Electronic Supplementary Material (ESI) for ChemComm.

Supporting Information

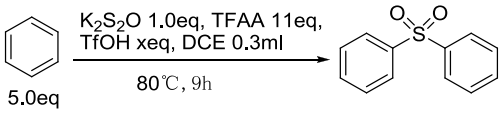
Synthesis of Diarylsulfones with Simple Arenes and $K_2S_2O_8$ through Double C-S Bond Formation

Yiqing Yang[†] , Zhang Chen[‡], and Yu Rao[†,*]

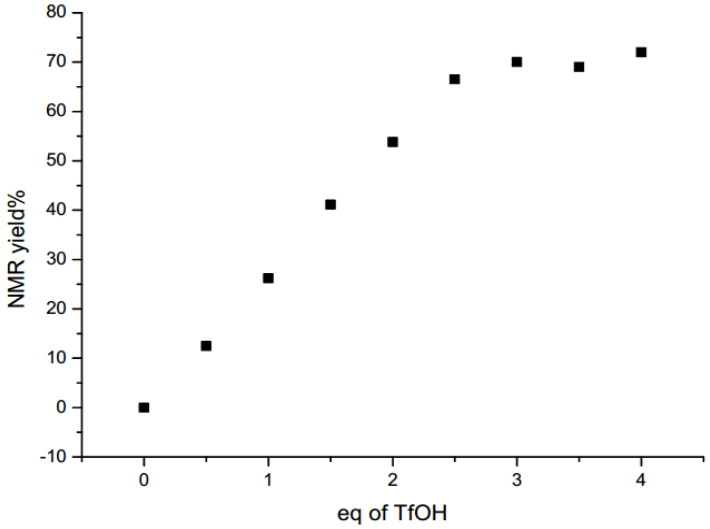
[†]Department of Pharmacology and Pharmaceutical Sciences, School of Medicine and School of Life Sciences, Tsinghua University, Beijing 100084, China

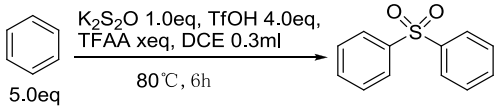
[‡]Department of Chemistry, Tsinghua University, Beijing 100084, China

yrao@mail.tsinghua.edu.cn

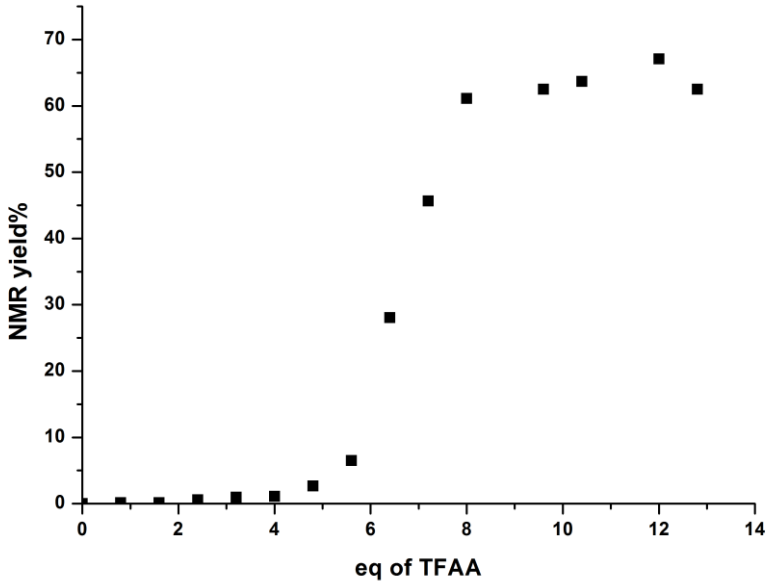


eq of TfOH	0	0. 5	1	1. 5	2	2. 5	3	3. 5	4
NMR yield%	0	12. 5	26. 2	41. 1	53. 8	66. 5	70	69	72





eq of TFAA	0	0. 8	1. 6	2. 4	3. 2	4	4. 8
NMR yield%	0	0. 16	0. 14	0. 57	0. 97	1. 1	2. 67
eq of TFAA	5. 6	6. 4	7. 2	8	9. 6	10. 4	12
NMR yield%	6. 5	28. 04	45. 64	61. 1	62. 5	63.7	67. 1

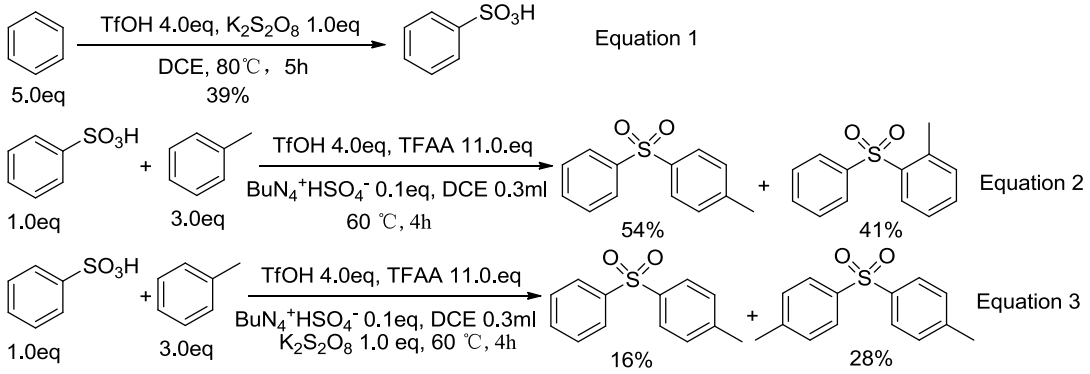


General procedure:

For symmetric diarylsulfones: $K_2S_2O_8$ (0.2 mmol, 54 mg), tetrabutylammonium hydrogen sulfate (0.1eq, 6.8mg), DCE 0.3 ml, arene(5.0eq) and TFAA (11eq, 0.3 ml) were added into a 10 ml sealed tube followed by adding TfOH (4.0 eq, 71 ul). The mixture was stirred at R.T or higher temperature for about 6 h. Then extract with dichloromethane (DCM) and wash it by water. The organic phase was purified by flash column chromatography to give the desired product.

For unsymmetric diarylsulfones: $K_2S_2O_8$ (0.2 mmol, 54 mg), tetrabutylammonium hydrogen sulfate (0.1eq, 6.8mg), DCE 0.3 ml, one of arenes (2.0 eq) and TfOH (4.0 eq, 71 ul) were added into a 10 ml sealed tube. After stirring at proper temperature for about 4 h, the other arene (3.0 eq) and TFAA (11eq, 0.3 ml) were added. The reaction was continued for another 4 h. Then extract with DCM and wash it by water. The organic phase was purified by flash column chromatography to give the desired product.

Mechanism study:



Equation 1: $K_2S_2O_8$ (0.2 mmol, 54 mg), DCE 0.3 ml, benzene (5 eq, 90 ul) and TfOH (5.0 eq, 90ul) were added into a 10 ml sealed tube. After stirring at 80 ℃ for 5 h, the mixture was transferred into a 50ml round-bottom flask to remove the solvent. Add CH_3COOK (0.2mmol) into the residual as an internal standard and dissolve with D_2O. The yield is 39% by NMR.

Equation 2: Benzenesulfonic acid (0.2mmol, 32mg), tetrabutylammonium hydrogen sulfate (0.1eq, 6.8mg), DCE 0.3 ml, toluene (3 eq, 48 ul), TfOH (4.0 eq, 72ul) and TFAA (11.0eq, 0.3ml) were added into a 10 ml sealed tube. After stirring at 60 ℃ for 4 h, the mixture was extracted with DCM and washed with water. After removing the solvent, add 4-nitrobenzaldehyde (0.1mmol) into the residual as an internal standard and dissolve with $CDCl_3$. The yield of **24** and its region isomer were 54% and is 41% respectively by NMR.

Equation 3: Benzenesulfonic acid (0.2mmol, 32mg), $K_2S_2O_8$ (1.0eq, 54 mg), tetrabutyl-ammonium hydrogen sulfate (0.1eq, 6.8mg), DCE 0.3 ml, toluene (3 eq, 48 ul), TfOH (4.0 eq, 72ul) and TFAA (11.0eq, 0.3ml) were added into a 10 ml sealed tube. After stirring at 60 ℃ for 4 h, the mixture was extracted with DCM and washed with water. After removing the solvent, add 4-nitrobenzaldehyde (0.1mmol) into the residual as an internal standard and dissolve with $CDCl_3$. The yield calculated based on benzenesulfonic acid of **24** and **3** were 16% and 28% respectively by NMR.

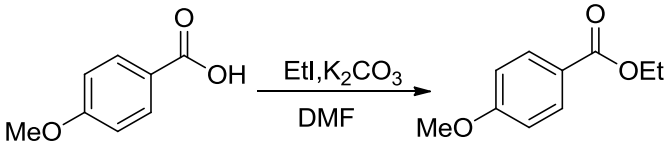
Materials and Methods

All commercial materials (Alfa Aesar, Aladdin, J&K Chemical LTD.) were used without further purification. All solvents were analytical grade. The potassium persulfate were ground to powder. The melting points were measured on WRS-1B from Shanghai INESA Physico Optical Instrument Co., Ltd. The ^{1}H NMR and ^{13}C NMR spectra were recorded on a Bruker AVANCE^{III} 400 MHz spectrometer in $CDCl_3$ or d_6-DMSO using TMS or solvent peak as a standard. All ^{13}C NMR spectra were recorded with complete proton decoupling. Low-resolution mass spectral analyses were performed with an Waters AQUITY UPLC^{TM}/MS. Most reactions were carried out in sealed tube with Teflon cap or round-bottom flask. Analytical TLC was performed on Yantai Chemical Industry Research Institute silica gel 60 F254 plates and flash column chromatography was performed on Qingdao Haiyang Chemical Co. Ltd silica gel 60 (200-300mesh). The rotavapor was BUCHI's Rotavapor R-3.

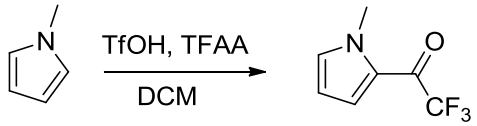
Preparation of substrates

Some substrates were prepared from simple arenes with simple reactions:

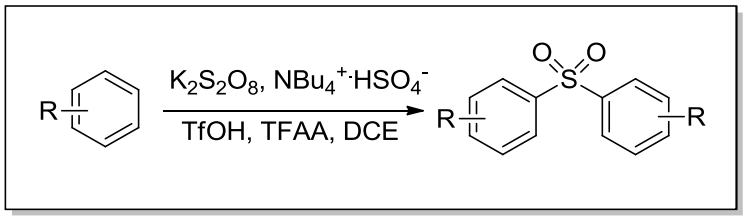
To a 100 ml round-bottom flask, was added aniline(20mmol,1.8ml), triethylamine(1.0eq, 2.8ml) and DCM 40 ml. TFAA (1.0eq, 2.8ml) was added dropwise to the mixture over 30min at ice bath. Then warm to room temperature and stir for about 4 hours. The mixture was washed by water and purified by column chromatography (Hexane : EtOAc = 5: 1 to 1:1) to get the desired product 3.6g (I.Y=95 %). It matched with the reported spectrum[8].

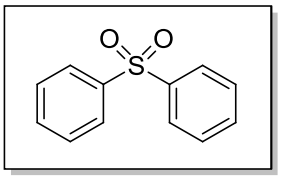


To a 100 ml round-bottom flask, was added 4-methoxybenzoic acid (10 mmol, 1.52 g), K_2CO_3 (1.0 eq, 1.4 g), iodoethane(1.5 eq, 1.7 ml) and DMF 20 ml. The mixture was stirred at 50 ℃ overnight. Then exacted with DCM, washed by water and purified by column chromatography (Hexane : EtOAc = 10:1) to get the desired product 1.6g (I.Y=90 %). It matched with the reported spectrum[9].

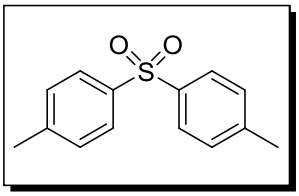


To a 50 ml round-bottom flask, was added 1-methyl-1H-pyrrole (20mmol,1.8ml), TFAA(1.0eq, 2.8ml) and DCM 20 ml. TfOH (1.0eq, 1.8ml) was added dropwise to the mixture over 30min at ice bath. Then warm to room temperature and stir for about 6 hours. The mixture was washed by water and purified by column chromatography (Hexane : EtOAc = 15:1) to get the desired product 2g (I.Y=65%). It matched with the reported spectrum[10].

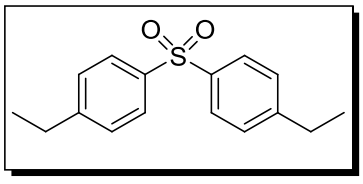




Sulfonyldibenzene(2): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3 ml), benzene (1.0 mmol, 90 ul), TFAA (2.2 mmol, 306 ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 80 ℃ for 6 h. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 15 : 1）to get 71mg product, which is a kind of white solid giving 81% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.94 (d, *J* = 7.72 Hz, 4H), 7.54 – 7.46 (m, 6H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 141.59, 133.24, 129.31, 127.63; LRMS (ESI) calcd for $C_{12}H_{11}O_2S$ $[M+H]^+$: 219.04, found 218.97. m.p. 124.0-124.2 ℃.

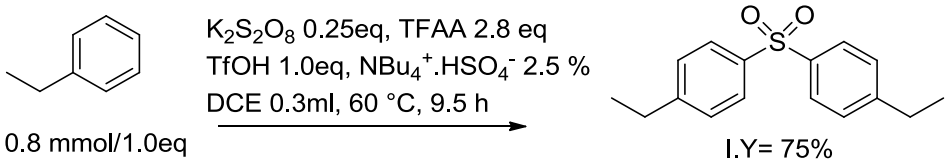


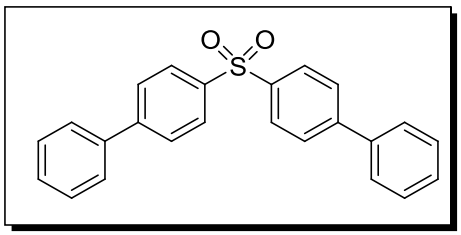
4,4'-sulfonylbis(methylbenzene)(3): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), toluene (1.0 mmol, 100ul), TFAA (2.2 mmol, 300 ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 60 ℃ for 7 h. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography （Hexane : EtOAc = 10 : 1） to get 69 mg 4,4'-sulfonylbis(methylbenzene) which is a kind of white solid with 71% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.80 (d, *J* = 7.96 Hz, 4H), 7.25 (d, *J* = 7.72 Hz, 4H)，2.35(s, 6H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 143.92, 139.03, 129.83, 127.48, 21.48. LRMS (ESI) calcd for $C_{14}H_{15}O_2S$ $[M+H]^+$: 247.07, found 247.18. m.p.150.8-153.7 ℃.



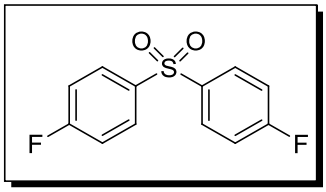
4,4'-sulfonylbis(ethylbenzene)(4): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), ethylbenzene (1.0 mmol, 123ul), TFAA (2.2 mmol, 300 ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 60 ℃ for 6 h. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 10 : 1） to get 103 mg 4,4'-sulfonylbis(ethylbenzene) which is a kind of white solid with 87% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.84 (d, *J* = 8.12 Hz, 4H), 7.30 (d, *J* = 8.08 Hz, 4H)，2.67(q, *J* = 7.52 Hz, 4H), 1.22(t, *J* = 7.60 Hz, 6H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 150.14, 139.33, 128.82, 127.80, 28.93, 15.19. LRMS (ESI) calcd for $C_{16}H_{19}O_2S$ $[M+H]^+$: 275.10, found 275.20. m.p.90.4-90.6 ℃.

If the condition was instead as follow, the isolated yield is 75%.



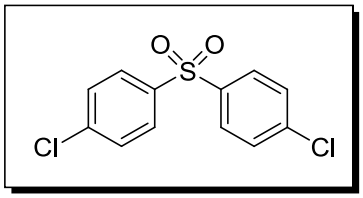


4,4'-sulfonyldibiphenyl(5): $K_2S_2O_8$ (0.3 mmol, 82 mg) and $NBu_4^+.HSO_4^-$ (0.03 mmol, 10 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), biphenyl (1.5 mmol, 232mg), TFAA (2.7 mmol, 250 ul) and TfOH (1.3 mmol, 117 ul) was added, the reaction was carried out at 80 ℃ for 7 h. After observing an obvious product spot on the TLC（Hexane : EtOAc = 4 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 4 : 1）to get 222 mg 4,4'-sulfonyldibiphenyl which is a kind of white solid with 98% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.03 (d, *J* = 8.28 Hz, 4H), 7.71 (d, *J* = 8.24 Hz, 4H), 7.56 (d, *J* = 7.12 Hz, 4H), 7.47 – 7.40 (m, 6H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 138.67, 136.02, 134.49, 134.11, 132.54, 129.88, 20.09, 19.54; LRMS (ESI) calcd for $C_{24}H_{19}O_2S$ $[M+H]^+$: 371.10, found 371.19. m.p.211.2-214.5 ℃.

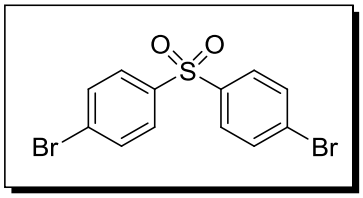


4,4'-sulfonylbis(fluorobenzene)(6): $K_2S_2O_8$ (0.3 mmol, 82 mg) and $NBu_4^+.HSO_4^-$ (0.03 mmol, 10 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), fluorobenzene(500ul), Tf_2O (400 ul) and TfOH (0.6 mmol, 52 ul) was added, the

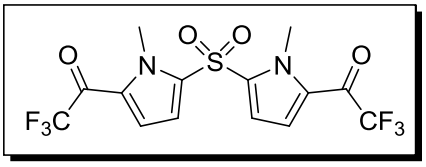
reaction was carried out at 80 ℃ for 11 h. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 20 : 1）to get 137 mg 4,4'-sulfonylbis(fluorobenzene) which is a kind of white solid with 90% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.97 (dd, *J* = 8.80 Hz, *J* = 5.08 Hz, 4H), 7.19 (t, *J* = 8.48Hz, 4H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 164.47 (d, *J* = 254.51 Hz), 137.59 (d, *J* = 3.13 Hz), 130.44 (d, *J* = 9.54 Hz), 116.70 (d, *J* = 22,59 Hz) The spectrum data is in accordance with literature reported [3]. m.p.93.0-96.9 ℃.



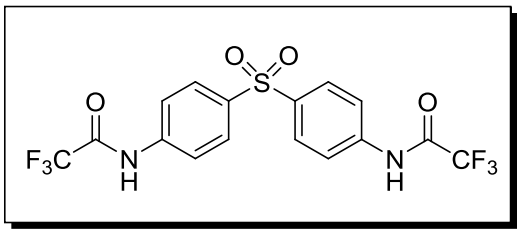
4,4'-sulfonylbis(chlorobenzene)(7): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), chlorobenzene(1.0 mmol, 100ul), TFAA (2.2 mmol, 300 ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 85 ℃ for 6 h. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 10 : 1）to get 92 mg 4,4'-sulfonylbis(chlorobenzene) which is a kind of white solid with 73% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.77 (d, *J* = 8.40 Hz, 4H), 7.37 (d, *J* = 8.40 Hz, 4H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 140.19, 139.77, 129.78, 129.16; The spectrum data is in accordance with literature reported [1]. m.p.138.8-142.1 ℃.



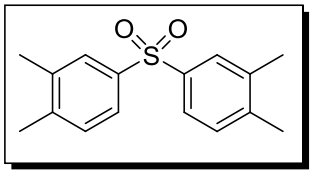
4,4'-sulfonylbis(bromobenzene)(8): $K_2S_2O_8$ (5 mmol, 1.35 g) and $NBu_4^+.HSO_4^-$ (0.3 mmol, 85 mg) was added into a 100ml sealed tube charged with a magnetic bar, following that, bromobenzene(30 mmol, 3.2 ml), TFAA (40 mmol, 5.6 ml) and TfOH (25 mmol, 2.2 ml) was added, the reaction was carried out at 85 ℃ for 8h. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was declorization by activated carbon in acetone after column chromatography（Hexane : EtOAc = 10 : 1）to get 3.8 g 4,4'-sulfonylbis(bromobenzene) which is a kind of white solid with 98% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.77 (d, *J* = 8.64 Hz, 4H), 7.64 (d, *J* = 8.56 Hz, 4H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 140.33, 132.88, 129.29, 128.93; The spectrum data is in accordance with literature reported [2]. m.p.155.7-158.1 ℃.



1,1'-(5,5'-sulfonylbis(1-methyl-1H-pyrrole-5,2-diyl))bis(2,2,2-trifluoroethanone)(9): $K_2S_2O_8$ (0.24 mmol, 65 mg) and $NBu_4^+.HSO_4^-$ (0.024 mmol, 8.2 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), 2,2,2-trifluoro-1-(1-methyl-1H-pyrrol-2- yl)ethanone (1.2 mmol, 220mg), TFAA (2.64 mmol, 367 ul) and TfOH (0.96 mmol, 85 ul) was added, the reaction was carried out at 60 ℃ for 5 h. After observing an obvious product spot on the TLC（Hexane : EtOAc = 5 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 5 : 1） to get 123 mg 1,1'-(5,5'-sulfonylbis(1-methyl-1H-pyrrole-5,2-diyl)) bis(2,2,2-trifluoroethanone) which is a kind of white solid with 61% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.56(s, 2H), 7.449(s, 2H), 4.00(s, 6H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 171.33(q, *J* = 36.62 Hz), 134.44, 127.43, 125.69, 121.57(q, *J* = 4.09 Hz), 116.39(q, *J* = 288.44 Hz), 38.93. LRMS (ESI) calcd for $C_{14}H_{11}F_6N_2O_4S$ $[M+H]^+$: 417.03, found 417.03. m.p.193.7-195.4 ℃.

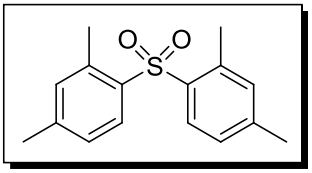


N,N'-(4,4'-sulfonylbis(4,1-phenylene))bis(2,2,2-trifluoroacetamide)(10): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), 2,2,2-trifluoro-N-phenylacetamide (1.0 mmol, 190mg), TFAA (2.2 mmol, 300 ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 80 ℃ for 6 h. After observing an obvious product spot on the TLC（Hexane : EtOAc = 5 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 5 : 1）to get 109 mg N,N'-(4,4'-sulfonyl bis(4,1-phenylene))bis(2,2,2-trifluoroacetamide) which is a kind of white solid with 62% yield. ^{1}H-NMR (400 MHz, d_6-DMSO) δ (ppm) 11.65(s, 2H), 8.00 (d, *J* = 8.68 Hz, 4H), 7.91 (d, *J* = 8.64 Hz, 4H); ^{13}C-NMR (100 MHz, d_6-DMSO) δ (ppm) 154.90(q, *J* = 35.84 Hz), 141.00, 137.39, 128.65, 121.42, 115.50(q, *J* = 284.66 Hz). LRMS (ESI) calcd for $C_{16}H_9F_6O_4S$ $[M-H]^-$: 439.03, found 439.21. m.p.133.4-135.0 ℃.

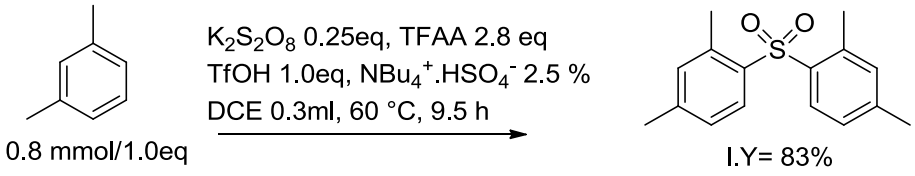


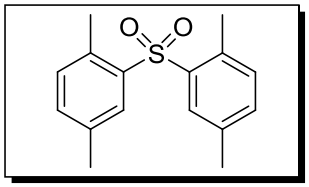
4,4'-sulfonylbis(1,2-dimethylbenzene)(11): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$

(0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), *o*-xylene (1.0 mmol, 121 ul), TFAA (2.2 mmol, 300 ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 50 ℃ for 7 h. After observing an obvious product spot on the TLC（Hexane : EtOAc = 4 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 4 : 1）to get 96 mg 4,4'-sulfonylbis(1,2-dimethylbenzene) which is a kind of white solid with 88% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.66 (m, 4H), 7.21 (d, *J* = 7.80 Hz, 2H), 2.25 (m, 12H) ; ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 142.60, 139.27, 137.98, 130.33, 128.22, 125.04, 19.91, 19.81; LRMS (ESI) calcd for $C_{16}H_{19}O_2S$ $[M+H]^+$: 275.10, found 275.10. m.p.153.62-155.6 ℃.



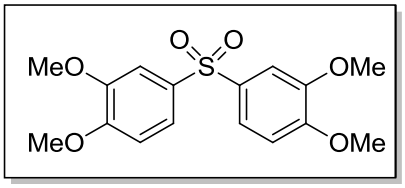
4,4'-sulfonylbis(1,3-dimethylbenzene)(12): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), *m*-xylene (1.0 mmol, 121 ul), TFAA (2.2 mmol, 300 ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 40 ℃ for 15 h. After observing an obvious product spot on the TLC（Hexane : EtOAc = 4 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 4 : 1）to get 101 mg 4,4'-sulfonylbis(1,3-dimethylbenzene) which is a kind of white solid with 92% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.05 (d, *J* = 8.12 Hz, 2H), 7.15 (d, *J* = 7.92 Hz, 2H), 7.00 (s, 2H), 2.33 (s, 6H), 2.28 (s, 6H) ; ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 144.02, 137.38, 136.12, 133.19, 129.71, 126.54, 21.19, 19.79; LRMS (ESI) calcd for $C_{16}H_{19}O_2S$ $[M+H]^+$: 275.10, found 275.10. m.p.115.6-119.3 ℃.
If the condition was instead as follow, the isolated yield is 83%.



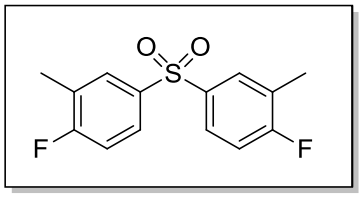


2,2'-sulfonylbis(1,4-dimethylbenzene)(13): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), *p*-xylene (1.0 mmol, 121 ul), TFAA (2.2 mmol, 300 ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 50 ℃ for 7 h. After observing an obvious product spot on the TLC（Hexane : EtOAc = 4 : 1 as the eluent）, the reaction was quenched by

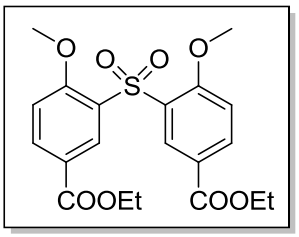
brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 4 : 1）to get 88 mg 2,2'-sulfonylbis(1,4-dimethylbenzene) which is a kind of white solid with 88% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.00 (s, 2H), 7.26 (d, *J* = 7.56 Hz, 2H), 7.08 (d, *J* = 7.68 Hz, 2H), 2.39 (s, 6H), 2.67 (s, 6H) ; ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 138.67, 136.02, 134.49, 134.11, 132.54, 129.88, 20.09, 19.54; LRMS (ESI) calcd for $C_{16}H_{19}O_2S$ $[M+H]^+$: 275.10, found 275.14. m.p.143.1-143.4 ℃.



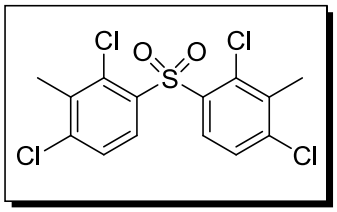
4,4'-sulfonylbis(1,2-dimethoxybenzene)(14): $K_2S_2O_8$ (0.3 mmol, 82 mg) and $NBu_4^+.HSO_4^-$ (0.03 mmol, 10 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), 1,2-dimethoxybenzene (1.8 mmol, 230 ul), TFAA (1.8 mmol, 250 ul) and TfOH (0.6 mmol, 52 ul) was added, the reaction was carried out at room temperature for 7 h. After observing an obvious product spot on the TLC（Hexane : EtOAc = 1 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 2 : 1）to get 190 mg 4,4'-sulfonylbis(1,2-dimethoxy benzene) which is a kind of white solid with 95% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.50 (d, *J* = 8.48 Hz, 2H), 7.34 (s, 2H), 6.88 (d, *J* = 8.48 Hz, 2H), 3.87 (s, 12H) ; ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 152.84, 149.25, 133.85, 121.49, 110.85, 109.68, 56.29, 56.21; LRMS (ESI) calcd for $C_{16}H_{19}O_6S$ $[M+H]^+$: 339.08.10, found 339.10. m.p.156.1-157.7 ℃.



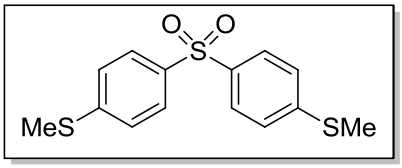
3,3'-sulfonylbis(1-fluoro-2-methylbenzene)(15): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), 1-fluoro-2-methylbenzene (1.0 mmol, 110ul), TFAA (2.2 mmol, 300 ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 85 ℃ for 6 h. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 20 : 1）to get 93 mg 3,3'-sulfonylbis(1-fluoro-2-methyl benzene) which is a kind of white solid with 83% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.81 – 7.77 (m, 4H), 7.11 (t, *J* = 8.80 Hz, 2H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 164.03 (d, *J* = 252.74 Hz), 137.26 (d, *J* = 3.47 Hz) , 131.21 (d, *J* = 6.71 Hz), 127.63 (d, *J* = 9.57 Hz), 126.83 (d, *J* = 18.55 Hz), 116.14 (d, *J* = 23.65Hz), 14.55 (d, *J* = 3.36 Hz). m.p.100.9-103.2 ℃.



diethyl 3,3'-sulfonylbis(4-methoxybenzoate)(16): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), TFAA(300ul) and TfOH (1.0 mmol, 90 ul) was added, the reaction was carried out at 80 ℃ for 4h. After adding ethyl 4-methoxybenzoate (1.0mmol, 163ul), the reaction was running for another 5h. The reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 1 : 1） to get 123 mg diethyl 3,3'-sulfonylbis(4-methoxybenzoate) which is a kind of white solid with 78% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.81 (d, *J* = 2.04 Hz, 2H), 8.22(dd, *J* = 8.68Hz, *J* = 2.04 Hz, 2H)，6.91(d, *J* = 8.72 Hz, 2H)，4.38(q, *J* = 7.12 Hz, 1H)， 3.71（s, 2H）, 1.39(t, *J* = 7.12 Hz 3H),; ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 165.24, 160.39, 136.83, 133.02, 128.75, 122.92, 111.96, 61.35, 56.42, 14.47. LRMS (ESI) calcd for $C_{20}H_{23}O_8S$ $[M+H]^+$: 423.10, found 423.44. m.p.182.6-184.2 ℃.

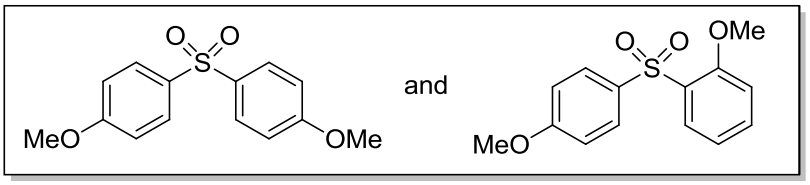


4,4'-sulfonylbis(1,3-dichloro-2-methylbenzene)(17): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), 1,3-dichloro-2-methylbenzene (1.0 mmol, 128ul), TFAA (2.2 mmol, 300 ul) and TfOH (1.0 mmol, 89 ul) was added, the reaction was carried out at 90 ℃ for 7 h. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography （Hexane : EtOAc = 20 : 1 ）to get 92 mg 4,4'-sulfonylbis(1,3-dichloro-2- methylbenzene) which is a kind of white solid with 81% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.24 (d, *J* = 8.46 Hz, 2H), 7.54 (d, *J* = 8.64 Hz, 4H), 2.45 (s, 6H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 141.46, 137.30, 136.63, 133.35, 130.77, 127.70, 17.77. m.p.165.2-167.6 ℃.

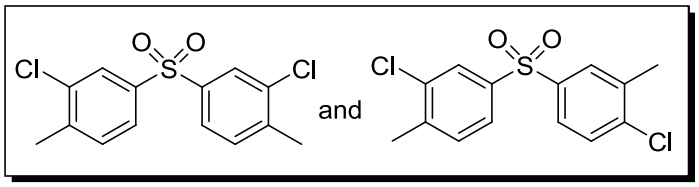


(sulfonylbis(4,1-phenylene))bis(methylsulfane)(18)： $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar,

following that, DCE (0.3ml), TFAA (2.2 mmol, 300 ul) and TfOH (0.8 mmol, 71 ul) was added, the mixture was stirredt at 80 ℃ for 1 h. Add methyl(phenyl)sulfane （1.4 mmol， 165ul），stir for another 5 h at 50℃. After observing an obvious product spot on the TLC（Hexane : EtOAc = 5 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 8 : 1） to get 97 mg (sulfonylbis(4,1-phenylene))bis(methylsulfane) which is a kind of white solid with 81% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.78 (d, *J* = 8.12 Hz, 4H), 7.26 (d, *J* = 8.08 Hz, 4H)，2.47(s, 6H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 146.98, 137.96, 128.22, 125.98, 15.22. LRMS (ESI) calcd for $C_{14}H_{14}O_2S_3$ $[M+H]^+$: 311.12, found 311.21. m.p.121.0-123.8 ℃.

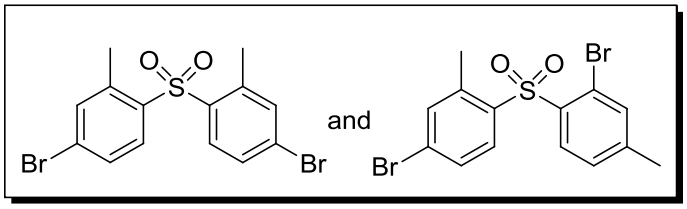


4,4'-sulfonylbis(methoxybenzene)(19a) and **1-methoxy-2-((4-methoxyphenyl) sulfonyl)benzene(19b):** $K_2S_2O_8$ (0.3 mmol, 82 mg) and $NBu_4^+.HSO_4^-$ (0.03 mmol, 10 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, anisole (400 ul), TFAA (200 ul) and TfOH (0.6 mmol, 52 ul) was added, the reaction was carried out at 50 ℃ for 9 h. After observing obvious product spots on the TLC（Hexane : EtOAc = 4 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 4 : 1）to get 89 mg 4,4'-sulfonylbis (methoxybenzene) which is a kind of white solid with 53% yield and 47 mg 1-methoxy-2-((4-methoxyphenyl) sulfonyl)benzene which is also a kind of white solid with 28% yield at the same time. For 4, 4'-sulfonylbis (methoxybenzene) : ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.82 (d, *J* = 8.96 Hz, 4H), 6.92 (d, *J* = 8.92 Hz, 4H), 3.80 (s, 6H) ; ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 163.14, 133.95, 129.31, 114.48, 55.67; LRMS (ESI) calcd for $C_{14}H_{15}O_4S$ $[M+H]^+$: 279.06, found 279.06. m.p.121.4-124.9 ℃. For 1-methoxy-2-((4-methoxyphenyl) sulfonyl)benzene : ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.12 (dd, *J* = 1.68 Hz, *J* = 7.88 Hz, 1H), 7.90 (d, *J* = 9.88 Hz, 2H), 7.50 (m, 1H), 7.07 (m, 1H), 7.50 (d, *J* = 9.84 Hz, 2H), 6.91(m, 1H) ; ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 163.29, 156.99, 135.30, 133.13, 130.77, 129.70, 129.66, 120.54, 113.77, 112.51, 55.97, 55.69; LRMS (ESI) calcd for $C_{14}H_{15}O_4S$ $[M+H]^+$: 279.06, found 279.06. m.p.122-124.3 ℃.

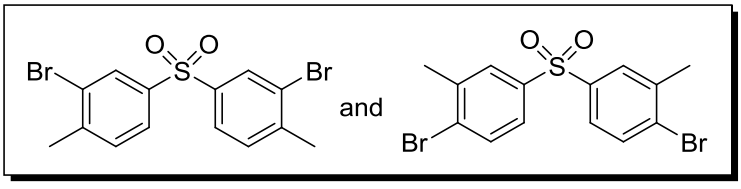


4,4'-sulfonylbis(2-chloro-1-methylbenzene)(20a) and **2-chloro-4-(4-chloro-3-methylphenylsulfonyl)-1-methylbenzene(20b):** $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), 1-chloro-2-methylbenzene (1.0 mmol, 117 ul), TFAA (300 ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 70 ℃ for 6 h. After observing

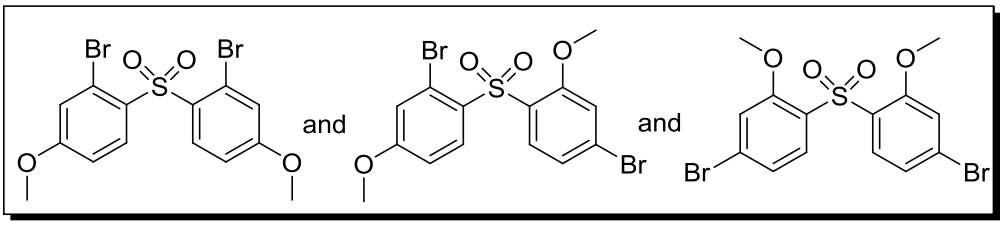
obvious product spots on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 20 : 1）to get 59 mg 4,4'-sulfonylbis(2-chloro-1-methylbenzene) which is a kind of white solid with 47% yield and 40 mg 2-chloro-4-(4-chloro-3-methyl phenylsulfonyl)-1-methylbenzene which is also a kind of white solid with 32% yield at the same time. For 4,4'-sulfonylbis (2-chloro-1-methylbenzene) : ^{1}H-NMR (400 MHz, CDCl3) δ (ppm) 7.78 (s, 2H), 7.67 (dd, *J* = 8.32 Hz, *J* = 1.60 Hz, 2H), 7.45 (d, *J* = 8.32 Hz, 2H), 2.41 (s, 6H) ; 13C-NMR (100 MHz, CDCl3) δ (ppm) 140.30, 139.81, 138.04, 130.21, 129.88, 126.44, 20.32. m.p.110.9-113.3 ℃. For 2-chloro-4-(4-chloro-3-methylphenyl sulfonyl)-1-methyl benzene : ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.88（s, 2H）, 7.78(s, 2H), 7.70(m, 4H), 7.46 (d, *J* = 8.36 Hz, 2H), 7.36 (d, *J* = 8.00 Hz, 2H), 2.42(s, 3H), 2.41(s, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 142.55, 140.51, 140.39, 139.74, 138.09, 135.66, 131.91, 130.25, 129.94, 128.26, 126.50, 125.84, 20.47, 20.35. m.p.105.7-107.3 ℃.



4,4'-sulfonylbis(1-bromo-3-methylbenzene)(21a) and **2-bromo-1-(4-bromo-2-methyl phenylsulfonyl)-4-methylbenzene(21b):** $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), 1-bromo-3-methylbenzene (121 ul), TFAA (300 ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 80 ℃ for 6 h. After observing obvious product spots on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 20 : 1）to get 99 mg 4,4'-sulfonylbis(1-bromo-3-methylbenzene) which is a kind of white solid with 55% yield and 66 mg 2-bromo-1-(4-bromo-2-methyl phenylsulfonyl)-4-methylbenzene which is also a kind of white solid with 38% yield at the same time. For 4,4'-sulfonylbis (1-bromo-3-methylbenzene)) : ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.01 (d, *J* = 8.44 Hz, 2H), 7.53 (d, *J* = 8.48 Hz, 2H), 7.39 (s, 2H), 2.29 (s, 6H) ; ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 139.79, 137.66, 135.59, 131.40, 129.54, 128.70, 19.95. m.p.126.9-127.5 ℃; For 2-bromo-1-(4-bromo-2-methyl phenylsulfonyl)-4-methyl benzene : ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.25 (d, *J* = 8.12 Hz, 1H), 8.15 (d, *J* = 8.48 Hz, 1H), 7.53 (d, *J* = 8.44 Hz, 1H), 7.47 (s, 1H), 7.38 (s, 1H), 7.34 (d, *J* = 8.12 Hz, 1H), 2.40(s, 3H), 2.28(s, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 146.36, 139.65, 137.16, 136.72, 136.17, 135.20, 133.20, 131.99, 129.27, 128.64, 128.47, 120.87, 21.26, 20,00. m.p.101.1-101.8 ℃.

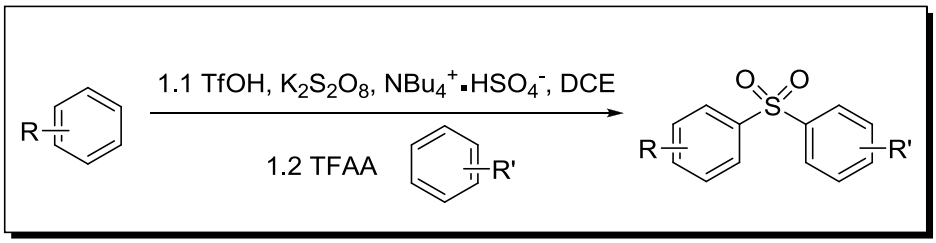


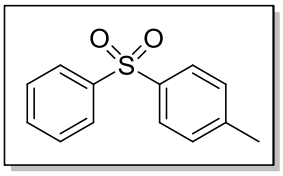
4,4'-sulfonylbis(2-bromo-1-methylbenzene)(22a) and **4,4'-sulfonylbis(1-bromo-2-methylbenzene)(22b):** $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), 1-bromo-2-methylbenzene (121 ul), TFAA (300 ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 70 ℃ for 6 h. After observing obvious product spots on the TLC （Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 20 : 1）to get 92 mg 4,4'-sulfonylbis(2-bromo-1-methylbenzene) which is a kind of white solid with 57% yield and 56 mg 4,4'-sulfonylbis(1-bromo-2- methylbenzene) which is also a kind of white solid with 35% yield at the same time. For 4,4'-sulfonylbis(2-bromo-1-methylbenzene) : ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.76 (d, *J* = 1.08 Hz, 2H), 7.65 (d, *J* = 8.48 Hz, 2H), 7.59 (dd, *J* = 8.46 Hz , *J* = 1.58 Hz 2H), 2.43 (s, 6H) ; ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 140.46, 139.96, 133.57, 131.20, 129.50, 126.41, 29.80. m.p.1112-113.2 ℃; For 2-bromo-1-(4-bromo-2-methyl phenylsulfonyl)-4-methylbenzene : ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.07（s, 2H）, 7.75 (d, *J* = 8.00 Hz, 2H), 7.36 (d, *J* = 7.96 Hz, 2H), 2.44(s, 6H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 144.33, 140.30, 131.55, 131.33, 126.41, 125.61, 23.21. m.p.104.5-105.0 ℃.



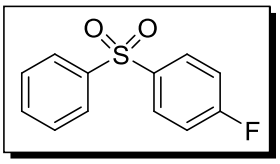
4,4'-sulfonylbis(3-bromo-1-methoxybenzene)(23a), 2-bromo-1-(4-bromo-2-methoxy phenylsulfonyl)-4-methoxybenzene(23b) and **4,4'-sulfonylbis(1-bromo-3-methoxy benzene)(23c):** $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), 1-bromo- 3-methoxybenzene (1.0 mmol, 126 ul), TFAA (300 ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at r.t. for 6 h. After observing obvious product spots on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 20 : 1）to get 70 mg 4,4'-sulfonylbis(3-bromo-1-methoxybenzene) which is a kind of white solid with 40% yield, 53 mg 2-bromo-1-(4-bromo-2-methoxyphenyl sulfonyl)-4-methoxybenzene which is a kind of white solid with 30% yield and 28mg 4,4'-sulfonylbis(1-bromo-3-methoxy which is also a kind of white solid with 16% yield at the same time. For 4,4'- sulfonylbis(3-bromo-1-methoxybenzene) : ^{1}H-NMR (400 MHz, CDCl3) δ (ppm) 8.41 (d, *J* = 8.92 Hz, 2H), 7.12(d, *J* = 2.04 Hz, 2H), 6.99 (dd, *J* = 8.96 Hz, *J* = 2.04 Hz, 2H), 3.85 (s, 6H); ^{13}C-NMR (100 MHz, CDCl3) δ (ppm) 163.74, 135.40, 130.93, 121.95, 120.57, 112.59, 56.08; LRMS (ESI) calcd for $C_{14}H_{13}Br_2N_2O_4S$ $[M+H]^+$: 434.88, found 435.03. m.p.123.5-126.1 ℃. For 2-bromo-1-(4-bromo-2-methoxyphenyl sulfonyl)-4-methoxy benzene : ^{1}H-NMR (400 MHz, CDCl3) δ (ppm) 8.22（d, *J* = 8.92 Hz, 1H）, 8.02(d, *J* = 8.44 Hz, 1H), 7.20(d, *J* = 9.88 Hz, 1H), 7.03 (d, *J* = 2.24 Hz, 1H), 6.96 (s, 1H), 6.91(dd, *J* = 8.92 Hz, *J* = 2.24 Hz, 1H), 3.79(s, 3H), 3.60(s, 3H); ^{13}C-NMR (100 MHz, CDCl3) δ (ppm) 163.57, 157.25, 134.42, 133.10,

131.81, 129.92, 127.17, 123.66, 121.89, 120.25, 116.02, 112.74, 56.41, 56.06. LRMS (ESI) calcd for $C_{14}H_{13}Br_2N_2O_4S$ $[M+H]^+$: 434.88, found 435.03. m.p.144.2-145.4 ℃. For 4,4'-sulfonylbis (1-bromo-3-methoxy) : ^{1}H-NMR (400 MHz, CDCl3) δ (ppm) 7.92 (d, *J* = 8.40 Hz, 2H), 7.67 (d, *J* = 7.60 Hz, 2H), 6.96 (s, 2H), 3.62 (s, 6H) ; ^{13}C-NMR (100 MHz, CDCl3) δ (ppm) 157.51, 132.44, 129.66, 127.97, 123.57, 115.98, 56.47. LRMS (ESI) calcd for $C_{14}H_{13}Br_2N_2O_4S$ $[M+H]^+$: 434.88, found 435.03. m.p.202.6-205.7 ℃.





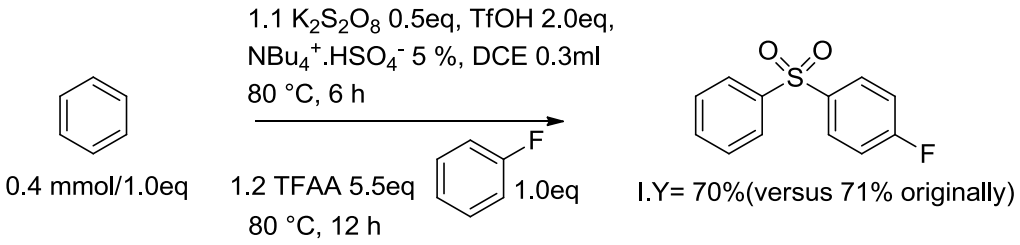
1-methyl-4-(phenylsulfonyl)benzene(24): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), toluene (0.4 mmol, 36ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 50 ℃ for 5h. Then TFAA(300ul) and benzene (0.6 mmol, 64ul) were added, stirring for another 5h at 40℃. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 20 : 1）to get 52 mg 1-methyl-4-(phenylsulfonyl)benzene which is a kind of white solid with 56% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.92 (d, *J* = 7.72Hz, 2H), 7.36(d, *J* = 7.60Hz, 2H)， 7.50(m, 3H)，7.28(d, *J* = 7.76 Hz, 2H), 2.37(s, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 144.23, 142.03,138.69, 133.06, 129.97, 129.33, 127.67, 127.57, 21.58. LRMS (ESI) calcd for $C_{13}H_{13}O_2S$ $[M+H]^+$: 233.06, found 233.24. m.p.104.4-108.7 ℃.

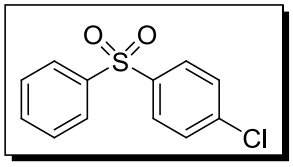


1-fluoro-4-(phenylsulfonyl)benzene(25): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), benzene (0.4 mmol, 36ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 80 ℃ for 5h. Then TFAA(300ul) and fluorobenzene (0.6 mmol, 64ul) were added, stirring for another 5h at 80℃. After observing an obvious product spot on the TLC （Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 20 : 1） to get 67 mg 1-fluoro-4-(phenylsulfonyl)benzene which is a kind of white solid

with 71% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.94 – 7.92 (m, 4H), 7.36(t, J = 7.36Hz, 1H)，7.51(t, J = 7.20 Hz, 2H)，7.17(t, J = 8.24 Hz, 2H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 165.56(d, J_{C-F} = 254.36 Hz), 141.59, 137.85(d, J_{C-F} = 3.07 Hz), 133.44, 130.58(d, J_{C-F} = 9.51 Hz), 129.49, 127.68, 116.71(d, J_{C-F} = 22.56 Hz). The spectrum data is in accordance with literature reported [6]. m.p.112.1-112.4 ℃.

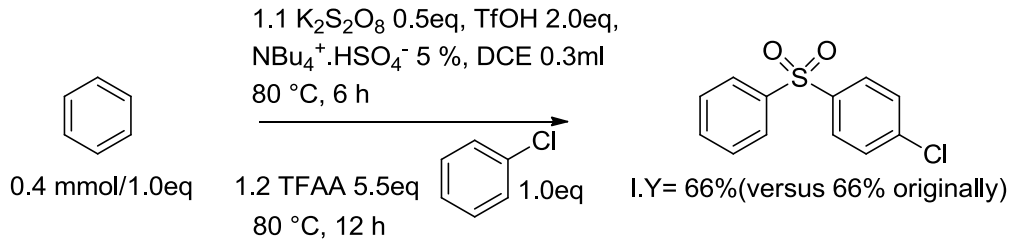
If the condition was instead as follow, the isolated yield is 70%.

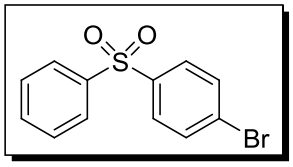




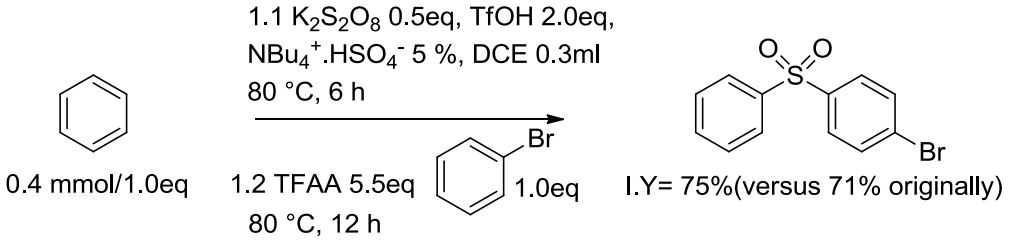
1-chloro-4-(phenylsulfonyl)benzene(26): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), benzene (0.4 mmol, 36ul) and TfOH (1.6 mmol, 138 ul) was added, the reaction was carried out at 80 ℃ for 6h. Then TFAA(300ul) and chlorobenzene (0.6 mmol, 62ul) were added, stirring for another 10h at 80℃. After observing an obvious product spot on the TLC （Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 20 : 1） to get 55 mg 1-chloro-4-(phenylsulfonyl)benzene which is a kind of white solid with 60% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.92 (d, J = 8.00 Hz, 2H), 7.87(d, J = 8.24Hz, 2H)，7.57(t, J = 7.24 Hz, 1H)，7.52 – 7.45(m, 4H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 141.31, 140.26, 139.98, 133.54, 129.71, 129.52, 129.22, 127.54. The spectrum data is in accordance with literature reported [4]. m.p.155.1-158.0 ℃.

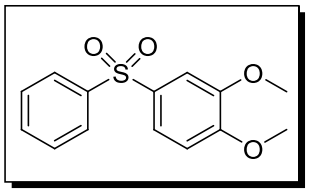
If the condition was instead as follow, the isolated yield is 66%.



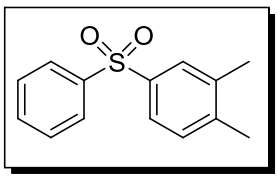


1-bromo-4-(phenylsulfonyl)benzene(27): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), benzene (0.4 mmol, 36ul) and TfOH (1.6 mmol, 138 ul) was added, the reaction was carried out at 80 ℃ for 6h. Then TFAA(300ul) and bromobenzene (0.6 mmol, 63ul) were added ,stirring for another 10h at 80℃. After observing an obvious product spot on the TLC （Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 20 : 1） to get 84 mg 1-bromo-4-(phenylsulfonyl)benzene which is a kind of white solid with 71% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.92 (d, *J* = 7.76 Hz, 2H), 7.89(d, *J* = 7.52Hz, 2H)，7.62 (d, *J* = 6.76 Hz, 2H)，7.56(t, *J* = 6.48 Hz, 1H), 7.53(d, *J* = 6.80 Hz, 2H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 141.24, 140.79, 133.58, 132.71, 129.54, 129.30, 128.55, 127.75. The spectrum data is in accordance with literature reported [5]. m.p.108.0-1110.1 ℃.
If the condition was instead as follow, the isolated yield is 75%.

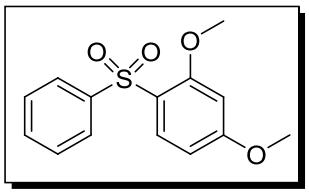




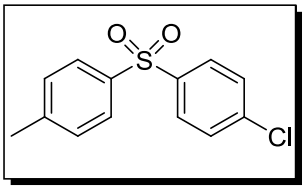
1,2-dimethoxy-4-(phenylsulfonyl)benzene(28): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), benzene (0.4 mmol, 36ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 80 ℃ overnight. Then TFAA(300ul) and 1,2-dimethoxybenzene (0.6 mmol, 76ul) were added ,stirring for another 5h at room temperature. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 10 : 1） to get 70 mg 1,2-dimethoxy -4-(phenylsulfonyl)benzene which is a kind of white solid with 63% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.90 (d, *J* = 7.44 Hz, 2H), 7.56 – 7.45 (m, 4H)，7.37(s, 1H), 6.91(d, *J* = 8.48 Hz, 1H), 3.89(s, 6H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 153.16, 149.38, 142.37, 133.19, 132.97, 129.30, 127.34, 122.02, 110.98, 110.04, 56.35, 56.29. LRMS (ESI) calcd for $C_{14}H_{15}O_4S$ $[M+H]^+$: 279.06, found 278.96. m.p.114.8-115.7 ℃.



1,2-dimethyl-4-(phenylsulfonyl)benzene(29): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), benzene (0.6 mmol, 54ul) and TfOH (1.6 mmol, 138 ul) was added, the reaction was carried out at 85 ℃ for 6h. Then TFAA(300ul) and 1,2-dimethylbenzene (0.4 mmol, 49ul) were added ,stirring for another 3h at 40℃. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography （Hexane : EtOAc = 10 : 1） to get 75 mg 1,2-dimethyl-4-(phenylsulfonyl)benzene which is a kind of white solid with 76% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.93 (d, *J* = 7.00 Hz, 2H), 7.69 – 7.66 (m, 2H)，7.53 – 7.51 (m, 3H)，7.24(d, *J* = 7.44 Hz, 2H), 2.28(s, 6H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 143.01, 142.16, 138.77, 138.18, 133.01, 130.48, 129.27, 128.48, 127.52, 125.31, 20.03, 19.90. LRMS (ESI) calcd for $C_{14}H_{15}O_2S$ $[M+H]^+$: 247.07, found 247.01. m.p.107.8-111.2 ℃.

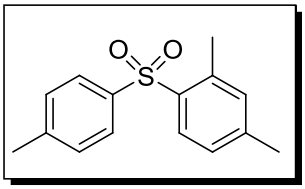


2,4-dimethoxy-1-(phenylsulfonyl)benzene(30): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), benzene (0.4 mmol, 36ul) and TfOH (0.8 mmol, 71 ul) was added, the reaction was carried out at 80 ℃ overnight. Then TFAA(300ul) and 1,3-dimethoxybenzene (0.6 mmol, 76ul) were added ,stirring for another 5h at room temperature. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography （Hexane : EtOAc = 10 : 1） to get 59 mg 2,4-dimethoxy -1-(phenylsulfonyl)benzene which is a kind of white solid with 53% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.06 (d, *J* = 8.80 Hz, 1H), 7.92 (d, *J* = 7.92 Hz, 2H)，7.52(t, *J* = 7.40 Hz, 1H), 7.45(t, *J* = 7.12 Hz, 2H), 6.57(d, *J* = 7.92 Hz, 2H), 6.37(s, 1H), 3.82(s, 3H), 3.71(s, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 165.75, 158.75, 142.22, 132.71, 131.81, 128.54, 128.16, 121.43, 104.77, 99.55, 55.94, 55.84. LRMS (ESI) calcd for $C_{14}H_{15}O_4S$ $[M+H]^+$: 279.06, found 278.96. m.p.118.3-118.9 ℃.

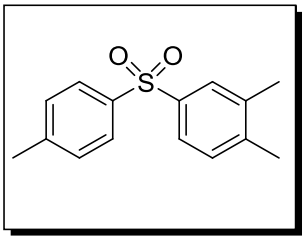


1-chloro-4-tosylbenzene(31): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), toluene (0.4 mmol, 43ul) and TfOH (1.6 mmol, 138 ul) was added, the reaction was carried out at 50 ℃ for 4h. Then TFAA(300ul) and chlorobenzene (0.6 mmol, 62ul) were added ,stirring for another 3h at 70℃. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1

as the eluent), the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography (Hexane : EtOAc = 10 : 1) to get 71 mg 1-chloro-4-tosylbenzene which is a kind of white solid with 66% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.85 (d, *J* = 8.32 Hz, 2H), 7.80 (d, *J* = 8.00 Hz, 2H), 7.44 (d, *J* = 8.32 Hz, 2H), 7.29(d, *J* = 8.00 Hz, 2H), 2.39(s, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 144.60, 140.66, 139.72, 138.34, 130.13, 129.62, 129.06, 127.79. The spectrum data is in accordance with literature reported [4]. m.p.119.1-120.0 ℃.

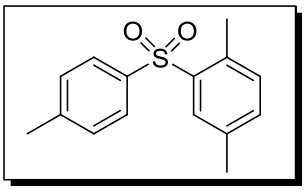


2,4-dimethyl-1-tosylbenzene(32): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), toluene (0.4 mmol, 43ul) and TfOH (1.1 mmol, 100 ul) was added, the reaction was carried out at 50 ℃ for 6h. Then TFAA(300ul) and 1,3-dimethylbenzene (0.6 mmol, 62ul) were added ,stirring overnight at room temperature.. After observing an obvious product spot on the TLC(Hexane : EtOAc = 10 : 1 as the eluent), the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography (Hexane : EtOAc = 10 : 1) to get 80 mg 2,4-dimethyl-1-tosylbenzene which is a kind of white solid with 77% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.07 (d, *J* = 8.08 Hz, 1H), 7.43 (d, *J* = 8.16 Hz, 2H), 7.26 (d, *J* = 7.96 Hz, 2H), 7.16(d, *J* = 8.04 Hz, 1H), 7.02(s, 1H), 2.40(s, 3H), 2.38(s, 3H), 2.34(s,3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 144.32, 143.79, 138.76, 137.73, 136.34, 133.40, 129.64, 129.51, 127.63, 127.08, 21.58, 21.35, 20.13. LRMS (ESI) calcd for $C_{15}H_{17}O_2S$ $[M+H]^+$: 261.09, found 261.17. m.p.46.1-48.2 ℃.

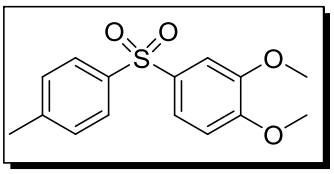


1,2-dimethyl-4-tosylbenzene(33): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), toluene (0.4 mmol, 43ul) and TfOH (1.6 mmol, 138 ul) was added, the reaction was carried out at 60 ℃ for 4h. Then TFAA(300ul) and 1,2-dimethylbenzene (0.6 mmol, 64ul) were added ,stirring for another 4h at room temperature.. After observing an obvious product spot on the TLC (Hexane : EtOAc = 10 : 1 as the eluent), the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography (Hexane : EtOAc = 10 : 1) to get 84 mg 1,2-dimethyl-4-tosylbenzene which is a kind of white solid with 81% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.80 (d, *J* = 8.16 Hz, 2H), 7.67 (s, 1H), 7.65 (d, *J* = 8.04 Hz, 1H), 7.27(d, *J* = 8.00 Hz, 2H), 7.23(d, *J* = 7.84 Hz, 1H), 2.38(s, 3H),

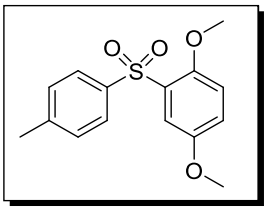
2.27(s,6H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 143.92, 142.76, 139.32, 139.26, 138.11, 130.44, 129.92, 128.39, 127.63, 125.19, 21.63, 20.02, 19.91. LRMS (ESI) calcd for $C_{15}H_{17}O_2S$ $[M+H]^+$: 261.09, found 261.17. m.p.121.2-123.0 ℃[20].



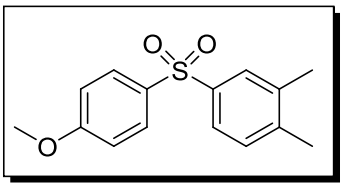
1,4-dimethyl-2-tosylbenzene(34): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), toluene (0.4 mmol, 43ul) and TfOH (1.6 mmol, 138 ul) was added, the reaction was carried out at 60 ℃ for 4h. Then TFAA(300ul) and 1,4-dimethylbenzene (0.6 mmol, 74ul) were added ,stirring overnight at room temperature.. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 10 : 1） to get 61 mg 1,4-dimethyl-2-tosylbenzene which is a kind of white solid with 58% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.02 (s, 1H), 7.73 (d, *J* = 8.12 Hz, 2H), 7.28 – 7.24 (m, 3H)，7.08(d, *J* = 7.68 Hz, 1H), 2.40(s, 3H), 2.37(s, 6H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 143.89, 138.80, 138.57, 136.42, 134.72, 134.23, 132.63, 129.66, 129.61, 127.69, 21.59, 20.93, 19.73. LRMS (ESI) calcd for $C_{15}H_{17}O_2S$ $[M+H]^+$: 261.09, found 261.17. m.p.104.0-105.7 ℃.



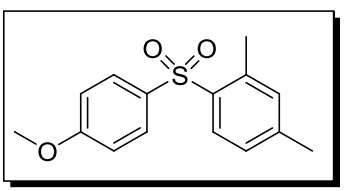
1,2-dimethoxy-4-tosylbenzene(35): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), toluene(0.4 mmol, 43ul) and TfOH (1.6 mmol, 138 ul) was added, the reaction was carried out at 60 ℃ for 4h. Then TFAA(300ul) and 1,2-dimethoxybenzene (0.6 mmol, 76ul) were added ,stirring for another 4h at room temperature. After observing an obvious product spot on the TLC（Hexane : EtOAc = 5 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 10 : 1） to get 77 mg 1,2-dimethoxy-4-tosylbenzene which is a kind of white solid with 66% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.81 (d, *J* = 7.80 Hz, 2H), 7.55 (d, *J* = 8.24 Hz, 1H)，7.38(s, 1H), 7.28(d, *J* = 7.68 Hz, 2H), 6.92(d, *J* = 7.68 Hz, 1H), 3.90(s, 6H), 2.38(s, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 152.97, 149.30, 143.86, 139.39, 133.58, 129.90, 127.36, 121.76, 110.92, 109.88, 56.29, 56.24, 21.56. LRMS (ESI) calcd for $C_{15}H_{17}O_4S$ $[M+H]^+$: 293.08, found 293.16. m.p.127.2-130.6 ℃.



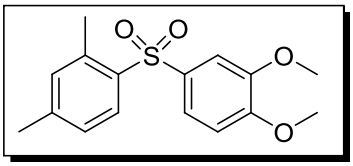
1,4-dimethoxy-2-tosylbenzene(36): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), toluene(0.4 mmol, 43ul) and TfOH (1.6 mmol, 138 ul) was added, the reaction was carried out at 60 ℃ for 4h. Then TFAA(300ul) and 1,4-dimethoxybenzene (0.6 mmol, 83mg) were added ,stirring for another 4h at room temperature. After observing an obvious product spot on the TLC（Hexane : EtOAc = 5 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography （Hexane : EtOAc = 10 : 1） to get 76 mg 1,4-dimethoxy-2-tosylbenzene which is a kind of white solid with 65% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.84 (d, *J* = 8.16 Hz, 2H), 7.67 (d, *J* = 3.04 Hz, 1H)，7.27(s, 1H), 7.28(d, *J* = 8.08 Hz, 2H), 7.05(dd, *J* = 9.00 Hz, *J* = 3.08 Hz, 1H), 6.83(d, *J* = 9.00 Hz, 1H), 3.83(s, 3H), 3.70(s, 3H), 2.40(s, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 153.26, 151.17, 143.86, 138.47, 129.87, 129.13, 128.41, 121.39, 114.35, 113.83, 56.52, 56.07, 21.56. LRMS (ESI) calcd for $C_{15}H_{17}O_4S$ $[M+H]^+$: 293.08, found 293.16. m.p.84.3-86.1 ℃.



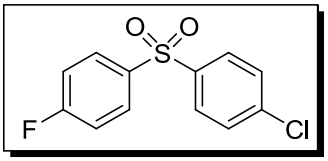
4-(4-methoxyphenylsulfonyl)-1,2-dimethylbenzene(37): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), anisole(0.4 mmol, 43ul) and TfOH (1.6 mmol, 138 ul) was added, the reaction was carried out at room temperature for 4h. Then TFAA(300ul) and *o*-xylene (0.6 mmol, 73ul) were added ,stirring overnight at room temperature. After observing an obvious product spot on the TLC（Hexane : EtOAc = 5 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 10 : 1） to get 59 mg 4-(4-methoxyphenylsulfonyl)-1,2-dimethylbenzene which is a kind of white solid with 54% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.85 (d, *J* = 8.44 Hz, 2H), 7.66 (s, 1H)，7.63(d, *J* = 8.16 Hz, 1H), 7.21(d, *J* = 7.88 Hz, 1H), 6.94(d, *J* = 8.44 Hz, 2H), 3.82(s, 3H), 2.28(s, 6H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 163.28, 142.58, 139.66, 138.09, 133.84, 130.43, 129.78, 128.22, 125.01, 114.53, 55.72, 20.01, 19.92. LRMS (ESI) calcd for $C_{15}H_{17}O_3S$ $[M+H]^+$: 277.08, found 277,22. m.p.75-76 ℃.



1-(4-methoxyphenylsulfonyl)-2,4-dimethylbenzene(38): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), anisole(0.4 mmol, 43ul) and TfOH (1.6 mmol, 138 ul) was added, the reaction was carried out at room temperature for 4h. Then TFAA(300ul) and *o*-xylene (0.6 mmol, 73ul) were added ,stirring overnight at room temperature. After observing an obvious product spot on the TLC（Hexane : EtOAc = 5 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 10 : 1） to get 60 mg 1-(4-methoxyphenylsulfonyl)-2,4-dimethylbenzene which is a kind of white solid with 55% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.04 (d, *J* = 8.04 Hz, 1H), 7.77 (d, *J* = 8.72 Hz, 2H)，7.15(d, *J* = 8.00 Hz, 1H), 7.01(s, 1H), 6.93(d, *J* = 8.72 Hz, 1H), 3.82(s, 3H), 2.40(s, 3H), 2.33(s, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 163.16, 144.18, 137.60, 133.42, 133.25, 129.85, 129.37, 127.08, 114.27, 55.71, 21.36, 21.14. LRMS (ESI) calcd for $C_{15}H_{17}O_3S$ $[M+H]^+$: 277.08, found 277,15. m.p.124.7-125.8 ℃.

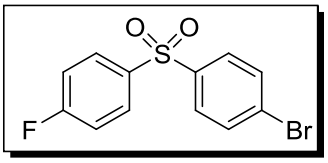


1-(3,4-dimethoxyphenylsulfonyl)-2,4-dimethylbenzene(39): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), m-xylene(0.4 mmol, 43ul) and TfOH (1.6 mmol, 138 ul) was added, the reaction was carried out at room temperature for 4h. Then TFAA(300ul) and 1,2-dimethoxybenzene (0.6 mmol, 73ul) were added ,stirring overnight at room temperature. After observing an obvious product spot on the TLC（Hexane : EtOAc = 5 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 10 : 1） to get 86 mg 1-(3,4-dimethoxyphenyl sulfonyl)-2,4-dimethylbenzene which is a kind of white solid with 71% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.01 (d, *J* = 8.08 Hz, 1H), 7.44 (d, *J* = 8.36 Hz, 1H)，7.30(s, 1H), 7.15(d, *J* = 8.04 Hz, 1H), 7.02(s, 1H), 6.89(d, *J* = 8.48 Hz, 1H), 3.89(s, 3H), 3.87(s, 3H), 2.42(s, 3H), 2.34(s, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 152.85, 149.11, 144.21, 137.65, 136.65, 133.47, 133.31, 129.35, 127.10, 121.84, 110.65, 110.10, 56.30, 56.27, 21.37, 20.19. LRMS (ESI) calcd for $C_{16}H_{19}O_4S$ $[M+H]^+$: 307.09, found 307.19. m.p.118.5-120.7 ℃.

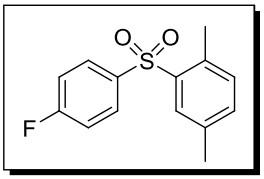


1-chloro-4-(4-fluorophenylsulfonyl)benzene(40): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), fluorobenzene (0.4 mmol, 38ul) and TfOH (1.0 mmol, 88 ul) was added, the reaction was carried out at 80 ℃ for 4h. Then TFAA(300ul) and fluorobenzene (0.6 mmol, 64ul) were added, stirring overnight at 60℃. After observing an obvious product spot on

the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography （Hexane : EtOAc = 20 : 1） to get 72 mg 1-chloro-4-(4-fluorophenylsulfonyl)benzene which is a kind of white solid with 66% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.94 (dd, *J* = 7.84Hz, *J* = 5.28Hz 2H), 7.85(d, *J* = 8.16Hz, 2H)，7.29(d, *J* = 8.24 Hz, 1H)，7.18(t, *J* = 8.48 Hz, 2H), 7.13(d, *J* = 8.28 Hz, 2H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 165.66(d, J_{C-F} = 255.12 Hz), 140.14, 140.10, 137.38(d, J_{C-F} = 3.14 Hz), 130.60(d, J_{C-F} = 9.50 Hz), 129.81, 129,14, 116.86(d, J_{C-F} = 23.46 Hz). m.p.110.2-111.0 ℃.

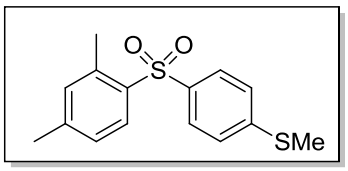


1-bromo-4-(4-fluorophenylsulfonyl)benzene(41): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), bromobenzene (0.4 mmol, 43ul) and TfOH (1.6 mmol, 138 ul) was added, the reaction was carried out at 80 ℃ for 5h. Then TFAA(300ul) and fluorobenzene (0.6 mmol, 64ul) were added, stirring for another 3h at 80℃. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography （Hexane : EtOAc = 20 : 1） to get 107 mg 1-bromo-4-(4-fluorophenylsulfonyl)benzene which is a kind of white solid with 86% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.94 (dd, *J* = 7.60 Hz, *J* = 5.32Hz, 2H), 7.85(d, *J* = 7.96Hz, 2H)，7.63(d, *J* = 8.00 Hz, 1H)，7.18(t, *J* = 8.20 Hz, 2H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 165.69(d, J_{C-F} = 255.12 Hz), 140.65, 137.35(d, J_{C-F} = 3.12 Hz), 132.82, 130.62(d, J_{C-F} = 9.58 Hz), 129.22, 128.73, 116.89(d, J_{C-F} = 23.36 Hz). m.p.101.5-102.2 ℃.

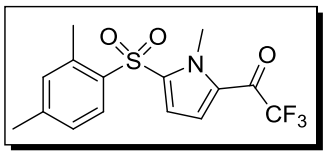


2-(4-fluorophenylsulfonyl)-1,4-dimethylbenzene(42): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), p-xylene (0.4 mmol, 50ul) and TfOH (1.0 mmol, 89 ul) was added, the reaction was carried out at 40 ℃ for 5h. Then TFAA(300ul) and fluorobenzene (0.6 mmol, 57ul) were added, stirring for another 5h at 80℃. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 20 : 1） to get 64 mg 2-(4-fluorophenylsulfonyl)-1,4-dimethylbenzene which is a kind of white solid with 60% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.02 (s, 1H), 7.88(dd, *J* = 8.36Hz, *J* = 5.16Hz 2H)，7.29(d, *J* = 7.52 Hz, 1H)，7.17(t, *J* = 8.48 Hz, 2H), 7.13(d, *J* = 7.76 Hz,

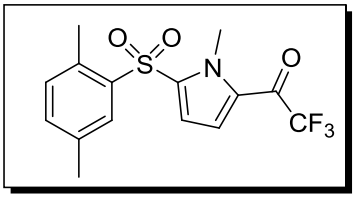
1H)，2.41（s, 3H）, 2.38(s, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 165.32(d, J_{C-F} = 253.12 Hz), 138.35, 137.62(d, J_{C-F} = 3.09 Hz), 136.70, 134.77, 134.60, 132.81, 130.49(d, J_{C-F} = 9.43 Hz), 129.75, 116.38(d, J_{C-F} = 22.24 Hz), 20.98, 19.79. m.p.109.7-111.3 ℃.



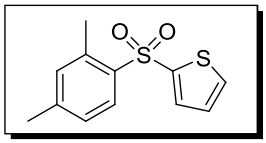
(4-((2,4-dimethylphenyl)sulfonyl)phenyl)(methyl)sulfane(43): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), m-xylene (0.4 mmol, 52ul)， TfOH (1.0 mmol, 90 ul) and TFAA(300ul) were added, the reaction was carried out at 50 ℃ for 1h. Then methyl(phenyl)sulfanee (0.8 mmol, 94ul) were added ,stirring 6 h at room temperature. After observing an obvious product spot on the TLC（Hexane : EtOAc = 8 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 10 : 1） to get 80 mg (4-((2,4-dimethylphenyl) sulfonyl)phenyl)(methyl)sulfane which is a kind of white solid with 53% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 8.06 (d, *J* = 8.08 Hz, 1H), 7.72 (d, *J* = 8.40 Hz, 2H)，7.25(d, *J* = 8.36 Hz, 2H), 7.01(s, 1H), 7.17(d, *J* = 8.00 Hz, 1H), 7.02(s, 1H), 2.47(s, 3H), 2.40 (s, 3H)，2.34(s, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 146.17, 144.40, 137.63, 137.21, 136.16, 133.41, 129.43, 127.88, 127.11, 125.20, 20.13, 14.73. LRMS (ESI) calcd for $C_{15}H_{17}O_2S_2$ $[M+H]^+$: 293.06, found 293.32. m.p.93.1-95.2 ℃.



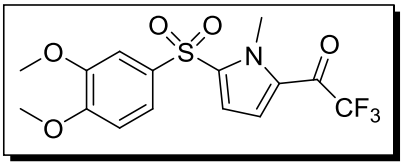
1-(5-(2,4-dimethylphenylsulfonyl)-1-methyl-1H-pyrrol-2-yl)-2,2,2-trifluoroethanone(44): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), 2,2,2-trifluoro-1-(1-methyl-1H-pyrrol-2-yl)ethanone (0.6 mmol, 107mg) and TfOH (1.6 mmol, 138 ul) was added, the reaction was carried out at 50 ℃ overnight. Then TFAA(300ul) and *m*-xylene (0.4 mmol, 51ul) were added, stirring for another 3h at 40 ℃. After observing an obvious product spot on the TLC （Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 20 : 1） to get 89 mg 1-(5-(2,4-dimethylphenylsulfonyl)-1-methyl-1H-pyrrol-2-yl)-2,2,2 -trifluoroethanone which is a kind of white solid with 65% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.98 (dd, *J* = 8.08 Hz, *J* = 1.04 H, 1H), 7.51(s, 1H)，7.41(s, 1H)，7.15(d, *J* = 1.04 H, 1H)，7.06(s, 1H), 3.97(s, 1H), 2.52(s, 3H), 2.35(s, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 171.17(q, *J* = 36.62 Hz), 144.67, 137.42, 136.82, 134.86, 133.55, 129.00, 127.39, 126.84, 125.21, 122.15(q, *J* = 3.81 Hz), 116.37(q, *J* = 288.56 Hz), 38.83, 21.37, 20.19. LRMS (ESI) calcd for $C_{15}H_{15}F_3NO_3S$ $[M+H]^+$: 346.06, found 345.98. m.p.118.7-120.7 ℃.



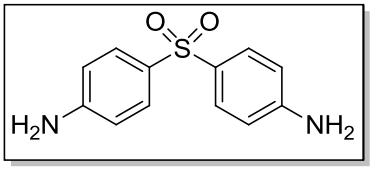
1-(5-(2,5-dimethylphenylsulfonyl)-1-methyl-1H-pyrrol-2-yl)-2,2,2-trifluoroethanone(45): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), 2,2,2-trifluoro-1-(1-methyl-1H-pyrrol-2-yl)ethanone (0.6 mmol, 107mg) and TfOH (1.6 mmol, 138 ul) was added, the reaction was carried out at 50 ℃ overnight. Then TFAA(300ul) and *p*-xylene (0.4 mmol, 51ul) were added, stirring for another 3h at 40 ℃. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 20 : 1） to get 88 mg 1-(5-(2,5-dimethylphenylsulfonyl)-1-methyl-1H-pyrrol-2-yl)-2,2,2-trifluoroethanone which is a kind of white solid with 64% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.86 (s, 1H), 7.44(s, 1H)，7.37(s, 1H)，7.20(d, *J* = 7.72 H, 1H)，7.06(d, *J* = 7.72 H, 1H), 3.91(s, 1H), 2.44(s, 3H), 2.31(s, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 171.20(q, *J* = 36.36 Hz), 139.29, 136.81, 134.89, 134.45, 132.78, 129.10, 126.67, 125.24, 122.20(q, *J* = 3.88 Hz), 116.35(q, *J* = 293.26 Hz), 38.82, 20.92, 19.79. LRMS (ESI) calcd for $C_{15}H_{15}F_3NO_3S$ $[M+H]^+$: 346.06, found 345.98. m.p.117.6-118.3 ℃.



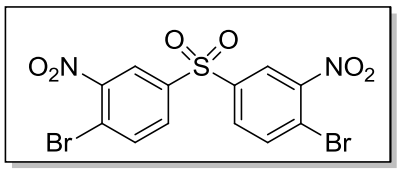
2-(2,4-dimethylphenylsulfonyl)thiophene(46): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), *m*-xylene (0.4 mmol, 46ul) and TfOH (0.4 mmol, 36 ul) was added, the reaction was carried out at 50 ℃ for 5h. Then TFAA(300ul) and thiophene (1.6 mmol, 128ul) were added, stirring for another 5h at room temperature. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 20 : 1） to get 47 mg 2-(2,4-dimethylphenylsulfonyl)thiophene which is a kind of white solid with 47% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.92 (d, *J* = 8.12 Hz, 1H), 7.65(d, *J* = 3.64Hz, 1H)，7.61(d, *J* = 4.92 Hz, 1H)，7.16(d, *J* = 4.92 Hz, 1H)， 7.06（m, 2H）, 2.55(s, 3H), 2.36(s, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 144.68, 143.61, 137.98, 136.96, 133.55, 133.24, 133.09, 129.33, 127.46, 127.38. LRMS (ESI) calcd for $C_{12}H_{13}O_2S_2$ $[M+H]^+$: 253.03, found 252.98. m.p.116.1-116.7 ℃.



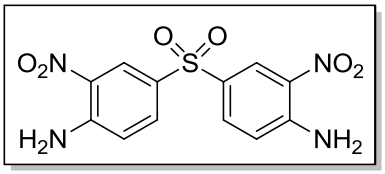
1-(5-(3,4-dimethoxyphenylsulfonyl)-1-methyl-1H-pyrrol-2-yl)-2,2,2-trifluoroetha none(47): $K_2S_2O_8$ (0.2 mmol, 54 mg) and $NBu_4^+.HSO_4^-$ (0.02 mmol, 6.8 mg) was added into a 10ml sealed tube charged with a magnetic bar, following that, DCE (0.3ml), 2,2,2-trifluoro-1-(1-methyl- 1H-pyrrol-2-yl)ethanone (0.6 mmol, 107mg) and TfOH (1.6 mmol, 138 ul) was added, the reaction was carried out at 50 ℃ for 5h. Then TFAA(300ul) and 1,2-dimethoxybenzene (0.4 mmol, 51ul) were added, stirring for another 5h at 40 ℃. After observing an obvious product spot on the TLC（Hexane : EtOAc = 10 : 1 as the eluent）, the reaction was quenched by brine solution, extract three times with DCM. Collect the organic phase to dry over anhydrous Na_2SO_4, which was removed under reduced pressure. The residual was purified by column chromatography（Hexane : EtOAc = 20 : 1） to get 80 mg 1-(5-(3,4-dimethoxyphenylsulfonyl)-1-methyl-1H- pyrrol-2-yl) -2,2,2-trifluoroethanone which is a kind of white solid with 53% yield. ^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm) 7.57 (d, *J* = 6.84 Hz, 1H), 7.52(s, 1H)，7.45(s, 1H)，7.39(s, 1H)， 6.95（d, *J* = 8.52 Hz, 1H）, 3.99(s, 3H), 3.93(s, 3H); ^{13}C-NMR (100 MHz, $CDCl_3$) δ (ppm) 177.02(q, *J* = 36.98 Hz), 153.32, 149.49, 134.38, 133.81, 127.59, 125.52, 121.78(q, *J* = 4.12 Hz), 121.42, 116.41(q, *J* = 288.56 Hz), 111.05, 109.54, 56.41, 56.35, 38.82. LRMS (ESI) calcd for $C_{15}H_{15}F_3NO_5S$ $[M+H]^+$: 378.05, found 377.96. m.p.119.1-123.6 ℃.



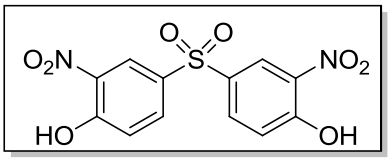
Dapsone: 4, 4'-sulfonylbis(bromobenzene) (6mmol, 2.3g) was added into a 50ml sealed tube followed by Cu_2O (0.1eq, 86mg), NH_3 (25% in H_2O, 13ml) and DMSO 20 ml. The mixture was heated at 90 ℃ for 20 h followed by extracting with EtOAc and washing with water. The organic phase was purified by column chromatography (from Hexane: EtOAc = 5: 1 to Hexane: EtOAc = 1 : 1) to get 1.5g Dapsone as white solid, the isolated yield is 98%. ^{1}H-NMR (400 MHz, d_6-acetone) δ (ppm) 7.56 (d, *J* = 8.48 H, 4H), 6.70 (d, *J* = 8.52 H, 4H), 5.43(s, 4H); ^{13}C-NMR (100 MHz, d_6-acetone) δ (ppm) 152.44, 130.17, 128.85, 113.23. LRMS (ESI) calcd for $C_{12}H_{13}N_2O_2S$ $[M+H]^+$: 248.16, found 249.21. m.p.173.5-175.0 ℃.



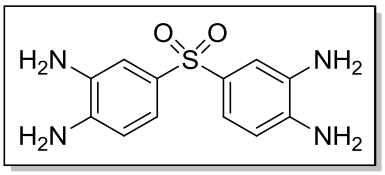
4,4'-sulfonylbis(1-bromo-2-nitrobenzene)(48): Add 4,4'-sulfonylbis(bromobenzene) (9mmol, 3.4g) into a 100ml round-bottom flask charged with a magnetic bar. After adding 40ml conc.H_2SO_4 and heating to 80℃，KNO_3（27mmol，3.7g）was added in several portions. After 3h, the mixture was poured into ice water, collect the appearing solid and dry under reduced pressure to give 4.3g 4,4'-sulfonylbis(1-bromo-2-nitrobenzene) with 91% isolated yield. ^{1}H-NMR (400 MHz, d_6-DMSO) δ (ppm) 8.69 (s, 2H), 8.21(s, 4H); ^{13}C-NMR (100 MHz, d_6-DMSO) δ (ppm) 150.09, 139.98, 136.74, 132.28, 125.03, 120.46. m.p.237.9-241.7 ℃.



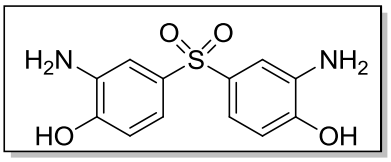
4,4'-sulfonylbis(2-nitroaniline)(49): Add 4,4'-sulfonylbis(1-bromo-2-nitrobenzene) (3mmol, 1.4g) into a 50ml round-bottom flask charged with a magnetic bar. After adding $NH_3 \cdot H_2O$ (25%, 1.5ml) and DMSO 6ml，the mixture was stirred at 50℃ for 3h. Add water and collect the appearing solid via filtration with suction giving 4,4'-sulfonylbis(2-nitroaniline) with quantitative yield. ^{1}H-NMR (400 MHz, d_6-DMSO) δ (ppm) 8.45 (d, J = 1.92 Hz, 2H), 8.08(s, 4H), 7.78(dd, J = 9.04 Hz, J = 2.08 Hz, 2H), 7.11(d, J = 9.04 Hz, 2H); ^{13}C-NMR (100 MHz, d_6-DMSO) δ (ppm) 148.68, 132.60, 129.17, 126.69, 126.32, 120.76. m.306.2-308.3 ℃



4,4'-sulfonylbis(2-nitrophenol)(50): Add 4,4'-sulfonylbis(1-bromo-2-nitrobenzene) (4mmol, 1.9g) into a 50ml round-bottom flask charged with a magnetic bar. After adding NaOH 1.3g，DMSO 10ml and H_2O 2.4ml，the mixture was stirred at 50℃ for 2h. Add dilute HCl solution and collect the appearing solid via filtration with suction giving 4,4'-sulfonylbis(2-nitrophenol) with quantitative yield. ^{1}H-NMR (400 MHz, d_6-DMSO) δ (ppm) 8.42 (d, J = 2.16 Hz, 2H), 8.04(dd, J = 8.84 Hz, J = 2.16 Hz, 2H), 7.26(d, J = 8.84 Hz, 2H); ^{13}C-NMR (100 MHz, d_6-DMSO) δ (ppm) 156.13, 137.21, 133.24, 130.55, 125.61, 120.46. m.234.9-235.8 ℃.



4,4'-sulfonylbis(benzene-1,2-diamine)(51): Add 4,4'-sulfonylbis(2-nitroaniline) (4mmol, 1.25g), Pd/C(10%wt, 67mg), EtOH 15ml and NH_2-$NH_2 \cdot H_2O$(20.0eq, 4ml) into a 50ml round-bottom flask charged with a magnetic bar under protection with Argon. After 24h under 60℃，the solvent was removed under reduced pressure to get the reddish-brown sticky product with 96% isolated yield. ^{1}H-NMR (400 MHz, d_6-DMSO) δ (ppm) 6.90 (d, J = 1.96 Hz, 2H), 6.85(dd, J = 8.12 Hz, J = 1.96 Hz, 2H), 6.52(d, J = 8.16 Hz, 4H), 5.26(s, 4H), 4.85(s, 2H; ^{13}C-NMR (100 MHz, d_6-DMSO) δ (ppm)139.45, 134.45, 129.80, 117.00, 112.51, 111.82. LRMS (ESI) calcd for $C_{12}H_{15}N_4O_2S$ $[M+H]^+$: 279.08, found 279.28.



4,4'-sulfonylbis(2-aminophenol)(52): Add 4,4'-sulfonylbis(2-nitrophenol) (3mmol, 1.1g), Pd/C(10%wt, 50mg), EtOH 4ml, 1,4-dioxane 6ml and NH_2-$NH_2 \cdot H_2O$(20.0eq, 3ml) into a 50ml

round-bottom flask charged with a magnetic bar under protection with Argon. After 24h under 95℃， the solvent was removed under reduced pressure to get the reddish-brown sticky product with 94% isolated yield. ^{1}H-NMR (400 MHz, d_6-DMSO) δ (ppm) 6.93 (d, J = 2.28 Hz, 2H), 8.86(dd, J = 8.20 Hz, J = 2.24 Hz, 2H), 6.64(d, J = 8.20 Hz, 2H); ^{13}C-NMR (100 MHz, d_6-DMSO) δ (ppm) 151.33, 137.89, 130.63, 116.48, 113.58, 111.05. LRMS (ESI) calcd for $C_{12}H_{13}N_2O_4S$ $[M-H]^-$: 279.05, found 279.18

References

[1] JOC,2007,72,5847-5850.

[2] Chemistry of Materials 2013, V25(13), P2630-2637

[3] Journal of Polymer Science, Part A: Polymer Chemistry 2005, V43(14), P2964-2976

[4] IJC-B Vol.44B(10) [October 2005], 2183-2185

[5] Chem. Mater.2013, 25, 2630−2637

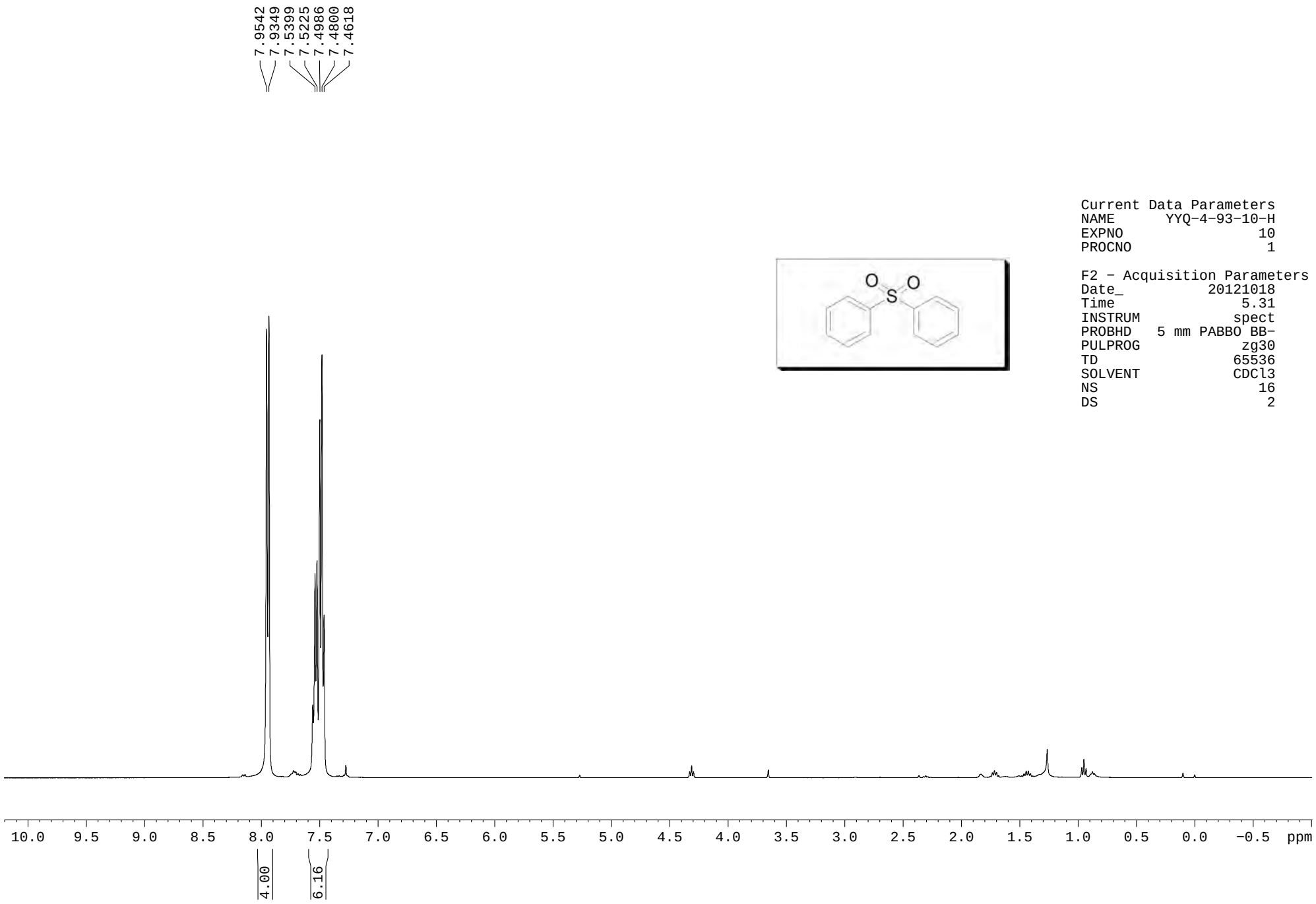
[6] Chemistry - A European Journal 2011, V17(20), P5652-5660.

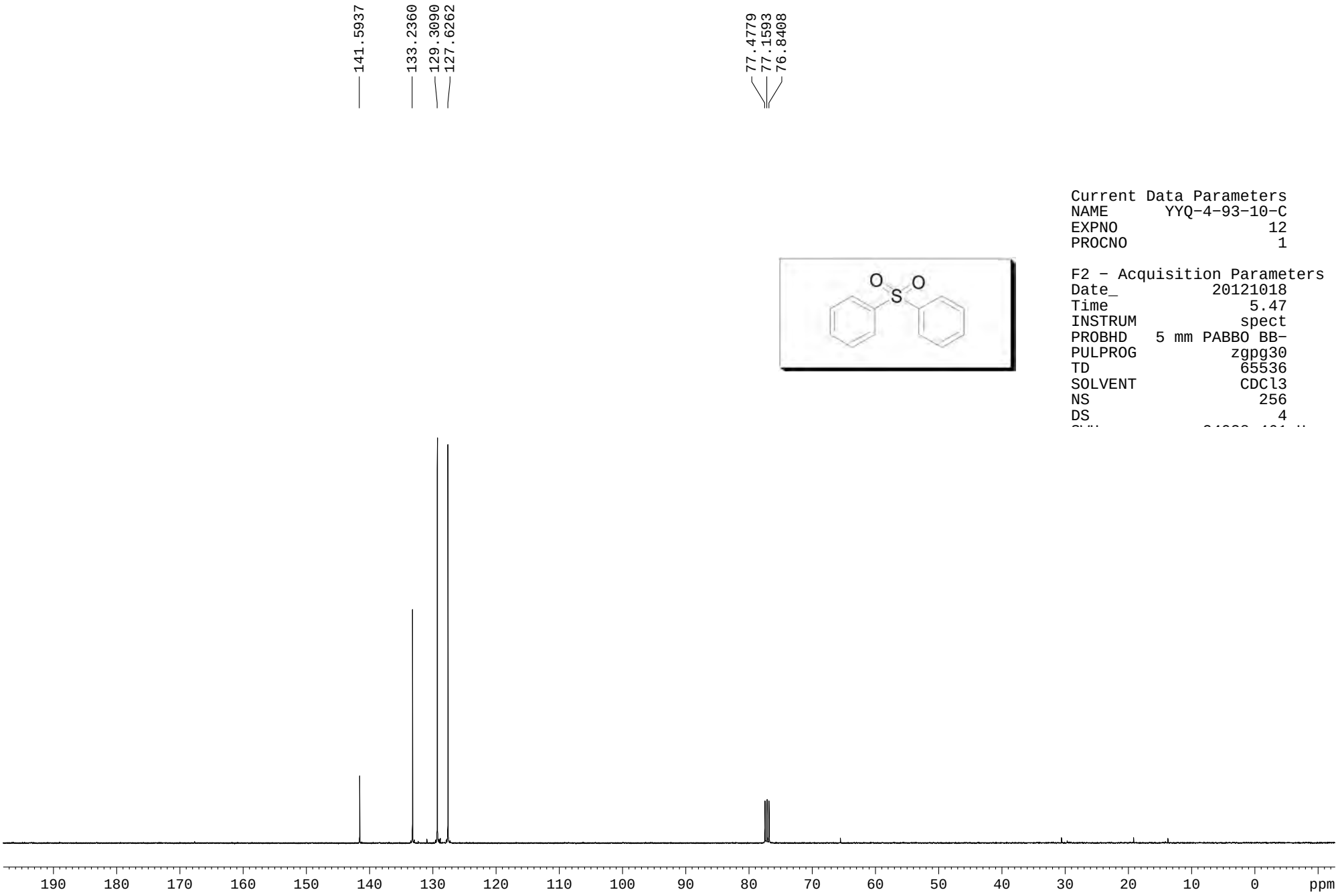
[7[Gesellschaft 1907, V40, P641-48.

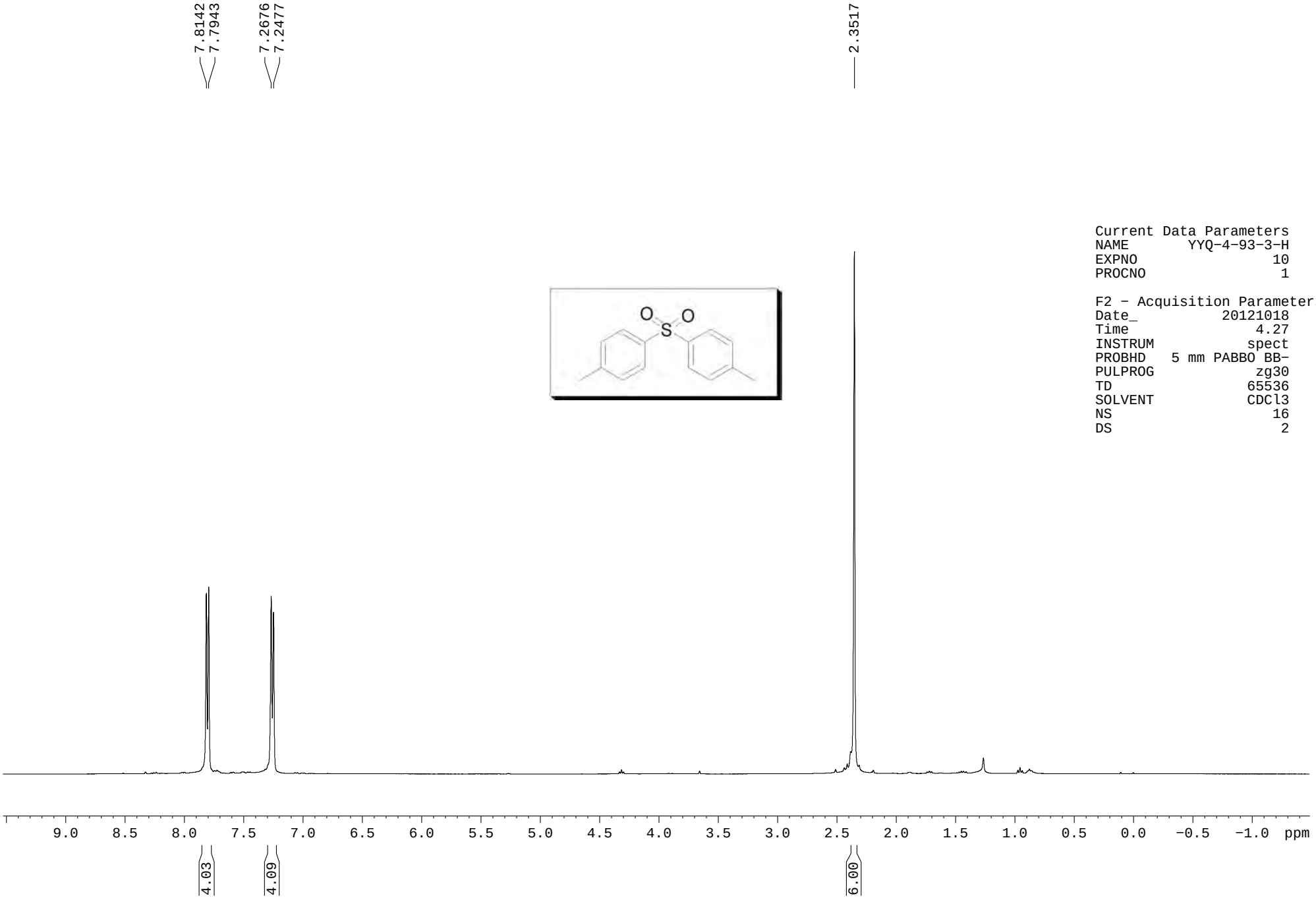
[8] Huchel, Uschi; Journal of Carbohydrate Chemistry 2010, V29(2).

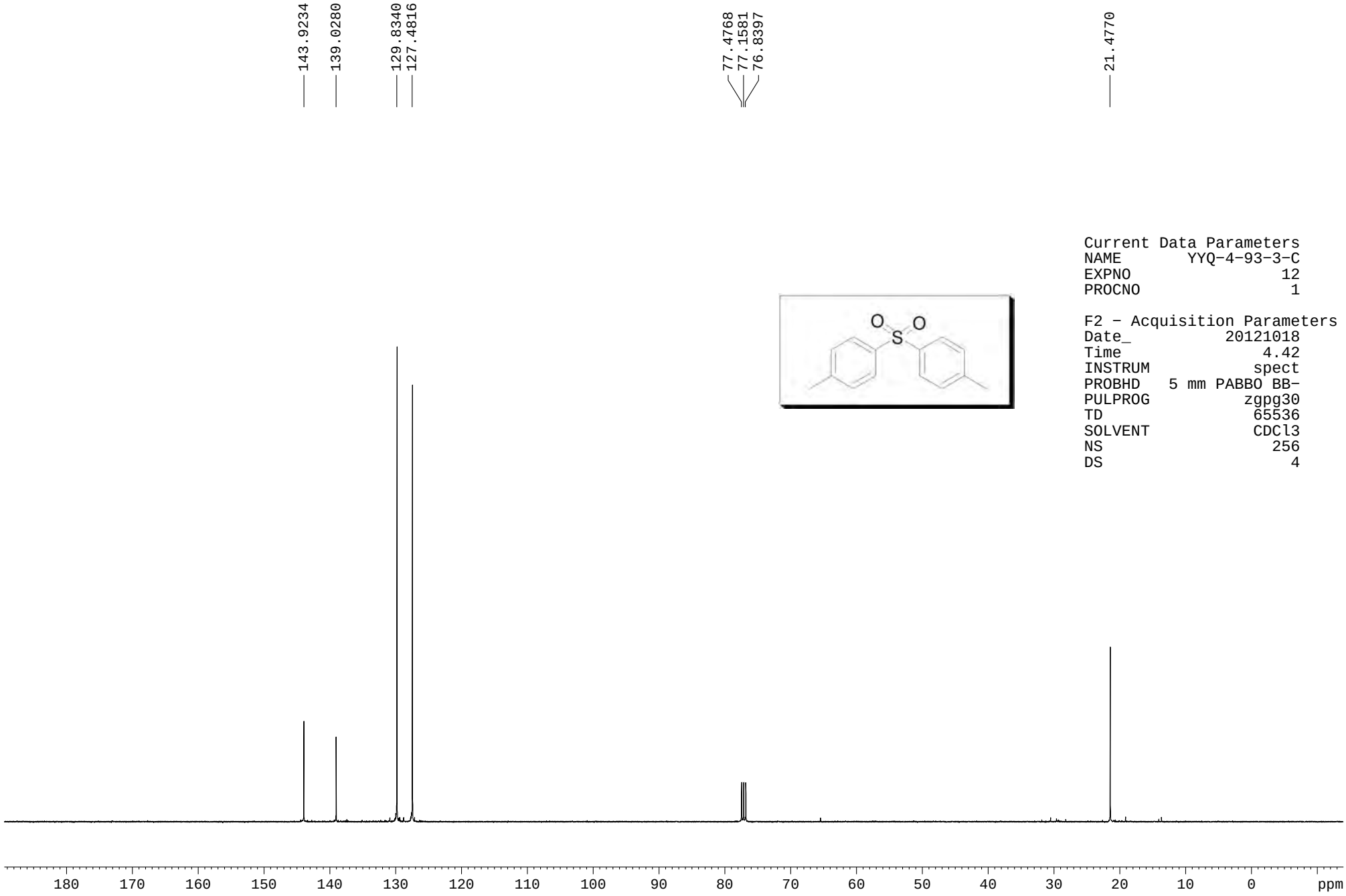
[9] Hang, Rui; Journal of the American Chemical Society 2009, V131(16),

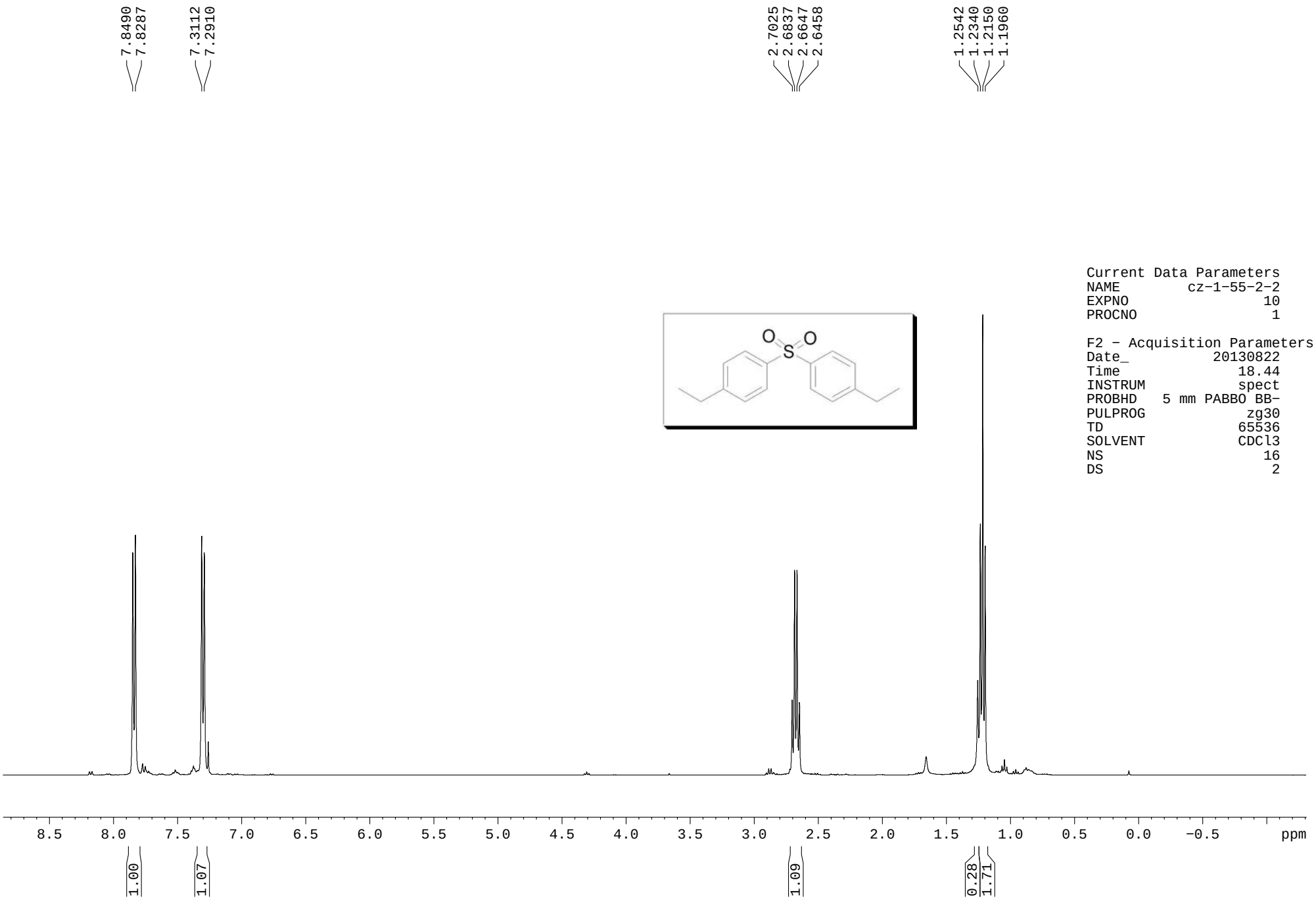
[10] Allen, Annette D.; Canadian Journal of Chemistry 1990, V68(10)

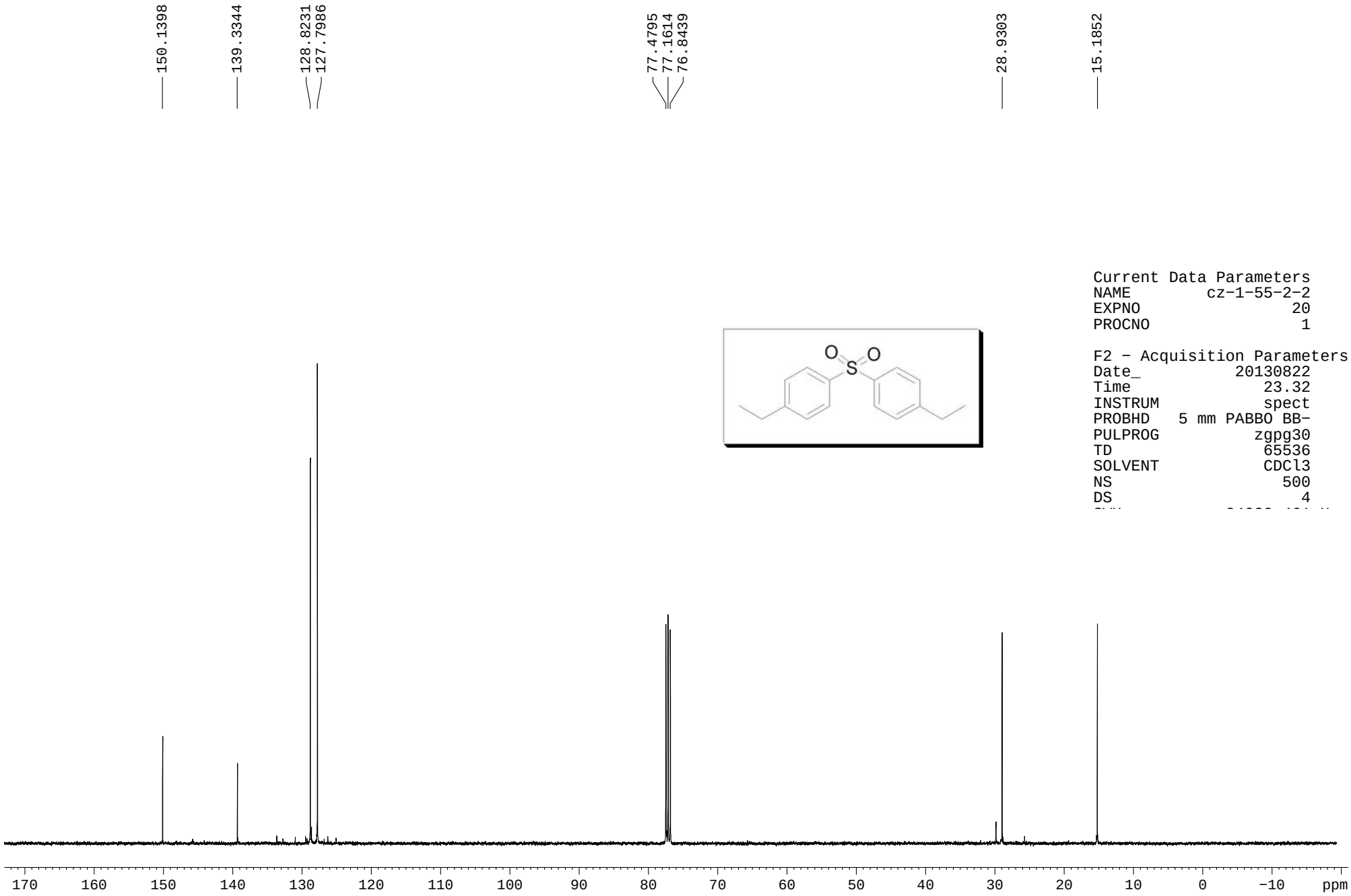

7.9542
7.9349
7.5399
7.5225
7.4986
7.4800
7.4618
Current Data Parameters
NAME YYQ-4-93-10-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121018
Time 5.31
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
S
O
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
4.00
6.16


141.5937
133.2360
129.3090
127.6262
77.4779
77.1593
76.8408
Current Data Parameters
NAME YYQ-4-93-10-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121018
Time 5.47
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 256
DS 4
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

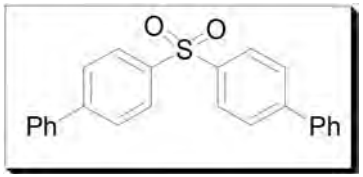

7.8142
7.7943
7.2676
7.2477
2.3517
Current Data Parameters
NAME YYQ-4-93-3-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121018
Time 4.27
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
S
O
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 ppm
4.03
4.09
6.00


143.9234
139.0280
129.8340
127.4816
77.4768
77.1581
76.8397
21.4770
O
S
O
Current Data Parameters
NAME YYQ-4-93-3-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121018
Time 4.42
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 256
DS 4
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


7.8490
7.8287
7.3112
7.2910
2.7025
2.6837
2.6647
2.6458
1.2542
1.2340
1.2150
1.1960
Current Data Parameters
NAME cz-1-55-2-2
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130822
Time 18.44
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
S
O
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
ppm
1.00
1.07
1.09
0.28
1.71

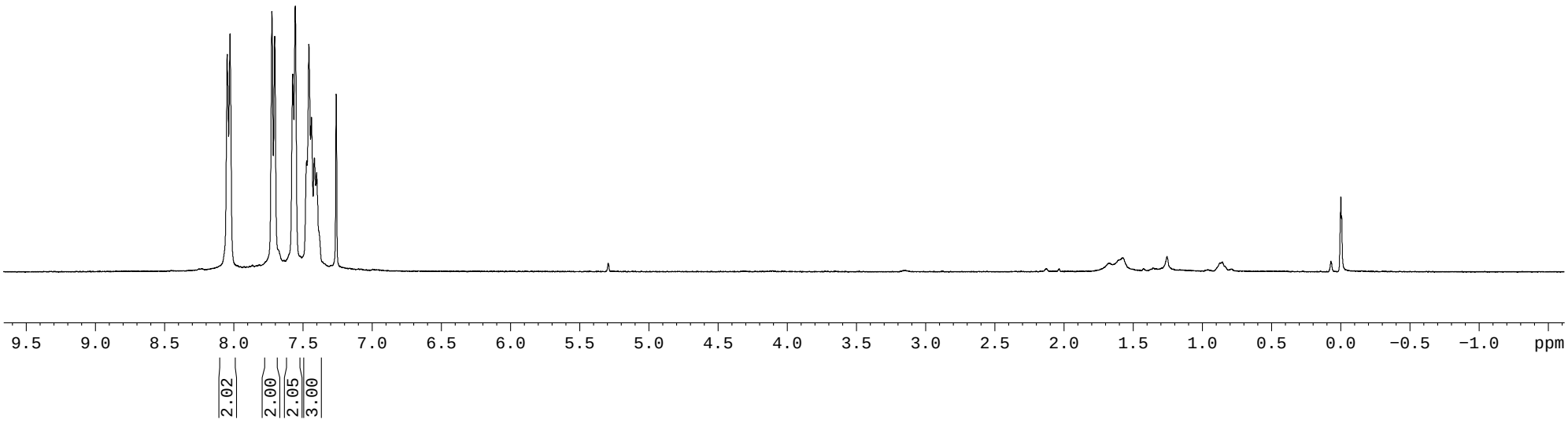

150.1398
139.3344
128.8231
127.7986
77.4795
77.1614
76.8439
28.9303
15.1852
O
S
O
Current Data Parameters
NAME cz-1-55-2-2
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130822
Time 23.32
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 500
DS 4
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 ppm

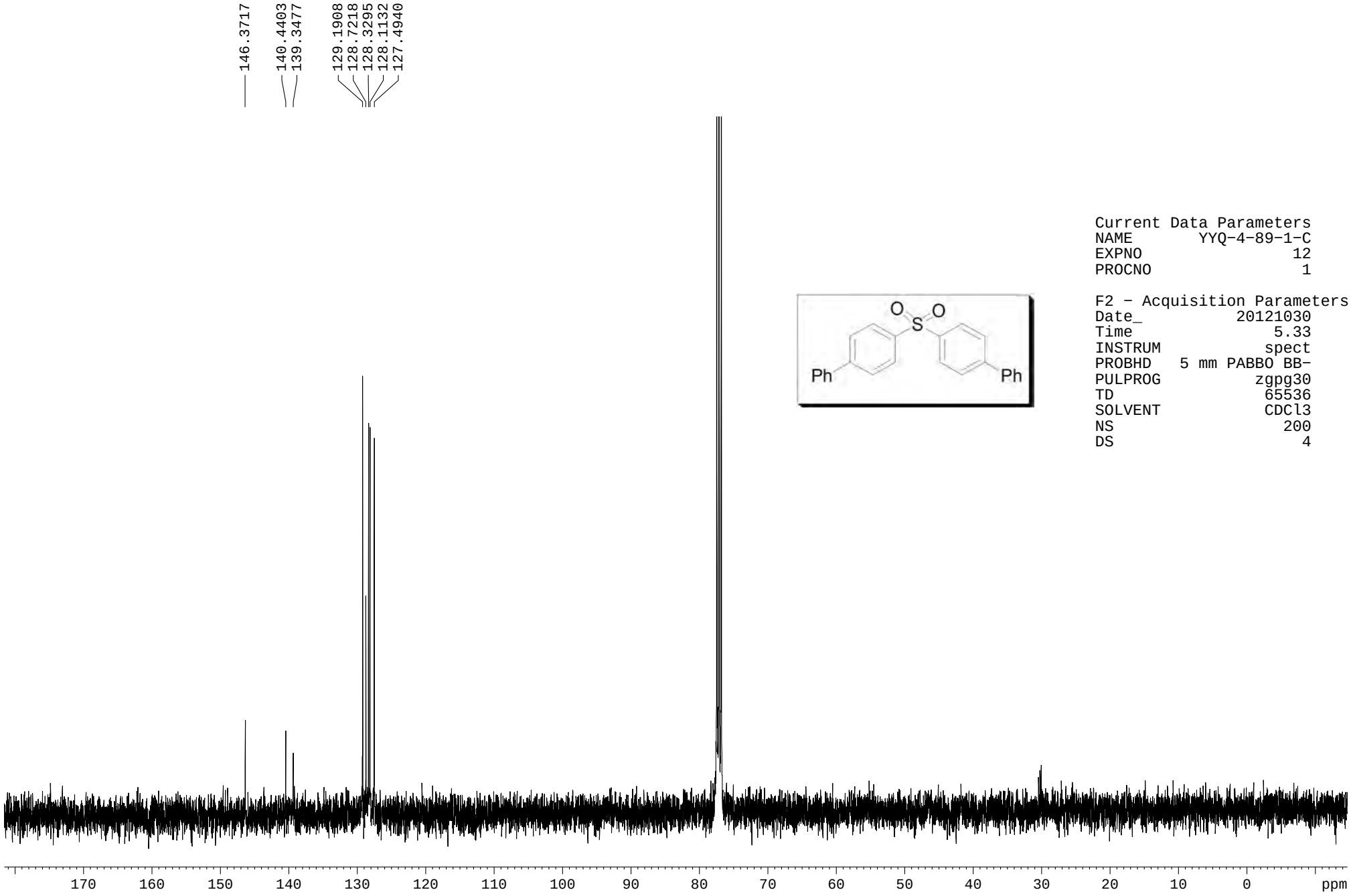
8.0471
8.0264
7.7242
7.7036
7.5731
7.5553
7.4731
7.4567
7.4382
7.4171
7.3999
7.2590

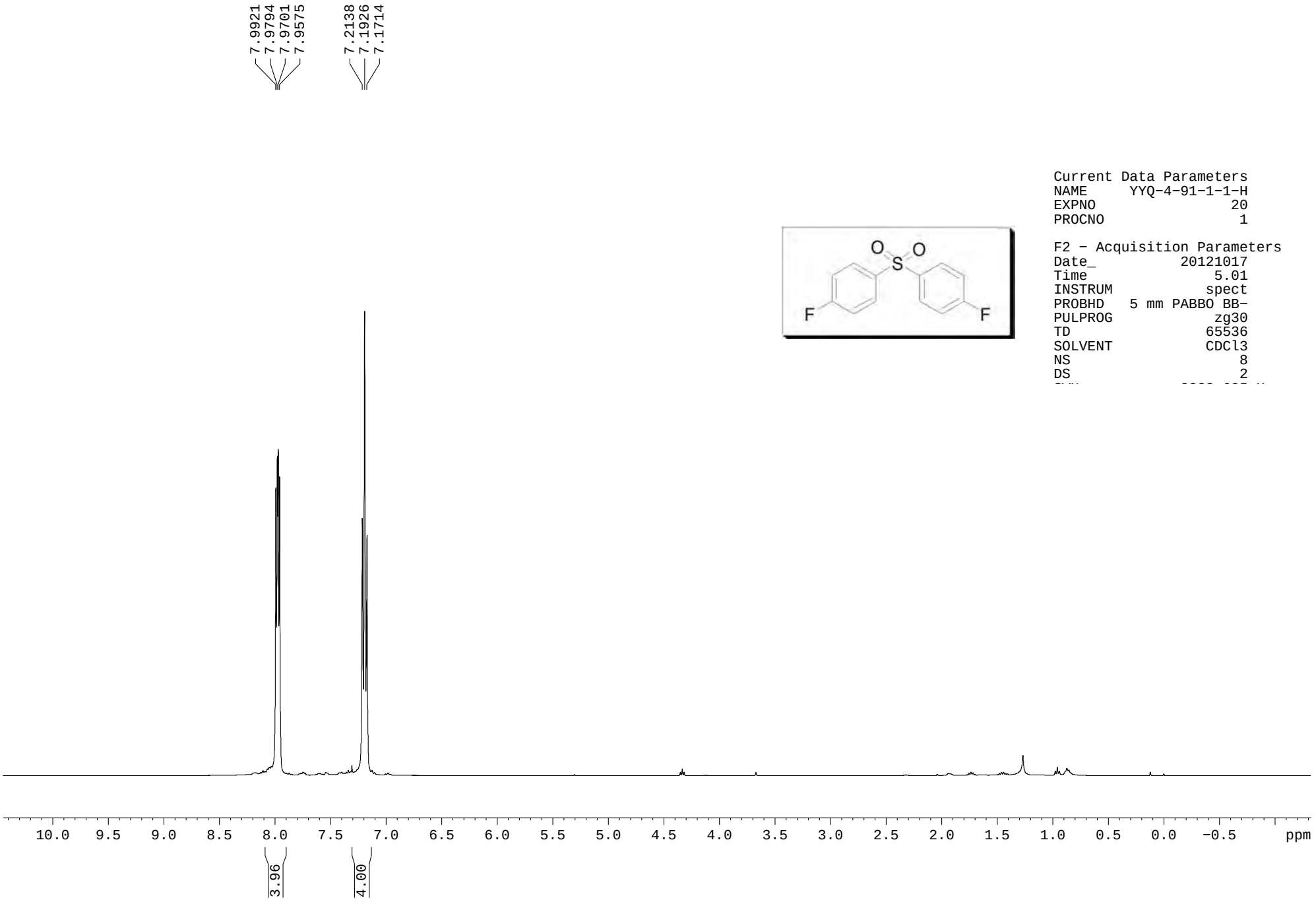


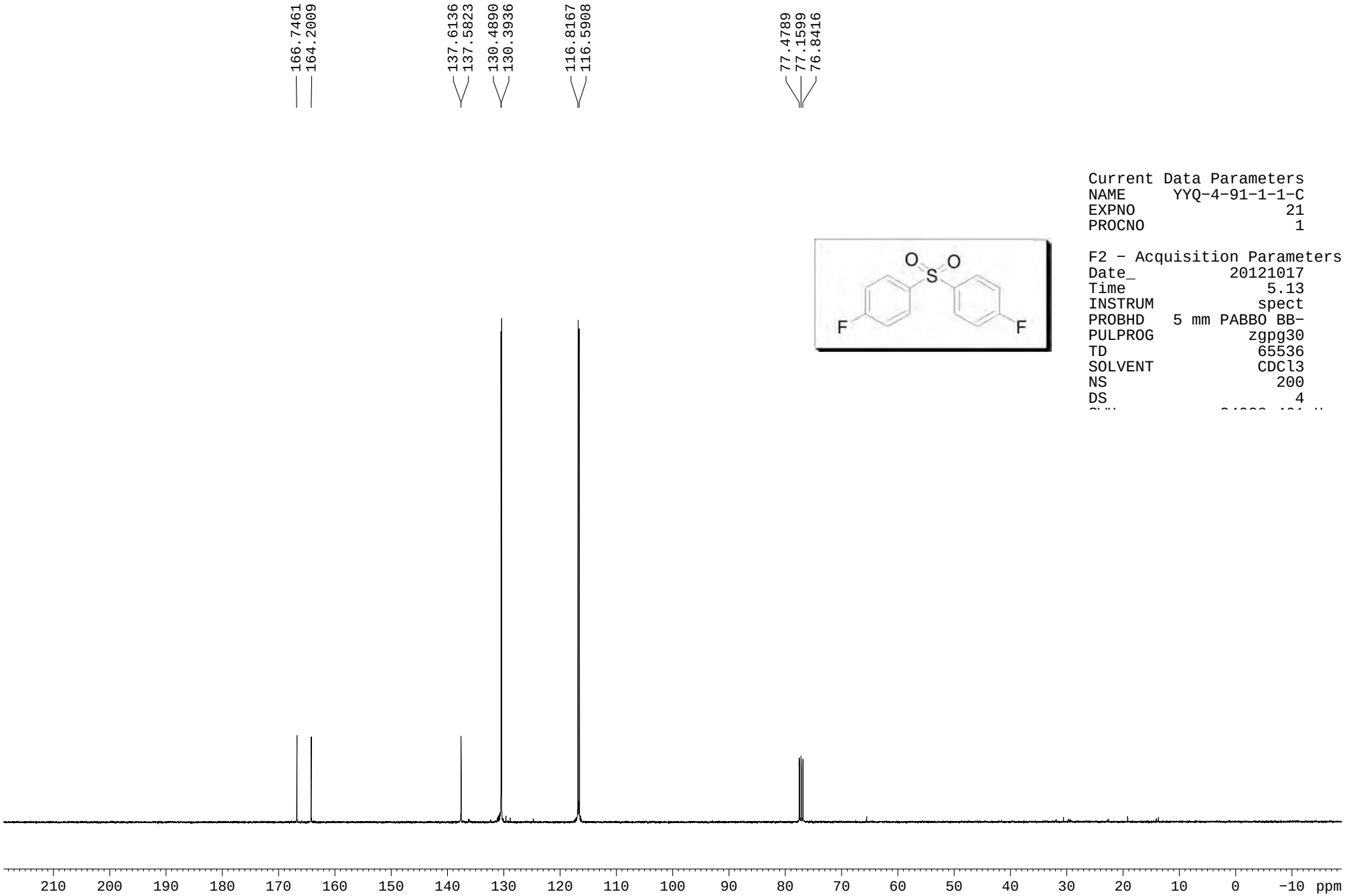
Current Data Parameters
NAME YYQ-4-89-1-H
EXPNO 10
PROCNO 1

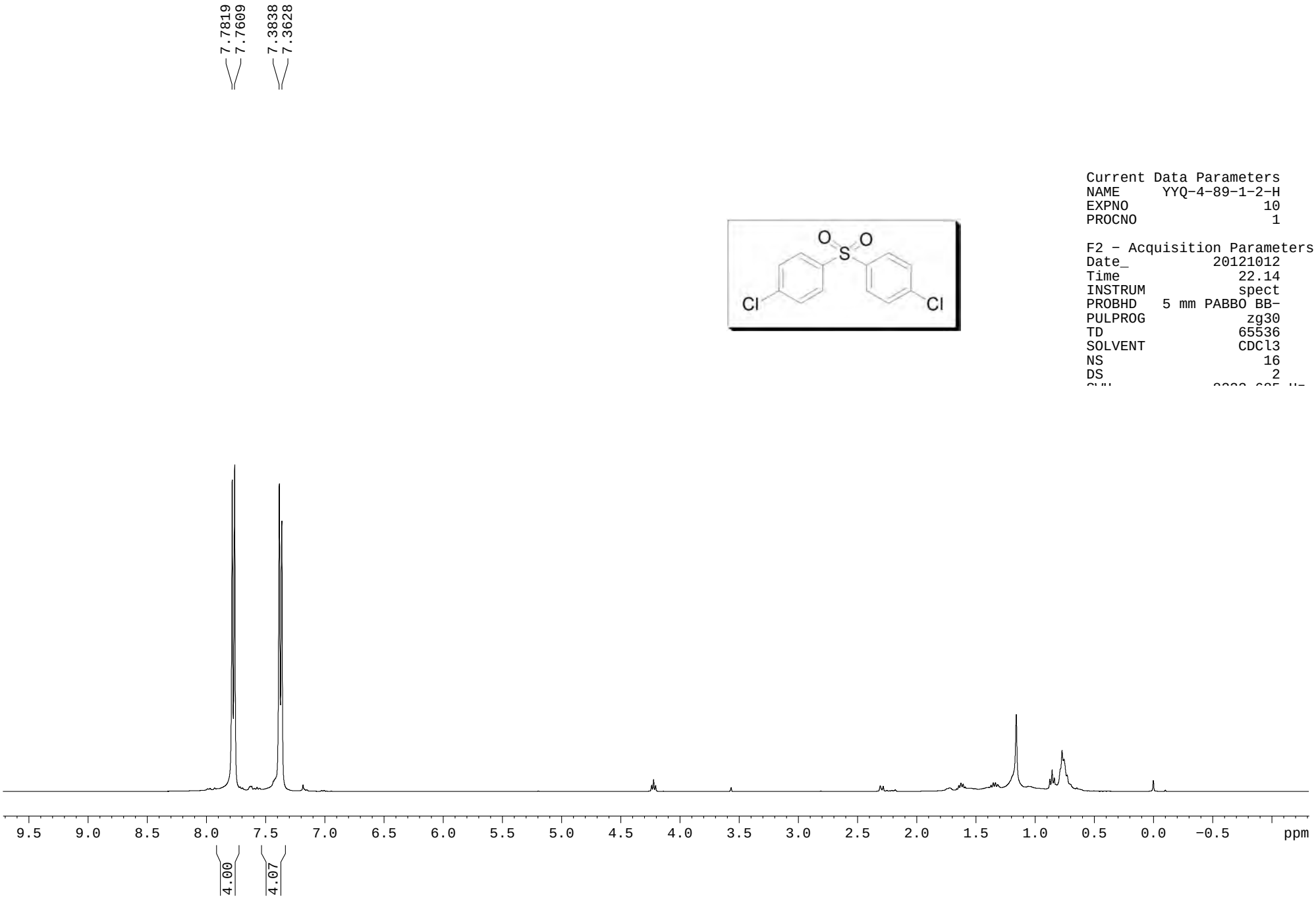
F2 - Acquisition Parameters
Date_ 20121030
Time 5.20
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2

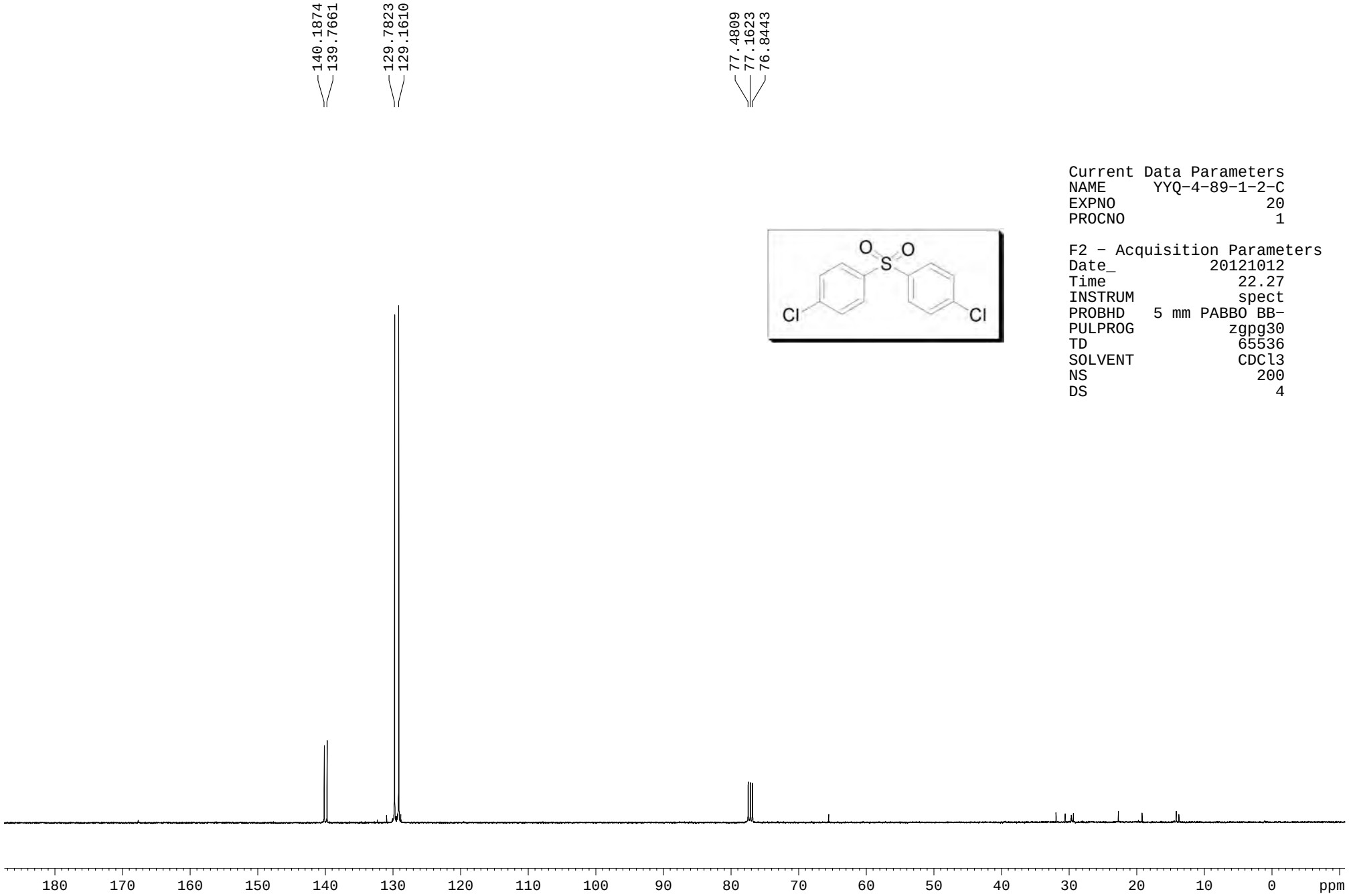


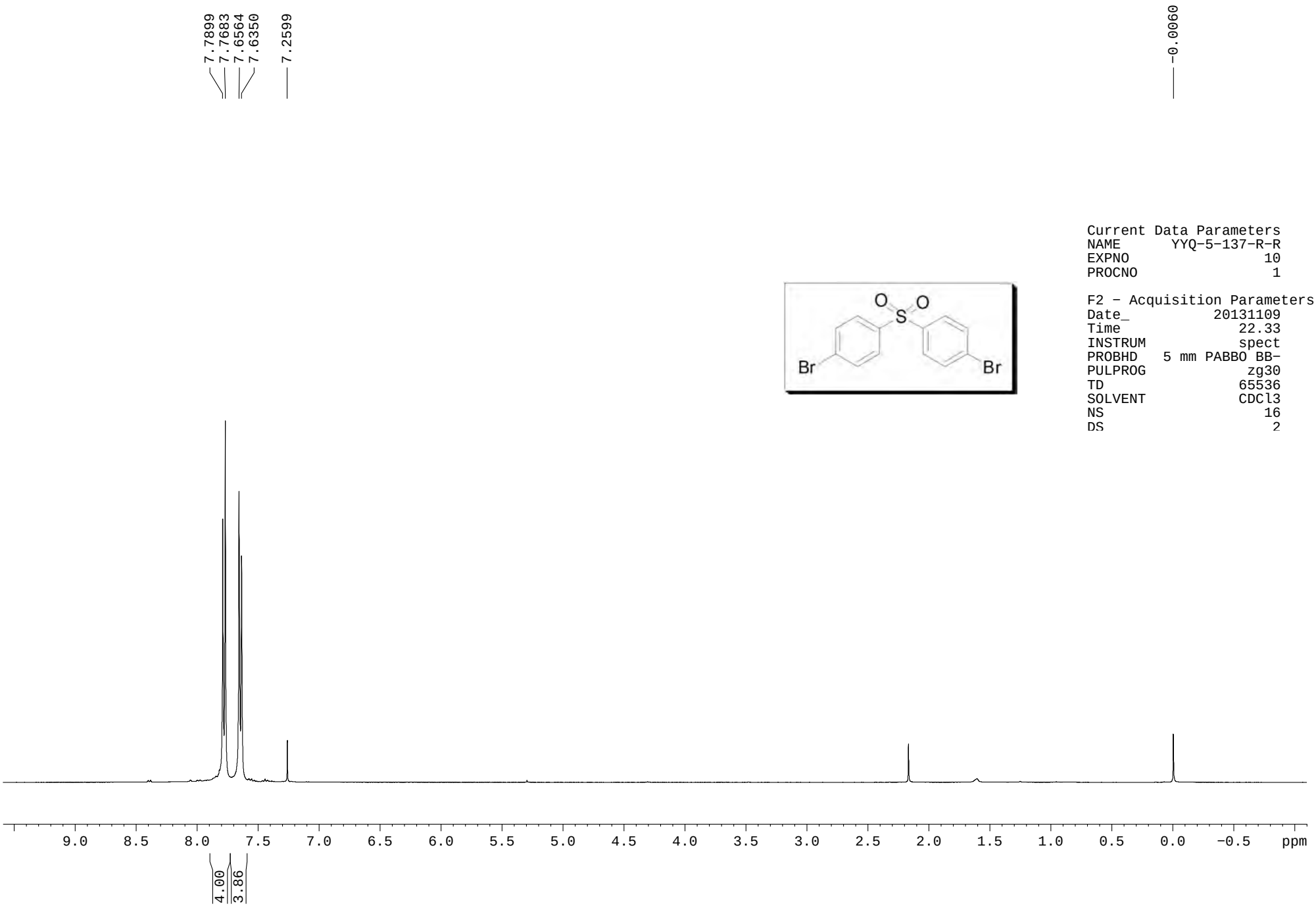

146.3717
140.4403
139.3477
129.1908
128.7218
128.3295
128.1132
127.4940
O
S
O
Ph
Ph
Current Data Parameters
NAME YYQ-4-89-1-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121030
Time 5.33
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

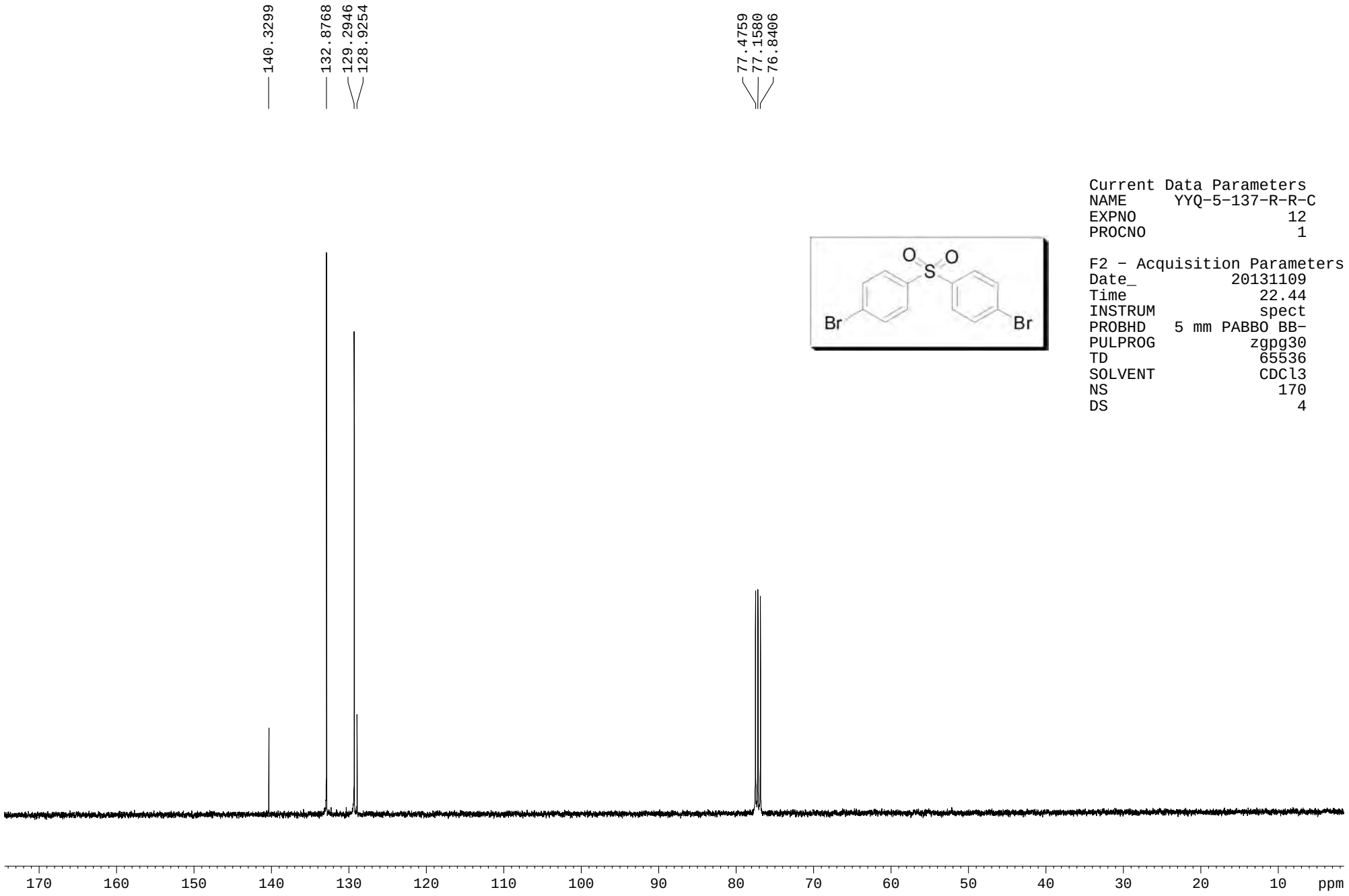

7.9921
7.9794
7.9701
7.9575
7.2138
7.1926
7.1714
O
S
O
F
F
Current Data Parameters
NAME YYQ-4-91-1-1-H
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121017
Time 5.01
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 8
DS 2
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
3.96
4.00

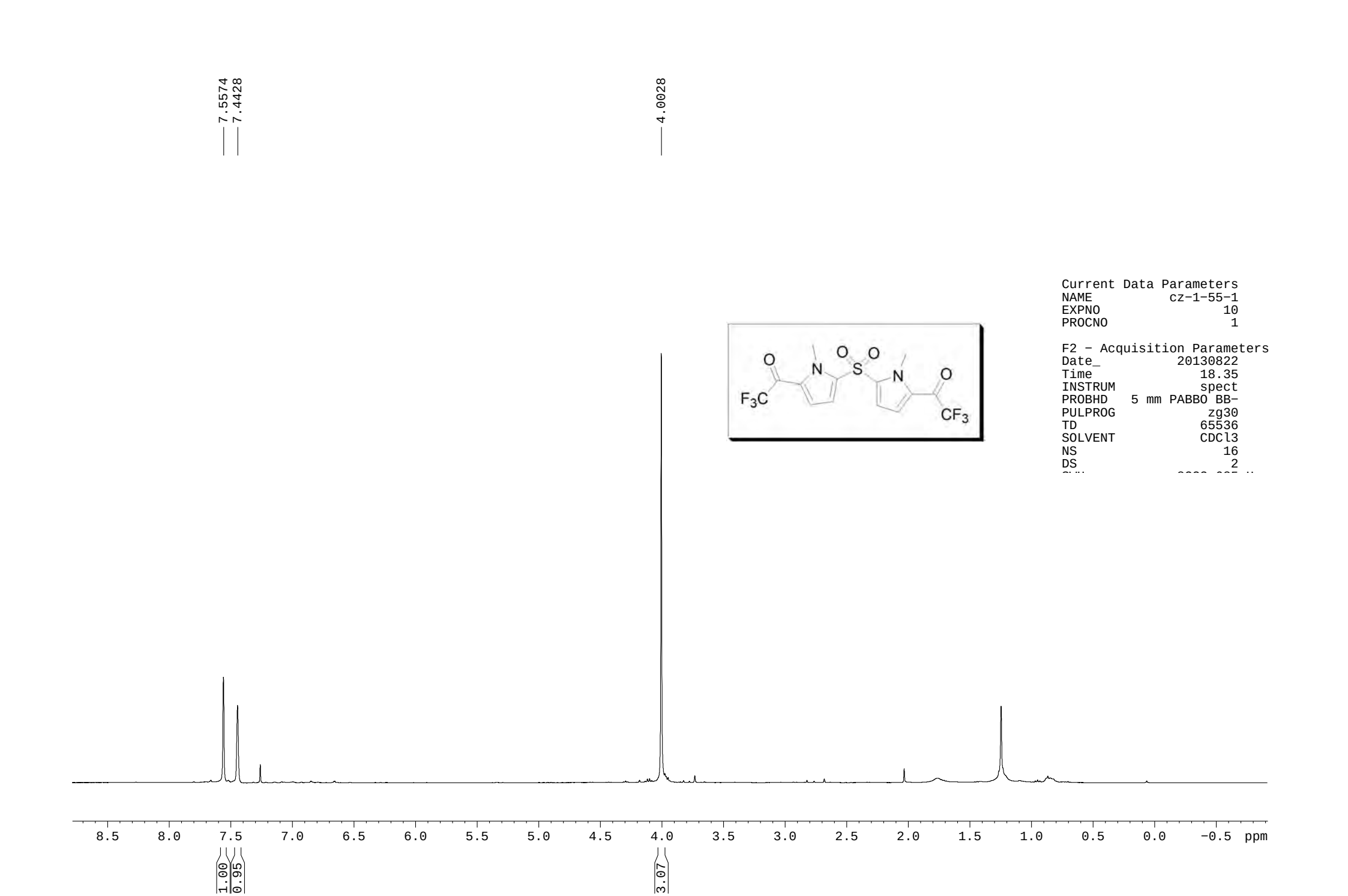

166.7461
164.2009
137.6136
137.5823
130.4890
130.3936
116.8167
116.5908
77.4789
77.1599
76.8416
Current Data Parameters
NAME YYQ-4-91-1-1-C
EXPNO 21
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121017
Time 5.13
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
O
S
O
F
F
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 ppm

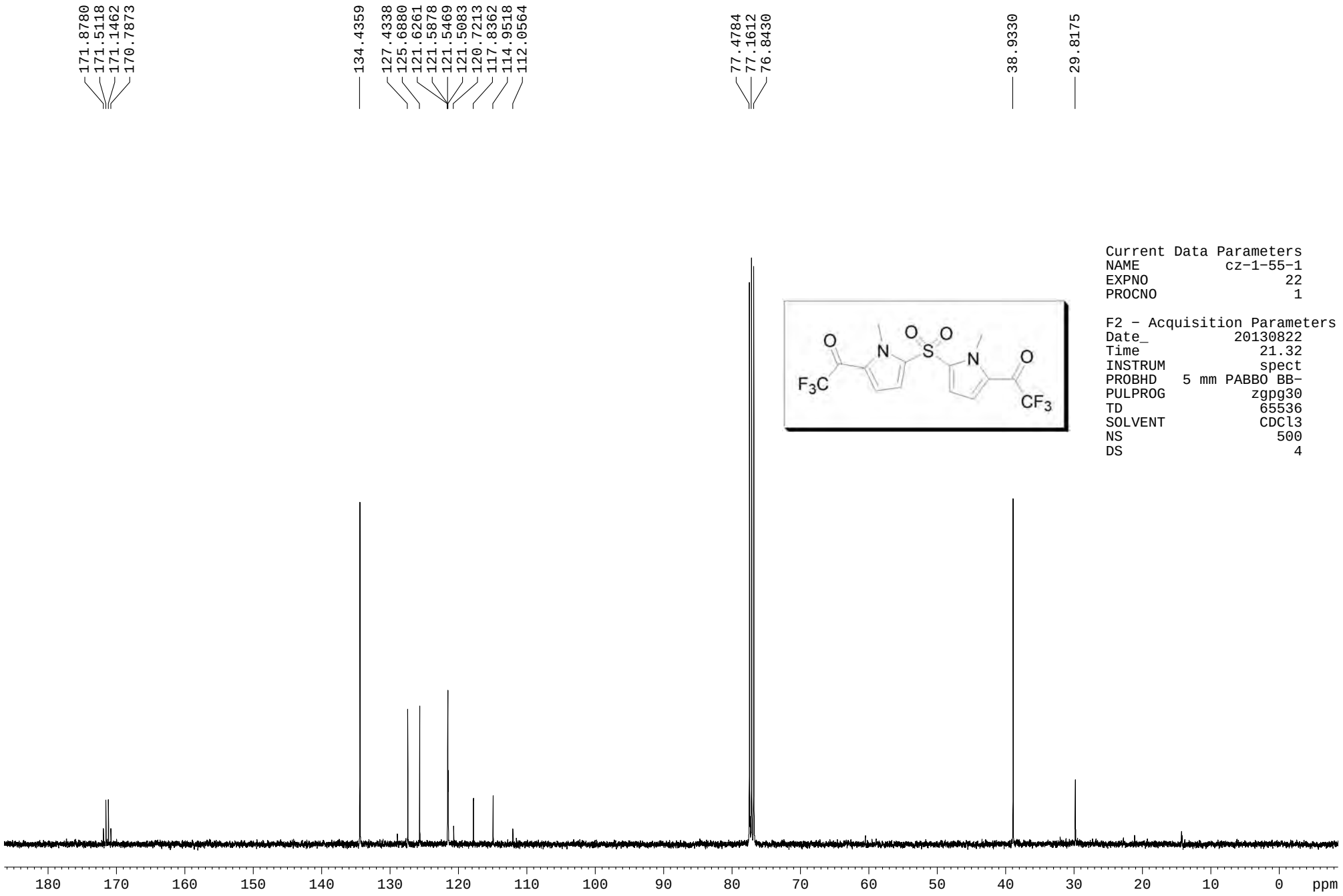

7.7819
7.7609
7.3838
7.3628
Current Data Parameters
NAME YYQ-4-89-1-2-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121012
Time 22.14
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
S
O
Cl
Cl
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
4.00
4.07

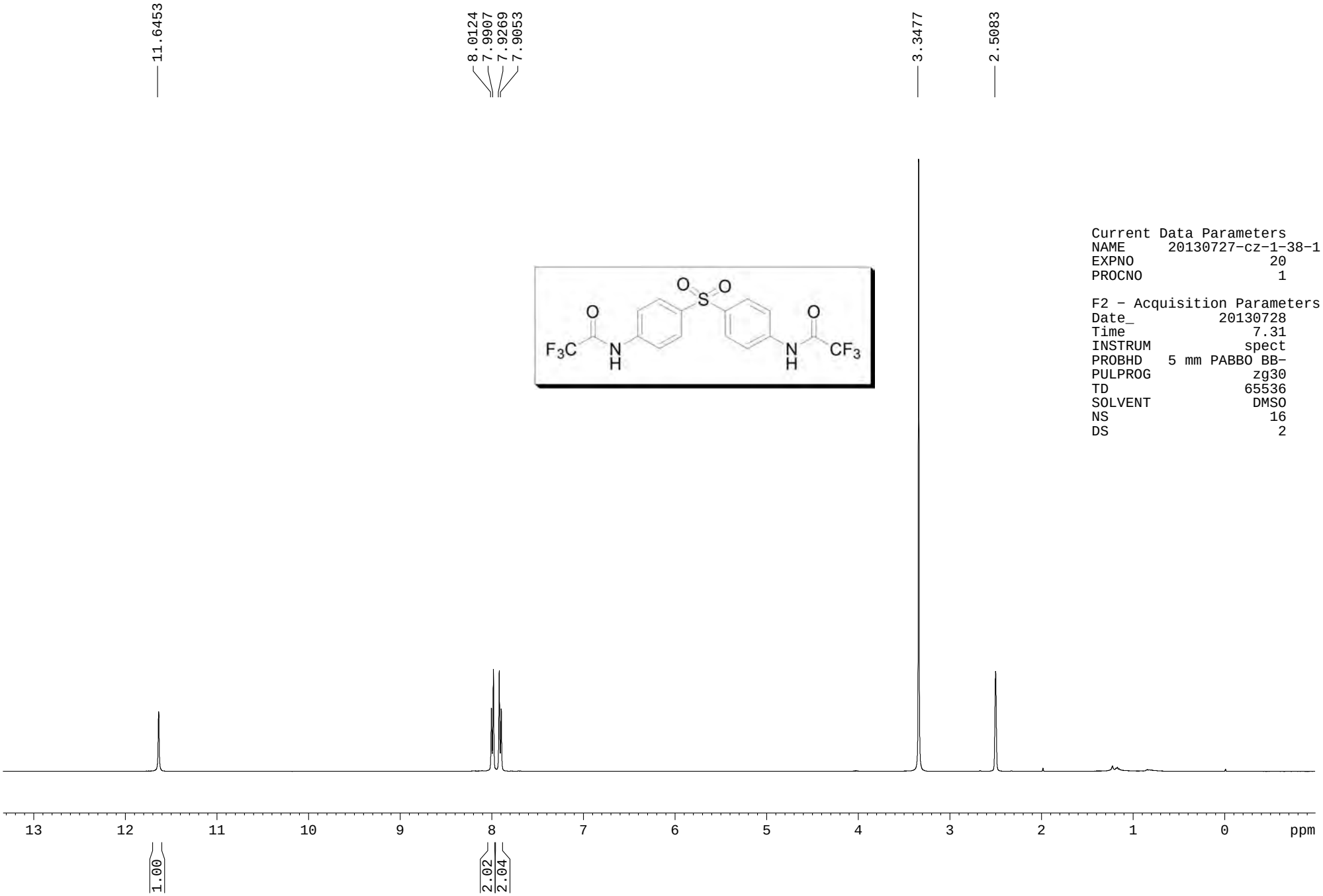

140.1874
139.7661
129.7823
129.1610
77.4809
77.1623
76.8443
O
S
O
Cl
Cl
Current Data Parameters
NAME YYQ-4-89-1-2-C
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121012
Time 22.27
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

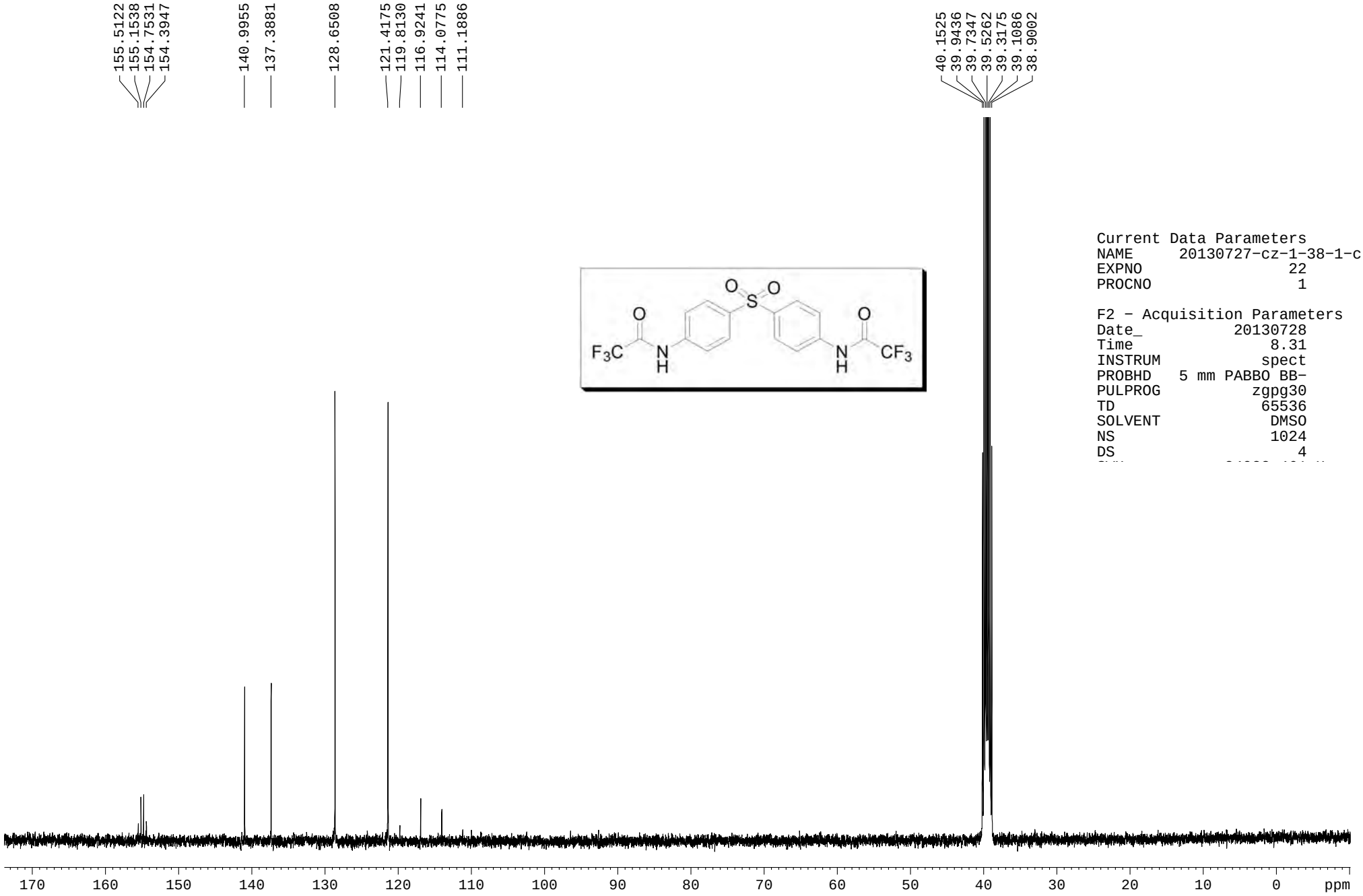

7.7899
7.7683
7.6564
7.6350
7.2599
-0.0060
Br
Br
O
O
S
Current Data Parameters
NAME YYQ-5-137-R-R
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20131109
Time 22.33
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
ppm
4.00
3.86

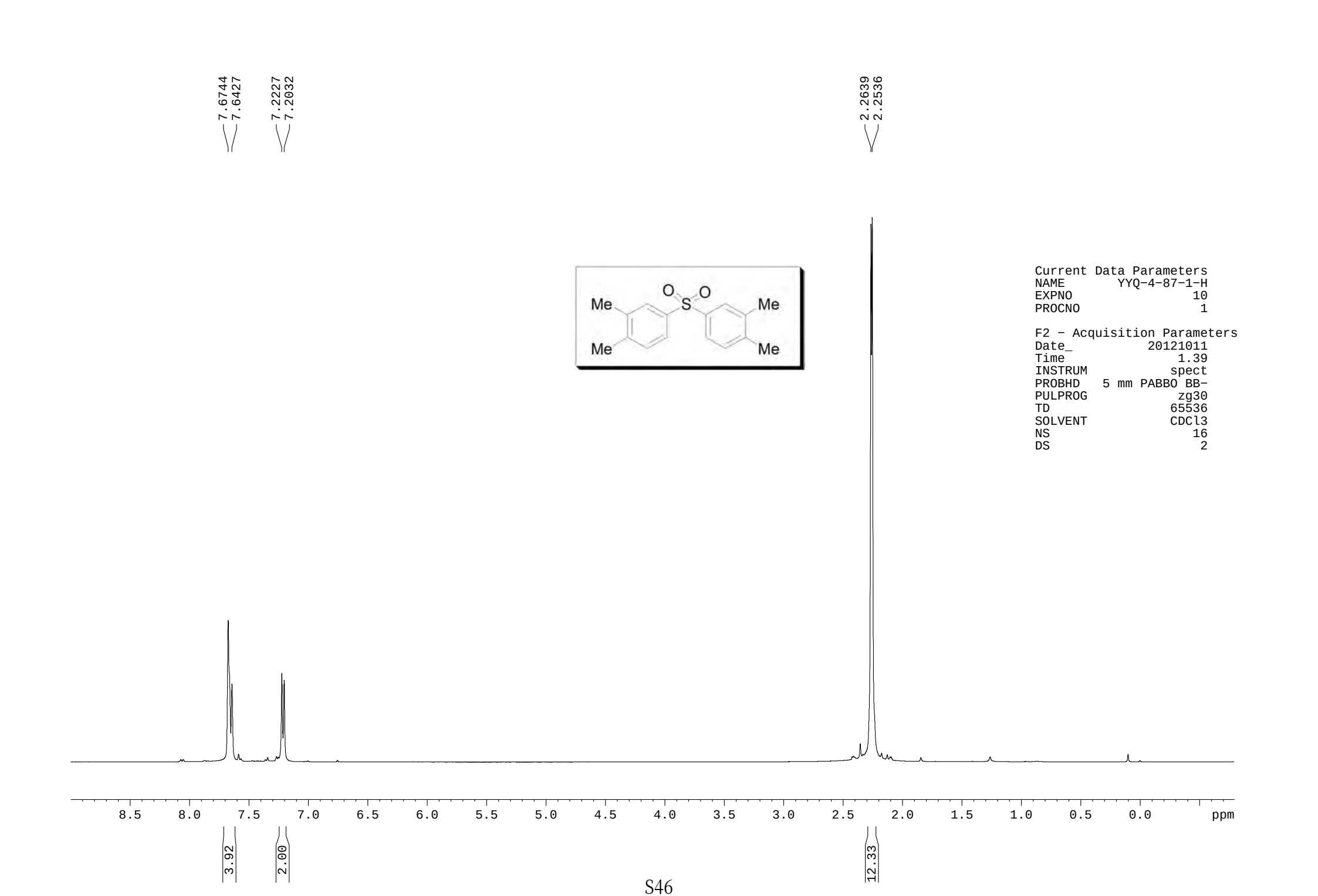

140.3299
132.8768
129.2946
128.9254
77.4759
77.1580
76.8406
O
S
O
Br
Br
Current Data Parameters
NAME YYQ-5-137-R-R-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20131109
Time 22.44
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 170
DS 4
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

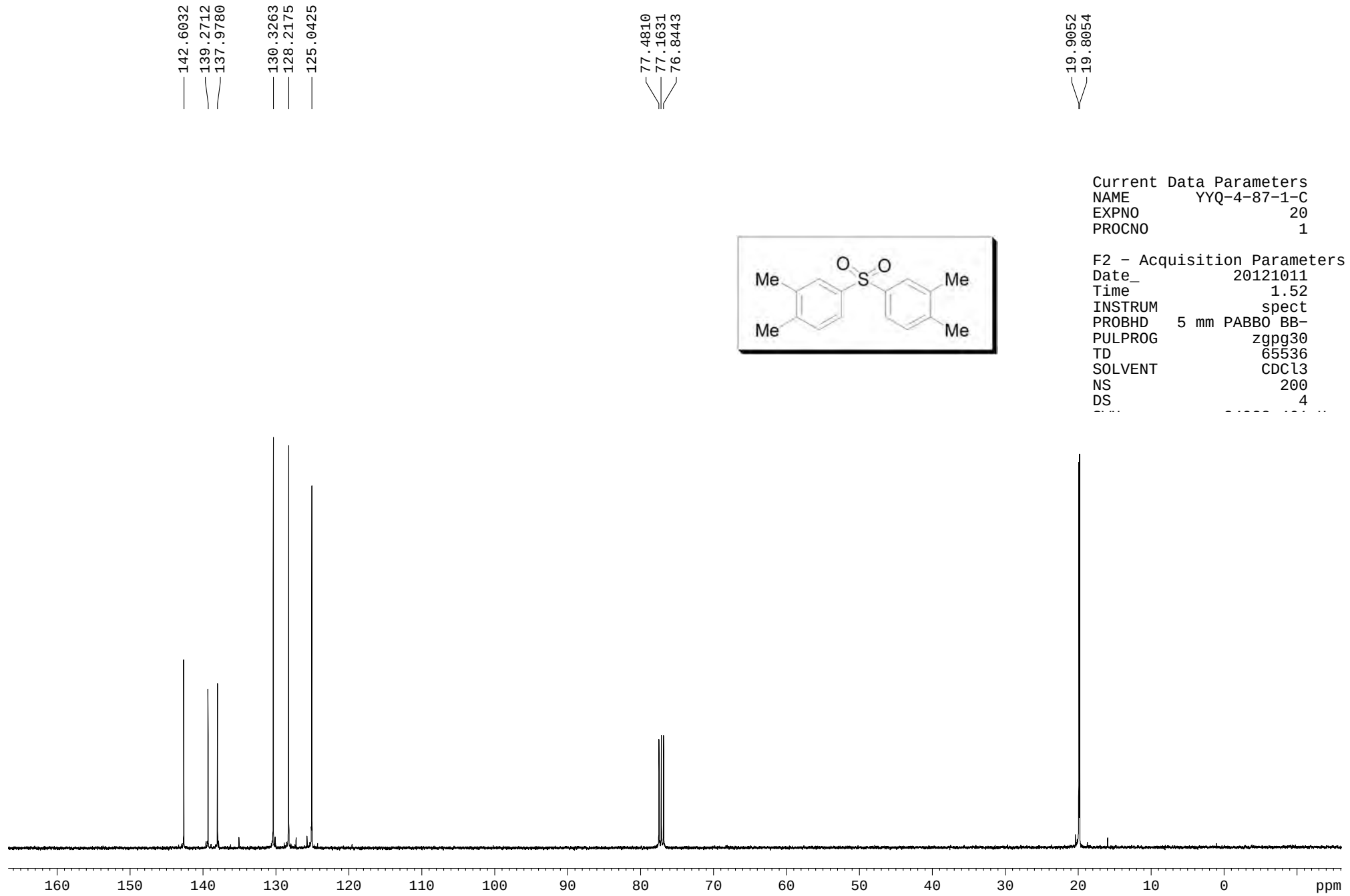

7.5574
7.4428
4.0028
Current Data Parameters
NAME cz-1-55-1
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130822
Time 18.35
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
N
O
S
O
N
O
F3C
CF3
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
ppm
1.00
0.95
3.07

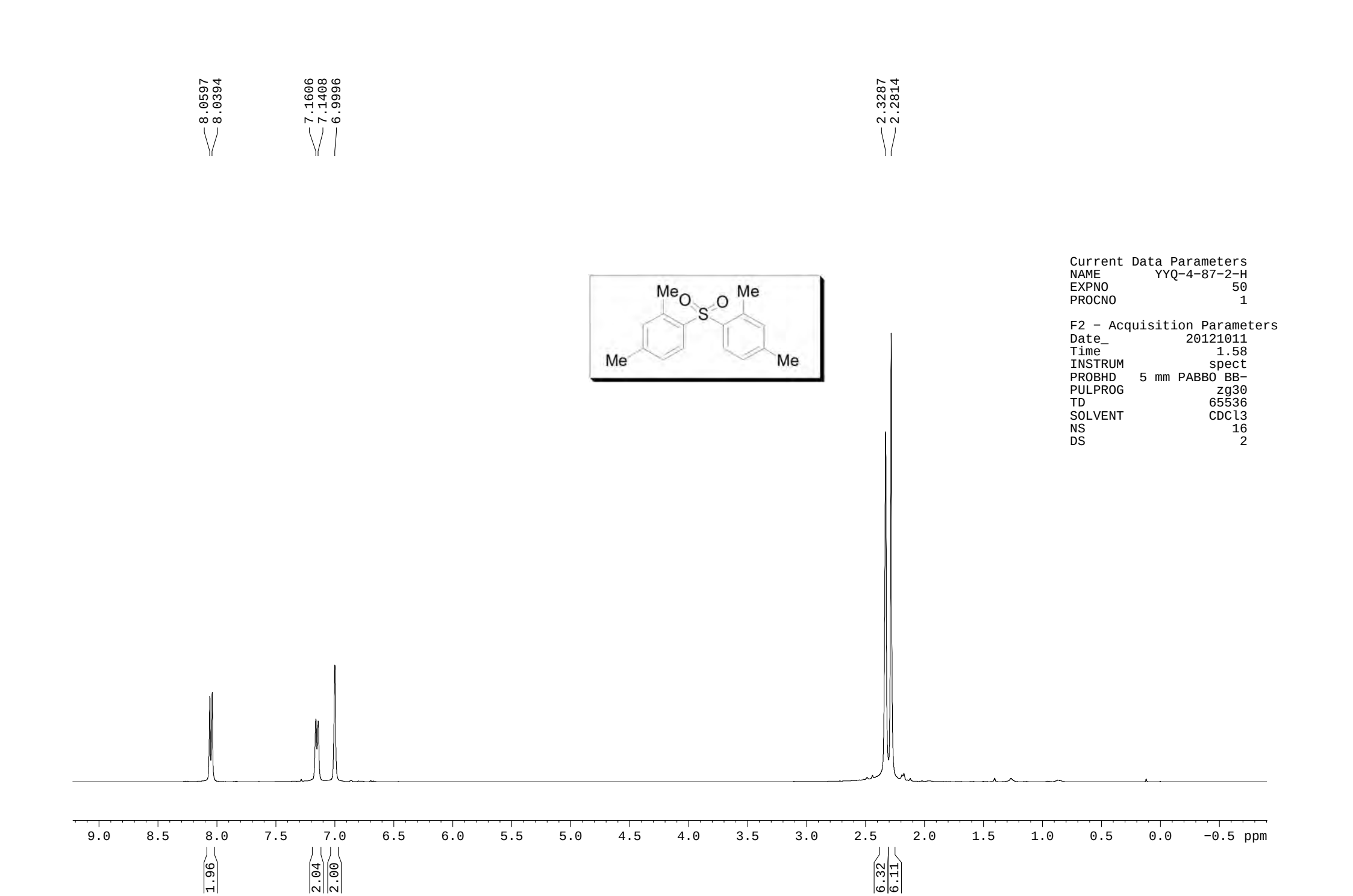

171.8780
171.5118
171.1462
170.7873
134.4359
127.4338
125.6880
121.6261
121.5878
121.5469
121.5083
120.7213
117.8362
114.9518
112.0564
77.4784
77.1612
76.8430
38.9330
29.8175
Current Data Parameters
NAME cz-1-55-1
EXPNO 22
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130822
Time 21.32
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 500
DS 4
O
N
O
S
O
N
O
F3C
CF3
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

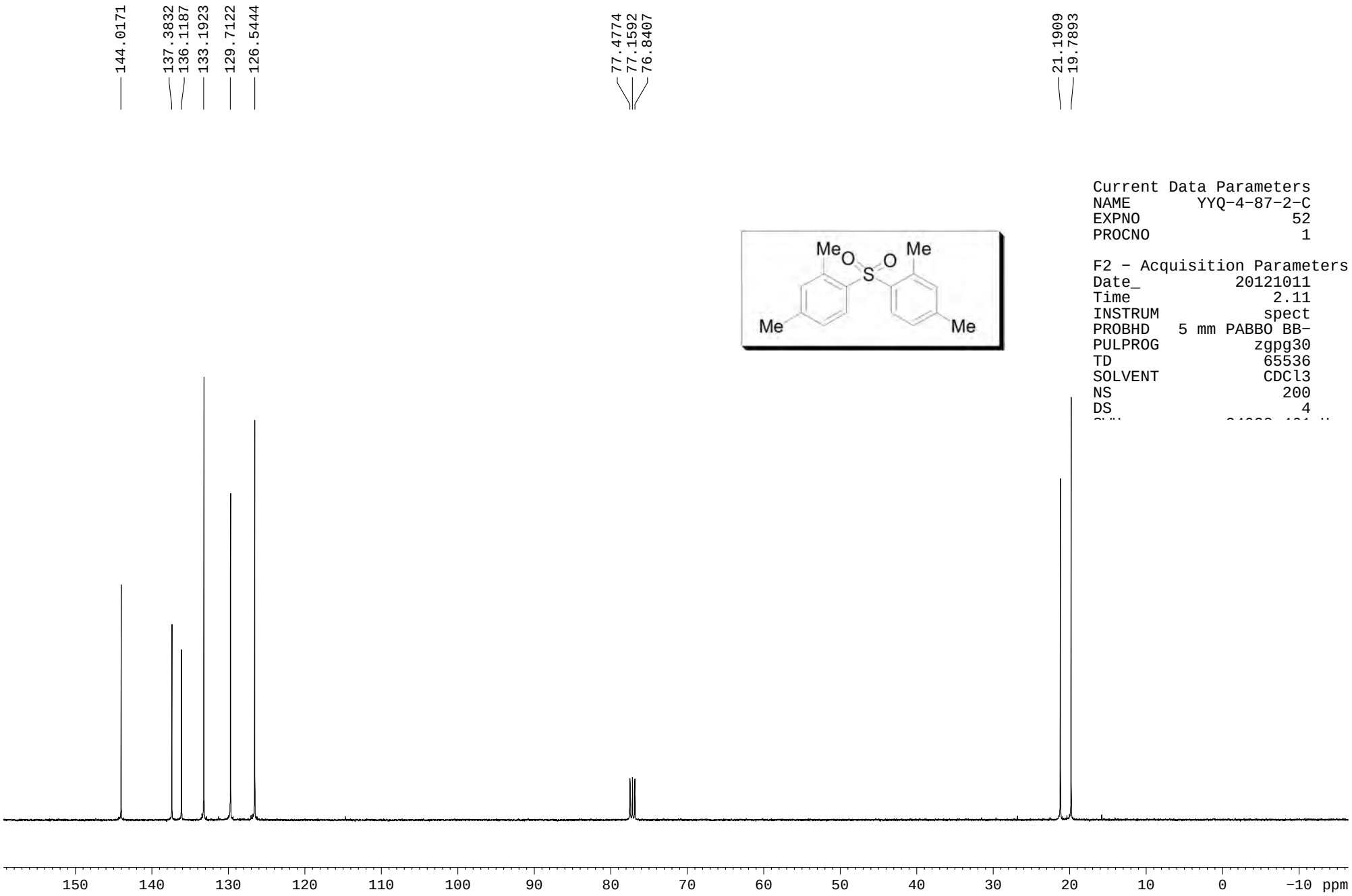

11.6453
8.0124
7.9907
7.9269
7.9053
3.3477
2.5083
Current Data Parameters
NAME 20130727-cz-1-38-1
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130728
Time 7.31
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 16
DS 2
13
12
11
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
2.02
2.04

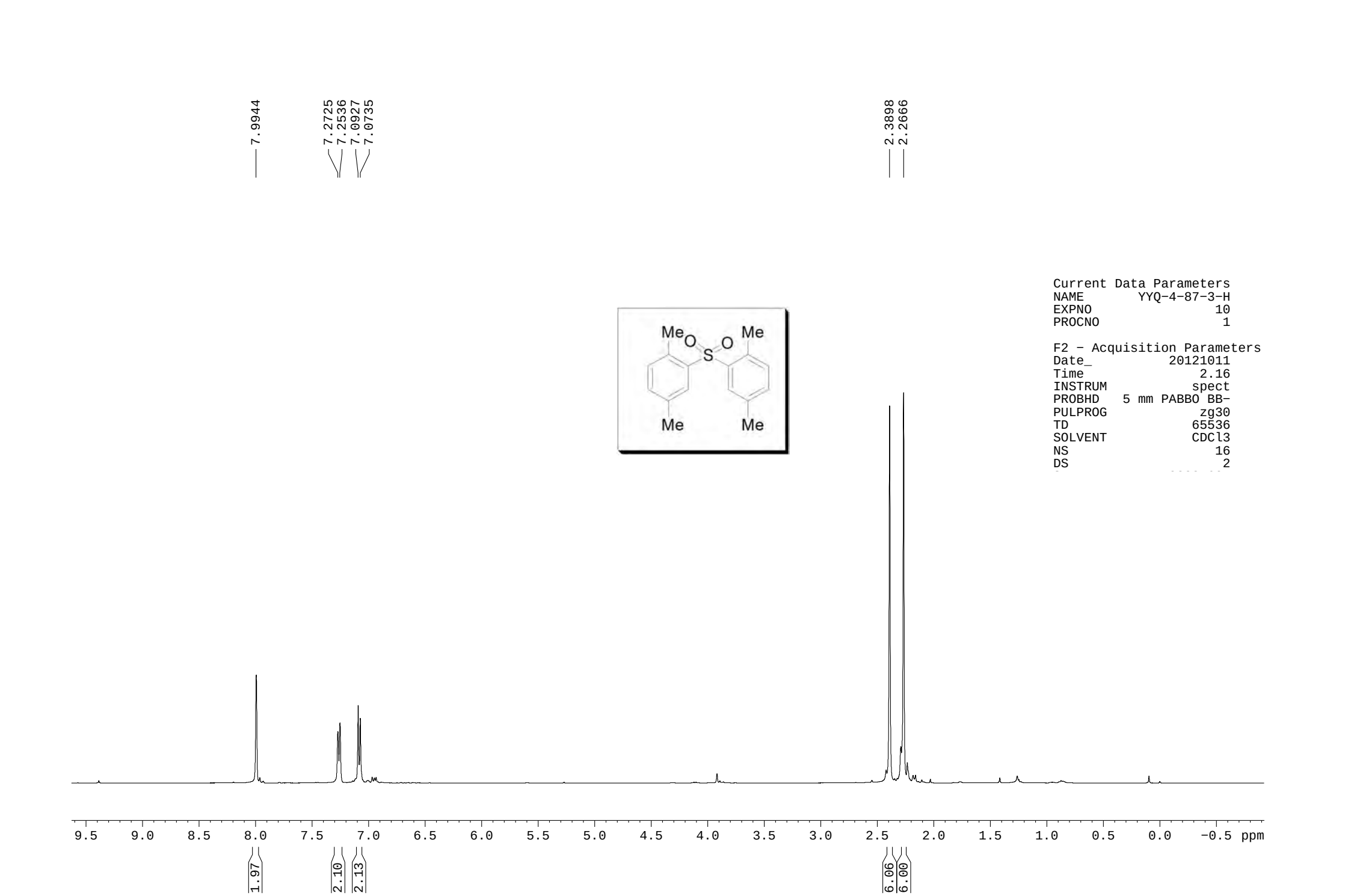

155.5122
155.1538
154.7531
154.3947
140.9955
137.3881
128.6508
121.4175
119.8130
116.9241
114.0775
111.1886
40.1525
39.9436
39.7347
39.5262
39.3175
39.1086
38.9002
Current Data Parameters
NAME 20130727-cz-1-38-1-c
EXPNO 22
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130728
Time 8.31
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 1024
DS 4
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

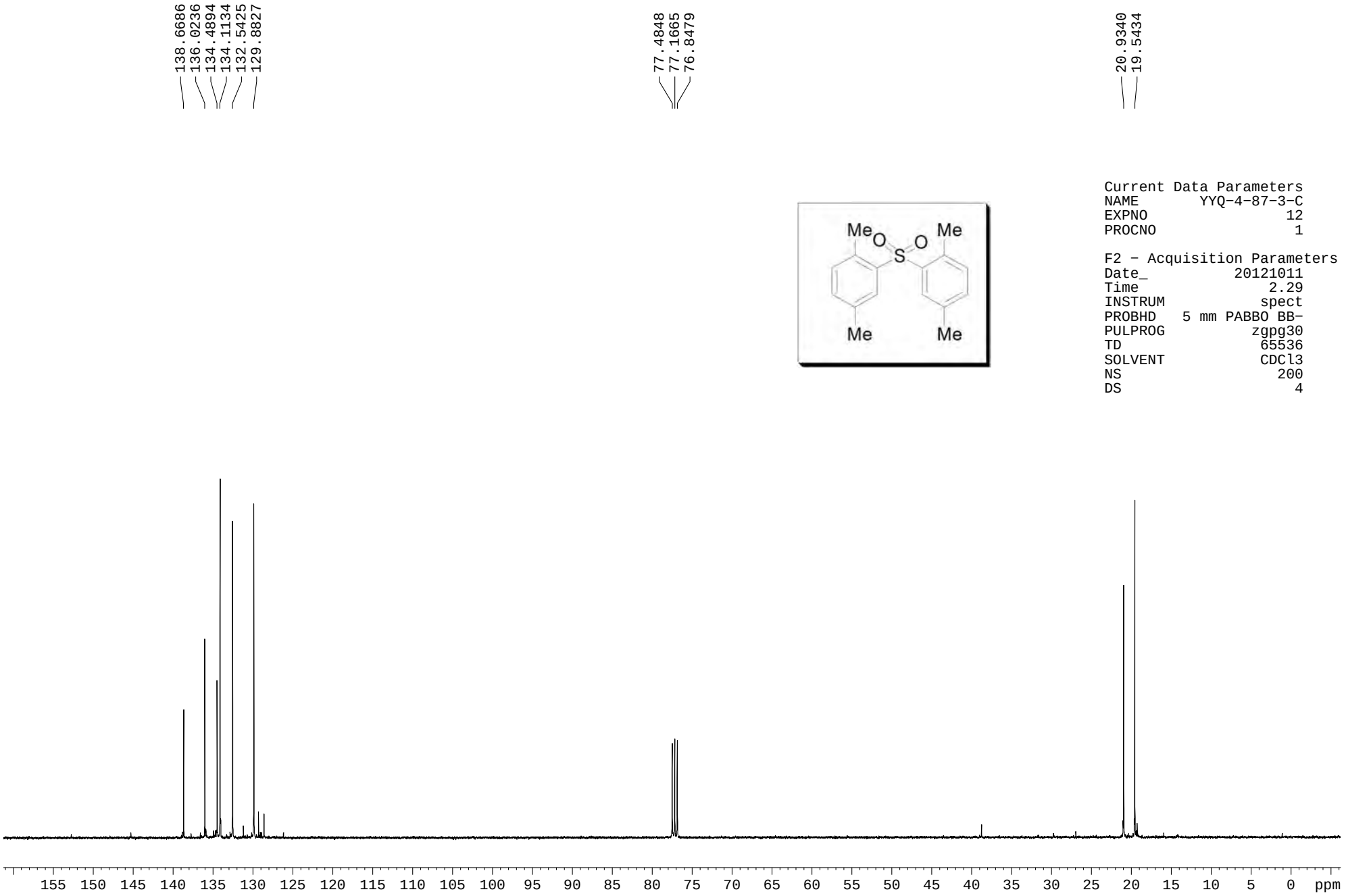

7.6744
7.6427
7.2227
7.2032
2.2639
2.2536
Me
Me
Me
Me
O
O
S
Current Data Parameters
NAME YYQ-4-87-1-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121011
Time 1.39
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
3.92
2.00
12.33

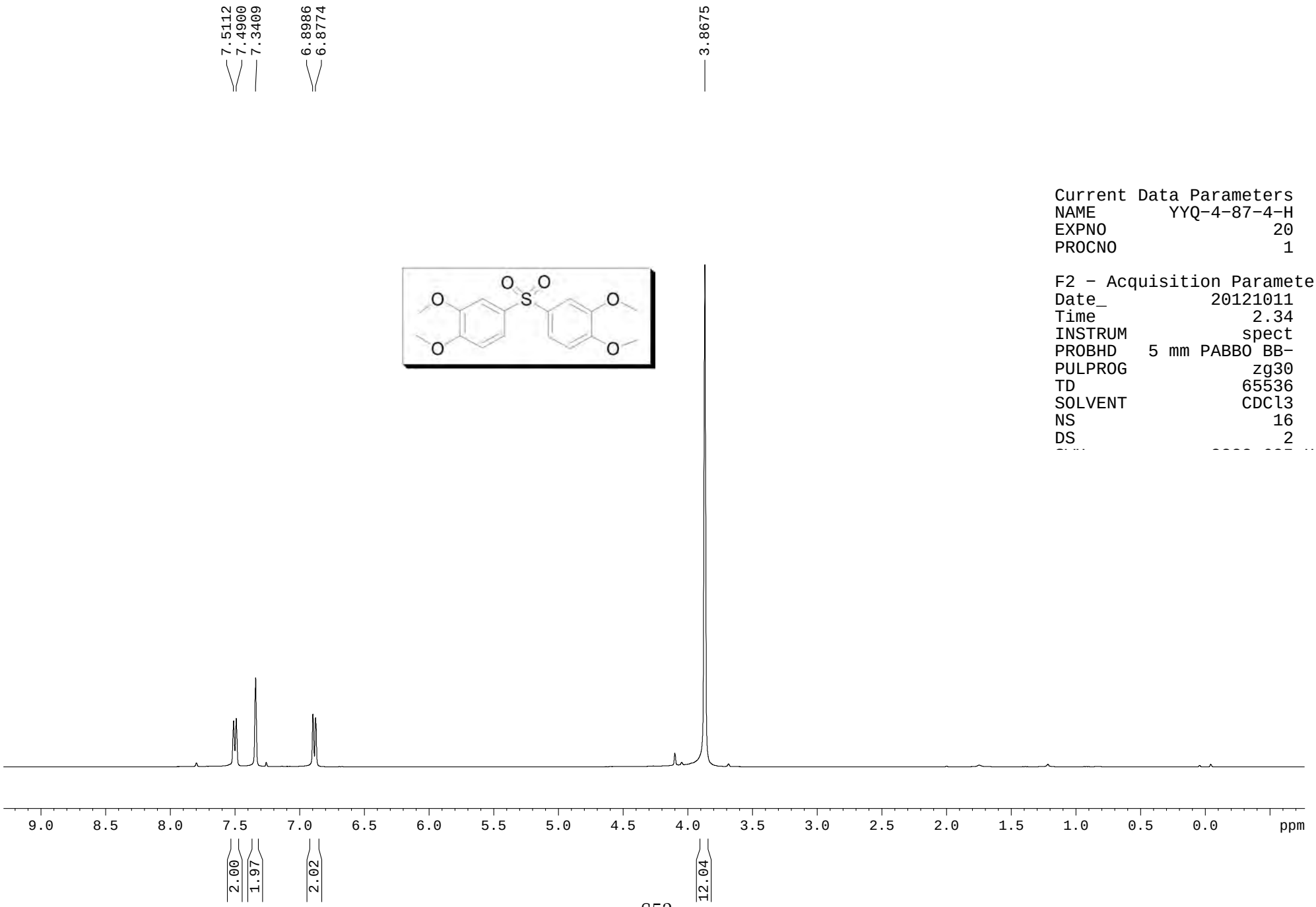

142.6032
139.2712
137.9780
130.3263
128.2175
125.0425
77.4810
77.1631
76.8443
19.9052
19.8054
Me
Me
Me
Me
O
O
S
Current Data Parameters
NAME YYQ-4-87-1-C
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121011
Time 1.52
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

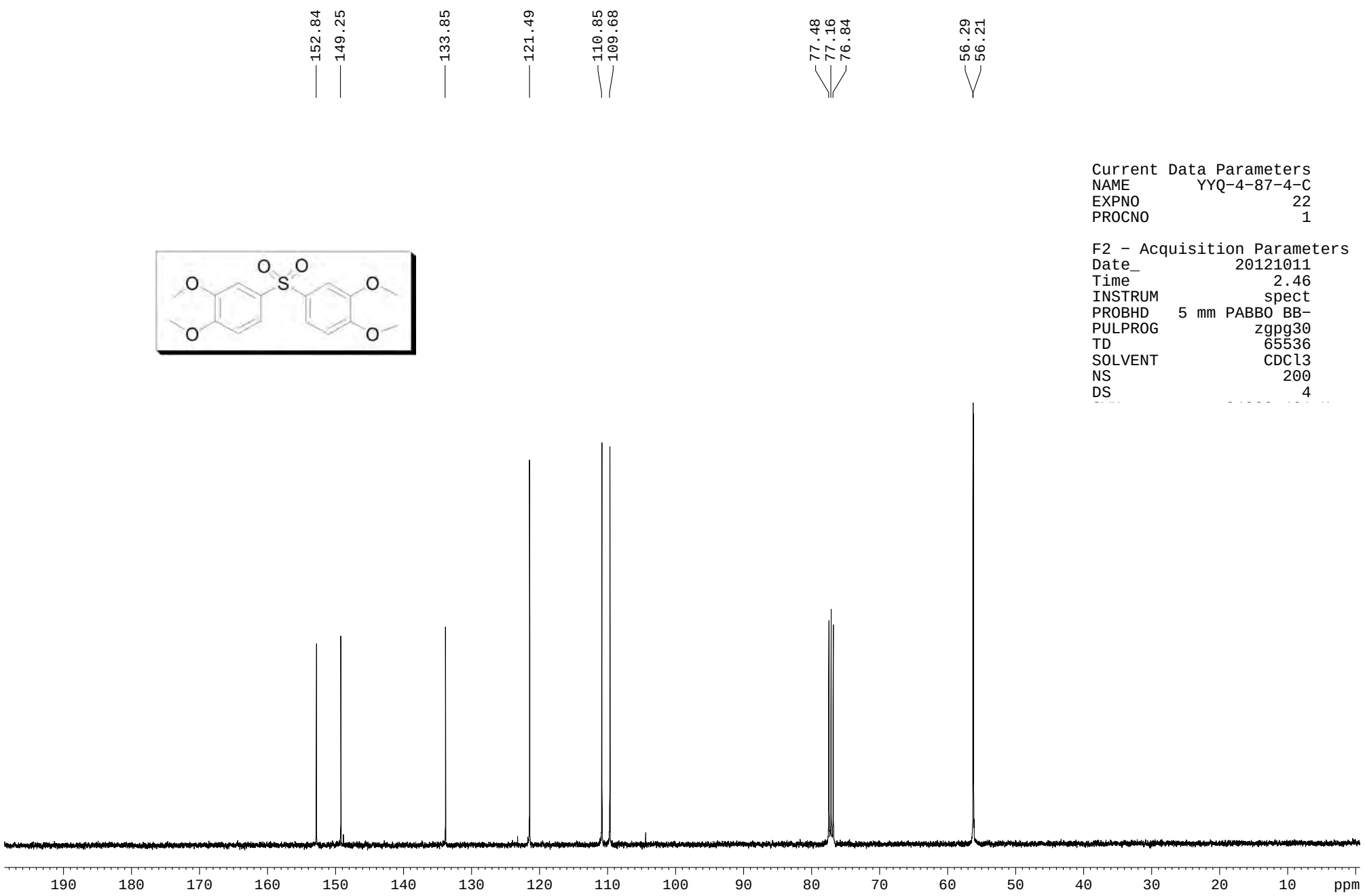

8.0597
8.0394
7.1606
7.1408
6.9996
2.3287
2.2814
Me
O
S
O
Me
Me
Me
Current Data Parameters
NAME YYQ-4-87-2-H
EXPNO 50
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121011
Time 1.58
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
1.96
2.04
2.00
6.32
6.11

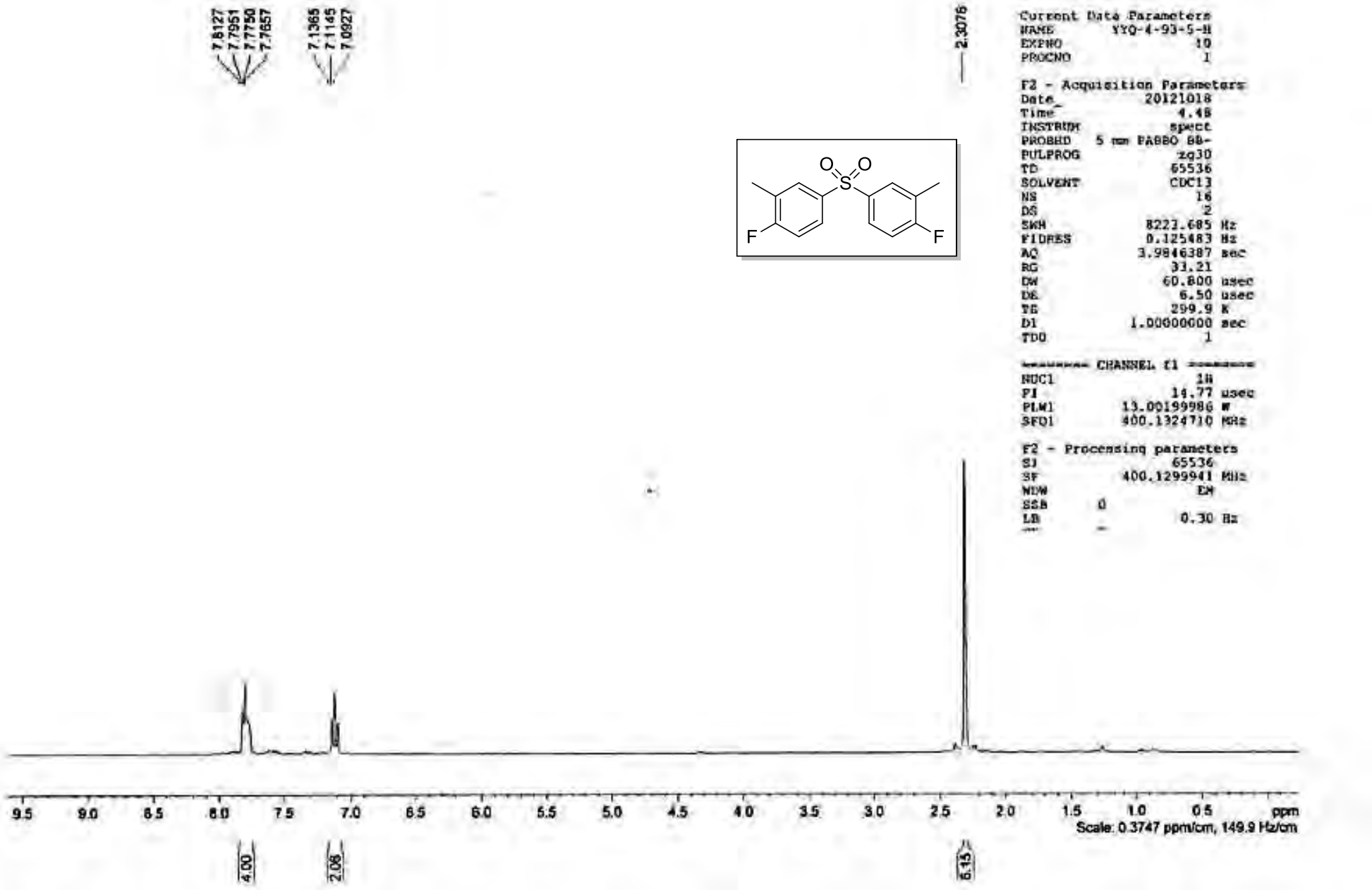

144.0171
137.3832
136.1187
133.1923
129.7122
126.5444
77.4774
77.1592
76.8407
21.1909
19.7893
Me
O
S
O
Me
Me
Me
Current Data Parameters
NAME YYQ-4-87-2-C
EXPNO 52
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121011
Time 2.11
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10 ppm

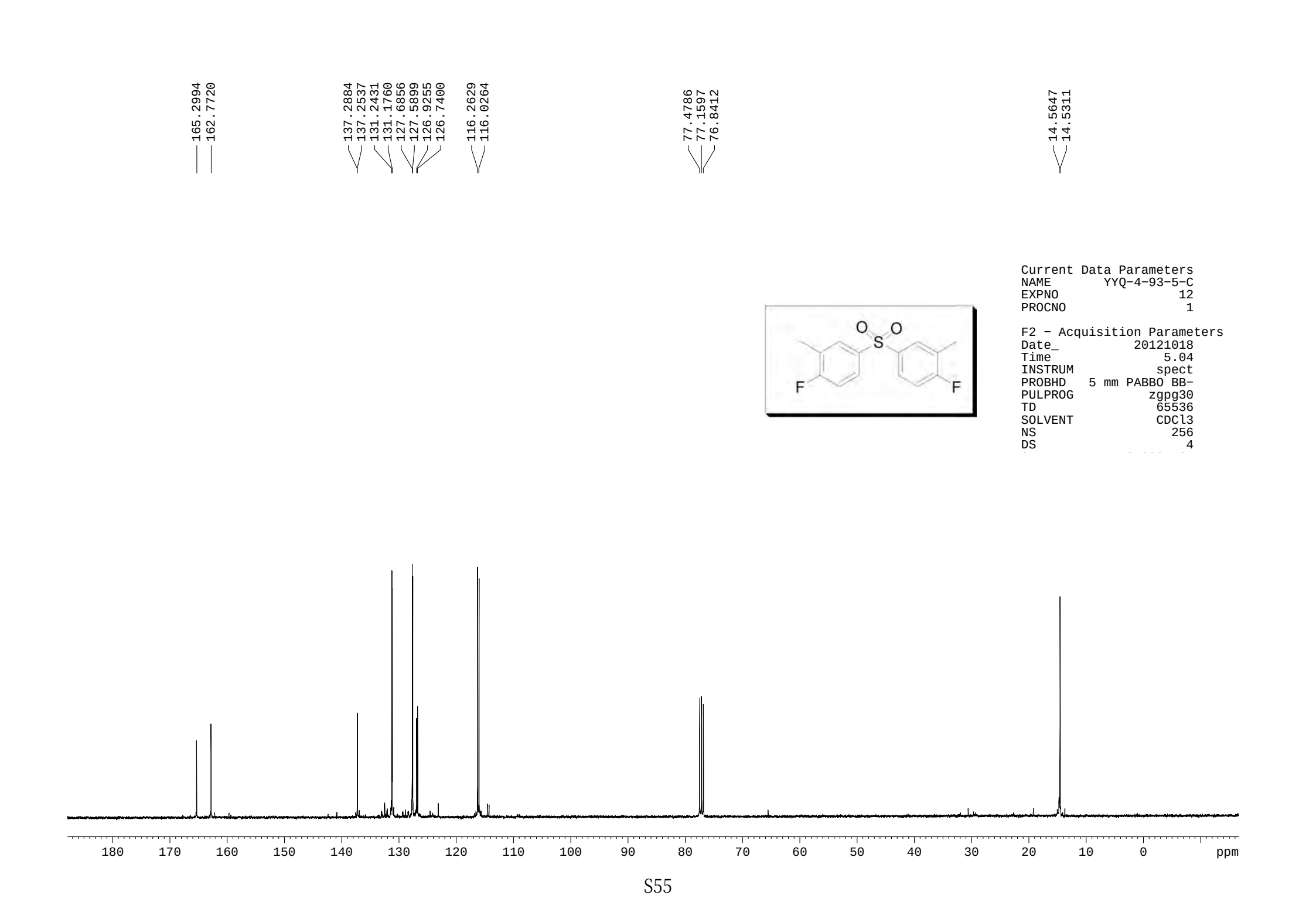

7.9944
7.2725
7.2536
7.0927
7.0735
2.3898
2.2666
Me
O
S
O
Me
Me
Me
Current Data Parameters
NAME YYQ-4-87-3-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121011
Time 2.16
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
1.97
2.10
2.13
6.06
6.00

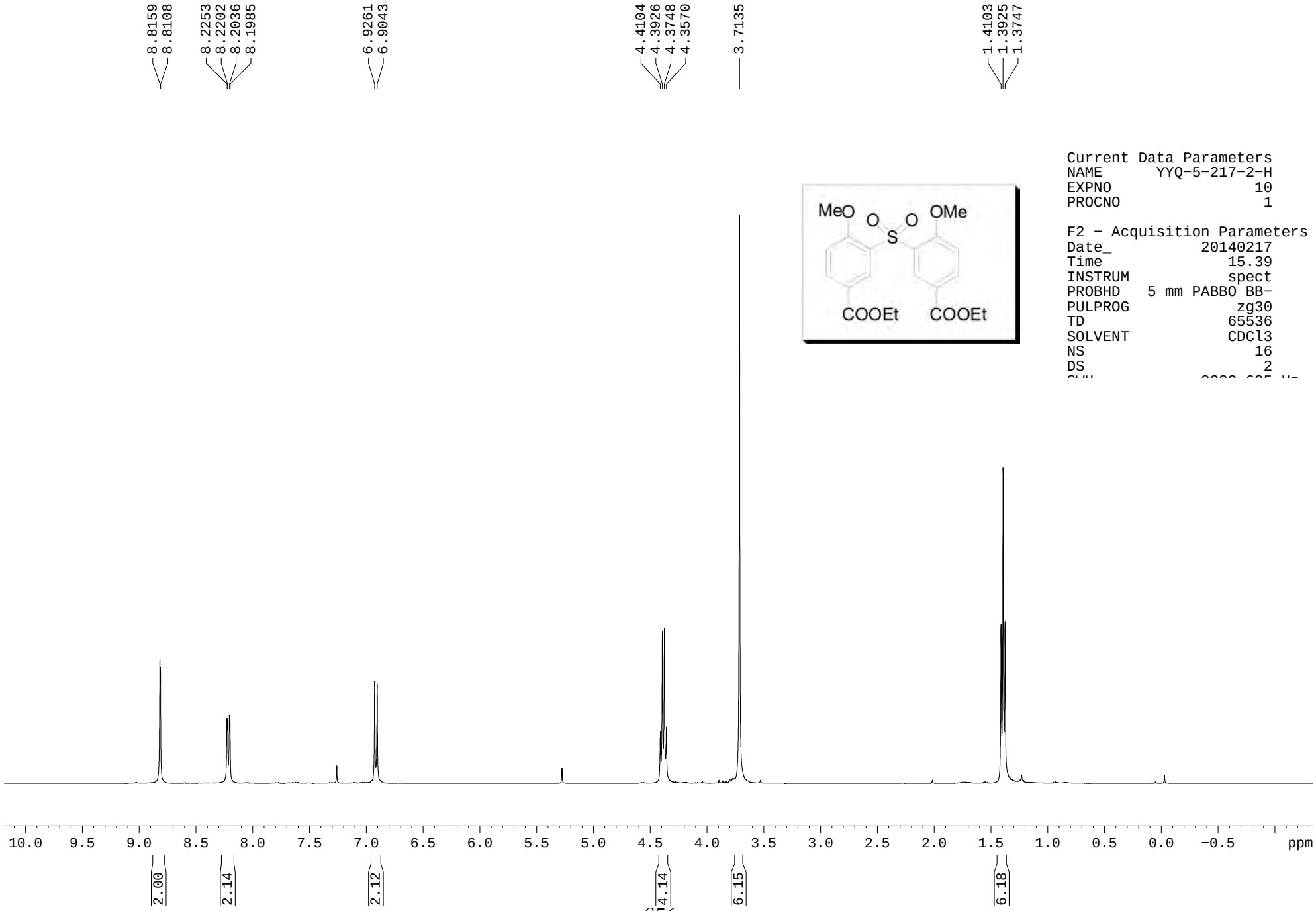

138.6686
136.0236
134.4894
134.1134
132.5425
129.8827
77.4848
77.1665
76.8479
20.9340
19.5434
Me
O
S
O
Me
Me
Me
Current Data Parameters
NAME YYQ-4-87-3-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121011
Time 2.29
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
155 150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 ppm

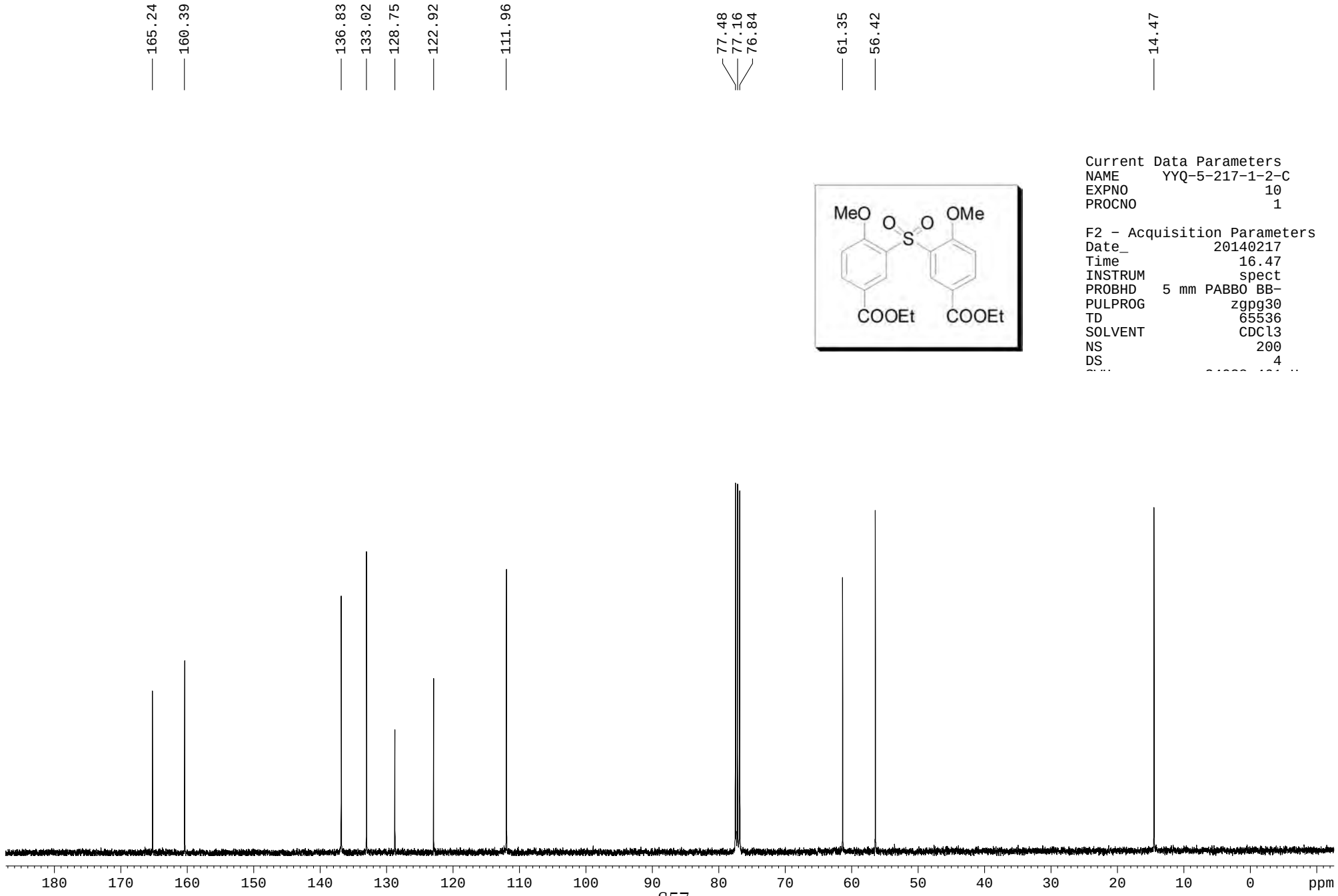

7.5112
7.4900
7.3409
6.8986
6.8774
3.8675
Current Data Parameters
NAME YYQ-4-87-4-H
EXPNO 20
PROCNO 1
F2 - Acquisition Parameter
Date_ 20121011
Time 2.34
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.97
2.02
12.04

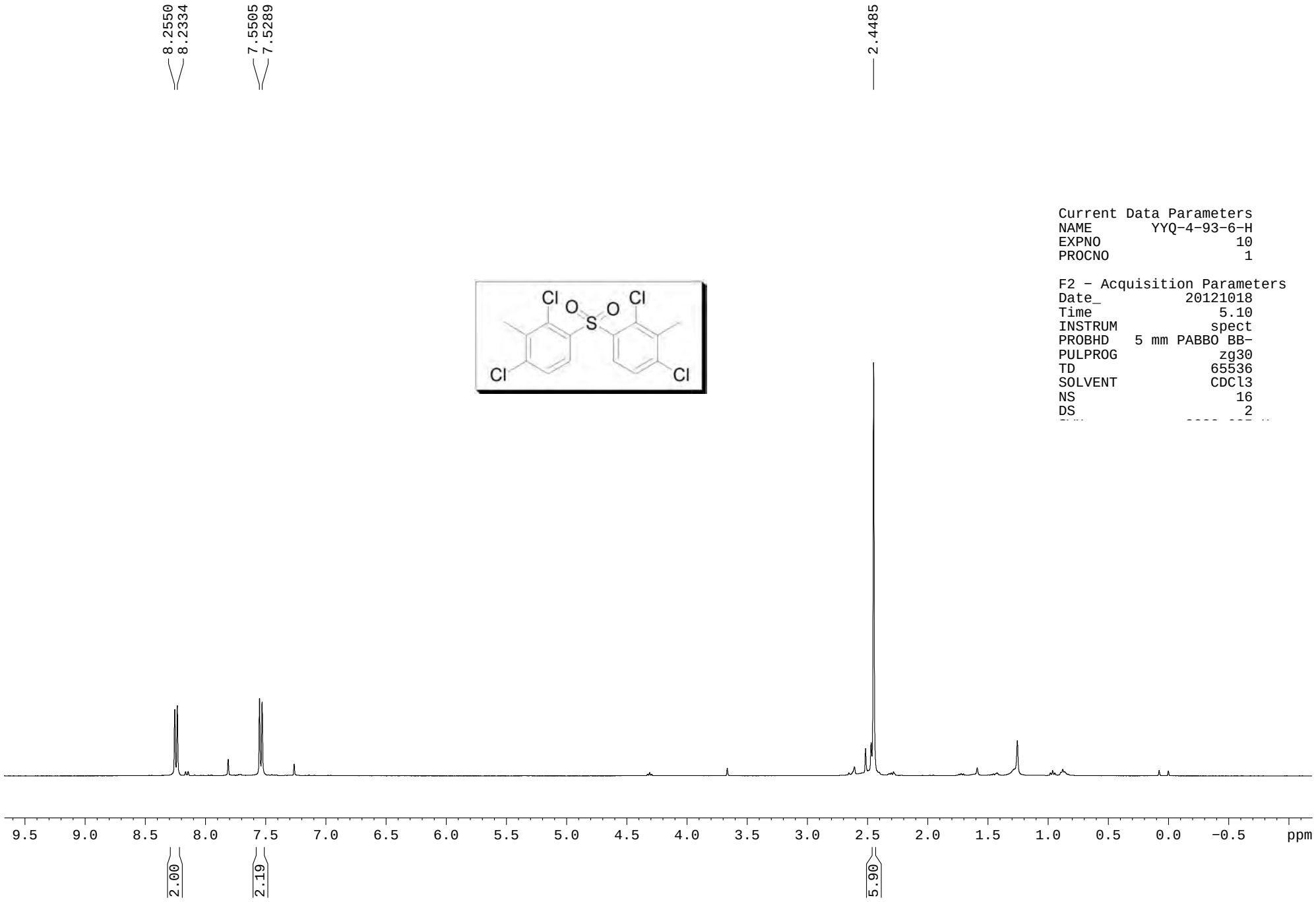

152.84
149.25
133.85
121.49
110.85
109.68
77.48
77.16
76.84
56.29
56.21
Current Data Parameters
NAME YYQ-4-87-4-C
EXPNO 22
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121011
Time 2.46
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
O
O
S
O
O
O
O
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

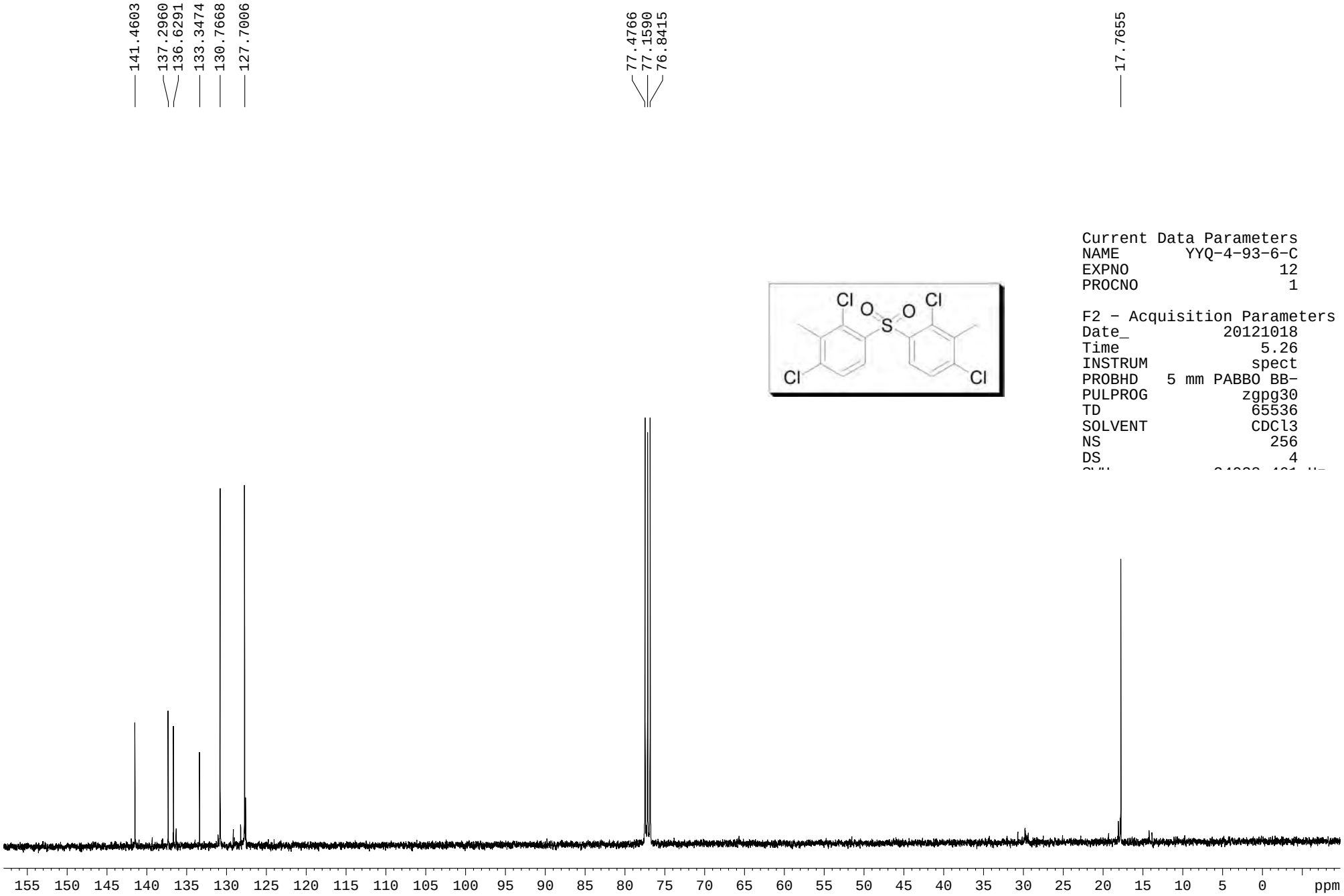

7.8127
7.7951
7.7750
7.7657
7.1365
7.1145
7.0927
2.3076
Current Data Parameters
NAME YYQ-4-93-5-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date 20121018
Time 4.48
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 31.21
DW 60.800 usec
DE 6.50 usec
TE 299.9 K
D1 1.00000000 sec
TD0 1
CHANNEL f1
NUC1 1H
P1 14.77 usec
PLW1 13.00199986 W
SFO1 400.1324710 MHz
F2 - Processing parameters
SI 65536
SF 400.1299941 MHz
WDW EM
SSB 0
LB 0.30 Hz
F
F
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
Scale: 0.3747 ppm/cm, 149.9 Hz/cm
4.00
2.08
6.15

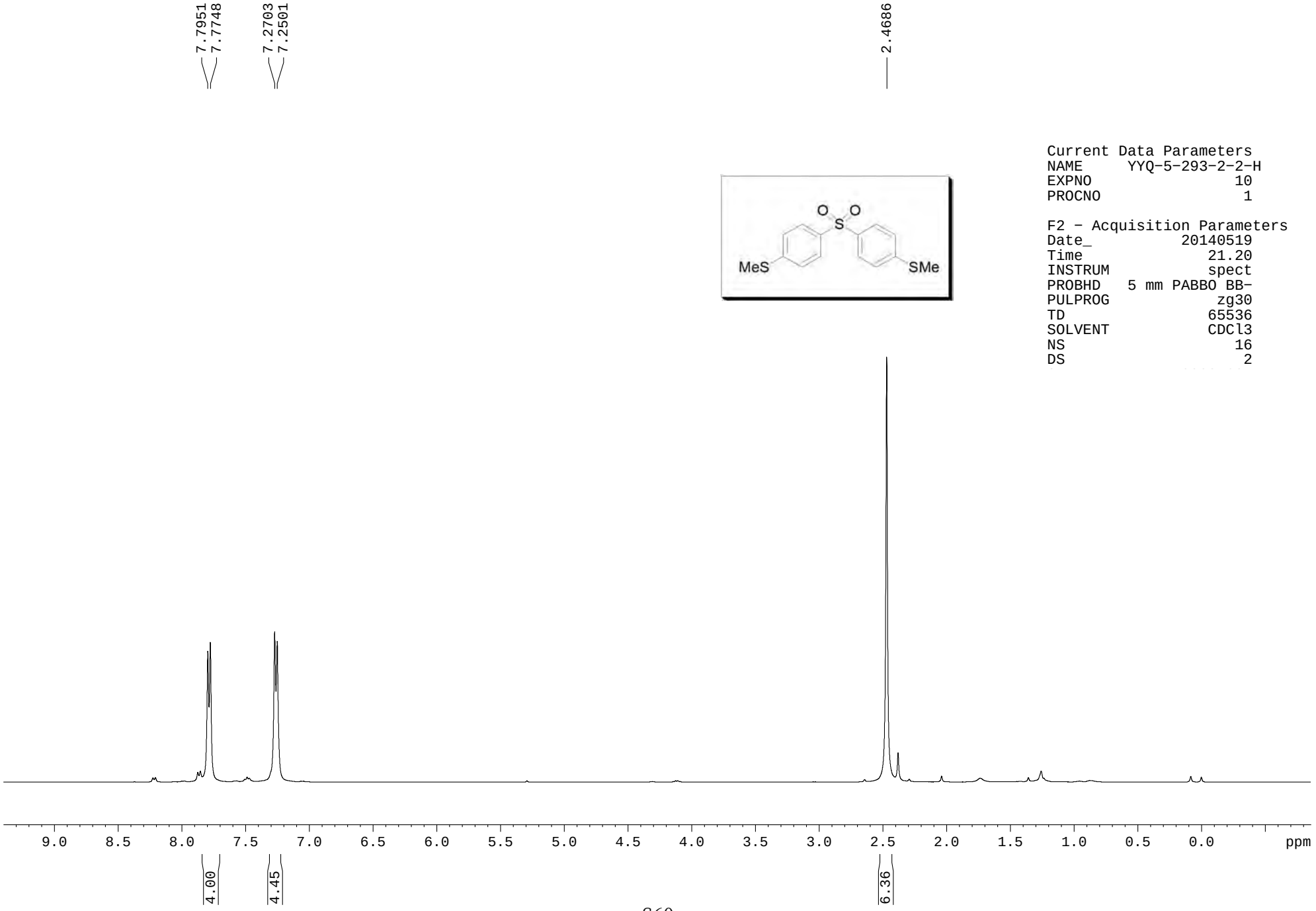

165.2994
162.7720
137.2884
137.2537
131.2431
131.1760
127.6856
127.5899
126.9255
126.7400
116.2629
116.0264
77.4786
77.1597
76.8412
14.5647
14.5311
O
O
S
F
F
Current Data Parameters
NAME YYQ-4-93-5-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121018
Time 5.04
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 256
DS 4
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

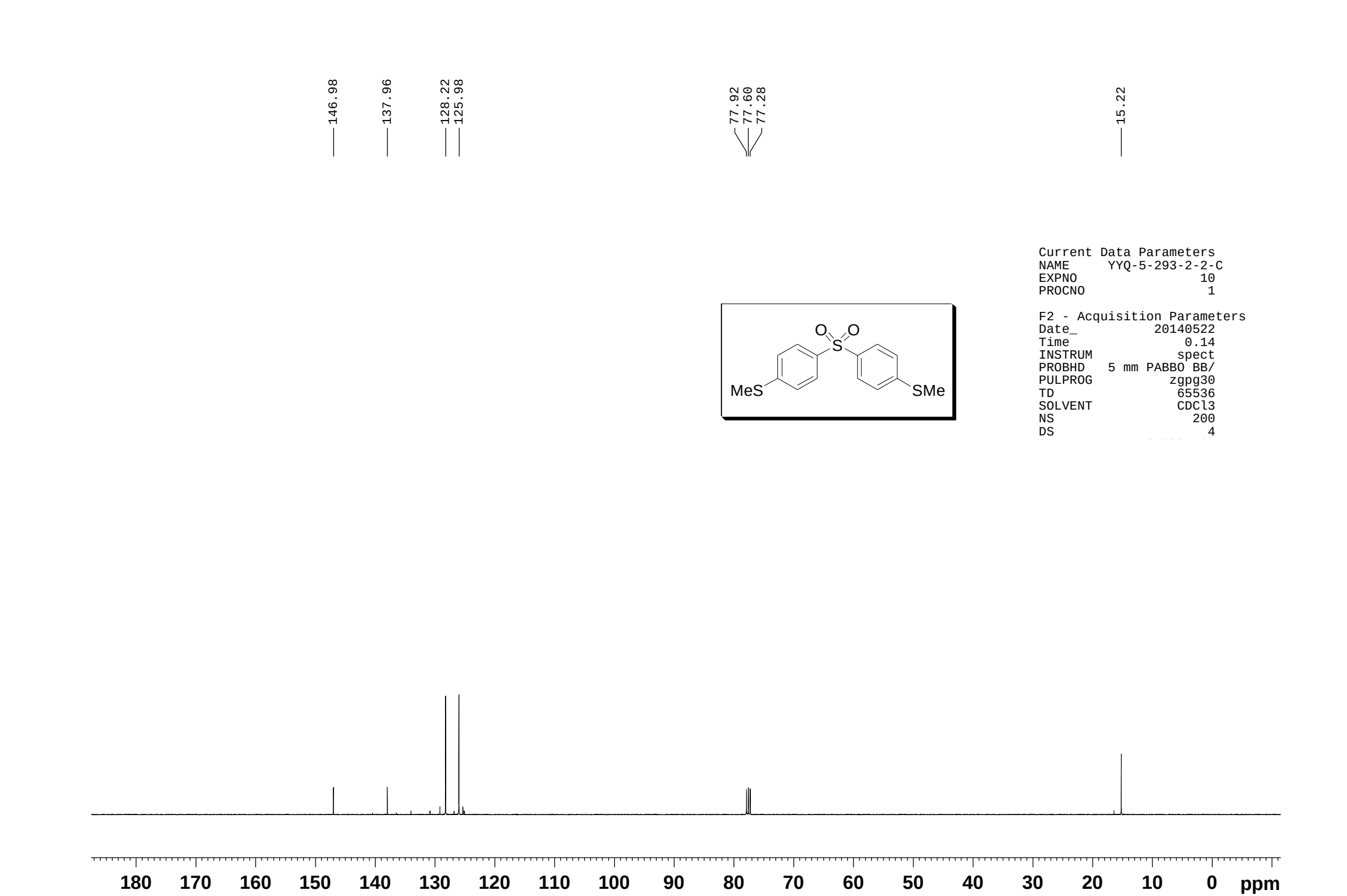

8.8159
8.8108
8.2253
8.2202
8.2036
8.1985
6.9261
6.9043
4.4104
4.3926
4.3748
4.3570
3.7135
1.4103
1.3925
1.3747
MeO
O
S
O
OMe
COOEt
COOEt
Current Data Parameters
NAME YYQ-5-217-2-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140217
Time 15.39
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
2.00
2.14
2.12
4.14
6.15
6.18

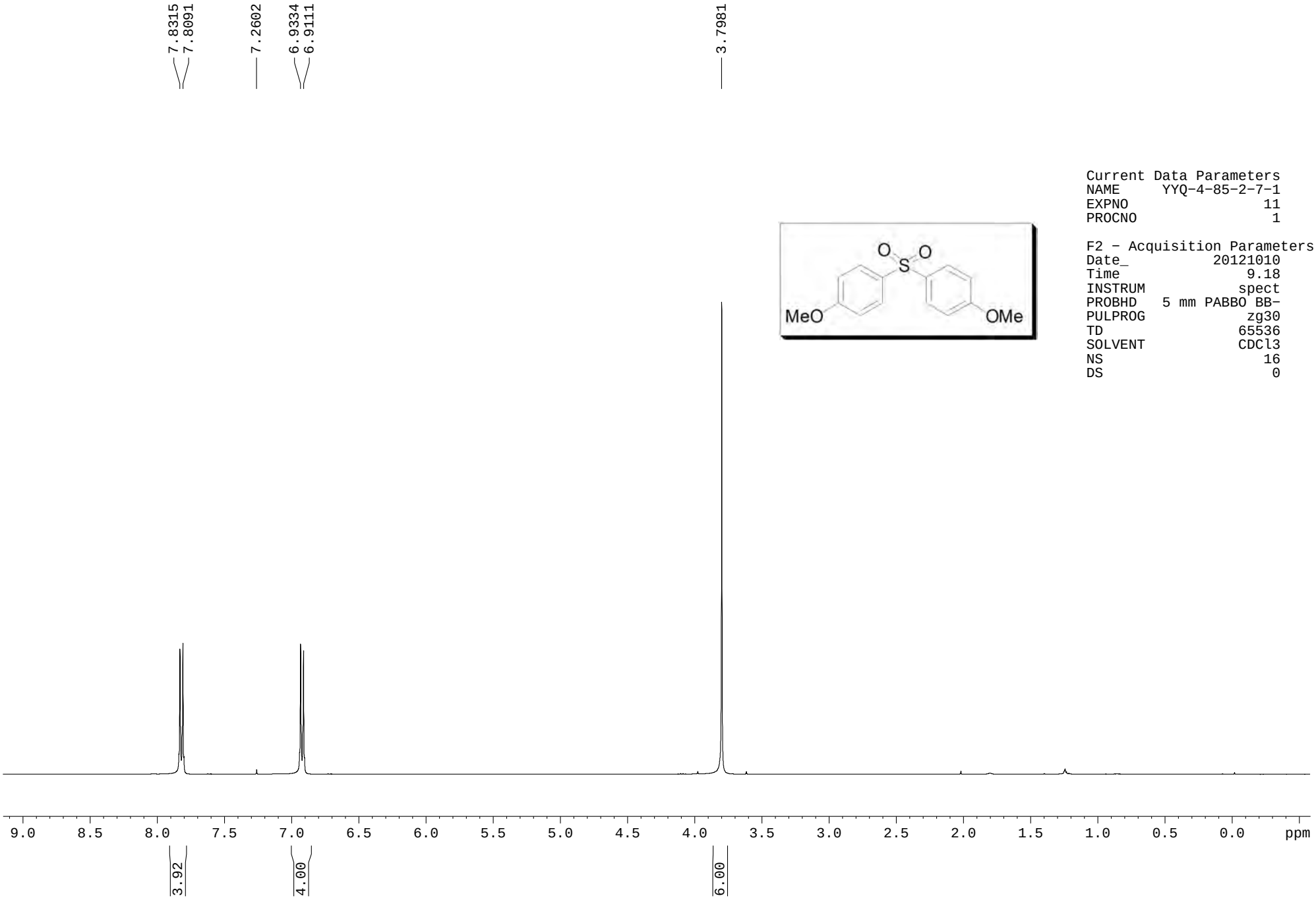

165.24
160.39
136.83
133.02
128.75
122.92
111.96
77.48
77.16
76.84
61.35
56.42
14.47
MeO
OMe
O
S
O
COOEt
COOEt
Current Data Parameters
NAME YYQ-5-217-1-2-C
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140217
Time 16.47
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

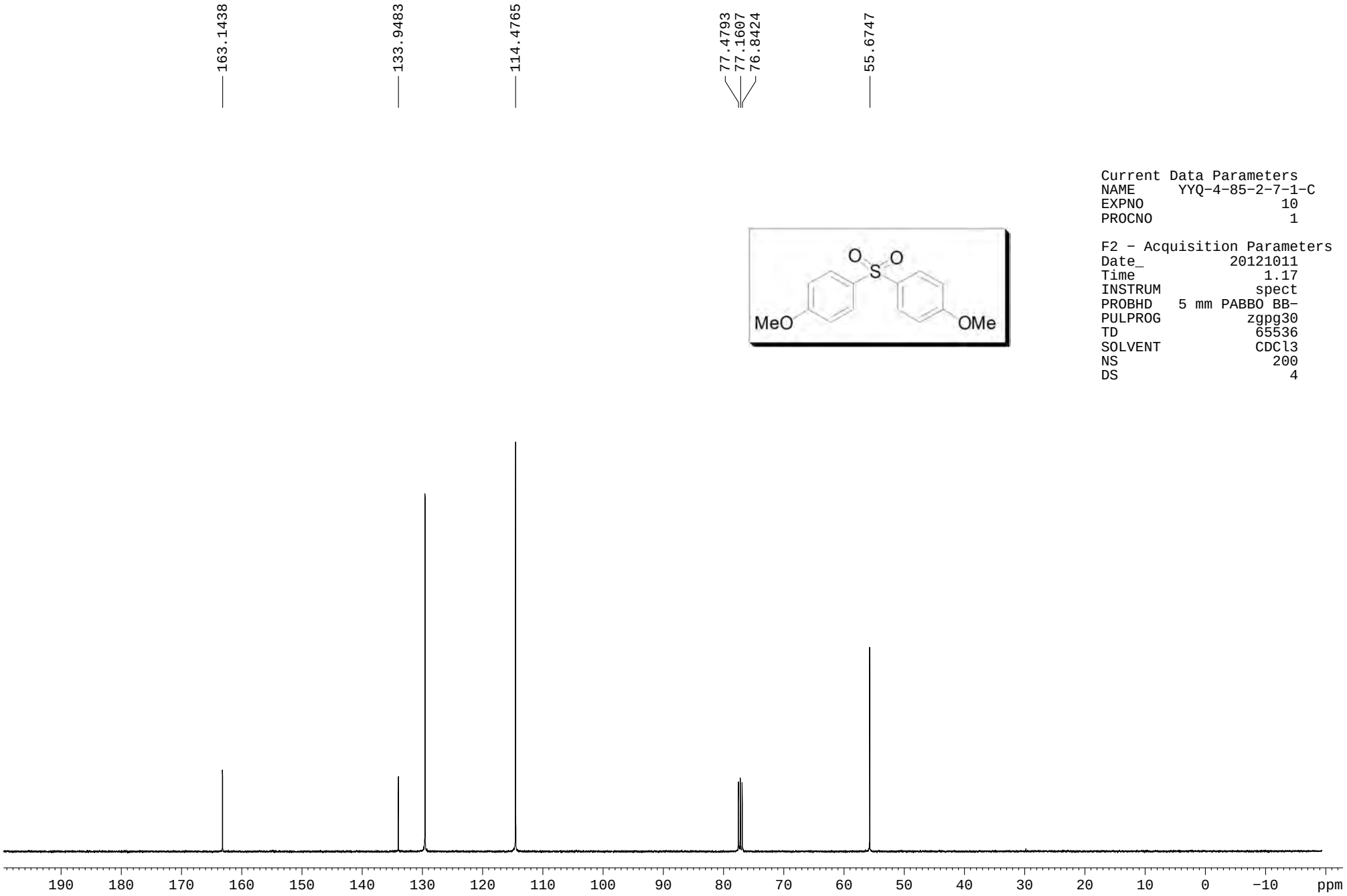

8.2550
8.2334
7.5505
7.5289
2.4485
Current Data Parameters
NAME YYQ-4-93-6-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121018
Time 5.10
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
Cl
O
S
O
Cl
Cl
Cl
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
2.00
2.19
5.90

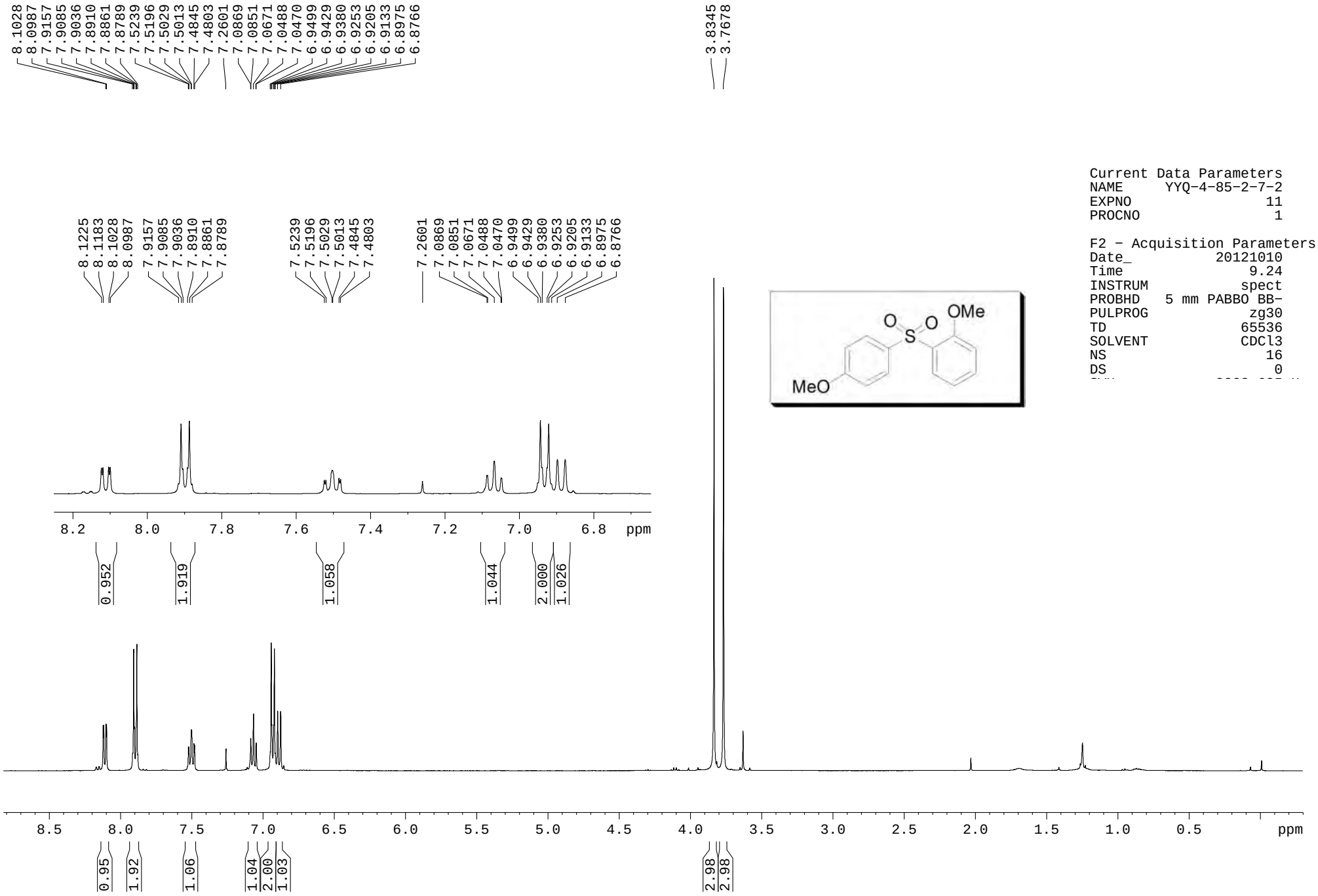

141.4603
137.2960
136.6291
133.3474
130.7668
127.7006
77.4766
77.1590
76.8415
17.7655
Cl
O
S
O
Cl
Cl
Cl
Current Data Parameters
NAME YYQ-4-93-6-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121018
Time 5.26
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 256
DS 4
155 150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 ppm

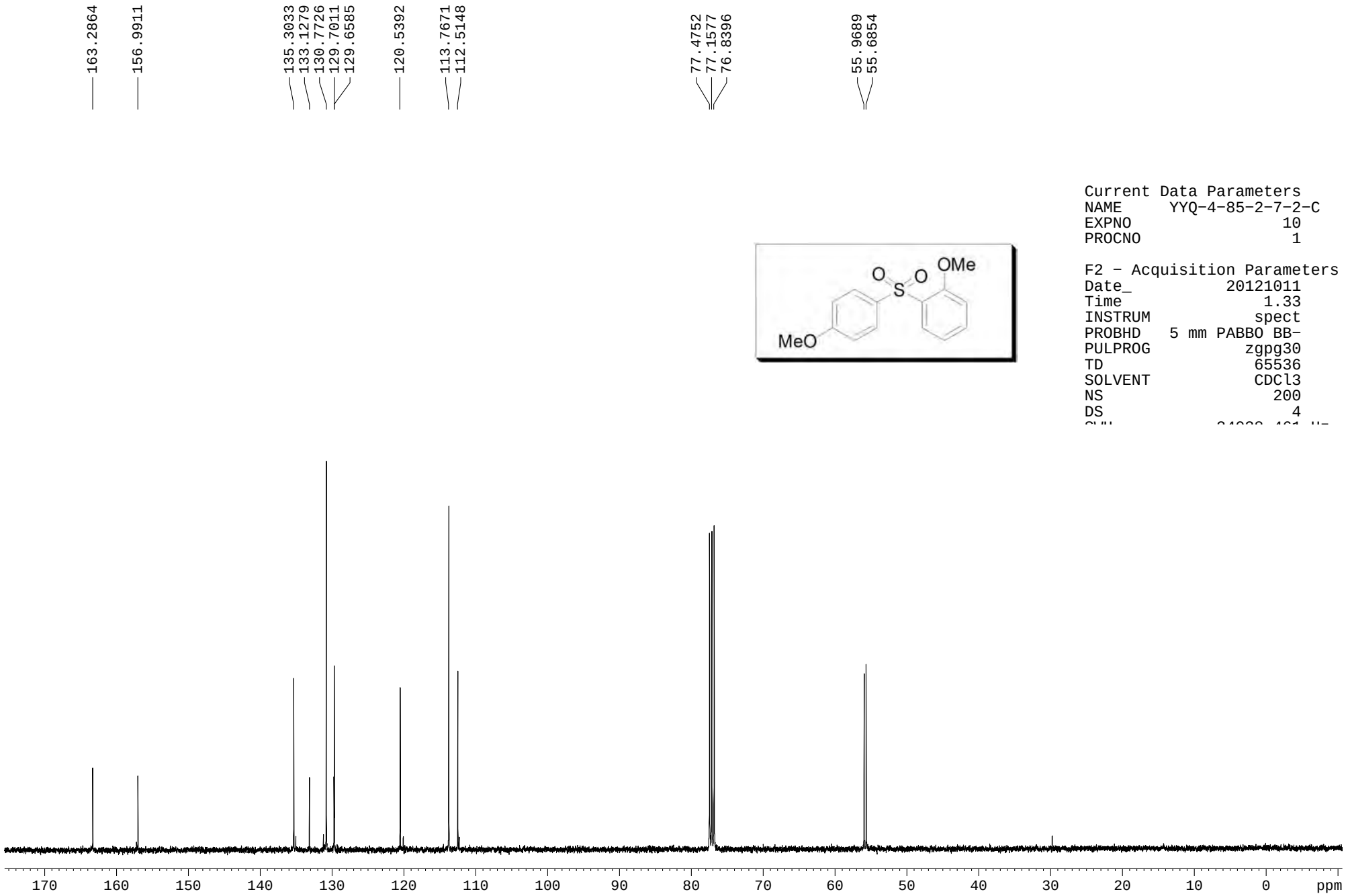

7.7951
7.7748
7.2703
7.2501
2.4686
O
O
S
MeS
SMe
Current Data Parameters
NAME YYQ-5-293-2-2-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140519
Time 21.20
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
4.00
4.45
6.36

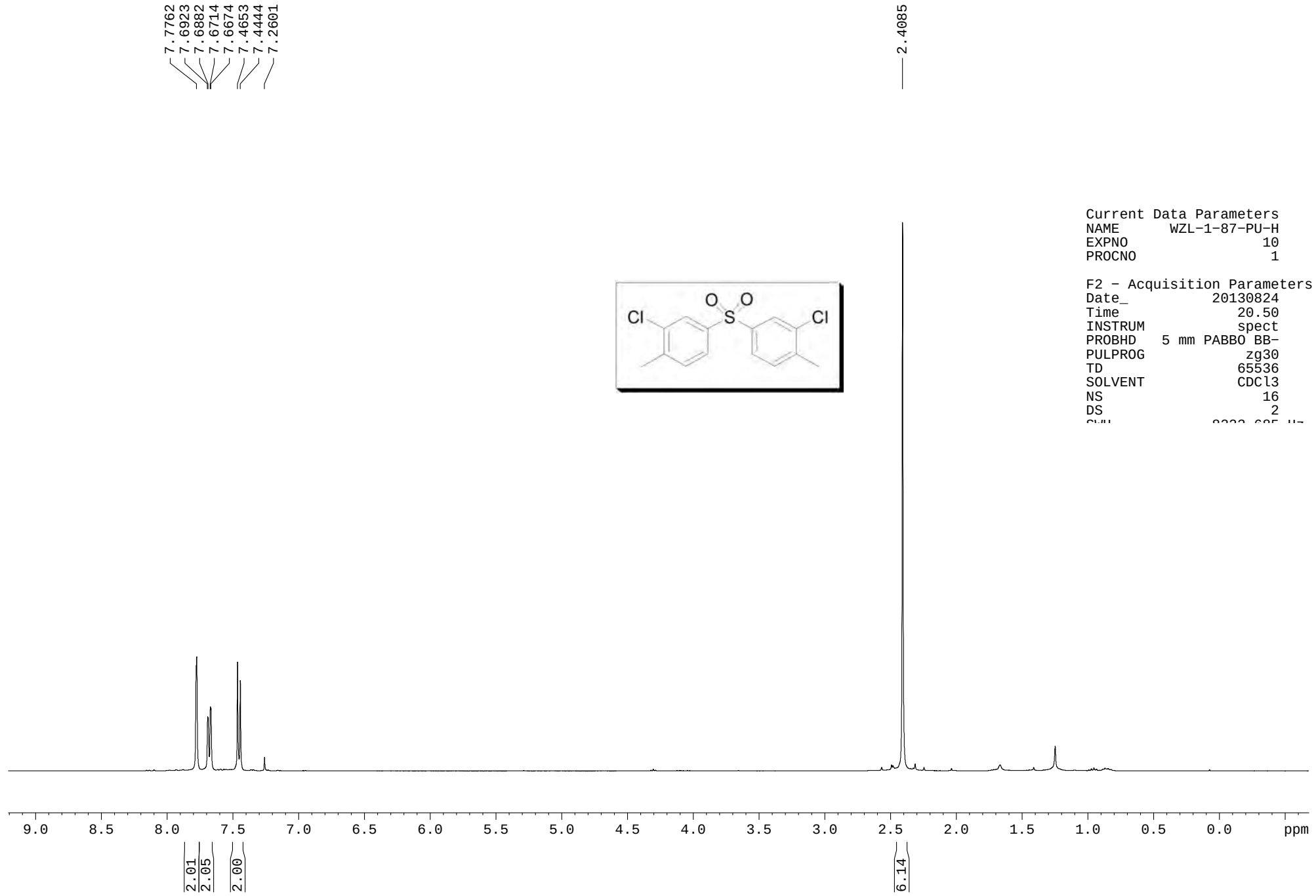

146.98
137.96
128.22
125.98
77.92
77.60
77.28
15.22
O
O
S
MeS
SMe
Current Data Parameters
NAME YYQ-5-293-2-2-C
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140522
Time 0.14
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

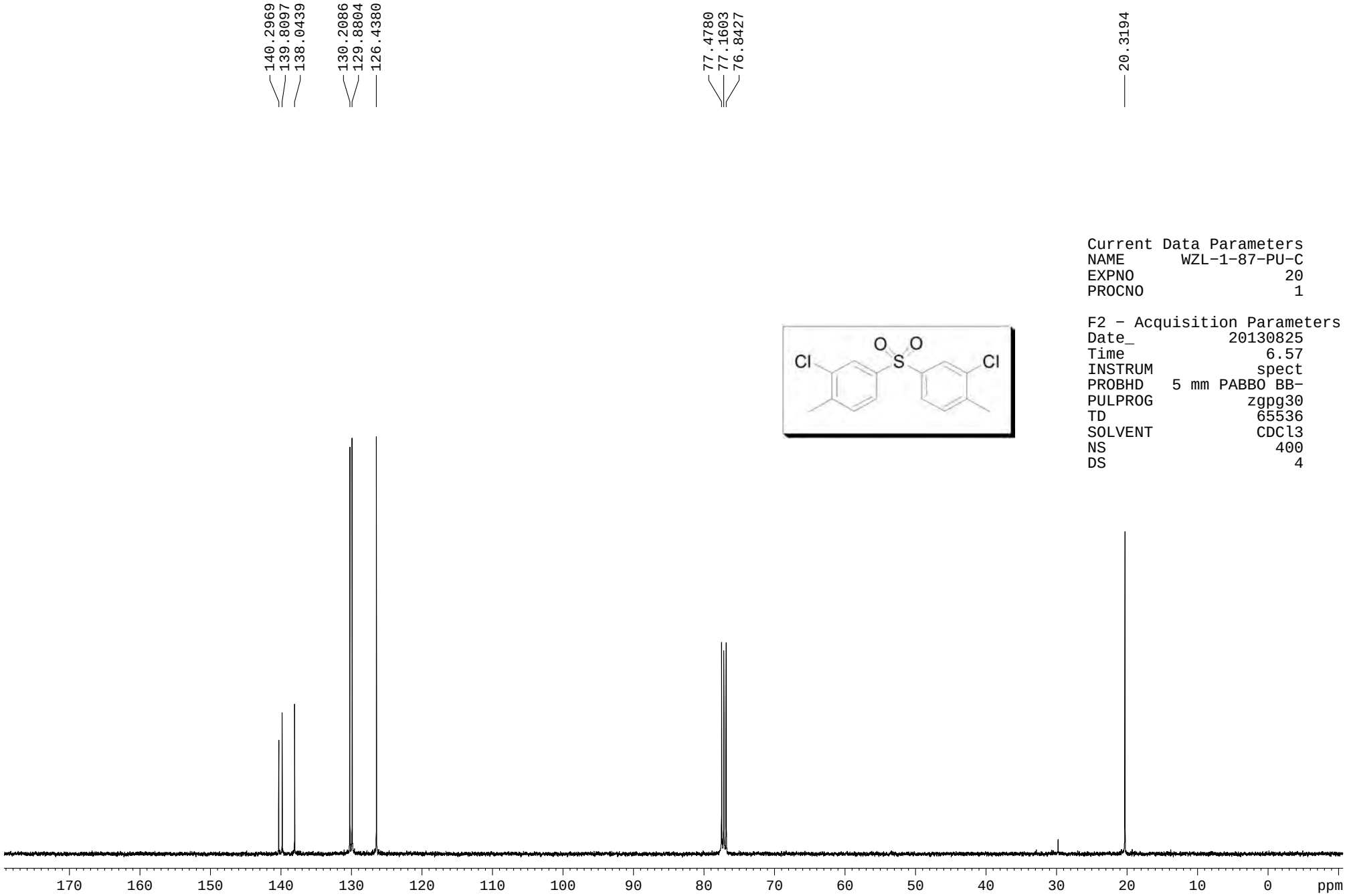

7.8315
7.8091
7.2602
6.9334
6.9111
3.7981
MeO
OMe
Current Data Parameters
NAME YYQ-4-85-2-7-1
EXPNO 11
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121010
Time 9.18
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 0
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
3.92
4.00
6.00

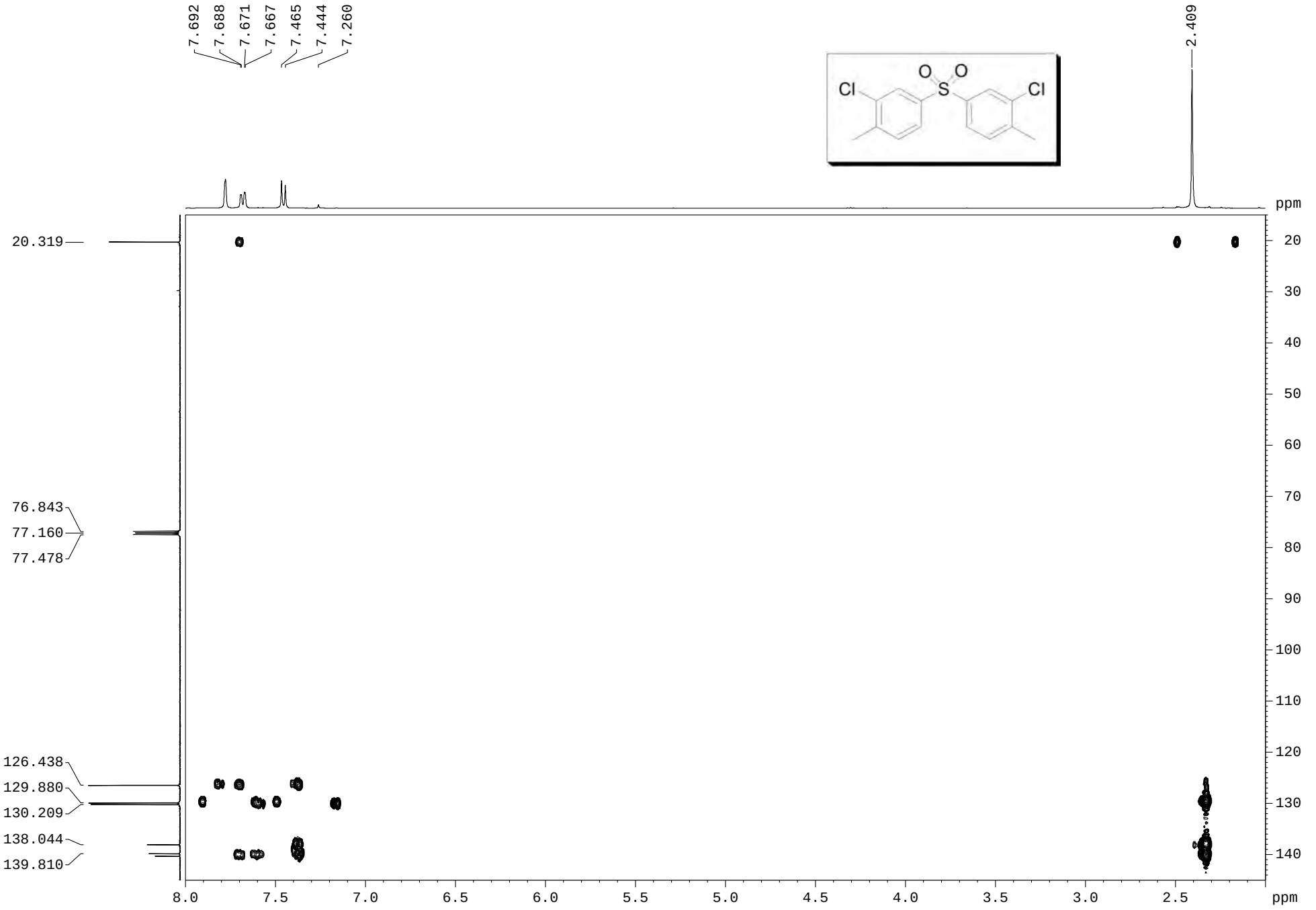

163.1438
133.9483
114.4765
77.4793
77.1607
76.8424
55.6747
MeO
OMe
Current Data Parameters
NAME YYQ-4-85-2-7-1-C
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121011
Time 1.17
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 ppm

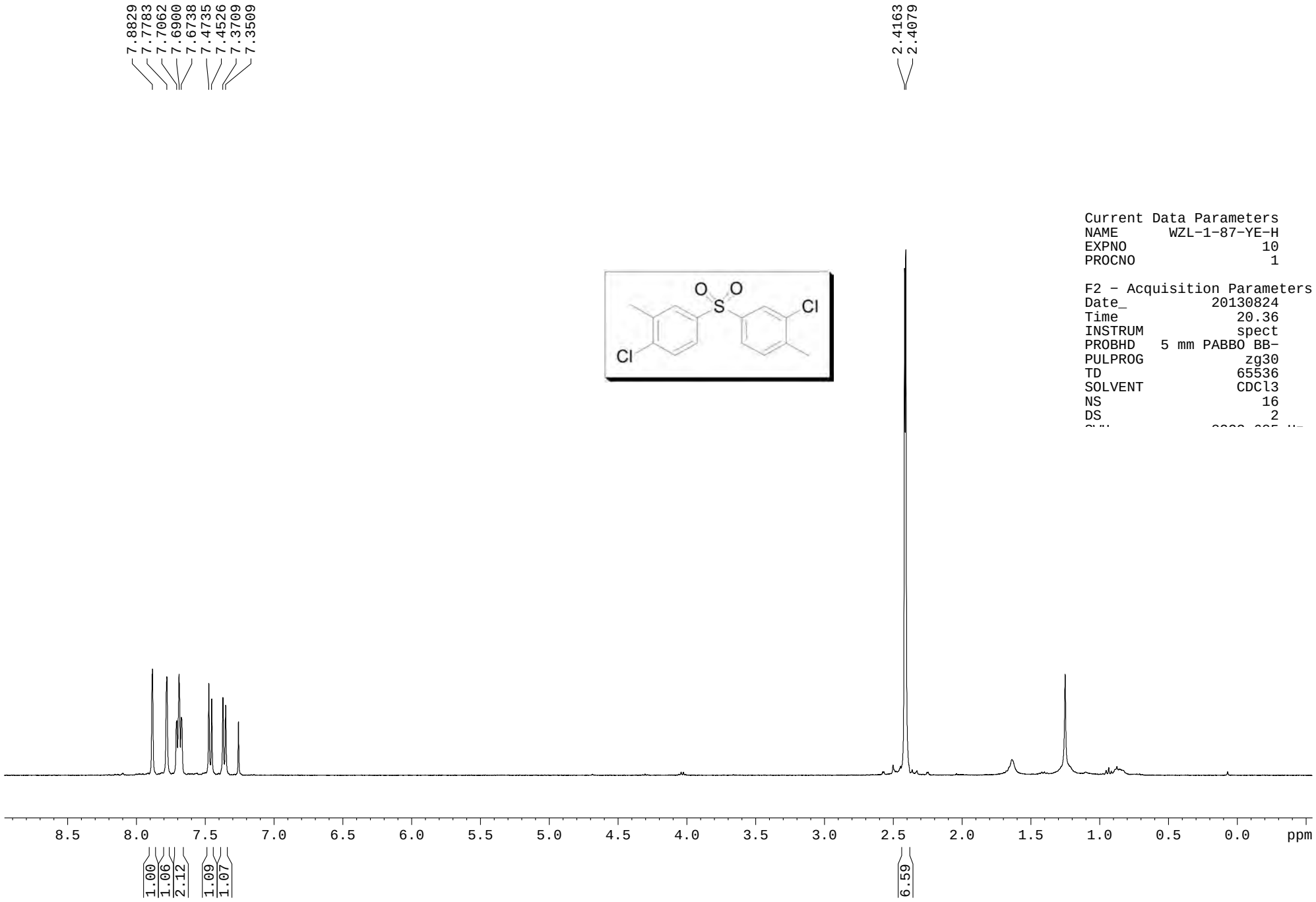

8.1028
8.0987
7.9157
7.9085
7.9036
7.8910
7.8861
7.8789
7.5239
7.5196
7.5029
7.5013
7.4845
7.4803
7.2601
7.0869
7.0851
7.0671
7.0488
7.0470
6.9499
6.9429
6.9380
6.9253
6.9205
6.9133
6.8975
6.8766
3.8345
3.7678
Current Data Parameters
NAME YYQ-4-85-2-7-2
EXPNO 11
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121010
Time 9.24
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 0
O
S
O
OMe
MeO
8.2
8.0
7.8
7.6
7.4
7.2
7.0
6.8
ppm
0.952
1.919
1.058
1.044
2.000
1.026
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
0.95
1.92
1.06
1.04
2.00
1.03
2.98
2.98

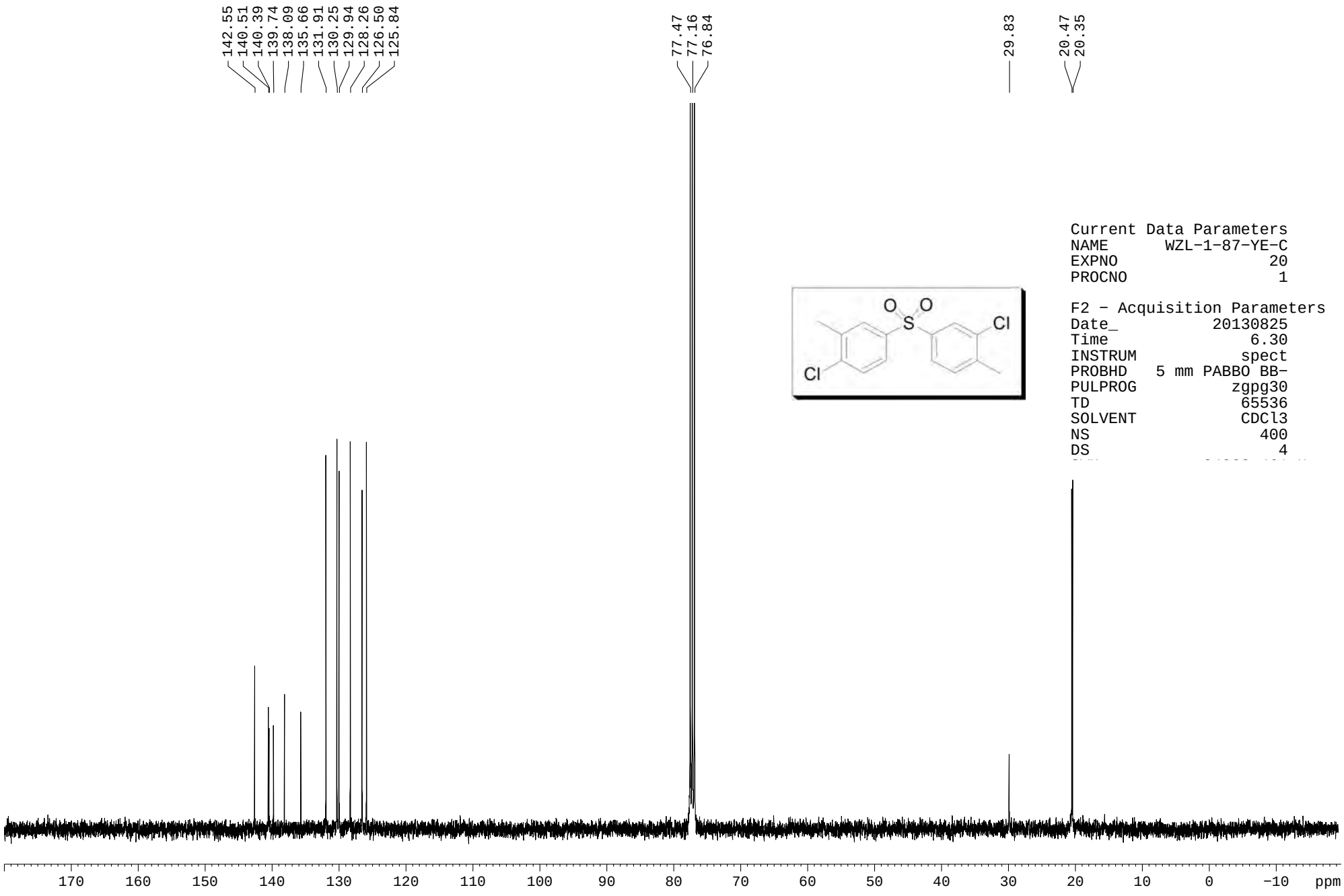

163.2864
156.9911
135.3033
133.1279
130.7726
129.7011
129.6585
120.5392
113.7671
112.5148
77.4752
77.1577
76.8396
55.9689
55.6854
OMe
O
S
O
MeO
Current Data Parameters
NAME YYQ-4-85-2-7-2-C
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121011
Time 1.33
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

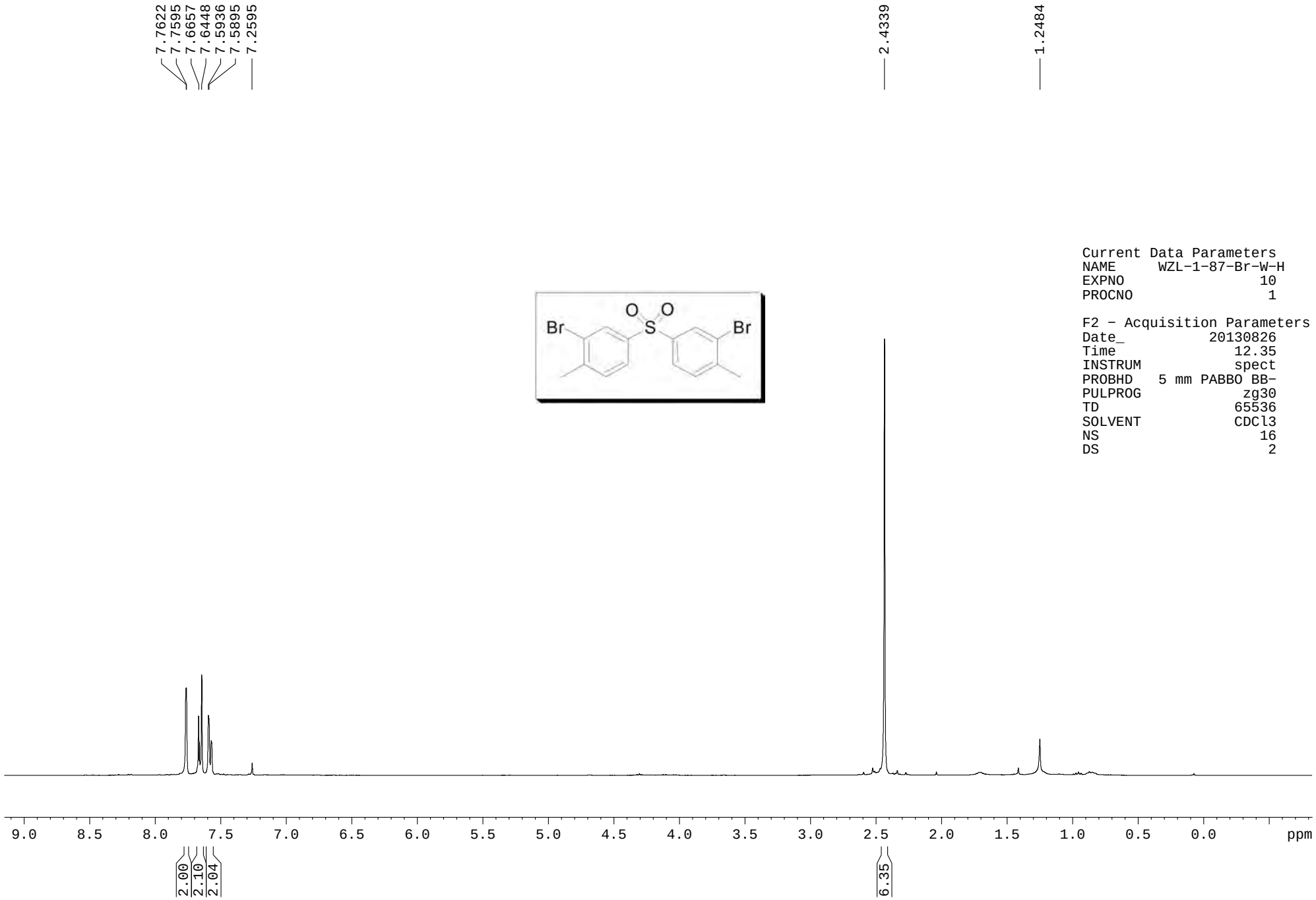

7.7762
7.6923
7.6882
7.6714
7.6674
7.4653
7.4444
7.2601
2.4085
Current Data Parameters
NAME WZL-1-87-PU-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130824
Time 20.50
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
Cl
O
O
S
Cl
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.01
2.05
2.00
6.14

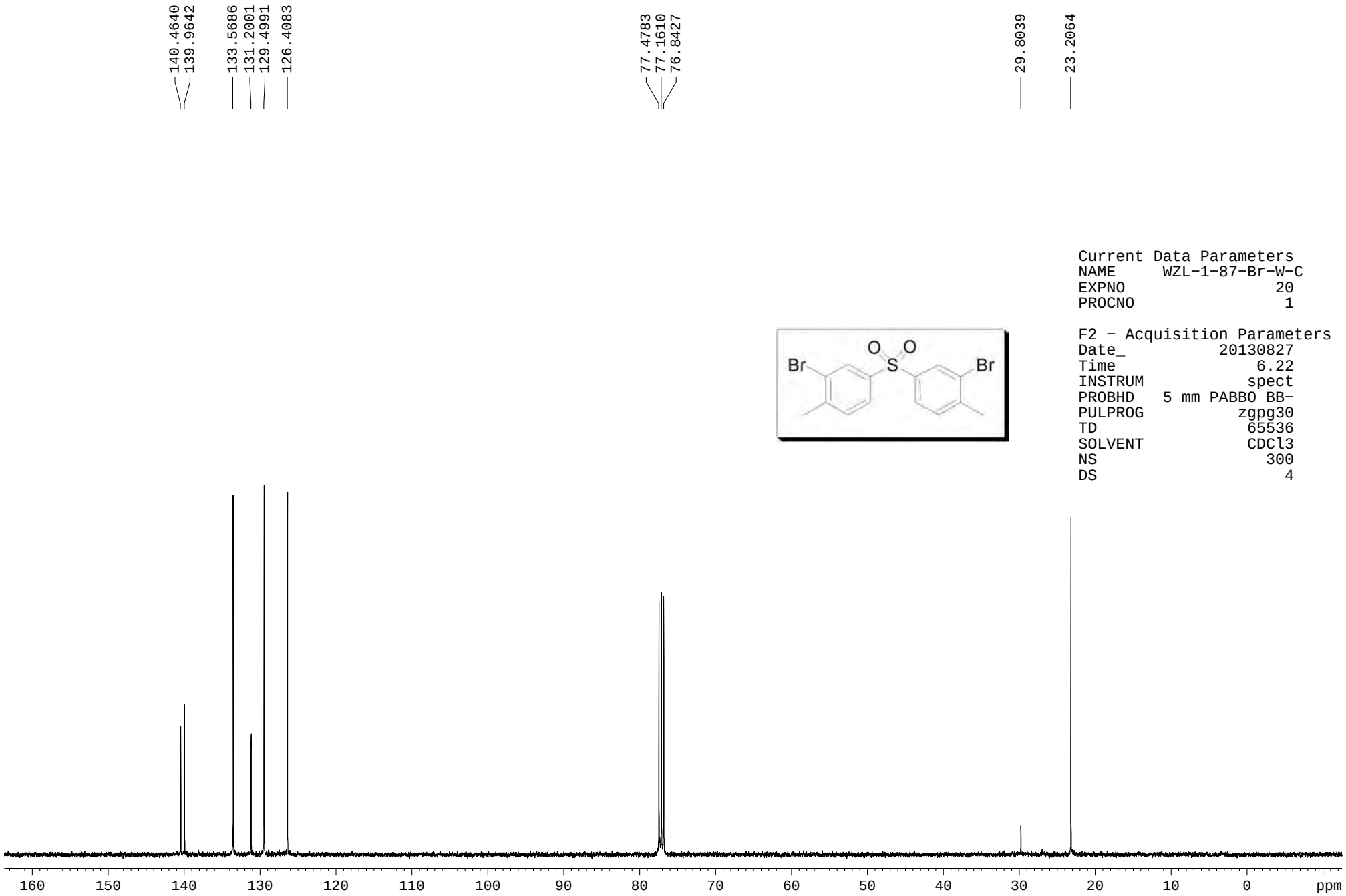

140.2969
139.8097
138.0439
130.2086
129.8804
126.4380
77.4780
77.1603
76.8427
20.3194
Cl
O
O
S
Cl
Current Data Parameters
NAME WZL-1-87-PU-C
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130825
Time 6.57
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 400
DS 4
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

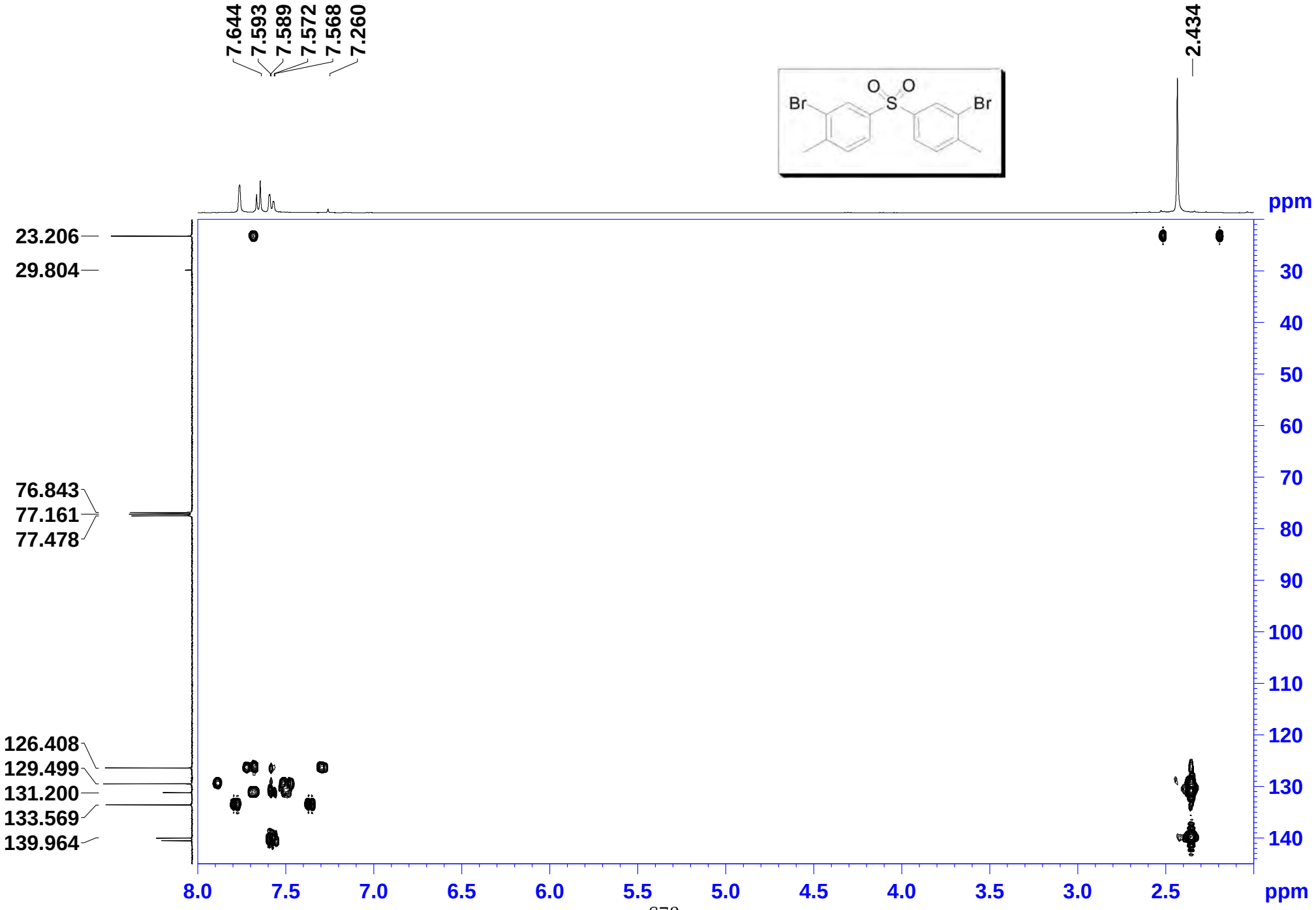

7.692
7.688
7.671
7.667
7.465
7.444
7.260
2.409
Cl
O
O
S
Cl
ppm
20.319
76.843
77.160
77.478
126.438
129.880
130.209
138.044
139.810
20
30
40
50
60
70
80
90
100
110
120
130
140
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
ppm

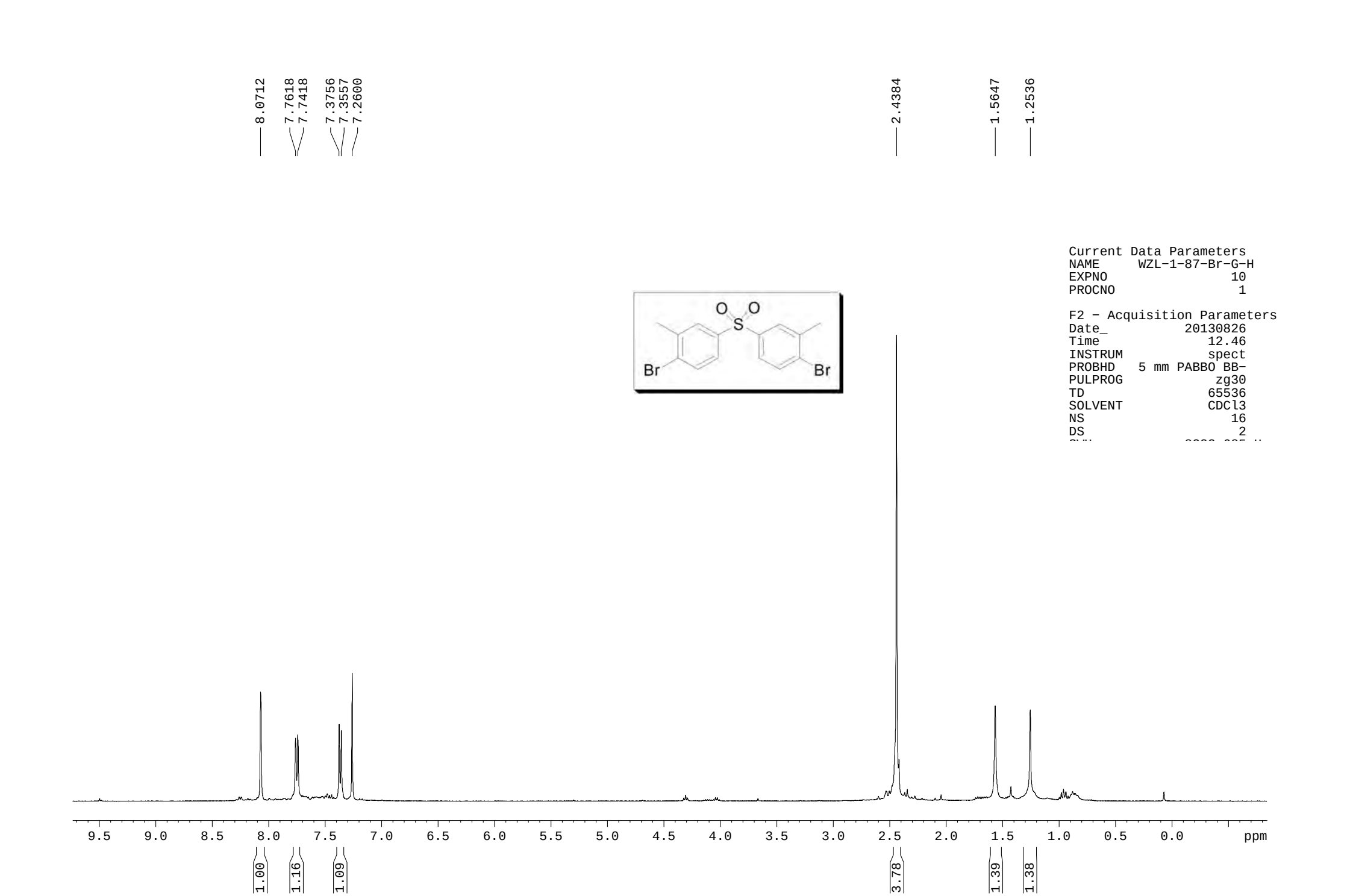

7.8829
7.7783
7.7062
7.6900
7.6738
7.4735
7.4526
7.3709
7.3509
2.4163
2.4079
Current Data Parameters
NAME WZL-1-87-YE-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130824
Time 20.36
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
O
S
Cl
Cl
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.00
1.06
2.12
1.09
1.07
6.59

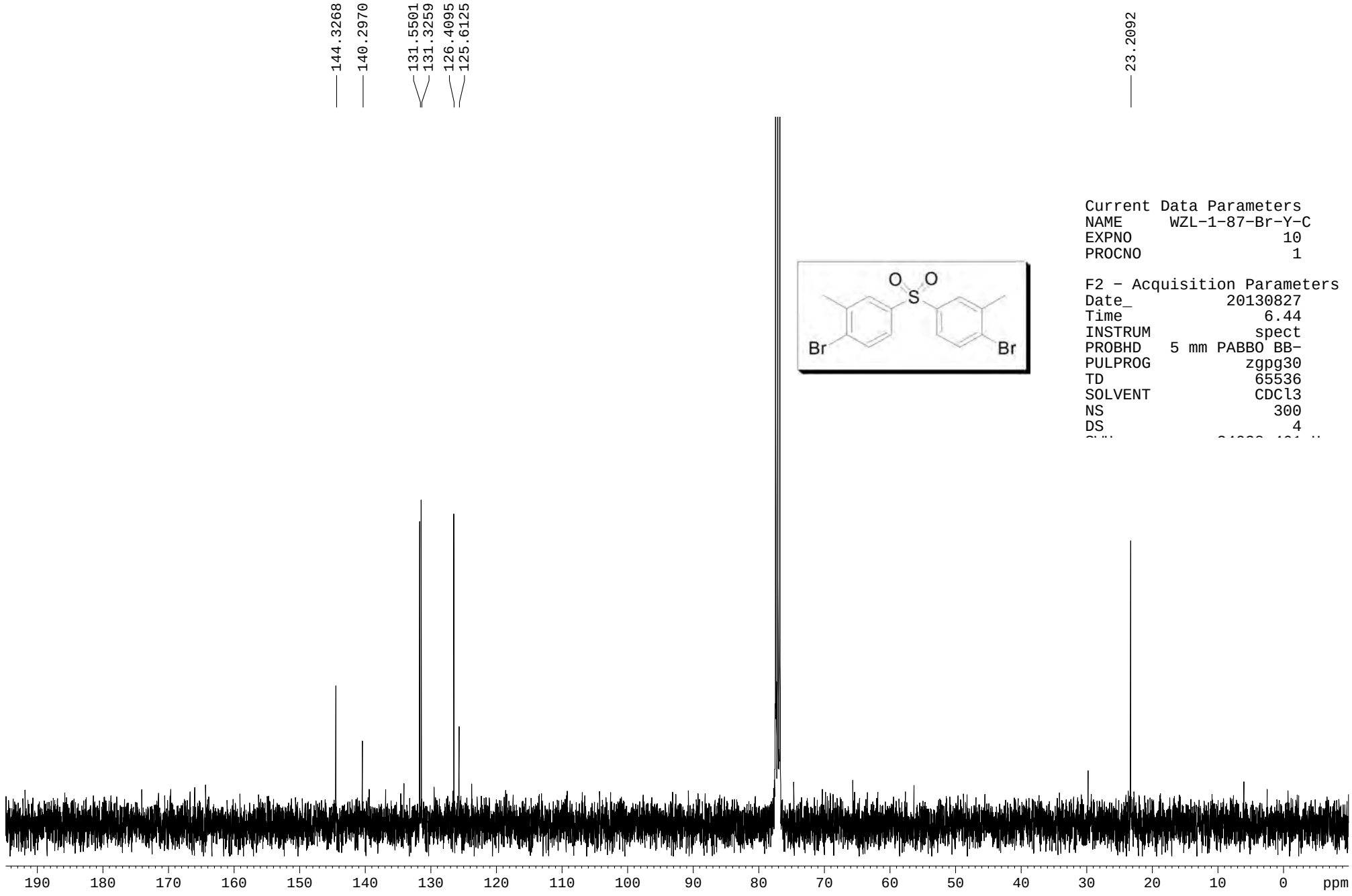

142.55
140.51
140.39
139.74
138.09
135.66
131.91
130.25
129.94
128.26
126.50
125.84
77.47
77.16
76.84
29.83
20.47
20.35
O
O
S
Cl
Cl
Current Data Parameters
NAME WZL-1-87-YE-C
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130825
Time 6.30
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 400
DS 4
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm

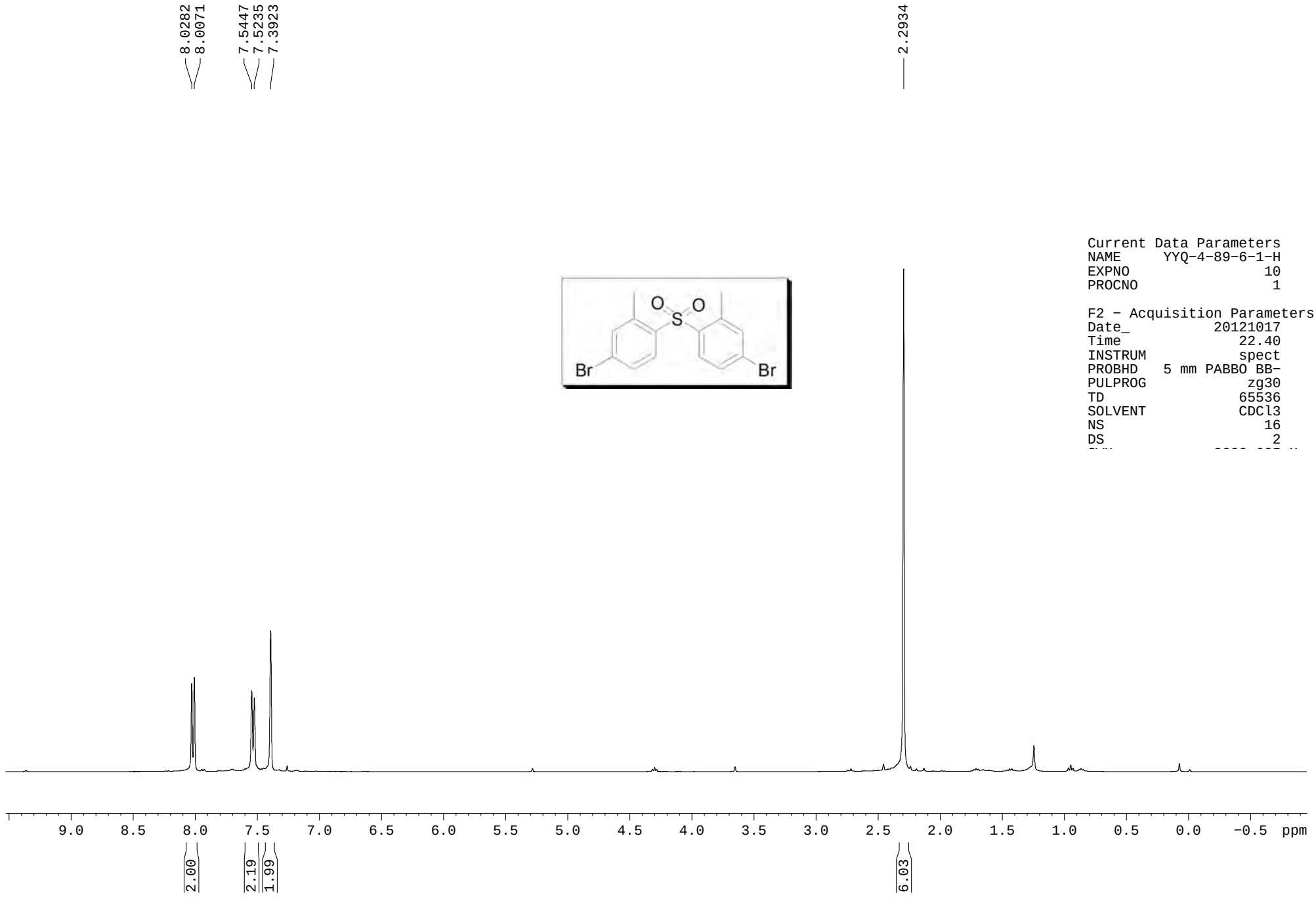

7.7622
7.7595
7.6657
7.6448
7.5936
7.5895
7.2595
2.4339
1.2484
Br
O
S
O
Br
Current Data Parameters
NAME WZL-1-87-Br-W-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130826
Time 12.35
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.00
2.10
2.04
6.35

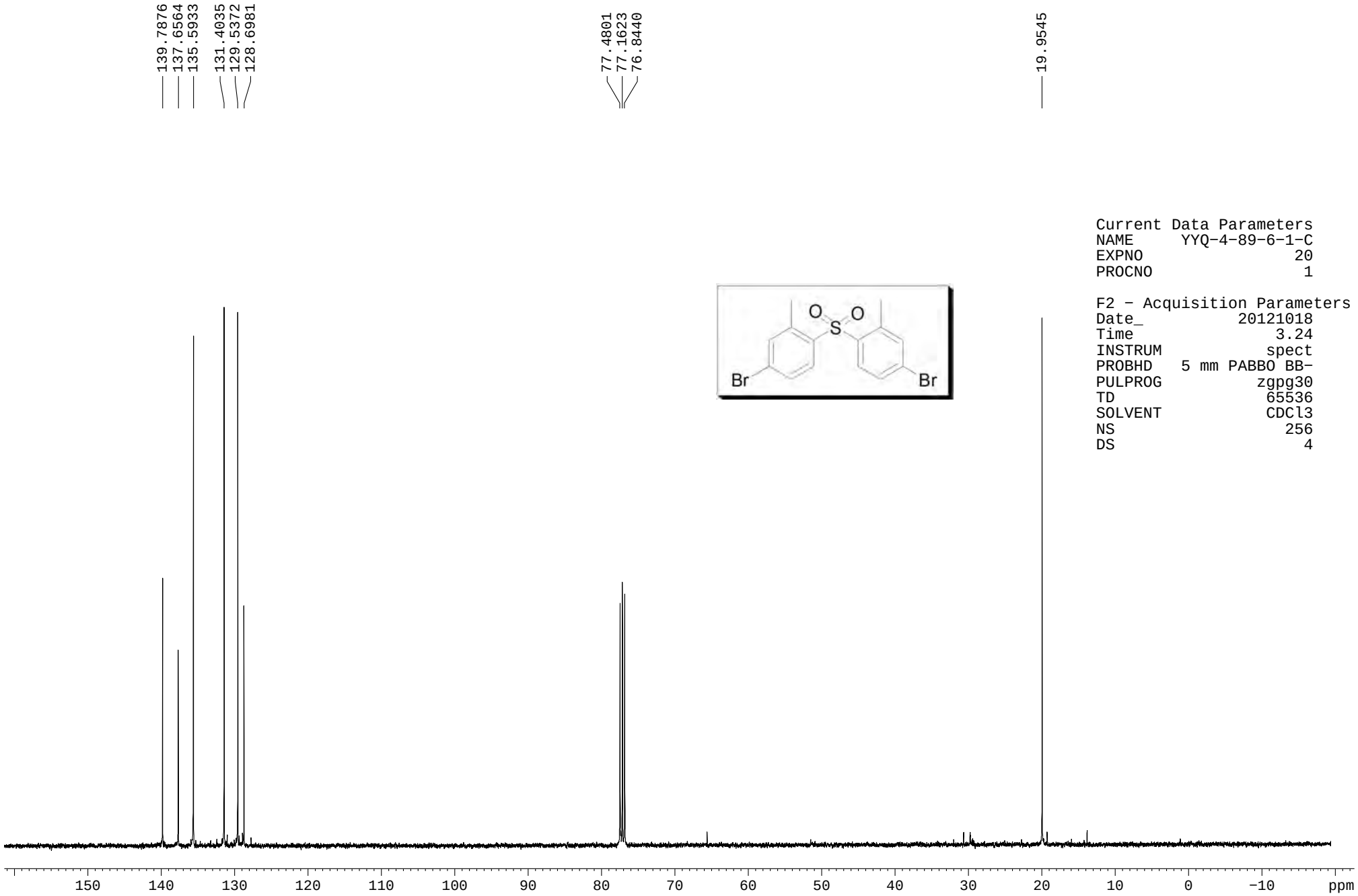

140.4640
139.9642
133.5686
131.2001
129.4991
126.4083
77.4783
77.1610
76.8427
29.8039
23.2064
Br
O
S
O
Br
Current Data Parameters
NAME WZL-1-87-Br-W-C
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130827
Time 6.22
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 300
DS 4
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

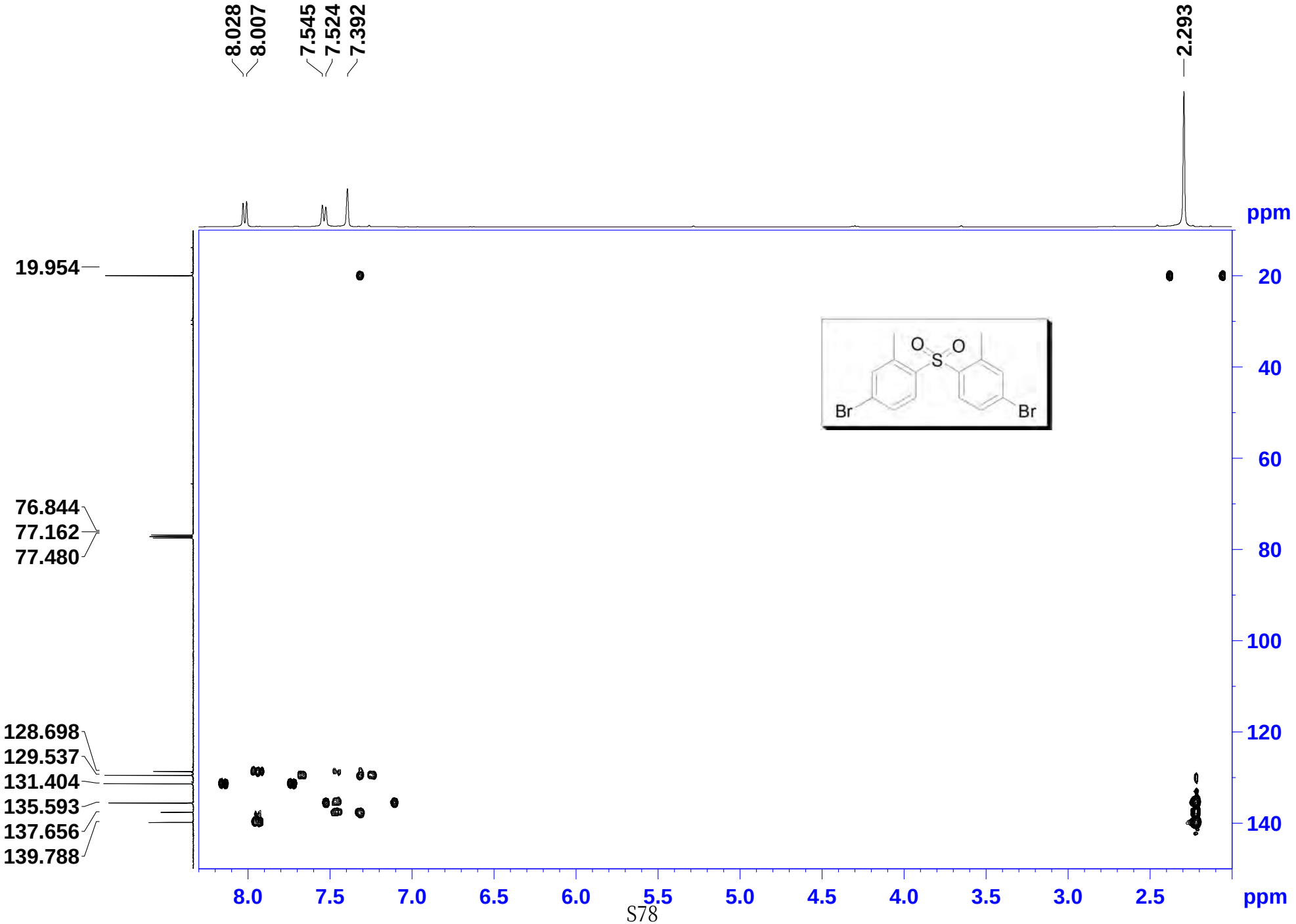

7.644
7.593
7.589
7.572
7.568
7.260
2.434
Br
O
S
O
Br
ppm
23.206
29.804
76.843
77.161
77.478
126.408
129.499
131.200
133.569
139.964
30
40
50
60
70
80
90
100
110
120
130
140
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
ppm

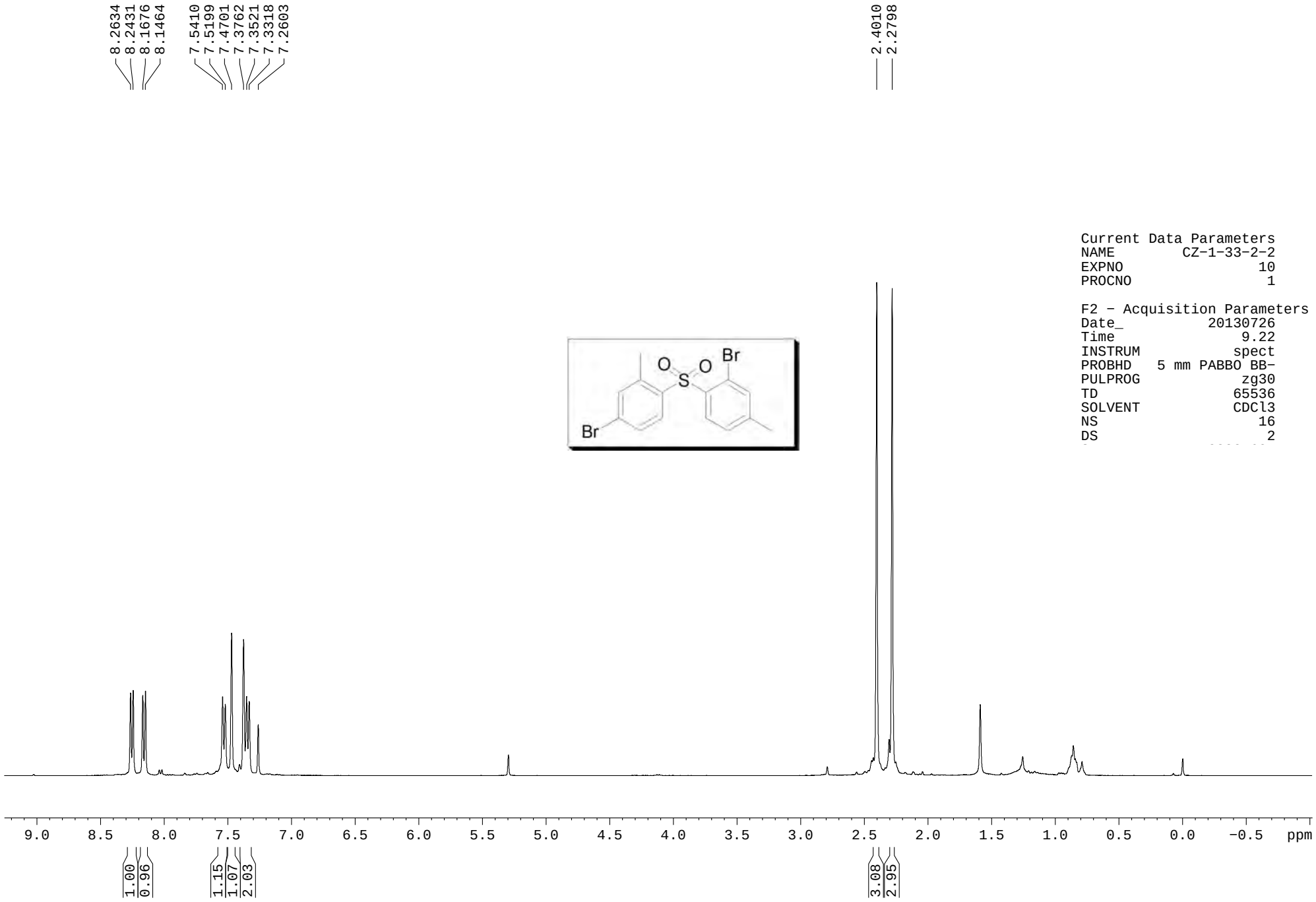

8.0712
7.7618
7.7418
7.3756
7.3557
7.2600
2.4384
1.5647
1.2536
Current Data Parameters
NAME WZL-1-87-Br-G-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130826
Time 12.46
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
O
S
Br
Br
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.00
1.16
1.09
3.78
1.39
1.38

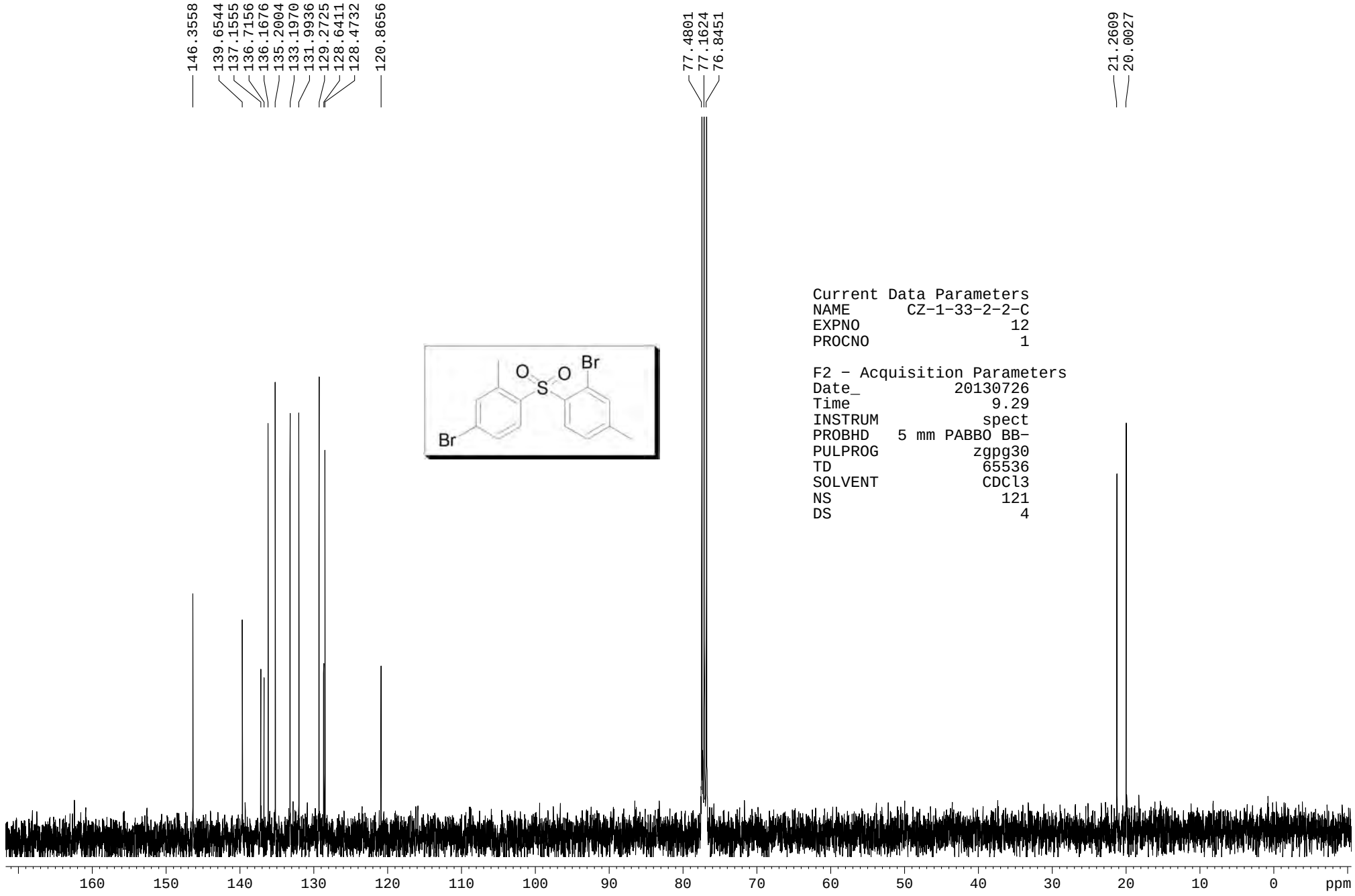

144.3268
140.2970
131.5501
131.3259
126.4095
125.6125
23.2092
O
O
S
Br
Br
Current Data Parameters
NAME WZL-1-87-Br-Y-C
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130827
Time 6.44
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 300
DS 4
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

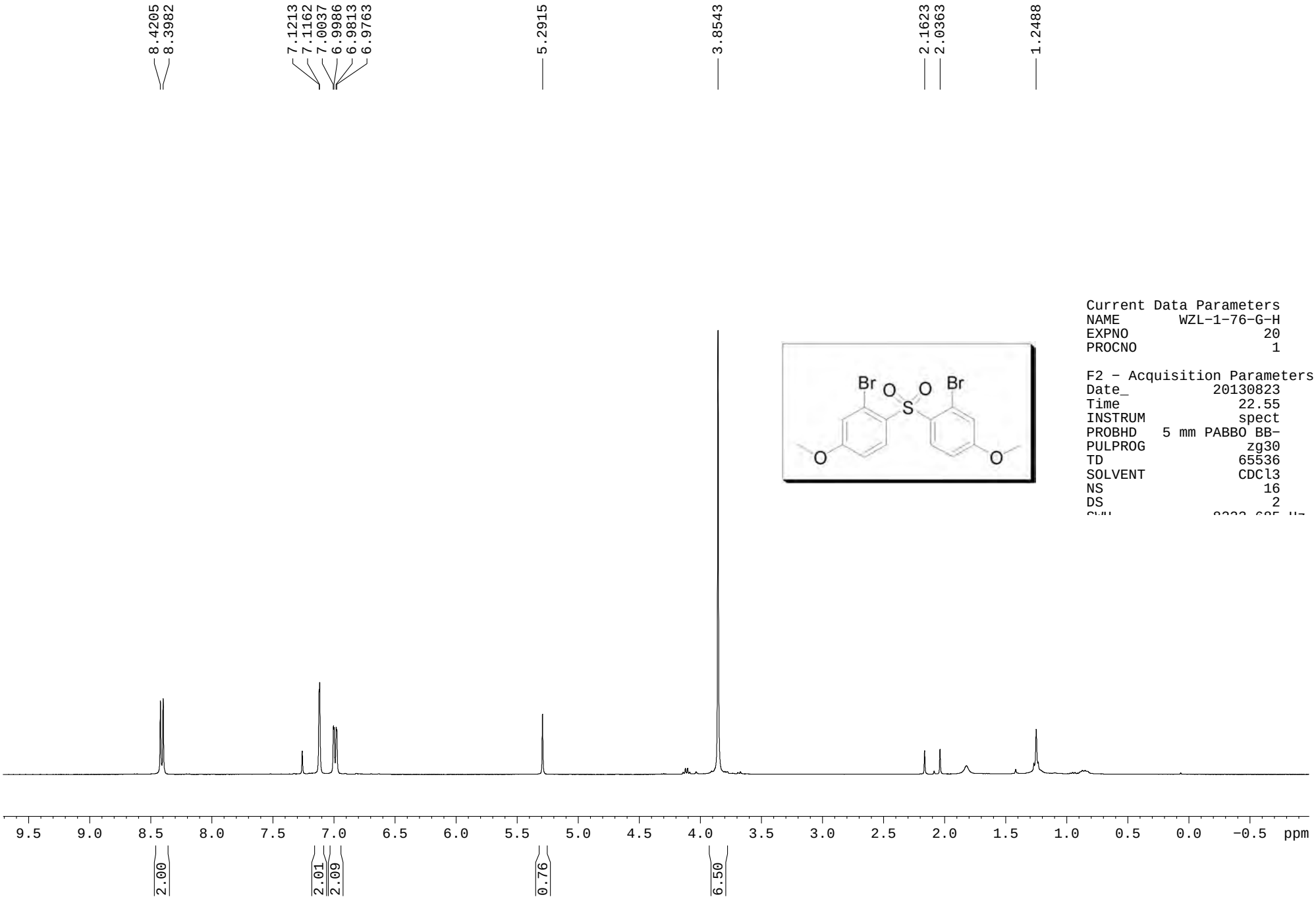

8.0282
8.0071
7.5447
7.5235
7.3923
2.2934
Current Data Parameters
NAME YYQ-4-89-6-1-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121017
Time 22.40
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
S
O
Br
Br
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
ppm
2.00
2.19
1.99
6.03

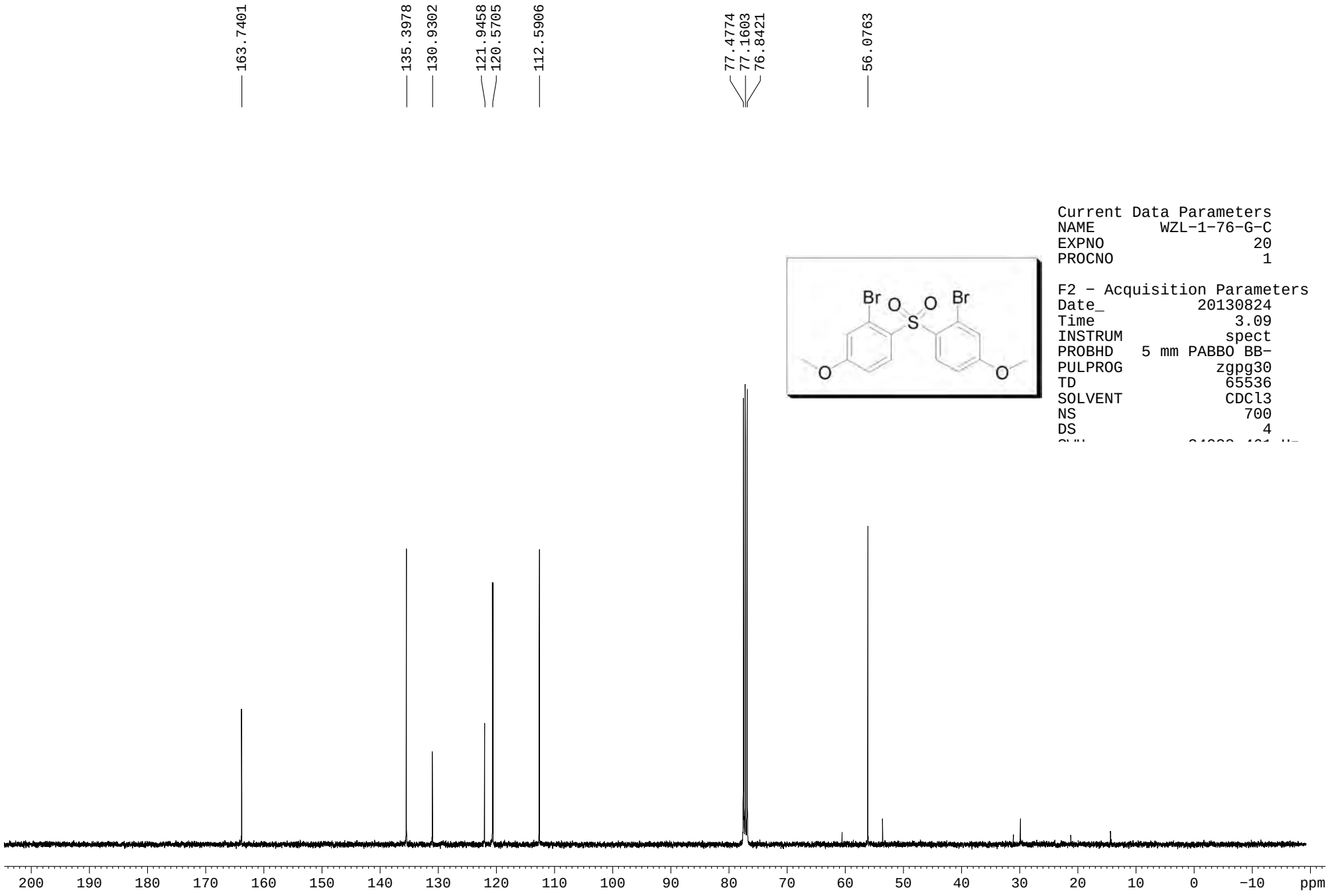

139.7876
137.6564
135.5933
131.4035
129.5372
128.6981
77.4801
77.1623
76.8440
19.9545
Current Data Parameters
NAME YYQ-4-89-6-1-C
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121018
Time 3.24
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 256
DS 4
O
S
O
Br
Br
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm

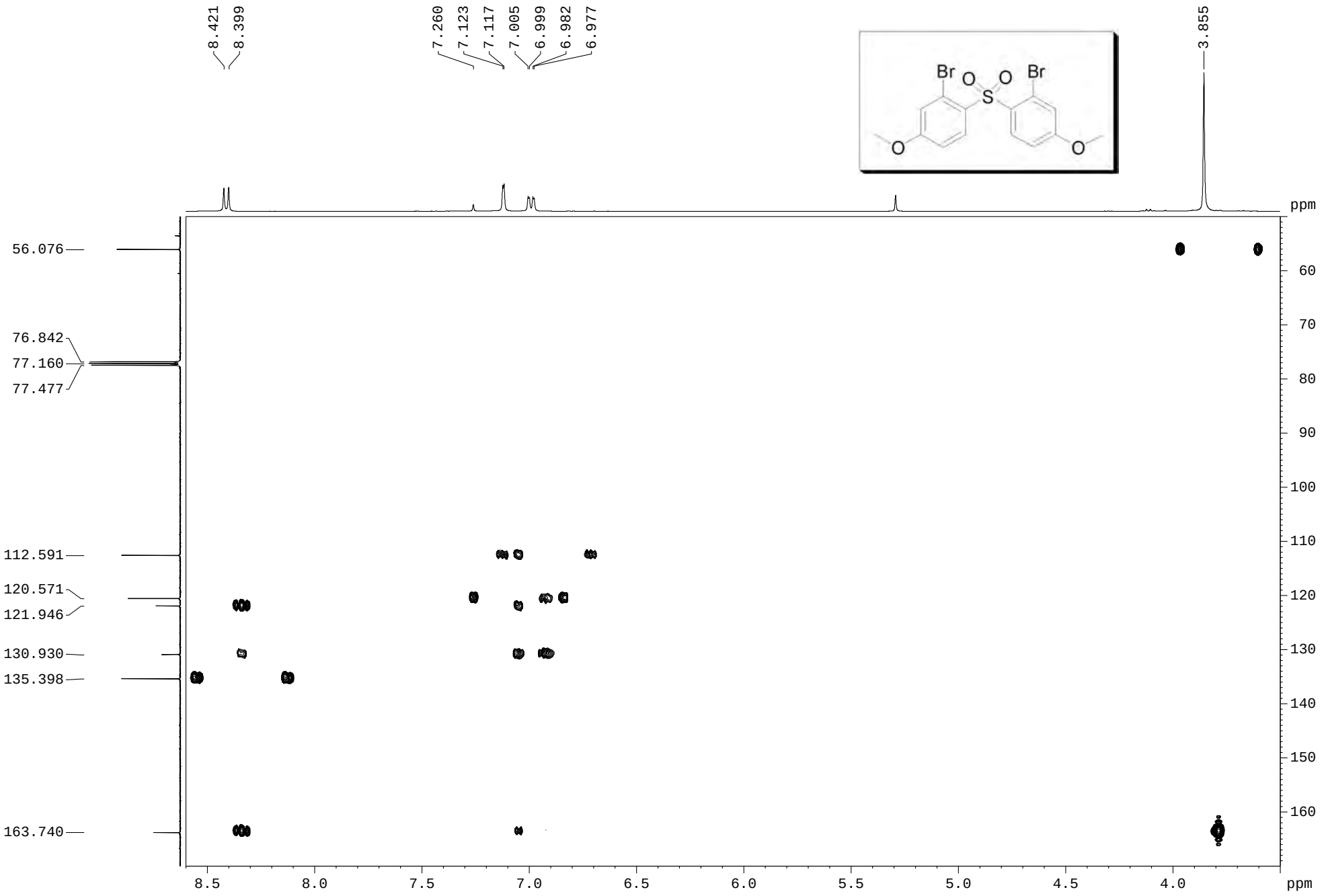

8.028
8.007
7.545
7.524
7.392
2.293
ppm
19.954
76.844
77.162
77.480
128.698
129.537
131.404
135.593
137.656
139.788
20
40
60
80
100
120
140
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
ppm
O
S
O
Br
Br

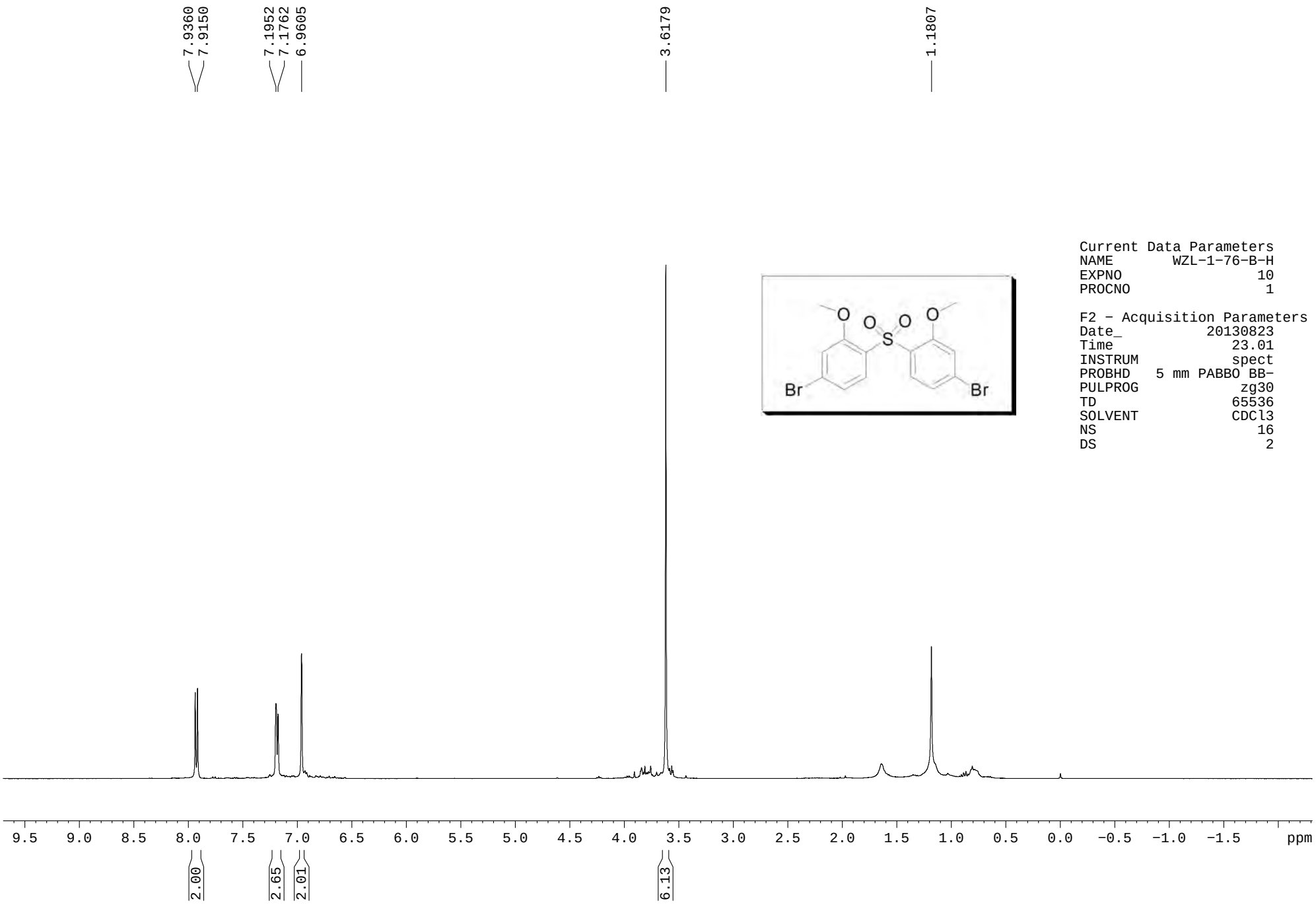

8.2634
8.2431
8.1676
8.1464
7.5410
7.5199
7.4701
7.3762
7.3521
7.3318
7.2603
2.4010
2.2798
Br
O
S
O
Br
Current Data Parameters
NAME CZ-1-33-2-2
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130726
Time 9.22
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
1.00
0.96
1.15
1.07
2.03
3.08
2.95

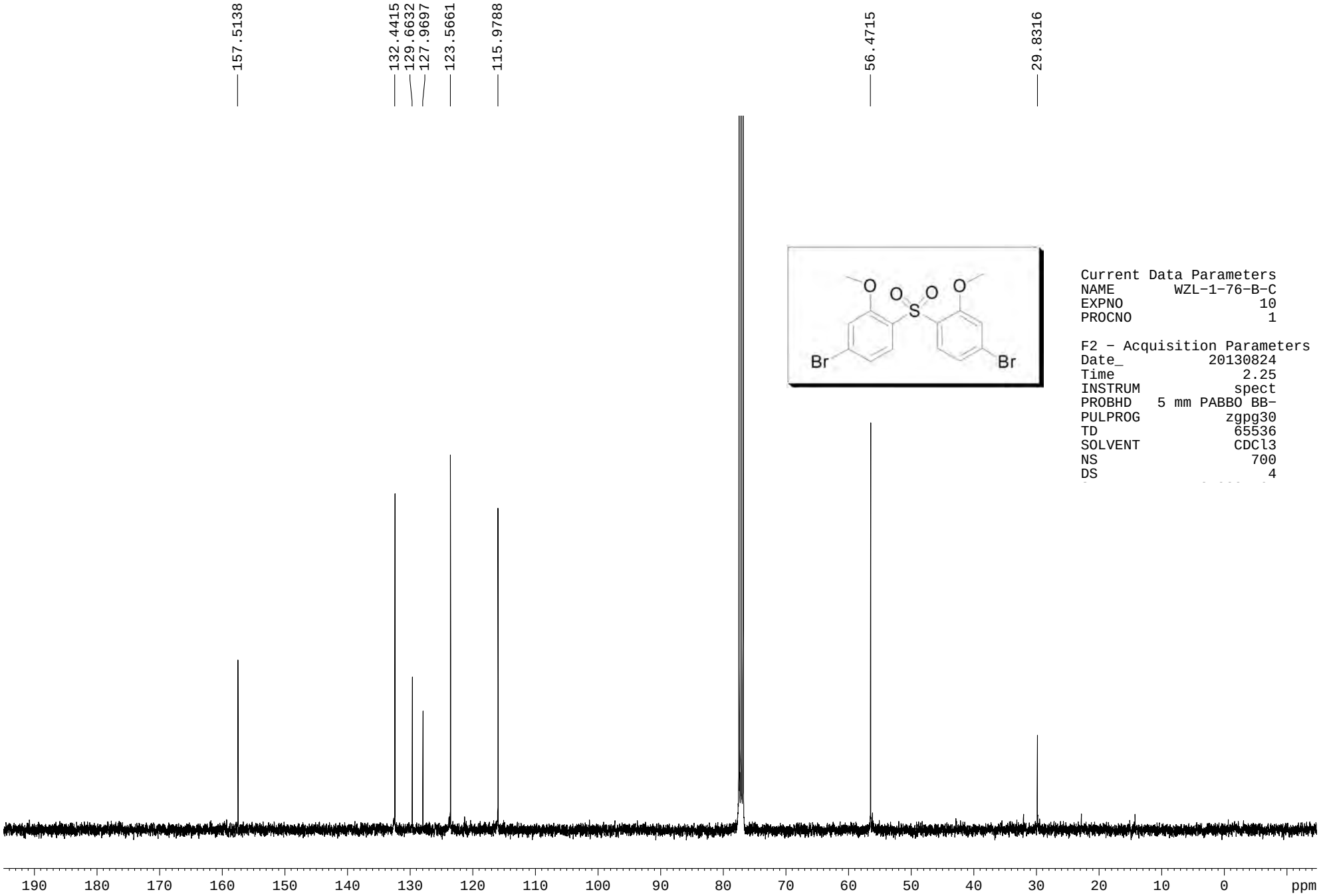

146.3558
139.6544
137.1555
136.7156
136.1676
135.2004
133.1970
131.9936
129.2725
128.6411
128.4732
120.8656
77.4801
77.1624
76.8451
21.2609
20.0027
Br
O
S
O
Br
Current Data Parameters
NAME CZ-1-33-2-2-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130726
Time 9.29
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 121
DS 4
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

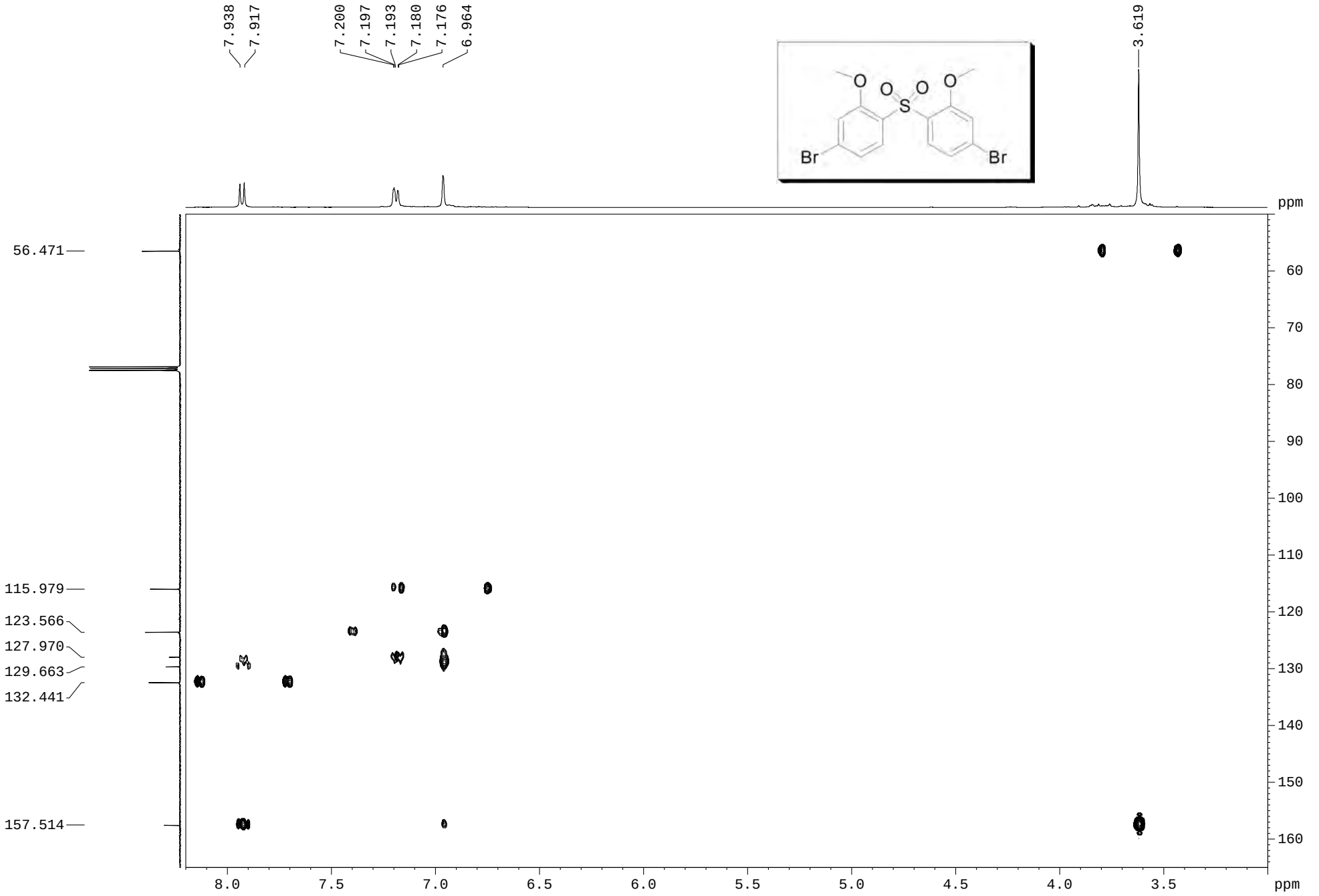

8.4205
8.3982
7.1213
7.1162
7.0037
6.9986
6.9813
6.9763
5.2915
3.8543
2.1623
2.0363
1.2488
Br
O
S
O
Br
O
O
Current Data Parameters
NAME WZL-1-76-G-H
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130823
Time 22.55
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
2.00
2.01
2.09
0.76
6.50

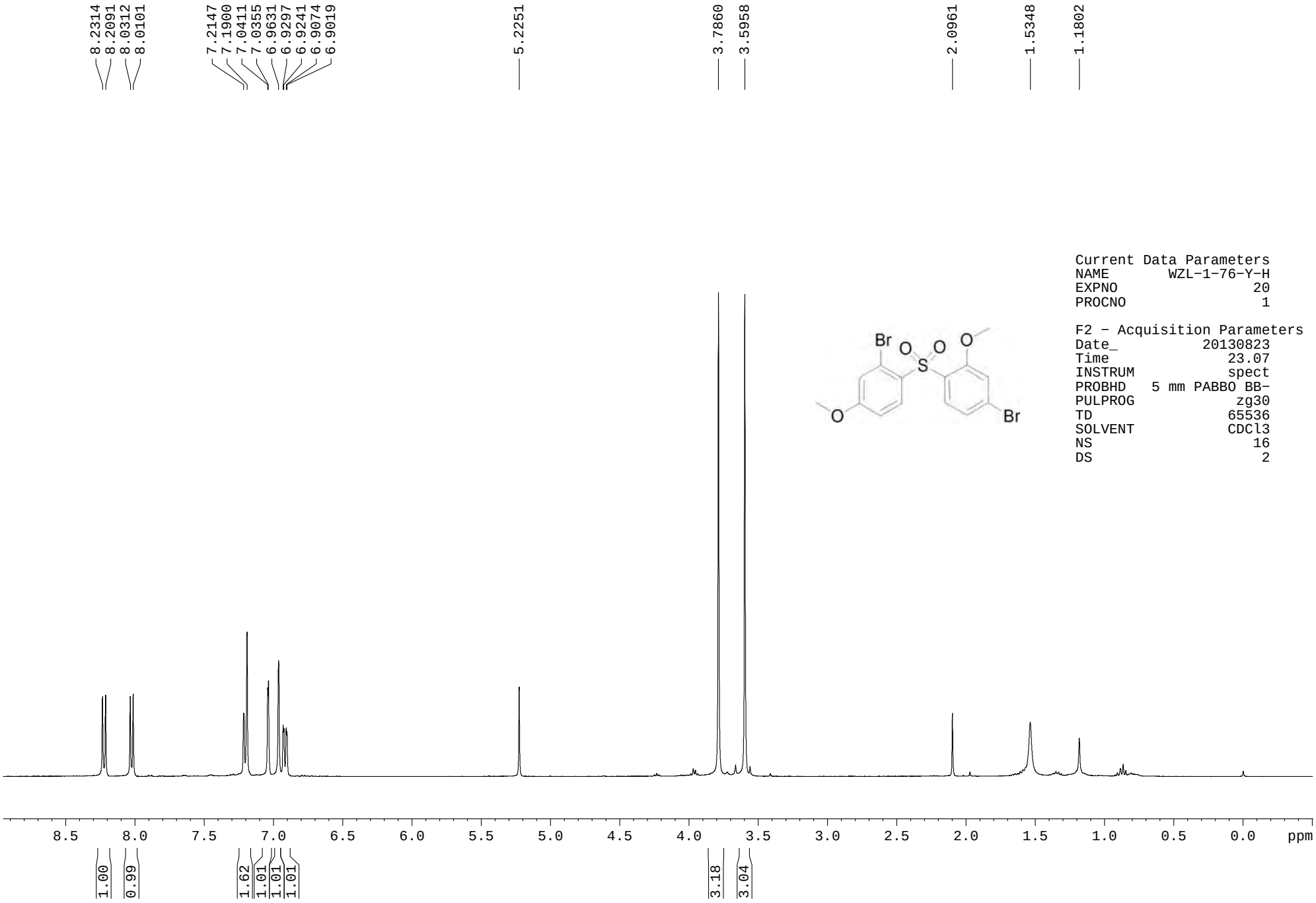

163.7401
135.3978
130.9302
121.9458
120.5705
112.5906
77.4774
77.1603
76.8421
56.0763
Br
O
S
O
Br
O
O
Current Data Parameters
NAME WZL-1-76-G-C
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130824
Time 3.09
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 700
DS 4
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 ppm

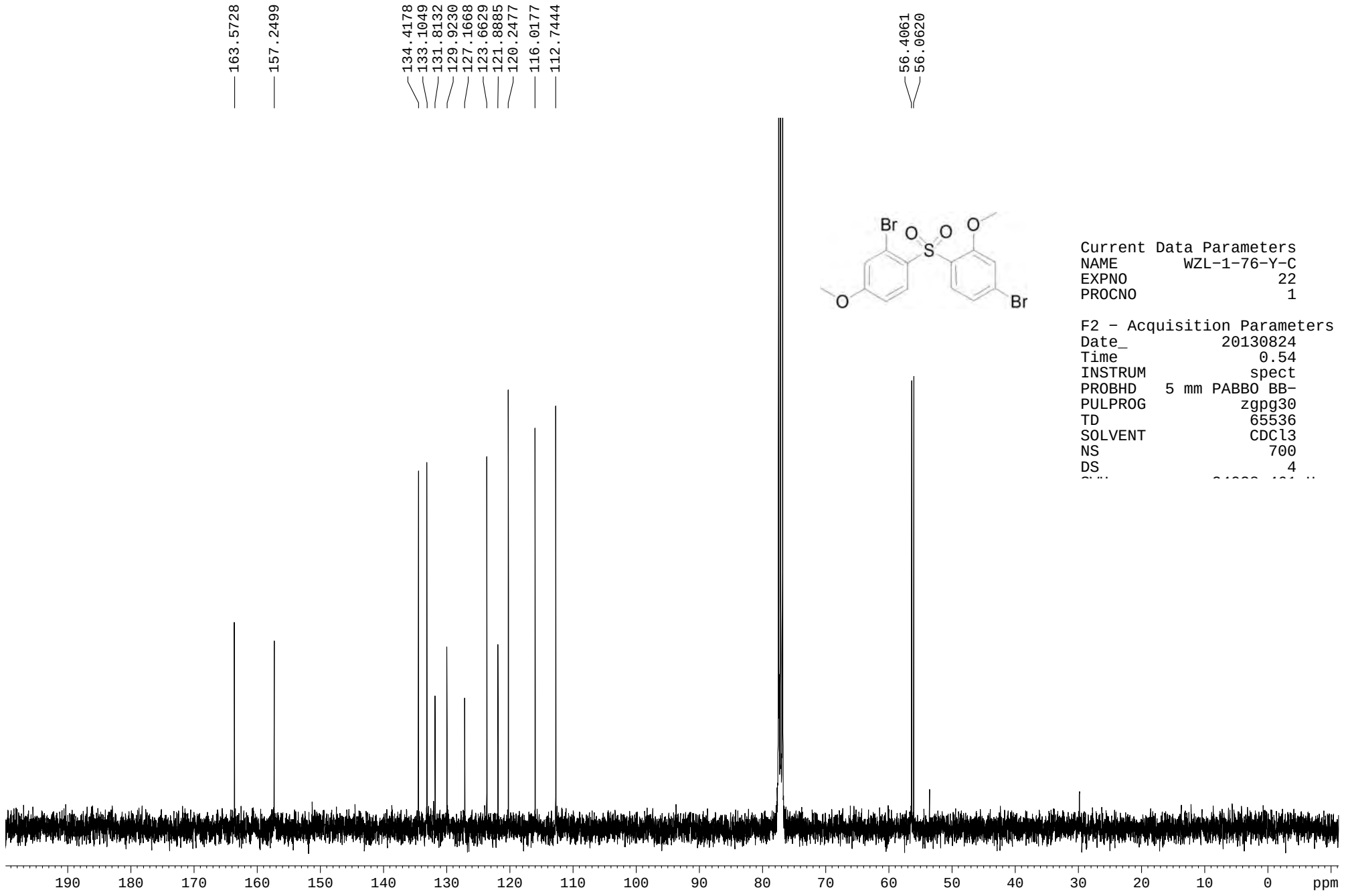

8.421
8.399
7.260
7.123
7.117
7.005
6.999
6.982
6.977
3.855
Br
O
O
Br
S
O
O
ppm
56.076
76.842
77.160
77.477
112.591
120.571
121.946
130.930
135.398
163.740
60
70
80
90
100
110
120
130
140
150
160
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
ppm

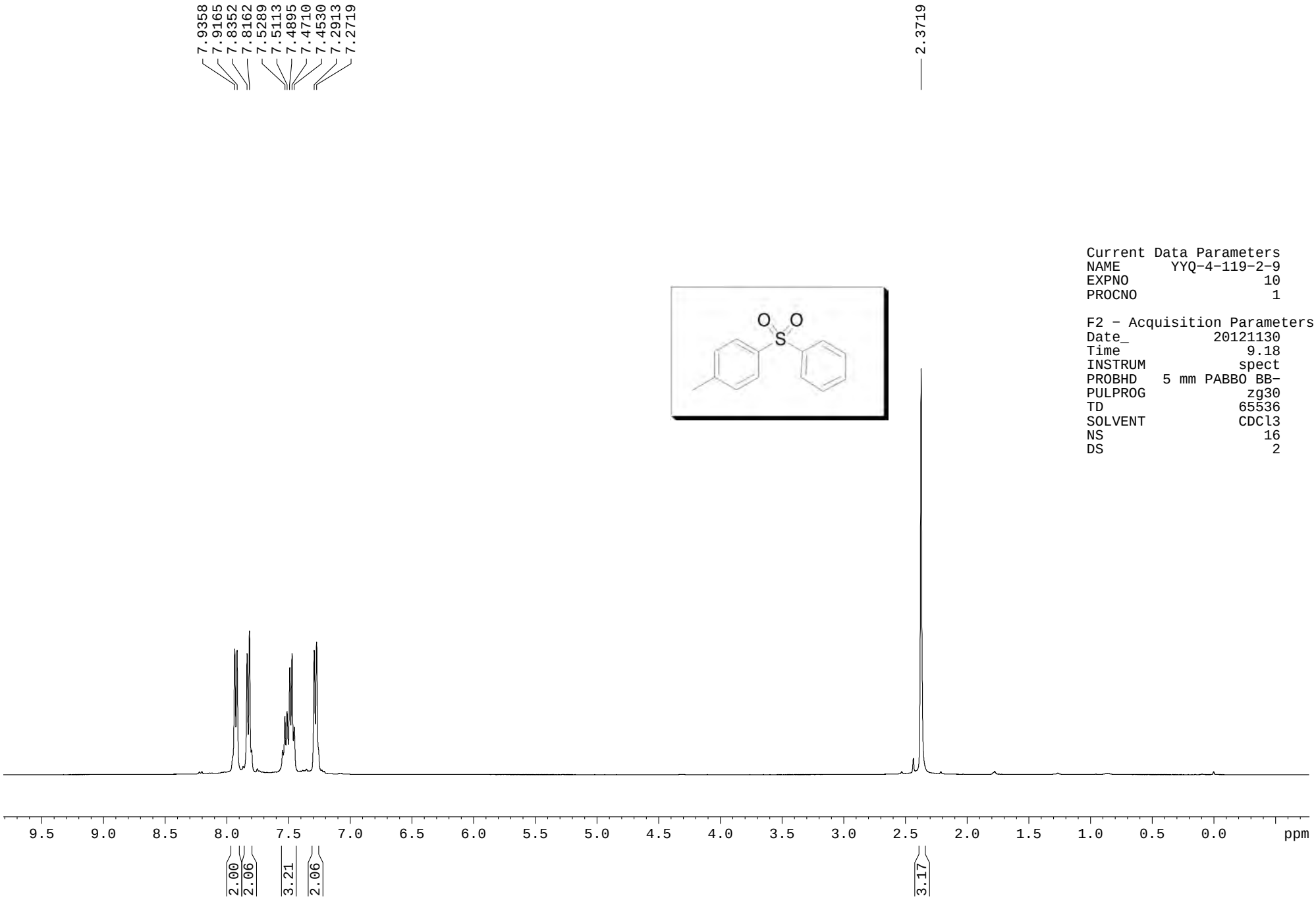

7.9360
7.9150
7.1952
7.1762
6.9605
3.6179
1.1807
Br
Br
O
O
S
O
O
Current Data Parameters
NAME WZL-1-76-B-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130823
Time 23.01
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 ppm
2.00
2.65
2.01
6.13

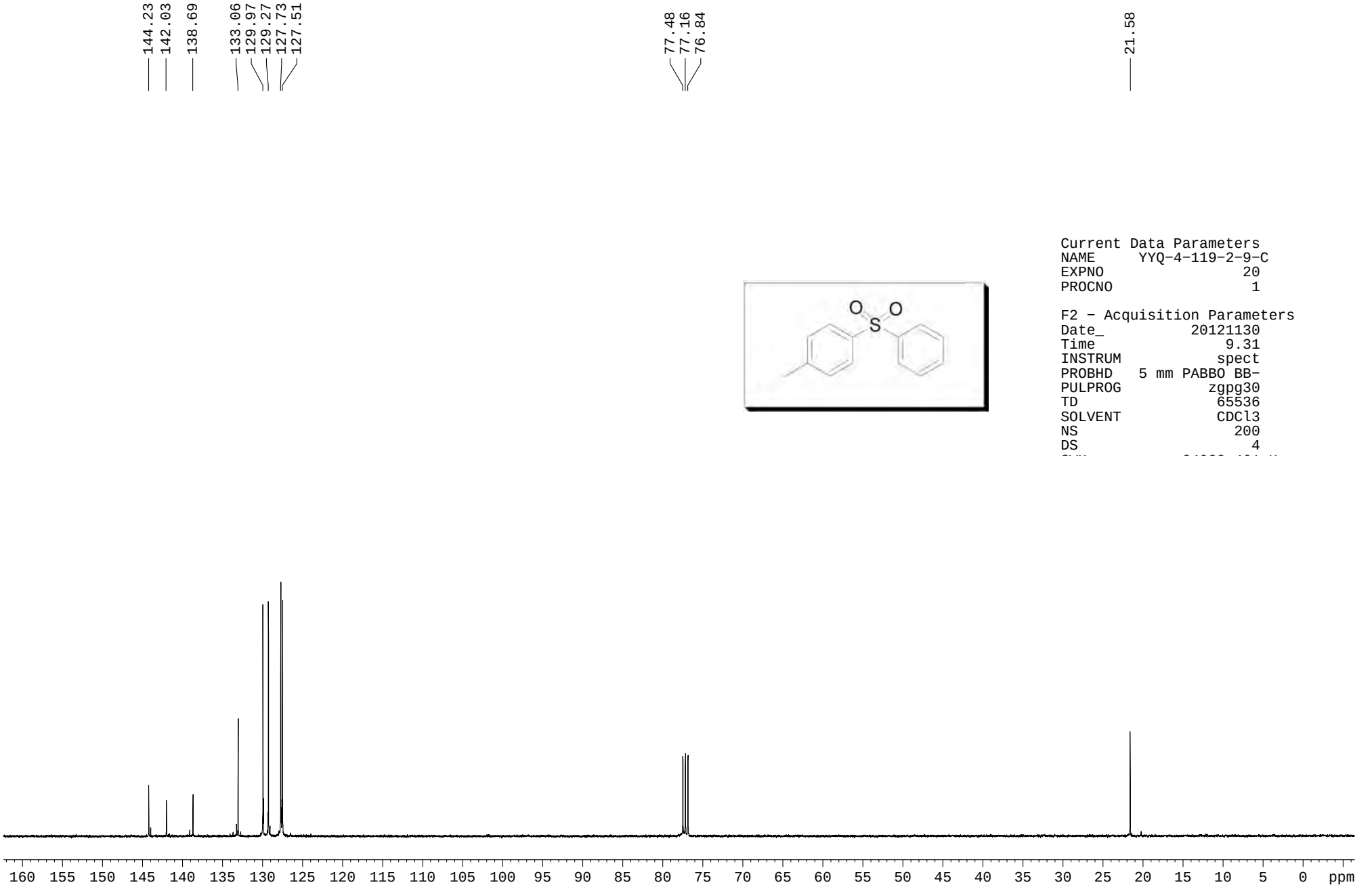

157.5138
132.4415
129.6632
127.9697
123.5661
115.9788
56.4715
29.8316
Br
Br
Current Data Parameters
NAME WZL-1-76-B-C
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130824
Time 2.25
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 700
DS 4
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

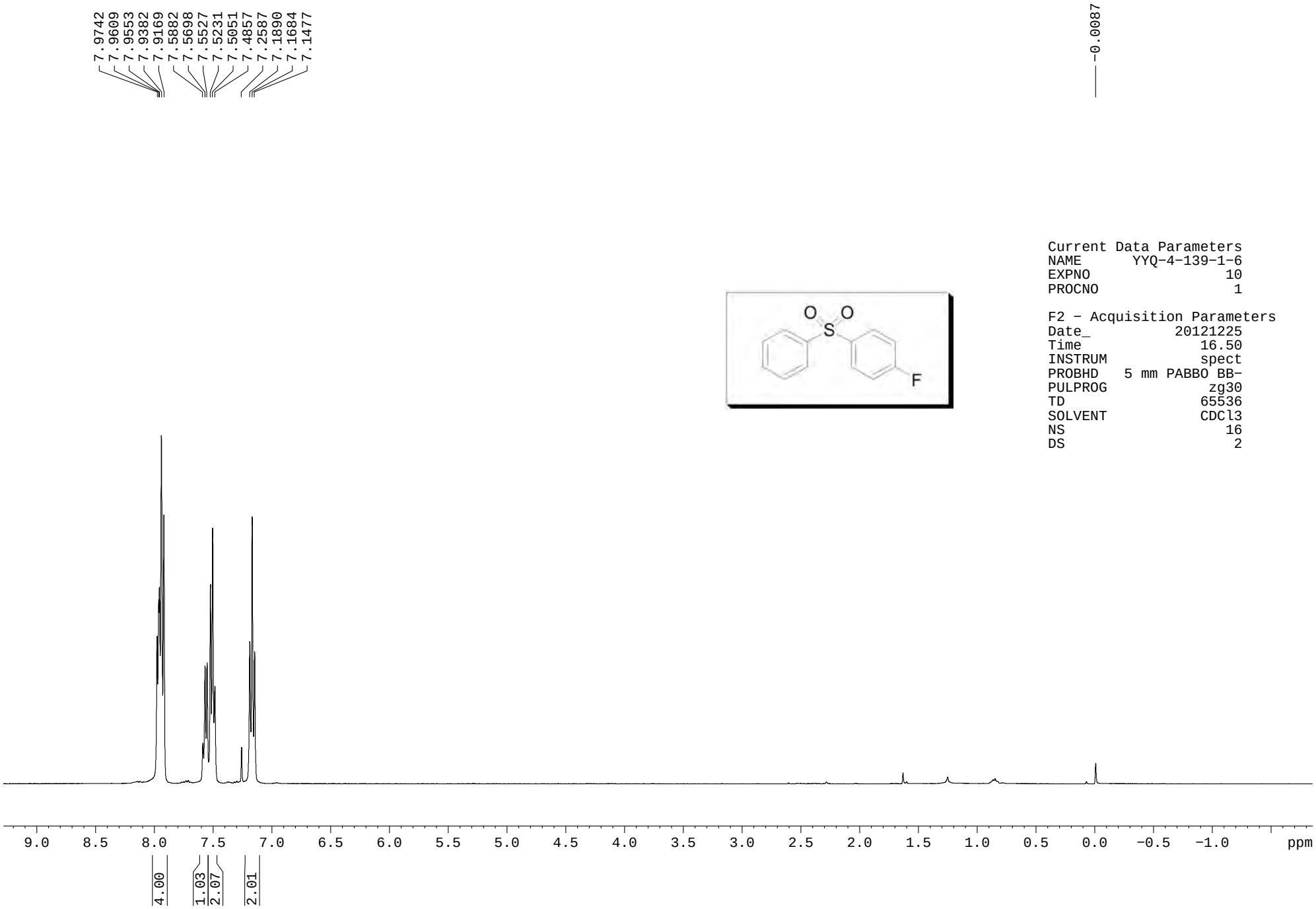

7.938
7.917
7.200
7.197
7.193
7.180
7.176
6.964
3.619
ppm
56.471
115.979
123.566
127.970
129.663
132.441
157.514
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
ppm
O
O
S
O
O
Br
Br

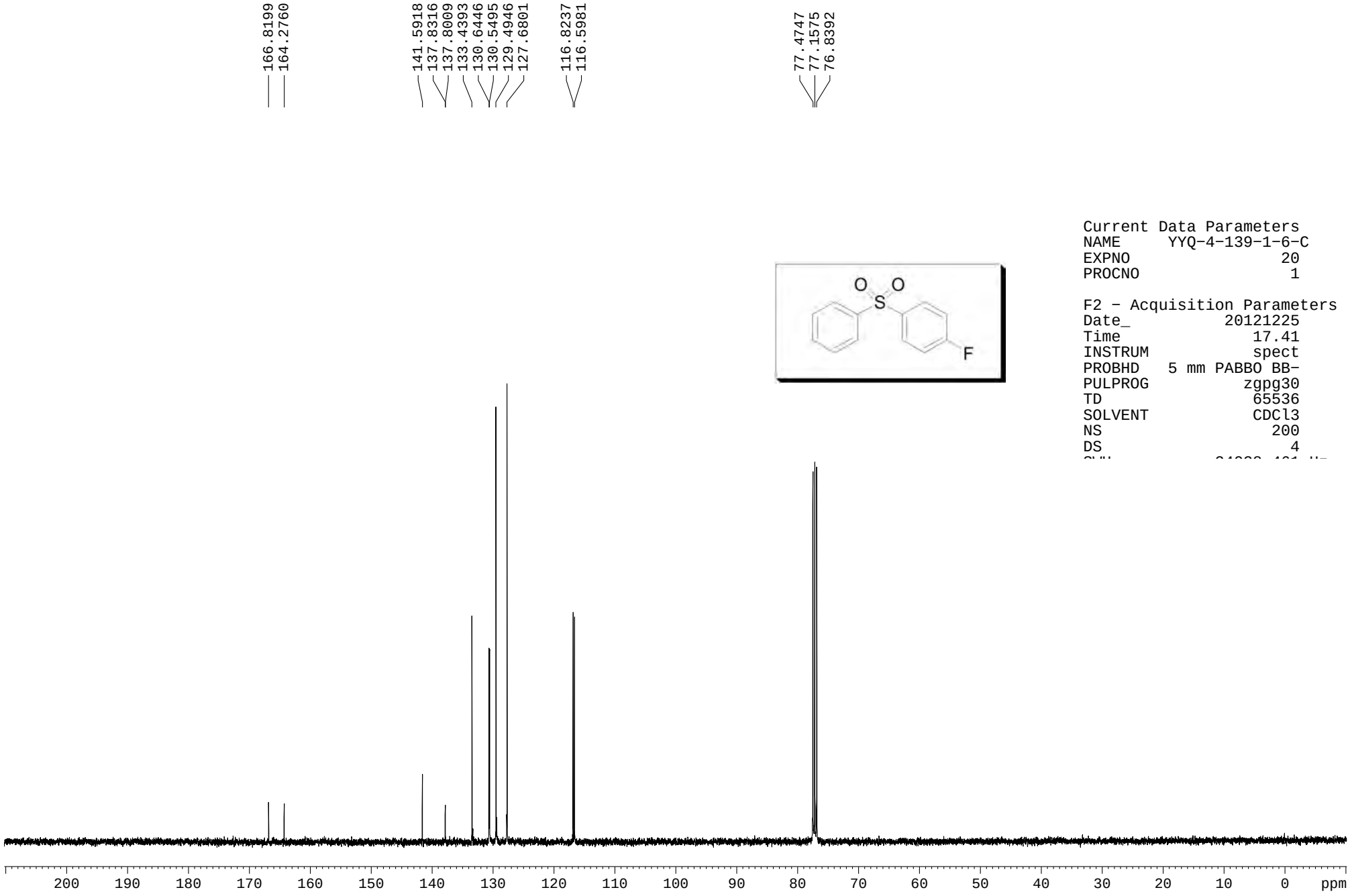

8.2314
8.2091
8.0312
8.0101
7.2147
7.1900
7.0411
7.0355
6.9631
6.9297
6.9241
6.9074
6.9019
5.2251
3.7860
3.5958
2.0961
1.5348
1.1802
Br
O
S
O
O
Br
Current Data Parameters
NAME WZL-1-76-Y-H
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130823
Time 23.07
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.00
0.99
1.62
1.01
1.01
1.01
3.18
3.04

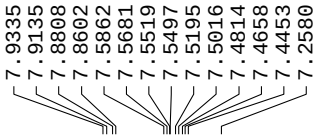

163.5728
157.2499
134.4178
133.1049
131.8132
129.9230
127.1668
123.6629
121.8885
120.2477
116.0177
112.7444
56.4061
56.0620
Br
O
O
S
O
O
Br
Current Data Parameters
NAME WZL-1-76-Y-C
EXPNO 22
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130824
Time 0.54
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 700
DS 4
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

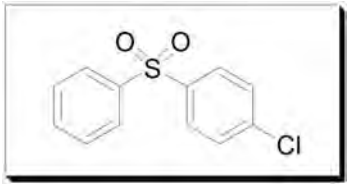

7.9358
7.9165
7.8352
7.8162
7.5289
7.5113
7.4895
7.4710
7.4530
7.2913
7.2719
2.3719
Current Data Parameters
NAME YYQ-4-119-2-9
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121130
Time 9.18
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
O
S
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.00
2.06
3.21
2.06
3.17


144.23
142.03
138.69
133.06
129.97
129.27
127.73
127.51
77.48
77.16
76.84
21.58
O
O
S
Current Data Parameters
NAME YYQ-4-119-2-9-C
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121130
Time 9.31
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
160 155 150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 ppm


7.9742
7.9609
7.9553
7.9382
7.9169
7.5882
7.5698
7.5527
7.5231
7.5051
7.4857
7.2587
7.1890
7.1684
7.1477
-0.0087
O
O
S
F
Current Data Parameters
NAME YYQ-4-139-1-6
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121225
Time 16.50
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 ppm
4.00
1.03
2.07
2.01

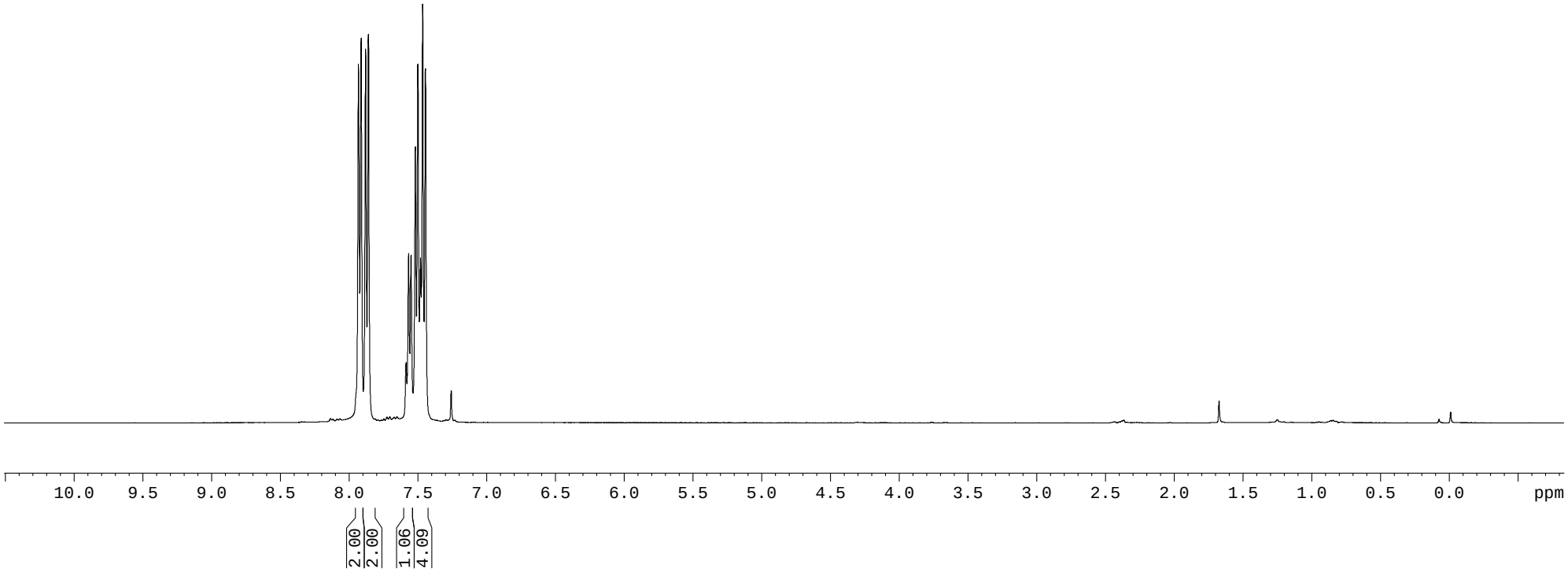

166.8199
164.2760
141.5918
137.8316
137.8009
133.4393
130.6446
130.5495
129.4946
127.6801
116.8237
116.5981
77.4747
77.1575
76.8392
O
O
S
F
Current Data Parameters
NAME YYQ-4-139-1-6-C
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121225
Time 17.41
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

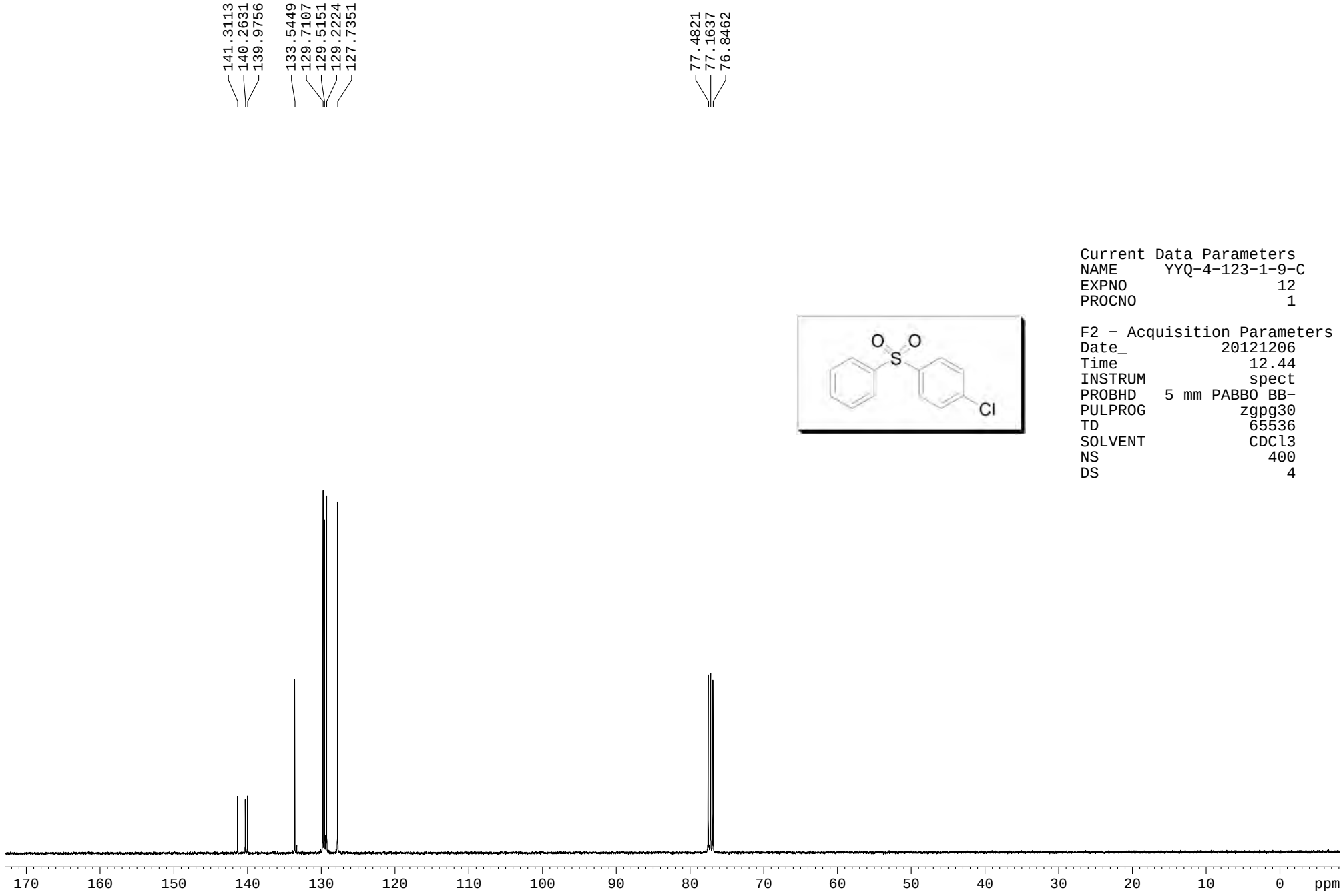


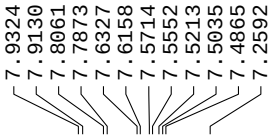


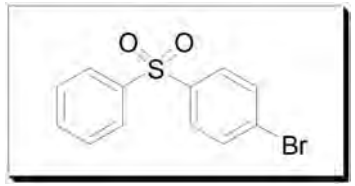
Current Data Parameters
NAME YYQ-4-123-1-9
EXPNO 10
PROCNO 1

F2 - Acquisition Parameters
Date_ 20121206
Time 12.20
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2

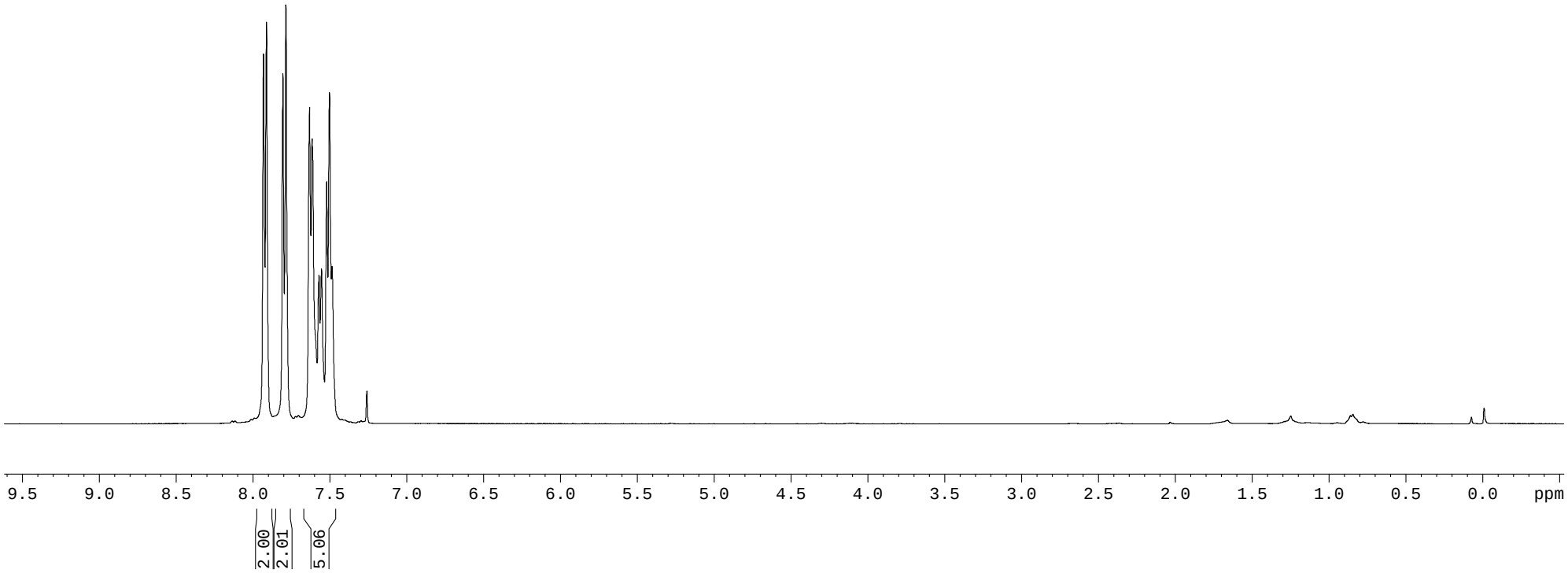


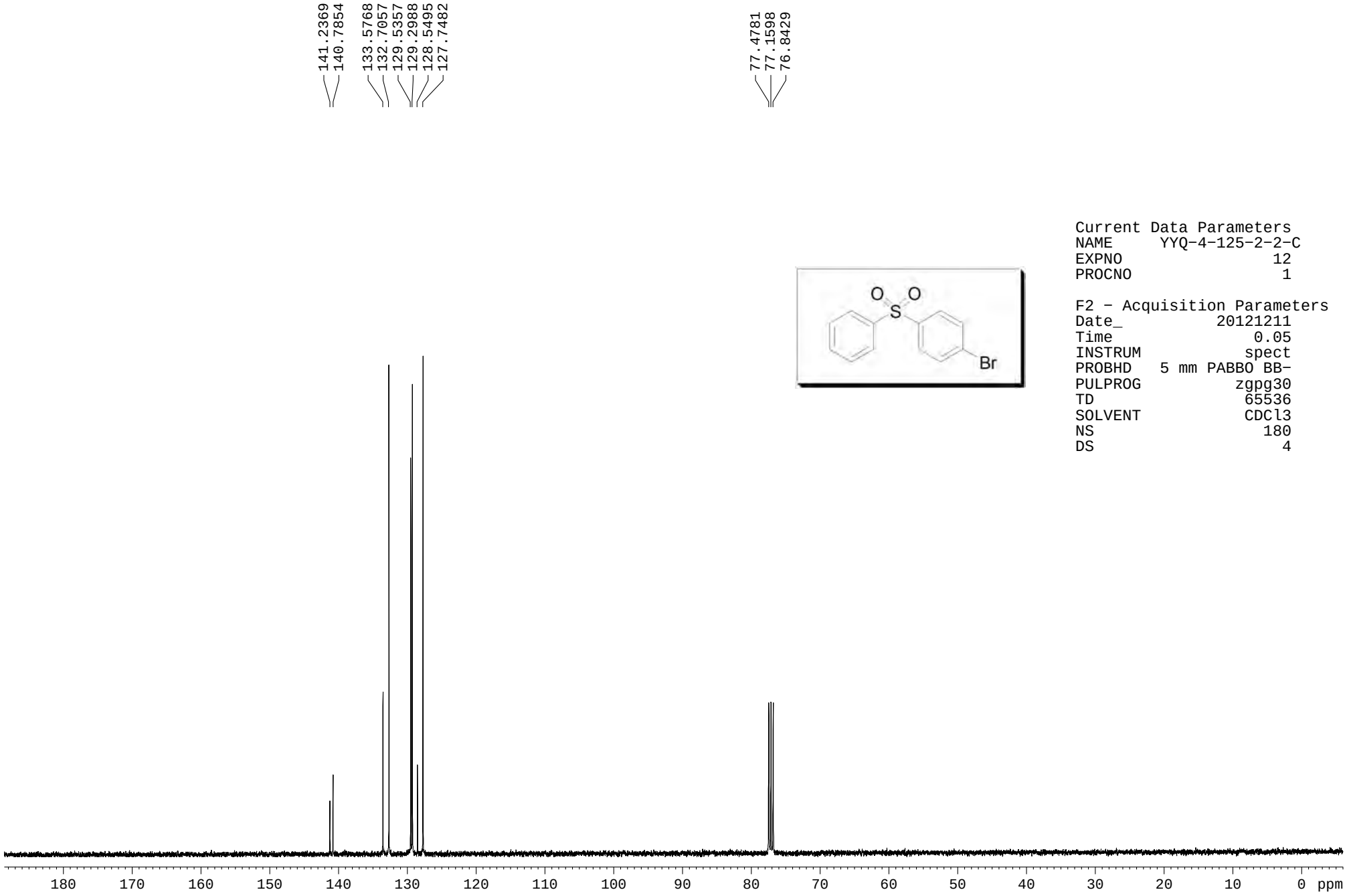

141.3113
140.2631
139.9756
133.5449
129.7107
129.5151
129.2224
127.7351
77.4821
77.1637
76.8462
O
O
S
Cl
Current Data Parameters
NAME YYQ-4-123-1-9-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121206
Time 12.44
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 400
DS 4
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

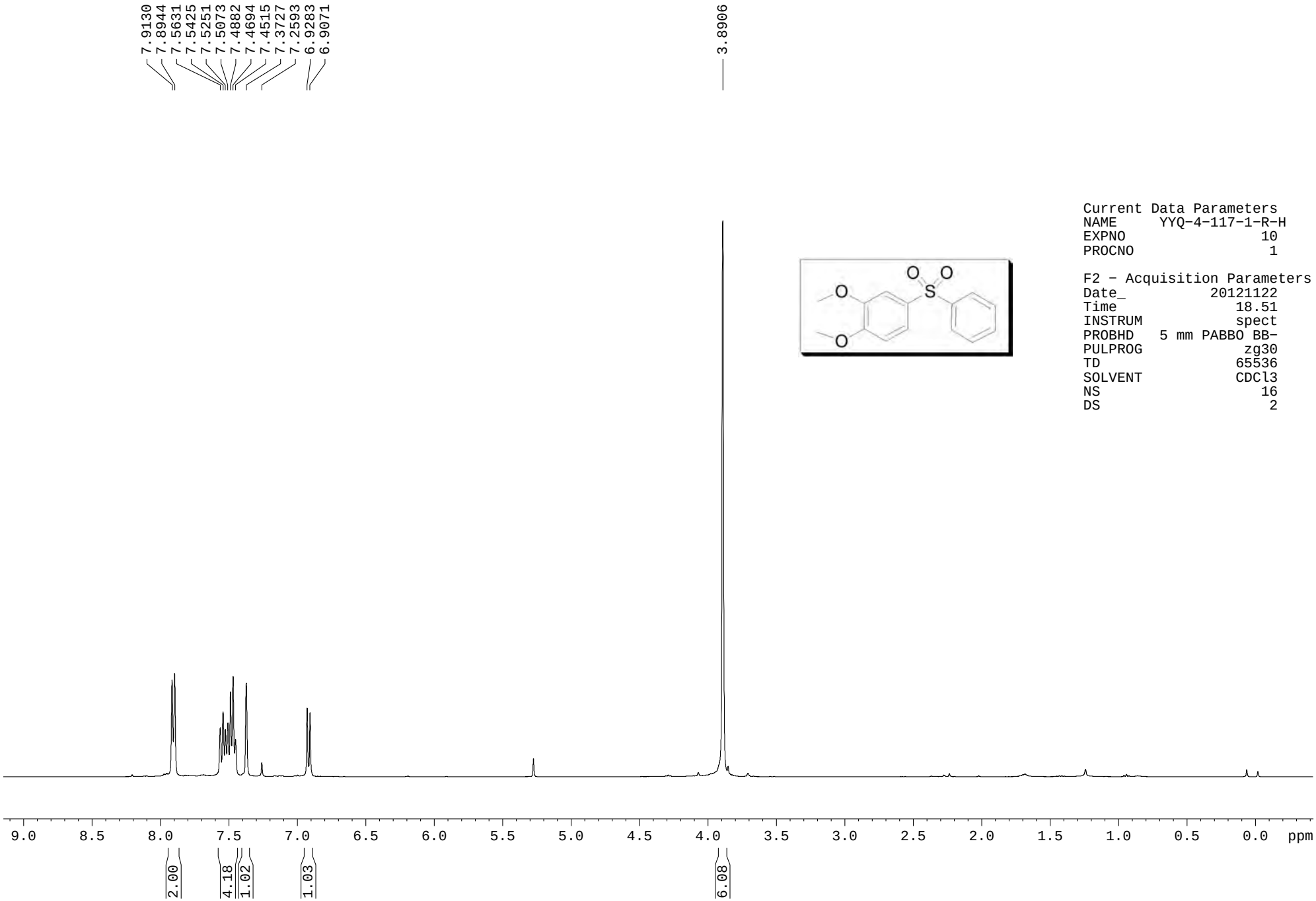


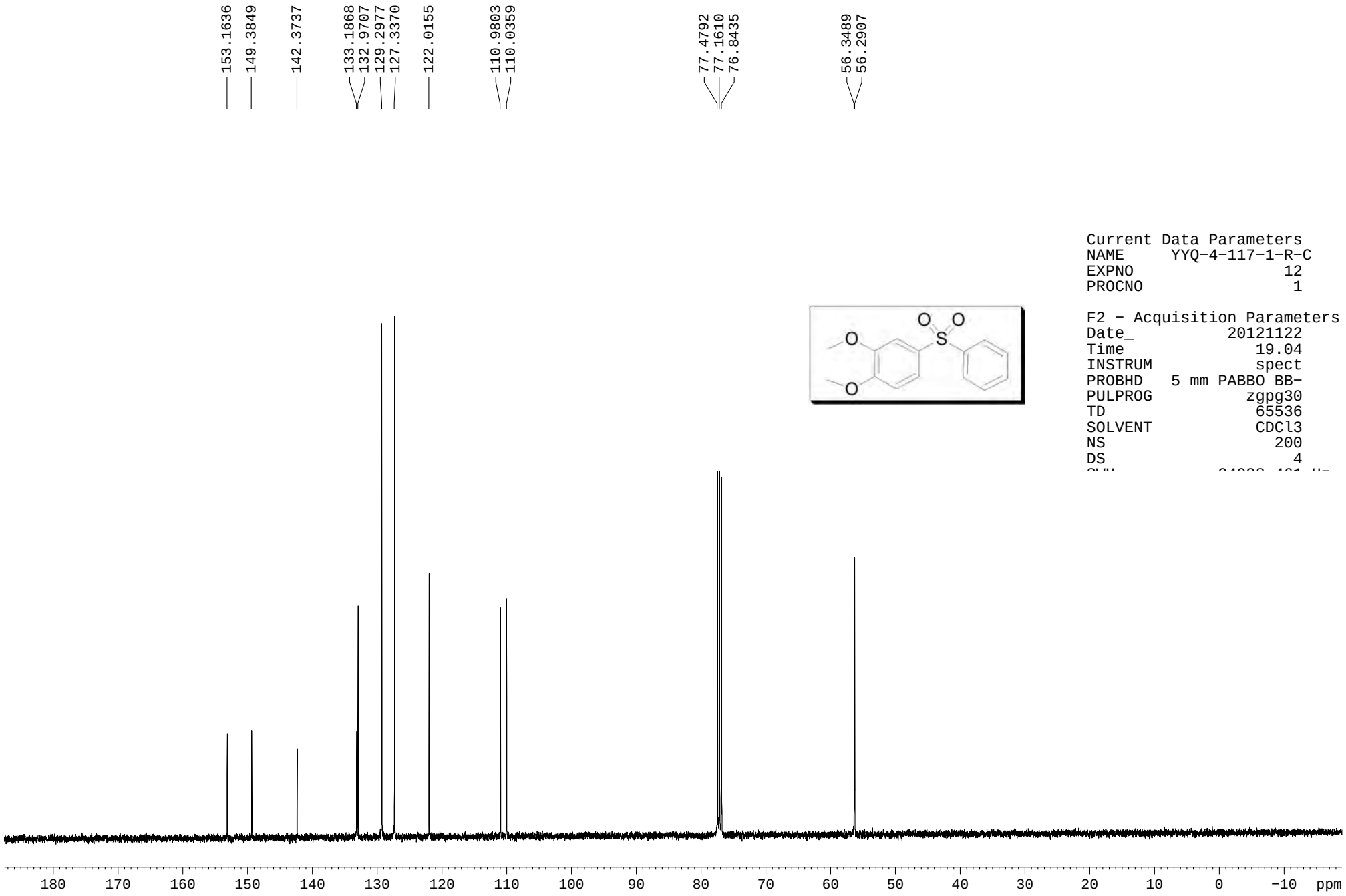


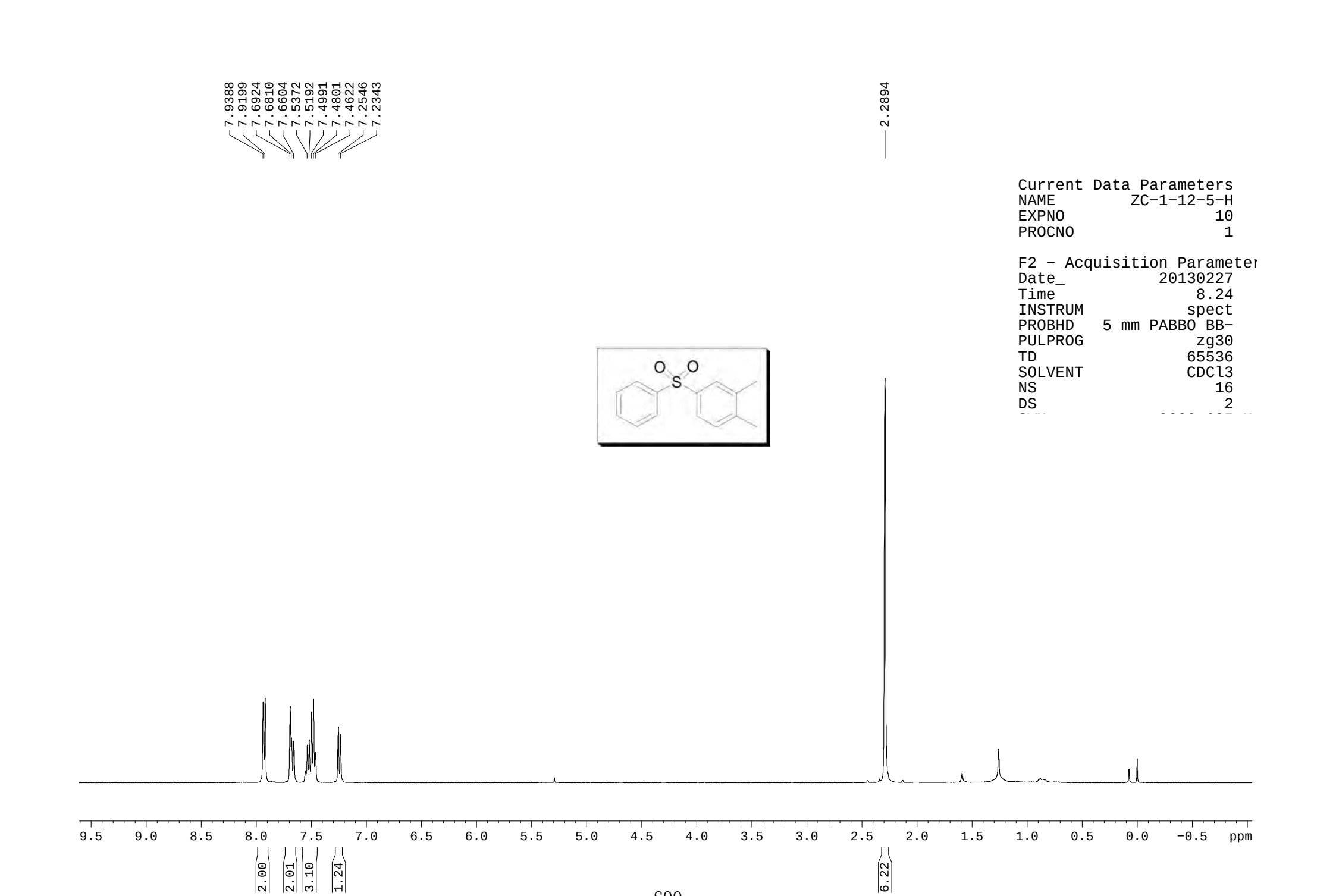

```
Current Data Parameters
NAME      YYQ-4-125-2-2-H
EXPNO                  10
PROCNO                  1

F2 - Acquisition Parameters
Date_           20121210
Time               23.53
INSTRUM            spect
PROBHD   5 mm PABBO BB-
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    16
DS                     2
```

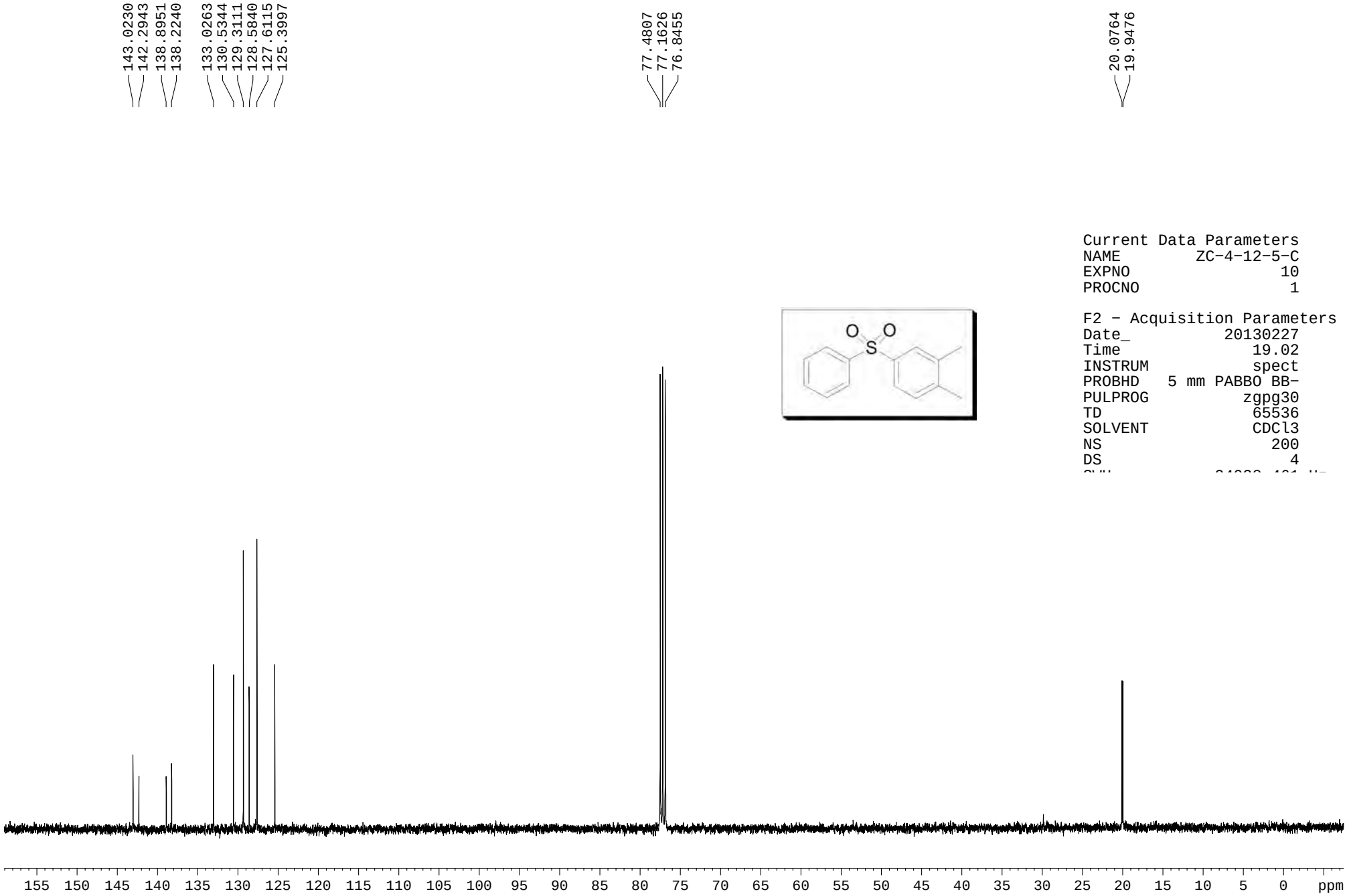


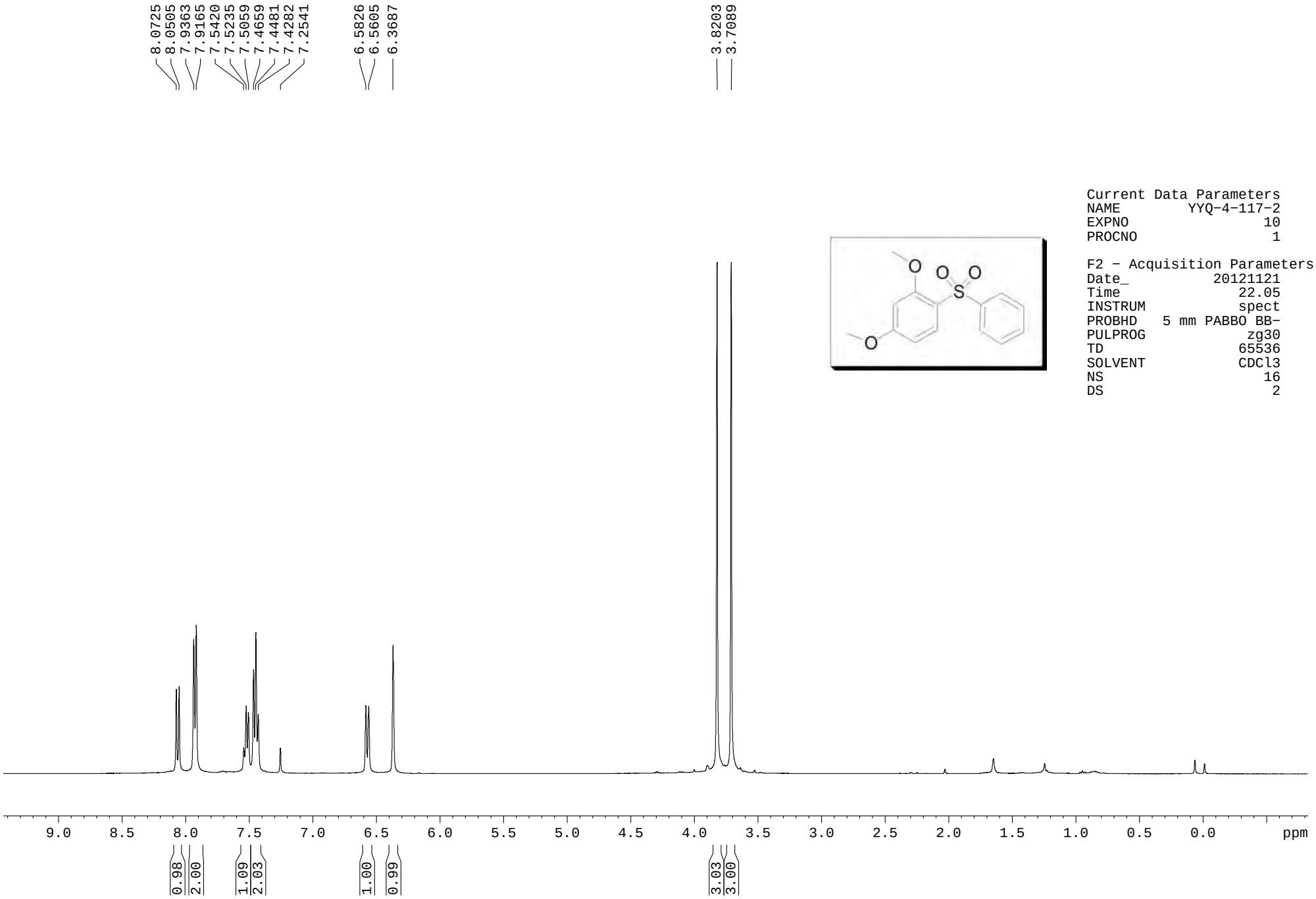

141.2369
140.7854
133.5768
132.7057
129.5357
129.2988
128.5495
127.7482
77.4781
77.1598
76.8429
O
O
S
Br
Current Data Parameters
NAME YYQ-4-125-2-2-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121211
Time 0.05
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 180
DS 4
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

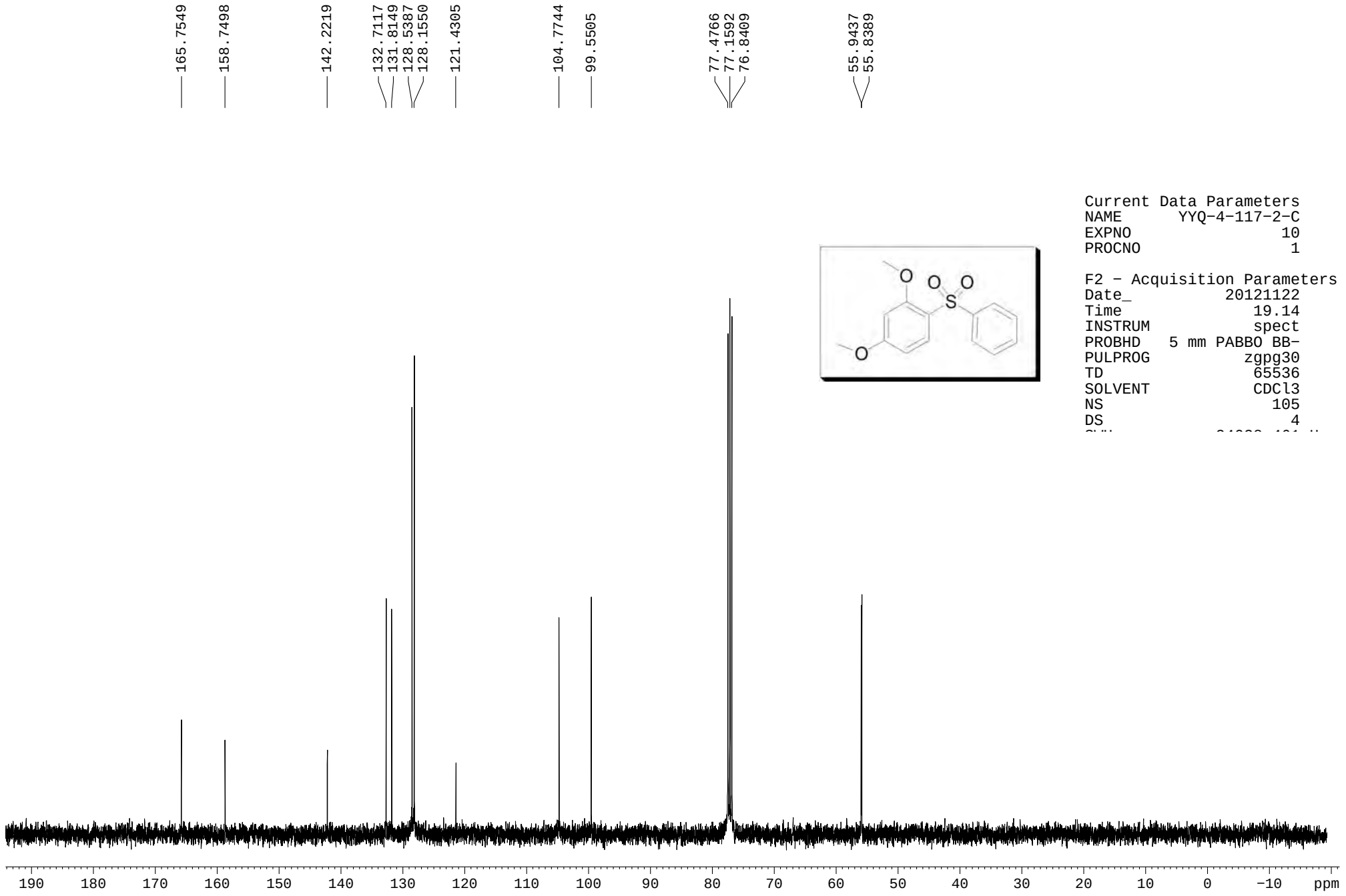

7.9130
7.8944
7.5631
7.5425
7.5251
7.5073
7.4882
7.4694
7.4515
7.3727
7.2593
6.9283
6.9071
3.8906
Current Data Parameters
NAME YYQ-4-117-1-R-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121122
Time 18.51
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
O
S
O
O
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.00
4.18
1.02
1.03
6.08

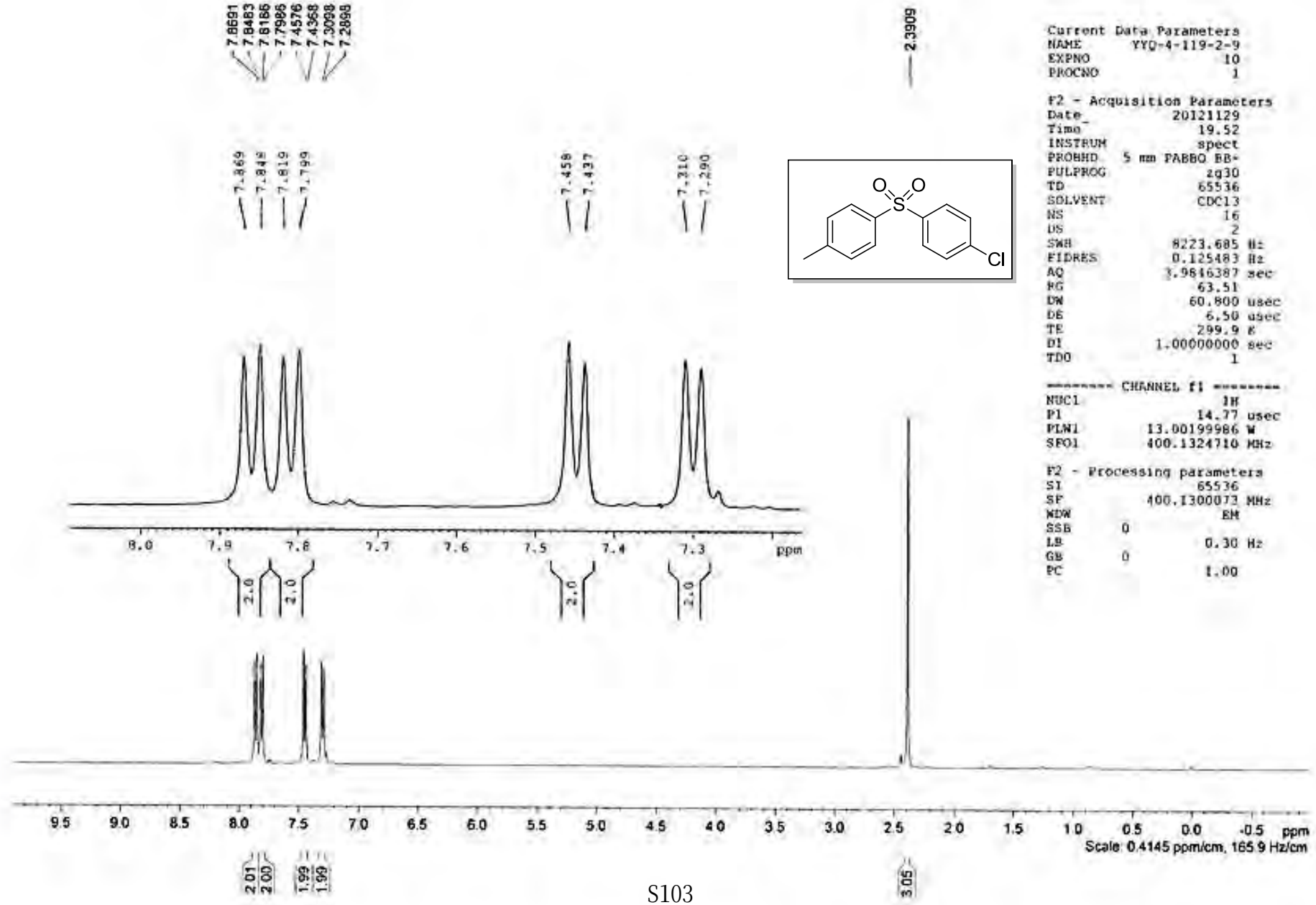

153.1636
149.3849
142.3737
133.1868
132.9707
129.2977
127.3370
122.0155
110.9803
110.0359
77.4792
77.1610
76.8435
56.3489
56.2907
Current Data Parameters
NAME YYQ-4-117-1-R-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121122
Time 19.04
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
O
O
S
O
O
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm

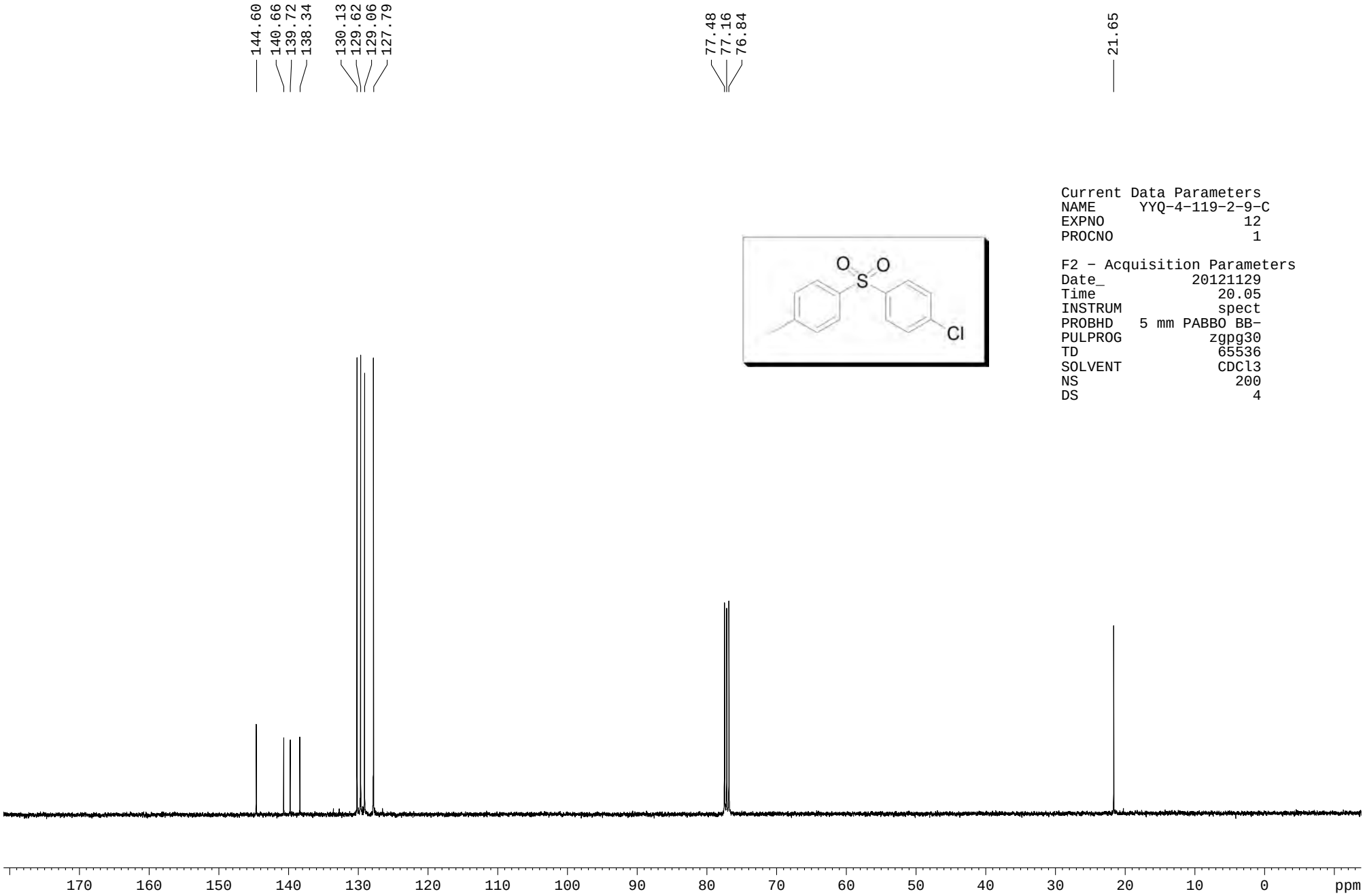

7.9388
7.9199
7.6924
7.6810
7.6604
7.5372
7.5192
7.4991
7.4801
7.4622
7.2546
7.2343
2.2894
Current Data Parameters
NAME ZC-1-12-5-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameter
Date_ 20130227
Time 8.24
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
S
O
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
2.00
2.01
3.10
1.24
6.22

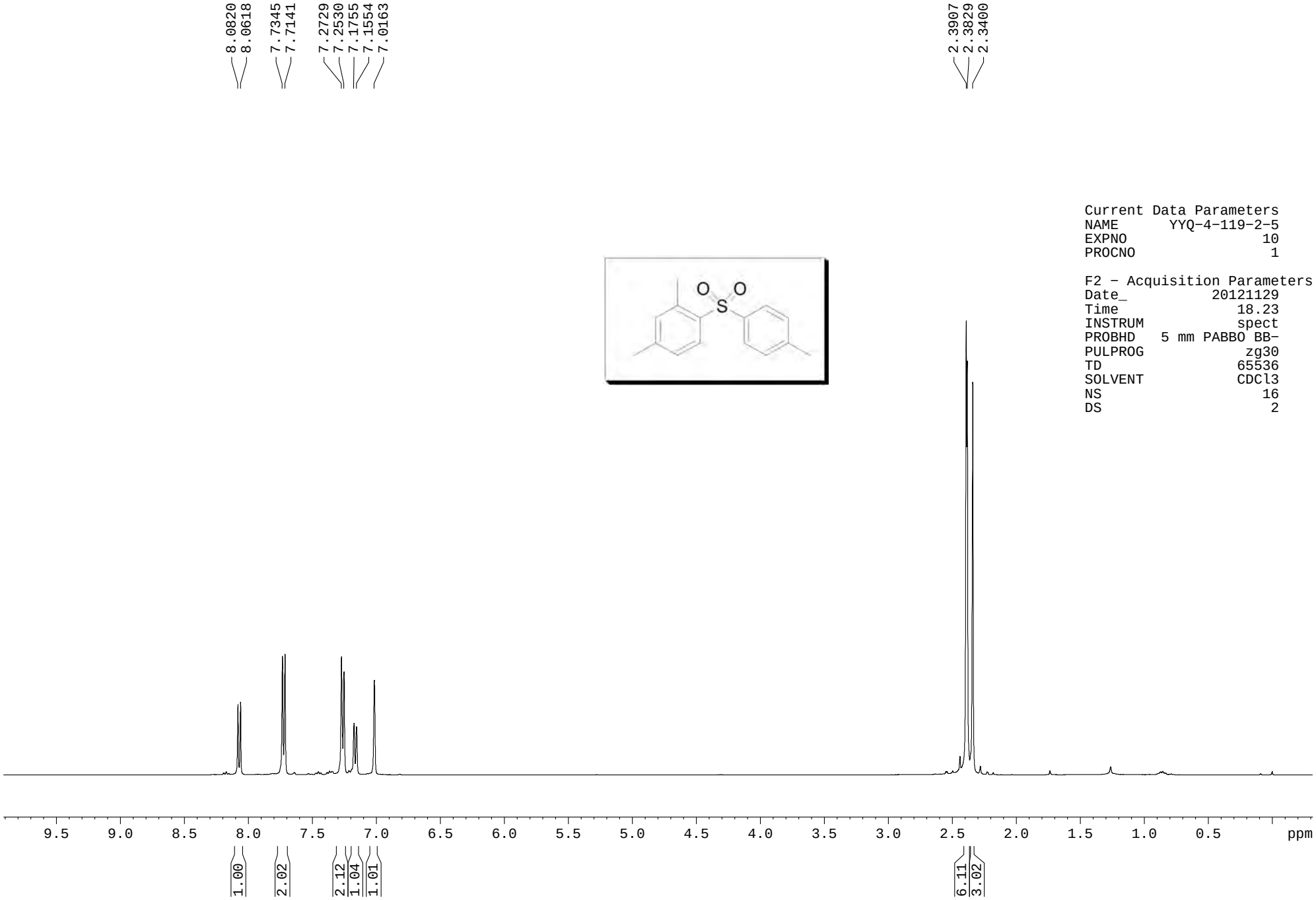

143.0230
142.2943
138.8951
138.2240
133.0263
130.5344
129.3111
128.5840
127.6115
125.3997
77.4807
77.1626
76.8455
20.0764
19.9476
Current Data Parameters
NAME ZC-4-12-5-C
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130227
Time 19.02
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
155 150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 ppm

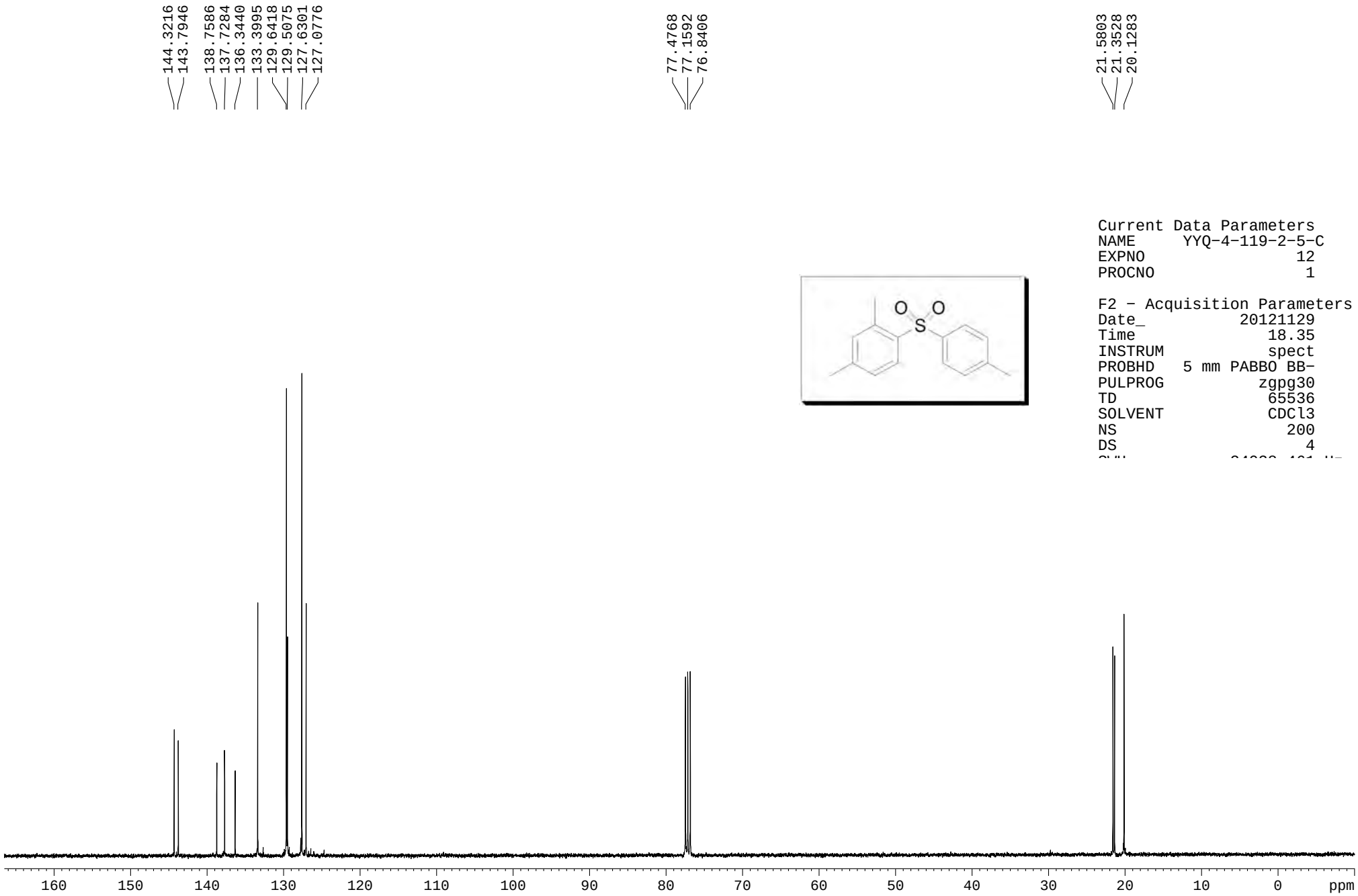

8.0725
8.0505
7.9363
7.9165
7.5420
7.5235
7.5059
7.4659
7.4481
7.4282
7.2541
6.5826
6.5605
6.3687
3.8203
3.7089
Current Data Parameters
NAME YYQ-4-117-2
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121121
Time 22.05
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
O
O
S
O
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
0.98
2.00
1.09
2.03
1.00
0.99
3.03
3.00

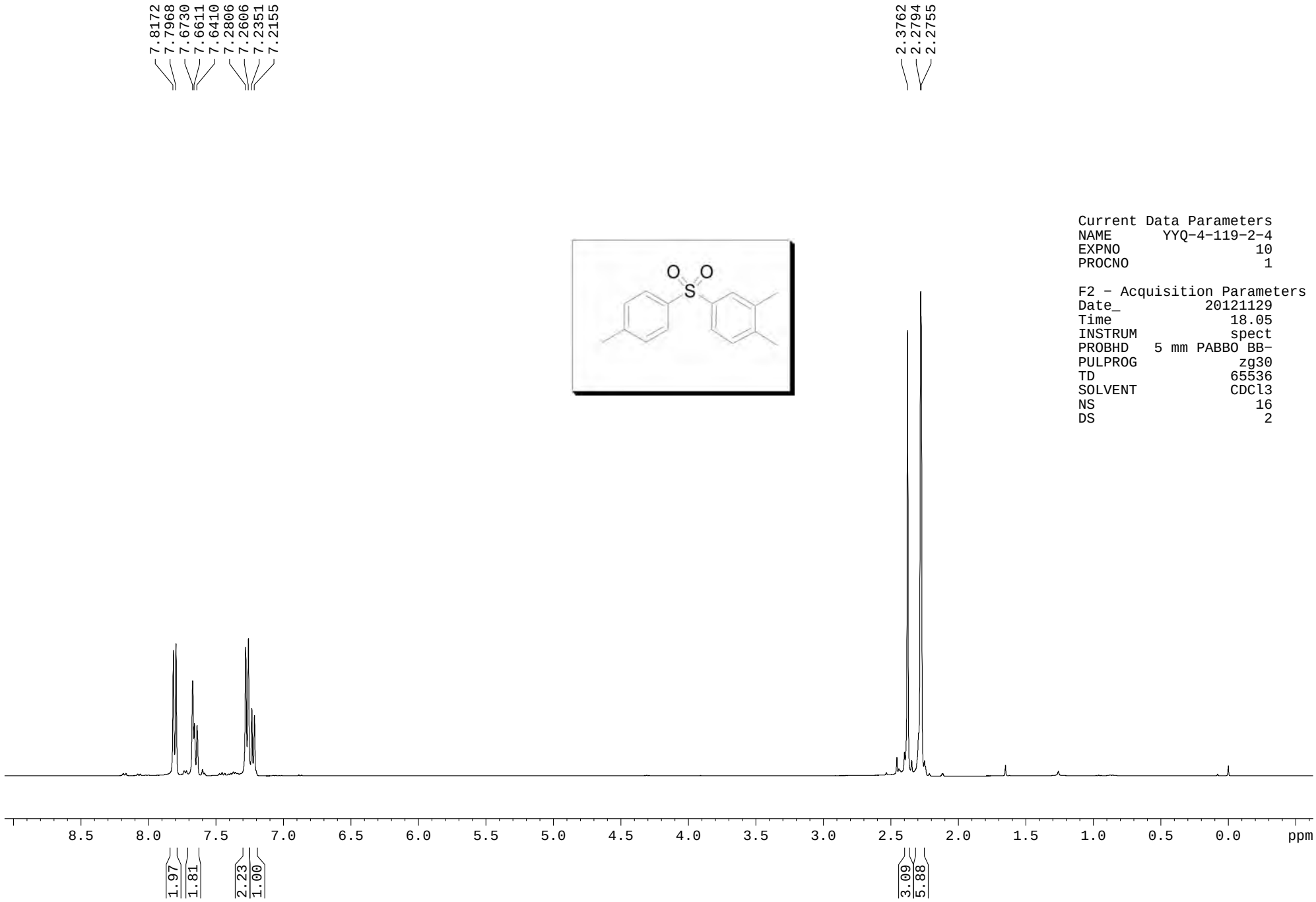

165.7549
158.7498
142.2219
132.7117
131.8149
128.5387
128.1550
121.4305
104.7744
99.5505
77.4766
77.1592
76.8409
55.9437
55.8389
Current Data Parameters
NAME YYQ-4-117-2-C
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121122
Time 19.14
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 105
DS 4
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 ppm

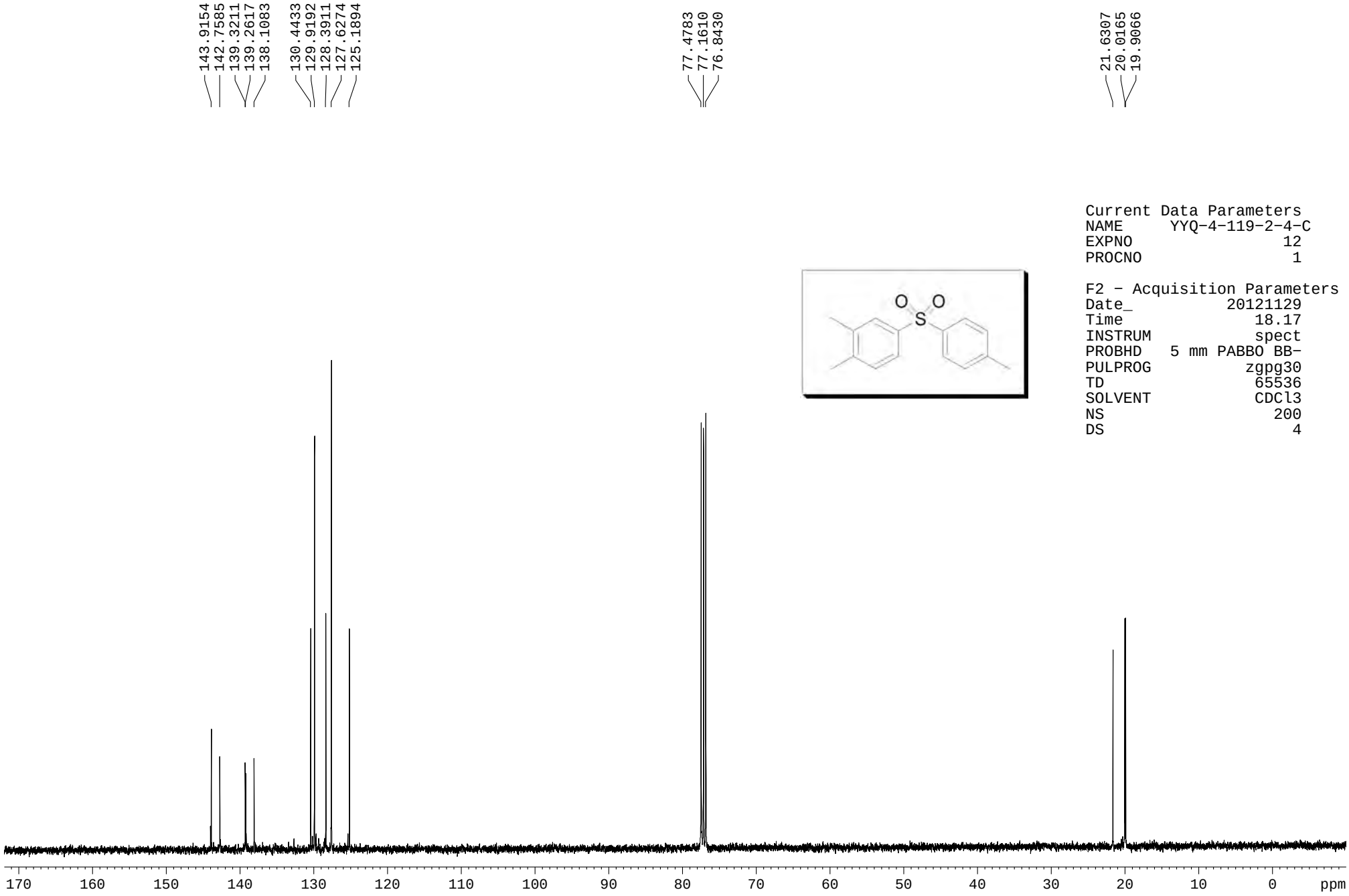

7.8691
7.8483
7.8186
7.7996
7.4576
7.4368
7.3098
7.2898
2.3909
7.869
7.848
7.819
7.799
7.458
7.437
7.310
7.290
Current Data Parameters
NAME YYQ-4-119-2-9
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121129
Time 19.52
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDC13
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9846387 sec
RG 63.51
DW 60.800 usec
DE 6.50 usec
TE 299.9 K
D1 1.00000000 sec
TD0 1
CHANNEL f1
NUC1 1H
P1 14.77 usec
PLW1 13.00199986 W
SFO1 400.1324710 MHz
F2 - Processing parameters
SI 65536
SF 400.1300073 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
Cl
ppm
Scale 0.4145 ppm/cm, 165.9 Hz/cm

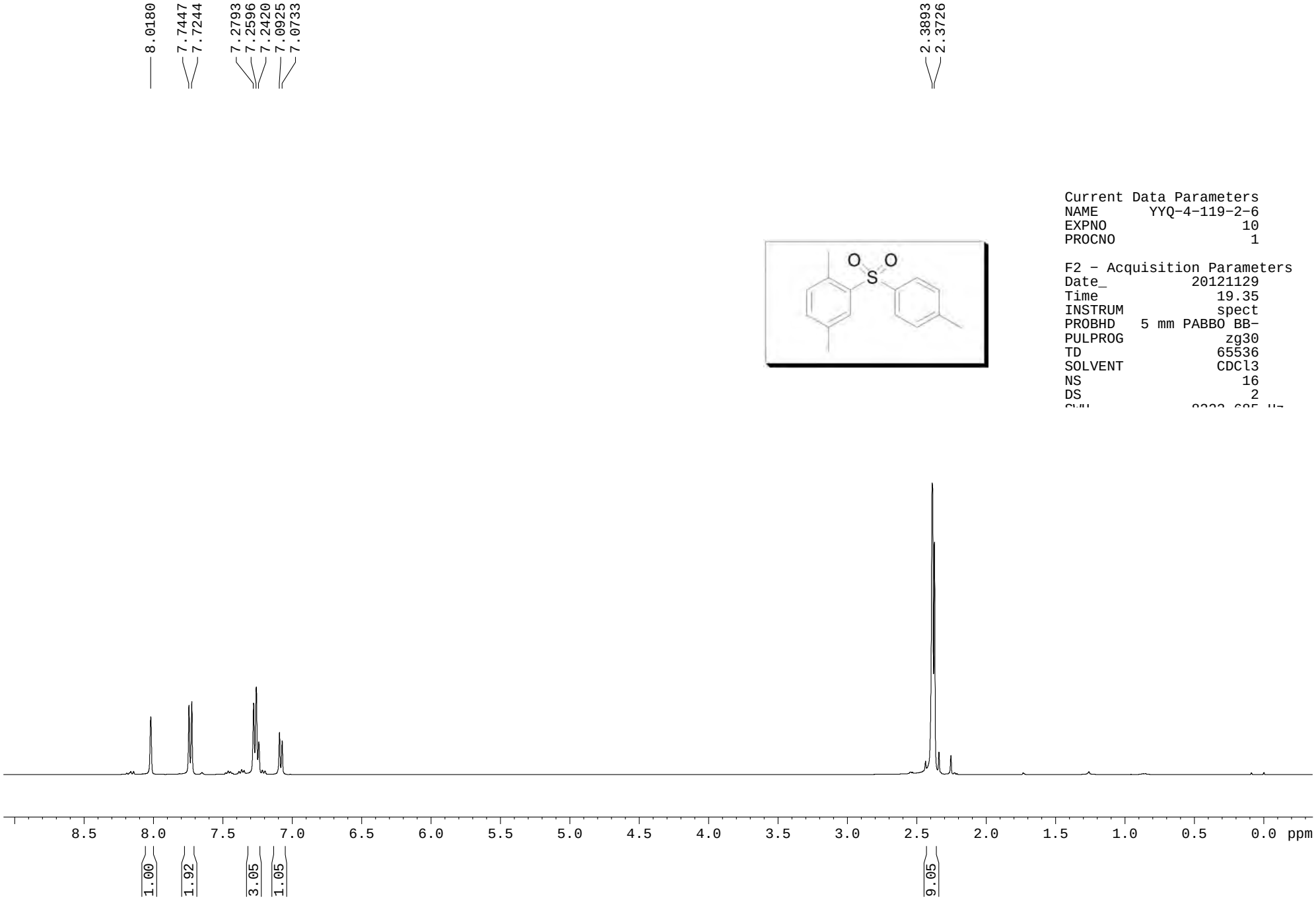

144.60
140.66
139.72
138.34
130.13
129.62
129.06
127.79
77.48
77.16
76.84
21.65
O
S
O
Cl
Current Data Parameters
NAME YYQ-4-119-2-9-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121129
Time 20.05
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

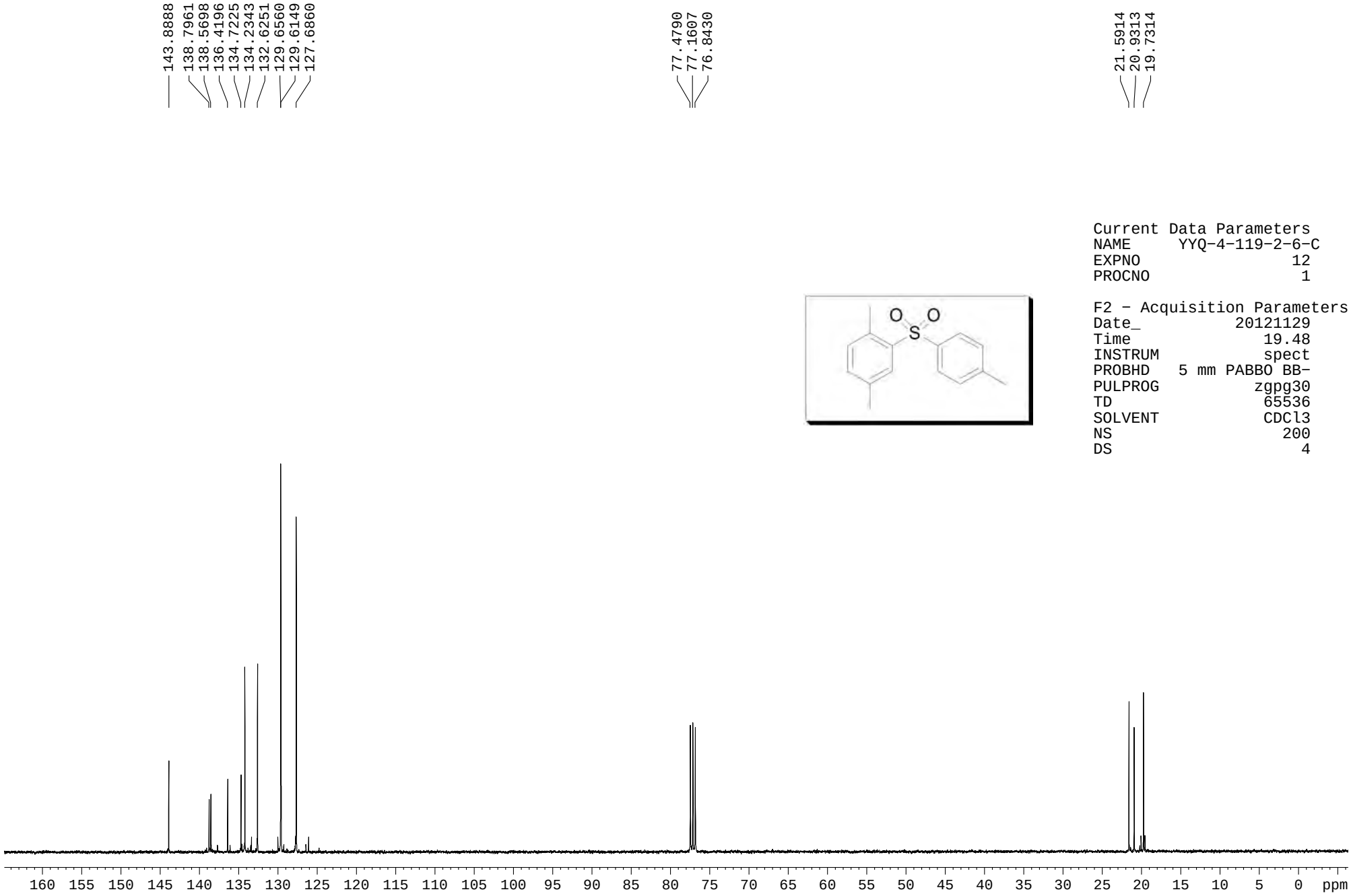

8.0820
8.0618
7.7345
7.7141
7.2729
7.2530
7.1755
7.1554
7.0163
2.3907
2.3829
2.3400
Current Data Parameters
NAME YYQ-4-119-2-5
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121129
Time 18.23
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
S
O
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 ppm
1.00
2.02
2.12
1.04
1.01
6.11
3.02

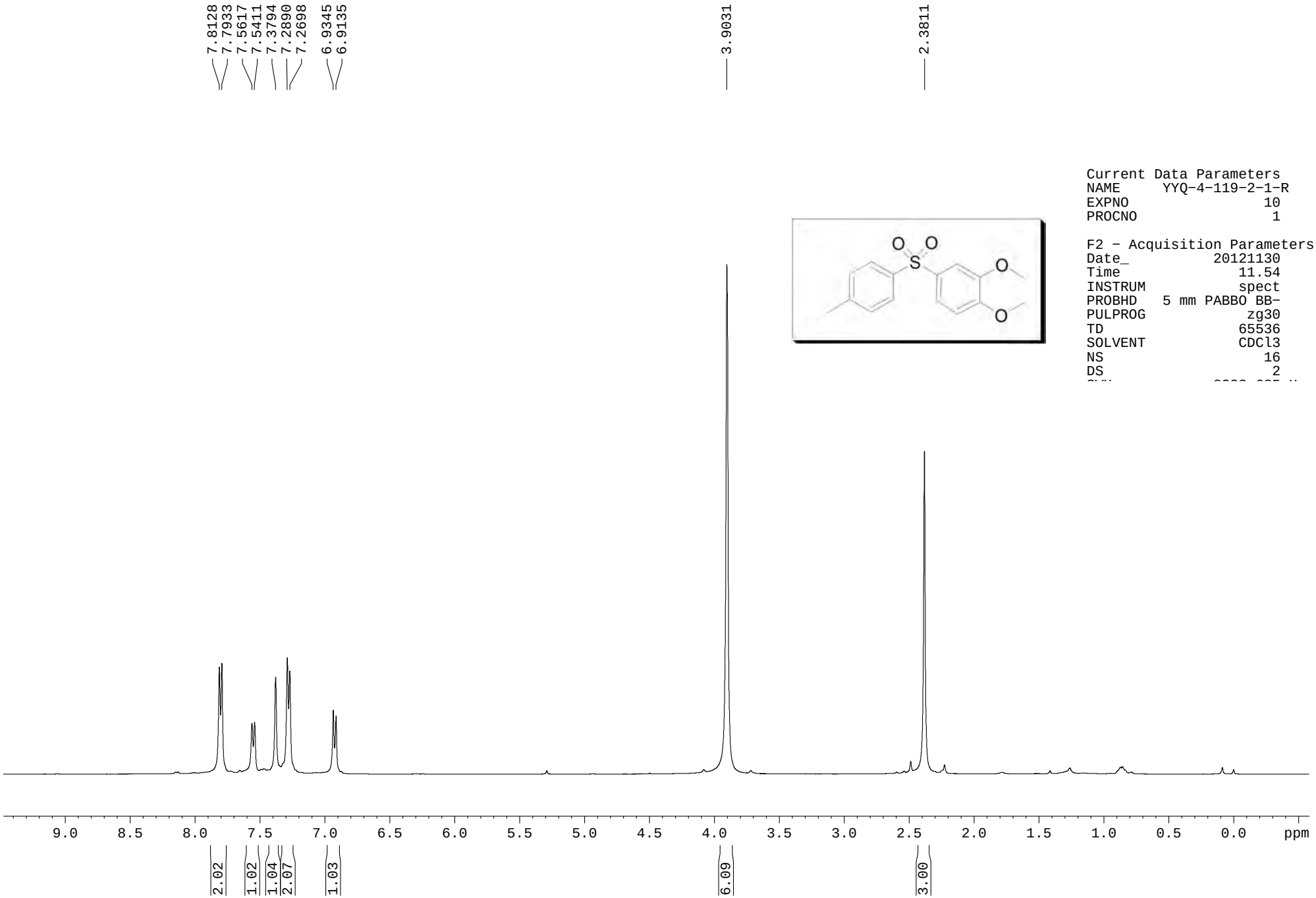

144.3216
143.7946
138.7586
137.7284
136.3440
133.3995
129.6418
129.5075
127.6301
127.0776
77.4768
77.1592
76.8406
21.5803
21.3528
20.1283
O
O
S
Current Data Parameters
NAME YYQ-4-119-2-5-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121129
Time 18.35
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

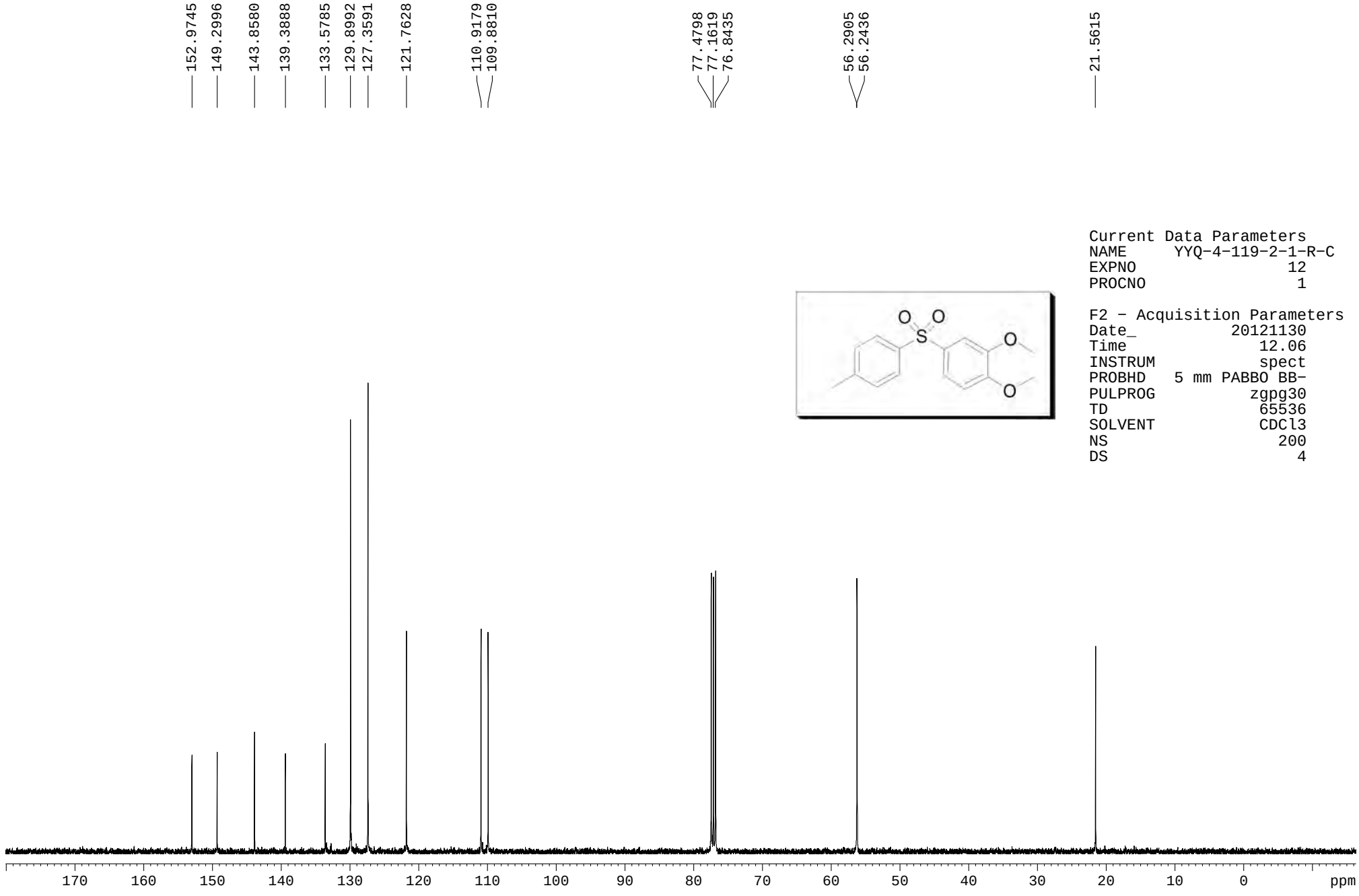

7.8172
7.7968
7.6730
7.6611
7.6410
7.2806
7.2606
7.2351
7.2155
2.3762
2.2794
2.2755
O
O
S
Current Data Parameters
NAME YYQ-4-119-2-4
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121129
Time 18.05
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.97
1.81
2.23
1.00
3.09
5.88

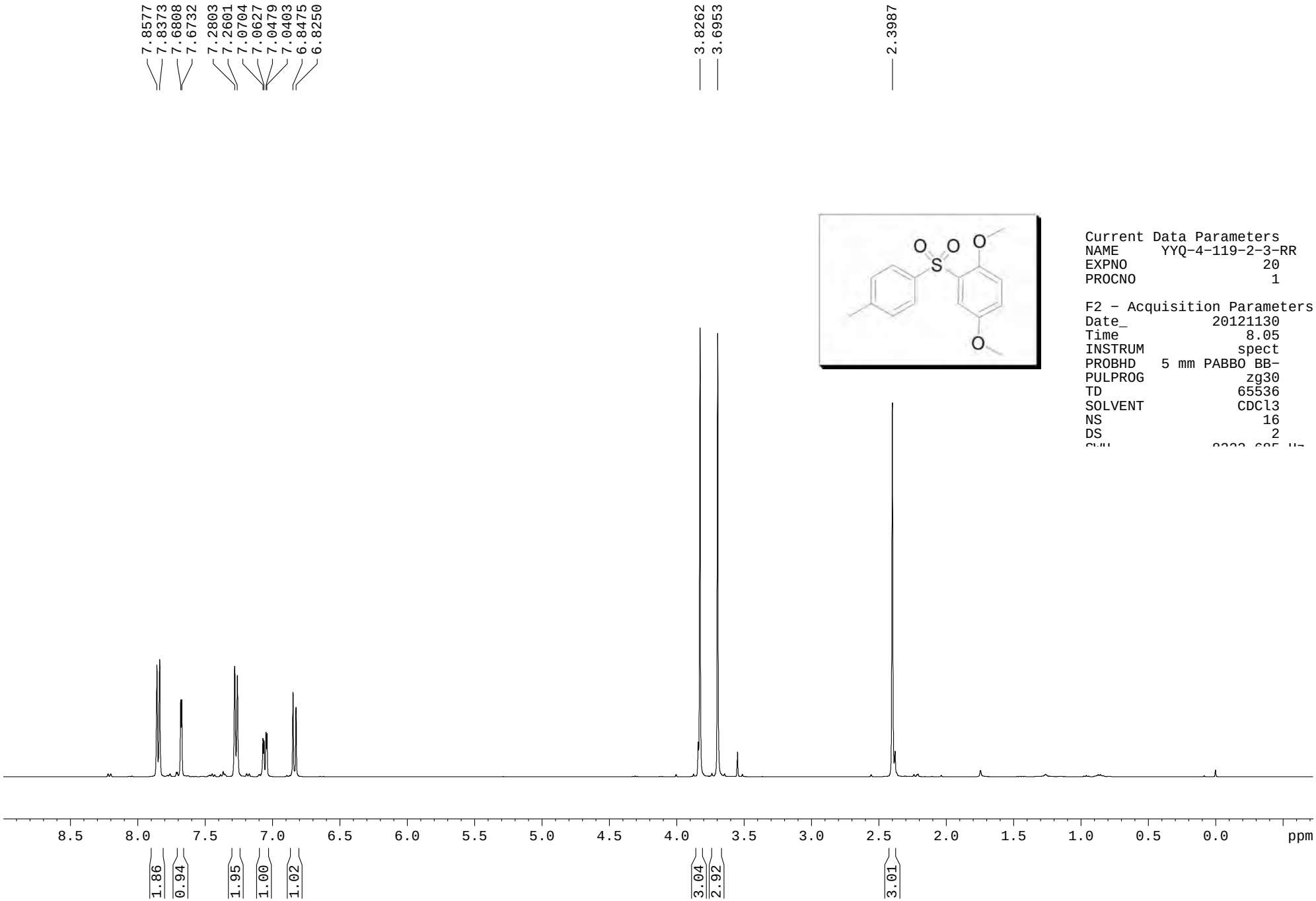

143.9154
142.7585
139.3211
139.2617
138.1083
130.4433
129.9192
128.3911
127.6274
125.1894
77.4783
77.1610
76.8430
21.6307
20.0165
19.9066
Current Data Parameters
NAME YYQ-4-119-2-4-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121129
Time 18.17
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
O
O
S
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

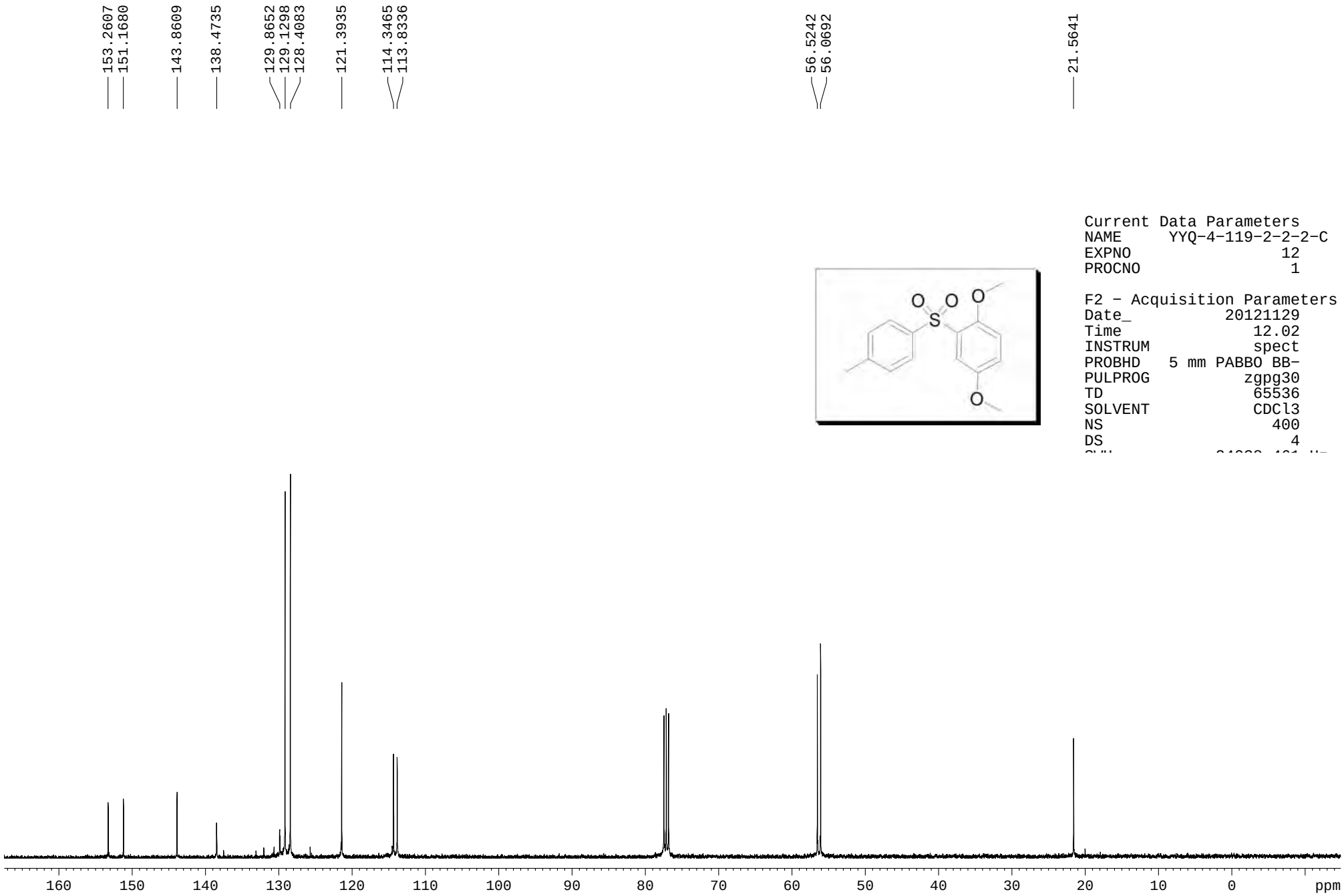

8.0180
7.7447
7.7244
7.2793
7.2596
7.2420
7.0925
7.0733
2.3893
2.3726
O
O
S
Current Data Parameters
NAME YYQ-4-119-2-6
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121129
Time 19.35
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
1.00
1.92
3.05
1.05
9.05

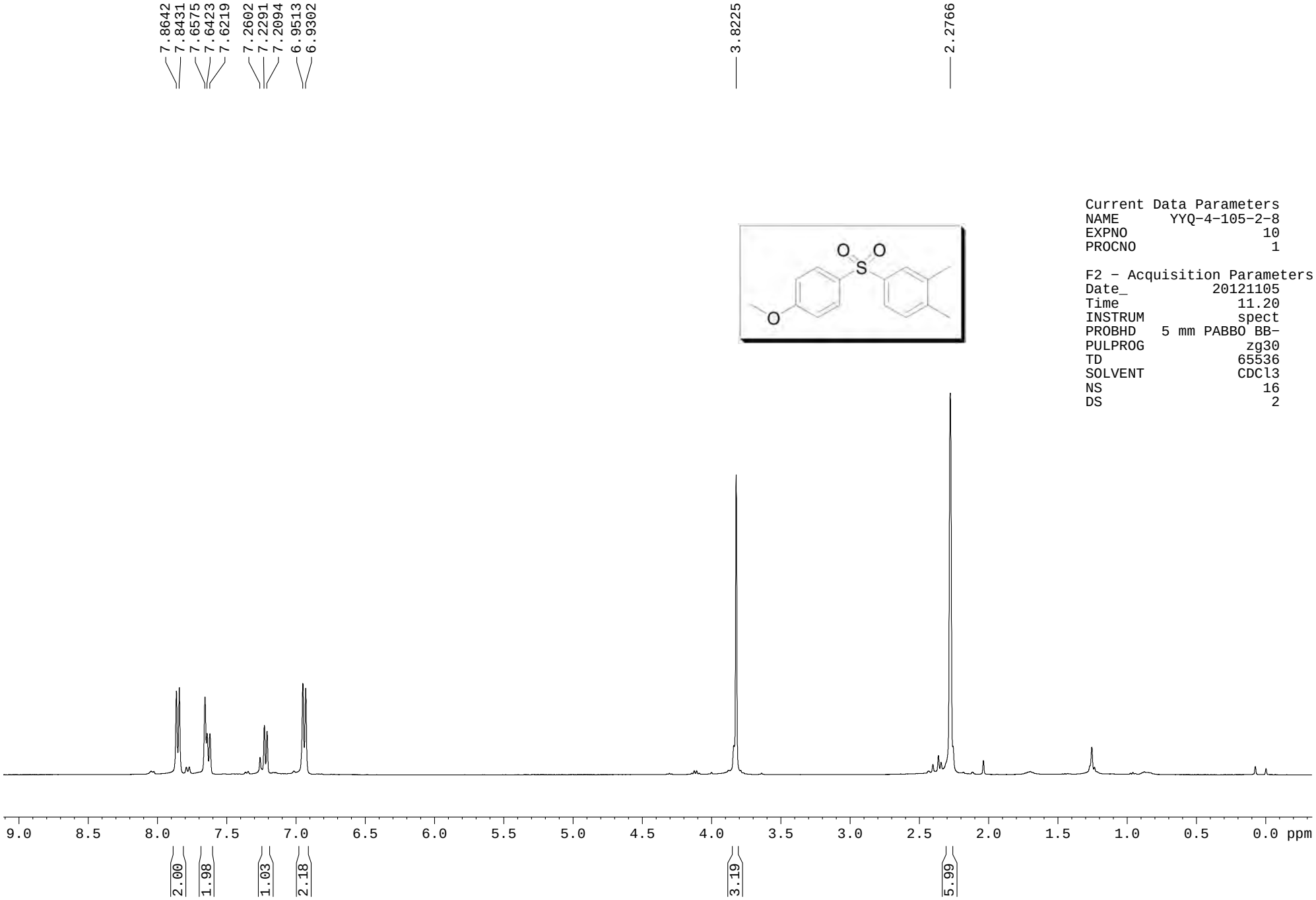

143.8888
138.7961
138.5698
136.4196
134.7225
134.2343
132.6251
129.6560
129.6149
127.6860
77.4790
77.1607
76.8430
21.5914
20.9313
19.7314
O
O
S
Current Data Parameters
NAME YYQ-4-119-2-6-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121129
Time 19.48
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
160 155 150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 ppm

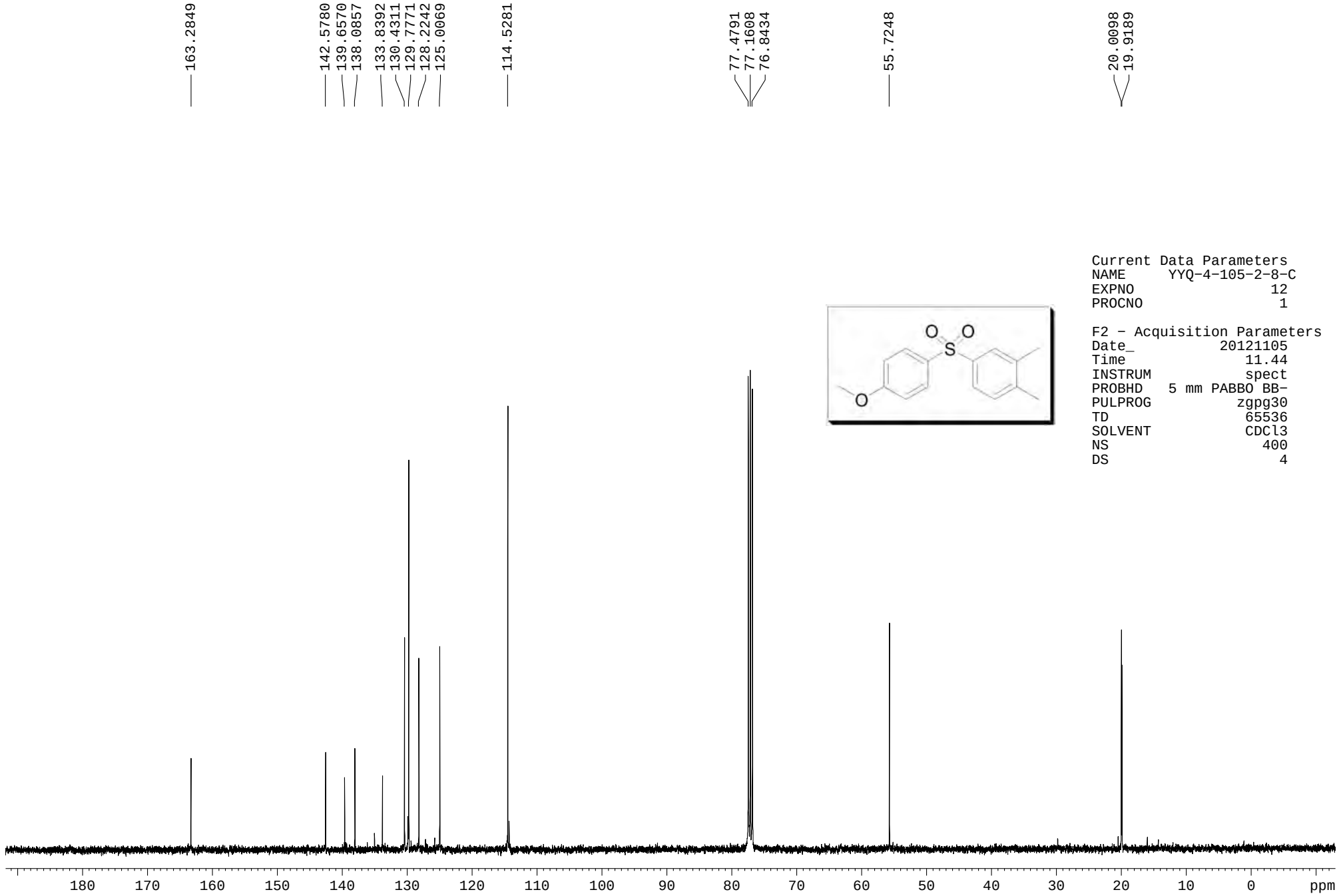

7.8128
7.7933
7.5617
7.5411
7.3794
7.2890
7.2698
6.9345
6.9135
3.9031
2.3811
Current Data Parameters
NAME YYQ-4-119-2-1-R
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121130
Time 11.54
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.02
1.02
1.04
2.07
1.03
6.09
3.00

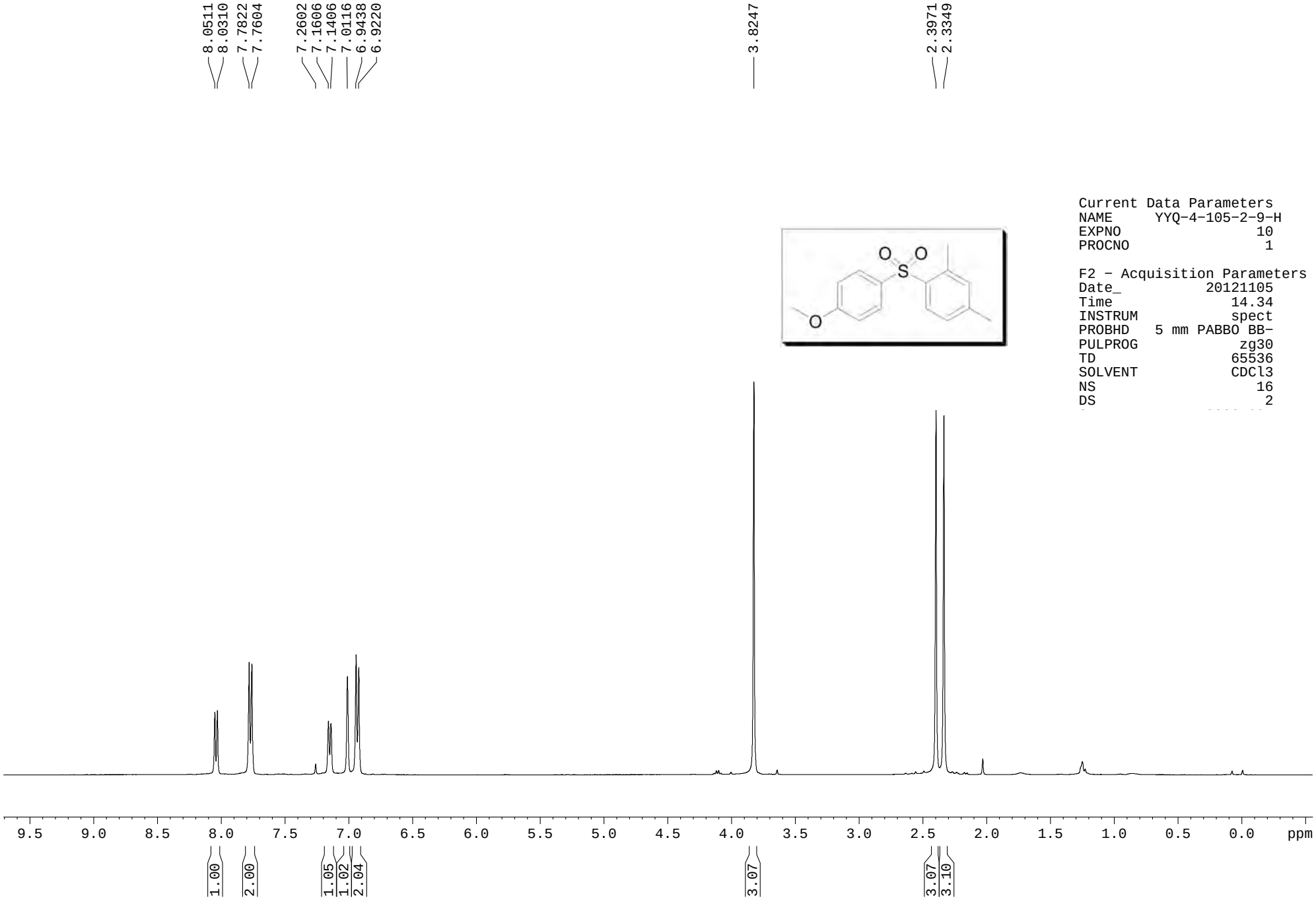

152.9745
149.2996
143.8580
139.3888
133.5785
129.8992
127.3591
121.7628
110.9179
109.8810
77.4798
77.1619
76.8435
56.2905
56.2436
21.5615
Current Data Parameters
NAME YYQ-4-119-2-1-R-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121130
Time 12.06
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
O
O
S
O
O
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

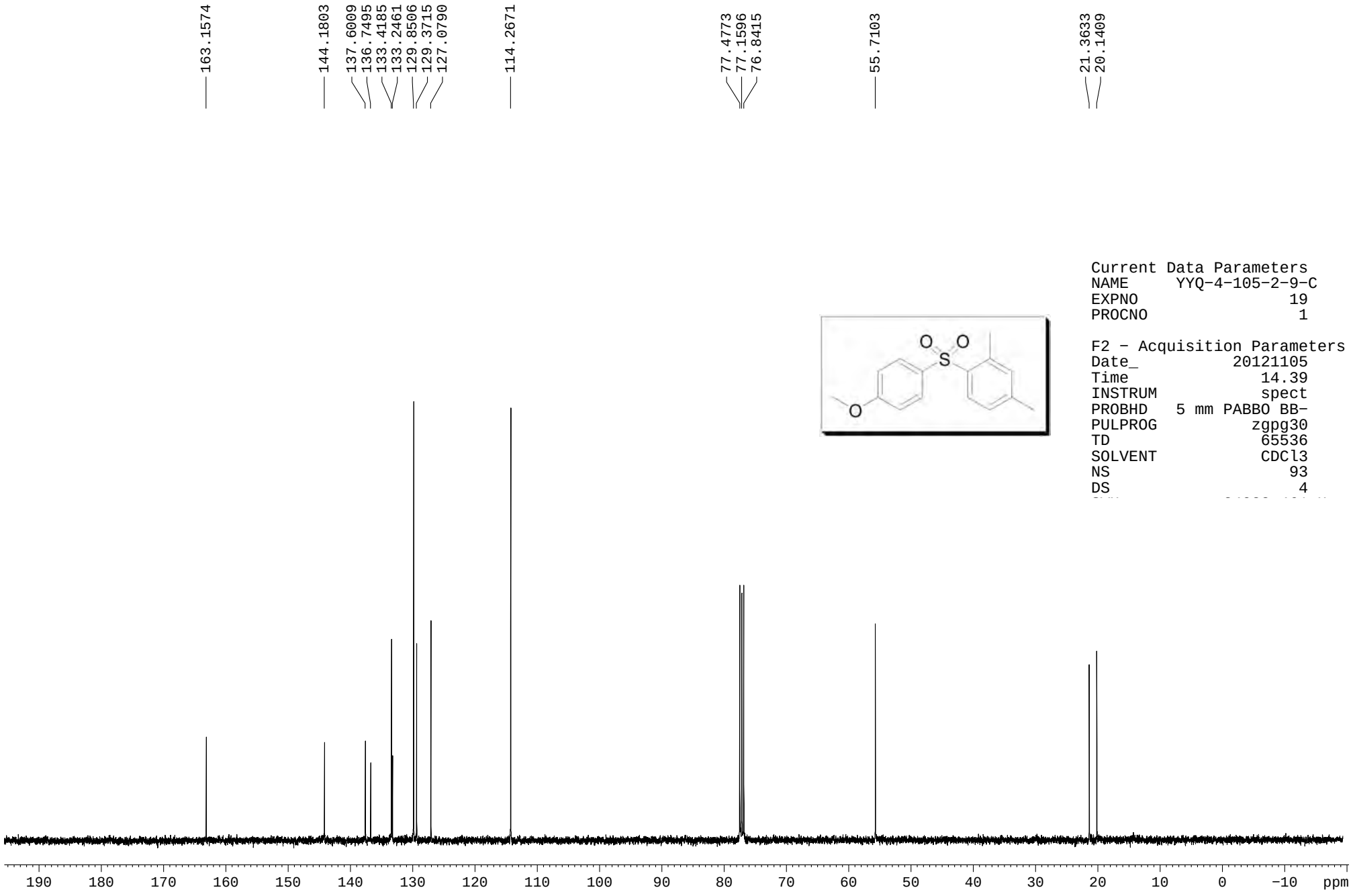

7.8577
7.8373
7.6808
7.6732
7.2803
7.2601
7.0704
7.0627
7.0479
7.0403
6.8475
6.8250
3.8262
3.6953
2.3987
Current Data Parameters
NAME YYQ-4-119-2-3-RR
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121130
Time 8.05
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
1.86
0.94
1.95
1.00
1.02
3.04
2.92
3.01

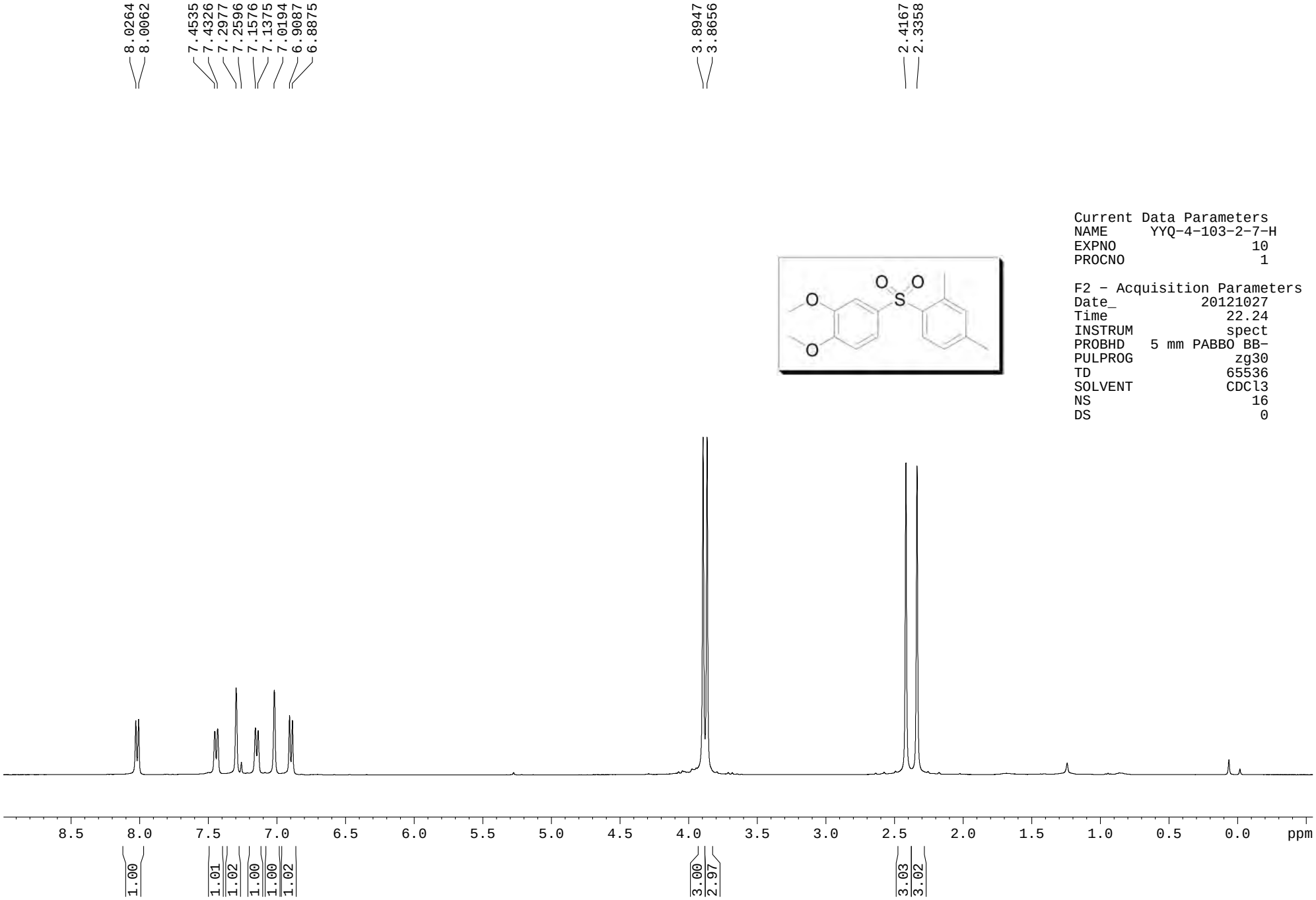

153.2607
151.1680
143.8609
138.4735
129.8652
129.1298
128.4083
121.3935
114.3465
113.8336
56.5242
56.0692
21.5641
Current Data Parameters
NAME YYQ-4-119-2-2-2-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121129
Time 12.02
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 400
DS 4
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

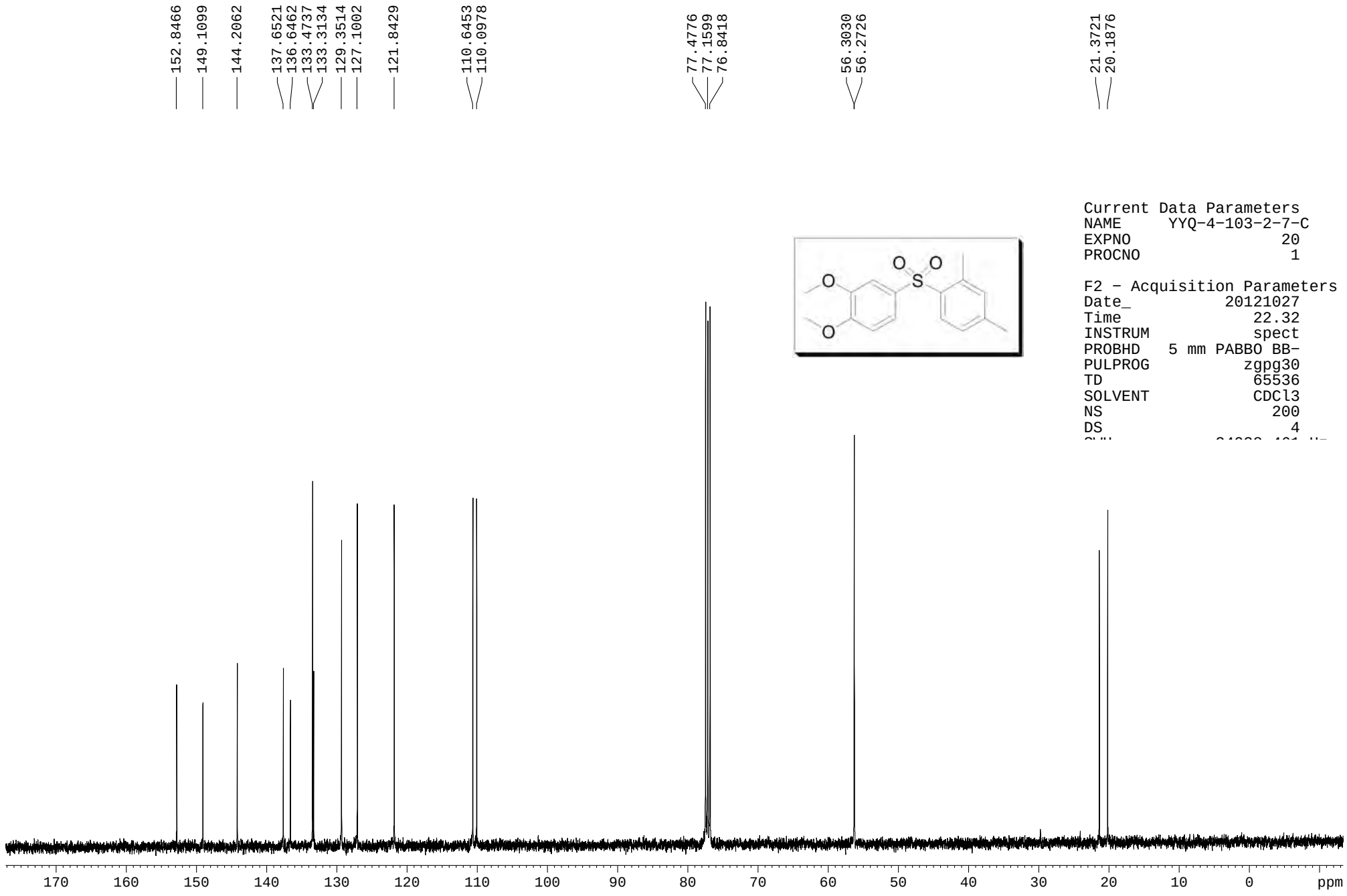

7.8642
7.8431
7.6575
7.6423
7.6219
7.2602
7.2291
7.2094
6.9513
6.9302
3.8225
2.2766
O
O
S
O
Current Data Parameters
NAME YYQ-4-105-2-8
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121105
Time 11.20
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0 ppm
2.00
1.98
1.03
2.18
3.19
5.99

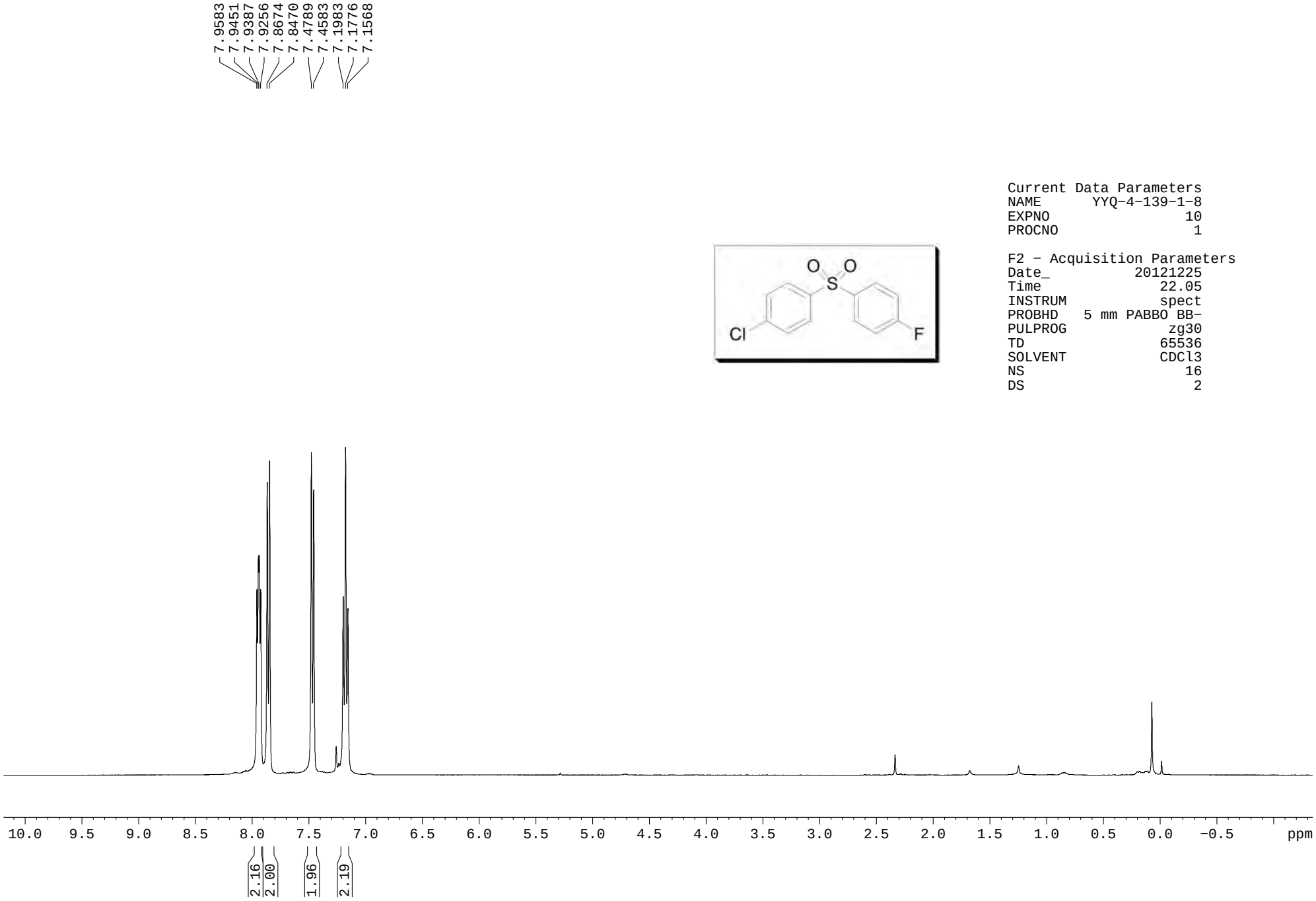

163.2849
142.5780
139.6570
138.0857
133.8392
130.4311
129.7771
128.2242
125.0069
114.5281
77.4791
77.1608
76.8434
55.7248
20.0098
19.9189
Current Data Parameters
NAME YYQ-4-105-2-8-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121105
Time 11.44
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 400
DS 4
O
O
S
O
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

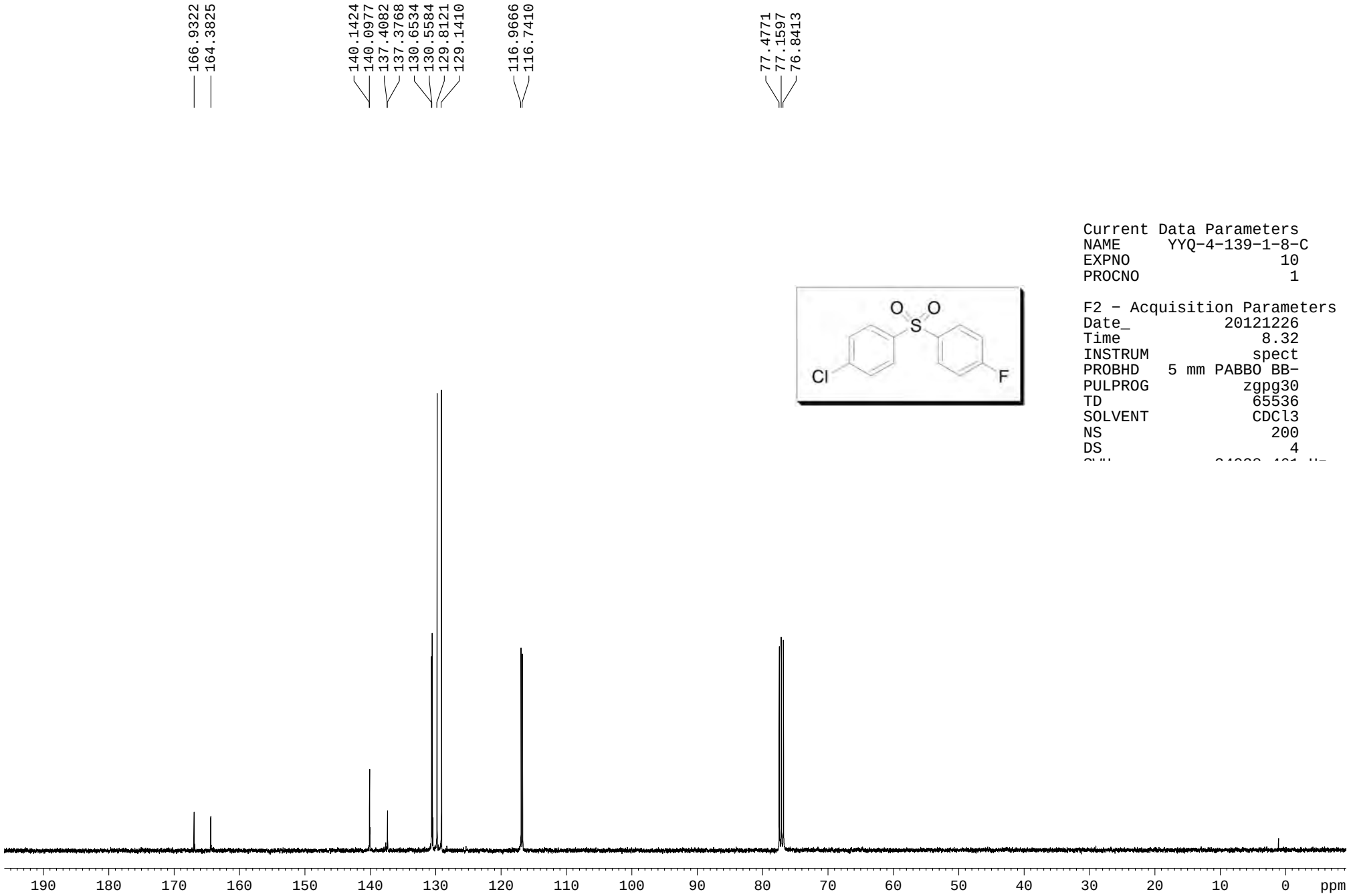

8.0511
8.0310
7.7822
7.7604
7.2602
7.1606
7.1406
7.0116
6.9438
6.9220
3.8247
2.3971
2.3349
Current Data Parameters
NAME YYQ-4-105-2-9-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121105
Time 14.34
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
S
O
O
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
1.00
2.00
1.05
1.02
2.04
3.07
3.07
3.10

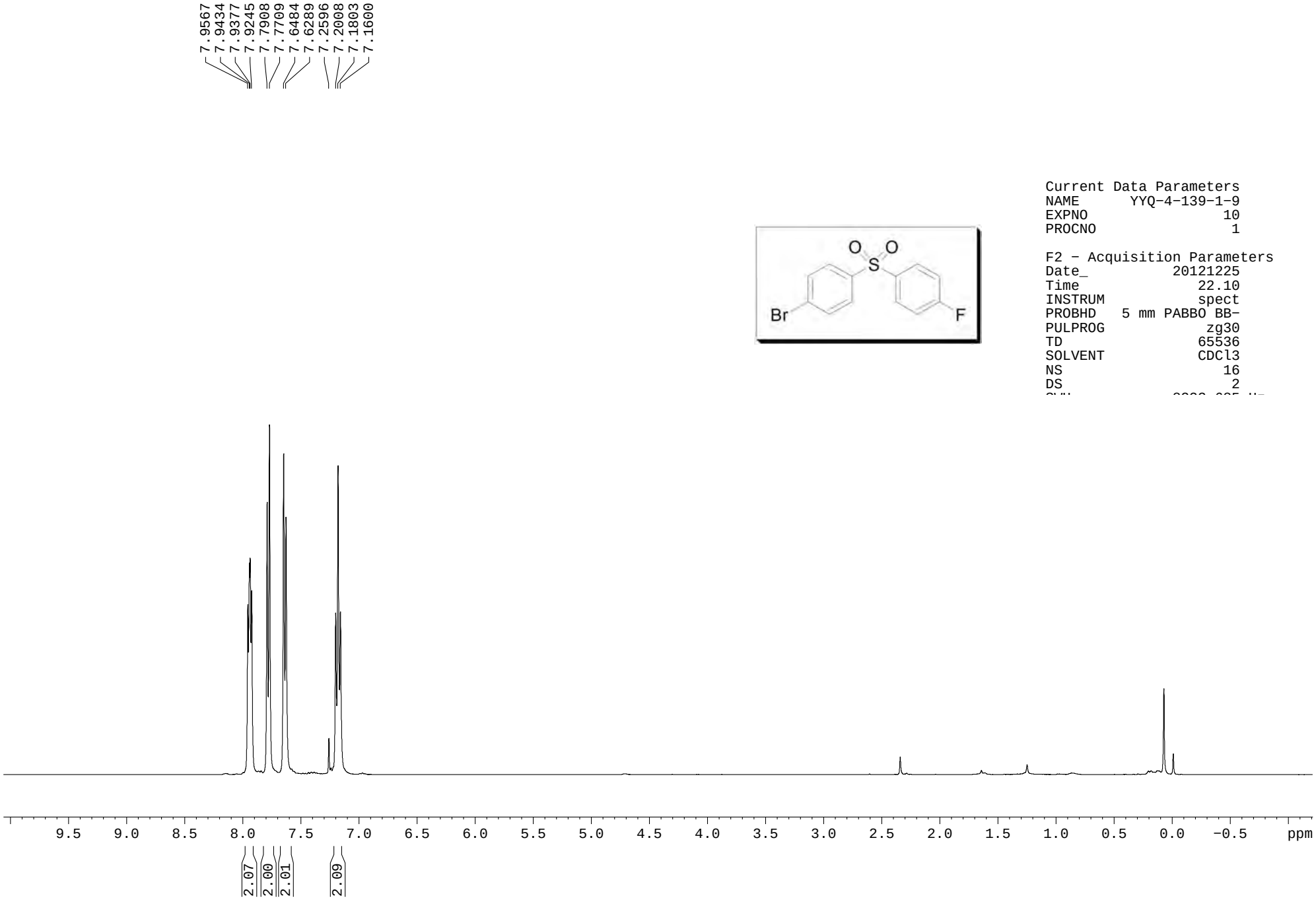

163.1574
144.1803
137.6009
136.7495
133.4185
133.2461
129.8506
129.3715
127.0790
114.2671
77.4773
77.1596
76.8415
55.7103
21.3633
20.1409
O
O
S
O
Current Data Parameters
NAME YYQ-4-105-2-9-C
EXPNO 19
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121105
Time 14.39
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 93
DS 4
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 ppm

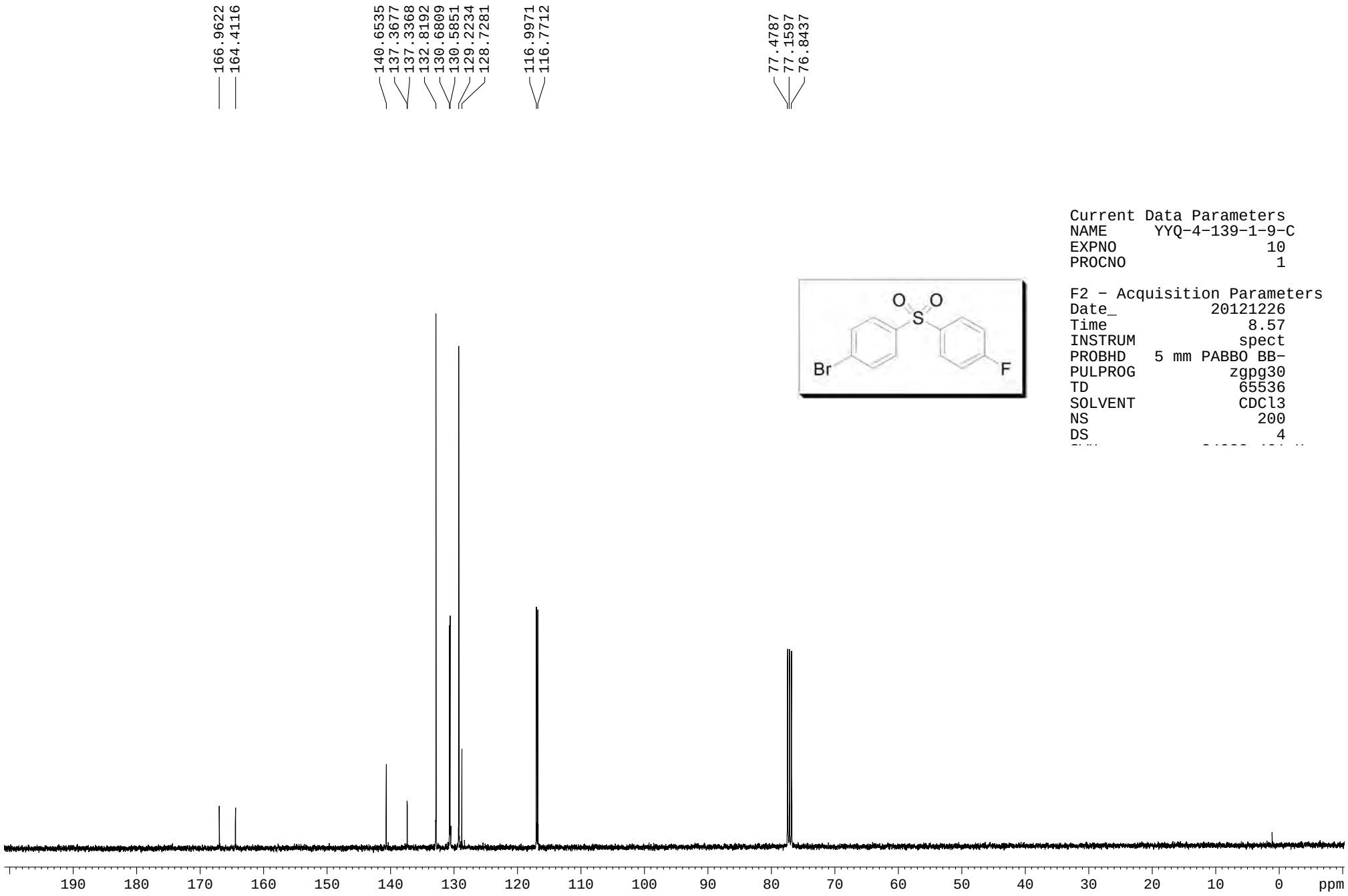

8.0264
8.0062
7.4535
7.4326
7.2977
7.2596
7.1576
7.1375
7.0194
6.9087
6.8875
3.8947
3.8656
2.4167
2.3358
Current Data Parameters
NAME YYQ-4-103-2-7-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121027
Time 22.24
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 0
O
O
S
O
O
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.00
1.01
1.02
1.00
1.00
1.02
3.00
2.97
3.03
3.02

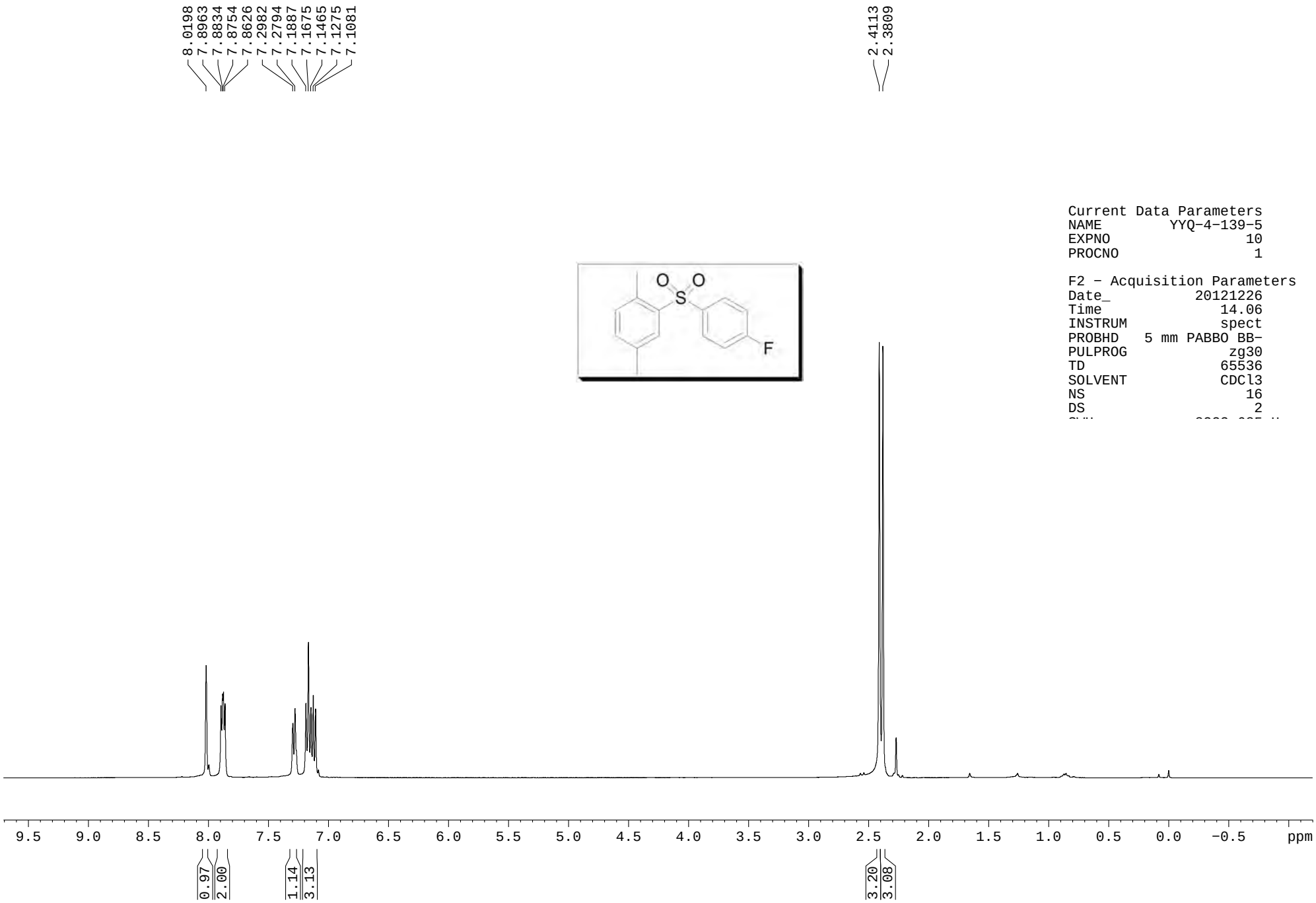

152.8466
149.1099
144.2062
137.6521
136.6462
133.4737
133.3134
129.3514
127.1002
121.8429
110.6453
110.0978
77.4776
77.1599
76.8418
56.3030
56.2726
21.3721
20.1876
Current Data Parameters
NAME YYQ-4-103-2-7-C
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121027
Time 22.32
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
O
O
S
O
O
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

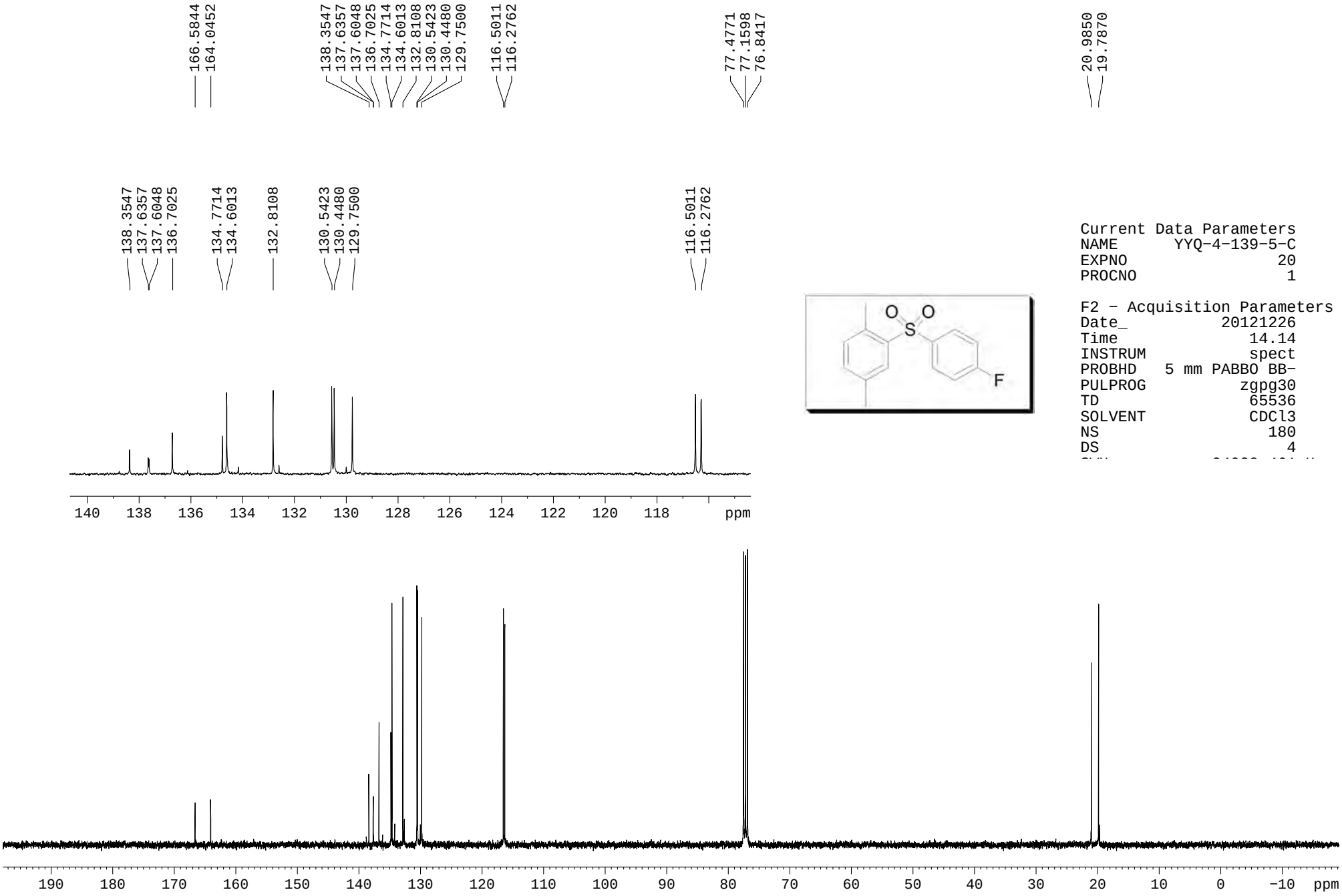

7.9583
7.9451
7.9387
7.9256
7.8674
7.8470
7.4789
7.4583
7.1983
7.1776
7.1568
O
O
S
Cl
F
Current Data Parameters
NAME YYQ-4-139-1-8
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121225
Time 22.05
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
2.16
2.00
1.96
2.19

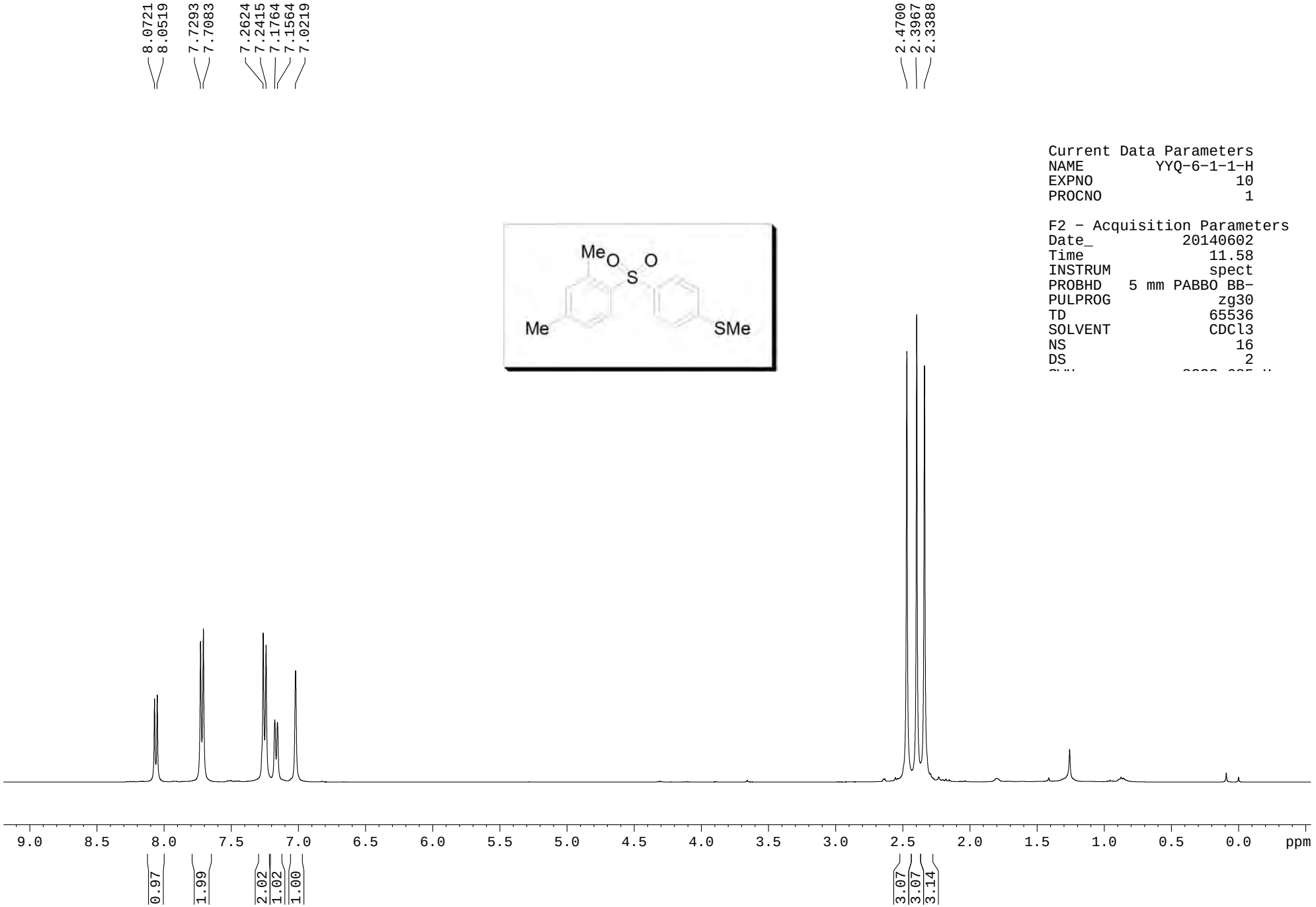

166.9322
164.3825
140.1424
140.0977
137.4082
137.3768
130.6534
130.5584
129.8121
129.1410
116.9666
116.7410
77.4771
77.1597
76.8413
O
O
S
Cl
F
Current Data Parameters
NAME YYQ-4-139-1-8-C
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121226
Time 8.32
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

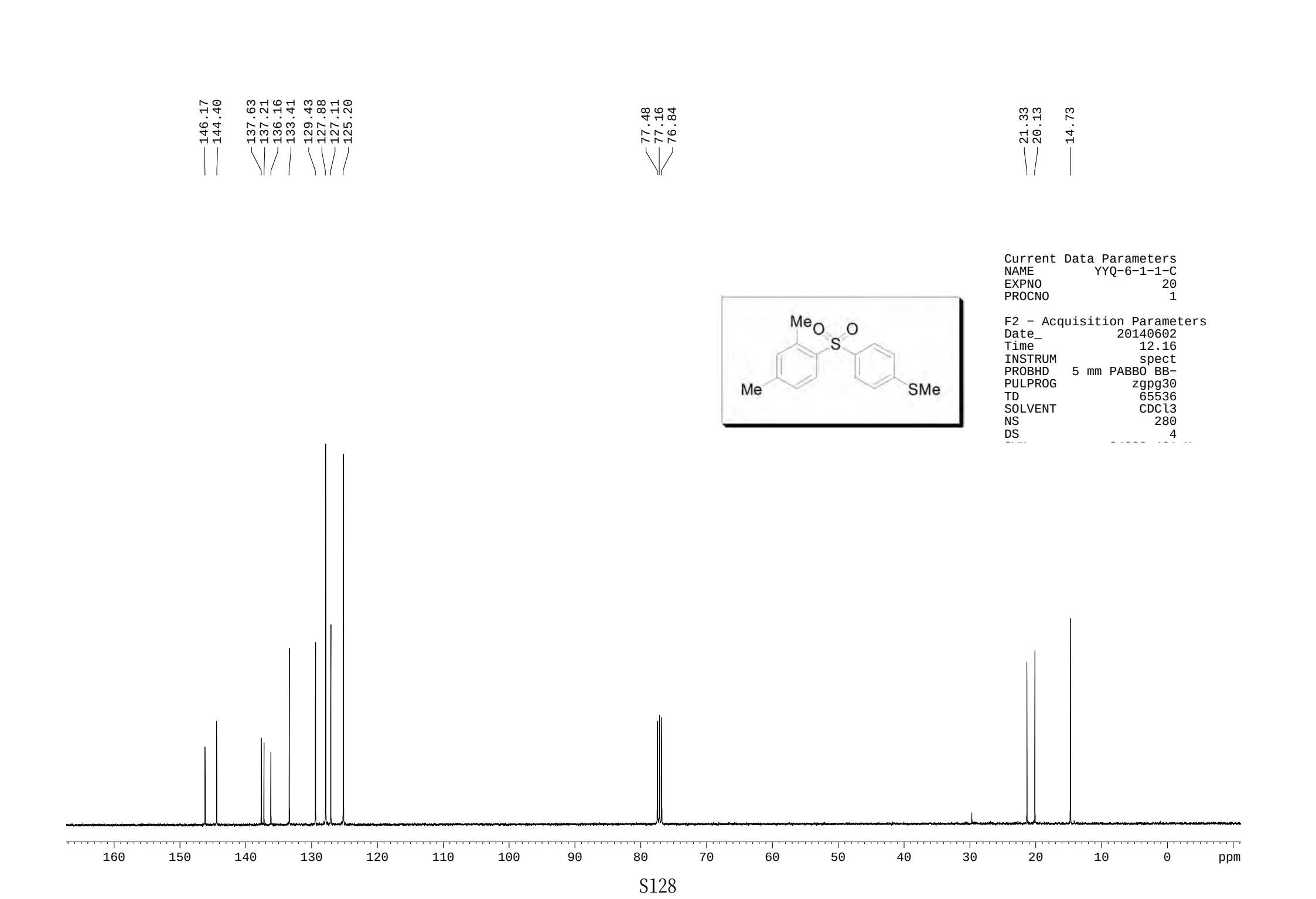

7.9567
7.9434
7.9377
7.9245
7.7908
7.7709
7.6484
7.6289
7.2596
7.2008
7.1803
7.1600
Br
F
Current Data Parameters
NAME YYQ-4-139-1-9
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121225
Time 22.10
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
2.07
2.00
2.01
2.09

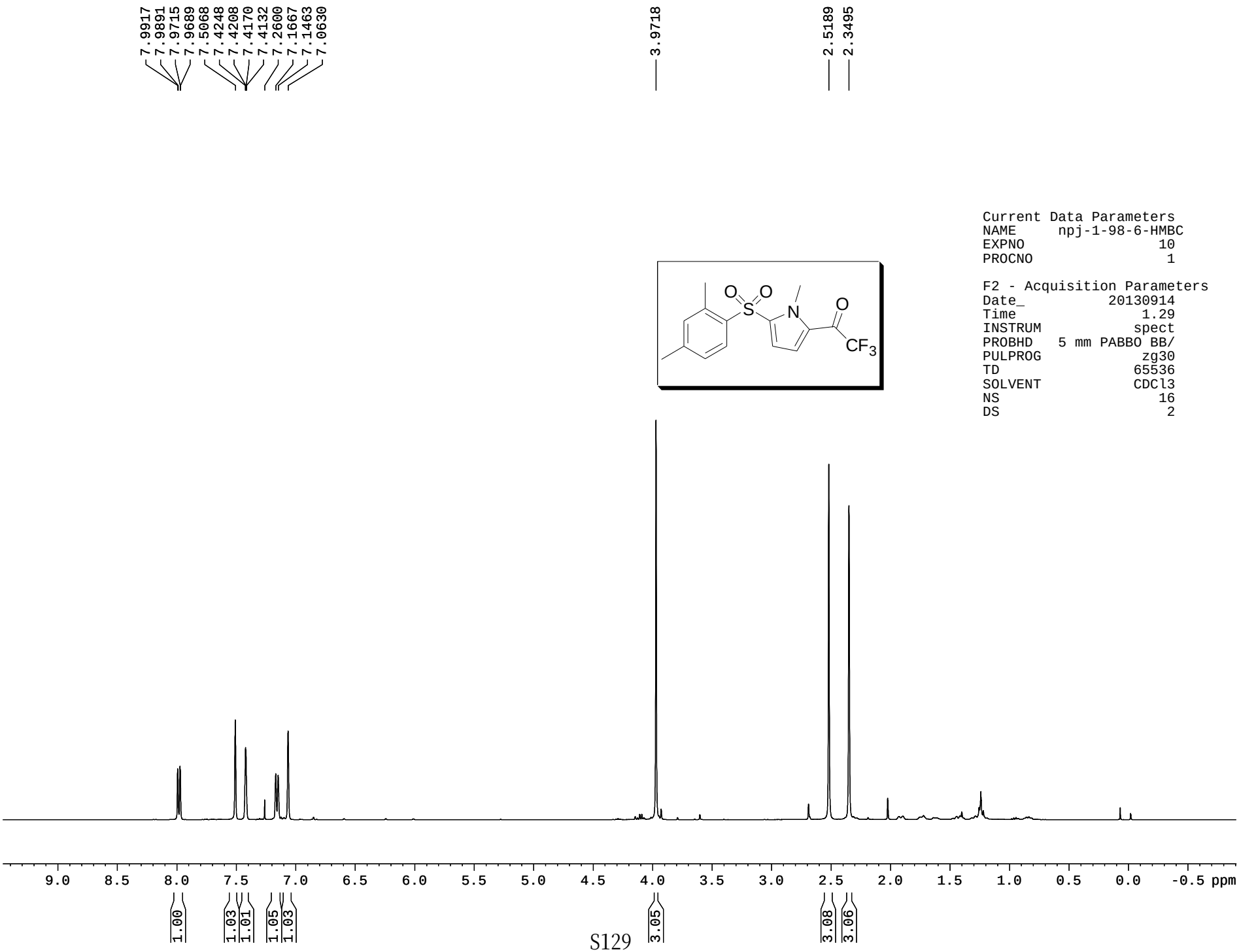

166.9622
164.4116
140.6535
137.3677
137.3368
132.8192
130.6809
130.5851
129.2234
128.7281
116.9971
116.7712
77.4787
77.1597
76.8437
O
O
S
Br
F
Current Data Parameters
NAME YYQ-4-139-1-9-C
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121226
Time 8.57
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

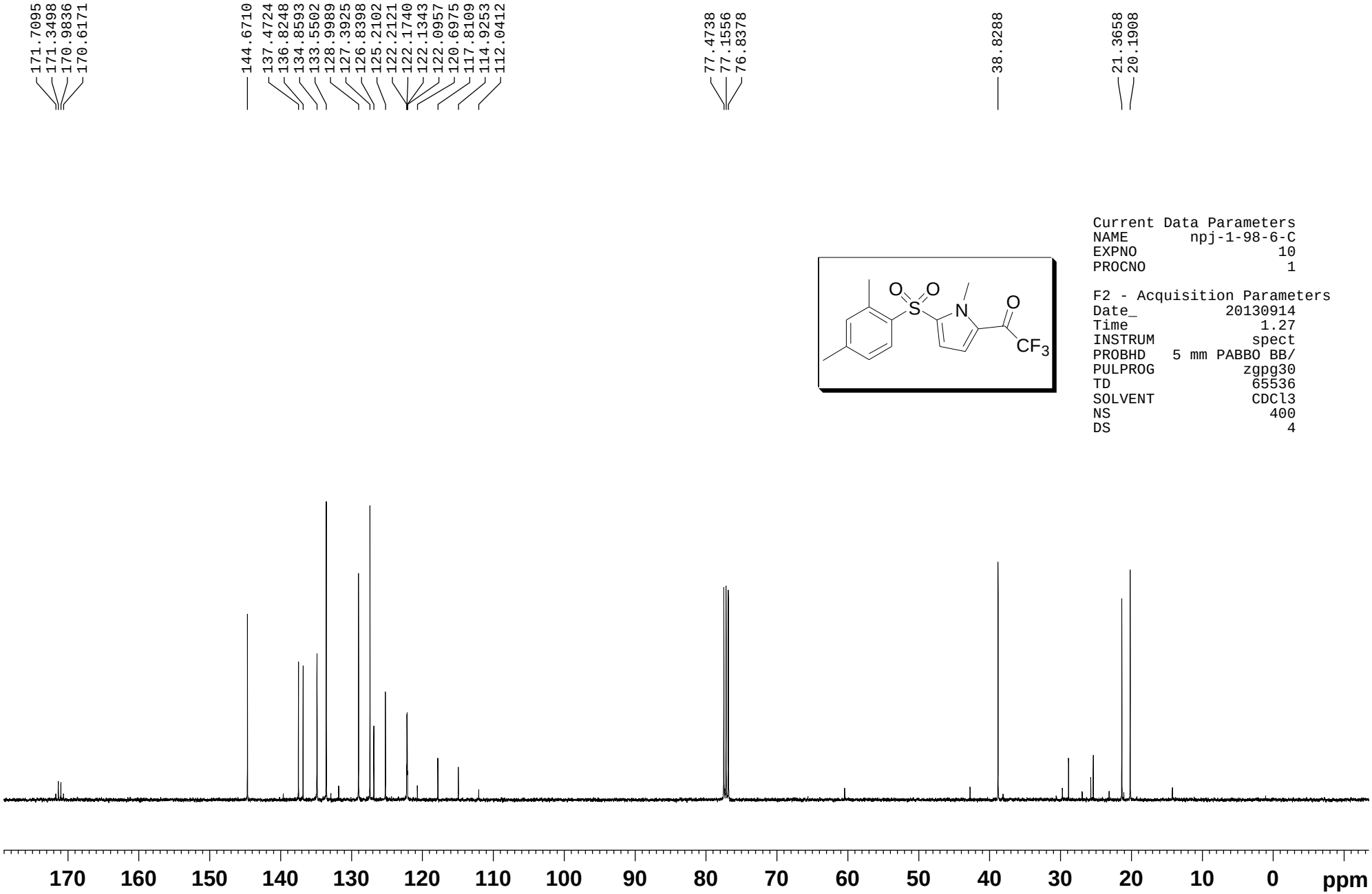

8.0198
7.8963
7.8834
7.8754
7.8626
7.2982
7.2794
7.1887
7.1675
7.1465
7.1275
7.1081
2.4113
2.3809
Current Data Parameters
NAME YYQ-4-139-5
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121226
Time 14.06
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
O
S
F
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
0.97
2.00
1.14
3.13
3.20
3.08

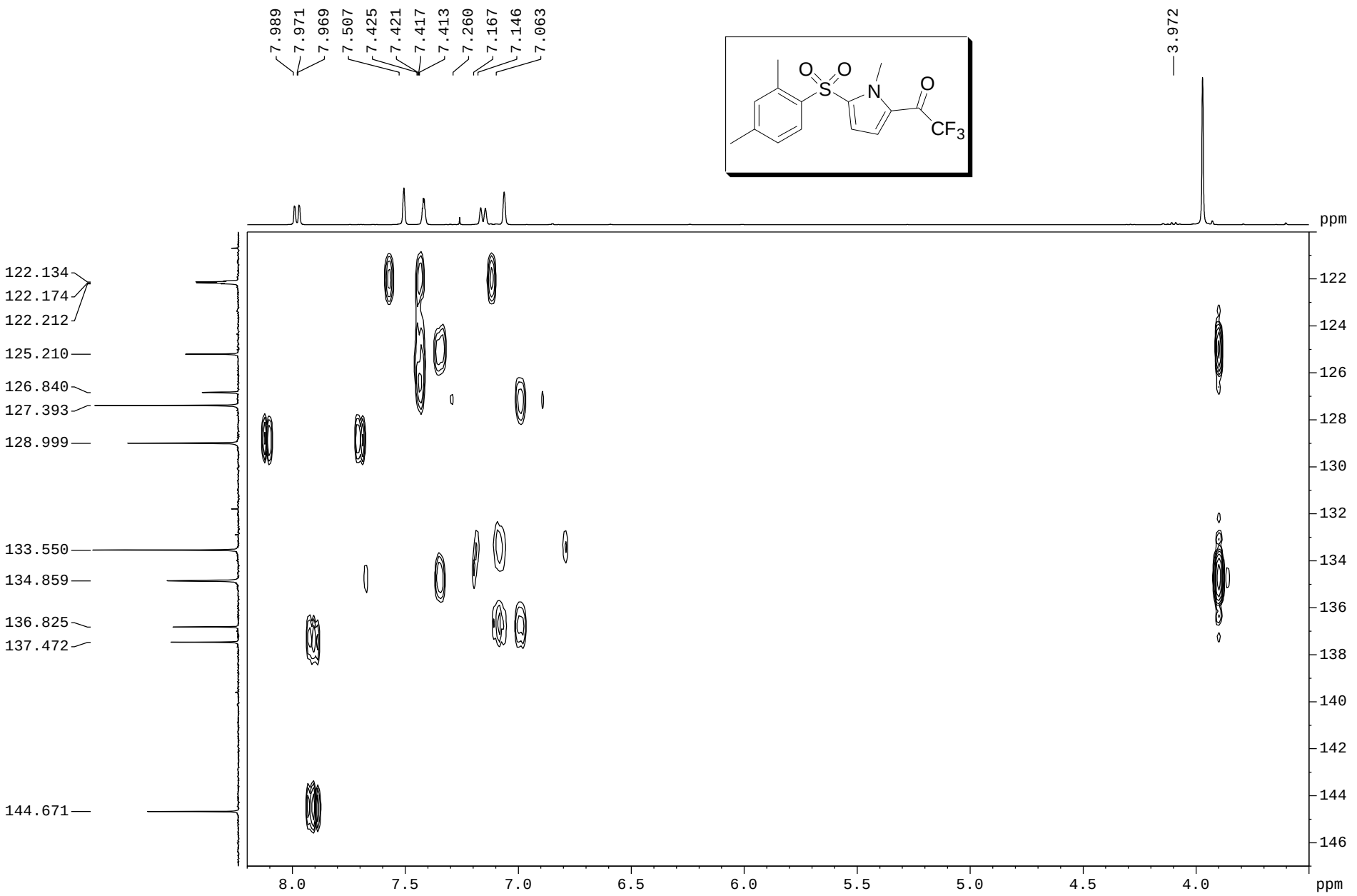

166.5844
164.0452
138.3547
137.6357
137.6048
136.7025
134.7714
134.6013
132.8108
130.5423
130.4480
129.7500
116.5011
116.2762
77.4771
77.1598
76.8417
20.9850
19.7870
O
O
S
F
Current Data Parameters
NAME YYQ-4-139-5-C
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121226
Time 14.14
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 180
DS 4
ppm

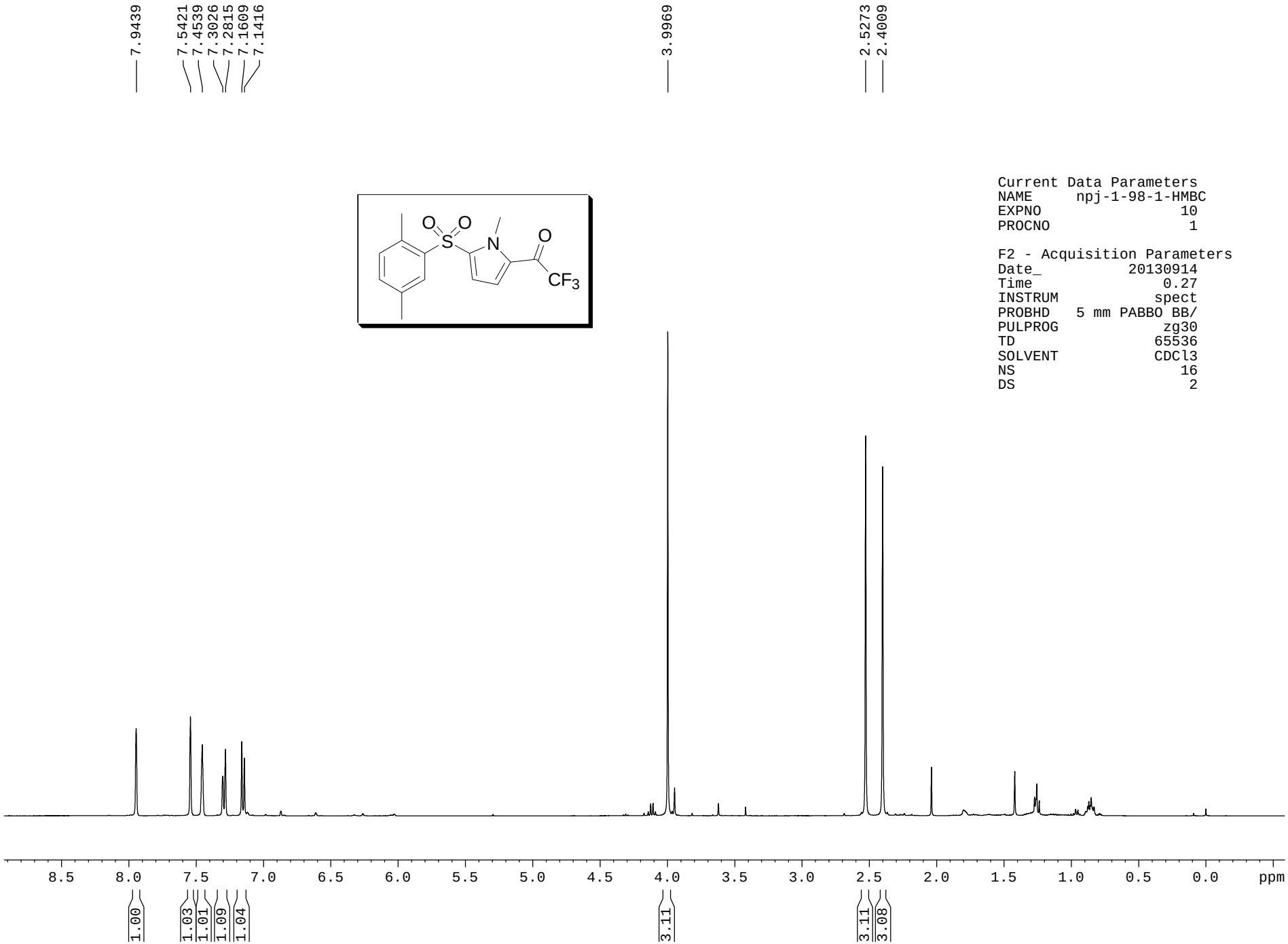

8.0721
8.0519
7.7293
7.7083
7.2624
7.2415
7.1764
7.1564
7.0219
2.4700
2.3967
2.3388
Current Data Parameters
NAME YYQ-6-1-1-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140602
Time 11.58
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
Me
O
O
S
Me
SMe
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
0.97
1.99
2.02
1.02
1.00
3.07
3.07
3.14

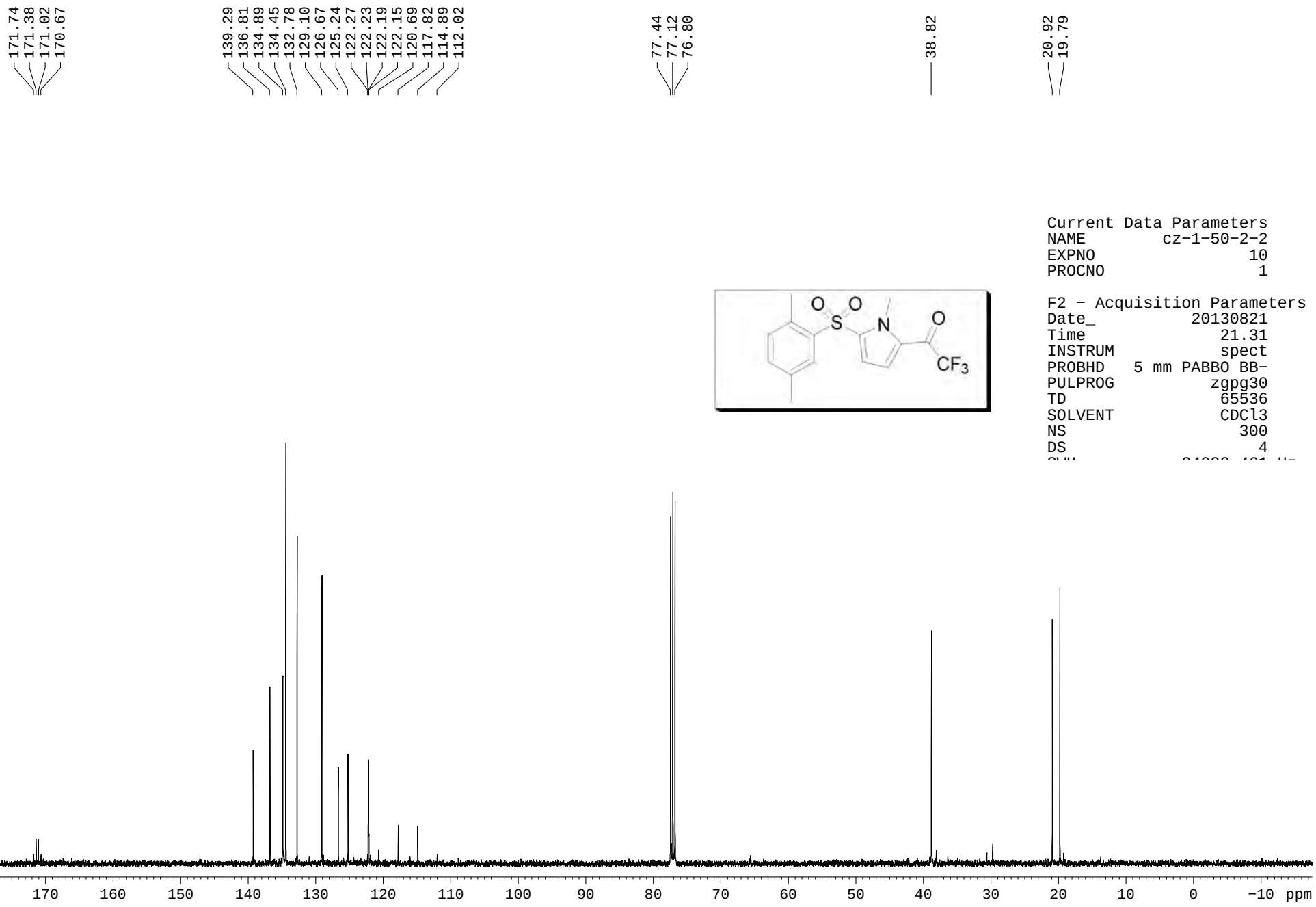

146.17
144.40
137.63
137.21
136.16
133.41
129.43
127.88
127.11
125.20
77.48
77.16
76.84
21.33
20.13
14.73
Me
O
O
S
Me
SMe
Current Data Parameters
NAME YYQ-6-1-1-C
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140602
Time 12.16
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 280
DS 4
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

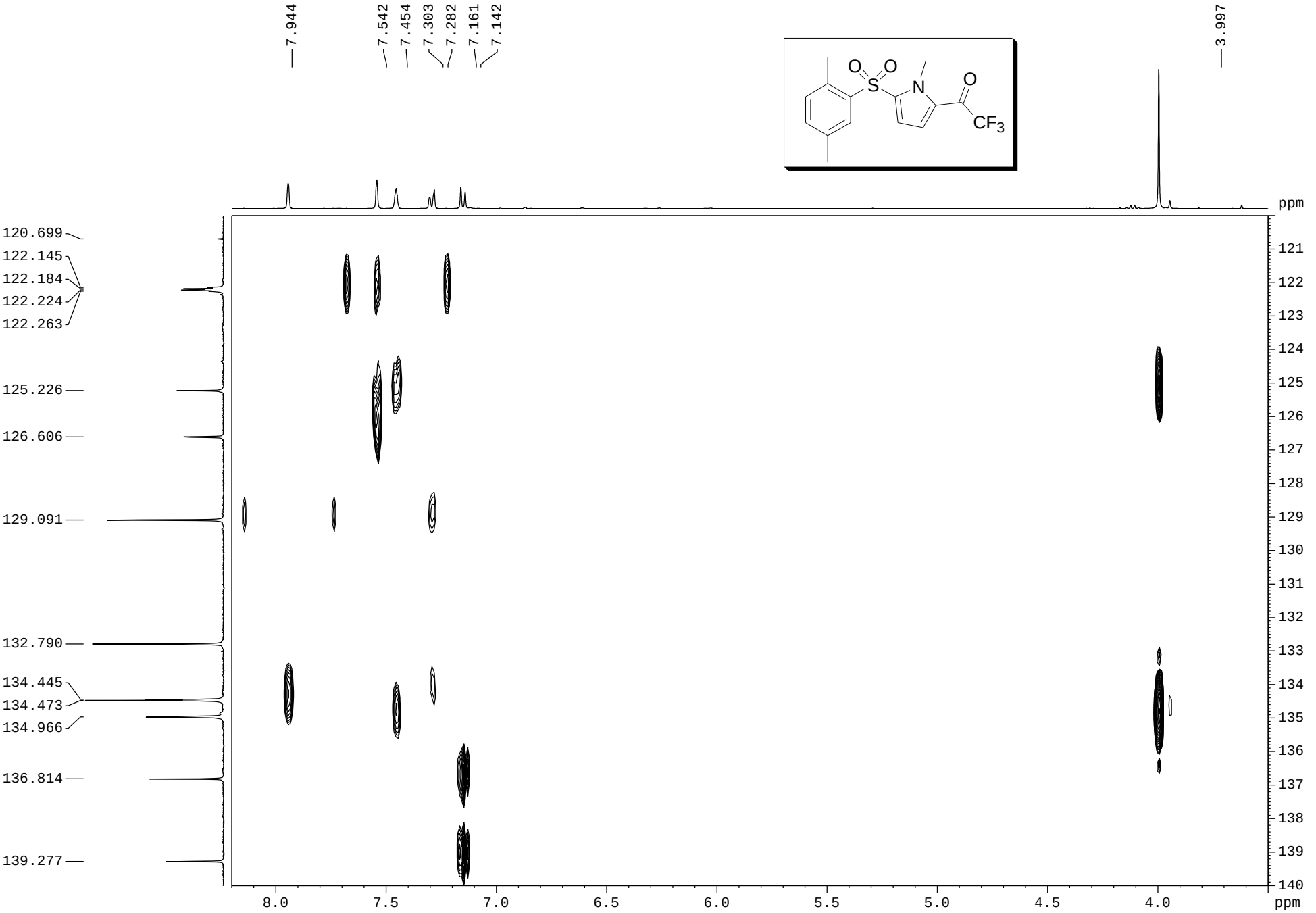

7.9917
7.9891
7.9715
7.9689
7.5068
7.4248
7.4208
7.4170
7.4132
7.2600
7.1667
7.1463
7.0630
3.9718
2.5189
2.3495
Current Data Parameters
NAME npj-1-98-6-HMBC
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130914
Time 1.29
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
O
S
N
O
CF3
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5 ppm
1.00
1.03
1.01
1.05
1.03
3.05
3.08
3.06

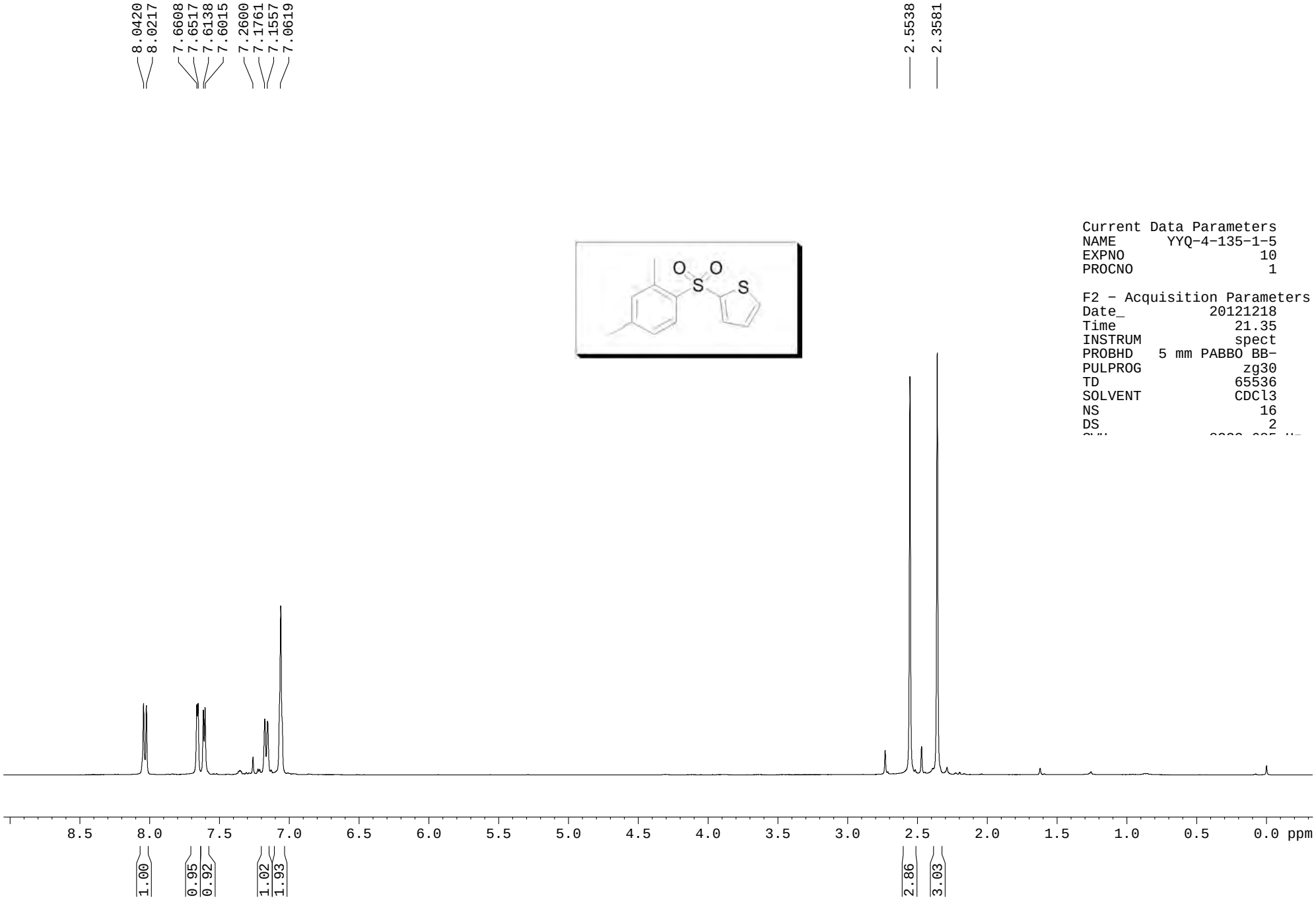

171.7095
171.3498
170.9836
170.6171
144.6710
137.4724
136.8248
134.8593
133.5502
128.9989
127.3925
126.8398
125.2102
122.2121
122.1740
122.1343
122.0957
120.6975
117.8109
114.9253
112.0412
77.4738
77.1556
76.8378
38.8288
21.3658
20.1908
O
O
S
N
O
CF3
Current Data Parameters
NAME npj-1-98-6-C
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130914
Time 1.27
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 400
DS 4
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

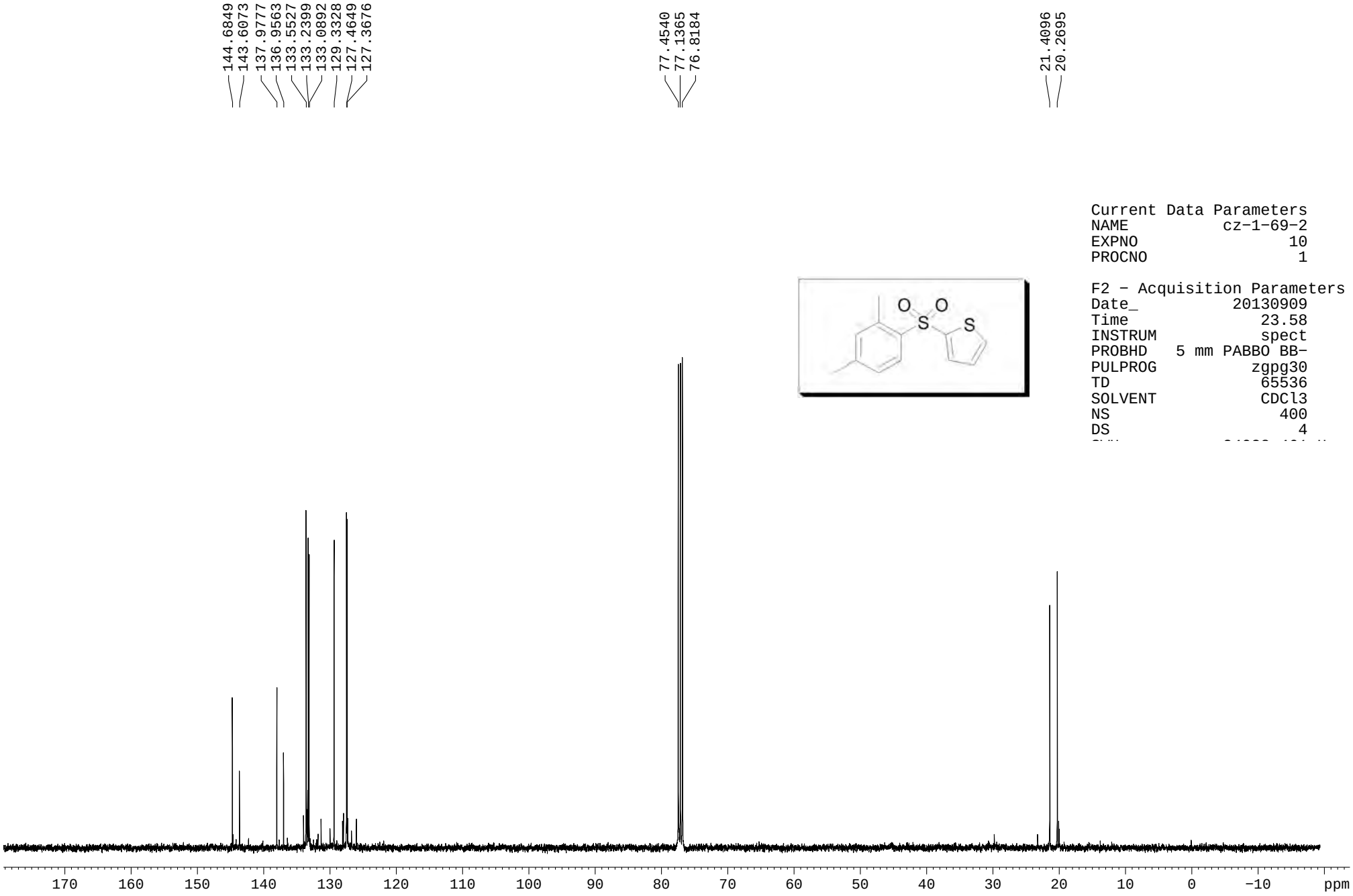

7.989
7.971
7.969
7.507
7.425
7.421
7.417
7.413
7.260
7.167
7.146
7.063
3.972
O
O
S
N
O
CF3
ppm
122.134
122.174
122.212
125.210
126.840
127.393
128.999
133.550
134.859
136.825
137.472
144.671
122
124
126
128
130
132
134
136
138
140
142
144
146
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
ppm

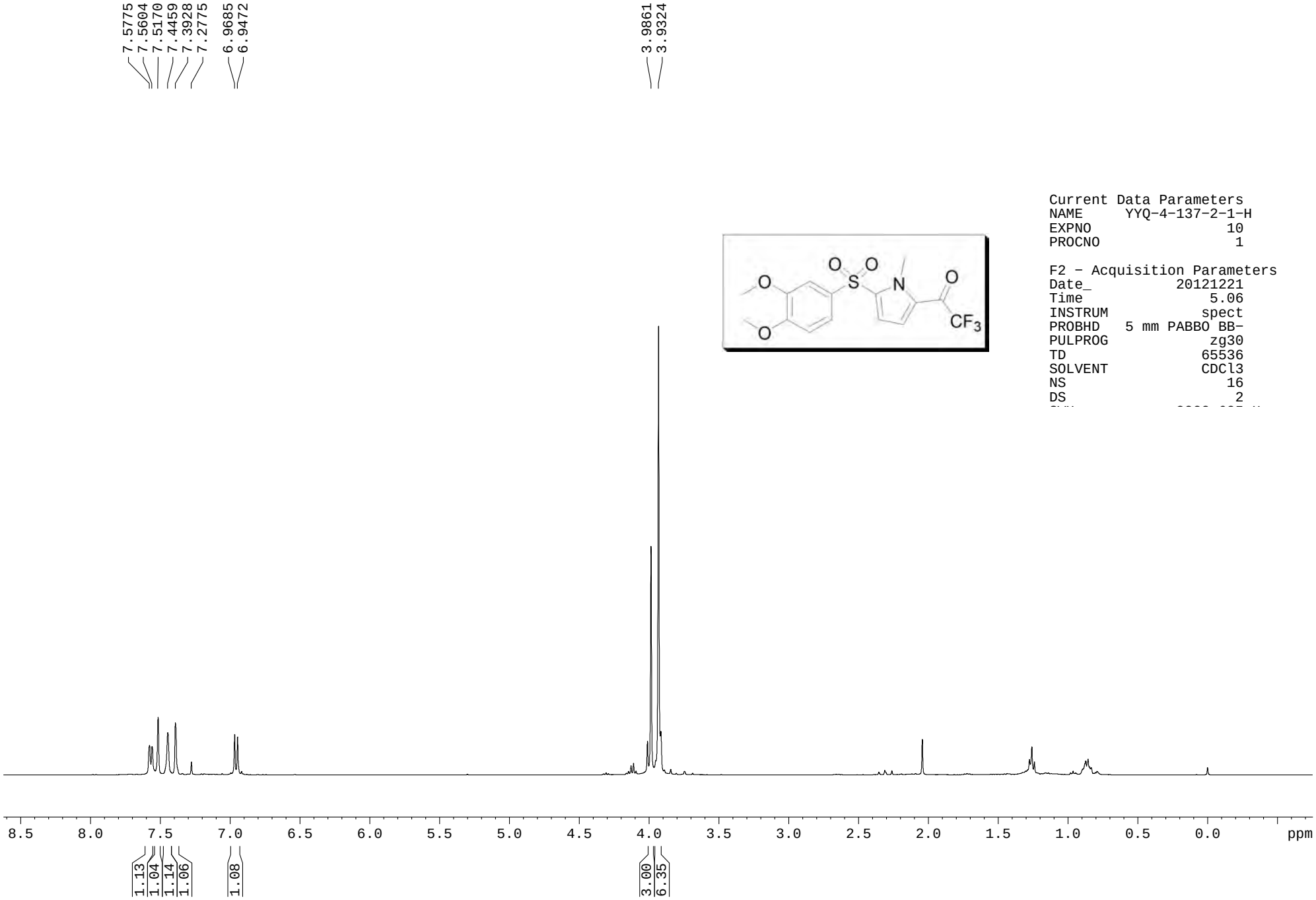

7.9439
7.5421
7.4539
7.3026
7.2815
7.1609
7.1416
3.9969
2.5273
2.4009
O
O
S
N
O
CF3
Current Data Parameters
NAME npj-1-98-1-HMBC
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130914
Time 0.27
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
1.00
1.03
1.01
1.09
1.04
3.11
3.11
3.08

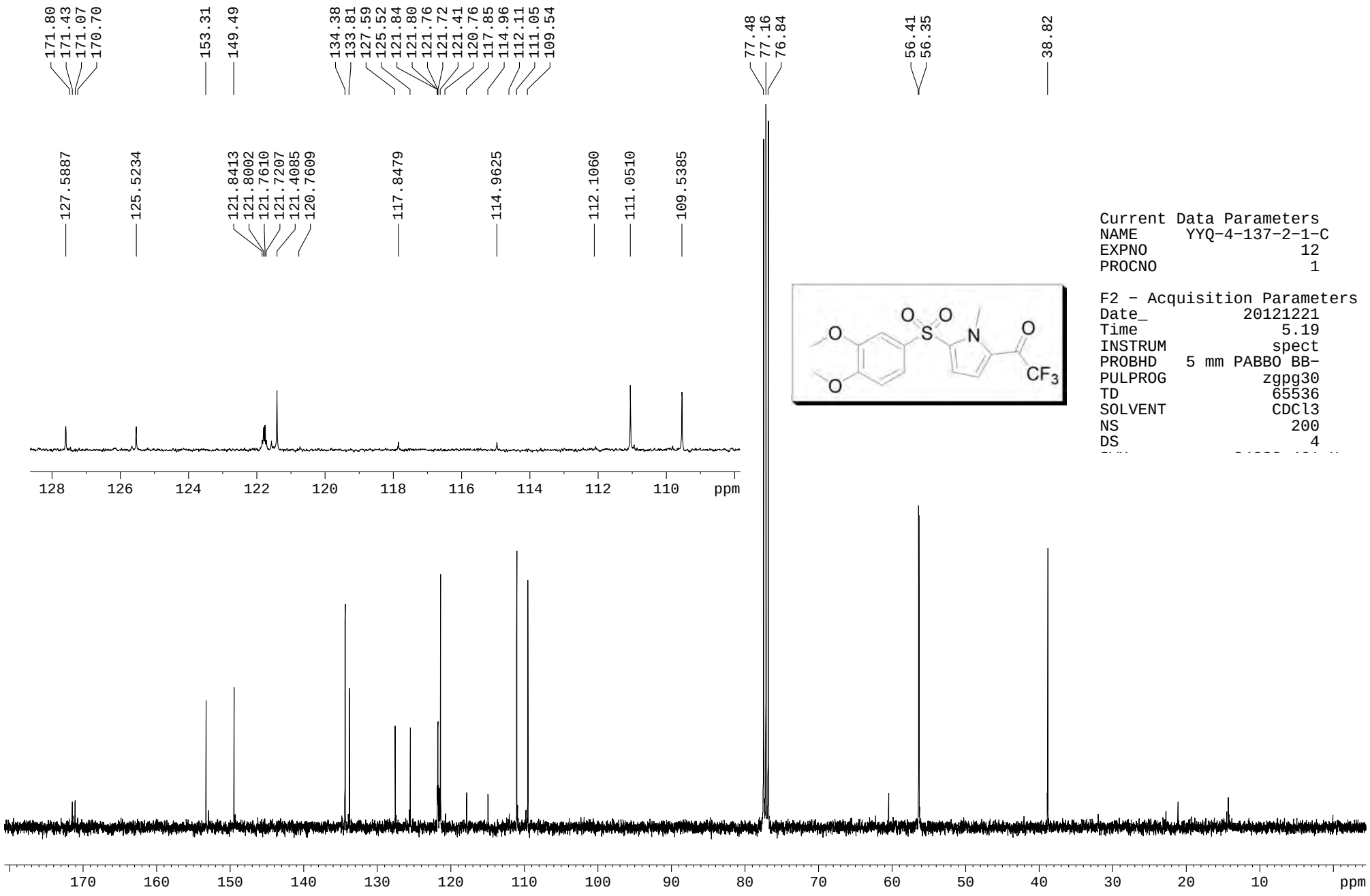

171.74
171.38
171.02
170.67
139.29
136.81
134.89
134.45
132.78
129.10
126.67
125.24
122.27
122.23
122.19
122.15
120.69
117.82
114.89
112.02
77.44
77.12
76.80
38.82
20.92
19.79
O
O
S
N
O
CF3
Current Data Parameters
NAME cz-1-50-2-2
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130821
Time 21.31
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 300
DS 4
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 ppm

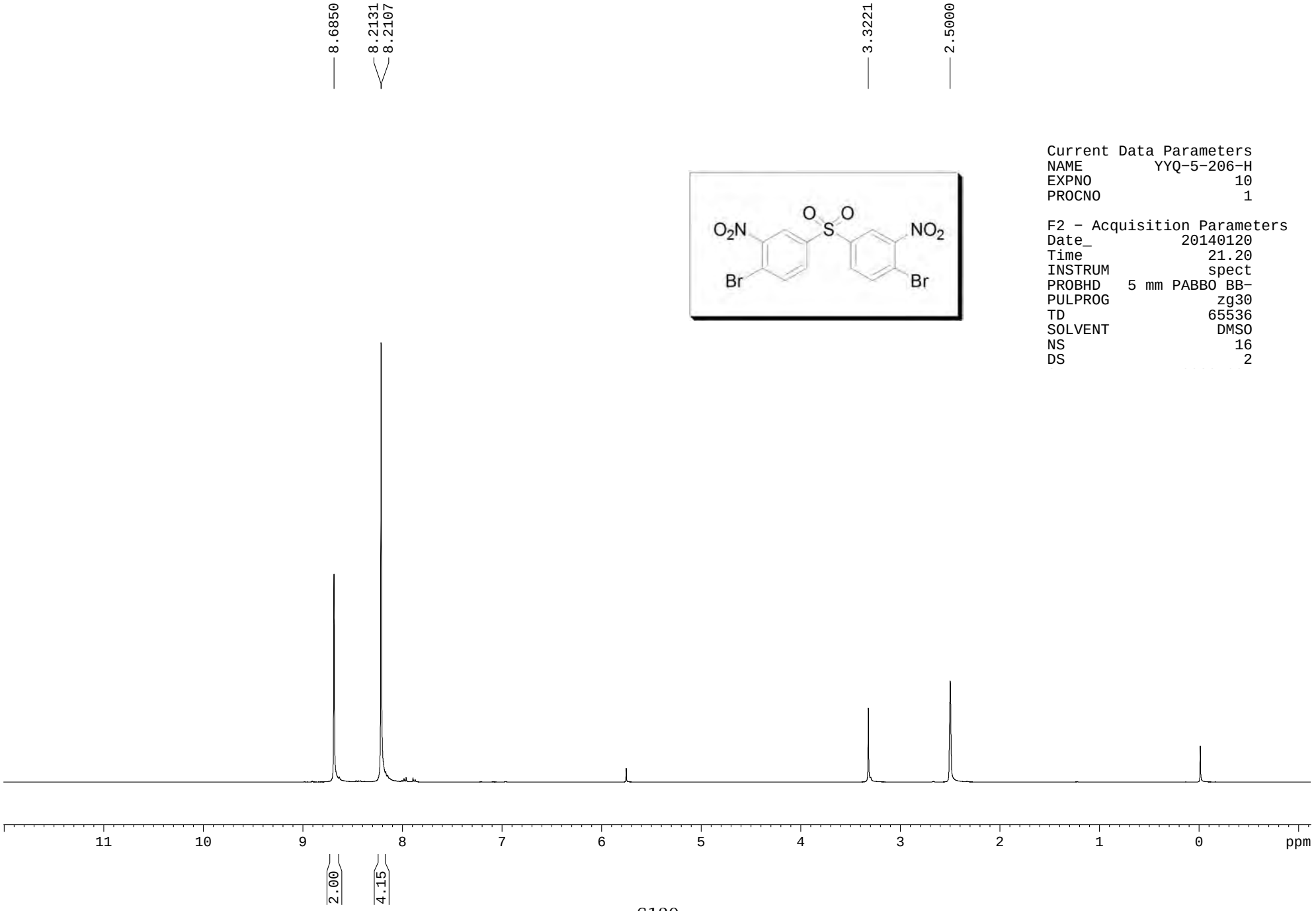

7.944
7.542
7.454
7.303
7.282
7.161
7.142
3.997
O
O
S
N
O
CF3
ppm
120.699
122.145
122.184
122.224
122.263
125.226
126.606
129.091
132.790
134.445
134.473
134.966
136.814
139.277
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
ppm

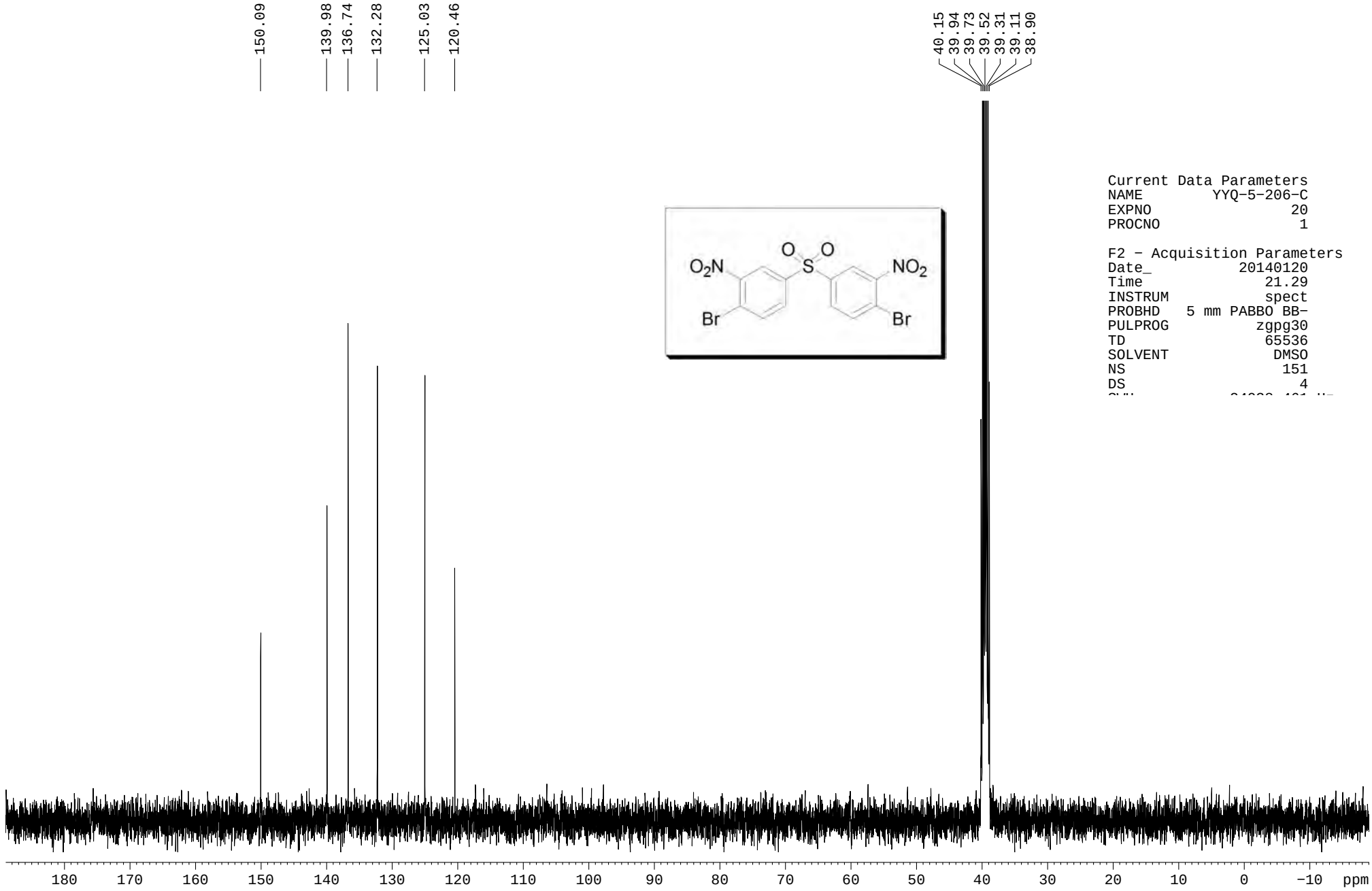

8.0420
8.0217
7.6608
7.6517
7.6138
7.6015
7.2600
7.1761
7.1557
7.0619
2.5538
2.3581
O
O
S
S
Current Data Parameters
NAME YYQ-4-135-1-5
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121218
Time 21.35
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0 ppm
1.00
0.95
0.92
1.02
1.93
2.86
3.03

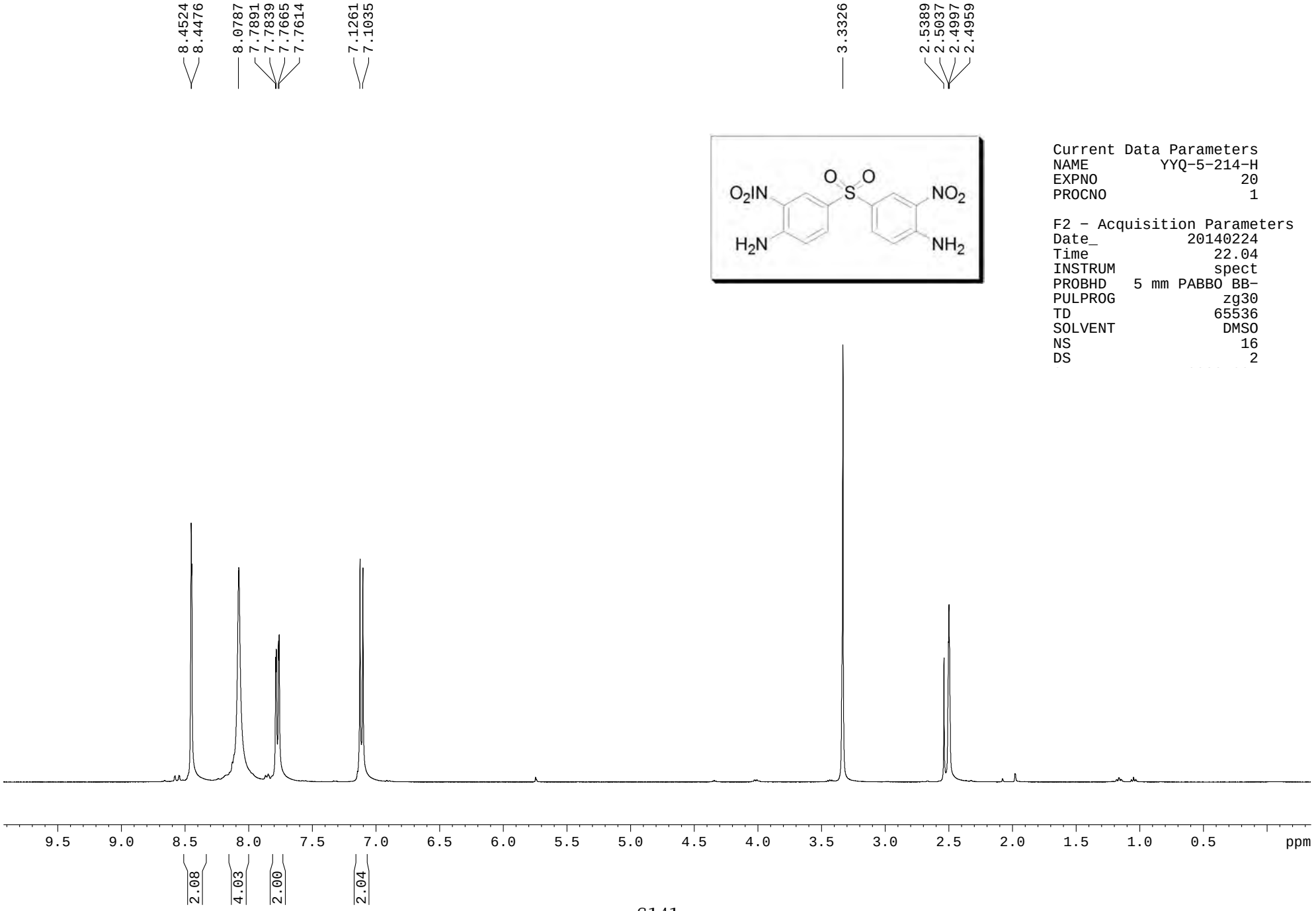

144.6849
143.6073
137.9777
136.9563
133.5527
133.2399
133.0892
129.3328
127.4649
127.3676
77.4540
77.1365
76.8184
21.4096
20.2695
Current Data Parameters
NAME cz-1-69-2
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20130909
Time 23.58
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 400
DS 4
O
O
S
S
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm

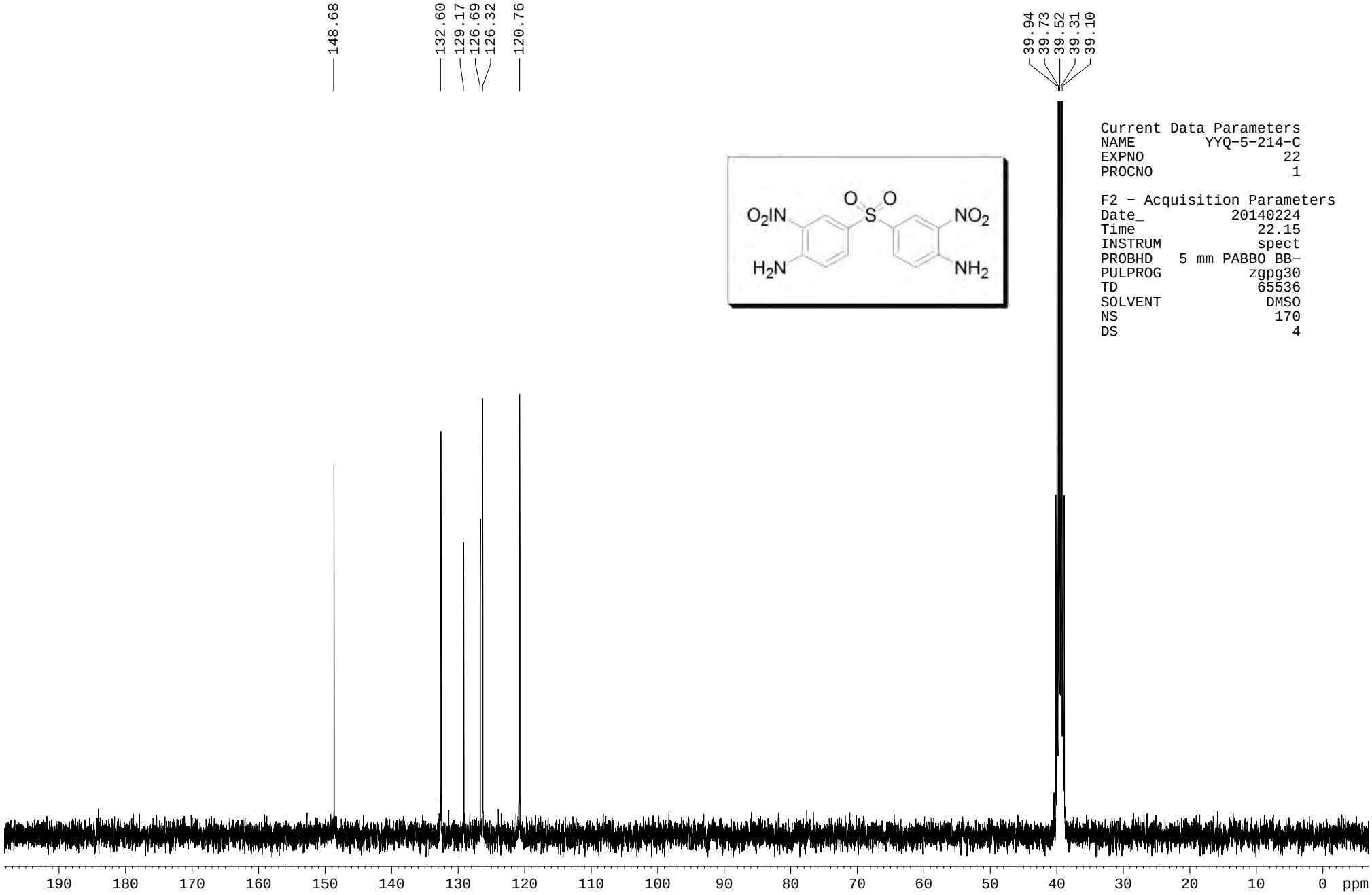

7.5775
7.5604
7.5170
7.4459
7.3928
7.2775
6.9685
6.9472
3.9861
3.9324
Current Data Parameters
NAME YYQ-4-137-2-1-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121221
Time 5.06
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
O
O
S
O
N
O
O
CF3
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.13
1.04
1.14
1.06
1.08
3.00
6.35

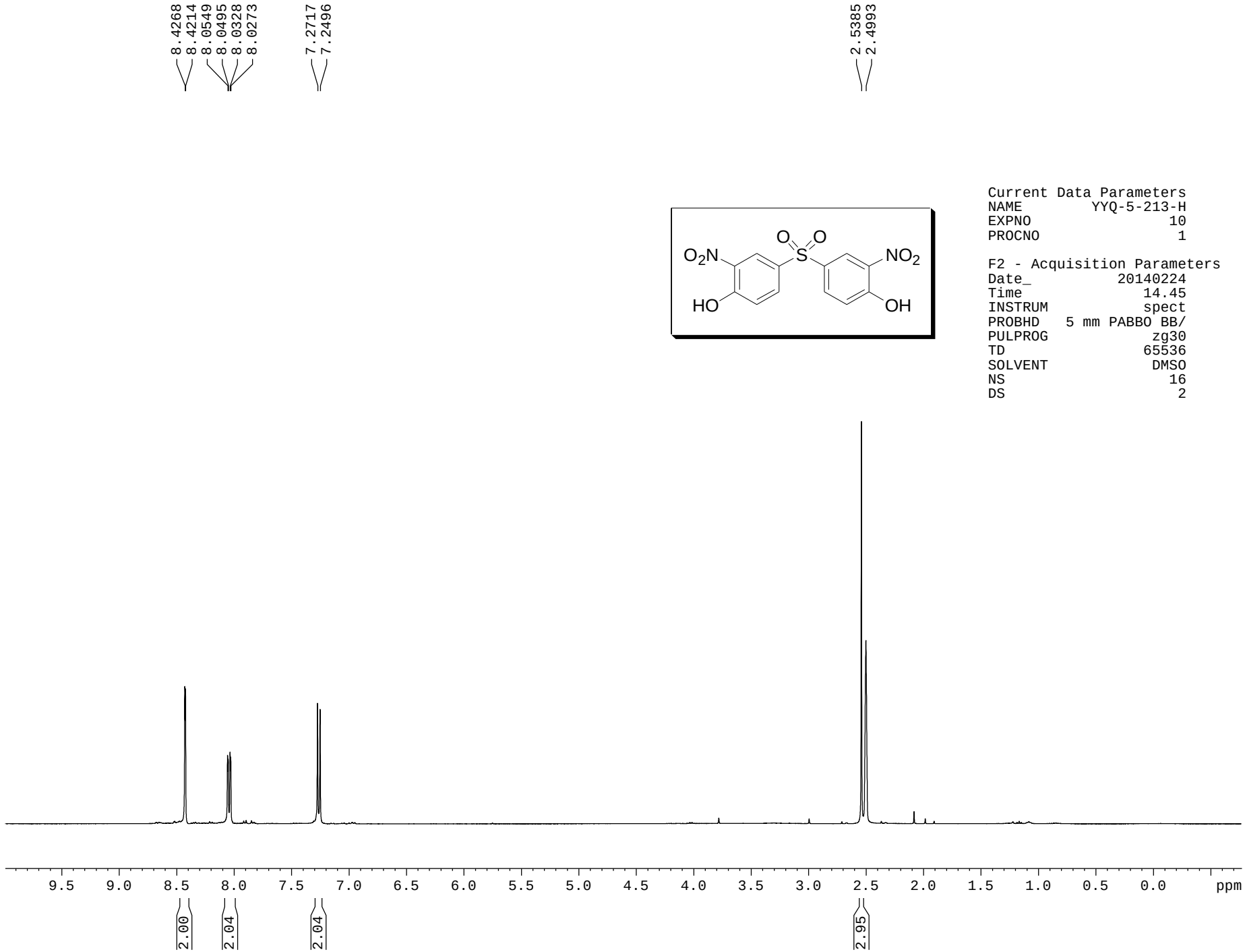

171.80
171.43
171.07
170.70
153.31
149.49
134.38
133.81
127.59
125.52
121.84
121.80
121.76
121.72
121.41
120.76
117.85
114.96
112.11
111.05
109.54
77.48
77.16
76.84
56.41
56.35
38.82
127.5887
125.5234
121.8413
121.8002
121.7610
121.7207
121.4085
120.7609
117.8479
114.9625
112.1060
111.0510
109.5385
Current Data Parameters
NAME YYQ-4-137-2-1-C
EXPNO 12
PROCNO 1
F2 - Acquisition Parameters
Date_ 20121221
Time 5.19
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 200
DS 4
O
O
S
O
N
O
O
CF3
128
126
124
122
120
118
116
114
112
110
ppm
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

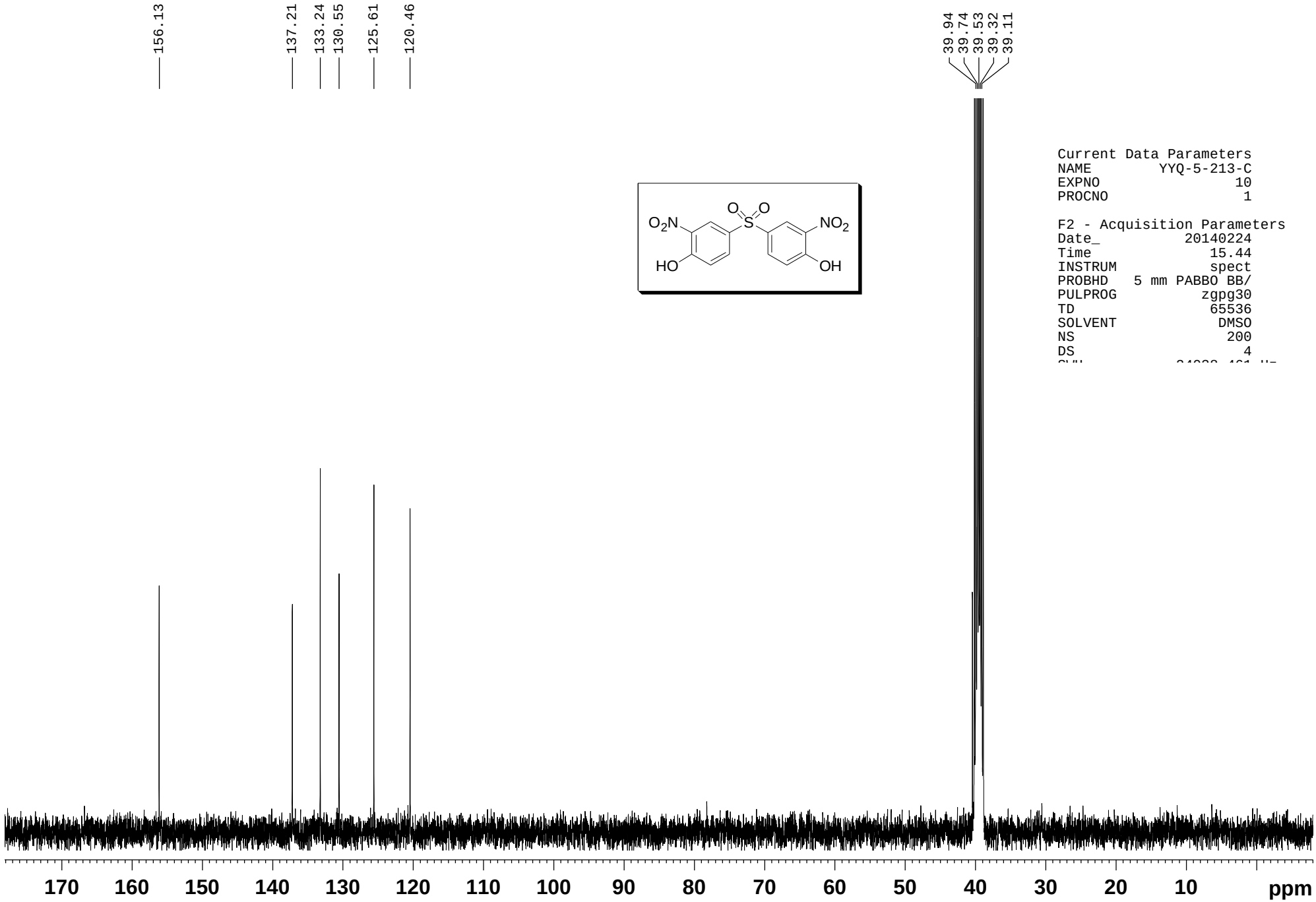

8.6850
8.2131
8.2107
3.3221
2.5000
O
O
S
O2N
NO2
Br
Br
Current Data Parameters
NAME YYQ-5-206-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140120
Time 21.20
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 16
DS 2
11
10
9
8
7
6
5
4
3
2
1
0
ppm
2.00
4.15

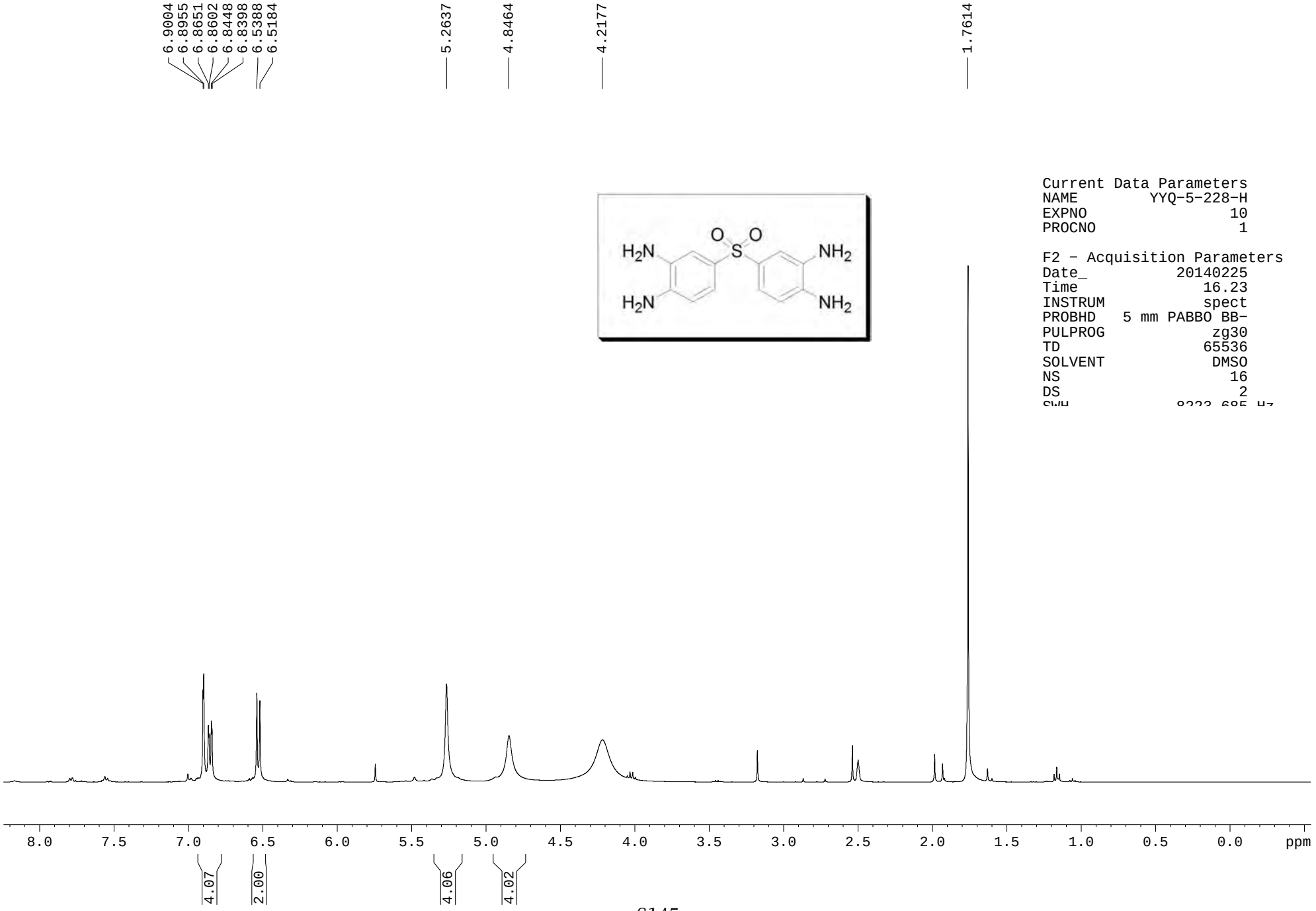

150.09
139.98
136.74
132.28
125.03
120.46
40.15
39.94
39.73
39.52
39.31
39.11
38.90
O2N
O
S
O
NO2
Br
Br
Current Data Parameters
NAME YYQ-5-206-C
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140120
Time 21.29
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 151
DS 4
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 ppm

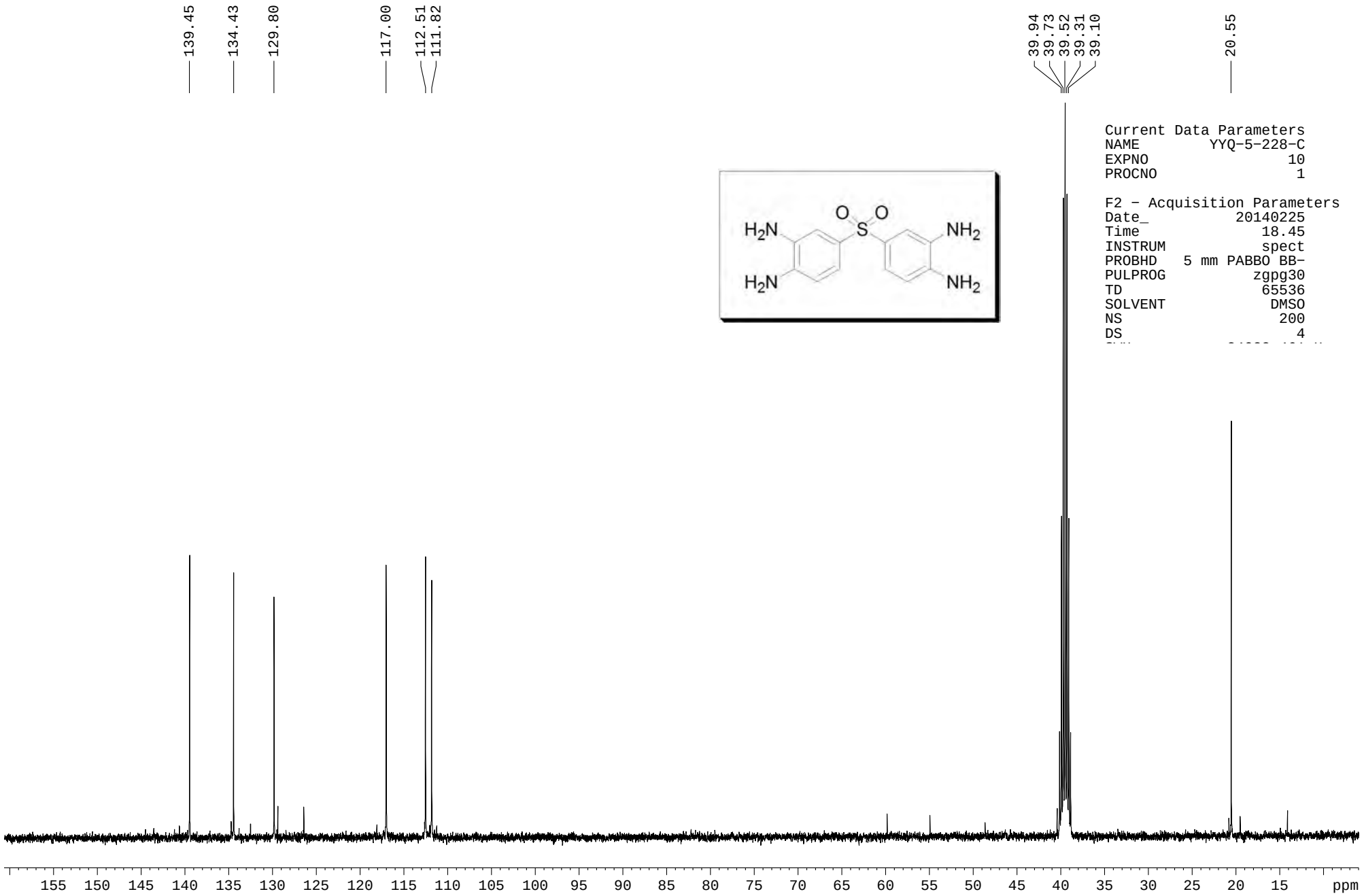

8.4524
8.4476
8.0787
7.7891
7.7839
7.7665
7.7614
7.1261
7.1035
3.3326
2.5389
2.5037
2.4997
2.4959
O2IN
NO2
H2N
NH2
O
S
O
Current Data Parameters
NAME YYQ-5-214-H
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140224
Time 22.04
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 16
DS 2
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.08
4.03
2.00
2.04

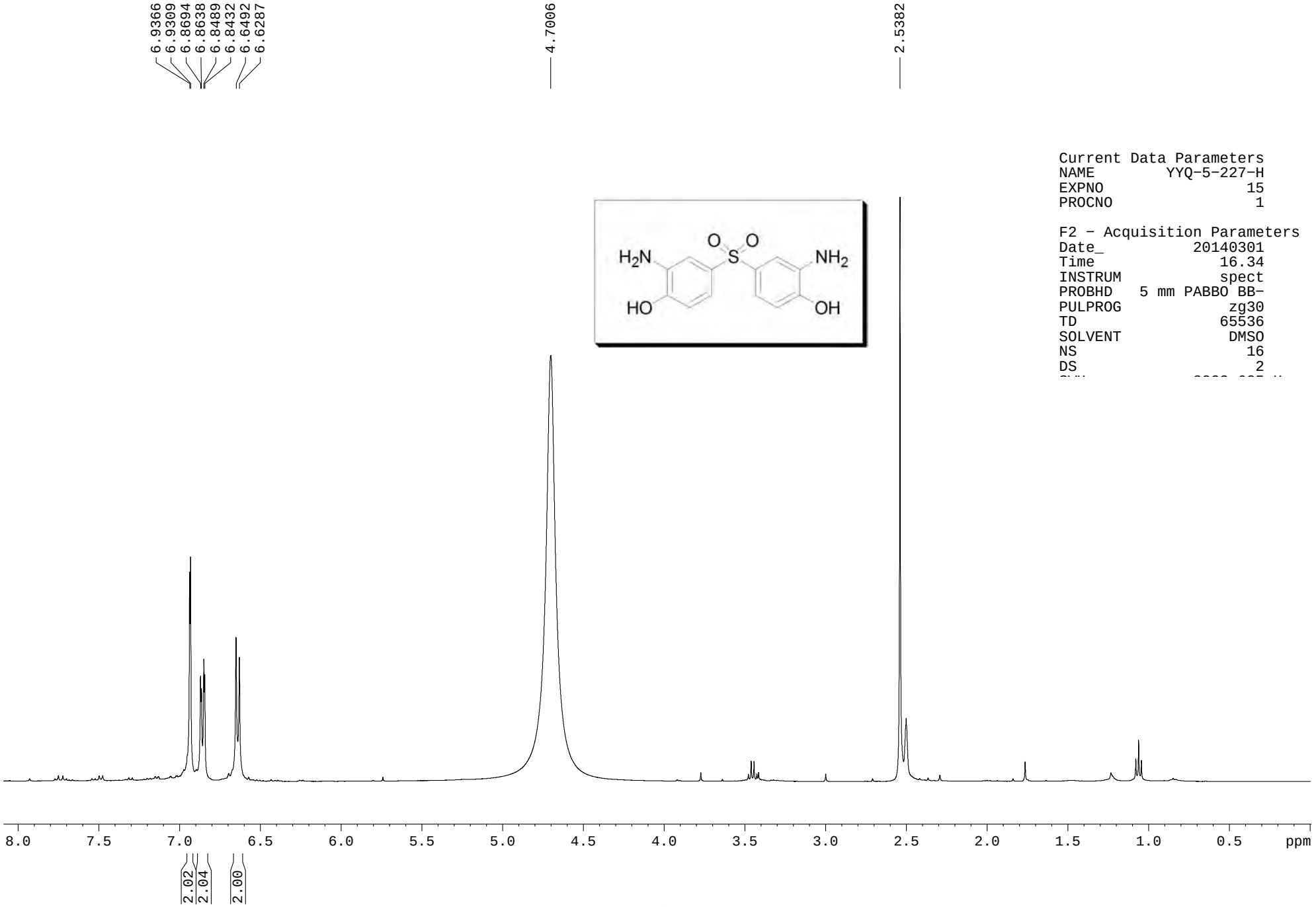

148.68
132.60
129.17
126.69
126.32
120.76
39.94
39.73
39.52
39.31
39.10
O
O
S
O2IN
NO2
H2N
NH2
Current Data Parameters
NAME YYQ-5-214-C
EXPNO 22
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140224
Time 22.15
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 170
DS 4
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

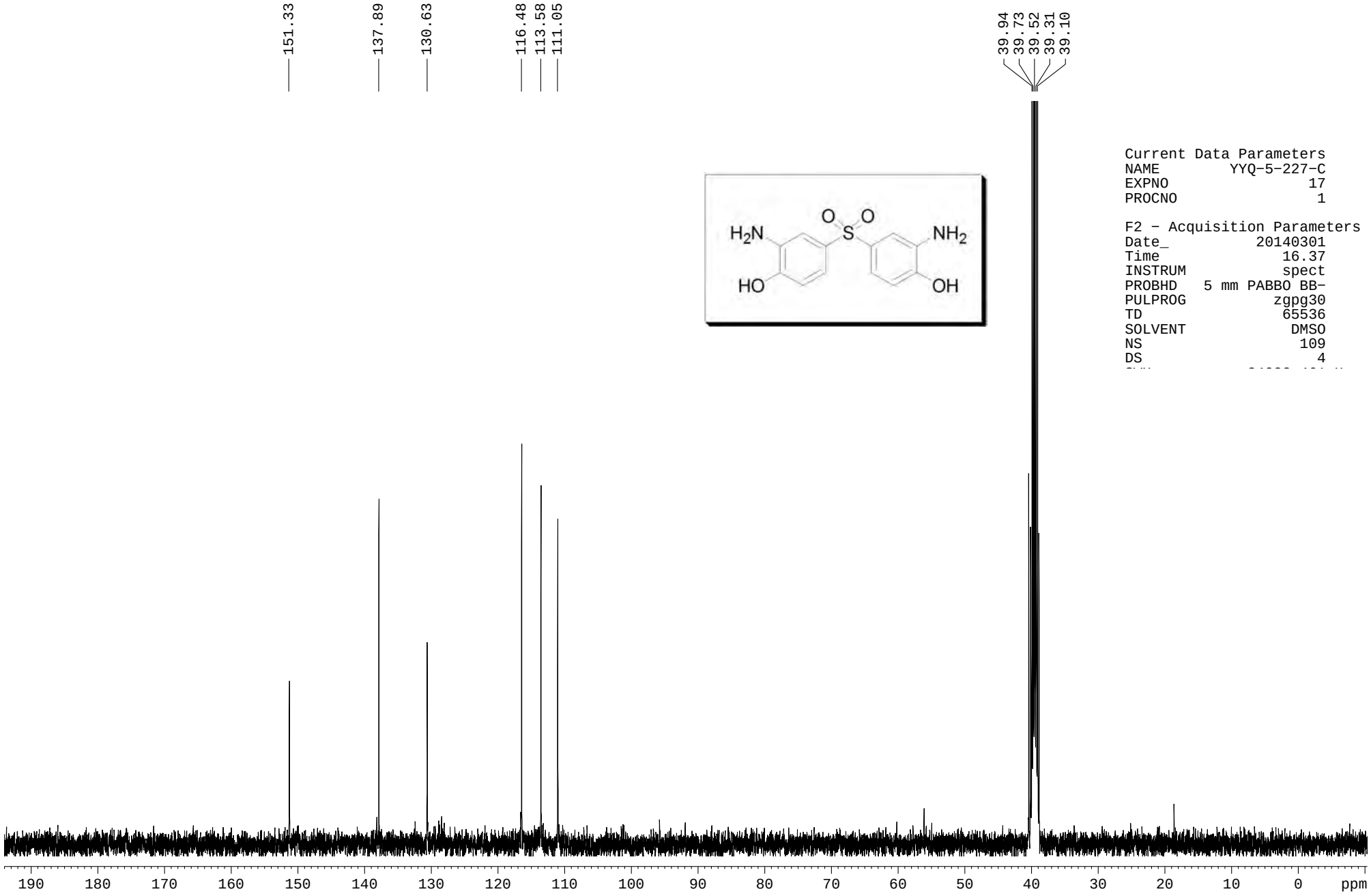

8.4268
8.4214
8.0549
8.0495
8.0328
8.0273
7.2717
7.2496
2.5385
2.4993
O2N
NO2
HO
OH
Current Data Parameters
NAME YYQ-5-213-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140224
Time 14.45
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 16
DS 2
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
2.04
2.04
2.95

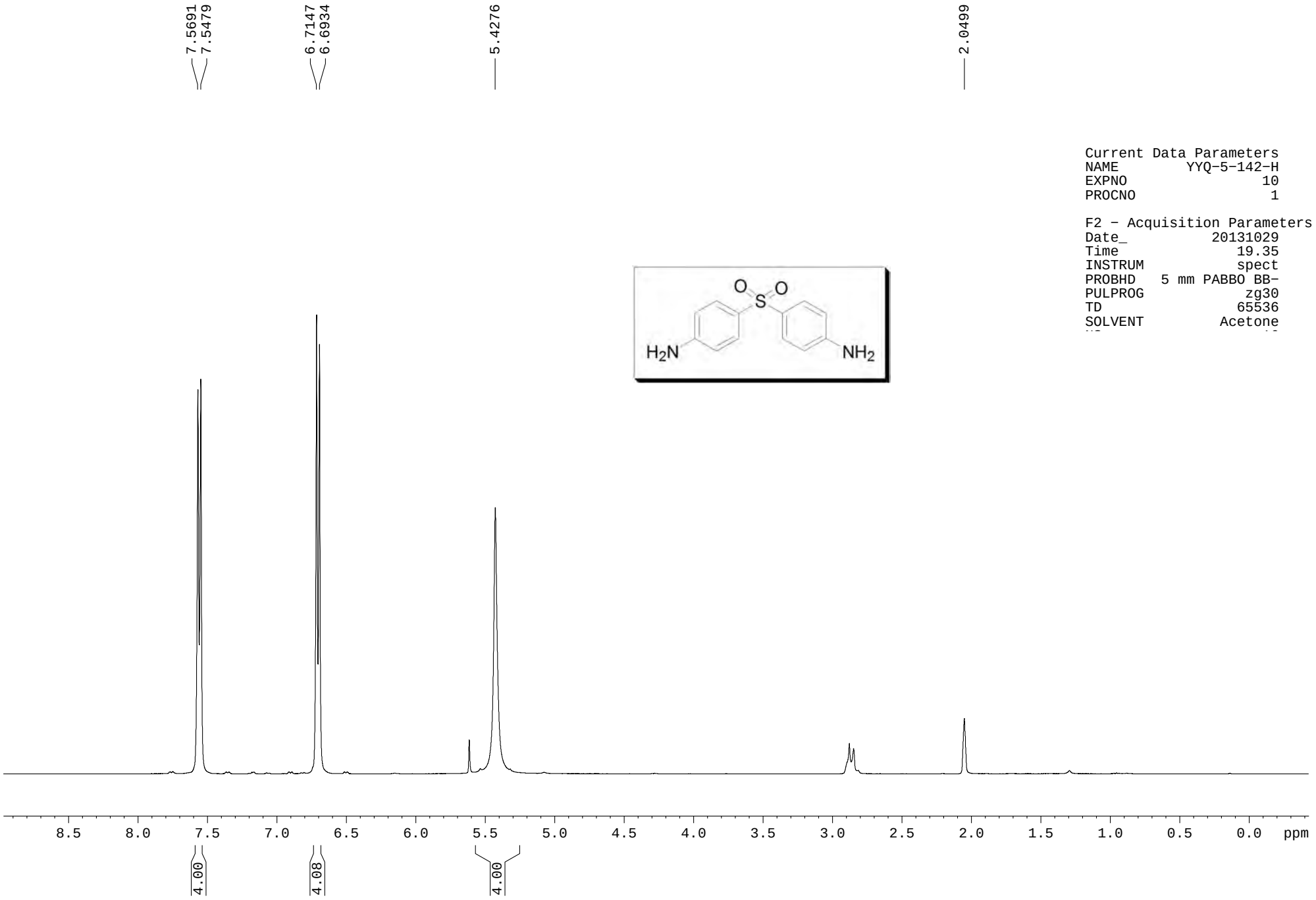

156.13
137.21
133.24
130.55
125.61
120.46
39.94
39.74
39.53
39.32
39.11
O2N
O
S
O
NO2
HO
OH
Current Data Parameters
NAME YYQ-5-213-C
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140224
Time 15.44
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 200
DS 4
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

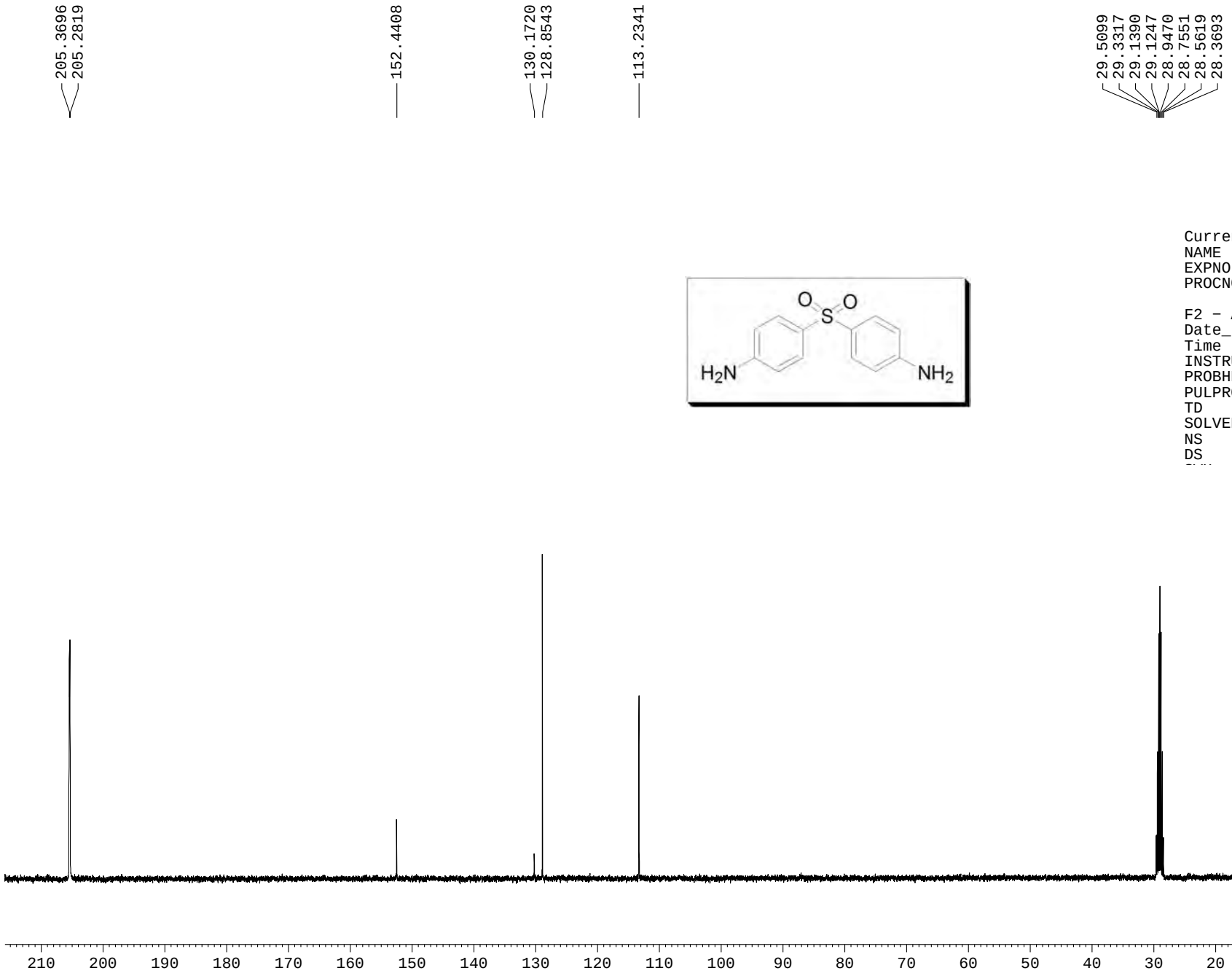

6.9004
6.8955
6.8651
6.8602
6.8448
6.8398
6.5388
6.5184
5.2637
4.8464
4.2177
1.7614
Current Data Parameters
NAME YYQ-5-228-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140225
Time 16.23
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 16
DS 2
H2N
NH2
O
S
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
4.07
2.00
4.06
4.02


139.45
134.43
129.80
117.00
112.51
111.82
39.94
39.73
39.52
39.31
39.10
20.55
Current Data Parameters
NAME YYQ-5-228-C
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140225
Time 18.45
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 200
DS 4
O
O
S
H2N
NH2
H2N
NH2
155 150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 ppm

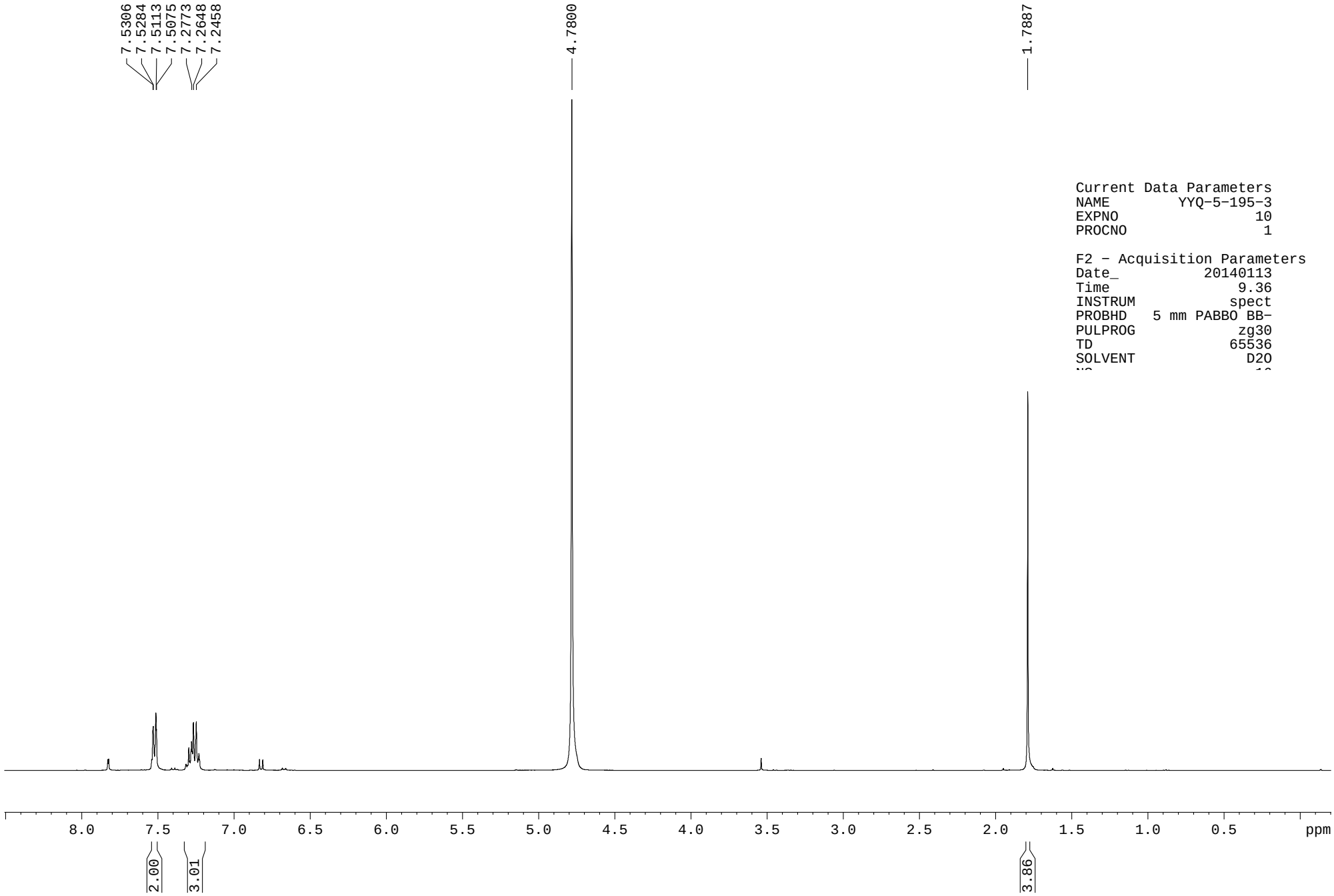

6.9366
6.9309
6.8694
6.8638
6.8489
6.8432
6.6492
6.6287
4.7006
2.5382
Current Data Parameters
NAME YYQ-5-227-H
EXPNO 15
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140301
Time 16.34
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 16
DS 2
H2N
NH2
HO
OH
O
S
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.02
2.04
2.00


151.33
137.89
130.63
116.48
113.58
111.05
39.94
39.73
39.52
39.31
39.10
Current Data Parameters
NAME YYQ-5-227-C
EXPNO 17
PROCNO 1
F2 - Acquisition Parameters
Date_ 20140301
Time 16.37
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 109
DS 4
H2N
NH2
HO
OH
O
S
O
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

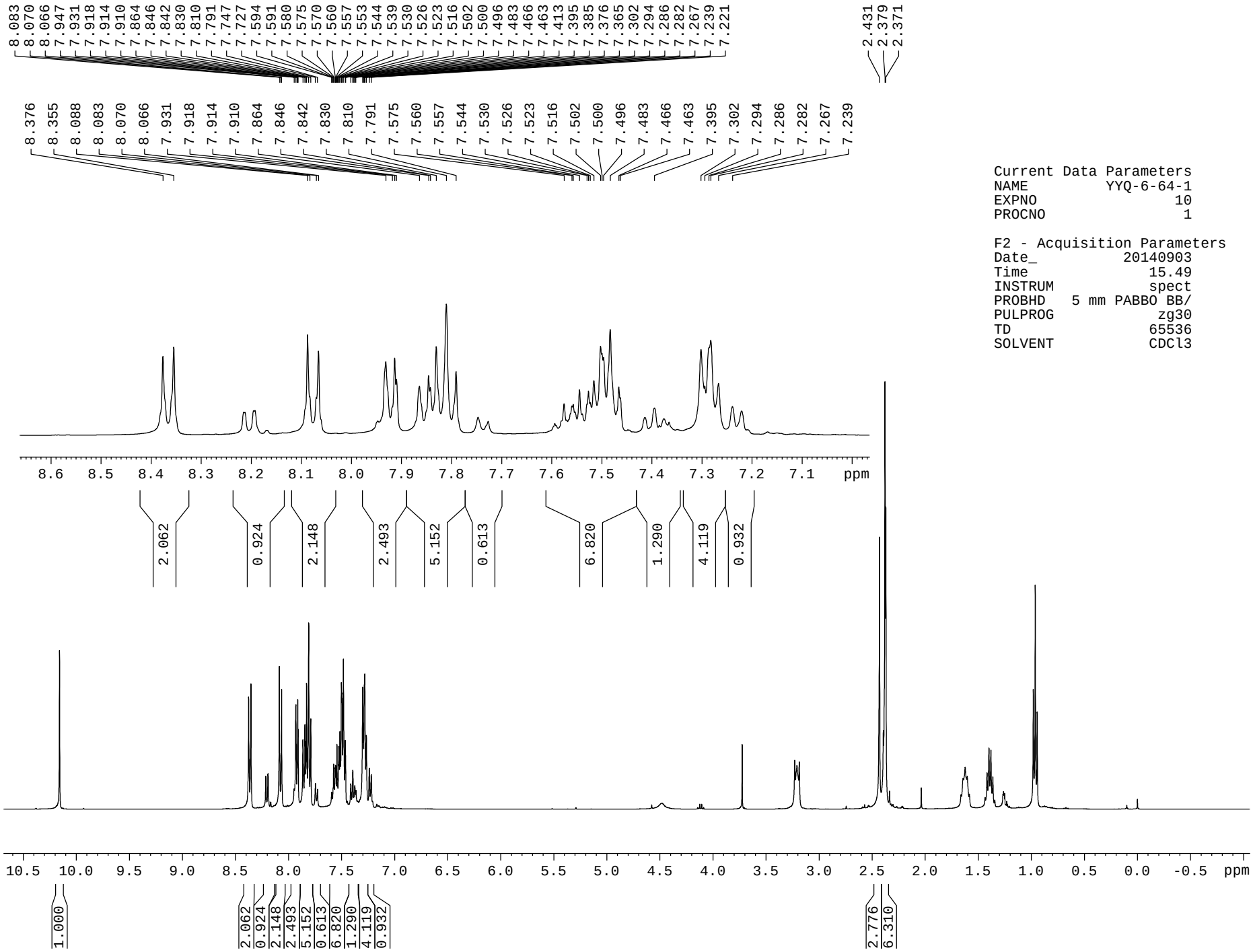

7.5691
7.5479
6.7147
6.6934
5.4276
2.0499
Current Data Parameters
NAME YYQ-5-142-H
EXPNO 10
PROCNO 1
F2 - Acquisition Parameters
Date_ 20131029
Time 19.35
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT Acetone
O
S
O
H2N
NH2
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
4.00
4.08
4.00


205.3696
205.2819
152.4408
130.1720
128.8543
113.2341
29.5099
29.3317
29.1390
29.1247
28.9470
28.7551
28.5619
28.3693
O
S
O
H2N
NH2
Current Data Parameters
NAME YYQ-5-142-C
EXPNO 20
PROCNO 1
F2 - Acquisition Parameters
Date_ 20131029
Time 19.38
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT Acetone
NS 89
DS 4
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

Mechansim study: Equation 1



Mechansim study: Equation 2



Mechansim study: Equation 3