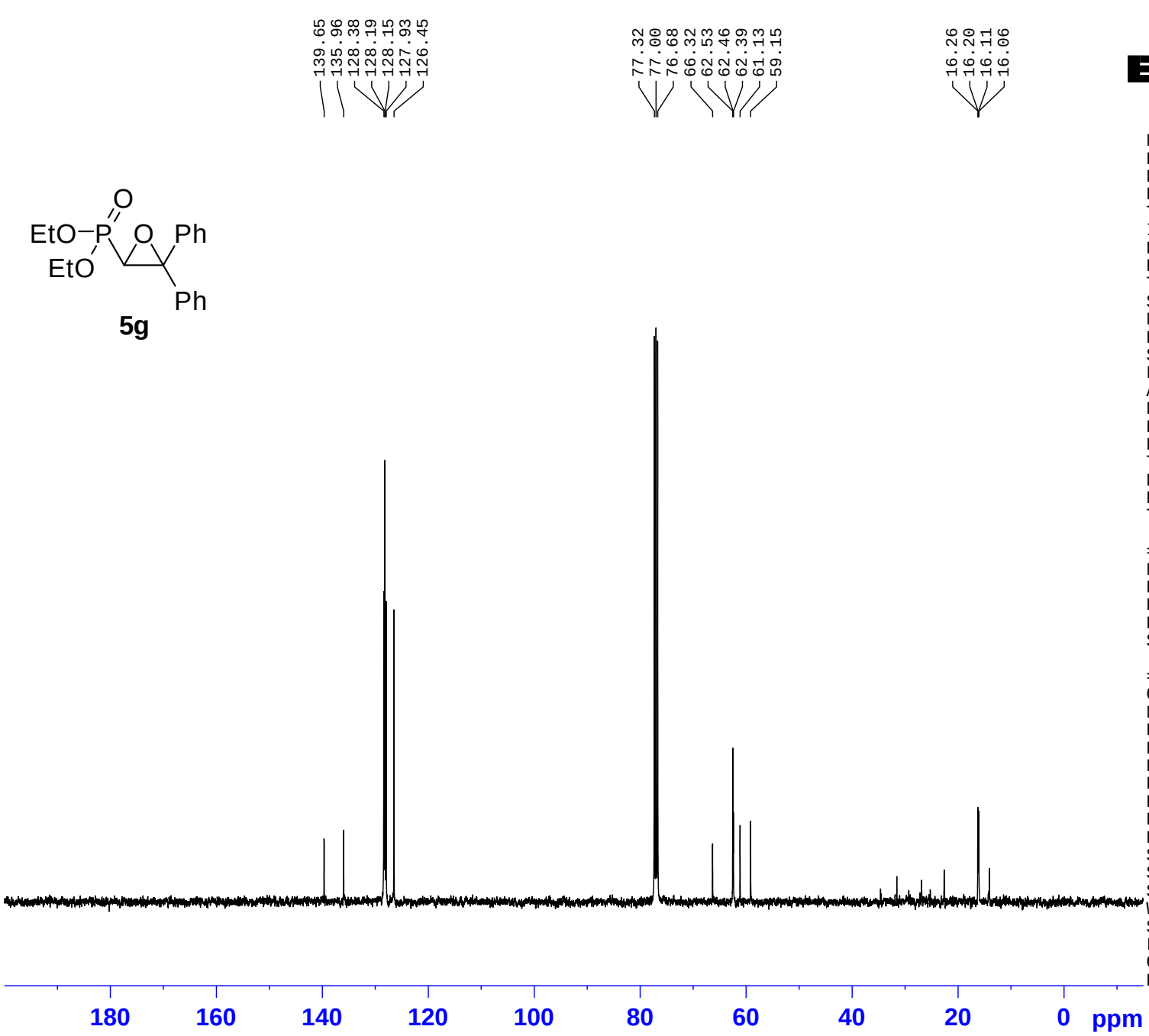



```
NAME                cy-211p
EXPNO                     4
PROCNO                    1
Date_              20171024
Time                  14.29
INSTRUM               spect
PROBHD   5 mm PABBO BB/
PULPROG              zgpg30
TD                    65536
SOLVENT               CDCl3
NS                       32
DS                        4
SWH               96153.844 Hz
FIDRES             1.467191 Hz
AQ                 0.3408372 sec
RG                    190.02
DW                     5.200 usec
DE                     6.50 usec
TE                    296.2 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                       1

======== CHANNEL f1 ========
SFO1             242.9411216 MHz
NUC1                     31P
P1                     11.90 usec
SI                     32768
SF               242.9532693 MHz
WDW                      EM
SSB                       0
LB                     1.00 Hz
GB                        0
PC                     1.40
```



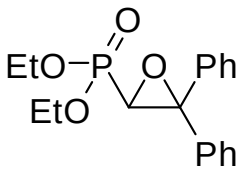
BRUKER

NAME	cy-188p-20170919
EXPNO	1
PROCNO	1
Date_	20170919
Time	23.00
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	203
DW	78.200 usec
DE	6.50 usec
TE	294.2 K
D1	1.00000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1300085 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00



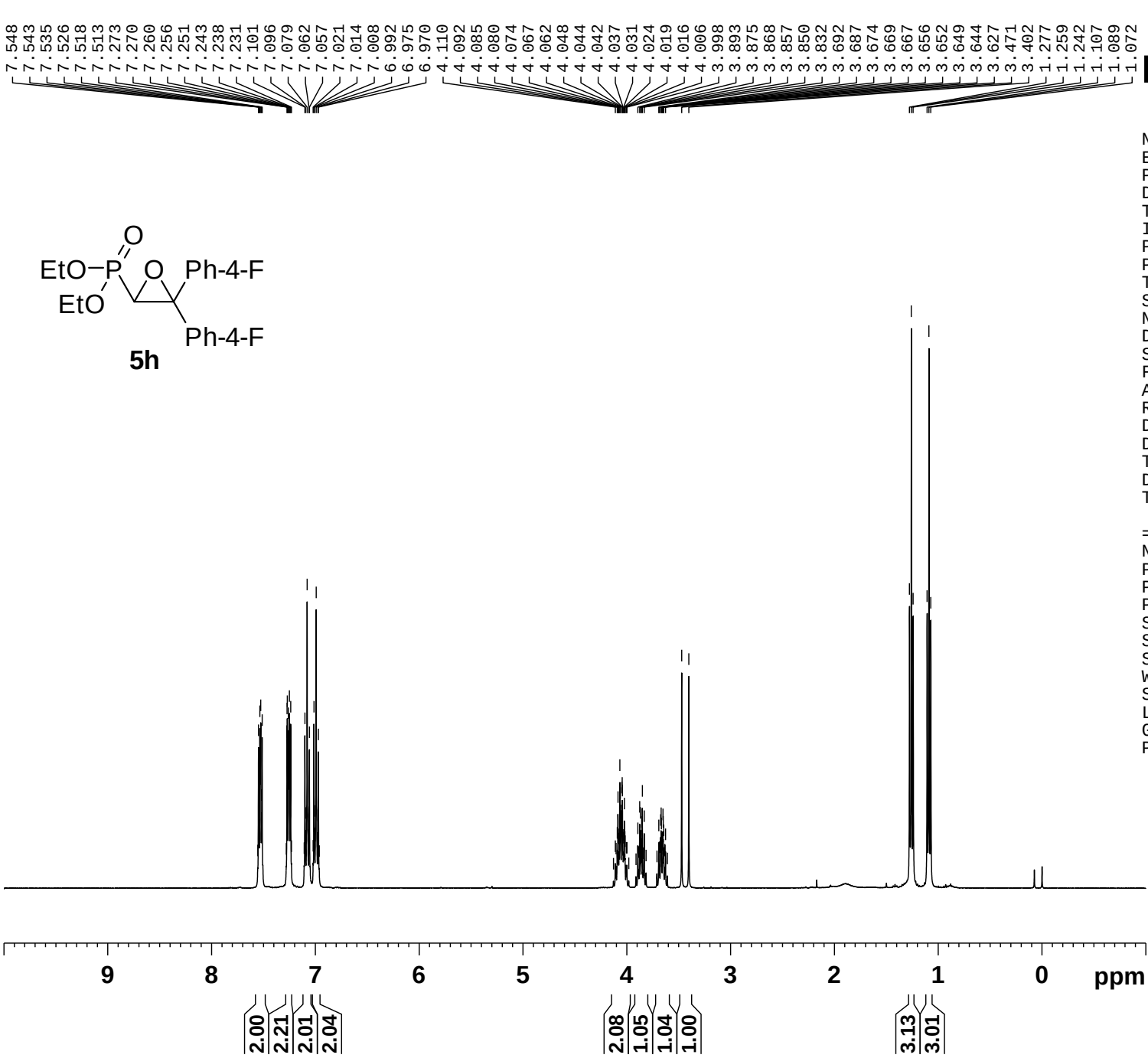
BRUKER

NAME	cy-212p-20171024
EXPNO	2
PROCNO	1
Date_	20171024
Time	9.10
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	232
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	295.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127749 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40



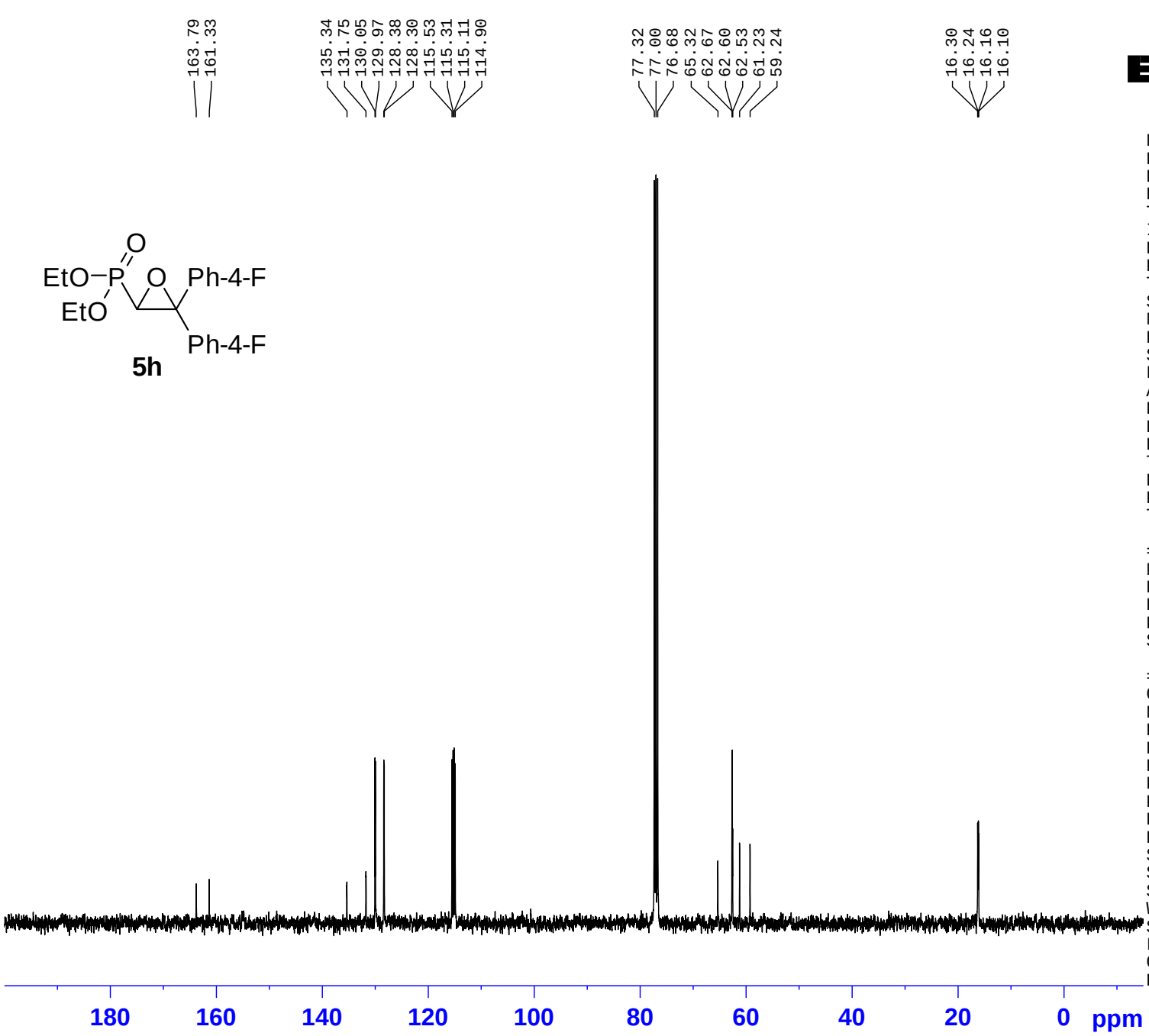
5g


```
NAME                cy-188p
EXPNO                     3
PROCNO                    1
Date_              20170920
Time                   9.51
INSTRUM               spect
PROBHD   5 mm PABBO BB/
PULPROG              zgpg30
TD                    65536
SOLVENT               CDCl3
NS                       32
DS                        4
SWH               96153.844 Hz
FIDRES             1.467191 Hz
AQ                 0.3408372 sec
RG                    190.02
DW                     5.200 usec
DE                     6.50 usec
TE                      0.0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                       1

======== CHANNEL f1 ========
SFO1             242.9411216 MHz
NUC1                     31P
P1                     11.90 usec
SI                     32768
SF               242.9532693 MHz
WDW                       EM
SSB                        0
LB                      3.00 Hz
GB                         0
PC                      1.40
```



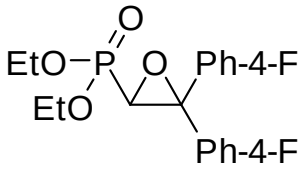
BRUKER

NAME	cy-195bp-20170929
EXPNO	1
PROCNO	1
Date_	20170929
Time	9.33
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	203
DW	78.200 usec
DE	6.50 usec
TE	296.6 K
D1	1.00000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1300059 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00



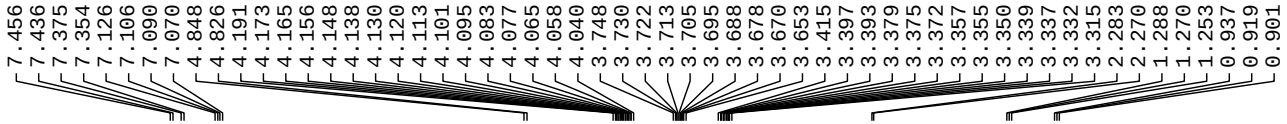
BRUKER

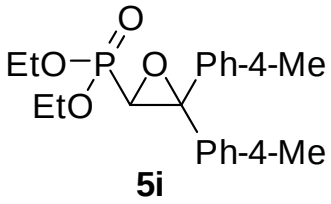
NAME	cy-195bp-20170929
EXPNO	2
PROCNO	1
Date_	20170929
Time	9.41
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	88
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	297.8 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127728 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40



5h


```
NAME            cy-205b-p
EXPNO                   3
PROCNO                  1
Date_            20171017
Time                10.14
INSTRUM             spect
PROBHD   5 mm PABBO BB/
PULPROG            zgpg30
TD                  65536
SOLVENT             CDCl3
NS                     32
DS                      4
SWH             96153.844 Hz
FIDRES           1.467191 Hz
AQ              0.3408372 sec
RG                 190.02
DW                  5.200 usec
DE                  6.50 usec
TE                 296.3 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                     1

======== CHANNEL f1 ========
SFO1          242.9411216 MHz
NUC1                  31P
P1                 11.90 usec
SI                 32768
SF            242.9532693 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```

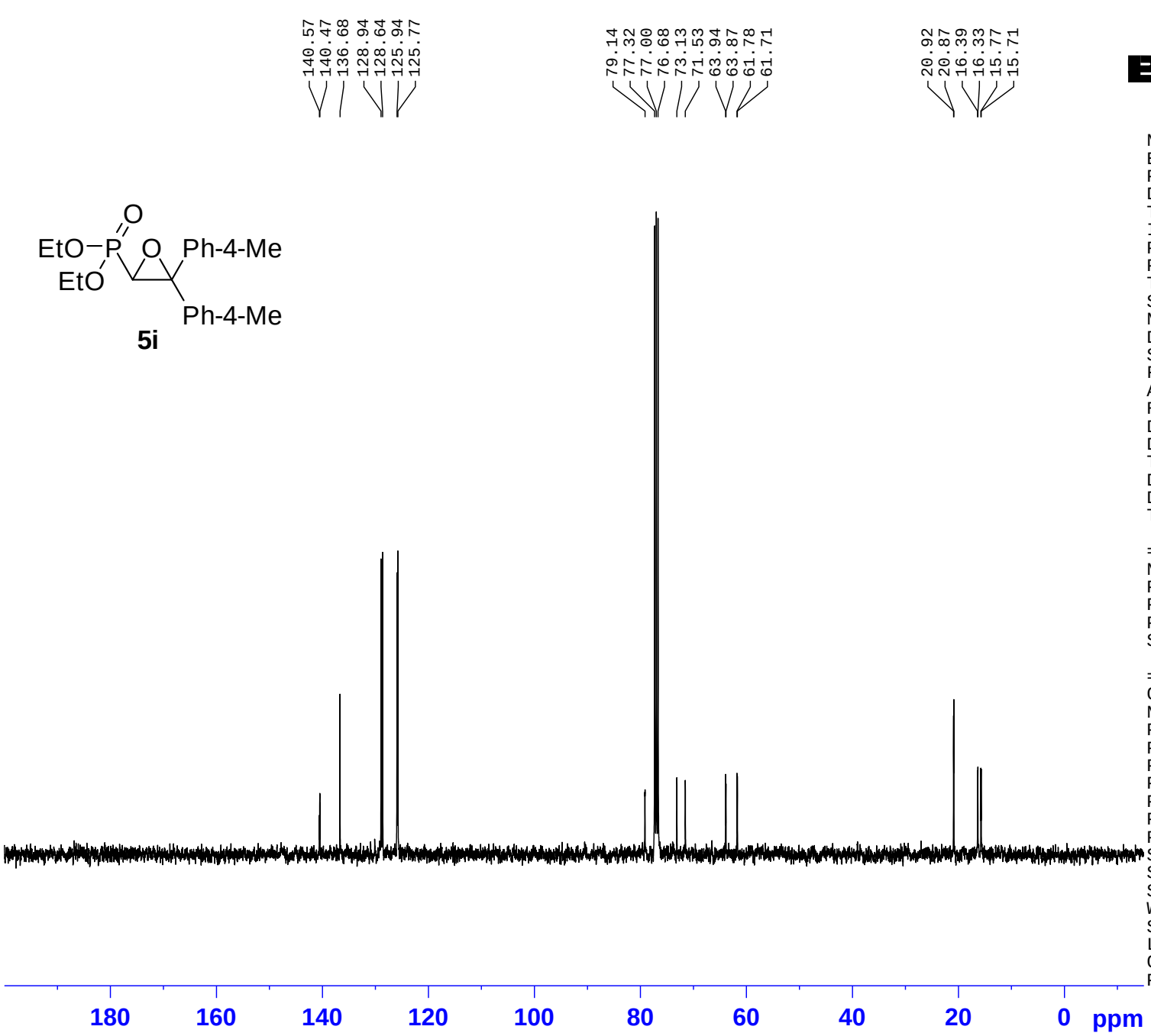




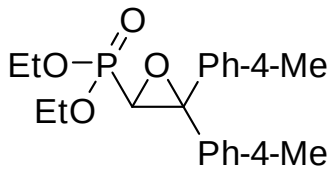
5i

BRUKER

```
NAME      cy-195ap-20171007
EXPNO                    1
PROCNO                   1
Date_             20171007
Time                 20.33
INSTRUM              spect
PROBHD   5 mm PADUL 13C
PULPROG               zg30
TD                   32768
SOLVENT              CDCl3
NS                       8
DS                       0
SWH               6393.862 Hz
FIDRES            0.195125 Hz
AQ               2.5625076 sec
RG                     181
DW                  78.200 usec
DE                   6.50 usec
TE                  297.0 K
D1             1.00000000 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                    1H
P1                   13.10 usec
PL1                   1.80 dB
PL1W          8.92857742 W
SFO1         400.1326008 MHz
SI                   32768
SF           400.1300114 MHz
WDW                    EM
SSB                     0
LB                   0.30 Hz
GB                      0
PC                   1.00
```

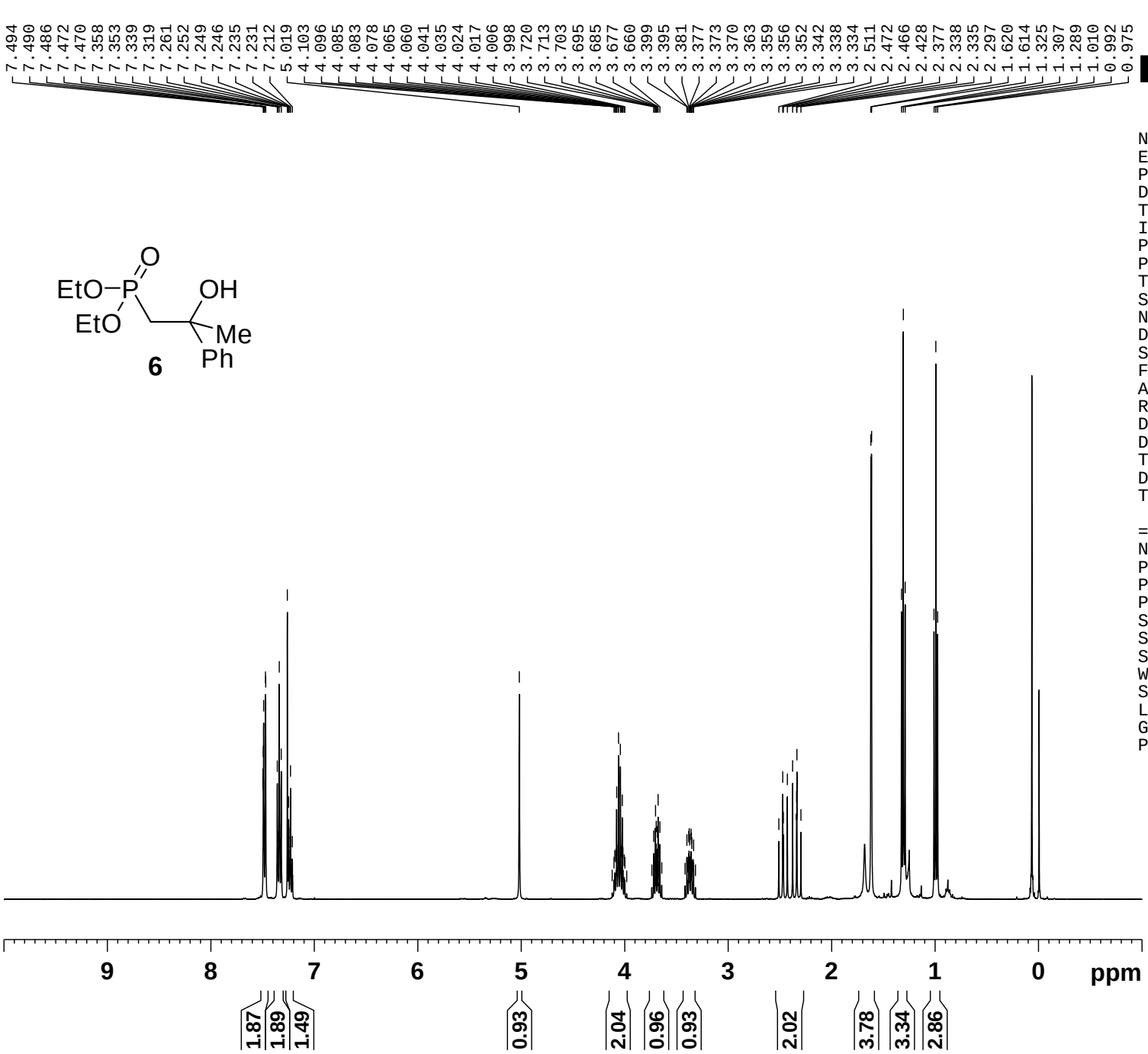



```
NAME      cy-195ap-20171007
EXPNO                    2
PROCNO                   1
Date_             20171007
Time                 20.38
INSTRUM              spect
PROBHD   5 mm PADUL 13C
PULPROG           zgpg30
TD                  65536
SOLVENT             CDCl3
NS                     96
DS                      4
SWH              25252.525 Hz
FIDRES           0.385323 Hz
AQ               1.2976629 sec
RG                    2050
DW                  19.800 usec
DE                   8.00 usec
TE                  297.6 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    10

======== CHANNEL f1 ========
NUC1                  13C
P1                  13.50 usec
PL1                  3.00 dB
PL1W          43.93649673 W
SFO1          100.6238364 MHz

======== CHANNEL f2 ========
CPDPRG2           waltz16
NUC2                  1H
PCPD2               80.00 usec
PL2                  1.80 dB
PL12                17.19 dB
PL13                18.46 dB
PL2W           8.92857742 W
PL12W          0.25809658 W
PL13W          0.19265592 W
SFO2          400.1316005 MHz
SI                 32768
SF            100.6127740 MHz
WDW                   EM
SSB                    0
LB                  3.00 Hz
GB                     0
PC                  1.40
```



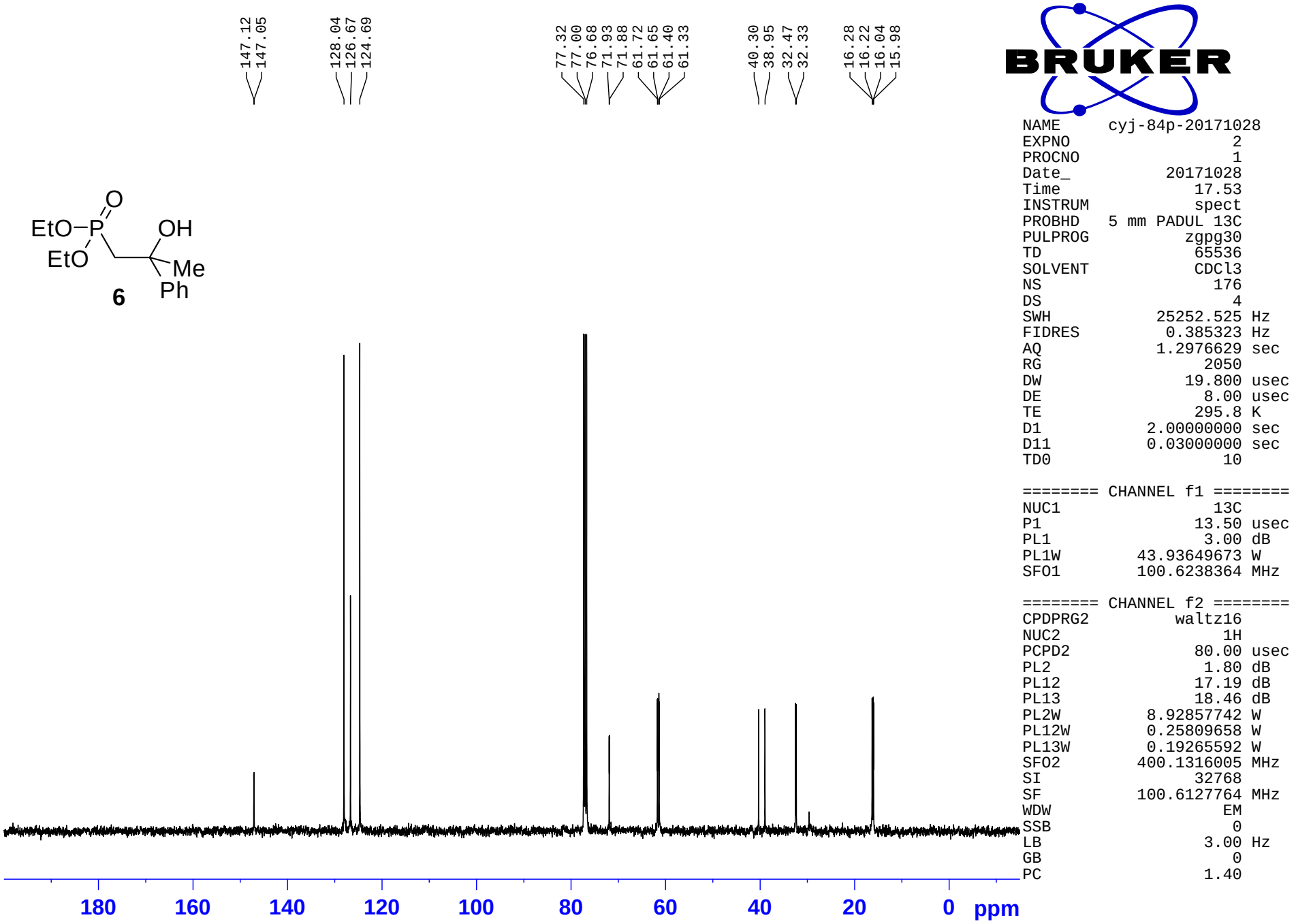
5i

NAME	cy-195ap
EXPNO	3
PROCNO	1
Date_	20171013
Time	10.14
INSTRUM	spect
PROBHD	5 mm PABBO BB/
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	32
DS	4
SWH	96153.844 Hz
FIDRES	1.467191 Hz
AQ	0.3408372 sec
RG	190.02
DW	5.200 usec
DE	6.50 usec
TE	0.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
SFO1	242.9411216 MHz
NUC1	31P
P1	11.90 usec
SI	32768
SF	242.9532693 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40



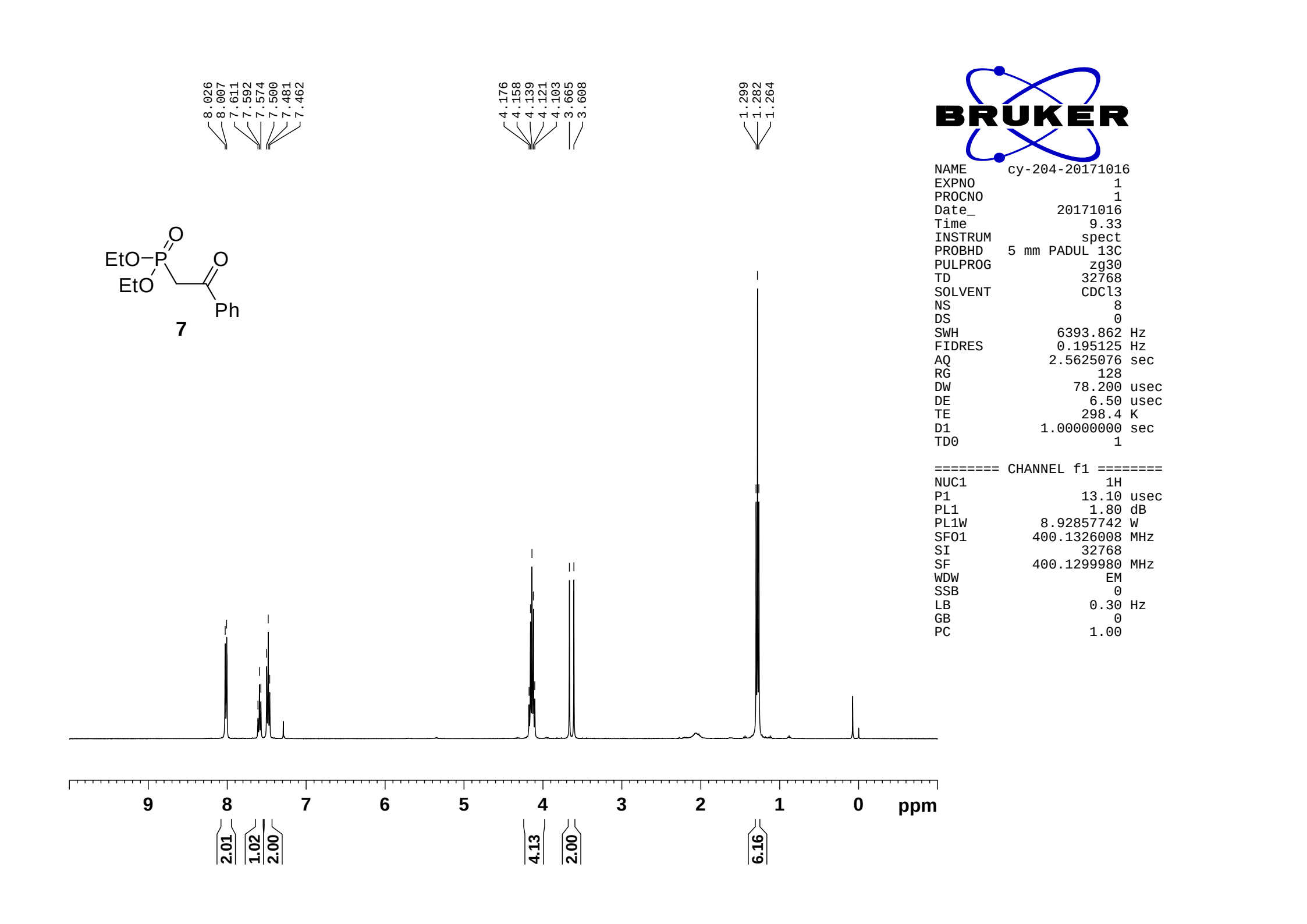
BRUKER

NAME	cyj84-20171026
EXPNO	1
PROCNO	1
Date_	20171026
Time	21.15
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	228
DW	78.200 usec
DE	6.50 usec
TE	294.6 K
D1	1.00000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1300096 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00



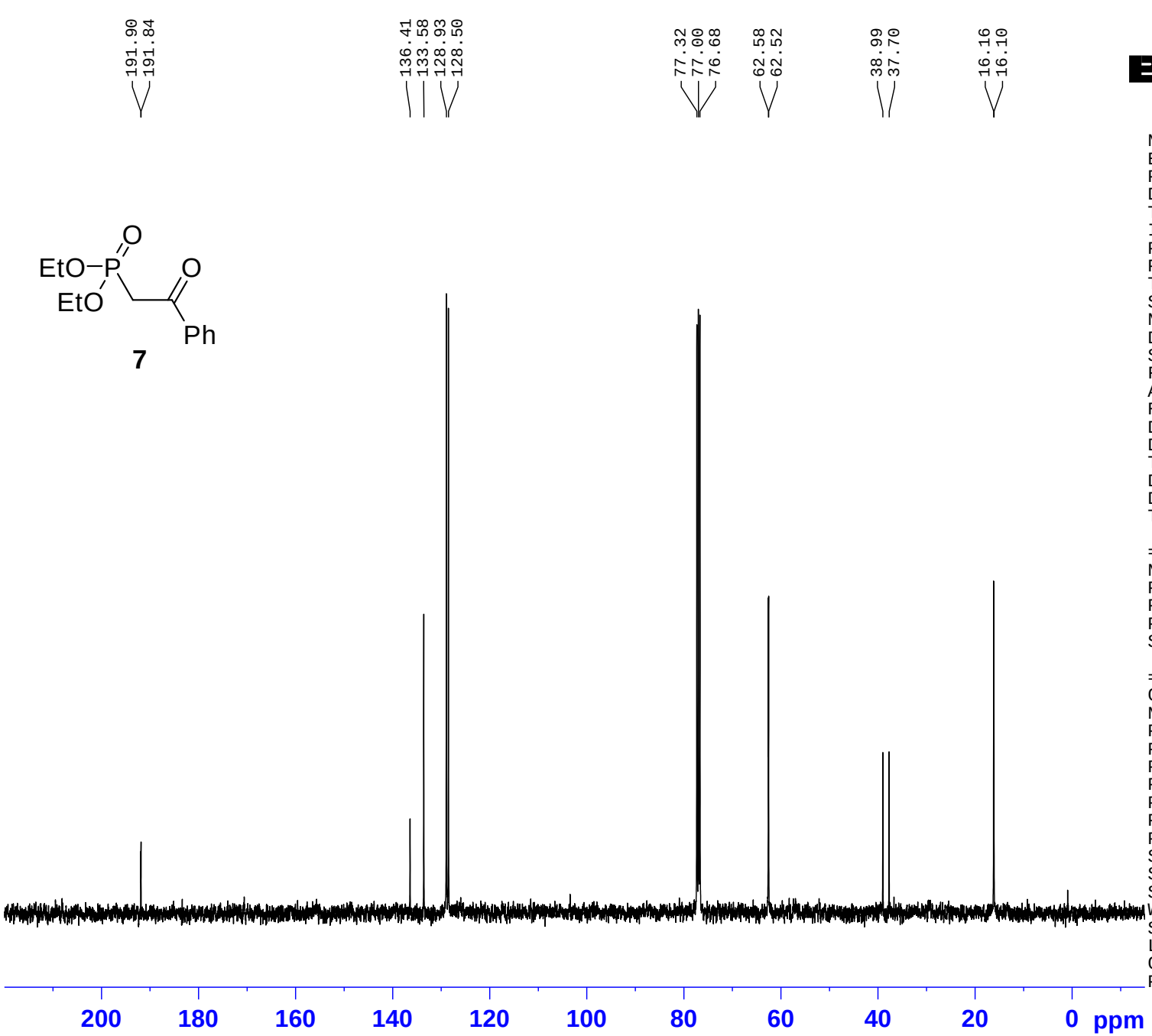
BRUKER

NAME	cyj-84p-20171028
EXPNO	2
PROCNO	1
Date_	20171028
Time	17.53
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	176
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	295.8 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127764 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40

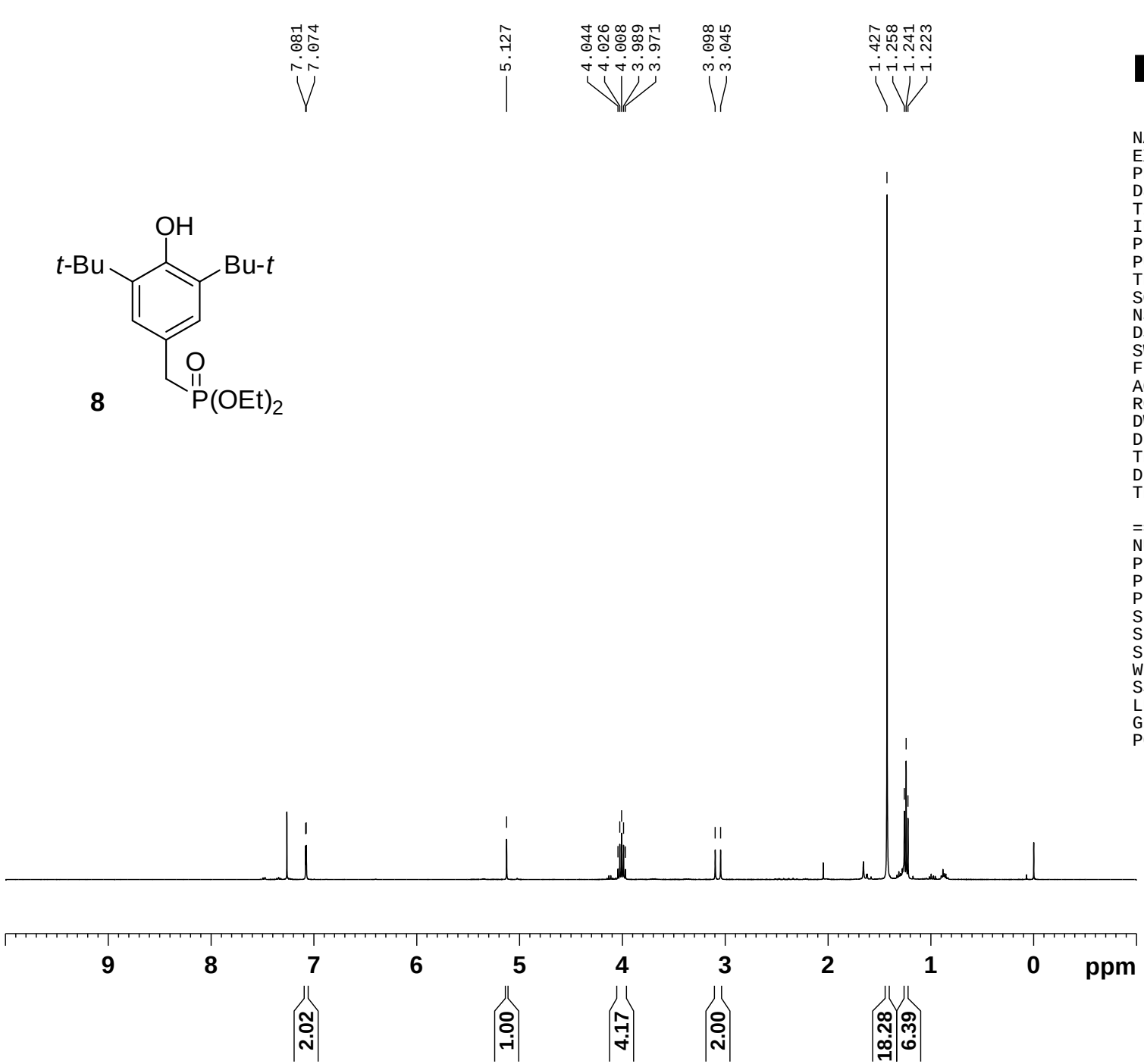


BRUKER

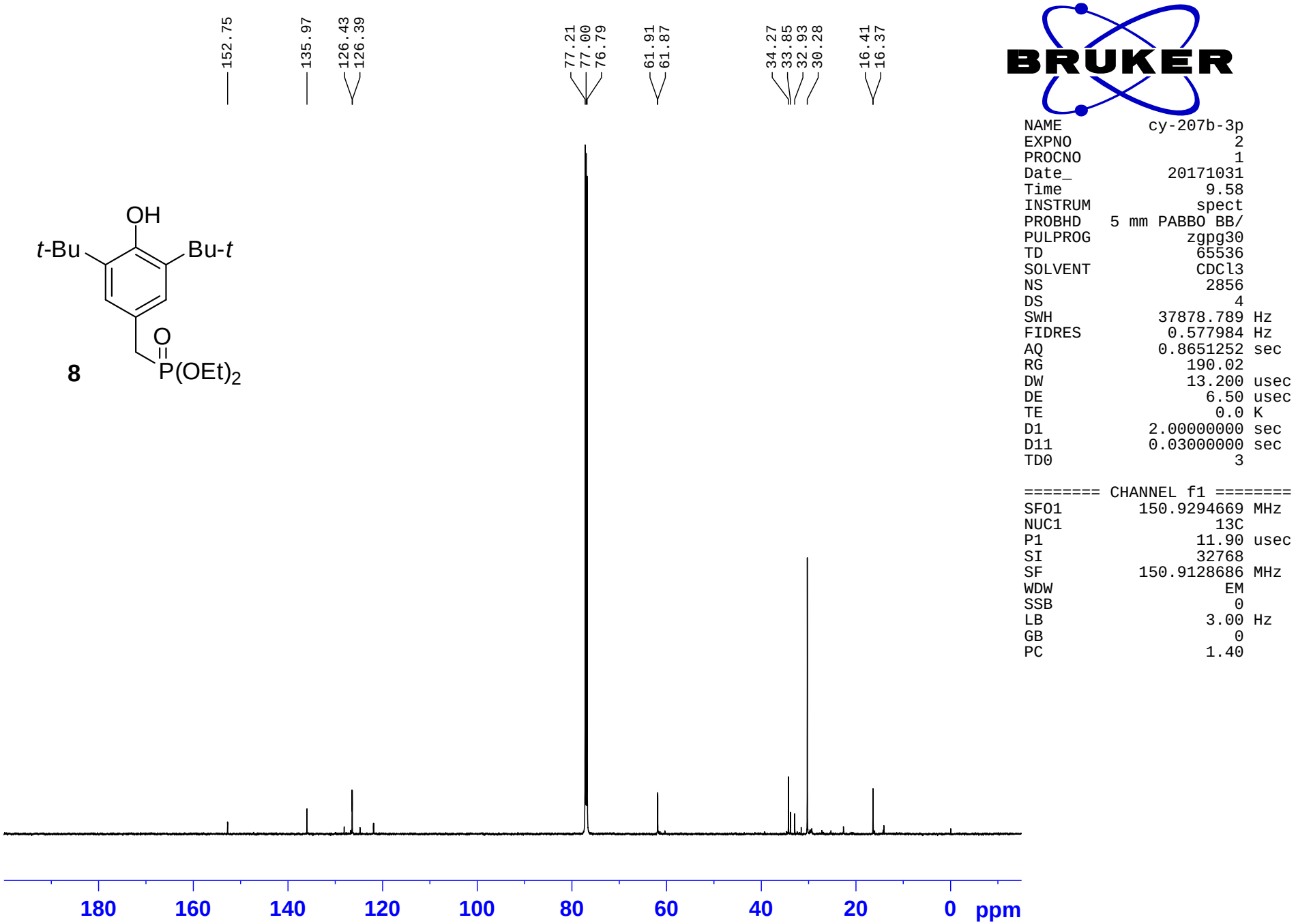
NAME	cy-204-20171016
EXPNO	1
PROCNO	1
Date_	20171016
Time	9.33
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zg30
TD	32768
SOLVENT	CDCl3
NS	8
DS	0
SWH	6393.862 Hz
FIDRES	0.195125 Hz
AQ	2.5625076 sec
RG	128
DW	78.200 usec
DE	6.50 usec
TE	298.4 K
D1	1.00000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	1H
P1	13.10 usec
PL1	1.80 dB
PL1W	8.92857742 W
SFO1	400.1326008 MHz
SI	32768
SF	400.1299980 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00



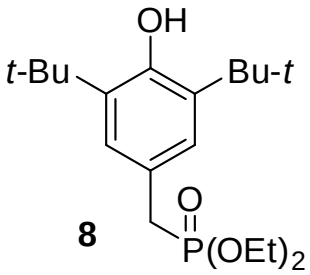
NAME	cy-204p-20171018
EXPNO	2
PROCNO	1
Date_	20171018
Time	16.37
INSTRUM	spect
PROBHD	5 mm PADUL 13C
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	56
DS	4
SWH	25252.525 Hz
FIDRES	0.385323 Hz
AQ	1.2976629 sec
RG	2050
DW	19.800 usec
DE	8.00 usec
TE	295.3 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	10
======== CHANNEL f1 ========	
NUC1	13C
P1	13.50 usec
PL1	3.00 dB
PL1W	43.93649673 W
SFO1	100.6238364 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.80 dB
PL12	17.19 dB
PL13	18.46 dB
PL2W	8.92857742 W
PL12W	0.25809658 W
PL13W	0.19265592 W
SFO2	400.1316005 MHz
SI	32768
SF	100.6127787 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40




```
NAME        cy-207b-3p-20171028
EXPNO                         1
PROCNO                        1
Date_                  20171028
Time                      19.18
INSTRUM                   spect
PROBHD    5 mm PADUL 13C
PULPROG                    zg30
TD                        32768
SOLVENT                   CDCl3
NS                            8
DS                            0
SWH                    6393.862 Hz
FIDRES                 0.195125 Hz
AQ                     2.5625076 sec
RG                          256
DW                       78.200 usec
DE                        6.50 usec
TE                       294.7 K
D1                  1.00000000 sec
TD0                           1

======== CHANNEL f1 ========
NUC1                         1H
P1                       13.10 usec
PL1                       1.80 dB
PL1W                8.92857742 W
SFO1               400.1326008 MHz
SI                        32768
SF                 400.1300085 MHz
WDW                          EM
SSB                           0
LB                        0.30 Hz
GB                            0
PC                        1.00
```



NAME	cy-207b-3p
EXPNO	2
PROCNO	1
Date_	20171031
Time	9.58
INSTRUM	spect
PROBHD	5 mm PABBO BB/
PULPROG	zgpg30
TD	65536
SOLVENT	CDCl3
NS	2856
DS	4
SWH	37878.789 Hz
FIDRES	0.577984 Hz
AQ	0.8651252 sec
RG	190.02
DW	13.200 usec
DE	6.50 usec
TE	0.0 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	3
======== CHANNEL f1 ========	
SFO1	150.9294669 MHz
NUC1	13C
P1	11.90 usec
SI	32768
SF	150.9128686 MHz
WDW	EM
SSB	0
LB	3.00 Hz
GB	0
PC	1.40



8


```
NAME            cy-207b-3p
EXPNO                    3
PROCNO                   1
Date_             20171031
Time                 9.53
INSTRUM             spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                    64
DS                     4
SWH            96153.844 Hz
FIDRES          1.467191 Hz
AQ             0.3408372 sec
RG                190.02
DW                 5.200 usec
DE                 6.50 usec
TE                  0.0 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         242.9411216 MHz
NUC1                  31P
P1                 11.90 usec
SI                 32768
SF           242.9532693 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.40
```