Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supporting Information

Phosphinoyl-functionalization of unactivated alkenes through phosphinoyl radical-triggered distal functional group migration

Dong Chen,[a] Zhen Wu,[b] Yingming Yao,*[,a] and Chen Zhu,*[,a,b]

[a] Key Laboratory of Organic Synthesis of Jiangsu Province, College of Chemistry, Chemical Engineering and Materials Science, Soochow University, 199 Ren-Ai Road, Suzhou, Jiangsu 215123, China

[b] Key Laboratory of Synthetic Chemistry of Natural Substances, Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences, 345 Lingling Road, Shanghai 200032, China.

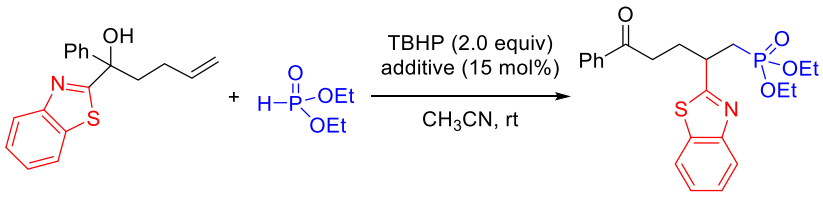
Email: chzhu@suda.edu.cn

Table of Contents

1. General experimental details

All reactions were maintained under a nitrogen atmosphere unless otherwise stated. Commercially available reagents were used without further purification. Infrared (FT-IR) spectra were recorded on a BRUKER VERTEX 70, ν_{max} in cm^{-1}. ^{1}H-NMR spectra were recorded on a BRUKER AVANCE III HD (400 MHz) spectrometer. Chemical shifts are reported in ppm from tetramethylsilane with the solvent resonance as internal standard ($CDCl_3$: δ 7.26). Data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quadruplet, br = broad, m = multiplet), coupling constants (Hz) and integration. ^{13}C-NMR spectra were recorded on a BRUKER AVANCE III HD (100 MHz) spectrometer with complete proton decoupling. Chemical shifts are reported in ppm from tetramethylsilane with the solvent resonance as the internal standard ($CDCl_3$: δ 77.16). ^{19}P-NMR spectra were recorded on a BRUKER AVANCE III HD (161 MHz) spectrometer. ^{19}F-NMR spectra were recorded on a BRUKER AVANCE III HD (376 MHz) spectrometer. Mass spectra were measured with an Agilent Technologies 6120 Quadrupole LC/MS. High resolution mass spectrometry (HRMS) were measured with a GCT Premier™ and BRUKER micrOTF-Q III. Melting points were measured using INESA WRR and values are uncorrected.

2. Reaction conditions survey for using phosphonates [a]

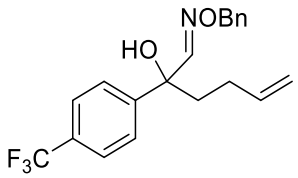


1a **2** **4e**

Entry	Additive	**Yield (%)[b]**
1	$FeCl_3$	0
2	$Mn(OAc)_3$	trace
3	$AgNO_3$	0
4	CuI	44
5	CuCl	trace
6	CuBr	trace
7	$Cu(OAc)_2$	38
8	$Cu(OTf)_2$	86
9	$CuSO_4$	27
10[c]	$Cu(OTf)_2$	0
11[d]	$Cu(OTf)_2$	93

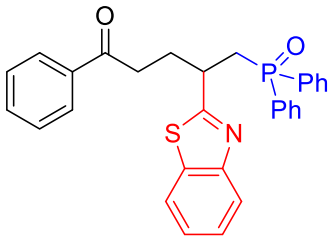
[a]Reaction conditions:**1a** (0.2 mmol), **2** (0.4 mmol), and TBHP (0.4 mmol) in CH_3CN (2 ml) at rt under N_2, 24 h. [b]Isolated yield. [c]Without TBHP. [d]$Cu(OTf)_2$ 10 mol%.

3. Characterization of new starting materials

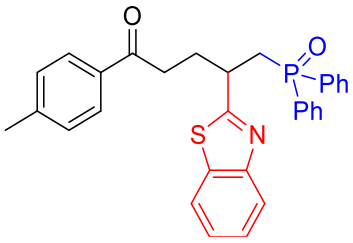


8g: yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (s, 1H), 7.66-7.61 (m, 2H), 7.60-7.55 (m, 2H), 7.42-7.32 (m, 5H), 5.86-5.74 (m, 1H), 5.18-5.09 (m, 2H), 5.04-4.94 (m, 2H), 3.52 (s, 1H), 2.20-1.95 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.7, 147.2 (q, $J_{C\text{-}F}$ = 1.0 Hz), 137.8, 136.9, 129.6 (q, $J_{C\text{-}F}$ = 32.3 Hz), 128.5, 128.4, 128.2, 127.2 (q, $J_{C\text{-}F}$ = 257.3 Hz), 125.7, 125.4 (q, $J_{C\text{-}P}$ = 3.7 Hz), 115.1, 76.6, 75.5, 40.1, 27.5; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.5. FT-IR: ν (cm^{-1}) 3524, 3033, 2927, 1641, 1618, 1497, 1454, 1411, 1366, 1324. HRMS [CI] calcd for $C_{22}H_{21}F_3NO_2$ $[M+H]^+$ 364.1519, found 364.1509.

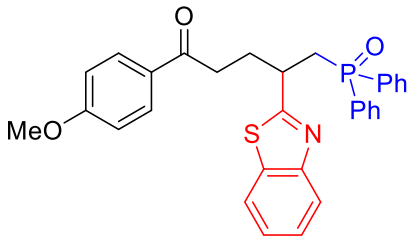
4. Characterization of new products



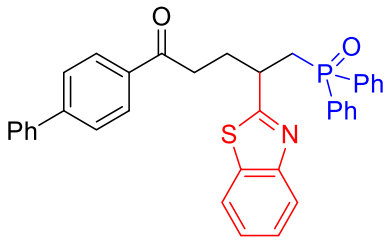
3a: colorless oil, 94.3 mg, 95%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85-7.78 (m, 3H), 7.78-7.71 (m, 2H), 7.69 (d, J = 8.0 Hz, 1H), 7.63-7.55 (m, 2H), 7.50-7.40 (m, 4H), 7.36 (dd, J = 14.4, 7.2 Hz, 1H), 7.19-7.09 (m, 3H), 3.94-3.83 (m, 1H), 3.26-3.15 (m, 1H), 3.04-2.86 (m, 2H), 2.80 (ddd, J = 14.8, 14.8, 5.2 Hz, 1H), 2.41 (dd, J = 14.8, 7.6 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.8, 173.1 (d, $J_{C\text{-}P}$ = 6.8 Hz), 152.9, 136.6, 134.7, 133.2 (d, $J_{C\text{-}P}$ = 98.9 Hz), 133.0, 131.8 (d, $J_{C\text{-}P}$ = 2.6 Hz), 131.6 (d, $J_{C\text{-}P}$ = 98.4 Hz), 131.2 (d, $J_{C\text{-}P}$ = 2.7 Hz), 130.9 (d, $J_{C\text{-}P}$ = 9.5 Hz), 130.5 (d, $J_{C\text{-}P}$ = 9.4 Hz), 128.7 (d, $J_{C\text{-}P}$ = 11.6 Hz), 128.5, 128.0 (d, $J_{C\text{-}P}$ = 11.4 Hz), 128.0, 125.8, 124.9, 122.7, 121.5, 37.8 (d, $J_{C\text{-}P}$ = 2.8 Hz), 35.8, 35.8 (d, $J_{C\text{-}P}$ = 69.7 Hz), 31.7 (d, $J_{C\text{-}P}$ = 9.0 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.62. FT-IR: ν (cm^{-1}) 3055, 2922, 2852, 1678, 1605, 1572, 1509, 1483, 1455, 1436, 1406, 1367, 1311, 1277. HRMS [ESI] calcd for $C_{30}H_{26}NO_2PSNa$ $[M+Na]^+$ 518.1314, found 518.1303.



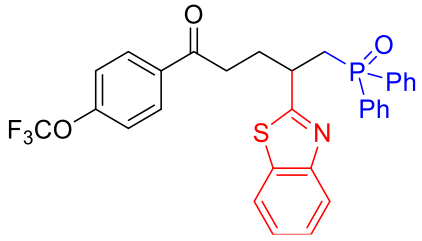
3b: white solid, m.p. 60-61 °C, 95.7 mg, 94%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 (d, J = 8.0 Hz, 1H), 7.78-7.72 (m, 2H), 7.72-7.67 (m, 3H), 7.62-7.56 (m, 2H), 7.49-7.35 (m, 5H), 7.31-7.26 (m, 1H), 7.17-7.11 (m, 4H), 3.93-3.82 (m, 1H), 3.25-3.15 (m, 1H), 3.01-2.84 (m, 2H), 2.79 (ddd, J = 14.8, 14.8, 5.2 Hz, 1H), 2.40 (dd, J = 14.8, 7.6 Hz, 2H), 2.34 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.4, 173.2 (d, $J_{C\text{-}P}$ = 6.7 Hz), 152.9, 143.7, 134.7, 134.2, 133.7 (d, $J_{C\text{-}P}$ = 98.8 Hz), 131.8 (d, $J_{C\text{-}P}$ = 2.7 Hz), 131.7 (d, $J_{C\text{-}P}$ = 98.9 Hz), 131.2 (d, $J_{C\text{-}P}$ = 2.9 Hz), 130.9 (d, $J_{C\text{-}P}$ = 9.5 Hz), 130.5 (d, $J_{C\text{-}P}$ = 9.4 Hz), 129.2, 128.7 (d, $J_{C\text{-}P}$ = 11.6 Hz), 128.1, 128.0 (d, $J_{C\text{-}P}$ = 11.8 Hz), 125.8, 124.9, 122.7, 121.5, 37.9 (d, $J_{C\text{-}P}$ = 2.8 Hz), 35.7, 35.8 (d, $J_{C\text{-}P}$ = 69.8 Hz), 31.8 (d, $J_{C\text{-}P}$ = 9.1 Hz), 21.6; ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.38. FT-IR: ν (cm^{-1}) 3057, 2958, 2925, 2853, 1682, 1596, 1579, 1509, 1484, 1436, 1368, 1311, 1262, 1240. HRMS [ESI] calcd for $C_{31}H_{28}NO_2PSNa$ $[M+Na]^+$ 532.1471, found 532.1461.



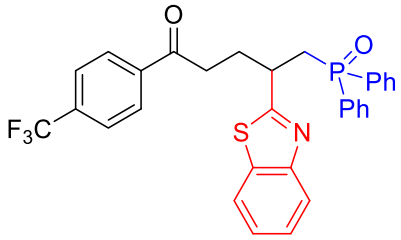
3c: white solid, m.p. 130-131 °C, 65.5 mg, 62%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86-7.71 (m, 5H), 7.68 (d, *J* = 7.6 Hz, 1H), 7.63-7.55 (m, 2H), 7.50-7.35 (m, 4H), 7.34-7.26 (m, 1H), 7.19-7.08 (m, 3H), 6.83 (d, *J* = 8.4 Hz, 2H), 3.95-3.82 (m, 1H), 3.80 (s, 3H), 3.27-3.16 (m, 1H), 2.99-2.86 (m, 2H), 2.81 (ddd, *J* = 14.8, 14.8, 5.2 Hz, 1H), 2.40 (dd, *J* = 14.4, 7.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.3, 173.4 (d, $J_{C\text{-}P}$ = 6.5 Hz), 163.4, 152.6, 134.6, 133.6 (d, $J_{C\text{-}P}$ = 98.9 Hz), 131.8 (d, $J_{C\text{-}P}$ = 2.4 Hz), 131.6 (d, $J_{C\text{-}P}$ = 98.3 Hz), 131.2 (d, $J_{C\text{-}P}$ = 2.5 Hz), 130.9 (d, $J_{C\text{-}P}$ = 9.5 Hz), 130.5 (d, $J_{C\text{-}P}$ = 9.3 Hz), 130.3, 129.7, 128.7 (d, $J_{C\text{-}P}$ = 11.7 Hz), 128.0 (d, $J_{C\text{-}P}$ = 11.7 Hz), 125.9, 124.9, 122.6, 121.5, 113.6, 55.4, 37.9 (d, $J_{C\text{-}P}$ = 2.7 Hz), 35.7 (d, $J_{C\text{-}P}$ = 69.7 Hz), 35.5, 32.0 (d, $J_{C\text{-}P}$ = 9.1 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.46. FT-IR: ν (cm^{-1}) 3054, 2956, 2924, 2853, 1670, 1599, 1509, 1456, 1436, 1365, 1313, 1255, 1235. HRMS [ESI] calcd for $C_{31}H_{28}NO_3PSNa$ $[M+Na]^+$ 548.1420, found 548.1414.



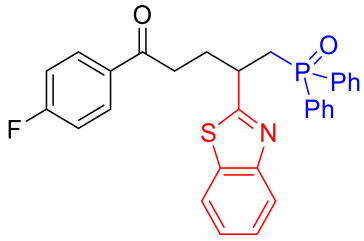
3d: white solid, m.p. 181-182 °C, 58.2 mg, 51%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92-7.82 (m, 3H), 7.81-7.73 (m, 2H), 7.70 (d, *J* = 7.6 Hz, 1H), 7.66-7.53 (m, 6H), 7.49-7.33 (m, 7H), 7.32-7.26 (m, 1H), 7.21-7.10 (m, 3H), 3.99-3.85 (m, 1H), 3.31-3.18 (m, 1H), 3.08-2.91 (m, 2H), 2.90-2.73 (m, 1H), 2.46 (dd, *J* = 13.2 6.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.4, 173.3 (d, $J_{C\text{-}P}$ = 6.2 Hz), 152.7, 145.6, 139.8, 135.3, 134.7, 133.7 (d, $J_{C\text{-}P}$ = 98.3 Hz), 131.9, 131.6 (d, $J_{C\text{-}P}$ =98.6 Hz), 131.2, 130.9 (d, $J_{C\text{-}P}$ = 9.1 Hz), 130.5 (d, $J_{C\text{-}P}$ = 9.0 Hz), 128.9, 128.7 (d, $J_{C\text{-}P}$ = 11.4 Hz), 128.6, 128.2, 128.1 (d, $J_{C\text{-}P}$ = 11.5 Hz), 127.2, 127.1, 125.9, 125.0, 122.7, 121.5, 37.9, 35.9, 35.8 (d, $J_{C\text{-}P}$ = 69.7 Hz), 31.8 (d, $J_{C\text{-}P}$ = 8.4 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.49. FT-IR: ν (cm^{-1}) 3059, 2925, 1679, 1602 1558, 1511 1484, 1453, 1437, 1381, 1313, 1268, 1231. HRMS [ESI] calcd for $C_{36}H_{20}NO_2PSNa$ $[M+Na]^+$ 594.1627, found 594.1616.



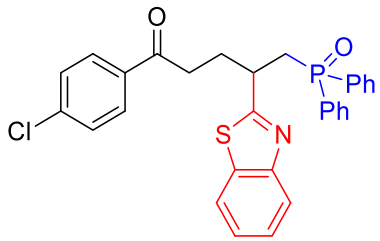
3e: yellow oil, 73.2 mg, 63%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90-7.84 (m, 2H), 7.81 (d, *J* = 8.4 Hz, 1H), 7.79-7.69 (m, 3H), 7.63-7.57 (m, 2H), 7.51-7.37 (m, 5H), 7.34-7.28 (m, 1H), 7.22-7.14 (m, 4H), 3.93-3.81 (m, 1H), 3.25-3.14 (m, 1H), 3.04-2.88 (m, 2H), 2.82 (ddd, *J* = 14.0, 14.0, 5.6 Hz, 1H), 2.42 (dd, *J* = 14.8, 7.6 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.8, 172.7 (d, $J_{C\text{-}P}$ = 7.4 Hz), 152.3, 152.0, 134.4, 134.2, 133.1 (d, $J_{C\text{-}P}$ = 99.2 Hz), 131.4 (d, $J_{C\text{-}P}$ = 2.7 Hz), 131.3 (q, $J_{C\text{-}F}$ = 2.4. Hz), 130.8 (d, $J_{C\text{-}P}$ = 2.7 Hz), 130.4 (d, $J_{C\text{-}P}$ = 9.5 Hz), 130.0 (d, $J_{C\text{-}P}$ = 9.3 Hz), 129.6, 128.3 (d, $J_{C\text{-}P}$ = 11.7 Hz), 127.6 (d, $J_{C\text{-}P}$ = 11.8 Hz), 125.4, 124.5, 121.7 (q, $J_{C\text{-}F}$ = 254.1 Hz), 122.2, 121.0, 119.8, 37.3 (d, $J_{C\text{-}P}$ = 2.7 Hz), 35.4, 35.2 (d, $J_{C\text{-}P}$ = 69.6 Hz), 31.1 (d, $J_{C\text{-}P}$ = 8.6 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.68; ^{19}F NMR (376 MHz, $CDCl_3$) δ -57.6. FT-IR: ν (cm^{-1}) 3059, 2925, 1686, 1602, 1506, 1437, 1411, 1370, 1309, 1254, 1209. HRMS [ESI] calcd for $C_{31}H_{25}F_3NO_3PSNa$ $[M+Na]^+$ 602.1137, found 602.1127.



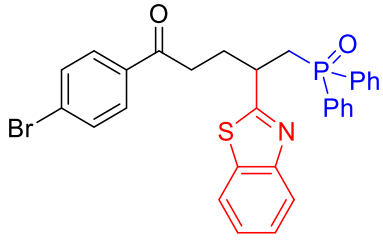
3f: white solid, m.p. 105-106 °C, 67.0 mg, 59%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (d, *J* = 8.0 Hz, 2H), 7.83 (d, *J* = 8.0 Hz, 1H), 7.80-7.70 (m, 3H), 7.66-7.58 (m, 4H), 7.52-7.36 (m, 4H), 7.35-7.28 (m, 1H), 7.24-7.14 (m, 3H), 3.94-3.81 (m, 1H), 3.27-3.14 (m, 1H), 3.08-2.92 (m, 2H), 2.83 (ddd, *J* = 14.4, 14.4, 5.6 Hz, 1H), 2.50-2.40 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.8, 173.1 (d, J_{C-P} = 7.3 Hz), 152.8, 139.2, 134.7, 134.2 (q, J_{C-F} = 32.4 Hz), 133.8 (d, J_{C-P} = 99.3 Hz), 131.6 (d, J_{C-P} = 99.0 Hz), 131.9 (d, J_{C-P} = 1.8 Hz), 131.3 (d, J_{C-P} = 1.8 Hz), 130.9 (d, J_{C-P} = 9.2 Hz), 130.5 (d, J_{C-P} = 9.1 Hz), 128.7 (d, J_{C-P} = 11.5 Hz), 128.3, 128.1 (d, J_{C-P} = 11.7 Hz), 125.9, 125.5 (q, J_{C-F} = 3.7 Hz), 125.0, 123.2 (q, J_{C-F} = 271.1 Hz), 122.7, 121.5, 37.8 (d, J_{C-P} = 1.6. Hz), 36.1, 35.3 (d, J_{C-P} = 68.9. Hz), 31.3 (d, J_{C-P} = 8.1 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.30; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.1. FT-IR: ν (cm^{-1}) 3056, 2920, 2852, 1691, 1653, 1577, 1508, 1486, 1456, 1436, 1372, 1323, 1240. HRMS [ESI] calcd for $C_{30}H_{25}F_3NO_2PSNa$ $[M+Na]^+$ 586.1188, found 586.1174.



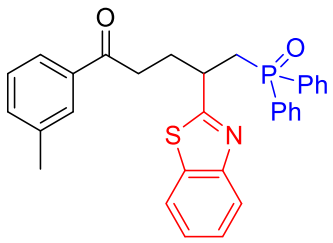
3g: white solid, m.p. 40-41 °C, 63.0 mg 61%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89-7.82 (m, 3H), 7.79-7.69 (m, 3H), 7.65-7.57 (m, 2H), 7.51-7.38 (m, 5H), 7.35-7.28 (m, 1H), 7.19-7.13 (m, 2H), 7.09-7.00 (m, 2H), 3.95-3.81 (m, 1H), 3.30-3.16 (m, 1H), 3.02-2.89 (m, 2H), 2.89-2.75 (m, 1H), 2.42 (dd, *J* = 13.6, 6.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.2, 173.2 (d, J_{C-P} = 7.2 Hz), 165.6 (d, J_{C-F} = 253.0 Hz), 152.9, 134.7, 133.7 (d, J_{C-P} = 98.9 Hz), 133.1 (d, J_{C-F} = 3.3 Hz), 131.9 (d, J_{C-P} = 2.6 Hz), 131.6 (d, J_{C-P} = 98.4 Hz), 131.2 (d, J_{C-P} = 2.7 Hz), 130.9 (d, J_{C-P} = 9.4 Hz), 130.6 (d, J_{C-F} = 9.3 Hz), 130.5 (d, J_{C-P} = 9.3 Hz), 128.7 (d, J_{C-P} = 11.6 Hz), 128.1 (d, J_{C-P} = 11.8 Hz), 125.9, 124.9, 122.7, 121.5, 115.6 (d, J_{C-F} = 21.7 Hz), 37.8 (d, J_{C-P} = 2.8 Hz), 35.7, 35.8 (d, J_{C-P} = 69.6 Hz), 31.7 (d, J_{C-P} = 8.6 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.67; ^{19}F NMR (376 MHz, $CDCl_3$) δ -105.4. FT-IR: ν (cm^{-1}) 3057, 2927, 1682, 1595, 1505, 1455, 1436, 1408, 1369, 1311, 1277, 1227. HRMS [ESI] calcd for $C_{30}H_{25}FNO_2PSNa$ $[M+Na]^+$ 536.1220, found 536.1192.



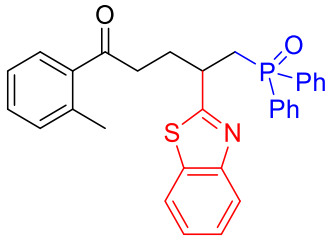
3h: white solid, m.p. 51-52 °C, 83.0 mg, 78%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.0 Hz, 1H), 7.80-7.73 (m, 4H), 7.72 (d, *J* = 8.0 Hz, 1H), 7.66-7.57 (m, 2H), 7.52-7.39 (m, 4H), 7.38-7.30 (m, 3H), 7.22-7.12 (m, 3H), 3.96-3.82 (m, 1H), 3.30-3.17 (m, 1H), 3.04-2.87 (m, 2H), 2.82 (ddd, *J* = 14.4, 14.4, 5.2 Hz, 1H), 2.44 (dd, *J* = 13.6, 6.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.6, 173.1 (d, J_{C-P} = 7.4 Hz), 152.8, 139.4, 134.9, 134.7, 133.7 (d, J_{C-P} = 99.0 Hz), 131.9 (d, J_{C-P} = 2.7 Hz), 131.6 (d, J_{C-P} = 98.4 Hz), 131.3 (d, J_{C-P} = 2.8 Hz), 130.9 (d, J_{C-P} = 9.4 Hz), 130.5 (d, J_{C-P} = 9.3 Hz), 129.4, 128.8, 128.7 (d, J_{C-P} = 11.4 Hz), 128.1 (d, J_{C-P} = 11.8 Hz), 125.9, 125.0, 122.7, 121.5, 37.8 (d, J_{C-P} = 2.8 Hz), 35.8, 35.7 (d, J_{C-P} = 69.6 Hz), 31.6 (d, J_{C-P} = 8.6 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.50. FT-IR: ν (cm^{-1}) 3057, 2923, 2852, 1682, 1587, 1571, 1508, 1486, 1456, 1436, 1399, 1368, 1311, 1261. HRMS [ESI] calcd for $C_{30}H_{25}ClNO_2PSNa$ $[M+Na]^+$ 552.0924, found 552.0933.



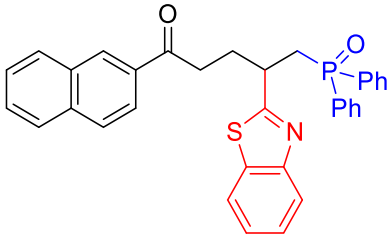
3i: white solid, m.p. 58-59 °C, 82.6 mg, 72%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 (d, *J* = 8.0 Hz, 1H), 7.79-7.70 (m, 3H), 7.69-7.65 (m, 2H), 7.64-7.56 (m, 2H), 7.50 (d, *J* = 8.8 Hz, 2H), 7.50-7.38 (m, 5H), 7.35-7.29 (m, 1H), 7.23-7.12 (m, 3H), 3.92-3.80 (m, 1H), 3.25-3.13 (m, 1H), 3.01-2.85 (m, 2H), 2.80 (ddd, *J* = 14.4, 14.4, 5.6 Hz, 1H), 2.42 (dd, *J* = 14.4, 7.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.8, 173.1 (d, $J_{C\text{-}P}$ = 7.3 Hz), 152.8, 135.3, 134.7, 133.6 (d, $J_{C\text{-}P}$ = 100.1 Hz), 131.9, 131.8, 131.3, 131.2, 130.9 (d, $J_{C\text{-}P}$ = 9.3 Hz), 130.5 (d, $J_{C\text{-}P}$ = 9.2 Hz), 129.6, 128.7 (d, $J_{C\text{-}P}$ = 11.5 Hz), 128.1 (d, $J_{C\text{-}P}$ = 99.2 Hz), 128.1 (d, $J_{C\text{-}P}$ = 11.4 Hz), 125.9, 125.0, 122.7, 121.5, 37.8, 35.8, 35.7 (d, $J_{C\text{-}P}$ = 69.5 Hz), 31.6 (d, $J_{C\text{-}P}$ = 8.3 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.69. FT-IR: ν (cm^{-1}) 2956, 2900, 2853, 1772, 1733, 1716, 1683, 1653, 1636, 1583, 1559, 1541, 1508, 1486, 1467, 1456, 1436, 1396, 1312, 1274, 1241. HRMS [ESI] calcd for $C_{30}H_{25}BrNO_2PSNa$ $[M+Na]^+$ 596.0419, found 596.0405.



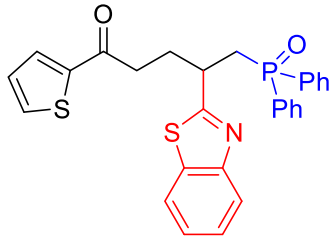
3j: white solid, m.p. 47-48 °C, 89.1 mg, 87%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 (d , *J* = 8.0 Hz, 1H), 7.78-7.72 (m, 2H), 7.70 (d, *J* = 8.0 Hz, 1H), 7.63-7.56 (m, 4H), 7.47-7.36 (m, 4H), 7.31-7.26 (m, 2H), 7.26-7.21 (m, 1H), 7.19-7.10 (m, 3H), 3.93-3.82 (m, 1H), 3.25-3.15 (m, 1H), 3.03-2.85 (m, 2H), 2.80 (ddd, *J* = 14.4, 14.4, 5.6 Hz, 1H), 2.41 (dd , *J* = 14.8, 7.6 Hz, 2H), 2.32 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 199.0, 173.2 (d, $J_{C\text{-}P}$ = 6.7 Hz), 152.9, 138.2, 136.7, 134.8, 133.7, 133.7 (d, $J_{C\text{-}P}$ = 98.9 Hz), 131.8 (d, $J_{C\text{-}P}$ = 2.7 Hz), 131.6 (d, $J_{C\text{-}P}$ = 98.4 Hz), 131.2 (d, $J_{C\text{-}P}$ = 2.7 Hz), 130.9 (d, $J_{C\text{-}P}$ = 9.4 Hz), 130.5 (d, $J_{C\text{-}P}$ = 9.3 Hz), 128.7 (d, $J_{C\text{-}P}$ = 11.6 Hz), 128.5, 128.4, 128.0 (d, $J_{C\text{-}P}$ = 11.7 Hz), 125.8, 125.2, 124.9, 122.7, 121.5, 37.9 (d, $J_{C\text{-}P}$ = 2.9 Hz), 35.9, 35.8 (d, $J_{C\text{-}P}$ = 69.7 Hz), 31.8 (d, $J_{C\text{-}P}$ = 9.1 Hz), 21.3; ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.37. FT-IR: ν (cm^{-1}) 3055, 2921, 2852, 1681, 1603, 1585, 1558, 1541, 1508, 1484, 1456, 1436, 1364, 1311, 1278, 1243. HRMS [ESI] calcd for $C_{31}H_{28}NO_2PSNa$ $[M+Na]^+$ 532.1471, found 532.1465.



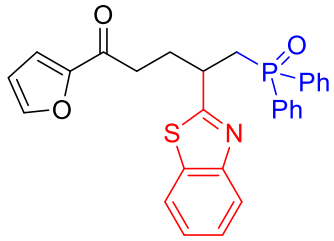
3k: white solid, m.p. 40-41 °C, 76.7 mg, 75%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 (d, *J* = 8.0 Hz, 1H), 7.79-7.72 (m, 2H), 7.69 (d, *J* = 8.0 Hz, 1H), 7.64-7.55 (m, 2H), 7.51-7.36 (m, 5H), 7.34-7.26 (m, 2H), 7.20-7.10 (m, 5H), 3.93-3.80 (m, 1H), 3.27-3.15 (m, 1H), 2.97-2.73 (m, 3H), 2.45-2.31 (m, 2H), 2.38 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 202.7, 173.2 (d, $J_{C\text{-}P}$ = 6.9 Hz), 152.9, 138.0, 137.5, 134.7, 133.7 (d, $J_{C\text{-}P}$ = 98.9 Hz), 131.8, 131.8 (d, $J_{C\text{-}P}$ = 2.8 Hz), 131.2, 131.2 (d, $J_{C\text{-}P}$ = 3.0 Hz), 130.9 (d, $J_{C\text{-}P}$ = 9.4 Hz), 130.5 (d, $J_{C\text{-}P}$ = 9.3 Hz), 128.7 (d, $J_{C\text{-}P}$ = 11.6 Hz), 128.6, 128.4, 128.0 (d, $J_{C\text{-}P}$ = 11.8 Hz), 125.8, 125.6, 124.9, 122.7, 121.5, 38.6, 37.8 (d, $J_{C\text{-}P}$ = 2.9 Hz), 35.8 (d, $J_{C\text{-}P}$ = 69.7 Hz), 31.8 (d, $J_{C\text{-}P}$ = 9.1 Hz), 21.3; ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.58. FT-IR: ν (cm^{-1}) 3058, 2926, 1682, 1591, 1570, 1509, 1484, 1456, 1436, 1380, 1311, 1263. HRMS [ESI] calcd for $C_{31}H_{28}NO_2PSNa$ $[M+Na]^+$ 532.1471, found 532.1465.



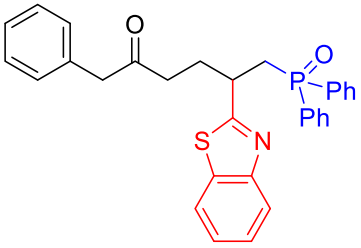
3l: white solid, m.p. 173-174 °C, 80.5 mg, 74%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 (s, 1H), 7.94-7.69 (m, 8H), 7.66-7.58 (m, 2H), 7.58-7.53 (m, 1H), 7.53-7.39 (m, 5H), 7.37-7.28 (m, 1H), 7.21-7.11 (m, 3H), 4.02-3.88 (m, 1H), 3.33-3.22 (m, 1H), 3.20-3.02 (m, 2H), 2.85 (ddd, J = 14.4, 14.4, 5.2 Hz, 1H), 2.49 (dd, J = 14.8, 7.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.8, 173.3 (d, $J_{C\text{-}P}$ = 6.9 Hz), 152.9, 135.5, 134.8, 133.9, 133.8 (d, $J_{C\text{-}P}$ = 99.0 Hz), 132.4, 131.8 (d, $J_{C\text{-}P}$ = 2.6 Hz), 131.6 (d, $J_{C\text{-}P}$ = 98.4 Hz), 131.2 (d, $J_{C\text{-}P}$ = 2.6 Hz), 130.9 (d, $J_{C\text{-}P}$ = 9.4 Hz), 130.5 (d, $J_{C\text{-}P}$ = 9.3 Hz), 129.7, 129.6, 129.6, 128.7 (d, $J_{C\text{-}P}$ = 11.6 Hz), 128.4, 128.3, 128.1 (d, $J_{C\text{-}P}$ = 11.8 Hz), 127.7, 126.7, 125.8, 124.9, 123.8, 122.7, 121.5, 37.9 (d, $J_{C\text{-}P}$ = 2.8 Hz), 35.9, 35.8 (d, $J_{C\text{-}P}$ = 69.7 Hz), 32.0 (d, $J_{C\text{-}P}$ = 8.9 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.65. FT-IR: ν (cm^{-1}) 3051, 2908, 1676, 1626 1576, 1507 1465, 1454, 1436, 1392, 1315, 1285, 1244. HRMS [ESI] calcd for $C_{36}H_{20}NO_2PSNa$ $[M+Na]^+$ 594.1627, found 594.1616.



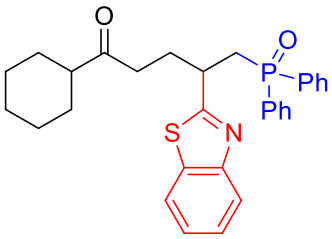
3m: white solid, m.p. 66-67 °C, 55.3 mg, 55%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, J = 8.0 Hz, 1H), 7.80-7.69 (m, 3H), 7.64-7.55 (m, 4H), 7.51-7.38 (m, 4H), 7.35-7.28 (m, 1H), 7.20-7.11 (m, 3H), 7.06-7.00 (m, 1H), 3.94-3.82 (m, 1H), 3.28-3.17 (m, 1H), 2.98-2.87 (m, 2H), 2.81 (ddd, J = 15.6, 15.6, 6.0 Hz, 1H), 2.44 (dd, J = 14.8, 7.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.7, 173.3 (d, $J_{C\text{-}P}$ = 6.7 Hz), 152.4, 143.9, 134.6, 133.5, 133.5 (d, $J_{C\text{-}P}$ = 99.2 Hz), 132.0, 131.9 (d, $J_{C\text{-}P}$ = 2.4 Hz), 131.2 (d, $J_{C\text{-}P}$ =2.5 Hz), 130.9 (d, $J_{C\text{-}P}$ = 9.5 Hz), 130.5 (d, $J_{C\text{-}P}$ = 9.3 Hz), 128.7 (d, $J_{C\text{-}P}$ = 11.7 Hz), 128.0, 128.1 (d, $J_{C\text{-}P}$ = 11.7 Hz), 126.0, 125.0, 122.6, 121.5, 37.8 (d, $J_{C\text{-}P}$ = 2.6 Hz), 36.5, 35.7 (d, $J_{C\text{-}P}$ = 69.7 Hz), 31.9 (d, $J_{C\text{-}P}$ = 9.0 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.62. FT-IR: ν (cm^{-1}) 3055, 2924, 1704 1655, 1590, 1483, 1455, 1436, 13554, 1311, 1278, 1236. HRMS [ESI] calcd for $C_{28}H_{24}NO_2PS_2Na$ $[M+Na]^+$ 524.0878, found 524.0862.



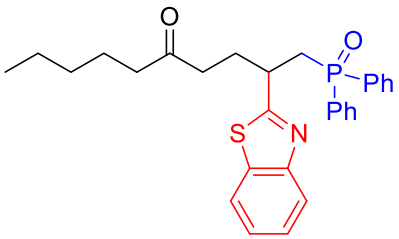
3n: yellow oil, 41.9 mg, 43%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (d, J = 8.0 Hz, 1H), 7.79-7.72 (m, 2H), 7.71 (d, J = 8.0 Hz, 1H), 7.63-7.56 (m, 2H), 7.52-7.37 (m, 5H), 7.34-7.28 (m, 1H), 7.20-7.11 (m, 3H), 7.08 (d, J = 3.6 Hz, 1H), 6.45 (dd, J = 3.6, 1.6 Hz, 1H), 3.92-3.81 (m, 1H), 3.26-3.15 (m, 1H), 2.89-2.74 (m, 3H), 2.40 (dd, J = 14.8, 7.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 187.9, 173.1 (d, $J_{C\text{-}P}$ = 6.6 Hz), 152.7, 152.3, 146.2, 134.7, 133.5 (d, $J_{C\text{-}P}$ = 98.9 Hz), 131.9 (d, $J_{C\text{-}P}$ = 2.3 Hz), 131.2 (d, $J_{C\text{-}P}$ = 2.4 Hz), 130.9 (d, $J_{C\text{-}P}$ = 9.4 Hz), 130.5 (d, $J_{C\text{-}P}$ = 9.3 Hz), 128.7 (d, $J_{C\text{-}P}$ = 11.6 Hz), 128.0 (d, $J_{C\text{-}P}$ = 11.8 Hz), 125.9, 124.9, 122.6, 121.5, 117.1, 112.1, 37.8 (d, $J_{C\text{-}P}$ = 2.5 Hz), 35.7 (d, $J_{C\text{-}P}$ = 69.6 Hz), 35.6, 31.5 (d, $J_{C\text{-}P}$ = 9.1 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.71. FT-IR: ν (cm^{-1}) 3294, 2956, 2922, 2864, 1590, 1489, 1467, 1437, 1389, 1316, 1276, 1240. HRMS [ESI] calcd for $C_{28}H_{25}NO_3PS$ $[M+H]^+$ 508.1107, found 508.1104.



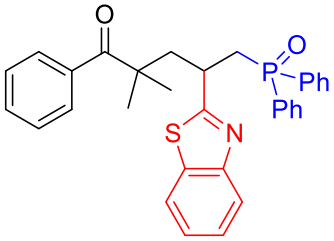
3o: white solid, m.p. 55-56 °C, 83.8 mg, 82%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 (d, J = 8.0 Hz, 1H), 7.76-7.66 (m, 3H), 7.61-7.54 (m, 2H), 7.49-7.37 (m, 4H), 7.32-7.26 (m, 1H), 7.24-7.10 (m, 6H), 7.07-7.02 (m, 2H), 3.80-3.65 (m, 1H), 3.55 (s, 2H), 3.17-3.04 (m, 1H), 2.70 (ddd, J = 14.4, 14.4, 5.6 Hz, 1H), 2.53-2.36 (m, 2H), 2.28-2.14 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 206.8, 173.1 (d, $J_{C\text{-}P}$ = 7.2 Hz), 152.8, 134.7, 134.0, 133.6 (d, $J_{C\text{-}P}$ = 99.0 Hz), 131.9 (d, $J_{C\text{-}P}$ = 2.5 Hz), 131.7 (d, $J_{C\text{-}P}$ = 98.4 Hz), 131.2 (d, $J_{C\text{-}P}$ = 2.6 Hz), 130.9 (d, $J_{C\text{-}P}$ = 9.4 Hz), 130.5 (d, $J_{C\text{-}P}$ = 9.3 Hz), 129.4, 128.7 (d, $J_{C\text{-}P}$ = 11.6 Hz), 128.6, 128.1 (d, $J_{C\text{-}P}$ = 11.7 Hz), 126.9, 125.8, 124.9, 122.7, 121.5, 49.9, 39.0, 37.6 (d, $J_{C\text{-}P}$ = 2.6 Hz), 35.6 (d, $J_{C\text{-}P}$ = 69.8 Hz), 31.1 (d, $J_{C\text{-}P}$ = 8.7 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.50. FT-IR: ν (cm^{-1}) 3294, 2956, 2922, 2864, 1590, 1489, 1467, 1437, 1389, 1316, 1276, 1240. HRMS [ESI] calcd for $C_{31}H_{28}NO_2PSNa$ $[M+Na]^+$ 532.1471, found 532.1470.



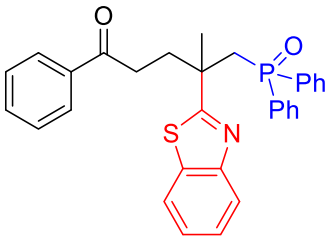
3p: white solid, m.p. 117-118 °C, 71.4 mg, 71%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, J = 8.0 Hz, 1H), 7.78-7.69 (m, 3H), 7.62-7.55 (m, 2H), 7.51-7.37 (m, 4H), 7.34-7.28 (m, 1H), 7.20-7.09 (m, 3H), 3.84-3.70 (m, 1H), 3.23-3.11 (m, 1H), 2.74 (ddd, J = 14.8, 14.8, 4.8 Hz, 1H), 2.51-2.33 (m, 2H), 2.27-2.14 (m, 3H), 1.75-1.63 (m, 4H), 1.62-1.55 (m, 1H), 1.23-1.08 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 212.1, 172.9 (d, $J_{C\text{-}P}$ = 6.5 Hz), 152.2, 134.2, 131.4 (d, $J_{C\text{-}P}$ = 1.8 Hz), 130.7 (d, $J_{C\text{-}P}$ = 1.8 Hz), 130.4 (d, $J_{C\text{-}P}$ = 9.0 Hz), 130.0 (d, $J_{C\text{-}P}$ = 9.2 Hz), 128.2 (d, $J_{C\text{-}P}$ = 11.5 Hz), 127.5 (d, $J_{C\text{-}P}$ = 11.6 Hz), 125.4, 124.4, 122.1, 121.0, 50.2, 37.3 (d, $J_{C\text{-}P}$ = 1.8 Hz), 37.2, 35.2 (d, $J_{C\text{-}P}$ = 69.7 Hz), 30.8 (d, $J_{C\text{-}P}$ = 8.9 Hz), 28.0, 27.8, 25.3, 25.1, 25.1; ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.37. FT-IR: ν (cm^{-1}) 3055, 2925, 2852, 1703, 1511, 1483, 1436, 1405, 1374, 1312, 1261, 1241. HRMS [ESI] calcd for $C_{30}H_{32}NO_2PSNa$ $[M+Na]^+$ 524.1784, found 524.1769.



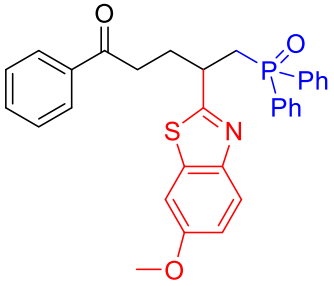
3q: yellow oil, 70.6 mg, 72%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (d, J = 8.0 Hz, 1H), 7.2 (dd, J = 11.2, 8.0 Hz, 2H), 7.65 (d, J = 7.6 Hz, 1H), 7.56 (dd, J = 11.2, 7.6 Hz, 2H), 7.47-7.33 (m, 4H), 7.32-7.27 (m, 1H), 7.15-7.02 (m, 3H), 3.89-3.74 (m, 1H), 3.09-2.96 (m, 1H), 2.76 (ddd, J = 14.8, 14.8, 4.8 Hz, 1H), 2.52-2.25 (m, 2H), 2.24-2.10 (m, 4H), 1.47-1.35 (m, 2H), 1.22-1.07 (m, 4H), 0.80 (t, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 209.3, 173.0 (d, $J_{C\text{-}P}$ = 5.3 Hz), 152.0, 134.1, 131.4, 130.7, 130.4 (d, $J_{C\text{-}P}$ = 8.7 Hz), 130.0 (d, $J_{C\text{-}P}$ = 9.1 Hz), 128.3 (d, $J_{C\text{-}P}$ = 11.3 Hz), 127.6 (d, $J_{C\text{-}P}$ = 11.4 Hz), 125.4, 124.5, 122.1, 121.0, 42.2, 39.2, 37.2, 35.2 (d, $J_{C\text{-}P}$ = 67.9 Hz), 30.8, 30.7 (d, $J_{C\text{-}P}$ = 9.0. Hz), 22.9, 21.9, 13.4; ^{31}P NMR (161 MHz, $CDCl_3$) δ 30.26. FT-IR: ν (cm^{-1}) 3056, 2953, 2926, 2856, 1708, 1483, 1455, 1436, 1374, 1311, 1278, 1243. HRMS [ESI] calcd for $C_{29}H_{32}NO_2PSNa$ $[M+Na]^+$ 512.1784, found 512.1783.



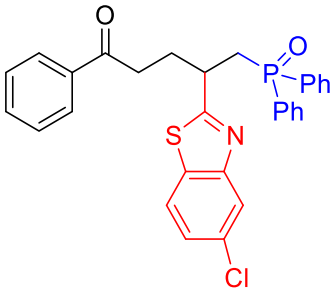
3r: yellow oil, 92.5 mg, 88%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73-7.66 (m, 3H), 7.64 (d, *J* = 7.6 Hz, 1H), 7.60-7.49 (m, 4H), 7.48-7.38 (m, 3H), 7.37-7.29 (m, 2H), 7.29-7.20 (m, 3H), 7.20-7.11 (m, 3H), 3.91-3.78 (m, 1H), 3.01-2.90 (m, 1H), 2.83 (dd, *J* = 14.4, 9.6 Hz, 1H), 2.73 (ddd, *J* = 14.0, 14.0, 6.4 Hz, 1H), 2.53 (dd, *J* = 14.4, 3.6 Hz, 1H), 1.26 (d, *J* = 4.4 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 207.3, 173.7 (d, $J_{C\text{-}P}$ = 7.1 Hz), 152.6, 137.9, 134.7, 133.9 (d, $J_{C\text{-}P}$ = 98.8 Hz), 131.8 (d, $J_{C\text{-}P}$ = 2.5 Hz), 131.2 (d, $J_{C\text{-}P}$ = 2.6 Hz), 130.9, 130.8 (d, $J_{C\text{-}P}$ = 9.2 Hz), 130.4 (d, $J_{C\text{-}P}$ = 9.0 Hz), 128.7 (d, $J_{C\text{-}P}$ = 11.4 Hz), 128.0, 128.0 (d, $J_{C\text{-}P}$ = 11.5 Hz), 127.8, 125.6, 124.8, 122.6, 121.4, 47.7, 47.1 (d, $J_{C\text{-}P}$ = 7.5 Hz), 37.8 (d, $J_{C\text{-}P}$ = 68.6 Hz), 35.5, 27.0, 26.3; ^{31}P NMR (161 MHz, $CDCl_3$) δ 28.85. FT-IR: ν (cm^{-1}) 3056, 2964, 2924, 1669, 1592, 1509, 1471, 1436, 1390, 1367, 1312, 1261. HRMS [ESI] calcd for $C_{32}H_{30}NO_2PSNa$ $[M+Na]^+$ 546.1627, found 546.1609.



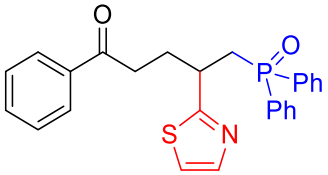
3s: white solid, m.p. 99-100 °C, 74.2 mg, 72%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85-7.79 (m, 3H), 7.78-7.73 (m, 2H), 7.71 (d, *J* = 7.6 Hz, 1H), 7.63-7.55 (m, 2H), 7.52-7.45 (m, 1H), 7.43-7.34 (m, 6H), 7.33-7.27 (m, 1H), 7.17-7.06 (m, 3H), 3.24 (dd, *J* = 15.2, 8.4 Hz, 1H), 3.02-2.89 (m, 2H), 2.86-2.74 (m, 1H), 2.68-2.58 (m, 1H), 2.38 (ddd, *J* = 15.6, 10.8, 4.8 Hz, 1H), 1.86 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 199.2, 177.8 (d, $J_{C\text{-}P}$ = 6.3 Hz), 152.7, 136.7, 134.9, 134.8 (d, $J_{C\text{-}P}$ = 98.3 Hz), 132.9, 133.0 (d, $J_{C\text{-}P}$ = 97.9 Hz), 131.5 (d, $J_{C\text{-}P}$ = 2.6 Hz), 130.8 (d, $J_{C\text{-}P}$ = 2.8 Hz), 130.9 (d, $J_{C\text{-}P}$ = 9.3 Hz), 130.4 (d, $J_{C\text{-}P}$ = 9.0 Hz), 128.6 (d, $J_{C\text{-}P}$ = 11.5 Hz), 128.5, 128.1, 127.9 (d, $J_{C\text{-}P}$ = 11.7 Hz), 125.7, 124.8, 122.8, 121.4, 43.6 (d, $J_{C\text{-}P}$ = 3.6 Hz), 41.7 (d, $J_{C\text{-}P}$ = 69.2 Hz), 38.5 (d, $J_{C\text{-}P}$ = 9.6 Hz), 33.7, 25.8 (d, $J_{C\text{-}P}$ = 3.4 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 27.19. FT-IR: ν (cm^{-1}) 3197, 3055, 2959, 1681, 1558, 1541, 1507, 1490, 1436, 1313, 1240. HRMS [ESI] calcd for $C_{31}H_{28}NO_2PSNa$ $[M+Na]^+$ 532.1471, found 532.1433.



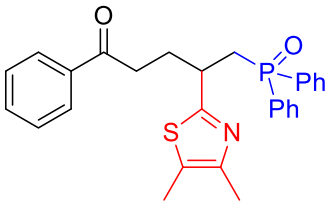
3t: white solid, m.p. 158-159 °C, 92.5 mg, 88%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83-7.79 (m, 2H), 7.78-7.72 (m, 2H), 7.69 (d, *J* = 8.8 Hz, 1H), 7.64-7.57 (m, 2H), 7.52-7.41 (m, 4H), 7.39-7.33 (m, 2H), 7.22-7.13 (m, 4H), 7.00 (dd, *J* = 8.8, 2.4 Hz, 1H), 3.89-3.78 (m, 1H), 3.83 (s, 3H) 3.25-3.14 (m, 1H), 3.04-2.86 (m, 2H), 2.78 (ddd, *J* = 14.4, 14.4, 5.6 Hz 1H), 2.43-2.35 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.4, 170.1 (d, $J_{C\text{-}P}$ = 6.9 Hz), 157.1, 146.8, 136.2, 135.5, 133.2 (d, $J_{C\text{-}P}$ = 99.0 Hz), 132.5, 131.4 (d, $J_{C\text{-}P}$ = 2.5 Hz), 131.1 (d, $J_{C\text{-}P}$ = 98.5 Hz), 130.7 (d, $J_{C\text{-}P}$ = 2.5 Hz), 130.4 (d, $J_{C\text{-}P}$ = 9.4 Hz), 130.0 (d, $J_{C\text{-}P}$ = 9.3 Hz), 128.2 (d, $J_{C\text{-}P}$ = 11.6 Hz), 128.0, 127.6 (d, $J_{C\text{-}P}$ = 11.6 Hz), 127.5, 122.6, 114.7, 103.4, 55.3, 37.2 (d, $J_{C\text{-}P}$ = 2.7 Hz), 35.3 (d, $J_{C\text{-}P}$ = 69.8 Hz), 35.3, 31.2 (d, $J_{C\text{-}P}$ = 8.9 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.49. FT-IR: ν (cm^{-1}) 3052, 2924, 1681, 1598, 1558, 1484, 1435, 1393, 1319, 1258, 1223. HRMS [ESI] calcd for $C_{31}H_{29}NO_3PS$ $[M+H]^+$ 526.1600, found 526.1587.



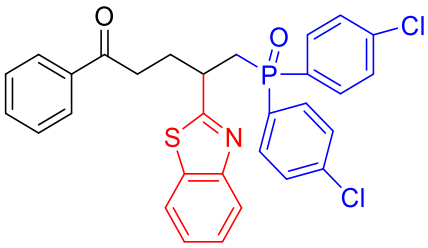
3u: white solid, m.p. 167-168 °C, 60.5 mg, 57%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84-7.78 (m, 3H), 7.77-7.71 (m, 2H), 7.64-7.53 (m, 3H), 7.53-7.41 (m, 4H), 7.41-7.34 (mz, 2H), 7.29-7.26 (m, 1H), 7.22-7.11 (m, 3H), 3.94-3.82 (m, 1H), 3.25-3.15 (m, 1H), 3.04-2.86 (m, 2H), 2.79 (ddd, J = 14.4, 14.4, 4.8 Hz, 1H), 2.40 (dd, J = 14.4, 7.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.6, 175.2 (d, $J_{C\text{-}P}$ = 6.1 Hz), 153.6, 136.6, 133.6 (d, $J_{C\text{-}P}$ = 99.1 Hz), 133.1, 133.0, 131.9 (d, $J_{C\text{-}P}$ = 2.4 Hz), 131.8, 131.8 (d, $J_{C\text{-}P}$ = 98.4 Hz), 131.2 (d, $J_{C\text{-}P}$ = 2.6 Hz), 130.9 (d, $J_{C\text{-}P}$ = 9.4 Hz), 130.5 (d, $J_{C\text{-}P}$ = 9.3 Hz), 128.7 (d, $J_{C\text{-}P}$ = 11.6 Hz), 128.5, 128.0 (d, $J_{C\text{-}P}$ = 11.9 Hz), 128.0, 125.4, 122.6, 122.2, 37.9 (d, $J_{C\text{-}P}$ = 2.7 Hz), 35.7 (d, $J_{C\text{-}P}$ = 69.7 Hz), 35.7, 31.7 (d, $J_{C\text{-}P}$ = 9.4 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.04. FT-IR: ν (cm^{-1}) 3294, 2956, 2922, 2864, 1590, 1489, 1467, 1437, 1389, 1316, 1276, 1240. HRMS [ESI] calcd for $C_{29}H_{32}NO_2PSNa$ $[M+Na]^+$ 552.0924, found 552.0903.



3v: white solid, m.p. 116-117 °C, 73.1 mg, 82%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86-7.79 (m, 2H), 7.77-7.71 (m, 2H), 7.64-7.58 (m, 2H), 7.56-7.42 (m, 5H), 7.42-7.36 (m, 3H), 7.36-7.29 (m, 2H), 7.03 (d, J = 3.2 Hz, 1H), 3.91-3.78 (m, 1H), 3.20-3.08 (m, 1H), 3.01-2.86 (m, 2H), 2.75 (ddd, J = 14.8, 14.8, 5.2 Hz, 1H), 2.37-2.29 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.9, 172.3 (d, $J_{C\text{-}P}$ = 7.0 Hz), 142.4, 136.7, 133.7 (d, $J_{C\text{-}P}$ = 98.8 Hz), 133.0, 132.0 (d, $J_{C\text{-}P}$ = 98.5 Hz), 131.8 (d, $J_{C\text{-}P}$ = 2.5 Hz), 131.4 (d, $J_{C\text{-}P}$ = 2.7 Hz), 130.9 (d, $J_{C\text{-}P}$ = 9.4 Hz), 130.5 (d, $J_{C\text{-}P}$ = 9.3 Hz), 128.7 (d, $J_{C\text{-}P}$ = 11.6 Hz), 128.5, 128.4 (d, $J_{C\text{-}P}$ = 11.7 Hz), 128.0, 118.5, 36.8 (d, $J_{C\text{-}P}$ = 2.8 Hz), 35.8 (d, $J_{C\text{-}P}$ = 69.8 Hz), 35.8, 32.1 (d, $J_{C\text{-}P}$ = 8.9 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.65. FT-IR: ν (cm^{-1}) 3062, 2927, 2854, 1676, 1595, 1508 1494, 1437, 1391, 1325, 1262, 1238. HRMS [ESI] calcd for $C_{26}H_{24}NO_2PSNa$ $[M+Na]^+$ 468.1158, found 468.1151.

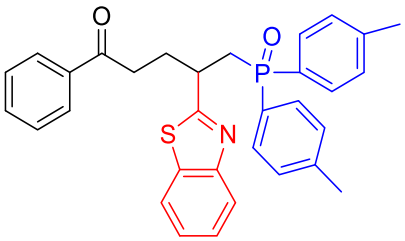


3w: white solid, m.p. 101-102 °C, 88.0 mg, 93%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89-7.81 (m, 2H), 7.74 (dd, J = 11.2, 6.8 Hz, 2H), 7.63 (dd, J = 11.2, 7.6 Hz, 2H), 7.54-7.38 (m, 7H), 7.35-7.29 (m, 2H), 3.79-3.63 (m, 1H), 3.27-3.10 (m, 1H), 3.00-2.83 (m, 2H), 2.71 (ddd, J = 14.8, 14.8, 4.8 Hz, 1H), 2.31 (dd, J = 12.0, 7.2 Hz, 2H), 2.13 (s, 3H), 2.12 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 199.0, 167.2 (d, $J_{C\text{-}P}$ = 5.9 Hz), 147.2, 136.7, 133.9 (d, $J_{C\text{-}P}$ = 98.7 Hz), 132.9, 131.9 (d, $J_{C\text{-}P}$ = 98.1 Hz), 131.7 (d, $J_{C\text{-}P}$ = 2.4 Hz), 131.1 (d, $J_{C\text{-}P}$ =3.7 Hz), 131.0 (d, $J_{C\text{-}P}$ = 9.6 Hz), 130.4 (d, $J_{C\text{-}P}$ = 9.3 Hz), 128.7 (d, $J_{C\text{-}P}$ = 11.6 Hz), 128.5, 128.0, 128.0 (d, $J_{C\text{-}P}$ = 11.7 Hz), 125.6, 36.7 (d, $J_{C\text{-}P}$ = 2.9 Hz), 36.0 (d, $J_{C\text{-}P}$ = 69.9 Hz), 36.0, 32.0 (d, $J_{C\text{-}P}$ = 9.8 Hz), 14.4, 11.0; ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.49. FT-IR: ν (cm^{-1}) 3054, 2957, 2920, 2861, 1716, 1682, 1578, 1473, 1384, 1321, 1278, 1231. HRMS [ESI] calcd for $C_{28}H_{28}NO_2PSNa$ $[M+Na]^+$ 496.1471, found 496.1460.

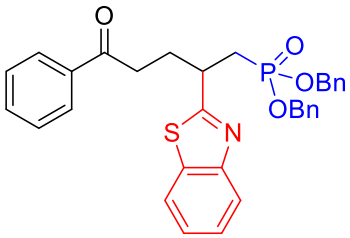


4a: white solid, m.p. 154-155 °C, 81.7 mg, 72%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85-7.75 (m, 3H), 7.71 (d, J = 8.0 Hz, 1H), 7.65 (dd, J = 10.4, 8.8 Hz, 2H), 7.51-7.34 (m, 8H), 7.34-7.28 (m, 1H), 7.08-6.99 (m, 2H), 3.93-3.80 (m,

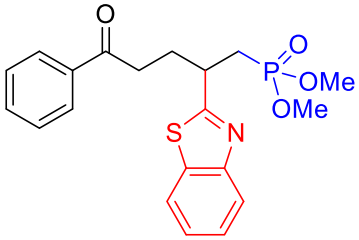
1H), 3.24-3.13 (m, 1H), 3.05-2.88 (m, 2H), 2.77 (ddd, J = 14.8, 14.8, 4.0 Hz, 1H), 2.41 (dd, J = 14.4, 7.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.2, 171.9 (d, $J_{C\text{-}P}$ = 5.3 Hz), 152.2, 138.2 (d, $J_{C\text{-}P}$ = 3.2 Hz), 137.6 (d, $J_{C\text{-}P}$ = 3.3 Hz), 136.1, 134.1, 132.6, 131.7 (d, $J_{C\text{-}P}$ = 10.3 Hz), 131.5 (d, $J_{C\text{-}P}$ = 100.3 Hz), 131.3 (d, $J_{C\text{-}P}$ = 10.1 Hz), 129.0 (d, $J_{C\text{-}P}$ = 99.5 Hz), 128.7 (d, $J_{C\text{-}P}$ = 12.2 Hz), 128.1, 127.9 (d, $J_{C\text{-}P}$ = 12.4 Hz), 127.5, 125.7, 124.7, 122.1, 121.0, 37.2 (d, $J_{C\text{-}P}$ = 3.0 Hz), 35.3 (d, $J_{C\text{-}P}$ = 70.9 Hz), 35.2, 31.4 (d, $J_{C\text{-}P}$ = 10.6 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 28.34. FT-IR: ν (cm^{-1}) 3056, 2932, 2901, 1686, 1581, 1512, 1481, 1435, 1389, 1320, 1293, 1235. HRMS [ESI] calcd for $C_{30}H_{24}Cl_2NO_2PSNa$ $[M+Na]^+$ 586.0535, found 586.0521.



4b: white solid, m.p. 73-74 °C, 63.2 mg, 60%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88-7.79 (m, 3H), 7.72 (d, J = 8.0 Hz, 1H), 7.63 (dd, J = 10.8, 8.0 Hz, 2H), 7.52-7.43 (m, 3H), 7.38 (dd, J = 15.6, 7.6 Hz, 3H), 7.34-7.28 (m, 1H), 7.22 (d, J = 6.8 Hz, 2H), 6.91 (d, J = 6.4 Hz, 2H), 3.95-3.82 (m, 1H), 3.25-3.14 (m, 1H), 3.05-2.87 (m, 2H), 2.78 (ddd, J = 14.0, 14.0, 4.0 Hz, 1H), 2.42 (dd, J = 14.4, 7.2 Hz, 2H), 2.34 (s, 3H), 2.11 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.3, 173.2 (d, $J_{C\text{-}P}$ = 5.8 Hz), 151.8, 141.8 (d, $J_{C\text{-}P}$ = 1.4 Hz), 141.3 (d, $J_{C\text{-}P}$ = 1.7 Hz), 136.1, 134.1, 132.5, 130.4 (d, $J_{C\text{-}P}$ = 9.5 Hz), 130.0 (d, $J_{C\text{-}P}$ = 9.4 Hz), 128.9 (d, $J_{C\text{-}P}$ = 11.9 Hz), 128.3 (d, $J_{C\text{-}P}$ = 12.0 Hz), 128.0, 127.5, 125.5, 124.5, 122.0, 121.0, 37.3 (d, $J_{C\text{-}P}$ = 1.5 Hz), 35.4 (d, $J_{C\text{-}P}$ = 69.8 Hz), 35.3, 31.3 (d, $J_{C\text{-}P}$ = 9.2 Hz), 21.1, 20.8; ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.77. FT-IR: ν (cm^{-1}) 2920, 2853, 1684, 1598, 1578, 1510, 1447, 1436, 1398, 1371, 1311, 1278, 1235. HRMS [ESI] calcd for $C_{32}H_{30}NO_2PSNa$ $[M+Na]^+$ 546.1627, found 546.1610.

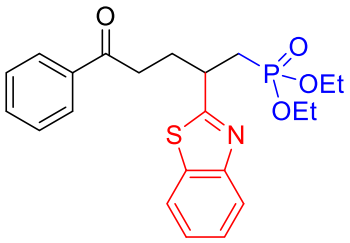


4c: white solid, m.p. 85-86 °C, 93.3 mg, 85%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, J = 8.4 Hz, 1H), 7.86-7.77 (m, 3H), 7.55-7.48 (m, 1H), 7.48-7.42 (m, 1H), 7.42-7.33 (m, 3H), 7.25-7.18 (m, 8H), 7.17-7.14 (m, 2H), 4.97-4.85 (m, 4H), 3.78-3.65 (m, 1H), 2.99-2.87 (m, 2H), 2.66 (ddd, J = 24.8, 16.8, 8.0 Hz, 1H), 2.44-2.23 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.7, 173.5 (d, $J_{C\text{-}P}$ = 9.5 Hz), 152.9, 136.6, 136.1 (d, $J_{C\text{-}P}$ = 5.7 Hz), 136.0 (d, $J_{C\text{-}P}$ = 5.9 Hz), 134.7, 133.0, 128.5 128.5, 128.5, 128.3, 128.3, 128.0, 127.9, 127.9, 126.1, 125.0, 122.8, 121.7, 67.4 (d, $J_{C\text{-}P}$ = 6.4 Hz), 67.3 (d, $J_{C\text{-}P}$ = 6.3 Hz), 38.6 (d, $J_{C\text{-}P}$ = 3.4 Hz), 35.5, 31.7 (d, $J_{C\text{-}P}$ = 155.1 Hz), 31.4 (d, $J_{C\text{-}P}$ = 2.7 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.18. FT-IR: ν (cm^{-1}) 3026, 2959, 2925, 2882, 2852, 1683, 1596, 1496, 1453, 1446, 1391, 1328, 1254, 1233. HRMS [ESI] calcd for $C_{32}H_{30}NO_4PSNa$ $[M+Na]^+$ 578.1525, found 578.1503.

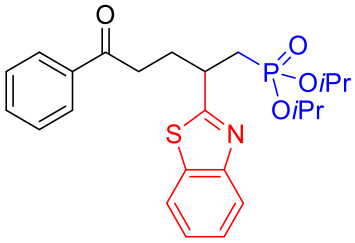


4d: yellow oil, 58.7 mg, 73%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (d, J = 8.4 Hz, 1H), 7.88-7.83 (m, 3H), 7.54-7.44 (m, 2H), 7.42-7.34 (m, 3H), 3.80-3.70 (m, 1H), 3.65 (d, J = 2.8 Hz, 3H), 3.63 (d, J = 2.8 Hz, 3H), 3.03-2.95 (m, 2H), 2.60 (ddd, J = 22.8, 15.2, 7.2 Hz, 1H), 2.51-2.40 (m, 1H), 2.39-2.24 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.4, 173.1 (d, $J_{C\text{-}P}$ = 10.6 Hz), 152.4, 136.2, 134.2, 132.6, 128.1, 127.5, 125.7, 124.6, 122.4,

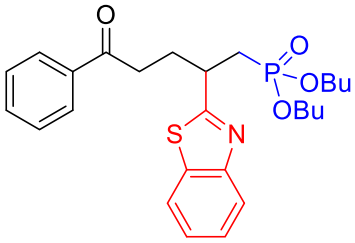
121.3, 52.0 (d, $J_{C\text{-}P}$ = 6.3 Hz), 52.0 (d, $J_{C\text{-}P}$ = 6.1 Hz), 38.0 (d, $J_{C\text{-}P}$ = 3.3 Hz), 35.1, 30.6 (d, $J_{C\text{-}P}$ = 10.9 Hz), 30.4 (d, $J_{C\text{-}P}$ = 140.3 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 30.82. FT-IR: ν (cm^{-1}) 3195, 3047, 2921, 2890, 1683, 1591, 1541, 1485, 1363, 1309, 1281, 1241. HRMS [ESI] calcd for $C_{20}H_{23}NO_4PS$ $[M+H]^+$ 404.1080, found 404.1074.



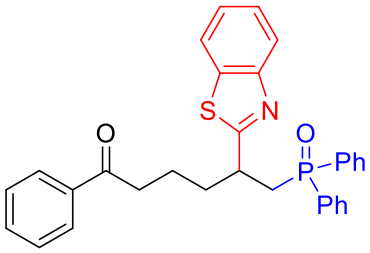
4e: yellow oil, 74.2 mg, 93%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.0 Hz, 1H), 7.88-7.82 (m, 3H), 7.53-7.42 (m, 2H), 7.42-7.32 (m, 3H), 4.05-3.95 (m, 4H), 3.77-3.67 (m, 1H), 3.05-2.92 (m, 2H), 2.56 (ddd, *J* = 23.2, 15.6, 7.6 Hz, 1H), 2.49-2.40 (m, 1H), 2.40-2.22 (m, 2H), 1.21-1.11 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.9, 173.6 (d, $J_{C\text{-}P}$ = 10.3 Hz), 153.0, 136.6, 134.7, 133.0, 128.5, 128.0, 126.1, 125.0, 122.8, 121.7, 61.8 (d, $J_{C\text{-}P}$ = 6.5 Hz), 38.7 (d, $J_{C\text{-}P}$ = 3.4 Hz), 36.0, 31.8 (d, $J_{C\text{-}P}$ = 122.9 Hz), 31.0 (d, $J_{C\text{-}P}$ = 6.2 Hz), 16.3 (d, $J_{C\text{-}P}$ = 5.6 Hz), 16.2 (d, $J_{C\text{-}P}$ = 5.8 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 27.99. FT-IR: ν (cm^{-1}) 3056, 2926, 2868, 1733, 1682, 1596, 1579, 1509, 1483, 1436 1371, 1311, 1264, 1242. HRMS [ESI] calcd for $C_{22}H_{27}NO_4PS$ $[M+H]^+$ 432.1393, found 432.1387.



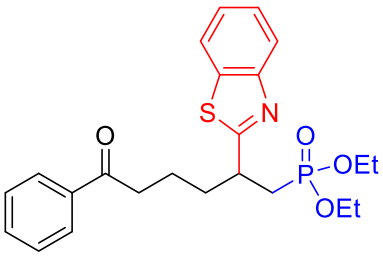
4f: yellow oil, 56.2 mg, 61%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80-7.94 (m, 1H), 7.89-7.79 (m, 3H), 7.53-7.43 (m, 2H), 7.42-7.31 (m, 3H), 4.70-4.58 (m, 2H), 3.78-3.65 (m, 1H), 3.06-2.91 (m, 2H), 2.57-2.42 (m, 2H), 2.57-2.42 (m, 2H), 2.40-2.18 (m, 2H), 1.24 (d, *J* = 6.0 Hz, 3H), 1.20 (d, *J* = 6.0 Hz, 6H), 1.17 (d, *J* = 6.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.5, 173.5 (d, $J_{C\text{-}P}$ = 11.0 Hz), 152.5, 136.2, 134.3, 132.5, 128.0, 127.5, 125.5, 124.5, 122.3, 121.2, 69.9 (d, $J_{C\text{-}P}$ = 6.5 Hz), 69.9 (d, $J_{C\text{-}P}$ = 6.6 Hz), 38.5 (d, $J_{C\text{-}P}$ = 3.5 Hz), 35.2, 32.7 (d, $J_{C\text{-}P}$ = 141.7 Hz), 30.6 (d, $J_{C\text{-}P}$ = 10.5 Hz), 23.6-23.0 (m, 4C(Me)); ^{31}P NMR (161 MHz, $CDCl_3$) δ 25.77. FT-IR: ν (cm^{-1}) 3061, 2977, 2928, 1683, 1579, 1558, 1448, 1438, 1384, 1311, 1221. HRMS [ESI] calcd for $C_{24}H_{30}NO_4PSNa$ $[M+Na]^+$ 482.1525, found 482.1533.



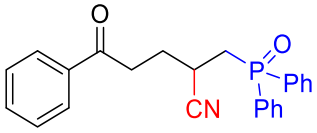
4g: yellow oil, 78.9 mg, 81%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.0 Hz, 1H), 7.89-7.81 (m, 3H), 7.53-7.48 (m, 1H), 7.48-7.42 (m, 1H), 7.41-7.33 (m, 3H), 3.97-3.86 (m, 4H), 3.78-3.65 (m, 1H), 3.06-2.91 (m, 2H), 2.58 (ddd, *J* = 23.6, 15.6, 8.0 Hz, 1H), 2.49-2.22 (m, 3H), 1.51-1.39 (m, 4H), 1.28-1.16 (m, 4H), 0.80 (dd, *J* = 16.0, 8.0 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.8, 173.8 (d, $J_{C\text{-}P}$ = 9.6 Hz), 152.8, 136.7, 134.7, 133.1, 128.5, 128.0, 126.1, 125.1, 122.8, 121.7, 65.5 (d, $J_{C\text{-}P}$ = 6.6 Hz), 65.5 (d, $J_{C\text{-}P}$ = 6.7 Hz), 38.7 (d, $J_{C\text{-}P}$ = 3.6 Hz), 35.6, 32.4 (d, $J_{C\text{-}P}$ = 2.9 Hz), 32.3 (d, $J_{C\text{-}P}$ = 3.0 Hz), 31.4 (d, $J_{C\text{-}P}$ = 140.6 Hz), 31.3 (d, $J_{C\text{-}P}$ = 11.8 Hz), 18.7, 18.6, 13.5, 13.5; ^{31}P NMR (161 MHz, $CDCl_3$) δ 28.02. FT-IR: ν (cm^{-1}) 3061, 2959, 2929, 2872, 1683, 1597, 1513, 1449, 1438, 1409, 1377, 1311, 1221. HRMS [ESI] calcd for $C_{26}H_{34}NO_4PSNa$ $[M+Na]^+$ 510.1838, found 510.1843.



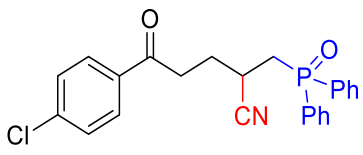
6b: white solid, m.p. 89-90 °C, 82.5 mg, 81%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88-7.81 (m, 3H), 7.78-7.68 (m, 3H), 7.65-7.58 (m, 2H), 7.53-7.37 (m, 7H), 7.32-7.27 (m, 1H), 7.24-7.13(m, 3H), 3.85-3.73 (m, 1H), 3.18-3.07 (m, 1H), 2.98-2.84 (m, 2H), 2.78 (ddd, J = 14.4, 14.4, 6.4 Hz, 1H), 2.14-1.98 (m, 2H), 1.77-1.63 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 199.6, 173.7 (d, $J_{C\text{-}P}$ = 7.8 Hz), 152.9, 136.8, 134.7, 133.9 (d, $J_{C\text{-}P}$ = 98.8 Hz), 132.9, 131.8 (d, $J_{C\text{-}P}$ = 2.6 Hz), 131.6 (d, $J_{C\text{-}P}$ = 98.2 Hz), 131.2 (d, $J_{C\text{-}P}$ = 2.7 Hz), 130.9 (d, $J_{C\text{-}P}$ =9.4 Hz), 130.5 (d, $J_{C\text{-}P}$ = 9.3 Hz), 128.7 (d, $J_{C\text{-}P}$ = 11.6 Hz), 128.5, 128.1 (d, $J_{C\text{-}P}$ = 11.7 Hz), 128.0, 125.8, 124.8, 122.6, 121.4, 38.3 (d, $J_{C\text{-}P}$ = 2.8 Hz), 38.0, 36.7 (d, $J_{C\text{-}P}$ = 7.8 Hz), 35.5 (d, $J_{C\text{-}P}$ = 69.7 Hz), 21.4; ^{31}P NMR (161 MHz, $CDCl_3$) δ 29.33. FT-IR: ν (cm^{-1}) 3051, 2922, 2854, 1682, 1597, 1578, 1509, 1446, 1435, 1398, 1373, 1312, 1237, 1206. HRMS [ESI] calcd for $C_{31}H_{29}NO_2PS$ $[M+H]^+$ 510.1651, found 5110.1637.



7b: yellow yellow oil, 57.1 mg, 64%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, J = 8.0 Hz, 1H), 7.92-7.87 (m, 2H), 7.84 (d, J = 8.0 Hz, 1H), 7.56-7.49 (m, 1H), 7.48-7.38 (m, 3H), 7.39-7.33 (m, 1H), 4.04-3.93 (m, 4H), 3.69-3.57 (m, 1H), 3.05-2.88 (m, 2H), 2.50 (ddd, J = 23.2, 15.6, 7.6 Hz, 1H), 2.27 (ddd, J = 24.4, 18.0, 6.0 Hz, 1H), 2.12-1.98 (m, 2H), 1.83-1.66 (m, 2H), 1.20-1.09 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 199.6, 174.2 (d, $J_{C\text{-}P}$ = 10.1 Hz), 152.9, 136.8, 134.7, 133.0, 128.5, 128.0, 126.0, 125.0, 122.7, 121.6, 61.8 (d, $J_{C\text{-}P}$ = 6.3 Hz), 61.7 (d, $J_{C\text{-}P}$ = 6.6 Hz), 39.3 (d, $J_{C\text{-}P}$ = 3.5 Hz), 38.0, 36.5 (d, $J_{C\text{-}P}$ = 10.8 Hz), 31.6 (d, $J_{C\text{-}P}$ = 140.1 Hz), 21.5, 16.3, 16.2, 16.2, 16.2; ^{31}P NMR (161 MHz, $CDCl_3$) δ 28.31. FT-IR: ν (cm^{-1}) 2981, 2929, 1681, 1596, 1580, 1513, 1477, 1438, 1392, 1367, 1311, 1223. HRMS [ESI] calcd for $C_{23}H_{28}NO_4PSNa$ $[M+Na]^+$ 468.1369, found 468.1357.

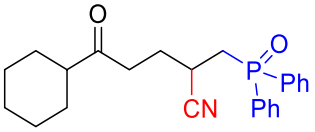


9a: white solid, m.p. 130-131 °C, 57.5 mg, 74%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96-7.88 (m, 2H), 7.85-7.71 (m, 4H), 7.62-7.48 (m, 7H), 7.48-7.41 (m, 2H), 3.32-3.08 (m, 3H), 2.82-2.72 (m, 1H), 2.57 (ddd, J = 18.8, 12.4, 6.0 Hz, 1H), 2.34-2.22 (m, 1H), 2.15-2.02 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.3, 135.9, 132.9, 132.1 (d, $J_{C\text{-}P}$ = 2.1 Hz), 131.9 (d, $J_{C\text{-}P}$ = 2.1 Hz), 131.8 (d, $J_{C\text{-}P}$ = 100.8 Hz), 130.6 (d, $J_{C\text{-}P}$ = 9.4 Hz), 130.4(d, $J_{C\text{-}P}$ = 101.2 Hz), 130.1 (d, $J_{C\text{-}P}$ = 9.3 Hz), 128.6 (d, $J_{C\text{-}P}$ = 3.0 Hz), 128.5 (d, $J_{C\text{-}P}$ = 3.0 Hz), 128.2, 127.5, 120.0 (d, $J_{C\text{-}P}$ = 9.1 Hz), 35.1, 32.4 (d, $J_{C\text{-}P}$ = 69.0 Hz), 27.6 (d, $J_{C\text{-}P}$ = 7.0 Hz), 24.4 (d, $J_{C\text{-}P}$ = 2.1 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 28.23. FT-IR: ν (cm^{-1}) 2919, 2958, 2850, 2243, 1680, 1599, 1579, 1507, 1449, 1412, 1378, 1360, 1259, 1210. HRMS [CI] calcd for $C_{24}H_{23}NO_2P$ $[M+H]^+$ 388.1461, found 388.1468.

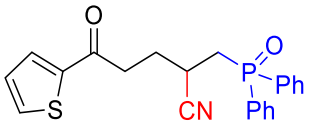


9b: white solid, m.p. 116-117 °C, 42.3 mg, 50%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89-7.82 (m, 2H), 7.83-7.71 (m, 4H), 7.62-7.485 (m, 6H), 7.45-7.38 m, 2H), 3.33-3.20 (m, 1H), 3.19-3.04 (m, 2H), 2.85-2.72 (m, 1H), 2.64-2.50 (m, 1H), 2.34-2.22 (m, 1H), 2.15-2.02 (m, 1H); ^{13}C NMR (100 MHz,

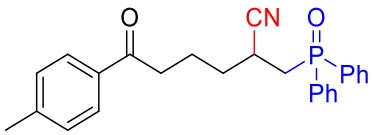
$CDCl_3$) δ 196.5, 139.8, 134.6, 132.6, 132.4, 131.1 (d, J_{C-P} = 7.8 Hz), 130.6 (d, J_{C-P} = 7.5 Hz), 129.4, 129.0, 129.0, 128.9, 120.5 (d, J_{C-P} = 7.6 Hz), 35.6, 32.9 (d, J_{C-P} = 70.1 Hz), 28.0 (d, J_{C-P} = 3.7 Hz), 24.9; ^{31}P NMR (161 MHz, $CDCl_3$) δ 28.29. FT-IR: ν (cm^{-1}) 3058, 2958, 2925, 2855, 2239, 1684, 1589, 1571, 1486, 1437, 1401, 1371, 1323, 1265. HRMS [ESI] calcd for $C_{24}H_{22}NO_2PCl$ $[M+H]^+$ 422.1071, found 422.1070.



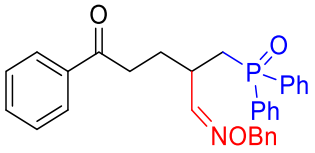
9c: white solid, m.p. 122-123 °C, 58.2 mg, 74%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83-7.69 (m, 4H), 7.61-7.45 (m, 6H), 3.20-3.08 (m, 1H), 2.76-2.43 (m, 4H), 2.33-2.24 (m, 1H), 2.12-2.01 (m, 1H), 1.93-1.83 (m, 1H), 1.83-1.68 (m, 4H), 1.67-1.59 (m, 1H), 1.35-1.10 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 211.2, 132.0 (d, J_{C-P} = 2.5 Hz), 131.9 (d, J_{C-P} = 100.9 Hz), 131.9 (d, J_{C-P} = 2.4 Hz), 130.6 (d, J_{C-P} = 9.4 Hz), 130.4 (d, J_{C-P} = 99.6 Hz), 130.1 (d, J_{C-P} = 9.5 Hz), 128.5 (d, J_{C-P} = 3.1 Hz), 128.4 (d, J_{C-P} = 3.1 Hz), 119.9 (d, J_{C-P} = 9.2 Hz), 50.3, 36.9, 32.3 (d, J_{C-P} = 69.2 Hz), 28.0, 27.9, 27.1 (d, J_{C-P} = 6.9 Hz), 25.3, 25.1, 25.1, 24.3 (d, J_{C-P} = 2.5 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 28.25. FT-IR: ν (cm^{-1}) 3061, 2929, 2850, 2240, 1705, 1590, 1483, 1438, 1409, 1374, 1324, 1265,1239. HRMS [CI] calcd for $C_{24}H_{29}NO_2P$ $[M+H]^+$ 394.1930, found 394.1929.



9d: white solid, m.p. 130-131 °C, 44.1 mg, 56%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84-7.72 (m, 4H), 7.72-7.68 m, 1H), 7.66-7.62 (m, 1H), 7.60-7.46 (m, 6H), 7.12 (dd, J = 4.8, 3.6 Hz, 1H), 3.31-3.20 (m, 1H), 3.20-3.02 (m, 2H), 2.82-2.69 (m, 1H), 2.63-2.49 (m, 1H), 2.33-2.21 (m, 1H), 2.14-2.03 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.1, 143.0, 133.5, 132.1 (d, J_{C-P} = 1.8 Hz), 132.0 (d, J_{C-P} = 1.6 Hz), 131.9 (d, J_{C-P} = 100.3 Hz), 131.8, 130.6 (d, J_{C-P} = 9.3 Hz), 130.4 (d, J_{C-P} = 99.1 Hz), 130.1 (d, J_{C-P} = 9.3 Hz), 128.6 (d, J_{C-P} = 3.2 Hz), 128.5 (d, J_{C-P} = 3.0 Hz), 127.8, 119.9 (d, J_{C-P} = 8.9 Hz), 35.7, 32.3 (d, J_{C-P} = 69.0 Hz), 27.7 (d, J_{C-P} = 6.9 Hz), 24.5 (d, J_{C-P} = 1.8 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 28.34. FT-IR: ν (cm^{-1}) 2956, 2920, 2234, 1681, 1651, 1606, 1519, 1484, 1436, 1362, 1315, 1297, 1237, 1204. HRMS [CI] calcd for $C_{22}H_{21}NO_2PS$ $[M+H]^+$ 394.1025, found 394.1027.

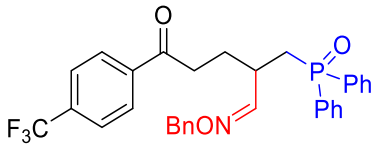


9e: white solid, m.p. 127-128 °C, 47.5 mg, 57%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85-7.78 (m, 3H), 7.79-7.70 (m, 3H), 7.61-7.44 (m, 6H), 7.28-7.21 (m, 2H), 3.21-3.07 (m, 1H), 3.01-2.83 (m, 2H), 2.79-2.67 (m, 1H), 2.53 (ddd, J = 13.6, 13.6, 6.0 Hz, 1H), 2.40 (s, 3H), 1.99-1.72 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.1, 143.5, 133.7, 132.0, 132.0 (d, J_{C-P} = 98.7 Hz), 131.9, 130.6 (d, J_{C-P} = 9.0 Hz), 130.1 (d, J_{C-P} = 9.0 Hz), 128.8, 128.5 (d, J_{C-P} = 11.3 Hz), 127.6, 120.2 (d, J_{C-P} = 9.5 Hz), 36.8, 32.5 (d, J_{C-P} = 5.3 Hz), 31.9 (d, J_{C-P} = 68.4 Hz), 24.8, 21.2, 20.7; ^{31}P NMR (161 MHz, $CDCl_3$) δ 28.47. FT-IR: ν (cm^{-1}) 2957, 2864, 2233, 1681, 1606, 1484, 1456, 1435, 1407, 1381, 1362, 1295, 1239. HRMS [ESI] calcd for $C_{26}H_{26}NO_2PNa$ $[M+Na]^+$ 438.1593, found 438.1651.



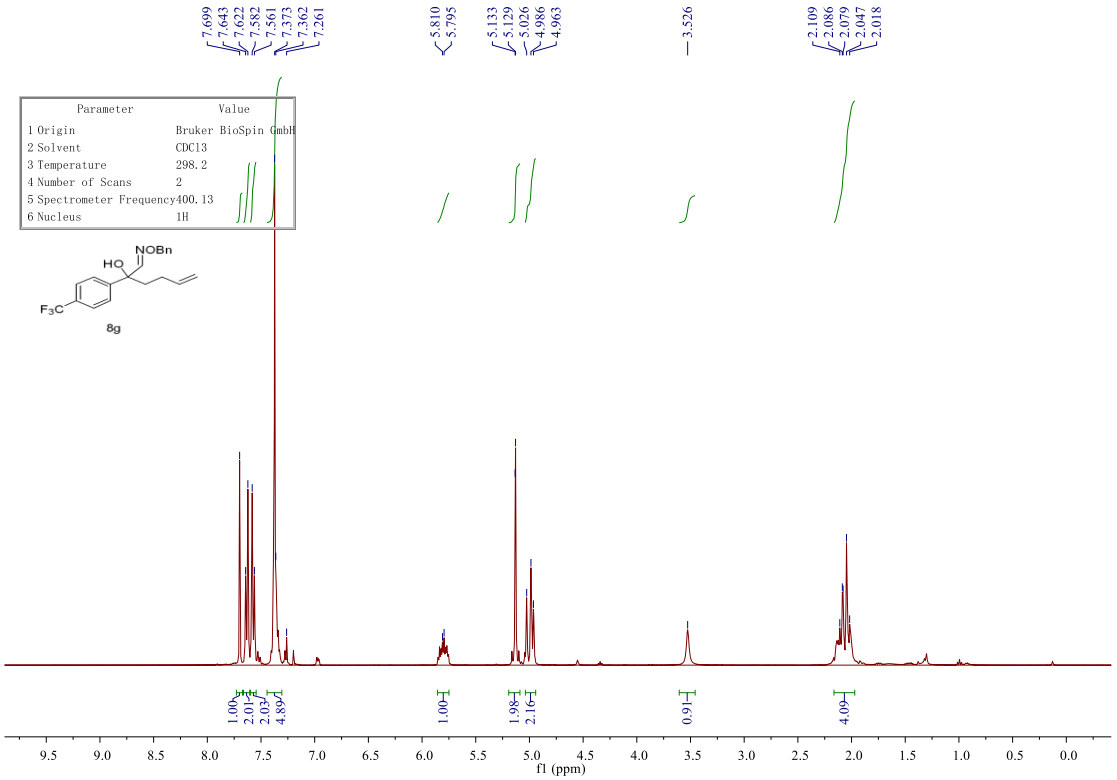
9f: yellow solid, m.p. 96-97 °C, 43.6 mg, 44%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86-7.81 (m, 2H), 7.77-7.69 (m, 4H), 7.56-7.48 (m, 3H), 7.47-7.38 (m, 6H), 7.32-7.22 (m, 5H), 4.89 (s, 2H), 2.99-2.83 (m,

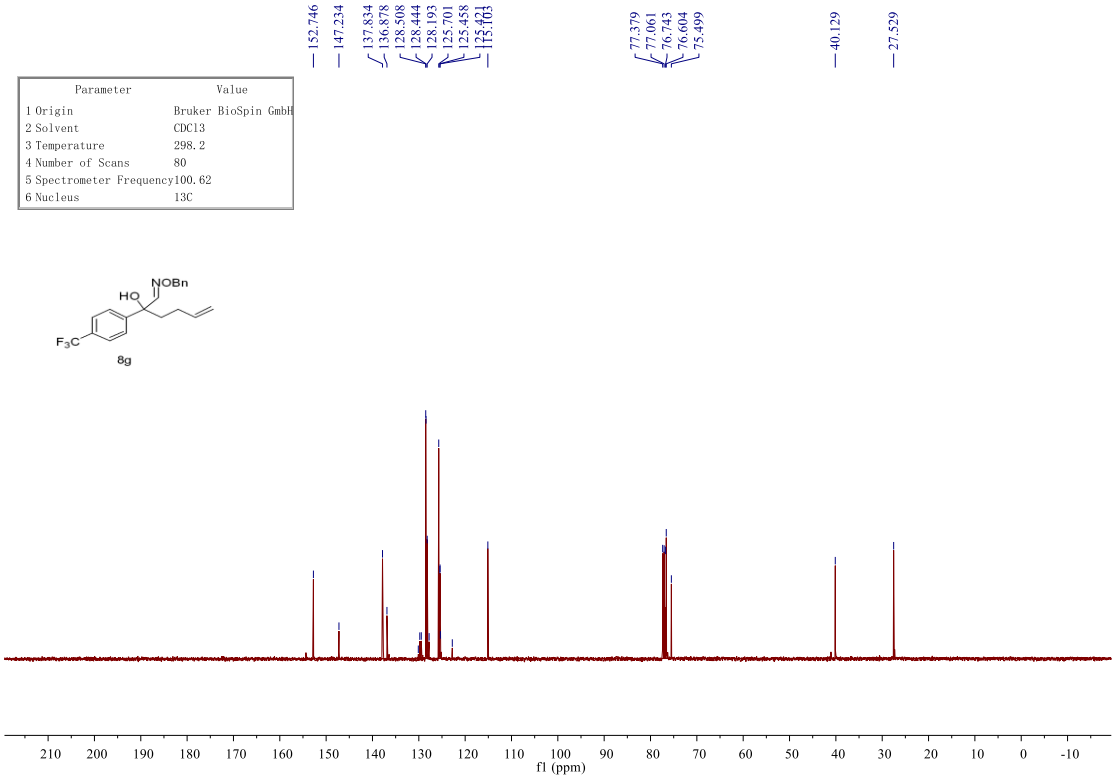
3H), 2.69-2.58 (m, 1H), 2.48-2.36 (m, 1H), 2.13-1.95 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 199.3, 152.3 (d, J_{C-P} = 7.1 Hz), 137.7, 136.8, 133.2 (d, J_{C-P} = 98.7 Hz), 133.0, 132.6 (d, J_{C-P} = 98.2 Hz), 131.9 (d, J_{C-P} = 3.2 Hz), 131.8 (d, J_{C-P} = 3.1 Hz), 131.0 (d, J_{C-P} = 9.2 Hz), 130.7 (d, J_{C-P} = 9.2 Hz), 128.8 (d, J_{C-P} = 11.6 Hz), 128.7 (d, J_{C-P} = 11.7 Hz), 128.5, 128.3, 128.2, 128.0, 127.7, 75.5, 35.6, 34.1 (d, J_{C-P} = 3.0 Hz), 33.0 (d, J_{C-P} = 70.2 Hz), 28.3 (d, J_{C-P} = 8.5 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 30.20. FT-IR: ν (cm^{-1}) 2920, 2851, 2213, 1682, 1632, 1596, 1580, 1495, 1449, 1437, 1409, 1369, 1230. HRMS [ESI] calcd for $C_{31}H_{31}NO_3P$ $[M+H]^+$ 496.2036, found 496.2029.

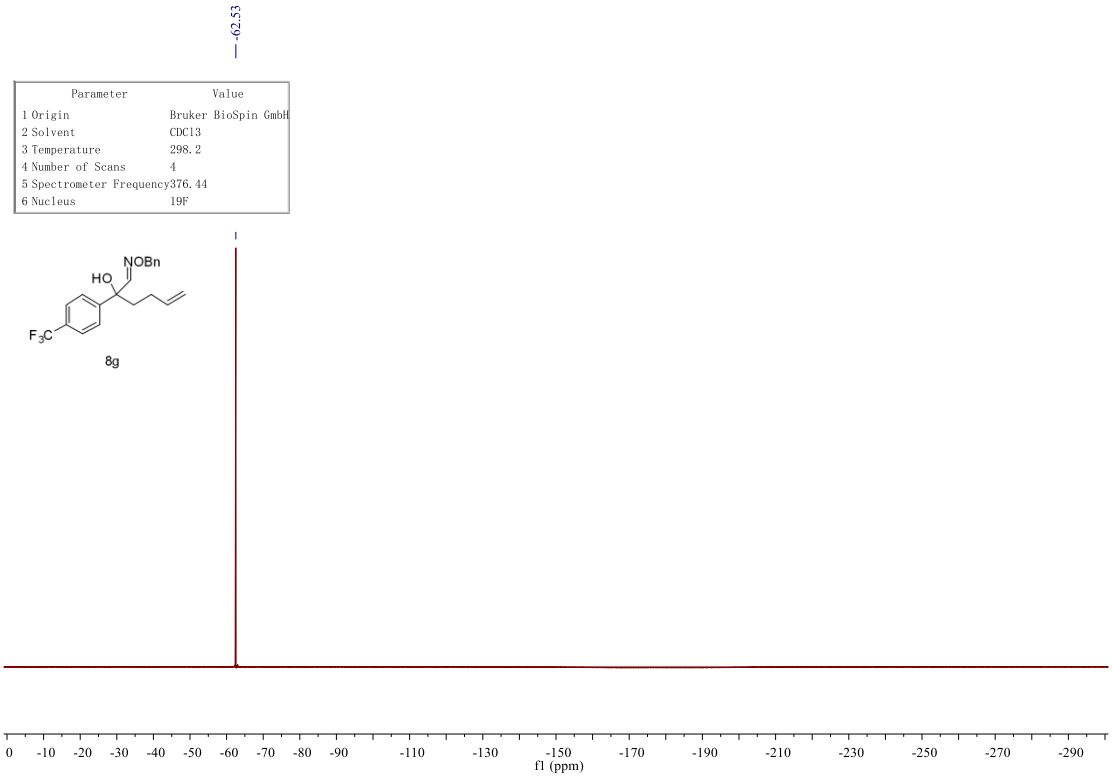


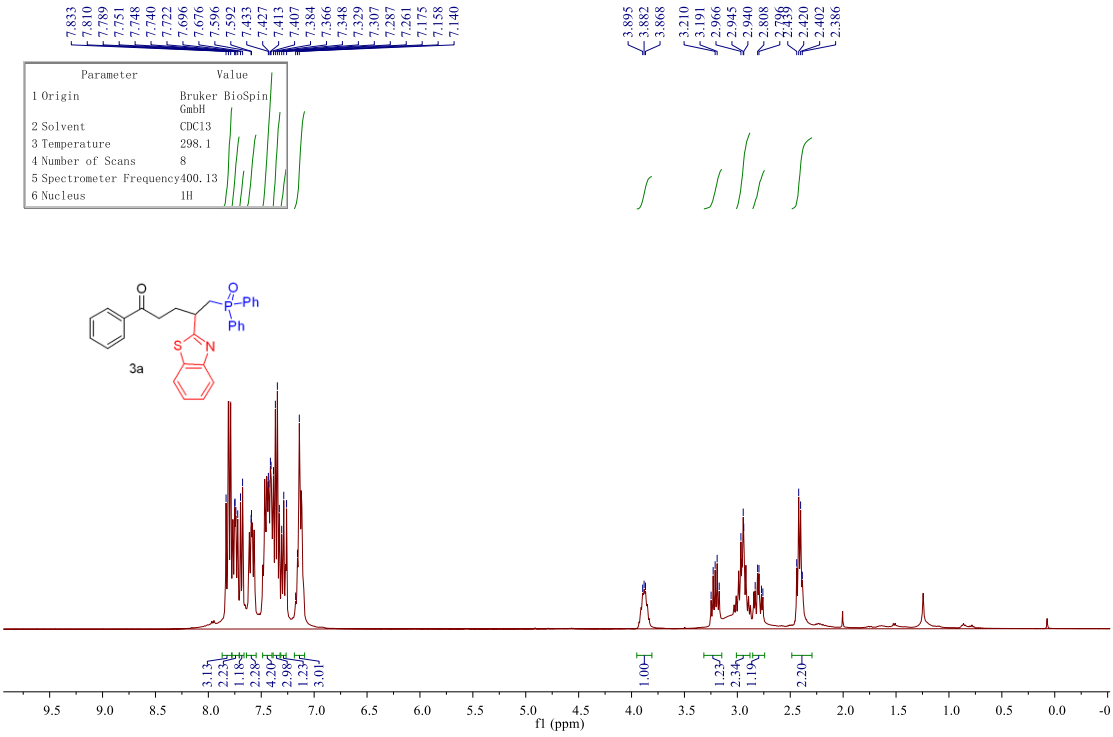
9g: white solid, m.p. 114-117 °C, 71.0 mg, 63% (mixture of *Z*/*E* oxime, ~3:1 ratio). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90-7.75 (m, 2.67H, two isomers), 7.73-7.51 (m, 8.0H, two isomers), 7.50-7.28 (m, 8.0H, two isomers), 7.28-7.06 (m, 8.0H, two isomers), 4.81 (s, 2H, two isomers), 2.96-2.72 (m, 3.33H, two isomers), 2.62-2.50 (m, 1.0H, one isomer), 2.44-2.26 (m, 1.67H, two isomers), 2.20-1.75 (m, 3.33H, two isomers); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.8 & 197.6 (two isomers), 152.6 (overlap, two isomers, d, J_{C-P} = 8.1 Hz), 151.8 (overlap, two isomers, q, J_{C-F} = 7.5 Hz), 138.9 & 138.8 (two isomers), 137.2 & 136.9 (two isomers), 133.8 (d, J_{C-F} = 32.6 Hz) & 133.5 (d, J_{C-F} = 32.6 Hz) (two isomers), 133.3 (overlap, two isomers, d, J_{C-P} = 1.8 Hz), 132.3 (overlap, two isomers, d, J_{C-P} = 1.9 Hz), 131.4 (overlap, two isomers), 130.5 (overlap, two isomers, d, J_{C-P} = 9.1 Hz), 130.1 (overlap, two isomers, d, J_{C-P} = 9.1 Hz), 128.3 (overlap, two isomers, d, J_{C-P} = 11.5 Hz), 128.3 (overlap, two isomers, d, J_{C-P} = 11.8 Hz), 127.9 (overlap, two isomers), 127.8 (overlap, two isomers), 127.7 (overlap, two isomers), 127.3 (overlap, two isomers), 125.9 (overlap, two isomers, q, J_{C-F} = 271.1 Hz), 125.1 (overlap, two isomers, q, J_{C-F} = 3.5 Hz), 75.5 & 75.1 (two isomers), 35.9 & 35.5 (two isomers), 33.6 (overlap, two isomers, d, J_{C-P} = 1.7 Hz), 32.6 (d, J_{C-P} = 70.5 Hz) & 32.4 (d, J_{C-P} = 70.0 Hz) (two isomers), 27.4 (overlap, two isomers, d, J_{C-P} = 7.7 Hz); ^{31}P NMR (161 MHz, $CDCl_3$) δ 30.40 (overlap, two isomers); ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.1 (overlap, two isomers). FT-IR: ν (cm^{-1}) 3060, 2960, 2929, 2852, 1691, 1578, 1509, 1485, 1454, 1437, 1371, 1323, 1233. HRMS [ESI] calcd for $C_{32}H_{29}F_3NO_2PNa$ $[M+Na]^+$ 586.1729, found 586.1701.

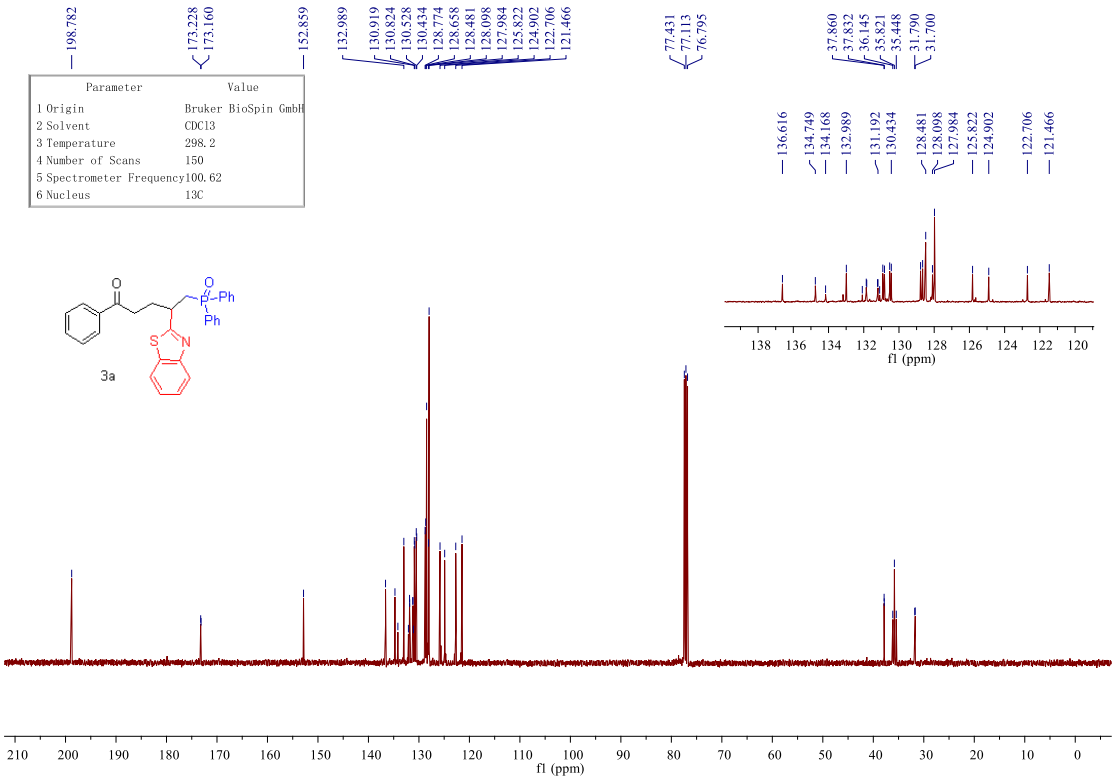
5. ^{1}H, ^{13}C, ^{19}F, and ^{31}P NMR spectra

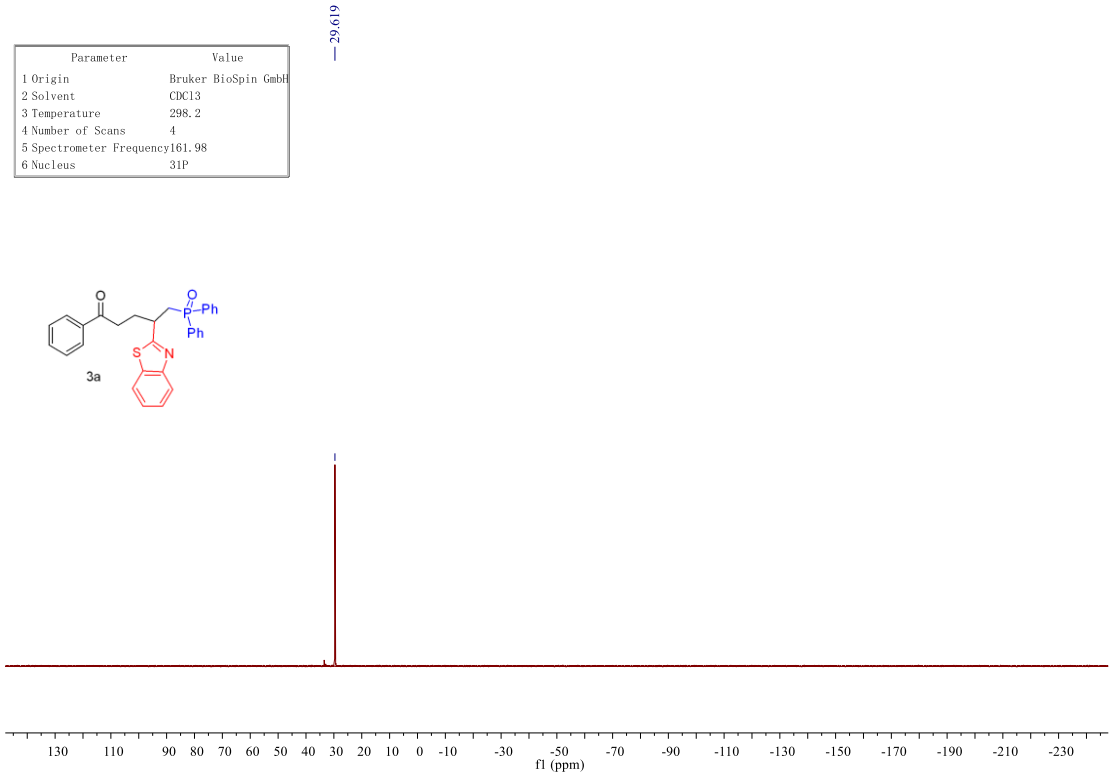


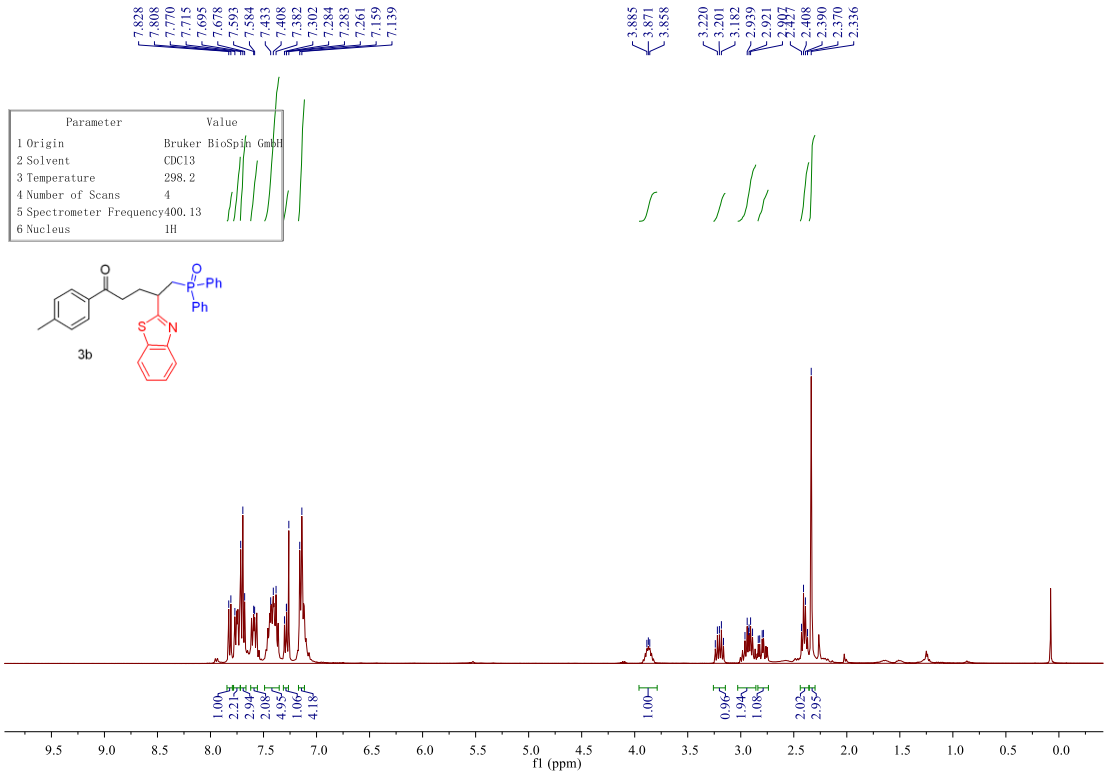


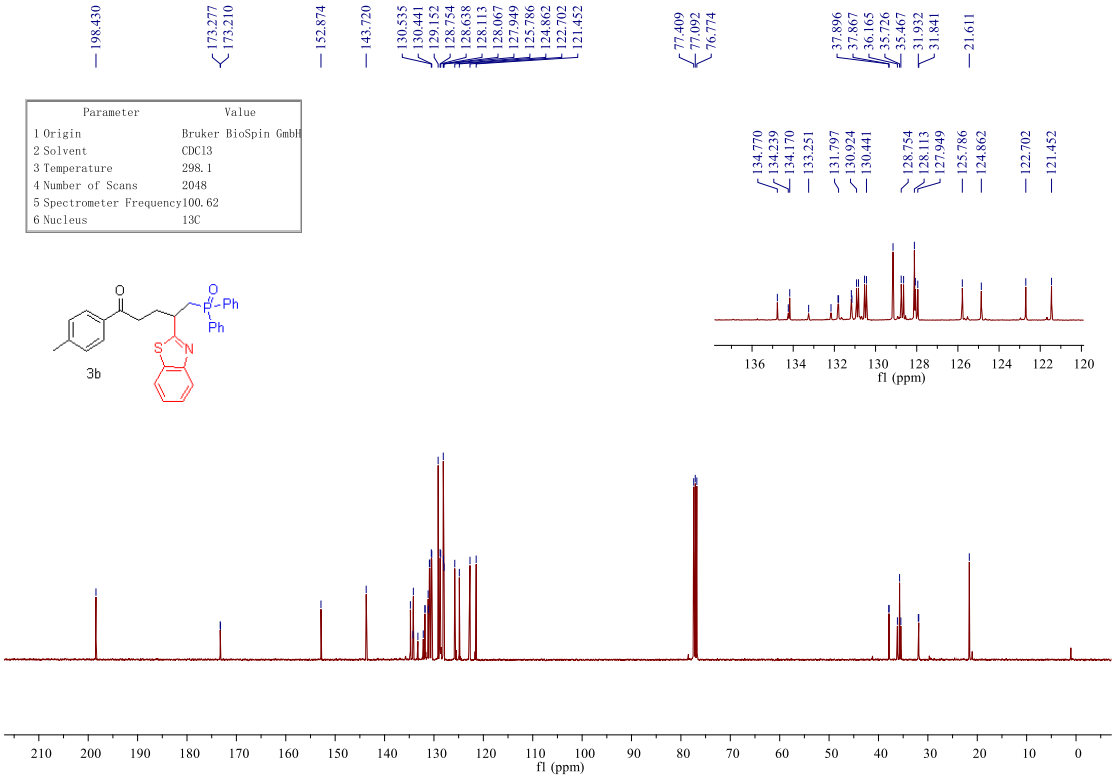

-62.53
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 4
5 Spectrometer Frequency 376.44
6 Nucleus 19F
NOBn
HO
F3C
8g
f1 (ppm)


7.833
7.810
7.789
7.751
7.748
7.740
7.722
7.696
7.676
7.596
7.592
7.433
7.427
7.413
7.407
7.384
7.366
7.348
7.329
7.307
7.287
7.261
7.175
7.158
7.140
3.895
3.882
3.868
3.210
3.191
2.966
2.945
2.940
2.808
2.736
2.439
2.420
2.402
2.386
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 8
5 Spectrometer Frequency 400.13
6 Nucleus 1H
O
P
Ph
Ph
S
N
3a
3.13
2.23
1.18
2.26
4.20
2.98
1.23
3.01
1.00
1.23
2.34
1.19
2.20
f1 (ppm)


198.782
173.228
173.160
152.859
132.989
130.919
130.824
130.528
130.434
128.774
128.658
128.481
128.098
127.984
125.822
124.902
122.706
121.466
77.431
77.113
76.795
37.860
37.832
36.145
35.821
35.448
31.790
31.700
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 150
5 Spectrometer Frequency 100.62
6 Nucleus 13C
3a
136.616
134.749
134.168
132.989
131.192
130.434
128.481
128.098
127.984
125.822
124.902
122.706
121.466
138 136 134 132 130 128 126 124 122 120
f1 (ppm)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

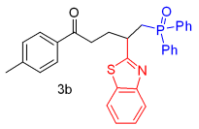

29.619
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 4
5 Spectrometer Frequency 161.98
6 Nucleus 31P
3a
130 110 90 80 70 60 50 40 30 20 10 0 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)


7.828
7.808
7.770
7.715
7.695
7.678
7.593
7.584
7.433
7.408
7.382
7.302
7.284
7.283
7.261
7.159
7.139
3.885
3.871
3.858
3.220
3.201
3.182
2.939
2.921
2.407
2.390
2.370
2.336
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 4
5 Spectrometer Frequency 400.13
6 Nucleus 1H
O
P
Ph
Ph
S
N
3b
1.00
2.21
2.94
2.08
4.95
1.06
4.18
1.00
0.96
1.94
1.08
2.02
2.95
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

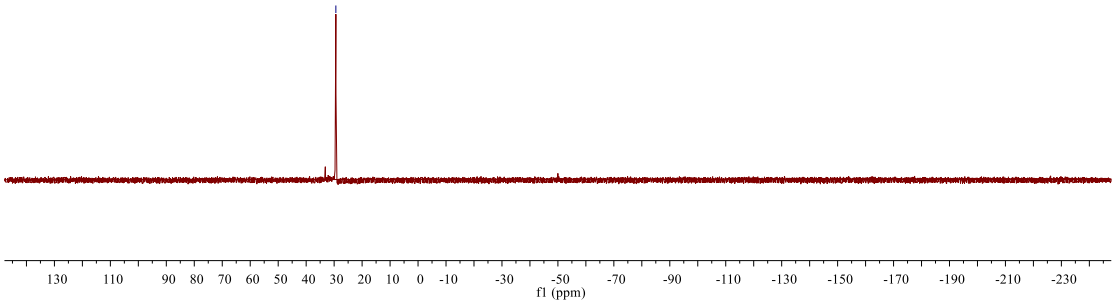

198.430
173.277
173.210
152.874
143.720
130.535
130.441
129.152
128.754
128.638
128.113
128.067
127.949
125.786
124.862
122.702
121.452
77.409
77.092
76.774
37.896
37.867
36.165
35.726
35.467
31.932
31.841
21.611
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 2048
5 Spectrometer Frequency 100.62
6 Nucleus 13C
O
P
Ph
Ph
S
N
3b
134.770
134.239
134.170
133.251
131.797
130.924
130.441
128.754
128.113
127.949
125.786
124.862
122.702
121.452
136 134 132 130 128 126 124 122 120
f1 (ppm)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	16
5 Spectrometer Frequency	161.97
6 Nucleus	31P

29.381



3b

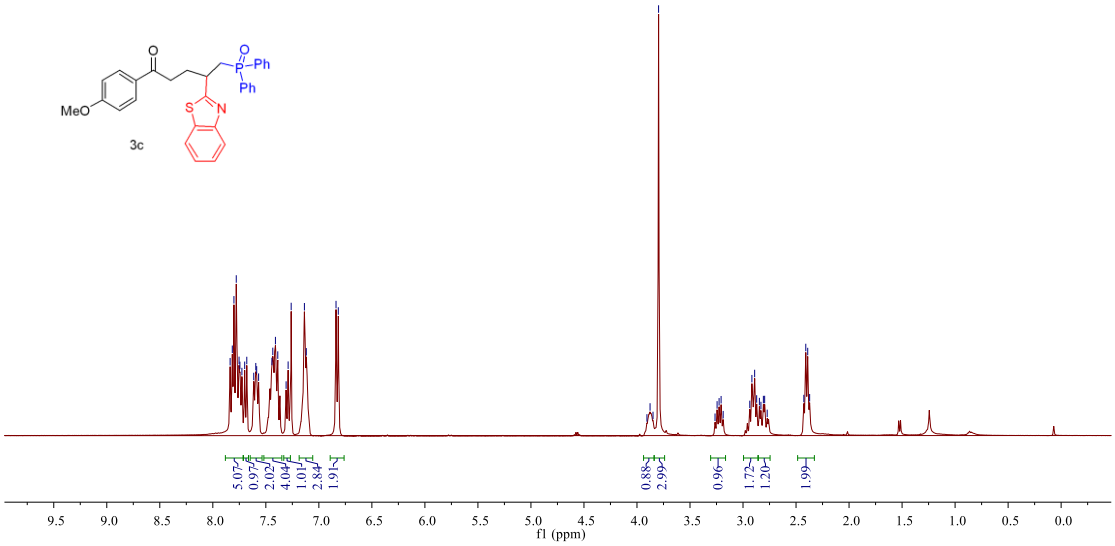


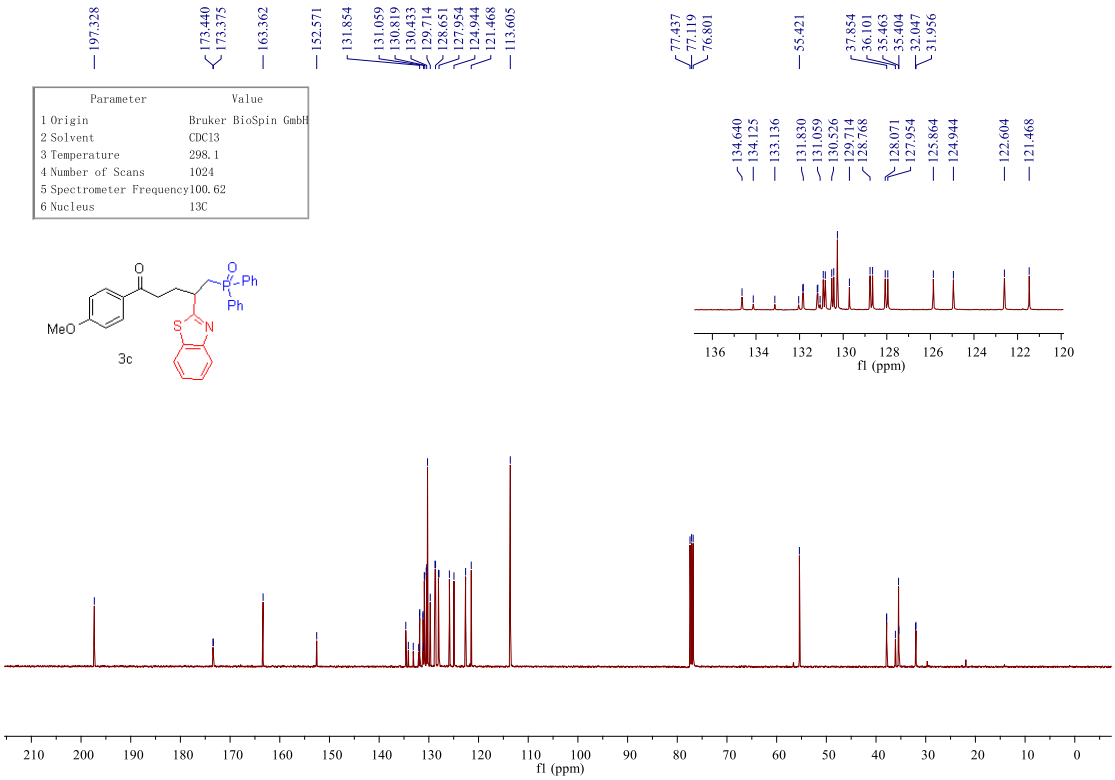
7.837 7.816 7.801 7.779 7.753 7.745 7.726 7.699 7.680 7.614 7.595 7.586 7.568 7.443 7.434 7.410 7.387 7.309 7.290 7.261 7.136 7.118 6.838 6.817

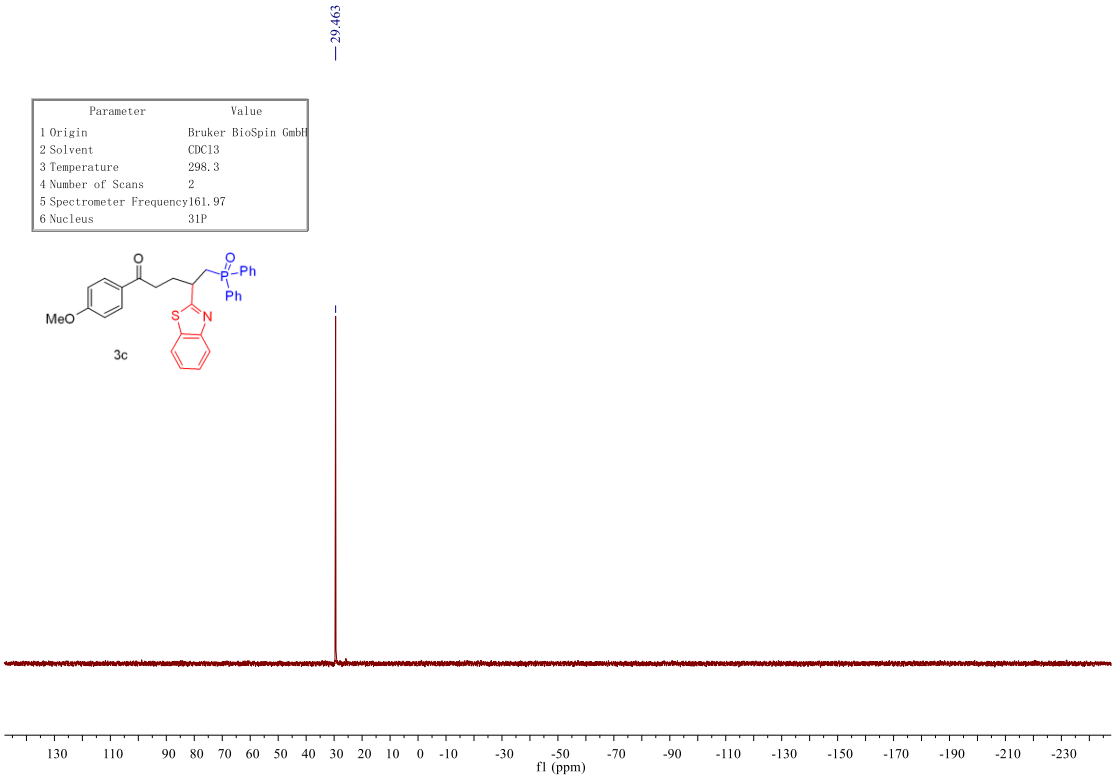
3.906 3.877 3.849 3.796 3.207 2.916 2.890 2.871 2.808 2.796 2.426 2.408 2.390 2.372

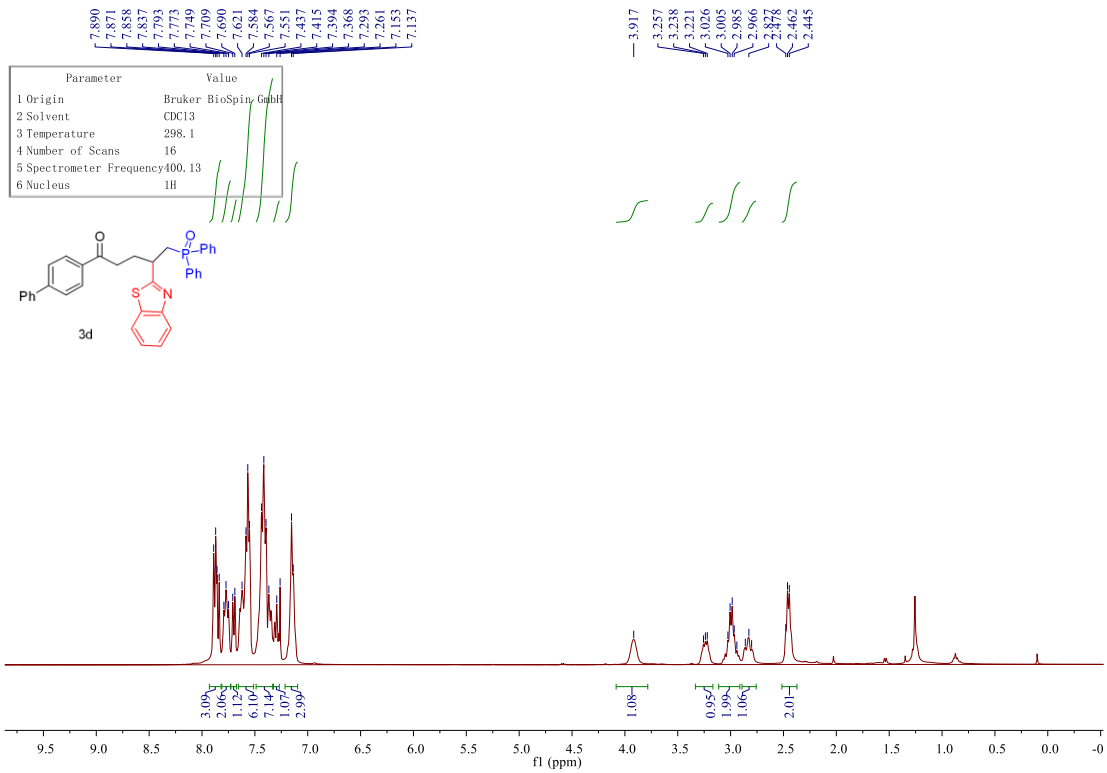
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.1
4 Number of Scans	2
5 Spectrometer Frequency	400.13
6 Nucleus	1H

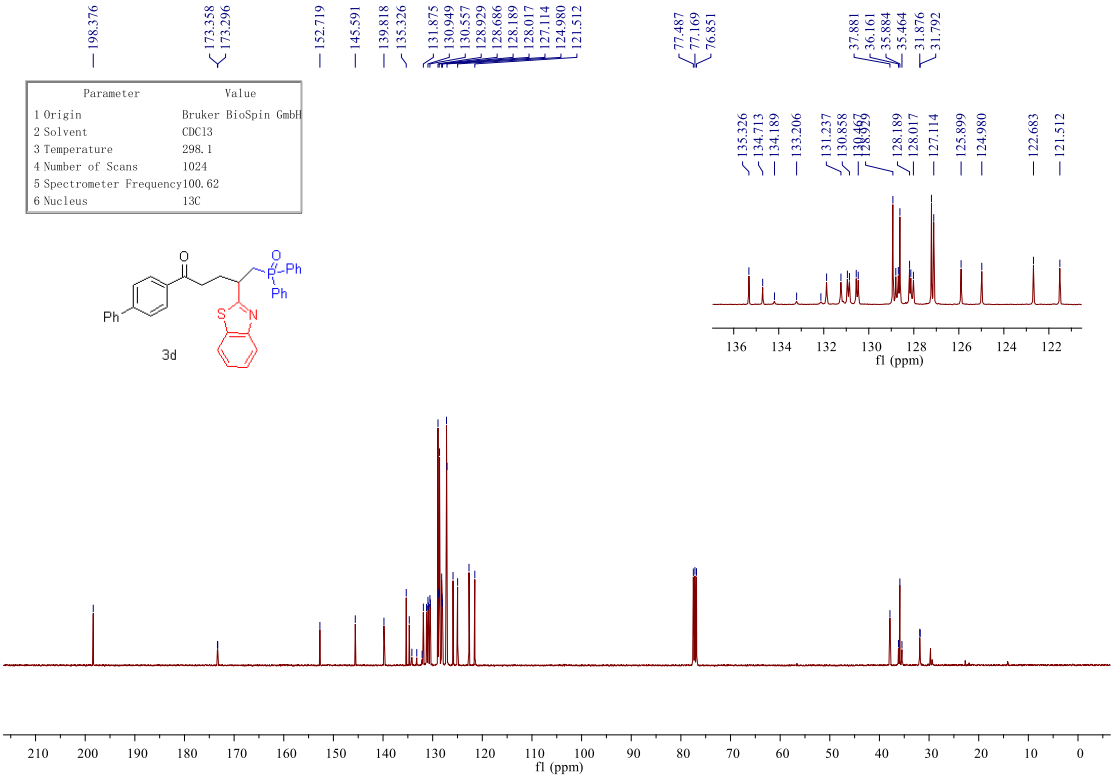
3c




197.328
173.440
173.375
163.362
152.571
131.854
131.059
130.819
130.433
129.714
128.651
127.954
124.944
121.468
113.605
77.437
77.119
76.801
55.421
37.854
36.101
35.463
35.404
32.047
31.956
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
MeO
3c
134.640
134.125
133.136
131.830
131.059
130.526
129.714
128.768
128.071
127.954
125.864
124.944
122.604
121.468
f1 (ppm)
f1 (ppm)

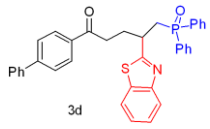

29.463
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.3
4 Number of Scans 2
5 Spectrometer Frequency 161.97
6 Nucleus 31P
MeO
3c
f1 (ppm)


7.890
7.871
7.858
7.837
7.793
7.773
7.749
7.709
7.690
7.621
7.584
7.567
7.551
7.437
7.415
7.394
7.368
7.293
7.261
7.153
7.137
3.917
3.257
3.238
3.221
3.026
3.005
2.985
2.966
2.462
2.445
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 16
5 Spectrometer Frequency 400.13
6 Nucleus 1H
Ph
O
P
Ph
Ph
S
N
3d
3.09
2.06
1.12
6.10
7.14
1.07
2.99
1.08
0.95
1.99
1.06
2.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0
f1 (ppm)

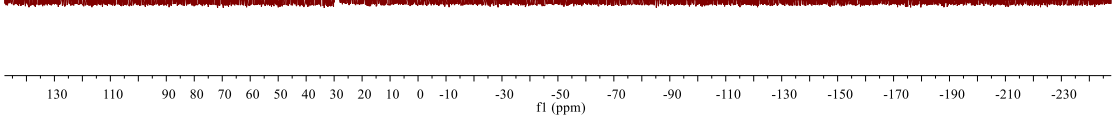

198.376
173.358
173.296
152.719
145.591
139.818
135.326
131.875
130.949
130.557
128.929
128.686
128.189
128.017
127.114
124.980
121.512
77.487
77.169
76.851
37.881
36.161
35.884
35.464
31.876
31.792
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ph
O
P
Ph
Ph
S
N
3d
135.326
134.713
134.189
133.206
131.237
130.858
128.189
128.017
127.114
125.899
124.980
122.683
121.512
136 134 132 130 128 126 124 122
f1 (ppm)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.3
4 Number of Scans	4
5 Spectrometer Frequency	161.97
6 Nucleus	31P

29.486



3d



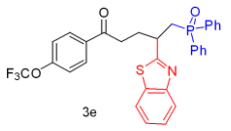
130 110 90 80 70 60 50 40 30 20 10 0 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230

f1 (ppm)

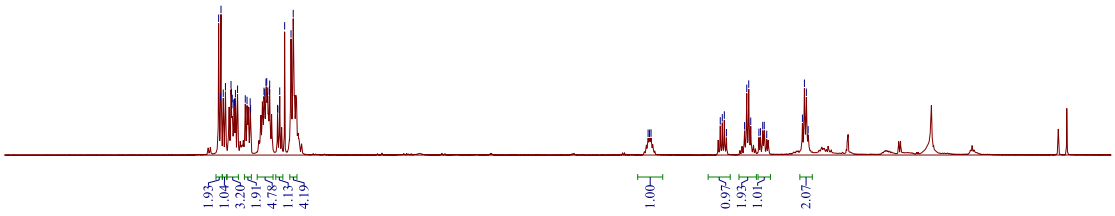
7.875 7.857 7.853 7.832 7.811 7.760 7.756 7.751 7.748 7.727 7.719 7.699 7.627 7.611 7.581 7.578 7.453 7.446 7.435 7.428 7.421 7.418 7.403 7.400 7.327 7.324 7.307 7.261 7.202 7.182

3.884 3.870 3.857 3.213 3.195 3.176 2.967 2.949 2.930 2.450 2.431 2.413 2.397

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	2
5 Spectrometer Frequency	400.13
6 Nucleus	1H



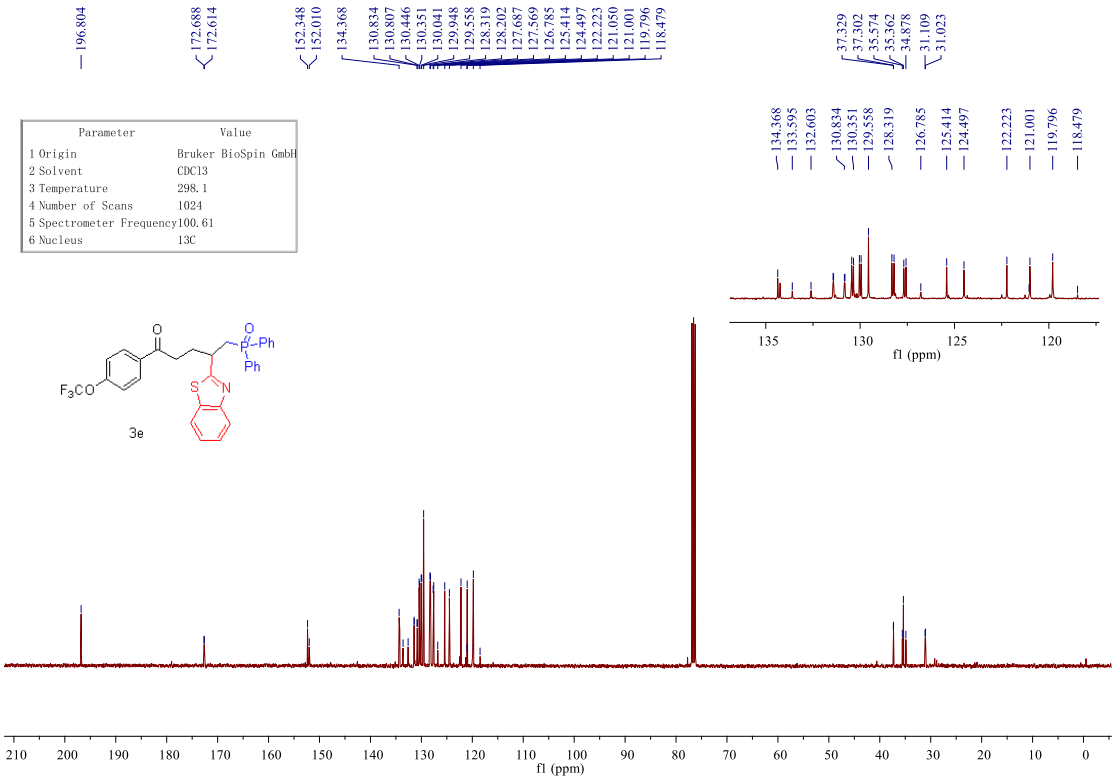
3e

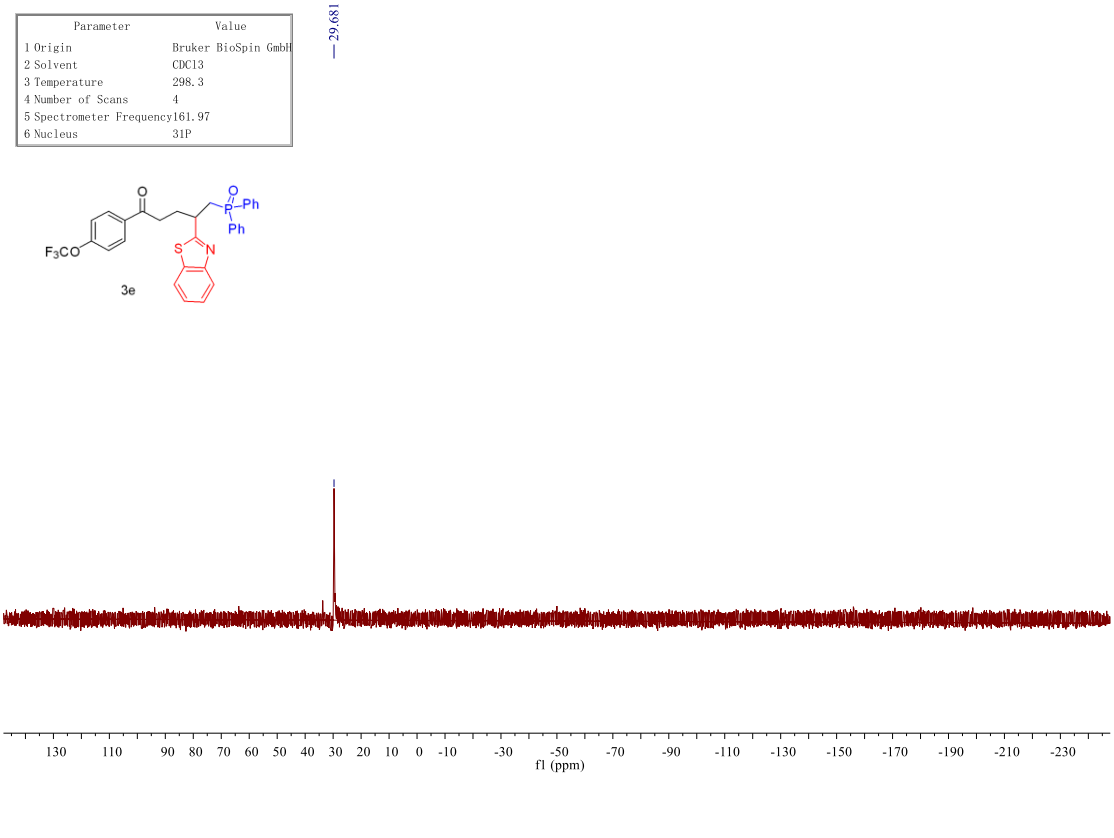


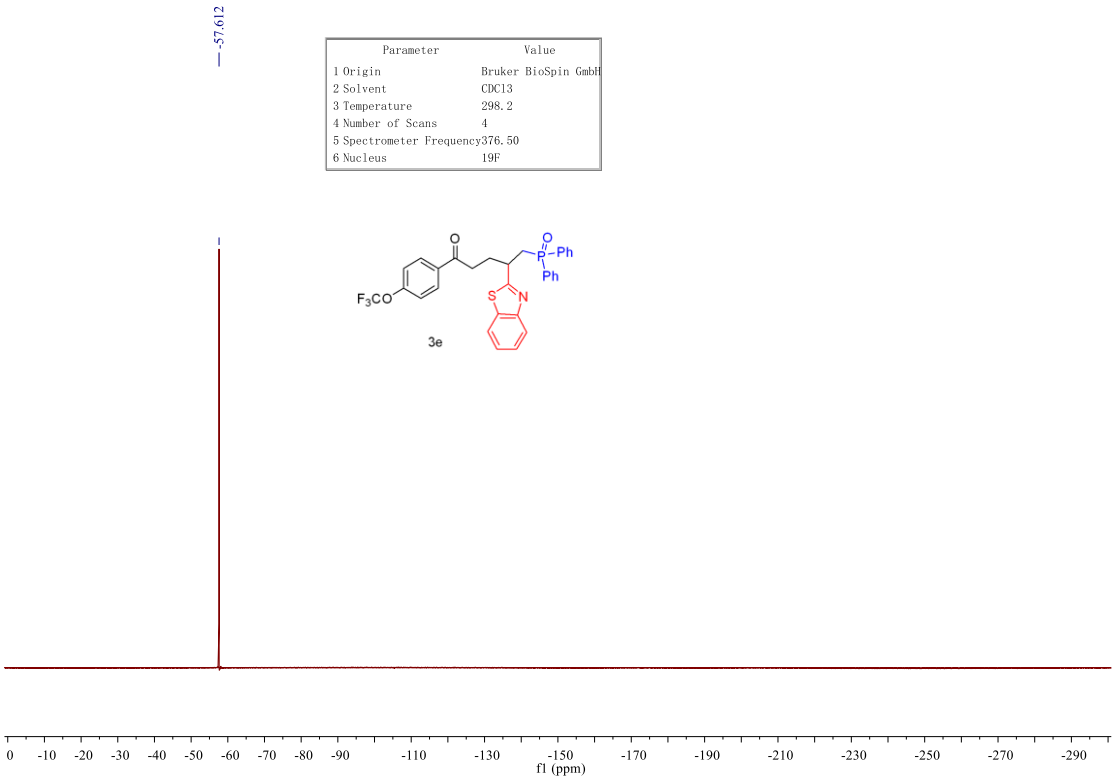
1.93 1.04 3.20 1.91 4.78 1.13 4.19 1.00 0.97 1.93 1.01 2.07

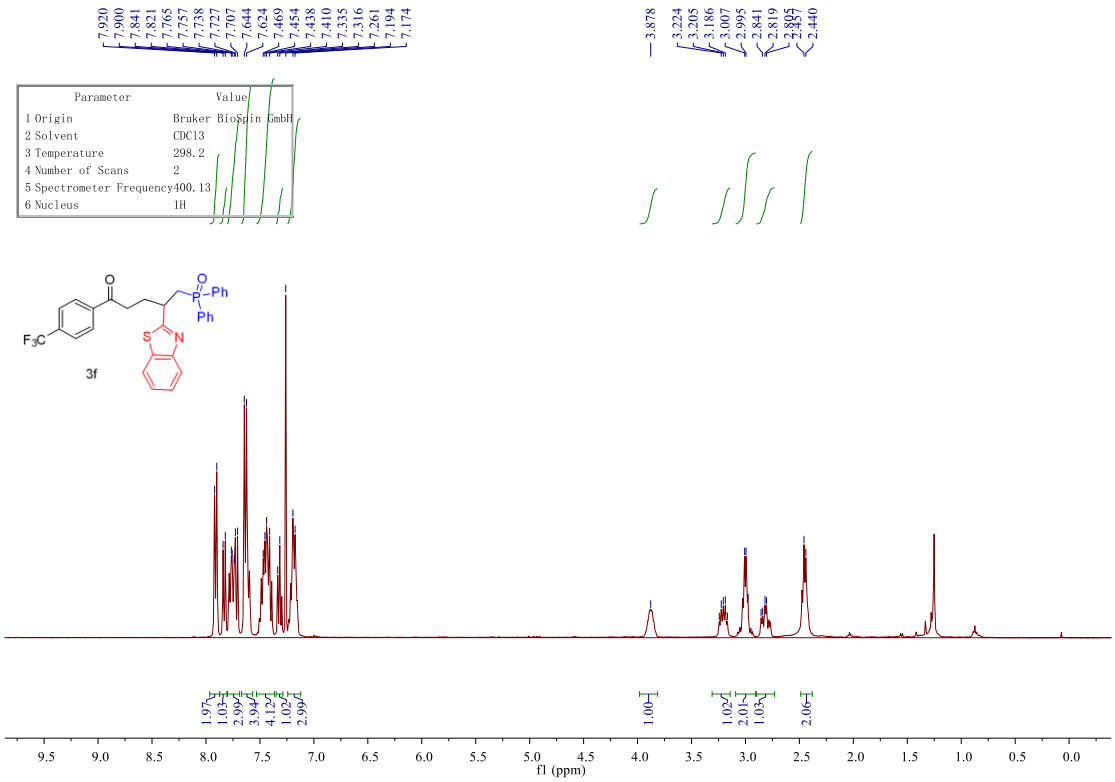
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

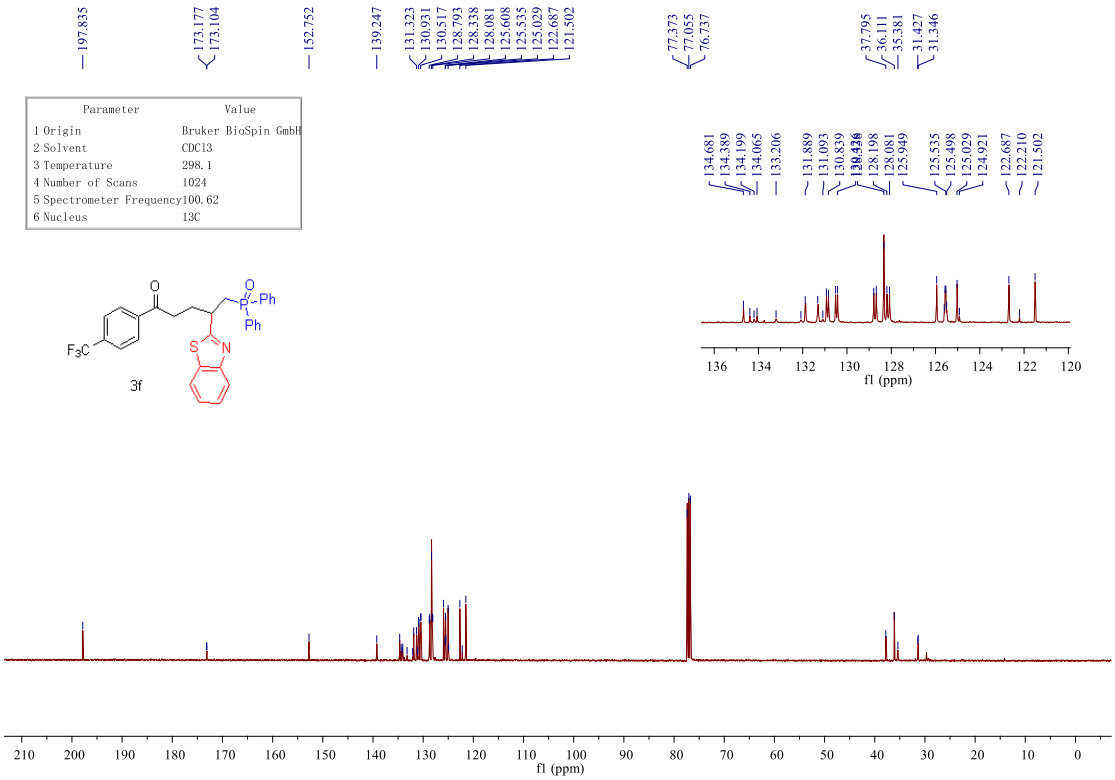
f1 (ppm)

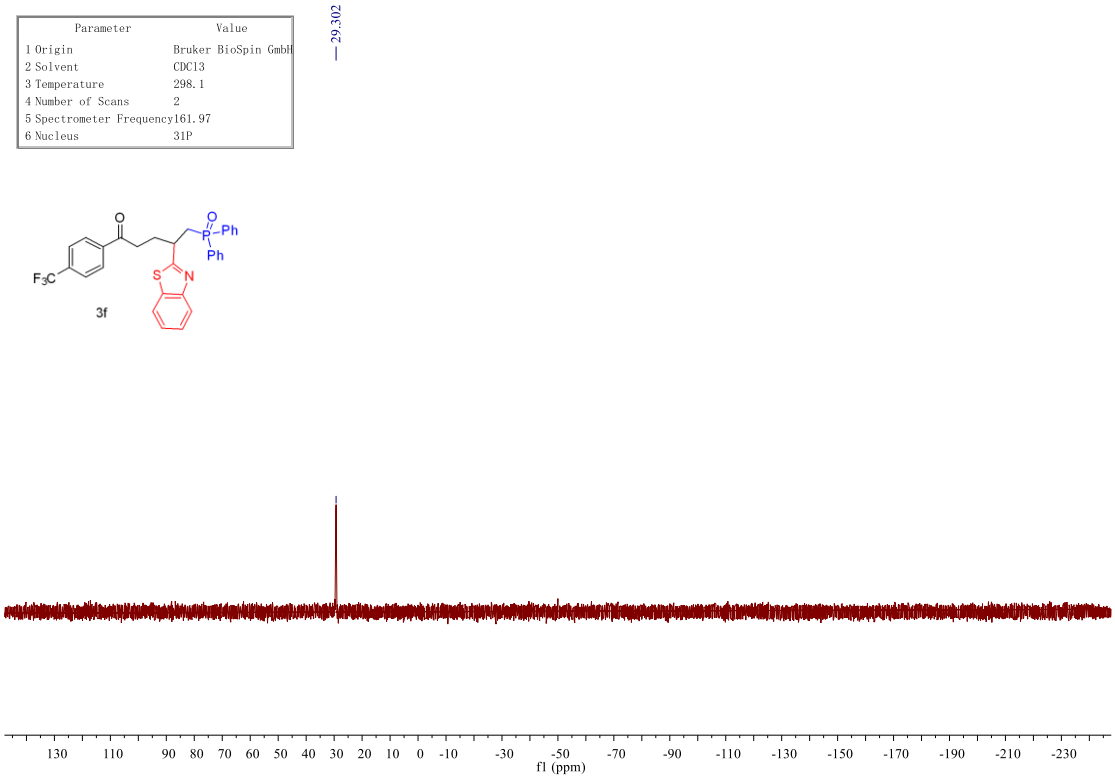

196.804
172.688
172.614
152.348
152.010
134.368
130.834
130.807
130.446
130.351
130.041
129.948
129.558
128.319
128.202
127.687
127.569
126.785
125.414
124.497
122.223
121.050
121.001
119.796
118.479
37.329
37.302
35.574
35.362
34.878
31.109
31.023
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.61
6 Nucleus 13C
3e
f1 (ppm)

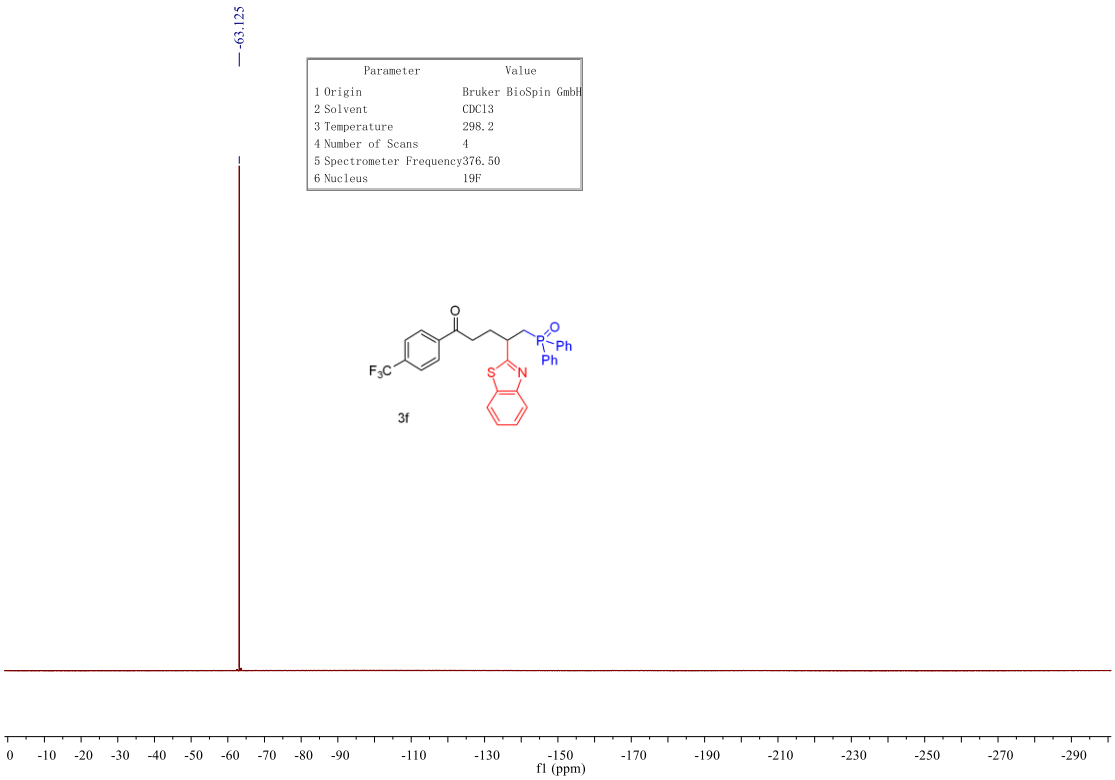

29.681
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.3
4 Number of Scans 4
5 Spectrometer Frequency 161.97
6 Nucleus 31P
3e
f1 (ppm)

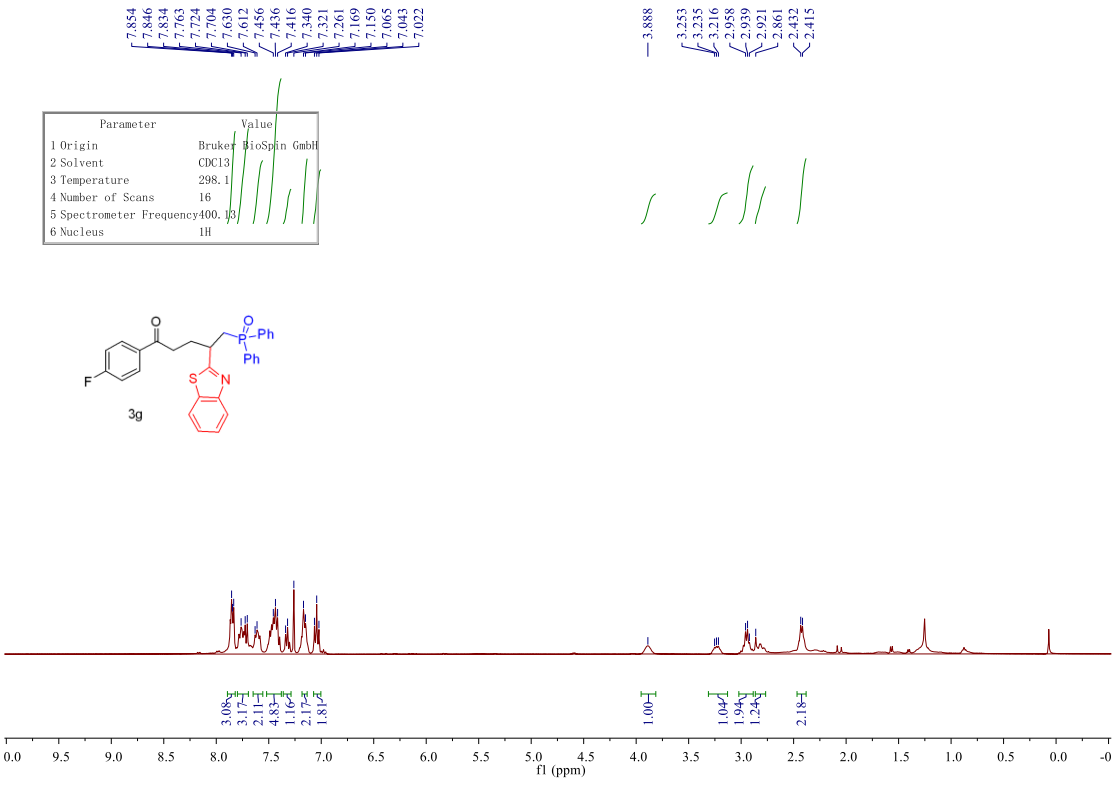

-57.612
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 4
5 Spectrometer Frequency 376.50
6 Nucleus 19F
F3CO
3e
f1 (ppm)

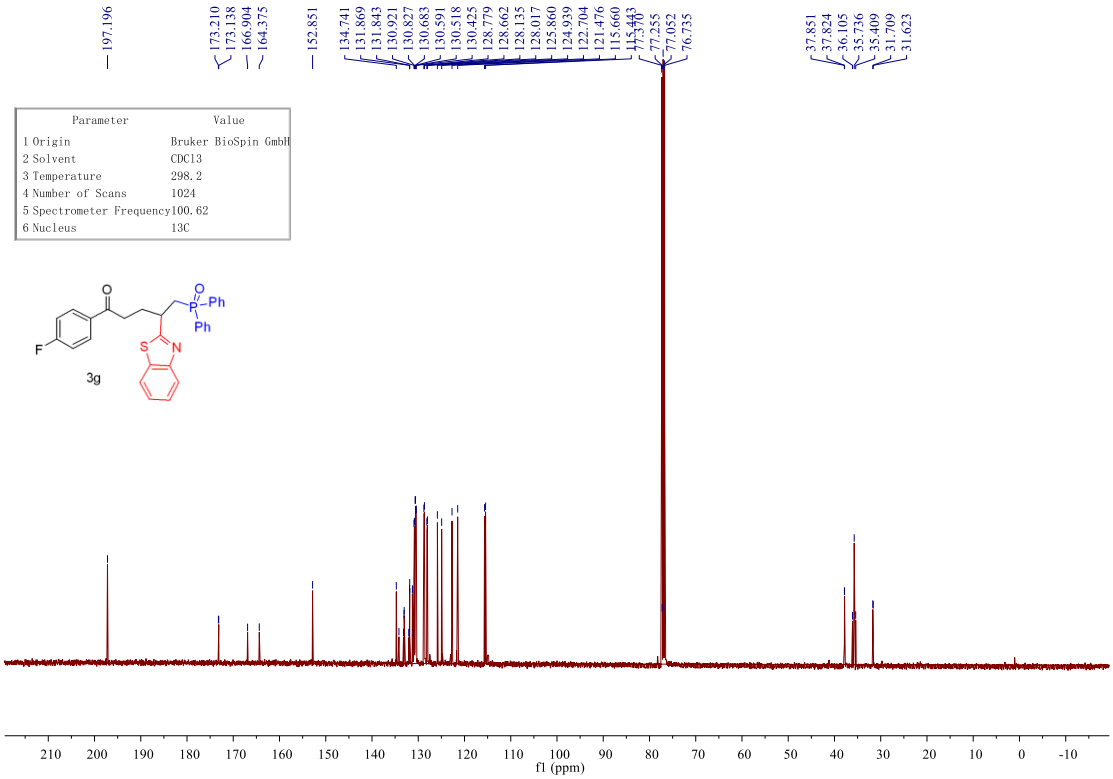

7.920
7.900
7.841
7.821
7.765
7.757
7.738
7.727
7.707
7.644
7.624
7.469
7.454
7.438
7.410
7.335
7.316
7.261
7.194
7.174
3.878
3.224
3.205
3.186
3.007
2.995
2.841
2.819
2.440
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
F3C
3f
1.97
1.03
2.99
3.94
4.12
1.02
2.99
1.00
1.02
2.01
1.03
2.06
f1 (ppm)

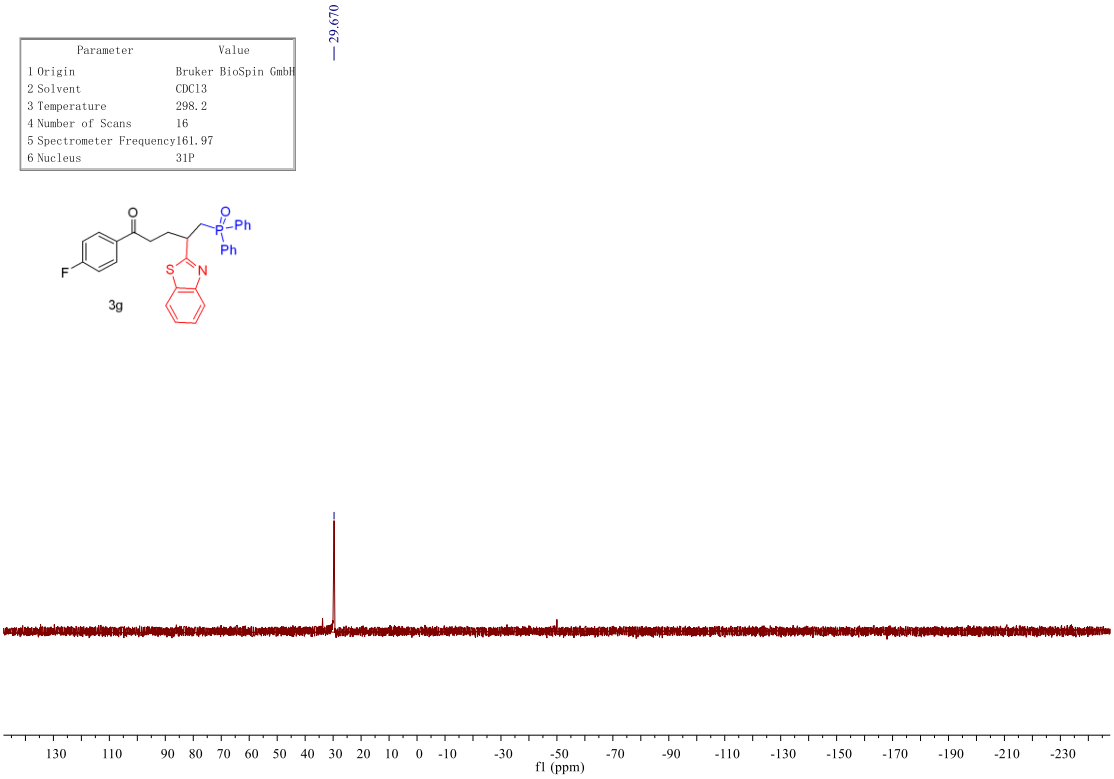

197.835
173.177
173.104
152.752
139.247
131.323
130.931
130.517
128.793
128.338
128.081
125.608
125.535
125.029
122.687
121.502
77.373
77.055
76.737
37.795
36.111
35.381
31.427
31.346
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
134.681
134.389
134.199
134.065
133.206
131.889
131.093
130.839
128.198
128.081
125.949
125.535
125.498
125.029
124.921
122.687
122.210
121.502
136 134 132 130 128 126 124 122 120
f1 (ppm)
3f
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


29.302
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 2
5 Spectrometer Frequency 161.97
6 Nucleus 31P
3f
130 110 90 80 70 60 50 40 30 20 10 0 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)


-63.125
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 4
5 Spectrometer Frequency 376.50
6 Nucleus 19F
F3C
O
P
Ph
Ph
S
N
3f
f1 (ppm)

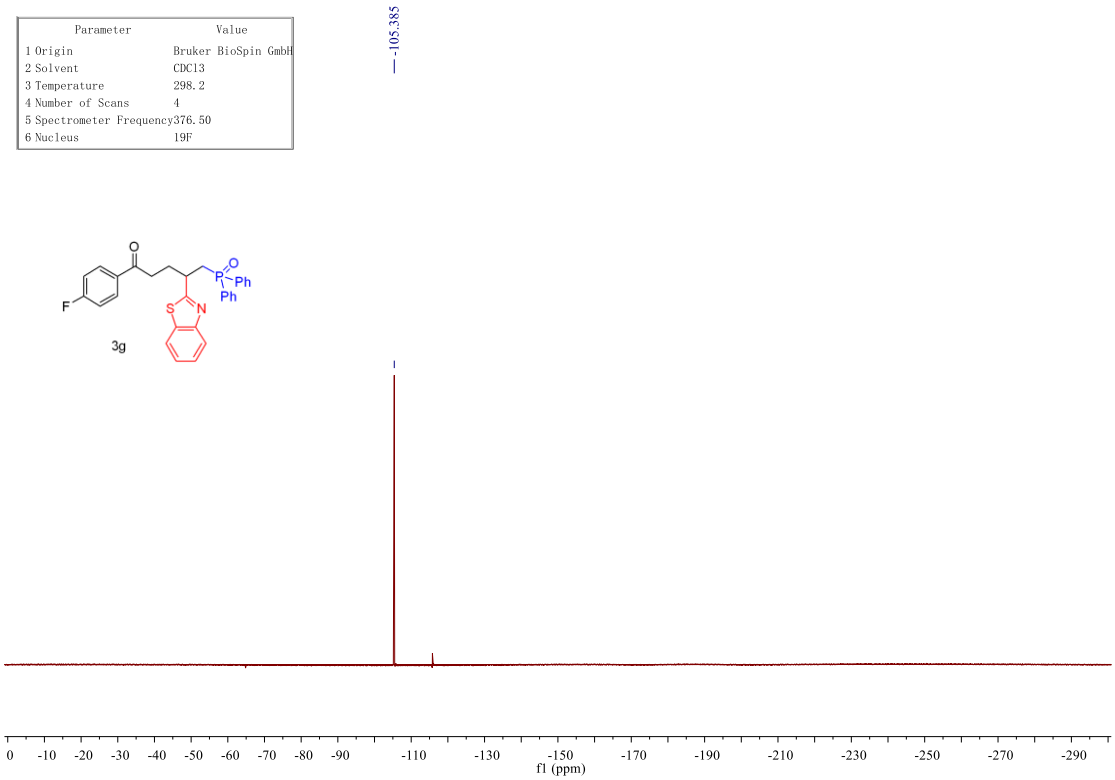

7.854
7.846
7.834
7.763
7.724
7.704
7.630
7.612
7.456
7.436
7.416
7.340
7.321
7.261
7.169
7.150
7.065
7.043
7.022
3.888
3.253
3.235
3.216
2.958
2.939
2.921
2.861
2.432
2.415
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 16
5 Spectrometer Frequency 400.13
6 Nucleus 1H
F
O
P
Ph
Ph
S
N
3g
3.08
3.17
2.11
4.83
1.16
2.17
1.81
1.00
1.04
1.94
1.24
2.18
f1 (ppm)

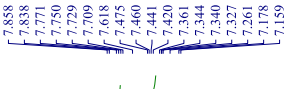

197.196
173.210
173.138
166.904
164.375
152.851
134.741
131.869
131.843
130.921
130.827
130.683
130.591
130.518
130.425
128.779
128.662
128.135
128.017
125.860
124.939
122.704
121.476
115.660
115.443
77.255
77.052
76.735
37.851
37.824
36.105
35.736
35.409
31.709
31.623
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
3g
f1 (ppm)


29.670
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 16
5 Spectrometer Frequency 161.97
6 Nucleus 31P
3g
f1 (ppm)

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	4
5 Spectrometer Frequency	376.50
6 Nucleus	19F

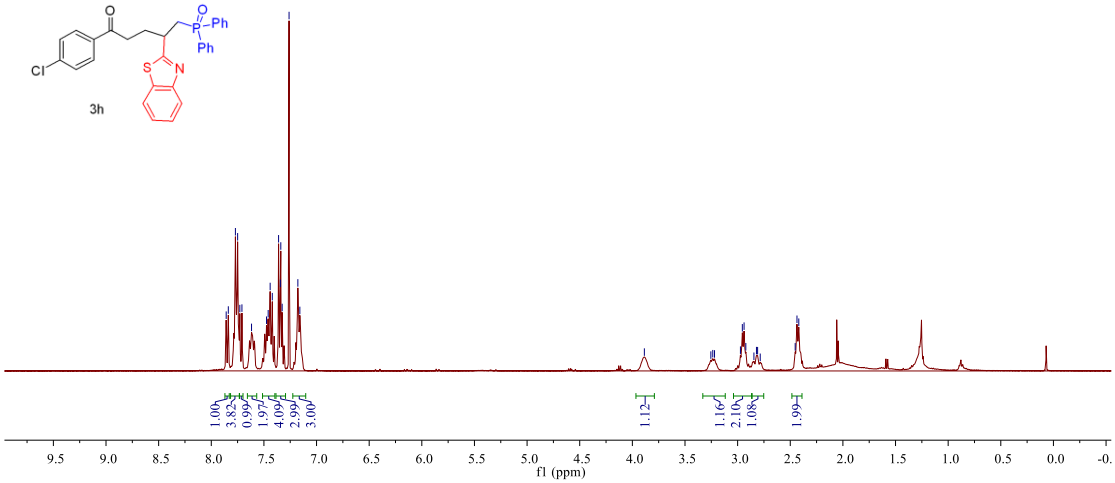
3g

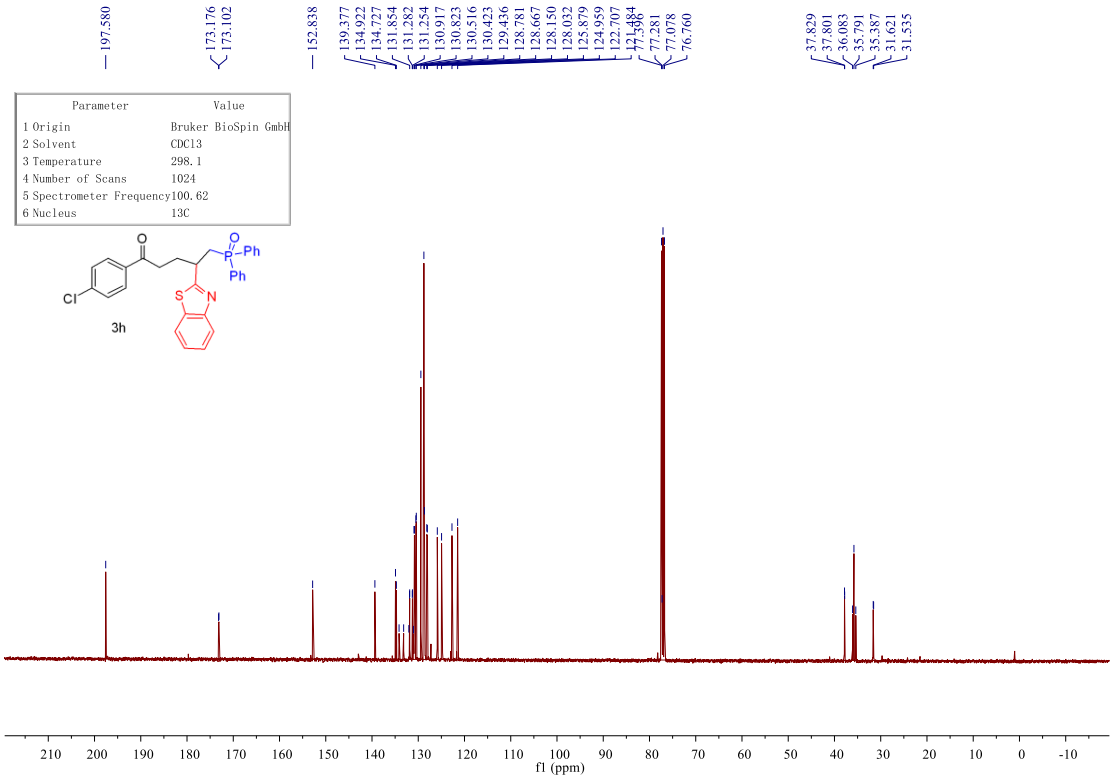


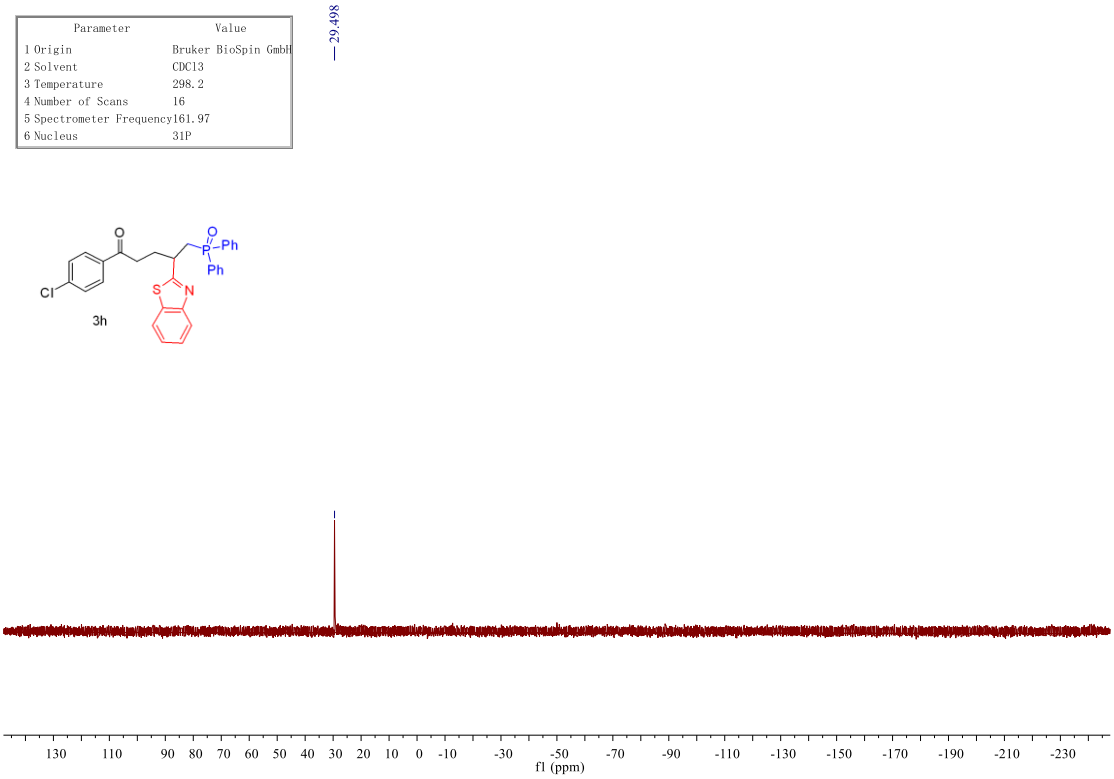


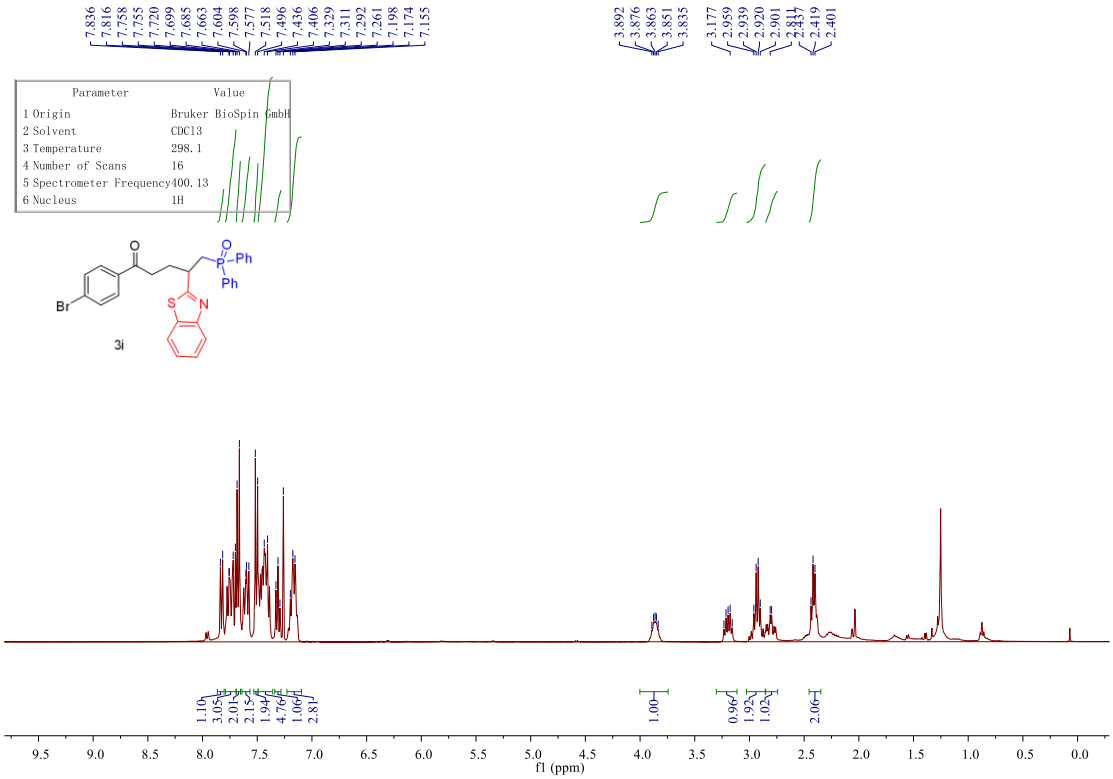
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	16
5 Spectrometer Frequency	400.13
6 Nucleus	1H

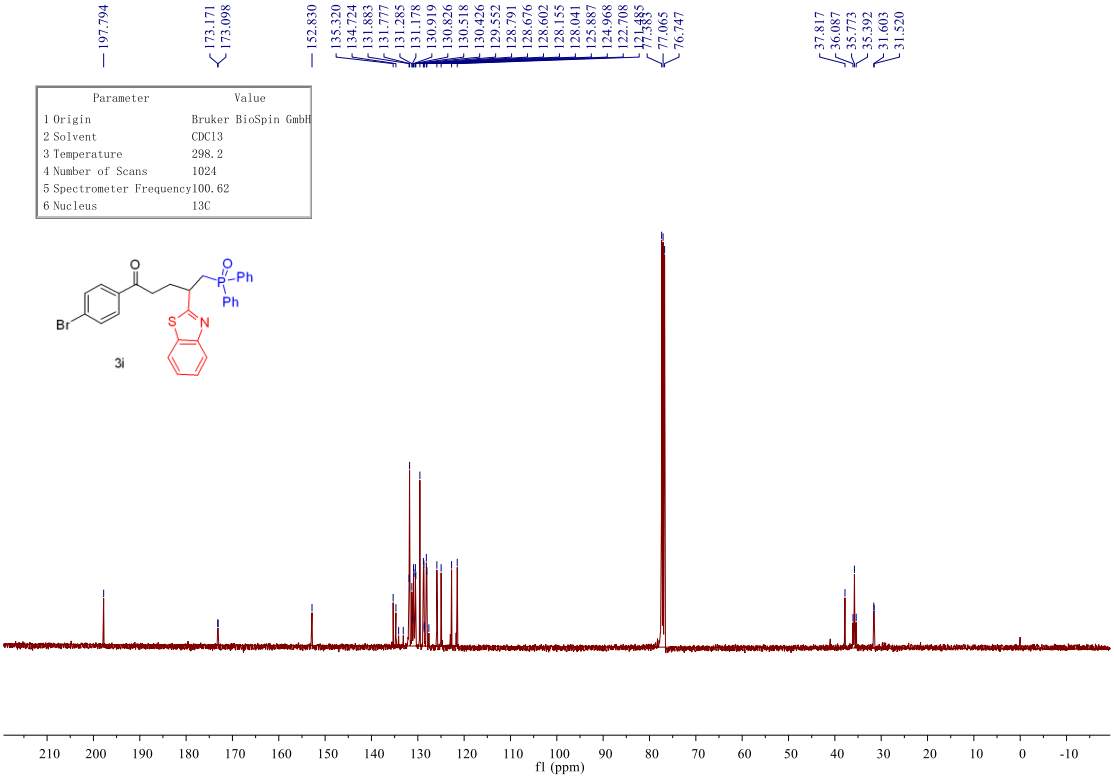
3h




197.580
173.176
173.102
152.838
139.377
134.922
134.727
131.854
131.282
131.254
130.917
130.823
130.516
130.423
129.436
128.781
128.667
128.150
128.032
125.879
124.959
122.707
77.281
77.078
76.760
37.829
37.801
36.083
35.791
35.387
31.621
31.535
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
3h
f1 (ppm)

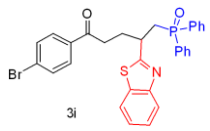

29.498
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 16
5 Spectrometer Frequency 161.97
6 Nucleus 31P
3h
f1 (ppm)


7.836
7.816
7.758
7.755
7.720
7.699
7.685
7.663
7.604
7.598
7.577
7.518
7.496
7.436
7.406
7.329
7.311
7.292
7.261
7.198
7.174
7.155
3.892
3.876
3.863
3.851
3.835
3.177
2.959
2.939
2.920
2.901
2.841
2.437
2.419
2.401
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 16
5 Spectrometer Frequency 400.13
6 Nucleus 1H
O
O
P
Ph
Ph
Br
S
N
3i
1.10
3.05
2.01
2.15
1.94
4.76
1.06
2.81
1.00
0.96
1.92
1.02
2.06
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

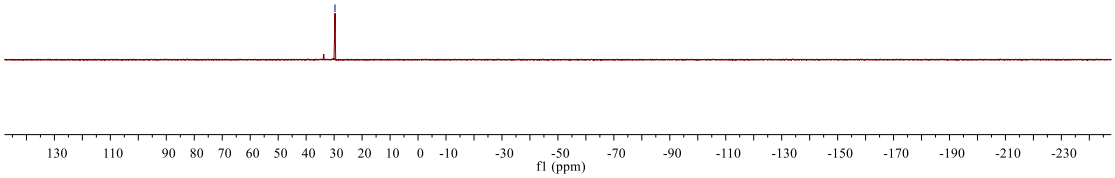

197.794
173.171
173.098
152.830
135.320
134.724
131.883
131.777
131.285
131.178
130.919
130.826
130.518
130.426
129.552
128.791
128.676
128.602
128.155
128.041
125.887
124.968
122.708
121.485
77.383
77.065
76.747
37.817
36.087
35.773
35.392
31.603
31.520
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
O
O
P
Ph
Ph
Br
S
N
3i
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	16
5 Spectrometer Frequency	161.97
6 Nucleus	31P

29.693



3i

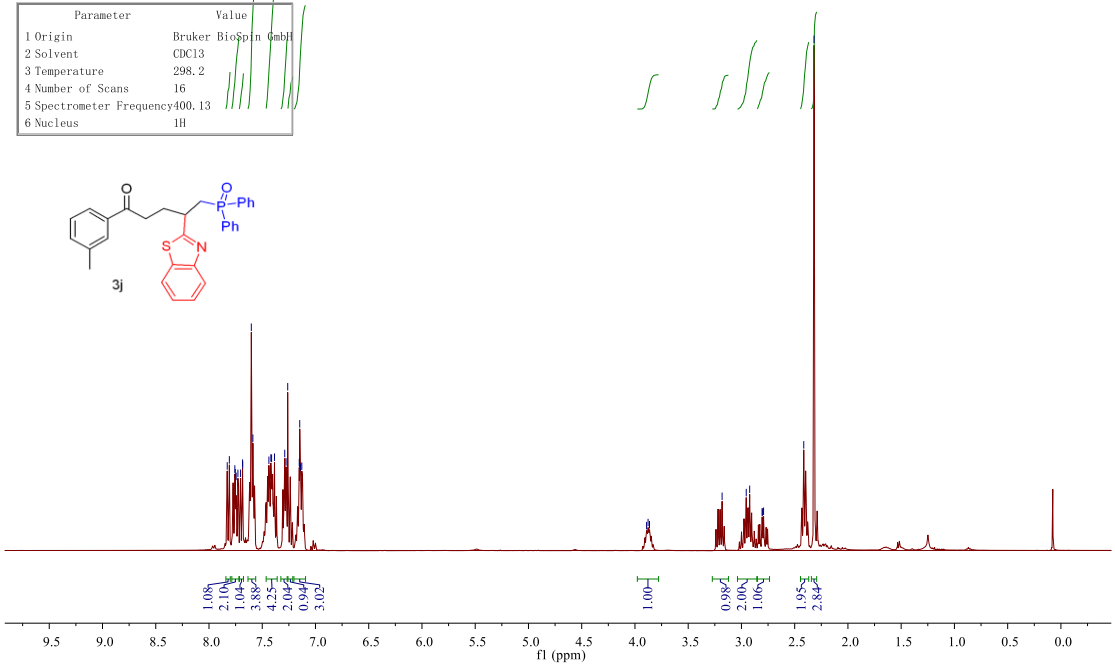


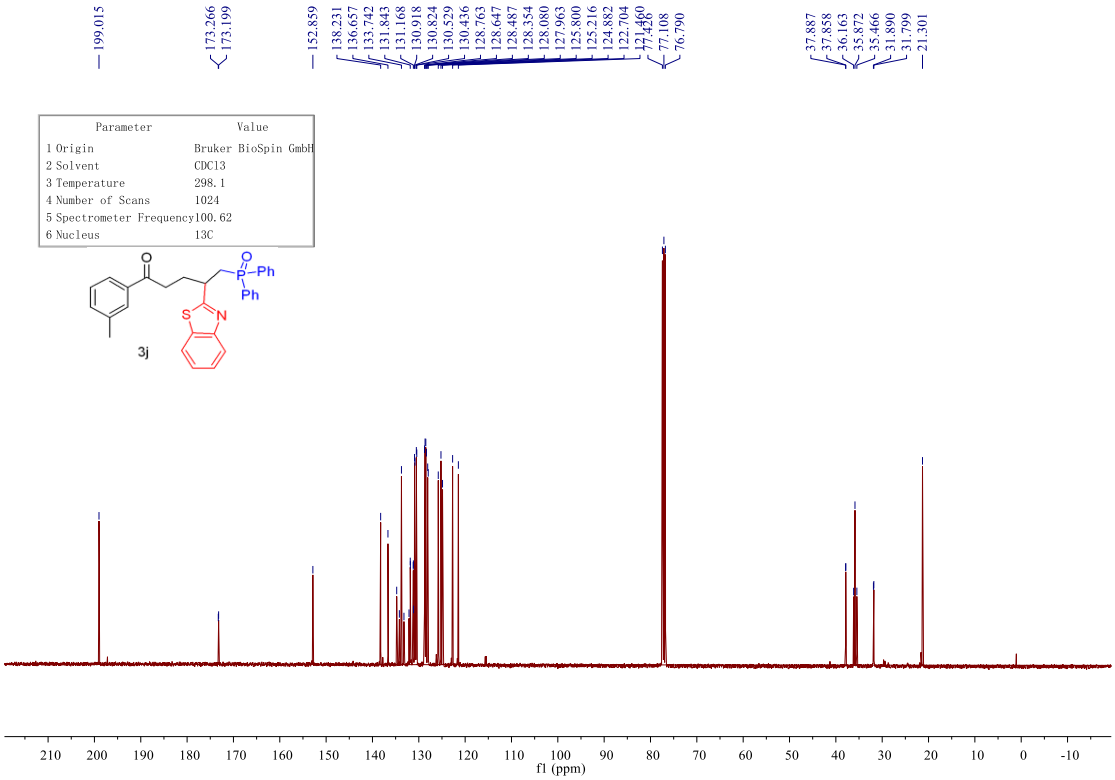
7.829 7.809 7.757 7.753 7.745 7.728 7.703 7.685 7.684 7.603 7.588 7.437 7.419 7.412 7.385 7.289 7.276 7.261 7.152 7.148 7.140 7.128

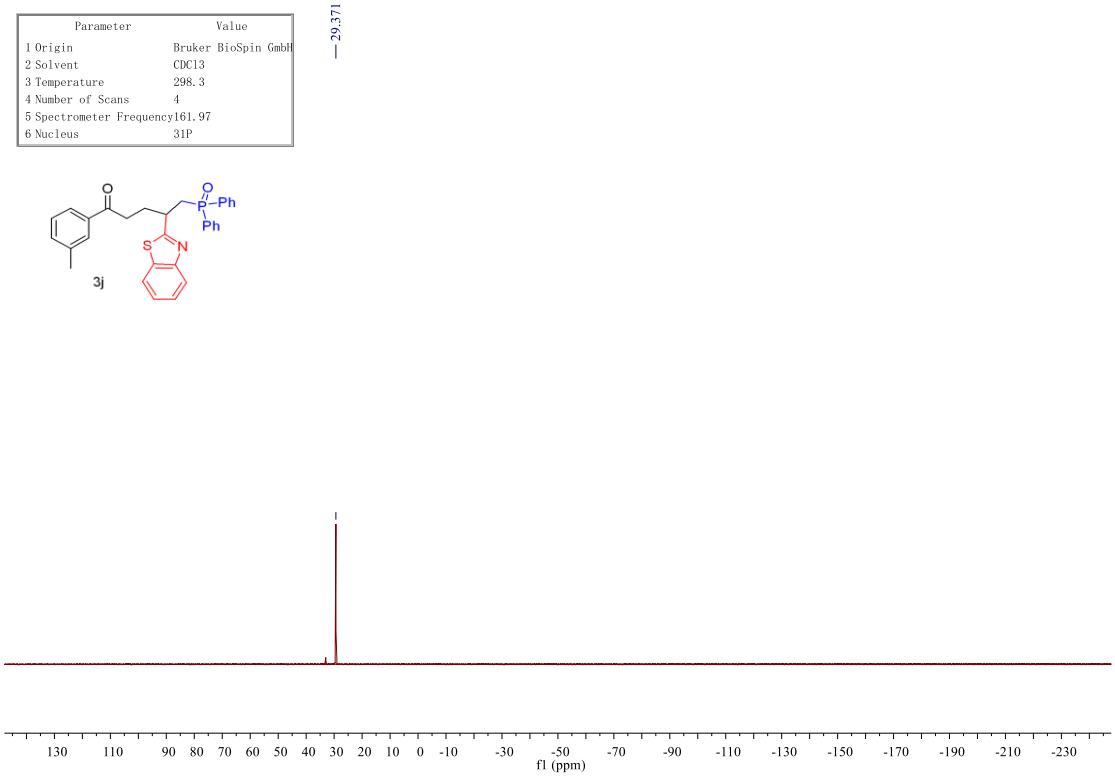
3.891 3.877 3.863 3.182 2.955 2.923 2.805 2.804 2.792 2.415 2.318

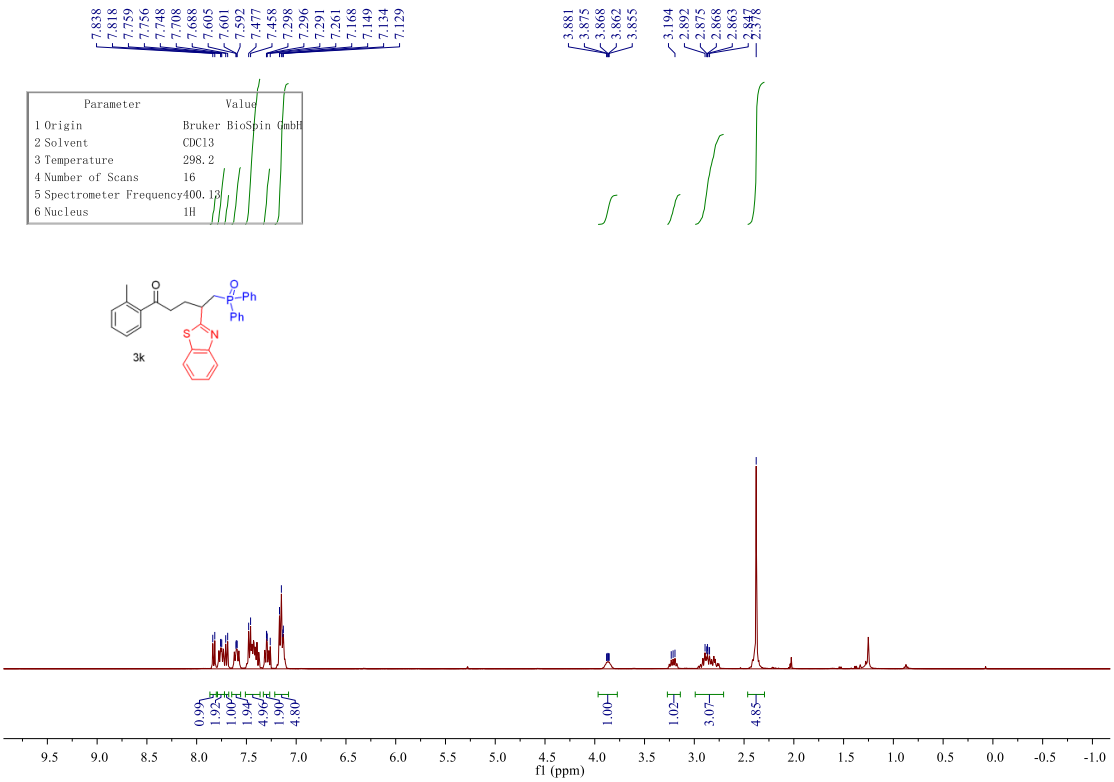
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	16
5 Spectrometer Frequency	400.13
6 Nucleus	1H

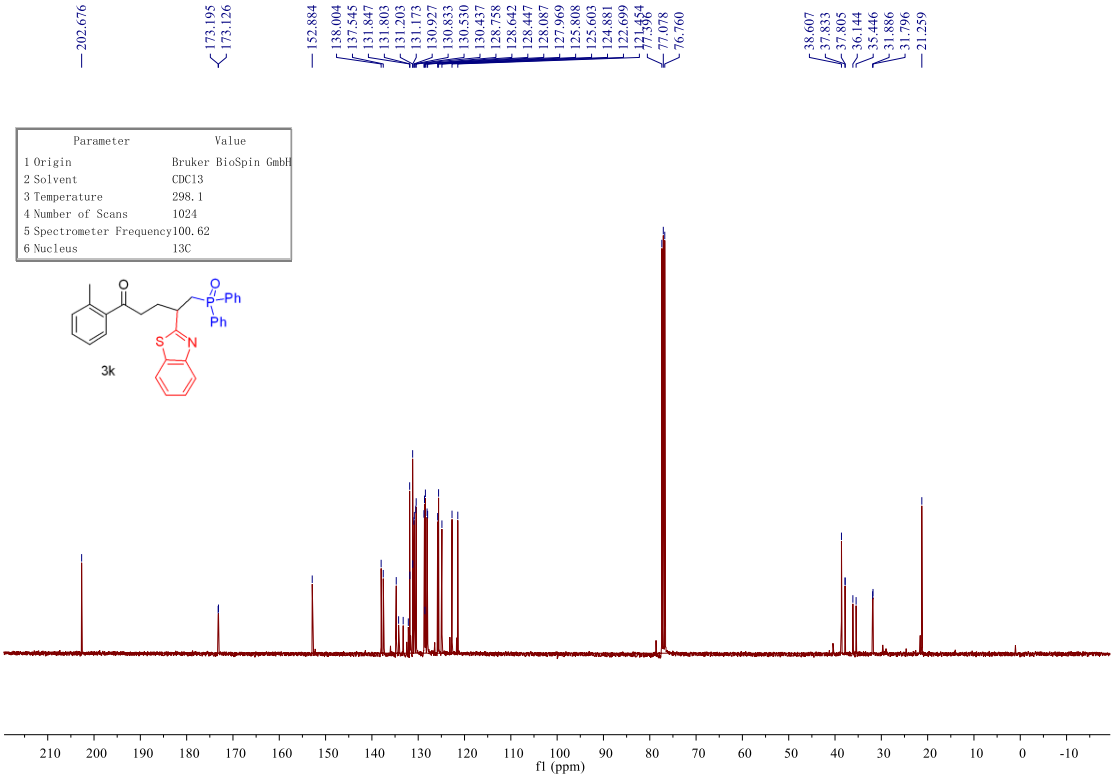
3j

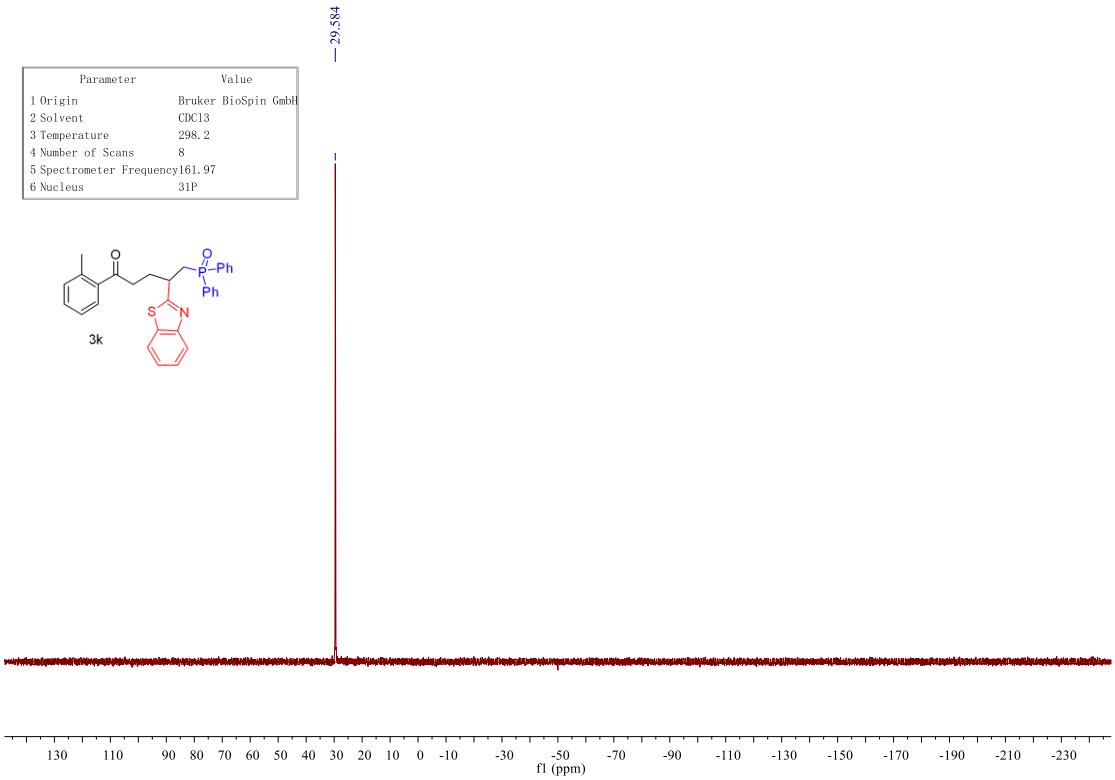


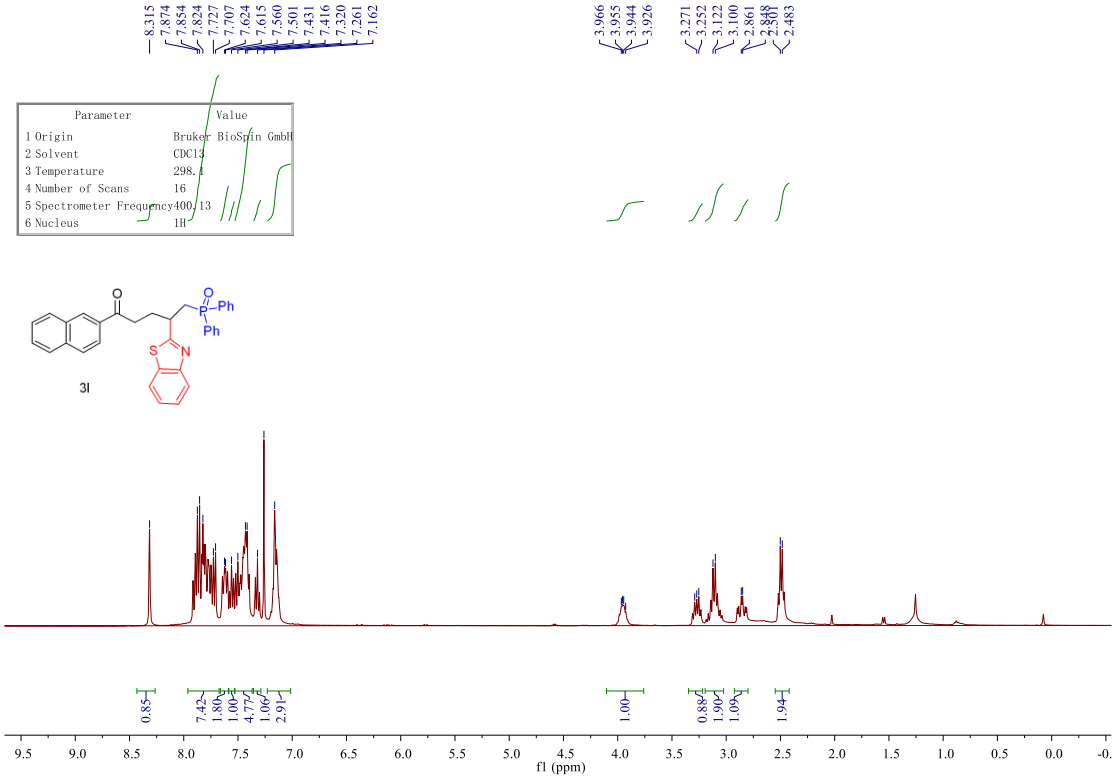

199.015
173.266
173.199
152.859
138.231
136.657
133.742
131.843
131.168
130.918
130.824
130.529
130.436
128.763
128.647
128.487
128.354
128.080
127.963
125.800
125.216
124.882
122.704
121.460
77.426
77.108
76.790
37.887
37.858
36.163
35.872
35.466
31.890
31.799
21.301
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
O
O
P
Ph
Ph
S
N
3j
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

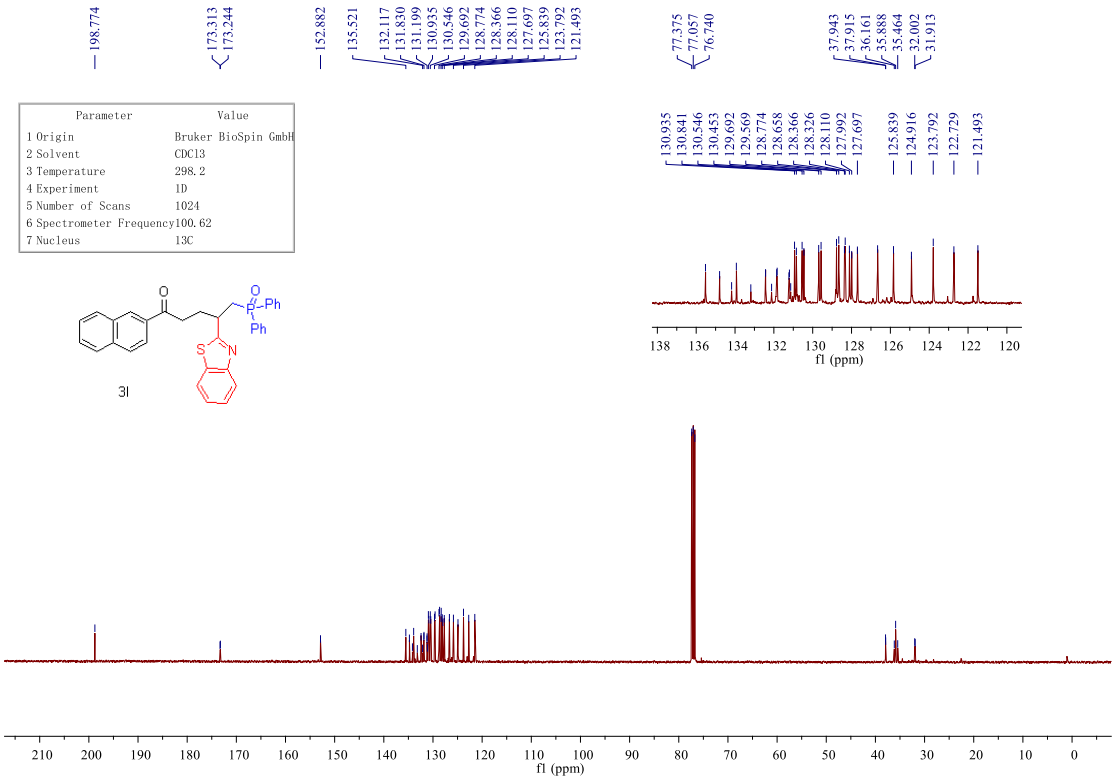

29.371
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.3
4 Number of Scans 4
5 Spectrometer Frequency 161.97
6 Nucleus 31P
O
O
P
Ph
Ph
S
N
3j
130 110 90 80 70 60 50 40 30 20 10 0 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)

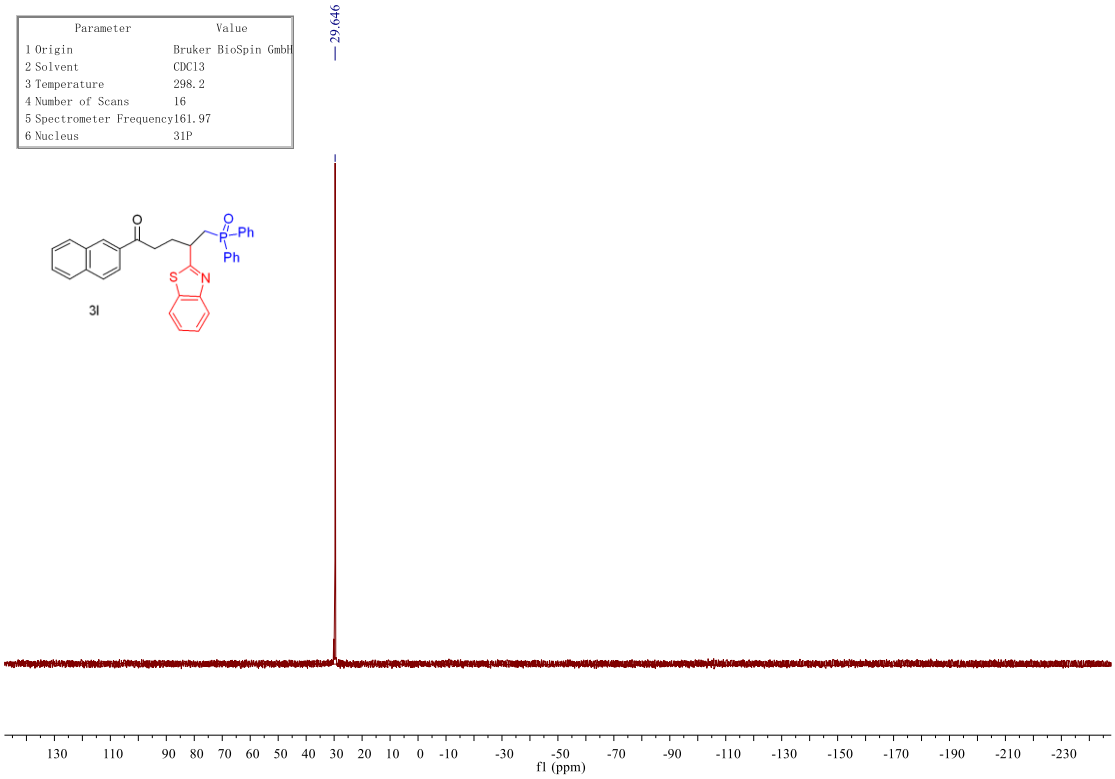

7.838
7.818
7.759
7.756
7.748
7.708
7.688
7.605
7.601
7.592
7.477
7.458
7.298
7.296
7.291
7.261
7.168
7.149
7.134
7.129
3.881
3.875
3.868
3.862
3.855
3.194
2.892
2.875
2.868
2.863
2.847
2.378
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 16
5 Spectrometer Frequency 400.13
6 Nucleus 1H
3k
0.99
1.92
1.00
1.94
4.96
1.90
4.80
1.00
1.02
3.07
4.85
f1 (ppm)

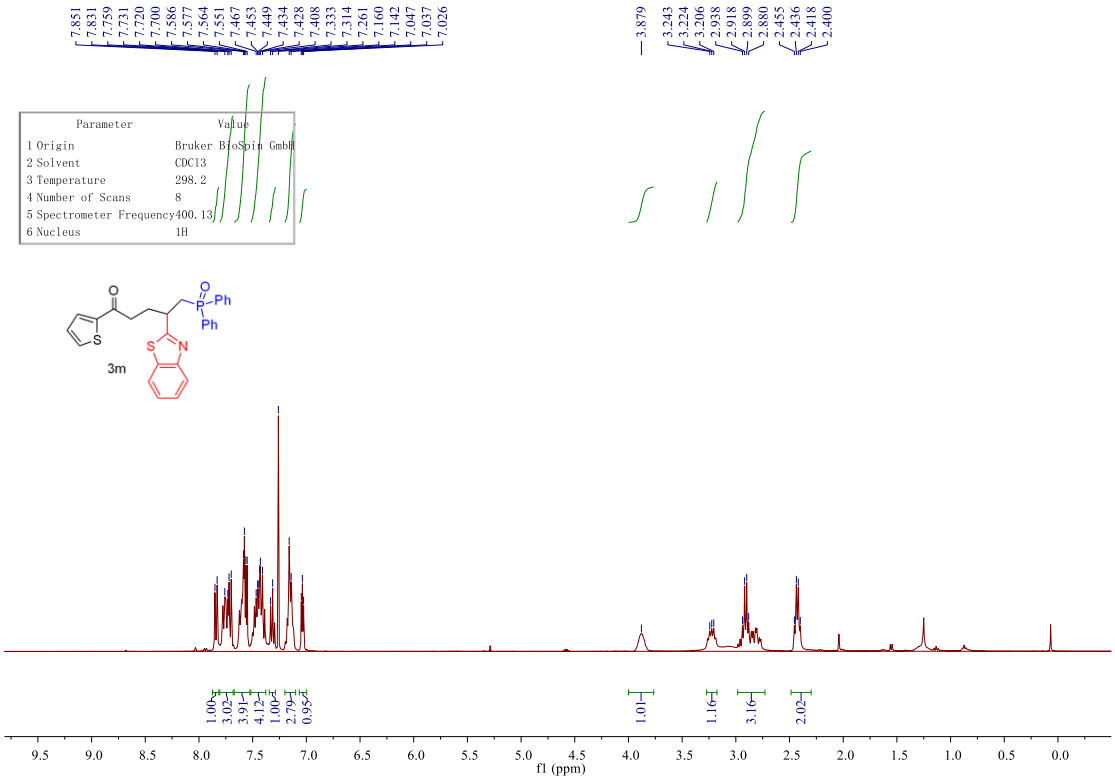

202.676
173.195
173.126
152.884
138.004
137.545
131.847
131.803
131.203
131.173
130.927
130.833
130.530
130.437
128.758
128.642
128.447
128.087
127.969
125.808
125.603
124.881
122.699
121.454
77.396
77.078
76.760
38.607
37.833
37.805
36.144
35.446
31.886
31.796
21.259
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
3k
f1 (ppm)

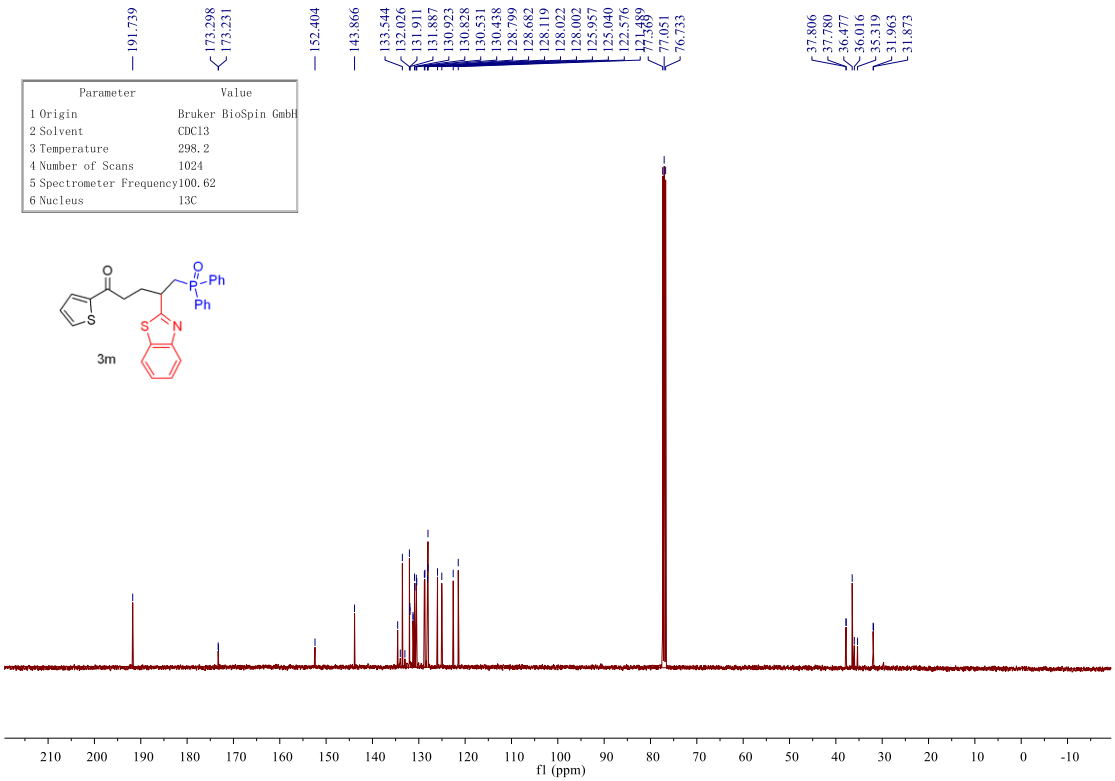

29.584
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 8
5 Spectrometer Frequency 161.97
6 Nucleus 31P
3k
f1 (ppm)


8.315
7.874
7.854
7.824
7.727
7.707
7.624
7.615
7.560
7.501
7.431
7.416
7.320
7.261
7.162
3.966
3.955
3.944
3.926
3.271
3.252
3.122
3.100
2.861
2.848
2.501
2.483
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 16
5 Spectrometer Frequency 400.13
6 Nucleus 1H
3l
0.85
7.42
1.80
1.00
4.77
1.06
2.91
1.00
0.89
1.90
1.09
1.94
f1 (ppm)


198.774
173.313
173.244
152.882
135.521
132.117
131.830
131.199
130.935
130.546
129.692
128.774
128.366
128.110
127.697
125.839
123.792
121.493
77.375
77.057
76.740
37.943
37.915
36.161
35.888
35.464
32.002
31.913
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Experiment 1D
5 Number of Scans 1024
6 Spectrometer Frequency 100.62
7 Nucleus 13C
3l
130.935
130.841
130.546
130.453
129.692
129.569
128.774
128.658
128.366
128.326
128.110
127.992
127.697
125.839
124.916
123.792
122.729
121.493
138 136 134 132 130 128 126 124 122 120
f1 (ppm)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

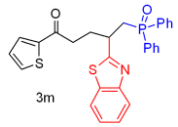

29.646
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 16
5 Spectrometer Frequency 161.97
6 Nucleus 31P
3l
130 110 90 80 70 60 50 40 30 20 10 0 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)


7.851
7.831
7.759
7.731
7.720
7.700
7.586
7.577
7.564
7.551
7.467
7.453
7.449
7.434
7.428
7.408
7.333
7.314
7.261
7.160
7.142
7.047
7.037
7.026
3.879
3.243
3.224
3.206
2.938
2.918
2.899
2.880
2.455
2.436
2.418
2.400
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 8
5 Spectrometer Frequency 400.13
6 Nucleus 1H
3m
1.00
3.02
3.91
4.12
1.00
2.79
0.95
1.01
1.16
3.16
2.02
f1 (ppm)

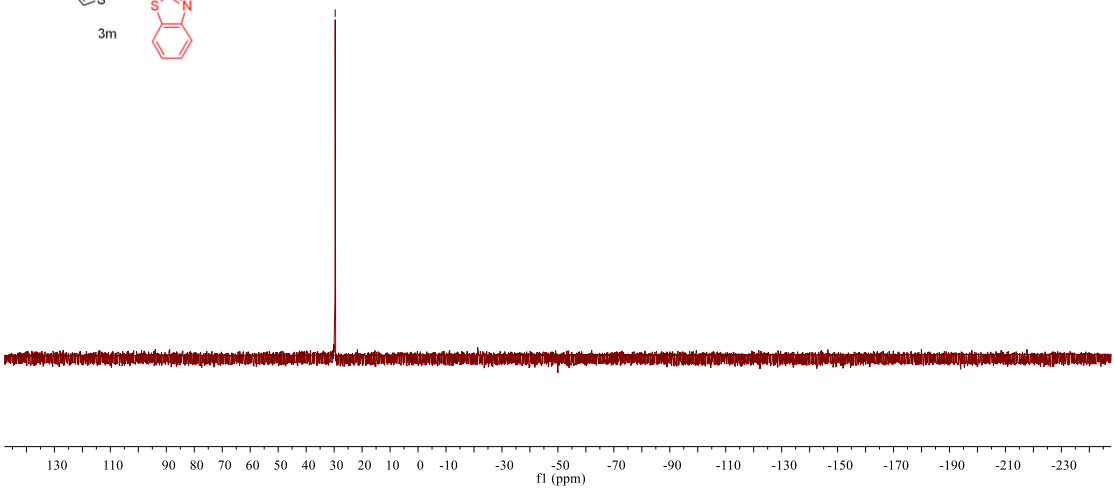

191.739
173.298
173.231
152.404
143.866
133.544
132.026
131.911
131.887
130.923
130.828
130.531
130.438
128.799
128.682
128.119
128.022
128.002
125.957
125.040
122.576
121.489
77.369
77.051
76.733
37.806
37.780
36.477
36.016
35.319
31.963
31.873
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
3m
f1 (ppm)

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	8
5 Spectrometer Frequency	161.97
6 Nucleus	31P

29.618



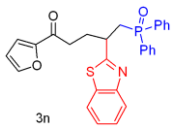
3m



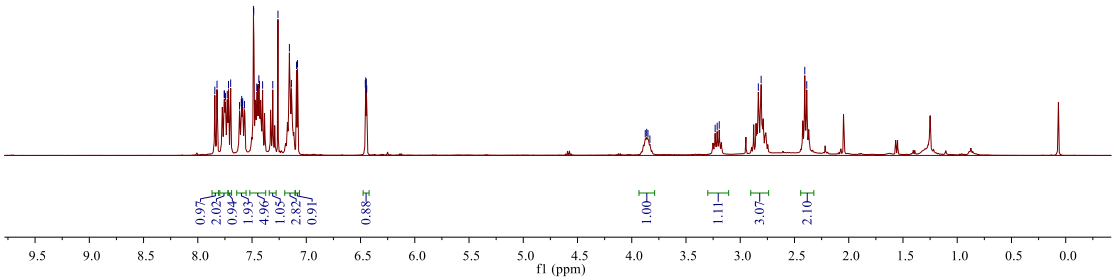
7.843 7.823 7.757 7.754 7.728 7.717 7.697 7.487 7.484 7.456 7.450 7.437 7.431 7.403 7.309 7.261 7.156 7.137 7.090 7.081 6.456 6.452 6.447 6.443

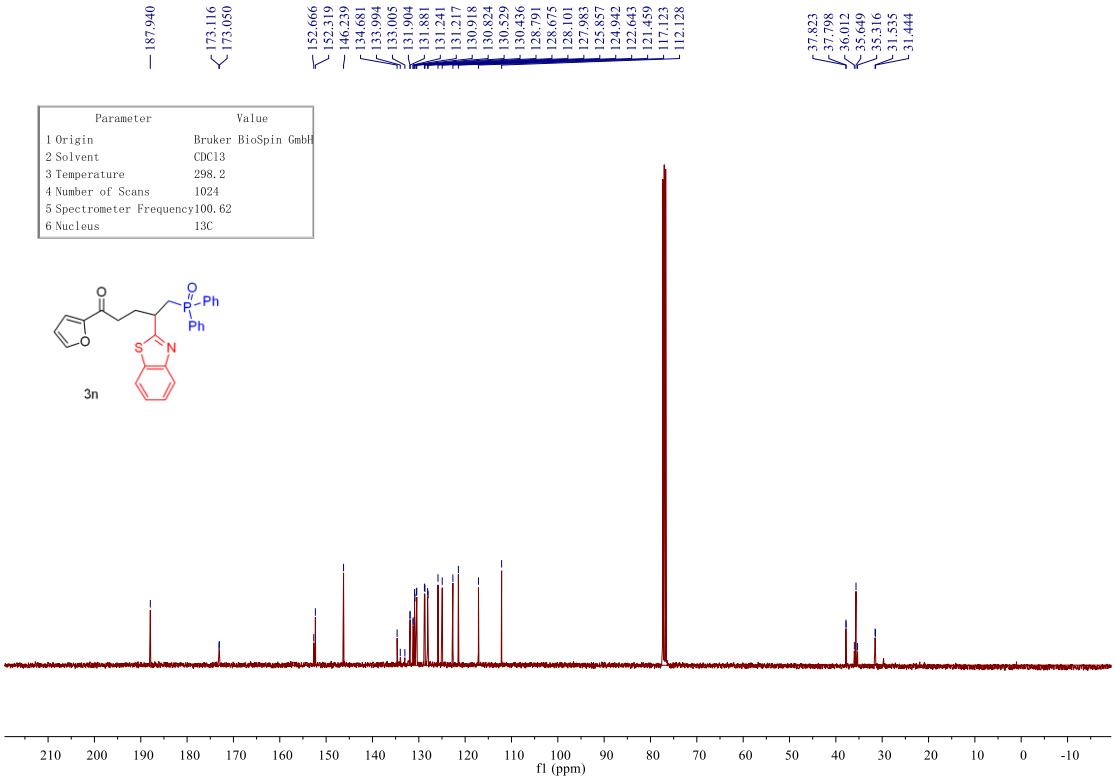
3.875 3.862 3.851 3.833 3.231 3.213 3.194 2.833 2.807 2.405 2.387

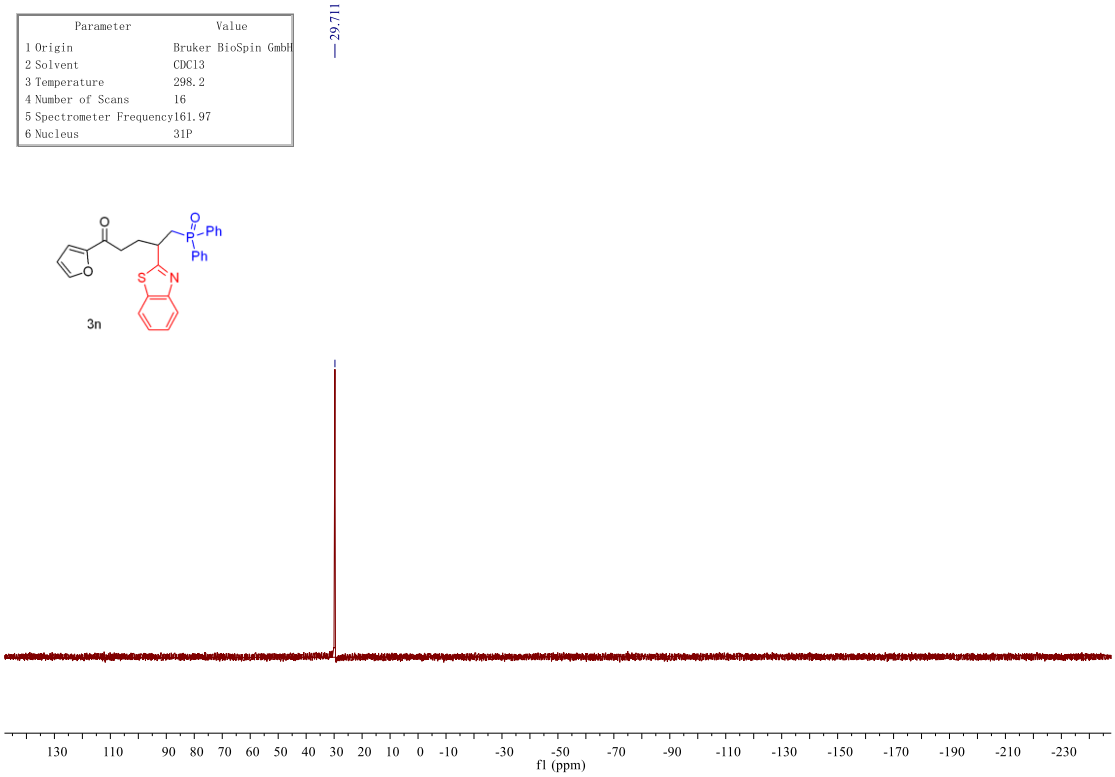
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.1
4 Number of Scans	16
5 Spectrometer Frequency	400.13
6 Nucleus	1H

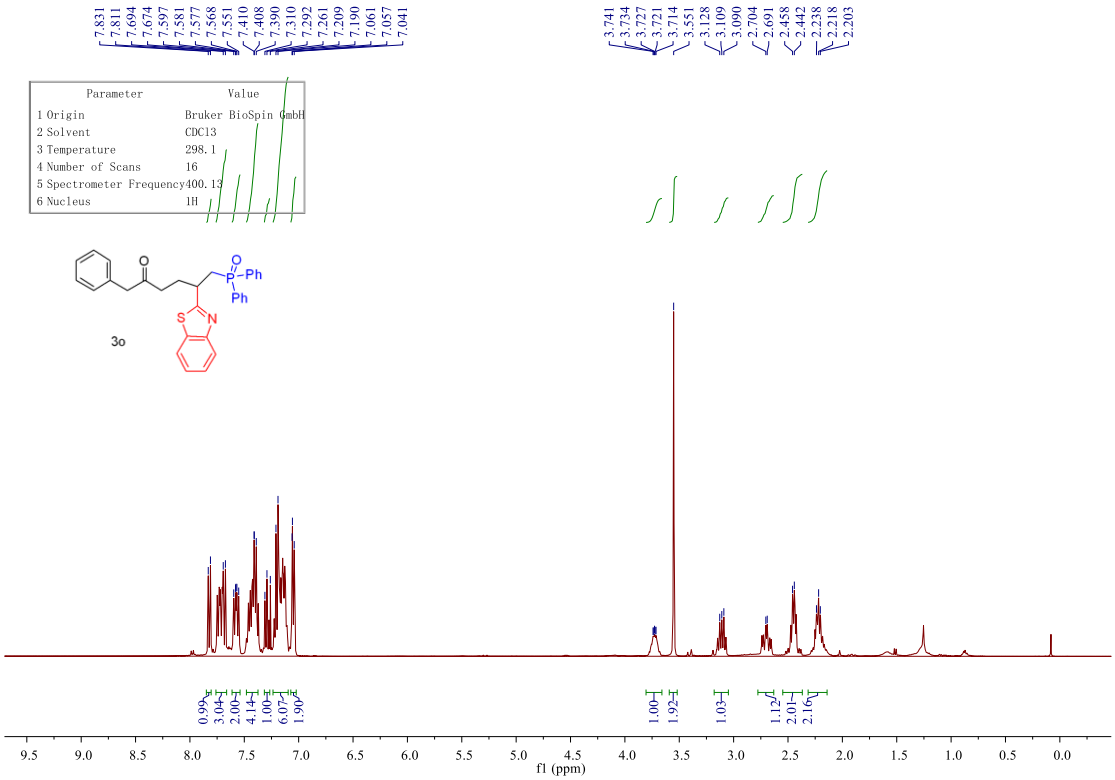


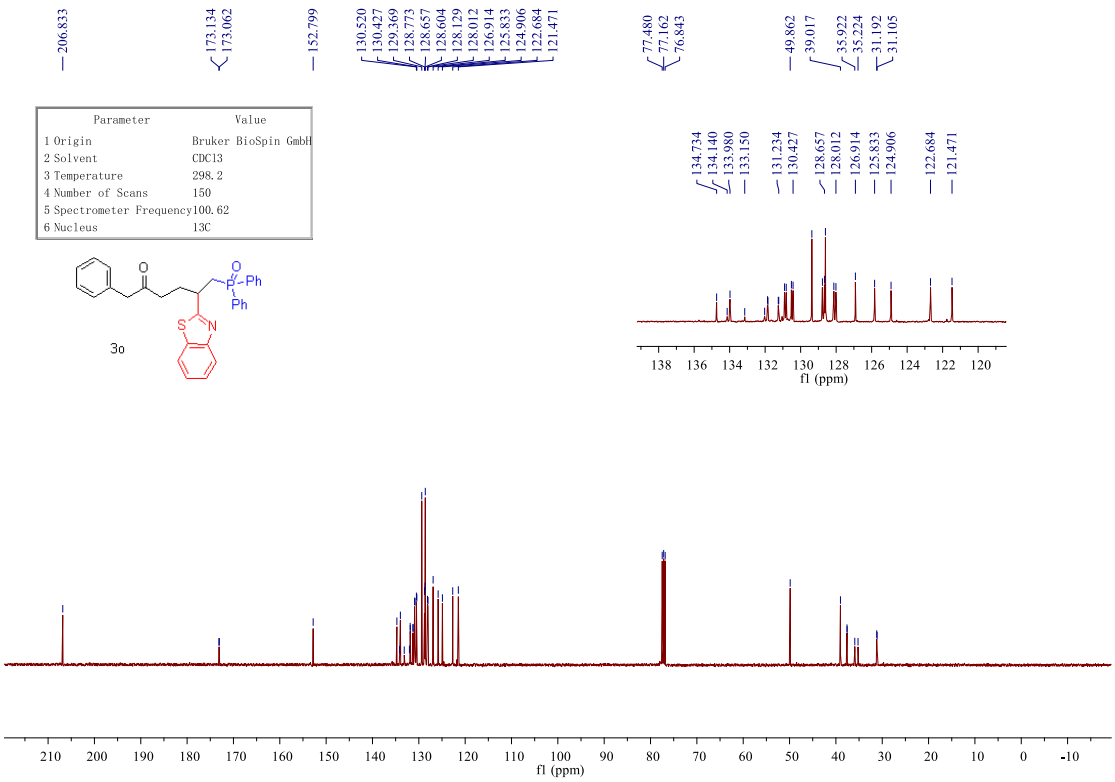
3n




187.940
173.116
173.050
152.666
152.319
146.239
134.681
133.994
133.005
131.904
131.881
131.241
131.217
130.918
130.824
130.529
130.436
128.791
128.675
128.101
127.983
125.857
124.942
122.643
121.459
117.123
112.128
37.823
37.798
36.012
35.649
35.316
31.535
31.444
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
O
O
P
Ph
Ph
S
N
3n
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

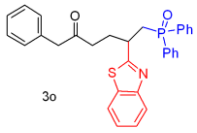

29.711
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 16
5 Spectrometer Frequency 161.97
6 Nucleus 31P
O
O
P
Ph
Ph
S
N
3n
130 110 90 80 70 60 50 40 30 20 10 0 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)


7.831
7.811
7.694
7.674
7.597
7.581
7.577
7.568
7.551
7.410
7.408
7.390
7.310
7.292
7.261
7.209
7.190
7.061
7.057
7.041
3.741
3.734
3.727
3.721
3.714
3.551
3.128
3.109
3.090
2.704
2.691
2.458
2.442
2.238
2.218
2.203
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 16
5 Spectrometer Frequency 400.13
6 Nucleus 1H
O
O
P
Ph
Ph
S
N
3o
0.99
3.04
2.00
4.14
1.00
6.07
1.90
1.00
1.92
1.03
1.12
2.01
2.16
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

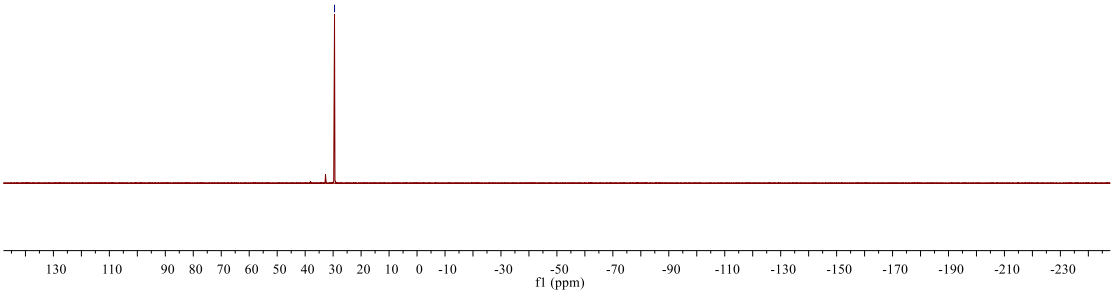

206.833
173.134
173.062
152.799
130.520
130.427
129.369
128.773
128.657
128.604
128.129
128.012
126.914
125.833
124.906
122.684
121.471
77.480
77.162
76.843
49.862
39.017
35.922
35.224
31.192
31.105
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 150
5 Spectrometer Frequency 100.62
6 Nucleus 13C
O
O
P
Ph
Ph
S
N
3o
134.734
134.140
133.980
133.150
131.234
130.427
128.657
128.012
126.914
125.833
124.906
122.684
121.471
138 136 134 132 130 128 126 124 122 120
f1 (ppm)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	16
5 Spectrometer Frequency	161.97
6 Nucleus	31P

29.500



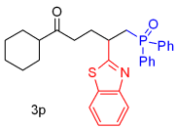
3o



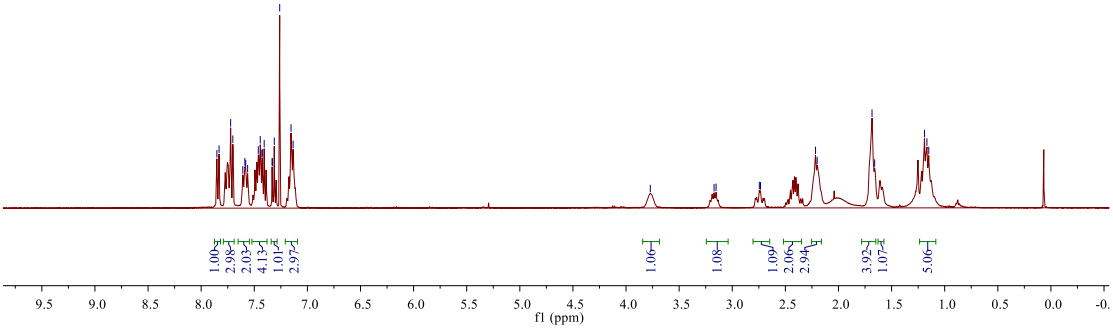
7.852
7.832
7.723
7.702
7.608
7.589
7.580
7.562
7.462
7.444
7.427
7.424
7.407
7.332
7.330
7.312
7.261
7.154
7.134

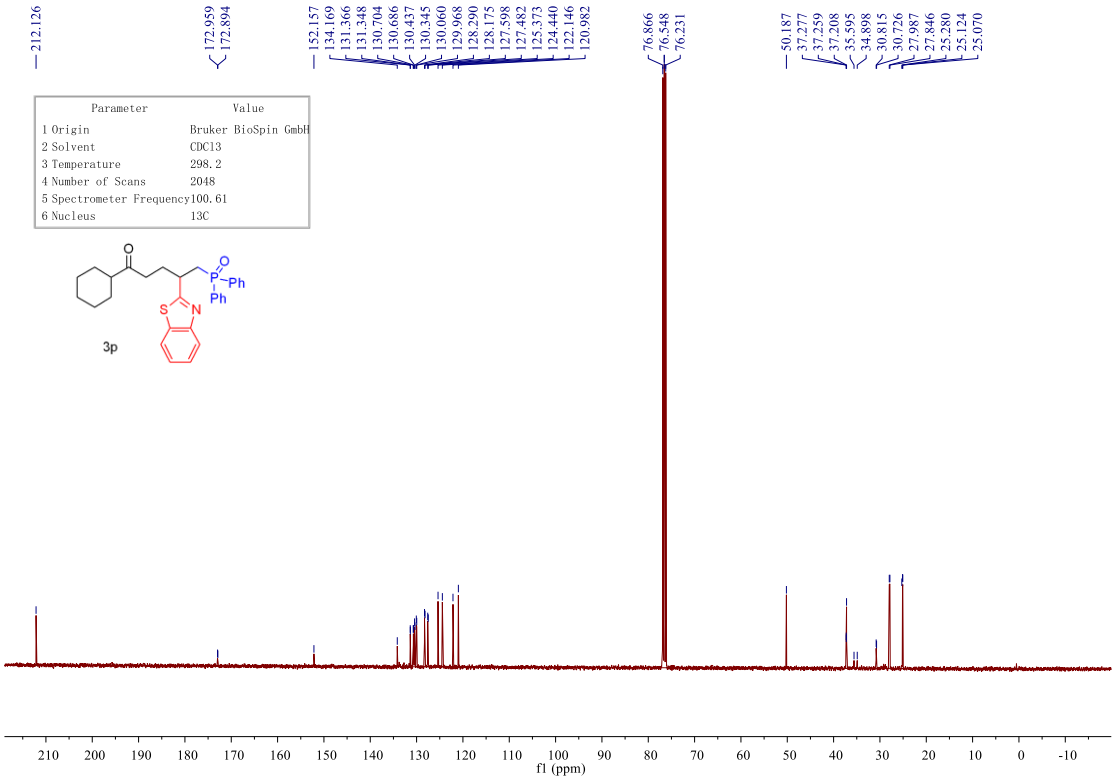
3.772
3.171
3.152
2.745
2.734
2.216
2.200
1.684
1.659
1.190
1.167
1.150

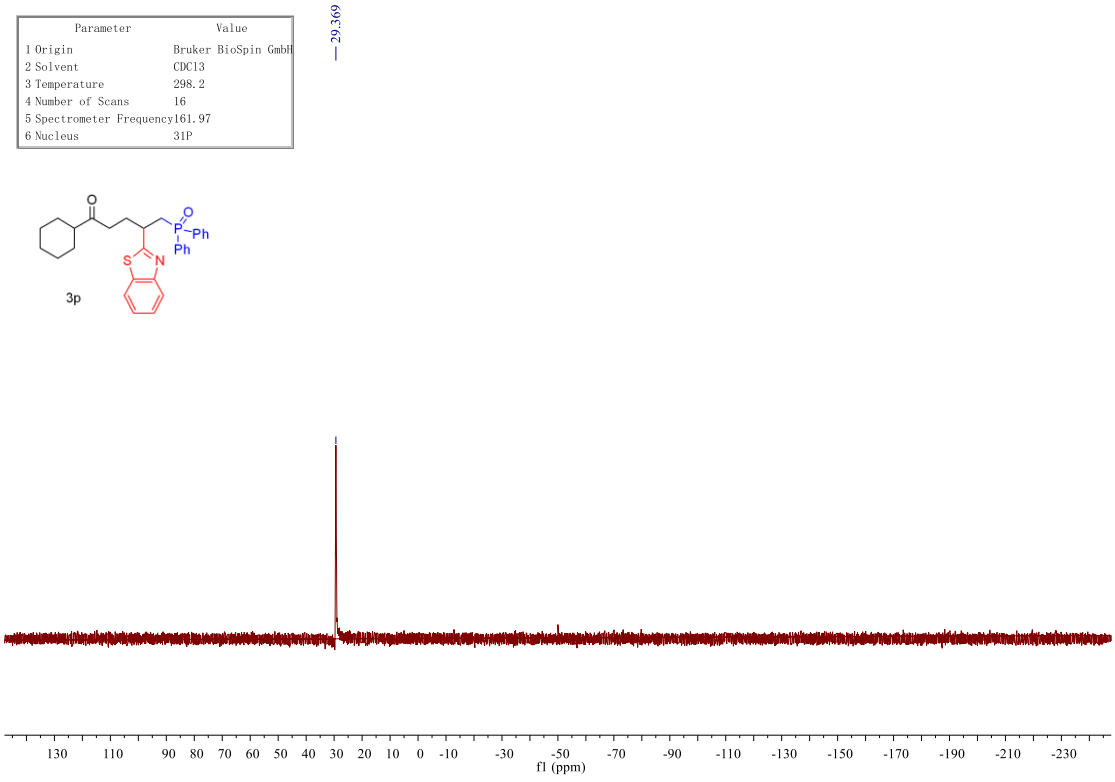
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.1
4 Number of Scans	2
5 Spectrometer Frequency	400.13
6 Nucleus	1H

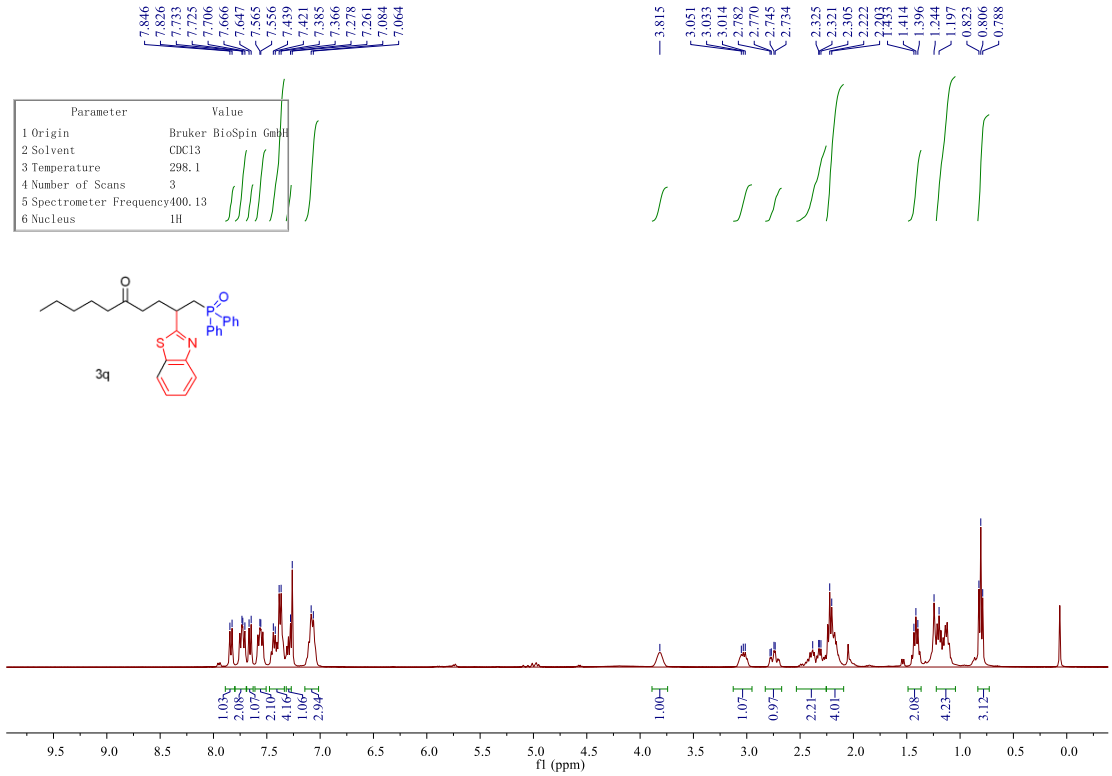


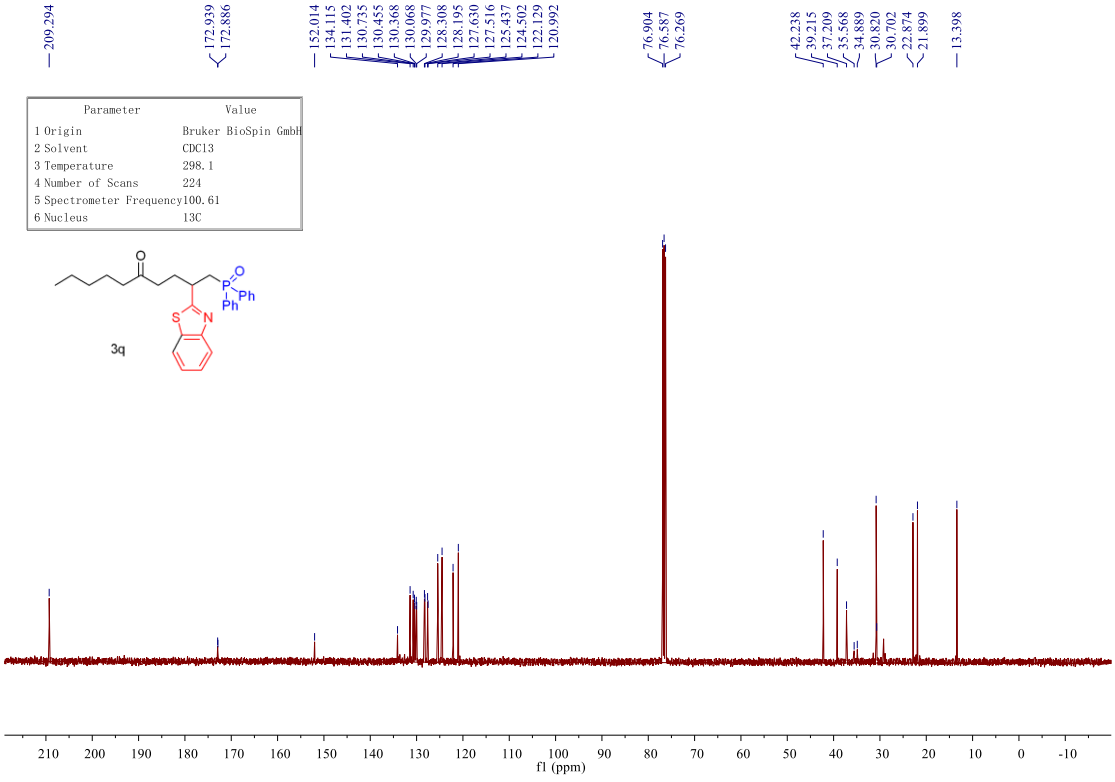
3p

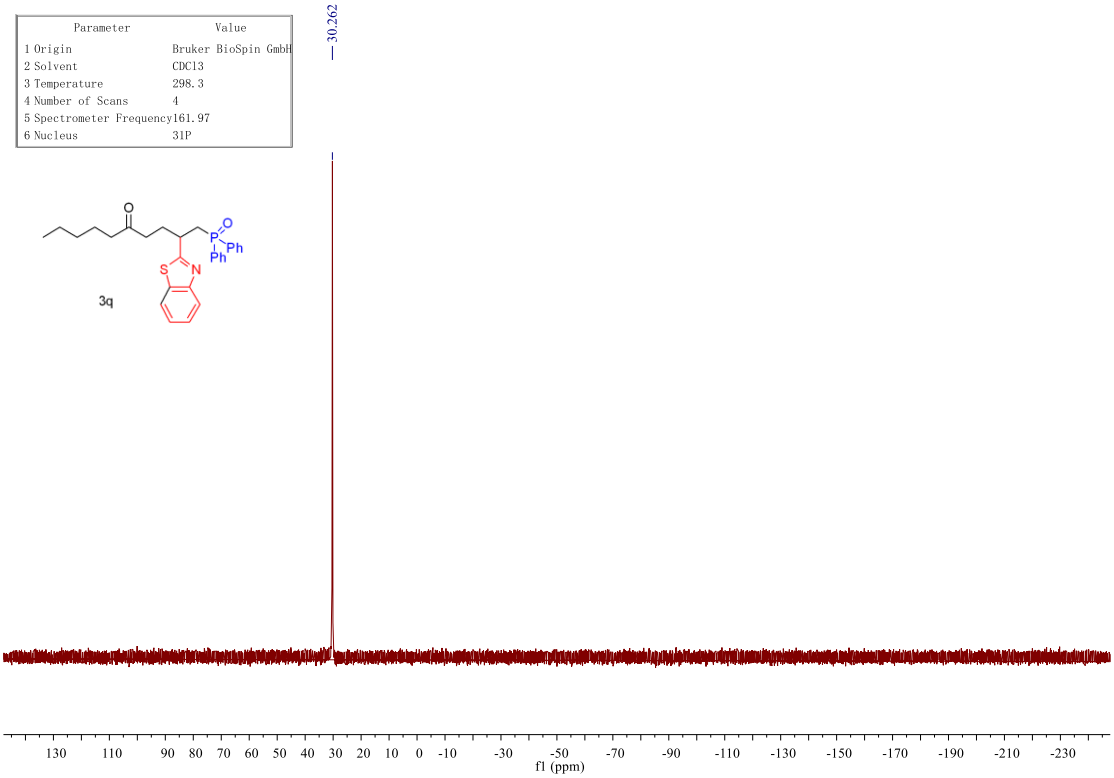


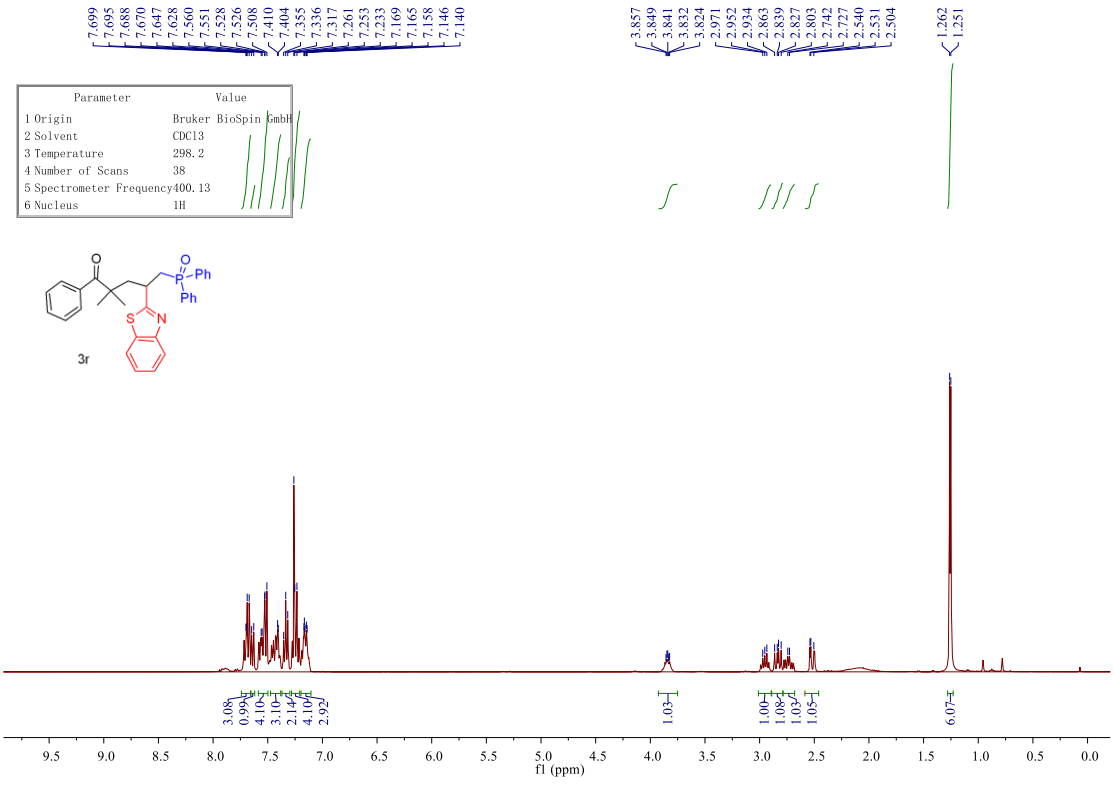

212.126
172.959
172.894
152.157
134.169
131.366
131.348
130.704
130.686
130.437
130.345
130.060
129.968
128.290
128.175
127.598
127.482
125.373
124.440
122.146
120.982
76.866
76.548
76.231
50.187
37.277
37.259
37.208
35.595
34.898
30.815
30.726
27.987
27.846
25.280
25.124
25.070
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 2048
5 Spectrometer Frequency 100.61
6 Nucleus 13C
3p
f1 (ppm)

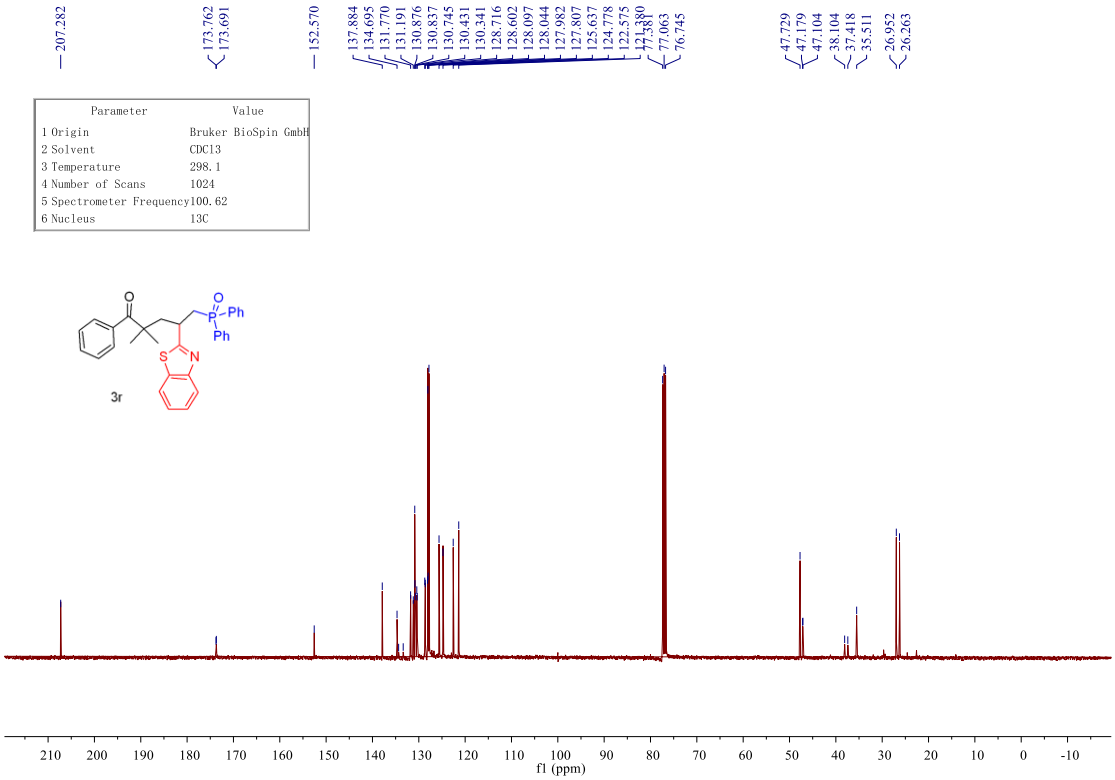

29.369
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 16
5 Spectrometer Frequency 161.97
6 Nucleus 31P
3p
f1 (ppm)

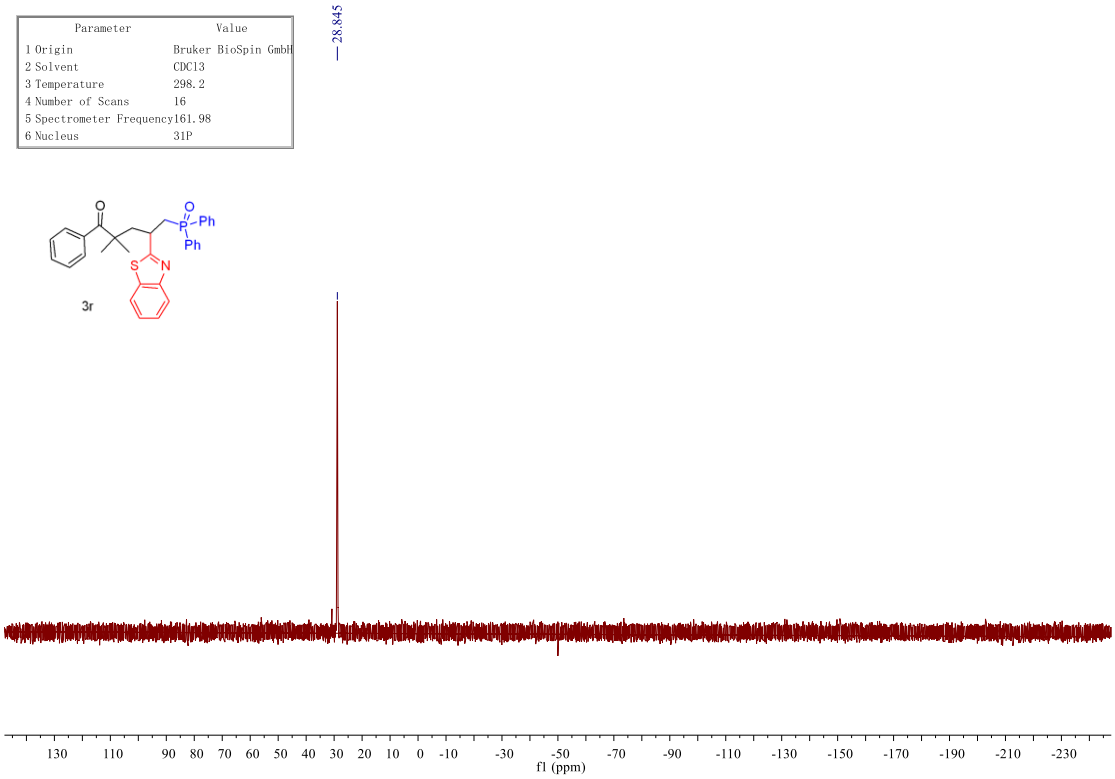

7.846
7.826
7.733
7.725
7.706
7.666
7.647
7.565
7.556
7.439
7.421
7.385
7.366
7.278
7.261
7.084
7.064
3.815
3.051
3.033
3.014
2.782
2.770
2.745
2.734
2.325
2.321
2.305
2.222
2.203
1.433
1.414
1.396
1.244
1.197
0.823
0.806
0.788
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 3
5 Spectrometer Frequency 400.13
6 Nucleus 1H
3q
1.03
2.08
1.07
2.10
4.16
1.06
2.94
1.00
1.07
0.97
2.21
4.01
2.08
4.23
3.12
f1 (ppm)

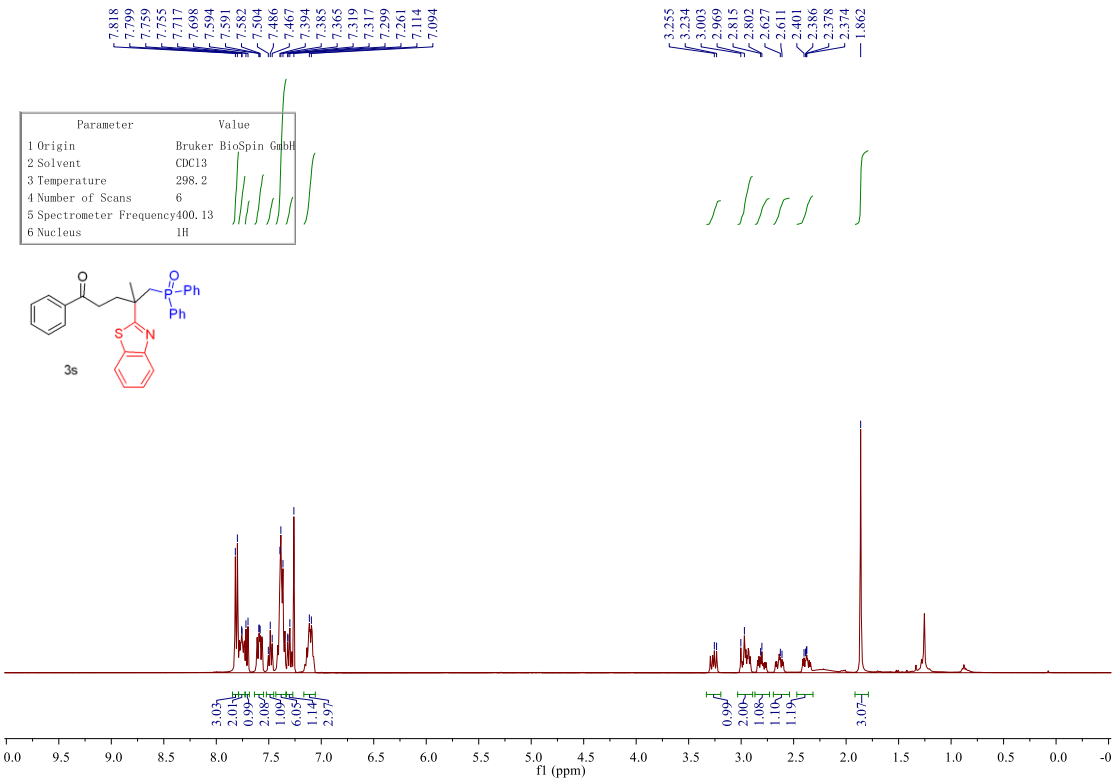

209.294
172.939
172.886
152.014
134.115
131.402
130.735
130.455
130.368
130.068
129.977
128.308
128.195
127.630
127.516
125.437
124.502
122.129
120.992
76.904
76.587
76.269
42.238
39.215
37.209
35.568
34.889
30.820
30.702
22.874
21.899
13.398
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 224
5 Spectrometer Frequency 100.61
6 Nucleus 13C
3q
f1 (ppm)

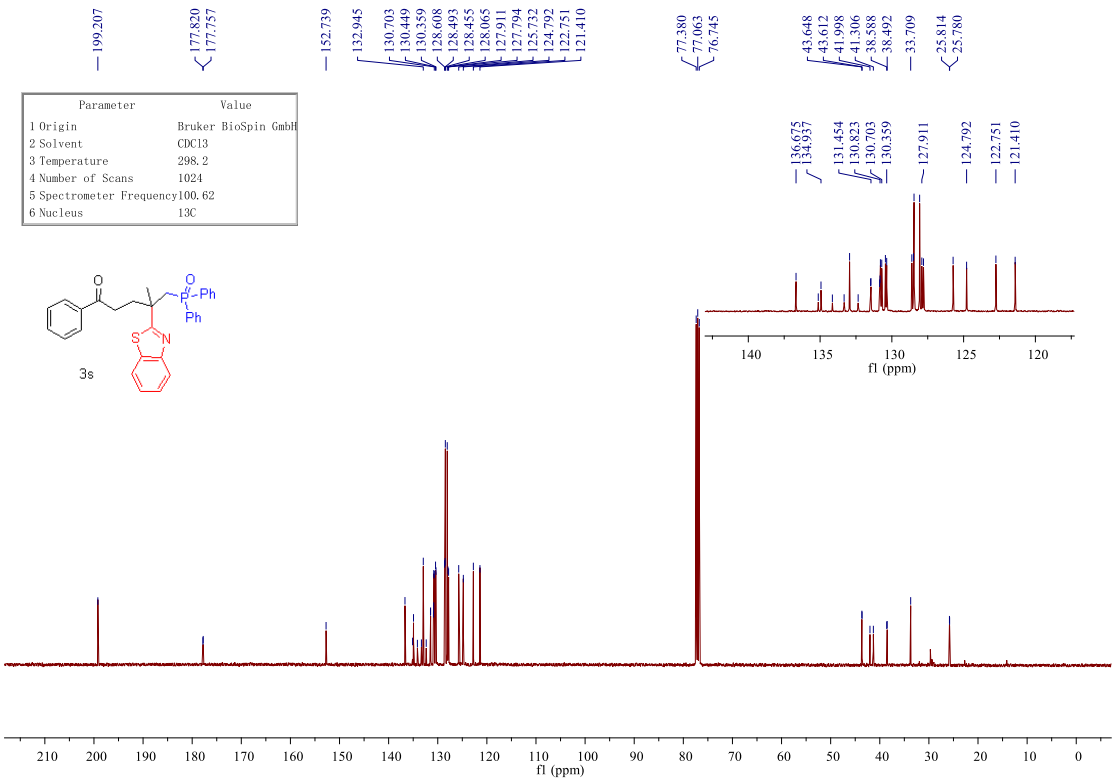

Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.3
4 Number of Scans 4
5 Spectrometer Frequency 161.97
6 Nucleus 31P
30.262
3q
f1 (ppm)


7.699 7.695 7.688 7.670 7.647 7.628 7.560 7.551 7.528 7.526 7.508 7.410 7.404 7.355 7.336 7.317 7.261 7.253 7.233 7.169 7.165 7.158 7.146 7.140
3.857 3.849 3.841 3.832 3.824 2.971 2.952 2.934 2.863 2.839 2.827 2.803 2.742 2.727 2.540 2.531 2.504
1.262 1.251
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 38
5 Spectrometer Frequency 400.13
6 Nucleus 1H
3r
3.08 0.99 4.10 3.10 2.14 4.10 2.92
1.03
1.00 1.08 1.03 1.05
6.07
f1 (ppm)


207.282
173.762
173.691
152.570
137.884
134.695
131.770
131.191
130.876
130.837
130.745
130.431
130.341
128.716
128.602
128.097
128.044
127.982
127.807
125.637
124.778
122.575
121.380
77.381
77.063
76.745
47.729
47.179
47.104
38.104
37.418
35.511
26.952
26.263
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
3r
f1 (ppm)

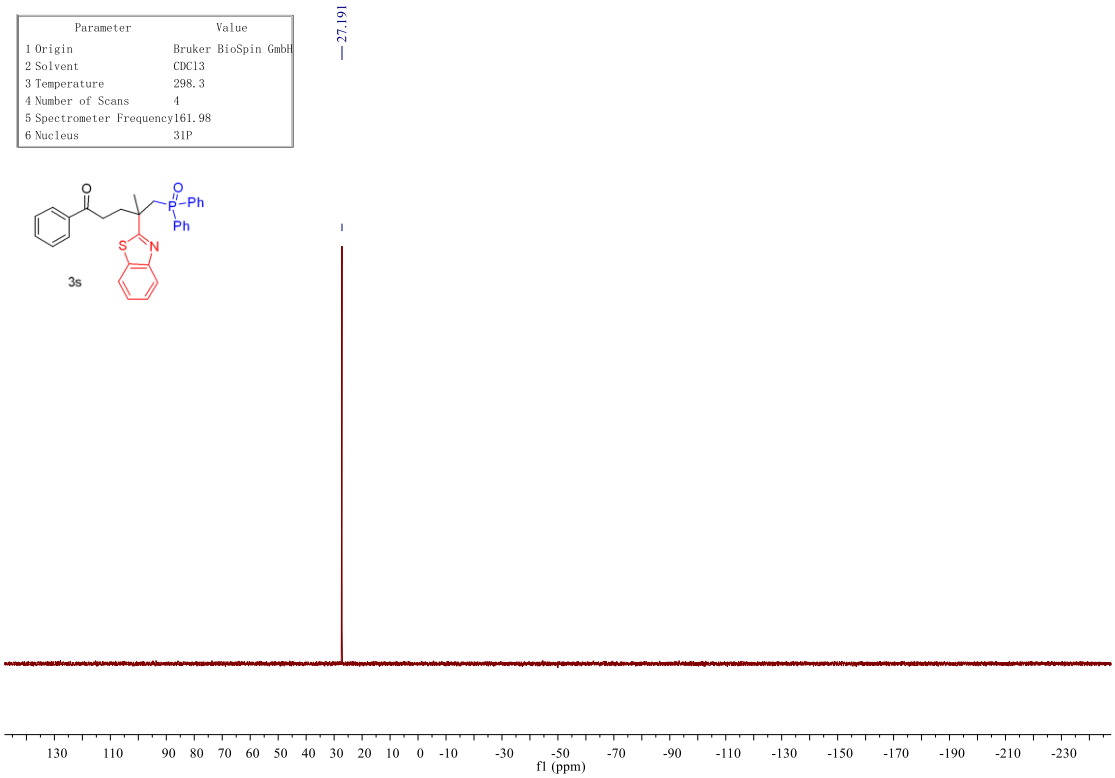

28.845
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 16
5 Spectrometer Frequency 161.98
6 Nucleus 31P
3r
f1 (ppm)


7.818
7.799
7.759
7.755
7.717
7.698
7.594
7.591
7.582
7.504
7.486
7.467
7.394
7.385
7.365
7.319
7.317
7.299
7.261
7.114
7.094
3.255
3.234
3.003
2.969
2.815
2.802
2.627
2.611
2.401
2.386
2.378
2.374
1.862
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 6
5 Spectrometer Frequency 400.13
6 Nucleus 1H
3s
3.03
2.01
0.99
2.08
1.09
6.05
1.14
2.97
0.99
2.00
1.08
1.10
1.19
3.07
f1 (ppm)


199.207
177.820
177.757
152.739
132.945
130.703
130.449
130.359
128.608
128.493
128.455
128.065
127.911
127.794
125.732
124.792
122.751
121.410
77.380
77.063
76.745
43.648
43.612
41.998
41.306
38.588
38.492
33.709
25.814
25.780
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
3s
136.675
134.937
131.454
130.823
130.703
130.359
127.911
124.792
122.751
121.410
f1 (ppm)
f1 (ppm)

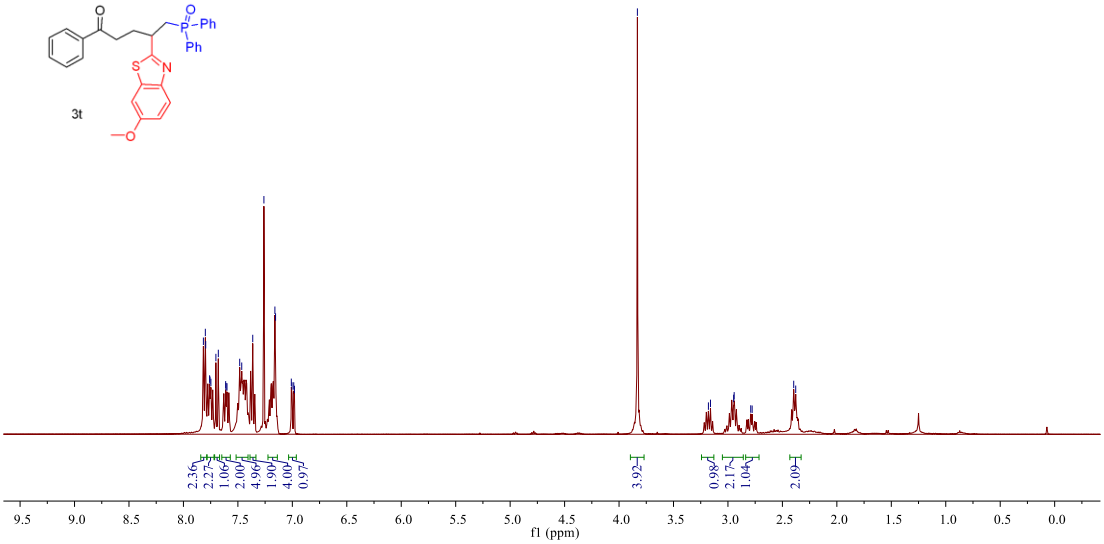
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.3
4 Number of Scans	4
5 Spectrometer Frequency	161.98
6 Nucleus	31P

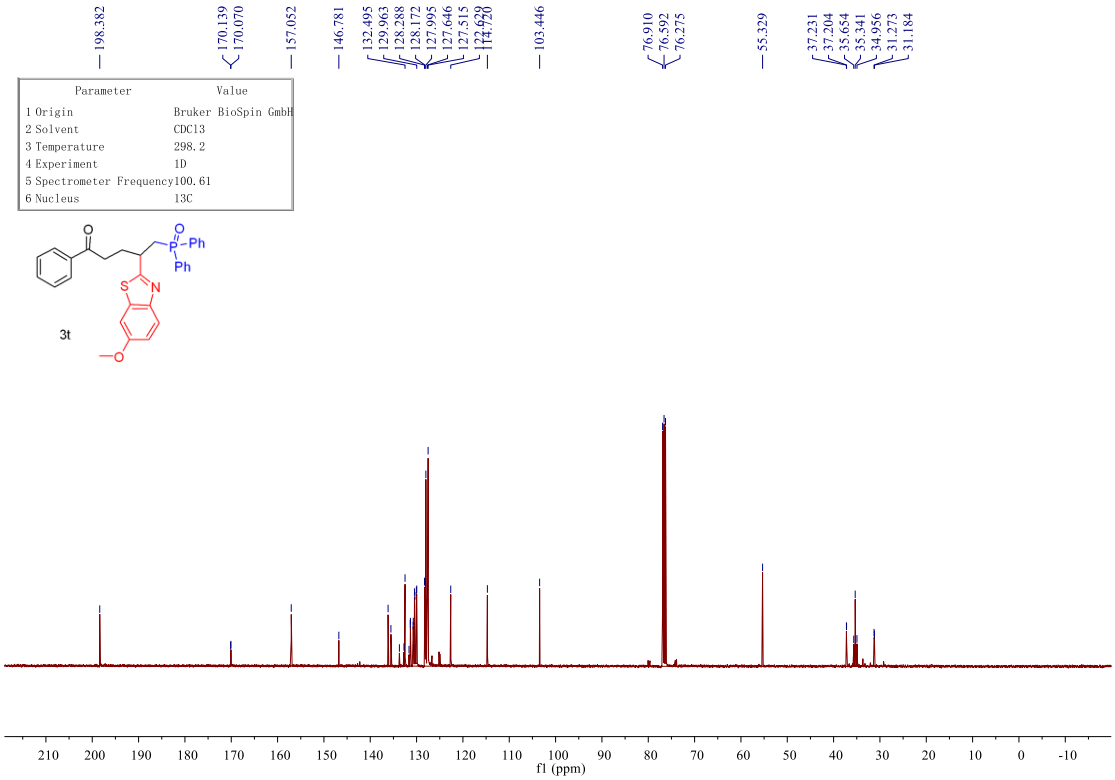
3s

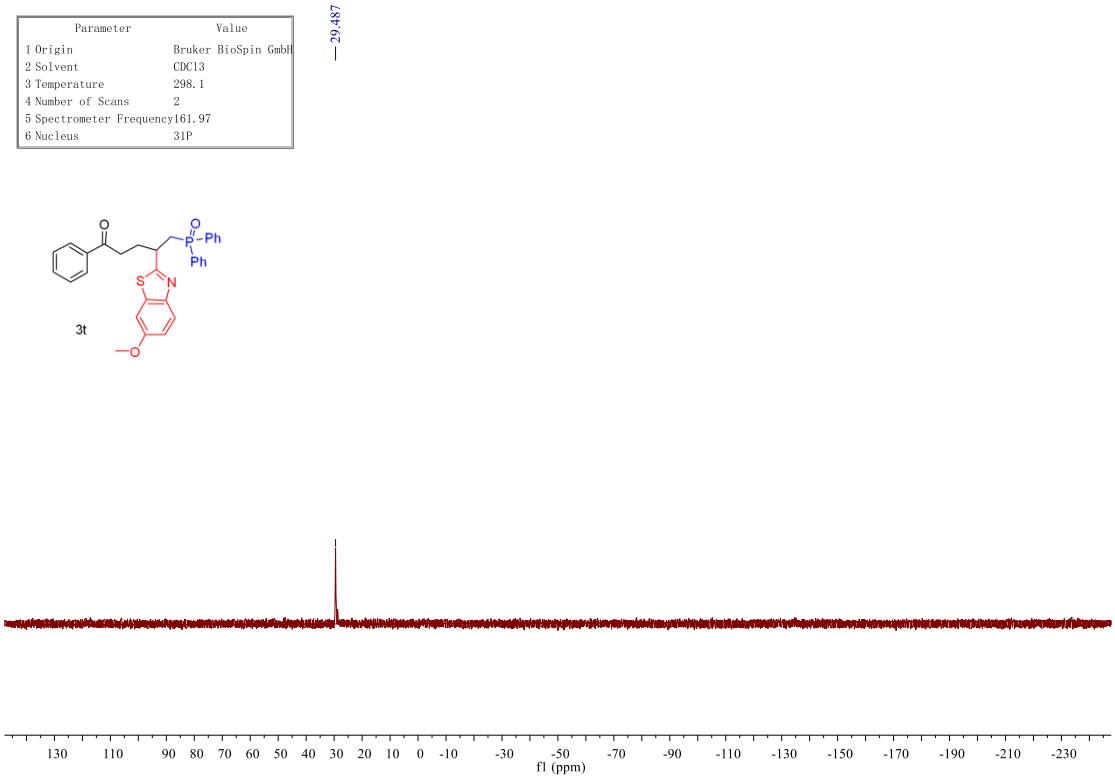


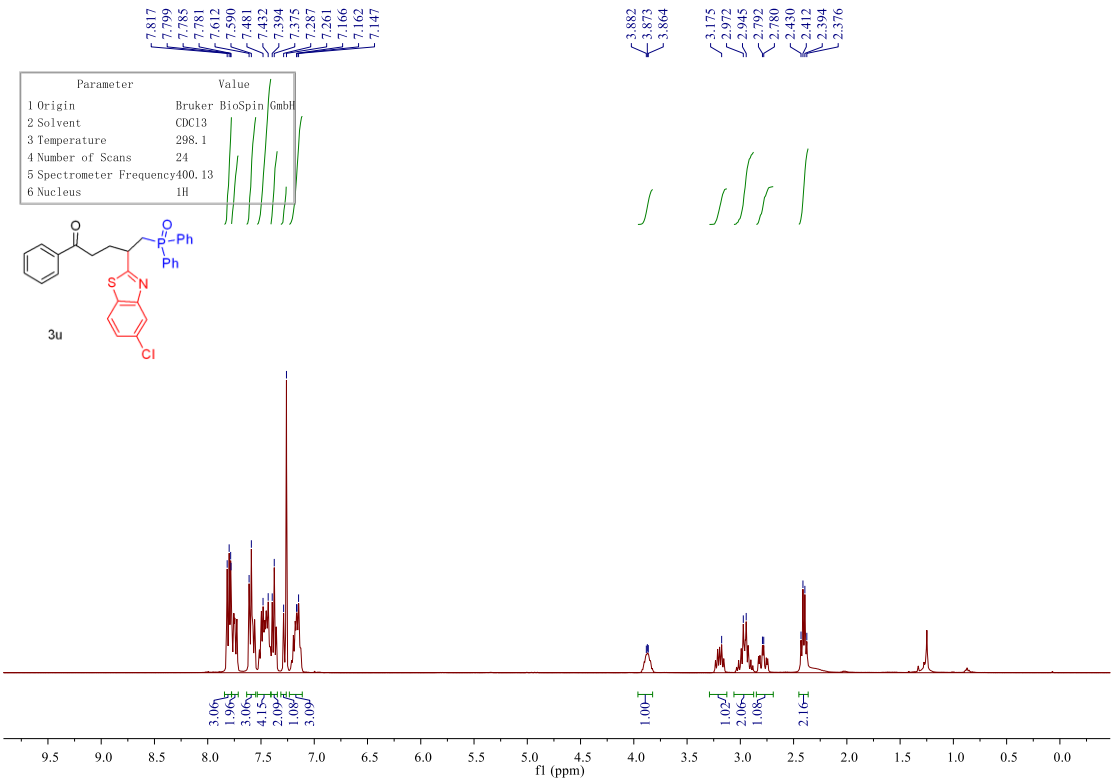
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	4
5 Spectrometer Frequency	400.13
6 Nucleus	1H

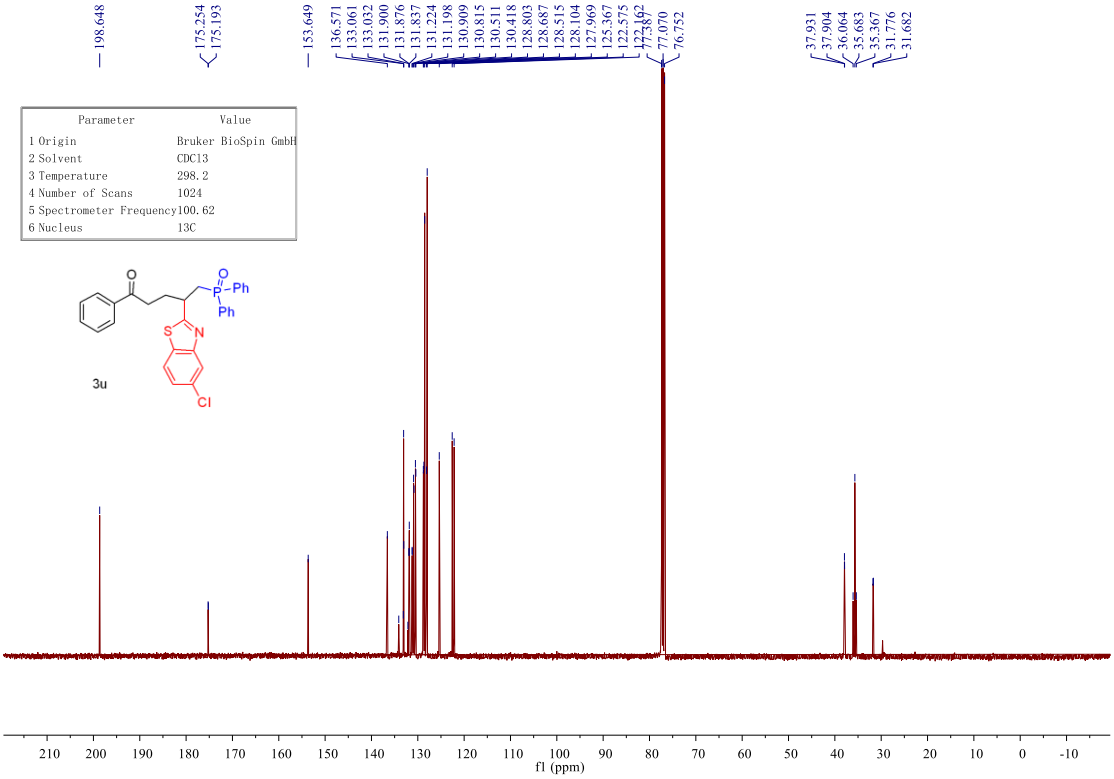
3t




198.382
170.139
170.070
157.052
146.781
132.495
129.963
128.288
128.172
127.995
127.646
127.515
103.446
76.910
76.592
76.275
55.329
37.231
37.204
35.654
35.341
34.956
31.273
31.184
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Experiment 1D
5 Spectrometer Frequency 100.61
6 Nucleus 13C
Ph
Ph
O
P
S
N
O
3t
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

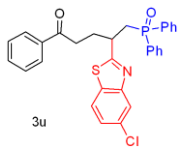

29.487
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 2
5 Spectrometer Frequency 161.97
6 Nucleus 31P
Ph
Ph
O
P
S
N
O
3t
130 110 90 80 70 60 50 40 30 20 10 0 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)


7.817
7.799
7.785
7.781
7.612
7.590
7.481
7.432
7.394
7.375
7.287
7.261
7.166
7.162
7.147
3.882
3.873
3.864
3.175
2.972
2.945
2.792
2.780
2.430
2.412
2.394
2.376
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 24
5 Spectrometer Frequency 400.13
6 Nucleus 1H
3u
3.06
1.96
3.06
4.15
2.09
1.08
3.09
1.00
1.02
2.06
1.08
2.16
f1 (ppm)

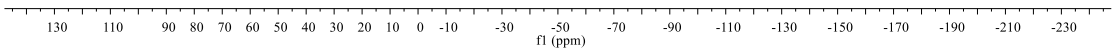

198.648
175.254
175.193
153.649
136.571
133.061
133.032
131.900
131.876
131.837
131.224
131.198
130.909
130.815
130.511
130.418
128.803
128.687
128.515
128.104
127.969
125.367
122.575
122.162
77.387
77.070
76.752
37.931
37.904
36.064
35.683
35.367
31.776
31.682
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
3u
f1 (ppm)

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	6
5 Spectrometer Frequency	161.97
6 Nucleus	31P

29.042



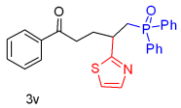
3u



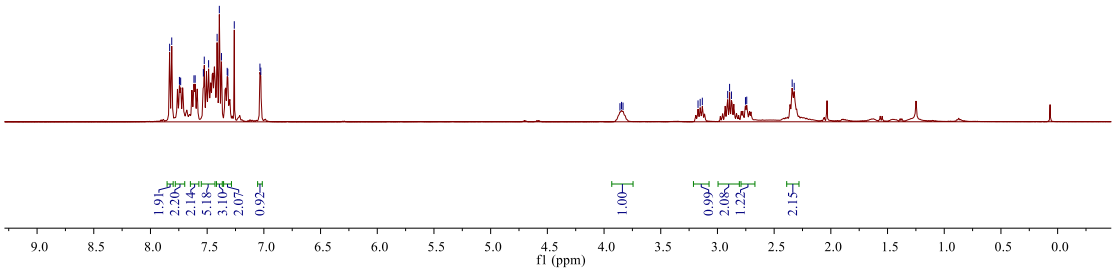
7.831
7.812
7.745
7.742
7.734
7.616
7.606
7.533
7.525
7.487
7.412
7.393
7.374
7.323
7.318
7.261
7.035
7.027

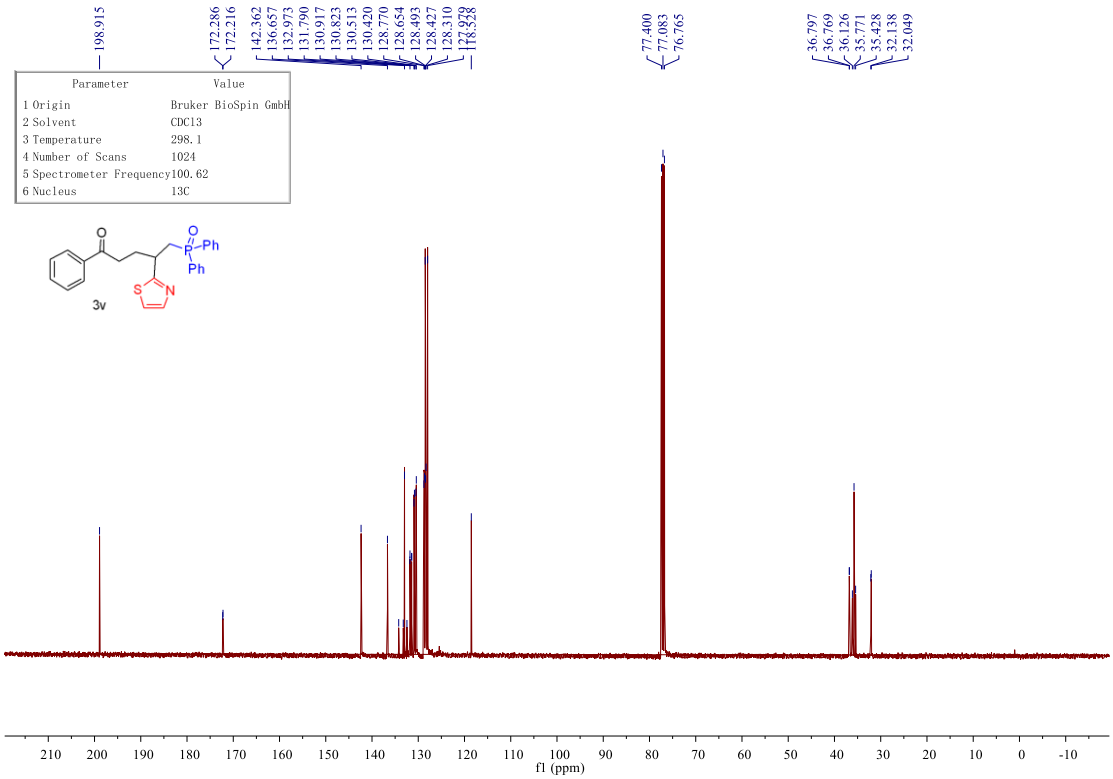
3.860
3.846
3.833
3.171
3.152
3.133
2.910
2.893
2.877
2.753
2.742
2.341
2.323

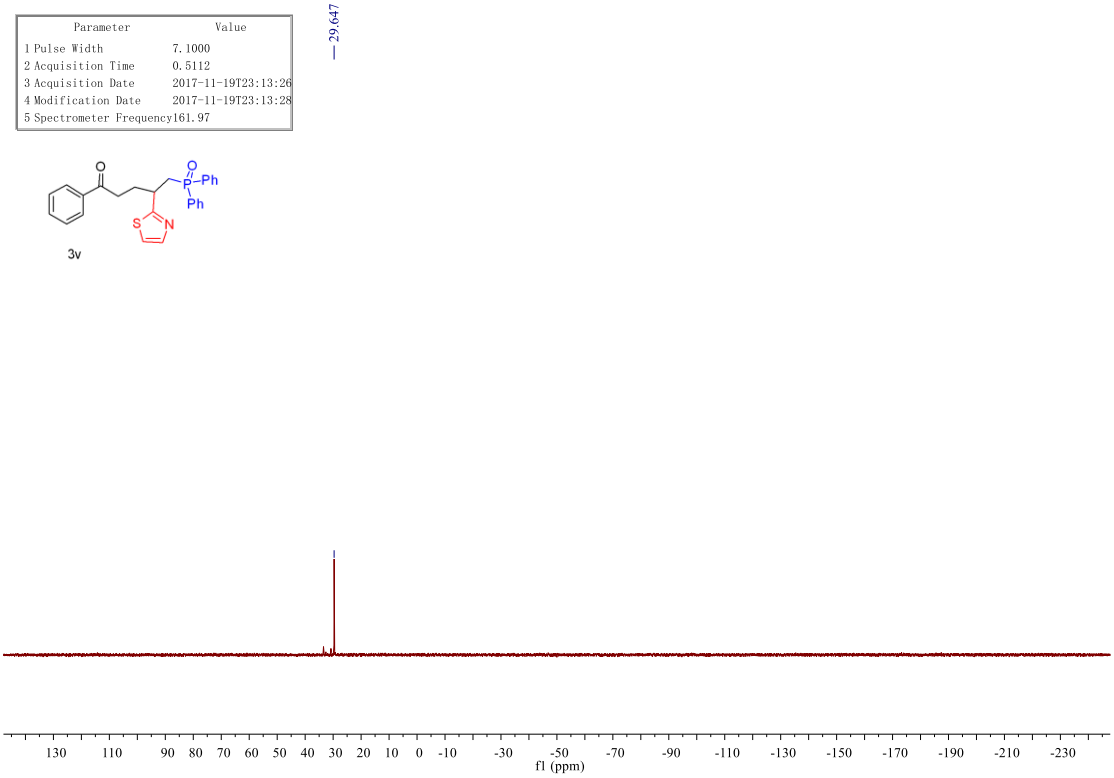
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.1
4 Number of Scans	16
5 Spectrometer Frequency	400.13
6 Nucleus	1H

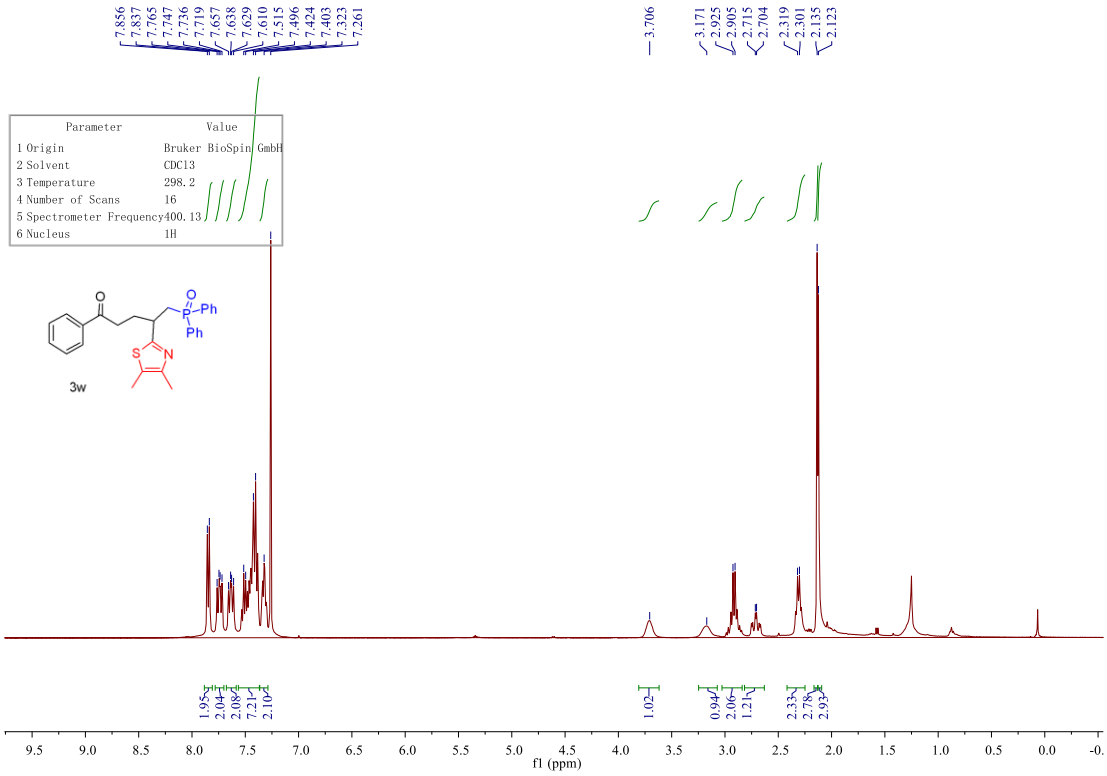


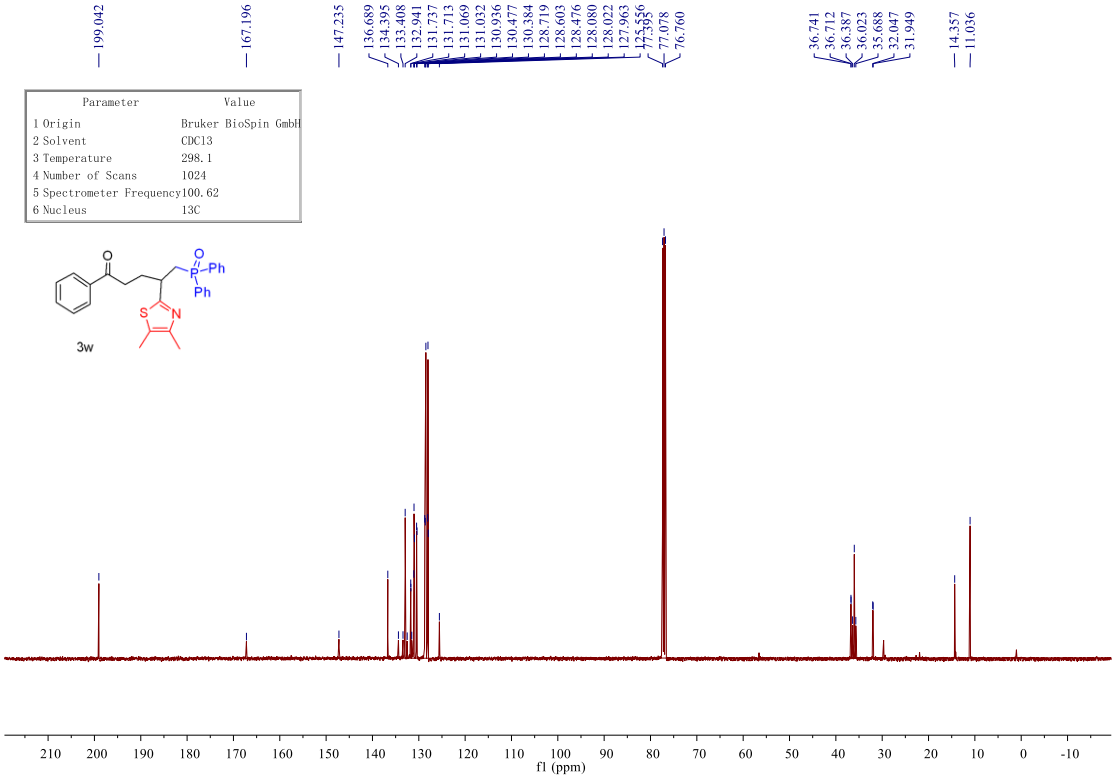
3v




198.915
172.286
172.216
142.362
136.657
132.973
131.790
130.917
130.823
130.513
130.420
128.770
128.654
128.493
128.427
128.310
127.979
118.328
77.400
77.083
76.765
36.797
36.769
36.126
35.771
35.428
32.138
32.049
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
O
O
Ph
P
Ph
S
N
3v
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

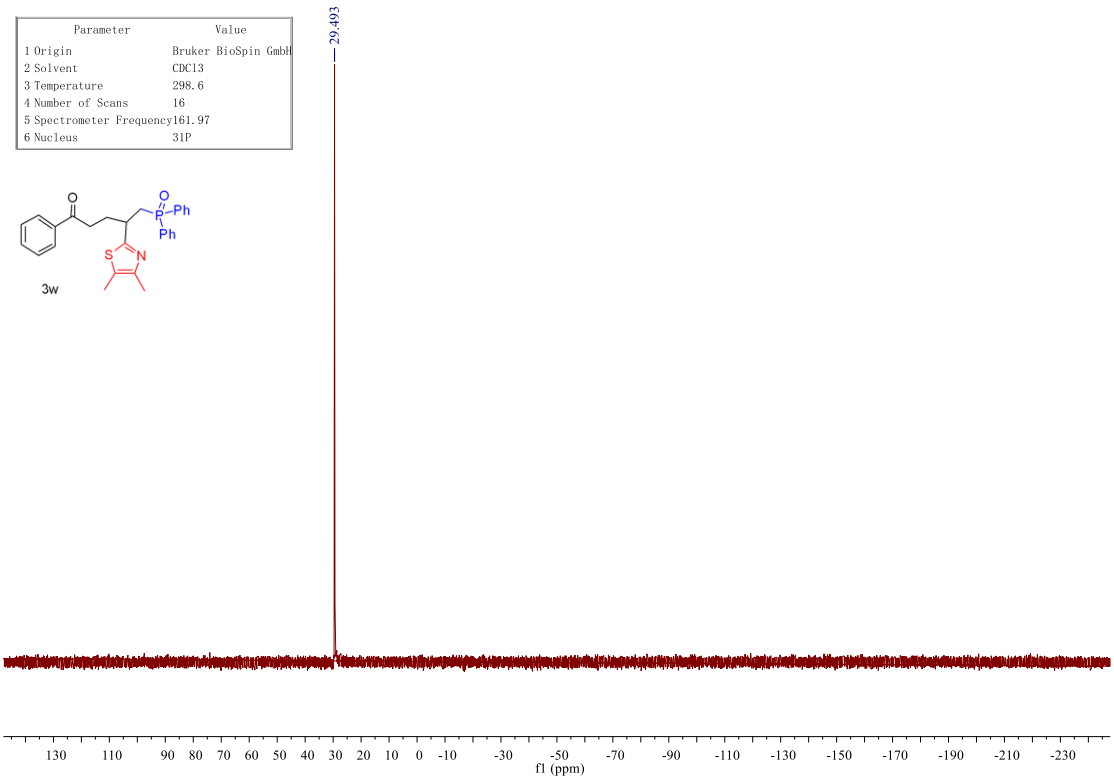

29.647
Parameter Value
1 Pulse Width 7.1000
2 Acquisition Time 0.5112
3 Acquisition Date 2017-11-19T23:13:26
4 Modification Date 2017-11-19T23:13:28
5 Spectrometer Frequency 161.97
O
O
Ph
P
Ph
S
N
3v
130 110 90 80 70 60 50 40 30 20 10 0 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)


7.856
7.837
7.765
7.747
7.736
7.719
7.657
7.638
7.629
7.610
7.515
7.496
7.424
7.403
7.323
7.261
3.706
3.171
2.925
2.905
2.715
2.704
2.319
2.301
2.135
2.123
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 16
5 Spectrometer Frequency 400.13
6 Nucleus 1H
3w
1.95
2.04
2.08
7.21
2.10
1.02
0.94
2.06
1.21
2.33
2.78
2.93
f1 (ppm)

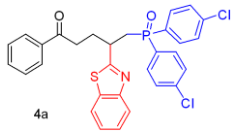

199.042
167.196
147.235
136.689
134.395
133.408
132.941
131.737
131.713
131.069
131.032
130.936
130.477
130.384
128.719
128.603
128.476
128.080
128.022
127.963
125.556
77.395
77.078
76.760
36.741
36.712
36.387
36.023
35.688
32.047
31.949
14.357
11.036
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
3w
f1 (ppm)

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.6
4 Number of Scans	16
5 Spectrometer Frequency	161.97
6 Nucleus	31P

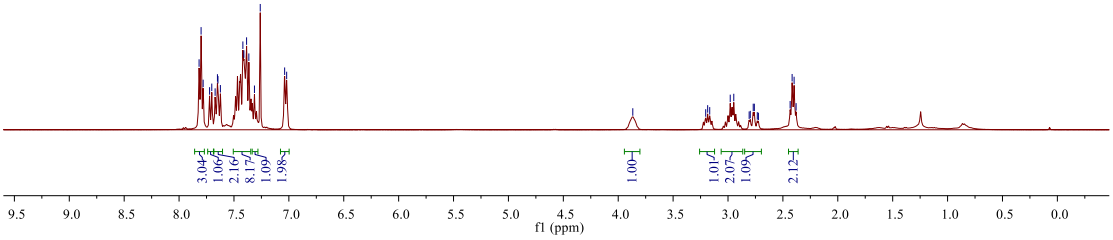
3w

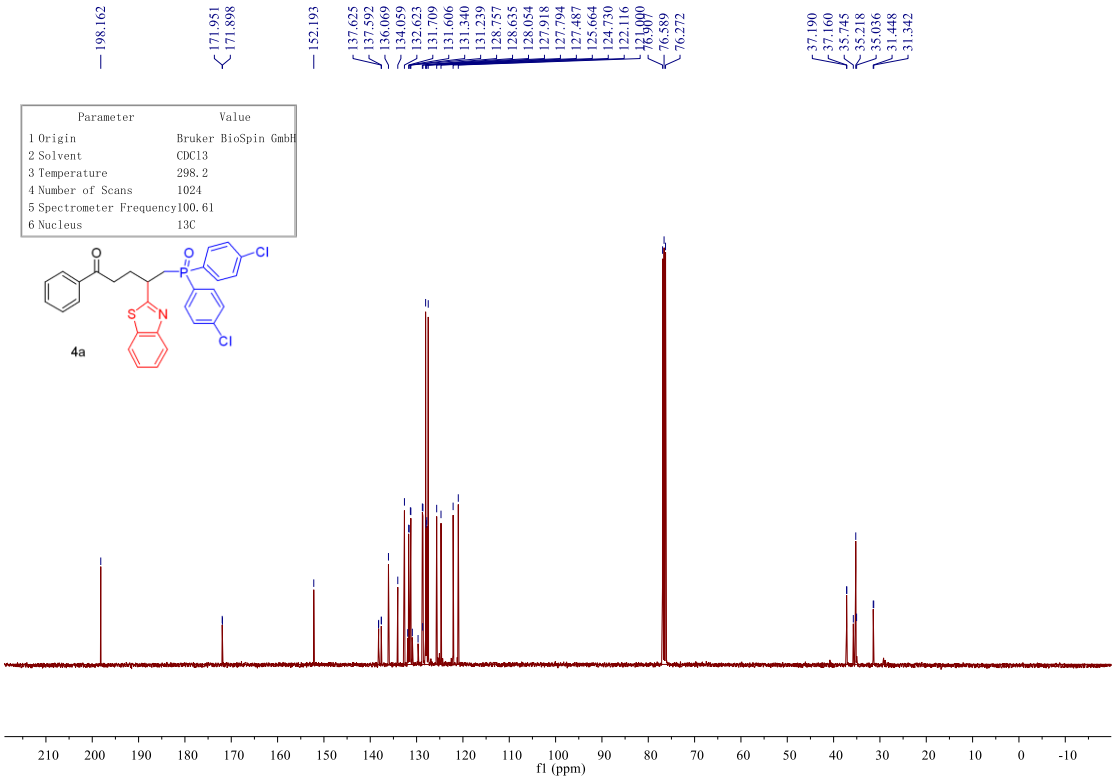


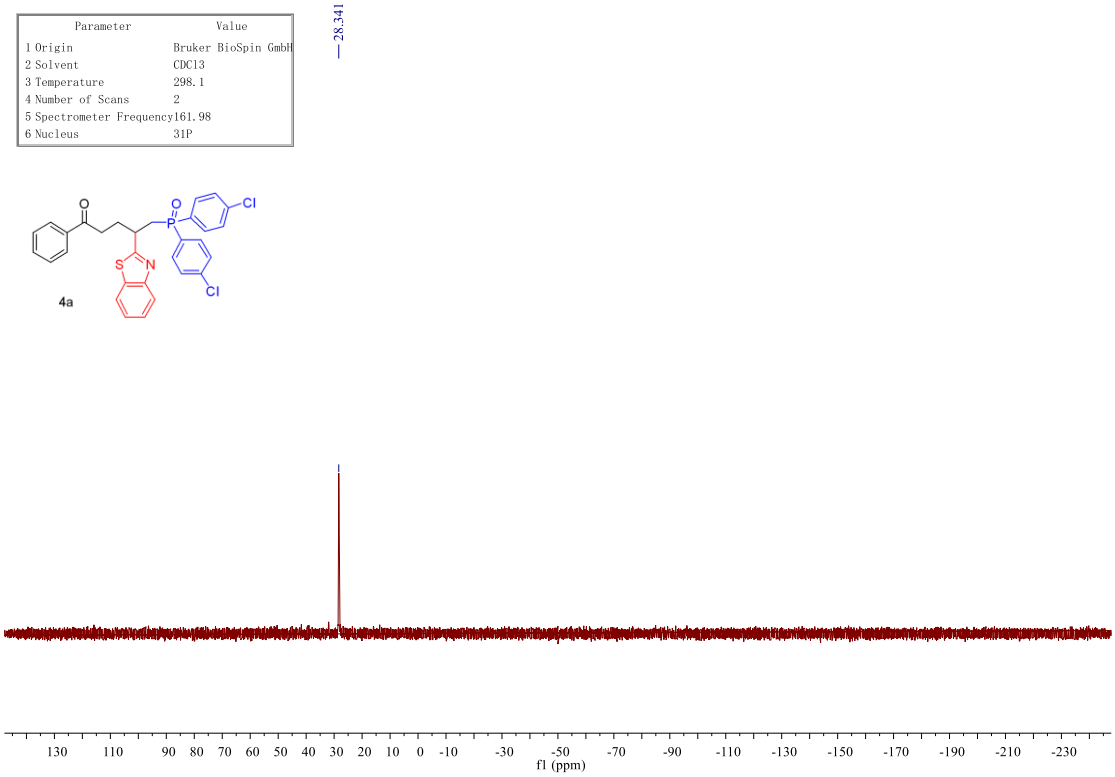
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	2
5 Spectrometer Frequency	400.13
6 Nucleus	1H

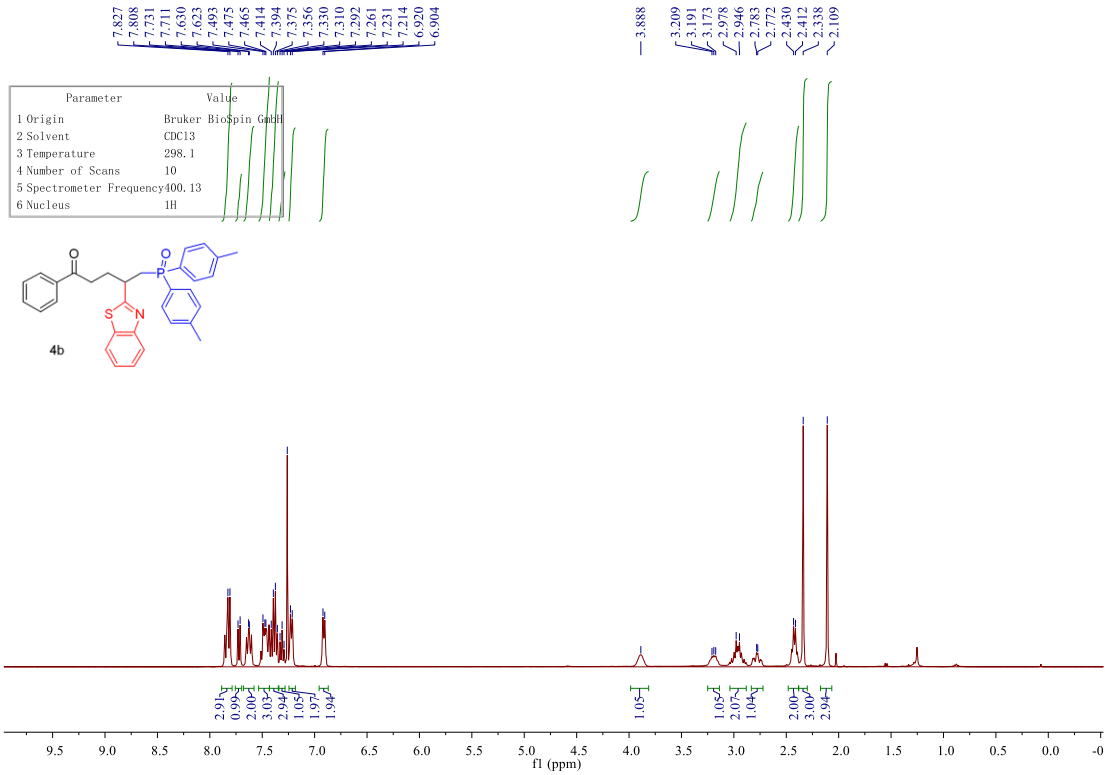


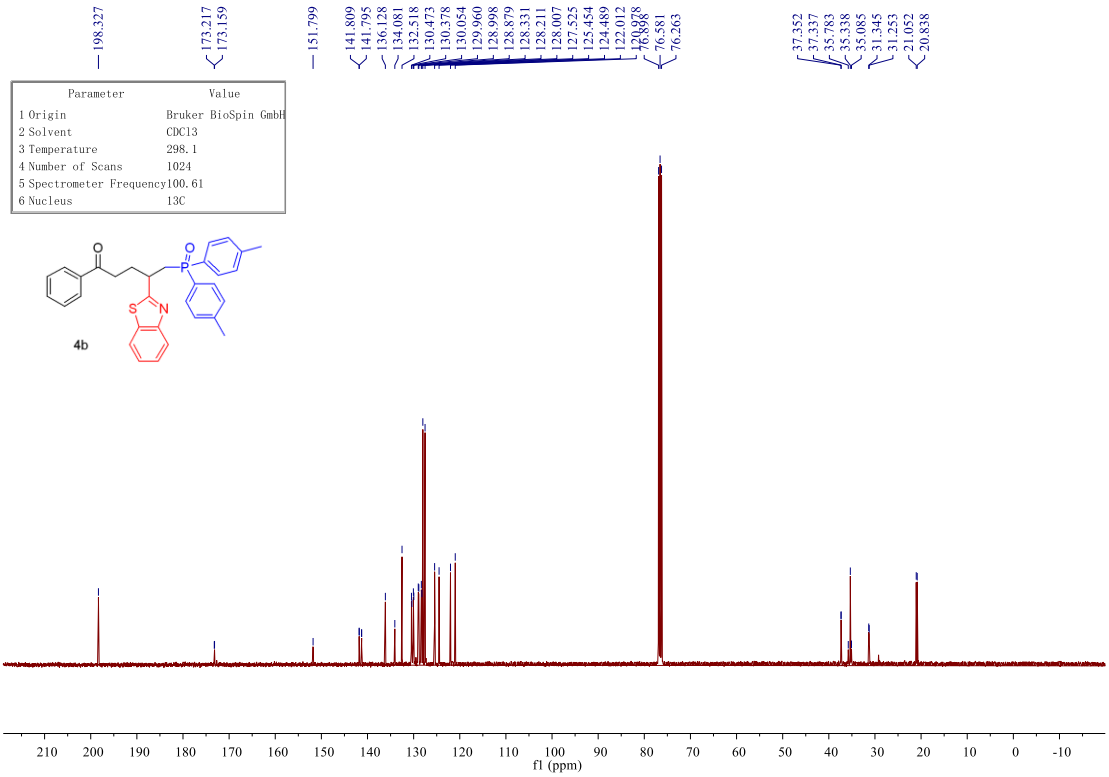
4a




198.162
171.951
171.898
152.193
137.625
137.592
136.069
134.059
132.623
131.709
131.606
131.340
131.239
128.757
128.635
128.054
127.918
127.794
127.487
125.664
124.730
122.116
121.000
76.907
76.589
76.272
37.190
37.160
35.745
35.218
35.036
31.448
31.342
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 1024
5 Spectrometer Frequency 100.61
6 Nucleus 13C
4a
f1 (ppm)

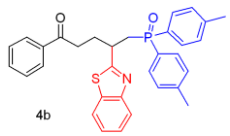

28.341
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 2
5 Spectrometer Frequency 161.98
6 Nucleus 31P
4a
f1 (ppm)


7.827
7.808
7.731
7.711
7.630
7.623
7.493
7.475
7.465
7.414
7.394
7.375
7.356
7.330
7.310
7.292
7.261
7.231
7.214
6.920
6.904
3.888
3.209
3.191
3.173
2.978
2.946
2.783
2.772
2.430
2.412
2.338
2.109
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 10
5 Spectrometer Frequency 400.13
6 Nucleus 1H
4b
2.91
0.99
2.00
3.03
2.94
1.05
1.97
1.94
1.05
1.05
2.07
1.04
2.00
3.00
2.94
f1 (ppm)

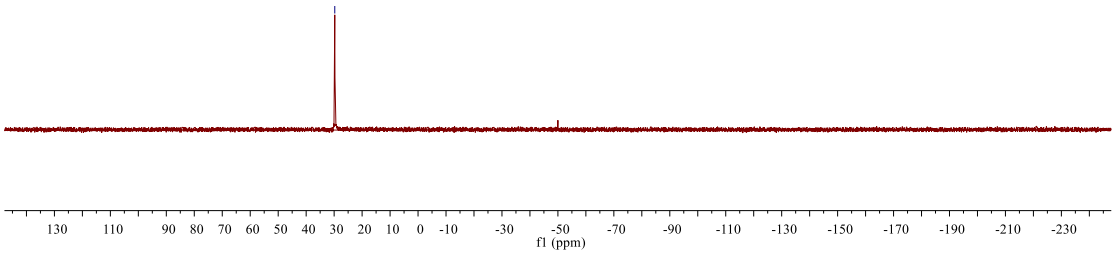

198.327
173.217
173.159
151.799
141.809
141.795
136.128
134.081
132.518
130.473
130.378
130.054
129.960
128.998
128.879
128.331
128.211
128.007
127.525
125.454
124.489
122.012
120.978
76.898
76.581
76.263
37.352
37.337
35.783
35.338
35.085
31.345
31.253
21.052
20.838
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.61
6 Nucleus 13C
4b
f1 (ppm)

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	6
5 Spectrometer Frequency	161.97
6 Nucleus	31P

29.771



4b

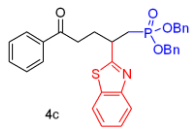


7.956 7.935 7.838 7.820 7.817 7.511 7.450 7.389 7.261 7.248 7.240 7.235 7.230 7.218 7.211 7.196 7.168 7.164 7.155

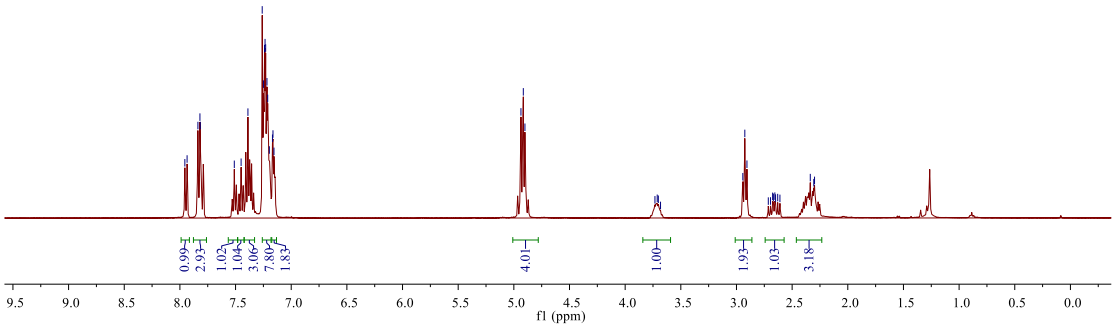
4.936 4.915 4.900

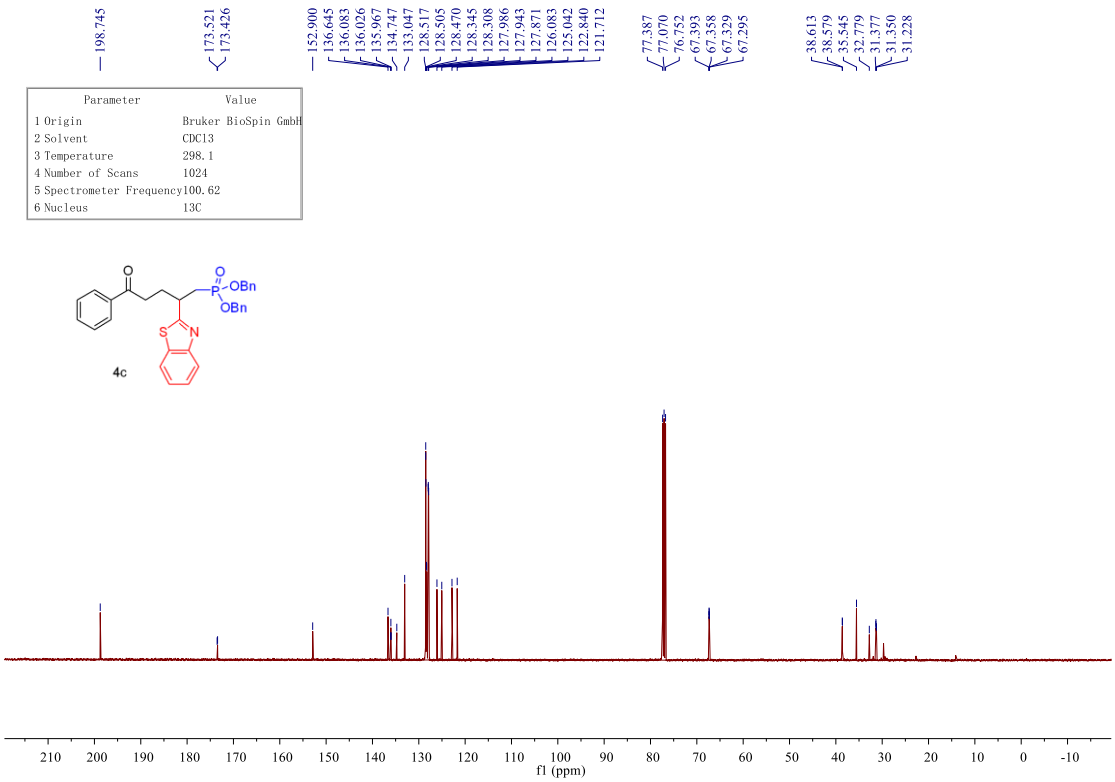
3.733 3.712 3.702 3.682 2.943 2.925 2.906 2.714 2.694 2.675 2.669 2.655 2.649 2.630 2.610 2.337 2.305 2.299

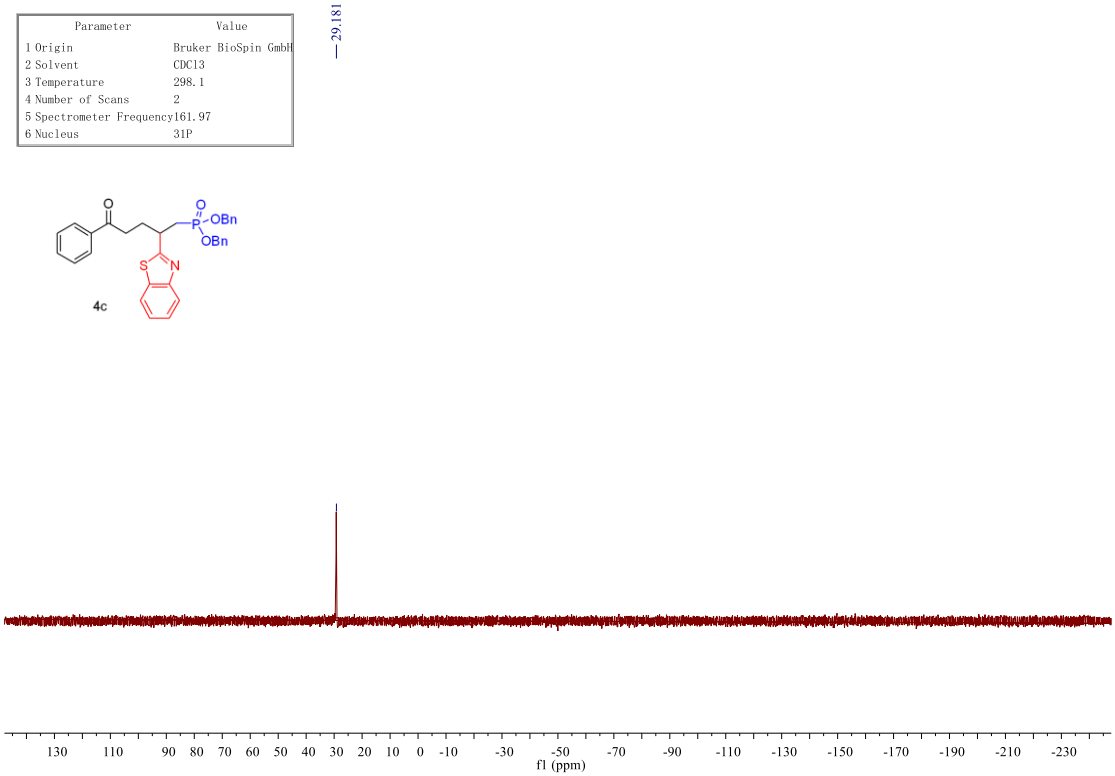
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	2
5 Spectrometer Frequency	400.13
6 Nucleus	1H

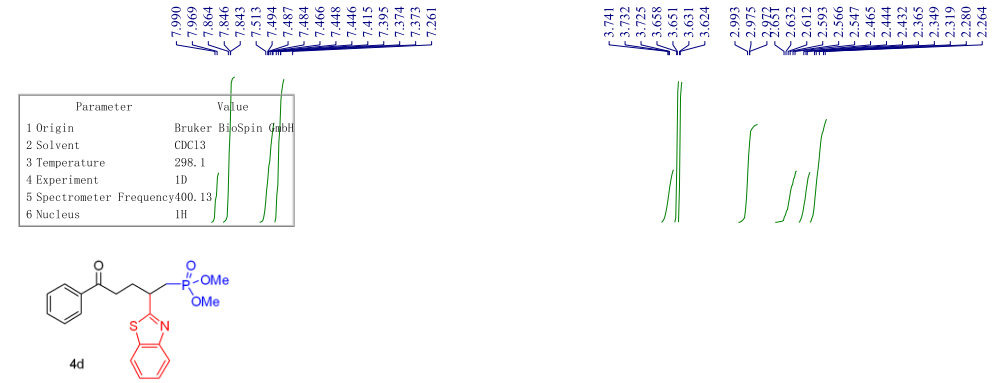


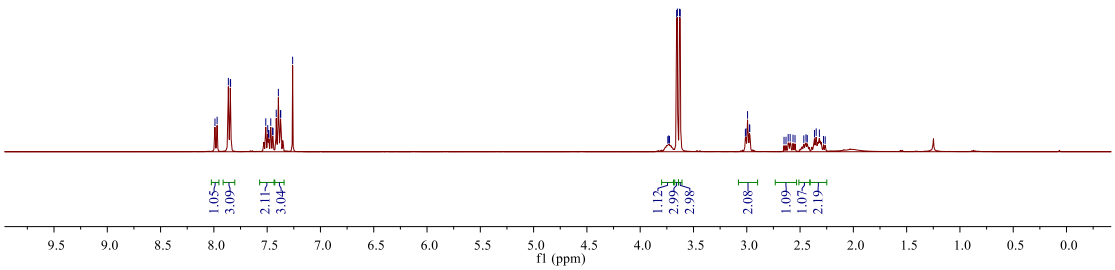
4c

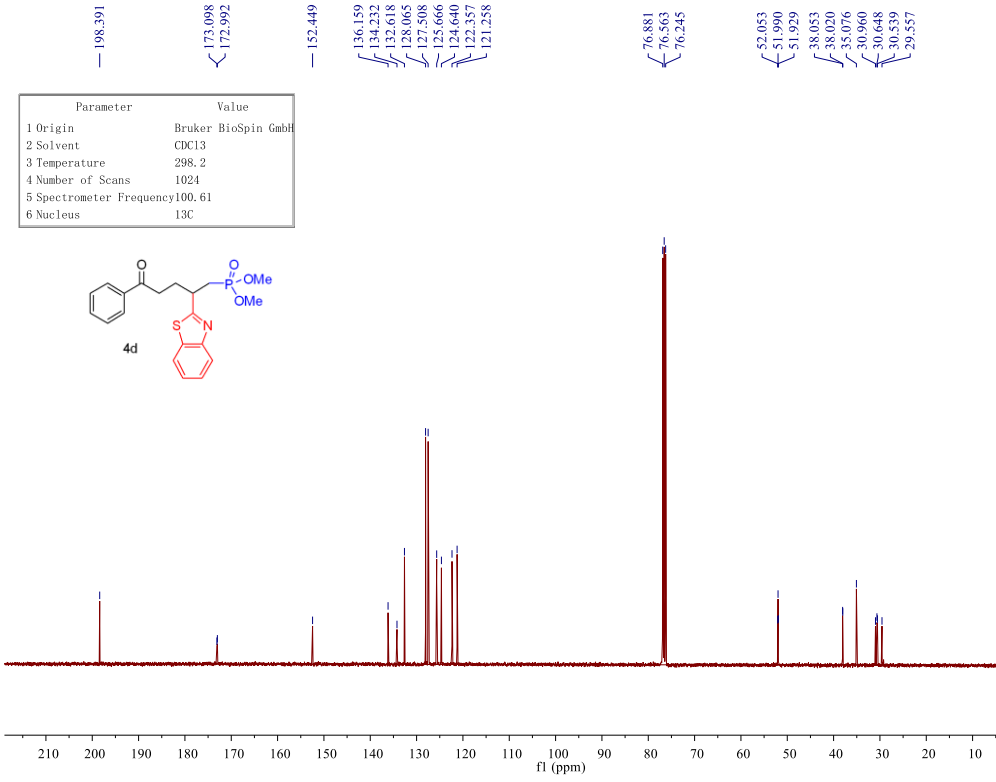



198.745
173.521
173.426
152.900
136.645
136.083
136.026
135.967
134.747
133.047
128.517
128.505
128.470
128.345
128.308
127.986
127.943
127.871
126.083
125.042
122.840
121.712
77.387
77.070
76.752
67.393
67.358
67.329
67.295
38.613
38.579
35.545
32.779
31.377
31.350
31.228
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
O
O
P
OBn
OBn
S
N
4c
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


29.181
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 2
5 Spectrometer Frequency 161.97
6 Nucleus 31P
O
O
P
OBn
OBn
S
N
4c
130 110 90 80 70 60 50 40 30 20 10 0 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)

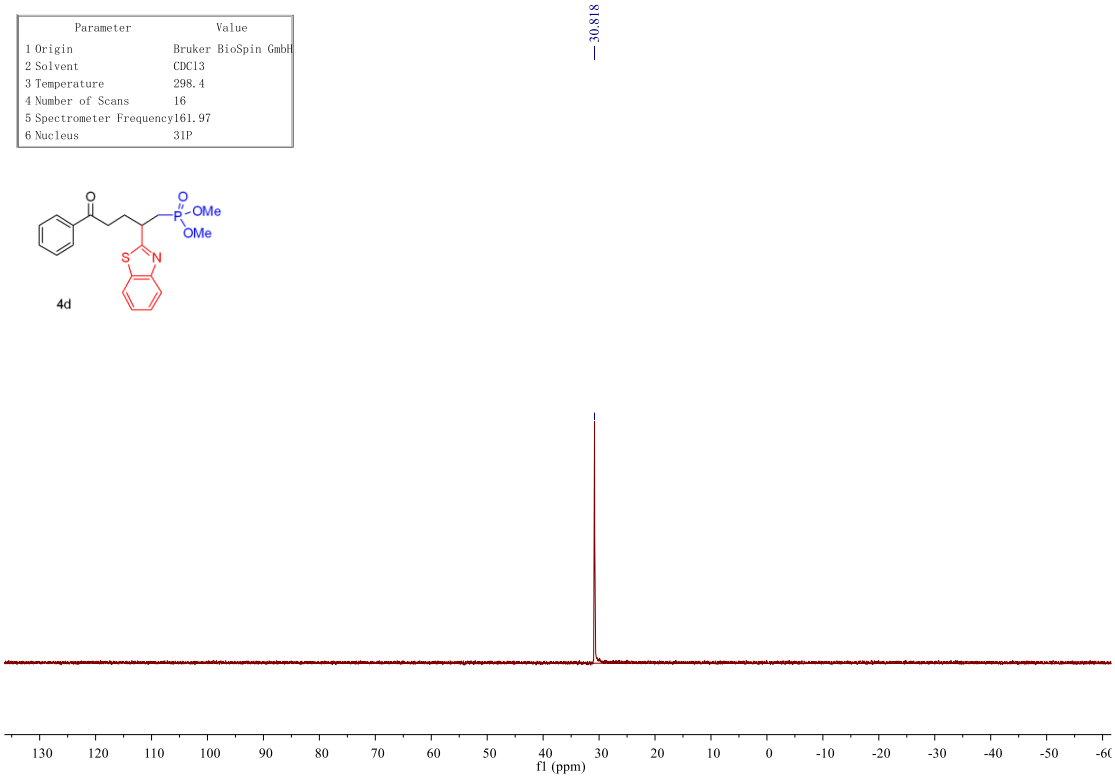

7.990
7.969
7.864
7.846
7.843
7.513
7.494
7.487
7.484
7.466
7.448
7.446
7.415
7.395
7.374
7.373
7.261
3.741
3.732
3.725
3.658
3.651
3.631
3.624
2.993
2.975
2.972
2.651
2.632
2.612
2.593
2.566
2.547
2.465
2.444
2.432
2.365
2.349
2.319
2.280
2.264
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Experiment 1D
5 Spectrometer Frequency 400.13
6 Nucleus 1H
OMe
OMe
4d


1.05
3.09
2.11
3.04
1.12
2.99
2.98
2.08
1.09
1.07
2.19
f1 (ppm)

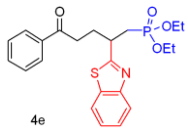

198.391
173.098
172.992
152.449
136.159
134.232
132.618
128.065
127.508
125.666
124.640
122.357
121.258
76.881
76.563
76.245
52.053
51.990
51.929
38.053
38.020
35.076
30.960
30.648
30.539
29.557
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 1024
5 Spectrometer Frequency 100.61
6 Nucleus 13C
OMe
OMe
4d
f1 (ppm)

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.4
4 Number of Scans	16
5 Spectrometer Frequency	161.97
6 Nucleus	31P

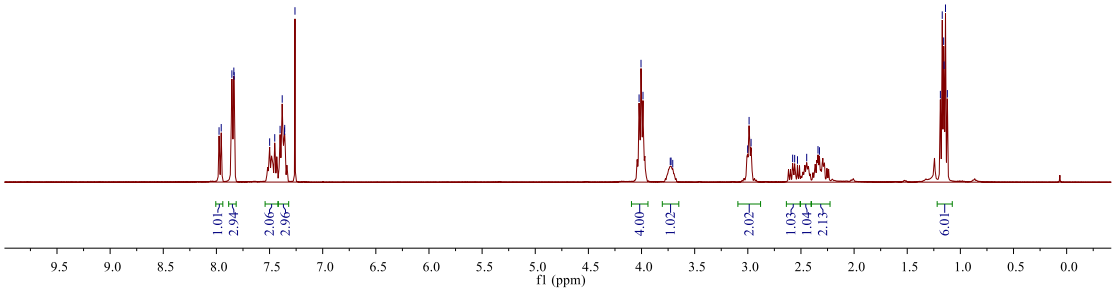
4d

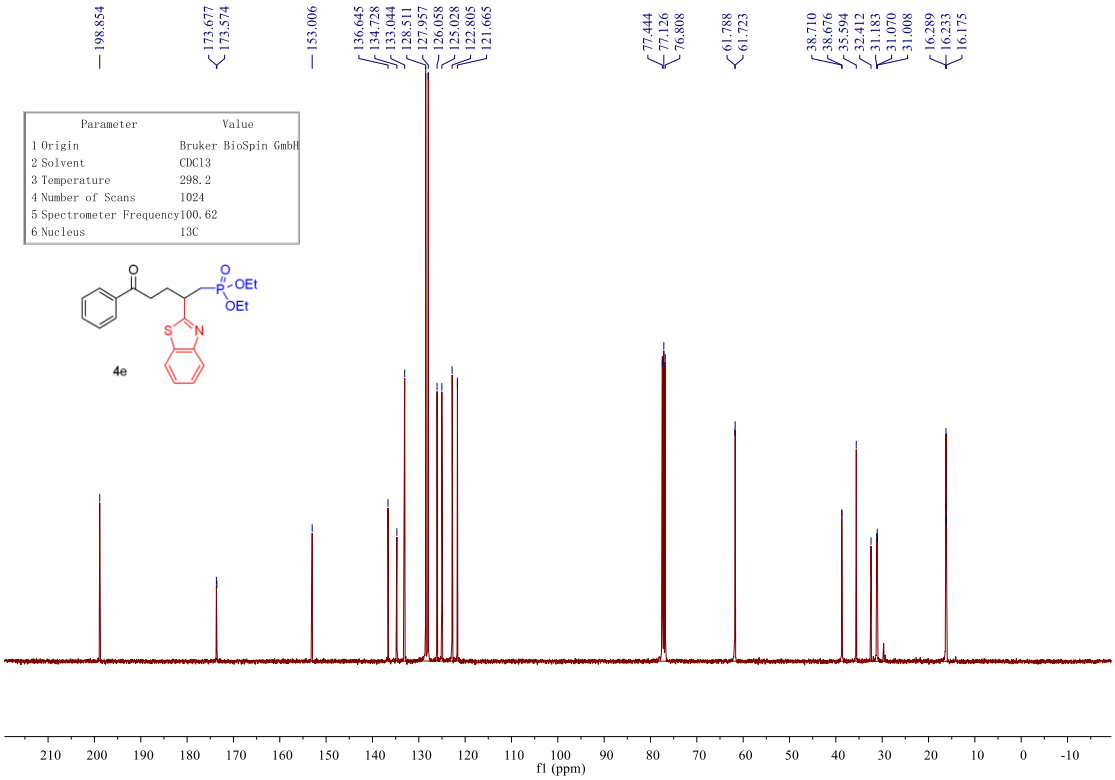


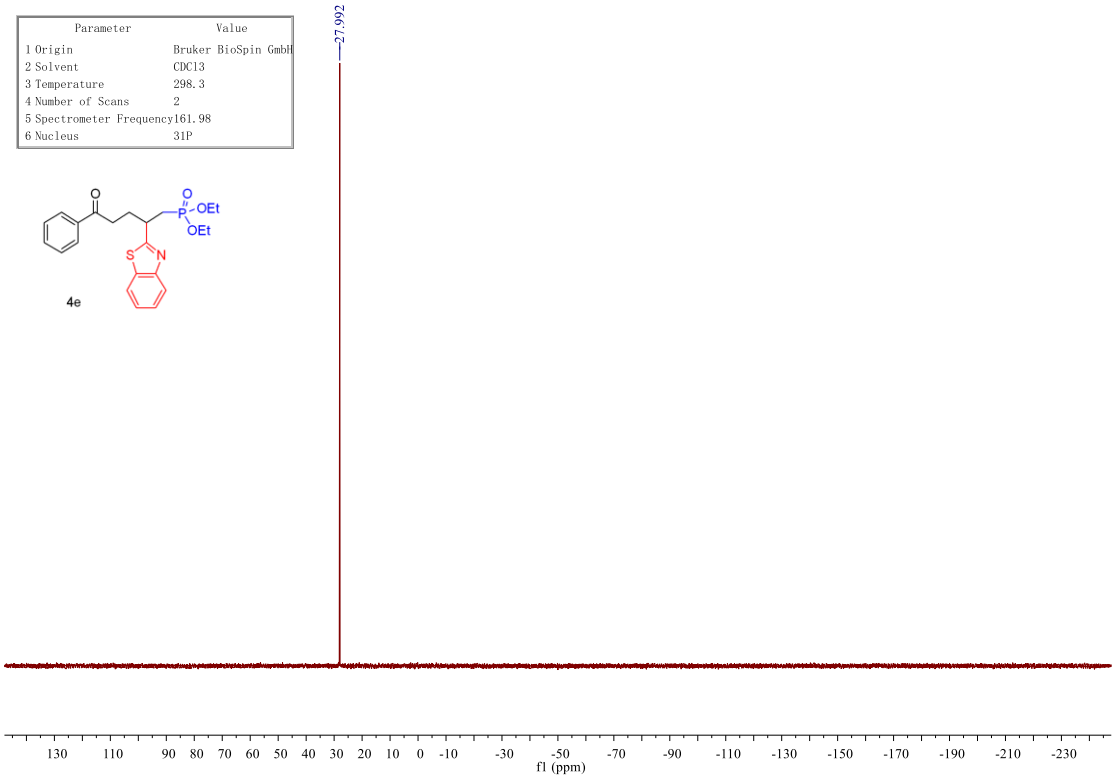
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.1
4 Number of Scans	2
5 Spectrometer Frequency	400.13
6 Nucleus	1H

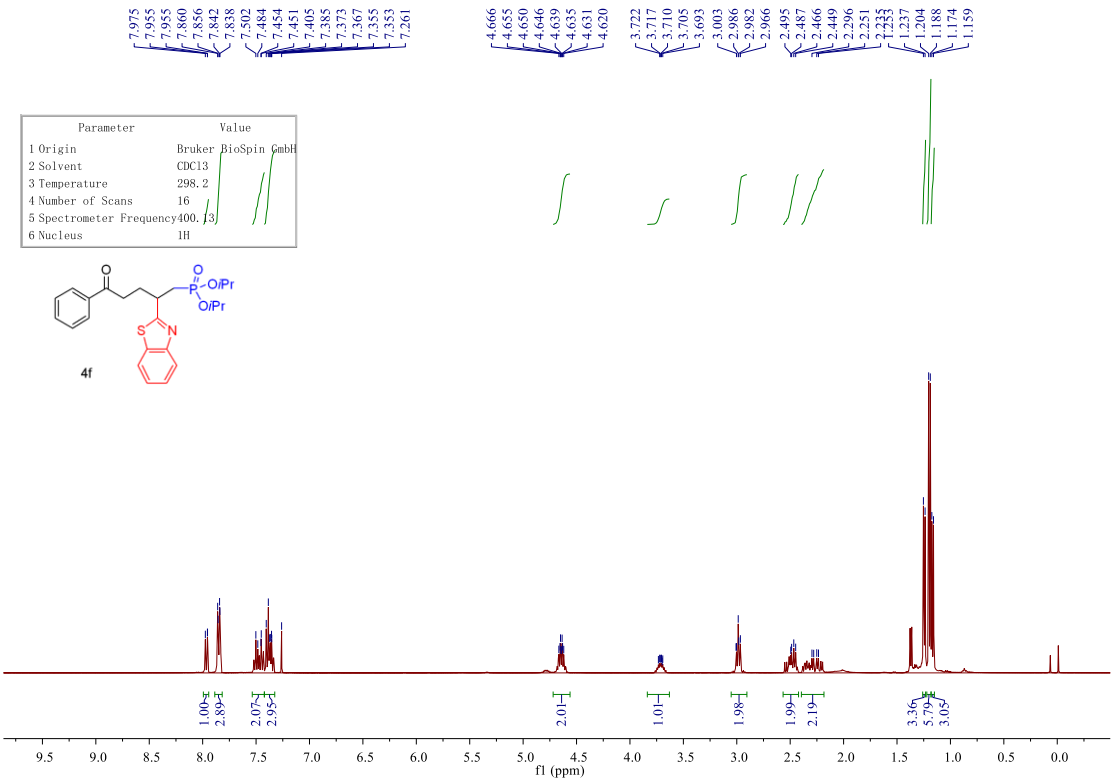


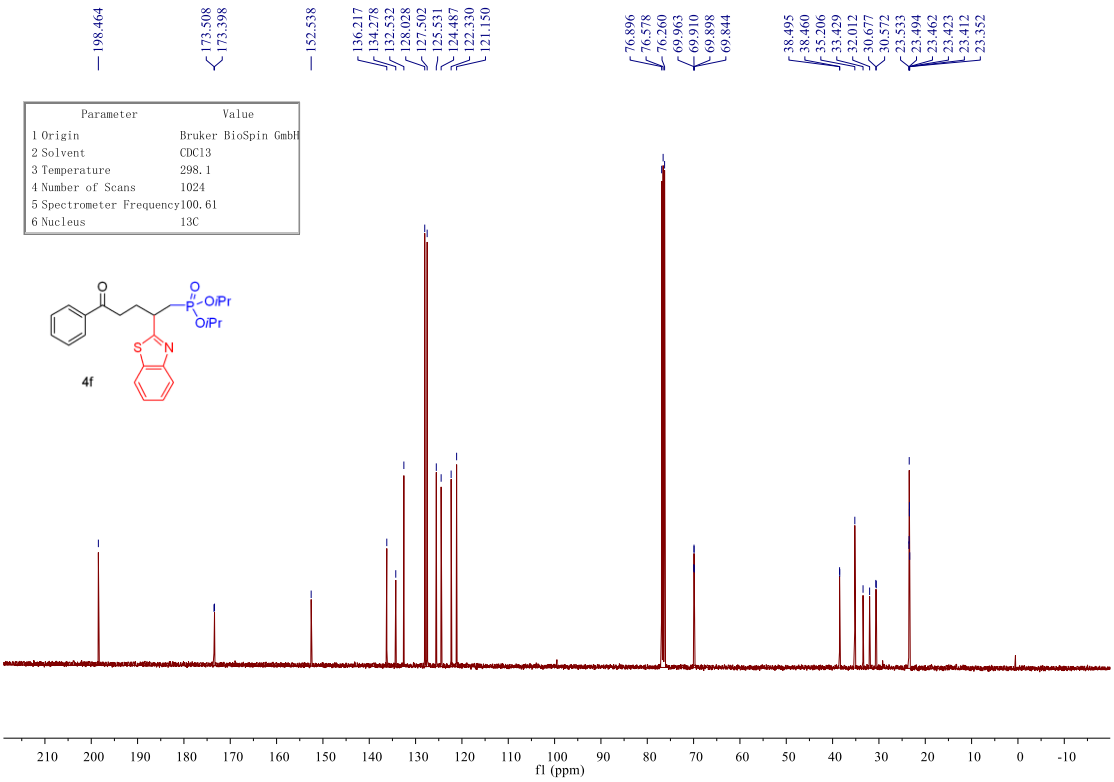
4e




198.854
173.677
173.574
153.006
136.645
134.728
133.044
128.511
127.957
126.058
125.028
122.805
121.665
77.444
77.126
76.808
61.788
61.723
38.710
38.676
35.594
32.412
31.183
31.070
31.008
16.289
16.233
16.175
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
O
P
OEt
OEt
S
N
4e
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

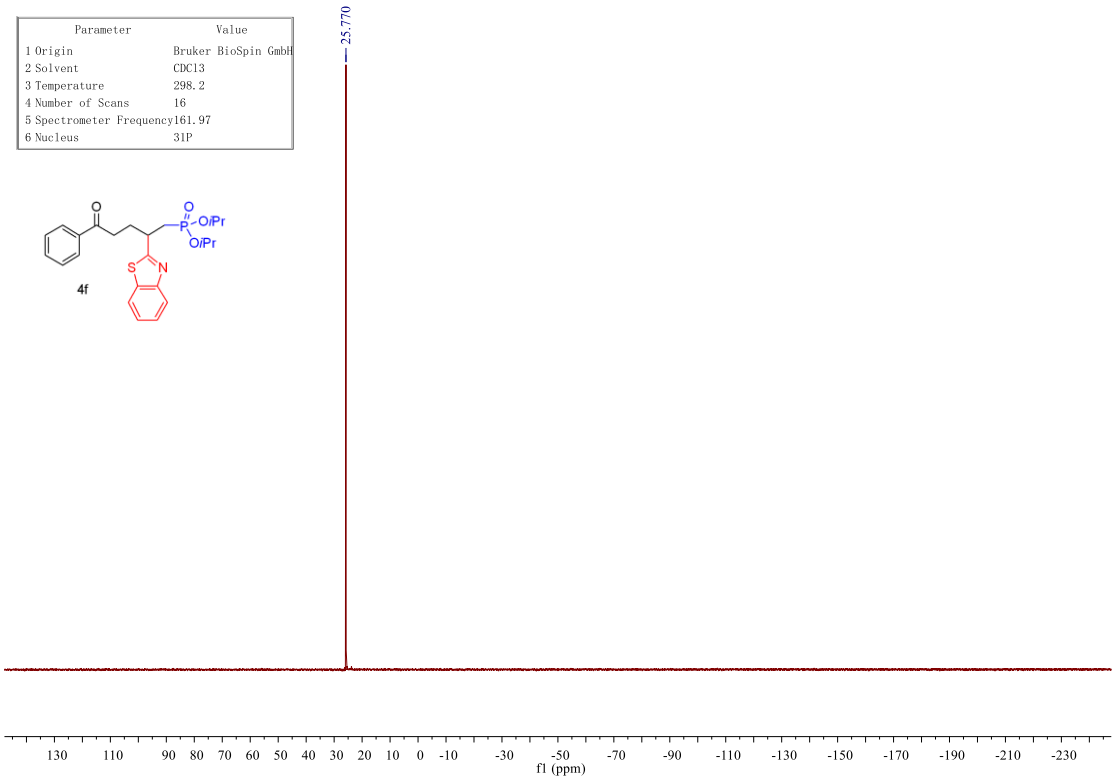

27.992
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.3
4 Number of Scans 2
5 Spectrometer Frequency 161.98
6 Nucleus 31P
O
P
OEt
OEt
S
N
4e
130 110 90 80 70 60 50 40 30 20 10 0 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)


7.975
7.955
7.955
7.860
7.856
7.842
7.838
7.502
7.484
7.454
7.451
7.405
7.385
7.373
7.367
7.355
7.353
7.261
4.666
4.655
4.650
4.646
4.639
4.635
4.631
4.620
3.722
3.717
3.710
3.705
3.693
3.003
2.986
2.982
2.966
2.495
2.487
2.466
2.449
2.296
2.251
2.235
1.253
1.237
1.204
1.188
1.174
1.159
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 16
5 Spectrometer Frequency 400.13
6 Nucleus 1H
O
O
P
O/Pr
O/Pr
S
N
4f
1.00
2.89
2.07
2.95
2.01
1.01
1.98
1.99
2.19
3.36
5.79
3.05
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

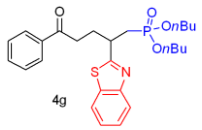

198.464
173.508
173.398
152.538
136.217
134.278
132.532
128.028
127.502
125.531
124.487
122.330
121.150
76.896
76.578
76.260
69.963
69.910
69.898
69.844
38.495
38.460
35.206
33.429
32.012
30.677
30.572
23.533
23.494
23.462
23.423
23.412
23.352
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.61
6 Nucleus 13C
O
O
P
O/Pr
O/Pr
S
N
4f
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	16
5 Spectrometer Frequency	161.97
6 Nucleus	31P

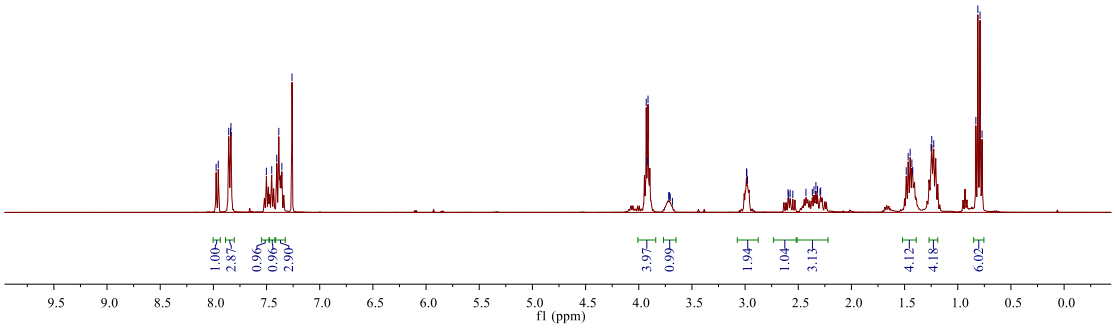
4f

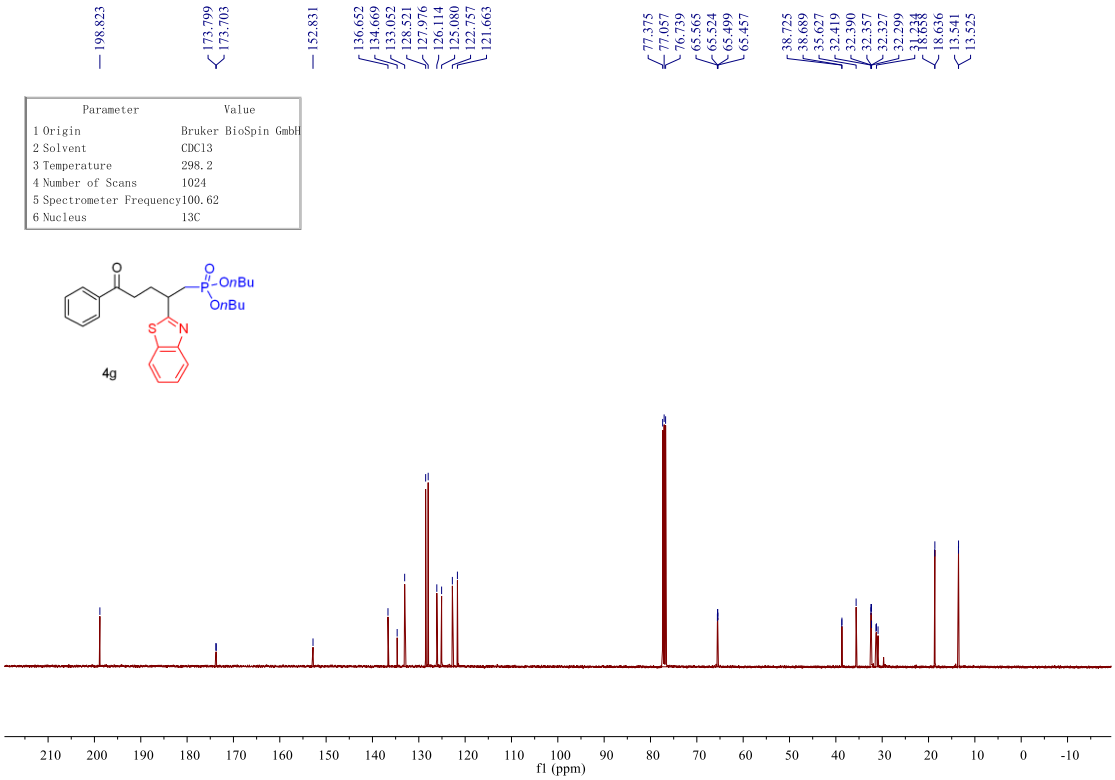


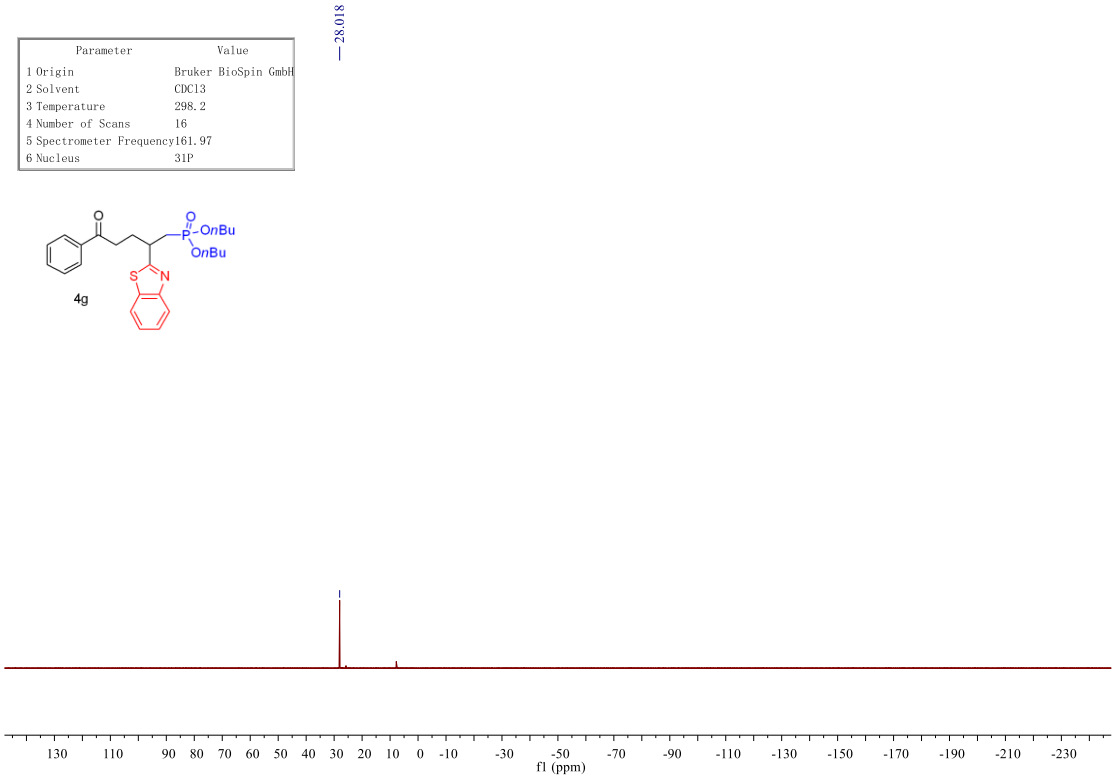
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.1
4 Number of Scans	16
5 Spectrometer Frequency	400.13
6 Nucleus	1H



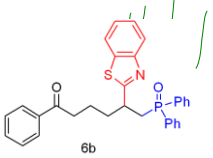
4g



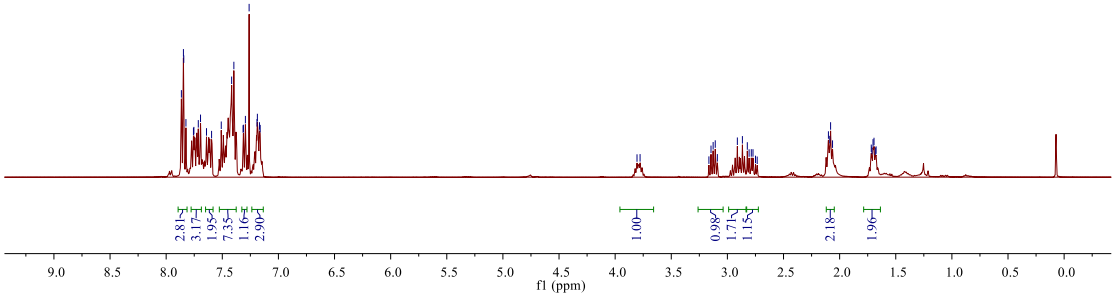

198.823
173.799
173.703
152.831
136.652
134.669
133.052
128.521
127.976
126.114
125.080
122.757
121.663
77.375
77.057
76.739
65.565
65.524
65.499
65.457
38.725
38.689
35.627
32.419
32.390
32.357
32.327
32.299
18.636
13.541
13.525
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
OnBu
OnBu
4g
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


28.018
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 16
5 Spectrometer Frequency 161.97
6 Nucleus 31P
OnBu
OnBu
4g
130 110 90 80 70 60 50 40 30 20 10 0 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)

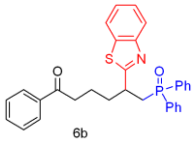
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	16
5 Spectrometer Frequency	400.13
6 Nucleus	1H



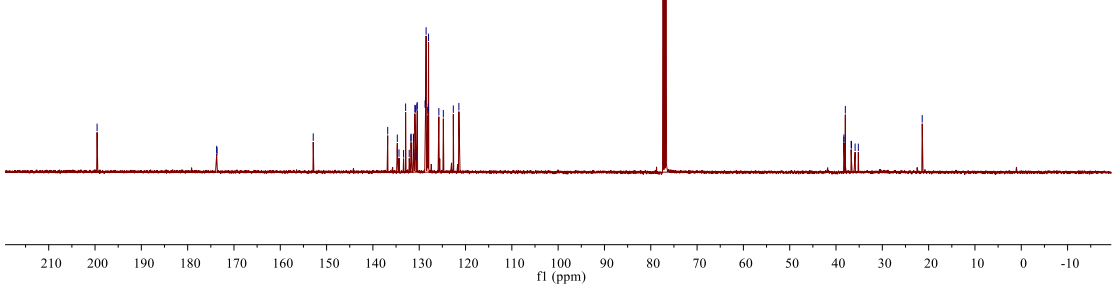
6b



Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	1024
5 Spectrometer Frequency	100.62
6 Nucleus	13C

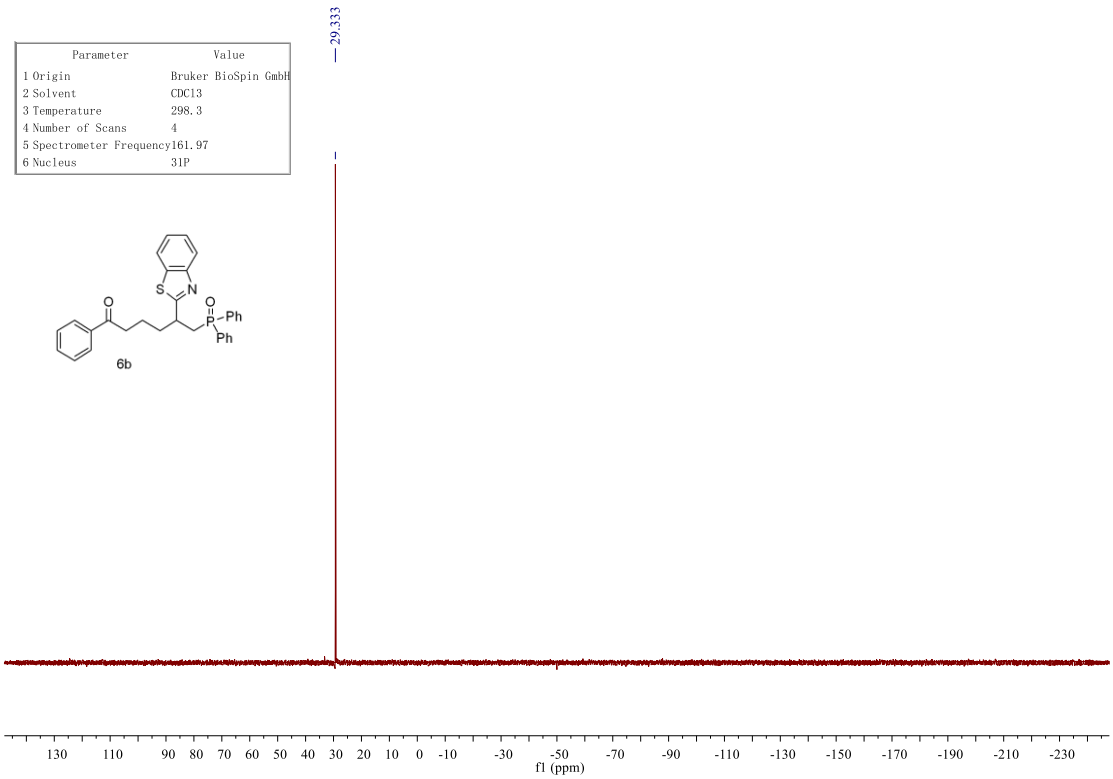


6b

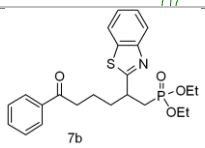


Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.3
4 Number of Scans	4
5 Spectrometer Frequency	161.97
6 Nucleus	31P

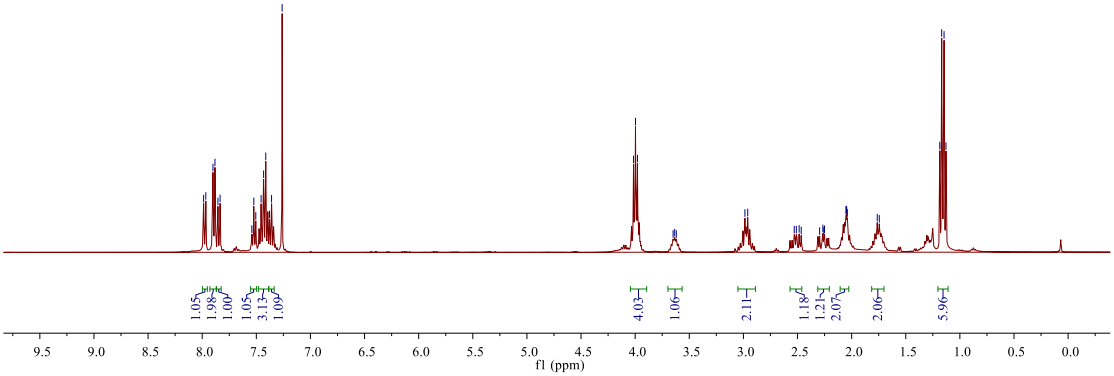
6b

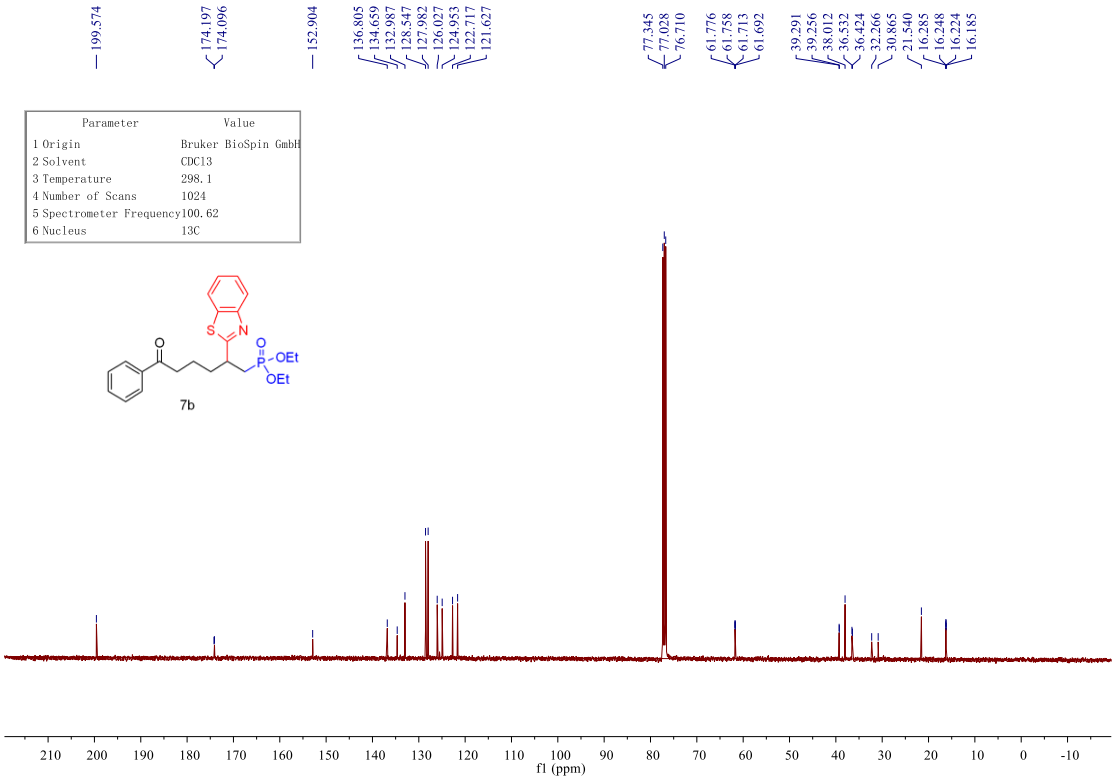


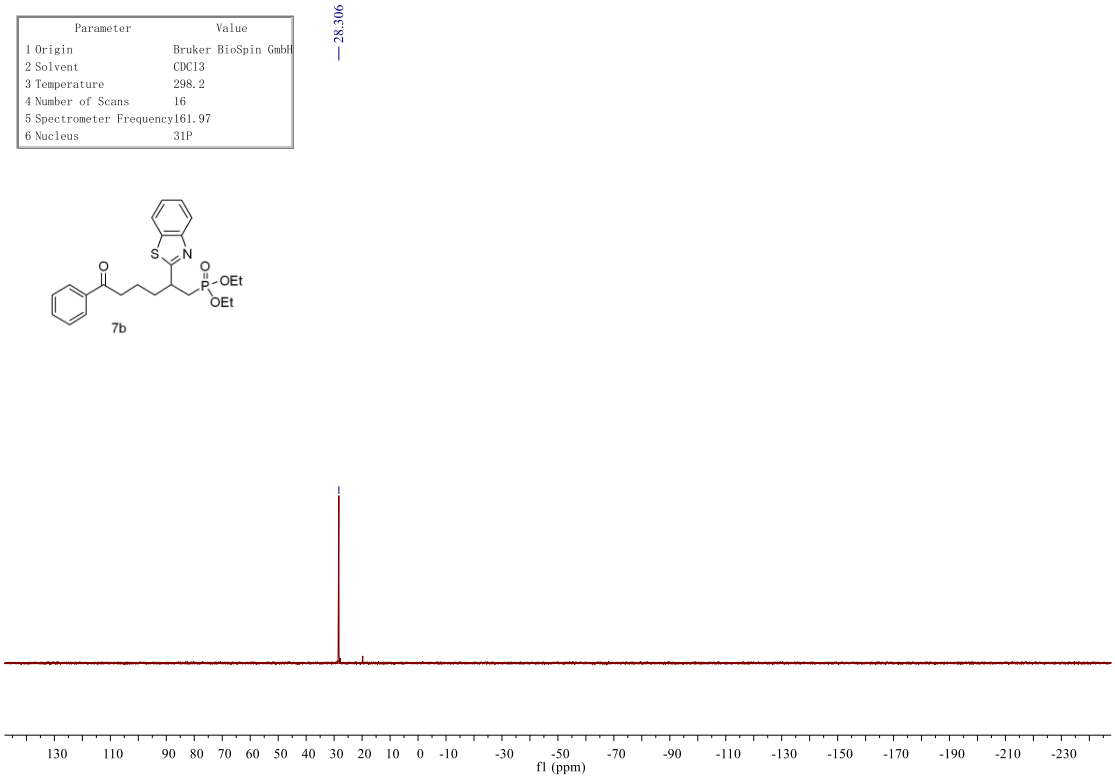
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.1
4 Number of Scans	16
5 Spectrometer Frequency	400.13
6 Nucleus	1H

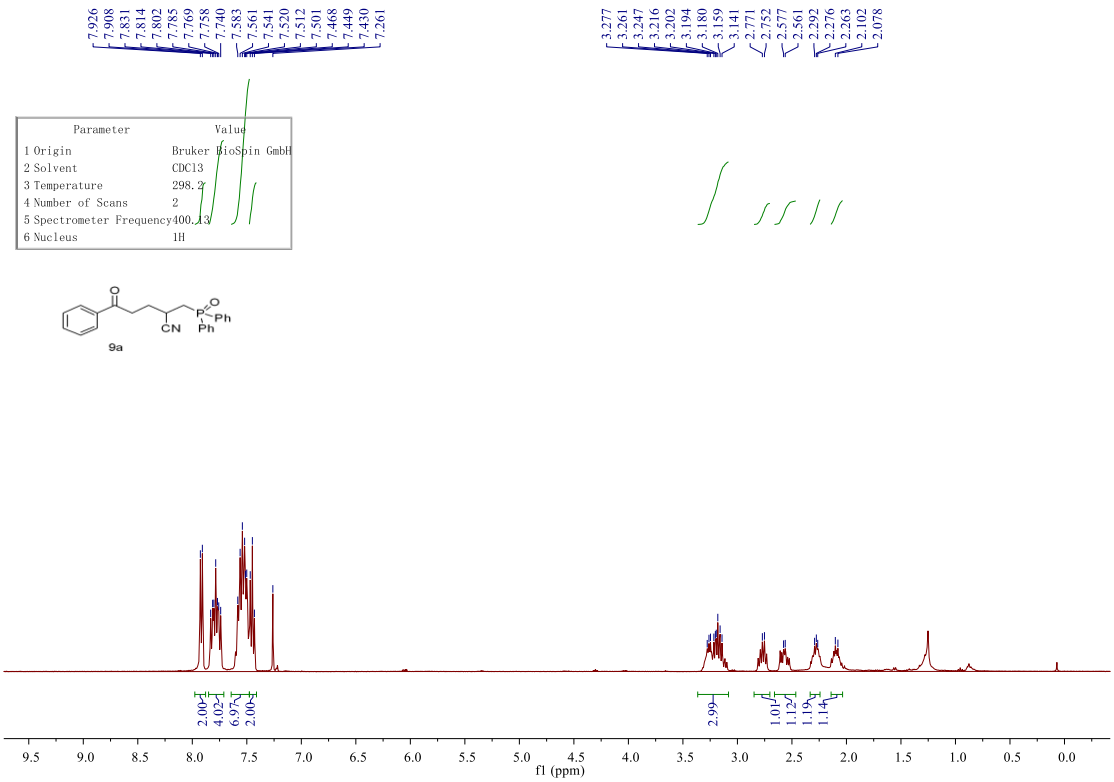


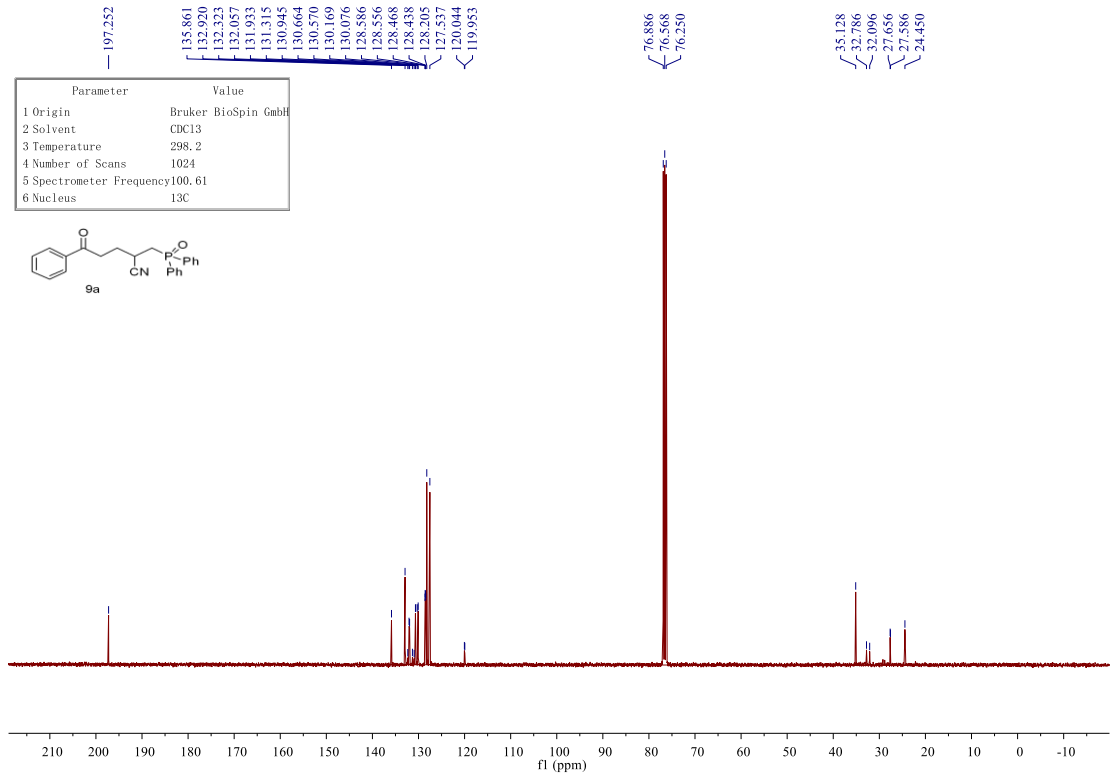
7b




199.574
174.197
174.096
152.904
136.805
134.659
132.987
128.547
127.982
126.027
124.953
122.717
121.627
77.345
77.028
76.710
61.776
61.758
61.713
61.692
39.291
39.256
38.012
36.532
36.424
32.266
30.865
21.540
16.285
16.248
16.224
16.185
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
OEt
OEt
7b
f1 (ppm)

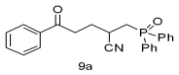

28.306
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 16
5 Spectrometer Frequency 161.97
6 Nucleus 31P
OEt
OEt
7b
f1 (ppm)


7.926
7.908
7.831
7.814
7.802
7.785
7.769
7.758
7.740
7.583
7.561
7.541
7.520
7.512
7.501
7.468
7.449
7.430
7.261
3.277
3.261
3.247
3.216
3.202
3.194
3.180
3.159
3.141
2.771
2.752
2.577
2.561
2.292
2.276
2.263
2.102
2.078
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
9a
2.00
4.02
6.97
2.00
2.99
1.01
1.12
1.19
1.14
f1 (ppm)

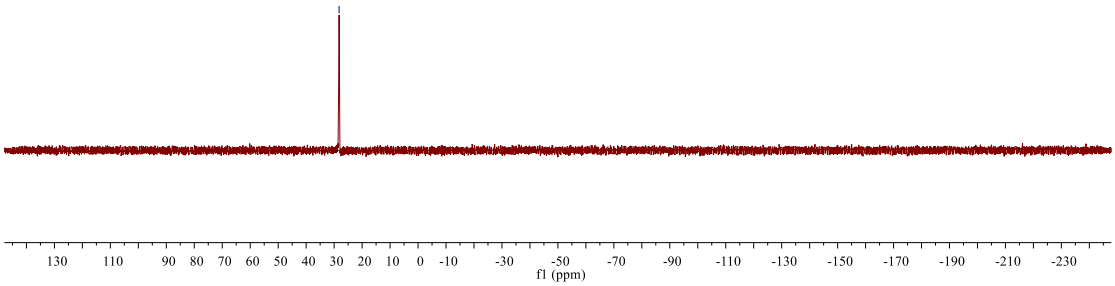

197.252
135.861
132.920
132.323
132.057
131.933
131.315
130.945
130.664
130.570
130.169
130.076
128.586
128.556
128.468
128.438
128.205
127.537
120.044
119.953
76.886
76.568
76.250
35.128
32.786
32.096
27.656
27.586
24.450
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 1024
5 Spectrometer Frequency 100.61
6 Nucleus 13C
9a
f1 (ppm)

28.229

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.3
4 Number of Scans	2
5 Spectrometer Frequency	161.97
6 Nucleus	31P



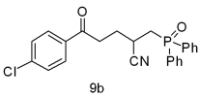
9a



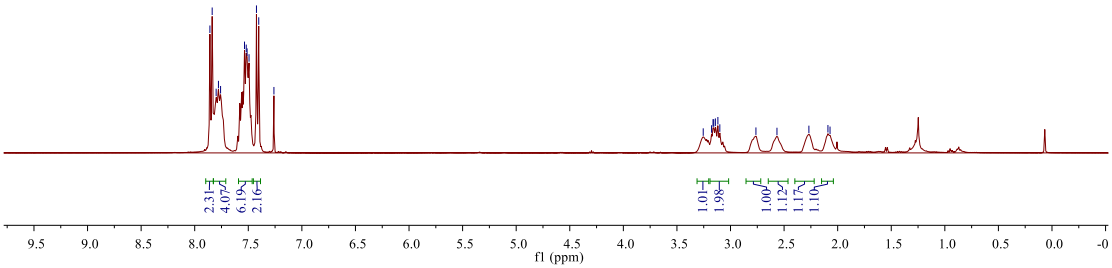
7.858
7.837
7.800
7.778
7.759
7.535
7.519
7.511
7.493
7.424
7.403
7.261

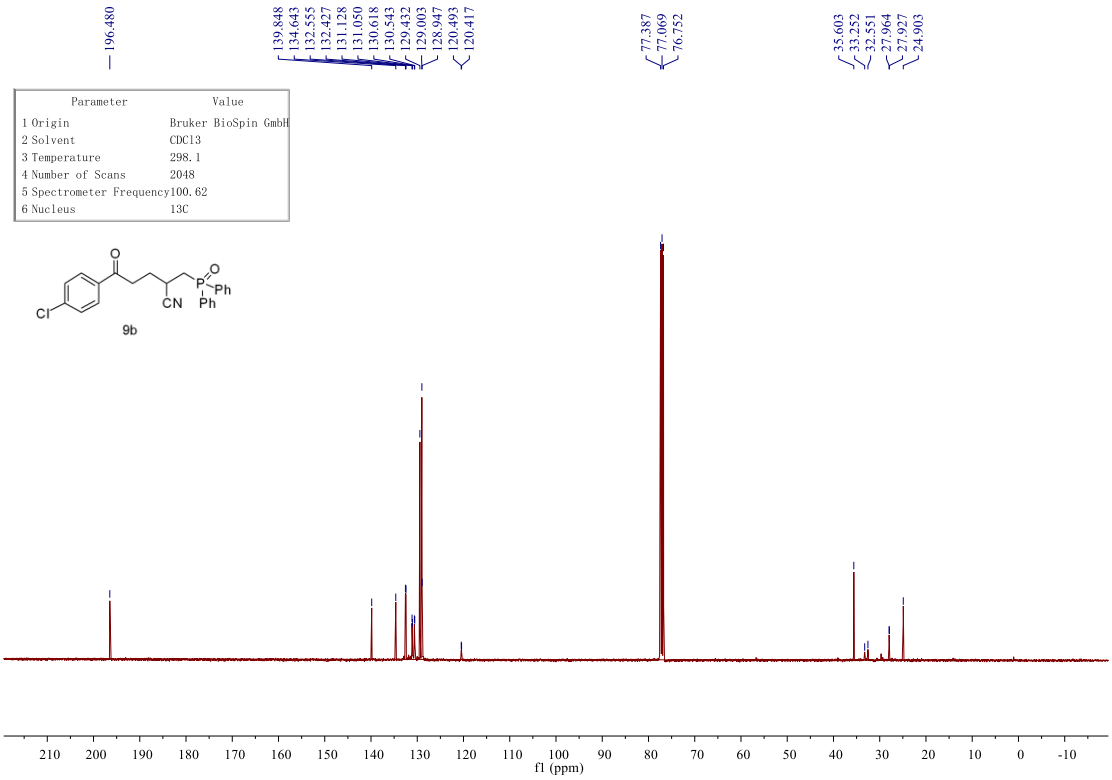
3.255
3.177
3.163
3.157
3.141
3.118
3.100
2.763
2.566
2.269
2.091
2.071

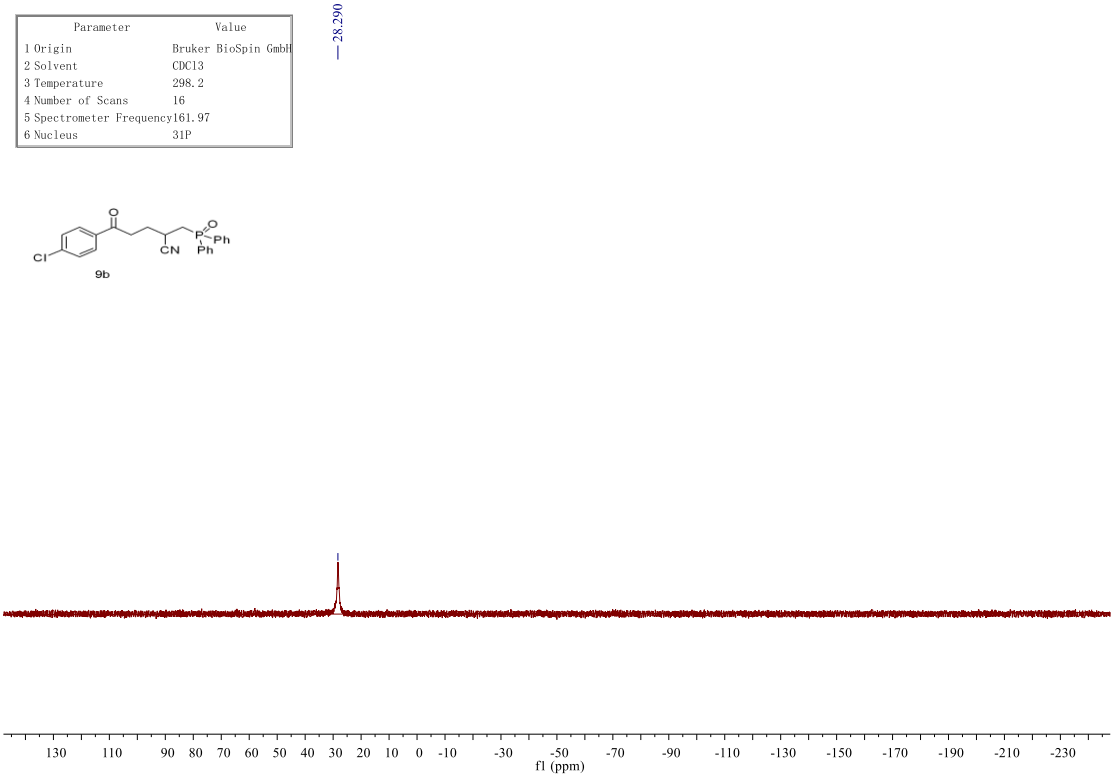
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	16
5 Spectrometer Frequency	400.13
6 Nucleus	1H

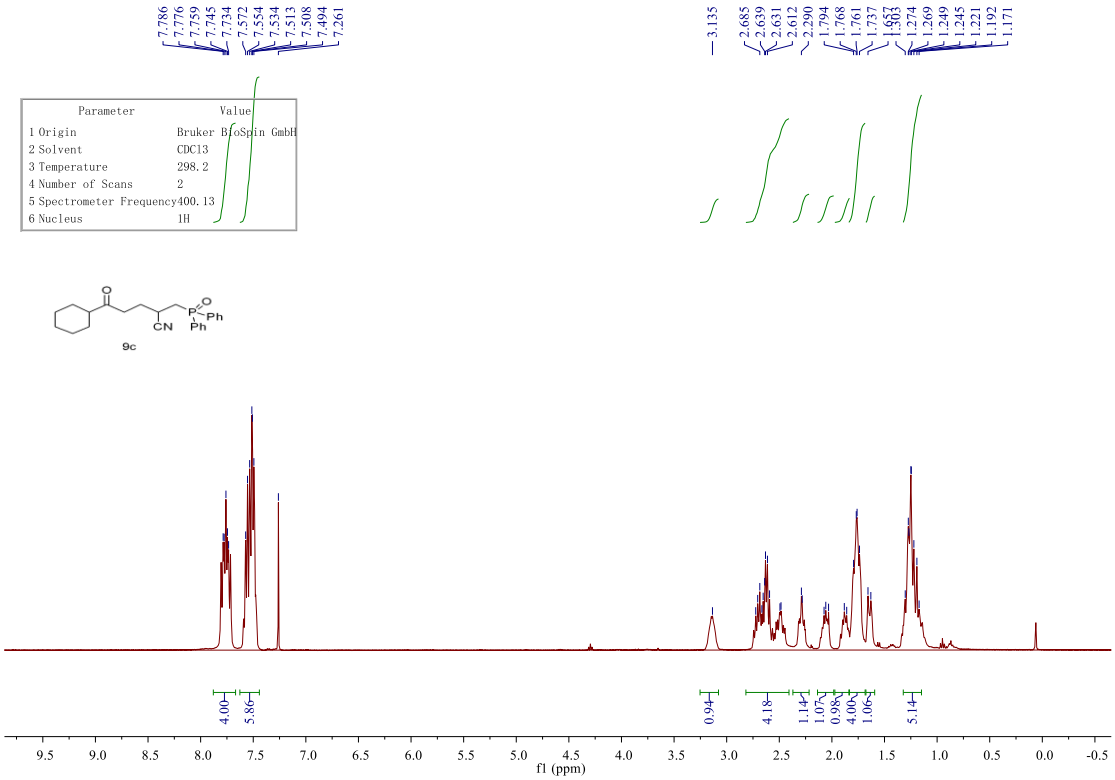


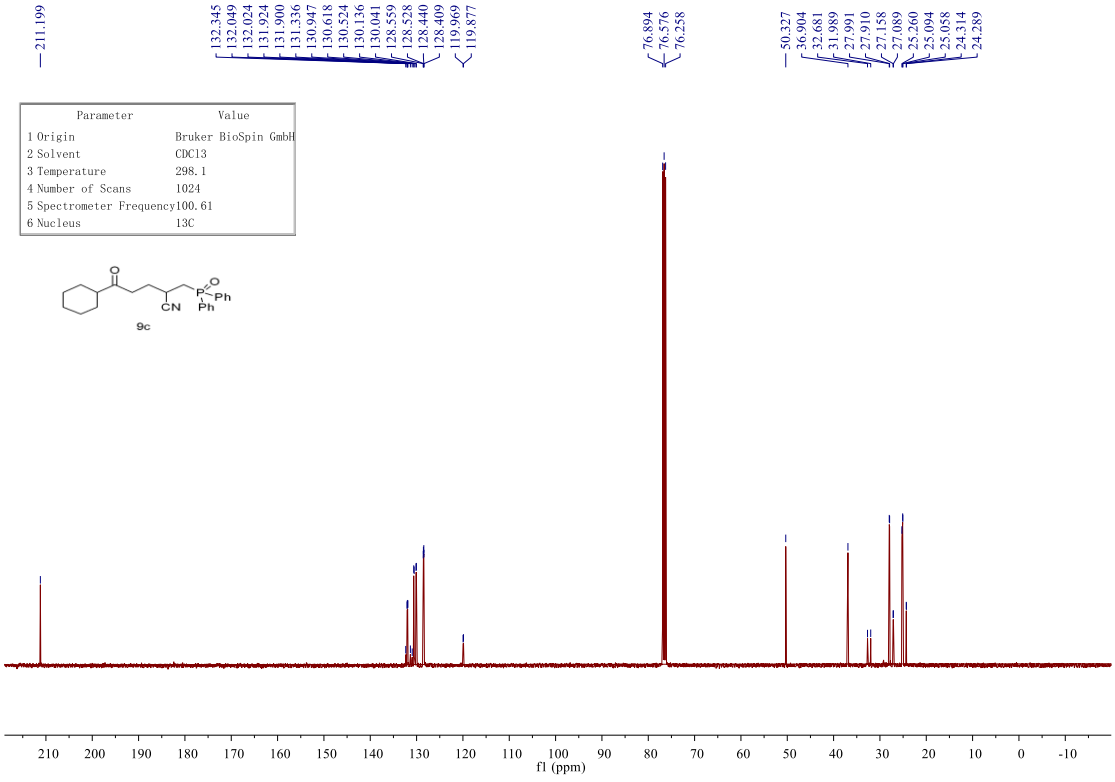
9b




196.480
139.848
134.643
132.555
132.427
131.128
131.050
130.618
130.543
129.432
129.003
128.947
120.493
120.417
77.387
77.069
76.752
35.603
33.252
32.551
27.964
27.927
24.903
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 2048
5 Spectrometer Frequency 100.62
6 Nucleus 13C
O
O
P
Ph
Ph
CN
Cl
9b
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

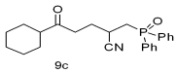

28.290
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 16
5 Spectrometer Frequency 161.97
6 Nucleus 31P
O
O
P
Ph
Ph
CN
Cl
9b
130 110 90 80 70 60 50 40 30 20 10 0 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)


7.786
7.776
7.759
7.745
7.734
7.572
7.554
7.534
7.513
7.508
7.494
7.261
3.135
2.685
2.639
2.631
2.612
2.290
1.794
1.768
1.761
1.737
1.274
1.269
1.249
1.245
1.221
1.192
1.171
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
CN
P
O
Ph
Ph
9c
4.00
5.86
0.94
4.18
1.14
1.07
0.98
4.00
1.06
5.14
f1 (ppm)

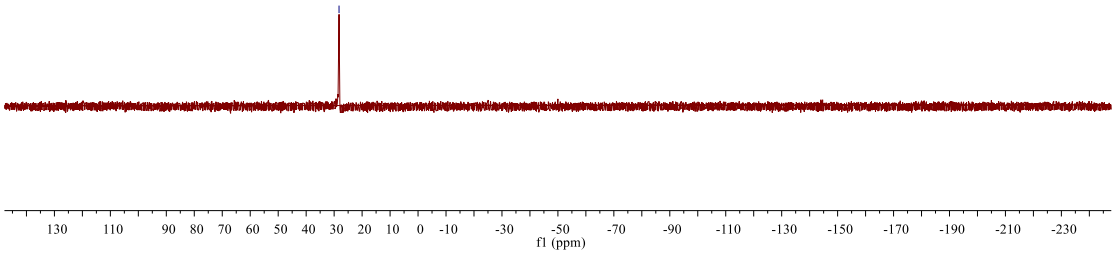

211.199
132.345
132.049
132.024
131.924
131.900
131.336
130.947
130.618
130.524
130.136
130.041
128.559
128.528
128.440
128.409
119.969
119.877
76.894
76.576
76.258
50.327
36.904
32.681
31.989
27.991
27.910
27.158
27.089
25.260
25.094
25.058
24.314
24.289
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.61
6 Nucleus 13C
CN
P
O
Ph
Ph
9c
f1 (ppm)

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.3
4 Number of Scans	2
5 Spectrometer Frequency	161.97
6 Nucleus	31P

28.246



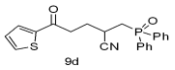
9c



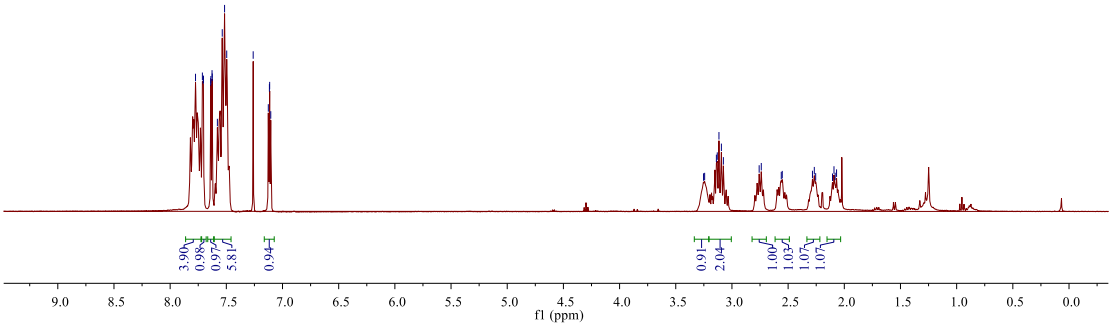
7.774
7.713
7.706
7.704
7.639
7.638
7.627
7.625
7.580
7.536
7.516
7.497
7.261
7.126
7.117
7.114
7.105

3.253
3.243
3.138
3.131
3.116
3.094
3.076
2.758
2.739
2.561
2.552
2.283
2.267
2.255
2.105
2.092
2.081
2.069

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.1
4 Number of Scans	2
5 Spectrometer Frequency	400.13
6 Nucleus	1H



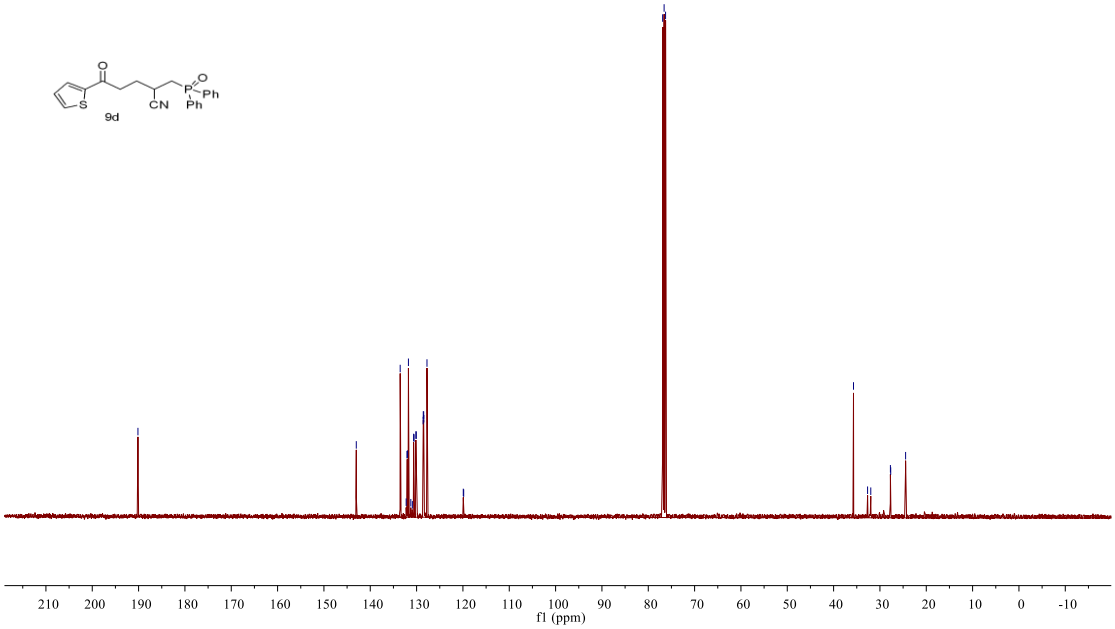
9d



Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	1024
5 Spectrometer Frequency	100.61
6 Nucleus	13C

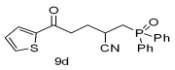
190.139
143.015
133.540
131.762
128.557
128.470
127.758
119.924
119.835
76.899
76.581
76.264
35.705
32.667
31.977
27.742
27.673
24.460

9d

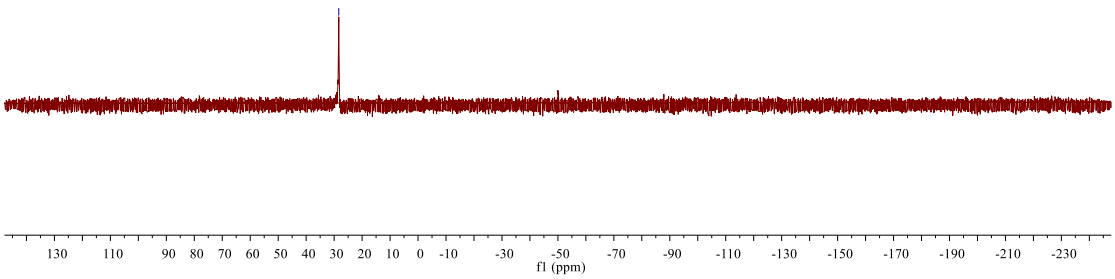


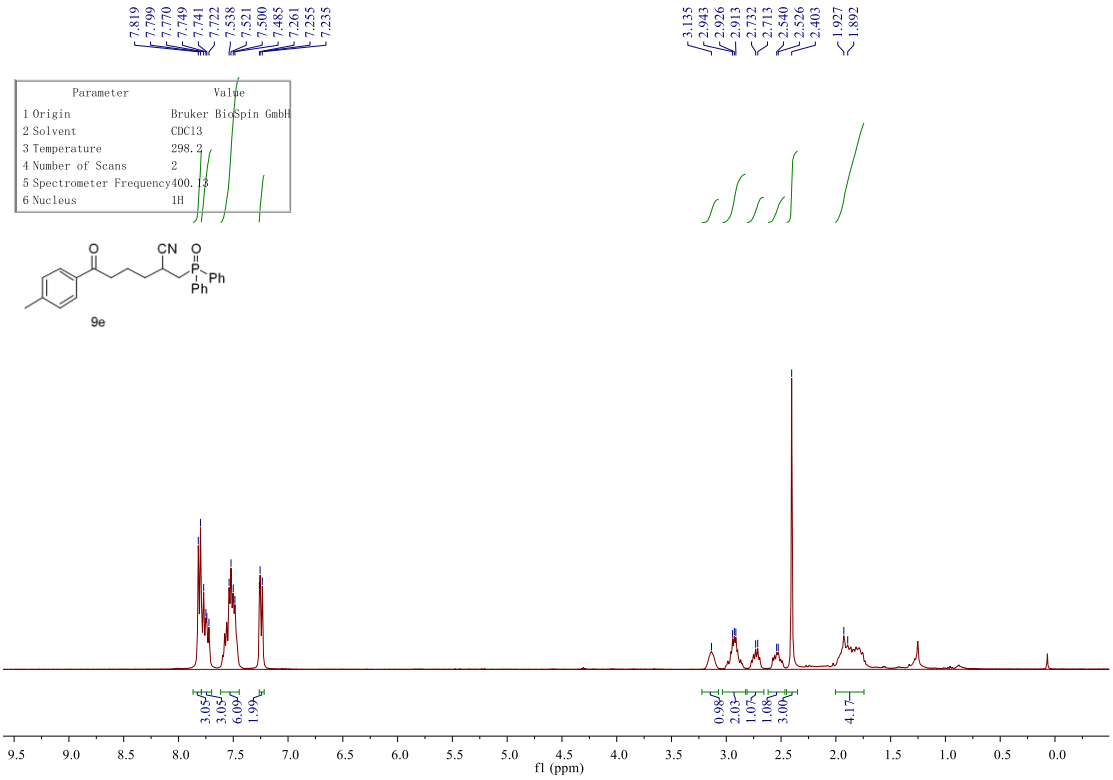
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.3
4 Number of Scans	2
5 Spectrometer Frequency	161.97
6 Nucleus	31P

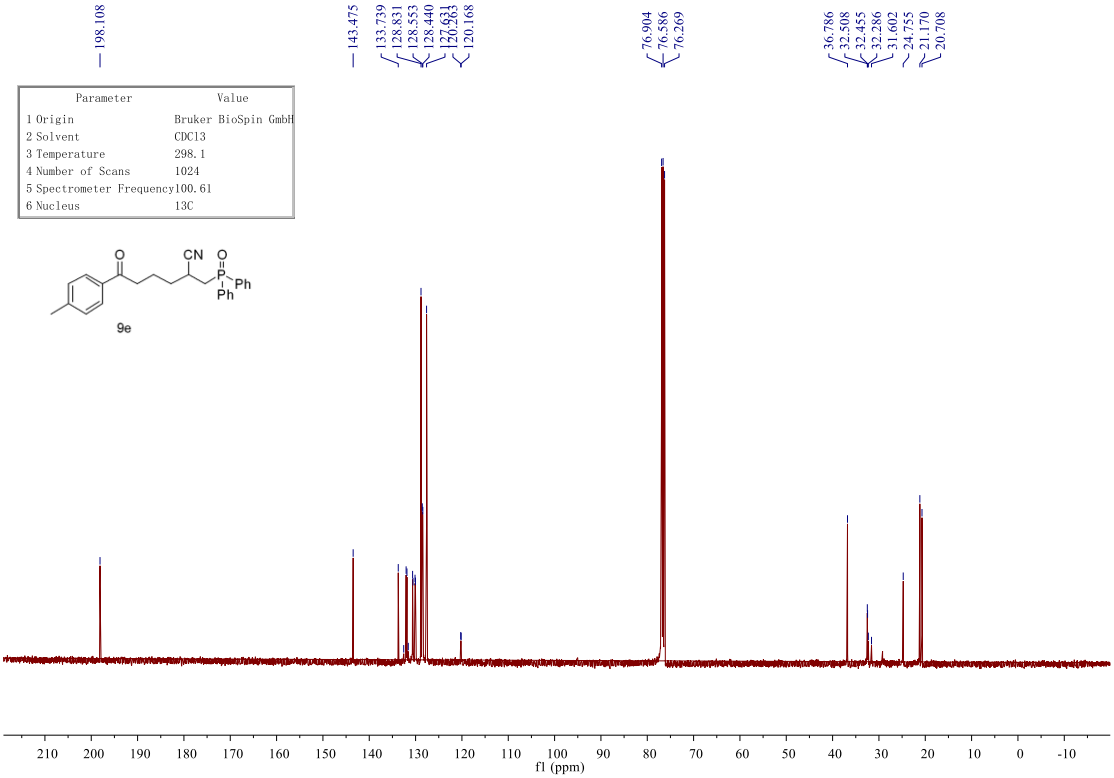
28.341



9d

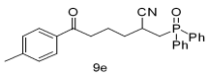



7.819
7.799
7.770
7.749
7.741
7.722
7.538
7.521
7.500
7.485
7.261
7.255
7.235
3.135
2.943
2.926
2.913
2.732
2.713
2.540
2.526
2.403
1.927
1.892
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
O
CN
O
P
Ph
Ph
9e
3.05
3.05
6.09
1.99
0.98
2.03
1.07
1.08
3.00
4.17
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

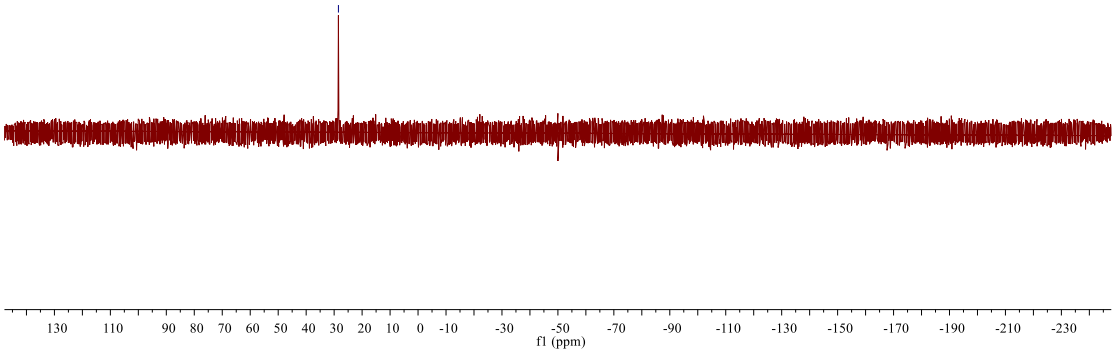

198.108
143.475
133.739
128.831
128.553
128.440
127.631
120.263
120.168
76.904
76.586
76.269
36.786
32.508
32.455
32.286
31.602
24.755
21.170
20.708
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.61
6 Nucleus 13C
O
CN
O
P
Ph
Ph
9e
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.3
4 Number of Scans	4
5 Spectrometer Frequency	161.97
6 Nucleus	31P

28.466



9e

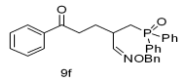


7.847 7.829 7.826 7.759 7.756 7.738 7.735 7.730 7.710 7.539 7.521 7.492 7.488 7.469 7.464 7.451 7.444 7.440 7.420 7.401 7.314 7.297 7.290 7.278 7.274 7.261 7.244

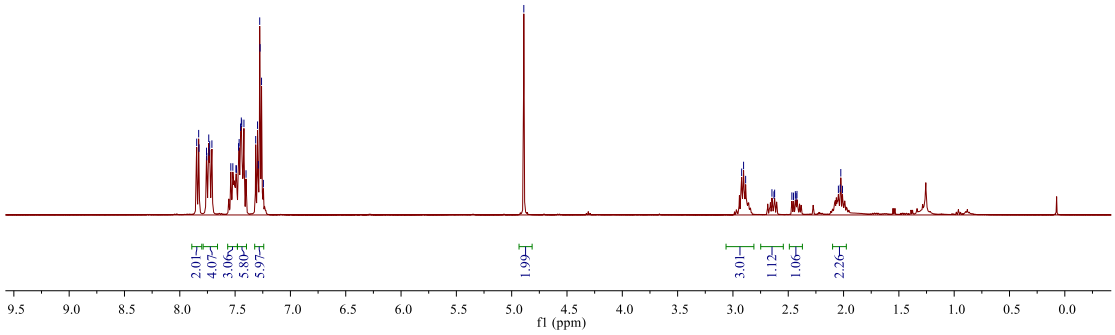
4.890

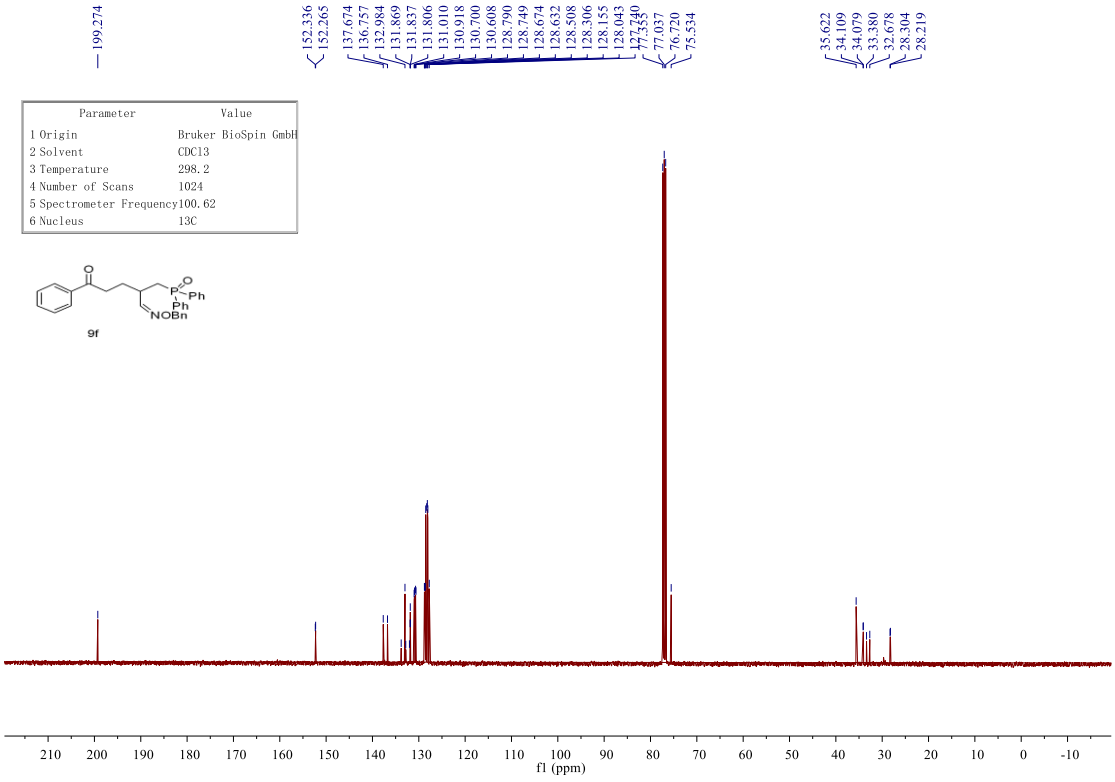
2.921 2.904 2.885 2.647 2.629 2.623 2.467 2.452 2.436 2.429 2.421 2.047 2.030 2.025 2.010

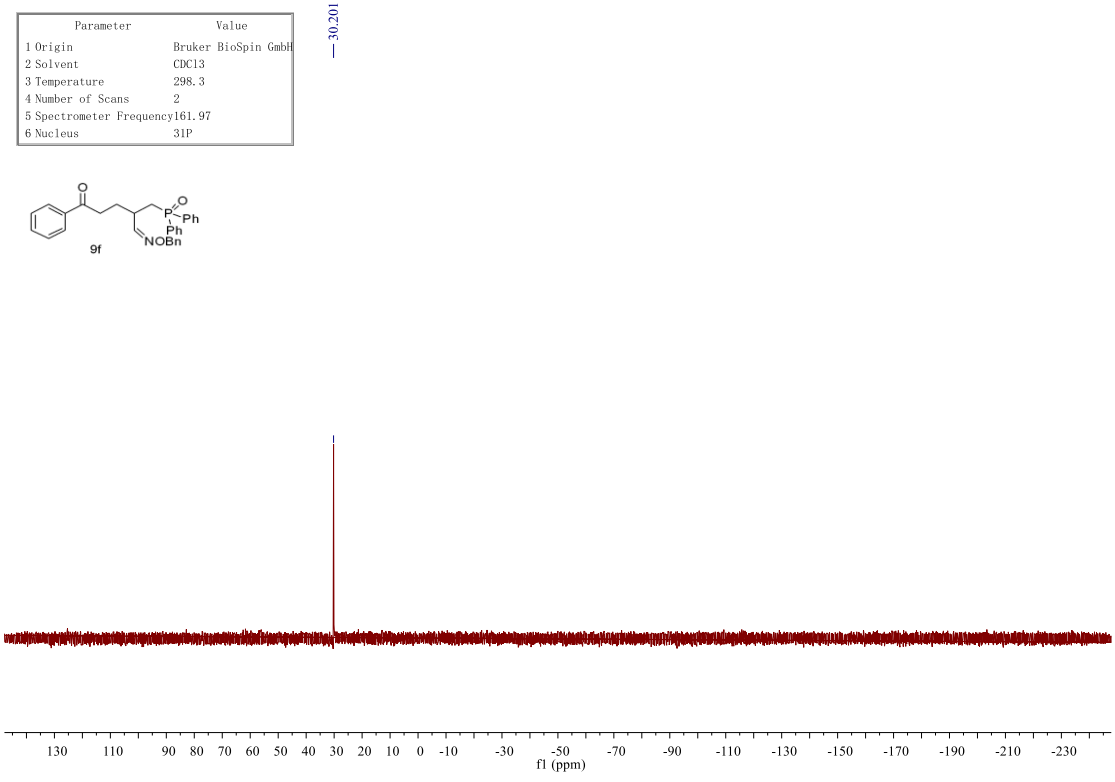
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	16
5 Spectrometer Frequency	400.13
6 Nucleus	1H

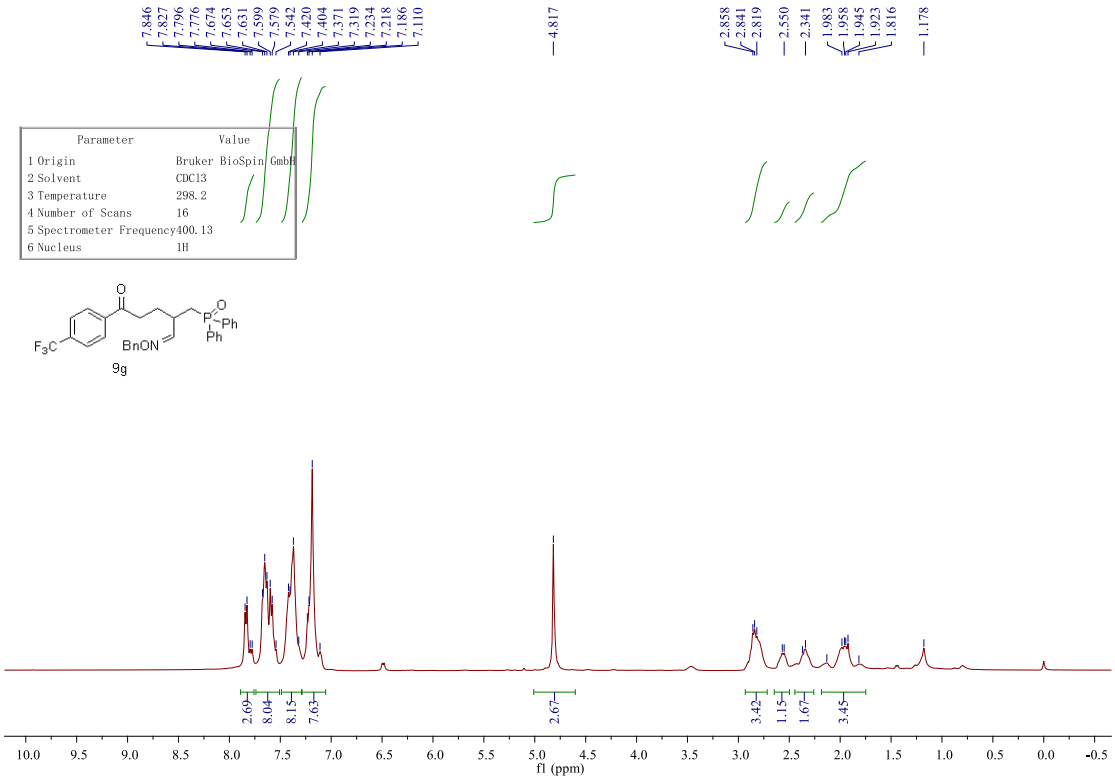


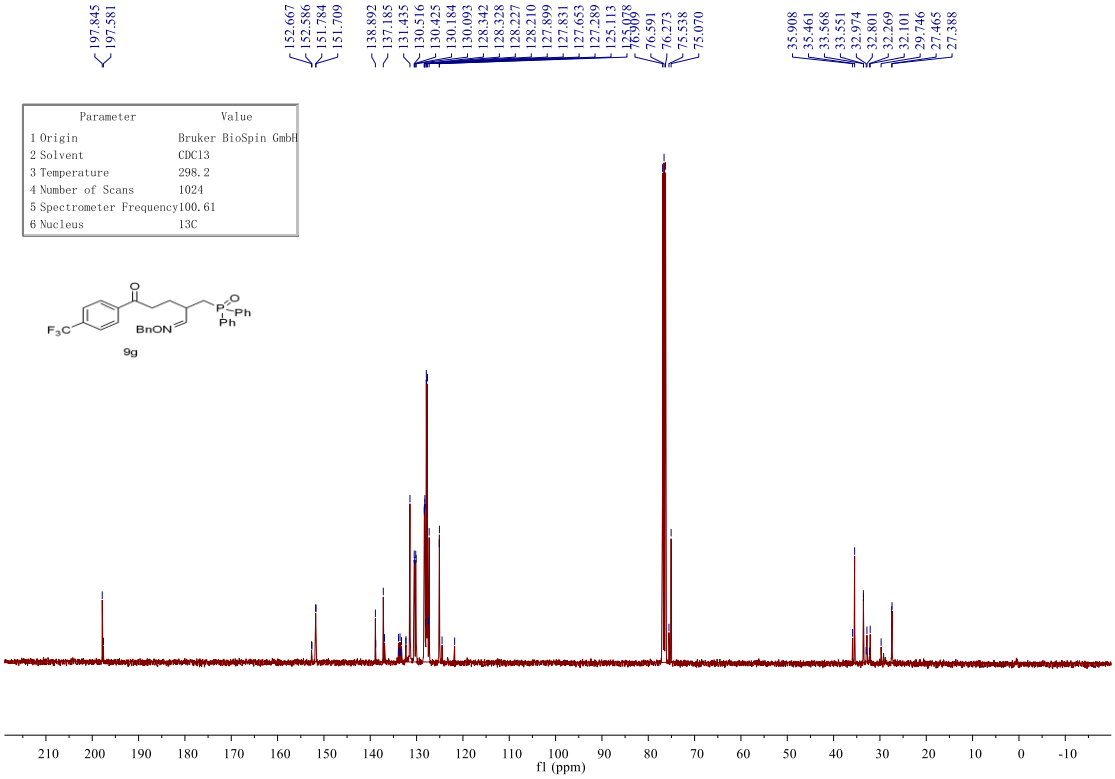
9f




199.274
152.336
152.265
137.674
136.757
132.984
131.869
131.837
131.806
131.010
130.918
130.700
130.608
128.790
128.749
128.674
128.632
128.508
128.306
128.155
128.043
77.037
76.720
75.534
35.622
34.109
34.079
33.380
32.678
28.304
28.219
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
9f
f1 (ppm)

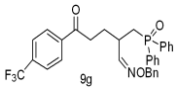

30.201
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.3
4 Number of Scans 2
5 Spectrometer Frequency 161.97
6 Nucleus 31P
9f
f1 (ppm)


7.846
7.827
7.796
7.776
7.674
7.653
7.631
7.599
7.579
7.542
7.420
7.404
7.371
7.319
7.234
7.218
7.186
7.110
4.817
2.858
2.841
2.819
2.550
2.341
1.983
1.958
1.945
1.923
1.816
1.178
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 16
5 Spectrometer Frequency 400.13
6 Nucleus 1H
O
P
O
Ph
Ph
F3C
BnON
9g
2.69
8.04
8.15
7.63
2.67
3.42
1.15
1.67
3.45
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

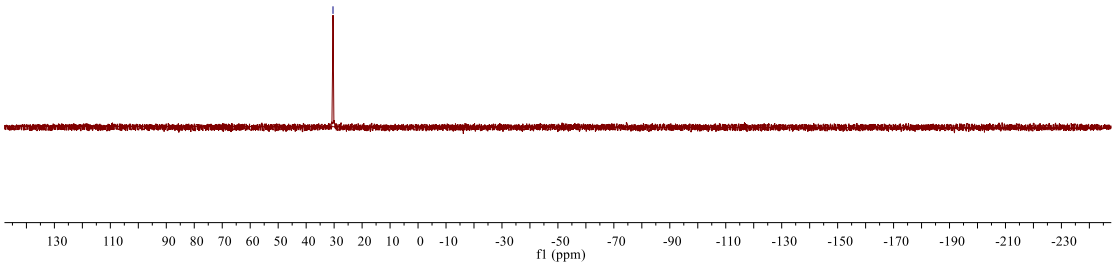

197.845
197.581
152.667
152.586
151.784
151.709
138.892
137.185
131.435
130.516
130.425
130.184
130.093
128.342
128.328
128.227
128.210
127.899
127.831
127.653
127.289
125.113
125.078
76.909
76.591
76.273
75.538
75.070
35.908
35.461
33.568
33.551
32.974
32.801
32.269
32.101
29.746
27.465
27.388
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 1024
5 Spectrometer Frequency 100.61
6 Nucleus 13C
O
P
O
Ph
Ph
F3C
BnON
9g
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.3
4 Number of Scans	2
5 Spectrometer Frequency	161.98
6 Nucleus	31P

30.404

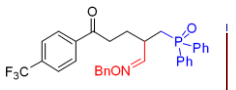


9g



-63.070

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	4
5 Spectrometer Frequency	376.44
6 Nucleus	19F



9g