Supporting information

Selective Hydrogen Isotope Exchange on Sulfonamides, Sulfilimides and Sulfoximines by Electrochemically Generated Bases

Carla Marie Stork[a], Elisabeth Glöckler[a], Dr. Volker Derdau[b], Dr. Philipp Schnieders[c], Prof. Dr. Siegfried R. Waldvogel[*a,d]

[a]Max-Planck-Institute for Chemical Energy Conversion, Stiftstraße 34–36, 45470 Mülheim an der Ruhr, Germany.

[b]Sanofi-Aventis Deutschland GmbH, 65929 Frankfurt am Main, Germany.

[c]Deutero GmbH, Am Ring 29, 56288 Kastellaun, Germany.

[d]Karlsruhe Institute of Technology, Institute of Biological and Chemical Systems – Functional Molecular Systems (IBCS FMS), 76131 Karlsruhe, Germany.

Email: siegfried.waldvogel@cec.mpg.de
TEL: +49 208/306-3131

Table of Contents

1 General information

Starting materials and reagents were purchased from commercial suppliers (Deutero, Sigma Aldrich, TCI, Carl Roth or Fluka) and were used without further purification if not stated otherwise. Solvents were used as p.a. grade whereas high purity water was obtained by circulating deionized water through a Milli-Q® water purification system. Reactions were monitored by UPLC-MS and analytic thin layer chromatography (TLC) using Fluka silica gel plates with a fluorescent indicator. Visualization of the developed TLC chromatogram was performed using 254 nm UV light source. Organic solutions were concentrated using rotary evaporator.

1.1 Column chromatography

Automated preparative chromatography was performed using a puriFlash™ XS 520 Plus (Interchim, Montluçon, France), using a prepacked puriFlash™ SI-HP silica gel PF-15SIHP-F0040 column (Interchim, Montluçon, France). Cyclohexane/ethyl acetate or dichloromethane/acetone mixtures were used as eluents. Reversed phase column chromatography was performed with a prepacked Sepacore™ C18 column (Büchi Labortechnik GmbH, Essen, Germany), using a preparative chromatography system (Büchi Labortechnik GmbH, Essen, Germany) with a Büchi Control Unit C-620, an UV detector Büchi UV photometer C-635, a Büchi fraction collector C-660 and two Pump Modules C-605 for adjusting the solvent mixtures. Mixtures of water (MilliQ™) and acetonitrile were used as eluents.

1.2 NMR spectroscopy

^{1}H and ^{13}C NMR spectra were recorded at 25 °C on a Bruker AVANCE III HD 500 MHz NMR spectrometer or Bruker Ascend Evo 400 MHz NMR spectrometer with a Bruker Prodigy probe (Bruker BioSpin GmbH, Rheinstetten, Germany) using DMSO-d_6 or $CDCl_3$ as deuterated solvent. All chemical shifts are reported in δ-scale as parts per million [ppm] (multiplicity, coupling constant J, number of protons), relative to the solvent residual peaks as the internal standard. Coupling constants J are given in Hertz [Hz]. Abbreviations used for signal multiplicity: ^{1}H NMR: s = singlet, d = doublet, t = triplet, q = quartet and m = multiplet.

1.3 Ultra-performance liquid chromatography – mass spectrometry (UPLC-MS)

Ultra performance liquid chromatography – mass spectrometry (UPLC-MS) was performed on a Waters™ ACQUITY™ UPLC™ H-Class PLUS System (Waters Corporation, Milford, USA) using a quaternary solvent manager (ACQ H-CLASS QSM PLUS), a sample manager with flow-through needle (ACQ H-Class FTN-H PLUS) design, a column heater (ACQUITY UPLC CM-A) and an ACQUITY UPLC® BEH C18 1.7 µm 2.1 x 50 mm column. Mass spectra were measured using a single quadrupole mass detection (ACQUITY QDa Detector) employing ESI+. Acetonitrile (HPLC-MS grade) and water (Milli-Q®) were used as eluents, eluent with 0.1% (v/v) formic acid was added directly before mass detection using a second isocratic solvent manager (Waters™ ACQ Isoc Solvent Mgr).

1.4 High resolution mass spectrometry (HRMS)

HRMS was measured using a Q Exactive GC Orbitrap (EI) with Trace 1310 GC and TriPlus Autosampler (Thermo Scientific, San Jose, USA).

1.5 Infrared spectroscopy

IR spectra were measured on a Bruker ALPHA FT-IR spectrometer with an ECO-ATR sampling module (Bruker BioSpin GmbH, Rheinstetten, Germany). The data was analyzed using the OPUS 7.5 software. Absorption bands are given in wave numbers (cm^{-1}).

1.6 Power supply

Galvanostat Rohde & Schwarz - HMP4040 programmable power supply was used as a power supply in all the electrochemical reactions (4 channels per device; max. electric current per channel: 10 A; max. power per channel: 160 W; total output power per device: 384 W; upper terminal voltage limit per channel: 32 V; Rohde & Schwarz GmbH & Co. KG, Munich, Germany). The experiments were performed under galvanostatic conditions using a simple two-electrode reaction setup.

1.7 Electrodes

SIGRADUR G (Glassy Carbon) electrodes were obtained from IKA Werke GmbH & Co. KG, Germany and HTW Hochtemperatur Werkstoffe GmbH, Germany.

1.8 Electrochemical setup

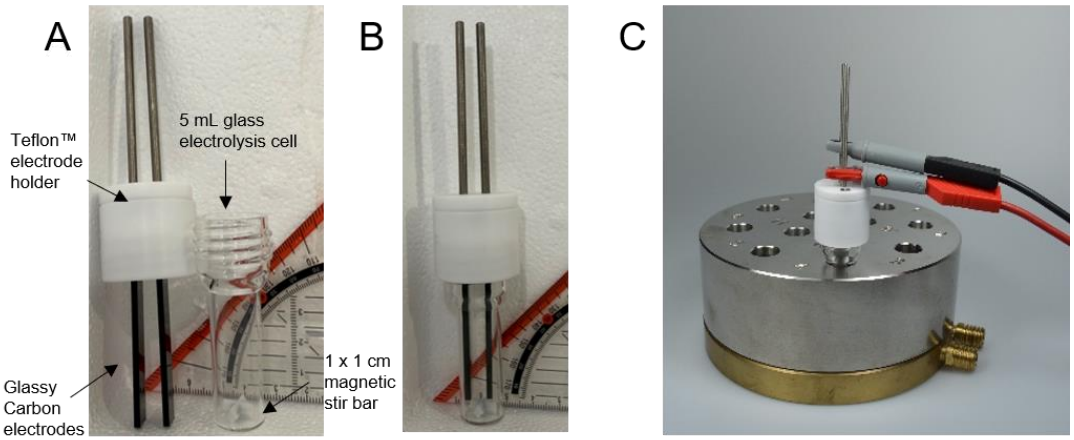


Figure S 1: Components of an undivided batch-type screening cell (A), assembled screening cell with electrodes (B), screening cell in a screening set-up (C). Scales depicted in cm.

Batch-type screening experiments were conducted in undivided 5 mL glass electrolysis cells which are commercially available as IKA ElectraSyn 2.0 package (IKA®-Werke GmbH & Co. KG, Germany). The cell was fitted with a 1 cm x 1 cm magnetic stirring cross. Two glassy carbon electrodes, each with an exposed geometric surface area of 3.0 cm^2 (corresponding to the submerged part of the electrode in a typical experiment), were positioned 8 mm apart from each other. The reactions were conducted at room temperature with a constant stirring rate of 200 rpm.

1.9 Analysis of deuterium incorporation

Analysis of deuterium incorporation by UPLC-MS was performed using IsoPat[2] evaluation in Excel (Excel sheet: Excel-Worksheet for deconvolution of MS-patterns (D,^{17}O,^{13}C,^{15}N) by Gruber and Kroutil.[1] This calculation method involves comparing the ratios of the signals in the mass spectrum of the isotopically

labeled compound to those of the unlabeled substance. By considering the isotopic pattern of the unlabeled molecule, the incorporation of deuterium can be determined in this manner.

Analysis of deuterium incorporation into a molecule by ^{1}H NMR was performed using MestReNova 15.0. software. The ^{1}H NMR spectra were adjusted to the respective solvent after the measurement. The comparison of the peak area of the signal to be analyzed before and after isotope labeling was done according to the following equation 1.

$$\text{Deuterium incorporation } [\%] = 100 - \left(\frac{\text{Peak intensity after labeling}}{\text{Peak intensity before labeling}} \cdot 100\right) \qquad (1)$$

2 General experimental procedures

2.1 Preparation of sulfonamides (GP 1)

Sulfonamides were prepared from the corresponding amines according to a method described by ZHOU et al.[2] To a cooled (0 °C) solution of the amine in dichloromethane (40 mL) was added. The corresponding sulfonyl chloride was added slowly. After 24 h the reaction mixture was quenched with 10 mL of saturated NH_4Cl solution. The solution was extracted with dichloromethane (3 x 25 mL), the combined organic fractions were washed with water (3 x 25 mL), dried over anhydrous $MgSO_4$ and the solvent removed under reduced pressure.

2.2 Preparation of sulfilimides and sulfoximines (GP 2.1)

Preparation of sulfilimides and following oxidation to sulfoximines was done according to an electrochemical protocol established by WALDVOGEL et al.[3] A solution of sulfide (1 eq.), sulfonamide (1 eq.) and NEt_4Br (4 eq.) in methanol (MeOH, 5 mL) was added into an undivided electrochemical screening cell with glassy carbon as an anode and stainless steel as the cathode. Constant current was applied (2.8 *F*, 50 mA/cm^2). After the electrolysis the reaction mixture was transferred into a separation funnel and water (20 mL) was added. The aqueous layer was extracted three times with dichloromethane (DCM, 20 mL). The combined organic fractions were dried using $MgSO_4$ and the solvent was removed under reduced pressure. The sulfilimide was purified using column chromatography before further oxidation.

The sulfilimide (1 eq.) was dissolved in MeOH (5 mL) and 5 vol% of MeCN was added. To the stirred mixture electrochemically generated[4] aq. peroxodicarbonate solution (9 eq.) was added. After 12 h, the reaction mixture was transferred into a separation funnel and water (20 mL) was added. The aqueous phase was extracted with ethylacetate (EtOAc, 20 mL) three times. The combined organic fractions were dried using $MgSO_4$ and the solvent was removed under reduces pressure. The sulfoximine was purified using column chromatography before being used in electrochemical deuteration reactions.

2.3 Preparation of sulfilimides and sulfoximines involving a nitrile functionality (GP 2.2)

Preparation of sulfilimides and following oxidation to sulfoximines was done according to another electrochemical protocol established by WALDVOGEL et al.[5] The sulfide (1 eq.) and cyanamide (1.5 eq.) were weighted into a 5 mL electrochemical Teflon™ screening cell and dissolved in a 25 mM solution of NMe_4OAc (2 mol%) in a mixture of MeOH (0.3 mL, 6% v/v) and MeCN (4.7 mL, 94% v/v). Graphite anode

and platinum foil cathode were placed into the solution (electrode area, A = 1.7 cm²). The electrolysis was performed under galvanostatic conditions using a current density of 12 mA/cm² for a total charge of 2.8 *F*. Upon completion of the electrolysis, the reaction mixture was transferred to a flask and the solvent was removed under reduced pressure. The crude sulfilimide was subsequently purified by flash column chromatography before being further oxidized to the respective sulfoximine.

For the oxidation step, electrochemically generated[6] sodium para-periodate (2 eq.) was suspended in water (2 mL) and acidified with 60% nitric acid to a pH between 3 and 4. To this mixture, EtOAc (5 mL), $RuCl_3 \cdot xH_2O$ (5 mol%), and acetonitrile (1 mL) were added in sequence. The reaction mixture was stirred, and sulfilimide (1 eq.), dissolved in EtOAc (1 mL), was added dropwise. Stirring continued at room temperature until the starting material was converted, as confirmed by TLC analysis. The mixture was then filtered through Celite™, dried over $MgSO_4$, and the solvent was removed. The reaction mixture was purified by flash column chromatography.

2.4 Screening and optimization studies (GP 3)

The reaction set-up used is shown in Figure S 1. Glassy carbon electrodes served both as anode and cathode. Different procedures for the different screenings described below. After the electrolysis mesitylene as an ^{1}H NMR standard (13.7 mg, 0.11 mmol, **GP-3.2**–**GP-3.5**) was added and the mixture was homogenized. A sample was prepared for UPLC-MS analysis by filtering over a SiO_2 column with acetonitrile. The deuterium incorporation was then determined by UPLC-MS with the method described in chapter 1.9. The deuterium incorporation was also determined by ^{1}H NMR of the reaction mixture (**GP-3.2**–**GP-3.5)**. The ^{1}H NMR yield was determined by comparison of the substrates signals with the respective standard signals.

- **GP-3.1**: General protocol for screening of the non-deuterated solvent (D_2O as the deuterium source)

1-(Methylsulfonyl)pyrrolidine **1** (37.3 mg, 0.25 mmol, 1 eq.) and Et_4NBF_4 (108.5 mg, 0.5 mmol, 0.1 M, 2 eq.) were weighted into the cell. The solvent (4.1 mL) and D_2O (0.9 mL, 50 mmol, 200 eq.) were added and 4–12 *F*/192–289 C of electric charge were applied under galvanostatic conditions at current density 5 mA/cm^2 (15 mA) with stirring at 200 rpm and room temperature.

- **GP-3.2**: General protocol for screening of the current density (DMSO-d_6 as the deuterium source)

1-(Methylsulfonyl)pyrrolidine **1** (37.3 mg, 0.25 mmol, 1 eq.) and Et_4NBF_4 (108.5 mg, 0.5 mmol, 0.1 M, 2 eq.) were weighted into the cell. Dimethylsulfoxide-d_6 (DMSO-d_6, 5 mL) was added and 4 *F*/48 C of electric charge were applied under galvanostatic conditions at current densities of 2.5–50 mA/cm^2 (8–148 mA) with stirring at 200 rpm and room temperature.

- **GP-3.3**: General protocol for screening of the amount of applied charge (DMSO-d_6 as the deuterium source)

1-(Methylsulfonyl)pyrrolidine **1** (37.3 mg, 0.25 mmol, 1 eq.) and Et_4NBF_4 (108.5 mg, 0.5 mmol, 0.1 M, 2 eq.) were weighted into the cell. Dimethylsulfoxide-d6 (DMSO-d_6, 5 mL) was added and 2–20 *F*/96–480 C of electric charge were applied under galvanostatic conditions at current density 5 mA/cm^2 (15 mA) with stirring at 200 rpm and room temperature.

- **GP-3.4**: General protocol for screening of the amount of additive (D_2O)

1-(Methylsulfonyl)pyrrolidine **1** (37.3 mg, 0.25 mmol, 1 eq.) and Et_4NBF_4 (54 mg, 0.25 mmol, 0.05 M, 2 eq.) were weighted into the cell. Dimethylsulfoxide-d_6 (DMSO-d_6, 5 mL) and D_2O (0.1–10 vol%) were added. 12 *F*/289 C of electric charge were applied under galvanostatic conditions at current density 5 mA/cm^2 (15 mA) with stirring at 200 rpm and room temperature.

- **GP-3.5**: General protocol for screening of the amount of supporting electrolyte

1-(Methylsulfonyl)pyrrolidine **1** (37.3 mg, 0.25 mmol, 1 eq.) and Et_4NBF_4 (10.9–109 mg, 0.01–0.1 M) were weighted into the cell. Dimethylsulfoxide-d_6 (DMSO-d_6, 5 mL) and D_2O (50 µL, 1 vol%) were added. 12 *F*/289 C of electric charge were applied under galvanostatic conditions at current density 5 mA/cm^2 (15 mA) with stirring at 200 rpm and room temperature.

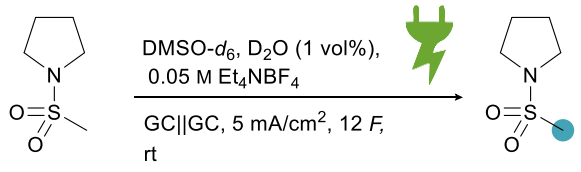
2.5 Preparative experiments (GP 4)

General protocol for preparative electrolysis used in synthetic scope investigations on 0.25 mmol scale is described here. The reaction set-up used is shown in Figure S 1. Glassy carbon electrodes served both as anode and cathode. The substrates **1**–**25** (0.25 mmol, 1 eq.) and Et_4NBF_4 (54.3 mg, 0.25 mmol, 0.05 M, 1 eq.) were weighted into the cell. Dimethylsulfoxide-d_6 (DMSO-d_6, 5 mL) and D_2O (50 µL, 1 vol%) were added and 12 *F*/298 C of electric charge were applied under galvanostatic conditions at current density 5 mA/cm^2 (15 mA) with stirring at 200 rpm and room temperature. After the electrolysis mesitylene as an ^{1}H NMR standard (13.7 mg, 0.11 mmol) was added and the mixture was homogenized. A sample was prepared for UPLC-MS analysis by filtering over a SiO_2 column with acetonitrile. The deuterium incorporation was then determined by UPLC-MS with the method described in chapter 1.9. If applicable the deuterium incorporation was also determined by ^{1}H NMR of the reaction mixture and the ^{1}H NMR yield was determined by comparison of the substrates signals with the respective standard signals. The work-up of the samples was done in two different approaches depending on the substrate. In the first approach (WUP 1) the reaction mixture and the NMR sample were then transferred into a separating funnel and water (20 mL) was added. The mixture was extracted four times with diethylether (20 mL) and the combined organic fractions were washed three times with water (10 mL) and one time with concentrated NaCl solution (10 mL). After drying over $MgSO_4$ the solvent was removed under reduced pressure. The crude product was separated using flash column chromatography (dichloromethane/acetone). In the second approach (WUP 2) the reaction mixture was filtered over C-18 RP silica gel and then separated by RP flash column chromatography (water/acetonitrile). The solvent was removed in a lyophilization process. In both work-ups the residue was dissolved in ^{1}H NMR solvent (DMSO-d_6 or $CDCl_3$) and analyzed for deuterium incorporation of the pure isolated product.

3 Screening and optimization tables

Following GP3, the influence of various variables on the incorporation of deuterium were evaluated (Table S1).

Table S1: General screening of reaction parameters.[a]



1 **^{2}H-1**

Entry	Deviation from optimised conditions	Deuterium incorporation (%D)
1	None	96
2[a]	DMAc-h_9 (instead of DMSO-d_6), D_2O (200 eq.)	81
3[a]	DMF-h_7 (instead of DMSO-d_6), D_2O (200 eq.), 4 *F*	60
4[a]	DMSO-h_6, D_2O (200 eq.)	58
5[a]	D_2O (no DMSO-d_6, 5mL)	-
6[a]	No D_2O	90
7[a]	Addition of 1 vol% MeOD-d_4	95
8	Graphite electrodes	94
9	Graphite foil electrodes	7
10	Graphite felt electrodes	93
11[a]	Recycled DMSO-d_6	77
12[a]	Stirring at doubled speed	39
13[a]	No electricity	-

[a]Reaction conditions unless indicated otherwise: 0.25 mmol **1**, 0.25 mmol Et_4NBF_4 in 5 mL DMSO-d_6 and 50 µL D_2O as the solvent and deuterium source. Electrochemical reactions were performed using glassy carbon electrodes as anode and cathode, 5 mA/cm^2, 12 *F*. After conformation of the position of deuterium incorporation via ^{1}H NMR the incorporation was determined via UPLC-MS in accordance with the ^{1}H NMR data. [a] 0.1 M NEt_4BF_4 used. [b]In the experiments, corrosion of the cathode was visible (see Figure S2).

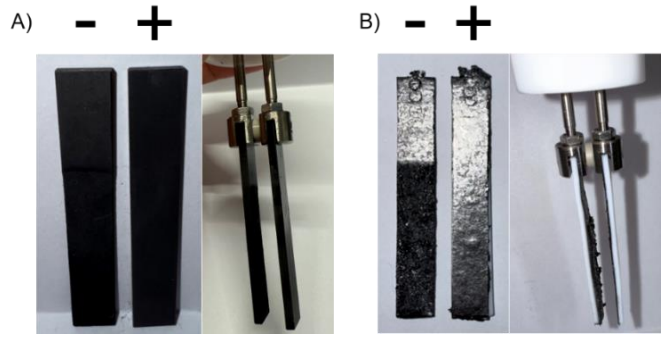
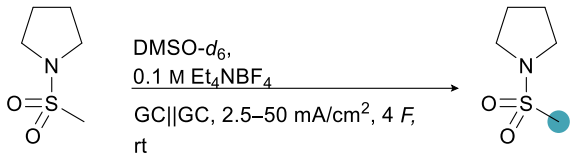


Figure S2: Visible corrosion of the isostatic graphite (A) and Sigraflex (B) cathode in the screening of different graphite electrode materials.

Next, the optimal current density was screened (Table S2). The current density was set by measuring the immersion depth of the electrode into the reaction solution using the set-up shown in Figure S 1 and adjusted to the respective current (GP-3.2).

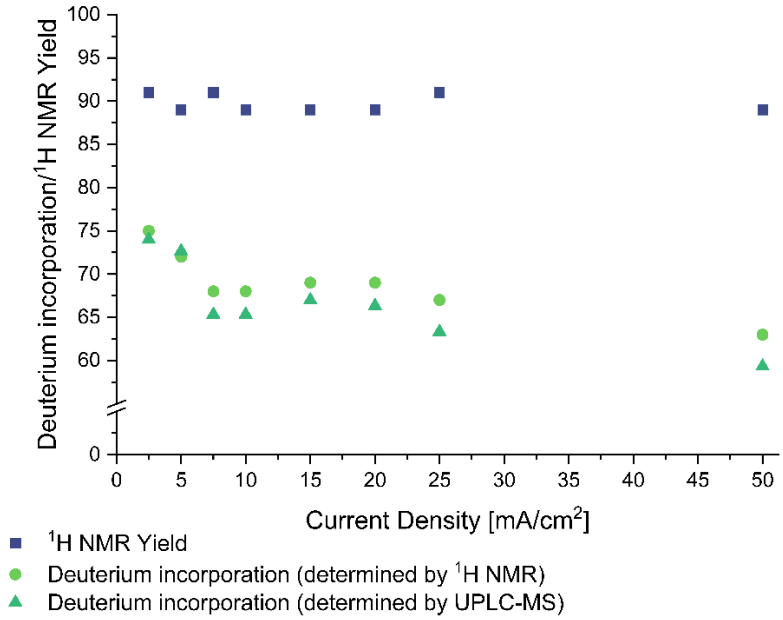
Table S2: Screening of current density.[a]



1 ^{2}H-**1**

Entry	Current density (mA/cm^2)	Deuterium incorporation (%D)[b]	Deuterium incorporation (%D)[c]	^{1}H NMR Yield (%)[d]
1	2.5	75	74	91
2	**5**	**72**	**73**	**89**
3	7.5	68	65	91
4	10	68	65	89
5	15	69	67	89
6	20	69	66	89
7	25	67	63	91
8	50	63	59	89

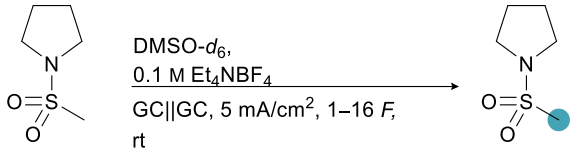
[a]Reaction conditions unless indicated otherwise: 0.25 mmol 1-(methylsulfonyl)pyrrolidine, 0.1 mmol Et_4NBF_4 in 5 mL DMSO-d_6 as the solvent and deuterium source. Electrochemical reactions were performed using glassy carbon electrodes as anode and cathode, 2.5–50 mA/cm^2, 4 *F*. [b]Deuterium incorporation determined by ^{1}H NMR. [c]Deuterium incorporation determined by UPLC-MS. [d] ^{1}H NMR Yields determined by addition of mesitylene (13.7 mg, 0.11 mmol) as an internal standard.



Although the highest deuterium incorporation was observed at 2.5 mA/cm^2, we decided to continue with 5 mA/cm^2 due to the shorter reaction times.

The amount of applied charge needed for the reaction was investigated next using the optimized current density and GP-3.3 (Table S3).

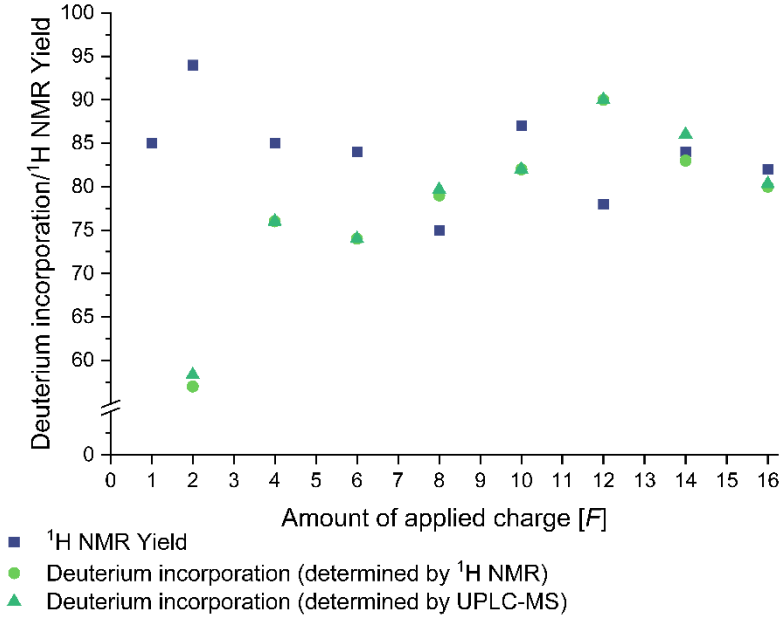
Table S3: Screening of the amount of applied charge.[a]



1 ^{2}H-**1**

Entry	Amount of applied charge (*F*)	Deuterium incorporation (%D)[b]	Deuterium incorporation (%D)[c]	^{1}H NMR yield (%)[d]
1	1	54	53	85
2	2	57	58	94
3	4	76	76	85
4	6	74	74	84
5	8	79	80	75
6	10	82	82	87
7	**12**	**90**	**90**	**78**
8	14	83	86	84
9	16	80	80	82

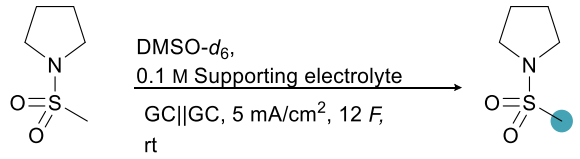
[a]Reaction conditions unless indicated otherwise: 0.25 mmol 1-(methylsulfonyl)pyrrolidine, 0.1 mmol Et_4NBF_4 in 5 mL DMSO-d_6 as the solvent and deuterium source. Electrochemical reactions were performed using glassy carbon electrodes as anode and cathode, 5 mA/cm^2, 1–16 *F*. [b]Deuterium incorporation determined by ^{1}H NMR. [c]Deuterium incorporation determined by UPLC-MS. [d] ^{1}H NMR yields determined by addition of mesitylene (13.7 mg, 0.11 mmol) as an internal standard.



The highest deuterium incorporation was reached when applying 12 *F* of current while maintaining sufficient ^{1}H NMR yield.

We decided on testing more supporting electrolytes in the reaction (Table S4).

Table S4: Screening of different supporting electrolytes and additives.[a]



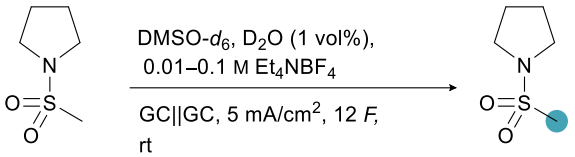
1 ^{2}H-**1**

Entry	Supporting electrolyte	Additive	Deuterium incorporation (%D)[b]	^{1}H NMR yield (%)[d]
1	$NaBF_4$	-	70	78
2	KPF_6	-	87	79
3	CsF	-	96	78
4	KF	-	96	73
5	KF	D_2O (1 vol%)	91	89
6	KF	MeOD-d_4 (1 vol%)	96	91
7	NEt_4BF_4	-	82	78
8	**NEt_4BF_4**	**D_2O (1 vol%)**	**94**	**91**
9	NEt_4BF_4	MeOD-d_4 (1 vol%)	95	88

[a]Reaction conditions unless indicated otherwise: 0.25 mmol 1-(methylsulfonyl)pyrrolidine, 0.1 mmol supporting electrolyte in 5 mL DMSO-d_6 as the solvent and deuterium source. Electrochemical reactions were performed using glassy carbon electrodes as anode and cathode, 5 mA/cm^2, 12 *F*. [b]Deuterium incorporation determined by ^{1}H NMR. [d] ^{1}H NMR yields determined by addition of mesitylene (13.7 mg, 0.11 mmol) as an internal standard.

With the electrochemically stable and less toxic supporting electrolyte NEt_4BF_4 we were observing very good deuterium incorporation while maintaining good ^1H NMR yields. D_2O as the additive was then chosen and screened for the optimal amount needed in the reaction. The concentration of supporting electrolyte was then screened (GP-3.5, Table S5).

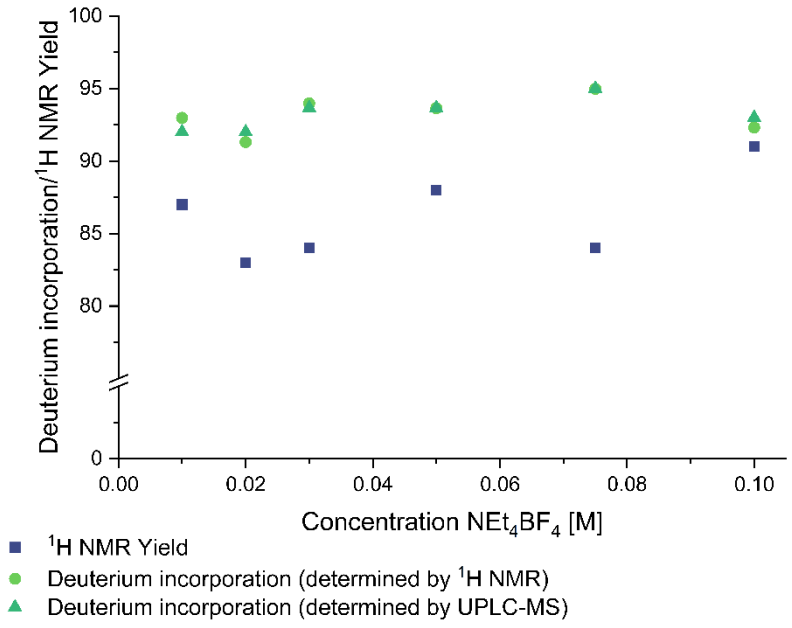
Table S5: Screening of the concentration of supporting electrolyte (NEt_4BF_4). [a]



1 ^{2}H-**1**

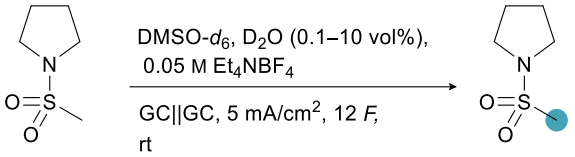
Entry	Concentration of supporting electrolyte (M)	Deuterium incorporation (%D)[b]	Deuterium incorporation (%D)[c]	^1H NMR yield (%)[d]
1	0.01	92	93	91
2	0.02	94	94	88
3	0.03	93	92	87
4	**0.05**	**91**	**92**	**83**
5	0.075	94	94	84
6	0.1	95	95	84

[a]Reaction conditions unless indicated otherwise: 0.25 mmol 1-(methylsulfonyl)pyrrolidine, 0.05–0.5 mmol Et_4NBF_4 in 5 mL DMSO-d_6 and 1 vol% D_2O as the additive. Electrochemical reactions were performed using glassy carbon electrodes as anode and cathode, 5 mA/cm^2, 12 *F*. [b]Deuterium incorporation determined by ^1H NMR. [d] ^1H NMR yields determined by addition of mesitylene (13.7 mg, 0.11 mmol) as an internal standard.



The amount of additive (D_2O) was screened last (GP-3.4, Table S6).

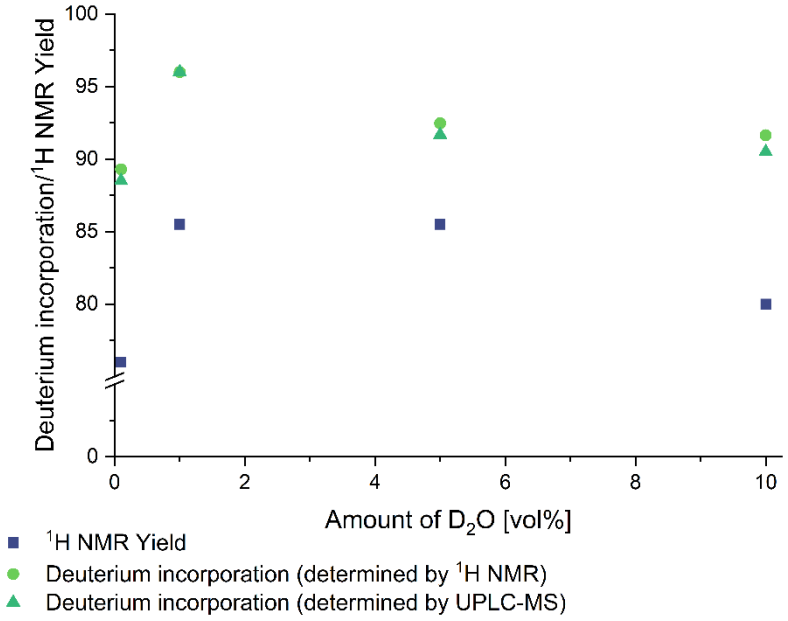
Table S6: Screening of the amount of additive (D_2O).[a]



1 ^{2}H-**1**

Entry	Amount of D_2O (vol%)	Deuterium incorporation (%D)[b]	Deuterium incorporation (%D)[c]	^{1}H NMR yield (%)[d]
1	0.1	93	93	86
2	**1**	**92**	**92**	**86**
3	5	92	91	80
4	10	89	89	76

[a]Reaction conditions unless indicated otherwise: 0.25 mmol 1-(methylsulfonyl)pyrrolidine, 0.25 mmol Et_4NBF_4 in 5 mL DMSO-d_6 and 0.1–10 vol% D_2O as the additive. Electrochemical reactions were performed using glassy carbon electrodes as anode and cathode, 5 mA/cm^2, 12 *F*. [b]Deuterium incorporation determined by ^{1}H NMR. [d] ^{1}H NMR Yields determined by addition of mesitylene (13.7 mg, 0.11 mmol) as an internal standard.



4 Mechanistical discussions and selectivity experiments

For mechanistical studies **1** (0.01 M) was examined using cyclic voltammetry experiments in 5 mL electrolyte (0.1 M NEt_4BF_4 in DMAc), using a glassy carbon WE, a glassy carbon CE, and an Ag/AgCl RE. Before measuring the samples, the solution was deoxygenated by saturating with argon for 5 minutes. The WE was polished with alumina paste (0.5 µm). For the blank and the sample 3 scans with a scan rate of 100 mV/s were recorded. The potential was referred to ferrocene. Graph a in Figure S3 is showing the measurement of the blank (NEt_4BF_4 in DMAc) while graph b is showing the test of **1** dissolved in the electrolyte.

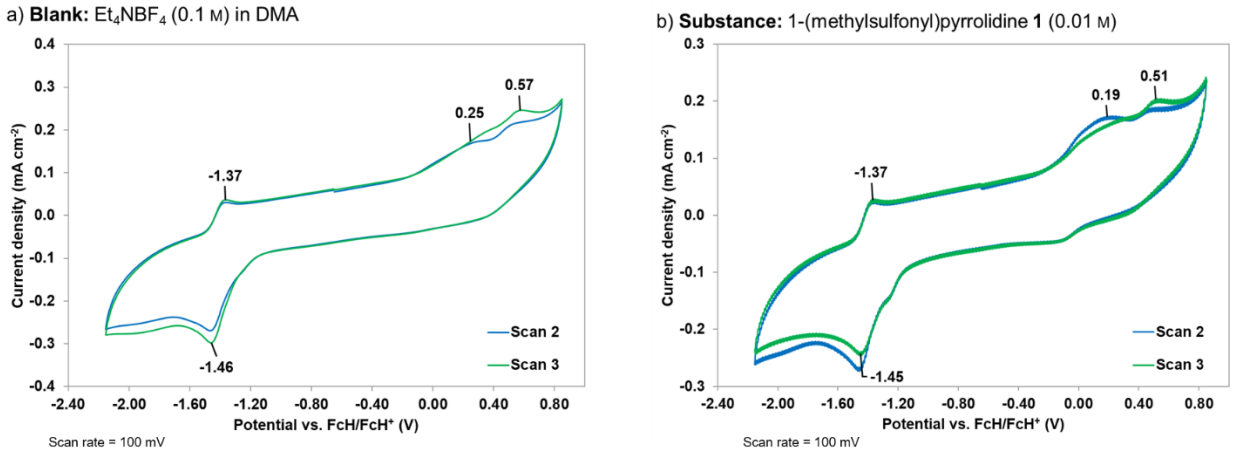


*Figure S3: Cyclic voltammetry studies on compound **1** in DMAc and NEt_4BF_4. a) measurement of the blank, NEt_4BF_4 (0.1 M) in DMAc (5 mL). b) measurement of **1** (0.01 M) dissolved in the electrolyte. Working electrode: glassy carbon, counter electrode: glassy carbon, reference electrode: Ag/AgCl. Scan rate: 100 mV/s, 3 scans. Potential referenced vs. FcH/FcH+ (FcH = $Fe(\eta^5\text{-}C_5H_5)_2$).*

Further experiments were done to undermine the necessity of electricity in the reaction. 1-(methylsulfonyl)pyrrolidine **1** (37.3 mg, 0.25 mmol, 1 eq.) and Et_4NBF_4 (108.5 mg, 0.5 mmol, 0.1 M, 2 eq.) were weighted into the cell. 5 mL DMAc and 0.9 mL D_2O (left graph) or 5 mL DMSO-d_6 (right graph) were added and 2 *F*/96 C of electric charge were applied under galvanostatic conditions at current density of 5 mA/cm^2 (15 mA) with stirring at 200 rpm and room temperature. After the first electrolysis cycle, a sample was taken and was prepared for UPLC-MS analysis by filtering over a SiO_2 column with acetonitrile. The deuterium incorporation was then determined by UPLC-MS with the method described in chapter 1.9. The reaction mixture was then stirred only for a reaction time equivalent of 2 *F* (50 min). A sample was taken and was prepared for UPLC-MS analysis by filtering over a SiO_2 column with acetonitrile. The deuterium incorporation was then determined by UPLC-MS with the method described in chapter 1.9. This alteration was continued for two more electricity and two more time cycles.

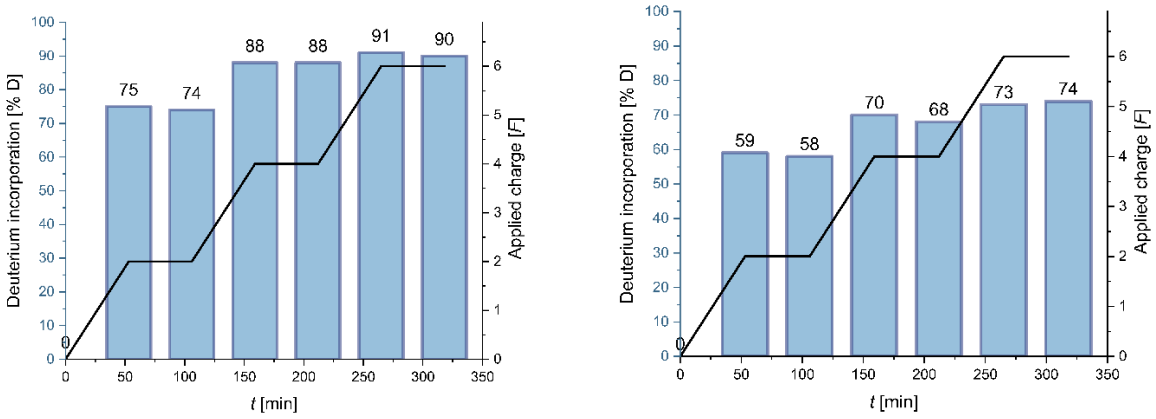


*Figure S4: On-Off-Screening of electricity. 0.25 mmol **1**, 0.1 M NEt_4BF_4 in 5 mL DMAc and 0.9 mL D_2O (left graph) or 5 mL DMSO-d_6 (right graph), 5 mA/cm², total 6 F and 150 min of reaction time without electricity in alternation, glassy carbon as anode and cathode.*

To determine the selectivity a disulfonamide **11** was tested. **11** (35.5 mg, 0.125 mmol, 1 eq.) and Et_4NBF_4 (108.5 mg, 0.5 mmol, 0.1 M, 5 eq.) were weighted into the cell. 5 mL DMAc and 0.9 mL were added and 2–20 *F* of electric charge were applied under galvanostatic conditions at current density 5 mA/cm² (15 mA) with stirring at 200 rpm and room temperature. The reaction mixture was poured onto ice and the precipitate filtered off. Analysis of the deuterium incorporation was done via ^{1}H NMR.

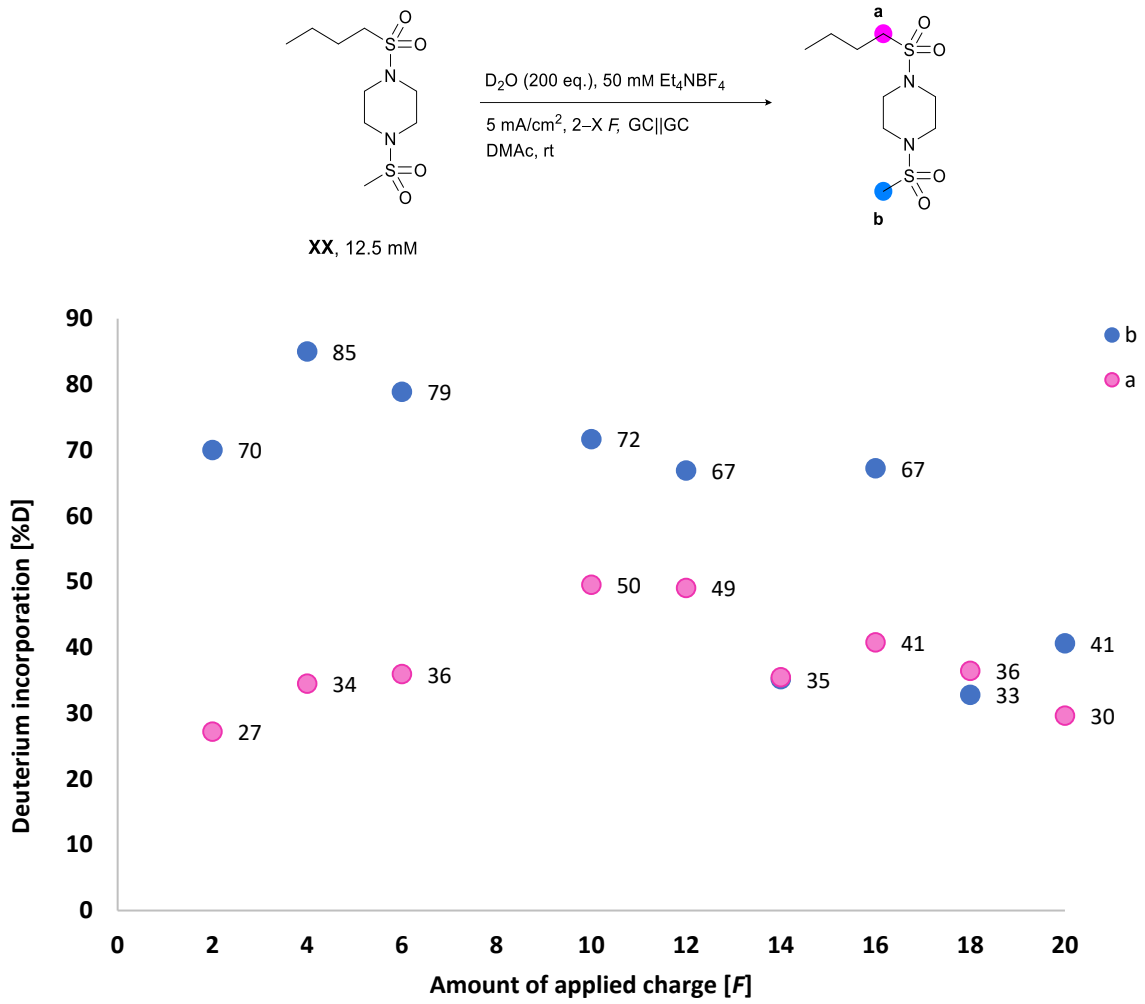
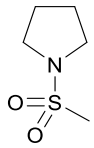
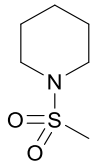


*Figure S5: Selectivity experiments on disulfonamide **11**. 0.125 mmol **11**, 0.5 mmol Et_4NBF_4 in 5 mL DMAc as the solvent and D_2O 0.9 mL (200 eq.) deuterium source. Electrochemical reactions were performed using glassy carbon electrodes as anode and cathode, 5 mA/cm², 2–20 F. Deuterium incorporation determined by ^1H NMR.*

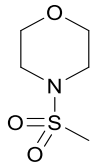
5 Synthesis and characterisation of sulfonamides, sulfilimides, sulfoximines

1-Methylsulfonylpyrrolidine **1**	
 **1**	
Procedure and Yield	GP 1: Pyrrolidine (3.56 g, 50 mmol, 1 eq.), methylsulfonyl chloride (6.87 g, 60 mmol, 1.2 eq.), NEt_3 (7.59 g, 75 mmol, 1.5 eq.). Purification of the compound by recrystallization from EtOH (5 mL). 31% (2.3 g, 15 mmol), white powder.
^{1}H NMR	(500 MHz, DMSO-d_6) δ = 3.23 – 3.15 (m, 4H), 2.85 (s, 3H), 1.87 – 1.79 (m, 4H) ppm.
^{13}C NMR	(126 MHz, DMSO-d_6): δ = 47.6, 33.0, 25.2 ppm.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 150.06, found: 149.99.

Analytic is in accordance with the literature.[2]

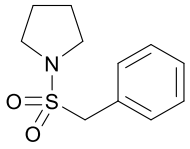
1-Methylsulfonylpiperidine **2**	
 **2**	
Procedure and Yield	GP 1: Piperidine (3.56 g, 43 mmol, 1 eq.), methylsulfonyl chloride (7.40 g, 64 mmol, 1.5 eq.), NEt_3 (4.34 g, 43 mmol, 1 eq.). Purification of the compound by recrystallization from EtOH (5 mL). 73% (5.1 g, 31.4 mmol), white powder.
^{1}H NMR	(400 MHz, DMSO-d_6) δ = 3.10 – 3.03 (m, 4H), 2.82 (s, 3H), 1.60 – 1.43 (m, 6H) ppm.
^{13}C NMR	(101 MHz, DMSO-d_6): δ = 46.1, 33.8, 24.9, 23.1 ppm.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 164.08, found: 164.02.

Analytic is in accordance with the literature.[2]

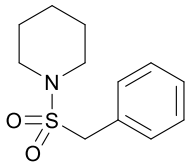
4-Methylsulfonylmorpholine **3**	
 **3**	
Procedure and Yield	GP 1: Morpholine (4.44 g, 51 mmol, 1 eq.), methylsulfonyl chloride (5.84 g, 51 mmol, 1 eq.), NEt_3 (5.16 g, 51 mmol, 1 eq.). Purification of the compound by recrystallization from EtOH (5 mL). 44% (3.7 g, 22.4 mmol), white powder.
^{1}H NMR	(500 MHz, DMSO-d_6) δ = 3.68 – 3.63 (m, 4H), 3.11 – 3.05 (m, 4H), 2.89 (s, 3H) ppm.
^{13}C NMR	(126 MHz, DMSO-d_6) δ = 65.6, 45.5, 33.4 ppm.

UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 166.06, found: 165.99.

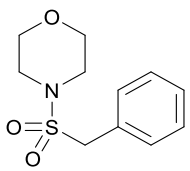
Analytic is in accordance with the literature.[2]

1-Benzylsulfonylpyrrolidine **4**	
 **4**	
Procedure and Yield	GP 1: Pyrrolidine (2.46 g, 35 mmol, 1 eq.), benzylsulfonyl chloride (9.9 g, 52 mmol, 1.5 eq.), NEt_3 (3.50 g, 35 mmol, 1 eq.). Purification of the compound by recrystallization from EtOH (5 mL) and flash column chromatography (DCM/MeOH) 61% (4.8 g, 21.3 mmol), white powder.
^{1}H NMR	^{1}H NMR (500 MHz, DMSO-d_6) δ = 7.45 – 7.32 (m, 5H), 4.42 (s, 2H), 3.17 – 3.09 (m, 4H), 1.83 – 1.72 (m, 4H) ppm.
^{13}C NMR	(126 MHz, DMSO-d_6): δ = 130.9, 130.0, 128.3, 128.1, 53.4, 47.6, 25.3 ppm.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 226.09, found: 226.05.

Analytic is in accordance with the literature.[2]

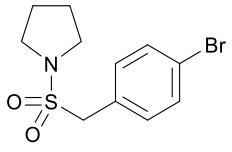
1-Benzylsulfonylpiperidine **5**	
 **5**	
Procedure and Yield	GP 1: Piperidine (2.17 g, 26 mmol, 1 eq.), benzylsulfonyl chloride (4.86 g, 26 mmol, 1 eq.), NEt_3 (2.58 g, 26 mmol, 1 eq.). (26 mmol amine), purification of the compound by recrystallization from EtOH (5 mL). 84% (5.2 g, 21.8 mmol), white powder.
^{1}H NMR	(400 MHz, DMSO-d_6) δ 7.43 – 7.32 (m, 5H), 4.35 (s, 2H), 3.07 (m, 4H), 1.54 – 1.41 (m, 6H) ppm.
^{13}C NMR	(101 MHz, DMSO-d_6) δ = 131.0, 129.3, 128.4, 128.3, 65.9, 54.0, 45.6 ppm.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 240.11, found: 240.02.

Analytic is in accordance with the literature.[2]

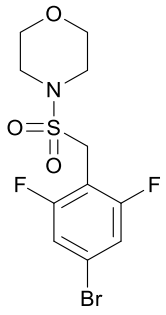
4-Benzylsulfonylmorpholine **6**
 **6**

Procedure and Yield	GP 1: Morpholine (2.60 g, 30 mmol, 1 eq.), benzylsulfonyl chloride (5.70 g, 30 mmol, 1 eq.), NEt_3 (3.03 g, 30 mmol, 1 eq.). Purification of the compound by recrystallization from EtOH (5 mL). 87% (6.3 g, 26.1 mmol), white powder.
^{1}H NMR	(500 MHz, DMSO-d_6) δ = 7.46 – 7.34 (m, 5H), 4.44 (s, 2H), 3.60 – 3.54 (m, 4H), 3.13 – 3.05 (m, 4H) ppm.
^{13}C NMR	(126 MHz, DMSO-d_6) δ = 131.0, 129.3, 128.4, 128.3, 65.9, 54.0, 45.6 ppm.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 242.09, found: 241.65.

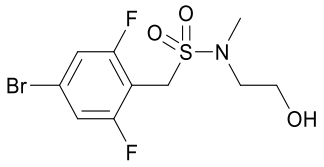
Analytic is in accordance with the literature.[2]

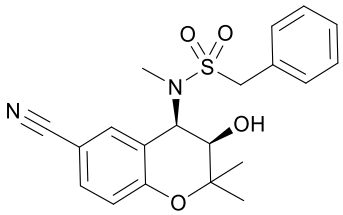
1-((4-Bromobenzyl)sulfonyl)pyrrolidine **7**	
 **7**	
Procedure and Yield	Compound was received from the Sanofi compound library without any knowledge on the synthesis procedure. Appearance: white powder.
^{1}H NMR	(400 MHz, DMSO-d_6) δ = 7.62 – 7.55 (m, 2H), 7.42 – 7.34 (m, 2H), 4.43 (s, 2H), 3.22 – 3.12 (m, 4H), 1.85 – 1.76 (m, 4H) ppm.
^{13}C NMR	(101 MHz, DMSO-d_6): δ = 133.0, 131.3, 129.6, 121.5, 52.5, 47.7, 25.3 ppm.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 304.00, found: 303.86.

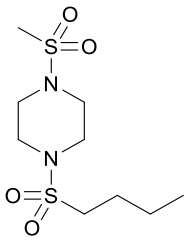
Analytic is in accordance with the literature.[7]

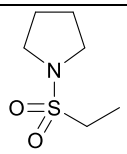
4-((4-Bromo-2,6-difluorobenzyl)sulfonyl)morpholine **8**	
 **8**	
Procedure and Yield	Compound was received from the Sanofi compound library without any knowledge on the synthesis procedure. Appearance: white powder.
^{1}H NMR	(400 MHz, DMSO-d_6) δ = 7.64 – 7.55 (m, 2H), 4.46 (s, 2H), 3.67 – 3.59 (m, 4H), 3.20 – 3.14 (m, 4H) ppm.
^{13}C NMR	(101 MHz, DMSO-d_6): δ = 160.9 (d, J = 254.0 Hz), 123.3 – 105.0 (m), 115.7 (dd, J = 26.4, 2.6 Hz), 65.8, 45.4, 42.3 ppm.
^{19}F NMR	(376 MHz, DMSO-d_6): δ = -110.4 (d, J = 7.1 Hz) ppm.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 355.98, found: 356.01.
HRMS (EI)	([M+H]$^+$ m/z): calc: 355.9767, found: 355.9762.

IR	(ATR, cm^{-1}): *v* = 3092, 2970, 2942, 2861, 1620, 1596, 1573, 1478, 1463, 1445, 1419, 1347, 1331, 1302, 1261, 1178, 1157, 1127, 1108, 1077, 1019, 951, 925, 870, 851, 837, 774, 763, 723, 686, 614, 577, 537, 519, 510, 491.

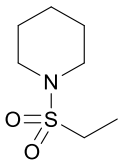
1-(4-Bromo-2,6-difluorophenyl)-*N*-(2-hydroxyethyl)-*N*-methylmethanesulfonamide **9**	
 **9**	
Procedure and Yield	Compound was received from the Sanofi compound library without any knowledge on the synthesis procedure. Appearance: white powder.
^{1}H NMR	(400 MHz, DMSO-d_6) δ =7.61 – 7.54 (m, 2H), 4.84 (t, *J* = 5.4 Hz, 1H), 4.45 (s, 2H), 3.49 (q, *J* = 5.8 Hz, 2H), 3.12 (t, *J* = 6.0 Hz, 2H), 2.85 (s, 3H) ppm.
^{13}C NMR	(101 MHz, DMSO-d_6): δ = 161.0 (d, *J* = 262.3 Hz), 123.0– 106.1 (m), 116.0 – 115.3 (m), 59.1, 51.8, 43.0, 35.2 ppm.
^{19}F NMR	(376 MHz, DMSO-d_6): δ = -110.9 (d, *J* = 7.4 Hz) ppm.
UPLC-MS (ESI)	($[M+H]^+$ m/z): calc: 343.98, found: 343.94.
HRMS (EI)	($[M+H]^+$ m/z): calc: 343.9764, found: 343.9762.
IR	(ATR, cm^{-1}): *v* = 3331, 3236, 3094, 2938, 2876, 1618, 1590, 1572, 1481, 1442, 1415, 1366, 1336, 1302, 1290, 1257, 1212, 1159, 1139, 1069, 1048, 1020, 952, 923, 869, 848, 776, 754, 717, 677, 580, 547, 524, 510, 484, 459.

(3*R*,4*S*)-6-cyano-2,3-dihydro-3-hydroxy-2,2-dimethyl-4-(*N*-methylbenzenemethanesulfonamidyl)-benzopyrane **10**	
 **10**	
Procedure and Yield	Compound was received from the Sanofi compound library without any knowledge on the synthesis procedure. Appearance: white powder.
^{1}H NMR	(400 MHz, DMSO-d_6) δ = 7.66 (dd, *J* = 8.5, 2.1 Hz, 1H), 7.53 – 7.45 (m, 2H), 7.43 – 7.35 (m, 4H), 6.98 (d, *J* = 8.5 Hz, 1H), 6.17 (d, *J* = 6.3 Hz, 1H), 4.83 (d, *J* = 10.3 Hz, 1H), 4.68 – 4.56 (m, 2H), 3.81 (m, 1H), 1.50 (s, 3H), 1.21 (s, 3H) ppm.
^{13}C NMR	(101 MHz, DMSO-d_6): δ = 157.5, 133.3, 131.7, 131.0, 129.8, 128.4, 128.2, 122.0, 119.0, 118.4, 103.1, 80.8, 67.5, 57.2, 28.9, 26.8, 18.6 ppm.
UPLC-MS (ESI)	($[M+H]^+$ m/z): calc: 387.14, found: 387.14.
HRMS (EI)	($[M+NH_4]^+$ m/z): calc: 404.1643, found: 404.1639.
IR	(ATR, cm^{-1}): *v* = 3473, 2980, 2934, 2891, 2229, 1610, 1574, 1486, 1456, 1418, 1389, 1369, 1315, 1259, 1221, 1205, 1662, 1132, 1115, 1095, 1072, 1027, 988, 975, 938, 914, 895, 838, 824, 790, 762, 741, 722, 704, 660, 605, 542, 515, 471, 457, 447, 423.

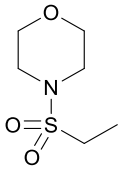
1-(Butylsulfonyl)-4-(methylsulfonyl)piperazine **11**	
 **11**	
Procedure and Yield	GP 1: 1-(Methylsulfonyl)piperazine (2.46 g, 15 mmol, 1 eq.), butylsulfonyl chloride (3.52 g, 22 mmol, 1.5 eq.), NEt_3 (1.51 g, 15 mmol, 1 eq.). Purification by precipitation from ice water. 47% (1.8 g, 6.4 mmol), white powder.
^{1}H NMR	(500 MHz, DMSO-d_6, 55 °C) δ = 3.29 (dd, J = 6.4, 3.5 Hz, 4H), 3.21 (dd, J = 6.4, 3.7 Hz, 5H), 3.10 – 3.03 (m, 2H), 2.91 (s, 3H), 1.66 (t, J = 7.7 Hz, 1H), 1.42 (q, J = 7.4 Hz, 2H), 0.91 (t, J = 7.4 Hz, 3H) ppm.
^{13}C NMR	(126 MHz, DMSO-d_6, 55 °C): δ = 48.2, 45.1, 44.6, 40.0, 39.9, 39.7, 39.5, 39.4, 39.2, 39.0, 34.7, 24.4, 20.7, 13.1 ppm.
UPLC-MS (ESI)	($[M+H]^+$ m/z): calc: 285.00, found: 284.98.
HRMS (EI)	($[M+H]^+$ m/z): calc: 285.0937, found: 285.0937.
IR	(ATR, cm^{-1}): ν = 3012, 2963, 2934, 2873, 2302, 2201, 2030, 1745, 1632, 1458, 1403, 1376, 1367, 1323, 1265, 1245, 1153, 1127, 1087, 1059, 1013, 970, 940, 781, 740, 715, 594, 547, 515, 429.

1-Ethylsulfonylpyrrolidine **12**	
 **12**	
Procedure and Yield	GP 1: Pyrrolidine (3.65 g, 51 mmol, 1 eq.), ethylsulfonyl chloride (9.90 g, 77 mmol, 1.5 eq.), NEt_3 (5.19 g, 51 mmol, 1 eq.). Purification by distillation (130-142°C, 11 mbar). 73% (6.1 g, 37.4 mmol), light yellow oil.
^{1}H NMR	(400 MHz, DMSO-d_6) δ = 3.29 – 3.17 (m, 4H), 3.05 (q, J = 7.4 Hz, 2H), 1.90 – 1.78 (m, 4H), 1.20 (t, J = 7.4 Hz, 3H) ppm.
^{13}C NMR	(101 MHz, DMSO-d_6): δ = 47.3, 41.8, 25.3, 7.6 ppm.
UPLC-MS (ESI)	($[M+H]^+$ m/z): calc: 164.08, found: 164.03.

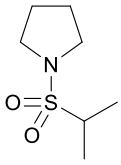
Analytic is in accordance with the literature.[8]

1-Ethylsulfonylpiperidine **13**	
 **13**	
Procedure and Yield	GP 1 : Piperidine (4.37 g, 51 mmol, 1 eq.), ethylsulfonyl chloride (9.90 g, 77 mmol, 1.5 eq.), NEt_3 (5.19 g, 51 mmol, 1 eq.). Purification by distillation (135-142°C, 9 mbar). 73% (6.3 g, 37.4 mmol), light yellow oil.
^{1}H NMR	(400 MHz, DMSO-d_6) δ = 3.18 – 3.10 (m, 4H), 2.99 (q, J = 7.4 Hz, 2H), 1.57 – 1.45 (m, 6H), 1.20 (t, J = 7.4 Hz, 3H) ppm.
^{13}C NMR	(101 MHz, DMSO-d_6): δ = 45.9, 42.4, 25.3, 23.2, 7.5 ppm.
UPLC-MS (ESI)	($[M+H]^+$ m/z): calc: 178.09, found: 178.05.

Analytic is in accordance with the literature.[8]

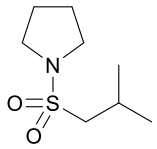
1-Ethylsulfonylmorpholine **14**	
 **14**	
Procedure and Yield	GP 1: Morpholine (4.44 g, 51 mmol, 1 eq.), ethylsulfonyl chloride (6.56 g, 51 mmol, 1 eq.), NEt_3 (5.19 g, 51 mmol, 1 eq.). Purification by recrystallization from ethanol (5 mL). 57% (5.3 g, 29 mmol), white powder.
^{1}H NMR	(400 MHz, DMSO-d_6) δ = 3.66 – 3.60 (m, 4H), 3.18 – 3.11 (m, 4H), 3.07 (q, J = 7.4 Hz, 2H), 1.22 (t, J = 7.4 Hz, 3H) ppm.
^{13}C NMR	(101 MHz, DMSO-d_6): δ = 65.9, 45.3, 42.1, 7.4 ppm.
UPLC-MS (ESI)	($[M+H]^+$ m/z): calc: 180.07, found: 180.03.

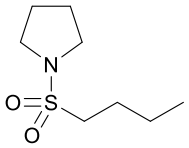
Analytic is in accordance with the literature.[8]

1-(Isopropylsulfonyl)pyrrolidine **15**	
 **15**	
Procedure and Yield	GP 1: Pyrrolidine (2.46 g, 35 mmol, 1 eq.), isopropylsulfonyl chloride (7.41 g, 52 mmol, 1.5 eq.), NEt_3 (3.50 g, 35 mmol, 1 eq.). Purification by distillation (110-115°C, 8 mbar). 11% (0.68 g, 3.8 mmol), light yellow oil.
^{1}H NMR	(400 MHz, DMSO-d_6) δ = 3.41 – 3.31 (m, 1H), 3.30 – 3.22 (m, 4H), 1.89 – 1.77 (m, 4H), 1.22 (d, J = 6.9 Hz, 6H) ppm.

^{13}C NMR	(101 MHz, DMSO-d_6): δ = 51.4, 47.7, 25.5, 16.4.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 178.09, found: 178.05.

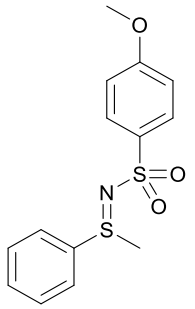
Analytic is in accordance with the literature.[9]

1-(Isobutylsulfonyl)pyrrolidine **16**	
 **16**	
Procedure and Yield	GP 1: Pyrrolidine (0.71 g, 10 mmol, 1 eq.), 1-isobutylsulfonyl chloride (1.57 g, 10 mmol, 1 eq.), NEt_3 (1.01 g, 10 mmol, 1 eq.). Purification by recrystallization from ethanol. 23% (0.44 g, 2.3 mmol), white solid.
^{1}H NMR	(400 MHz, DMSO-d_6) δ = 3.26 – 3.15 (m, 4H), 2.91 (d, J = 6.6 Hz, 2H), 2.17 – 2.03 (m, 1H), 1.89 – 1.77 (m, 4H), 1.03 (d, J = 6.7 Hz, 6H) ppm.
^{13}C NMR	(101 MHz, DMSO-d_6): δ = 53.5, 47.2, 25.2, 24.0, 22.3 ppm.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 192.11, found: 192.07.
HRMS (EI)	([M+H]$^+$ m/z): calc: 192.1057, found: 192.1053.
IR	(ATR, cm^{-1}): ν = 2960, 2875, 2058, 1466, 1408, 1388, 1346, 1319, 1262, 1197, 1141, 1067, 1007, 910, 862, 824, 770, 612, 568, 553, 530, 461, 415.

1-Butylsulfonylpyrrolidine **17**	
 **17**	
Procedure and Yield	GP 1: Pyrrolidine (0.71 g, 10 mmol, 1 eq.), 1-isobutylsulfonyl chloride (1.57 g, 10 mmol, 1 eq.), NEt_3 (1.01 g, 10 mmol, 1 eq.). (10 mmol), purification by distillation (117-125°C, 10 mbar). 51% (0.97 g, 5.1 mmol), light yellow oil.
^{1}H NMR	(400 MHz, DMSO-d_6) δ = 3.32 – 3.13 (m, 4H), 3.05 – 2.97 (m, 2H), 1.90 – 1.76 (m, 4H), 1.69 – 1.57 (m, 2H), 1.40 (h, J = 7.4 Hz, 2H), 0.93 – 0.86 (m, 3H) ppm.
^{13}C NMR	(101 MHz, DMSO-d_6): δ = 47.3, 46.7, 25.3, 24.9, 21.1, 13.5 ppm.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 192.11, found: 192.08.

Analytic is in accordance with the literature.[10]

(*E*)-4-Methoxy-*N*-(methyl(phenyl)-λ^4-sulfanylidene)benzenesulfonamide **18**

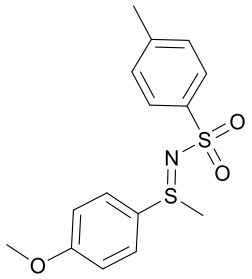


18

Procedure and Yield	GP 2.1: Methylphenylsulfide (62.0 mg, 0.5 mmol, 1 eq.), 4-methoxybenzenesulfonamide (93.5 mg, 0.5 mmol, 1 eq.), NEt_4Br (420.0 mg, 2 mmol, 4 eq.). Purification of the compound by flash column chromatography (Cyclohexane/Ethylacetate) 68% (102.1 mg, 0.33 mmol), white solid.
^{1}H NMR	(500 MHz, $CDCl_3$) δ = 7.74 – 7.64 (m, 4H), 7.55 – 7.44 (m, 3H), 7.17 – 7.12 (m, 2H), 2.82 (s, 3H), 2.33 (s, 3H) ppm.
^{13}C NMR	(126 MHz, $CDCl_3$) δ = 141.8, 141.3, 136.1, 132.5, 130.1, 129.3, 126.3, 125.9, 39.2, 21.5 ppm.
UPLC-MS (ESI)	($[M+H]^+$ m/z): calc: 310.06, found: 310.00.

Analytic is in accordance with the literature.[3]

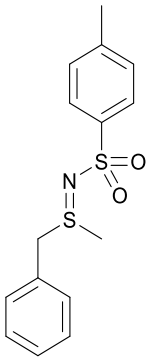
(*E*)-*N*-((4-Methoxyphenyl)(methyl)-λ^4-sulfaneylidene)-4-methylbenzenesulfonamide **19**



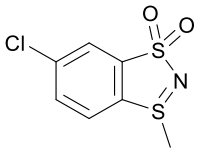
19

Procedure and Yield	GP 2.1: 1-Methoxy-4-methylsulfanyl-benzene (308.0 mg, 2 mmol, 1 eq.), 4-methylbenzenesulfonamide (342.0 mg, 2 mmol, 1 eq.), NEt_4Br (1.68 g, 8 mmol, 4 eq.). Purification of the compound by recrystallization from hot MeOH/water 9:1 35% (228.9 mg, 0.7 mmol), white solid.
^{1}H NMR	(500 MHz, DMSO-d_6) δ = 7.39 – 7.33 (m, 3H), 7.33 – 7.28 (m, 2H), 7.27 – 7.24 (m, 2H), 7.16 – 7.12 (m, 2H), 4.34 (d, J = 12.7 Hz, 1H), 4.22 (d, J = 12.7 Hz, 1H) ppm.
^{13}C NMR	(126 MHz, DMSO-d_6) δ = 141.7, 140.7, 130.8, 129.1, 129.0, 128.6, 128.5, 125.5, 53.2, 32.8, 20.9 ppm.
UPLC-MS (ESI)	($[M+H]^+$ m/z): calc: 324.07, found: 324.05.

Analytic is in accordance with the literature.[3]

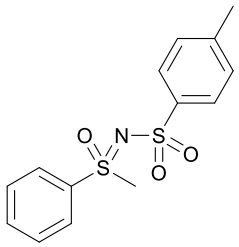
(*E*)-*N*-(Benzyl(methyl)-λ^4-sulfanylidene)-4-methylbenzenesulfonamide **20**	
 **20**	
Procedure and Yield	GP 2.1: (Methylthio)methylbenzene (69.0 mg, 0.5 mmol, 1 eq.), 4-methylbenzenesulfonamide (85.5 mg, 0.5 mmol, 1 eq.), NEt_4Br (420.0 mg, 2 mmol, 4 eq.). (0.5 mmol sulfide), purification of the compound by flash column chromatography (DCM/Acetone) 58% (88.5 mg, 0.29 mmol), white solid.
^{1}H NMR	(500 MHz, DMSO-d_6) δ = 7.39 – 7.33 (m, 3H), 7.33 – 7.28 (m, 2H), 7.27 – 7.24 (m, 2H), 7.16 – 7.12 (m, 2H), 4.34 (d, J = 12.7 Hz, 1H), 4.22 (d, J = 12.7 Hz, 1H) ppm.
^{13}C NMR	(126 MHz, DMSO-d_6) δ = 141.7, 140.7, 130.8, 129.1, 129.0, 128.6, 128.5, 125.5, 53.2, 32.8, 20.9 ppm.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 308.07, found: 308.02.

Analytic is in accordance with the literature.[3]

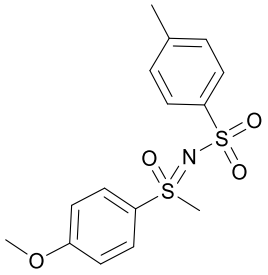
1*H*-5-Chloro-1-methyl-1,3,2-benzodithiazol-3,3-dioxide **21**	
 **21**	
Procedure and Yield	GP 2.1: 5-Chloro-2-(methylthio)benzenesulfonamide (118.9 mg, 0.5 mmol, 1 eq.), NEt_4Br (420.0 mg, 2 mmol, 4 eq.), purification of the compound by RP column chromatography (Water/Acetonitrile) 95% (112.9 mg, 0.47 mmol), white solid.
^{1}H NMR	(500 MHz, DMSO-d_6) δ = 8.23 (d, J = 8.4 Hz, 1H), 8.19 (d, J = 1.9 Hz, 1H), 7.95 (dd, J = 8.4, 1.9 Hz, 1H), 3.02 (s, 3H) ppm.
^{13}C NMR	(126 MHz, DMSO-d_6) δ = 138.9, 138.4, 134.5, 132.9, 127.6, 122.6, 37.6 ppm.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 235.96, found: 235.87.

Analytic is in accordance with the literature.[3]

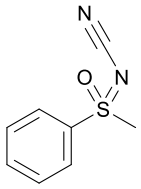
4-Methyl-*N*-(methyl(oxo)(phenyl)-λ^6-sulfanylidene)benzenesulfonamide **22**

 **22**	
Procedure and Yield	GP 2.1: Methylphenylsulfide (62.0 mg, 0.5 mmol, 1 eq.), 4-methylbenzenesulfonamide (85.5 mg, 0.5 mmol, 1 eq.), NEt_4Br (420.0 mg, 2 mmol, 4 eq.); oxidation step: peroxodicarbonate solution (800 mM, 6 mL, 4.5 mmol, 9 eq.). Purification of the compound by recrystallization from hot MeOH/water 9:1 91% (133.8 mg, 0.46 mmol), white solid.
^{1}H NMR	(500 MHz, DMSO-d_6) δ = 8.00 – 7.91 (m, 2H), 7.81 – 7.74 (m, 1H), 7.71 – 7.61 (m, 4H), 7.31 (d, J = 8.1 Hz, 2H), 3.61 (s, 3H), 2.36 (s, 3H) ppm.
^{13}C NMR	(126 MHz, DMSO-d_6) δ = 142.4, 140.8, 138.2, 134.2, 129.5, 129.3, 127.3, 126.0, 44.8, 20.9 ppm.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 310.06, found: 309.98.

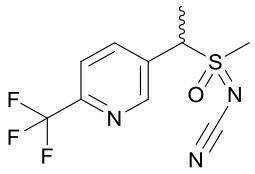
Analytic is in accordance with the literature.[3]

(*E*)-*N*-((4-Methoxyphenyl)(methyl)(oxo)-λ^6-sulfanylidene)-4-methylbenzenesulfonamide **23**	
 **23**	
Yield	GP 2.1: 1-Methoxy-4-methylsulfanyl-benzene (77.0 mg, 0.5 mmol, 1 eq.), 4-methylbenzenesulfonamide (85.5 mg, 0.5 mmol, 1 eq.), NEt_4Br (420.0 mg, 2 mmol, 4 eq.); oxidation step: peroxodicarbonate solution (820 mM, 5.7 mL, 4.5 mmol, 9 eq.). Purification of the compound by flash column chromatography (Cyclohexane/Ethylacetate) 72% (122.4 mg, 0.36 mmol), white solid.
^{1}H NMR	(400 MHz, DMSO-d_6) δ = 7.88 – 7.82 (m, 2H), 7.65 – 7.59 (m, 2H), 7.33 – 7.27 (m, 2H), 7.20 – 7.14 (m, 2H), 3.87 (s, 3H), 3.55 (s, 3H), 2.36 (s, 3H) ppm.
^{13}C NMR	(101 MHz, DMSO-d_6) δ = 163.62, 142.26, 140.91, 129.63, 129.24, 129.08, 126.02, 114.74, 55.97, 45.36, 20.95 ppm.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 340.07, found: 340.00.

Analytic is in accordance with the literature.[3]

N-(Methyl(oxo)(phenyl)-λ^6-sulfanylidene)cyanamide **24**	
 **24**	
Procedure and Yield	GP 2.2: Methylphenylsulfide (310.0 mg, 2.5 mmol, 1 eq.), cyanamide (157.5 mg, 3.75 mmol, 1.5 eq.), NMe_4OAc (6.7 mg, 0.05 mmol, 2 mol%); oxidation step: sodium para-periodate (1.47 g, 5 mmol, 2 eq.), $RuCl_3*xH_2O$ (26.0 mg, 0.125 mmol, 5 mol%). Purification of the compound by flash column chromatography (DCM/Acetone) 88% (359.7 mg, 1.9 mmol), white solid.
^{1}H NMR	(500 MHz, DMSO-d_6) δ = 8.09 – 8.04 (m, 2H), 7.92 – 7.86 (m, 1H), 7.79 (m, 2H), 3.73 (s, 3H) ppm.
^{13}C NMR	(126 MHz, DMSO-d_6) δ = 136.3, 135.3, 130.1, 127.7, 112.3, 42.7 ppm.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 181.05, found: 180.99.

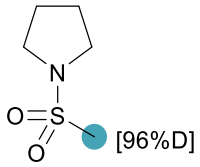
Analytic is in accordance with the literature.[5]

N-(Methyl(oxo)(1-(6-(trifluoromethyl)pyridin-3-yl)ethyl)-λ^6-sulfanylidene)cyanamide / Sulfoxaflor **25**	
 **25**	
Yield	GP 2.2: 5-(1-(Methylthio)ethyl)-2-(trifluoromethyl)pyridine (110.5 mg, 0.5 mmol, 1 eq.), cyanamide (31.5 mg, 0.75 mmol, 1.5 eq.), NMe_4OAc (1.3 mg, 0.01 mmol, 2 mol%); oxidation step: sodium para-periodate (294.0 mg, 1 mmol, 2 eq.), $RuCl_3*xH_2O$ (5.2 mg, 0.025 mmol, 5 mol%). Purification of the compound by flash column chromatography (Cyclohexane/Ethylacetate) 54% (74.5 mg, 0.27 mmol), white solid, diastereomeric mixture (4.1 to 5.9, determined by ^{1}H NMR).
^{1}H NMR	(500 MHz, $CDCl_3$) δ = 8.81 (d, *J* = 2.6 Hz, 1H), 8.10 (dd, *J* = 8.3, 2.3 Hz, 1H), 7.81 (d, *J* = 8.2 Hz, 1H), 4.76 (q, *J* = 7.1 Hz, 1H), 3.15 (s, 1H), 3.11 (s, 2H), 2.00 (d, *J* = 7.2 Hz, 3H) ppm.
^{13}C NMR	(126 MHz, $CDCl_3$) δ = 150.79, 149.97 (q, *J* = 35.3 Hz), 138.69, 130.98, 121.16 (m), 121.13 (q, *J* = 274.5 Hz), 111.79, 63.95, 38.46, 14.13 ppm. Mayor diastereomer. (126 MHz, $CDCl_3$) δ = 150.84, 150.35, 150.06, 149.78, 149.50, 138.74, 130.89, 124.44, 122.25, 121.14 (m), 121.13, 121.11, 120.07, 117.86, 111.61, 63.86, 38.03, 14.05 ppm. Minor diastereomer.
UPLC-MS (ESI)	([M+H]$^+$ m/z): calc: 278.06, found: 277.96.

Analytic is in accordance with the literature.[5]

6 Deuterium labelling results

^{2}H-1-Methylsulfonylpyrrolidine, **^{2}H-1**



^{2}H-1, 93%

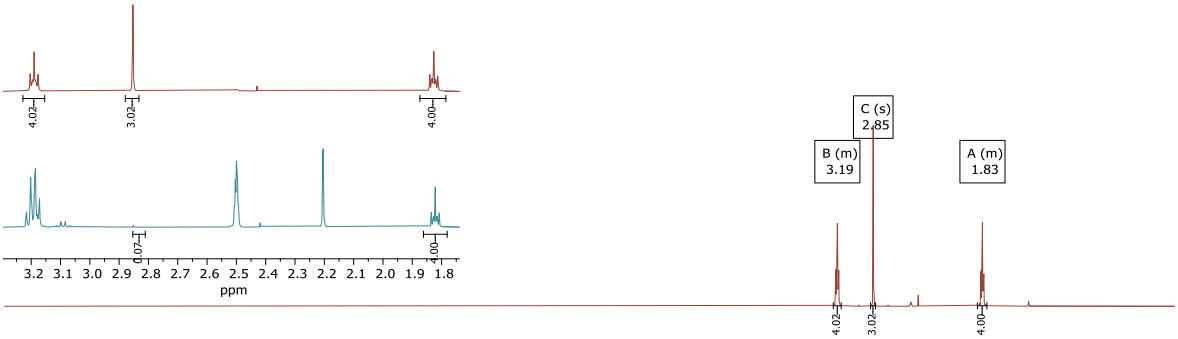
Deuteration via GP 4

1 (37.3 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.), 5.0 mL DMSO-d_6, 0.05 mL D_2O

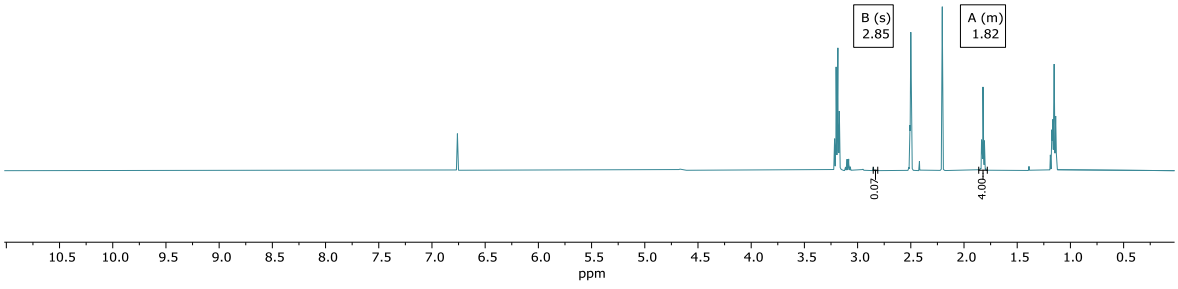
Incorporation expected at 2.85 ppm, measured relative to the signal at 1.82 ppm (NMR solvent: DMSO-d_6). Deuterium incorporation determined of the crude reaction mixture because of difficulties in the isolation procedure.
Signals at 6.7 ppm and 2.2 ppm referring to the internal standard mesitylene (13.7 mg, 0.11 mmol) needed for the ^{1}H NMR yield. Signals at 3.2 ppm and 1.1 ppm referring to the supporting electrolyte (NEt_4BF_4).

Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **96%D**

1

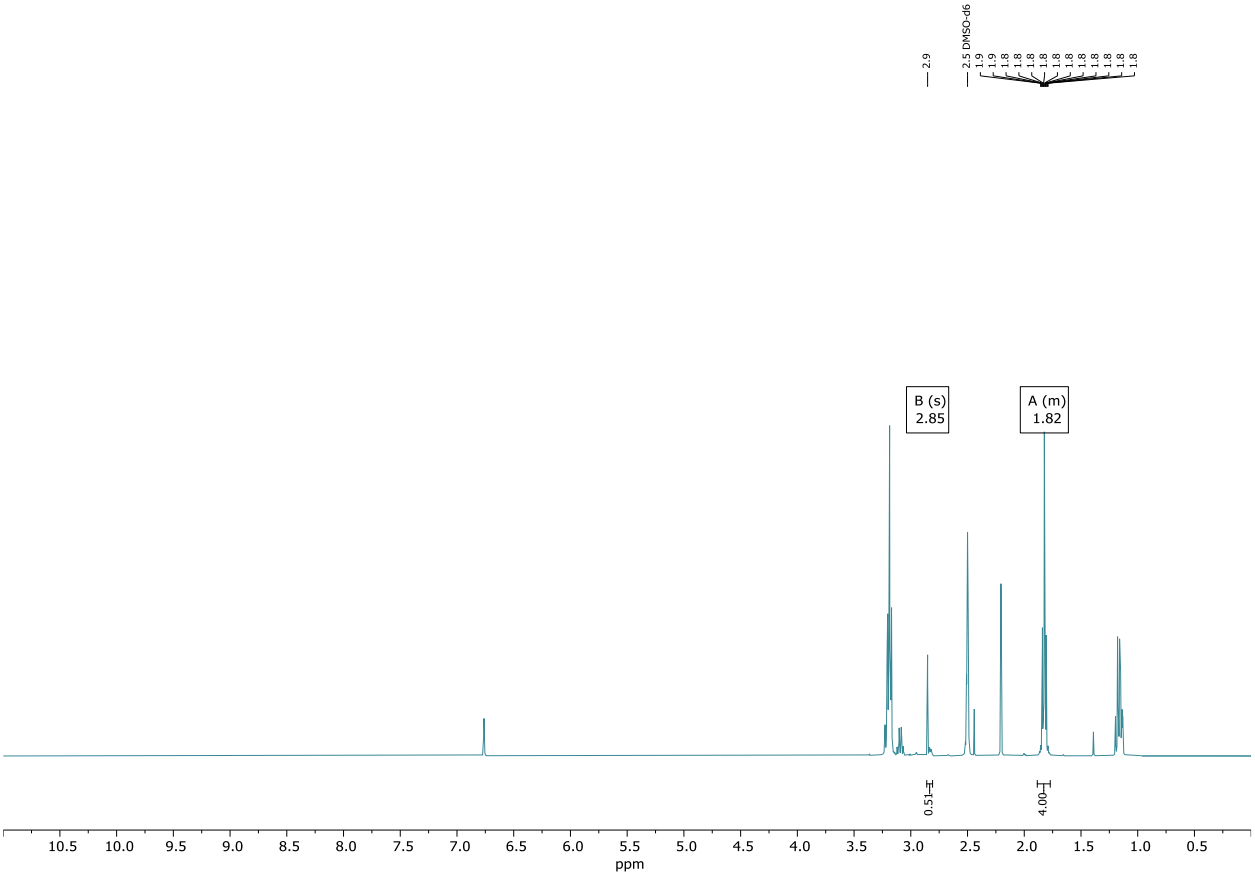


^{2}H-1

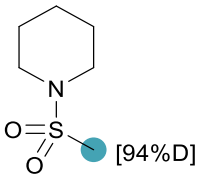


This reaction was upscaled four-fold using **1** (149.0 mg, 1.0 mmol) in DMSO-d_6 (5 mL) and D_2O (50 µL, 1 vol%) for 12 *F* at 5 mA/cm^2 with glassy carbon anode and cathode yielding the deuterated product **^{2}H-1** (83%D, 92% determined using mesitylene (13.7 mg, 0.11 mmol) as an internal standard). The deuterium incorporation was determined by ^{1}H NMR with the method described in chapter 1.9. The respective ^{1}H NMR is shown below. Signals at 6.7 ppm and 2.2 ppm referring to the internal standard mesitylene

needed for the ^{1}H NMR yield. Signals at 3.2 ppm and 1.1 ppm referring to the supporting electrolyte (NEt_4BF_4).



^{2}H-1-Methylsulfonylpiperidine, **^{2}H-2**



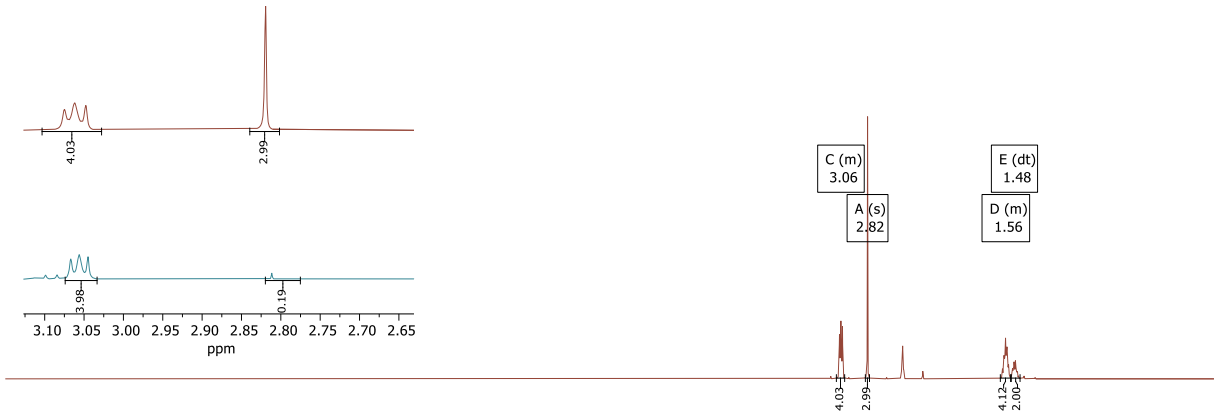
Deuteration via GP 4
2 (40.8 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.), 5.0 mL DMSO-d_6, 0.05 mL D_2O

^{2}H-2, 75%

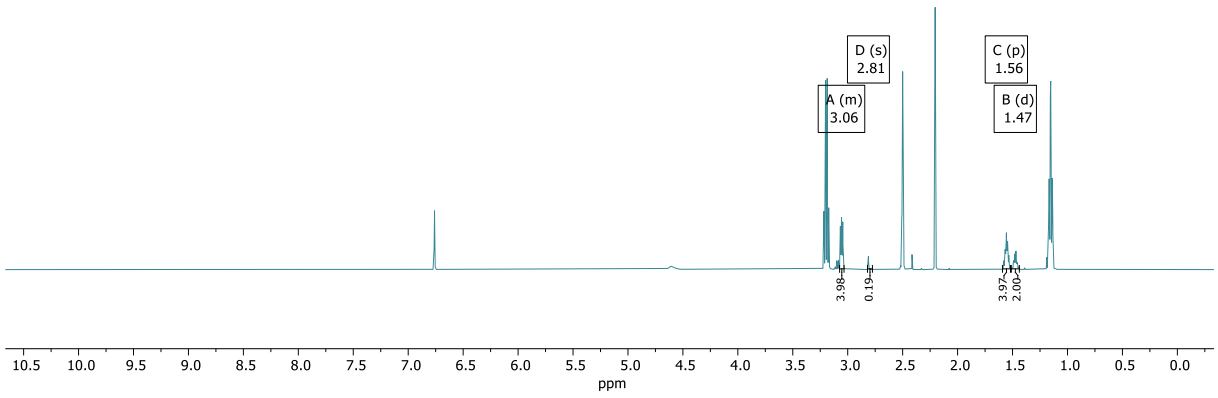
Incorporation expected at 2.81 ppm, measured relative to the signal at 1.47 ppm (NMR solvent: DMSO-d_6). Deuterium incorporation determined of the crude reaction mixture because of difficulties in the isolation procedure.
Signals at 6.7 ppm and 2.2 ppm referring to the internal standard mesitylene (13.7 mg, 0.11 mmol) needed for the ^{1}H NMR yield. Signals at 3.2 ppm and 1.1 ppm referring to the supporting electrolyte (NEt_4BF_4).

Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **94%D**

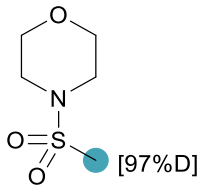
2



^{2}H-2



^{2}H-4-Methylsulfonylmorpholine, **^{2}H-3**



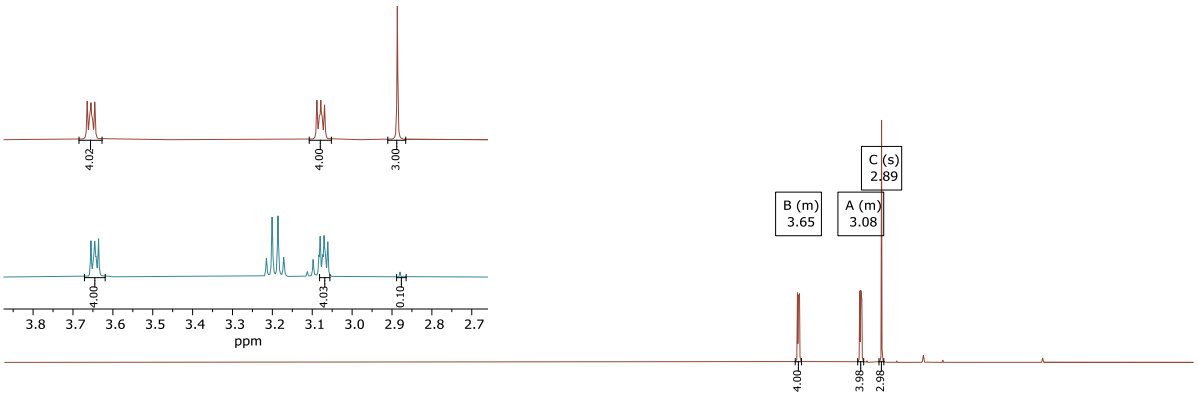
Deuteration via GP 4
3 (41.3 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.), 5.0 mL DMSO-d_6, 0.05 mL D_2O

^{2}H-3, quant.

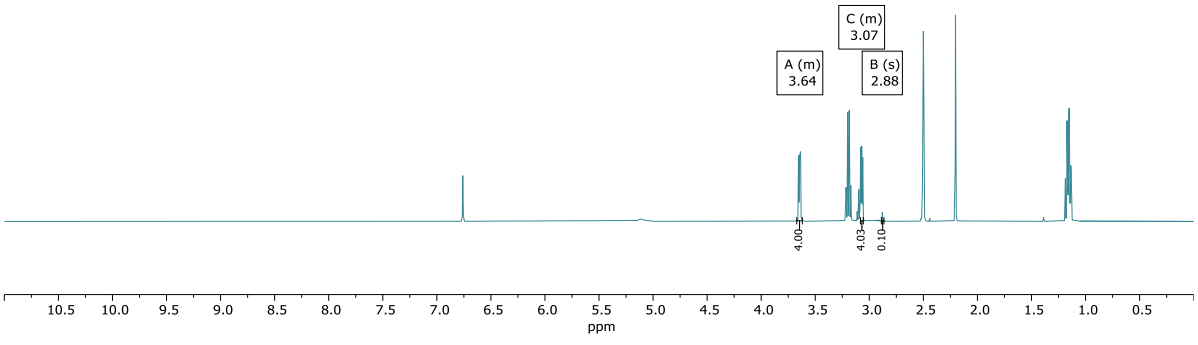
Incorporation expected at 2.88 ppm, measured relative to the signal at 3.64 ppm (NMR solvent: DMSO-d_6). Deuterium incorporation determined of the crude reaction mixture because of difficulties in the isolation procedure.
Signals at 6.7 ppm and 2.2 ppm referring to the internal standard mesitylene (13.7 mg, 0.11 mmol) needed for the ^{1}H NMR yield. Signals at 3.2 ppm and 1.1 ppm referring to the supporting electrolyte (NEt_4BF_4).

Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **97%D**

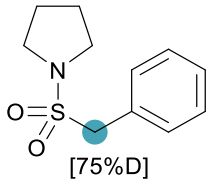
3



^{2}H-3



^{2}H-1-Benzylsulfonylpyrrolidine, **^{2}H-4**



Deuteration via GP 4
4 (56.3 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.), 5.0 mL DMSO-d_6, 0.05 mL D_2O
Work-up via WUP 2

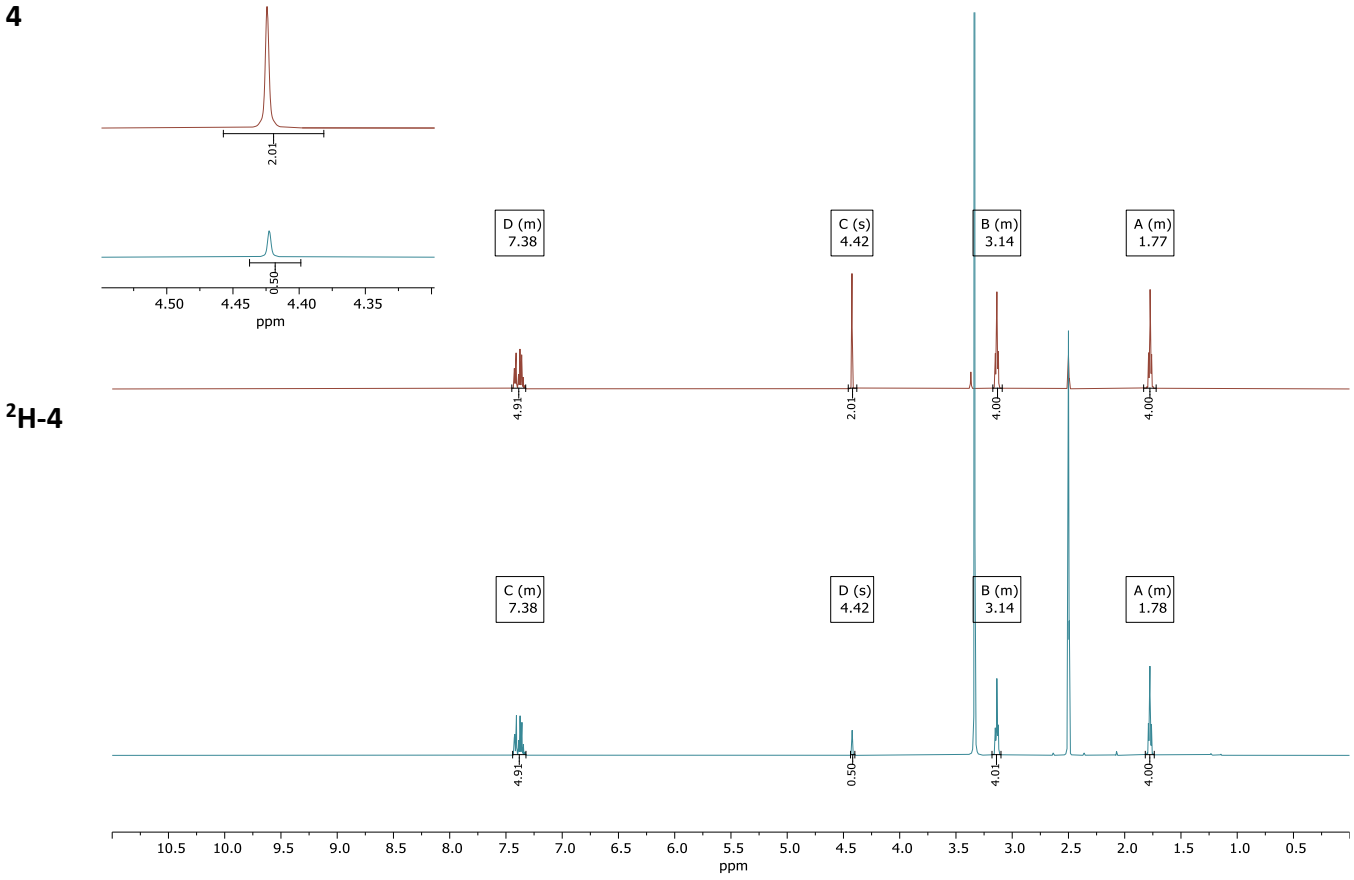
^{2}H-4, 4% (1.6 mg, 0.01 mol)

Incorporation expected at 4.42 ppm, measured relative to the signal at 1.78 ppm (NMR solvent: DMSO-d_6).

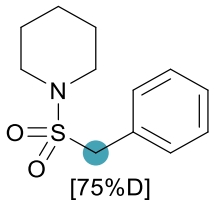
Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **75%D**

4

^{2}H-4



^{2}H-1-(Benzylsulfonyl)piperidine, **^{2}H-5**



Deuteration via GP 4
5 (59.8 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.), 5.0 mL DMSO-d_6, 0.05 mL D_2O
Work-up via WUP 2

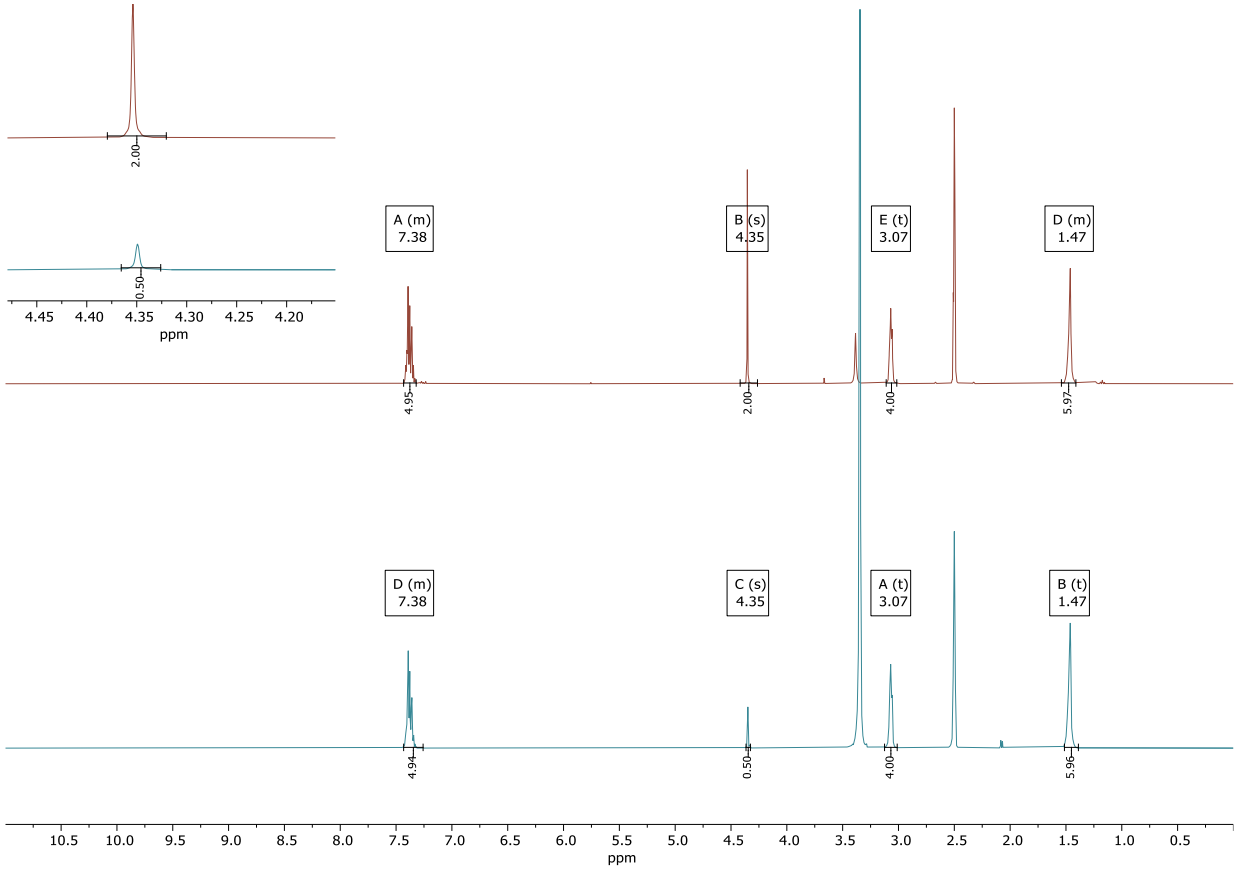
^{2}H-5, 16% (9.7 mg, 0.04 mmol)

Incorporation expected at 4.35 ppm, measured relative to the signal at 3.07 ppm (NMR solvent: DMSO-d_6).

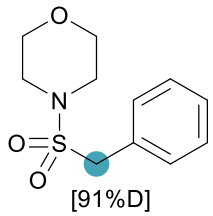
Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **75%D**

5

^{2}H-5



^{2}H-4-(Benzylsulfonyl)morpholine, **^{2}H-6**



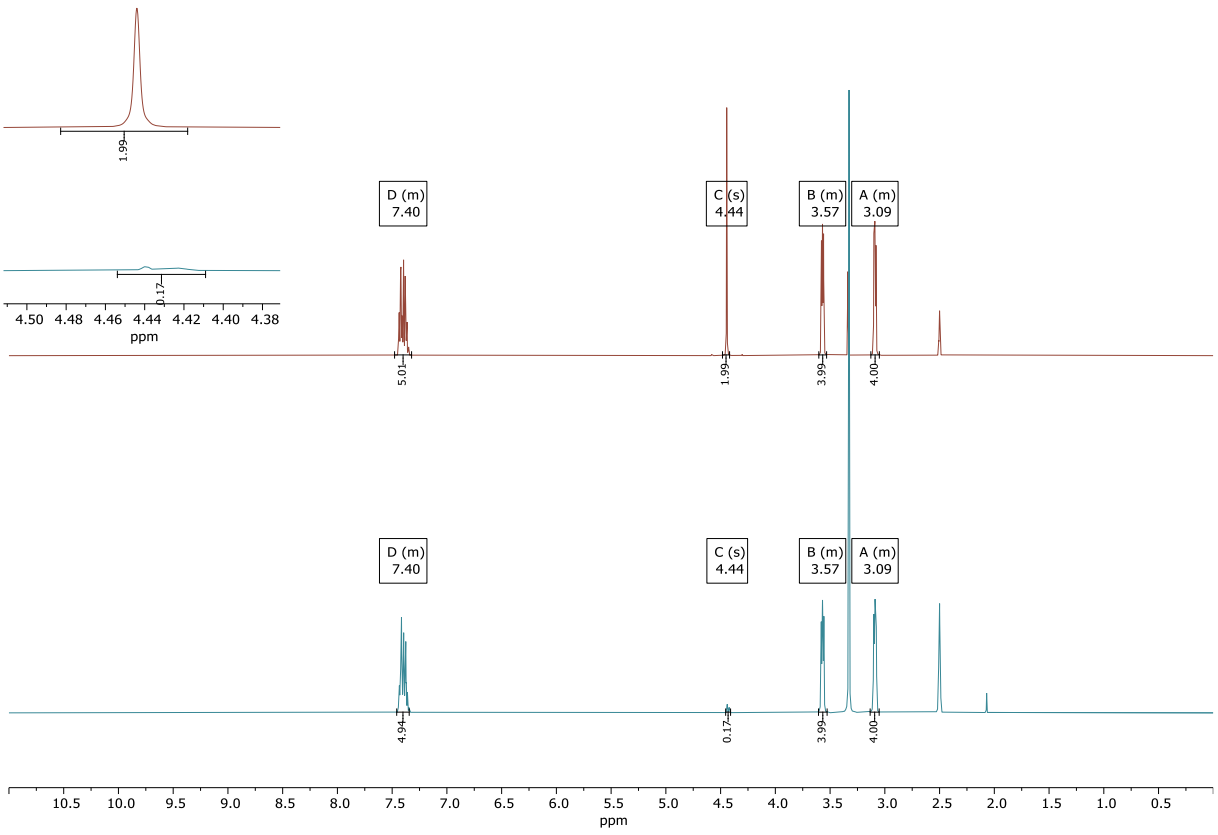
Deuteration via GP 4
6 (41.3 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.), 5.0 mL DMSO-d_6, 0.05 mL D_2O
Work-up via WUP 2

^{2}H-6, 24% (14.5 mg, 0.06 mmol)

Incorporation expected at 4.44 ppm, measured relative to the signal at 3.09 ppm (NMR solvent: DMSO-d_6).

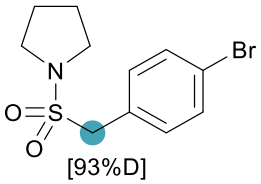
Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **91%D**

6



^{2}H-6

^{2}H-1-((4-Bromobenzyl)sulfonyl)pyrrolidine, **^{2}H-7**



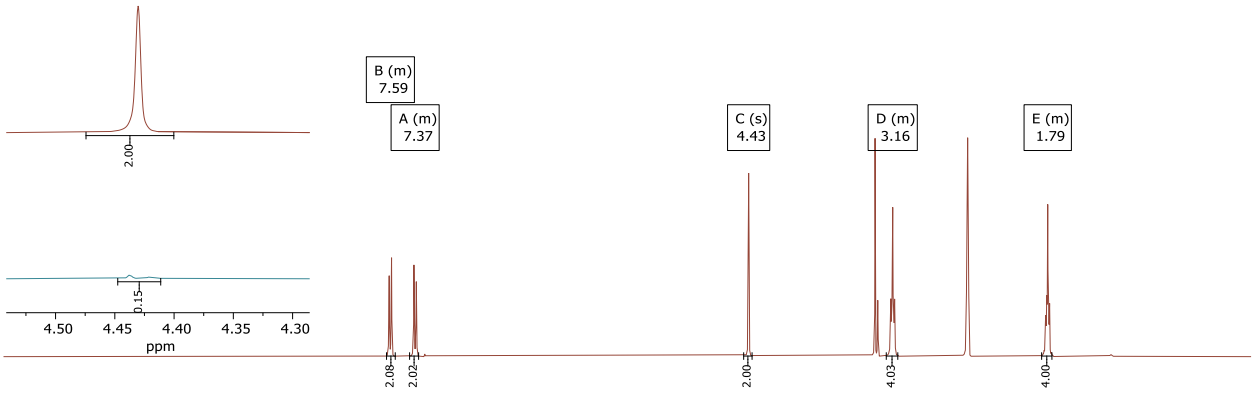
Deuteration via GP 4
7 (76.1 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.),
5.0 mL DMSO-d_6, 0.05 mL D_2O
Work-up via WUP 1, no column chromatography

^{2}H-7, quant. (76.0 mg, 0.25 mmol)

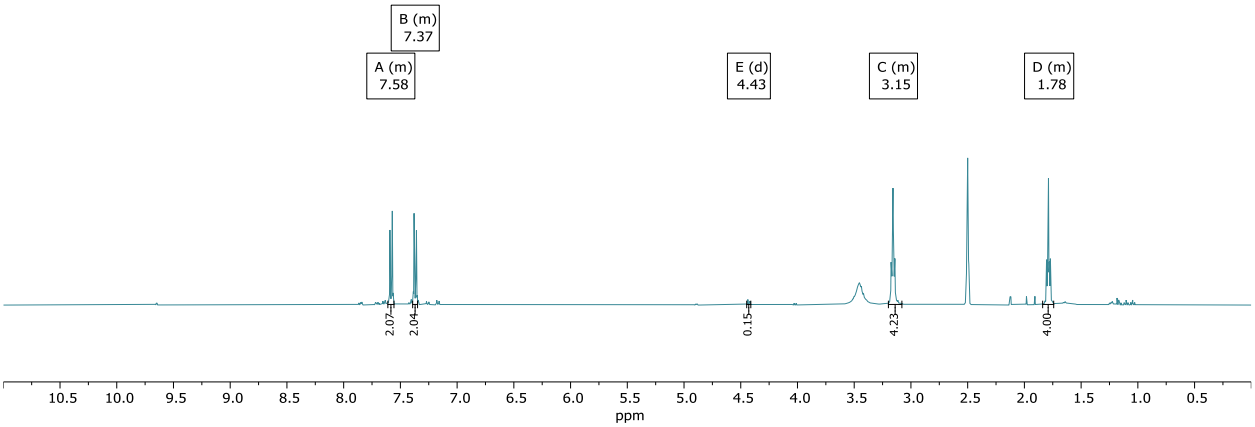
Incorporation expected at 4.43 ppm, measured relative to the signal at 1.78 ppm (NMR solvent: DMSO-d_6).

Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **93%D**

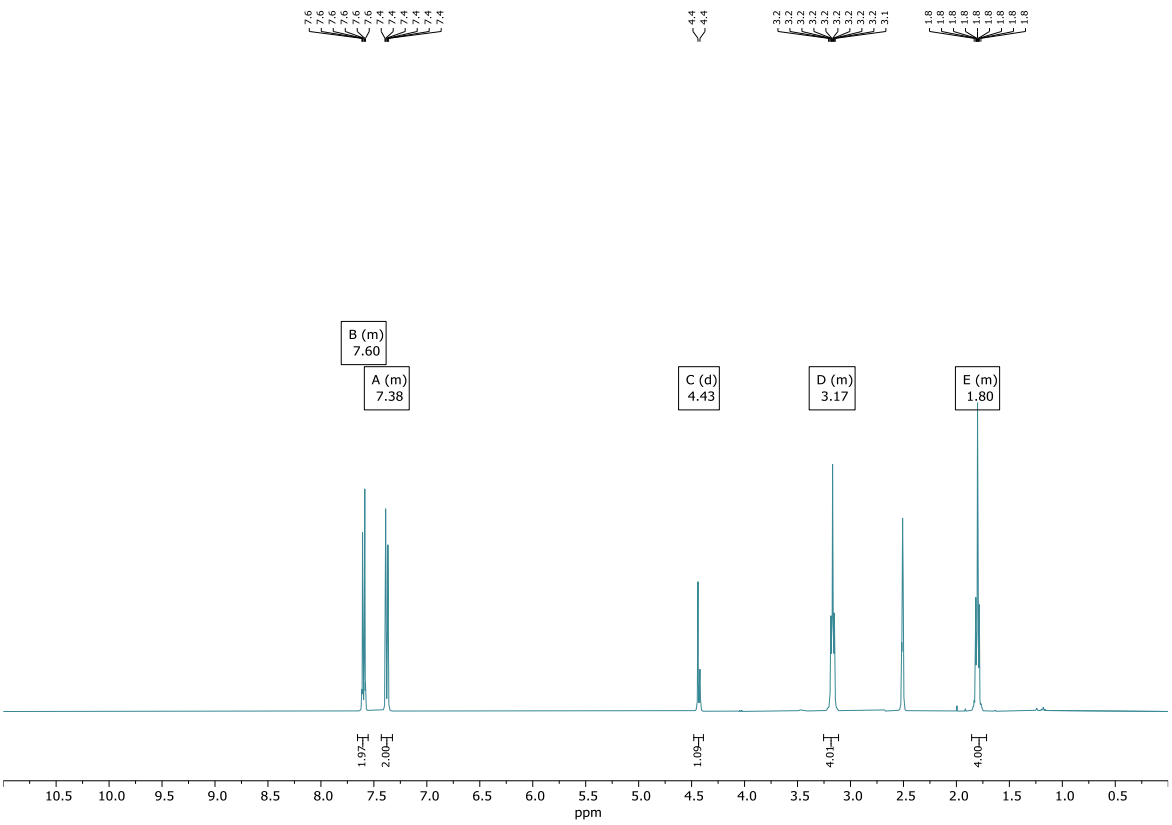
7



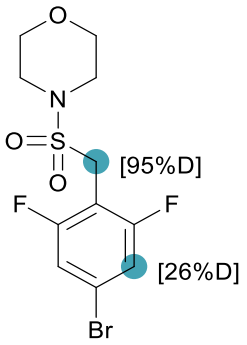
^{2}H-7



This reaction was upscaled four-fold using **7** (304.0 mg, 1.0 mmol) in DMSO-d_6 (5 mL) and D_2O (50 µL, 1 vol%) for 12 *F* at 5 mA/cm^2 with glassy carbon anode and cathode yielding the deuterated product **^{2}H-7** (46%D, 271.2 mg, 89 %). The deuterium incorporation was determined by ^{1}H NMR with the method described in chapter 1.9. The respective ^{1}H NMR is shown below.


B (m)
7.60
A (m)
7.38
C (d)
4.43
D (m)
3.17
E (m)
1.80
1.97
2.00
1.09
4.01
4.00
ppm

^{2}H-4-((4-Bromo-2,6-difluorobenzyl)sulfonyl)morpholine, **^{2}H-8**



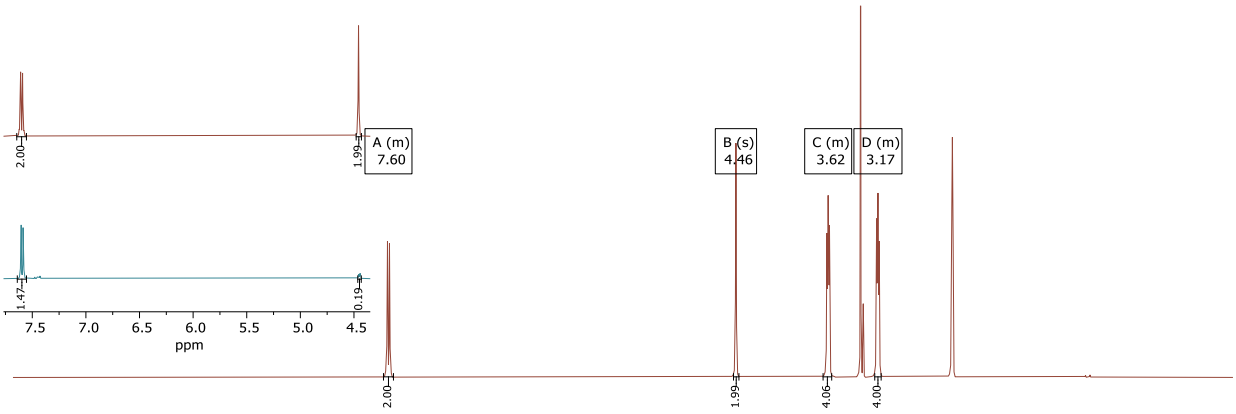
Deuteration via GP 4
8 (89.0 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.),
5.0 mL DMSO-d_6, 0.05 mL D_2O
Work-up via WUP 1

^{2}H-8, 36% (32.4 mg, 0.09 mmol)

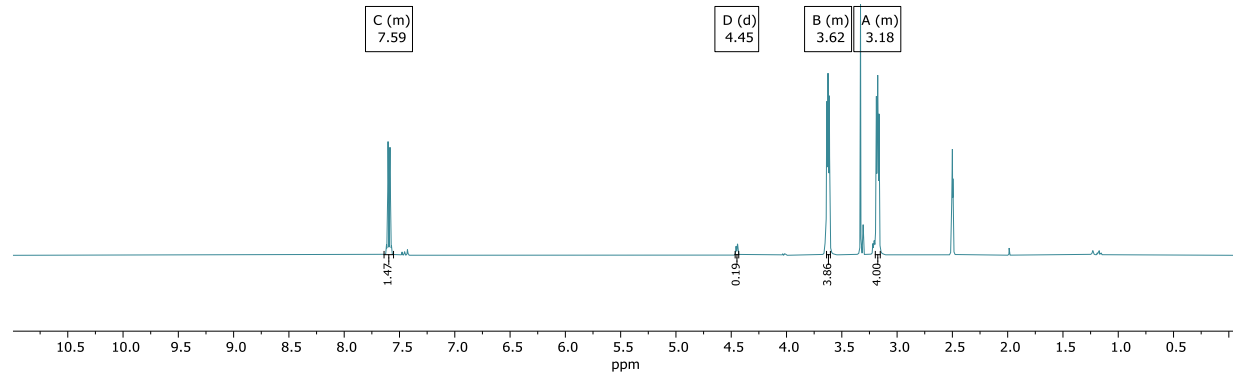
Incorporation overserved at 4.45 ppm (benzylic protons) and 7.59 ppm (aromatic protons), measured relative to the signal at 3.18 ppm (NMR solvent: DMSO-d_6).

Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **95%D** (benzylic)**, 26%D** (aromatic).

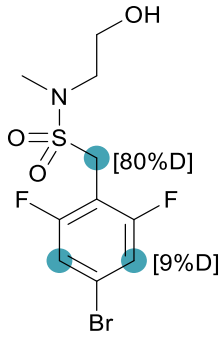
8



^{2}H-8



^{2}H-1-(4-Bromo-2,6-difluorophenyl)-*N*-(2-hydroxyethyl)-*N*-methylmethanesulfonamide, **^{2}H-9**



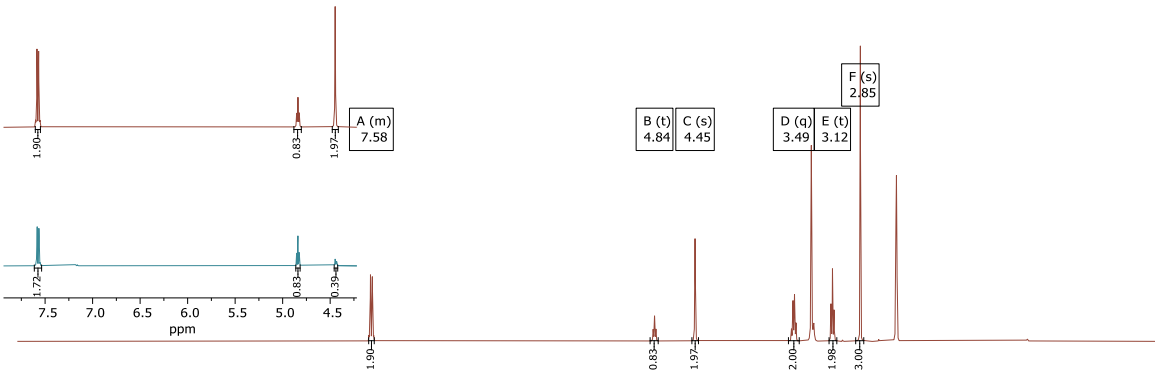
Deuteration via GP 4
9 (86.0 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.), 5.0 mL DMSO-d_6, 0.05 mL D_2O
Work-up via WUP 1

^{2}H-9, 82% (71.7 mg, 0.21 mmol)

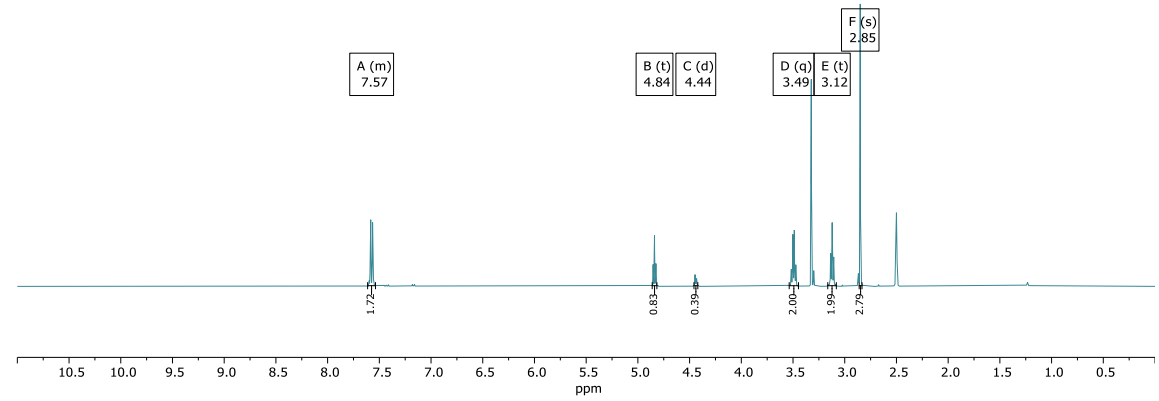
Incorporation overserved at 4.44 ppm (benzylic protons) and 7.57 ppm (aromatic protons), measured relative to the signal at 3.49 ppm (NMR solvent: DMSO-d_6).

Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **80%D** (benzylic)**, 9%D** (aromatic).

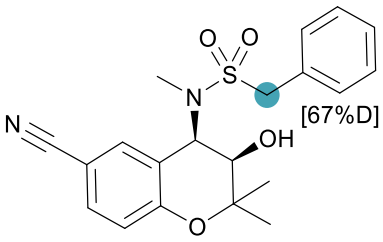
9



^{2}H-9



^{2}H-(3*R*,4*S*)-6-Cyano-2,3-dihydro-3-hydroxy-2,2-dimethyl-4-(*N*-methylbenzenemethanesulfonamidyl)-benzopyrane, **^{2}H-10**



Deuteration via GP 4

10 (96.6 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.), 5.0 mL DMSO-d_6, 0.05 mL D_2O

Work-up via WUP 1

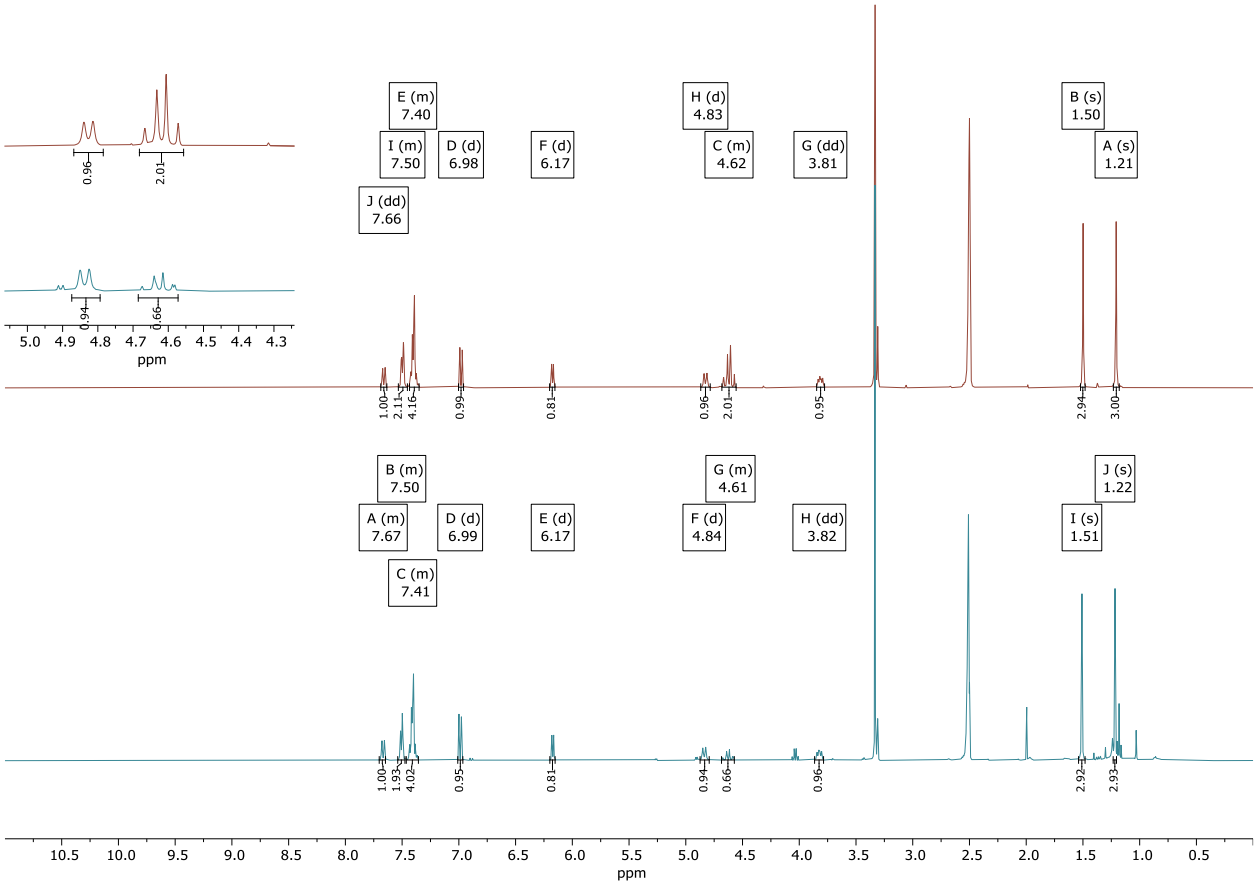
^{2}H-10, 4% (3.5 mg, 0.01 mmol)

Incorporation expected at 4.61 ppm, measured relative to the signal at 7.67 ppm (NMR solvent: DMSO-d_6).

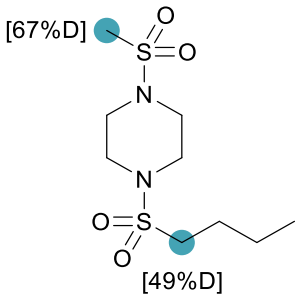
Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **67%D**

10

^{2}H-10



^{2}H-1-(Butylsulfonyl)-4-(methylsulfonyl)piperazine, **^{2}H-11**



Deuteration and Work-Up see SI chapter 4

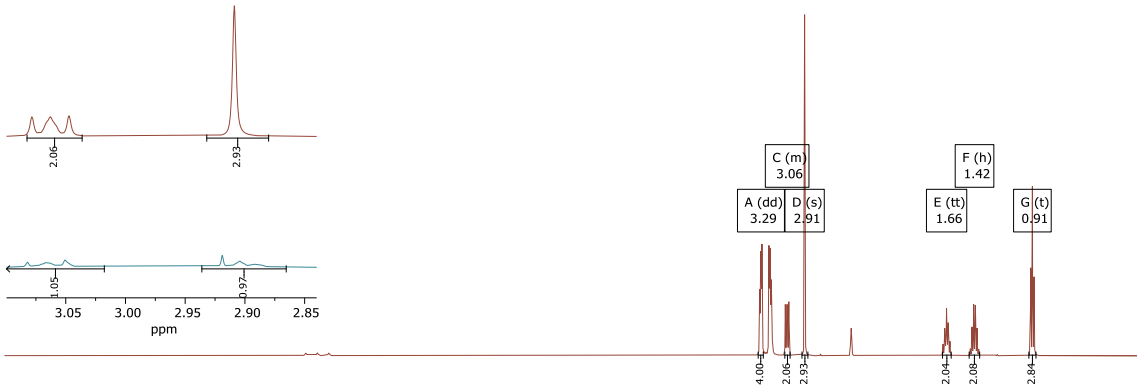
11 (35.5 mg, 0.125 mmol)

^{2}H-11, 46% (32.7 mg, 0.12 mmol)

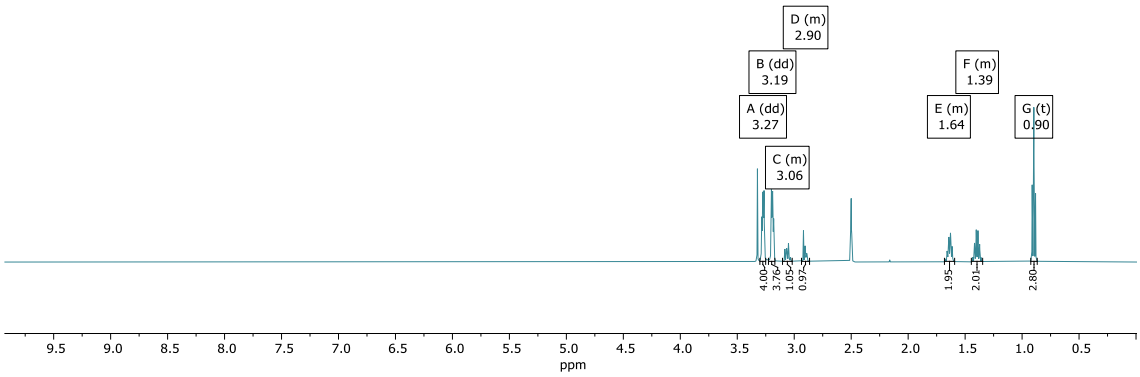
Incorporation overserved at 3.06 ppm (butyl) and 2.90 ppm (methyl), measured relative to the signal at 3.27 ppm (NMR solvent: DMSO-d_6).

Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **49%D (butyl), 67%D (methyl)**

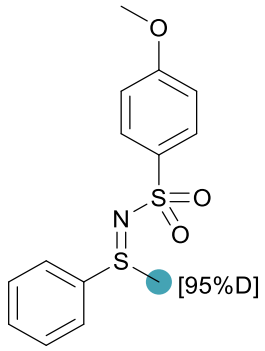
11



^{2}H-11



^{2}H-(*E*)-4-Methoxy-*N*-(methyl(phenyl)-λ^{4}-sulfanylidene)benzenesulfonamide, **^{2}H-18**



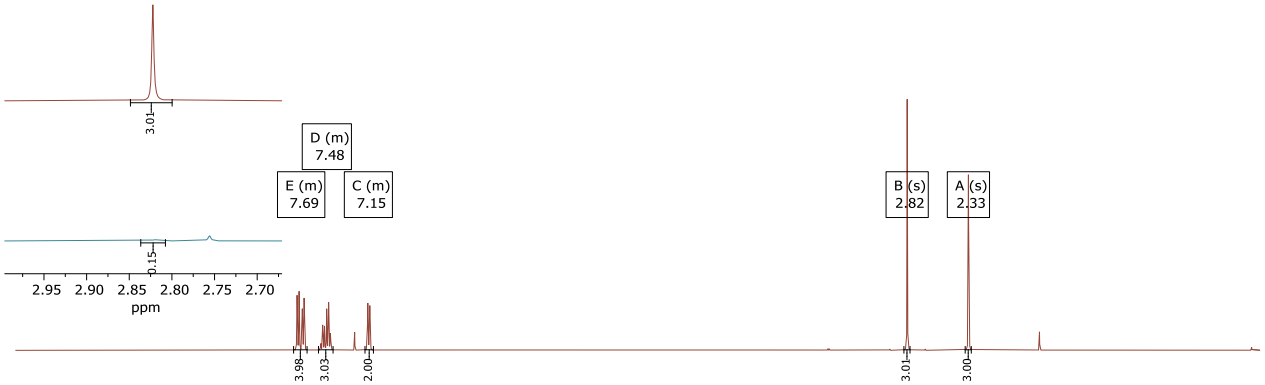
Deuteration via GP 4,
18 (73.4 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.)
DMAc-h_9 (5 mL, solvent), D_2O (0.9 mL, D-source)
Work-up via WUP 2

^{2}H-18, 40% (30.6 mg, 0.1 mmol)

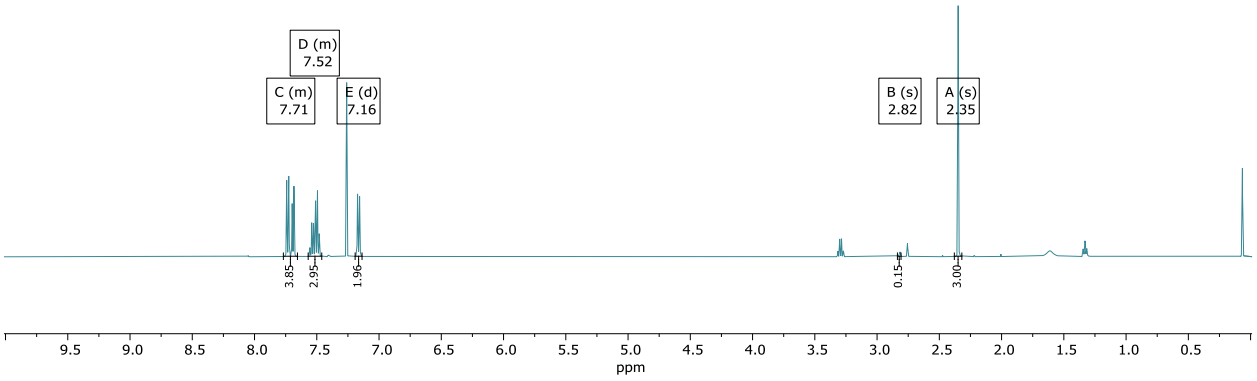
Incorporation expected at 2.82 ppm, measured relative to the signal at 2.35 ppm (NMR solvent: $CDCl_3$).

Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **95%D**

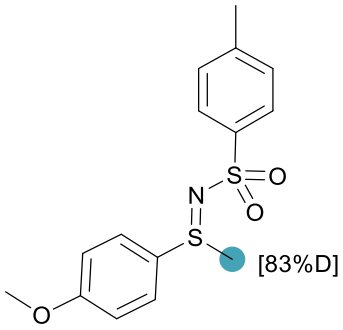
18



^{2}H-18



^{2}H-(*E*)-*N*-((4-Methoxyphenyl)(methyl)-λ^{4}-sulfaneylidene)-4-methylbenzenesulfonamide, **^{2}H-19**



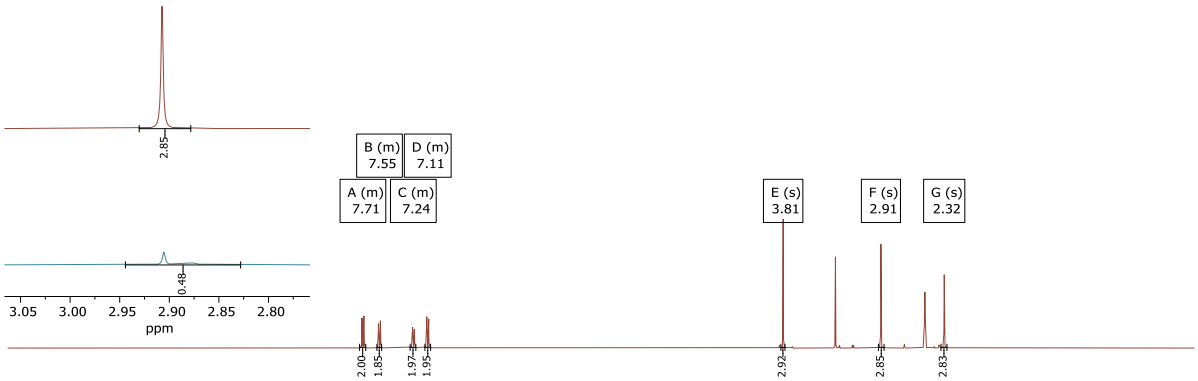
Deuteration via GP 4
19 (80.9 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.),
5.0 mL DMSO-d_6, 0.05 mL D_2O
Work-up via WUP 2

^{2}H-19, 13% (10.6 mg, 0.03 mmol)

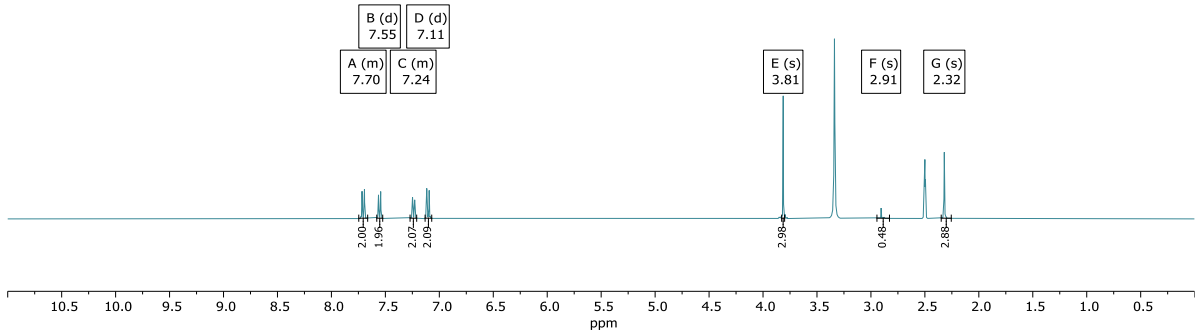
Incorporation expected at 2.91 ppm, measured relative to the signal at 7.70 ppm (NMR solvent: DMSO-d_6).

Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **83%D**

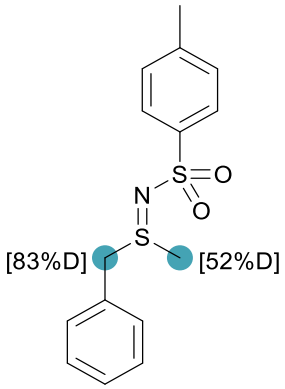
19



^{2}H-19



^{2}H-(*E*)-*N*-(Benzyl(methyl)-λ^{4}-sulfanylidene)-4-methylbenzenesulfonamide, **^{2}H-20**



^{2}H-20, traces

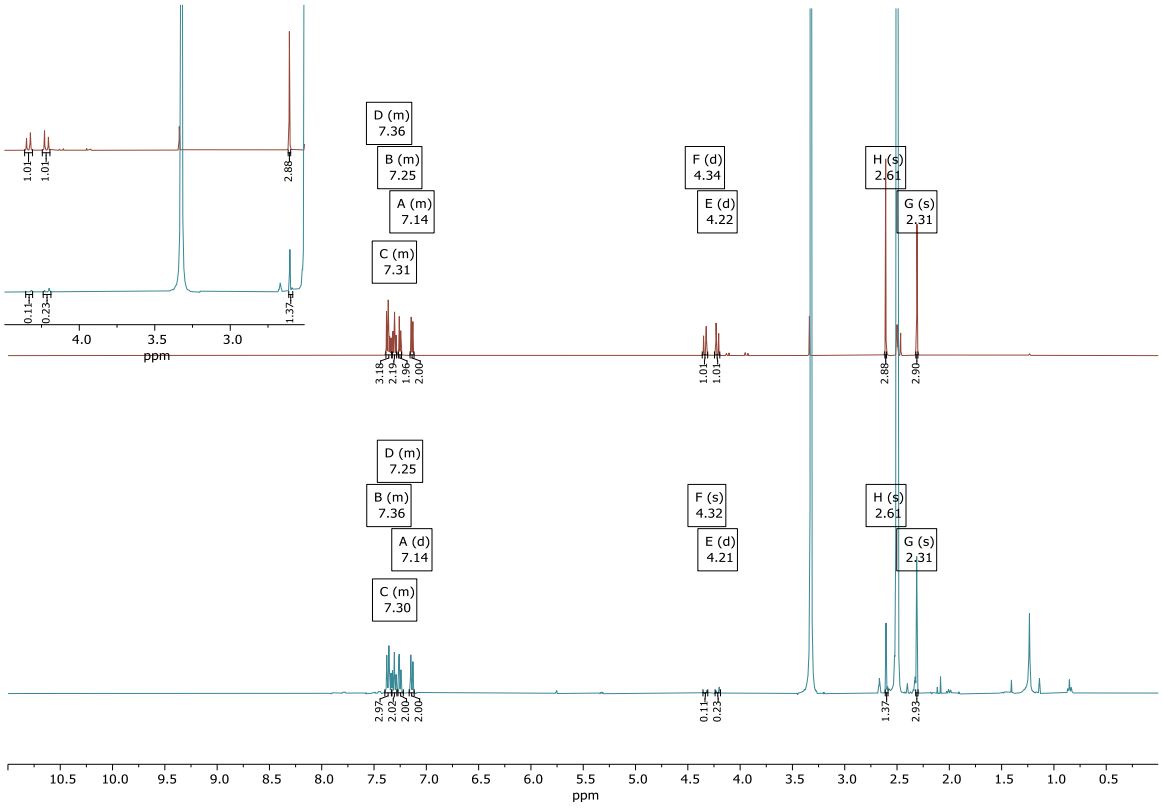
Deuteration via GP 4
20 (76.9 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.), 5.0 mL DMSO-d_6, 0.05 mL D_2O
Work-up via WUP 1

Incorporation expected at 4.32 and 4.21 ppm (benzyl) and 2.61 ppm (methyl), measured relative to the signal at 7.14 ppm (NMR solvent: DMSO-d_6).

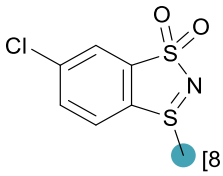
Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **83%D** (benzyl), **52%D** (methyl).

20

^{2}H-20



^{2}H-1*H*-5-Chloro-1-methyl-1,3,2-benzodithiazol-3,3-dioxide, **^{2}H-21**



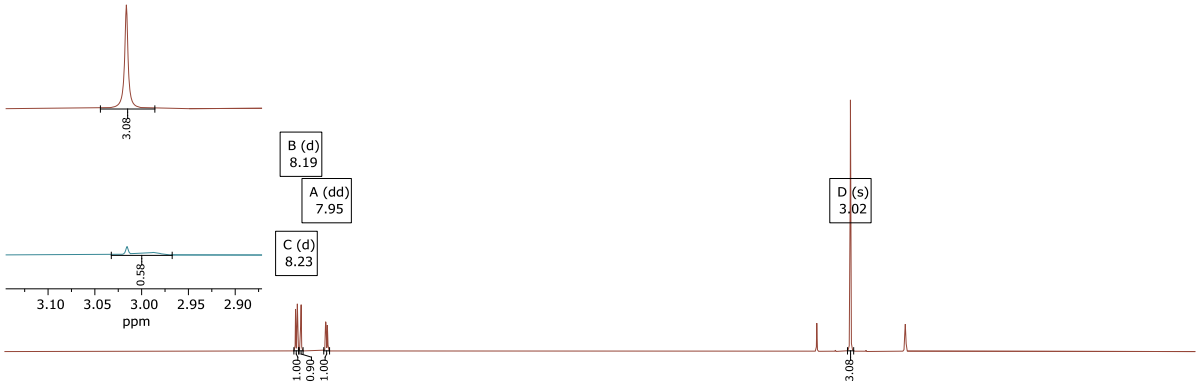
Deuteration via GP 4
21 (58.9 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.),
5.0 mL DMSO-d_6, 0.05 mL D_2O
Work-up via WUP 2

^{2}H-21, 34% (20.1 mg, 0.08 mmol)

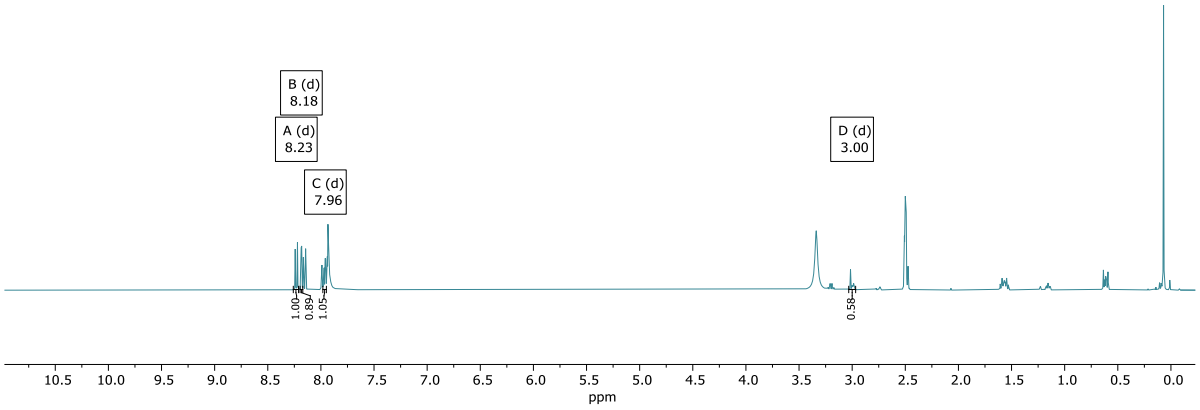
Incorporation expected at 3.00 ppm, measured relative to the signal at 8.23 ppm (NMR solvent: DMSO-d_6).

Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **81%D**

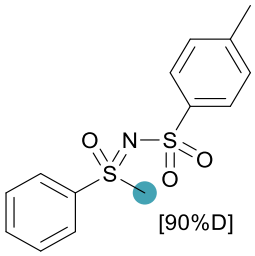
21



^{2}H-21



^{2}H-4-Methyl-*N*-(methyl(oxo)(phenyl)-λ^{6}-sulfanylidene)benzenesulfonamide, **^{2}H-22**



Deuteration via GP 4
22 (77.3 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1.3 eq.),
5.0 mL DMSO-d_6, 0.05 mL D_2O
Work-up via WUP 2

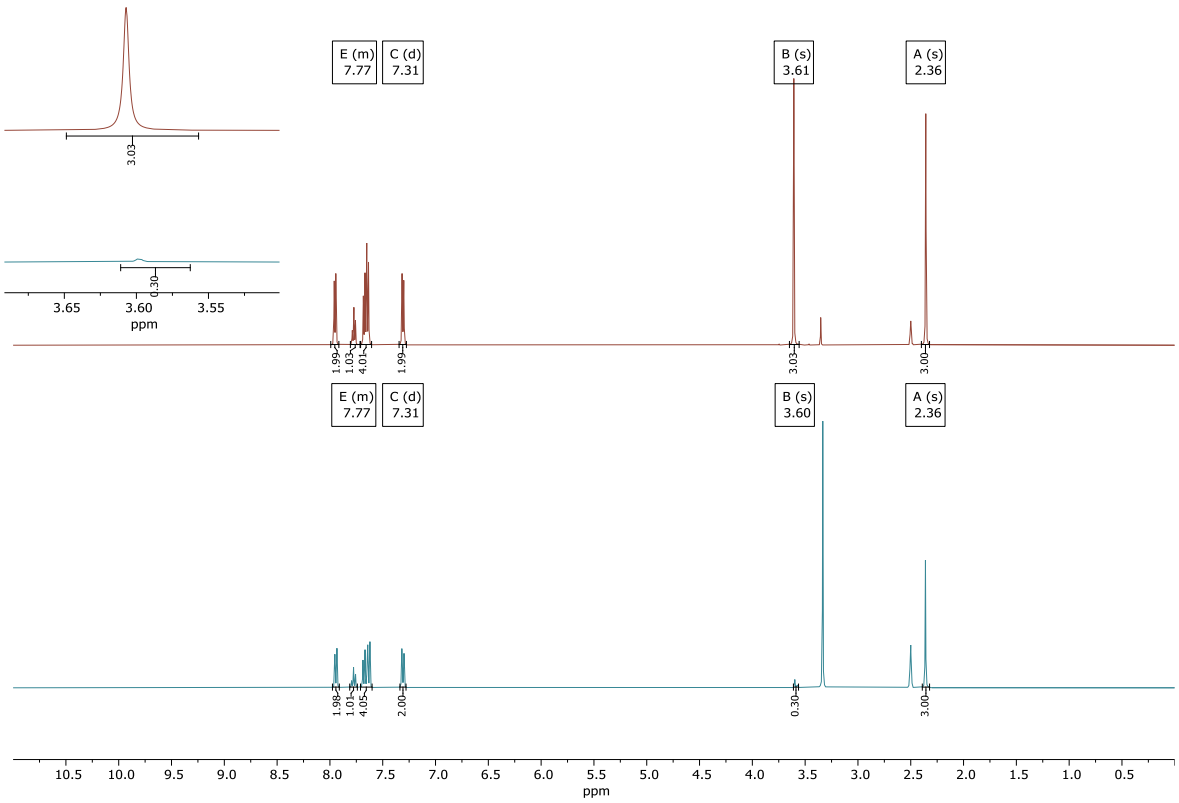
^{2}H-22, 24% (18.6 mg, 0.06 mmol)

Incorporation expected at 3.60 ppm, measured relative to the signal at 2.36 ppm (NMR solvent: DMSO-d_6).

Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **90%D**

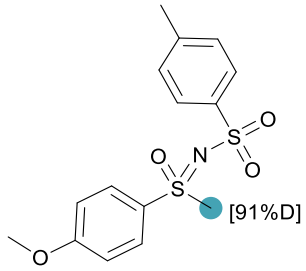
22

^{2}H-22



Reactions using DMAc-h_9 (5 mL) as the solvent and D_2O (0.9 mL) as the deuterium source achieved equal deuterium incorporation (90%D) while more product could be isolated (40%).

^{2}H-(*E*)-*N*-((4-Methoxyphenyl)(methyl)(oxo)-λ^{6}-sulfanylidene)-4-methylbenzenesulfonamide, **^{2}H-23**



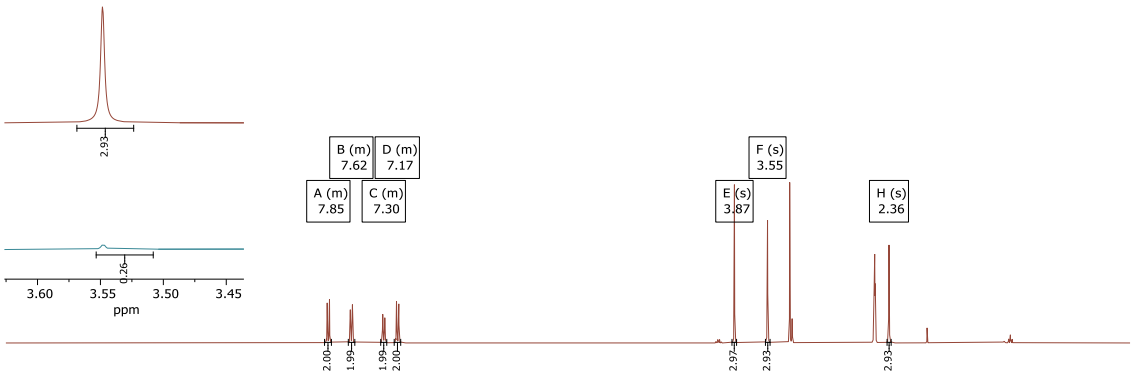
Deuteration via GP 4
23 (65.9 mg, 0.19 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.),
5.0 mL DMSO-d_6, 0.05 mL D_2O
Work-up via WUP 2

^{2}H-23, 13% (8.5 mg, 0.025 mmol)

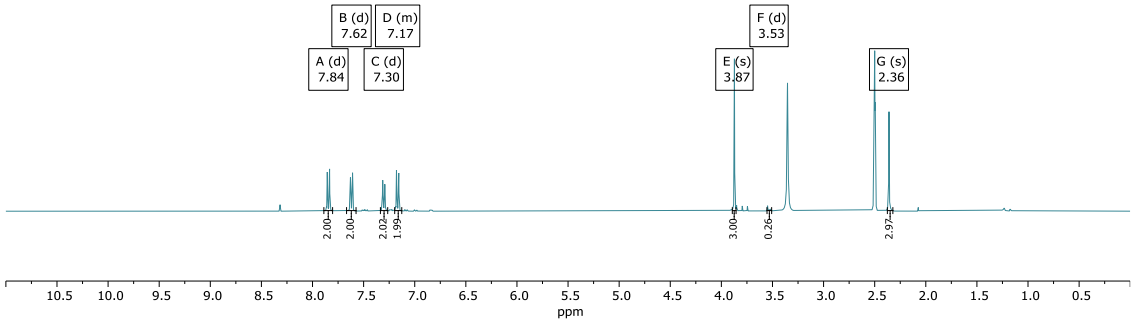
Incorporation expected at 3.53 ppm, measured relative to the signal at 7.84 ppm (NMR solvent: DMSO-d_6).

Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **91%D**

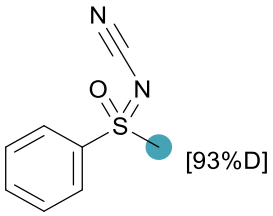
23



^{2}H-23



^{2}H-*N*-(Methyl(oxo)(phenyl)-λ^{6}-sulfanylidene)cyanamide, **^{2}H-24**



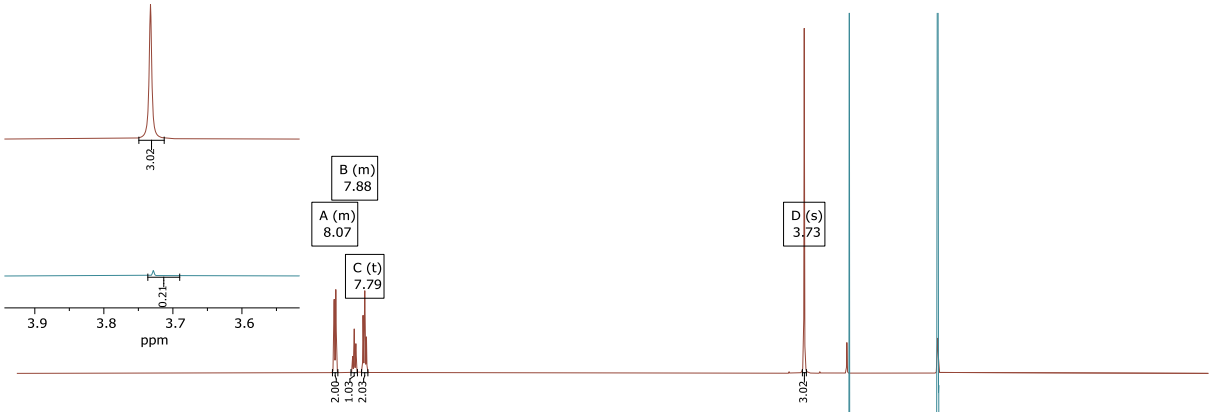
Deuteration via GP 4
24 (45.1 mg, 0.25 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.), 5.0 mL DMSO-d_6, 0.05 mL D_2O
Work-up via WUP 1

^{2}H-24, 5% (2.2 mg,0.01 mmol)

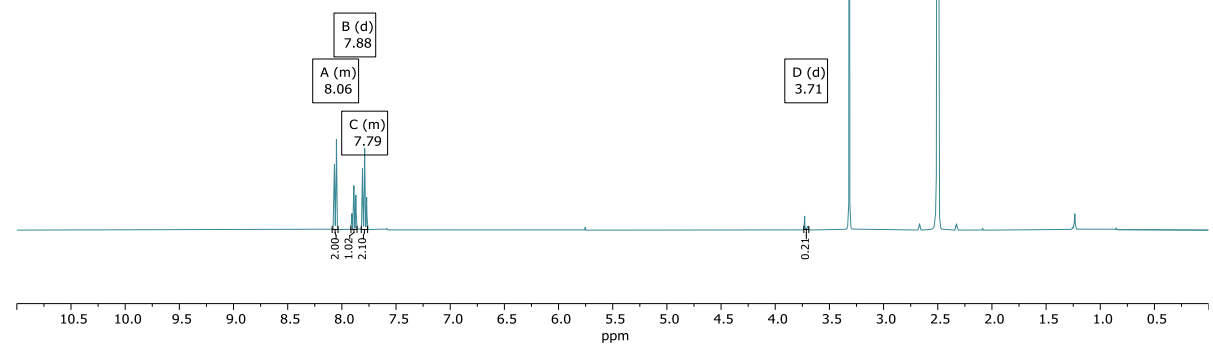
Incorporation expected at 3.71 ppm, measured relative to the signal at 8.06 ppm (NMR solvent: DMSO-d_6).

Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **93%D**

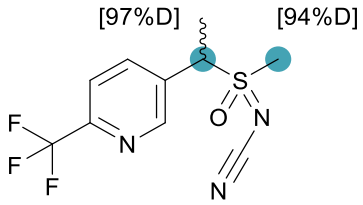
24



^{2}H-24



^{2}H-*N*-(Methyl(oxo)(1-(6-(trifluoromethyl)pyridin-3-yl)ethyl)-λ^{6}-sulfanylidene)cyanamide / Sulfoxaflor, **^{2}H-25**



Deuteration via GP 4
25 (32.6 mg, 0.12 mmol), NEt_4BF_4 (54.3 mg, 0.25 mmol, 1 eq.),
5.0 mL DMSO-d_6, 0.05 mL D_2O
Work-up via WUP 2

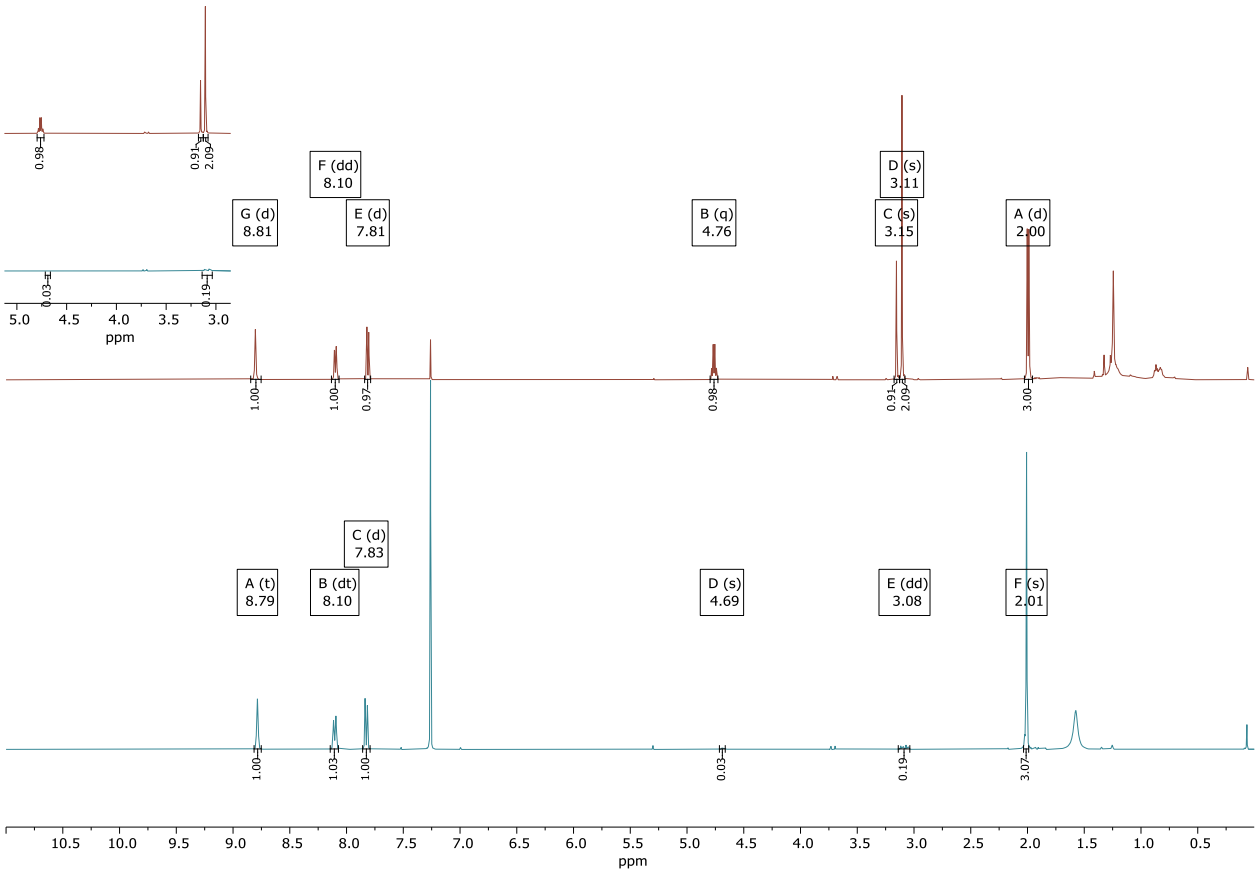
^{2}H-25, 43% (15.5 mg, 0.05 mmol)

Incorporation expected at 4.69 ppm (benzyl) and 3.08 ppm (methyl), measured relative to the signal at 8.79 ppm (NMR solvent: $CDCl_3$).

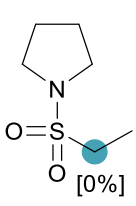
Deuterium incorporation (determined by ^{1}H NMR with method described in chapter 1.9): **97%D** (benzyl), **94%D** (methyl).

25

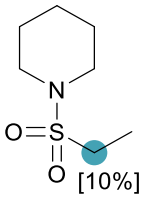
^{2}H-25



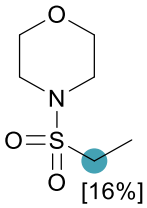
Limitations: 1-Ethylsulfonylpyrrolidine **12,** 1-Ethylsulfonylpiperidine **13,** 1-Ethylsulfonyl-morpholine **14**



^{2}H-12



^{2}H-13



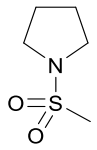
^{2}H-14

Deuteration via GP 4 (0.25 mmol substrate), DMAc (4.1 mL) as the solvent and D_2O (0.9 mL) as the deuterium source.

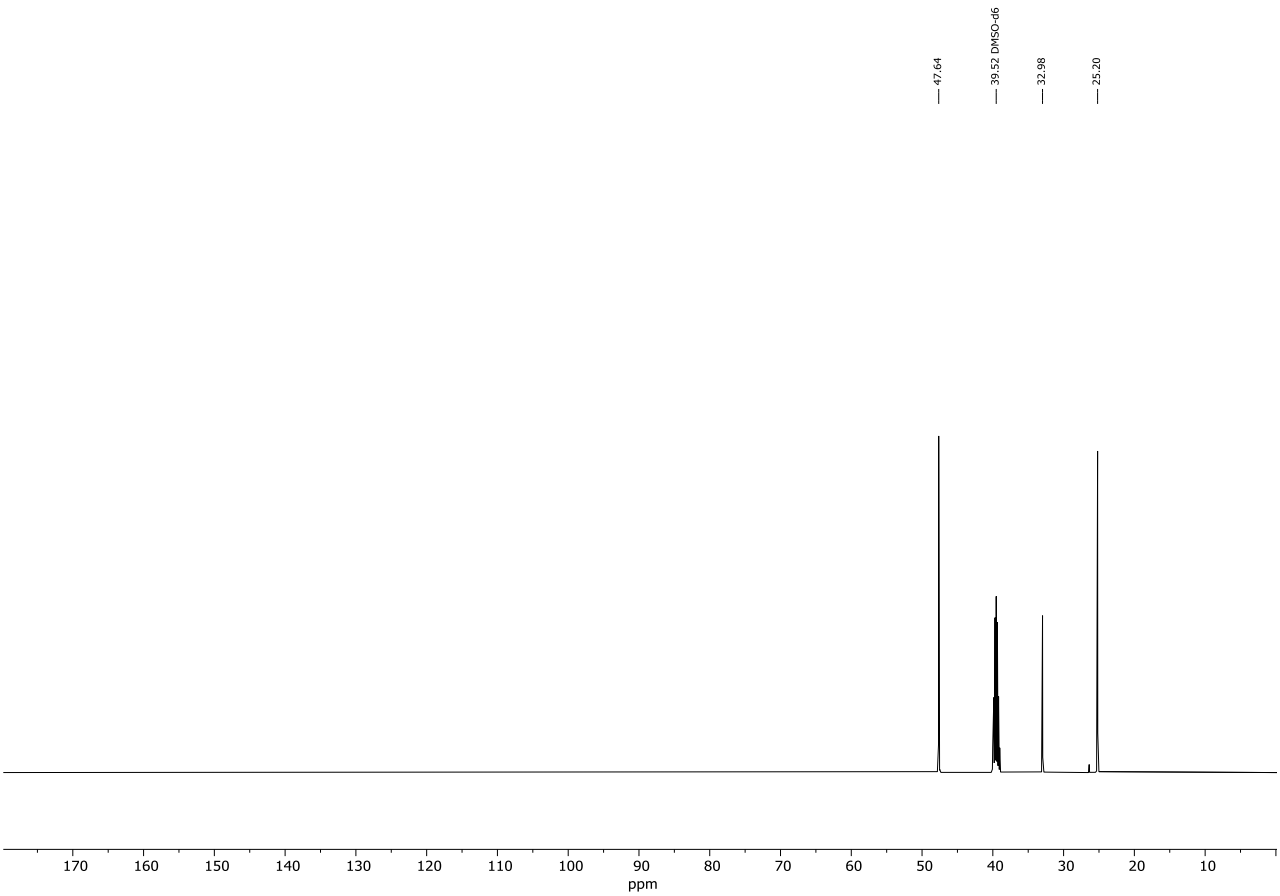
Deuterium incorporation (determined by UPLC-MS with method described in chapter 1.9): 0%D (**^{2}H-12**), 10%D (**^{2}H-13**) and 16%D (**^{2}H-14**). Deuterium incorporation was not determined by ^{1}H NMR as the signals referring to the ethyl group of the compounds could not be differentiated from the signals by the supporting electrolyte (NEt_4BF_4).

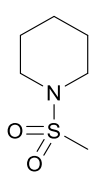
7 Spectra

^{1}H and ^{13}C NMR spectra of the non-deuterated starting materials are shown below on one page each with the respective molecules always in the order ^{1}H NMR as the upper spectrum followed by the ^{13}C NMR spectra and the ^{19}F NMR spectra if applicable. For previously unpublished substrates IR spectra are shown as well.



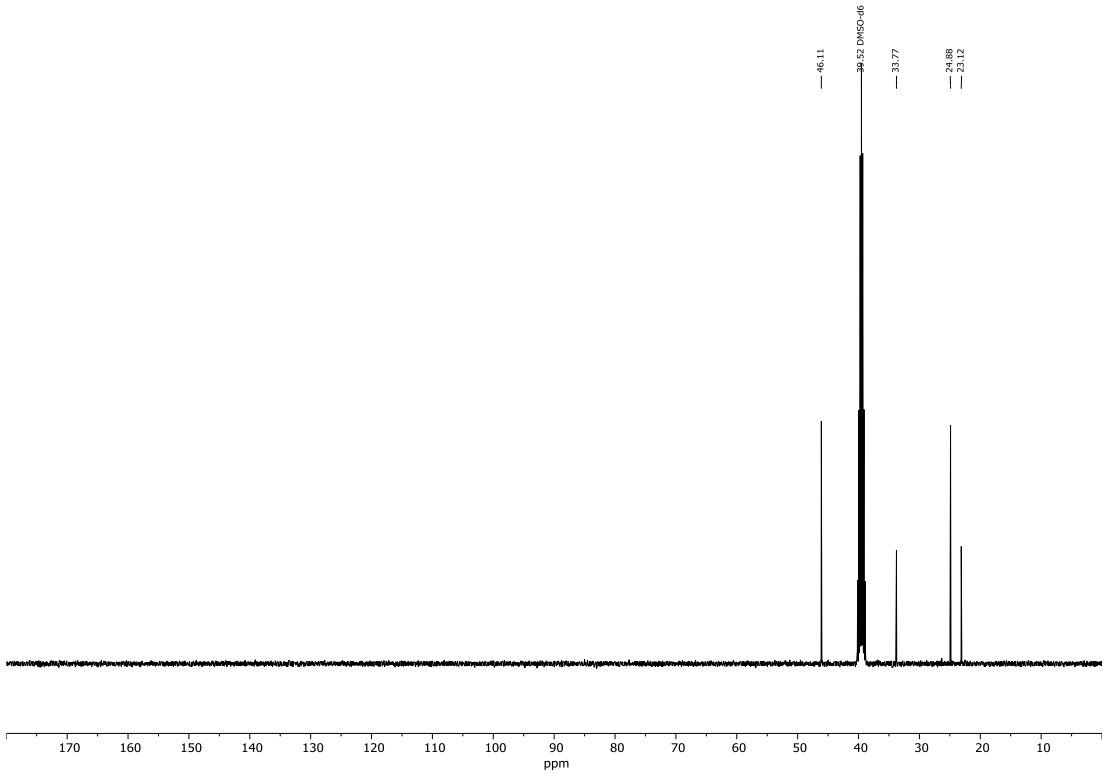
1

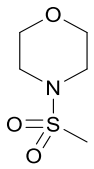

47.64
39.52 DMSO-d6
32.98
25.20
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm



2

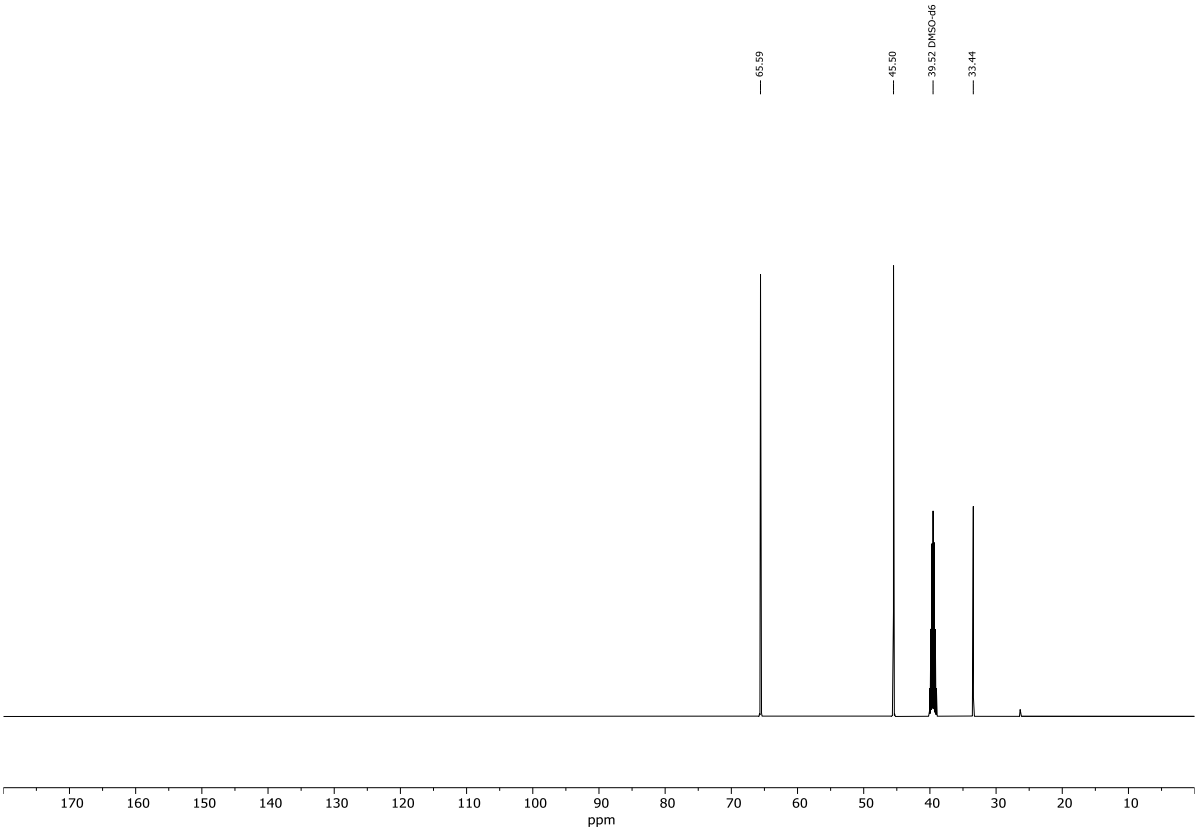
3.07
3.06
3.05
2.82
2.51
2.50
2.50 DMSO-d6
2.50
2.50
1.59
1.58
1.57
1.56
1.55
1.55
1.54
1.50
1.49
1.49
1.48
1.47
1.47
4.00
2.98
6.09
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm

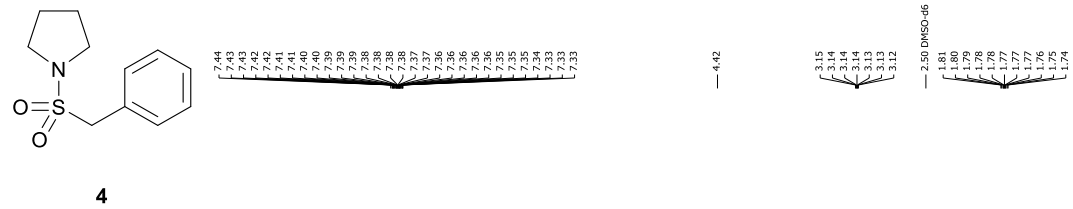

46.11
39.52 DMSO-d6
33.77
24.88
23.12
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
ppm



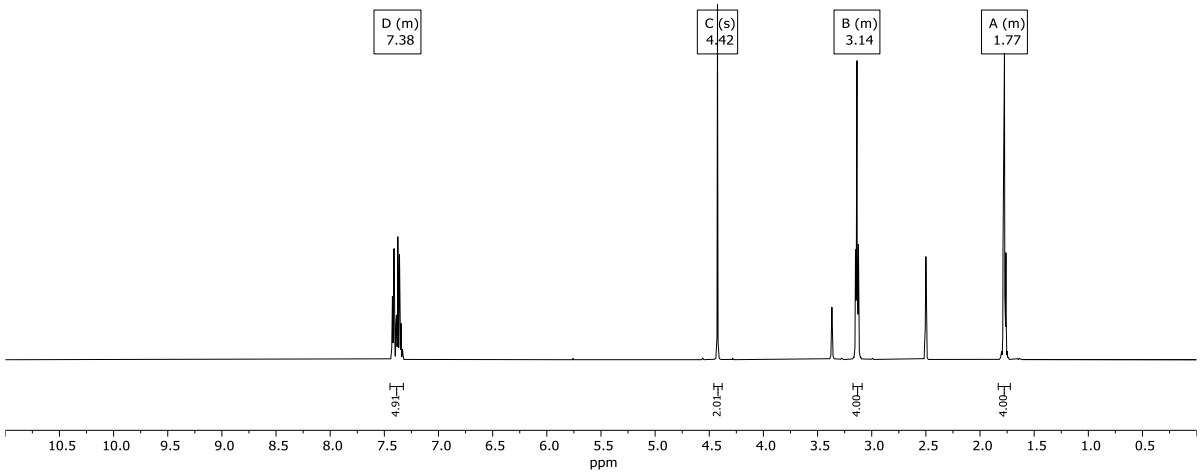
3

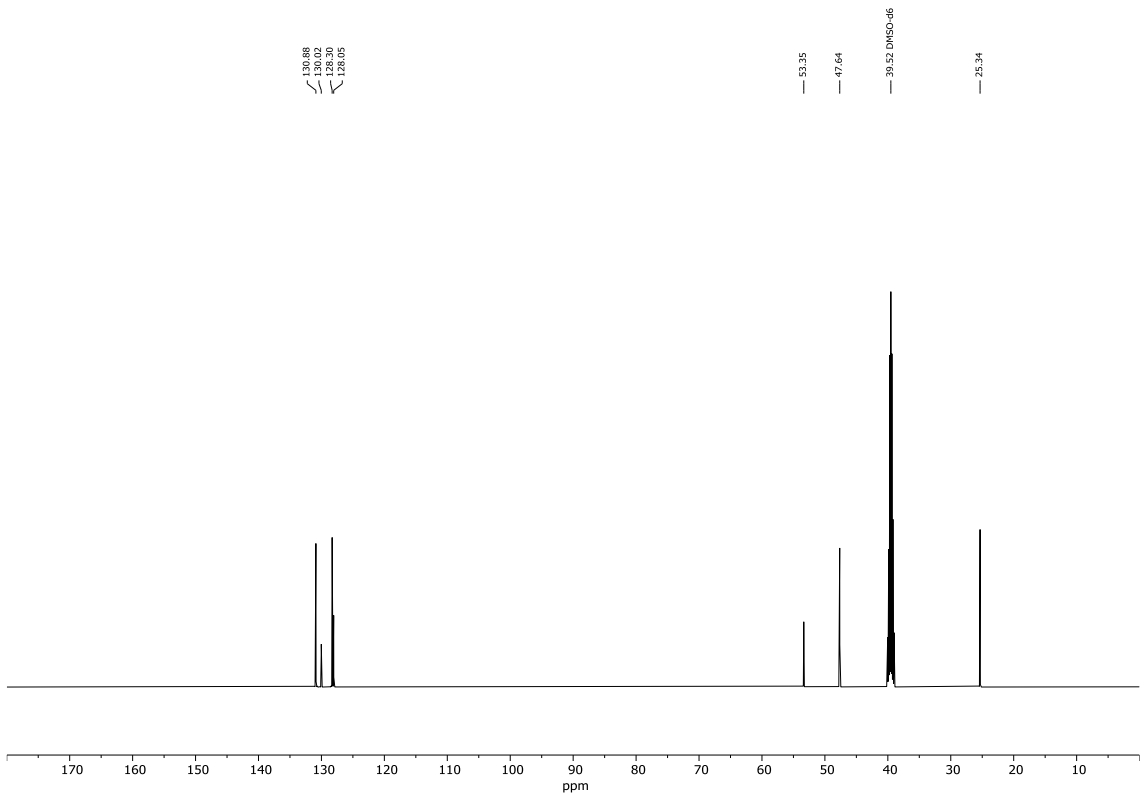
3.66
3.66
3.65
3.65
3.65
3.09
3.08
3.08
3.08
3.07
2.89
2.50 DMSO-d6
4.03
4.00
3.01
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm

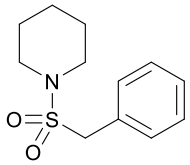

65.59
45.50
39.52 DMSO-d6
33.44
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
ppm


7.44
7.43
7.43
7.42
7.42
7.41
7.41
7.40
7.40
7.39
7.39
7.39
7.38
7.38
7.38
7.38
7.37
7.37
7.36
7.36
7.36
7.36
7.35
7.35
7.35
7.34
7.33
7.33
7.33
4.42
3.15
3.14
3.14
3.14
3.13
3.13
3.12
2.50 DMSO-d6
1.81
1.80
1.79
1.78
1.78
1.77
1.77
1.77
1.76
1.75
1.74

4

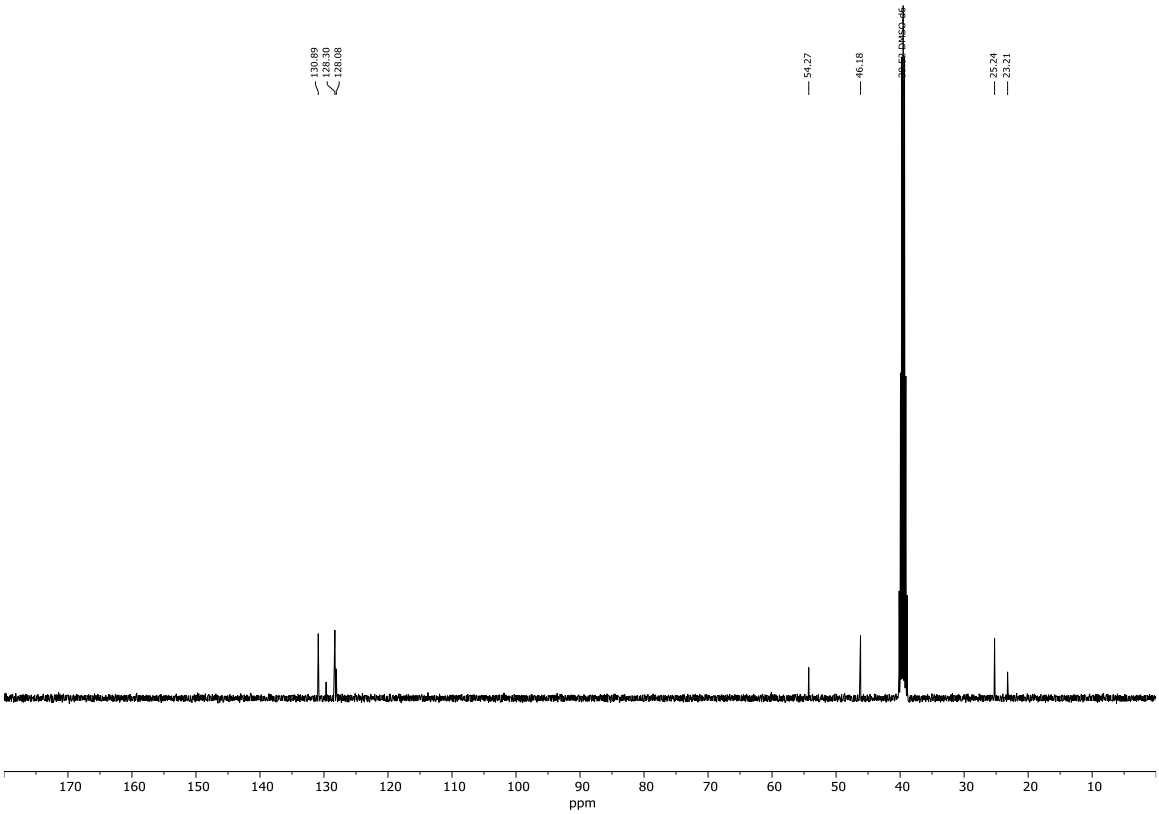

D (m)
7.38
C (s)
4.42
B (m)
3.14
A (m)
1.77
4.91
2.01
4.00
4.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm

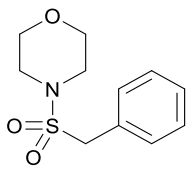

130.88
130.32
128.30
128.05
53.35
47.64
39.52 DMSO-d6
25.34
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm



5

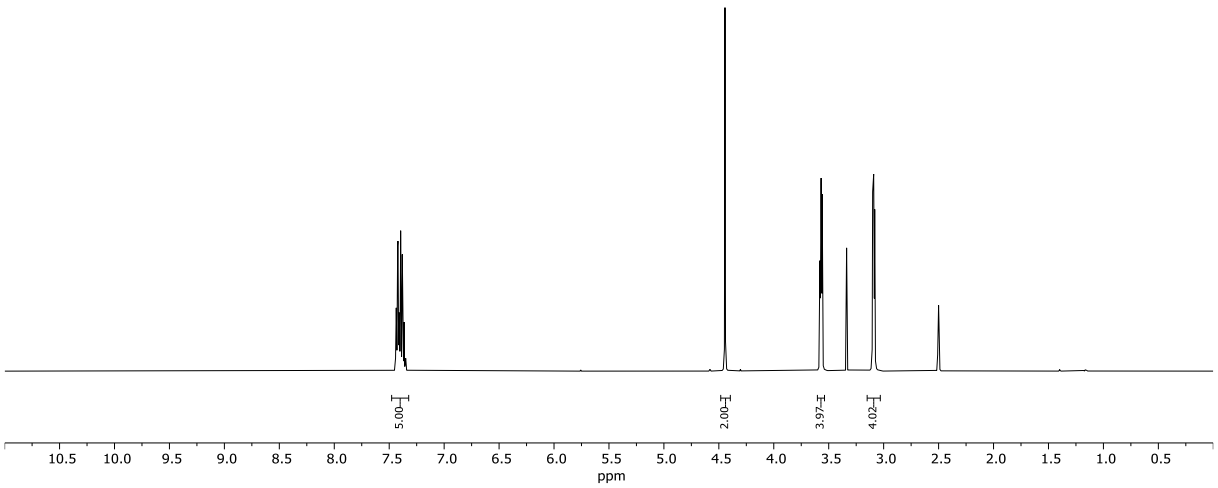
7.42
7.42
7.41
7.41
7.40
7.40
7.40
7.39
7.39
7.38
7.38
7.38
7.37
7.37
7.36
7.35
7.35
7.34
7.33
7.33
4.35
4.35
3.38
3.08
3.08
3.07
3.06
2.50 DMSO-d6
1.50
1.49
1.48
1.47
1.47
1.46
1.46
1.44
5.00
2.01
4.04
6.01
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm

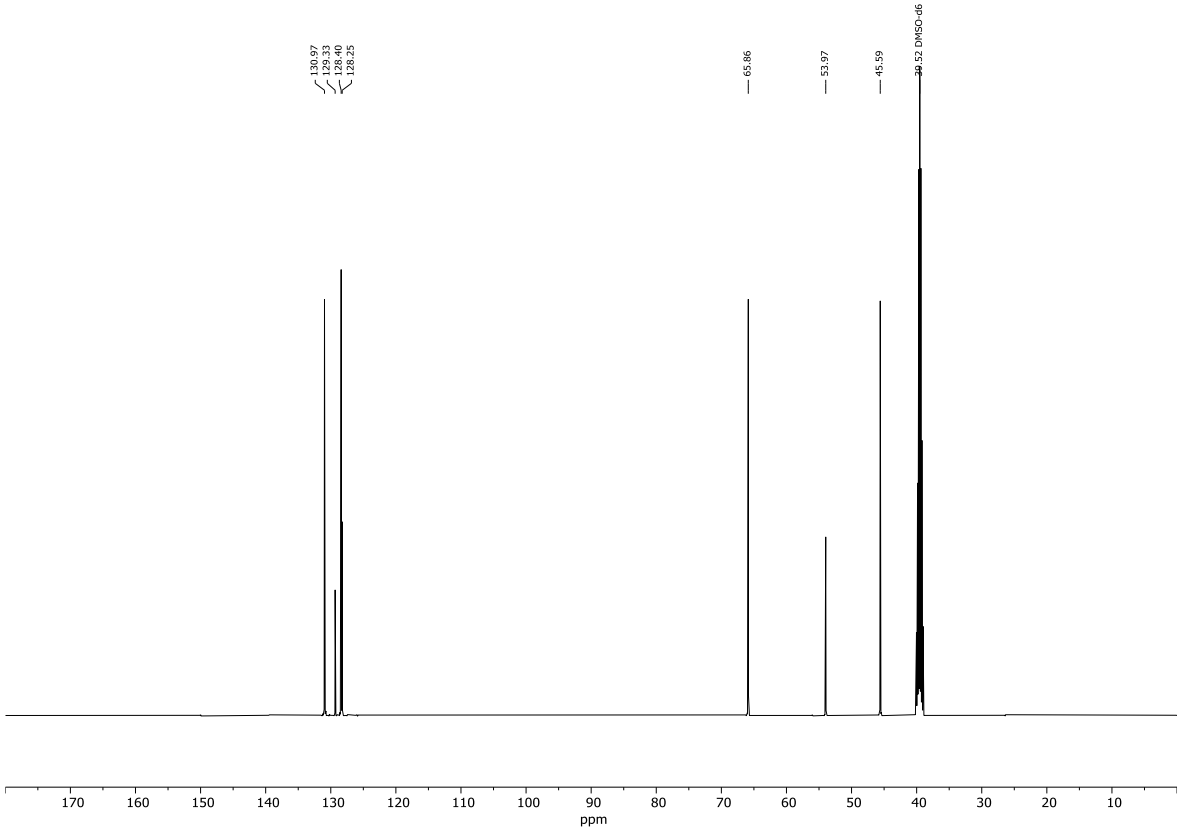

130.89
128.30
128.08
54.27
46.18
39.52 DMSO-d6
25.24
23.21
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

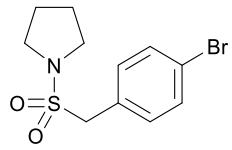


6


7.44
7.44
7.43
7.43
7.42
7.42
7.42
7.41
7.41
7.40
7.40
7.40
7.40
7.39
7.39
7.38
7.38
7.38
7.37
7.37
7.36
7.35
4.44
3.58
3.57
3.57
3.57
3.56
3.10
3.09
3.09
3.09
3.08
2.50 DMSO-d6

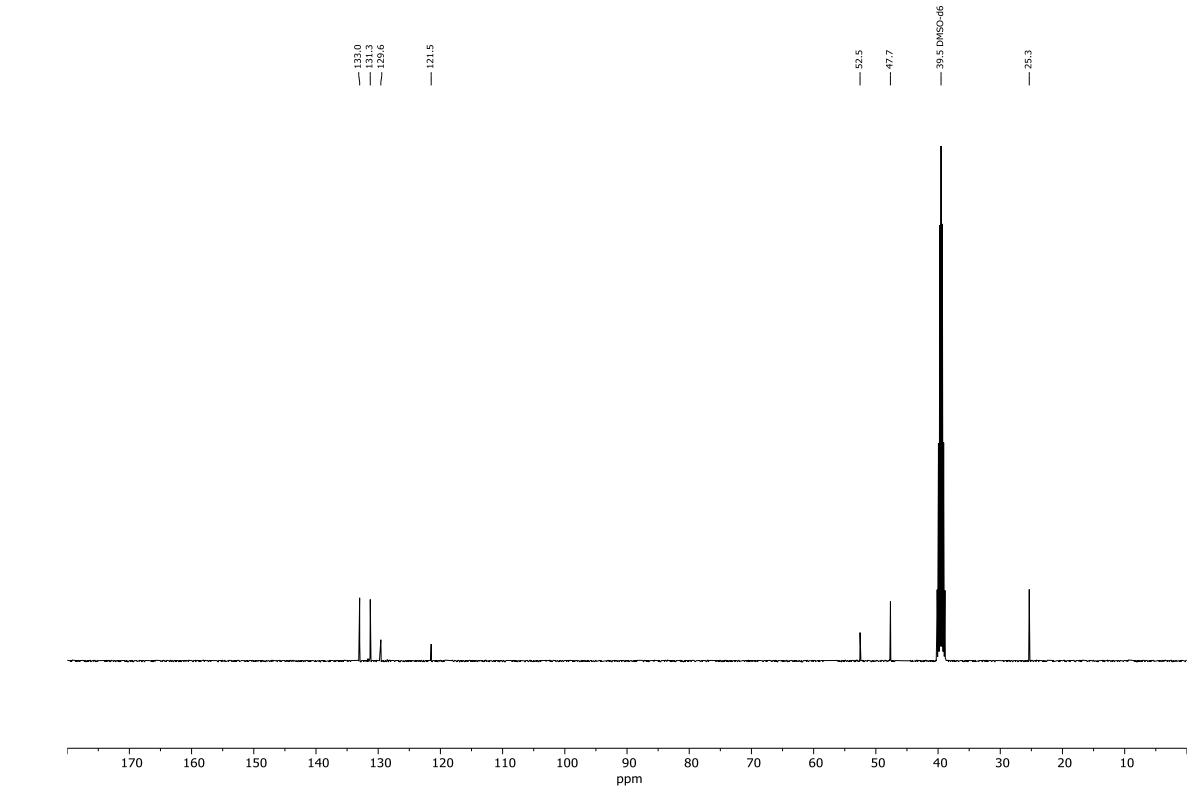

5.00
2.00
3.97
4.02
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm

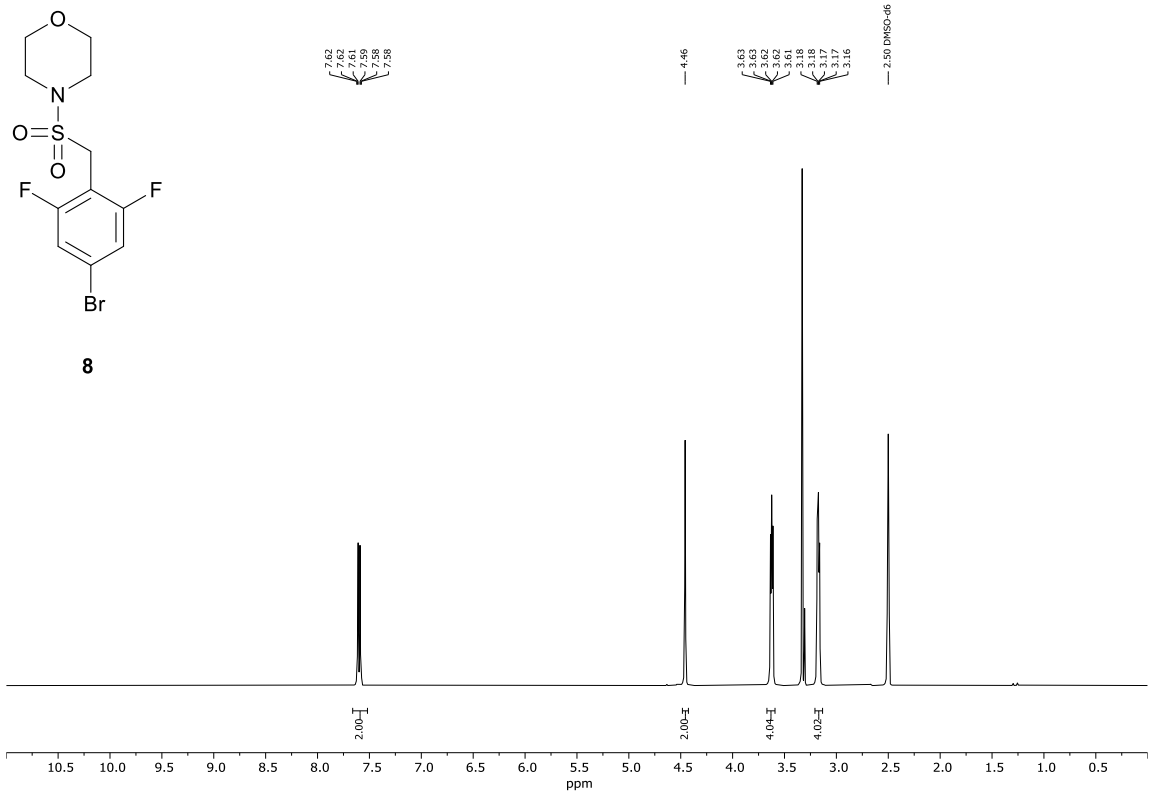

130.97
129.33
128.40
128.25
65.86
53.97
45.59
39.52 DMSO-d6
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm


Br
N
O
S
O

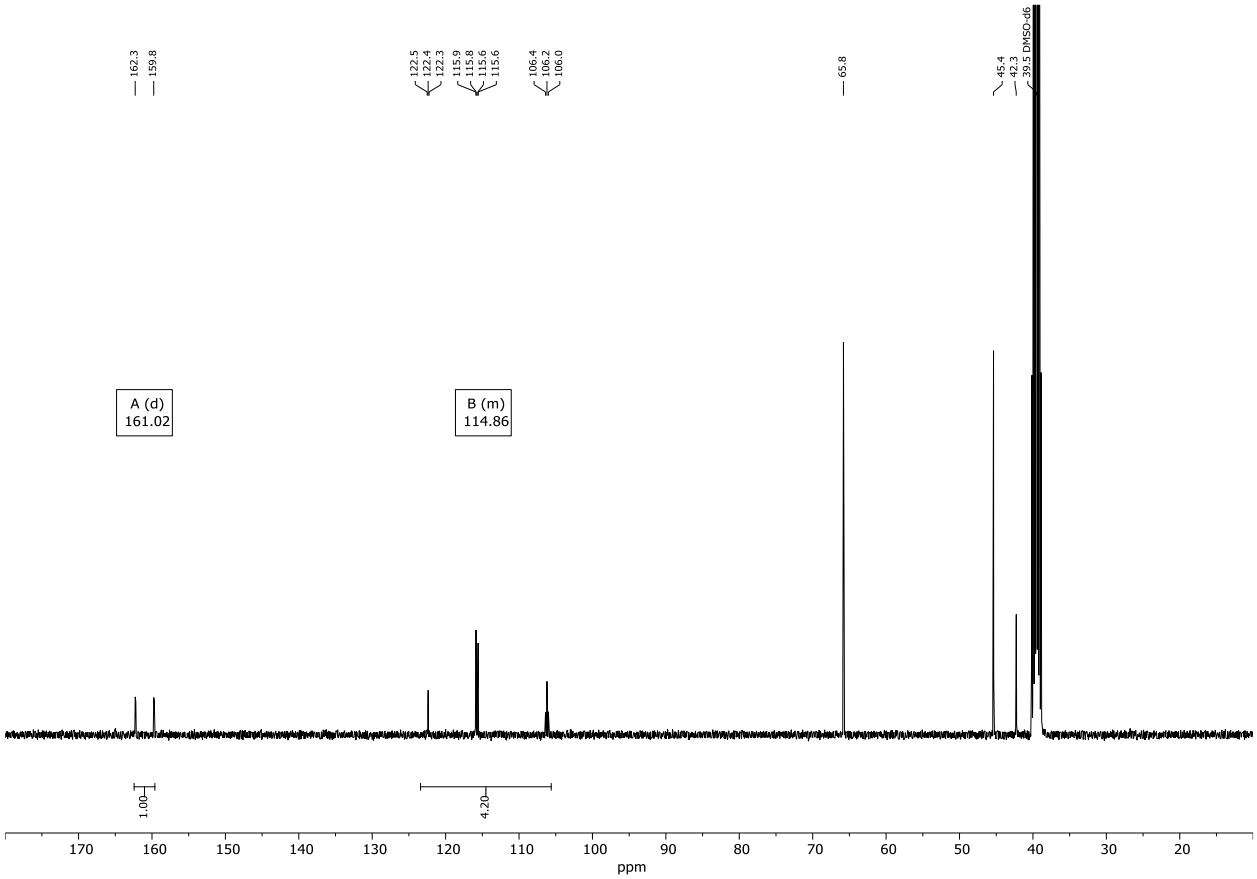
7

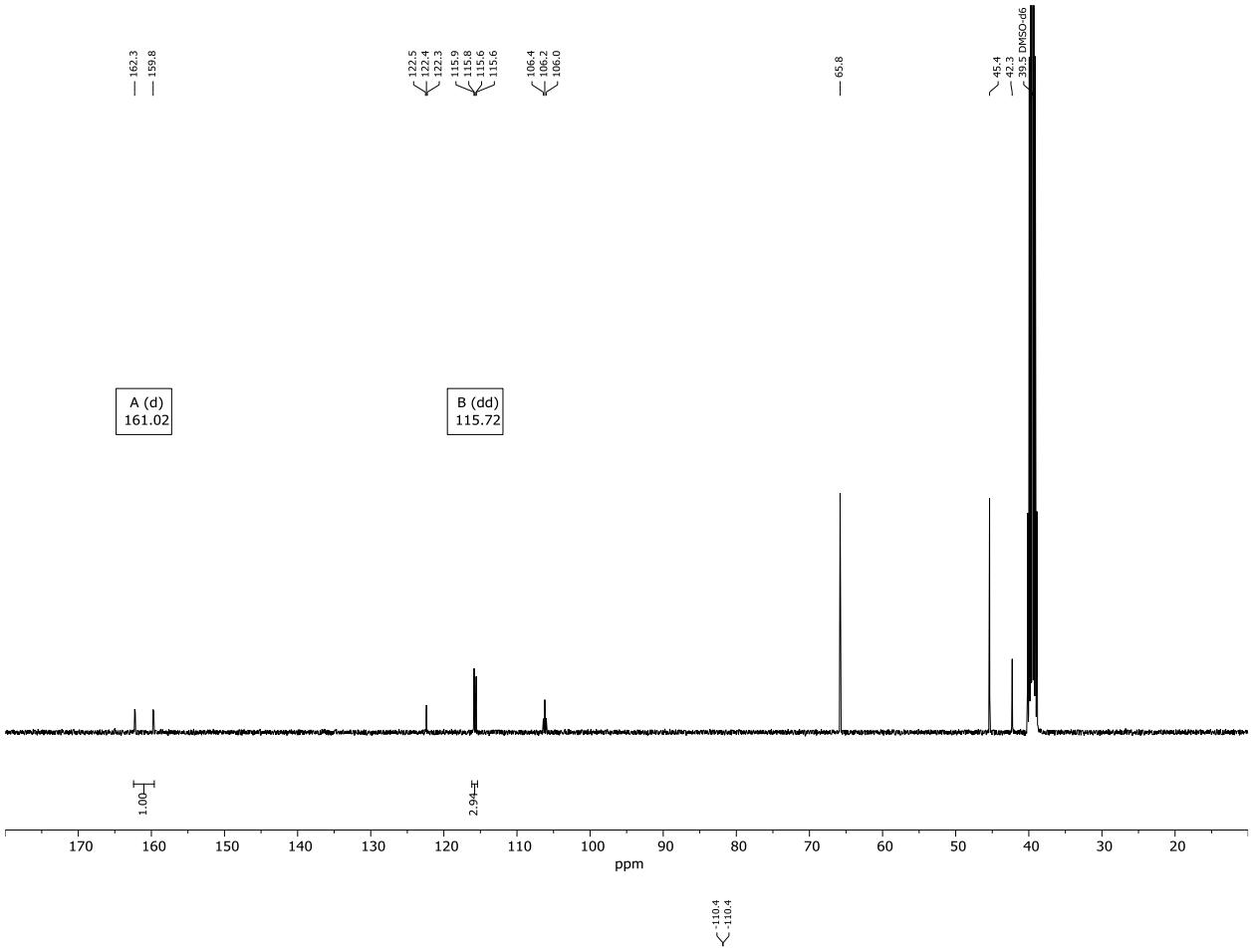
7.61
7.60
7.59
7.58
7.58
7.57
7.39
7.38
7.38
7.36
7.36
7.35
4.43
3.18
3.17
3.17
3.16
3.15
3.15
3.14
2.50 DMSO-d6
1.83
1.81
1.80
1.79
1.79
1.78
1.76
2.08
2.00
1.99
4.00
4.00
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm

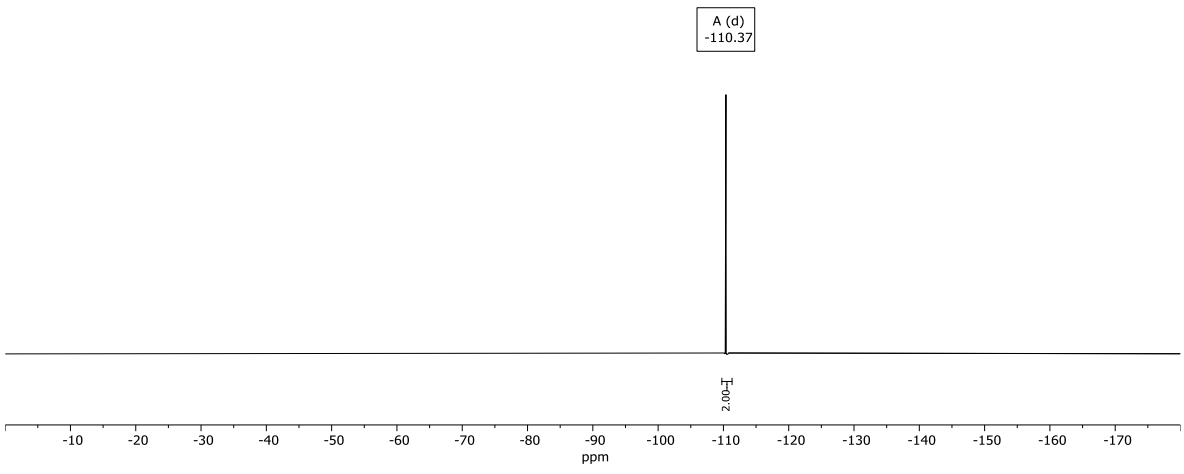

133.0
131.3
129.6
121.5
52.5
47.7
39.5 DMSO-d6
25.3
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
ppm

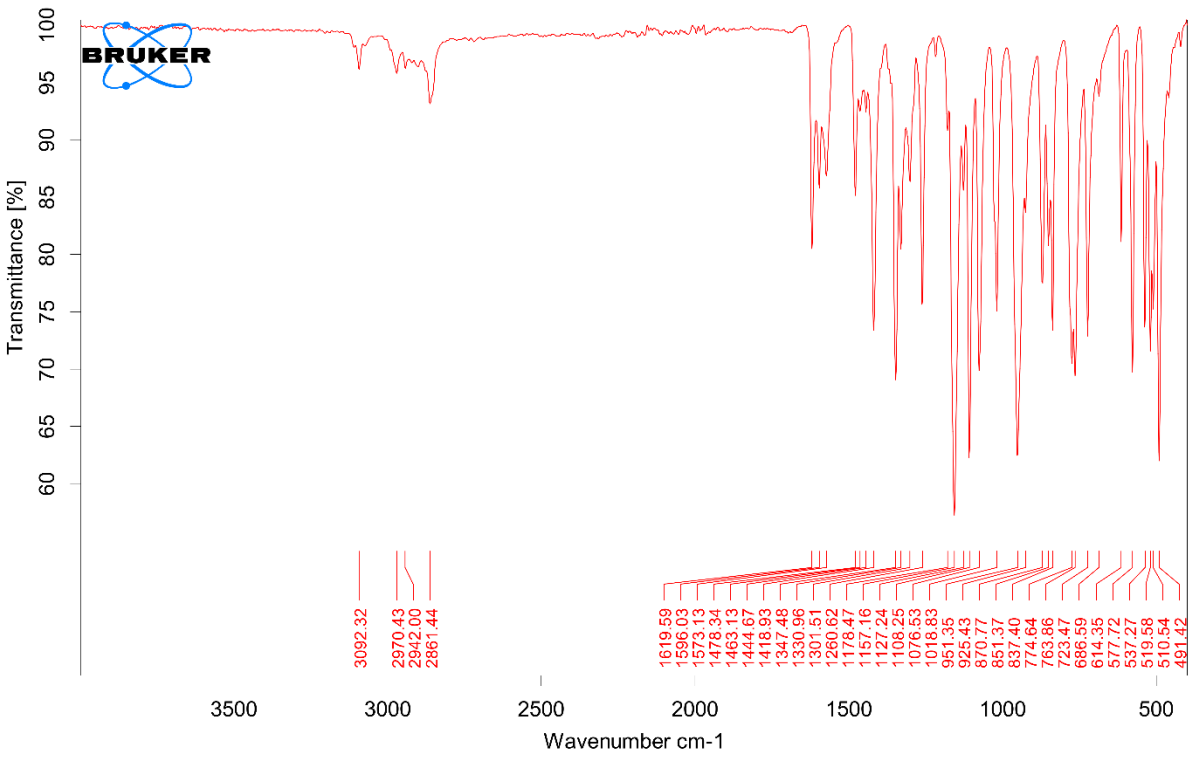

7.62
7.62
7.61
7.59
7.58
7.58
4.46
3.63
3.63
3.62
3.62
3.61
3.18
3.18
3.17
3.17
3.16
2.50 DMSO-d6
2.00
2.00
4.04
4.02
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm

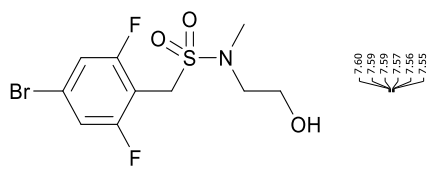
8


162.3
159.8
122.5
122.4
122.3
115.9
115.8
115.6
115.6
106.4
106.2
106.0
65.8
45.4
42.3
39.5 DMSO-d6
A (d)
161.02
B (m)
114.86
1.00
4.20
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20
ppm


162.3
159.8
122.5
122.4
122.3
115.9
115.8
115.6
115.6
106.4
106.2
106.0
65.8
45.4
42.3
39.5
DMSO-d6
A (d)
161.02
B (dd)
115.72
1.00
2.94
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm

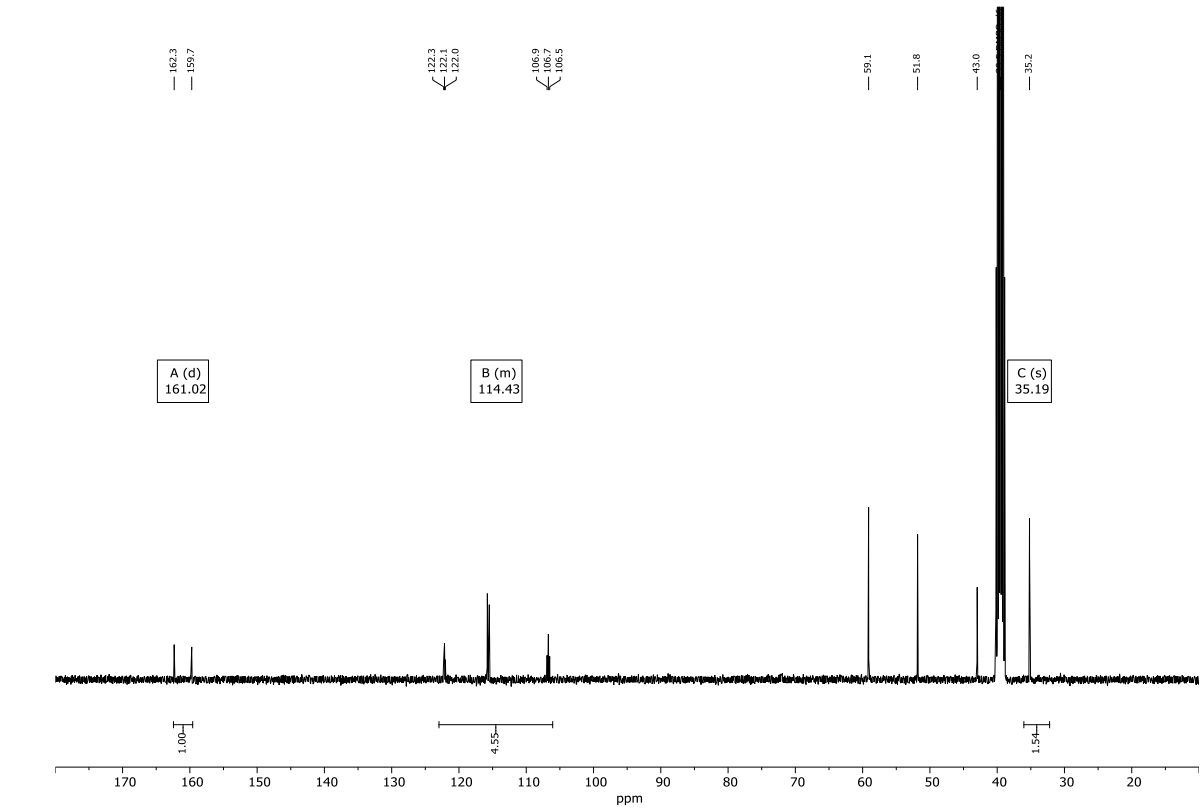

-110.4
-110.4
A (d)
-110.37
2.00
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
ppm

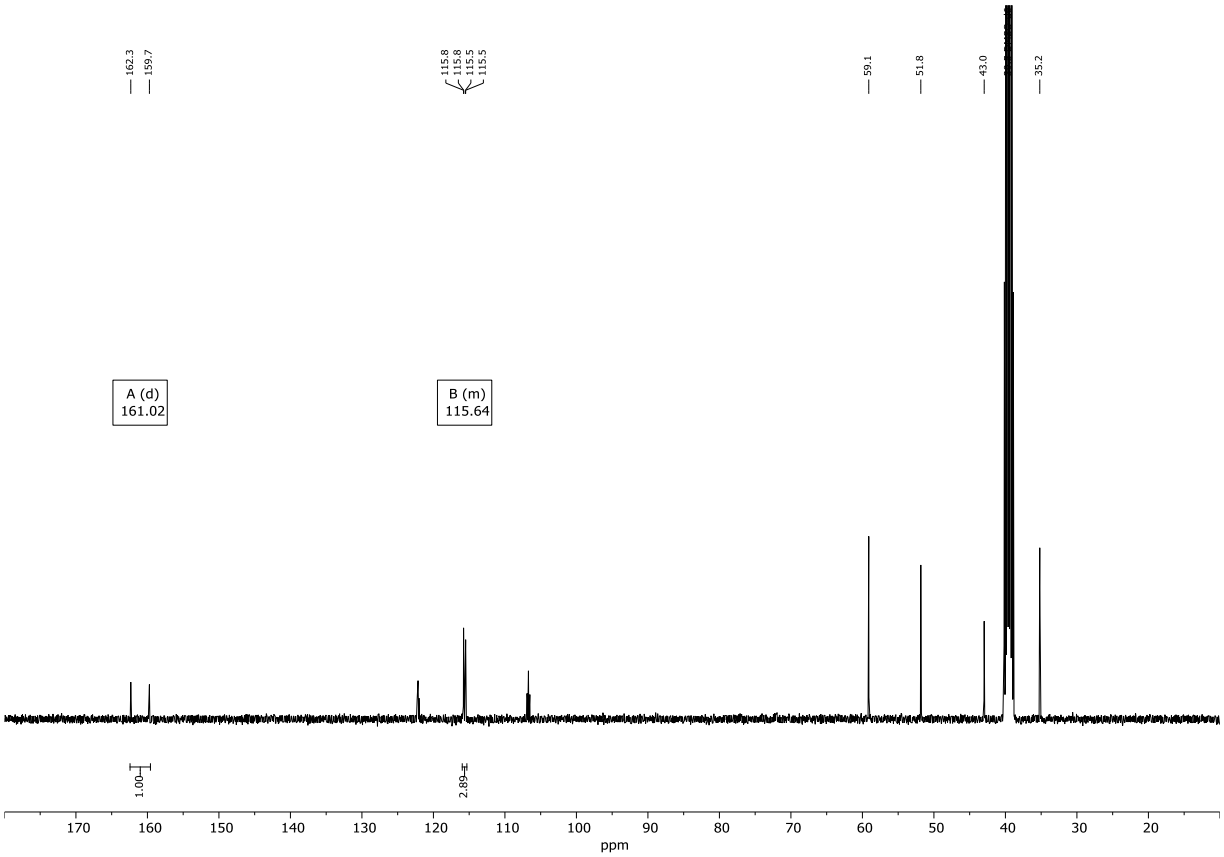

BRUKER
Transmittance [%]
100
95
90
85
80
75
70
65
60
3092.32
2970.43
2942.00
2861.44
1619.59
1596.03
1573.13
1478.34
1463.13
1444.67
1418.93
1347.48
1330.96
1301.51
1260.62
1178.47
1157.16
1127.24
1108.25
1076.53
1018.83
951.35
925.43
870.77
851.37
837.40
774.64
763.86
723.47
686.59
614.35
577.72
537.27
519.58
510.54
491.42
3500
3000
2500
2000
1500
1000
500
Wavenumber cm-1

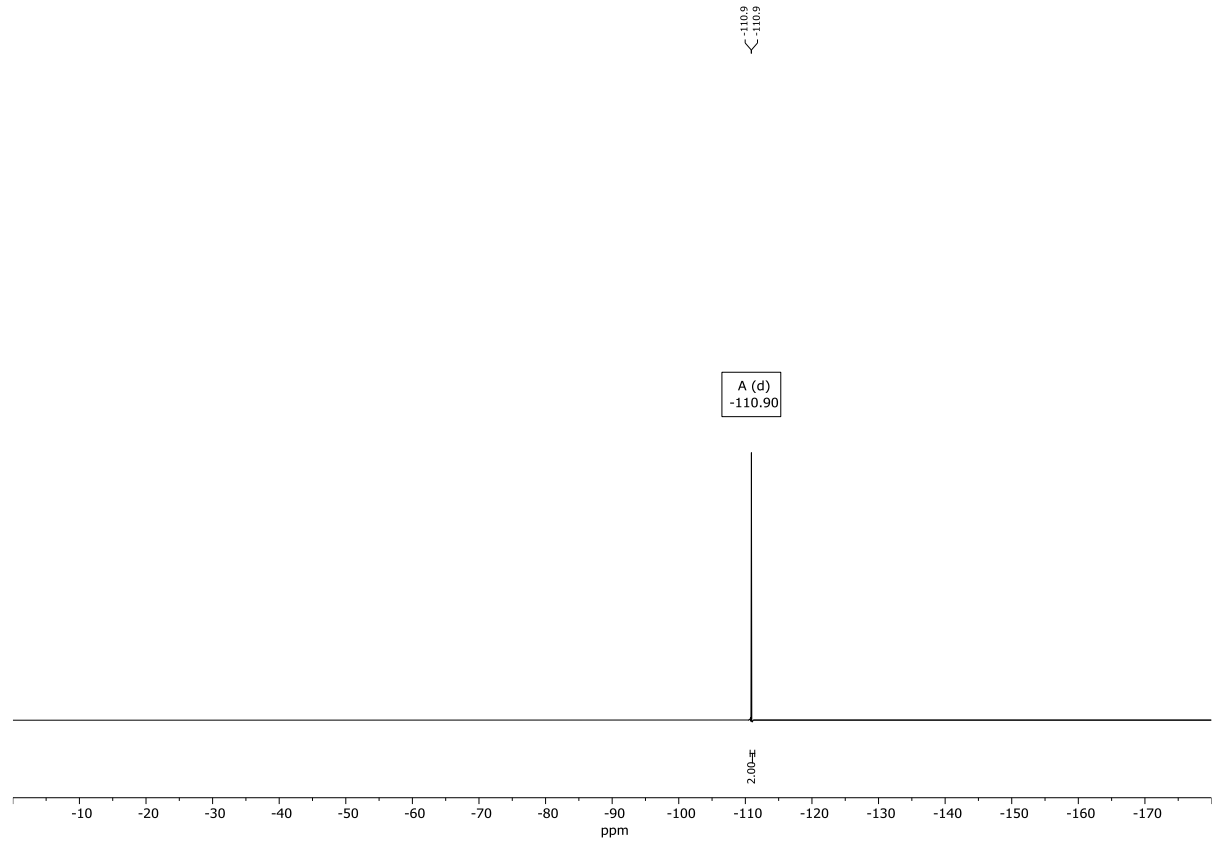

F
O
O
S
N
Br
OH
F

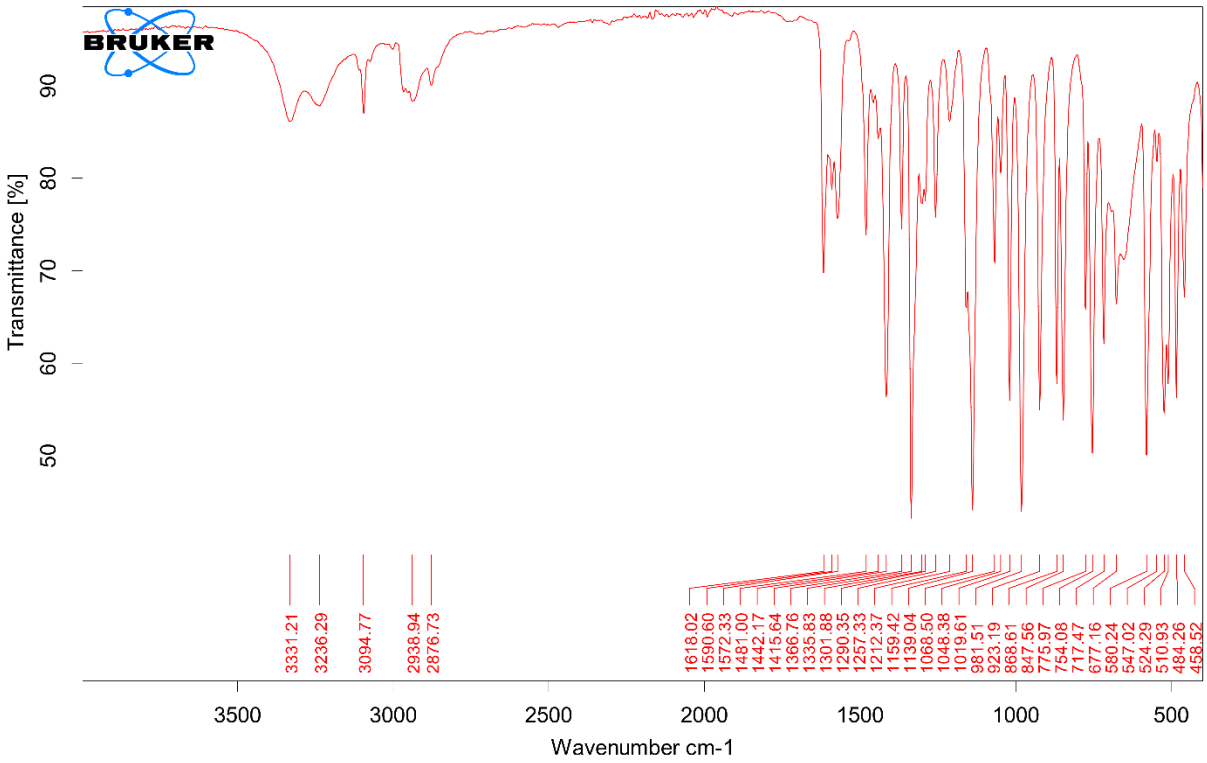
9

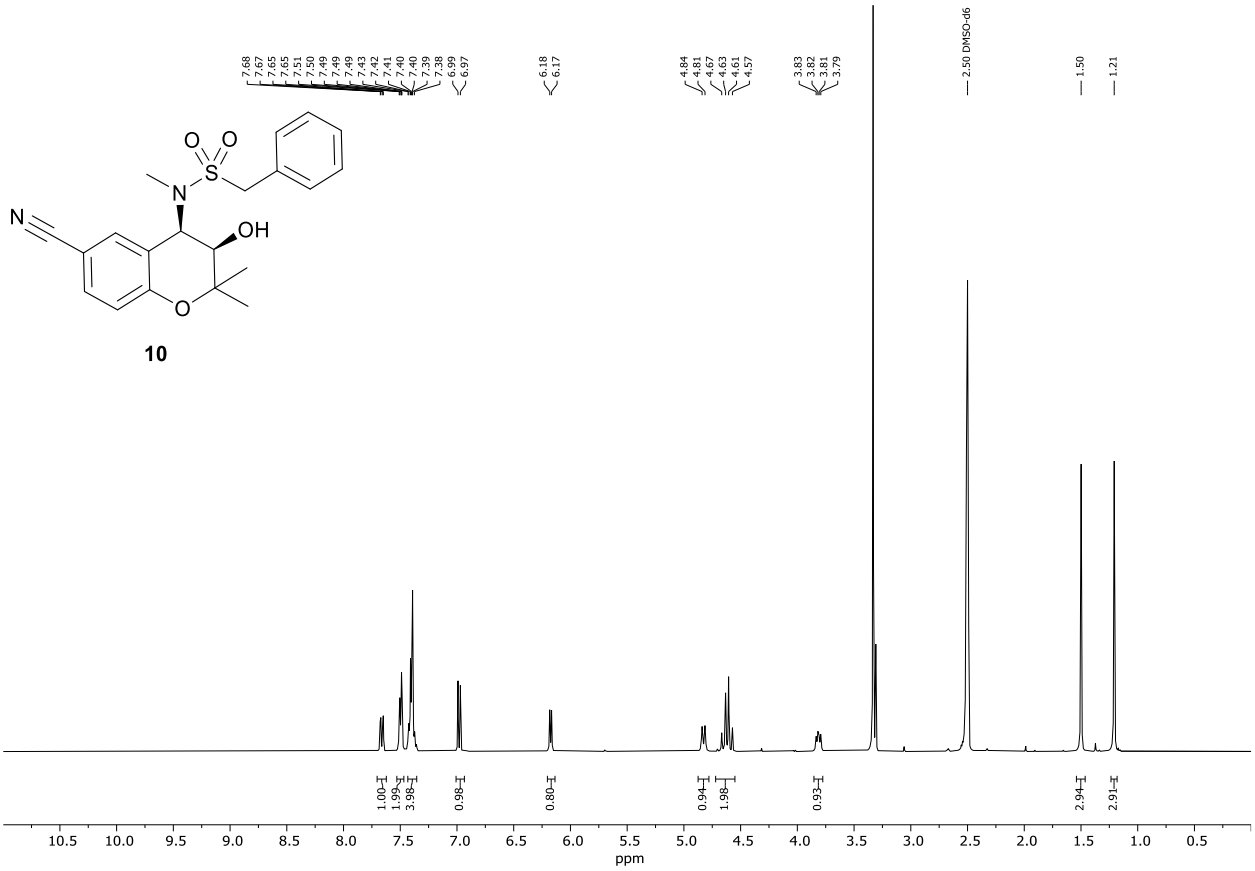
7.60
7.59
7.59
7.57
7.56
7.55
4.85
4.84
4.83
4.45
3.51
3.50
3.49
3.47
3.13
3.12
3.10
2.86
2.85
2.50 DMSO-d6
2.00
0.85
2.05
2.06
2.05
3.09
ppm

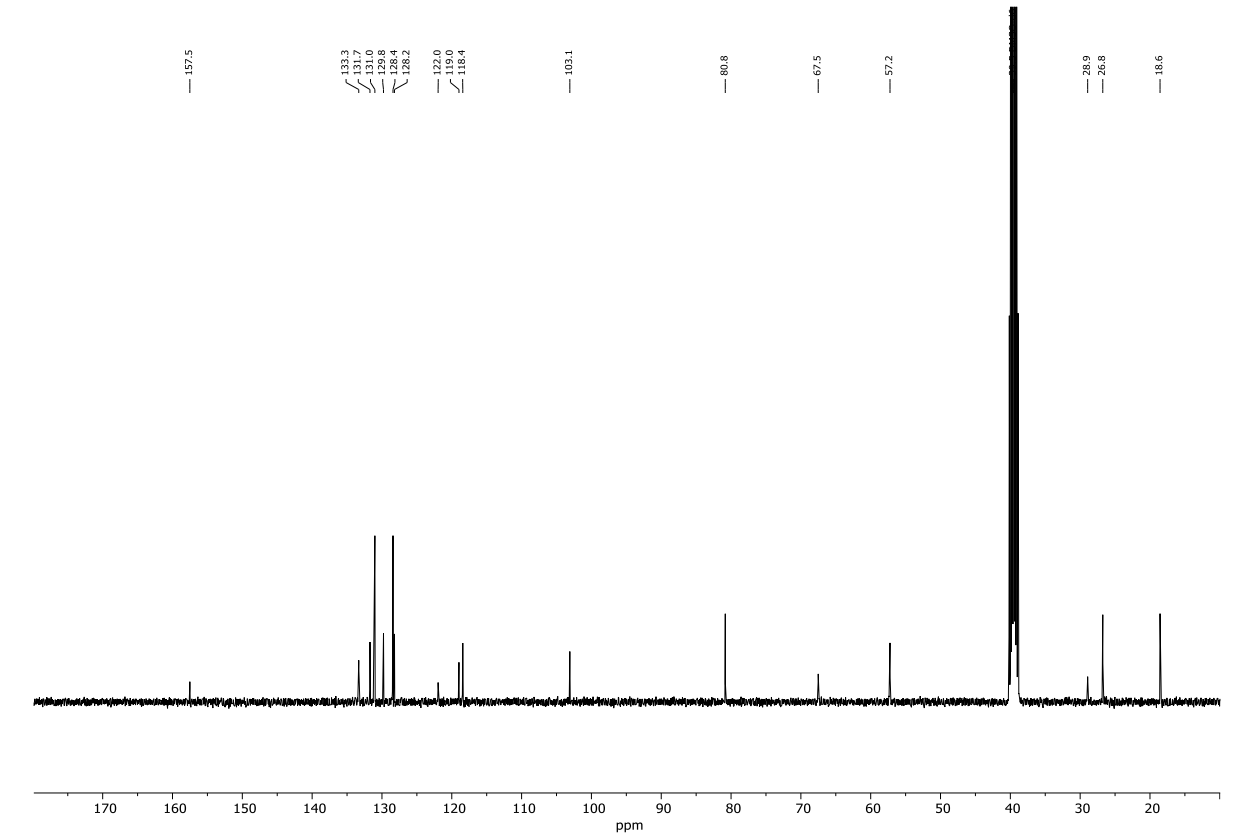

162.3
159.7
122.3
122.1
122.0
106.9
106.7
106.5
59.1
51.8
43.0
35.2
A (d)
161.02
B (m)
114.43
C (s)
35.19
1.00
4.55
1.54
ppm

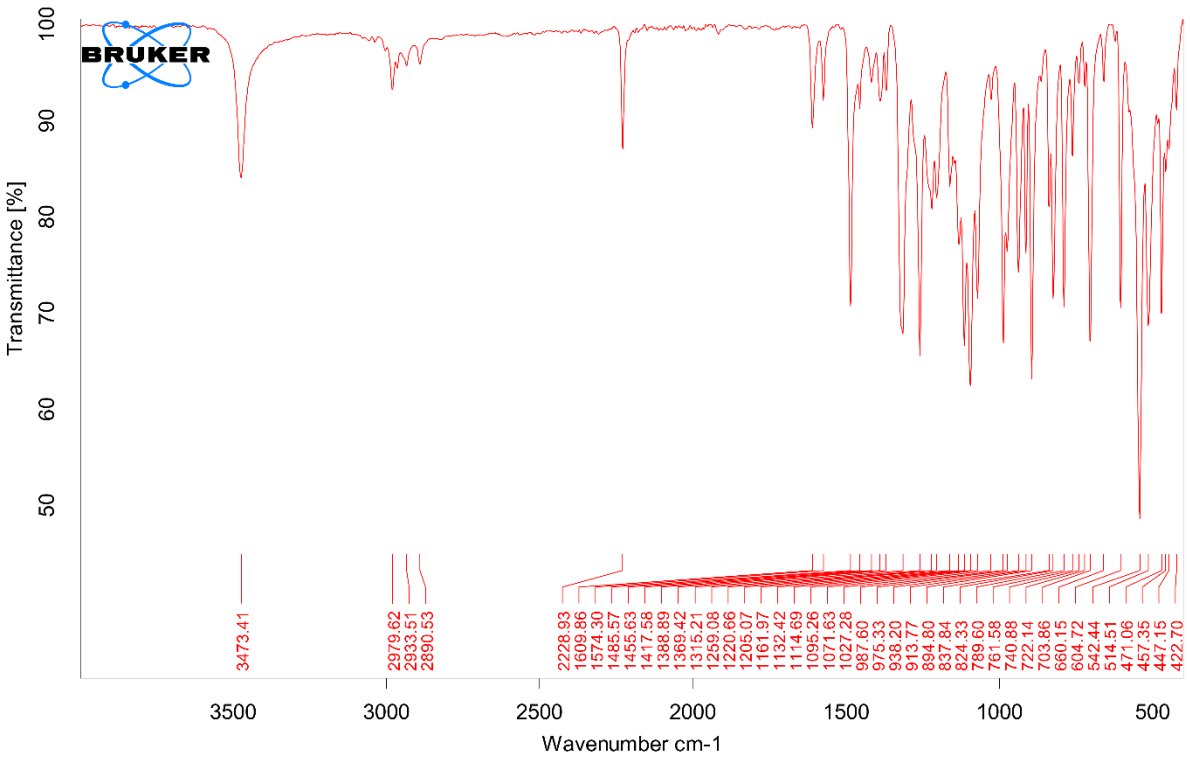

162.3
159.7
115.8
115.8
115.5
115.5
59.1
51.8
43.0
35.2
A (d)
161.02
B (m)
115.64
1.00
2.89
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm

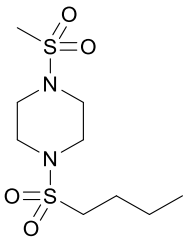

-110.9
-110.9
A (d)
-110.90
2.00
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
ppm


BRUKER
Transmittance [%]
90
80
70
60
50
3331.21
3236.29
3094.77
2938.94
2876.73
1618.02
1590.60
1572.33
1481.00
1442.17
1415.64
1366.76
1335.83
1301.88
1290.35
1257.33
1212.37
1159.42
1139.04
1068.50
1048.38
1019.61
981.51
923.19
868.61
847.56
775.97
754.08
717.47
677.16
580.24
547.02
524.29
510.93
484.26
458.52
3500
3000
2500
2000
1500
1000
500
Wavenumber cm-1

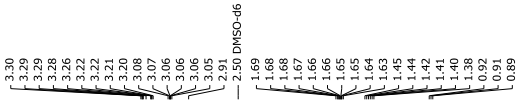

7.68
7.67
7.65
7.65
7.51
7.50
7.49
7.49
7.49
7.49
7.43
7.42
7.41
7.40
7.40
7.39
7.38
6.99
6.97
6.18
6.17
4.84
4.81
4.67
4.63
4.61
4.57
3.83
3.82
3.81
3.79
2.50 DMSO-d6
1.50
1.21
O
O
S
N
OH
N
O
1.00
1.99
3.98
0.98
0.80
0.94
1.98
0.93
2.94
2.91
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm

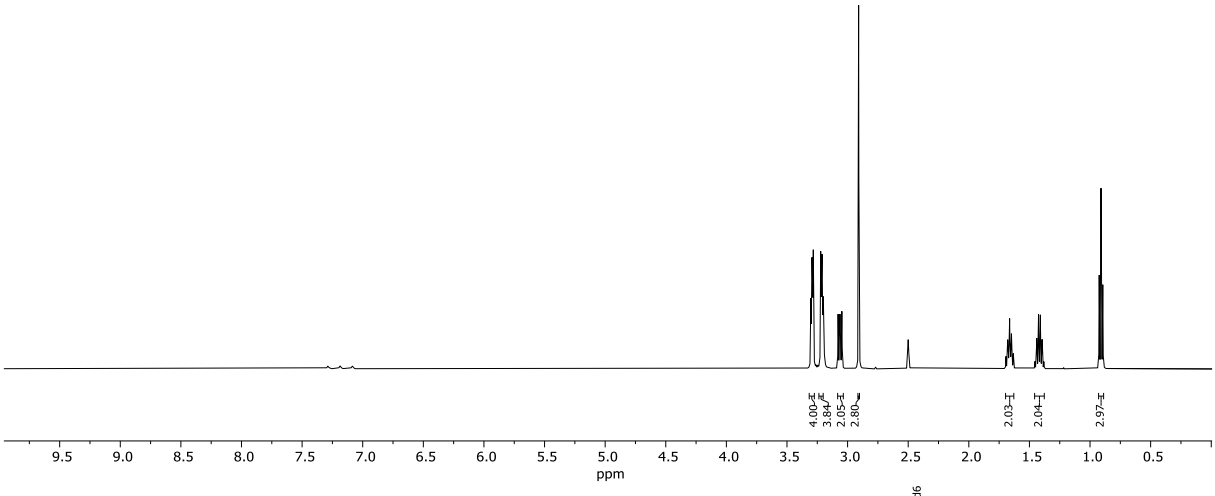

157.5
133.3
131.7
131.0
129.8
128.4
128.2
122.0
119.0
118.4
103.1
80.8
67.5
57.2
28.9
26.8
18.6
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20
ppm

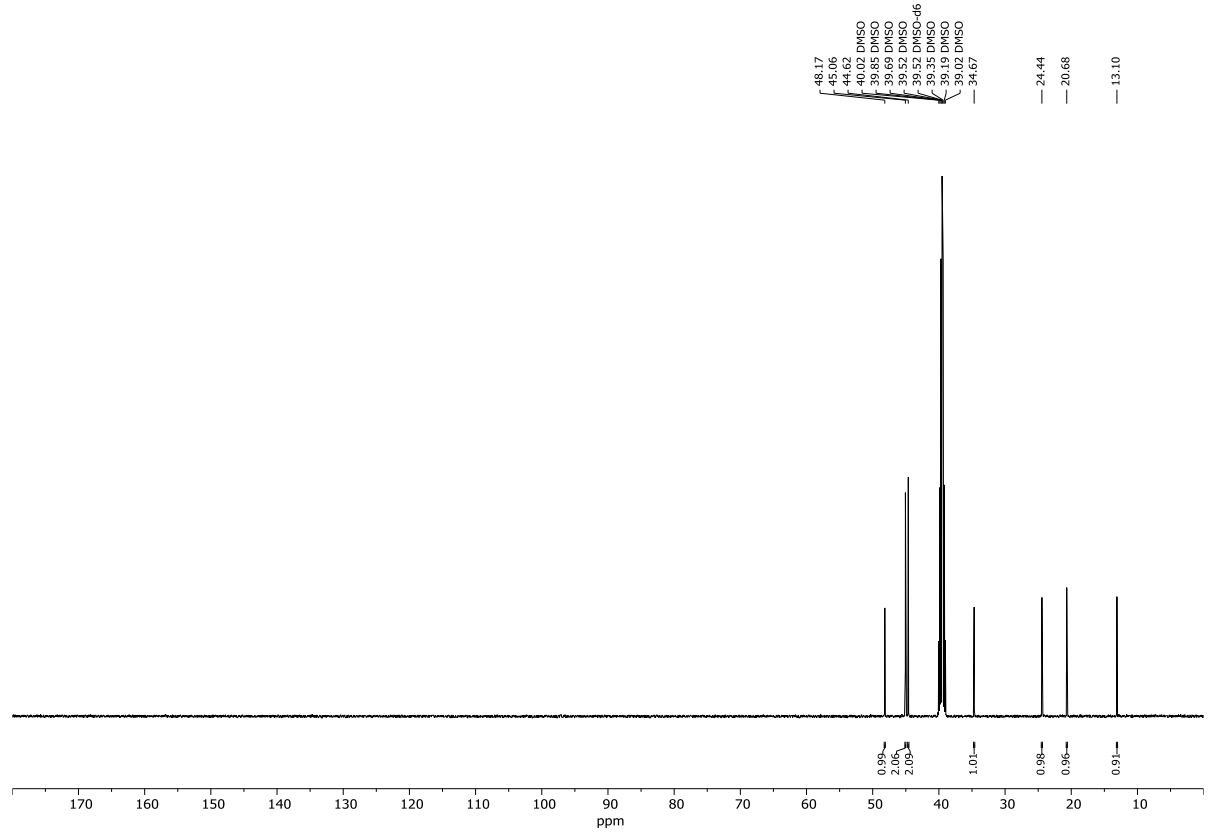

BRUKER
Transmittance [%]
100
90
80
70
60
50
3473.41
2979.62
2933.51
2890.53
2228.93
1609.86
1574.30
1485.57
1455.63
1417.58
1388.89
1369.42
1315.21
1259.08
1220.66
1205.07
1161.97
1132.42
1114.69
1095.26
1071.63
1027.28
987.60
975.33
938.20
913.77
894.80
837.84
824.33
789.60
761.58
740.88
722.14
703.86
660.15
604.72
542.44
514.51
471.06
457.35
447.15
422.70
3500
3000
2500
2000
1500
1000
500
Wavenumber cm-1

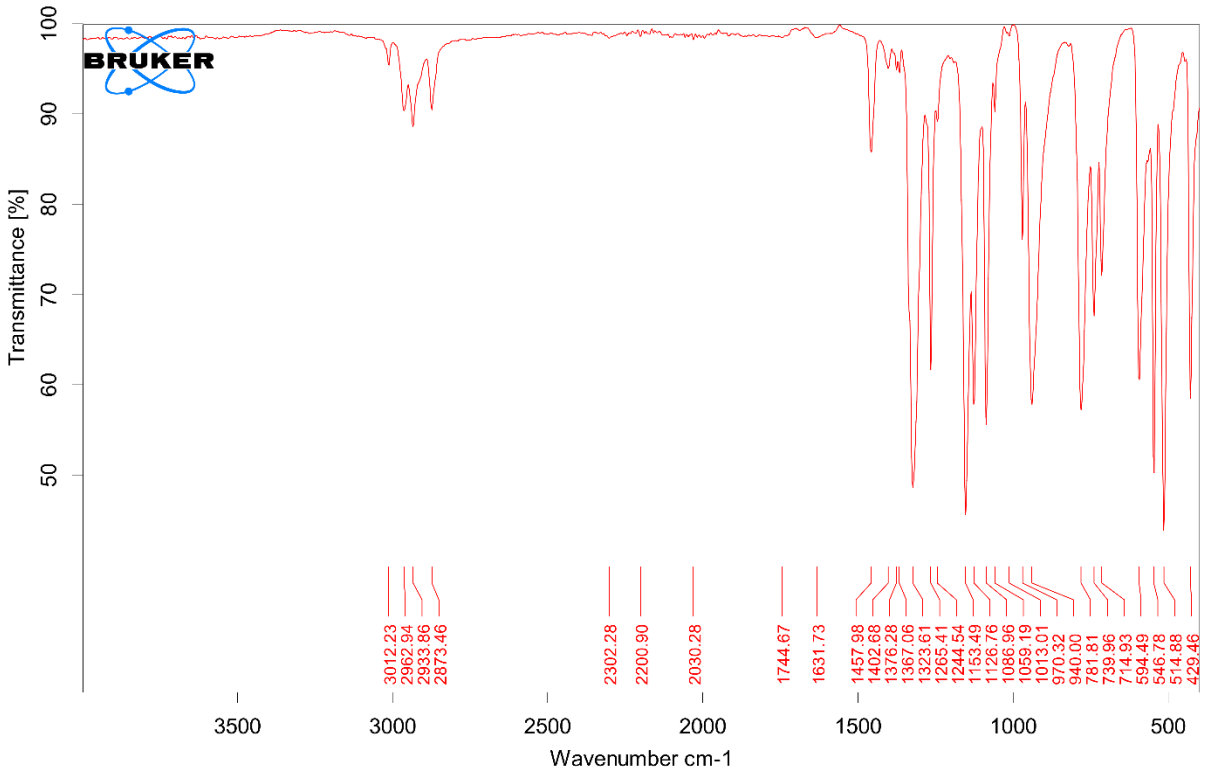


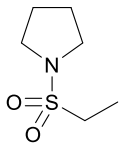
11


3.30
3.29
3.29
3.28
3.26
3.22
3.22
3.21
3.20
3.08
3.07
3.06
3.06
3.06
3.05
2.91
2.50 DMSO-d6
1.69
1.68
1.68
1.67
1.66
1.66
1.65
1.65
1.64
1.63
1.45
1.44
1.42
1.41
1.40
1.38
0.92
0.91
0.89

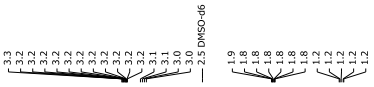

4.00
3.84
2.05
2.80
2.03
2.04
2.97
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm

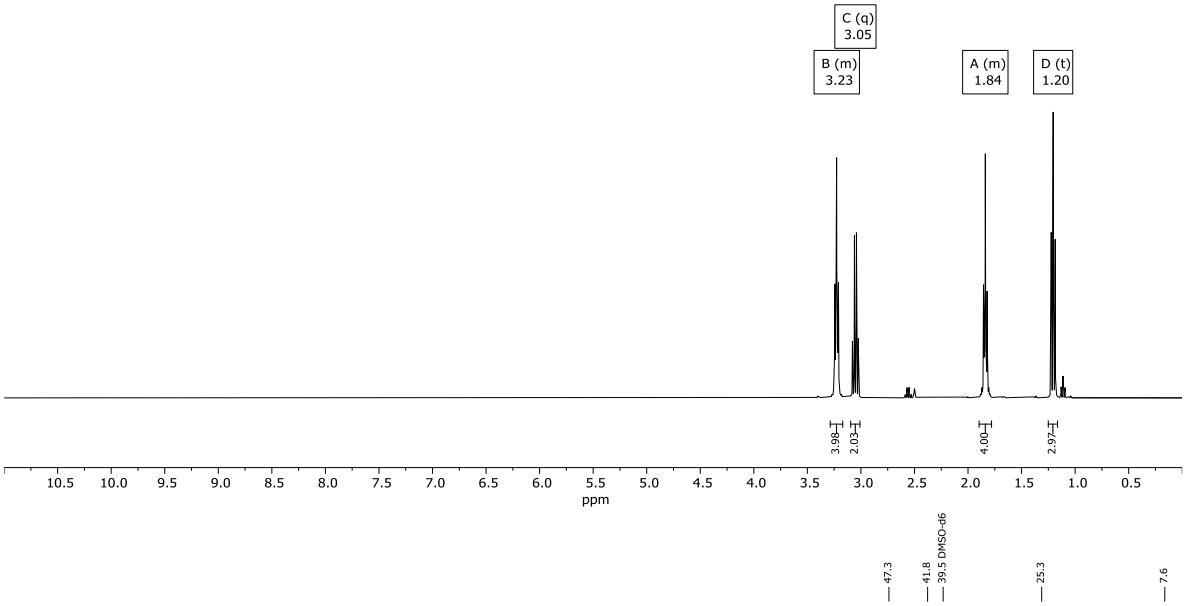

48.17
45.06
44.62
40.02 DMSO
39.85 DMSO
39.69 DMSO
39.52 DMSO
39.52 DMSO-d6
39.35 DMSO
39.19 DMSO
39.02 DMSO
34.67
24.44
20.68
13.10
0.99
2.06
2.09
1.01
0.98
0.96
0.91
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
ppm

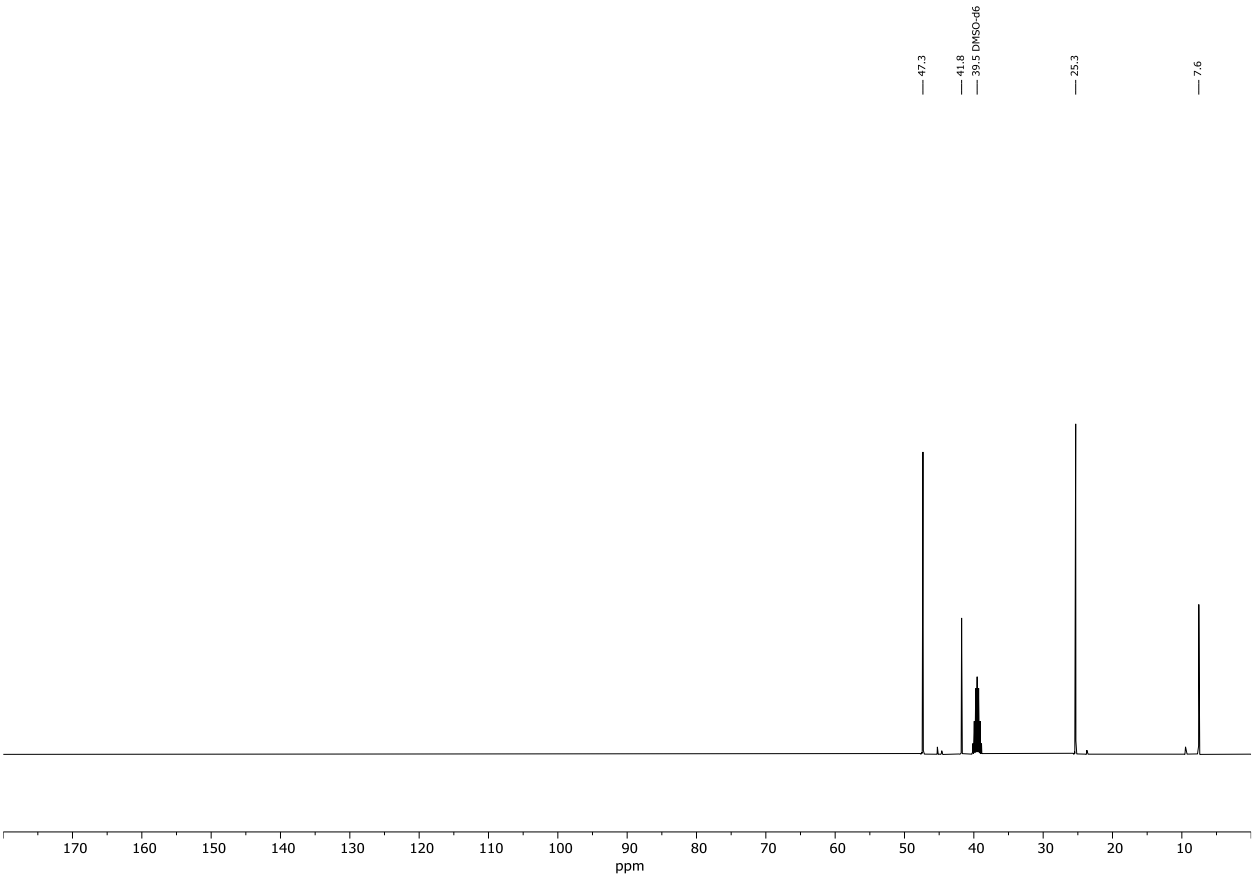

BRUKER
Transmittance [%]
100
90
80
70
60
50
3012.23
2962.94
2933.86
2873.46
2302.28
2200.90
2030.28
1744.67
1631.73
1457.98
1402.68
1376.28
1367.06
1323.61
1265.41
1244.54
1153.49
1126.76
1086.96
1059.19
1013.01
970.32
940.00
781.81
739.96
714.93
594.49
546.78
514.88
429.46
3500
3000
2500
2000
1500
1000
500
Wavenumber cm-1

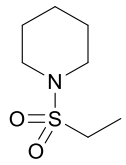


12


3.3
3.2
3.2
3.2
3.2
3.2
3.2
3.2
3.2
3.2
3.2
3.2
3.1
3.1
3.0
3.0
2.5 DMSO-d6
1.9
1.8
1.8
1.8
1.8
1.8
1.8
1.2
1.2
1.2
1.2
1.2
1.2

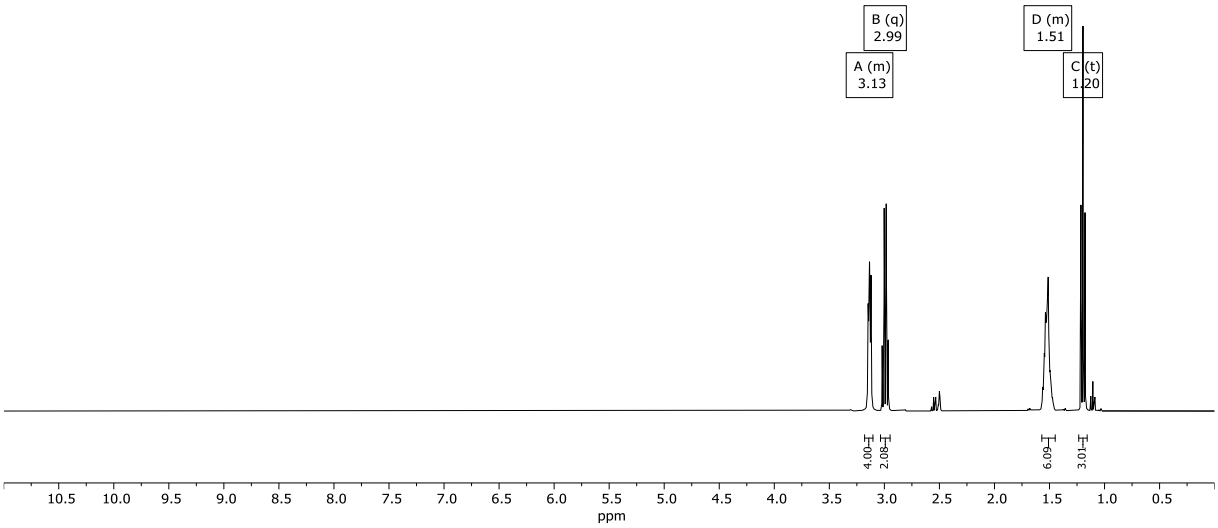

C (q)
3.05
B (m)
3.23
A (m)
1.84
D (t)
1.20
3.98
2.03
4.00
2.97
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm

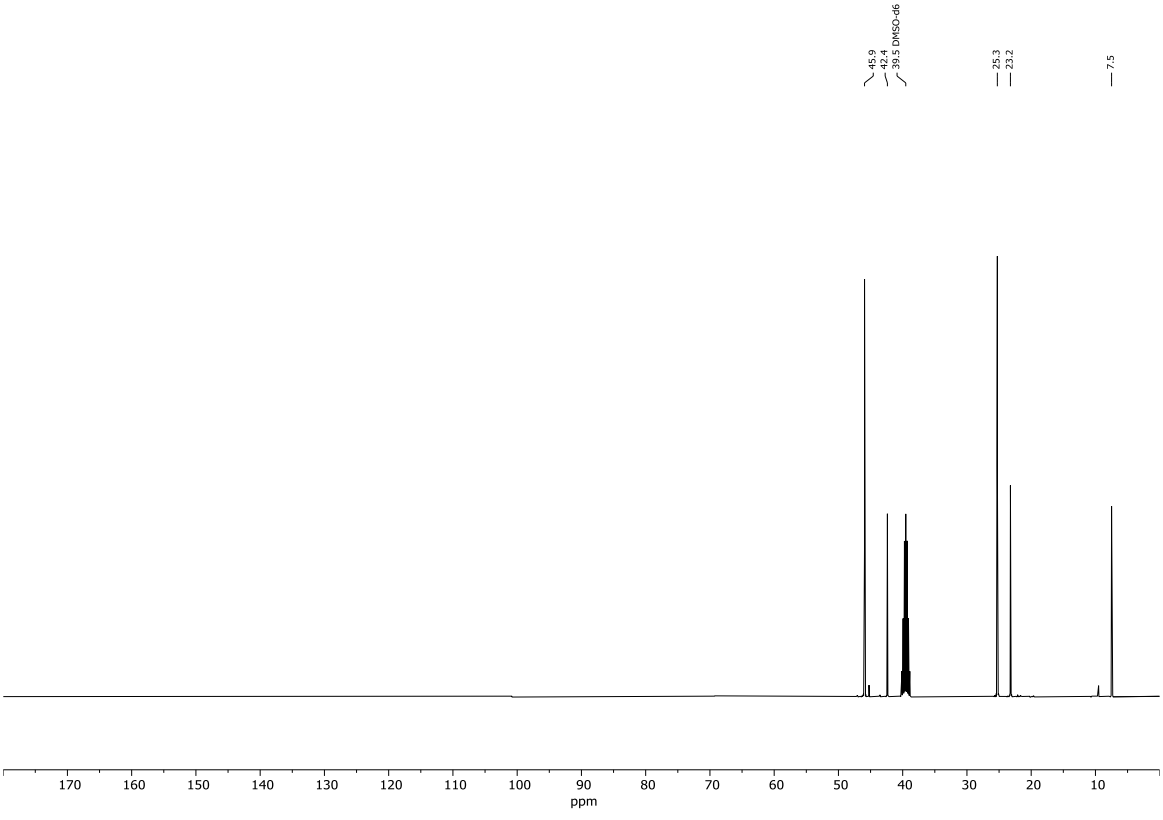

47.3
41.8
39.5 DMSO-d6
25.3
7.6
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

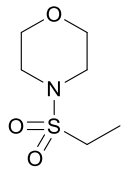


13


3.1
3.1
3.1
3.0
3.0
3.0
3.0
3.0
2.5 DMSO-d6
1.6
1.6
1.5
1.5
1.5
1.5
1.5
1.5
1.5
1.5
1.5
1.5
1.5
1.5
1.5
1.2
1.2
1.2
1.2

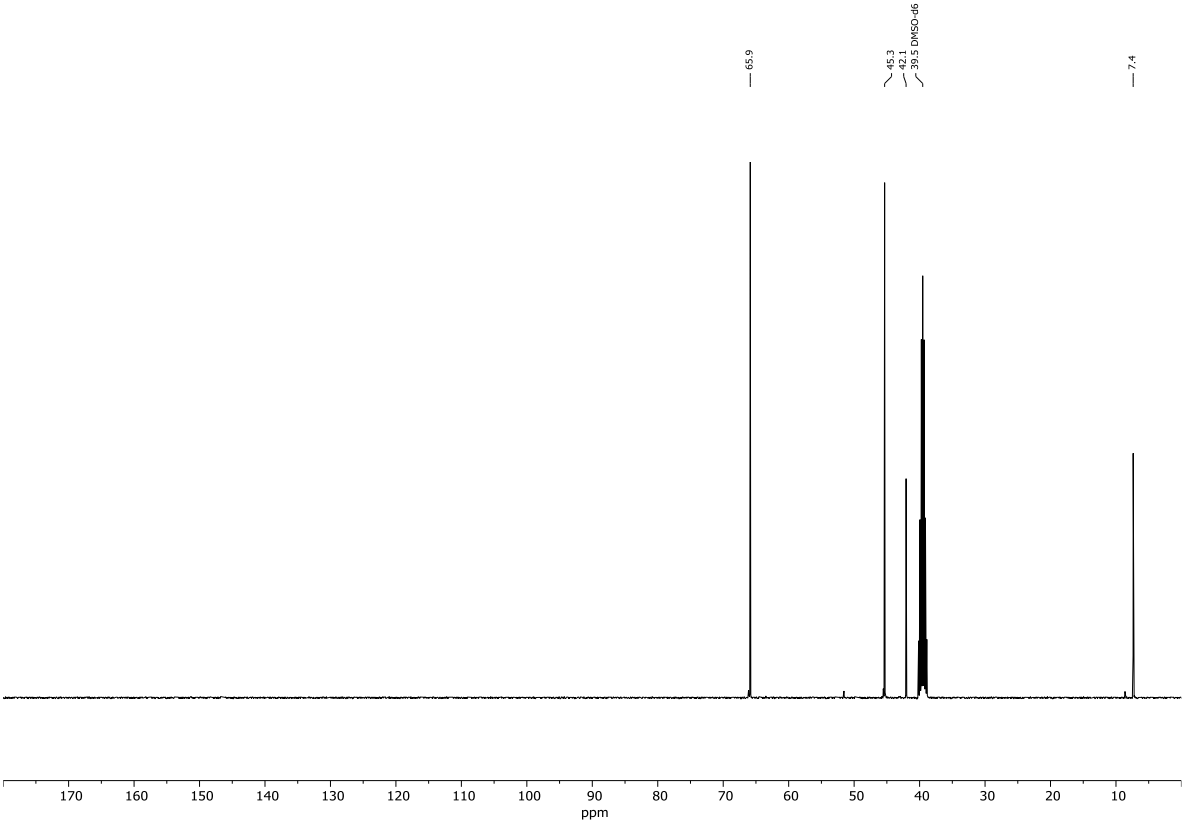

B (q)
2.99
A (m)
3.13
D (m)
1.51
C (t)
1.20
4.00
2.08
6.09
3.01
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm

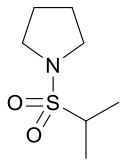

45.9
42.4
39.5 DMSO-d6
25.3
23.2
7.5
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
ppm



14

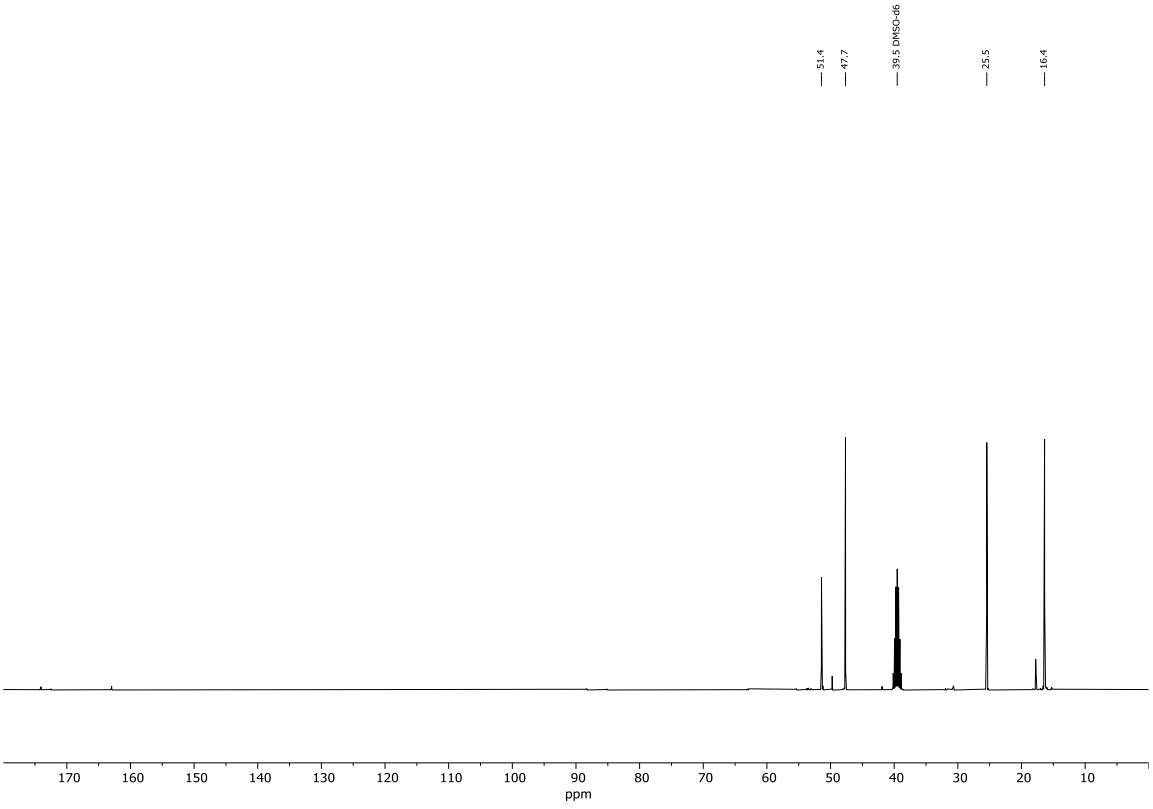
3.6
3.6
3.6
3.6
3.6
3.2
3.2
3.1
3.1
3.1
3.1
3.1
3.0
2.5 DMSO-d6
1.2
1.2
1.2
1.2
1.2
C (q)
3.07
A (m)
3.63
B (m)
3.15
D (t)
1.22
4.00
4.01
2.12
3.02
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm

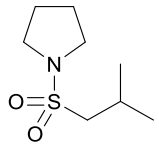

65.9
45.3
45.1
39.5 DMSO-d6
7.4
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm



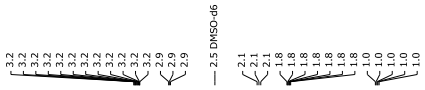
15

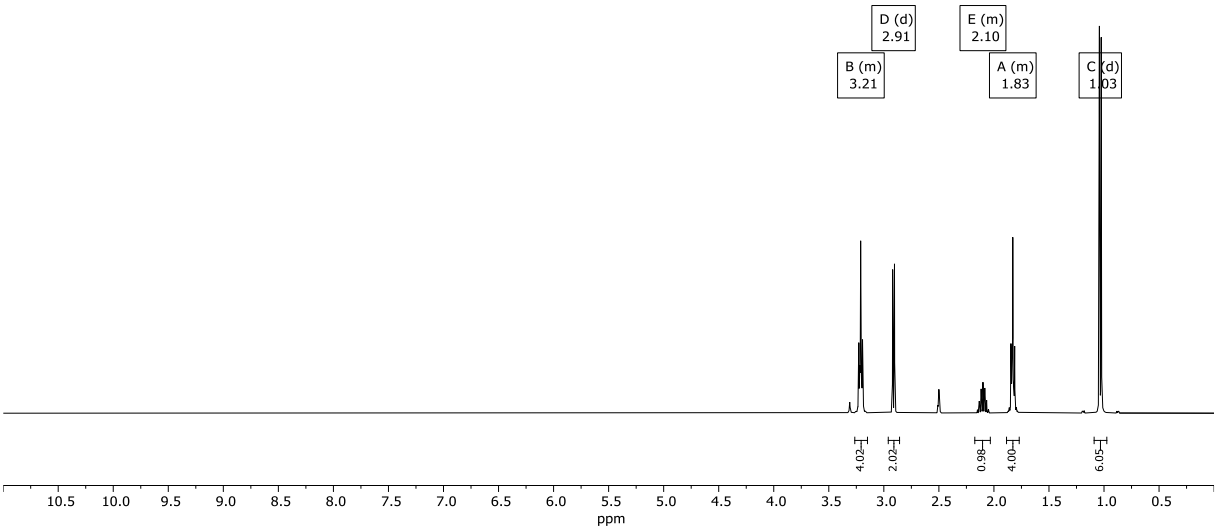
3.4
3.4
3.3
3.3
3.3
3.3
3.3
3.3
3.3
3.2
2.5 DMSO-d6
1.9
1.9
1.9
1.8
1.8
1.8
1.8
1.2
1.2
1.1
1.1
E (m)
3.35
D (m)
3.27
A (m)
1.85
C (d)
1.22
1.10
3.90
4.00
6.32
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm

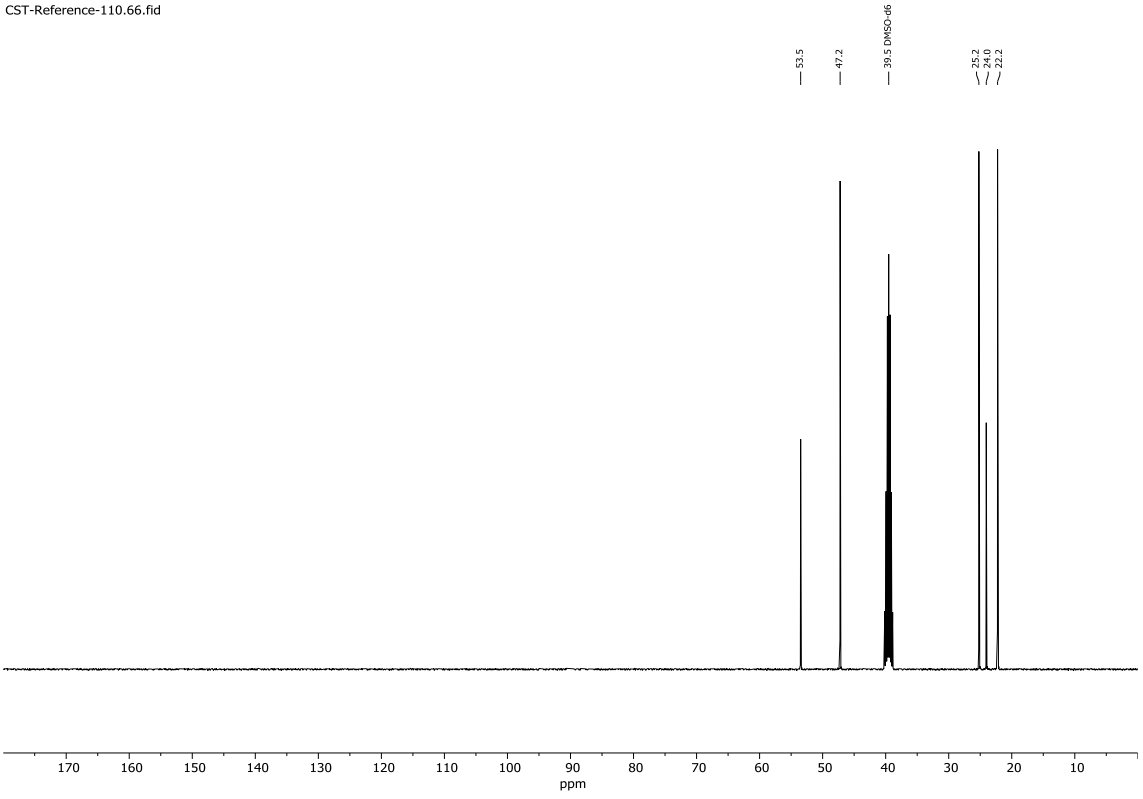

51.4
47.7
39.5 DMSO-d6
25.5
16.4
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
ppm

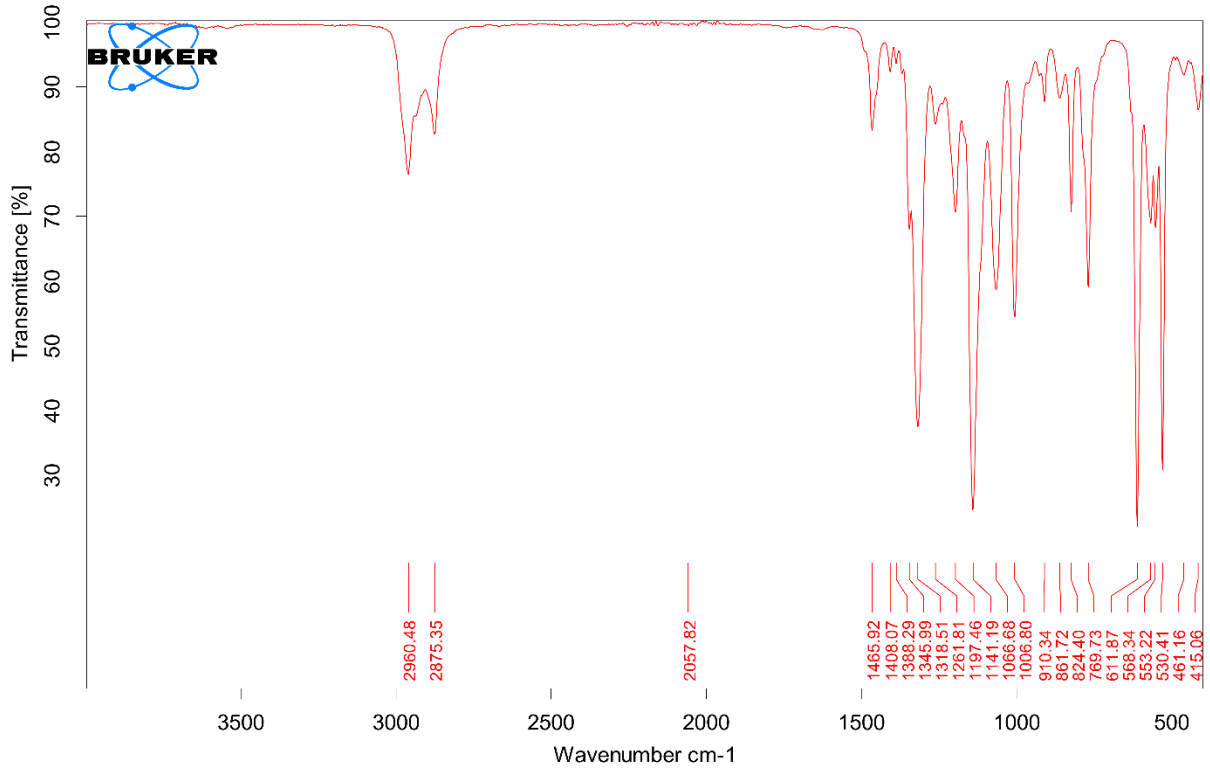


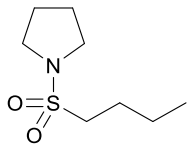
16


3.2
3.2
3.2
3.2
3.2
3.2
3.2
3.2
3.2
3.2
2.9
2.9
2.9
2.5 DMSO-d6
2.1
2.1
2.1
1.8
1.8
1.8
1.8
1.8
1.8
1.0
1.0
1.0
1.0

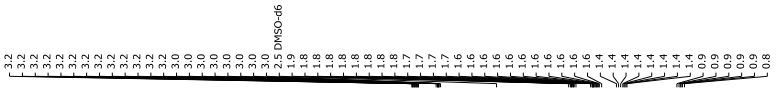

D (d)
2.91
E (m)
2.10
B (m)
3.21
A (m)
1.83
C (d)
1.03
4.02
2.02
0.98
4.00
6.05
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm

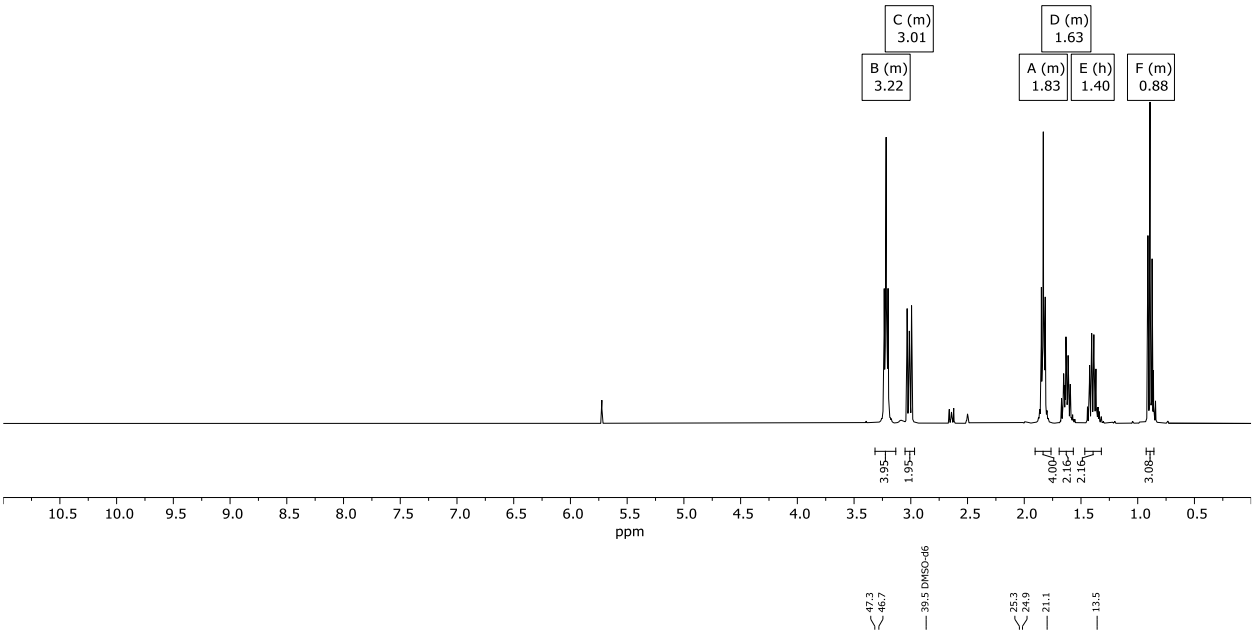

CST-Reference-110.66.fid
53.5
47.2
39.5 DMSO-d6
25.2
24.0
22.2
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

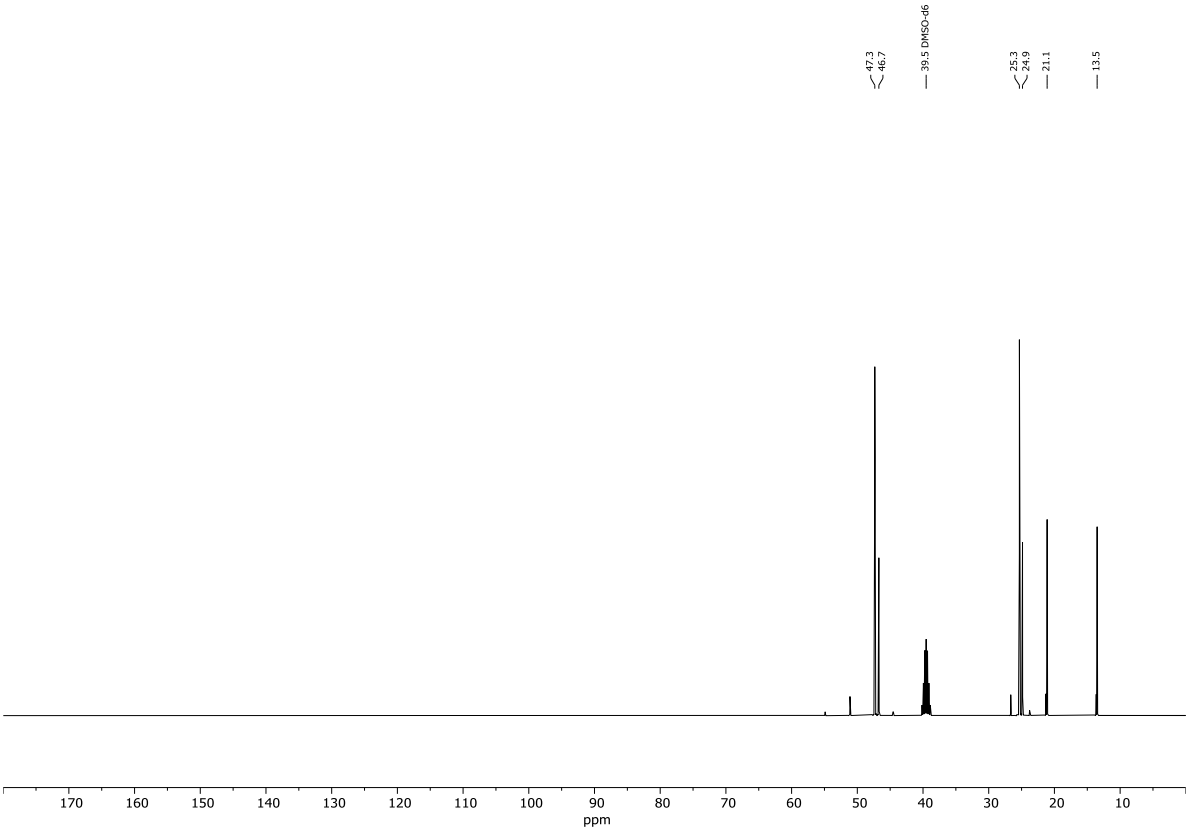

BRUKER
Transmittance [%]
100
90
80
70
60
50
40
30
2960.48
2875.35
2057.82
1465.92
1408.07
1388.29
1345.99
1318.51
1261.81
1197.46
1141.19
1066.68
1006.80
910.34
861.72
824.40
769.73
611.87
568.34
553.22
530.41
461.16
415.06
3500
3000
2500
2000
1500
1000
500
Wavenumber cm-1

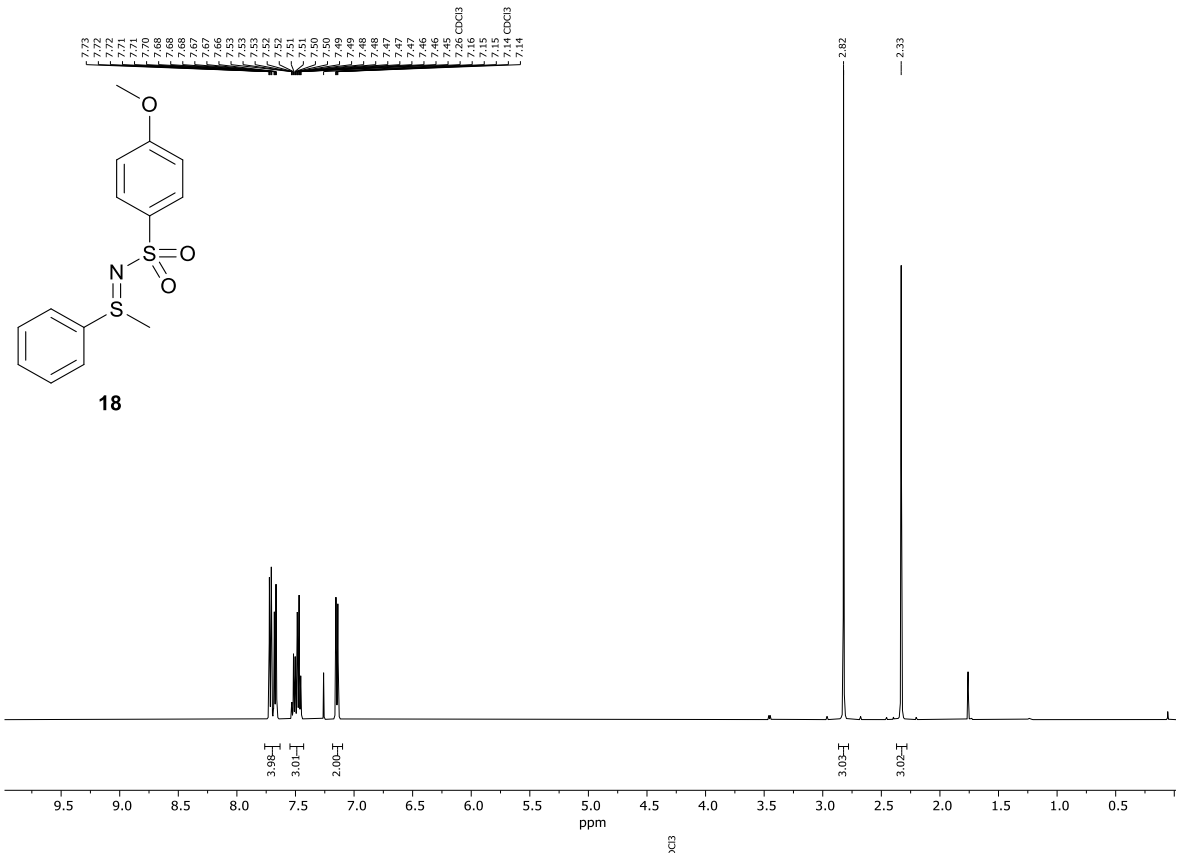


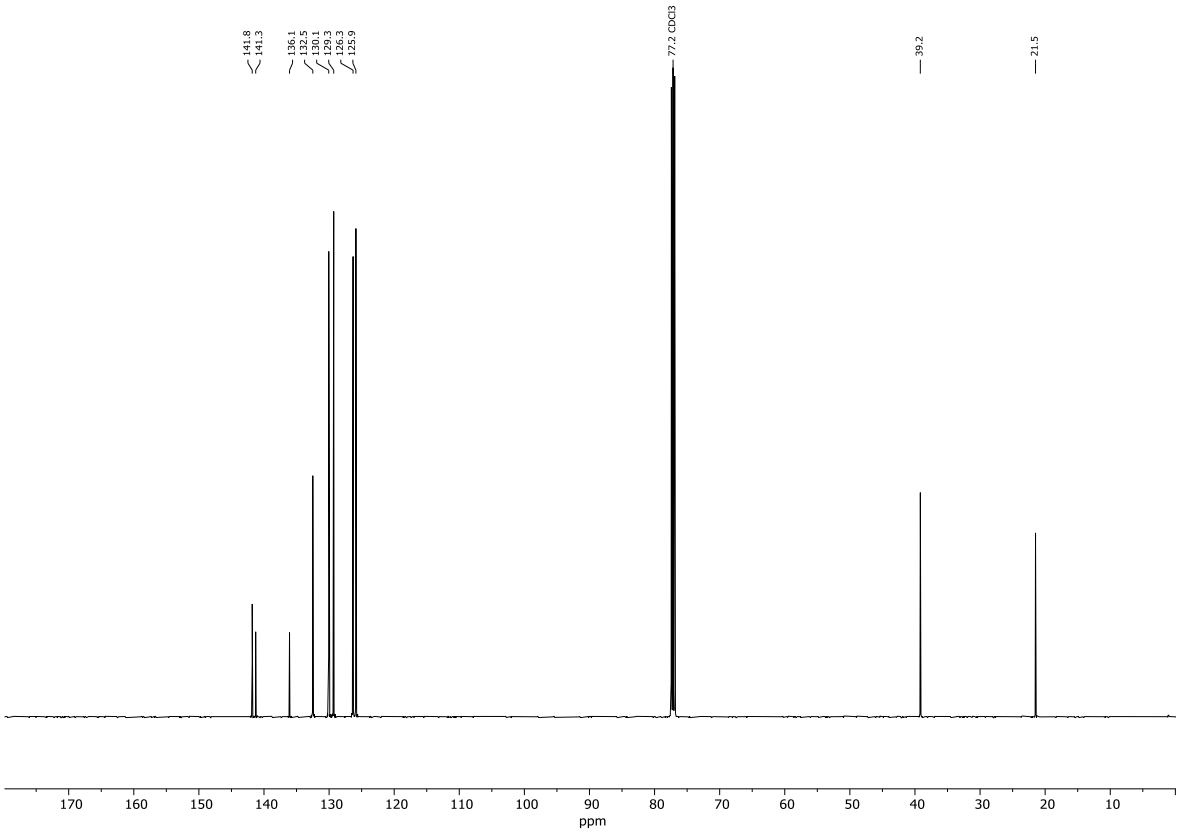
17

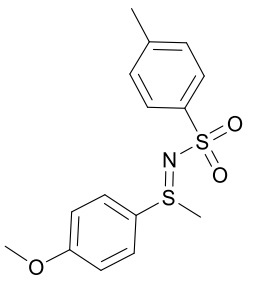

DMSO-d6


C (m)
3.01
D (m)
1.63
B (m)
3.22
A (m)
1.83
E (h)
1.40
F (m)
0.88
3.95
1.95
4.00
2.16
2.16
3.08
ppm


47.3
46.7
39.5 DMSO-d6
25.3
24.9
21.1
13.5
ppm

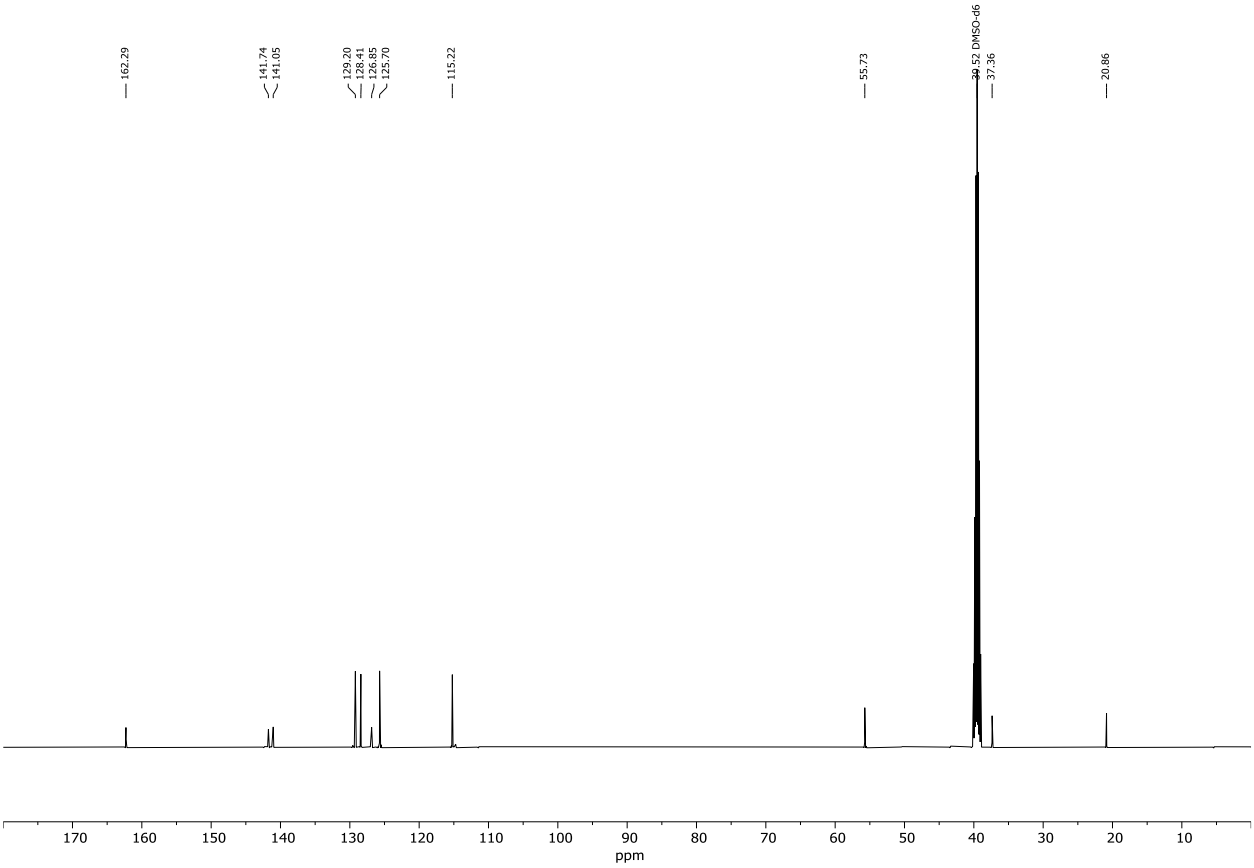

7.73 7.72 7.72 7.72 7.71 7.71 7.70 7.68 7.68 7.68 7.67 7.67 7.66 7.53 7.53 7.53 7.52 7.52 7.51 7.51 7.50 7.50 7.49 7.49 7.48 7.48 7.47 7.47 7.47 7.46 7.46 7.45 CDCl3 7.16 7.15 7.15 7.14 CDCl3 7.14
2.82
2.33
O
S
O
N
O
S
18
3.98
3.01
2.00
3.03
3.02
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm

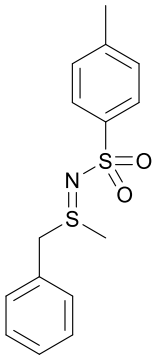

141.8
141.3
136.1
132.5
130.1
129.3
126.3
125.9
77.2 CDCl3
39.2
21.5
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
ppm



19

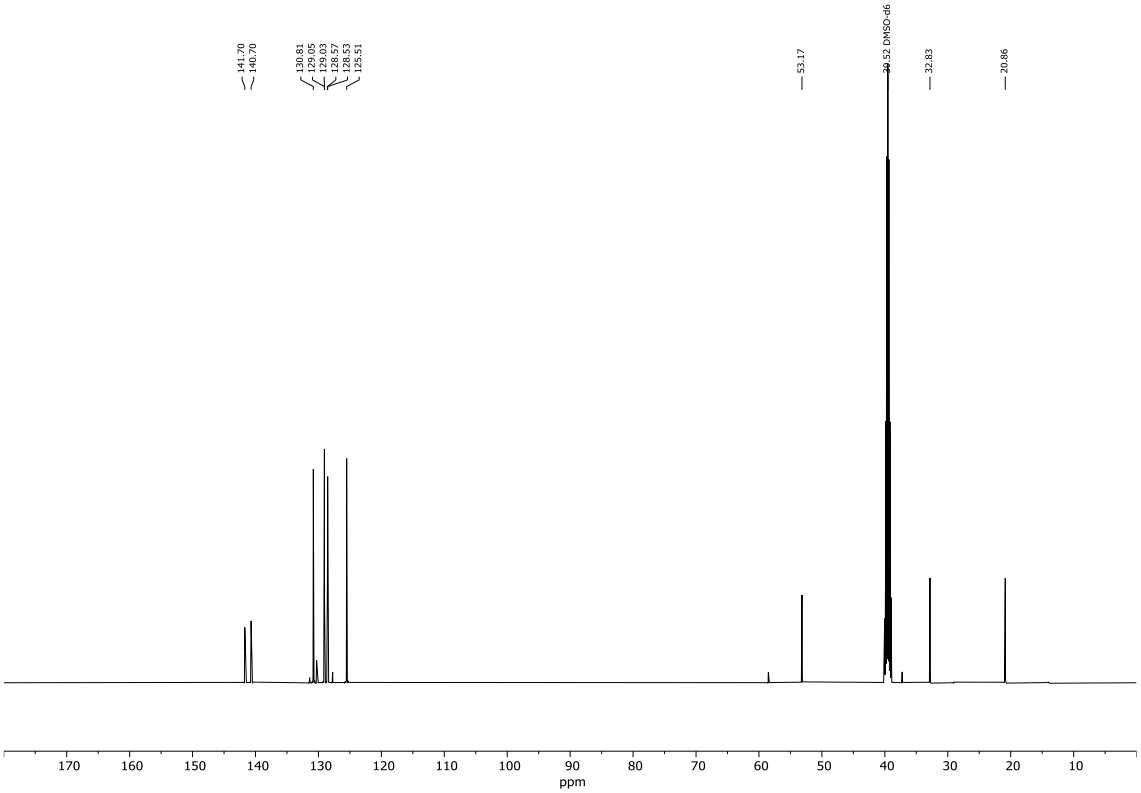
7.72
7.71
7.70
7.70
7.56
7.56
7.55
7.55
7.25
7.25
7.24
7.23
7.12
7.11
7.10
7.10
3.81
2.91
2.50 DMSO-d6
2.32
2.00
1.85
1.94
1.94
2.92
2.85
2.84
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm

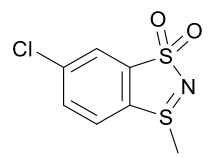

162.29
141.74
141.05
129.20
128.41
126.85
125.70
115.22
55.73
39.52 DMSO-d6
37.36
20.86
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
ppm



20

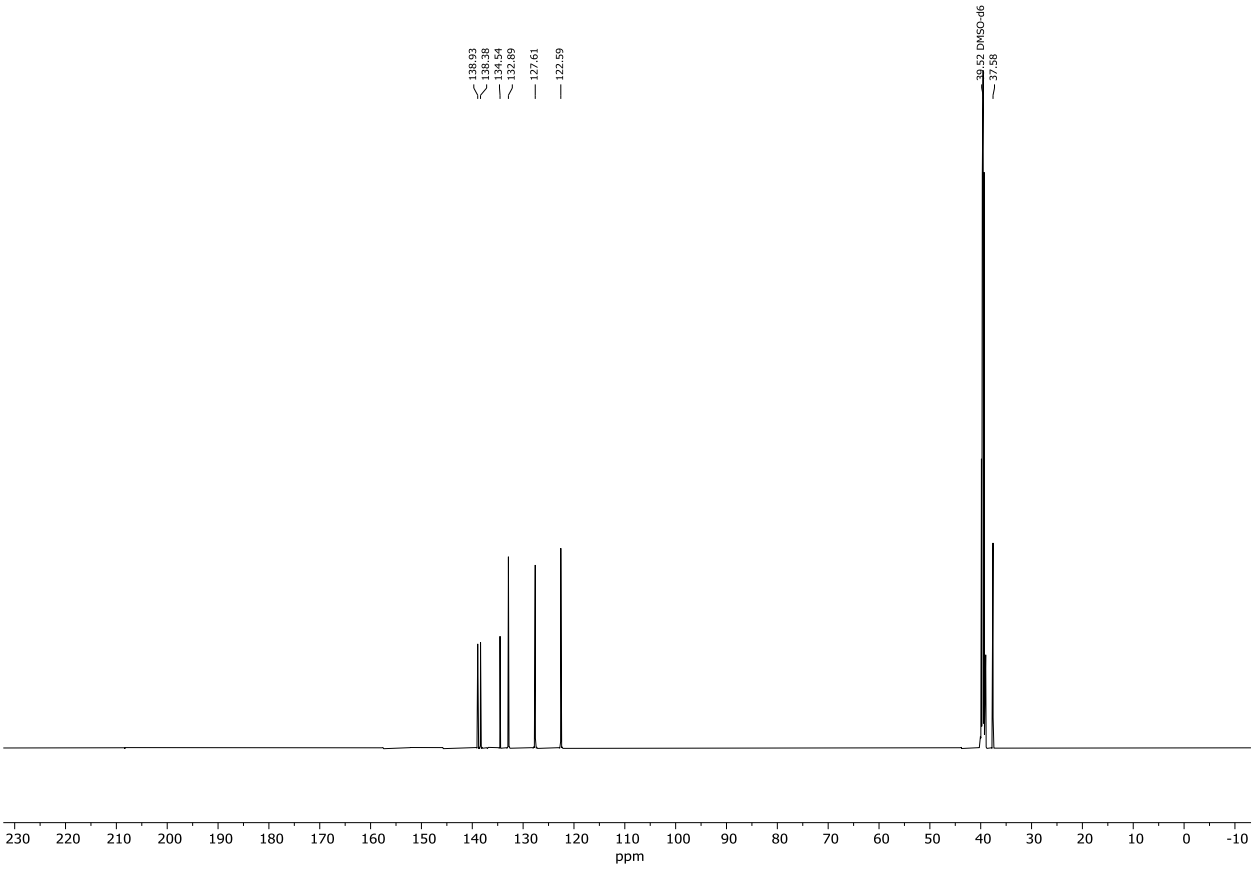
7.38
7.37
7.36
7.35
7.34
7.32
7.32
7.31
7.30
7.30
7.29
7.26
7.26
7.25
7.24
7.15
7.14
7.13
7.13
4.35
4.32
4.23
4.20
2.61
2.50 DMSO-d6
2.31
3.24
2.19
2.00
1.99
1.01
1.01
2.98
2.95
ppm

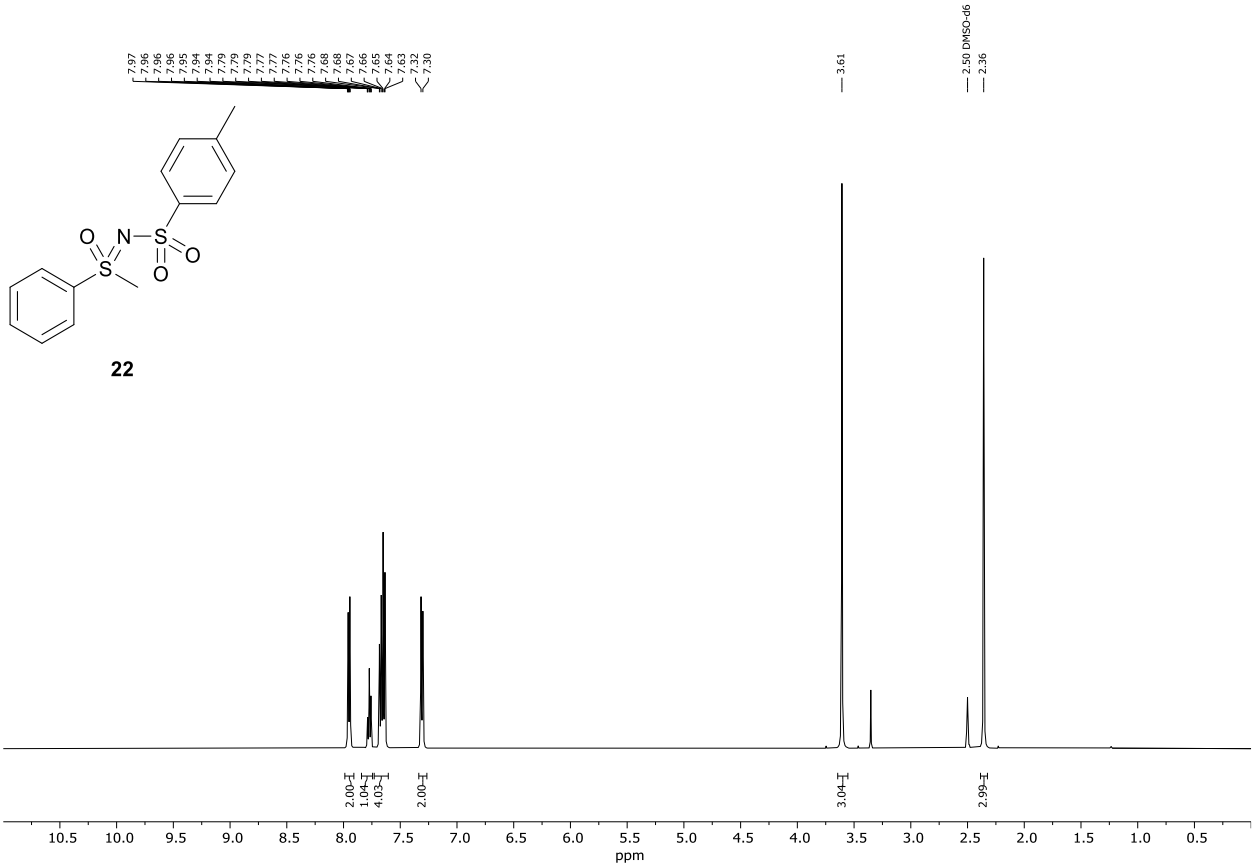

141.70
140.70
130.81
129.05
129.03
128.57
128.53
125.51
53.17
39.52 DMSO-d6
32.83
20.86
ppm


Cl
O
O
S
N
S

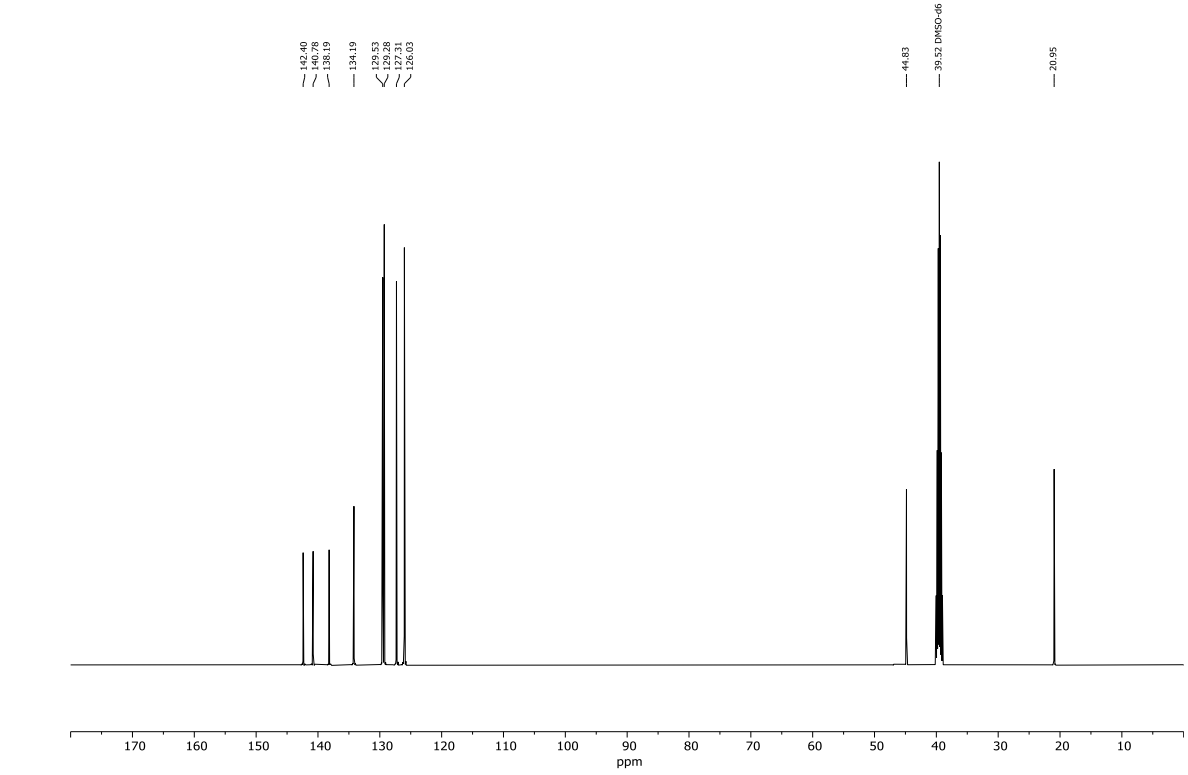
21

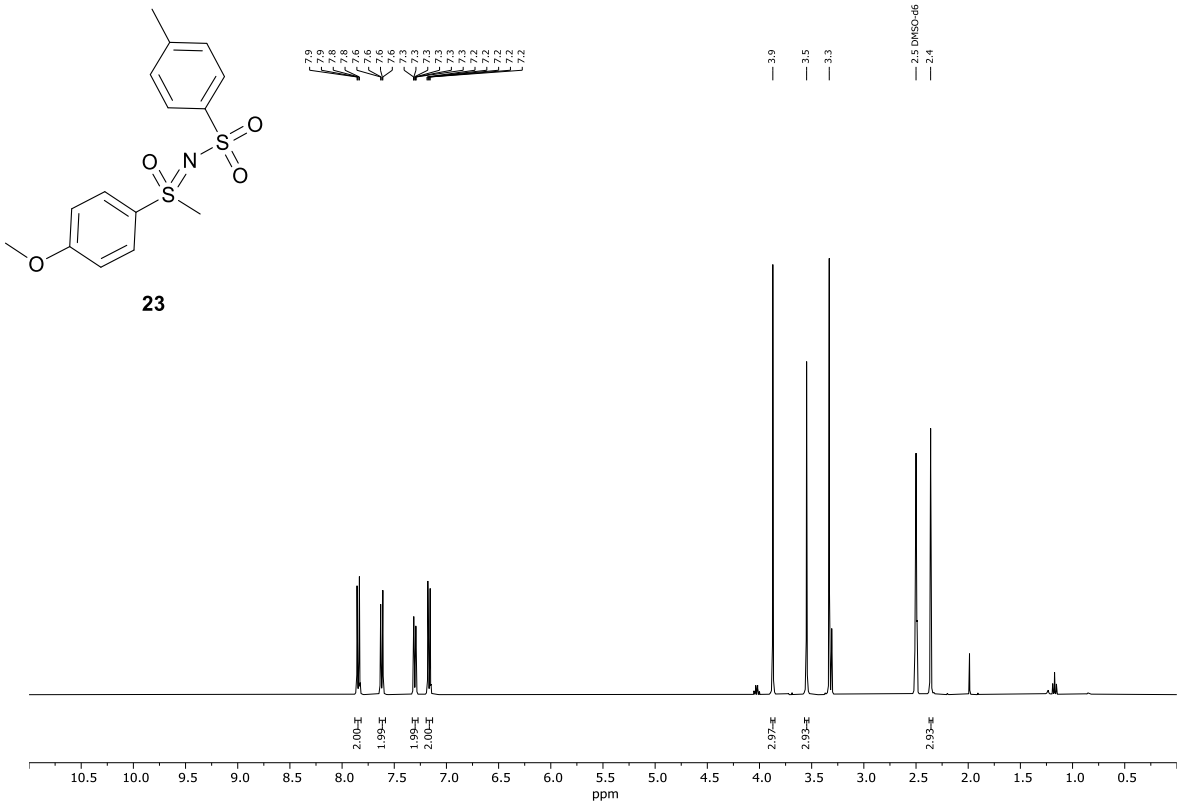
8.24
8.22
8.19
8.19
7.96
7.95
7.94
7.94
3.02
2.50 DMSO-d6
1.02
0.92
1.00
3.17
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm

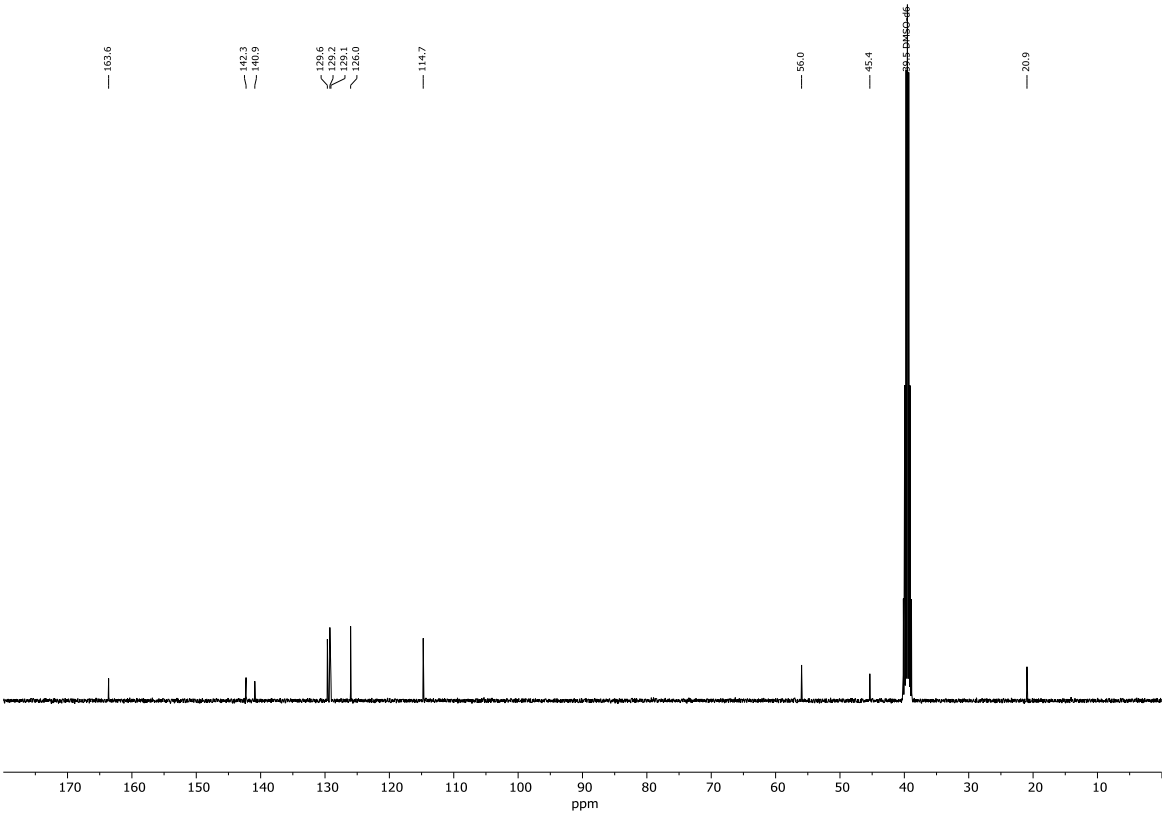

138.93
138.38
134.54
132.89
127.61
122.59
39.52 DMSO-d6
37.58
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
ppm

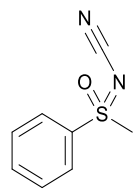

7.97
7.96
7.96
7.96
7.95
7.94
7.94
7.79
7.79
7.77
7.77
7.76
7.76
7.68
7.68
7.67
7.66
7.65
7.64
7.63
7.32
7.30
3.61
2.50 DMSO-d6
2.36
O
N
S
O
S
O
2.00
1.04
4.03
2.00
3.04
2.99
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm

22


142.40
140.78
138.19
134.19
129.53
129.28
127.31
126.03
44.83
39.52 DMSO-d6
20.95
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
ppm


23
7.9
7.9
7.8
7.8
7.6
7.6
7.6
7.6
7.3
7.3
7.3
7.3
7.3
7.2
7.2
7.2
7.2
7.2
3.9
3.5
3.3
2.5 DMSO-d6
2.4
2.00
1.99
1.99
2.00
2.97
2.93
2.93
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm


163.6
142.3
140.9
129.6
129.2
129.1
126.0
114.7
56.0
45.4
39.5 DMSO-d6
20.9
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
ppm

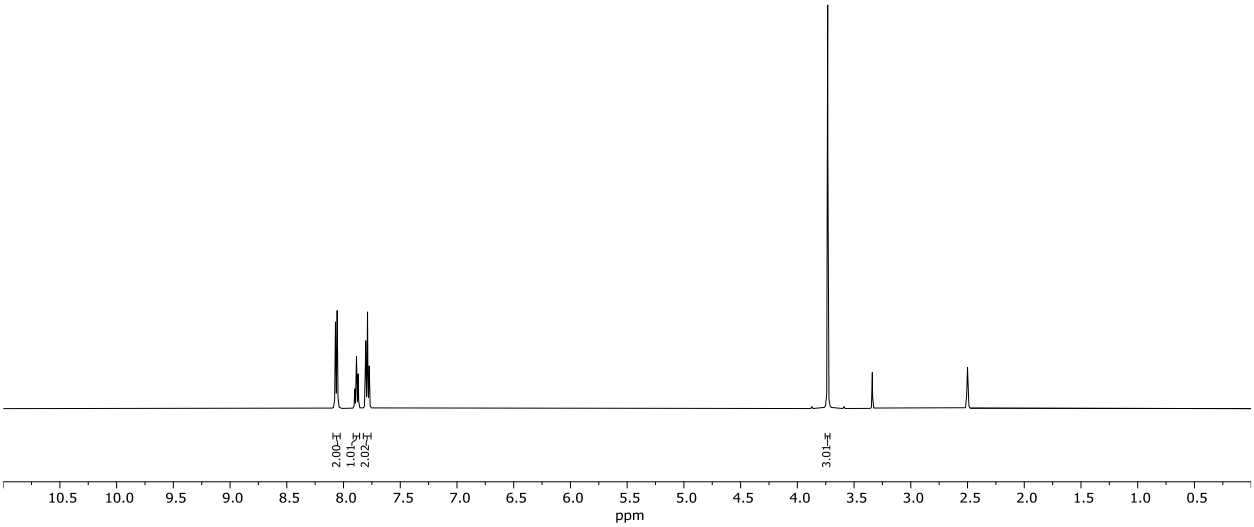


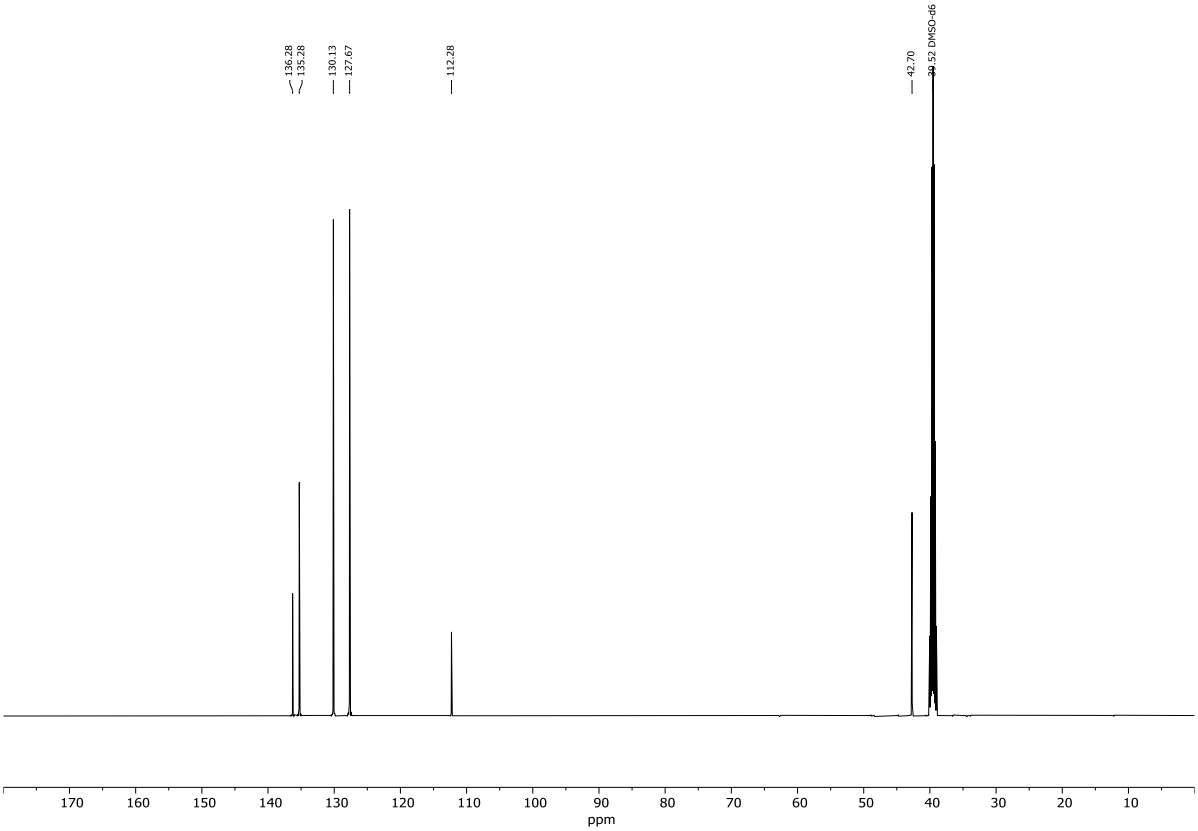
24

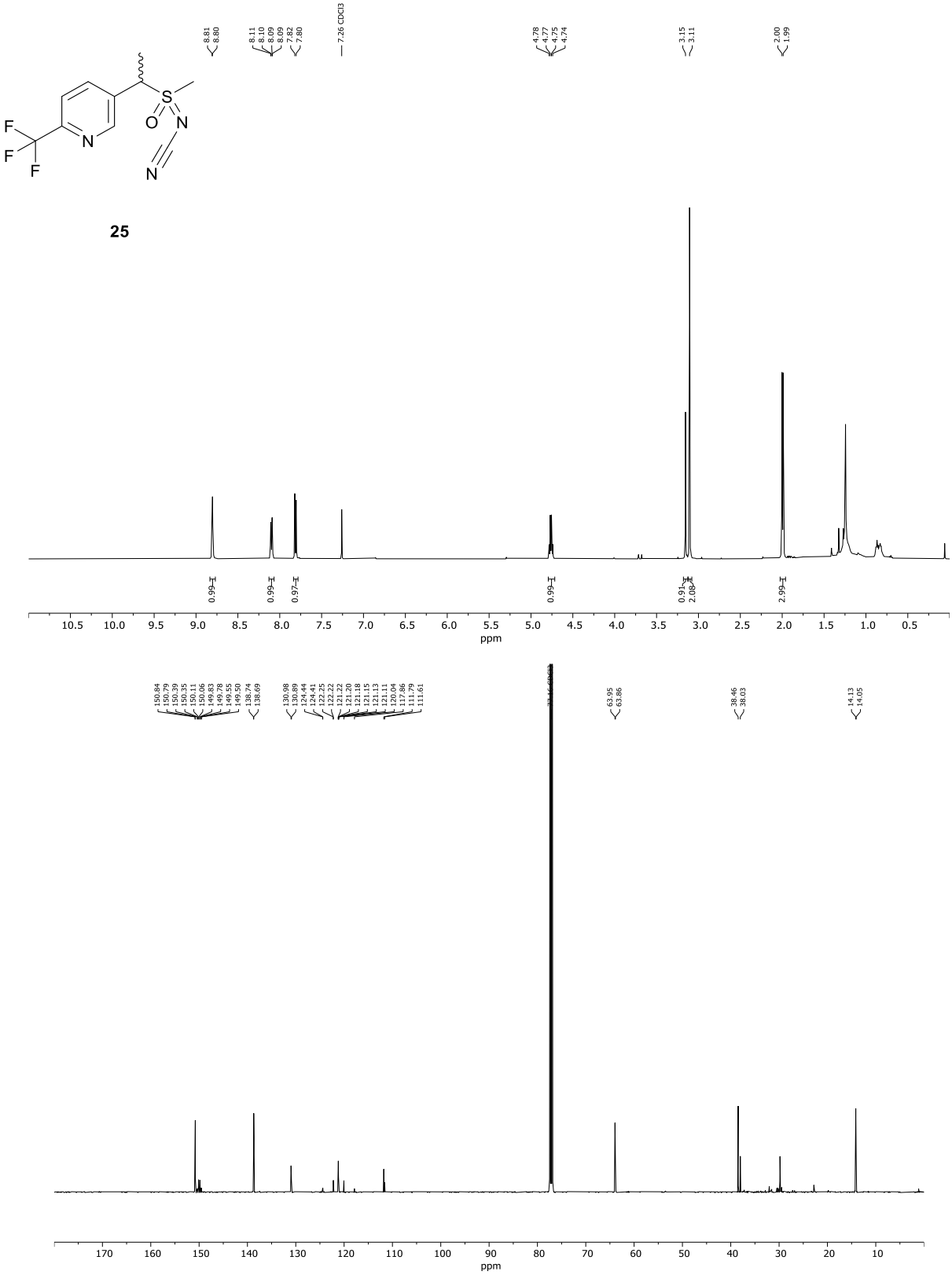

8.07
8.07
8.07
8.06
8.06
8.05
7.90
7.89
7.88
7.87
7.87
7.87
7.80
7.80
7.79
7.78
7.77

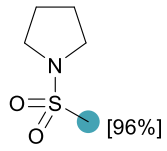
3.73

2.50 DMSO-d6

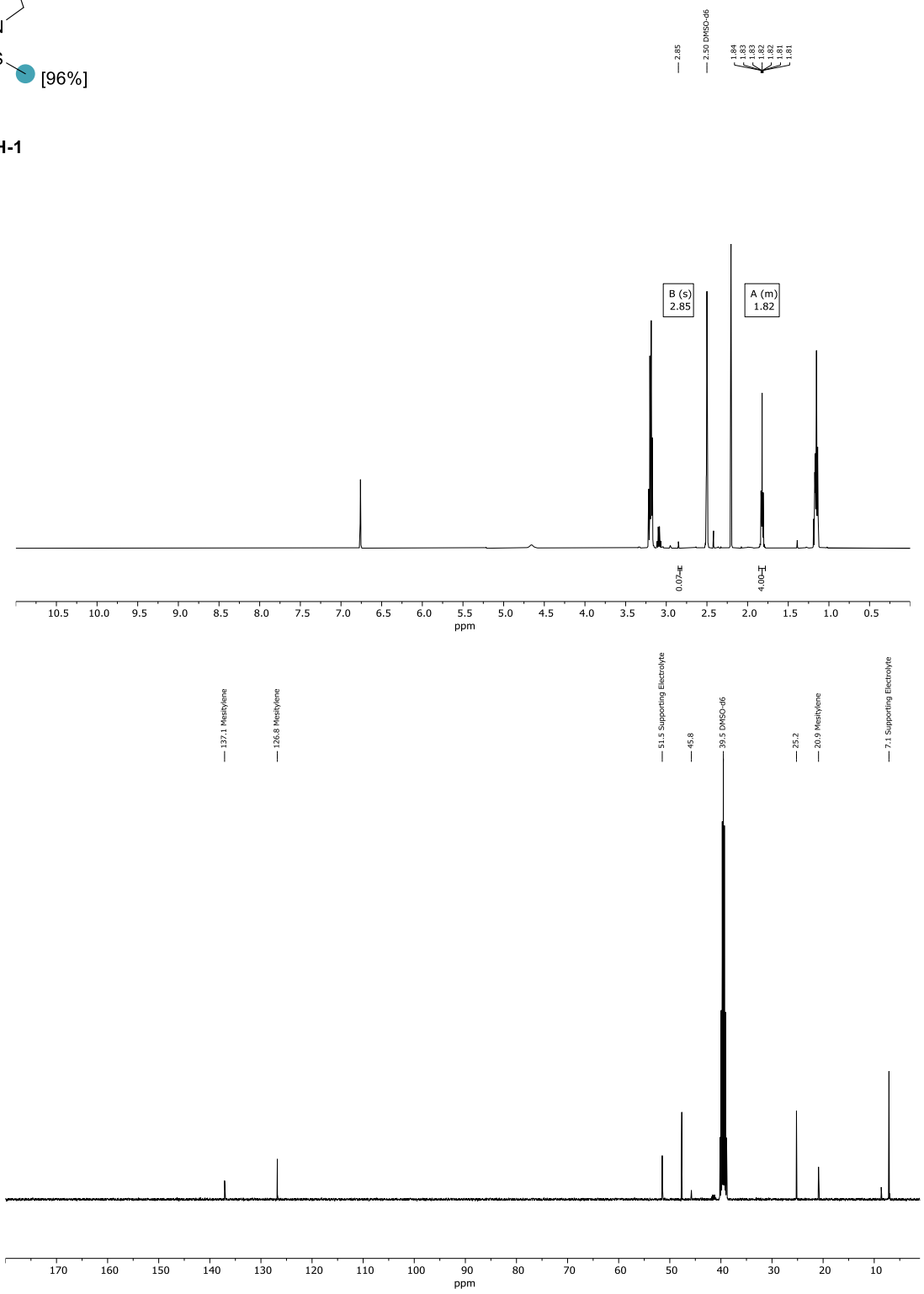

2.00
1.01
2.02
3.01
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm


136.28
135.28
130.13
127.67
112.28
42.70
39.52 DMSO-d6
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
ppm

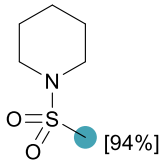

8.81
8.80
8.11
8.10
8.09
8.09
7.82
7.80
7.26 CDCl3
4.78
4.77
4.75
4.74
3.15
3.11
2.00
1.99
F
F
F
N
S
O
N
N
25
0.99
0.99
0.97
0.99
0.91
2.08
2.99
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm
150.84
150.79
150.39
150.35
150.11
150.06
149.83
149.78
149.55
149.50
138.74
138.69
130.98
130.89
124.44
124.41
122.25
122.22
121.22
121.20
121.18
121.15
121.13
121.11
120.04
117.86
111.79
111.61
63.95
63.86
38.46
38.03
14.13
14.05
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
ppm



^{2}H-1

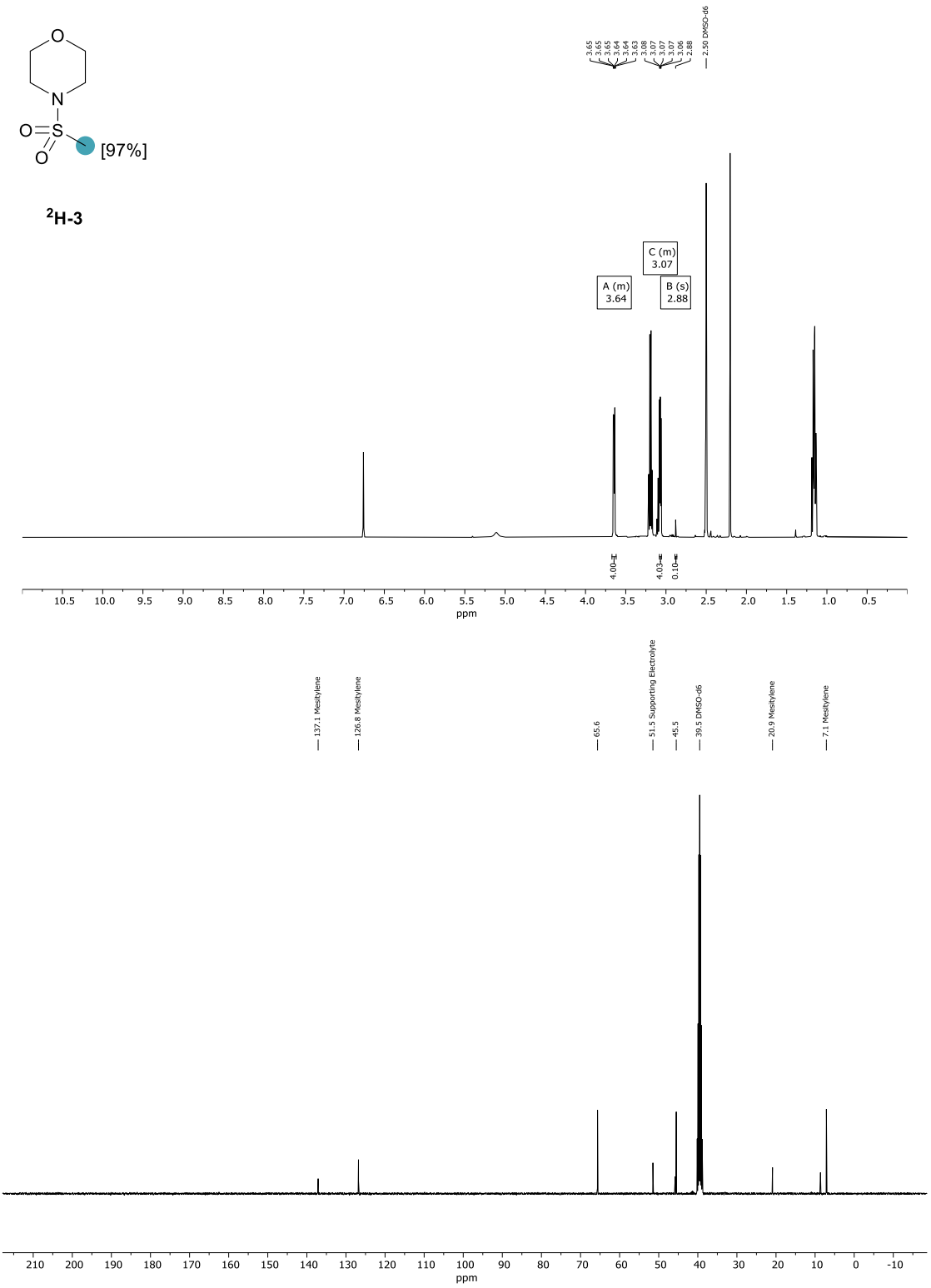


It has to be noted, that the deuterium incorporation of this compound as well as the yield was determined out of the crude reaction mixture via ^{1}H NMR using mesitylene as an internal standard. Therefore, the signals of mesitylene and the supporting electrolyte (NEt_4BF_4) are still present in the ^{1}H NMR and ^{13}C NMR of this compound.

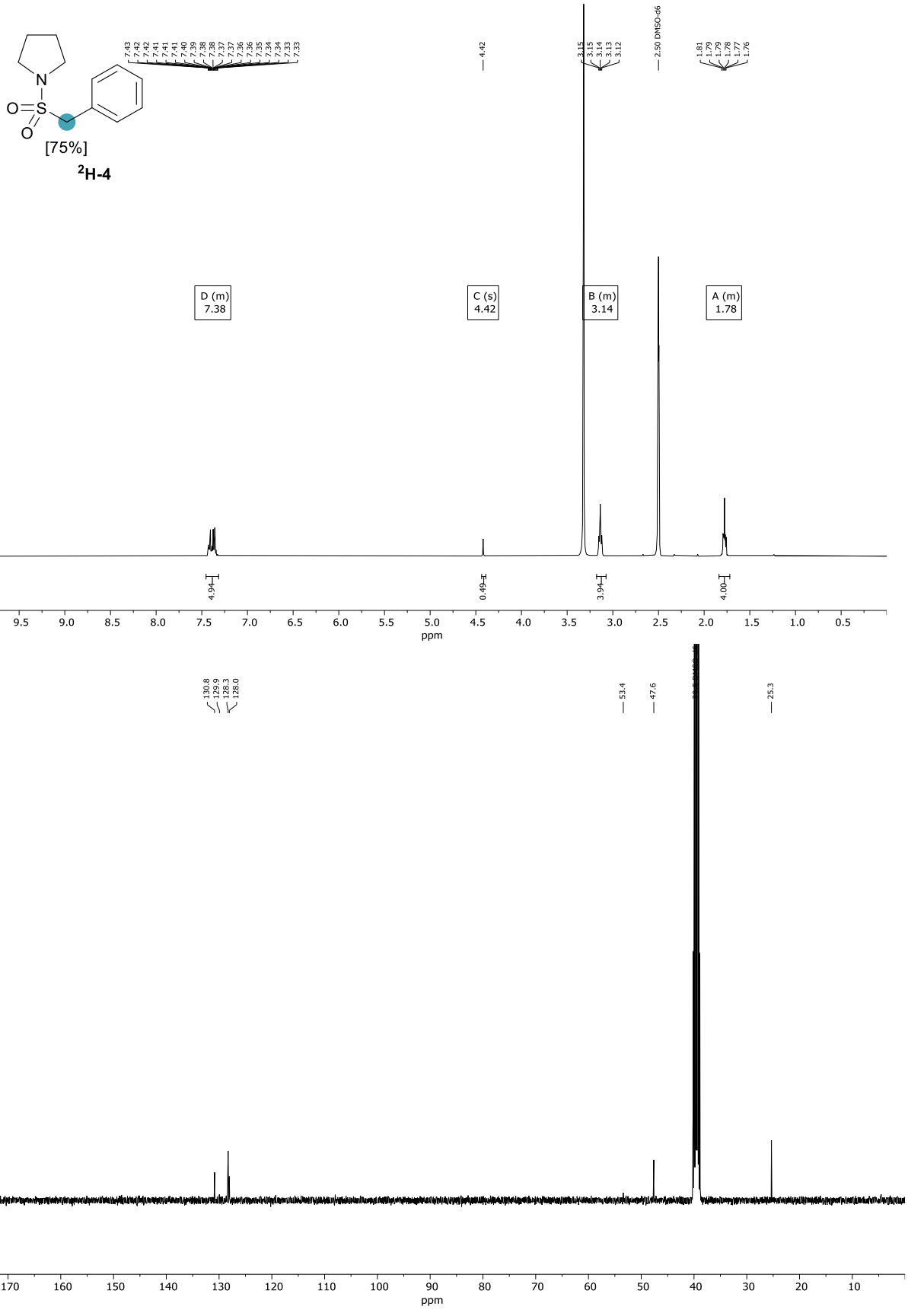


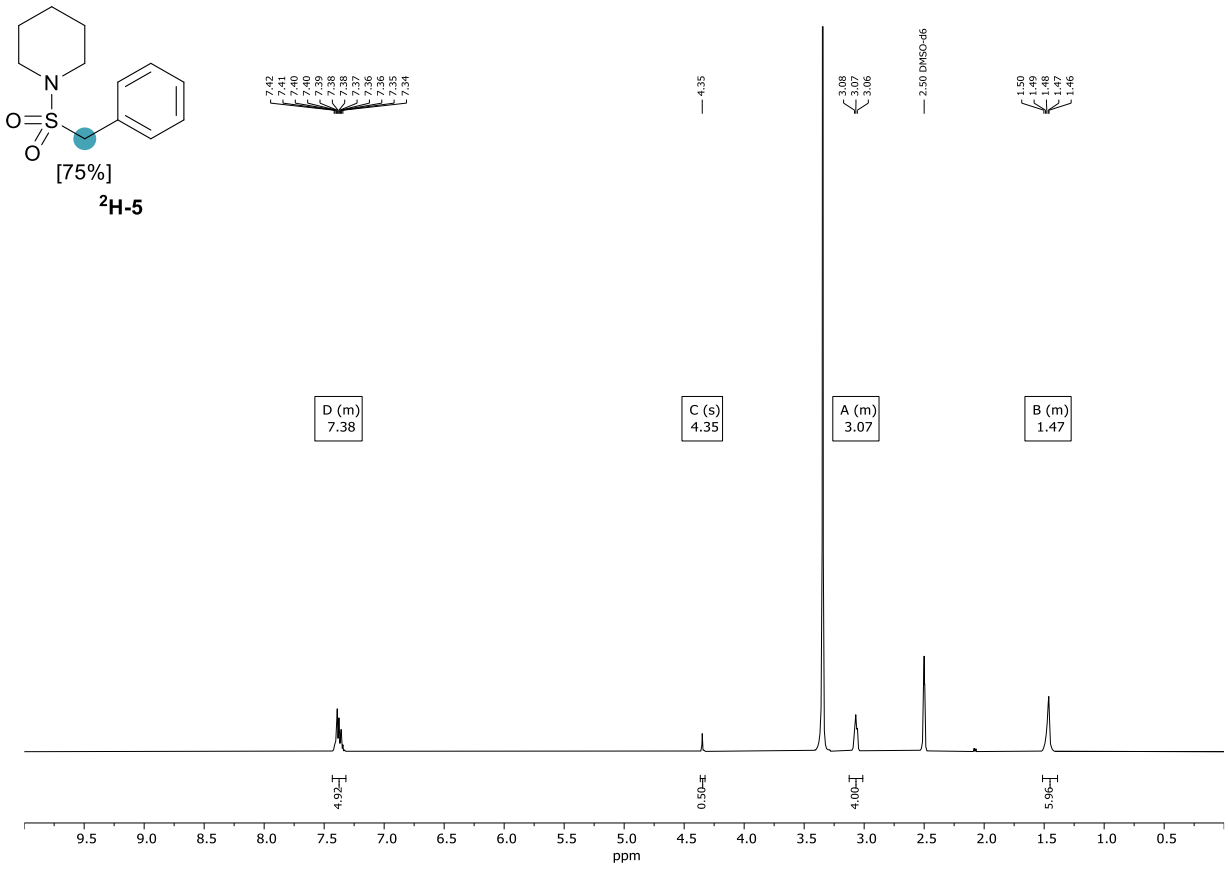
^{2}H-2

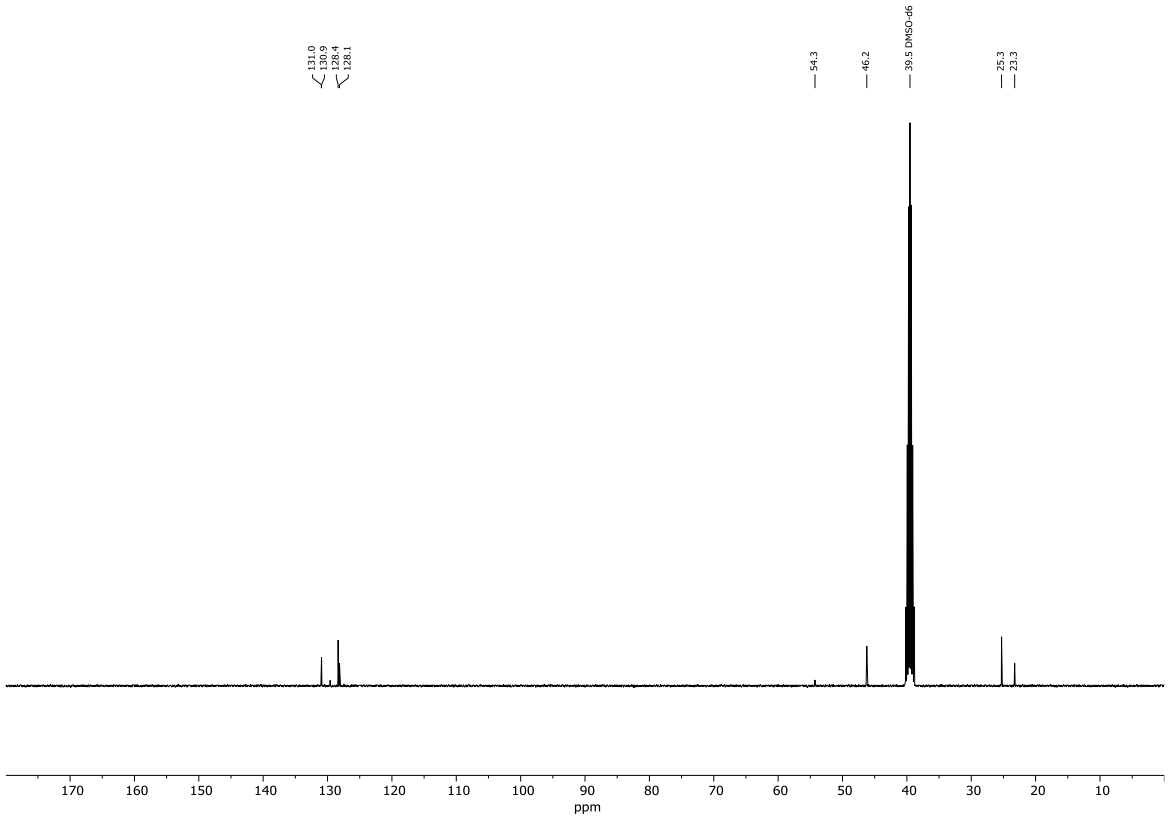
It has to be noted, that the deuterium incorporation of this compound as well as the yield was determined out of the crude reaction mixture via ^{1}H NMR using mesitylene as an internal standard. Therefore, the signals of mesitylene and the supporting electrolyte (NEt_4BF_4) are still present in the ^{1}H NMR and ^{13}C NMR of this compound.

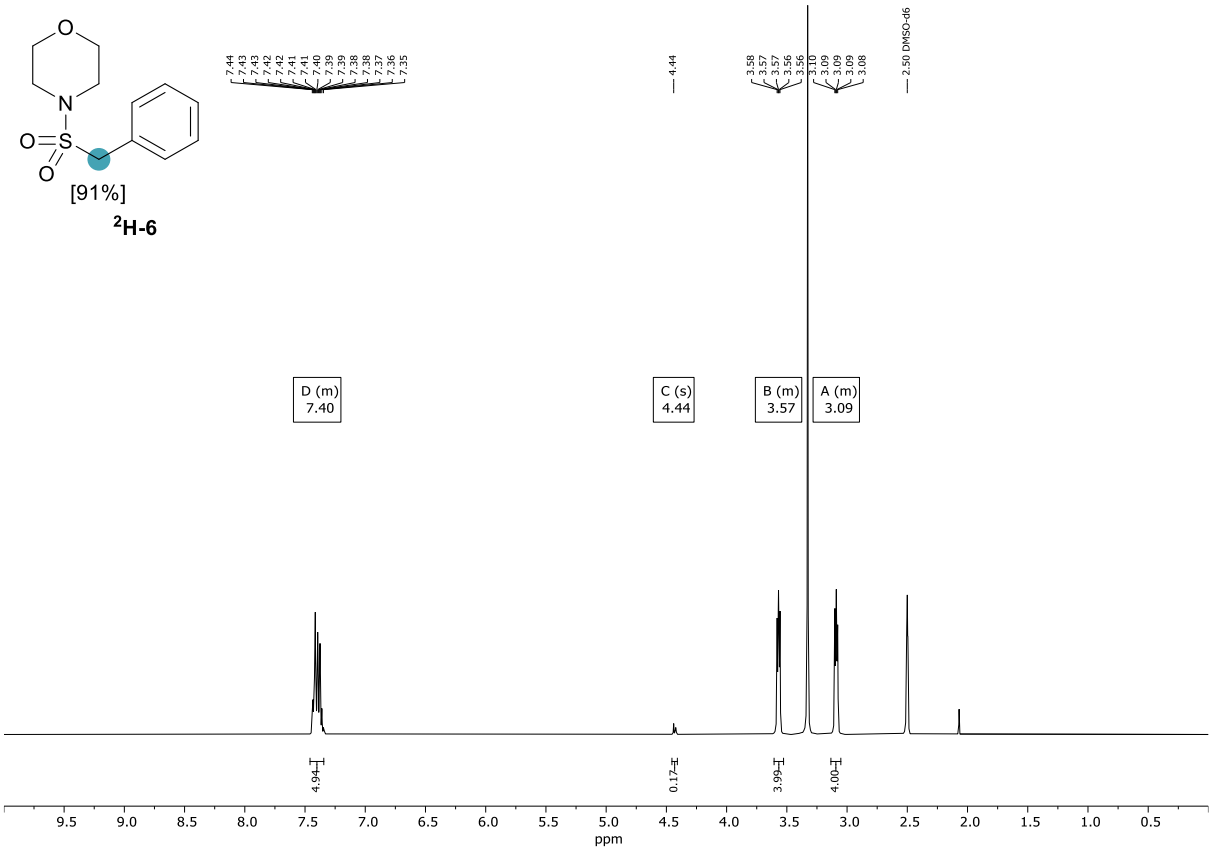


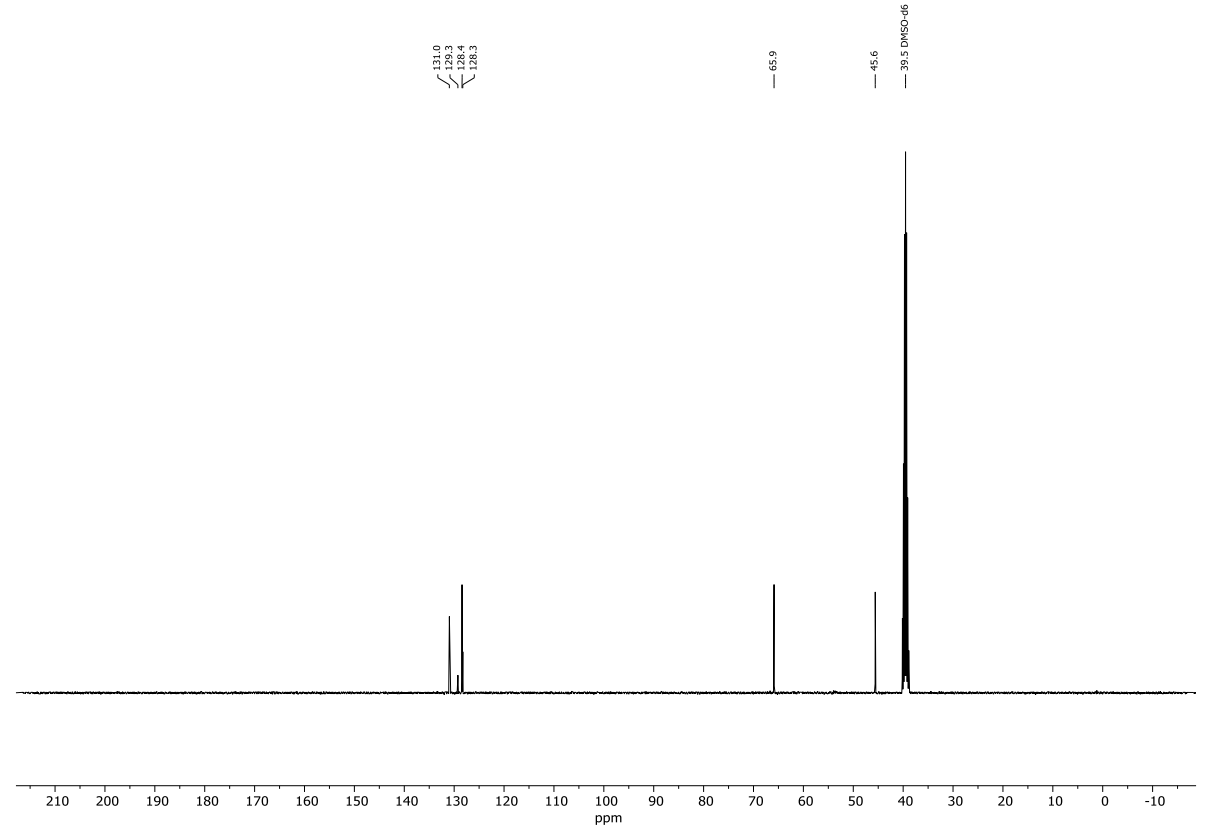
It has to be noted, that the deuterium incorporation of this compound as well as the yield was determined out of the crude reaction mixture via ^{1}H NMR using mesitylene as an internal standard. Therefore, the signals of mesitylene and the supporting electrolyte (NEt_4BF_4) are still present in the ^{1}H NMR and ^{13}C NMR of this compound.

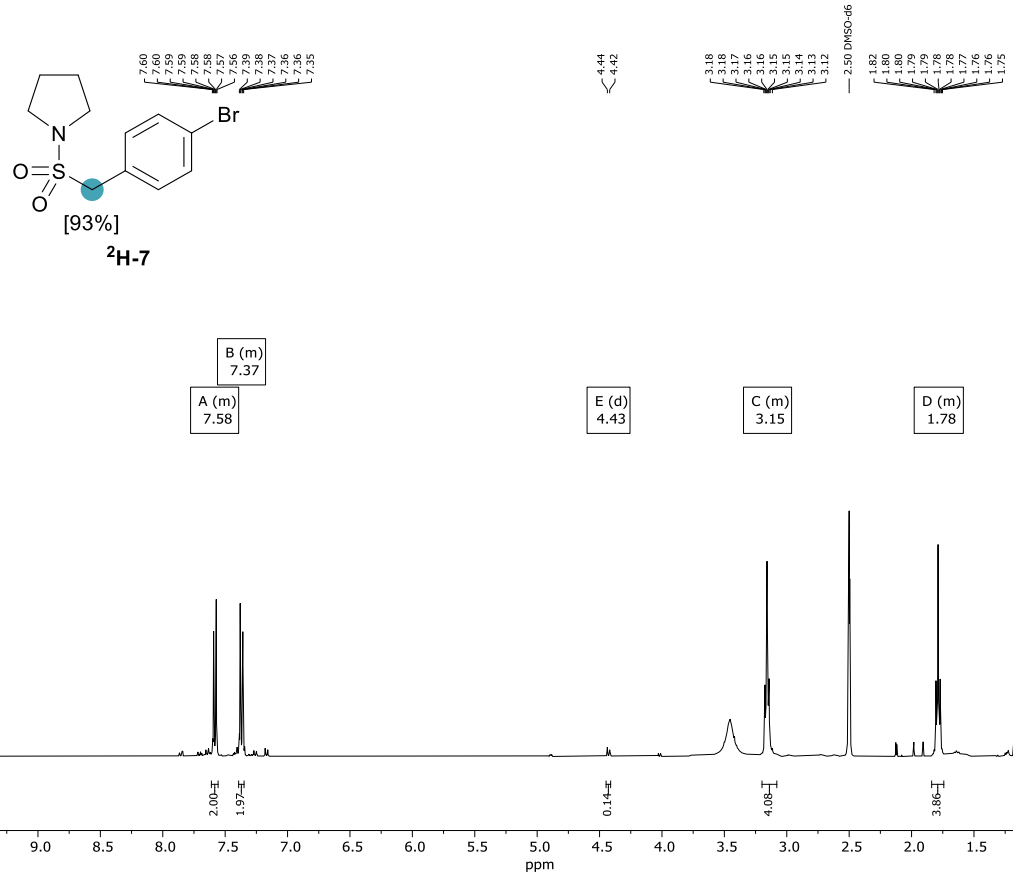

[75%]
^{2}H-4
D (m) 7.38
C (s) 4.42
B (m) 3.14
A (m) 1.78
4.94
0.49
3.94
4.00
ppm
ppm

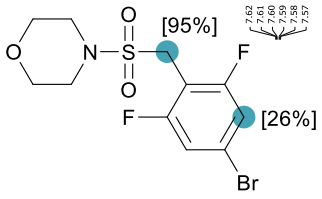

[75%]
^{2}H-5
7.42
7.41
7.40
7.40
7.39
7.38
7.38
7.37
7.36
7.36
7.35
7.34
4.35
3.08
3.07
3.06
2.50 DMSO-d6
1.50
1.49
1.48
1.47
1.46
D (m)
7.38
C (s)
4.35
A (m)
3.07
B (m)
1.47
4.92
0.50
4.00
5.96
ppm


131.0
130.9
128.4
128.1
54.3
46.2
39.5 DMSO-d6
25.3
23.3
ppm


[91%]
^{2}H-6
7.44
7.43
7.43
7.42
7.42
7.41
7.41
7.40
7.39
7.39
7.38
7.38
7.37
7.36
7.35
4.44
3.58
3.57
3.57
3.56
3.56
3.10
3.09
3.09
3.09
3.08
2.50 DMSO-d6
D (m) 7.40
C (s) 4.44
B (m) 3.57
A (m) 3.09
4.94
0.17
3.99
4.00
ppm

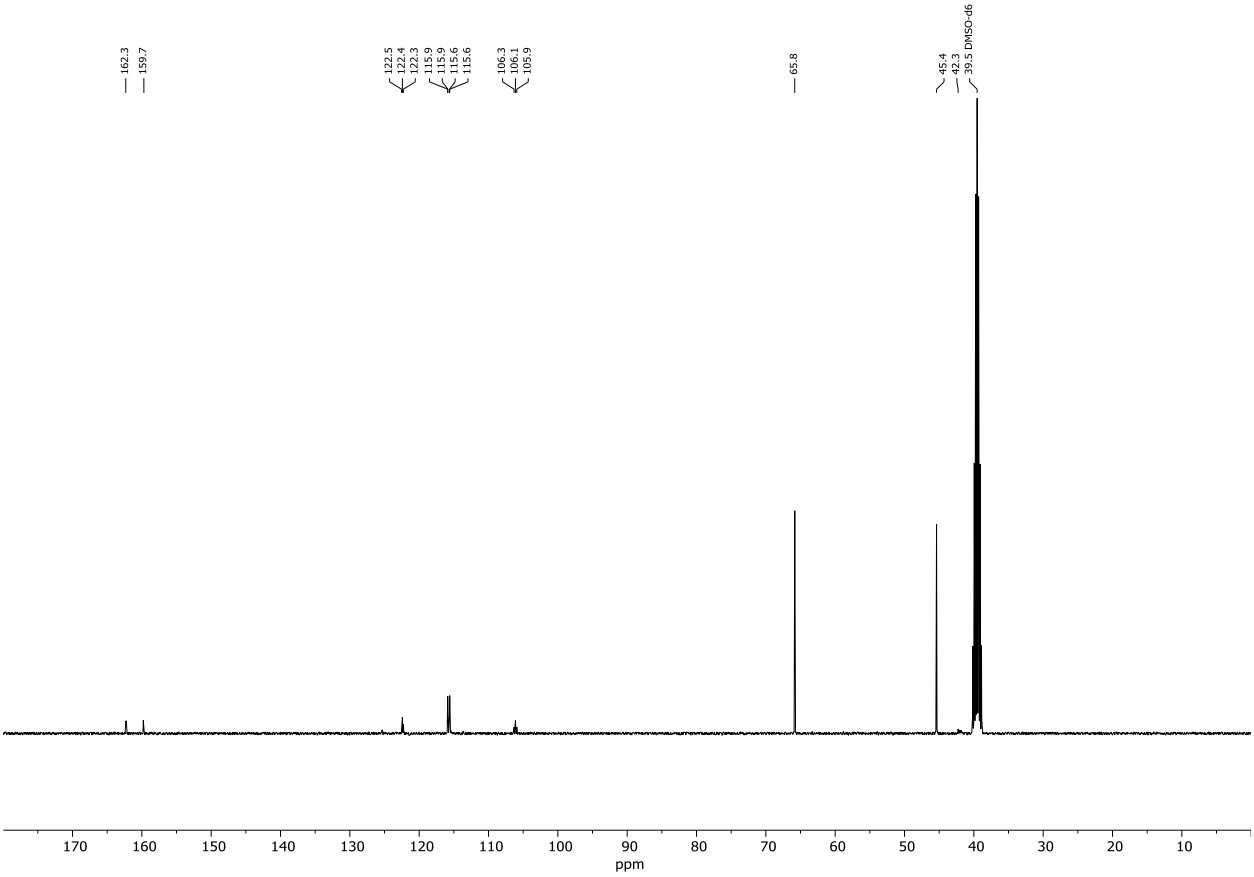

131.0
129.3
128.4
128.3
65.9
45.6
39.5 DMSO-d6
ppm

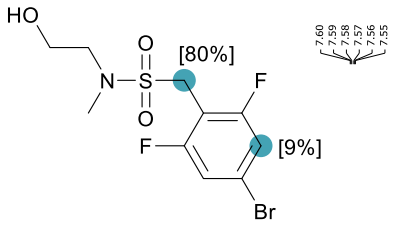

[93%]
^{2}H-7
B (m) 7.37
A (m) 7.58
E (d) 4.43
C (m) 3.15
D (m) 1.78
2.00
1.97
0.14
4.08
3.86
ppm
39.5 DMSO-d6
2.50 DMSO-d6
ppm


O
N
S
O
O
[95%]
F
F
[26%]
Br

^{2}H-8

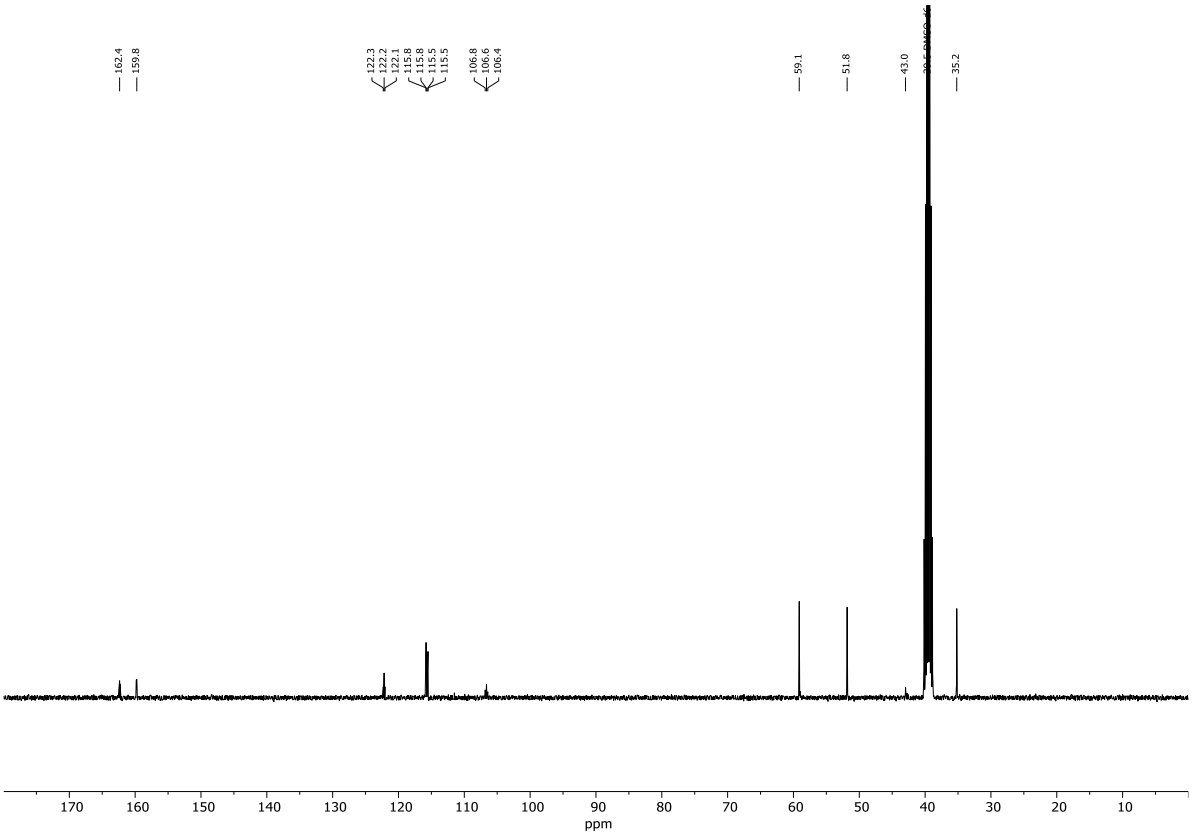
C (m)
7.59
D (d)
4.45
B (m)
3.62
A (m)
3.18
1.47
0.19
3.86
4.00
ppm

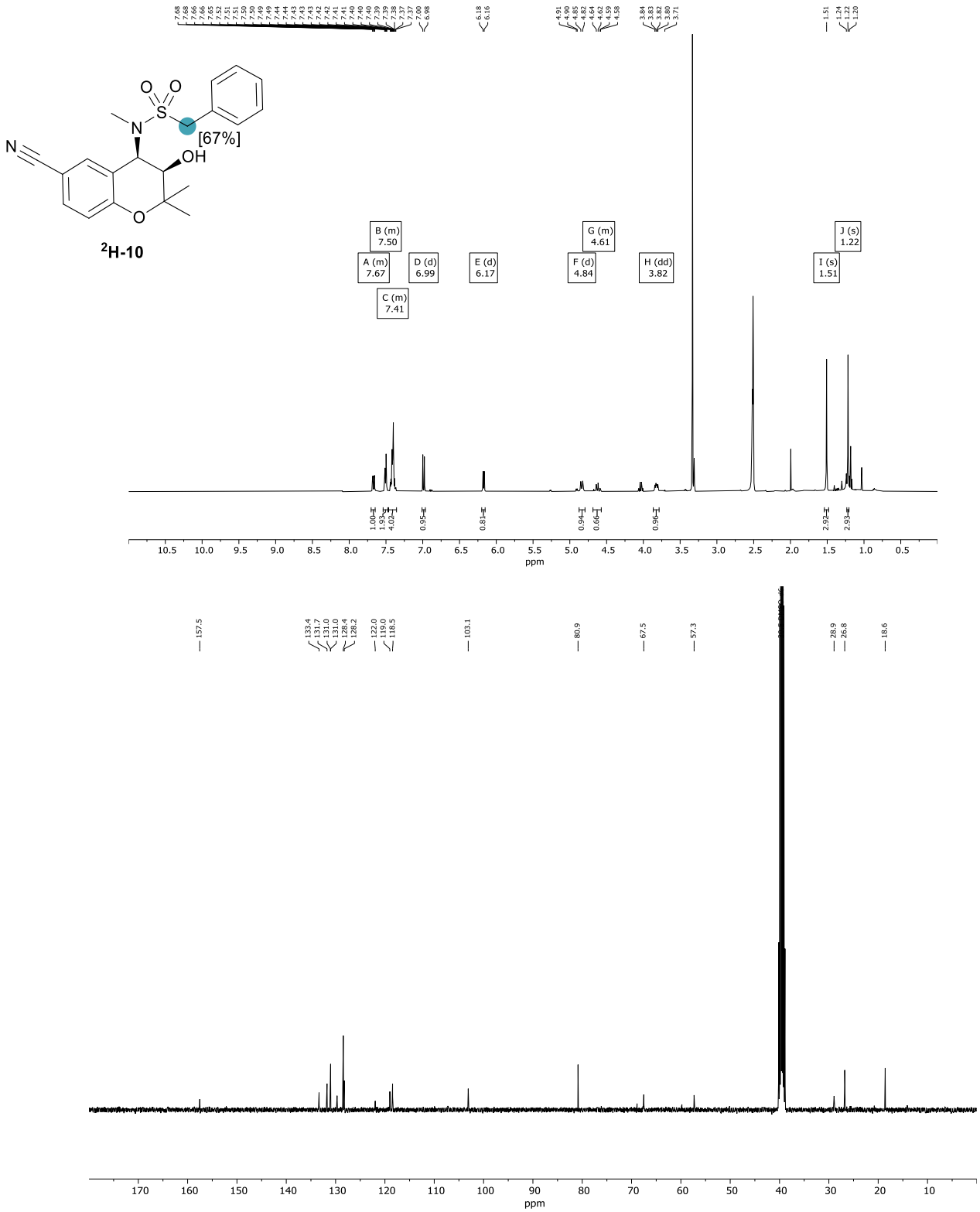

162.3
159.7
122.5
122.4
122.3
115.9
115.9
115.6
115.6
106.3
106.1
105.9
65.8
45.4
42.3
39.5 DMSO-d6
ppm

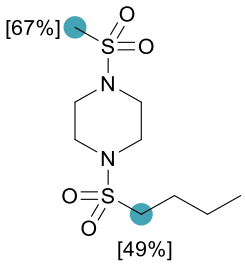

HO
O
N
S
O
[80%]
F
F
[9%]
Br

^{2}H-9

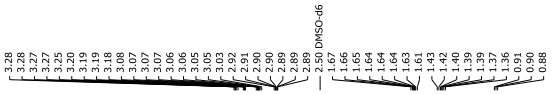
A (m) 7.57
B (t) 4.84
C (d) 4.44
D (q) 3.49
E (t) 3.12
F (s) 2.85
1.72
0.83
0.39
2.00
1.99
2.79
ppm

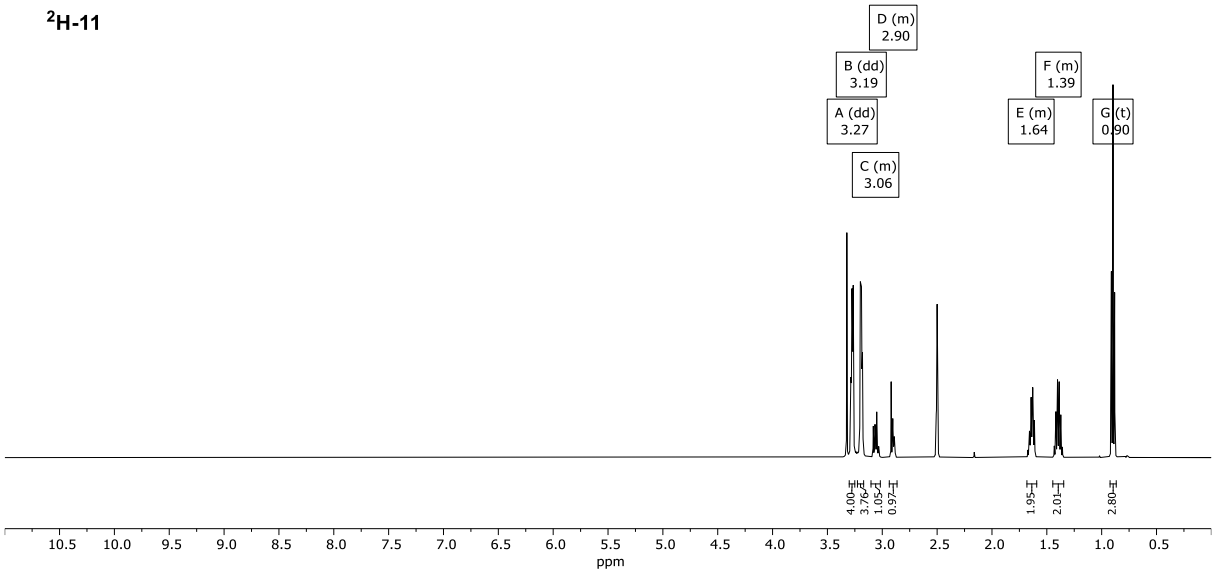

162.4
159.8
122.3
122.2
122.1
115.8
115.8
115.5
115.5
106.8
106.6
106.4
59.1
51.8
43.0
35.2
ppm

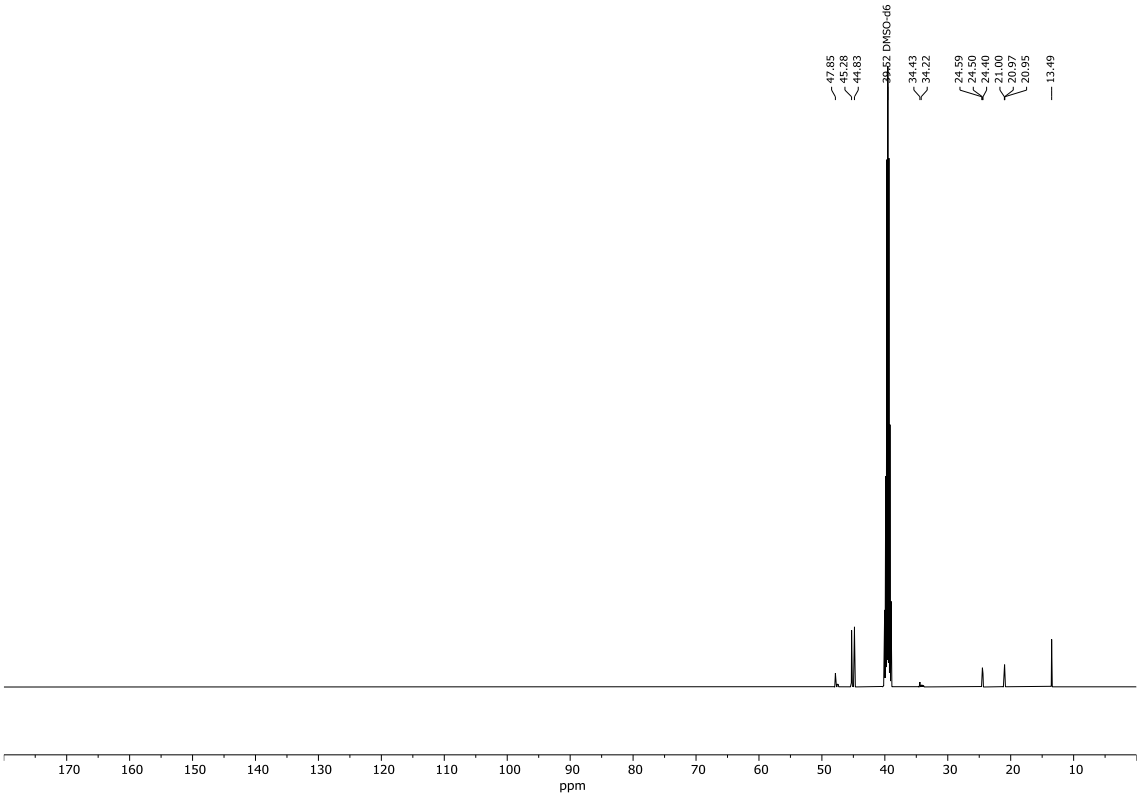

[67%]
OH
^{2}H-10
B (m) 7.50
A (m) 7.67
C (m) 7.41
D (d) 6.99
E (d) 6.17
G (m) 4.61
F (d) 4.84
H (dd) 3.82
J (s) 1.22
I (s) 1.51
ppm

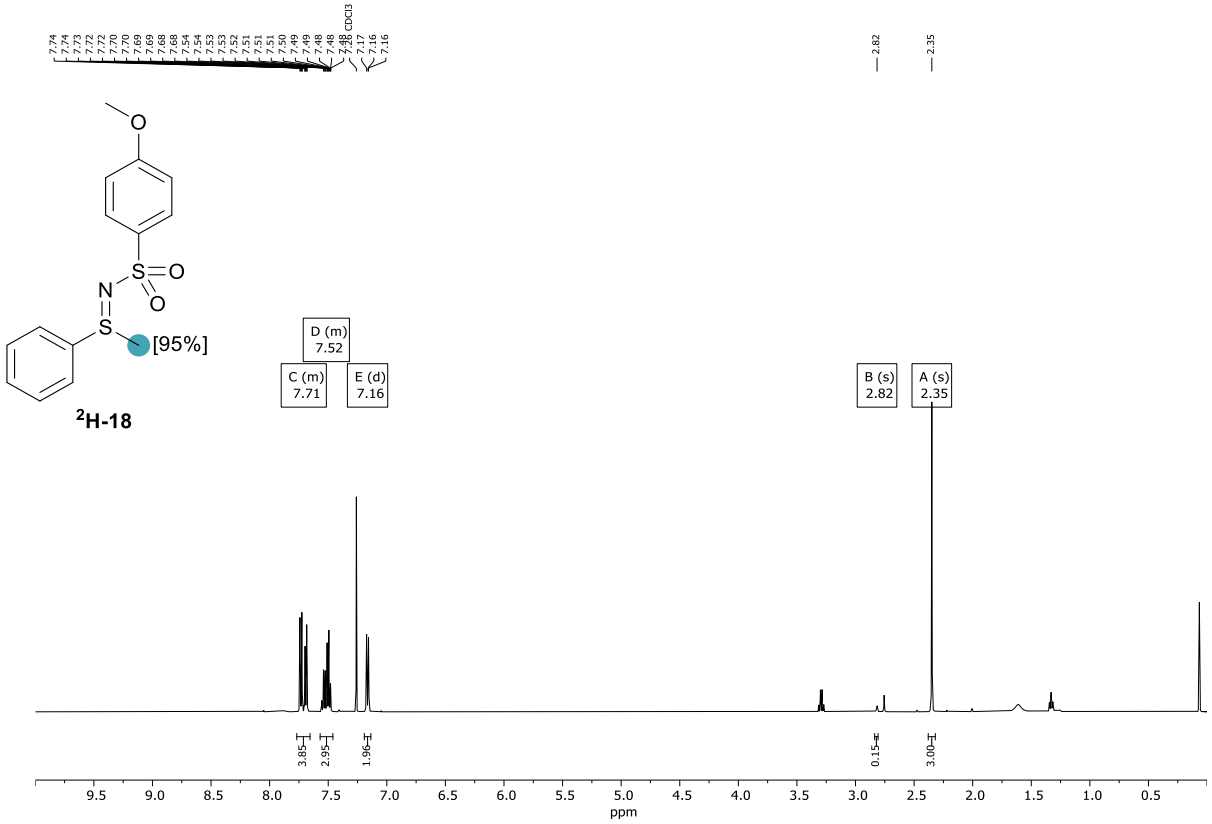

[67%]
O
S
O
N
N
O
S
O
O
[49%]

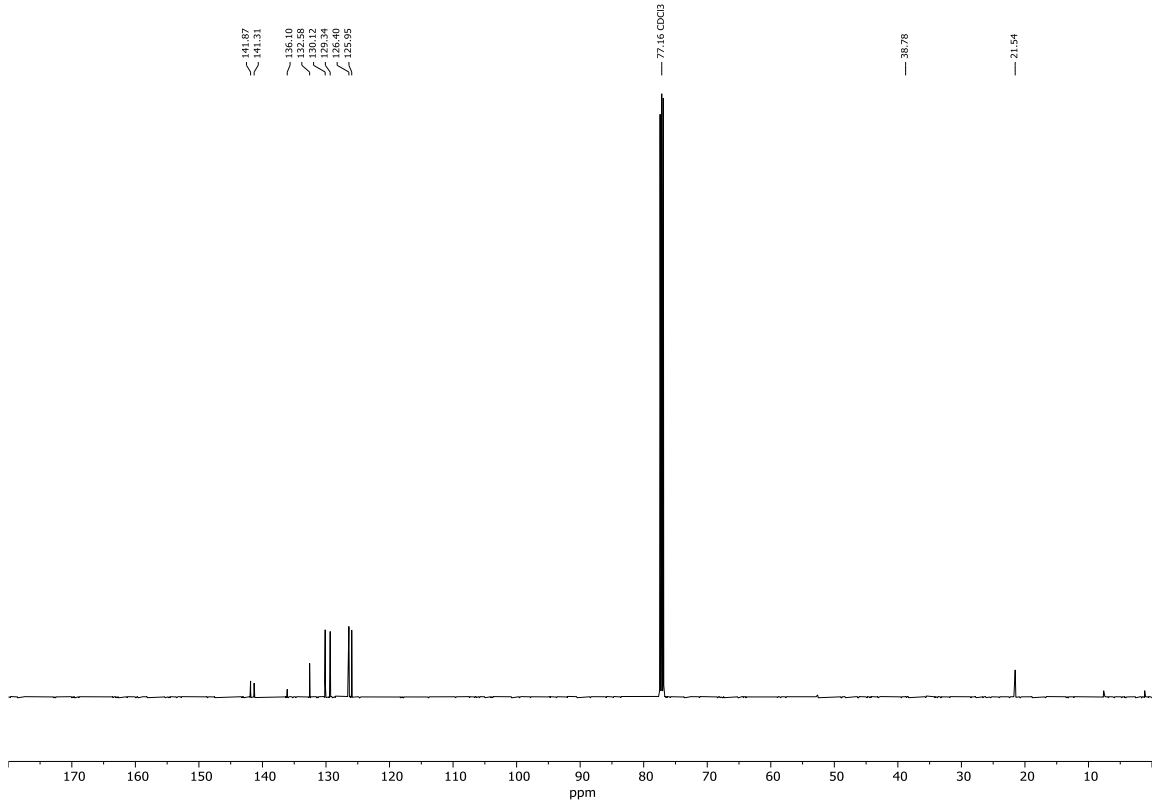
^{2}H-11

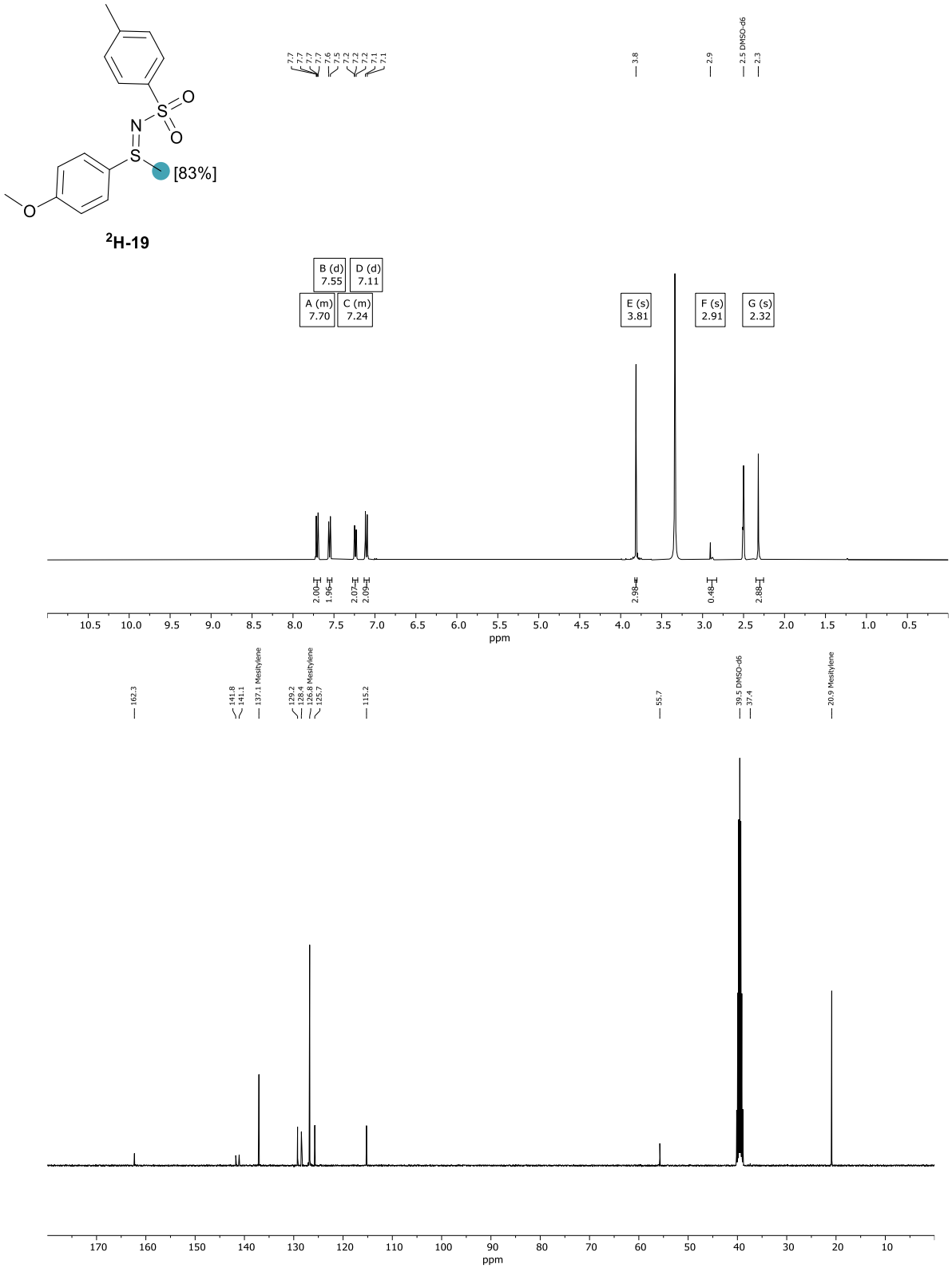

3.28
3.28
3.27
3.27
3.25
3.20
3.19
3.19
3.18
3.08
3.07
3.07
3.07
3.06
3.06
3.05
3.05
3.03
2.92
2.91
2.90
2.90
2.89
2.89
2.50 DMSO-d6
1.67
1.66
1.65
1.64
1.64
1.64
1.63
1.61
1.43
1.42
1.40
1.39
1.39
1.37
1.36
0.91
0.90
0.88


D (m)
2.90
B (dd)
3.19
A (dd)
3.27
C (m)
3.06
F (m)
1.39
E (m)
1.64
G (t)
0.90
4.00
3.76
1.05
0.97
1.95
2.01
2.80
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm

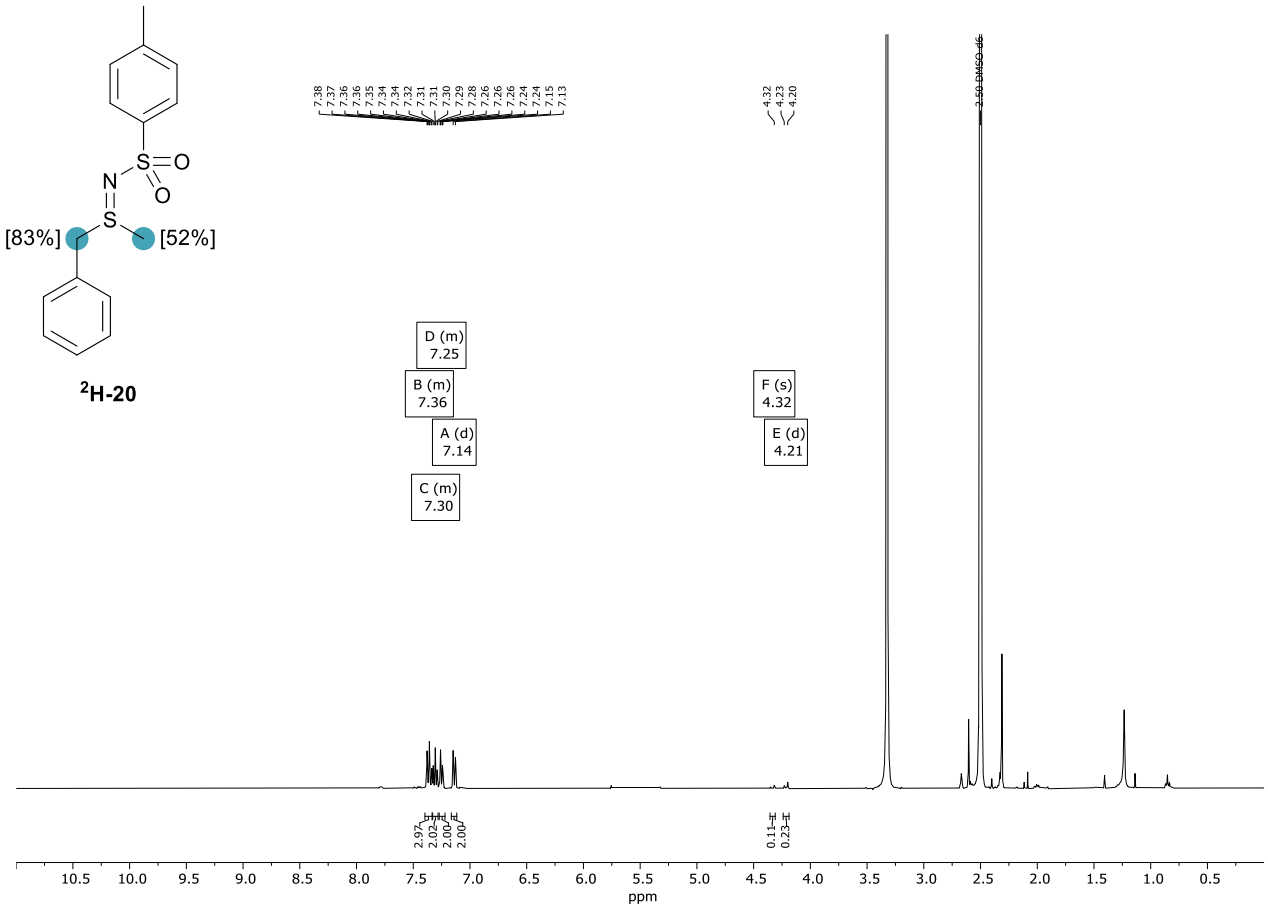

47.85
45.28
44.83
39.52 DMSO-d6
34.43
34.22
24.59
24.50
24.40
21.00
20.97
20.95
13.49
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm


7.74
7.74
7.73
7.72
7.72
7.70
7.70
7.69
7.68
7.68
7.54
7.54
7.53
7.53
7.52
7.51
7.51
7.51
7.50
7.49
7.49
7.48
7.48
CDCl3
7.17
7.16
7.16
2.82
2.35
O
S
O
N
O
S
[95%]
2H-18
D (m)
7.52
C (m)
7.71
E (d)
7.16
B (s)
2.82
A (s)
2.35
3.85
2.95
1.96
0.15
3.00
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm

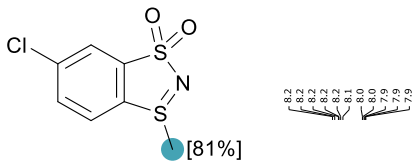

141.87
141.31
136.10
132.58
130.12
129.34
128.40
125.95
77.16 CDCl3
38.78
21.54
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm



The isolated yield was cross-checked by using mesitylene as an NMR standard. Therefore, the ^{13}C NMR shows the signals of mesitylene.



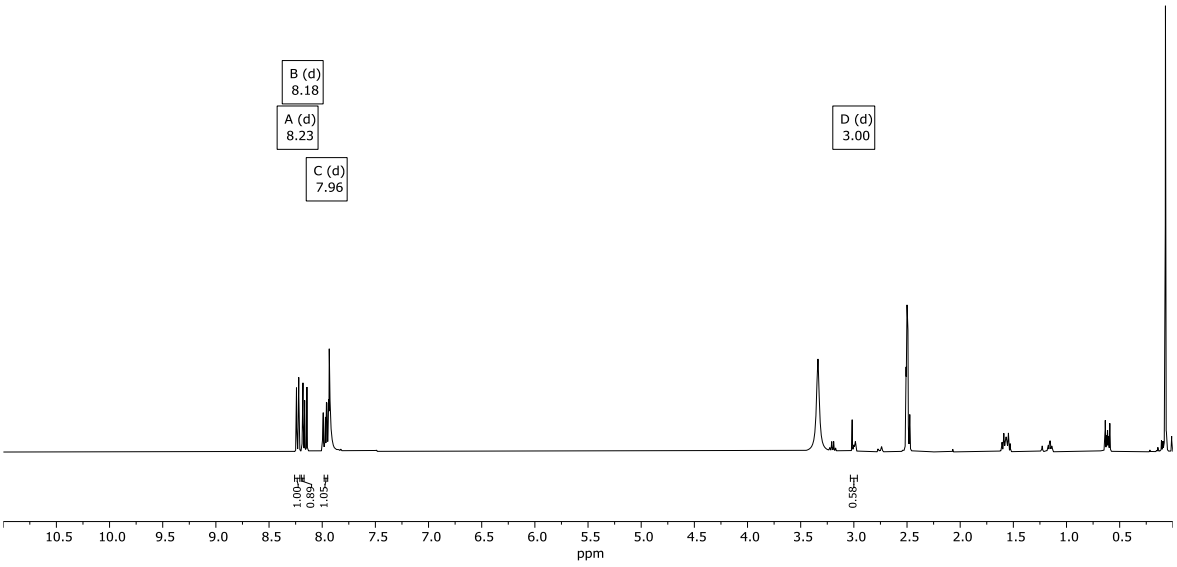
It has to be noted, that this compound was only isolated in traces. Therefore, a ^{13}C NMR of the compound could not be obtained.

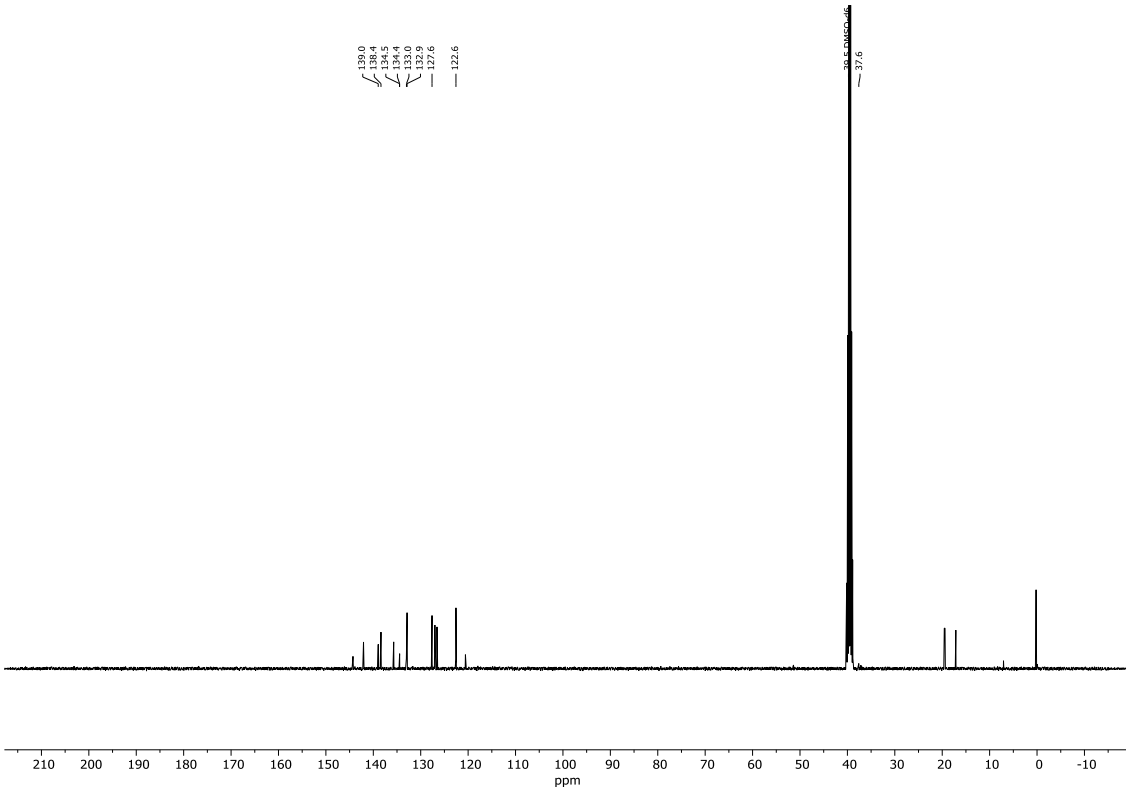

O
O
Cl
S
N
S
[81%]

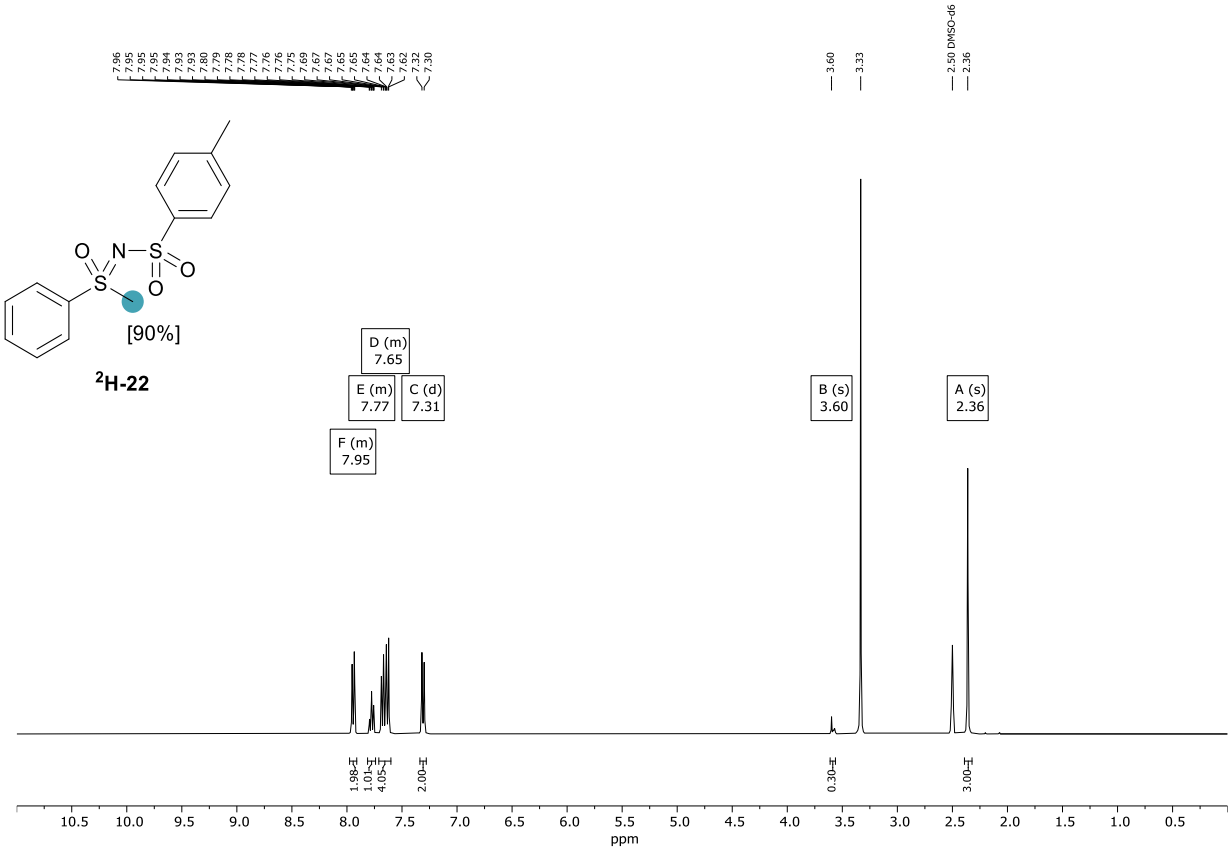
^{2}H-21

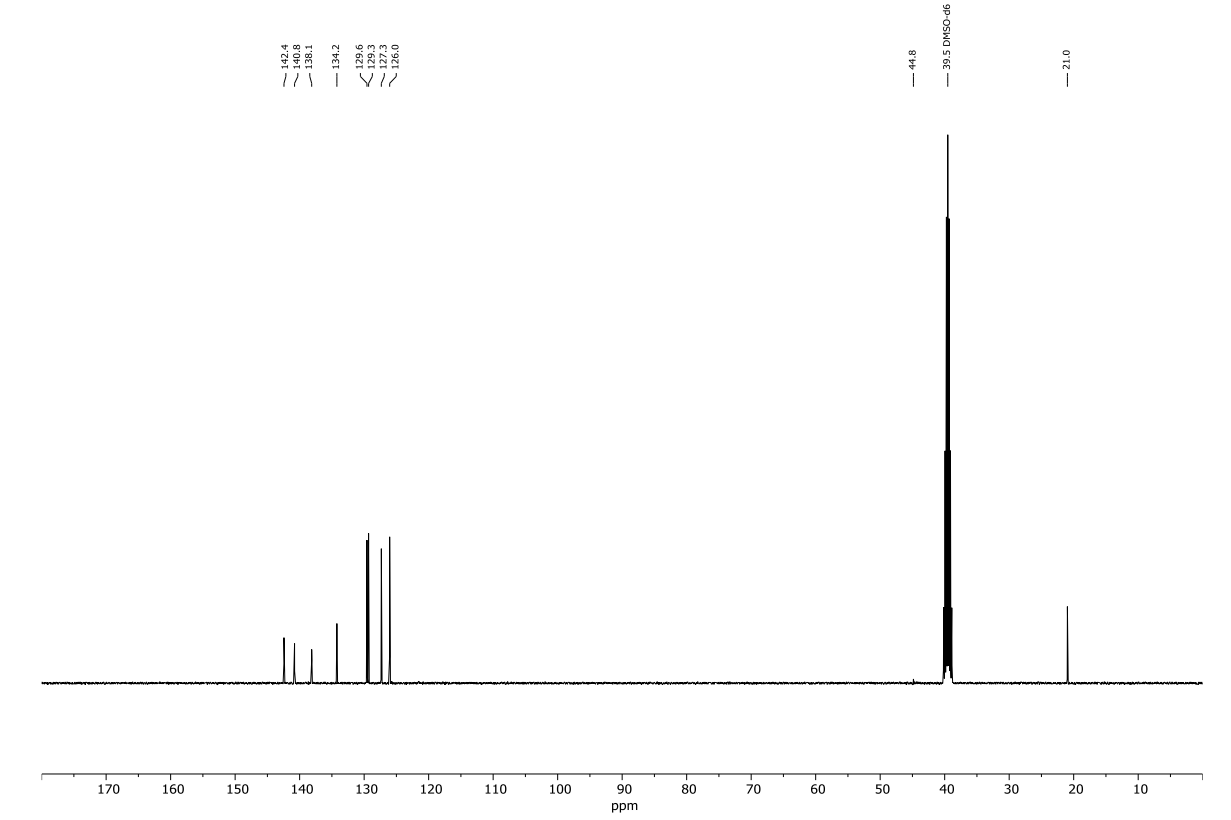
8.2
8.2
8.2
8.2
8.2
8.1
8.0
8.0
7.9
7.9
7.9
7.9

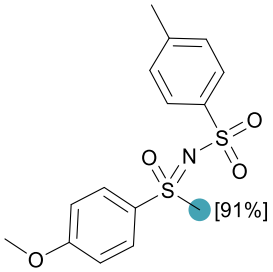

3.0
3.0
2.5 DMSO-d6


B (d)
8.18
A (d)
8.23
C (d)
7.96
D (d)
3.00
1.00
0.89
1.05
0.58
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm


139.0
138.4
134.5
134.4
133.0
132.9
127.6
122.6
39.5 DMSO-d6
37.6
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm

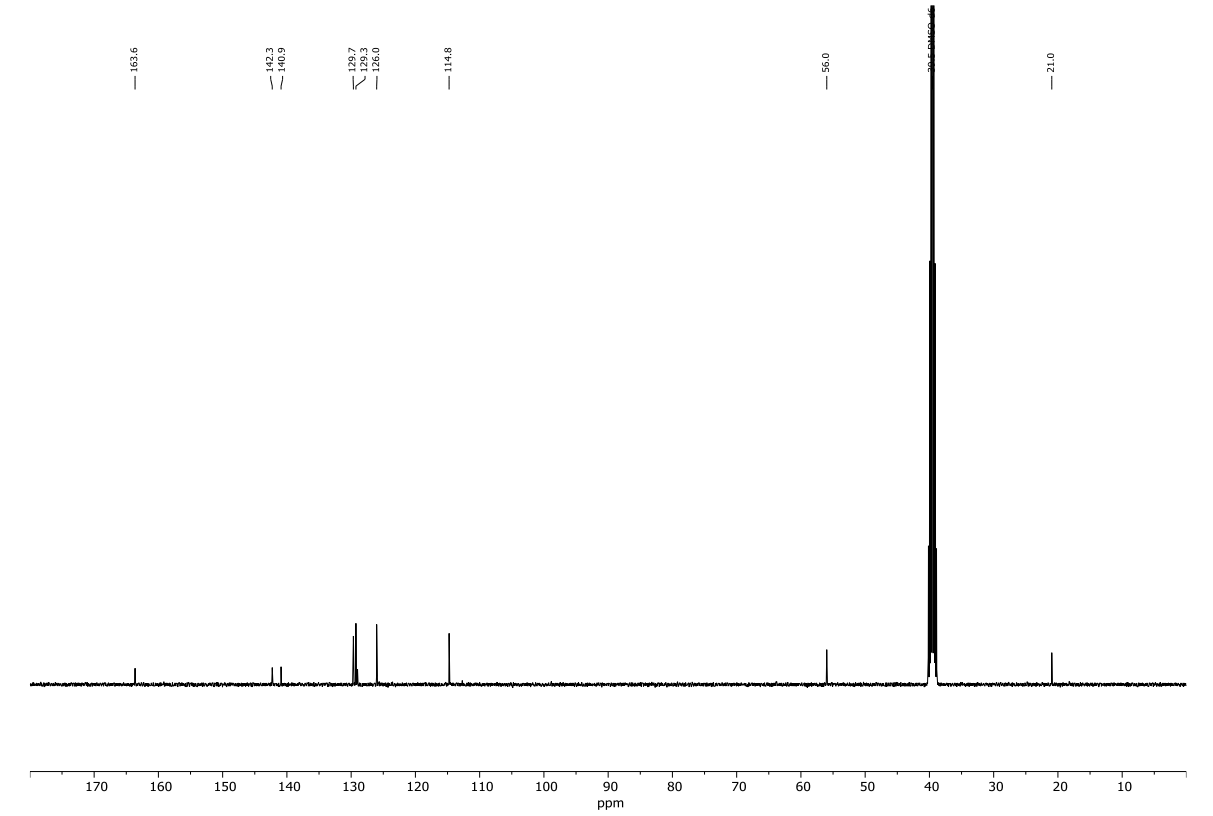

7.96
7.95
7.95
7.95
7.94
7.93
7.93
7.80
7.79
7.78
7.78
7.77
7.76
7.76
7.75
7.69
7.67
7.67
7.65
7.65
7.64
7.64
7.63
7.62
7.32
7.30
3.60
3.33
2.50 DMSO-d6
2.36
O
N
S
O
S
O
O
[90%]
^{2}H-22
D (m)
7.65
E (m)
7.77
C (d)
7.31
F (m)
7.95
B (s)
3.60
A (s)
2.36
1.98
1.01
4.05
2.00
0.30
3.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm

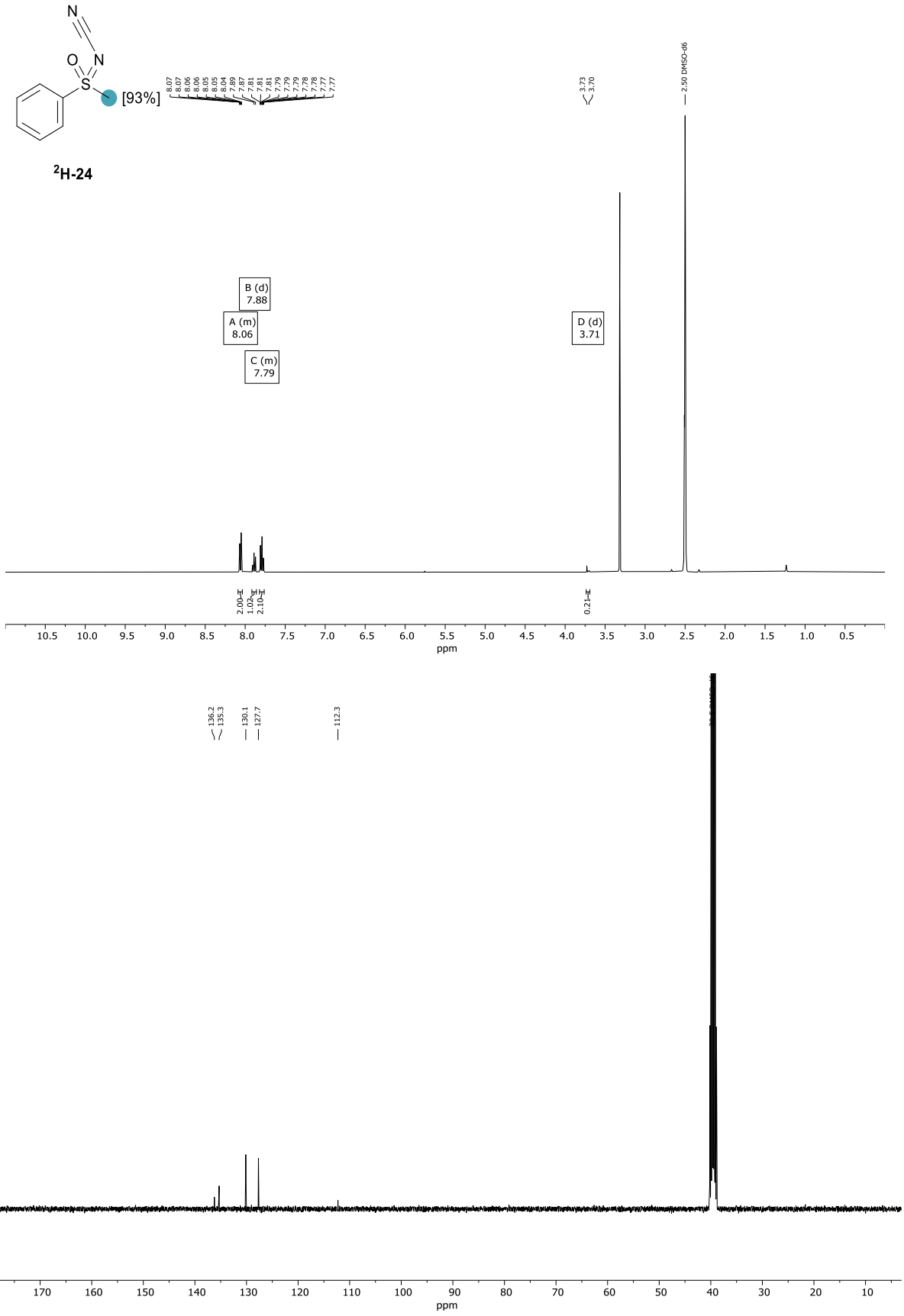

142.4
140.8
138.1
134.2
129.6
129.3
127.3
126.0
44.8
39.5 DMSO-d6
21.0
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm


O
S
O
N
O
S
O
[91%]
O

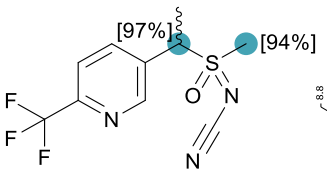
^{2}H-23

7.9
7.8
7.6
7.6
7.3
7.3
7.2
7.2
7.2
7.2
3.9
3.5
3.5
3.5
2.5 DMSO-d6
2.4
B (d) 7.62
D (m) 7.17
A (d) 7.84
C (d) 7.30
F (d) 3.53
E (s) 3.87
G (s) 2.36
2.00
2.00
2.02
1.99
3.00
0.26
2.97
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
ppm


163.6
142.3
140.9
129.7
129.3
126.0
114.8
56.0
39.5 DMSO-d6
21.0
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
ppm

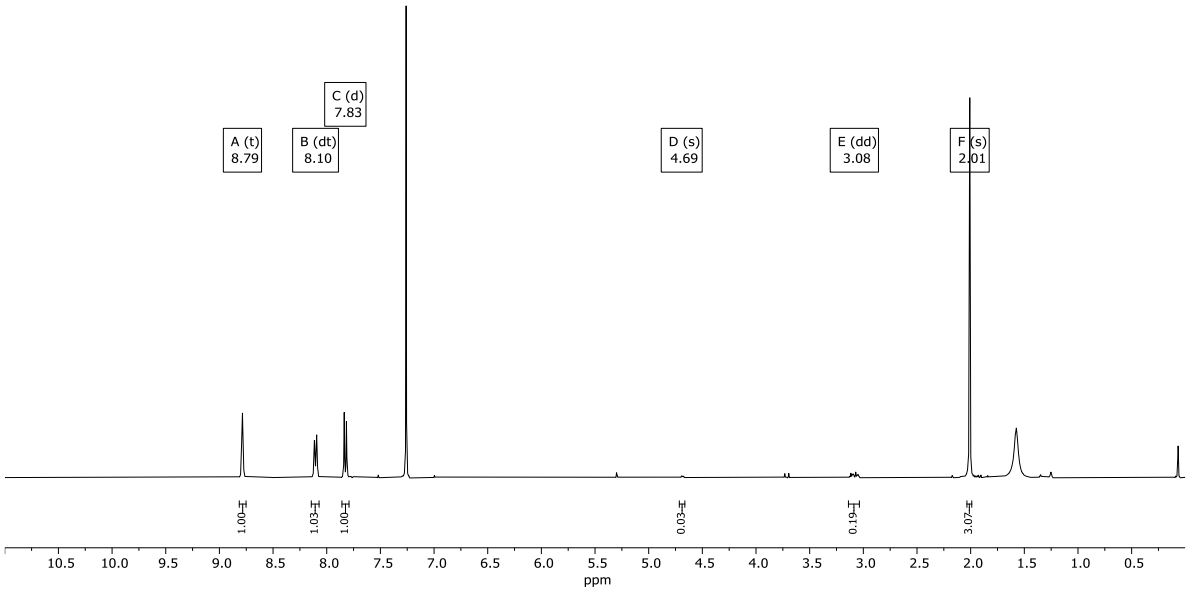

[93%]
8.07
8.07
8.06
8.06
8.05
8.05
8.04
7.89
7.87
7.81
7.81
7.79
7.79
7.79
7.78
7.78
7.77
7.77
3.73
3.70
2.50 DMSO-d6
B (d)
7.88
A (m)
8.06
C (m)
7.79
D (d)
3.71
2.00
1.02
2.10
0.21
ppm
136.2
135.3
130.1
127.7
112.3
ppm

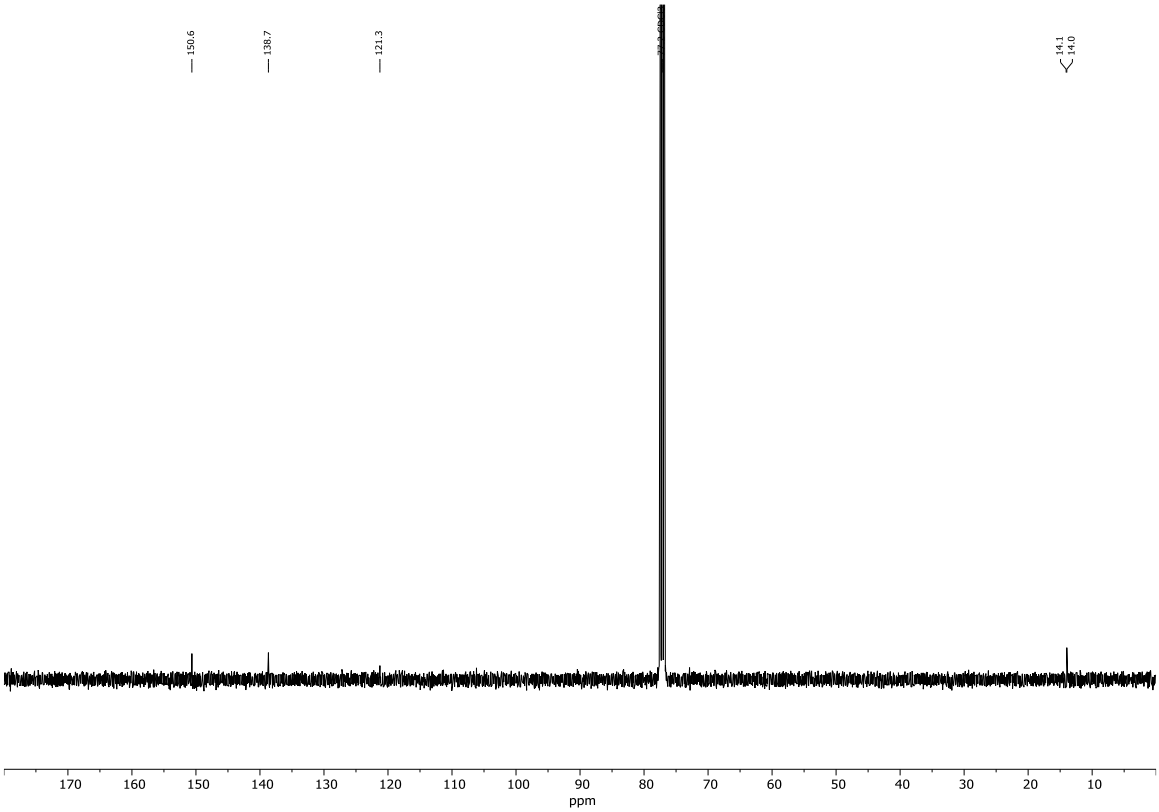
^{2}H-24


[97%]
[94%]
S
O
N
F
F
F
N
N


8.8
8.8
8.8
8.1
8.1
8.1
8.1
8.1
7.8
7.8
7.3 CDCl3
4.7
3.1
3.1
3.1
3.1
2.0
2.0

^{2}H-25


A (t)
8.79
B (dt)
8.10
C (d)
7.83
D (s)
4.69
E (dd)
3.08
F (s)
2.01
1.00
1.03
1.00
0.03
0.19
3.07
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm


150.6
138.7
121.3
14.1
14.0
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

8 References

1 C. C. Gruber, G. Oberdorfer, C. V. Voss, J. M. Kremsner, C. O. Kappe and W. Kroutil, *J. Org. Chem.,* 2007, **72**, 5778.

2 G. Zhou, P. Ting, R. Aslanian and J. J. Piwinski, *Org. Lett.,* 2008, **10**, 2517.

3 M. Klein, D. L. Troglauer and S. R. Waldvogel, *JACS Au,* 2023, **3**, 575.

4 A.-K. Seitz, P. J. Kohlpaintner, T. van Lingen, M. Dyga, F. Sprang, M. Zirbes, S. R. Waldvogel and L. J. Gooßen, *Angew. Chem., Int. Ed.,* 2022, **61**, e202117563.

5 M. Klein and S. R. Waldvogel, *Angew. Chem., Int. Ed.,* 2021, **60**, 23197.

6 S. Arndt, D. Weis, K. Donsbach and S. R. Waldvogel, *Angew. Chem., Int. Ed.,* 2020, **59**, 8036.

7 M. L. Childers, C. Dinsmore, P. H. Fuller, D. J. Guerin, J. D. Katz, Q. Pu, M. E. Scott, T. C. F., H. Zhang, J. Cai, X. Du, C. Wang, N. Kong and Y. Liu*, Vol. WO2014146246A1* (Ed.: WIPO), China, **2014**.

8 Z. Xiong, C. Pei, P. Xue, H. Lv and X. Zhang, *Chem. Commun.,* 2018, **54**, 3883.

9 J. L. García Ruano, A. Parra, L. Marzo, F. Yuste and V. M. Mastranzo, *Tetrahedron,* 2011, **67**, 2905.

10 S. Chung and J. Kim, *Tetrahedron Lett.,* 2019, **60**, 792.