Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

A general route to sulfones via insertion of sulfur dioxide promoted by cobalt oxide

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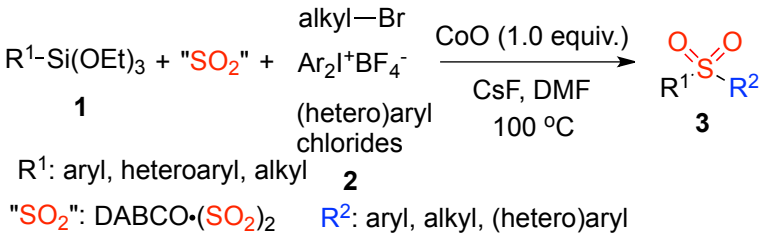
Supporting Information

General experimental methods:

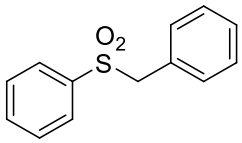
Unless otherwise stated, all commercial reagents were used as received. All solvents were dried and distilled according to standard procedures. Flash column chromatography was performed using silica gel (60-Å pore size, 32–63μm, standard grade). Analytical thin–layer chromatography was performed using glass plates pre-coated with 0.25 mm 230–400 mesh silica gel impregnated with a fluorescent indicator (254 nm). Thin layer chromatography plates were visualized by exposure to ultraviolet light. Organic solutions were concentrated on rotary evaporators at ~20 Torr at 25–35°C. Nuclear magnetic resonance (NMR) spectra are recorded in parts per million from internal tetramethylsilane on the δ scale. ^{1}H and ^{13}C NMR spectra were recorded in $CDCl_3$ on a Bruker DRX-400 spectrometer operating at 400 MHz and 100 MHz, respectively. All chemical shift values are quoted in ppm and coupling constants quoted in Hz. High resolution mass spectrometry (HRMS) spectra were obtained on a micrOTOF II Instrument.

General experimental procedure for the sulfonylation reaction of triethoxysilanes ***1****, DABCO•$(SO_2)_2$, and electrophiles*

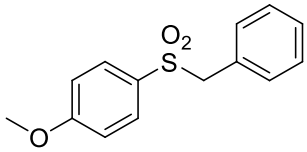


To a test tube was added CoO (0.3 mmol), CsF (0.6 mmol), and DABCO•$(SO_2)_2$ (0.3 mmol). The tube was evacuated and back-filled with N_2 three times. DMF (2.0 mL) was added through a syringe, followed by the addition of triethoxysilane **1** (0.3 mmol) and electrophile **2** (0.6 mmol) (the electrophiles should be added previously if they are solids). The mixture was stirred at 100 °C for 10-15 hours. After completion of reaction as indicated by TLC, the mixture was poured into water and extracted with ethyl acetate. The organic layer was washed with brine and dried over Na_2SO_4, and the solvent was evaporated under reduced pressure. The residue was purified directly by flash column chromatograph (EtOAc/*n*-hexane, 1:6) to give the desired

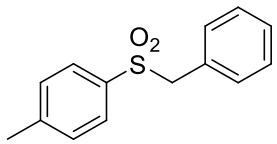
product **3**.



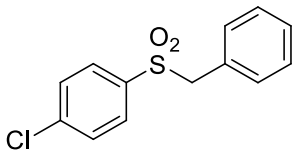
Benzylsulfonylbenzene (**3a**)[1] (Rf ≈ 0.3, petroleum ether/EtOAc = 4:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59-7.65 (m, 3H), 7.46 (t, *J* = 8.0 Hz, 2H), 7.25-7.35 (m, 3H), 7.09 (d, *J* = 7.2 Hz, 2H), 4.32 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 137.8, 133.6, 130.7, 128.8, 128.7, 128.6, 128.5, 128.0, 62.8; HRMS (ESI) calcd for $C_{13}H_{12}O_2NaS^+$: 255.0450 (M + Na^+), found: 255.0464.



1-(Benzylsulfonyl)-4-methoxybenzene (**3b**)[1] (Rf ≈ 0.3, petroleum ether/EtOAc = 3:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (d, *J* = 7.2Hz, 2H), 7.25-7.33 (m, 3H), 7.09 (d, *J* = 6.8Hz, 2H), 6.90 (d, *J* = 8.8Hz, 2H), 4.29 (s, 2H), 3.86 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.6, 130.7, 129.4, 128.6, 128.4, 113.9, 63.0, 55.5.

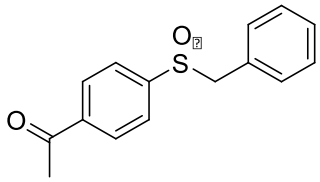


1-(Benzylsulfonyl)-4-methylbenzene (**3c**)[1] (Rf ≈ 0.3, petroleum ether/EtOAc = 4:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (d, *J* = 8.0 Hz, 2H), 7.21-7.33 (m, 5H), 7.08 (d, *J* = 6.8 Hz, 2H), 4.28 (s, 2H), 2.41 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.6, 134.1, 130.7, 129.4, 128.7, 128.6, 128.5, 128.2, 62.8, 21.5.

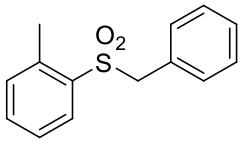


1-(Benzylsulfonyl)-4-chlorobenzene (**3d**)[1] (Rf ≈ 0.3, petroleum ether/EtOAc = 4:1): ^{1}H

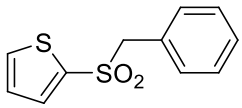
NMR (400 MHz, $CDCl_3$) δ 7.53 (d, *J* = 8.4 Hz, 2H), 7.41 (d, *J* = 8.4 Hz, 2H), 7.26-7.35 (m, 3H), 7.08 (d, *J* = 7.2 Hz, 2H), 4.30 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 140.4, 136.2, 130.7, 130.0, 129.1, 128.9, 128.6, 127.8, 62.8.



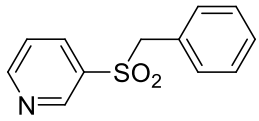
1-(4-(Benzylsulfonyl)phenyl)ethanone (**3e**)[6] (Rf ≈ 0.5, petroleum ether/EtOAc = 2:1): ^1H NMR (400 MHz, $CDCl_3$) δ 7.99 (d, *J* = 8.4 Hz, 2H), 7.72 (d, *J* = 8.4 Hz, 2H), 7.33 (t, *J* = 7.6 Hz, 1H), 7.25-7.28 (m, 2H), 7.09 (d, *J* = 7.2 Hz, 2H), 4.35 (s, 2H), 2.64 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) 196.7, 141.5, 140.7, 130.7, 129.0, 128.9, 128.6, 128.5, 127.5, 62.7, 26.8.



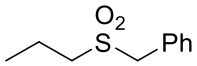
1-(Benzylsulfonyl)-2-methylbenzene (**3f**)[1] (Rf ≈ 0.3, petroleum ether/EtOAc = 4:1): ^1H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.0 Hz, 1H), 7.46 (t, *J* = 8.0 Hz, 1H), 7.21-7.31 (m, 5H), 7.06 (d, *J* = 7.2 Hz, 2H), 4.32 (s, 2H), 2.51 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.6, 135.9, 133.6, 132.3, 130.8, 130.7, 128.7, 128.5, 127.9, 126.3, 62.2, 20.2.



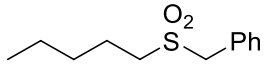
2-(Benzylsulfonyl)thiophene (**3g**)[7] (Rf ≈ 0.4, petroleum ether/EtOAc = 4:1): ^1H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, *J* = 4.8 Hz, 1H), 7.27-7.36 (m, 4H), 7.15 (d, *J* = 7.2 Hz, 2H), 7.06 (t, *J* = 4.4 Hz, 1H), 4.41 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 134.8, 134.3, 130.6, 128.9, 128.6, 128.1, 127.6, 64.0.



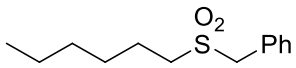
3-(Benzylsulfonyl)pyridine (**3h**)[8] (Rf ≈ 0.4, petroleum ether/EtOAc = 3:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.81-8.83 (m, 2H), 7.85 (d, *J* = 8.0 Hz, 1H), 7.29-7.40 (m, 4H), 7.11 (d, *J* = 7.2Hz, 2H), 4.38 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.1, 149.4, 136.4, 134.2, 130.7, 129.1, 128.8, 127.4, 123.3, 63.2.



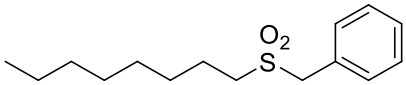
(Propylsulfonylmethyl)benzene (**3i**) (Rf ≈ 0.4, petroleum ether/EtOAc = 8:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 (s, 5H), 4.22 (s, 2H), 2.81 (t, *J* = 8.0Hz, 2H), 1.81-1.90 (m, 2H), 1.04 (t, *J* = 7.6Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 130.4, 129.0, 128.9, 128.1, 59.4, 52.6, 15.5, 13.0; HRMS (ESI) calcd for $C_{10}H_{15}O_2S^+$: 199.0787 (M + H^+), found: 199.0779.



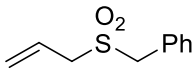
(Pentylsulfonylmethyl)benzene (**3j**) (Rf ≈ 0.4, petroleum ether/EtOAc = 8:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ7.41 (s, 5H), 4.22 (s, 2H), 2.82 (t, *J* = 8.0Hz, 2H), 1.76-1.84 (m, 2H), 1.27-1.40 (m, 6H), 0.88 (t, *J* = 6.8Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 130.4, 129.0, 128.9, 128.1, 59.3, 51.0,31.1, 28.0, 22.2, 21.6, 13.8; HRMS (ESI) calcd for $C_{12}H_{19}O_2S^+$: 227.1100 (M + H^+), found: 227.1088.



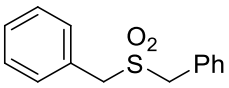
(Hexylsulfonylmethyl)benzene (**3k**) (Rf ≈ 0.4, petroleum ether/EtOAc = 8:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ7.41 (s, 5H), 4.22 (s, 2H), 2.81 (t, *J* = 8.0Hz, 2H), 1.77-1.85 (m, 2H), 1.29-1.38 (m, 4H), 0.90 (t, *J* = 7.2Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 130.4, 129.0, 128.9, 128.1, 59.3, 51.0, 30.4, 22.0, 21.4, 13.6; HRMS (ESI) calcd for $C_{13}H_{21}O_2S^+$: 241.1257 (M + H^+), found: 241.1258.



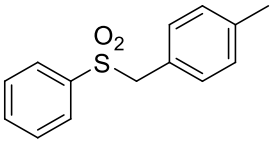
(Octylsulfonylmethyl)benzene (**3l**)[1] (Rf ≈ 0.4, petroleum ether/EtOAc = 8:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 (s, 5H), 4.21 (s, 2H), 2.81 (t, *J* = 8.0Hz, 2H), 1.75-1.82 (m, 2H), 1.25-1.38 (m, 10H), 0.87 (t, *J* = 7.2Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 130.4, 129.0, 128.9, 128.1, 59.4, 51.0, 31.6, 28.9, 28.8, 28.3, 22.5, 21.7, 13.9.



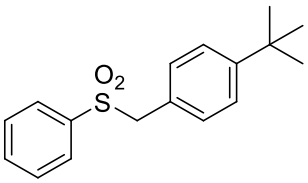
(Allylsulfonylmethyl)benzene (**3m**) (Rf ≈ 0.4, petroleum ether/EtOAc = 8:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 (s, 5H), 5.89-5.99 (m, 1H), 5.53 (dd, *J* = 0.4Hz, 10.0Hz, 1H), 5.43 (dd, *J* = 1.2Hz, 17.2Hz, 1H), 4.23 (s, 2H), 3.60 (d, J = 7.6Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 130.7, 129.0, 127.6, 124.9, 124.8, 57.9, 55.8; HRMS (ESI) calcd for $C_{10}H_{13}O_2S^+$: 197.0631 ($M + H^+$), found: 197.0641.



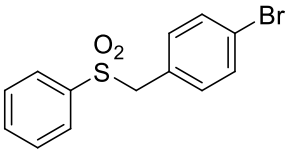
sulfonylbis(methylene)dibenzene (**3n**) (Rf ≈ 0.4, petroleum ether/EtOAc = 8:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39-7.41 (m, 8H), 4.15 (s, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 130.8, 129.0, 128.9, 127.5, 57.9; HRMS (ESI) calcd for $C_{14}H_{15}O_2S^+$: 247.0787 ($M + H^+$), found: 247.0792.



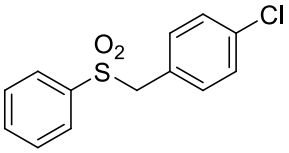
1-Methyl-4-(phenylsulfonylmethyl)benzene (**3o**)[1] (Rf ≈ 0.3, petroleum ether/EtOAc = 4:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57-7.65 (m, 3H), 7.45 (t, *J* = 8.0 Hz, 2H), 7.06 (d, *J* = 8.0 Hz, 2H), 6.96 (d, *J* = 8.0 Hz, 2H), 4.26 (s, 2H), 2.31 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.6, 137.9, 133.5, 130.6, 129.2, 128.8, 128.6, 124.9, 62.5, 21.1.



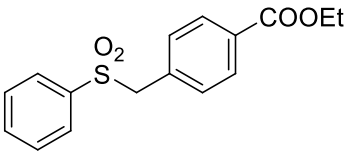
1-*tert*-Butyl-4-(phenylsulfonylmethyl)benzene (**3p**)[1] (Rf ≈ 0.3, petroleum ether/EtOAc = 4:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 8.0 Hz, 2H), 7.59 (t, *J* = 7.6 Hz, 1H), 7.44 (t, *J* = 8.0 Hz, 2H), 7.25-7.29 (m, 2H), 7.02 (d, *J* = 8.4 Hz, 2H), 4.27 (s, 2H), 1.28 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 133.5, 130.5, 128.8, 128.5, 125.5, 124.8, 62.5, 31.1.



1-Bromo-4-(phenylsulfonylmethyl)benzene (**3q**)[1] (Rf ≈ 0.3, petroleum ether/EtOAc = 4:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63-7.65 (m, 3H), 7.47 (t, *J* = 8.0 Hz, 2H), 7.39 (d, *J* = 8.4 Hz, 2H), 6.95 (d, *J* = 8.4 Hz, 2H), 4.25 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 137.6, 133.8, 132.3, 131.7, 129.0, 128.5, 127.1, 123.2, 62.1.

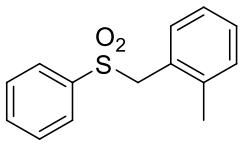


1-Chloro-4-(phenylsulfonylmethyl)benzene (**3r**)[1] (Rf ≈ 0.3, petroleum ether/EtOAc = 4:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60-7.65 (m, 3H), 7.47 (t, *J* = 7.6 Hz, 2H), 7.24 (t, *J* = 8.0 Hz, 2H), 7.02 (d, *J* = 8.4 Hz, 2H), 4.27 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 137.6, 135.0, 133.8, 132.0, 129.0, 128.8, 128.5, 126.6, 62.0.

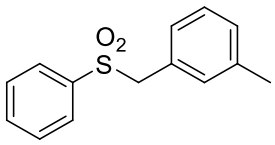


Ethyl 4-(phenylsulfonylmethyl)benzoate (**3s**)[1] (Rf ≈ 0.4, petroleum ether/EtOAc = 3:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 8.0 Hz, 2H), 7.58-7.63 (m, 3H), 7.46 (t, *J* = 8.0 Hz, 2H), 7.14 (d, *J* = 8.0 Hz, 2H), 4.33-4.38 (m, 4H), 1.38 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR

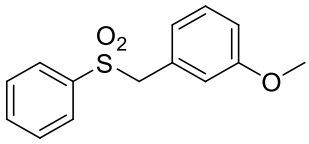
(100 MHz, $CDCl_3$) δ 165.9, 137.6, 133.9, 132.9, 130.7, 129.6, 129.0, 128.5, 126.3, 62.5, 61.1, 14.2.



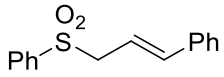
1-Methyl-2-(phenylsulfonylmethyl)benzene (**3t**)[1] (Rf ≈ 0.3, petroleum ether/EtOAc = 4:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60-7.66 (m, 3H), 7.46(t, *J* = 8.0 Hz, 2H), 7.21 (t, *J* = 7.6 Hz, 1H), 7.08-7.12 (m, 2H), 7.02 (d, *J* = 7.6 Hz, 1H), 4.38 (s, 2H), 2.11 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.2, 133.7, 131.8, 130.6, 128.9, 128.8, 128.6, 126.5, 126.0, 60.0, 19.2.



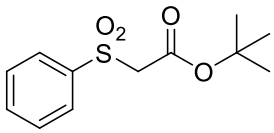
1-Methyl-3-(phenylsulfonylmethyl)benzene (**3u**)[1] (Rf ≈ 0.3, petroleum ether/EtOAc = 4:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58-7.65 (m, 3H), 7.44 (t, *J* = 7.6 Hz, 2H), 7.11-7.13 (m, 2H), 6.89 (s, 1H), 6.84 (t, *J* = 6.0 Hz, 1H), 4.26 (s, 2H), 2.26 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.2, 137.9, 133.6, 131.5, 129.4, 128.7, 128.6, 128.3, 127.8, 62.8, 21.1.



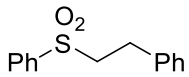
1-Methoxy-3-(phenylsulfonylmethyl)benzene (**3v**)[1] (Rf ≈ 0.3, petroleum ether/EtOAc = 3:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58-7.66 (m, 3H), 7.44 (t, *J* = 7.6 Hz, 2H), 7.15 (t, *J* = 8.0 Hz, 1H), 6.84 (d, *J* = 8.0 Hz, 1H), 6.60-6.64 (m, 2H), 4.28 (s, 2H), 3.70 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.5, 137.8, 133.6, 129.4, 129.3, 128.8, 128.6, 123.1, 115.8, 114.7, 62.8, 55.1.



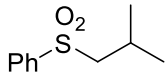
Cinnamylsulfonylbenzene (**3w**)[2] (Rf ≈ 0.4, petroleum ether/EtOAc = 8:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 (d, *J* = 8.0 Hz, 2H), 7.65 (t, *J* = 7.2 Hz, 1H), 7.55 (t, *J* = 8.0 Hz, 2H), 7.26-7.34 (m, 5H), 6.38 (d, *J* = 16.0 Hz, 1H), 6.08-6.15 (m, 1H), 3.97 (d, *J* = 7.6 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.1, 138.3, 135.7, 133.7, 129.0, 128.6, 128.4, 126.5, 115.0, 60.4.



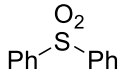
Tert-butyl 2-(phenylsulfonyl)acetate (**3x**)[1] (Rf ≈ 0.3, petroleum ether/EtOAc = 8:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94-7.96 (m, 2H), 7.68 (t, *J* = 7.2Hz, 1H), 7.58 (t, *J* = 7.2 Hz, 2H), 4.04 (s, 2H), 1.36 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.1, 138.8, 134.0, 129.0, 128.4, 83.5, 62.0, 27.5; HRMS (ESI) calcd for $C_{12}H_{16}O_4NaS^+$: 279.0662 (M + Na^+), found: 279.0669.



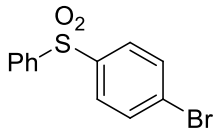
Phenethylsulfonylbenzene (**3y**)[3] (Rf ≈ 0.3, petroleum ether/EtOAc = 8:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.0 Hz, 2H), 7.68 (t, *J* = 7.2 Hz, 1H), 7.59 (t, *J* = 8.0 Hz, 2H), 7.20-7.30 (m, 3H), 7.13 (d, *J* = 6.8 Hz, 2H), 3.40-3.61 (m, 2H), 3.04-3.09 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.9, 137.4, 133.7, 129.3, 128.7, 128.2, 128.0, 126.8, 57.4, 28.6.



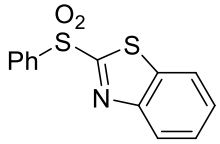
Isobutylsulfonylbenzene (**3z**)[4] (Rf ≈ 0.3, petroleum ether/EtOAc = 8:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 8.0 Hz, 2H), 7.65 (t, *J* = 7.2 Hz, 1H), 7.57 (t, *J* = 7.6 Hz, 2H), 3.00 (d, *J* = 6.4 Hz, 2H), 2.19-2.27 (m, 1H), 1.06 (d, *J* = 6.4 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 140.1, 133.4, 129.2, 127.7, 63.9, 24.0, 22.6.



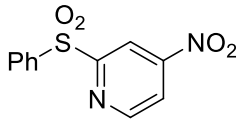
Sulfonyldibenzene (**3aa**)[5] (Rf ≈ 0.4, petroleum ether/EtOAc = 8:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.0 Hz, 4H), 7.58 (t, *J* = 8.0 Hz, 2H), 7.51 (t, *J* = 8.0 Hz, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.5, 133.1, 129.2, 127.6.



1-Bromo-4-(phenylsulfonyl)benzene (**3ab**)[5] (Rf ≈ 0.3, petroleum ether/EtOAc = 8:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.0 Hz, 2H), 7.82 (d, *J* = 8.0 Hz, 2H), 7.65 (d, *J* = 8.0 Hz, 2H), 7.60 (t, *J* = 6.8 Hz, 1H), 7.53 (t, *J* = 7.6 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.1, 140.6, 133.4, 132.5, 129.3, 129.1, 128.4, 127.6.

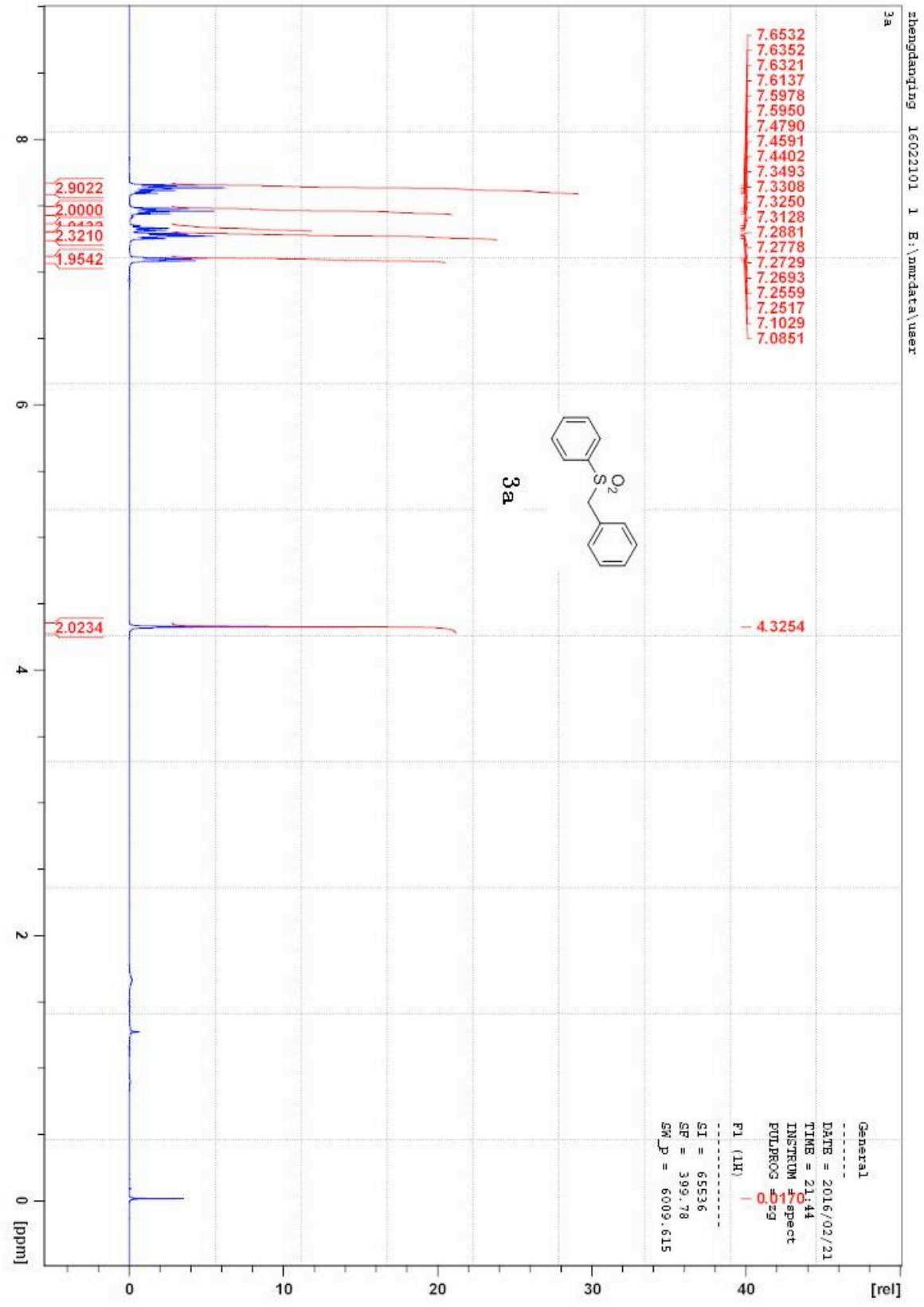


2-(Phenylsulfonyl)benzo[*d*]thiazole (**3ac**) (Rf ≈ 0.3, petroleum ether/EtOAc = 2:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.16-8.19 (m, 3H), 7.97 (d, *J* = 7.2 Hz, 1H), 7.68 (t, *J* = 7.2 Hz, 1H), 7.53-7.61 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.8, 138.4, 137.0, 134.5, 133.9, 129.4, 128.9, 127.8, 127.4, 125.5, 122.1; HRMS (ESI) calcd for $C_{13}H_{10}NO_2S2^+$: 276.0147 ($M + H^+$), found: 276.0150.



4-Nitro-2-(phenylsulfonyl)pyridine (**3ad**) (Rf ≈ 0.3, petroleum ether/EtOAc = 2:1): ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.43 (s, 1H), 8.72 (d, *J* = 8.0 Hz, 1H), 8.43 (d, *J* = 8.4 Hz, 1H), 8.09 (d, *J* = 8.0 Hz, 2H), 7.70 (t, *J* = 8.0 Hz, 1H), 7.59 (t, *J* = 8.0 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.2, 145.7, 145.1, 137.2, 134.6, 133.5, 129.4, 122.5; HRMS (ESI) calcd for $C_{11}H_9N_2O_4S_2^+$: 265.0278 ($M + H^+$), found: 265.0270.

1. D. Zheng, R. Mao, Z. Li, J. Wu, *Org. Chem. Front.* **2016**, *3*, 359.
2. *J*. Aydin, *J*. M. Larsson, N. Selander, K. *J*. Szabó, *Org. Lett*. **2009**, *11*, 2852.
3. C. Yao, Q. Li, M. Wang, X. Ning, Y. Kang, *Chem. Commun.* **2015**, 51, 7729.
4. L. Řehová, I. Císařová, U. *J*ahn, *Eur. J . Org. Chem.* **2014**,1461.
5. N. Umierski, G. Manolikakes, *Org. Lett.* **2013**, 15, 188.
6. B. A. Hathaway, M. M. Triefenbach, *Molecules* 2011, 6, M245.
7. A. S. Deeming, C. J. Russell, A. J. Hennessy, M. C. Willis, *Org. Lett.* **2014**, 16, 150.
8. B. Zheng, T. Jia, P. J. Walsh, *Org. Lett.* **2013**, 15, 1690.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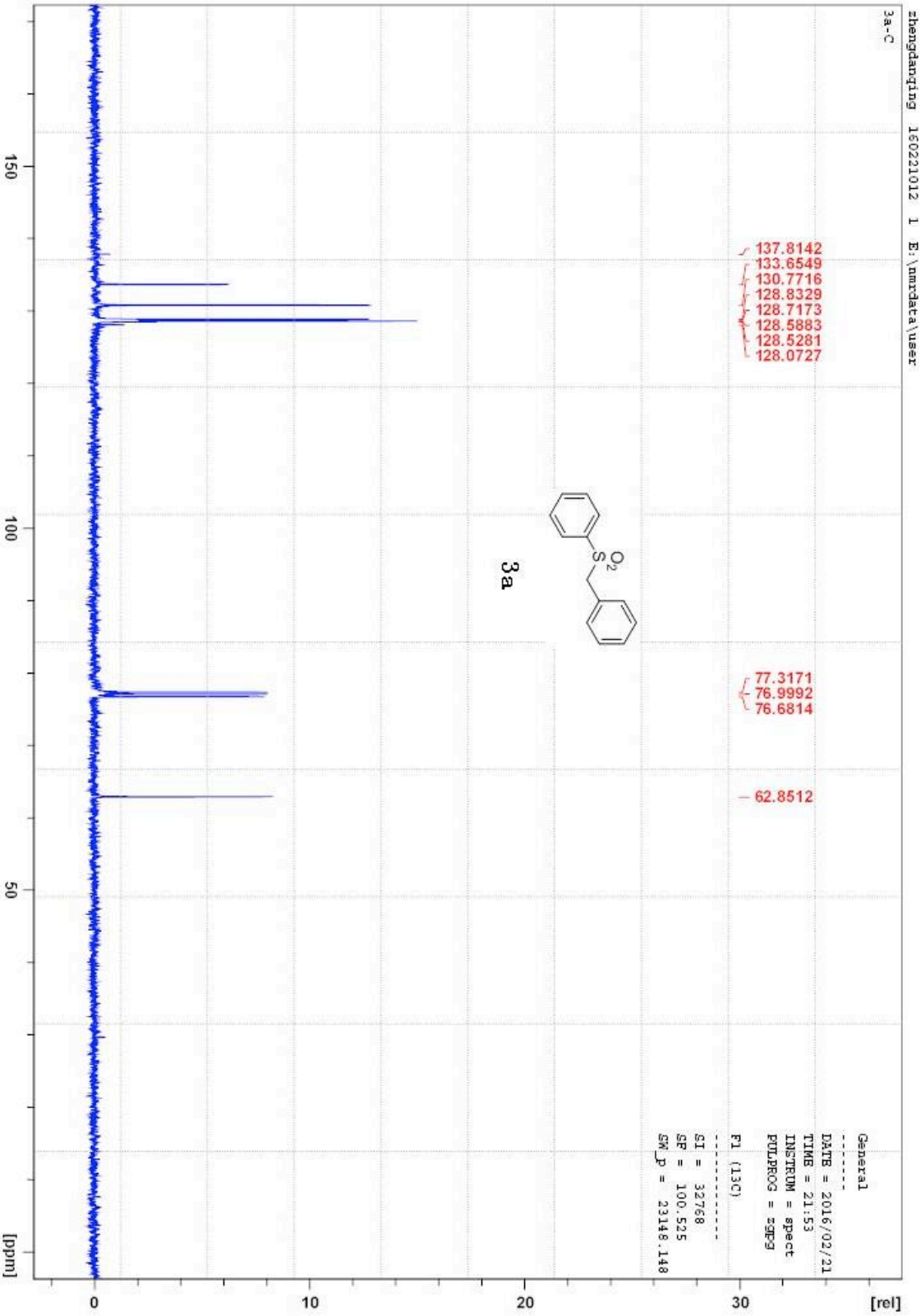
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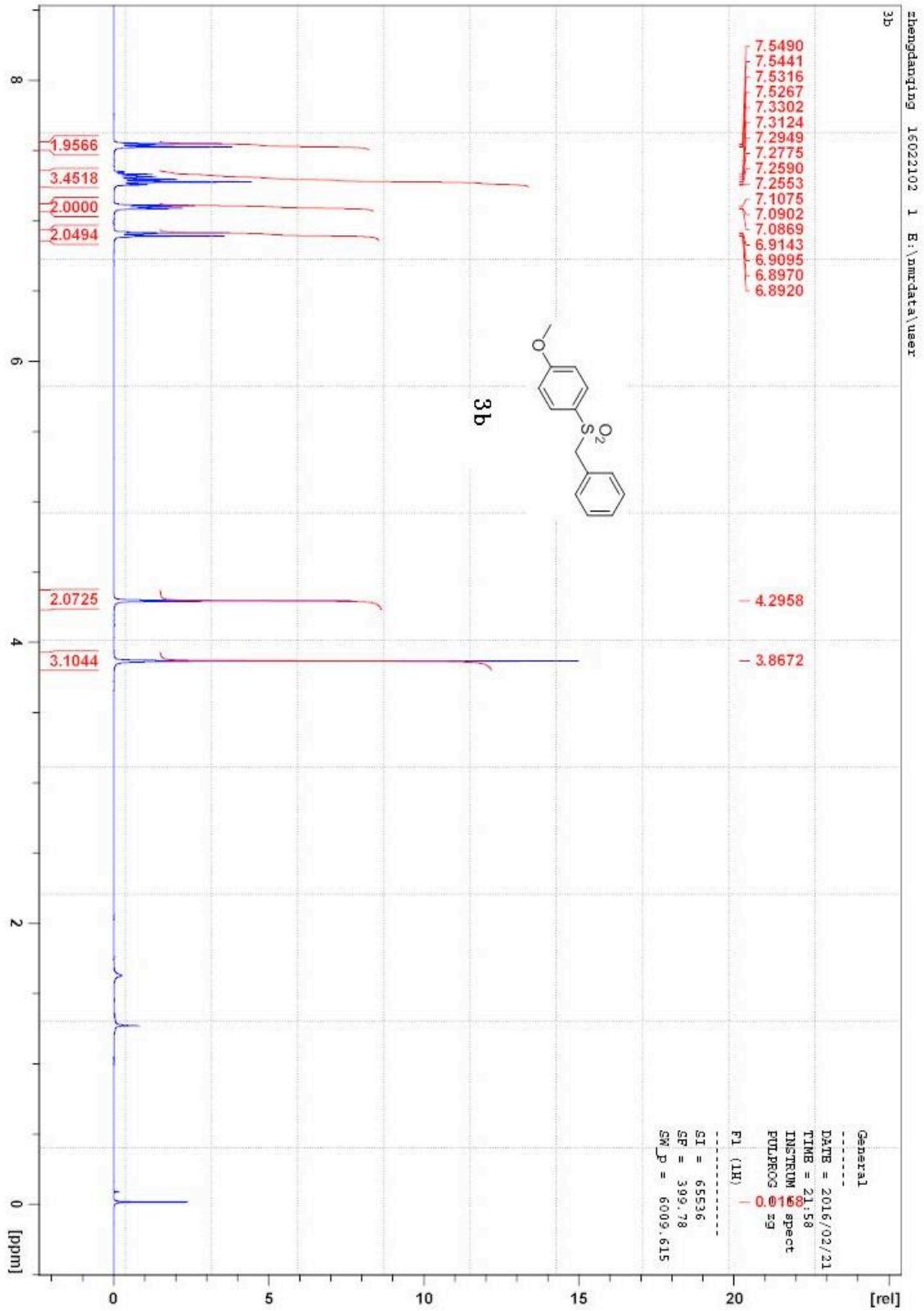
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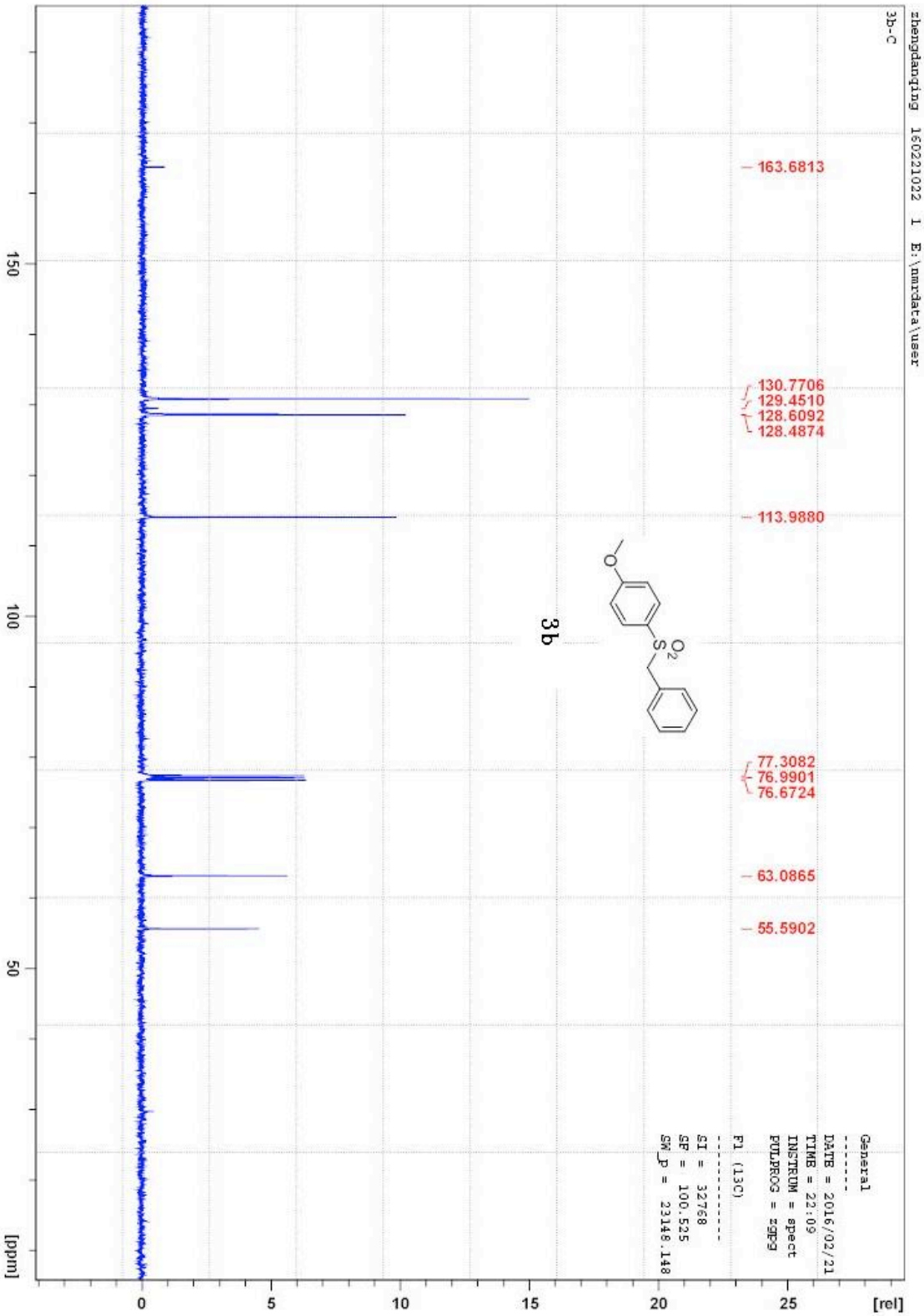
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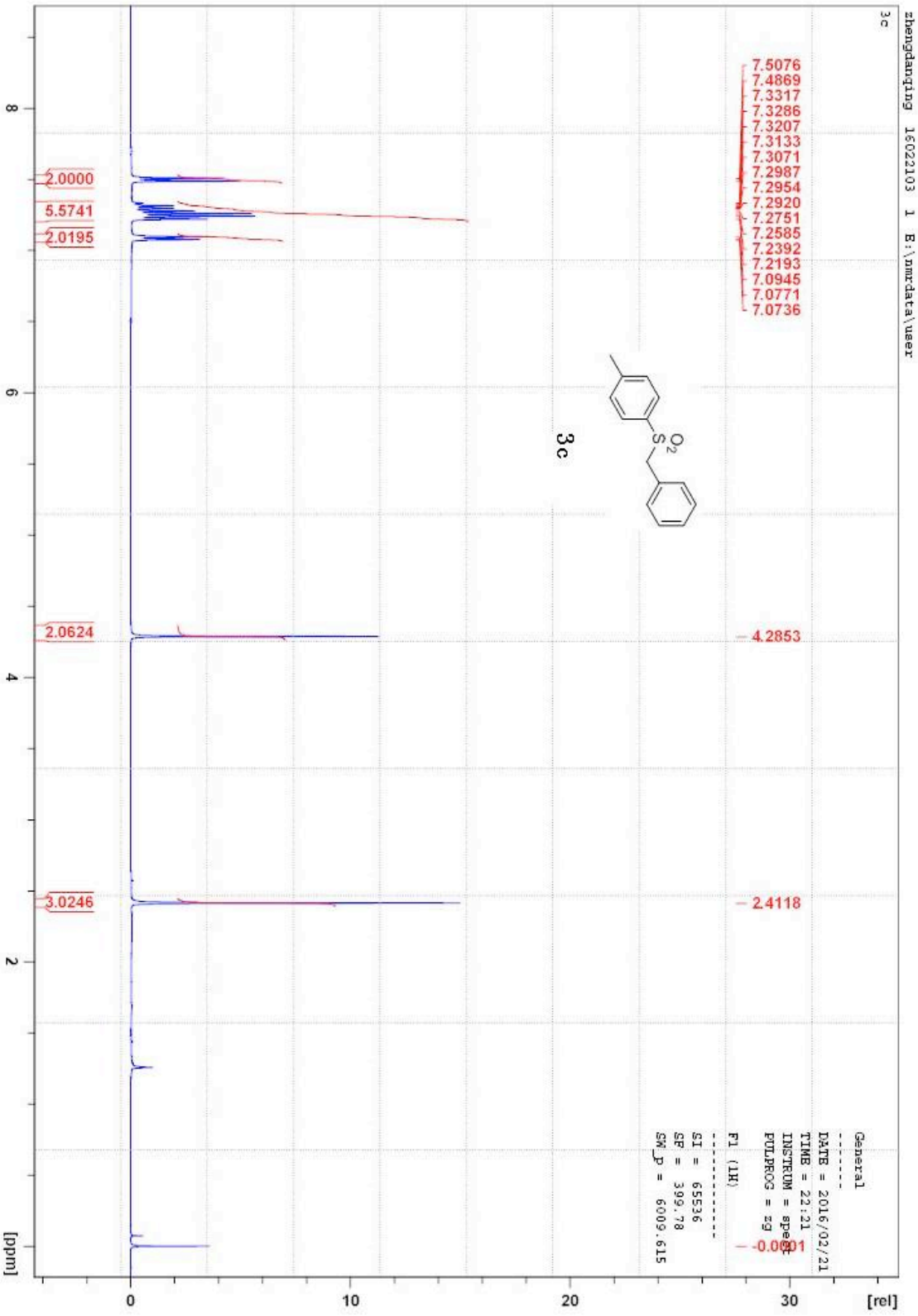
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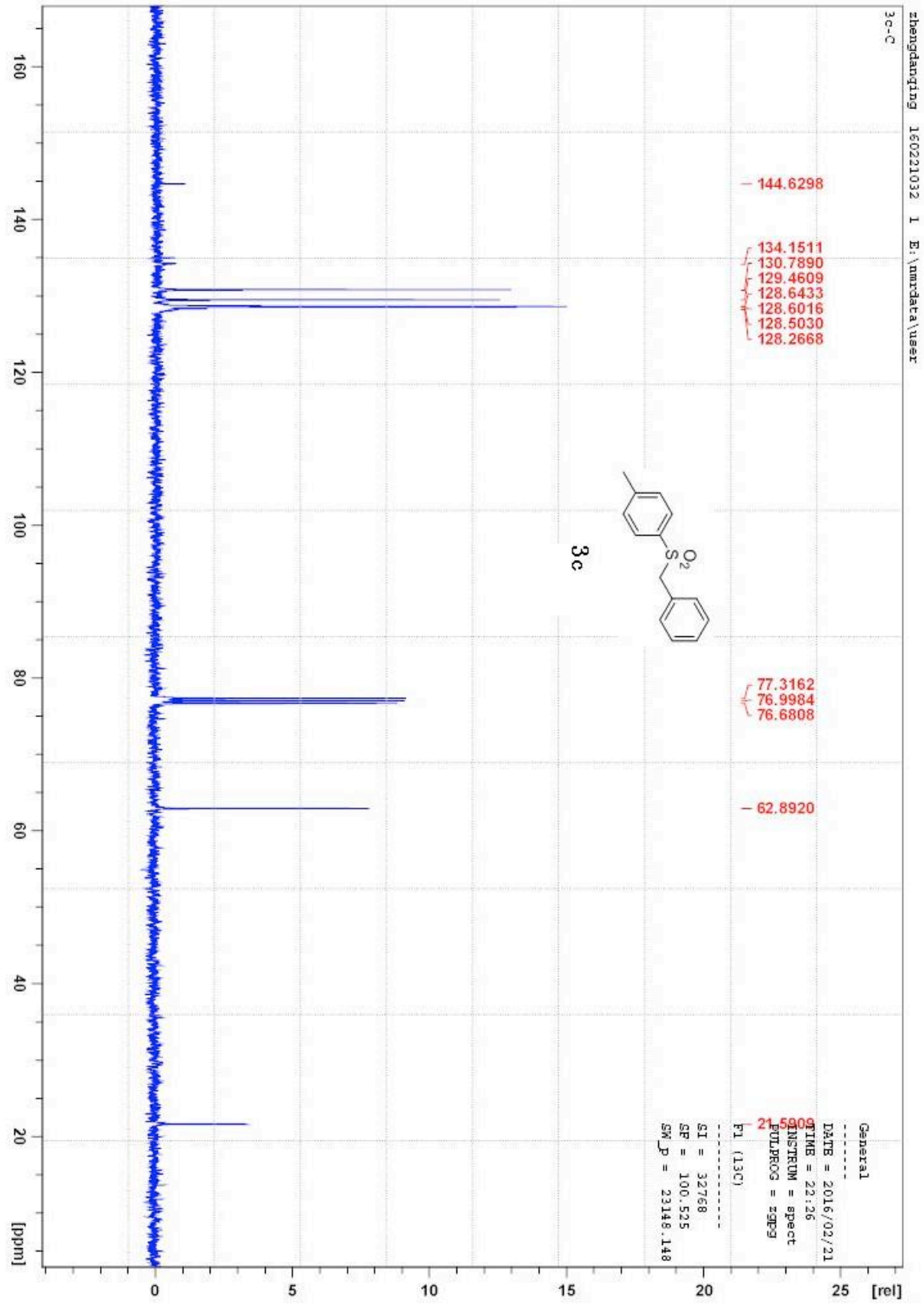
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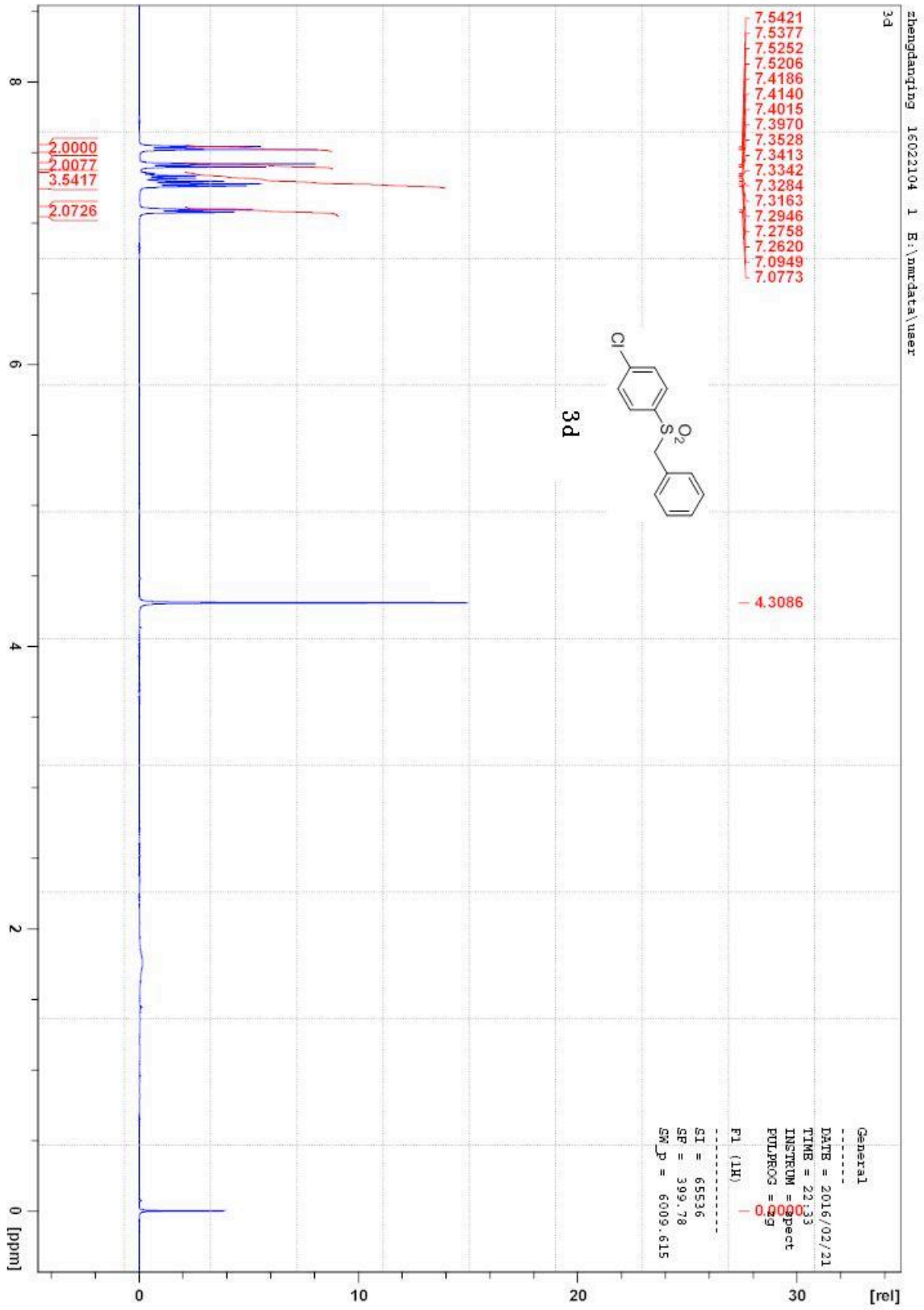
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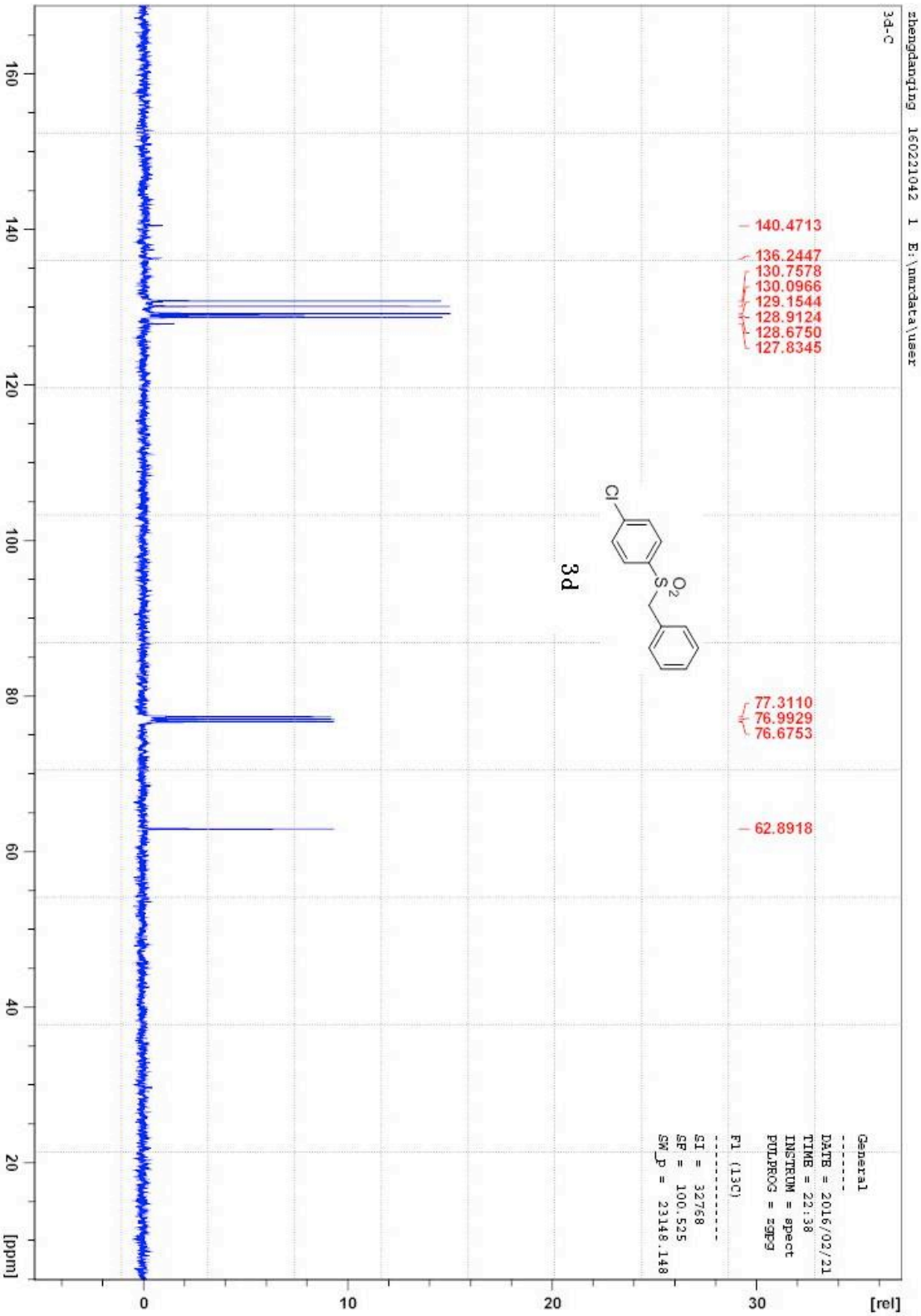
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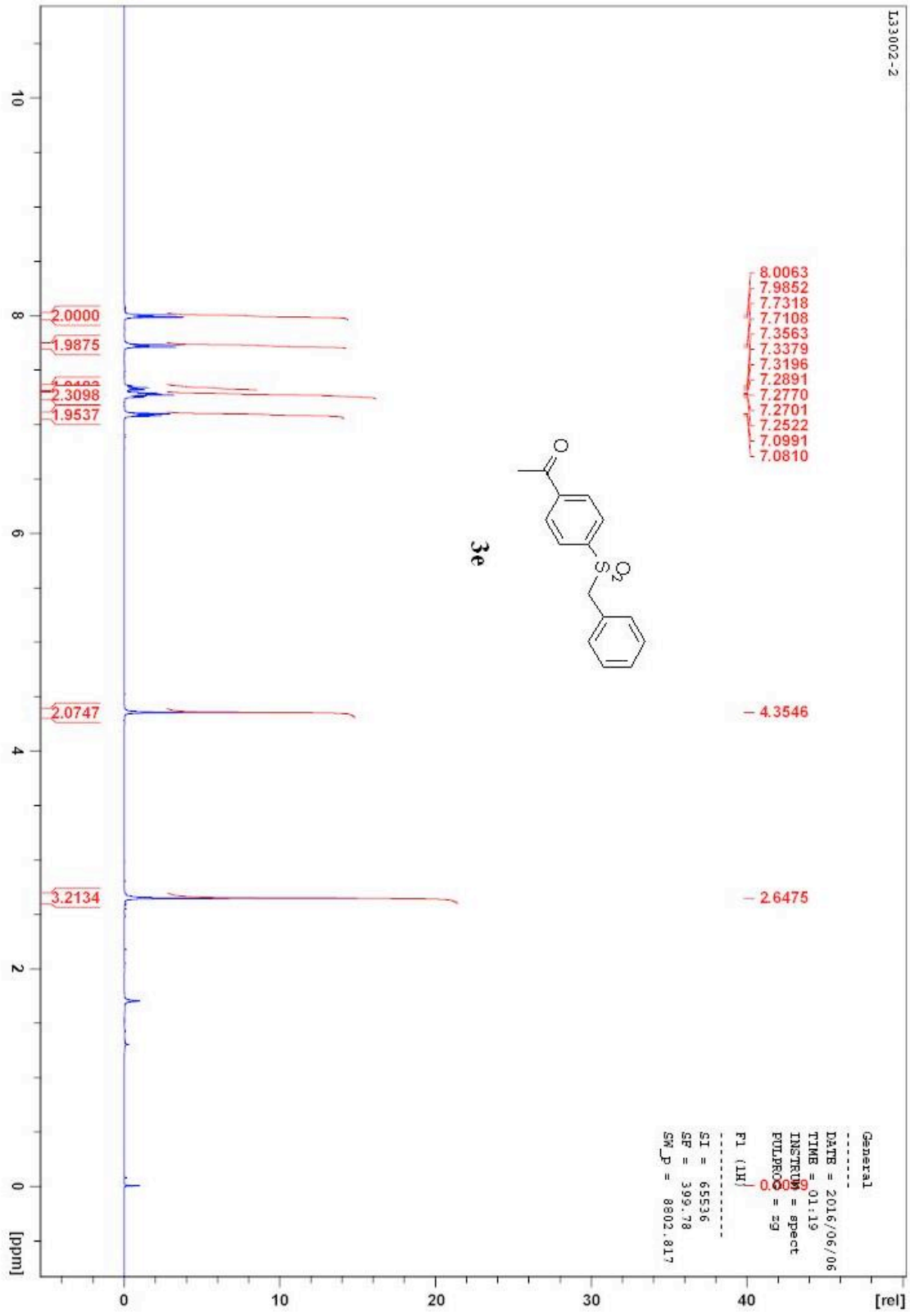
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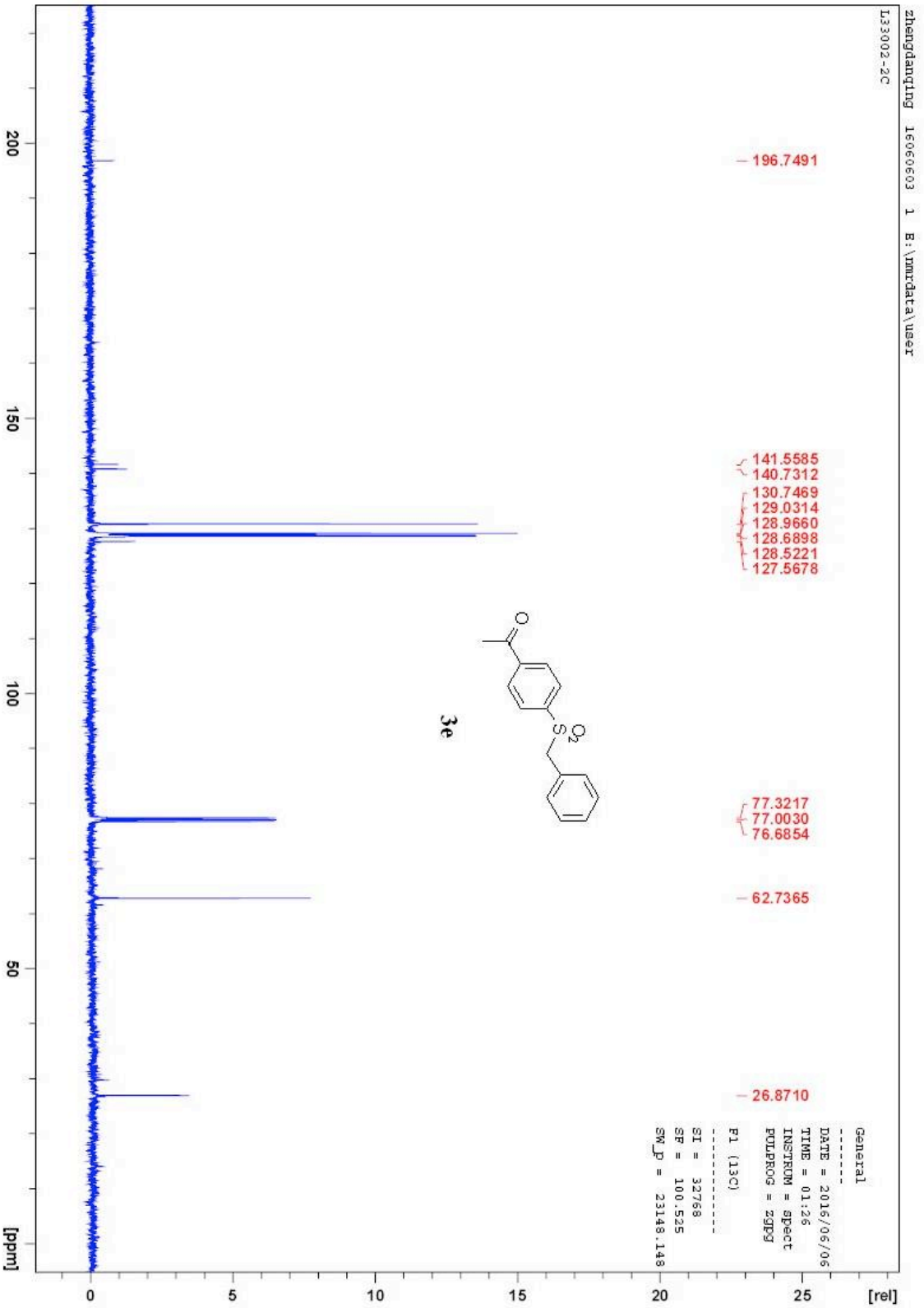
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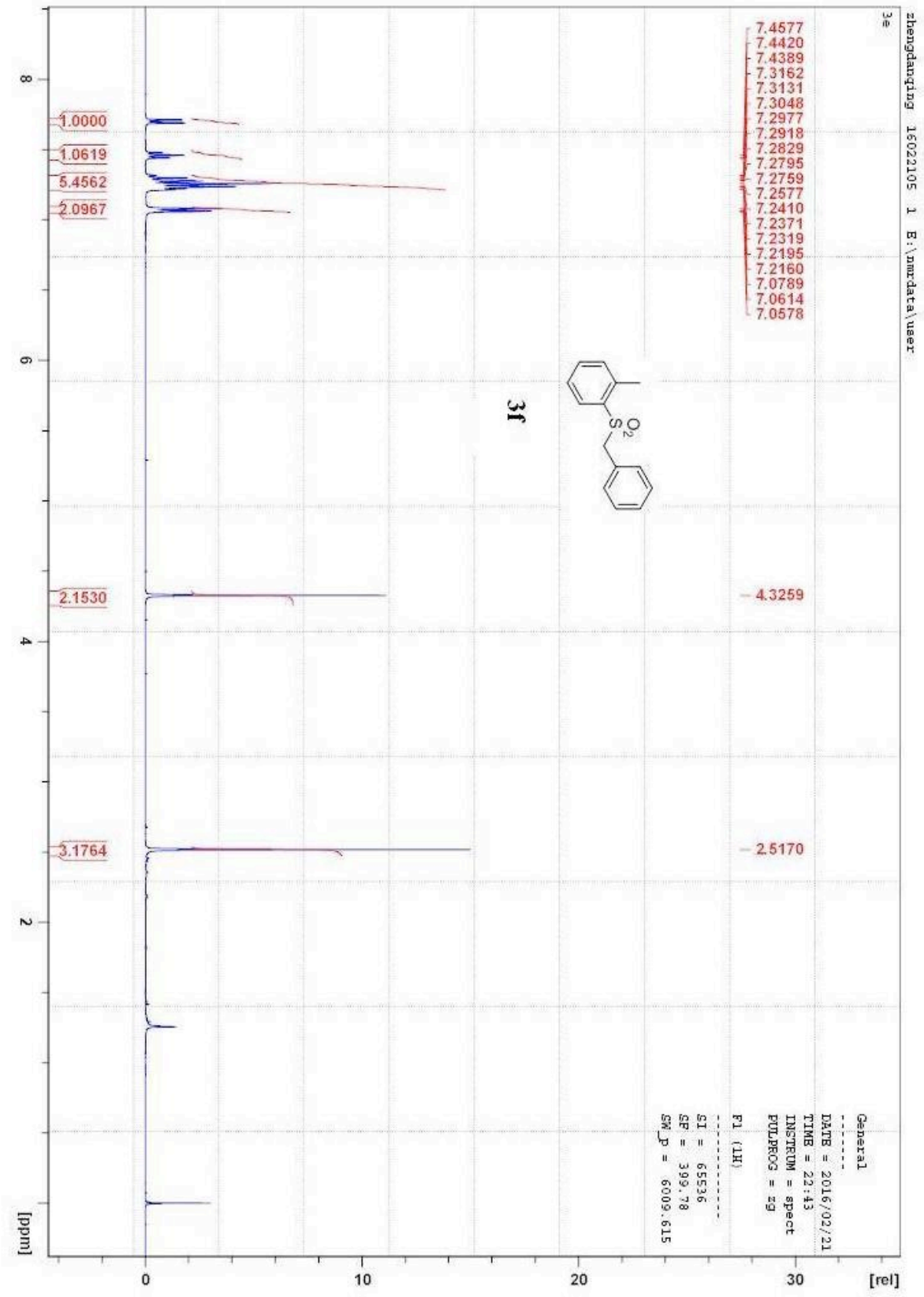
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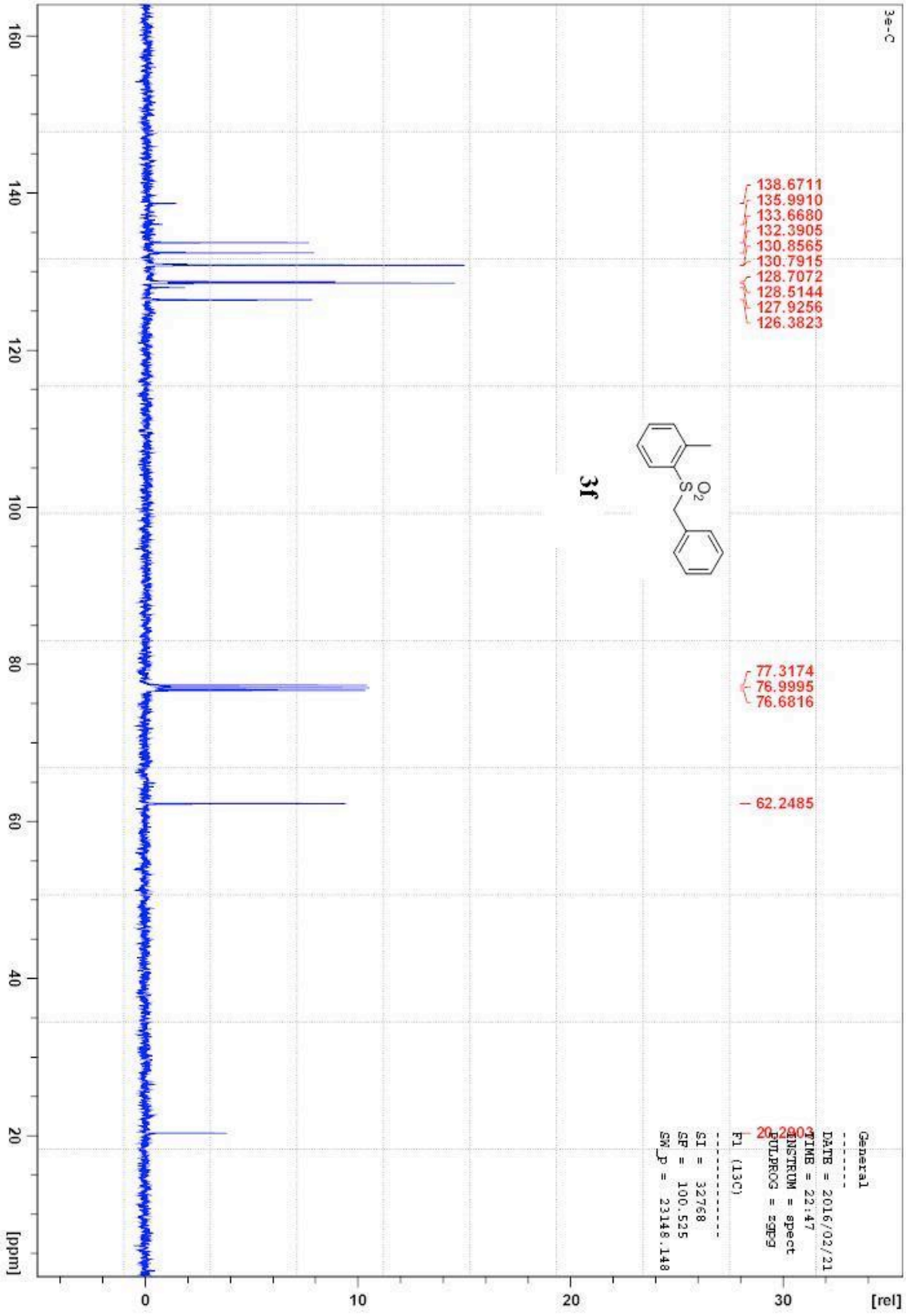
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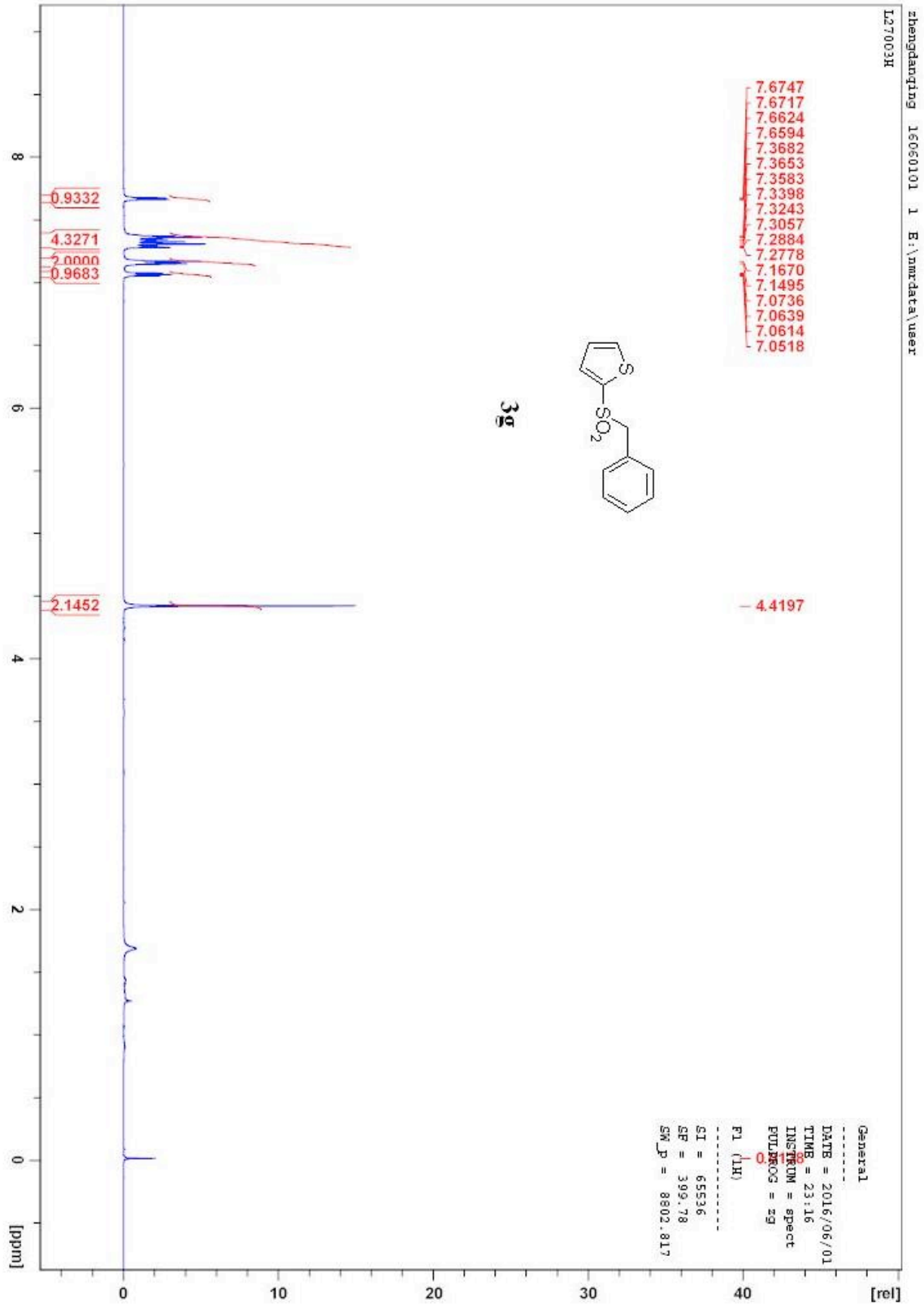
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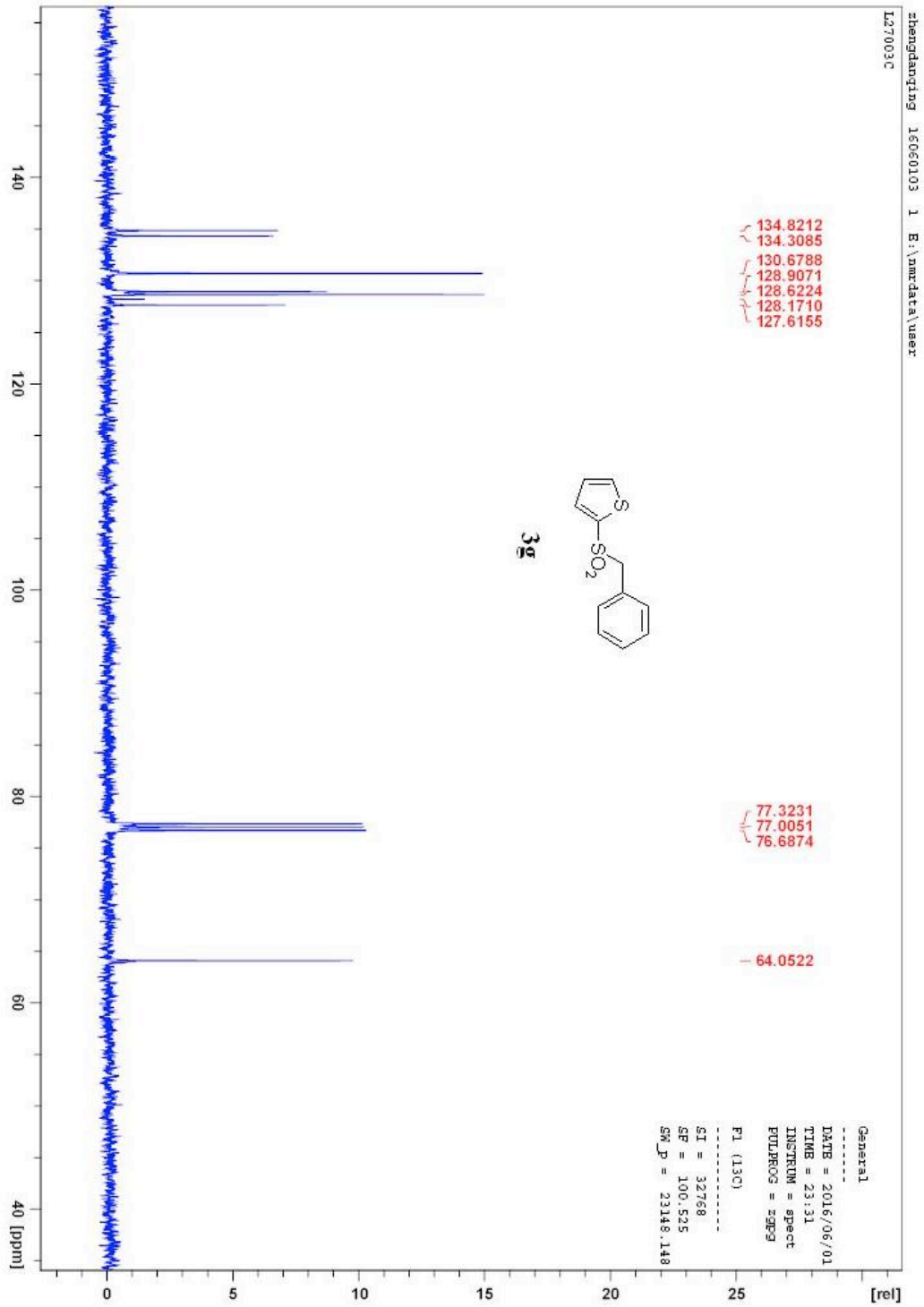
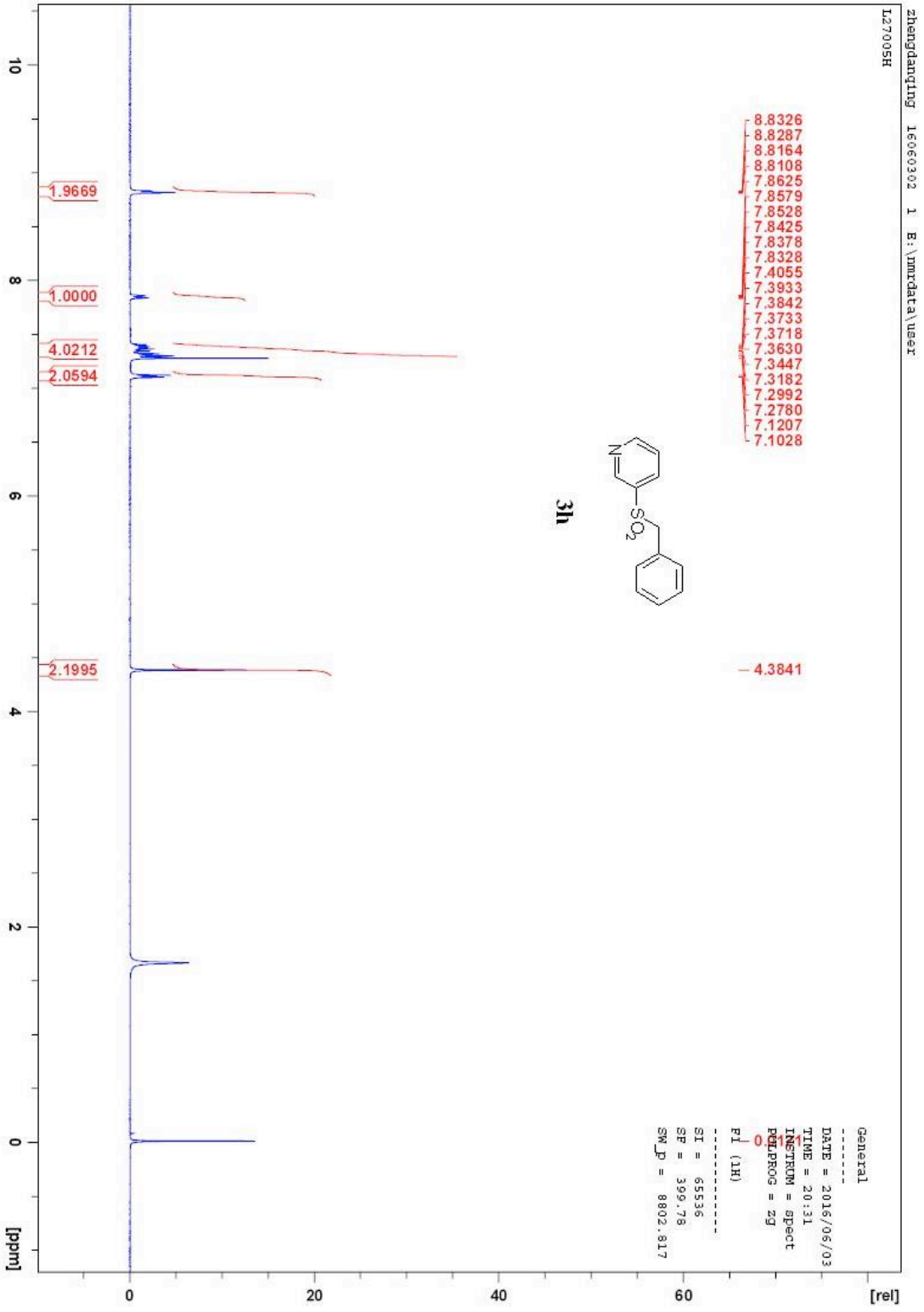
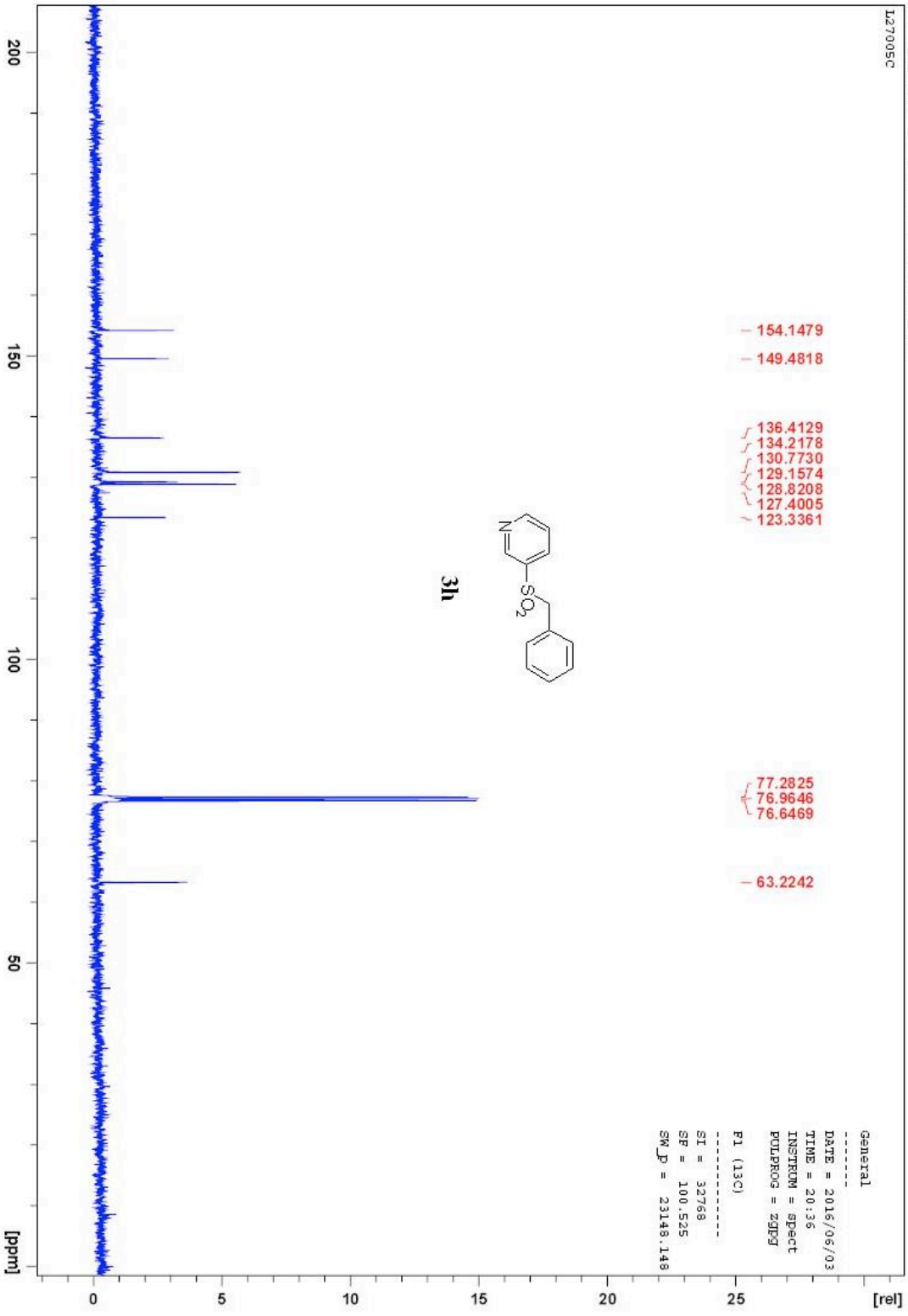

zhengdanqing 16060103 1 E:\nmrdata\user
L270031C
134.8212
134.3085
130.6788
128.9071
128.6224
128.1710
127.6155
77.3231
77.0051
76.6874
64.0522
3g
S
SO2
General
DATE = 2016/06/01
TIME = 23:31
INSTRUM = spect
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
140
120
100
80
60
40 [ppm]
0
5
10
15
20
25
[rel]


zhengdanqing 16060302 1 E:\nmrdata\ueer
L27005H
8.8326
8.8287
8.8164
8.8108
7.8625
7.8579
7.8528
7.8425
7.8378
7.8328
7.4055
7.3933
7.3842
7.3733
7.3718
7.3630
7.3447
7.3182
7.2992
7.2780
7.1207
7.1028
4.3841
1.9669
1.0000
4.0212
2.0594
2.1995
3h
N
SO2
General
DATE = 2016/06/03
TIME = 20:31
INSTRUM = spect
PULPROG = zg
PL (1H)
SI = 65536
SF = 399.78
SW_p = 8802.817
[ppm]
[rel]


zhengdanqing 16060303 1 E:\nmrdata\user
L27005C
154.1479
149.4818
136.4129
134.2178
130.7730
129.1574
128.8208
127.4005
123.3361
77.2825
76.9646
76.6469
63.2242
3h
N
SO2
General
DATE = 2016/06/03
TIME = 20:36
INSTROM = spect
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
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150
100
50
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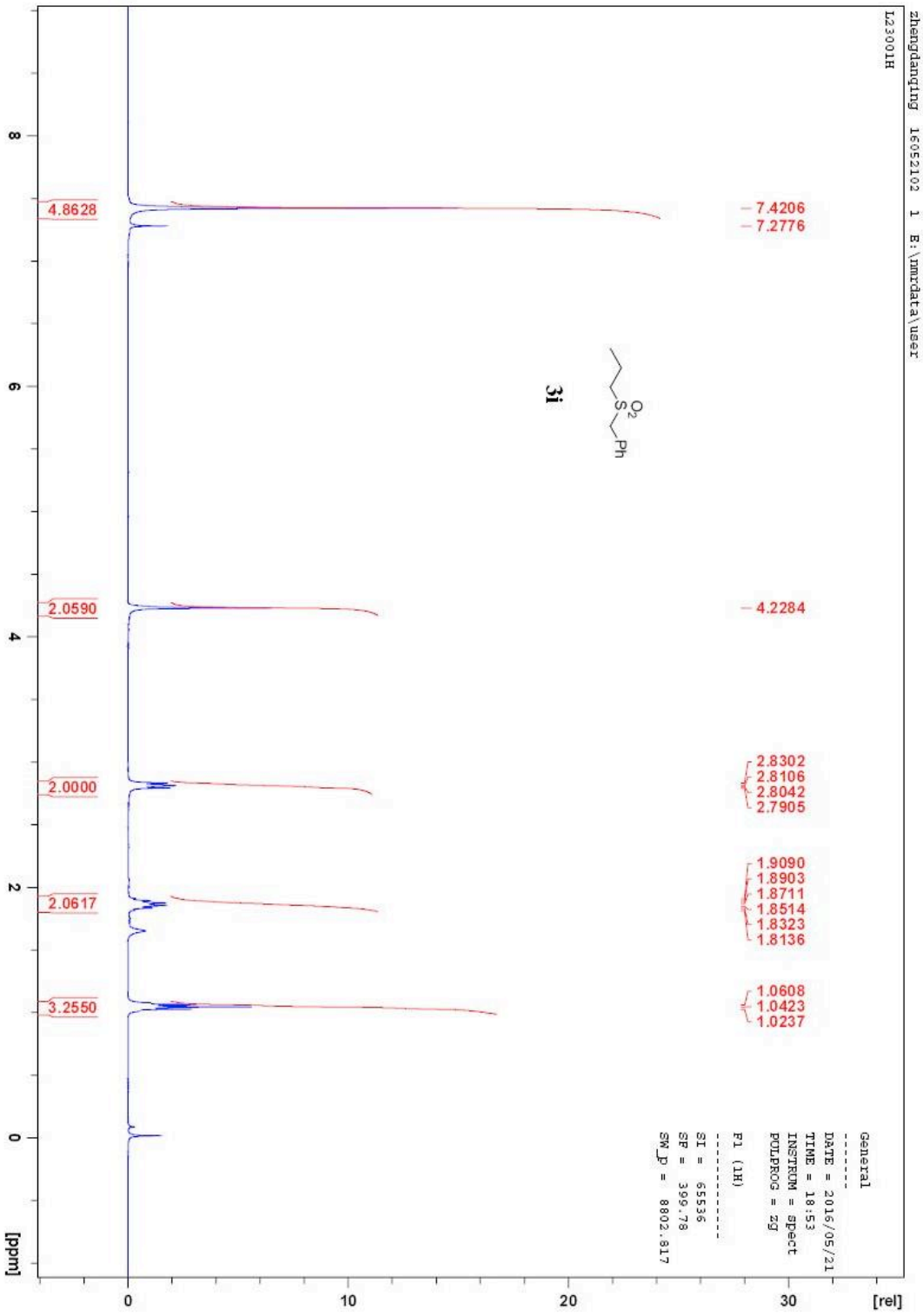
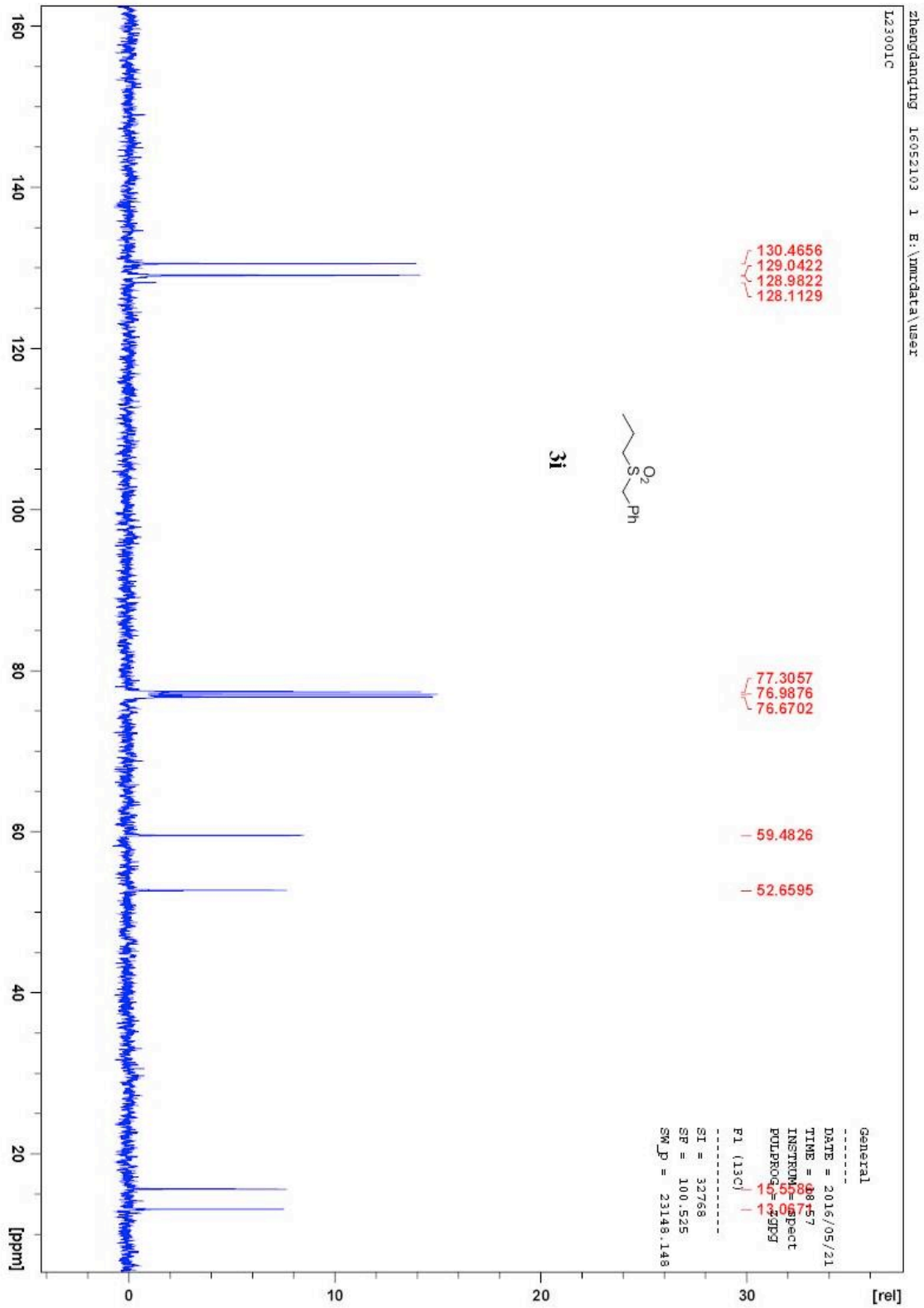
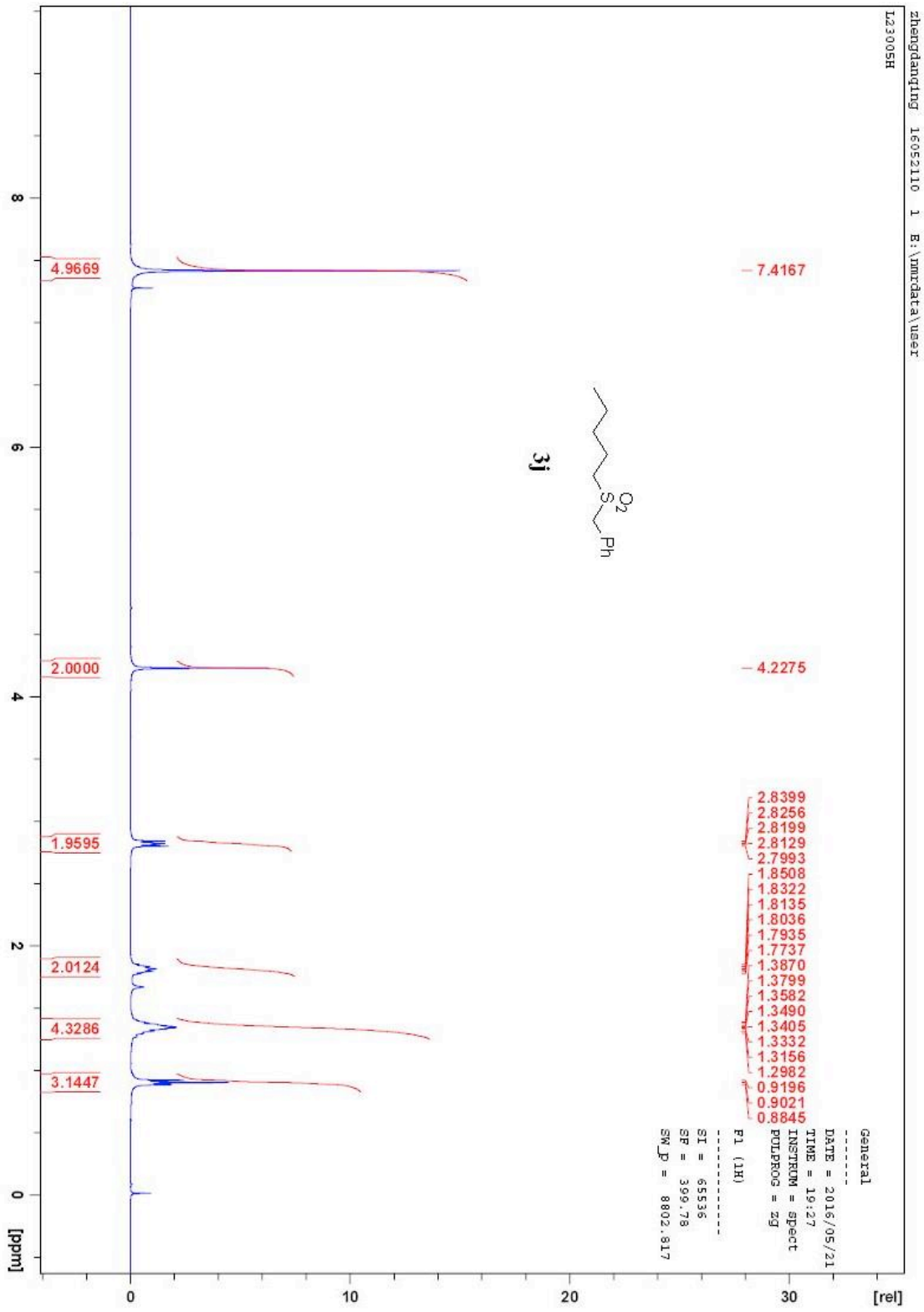
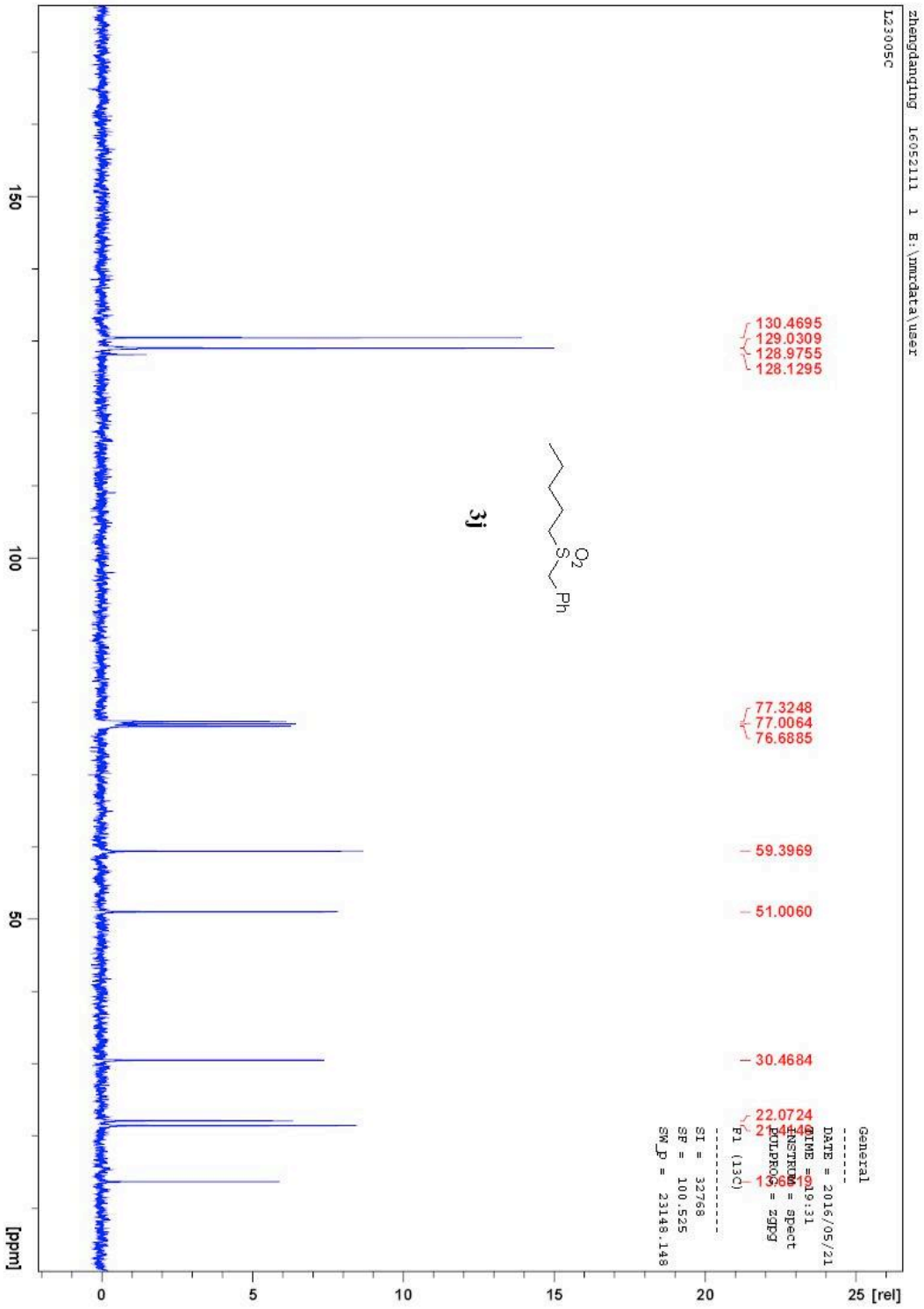
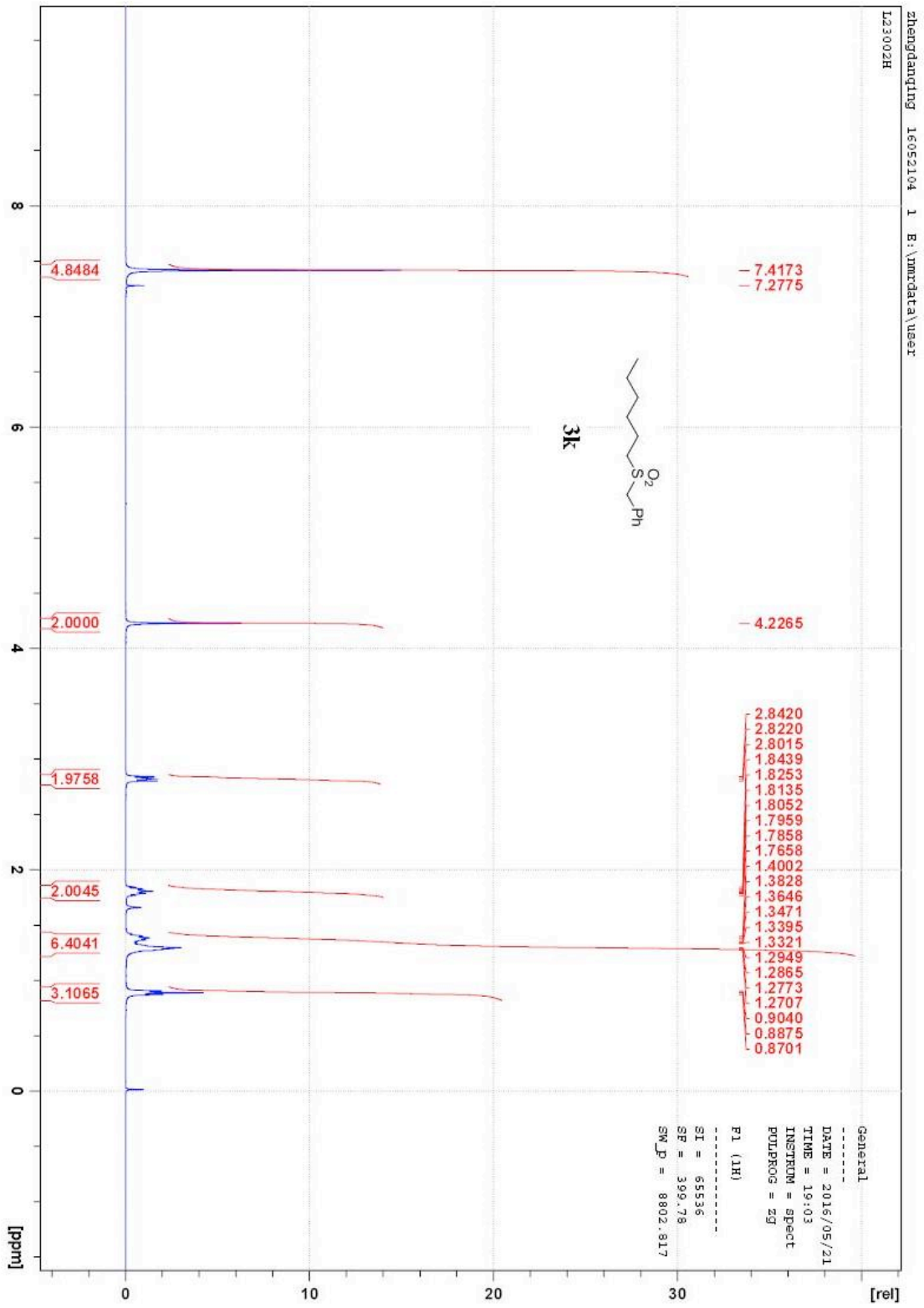
10
15
20
25
[rel]

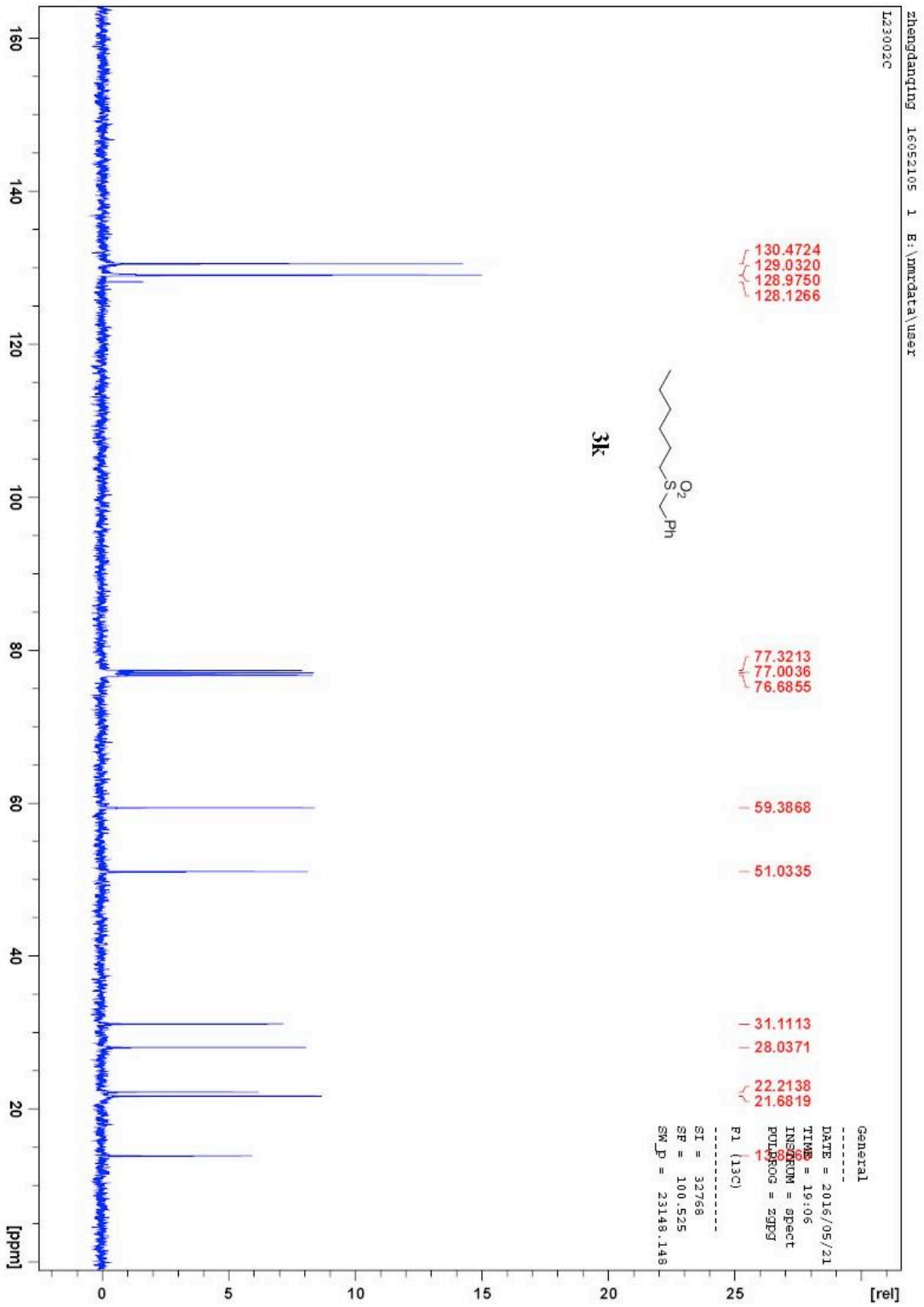

zhengdanqing 16052102 1 B:\nmrdata\user
L23001H
4.8628
2.0590
2.0000
2.0617
3.2550
7.4206
7.2776
4.2284
2.8302
2.8106
2.8042
2.7905
1.9090
1.8903
1.8711
1.8514
1.8323
1.8136
1.0608
1.0423
1.0237
3i
O2
S
Ph
General
DATE = 2016/05/21
TIME = 18:53
INSTRUM = spect
PULPROG = zg
F1 (1H)
SI = 65536
SF = 399.78
SW_p = 8802.817
[ppm]
[rel]

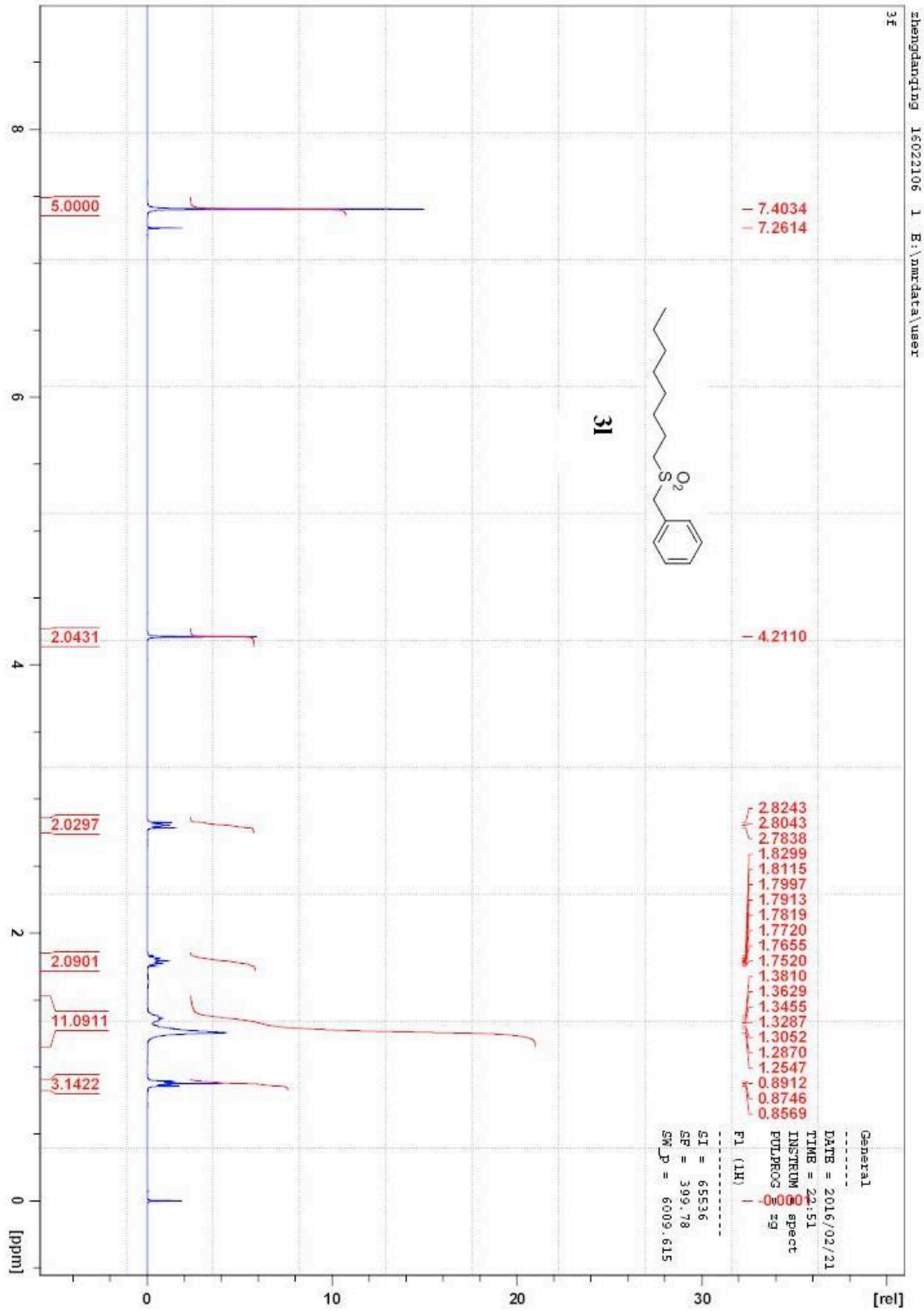

zhengdanqing 16052103 1 E:\nmrdata\user
L23001C
130.4656
129.0422
128.9822
128.1129
77.3057
76.9876
76.6702
59.4826
52.6595
13.0671
3i
O2
S
Ph
General
DATE = 2016/05/21
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
[ppm]
[rel]

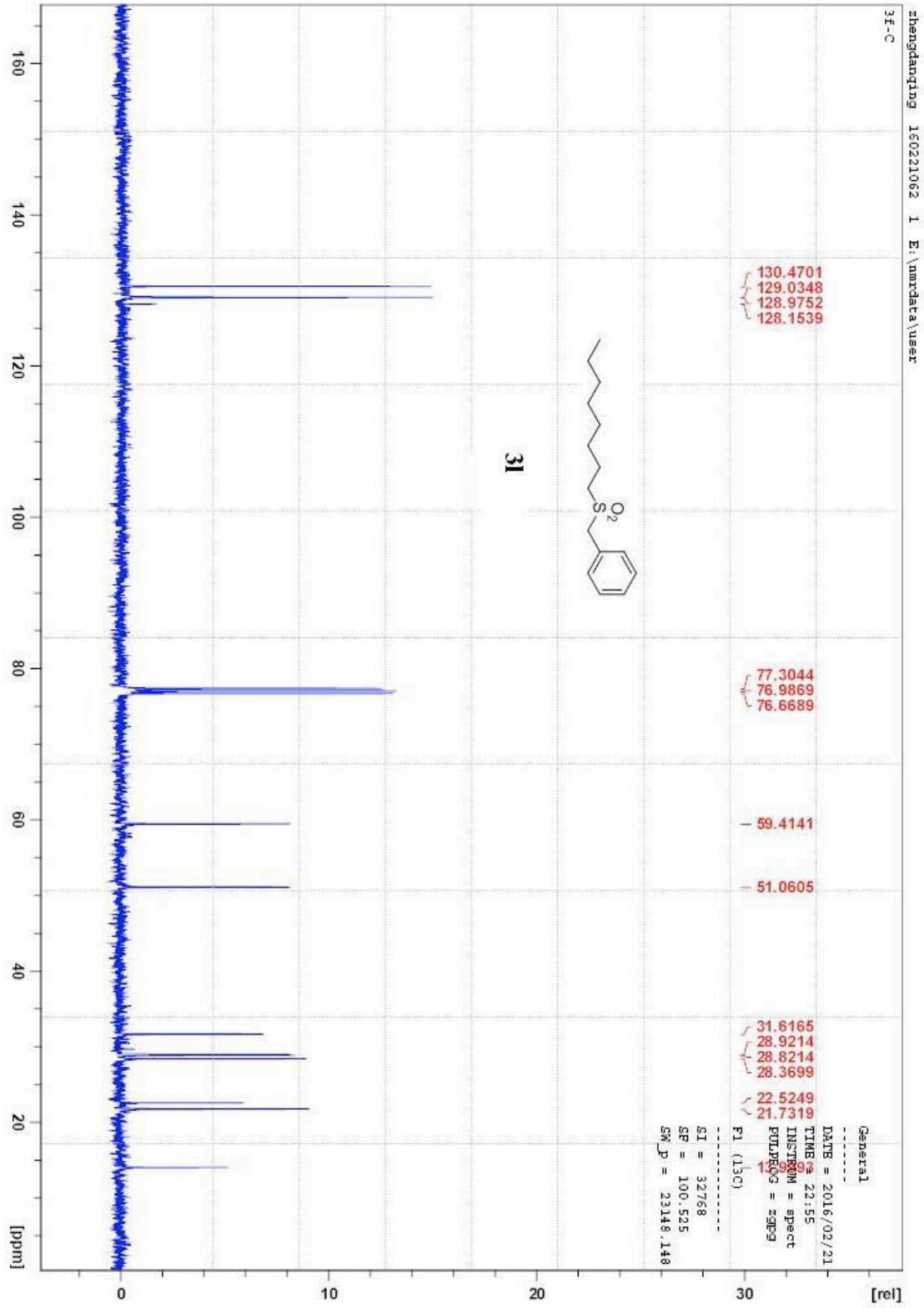

zhengdanqing 16052110 1 B:\nmrdata\uer
L23005H
3j
O2
S
Ph
4.9669
2.0000
1.9595
2.0124
4.3286
3.1447
7.4167
4.2275
2.8399
2.8256
2.8199
2.8129
2.7993
1.8508
1.8322
1.8135
1.8036
1.7935
1.7737
1.3870
1.3799
1.3582
1.3490
1.3405
1.3332
1.3156
1.2982
0.9196
0.9021
0.8845
General
DATE = 2016/05/21
TIME = 19:27
INSTRUM = spect
PULPROG = zg
F1 (1H)
SI = 65536
SF = 399.78
SW_p = 8802.817
[ppm]
[rel]

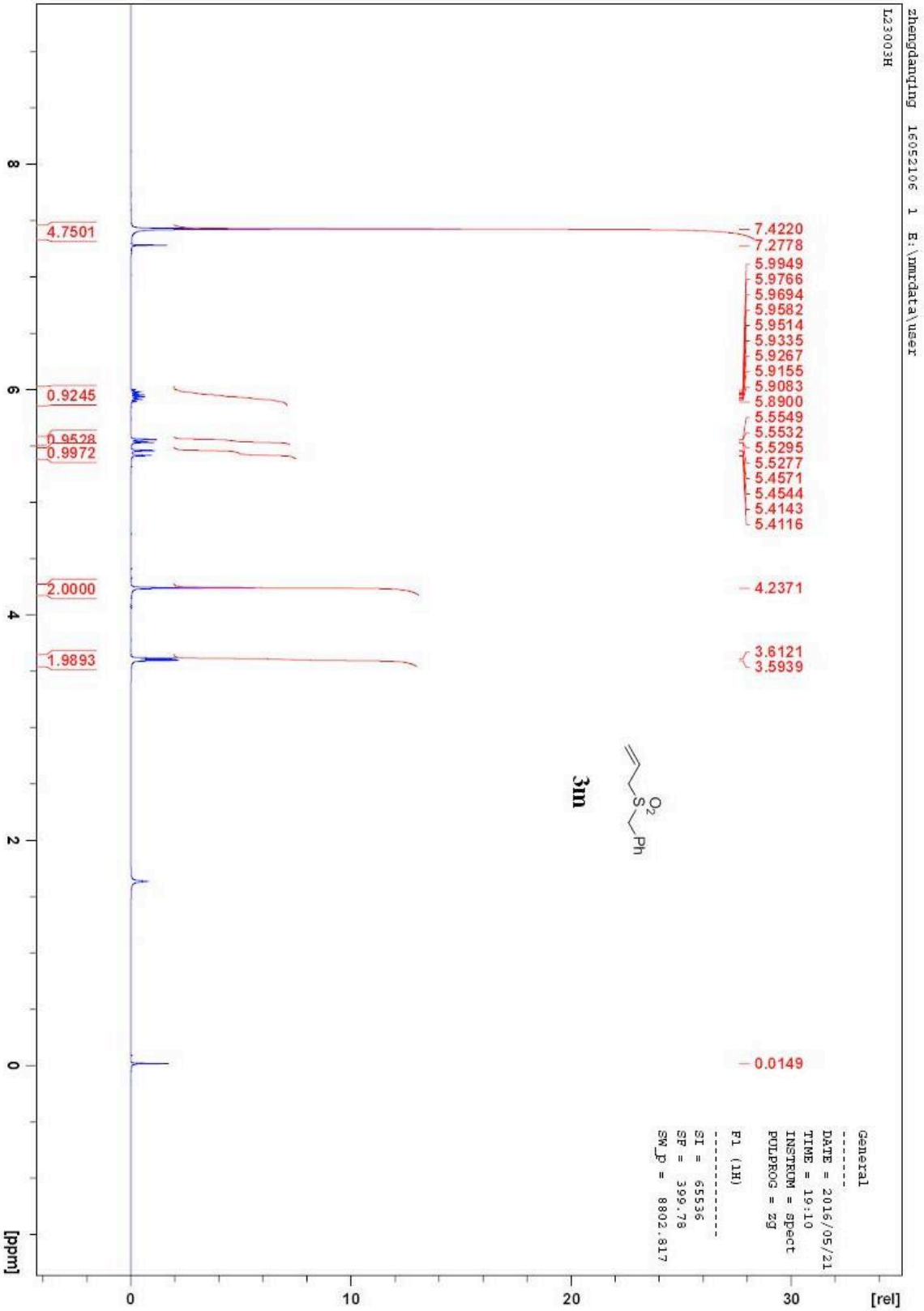

zhengdanqing 16052111 1 E:\nmrdata\user
L23005C
130.4695
129.0309
128.9755
128.1295
3j
O2
S
Ph
77.3248
77.0064
76.6885
59.3969
51.0060
30.4684
22.0724
21.4
13.6
General
DATE = 2016/05/21
TIME = 19:31
INSTRUM = spect
PULPROG = zgpg
P1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
150
100
50
[ppm]
0
5
10
15
20
25 [rel]

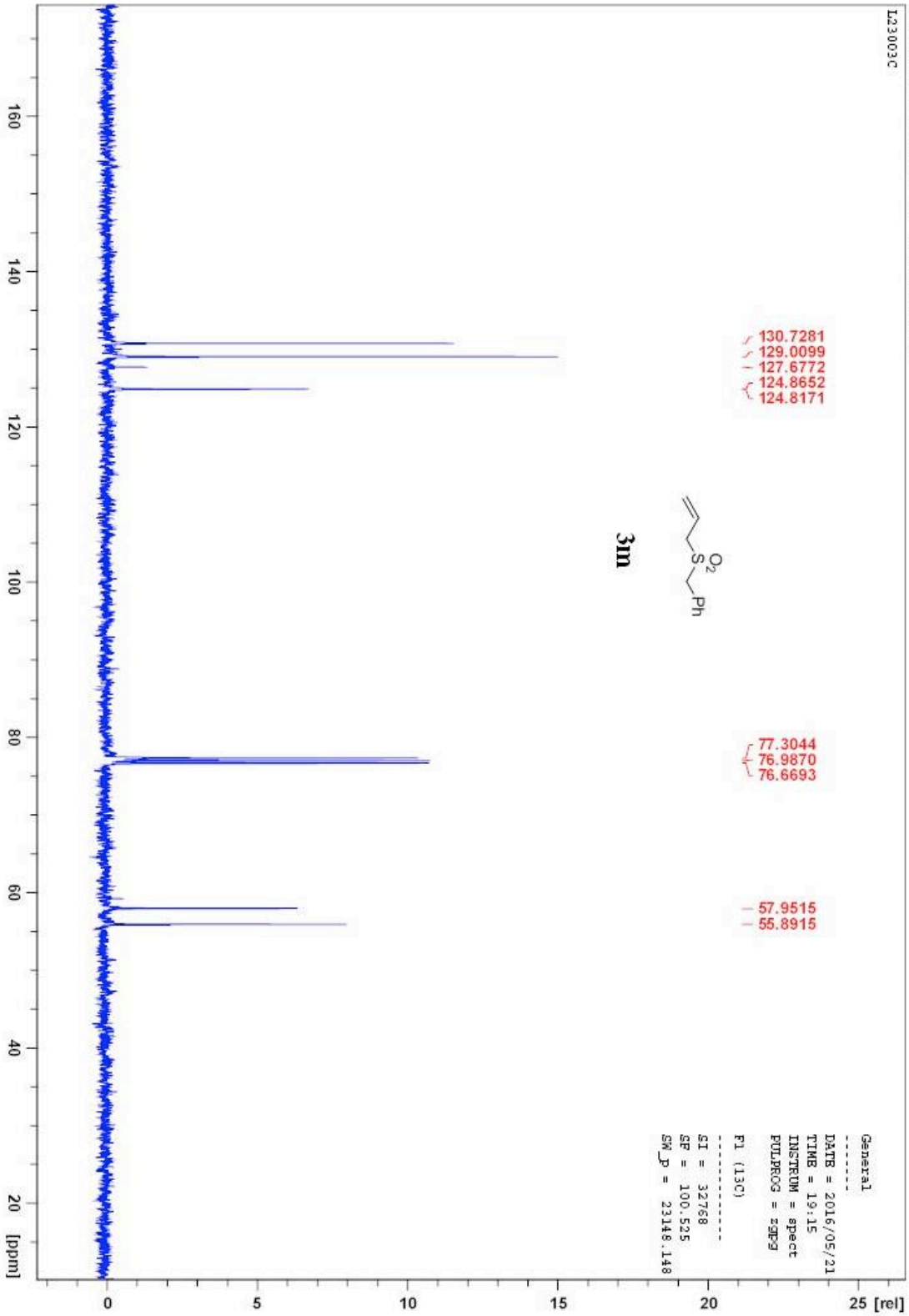

zhengdanqing 16052104 1 B:\nmrdata\user
L23002H
4.8484
2.0000
1.9758
2.0045
6.4041
3.1065
7.4173
7.2775
4.2265
2.8420
2.8220
2.8015
1.8439
1.8253
1.8135
1.8052
1.7959
1.7858
1.7658
1.4002
1.3828
1.3646
1.3471
1.3395
1.3321
1.2949
1.2865
1.2773
1.2707
0.9040
0.8875
0.8701
3k
O2
S
Ph
General
DATE = 2016/05/21
TIME = 19:03
INSTRUM = spect
PULPROG = zg
F1 (1H)
SI = 65536
SF = 399.78
SW_p = 8802.817
[ppm]
[rel]

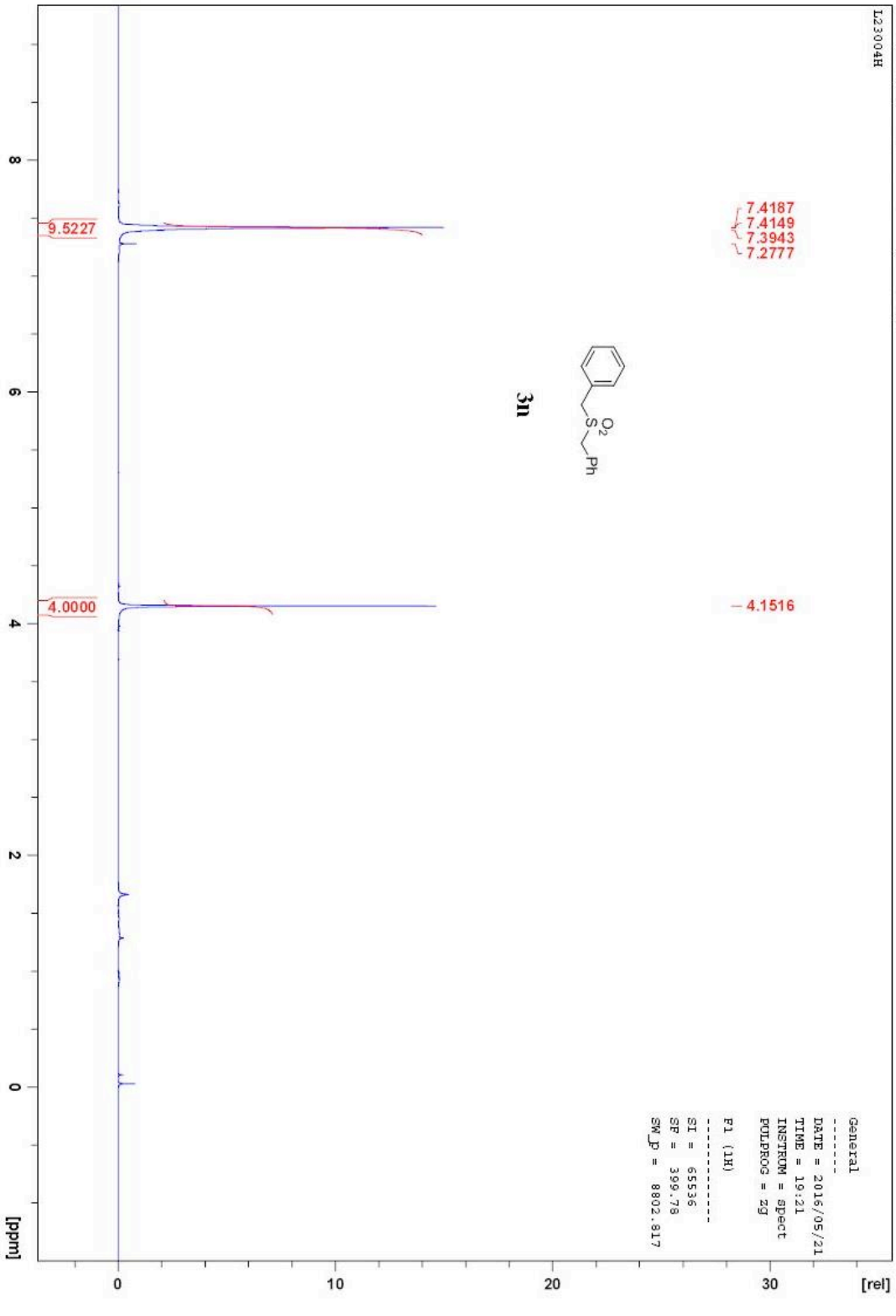

zhengdanqing 16052105 1 B:\nmrdata\user
L23002C
130.4724
129.0320
128.9750
128.1266
77.3213
77.0036
76.6855
59.3868
51.0335
31.1113
28.0371
22.2138
21.6819
3k
O2
S
Ph
General
DATE = 2016/05/21
TIME = 19:06
INSTRUM = spect
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
[ppm]
[rel]

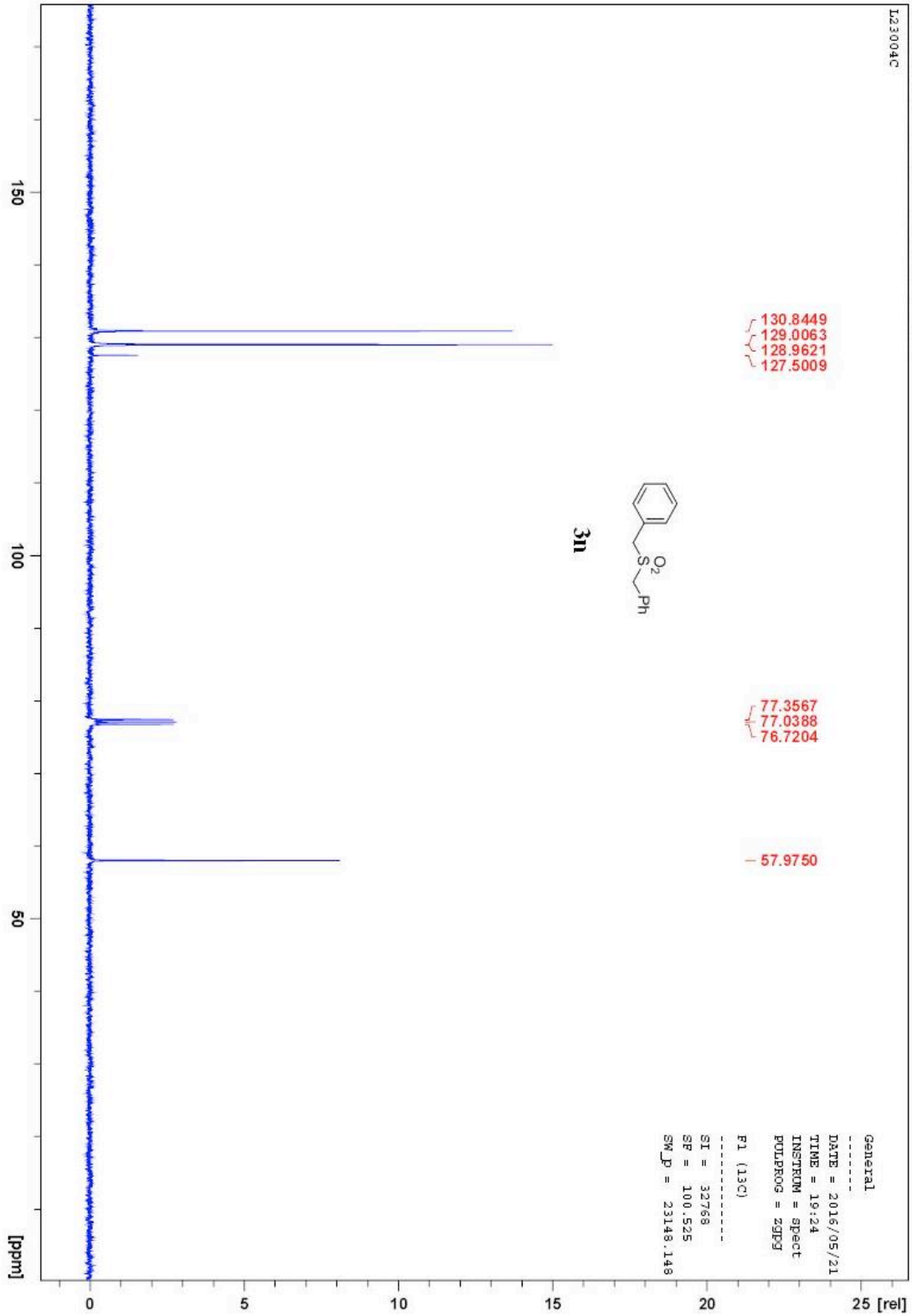

zhengdanqing 16022106 1 E:\nmrdata\user
3f
5.0000
2.0431
2.0297
2.0901
11.0911
3.1422
7.4034
7.2614
4.2110
2.8243
2.8043
2.7838
1.8299
1.8115
1.7997
1.7913
1.7819
1.7720
1.7655
1.7520
1.3810
1.3629
1.3455
1.3287
1.3052
1.2870
1.2547
0.8912
0.8746
0.8569
31
O2
S
General
DATE = 2016/02/21
TIME = 22:51
INSTRUM spect
PULPROG zg
F1 (1H)
SI = 65536
SF = 399.78
SW_p = 6009.615
[ppm]
[rel]

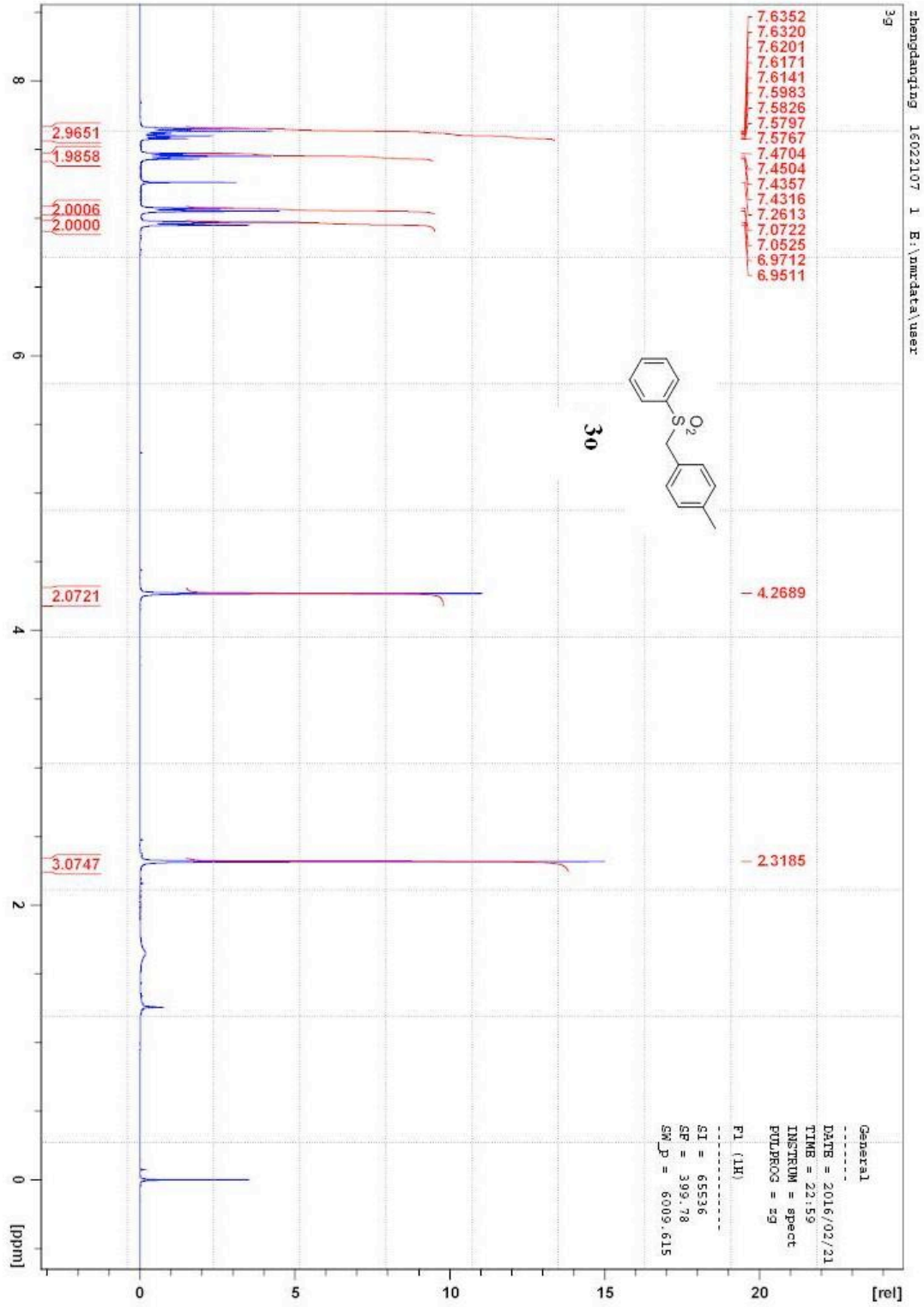

zhengdanqing 160221062 1 E:\nmrdata\user
3f-C
31
130.4701
129.0348
128.9752
128.1539
77.3044
76.9869
76.6689
59.4141
51.0605
31.6165
28.9214
28.8214
28.3699
22.5249
21.7319
General
DATE = 2016/02/21
TIME = 22:55
INSTRUM = spect
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
[ppm]
[rel]

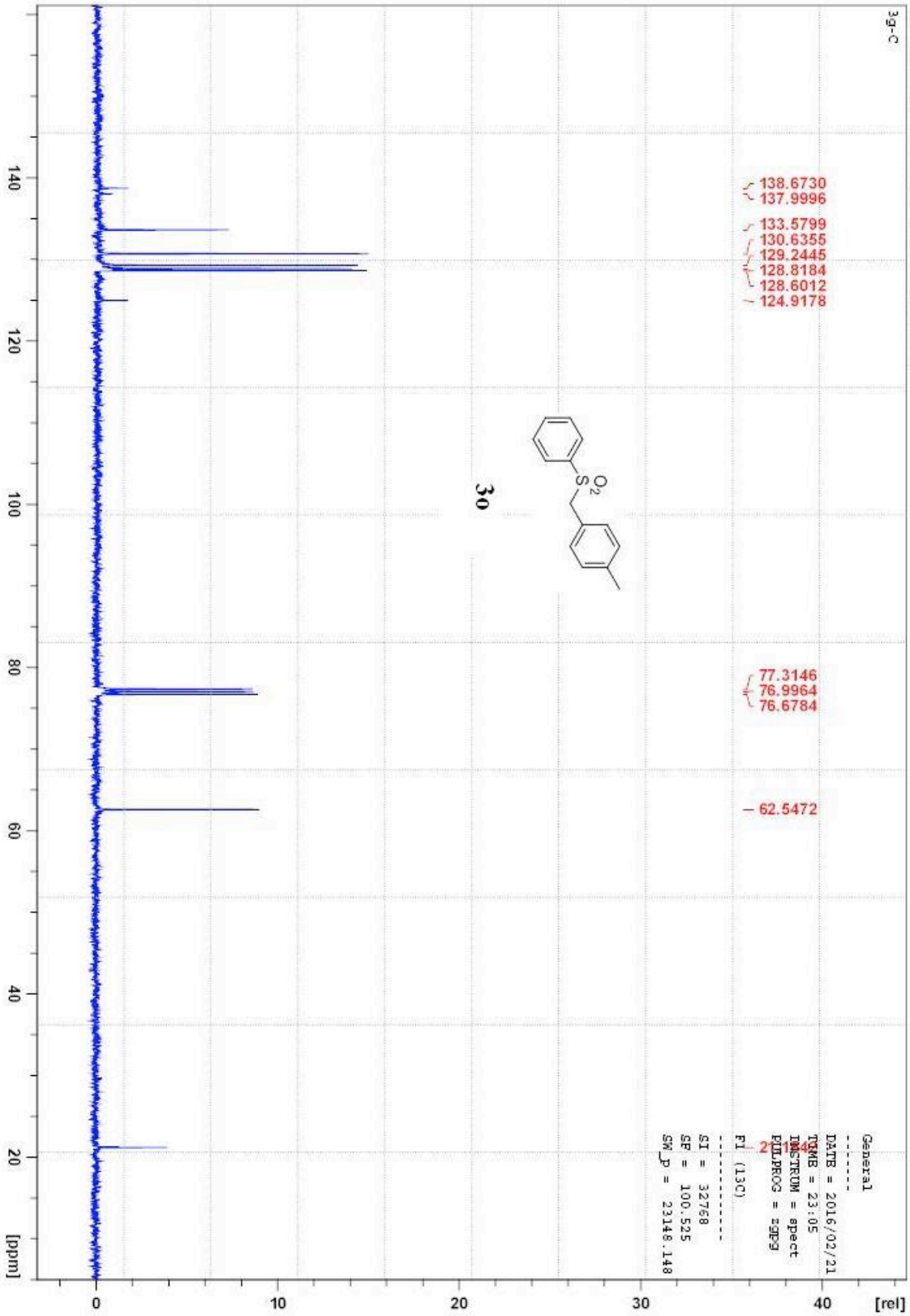

zhengdanqing 16052106 1 E:\nmrdata\uer
L23003H
4.7501
0.9245
0.9528
0.9972
2.0000
1.9893
7.4220
7.2778
5.9949
5.9766
5.9694
5.9582
5.9514
5.9335
5.9267
5.9155
5.9083
5.8900
5.5549
5.5532
5.5295
5.5277
5.4571
5.4544
5.4143
5.4116
4.2371
3.6121
3.5939
0.0149
3m
O2
S
Ph
General
DATE = 2016/05/21
TIME = 19:10
INSTRUM = spect
PULPROG = zg
F1 (1H)
SI = 65536
SF = 399.78
SW_p = 8802.817
[ppm]
[rel]

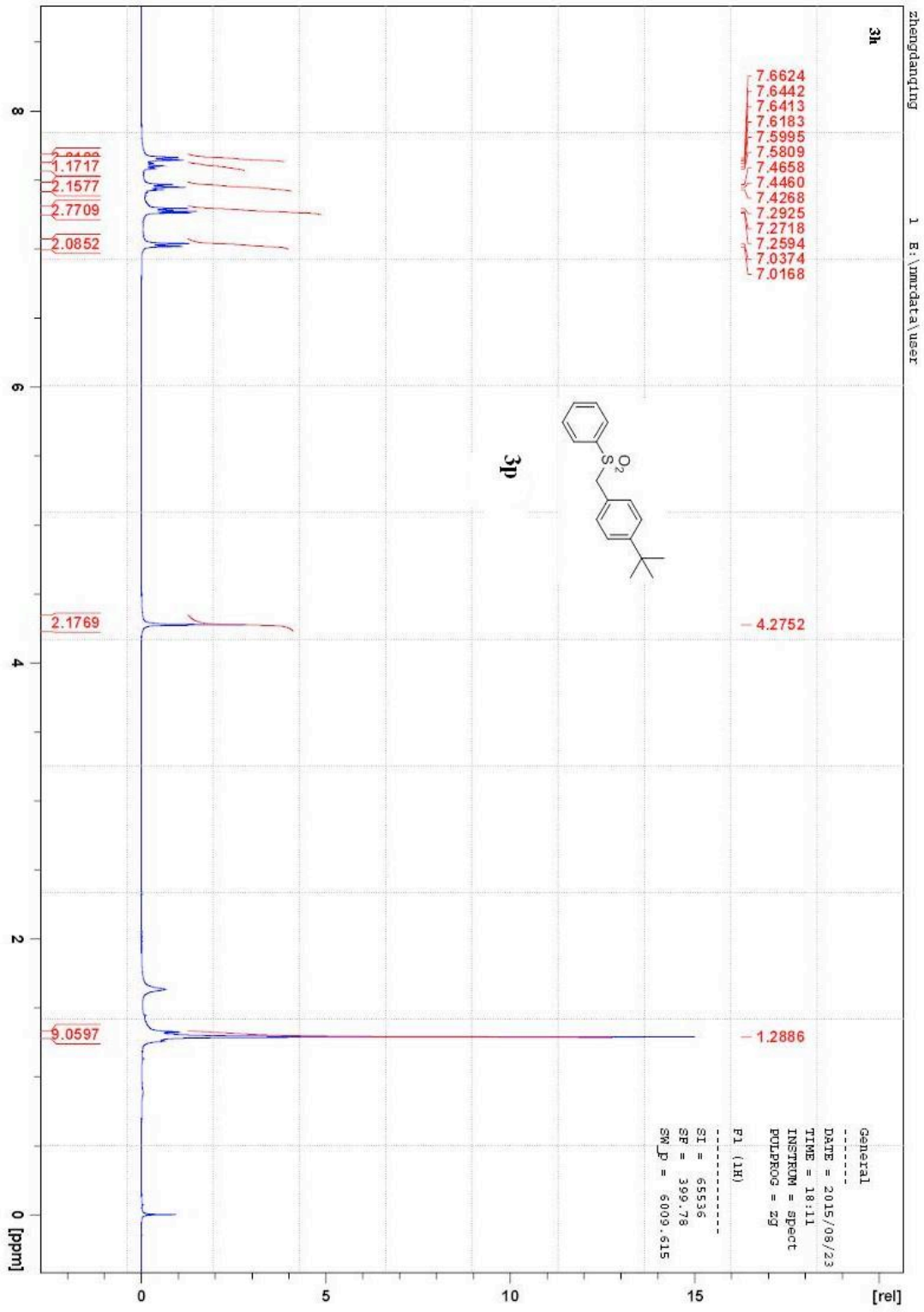

zhengdanqing 16052107 1 E:\nmrdata\user
Lz3003C
130.7281
129.0099
127.6772
124.8652
124.8171
77.3044
76.9870
76.6693
57.9515
55.8915
3in
O2
S
Ph
General
DATE = 2016/05/21
TIME = 19:15
INSTRUM = spect
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
[ppm]
[rel]

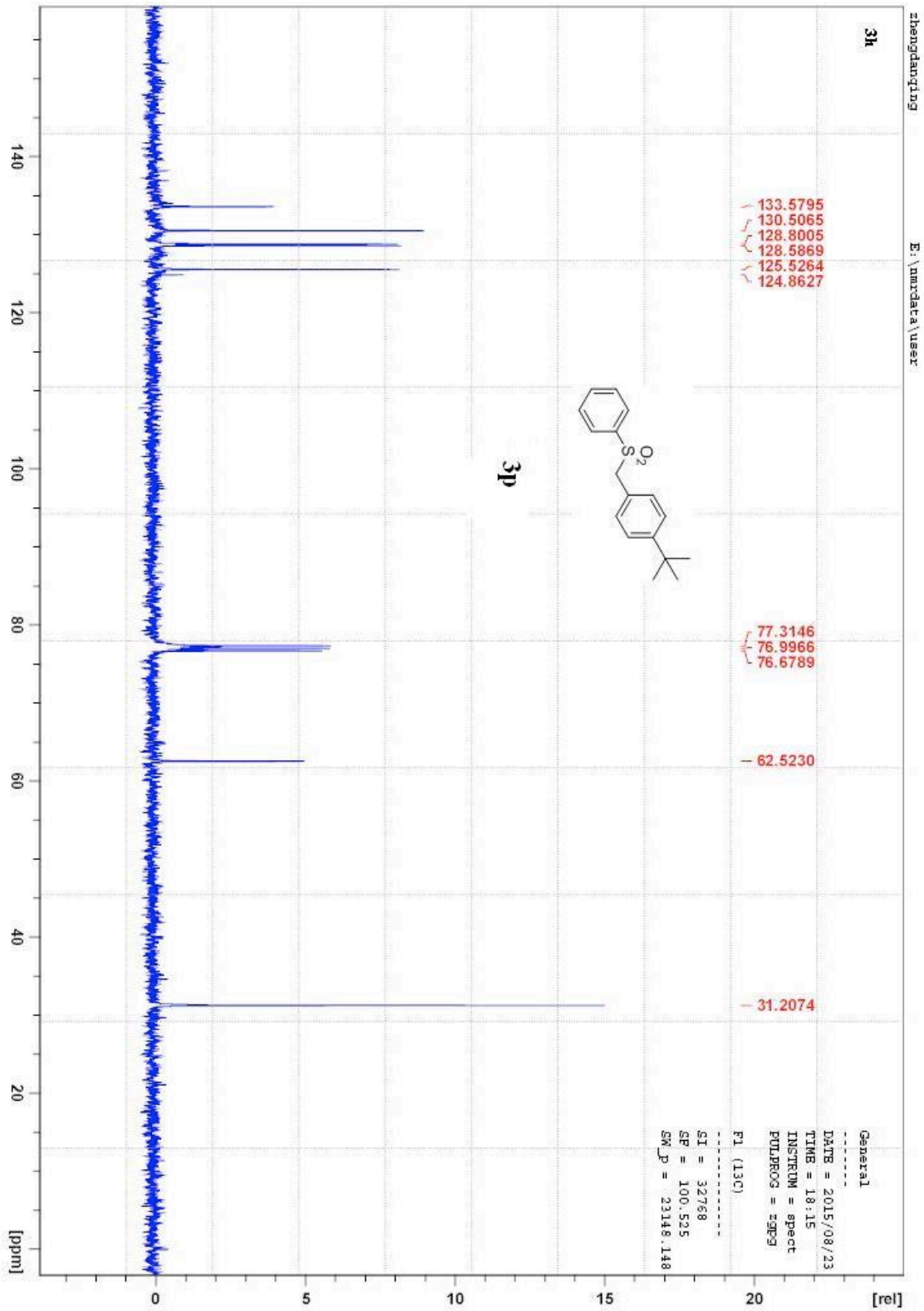

zhengdanqing 16052108 1 E:\nmrdata\user
Lz3004H
7.4187
7.4149
7.3943
7.2777
9.5227
4.0000
4.1516
3ll
O2
S
Ph
General
DATE = 2016/05/21
TIME = 19:21
INSTRUM = spect
PULPROG = zg
F1 (1H)
SI = 65536
SF = 399.78
SW_p = 8802.817
[ppm]
[rel]


zhengdanqing 16052109 1 E:\nmrdata\user
L23004C
130.8449
129.0063
128.9621
127.5009
77.3567
77.0388
76.7204
57.9750
3n
O2
S
Ph
General
DATE = 2016/05/21
TIME = 19:24
INSTRUM = spect
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
150
100
50
[ppm]
0
5
10
15
20
25 [rel]


zhengdanqing 16022107 1 E:\nmrdata\user
3g
7.6352
7.6320
7.6201
7.6171
7.6141
7.5983
7.5826
7.5797
7.5767
7.4704
7.4504
7.4357
7.4316
7.2613
7.0722
7.0525
6.9712
6.9511
2.9651
1.9858
2.0006
2.0000
2.0721
3.0747
4.2689
2.3185
3o
O2
S
General
DATE = 2016/02/21
TIME = 22:59
INSTRUM = spect
PULPROG = zg
F1 (1H)
SI = 65536
SF = 399.78
SW_p = 6009.615
[ppm]
[rel]


zhengdanqing 160221072 1 E:\nmrdata\user
3g-C
138.6730
137.9996
133.5799
130.6355
129.2445
128.8184
128.6012
124.9178
77.3146
76.9964
76.6784
62.5472
3o
O2
S
General
DATE = 2016/02/21
TIME = 23:05
INSTRUM = spect
PULPROG = zgpg
FI (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
[ppm]
[rel]


zhengdanqing
1 E:\nmrdata\wer
3h
7.6624
7.6442
7.6413
7.6183
7.5995
7.5809
7.4658
7.4460
7.4268
7.2925
7.2718
7.2594
7.0374
7.0168
1.1717
2.1577
2.7709
2.0852
2.1769
9.0597
4.2752
1.2886
3p
O2
S
General
DATE = 2015/08/23
TIME = 18:11
INSTRUM = spect
PULPROG = zg
F1 (1H)
SI = 65536
SF = 399.78
SW_p = 6009.615
0 [ppm]
2
4
6
8
0
5
10
15
[rel]


zhengdanqing
E:\nmrdata\user
3h
133.5795
130.5065
128.8005
128.5869
125.5264
124.8627
3p
77.3146
76.9966
76.6789
62.5230
31.2074
General
DATE = 2015/08/23
TIME = 18:15
INSTRUM = spect
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
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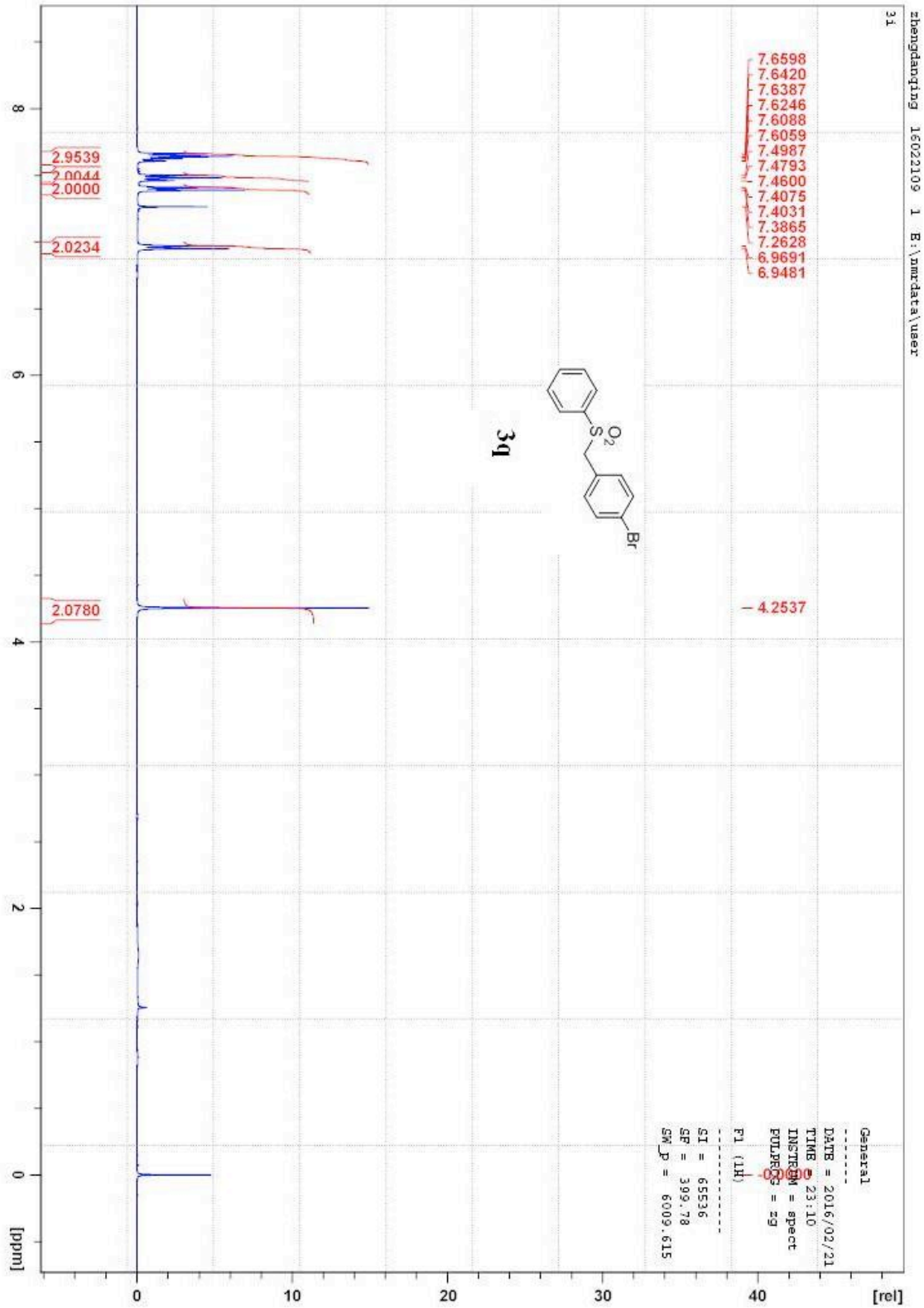
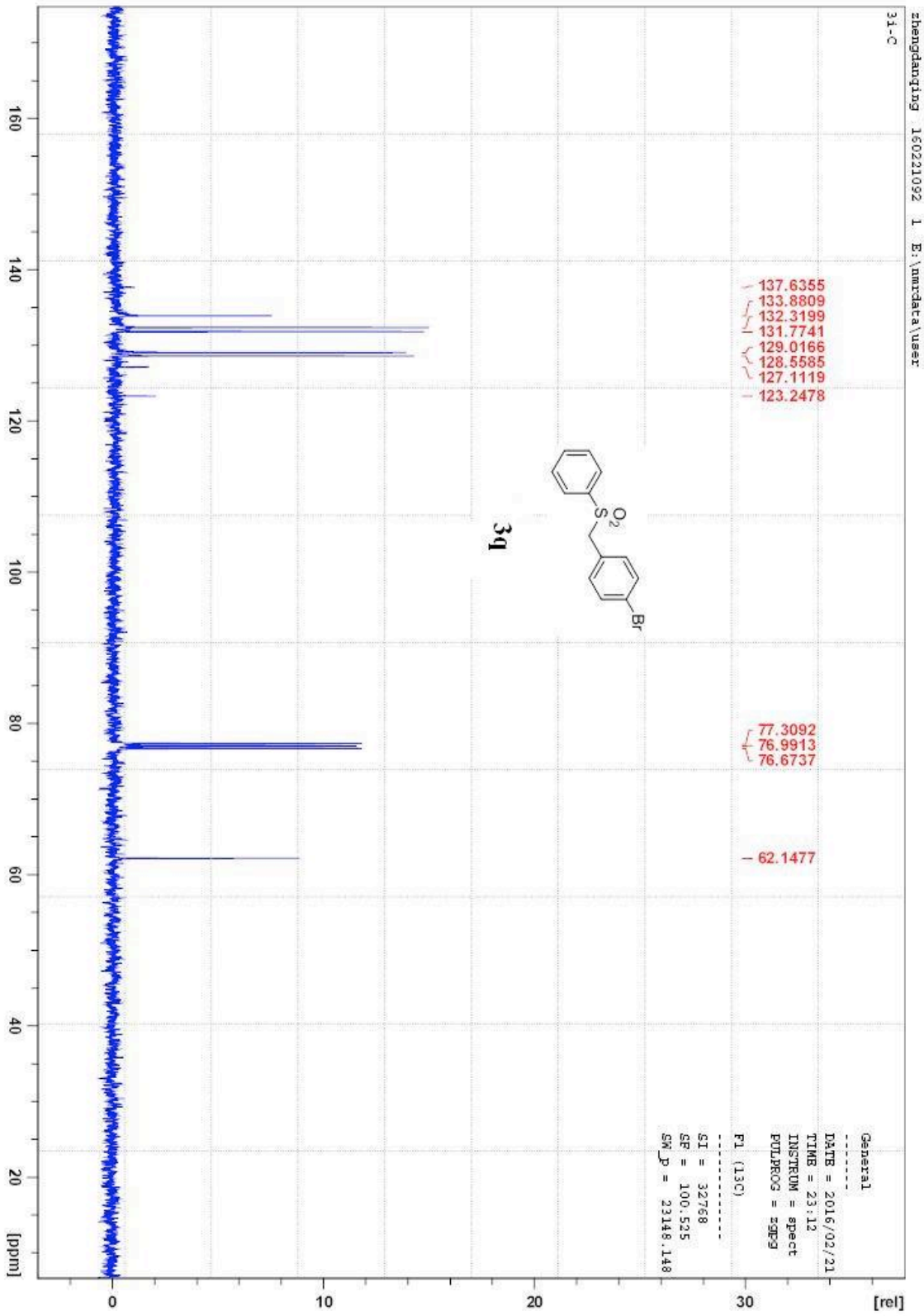
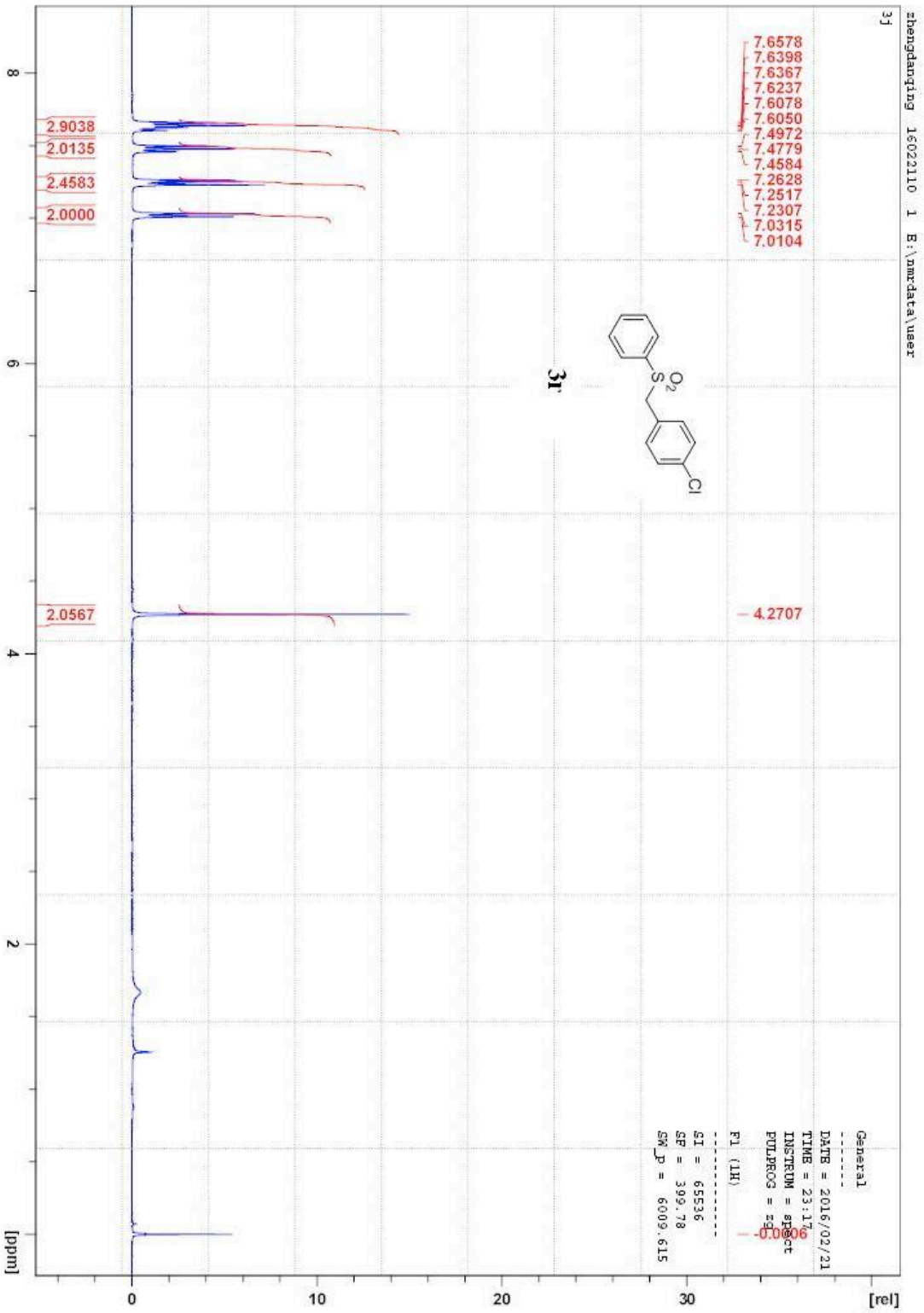
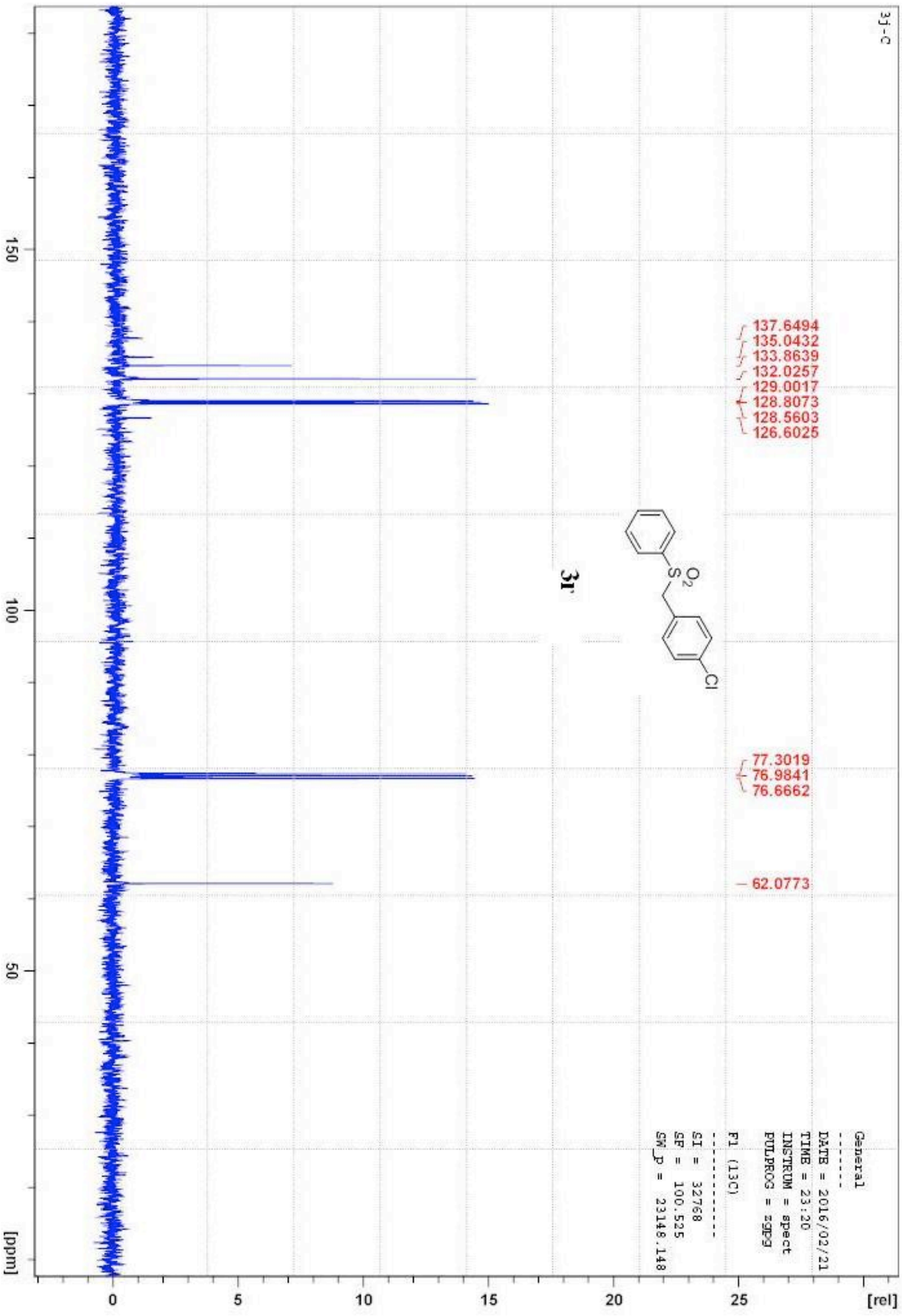
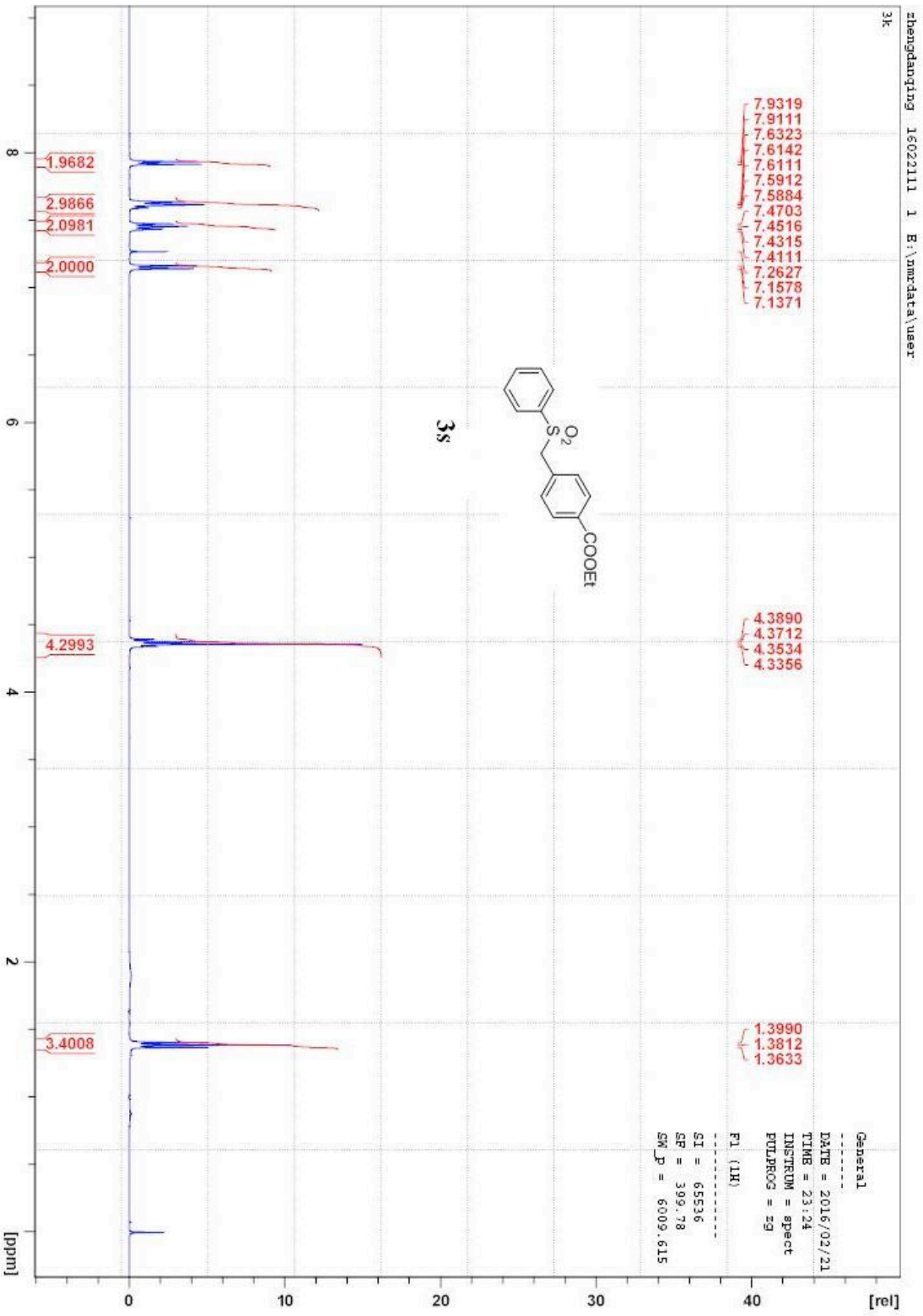
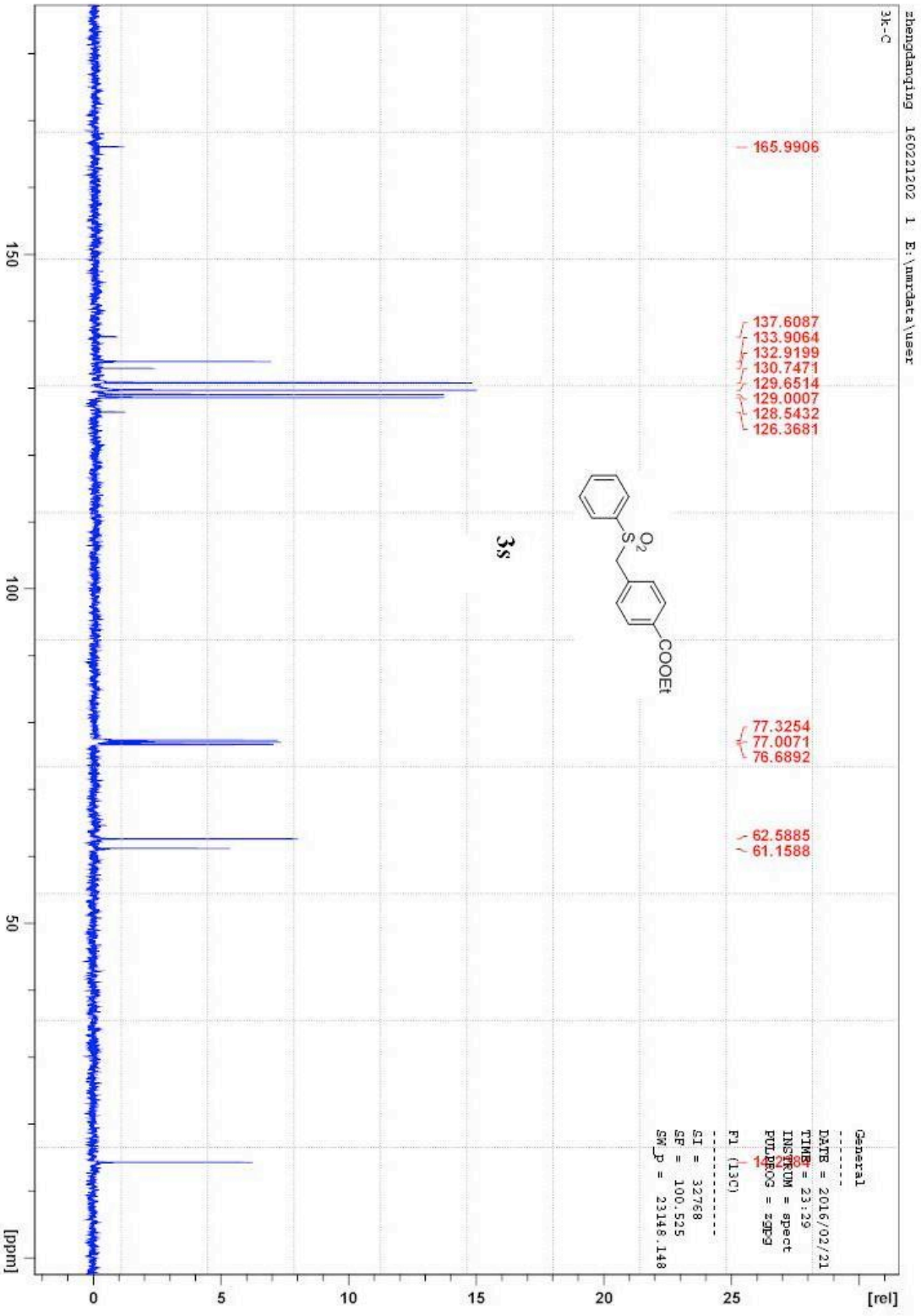

zhengdanqing 16022109 1 B:\nmrdata\user
31
7.6598
7.6420
7.6387
7.6246
7.6088
7.6059
7.4987
7.4793
7.4600
7.4075
7.4031
7.3865
7.2628
6.9691
6.9481
2.9539
2.0044
2.0000
2.0234
2.0780
4.2537
3q
O2
S
Br
General
DATE = 2016/02/21
TIME = 23:10
INSTRUM = spect
PULPROG = zg
F1 (1H)
SI = 65536
SF = 399.78
SW_p = 6009.615
[ppm]
[rel]


zhengdanqing 160221092 1 E:\nmrdata\user
31-C
137.6355
133.8809
132.3199
131.7741
129.0166
128.5585
127.1119
123.2478
77.3092
76.9913
76.6737
62.1477
3q
O2
S
Br
General
DATE = 2016/02/21
TIME = 23:12
INSTRUM = spect
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
[ppm]
[rel]


zhengdanqing 16022110 1 E:\nmrdata\user
3j
7.6578
7.6398
7.6367
7.6237
7.6078
7.6050
7.4972
7.4779
7.4584
7.2628
7.2517
7.2307
7.0315
7.0104
2.9038
2.0135
2.4583
2.0000
2.0567
4.2707
3r
O2
S
Cl
General
DATE = 2016/02/21
TIME = 23:17
INSTRUM = spect
PULPROG = zg
F1 (1H)
SI = 65536
SF = 399.78
SW_p = 6009.615
[ppm]
[rel]
0
10
20
30
2
4
6
8


zhengdanqing 160221102 1 E:\nmrdata\user
3j-C
137.6494
135.0432
133.8639
132.0257
129.0017
128.8073
128.5603
126.6025
77.3019
76.9841
76.6662
62.0773
3r
O2
S
Cl
General
DATE = 2016/02/21
TIME = 23:20
INSTRUM = spect
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
[ppm]
[rel]
150
100
50
0
5
10
15
20
25


zhengdanqing 16022111 1 B:\nmrdata\user
3k
7.9319
7.9111
7.6323
7.6142
7.6111
7.5912
7.5884
7.4703
7.4516
7.4315
7.4111
7.2627
7.1578
7.1371
1.9682
2.9866
2.0981
2.0000
4.2993
3.4008
4.3890
4.3712
4.3534
4.3356
1.3990
1.3812
1.3633
3s
O2
S
COOEt
General
DATE = 2016/02/21
TIME = 23:24
INSTRUM = spect
PULPROG = zg
F1 (1H)
SI = 65536
SF = 399.78
SW_p = 6009.615
[ppm]
[rel]


zhengdanqing 160221202 1 E:\nmrdata\user
3k-C
165.9906
137.6087
133.9064
132.9199
130.7471
129.6514
129.0007
128.5432
126.3681
77.3254
77.0071
76.6892
62.5885
61.1588
14.2887
General
DATE = 2016/02/21
TIME = 23:29
INSTRUM = spect
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
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O2
S
COOEt
[ppm]
[rel]
150
100
50
0
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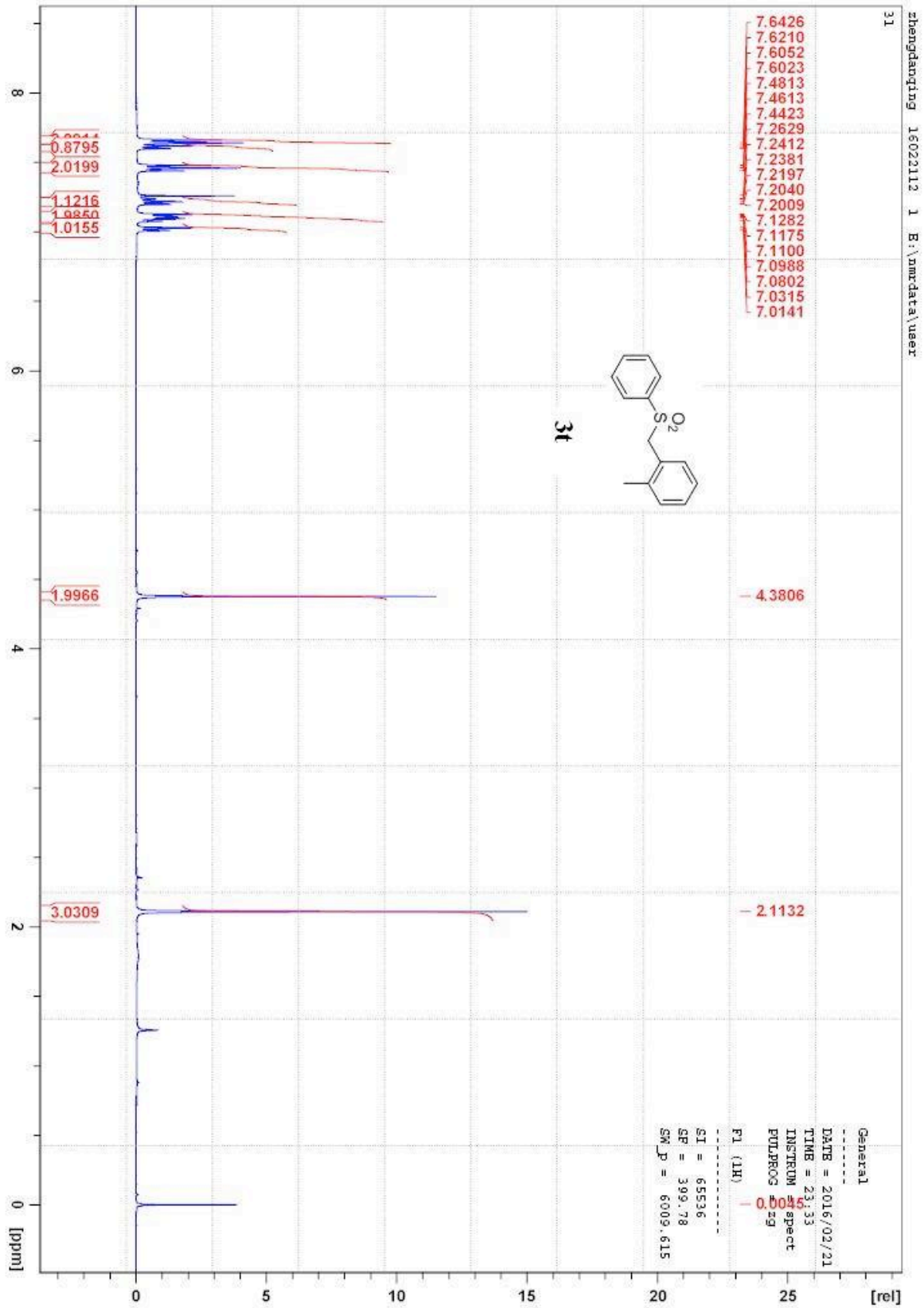
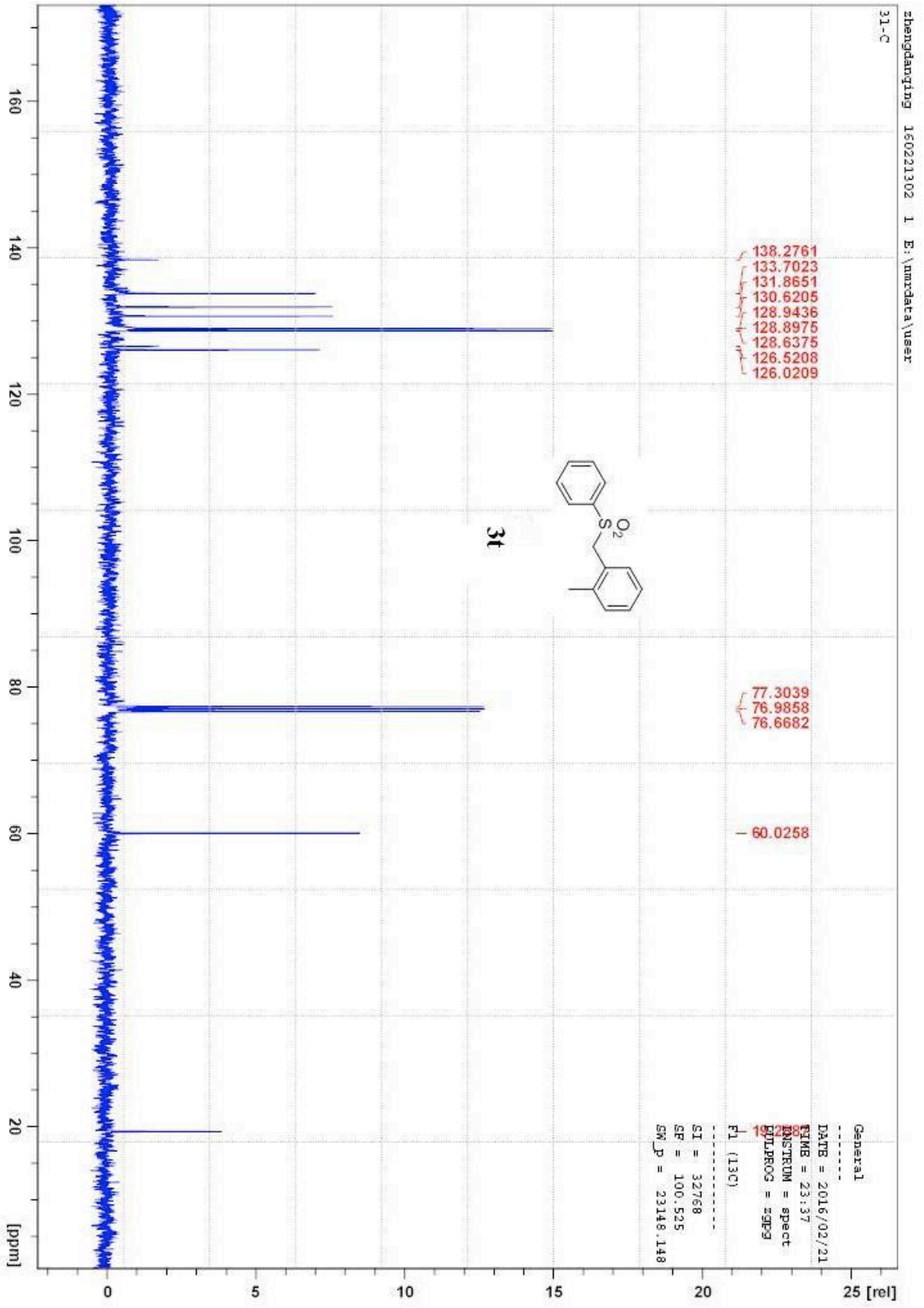
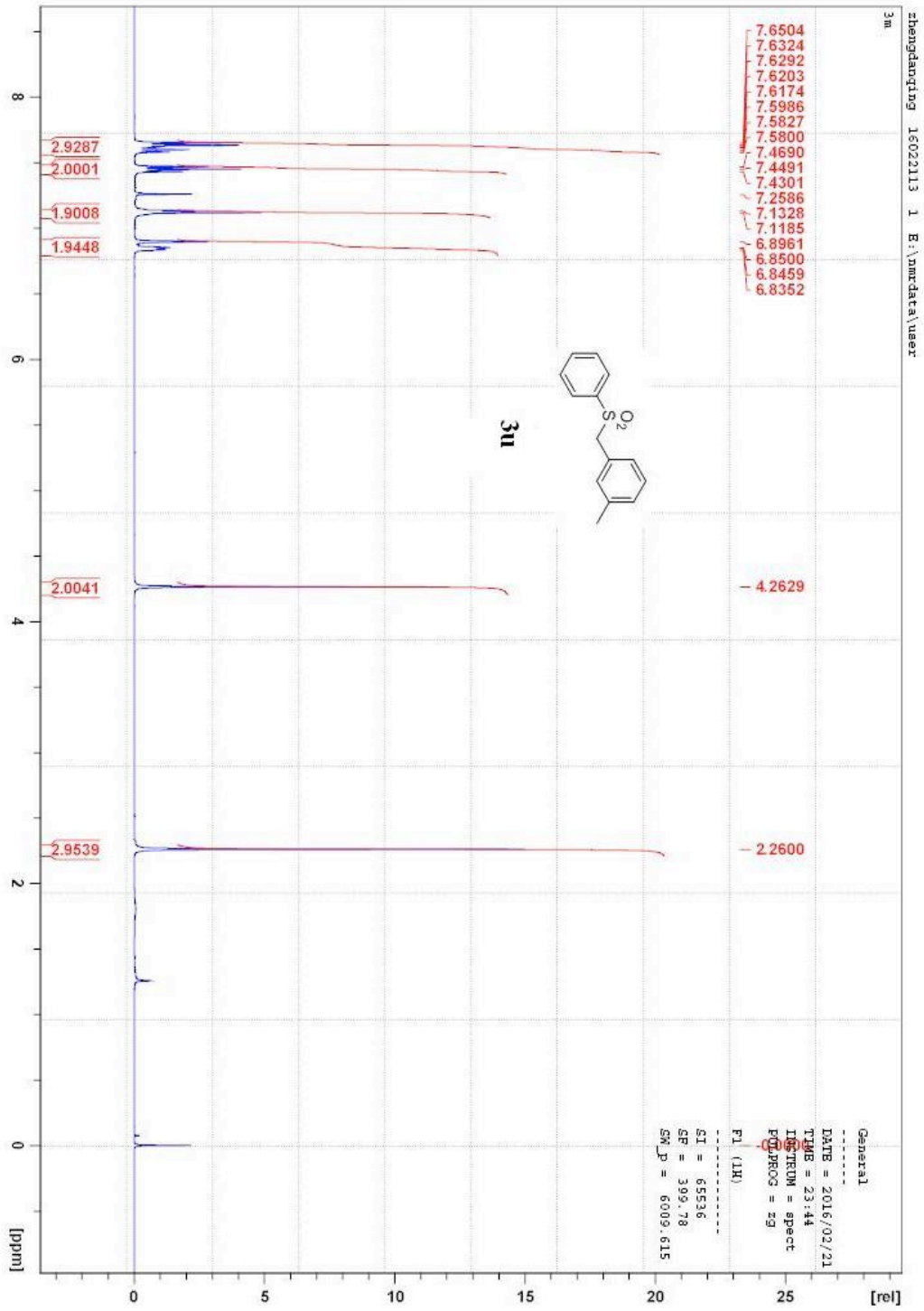
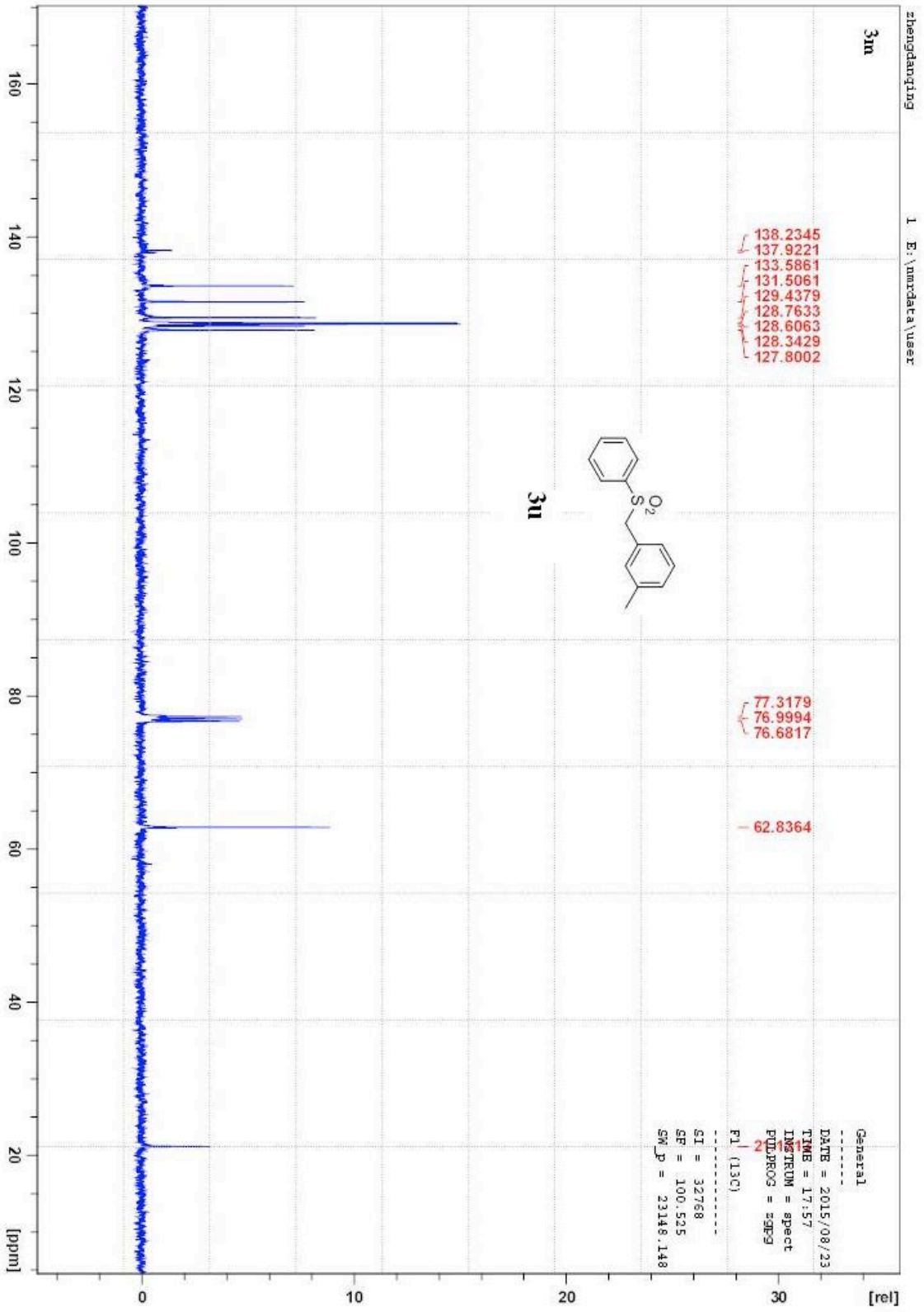
10
15
20
25


zhengdanqing 16022112 1 B:\nmrdata\uaer
31
7.6426
7.6210
7.6052
7.6023
7.4813
7.4613
7.4423
7.2629
7.2412
7.2381
7.2197
7.2040
7.2009
7.1282
7.1175
7.1100
7.0988
7.0802
7.0315
7.0141
0.8795
2.0199
1.1216
1.0155
1.9966
3.0309
4.3806
2.1132
0.0045
3t
O2
S
General
DATE = 2016/02/21
TIME = 23:33
INSTRUM = spect
PULPROG = zg
F1 (1H)
SI = 65536
SF = 399.78
SW_p = 6009.615
[ppm]
[rel]


zhengdanqing 160221302 1 E:\nmrdata\user
31-C
138.2761
133.7023
131.8651
130.6205
128.9436
128.8975
128.6375
126.5208
126.0209
77.3039
76.9858
76.6682
60.0258
3t
O2
S
General
DATE = 2016/02/21
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
[ppm]
[rel]


zhengdanqing 16022113 1 E:\nmrdata\user
3m
7.6504
7.6324
7.6292
7.6203
7.6174
7.5986
7.5827
7.5800
7.4690
7.4491
7.4301
7.2586
7.1328
7.1185
6.8961
6.8500
6.8459
6.8352
2.9287
2.0001
1.9008
1.9448
2.0041
4.2629
2.9539
2.2600
3ll
O2
S
DATE = 2016/02/21
TIME = 23:44
INSTRUM = spect
PULPROG = zg
F1 (1H)
SI = 65536
SF = 399.78
SW_p = 6009.615
[ppm]
[rel]


zhengdanqing
1 E:\nmrdata\user
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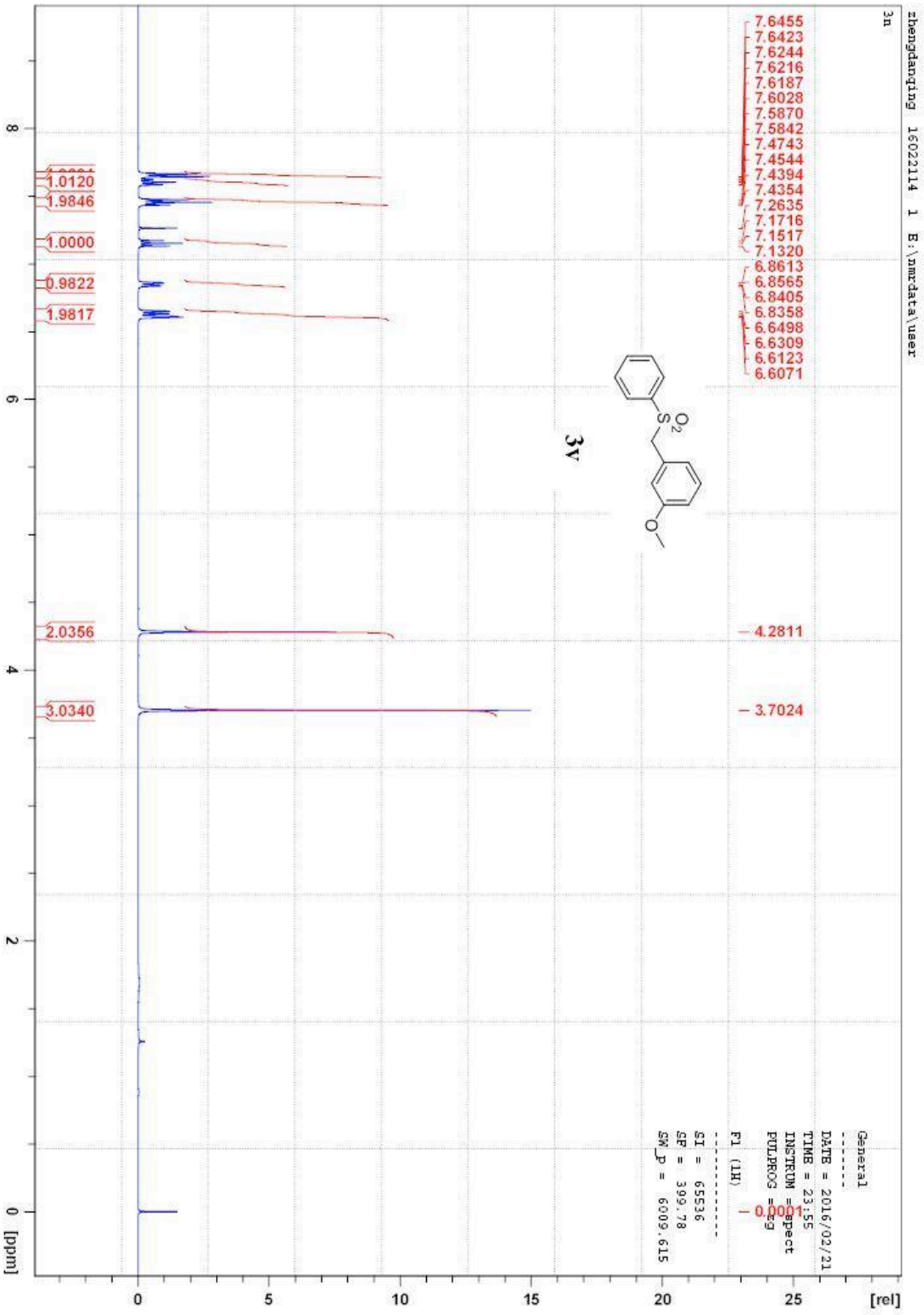
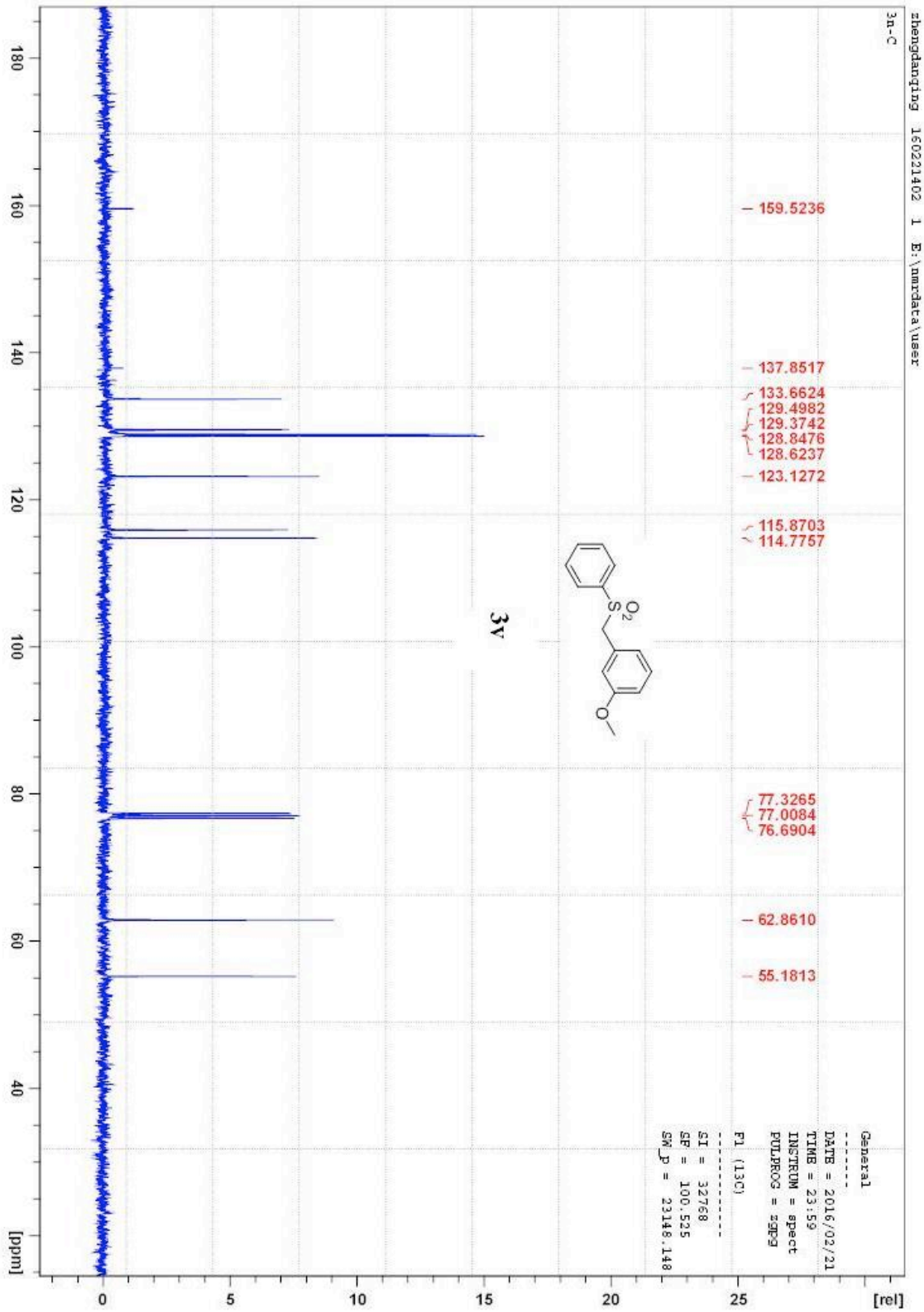
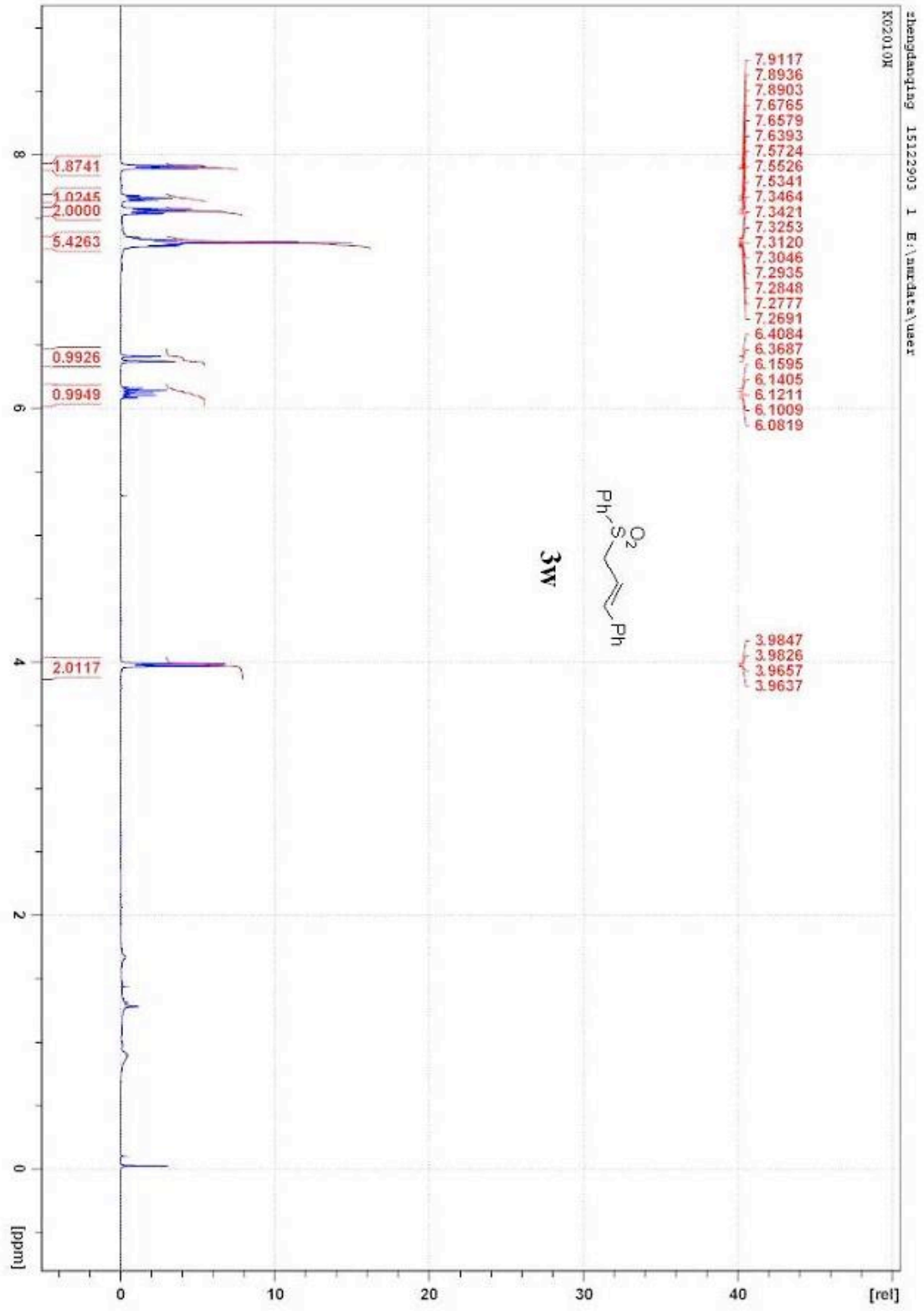
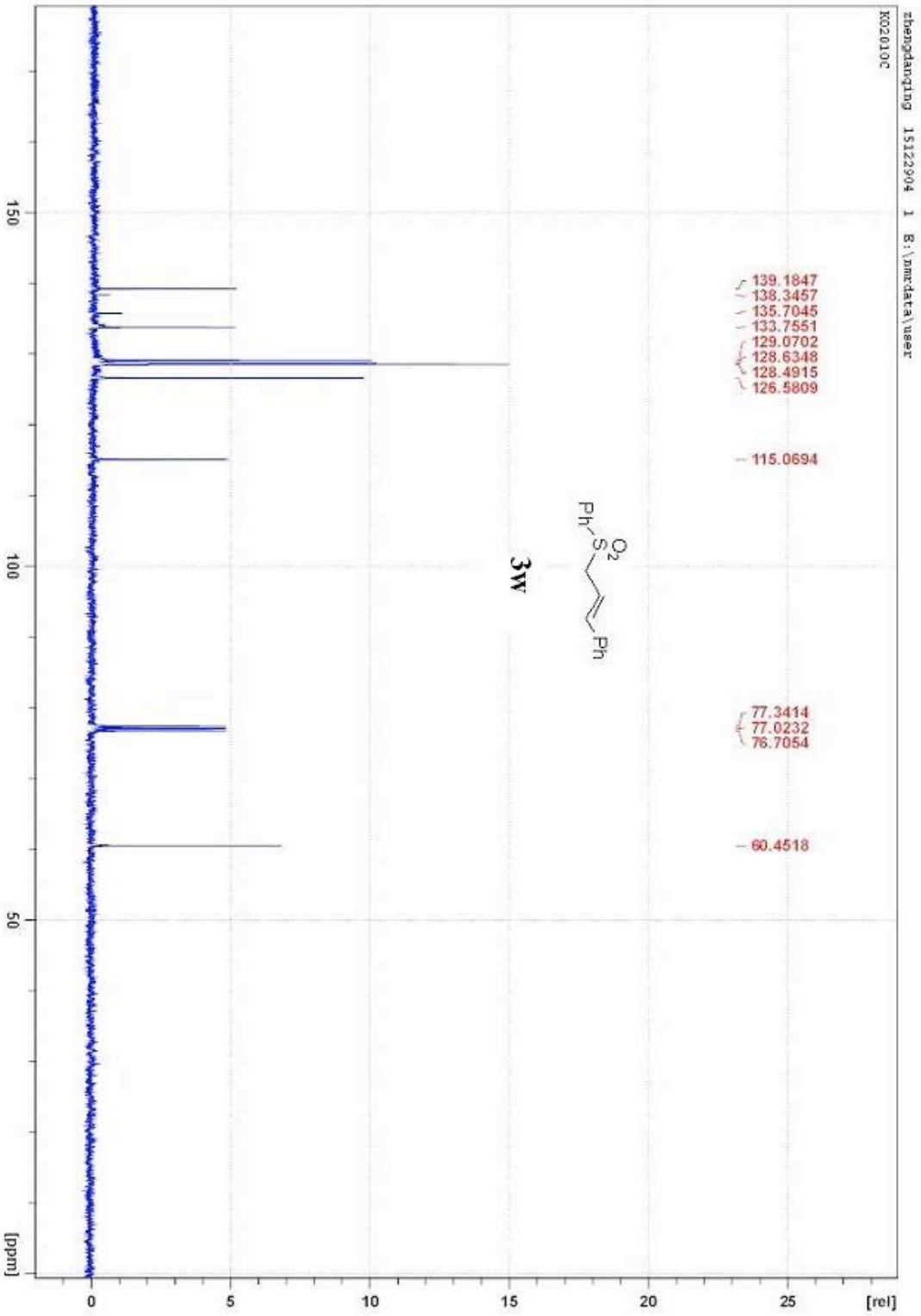
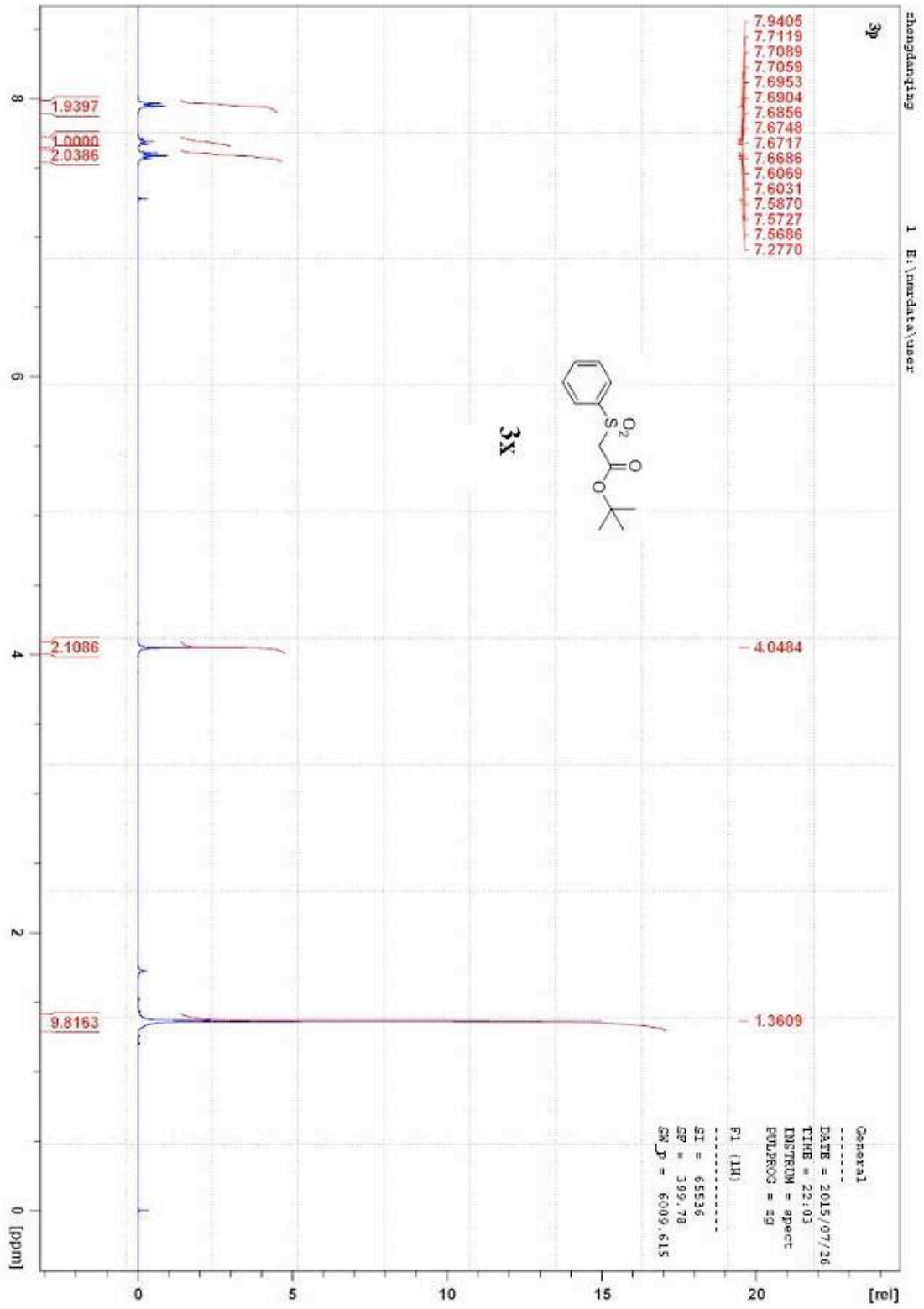
137.9221
133.5861
131.5061
129.4379
128.7633
128.6063
128.3429
127.8002
3u
77.3179
76.9994
76.6817
62.8364
General
DATE = 2015/08/23
TIME = 17:57
INSTRUM = spect
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
[ppm]
[rel]


zhengdanqing 16022114 1 B:\nmr\data\user
3n
7.6455
7.6423
7.6244
7.6216
7.6187
7.6028
7.5870
7.5842
7.4743
7.4544
7.4394
7.4354
7.2635
7.1716
7.1517
7.1320
6.8613
6.8565
6.8405
6.8358
6.6498
6.6309
6.6123
6.6071
1.0120
1.9846
1.0000
0.9822
1.9817
2.0356
3.0340
4.2811
3.7024
3v
O2
S
O
Generall
DATE = 2016/02/21
TIME = 23:55
INSTRUM = spect
PULPROG = zg
F1 (1H)
SI = 65536
SF = 399.78
SW_p = 6009.615
0.0001
[ppm]
[rel]


zhengdanqing 160221402 1 E:\nmrdata\user
3n-C
159.5236
137.8517
133.6624
129.4982
129.3742
128.8476
128.6237
123.1272
115.8703
114.7757
77.3265
77.0084
76.6904
62.8610
55.1813
3v
O2
S
O
General
DATE = 2016/02/21
TIME = 23:59
INSTRUM = spect
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
[ppm]
[rel]


shengdanqing 15122903 1 E:\nmrdata\wer
K02010K
7.9117
7.8936
7.8903
7.6765
7.6579
7.6393
7.5724
7.5526
7.5341
7.3464
7.3421
7.3253
7.3120
7.3046
7.2935
7.2848
7.2777
7.2691
6.4084
6.3687
6.1595
6.1405
6.1211
6.1009
6.0819
3.9847
3.9826
3.9657
3.9637
1.8741
1.0245
2.0000
5.4263
0.9926
0.9949
2.0117
3W
Ph
S
O2
Ph
8
6
4
2
0
[ppm]
0
10
20
30
40
[rel]


zhengdanqing 15122904 1 E:\nmrdata\user
KO2010C
139.1847
138.3457
135.7045
133.7551
129.0702
128.6348
128.4915
126.5809
115.0694
77.3414
77.0232
76.7054
60.4518
3w
Ph
S
O2
Ph
150
100
50
[ppm]
0
5
10
15
20
25
[rel]


zhengdanqing 1 E:\nmrdata\user
3p
7.9405
7.7119
7.7089
7.7059
7.6953
7.6904
7.6856
7.6748
7.6717
7.6686
7.6069
7.6031
7.5870
7.5727
7.5686
7.2770
1.9397
1.0000
2.0386
2.1086
9.8163
4.0484
1.3609
3x
General
DATE = 2015/07/26
TIME = 22:03
INSTRUM = spect
PULPROG = zg
F1 (1H)
SI = 65536
SF = 399.78
SW_p = 6009.615
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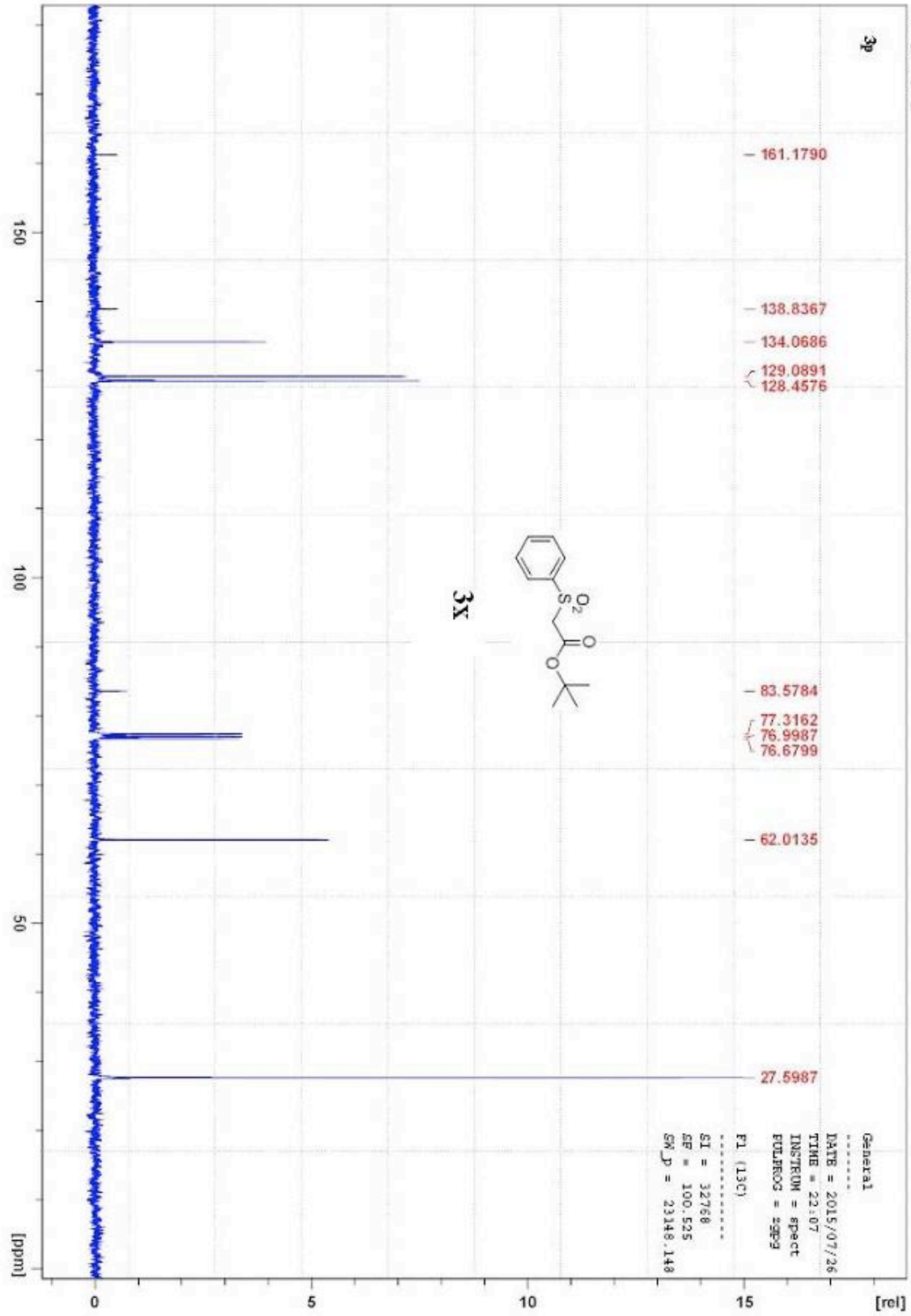
[rel]


zhengdanqing
1 E:\nmrdata\user
3p
161.1790
138.8367
134.0686
129.0891
128.4576
83.5784
77.3162
76.9987
76.6799
62.0135
27.5987
3X
General
DATE = 2015/07/26
TIME = 22:07
INSTRUM = spect
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.525
SW_p = 23148.148
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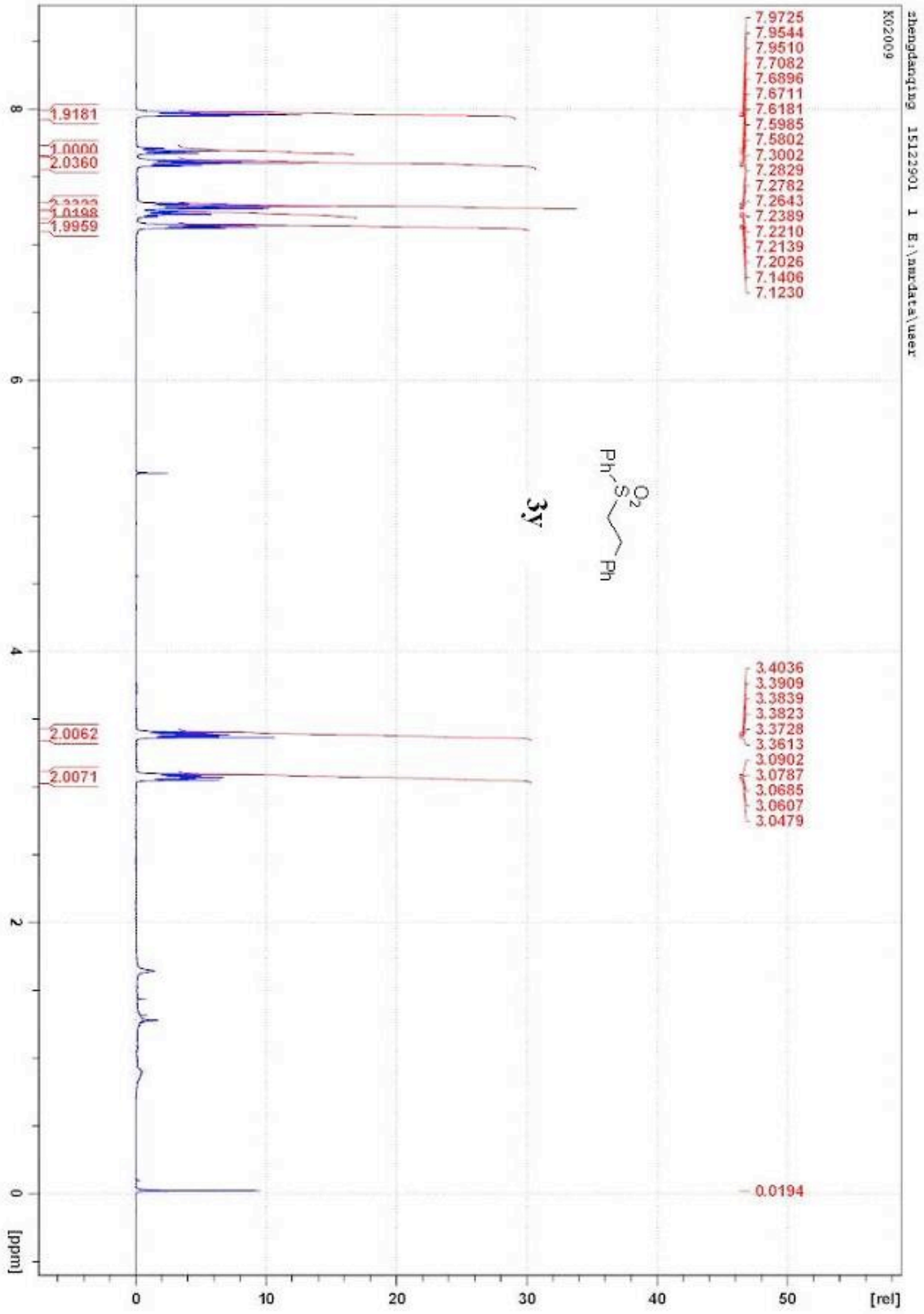
zhengdanqing 15122901 1 E:\nmrdata\uer
K02009
7.9725
7.9544
7.9510
7.7082
7.6896
7.6711
7.6181
7.5985
7.5802
7.3002
7.2829
7.2782
7.2643
7.2389
7.2210
7.2139
7.2026
7.1406
7.1230
3.4036
3.3909
3.3839
3.3823
3.3728
3.3613
3.0902
3.0787
3.0685
3.0607
3.0479
1.9181
1.0000
2.0360
1.0198
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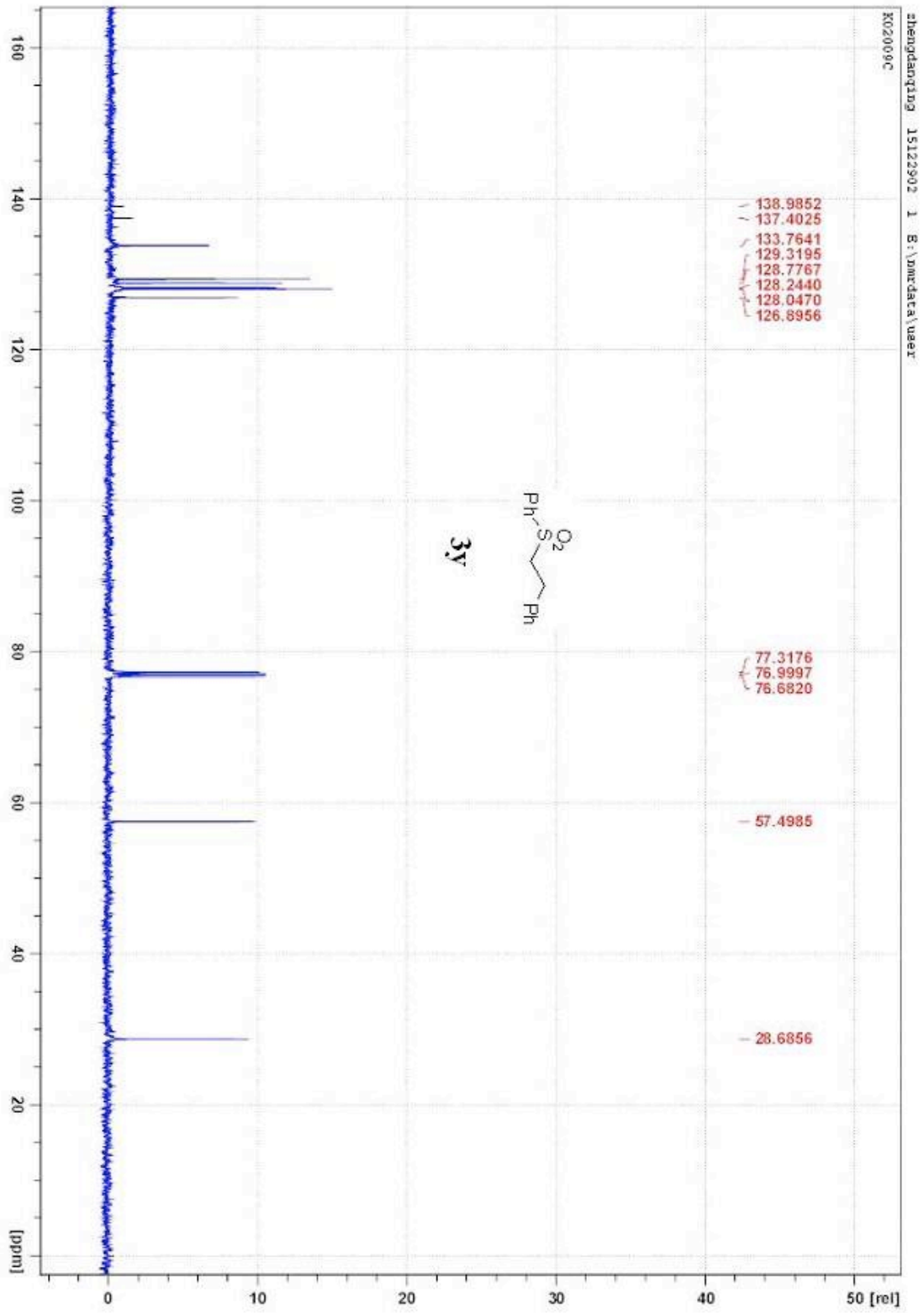
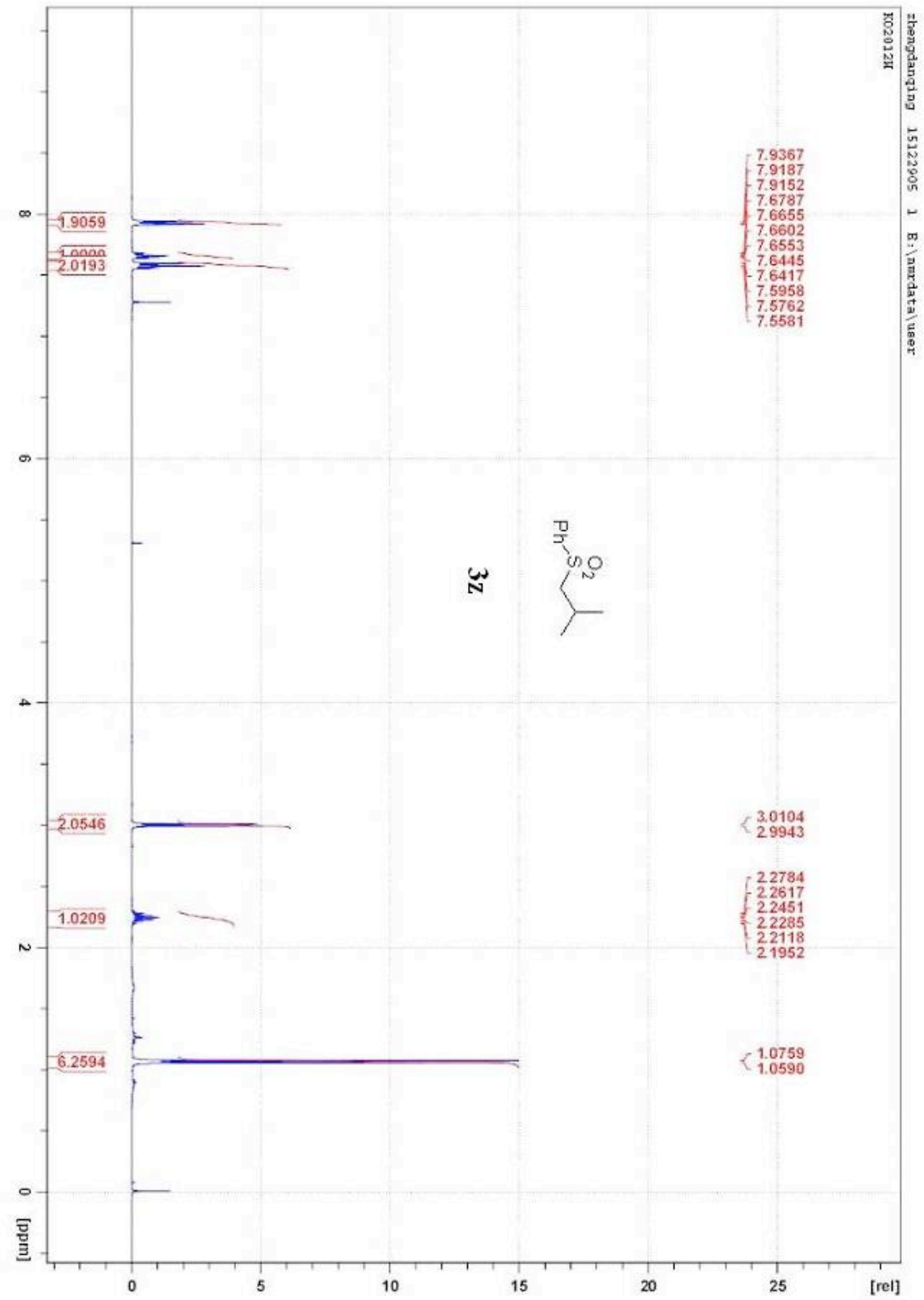
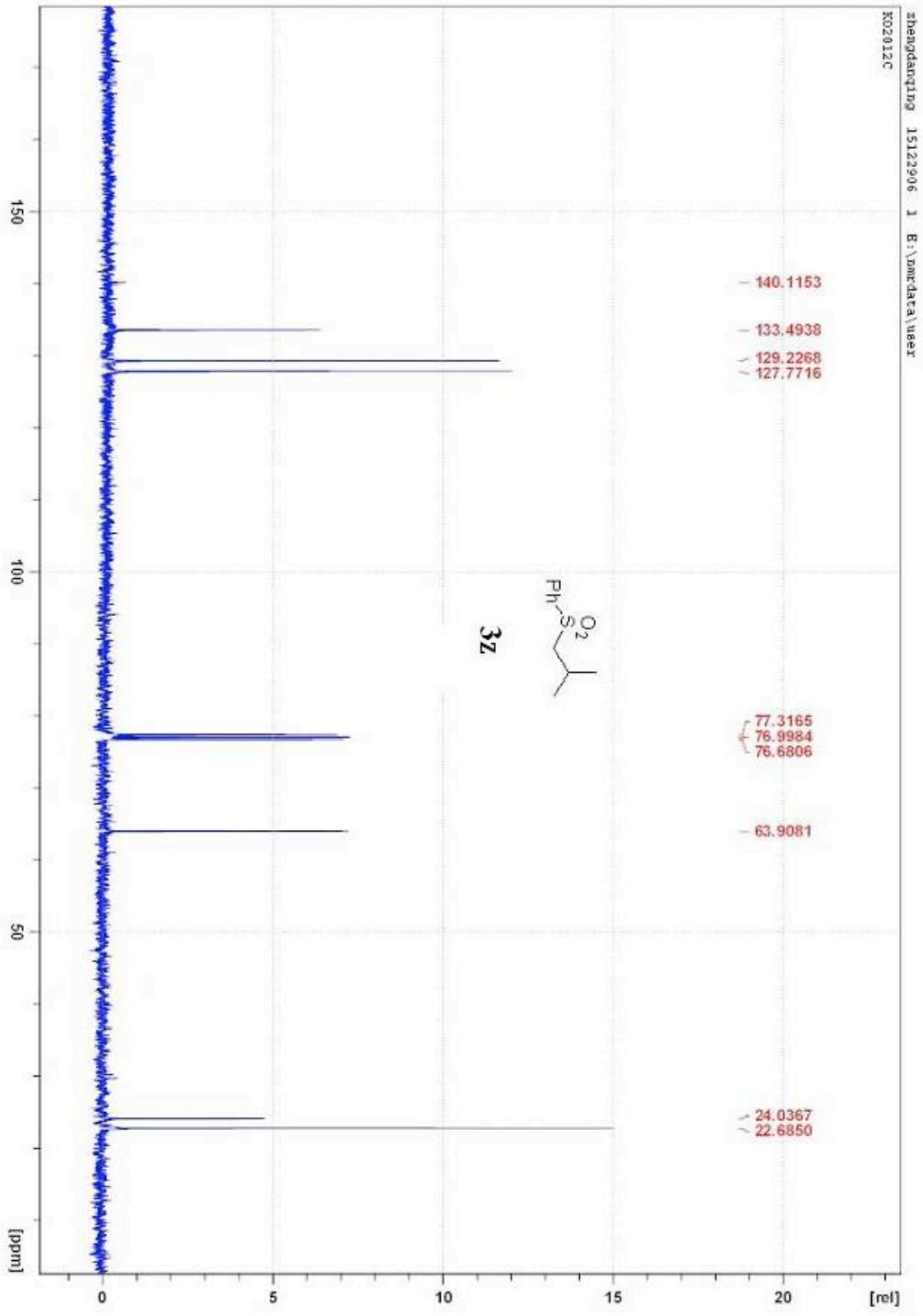
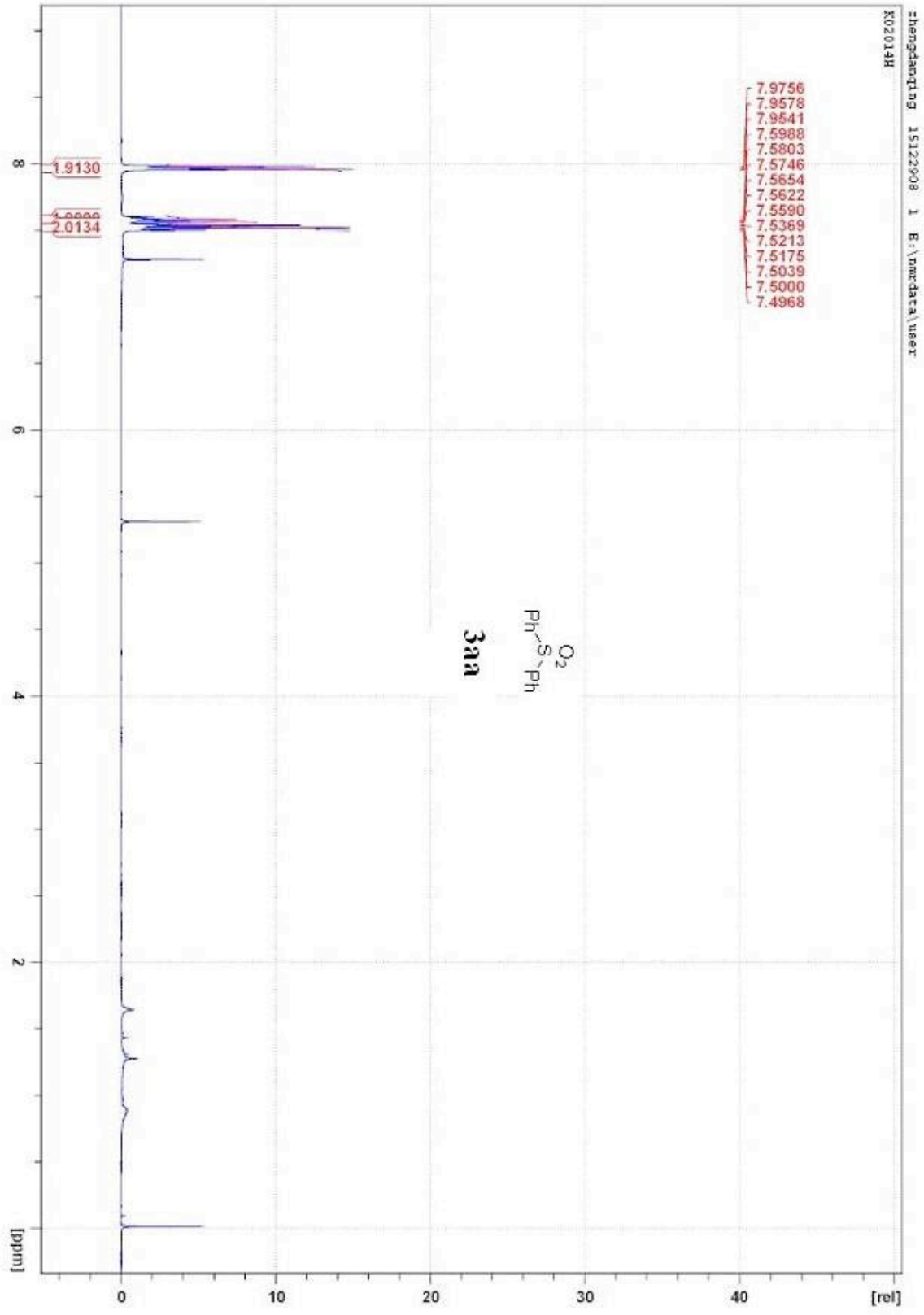
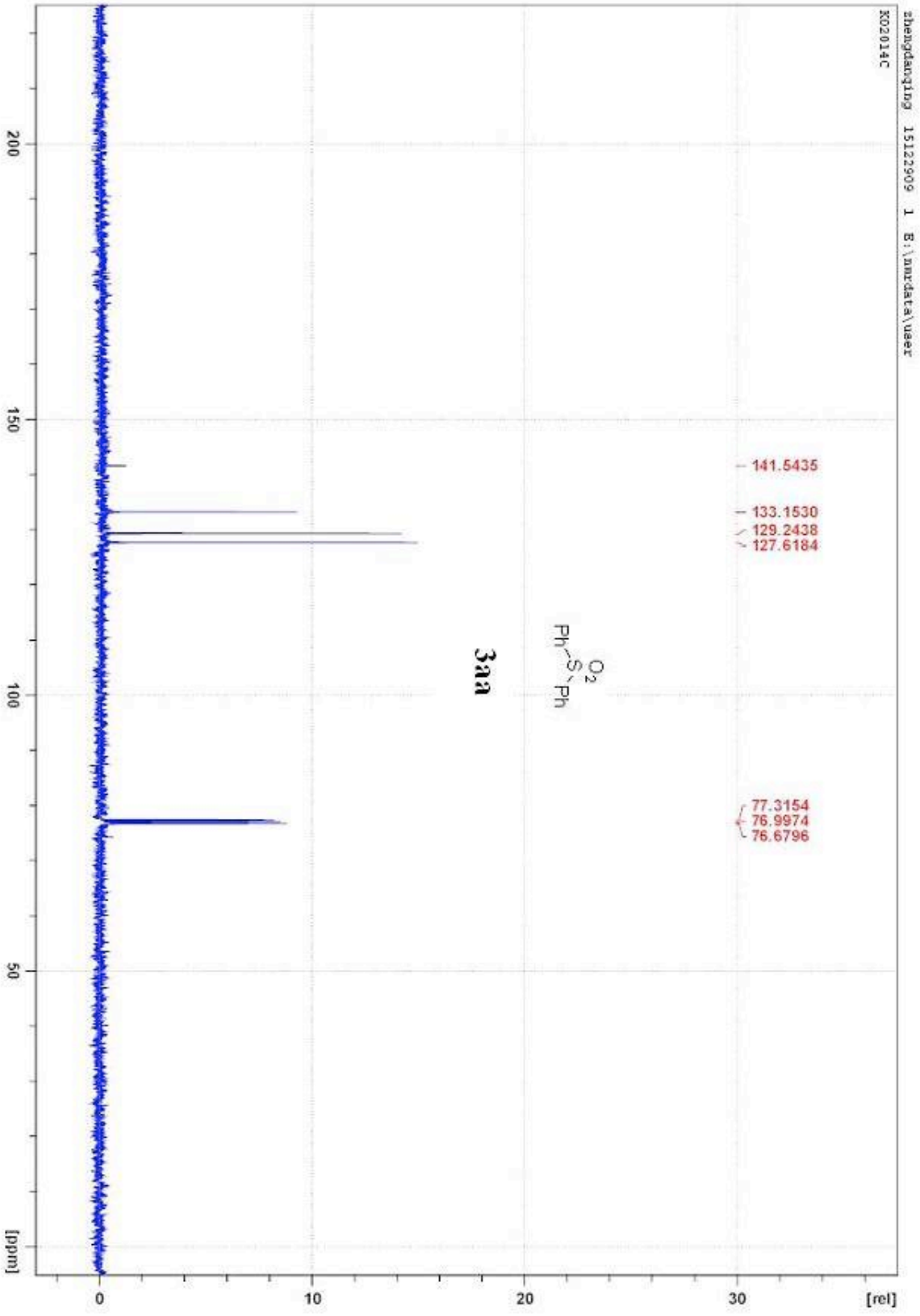
2.0062
2.0071
0.0194
3y
Ph
S
O2
Ph
[ppm]
[rel]


zhengdanqing 15122902 1 S:\nmrdata\uaer
K02009C
138.9852
137.4025
133.7641
129.3195
128.7767
128.2440
128.0470
126.8956
77.3176
76.9997
76.6820
57.4985
28.6856
3y
Ph
S
O2
Ph
160
140
120
100
80
60
40
20
[ppm]
0
10
20
30
40
50 [rel]


zhengdanqing 15122905 1 B:\nmrdata\user
KO2012H
7.9367
7.9187
7.9152
7.6787
7.6655
7.6602
7.6553
7.6445
7.6417
7.5958
7.5762
7.5581
1.9059
2.0193
2.0546
1.0209
6.2594
3.0104
2.9943
2.2784
2.2617
2.2451
2.2285
2.2118
2.1952
1.0759
1.0590
3z
Ph
S
O2
8
6
4
2
0
[ppm]
0
5
10
15
20
25
[rel]


zhengdanqing 15122906 1 B:\pmrdata\user
K02012C
140.1153
133.4938
129.2268
127.7716
77.3165
76.9984
76.6806
63.9081
24.0367
22.6850
3z
Ph
S
O2
150
100
50
[ppm]
0
5
10
15
20
[rel]


zhengdanqing 15122908 1 E:\nmrdata\user
K02014H
7.9756
7.9578
7.9541
7.5988
7.5803
7.5746
7.5654
7.5622
7.5590
7.5369
7.5213
7.5175
7.5039
7.5000
7.4968
1.9130
2.0134
O2
Ph
S
Ph
3aa
8
6
4
2
[ppm]
0
10
20
30
40
[rel]


zhengdanqing 15122909 1 E:\nmrdata\user
KO2014C
141.5435
133.1530
129.2438
127.6184
77.3154
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76.6796
3aa
O2
Ph
S
Ph
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150
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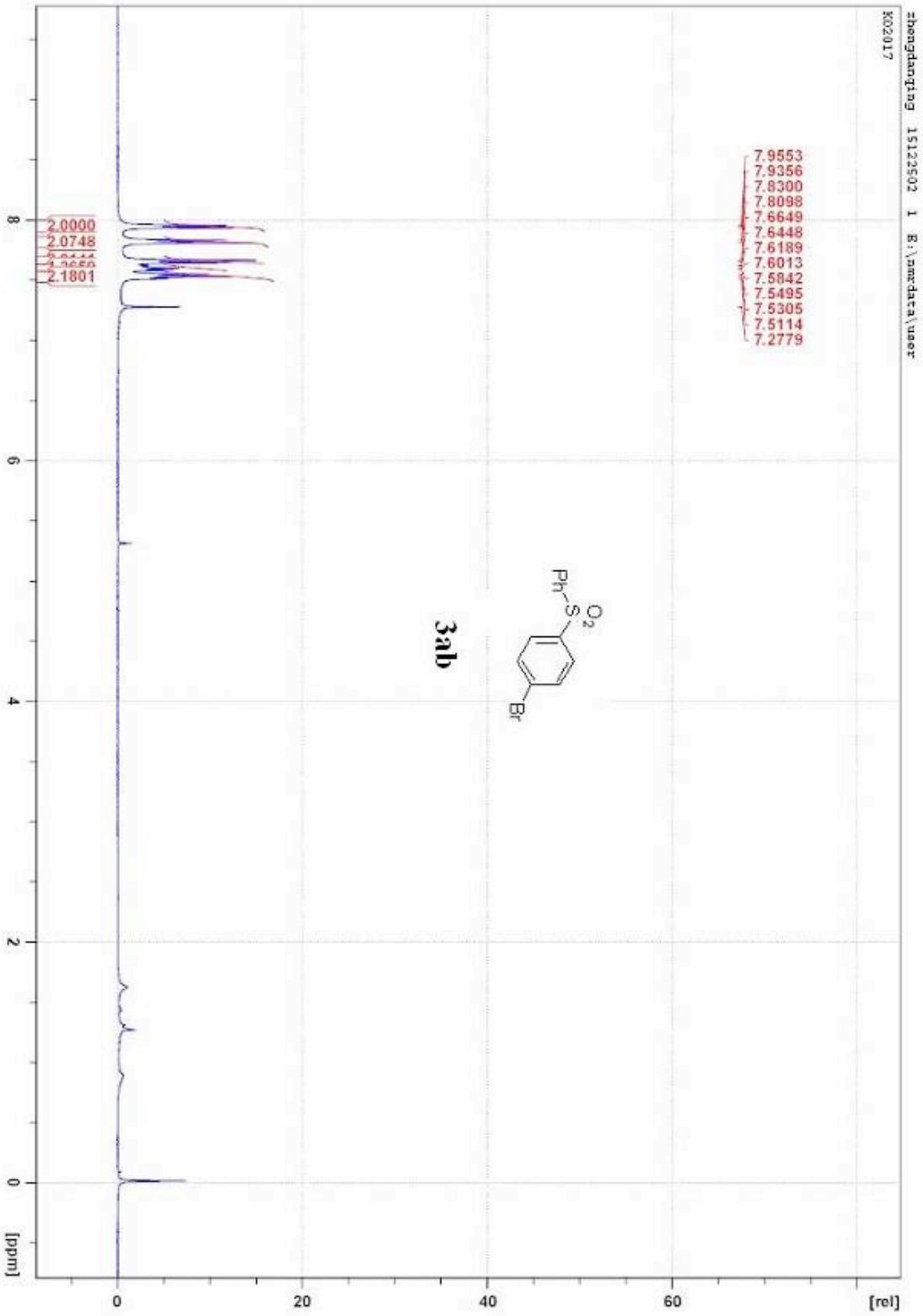
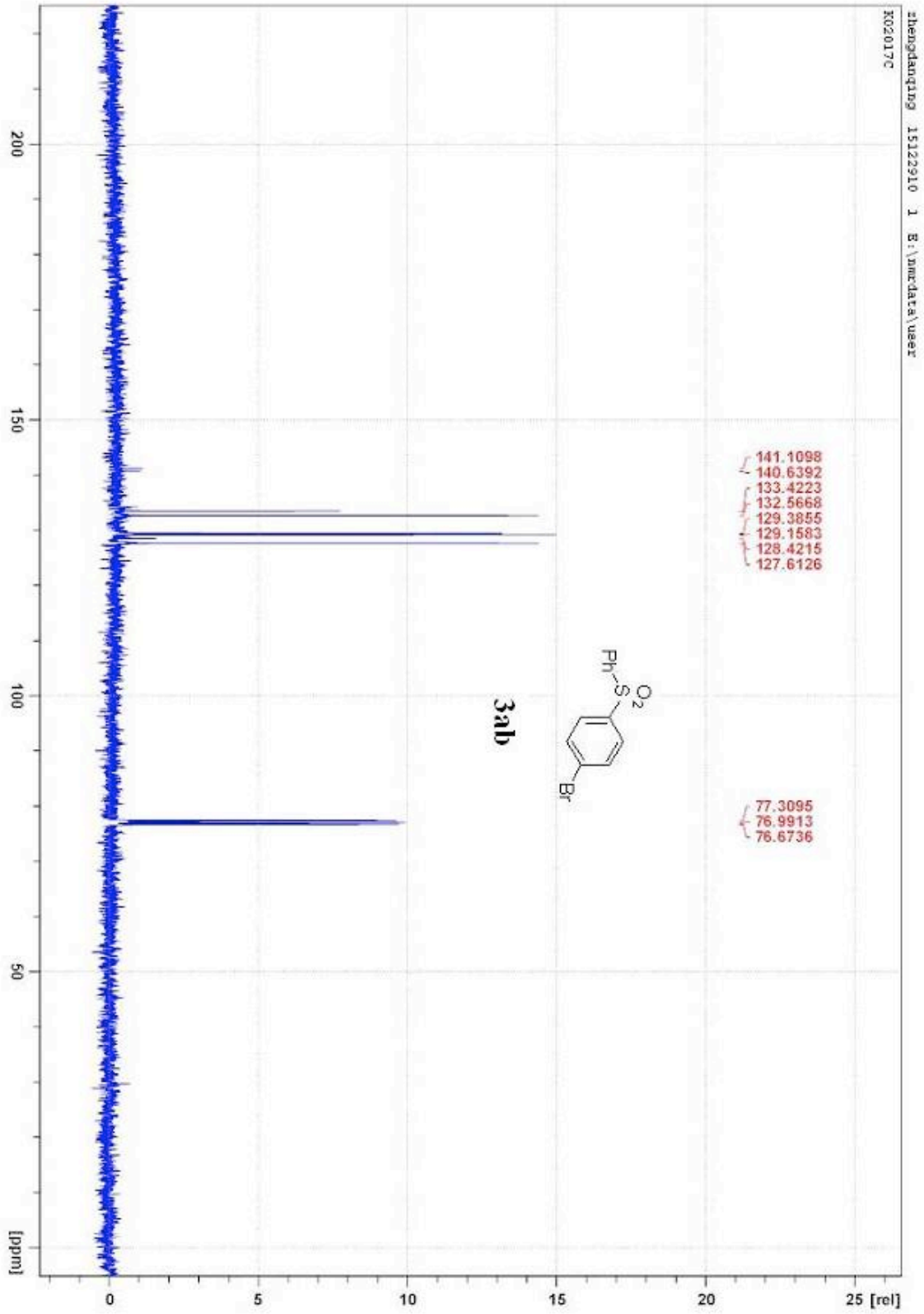
50
[ppm]
0
10
20
30
[rel]


zhengdanqing 15122502 1 B:\pmrdata\user
K02017
7.9553
7.9356
7.8300
7.8098
7.6649
7.6448
7.6189
7.6013
7.5842
7.5495
7.5305
7.5114
7.2779
2.0000
2.0748
2.1801
3ab
Ph
S
O2
Br
8
6
4
2
0
[ppm]
0
20
40
60
[rel]


zhengdanqing 15122910 1 E:\nmrdata\user
K02017C
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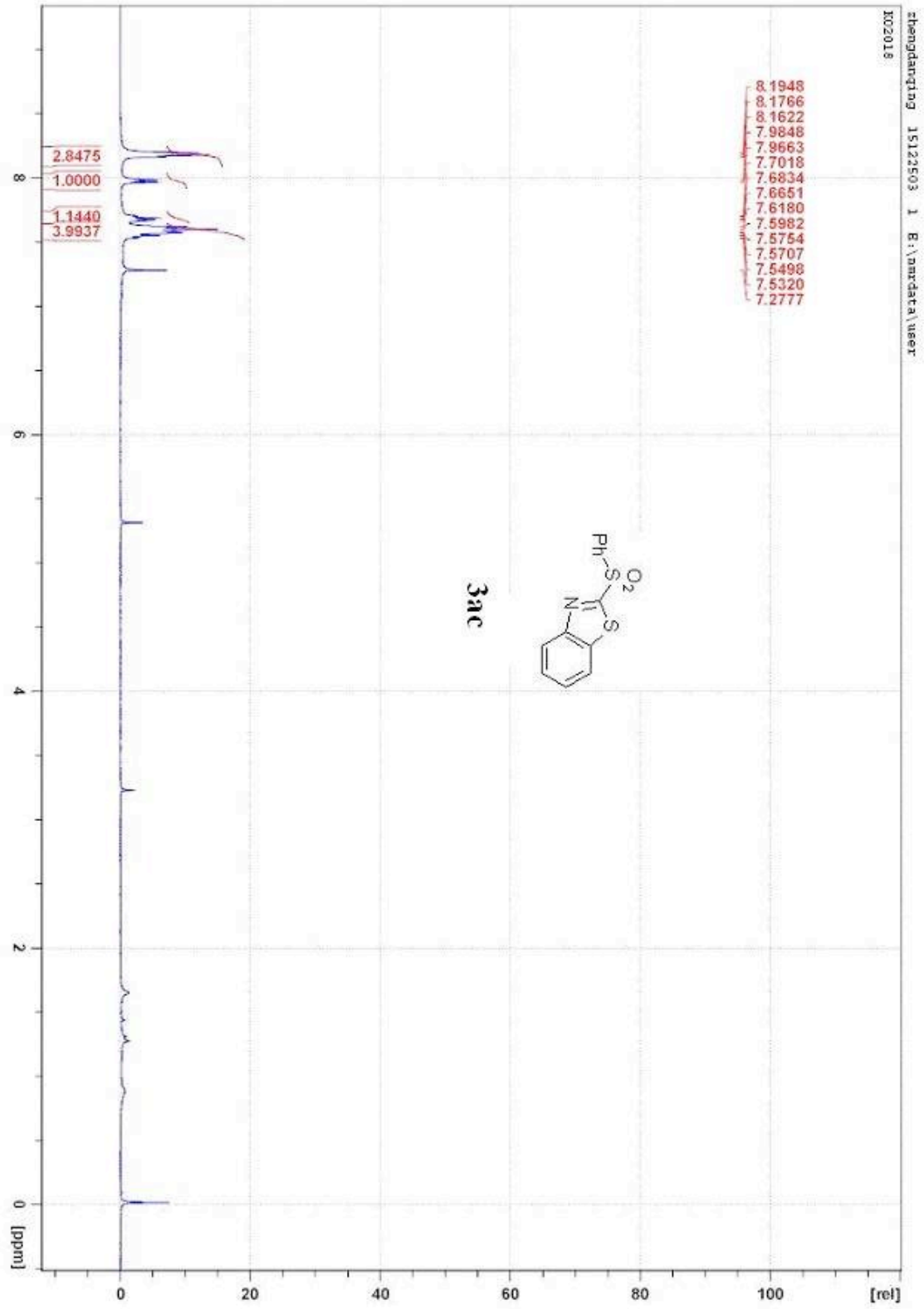
140.6392
133.4223
132.5668
129.3855
129.1583
128.4215
127.6126
77.3095
76.9913
76.6736
3ab
Ph
S
O2
Br
200
150
100
50
[ppm]
0
5
10
15
20
25 [rel]


zhengdanqing 15122503 1 B:\nmrdata\user
KO2018
8.1948
8.1766
8.1622
7.9848
7.9663
7.7018
7.6834
7.6651
7.6180
7.5982
7.5754
7.5707
7.5498
7.5320
7.2777
2.8475
1.0000
1.1440
3.9937
3aC
Ph
S
O2
S
N
S
8
6
4
2
0
[ppm]
0
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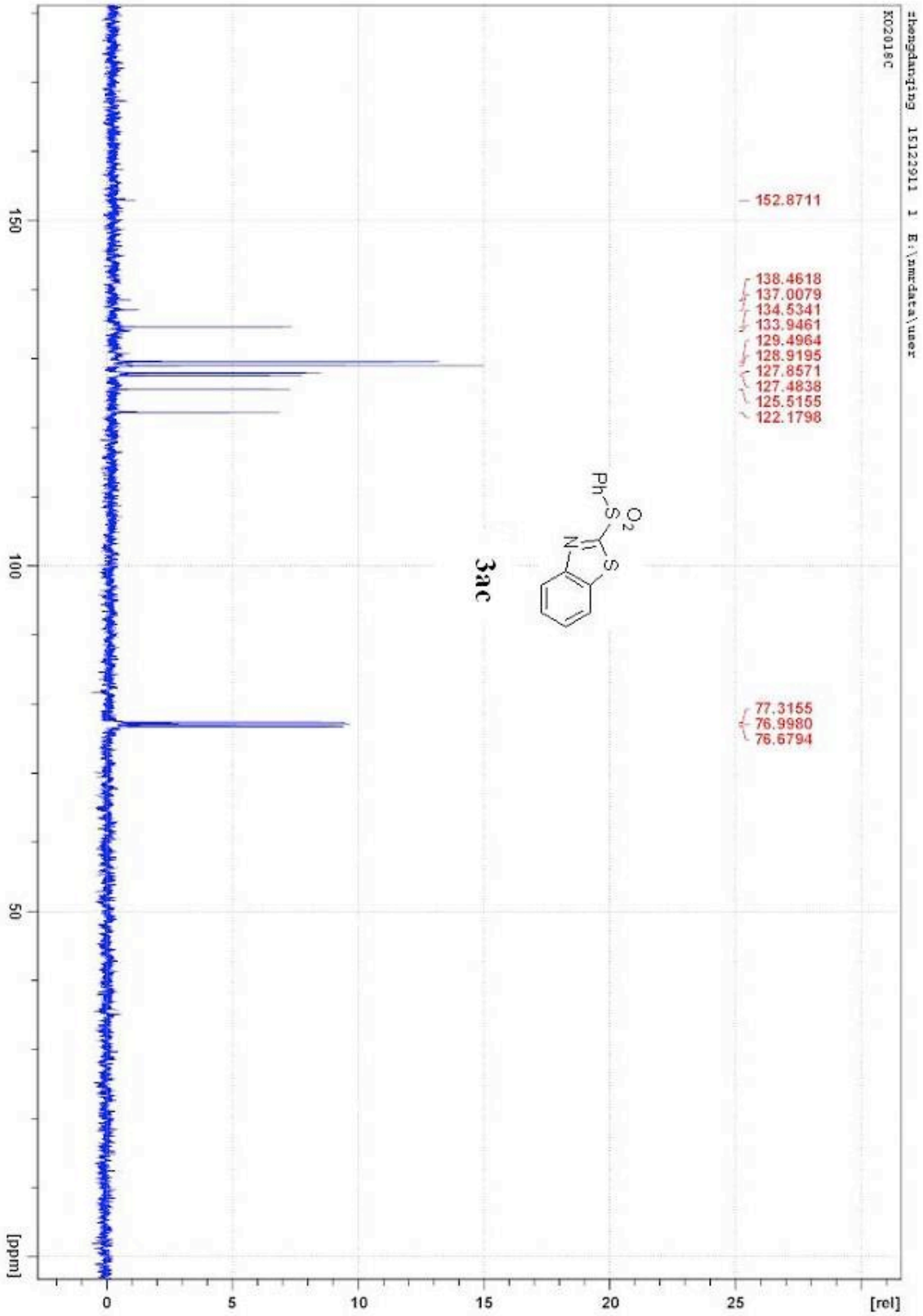
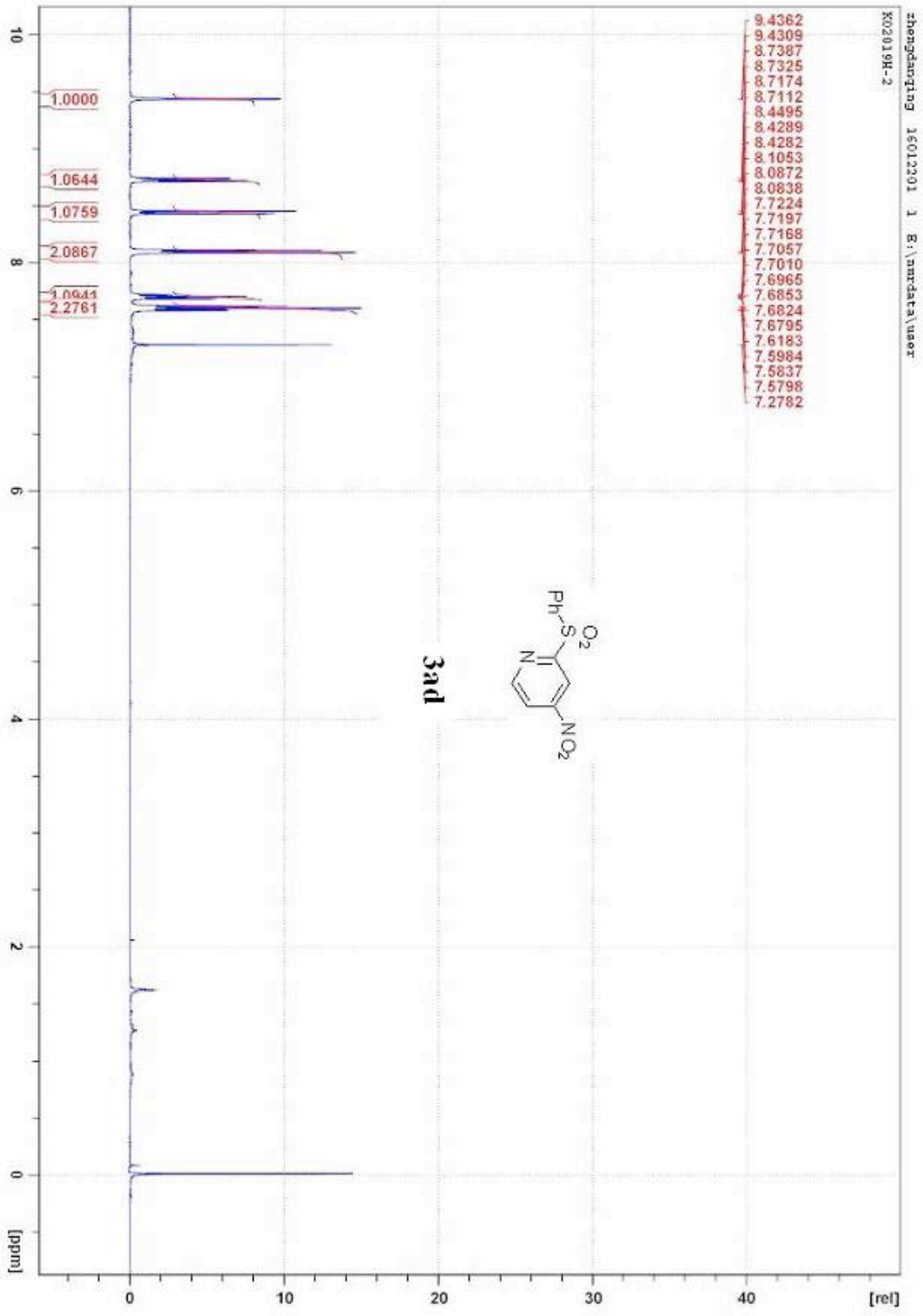
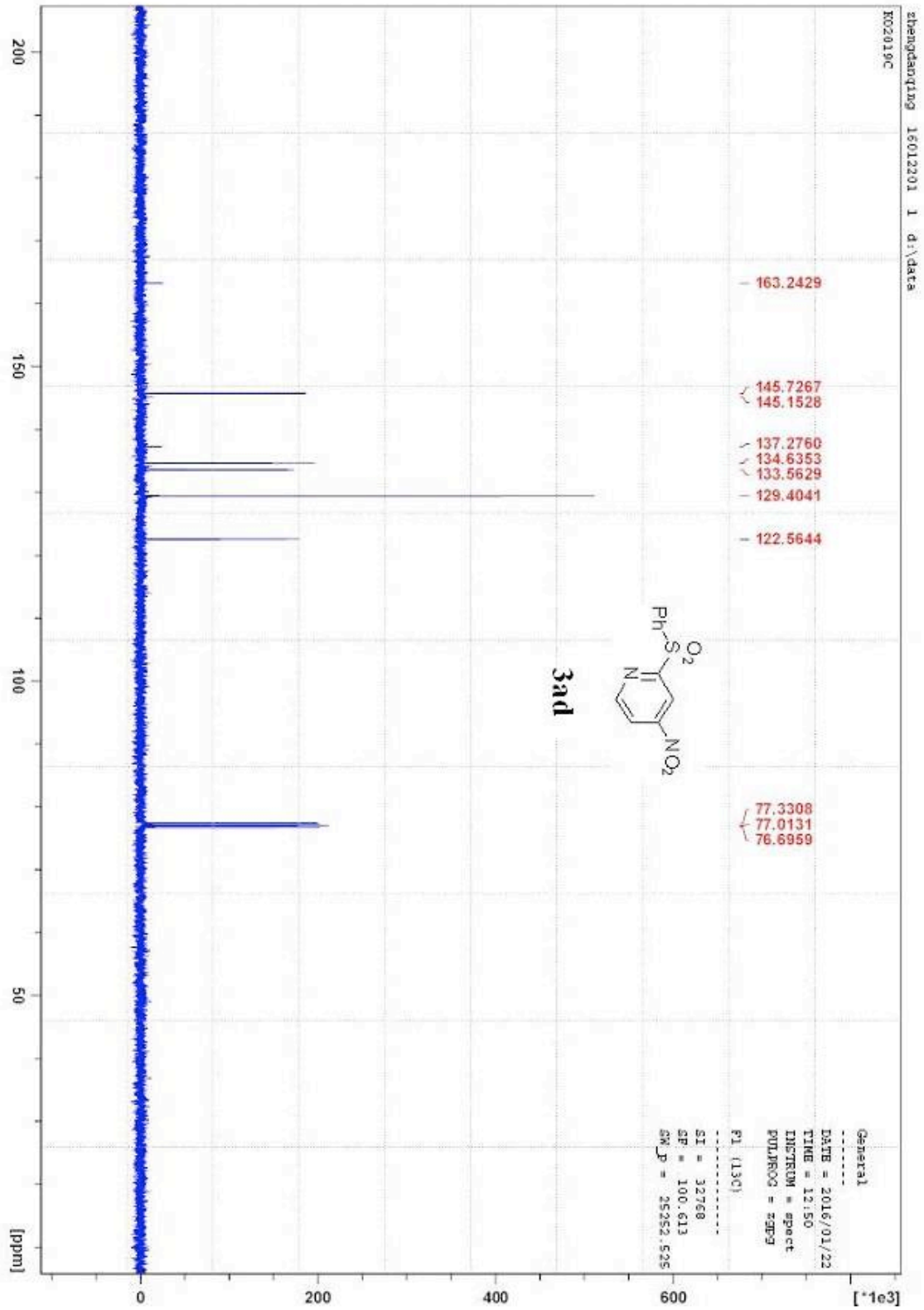
40
60
80
100
[rel]


152.8711
138.4618
137.0079
134.5341
133.9461
129.4964
128.9195
127.8571
127.4838
125.5155
122.1798
77.3155
76.9980
76.6794
3ac
Ph
S
O2
N
S
[ppm]
150
100
50
0
5
10
15
20
25
[rel]


zhengdanqing 160122o1 1 E:\nmrdata\user
KO2019H-2
9.4362
9.4309
8.7387
8.7325
8.7174
8.7112
8.4495
8.4289
8.4282
8.1053
8.0872
8.0838
7.7224
7.7197
7.7168
7.7057
7.7010
7.6965
7.6853
7.6824
7.6795
7.6183
7.5984
7.5837
7.5798
7.2782
1.0000
1.0644
1.0759
2.0867
1.0941
2.2761
3ad
Ph
S
O2
N
NO2
[ppm]
[rel]


zhengdanqing 16012201 1 d:\data
E02019C
163.2429
145.7267
145.1528
137.2760
134.6353
133.5629
129.4041
122.5644
77.3308
77.0131
76.6959
3ad
Ph
S
O2
N
NO2
General
DATE = 2016/01/22
TIME = 12:50
INSTRUM = spect
PULPROG = zgpg
F1 (13C)
SI = 32768
SF = 100.613
SW_p = 25252.525
[ppm]
[*1e3]