Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry.

Supporting Information

Modular synthesis of oligoacetylacetones *via* site-selective silylation of acetylacetone derivatives

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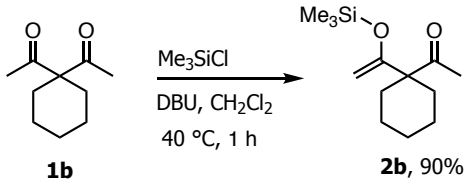
1. General Information

Solvents and reagents were purchased from WAKO Pure Chemical Industries Ltd. and TCI Co., Ltd. and used without further purification unless otherwise mentioned. Compound **1b-d** were prepared by reported procedure.[1-3] All the ^{1}H and ^{13}C NMR spectra were recorded using a JEOL JMN-ECS400 spectrometer. Chemical shifts are reported in parts per million (ppm) relative to tetramethylsilane ($\delta = 0.00$ ppm) for ^{1}H NMR and $CDCl_3$ ($\delta = 77.16$ ppm) for ^{13}C NMR. Infrared spectra were measured using a JASCO Co. FT/IR-4600 spectrometer. Elemental analysis were performed using a CE440 elemental analyzer (Exeter Analytical, Inc.). Elemental analysis for silylated products were not performed as slow hydrolysis were observed for all silylated products and they were quickly utilized for coupling reaction. Thin layered chromatography (TLC) was performed on a silica gel sheet, MERCK silica gel 60 F_{254}. Preparative scale separations were carried out using silica gel gravity column chromatography (Wakosil® 60 ~ 210 μm). HPLC chromatograms were recorded using a JASCO MD-2018 photodiode array detector equipped with TSKgel G2000H column (two connected columns of 4.6ϕ × 250 mm), a JASCO PU-2089 pump, JASCO AS-2059 sampler, JASCO CO-2060 column thermostat, ADVANTEC CHF 122SC fraction collector. GPC was performed on Japan Analytical Industry LaboACE with JAIGEL-2HR polystyrene columns (two connected columns of 20ϕ × 600 mm) with $CHCl_3$ as mobile phase. ESI-TOF-MS spectra were recorded on a Thermo scientific Exactive spectrometer using MeOH in both positive and negative mode. Single crystal X-ray diffraction data were collected by a Rigaku XtaLAB P200 diffractometer equipped with a PILATUS200K detector using a multi-layer mirror (MoKα radiation $\lambda = 0.71073$ Å). All structures were solved using a dual-space algorithm (SHELXT[4]) and refined using full-matrix least-squares method (SHELXL[5]).

2. Synthetic Procedures

2-1 Silylation of acetylacetone monomers 1

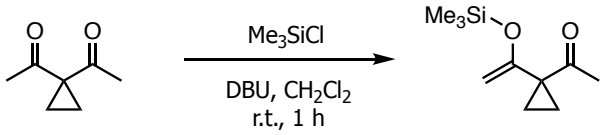
Synthesis of mono-silylated monomer 2b



To a 50 mL two-necked round bottom flask equipped with a reflux condenser, 1,1-diacetylcyclohexane **1b** (3.36 g, 20 mmol) and degassed dichloromethane (14 mL) were added and cooled to 0 °C with ice/ water bath. To this solution, dropwise addition of trimethylchlorosilane (3.1 mL, 24 mmol) followed by 1,8- diazabicyclo[5.4.0]undec-7-ene (3.9 mL, 26 mmol) were done at 0 °C while stirring. The ice/water bath was removed, and the mixture was heated to reflux for 1 h. Upon cooling to room temperature, hexane (40 mL) was added to the reaction mixture and the product was extracted with hexane (20 mL x 3) followed by washing with brine (50 mL × 2) and water (50 mL) using an extraction funnel. The organic layer was dried over anhydrous sodium sulfate and evaporated under reduced pressure. The crude product was purified by column chromatography through a silica gel column (diameter 2.2 cm, height 10.0 cm) using a mixture of hexane/ ethyl acetate = 25:1 as eluent to obtain mono-silylated monomer (**2b**) as colourless oil (4.3 g) in 90% yield.

^{1}H NMR (400 MHz, $CDCl_3$, 298 K): δ 4.29 (d, J = 2.2 Hz, 1H, vinyl), 4.23 (d, J = 2.2 Hz, 1H, vinyl), 2.12 (s, 3H, acetyl), 1.95 (m, 2H, cyclohexyl), 1.60 (m, 4H, cyclohexyl), 1.39 (m, 4H, cyclohexyl), 0.20 (s, 9H, trimethylsilyl) ppm; ^{13}C NMR (100 MHz, $CDCl_3$, 298 K): δ 210.1, 160.5, 90.2, 58.3, 31.3, 26.1, 25.3, 22.9, 0.07 ppm; HR-ESI-TOF MS: *m/z* calculated for $C_{13}H_{24}O_2Si$: 263.1438 $[M+Na]^+$, found 263.1436; R_f = 0.36 (eluent: hexane/ethyl acetate = 25:1).

Synthesis of mono-silylated monomer 2c

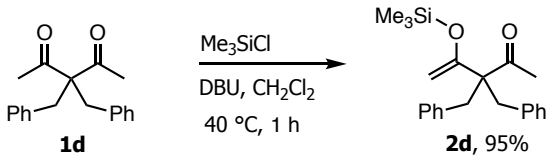


1c **2c**, 56%

In a 50 mL round bottom flask, 1,1-diacetylcyclopropane **1c** (2.01 g, 15.9 mmol) and dichloromethane (10.0 mL) were cooled to 0 °C using ice/water bath. To this solution, dropwise addition of trimethylchlorosilane (2.40 mL, 18.9 mmol) followed by 1,8-diazabicyclo[5.4.0]undec-7-ene (3.00 mL, 20.5 mmol) were done at 0 °C while stirring. The ice/water bath was removed, and the mixture was stirred at room temperature for 1 h. Hexane (10 mL) was added to the reaction mixture and the product was extracted with hexane (5 mL × 3) followed by washing with brine (5 mL) and water (5 mL) using an extraction funnel. The organic layer was dried over anhydrous sodium sulfate and evaporated under reduced pressure. The crude product was purified by silica gel column chromatography (diameter 4.2 cm, height 6.0 cm) using a mixture of hexane/ ethyl acetate = 20:1 as eluent to obtain mono-silylated monomer (**2c**) as colourless oil (1.73 g) in 56% yield.

^{1}H NMR (400 MHz, $CDCl_3$, 298 K): δ 4.29 (d, J = 1.4 Hz, 1H, vinyl), 4.25 (d, J = 1.4 Hz, 1H, vinyl), 2.33 (s, 3H, acetyl), 1.30 (m, 2H, cyclopropyl), 0.98 (m, 2H, cyclopropyl), 0.24 (s, 9H, trimethylsilyl) ppm; ^{13}C NMR (100 MHz, $CDCl_3$, 298 K): δ 208.0, 158.5, 92.4, 37.7, 28.2, 18.2, 0.13 ppm; HR-ESI-TOF MS: *m/z* calculated for $C_{10}H_{18}O_2Si$, 221.0968 $[M+Na]^+$, found 221.0971; R_f = 0.38 (eluent: hexane/ethyl acetate = 25:1).

Synthesis of mono-silylated monomer 2d



To a 250 mL two-necked round bottom flask equipped with a reflux condenser, 3,3-bis(phenylmethyl)-2,4-pentanedione **1d** (26.0 g, 93 mmol) and degassed dichloromethane (60 mL) were added and cooled to 0 °C with ice/ water bath. To this solution, dropwise addition of trimethylchlorosilane (14.1 mL, 111 mmol) followed by 1,8- diazabicyclo[5.4.0]undec-7-ene (18.1 mL, 121 mmol) were done at 0 °C while stirring. The ice/water bath was removed, and the mixture was heated to reflux for 1 h. Upon cooling to room temperature, hexane (100 mL) was added to the reaction mixture and the product was extracted with hexane (100 mL x 3) followed by washing with brine (100 mL × 2) and water (100 mL) using an extraction funnel. The organic layer was dried over anhydrous sodium sulfate and evaporated under reduced pressure. The crude product was purified by column chromatography through a silica gel column (diameter 8.0 cm, height 9.0 cm) using a mixture of hexane/ ethyl acetate = 20:1 as eluent to obtain mono-silylated monomer (**2d**) as white solid (31.2 g) in 95% yield.

^{1}H NMR (400 MHz, $CDCl_3$, 298 K): δ 7.22 (m, 6H, phenyl), 7.11 (m, 4H, phenyl), 4.28 (s, 2H, vinyl), 3.00 (ABq, $\Delta\delta_{AB}$ = 0.04, J = 15.1 Hz, 4H, benzyl), 2.20 (s, 3H, acetyl), 0.22 (s, 9H, trimethylsilyl) ppm; ^{13}C NMR (100 MHz, $CDCl_3$, 298 K): δ 208.8, 158.8, 137.6, 130.5, 128.0, 126.5, 91.1, 63.1, 37.2, 26.6, -0.1 ppm; IR (ATR, neat): 3087 (w), 3053 (w), 3027 (w), 2958 (w), 1715 (s), 1626 (s), 1494 (m), 1451 (s), 1355 (m), 1256 (m), 1252 (s), 1196 (m), 1150 (m), 1086 (m), 1005 (s), 836 (s), 751 (s), 699 (s) cm^{-1}; mp 51 - 53 °C; HR-ESI-TOF MS: *m/z* calculated for $C_{22}H_{28}O_2Si$, 375.1751 $[M+Na]^+$, 375.1748; R_f = 0.31 (eluent: hexane/ethyl acetate = 20:1).

2-2 Selectivity of mono-silylation of acetylacetone derivatives 1

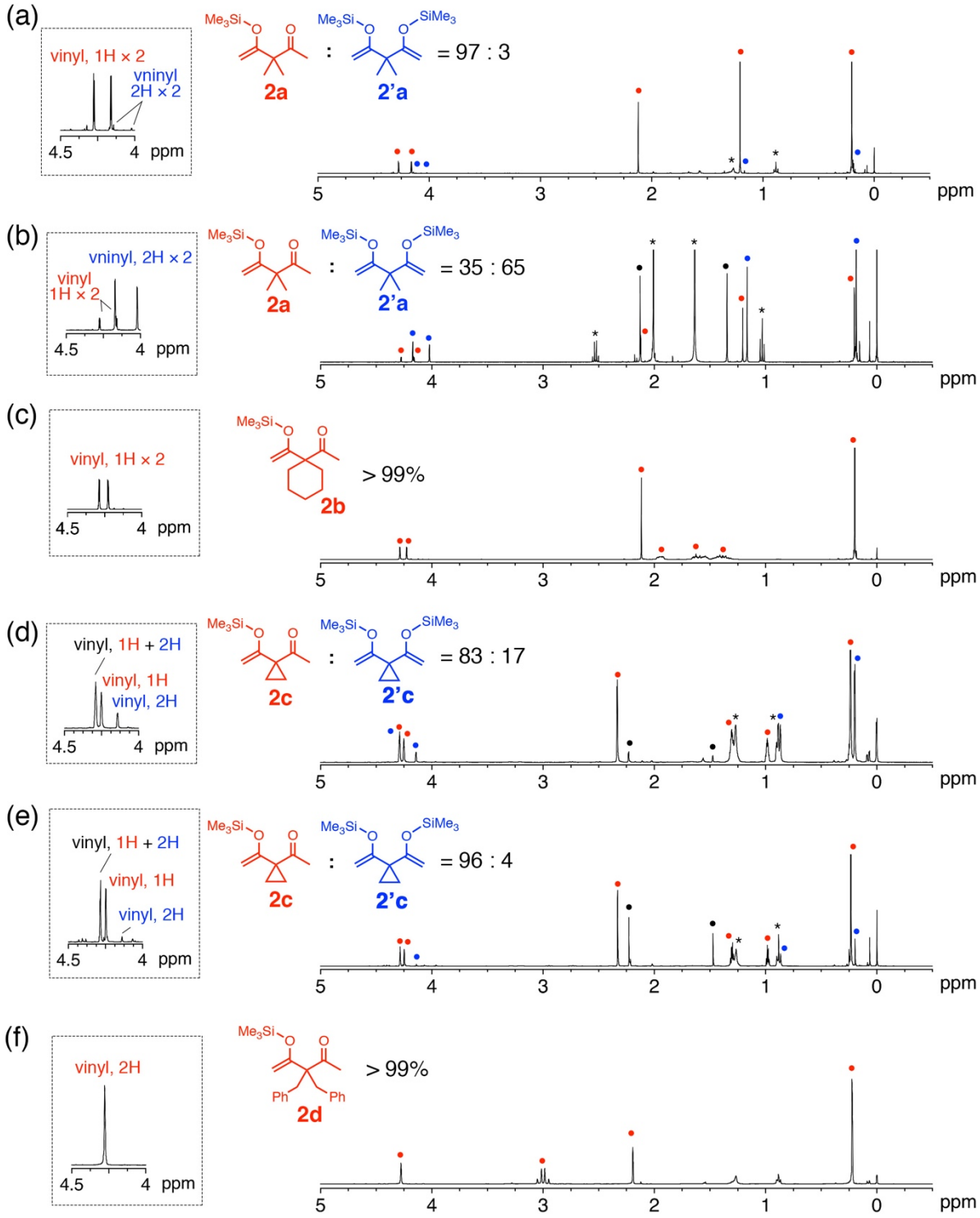
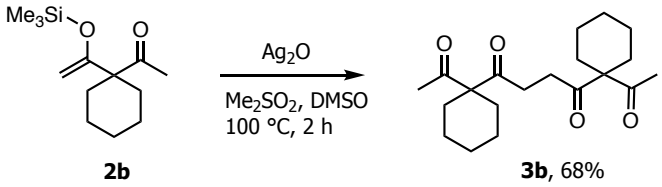


Figure S1. ^{1}H NMR spectra in $CDCl_3$ of crude reaction products for the synthesis of (a) **2a** with DBU, (b) **2a** with Et_3N, (c) **2b**, (d) **2c** at reflux, (e) **2c** at room temperature and (f) **2d** (corresponding to Entries 1–6, in Table 1, respectively).

2-3 Synthesis of tetraketones 3

Synthesis of tetraketone 3b

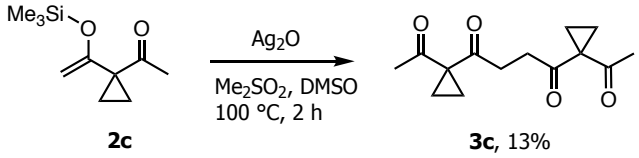


2b **3b**, 68%

To a 50 mL round bottom flask equipped with a reflux condenser, enol silyl ether **2b** (1.88 g, 7.82 mmol), dimethyl sulfone (2.20 g, 23.5 mmol), dimethyl sulfoxide (111 µL, 1.6 mmol) and silver(I) oxide (1.09 g, 4.7 mmol) were added, and the reaction mixture was stirred at 100 ºC for 2 h. After cooling to room temperature, the reaction mixture was diluted with 20 mL ethyl acetate and filtered through celite pad using additional 50 mL of ethyl acetate. The combined filtrate was washed with brine (50 mL × 3), dried over anhydrous sodium sulfate and the solvent was evaporated under reduced pressure. The crude product was chromatographed through a silica gel column (diameter 2.2 cm, height 9.0 cm) using a mixture of hexane/ethyl acetate/dichloromethane = 5:1:1 as eluent. The resulting solid was then washed in hexane (5 mL) with sonication and then filtered to obtain tetraketone (**3b**) as white solid (890 mg) in 68% yield.

^{1}H NMR (400 MHz, $CDCl_3$, 298 K): δ 2.63 (s, 4H, ethylene), 2.12 (s, 6H, acetyl) 1.99 (t, J = 5.7 Hz , 8H, cyclohexyl), 1.47 (m, 8H, cyclohexyl), 1.39 (m, 4H, cyclohexyl) ppm; ^{13}C NMR (100 MHz, $CDCl_3$, 298 K): δ 207.4, 207.3, 68.1, 32.2, 30.5, 26.4, 25.5, 23.0 ppm; IR (ATR, neat): 2926 (m), 2852 (w), 1685 (s), 1454, (w), 1394 (m), 1351 (m), 1182 (m), 1114 (m), 999 (m), 973 (m), 907 (m), 643 (m) cm^{-1}; mp 80 - 82 °C; HR-ESI-TOF MS: *m/z* calculated for $C_{20}H_{30}O_4$, 357.2036 $[M+Na]^+$, found 357.2034; Elemental analysis (%): calculated for $C_{20}H_{30}O_4$ (%): C, 71.82; H, 9.04, found C, 71.94; H, 9.09; R_f = 0.33 (eluent: hexane/ethyl acetate/dichloromethane = 5:1:1).

Synthesis of tetraketone 3c

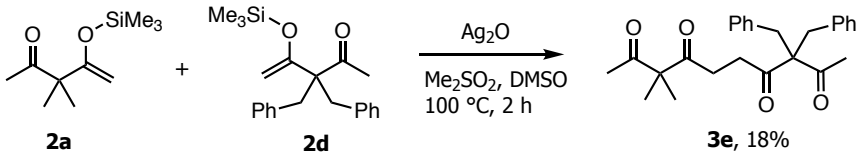


2c **3c**, 13%

To a 50 mL round bottom flask equipped with a reflux condenser, enol silyl ether **2c** (3.99 g, 20.0 mmol), dimethyl sulfone (5.67 g, 60.0 mmol), dimethyl sulfoxide (290 µL, 4.0 mmol) and silver(I) oxide (2.78 g, 12.0 mmol) were added, and the reaction mixture was stirred at 100 ºC for 2 h. After cooling to room temperature, the reaction mixture was diluted with 20 mL ethyl acetate and filtered through celite pad using additional 50 mL of ethyl acetate. The combined filtrate was washed with brine (50 mL × 3), dried over anhydrous sodium sulfate and the solvent was evaporated under reduced pressure. The crude product was chromatographed through a silica gel column (diameter 2.2 cm, height 9.0 cm) using a mixture of hexane/ethyl acetate/dichloromethane = 5:1:1 as eluent. The resulting solid was then washed in hexane (5 mL) with sonication and then filtered to obtain tetraketone (**3c**) as colourless oil (325 mg) in 13% yield.

^{1}H NMR (400 MHz, $CDCl_3$, 298 K): δ 2.83 (s, 4H, ethylene), 2.21 (s, 6H, acetyl) 1.54 (m, 4H, cyclopropyl), 1.52 (m, 4H, cyclopropyl) ppm; ^{13}C NMR (100 MHz, $CDCl_3$, 298 K): δ 204.9, 204.2, 43.0, 34.0, 27.6, 17.6 ppm; HR-ESI-TOF MS: *m/z* calculated for $C_{14}H_{18}O_4$, 273.1097 $[M+Na]^+$, found 273.1096; R_f = 0.29 (eluent: hexane/ethyl acetate/dichloromethane = 5:1:1).

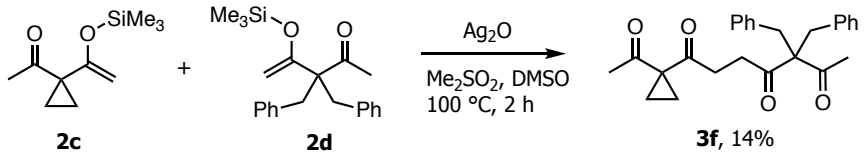
Synthesis of tetraketone 3e



To a 100 mL round bottom flask equipped with a reflux condenser, enol silyl ethers **2a** (6.61 g, 33 mmol) and **2d** (3.89 g, 11 mmol) were mixed and stirred for 5 min. To this mixture, dimethyl sulfone (12.4 g, 132 mmol), dimethyl sulfoxide (625 μL, 8.8 mmol) and silver(I) oxide (6.20 g, 26.4 mmol) were added and the reaction mixture was stirred at 100 ºC for 2 h. After cooling to room temperature, the reaction mixture was diluted with 50 mL ethyl acetate and filtered through celite pad using additional 150 mL of ethyl acetate. The combined filtrate was washed with brine (100 mL × 3), dried over anhydrous sodium sulfate and the solvent was evaporated under reduced pressure. The crude product was first chromatographed through a silica gel column (diameter 5.0 cm, height 14.0 cm) using a mixture of hexane/ethyl acetate/dichloromethane = 6:1:4 as eluent and then further purified by GPC. The resulting viscous oil was passed through silica plug using ethyl acetate as eluent to obtain 3,3-bis(phenylmethyl)-8,8-dimethyldecane-2,4,7,9-tetraone (**3e**) as colourless viscous oil (800 mg) in 18% yield.

^{1}H NMR (400 MHz, $CDCl_3$, 298 K): δ 7.23 (m, 6H, phenyl), 6.97 (dd, J = 7.3 Hz, 1.6 Hz, 4H, phenyl) 3.33 (ABq, $\Delta\delta_{AB}$ = 0.04, J = 15.1 Hz, 4H, benzyl), 2.66 (dd, J = 5.5 Hz, 4.0 Hz, 2H, ethylene), 2.58 (dd, J = 5.5 Hz, 4.0 Hz, 2H, ethylene), 2.24 (s, 3H, acetyl), 2.16 (s, 3H, acetyl), 1.38 (s, 6H, -C(CH_3)$_2$-) ppm; ^{13}C NMR (100 MHz, $CDCl_3$, 298 K): δ 208.3, 207.8, 207.7, 206.5, 136.1, 129.8, 128.6, 127.0, 71.3, 62.3, 37.2, 34.6, 32.0, 28.4, 26.4, 21.6 ppm; HR-ESI-TOF MS: *m/z* calculated for $C_{26}H_{30}O_4$, 429.2036 $[M+Na]^+$, found 429.2039; Elemental analysis (%): calculated for $C_{26}H_{30}O_4$ (%): C, 76.82; H, 7.44, found C, 76.78; H, 7.55; R_f = 0.43 (eluent: hexane/ethyl acetate/dichloromethane = 6:1:4).

Synthesis of tetraketone 3f

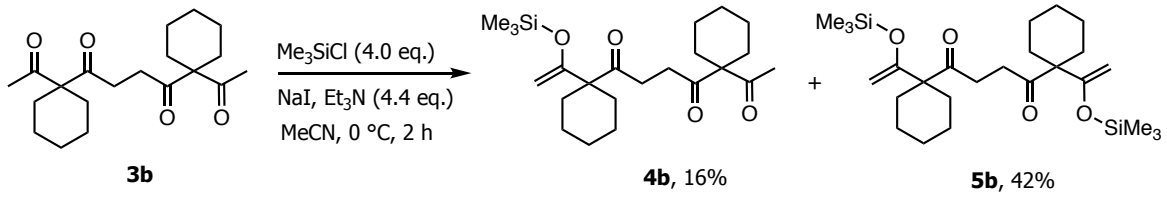


Synthesis of tetraketone **3f** was performed similarly as described previously for **3e** with enol silyl ethers **2c** (2.58 g, 13.0 mmol) and **2d** (2.30 g, 6.5 mmol), dimethyl sulfone (5.50 g, 58.5 mmol), dimethyl sulfoxide (277 µL, 3.9 mmol) and silver(I) oxide (2.71 g, 11.7 mmol). Tetraketone (**3f**) was obtained as colourless viscous oil (365 mg) in 14% yield.

^{1}H NMR (400 MHz, $CDCl_3$, 298 K): δ 7.23 (m, 6H, phenyl), 6.97 (dd, J = 7.3 Hz, 1.6 Hz, 4H, phenyl) 3.32 (ABq, $\Delta\delta_{AB}$ = 0.04, J = 15.1 Hz, 4H, benzyl), 2.73 (m, 2H, ethylene), 2.68 (m, 2H, ethylene), 2.22 (s, 3H, acetyl), 2.21 (s, 3H, acetyl), 1.55 (m, 2H, cyclopropyl), 1.50 (m, 2H, cyclopropyl) ppm; ^{13}C NMR (100 MHz, $CDCl_3$, 298 K): δ 208.0, 206.5, 204.6, 204.2, 136.2, 129.8, 128.6, 127.0, 71.3, 43.1, 37.2, 34.9, 33.8, 28.4, 27.6, 17.7 ppm; HR-ESI-TOF MS: *m/z* calculated for $C_{26}H_{28}O_4$, 427.1880 $[M+Na]^+$, found 427.1886; Elemental analysis (%): calculated for $C_{26}H_{28}O_4$ (%): C, 77.20; H, 6.98, found C, 77.15; H, 7.08; R_f = 0.33 (eluent: hexane/ethyl acetate/dichloromethane = 6:1:4).

2-4 Silylation of acetylacetone tetraketones 3

Synthesis of 4b and 5b



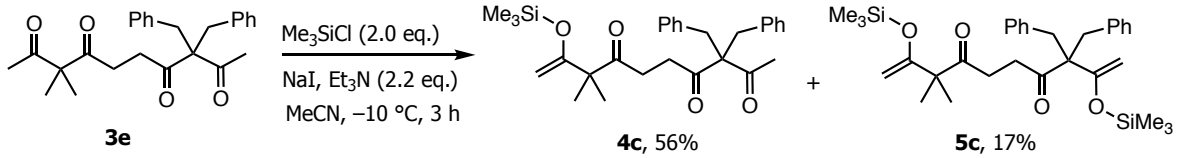
3b **4b**, 16% **5b**, 42%

To a 50 mL round bottom flask, tetraketone **3b** (760 mg, 2.27 mmol), sodium iodide (1.36 g, 9.10 mmol), triethylamine (1.4 mL, 10.0 mmol) and degassed acetonitrile (4 mL) were added. The resulting suspension was cooled to 0 °C with an ice/water bath while stirring. To this mixture, trimethylchlorosilane (1.2 mL, 9.1 mmol) were added slowly *via* syringe keeping the temperature at 0 °C. After additional stirring for 2 h at 0 °C, the reaction was quenched by addition of water (10 mL) and the product mixture were extracted with hexane (50 mL × 3). The combined organic layer was washed with water (50 mL), dried over anhydrous sodium sulfate and the solvent was evaporated under reduced pressure. The residue was chromatographed through silica gel column (diameter 3.0 cm, height 17.0 cm) using a mixture of hexane/ethyl acetate = 19:1 as eluent to obtain bis-silylated product **5b** (450 mg, 42%) as the first fraction followed by mono-silylated product **4b** (150 mg, 16%) as colourless oils, along with recovery of **3b** (290 mg, 38%) in the last fraction.

4b: ^{1}H NMR (400 MHz, $CDCl_3$, 298 K): δ 4.30 (d, J = 1.8 Hz, 1H, vinyl), 4.24 (d, J = 1.8 Hz, 1H, vinyl), 2.80 (dd, J = 6.0 Hz, 4.6 Hz, 2H, ethylene), 2.58 (dd, J = 6.0 Hz, 4.6 Hz, 2H, ethylene), 2.13 (s, 3H, acetyl), 2.00 (t, J = 6.0 Hz, 4H, cyclohexyl), 1.93 (m, 2H, cyclohexyl), 1.66 (m, 2H, cyclohexyl), 1.56-1.36 (m, 12H, cyclohexyl), 0.20 (s, 9H, trimethylsilyl) ppm; ^{13}C NMR (100 MHz, $CDCl_3$, 298 K): δ 210.1, 207.9, 207.4, 160.1, 90.6, 68.2, 57.7, 32.4, 31.4, 31.0, 30.5, 26.5, 26.0, 25.5, 23.0, 22.8, 0.04 ppm; HR-ESI-TOF MS: *m/z* calculated for $C_{23}H_{38}O_4Si$, 429.2432 $[M+Na]^+$, found 429.2429; R_f = 0.23 (eluent: hexane/ethyl acetate = 19:1).

5b: ^{1}H NMR (400 MHz, $CDCl_3$, 298 K): δ 4.30 (d, J = 1.8 Hz, 2H, vinyl), 4.23 (d, J = 1.8 Hz, 2H, vinyl), 2.74 (s, 4H, ethylene), 1.96 (m, 4H, cyclohexyl), 1.66 (m, 4H, cyclohexyl), 1.56-1.34 (m, 12H, cyclohexyl), 0.20 (s, 18H, trimethylsilyl) ppm; ^{13}C NMR (100 MHz, $CDCl_3$, 298 K): δ 210.9, 160.3, 90.5, 57.9, 31.4, 26.1, 22.9, 0.09 ppm; HR-ESI-TOF MS: *m/z* calculated for $C_{26}H_{46}O_4Si_2$, 501.2827 $[M+Na]^+$, found 501.2845; R_f = 0.40 (eluent: hexane/ethyl acetate = 19:1).

Synthesis of 4c and 5c

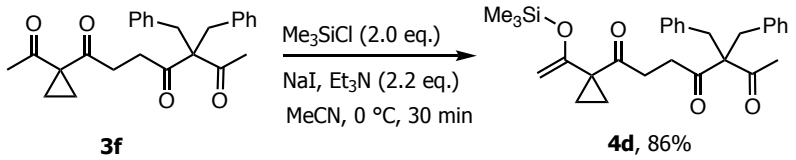


To a 50 mL round bottom flask, tetraketone **3e** (1.54 g, 3.79 mmol), sodium iodide (1.14 g, 7.58 mmol), triethylamine (1.2 mL, 8.33 mmol) and degassed acetonitrile (8 mL) were added. The resulting suspension was cooled to –10 °C using cooling bath while stirring. To this mixture, trimethylchlorosilane (1.0 mL, 7.58 mmol) were added slowly *via* syringe keeping the temperature at –10 °C. After additional stirring for 3 h at –10 °C, the reaction was quenched by addition of water (20 mL) and the product mixture were extracted by hexane (50 mL × 3). The combined organic layer was washed with water (50 mL), dried over anhydrous sodium sulfate and the solvent was evaporated under reduced pressure. The residue was chromatographed through silica gel column (diameter 3.0 cm, height 17.0 cm) using a mixture of hexane/ethyl acetate = 9:1 as eluent to obtain bis-silylated product **5c** (370 mg, 17%) as the first fraction followed by mono-silylated product **4c** (1.02 g, 56%) as colourless oils, along with recovery of **3e** (310 mg, 20%) in the last fraction.

4c: ^{1}H NMR (400 MHz, $CDCl_3$, 298 K): δ 7.23 (m, 6H, phenyl), 6.97 (dd, J = 7.3 Hz, 1.6 Hz, 4H, phenyl), 4.32 (d, J = 1.8 Hz, 1H, vinyl), 4.19 (d, J = 1.8 Hz, 1H, vinyl), 3.32 (ABq, $\Delta\delta_{AB}$ = 0.04, J = 15.1 Hz, 4H, benzyl), 2.74 (dd, J = 6.4 Hz, 6.0 Hz, 2H, ethylene), 2.63 (dd, J = 6.4 Hz, 6.0 Hz, 2H, ethylene), 2.23 (s, 3H, acetyl), 1.23 (s, 6H, -C(CH_3)$_2$-), 0.20 (s, 9H, trimethylsilyl) ppm; ^{13}C NMR (100 MHz, $CDCl_3$, 298 K): δ 211.2, 207.9, 206.7, 162.0, 136.3, 129.8, 128.6, 126.9, 89.1, 71.4, 53.7, 37.2, 34.8, 30.8, 28.5, 23.1, 0.1 ppm; HR-ESI-TOF MS: *m/z* calculated for $C_{29}H_{38}O_4Si$, 501.2432 $[M+Na]^+$, found 501.2433; R_f = 0.40 (eluent: hexane/ethyl acetate = 9:1).

5c: ^{1}H NMR (400 MHz, $CDCl_3$, 298 K): δ 7.20 (m, 6H, phenyl), 7.08 (m, 4H, phenyl), 4.31 (d, J = 1.6 Hz, 1H, vinyl), 4.29 (s, 2H, vinyl), 4.20 (d, J = 1.8 Hz, 1H, vinyl), 3.02 (s, 4H, benzyl), 2.85 (dd, J = 6.4 Hz, 5.0 Hz, 2H, ethylene), 2.71 (dd, J = 6.4 Hz, 5.0 Hz, 2H, ethylene), 1.23 (s, 6H, -C(CH_3)$_2$-), 0.23 (s, 9H, trimethylsilyl), 0.19 (s, 9H, trimethylsilyl) ppm; ^{13}C NMR (100 MHz, $CDCl_3$, 298 K): δ 211.4, 209.9, 162.2, 158.8, 137.5, 130.5, 128.0, 126.4, 91.3, 89.1, 62.5, 53.8, 37.2, 33.2, 31.4, 23.1, 0.1, 0.0 ppm; HR-ESI-TOF MS: *m/z* calculated for $C_{32}H_{46}O_4Si_2$, 573.2827 $[M+Na]^+$, found 573.2831; R_f = 0.50 (eluent: hexane/ethyl acetate = 9:1).

Synthesis of 4d



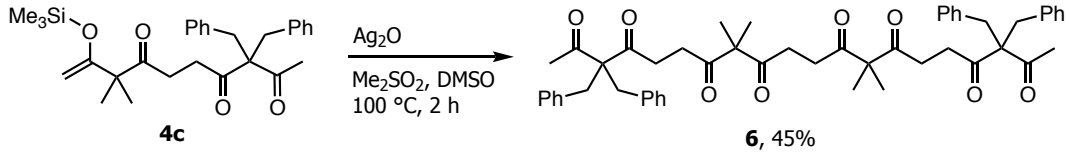
3f **4d**, 86%

Synthesis of **4d** was performed similarly as described previously for **4c** with tetraketone **3f** (340 mg, 0.84 mmol), sodium iodide (252 mg, 1.68 mmol), triethylamine (0.26 mL, 1.84 mmol), degassed acetonitrile (2 mL) and trimethylchlorosilane (0.21 mL, 1.68 mmol) at 0 °C for 30 minutes. The product was purified by silica gel column chromatography (diameter 3.0 cm, height 5.0 cm) using a mixture of hexane/ethyl acetate = 9:1 as eluent to obtain mono-silylated product **4d** (343 mg) in 86% yield as colourless oil.

^{1}H NMR (400 MHz, $CDCl_3$, 298 K): δ 7.23 (m, 6H, phenyl), 6.98 (dd, J = 7.3 Hz, 1.9 Hz, 4H, phenyl), 4.35 (d, J = 1.4 Hz, 1H, vinyl), 4.30 (d, J = 1.4 Hz, 1H, vinyl), 3.32 (ABq, $\Delta\delta_{AB}$ = 0.04, J = 15.1 Hz, 4H, benzyl), 2.98 (dd, J = 6.4 Hz, 6.0 Hz, 2H, ethylene), 2.65 (dd, J = 6.4 Hz, 6.0 Hz, 2H, ethylene), 2.22 (s, 3H, acetyl), 1.31 (m, 2H, cyclopropyl), 1.00 (m, 2H, cyclopropyl), 0.25 (s, 9H, trimethylsilyl) ppm; ^{13}C NMR (100 MHz, $CDCl_3$, 298 K): δ 207.9, 207.8, 206.7, 157.9, 136.3, 129.8, 128.5, 126.9, 93.2, 71.4, 37.4, 37.1, 34.7, 33.8, 28.4, 18.3, 0.2 ppm; HR-ESI-TOF MS: *m/z* calculated for $C_{29}H_{36}O_4Si$, 499.2275 $[M+Na]^+$, found 499.2282; R_f = 0.55 (eluent: hexane/ethyl acetate = 9:1).

2-5 Synthesis of octaketones

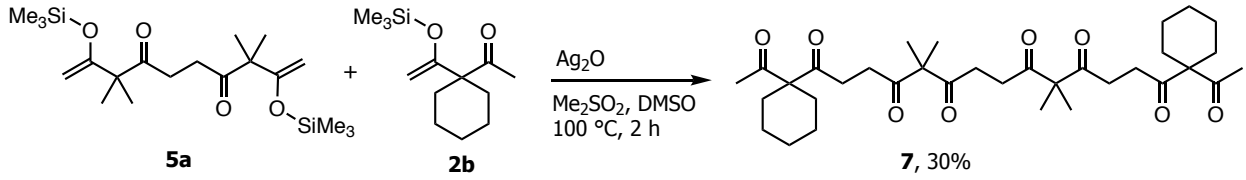
Synthesis of octaketone 6



To a 50 mL round bottom flask equipped with a reflux condenser, enol silyl ether **4c** (1.00 g, 2.1 mmol) dimethyl sulfone (593 mg, 6.3 mmol), dimethyl sulfoxide (30 μL, 0.42 mmol) and silver(I) oxide (292 mg, 1.26 mmol) were added and the reaction mixture was stirred at 100 ºC for 2 h. After cooling to room temperature, the reaction mixture was diluted with 50 mL dichloromethane and filtered through celite pad using additional 150 mL of dichloromethane. The combined filtrate was washed with brine (100 mL × 3), dried over anhydrous sodium sulfate and the solvent was evaporated under reduced pressure. The crude product was first chromatographed through a silica gel column (diameter 2.2 cm, height 17.0 cm) using a mixture of hexane/ethyl acetate/dichloromethane = 6:1:2 as eluent and then further purified by GPC. The resulting viscous oil was passed through silica plug using ethyl acetate as eluent to obtain 3,3,18,18-tetra(phenylmethyl)-8,8,13,13-tetramethyl-icosane-2,4,7,9,12,14,17,19-octaone (**6**) as colourless viscous oil (380 mg) in 45% yield.

^{1}H NMR (400 MHz, $CDCl_3$, 298 K): δ 7.24 (m, 12H, phenyl), 6.97 (dd, J = 7.3 Hz, 1.9 Hz, 8H, phenyl) 3.31 (ABq, $\Delta\delta_{AB}$ = 0.04, J = 15.1 Hz, 8H, benzyl), 2.75 (s, 4H, central ethylene) 2.70 (dd, J = 5.0 Hz, 4.5 Hz, 4H, terminal ethylene), 2.62 (dd, J = 5.0 Hz, 4.5 Hz, 4H, terminal ethylene), 2.23 (s, 6H, acetyl), 1.41 (s, 12H, -C(CH_3)$_2$-) ppm; ^{13}C NMR (100 MHz, $CDCl_3$, 298 K): δ 208.4, 208.2, 207.8, 206.5, 136.2, 129.8, 128.6, 126.9, 71.3, 61.9, 37.2, 34.6, 32.3, 32.1, 28.4, 21.8 ppm; HR-ESI-TOF MS: *m/z* calculated for $C_{52}H_{58}O_8$, 833.4024 $[M+Na]^+$, found 833.4016; Elemental analysis (%): calculated for $C_{52}H_{58}O_8$ (%): C, 77.01; H, 7.21, found C, 76.75; H, 7.36; R_f = 0.14 (eluent: hexane/ethyl acetate/dichloromethane = 6:1:2).

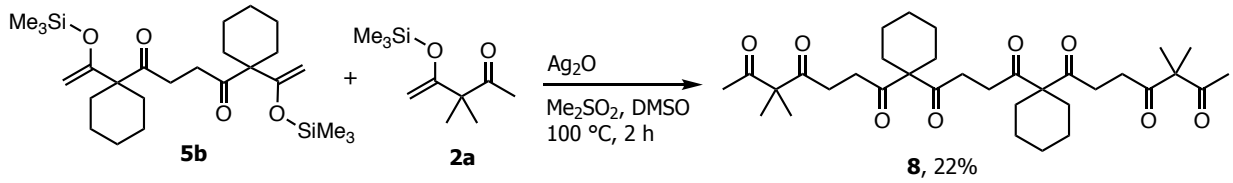
Synthesis of octaketone 7



To a 50 mL round bottom flask equipped with a reflux condenser, enol silyl ethers **5a** (666 mg, 1.67 mmol) and **2b** (4.0 g, 16.6 mmol) were mixed and stirred for 5 min. To this mixture, dimethyl sulfone (5.2 g, 54.9 mmol), dimethyl sulfoxide (260 µL, 3.66 mmol) and silver(I) oxide (2.55 g, 11.0 mmol) were added and the reaction mixture was stirred at 100 ºC for 2 h. After cooling to room temperature, the reaction mixture was diluted with 50 mL dichloromethane and filtered through celite pad using additional 150 mL of dichloromethane. The combined filtrate was washed with brine (100 mL × 3), dried over anhydrous sodium sulfate and the solvent was evaporated under reduced pressure. The crude product was first chromatographed through a silica gel column (diameter 5.0 cm, height 9.0 cm) using a mixture of hexane/ethyl acetate/dichloromethane = 6:1:2 as eluent and then further purified by GPC. The resulting solid was passed through silica plug using ethyl acetate as eluent and precipitated by addition of hexane to obtain octaketone (**7**) as white solid (290 mg) in 30% yield.

^{1}H NMR (400 MHz, $CDCl_3$, 298 K): δ 2.73 (s, 4H, central ethylene), 2.69 (m, 8H, terminal ethylene), 2.12 (s, 6H, acetyl), 1.99 (broad t, J = 5.5 Hz , 8H, cyclohexyl), 1.47 (m, 8H, cyclohexyl), 1.39 – 1.37 (m, 4H, cyclohexyl), 1.39 (s, 12H, -C(CH_3)$_2$-) ppm; ^{13}C NMR (100 MHz, $CDCl_3$, 298 K): δ 208.3, 208.1, 207.6, 207.2, 68.0, 61.8, 32.3, 32.2, 32.1, 30.4, 26.4, 25.4, 22.9, 21.8 ppm; IR (ATR, neat): $\tilde{\nu}$ = 2994 (w), 2930 (m), 2862 (w), 1687 (s), 1465 (m), 1452 (m), 1391 (m), 1363 (m), 1345 (m), 1296 (w), 1179 (m), 1066 (m), 1015 (m), 968 (m), 803 (m) cm^{-1}; mp 83 - 85 °C; HR-ESI-TOF MS: *m/z* calculated for $C_{34}H_{50}O_8$, 609.3398 $[M+Na]^+$, found 609.3414; Elemental analysis (%): calculated for $C_{34}H_{50}O_8$ (%): C, 69.60; H, 8.59, found C, 69.55; H, 8.57; R_f = 0.15 (eluent: hexane/ethyl acetate/dichloromethane = 6:1:2).

Synthesis of octaketone 8



The synthesis of the octaketone **8** was performed similarly as described previously for **7** with enol silyl ethers **5b** (450 mg, 0.94 mmol) and **2a** (1.88 g, 9.4 mmol), dimethyl sulfone (2.80 g, 30.0 mmol), dimethyl sulfoxide (147 µL, 2.1 mmol) and silver(I) oxide (1.44 g, 6.2 mmol). After purification, octaketone (**8**) was obtained as white solid (290 mg) in 30% yield.

^{1}H NMR (400 MHz, $CDCl_3$, 298 K): δ 2.71 (m, 4H, terminal ethylene), 2.67 (m, 4H, terminal ethylene), 2.66 (s, 4H, central ethylene), 2.16 (s, 6H, acetyl) 2.02 (broad t, J = 5.5 Hz , 8H, cyclohexyl), 1.47 (m, 8H, cyclohexyl), 1.39 (m, 4H, cyclohexyl), 1.37 (s, 12H, -C(CH_3)$_2$-) ppm; ^{13}C NMR (100 MHz, $CDCl_3$, 298 K): δ 208.7, 207.8, 207.7, 207.4, 67.7, 62.3, 32.32, 32.29, 30.6, 26.5, 25.5, 23.0, 21.6 ppm; IR (ATR, neat): $\tilde{\nu}$ = 2995 (w), 2935 (m), 2858 (w), 1687 (s), 1451 (w), 1444 (m), 1394 (m), 1346 (m), 1304 (m), 1206 (m), 1116 (m), 1066 (m), 1028 (m), 998 (m), 962 (m), 756 (m), 693 (m) cm^{-1}; mp 164 – 166 °C; HR-ESI-TOF MS: *m/z* calculated for $C_{34}H_{50}O_8$, 585.3433 $[M\text{-}H]^-$, found 585.3446; Elemental analysis (%): calculated for $C_{34}H_{50}O_8$ (%): C, 69.60; H, 8.59, found C, 69.41; H, 8.57; R_f = 0.13 (eluent: hexane/ethyl acetate/dichloromethane = 6:1:2).

2-6 NMR analysis of homo-coupling reaction of 2c

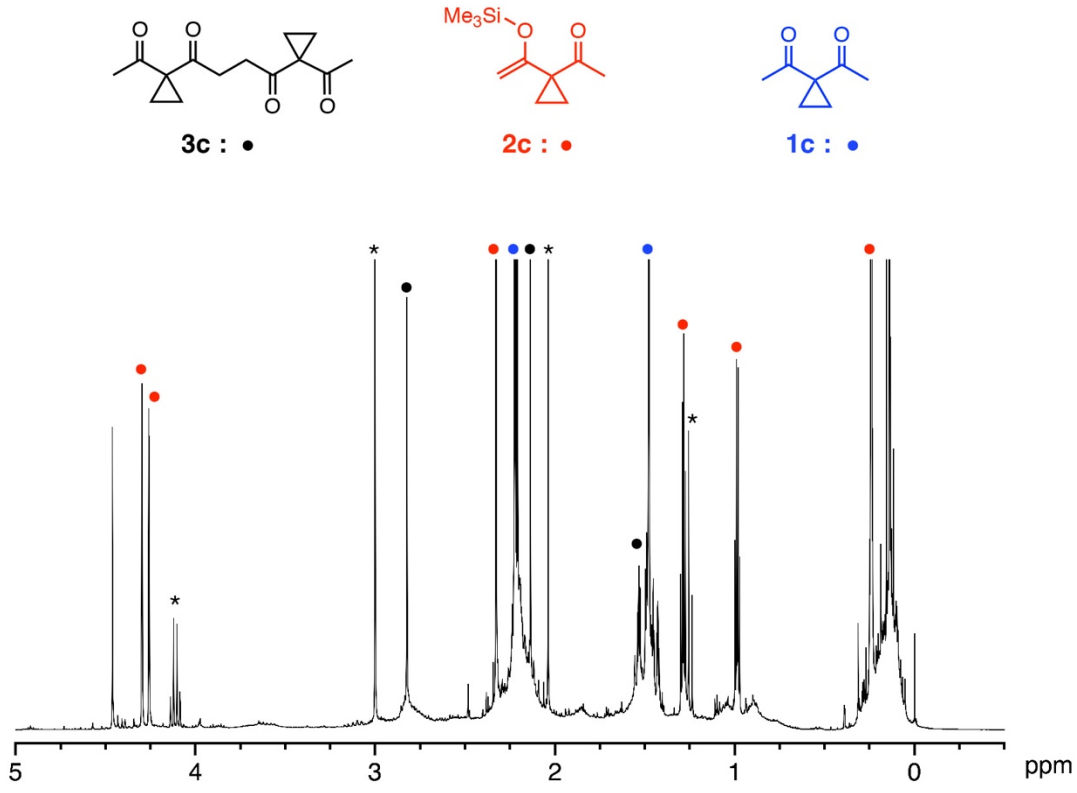


Figure S2. ^{1}H NMR spectrum (blow-up of the aliphatic region in $CDCl_3$) of crude products obtained from coupling reaction of **2c** (Table 2, for the synthesis of **3c**).

2-7 NMR monitoring of the coupling reactions using 2a and 2d

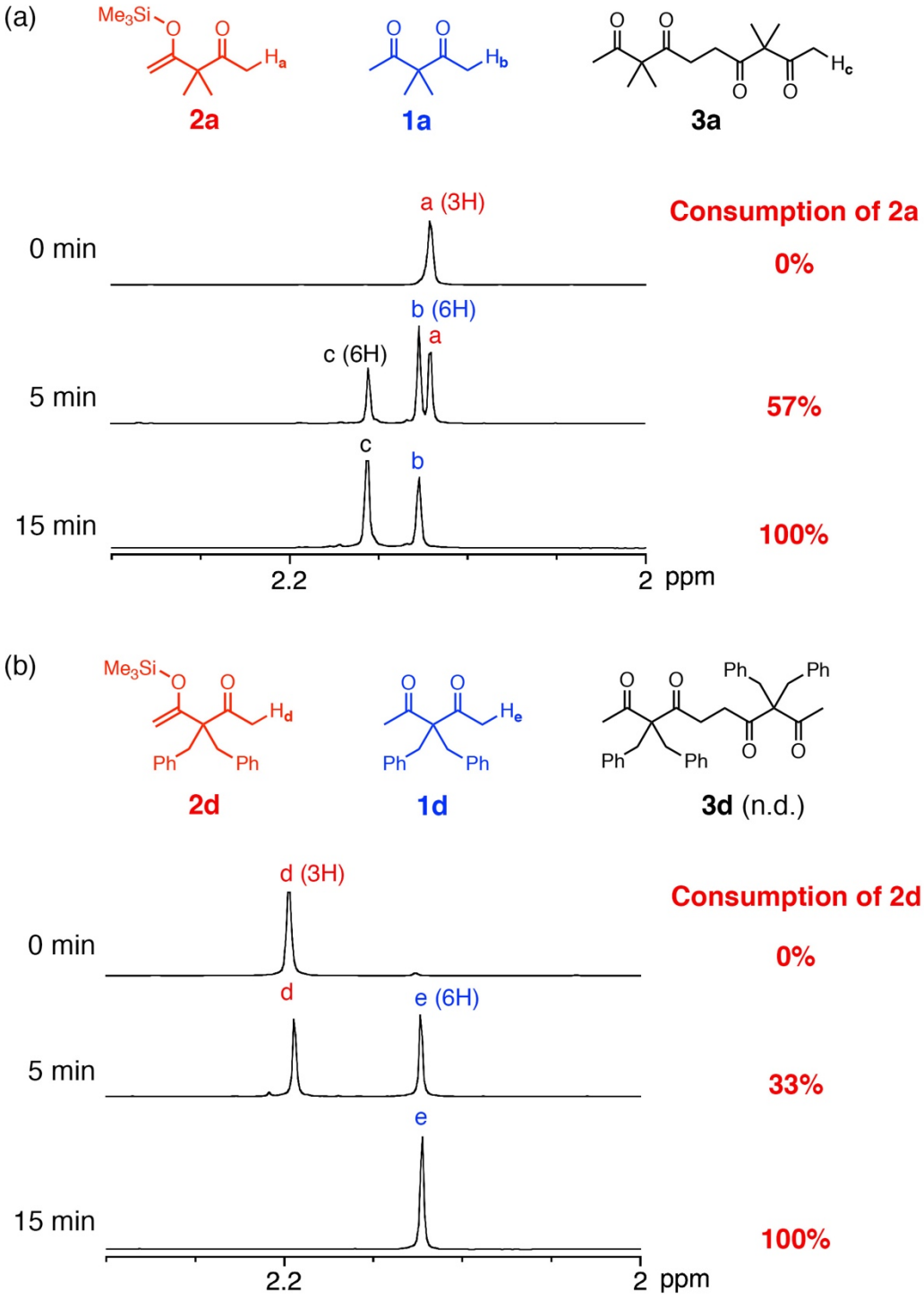


Figure S3. ^{1}H NMR spectra of reaction mixtures under the Ag_2O-mediated homo-coupling conditions using (a) **2a** and (b) **2d**. (top: before heating, middle: after heating to 100 °C for 5 min, bottom: after heating to 100 °C for 15 min, *: solvent peaks)

3. X-ray Crystallographic Analysis

Single crystal X-ray diffraction data for (2d)

Single crystals of **2d** were grown by slow evaporation of the solution in hexane at 0 °C. Colourless needle-like crystal of approximate size 0.40 × 0.20 × 0.06 mm^3, was used for data collection. $C_{22}H_{28}O_2Si$, M_W = 352.53, Monoclinic, space group *C*2, a = 19.7751(7) Å, b = 7.6977(3) Å, c =13.7091(5) Å, β = 104.859(4)°, V = 2017.05(13) $Å^3$, Z = 4, T = 123(2) K, μ = 0.128 mm^{-1}, D_{calc} = 1.161 g/cm^3, 2.286° ≤ θ ≤ 24.998°, 3240 unique reflections out of 3316 with $I > 2\sigma(I)$, GOF = 1.082, R_1 = 0.0268, wR_2 = 0.0720. CCDC deposit number: 1987581.

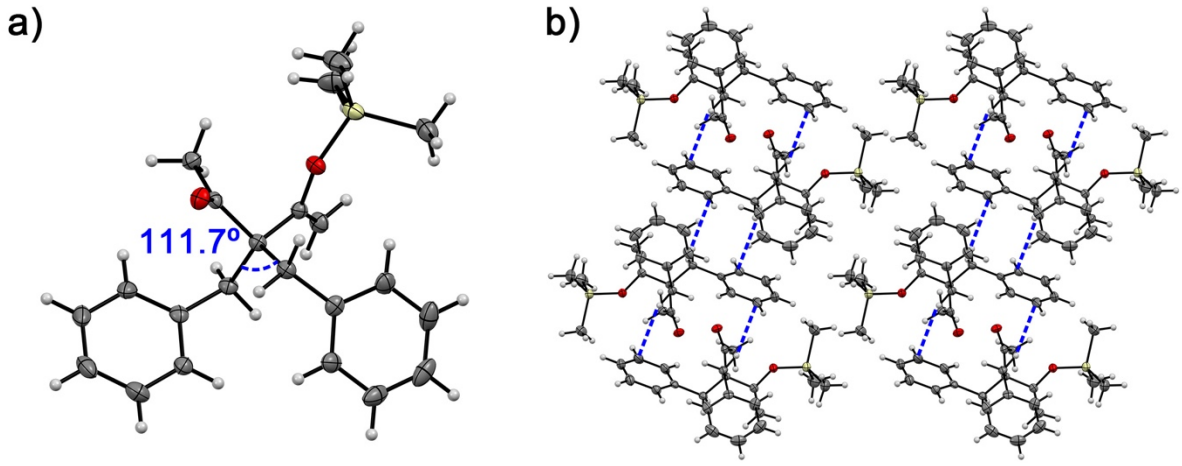


Figure S4. a) Crystal structure of mono-silylated monomer **2d**. Thermal ellipsoid are set at 50% probability b) crystal packing for mono-silylated monomer **2d** viewing along *b*-axis. Blue-dashed lines indicate presence of intermolecular CH-π interaction.

4. 1D and 2D NMR Spectra

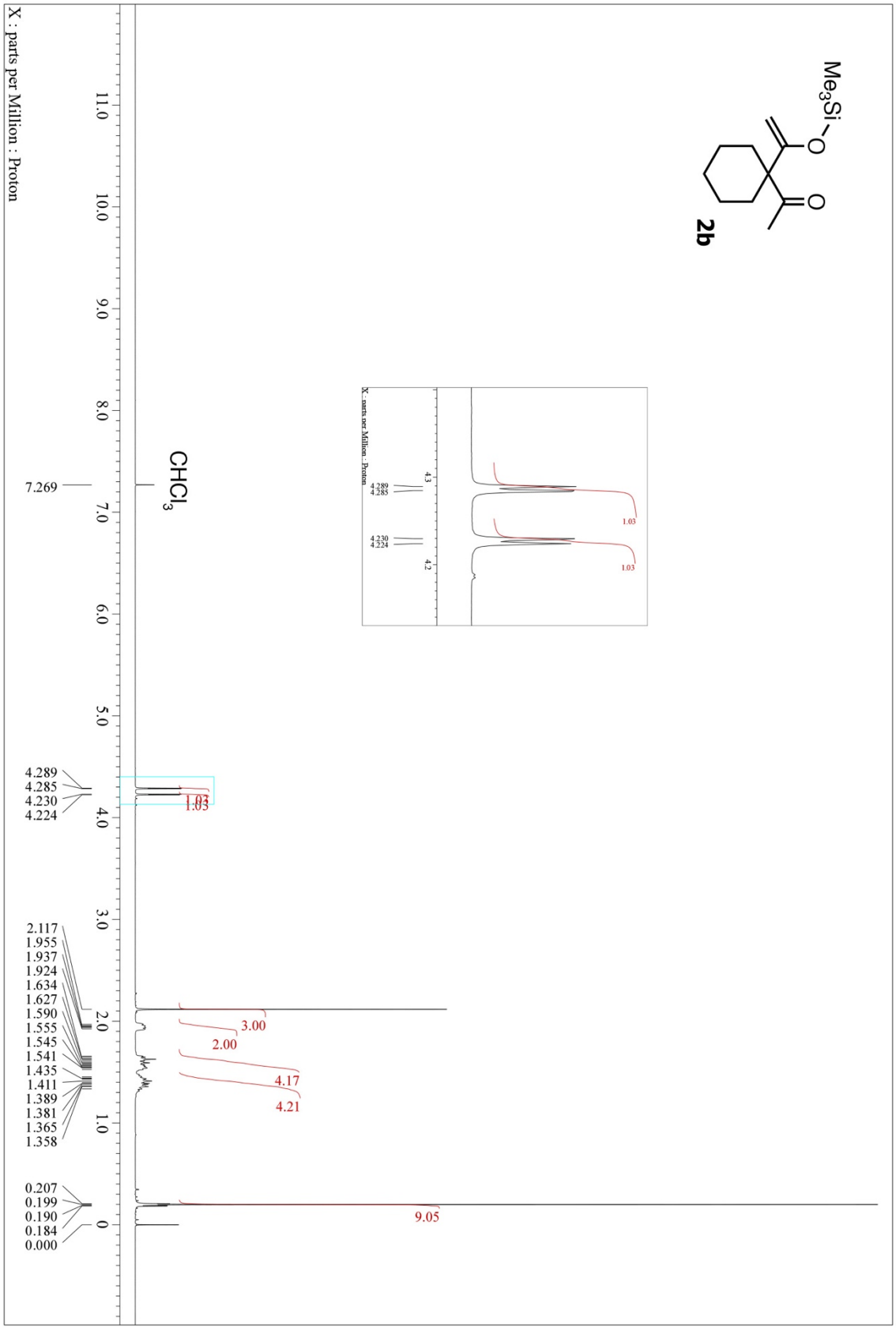


Figure S5. ^{1}H NMR spectrum of **2b** in $CDCl_3$ at 25 °C.

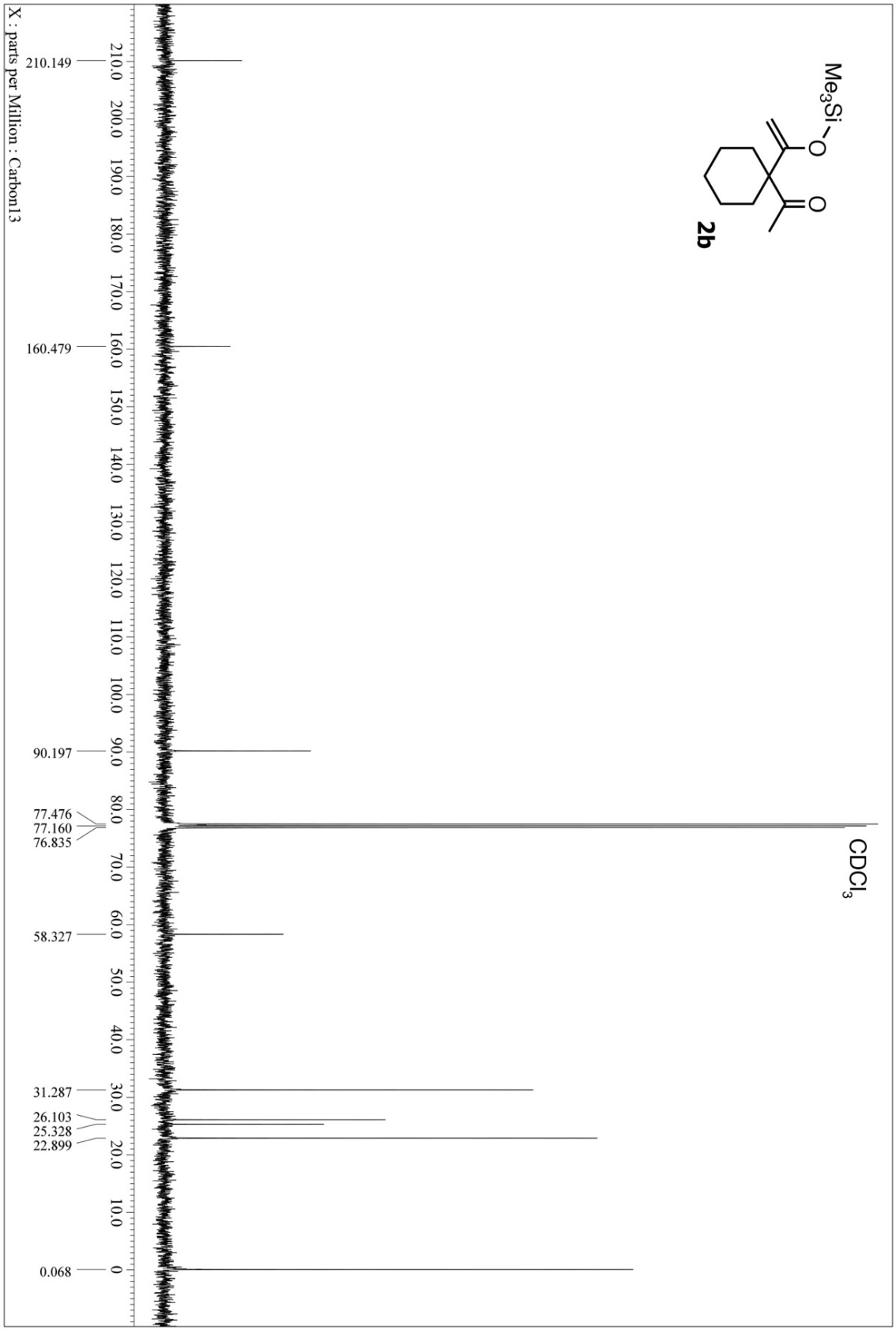


Figure S6. ^{13}C NMR spectrum of **2b** in $CDCl_3$ at 25 °C.

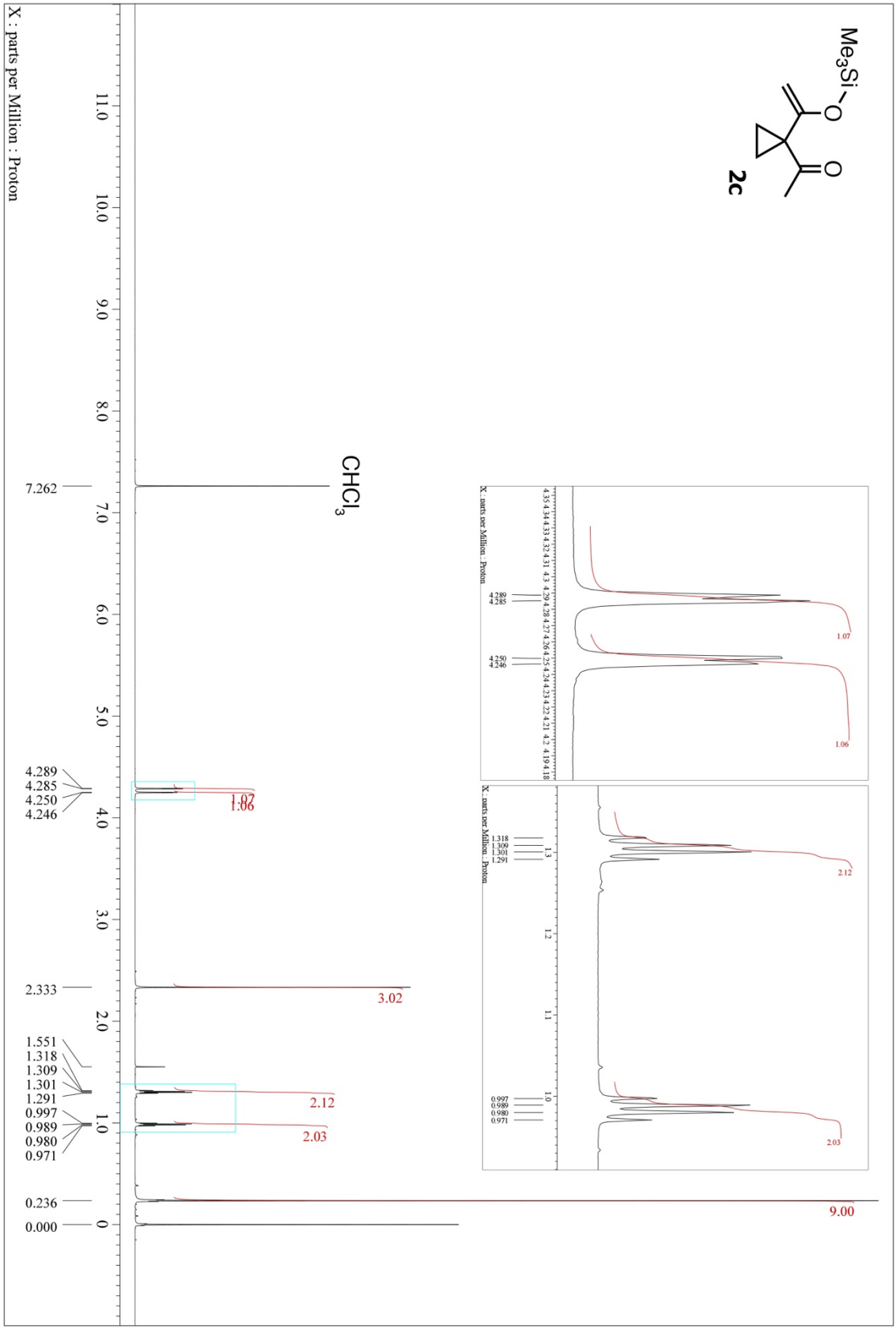


Figure S7. ^{1}H NMR spectrum of **2c** in $CDCl_3$ at 25 °C.

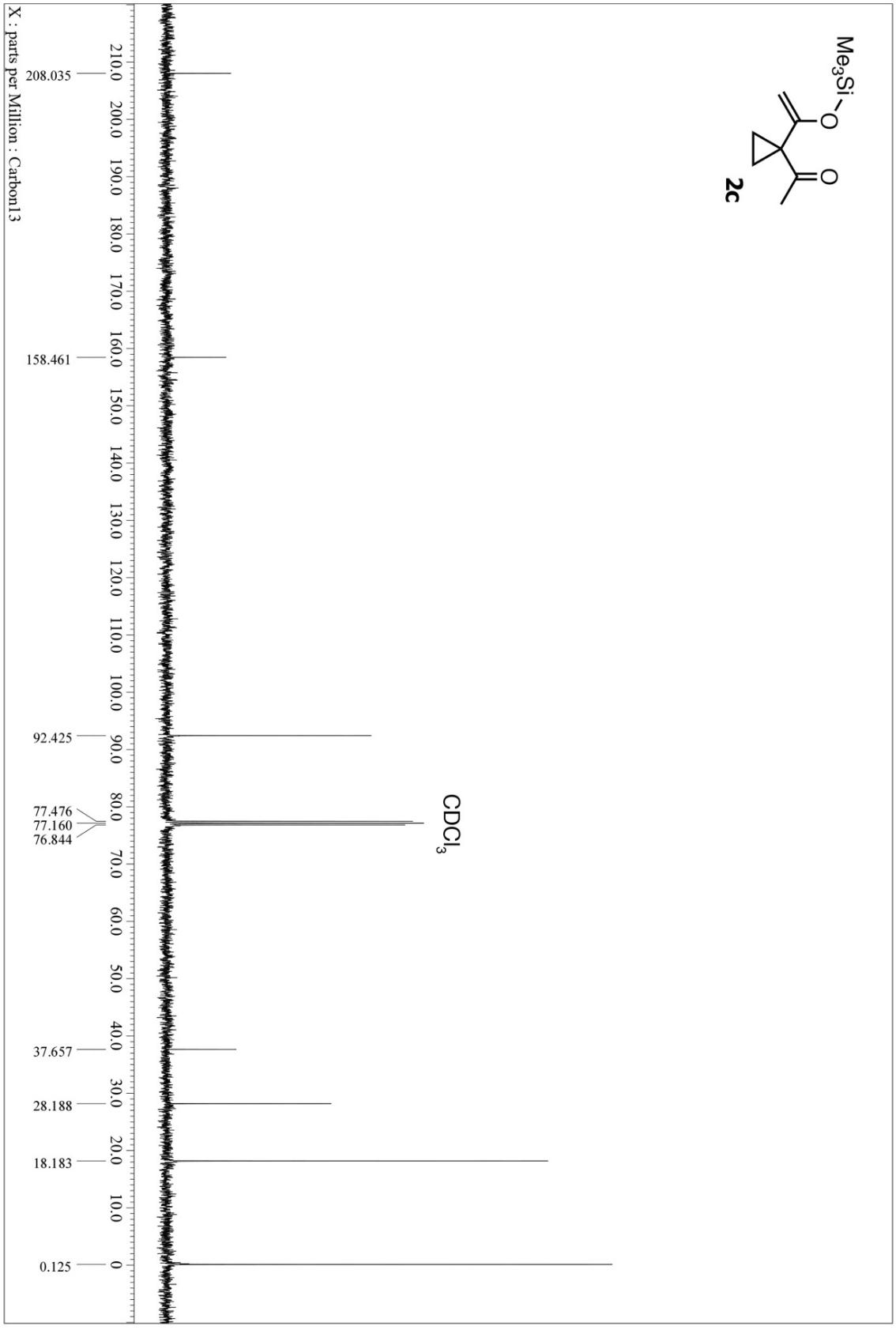


Figure S8. ^{13}C NMR spectrum of **2c** in $CDCl_3$ at 25 °C.

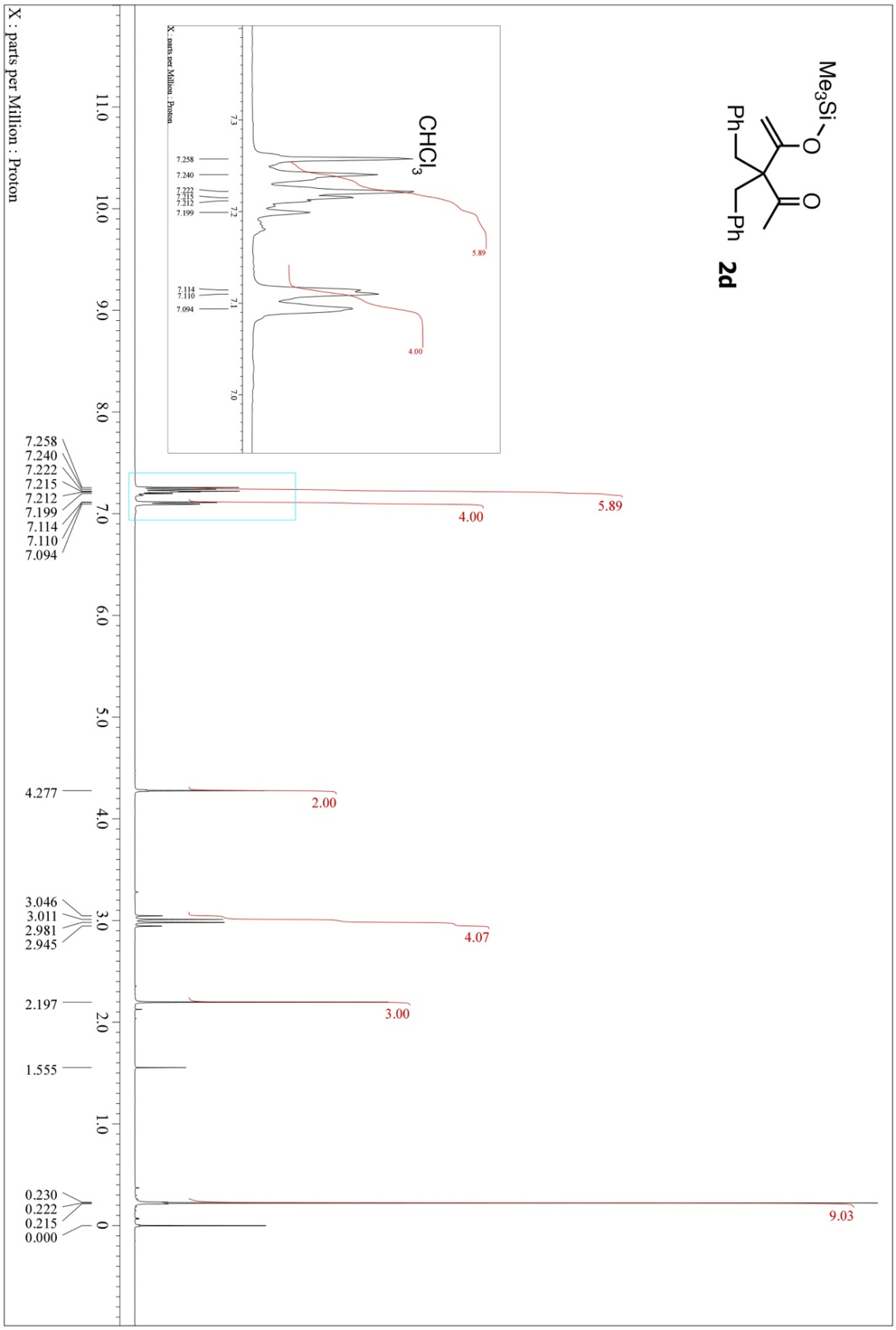


Figure S9. ^{1}H NMR spectrum of **2d** in $CDCl_3$ at 25 °C.

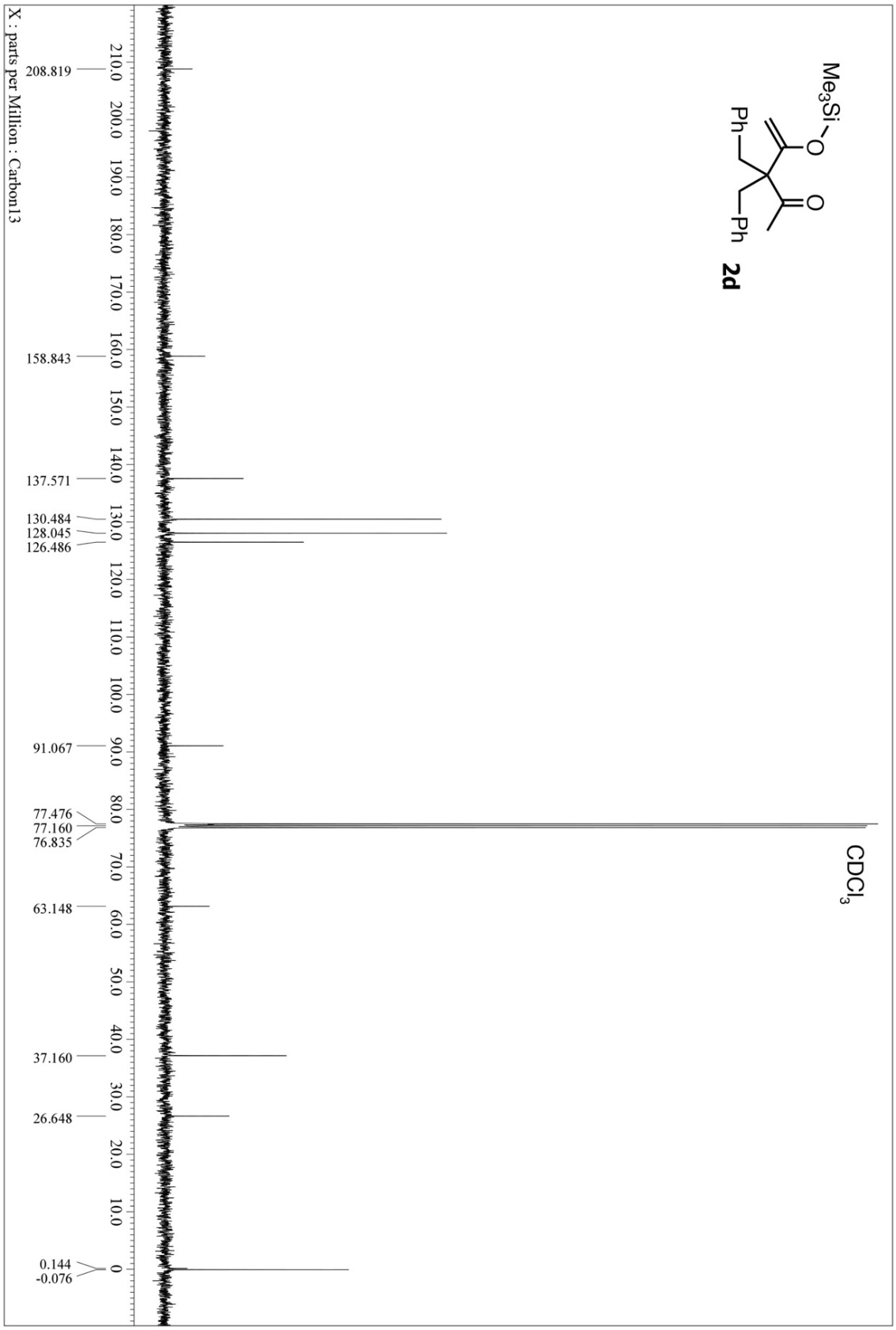


Figure S10. ^{13}C NMR spectrum of **2d** in $CDCl_3$ at 25 °C.

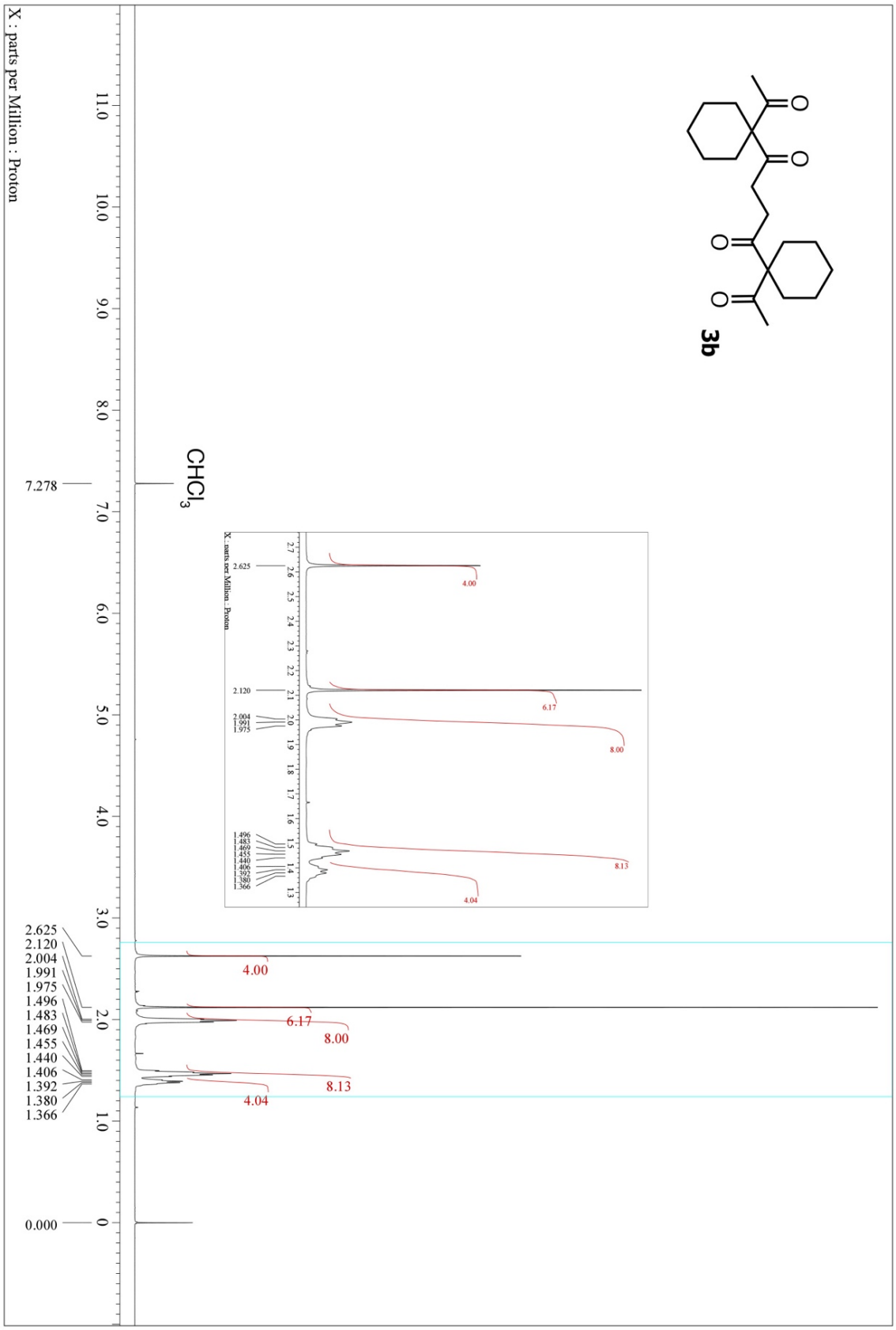


Figure S11. ^{1}H NMR spectrum of **3b** in $CDCl_3$ at 25 °C.

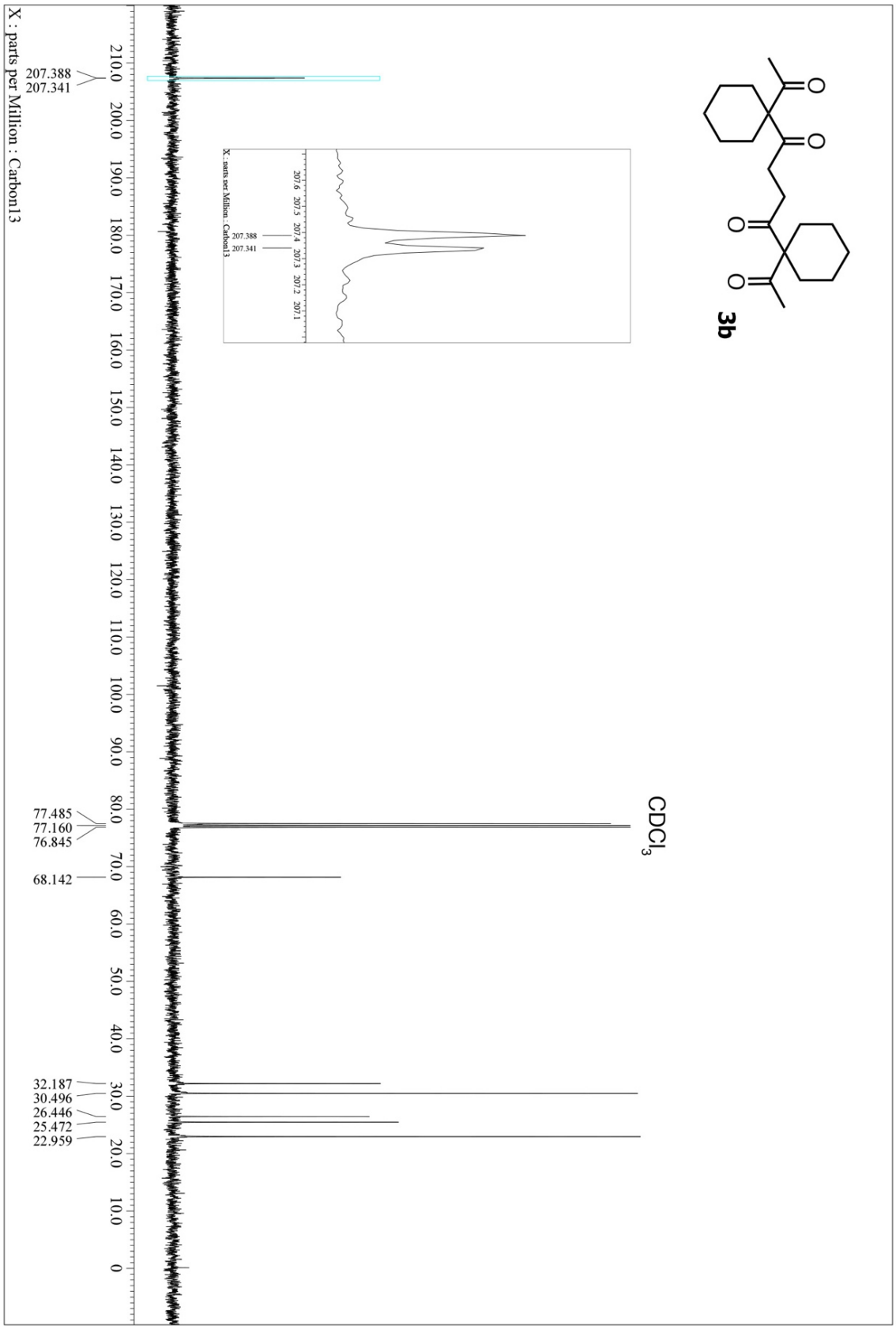


Figure S12. ^{13}C NMR spectrum of **3b** in $CDCl_3$ at 25 °C.

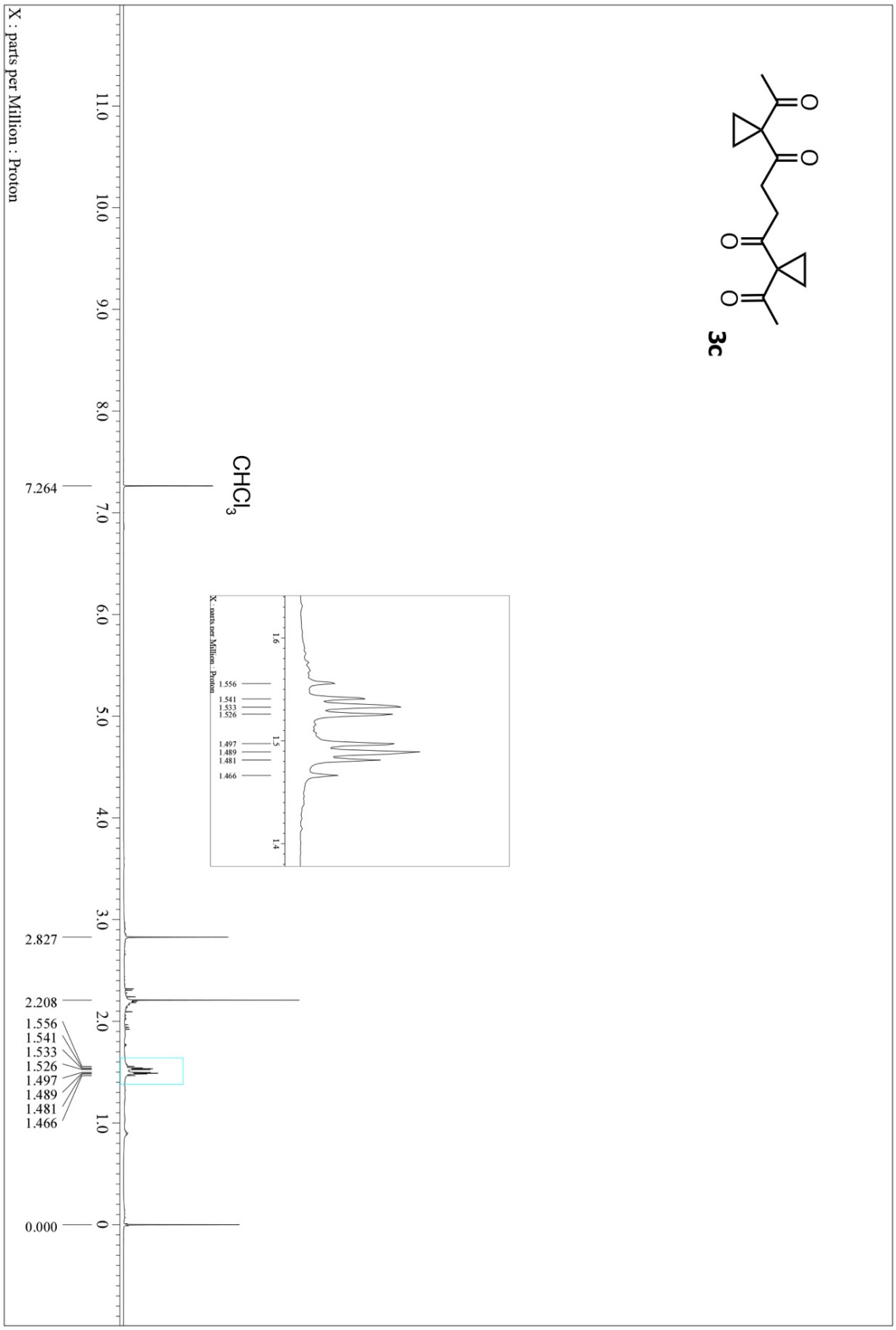


Figure S13. ^{1}H NMR spectrum of **3c** in $CDCl_3$ at 25 °C.

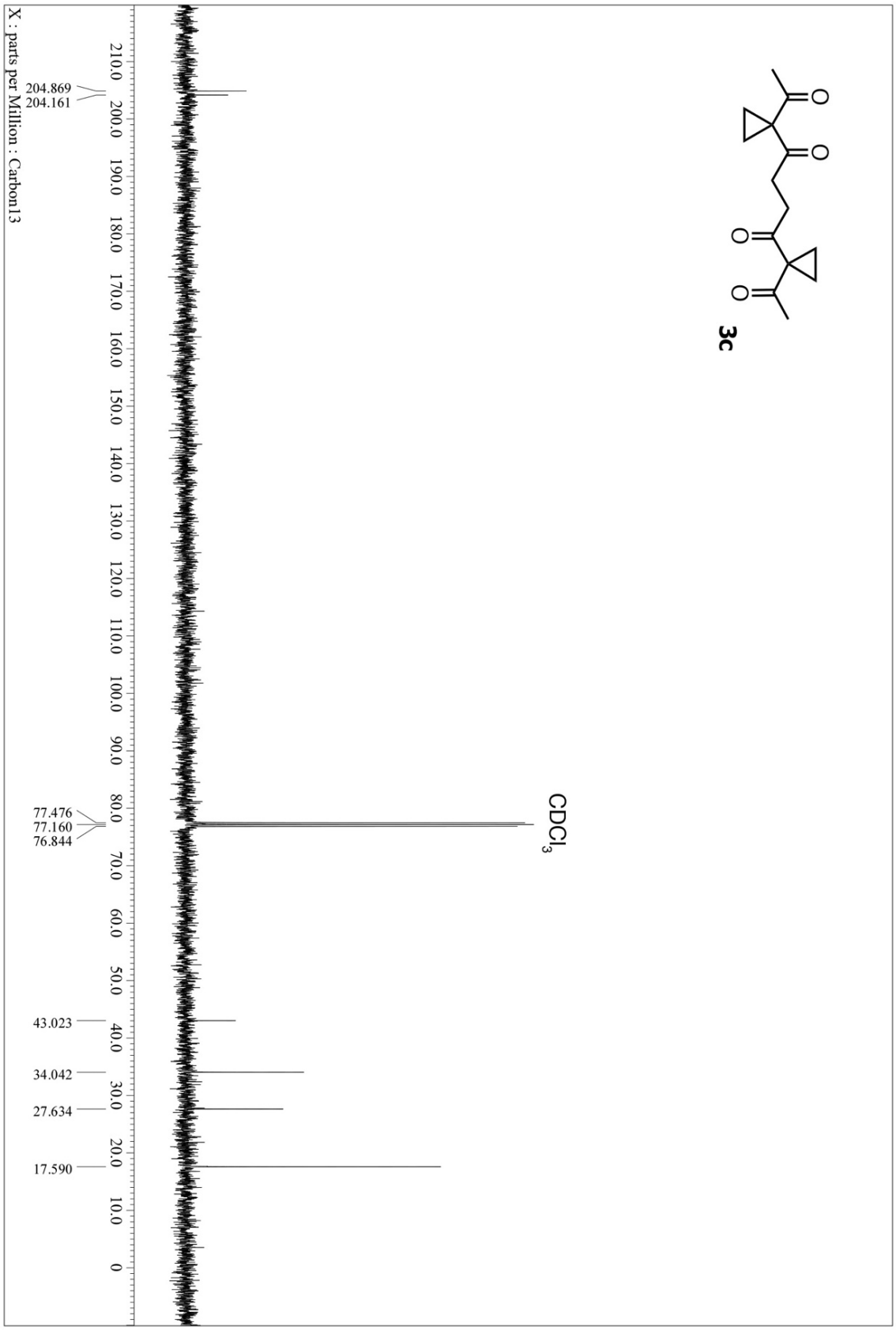


Figure S14. ^{13}C NMR spectrum of **3c** in $CDCl_3$ at 25 °C.

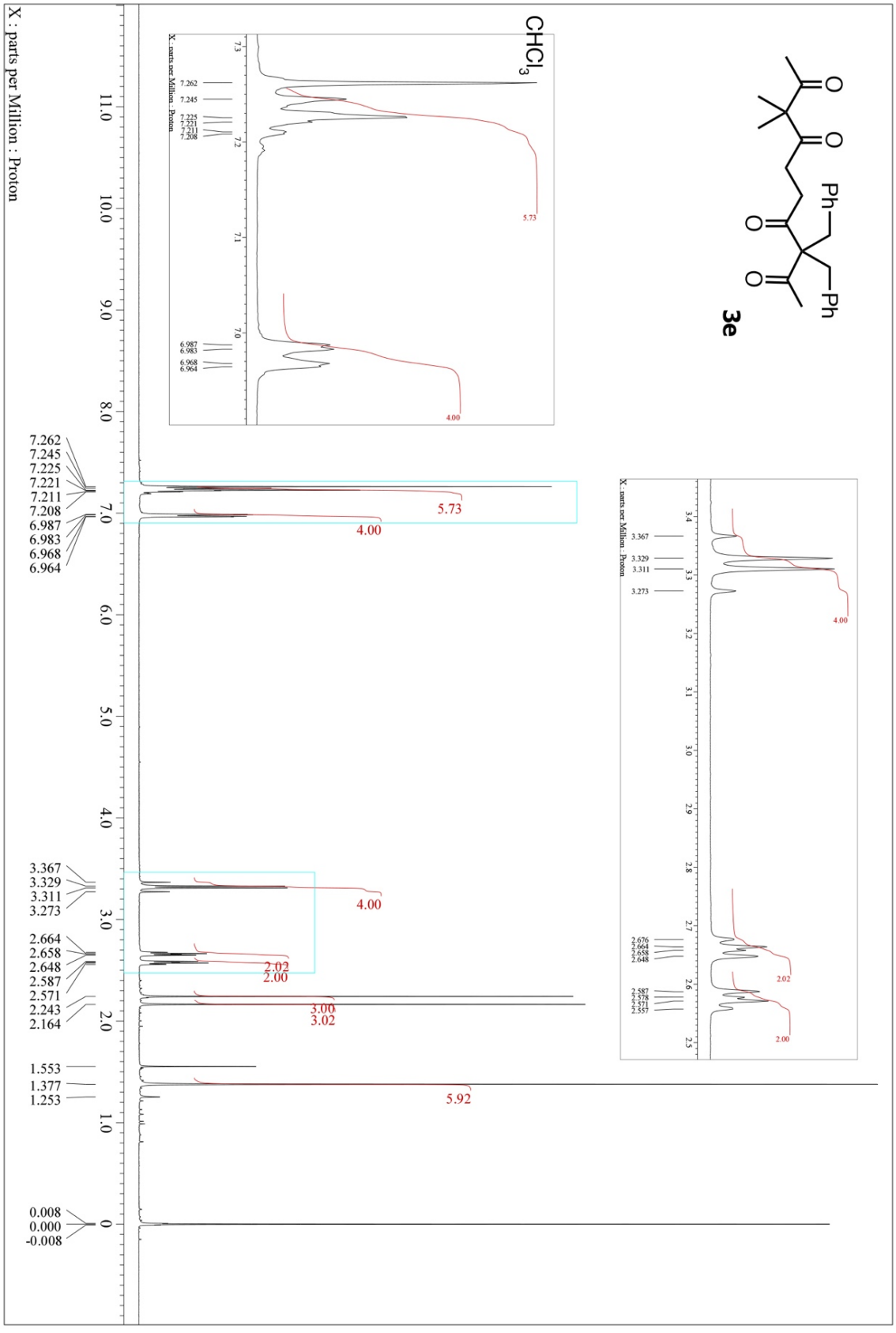


Figure S15. ^{1}H NMR spectrum of **3e** in $CDCl_3$ at 25 °C.

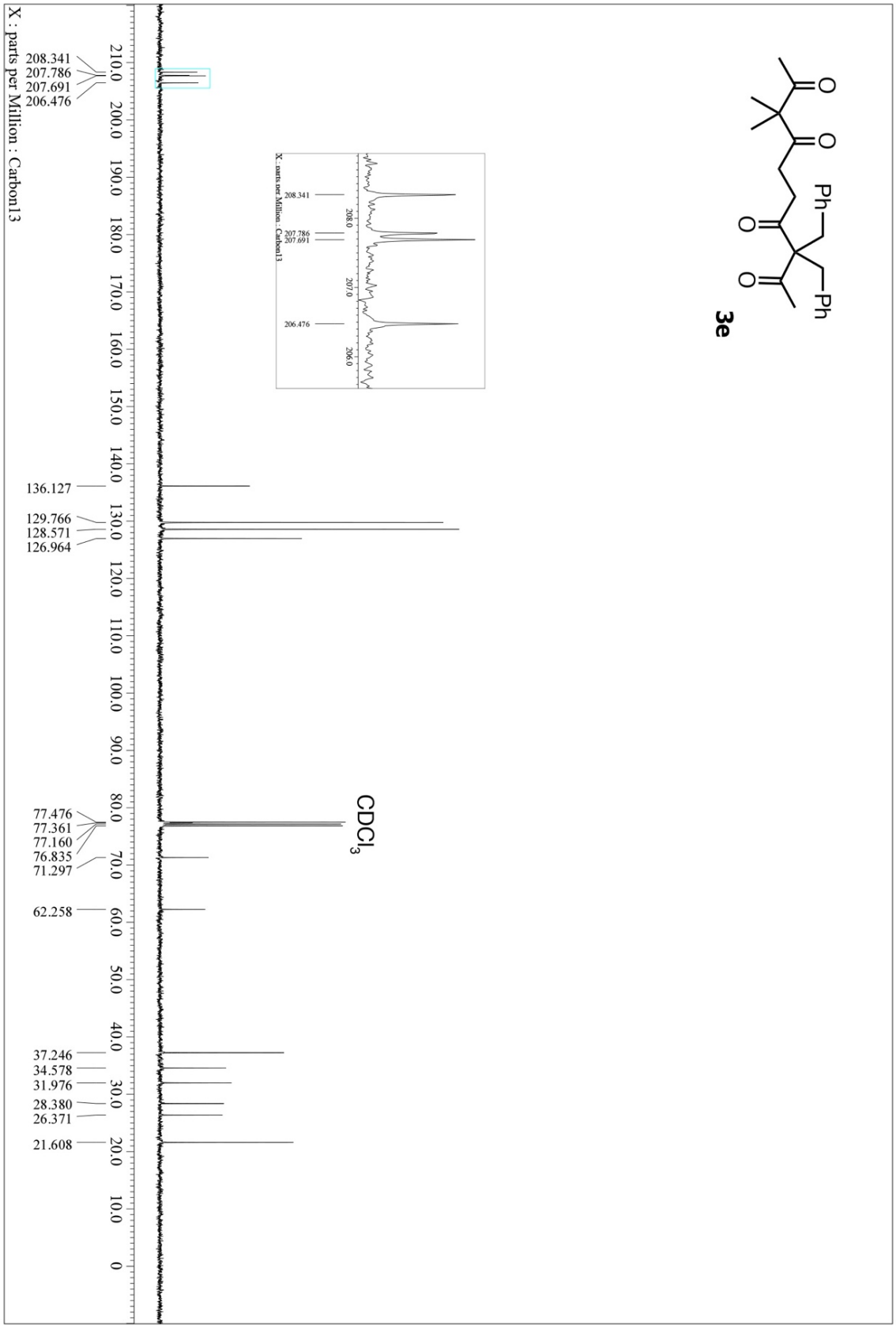


Figure S16. ^{13}C NMR spectrum of **3e** in $CDCl_3$ at 25 °C.

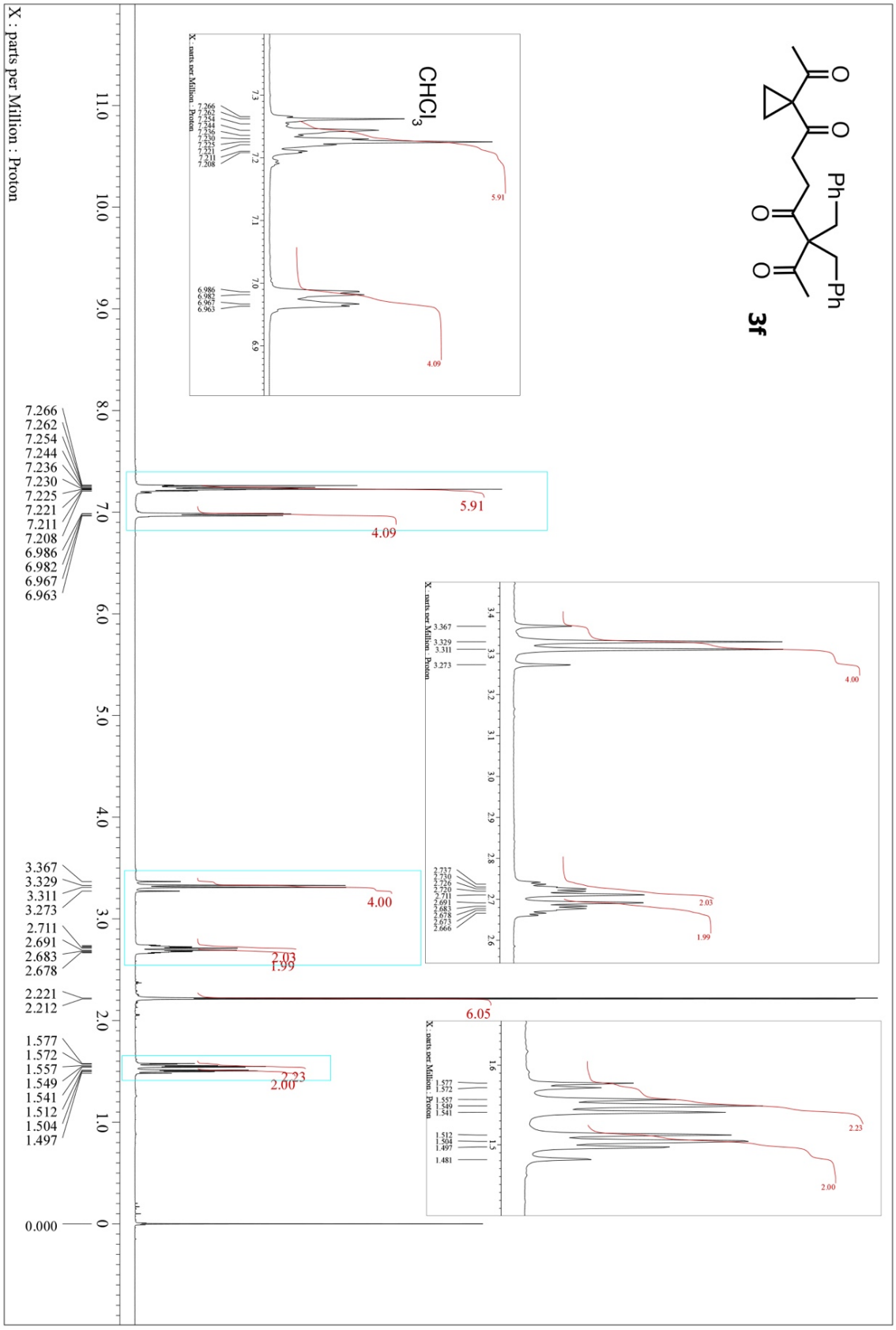


Figure S17. ^{1}H NMR spectrum of **3f** in $CDCl_3$ at 25 °C.

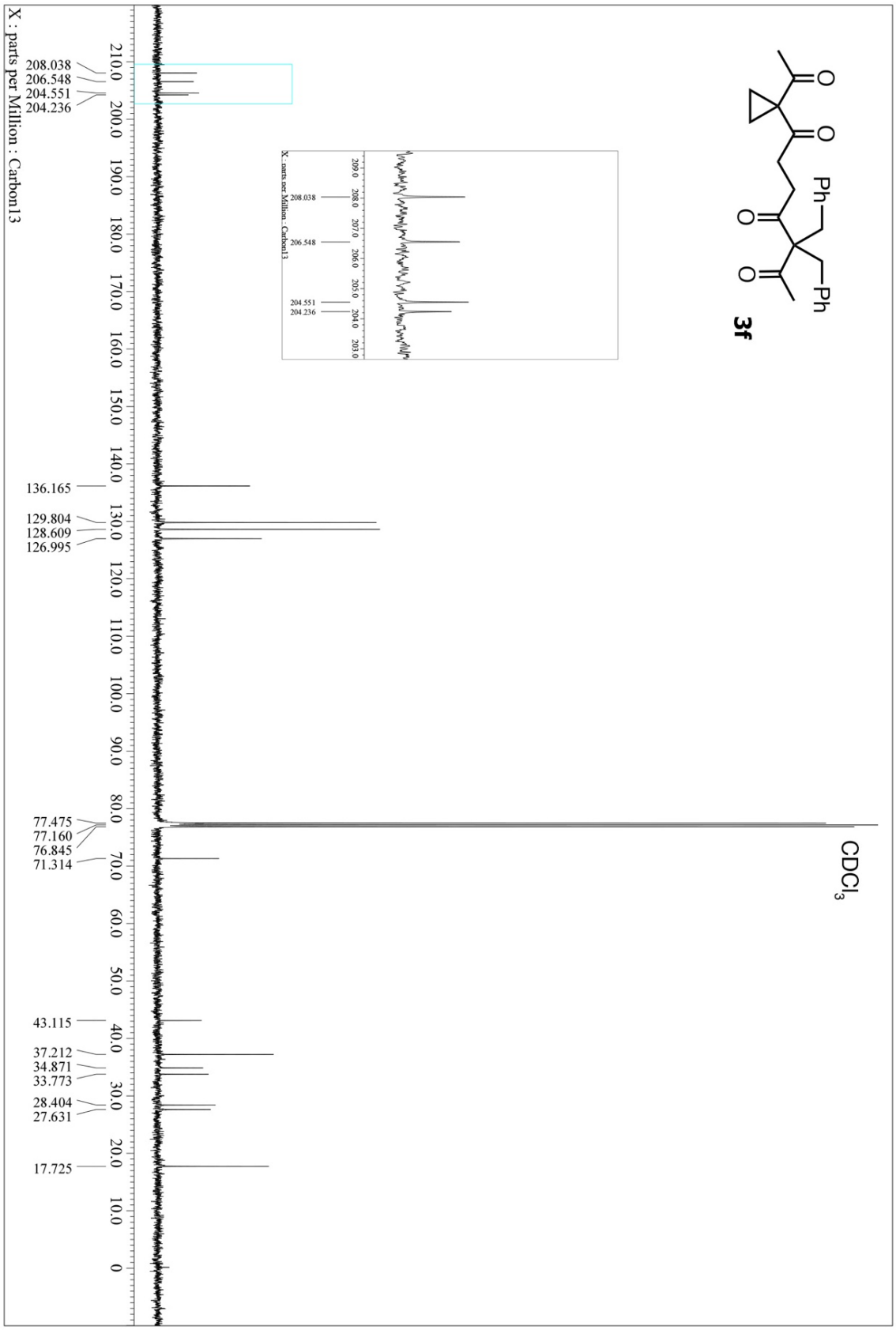


Figure S18. ^{13}C NMR spectrum of **3f** in $CDCl_3$ at 25 °C.

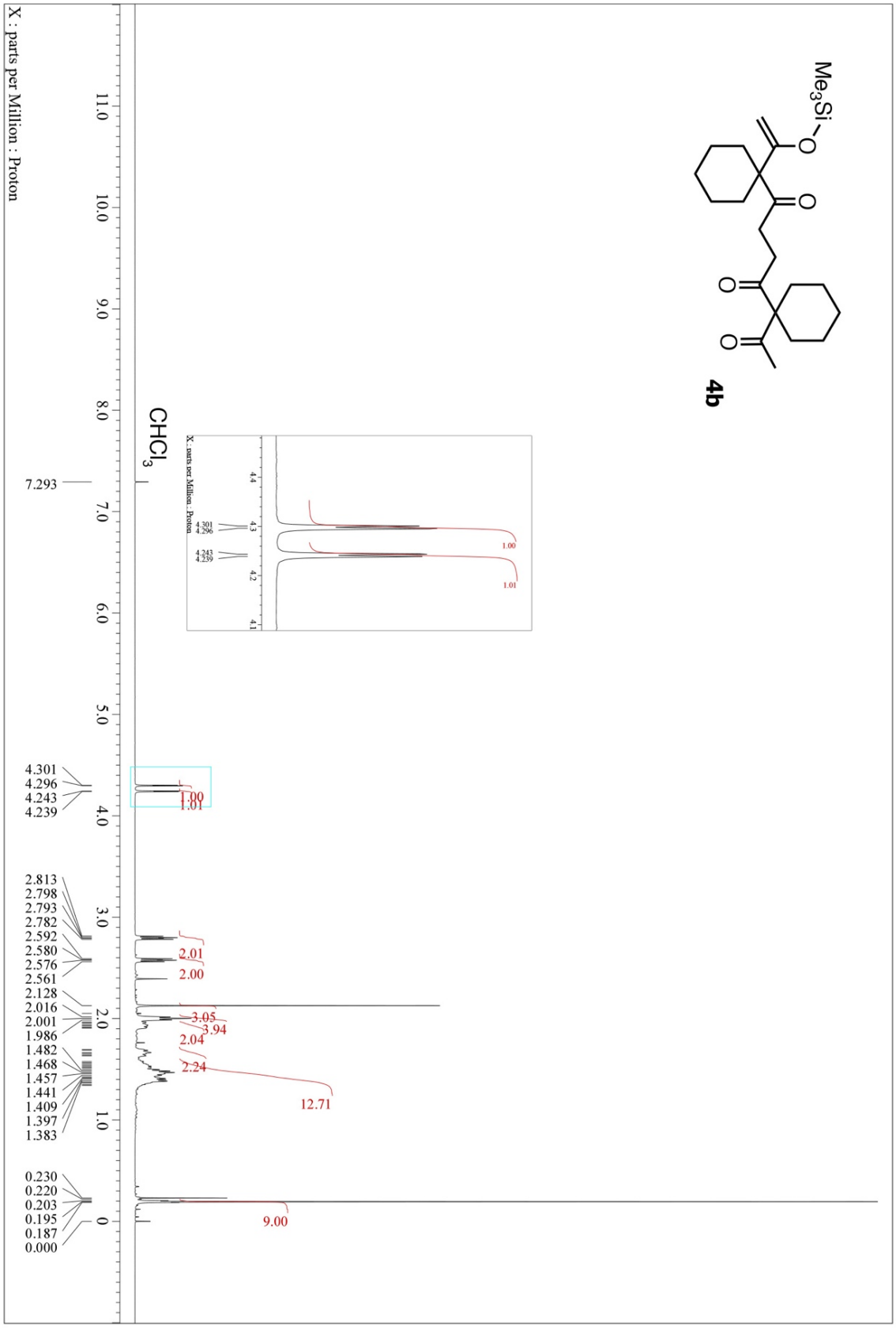


Figure S19. ^{1}H NMR spectrum of **4b** in $CDCl_3$ at 25 °C.

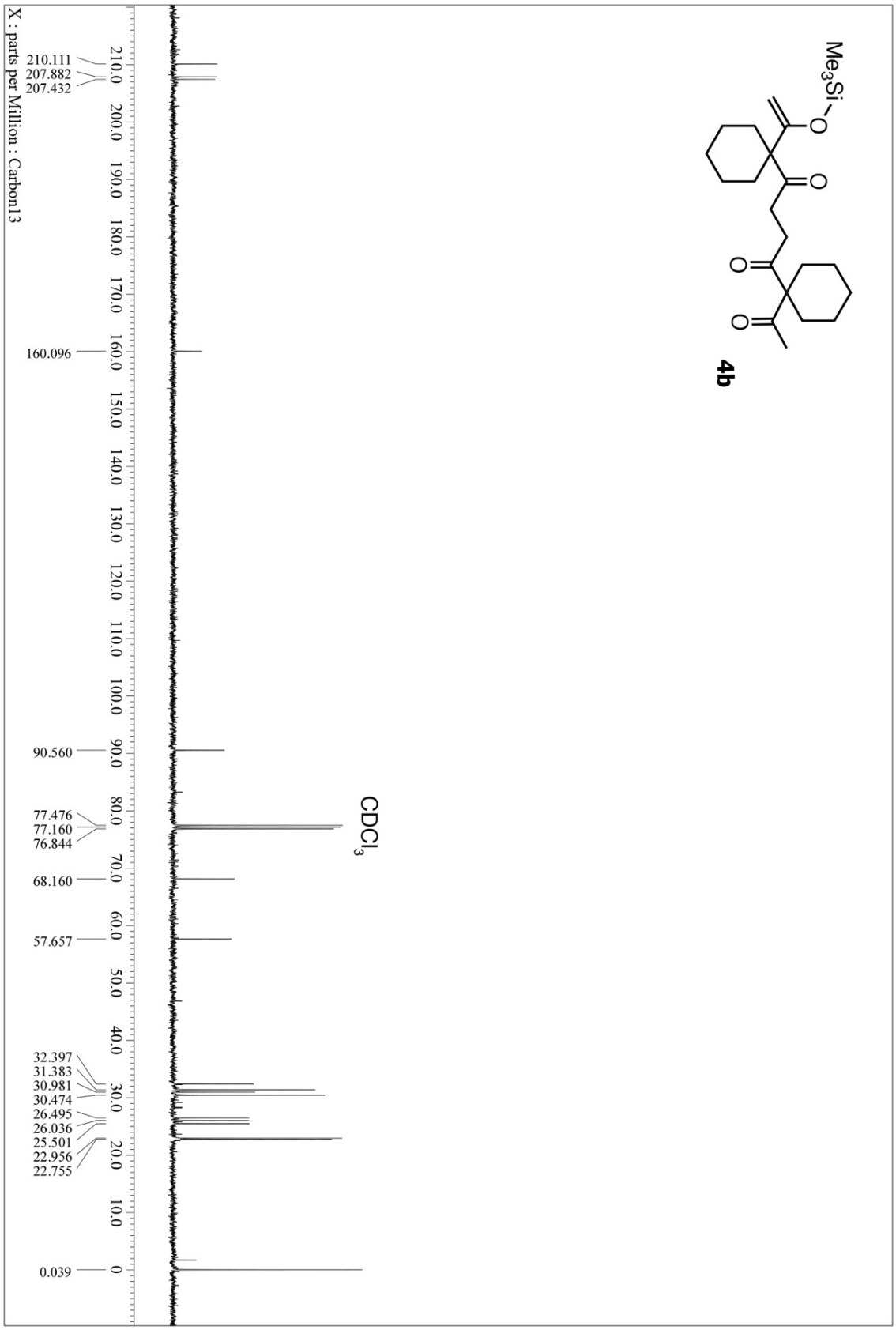


Figure S20. ^{13}C NMR spectrum of **4b** in $CDCl_3$ at 25 °C.

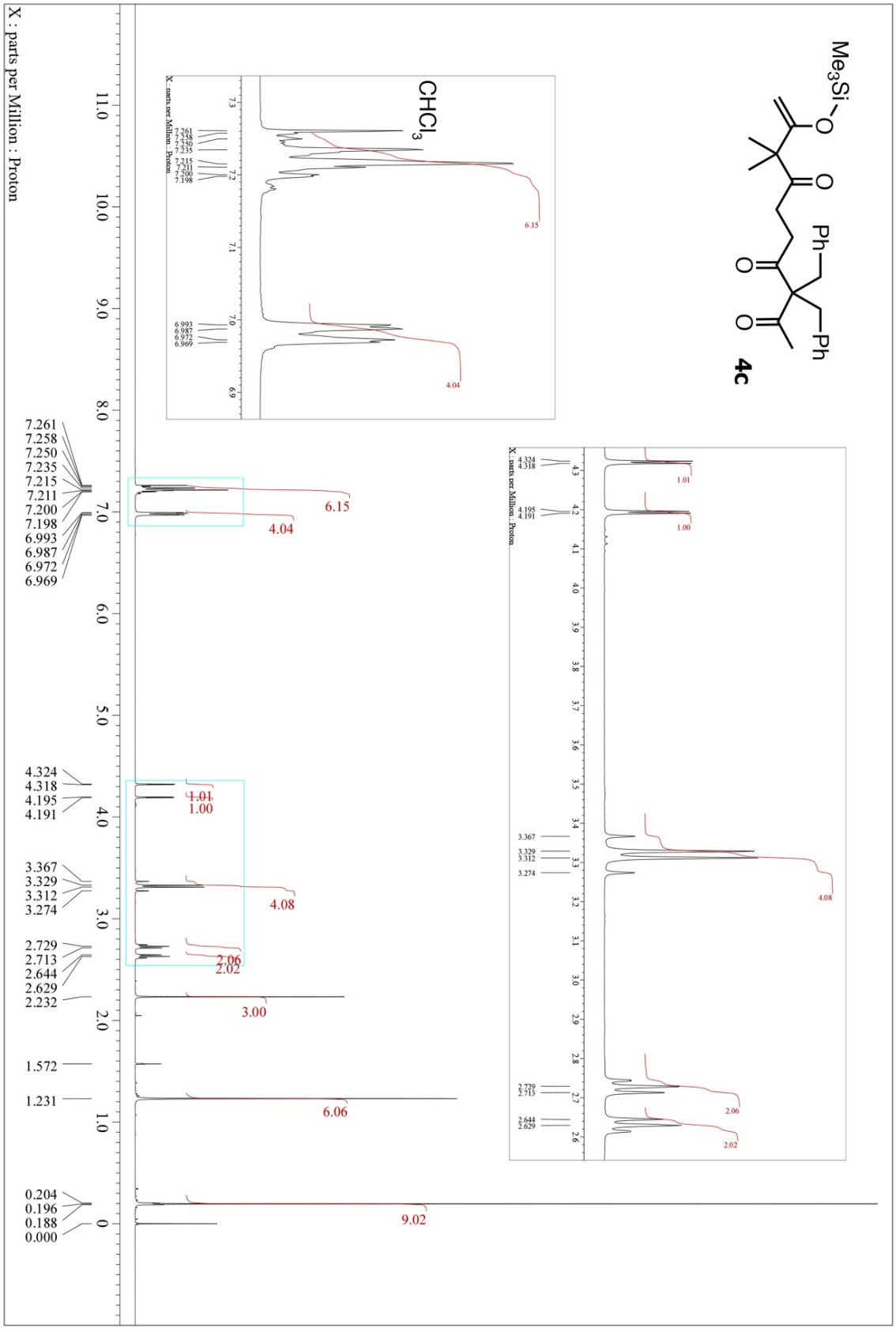


Figure S21. ^{1}H NMR spectrum of **4c** in $CDCl_3$ at 25 °C.

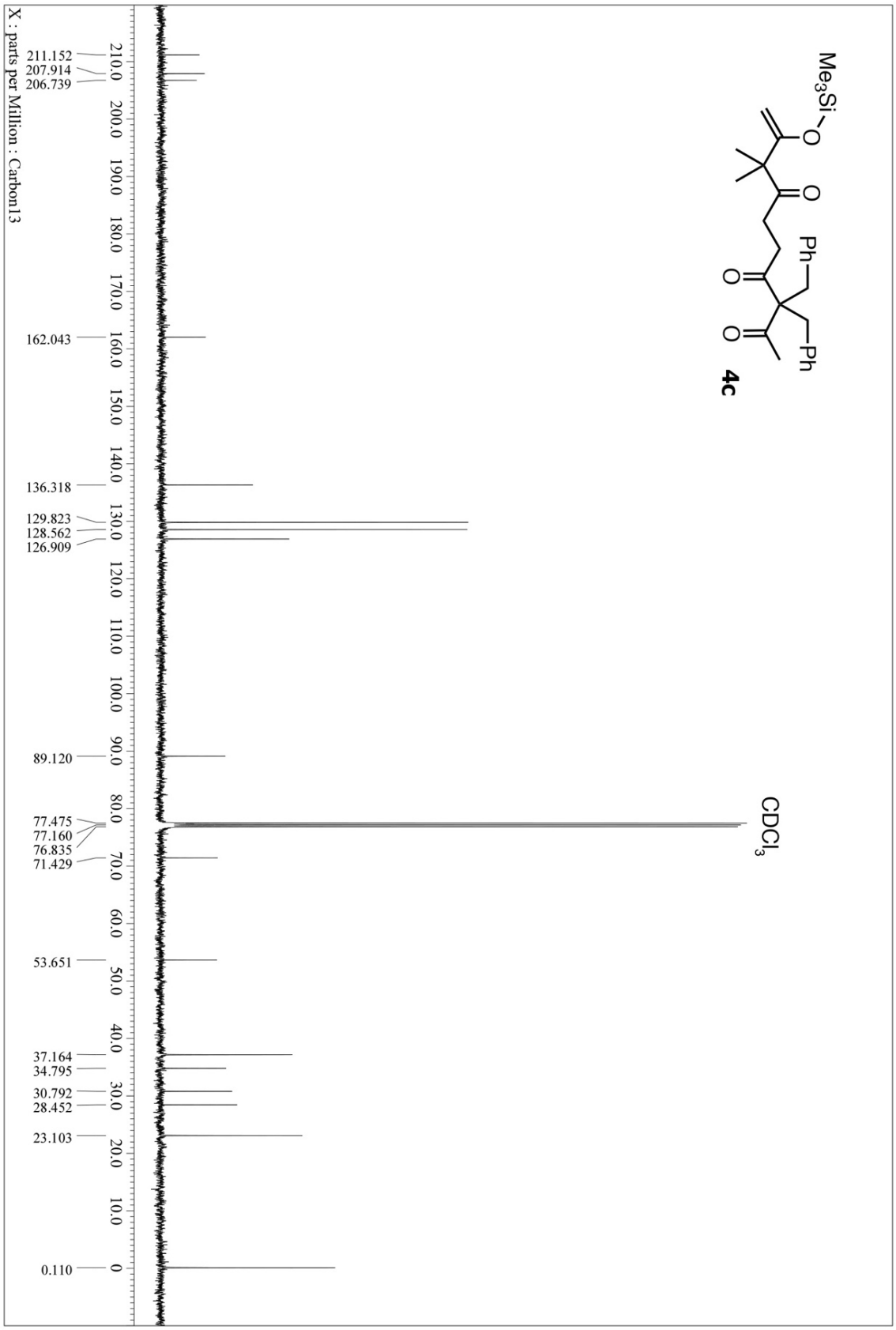


Figure S22. ^{13}C NMR spectrum of **4c** in $CDCl_3$ at 25 °C.

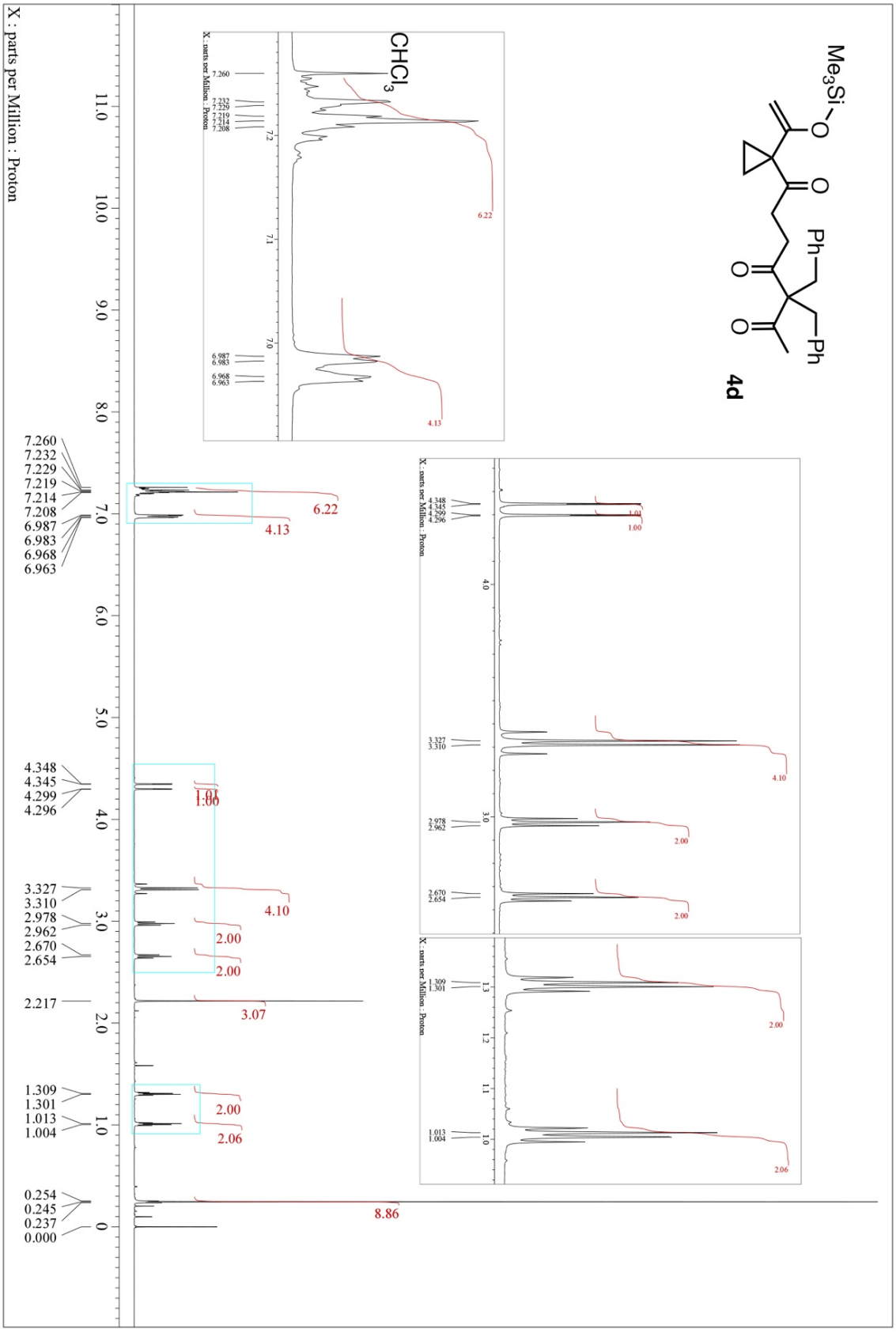


Figure S23. ^{1}H NMR spectrum of **4d** in $CDCl_3$ at 25 °C.

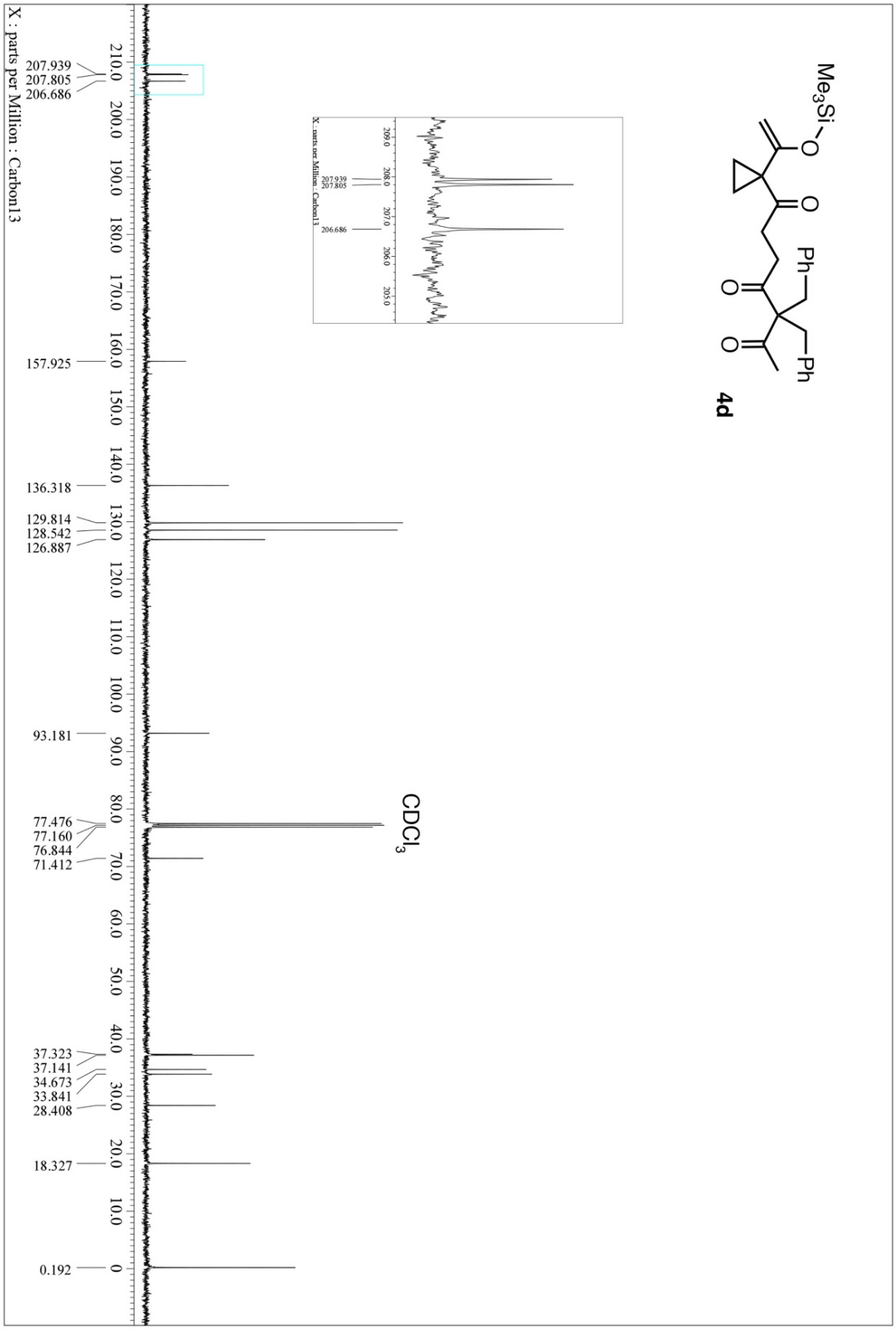


Figure S24. ^{13}C NMR spectrum of **4d** in $CDCl_3$ at 25 °C.

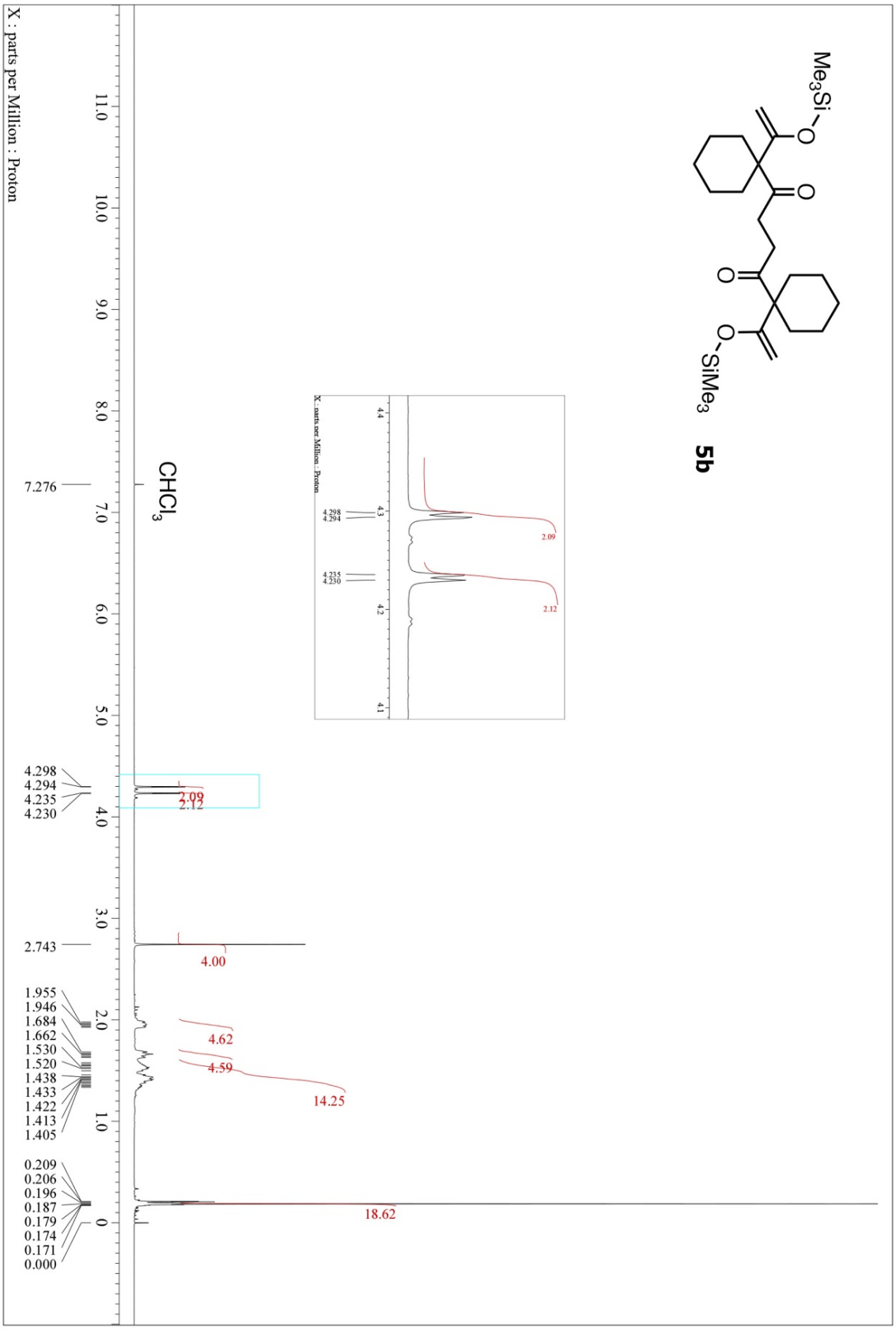


Figure S25. ^{1}H NMR spectrum of **5b** in $CDCl_3$ at 25 °C.

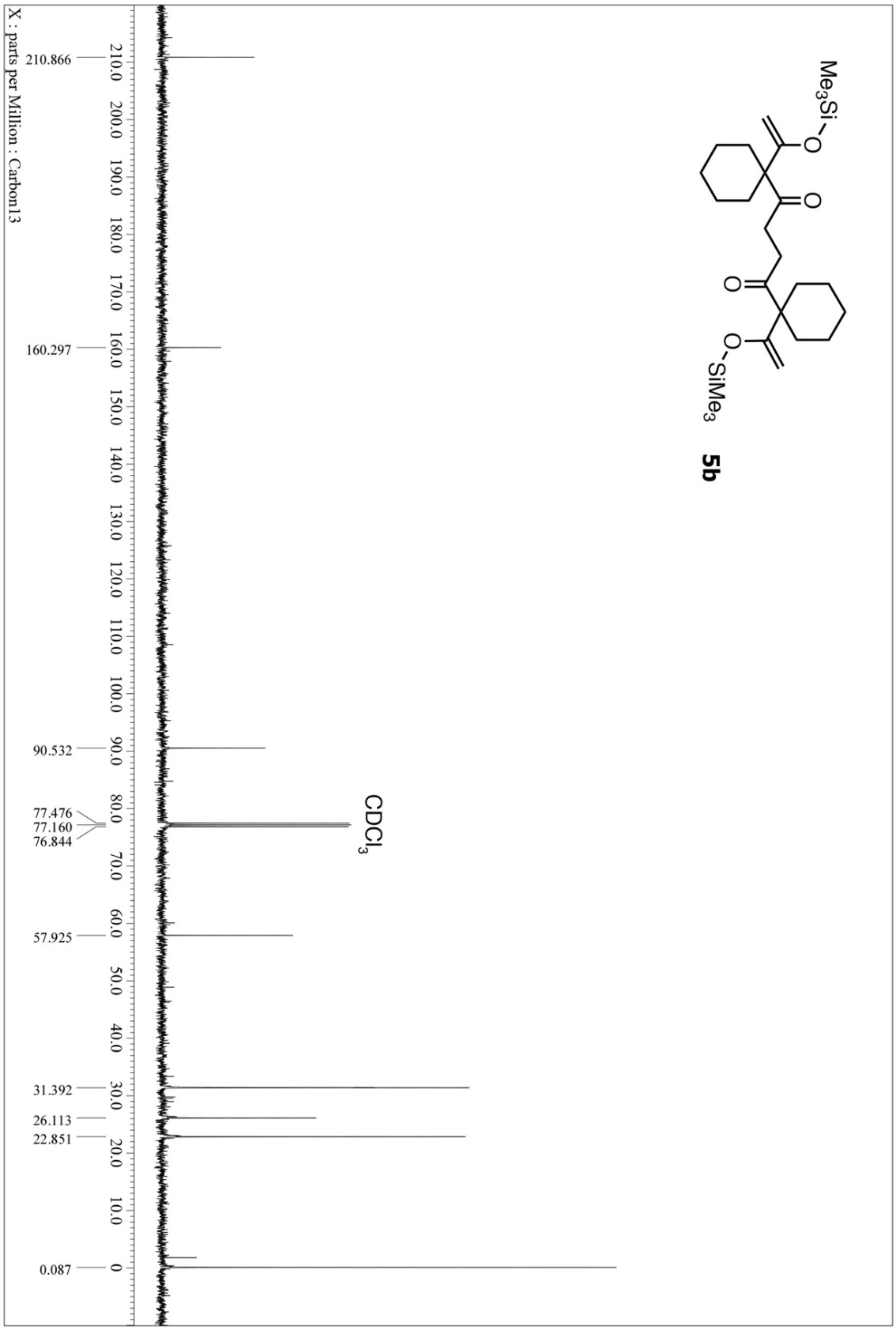


Figure S26. ^{13}C NMR spectrum of **5b** in $CDCl_3$ at 25 °C.

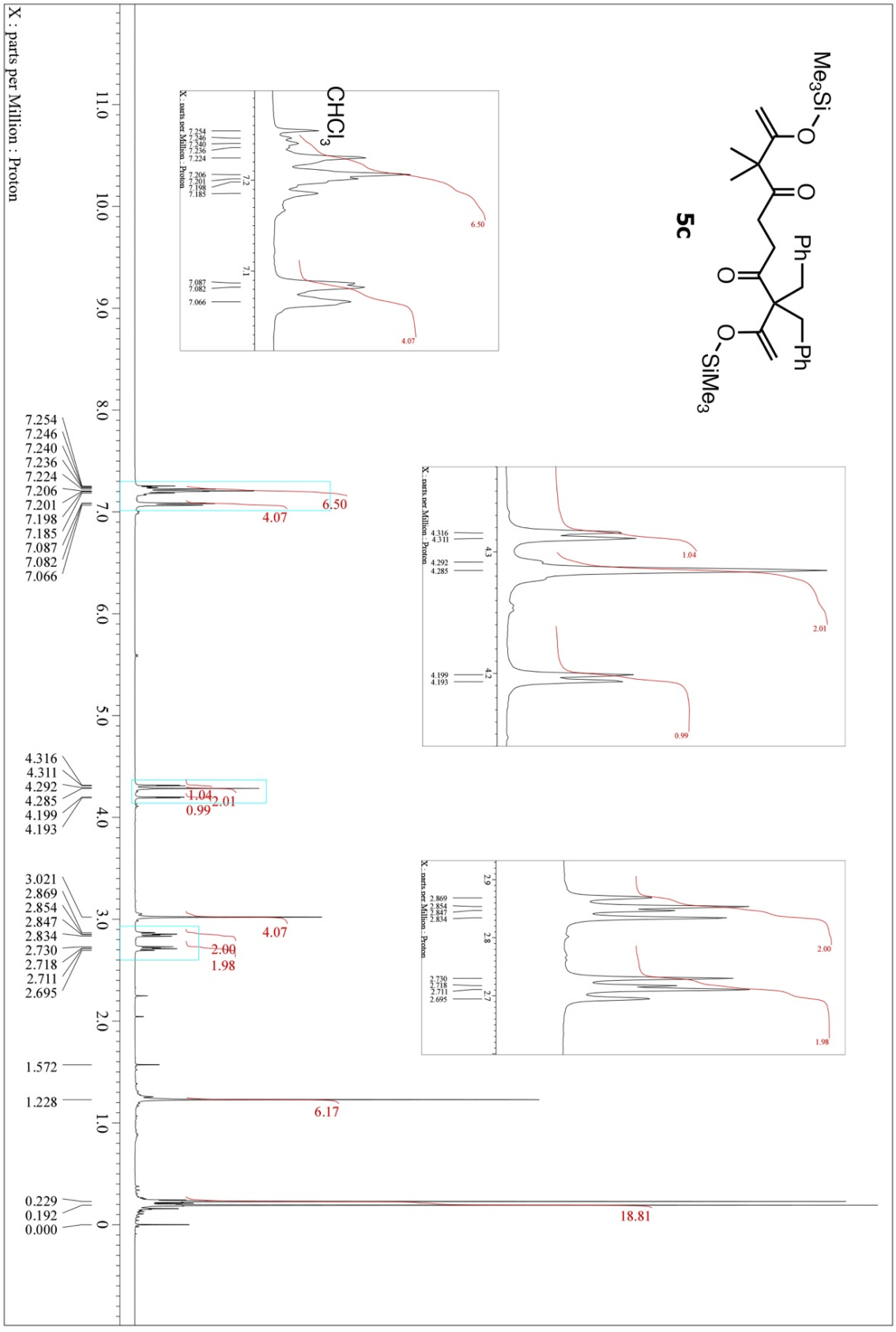


Figure S27. ^{1}H NMR spectrum of **5c** in $CDCl_3$ at 25 °C.

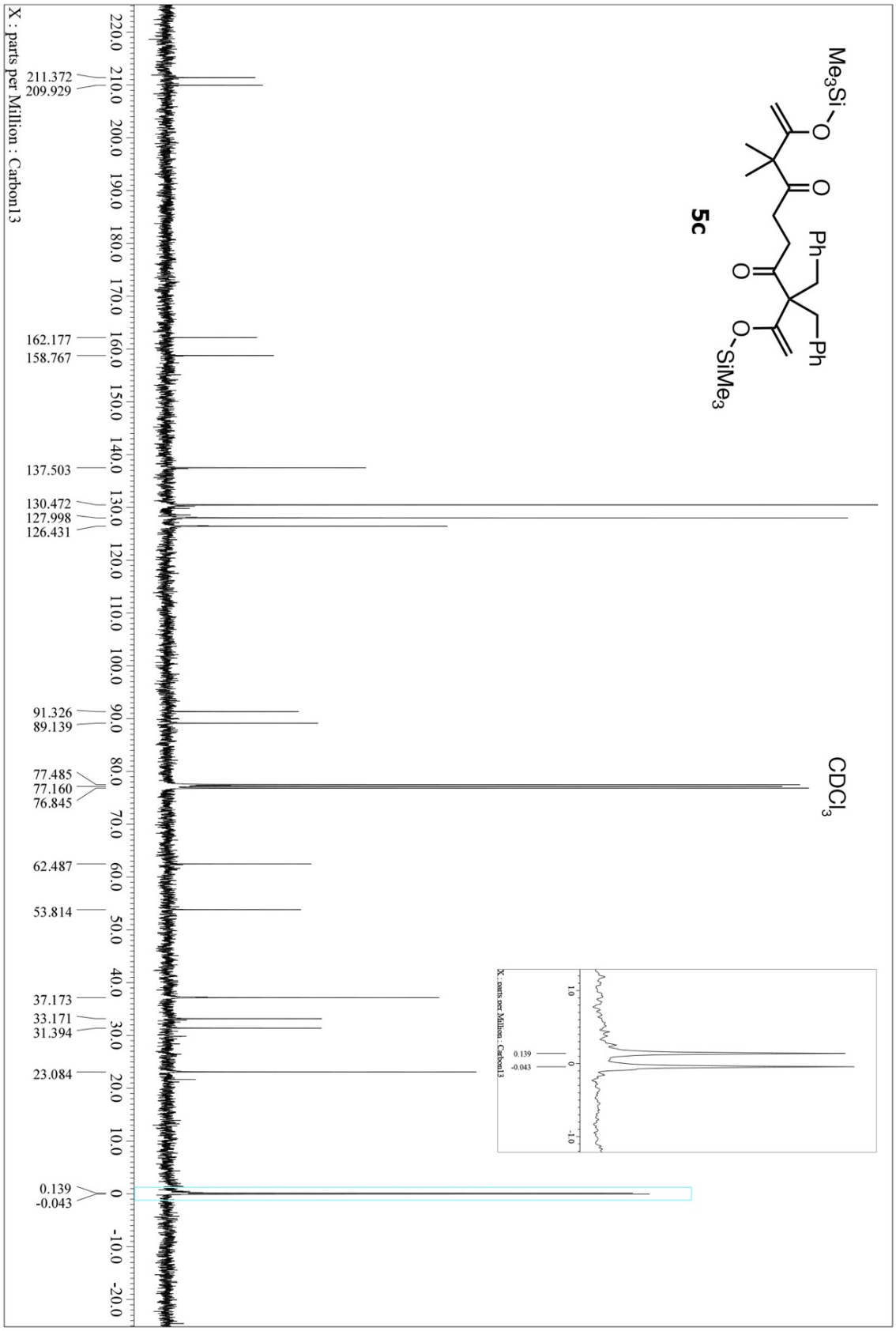


Figure S28. ^{13}C NMR spectrum of **5c** in $CDCl_3$ at 25 °C.

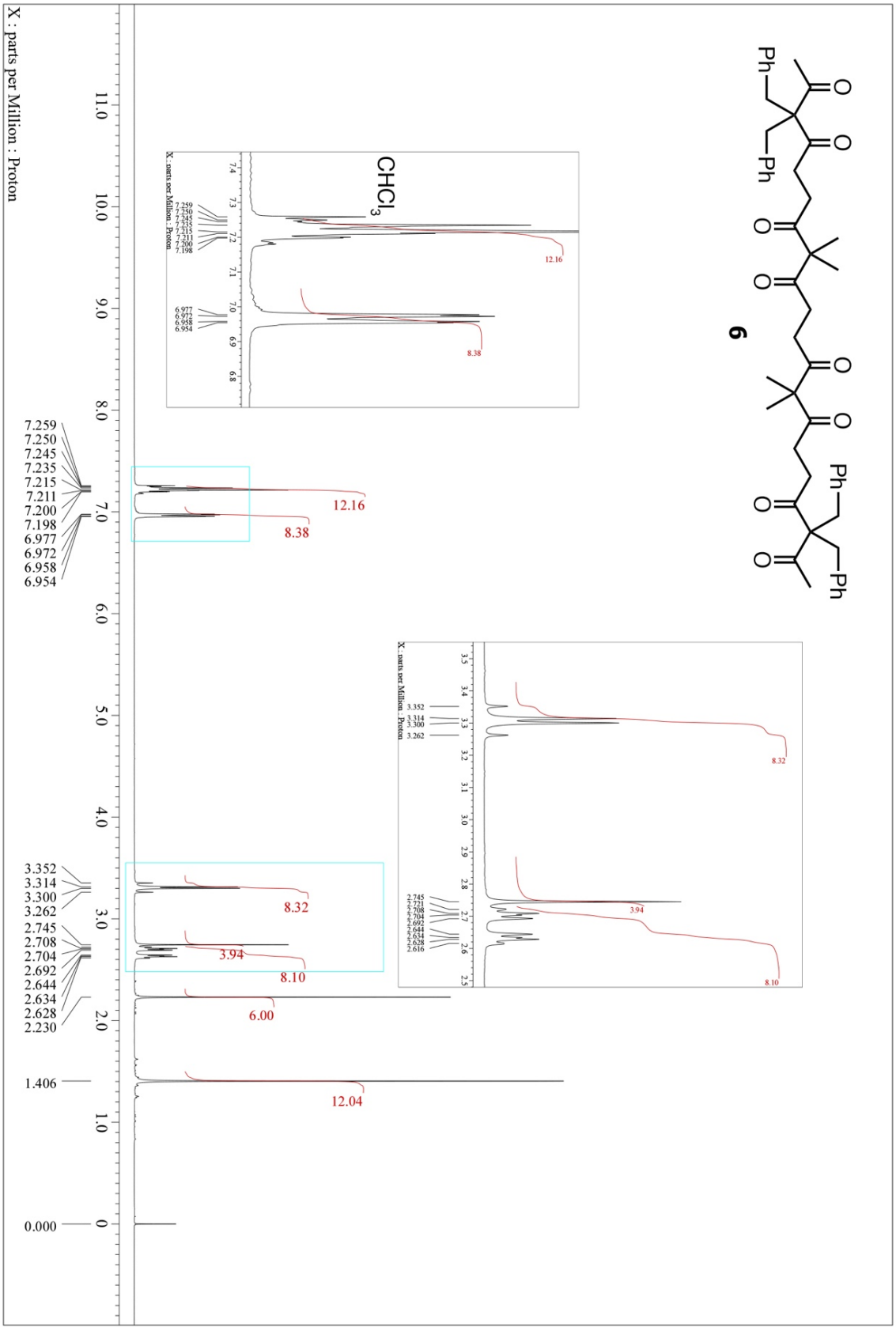


Figure S29. ^{1}H NMR spectrum of **6** in $CDCl_3$ at 25 °C.

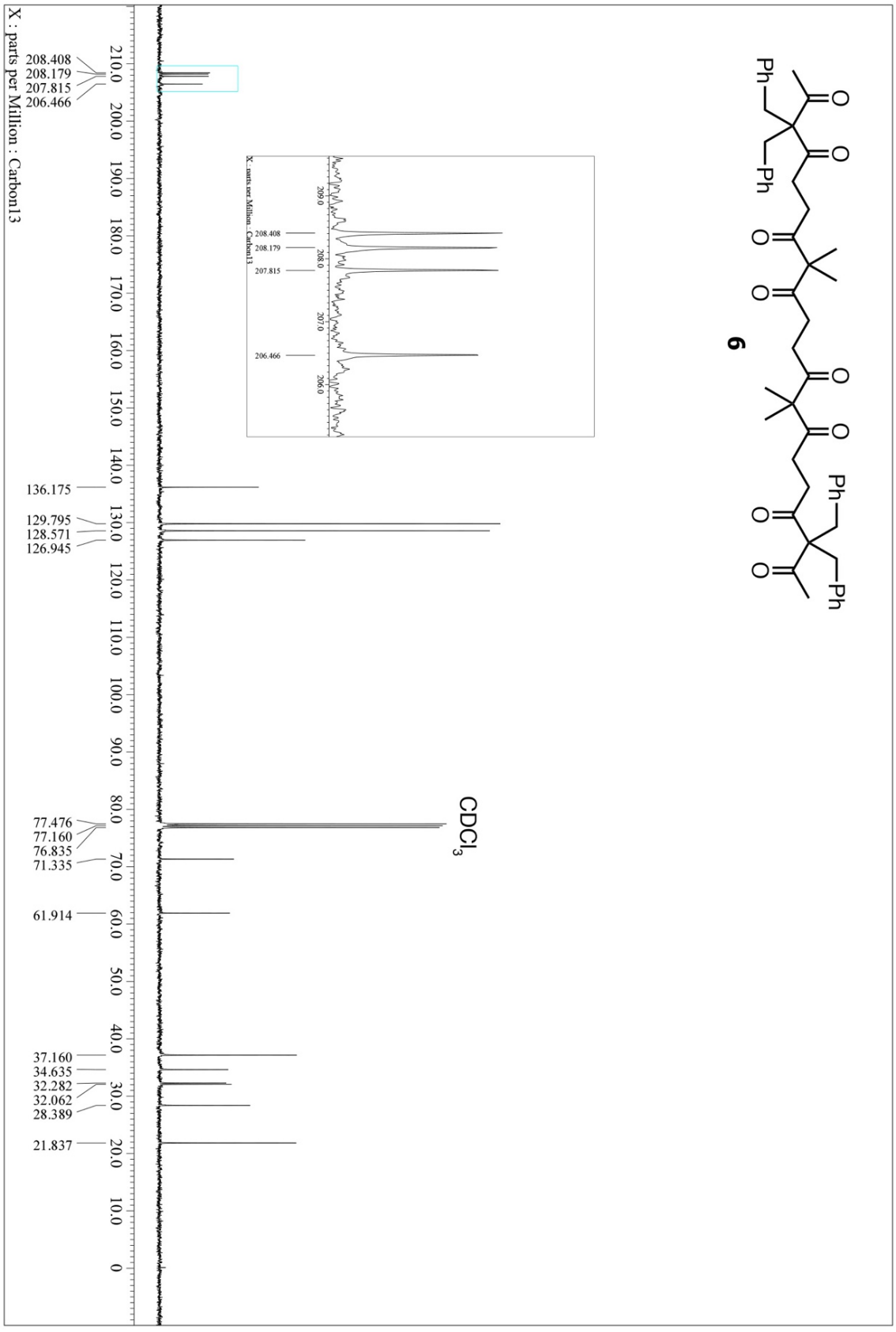


Figure S30. ^{13}C NMR spectrum of **6** in $CDCl_3$ at 25 °C.

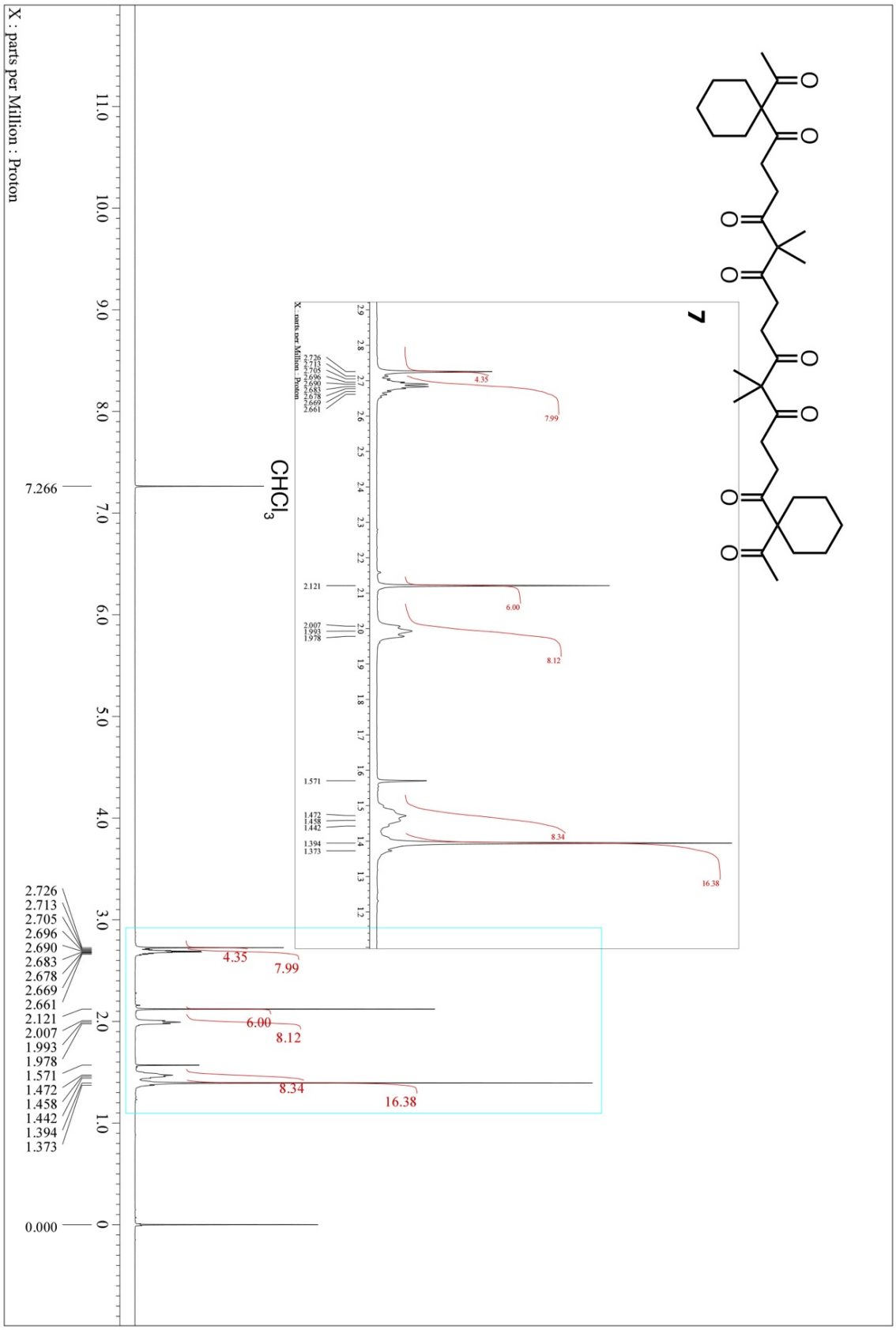


Figure S31. ^{1}H NMR spectrum of **7** in $CDCl_3$ at 25 °C.

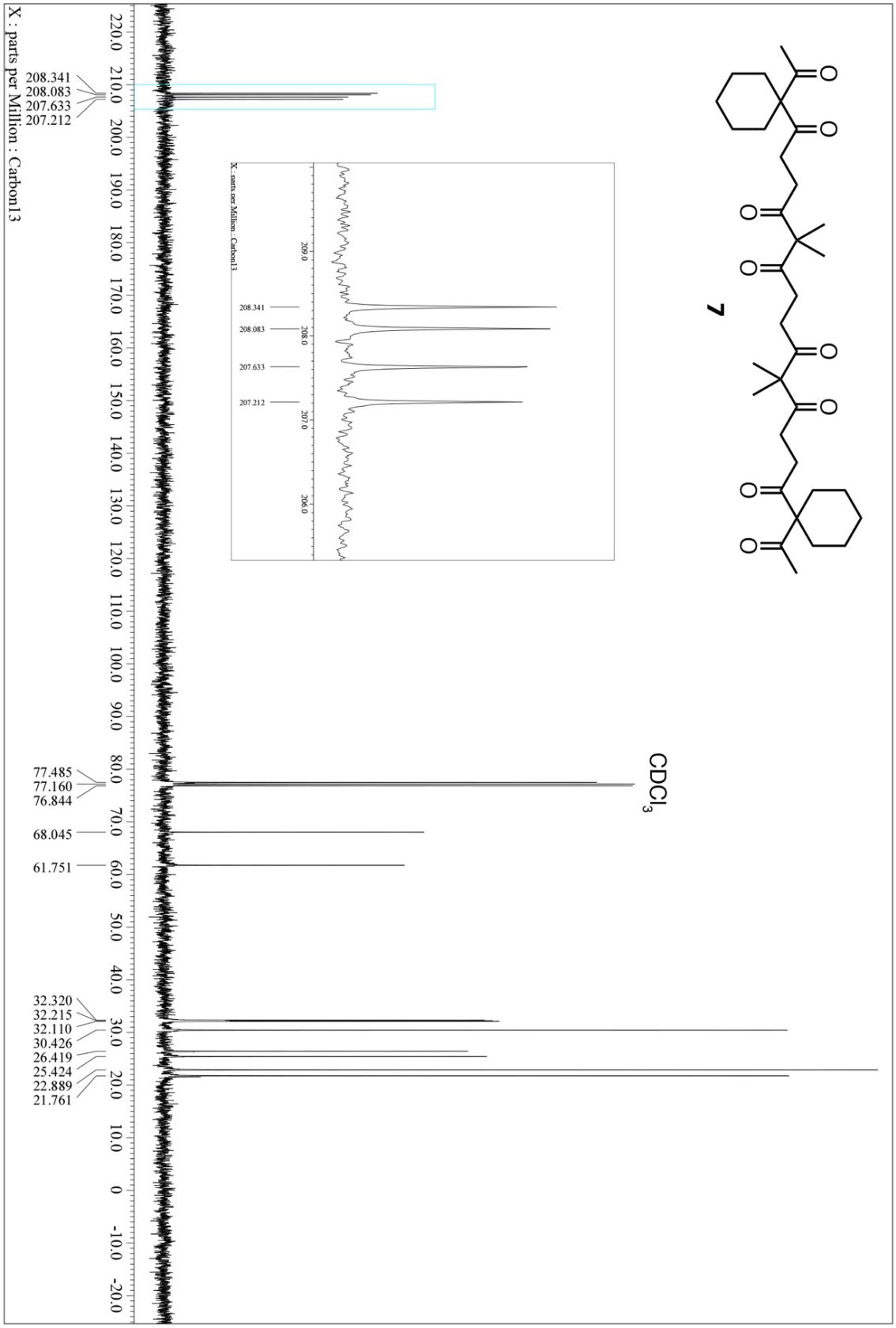


Figure S32. ^{13}C NMR spectrum of **7** in $CDCl_3$ at 25 °C.

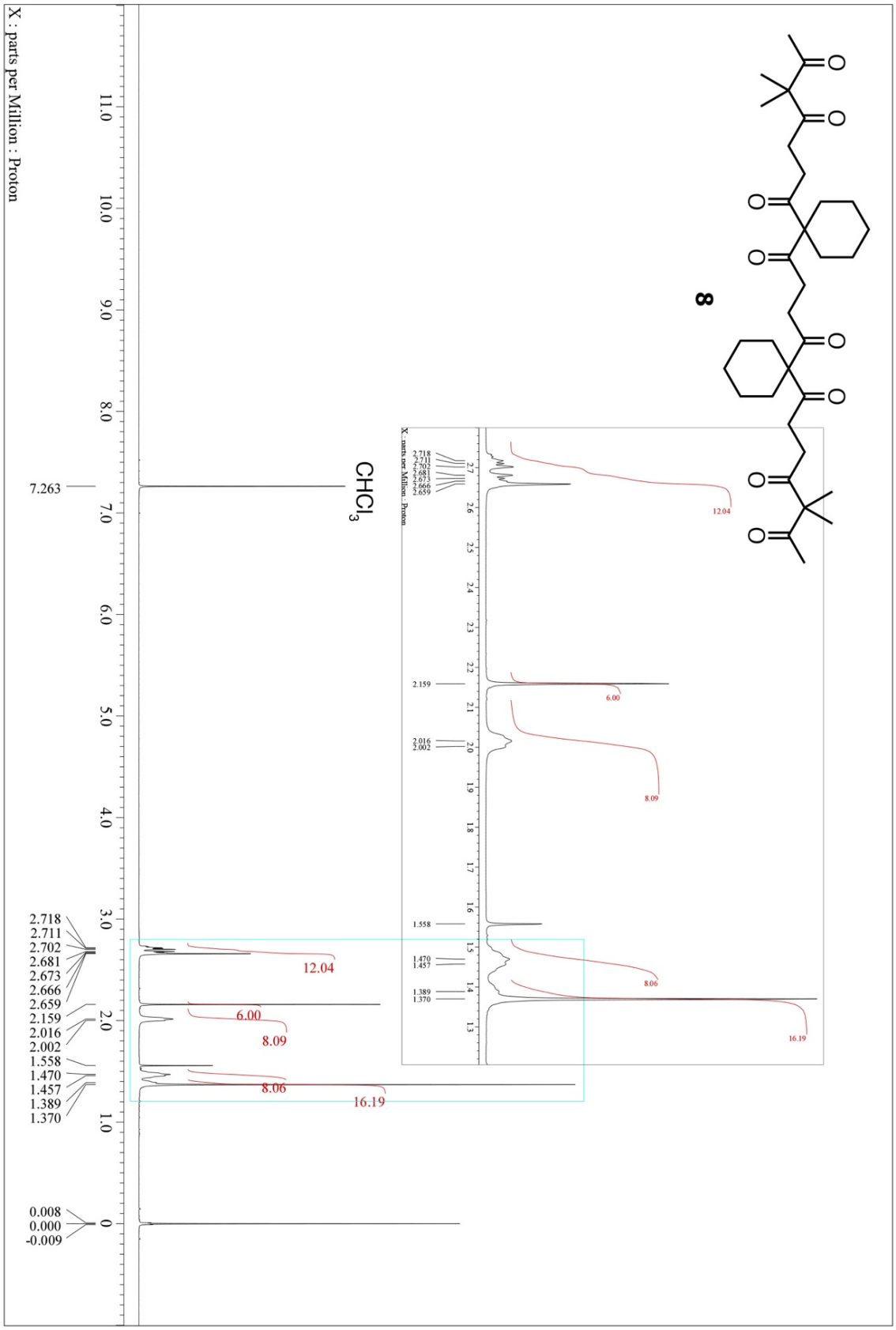


Figure S33. ^{1}H NMR spectrum of **8** in $CDCl_3$ at 25 °C.

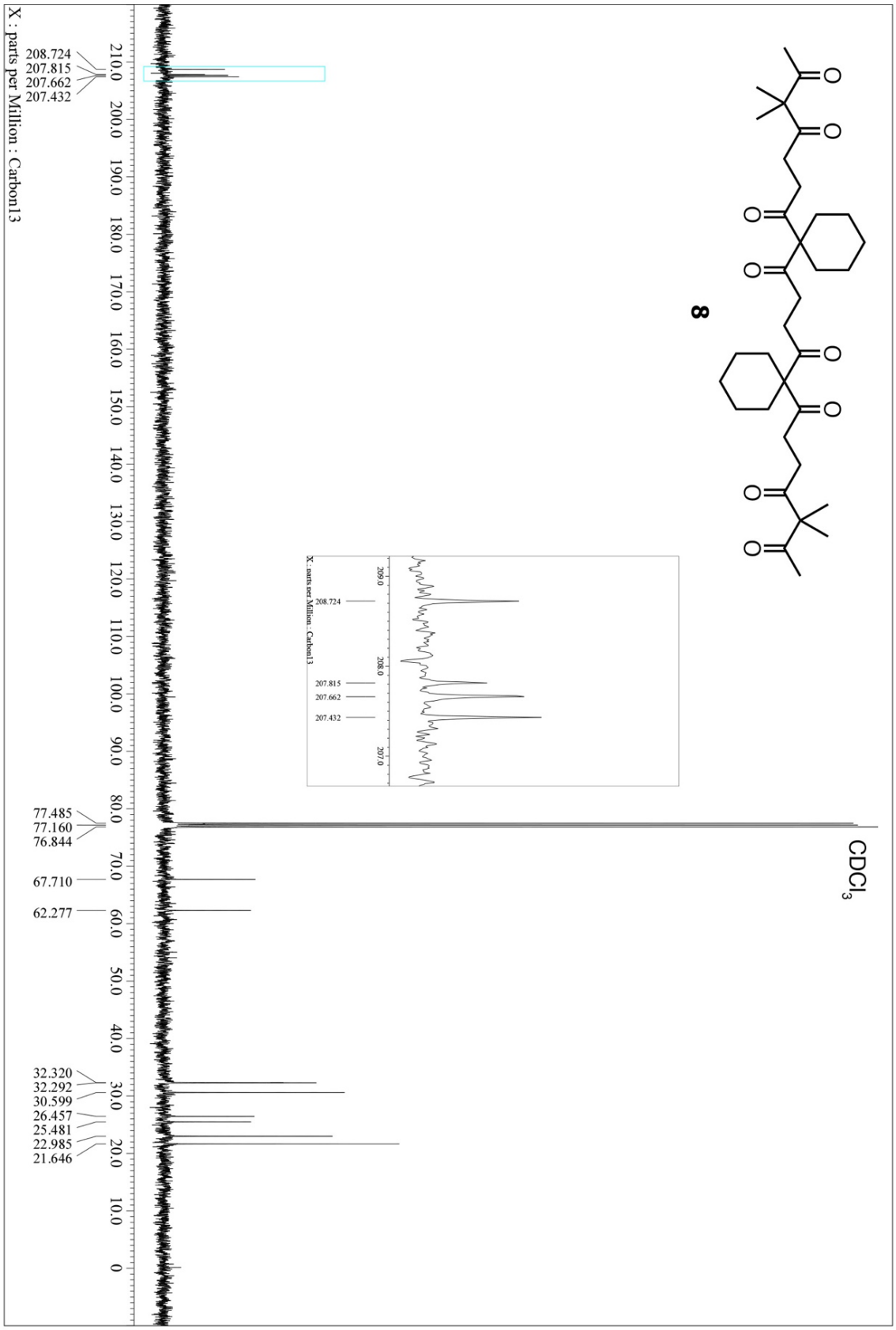


Figure S34. ^{13}C NMR spectrum of **8** in $CDCl_3$ at 25 °C.

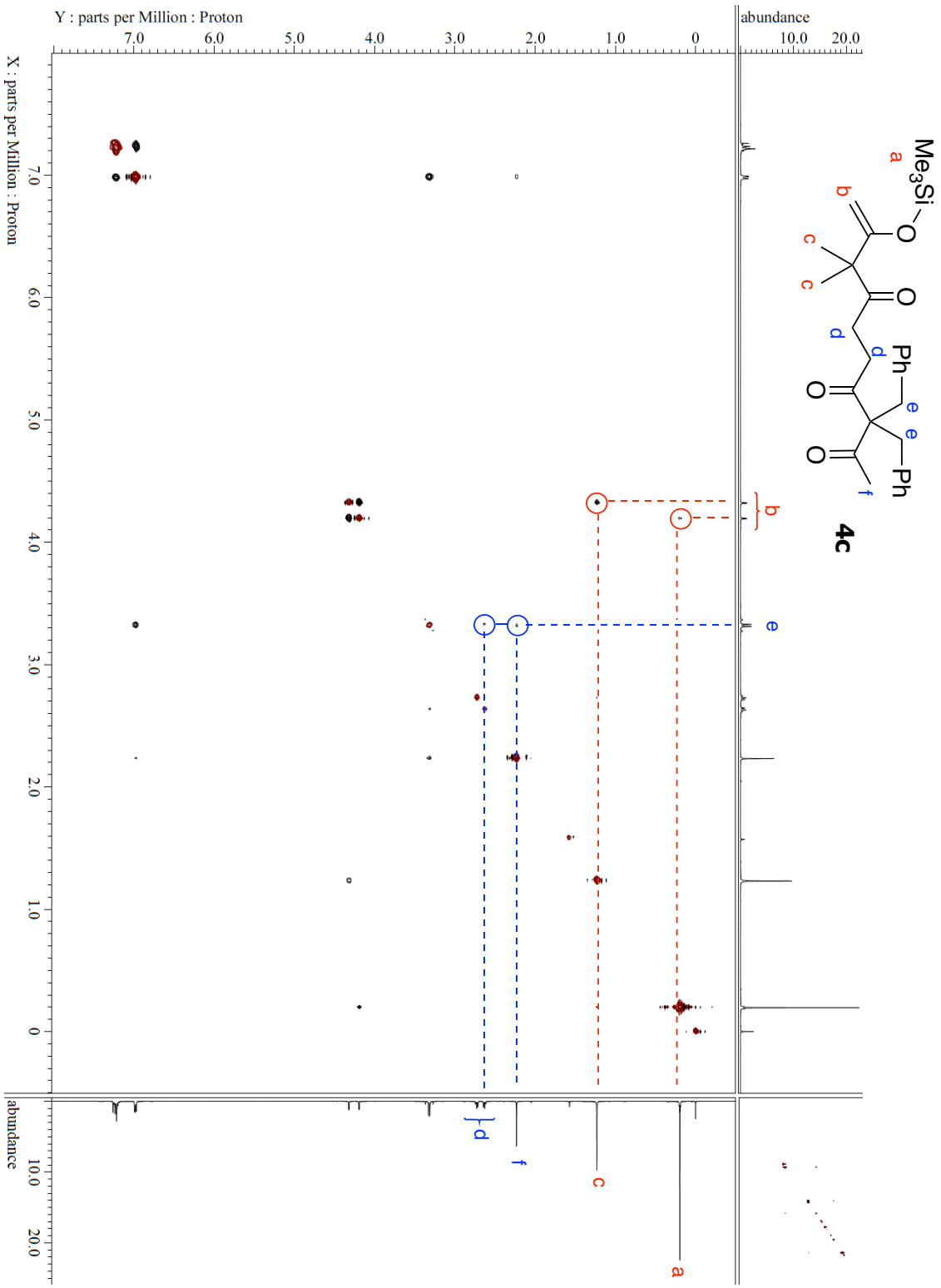


Figure S35. NOESY spectrum of **4c** in in $CDCl_3$ at 25 °C. The NOE correlated protons are indicated in same colour (red and blue).

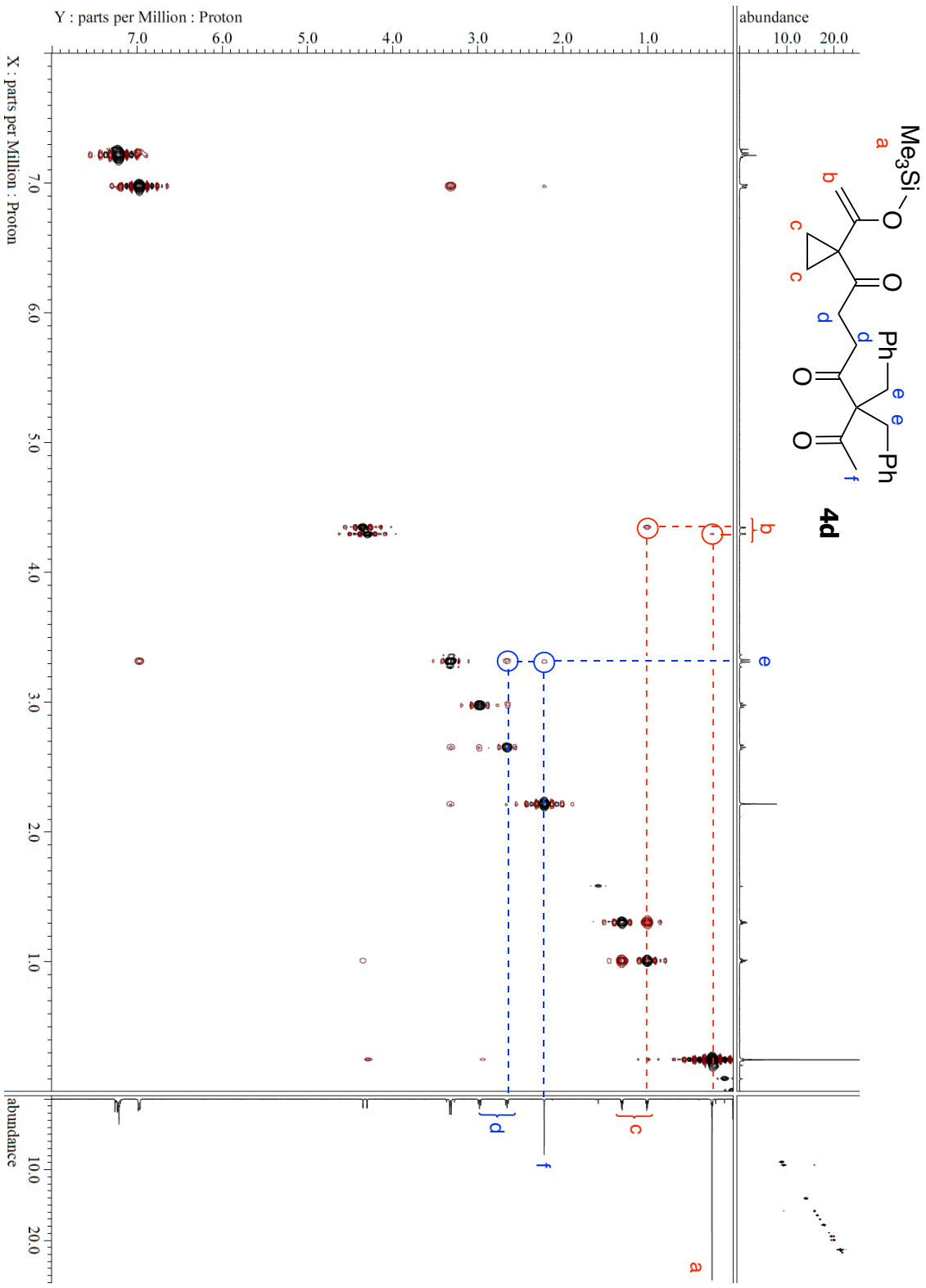


Figure S36. NOESY spectrum of **4d** in in $CDCl_3$ at 25 °C. The NOE correlated protons are indicated in same colour (red and blue).

5. ESI-TOF MS Spectra of Octaketones

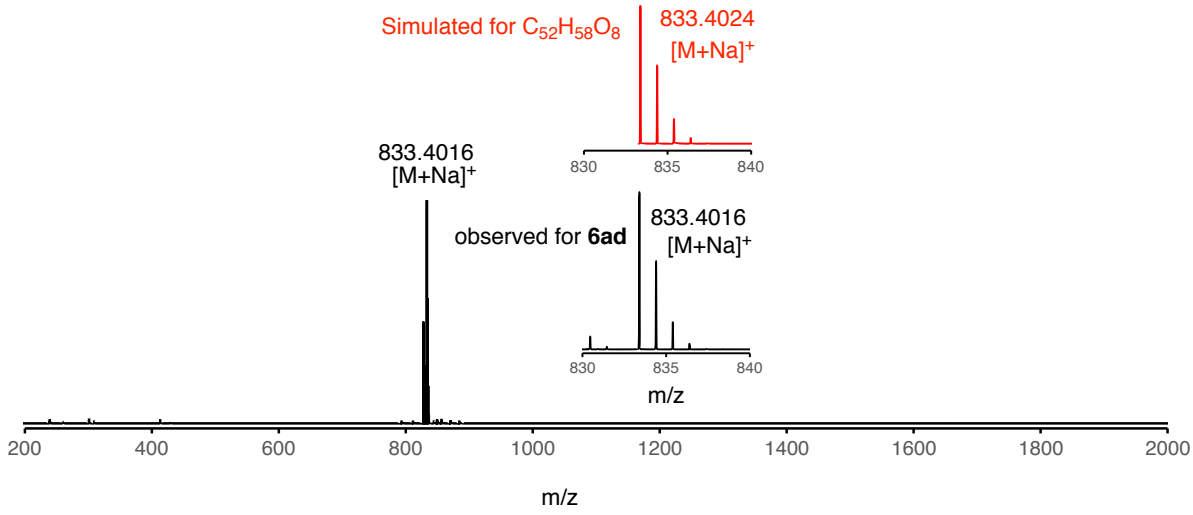


Figure S37. ESI-TOF MS spectrum of **6** with observed and simulated isotopic pattern for $[M+Na]^+$.

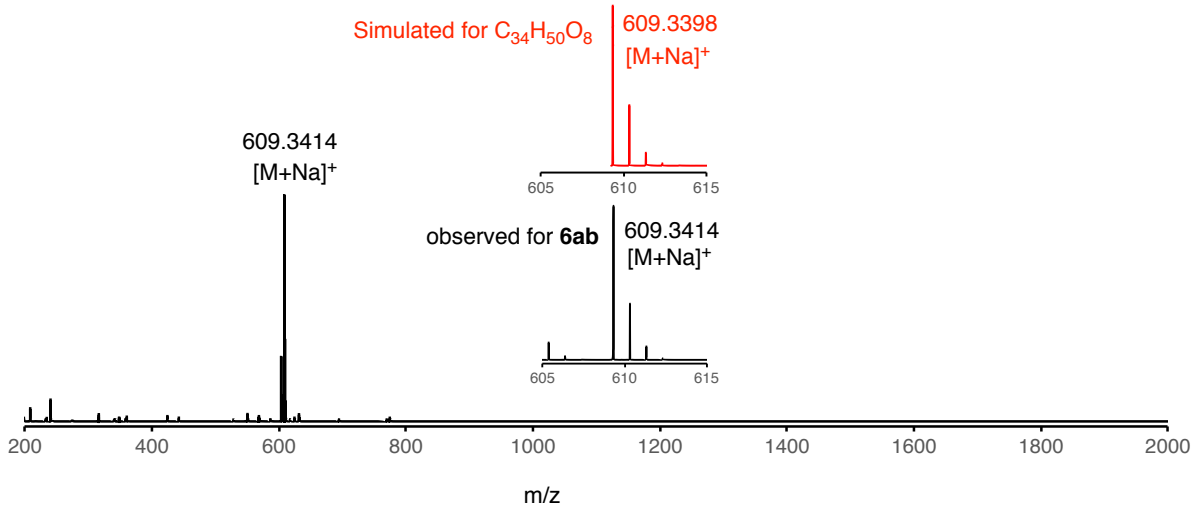


Figure S38. ESI-TOF MS spectrum of **7** with observed and simulated isotopic pattern for $[M+Na]^+$.

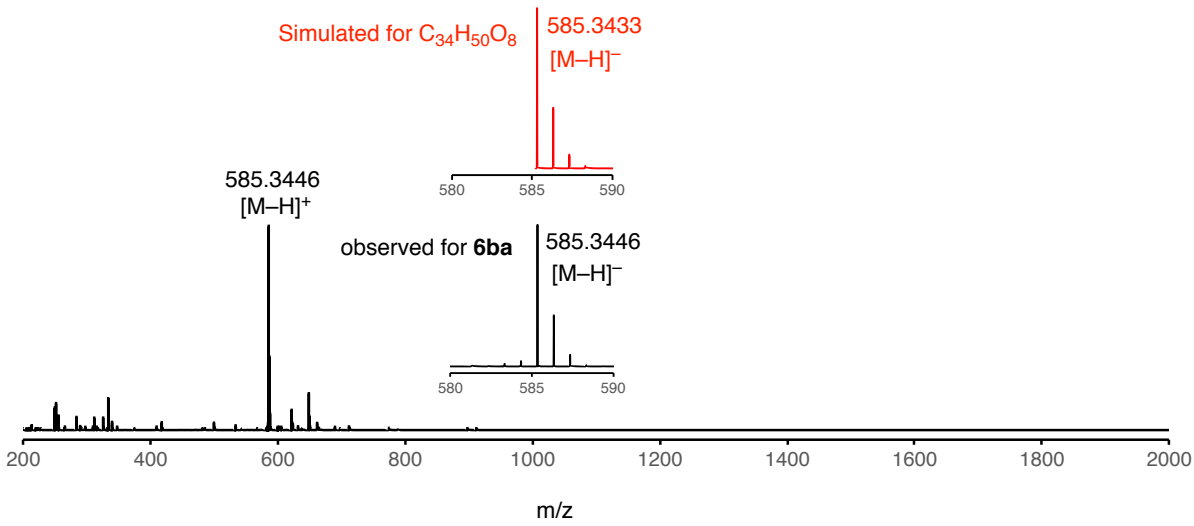


Figure S39. ESI-TOF MS spectrum of **8** with observed and simulated isotopic pattern for $[M-H]^-$.

6. References

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