

Supplementary

Chloroaluminate ionic liquid immobilized on magnetic nanoparticle as a heterogeneous Lewis acidic catalyst for the Friedel–Crafts sulfonylation of aromatic compounds

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Surface area of $\text{Fe}_3\text{O}_4@\text{O}_2\text{Si}[\text{PrMIM}]\text{Cl}\cdot\text{AlCl}_3$

Multi-Point BET Plot

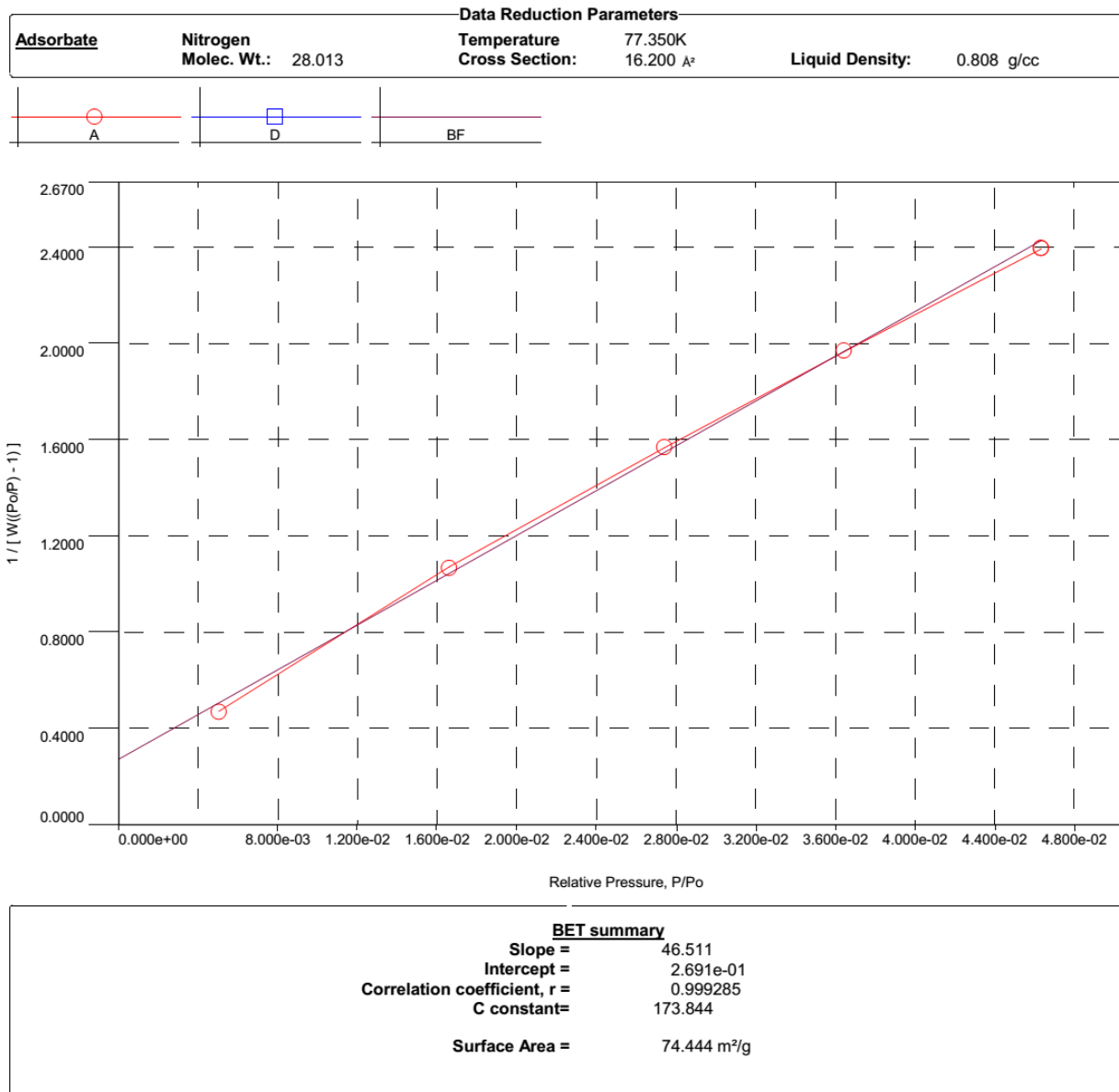


Figure S1. BET surface area of $\text{Fe}_3\text{O}_4@\text{O}_2\text{Si}[\text{PrMIM}]\text{Cl}\cdot\text{AlCl}_3$

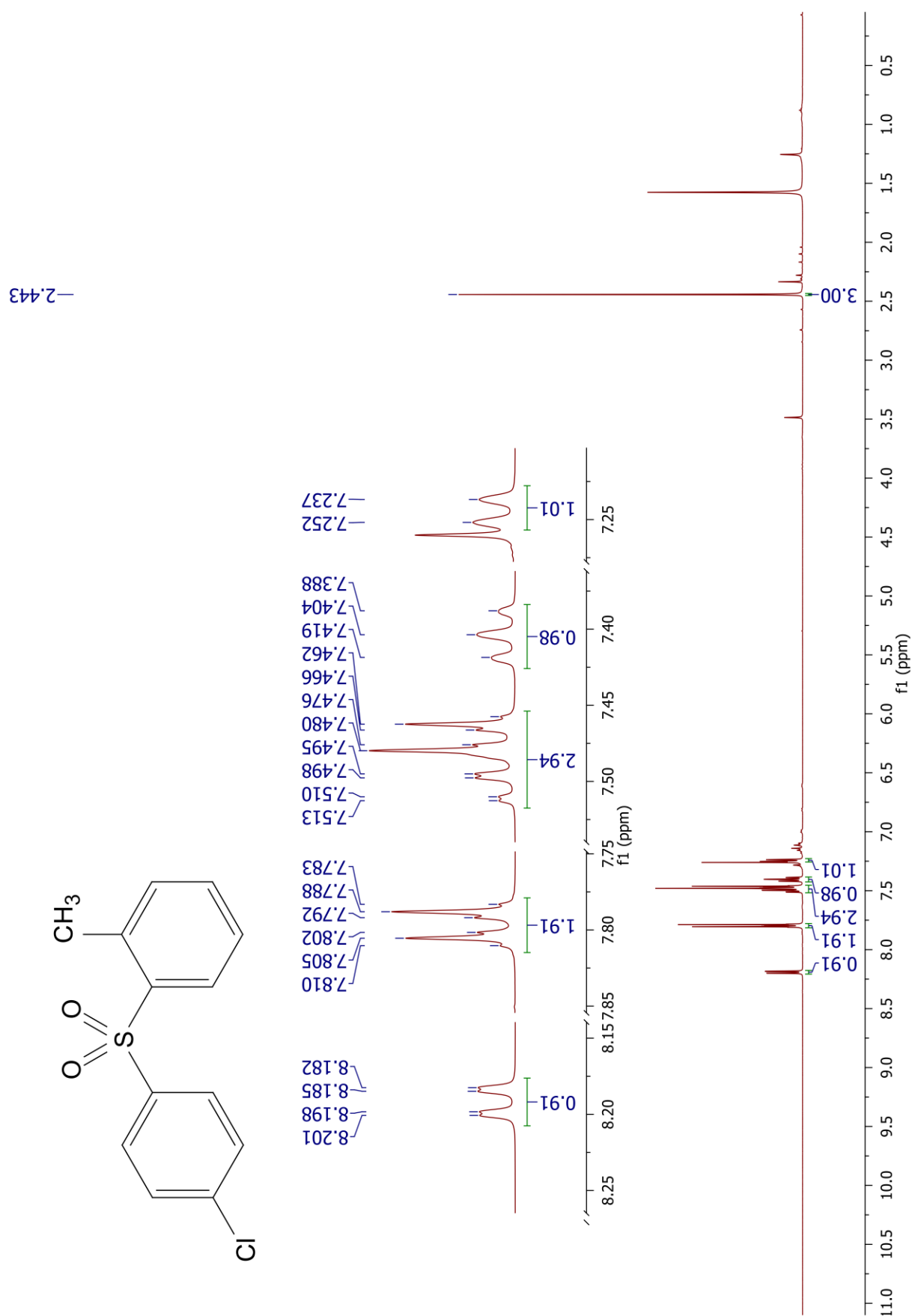


Figure S2. ¹H-NMR of 1-((4-chlorophenyl)sulfonyl)-2-methylbenzene (**3c'**)

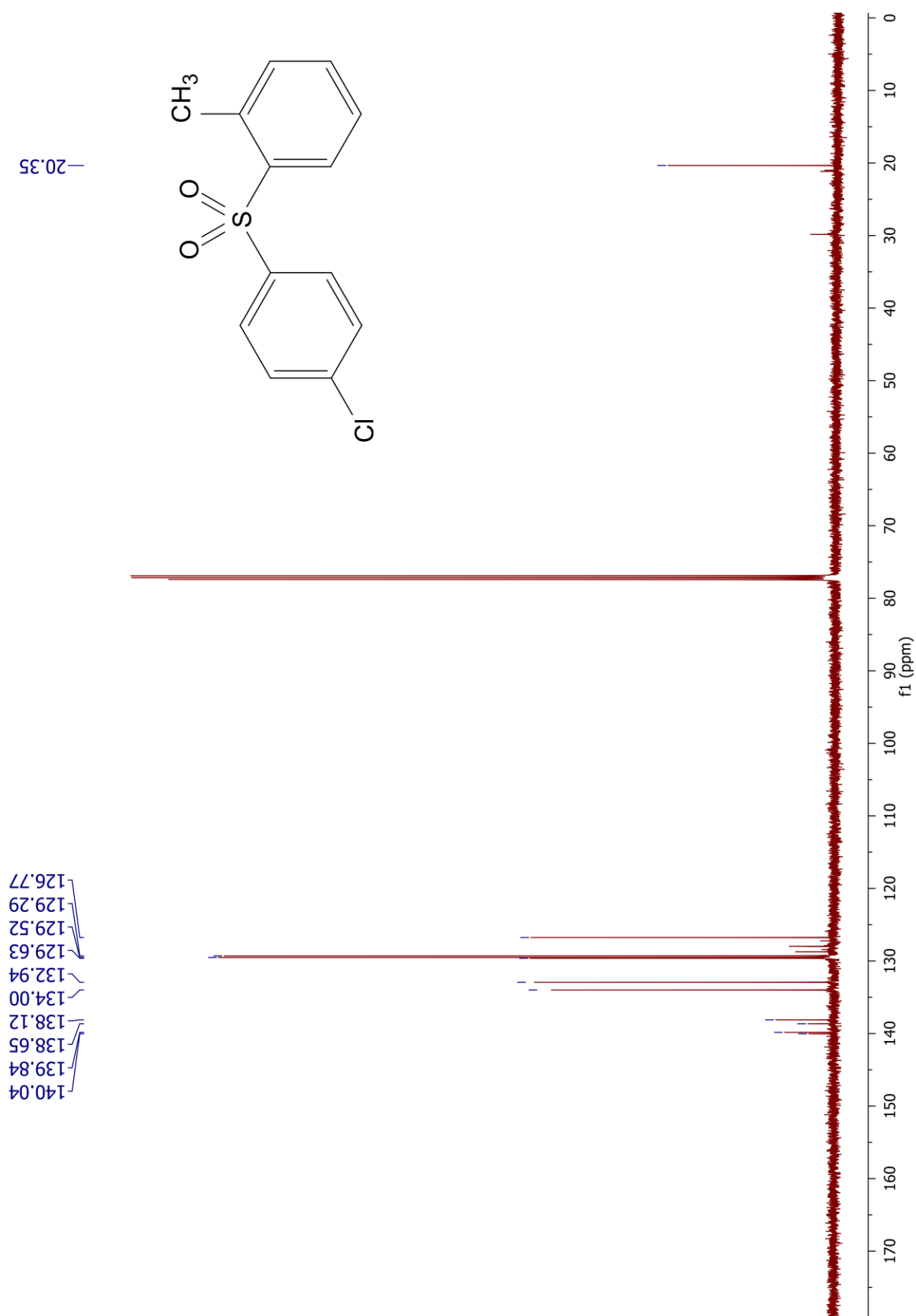


Figure S3. ¹³C-NMR of 1-((4-chlorophenyl)sulfonyl)-2-methylbenzene (3c')

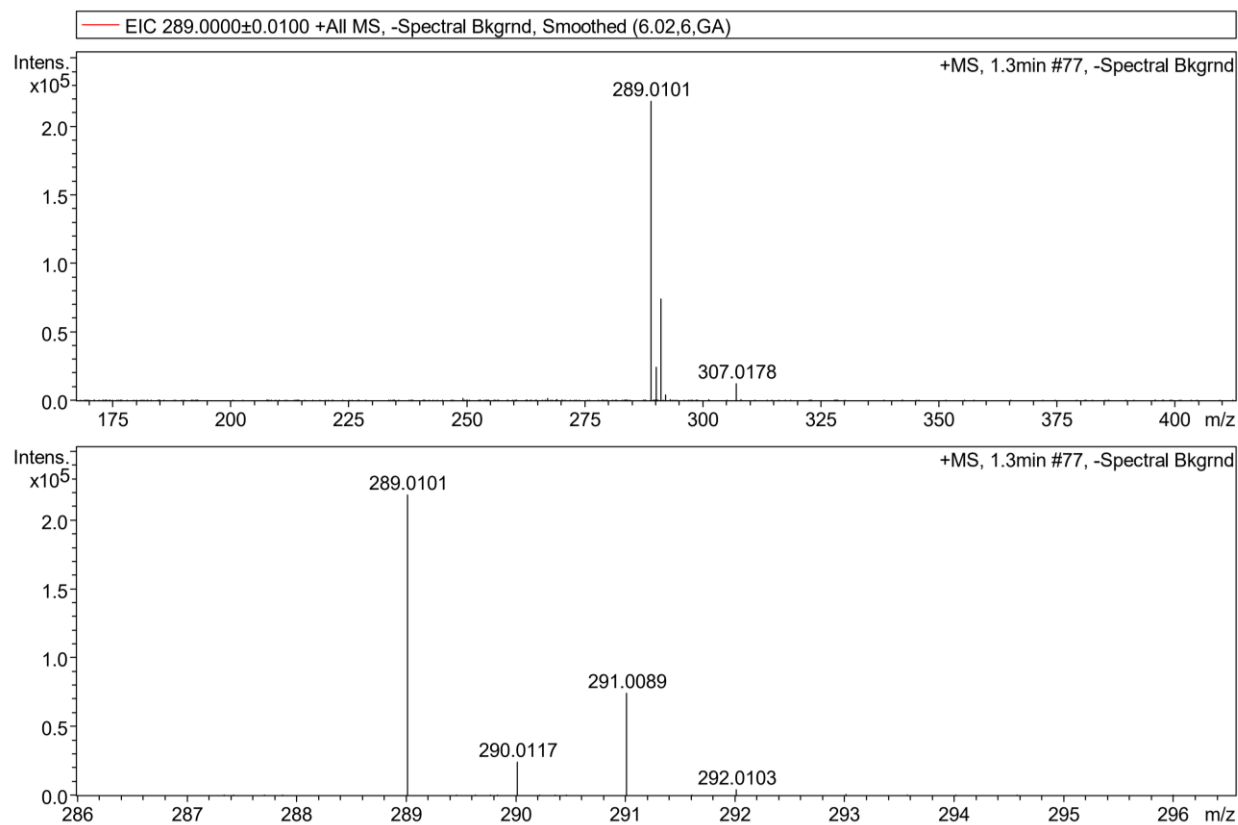


Figure S4. HRMS of 1-((4-chlorophenyl)sulfonyl)-2-methylbenzene (**3c'**)

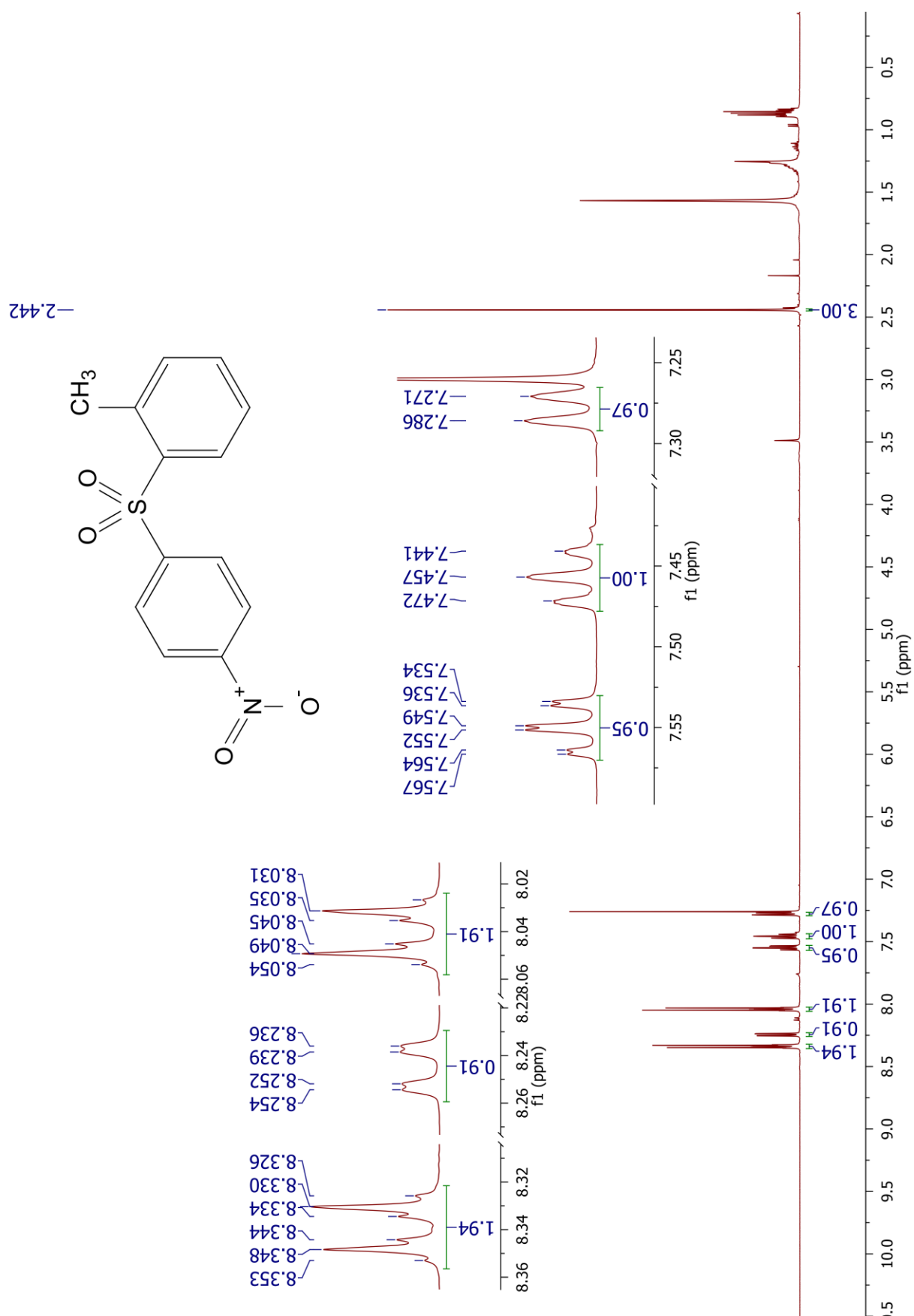


Figure S5. ¹H-NMR of 1-methyl-2-((4-nitrophenyl)sulfonyl)benzene (3d')

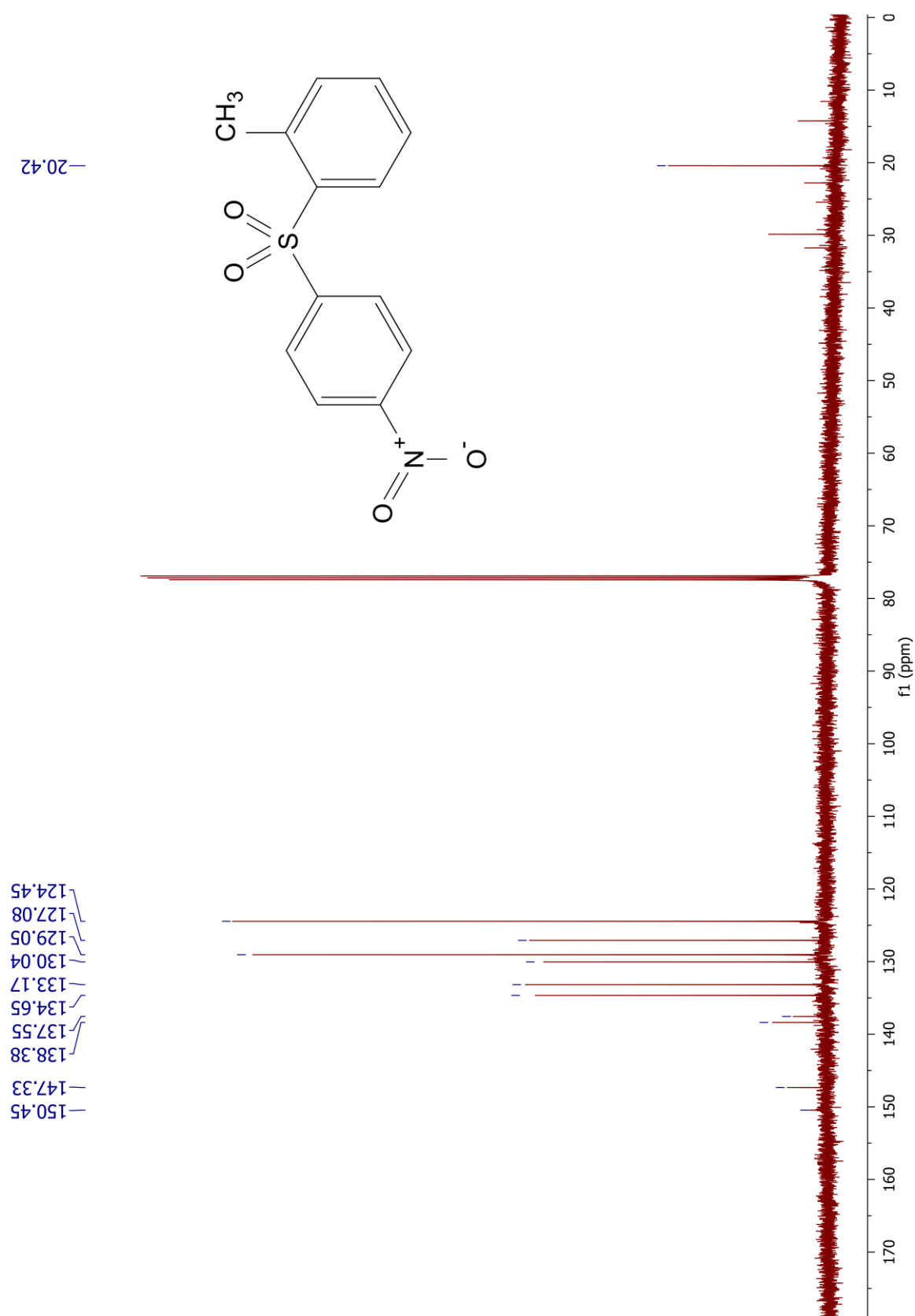


Figure S6. ¹³C-NMR of 1-methyl-2-((4-nitrophenyl)sulfonyl)benzene (3d')

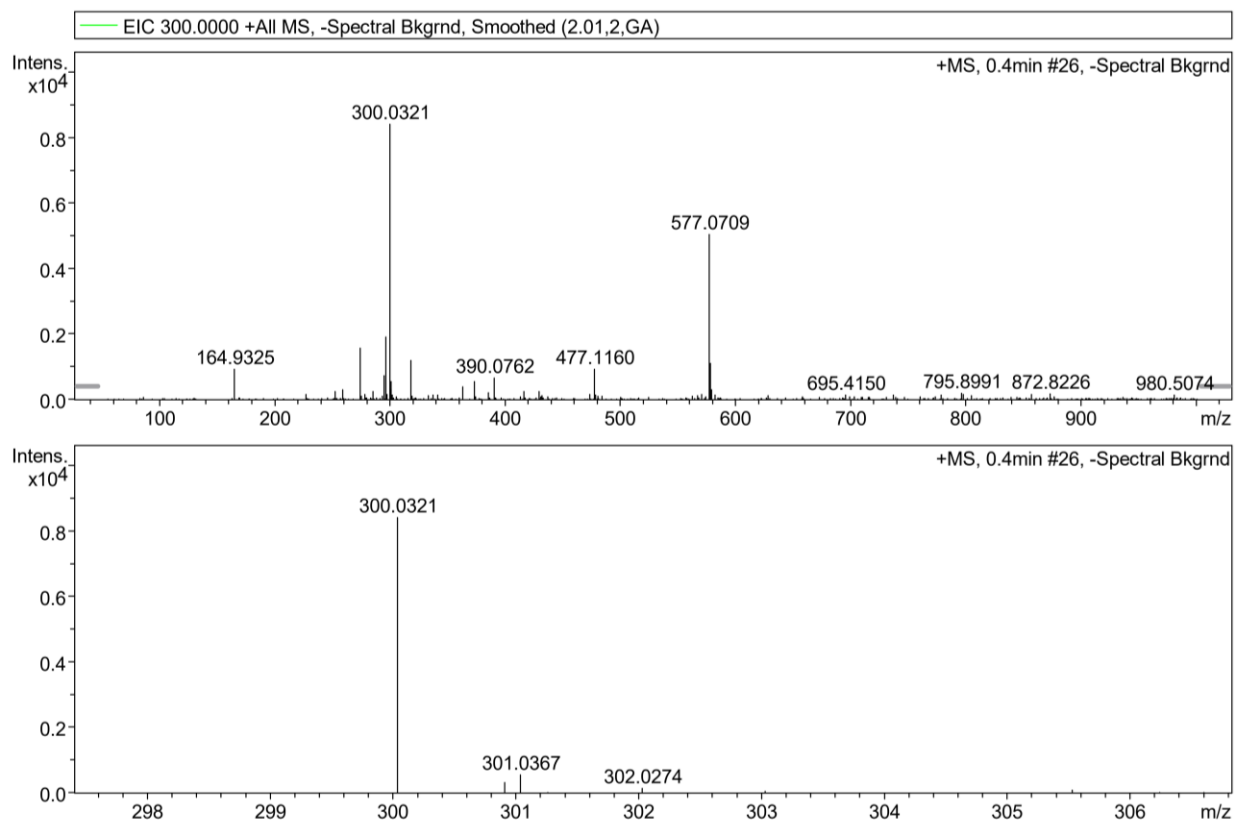


Figure S7. HRMS of 1-methyl-2-((4-nitrophenyl)sulfonyl)benzene (**3d'**)

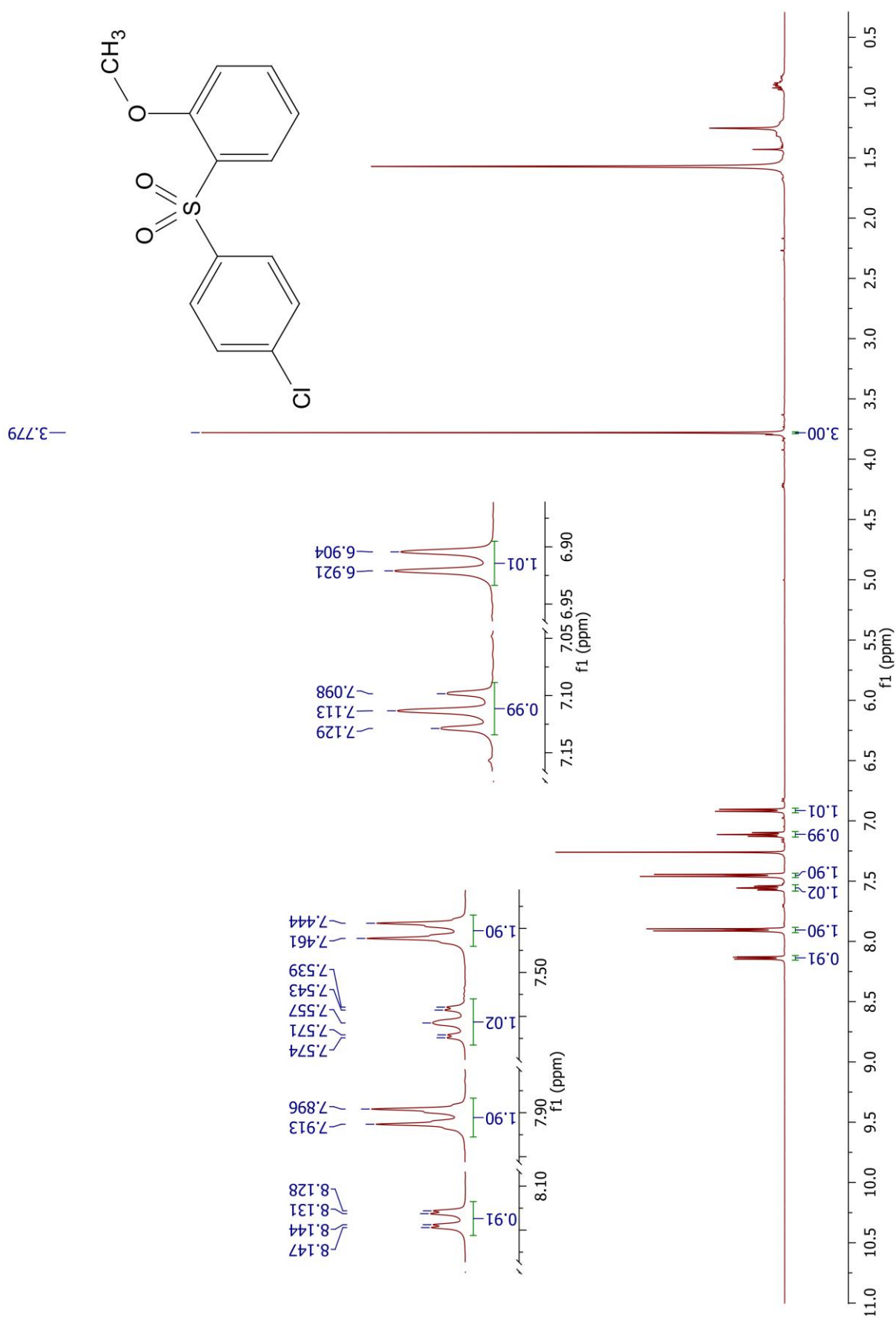


Figure S8. ¹H-NMR of 1-((4-chlorophenyl)sulfonyl)-2-methoxybenzene (3h')

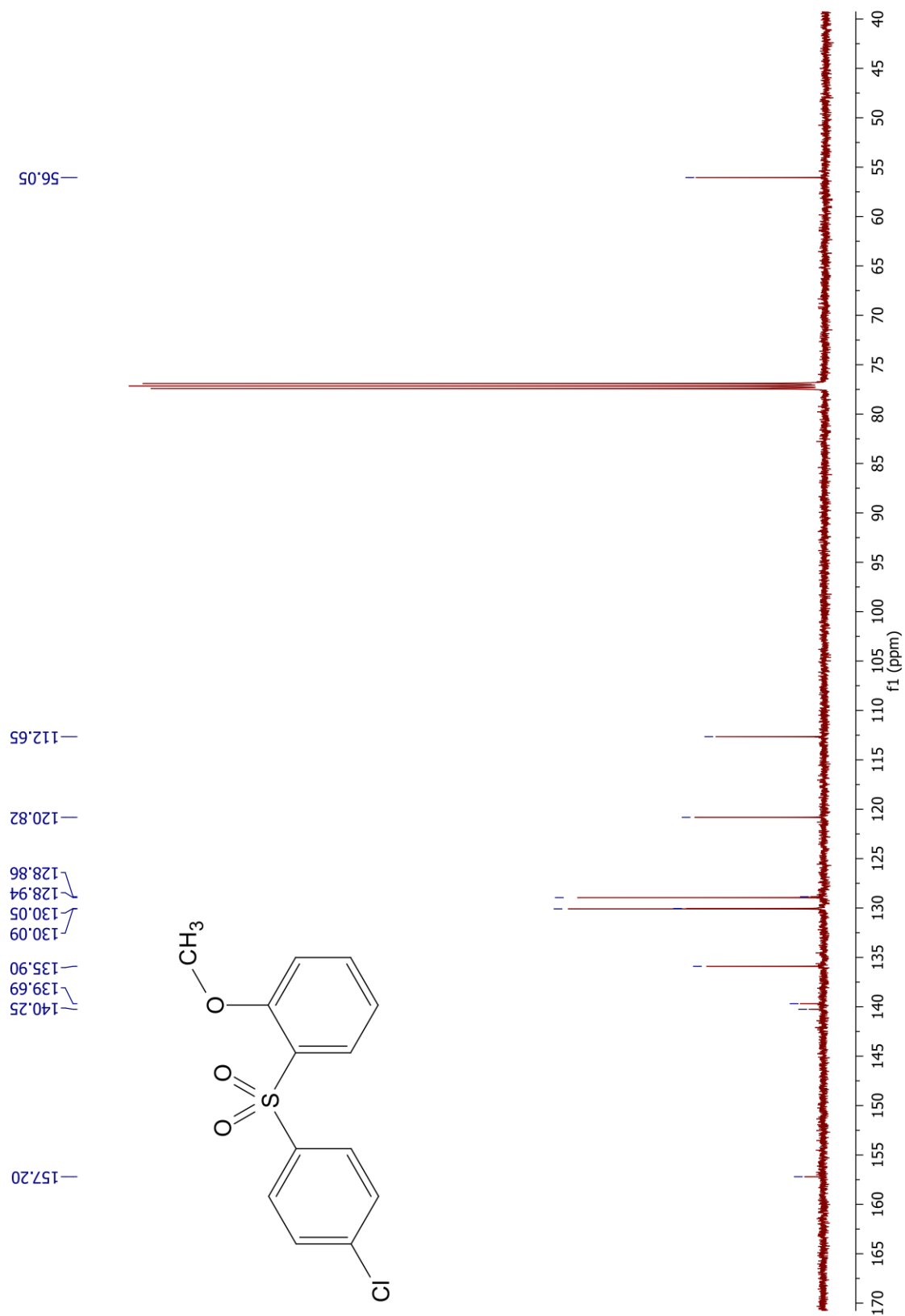


Figure S9. ^{13}C -NMR of 1-((4-chlorophenyl)sulfonyl)-2-methoxybenzene (3h')

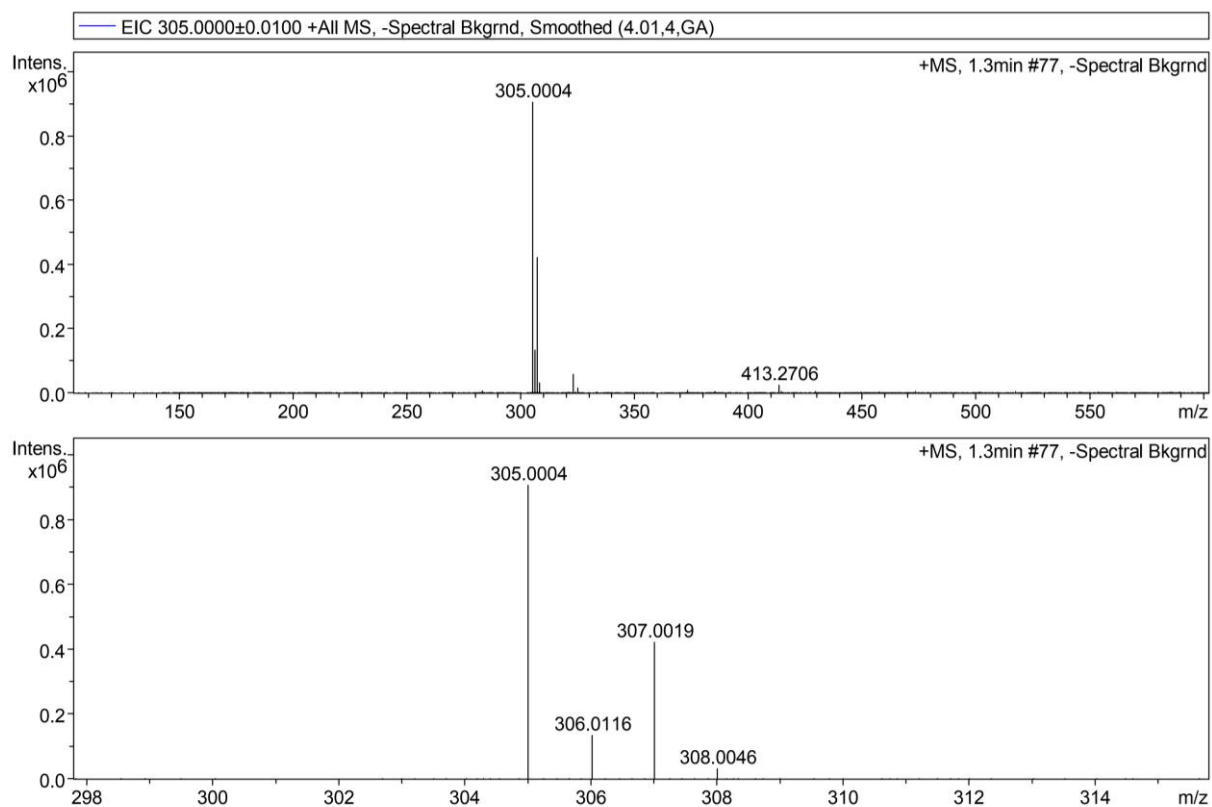


Figure S10. HRMS of 1-((4-chlorophenyl)sulfonyl)-2-methoxybenzene (**3h'**)

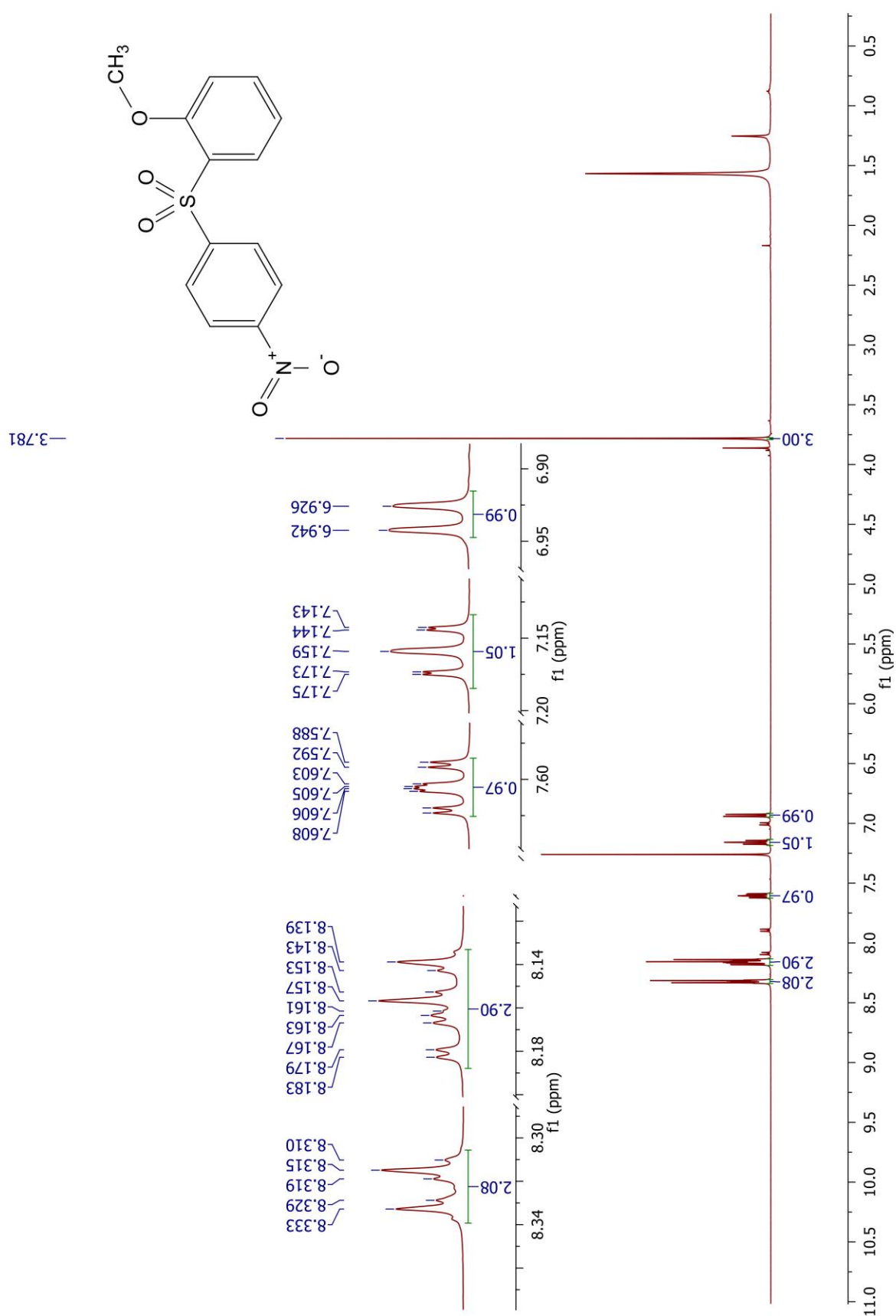


Figure S11. ¹H-NMR of 1-methoxy-2-((4-nitrophenyl)sulfonyl)benzene (**3i'**)

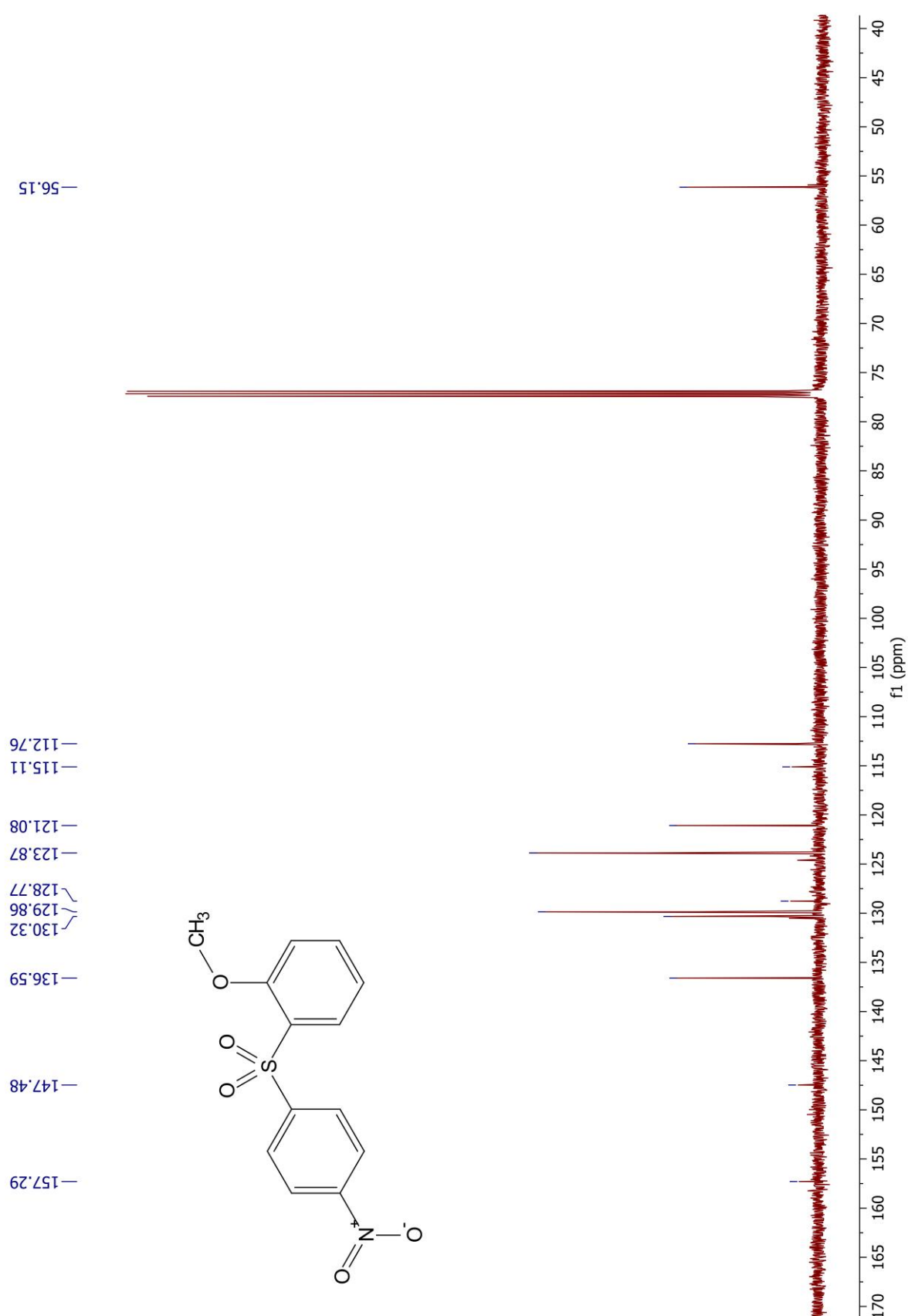


Figure S12. ^{13}C -NMR of 1-methoxy-2-((4-nitrophenyl)sulfonyl)benzene (**3i'**)

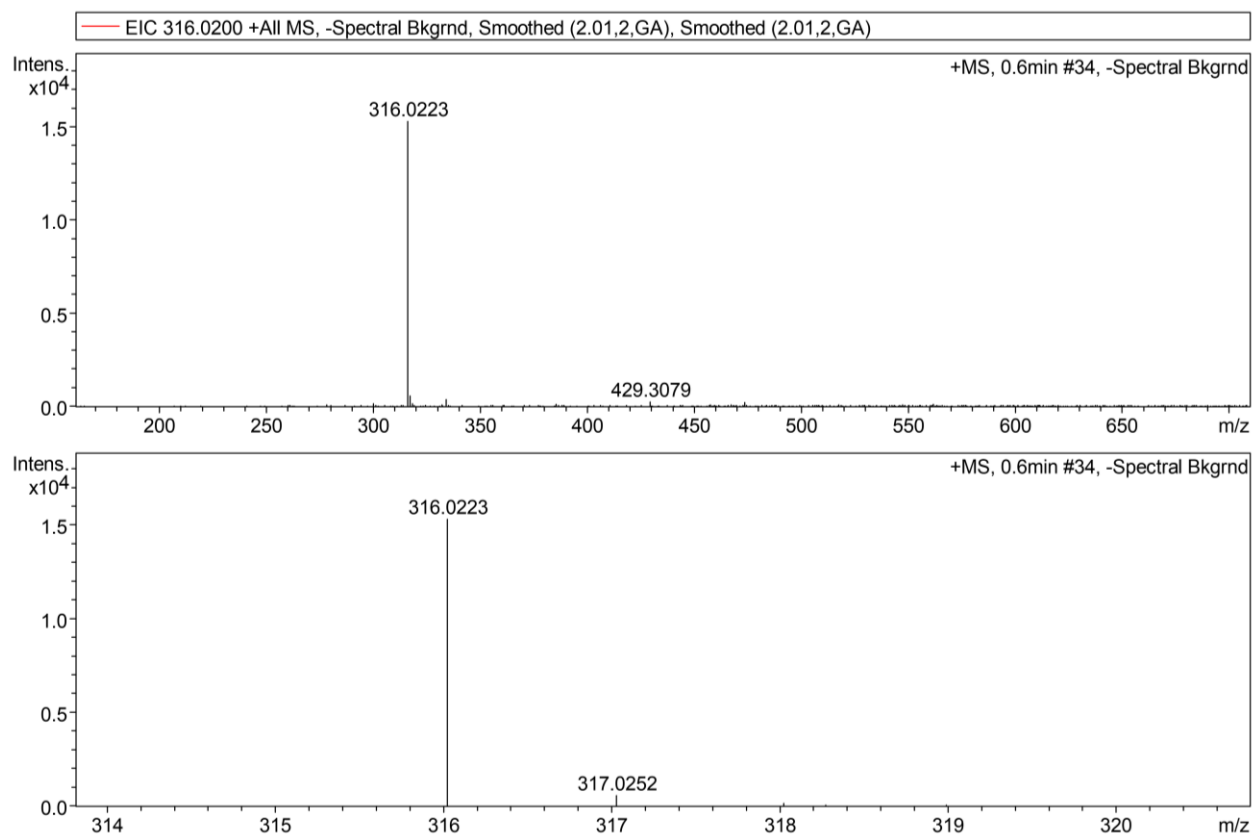


Figure S13. HRMS of 1-methoxy-2-((4-nitrophenyl)sulfonyl)benzene (**3i'**)

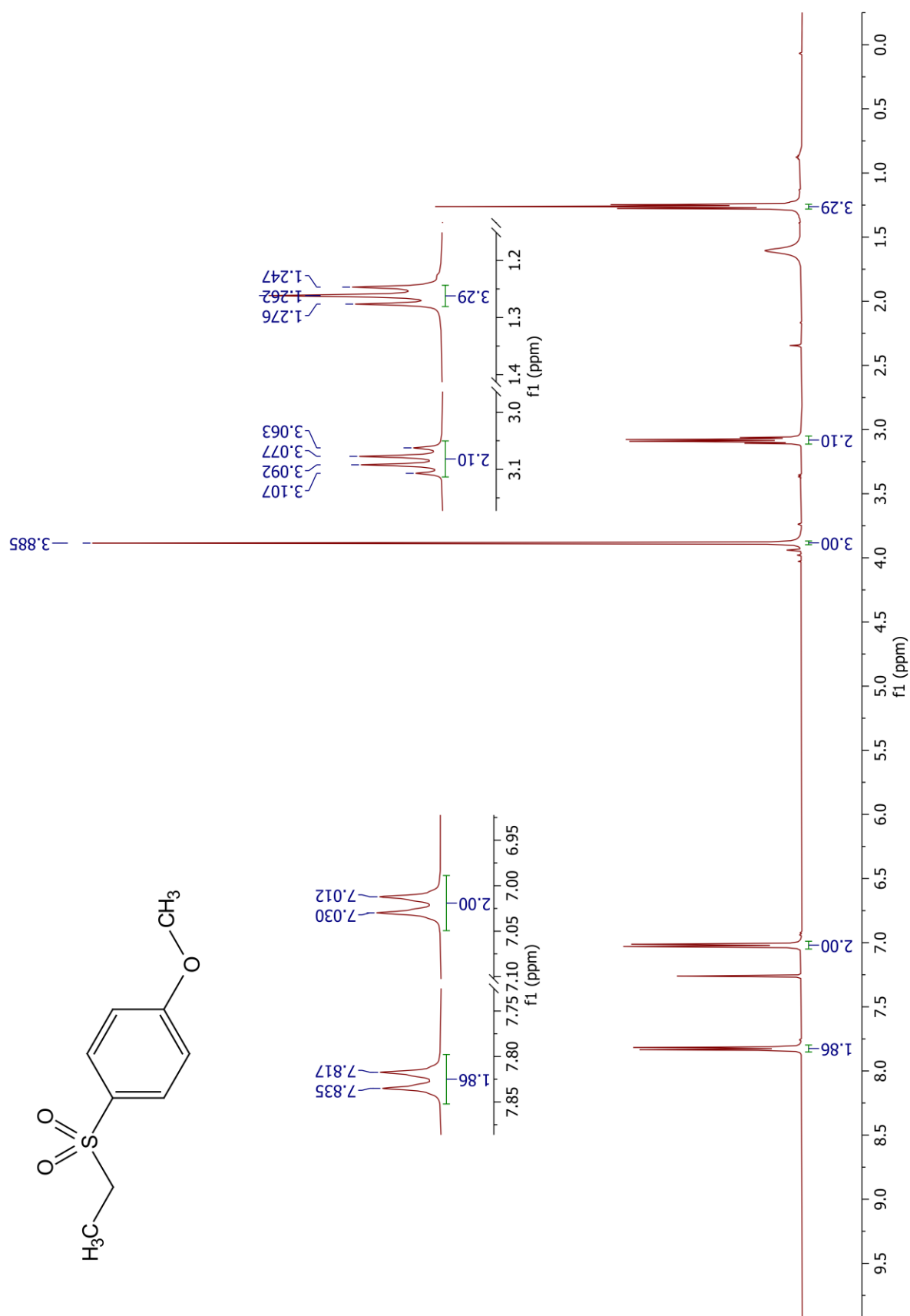


Figure S14. ¹H-NMR of 1-(ethylsulfonyl)-4-methoxybenzene (3j)

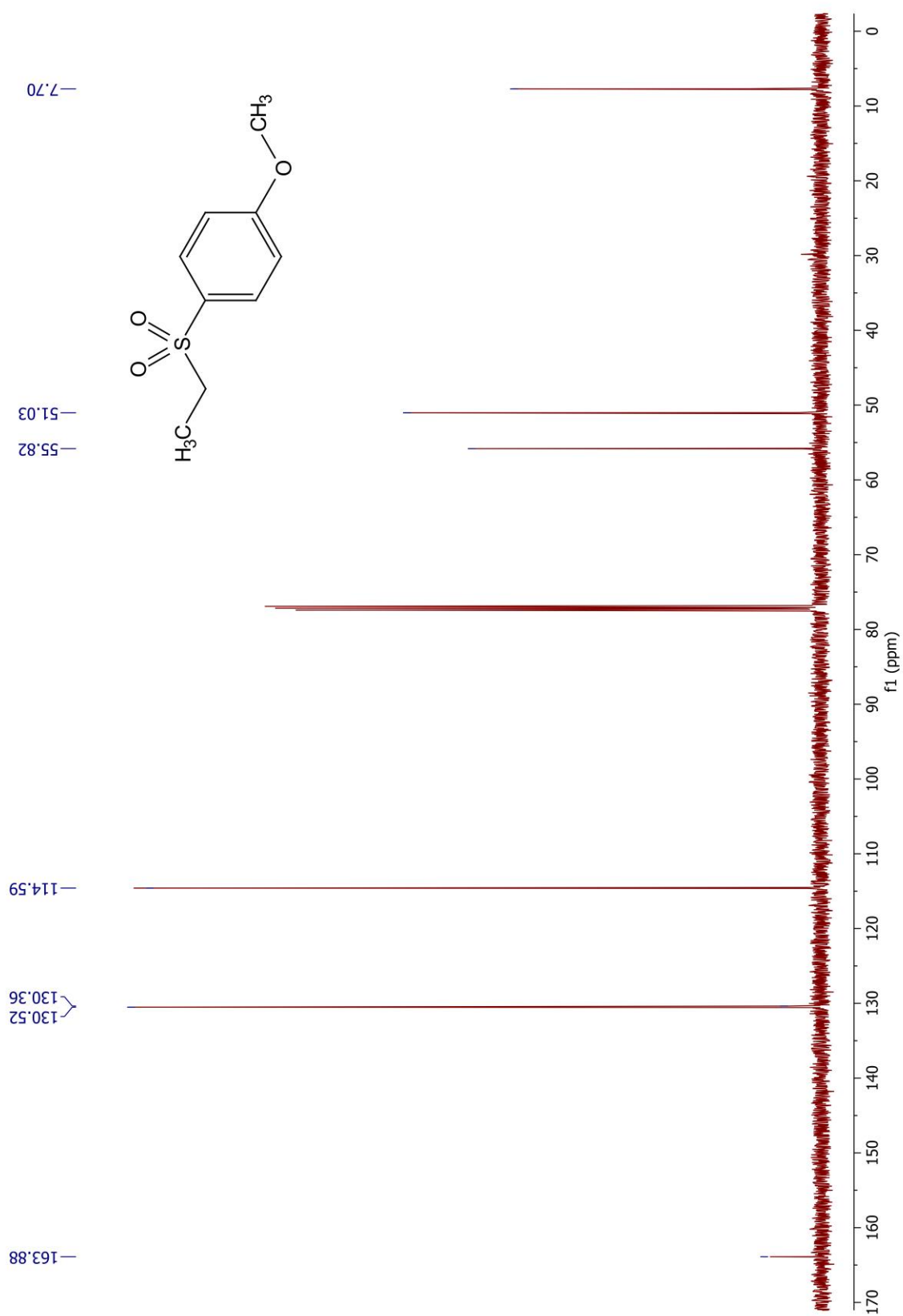
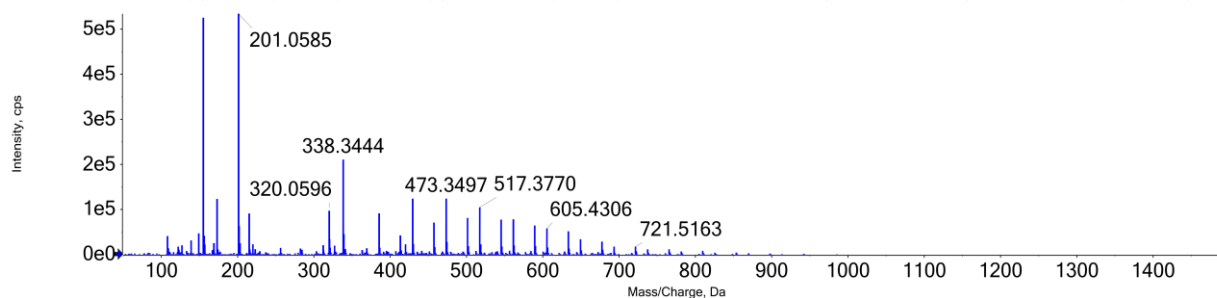


Figure S15. ¹³C-NMR of 1-(ethylsulfonyl)-4-methoxybenzene (3j)

Full mass spectrum

Spectrum from ETHAN-P_(+).wiff2 (sample 1) - ETHAN-P_(+).ESI, +TOF MS (50 - 1500) from 0.153 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)



Expanded spectrum

Spectrum from ETHAN-P_(+).wiff2 (sample 1) - ETHAN-P_(+).ESI, +TOF MS (50 - 1500) from 0.153 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)

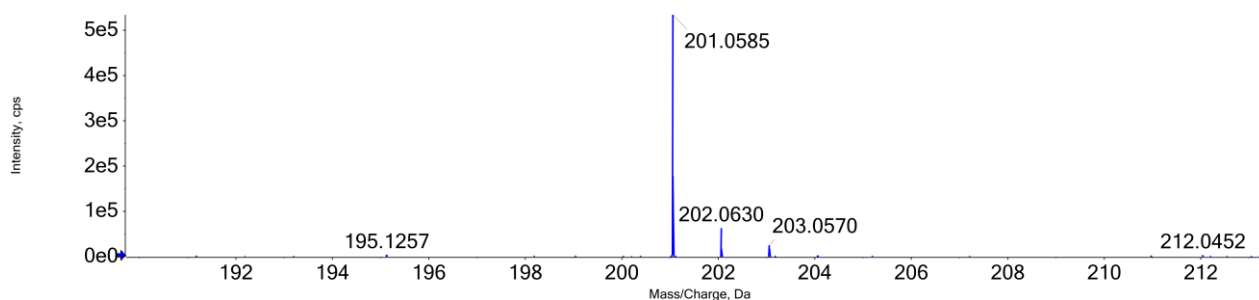


Figure S16. HRMS of 1-(ethylsulfonyl)-4-methoxybenzene (**3j**)

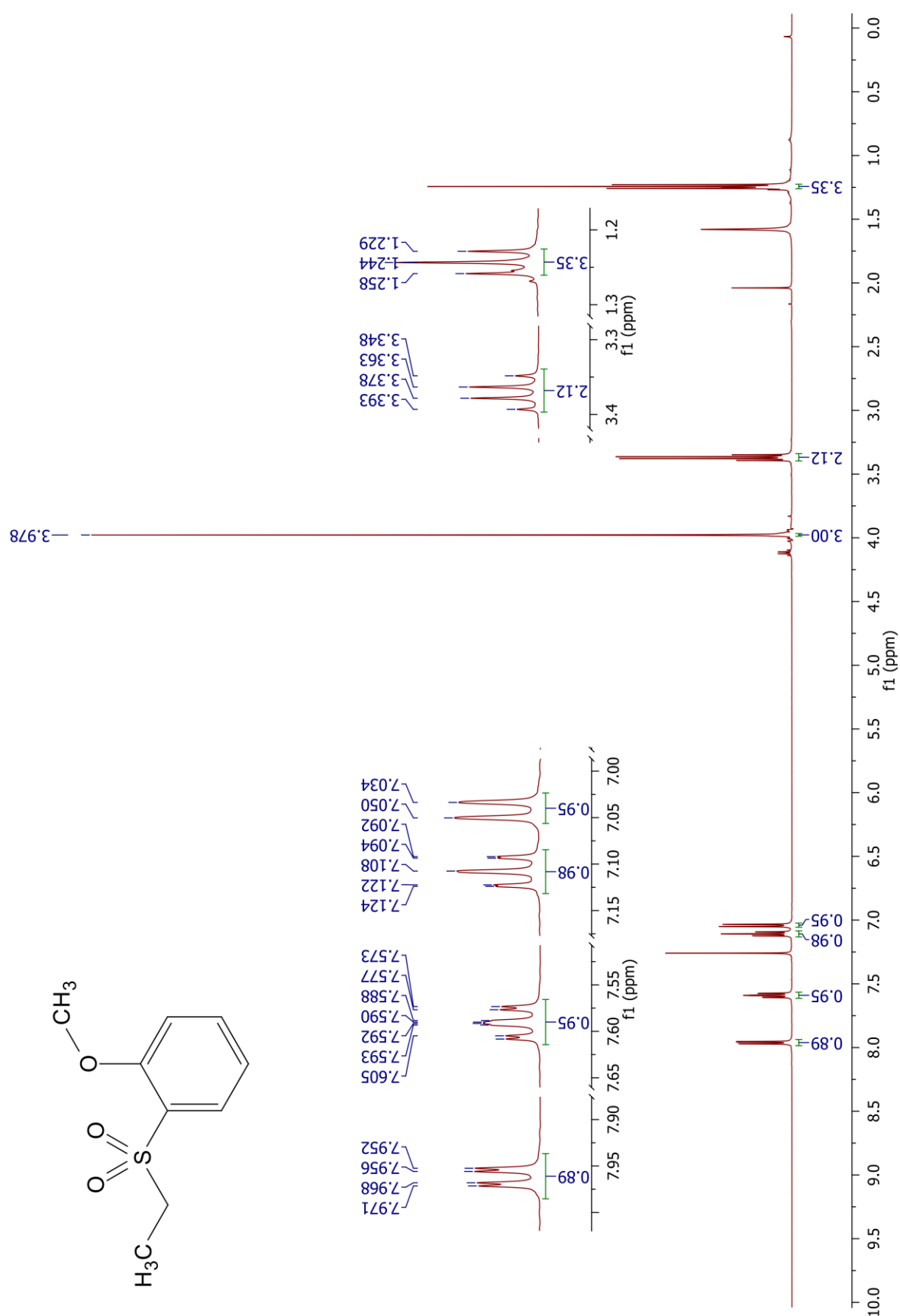


Figure S17. ¹H-NMR of 1-(ethylsulfonyl)-2-methoxybenzene (3j')

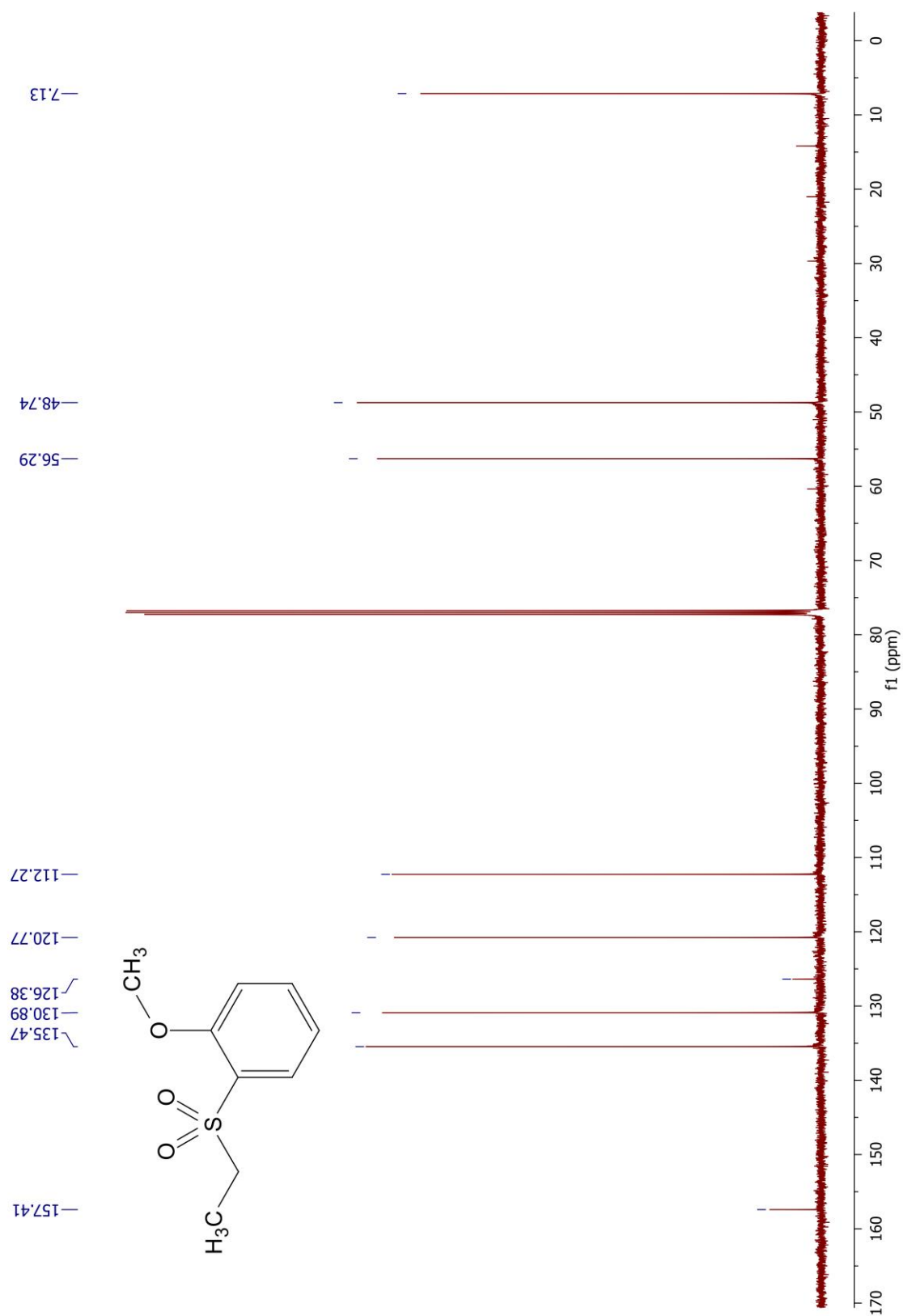
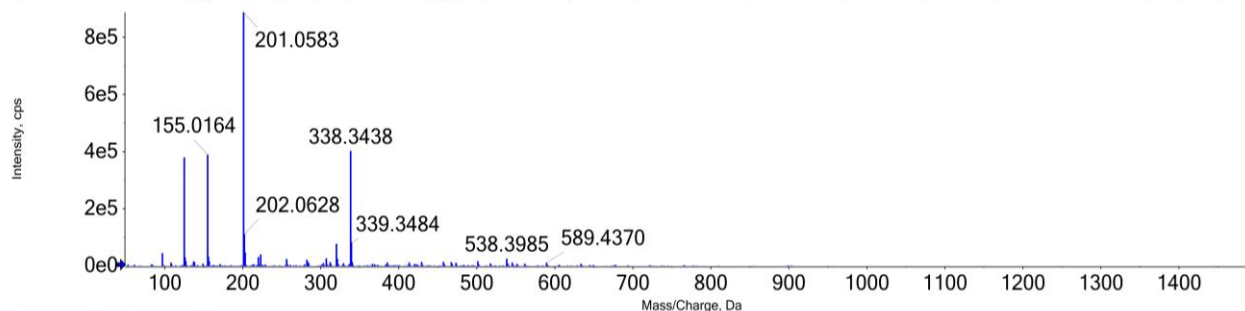


Figure S18. ^{13}C -NMR of 1-(ethylsulfonyl)-2-methoxybenzene (**3j'**)

Full mass spectrum

Spectrum from ETHAN-O_(+)ESI.wiff2 (sample 1) - ETHAN-O_(+)ESI, +TOF MS (50 - 1500) from 0.148 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)



Expanded spectrum

Spectrum from ETHAN-O_(+)ESI.wiff2 (sample 1) - ETHAN-O_(+)ESI, +TOF MS (50 - 1500) from 0.148 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)

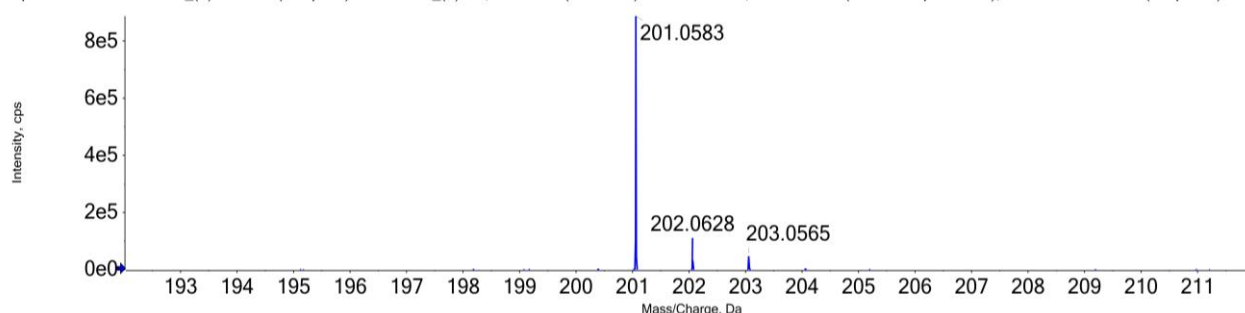


Figure S19. HRMS of 1-(ethylsulfonyl)-2-methoxybenzene (**3j'**)

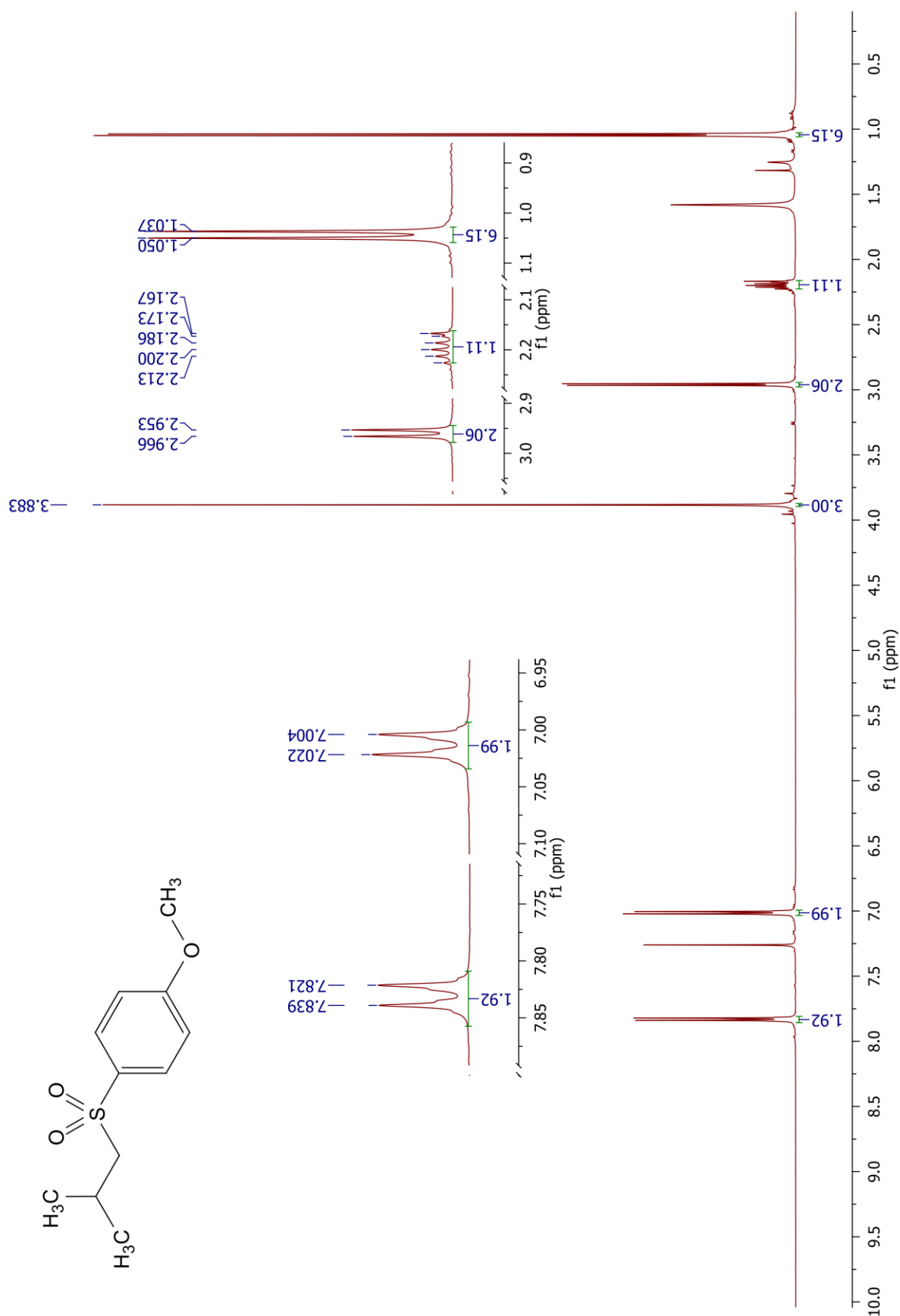


Figure S20. ¹H-NMR of 1-(isobutylsulfonyl)-4-methoxybenzene (3k)

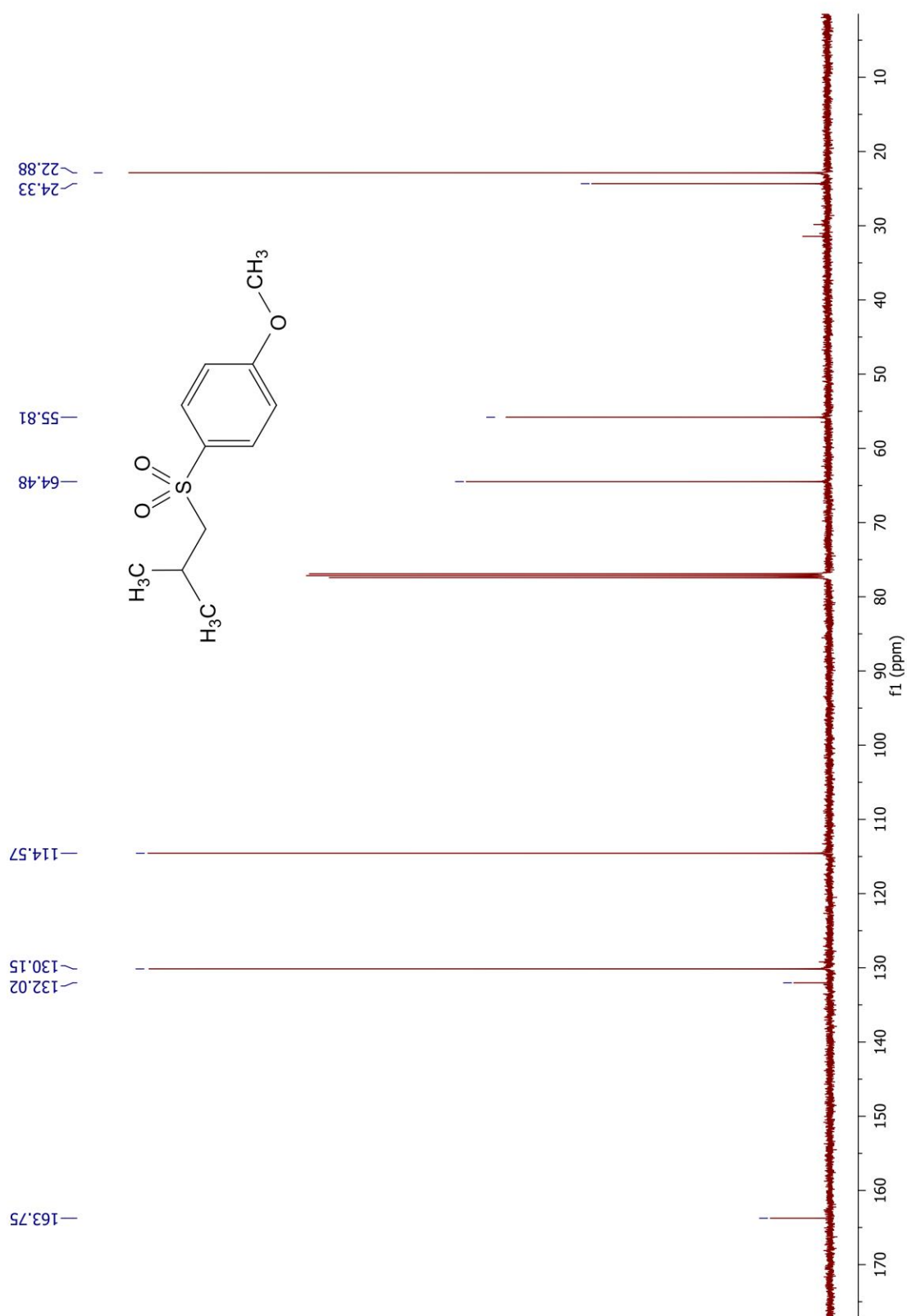
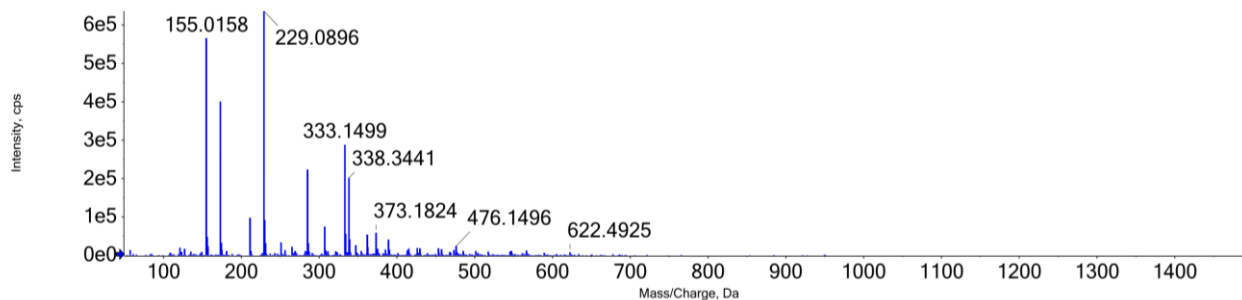


Figure S21. ^{13}C -NMR of 1-(isobutylsulfonyl)-4-methoxybenzene (3k)

Full mass spectrum

Spectrum from ISB-P_(+)ESI.wiff2 (sample 1) - ISB-P_(+)ESI, +TOF MS (50 - 1500) from 0.153 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)



Expanded spectrum

Spectrum from ISB-P_(+)ESI.wiff2 (sample 1) - ISB-P_(+)ESI, +TOF MS (50 - 1500) from 0.153 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)

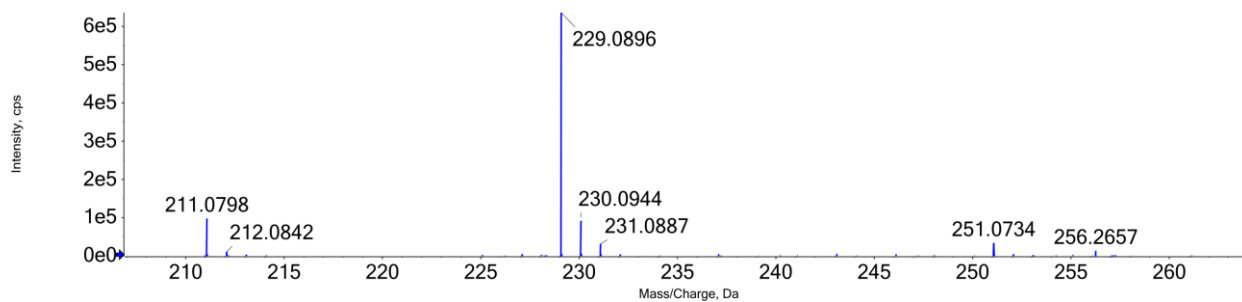


Figure S22. HRMS of 1-(isobutylsulfonyl)-4-methoxybenzene (**3k**)

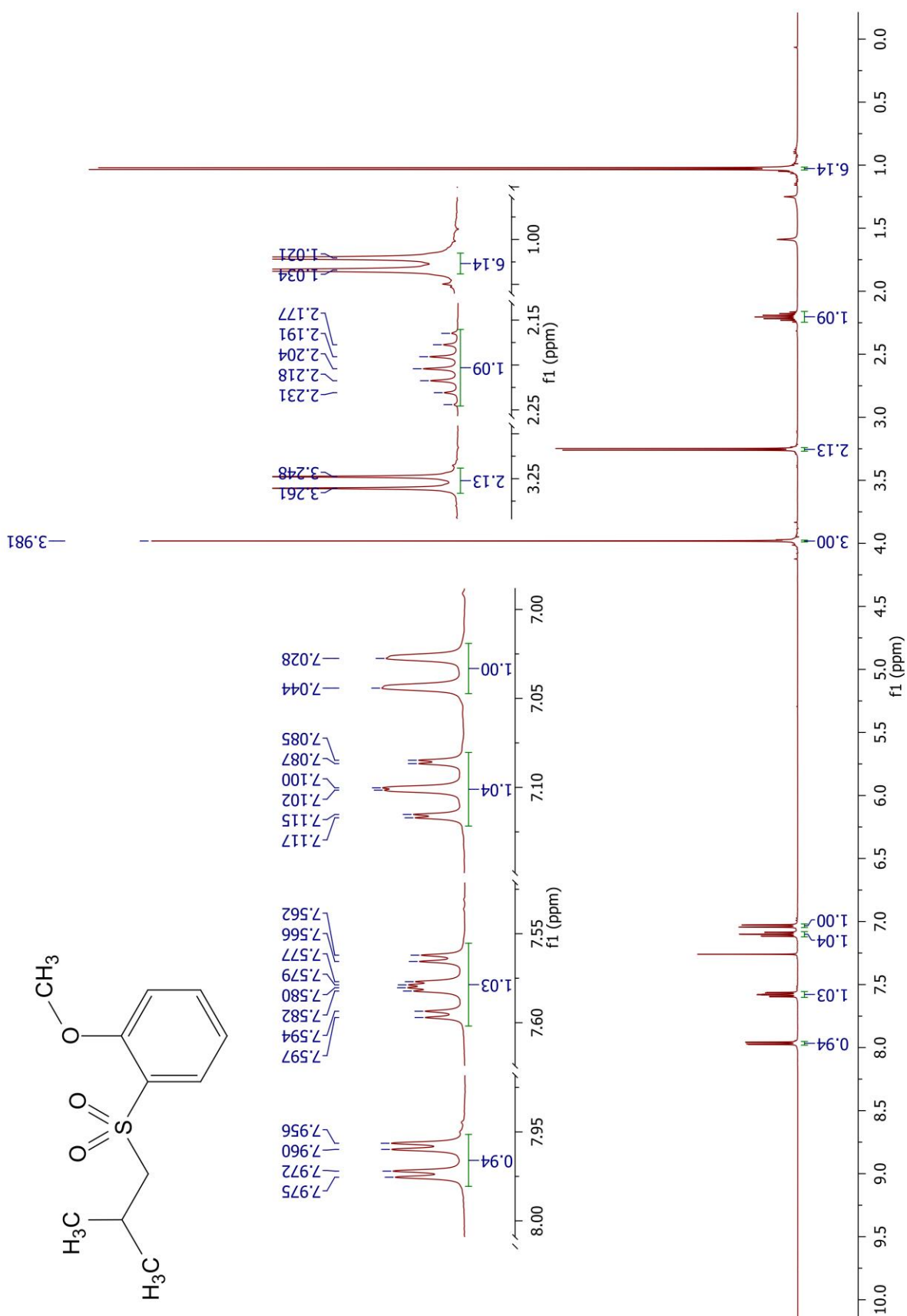


Figure S23. ¹H-NMR of 1-(isobutylsulfonyl)-2-methoxybenzene (**3k'**)

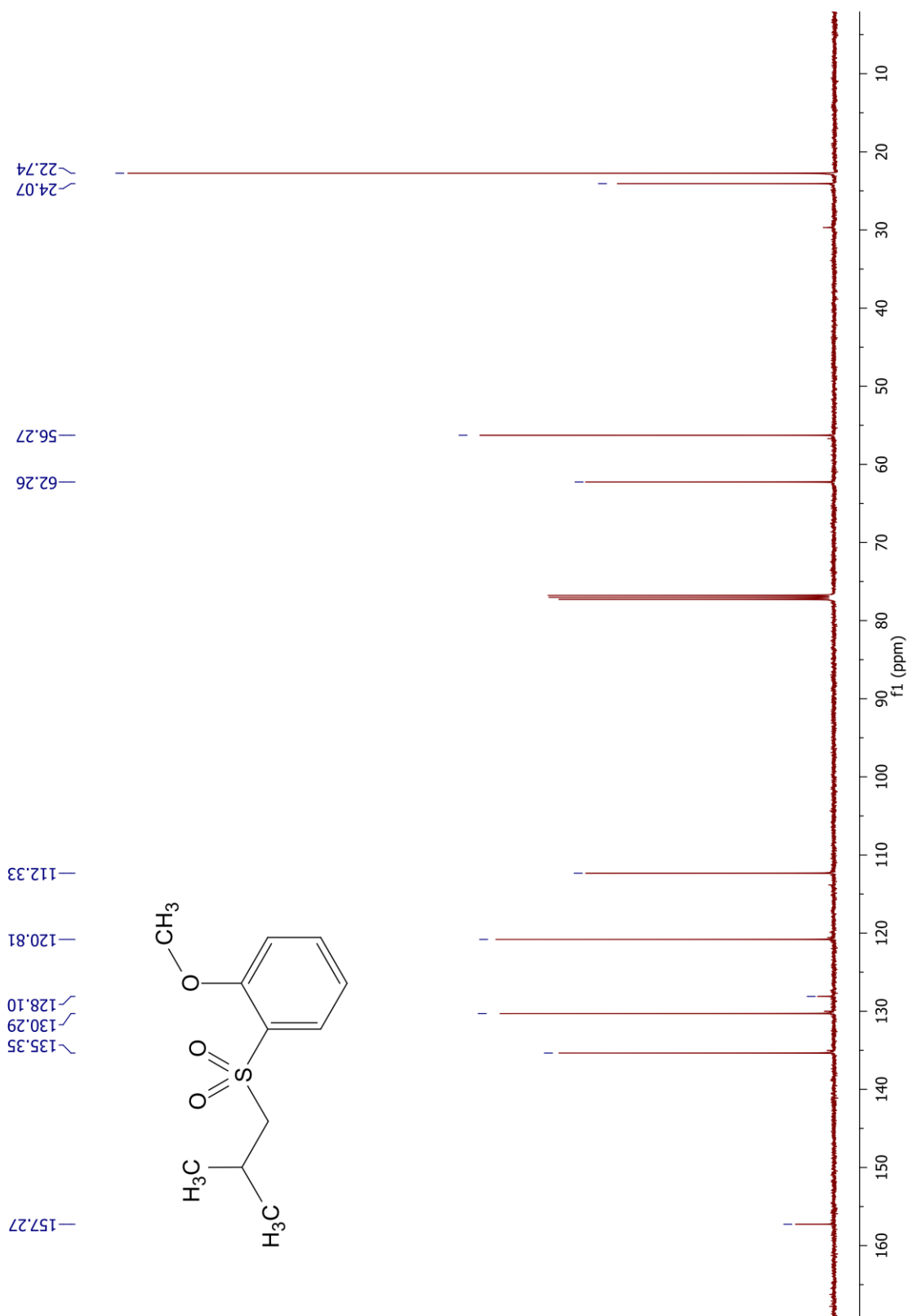
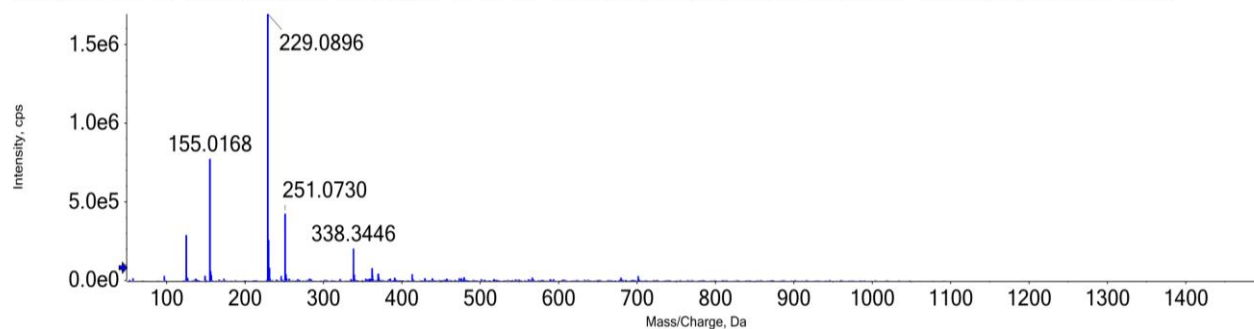


Figure S24. ^{13}C -NMR of 1-(isobutylsulfonyl)-2-methoxybenzene (**3k'**)

Full mass spectrum

Spectrum from ISB-O_(+)ESI.wiff2 (sample 1) - ISB-O_(+)ESI, +TOF MS (50 - 1500) from 0.143 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)



Expanded spectrum

Spectrum from ISB-O_(+)ESI.wiff2 (sample 1) - ISB-O_(+)ESI, +TOF MS (50 - 1500) from 0.143 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)

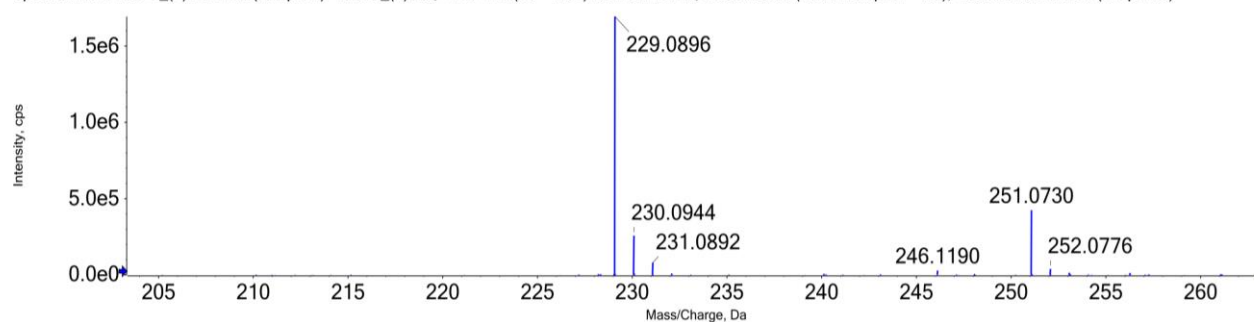


Figure S25. HRMS of 1-(isobutylsulfonyl)-2-methoxybenzene (**3k'**)

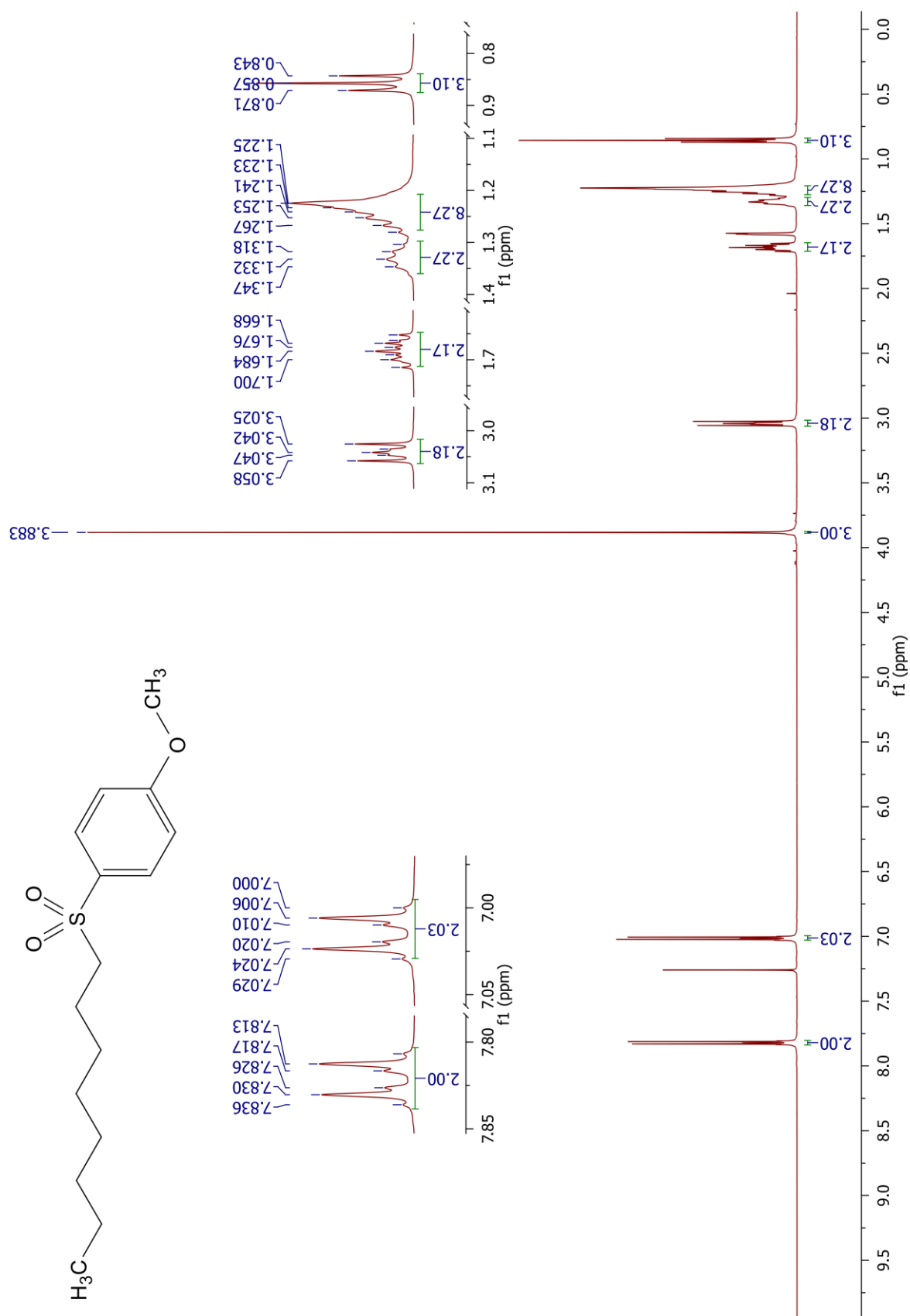


Figure S26. ¹H-NMR of 1-methoxy-4-(octylsulfonyl)benzene (3I)

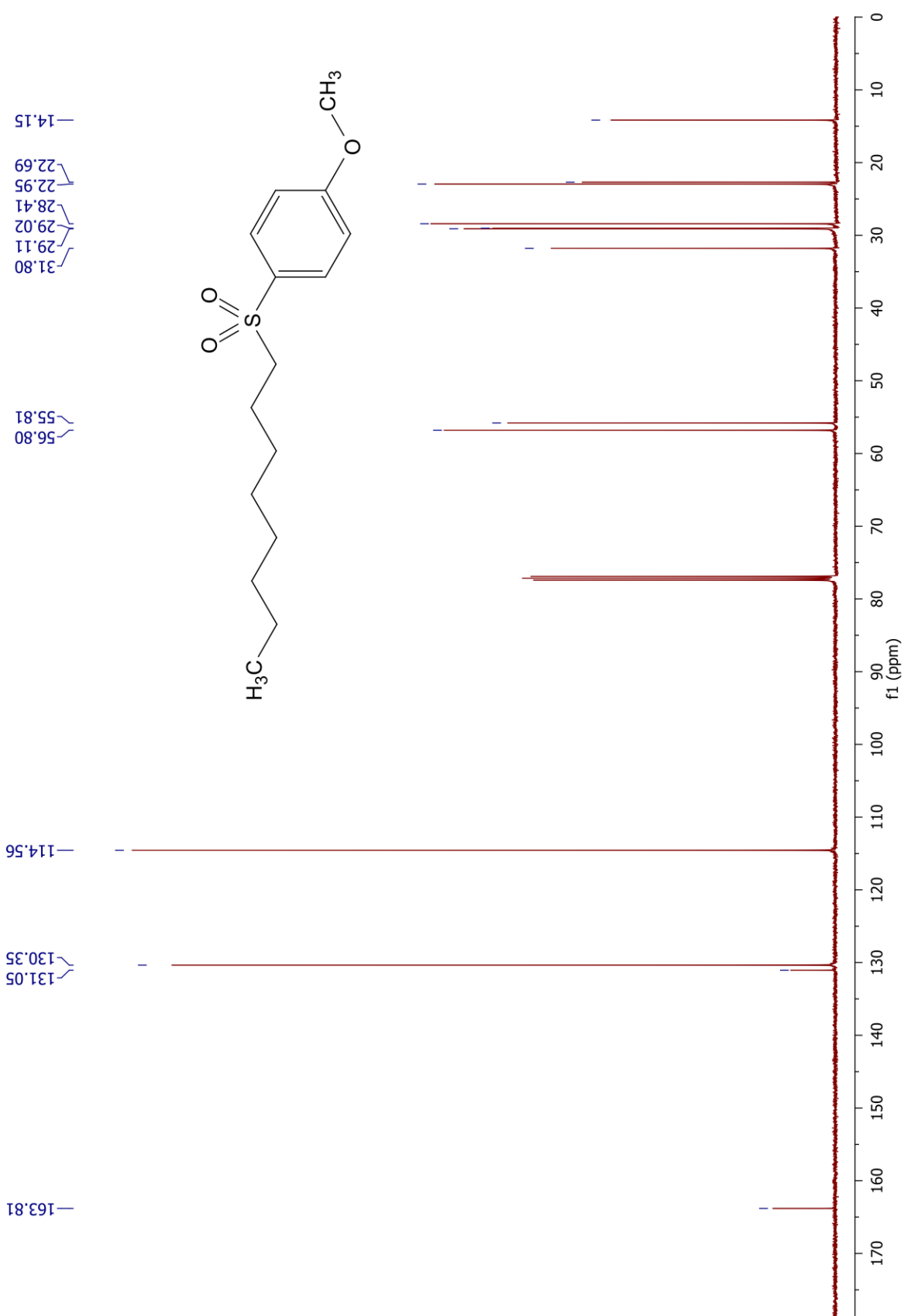
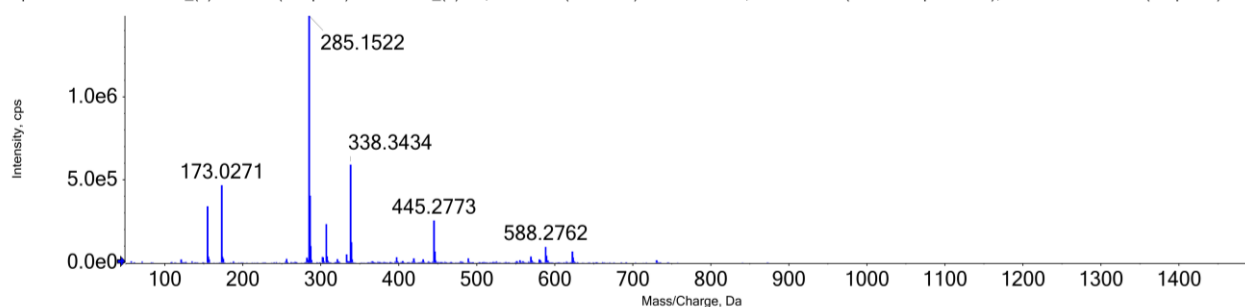


Figure S27. ¹³C-NMR of 1-methoxy-4-(octylsulfonyl)benzene (3I)

Full mass spectrum

Spectrum from OCTAN-P_(+)ESI.wiff2 (sample 1) - OCTAN-P_(+)ESI, +TOF MS (50 - 1500) from 0.153 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)



Expanded spectrum

Spectrum from OCTAN-P_(+)ESI.wiff2 (sample 1) - OCTAN-P_(+)ESI, +TOF MS (50 - 1500) from 0.153 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)

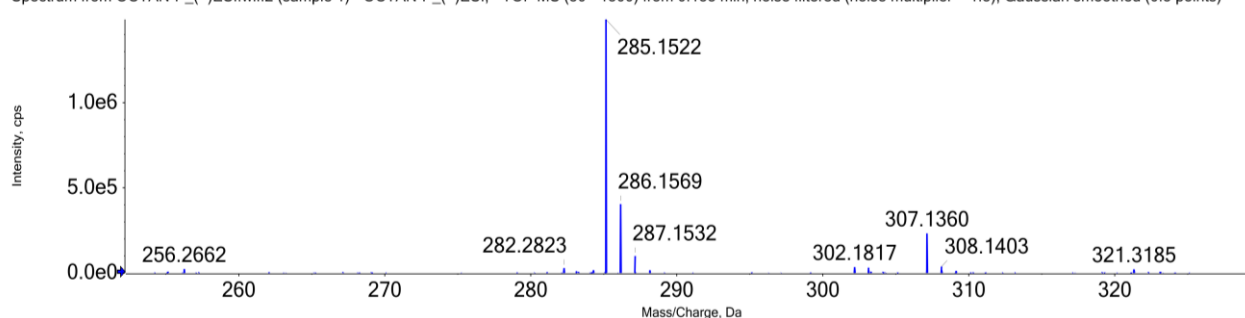


Figure S28. HRMS of 1-methoxy-4-(octylsulfonyl)benzene (**3I**)

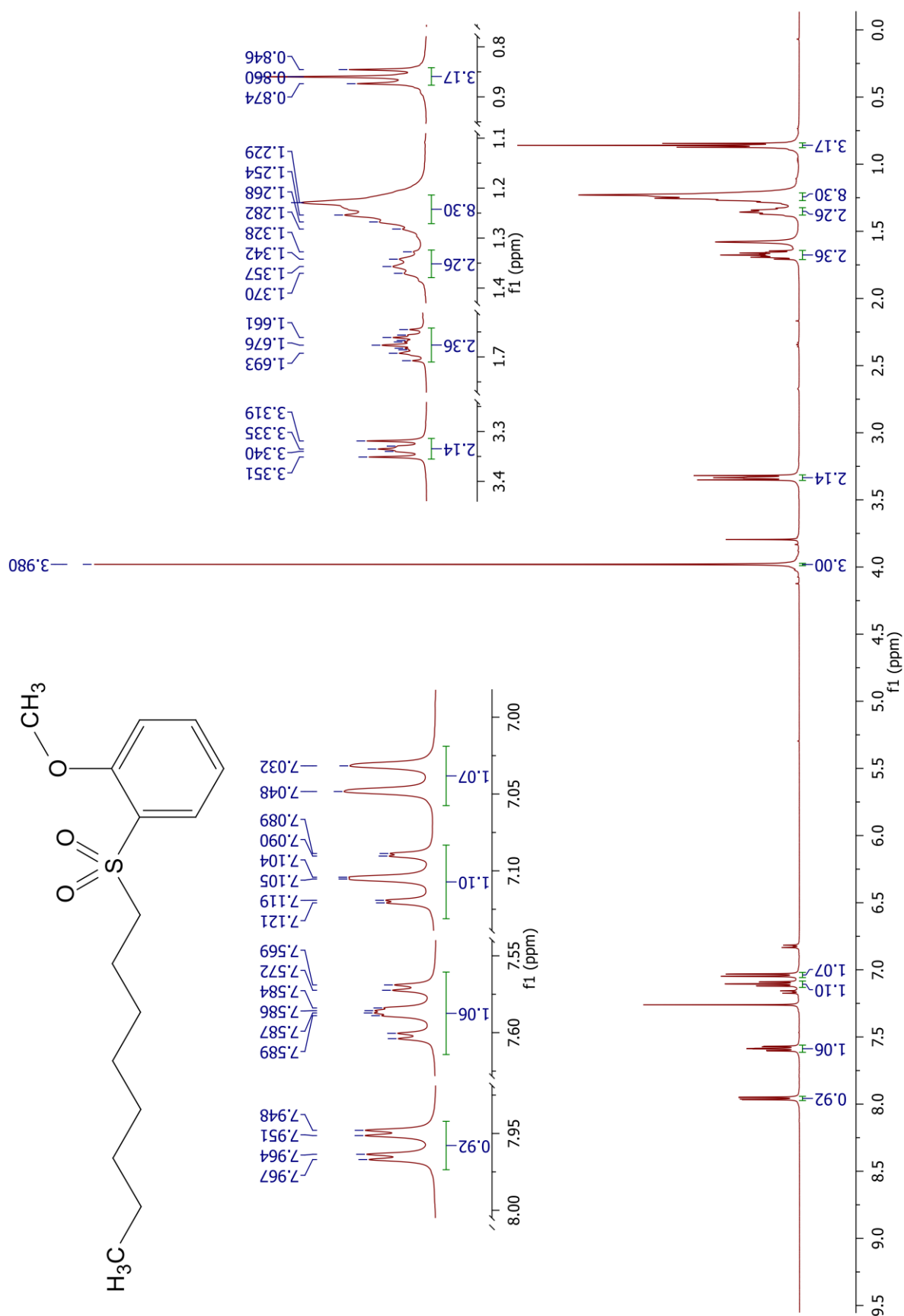


Figure S29. ¹H-NMR of 1-methoxy-2-(octylsulfonyl)benzene (31l')

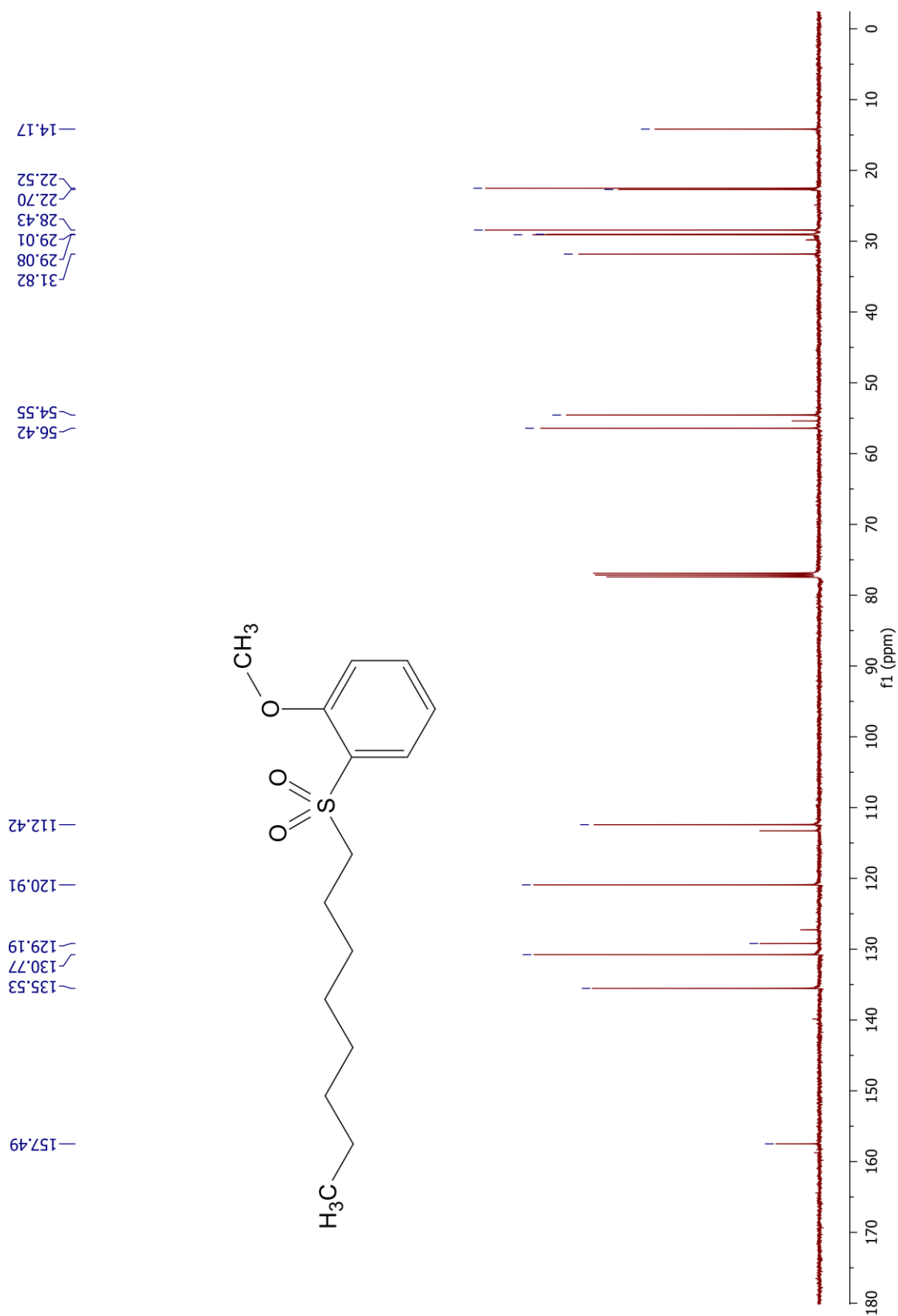
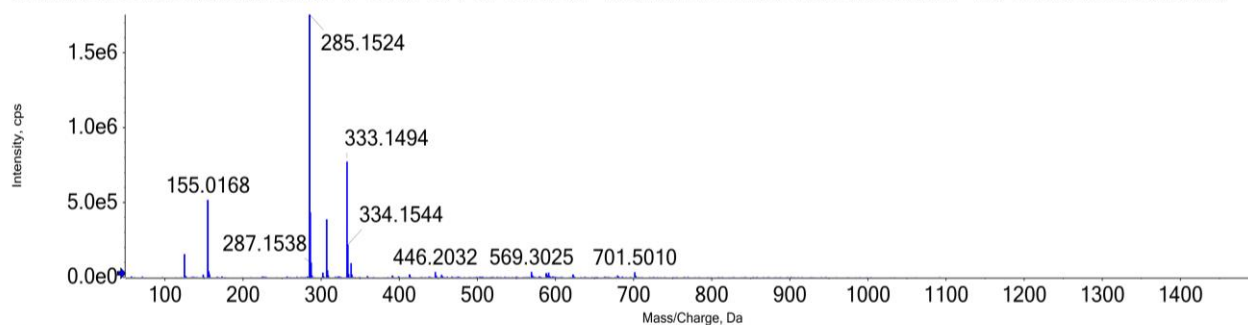


Figure S30. ^{13}C -NMR of 1-methoxy-2-(octylsulfonyl)benzene (31')

Full mass spectrum

Spectrum from OCTAN-O₂(+)ESI.wiff2 (sample 1) - OCTAN-O₂(+)ESI, +TOF MS (50 - 1500) from 0.143 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)



Expanded spectrum

Spectrum from OCTAN-O₂(+)ESI.wiff2 (sample 1) - OCTAN-O₂(+)ESI, +TOF MS (50 - 1500) from 0.143 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)

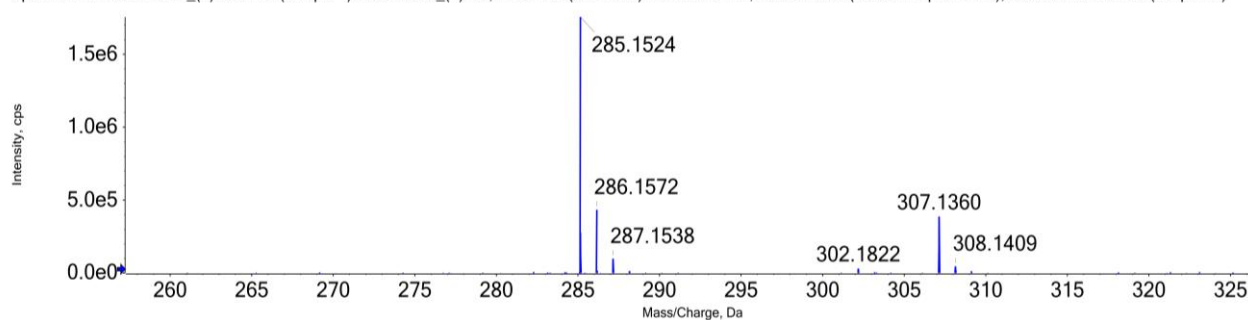


Figure S31. HRMS of 1-methoxy-2-(octylsulfonyl)benzene (**3I'**)

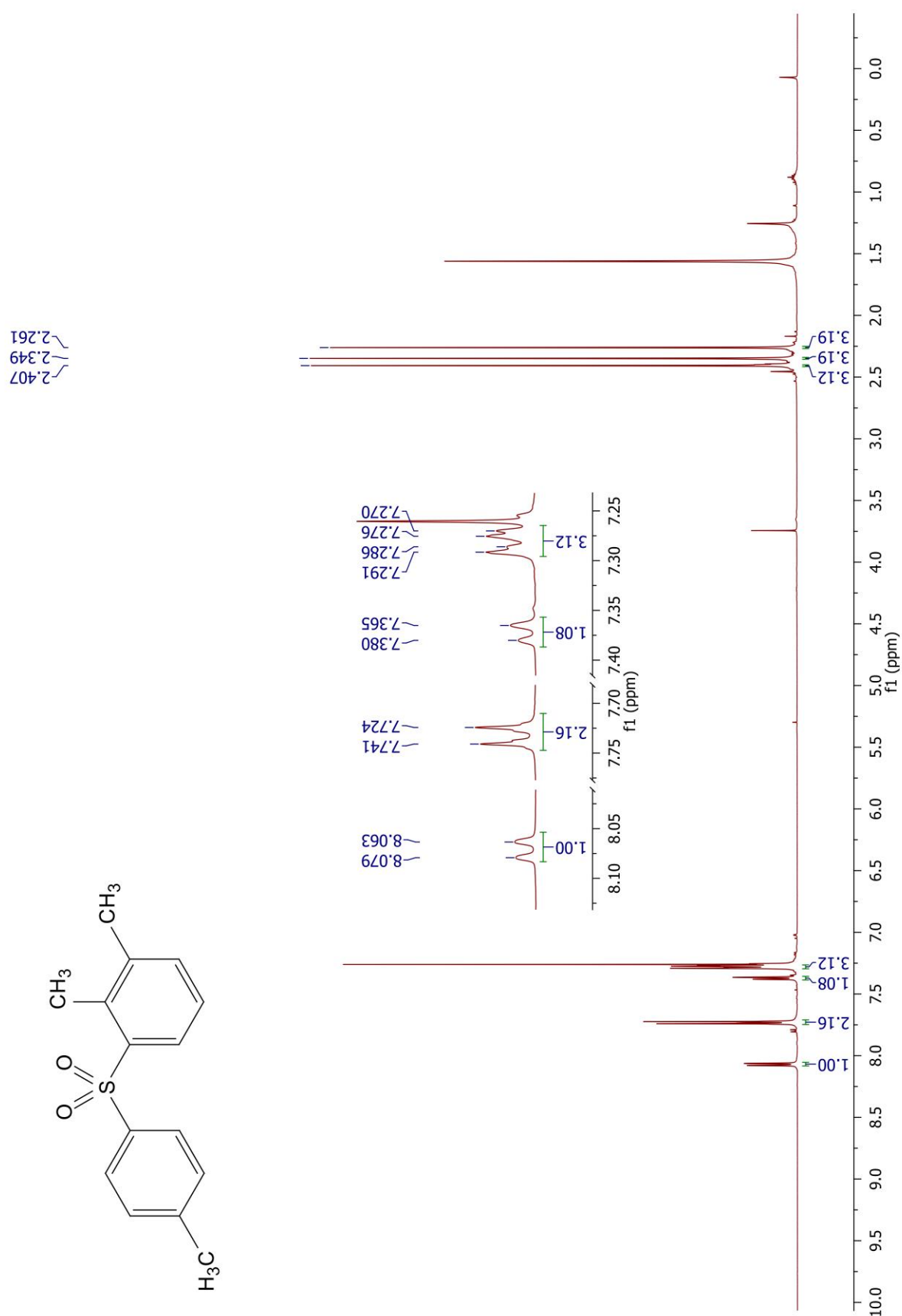


Figure S32: ¹H-NMR of 2,3-dimethyl-1-tosylbenzene (**30'**)

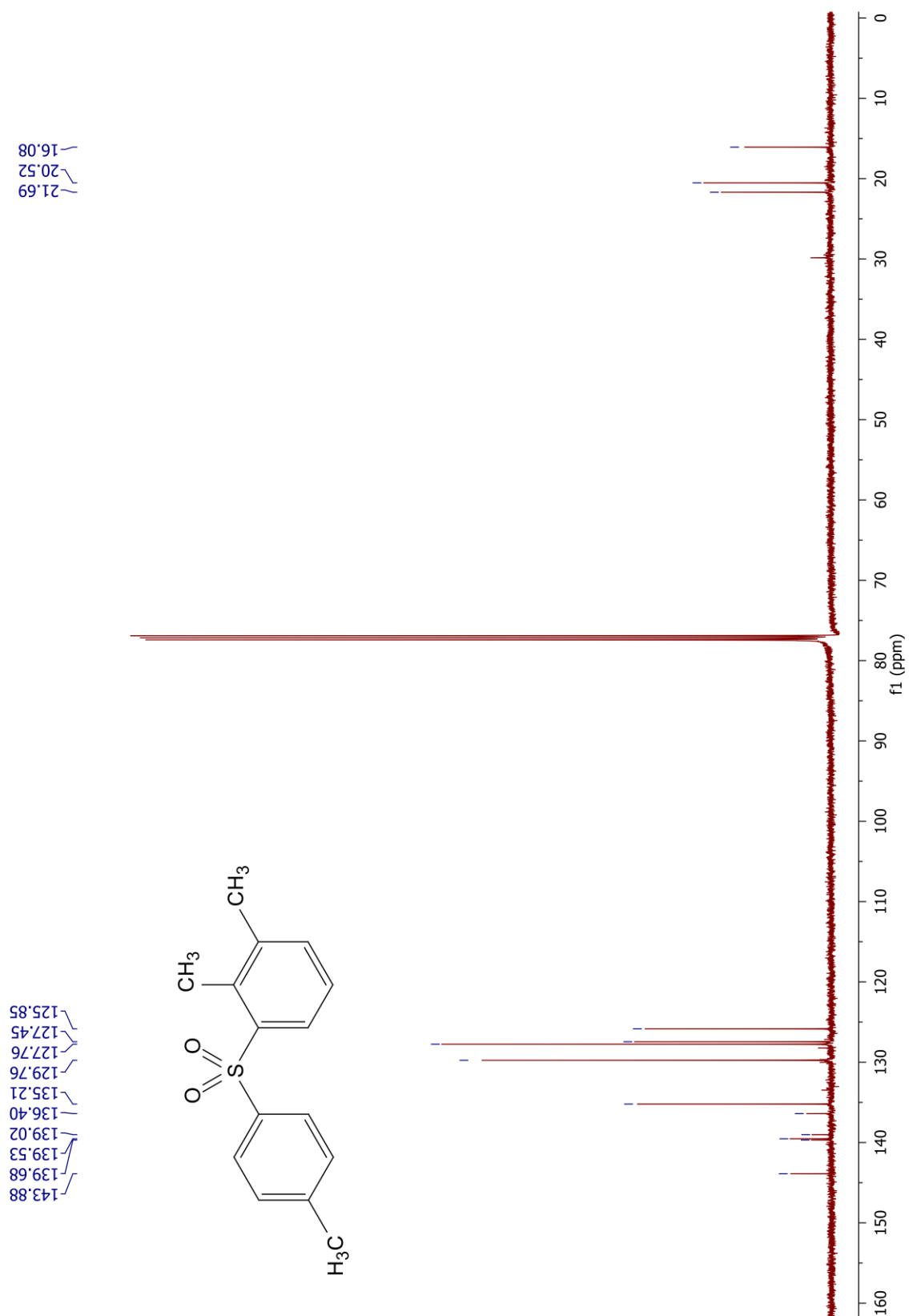
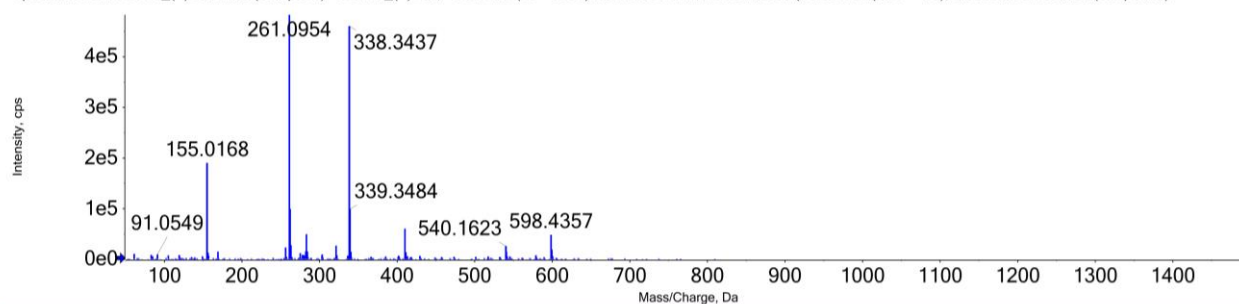


Figure S33: ¹³C-NMR of 2,3-dimethyl-1-tosylbenzene (**3o'**)

Full mass spectrum

Spectrum from TOX-T_(+)ESI.wiff2 (sample 1) - TOX-T_(+)ESI, +TOF MS (50 - 1500) from 0.167 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)



Expanded spectrum

Spectrum from TOX-T_(+)ESI.wiff2 (sample 1) - TOX-T_(+)ESI, +TOF MS (50 - 1500) from 0.167 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)

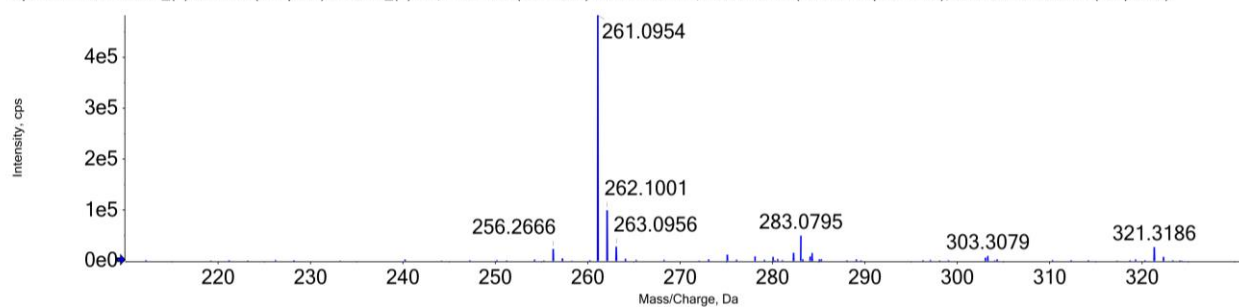


Figure S34: HRMS of 2,3-dimethyl-1-tosylbenzene (**3o'**)

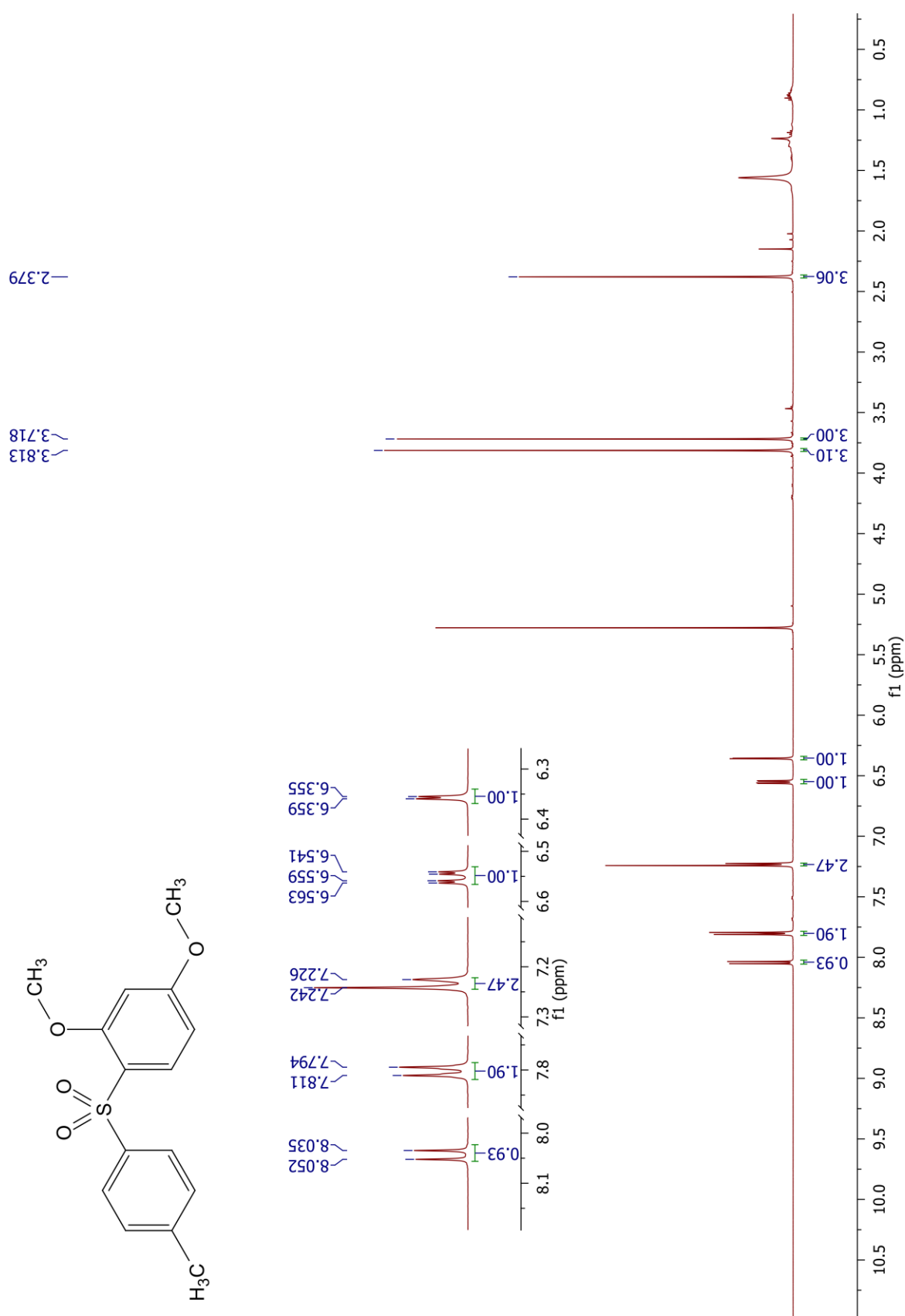


Figure S35. ¹H-NMR of 2,4-dimethoxy-1-tosylbenzene (**3p**)

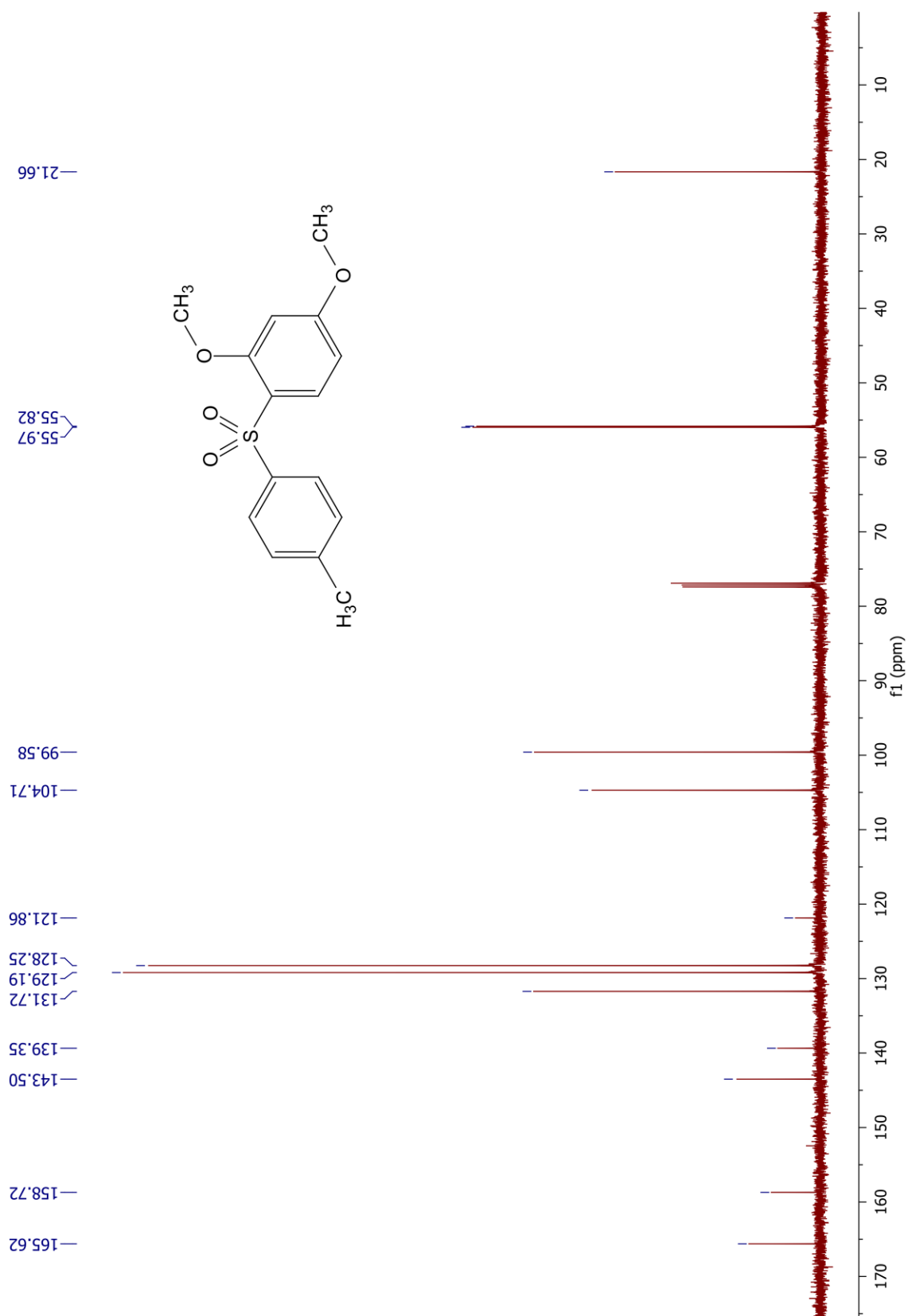


Figure S36. ^{13}C -NMR of 2,4-dimethoxy-1-tosylbenzene (3p)

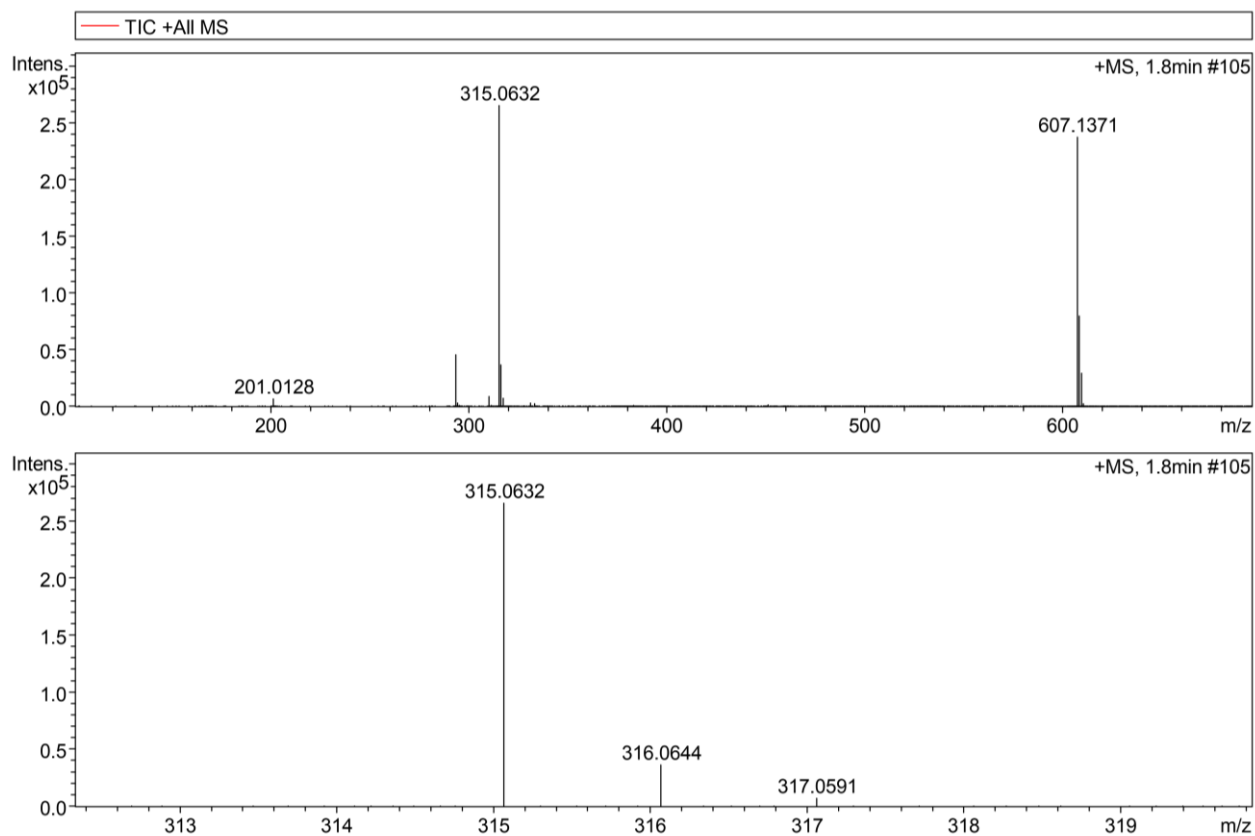


Figure S37. HRMS of 2,4-dimethoxy-1-tosylbenzene (**3p**)

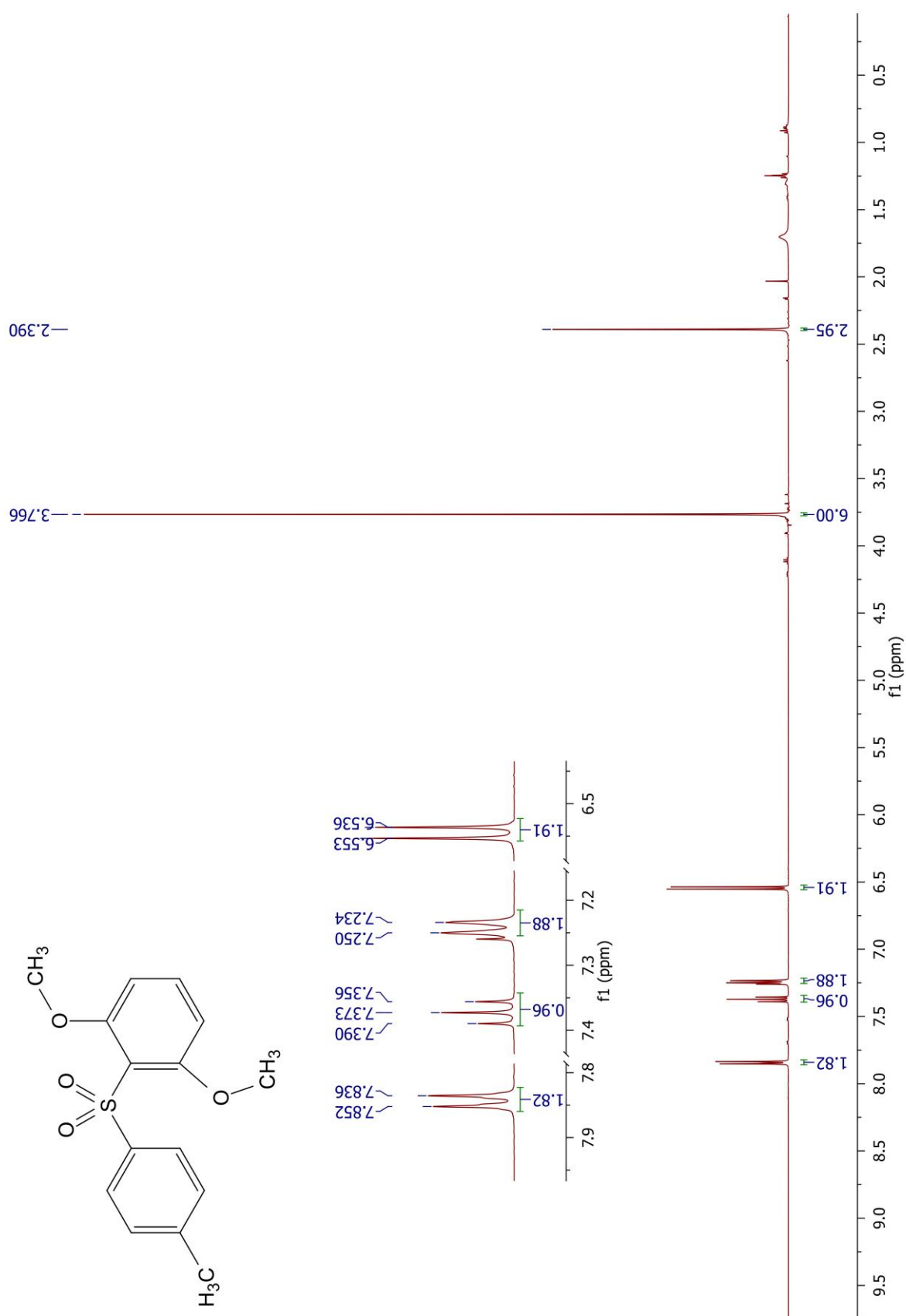


Figure S38. ¹H-NMR of 1,3-dimethoxy-2-tosylbenzene (3p')

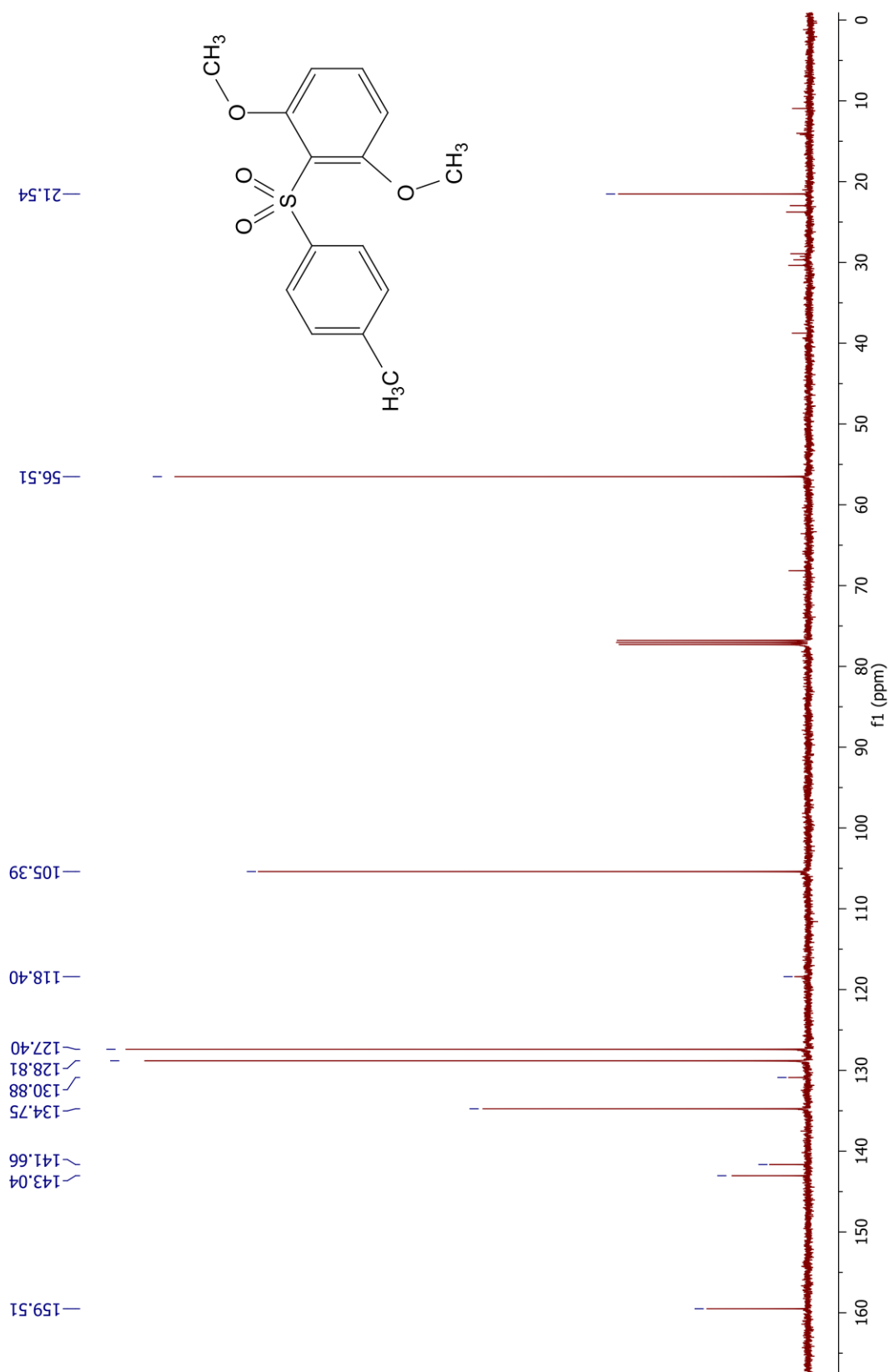


Figure S39. ^{13}C -NMR of 1,3-dimethoxy-2-tosylbenzene (3p')

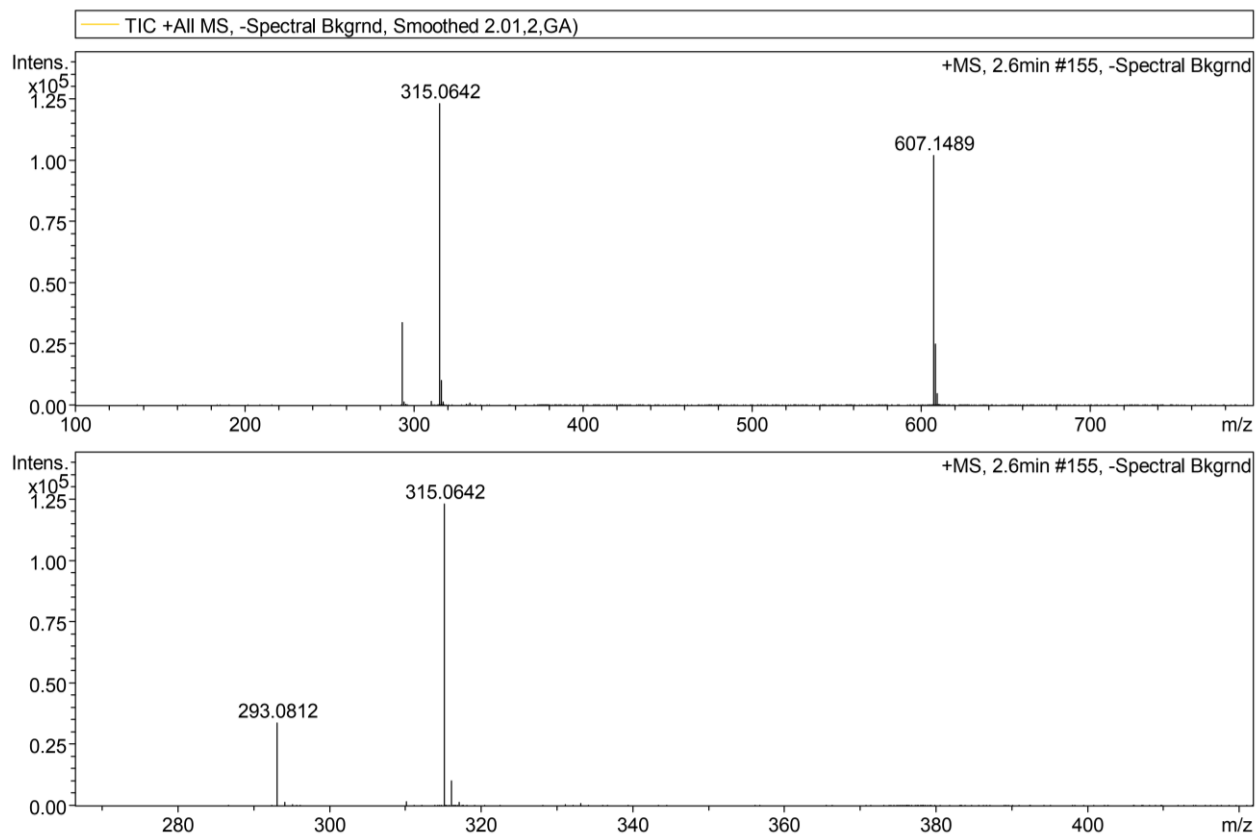


Figure S40. HRMS of 1,3-dimethoxy-2-tosylbenzene (**3p'**)

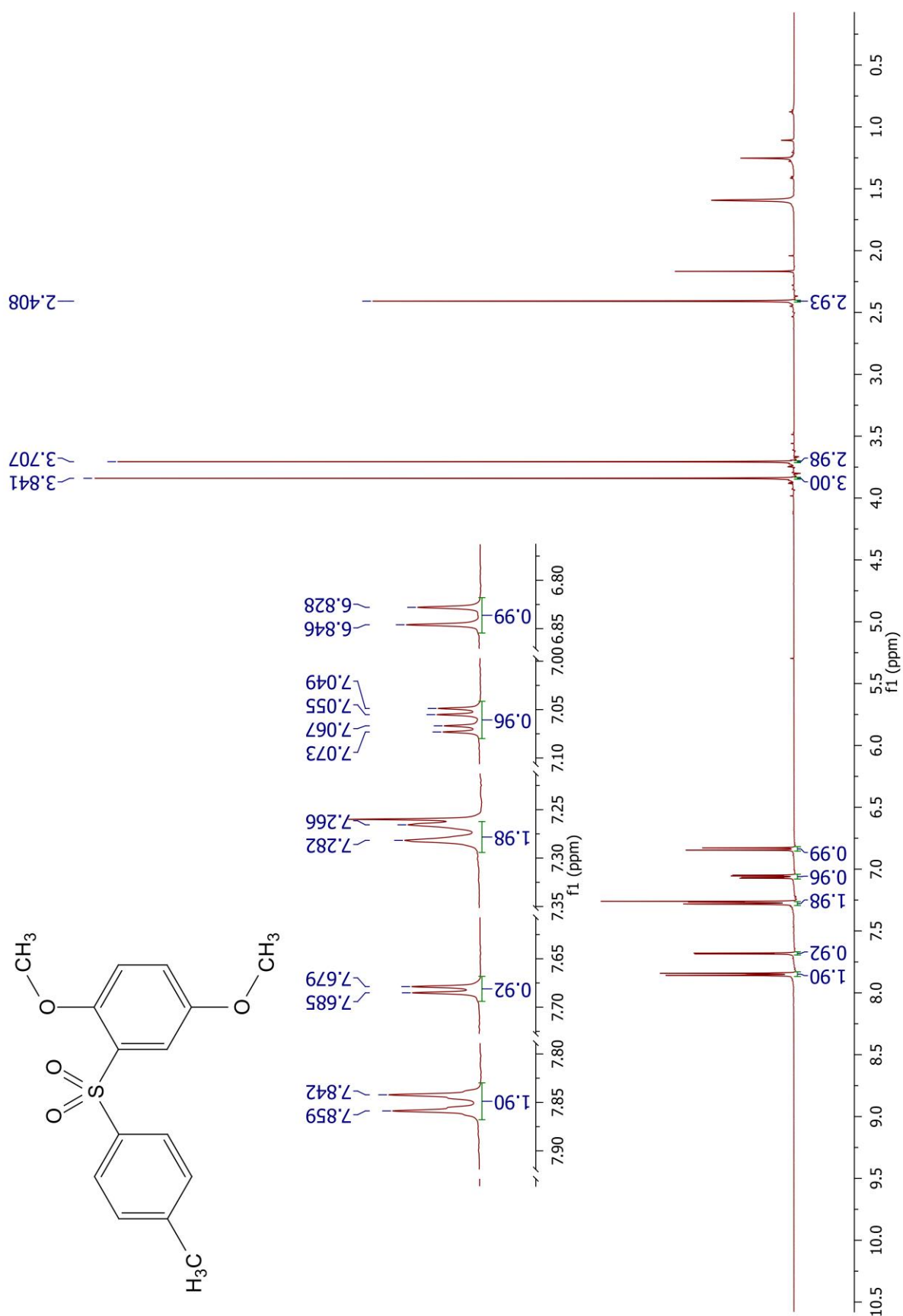


Figure S41. ¹H-NMR of 1,4-dimethoxy-2-tosylbenzene (**3q**)

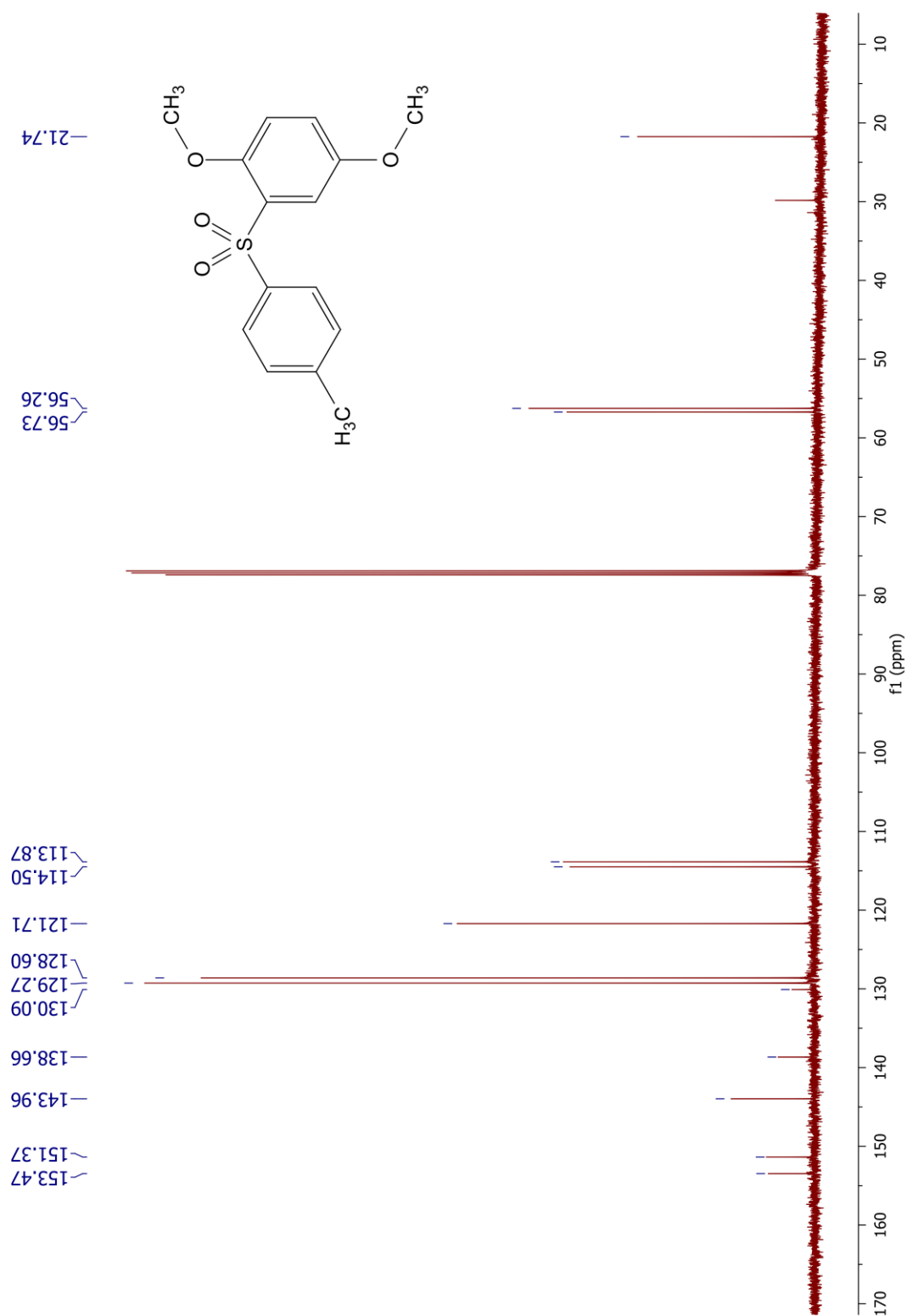


Figure S42. ¹³C-NMR of 1,4-dimethoxy-2-tosylbenzene (**3q**)

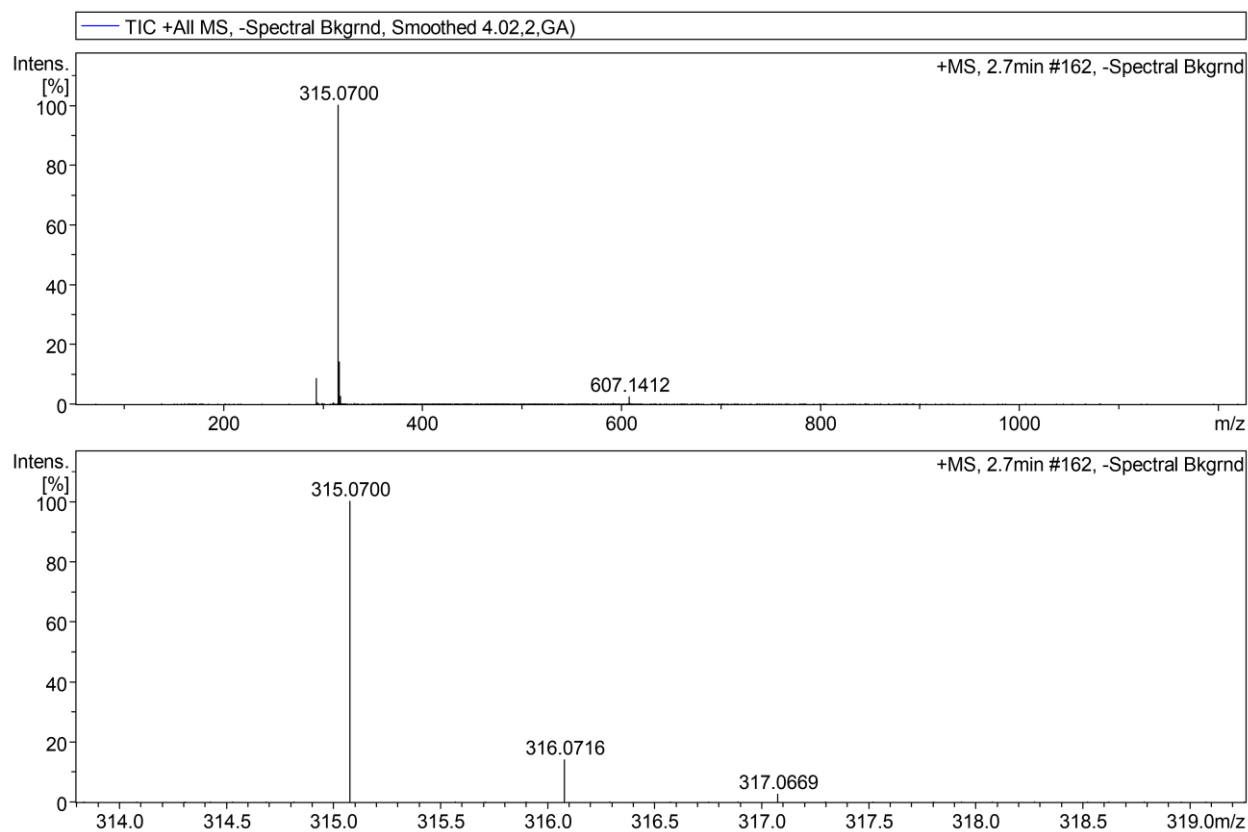


Figure S43. HRMS of 1,4-dimethoxy-2-tosylbenzene (**3q**)

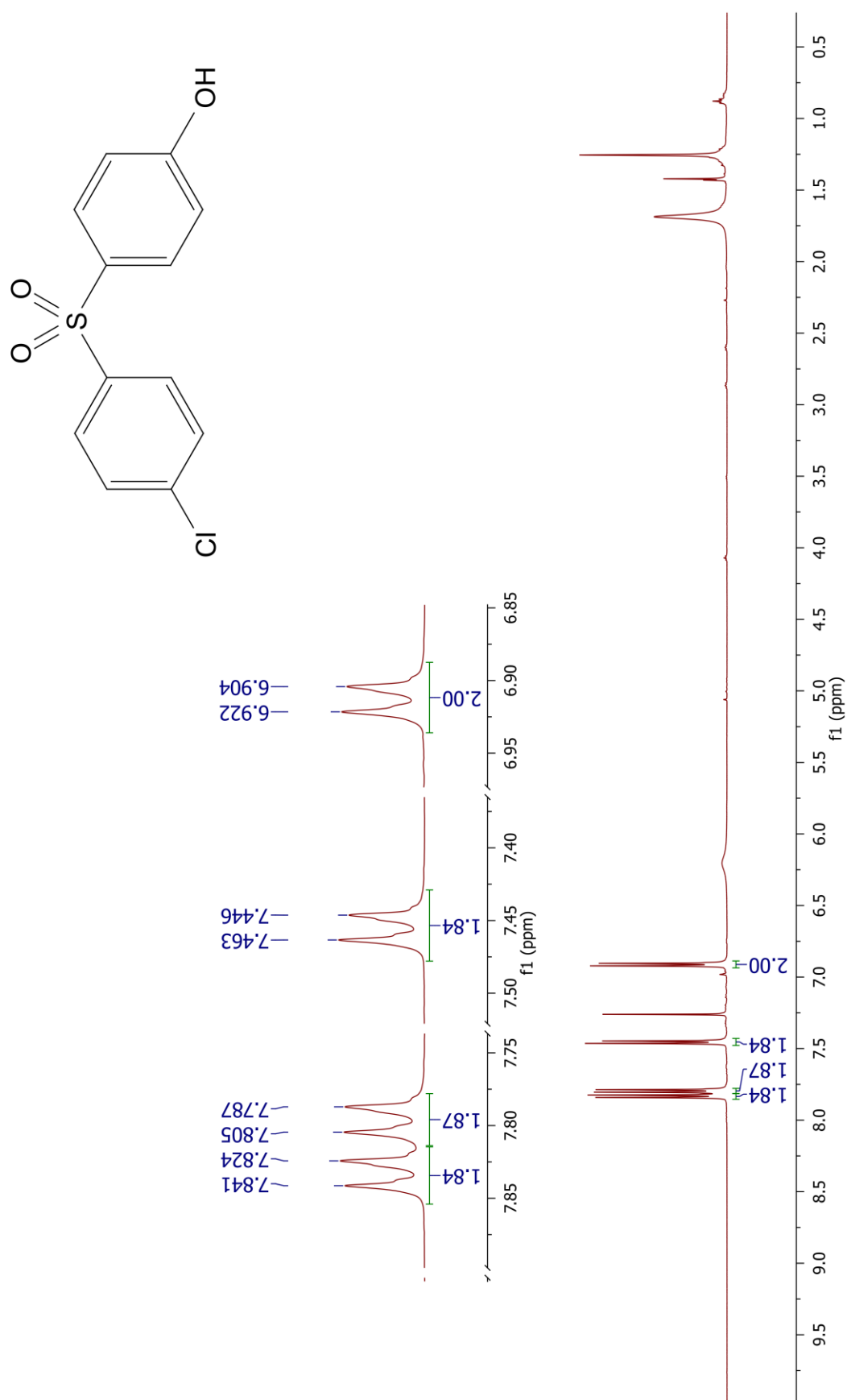


Figure S44. ¹H-NMR of 4-((4-chlorophenyl)sulfonyl)phenol (3r)

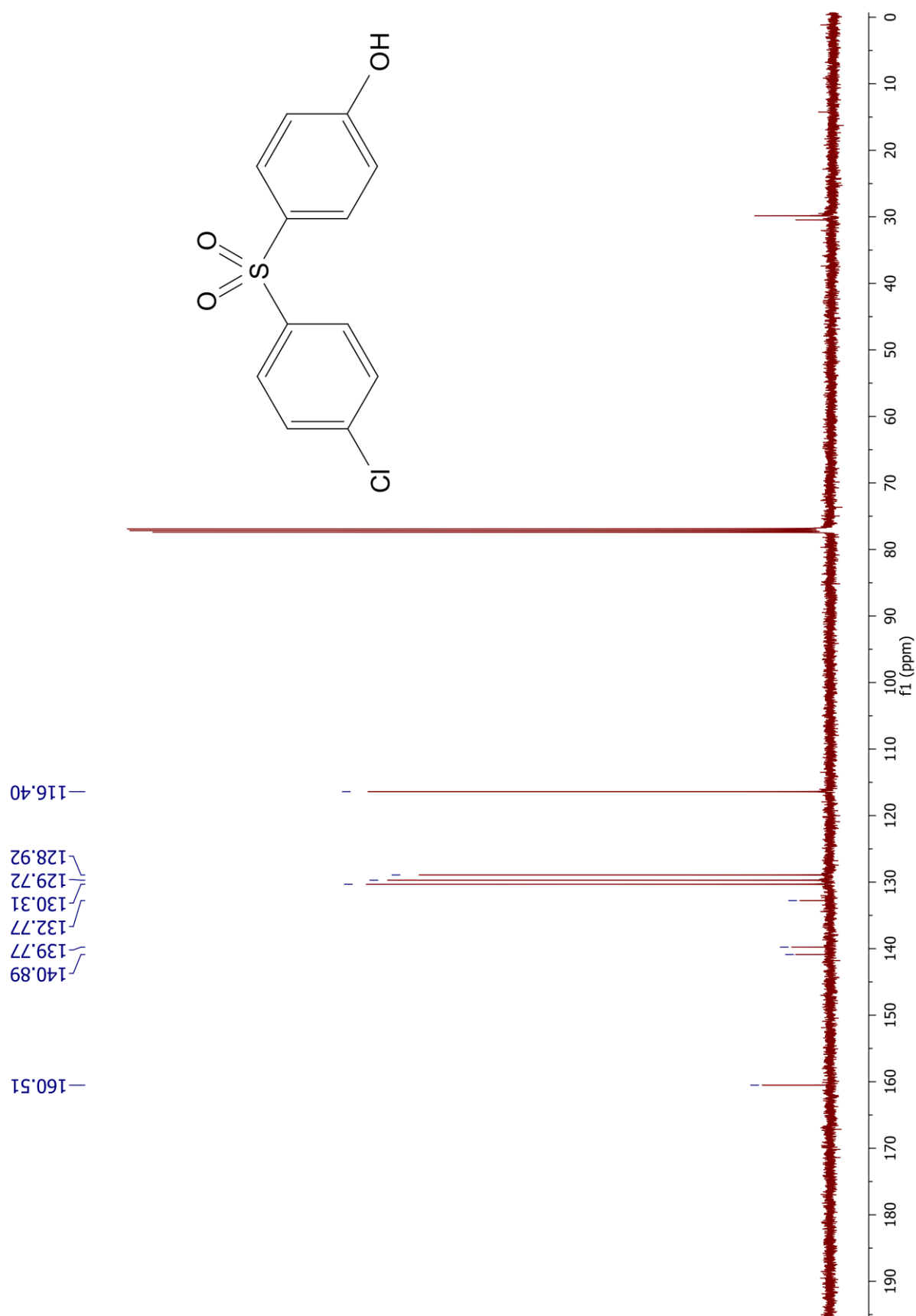


Figure S45. ¹³C-NMR of 4-((4-chlorophenyl)sulfonyl)phenol (3r)

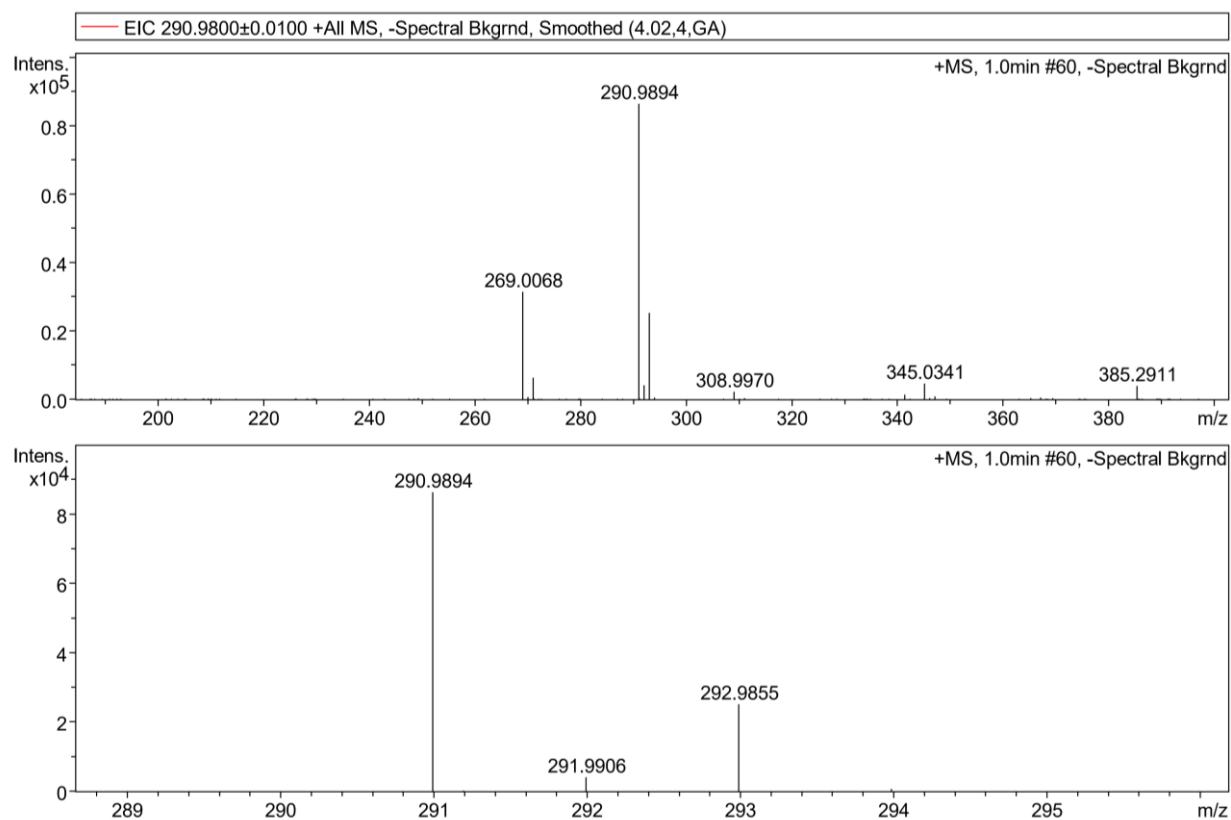


Figure S46. HRMS of 4-((4-chlorophenyl)sulfonyl)phenol (**3r**)

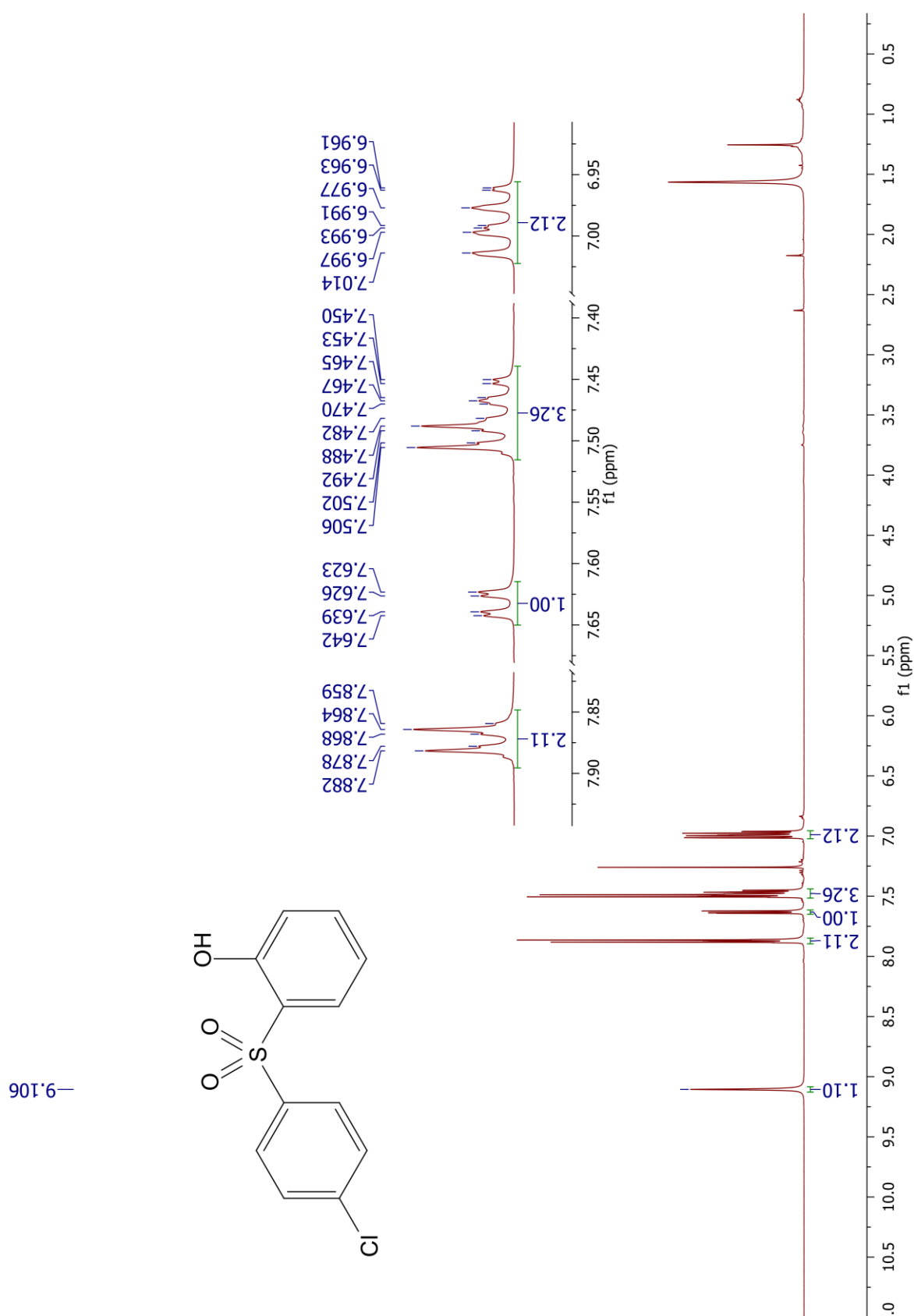


Figure S47. ¹H-NMR of 2-((4-chlorophenyl)sulfonyl)phenol (**3r'**)

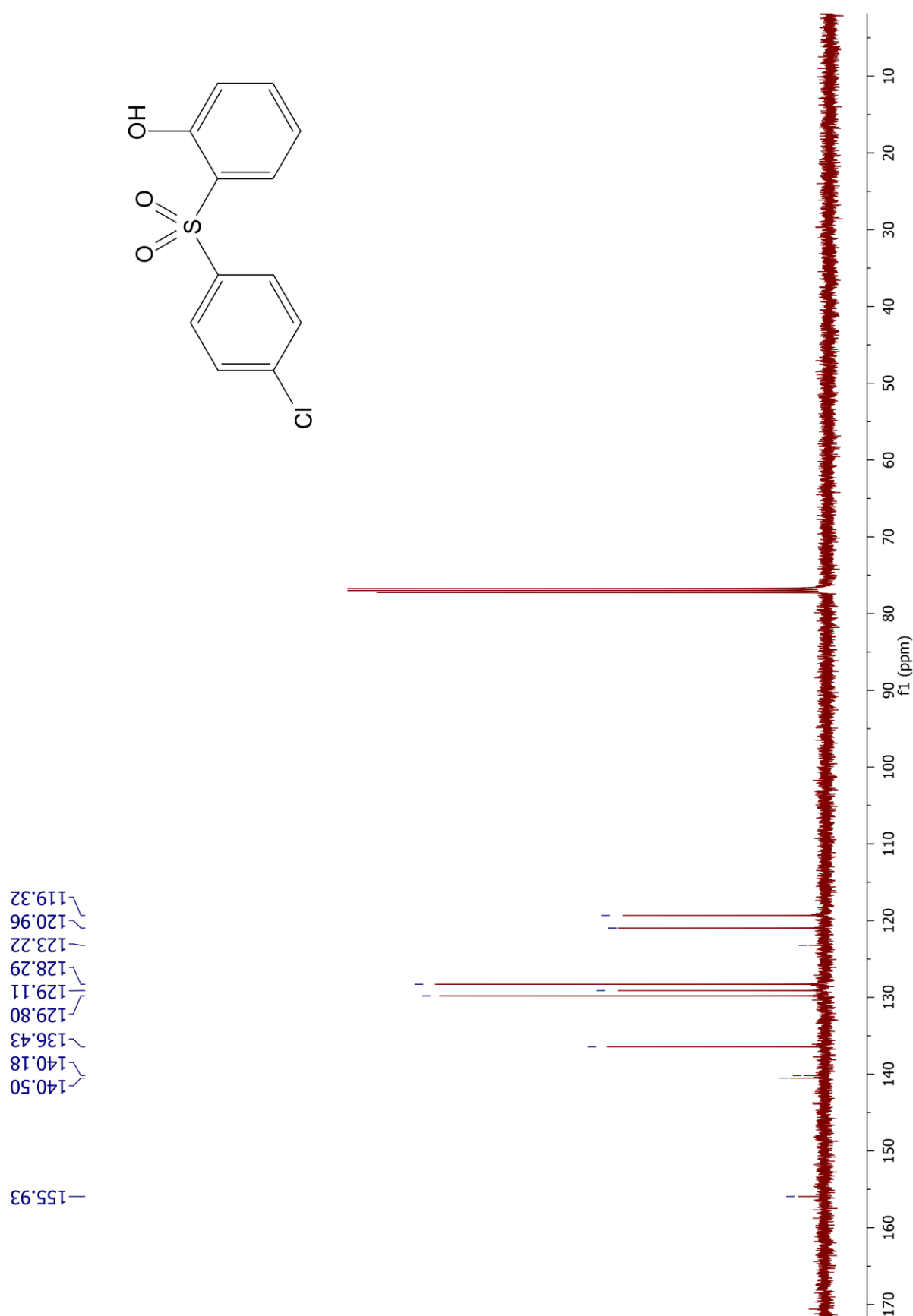


Figure S48. ¹³C-NMR of 2-((4-chlorophenyl)sulfonyl)phenol (**3r'**)

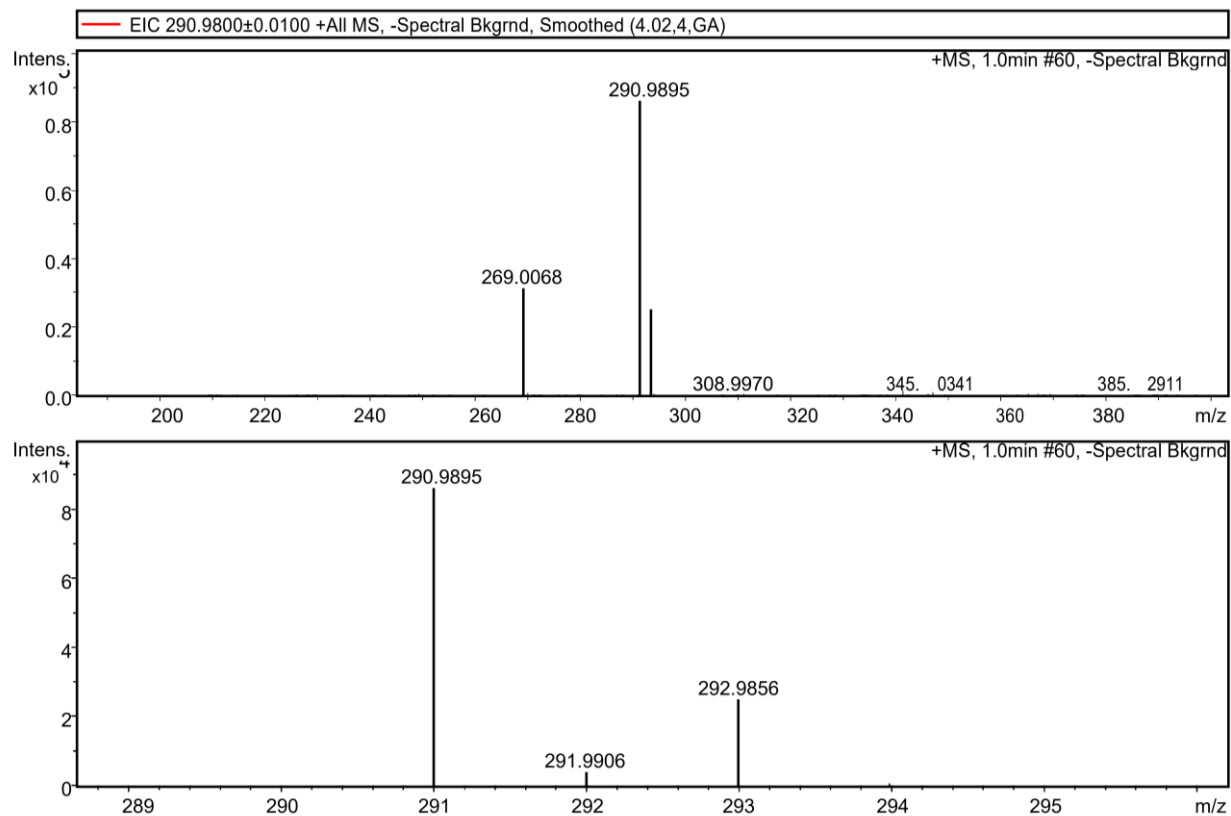


Figure S49. HRMS of 2-((4-chlorophenyl)sulfonyl)phenol (**3r'**)

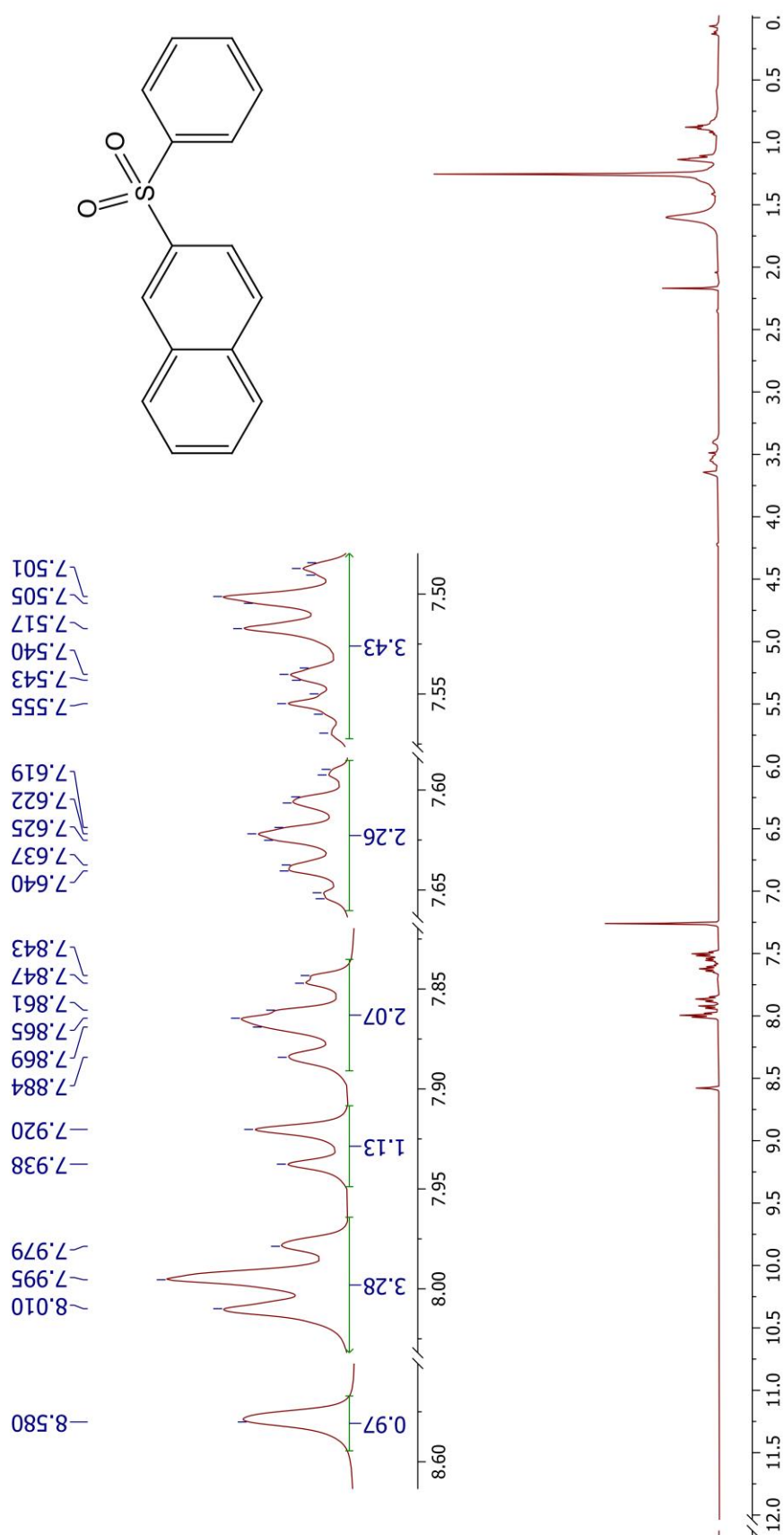


Figure S50. ¹H-NMR of 2-(phenylsulfonyl)naphthalene (**3s'**)

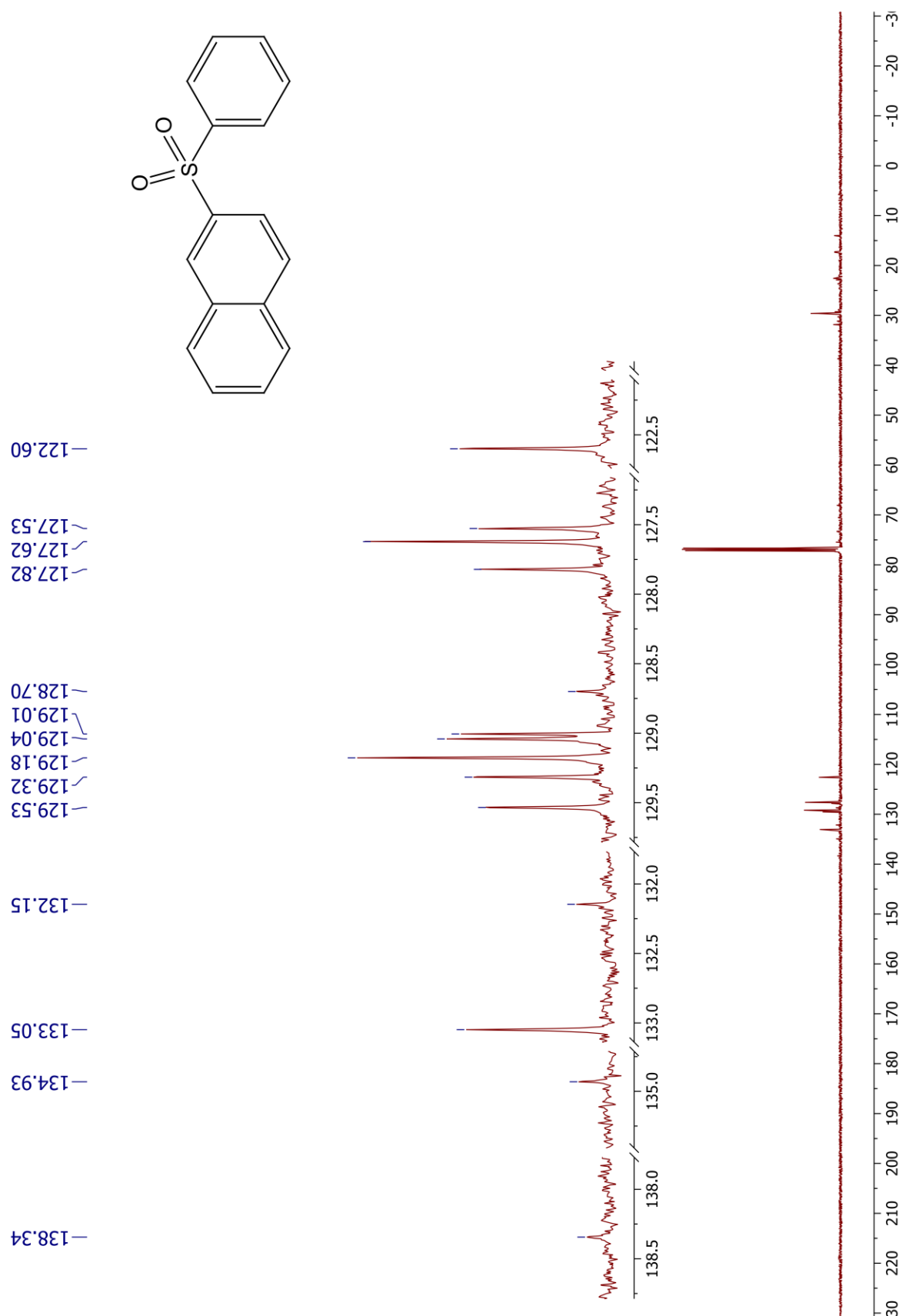


Figure S51. ¹³C-NMR of 2-(phenylsulfonyl)naphthalene (**3s'**)

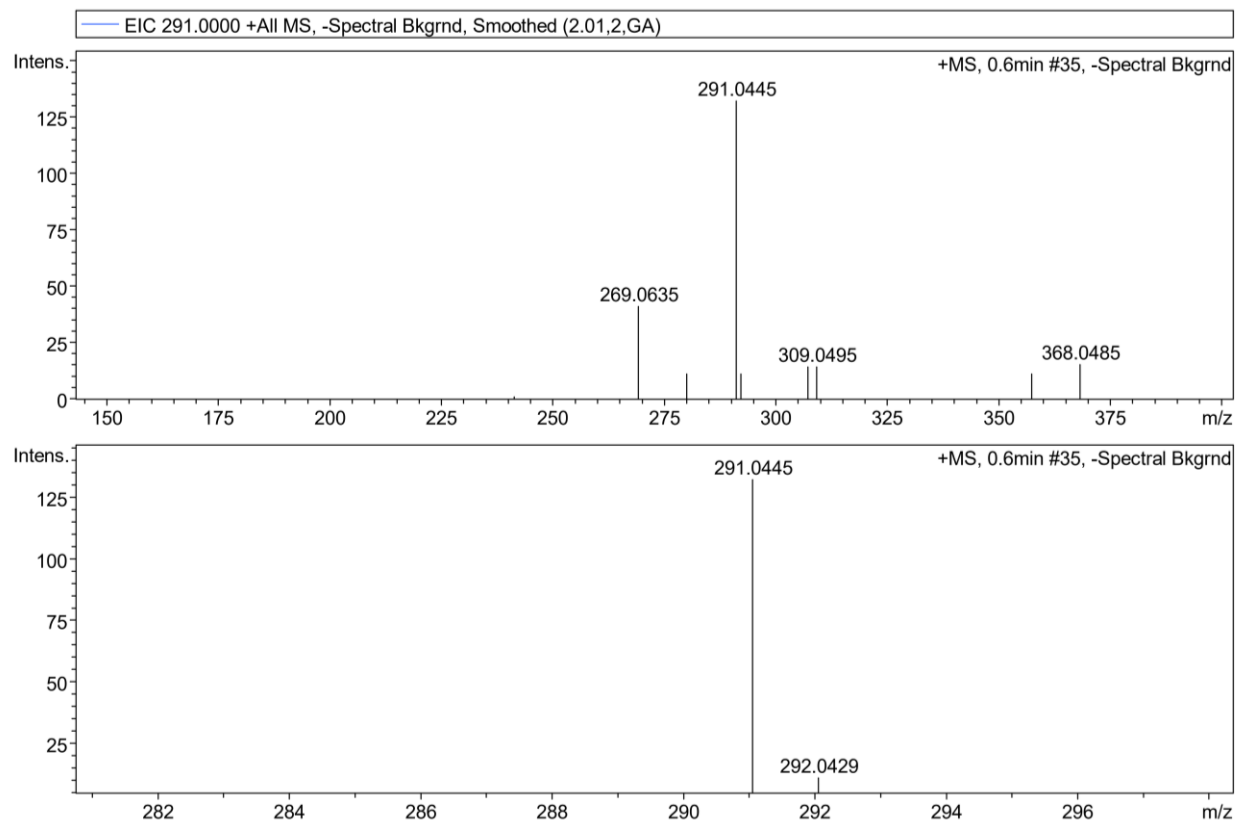


Figure S52. HRMS of 2-(phenylsulfonyl)naphthalene (**3s'**)

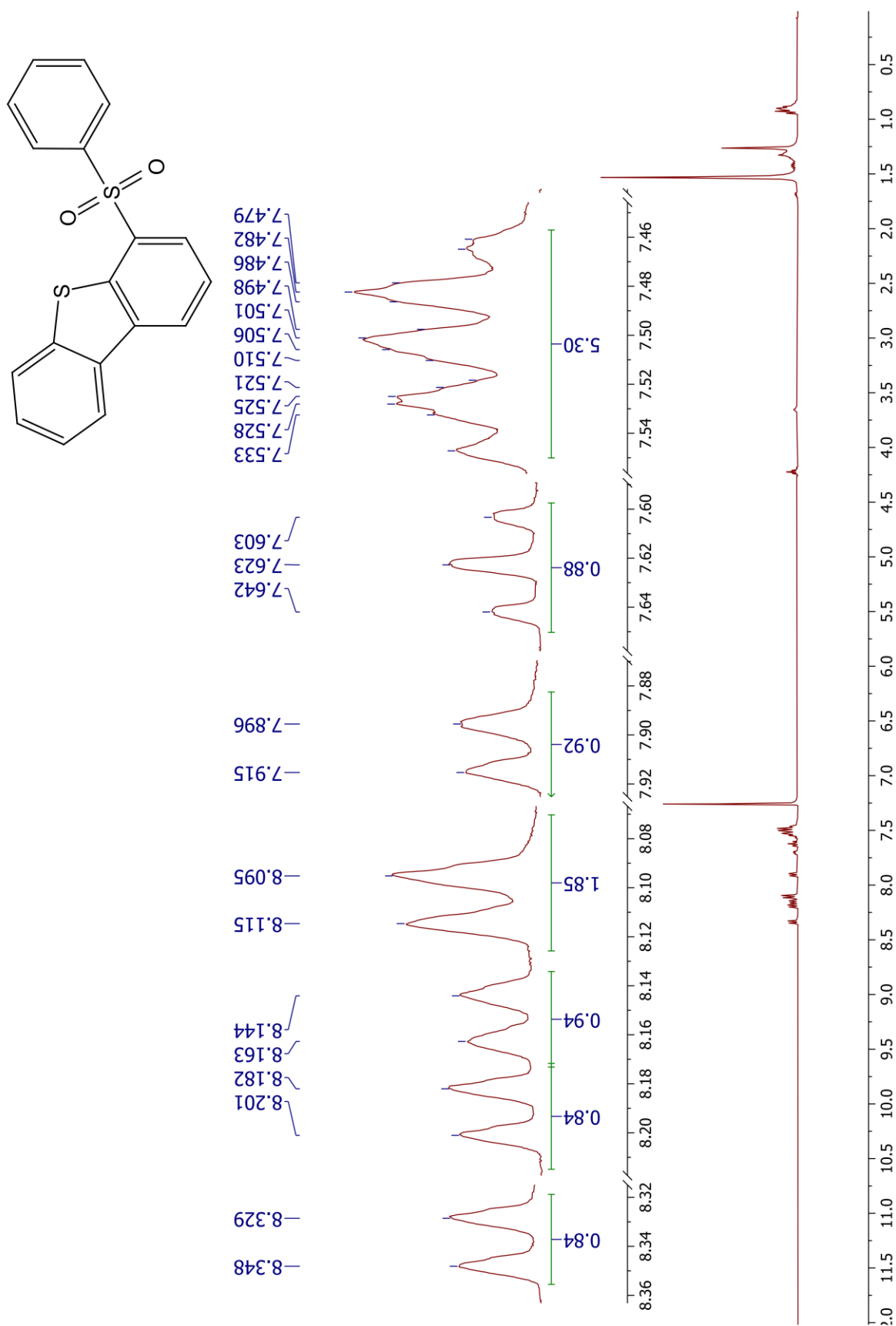


Figure S53. ¹H-NMR of 4-(phenylsulfonyl)dibenzo[b,d]thiophene (**3t'**)

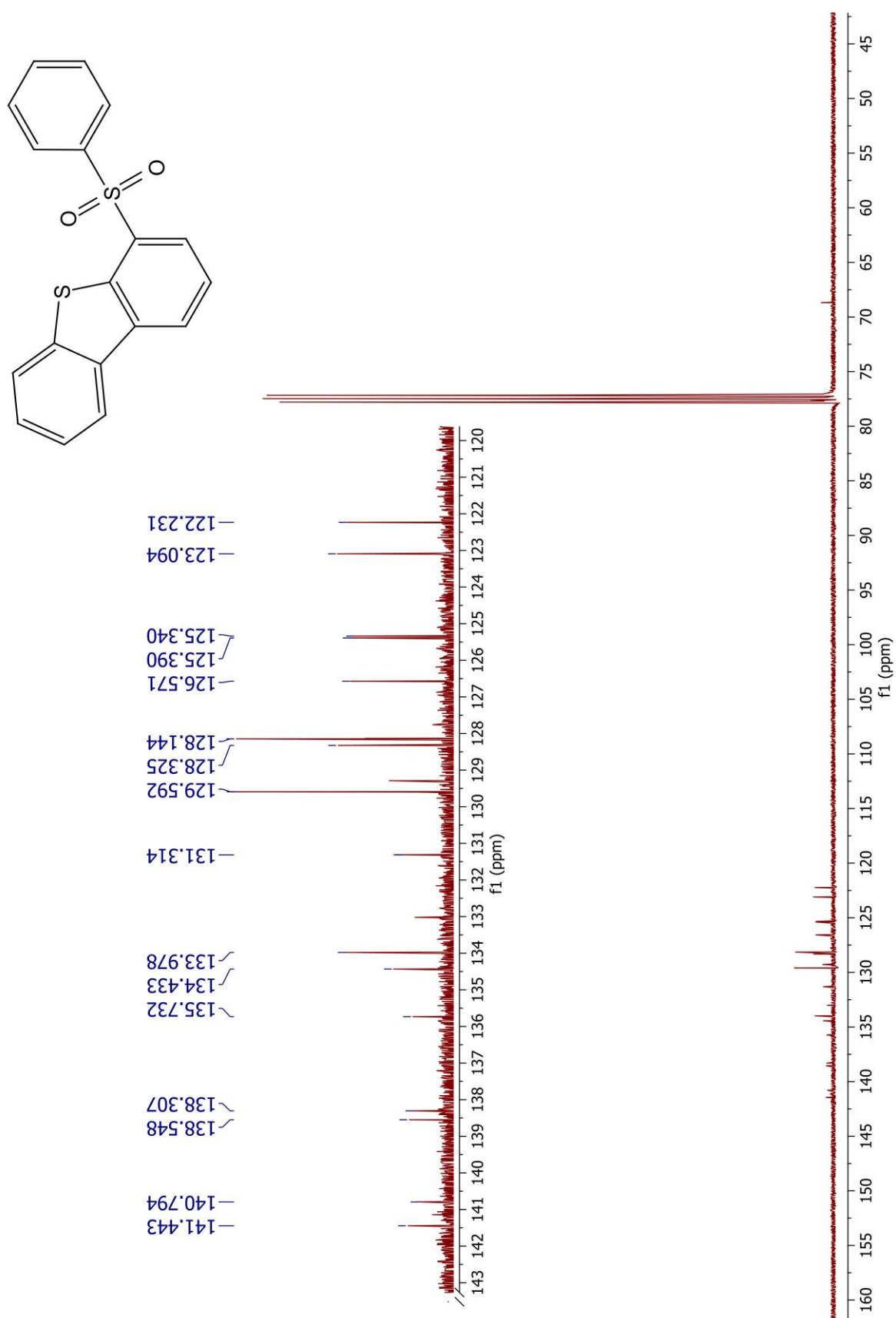


Figure S54. ^{13}C -NMR of 4-(phenylsulfonyl)dibenzo[b,d]thiophene (3t')

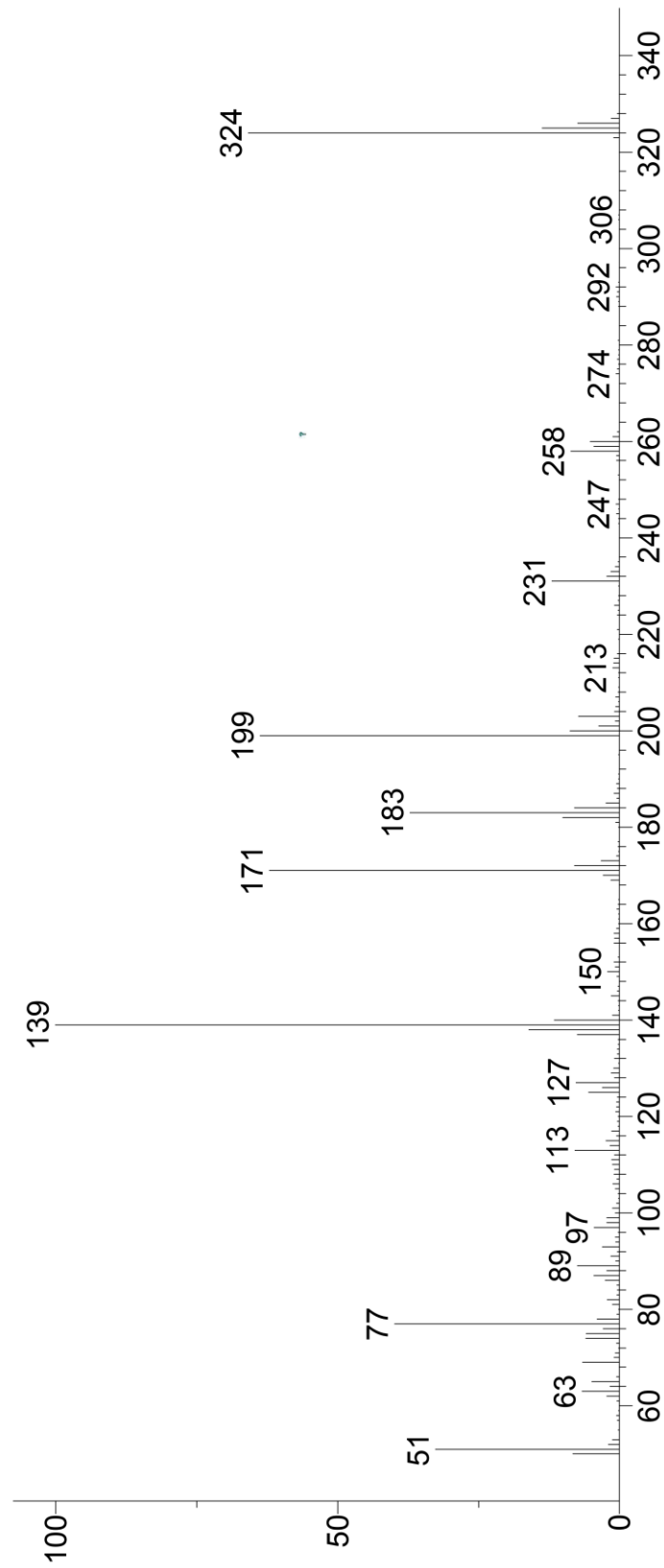


Figure S55. GC-MS of 4-(phenylsulfonyl)dibenzo[b,d]thiophene (**3t'**)

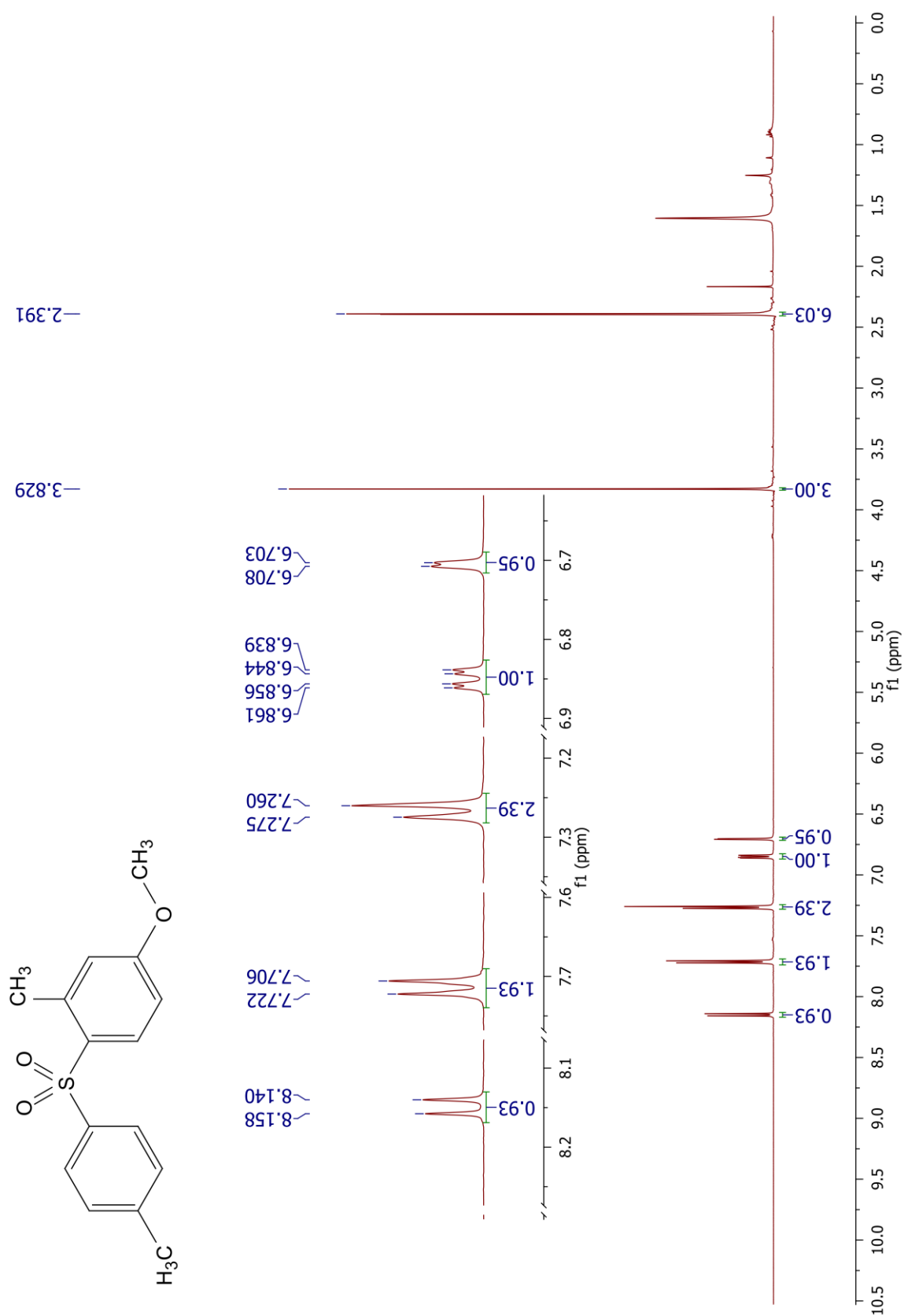


Figure S56. ¹H-NMR of 4-methoxy-2-methyl-1-tosylbenzene (**3v**)

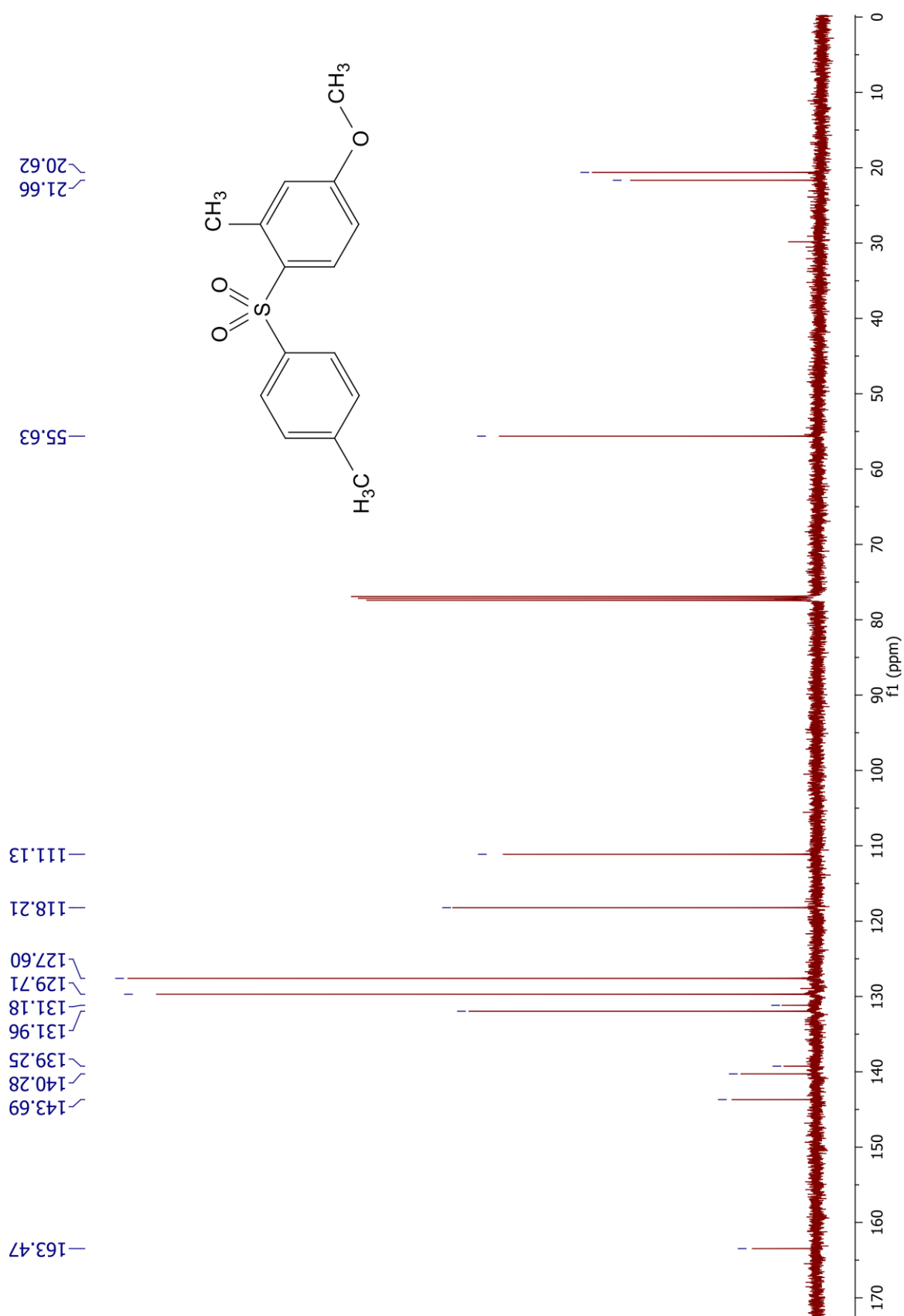


Figure S57. ^{13}C -NMR of 4-methoxy-2-methyl-1-tosylbenzene (3v)

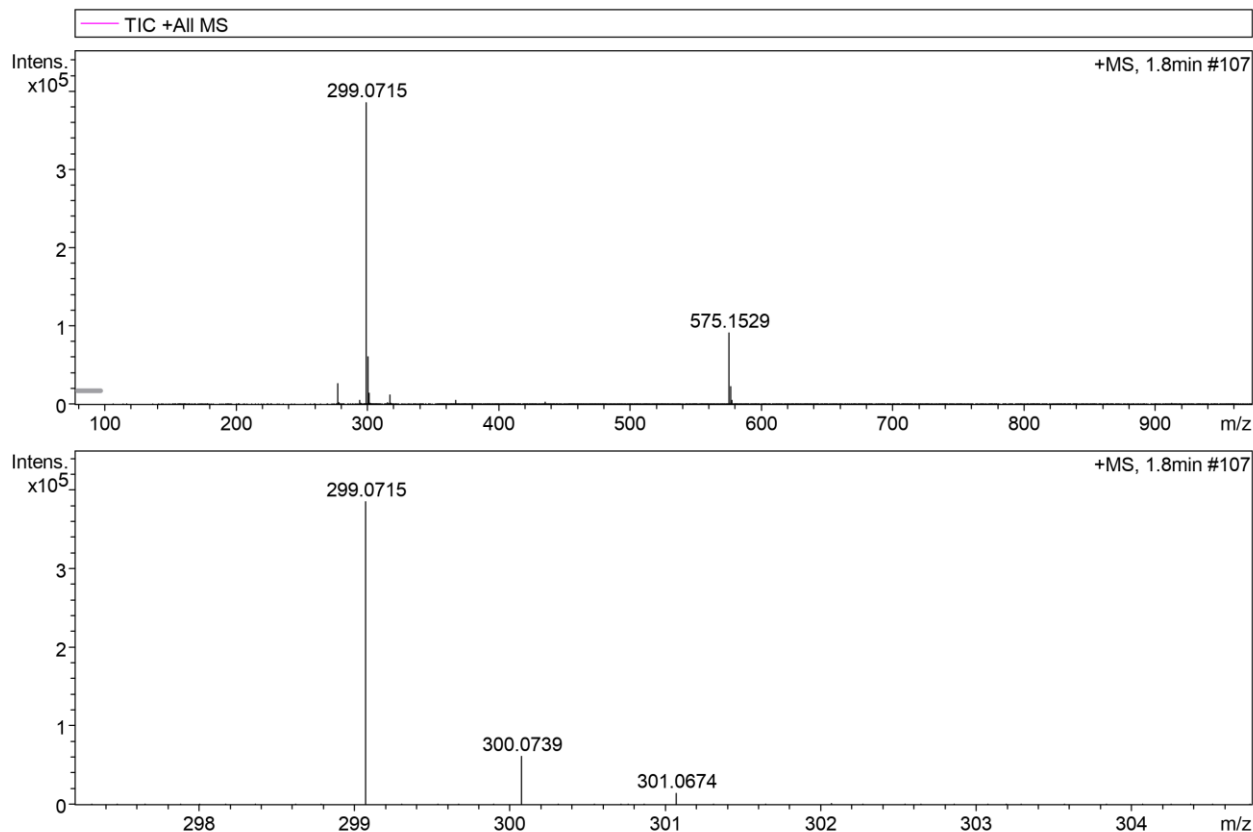


Figure S58. HRMS of 4-methoxy-2-methyl-1-tosylbenzene (**3v**)

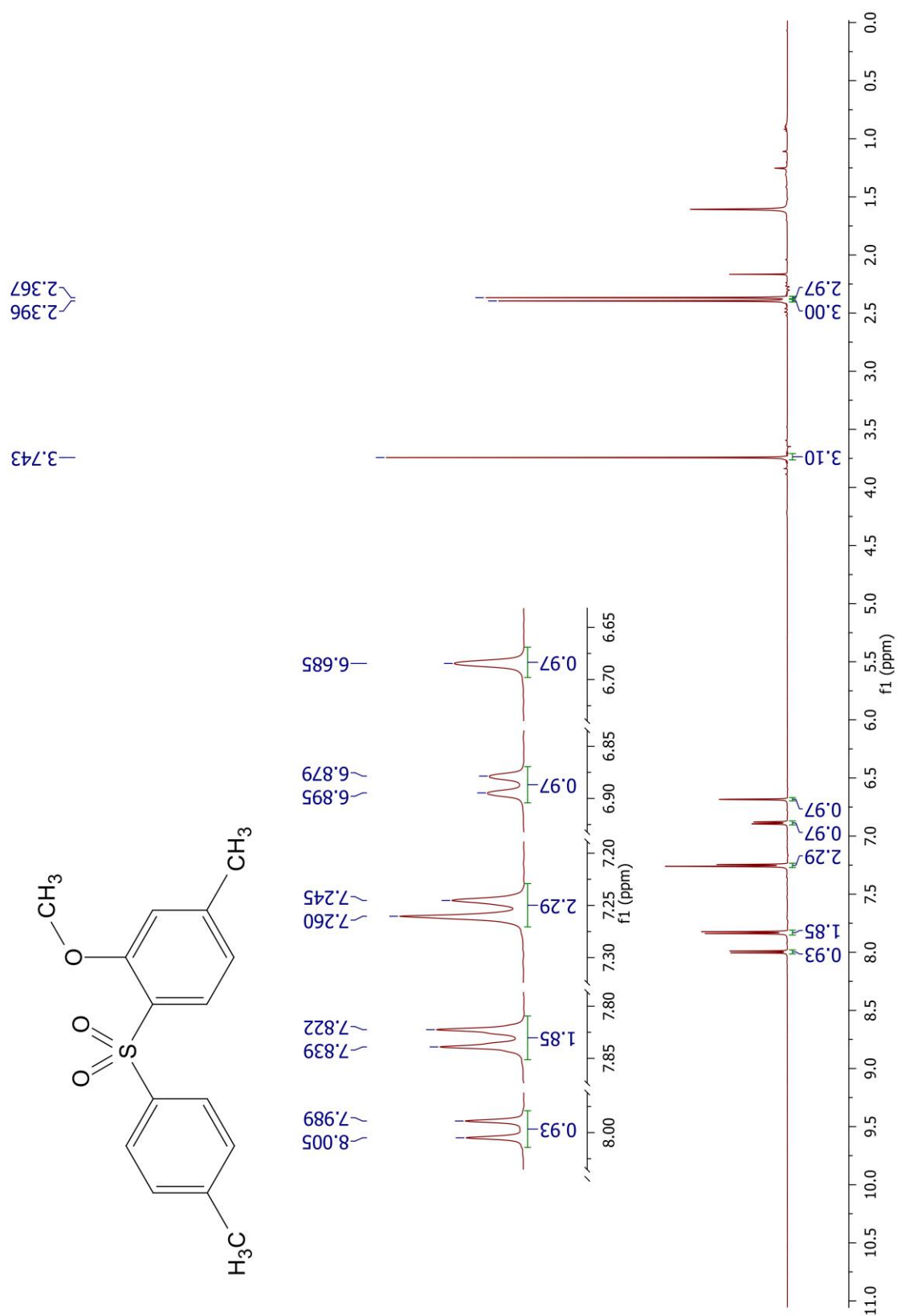


Figure S59. ¹H-NMR of 2-methoxy-4-methyl-1-tosylbenzene (**3v'**)

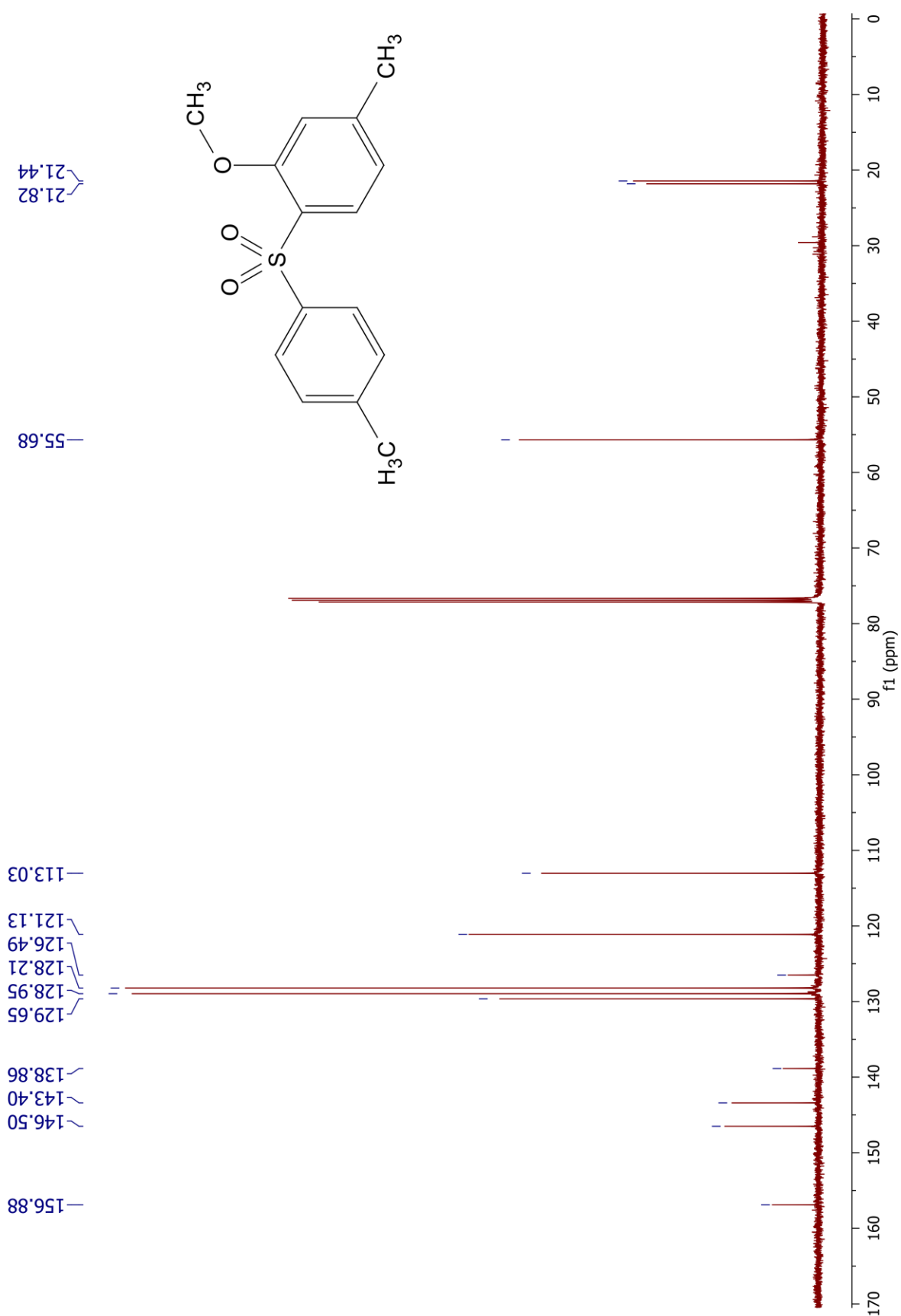


Figure S60. ^{13}C -NMR of 2-methoxy-4-methyl-1-tosylbenzene (3v')

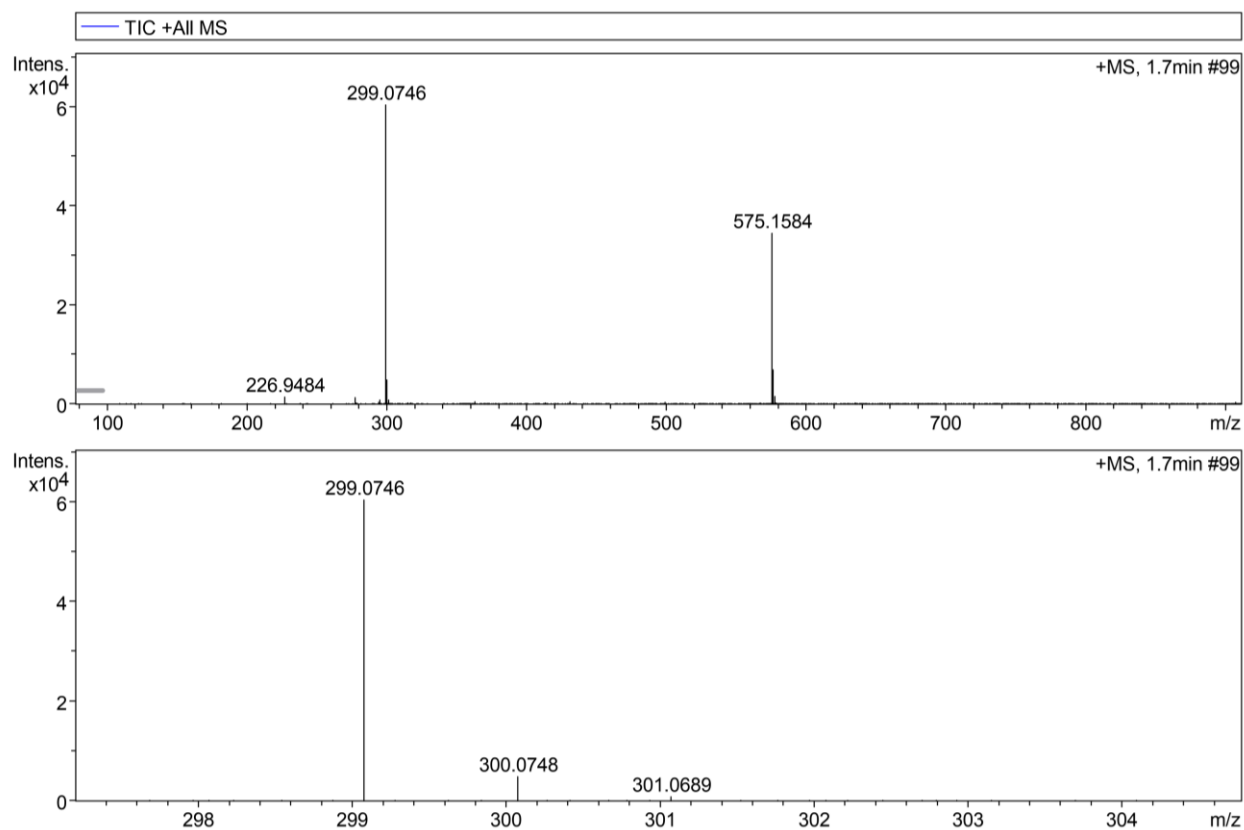


Figure S61. HRMS of 2-methoxy-4-methyl-1-tosylbenzene (**3v'**)

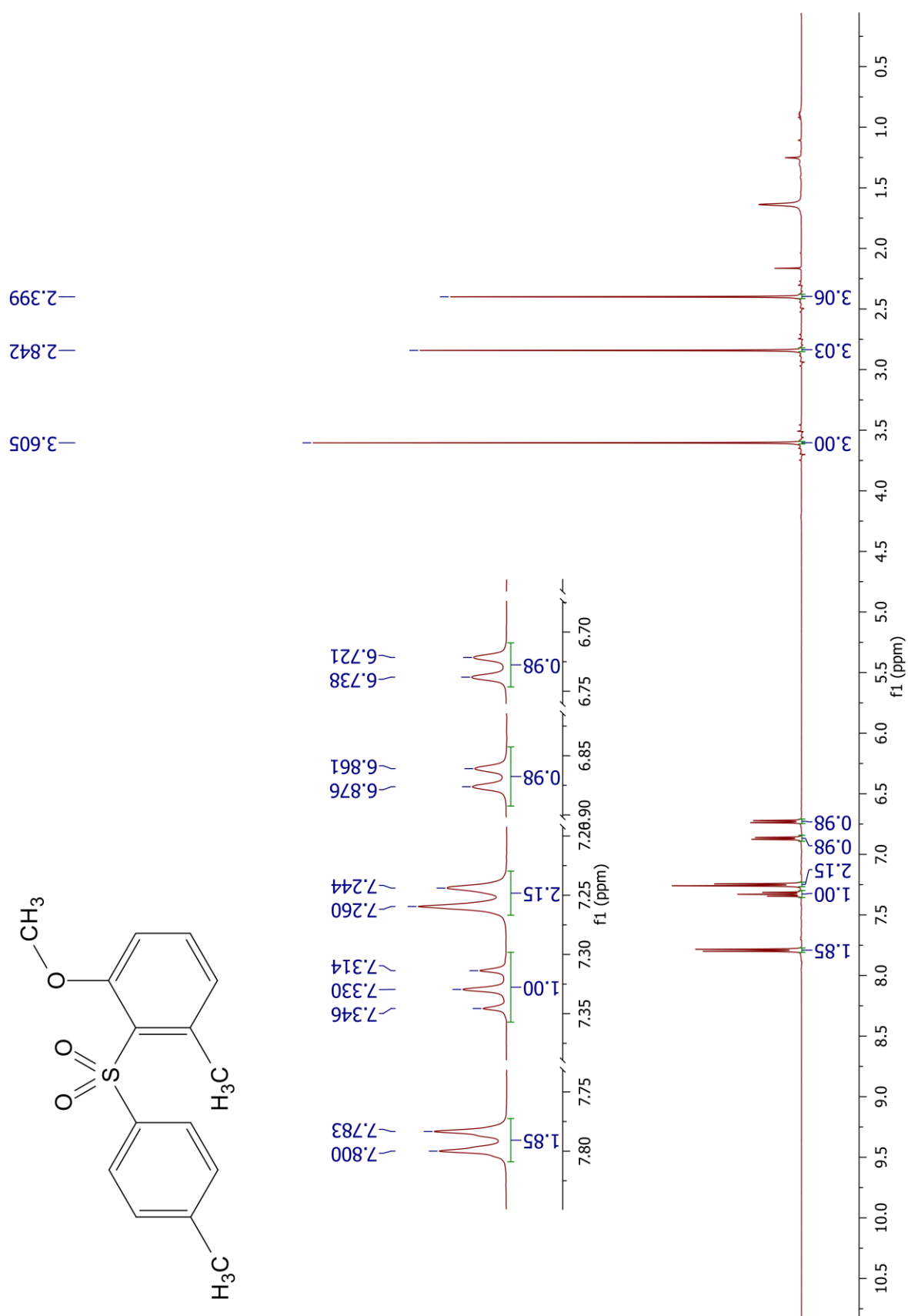


Figure S62. ¹H-NMR of 1-methoxy-3-methyl-1-tosylbenzene (3v'')

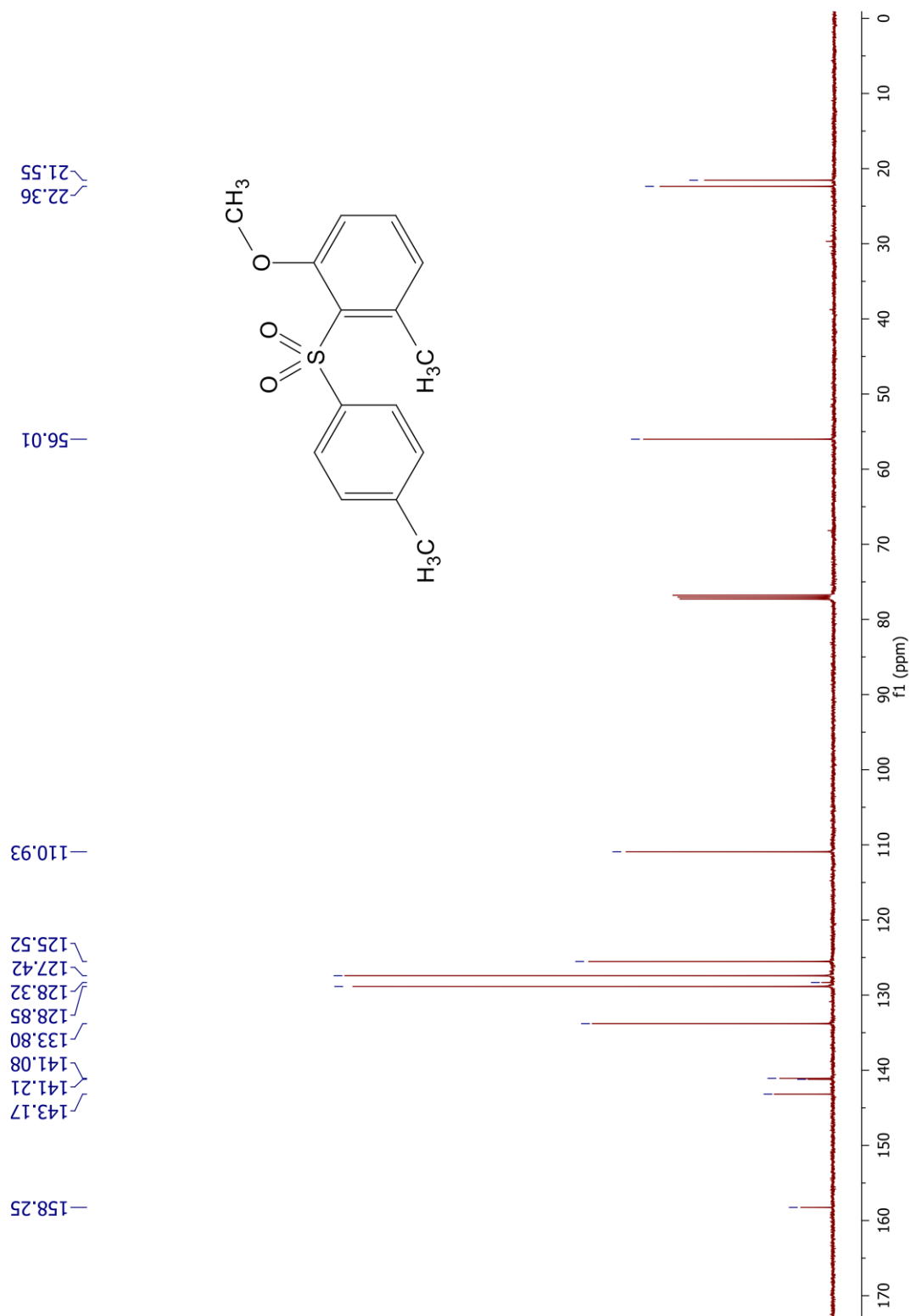


Figure S63. ¹³C-NMR of 1-methoxy-3-methyl-1-tosylbenzene (**3v''**)

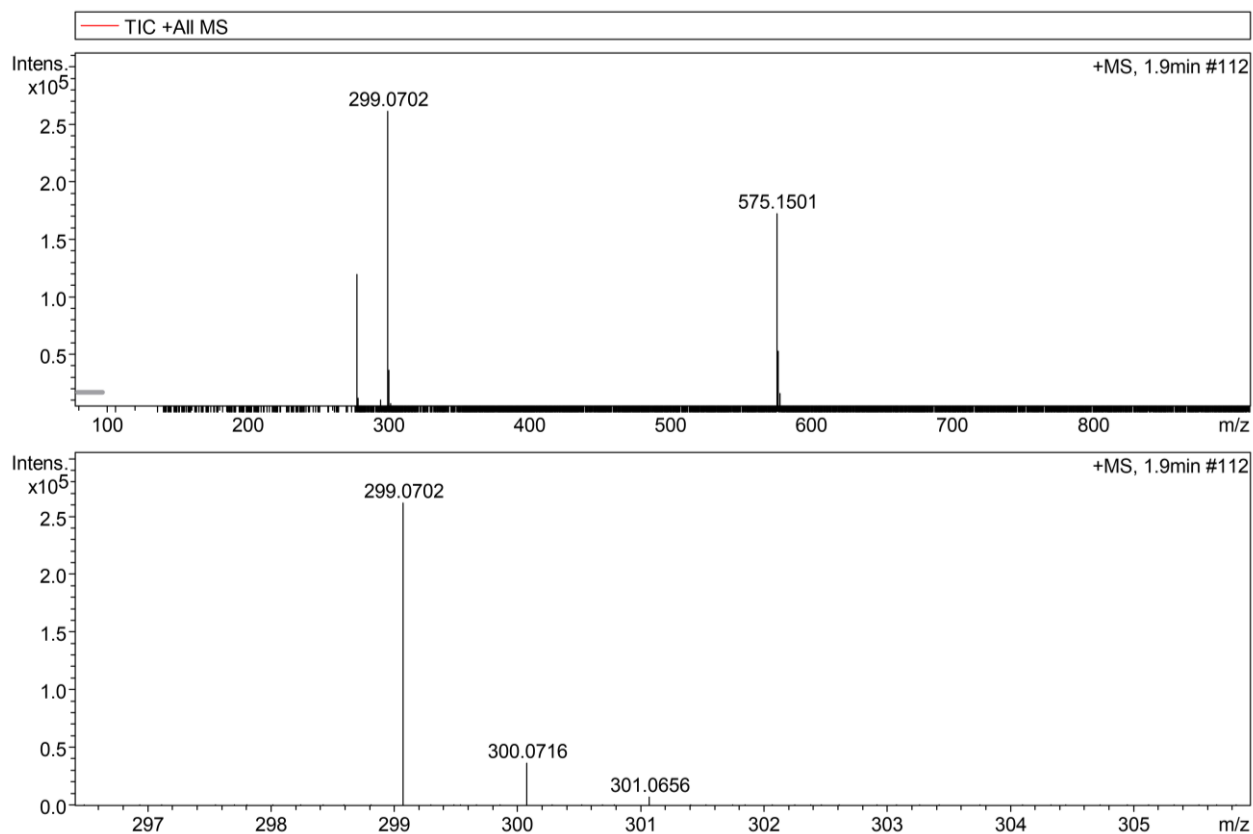


Figure S64. HRMS of 1-methoxy-3-methyl-1-tosylbenzene (**3v''**)

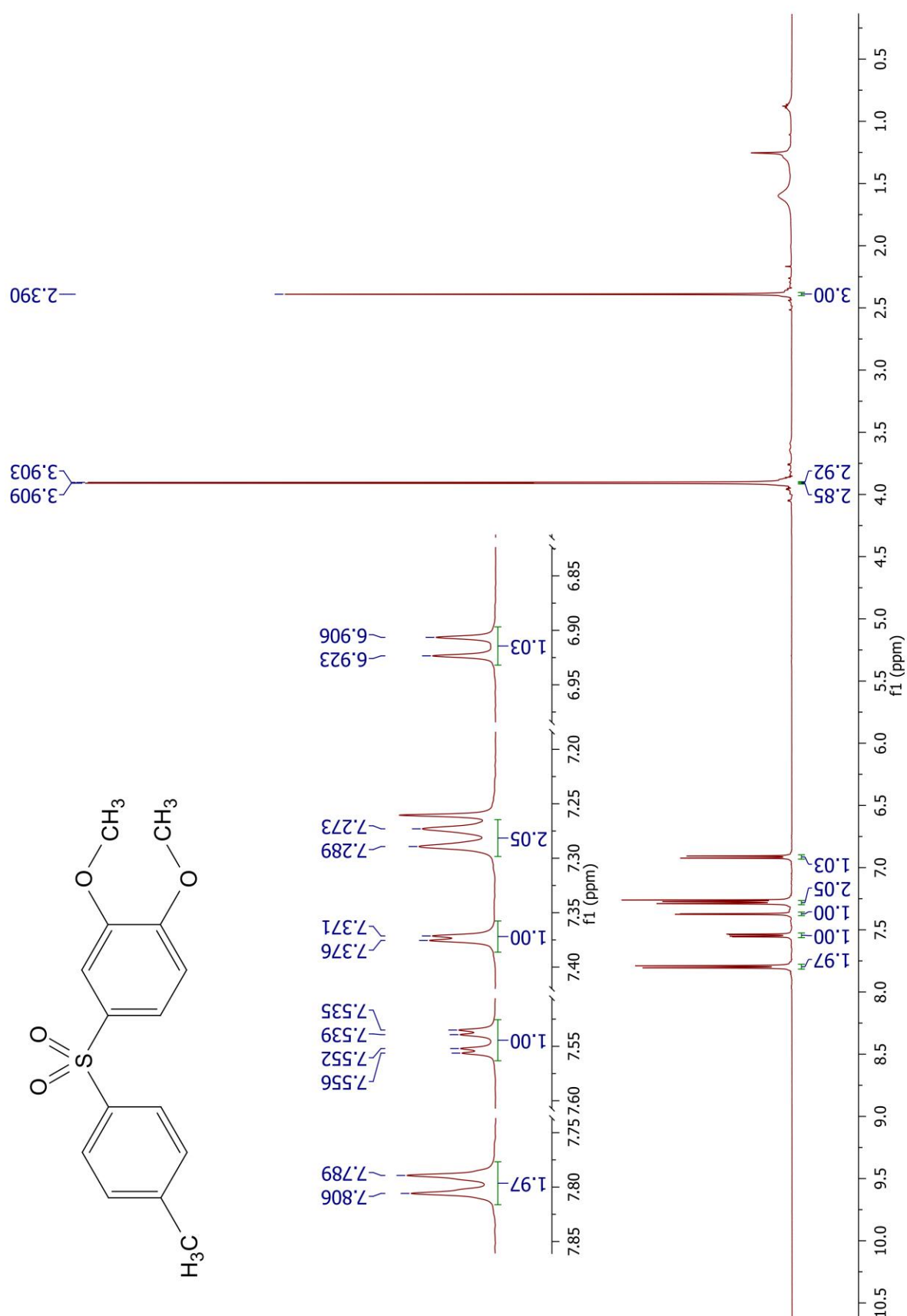


Figure S65. ¹H-NMR of 1,2-dimethoxy-4-tosylbenzene (**3w**)

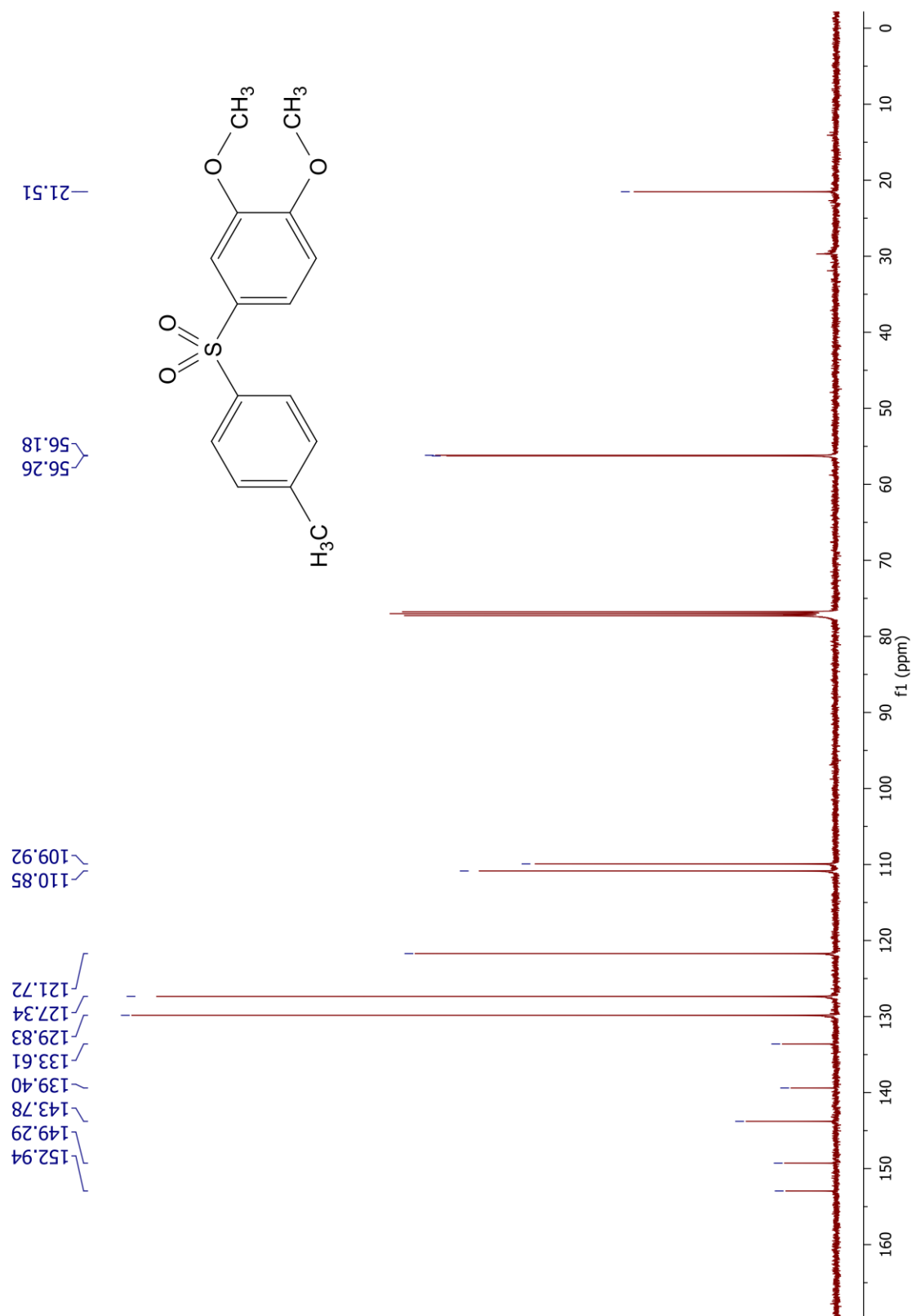
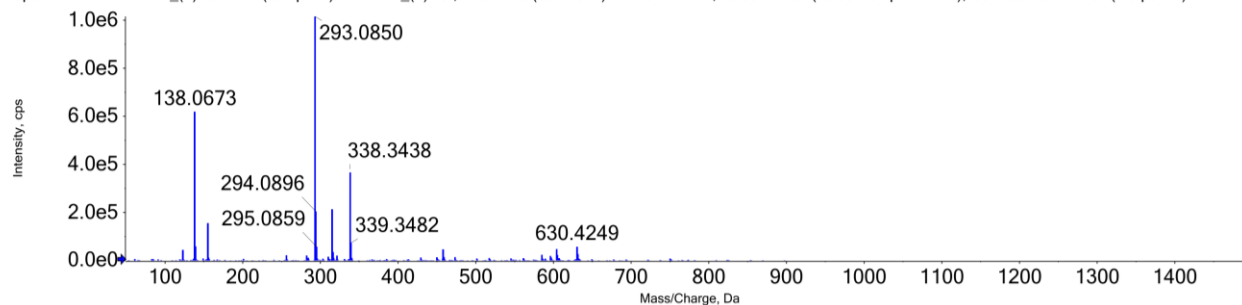


Figure S66. ¹³C-NMR of 1,2-dimethoxy-4-tosylbenzene (3w)

Full mass spectrum

Spectrum from TD12-D_(+)ESI.wiff2 (sample 1) - TD12-D_(+)ESI, +TOF MS (50 - 1500) from 0.148 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)



Expanded spectrum

Spectrum from TD12-D_(+)ESI.wiff2 (sample 1) - TD12-D_(+)ESI, +TOF MS (50 - 1500) from 0.148 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)

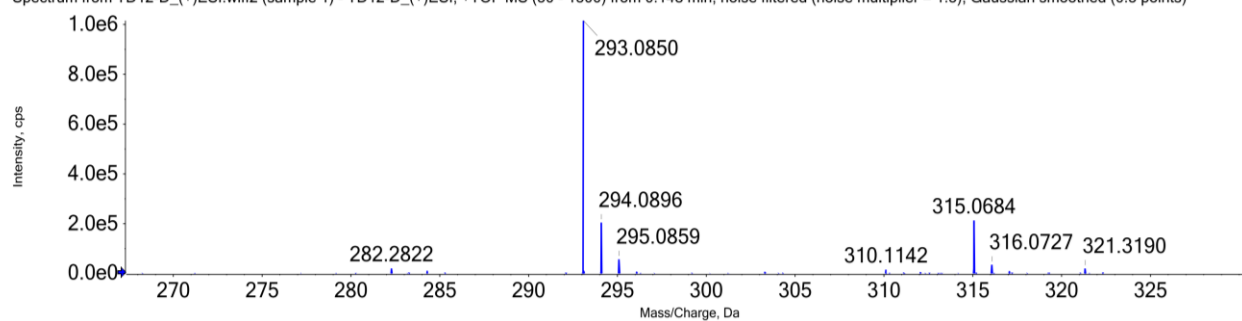


Figure S67. HRMS of 1,2-dimethoxy-4-tosylbenzene (**3w**)

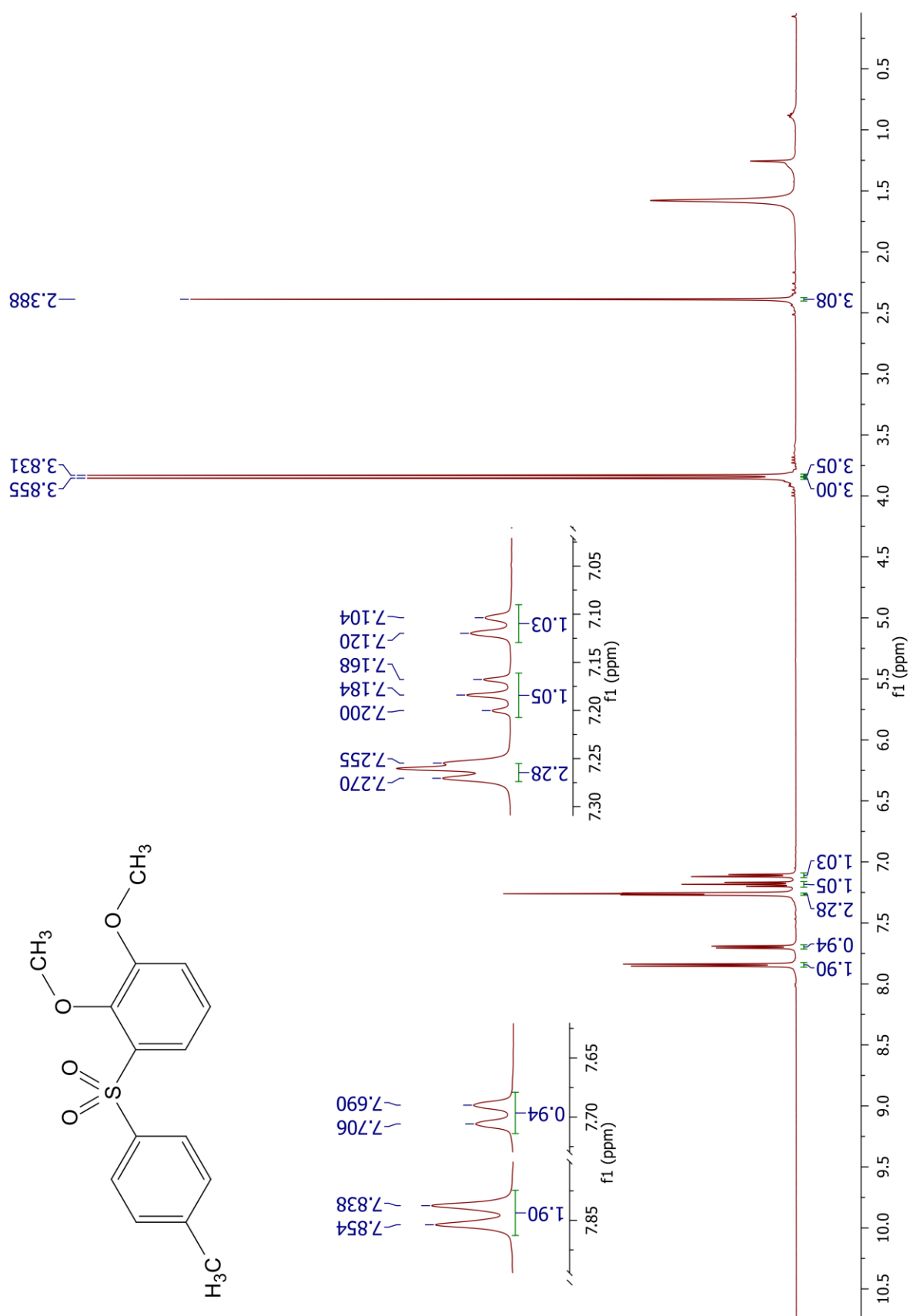


Figure S68. ¹H-NMR of 1,2-dimethoxy-3-tosylbenzene (**3w'**)

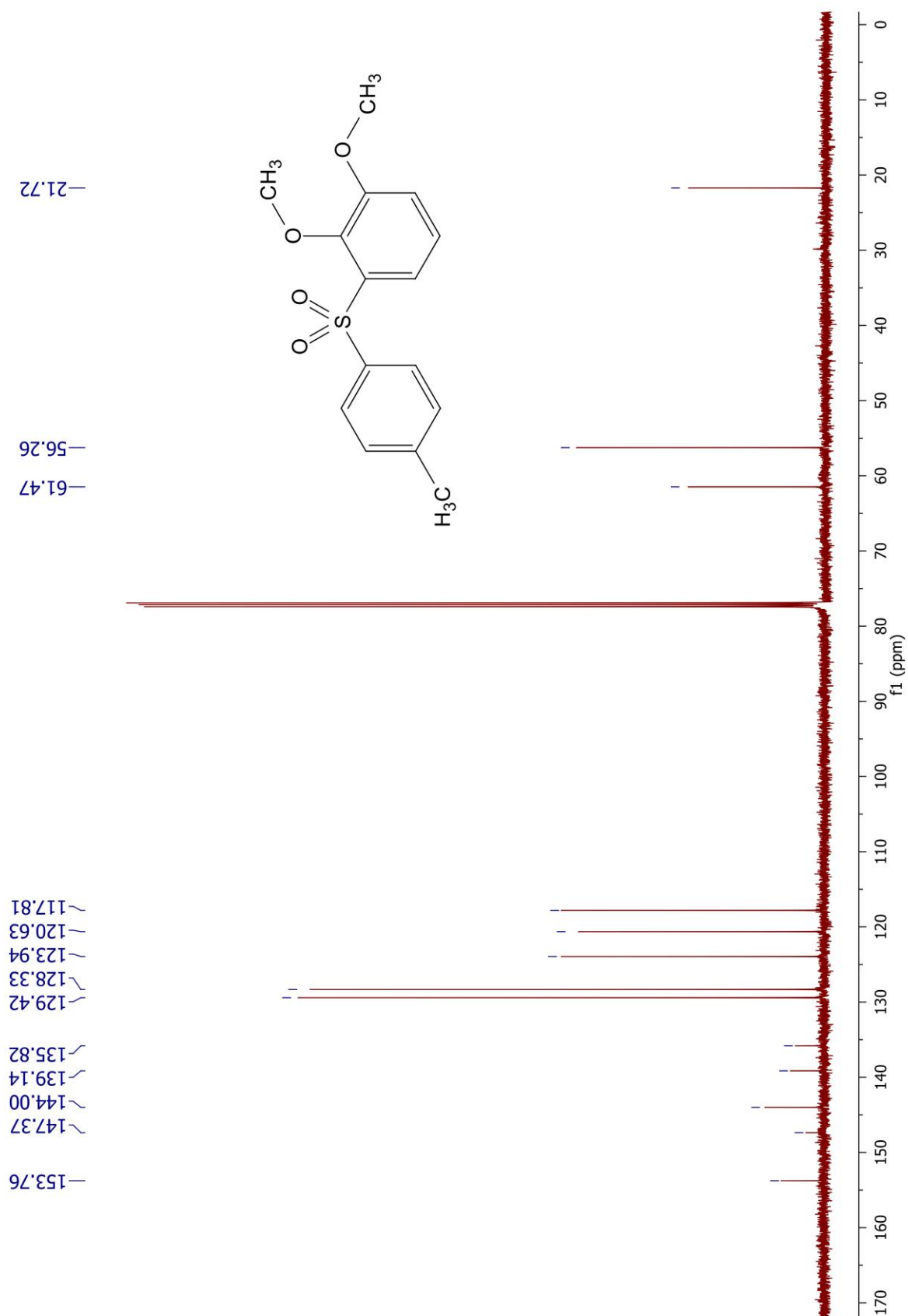
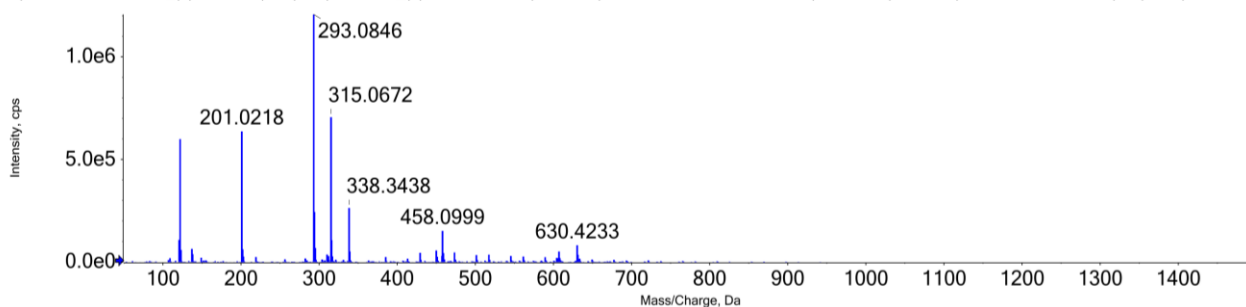


Figure S69. ¹³C-NMR of 1,2-dimethoxy-3-tosylbenzene (**3w'**)

Full mass spectrum

Spectrum from TD12-T_(+).ESI.wiff2 (sample 1) - TD12-T_(+).ESI, +TOF MS (50 - 1500) from 0.148 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)



Expanded spectrum

Spectrum from TD12-T_(+).ESI.wiff2 (sample 1) - TD12-T_(+).ESI, +TOF MS (50 - 1500) from 0.148 min, noise filtered (noise multiplier = 1.5), Gaussian smoothed (0.5 points)

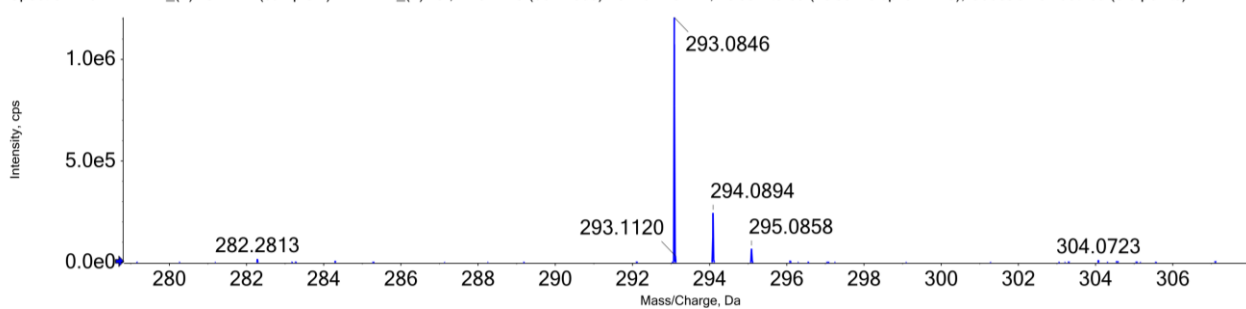


Figure S70. HRMS of 1,2-dimethoxy-3-tosylbenzene (**3w'**)