PT status

Norihiro DOSHITA
July 19 2022

- Summary of activities since last TB
- Polarizations for physics data taking
- TE calibration, gain factor measurement
- SM1 effect
- Manpower

Activities

- 14-25/04 : TE calibration
- 28-29/04 : 3He condensation
- 02/05 : First DNP with 3 gunn diodes
  - New gunn diodes : checked all functions by Christophe
  - Large downstream cavity
    -- Lack of power at the first a few hours (Maximum 2.5 W)
    -- First model has more power (Maximum 4 W)
  - +44.4%, -41.2%, +46.4% after 3 days
- 4 times DNP tests before data taking
- Slow dipole discharge due to low LHe level (5/5)
- Main gate valve (VH1) on DR was closed due to electromagnetic coil (19/5, 5/6)
  - removed the coil and connected the pressurized air
- Magnet control stuck (16/6, 28/6)
- NMR synthesizer communication lost (15/6)
- High LHe consumption
  - deterioration of distribution box : Cryo group keeps isolation vacuum pump running.
  - target magnet mode + SM1 : movement of magnet helium vessel
- Modification of cooling water for diffusion pump (14/6)

Activities 2 (DNP for data taking)

4th attempt (23 – 25/5) (Last test before data taking starts)
- -42.2%, +44.6%, -41.8% after 51 hours DNP
- relaxation time 13000 h at 0.6 T for 7 days (25/5 – 1/6)

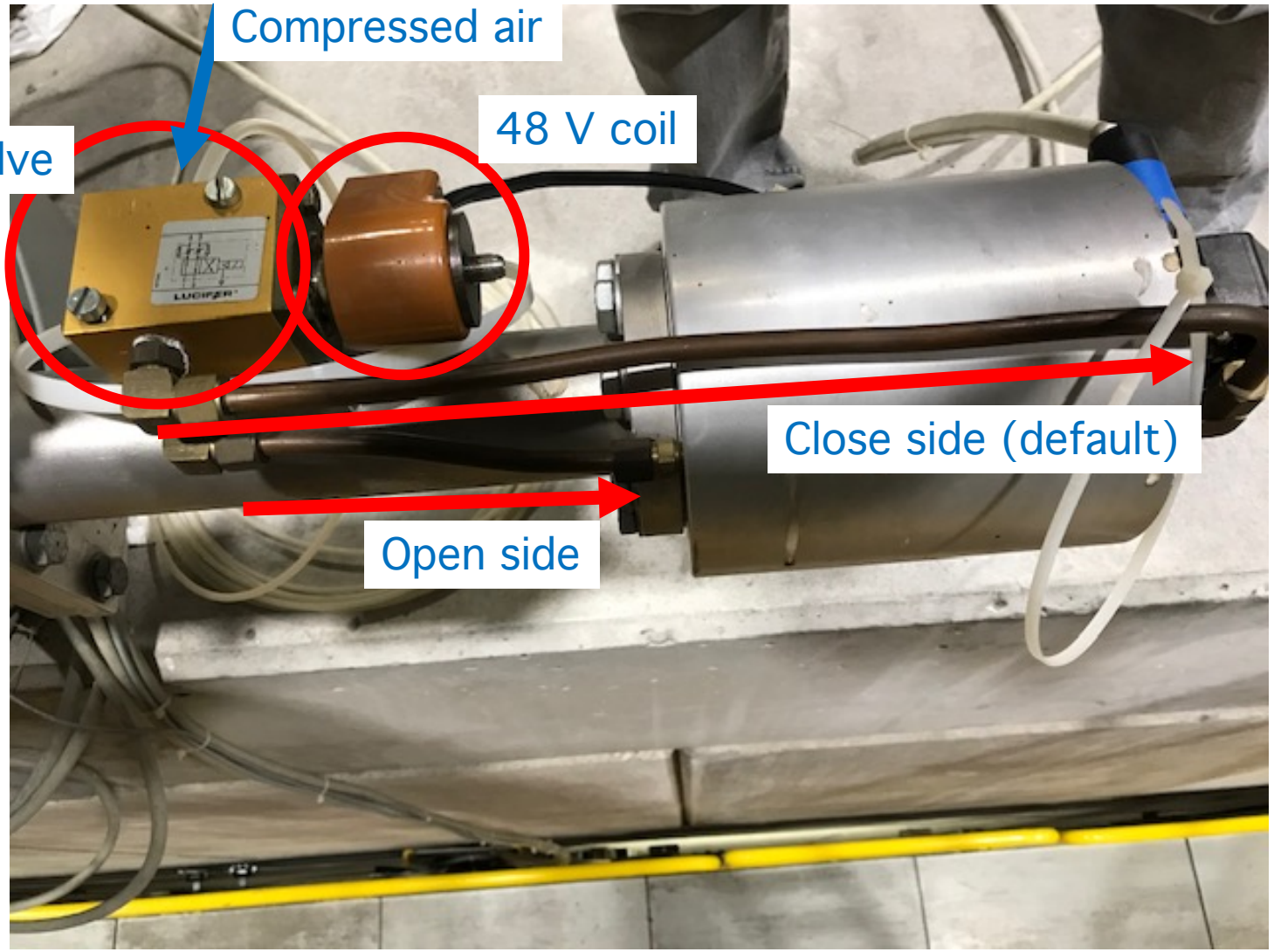
5th attempt (5 – 7/6)
- +39.7%, -41.1%, +42.5% after 48 hours DNP

6th attempt (14 – 16/6)
- -42.6%, +44.8%, -42.0% after 48 hours
- 28/6 relaxation time (5680h, 5440h, 6753h)

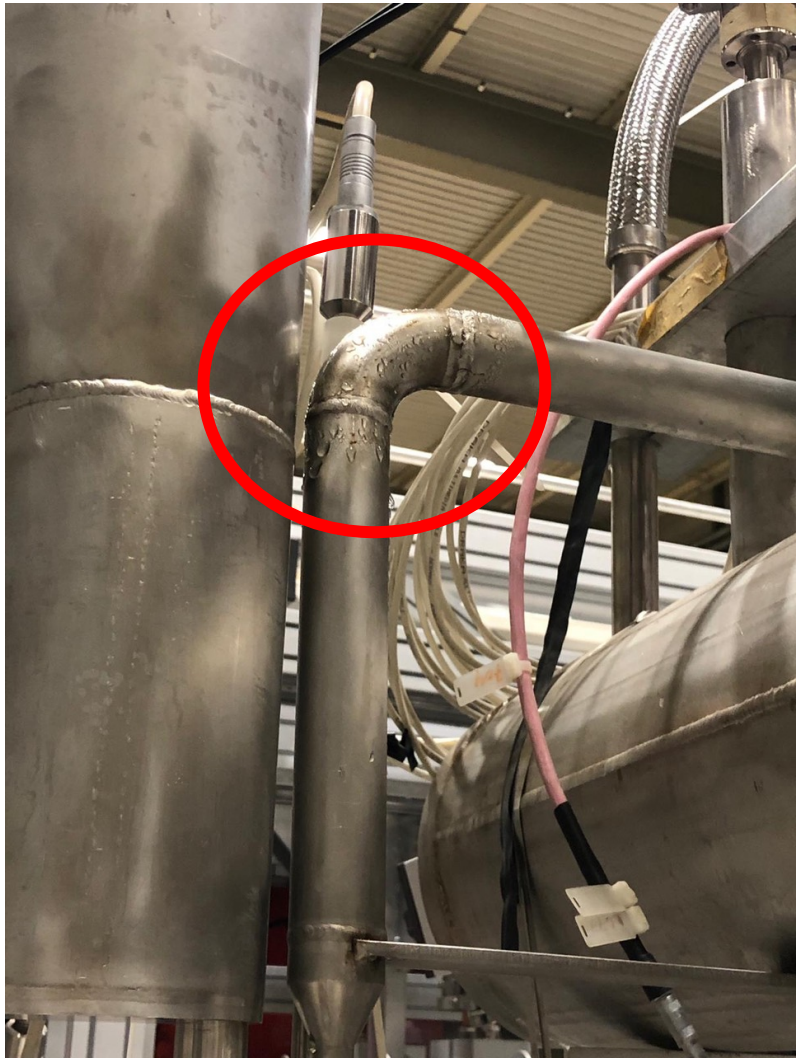
7th attempt (28/6 – 1/7)
- +41.8%, -41.6%, +43.9% after 66 hours
- relaxation time for 272 h (3600h, 7100h, 4400h)

8th attempt (12 – 14/7)
- -42.8%, +43.5%, -42.3% after 50 hours

VH1 control valve

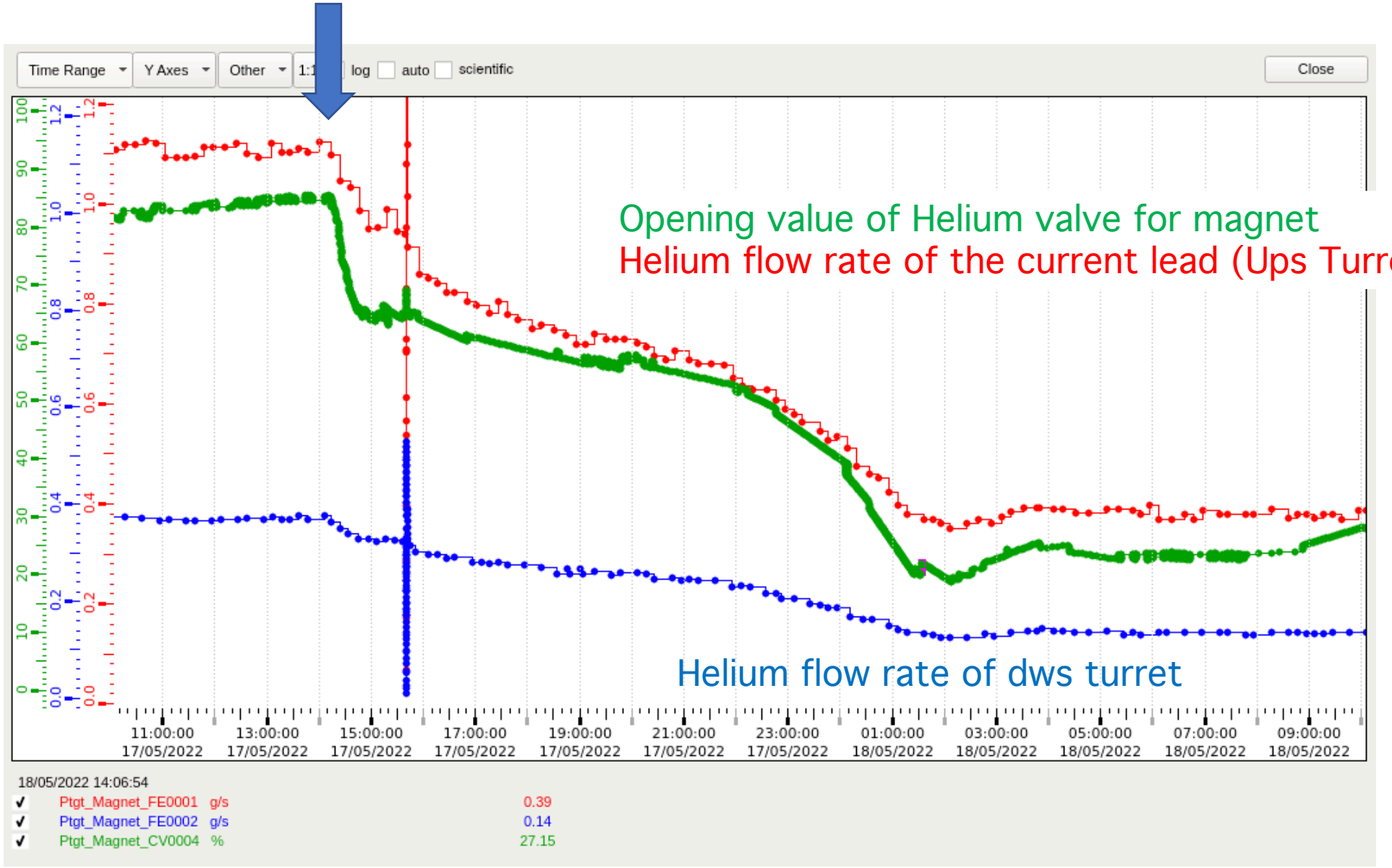


Humidity on the tube of the distribution box



- Michael found the water drop on 16/5.
- Michel (CryoOperator) installed the pump on 17/5.

Pumping starts for the isolation vacuum of the distribution box

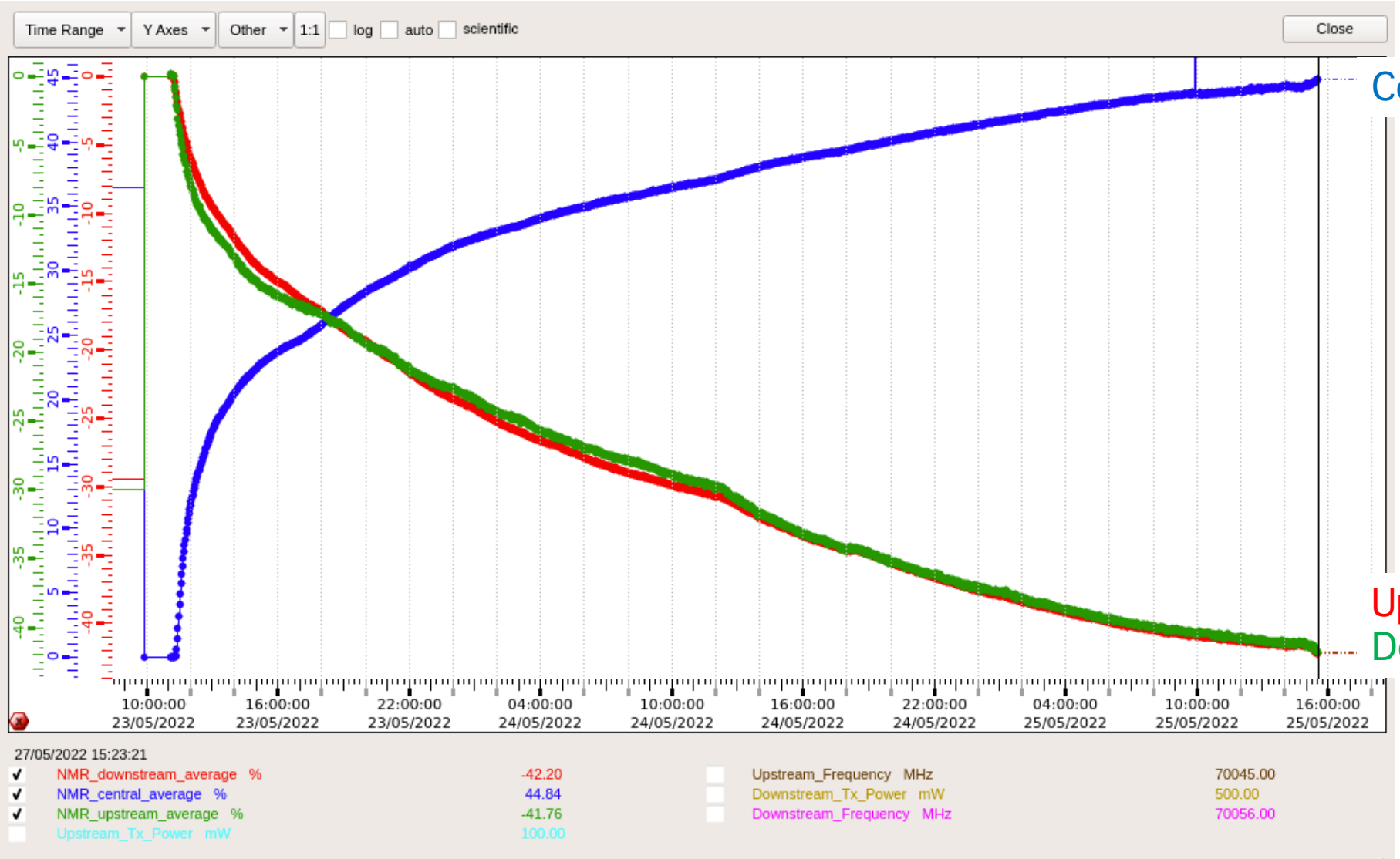


Low flow rate for cooling water of diffusion pump

- Normal range ~ 1.2 x 6 L/min.
- Present value : 0.4 x 6 L/min.
  - temperature looks fine.
- Interlock killed

- Raw water →Tap water → Straw cooling water
- New pump installed by Stefano

Polarization (23 – 25 /5)

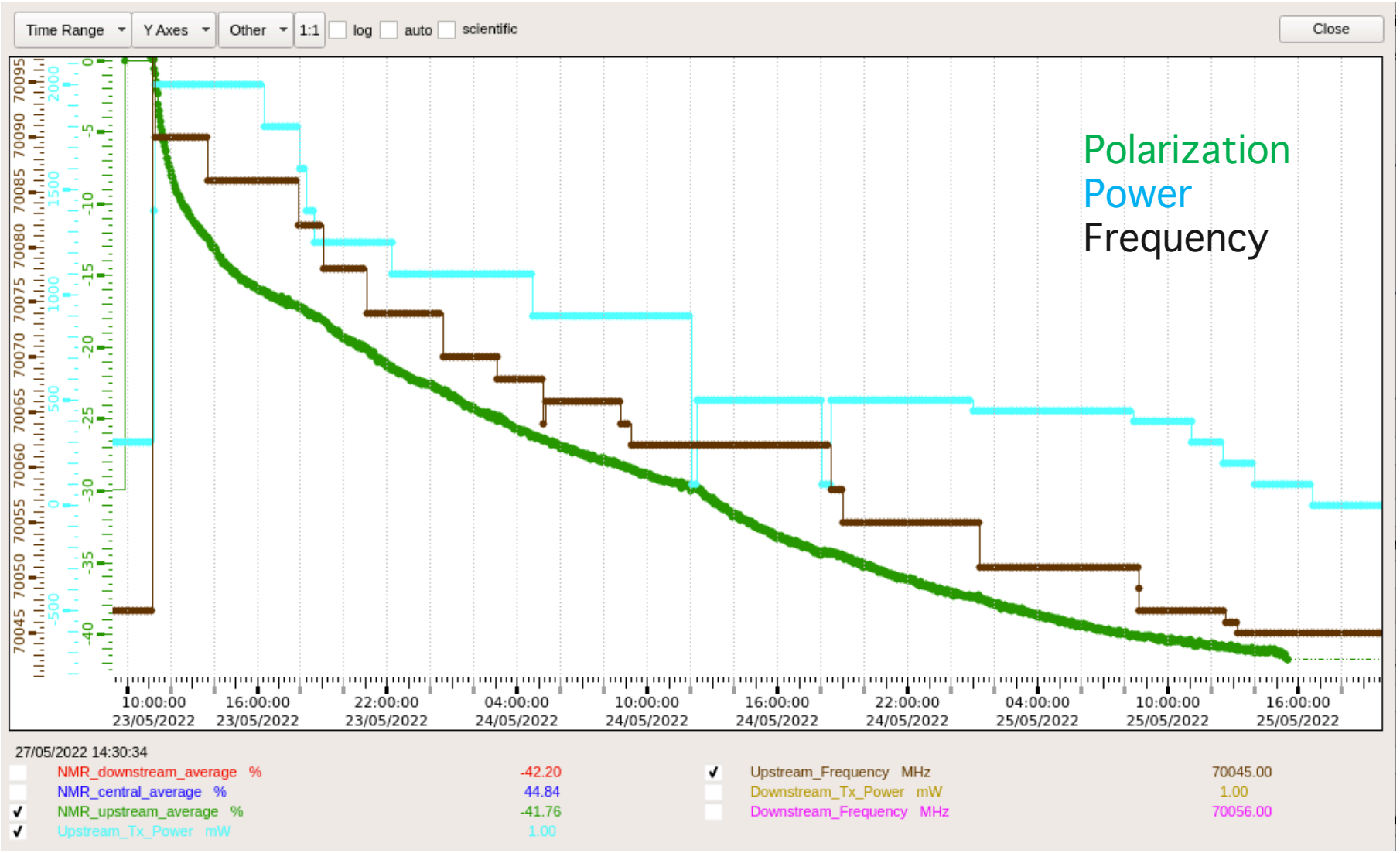


Central

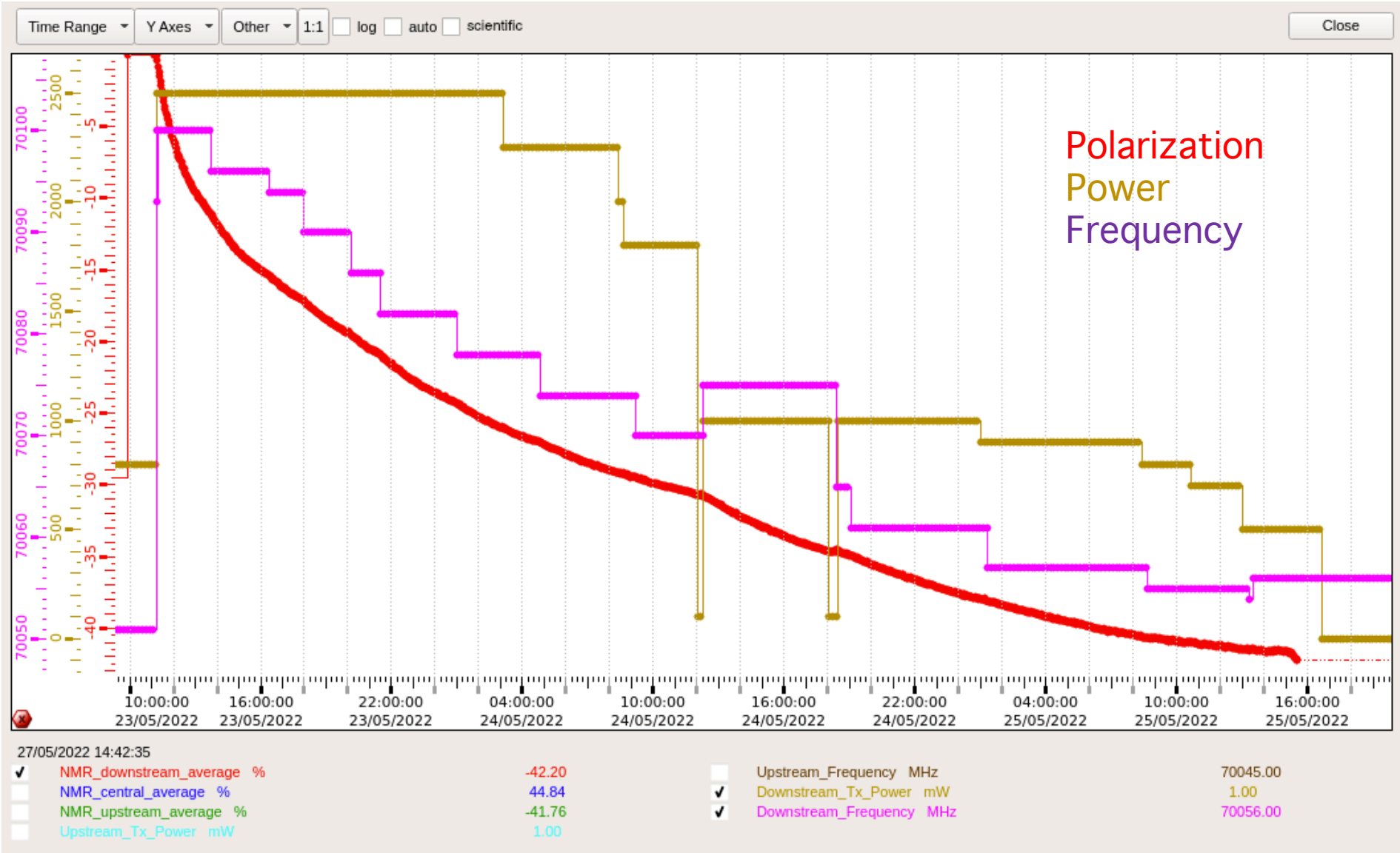
Upstream

Downstream

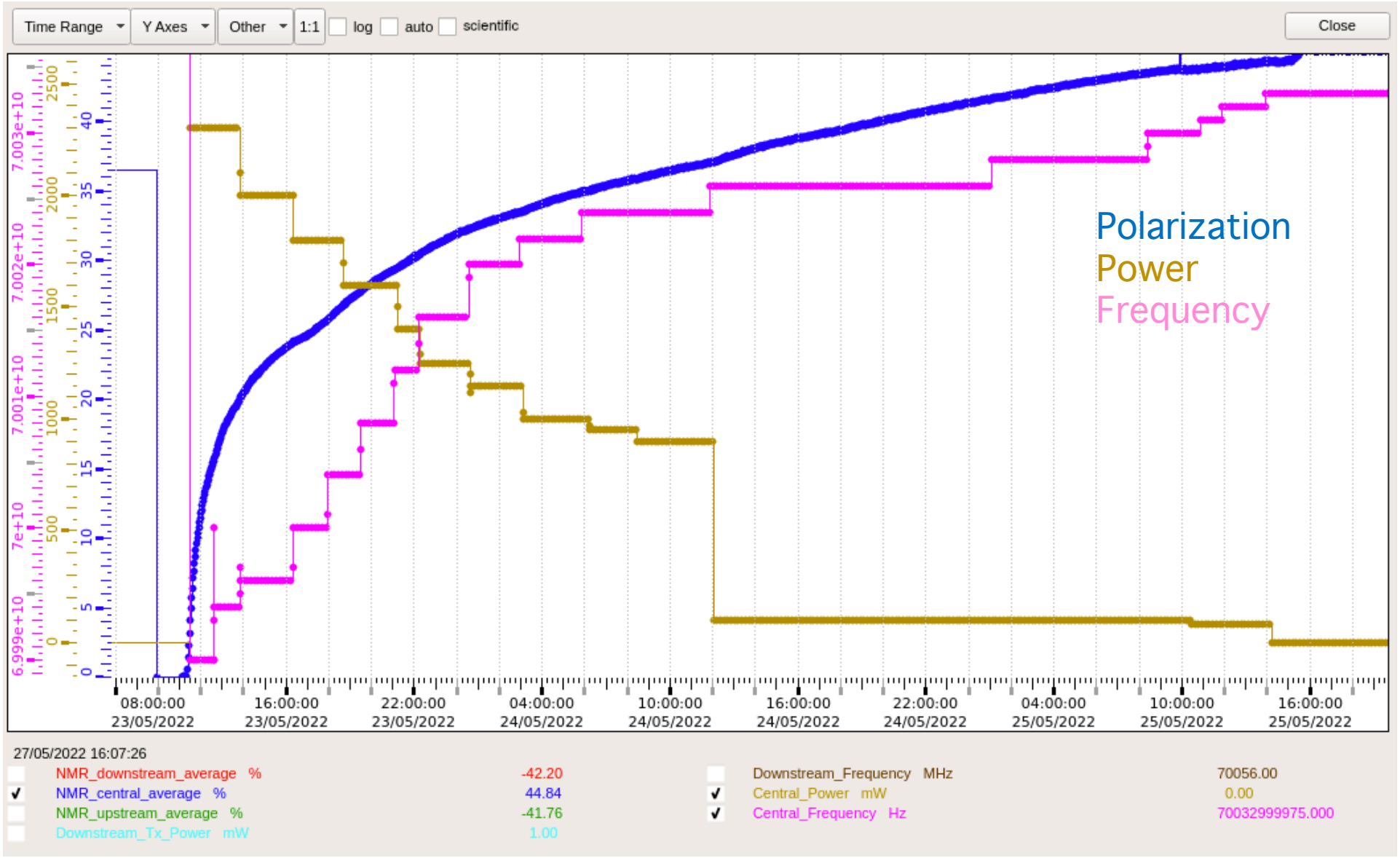
Upstream Polarization (23 – 25 /5)



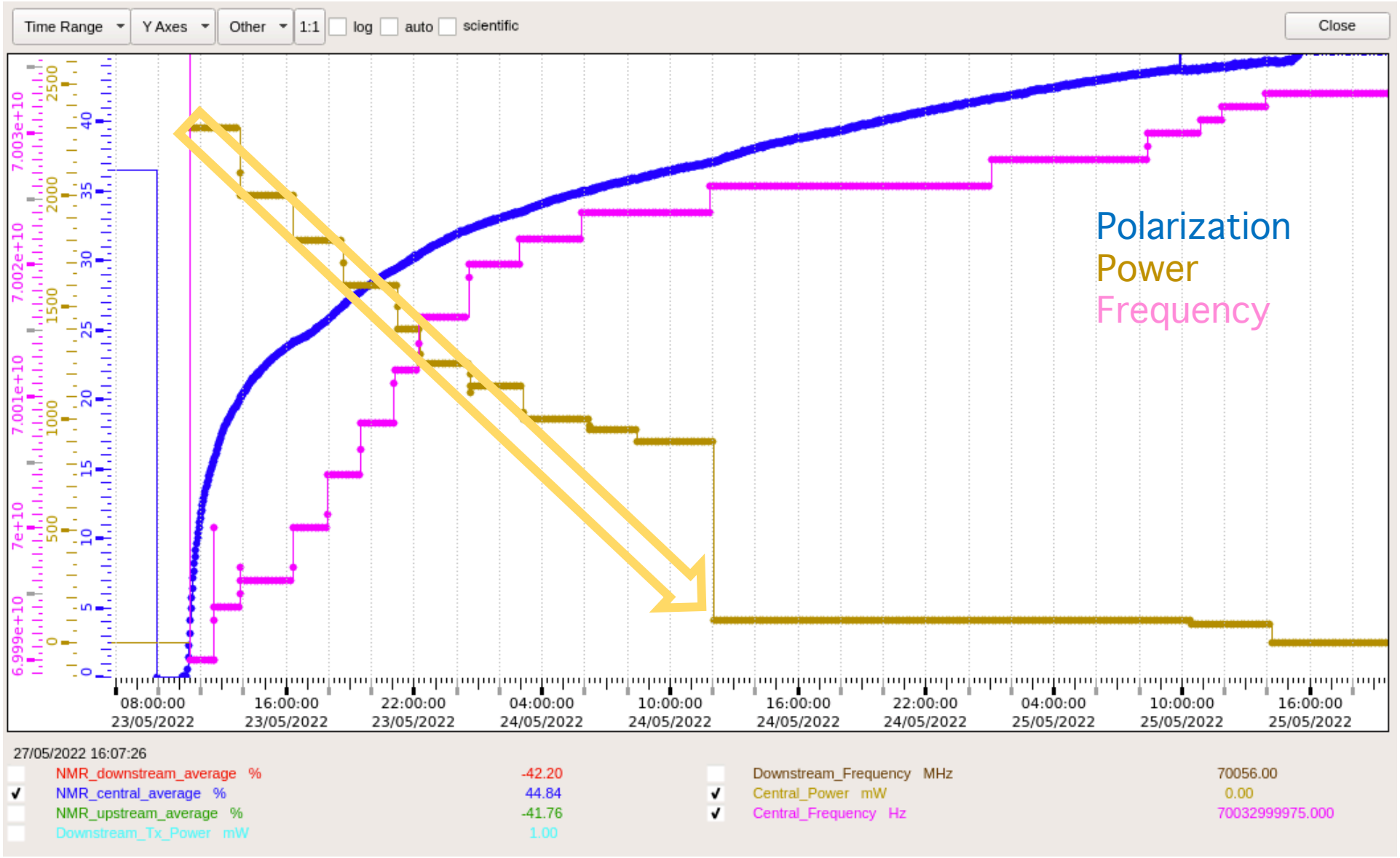
Downstream Polarization (23 – 25 /5)



Centralcell Polarization (23 – 25 /5)



Centralcell Polarization (23 – 25 /5)



DNP (neg, pos, neg) with SM1 ON

Frequency : about 4 MHz step to be changed
Power : 10 – 15% to be reduced

June 30 2022

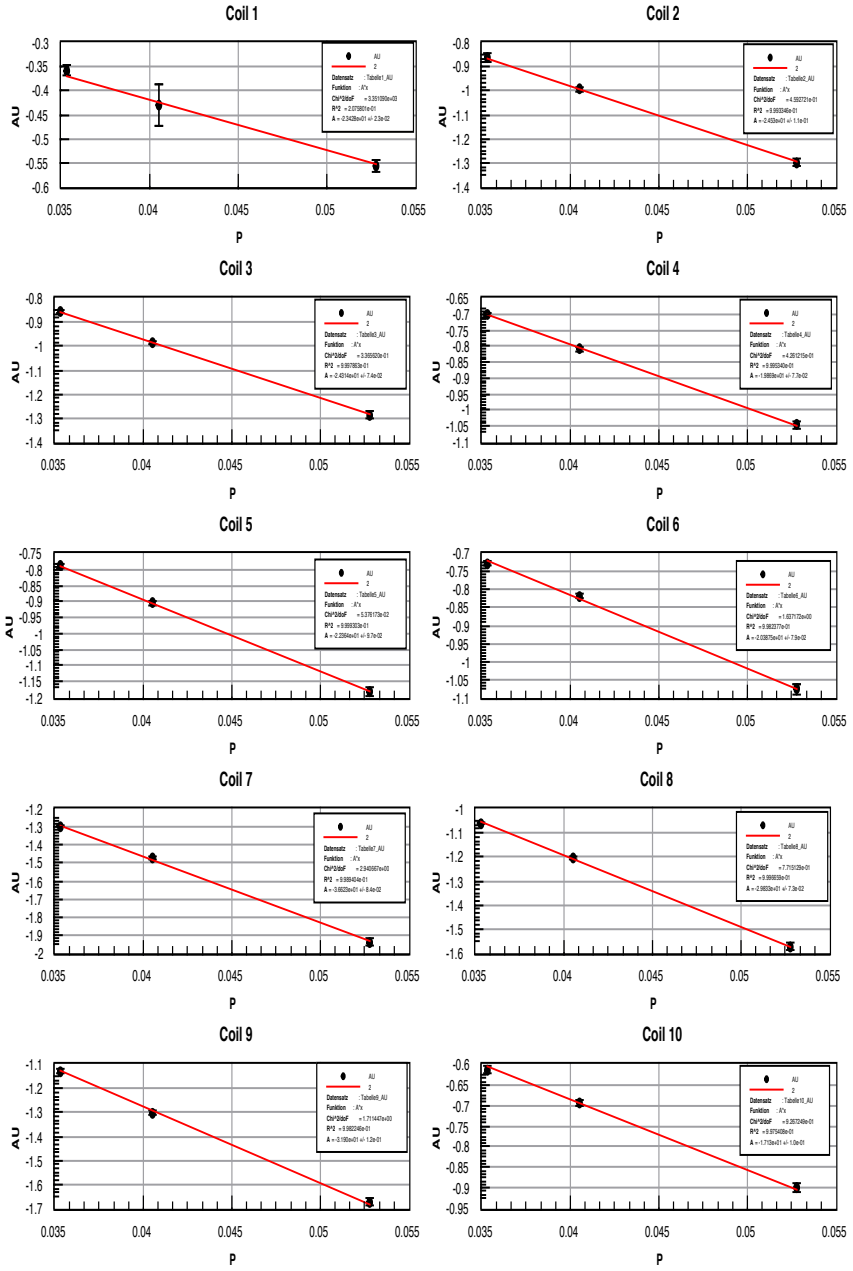
SM1 ON	Upstream negative (same as SM1 OFF)	Central (5 MHz lower if SM1 OFF)	Downstream negative (10 MHz lower if SM1 OFF)
0 - 20%	2000 → 1000 mW 70.090 → 70.070 GHz	2300 → 2000 mW 69.990 → 69.998 GHz	2500 mW 70.100 →70.080 GHz
20 – 30%	1000 → 500 mW 70.070 → 70.060 GHz	2000 → 1500 mW 69.998 → 70.015 GHz	2500 → 1000 mW 70.080 → 70.065 GHz
30 – 40% or more	500 → 300 mW 70.060 → 70.045 GHz	1500 → 100 mW (100 mW @ 35%) 70.015 → 70.028 GHz	1000 → 500 mW 70.065 → 70.055 GHz

DNP (pos, neg, pos) with SM1 ON

Frequency : about 4 MHz step to be changed
Power : 10 – 15% to be reduced

June 30 2022

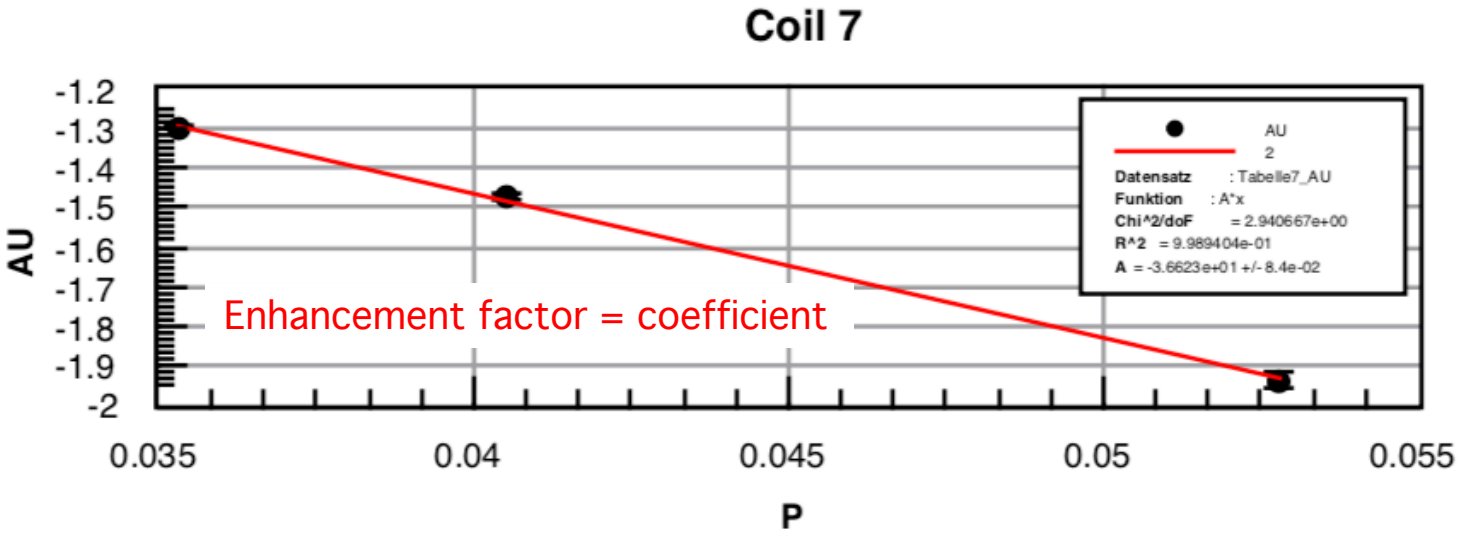
SM1 ON	Upstream negative (same as SM1 OFF)	Central (5 MHz lower if SM1 OFF)	Downstream negative (10 MHz lower if SM1 OFF)
0 - 20%	2000 → 1200 mW 69.980 → 70.000 GHz	2500 → 1500 mW 70.100 → 70.080 GHz	2500 → 2000 mW 69.990 →70.010 GHz
20 – 30%	1200 → 700 mW 70.000 → 70.010 GHz	1500 → 1000 mW 70.080 → 70.070 GHz	2500 → 1500 mW 70.010 → 70.020 GHz
30 – 40% or more	700 → 70 mW (200 mW @ 35%) 70.010 → 70.022 GHz	1500 → 500 mW 70.070 → 70.055 GHz	1500 → 150 mW (400 mW @ 35%) 70.020 → 70.032 GHz



TE analysis - Gerhard-

E = Enhancement factor

Coil	1/E	d1/E	d1/Erel	E	dE
1	-10.47	0.12	-1.2	-0.09548	0.0011
2	-24.53	0.11	-0.47	-0.04077	0.00019
3	-24.31	0.074	-0.3	-0.04113	0.00013
4	-19.87	0.077	-0.39	-0.05033	0.0002
5	-22.36	0.097	-0.43	-0.04472	0.00019
6	-20.39	0.079	-0.39	-0.04905	0.00019
7	-36.62	0.084	-0.23	-0.0273	6.3e-05
8	-29.83	0.073	-0.25	-0.03352	8.2e-05
9	-31.9	0.12	-0.37	-0.03135	0.00012
10	-17.13	0.1	-0.59	-0.05836	0.00034



TE analysis - Gerhard & Kaori -

Polarization determination at DNP

$$P = E \cdot S$$

The enhancement factor can be measured
By TE calibration at 2.5 T.

$$P_{TE} = ES_{TE}$$

$$S_{TE} = \frac{1}{E} P_{TE}$$

$$P_{TE=1K} = 0.0522789\ \%$$

$$P_{DNP} = ES_{DNP}$$

Polarization can be determined
with DNP NMR signal.

E = Enhancement factor

Coil	1/E	d1/E	d1/Erel	E	dE
1	-10.47	0.12	-1.2	-0.09548	0.0011
2	-24.53	0.11	-0.47	-0.04077	0.00019
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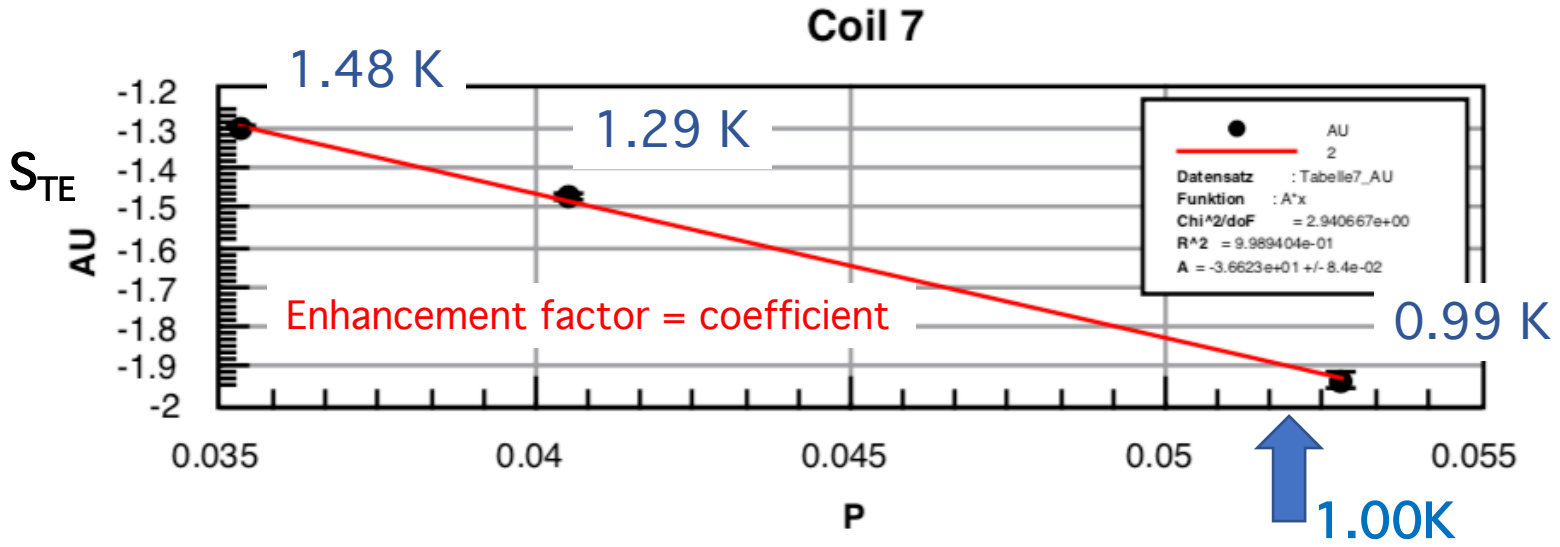
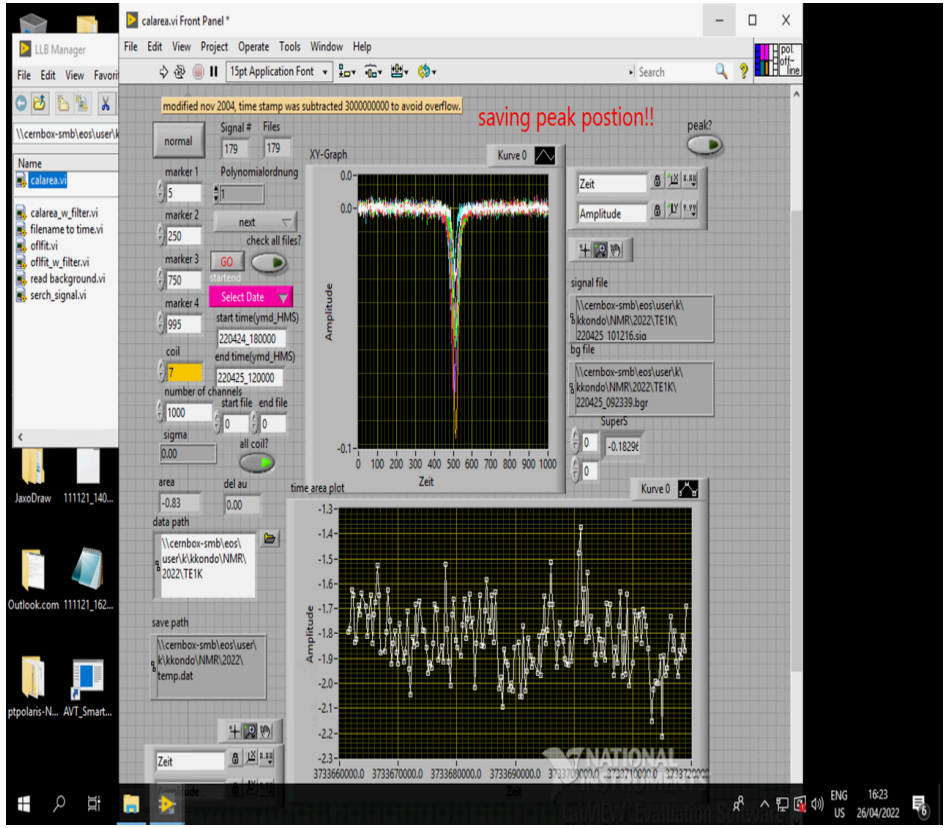


TE analysis - Kaori-



Area of NMR signal

$S_{TE=0.99K}$

Coil 1	= -0.568297	+/- 0.01609	(2.831%)
Coil 2	= -1.3127	+/- 0.01054	(0.8033%)
Coil 3	= -1.24578	+/- 0.009335	(0.7493%)
Coil 4	= -1.0356	+/- 0.01134	(1.095%)
Coil 5	= -1.14455	+/- 0.009615	(0.84%)
Coil 6	= -1.0114	+/- 0.01384	(1.369%)
Coil 7	= -1.81941	+/- 0.009862	(0.542%)
Coil 8	= -1.50919	+/- 0.01045	(0.6923%)
Coil 9	= -1.62441	+/- 0.01493	(0.9188%)
Coil 10	= -0.916692	+/- 0.01174	(1.281%)

179 signals at 0.99 K

Comparison

	Coil #	Gerhard E	S_{TE}@1K(G)	Kaori S_{TE}@0.99K	S_{TE}@1K(K)	Gerhard/Kaori
Up	1	-10.47	-0.5474	-0.568297	-0.5626	0.973
	2	-24.53	-1.2824	-1.3127	-1.2996	0.987
	3	-24.31	-1.2709	-1.24578	-1.2333	1.030
Central	4	-19.87	-1.0388	-1.0356	-1.0252	1.013
	5	-22.36	-1.1690	-1.14455	-1.1331	1.032
	6	-20.36	-1.0644	-1.0114	-1.0013	1.063
	7	-36.62	-1.9145	-1.81941	-1.8012	1.063
Down	8	-29.83	-1.5595	-1.50919	-1.4941	1.044
	9	-31.9	-1.6677	-1.62441	-1.6082	1.037
	10	-17.13	-0.8955	-0.91662	-0.9075	0.987

Average 1.023

Gain factor measurement by Gerhard

coil	gain2015/2018	gain2022	2022/2015	cell average
1	216.201	214.12	0.990	
2	214.013	213.13	0.996	1.000
3	211.979	214.86	1.014	
4	213.52	214.38	1.004	
5	212.402	207.29	0.976	
6	211.6	208.94	0.987	0.995
7	213.843	216.14	1.011	
8	212.995	211.61	0.993	
9	215.306	211.09	0.980	0.994
10	213.928	215.77	1.009	

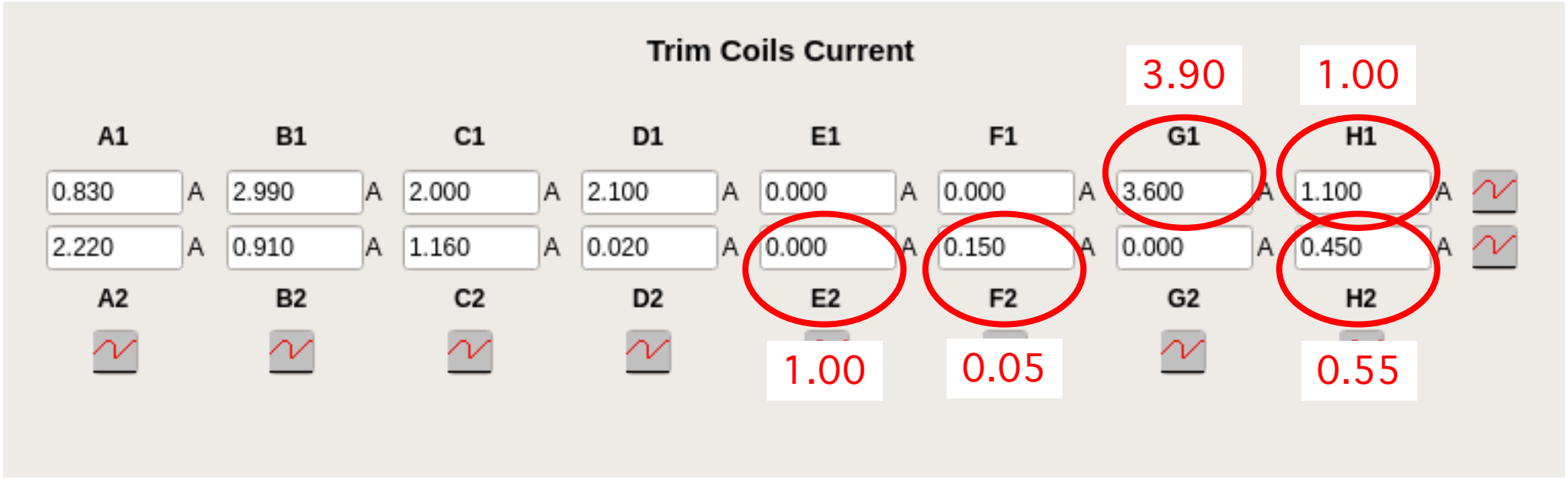
SM1 effect

2ch = 1MHz MW

Coil	Pol. [%]	NMR signal Peak [ch] SM1 OFF	NMR signal Peak [ch] SM1 ON	Shift[ch]
1	-34.91	506	498	8
2	-29.45	496	489	7
3	-29.31	507	499	8
4	34.02	520	512	8
5	33.55	514	505	9
6	34.75	515	505	10
7	37.55	517	506	11
8	-31.91	509	497	12
9	-31.34	505	491	14
10	-31.11	497	484	13

Trim coils setting – with SM1 -

To make each cell good homogeneity



Up/down cell has 10 MHz difference of MW

Manpower

- Routine work : Filling LN2 to target material storage and dewar, water filling : Christophe
- TE and dilution mode tests
  - Remote or night shifts : Jaakko, Genki and Triloki
- DNP remote shifts
  - Gerhard, Genki, Yuya
- Support from Trieste
  - Triloki
- Japanese students from July to September

Japanese manpower for summer

- Yuki ITO (Nagoya University, Master Student)
  04/07 – 17/08
  Target and spectrometer shifts
- Taiga GOKE (Tohoku University, PhD student)
  22/08 – 16/09
  Spectrometer and target shifts
- Clement LEGRIS (Tohoku University, PhD student)
  22/08 – 16/09
  Spectrometer shifts
- Yuya TAKANASHI (Yamagata University, Master student)
  10/08 – 29/09
  Target and spectrometer shifts
- Hajime SUZUKI
  10/08 – 01/09
  Spectrometer shift
- Takahiro IWATA
  18/08 – 04/09
- Hideki KORI
  October or November for target shifts?

Instruction (Solenoid → Dipole)

- Inform shifts
  - Inform shift crews about the filed rotation
- Stop NMR
  - stop “Auto Acquire”
  - write the last signal file name in logbook
- Mask alarm
  - Go to Magnet on DCS
  - mask the alarm of iSolenoid
- Start “Solenoid to Dipole -“
  - Go to “Power Interface”
  - Select “Solenoid to Dipole -“ in “Procedure selection”
  - Wait for the dipole current of -590 A
- Unmask alarm
  - Go to Magnet on DCS
  - Unmask the alarm of iDipole
- Inform shifts
  - inform the shift crews
- Write comment
  - comment on your activities in elog.

Dipole → Solenoid

- Inform shifts

- Inform shift crews about the filed rotation

- Mask alarm

- Go to Magnet on DCS

- mask the alarm of iDipole

- Start “Dipole to Solenoid +“

- Go to “Power Interface”

- Select “Dipole to Solenoid +“ in “Procedure selection”

- Wait for the solenoid current of +640.0 A

- Press “acquire baseline” at PXI-NMR.vi @ na58nmr4.cern.ch

- Write the file name in logbook

- Push “NMR Baseline OK” and wait for +646.7 A

- Press ”acquire signal” and check the NMR signal positions

- Start NMR

- start “Auto Acquire” at PXI-NMR.vi @ na58nmr4.cern.ch

- Unmask alarm

- Go to Magnet on DCS

- Unmask the alarm of iDipole

- Inform shifts

- inform the shift crews

- Write comment

- comment on your activities in elog.