Organocatalytic enantioselective synthesis of β-amino sulfonic acid derivatives

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Supporting Information

I General information

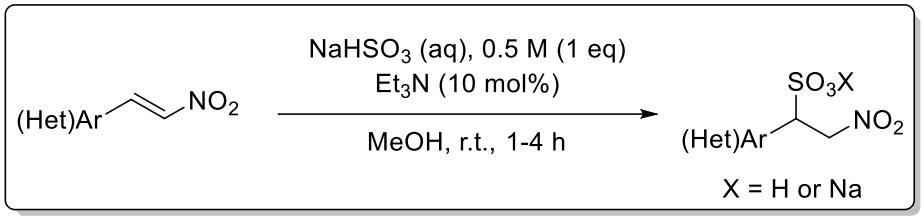
Reactions were performed using oven dried glassware under inert atmosphere of nitrogen. Unless otherwise noted, all reagent-grade chemicals and solvents were obtained from commercial suppliers and were used as received. THF, Toluene, MeCN and CH_2Cl_2 were dried over MBRAUN MB SPS-800 Apparatus. Reactions were monitored by thin-layer chromatography with silica gel 60 F254 pre-coated aluminium plates (0.25 mm). Visualization was performed under UV light, phosphomolybdic acid or $KMnO_4$ oxidation. Chromatographic purification of compounds was achieved with 60 silica gel (40-63 μm). Purification of sulfonic acids was carried out on DOWEX® 50WX8 (H^+) resin (50-100 Mesh). The DOWEX ion exchange resin was always washed and reconditioned (deionized water, then HCl 6M, then deionized water until the filtrate was neutral) prior to first use. Melting points were measured on a WME Köfler hot-stage (Stuart SMP3) and are uncorrected. Infrared spectra (IR) were recorded on a PerkinElmer Spectrum 100 Series FT-IR spectrometer. Liquids and solids were applied on the Single Reflection Attenuated Total Reflectance (ATR) Accessories. Data are reported in cm^{-1}. ^1H Spectra (300 MHz) and ^{13}C NMR spectra (75 MHz) were recorded on a Bruker Avance300. Processing and analysis of the spectra were performed with the Topspin 3.5 software from Bruker on a PC workstation. Data appear in the following order: chemical shifts in ppm which were referenced to the internal solvent signal, number of protons, multiplicity (*s*, singlet; *d*, doublet; *t*, triplet; *q*, quadruplet; *dd*, doublet of doublet, *ddd*, doublet of doublet of doublet, *dt*, doublet of triplet; *ddt*, doublet of doublet of triplet, *td*, triplet of doublet; *tdd*, triplet of doublet of doublet; *m*, multiplet, AB_q, AB system) and coupling constant *J* in Hertz. Chiral HPLC analyses were carried out on a Dionex Ultimate 3000 equipped with an RS pump, an RS autosampler, and an RS diode array detector, controlled with Chromoleon. Accurate Mass measurements (HRMS) were performed by the Mass Spectrometry Laboratory of the University of Rouen and were recorded with a Waters LCP 1er XR spectrometer. Remark: In case of use of ES-OVM HPLC column, a very specific and sensitive column, the retention time could varied from one injection to another. However, when we faced this phenomenon, we have validated the robustness of the methodology by the injection of a premix of racemic and

enantioenriched mixture leading in all cases to the only two peaks of each enantiomers. The Takemoto type catalyst was prepared according to a literature procedure.[1]

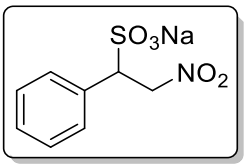
[1] Wang, P.; Li, H.-F.; Zhao, J.-Z.; Du, Z.-H.; Da, C.-S., Organocatalytic Enantioselective Cross-Aldol Reaction of o-Hydroxyarylketones and Trifluoromethyl Ketones. *Org. Lett.* **2017**, *19*, 2634.

II Experimental procedures

II.1 Synthesis of racemic sulfonic acids

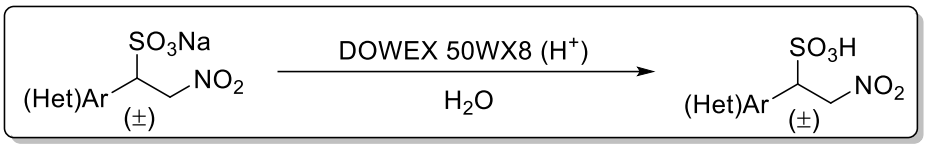


General procedure for racemic products. An aqueous solution of sodium bisulfite (3 mL, C = 0.5 M, 1 eq) was added dropwise to a stirred solution of the appropriate nitrovinylarene (1.5 mmol, 1 eq) and Et_3N (150 µmol, 21 µL, 10 mol%) in MeOH (7.5 mL). The mixture was vigorously stirred 1-4h, until complete disappearance of the starting material. The reaction media was filtered on a pad of cotton and concentrated *in vacuo*. The crude material was either solubilized in a small volume of deionized water (MeOH for products **(±)-2m**), eluted with deionized water (product was followed with pH paper) on a pad of DOWEX® 50WX8 (H^+) (60 eq) and the filtrate was evaporated *in vacuo* to yield the desired nitrosulfonic acid; or solubilized in a 3/1 mixture of MeOH/acetone at room temperature and carefully precipitated from Et_2O at 0 °C to yield the desired sodium nitrosulfonate. *Remark:* In the same deuteriated solvent (in this study, DMSO-d_6), a nitrosulfonic acid and its conjugate base (sodium sulfonate) have the exact same chemical shifts in all cases. The only major difference lies in the presence of a large broad singlet due do the presence of residual water (hydration) after ion exchange resin in the case of a sulfonic acid.



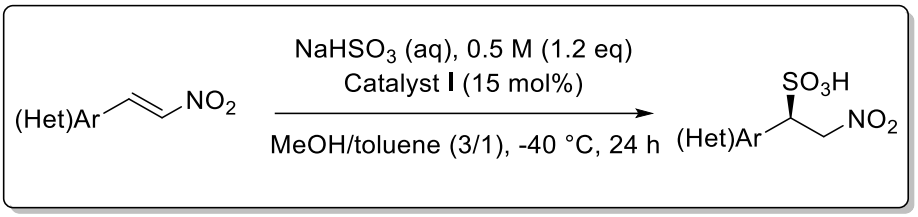
As an exemple for the synthesis of Sodium 2-nitro-1-phenylethane-1-sulfonate **2a-Na$^+$** from (*E*)-(2-nitrovinyl)benzene (223.7 mg, 1.5 mmol) and isolated according to general procedure making use of the Et_2O based precipitation to yield a colorless solid (65%, 247 mg), m.p. = 223-225 °C. ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 7.65 – 6.93 (m, 5H), 5.20 (dd, J = 13.4, 5.1 Hz, 1H), 4.92 (dd, J = 13.4, 10.2 Hz, 1H), 4.33 (dd, J = 10.3, 5.1 Hz, 1H); ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 135.5 (C_q), 129.0 (CH), 127.8 (CH), 127.3 (CH), 77.6 (CH_2), 63.0 (CH) ppm; IR (ATR) 3026, 2962,

1570, 1548, 1385, 1248, 1205, 1188, 1058, 700, 628, 596 cm^{-1}; HRMS calcd for $[M]^-$ $C_8H_8NO_5S$ 230.0129 found 230.0122. HPLC analysis: ES-OVM, 1 $mL.min^{-1}$, 30 °C, KH_2PO_4(aq) (20 mM)/ACN (99/1), UV 205 nm, *t* = 9.7 min; *t* = 11.5 min. Remark : In the same eluting conditions (column, flow rate, T°, solvent ratios), sulfonic acids and their conjugate bases, sodium sulfonates, have the same retention times by HPLC analysis in buffered aqueous media.



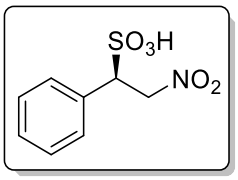
The appropriate sodium nitrosulfonate (3 mmol) was solubilized in a minimum amount of water and eluted on a pad of DOWEX® 50WX8 (H^+) (60 eq). The filtrate was eluted with water, concentrated *in vacuo*, and thoroughly dried to yield the desired nitrosulfonic acid. Remark: In the same deuteriated solvent (for instance DMSO-d_6), a nitrosulfonic acid and its conjugate base (sodium sulfonate) have the same chemical shifts. The only major difference lies in the presence of a large broad singlet due do the presence of residual water (hydration) after ion exchange resin in the case of a sulfonic acid.

II.2 Synthesis of enantioenriched sulfonic acids

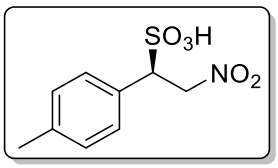


General procedure for enantioenriched products. The appropriate nitrovinylarene (0.5 mmol, 1 eq) and catalyst **3g** (34 mg, 75 µmol, 15 mol%) in a MeOH/toluene mixture (3/1, 5 mL) were cooled to -40 °C and vigorously stirred for 30 min. An aqueous solution of sodium bisulfite (1.2 mL, C = 0.5 M, 1.2 eq) was slowly added dropwise. The biphasic mixture was vigorously stirred for 24h, until complete disappearance of the starting material. The reaction media was concentrated *in vacuo*. The crude was (**general procedure A**) solubilized in water (or a 1/1 MeOH/H_2O mixture) and eluted on a pad of DOWEX® 50WX8 (H^+-60 eq). The filtrate was concentrated *in vacuo* and dried overnight to yield the desired enantioenriched nitrosulfonic acid or zwitterion. On the other hand, the crude product could be (**general procedure B**)

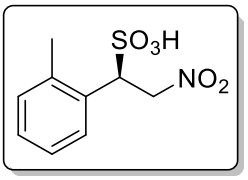
partitioned between water and DCM. The aqueous layer was washed once with DCM and concentrated *in vacuo* to yield the desired enantioenriched sodium nitrosulfonate **2l** for instance. Remark: this family of products tend to be rather hygroscopic, should be kept under a humidity-free environnement and dryed under P2O5 beforehand.



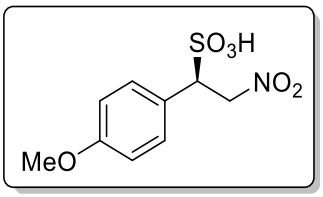
2-nitro-1-phenylethane-1-sulfonic acid (2a). Synthesized from (E)-(2-nitrovinyl)benzene (76 mg, x mmol) and isolated according to **general procedure A**. Light beige (99%, 116 mg). Similarly, the reaction was performed from 224 mg (1.5 mmol) of (E)-(2-nitrovinyl)benzene to give **2a** in 98% yield (m = 341 mg). m.p. = 89-91 °C. ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 7.65 – 6.93 (m, 5H), 5.69 (bs, SO_3H), 5.20 (dd, *J* = 13.4, 5.1 Hz, 1H), 4.92 (dd, *J* = 13.4, 10.2 Hz, 1H), 4.33 (dd, *J* = 10.3, 5.1 Hz, 1H); ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 135.5 (C_q), 129.0 (CH), 127.8 (CH), 127.3 (CH), 77.6 (CH_2), 63.0 (CH) ppm; IR (ATR) 3027, 2959, 1559, 1139, 1041, 698 cm^{-1} ; HRMS calcd for [M-H]$^-$ $C_8H_8NO_5S$ 230.0129 found 230.0115. HPLC analysis (95% ee): ES-OVM, 1 mL.min^{-1}, 15 °C, KH_2PO_4(aq) (20 mM)/EtOH (90/10), UV 205 nm, t_{major} = 29.9 min; t_{min} = 35,0 min.



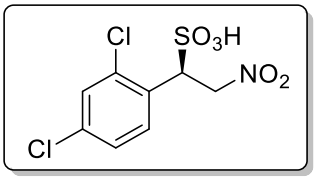
2-Nitro-1-(p-tolyl)ethane-1-sulfonic acid (2b). Synthesized from (*E*)-1-methyl-4-(2-nitrovinyl)benzene (81.6, 0,5 mmol) and isolated according to **general procedure A**. Brown oil (82%, 100 mg). ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 7.22 (d, *J* = 8.0 Hz, 2H), 7.08 (d, *J* = 7.9 Hz, 2H), 5.46 (bs, SO_3H), 5.18 (dd, *J* = 13.3, 5.0 Hz, 1H), 4.87 (dd, *J* = 13.3, 10.4 Hz, 1H), 4.28 (dd, *J* = 10.4, 5.1 Hz, 1H), 2.26 (s, 3H); ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 136.5 (C_q), 132.4 (C_q), 128.9 (CH), 128.4 (CH), 77.7 (CH_2), 62.7 (CH), 20.8 (CH_3); IR (ATR) 3387, 3033, 2921, 1555, 1375, 1144, 1034, 608, 502 cm^{-1}; HRMS calcd for [M-H]$^-$ $C_9H_{10}NO_5S$ 244.0285 found 244.0273. HPLC analysis (93% ee): ES-OVM, 1 mL.min^{-1}, 15 °C, KH_2PO_4(aq) (20 mM)/EtOH (90/10), UV 205 nm, t_{min} = 20,9 min; t_{major} = 25.1 min.



2-Nitro-1-(o-tolyl)ethane-1-sulfonic acid (2c). Synthesized from (*E*)-1-methyl-2-(2-nitrovinyl)benzene (93.2 mg, 0.57 mmol) and isolated according to **general procedure A**. Brown oil (81%, 114 mg). ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 7.38 (q, J = 2.9, 2.5 Hz, 1H), 7.12 (d, J = 3.1 Hz, 3H), 6.07 (bs, SO_3H), 5.21 (dd, J = 13.6, 5.2 Hz, 1H), 4.94 (dd, J = 13.5, 10.1 Hz, 1H), 4.70 (dd, J = 10.1, 5.0 Hz, 1H), 2.36 (s, 3H); ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 137.6 (C_q), 133.9 (C_q), 130.0 (CH), 127.1(CH), 127.0 (CH), 125.7 (CH), 77.6 (CH_2), 57.9 (CH), 19.6 (CH_3); IR (ATR) 3022, 2961, 1555, 1375, 1128, 1031, 975, 592 cm^{-1}; HRMS calcd for [M-H]$^-$ $C_9H_{10}NO_5S$ 244.0285 found 244.0279. HPLC analysis (96% ee): Chiralpak QN-AX, 0.5 mL.min^{-1}, 25 °C, MeOH/AcOH/NH_4OAc (98/2/0.5, v/v/w), UV 254 nm, t_{major} = 12.7 min; t_{min} = 14.5 min.

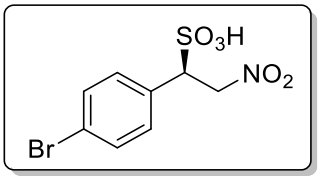


1-(4-methoxyphenyl)-2-nitroethane-1-sulfonic acid (2d). Synthesized from (*E*)-1-methoxy-4-(2-nitrovinyl)benzene (89 mg, 0.5 mmol) and isolated according to **general procedure A**. Brown oil (99%, 130 mg). ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 7.26 (d, J = 8.6 Hz, 2H), 6.84 (d, J = 8.6 Hz, 2H), 5.20 (bs, SO_3H), 5.17 (dd, J = 13.2, 5.1 Hz, 1H), 4.85 (dd, J = 13.2, 10.5 Hz, 1H), 4.27 (dd, J = 10.4, 5.0 Hz, 1H), 3.72 (s, 3H) – *due to overlapping with water pic some signal are described with regard to sodium sulfonate compound*; ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 158.6 (C_q), 130.1 (CH), 127.4 (C_q), 113.3 (CH), 77.8 (CH_2), 62.4 (CH), 55.1 (CH_3); IR (ATR) 3364, 2971, 2896, 1547, 1512, 1142, 1037, 850, 608 cm^{-1}; HRMS calcd for [M-H]$^-$ $C_9H_{10}NO_6S$ 260.0234 found 260.0221. HPLC analysis (95% ee): ES-OVM, 1 mL.min^{-1}, 15 °C, KH_2PO_4(aq) (20 mM)/EtOH (95/5), UV 205 nm, t_{min} = 53,1 min; t_{major} = 38,6 min.

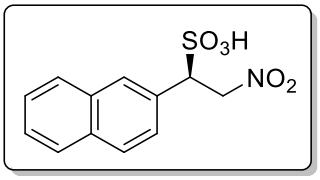


1-(2,4-Dichlorophenyl)-2-nitroethane-1-sulfonic acid (2e). Synthesized from (*E*)-2,4-dichloro-1-(2-nitrovinyl)benzene (109 mg, 0.5 mmol) and isolated according to **general procedure A**.

Light brown oil (96%, 144 mg). ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 7.70 – 7.55 (m, 1H), 7.40 (dd, J = 8.5, 2.3 Hz, 2H), 5.70 (bs, SO_3H), 5.28 – 5.14 (m, 1H), 5.02 – 4.90 (m, 2H); ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 135.6 (C_q), 132.9 (C_q), 132.8 (C_q), 130.6 (CH), 128.7 (CH), 127.3 (CH), 77.3 (CH_2), 57.8 (CH); IR (ATR) 3387, 2971, 1724, 1557, 1157, 1035, 606 cm^{-1} ; HRMS calcd for [M-H]$^-$ $C_8H_6Cl_2NO_5S$ 297.9349 found 297.9345. HPLC analysis (86% ee): QN-AX, 1 mL.min^{-1}, 25 °C, ACN/NH_4OOCH(aq) (0.2 M, pH = 2.5) (9/1), UV 201 nm, t_{major} = 41.9 min; t_{min} = 44.8 min.

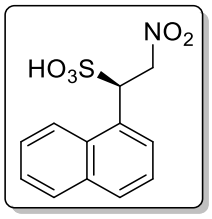


1-(4-bromophenyl)-2-nitroethane-1-sulfonic acid (2f). Synthesized from (*E*)-1-bromo-4-(2-nitrovinyl)benzene (114 mg, 0.5 mmol) and isolated according to **general procedure A**. Light brown oil (99%, 153 mg). ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 7.49 (d, J = 8.4 Hz, 2H), 7.34 (d, J = 8.4 Hz, 2H), 5.26 (bs, SO_3H), 5.22 (dd, J = 13.6, 5.1 Hz, 1H), 4.97 (dd, J = 13.6, 10.3 Hz, 1H), 4.40 (dd, J = 10.2, 5.1 Hz, 1H) – *due to overlapping with water pic and some signal the NMR of sodium sulfonate compound is also provided*; ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 135.0 (C_q), 131.3 (CH), 130.8 (CH), 120.7 (C_q), 77.2 (CH_2), 62.3 (CH) ; IR (ATR) 3388, 2971, 2906, 1554, 1147, 1036, 1009, 707, 597 cm^{-1} ; HRMS calcd for [M-H]$^-$ $C_8H_7NO_5SBr$ 307.9234 found 307.9227. HPLC analysis (93% ee): ES-OVM, 1 mL.min^{-1}, 15 °C, KH_2PO_4(aq) (20 mM)/ACN (90/10), UV 205 nm, t_{min} = 28,4 min; t_{major} = 39,2 min.

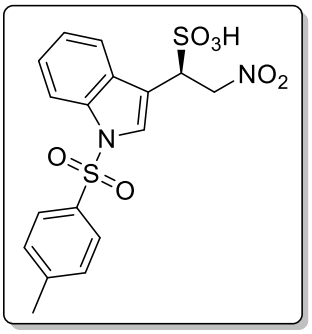


1-(naphthalen-2-yl)-2-nitroethane-1-sulfonic acid (2g). Synthesized from (*E*)-2-(2-nitrovinyl)naphthalene (99.6 mg, 0.5 mmol) and isolated according to **general procedure A**. beige solid (99%, 139 mg), m.p. = 90-92 °C. ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 7.95 – 7.79 (m, 4H), 7.62 – 7.41 (m, 3H), 5.97 (bs, SO_3H), 5.29 (dd, J = 13.4, 5.0 Hz, 1H), 5.08 (dd, J = 13.5, 10.3 Hz, 1H), 4.52 (dd, J = 10.3, 5.0 Hz, 1H); ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 133.2 (C_q), 132.7 (C_q), 132.4 (C_q), 127.8 (CH), 127.7 (CH), 127.4 (CH), 127.2 (CH), 127.1 (CH), 126.0 (CH), 125.9 (CH), 77.6 (CH_2), 63.2 (CH); IR (ATR) 3340, 3038, 2962, 1540, 1239, 1128, 1035, 751, 655, 602, 477 cm^{-1}; HRMS calcd for [M-H]$^-$ $C_{12}H_{10}NO_5S$ 280.0285 found 280.0272. HPLC analysis (92% ee): ES-

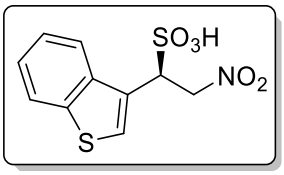
OVM, 1 mL.min^{-1}, 15 °C, KH_2PO_4(aq) (20 mM)/EtOH (80/20), UV 205 nm, t_{major} = 52,1 min; t_{min} = 62.0 min.



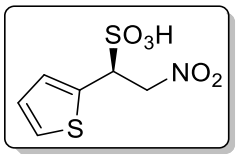
1-(naphthalen-1-yl)-2-nitroethane-1-sulfonic acid (2h). Synthesized from (*E*)-1-(2-nitrovinyl)naphthalene (99 mg, 0.5 mmol) and isolated according to **general procedure A**. Dark brown oil (82%, 115 mg). ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 8.22 (d, J = 8.3 Hz, 1H), 7.91 (dd, J = 8.2, 1.3 Hz, 1H), 7.84 (d, J = 8.2 Hz, 1H), 7.69 (d, J = 7.2 Hz, 1H), 7.52 (m, 3H), 6.09 (bs, SO_3H), 5.46 – 5.33 (m, 2H), 5.19 – 5.08 (m, 1H); ^{13}C NMR (75 MHz, DMSO) δ_C 133.4 (C_q), 132.3 (C_q), 131.9 (C_q), 128.5 (CH), 127.7 (CH), 126.2 (CH), 125.5 (CH), 125.2 (CH), 123.9 (CH), 78.0 (CH_2), 56.7 (CH); IR (ATR) 3373, 3053, 2926, 1554, 1142, 1031, 773, 650, 591 cm^{-1}; HRMS calcd for [M-H]$^-$ $C_{12}H_{10}NO_5S$ 280.0285 found 280.0273. HPLC analysis (88% ee): ES-OVM, 1 mL.min^{-1}, 10 °C, KH_2PO_4(aq) (20 mM)/ACN (80/20), UV 205 nm, t_{min} = 6.8 min; t_{major} = 8.0 min.



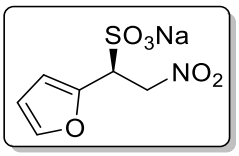
2-Nitro-1-(1-tosyl-1H-indol-3-yl)ethane-1-sulfonic acid (2i). Synthesized from (*E*)-3-(2-nitrovinyl)-1-tosyl-1*H*-indole (85.6 mg, 0.25 mmol) and isolated according to **general procedure A**. Dark brown deliquescent solid (94%, 100 mg). ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 7.88 – 7.75 (m, 4H), 7.72 – 7.67 (m, 1H), 7.39 – 7.19 (m, 4H), 5.88 (bs, SO_3H), 5.22 (dd, J = 13.4, 5.3 Hz, 1H), 5.05 (dd, J = 13.4, 9.7 Hz, 1H), 4.66 (dd, J = 9.7, 5.3 Hz, 1H), 2.31 (s, 3H) ppm; ^{13}C NMR (75 MHz, DMSO) δ_C 145.4 (C_q), 134.1 (C_q), 134.0 (C_q), 130.4 (C_q), 130.2 (CH), 126.7 (CH), 125.1 (CH), 124.6 (CH), 123.1 (CH), 121.0 (CH), 117.7 (C_q), 112.8 (CH), 77.2 (CH_2), 54.7 (CH), 21.0 (CH_3); IR (ATR) 3118, 3019, 2953, 1571, 1549, 1263, 1198, 1058, 698, 632, 599, 517 cm^{-1} ; HRMS calcd for [M-H]$^-$ $C_{17}H_{15}N_2O_7S_2$ 423.0326 found 423.0327. HPLC analysis (81% ee): Chiralpak QN-AX, 0.5 mL.min^{-1}, 25 °C, MeOH/AcOH/NH_4OAc (98/2/0.5, v/v/w), UV 254 nm, t_{major} = 19.2 min; t_{min} = 20.7 min.



1-(Benzo[b]thiophen-3-yl)-2-nitroethane-1-sulfonic acid (2j). Synthesized from (*E*)-3-(2-nitrovinyl)benzo[*b*]thiophene (103 mg, 0.5 mmol) and isolated according to **general procedure A**. Dark brown visquous oil (99%, 142 mg). ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 7.99 – 7.88 (m, 2H), 7.74 (s, 1H), 7.47 (bs, SO_3H), 7.47 – 7.29 (m, 2H), 5.30 (dd, J = 13.6, 5.3 Hz, 1H), 5.08 (dd, J = 13.6, 9.7 Hz, 1H), 4.91 (dd, J = 9.6, 5.3 Hz, 1H); ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 139.1 (C_q), 139.0 (C_q), 130.6 (C_q), 124.7 (CH), 124.3 (CH), 124.0 (CH), 122.6 (CH), 122.5 (CH), 77.5 (CH_2), 56.3 (CH); IR (ATR) 3405, 3101, 1711, 1556, 1378, 1161, 1041, 760, 580 cm^{-1}; HRMS calcd for [M-H]$^-$ $C_{10}H_8NO_5S_2$ 285.9849 found 285.9843. HPLC analysis (76% ee): Chiralpak QN-AX, 0.5 mL.min^{-1}, 25 °C, MeOH/AcOH/NH_4OAc (98/2/0.5, v/v/w), UV 254 nm, t_{min} = 23.9 min; t_{major} = 25.4 min.

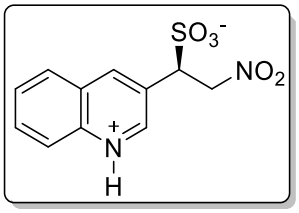


2-nitro-1-(thiophen-2-yl)ethane-1-sulfonate (2k). Synthesized from (*E*)-2-(2-nitrovinyl)thiophene (77 mg, 0.5 mmol) and isolated according to **general procedure A**. Deliquescent dark brown oil (98%, 116 mg). ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 7.40 (d, J = 5.1 Hz, 1H), 7.00 (d, J = 3.4 Hz, 1H), 6.44 (bs, SO_3H), 6.93 (dd, J = 5.0, 3.6 Hz, 1H), 5.21 (dd, J = 13.2, 4.8 Hz, 1H), 4.77 (dd, J = 13.2, 10.1 Hz, 1H), 4.60 (dd, J = 10.1, 4.8 Hz, 1H) ppm; ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 137.3 (C_q), 127.0 (CH), 1263 (CH), 125.7 (CH), 78.7 (CH_2), 58.7 (CH); IR (ATR) 3119, 3019, 2953, 1573, 1549, 1386, 1265, 1242, 1200, 1064, 854, 698, 633, 610, 572, 518 cm^{-1}; IR (ATR) 3391, 3105, 1708, 1554, 1145, 1032, 707 cm^{-1}; HRMS calcd for [M]$^-$ $C_6H_6NO_5S_2$ 235.9693 found 235.9680. HPLC analysis (85% ee): chiralpak AGP, 0.7 mL.min-1, 25 °C, NH_4OAc (aq) (10 mM, pH = 4)/iPrOH (85/15), UV 233 nm, t_{min} = 7.0 min; t_{major} = 8.7 min.

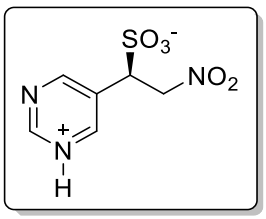


Sodium 1-(furan-2-yl)-2-nitroethane-1-sulfonate (2l). Synthesized from (*E*)-2-(2-nitrovinyl)furane (69.6 mg, 0.5 mmol) and isolated according to **general procedure B** to yield

the untitled product (91%, 110 mg, 87% ee). Reprecipitation from MeOH/acetone solution with Et_2O at 0 °C led to a light beige deliquescent solid (57%, 69 mg, 94% ee), $T_{decomp.}$ estimated = 209-211 °C. ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 7.55 (d, J = 1.7 Hz, 1H), 6.40 – 6.38 (m, 1H), 6.35 – 6.34 (m, 1H), 5.14 (dd, J = 13.8, 5.0 Hz, 1H), 4.90 (dd, J = 13.8, 10.1 Hz, 1H), 4.48 (dd, J = 10.1, 5.0 Hz, 1H). ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 149.2 (C_q), 142.5 (CH), 110.7 (CH), 108.2 (CH), 75.7 (CH_2), 57.1 (CH); IR (ATR) 3025, 2963, 1574, 1551, 1268, 1244, 1216, 1068, 740, 664, 593, 523 cm^{-1} ; HRMS calcd for $[M]^-$ $C_6H_6NO_6S$ 219.9921 found 219.9918. HPLC analysis (94% ee): chiralpak AGP, 0.7 mL.min-1, 25 °C, NH_4OAc (aq) (10 mM, pH = 4)/iPrOH (85/15), UV 215 nm, t_{min} = 5.3 min; t_{major} = 5.9 min.

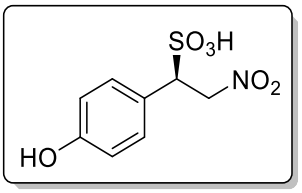


Nitro-1-(quinolin-1-ium-3-yl)ethane-1-sulfonate (2m). Synthesized from (*E*)-3-(2-nitrovinyl)quinoline (100 mg, 0.5 mmol) and isolated according to **general procedure A**. Off-white solid (78%, 110 mg), m.p. = 245-247 °C. ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 9.51 (d, J = 2.0 Hz, 1H), 9.29 (s, 1H), 8.34 (d, J = 8.2 Hz, 1H), 8.21 (d, J = 8.5 Hz, 1H), 8.12 (t, J = 7.7 Hz, 1H), 7.95 (t, J = 7.6 Hz, 1H), 5.38 (m, 2H), 4.93 (dd, J = 9.2, 5.6 Hz, 1H); ^{13}C NMR (75 MHz, DMSO) δ_C 146.7 (CH), 144.4 (CH), 137.1 (C_q), 134.2 (CH), 131.1 (C_q), 129.8 (CH), 128.9 (CH), 127.9 (C_q), 121.3 (CH), 75.3 (CH_2), 59.5 (CH) ppm; IR (ATR) 3560, 3078, 2159, 2029, 1557, 1383, 1184, 1037, 646 cm^{-1}; HRMS calcd for $[M-H]^-$ $C_{11}H_9N_2O_5S$ 281.0238 found 281.0223. HPLC analysis (88% ee): ES-OVM, 1 mL.min^{-1}, 15 °C, KH_2PO_4(aq) (20 mM)/ACN (90/10), UV 205 nm, t_{major} = 25,2 min; t_{min} = 34,3 min.

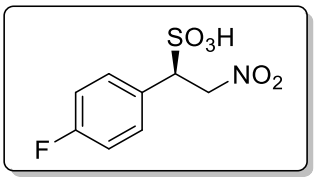


2-Nitro-1-(pyrimidin-1-ium-5-yl)ethane-1-sulfonate (2n). Synthesized from (*E*)-5-(2-nitrovinyl)pyrimidine (75.5 mg, 0.5 mmol) and isolated according to **general procedure B**. Orange deliquescent solid (98%, 114 mg). ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 9.10 (s, 1H), 8.86 (s, 1H), 5.34 – 5.08 (m, 2H), 4.50 (dd, J = 8.2, 6.9 Hz, 1H) ppm; ^{13}C NMR (75 MHz, DMSO-d_6) δ_c ^{13}C NMR (75 MHz, DMSO) δ 157.0 (CH), 156.6 (CH), 130.4 (C_q), 75.7 (CH_2), 58.3 (CH) ppm; IR

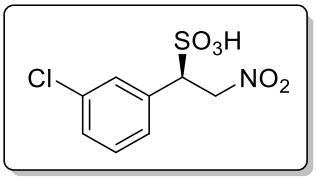
(ATR) 3080, 1563, 1167, 1031, 873, 689 cm^{-1} ; HRMS calcd for $[M-H]^-$ $C_6H_6N_3O_5S$ 232.0034 found 232.0023. HPLC analysis (84% ee): Chiralpak AGP 0.6 $mL.min^{-1}$, 25 °C, NH_4OAc (aq) (10 mM, pH = 4)/iPrOH (93/7), UV 215 nm, t_{min} = 6.1 min; t_{major} = 6.5 min.



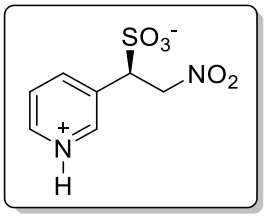
1-(4-hydroxyphenyl)-2-nitroethane-1-sulfonic acid (2o). Synthesized from (*E*)-4-(2-nitrovinyl)phenol (247 mg, 1.5 mmol) and isolated according to **general procedure A**. Dark brown deliquescent solid (99%, 371 mg). ^1H NMR (300 MHz, DMSO-d_6) δ_H 7.12 (d, *J* = 8.5 Hz, 2H), 6.65 (d, *J* = 8.5 Hz, 2H), 6.57 (bs, SO_3H+Ph-OH), 5.14 (dd, *J* = 13.2, 5.1 Hz, 1H), 4.81 (dd, *J* = 13.2, 10.3 Hz, 1H), 4.21 (dd, *J* = 10.3, 5.1 Hz, 1H). ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 156.8 (C_q), 130.0 (CH), 125.5 (C_q), 114.7 (CH), 77.82(CH_2), 62.5 (CH); IR (ATR) 3343, 3033, 2967, 1553, 1515, 1376, 1147, 1034, 607, 507 cm^{-1}; HRMS calcd for $[M-H]^-$ $C_8H_8NO_6S$ 246.0078 found 246.0063. The enantiomeric excess was determined after palladium-catalyzed reduction procedure (*vide infra*).



1-(4-fluorophenyl)-2-nitroethane-1-sulfonic acid (2p). Synthesized from (*E*)-1-fluoro-4-(2-nitrovinyl)benzene (250.7 mg, 1.5 mmol) and isolated according to **general procedure B**. Light brown deliquescent solid (99%, 371 mg). ^1H NMR (300 MHz, DMSO-d_6) δ_H 7.43 (dd, *J* = 8.5, 5.7 Hz, 2H), 7.12 (t, *J* = 8.9 Hz, 2H), 6.55 (bs, SO_3H), 5.24 (dd, *J* = 13.6, 5.1 Hz, 1H), 4.97 (dd, *J* = 13.5, 10.3 Hz, 1H), 4.44 (dd, *J* = 10.3, 5.1 Hz, 1H); ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 161.71 (d, *J* = 243.2 Hz) (C_q), 131.74 (d, *J* = 3.0 Hz) (CH), 131.04 (d, *J* = 8.2 Hz) (CH), 114.75 (d, *J* = 21.2 Hz) (CH), 77.5 (CH_2), 62.3 (CH) ppm ; IR (ATR) 3079, 3019, 2968, 1578, 1253, 1216, 1205, 1067, 864, 616, 521 cm^{-1} ; IR (ATR) 3388, 3078, 2962, 1555, 1510, 1223, 1159, 1035, 979, 606 cm^{-1} ; HRMS calcd for $[M-H]^-$ $C_8H_7NO_5SF$ 248.0034 found 248.0020. The enantiomeric exces was determined after palladium-catalyzed reduction procedure (*vide infra*).



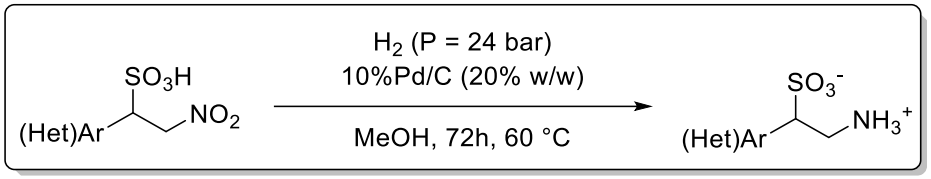
1-(3-Chlorophenyl)-2-nitroethane-1-sulfonic acid (2q). Synthesized from (*E*)-1-chloro-3-(2-nitrovinyl)benzene (275 mg, 1.5 mmol) and isolated according to **general procedure A**. Brown oil (99%, 395 mg). ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 7.44 (m, 1H), 7.31 (m, 3H), 6.31 (bs, SO_3H), 5.18 (dd, *J* = 13.6, 5.1 Hz, 1H), 4.96 (dd, *J* = 13.6, 10.1 Hz, 1H), 4.38 (dd, *J* = 10.1, 5.1 Hz, 1H); ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 138.2 (C_q), 132.7 (C_q), 129.9 (CH), 128.9 (CH), 128.1 (CH), 127.6 (CH), 77.3 (CH_2), 62.6 (CH); IR (ATR) 3400, 2957, 1555, 1376, 1127, 1035, 695 cm^{-1}; HRMS calcd for $[M-H]^-$ $C_8H_7ClNO_5S$ 263.9739 found 263.9732. The enantiomeric excess was determined after palladium-catalyzed reduction procedure (*vide infra*).



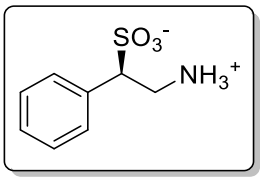
2-Nitro-1-(pyridin-1-ium-3-yl)ethane-1-sulfonate (2r). Synthesized from (*E*)-3-(2-nitrovinyl)pyridine[2] (225 mg, 1.5 mmol) and isolated according to **general procedure A**. Pale yellow solid slightly delisquencent (97%, 337 mg), m.p. = 217-219 °C. ^{1}H NMR (300 MHz, DMSO-d_6) δ_H 9.06 (d, *J* = 1.9 Hz, 1H), 8.84 (d, *J* = 5.7 Hz, 1H), 8.70 (d, *J* = 8.1 Hz, 1H), 8.06 (dd, *J* = 8.1, 5.7 Hz, 1H), 5.39 – 5.18 (m, 2H), 4.80 (dd, *J* = 9.4, 5.4 Hz, 1H) ppm; ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 146.3 (CH), 142.0 (CH), 140.8 (CH), 136.8 (C_q), 126.6 (CH), 75.4 (CH_2), 59.4 (CH); IR (ATR) 3072, 3039, 2967, 2633, 2111, 1558, 1233, 1171, 1039, 833, 690, 594, 554, 513 cm^{-1}; HRMS calcd for $[M]^-$ $C_7H_7N_2O_5S$ 231.0081 found 231.0067. The enantiomeric excess was determined after palladium-catalyzed reduction procedure (*vide infra*).

[2] *Can. J. Chem.* **1985**, *63*, 2354-2361

II.3 Reduction of nitrosulfonic acid derivatives

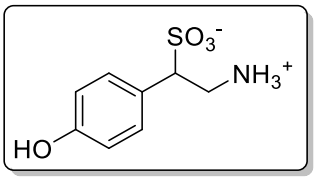


General procedure. In an autoclave apparatus, the appropriate nitrosulfonic acid or zwitterion (1.5 mmol) and 10% Pd/C (20% w/w) or $PtO_2.H_2O$ (5 mol%) in MeOH (5 mL) were initially purged under a stream of nitrogen (20 min). The mixture was then purged twice with hydrogen (P = 20 bar) and finally pressurized with hydrogen (P = 24 bar). The mixture was gradually heated to 60 °C (internal temperature control) and vigorously stirred for 72h. The reaction mixture was brought back to room temperature, the excess hydrogen was evacuated and the autoclave was purged with nitrogen. The reaction mixture was diluted with methanol, and filtered off on a pad of diatomeous silica. The pad was thoroughly rinsed with a $HCOOH/H_2O$ (1/1) mixture. The filtrate was concentrated *in vacuo* to yield the desired ammonium sulfonate generally in analytically pure form but as an oil. Otherwise, the product could be precipitated by stirring (5-10 min) in a minimum amount of MeOH at 0 °C and the resulting solid was filtered off on a Büchner funnel. Usually, this process had a negligible impact on ee and could remove traces of impurities.

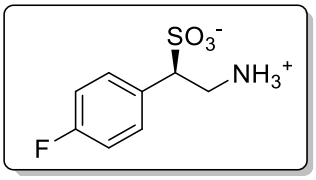


2-ammonio-1-phenylethane-1-sulfonate (4a). Synthesized from nitrosulfonic acid compound **2a** (341 mg, 1.5 mmol) and isolated according to **general procedure** using 10% Pd/C. The product (98%, 291 mg, 96% ee) was obtained in 61% yield (181 mg, 97% ee) after precipitation in MeOH giving a colorless solid. $[\alpha]_D^{20}$ = -4.98 ° (C = 1, H_2O). m.p. > 300 °C. ^{1}H NMR (300 MHz, D_2O) δ_H 7.45 (brs, 5H), 4.34 (dd, *J* = 8.5, 6.7 Hz, 1H), 3.83 (dd, *J* = 13.3, 6.7 Hz, 1H), 3.62 (dd, *J* = 13.3, 8.5 Hz, 1H); ^{13}C NMR (75 MHz, D_2O) δ_C 131.9 (C_q), 129.3 (CH), 129.1 (CH), 129.0 (CH), 62.8 (CH), 40.1 (CH_2); IR (ATR): 3126, 3064, 1629, 1497, 1145, 1027, 764, 696, 591; HRMS calcd for $[M-H]^-$ $C_8H_{10}NO_3S$ 200.0387 found 200.0381. HPLC analysis (96% ee): Chiralpak Zwix (+), 1

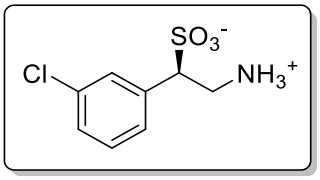
mL.min^{-1}, 25 °C, MeOH/$HCOONH_4$ (25mM aq)+HCOOH(25mM aq) (98/2), UV 210 nm, t_{major} = 8.4 min; t_{min} = 18.9 min.



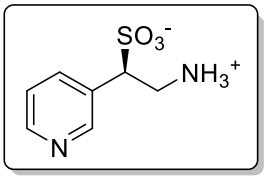
2-Ammonio-1-(4-hydroxyphenyl)ethane-1-sulfonate (4b). Synthesized from nitrosulfonic acid compound **2o** (371 mg, 1.5 mmol) and isolated according to **general procedure** using 10% Pd/C. The product (96%, 313 mg, 93% ee) was obtained in 70% yield (229 mg, 96% ee) after recrystallization in MeOH. m.p. > 300 °C; ^{1}H NMR (300 MHz, D_2O) δ_H 7.31 (d, J = 8.1 Hz, 2H), 6.91 (d, J = 8.1 Hz, 2H), 4.27 (t, J = 7.6 Hz, 1H), 3.78 (dd, J = 13.3, 6.6 Hz, 1H), 3.55 (dd, J = 13.3, 8.7 Hz, 1H); ^{13}C NMR (75 MHz, D_2O) δ_C 156.2 (C_q), 130.6 (CH), 123.5 (C_q), 115.8 (CH), 62.1 (CH), 40.1 (CH_2); IR (ATR) 3160, 1597, 1483, 1212, 1148, 1015, 834, 612. HRMS calcd for [M-H]$^-$ $C_8H_{10}NO_4S$ 216.0336 found 216.0326. HPLC analysis (93% ee): Chiralpak Zwix (+), 1 mL.min^{-1}, 25 °C, MeOH/$HCOONH_4$ (25mM aq)+HCOOH(25mM aq) (98/2) (98/2), UV 277 nm, t_{miajor} = 12.1 min; t_{min} = 24.5 min.



2-ammonio-1-(4-fluorophenyl)ethane-1-sulfonate (4c). Synthesized from **2p** (226 mg, 0.91 mmol) and isolated according to **general procedure** using 10% Pd/C. Colorless solid (99%, 199 mg). m.p. > 300 °C. ^{1}H NMR (300 MHz, D_2O) δ_H 7.47 (dd, J = 8.5, 5.4 Hz, 1H), 7.19 (t, J = 8.9 Hz, 1H), 4.36 (dd, J = 8.5, 6.7 Hz, 1H), 3.82 (dd, J = 13.4, 6.7 Hz, 1H), 3.60 (dd, J = 13.3, 8.5 Hz, 1H) ppm; ^{13}C NMR (75 MHz, D_2O) δ_C 162.9 (C_q) (d, J = 245.8 Hz), 131.0 (CH) (d, J = 8.7 Hz), 127.9 (C_q) (d, J = 3.2 Hz), 115.9 (CH) (d, J = 21.9 Hz), 62.0 (CH), 40.1 (CH_2) ppm; IR (ATR) 3217, 3056, 2942, 1513, 1495, 1210, 1139, 1046, 830, 706, 605; ; HRMS calcd for [M-H]$^-$ $C_8H_9FNO_3S$ 218.0293 found 218.0283. HPLC analysis (90% ee): Chiralpak Zwix (+), 1 mL.min^{-1}, 25 °C, MeOH/$HCOONH_4$ (25mM aq)+HCOOH(25mM aq) (98/2), UV 264 nm, t_{major} = 8.5 min; t_{min} = 18.0 min.

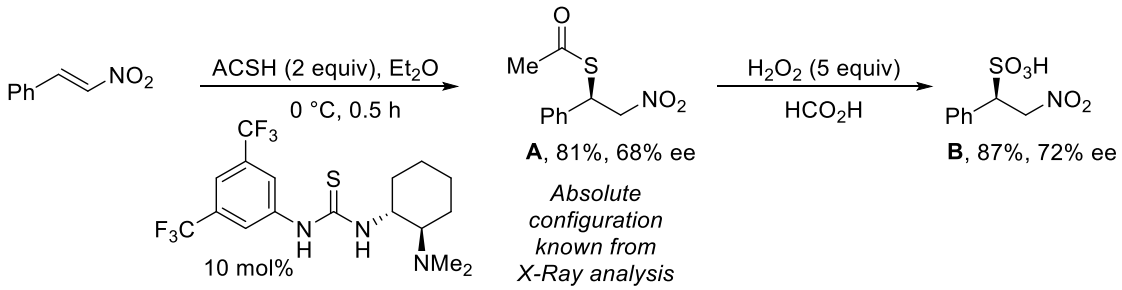


2-ammonio-1-(3-chlorophenyl)ethane-1-sulfonate (4d). Synthesized from **2q** (395 mg, 1.5 mmol) and isolated according to **general procedure** using $PtO_2.H_2O$. Colorless solid (74% after trituration in cold MeOH, 262 mg). m.p. > 300 °C; ^{1}H NMR (300 MHz, D_2O) δ_H 7.62 – 7.27 (m, 4H), 4.35 (t, *J* = 7.6 Hz, 1H), 3.83 (dd, *J* = 13.3, 6.7 Hz, 1H), 3.61 (dd, *J* = 13.1, 8.4 Hz, 1H); ^{13}C NMR (75 MHz, DMSO-d_6) δ_C 138.5 (C_q), 132.5 (C_q), 129.8 (CH), 128.7 (CH), 128.1 (CH), 127.3 (CH), 61.4 (CH), 40.8 (CH_2); IR (ATR) 3187, 3032, 2945, 1497, 1476, 1208, 1168, 1047, 782, 687; HRMS calcd for $[M-H]^-$ $C_8H_9ClNO_3S$ 233.9997 found 233.9990. HPLC analysis (75% ee): Chiralpak Zwix (+), 1 mL.min^{-1}, 25 °C, MeOH/$HCOONH_4$ (25mM aq)+HCOOH(25mM aq) (98/2), UV 254 nm, t_{major} = 10.6 min; t_{min} = 22.4 min.



2-ammonio-1-(pyridin-3-yl)ethane-1-sulfonate (4e). Synthesized from **2r** (200 mg, 0.86 mmol) and isolated according to **general procedure** using 10% Pd/C. The product (97%, 294.2 mg, 88% ee) was obtained in 84% yield (147 mg, 90% ee) after precipitation in MeOH giving a Light pink solid. m.p. = 282-284 °C. ^{1}H NMR (300 MHz, D_2O) δ_H 8.58 (s, 2H), 7.98 (d, *J* = 8.0 Hz, 1H), 7.54 (s, 1H), 4.44 (t, *J* = 7.4 Hz, 1H), 3.88 (dd, *J* = 13.5, 7.3 Hz, 1H), 3.64 (dd, *J* = 13.5, 7.6 Hz, 1H); ^{13}C NMR (75 MHz, D_2O) δ_C 148.9 (CH), 148.8 (CH), 137.9 (CH), 129.2 (C_q), 124.7 (CH), 60.2 (CH), 39.6 (CH_2) ppm; IR (ATR) 3006, 1633, 1551, 1219, 1173, 1024, 711; HRMS calcd for $[M-H]^-$ $C_7H_9N_2O_3S$ 201.0339 found 201.0324. HPLC analysis (88% ee): Chiralpak Zwix (+), 1 mL.min^{-1}, 25 °C, MeOH/$HCOONH_4$ (25mM aq)+HCOOH(25mM aq) (98/2), UV 261 nm, t_{major} = 8.0 min; t_{min} = 16.1 min.

II.4 Determination of the absolute configuration

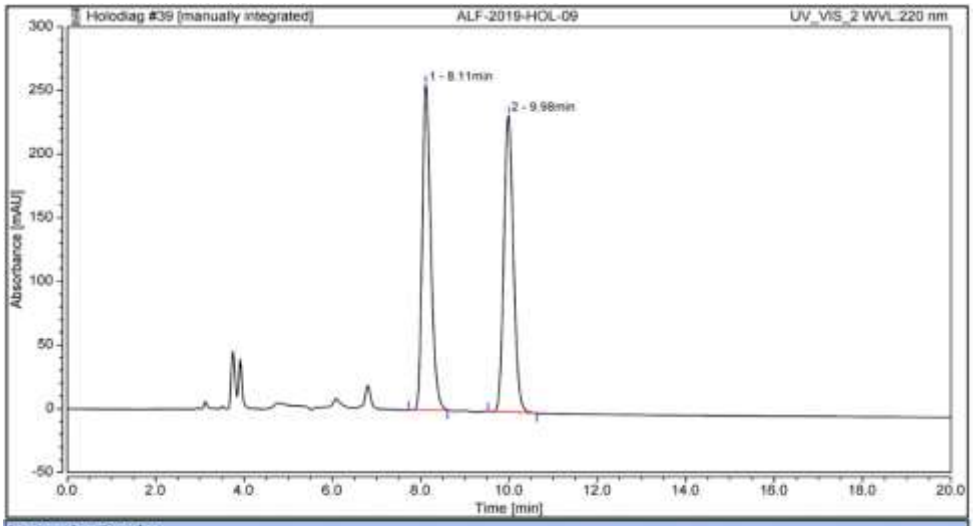


According to Wang's paper,[3] the Takemoto catalyst promotes the sulfa-Michael addition reaction to give the (*R*)-adduct **A** (81%, 68% ee, see HPLC below). Then, according to a literature procedure,[4] we carried out the oxidation reaction to synthesize the corresponding (*R*)-nitro sulfonic acid **B** (87%, 72% ee) as major enantiomer, given that any racemization is very unlikely. The comparison between the peaks in HPLC analyses of this reference and the nitro sulfonic acid **2a** obtained in our conditions could be achieved, showing that the (R)-adduct **2a** was formed. See the analyses below.

[3] Li, H.; Wang, J.; Zu, L.; Wang, W., Organocatalytic asymmetric conjugate addition of thioacetic acid to β-nitrostyrenes. *Tetrahedron Lett.* **2006**, *47*, 2585-2589

[4] Chen, N.; Xu, J., Facile synthesis of various substituted taurines, especially syn- and anti-1,2-disubstituted taurines, from nitroolefins. *Tetrahedron* **2012**, *68*, 2513-2522.

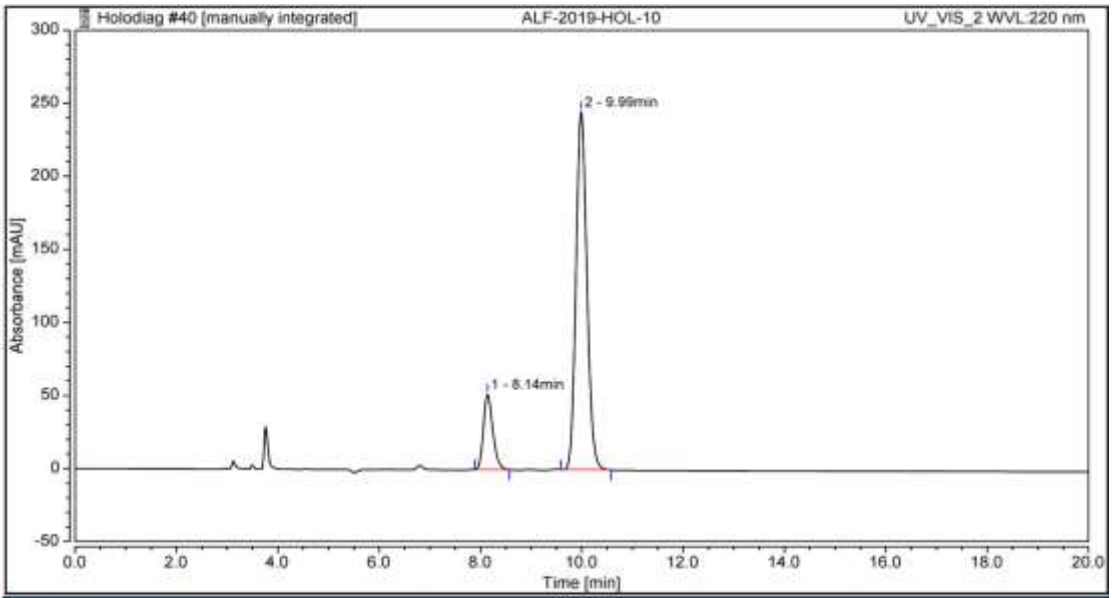
Sulfa-Michael adduct **A** (racemic)



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		8.113	57.701	255.463	49.98	52.29	n.a.
2		9.983	57.745	233.066	50.02	47.71	n.a.
Total:			**115.446**	**488.529**	**100.00**	**100.00**	

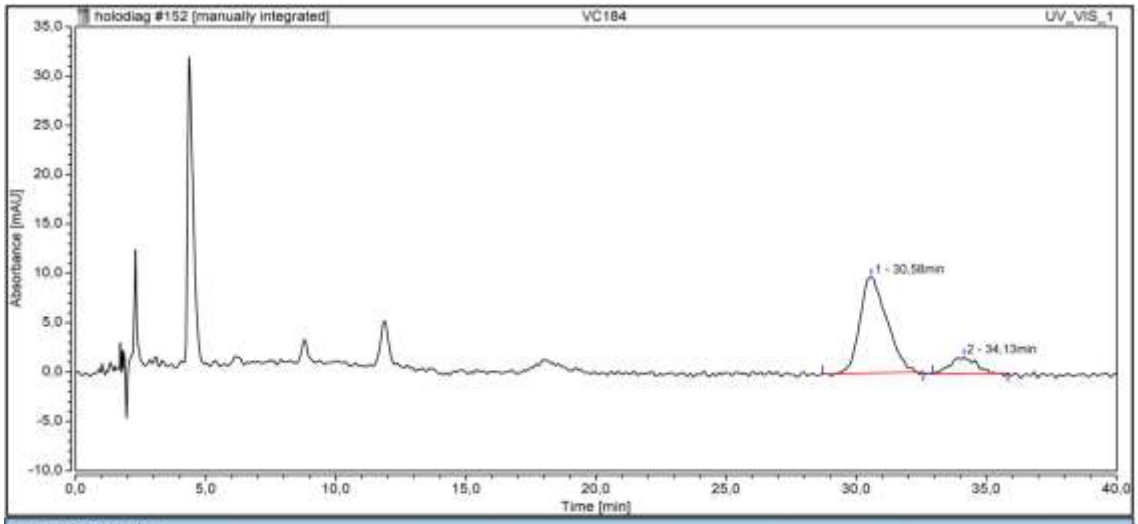
Sulfa-Michael adduct **A** (68% ee)



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		8.137	11.252	51.627	15.68	17.41	n.a.
2		9.987	60.528	244.943	84.32	82.59	n.a.
Total:			**71.780**	**296.570**	**100.00**	**100.00**	

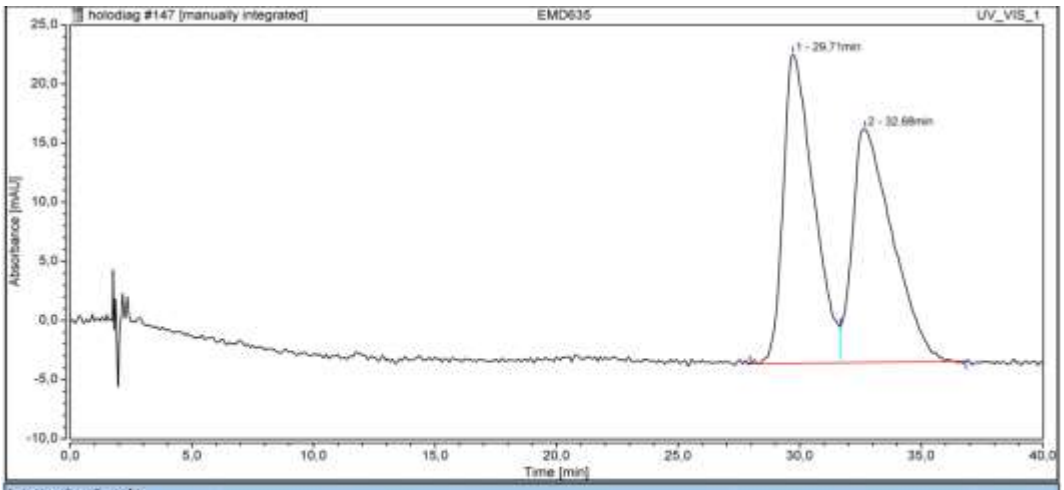
Nitro sulfonic acid **B** (68% ee)



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		30,58	11,648	9,695	86,18	85,44	n.a.
2		34,13	1,868	1,652	13,82	14,56	n.a.
Total:			**13,516**	**11,347**	**100,00**	**100,00**	

Nitro sulfonic acid **B** (racemic)

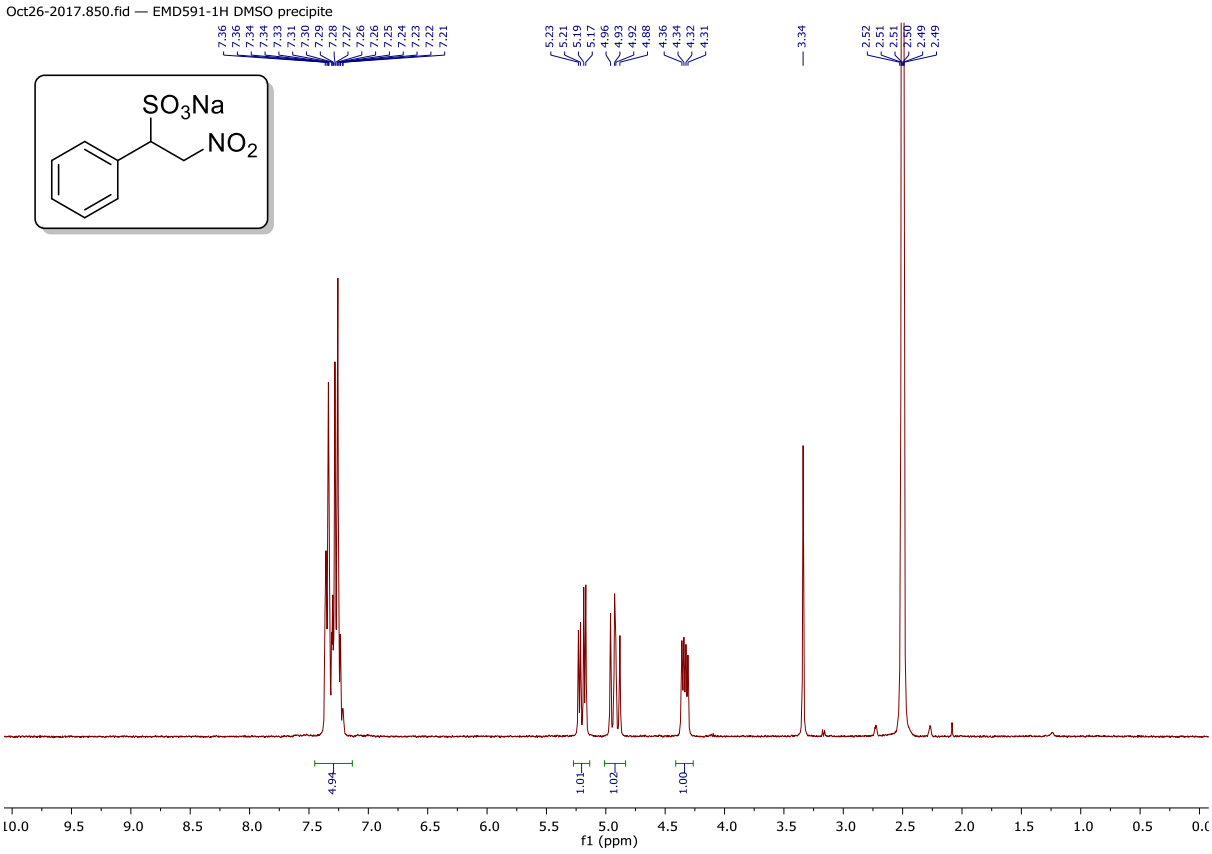


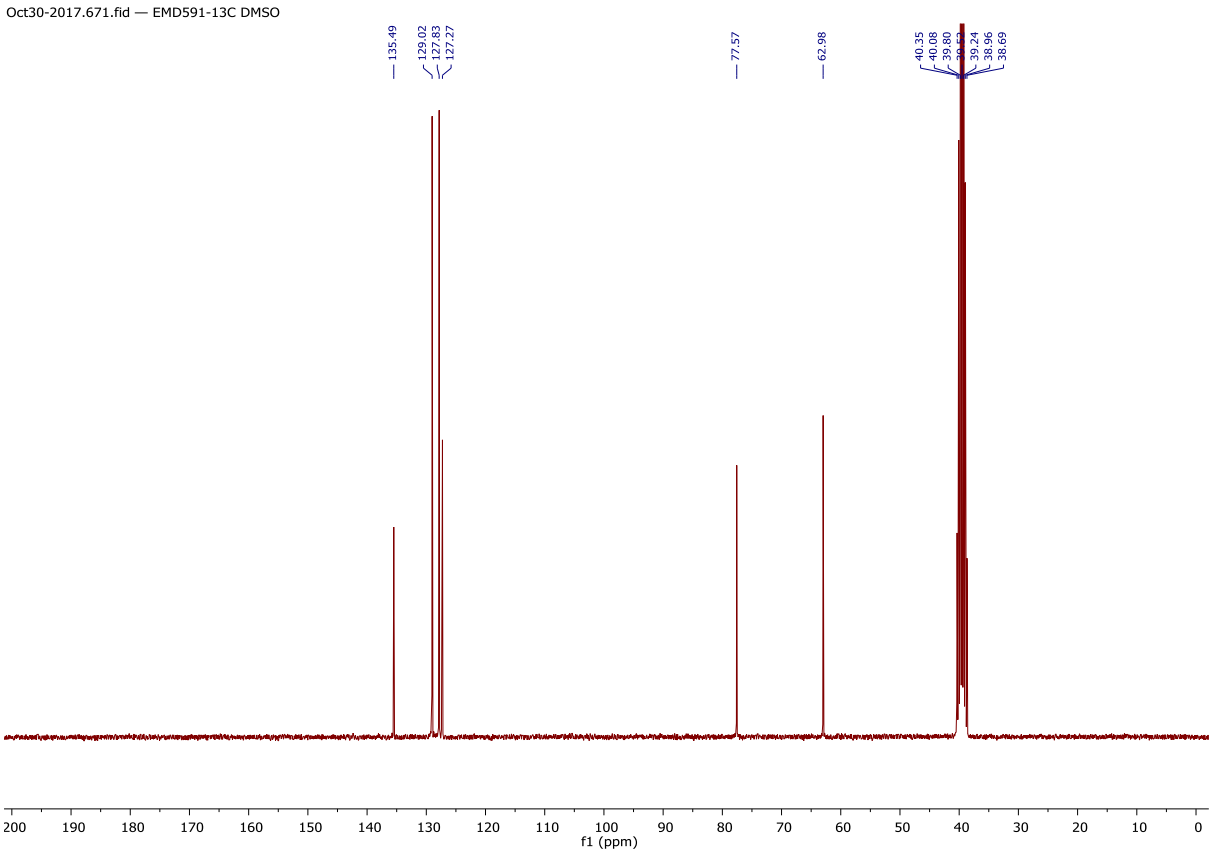
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		29,71	38,011	26,111	50,21	56,97	n.a.
2		32,68	37,698	19,725	49,79	43,03	n.a.
Total:			**75,709**	**45,836**	**100,00**	**100,00**	

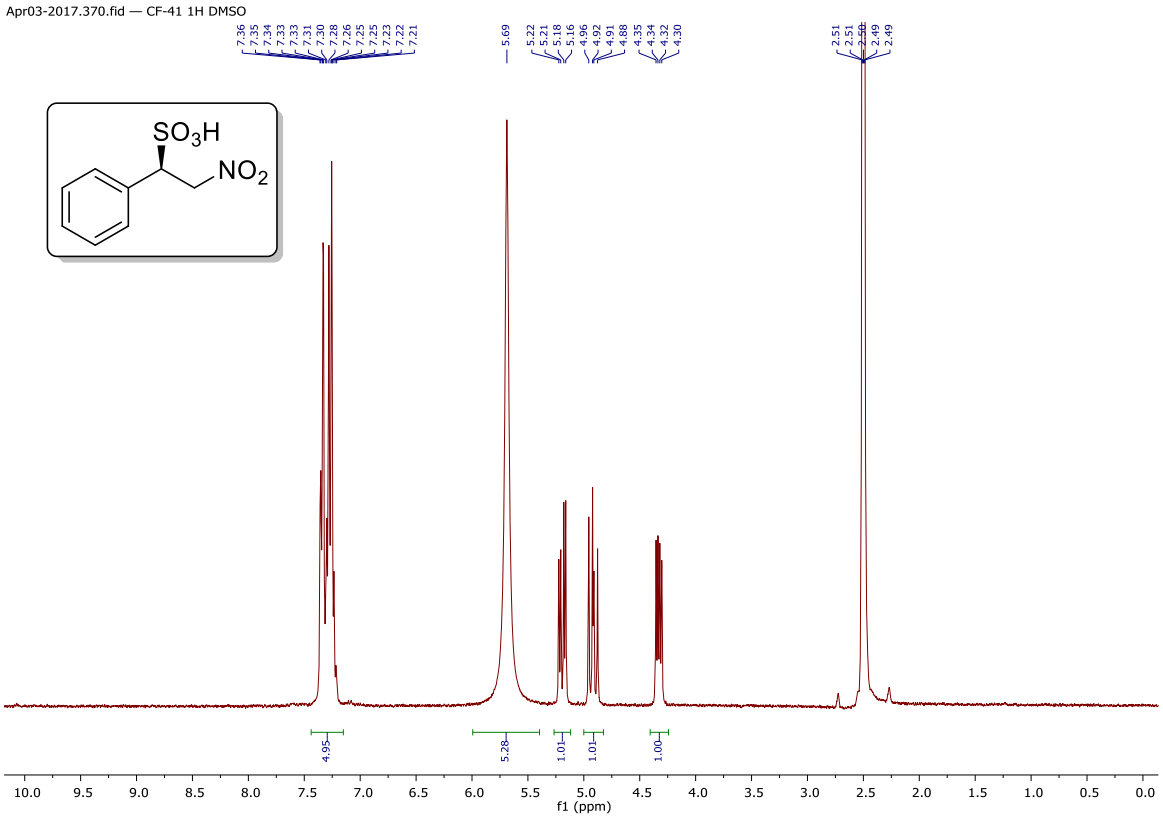
VII NMR spectra

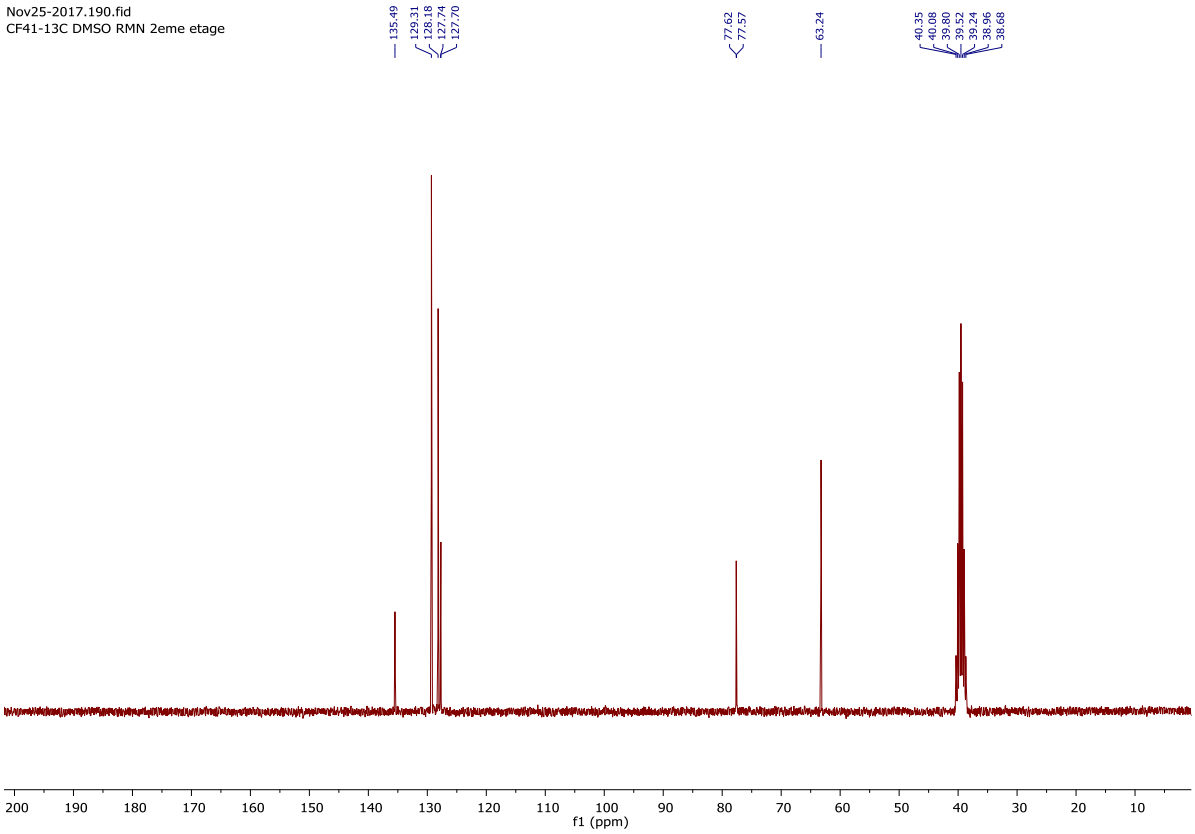
Sodium 2-nitro-1-phenylethane-1-sulfonate (racemic 2a-Na+)



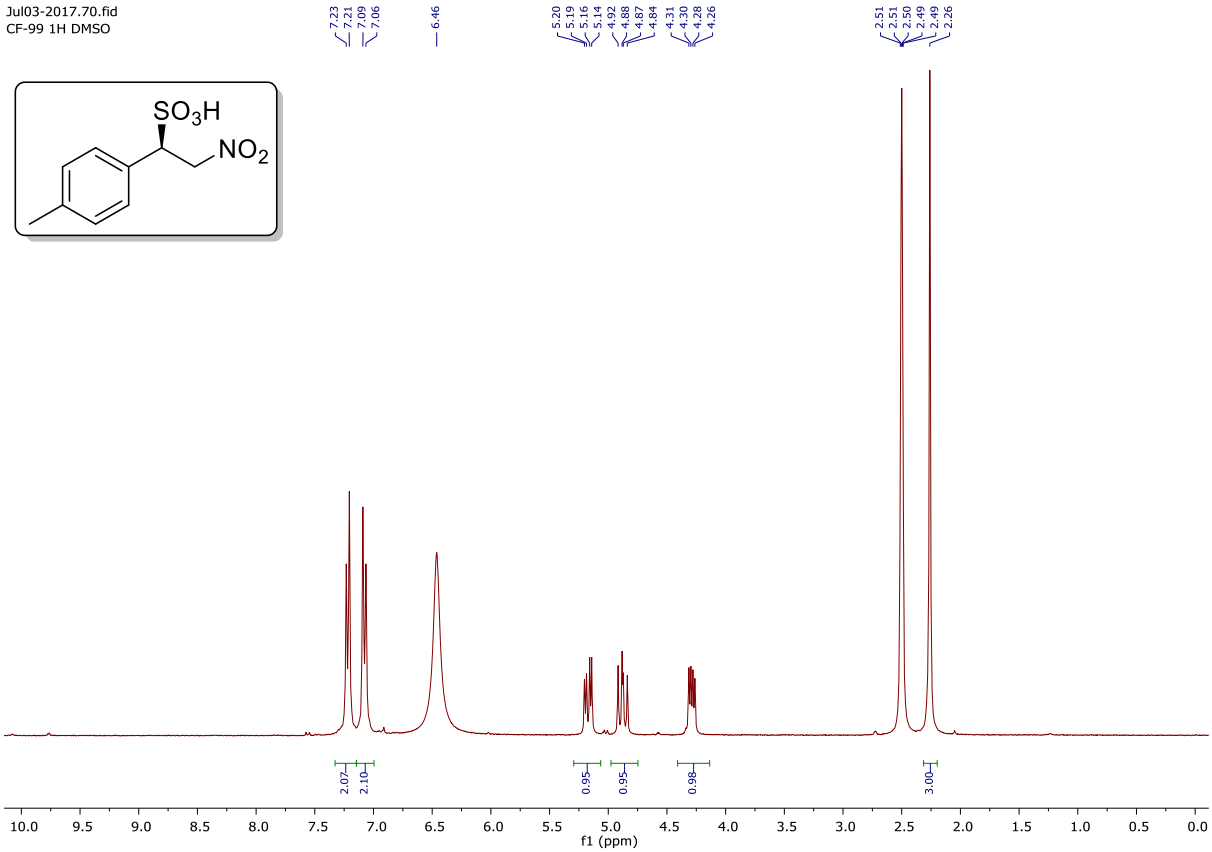


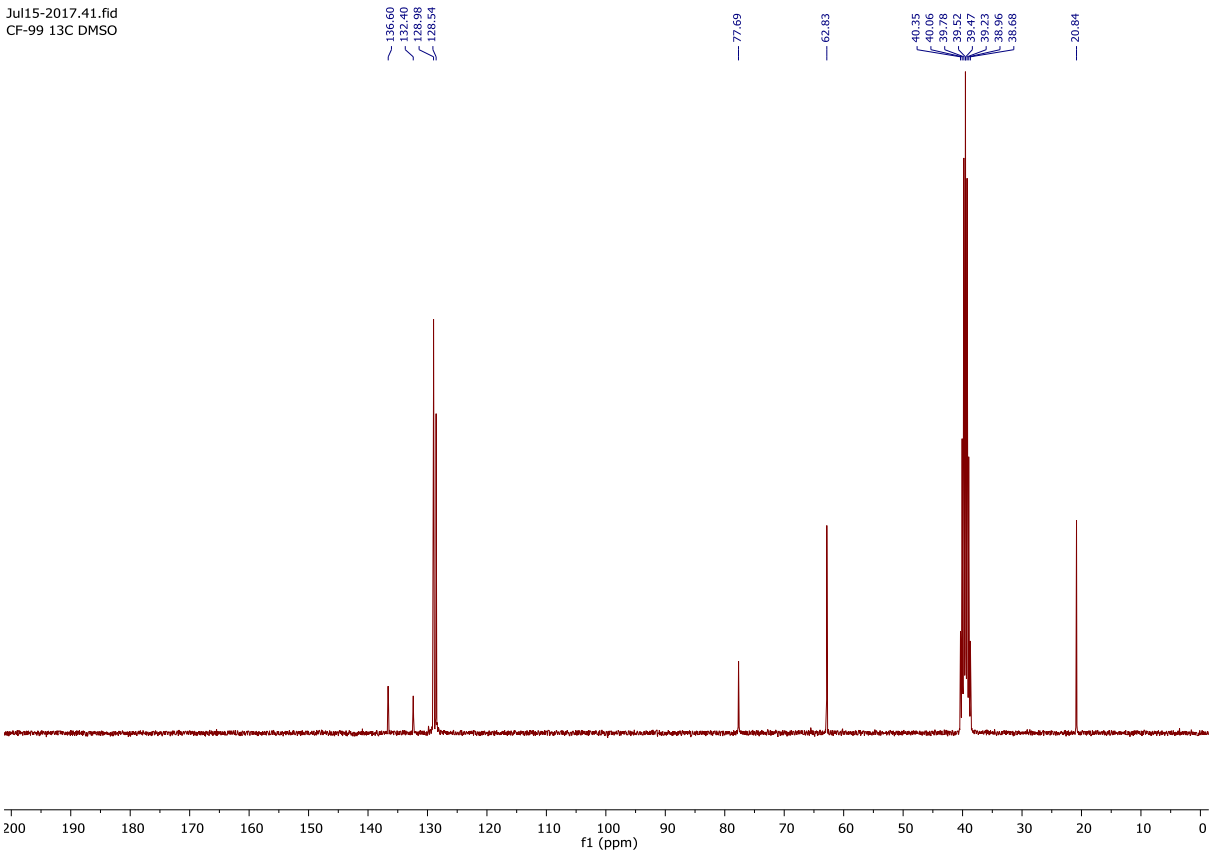
2-nitro-1-phenylethane-1-sulfonic acid (2a)



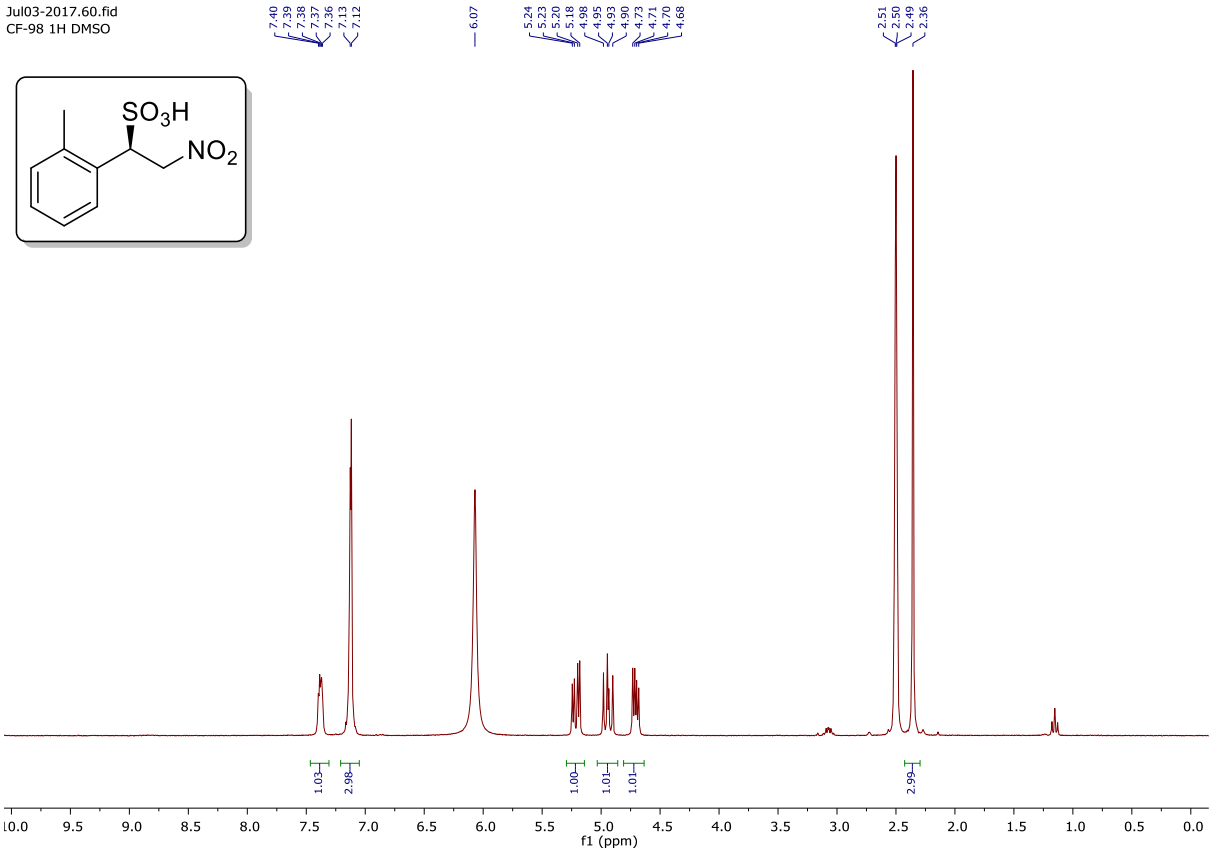


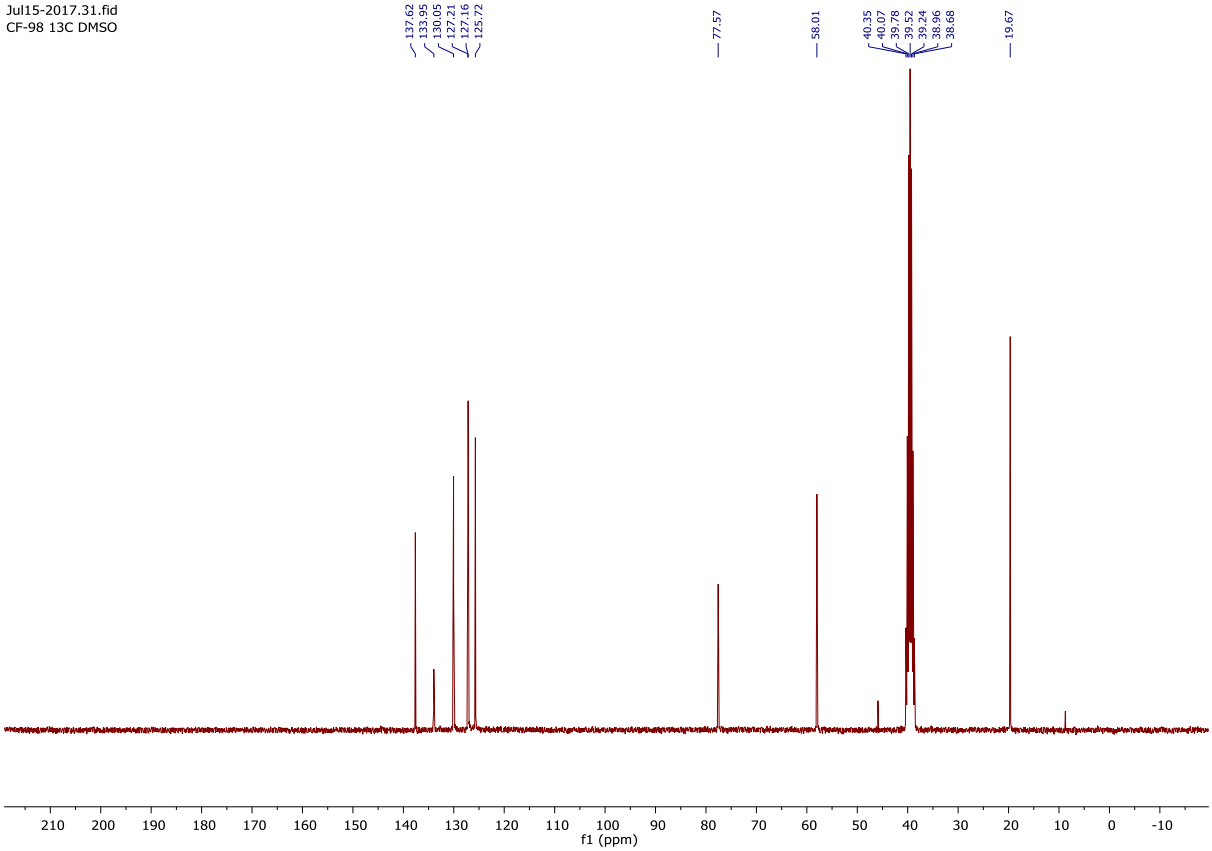
2-nitro-1-(p-tolyl)ethane-1-sulfonic acid (2b)



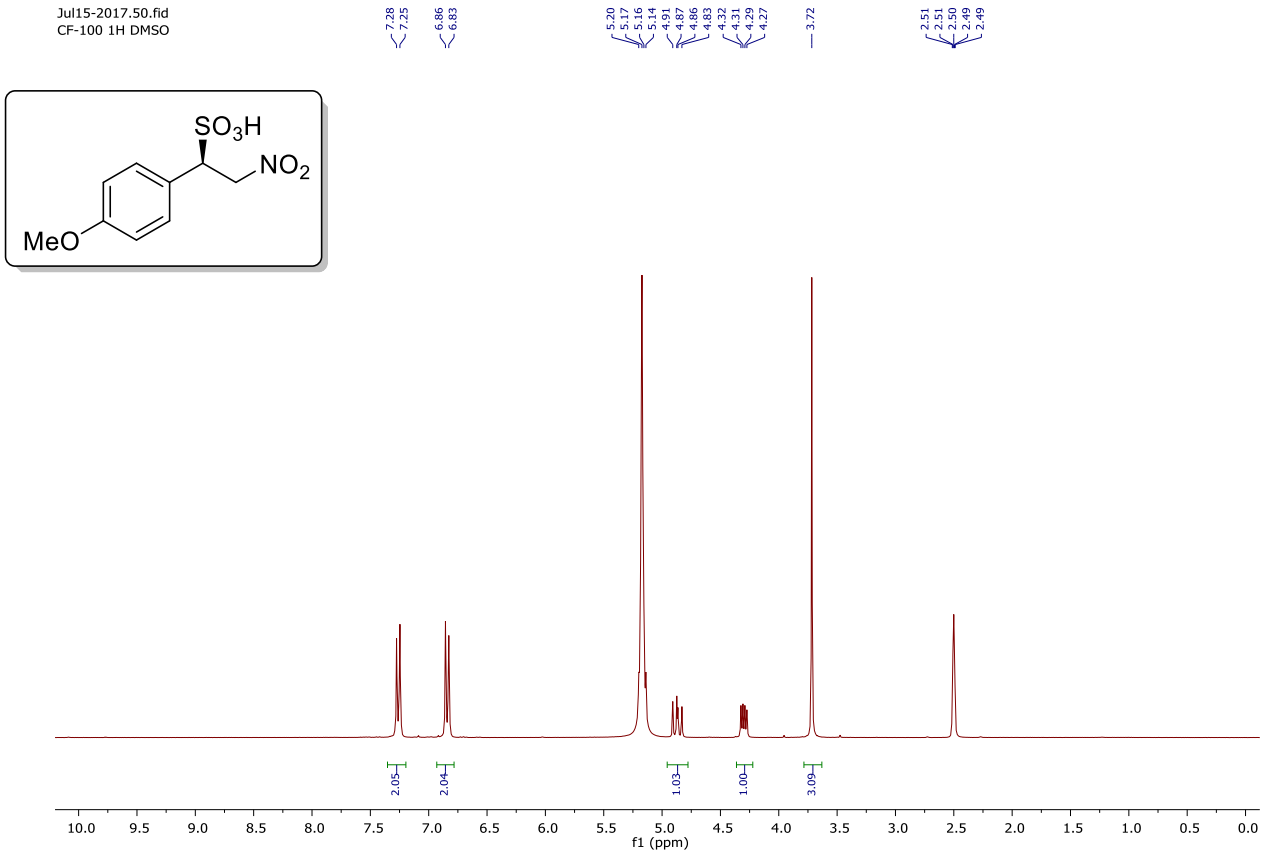


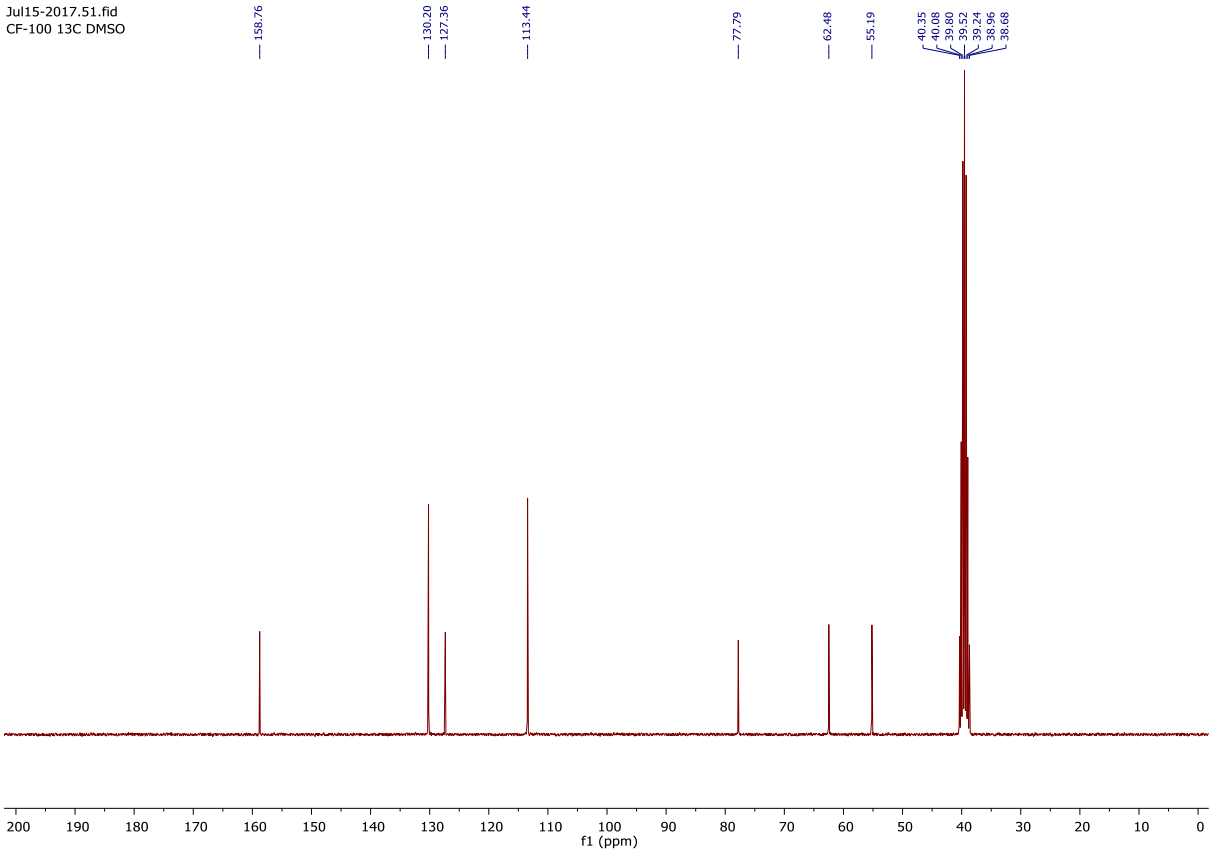
2-nitro-1-(o-tolyl)ethane-1-sulfonic acid (2c)



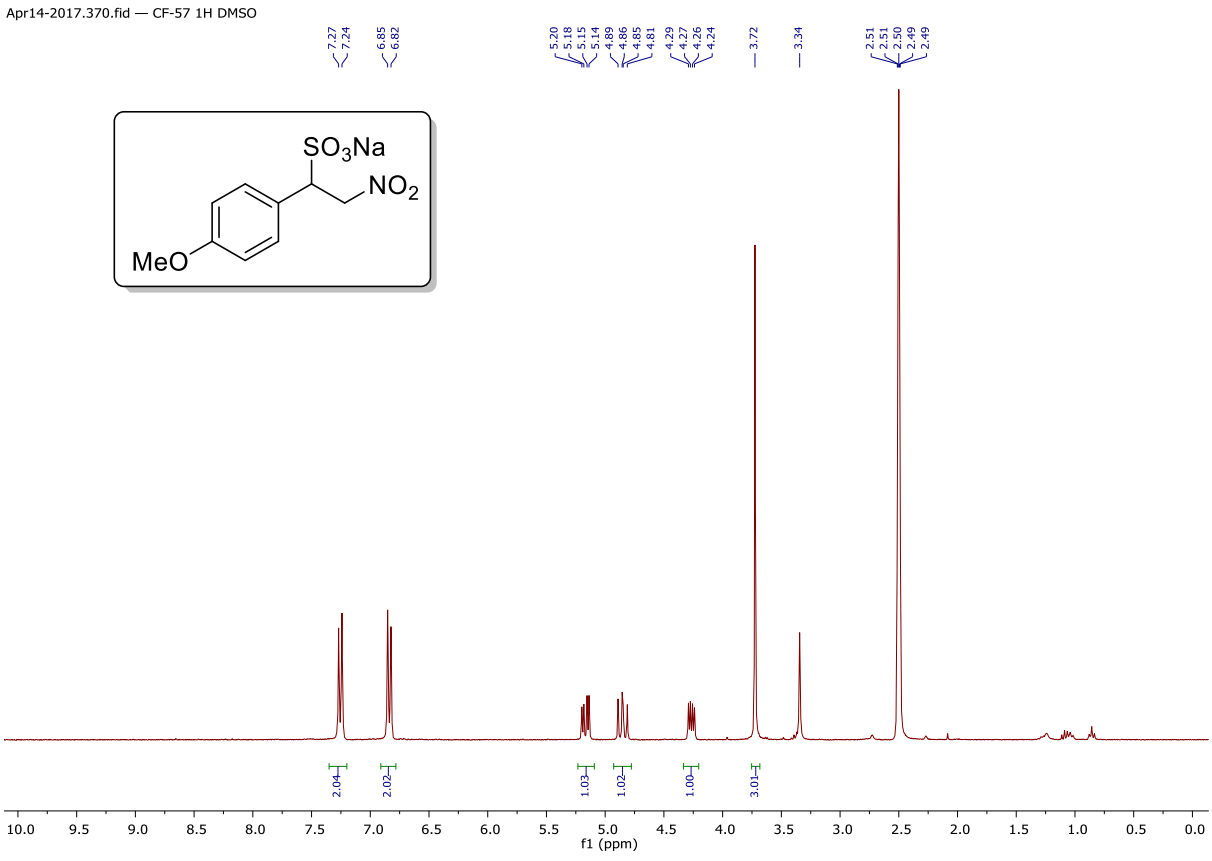


(R)-1-(4-methoxyphenyl)-2-nitroethane-1-sulfonic acid (2d)

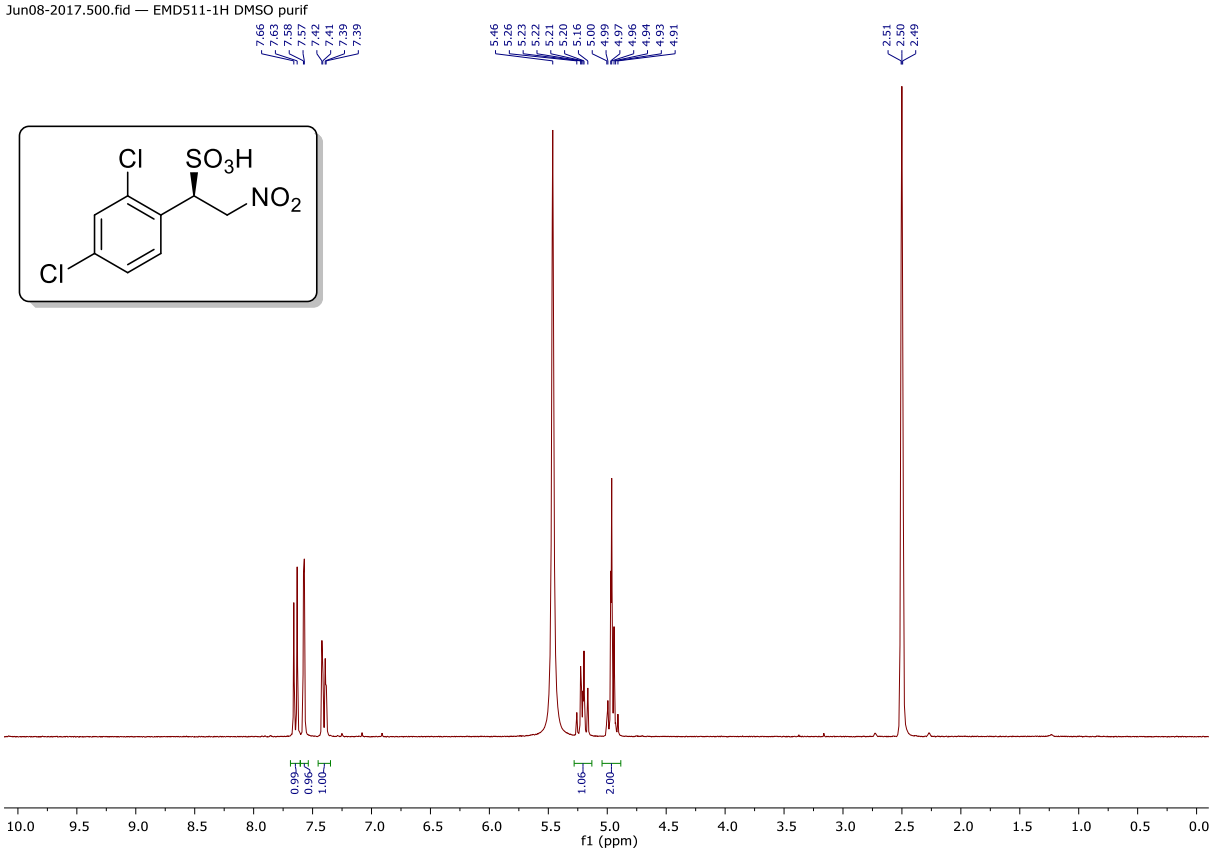


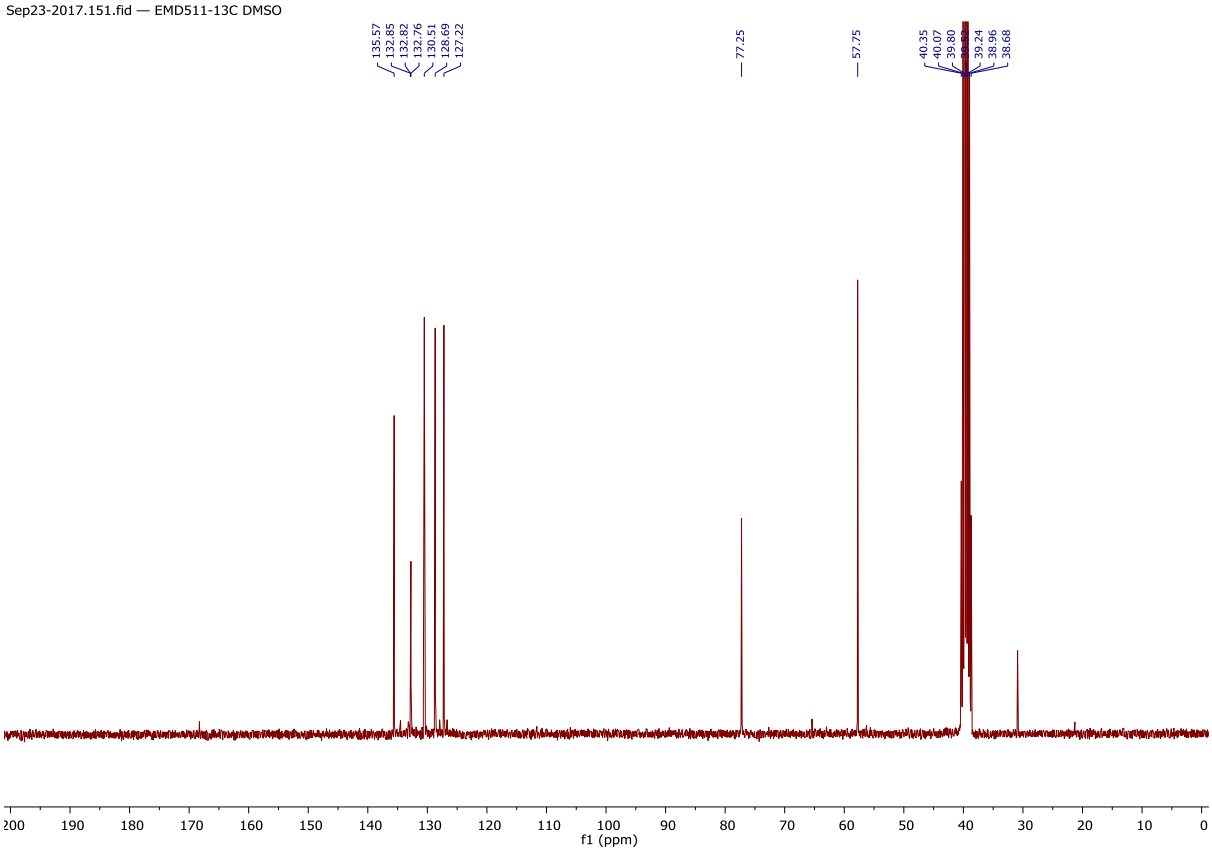


Sodium 1-(4-methoxyphenyl)-2-nitroethane-1-sulfonate (2d-Na+)

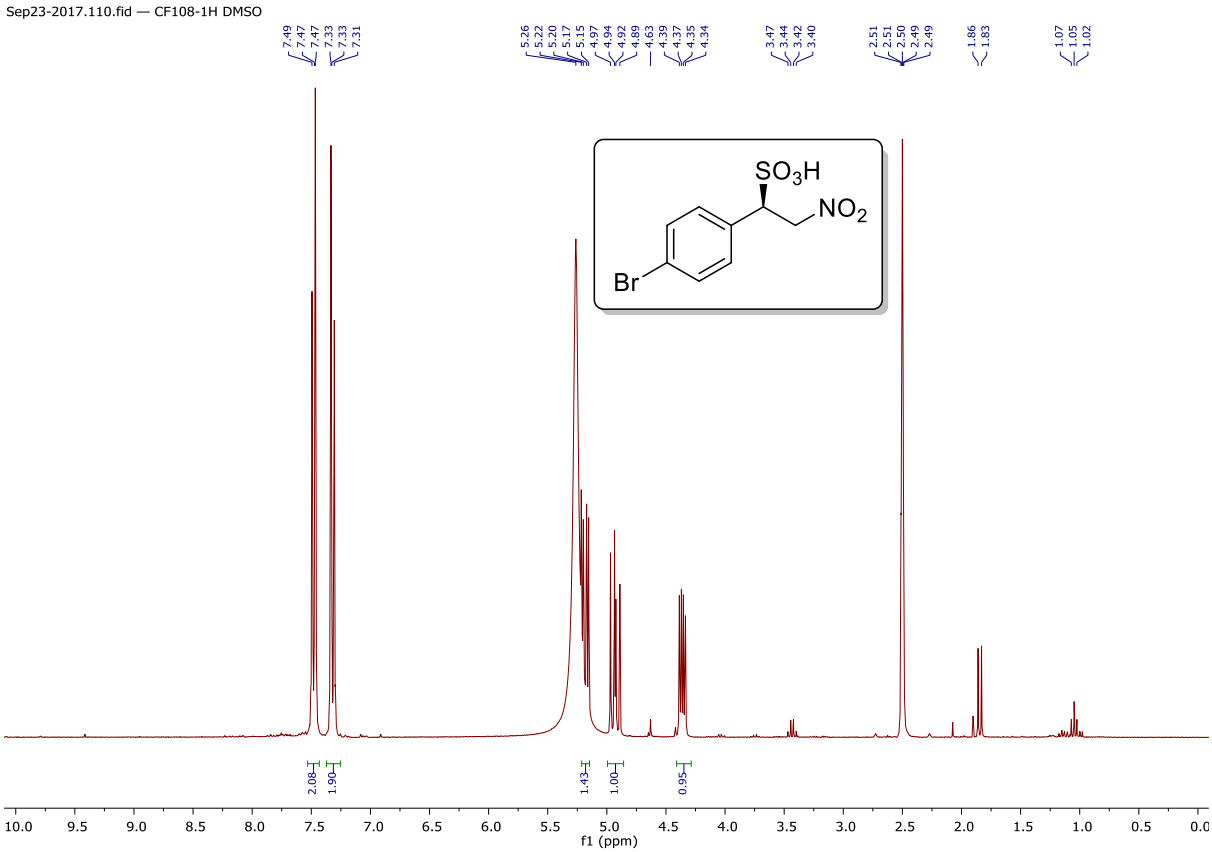


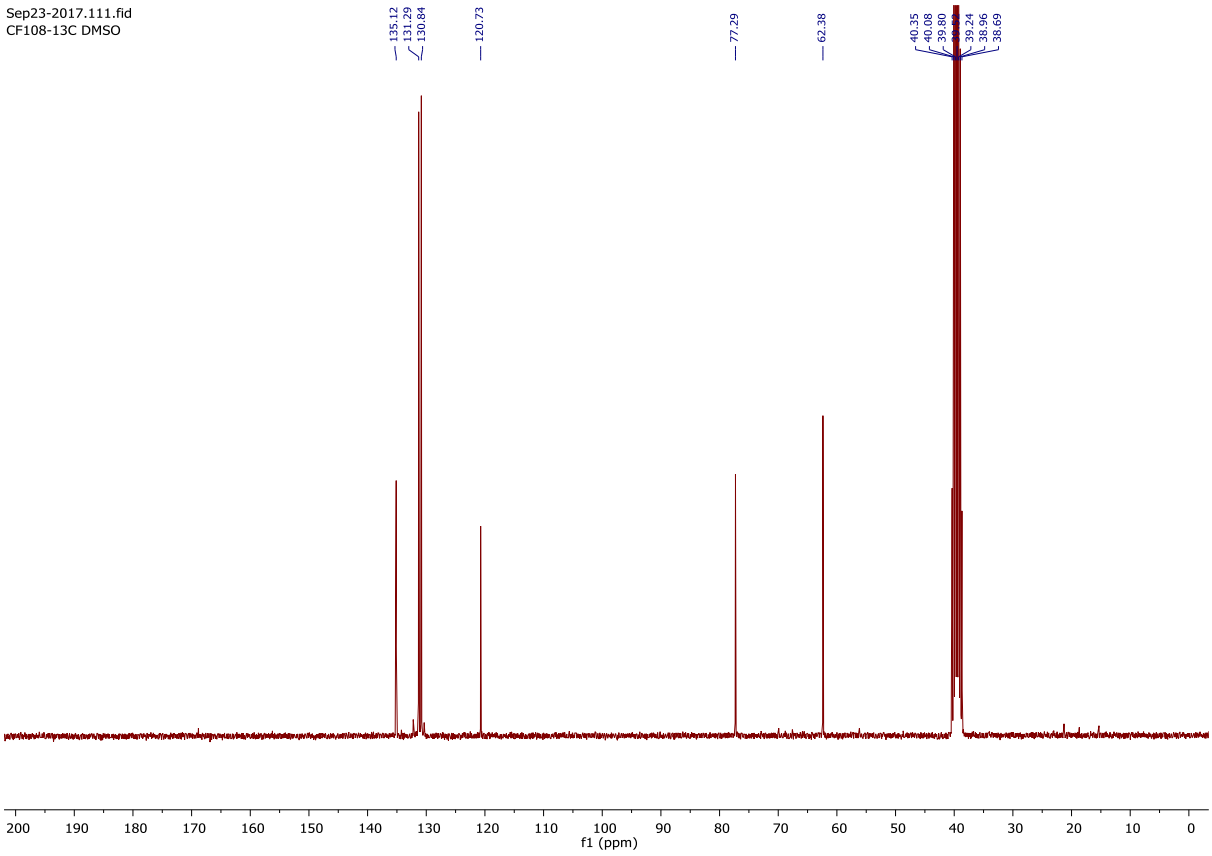
1-(2,4-Dichlorophenyl)-2-nitroethane-1-sulfonic acid (2e)



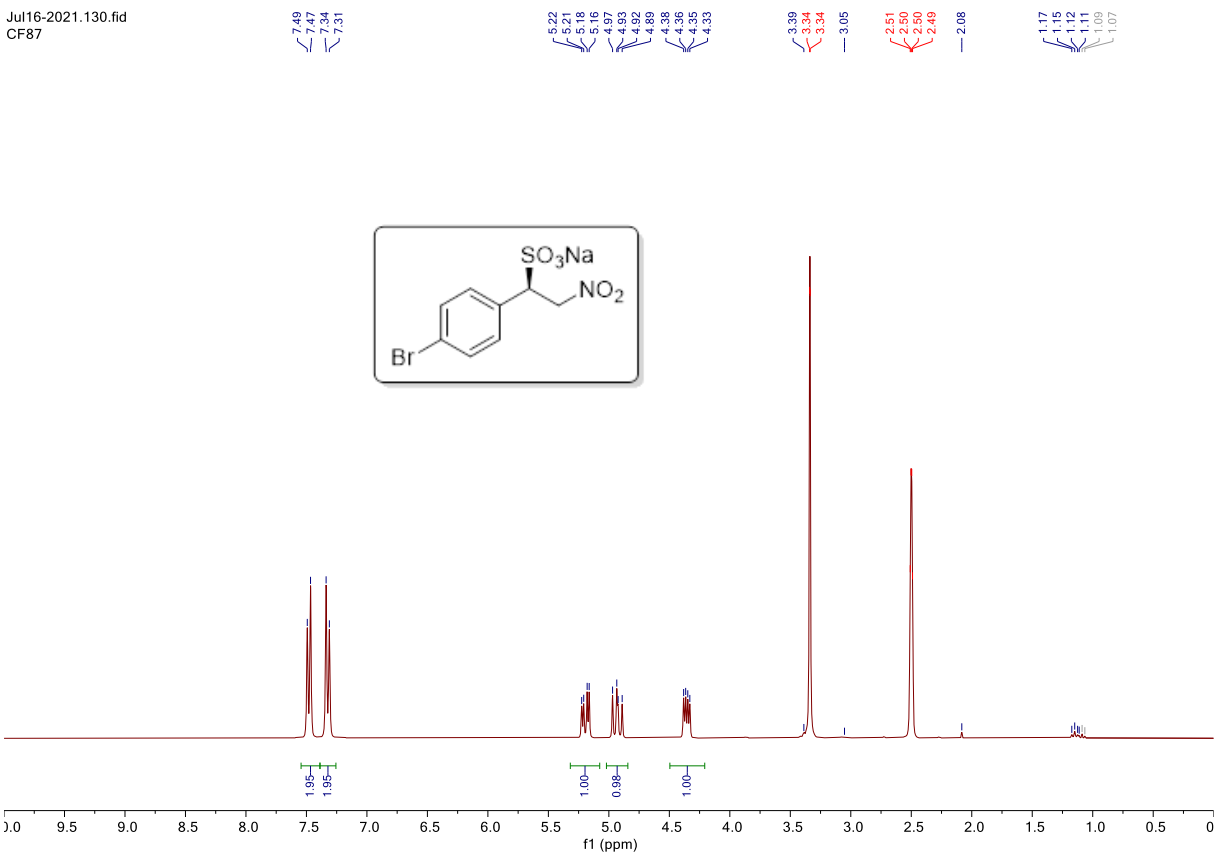


1-(4-bromophenyl)-2-nitroethane-1-sulfonic acid (2f)

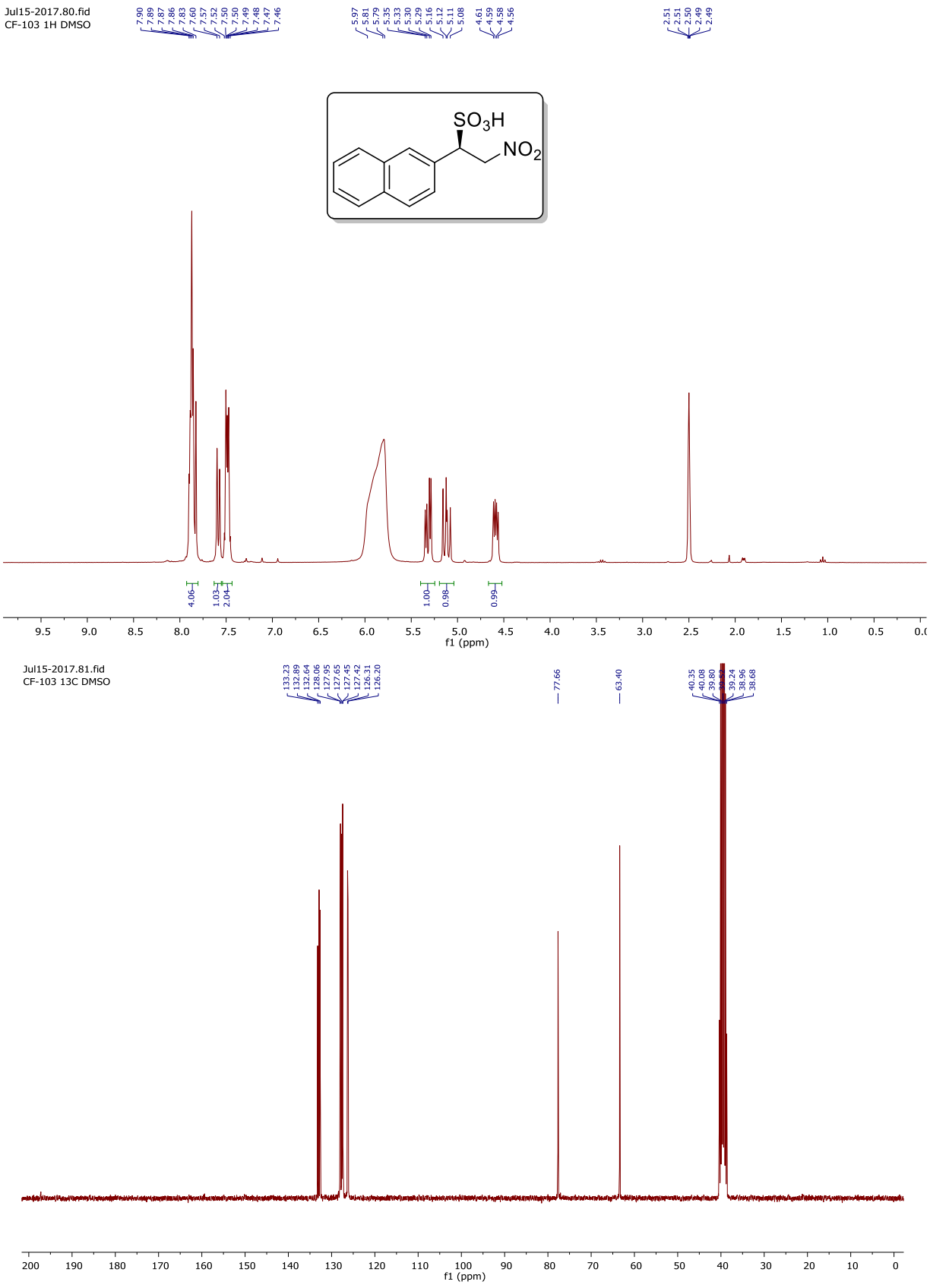




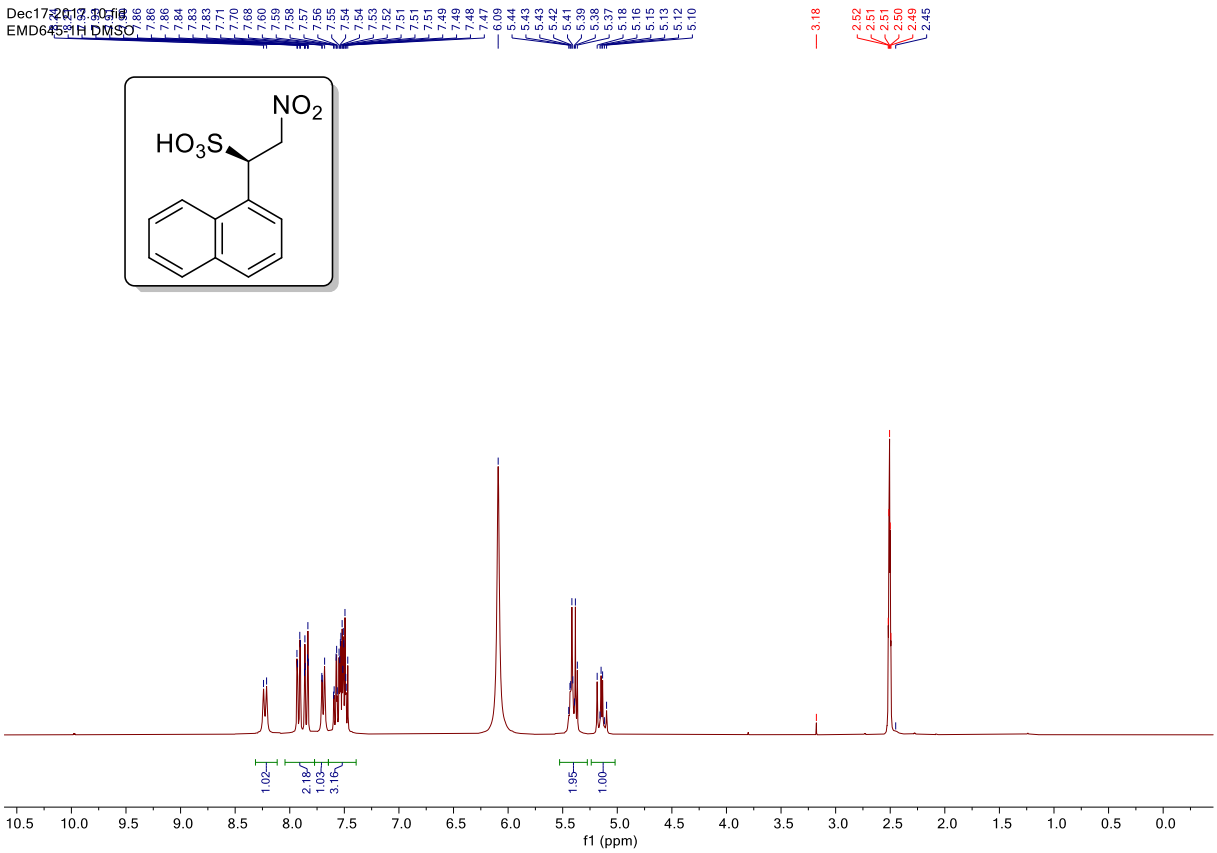
Sodium 1-(4-bromophenyl)-2-nitroethane-1- (2f-Na+)

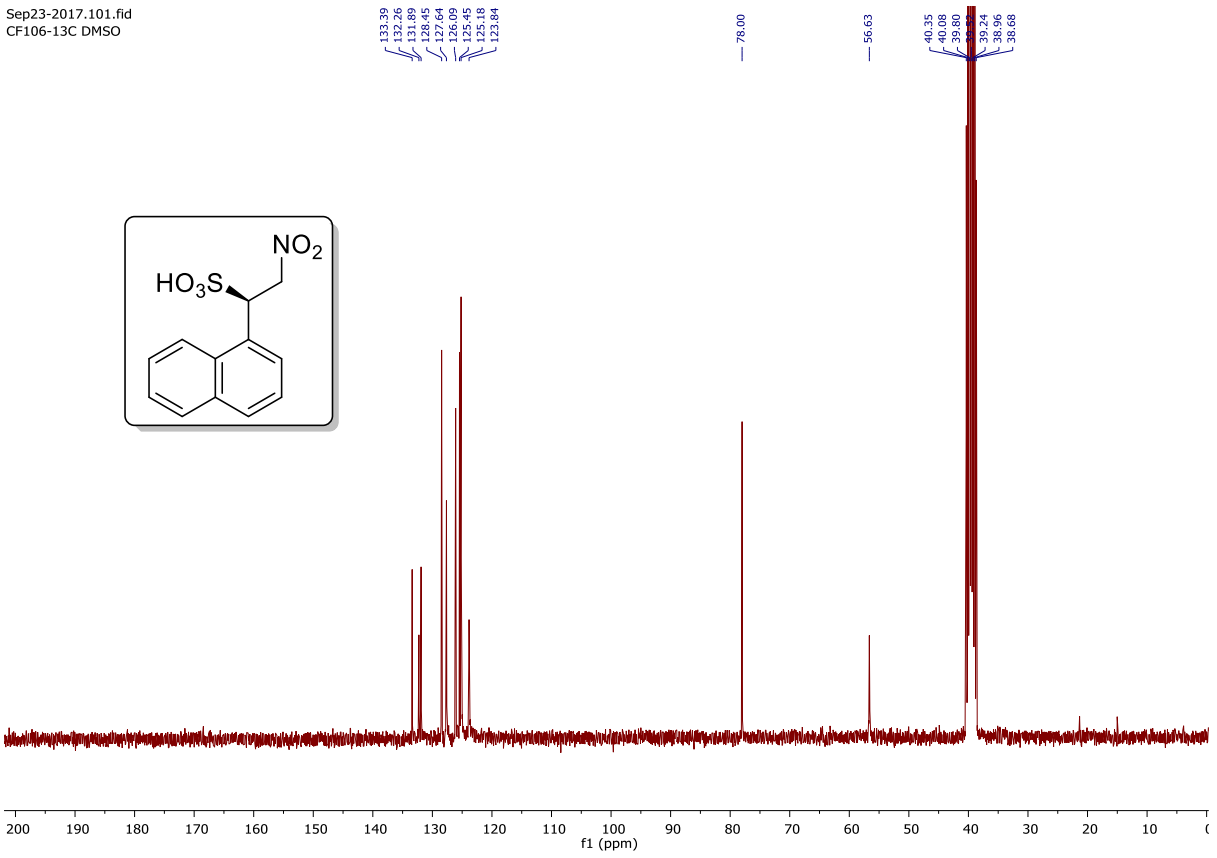


1-(Naphthalen-2-yl)-2-nitroethane-1-sulfonic acid (2g)

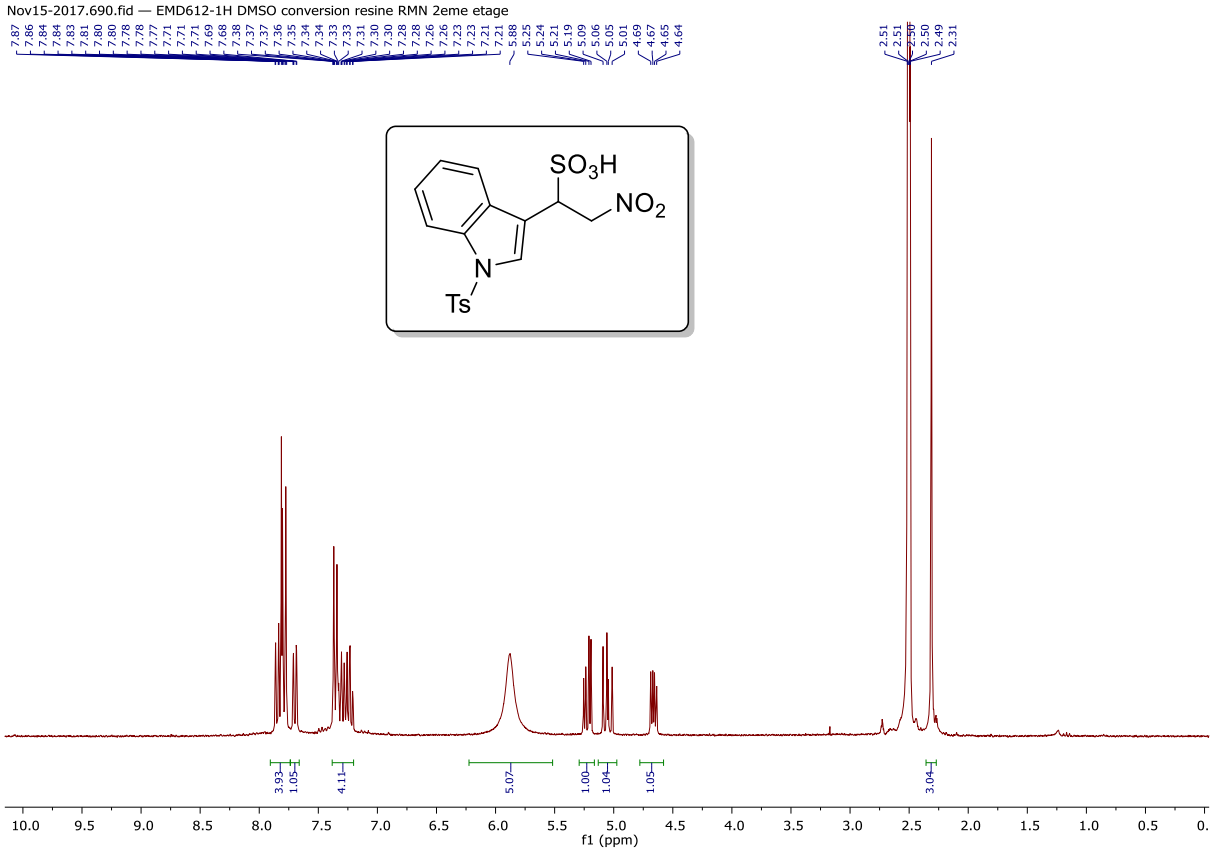


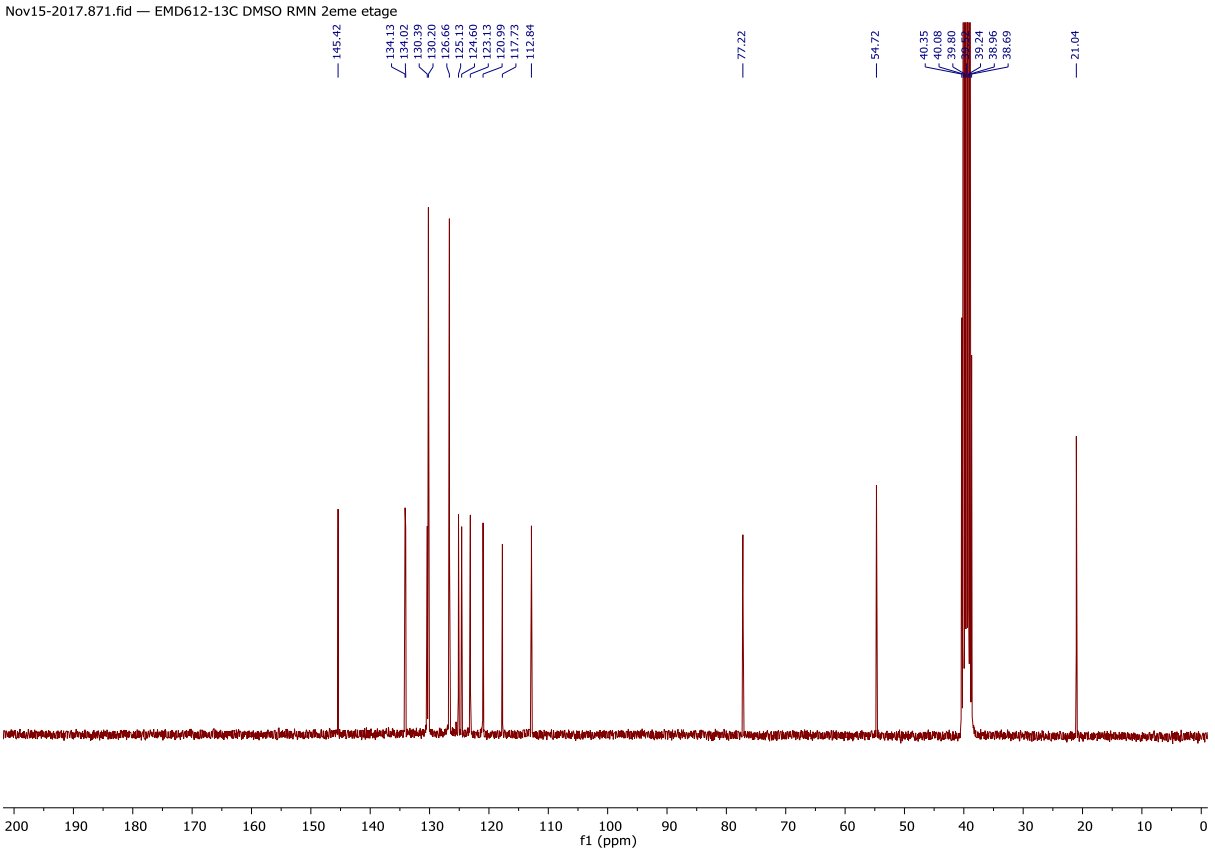
1-(naphthalen-1-yl)-2-nitroethane-1-sulfonic acid (2h)



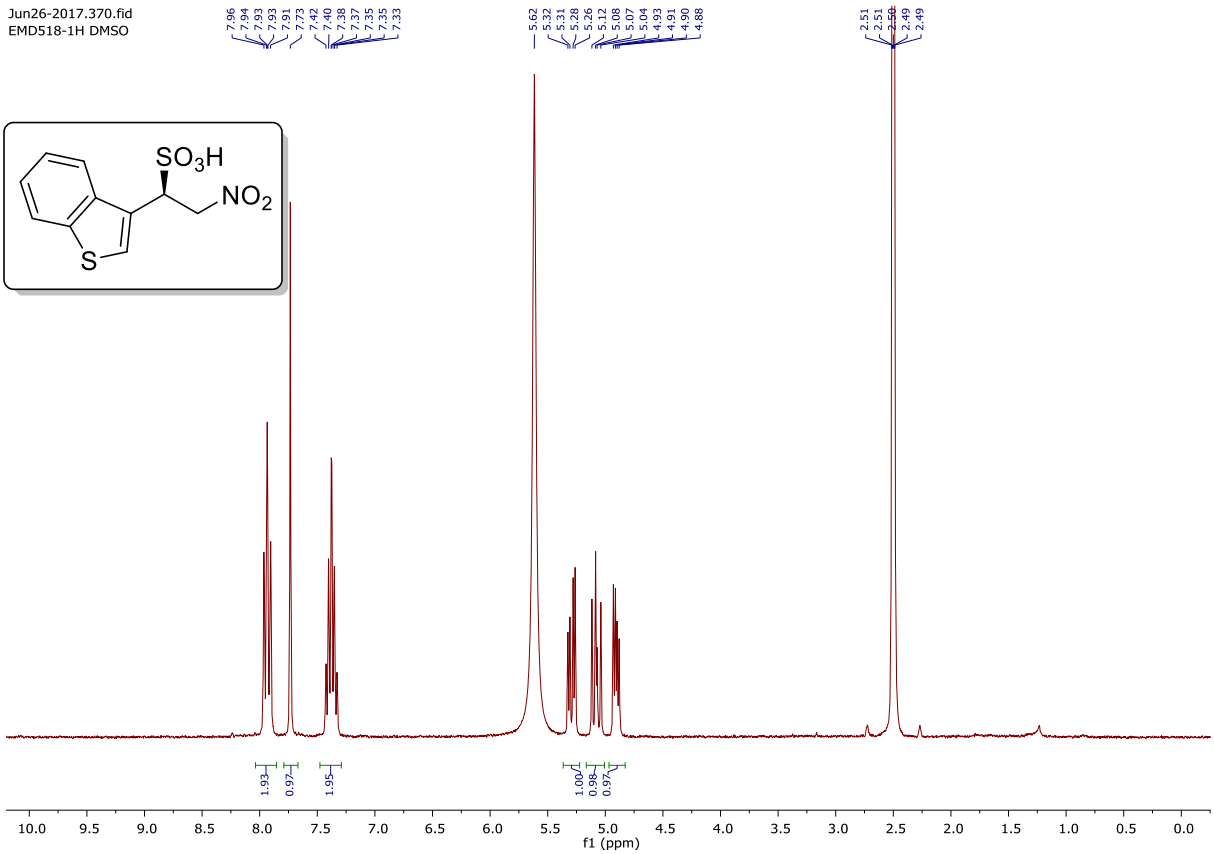


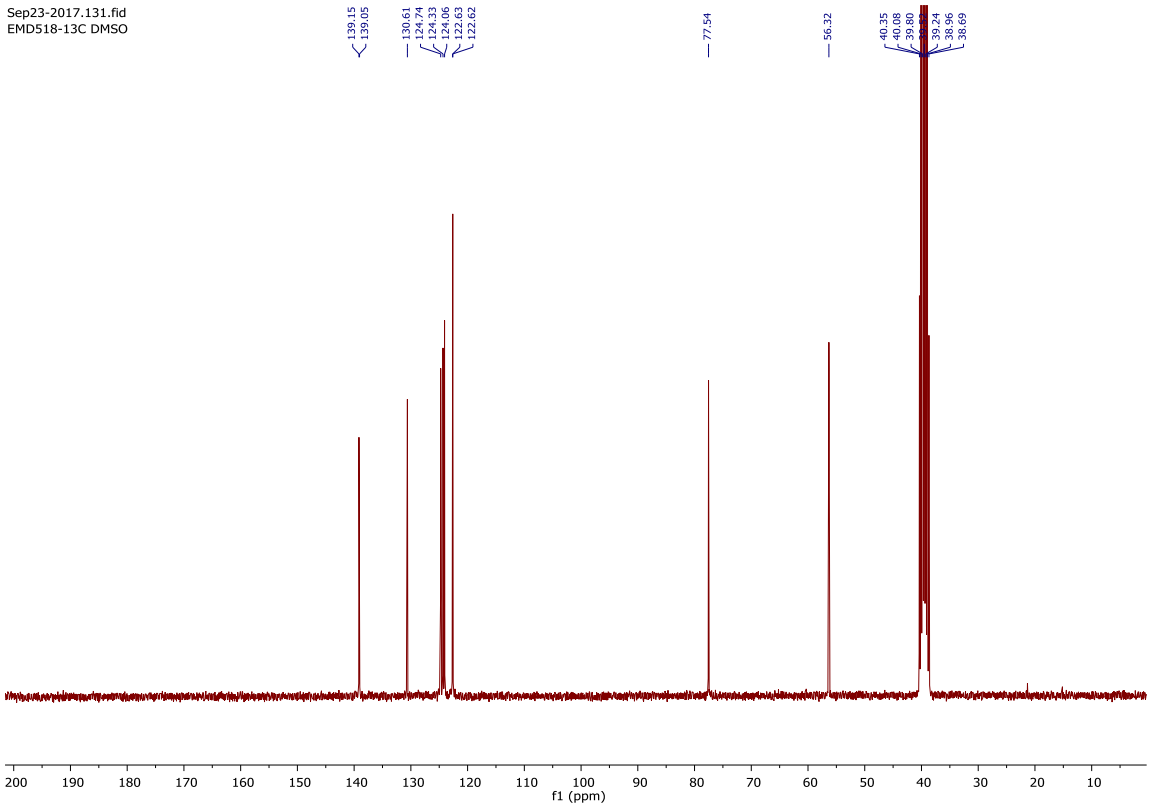
2-nitro-1-(1-tosyl-1H-indol-3-yl)ethane-1-sulfonic acid (2i)



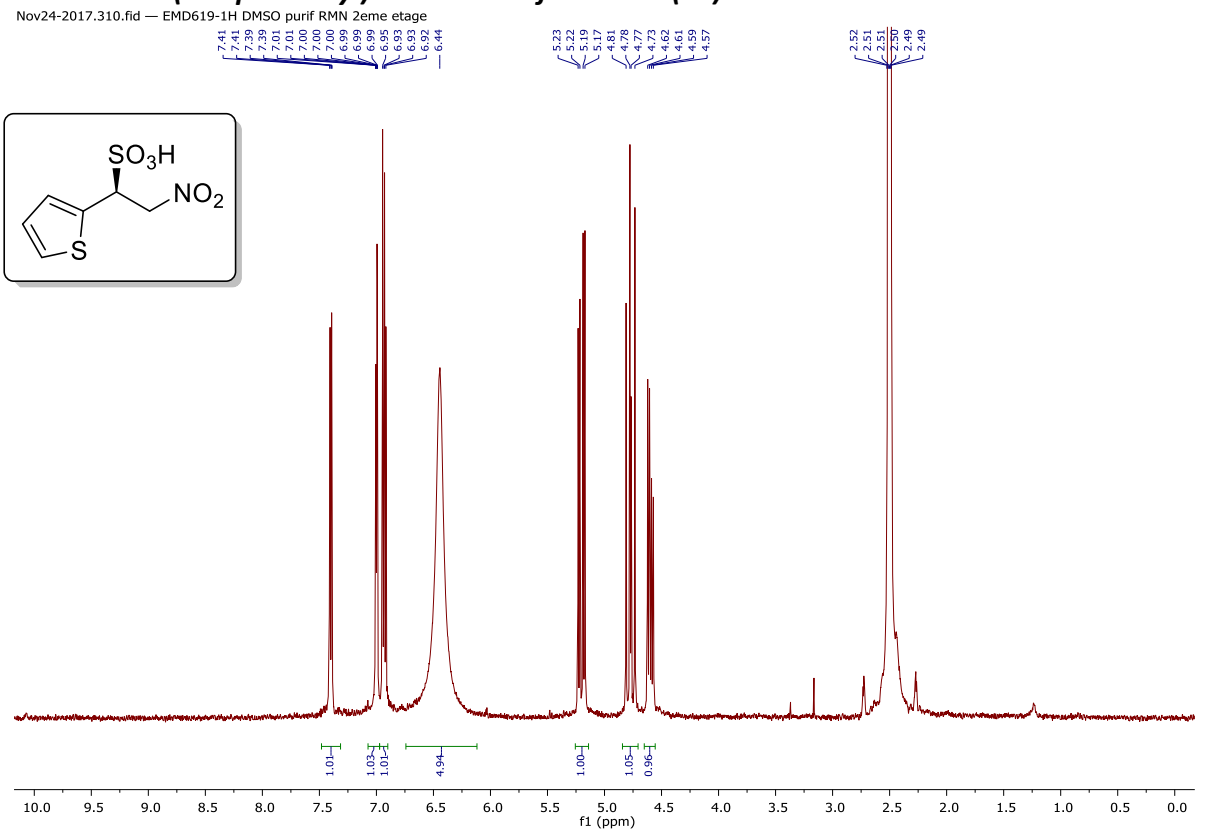


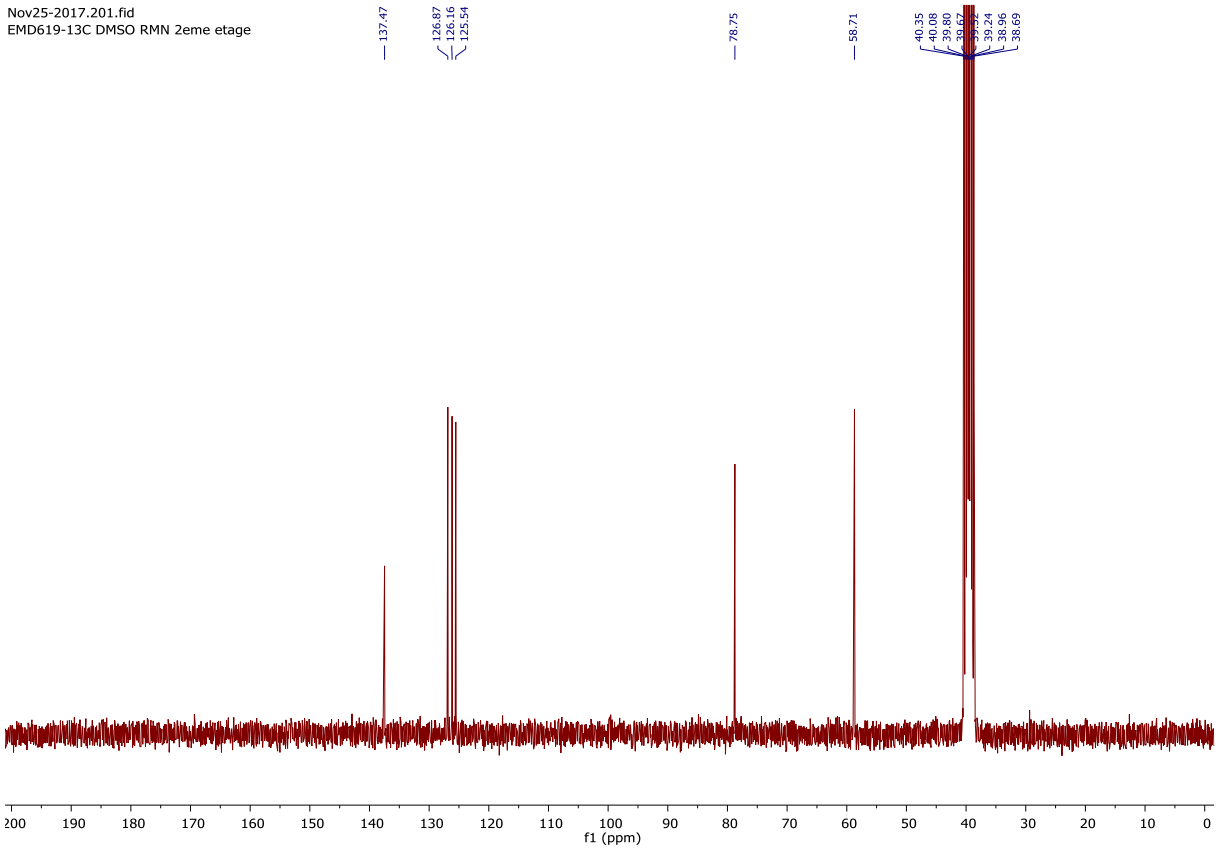
1-(benzo[b]thiophen-3-yl)-2-nitroethane-1-sulfonic acid (2j)



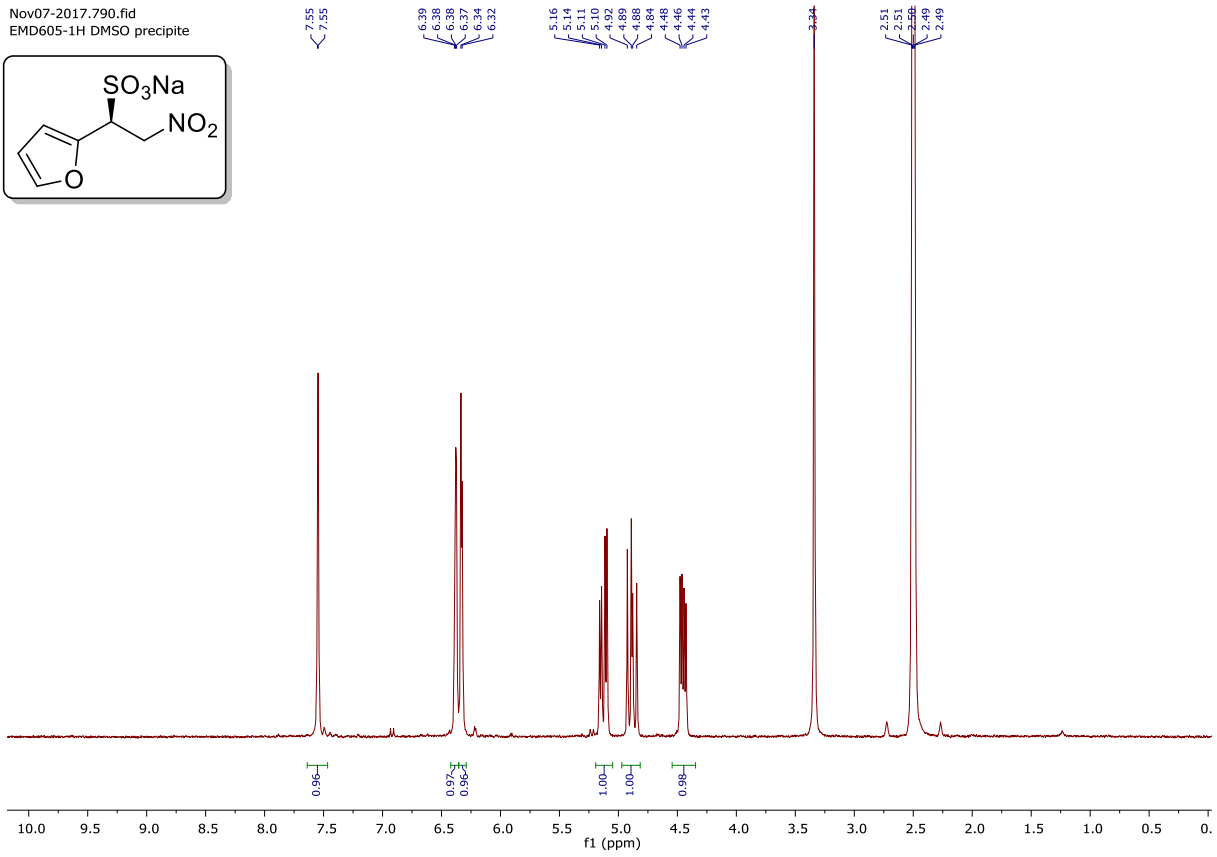


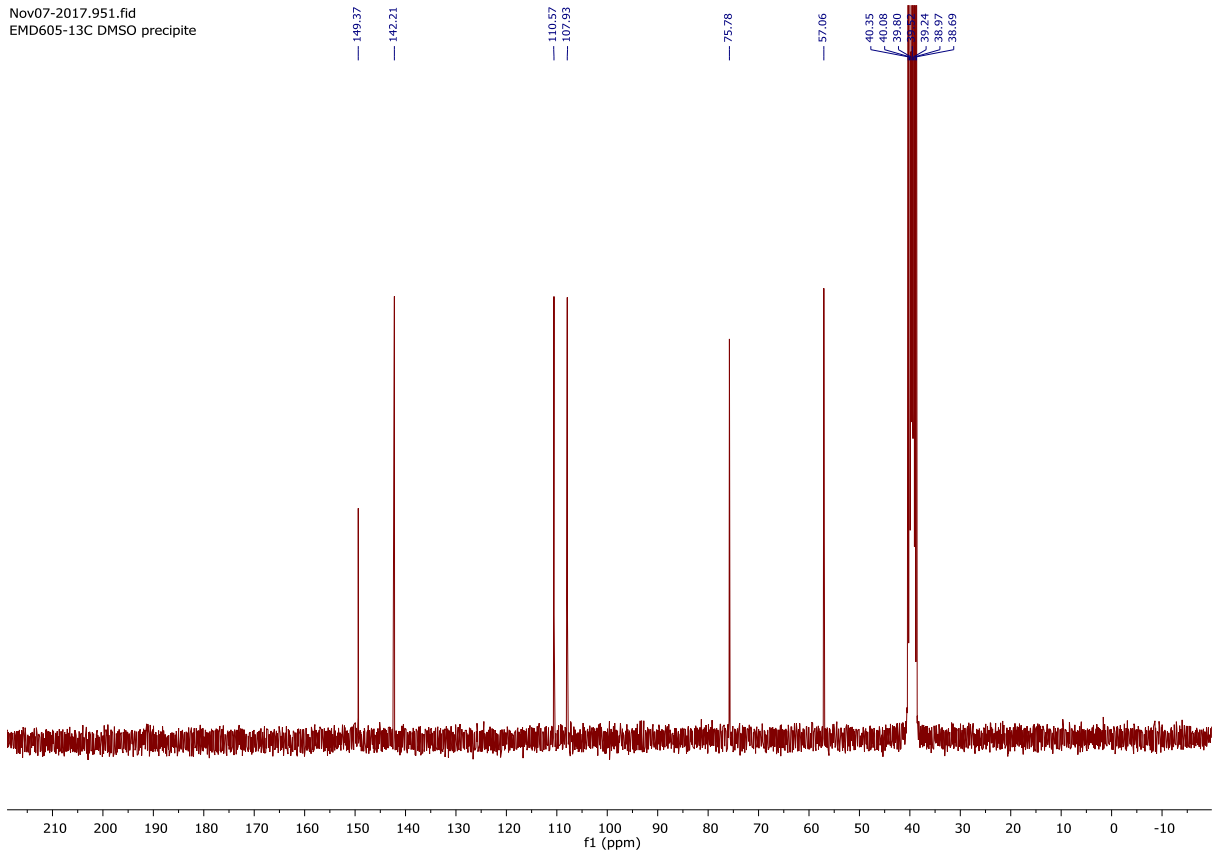
2-Nitro-1-(thiophen-2-yl)ethane-1-sulfonic acid (2k)



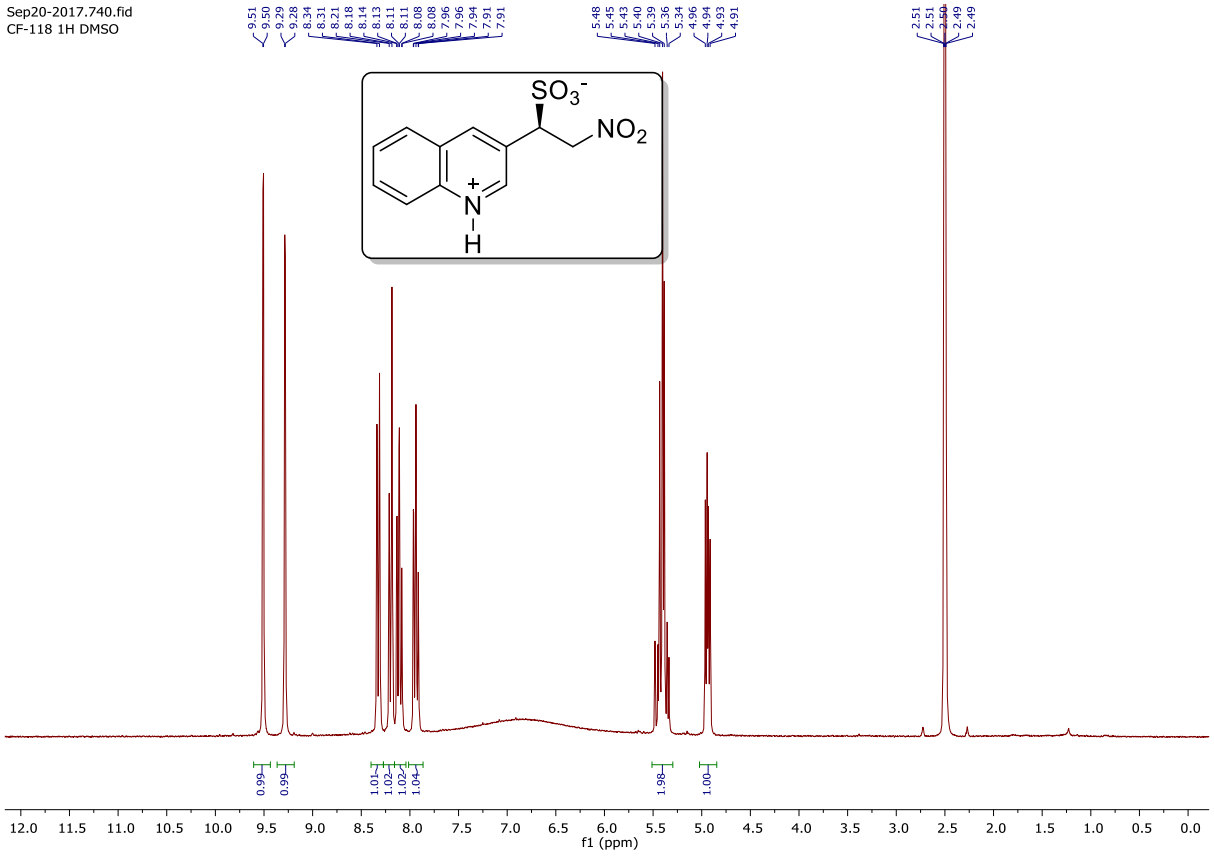


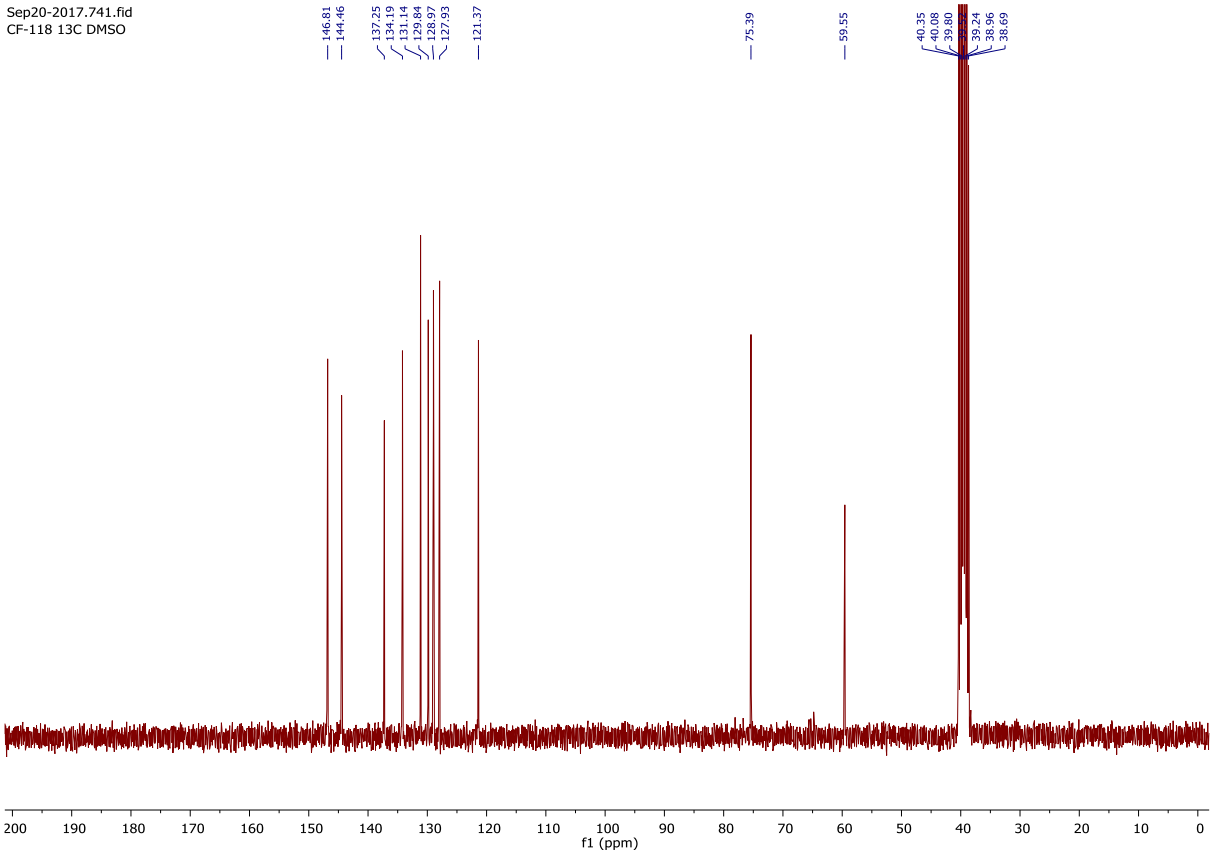
sodium (S)-1-(furan-2-yl)-2-nitroethane-1-sulfonate (2l)



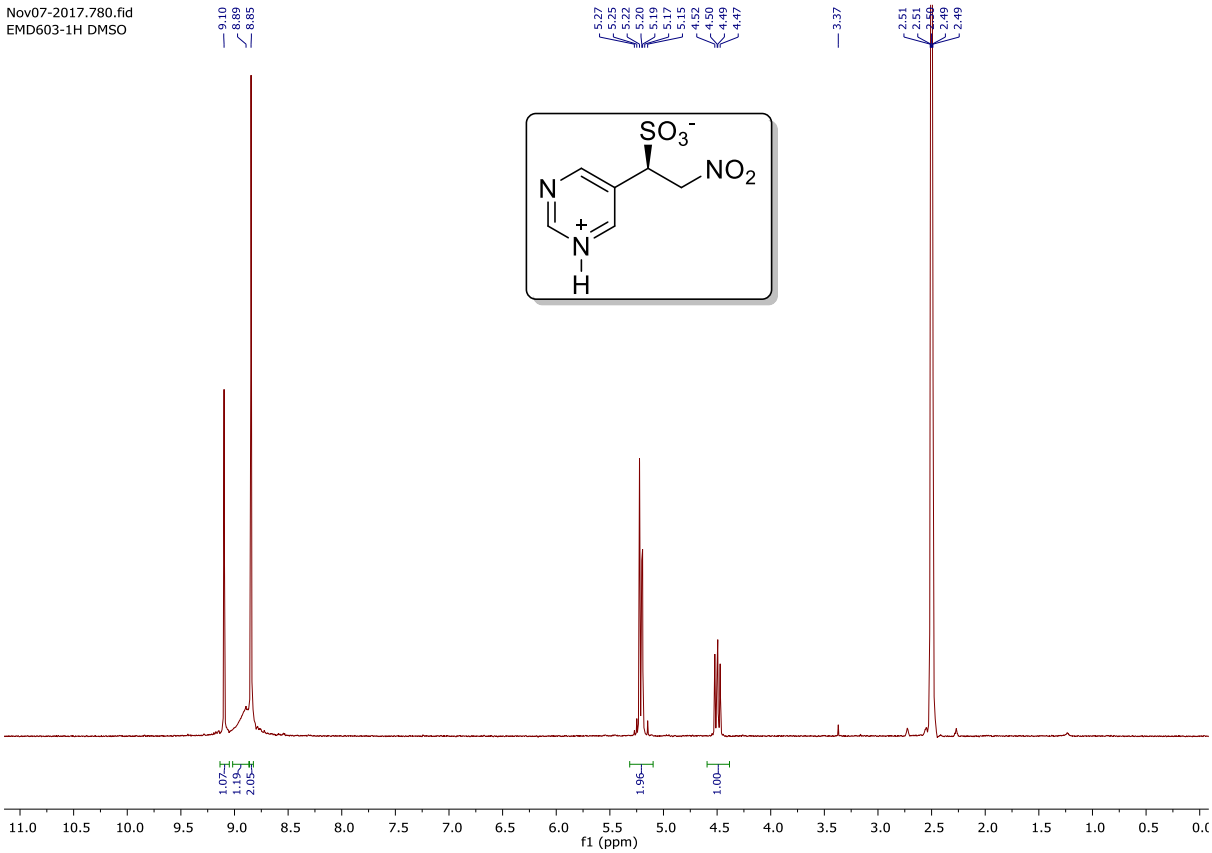


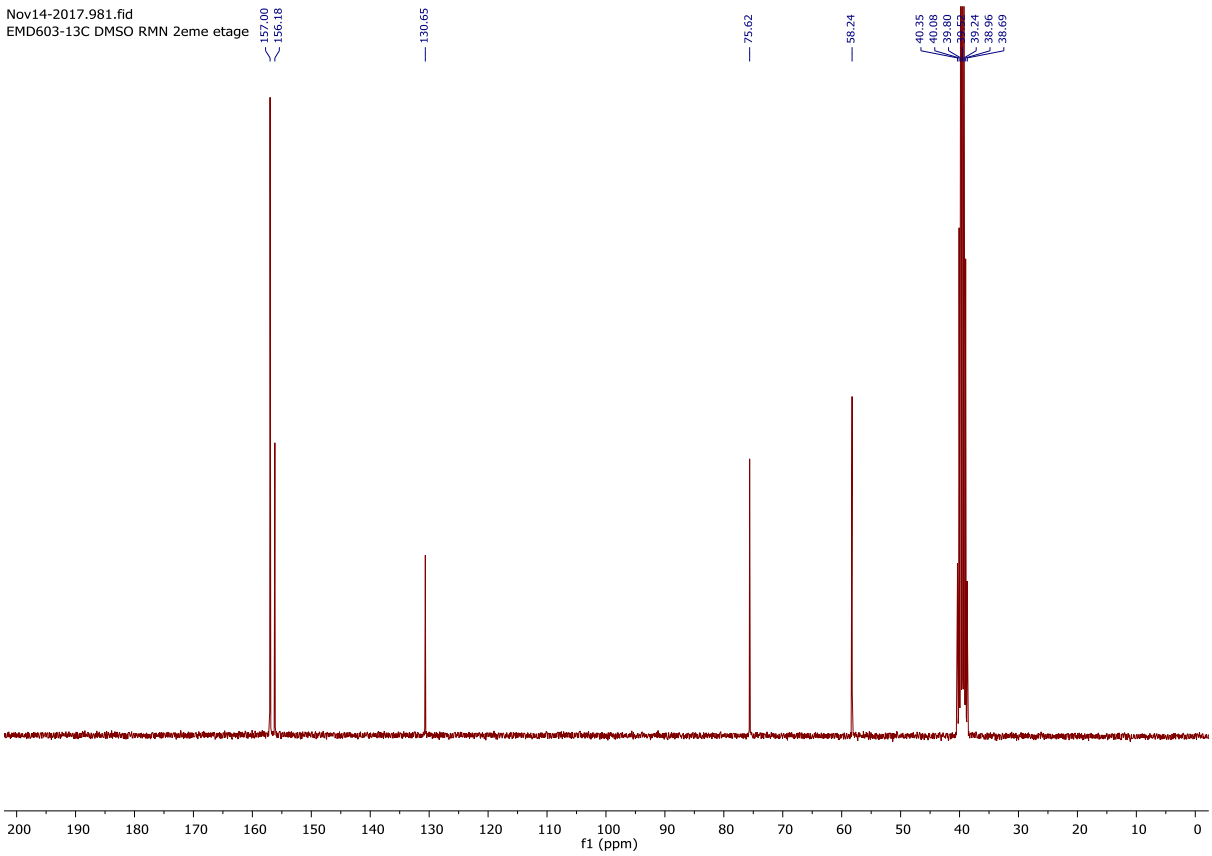
2-Nitro-1-(quinolin-1-ium-3-yl)ethane-1-sulfonate (2m)



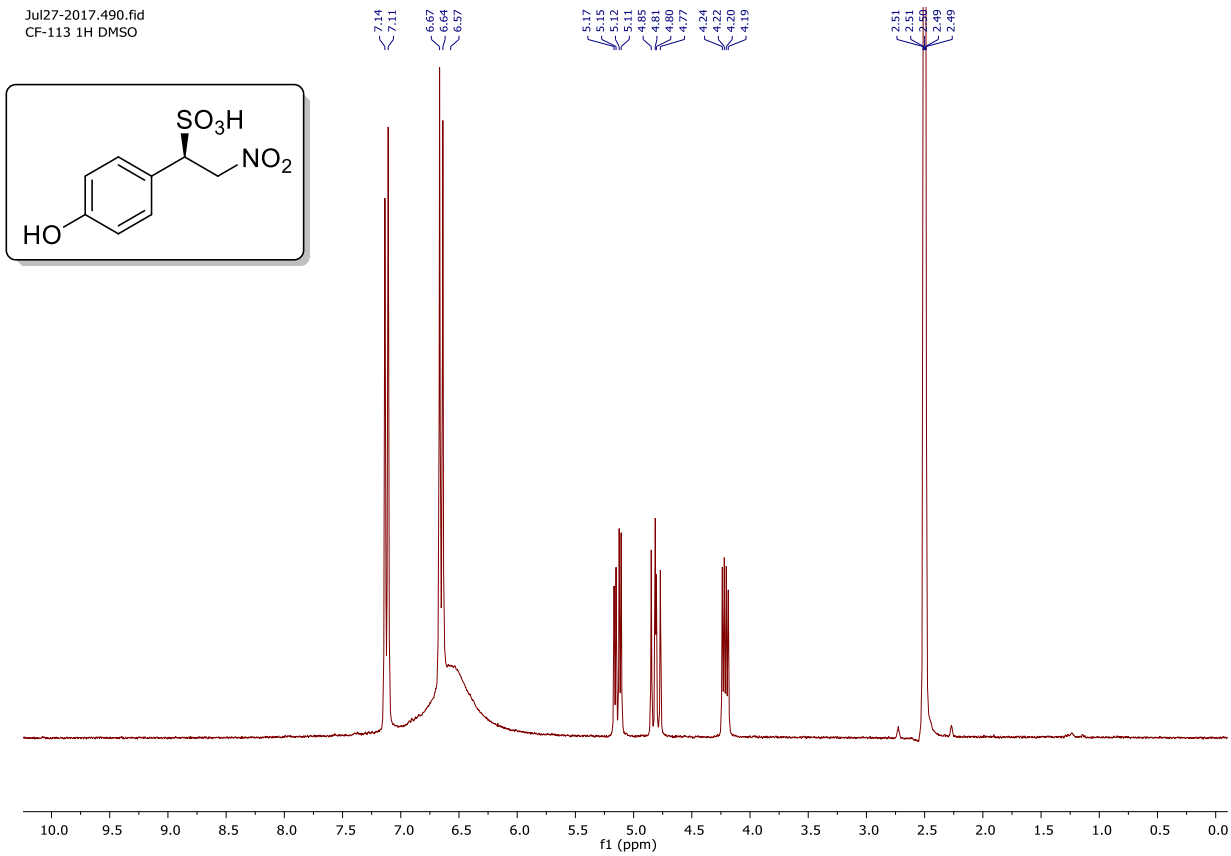


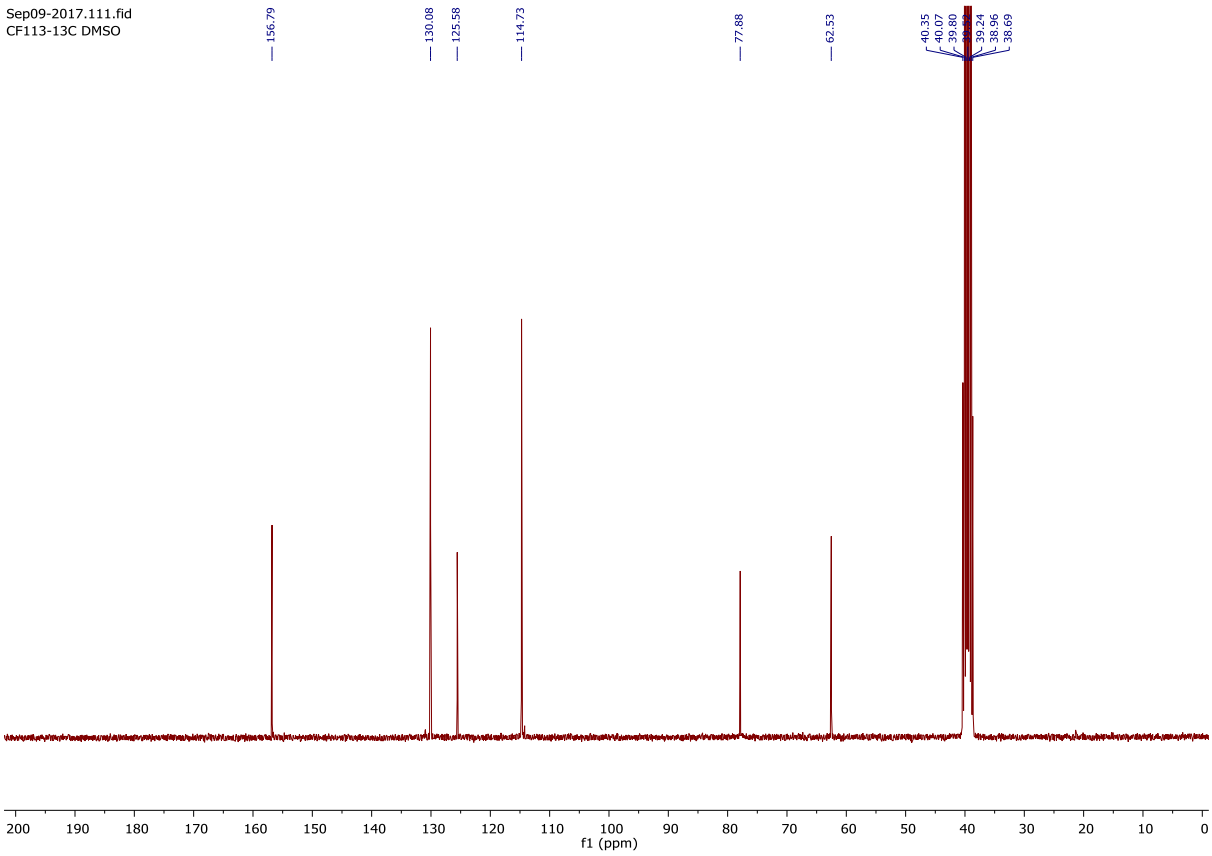
2-nitro-1-(pyrimidin-1-ium-5-yl)ethane-1-sulfonate (2n)



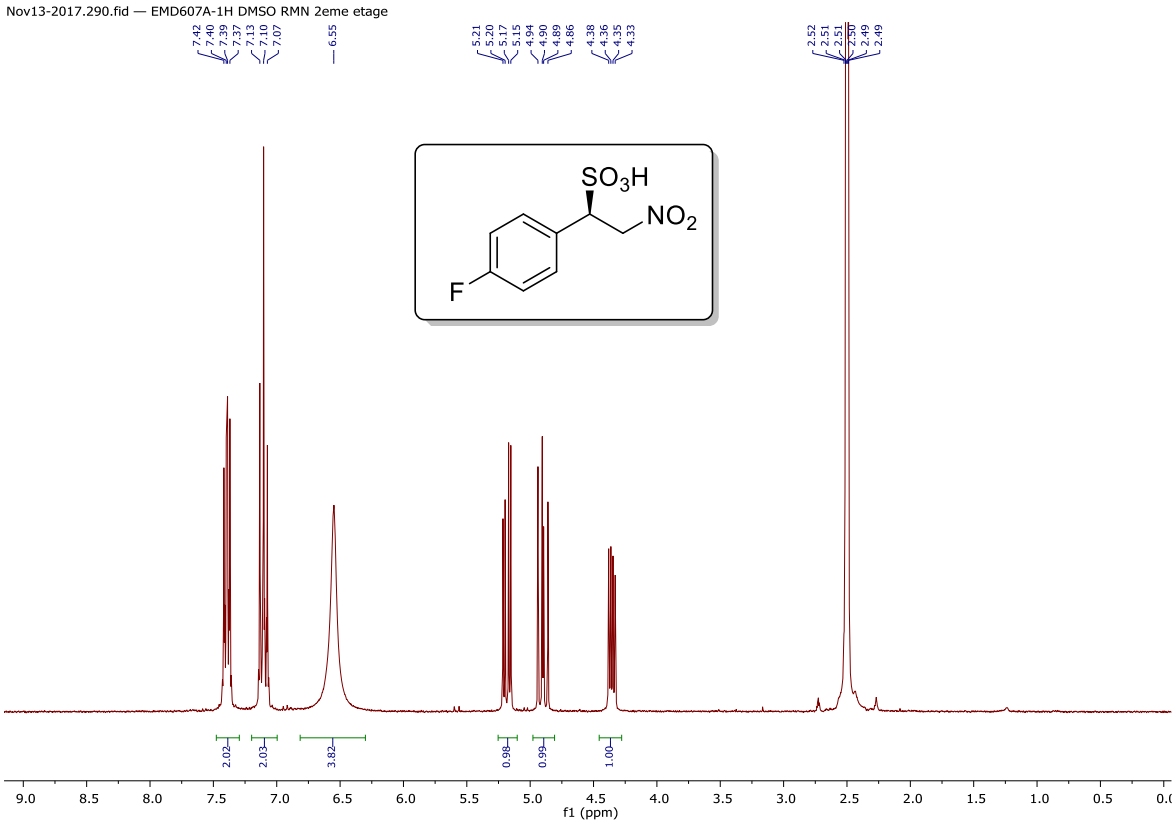


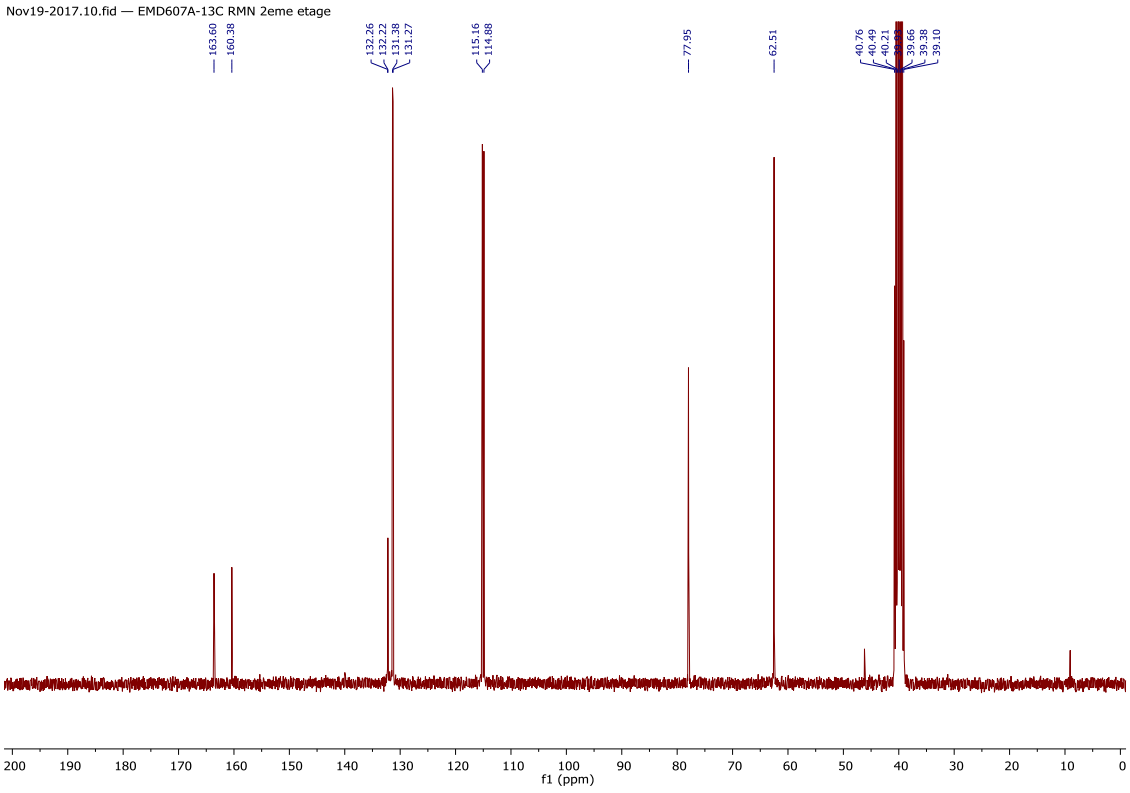
1-(4-hydroxyphenyl)-2-nitroethane-1-sulfonic acid (2o)



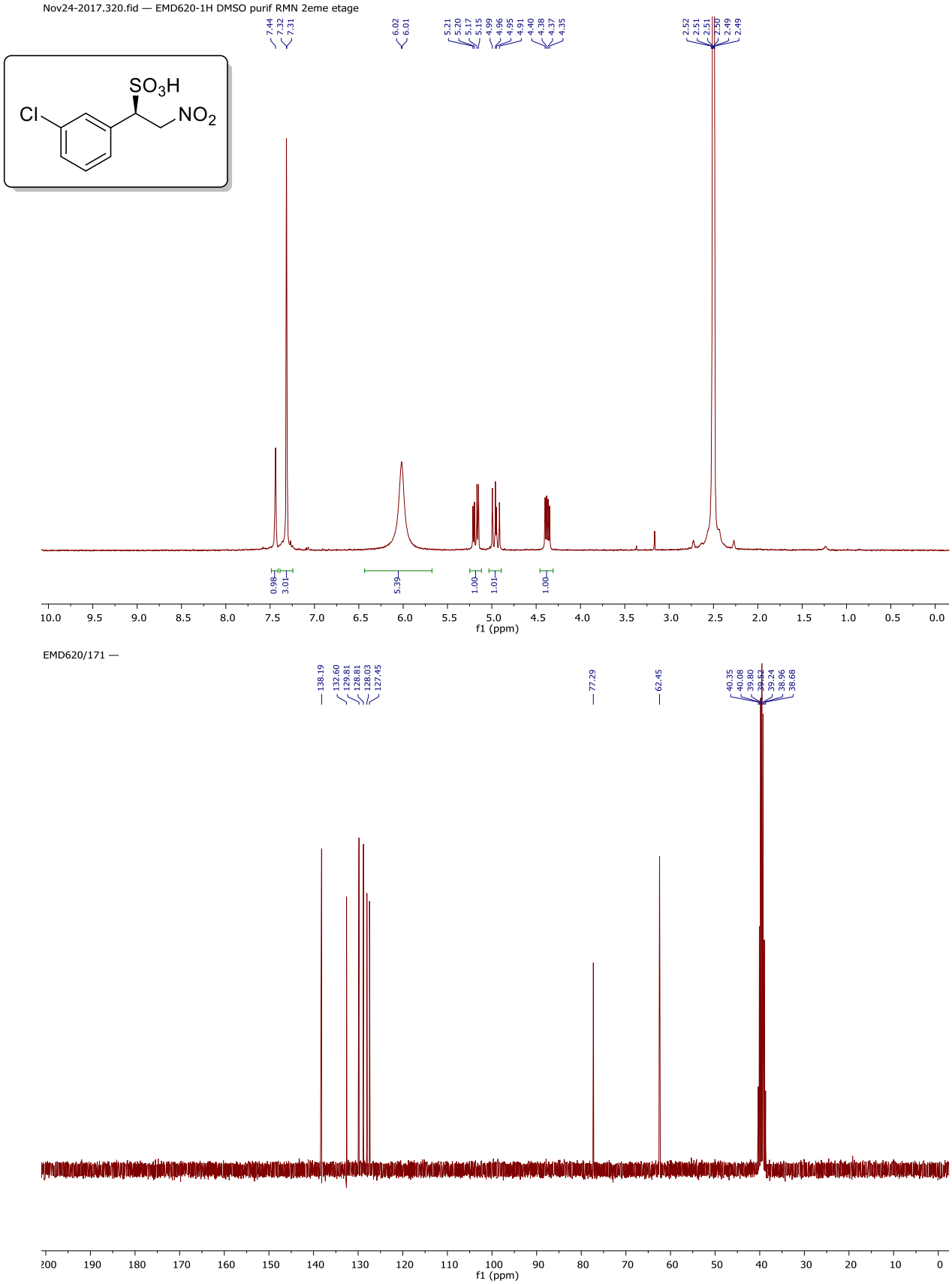


1-(4-bromophenyl)-2-nitroethane-1-sulfonic acid (2p)

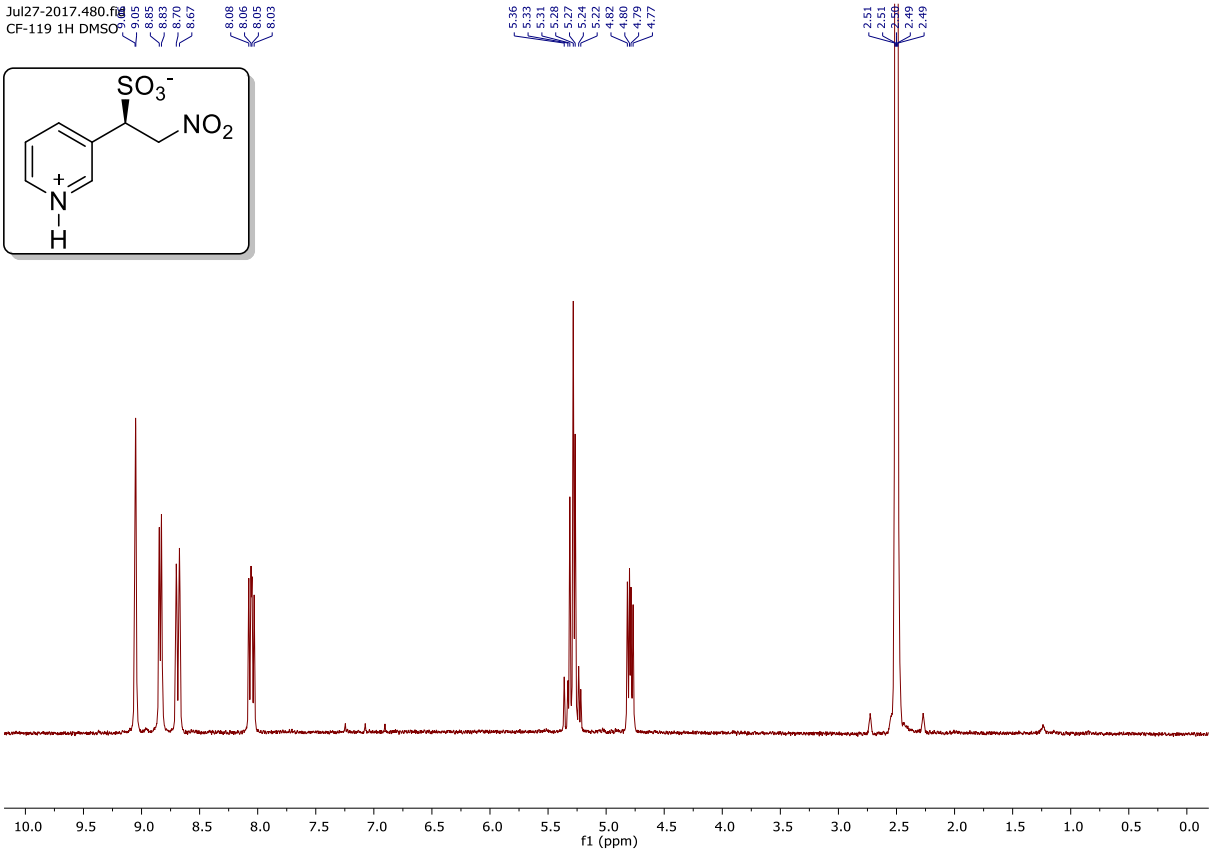


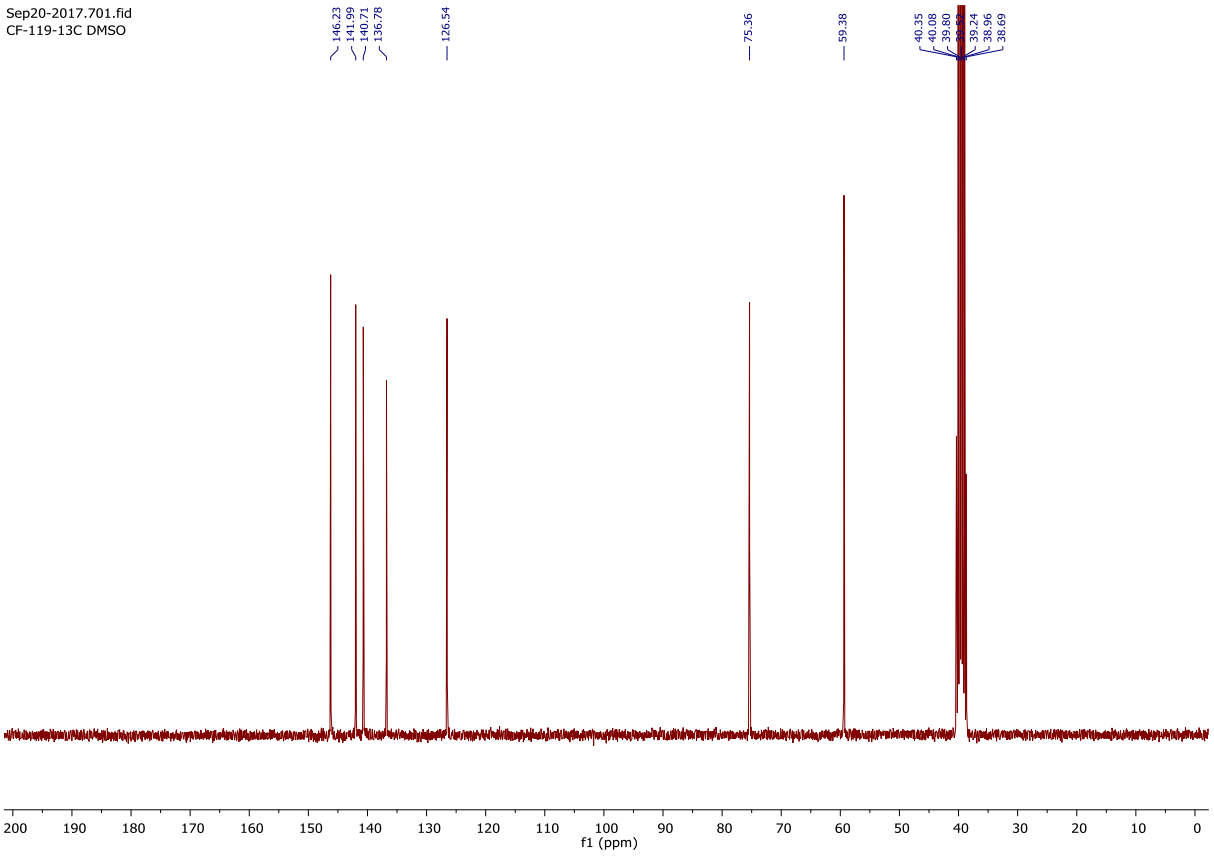


1-(3-Chlorophenyl)-2-nitroethane-1-sulfonic acid (2q)

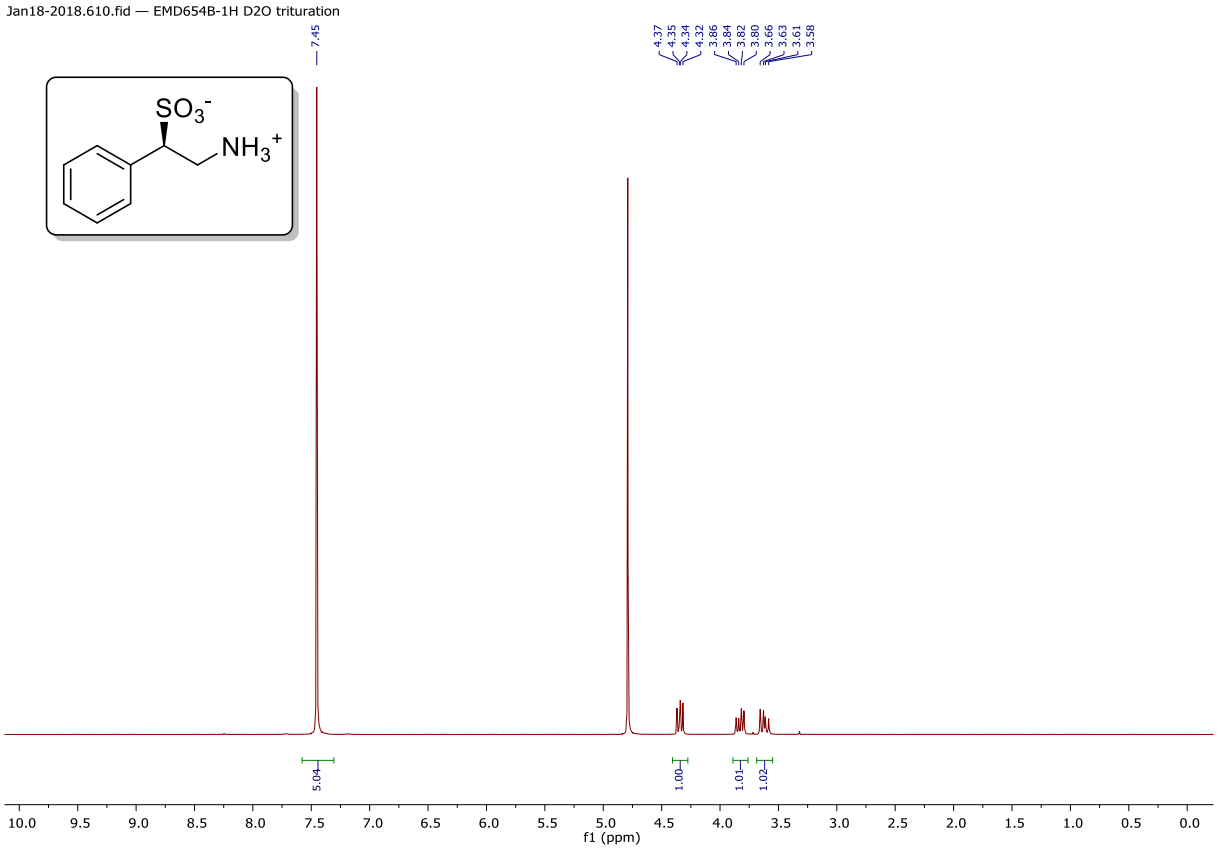


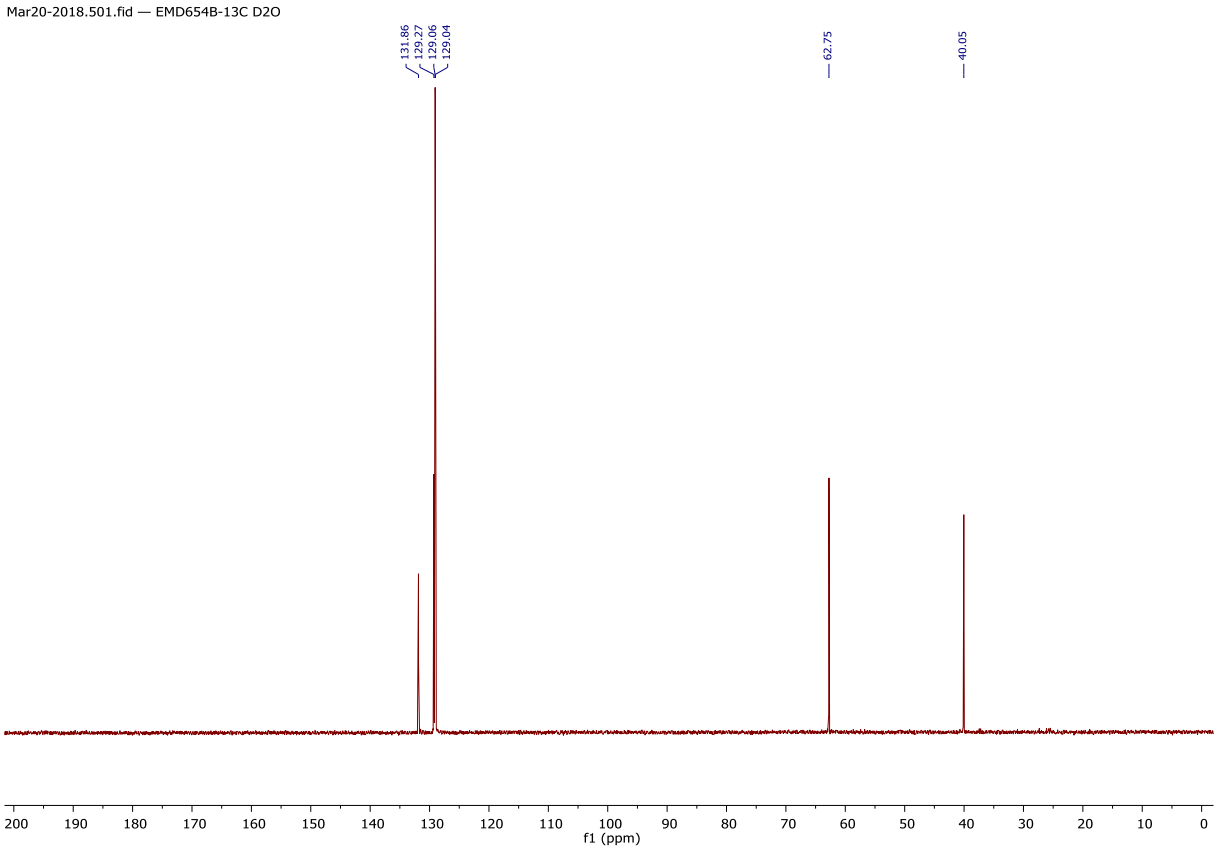
2-Nitro-1-(pyridin-1-ium-3-yl)ethane-1-sulfonate (2r)



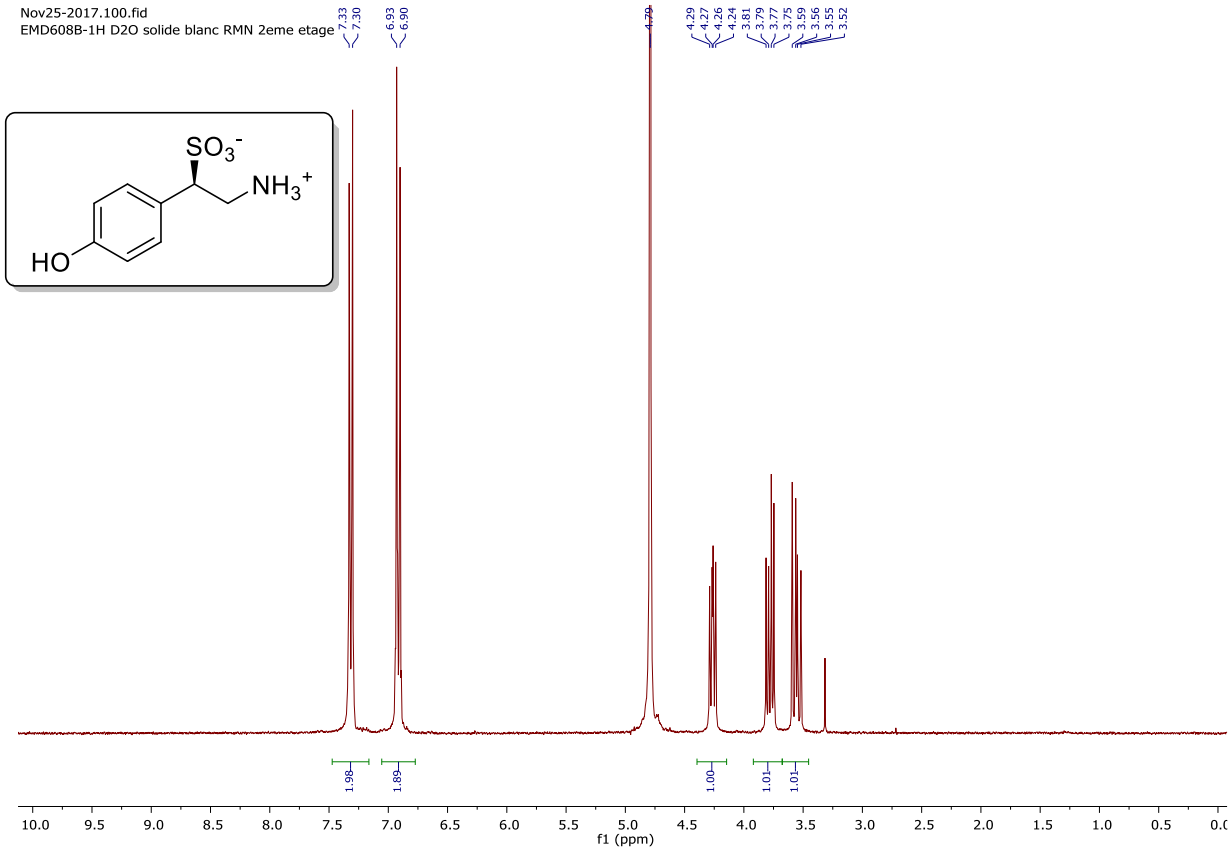


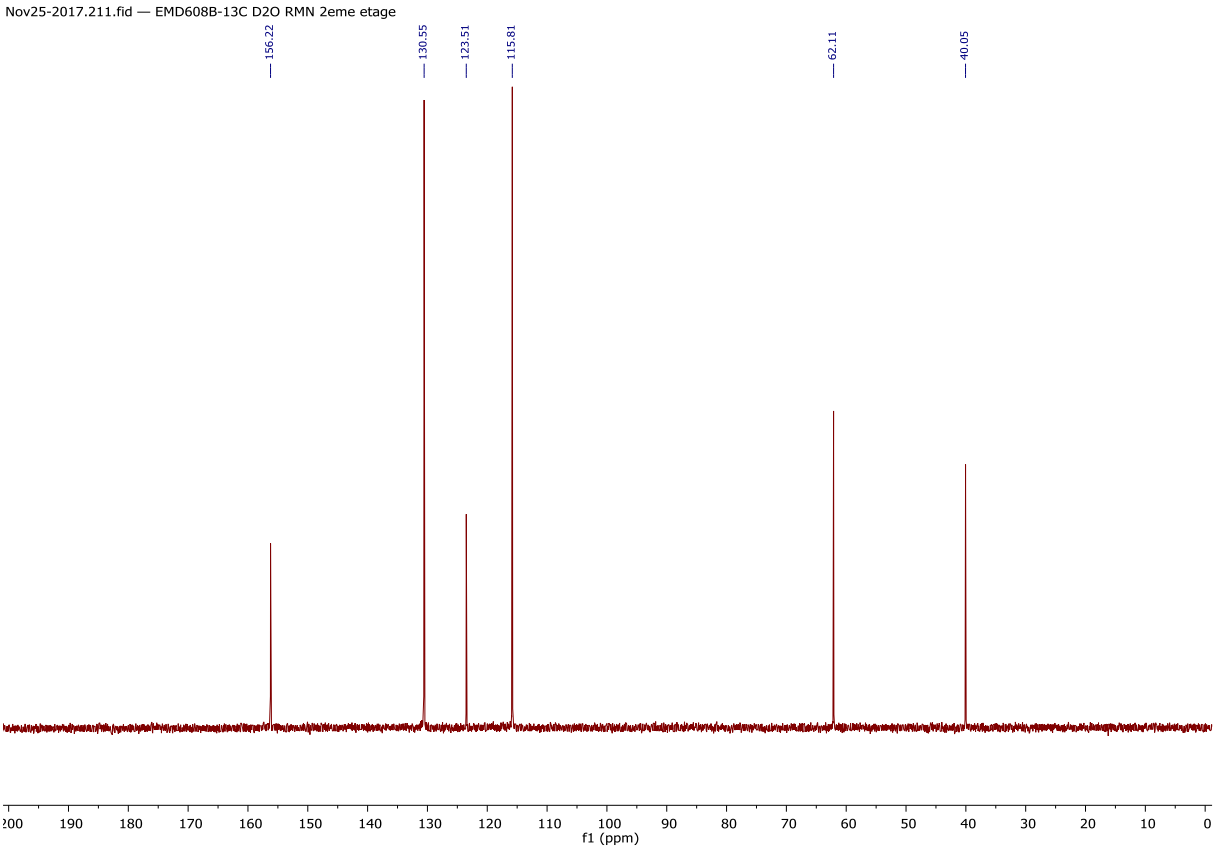
2-ammonio-1-phenylethane-1-sulfonate (4a)



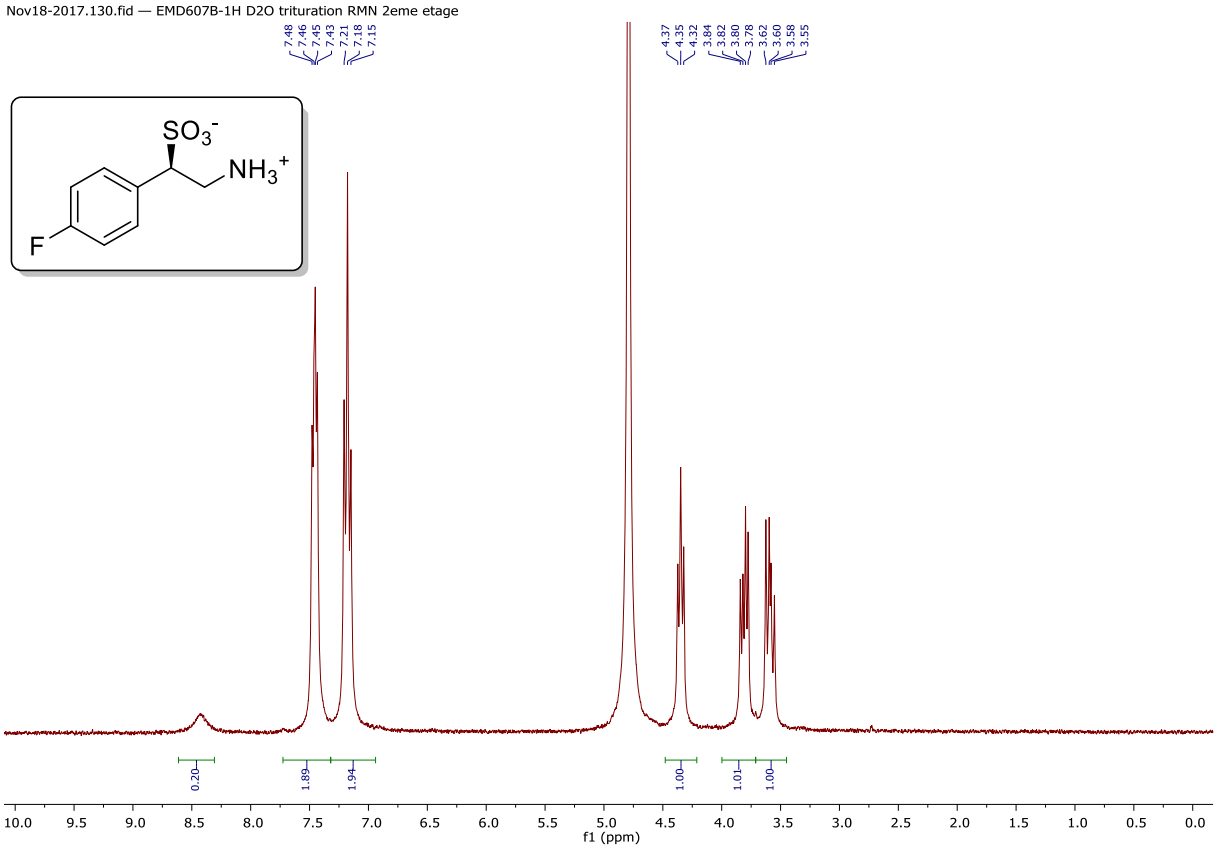


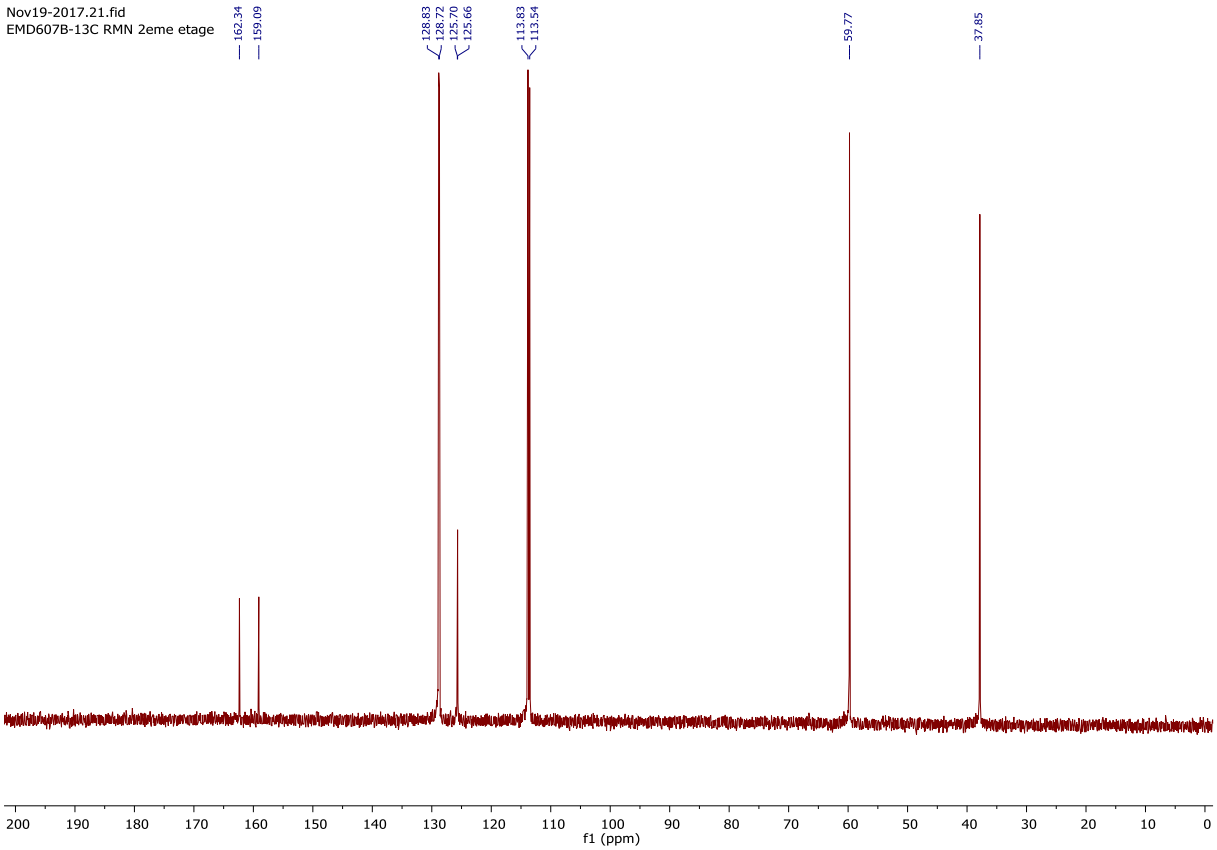
2-ammonio-1-(4-hydroxyphenyl)ethane-1-sulfonate (4b)



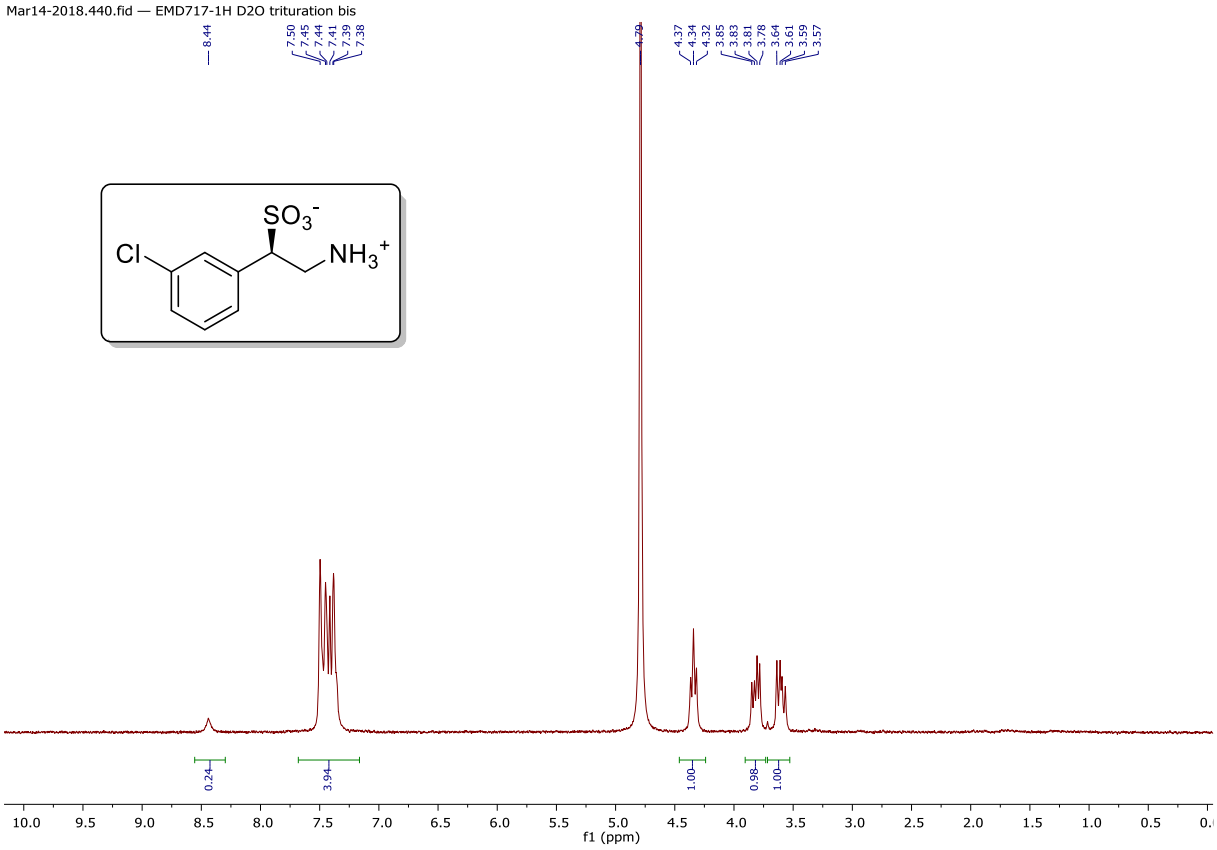


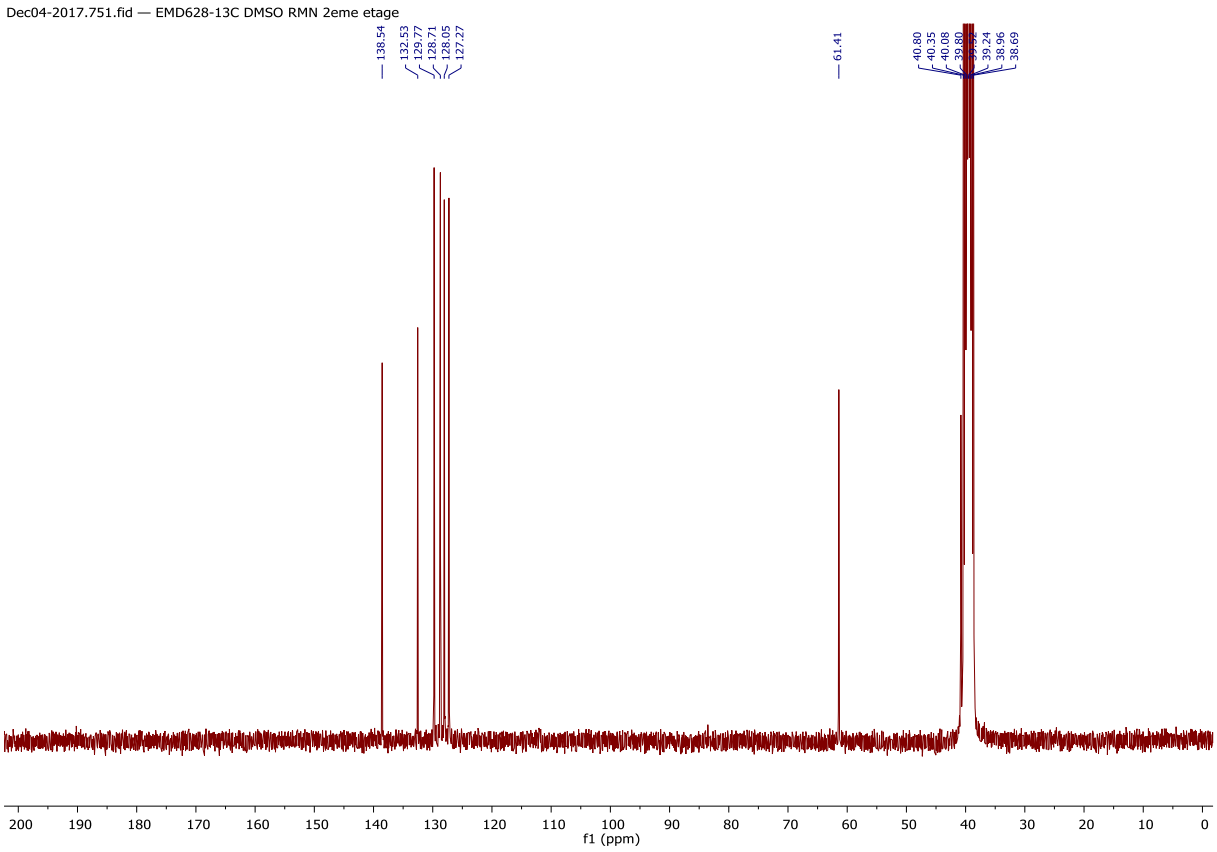
2-ammonio-1-(4-fluorophenyl)ethane-1-sulfonate (4c)



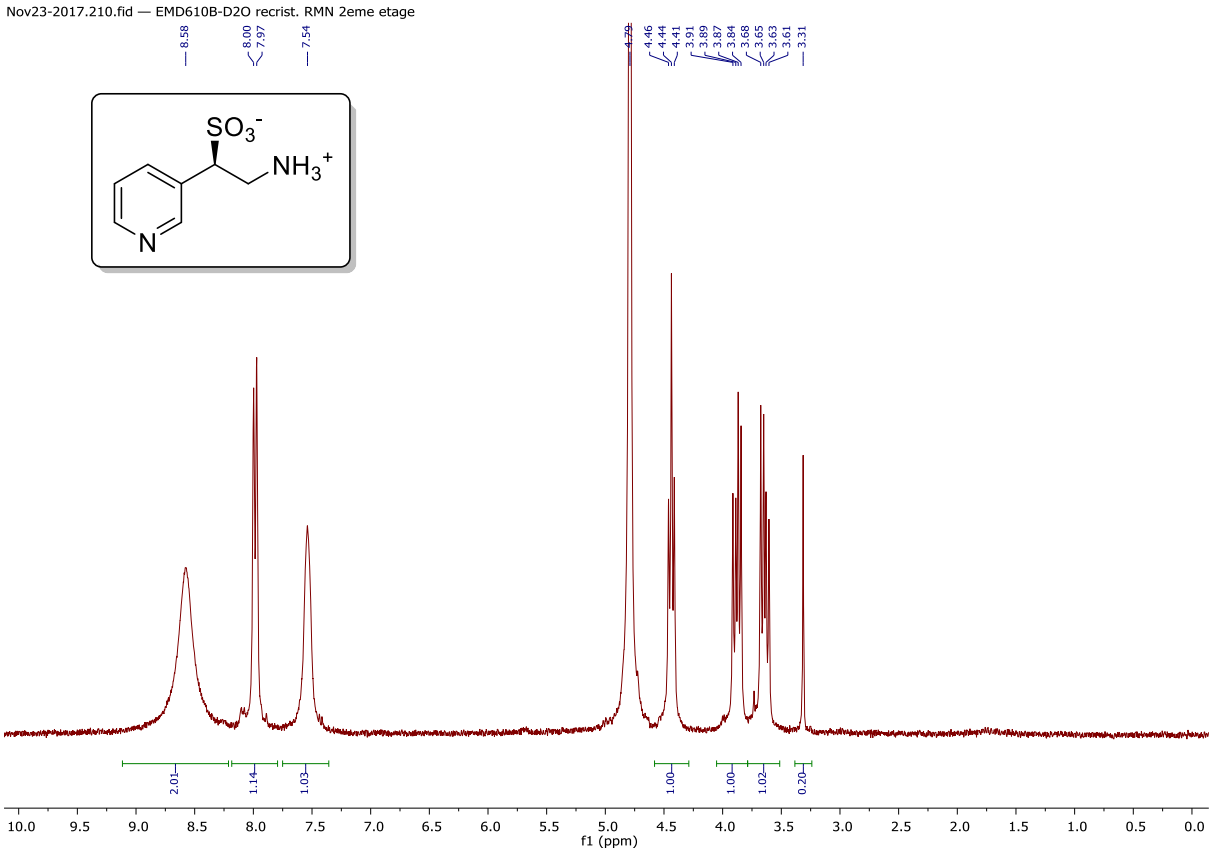


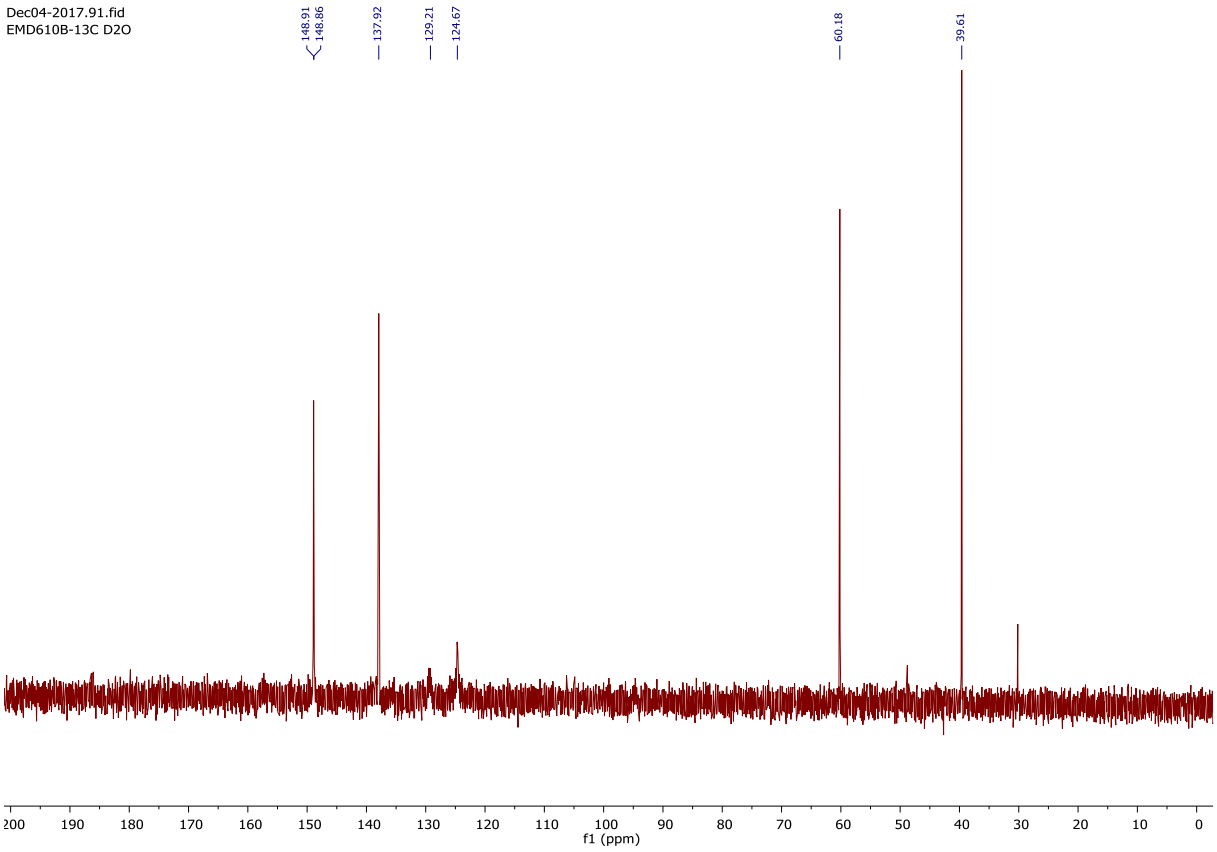
2-ammonio-1-(3-chlorophenyl)ethane-1-sulfonate (4d)





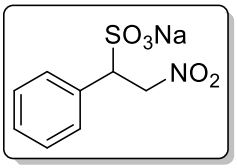
2-ammonio-1-(pyridin-3-yl)ethane-1-sulfonate (4e)



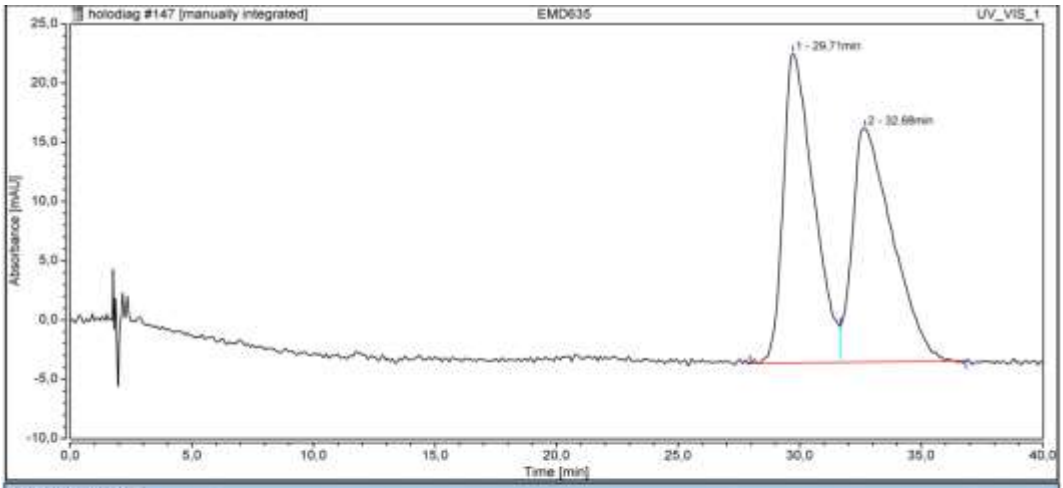


VIII HPLC Analyses

2-nitro-1-phenylethane-1-sulfonic acid (2a)



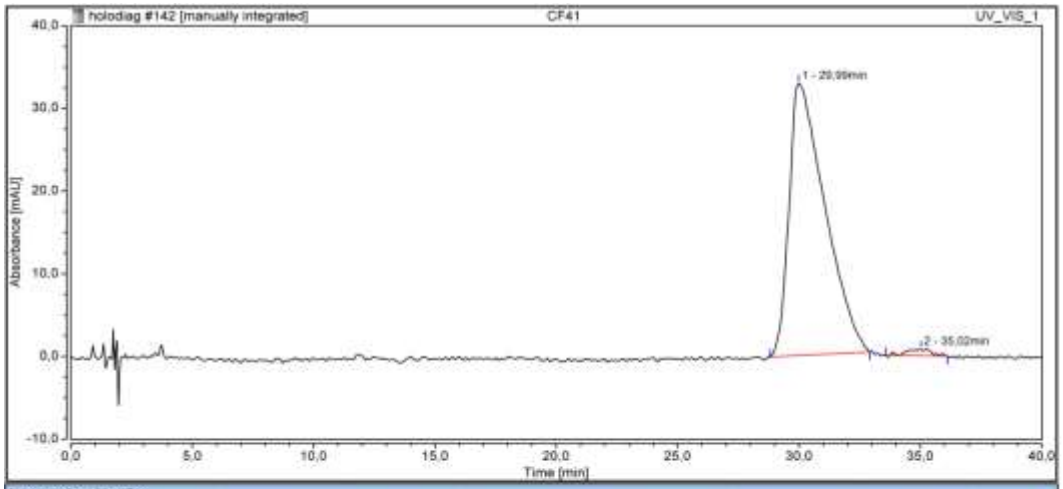
Racemic



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		29,71	38,011	26,111	50,21	56,97	n.a.
2		32,68	37,698	19,725	49,79	43,03	n.a.
Total:			**75,709**	**45,836**	**100,00**	**100,00**	

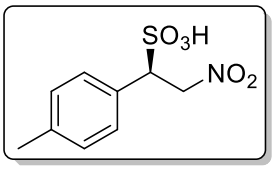
Enantioenriched (95% ee)



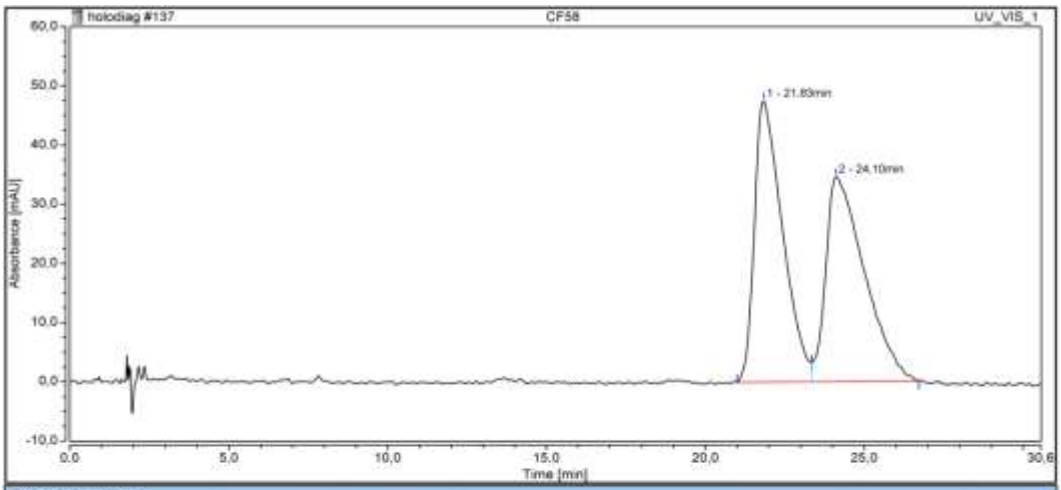
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		29,99	56,353	32,961	98,37	97,57	n.a.
2		35,02	0,936	0,822	1,63	2,43	n.a.
Total:			**57,289**	**33,783**	**100,00**	**100,00**	

2-nitro-1-(p-tolyl)ethane-1-sulfonic acid (2b)



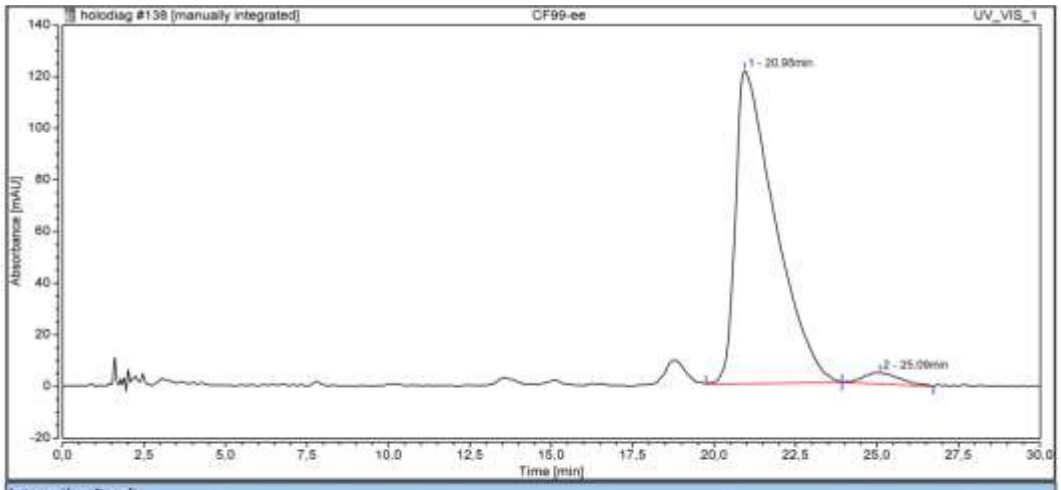
Racemic



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		21,83	48,739	47,530	50,00	57,87	n.a.
2		24,10	48,736	34,602	50,00	42,13	n.a.
Total:			**97,475**	**82,132**	**100,00**	**100,00**	

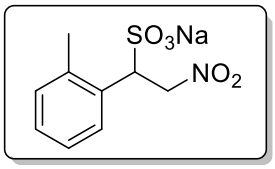
Enantioenriched (93% ee)



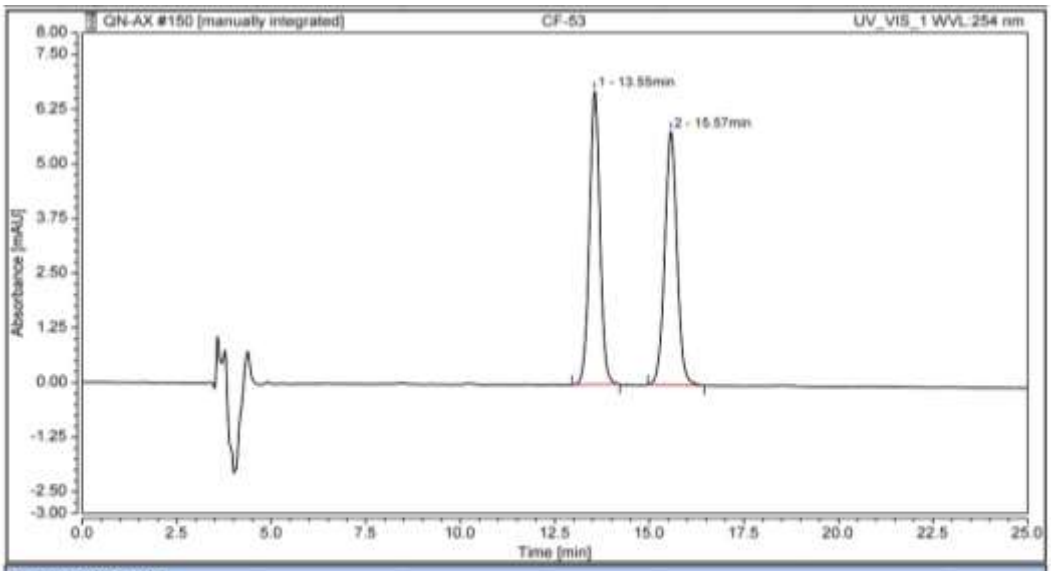
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		20,95	171,095	121,266	96,71	96,47	n.a.
2		25,09	5,814	4,439	3,29	3,53	n.a.
Total:			**176,909**	**125,706**	**100,00**	**100,00**	

2-Nitro-1-(o-tolyl)ethane-1-sulfonic acid (2c)



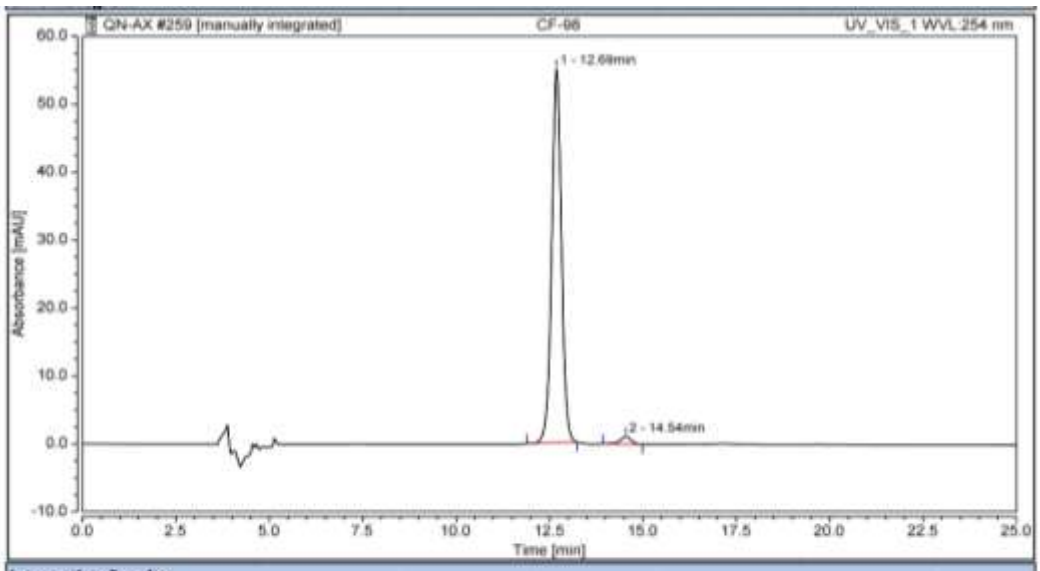
Racemic



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		13.553	2.158	6.709	49.79	53.67	n.a.
2		15.570	2.176	5.792	50.21	46.33	n.a.
Total:			**4.334**	**12.501**	**100.00**	**100.00**	

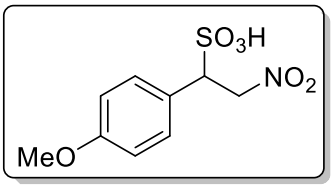
Enantioenriched (96% ee)



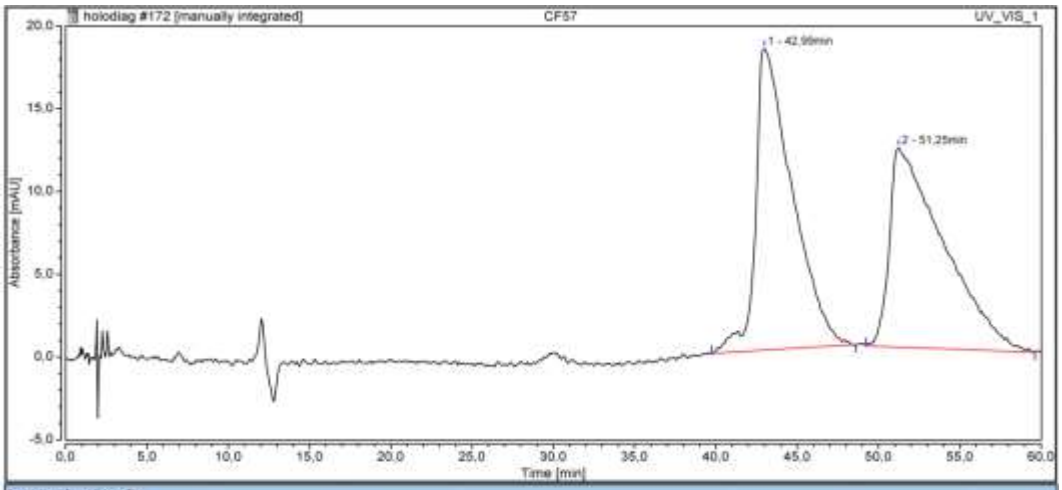
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		12.687	16.565	55.045	97.83	98.14	n.a.
2		14.540	0.368	1.044	2.17	1.86	n.a.
Total:			**16.933**	**56.088**	**100.00**	**100.00**	

1-(4-Methoxyphenyl)-2-nitroethane-1-sulfonic acid (2d)



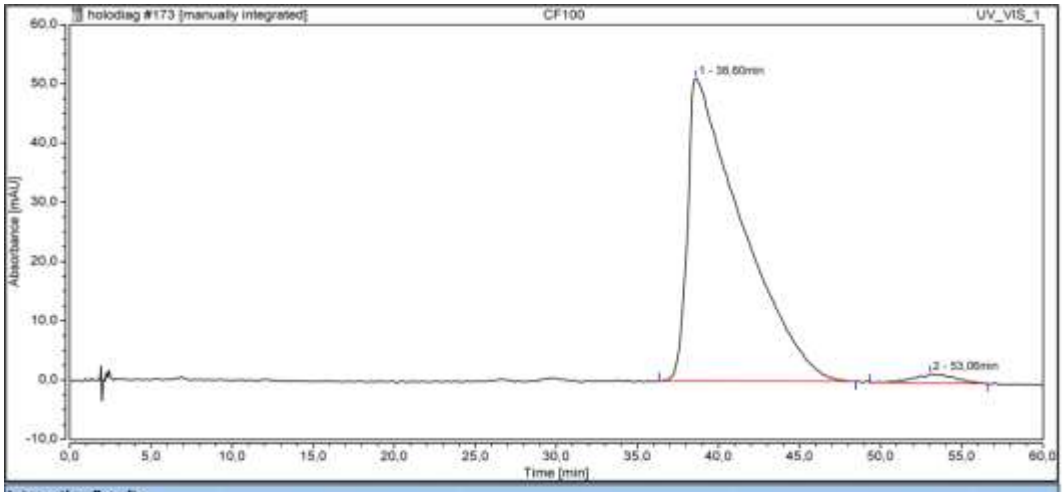
Racemic



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		42,99	47,533	18,218	50,63	60,22	n.a.
2		51,25	46,356	12,035	49,37	39,78	n.a.
Total:			**93,888**	**30,253**	**100,00**	**100,00**	

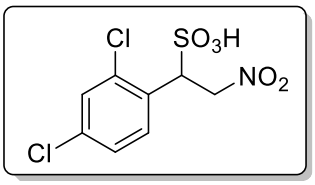
Enantioenriched (95% ee)



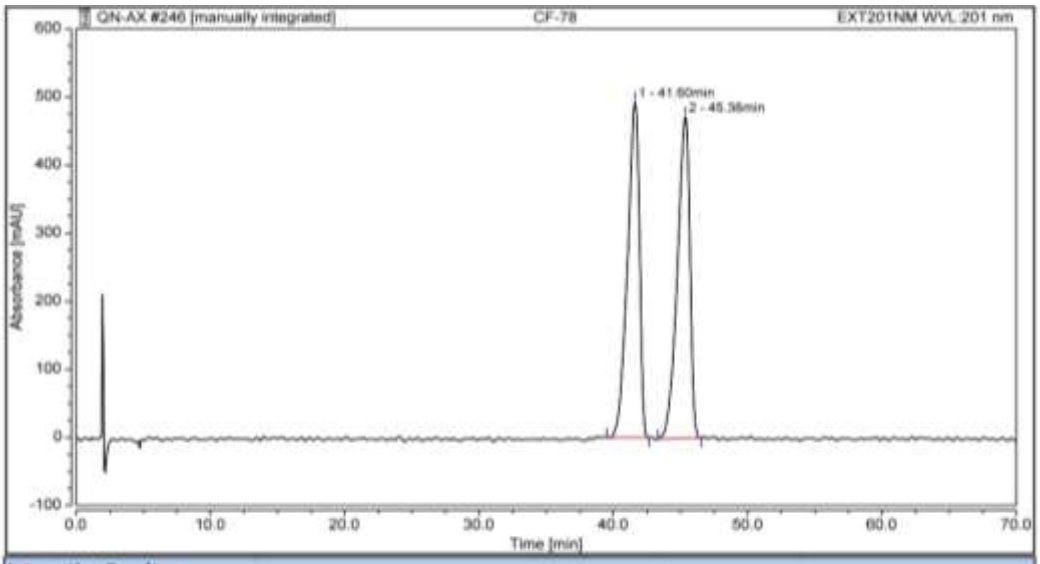
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		38,60	199,288	51,090	97,87	97,09	n.a.
2		53,06	4,327	1,532	2,13	2,91	n.a.
Total:			**203,615**	**52,622**	**100,00**	**100,00**	

1-(2,4-Dichlorophenyl)-2-nitroethane-1-sulfonic acid (2e)



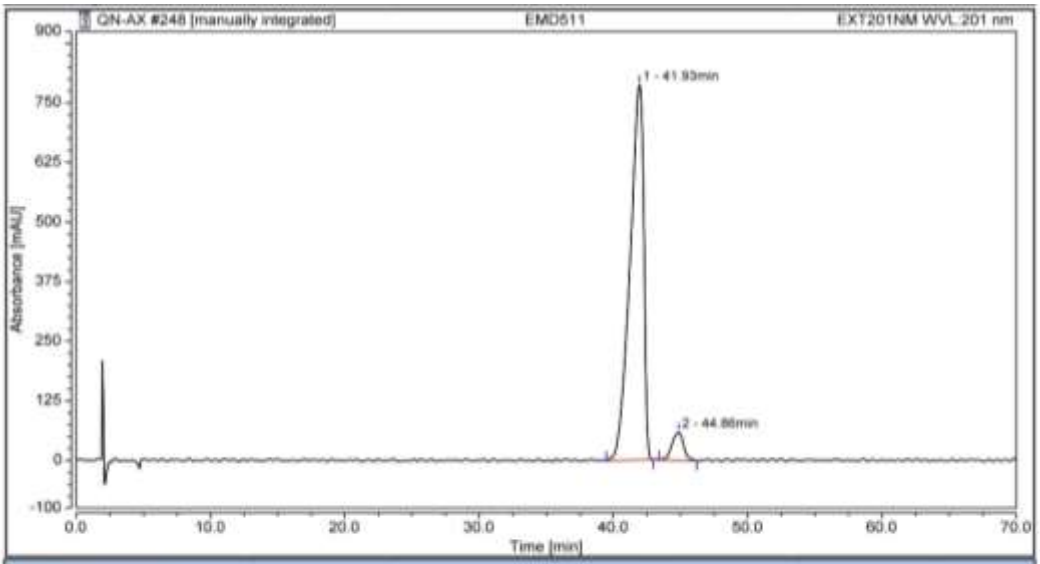
Racemic



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		41.600	504.459	492.649	49.72	51.05	n.a.
2		45.360	510.130	472.465	50.28	48.95	n.a.
Total:			**1014.589**	**965.114**	**100.00**	**100.00**	

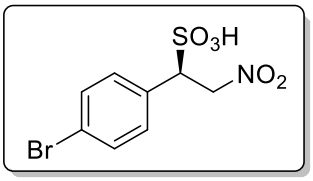
Enantioenriched (86% ee)



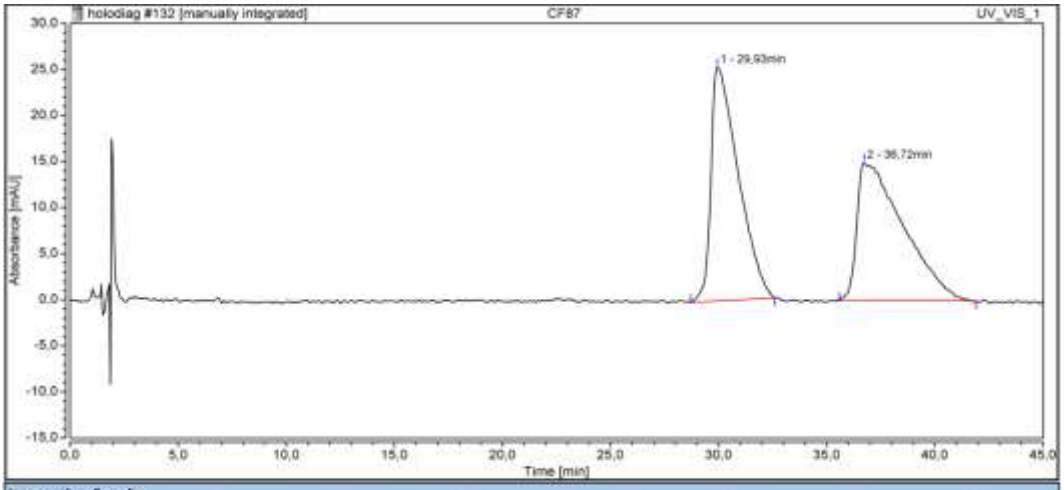
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		41.933	929.928	786.874	93.94	93.05	n.a.
2		44.857	59.973	58.798	6.06	6.95	n.a.
Total:			**989.901**	**845.672**	**100.00**	**100.00**	

1-(4-Bromophenyl)-2-nitroethane-1-sulfonic acid (2f)



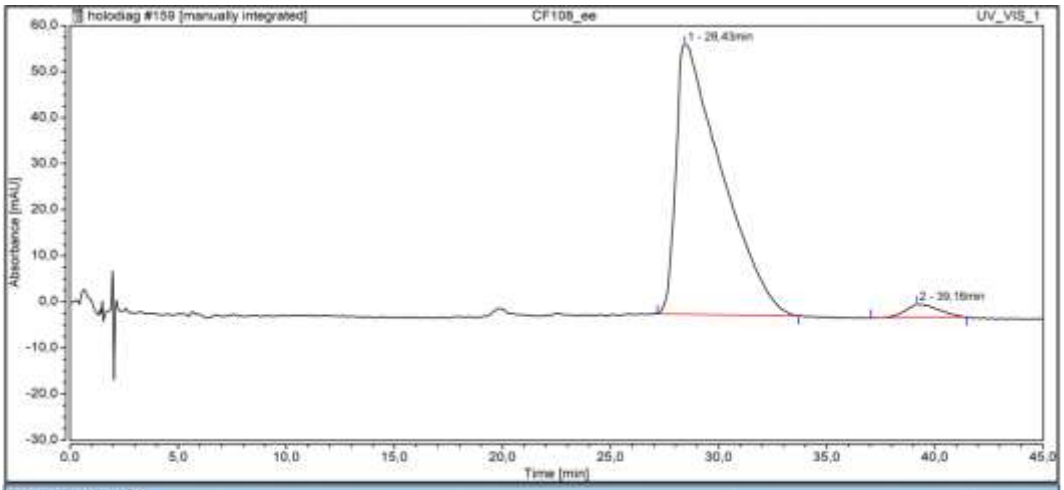
Racemic



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		29,93	37,136	25,430	50,01	62,88	n.a.
2		36,72	37,117	15,011	49,99	37,12	n.a.
Total:			**74,253**	**40,441**	**100,00**	**100,00**	

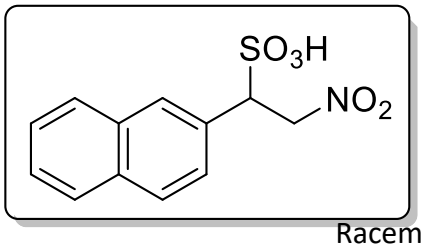
Enantioenriched (93% ee)



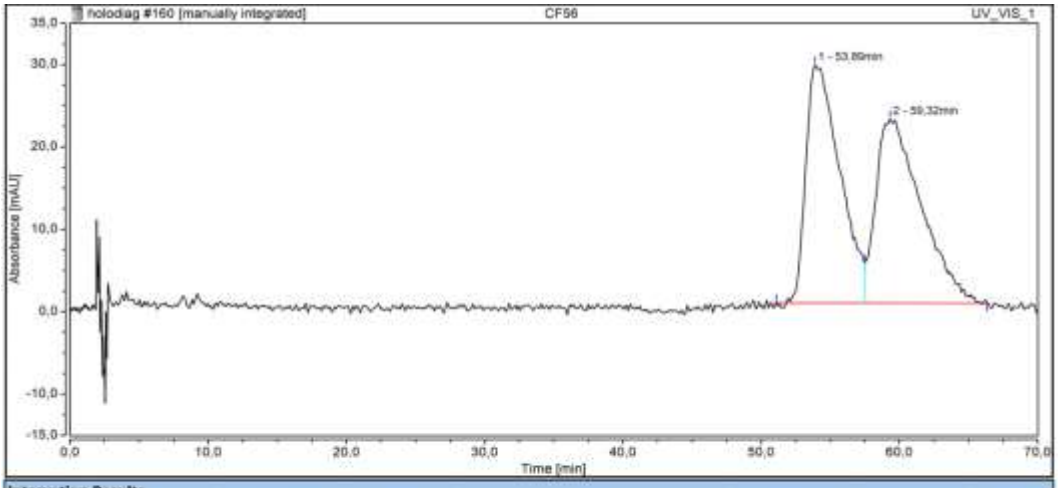
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		28,43	143,871	58,573	96,65	95,28	n.a.
2		39,16	4,987	2,899	3,35	4,72	n.a.
Total:			**148,858**	**61,472**	**100,00**	**100,00**	

1-(Naphthalen-2-yl)-2-nitroethane-1-sulfonic acid (2g)



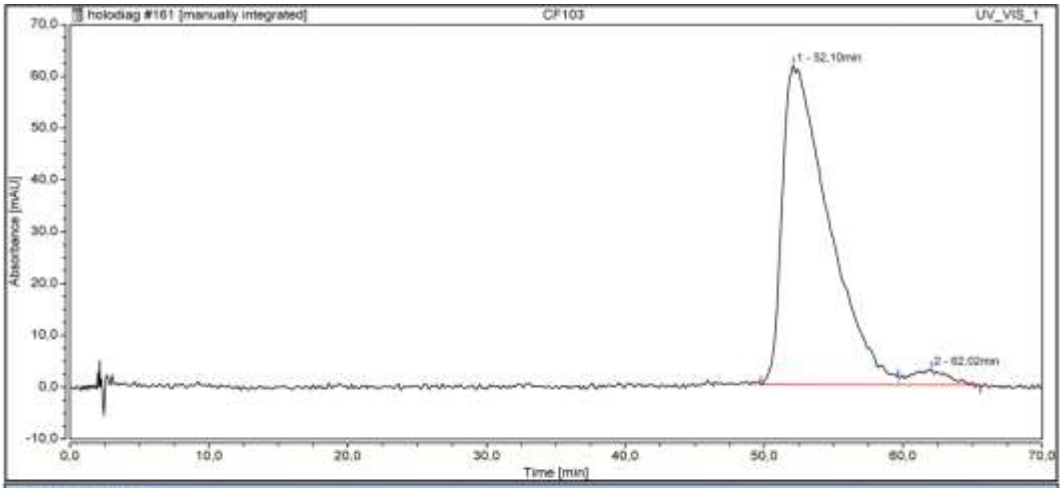
Racemic



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		53,89	81,968	26,951	49,24	56,40	n.a.
2		59,32	84,506	22,379	50,76	43,60	n.a.
Total:			**166,474**	**51,330**	**100,00**	**100,00**	

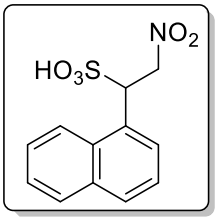
Enantioenriched (92% ee)



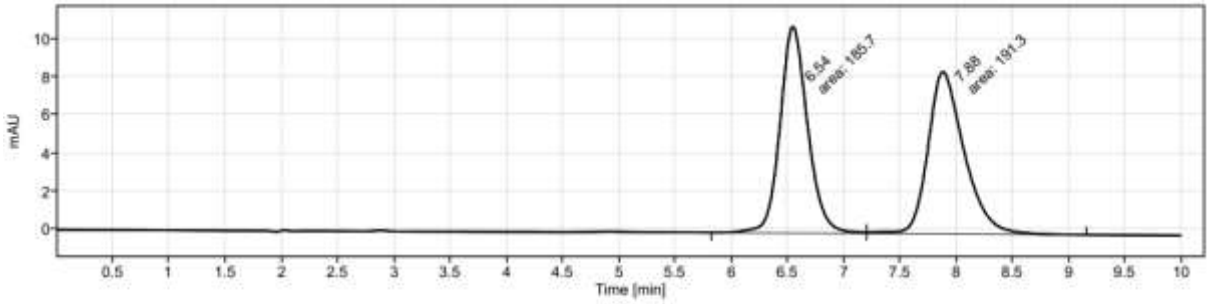
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		52,10	238,362	61,649	96,26	95,26	n.a.
2		62,02	9,262	3,065	3,74	4,74	n.a.
Total:			**247,624**	**64,715**	**100,00**	**100,00**	

1-(Naphthalen-1-yl)-2-nitroethane-1-sulfonic acid (2h)



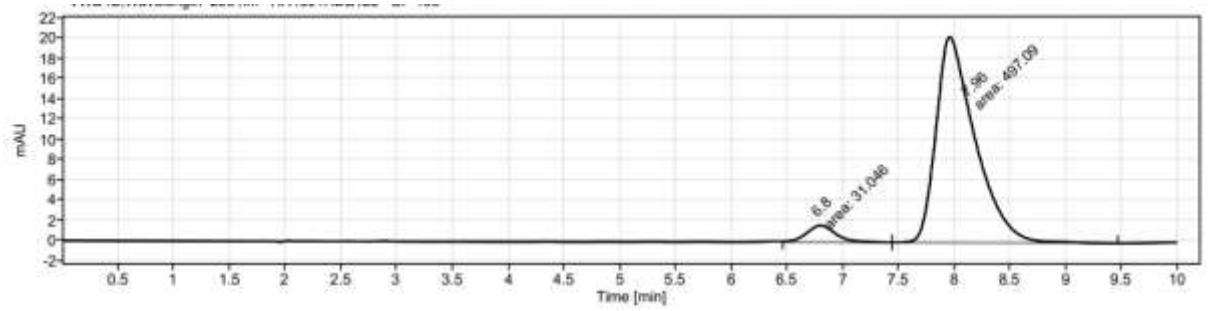
Racemic



Signal: VWD1A,Wavelength=205 nm

Ret. Time (min)	Type	Width (min)	Area (mAU.s)	Height (mAU)	Area (%)	Res
6.542	MM m	0.26	2008.29805	117.49867	49.7359	
7.875	MM m	0.33	2029.62255	91.02114	50.2641	2.69
		Sum	4037.92			

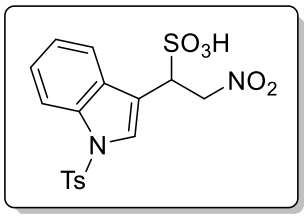
Enantioenriched (88% ee)



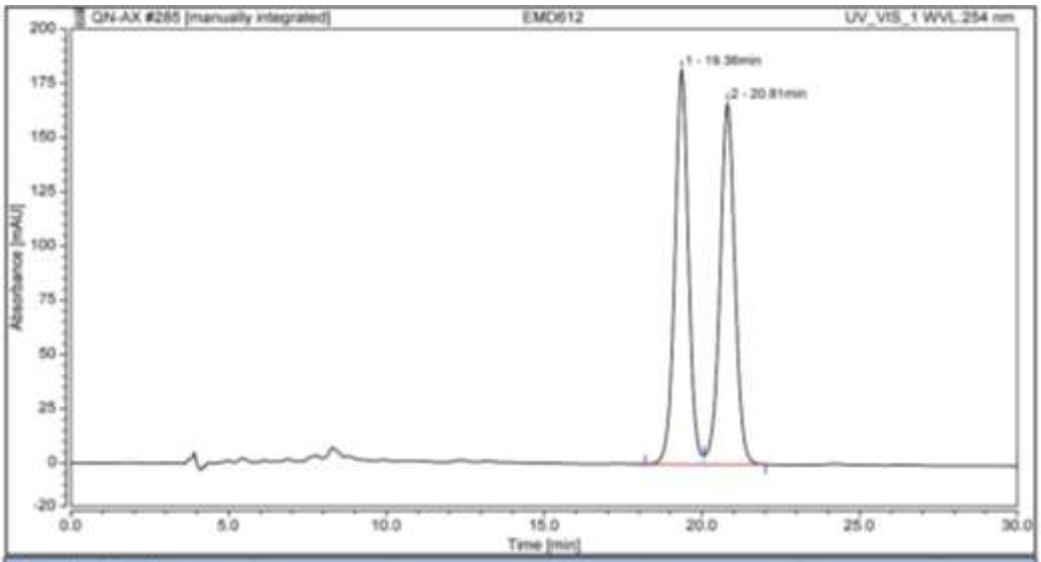
Signal: VWD1A,Wavelength=205 nm

Ret. Time (min)	Type	Width (min)	Area (mAU.s)	Height (mAU)	Area (%)	Res
6.797	MM m	0.28	339.23584	18.22262	5.9812	
7.955	MM m	0.35	5332.50065	218.84587	94.0188	2.15
		Sum	5671.74			

2-Nitro-1-(1-tosyl-1H-indol-3-yl)ethane-1-sulfonic acid (2i)



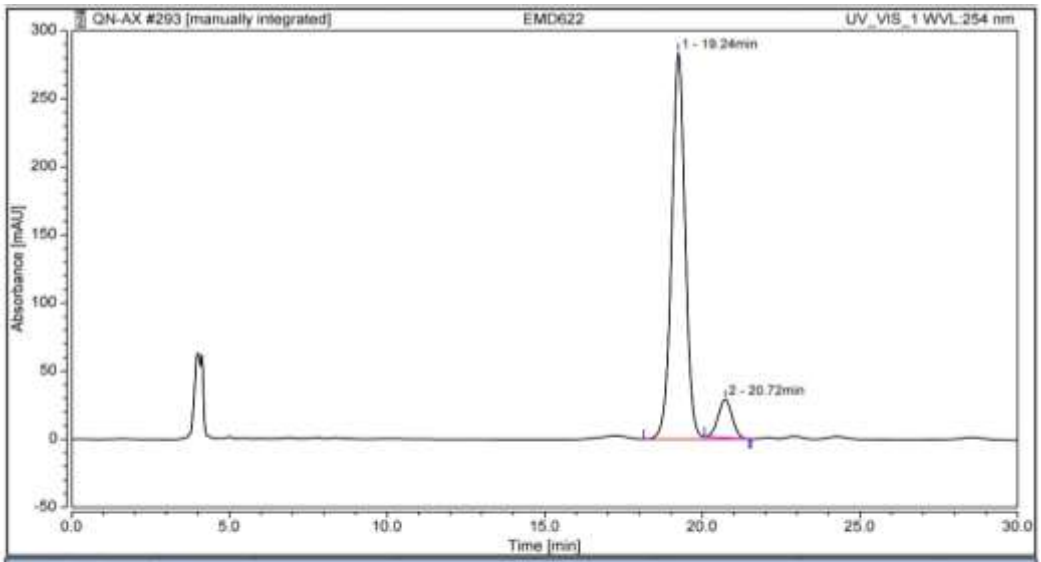
Racemic



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		19.357	91.015	181.934	50.06	52.20	n.a.
2		20.807	90.790	166.591	49.94	47.80	n.a.
Total:			**181.805**	**348.525**	**100.00**	**100.00**	

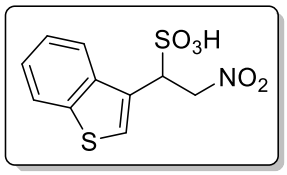
Enantioenriched (81% ee)



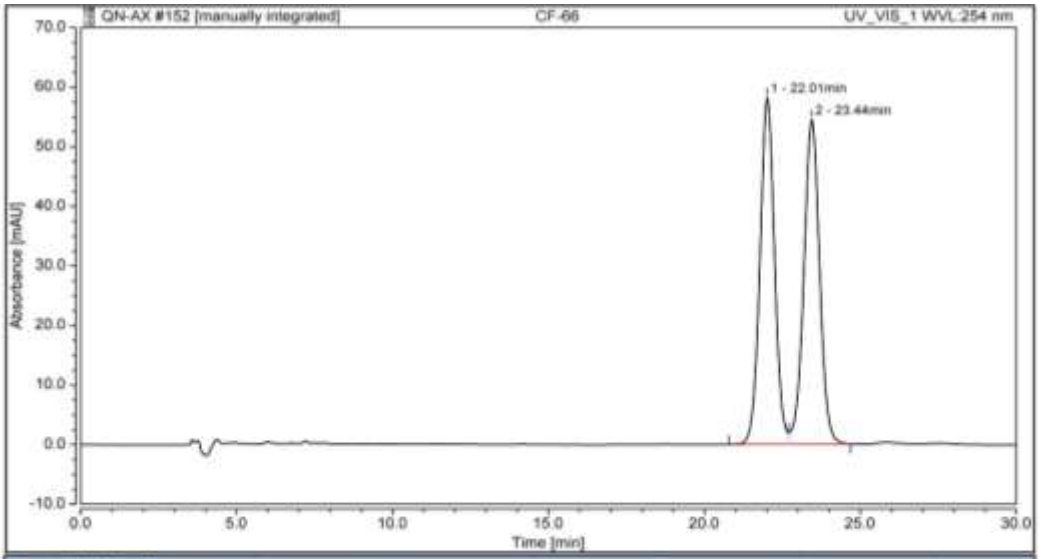
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		19.240	141.969	283.671	90.75	90.97	n.a.
2		20.723	14.462	28.151	9.25	9.03	n.a.
Total:			**156.431**	**311.822**	**100.00**	**100.00**	

1-(Benzo[b]thiophen-3-yl)-2-nitroethane-1-sulfonic acid (2j)



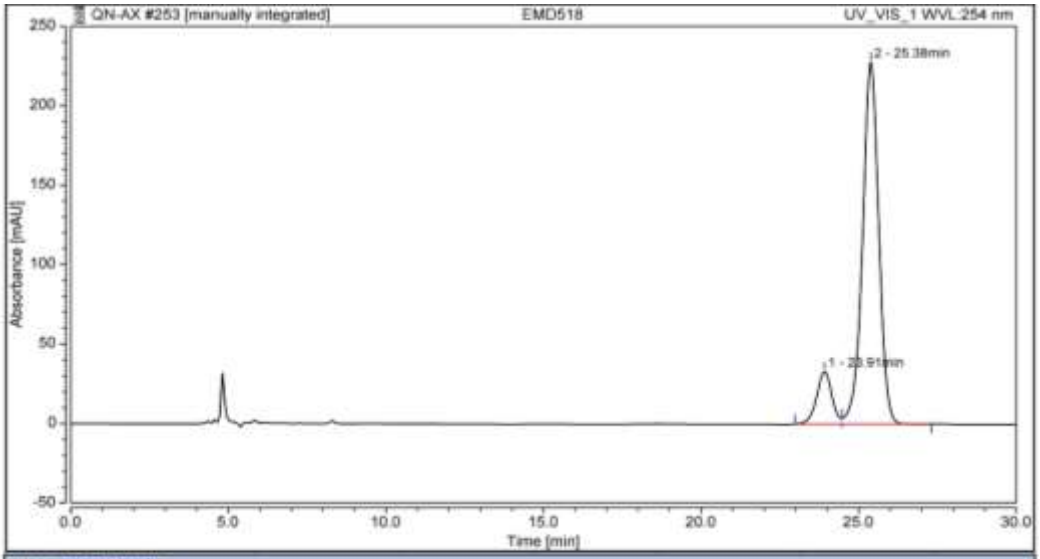
Racemic



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		22.013	31.578	58.256	49.71	51.65	n.a.
2		23.443	31.944	54.525	50.29	48.35	n.a.
Total:			**63.522**	**112.782**	**100.00**	**100.00**	

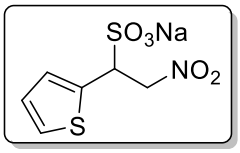
Enantioenriched (76% ee)



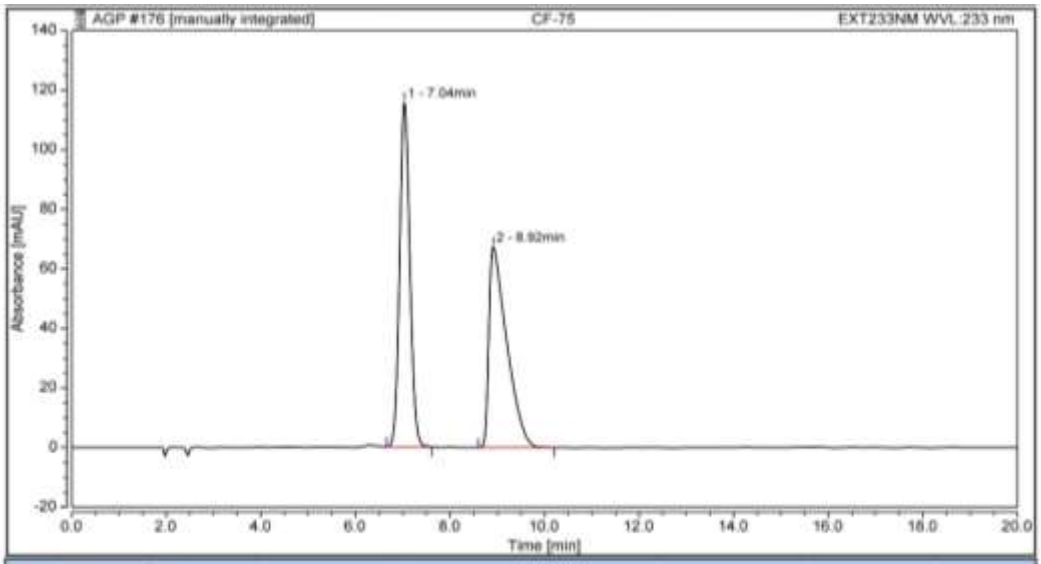
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		23.913	18.515	33.112	11.99	12.69	n.a.
2		25.380	135.906	227.792	88.01	87.31	n.a.
Total:			**154.420**	**260.904**	**100.00**	**100.00**	

1-(Benzo[b]thiophen-3-yl)-2-nitroethane-1-sulfonic acid (2k)



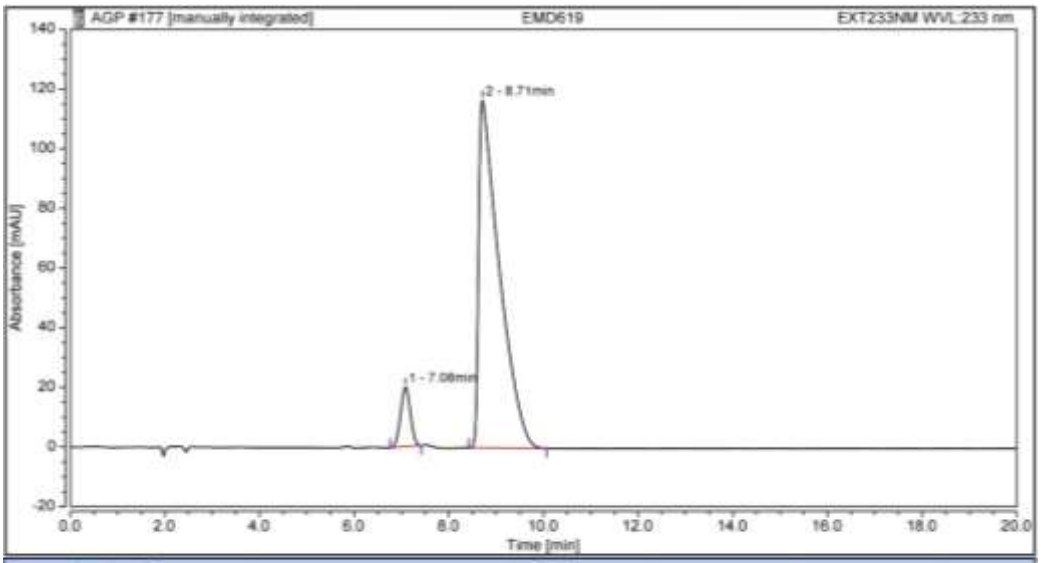
Racemic



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		7.04	29.175	115.760	49.87	63.15	n.a.
2		8.92	29.325	67.555	50.13	36.85	n.a.
Total:			**58.500**	**183.315**	**100.00**	**100.00**	

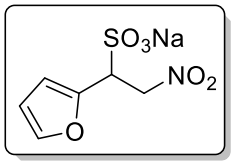
Enantioenriched (85% ee)



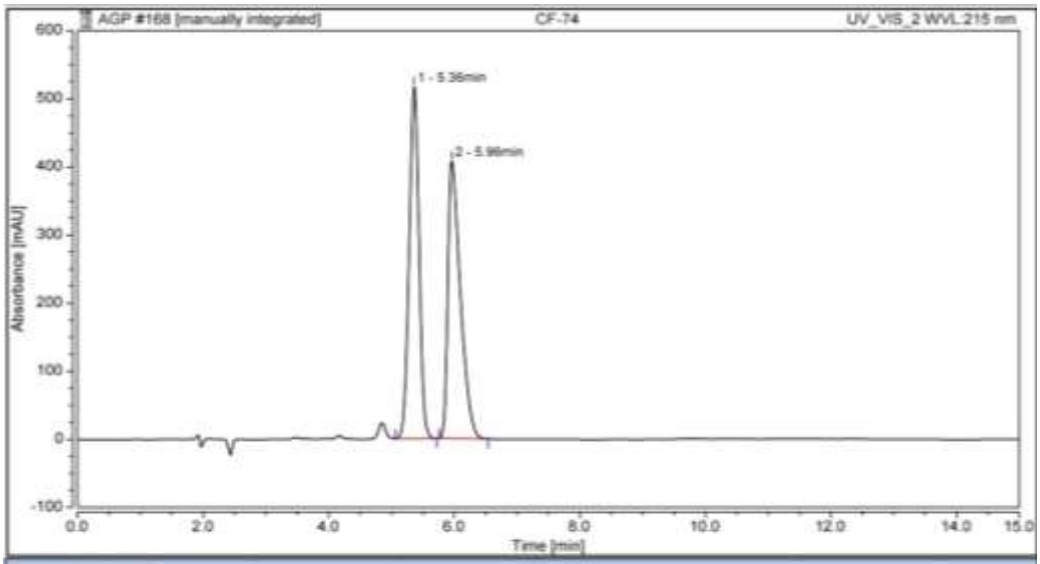
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		7.08	4.869	20.033	7.66	14.66	n.a.
2		8.71	58.724	116.632	92.34	85.34	n.a.
Total:			**63.593**	**136.665**	**100.00**	**100.00**	

Sodium 1-(furan-2-yl)-2-nitroethane-1-sulfonate (2l)



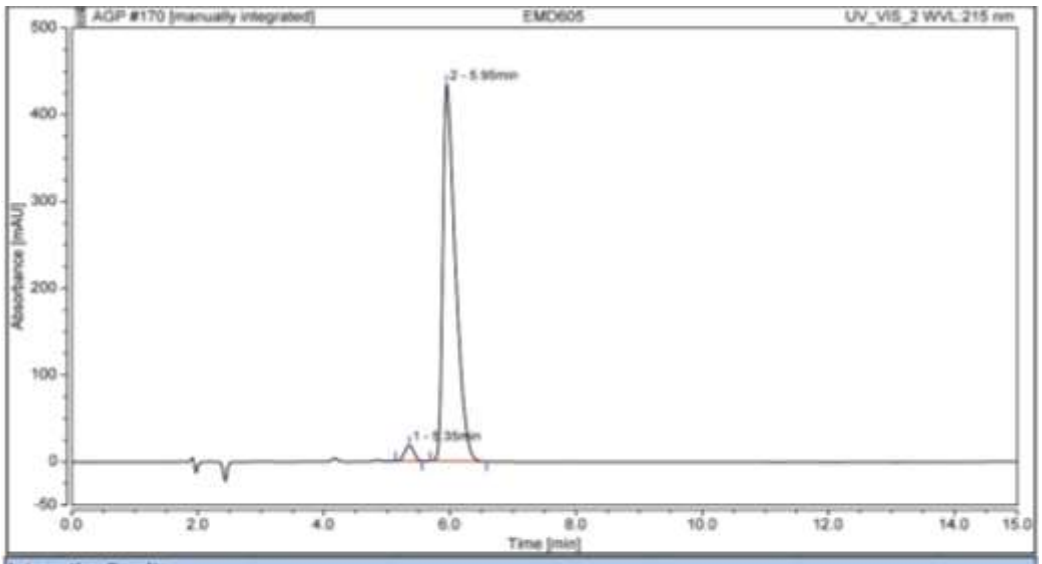
Racemic



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.36	93.897	517.059	50.00	55.93	n.a.
2		5.96	93.885	407.368	50.00	44.07	n.a.
Total:			**187.781**	**924.427**	**100.00**	**100.00**	

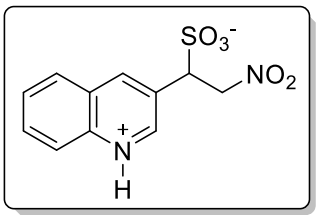
Enantioenriched (94% ee)



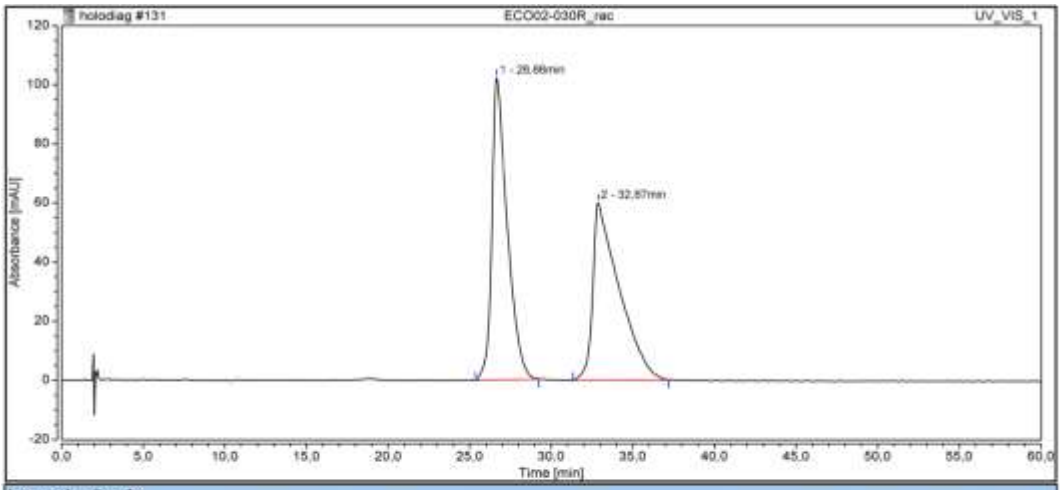
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.35	3.131	18.249	3.02	4.03	n.a.
2		5.95	100.666	434.283	96.98	95.97	n.a.
Total:			**103.797**	**452.532**	**100.00**	**100.00**	

2-Nitro-1-(quinolin-1-ium-3-yl)ethane-1-sulfonate (2m)



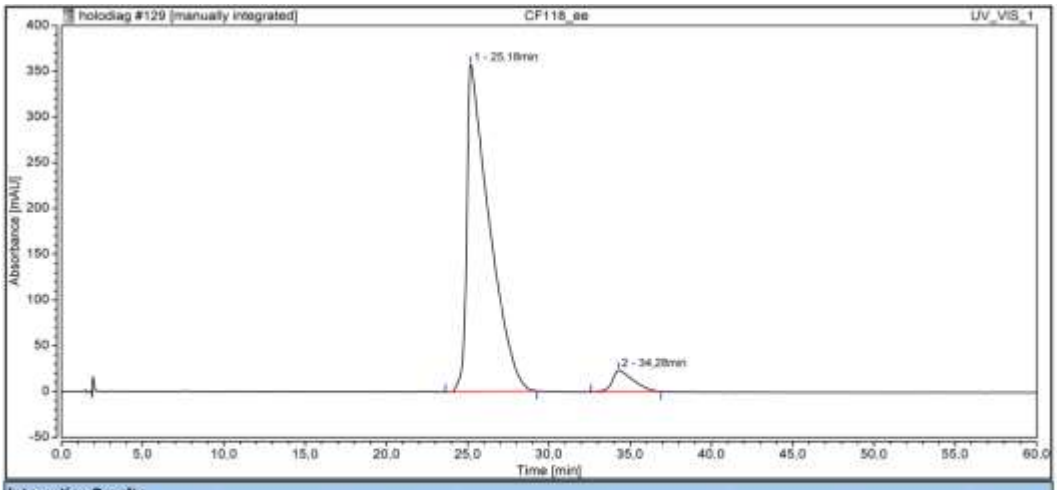
Racemic



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		26,66	112,275	102,320	49,96	62,97	n.a.
2		32,87	112,468	60,174	50,04	37,03	n.a.
Total:			**224,743**	**162,494**	**100,00**	**100,00**	

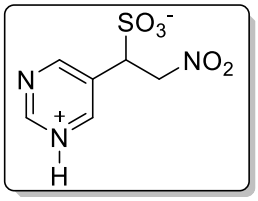
Enantioenriched (88% ee)



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		25,18	574,322	357,568	94,24	93,89	n.a.
2		34,28	35,104	23,284	5,76	6,11	n.a.
Total:			**609,426**	**380,852**	**100,00**	**100,00**	

2-nitro-1-(pyrimidin-1-ium-5-yl)ethane-1-sulfonate (2n)



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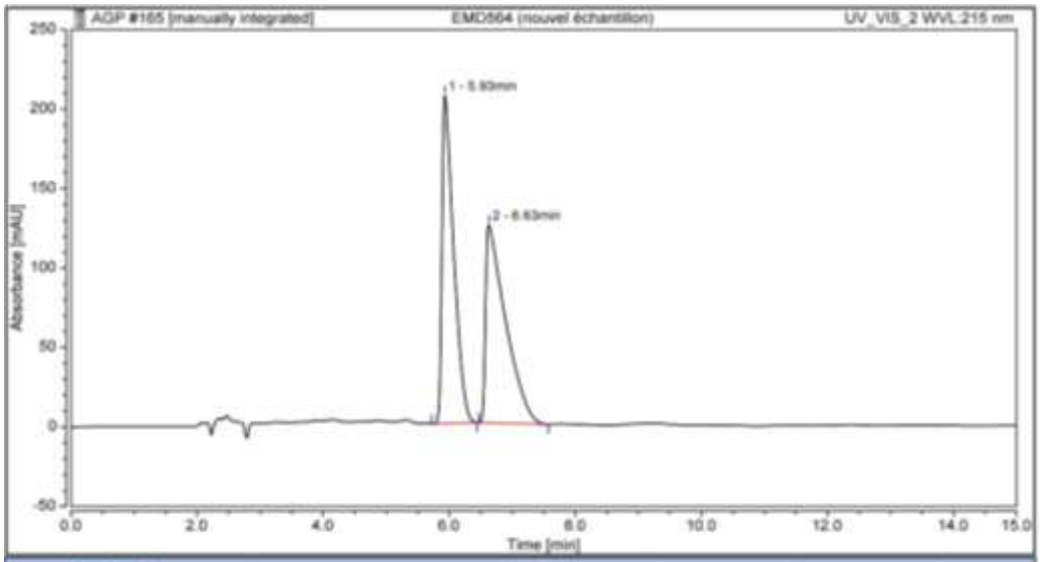
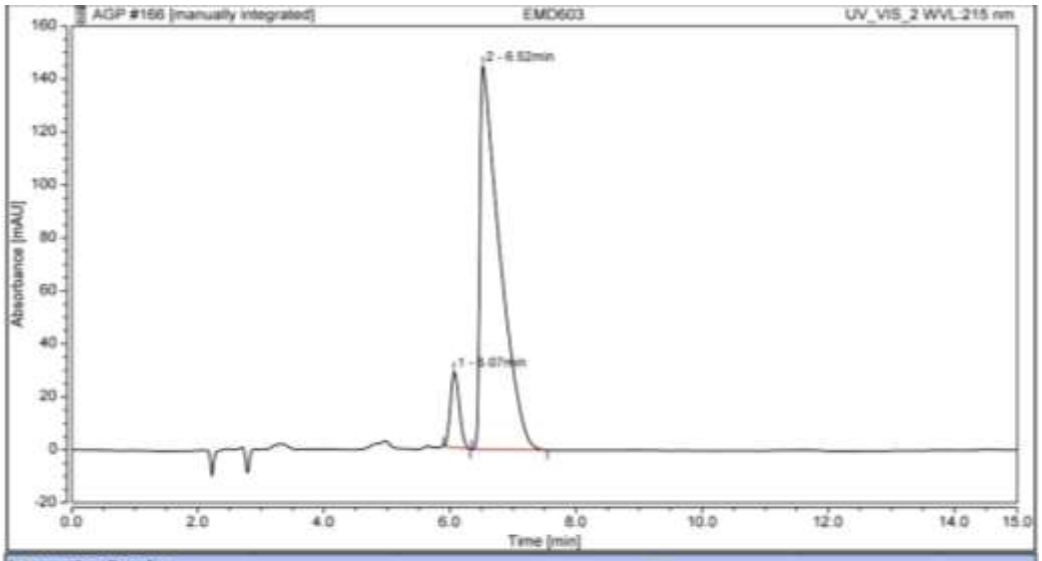


Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.93	44.376	206.646	49.29	62.36	n.a.
2		6.63	45.647	124.718	50.71	37.64	n.a.
Total:			**90.023**	**331.364**	**100.00**	**100.00**	

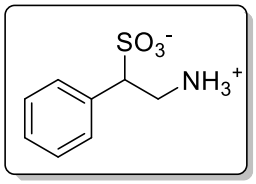
Enantioenriched (83% ee)



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.07	4.675	28.655	8.15	16.51	n.a.
2		6.52	52.694	144.888	91.85	83.49	n.a.
Total:			**57.369**	**173.543**	**100.00**	**100.00**	

2-ammonio-1-(3-chlorophenyl)ethane-1-sulfonate (4a)



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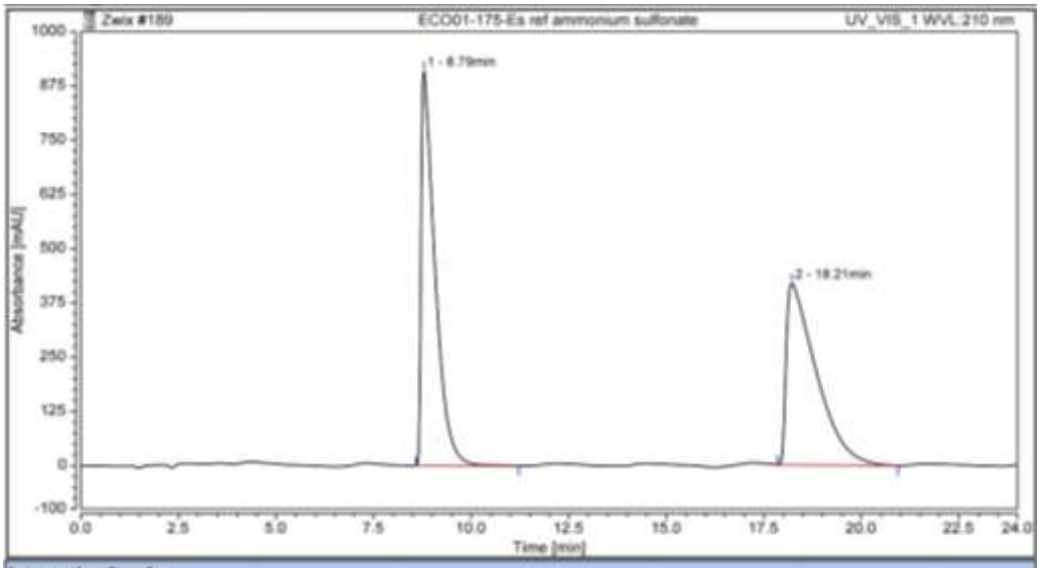
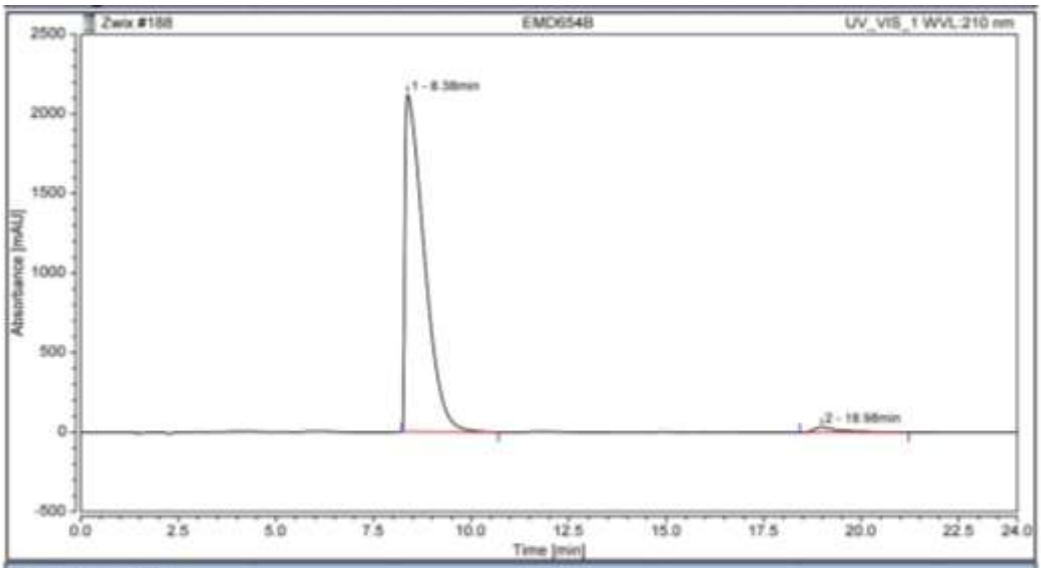


Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		8.79	374.229	909.530	50.20	68.48	n.a.
2		18.21	371.233	418.710	49.80	31.52	n.a.
Total:			**745.461**	**1328.240**	**100.00**	**100.00**	

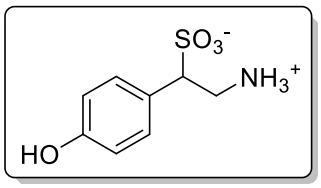
Enantioenriched (96% ee)



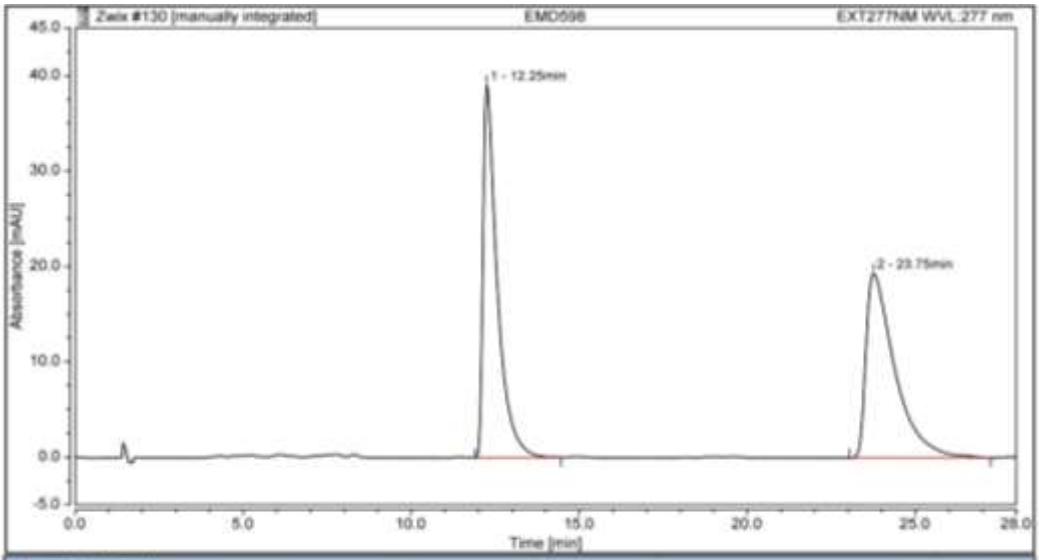
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		8.38	1207.203	2116.348	97.82	98.44	n.a.
2		18.98	26.948	33.607	2.18	1.56	n.a.
Total:			**1234.151**	**2149.955**	**100.00**	**100.00**	

2-Ammonio-1-(4-hydroxyphenyl)ethane-1-sulfonate (4b)



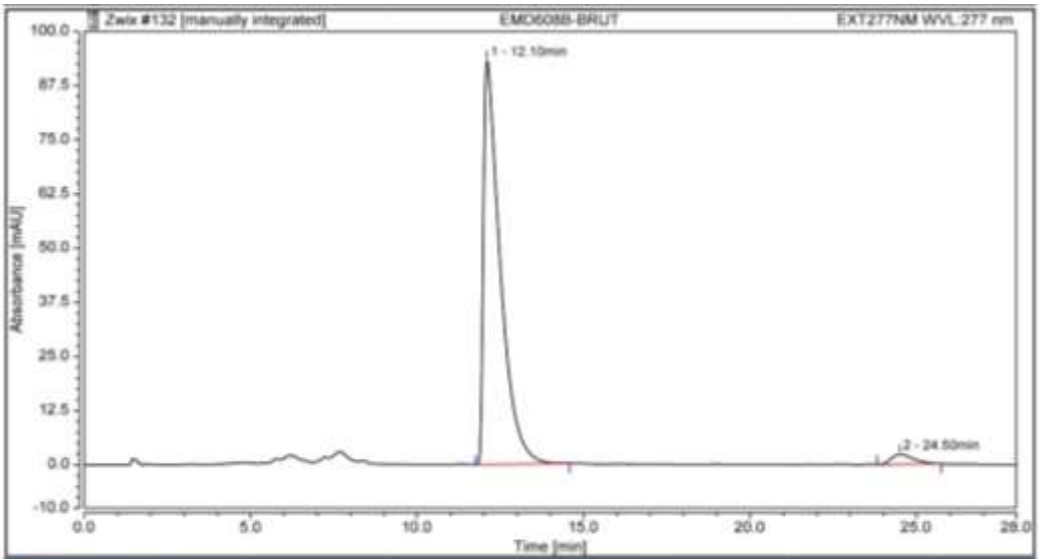
Racemic



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		12.25	19.119	39.104	49.82	66.86	n.a.
2		23.75	19.255	19.385	50.18	33.14	n.a.
Total:			**38.374**	**58.489**	**100.00**	**100.00**	

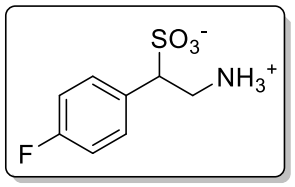
Enantioenriched (93% ee)



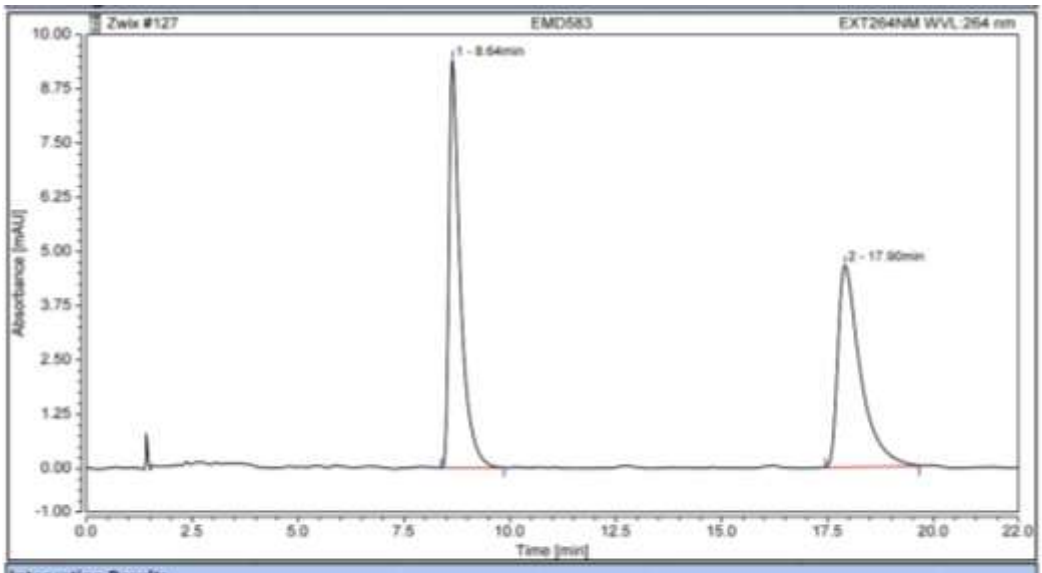
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		12.10	54.370	93.242	96.76	97.55	n.a.
2		24.50	1.818	2.345	3.24	2.45	n.a.
Total:			**56.188**	**95.587**	**100.00**	**100.00**	

2-Ammonio-1-(4-fluorophenyl)ethane-1-sulfonate (4c)



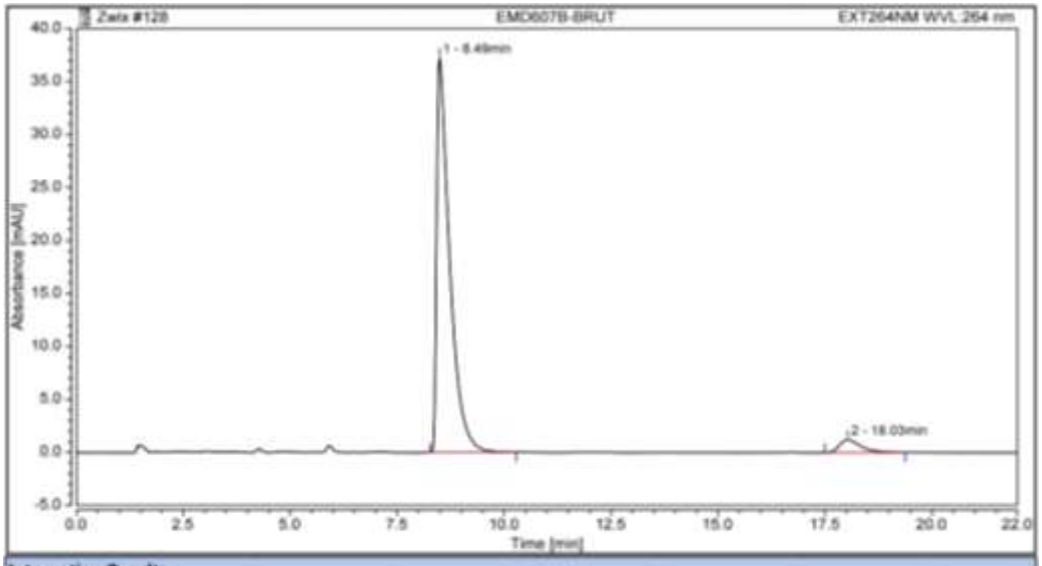
Racemic



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		8.64	2.942	9.394	50.52	66.86	n.a.
2		17.90	2.881	4.655	49.48	33.14	n.a.
Total:			**5.824**	**14.050**	**100.00**	**100.00**	

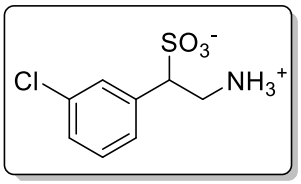
Enantioenriched (90% ee)



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		8.49	13.241	37.263	94.80	96.80	n.a.
2		18.03	0.727	1.232	5.20	3.20	n.a.
Total:			**13.968**	**38.495**	**100.00**	**100.00**	

2-ammonio-1-(3-chlorophenyl)ethane-1-sulfonate (4d)



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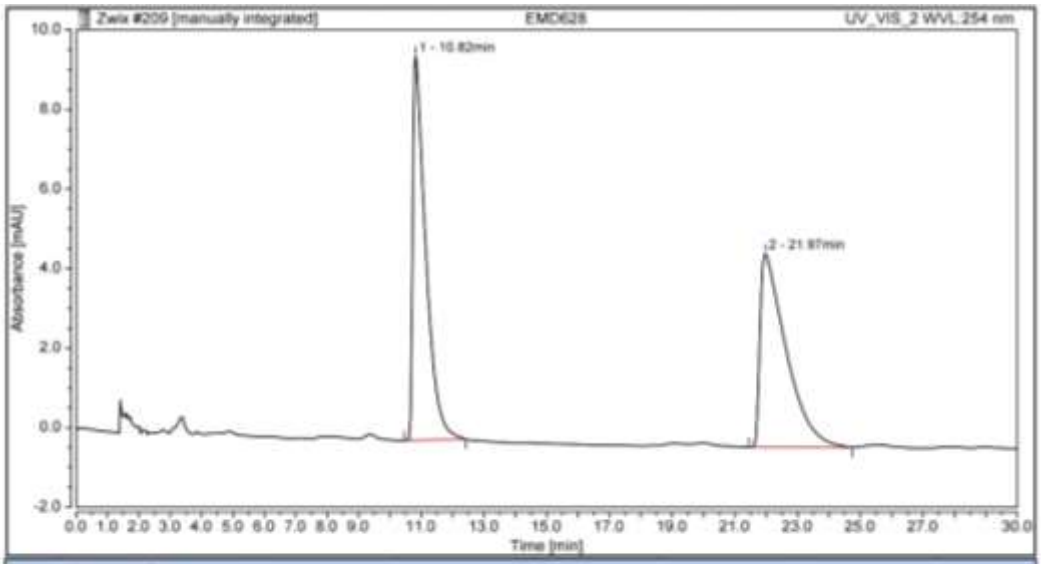
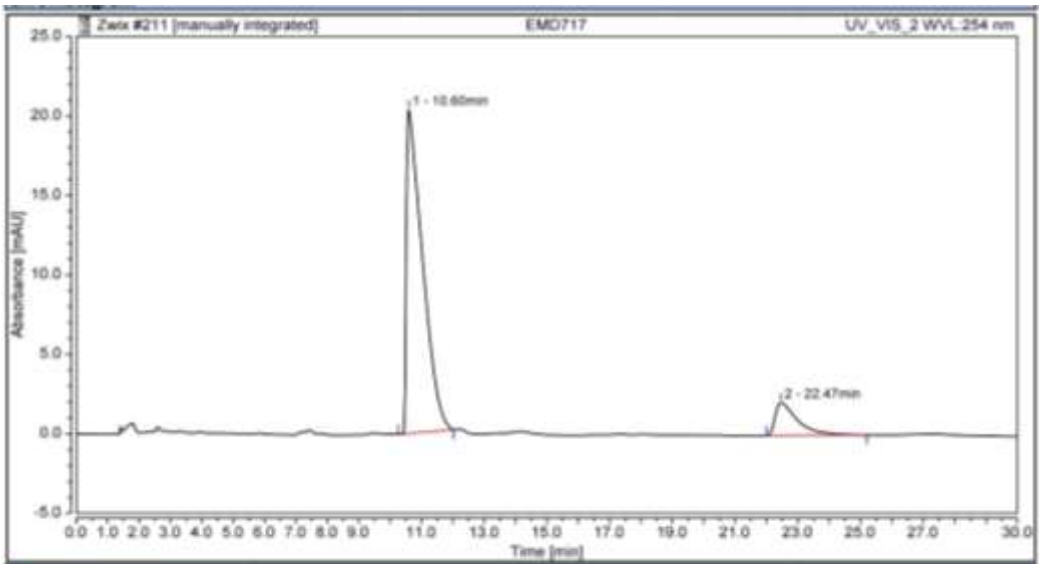


Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		10.82	4.602	9.660	49.63	66.49	n.a.
2		21.97	4.670	4.868	50.37	33.51	n.a.
Total:			**9.272**	**14.528**	**100.00**	**100.00**	

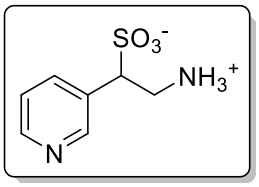
Enantioenriched (75% ee)



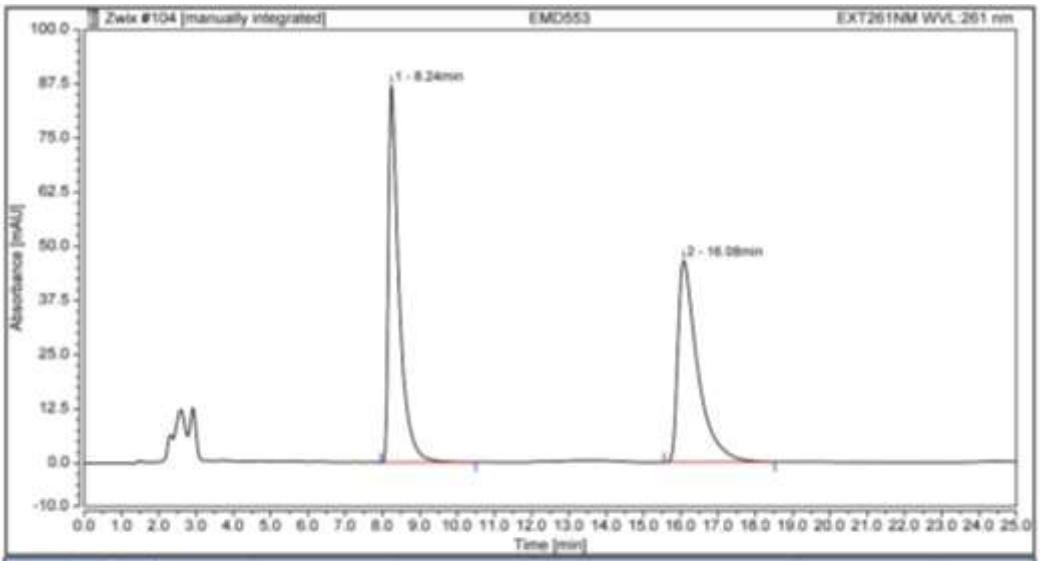
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		10.60	12.078	20.366	87.59	90.81	n.a.
2		22.47	1.711	2.061	12.41	9.19	n.a.
Total:			**13.789**	**22.427**	**100.00**	**100.00**	

2-Ammonio-1-(pyridin-3-yl)ethane-1-sulfonate (4e)



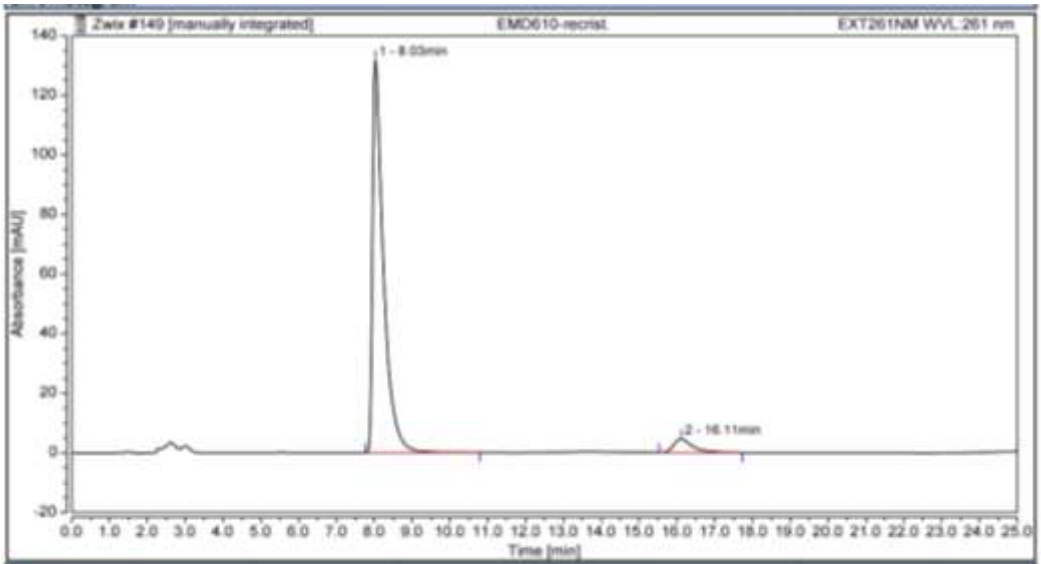
Racemic



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		8.24	28.623	86.971	50.09	65.15	n.a.
2		16.08	28.519	46.532	49.91	34.85	n.a.
Total:			**57.142**	**133.503**	**100.00**	**100.00**	

Enantioenriches (88% ee)



Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		8.03	44.047	131.856	94.22	96.66	n.a.
2		16.11	2.700	4.558	5.78	3.34	n.a.
Total:			**46.747**	**136.414**	**100.00**	**100.00**	