A Novel Modified-Baylis-Hillman Reaction of Propiolate

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Supporting Information

Experimental procedures and spectral data for compound **2**, **3** and **4**

General Remarks. All nonaqueous reactions were carried out under an Ar atmosphere. Reagents were purchased from commercial sources and used as received. Anhydrous solvents were prepared by distillation over CaH₂. ¹H and ¹³C NMR spectra were obtained on a Varian Gemini 300 (300 MHz for ¹H and 75.46 MHz for ¹³C) instrument or a Varian UNITY plus 500 (500 MHz for ¹H and 125 MHz for ¹³C) instrument, using tetramethylsilane or chloroform as an internal reference. Mass spectra were measured on a JEOL D-200 or a JEOL AX 505 mass spectrometer, and the ionization method was electron impact (EI, 70 eV). IR spectra were recorded on a Perkin-Elmer 1600 spectrometer. Column chromatography was carried out by employing Cica Silica Gel 60N (spherical, neutral, 40-50 µm or 63-210 µm).

General Procedure for the Reaction of Propiolate (1) with Aldehydes.

A solution of methyl 3-trimethylsilylpropiolate (156 mg, 1 mmol), aldehyde (0.5 mmol), and DABCO (112 mg, 1 mmol) in anhydrous benzene (1 ml) was refluxed for 0.5 – 1 h. The mixture was cooled to room temperature and diluted with CH₂Cl₂ (20 ml). This brownish solution was washed with 10% hydrochloric acid, and the color of the solution turned pale yellow. The organic layer was then washed with brine and dried over MgSO₄. After evaporation of the solvent, the residue was subjected to silica gel column chromatography (CH₂Cl₂ then 10% AcOEt/CH₂Cl₂) to afford the products **2**, **3** or **4** in the yields listed in Table 1 and Scheme 2.

Methyl (Z)-4-oxo-4-phenyl-2-[phenyl-(trimethylsilyloxy)methyl]but-2-enoate (2a). ¹H-NMR (CDCl₃) δ: -0.03 (9H, s), 3.41 (3H, s), 5.56 (1H, d, *J* = 1.7 Hz), 6.12 (1H, d, *J* = 1.7 Hz), 7.17 – 7.31 (7H, m), 7.43 (1H, t, *J* = 7.3 Hz), 7.66 (2H, d, *J* = 8.1 Hz); ¹³C-NMR (CDCl₃) δ: -0.31, 51.55, 75.48, 117.55, 126.86, 128.11, 128.17, 128.38, 128.47, 132.88, 136.31, 139.68, 159.82, 165.55, 197.13; IR (neat) cm⁻¹: 1724, 1669; MS *m/z* 368 (M⁺); HRMS Calcd for C₂₁H₂₄O₄Si: 368.1444 (M⁺), found: 368.1443.

Methyl 2-benzoyl-4-oxo-4-phenylbutyrate (3a). ¹H-NMR (CDCl₃) δ: 3.10 (2H, d, *J* = 6.4 Hz), 3.70 (3H, s), 5.80 (1H, t, *J* = 6.4 Hz), 7.46 (4H, t, *J* = 7.3 Hz), 7.58 (2H, t, *J* = 7.3 Hz), 7.97 (4H, d, *J* = 7.3 Hz); ¹³C-NMR (CDCl₃) δ: 33.18, 52.25, 52.28, 128.64, 128.94, 133.77, 135.34, 171.82, 195.11; IR (neat) cm⁻¹: 1729, 1686; MS *m/z* 296 (M⁺); HRMS Calcd for C₁₈H₁₆O₄: 296.1049 (M⁺), found: 296.1046.

Methyl (Z)-4-oxo-4-(2-methylphenyl)-2-[(2-methylphenyl)-(trimethylsilyloxy)methyl]but-2-enoate (2b). ¹H-NMR (CDCl₃) δ: -0.07 (9H, s), 2.29 (3H, s), 2.61 (3H, s), 3.41 (3H, s), 5.82 (1H, bs), 5.83 (1H, d, *J* = 1.3 Hz), 7.06 – 7.22 (5H, m), 7.32 (1H, t, *J* = 7.3 Hz), 7.44 (1H, d, *J* = 7.7 Hz), 7.52 (1H, d, *J* = 7.7 Hz); ¹³C-NMR (CDCl₃) δ: -0.40, 19.05, 21.54, 51.45, 72.72, 118.43, 125.09, 126.15, 127.78, 128.00, 130.52, 131.56, 131.59, 131.75, 135.25, 135.57, 137.88, 139.83, 159.85, 165.67, 198.56; IR (neat) cm⁻¹: 1725, 1667; MS *m/z* 396 (M⁺); HRMS Calcd for C₂₃H₂₈O₄Si: 396.1757 (M⁺), found: 396.1759.

Methyl (Z)-4-oxo-4-(3-methylphenyl)-2-[(3-methylphenyl)-(trimethylsilyloxy)methyl]but-2-enoate (2c). ¹H-NMR (CDCl₃) δ: -0.01 (9H, s), 2.25 (3H, s), 2.29 (3H, s), 3.45 (3H, s), 5.51 (1H, d, *J* = 1.7 Hz), 6.15 (1H, d, *J* = 1.7 Hz), 6.99 (1H, d, *J* = 7.3 Hz), 7.04 – 7.12 (3H, m), 7.18 (1H, t, *J* = 7.7 Hz), 7.24 (1H, d, *J* = 7.3 Hz), 7.45 – 7.47 (2H, m); ¹³C-NMR (CDCl₃) δ: -0.27, 21.17, 21.27, 51.54, 75.48, 117.15, 123.95, 125.84, 127.47, 127.92, 128.17, 128.83, 128.92, 133.68, 136.26, 137.73, 137.94, 139.57,

160.27, 165.63, 197.27; IR (neat) cm^{-1} : 1725, 1668; MS m/z 396 (M^+); HRMS Calcd for $\text{C}_{23}\text{H}_{28}\text{O}_4\text{Si}$: 396.1757 (M^+), found: 396.1759.

Methyl 2-(3-methylbenzoyl)-4-oxo-4-(3-methylphenyl)butyrate (3c). ^1H -NMR (CDCl_3) δ : 2.38 (6H, s), 3.08 (2H, d, $J = 6.8$ Hz), 3.70 (3H, s), 5.77 (1H, t, $J = 6.8$ Hz), 7.33 (2H, t, $J = 7.7$ Hz), 7.39 (2H, d, $J = 7.7$ Hz), 7.76 (2H, d, $J = 7.7$ Hz), 7.79 (2H, s); ^{13}C -NMR (CDCl_3) δ : 21.33, 33.27, 52.19, 52.42, 125.83, 128.74, 129.16, 134.49, 134.52, 135.45, 138.81, 171.90, 195.33; IR (neat) cm^{-1} : 1738, 1695; MS m/z 324 (M^+); HRMS Calcd for $\text{C}_{20}\text{H}_{20}\text{O}_4$: 324.1361 (M^+), found: 324.1360.

Methyl (Z)-4-oxo-4-(4-methylphenyl)-2-[(4-methylphenyl)-(trimethylsilyloxy)methyl]but-2-enoate (2d). ^1H -NMR (CDCl_3) δ : -0.04 (9H, s), 2.28 (3H, s), 2.35 (3H, s), 3.43 (3H, s), 5.52 (1H, d, $J = 1.7$ Hz), 6.09 (1H, d, $J = 1.7$ Hz), 7.05 (2H, d, $J = 8.1$ Hz), 7.12 (2H, d, $J = 8.1$ Hz), 7.15 (2H, d, $J = 8.1$ Hz), 7.60 (2H, d, $J = 8.1$ Hz); ^{13}C -NMR (CDCl_3) δ : 0.00, 21.37, 21.92, 51.79, 75.58, 117.61, 127.10, 128.93, 129.15, 129.29, 134.29, 137.02, 138.07, 143.91, 160.45, 165.92, 197.00; IR (neat) cm^{-1} : 1725, 1667; MS m/z 396 (M^+); HRMS Calcd for $\text{C}_{23}\text{H}_{28}\text{O}_4\text{Si}$: 396.1757 (M^+), found: 396.1756.

Methyl 2-(4-methylbenzoyl)-4-oxo-4-(4-methylphenyl)butyrate (3d). ^1H -NMR (CDCl_3) δ : 2.40 (6H, s), 3.08 (2H, d, $J = 6.9$ Hz), 3.69 (3H, s), 5.75 (1H, t, $J = 6.9$ Hz), 7.25 (4H, d, $J = 8.2$ Hz), 7.88 (4H, d, $J = 8.2$ Hz); ^{13}C -NMR (CDCl_3) δ : 21.63, 33.25, 52.14, 128.74, 129.56, 132.86, 144.68, 171.90, 194.74; IR (neat) cm^{-1} : 1737, 1692; MS m/z 324 (M^+); HRMS Calcd for $\text{C}_{20}\text{H}_{20}\text{O}_4$: 324.1361 (M^+), found: 324.1361.

Methyl (Z)-4-oxo-4-(2-methoxyphenyl)-2-[hydroxy-(2-methoxyphenyl)methyl]but-2-enoate (2e). ^1H -NMR (CDCl_3) δ : 3.47 (3H, s), 3.73 (3H, s), 3.76 (3H, s), 5.82 (1H, d, $J = 1.3$ Hz), 5.90 (1H, d, $J = 1.3$ Hz), 6.81 (1H, d, $J = 7.7$ Hz), 6.88 – 6.98 (3H, m), 7.22 – 7.30 (2H, m), 7.44 (1H, ddd, $J = 9.0, 7.3, 2.1$ Hz), 7.82 (1H, dd, $J = 7.7, 1.7$ Hz); ^{13}C -NMR (CDCl_3) δ : 51.41, 55.12, 55.59, 71.39, 110.44, 112.02, 115.89, 120.56, 120.76, 125.91, 127.57, 128.13, 129.26, 131.20, 134.50, 156.48, 159.07, 161.56, 165.89, 194.82; IR (neat) cm^{-1} : 3485, 1722, 1655; MS m/z 356 (M^+); HRMS Calcd for $\text{C}_{20}\text{H}_{20}\text{O}_6$: 356.1260 (M^+), found: 356.1261.

Methyl (Z)-4-oxo-4-(3-methoxyphenyl)-2-[(3-methoxyphenyl)-(trimethylsilyloxy)methyl]but-2-enoate (2f). ^1H -NMR (CDCl_3) δ : 0.00 (9H, s), 3.42 (3H, s), 3.71 (3H, s), 3.74 (3H, s), 5.55 (1H, d, $J = 1.6$ Hz), 6.15 (1H, d, $J = 1.6$ Hz), 6.73 (1H, dt, $J = 7.4, 1.6$ Hz), 6.83 – 6.86 (2H, m), 6.99 (1H, dt, $J = 6.6, 2.7$ Hz), 7.10 – 7.25 (4H, m); ^{13}C -NMR (CDCl_3) δ : -0.23, 51.62, 55.17, 55.27, 75.33, 111.81, 112.20, 113.75, 117.61, 119.20, 119.96, 121.62, 129.13, 129.43, 137.65, 141.33, 159.38, 159.58, 159.70, 165.59, 196.84; IR (neat) cm^{-1} : 1725, 1671; MS m/z 428 (M^+); HRMS Calcd for $\text{C}_{23}\text{H}_{28}\text{O}_6\text{Si}$: 428.1656 (M^+), found: 428.1652.

Methyl 2-(3-methoxybenzoyl)-4-oxo-4-(3-methoxyphenyl)butyrate (3f). ^1H -NMR (CDCl_3) δ : 3.09 (2H, d, $J = 6.9$ Hz), 3.70 (3H, s), 3.80 (6H, s), 5.76 (1H, t, $J = 6.9$ Hz), 7.12 (2H, ddd, $J = 8.2, 2.4, 0.8$ Hz), 7.36 (2H, t, $J = 8.2$ Hz), 7.49 (2H, dd, $J = 2.4, 0.8$ Hz), 7.55 (2H, ddd, $J = 8.2, 2.4, 0.8$ Hz); ^{13}C -NMR (CDCl_3) δ : 33.24, 52.18, 52.37, 55.32, 112.60, 120.51, 121.07, 129.87, 136.61, 159.97, 171.72, 194.81; IR (neat) cm^{-1} : 1738, 1696; MS m/z 356 (M^+); HRMS Calcd for $\text{C}_{20}\text{H}_{20}\text{O}_6$: 356.1260 (M^+), found: 356.1252.

Methyl (Z)-4-oxo-4-(4-methoxyphenyl)-2-[(4-methoxyphenyl)-(trimethylsilyloxy)methyl]but-2-enoate (2g). ^1H -NMR (CDCl_3) δ : -0.03 (9H, s), 3.45 (3H, s), 3.74 (3H, s), 3.82 (3H, s), 5.50 (1H, d, $J = 1.7$ Hz), 6.11 (1H, d, $J = 1.7$ Hz), 6.76 (2H, d, $J = 9.0$ Hz), 6.79 (2H, d, $J = 9.0$ Hz), 7.18 (2H, d, $J = 8.5$ Hz), 7.65 (2H, d, $J = 8.5$ Hz); ^{13}C -NMR

(CDCl₃) δ : -0.23, 51.56, 55.18, 55.35, 75.08, 113.42, 113.72, 116.90, 128.14, 129.67, 130.88, 131.93, 159.32, 160.24, 163.30, 165.73, 195.71; IR (neat) cm⁻¹: 1724, 1659; MS m/z 428 (M⁺); HRMS Calcd for C₂₃H₂₈O₆Si: 428.1656 (M⁺), found: 428.1652.

Methyl 2-(4-methoxybenzoyl)-4-oxo-4-(4-methoxyphenyl)butyrate (3g). ¹H-NMR (CDCl₃) δ : 3.07 (2H, d, J = 6.8 Hz), 3.69 (3H, s), 3.85 (6H, s), 5.67 (1H, t, J = 6.8 Hz), 6.92 (4H, d, J = 9.0 Hz), 7.96 (4H, d, J = 9.0 Hz); ¹³C-NMR (CDCl₃) δ : 33.40, 52.06, 52.17, 55.51, 114.08, 128.38, 131.04, 163.93, 172.08, 193.69; IR (neat) cm⁻¹: 1735, 1686; MS m/z 356 (M⁺); HRMS Calcd for C₂₀H₂₀O₆: 356.1260 (M⁺), found: 356.1258.

Methyl (Z)-4-oxo-4-(4-chlorophenyl)-2-[(4-chlorophenyl)-(trimethylsilyloxy)methyl]but-2-enoate (2h). ¹H-NMR (CDCl₃) δ : -0.03 (9H, s), 3.47 (3H, s), 5.52 (1H, d, J = 1.7 Hz), 6.06 (1H, d, J = 1.7 Hz), 7.21 (2H, d, J = 9.0 Hz), 7.25 (2H, d, J = 8.5 Hz), 7.35 (2H, d, J = 9.0 Hz), 7.62 (2H, d, J = 8.5 Hz); ¹³C-NMR (CDCl₃) δ : -0.32, 51.79, 74.79, 118.12, 128.14, 128.64, 128.73, 129.79, 134.13, 134.73, 138.21, 139.52, 158.95, 165.29, 195.83; IR (neat) cm⁻¹: 1725, 1673; MS m/z 436 (M⁺); HRMS Calcd for C₂₁H₂₂Cl₂O₄Si: 436.0664 (M⁺), found: 436.0664.

Methyl 2-(4-chlorobenzoyl)-4-oxo-4-(4-chlorophenyl)butyrate (3h). ¹H-NMR (CDCl₃) δ : 3.09 (2H, d, J = 6.8 Hz), 3.70 (3H, s), 5.67 (1H, t, J = 6.8 Hz), 7.43 (4H, d, J = 8.5 Hz), 7.89 (4H, d, J = 8.5 Hz); ¹³C-NMR (CDCl₃) δ : 33.10, 52.33, 52.35, 129.32, 129.97, 133.55, 140.48, 171.61, 193.70; IR (neat) cm⁻¹: 1734, 1697; MS m/z 364 (M⁺); HRMS Calcd for C₁₈H₁₄Cl₂O₄: 364.0269 (M⁺), found: 364.0271.

Methyl (Z)-4-oxo-4-(1-naphthyl)-2-[(1-naphthyl)-(trimethylsilyloxy)methyl]but-2-enoate (2i). ¹H-NMR (CDCl₃) δ : -0.08 (9H, s), 3.15 (3H, s), 5.87 (1H, br), 6.44 (1H, brs), 7.26 (1H, br), 7.42 – 7.58 (4H, m), 7.62 – 7.91 (7H, m), 8.30 (1H, br), 9.08 (1H, d, J = 8.5 Hz); ¹³C-NMR (CDCl₃) δ : -0.37, 51.55, 119.88, 123.88, 125.13, 125.70, 125.90, 126.06, 126.15, 126.34, 126.42, 128.21, 128.31, 128.69, 128.93, 130.41, 130.61, 131.72, 133.56, 133.70, 135.30, 159.64, 165.62, 198.66; IR (neat) cm⁻¹: 1725, 1658; MS m/z 468 (M⁺); HRMS Calcd for C₂₉H₂₈O₄Si: 468.1757 (M⁺), found: 468.1758.

Methyl (Z)-4-oxo-4-(2-naphthyl)-2-[(2-naphthyl)-(trimethylsilyloxy)methyl]but-2-enoate (2j). ¹H-NMR (CDCl₃) δ : -0.00 (9H, s), 3.40 (3H, s), 5.82 (1H, d, J = 1.7 Hz), 6.23 (1H, d, J = 1.7 Hz), 7.40 – 7.46 (3H, m), 7.50 – 7.55 (2H, m), 7.71 – 7.88 (7H, m), 7.90 (1H, dd, J = 8.5, 1.7 Hz), 8.08 (1H, s); ¹³C-NMR (CDCl₃) δ : -0.22, 51.64, 75.70, 118.19, 123.71, 124.56, 126.09, 126.13, 126.15, 126.40, 127.61, 127.91, 128.10, 128.29, 128.44, 129.54, 130.85, 132.19, 132.96, 133.17, 133.90, 135.46, 137.19, 159.96, 165.55, 197.07; IR (neat) cm⁻¹: 1724, 1664; MS m/z 468 (M⁺); HRMS Calcd for C₂₉H₂₈O₄Si: 468.1757 (M⁺), found: 468.1767.

Methyl 2-(2-naphthyl)-4-oxo-4-(2-naphthyl)butyrate (3j). ¹H-NMR (CDCl₃) δ : 3.24 (2H, d, J = 6.8 Hz), 3.74 (3H, s), 6.11 (1H, t, J = 6.8 Hz), 7.52 – 7.55 (2H, m), 7.59 – 7.62 (2H, m), 7.85 – 7.90 (6H, m), 8.04 (2H, dd, J = 8.5, 1.7 Hz), 8.58 (2H, s); ¹³C-NMR (CDCl₃) δ : 33.53, 52.30, 52.58, 124.07, 126.97, 127.76, 128.92, 128.94, 129.71, 130.59, 132.43, 132.77, 135.80, 172.01, 195.09; IR (neat) cm⁻¹: 1735, 1692; MS m/z 396 (M⁺); HRMS Calcd for C₂₆H₂₀O₄: 396.1362 (M⁺), found: 396.1353.

Methyl (Z)-4-oxo-4-(2-bromo-4,5-dimethoxyphenyl)-2-[(2-bromo-4,5-dimethoxyphenyl)-(trimethylsilyloxy)methyl]but-2-enoate (2k). ¹H-NMR (CDCl₃) δ : -0.03 (9H, s), 3.54 (3H, s), 3.77 (3H, s), 3.84 (3H, s), 3.86 (3H, s), 3.91 (3H, s), 5.93 (1H, s), 5.97 (1H, s), 6.89 (1H, s), 7.00 (1H, s), 7.09 (1H, s), 7.15 (1H, s); ¹³C-NMR

(CDCl₃) δ : -0.20, 51.95, 55.98, 56.05, 56.11, 56.31, 74.02, 111.38, 112.66, 114.12, 114.64, 114.71, 117.20, 119.27, 128.55, 131.33, 147.44, 148.83, 149.45, 152.09, 165.58, 193.07; IR (neat) cm⁻¹: 1724, 1675; MS m/z 644 (M⁺); HRMS Calcd for C₂₅H₃₀Br₂O₈Si: 644.0077 (M⁺), found: 644.0049.

Methyl 4-trimethylsilyloxy-2-heptynoate (4a). ¹H-NMR (CDCl₃) δ : 0.17 (9H, s), 0.92 (3H, t, J = 7.2 Hz), 1.39 – 1.48 (2H, m), 1.65 – 1.72 (2H, m), 3.76 (3H, s), 4.43 (1H, t, J = 6.6 Hz); ¹³C-NMR (CDCl₃) δ : -0.05, 13.57, 18.29, 39.70, 52.66, 61.99, 75.67, 88.91, 153.88; IR (neat) cm⁻¹: 2361, 1722, 1253; MS m/z 228 (M⁺); HRMS Calcd for C₁₁H₂₀O₃Si: 228.1182 (M⁺), found: 228.1177.

Methyl 5-methyl-4-trimethylsilyloxy-2-hexynoate (4b). ¹H-NMR (CDCl₃) δ : 0.16 (9H, s), 0.96 (3H, d, J = 6.8 Hz), 0.97 (3H, d, J = 6.8 Hz), 1.84 – 1.89 (1H, m), 3.76 (3H, s), 4.18 (1H, d, J = 6.0 Hz); ¹³C-NMR (CDCl₃) δ : -0.10, 17.65, 17.94, 34.82, 52.64, 67.71, 76.38, 88.09, 153.88; IR (neat) cm⁻¹: 2235, 1721, 1252; MS m/z 228 (M⁺); HRMS Calcd for C₁₁H₂₀O₃Si: 228.1182 (M⁺), found: 228.1163.

The Reaction of Propiolate (1) with Benz(aldehyde-*d*).

Benz(aldehyde-*d*) was purchased from Aldrich (98 atom % D) and used as received.

A solution of methyl 3-trimethylsilylpropiolate (156 mg, 1 mmol), benz(aldehyde-*d*) (54 mg, 0.5 mmol), and DABCO (112 mg, 1 mmol) in anhydrous benzene (1 ml) was refluxed for 40 min. The mixture was cooled to room temperature and diluted with CH₂Cl₂ (20 ml). This solution was washed with 10% hydrochloric acid and brine successively, and dried over MgSO₄. After evaporation of the solvent, the residue was subjected to silica gel column chromatography (CH₂Cl₂) to afford **2a-d** (57 mg, 62%). The product (**3a-d**) could only be detected on TLC with trace amount.

A solution of **2a-d** (40 mg, 0.11 mmol) and DABCO (24 mg, 0.22 mmol) in anhydrous benzene (0.5 ml) was refluxed for 14 h. The same work-up procedure as mentioned above afforded **3a-d** (11 mg, 34%) and starting material **2a-d** (24 mg, 60%).

Product 2a-d. ¹H-NMR (CDCl₃) δ : -0.01 (9H, s), 3.45 (3H, s), 7.17 – 7.31 (7H, m), 7.46 (1H, t, J = 7.3 Hz), 7.68 (2H, d, J = 8.1 Hz); MS m/z 370 (M⁺); HRMS Calcd for C₂₁H₂₂D₂O₄Si: 370.1567 (M⁺), found: 370.1578.

In the ¹H-NMR spectra, the peaks 5.56 (1H, d, J = 1.7 Hz) and 6.12 (1H, d, J = 1.7 Hz), which were observed in the spectra of the compound **2a**, were disappeared.

Product 3a-d. ¹H-NMR (CDCl₃) δ : 3.70 (3H, s), 5.79 (1H, s), 7.46 (4H, t, J = 7.3 Hz), 7.58 (2H, t, J = 7.3 Hz), 7.97 (4H, d, J = 7.3 Hz); MS m/z 298 (M⁺); HRMS Calcd for C₁₈H₁₄D₂O₄: 298.1174 (M⁺), found: 298.1183.

In the ¹H-NMR spectra, the peak 3.10 (2H, d, J = 6.4 Hz), which was observed in the spectra of the compound **3a**, was disappeared, and the peak 5.80 (1H, t, J = 6.4 Hz) in **3a** was simplified to singlet.

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pu1

Pulse Sequence: s2pul

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pu1

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1

STANDARD CARBON PARAMETERS
Pulse Sequence: szpu]

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1

STANDARD CARBON PARAMETERS
Pulse Sequence: szpu1

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1

STANDARD CARBON PARAMETERS
Pulse Sequence: szpu1

2d

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1

2d

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pu1

3d

STANDARD 1H OBSERVE

Pulse Sequence: s2pu1

3d

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pu1

STANDARD PROTON PARAMETERS

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pu1

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pu1

STANDARD 1H OBSERVE

Pulse Sequence: s2pul

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pu1

2g

STANDARD PROTON PARAMETERS
Pulse Sequence: szpu]

2g

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pu1

3g

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1

3g

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pul

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1

2h

2h

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pul

3h

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1

3h

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pu1

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pu1

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1

STANDARD CARBON PARAMETERS

3j

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1

3j

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pu1

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pu1

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pul

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1

STANDARD CARBON PARAMETERS
Pulse Sequence: s2pul

STANDARD PROTON PARAMETERS
Pulse Sequence: s2pu1