UPPSALA
UNIVERSITET

ESS weekly meeting (W20)

A. Miyazaki et al.

W19&W20: what was performed

W19&20 2021			next next CM	next CM	CM under test
			CM01	**CM03**	**CM05**
THU	06-maj	m	prepared at Orsay		warm up
		a			
FRI	07-maj	m			
		a			
SAT	08-maj				
SUN	09-maj				
MON	10-maj	m			dismount bellows
		a			
TUE	11-maj	m		install TP for insulation vacuum, GHe pressure gauges	docking area
		a			investigation
WED	12-maj	m			
		a			
THU	13-maj	m	longer weekend		
		a			
FRI	14-maj	m			
		a			
SAT	15-maj				
SUN	16-maj				
MON	17-maj	m	ready for shppping to Uppsala	move to bunker	dry N2 to insulation vac
		a		waveguide connection	
TUE	18-maj	m		cryogenic line	doorknob, out-going test
		a		He line's leak test	
WED	19-maj	m		cryogenic bellows	install into the box
		a		insulating vacuum	

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Tentative plan of W21

W21 2021			next next CM	next CM	CM under test
			CM01	**CM03**	**CM05**
THU	20-maj	m	ready for shppping to Uppsala	beam vacuum	inside the transportation box At which time?
		a			
FRI	21-maj	m		RF preparation	
		a		coupler warm conditioning	
SAT	22-maj				
SUN	23-maj				
MON	**24-maj**	m	Pick-up at Orsay		**pick-up at Uppsala**
		a			
TUE	25-maj	m	**To arrive on TUR 27-maj**		arrive at ESS
		a			
WED	26-maj	m		cooling down?	
		a			

I heard arrival on June 3rd instead (From Felix)

Empty box transport?? for CM04????

A. Miyazaki, ESS meeting W20

W19&W20: what was performed

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			CM01	**CM03**	**CM05**
THU	06-maj	m	prepared at Orsay		warm up
		a			
FRI	07-maj	m			
		a			
SAT	08-maj				
SUN	09-maj				
MON	10-maj	m			dismount bellows
		a			
TUE	11-maj	m		install TP for insulation vacuum, GHe pressure gauges	docking area
		a			investigation
WED	12-maj	m			
		a			
THU	13-maj	m	longer weekend		
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FRI	14-maj	m			
		a			
SAT	15-maj				
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WED	19-maj	m		cryogenic bellows	install into the box
		a		insulating vacuum	

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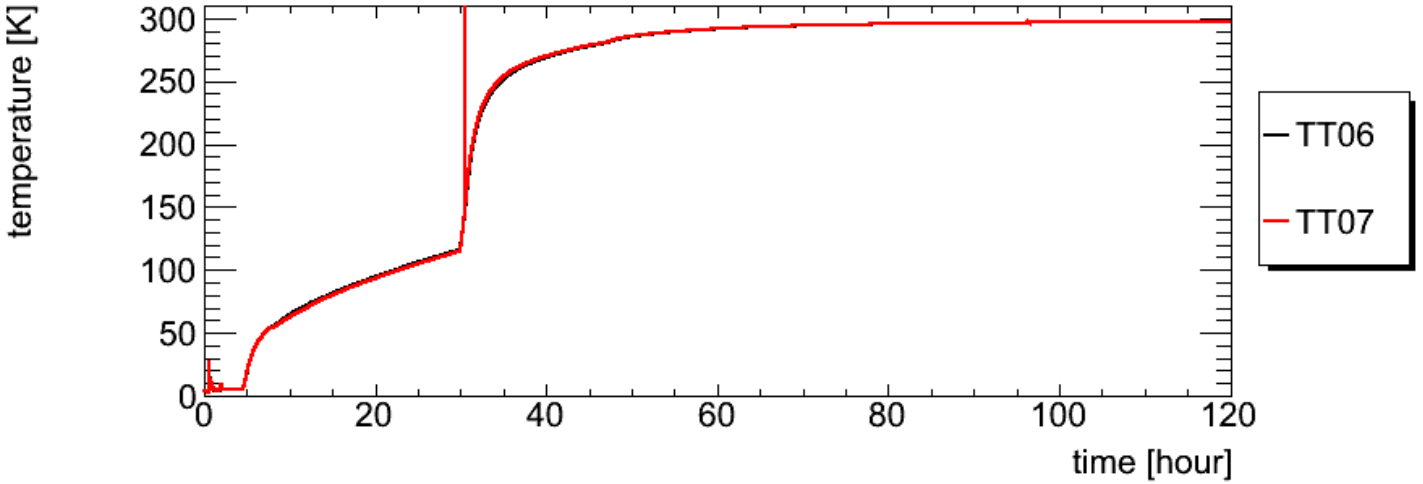
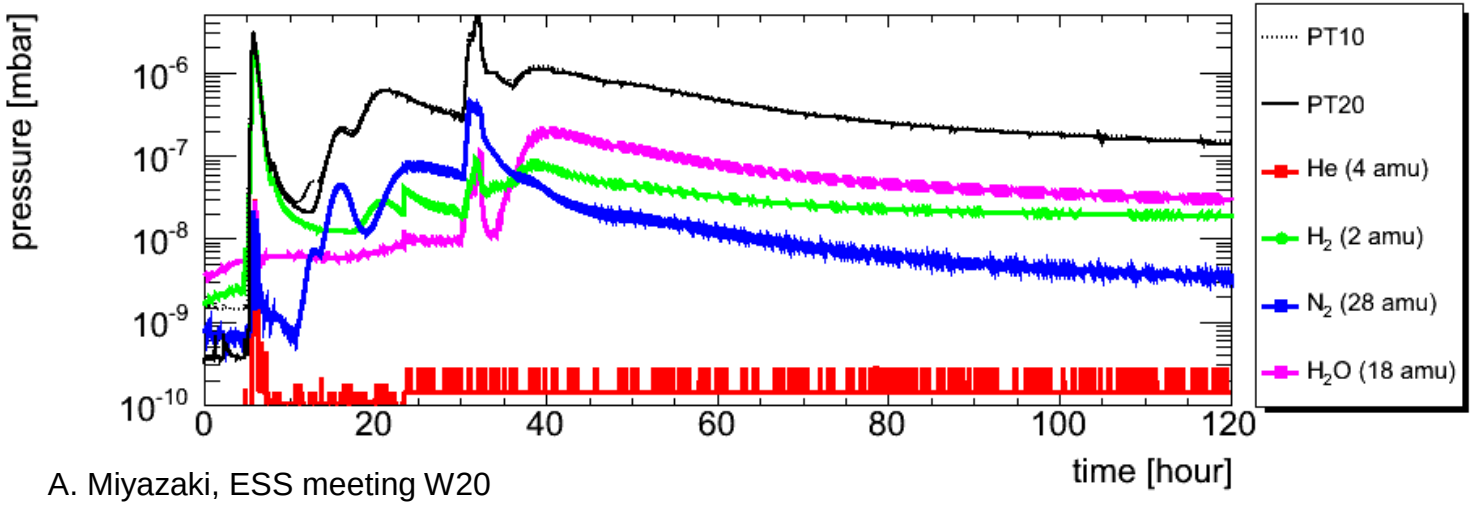
warm up & gas species





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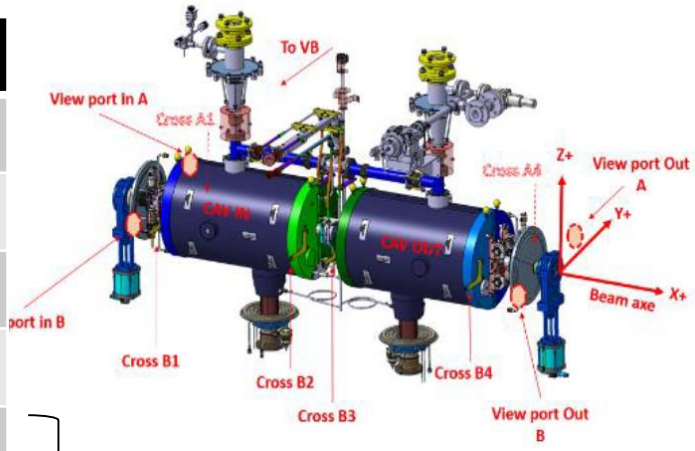
Cavity shrinkage measurement

T (K)	Side B	Y (mm)	Z (mm)	ΔY (mm)	ΔZ (mm)
300	Cross B1	1.00 (red)	0.01 (red)		
	Cross B2	1.10 (red)	0.59 (black)		
	Cross B3	0.13 (red)	>1.2 (red)		
	Cross B4	1.20 (red)	0.05 (red)		
4.2	Cross B1	0.22 (red)	0.12 (red)	**+0.78**	+0.11
	Cross B2	0.18 (red)	0.25 (black)	**+0.92**	+0.34
	Cross B3	1.15 (black)	>1.2 (red)	**+1.02**	No data
	Cross B4	0.49 (red)	0.67 (red)	**+0.71**	+0.62
300	Cross B1	0.78 (red)	0.10 (red)	+0.22	+0.09
	Cross B2	0.91 (red)	0.78 (black)	+0.19	+0.19
	Cross B3	0.09 (red)	>1.2 (red)	+0.04	No data
	Cross B4	1.05 (red)	0.42 (red)	+0.15	+0.37



Horizontal
uniform shrinkage
0.86 +/- 0.24 mm (RMS)

Horizontal
Reproduced within
0.2 mm

We will return the telescope to Orsay

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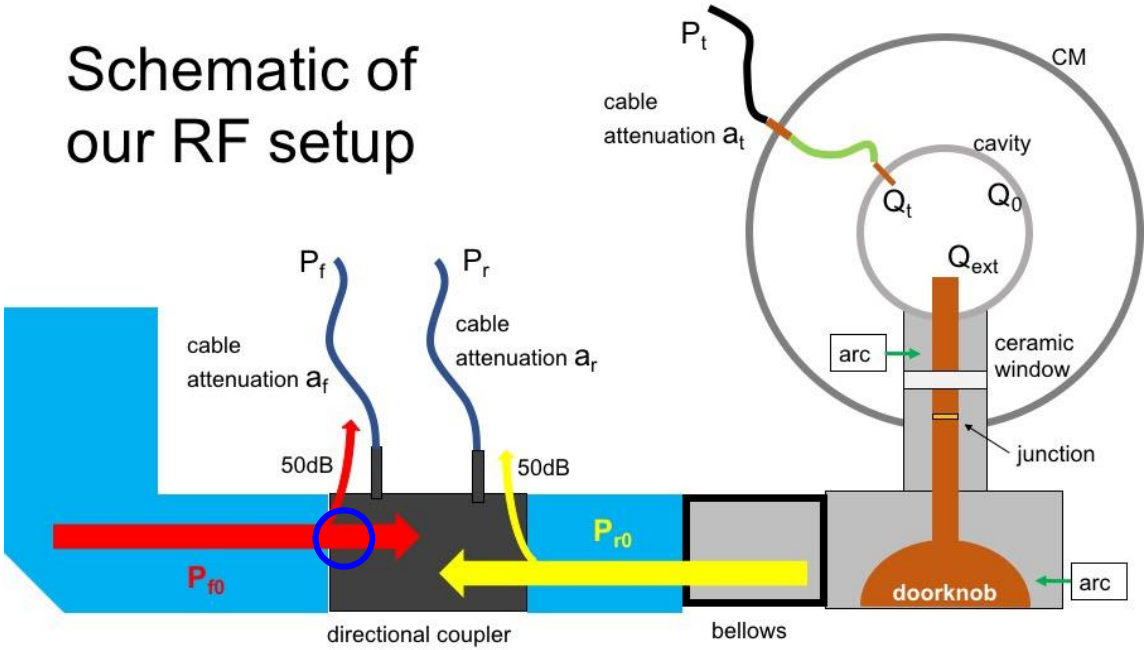
Doubt in power measurement (**CAV IN**)

Schematic of our RF setup



$$E_{acc\_pk\_Pt} = \sqrt{\frac{Q_t P_t}{k\omega}},$$

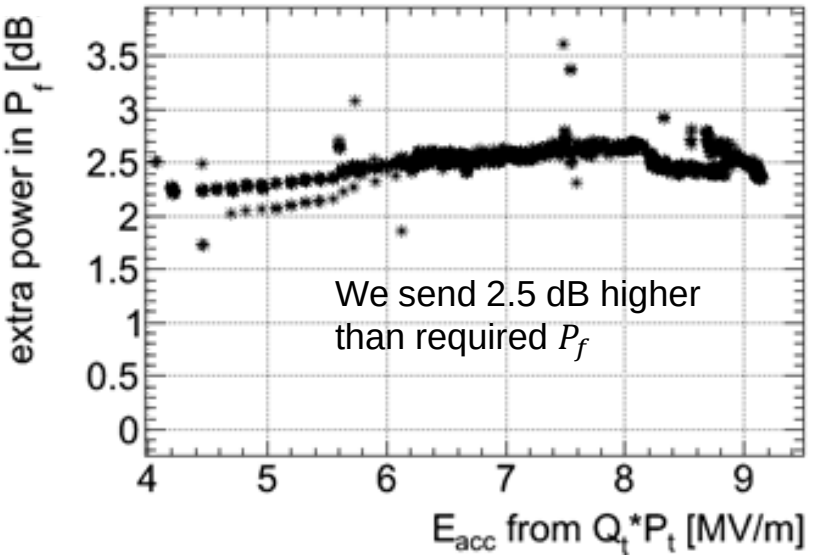
$$E_{acc\_pk\_Pf} = \sqrt{\frac{4Q_L P_f}{k\omega}}$$

Tuner was fine tuned

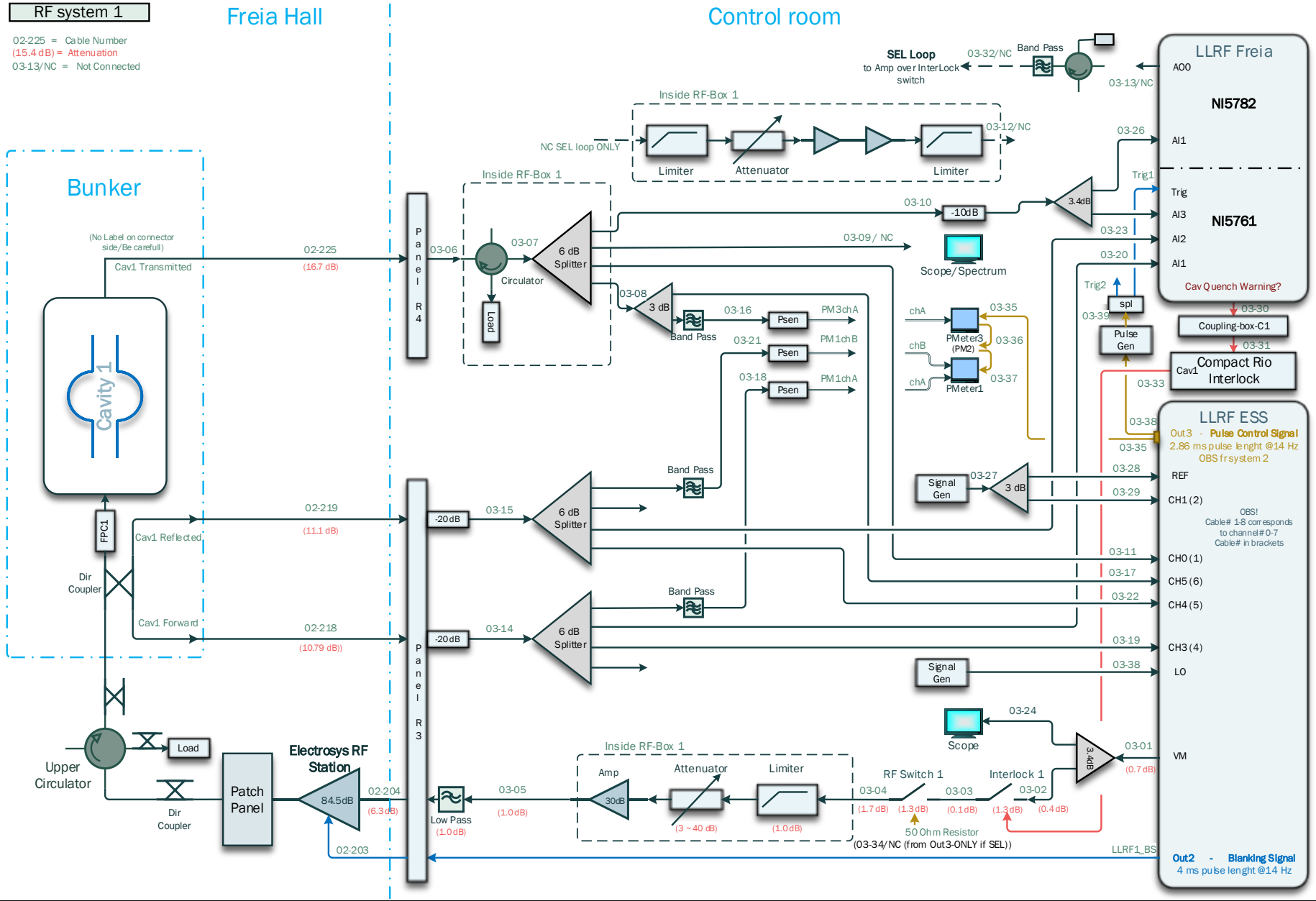
Eacc_pk_Pt	Eacc_pk_Pf
5,98785	8,49807

The checked..,

1. Low power side (cables, filters, splitters, attenuators, power meters, LLRF)
2. High power side (WR2300HH waveguide, WR230HH directional coupler, 6-1/8 inch coaxial line, coaxial circulator)
3. Cavity through doorknob



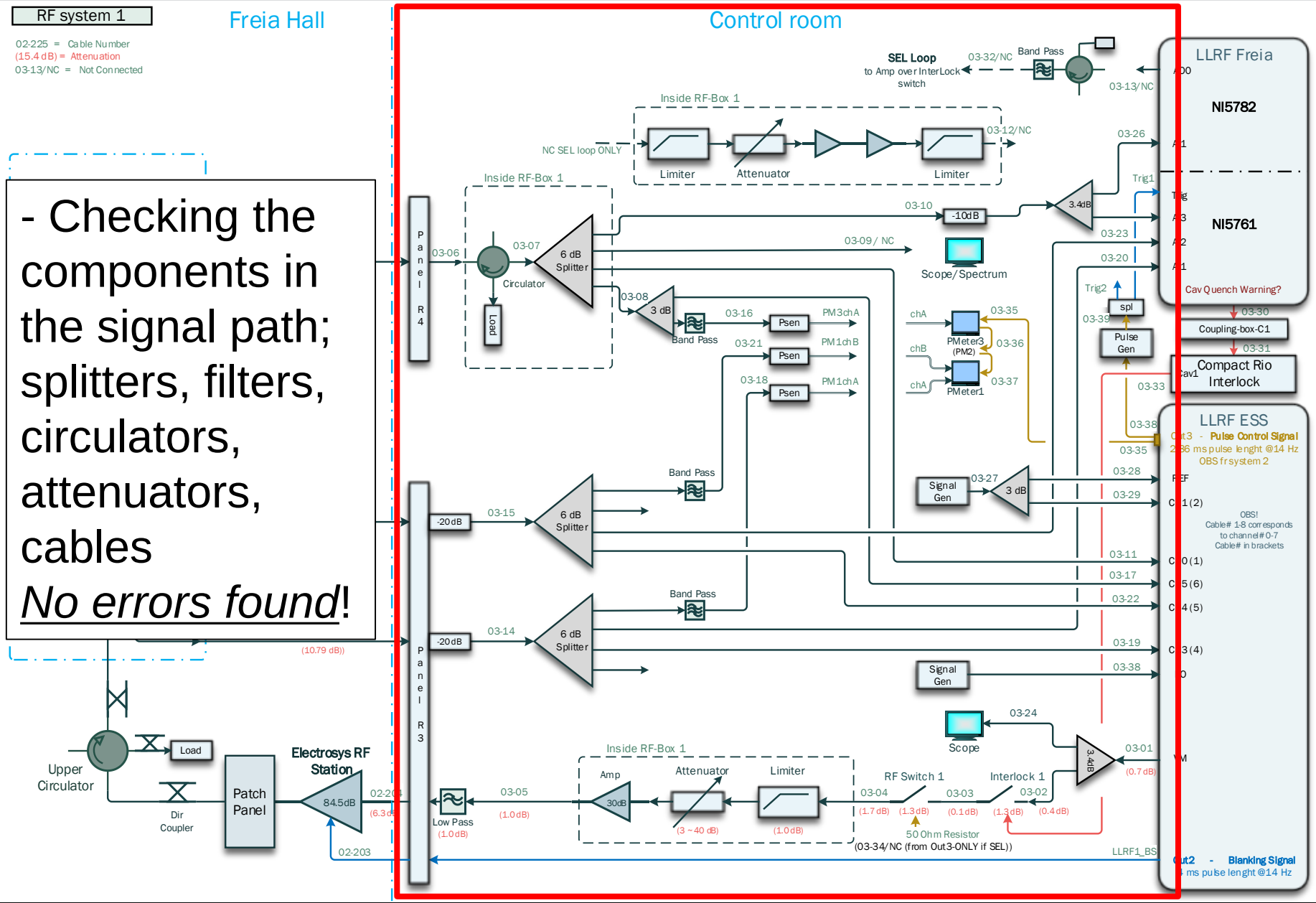
Looking for errors in the power measurement.



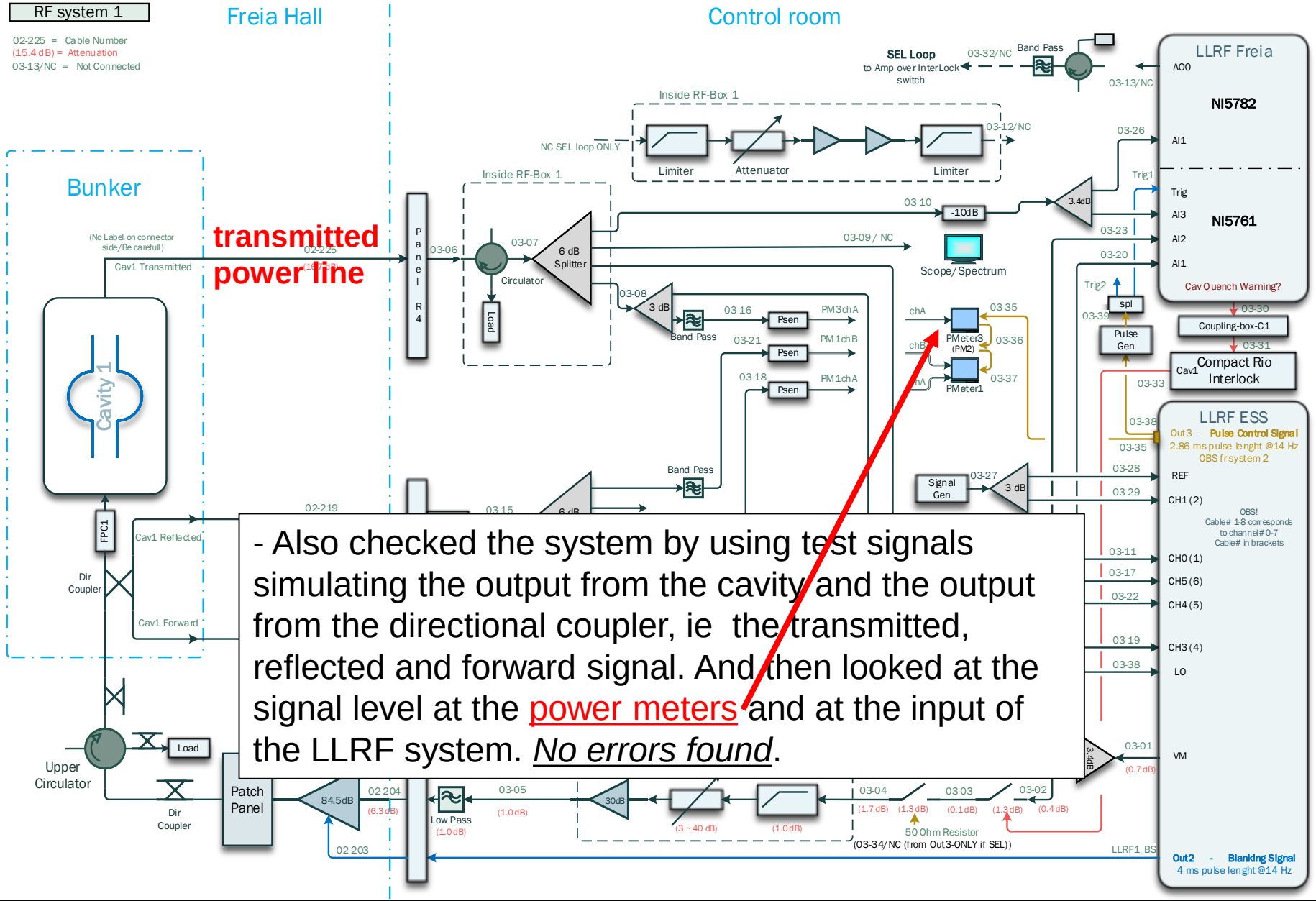
Looking for errors in the power measurement.

- Checking the components in the signal path; splitters, filters, circulators, attenuators, cables

No errors found!

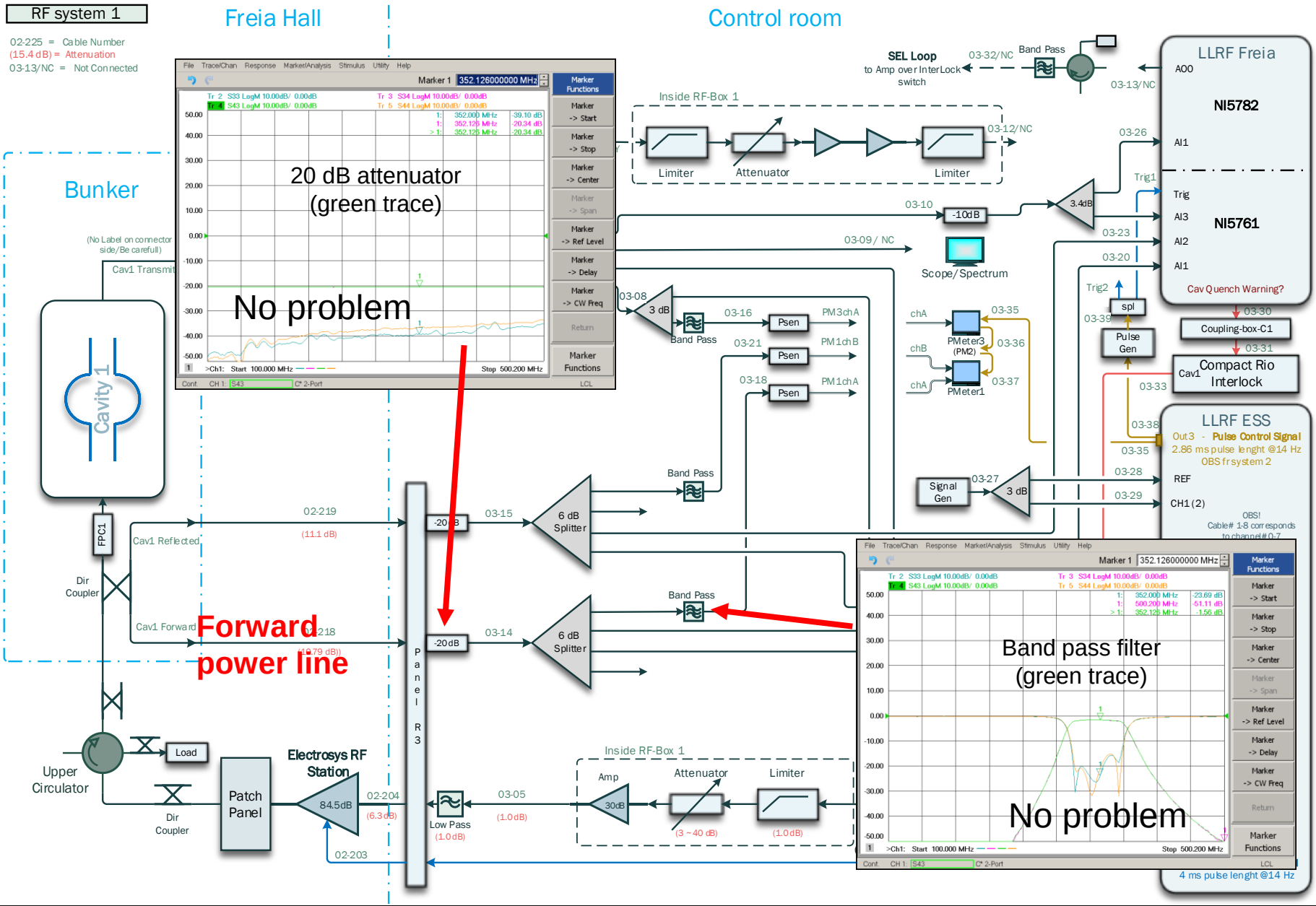


Looking for errors in the power measurement.

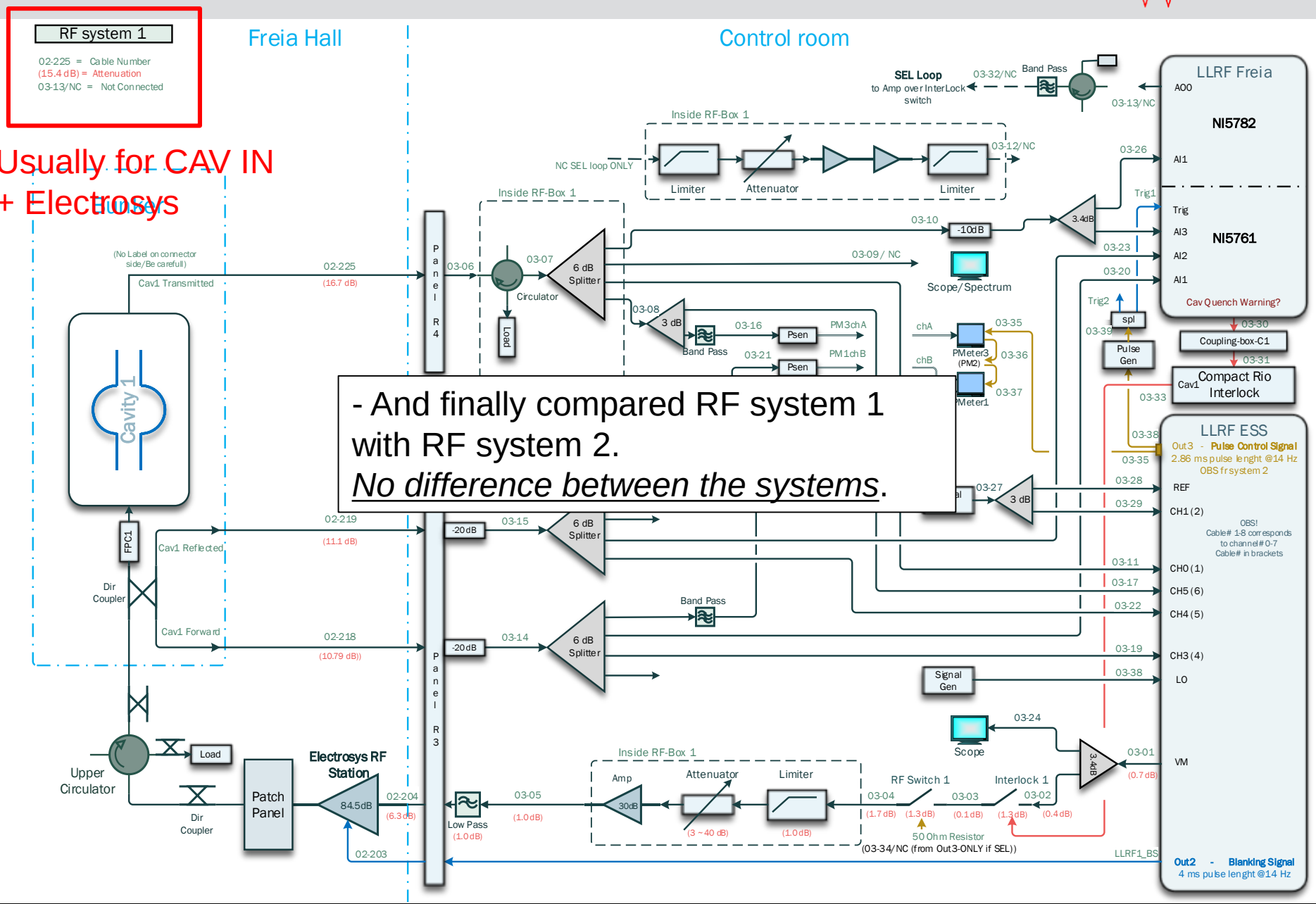


- Also checked the system by using test signals simulating the output from the cavity and the output from the directional coupler, ie the transmitted, reflected and forward signal. And then looked at the signal level at the power meters and at the input of the LLRF system. *No errors found*.

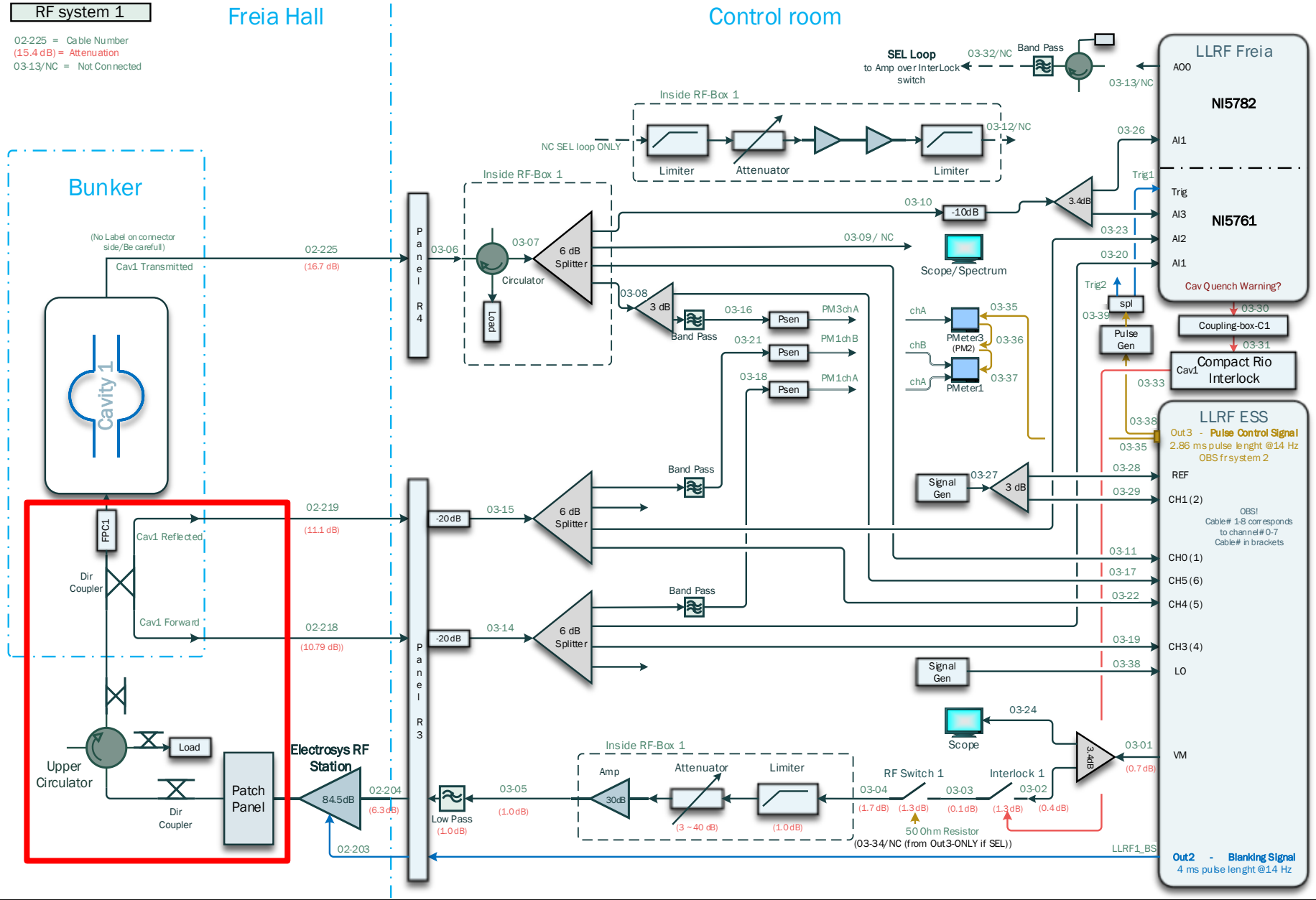
Looking for errors in the power measurement.



Looking for errors in the power measurement.

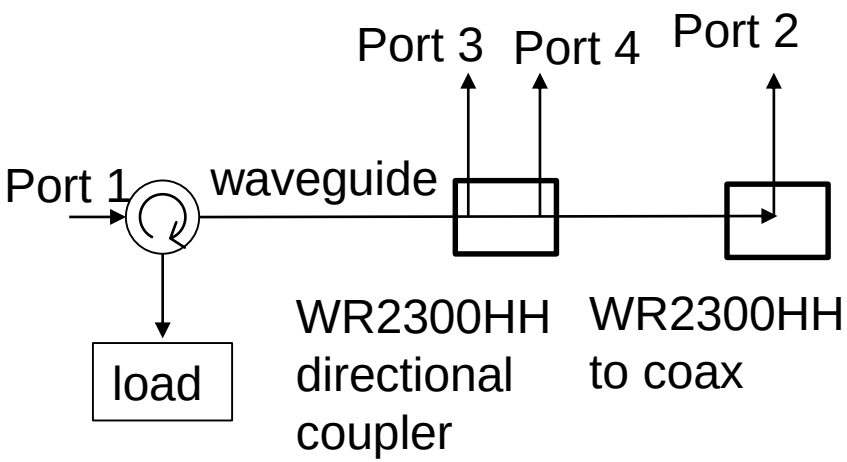


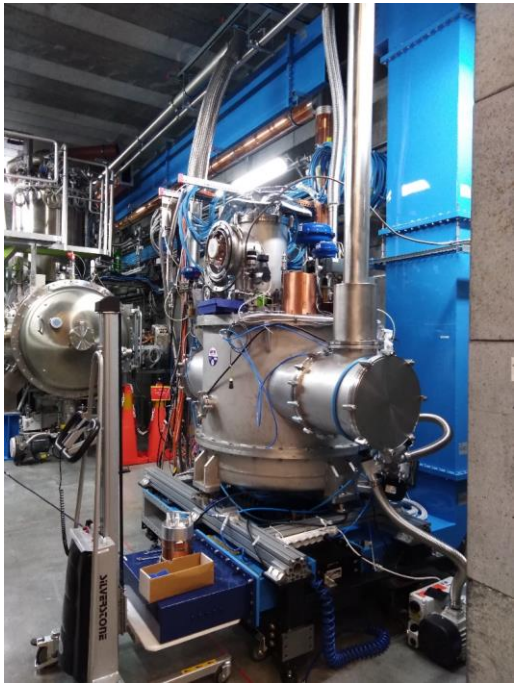
Next step: High power side



Measure WR2300HH waveguide

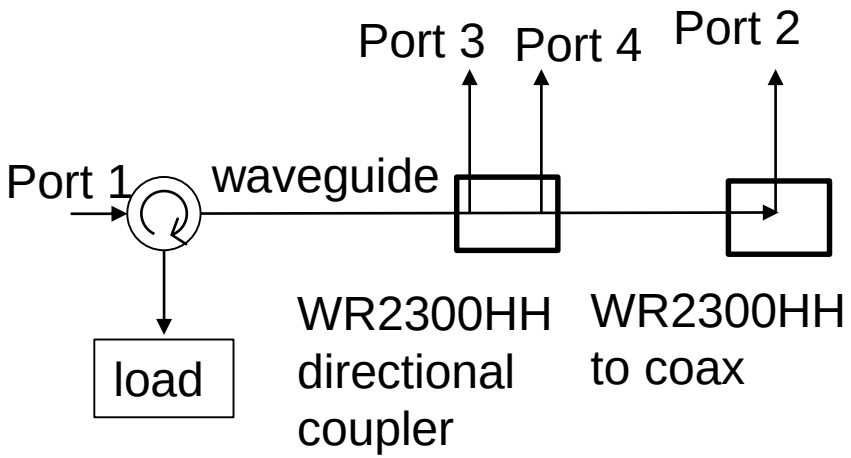
Long (~20m) RF cable was calibrated and connected to VNA's ports





- In reality, 2-port measurement was performed with matched or open condition at port 2
- Measurement around 352.21 MHz +/- 1MHz

Measure WR2300HH waveguide



- The cavity powering is performed under a strongly over coupling condition
- The relevant impedance condition to generate identical standing wave of cavity measurement is tricky
- The conservative guess is to compare short and open condition ($\lambda/4$ shifts in standing wave)

CAV IN

S-parameter	value [dB]	coupling
S21	-0.09	
S31 w port 2 50 W	-49.67	-49.58
S31 w port 2 open	-49.49	-49.40
S31 w port 2 short	-50.13	-50.04
S41 w port 2 50 W	-74.72	
S41 w port 2 open	-49.03	
S41 w port 2 open	-49.72	

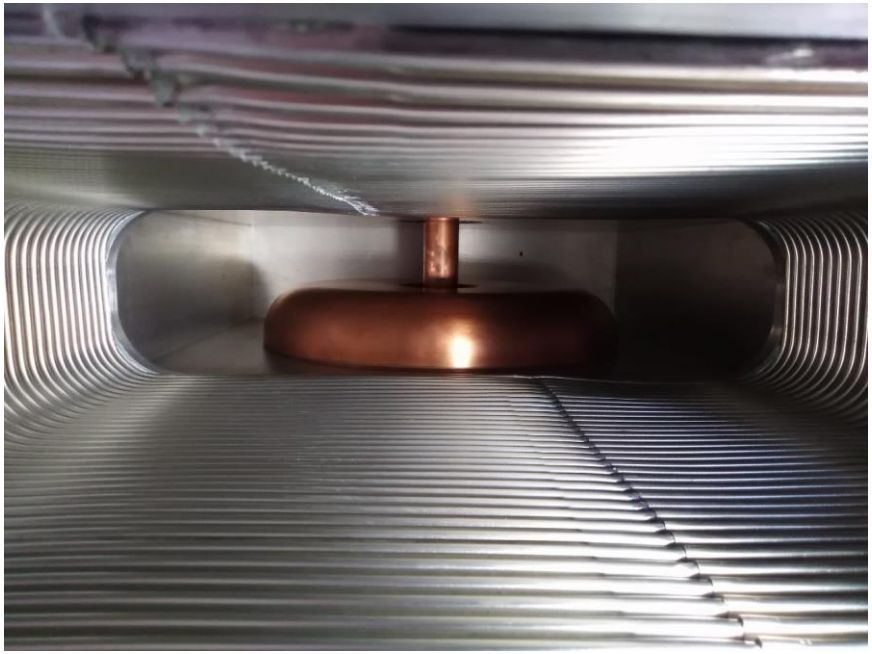
We have used manufactured value 50 dB but the real value seems **0.5 dB** lower except for the short case

CAV OUT

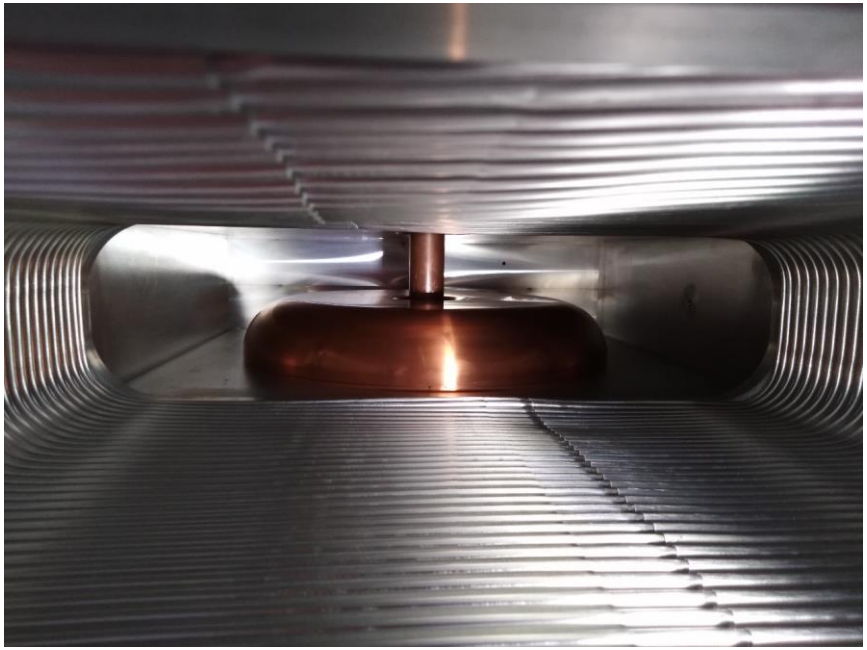
S-parameter	value [dB]	coupling
S21	-0.28	
S31 w port 2 50 W	-49.85	-49.57
S31 w port 2 open	-48.70	-48.42
S31 w port 2 short	-51.08	-50.80
S41 w port 2 50 W	-77.00	
S41 w port 2 short	-51.25	
S41 w port 2 open	-49.22	

Visual inspection of doorknob

CAV IN



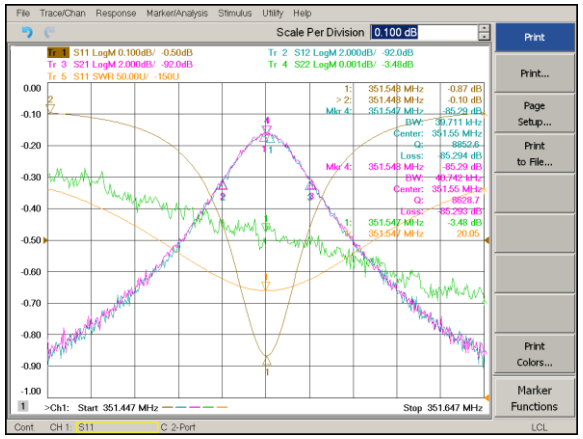
CAV OUT



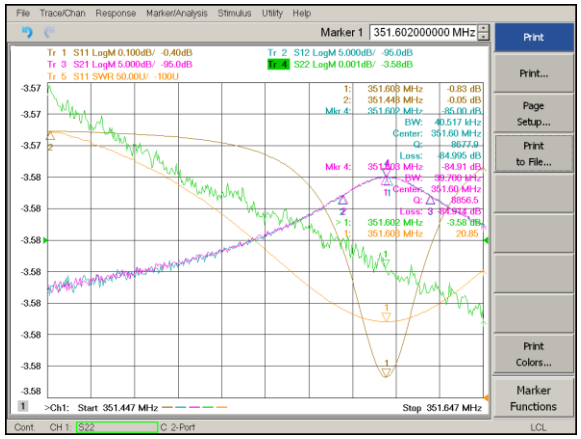
Nothing special

Cavity measurement through doorknob

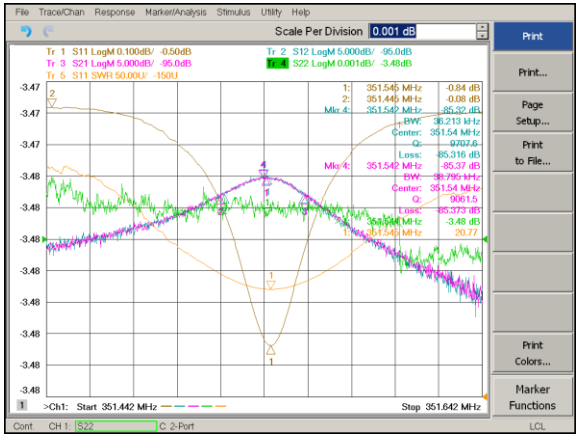
CAV IN

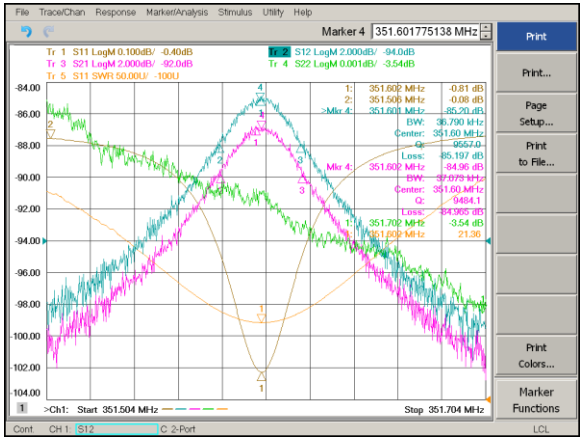


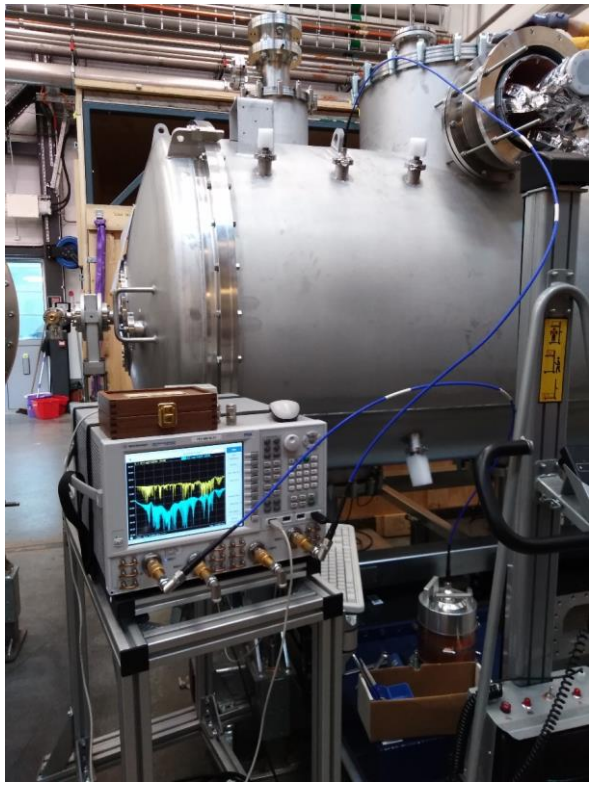
CAV OUT



Cf. At the reception w/o doorknob







Port 1: coupler → **cav** → Port 2: Pick-up

Nothing special

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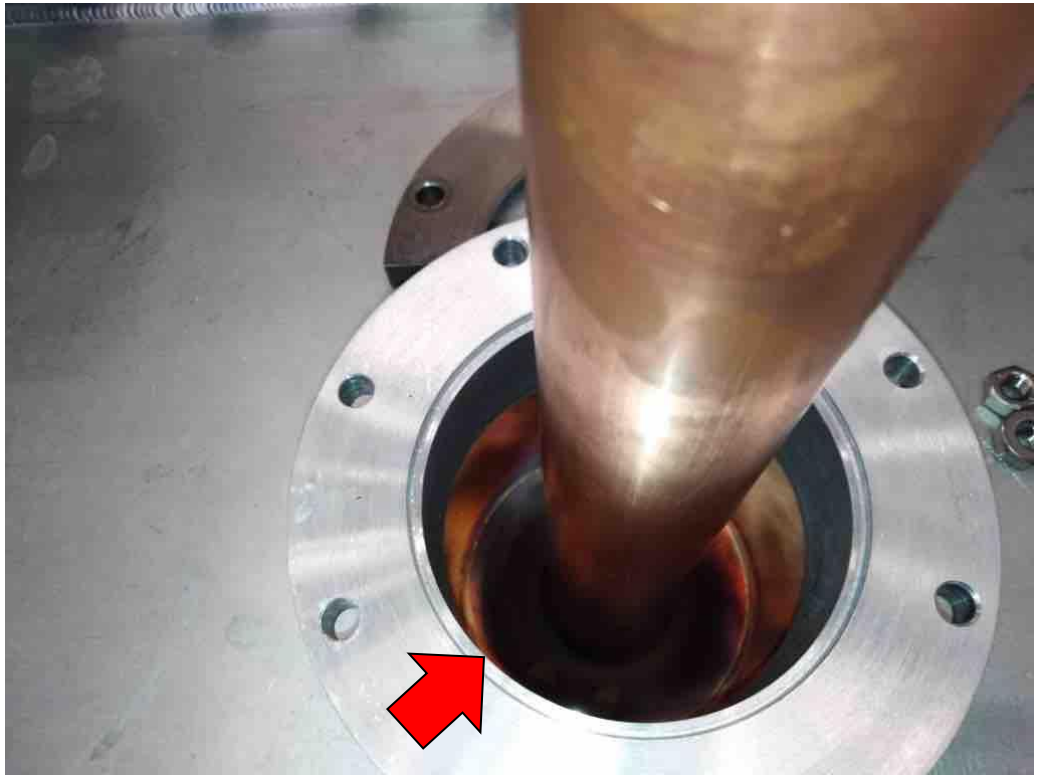
CM05: Doorknob dismounting



- Doorknob is black (from the beginning)→does it affect?
- Nothing in the ceramic window

Cf. doorknobs in December 2020

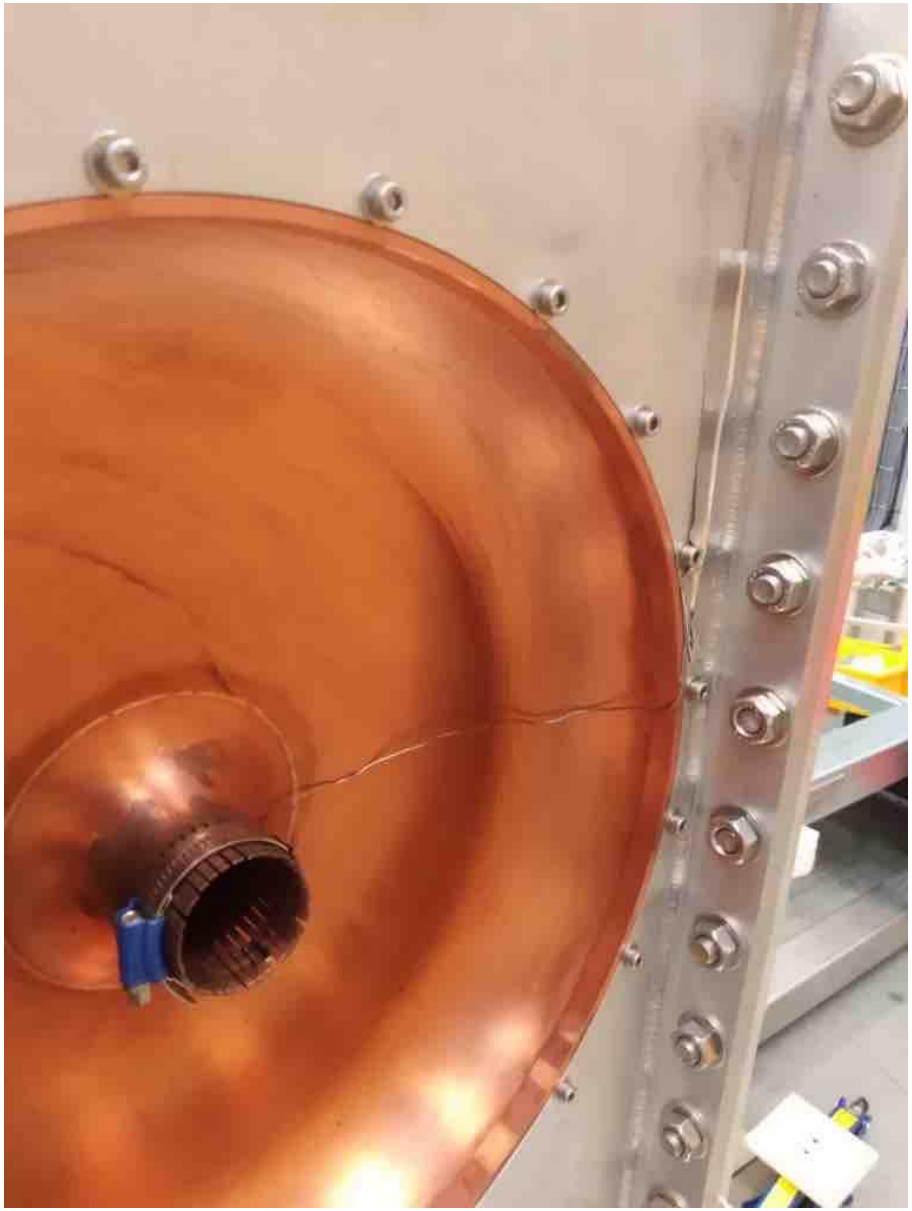
CAV IN

CAV OUT

- It was already black → no major change is visible
- CAV IN's arc detector at the doorknob tripped a lot in CM02 and CM04 but it was very calm during CM05 testing

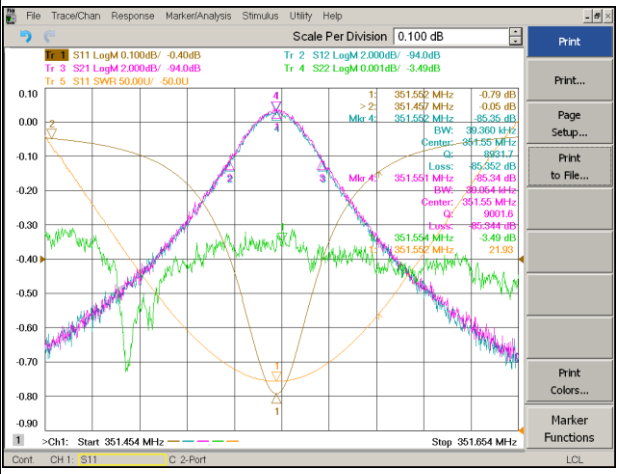
Temperature sensor for the next next test

- Temperature sensor was mounted on the other side of black region
- The doorknob will be used in the next next test with CM01

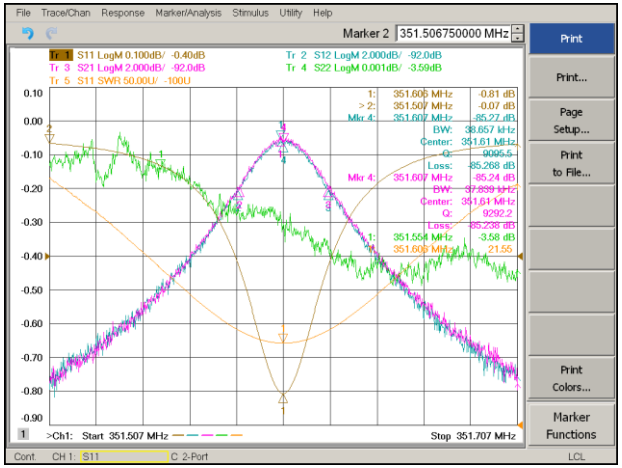


VNA measurement without doorknob

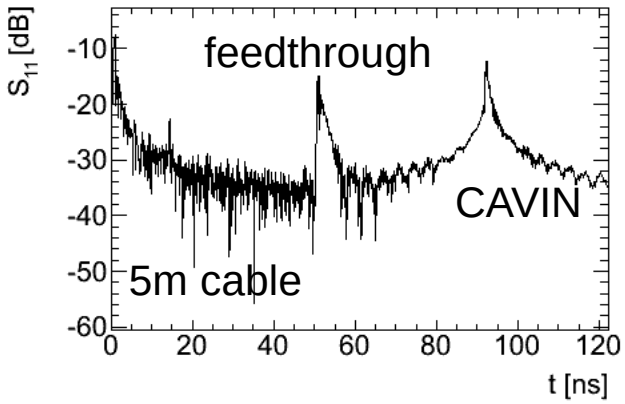
CAV IN

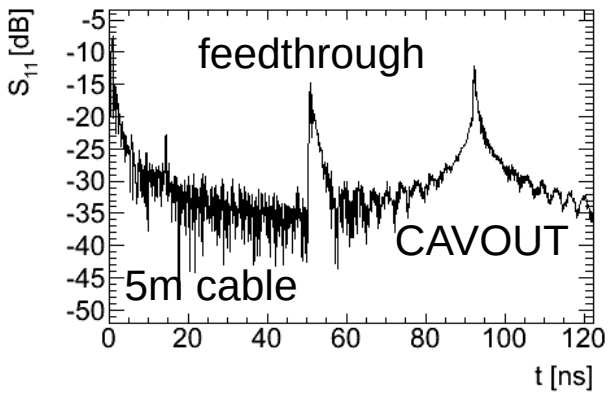


CAV OUT



TDR: pick-up cable





Port 1: coupler → **cav** → Port 2: Pick-up

A. Miyazaki, ESS meeting W20

Nothing special

Summary of VNA measurement for CM05

	CAV IN			CAV OUT		
	Before cold test	after cold test w doorknob	after cold test w/o doorknob	Before cold test	after cold test w doorknob	after cold test w/o doorknob
f_0 [MHz]	351.542	351.548	351.552	351.602	351.603	351.607
Q_L	9061	8628	8931	9484	8857	9095
S_{21} (f_0) [dB]	-85.37	-85.29	-85.35	-85.97	-84.91	-85.27
S_{11} (f_0) [dB]	-0.84	-0.87	-0.79	-0.81	-0.83	-0.81
S_{11} (f_0-Δf) [dB]	-0.08	-0.10	-0.05	-0.08	-0.05	-0.07
S_{22} (f_0) [dB]	-3.48	-3.48	-3.49	-3.54	-3.58	-3.58

- Nothing explains the anomalous 2.5 dB from cavity measurement
- The VNA measurement at warm is not precise but hypothetical damage for 2.5 dB must be visible if such a thing exists

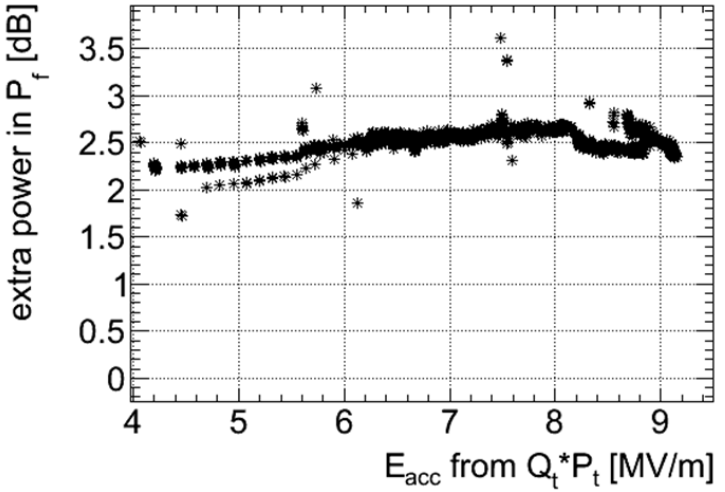
Summary: CM05's anomaly

- In the cold measurement with high power (>10kW), we saw strange discrepancy between two independent field estimations of CAV IN
- This corresponds to 2.5 dB error in power
- No arc signal, electron pick-up, distortion of reflected waveform
- No problem in cable calibration, power meters and LabVIEW code
- We found 0.5 dB error in our WR2300HH directional coupler
- From visual inspection & RF measurement of doorknobs, couplers, and cavities, we did not find any damages or strange values
- In general Q_t from vertical tests might not be very precise

$$E_{acc\_pk\_Pt} = \sqrt{\frac{Q_t P_t}{k\omega}},$$

$$E_{acc\_pk\_Pf} = \sqrt{\frac{4Q_L P_f}{k\omega}}$$

Eacc_pk_Pt	Eacc_pk_Pf
5,98785	8,49807



CM05: preparation for shipping

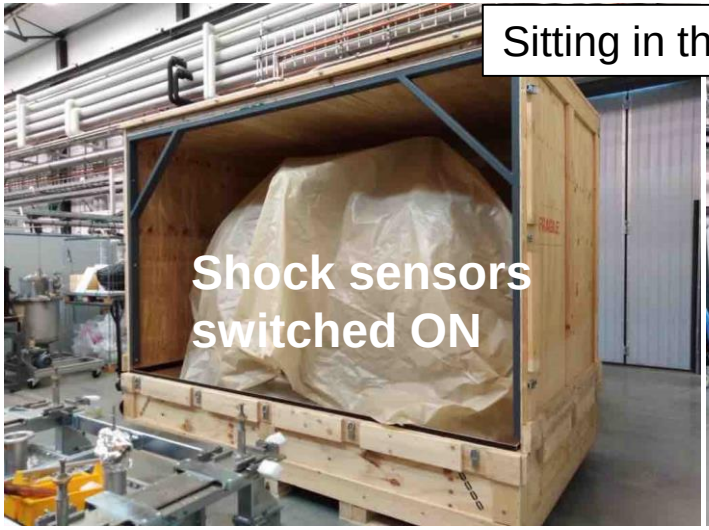
CM05 & CM03 swapped

Shock sensors mounted

Dry N_2 into insulation vacuum

LEMO tests

Sitting in the box



A. Miyazaki, ESS meeting W20

CM05 will be shipped on next Monday (May 24th)

W19&W20: what was performed

W19&20 2021			next next CM	next CM	CM under test
			CM01	**CM03**	**CM05**
THU	06-maj	m	prepared at Orsay		warm up
		a			
FRI	07-maj	m			
		a			
SAT	08-maj				
SUN	09-maj				
MON	10-maj	m			dismount bellows
		a			
TUE	11-maj	m		install TP for insulation vacuum, GHe pressure gauges	docking area
		a			investigation
WED	12-maj	m			
		a			
THU	13-maj	m		longer weekend	
		a			
FRI	14-maj	m			
		a			
SAT	15-maj				
SUN	16-maj				
MON	17-maj	m	ready for shppping to Uppsala	move to bunker	dry N2 to insulation vac
		a		waveguide connection	
TUE	18-maj	m		cryogenic line	doorknob, out-going test
		a		He line's leak test	
WED	19-maj	m		cryogenic bellows	install into the box
		a		insulating vacuum	

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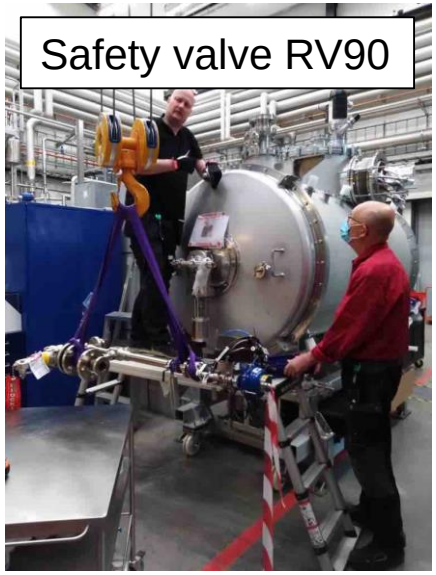
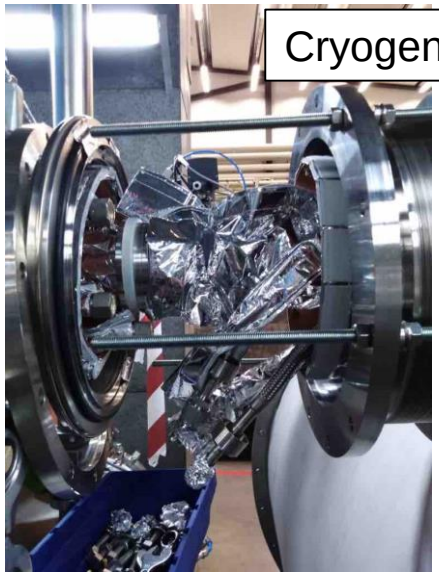
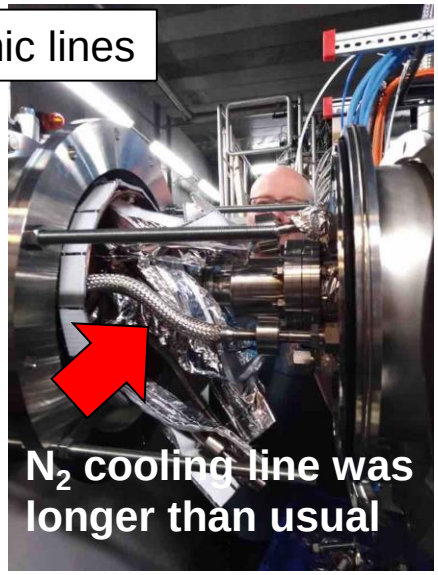
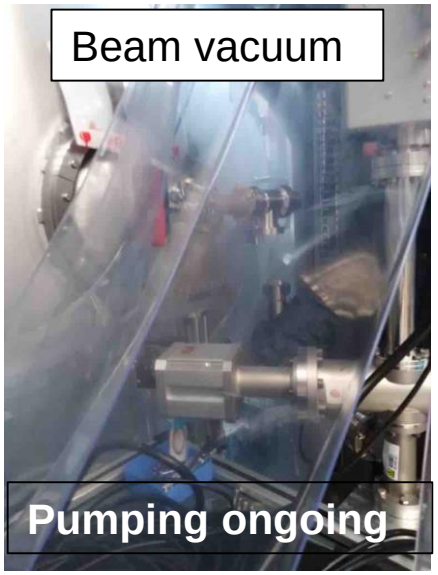
Preparation of CM03

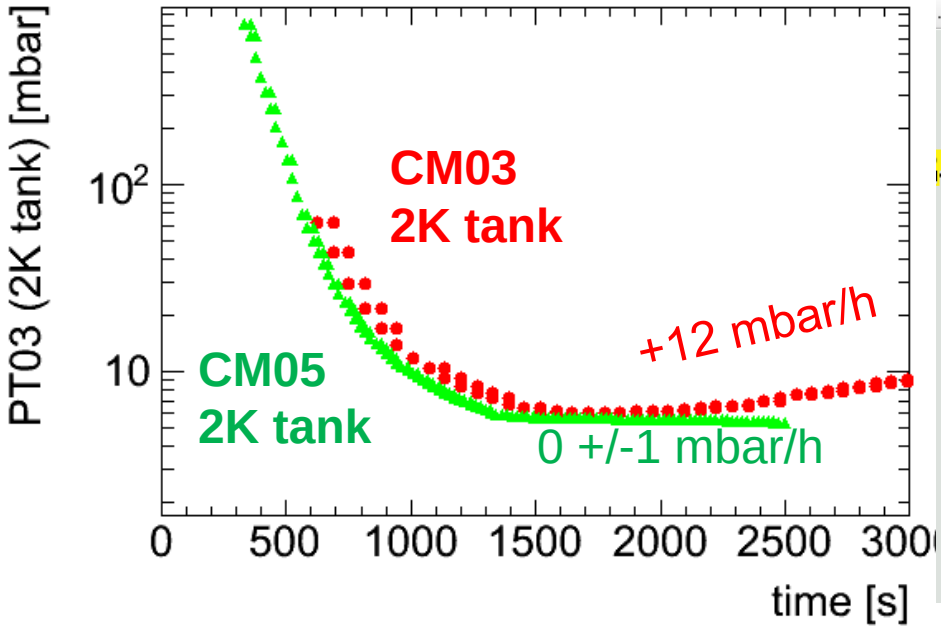


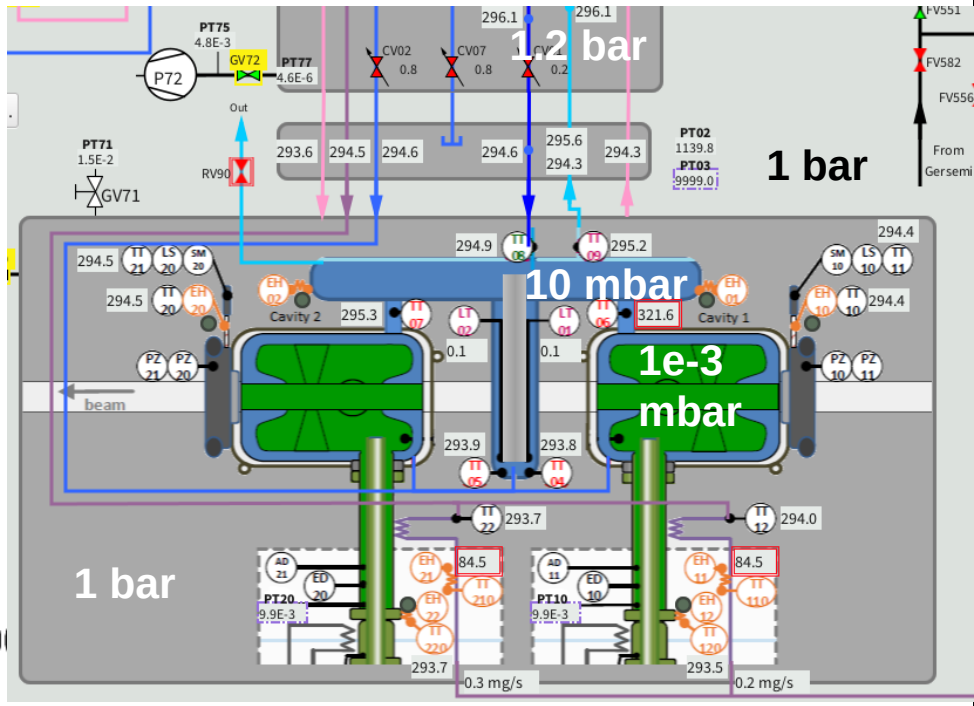


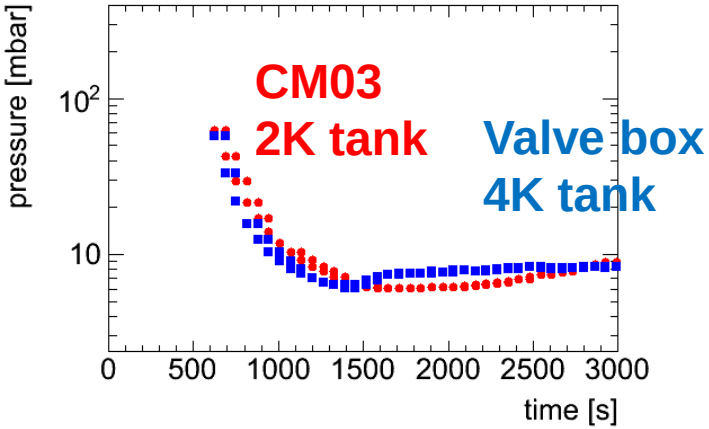




Leak test in the He circuit (under pressure)







The He tank inside isolated
CM03 seems leaky

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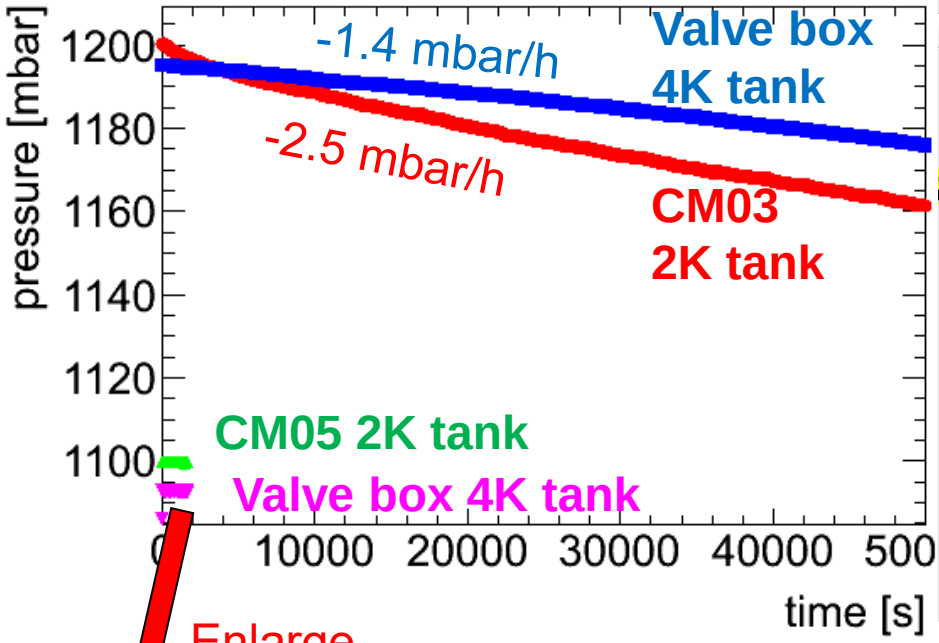
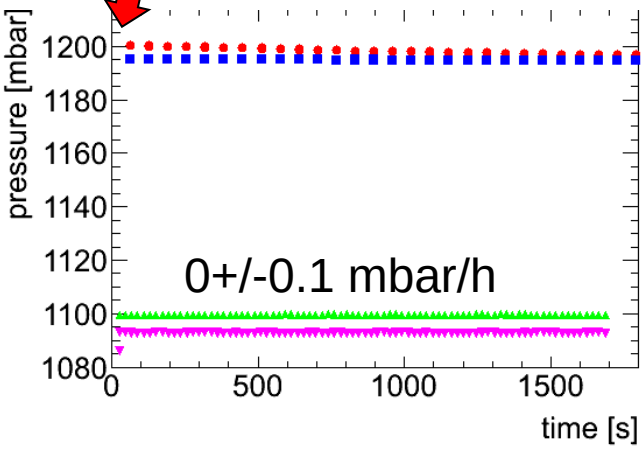
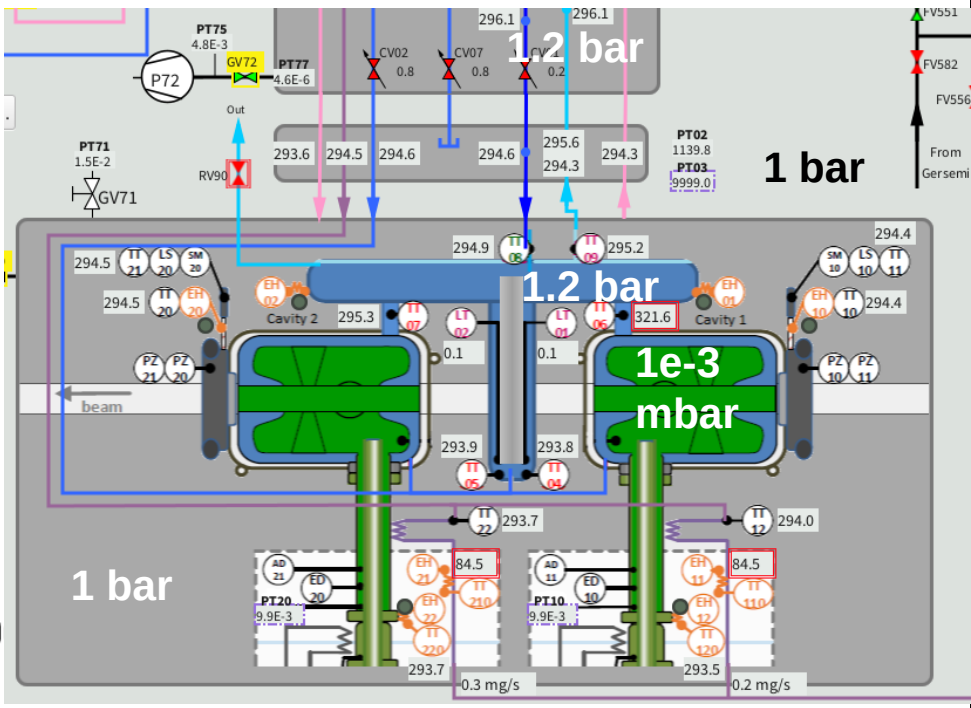
Leak test in the He circuit (over pressure)



Enlarge…





It looks like a leak through 1 bar

Leak rate Q_L vs differential pressure ΔP

$\Delta P \sim 1000$ mbar: $Q_L \sim +12$ mbar/h

$\Delta P \sim -200$ mbar: $Q_L -2.5$ mbar/h

→ $Q_L \sim 1.2 \times 10^{-2} \Delta P$

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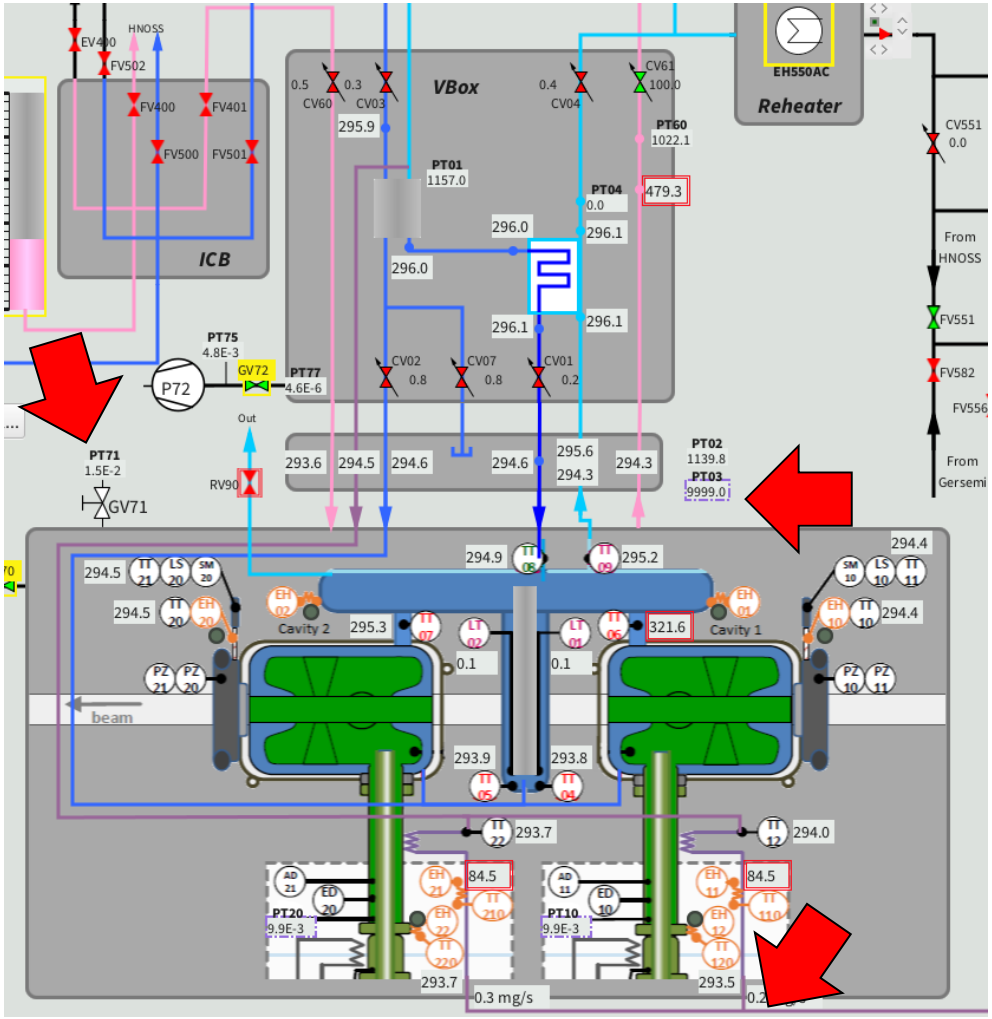
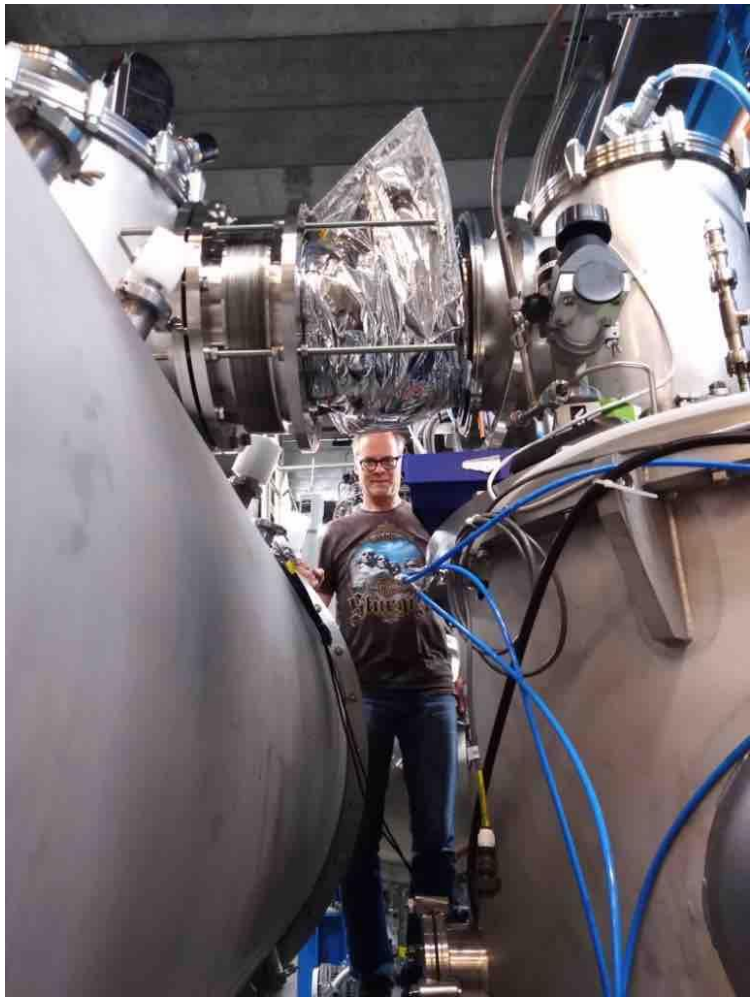
To localize the leak…





- Nothing in the connection and SCHe line

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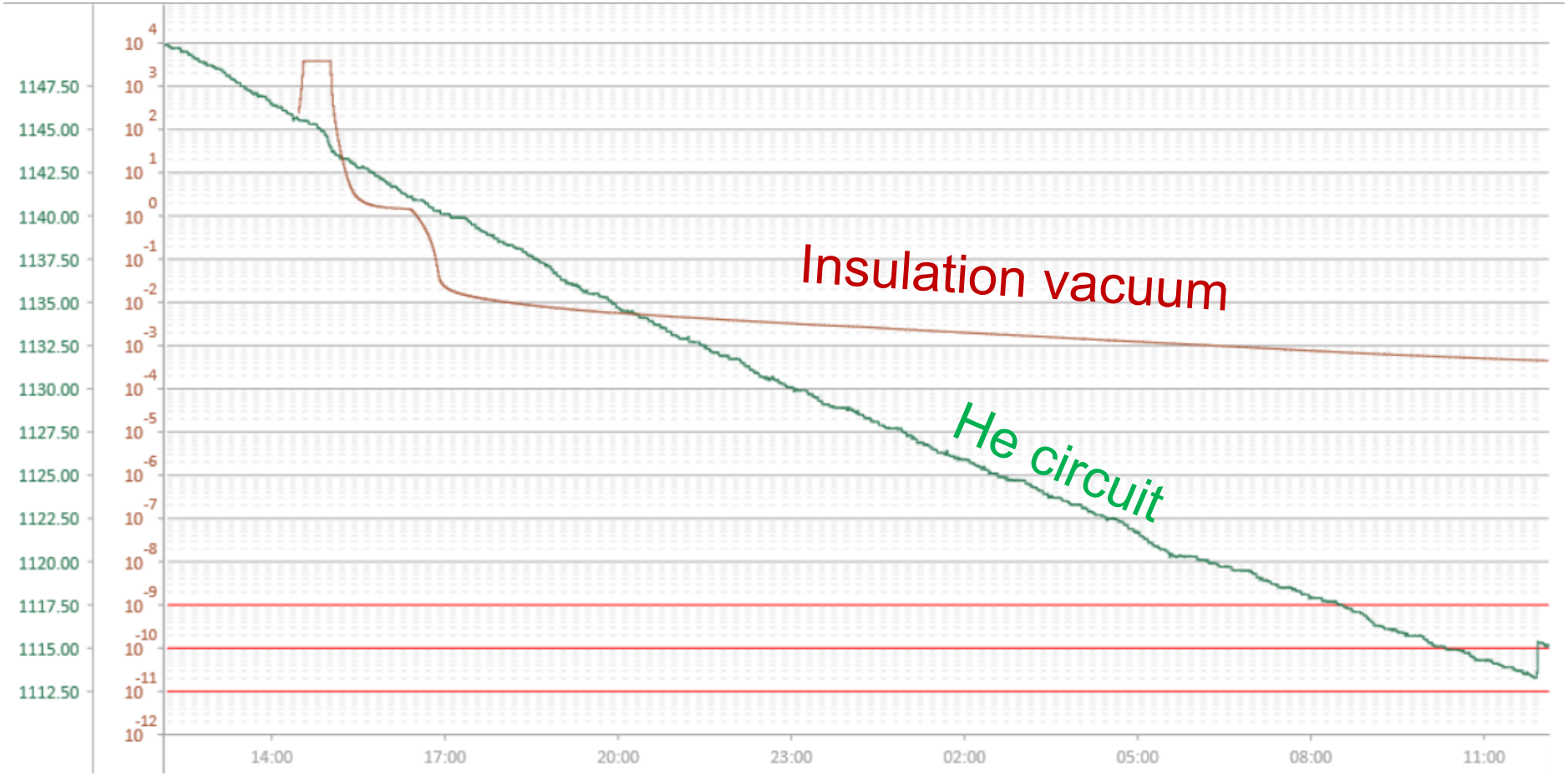
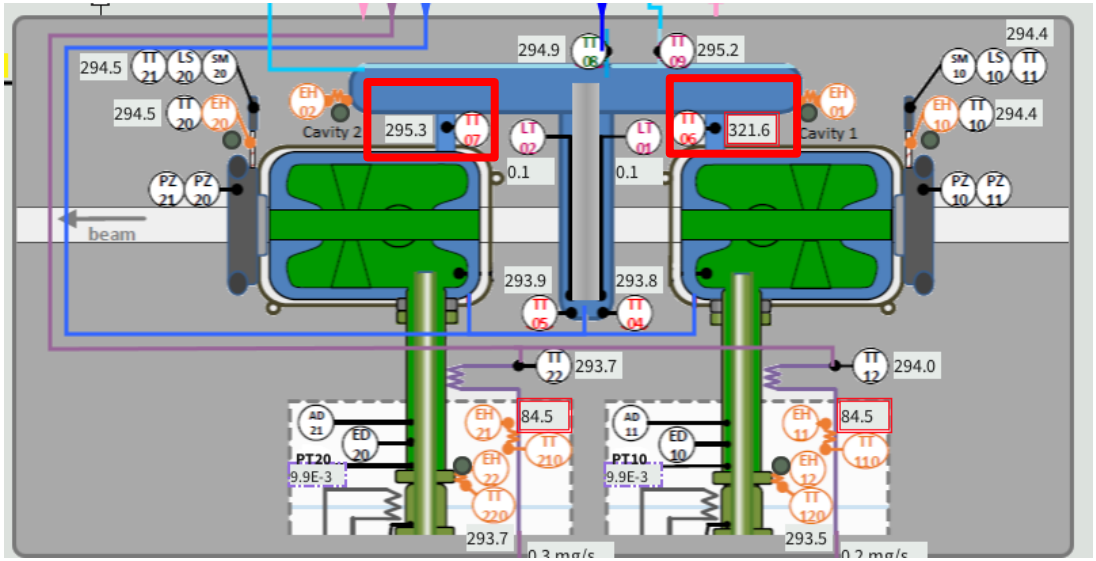
Leak through insulation vacuum?



- Pumping insulation vacuum from 1 bar to <1e-3 mbar did not influence the leak rate of the He circuit
- Also, no He signal was detected in the insulation vacuum

Doubt on temperature sensors



TT04:		295.426 K	66.149 Ω
TT05:		295.552 K	66.277 Ω
TT06:		321.878 K	65.866 Ω
TT07:		295.421 K	63.472 Ω
TT08:		295.565 K	62.376 Ω
TT09:		295.786 K	71.024 Ω

- Two **crucial sensors** for cryogenic regulation are suspicious
  - TT06 (X138025)
  - TT07 (X138026)
- They seem swapped between Orsay's document and our measurement at reception
- Swapped calibration curves for "TT07" (X138025) works but "TT06" (X138026) still does not work

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Cables verification CM03 at IJCLab			v1
Socket assembly		Verified by : J.-C. Roux	
Socket name	PID name	Electrical value (Ω) (before shipment)	C / NC
	TT04	66,27	C
	TT05	66,42	C
	TT06	63,58	C
	TT07	66,01	C
LC01	TT08	62,51	C
	TT09	71,25	C
	TT10	108,55	C
	TT11	108,6	C
	TT12	69,44	C
	TT20	108,37	C
	TT21	108,43	C
	TT22	64,23	C
PT Coupler	TT120	108,50	C
	TT220	108,51	C
LC02	EH01	84,17 Ω	C
	EH02	84,74 Ω	C
	EH10	82,54 Ω	C
	EH20	84,74 Ω	C
LC03	SM10	2,46 / 2,49 Ω	C
	LS10	2,14 Ω	C
	SM20	2,51 / 2,40 Ω	C
	LS20	2 Ω	C
LC07	LT01	366,70 Ω	C
	LT02	369,55 Ω	C

Cables verification CM03 at UU			v1
Socket assembly		Verified by :	
Socket name	PID name	Electrical value (Ω) (before shipment)	C / NC
	TT04	66,25	C
	TT05	66,35	C
	TT06	66	NC
	TT07	63,65	NC
LC01	TT08	62,6	C
	TT09	71,4	C
	TT10	106,6	c
	TT11	106,9	C
	TT12	69,5	c
	TT20	106,8	C
	TT21	106,45	C
	TT22	64,35	c
PT Coupler	TT120	107,87	c
	TT220	107,85	c
LC02	EH01	84.6 Ω	c
	EH02	83.9 Ω	C
	EH10	82.5 Ω	C
	EH20	82.4 Ω	C
LC03	SM10	2.3 / 2.3 Ω	C
	LS10	2 Ω	C
	SM20	2.5 / 2.6 Ω	C
	LS20	2.1 Ω	C
LC07	LT01	363,95	c
	LT02	367,55	C

W19&W20: what was performed

W19&20 2021			next next CM	next CM	CM under test
			CM01	**CM03**	**CM05**
THU	06-maj	m	prepared at Orsay		warm up
		a			
FRI	07-maj	m			
		a			
SAT	08-maj				
SUN	09-maj				
MON	10-maj	m			dismount bellows
		a			
TUE	11-maj	m		install TP for insulation vacuum, GHe pressure gauges	docking area
		a			investigation
WED	12-maj	m			
		a			
THU	13-maj	m	longer weekend		
		a			
FRI	14-maj	m			
		a			
SAT	15-maj				
SUN	16-maj				
MON	17-maj	m	ready for shppping to Uppsala	move to bunker	dry N2 to insulation vac
		a		waveguide connection	
TUE	18-maj	m		cryogenic line	doorknob, out-going test
		a		He line's leak test	
WED	19-maj	m		cryogenic bellows	install into the box
		a		insulating vacuum	

Electrosys

Continuous fight against Electrosys including WE

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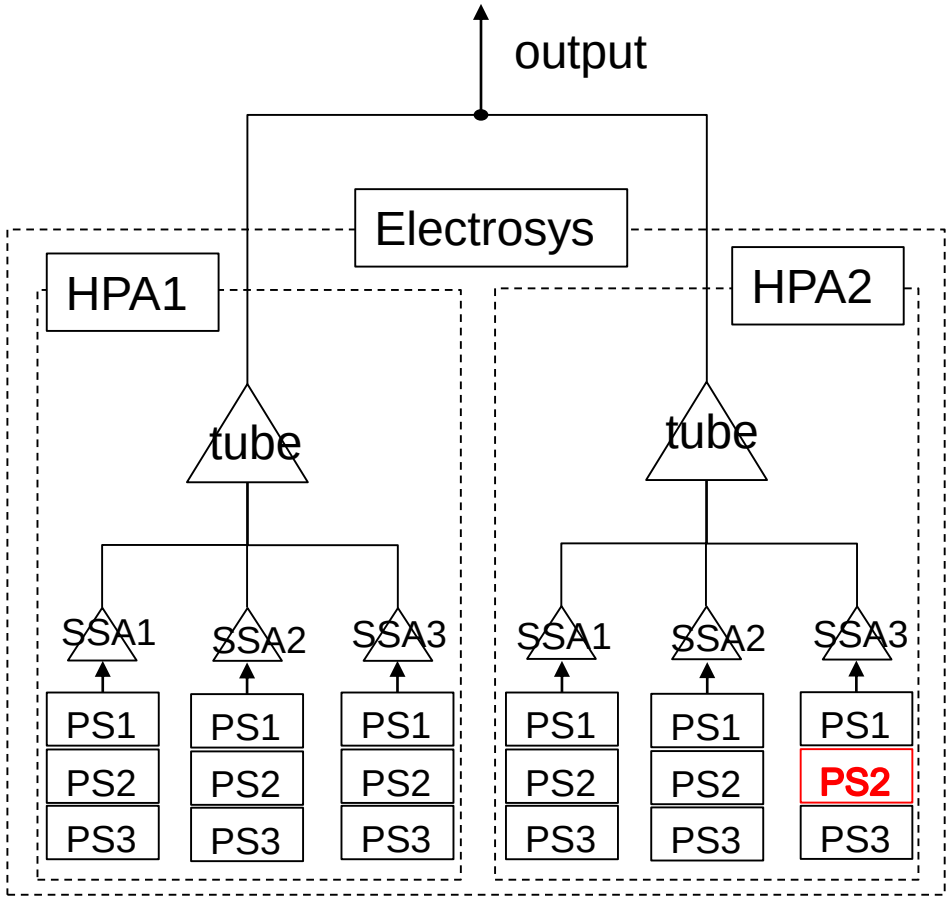
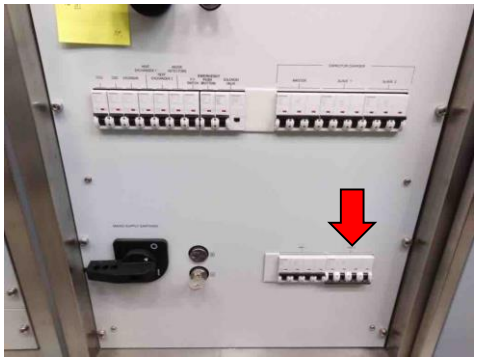
Electrosys→ broken power supply fixed

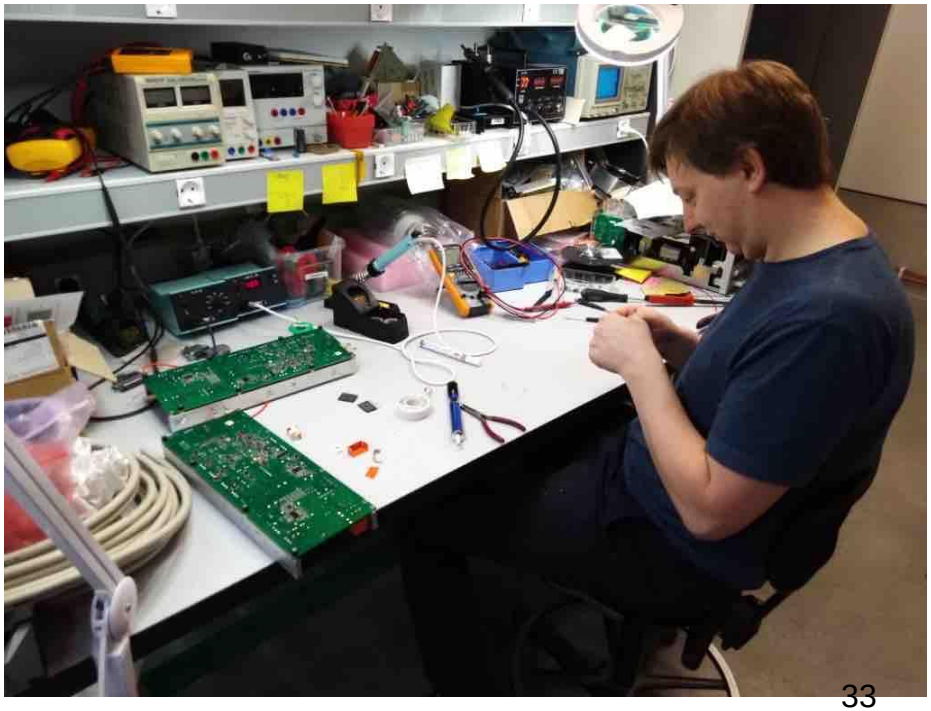


Spare PSs around middle of May are also coming

Issue found in W15

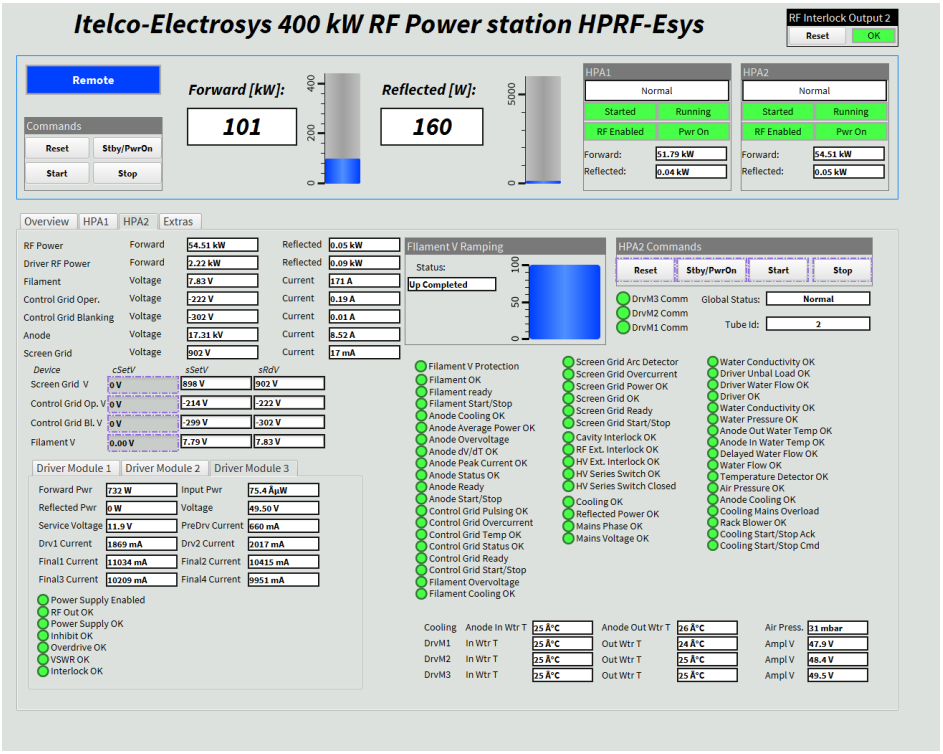


(This error does not trip interlock)

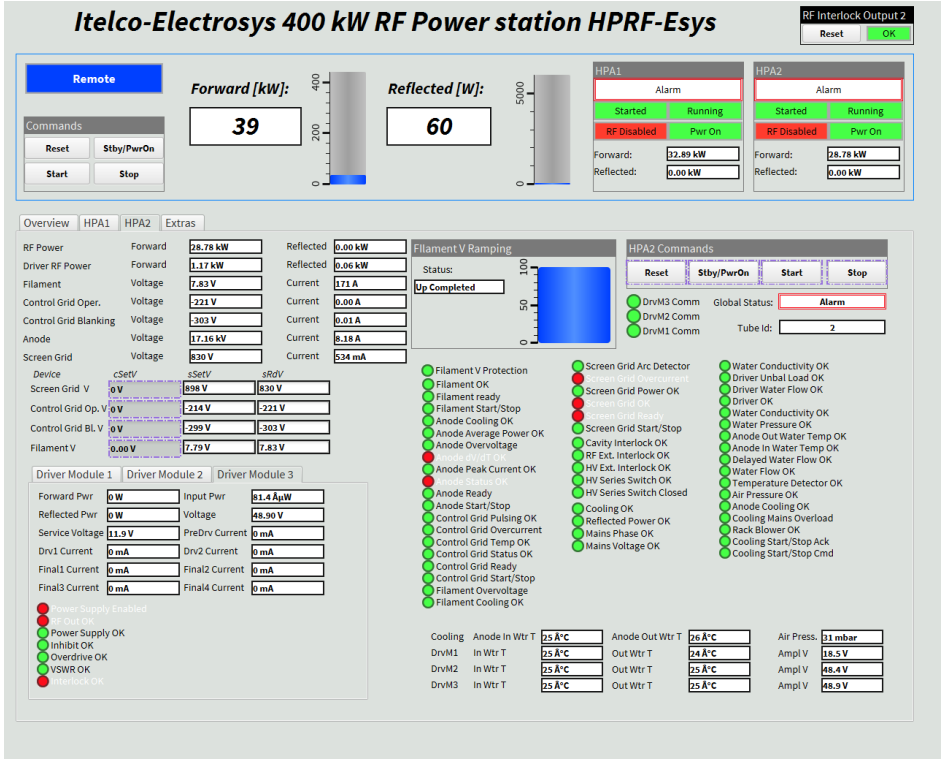


Problem remained

Up to 100kW OK



>100kW discharging sounds



- When HV is rapidly changed, Electrosys tempolarily switches OFF the preamplifier to protect the system
- When power is down → switch ON → discharge → …

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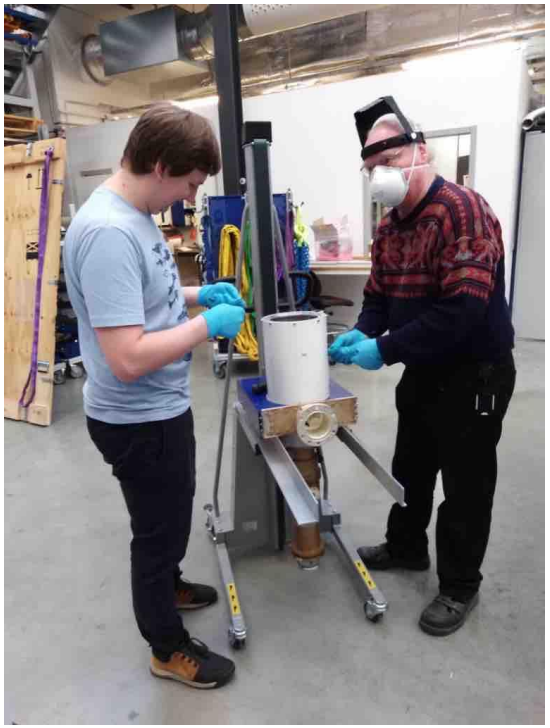
What was the cause?

We have thought…

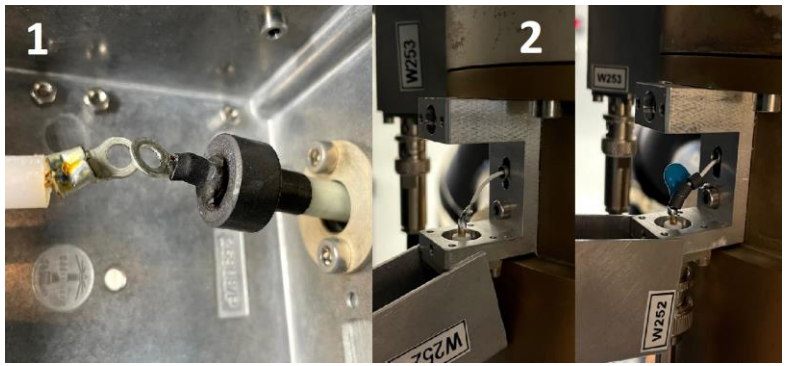
Discharge in tube or cavity → Switch ON/OFF in preamplifier → Power supply damaged

Replace cavity

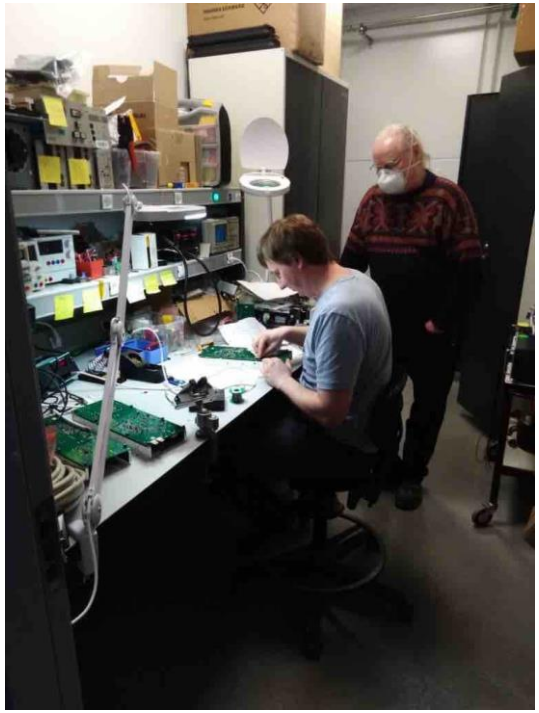


Minor issues identified

1. Overheated HV cable in HPA2 cavity
2. Found missing 1nf capacitor in HPA2 cavity G1 input connector



Two guys sacrificed long WE…

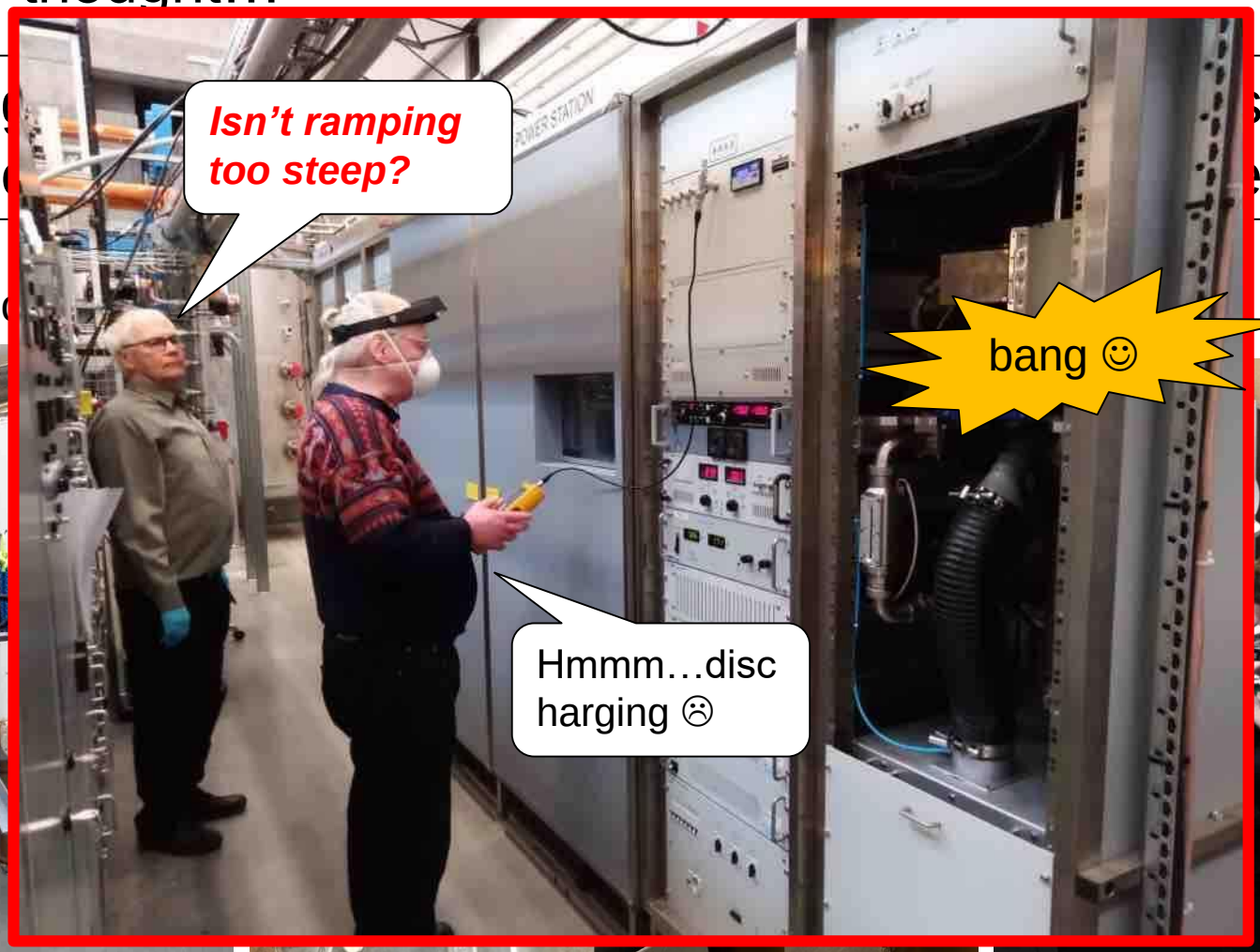


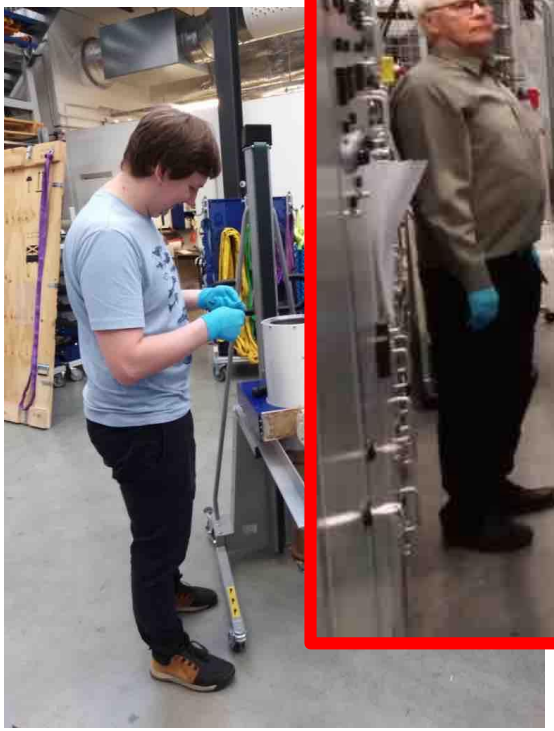
What was the cause?

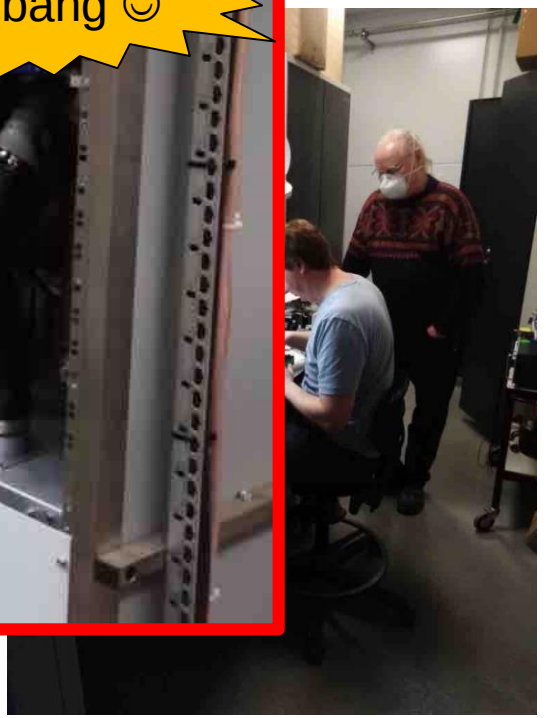
We have thought…

Discharg… supply tube or … ed

Replace … long WE…



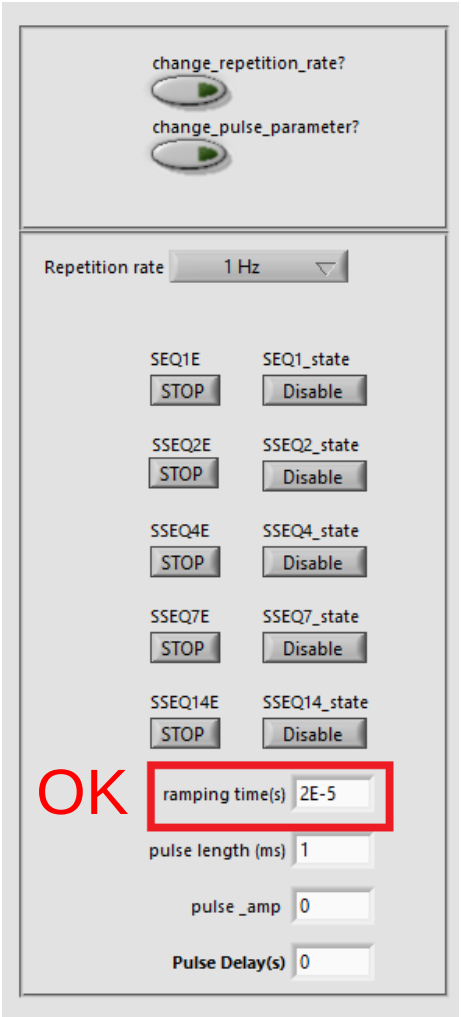




Reality

The software + LLRF for driving Electrosys

The software + LLRF for driving DB station



A wrong default parameter in software

↓

Too fast ramp up of 2 us

↓

Discharge in tube or cavity

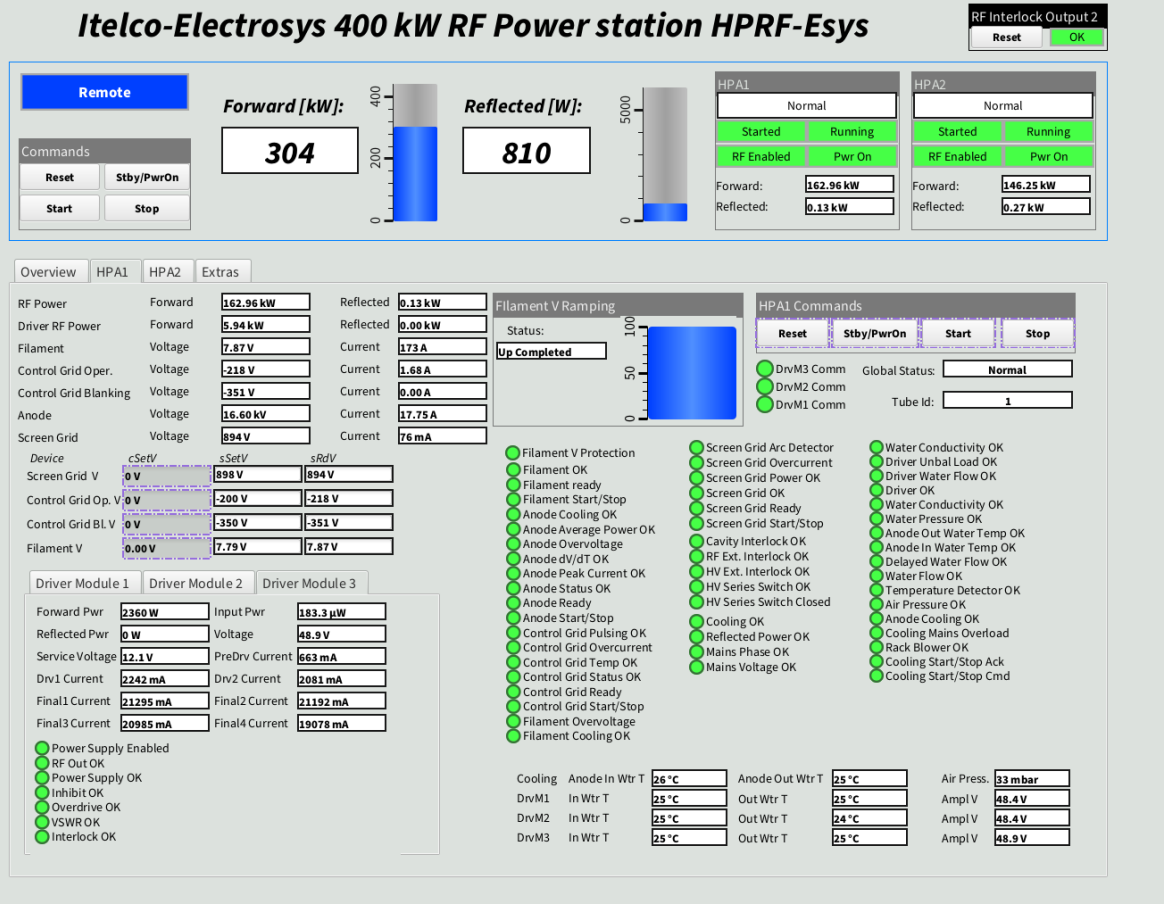
↓

Switch ON/OFF in preamplifier

↓

Power supply damaged

Electrosys back in business



We achieved
Total 344 kW
HPA1 188 kW
HPA2 161kW

We plan to fine tune the cavity

We will change the default ramping time to 20-50 us for all the software

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