Supporting Information part 1

Significantly improved Radiochemical Yields in gaseous Tritium Reactions by Iridium(I)-catalyzed Hydrogen Isotope Exchange

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Table of content

1. General Information

All substrates and solvents were obtained from commercial suppliers and used without further purification. All deuteration reactions were carried out on a RC Tritec® manifold shown below:

The distribution of hydrogen isotopes and the degree of deuterium incorporation in the substrates was determined by a liquid chromatography mass spectrometry (LC-MS) system with a Symmetry Shield RP18 column, 3.9 x 150 mm, with a gradient program. LC column conditions were as follows: mobile phase A: water (900 mL), acetonitrile (100 mL), TFA (1 mL) mobile phase B: water (100 mL), acetonitrile (900 mL), TFA (0.75 mL), Flow rate: 0.6 mL/min; Detection: UV 254 nm and UV 210 nm. The regioselectivity of deuterium incorporation were determined by ^{1}H-NMR. ^{1}H (300 MHz) spectra were obtained on a Bruker spectrometer in DMSO-d_6 (or otherwise indicated).

The degree of deuterium incorporation (%D) was determined with either the distribution of hydrogen isotopes (LC-MS) and calculated according to

$$\%\mathrm{D} = \frac{\text{incorporated deuterium atoms (per molecule)}}{\text{labelled atoms (per molecule)}}.$$

or by integration of ^{1}H-NMR of starting material and the deuterated product and calculated according to

$$\%\mathrm{D} = \frac{\text{labelled atoms (per molecule)} - \text{rest signal integration of } {}^{1}\mathrm{H} - \mathrm{NMR}}{\text{labelled atoms (per molecule)}}$$

The deuterium chemical yield (DCY) was calculated using the following equation

$$\mathrm{DCY} = \frac{\%\mathrm{D} \cdot \text{yield} \cdot \text{labelled atoms (per molecule)}}{\text{eq } (\mathrm{D_2}) \cdot 2}$$

and indicates how much of deuterium used in a reaction was incorporated into the isolated product. DCY is considered a model for the radioactive chemical yield (RCY). As tritium is radioactive the work with this isotope should be limited to the absolutely necessary to minimize radioactive waste. Therefore, the optimization reactions have been performed with deuterium instead of tritium with a much more complicated calculation of DCY.

$$\mathrm{RCY} = \frac{\text{isolated product (MBq)}}{\text{starting material } \mathrm{T_2} \text{ (mbar} \rightarrow \text{mmol} \rightarrow \text{MBq)}}$$

2. Experimental procedures

Deuterium experiments

General HIE protocol A:
Substrate (1 eq.) and catalyst (5mol%, 0.05 eq.) were dissolved in isopropyl acetate for a total volume of 1ml and added to a reaction flask with a stirring bar. The flasks were connected to a RC Tritec® deuterium manifold system, then frozen by liquid nitrogen and evacuated. A flask was filled with deuterium gas and evacuated. This was repeated thrice. Then the flask was filled with the desired amount of deuterium gas (1 eq. D_2, 25mbar or 50 mbar or 300 mbar) and sealed. The reaction was run for 2h at rt while stirring (500RPM). After two hours the reaction was stopped by disconnecting the flask. The reaction for each substrate was run thrice. The products were analyzed by LC/MS.

General HIE protocol B:
Substrate (1 eq.) and catalyst (5mol%, 0.05 eq.) were dissolved in isopropyl acetate for a total volume of 1ml and added to a reaction flask with a stirring bar. The flasks were connected to a RC Tritec® deuterium manifold system, then frozen by liquid nitrogen and evacuated. A flask was filled with deuterium gas and evacuated. This was repeated thrice. Then the flask was filled with the desired amount of deuterium gas (10 eq. D_2, 300mbar) and sealed. The reaction was run for 2h at rt while stirring (500RPM). After two hours the reaction was stopped by disconnecting the flask. The reaction for each substrate was run thrice. The products were analyzed by LC/MS.

Workup protocol C:
The products of each HIE reaction were pooled and then separated on a silica flash column with ethyl acetate. The Yield was determined and the DCY calculated. The pooled products were analyzed by ^{1}H-NMR.

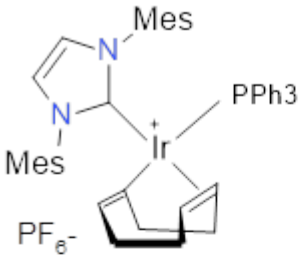
General HIE protocol D:
Substrate (1 eq.) and catalyst (10mol%, 0.1 eq.) were dissolved in isopropyl acetate for a total volume of 1ml and added to a reaction flask with a stirring bar. The flasks were connected to a RC Tritec® deuterium manifold system, then frozen by liquid nitrogen and evacuated. A flask was filled with deuterium gas and evacuated. This was repeated thrice. Then the flask was filled with the desired amount of deuterium gas (1 eq. D_2, 25mbar) and sealed. The reaction was run for 2h at rt while stirring (500RPM). After two hours the reaction was stopped by disconnecting the flask. The reaction for each substrate was run thrice. The products were analyzed by LC/MS and the products of each substrate were pooled and purified in the purification laboratory. The pooled products were analyzed by ^{1}H-NMR.

Pre-activation of catalyst HIE protocol E:
Substrate (1 eq.) and catalyst (varying mol%, varying eq.) were dissolved in isopropyl acetate for a total volume of 1ml and added to a reaction flask with a stirring bar. The flasks were connected to a RC Tritec® deuterium manifold system, then frozen by liquid nitrogen and evacuated. A flask was filled with hydrogen gas and evacuated. This was repeated thrice. Then the flask was filled with the desired amount of hydrogen gas (100mbar) and sealed. The reaction was run 1h at rt while stirring (500RPM). After one hour the reaction was stopped by freezing the solution with liquid nitrogen and evacuating. After evacuation the solution was warmed to rt, stirred for one minute, then frozen and evacuated again. This was repeated thrice. The flask was filled with the desired amount of deuterium gas (1 eq. D_2, 25mbar) and sealed. The reaction was run for 3h at rt while stirring (500RPM). After three hours the reaction was stopped by disconnecting the flask. The reaction for each substrate was run thrice. The products were analyzed by LC/MS and the products of each substrate were pooled and purified in the purification laboratory. The pooled products were analyzed by ^{1}H-NMR.

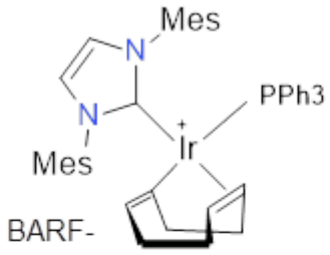
Activity measurement of 3H compounds (general procedure)
The probe is transferred into a volumetric flask (2 mL, 5 mL or 10 mL) and an aliquot of 10 or 100 µL is taken. This is given into a volumetric flask (10 mL) filled to the calibration mark with ethanol (10 or 100 µL are taken out prior addition of the aliquot). This procedure is done at least twice to generate a double measurement. The flasks are shaken until a homogeneous solution is produced. Aliquots from these flasks are measured via liquid scintillation counting (Perkin Elmer), three times for each flask. From the median of the obtained value the activity of the probe is calculated.

For clarity:
Deuterium standard conditions (black text color, scheme 2): HIE catalyst, 300 mbar D_2 (10 eq.), CH_2Cl_2, 2h.
tritium standard conditions (orange text color, scheme 3): HIE catalyst, 300 mbar T_2 (10 eq.), isopropyl acetate, 5h

3. Catalysts:

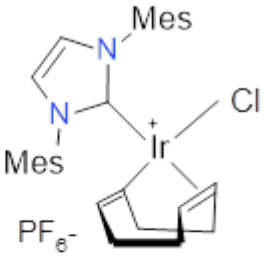


2



2b

(Kerr)



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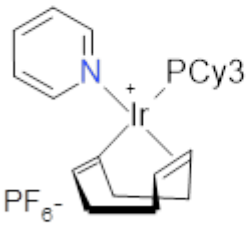
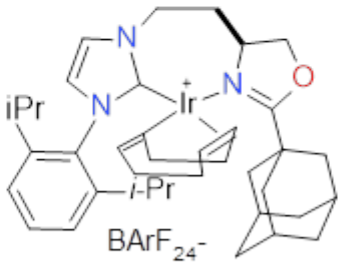


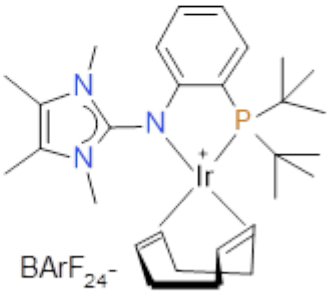
(Crabtree)

20



(Burgess)

21



(Tamm)

22

4. Radioactive waste overview

To get a better understanding of a standard tritium reaction and the impact of the new protocol, follow the radioactivity in %. However, the most significant change is the reduction of the radioactive waste in absolute numbers.

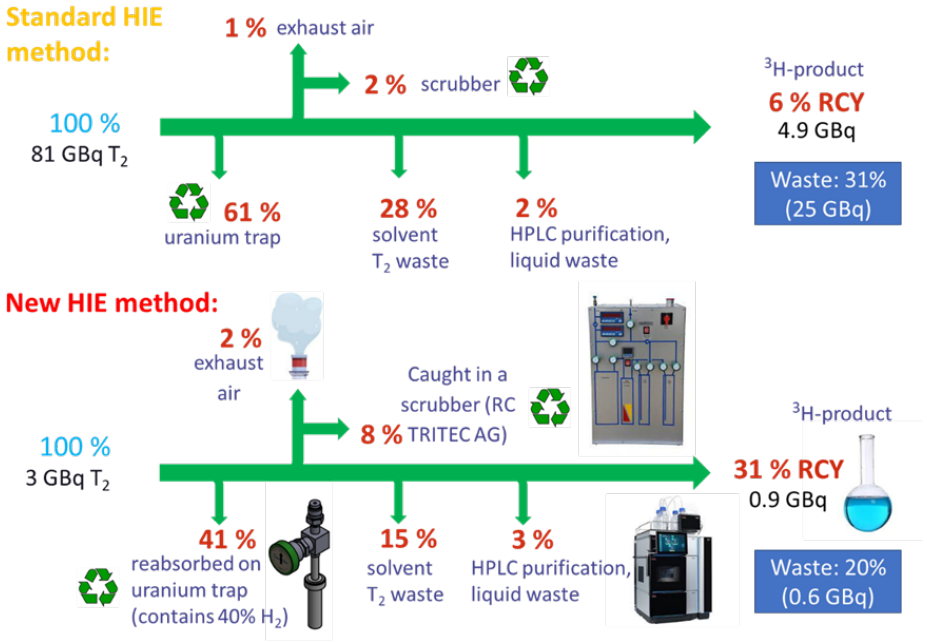


Figure: Comparison of the percentual radioactivity distribution in HIE reactions of celecoxib 17 under standard (10 eq T_2) and new (1 eq T_2) reaction conditions. Waste: sum of exhaust air, reaction solvent and HPLC purification waste. Tritium collected on the scrubber (as HTO) or the uranium bed (as HT) can be recycled (marked with green recycle icon).

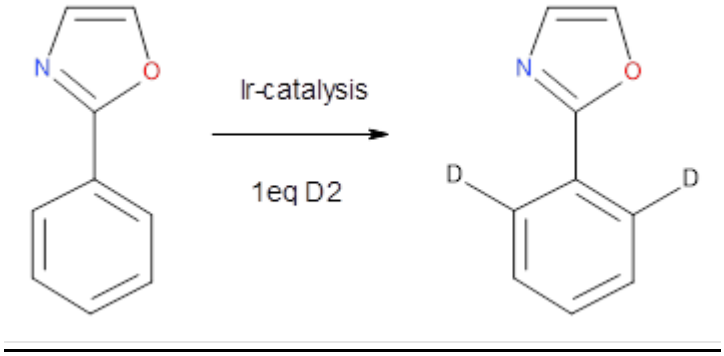
Please be aware that data shown in the figure is based on data from our lab. Depending on the used setup (manifold, scrubber, glove box etc) the values can differ. The same is true for the different regulations of waste disposal in every country. Therefore, this example should be seen as guidance and not as general overview.

If interested to learn more about the scrubber technology (CuO catalyst to generate ^{3}HOH with molecular sieve trap) follow the link:
https://www.rctritec.com/de/tritiumtechnologie/tritium-mini-scrubber.html?oreawe67tdyfc=yes&cHash=5ecf4f1c0a4928d08fc75f7c672a9631

Or search in Google: “TRITEC scrubber”

5. Catalyst/Solvent Screening

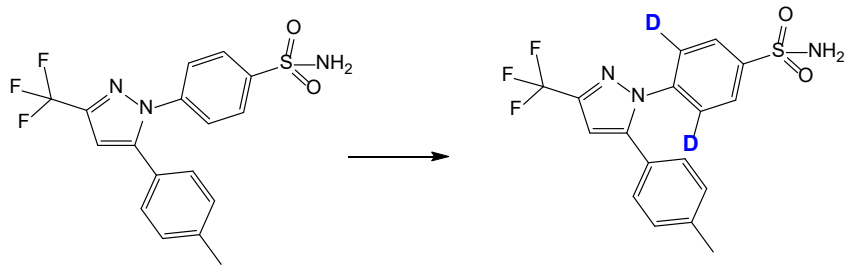
Table S1: Catalyst screening of catalysts **2,2b, 19-22** with 2-phenyloxazole **1** in DCM or Isopropylacetate



		DCY (%)	
RG Nr	catalyst	isopropyl acetate	DCM
1/table1,entry 3	Kerr PF_6 **2**	62	56
2/7	Kerr BARF **2b**	88	43
3/8	Kerr-Cl **19**	1	1
4/9	Crabtree **20**	32	47
5/10	Burgess **21**	10	40
6/11	Tamm **22**	18	15

Conditions: 2 mg 2-phenyloxazole **1**, 5 mol % cat, 1 Eq D_2, 2h RT

Table S2: Catalyst screening of catalysts **2,2b, 19-22** with Celecoxib **17** in DCM or Isopropylacetate



		DCY (%)	
RG Nr	catalyst	Isopropylacetat	DCM
12/18	Kerr PF_6 **2**	38	38
13/19	Kerr BARF **2b**	63	51
14/20	Kerr-Cl **19**	3	6
15/21	Crabtree **20**	1	44
16/22	Burgess **21**	0	1
17/23	Tamm **22**	5	5

Conditions: 5 mg celecoxib **16**, 5 mol % cat, 1 Eq D_2, 2h RT

Table S3: Solvent screening with catalysts **2** and **2b** with Celecoxib **17**

		DCY (%)	
RG Nr	solvent	Catalyst **2**	**2b**
18/19	DCM	38	51
24/28	THF	3	3
25/29	MeTHF	55	54
26/30	MTBE	55	55
12/13	Isopropylacetate	38	63
27/31	MeOH	26	13

Conditions: 5 mg celecobix **17**, 5 mol% cat, Kerr PF_6 **2,** Kerr BARF **2b**, 1Eq D_2, 2h, RT

5. Time/DCY evaluation

Table S4: Time/DCY evaluation with catalysts **2b** with Celecoxib **17**

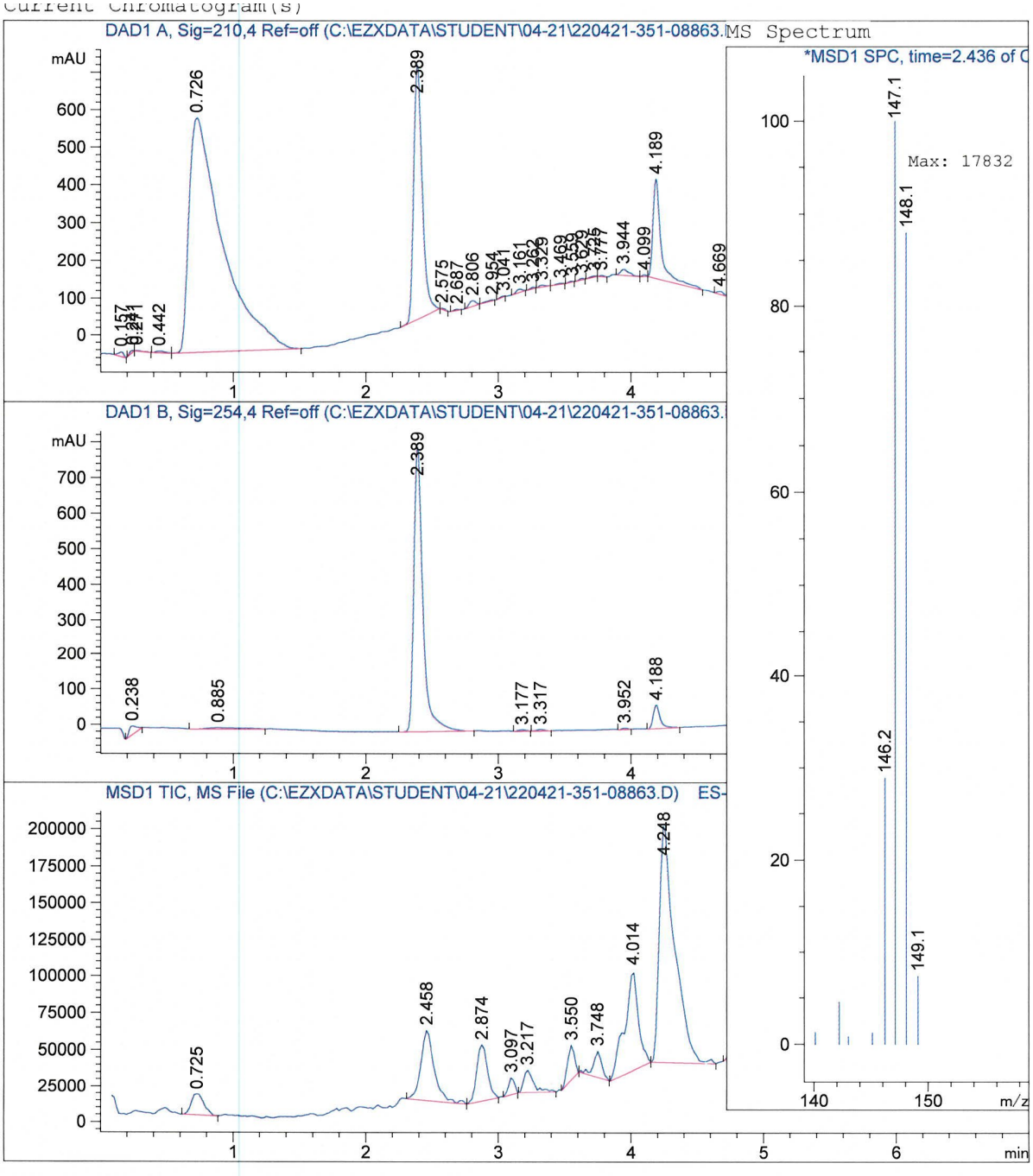
		DCY (%)
RG Nr	time	Catalyst **2b**
32	1	51
33	4	59
34	8	56
35	16	49
36	24	43

Conditions: 5 mg celecoxib **17**, 5 mol % cat, Isopropyl acetate, 1 Eq D_2, RT

RG Nr. 1

2 mg 2-Phenyloxazole, 5 mol% Kerr PF6, Isopropyl acetate, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.458 min)

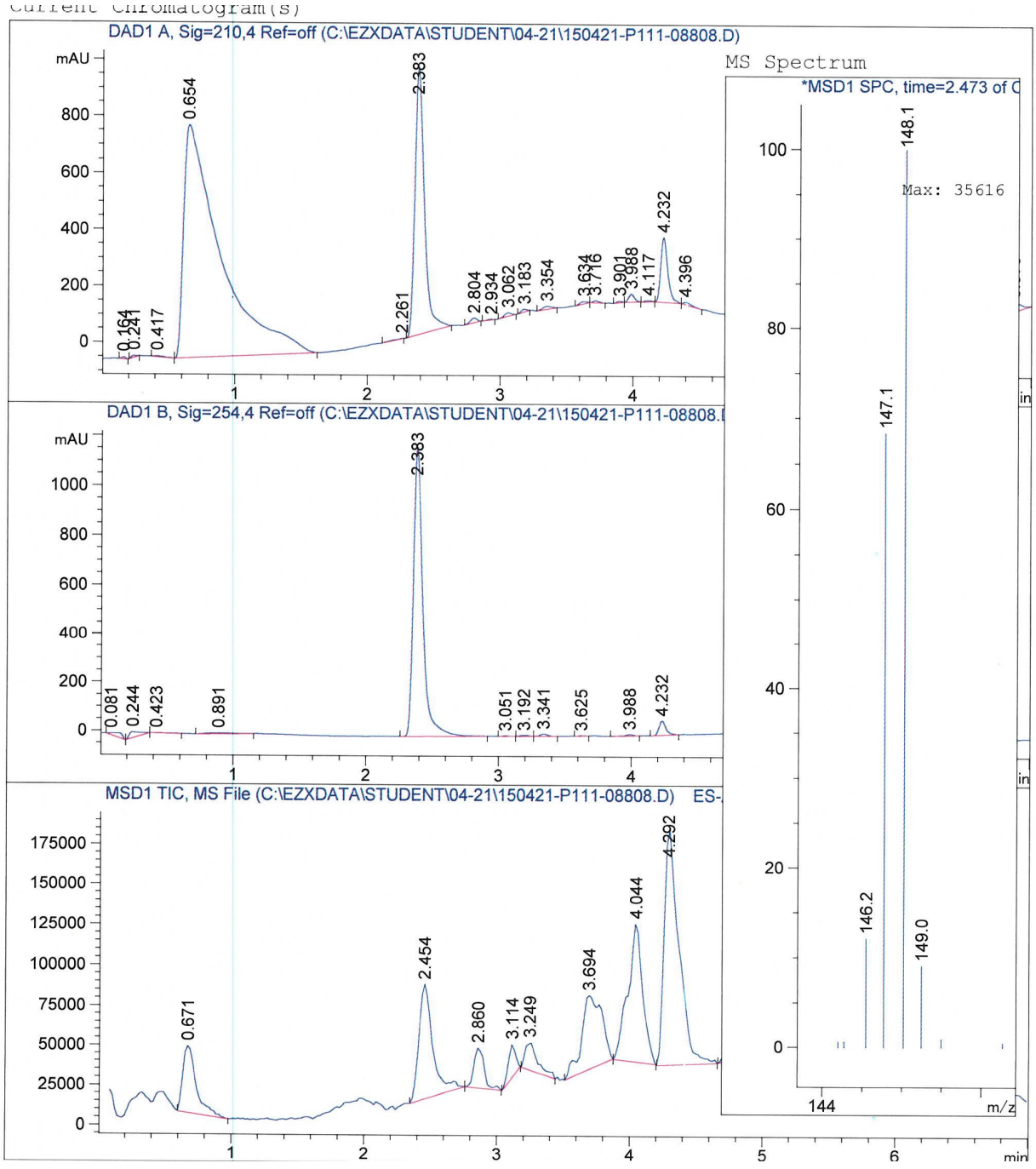


Result: 62% DCY

RG Nr. 2

2 mg 2-Phenyloxazole, 5 mol% Kerr BArF, Isopropyl acetate, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.454 min)

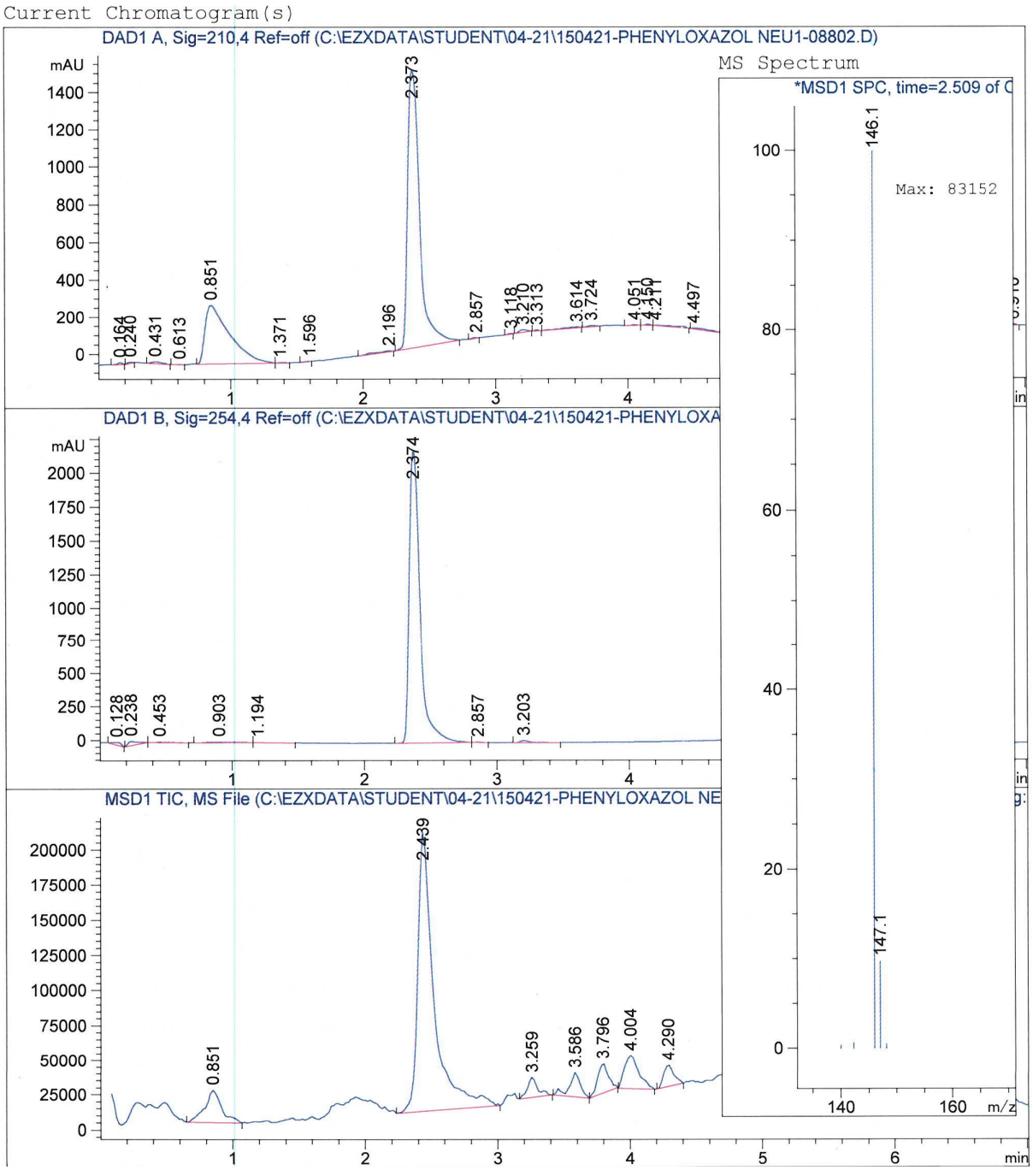


Result: 88% DCY

RG Nr. 3

2 mg 2-Phenyloxazole, 5 mol% Kerr Cl, Isopropyl acetate, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.454 min

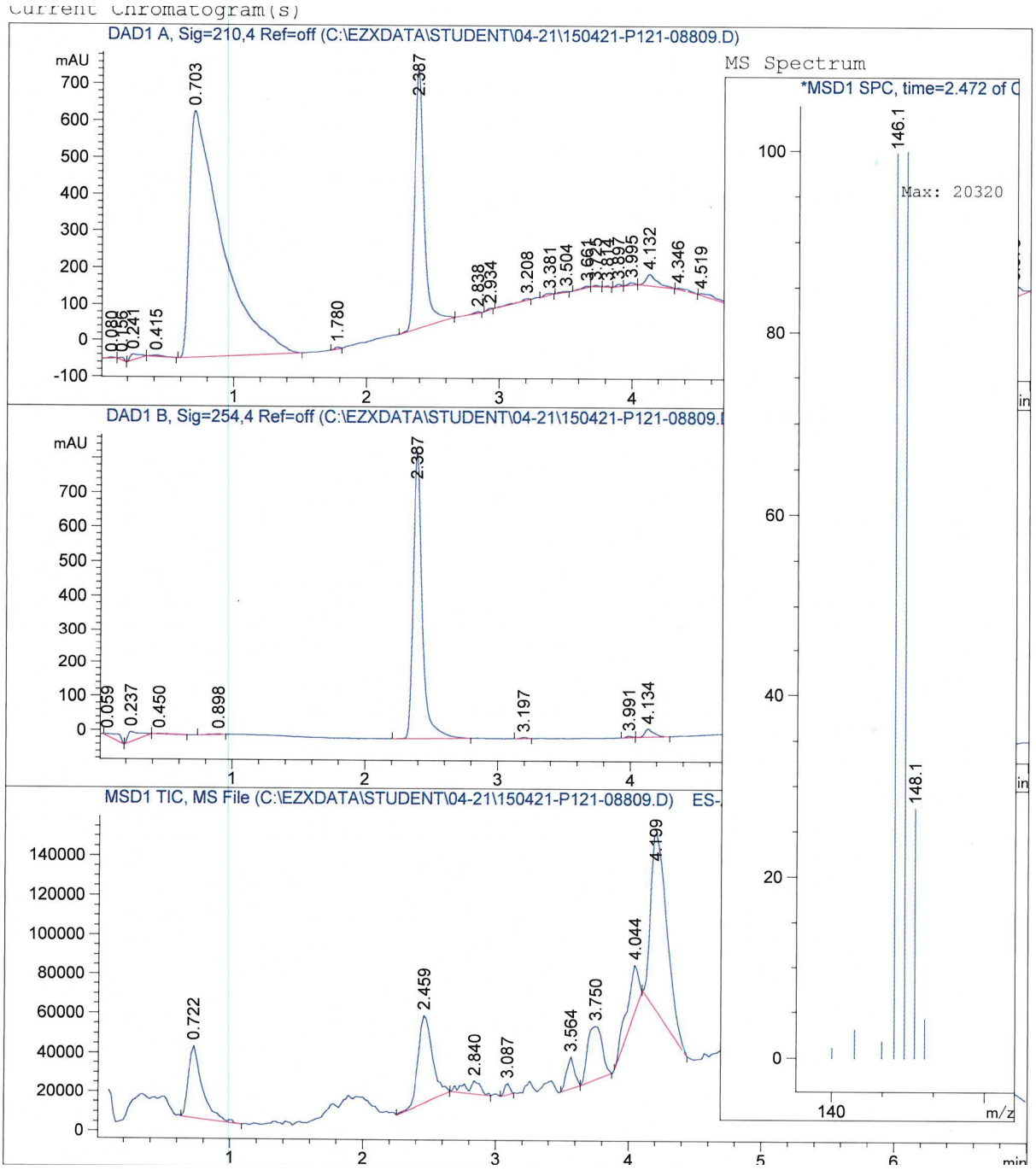


Result: 1% DCY

RG Nr.4

2 mg 2-Phenyloxazole, 5 mol% Crabtree, Isopropyl acetate, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.459 min)

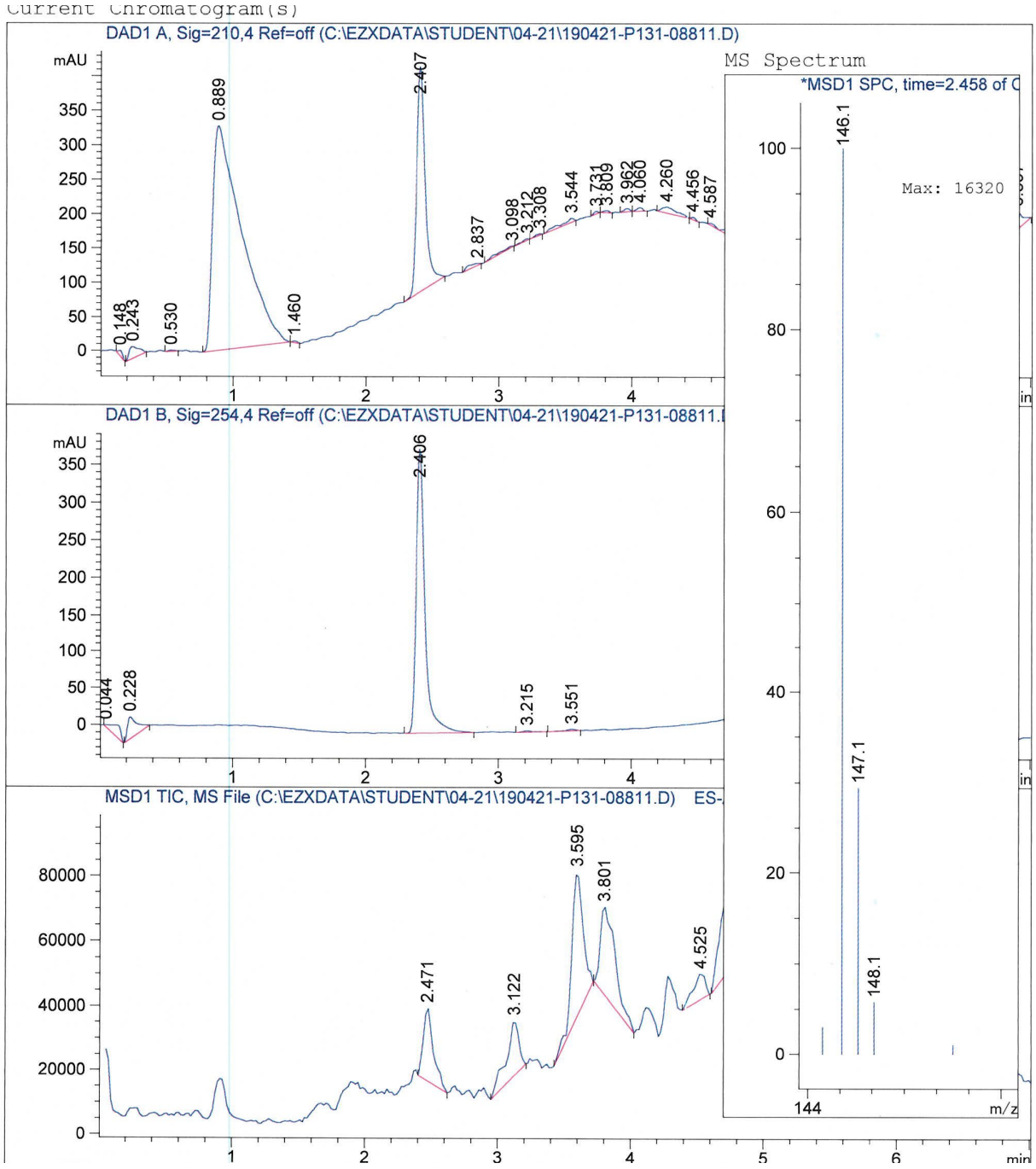


Result: 32% DCY

RG Nr.5

2 mg 2-Phenyloxazole, 5 mol% Burgess, Isopropyl acetate, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.471 min)

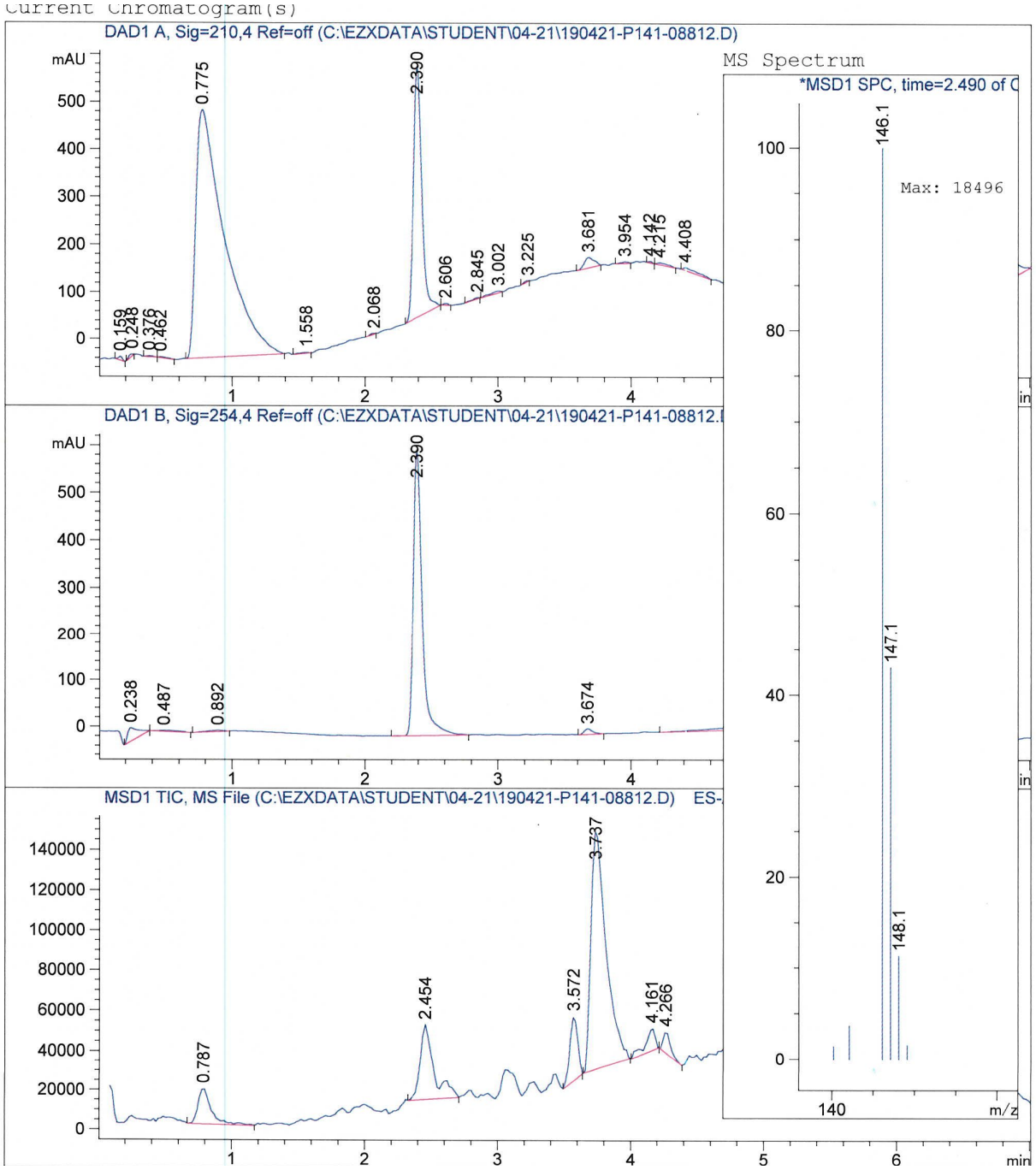


Result: 10% DCY

RG Nr. 6

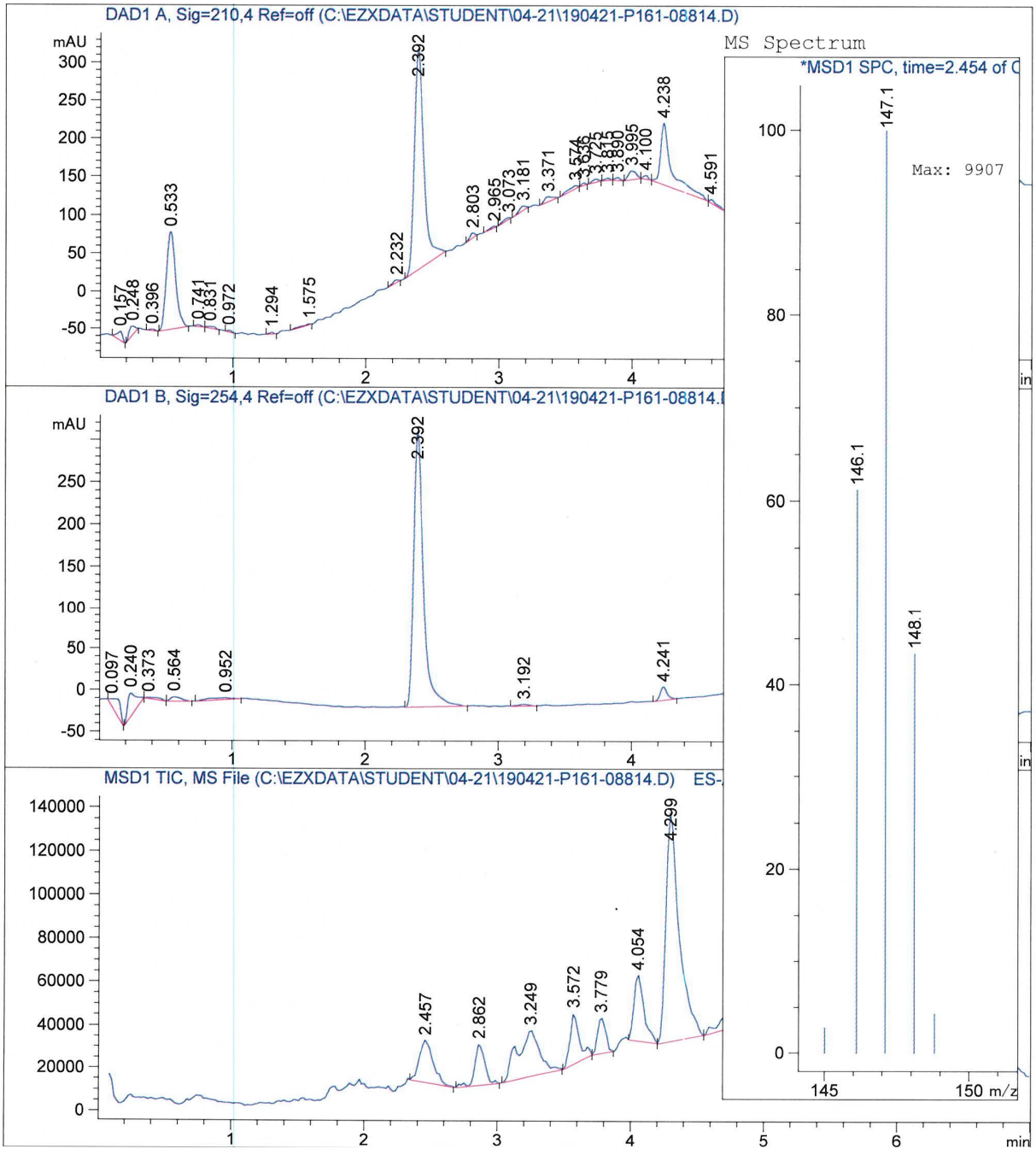
2 mg 2-Phenyloxazole, 5 mol% Tamm, Isopropyl acetate, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.454 min)



Result: 18% DCY

RG Nr. 7
2 mg 2-Phenyloxazole, 5 mol% Kerr BArF, DCM, 1Eq D2, 2h RT:
LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.457 min)

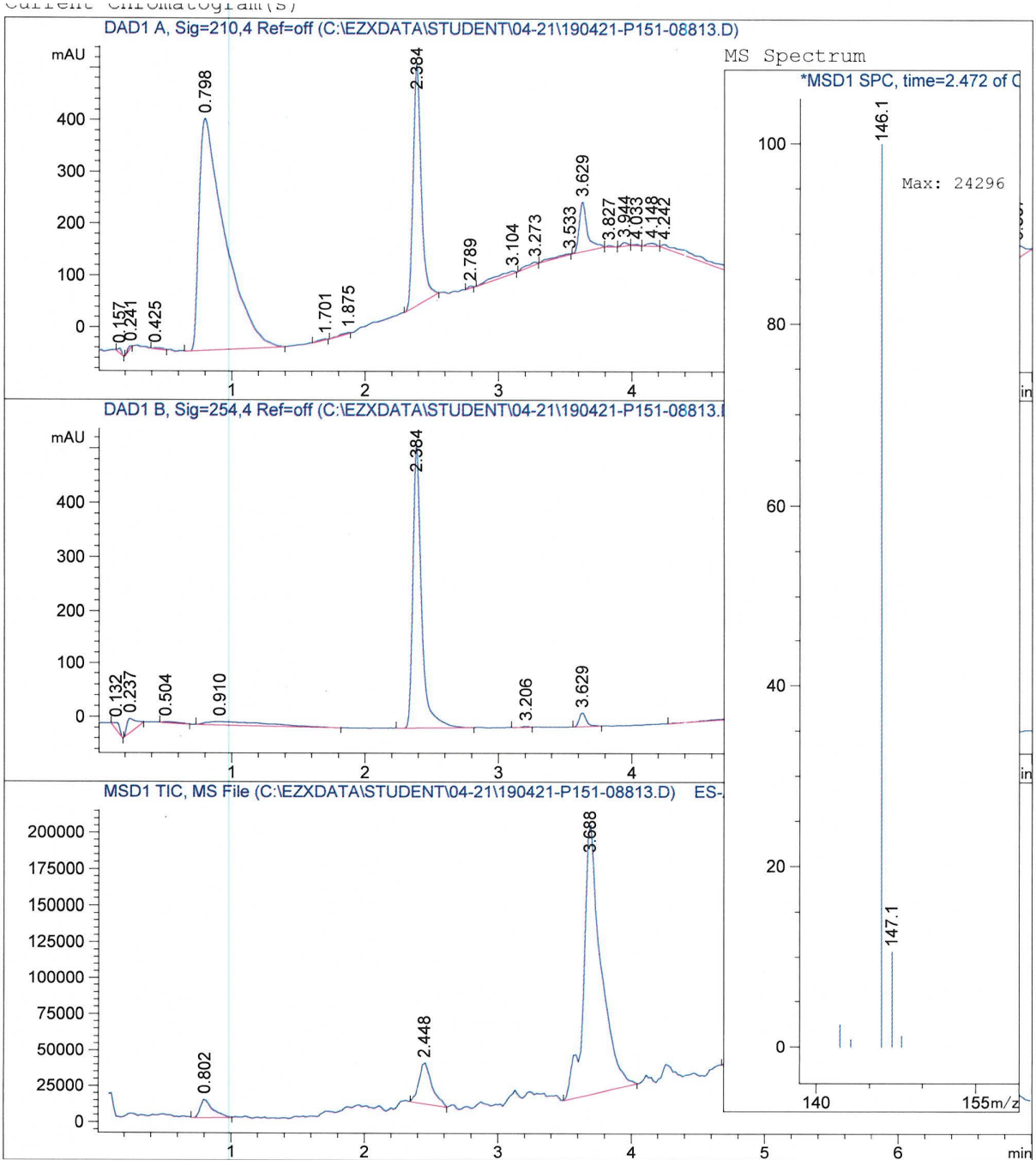


Result: 43% DCY

RG Nr.8

2 mg 2-Phenyloxazole, 5 mol% Kerr Cl, Isopropyl acetate, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.448 min)

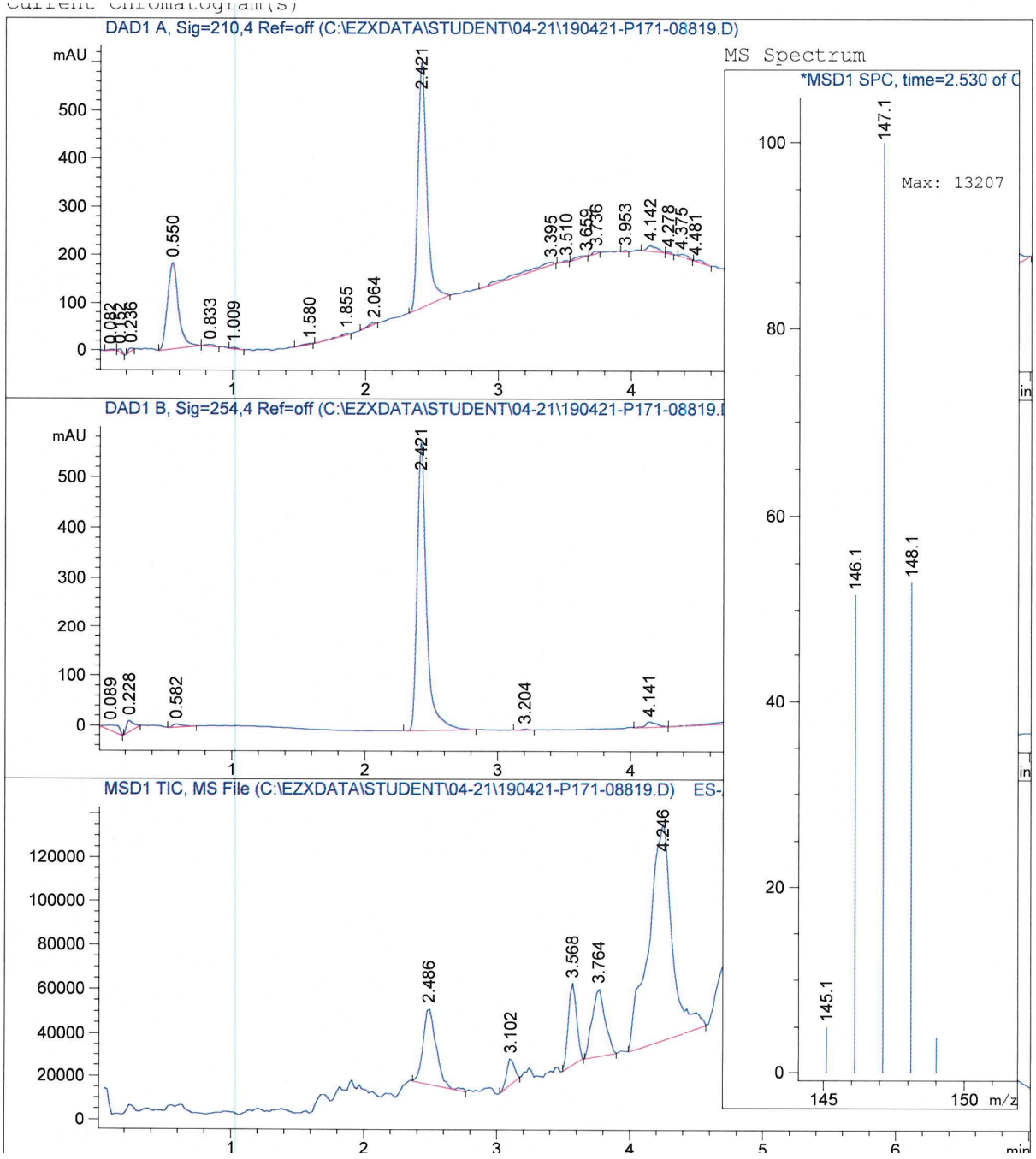


Result: 1% DCY

RG Nr. 9

2 mg 2-Phenyloxazole, 5 mol% Crabtree, DCM, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.486 min)

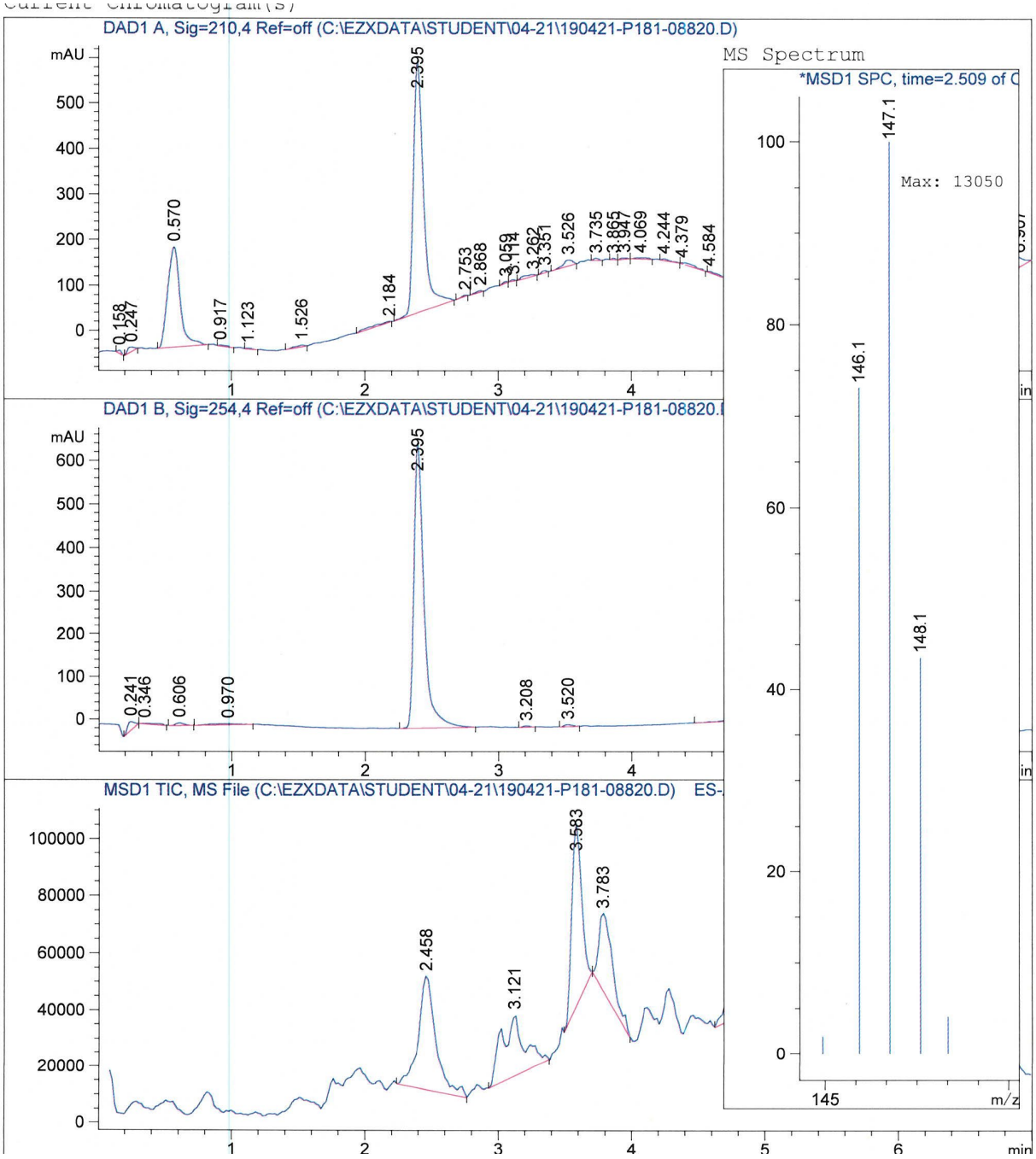


Result: 47% DCY

RG Nr. 10

2 mg 2-Phenyloxazole, 5 mol% Burgess, DCM, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.458 min)

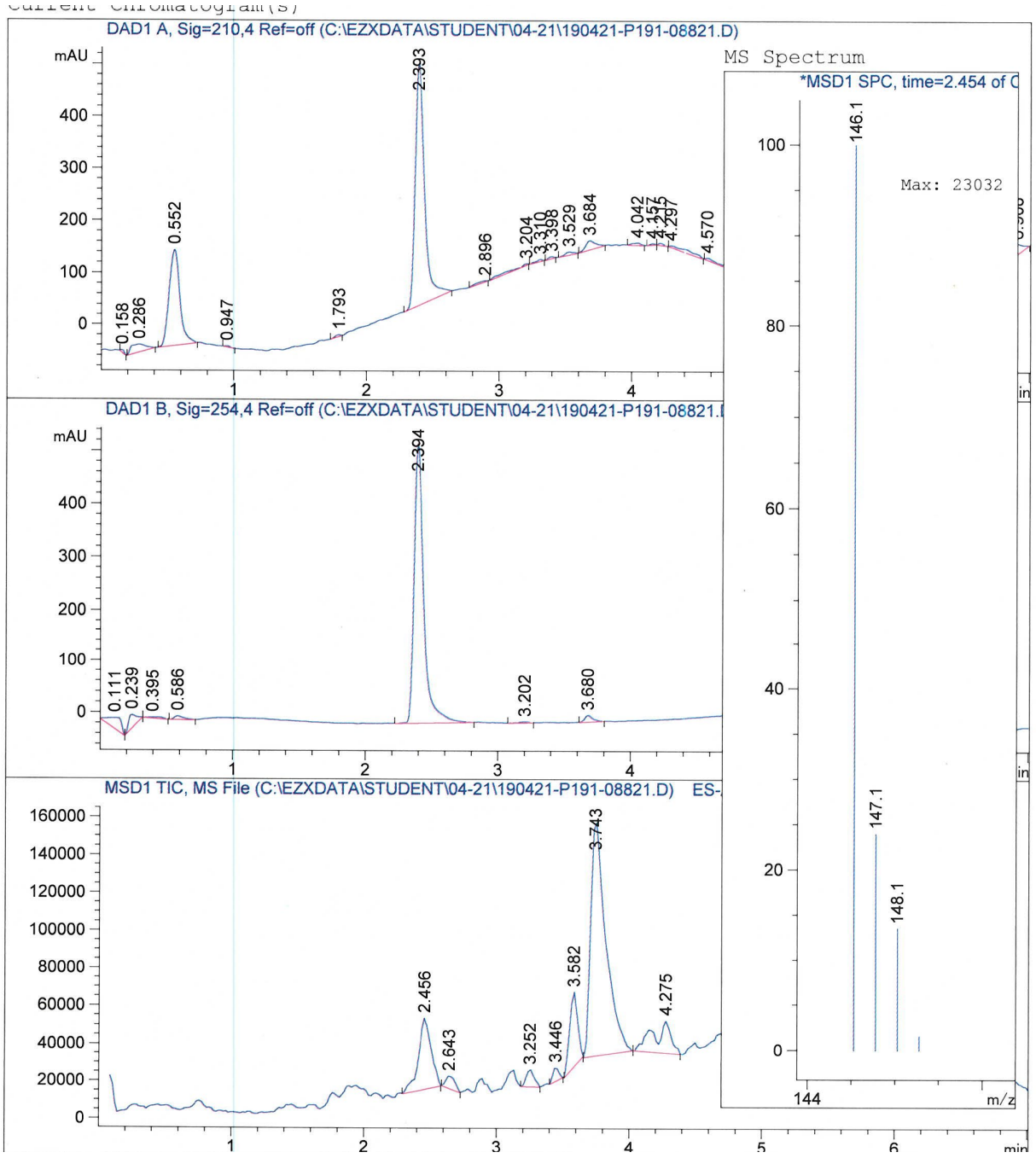


Result: 40% DCY

RG Nr. 11

2 mg 2-Phenyloxazole, 5 mol% Tamm, DCM, 1Eq D_2, 2h RT:

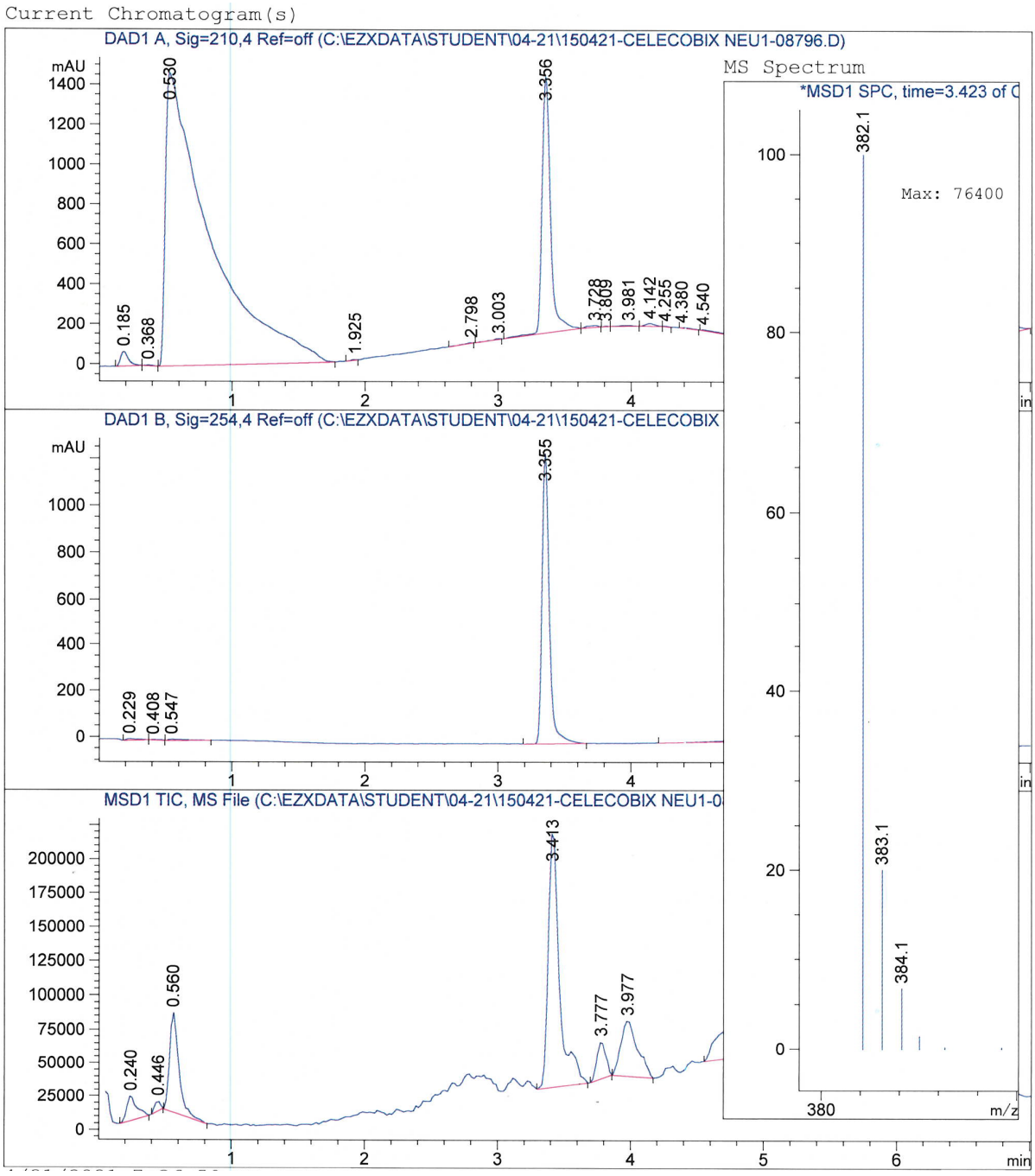
LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.456 min)



Result: 15% DCY

Celecoxib **17** reference:

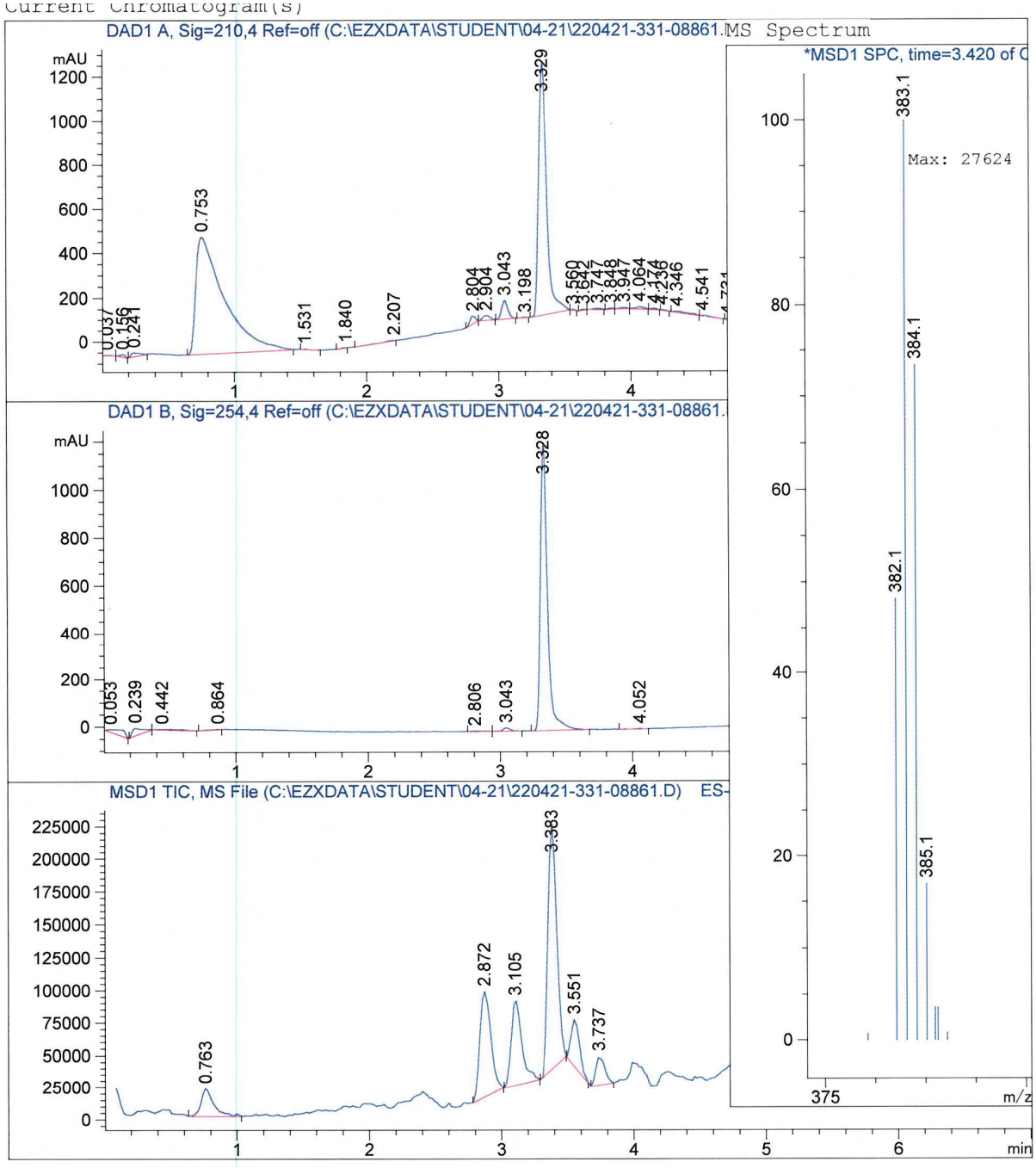
LC-MS:



RG Nr: 12

5 mg Celecoxib, 5 mol% Kerr PF6, Isopropyl acetate, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.383 min)

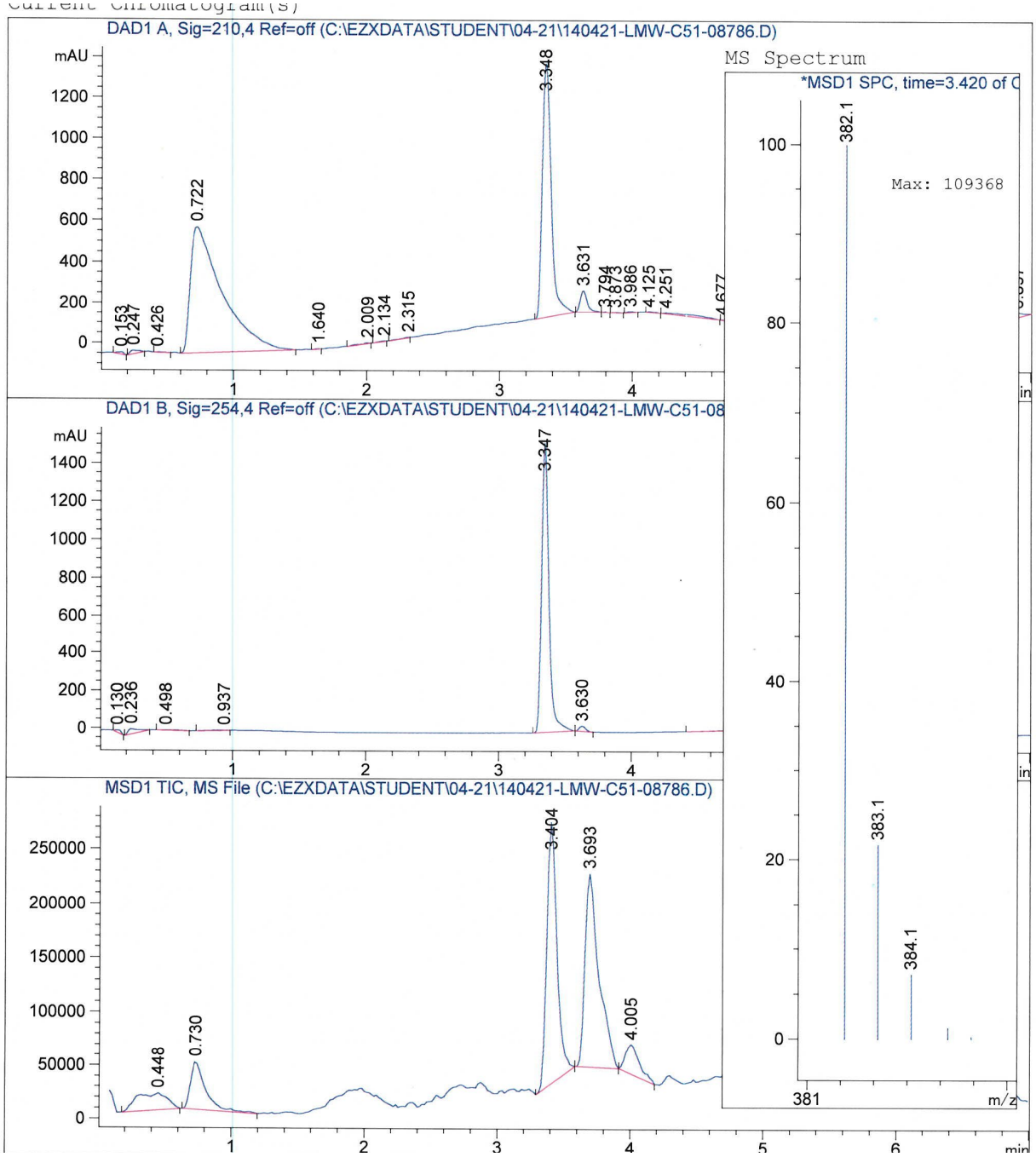


Result: 38% DCY

RG Nr: 14

5 mg Celecoxib, 5 mol% Kerr Cl, Isopropyl acetate, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.404 min)

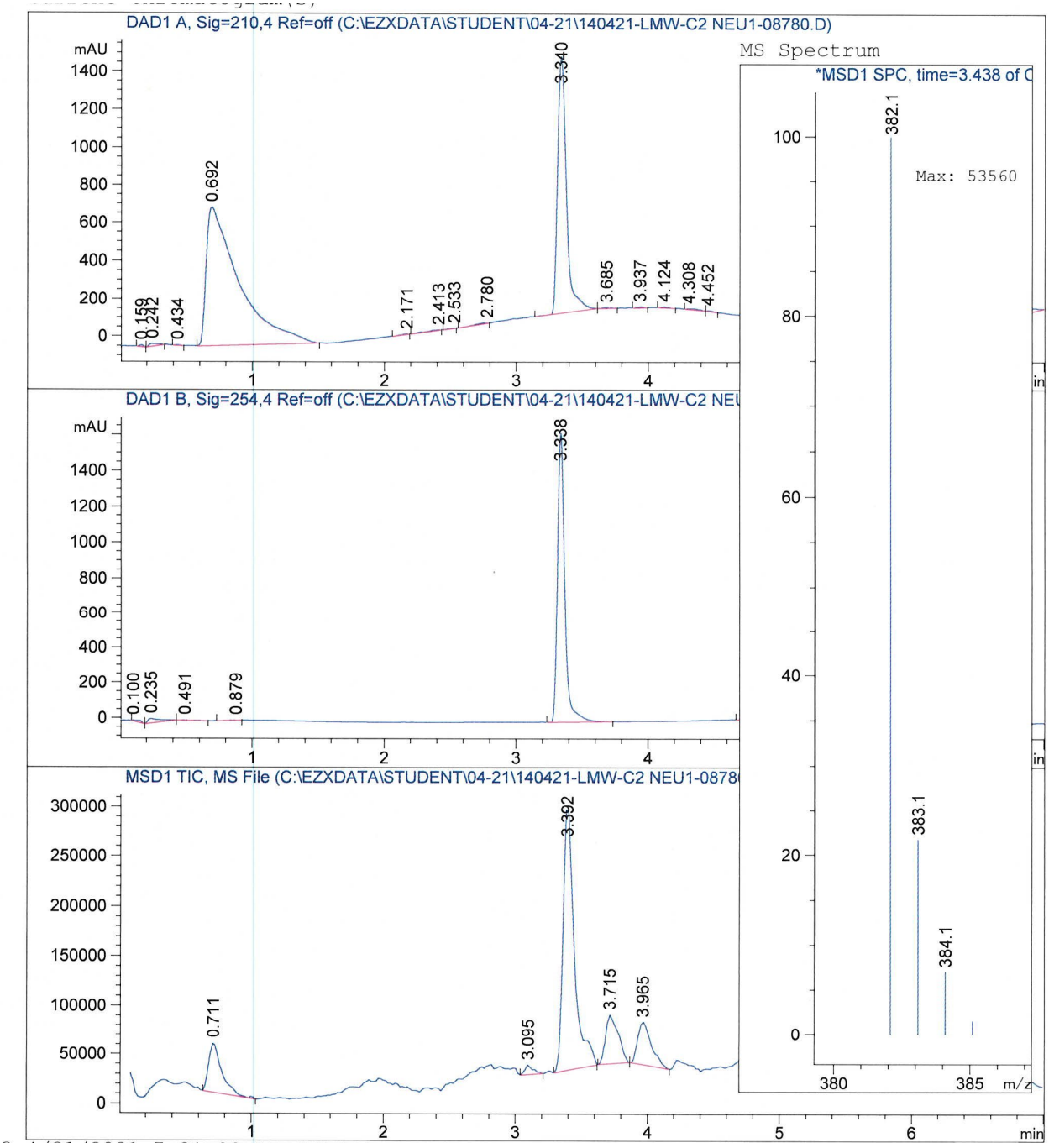


Result: 3% DCY

RG Nr: 15

5 mg Celecoxib, 5 mol% Crabtree, Isopropyl acetate, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.392 min)

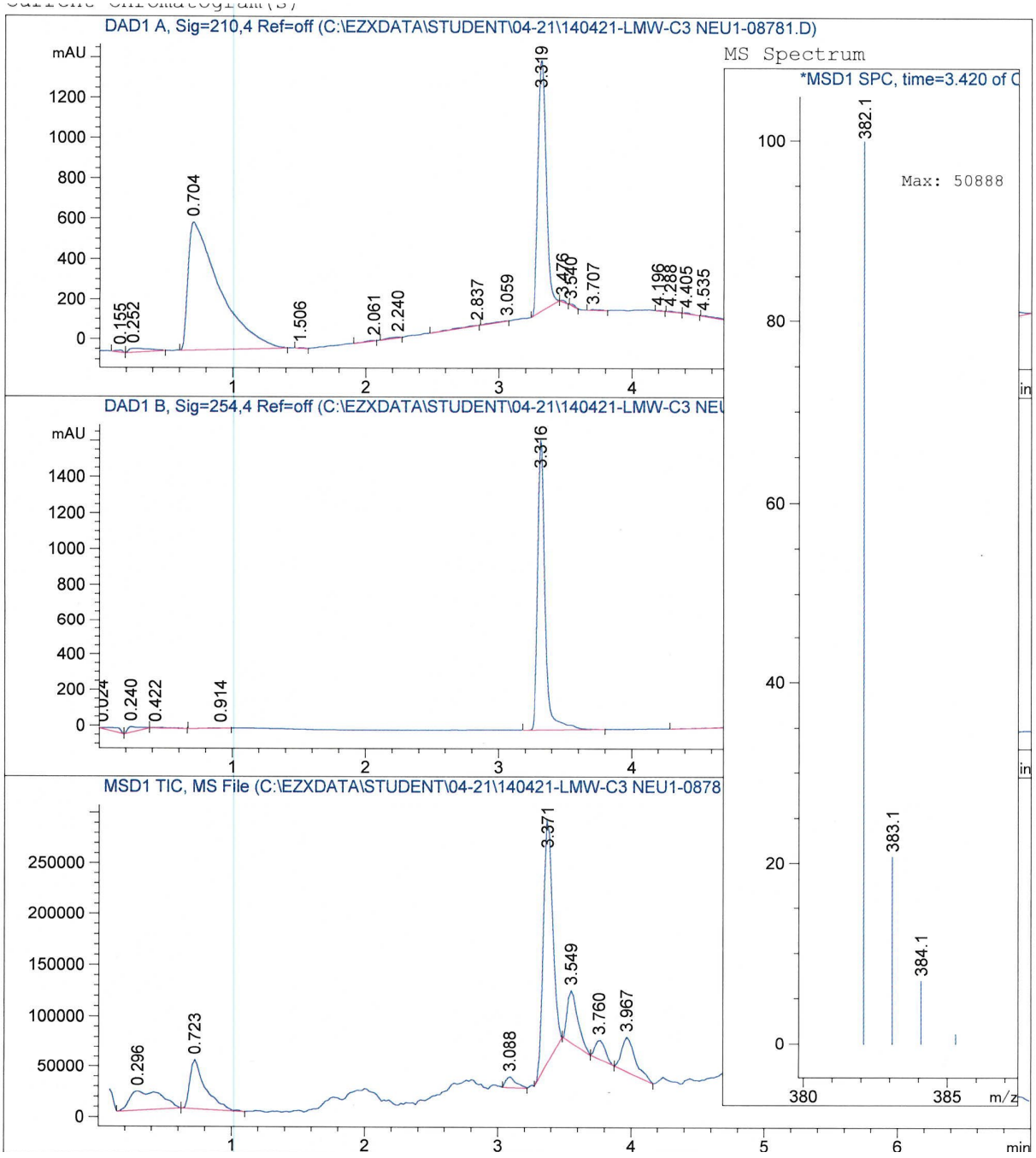


Result: 1.4% DCY

RG Nr: 16

5 mg Celecoxib, 5 mol% Burgess, Isopropyl acetate, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.371 min)

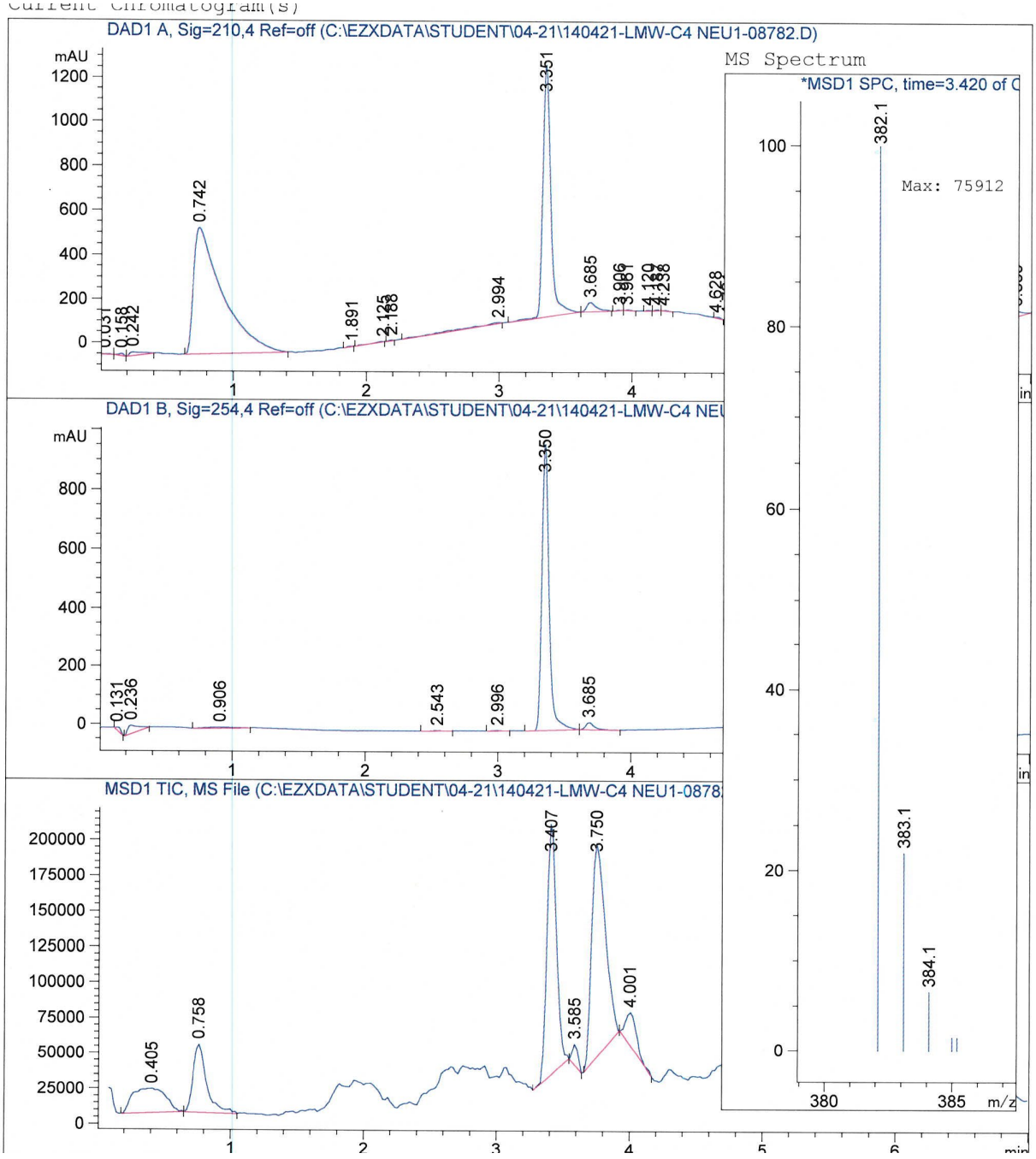


Result: 0.3% DCY

RG Nr: 17

5 mg Celecoxib, 5 mol% Tamm, Isopropyl acetate, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.407 min)

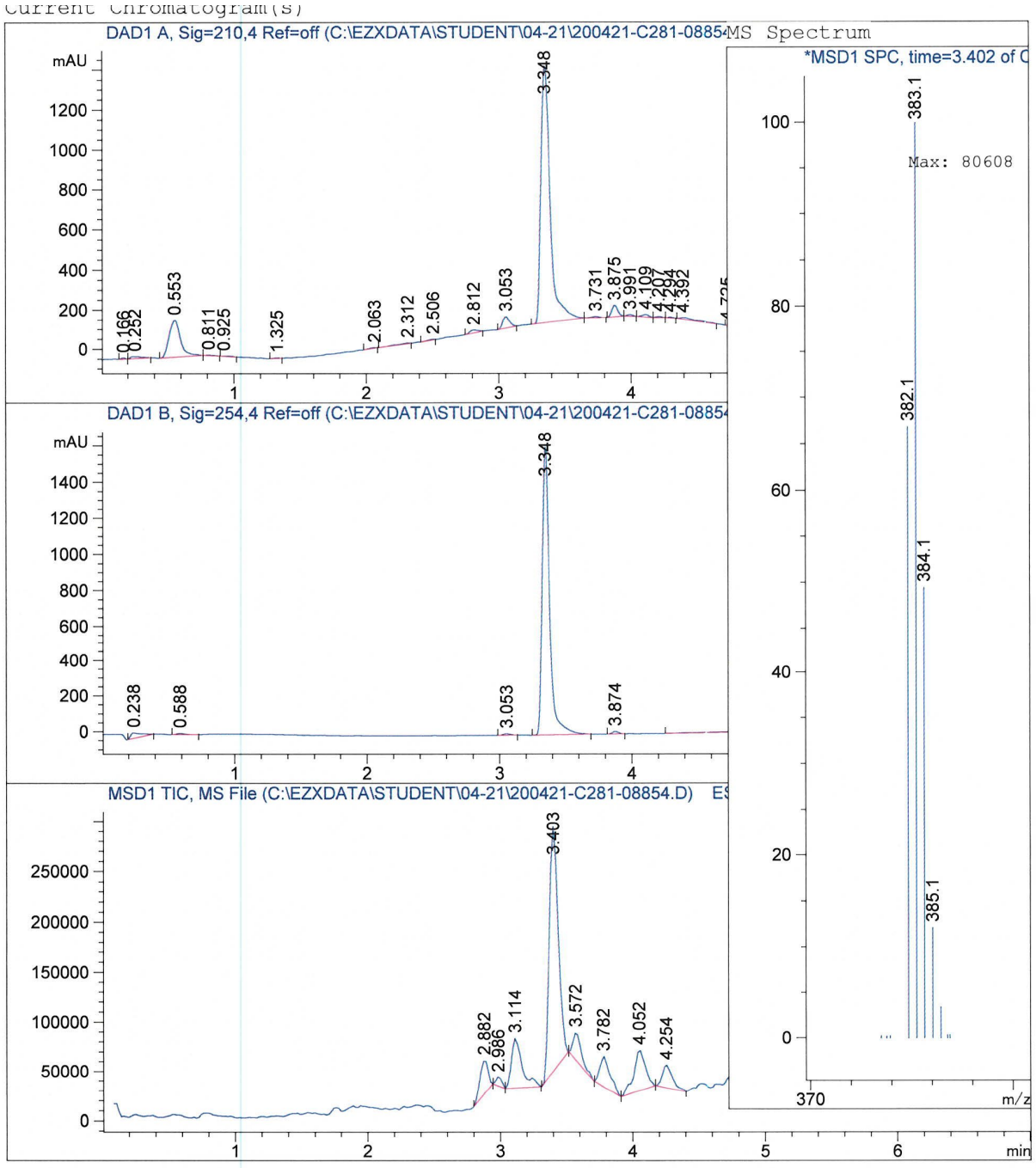


Result: 4.6% DCY

RG Nr. 18

5 mg Celecoxib, 5 mol% Kerr PF6, DCM, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.403 min)

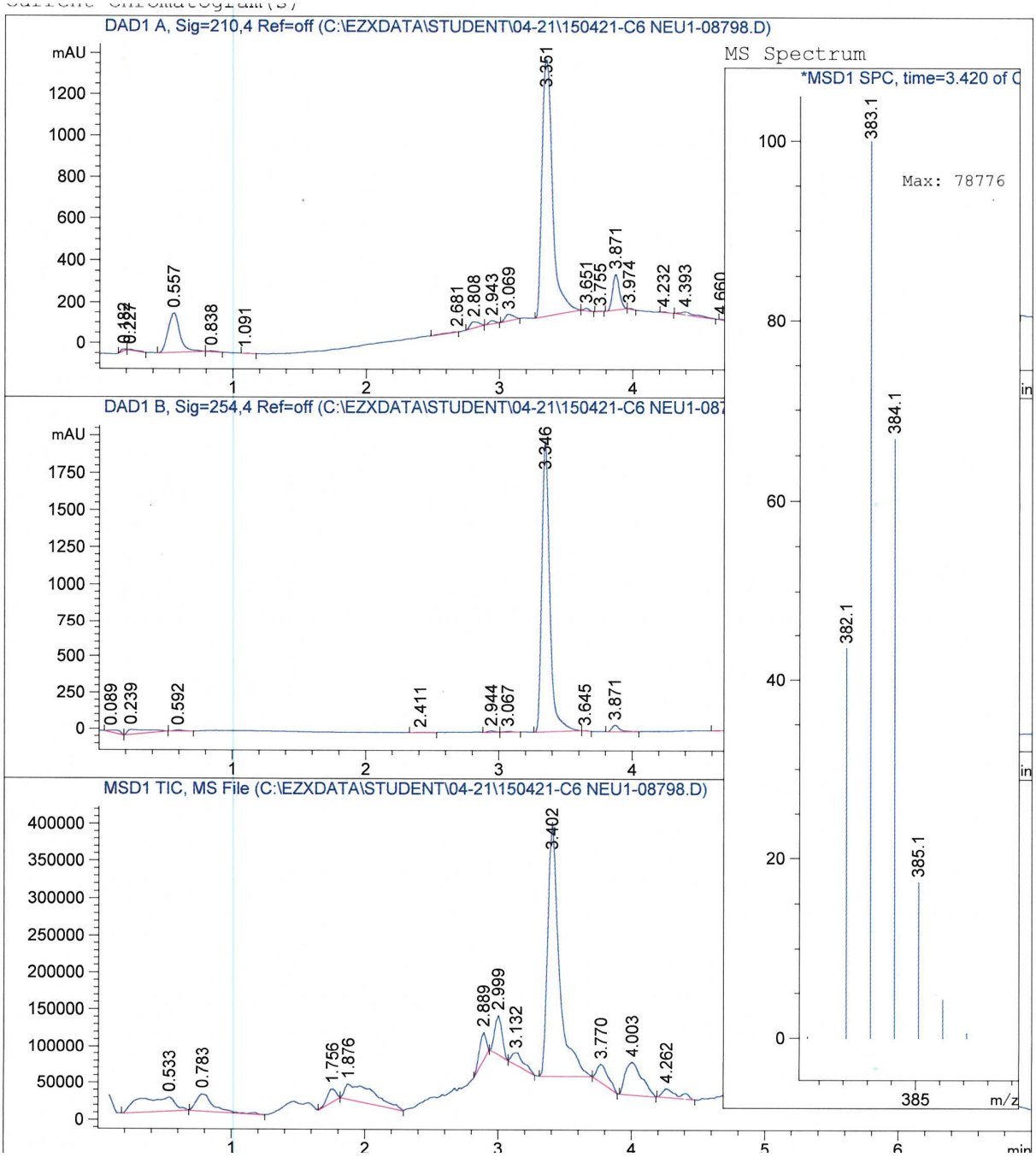


Result: 37.7% DCY

RG Nr: 19

5 mg Celecoxib, 5 mol% Kerr BArF, DCM, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.402 min)

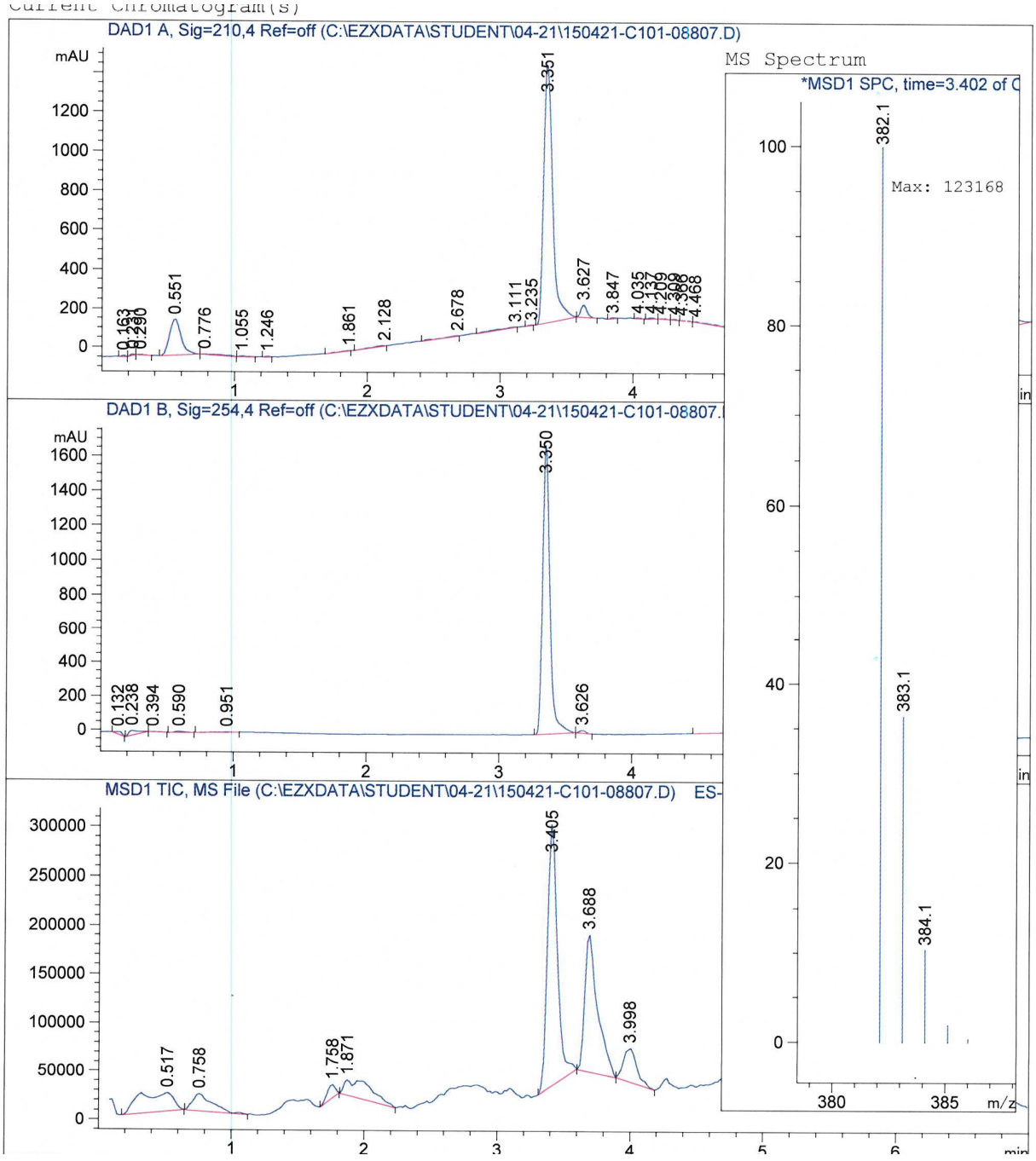


Result: 51.2% DCY

RG Nr: 20

5 mg Celecoxib, 5 mol% Kerr Cl, DCM, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.405 min)

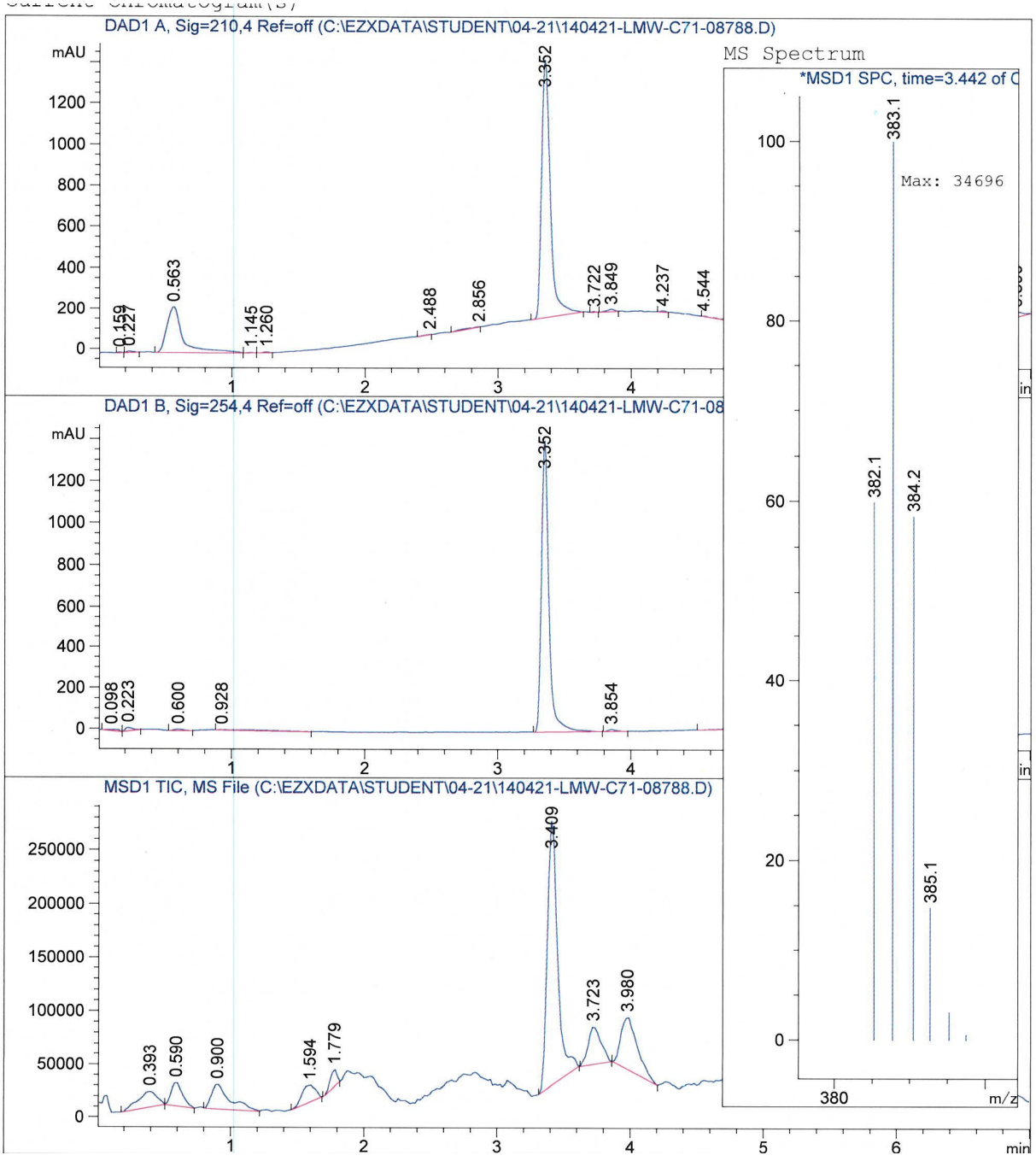


Result: 5.8% DCY

RG Nr: 21

5 mg Celecoxib, 5 mol% Crabtree, DCM, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.409 min)

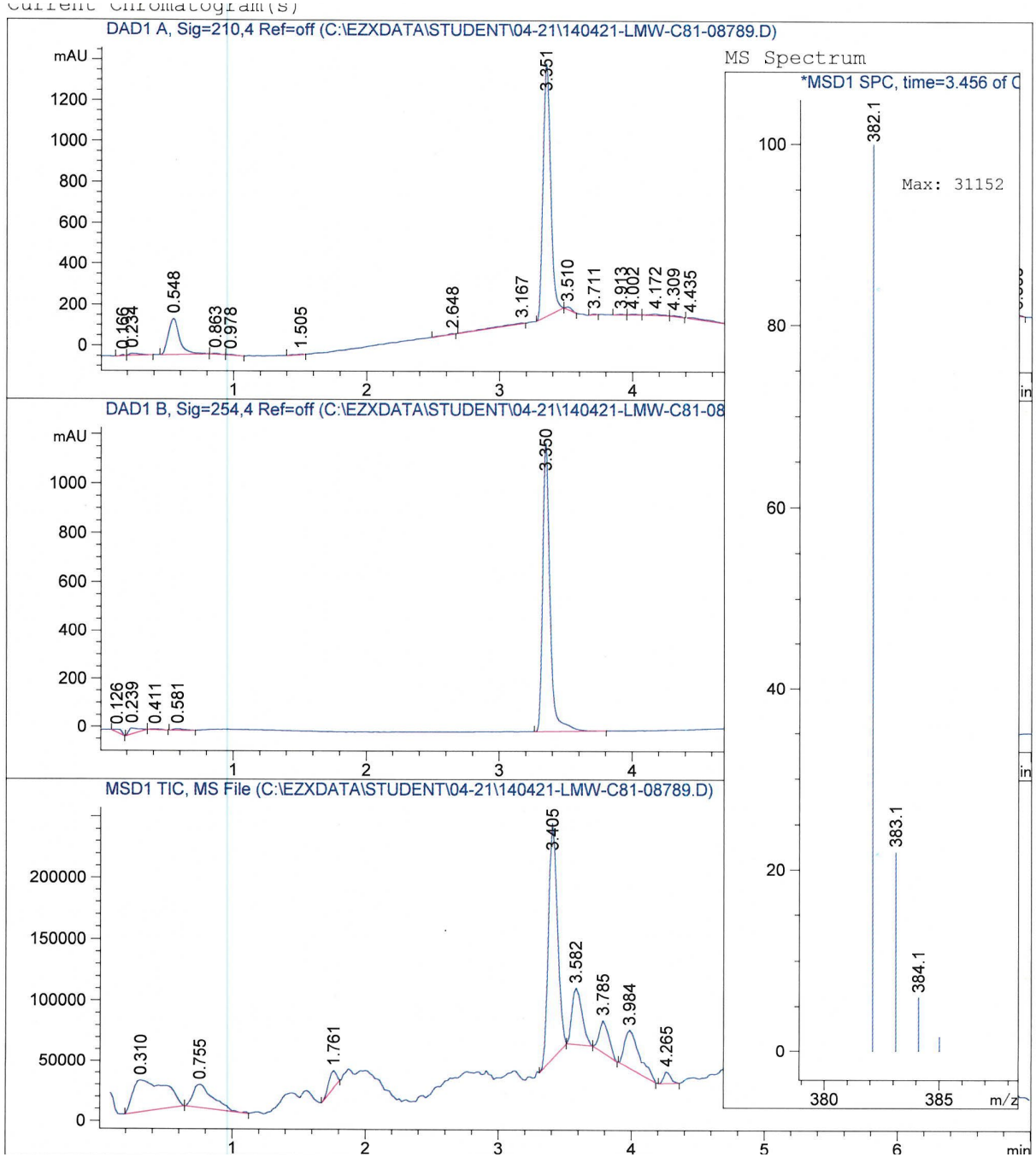


Result: 43.6% DCY

RG Nr: 22

5 mg Celecoxib, 5 mol% Burgess, DCM, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.405 min)

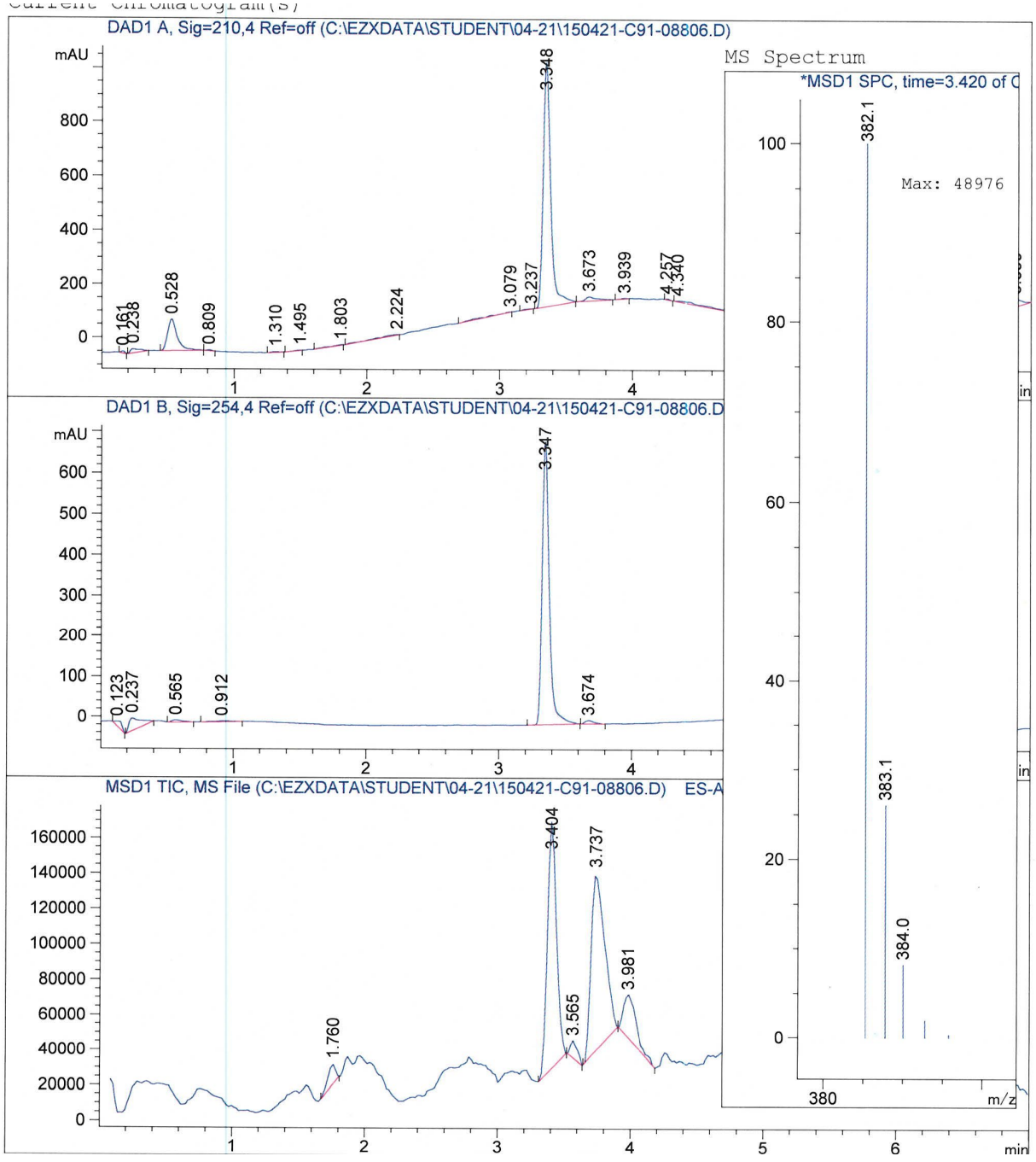


Result: 0.9% DCY

RG Nr: 23

5 mg Celecoxib, 5 mol% Tamm, DCM, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.404 min)

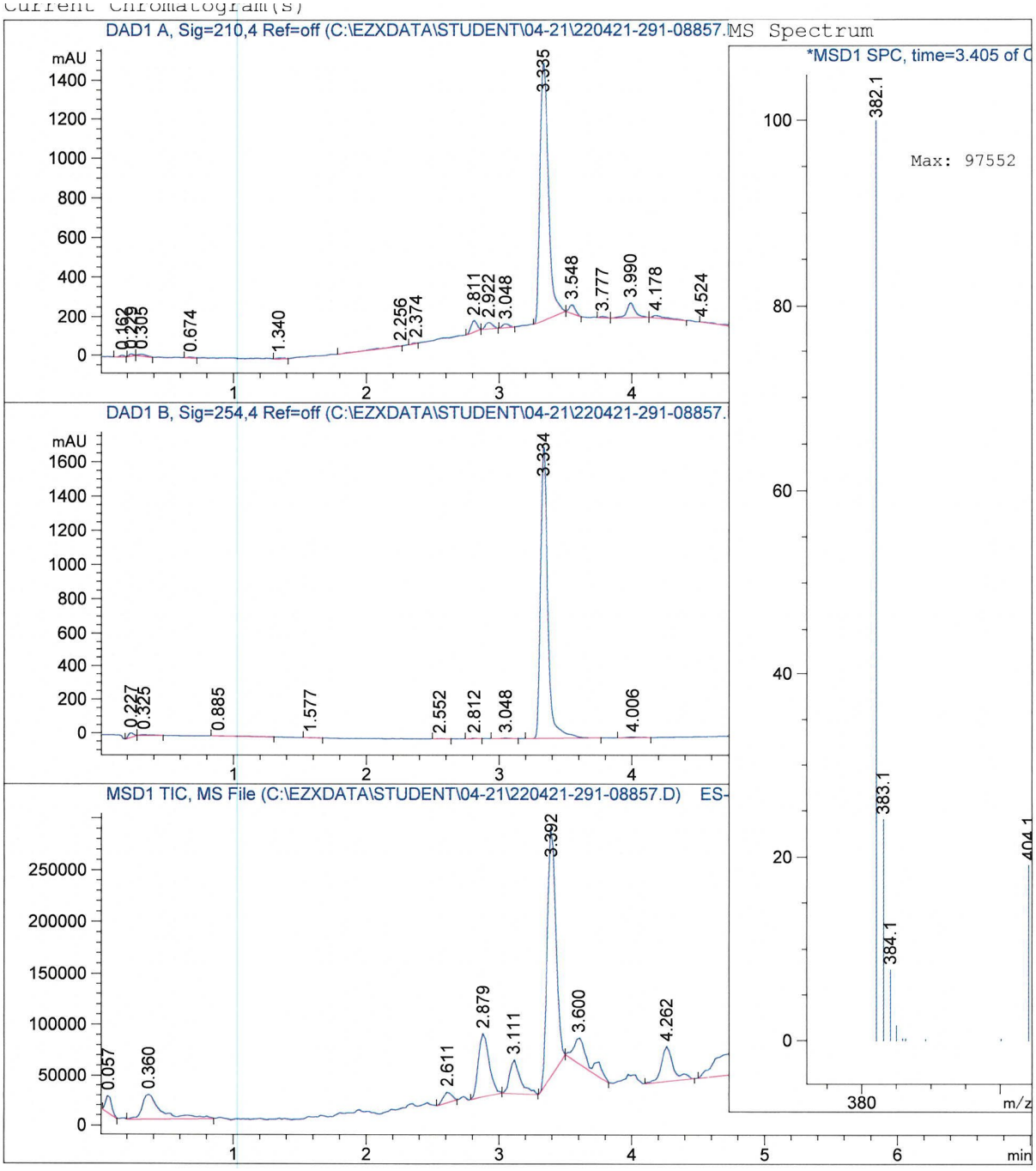


Result: 4.7% DCY

RG Nr: 24

5 mg Celecoxib, 5 mol% Kerr PF6, THF, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.392 min)

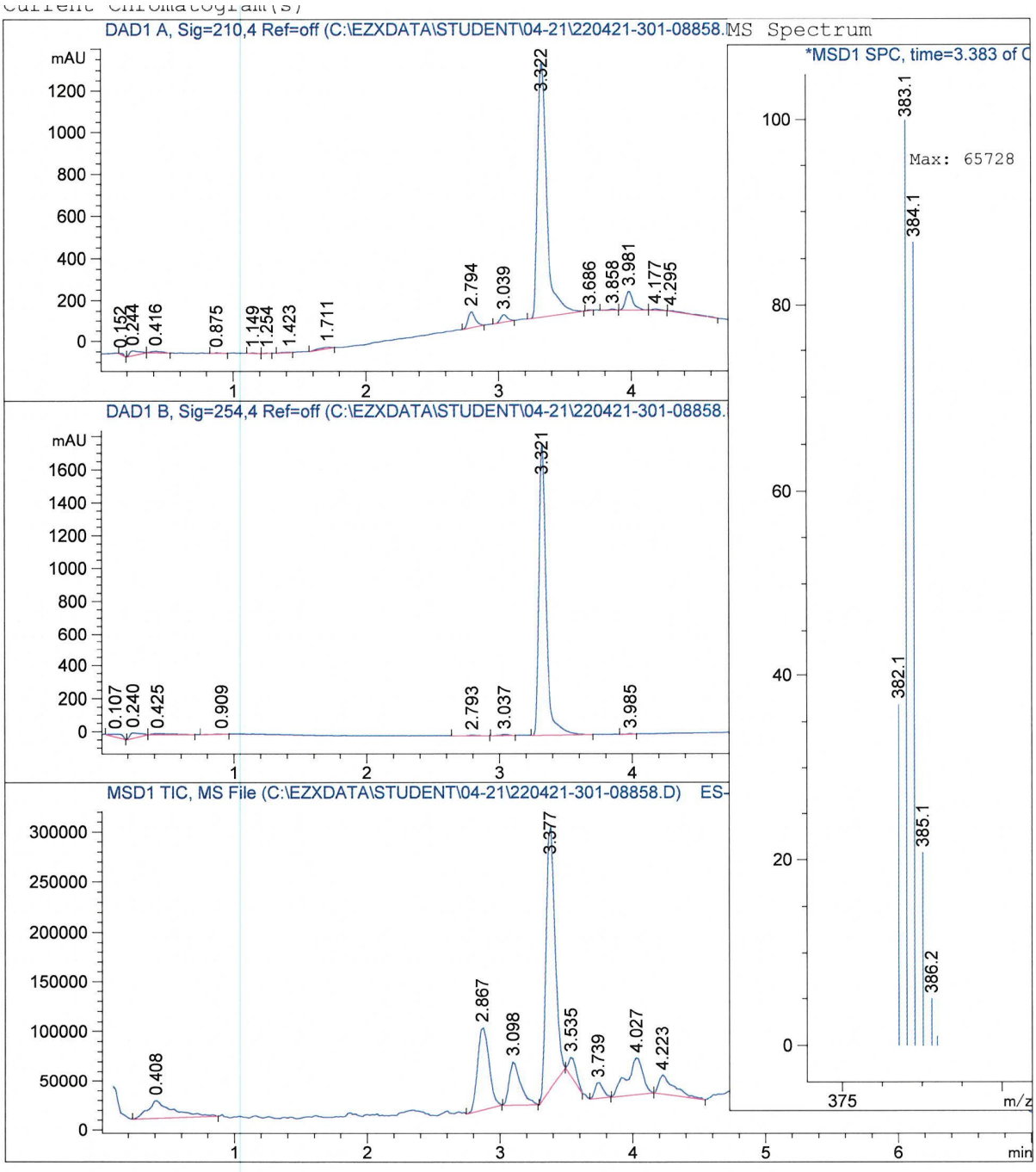


Result: 2.8% DCY

RG Nr:25

5 mg Celecoxib, 5 mol% Kerr PF6, MeTHF, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.377 min)

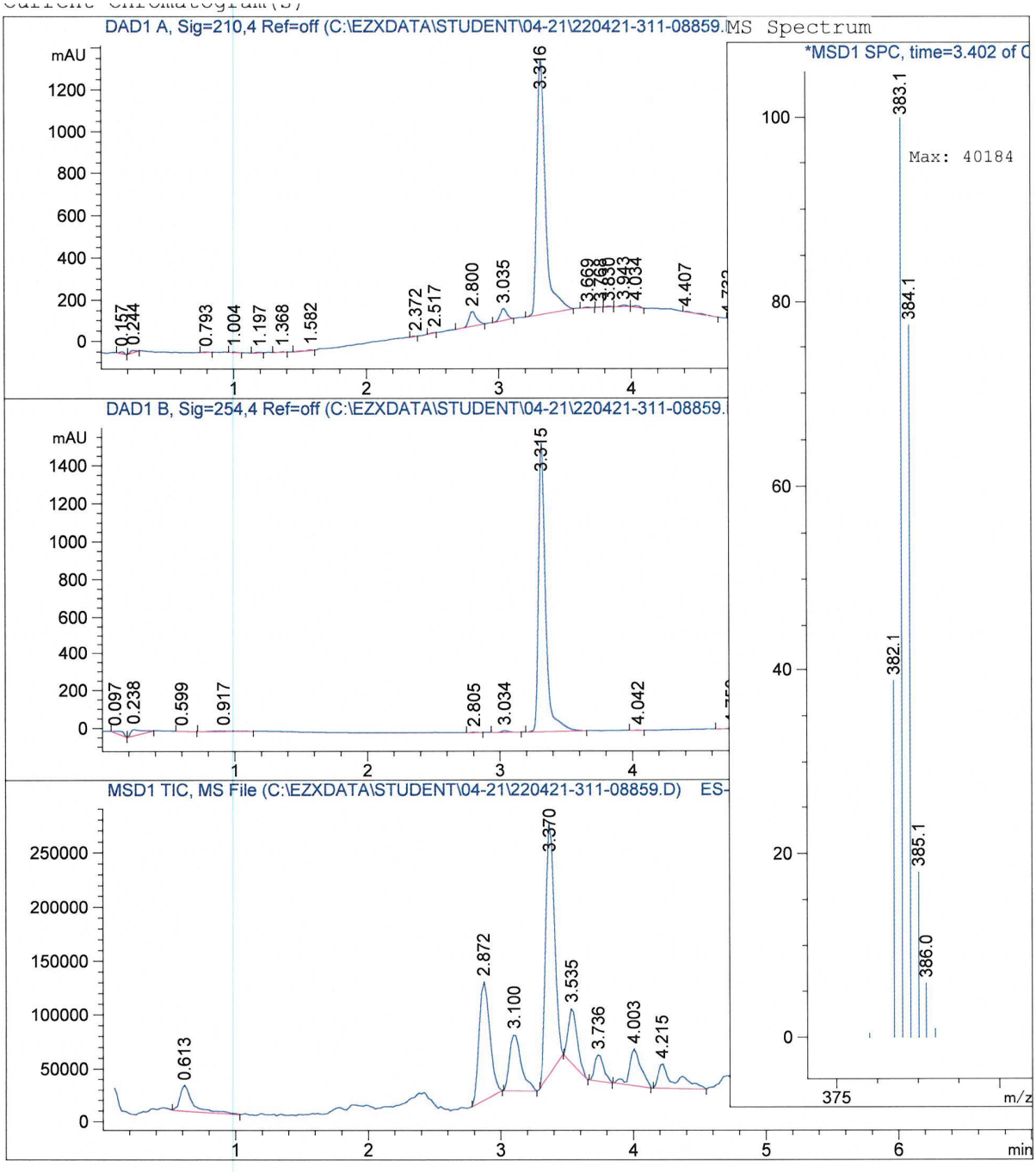


Result: 55.1% DCY

RG Nr: 26

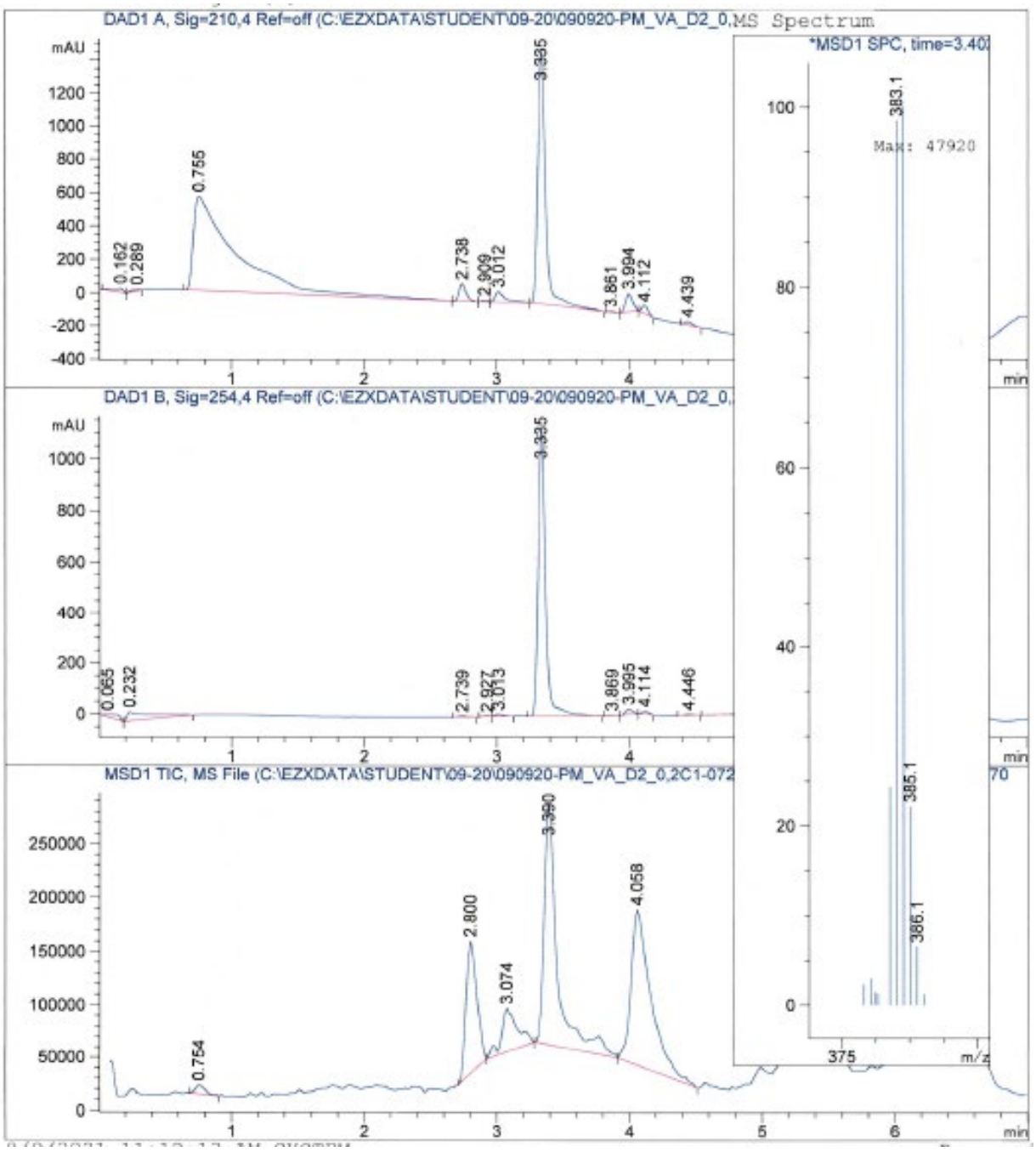
5 mg Celecoxib, 5 mol% Kerr PF6, MTBE, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.370 min)



Result: 55.1% DCY

RG Nr: 13
5 mg Celecoxib, 5 mol% Kerr BArF, Isopropyl acetate, 1Eq D_2, 2h RT:
LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.370 min)

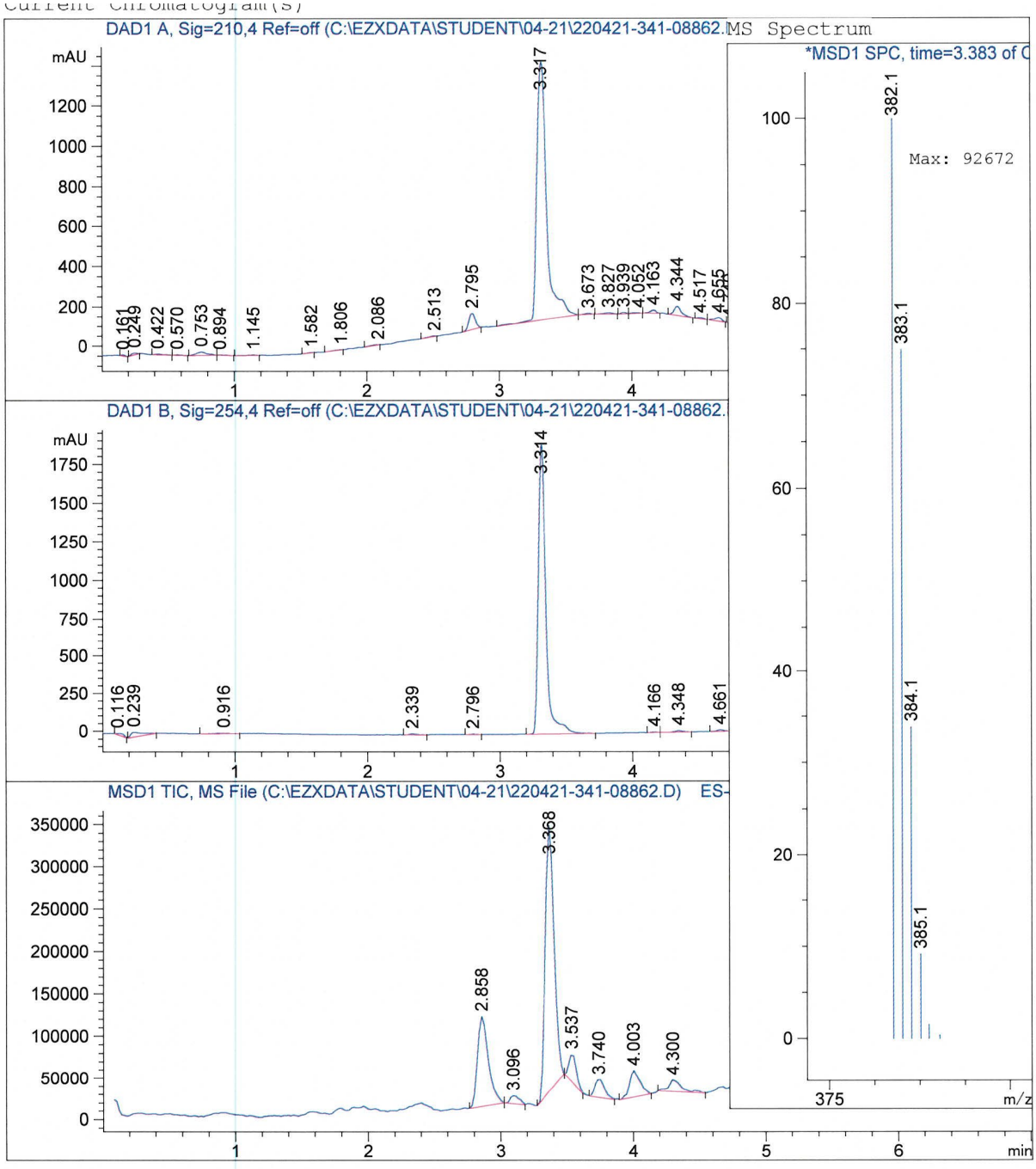


Result: 63.1% DCY

RG Nr: 27

5 mg Celecoxib, 5 mol% Kerr PF6, MeOH, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.368 min)

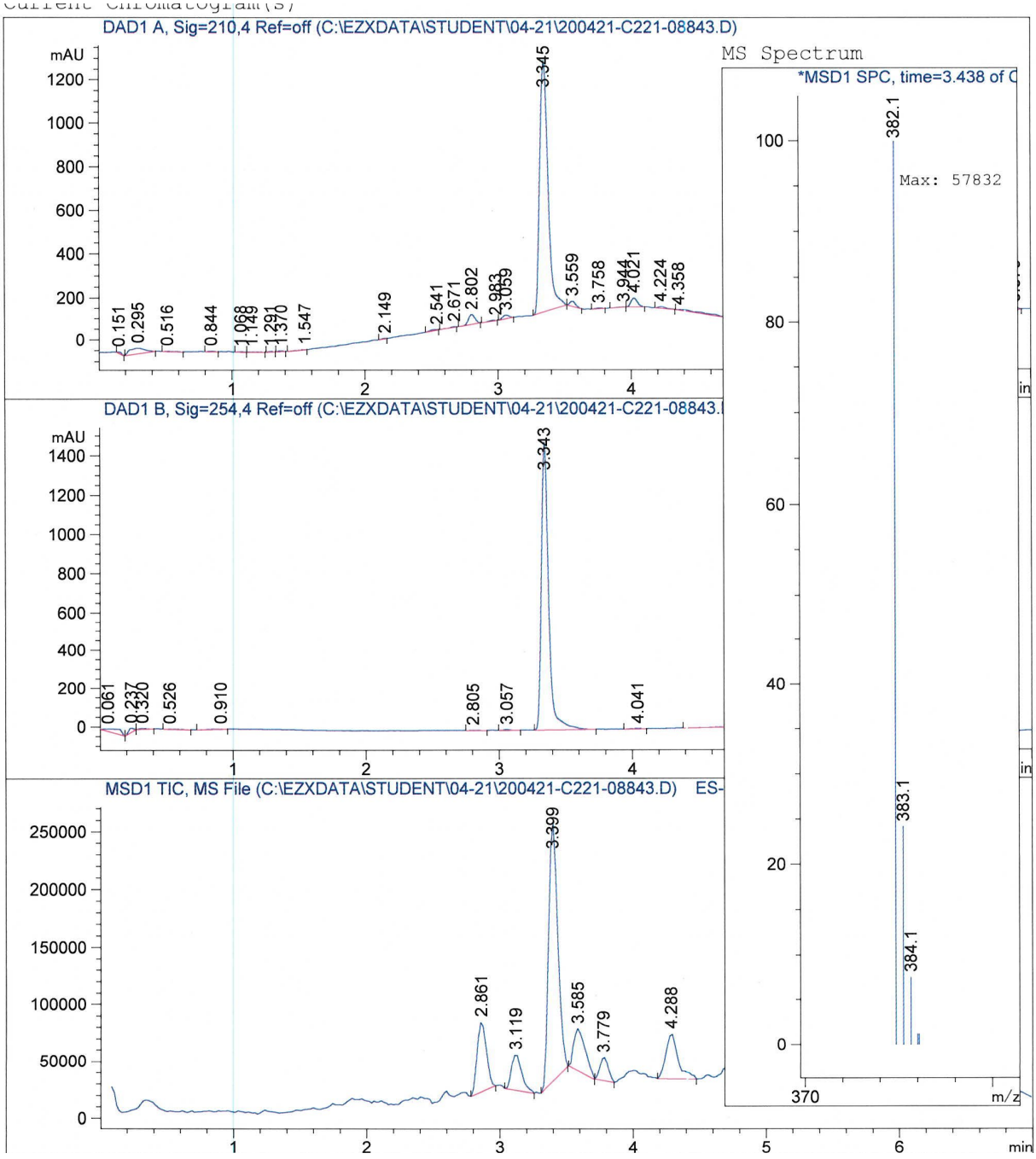


Result: 25.5% DCY

RG Nr: 28

5 mg Celecoxib, 5 mol% Kerr BArF, THF, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.399 min)

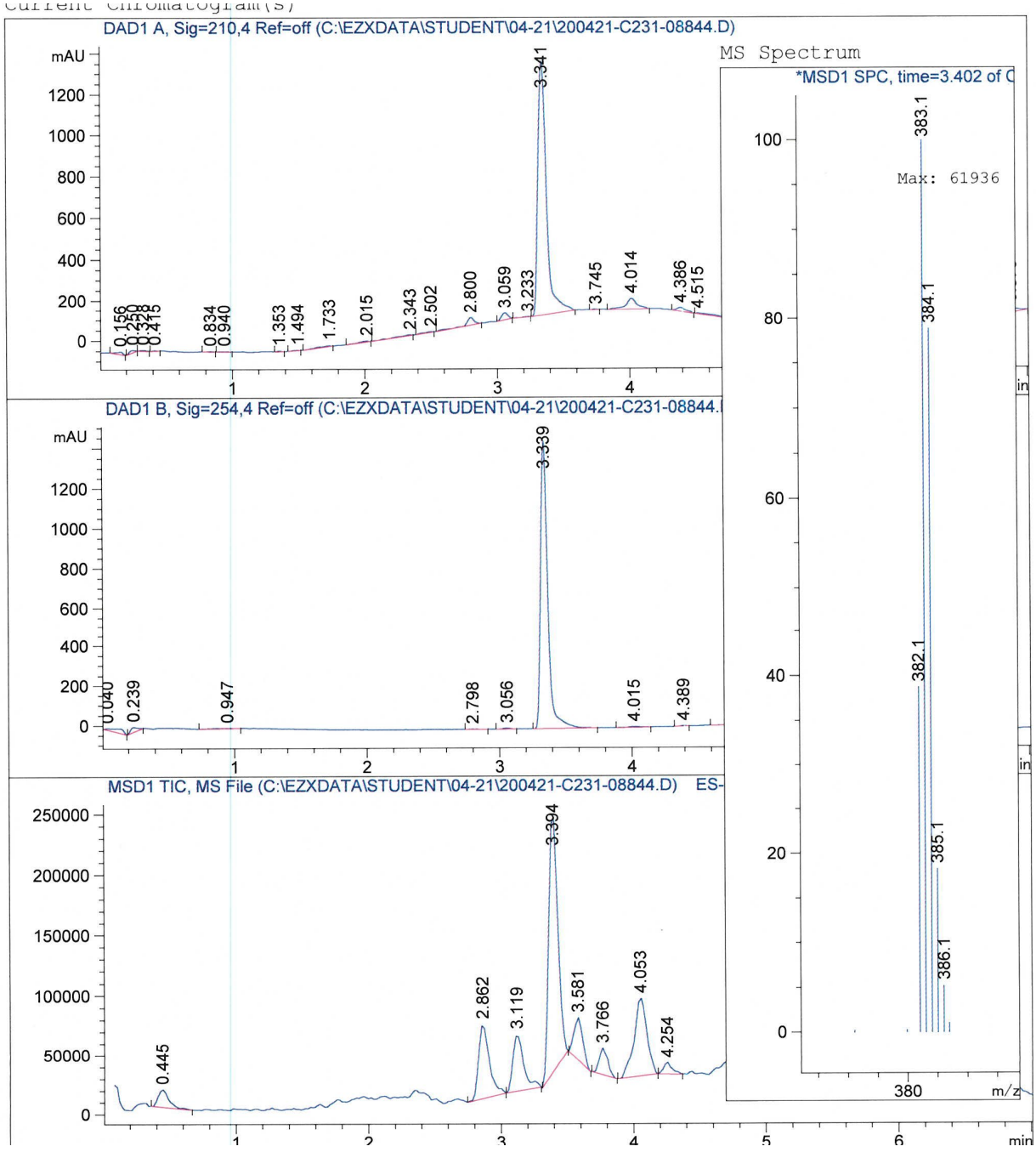


Result: 2.5% DCY

RG Nr: 29

5 mg Celecoxib, 5 mol% Kerr BArF, MeTHF, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.394 min)

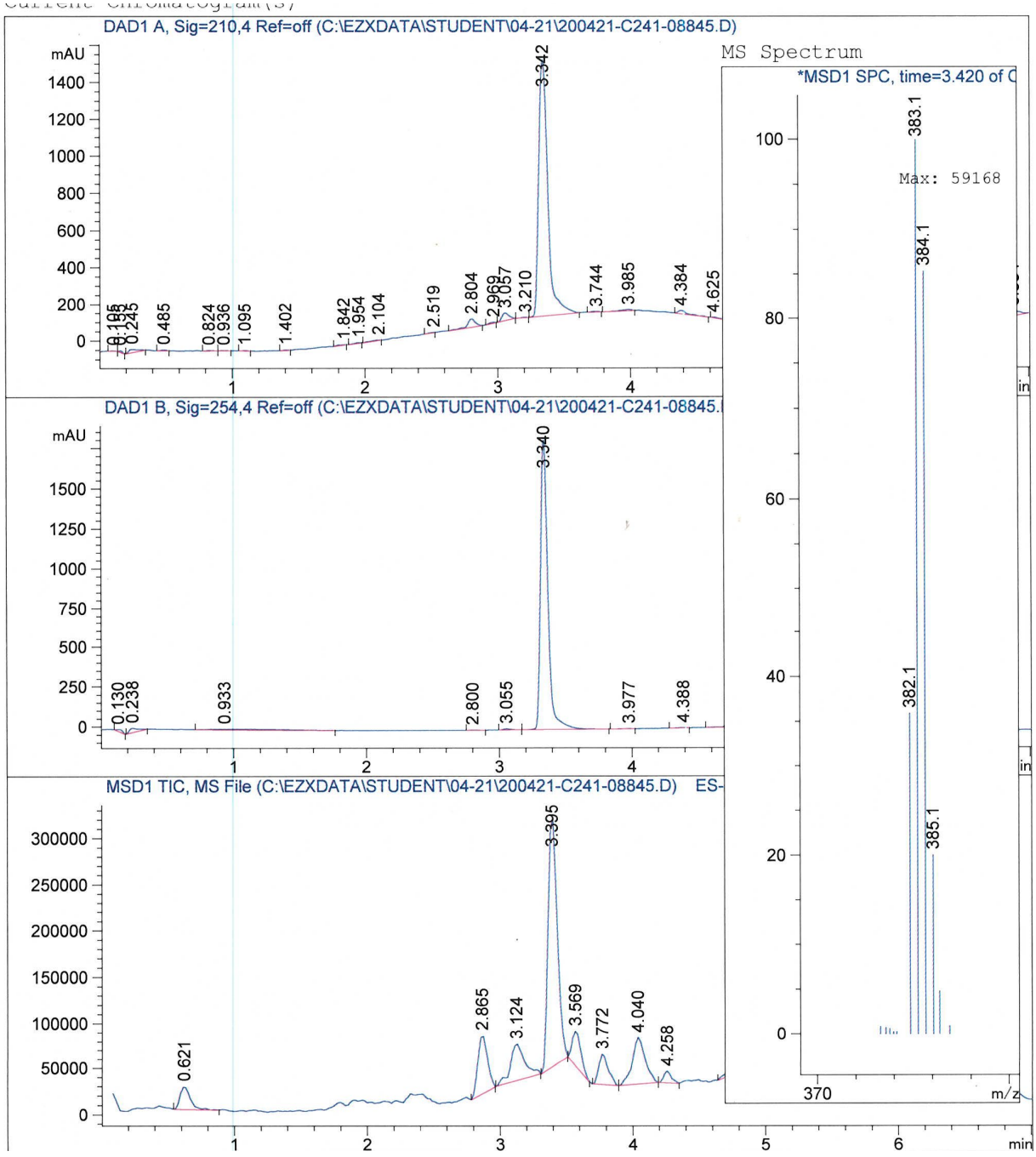


Result: 54.2% DCY

RG Nr: 30

5 mg Celecoxib, 5 mol% Kerr BArF, MTBE, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.395 min)

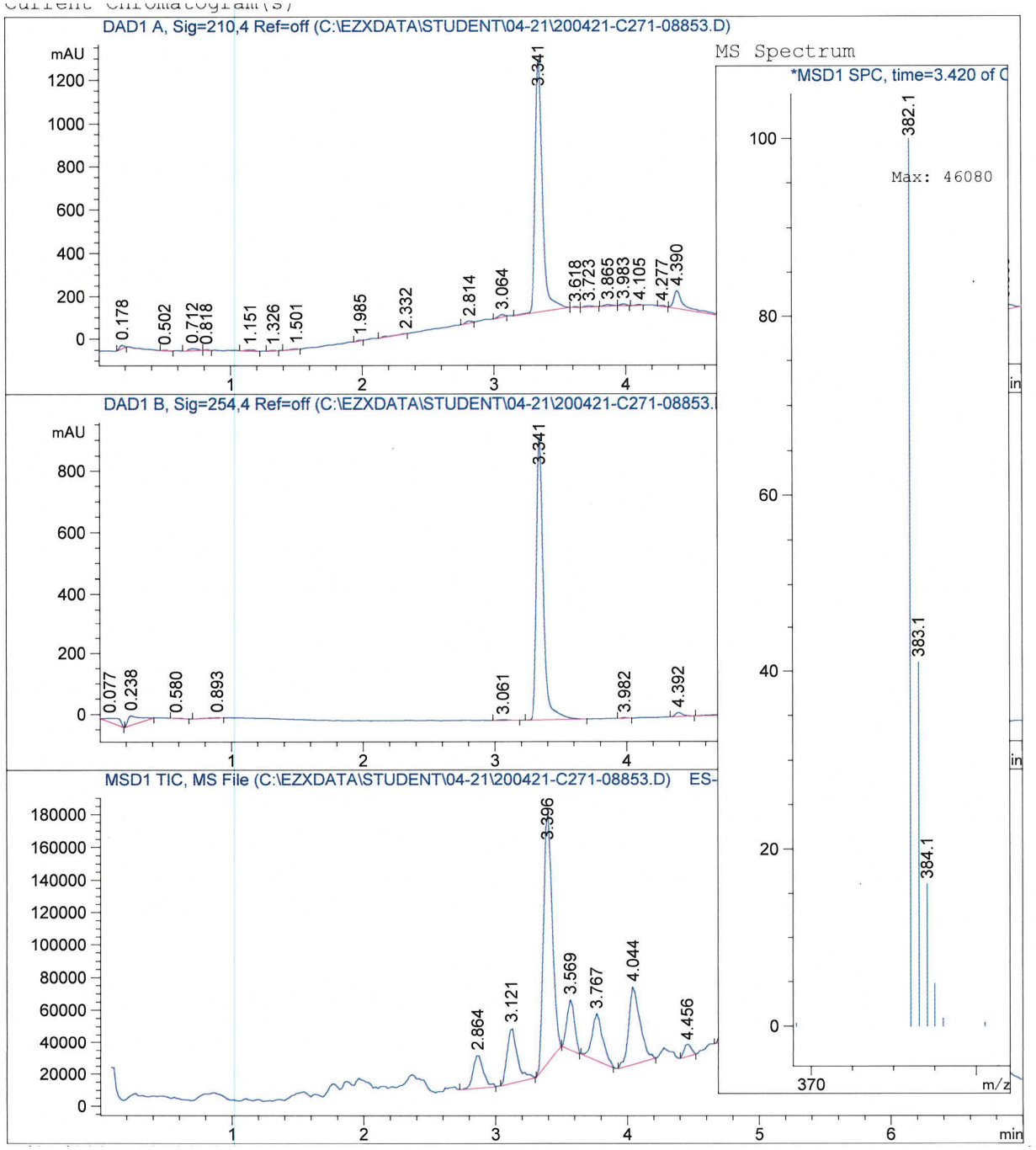


Result: 55.4% DCY

RG Nr: 31

5 mg Celecoxib, 5 mol% Kerr BArF, MeOH, 1Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.396 min)

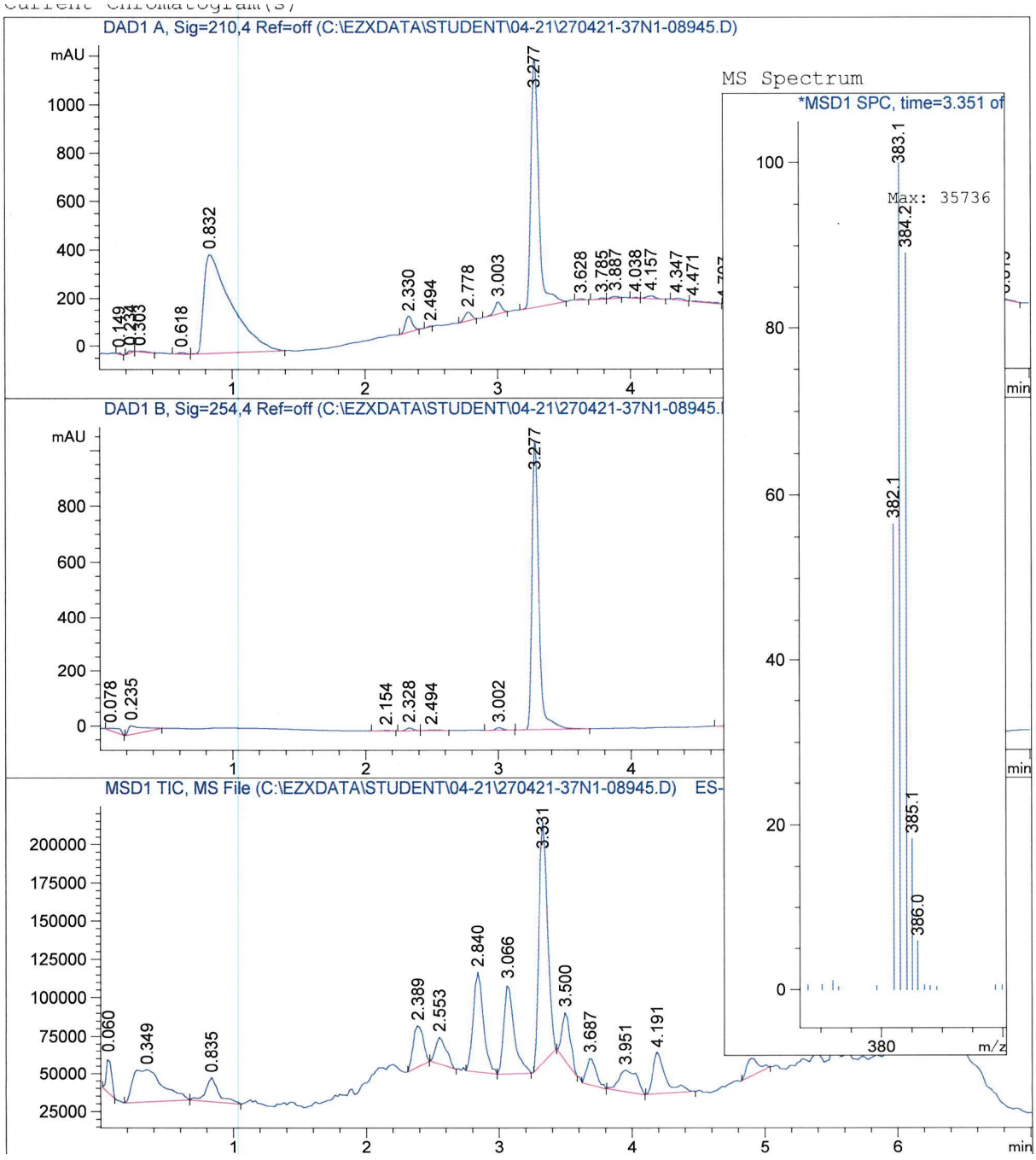


Result: 13.0%

RG Nr: 32

5 mg Celecoxib, 5 mol% Kerr BArF, Isopropyl acetate, 1 Eq D_2, 1h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.331 min)

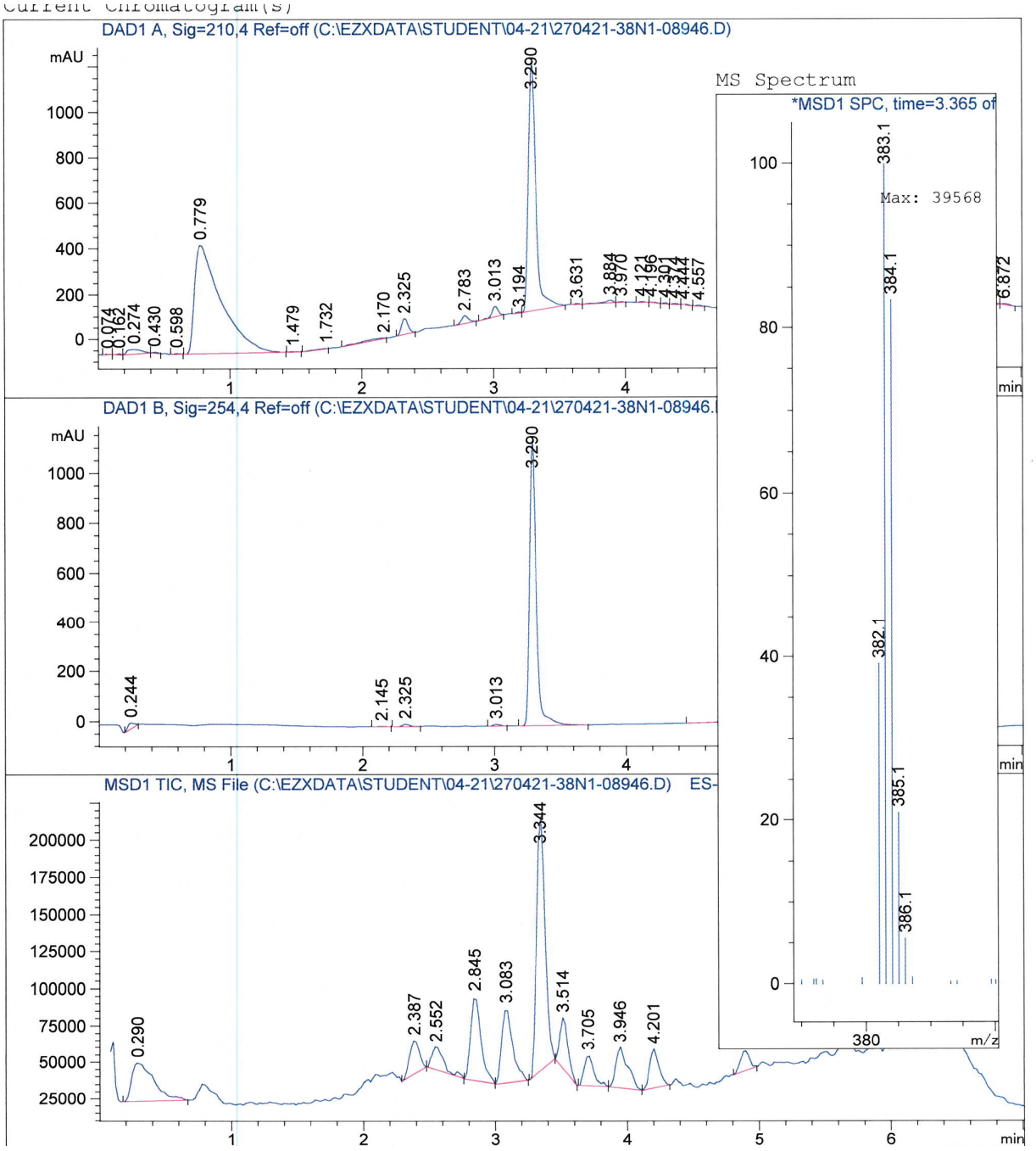


Result: 51.0% DCY

RG Nr: 33

5 mg Celecoxib, 5 mol% Kerr BArF, Isopropyl acetate, 1 Eq D_2, 4h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.344 min)

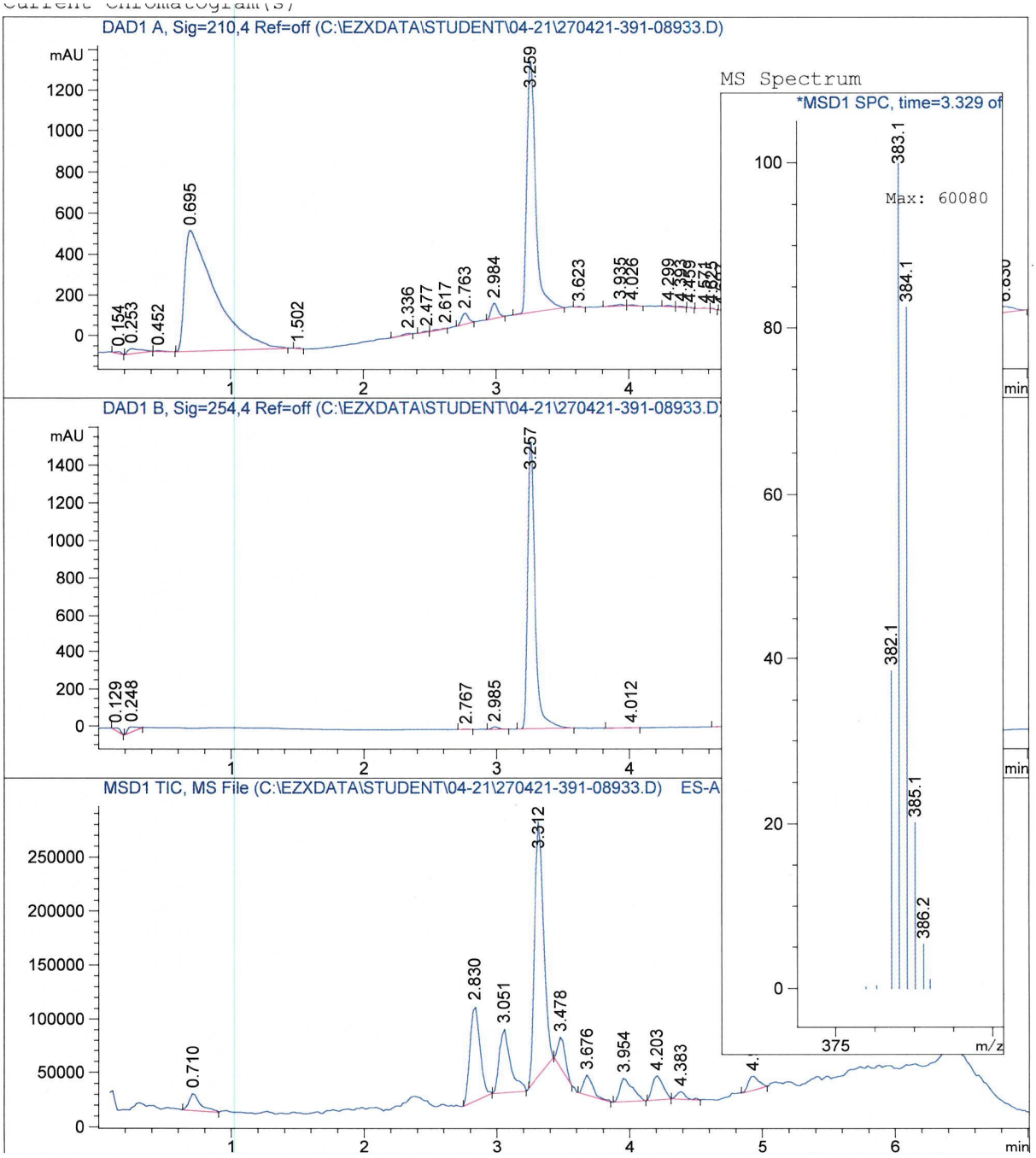


Result: 59.1% DCY

RG Nr: 34

5 mg Celecoxib, 5 mol% Kerr BArF, Isopropyl acetate, 1 Eq D_2, 8h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.312 min)

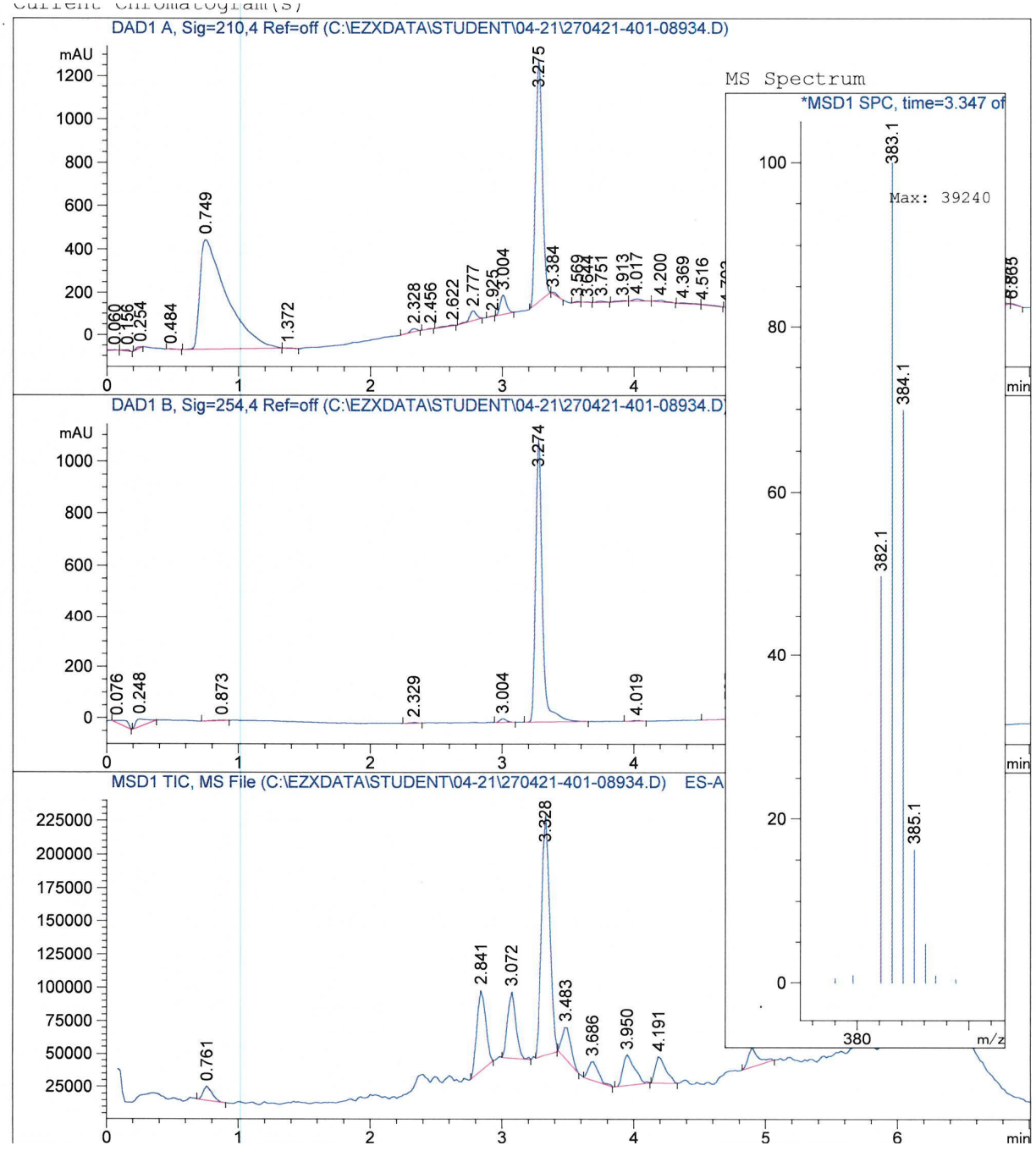


Result: 55.5% DCY

RG Nr:35

5 mg Celecoxib, 5 mol% Kerr BArF, Isopropyl acetate, 1 Eq D_2, 16h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.328 min)

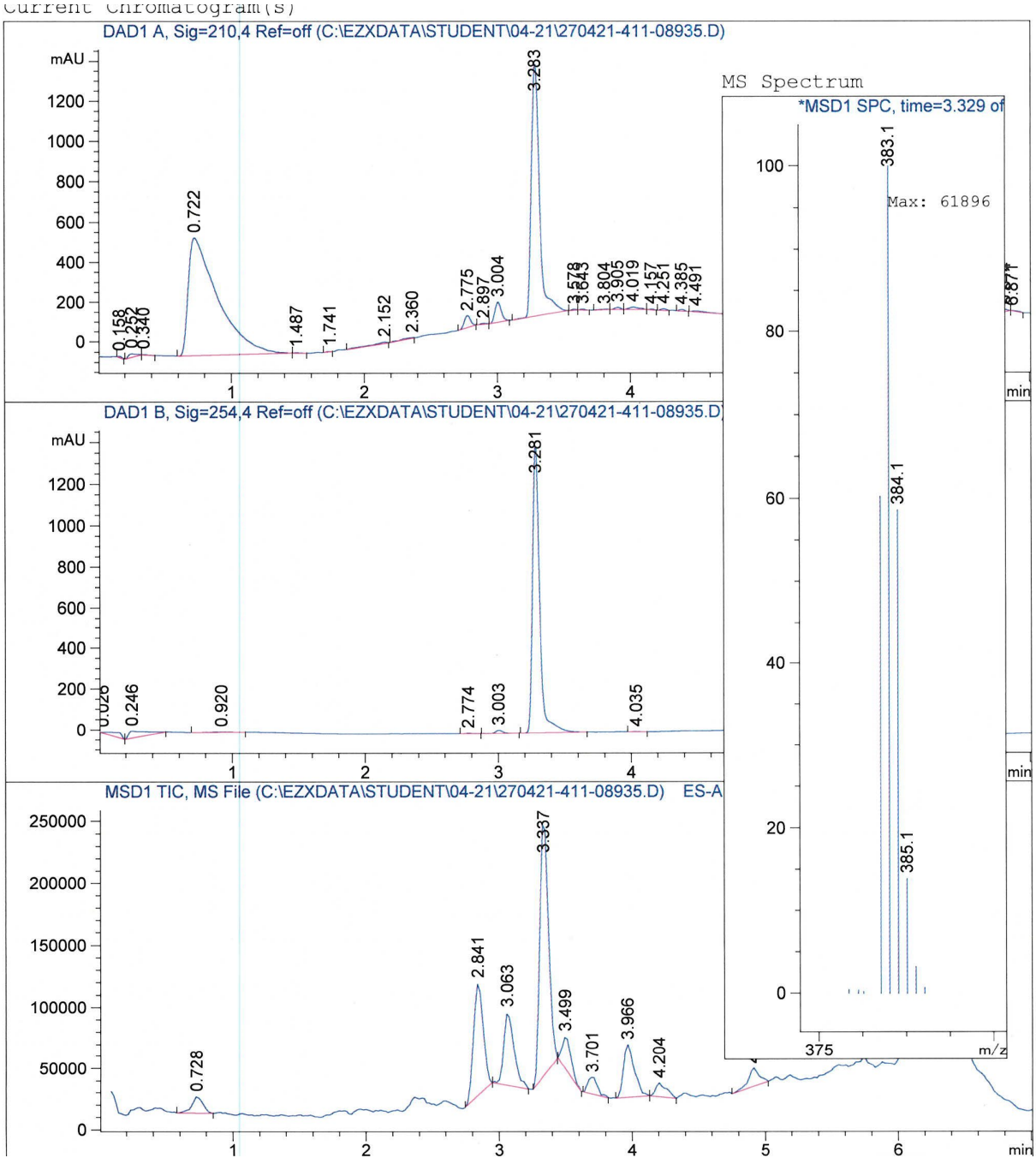


Result: 49.2% DCY

RG Nr: 36

5 mg Celecoxib, 5 mol% Kerr BArF, Isopropyl acetate, 1 Eq D_2, 24h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 3.337 min)



Result: 42.6% DCY

Screening of HIE reactions of 2-phenylbenzoxazole with catalyst 2, Table 1 in manuscript

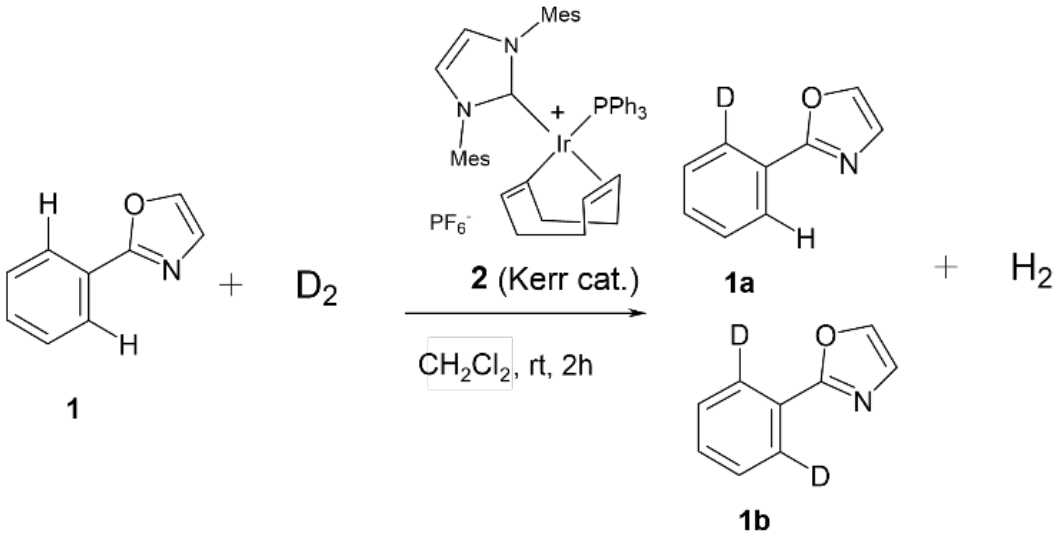


Table 1: Screening of HIE reactions of 2-phenylbenzoxazole with catalyst **2**[a,b]

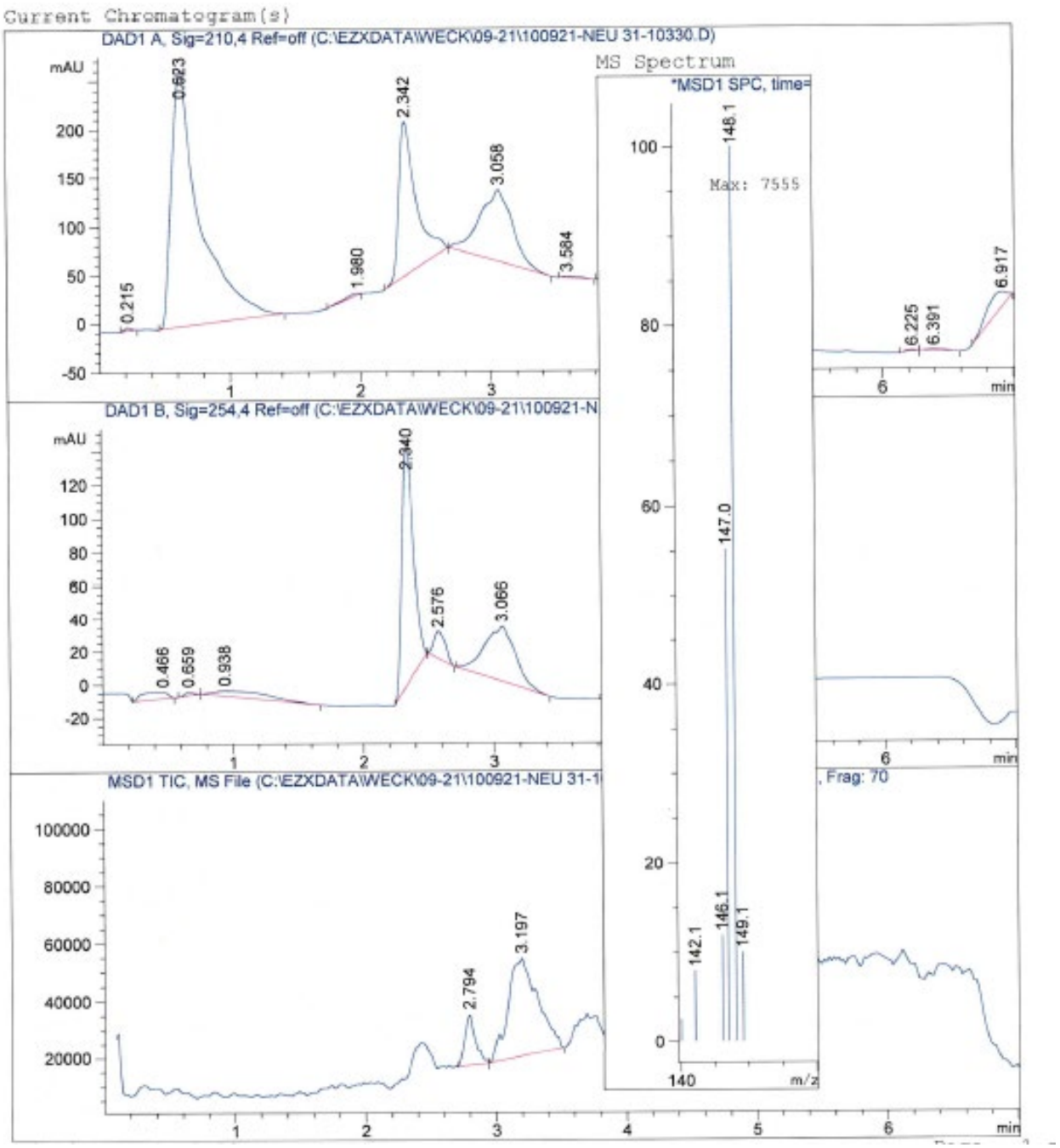
Entry	eq Deuterium	p(D_2) mbar	D_{max} (%) (**1a** +**1b**/2)	DCY (%)[c]
1	5.0	25	75	15
2	3.0	25	65	22
3	1.0	25	56	56
4	5.0	50	72	14
5	3.0	50	71	24
6	1.0	50	56	56
7	10	300	81	8

a) Conditions: catalyst-**2** (PF_6^-) (5 mol%); 0.018 mmol D_2 (25 mbar); b) 0.035 mmol D_2 (50 mbar), c) not isolated, yield considered 100%

General HIE protocol A:

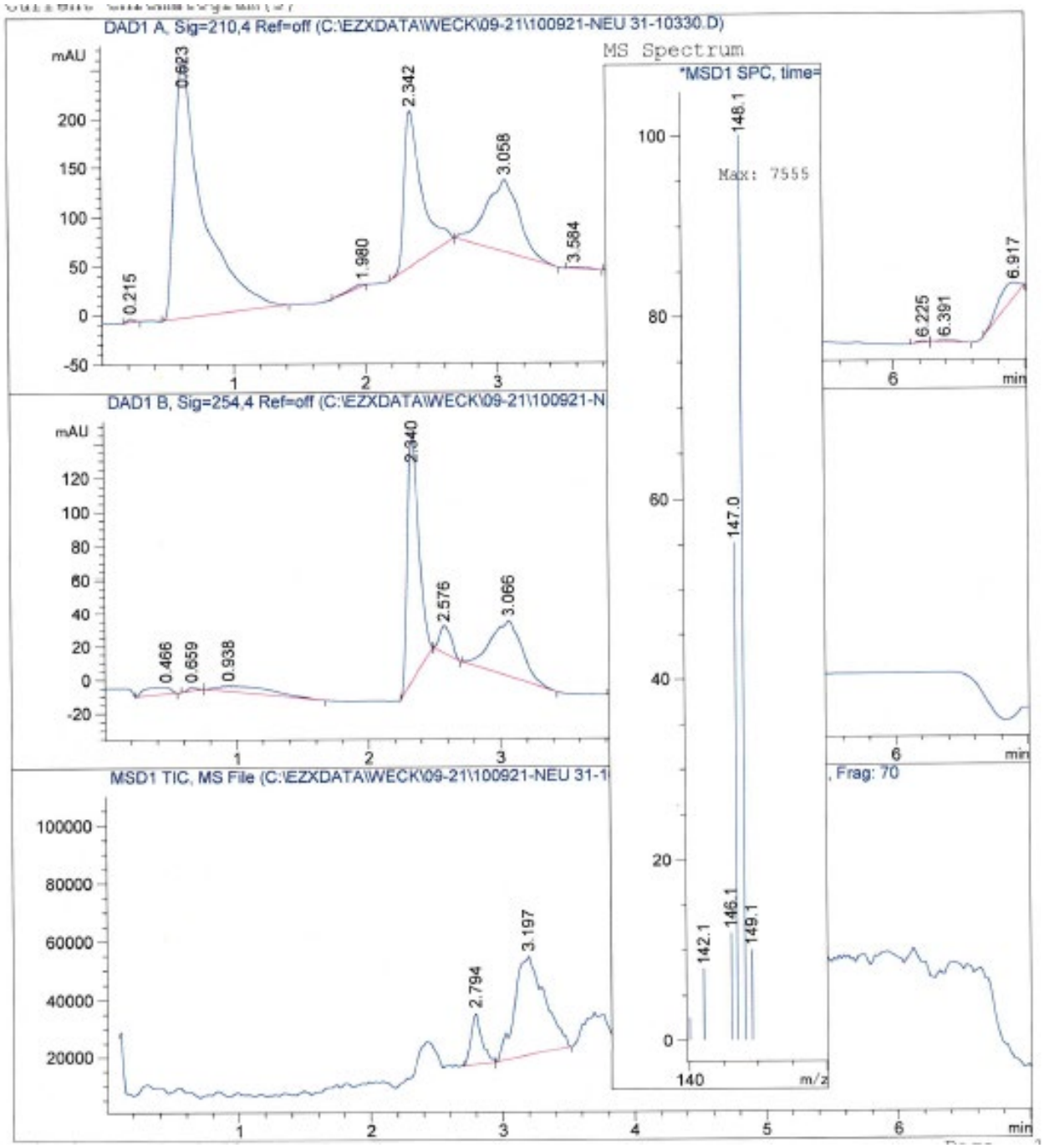
Substrate (1 eq.) and catalyst (5mol%, 0.05 eq.) were dissolved in isopropyl acetate for a total volume of 1ml and added to a reaction flask with a stirring bar. The flasks were connected to a RC Tritec® deuterium manifold system, then frozen by liquid nitrogen and evacuated. A flask was filled with deuterium gas and evacuated. This was repeated thrice. Then the flask was filled with the desired amount of deuterium gas (1 eq. D_2, 25mbar or 50 mbar or 300 mbar) and sealed. The reaction was run for 2h at rt while stirring (500RPM). After two hours the reaction was stopped by disconnecting the flask. The reaction for each substrate was run thrice. The products were analyzed by LC/MS.

Table 1, entry 1:
0.24 mg 2-phenyloxazole, 5 mol% Kerr PF6, DCM, 1 Eq D_2, 2h RT:
LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.34 min)



Result: 15 % DCY

Table1, entry 2:
0,40 mg 2-phenyloxazole, 5 mol% Kerr PF6, DCM, 1 Eq D_2, 2h RT:
LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.34 min)

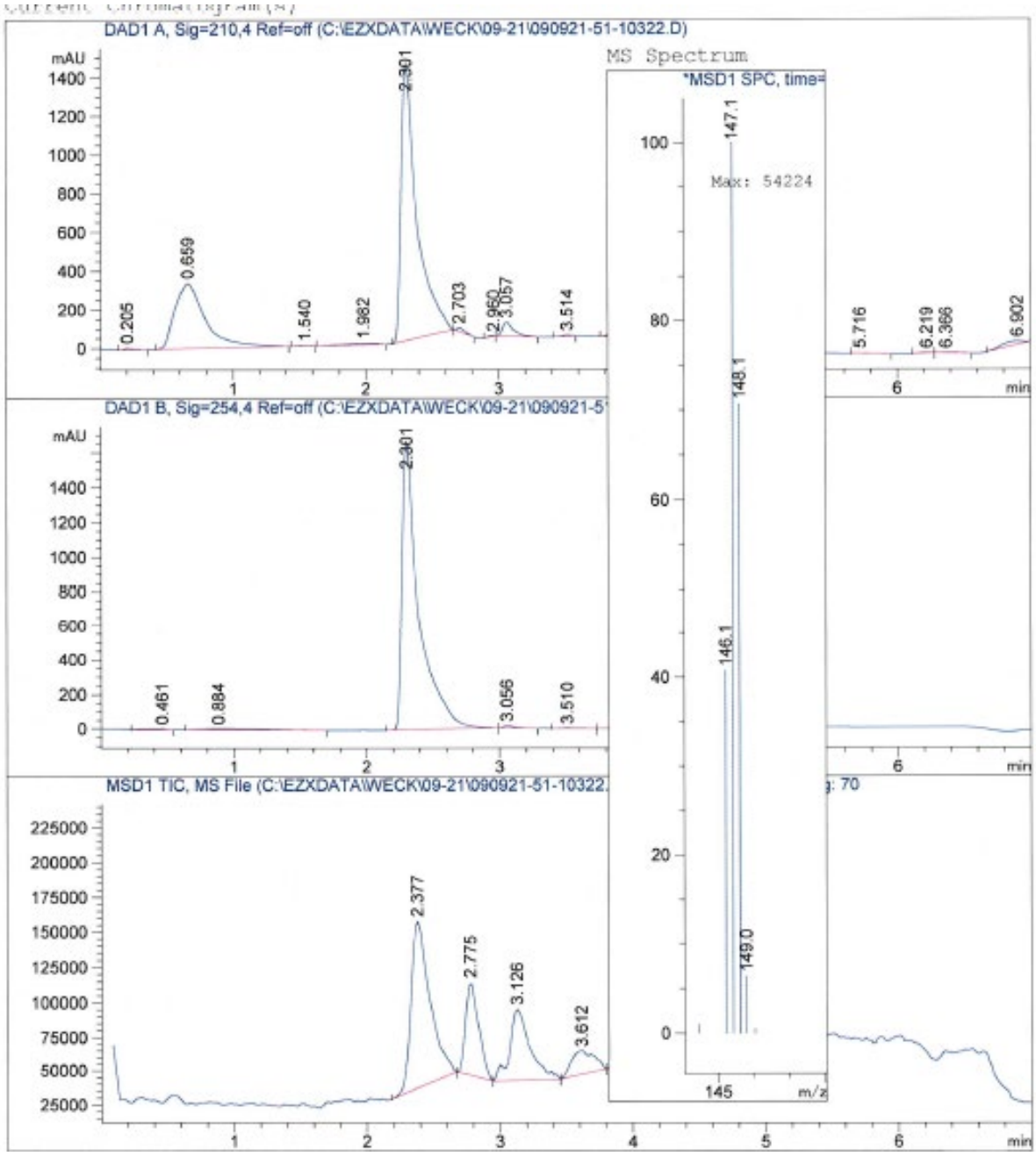


Result: 22 % DCY

Table1 entry3

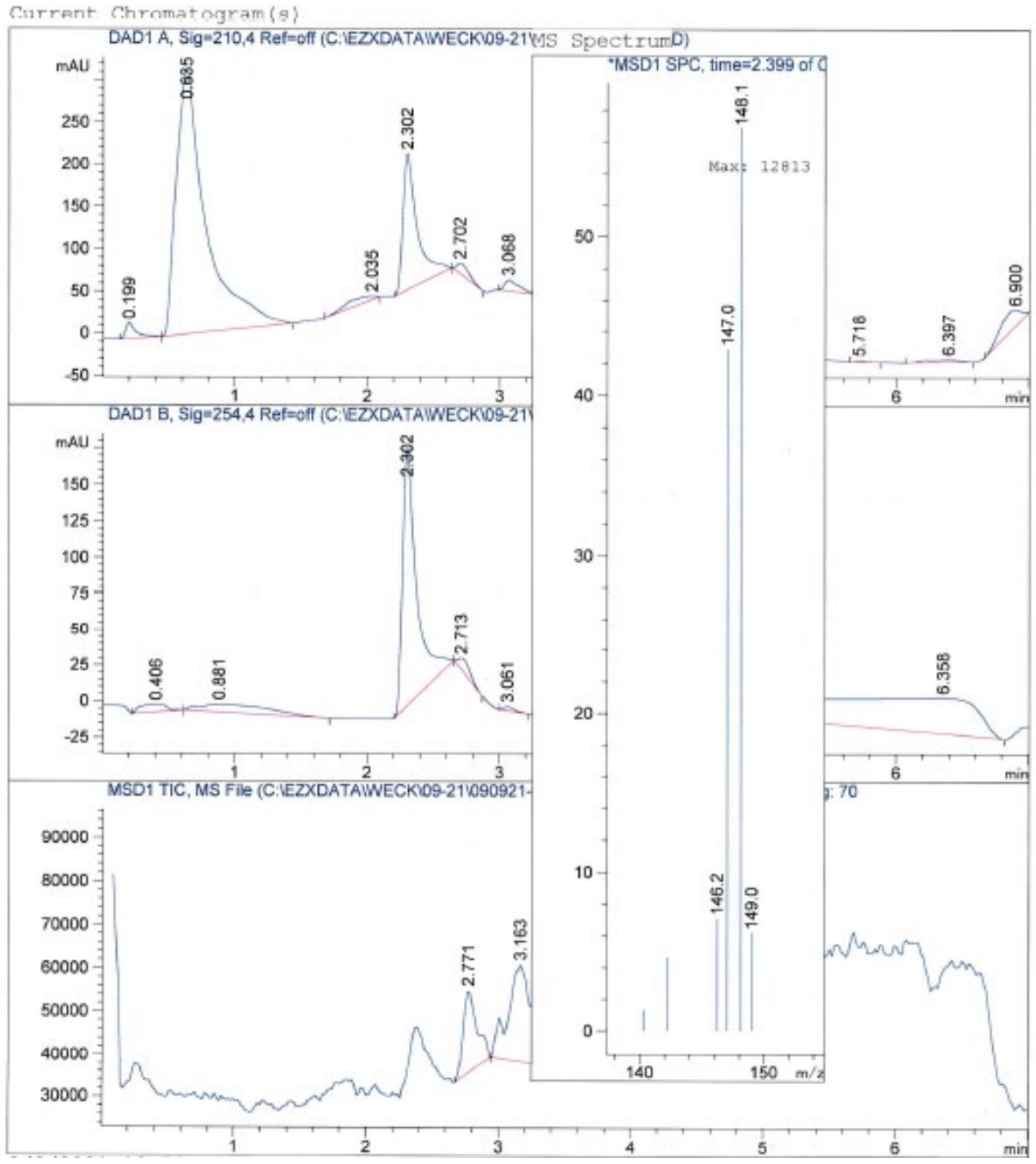
1,20 mg 2-phenyloxazole, 5 mol% Kerr PF6, DCM, 1 Eq D_2, 2h RT:

LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.30 min)



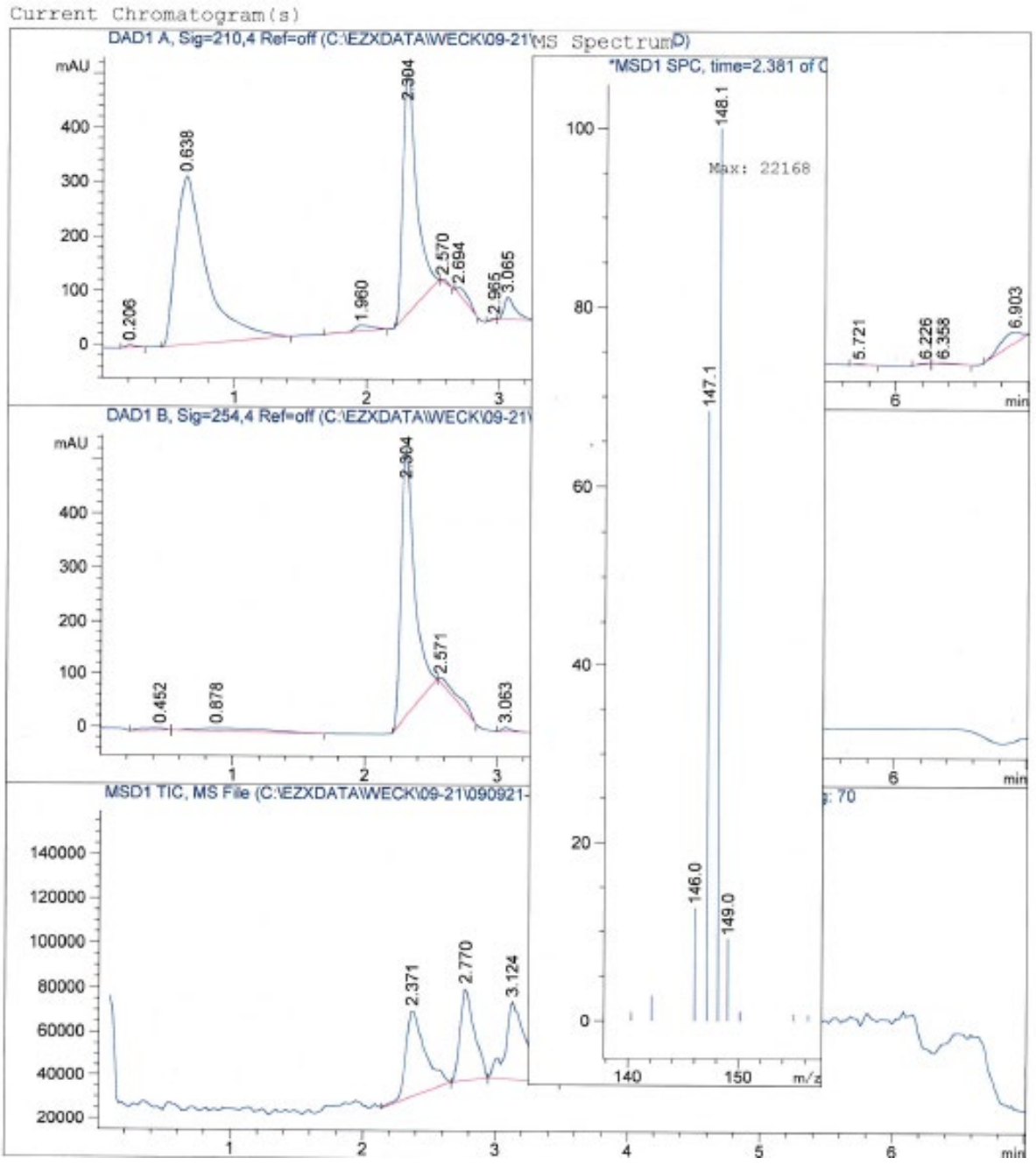
Result: 56 % DCY

Table1 entry 4
2,25 mg 2-phenyloxazole, 5 mol% Kerr PF6, DCM, 1 Eq D_2, 2h RT:
LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.30 min)



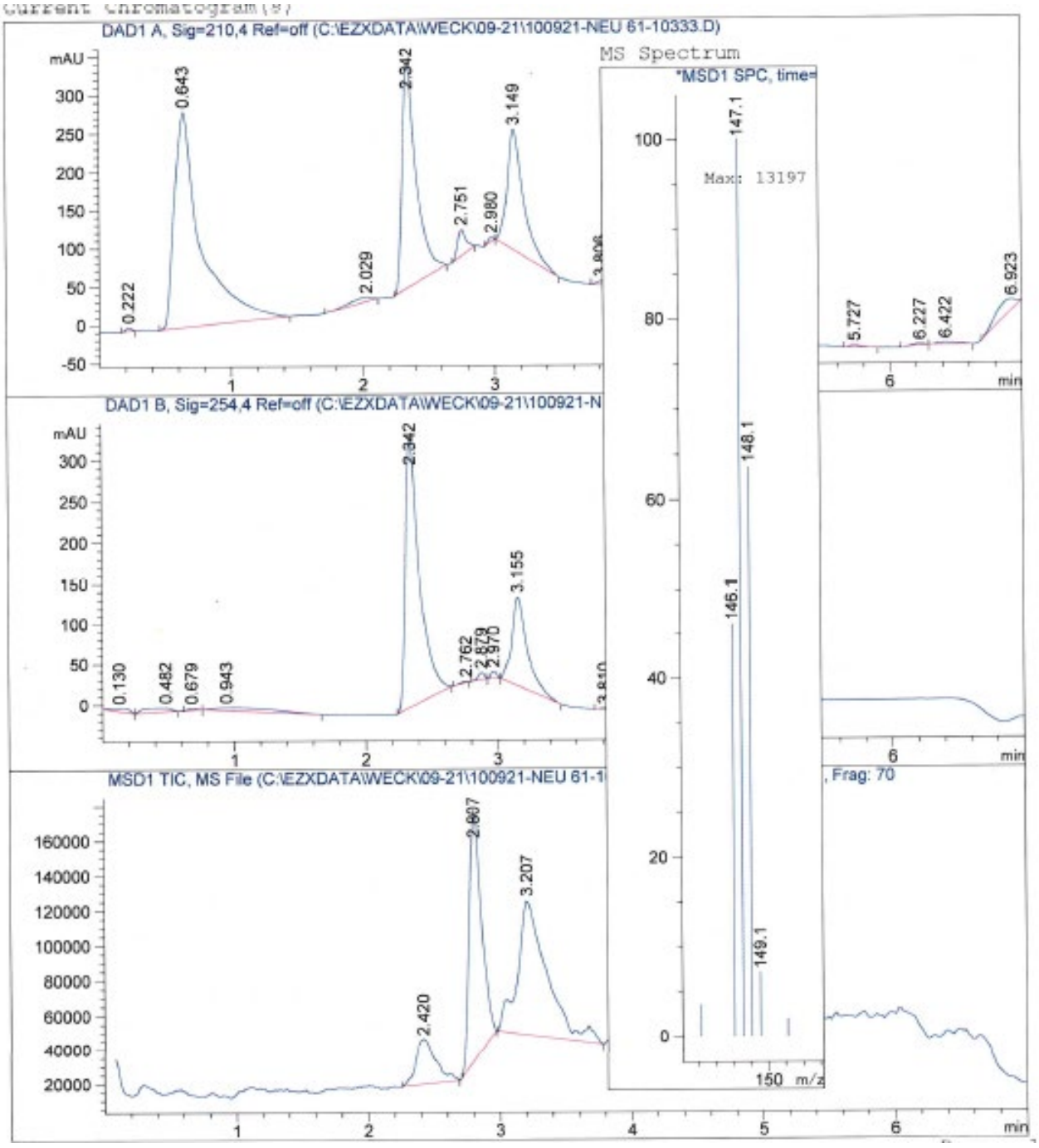
Result: 14 % DCY

Table1 entry 5
0,75 mg 2-phenyloxazole, 5 mol% Kerr PF6, DCM, 1 Eq D_2, 2h RT:
LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.30 min)



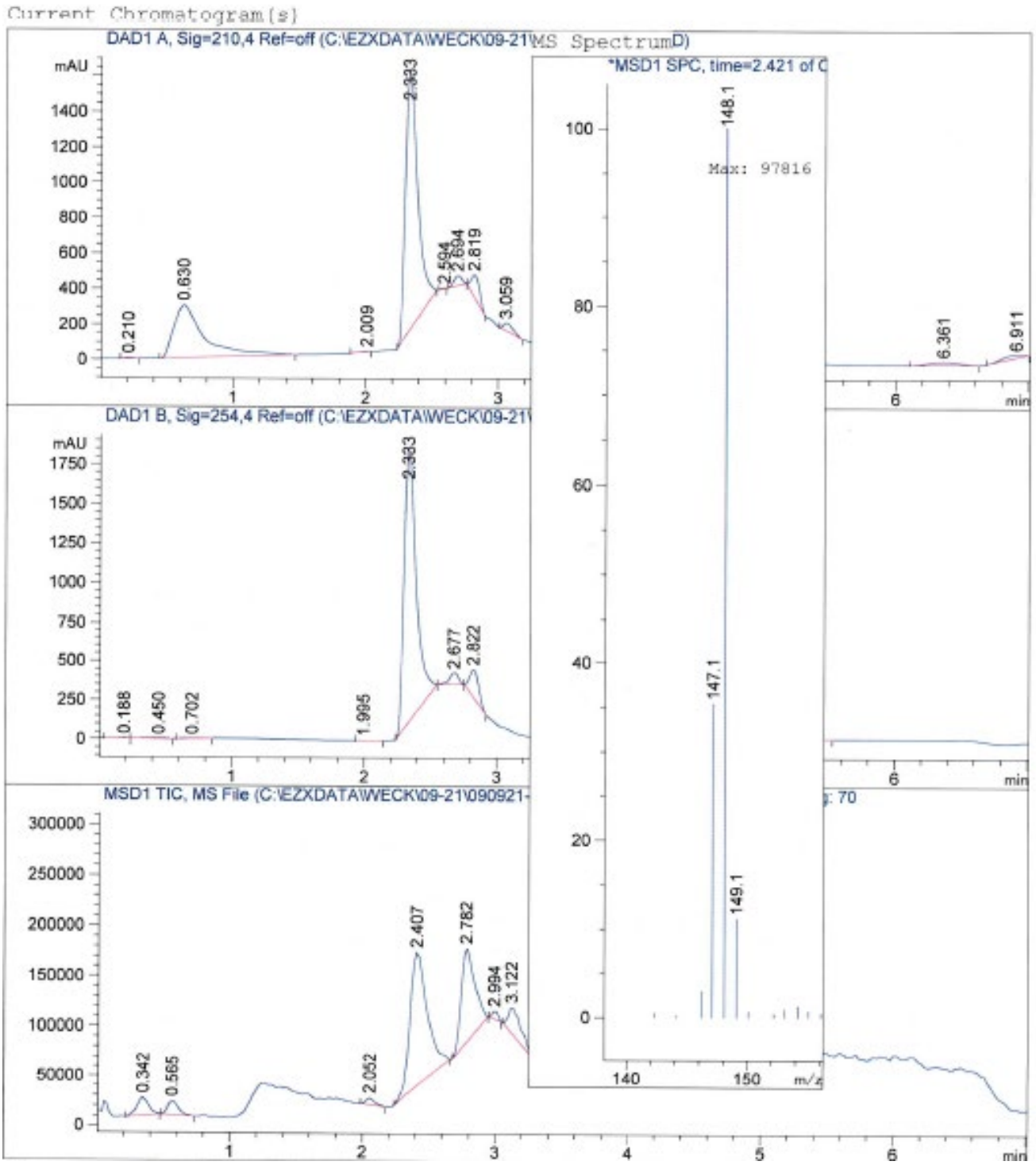
Result: 24 % DCY

Table1 entry 6
0,45 mg 2-phenyloxazole, 5 mol% Kerr PF6, DCM, 1 Eq D_2, 2h RT:
LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.30 min)



Result: 56 % DCY

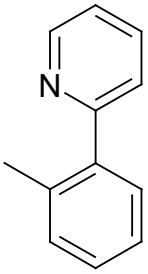
Table1 entry 7
1,30 mg 2-phenyloxazole, 5 mol% Kerr PF6, DCM, 1 Eq D_2, 2h RT:
LC-MS Chromatogram: DAD1 = 210 nm; DAD2 =254 nm; MS-TIC and MS spectra (peak 2.30 min)



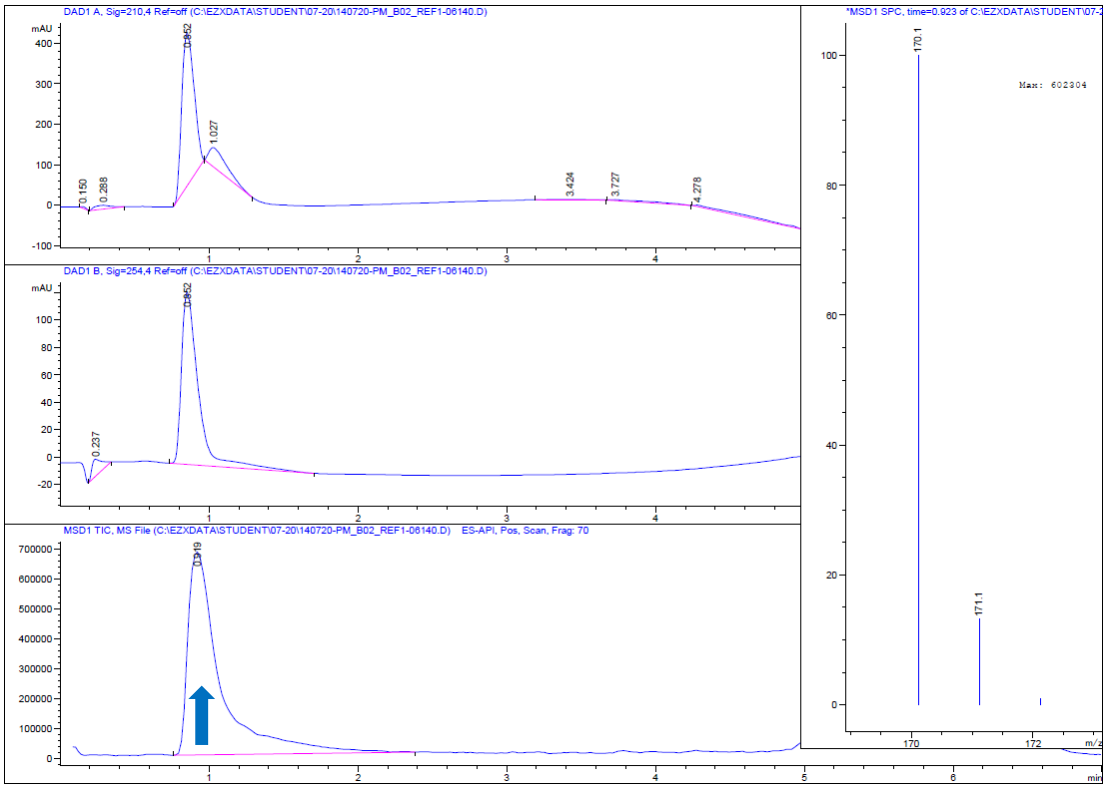
Result: 8 % DCY

Experimental details of scheme 2 in the manuscript:

Data for 2-(o-tolyl)pyridine **3**



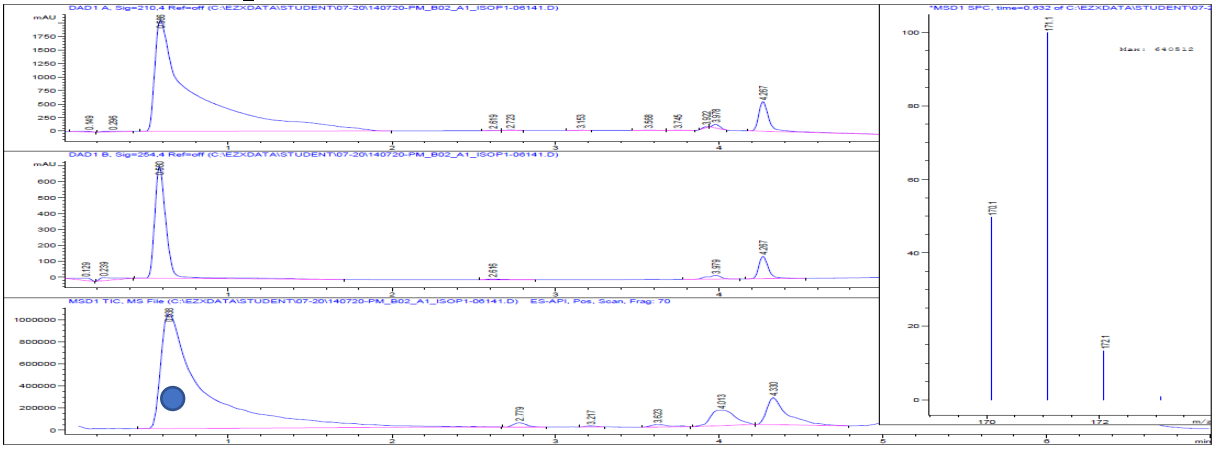
3



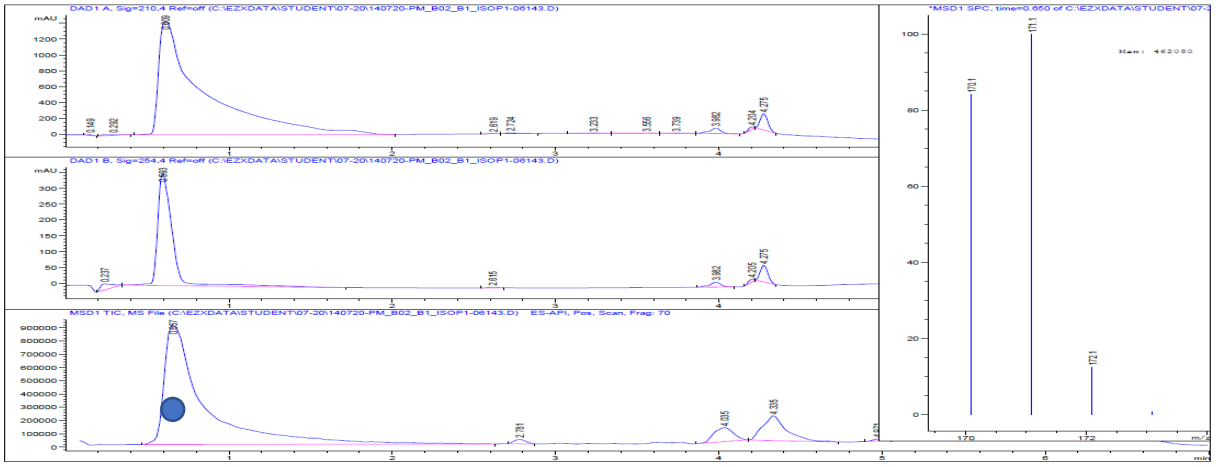
LC-MS (positive ESI): m/z 170.1 $[M+H]^+$ (100), 171.1 $[M+1+H]^+$ (13.2), 172.1 $[M+2+H]^+$ (0.9)

Deuterium experiments with 2-(o-tolyl)pyridine **3**

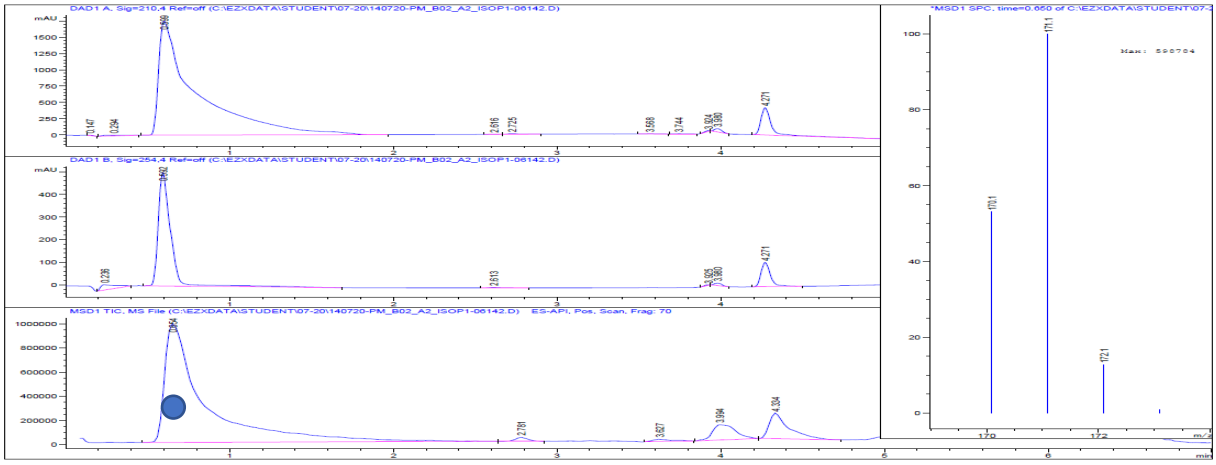
Method A (1 eq. D_2), workup C: 2.4 mg (14 µmol) 2-(o-tolyl)pyridine **3**



LC-MS (positive ESI): m/z 170.1 $[M+H]^+$ (49.7), 171.1 $[M(1D)+H]^+$ (100), 172.1 $[M(2D)+H]^+$ (13.4), 173.1 $[M(3D)+H]^+$ (0.8) : 67% D



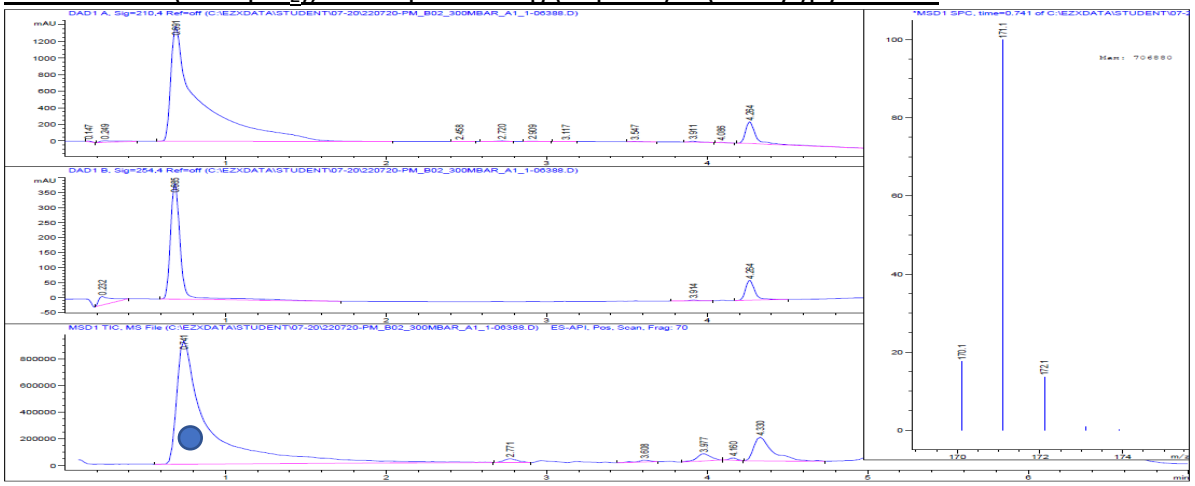
LC-MS (positive ESI): m/z 170.1 $[M+H]^+$ (84.2), 171.1 $[M(1D)+H]^+$ (100), 172.1 $[M(2D)+H]^+$ (12.5), 173.1 $[M(3D)+H]^+$ (0.7) : 54% D



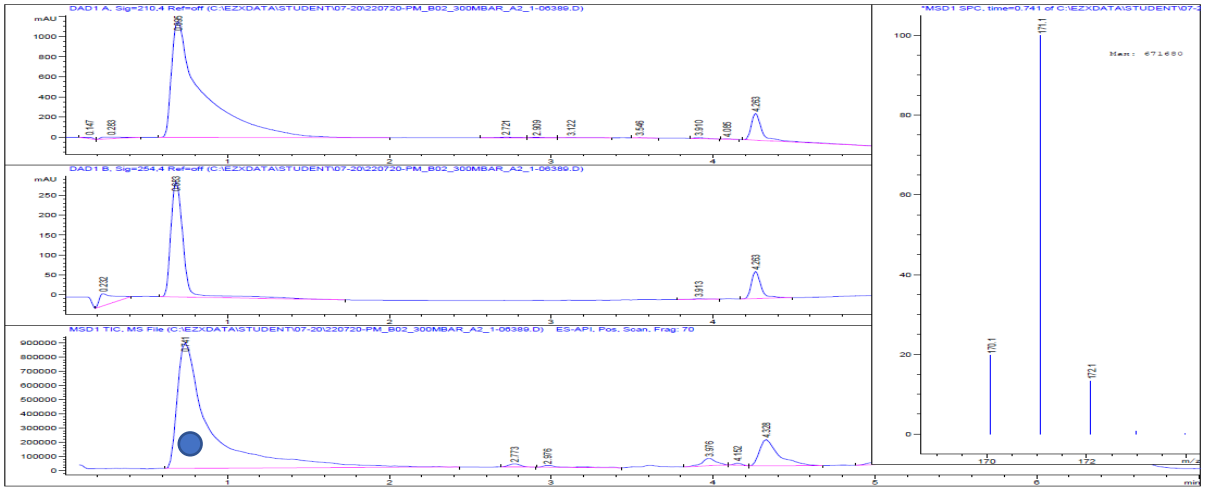
LC-MS (positive ESI): m/z 170.1 $[M+H]^+$ (43.2), 171.1 $[M(1D)+H]^+$ (100), 172.1 $[M(2D)+H]^+$ (12.9), 173.1 $[M(3D)+H]^+$ (0.8) : 68% D

Average of three reactions: 62% D, Yield: 83%, DCY: 26%

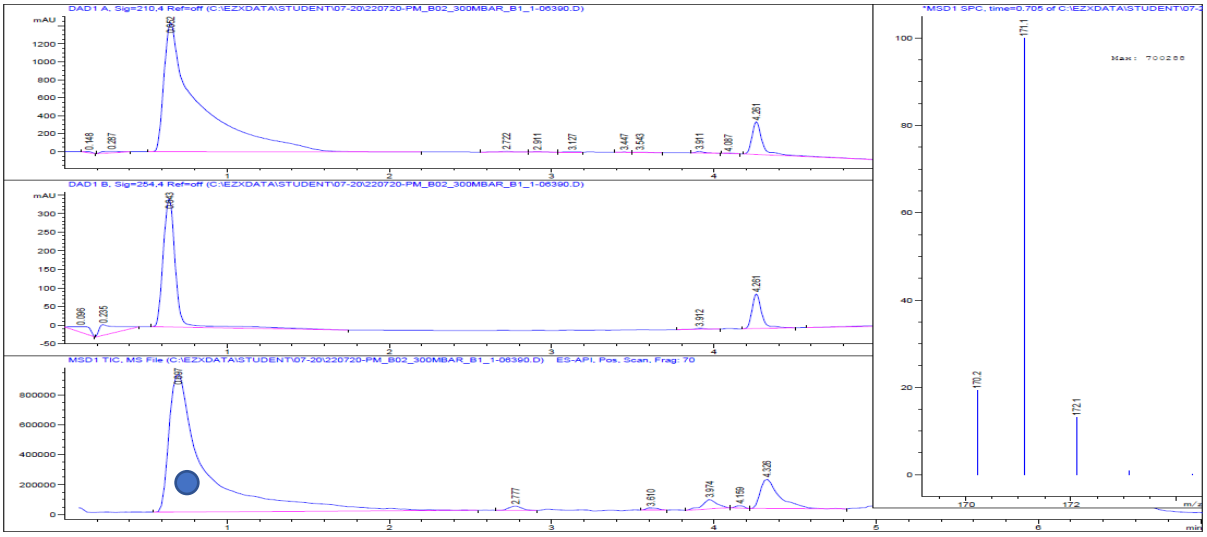
3: Method B (10 eq. D_2), workup C: 2.6mg (15µmol) 2-(o-tolyl)pyridine **3**



LC-MS (positive ESI): m/z 170.1 $[M+H]^+$ (17.6), 171.1 $[M(1D)+H]^+$ (100), 172.1 $[M(2D)+H]^+$ (13.6), 173.1 $[M(3D)+H]^+$ (0.9) : 86% D



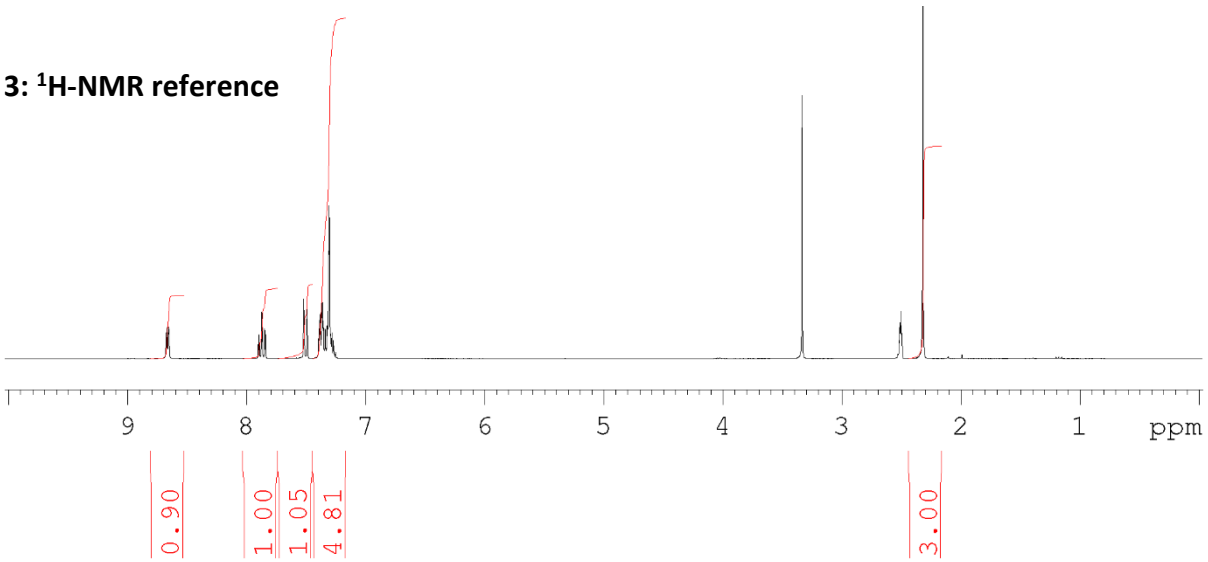
LC-MS (positive ESI): m/z 170.1 $[M+H]^+$ (19.7), 171.1 $[M(1D)+H]^+$ (100), 172.1 $[M(2D)+H]^+$ (13.3), 173.1 $[M(3D)+H]^+$ (0.8) : 84% D



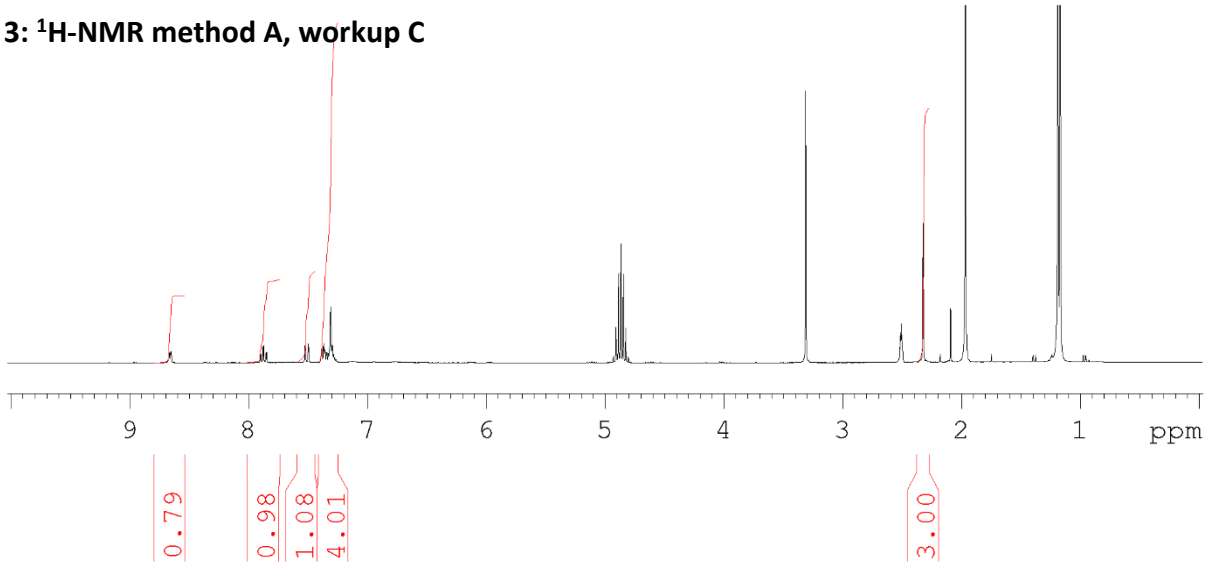
LC-MS (positive ESI): m/z 170.1 $[M+H]^+$ (19.3), 171.1 $[M(1D)+H]^+$ (100), 172.1 $[M(2D)+H]^+$ (13.1), 173.1 $[M(3D)+H]^+$ (0.9) : 84% D

Average of three reactions: 85% D, Yield: 96%, DCY: 4%

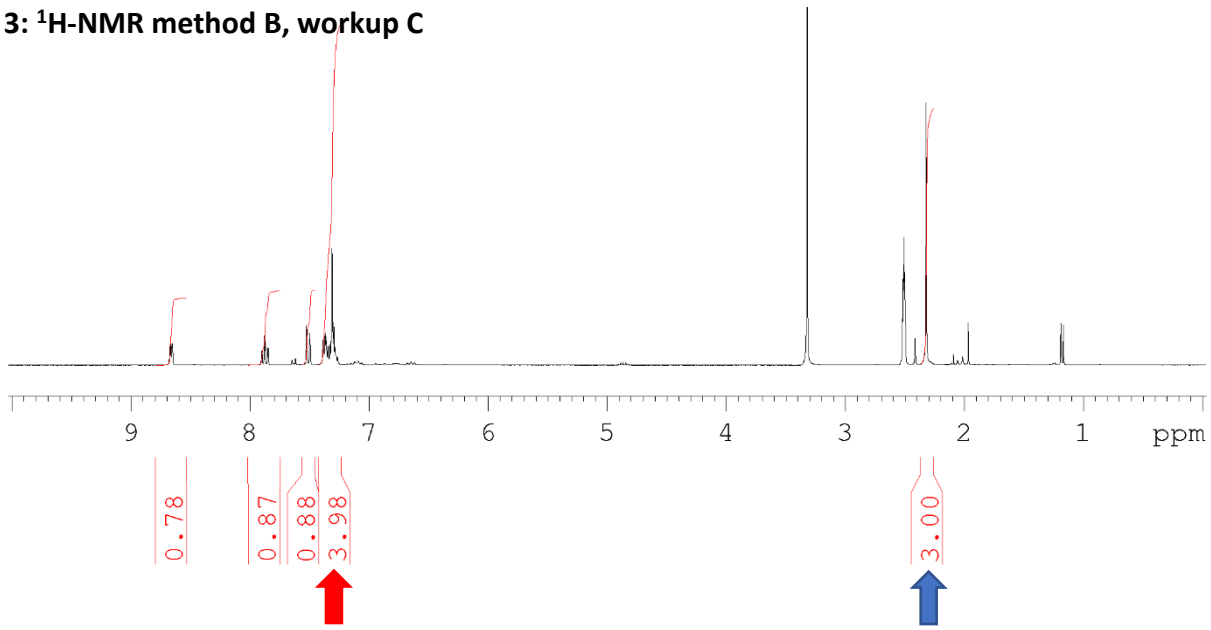
3: ^{1}H-NMR reference



3: ^{1}H-NMR method A, workup C

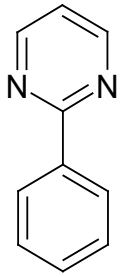


3: ^{1}H-NMR method B, workup C

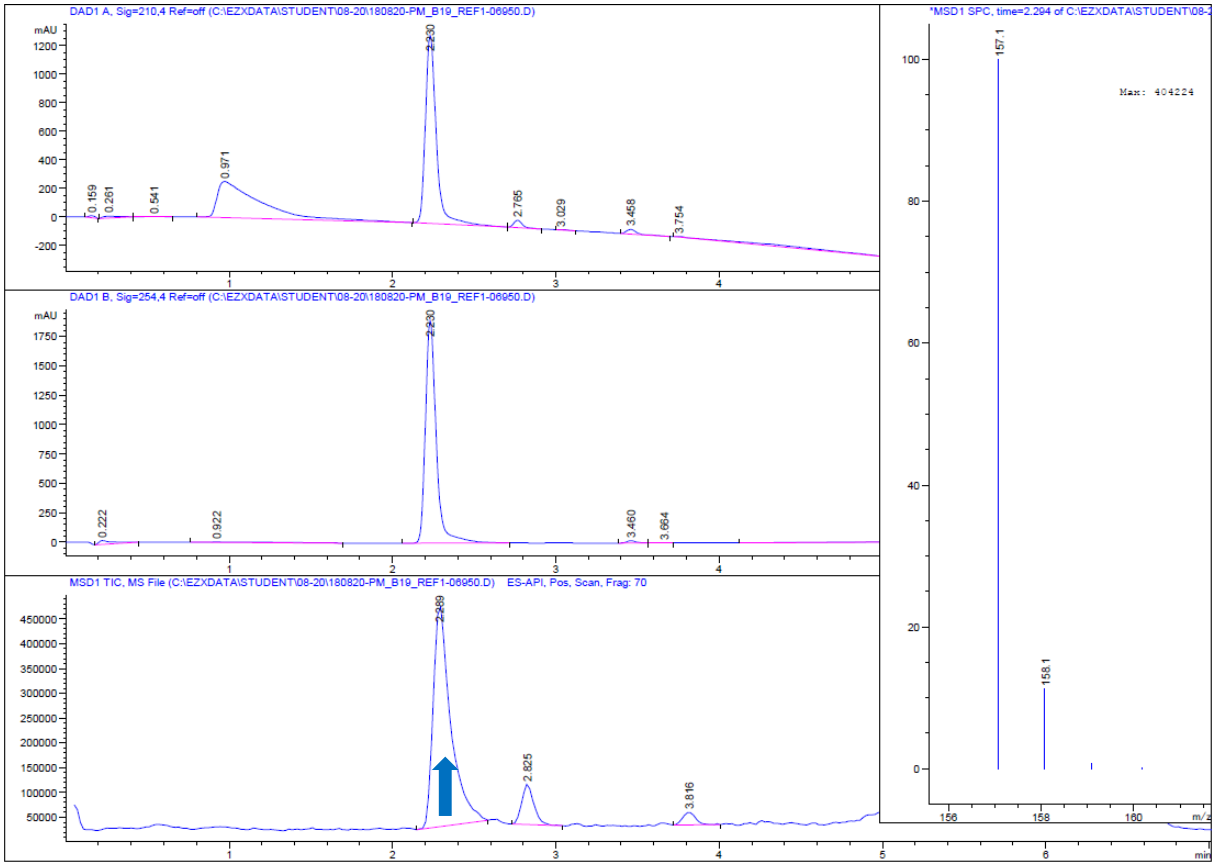


Deuterium incorporation: red arrow. Reference-integral: blue arrow.

Data for 2-phenylpyrimidine **4**



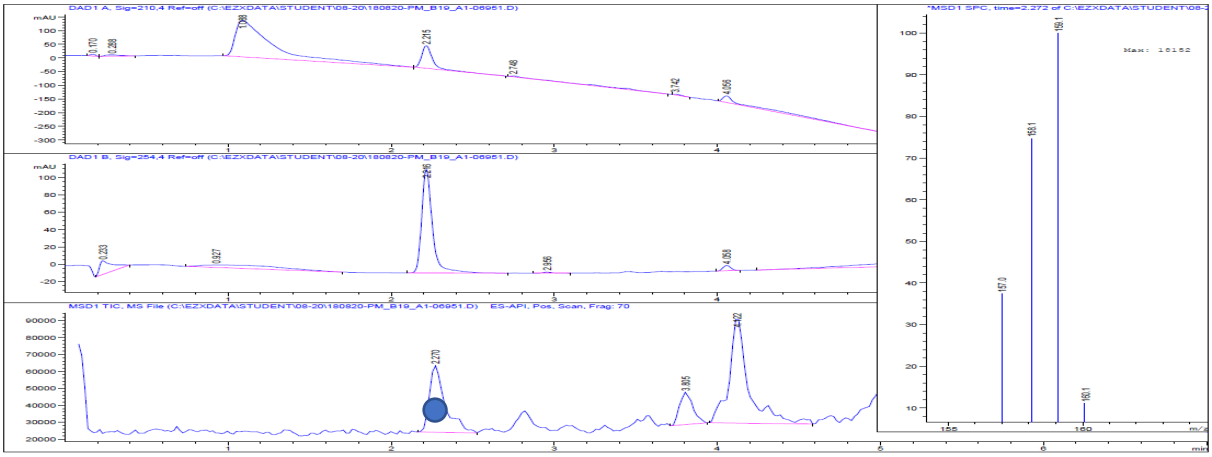
4



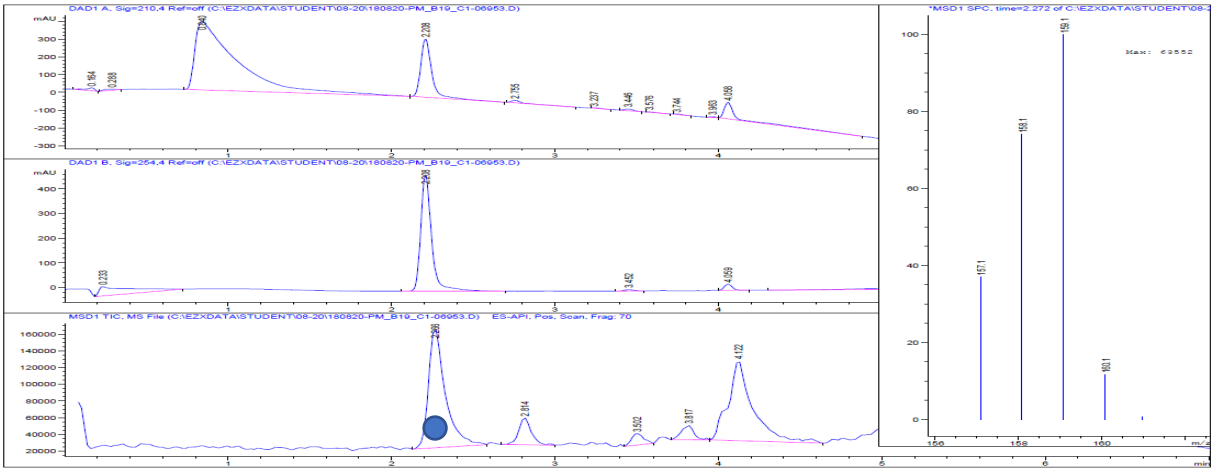
LC-MS (positive ESI): m/z 157.1 $[M+H]^+$ (100), 158.1 $[M+1+H]^+$ (11.3), 159.1 $[M+2+H]^+$ (0.7)

Deuterium experiments with 2-phenylpyrimidine **4**

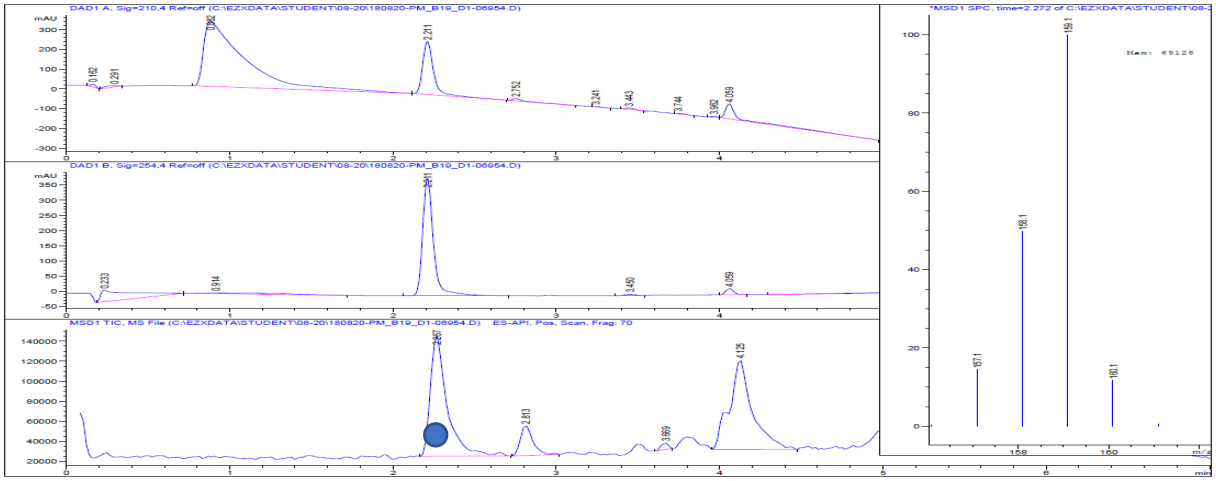
Method A (1 eq. D_2), workup C: 1.6mg (10µmol) 2-phenylpyrimidine **4**



LC-MS (positive ESI): m/z 157.0 $[M+H]^+$ (37.5), 158.1 $[M(1D)+H]^+$ (74.7), 159.1 $[M(2D)+H]^+$ (100), 160.1 $[M(3D)+H]^+$ (11.1) : 64% D



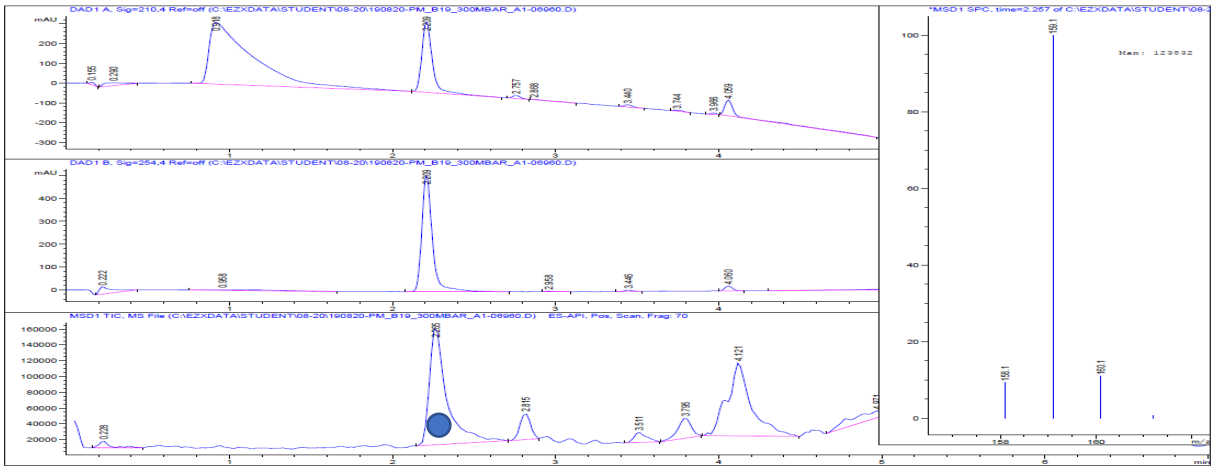
LC-MS (positive ESI): m/z 157.0 $[M+H]^+$ (37.1), 158.1 $[M(1D)+H]^+$ (74.1), 159.1 $[M(2D)+H]^+$ (100), 160.1 $[M(3D)+H]^+$ (11.8) : 65% D



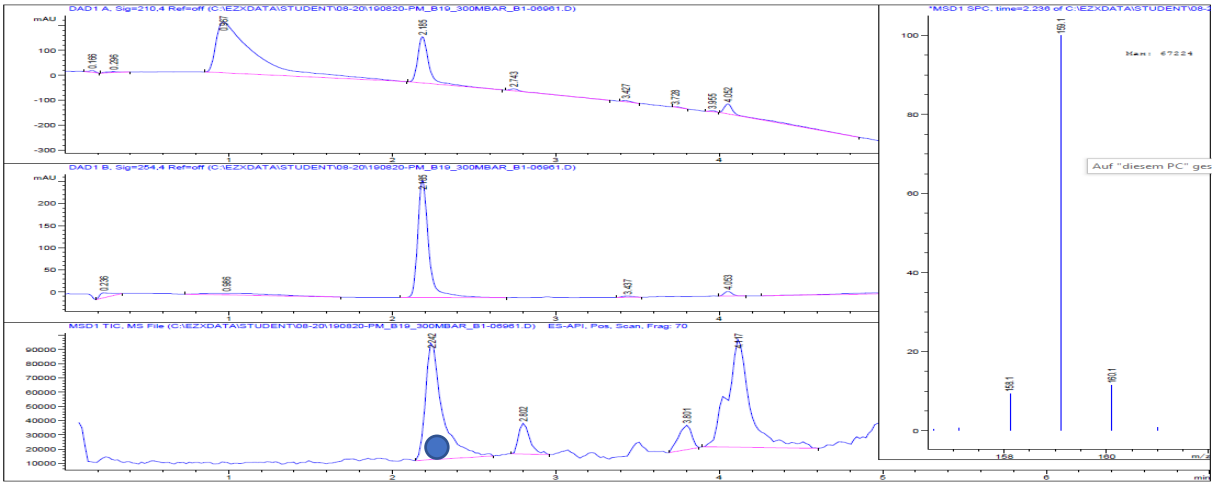
LC-MS (positive ESI): m/z 157.0 $[M+H]^+$ (14.5), 158.1 $[M(1D)+H]^+$ (49.8), 159.1 $[M(2D)+H]^+$ (100), 160.1 $[M(3D)+H]^+$ (11.7) : 76% D

Average of three reactions: 68%, Yield 94%, DCY: 64%

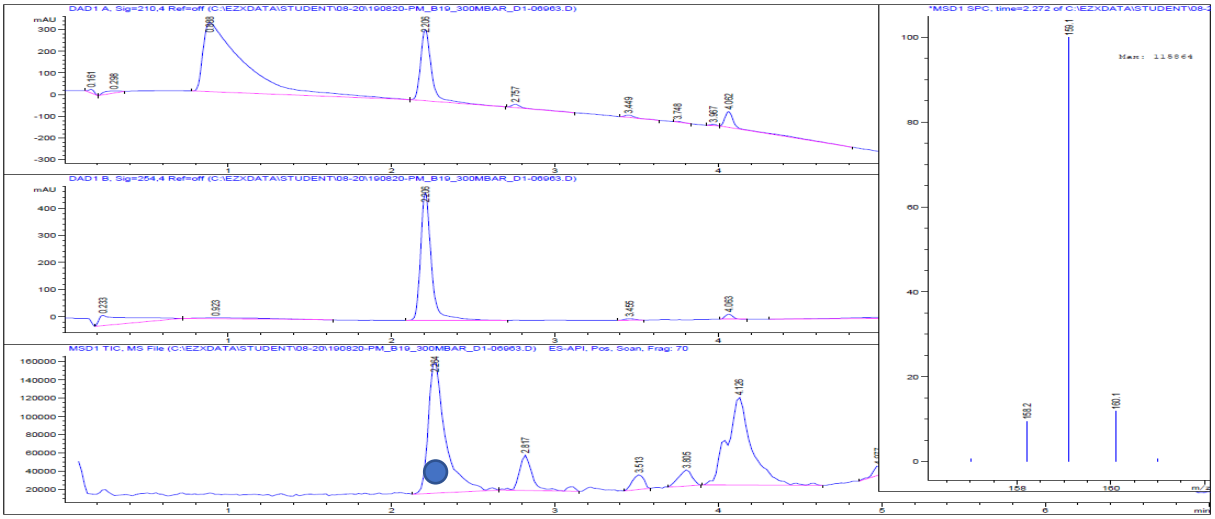
4: Method B (10 eq. D_2), workup C: 2.0mg (13µmol) 2-phenylpyrimidine **4**



LC-MS (positive ESI): m/z 157.0 $[M+H]^+$ (0), 158.1 $[M(1D)+H]^+$ (9.4), 159.1 $[M(2D)+H]^+$ (100), 160.1 $[M(3D)+H]^+$ (11.0) : 95% D



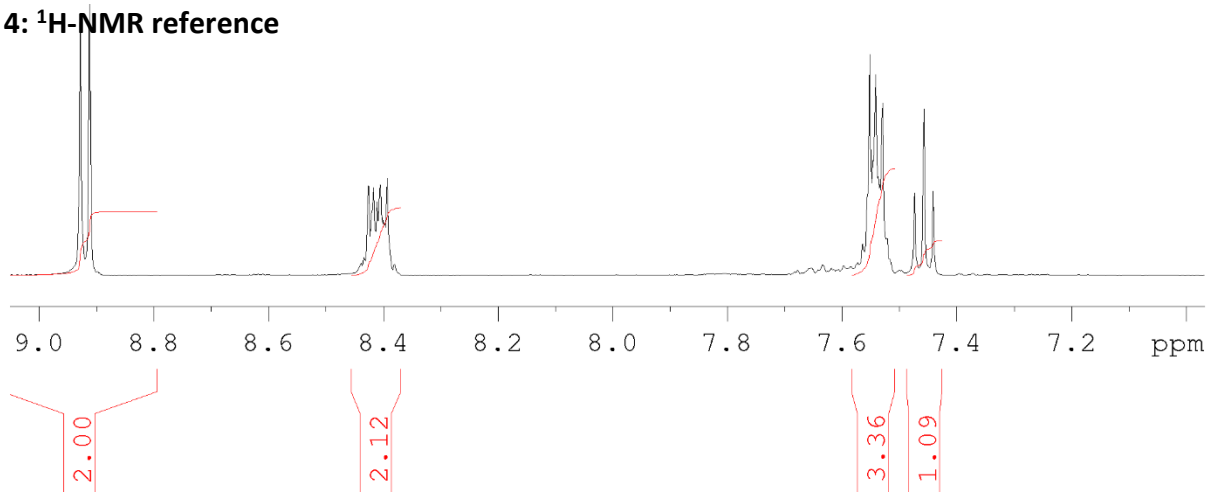
LC-MS (positive ESI): m/z 157.0 $[M+H]^+$ (0), 158.1 $[M(1D)+H]^+$ (9.4), 159.1 $[M(2D)+H]^+$ (100), 160.1 $[M(3D)+H]^+$ (11.6) : 95% D



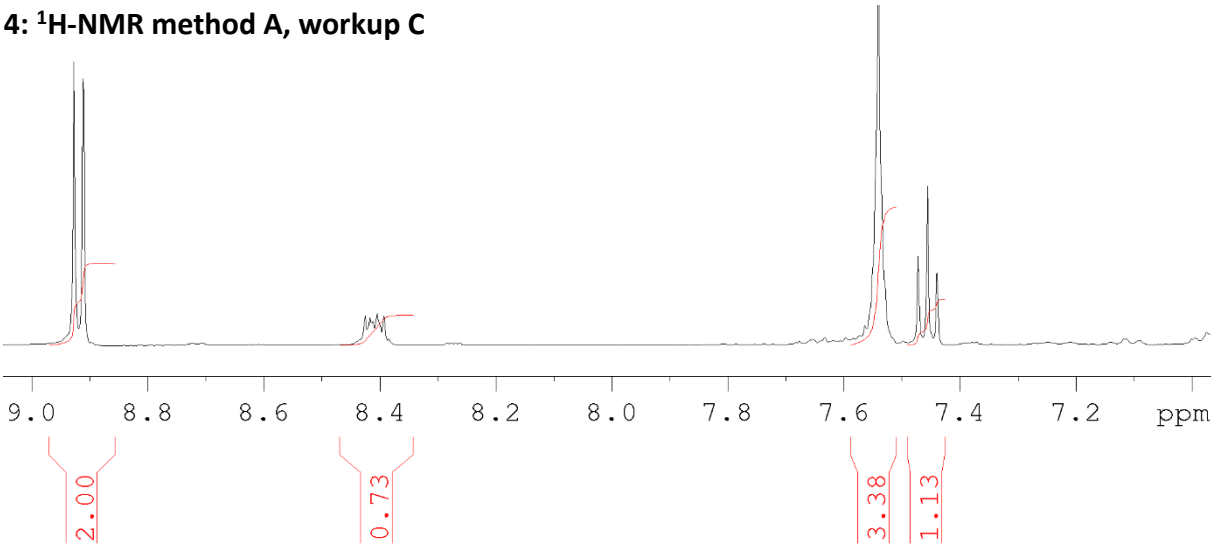
LC-MS (positive ESI): m/z 157.0 $[M+H]^+$ (0), 158.1 $[M(1D)+H]^+$ (9.5), 159.1 $[M(2D)+H]^+$ (100), 160.1 $[M(3D)+H]^+$ (11.9) : 95% D

Average of three reactions: 95% D, Yield: 94%, DCY: 9%

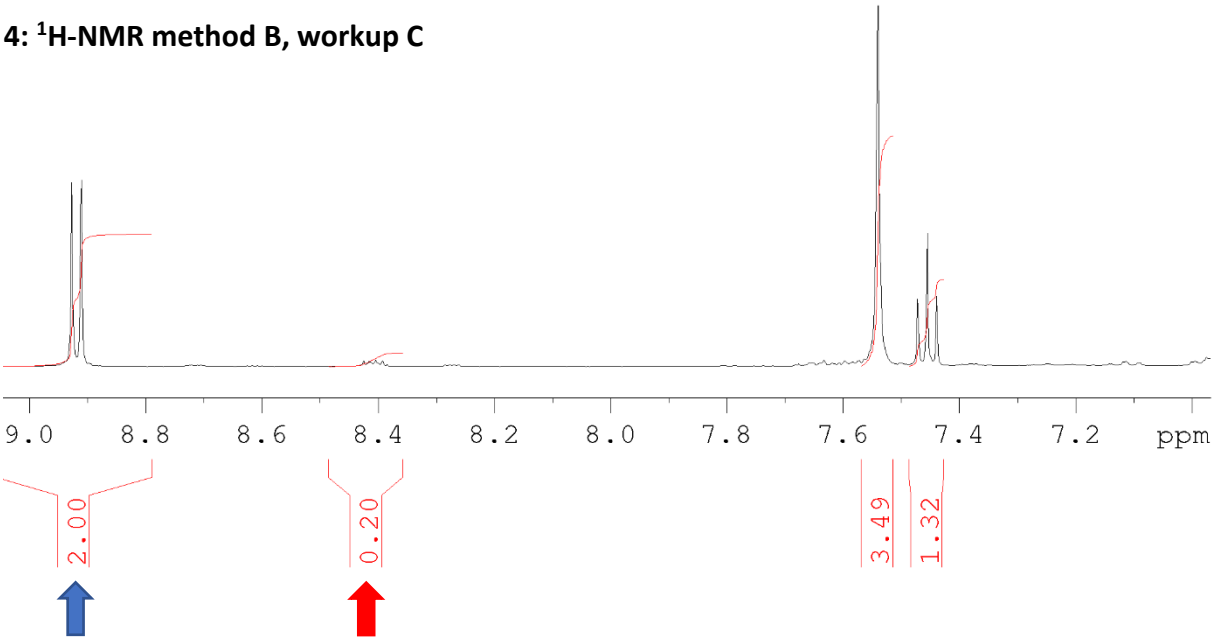
4: ^{1}H-NMR reference



4: ^{1}H-NMR method A, workup C

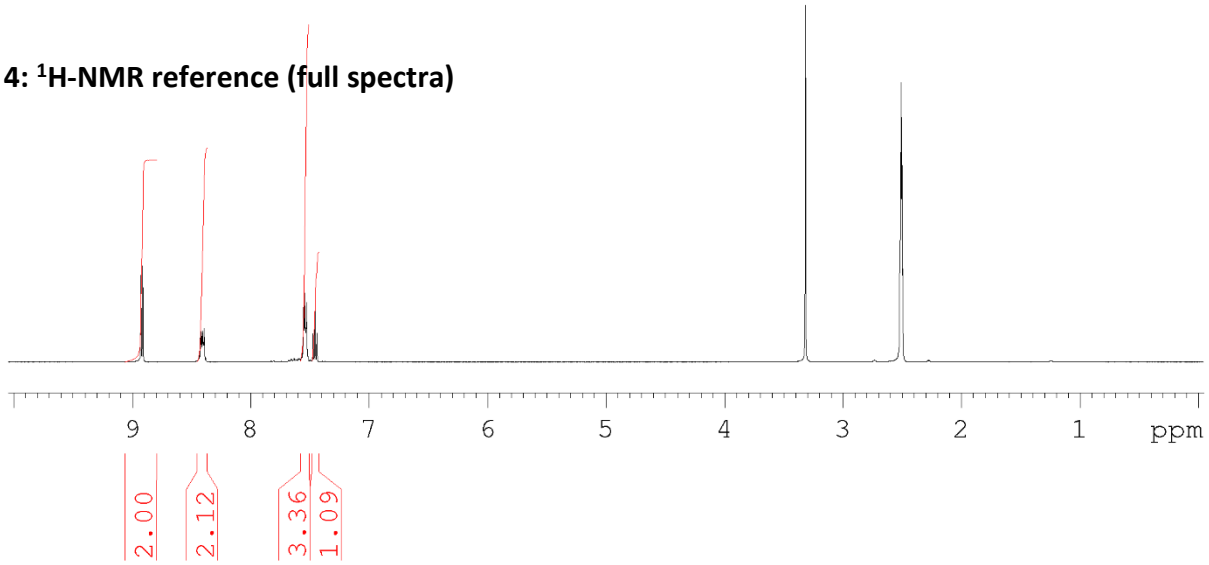


4: ^{1}H-NMR method B, workup C

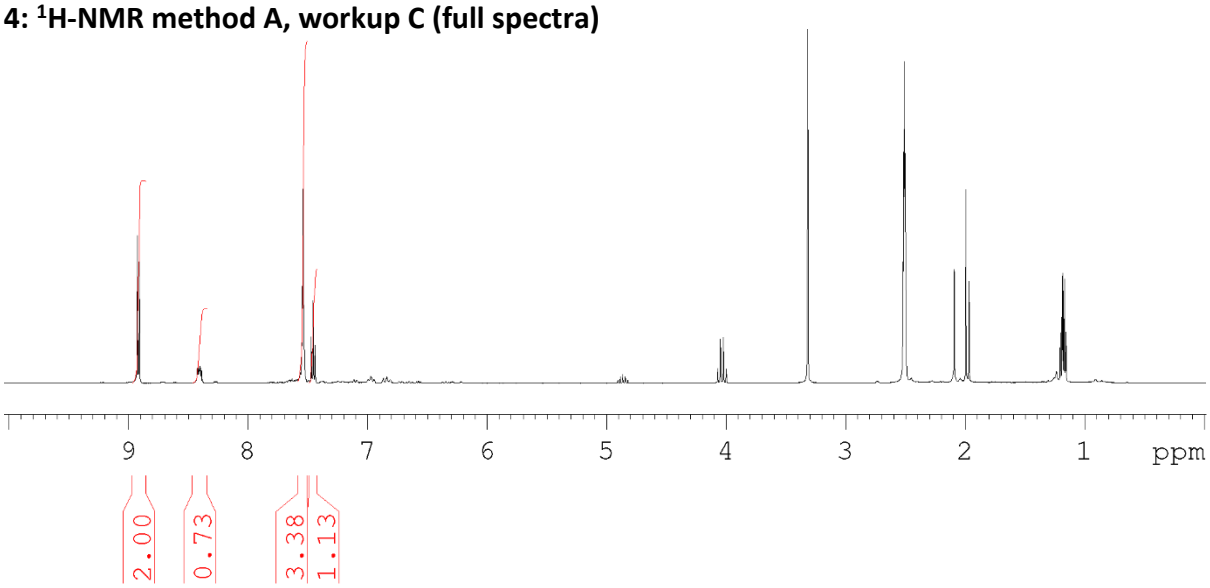


Deuterium incorporation: red arrow. Reference-integral: blue arrow.

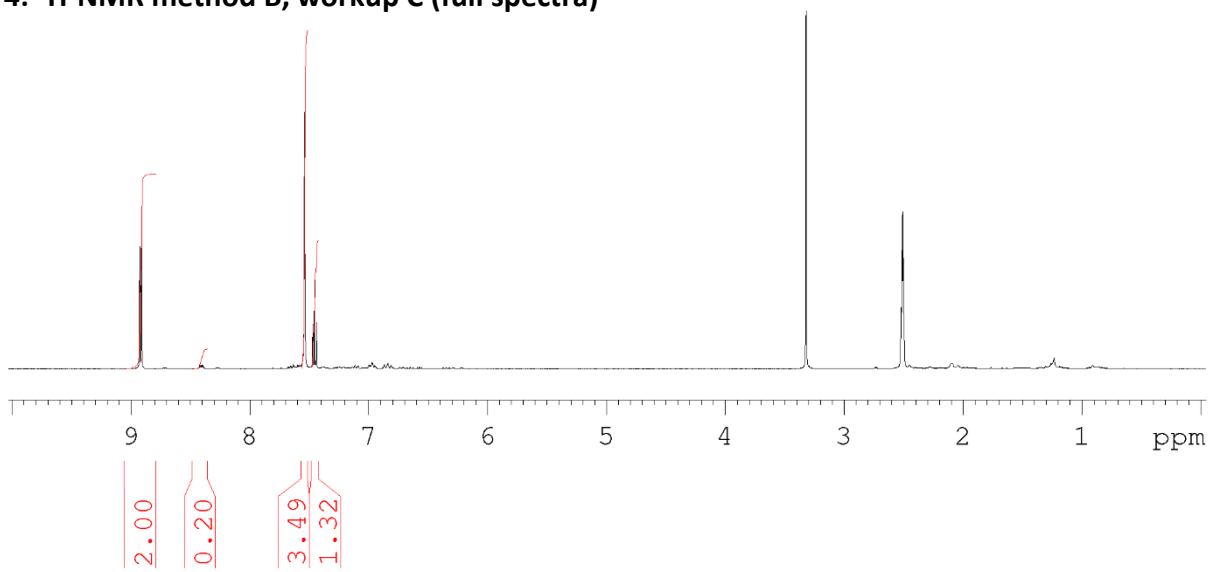
4: ^{1}H-NMR reference (full spectra)



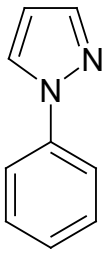
4: ^{1}H-NMR method A, workup C (full spectra)



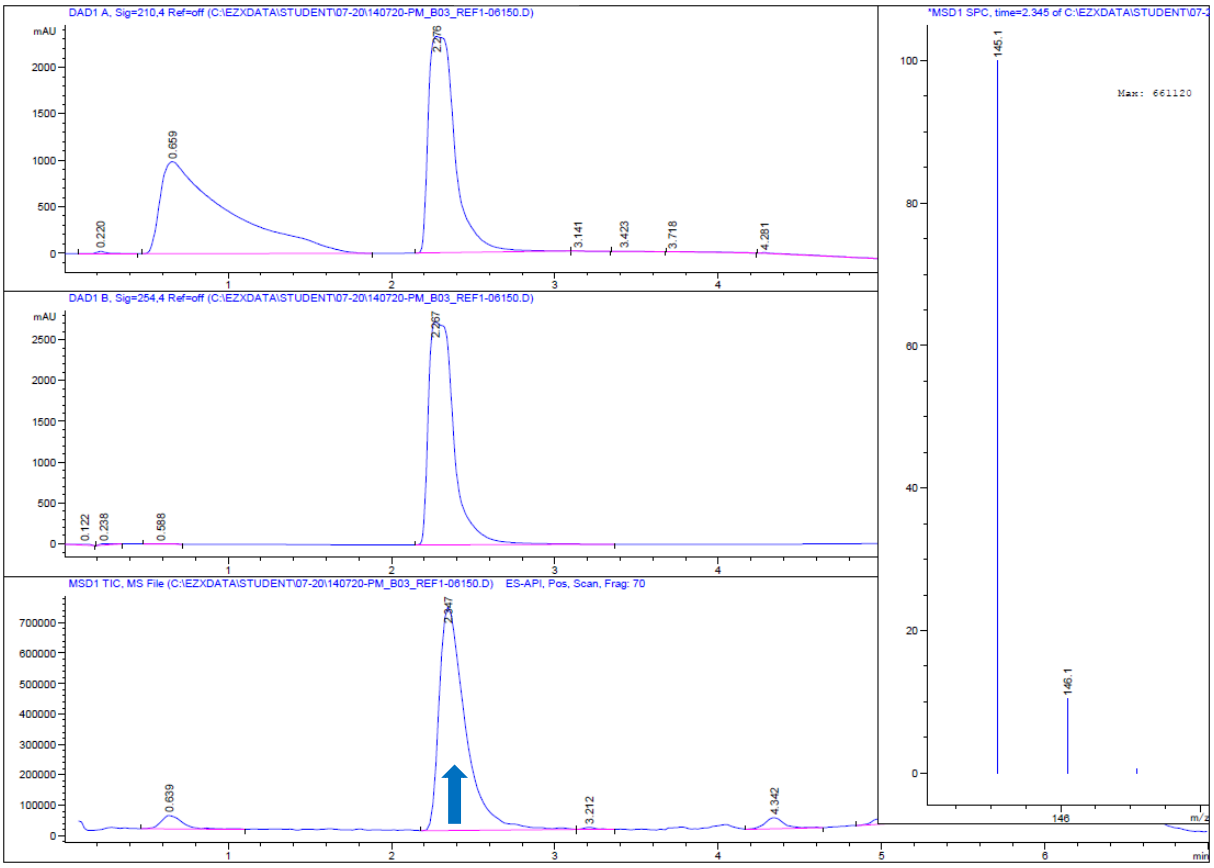
4: ^{1}H-NMR method B, workup C (full spectra)



Data for 1-phenylpyrazole **5**



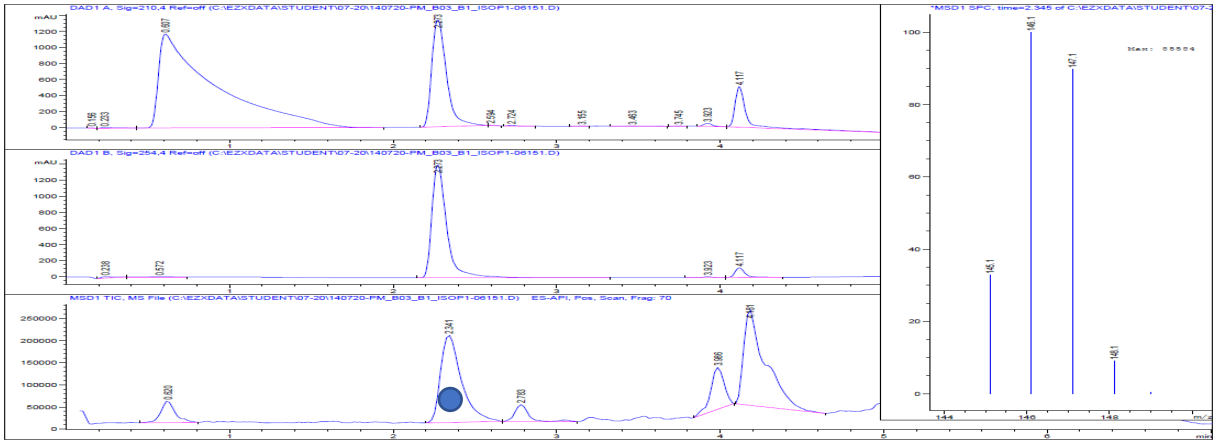
5



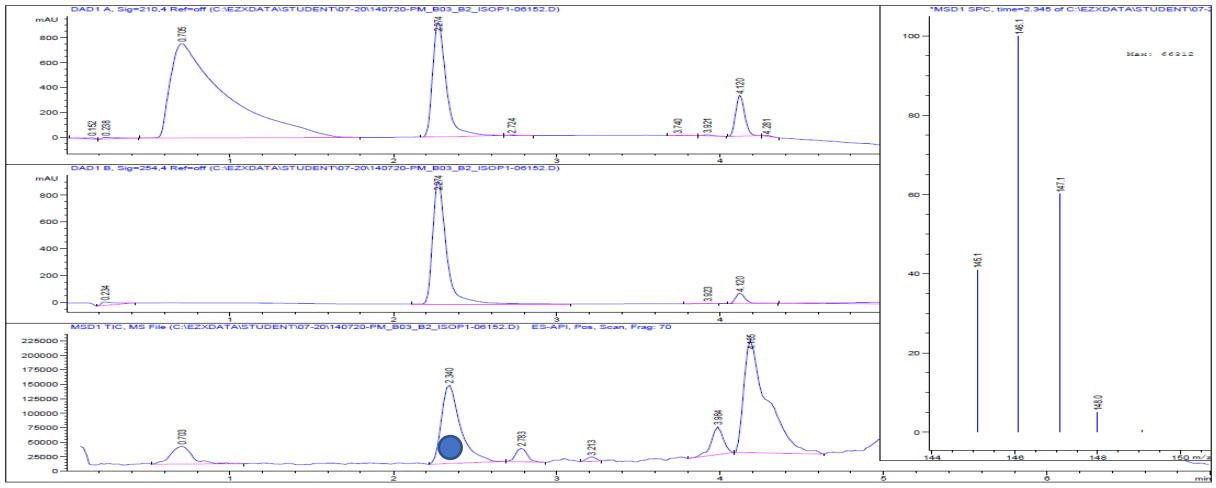
LC-MS (positive ESI): m/z 145.1 $[M+H]^+$ (100), 146.1 $[M+1+H]^+$ (10.4), 147.1 $[M+2+H]^+$ (0.5)

Deuterium experiments with 1-phenylpyrazole **5**

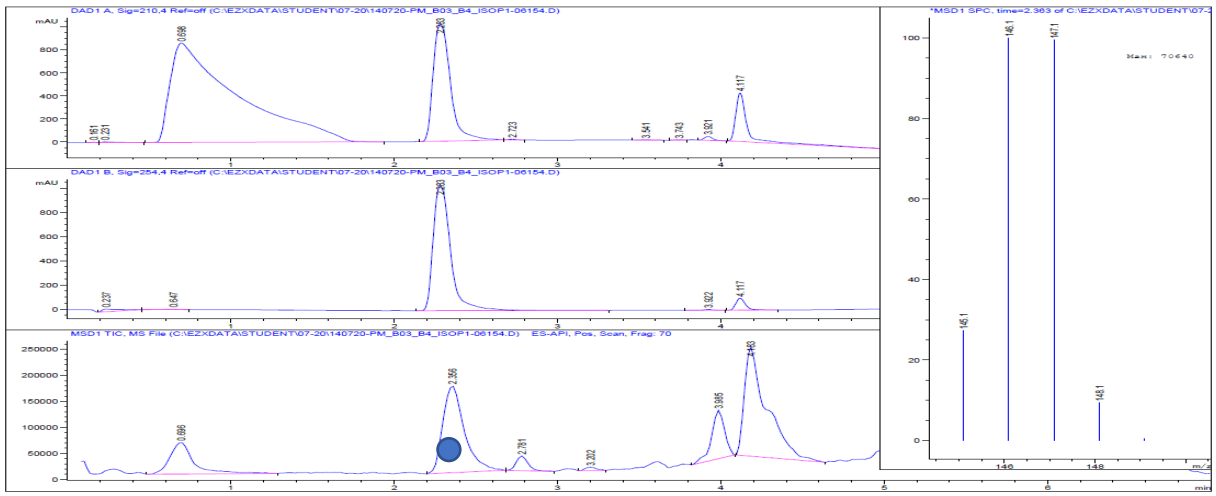
Method A, workup C: 1.5mg (10µmol) 1-phenylpyrazole **5**



LC-MS (positive ESI): m/z 145.1 $[M+H]^+$ (32.8), 146.1 $[M(1D)+H]^+$ (100), 147.1 $[M(2D)+H]^+$ (89.8), 148.1 $[M(3D)+H]^+$ (9.0) : 61% D



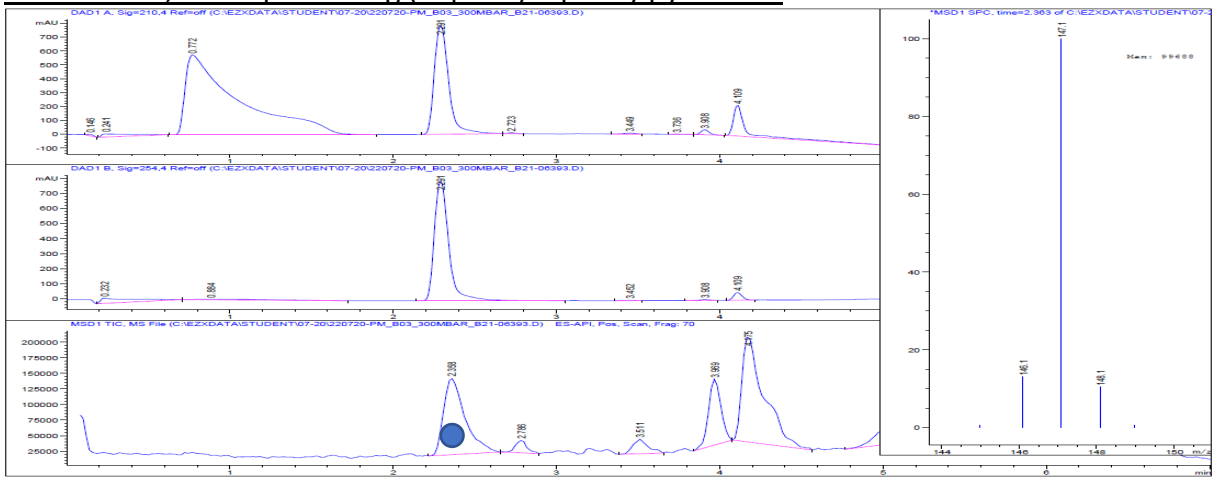
LC-MS (positive ESI): m/z 145.1 $[M+H]^+$ (41.0), 146.1 $[M(1D)+H]^+$ (100), 147.1 $[M(2D)+H]^+$ (60.1), 148.1 $[M(3D)+H]^+$ (5.0) : 53% D



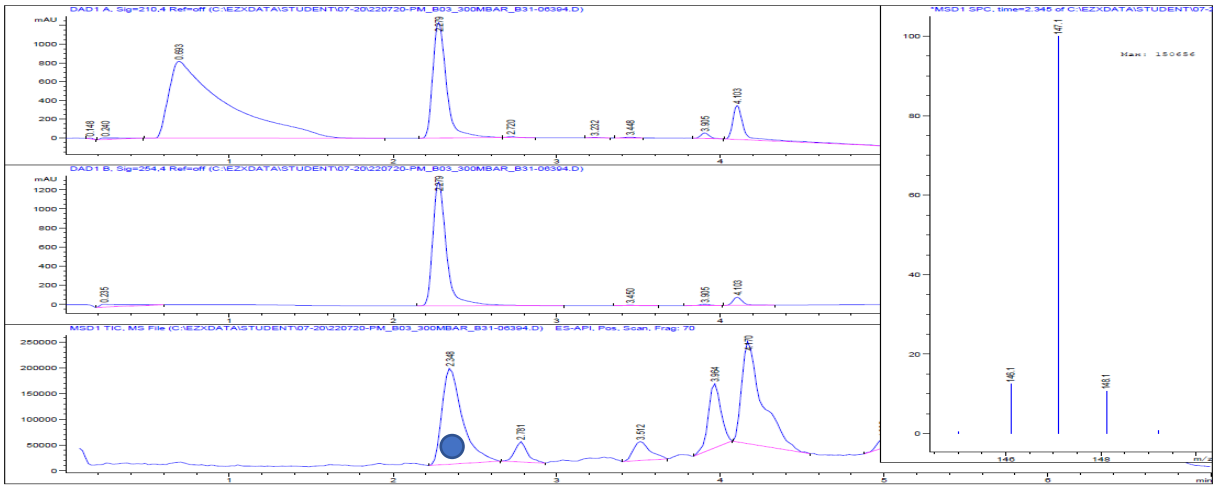
LC-MS (positive ESI): m/z 145.1 $[M+H]^+$ (27.3), 146.1 $[M(1D)+H]^+$ (100), 147.1 $[M(2D)+H]^+$ (99.4), 148.1 $[M(3D)+H]^+$ (9.5) : 64% D

Average of three reactions: 59% D, Yield: 96%, DCY: 57%

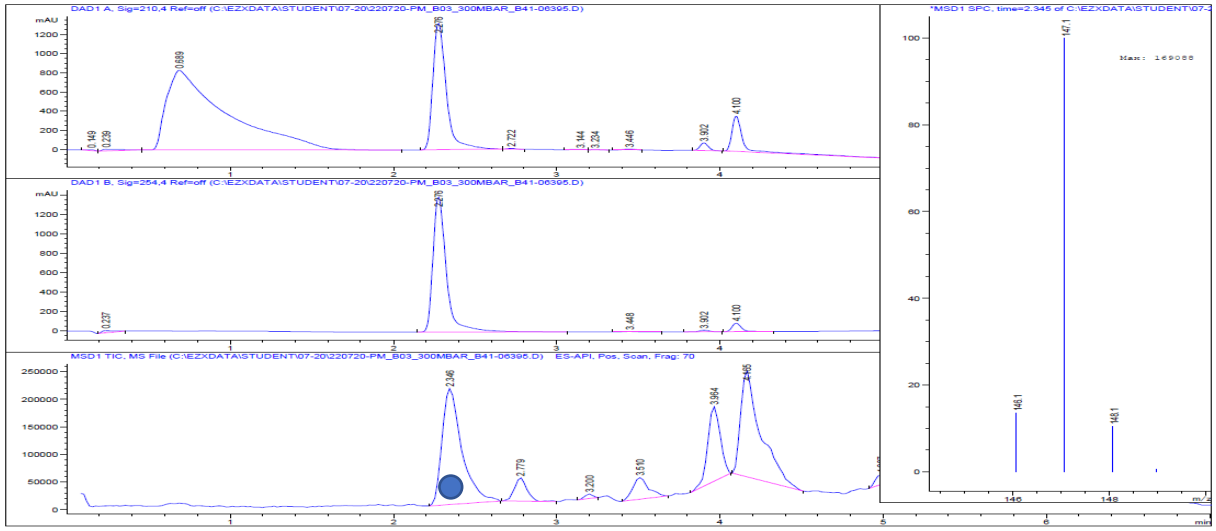
5: Method B, workup C: 1.8mg (13µmol) 1-phenylpyrazole **5**



LC-MS (positive ESI): m/z 145.0 $[M+H]^+$ (0.6), 146.1 $[M(1D)+H]^+$ (13.1), 147.1 $[M(2D)+H]^+$ (100), 148.1 $[M(3D)+H]^+$ (10.5) : 94% D



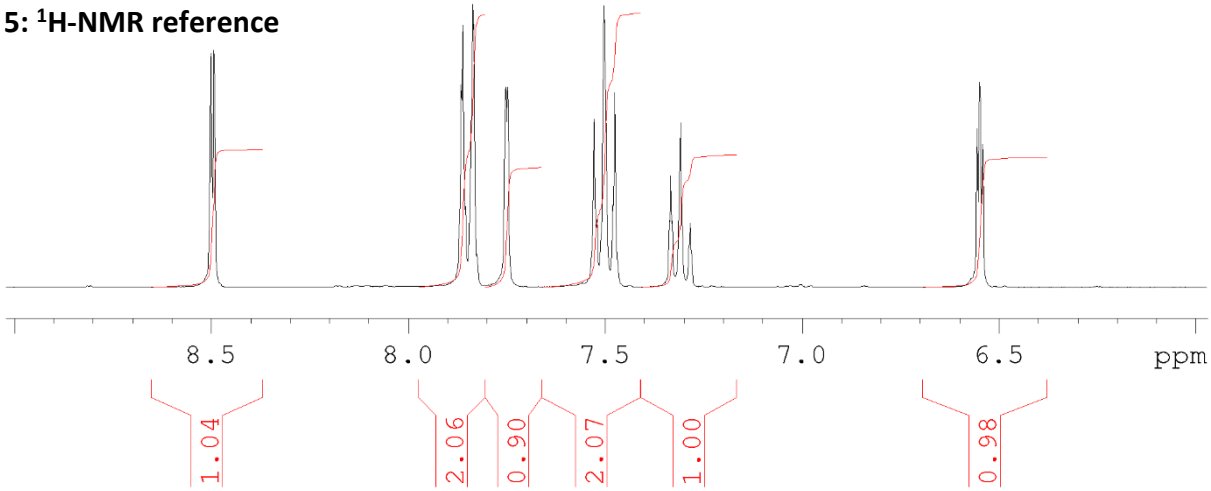
LC-MS (positive ESI): m/z 145.0 $[M+H]^+$ (0.4), 146.1 $[M(1D)+H]^+$ (12.5), 147.1 $[M(2D)+H]^+$ (100), 148.1 $[M(3D)+H]^+$ (10.7) : 94% D



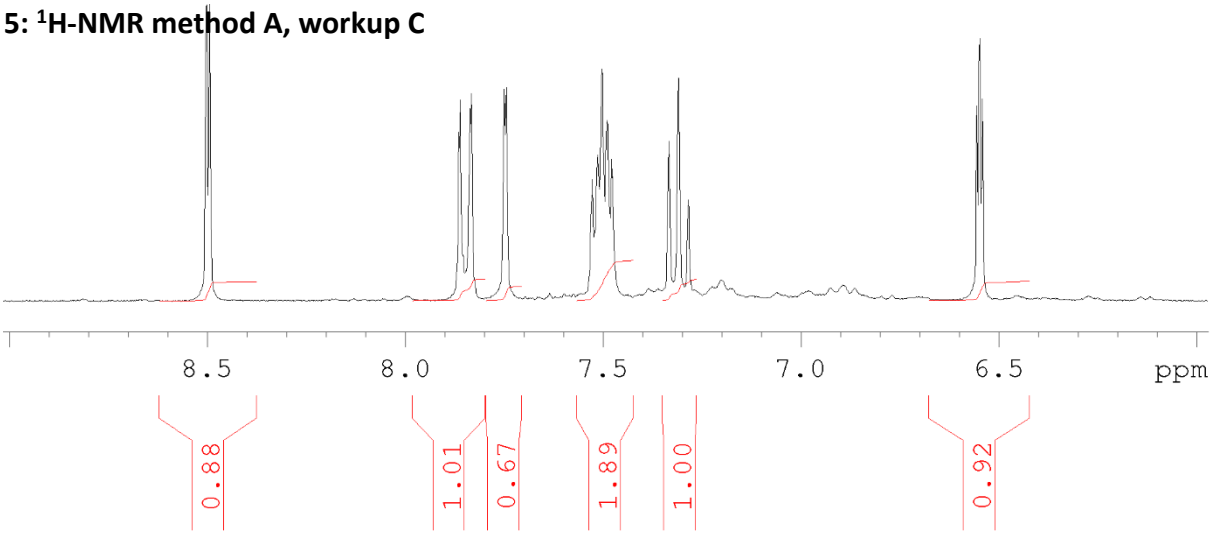
LC-MS (positive ESI): m/z 145.0 $[M+H]^+$ (0), 146.1 $[M(1D)+H]^+$ (13.6), 147.1 $[M(2D)+H]^+$ (100), 148.1 $[M(3D)+H]^+$ (10.5) : 94% D

Average of three reactions: 94% D, Yield: 94%, DCY: 9%

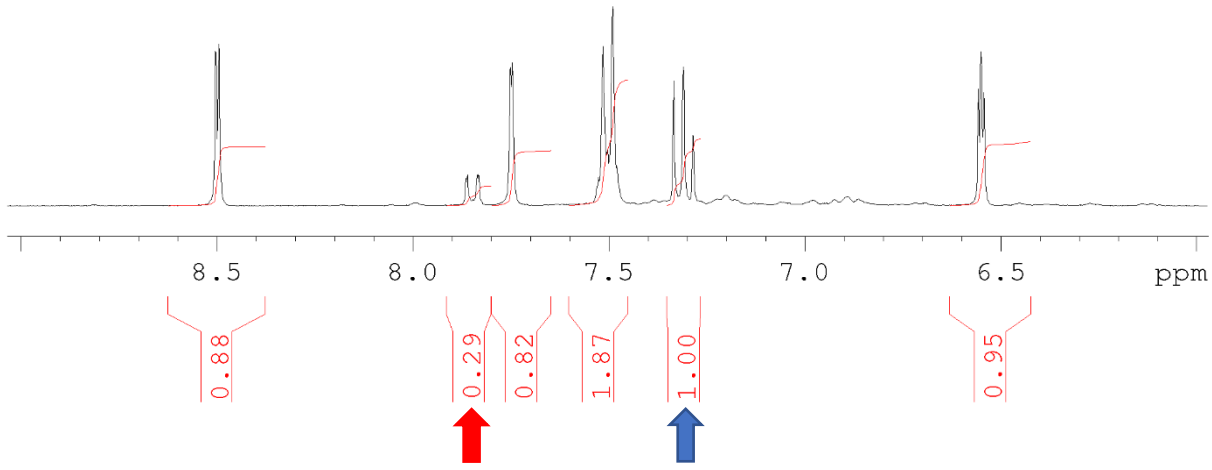
5: ^{1}H-NMR reference



5: ^{1}H-NMR method A, workup C

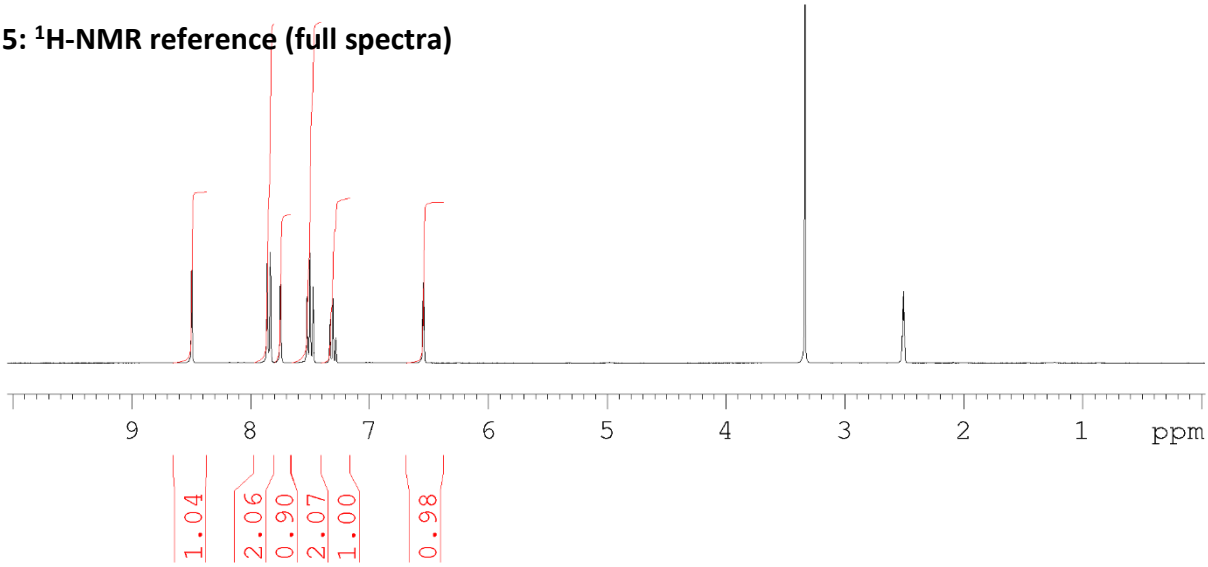


5: ^{1}H-NMR method B, workup C

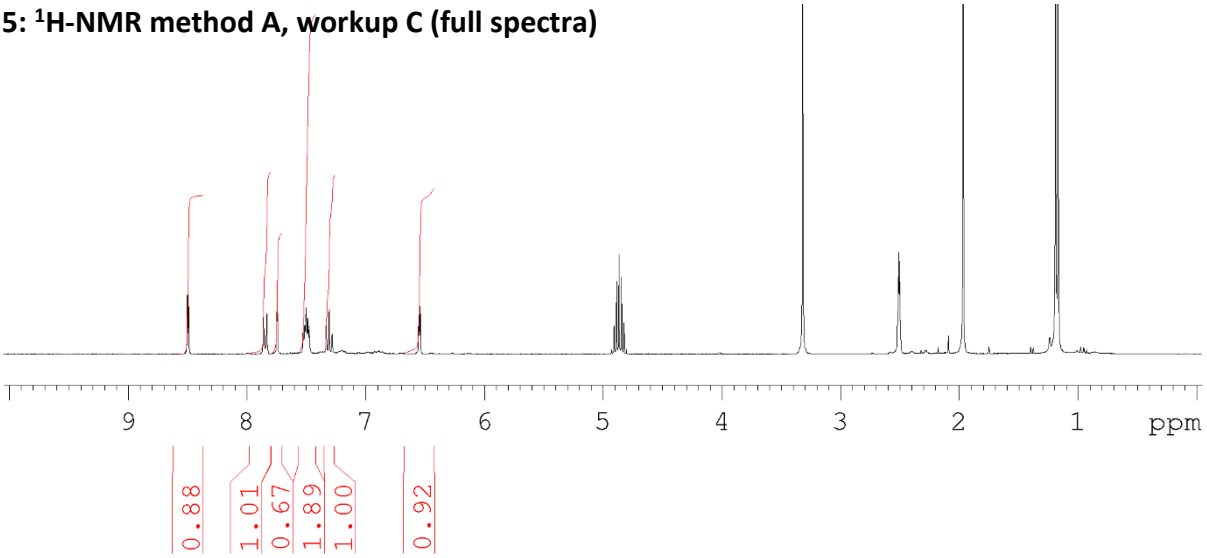


Deuterium incorporation: red arrow. Reference-integral: blue arrow.

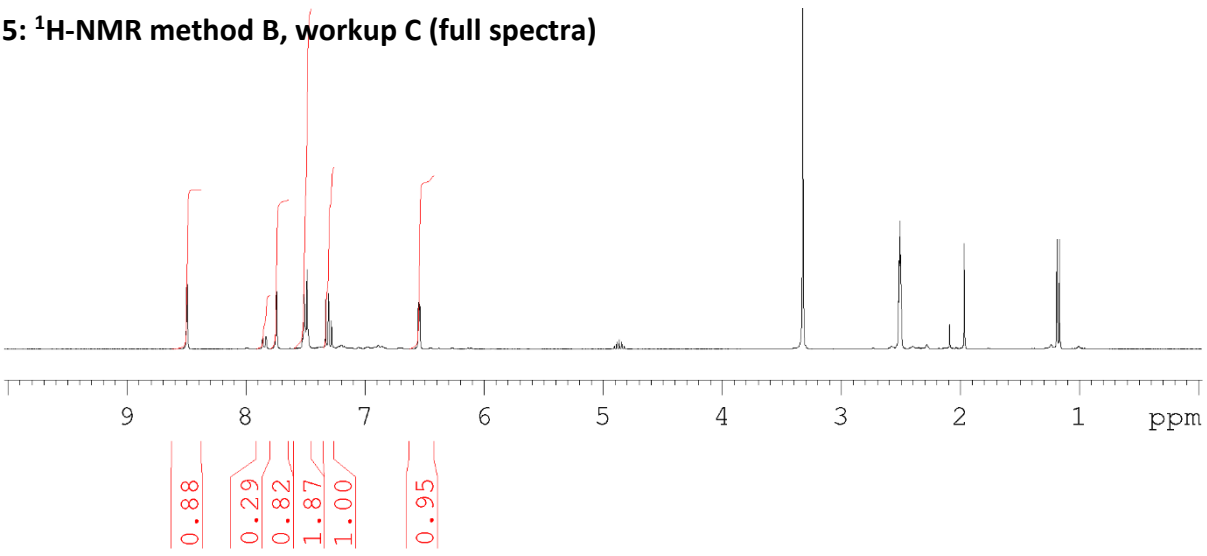
5: ^{1}H-NMR reference (full spectra)



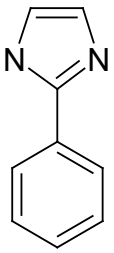
5: ^{1}H-NMR method A, workup C (full spectra)



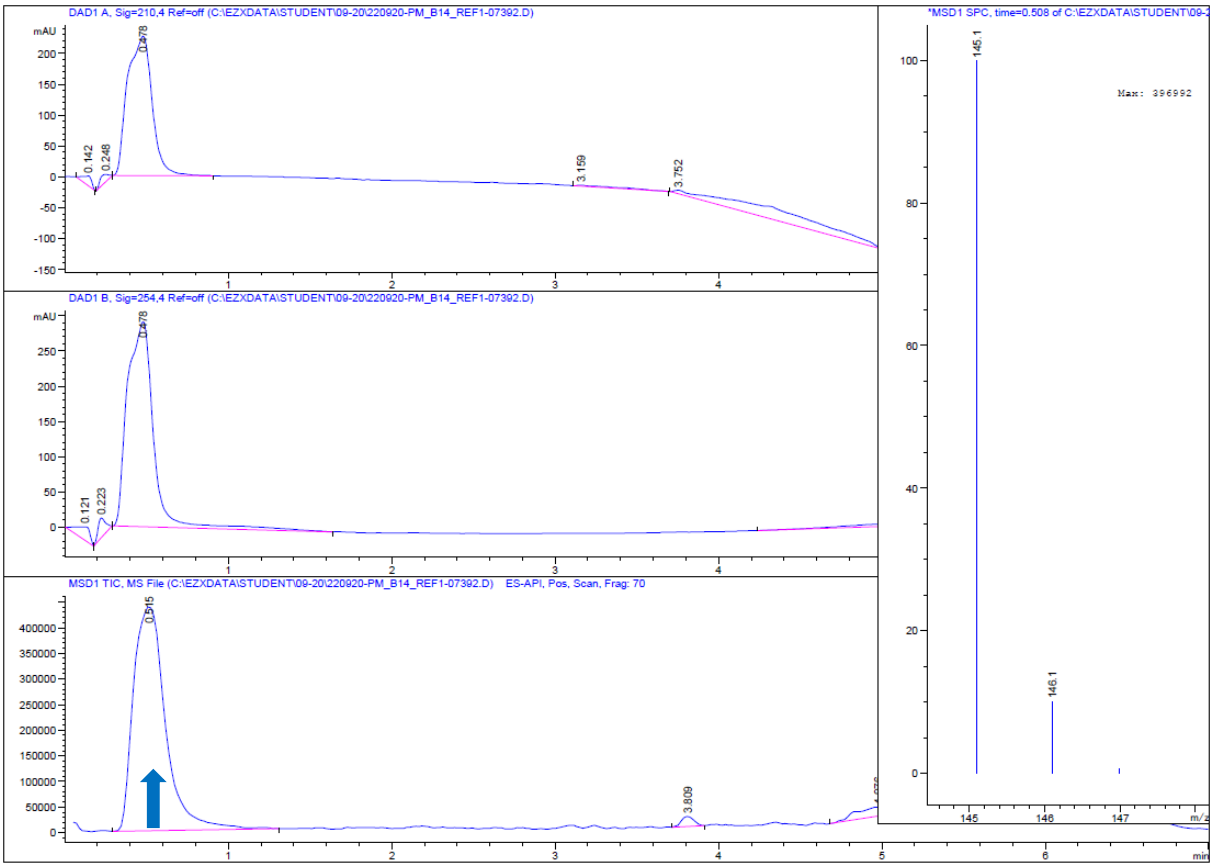
5: ^{1}H-NMR method B, workup C (full spectra)



Data for 2-phenylimidazole **6**



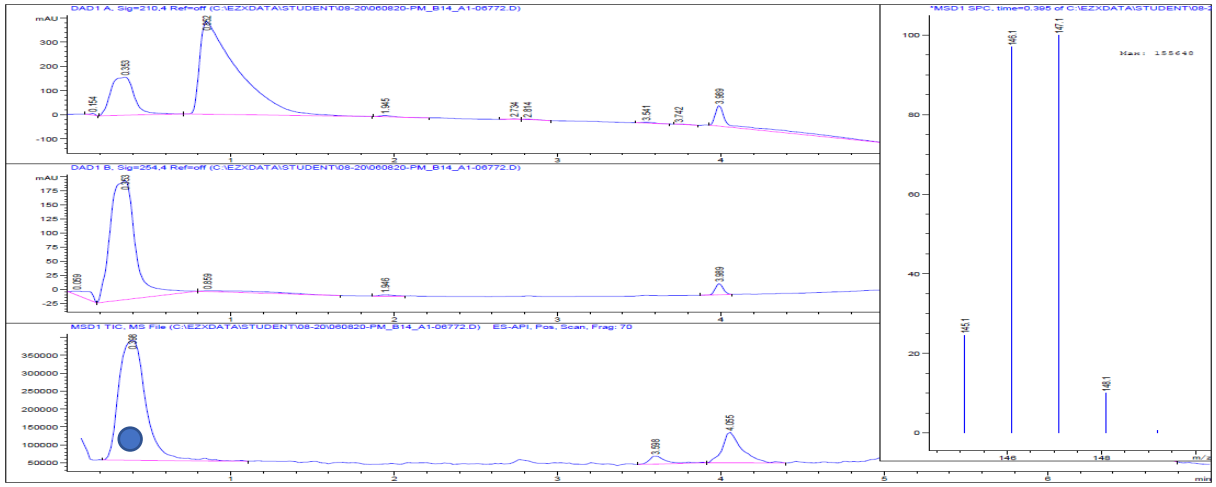
6



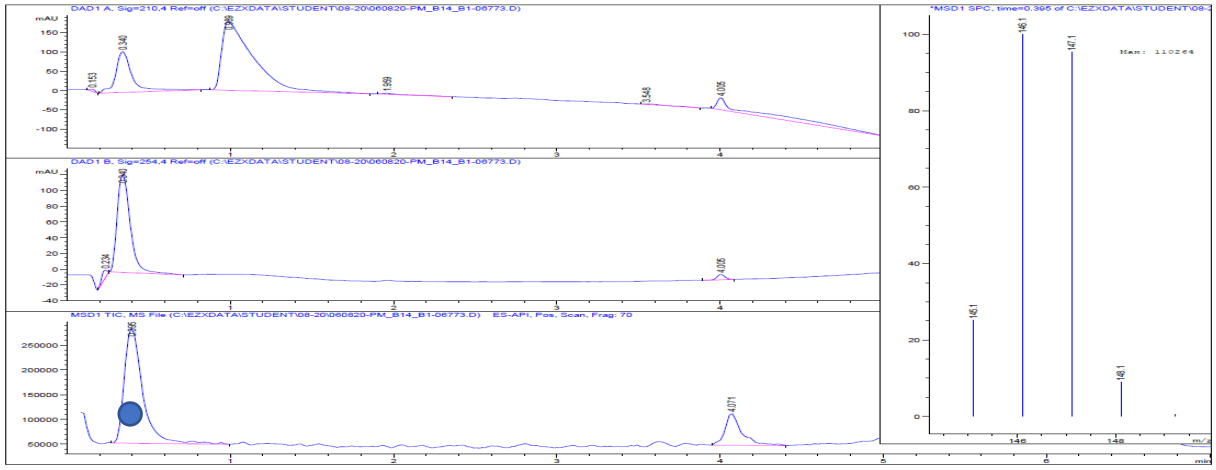
LC-MS (positive ESI): m/z 145.1 $[M+H]^+$ (100), 146.1 $[M+1+H]^+$ (10.0), 147.1 $[M+2+H]^+$ (0.5)

Deuterium experiments with 2-phenylimidazole **6**

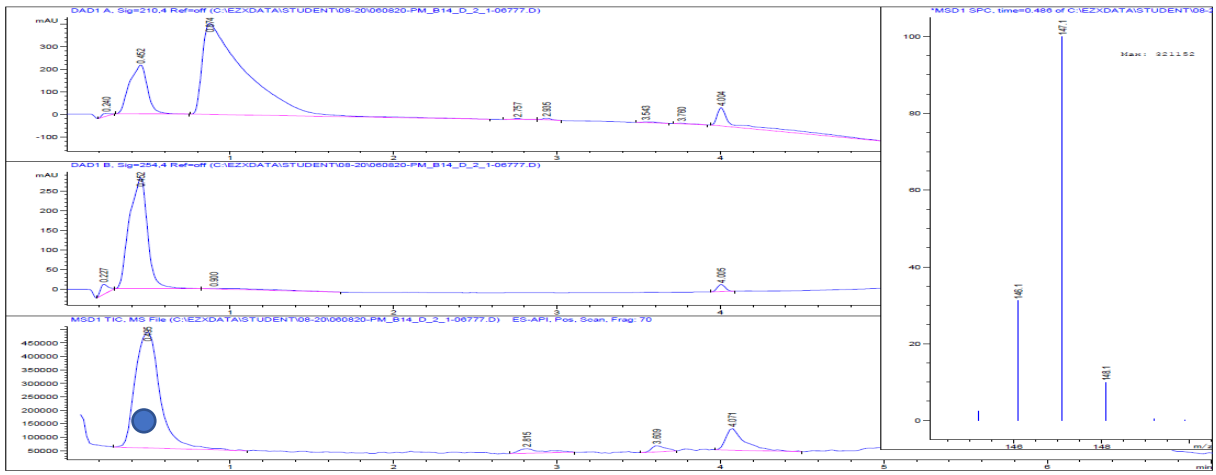
Method A, workup C: 1.5mg (10µmol) 2-phenylimidazole **6**



LC-MS (positive ESI): m/z 145.1 $[M+H]^+$ (24.6), 146.1 $[M(1D)+H]^+$ (97.0), 147.1 $[M(2D)+H]^+$ (100), 148.1 $[M(3D)+H]^+$ (10.0) : 65% D



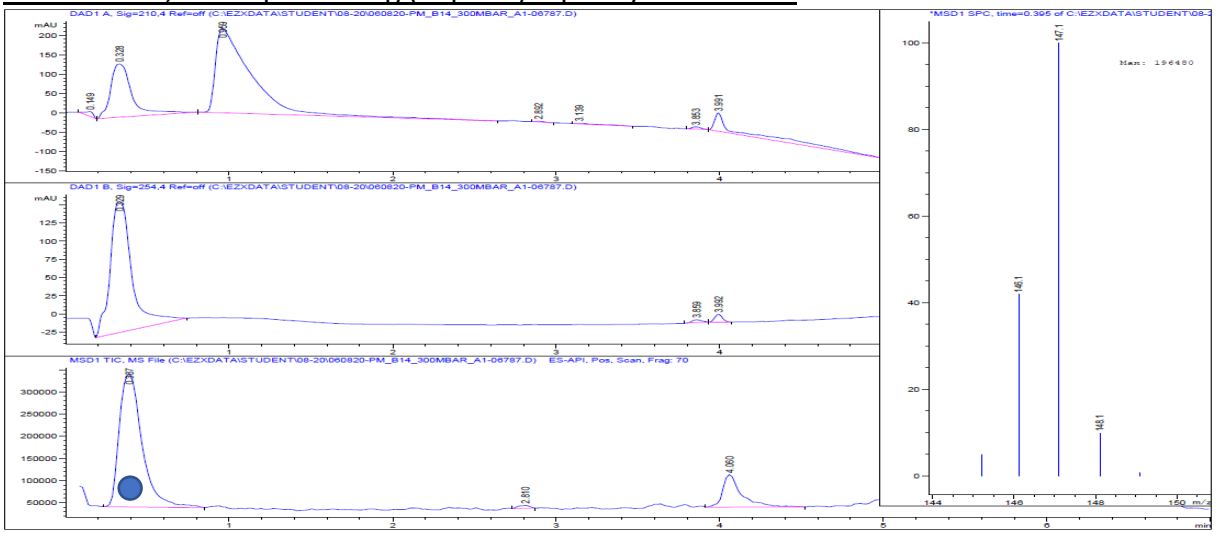
LC-MS (positive ESI): m/z 145.1 $[M+H]^+$ (25.2), 146.1 $[M(1D)+H]^+$ (100), 147.1 $[M(2D)+H]^+$ (95.4), 148.1 $[M(3D)+H]^+$ (9.0) : 64% D



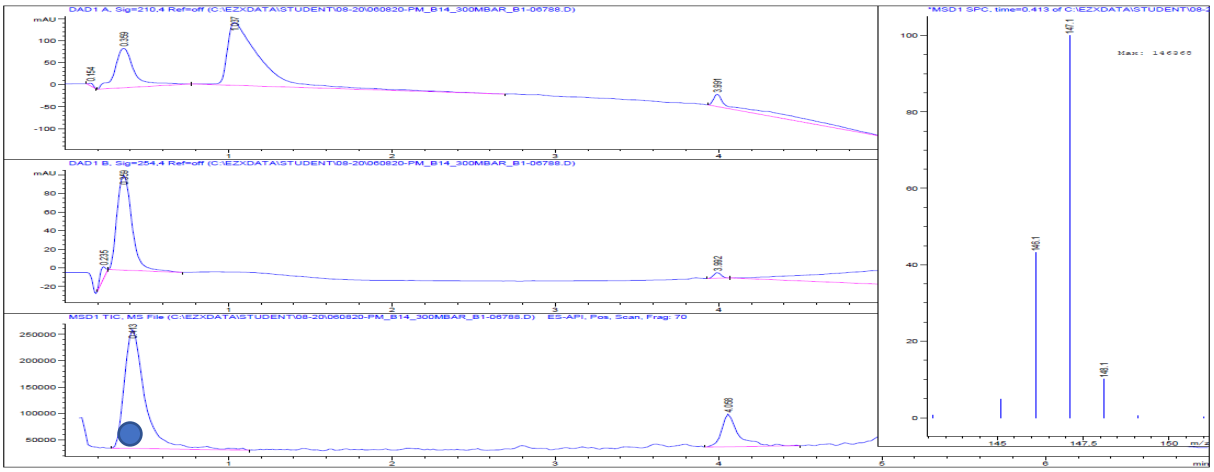
LC-MS (positive ESI): m/z 145.1 $[M+H]^+$ (2.0), 146.1 $[M(1D)+H]^+$ (29.6), 147.1 $[M(2D)+H]^+$ (100), 148.1 $[M(3D)+H]^+$ (10.8) : 86% D

Average of three reactions: 71% D, Yield: 95%, DCY: 68%

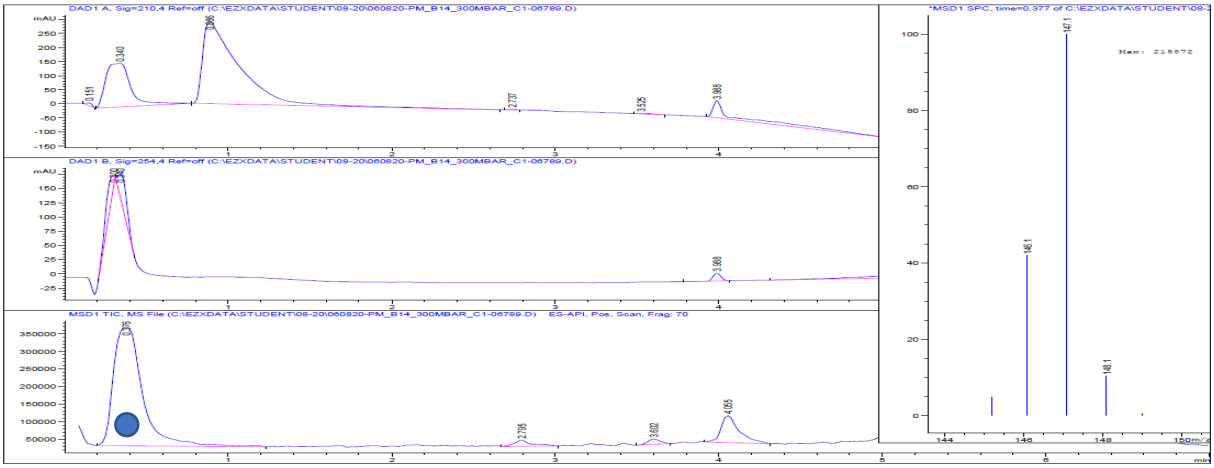
6: Method B, workup C: 1.8mg (13µmol) 2-phenylimidazole **6**



LC-MS (positive ESI): m/z 145.2 $[M+H]^+$ (4.9), 146.1 $[M(1D)+H]^+$ (41.9), 147.1 $[M(2D)+H]^+$ (100), 148.1 $[M(3D)+H]^+$ (9.8) : 82% D



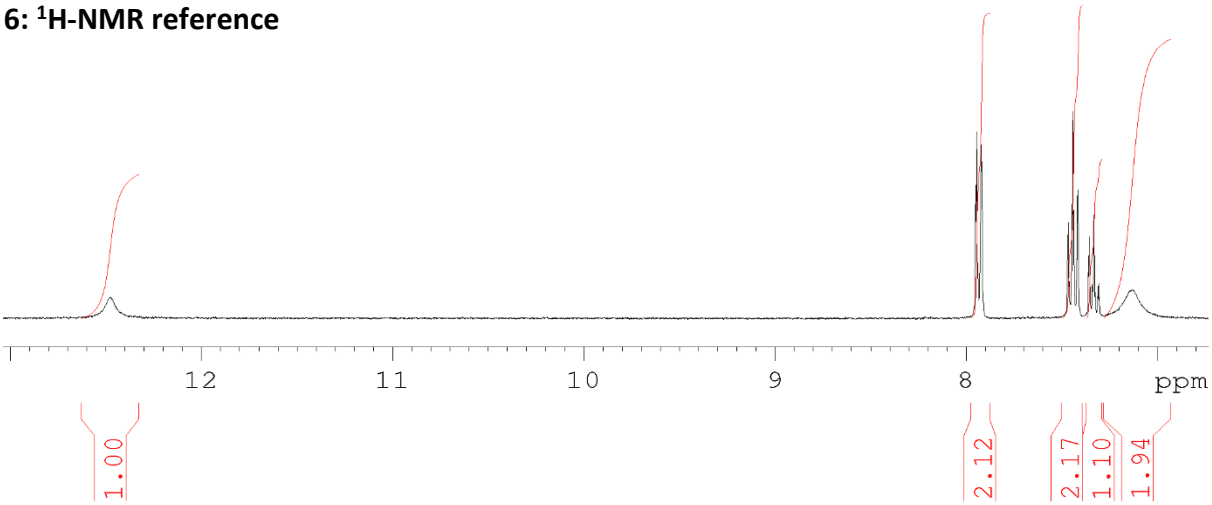
LC-MS (positive ESI): m/z 145.1 $[M+H]^+$ (4.9), 146.1 $[M(1D)+H]^+$ (43.2), 147.1 $[M(2D)+H]^+$ (100), 148.1 $[M(3D)+H]^+$ (10.1) : 82% D



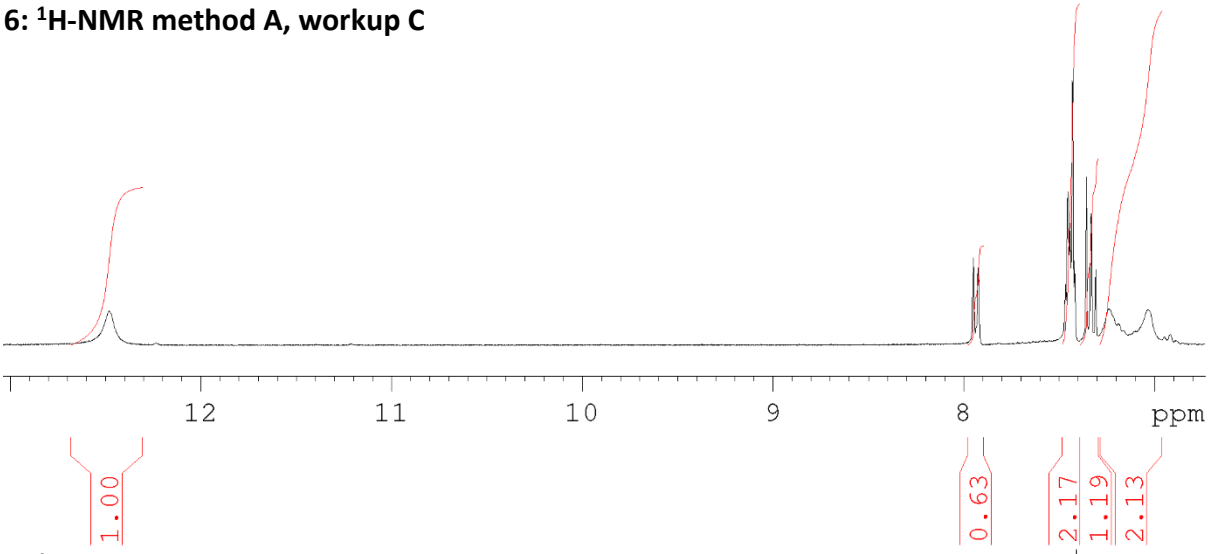
LC-MS (positive ESI): m/z 145.2 $[M+H]^+$ (4.9), 146.1 $[M(1D)+H]^+$ (42.0), 147.1 $[M(2D)+H]^+$ (100), 148.1 $[M(3D)+H]^+$ (10.4) : 82% D

Average of three reactions: 82% D, Yield: 96%, DCY: 8%

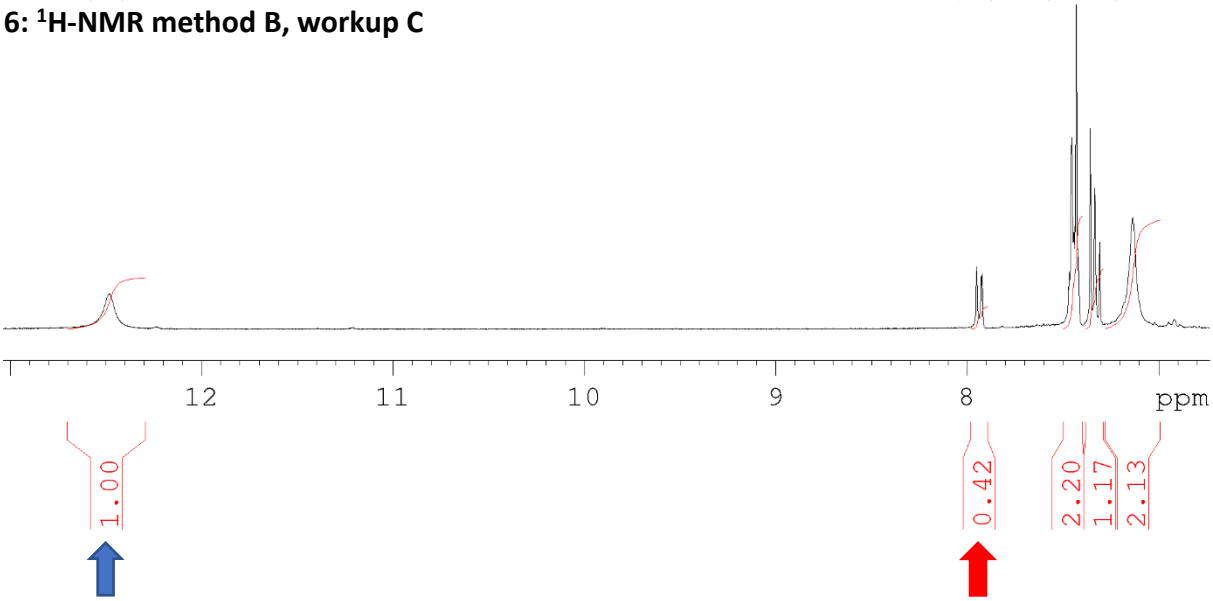
6: ^{1}H-NMR reference



6: ^{1}H-NMR method A, workup C

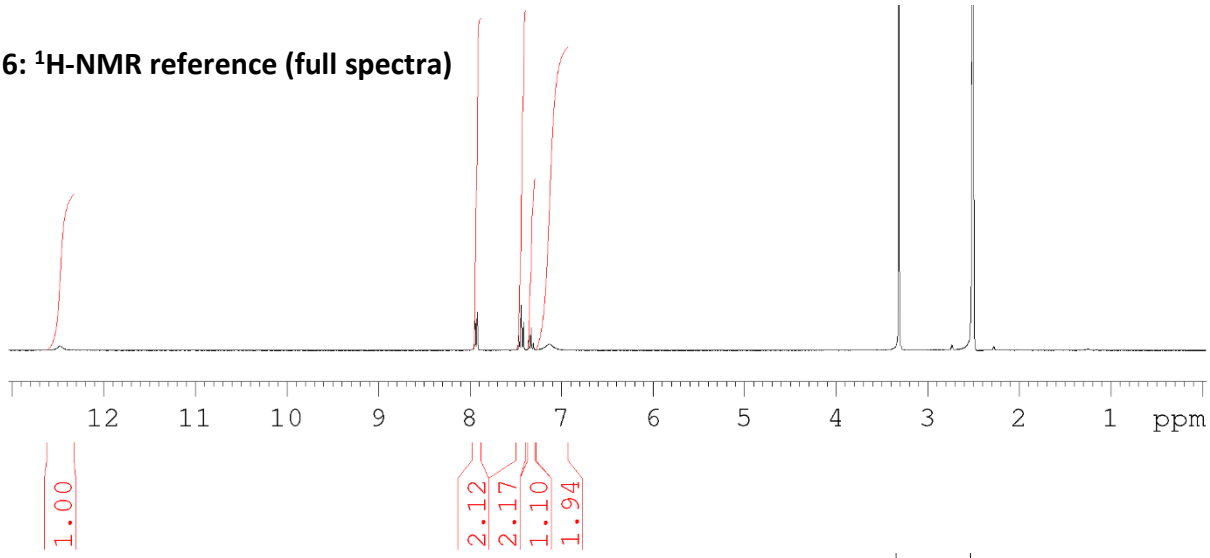


6: ^{1}H-NMR method B, workup C

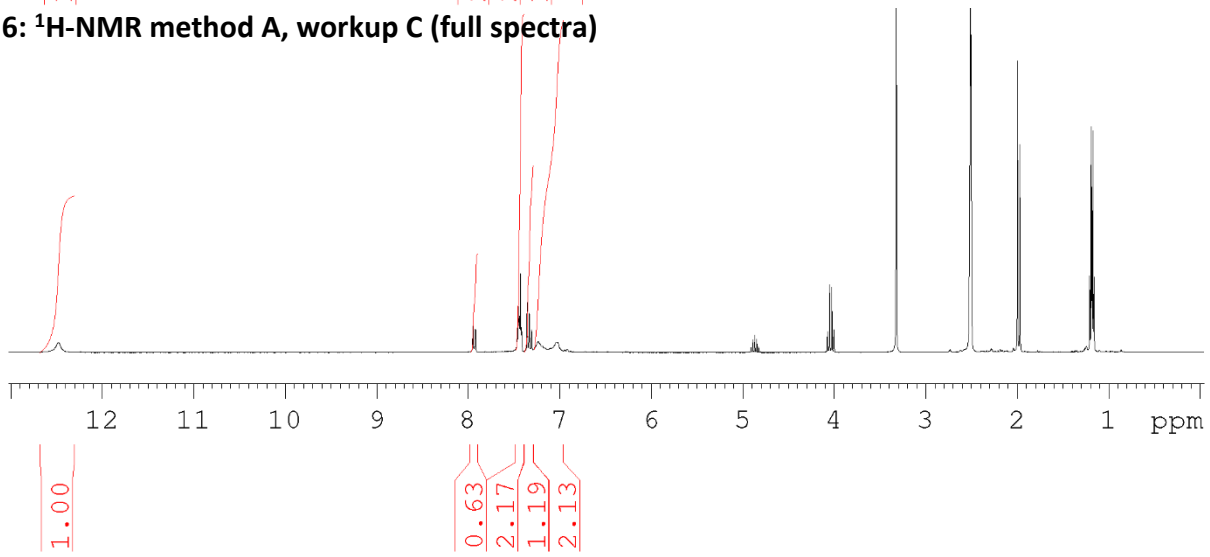


Deuterium incorporation: red arrow. Reference-integral: blue arrow.

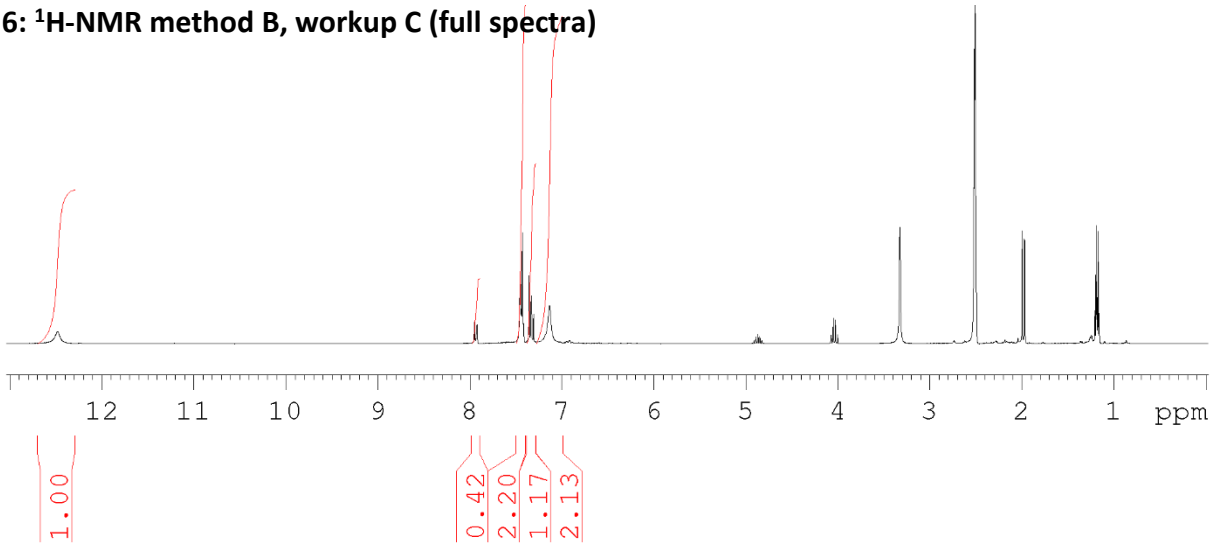
6: ^{1}H-NMR reference (full spectra)



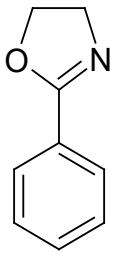
6: ^{1}H-NMR method A, workup C (full spectra)



6: ^{1}H-NMR method B, workup C (full spectra)

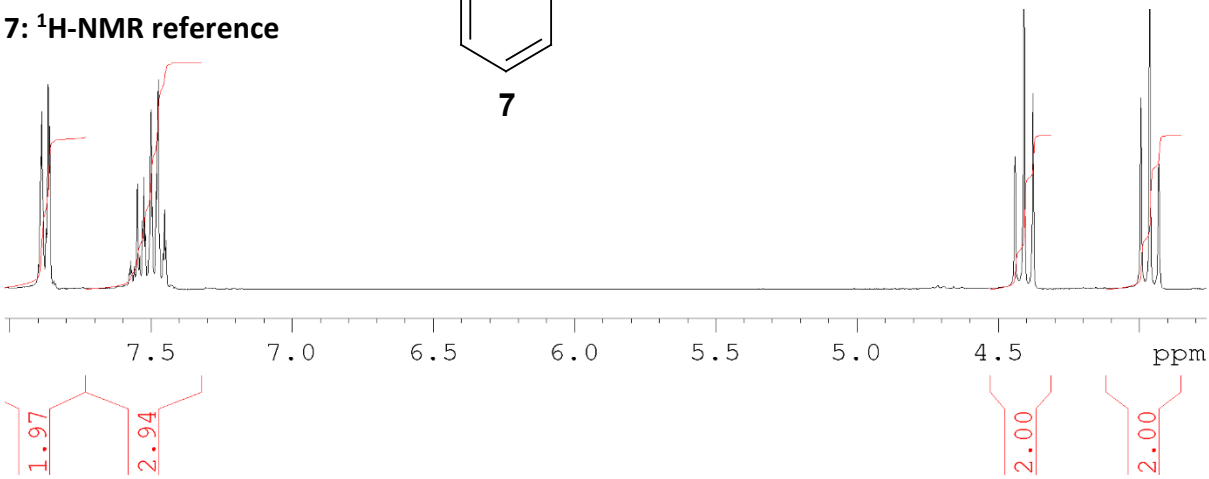


Data for 2-phenyl-2-oxazoline **7**



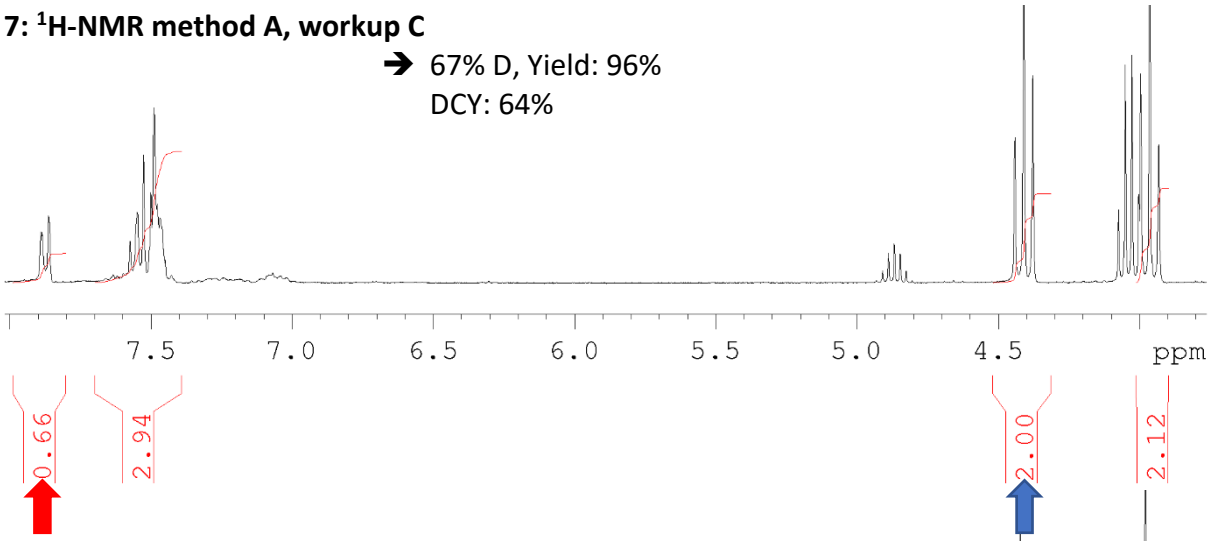
7

7: ^{1}H-NMR reference



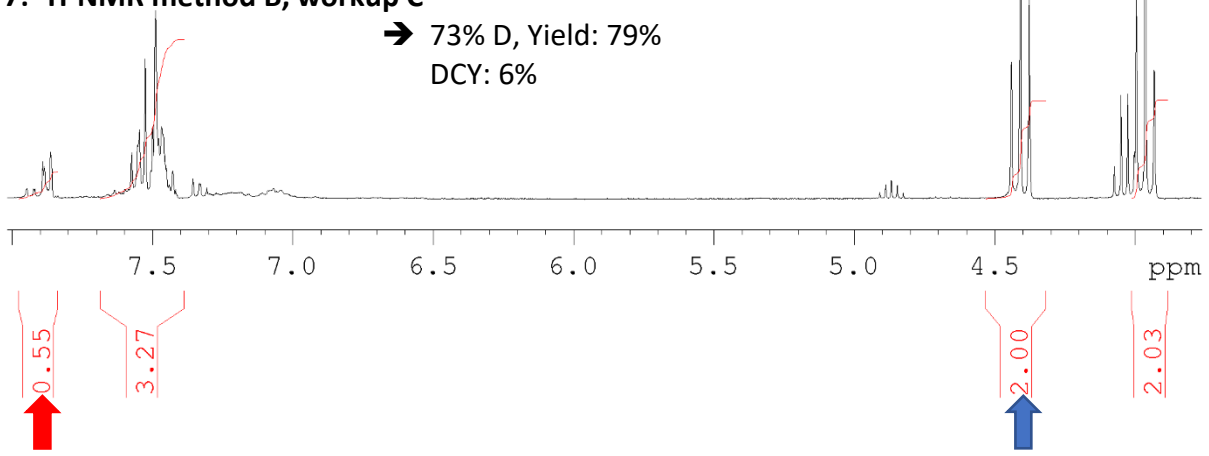
7: ^{1}H-NMR method A, workup C

➔ 67% D, Yield: 96%
DCY: 64%



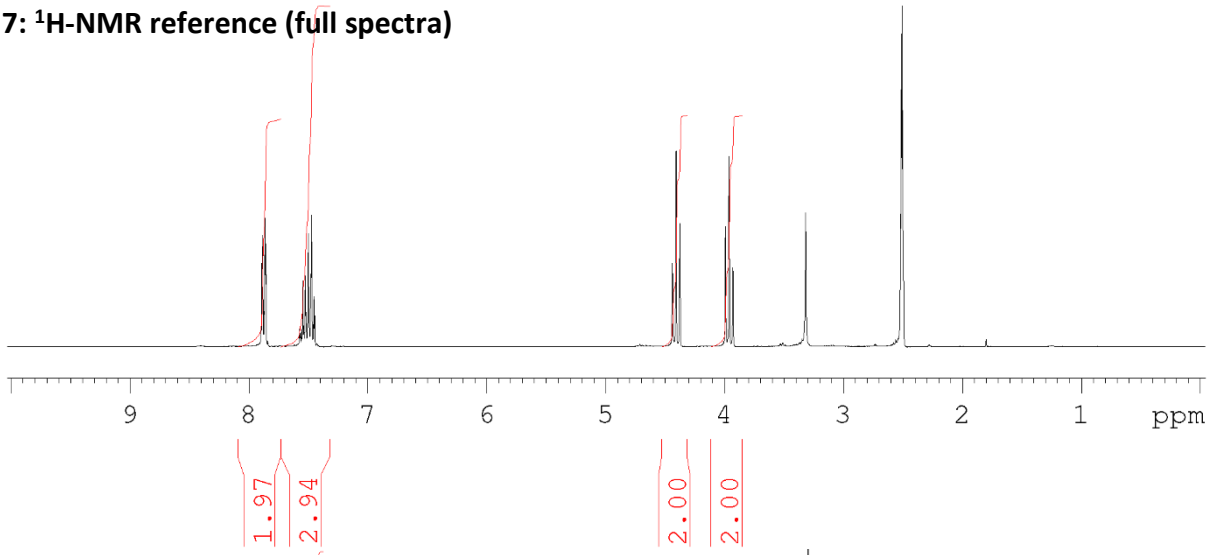
7: ^{1}H-NMR method B, workup C

➔ 73% D, Yield: 79%
DCY: 6%

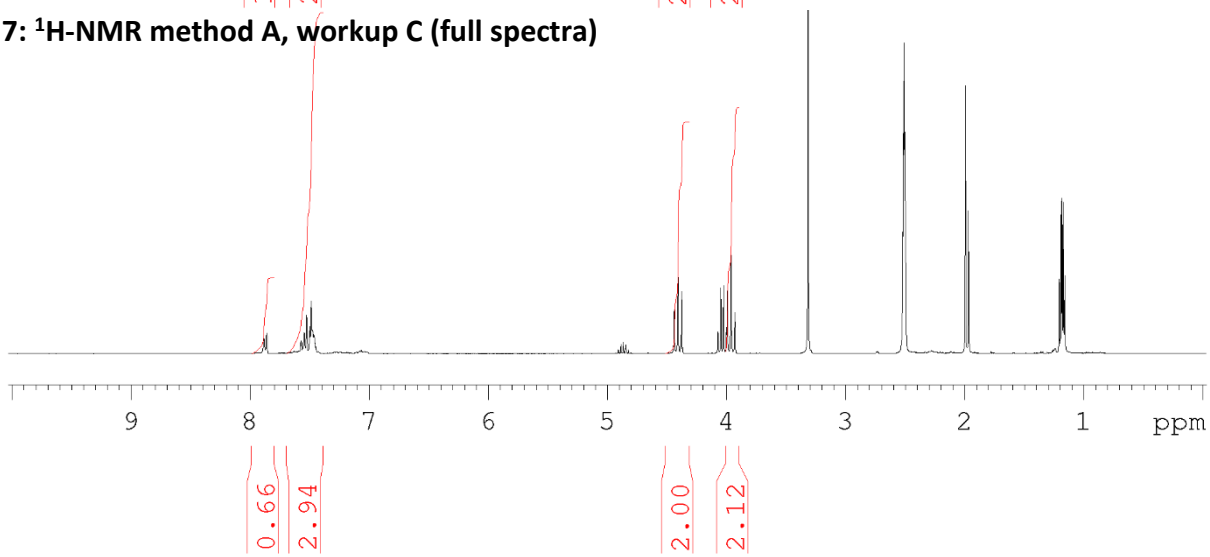


Deuterium incorporation: red arrow. Reference-integral: blue arrow.

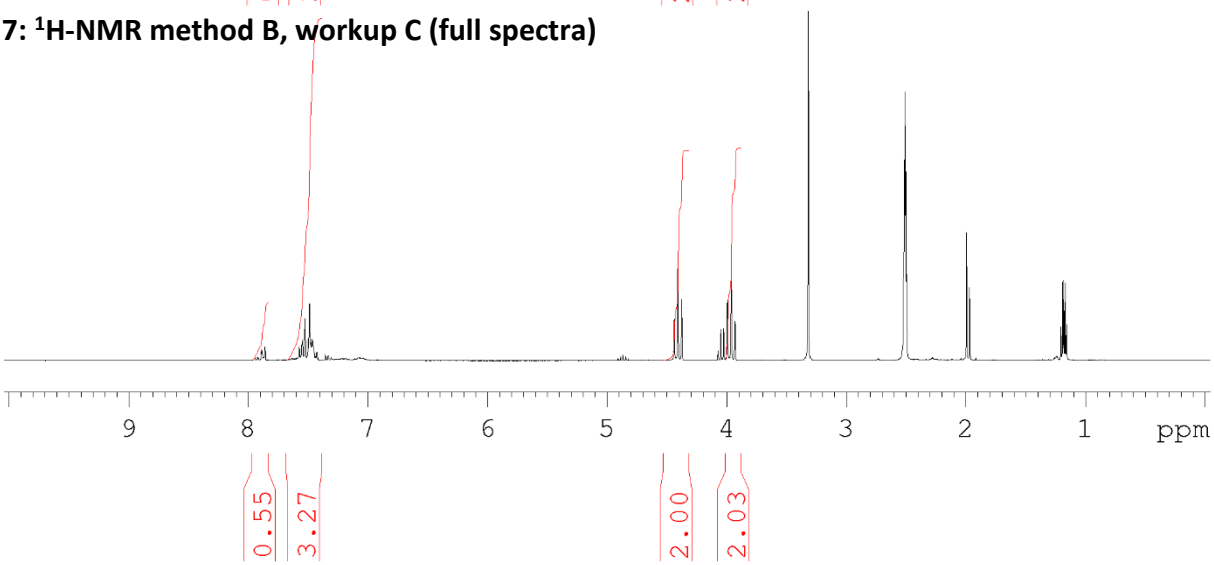
7: ^{1}H-NMR reference (full spectra)



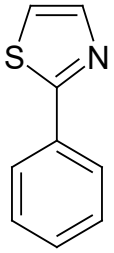
7: ^{1}H-NMR method A, workup C (full spectra)



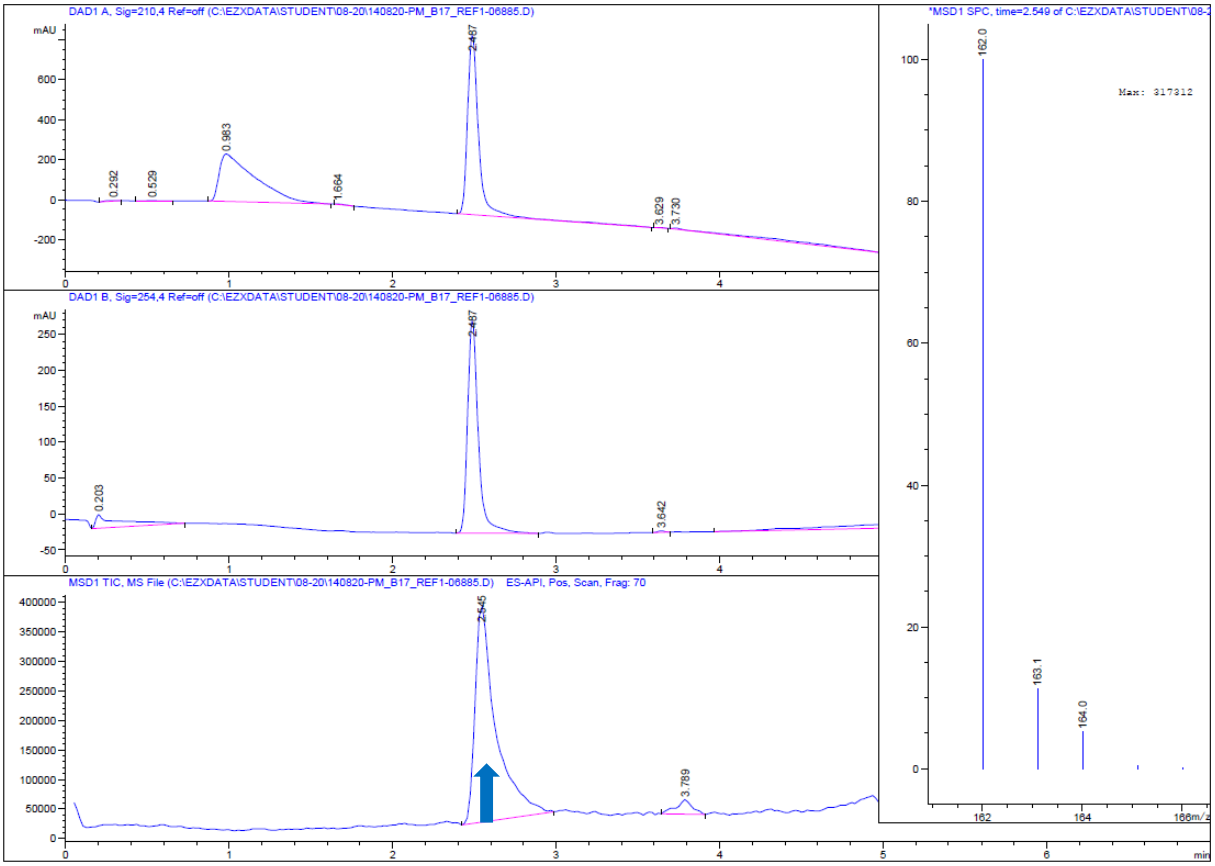
7: ^{1}H-NMR method B, workup C (full spectra)



Data for 2-phenylthiazole **8**



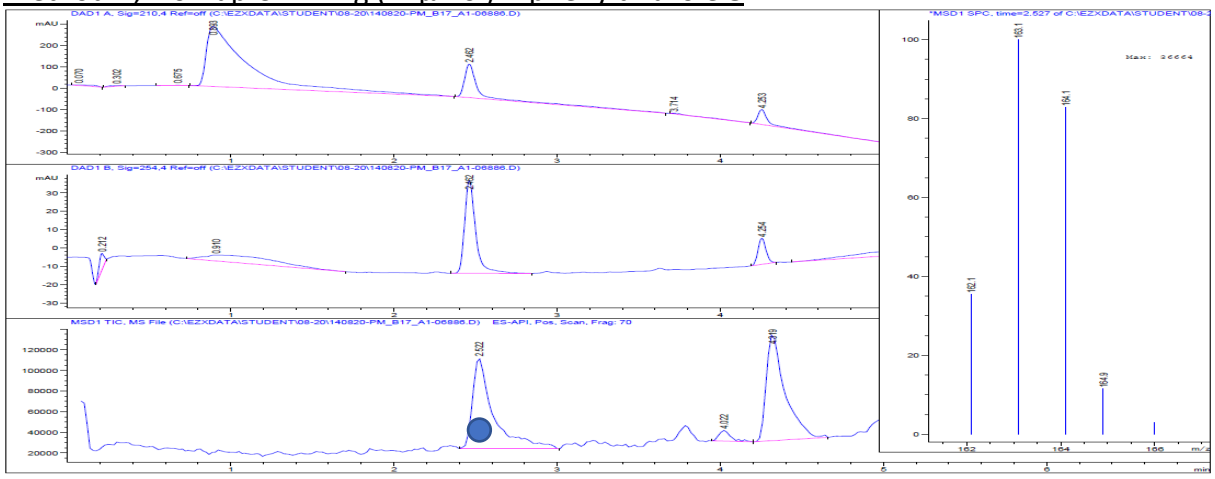
8



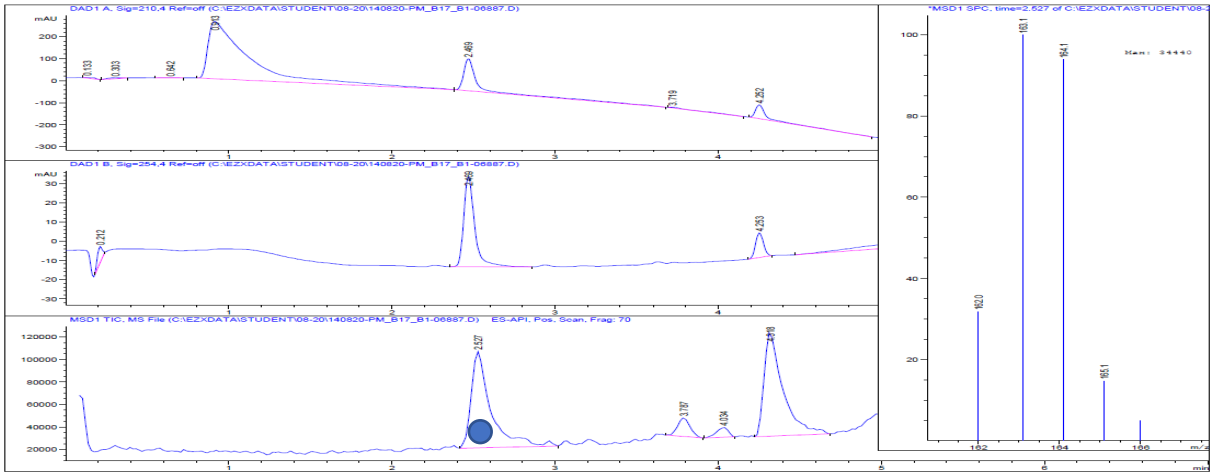
LC-MS (positive ESI): m/z 162.0 $[M+H]^+$ (100), 163.1 $[M+1+H]^+$ (11.2), 164.0 $[M+2+H]^+$ (5.2), 165.1 $[M+3+H]^+$ (0.4)

Deuterium experiments with 2-phenylthiazole **8**

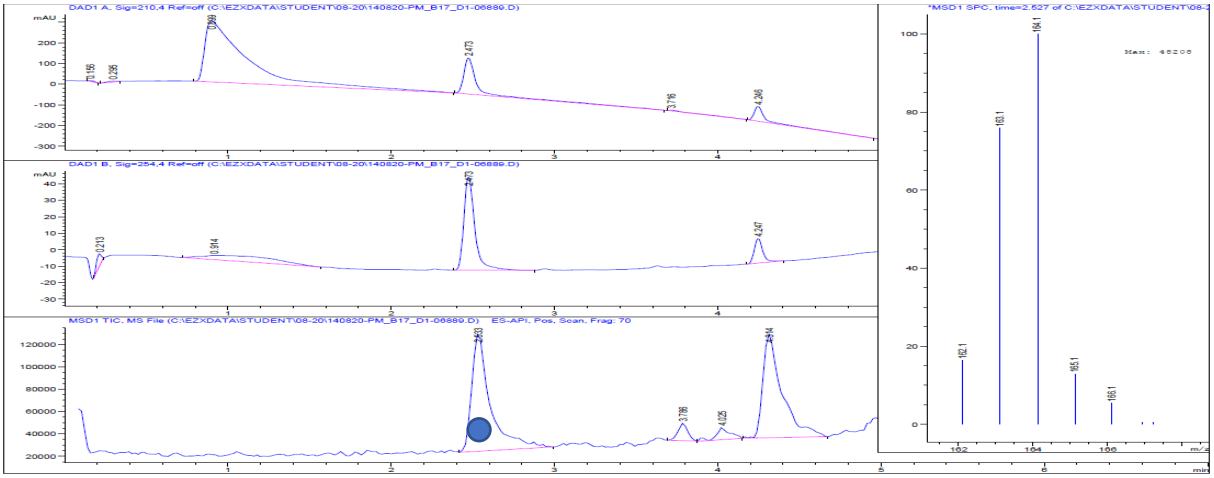
Method A, workup C: 1.7mg (11µmol) 2-phenylthiazole **8**



LC-MS (positive ESI): m/z 162.1 $[M+H]^+$ (35.5), 163.1 $[M(1D)+H]^+$ (100), 164.1 $[M(2D)+H]^+$ (82.8), 164.9 $[M(3D)+H]^+$ (11.5), 166.0 $[M(4D)+H]^+$ (2.9): 60% D



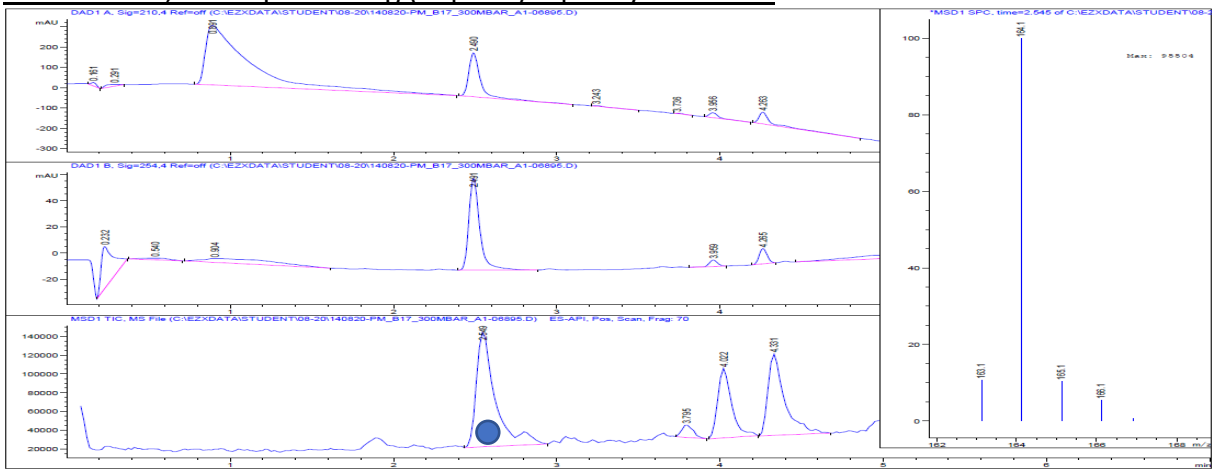
LC-MS (positive ESI): m/z 162.0 $[M+H]^+$ (31.8), 163.1 $[M(1D)+H]^+$ (100), 164.1 $[M(2D)+H]^+$ (93.9), 165.1 $[M(3D)+H]^+$ (14.8), 166.0 $[M(4D)+H]^+$ (4.9) : 62% D



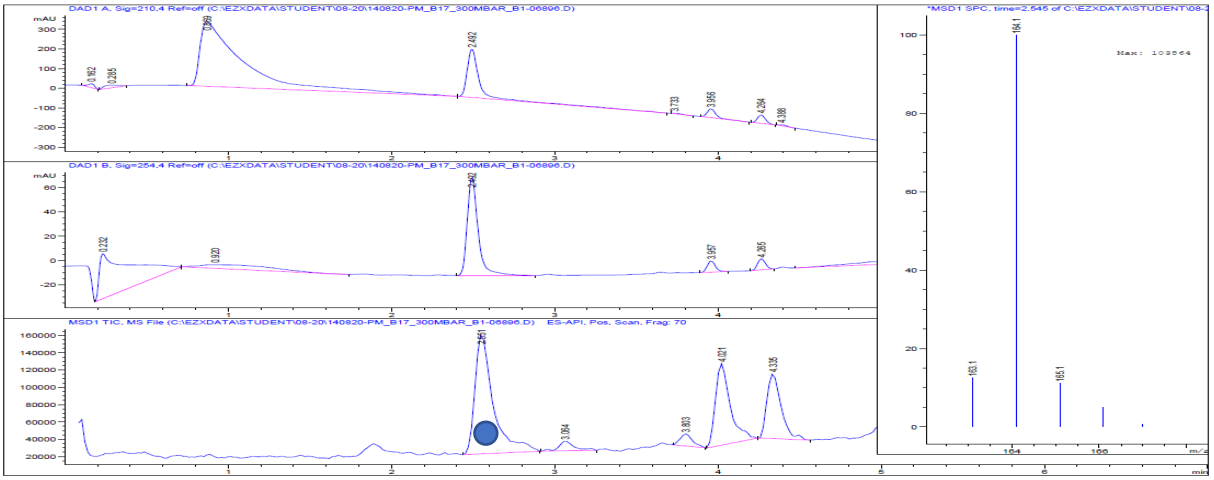
LC-MS (positive ESI): m/z 162.1 $[M+H]^+$ (16.4), 163.1 $[M(1D)+H]^+$ (75.9), 164.1 $[M(2D)+H]^+$ (100), 165.1 $[M(3D)+H]^+$ (12.9), 166.1 $[M(4D)+H]^+$ (5.5) : 70% D

Average of three reactions: 64% D, Yield: 91%, DCY: 58%

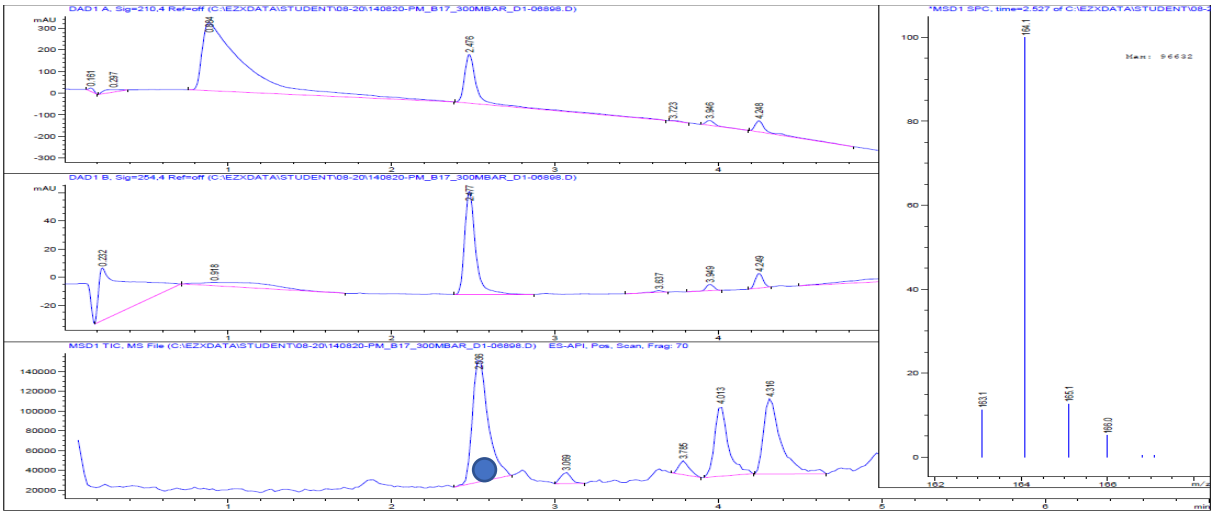
8: Method B, workup C: 2.1mg (13µmol) 2-phenylthiazole **8**



LC-MS (positive ESI): m/z 162.1 $[M+H]^+$ (0), 163.1 $[M(1D)+H]^+$ (10.7), 164.1 $[M(2D)+H]^+$ (100), 165.1 $[M(3D)+H]^+$ (10.4), 166.1 $[M(4D)+H]^+$ (5.4): 95% D



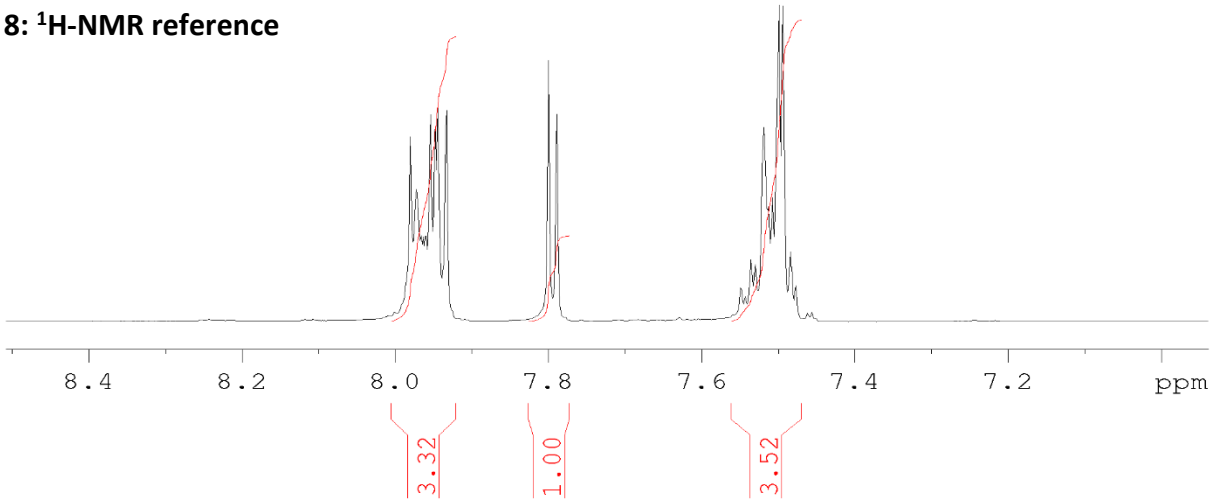
LC-MS (positive ESI): m/z 162.1 $[M+H]^+$ (0), 163.1 $[M(1D)+H]^+$ (12.5), 164.1 $[M(2D)+H]^+$ (100), 165.1 $[M(3D)+H]^+$ (11.1), 166.1 $[M(4D)+H]^+$ (5.0): 95% D



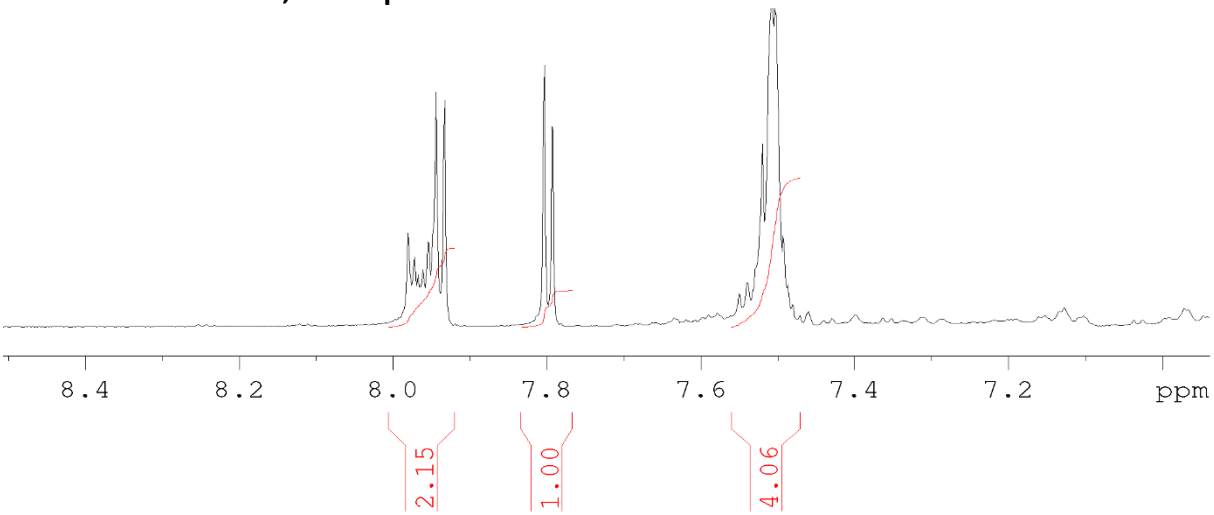
LC-MS (positive ESI): m/z 162.1 $[M+H]^+$ (0), 163.1 $[M(1D)+H]^+$ (11.3), 164.1 $[M(2D)+H]^+$ (100), 165.1 $[M(3D)+H]^+$ (12.7), 166.0 $[M(4D)+H]^+$ (5.2): 95% D

Average of three reactions: 95% D, Yield: 95%, DCY: 9%

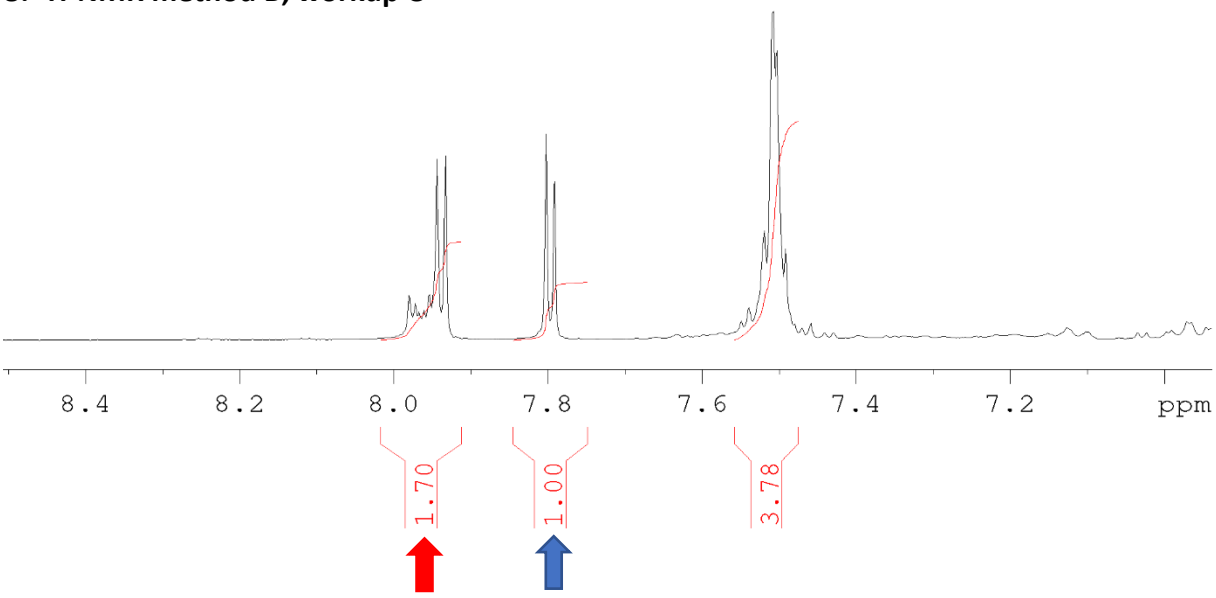
8: ^{1}H-NMR reference



8: ^{1}H-NMR method A, workup C

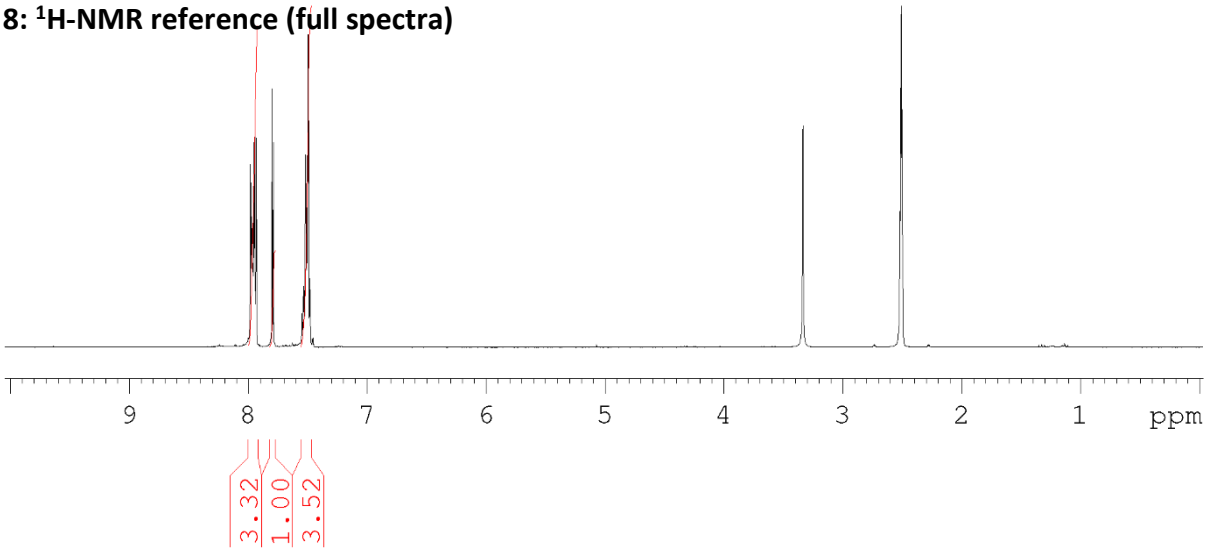


8: ^{1}H-NMR method B, workup C

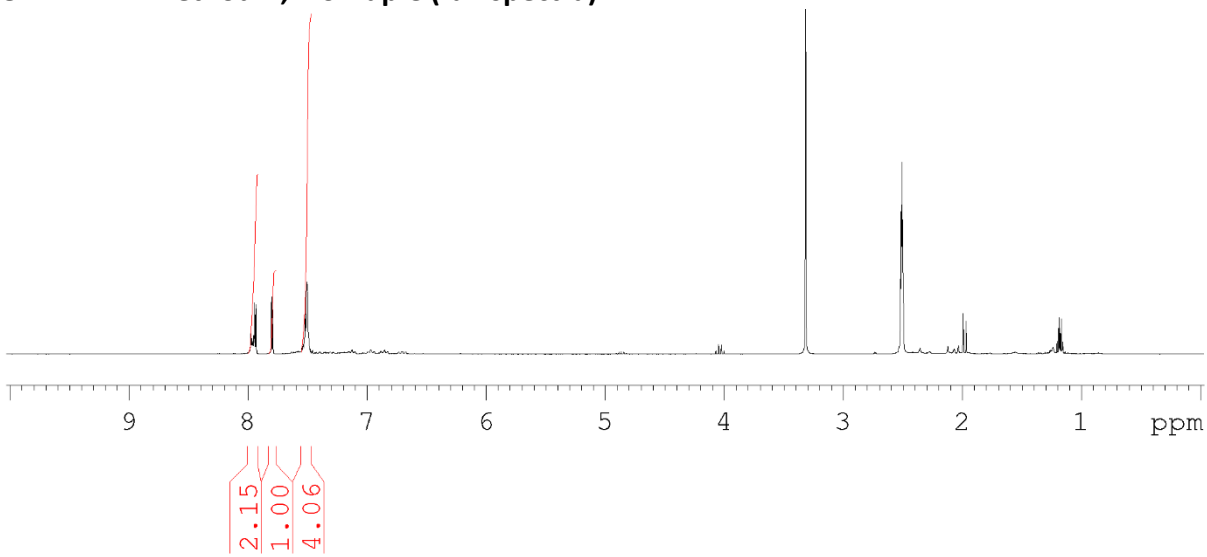


Deuterium incorporation: red arrow. Reference-integral: blue arrow.

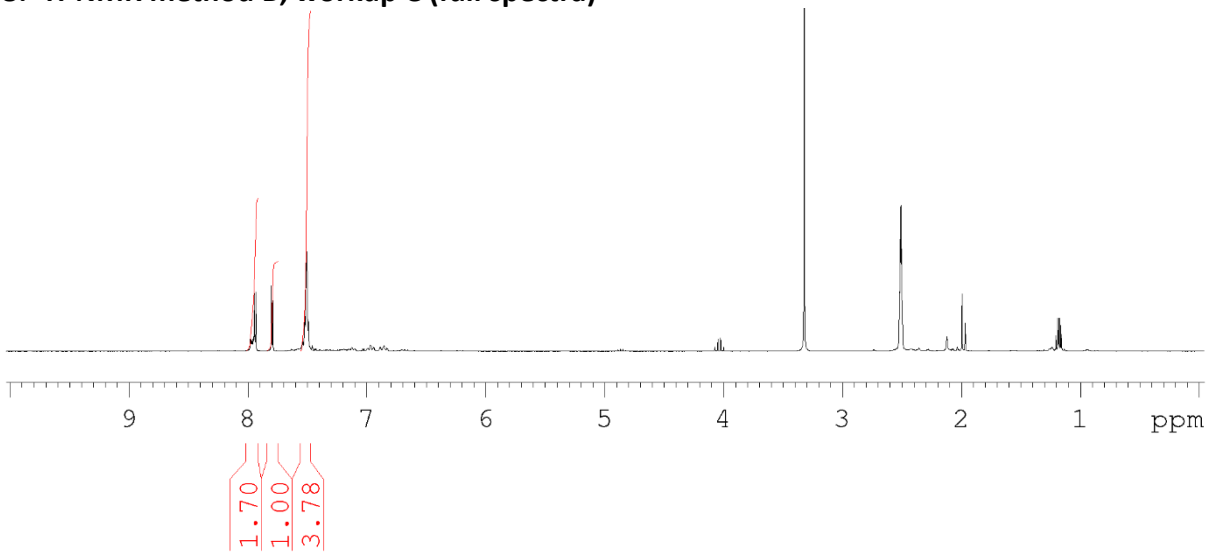
8: ^{1}H-NMR reference (full spectra)



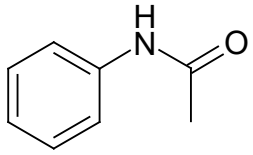
8: ^{1}H-NMR method A, workup C (full spectra)



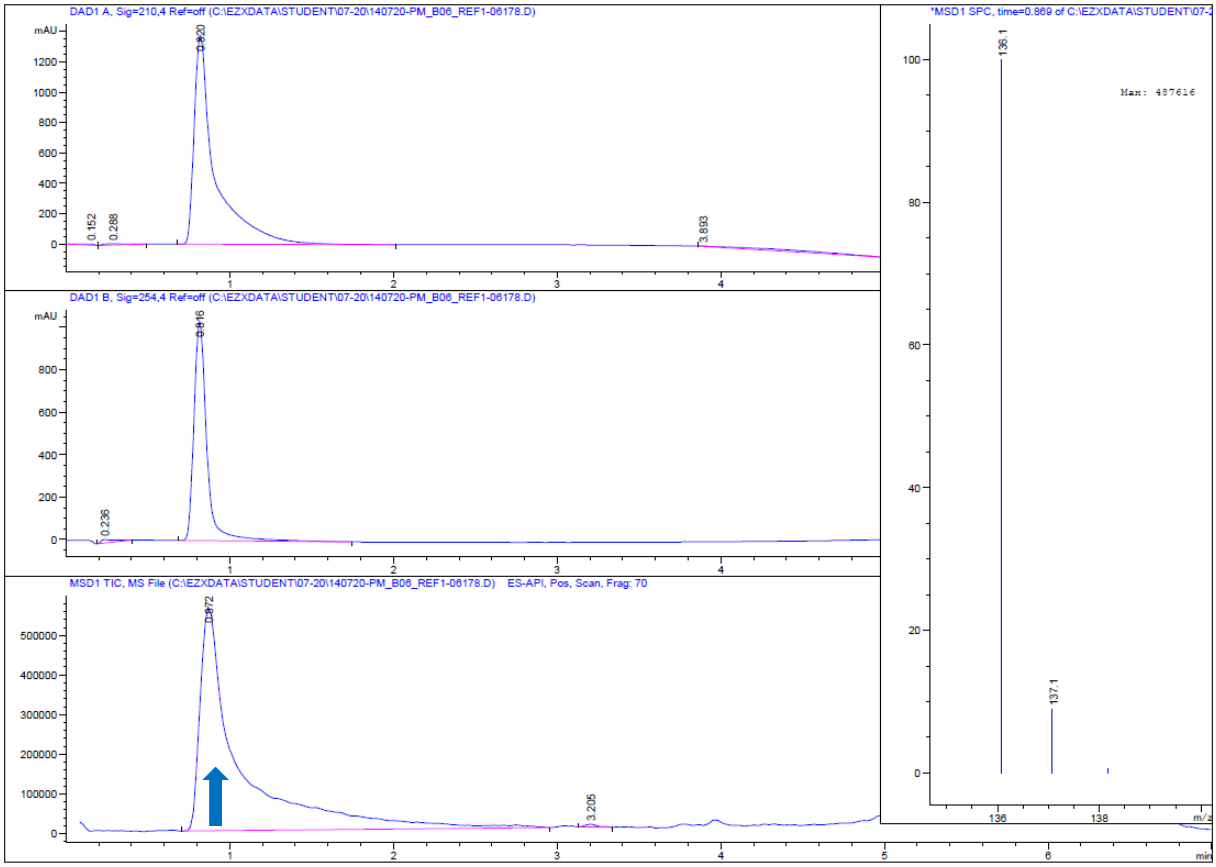
8: ^{1}H-NMR method B, workup C (full spectra)



Data for acetanilide **9**



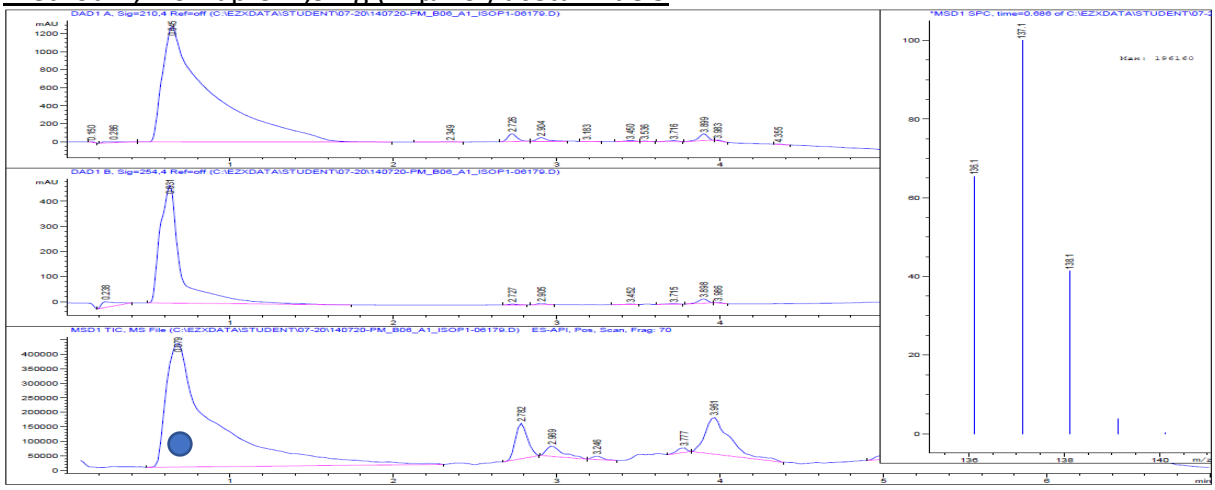
9



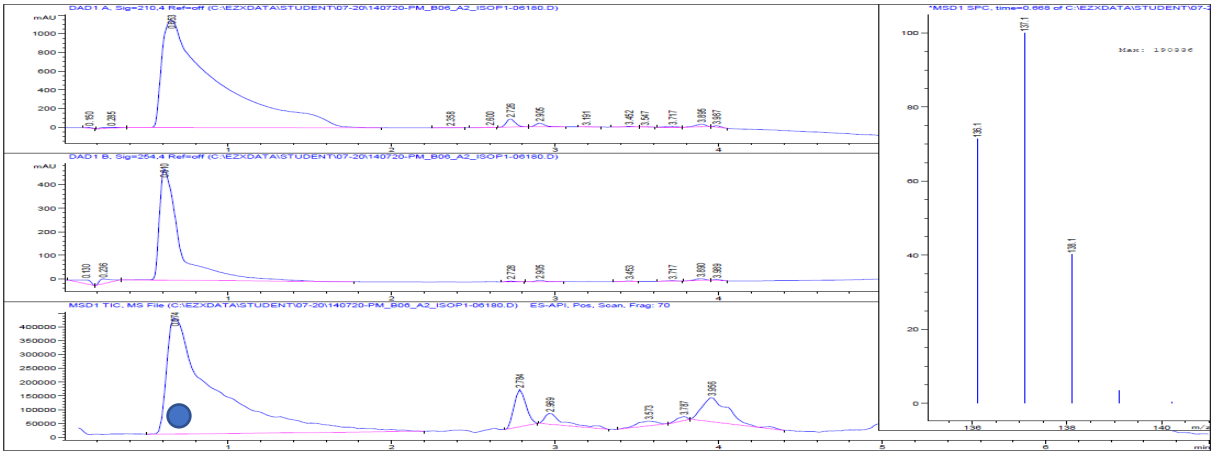
LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (100), 137.1 $[M+1+H]^+$ (9.0), 138.2 $[M+2+H]^+$ (0.5)

Deuterium experiments with acetanilide **9**

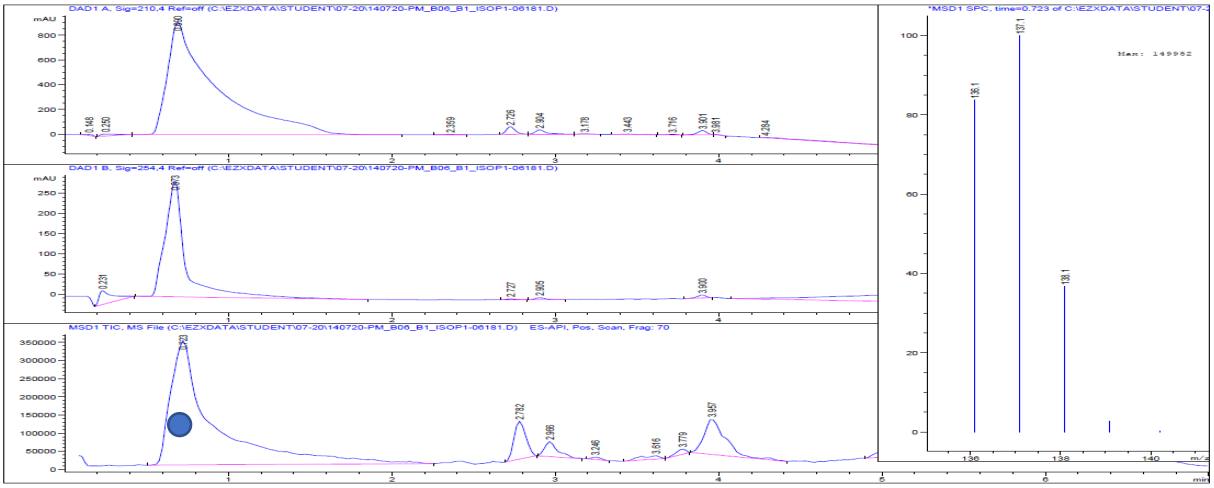
Method A, workup C: 1,9mg (14µmol) acetanilide **9**



LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (65.4), 137.1 $[M(1D)+H]^+$ (100), 138.1 $[M(2D)+H]^+$ (41.4), 139.1 $[M(3D)+H]^+$ (3.8) : 42% D



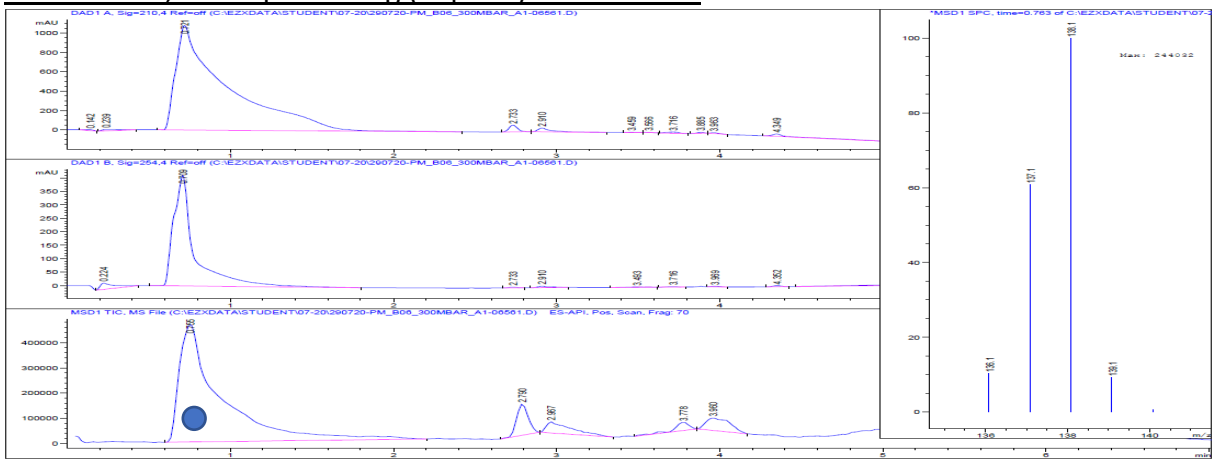
LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (71.4), 137.1 $[M(1D)+H]^+$ (100), 138.1 $[M(2D)+H]^+$ (40.2), 139.1 $[M(3D)+H]^+$ (3.5) : 40% D



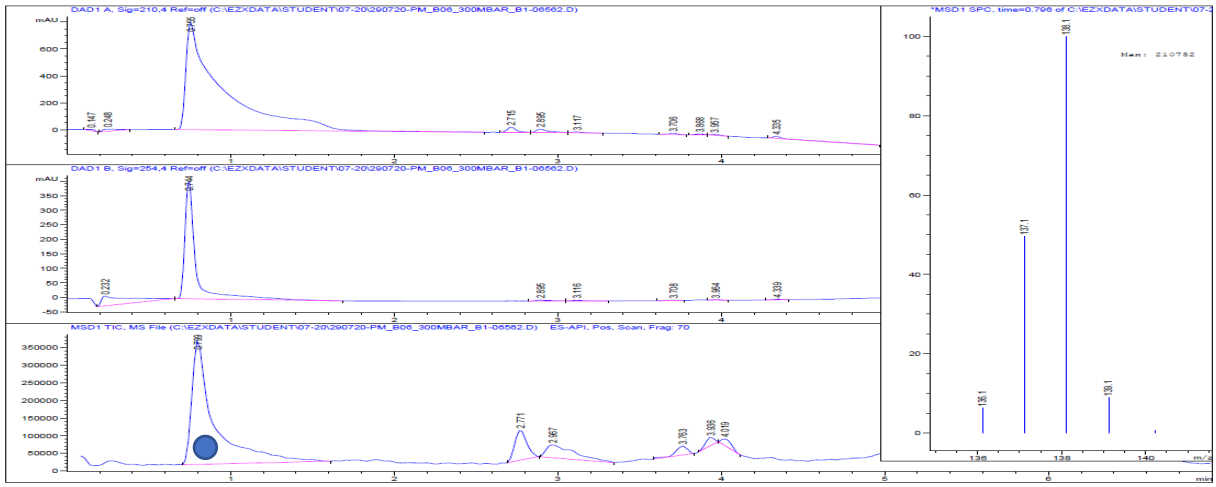
LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (83.7), 137.1 $[M(1D)+H]^+$ (100), 138.1 $[M(2D)+H]^+$ (36.7), 139.1 $[M(3D)+H]^+$ (2.8) : 36% D

Average of three reactions: 39% D, Yield: 96%, DCY: 37%

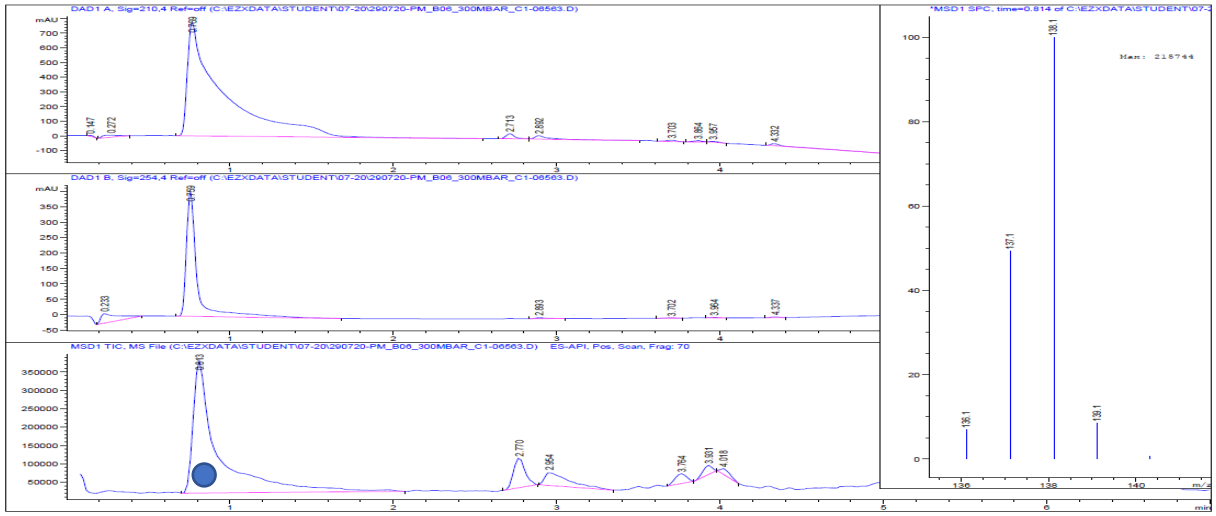
9: Method B, workup C: 1.7mg (13µmol) acetanilide **9**



LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (10.3), 137.1 $[M(1D)+H]^+$ (60.9), 138.1 $[M(2D)+H]^+$ (100), 139.1 $[M(3D)+H]^+$ (9.2) : 76% D



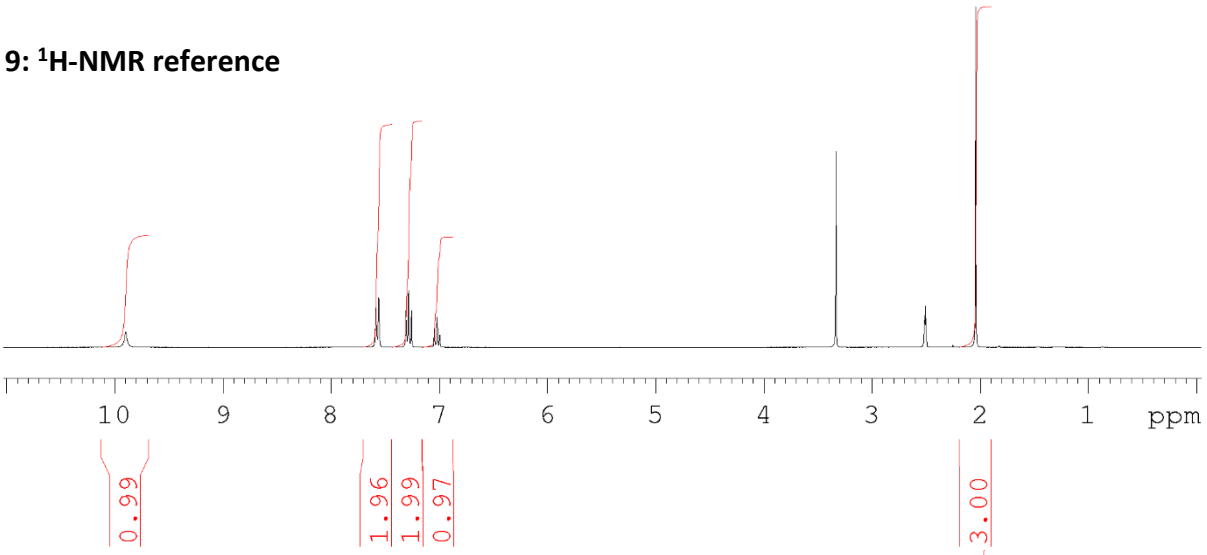
LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (6.3), 137.1 $[M(1D)+H]^+$ (49.6), 138.1 $[M(2D)+H]^+$ (100), 139.1 $[M(3D)+H]^+$ (8.9) : 80% D



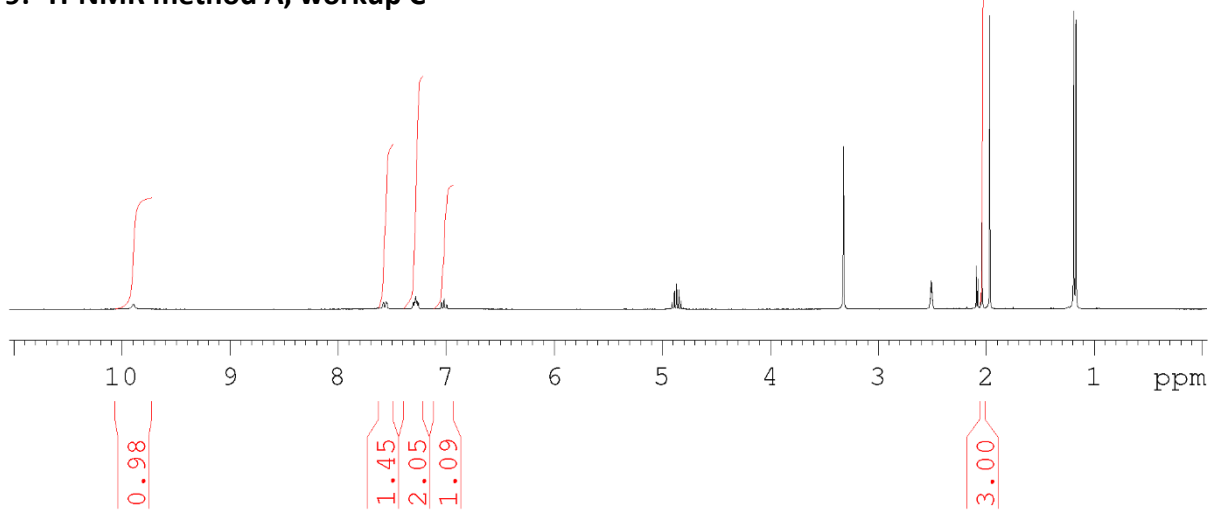
LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (6.9), 137.1 $[M(1D)+H]^+$ (49.3), 138.1 $[M(2D)+H]^+$ (100), 139.1 $[M(3D)+H]^+$ (8.5) : 79% D

Average of three reactions: 78% D, Yield: 56%, DCY: 4%

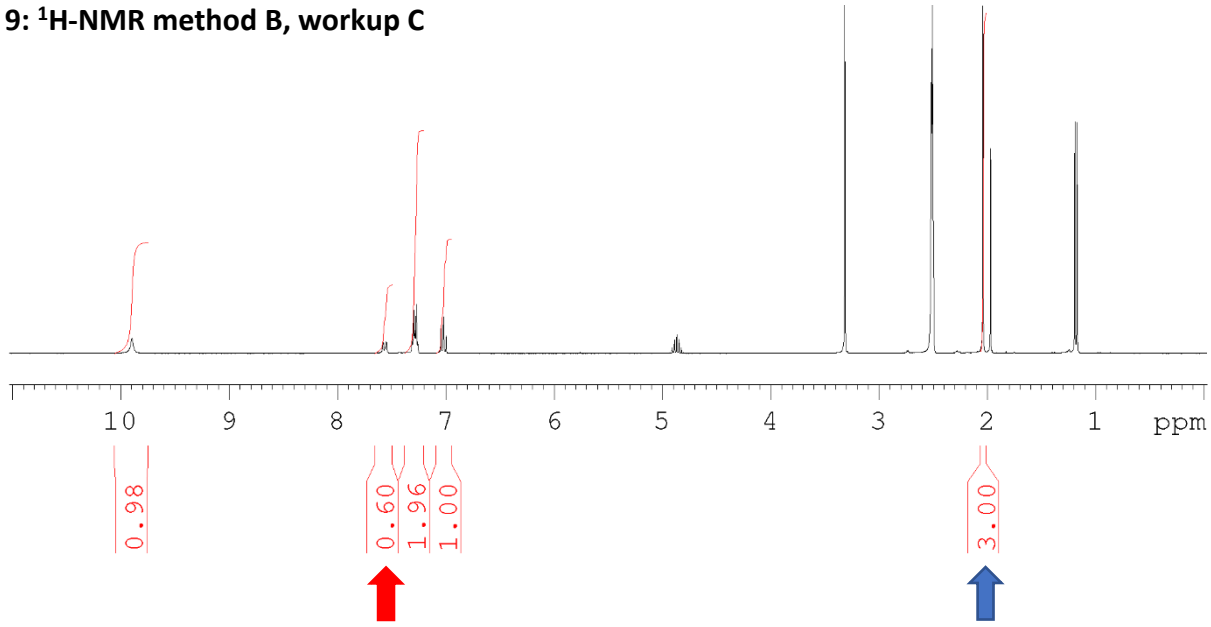
9: ^{1}H-NMR reference



9: ^{1}H-NMR method A, workup C

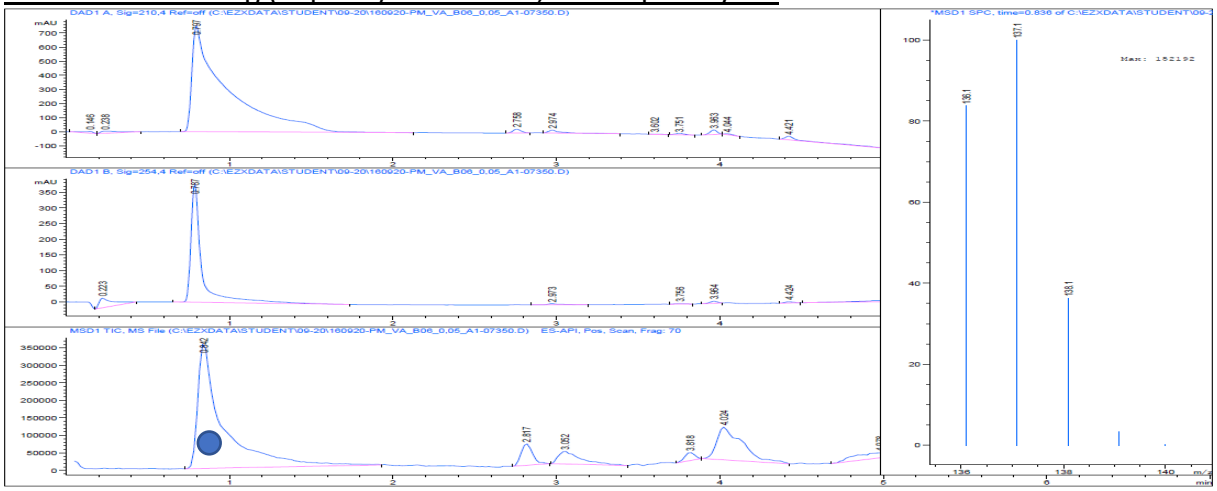


9: ^{1}H-NMR method B, workup C

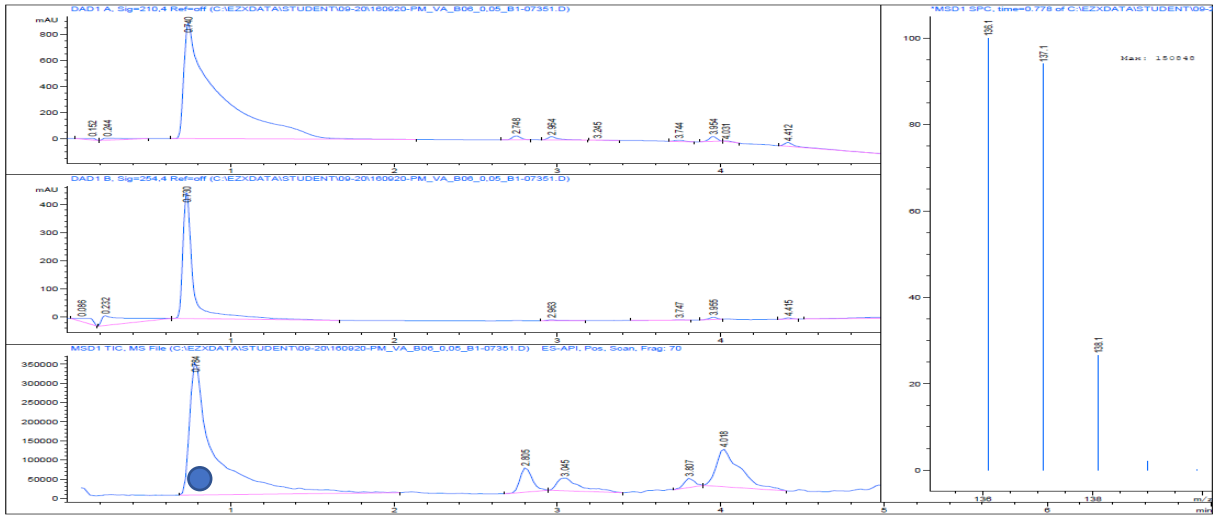


Deuterium incorporation: red arrow. Reference-integral: blue arrow.

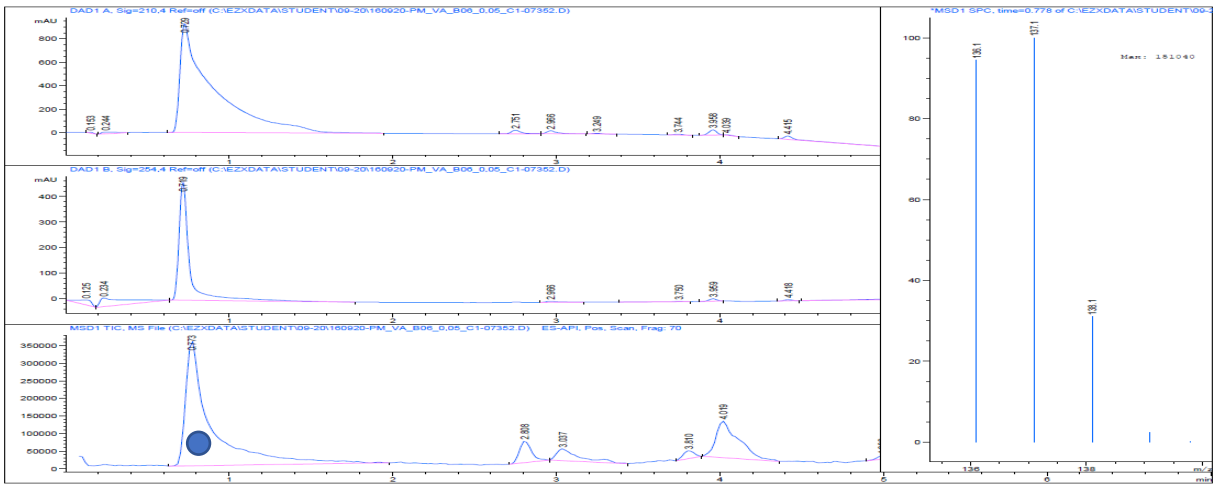
9: Method E: 1.9mg (14µmol) acetanilide, 0.05 eq catalyst **9**



LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (83.8), 137.1 $[M(1D)+H]^+$ (100), 138.1 $[M(2D)+H]^+$ (36.3), 139.1 $[M(3D)+H]^+$ (3.3) : 37% D



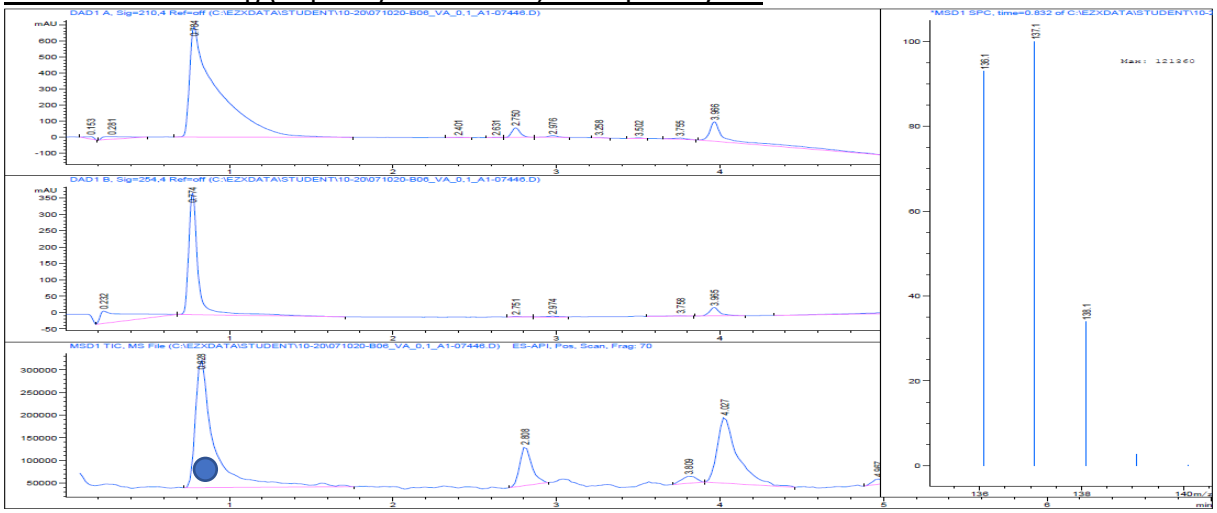
LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (100), 137.1 $[M(1D)+H]^+$ (94.0), 138.1 $[M(2D)+H]^+$ (26.6), 139.1 $[M(3D)+H]^+$ (2.1) : 30% D



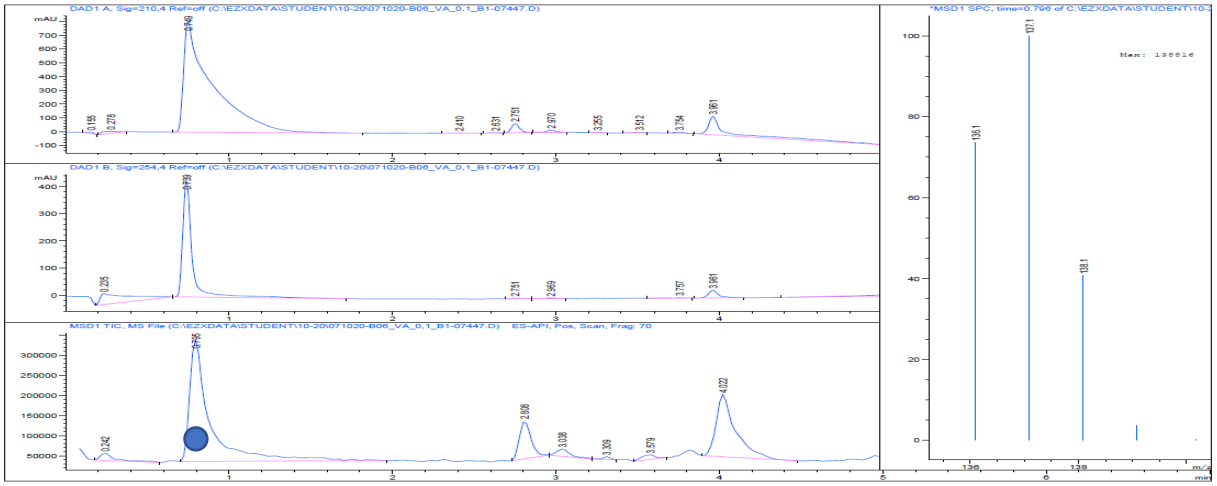
LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (6.9), 137.1 $[M(1D)+H]^+$ (49.3), 138.1 $[M(2D)+H]^+$ (100), 139.1 $[M(3D)+H]^+$ (8.5) : 7.9% D

Average of three reactions: 33% D, Yield: 96%, DCY: 32%

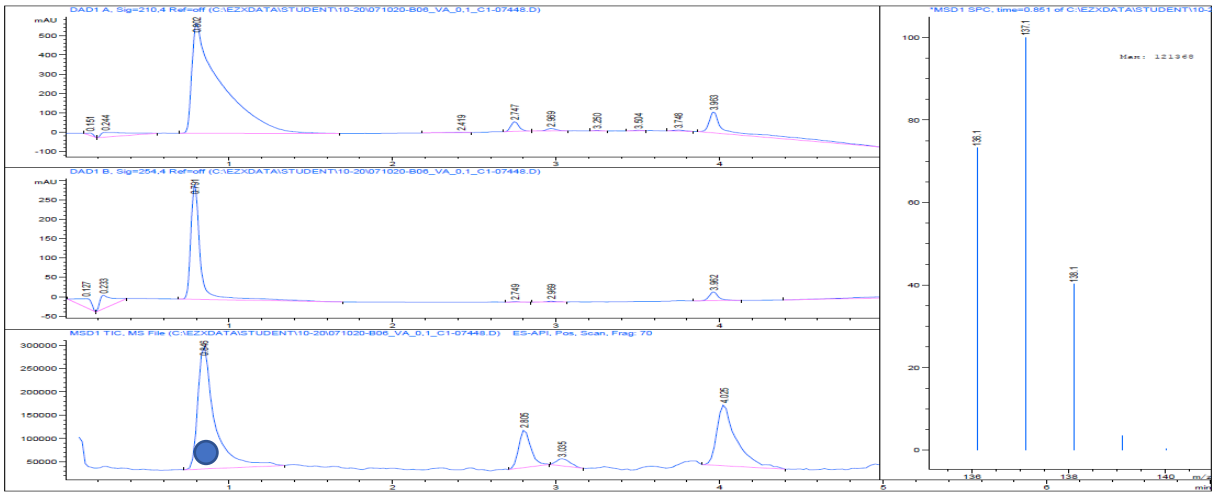
9: Method E: 1.9mg (14µmol) acetanilide, 0.1 eq catalyst **9**



LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (93.0), 137.1 $[M(1D)+H]^+$ (100), 138.1 $[M(2D)+H]^+$ (33.9), 139.1 $[M(3D)+H]^+$ (2.8) : 34% D



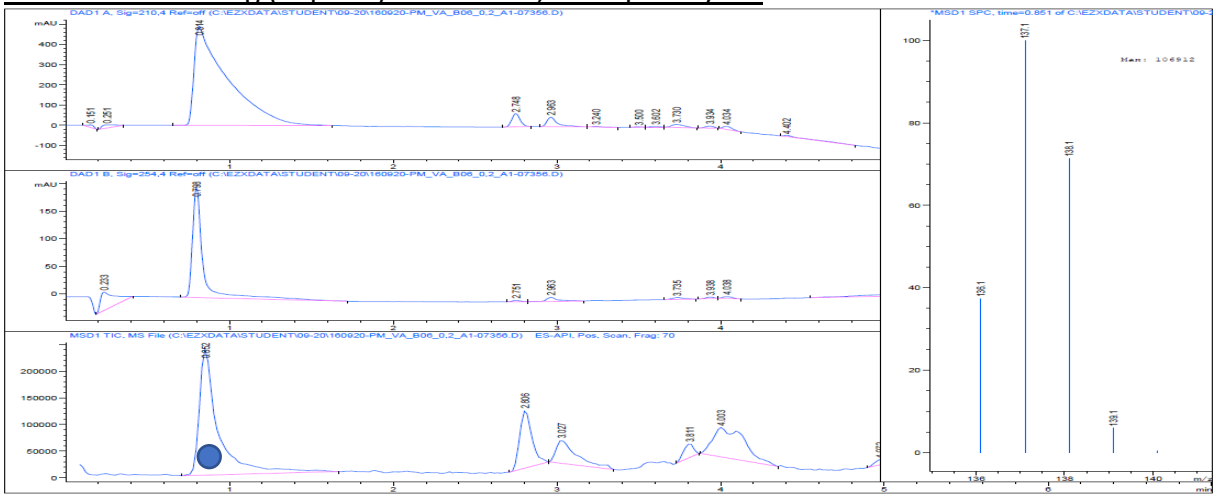
LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (73.7), 137.1 $[M(1D)+H]^+$ (100), 138.1 $[M(2D)+H]^+$ (40.7), 139.1 $[M(3D)+H]^+$ (3.7) : 40% D



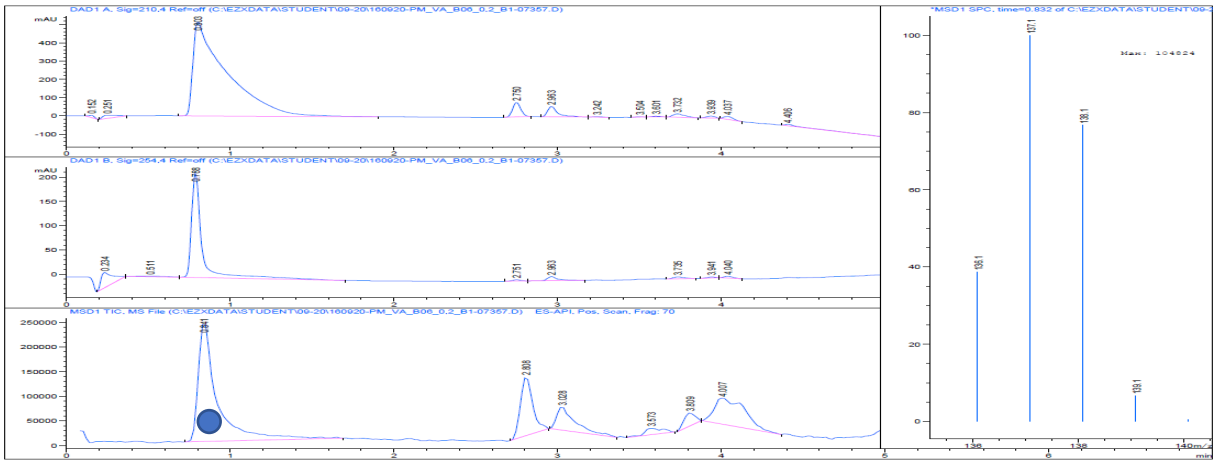
LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (73.3), 137.1 $[M(1D)+H]^+$ (100), 138.1 $[M(2D)+H]^+$ (40.2), 139.1 $[M(3D)+H]^+$ (3.5) : 40% D

Average of three reactions: 38% D, Yield: 82%, DCY: 31%

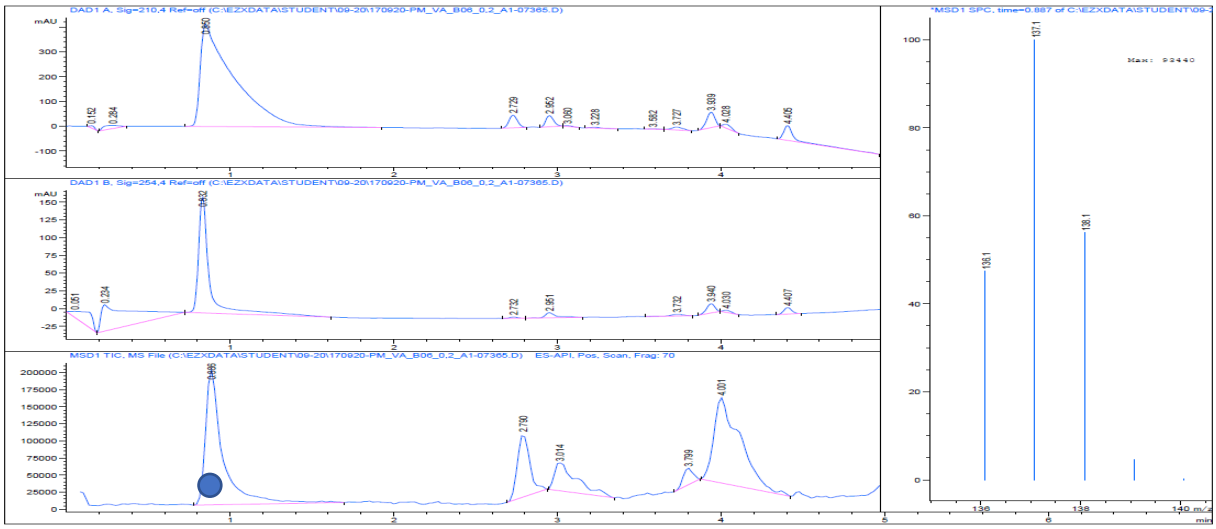
9: Method E: 1.9mg (14µmol) acetanilide, 0.2 eq catalyst **9**



LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (37.4), 137.1 $[M(1D)+H]^+$ (100), 138.1 $[M(2D)+H]^+$ (71.4), 139.1 $[M(3D)+H]^+$ (6.0) : 57% D



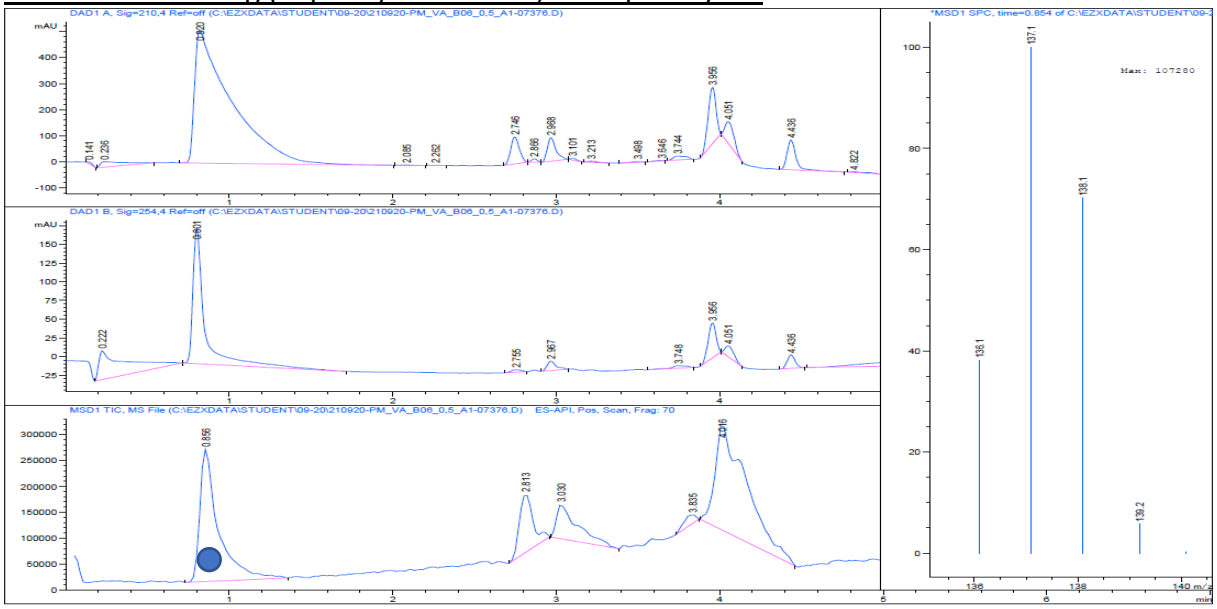
LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (38.7), 137.1 $[M(1D)+H]^+$ (100), 138.1 $[M(2D)+H]^+$ (76.8), 139.1 $[M(3D)+H]^+$ (6.7) : 57% D



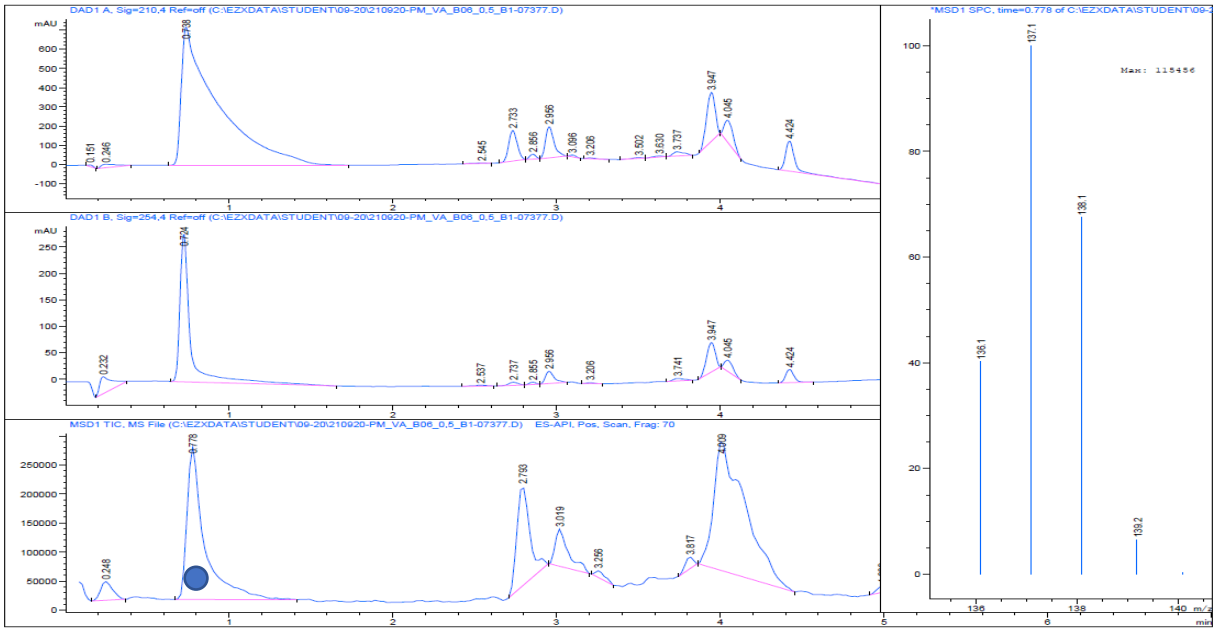
LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (47.5), 137.1 $[M(1D)+H]^+$ (100), 138.1 $[M(2D)+H]^+$ (56.2), 139.1 $[M(3D)+H]^+$ (4.6) : 50% D

Average of three reactions: 55% D, Yield: 60%, DCY: 33%

9: Method E: 1.9mg (14µmol) acetanilide, 0.5 eq catalyst **9**



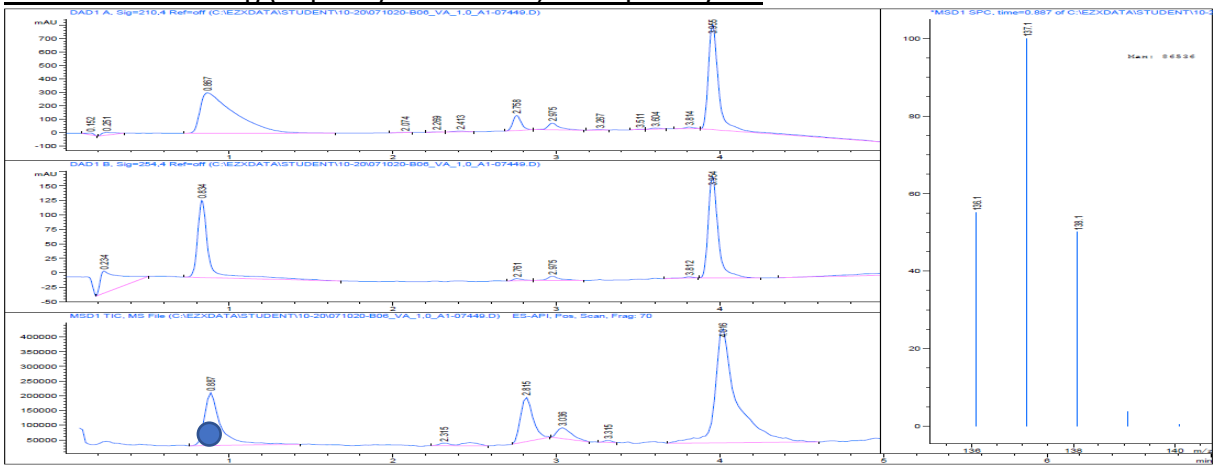
LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (38.1), 137.1 $[M(1D)+H]^+$ (100), 138.1 $[M(2D)+H]^+$ (70.2), 139.1 $[M(3D)+H]^+$ (5.8) : 56% D



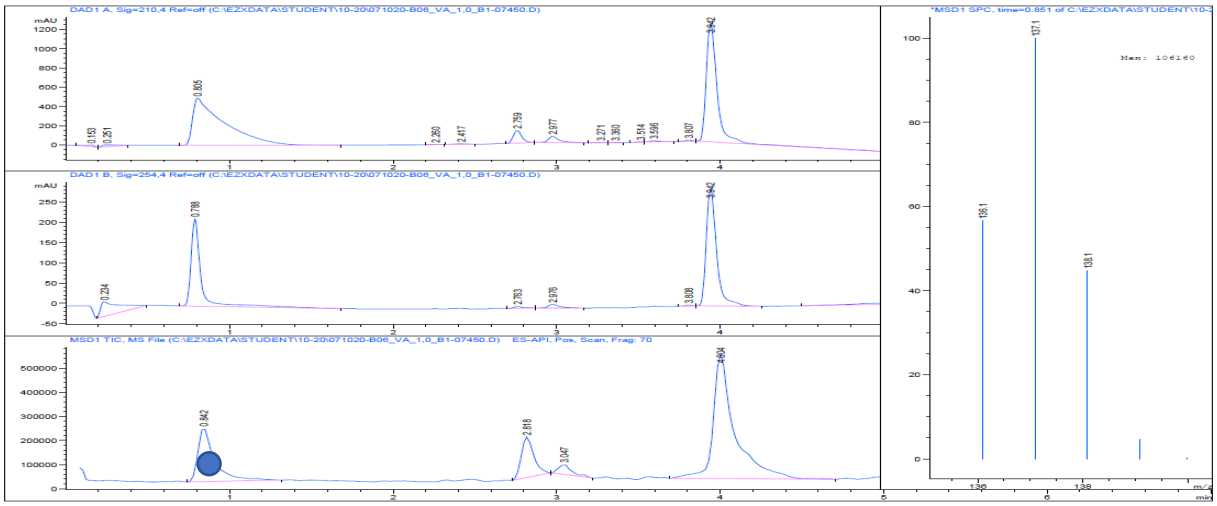
LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (40.3), 137.1 $[M(1D)+H]^+$ (100), 138.1 $[M(2D)+H]^+$ (67.5), 139.2 $[M(3D)+H]^+$ (6.6) : 56% D

Average of three reactions: 56% D, Yield: 68%, DCY: 38%

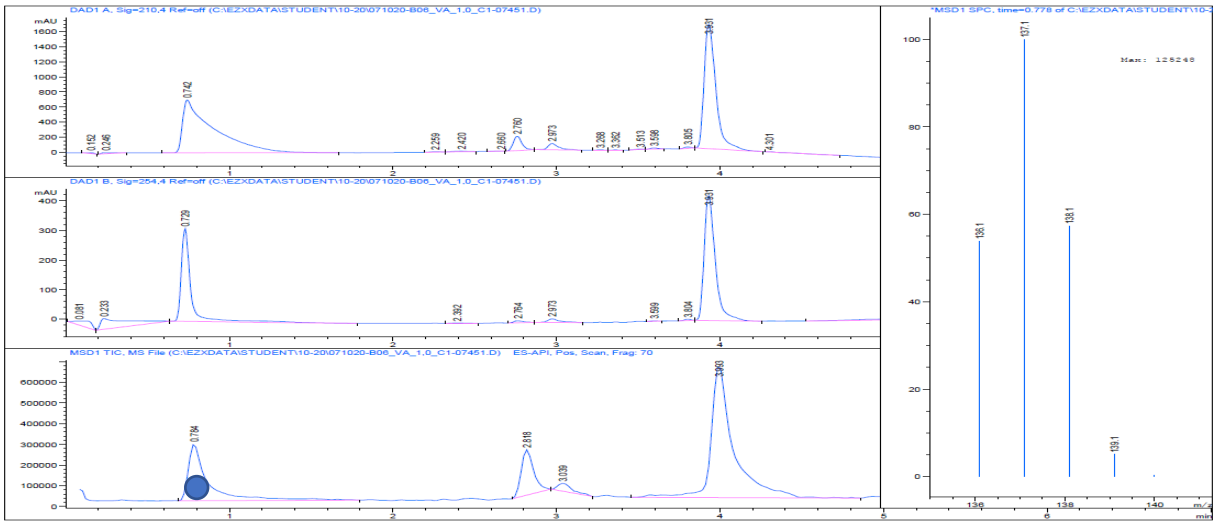
9: Method E: 1.9mg (14µmol) acetanilide, 1.0 eq catalyst **9**



LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (53.1), 137.1 $[M(1D)+H]^+$ (100), 138.1 $[M(2D)+H]^+$ (56.1), 139.1 $[M(3D)+H]^+$ (4.5) : 49% D



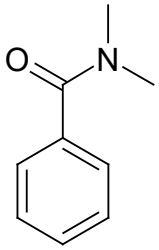
LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (45.7), 137.1 $[M(1D)+H]^+$ (100), 138.1 $[M(2D)+H]^+$ (65.6), 139.1 $[M(3D)+H]^+$ (6.3) : 53% D



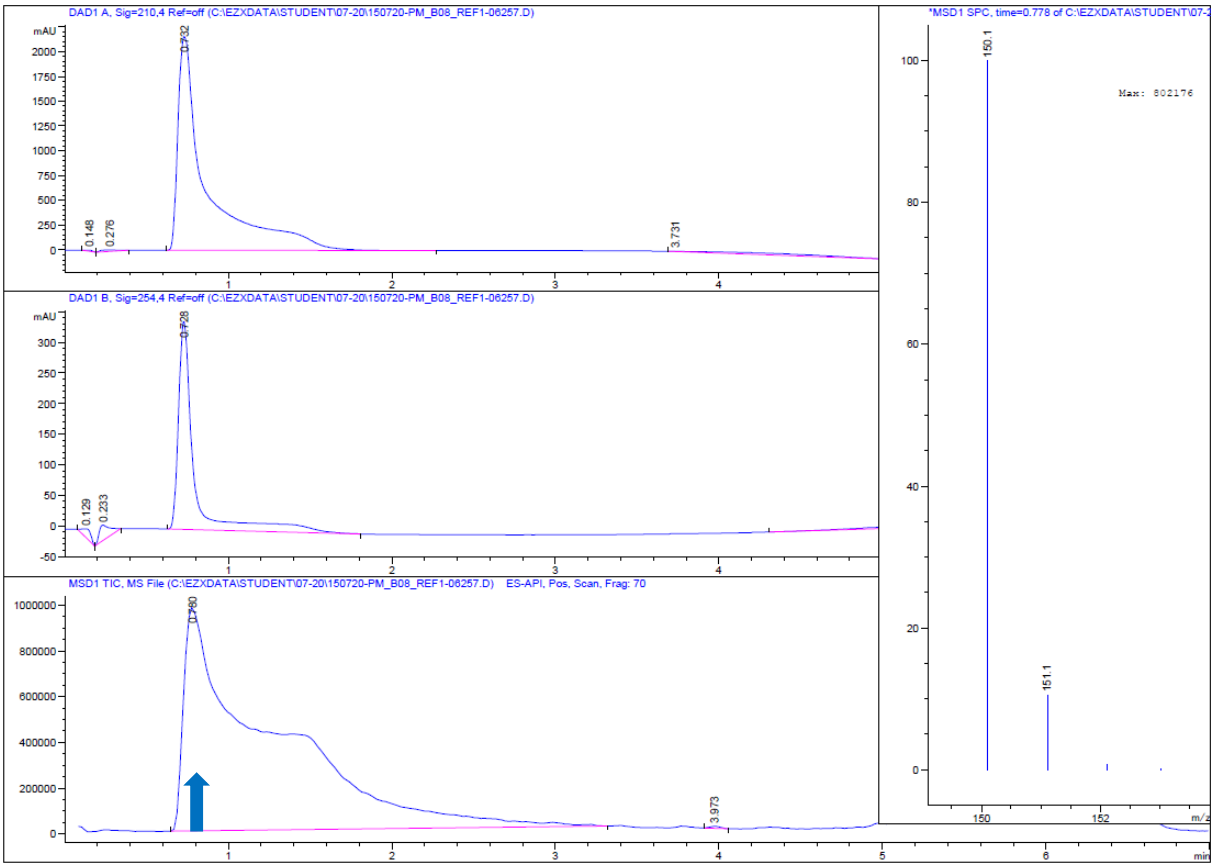
LC-MS (positive ESI): m/z 136.1 $[M+H]^+$ (53.9), 137.1 $[M(1D)+H]^+$ (100), 138.1 $[M(2D)+H]^+$ (57.4), 139.1 $[M(3D)+H]^+$ (5.1) : 50% D

Average of three reactions: 51% D, Yield: 40%, DCY: 20%

Data for N,N-dimethylbenzamide **10**



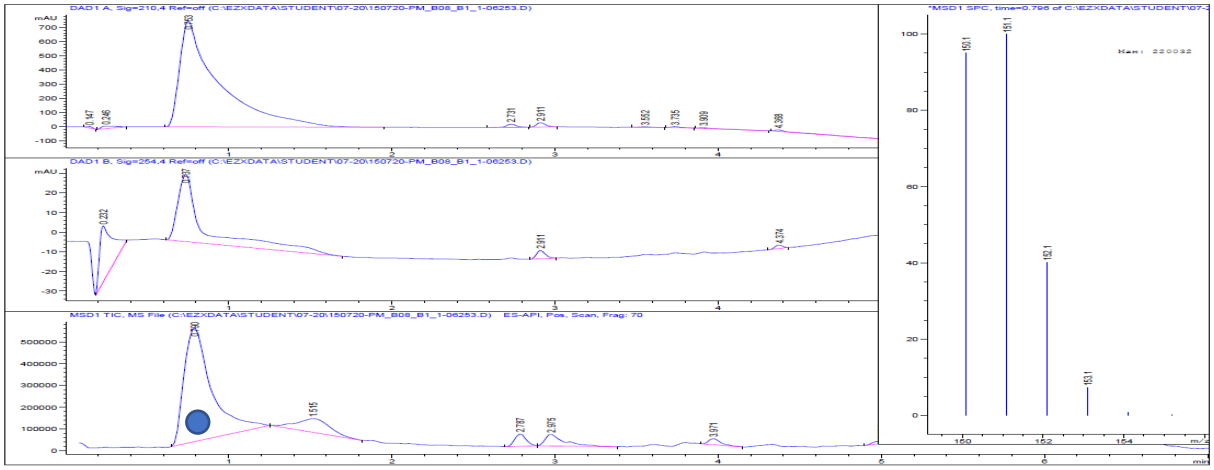
10



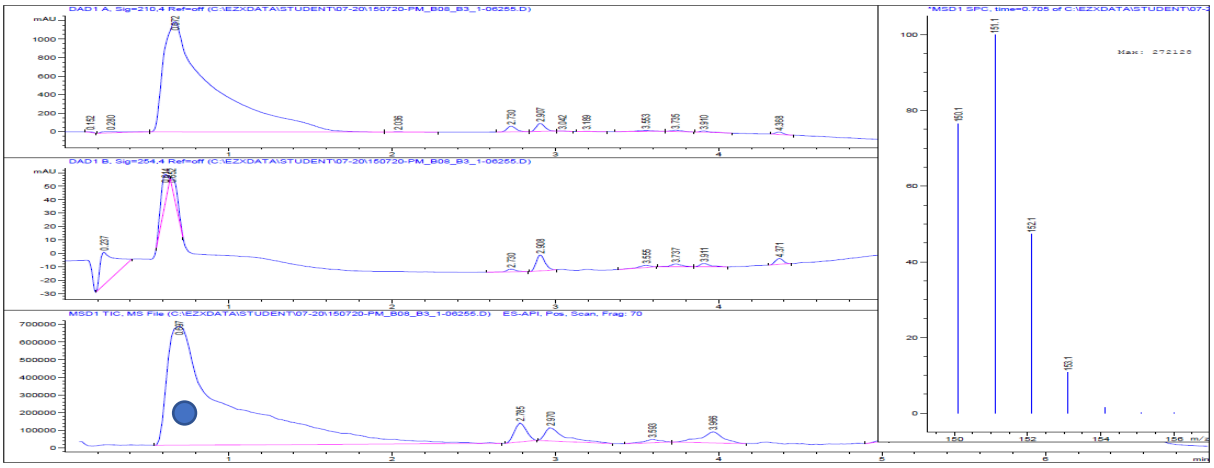
LC-MS (positive ESI): m/z 150.1 $[M+H]^+$ (100), 151.1 $[M+1+H]^+$ (10.6), 152.1 $[M+2+H]^+$ (0.7)

experiments with N,N-dimethylbenzamide **10**

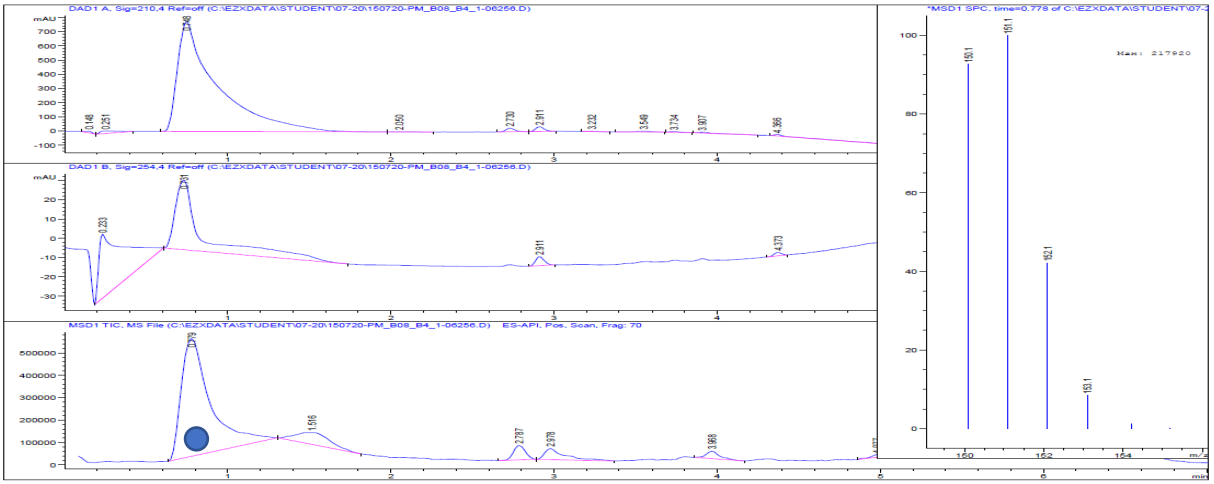
Method A, workup C: 1.6mg (14µmol) N,N-dimethylbenzamide **10**



LC-MS (positive ESI): m/z 150.1 $[M+H]^+$ (94.9), 151.1 $[M(1D)+H]^+$ (100), 152.1 $[M(2D)+H]^+$ (40.2), 153.1 $[M(3D)+H]^+$ (7.4), 154.1 $[M(4D)+H]^+$ (0.8) : 36% D



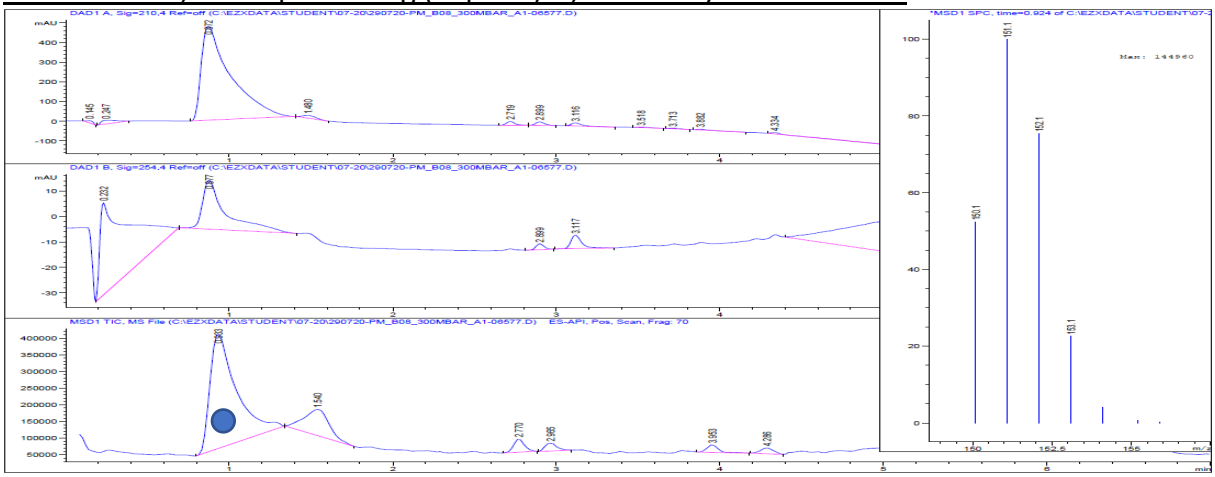
LC-MS (positive ESI): m/z 150.1 $[M+H]^+$ (76.5), 151.1 $[M(1D)+H]^+$ (100), 152.1 $[M(2D)+H]^+$ (47.4), 153.1 $[M(3D)+H]^+$ (10.8), 154.1 $[M(4D)+H]^+$ (1.6) : 44% D



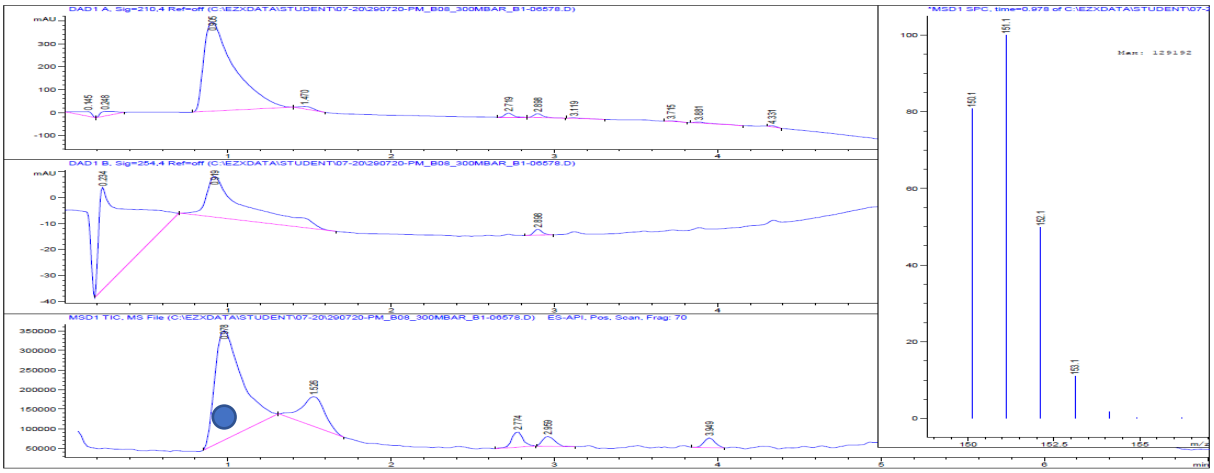
LC-MS (positive ESI): m/z 150.1 $[M+H]^+$ (92.7), 151.1 $[M(1D)+H]^+$ (100), 152.1 $[M(2D)+H]^+$ (42.2), 153.1 $[M(3D)+H]^+$ (8.5), 154.1 $[M(4D)+H]^+$ (1.3) : 38% D

Average of three reactions: 39% D, Yield: 84%, DCY: 33%

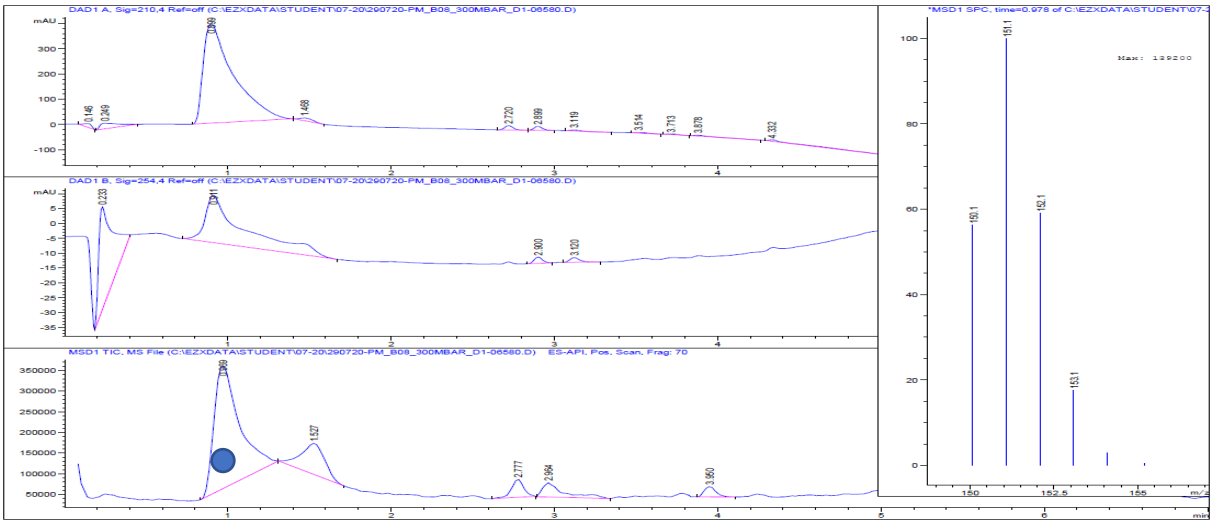
10: Method B, workup C: 1.9mg (13µmol) N,N-dimethylbenzamide **10**



LC-MS (positive ESI): m/z 150.1 $[M+H]^+$ (52.4), 151.1 $[M(1D)+H]^+$ (100), 152.1 $[M(2D)+H]^+$ (75.4), 153.1 $[M(3D)+H]^+$ (22.6), 154.1 $[M(4D)+H]^+$ (4.2) : 61% D



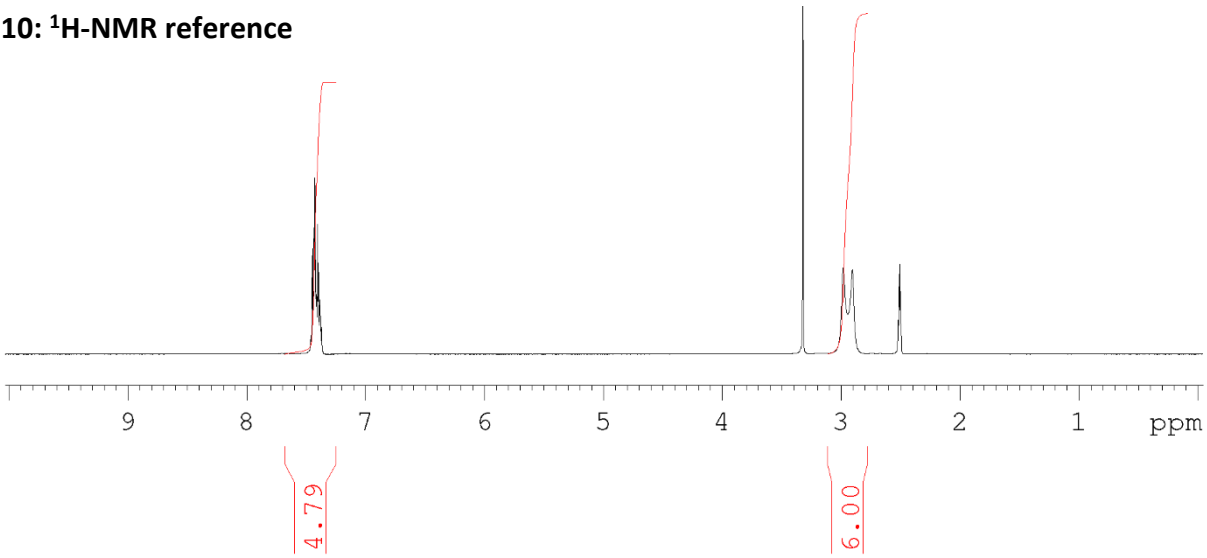
LC-MS (positive ESI): m/z 150.1 $[M+H]^+$ (80.8), 151.1 $[M(1D)+H]^+$ (100), 152.1 $[M(2D)+H]^+$ (49.9), 153.1 $[M(3D)+H]^+$ (11.0), 154.1 $[M(4D)+H]^+$ (1.7) : 44% D



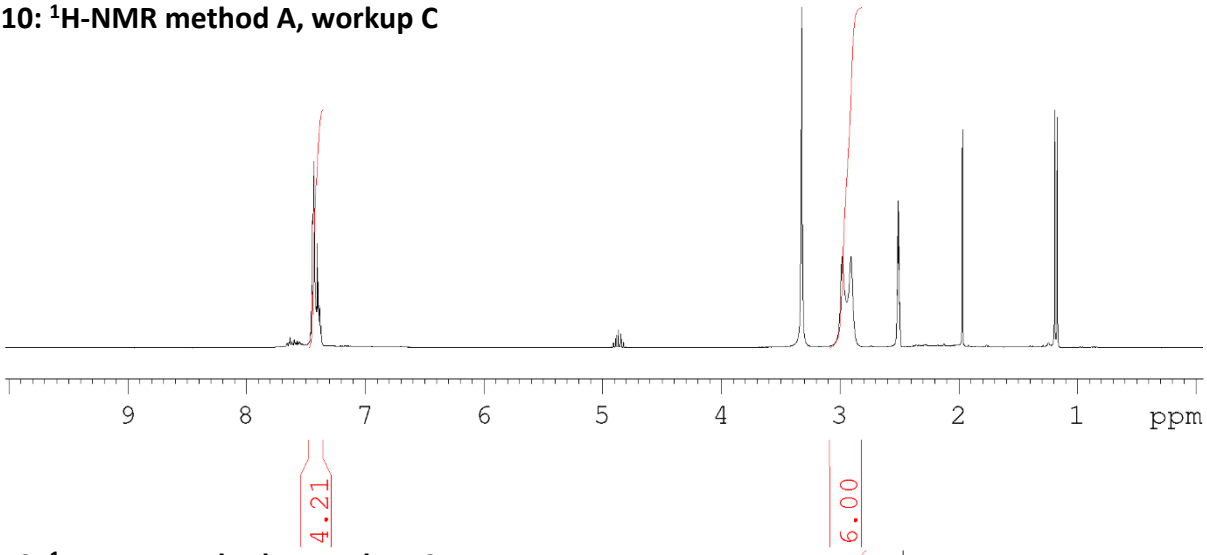
LC-MS (positive ESI): m/z 150.1 $[M+H]^+$ (56.3), 151.1 $[M(1D)+H]^+$ (100), 152.1 $[M(2D)+H]^+$ (59.1), 153.1 $[M(3D)+H]^+$ (17.6), 154.1 $[M(4D)+H]^+$ (2.9) : 54% D

Average of three reactions: 53% D, Yield: 83%, DCY: 4%

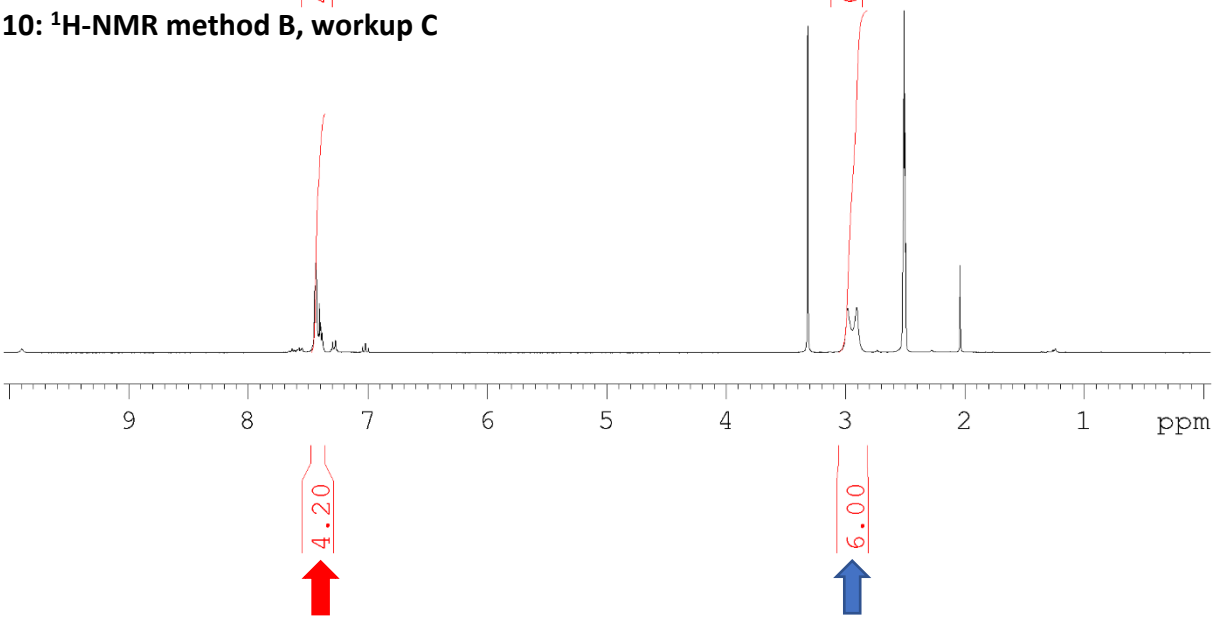
10: ^{1}H-NMR reference



10: ^{1}H-NMR method A, workup C

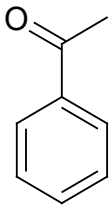


10: ^{1}H-NMR method B, workup C



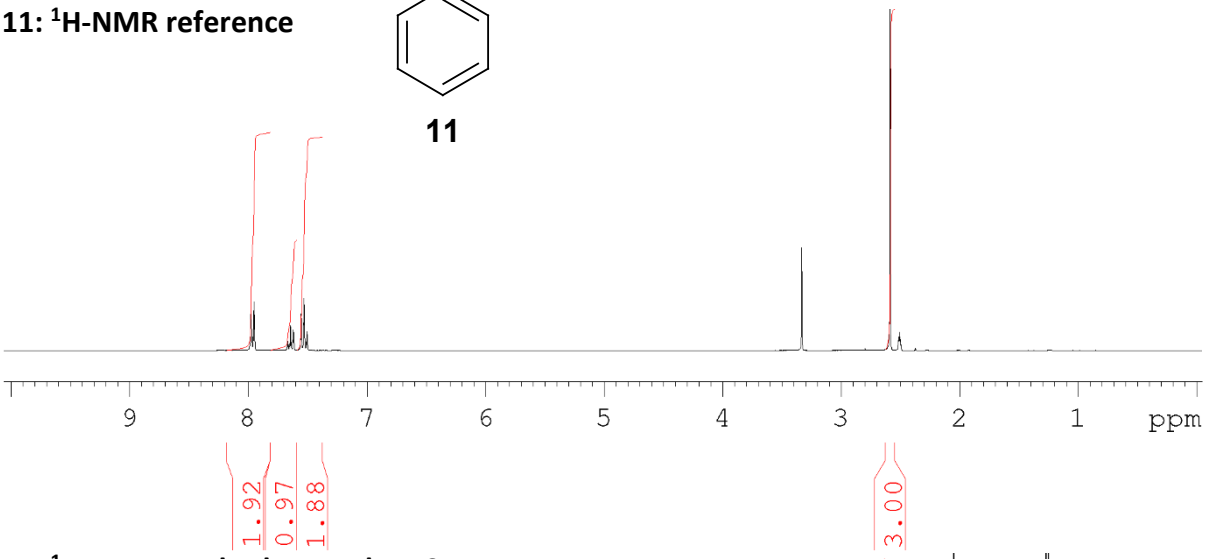
Deuterium incorporation: red arrow. Reference-integral: blue arrow.

Data for acetophenone **11**



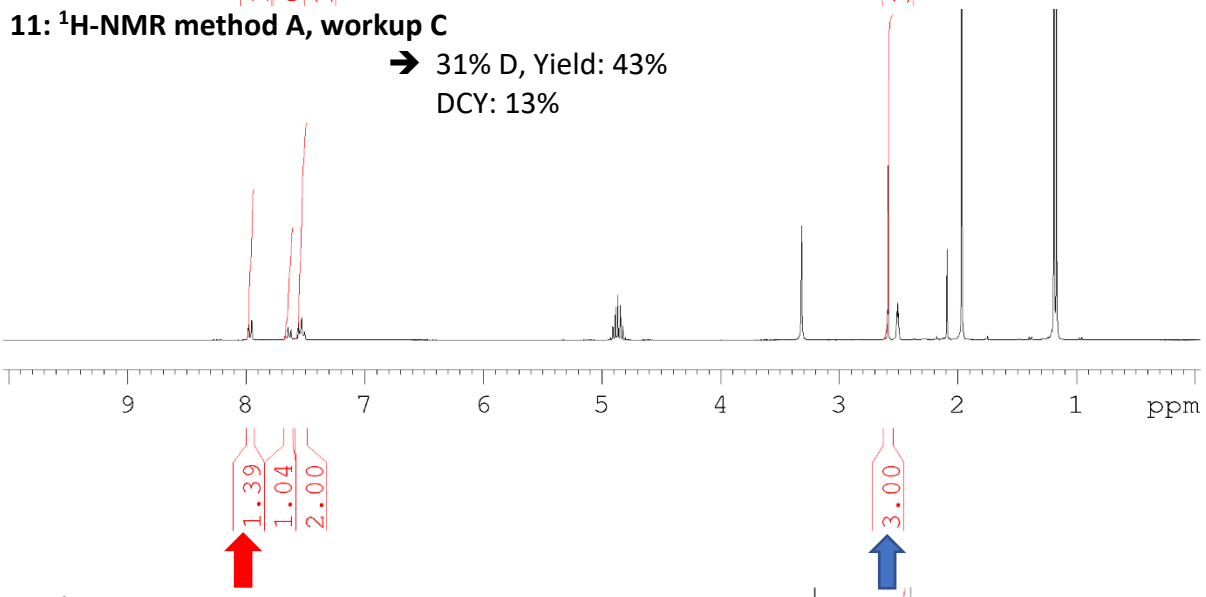
11

11: ^{1}H-NMR reference



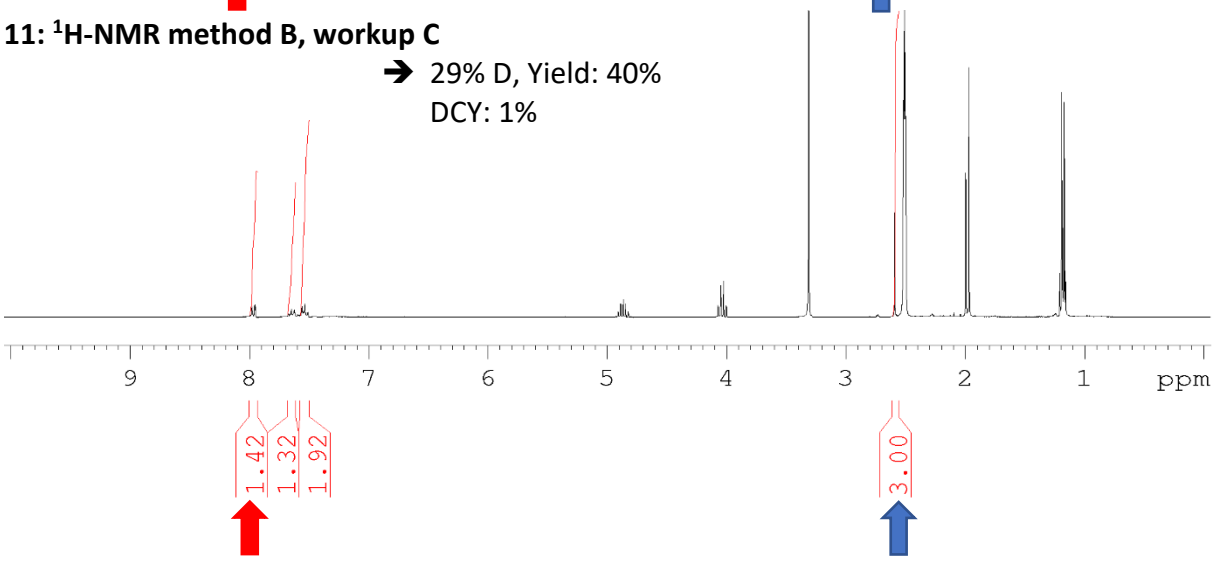
11: ^{1}H-NMR method A, workup C

➔ 31% D, Yield: 43%
DCY: 13%



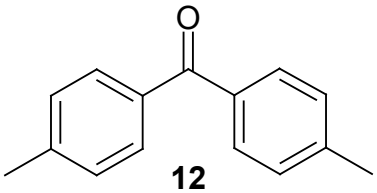
11: ^{1}H-NMR method B, workup C

➔ 29% D, Yield: 40%
DCY: 1%

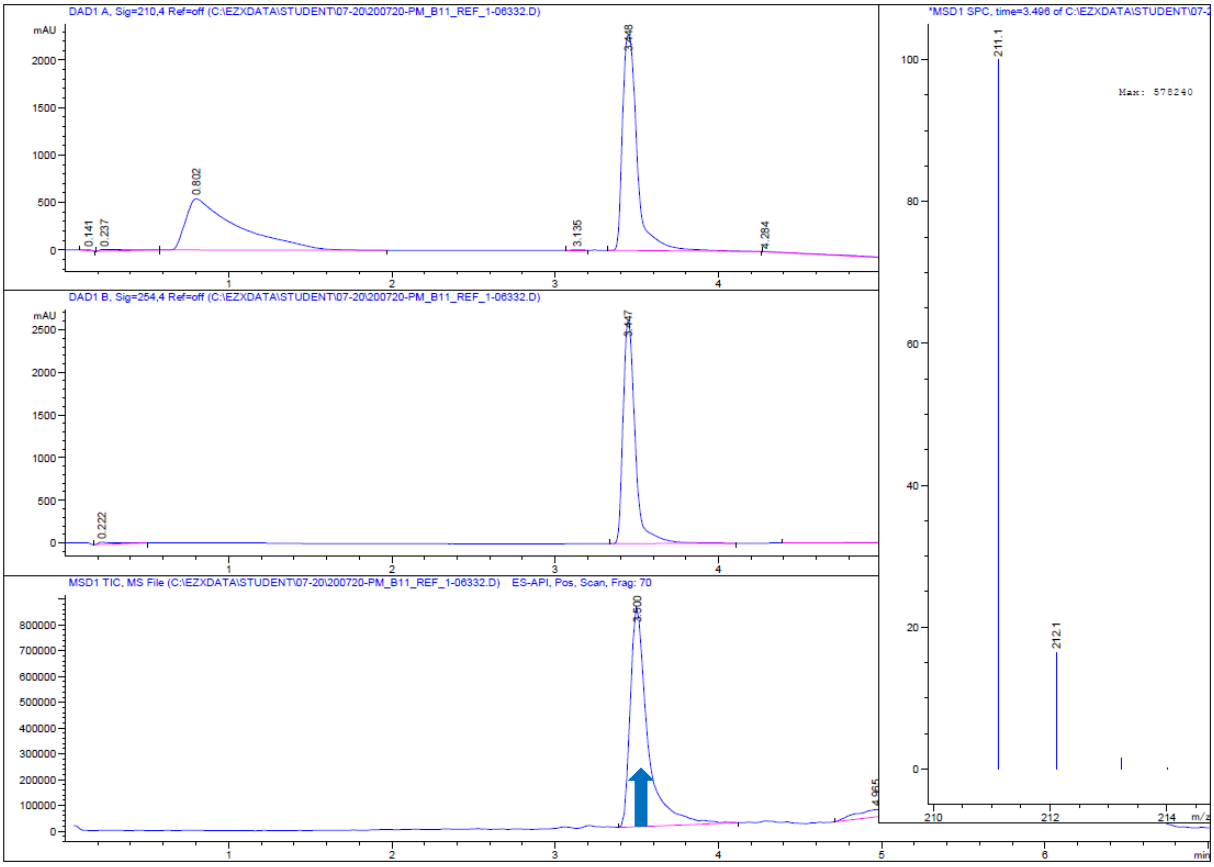


Deuterium incorporation: red arrow. Reference-integral: blue arrow.

Data for 4,4'-dimethylbenzophenone **12**



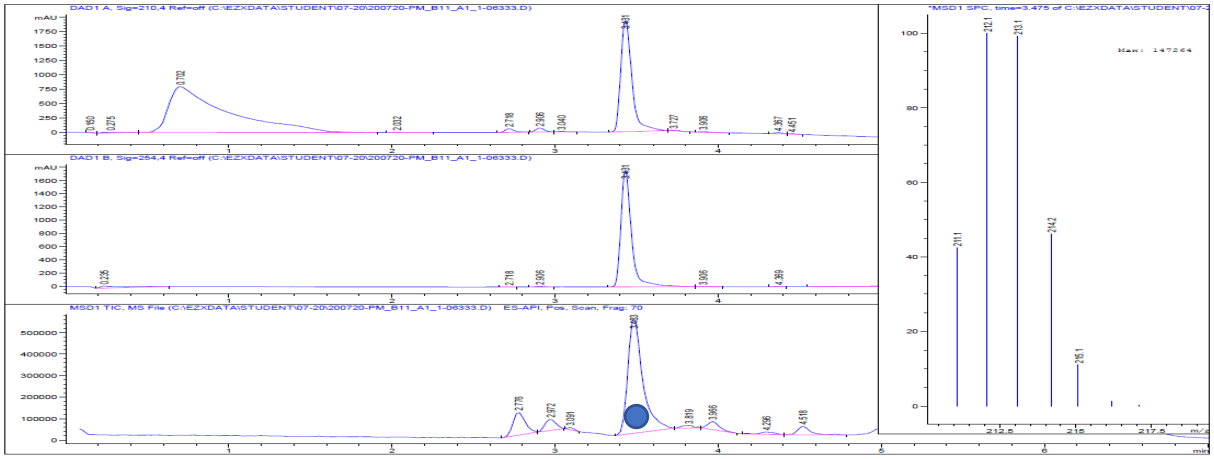
12



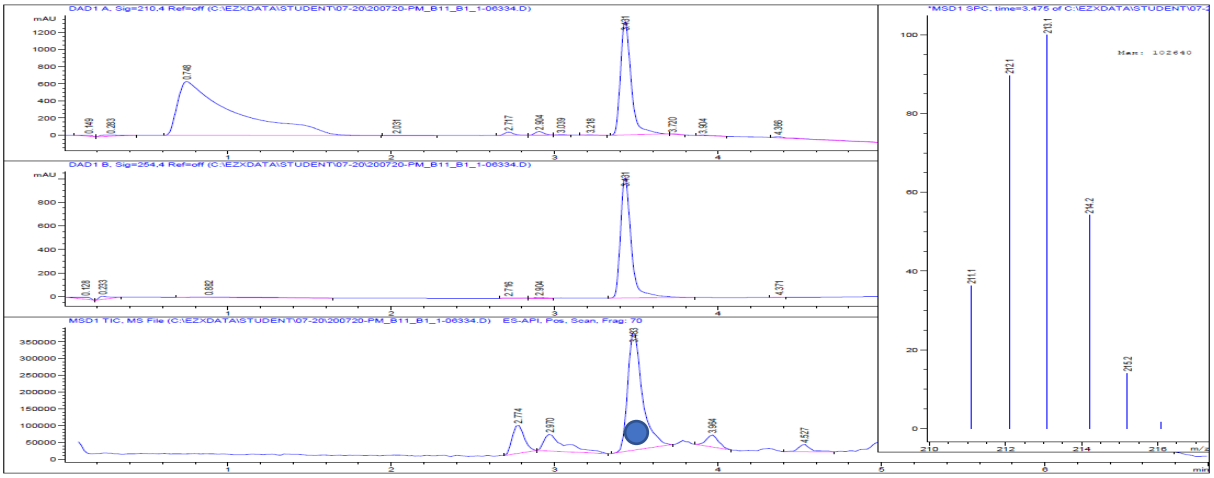
LC-MS (positive ESI): m/z 211.1 $[M+H]^+$ (100), 212.1 $[M+1+H]^+$ (16.4), 213.2 $[M+2+H]^+$ (1.5)

Deuterium experiments with 4,4'-dimethylbenzophenone **12**

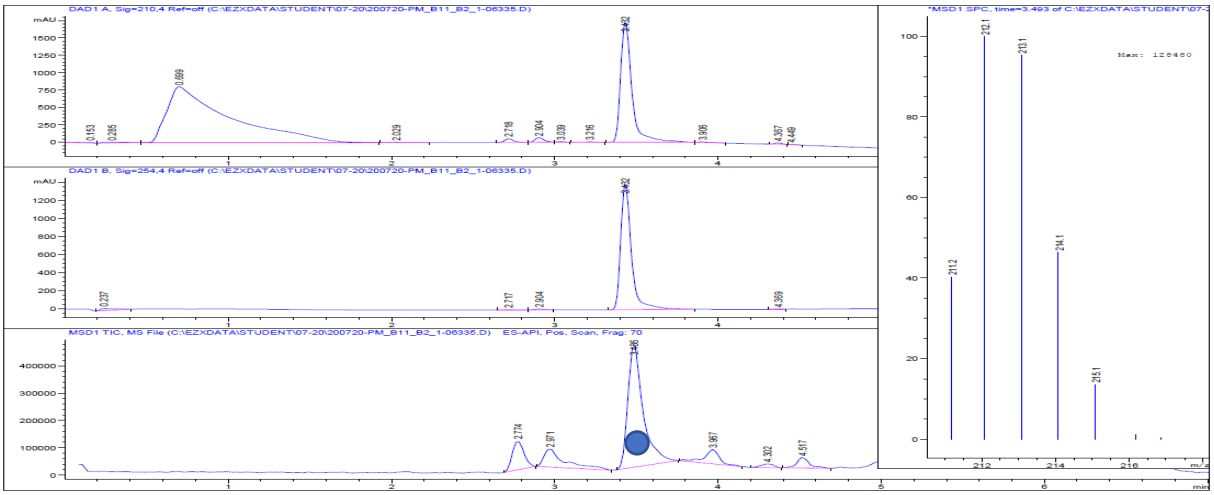
Method A, workup C: 3mg (14µmol) 4,4'-dimethylbenzophenone **12**



LC-MS (positive ESI): m/z 211.1 $[M+H]^+$ (42.4), 212.1 $[M(1D)+H]^+$ (100), 213.1 $[M(2D)+H]^+$ (99.2), 214.2 $[M(3D)+H]^+$ (46.2), 215.1 $[M(4D)+H]^+$ (11.1) : 37% D



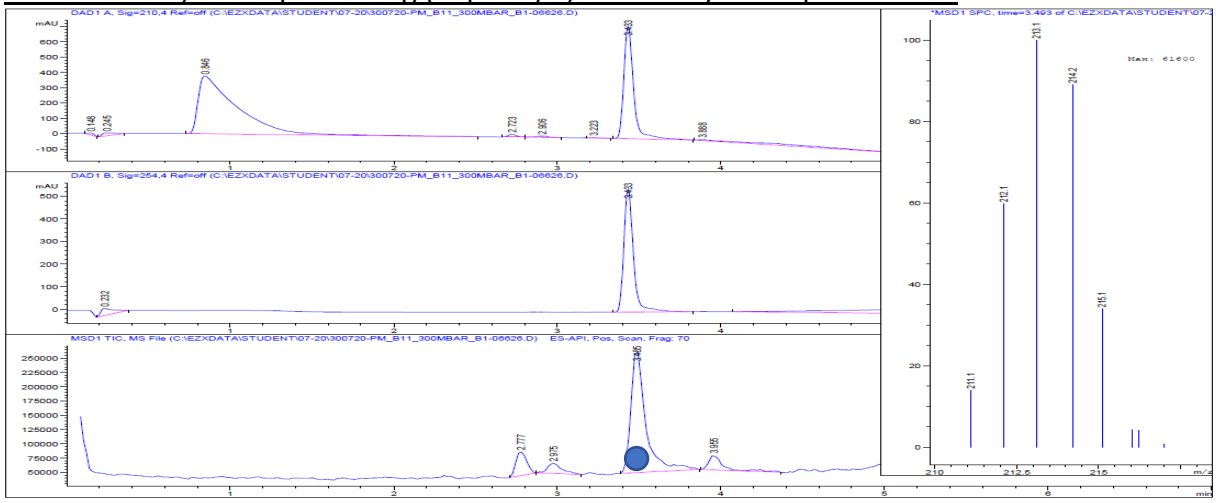
LC-MS (positive ESI): m/z 211.1 $[M+H]^+$ (36.2), 212.1 $[M(1D)+H]^+$ (89.6), 213.1 $[M(2D)+H]^+$ (100), 214.2 $[M(3D)+H]^+$ (54.2), 215.2 $[M(4D)+H]^+$ (14.0) : 39% D



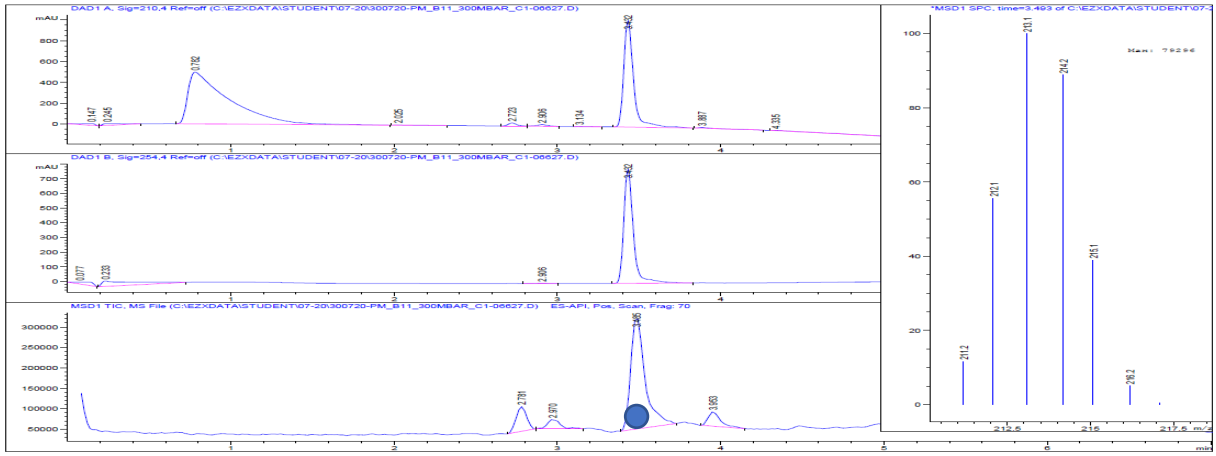
LC-MS (positive ESI): m/z 211.1 $[M+H]^+$ (40.3), 212.1 $[M(1D)+H]^+$ (100), 213.1 $[M(2D)+H]^+$ (95.3), 214.1 $[M(3D)+H]^+$ (46.4), 215.1 $[M(4D)+H]^+$ (13.6) : 37% D

Average of three reactions: 38% D, Yield: 97%, DCY: 74%

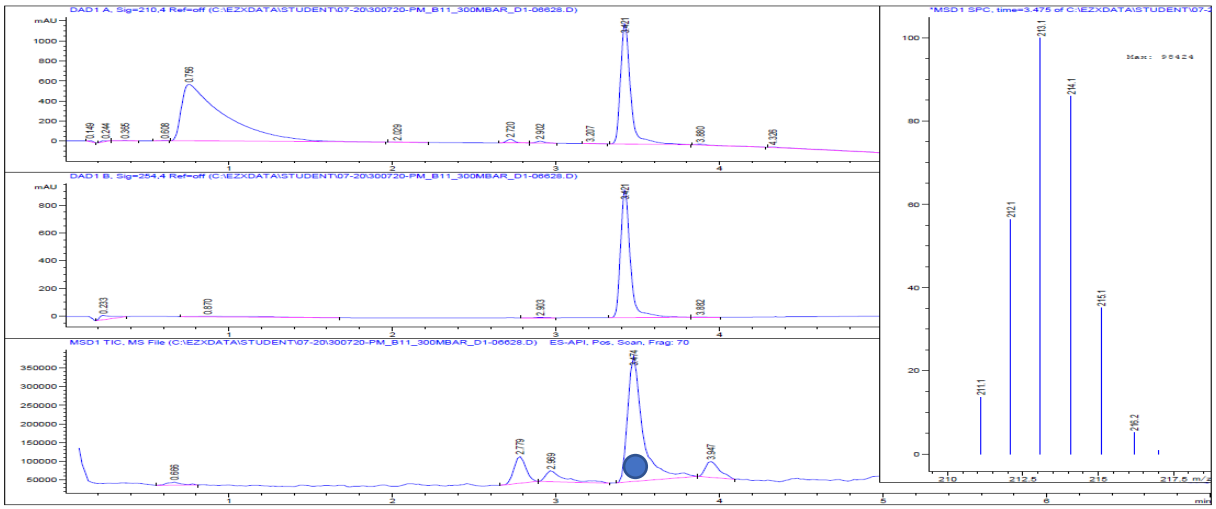
12: Method B, workup C: 2.7mg (13µmol) 4,4'-dimethylbenzophenone **12**



LC-MS (positive ESI): m/z 211.1 $[M+H]^+$ (13.9), 212.1 $[M(1D)+H]^+$ (59.8), 213.1 $[M(2D)+H]^+$ (100), 214.2 $[M(3D)+H]^+$ (89.0), 215.1 $[M(4D)+H]^+$ (33.9) : 53% D



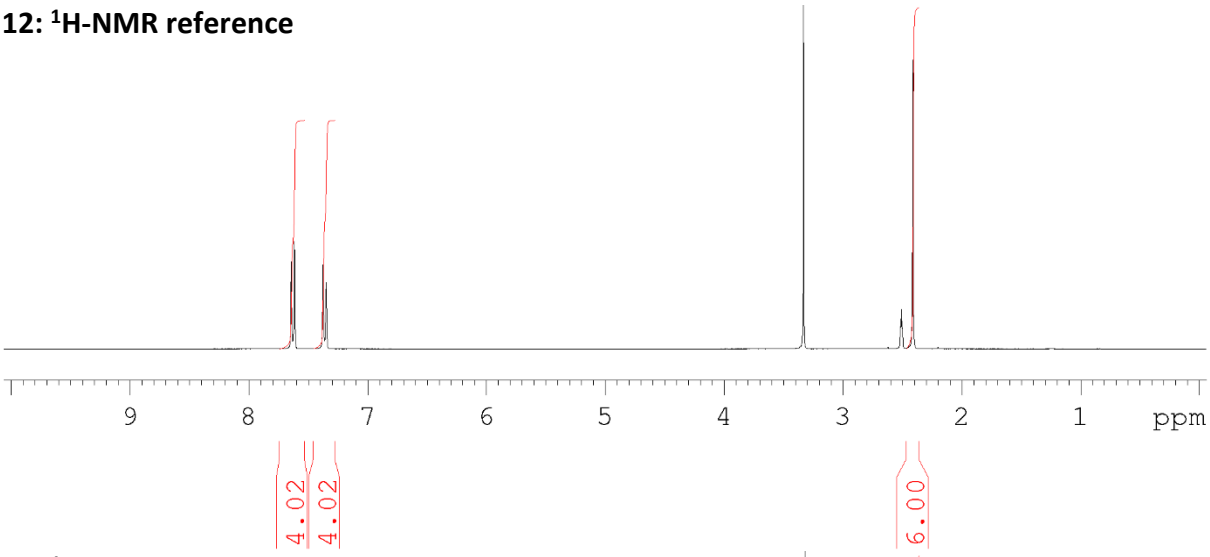
LC-MS (positive ESI): m/z 211.2 $[M+H]^+$ (11.7), 212.1 $[M(1D)+H]^+$ (55.6), 213.1 $[M(2D)+H]^+$ (100), 214.2 $[M(3D)+H]^+$ (88.8), 215.1 $[M(4D)+H]^+$ (39.0) : 55% D



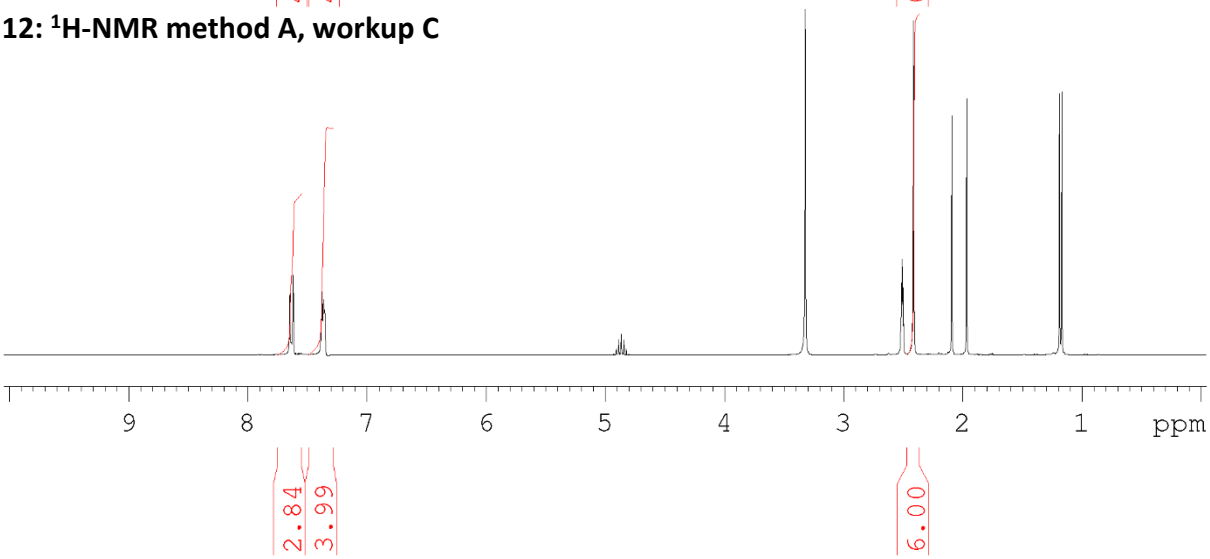
LC-MS (positive ESI): m/z 211.1 $[M+H]^+$ (13.6), 212.1 $[M(1D)+H]^+$ (56.4), 213.1 $[M(2D)+H]^+$ (100), 214.1 $[M(3D)+H]^+$ (86.0), 215.1 $[M(4D)+H]^+$ (35.2) : 54% D

Average of three reactions: 54%D, Yield: 96%, DCY: 10%

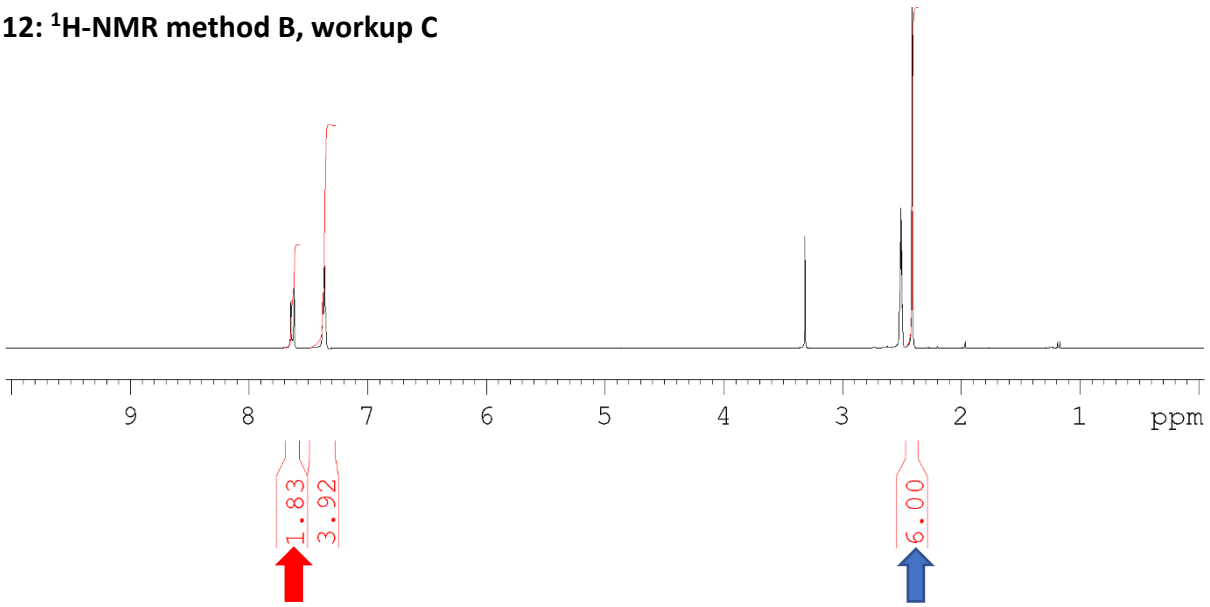
12: ^{1}H-NMR reference



12: ^{1}H-NMR method A, workup C



12: ^{1}H-NMR method B, workup C



Deuterium incorporation: red arrow. Reference-integral: blue arrow.