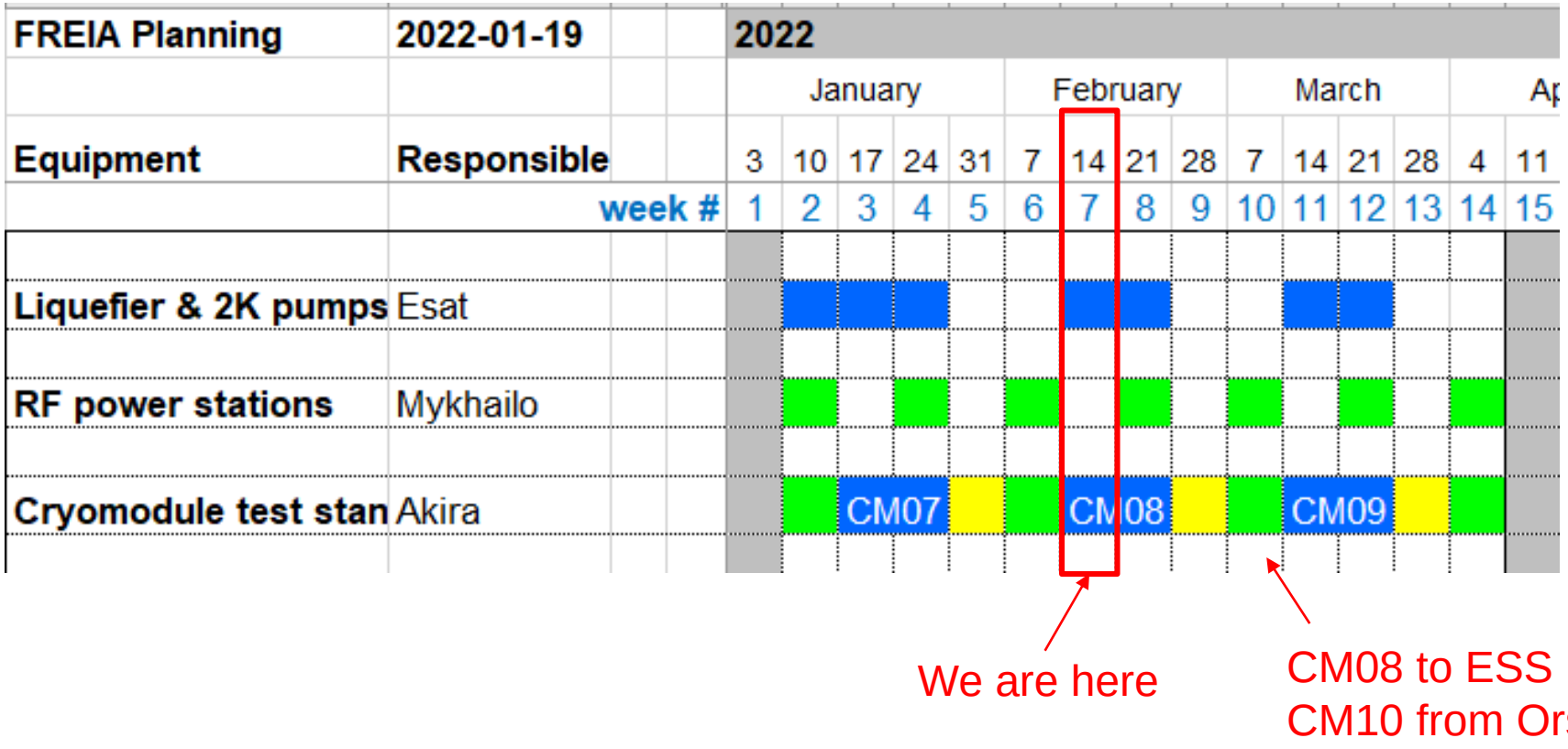
UPPSALA
UNIVERSITET

ESS weekly meeting (2022 W07)

A. Miyazaki et al

General planning: trouble shooting mode



- We found a leak in our flange connection between CM08 and VBox
- We will try to catch up the initial plan and try to be ready on W10

W06 & W07 progress & W08 planning

week		W06													
date		MON		TUE		WED		THU		FRI		SAT	SUN		
		07-feb		08-feb		09-feb		10-feb		11-feb		12-feb	13-feb		
		m	a	m	a	m	a	m	a	m	a				
previous CM	**CM07**	departure to ESS		preparing report				publish report							
present CM	**CM08**	coupler warm conditioning		Electrosys tripped		coupler warm conditioning continued			purging	N2 cooling					
		build concrete blocks on the bunker		change SCHe valve to the original ones		Service in circulation compressor; test valves in requifier		trouble shooting		start liquifier to fill the Dewar					
next CM	**CM09**	departure from Orsay		transport from Orsay				arrival at UU		reception test					

week		W07													
date		MON		TUE		WED		THU		FRI		SAT	SUN		
		14-feb		15-feb		16-feb		17-feb		18-feb		19-feb	20-feb		
		m	a	m	a	m	a	m	a	m	a				
present CM	**CM08**	LHe cooling	leak between insulation vac and Lhe	warming up		leak test		reconnect cryolines		coupler conditioning	start LN2 cooling				
next CM	**CM09**				reception test VNA										

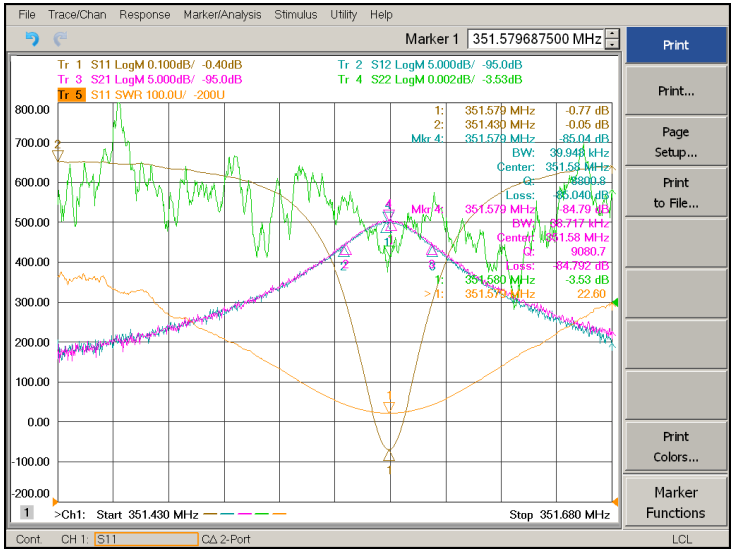
We are here

week		W08											
date		MON		TUE		WED		THU		FRI		SAT	SUN
		21-feb		22-feb		23-feb		24-feb		25-feb		26-feb	27-feb
		m	a	m	a	m	a	m	a	m	a		
present CM	**CM08**	LHe cooling		4K filling	coupler conditioning	2K pumping	RF calibration & interlock setup	CTS		MP conditioning	heat load	warming up	
next CM	**CM09**	doorknob mounting											
next next CM	**CM10**	preparation at Orsay											

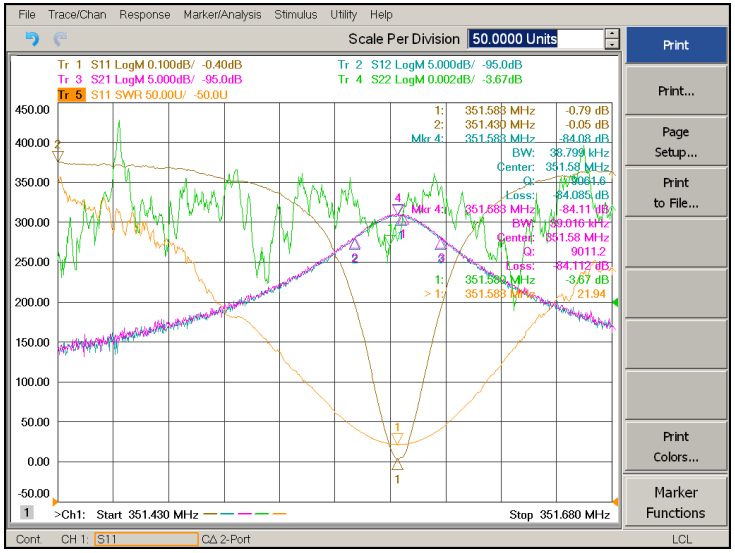
Try to compensate the delay

CM09 reception tests

CAV IN



CAV OUT



LHe level gauge does not touch the ground

Cables verification CM09 at UU					v1
Socket assembly				Verified by :	
Socket name	***Sensor / Actuator type***	***PID name***	***Serial number***	***Electrical value (Ω) (before shipping)***	***C / NC***
LC01	Cernox	TT04	X138367	***58,4***	C
	Cernox	TT05	X133137	***56,95***	C
	Cernox	TT06	X133621	***57,45***	C
	Cernox	TT07	X133178	***58,5***	C
	Cernox	TT08	X133616	***54,9***	C
	Cernox	TT09	X138366	***58,7***	C
	PT100	TT10	PT62	***106,25***	C
	PT100	TT11	PT57	***106,2***	C
	Cernox	TT12	X138368	***73,3***	C
	PT100	TT20	PT66	***105,8***	C
	PT100	TT21	PT69	***105,95***	C
	Cernox	TT22	X138365	***69,4***	C
PT Coupler	PT100	TT120	PTC31	108	C
		TT220	PTC32	107	C
LC02	Heaters	EH01	EH08	***82,5***	C
		EH02	EH09	***84,2***	C
		EH10		***83,9***	C
		EH20		***82,5***	C
LC03	Motor sensor	SM10		2.2 / 2.3	C
	a limit sensor	LS10		4,6	C
	Motor sensor	SM20		2.2 / 2.2	C
	a limit sensor	LS20		1,9	C
LC07	Liquid Helium Level Sensor	LT01	7343	367,75	C
		LT02	7345	365,65	C
Socket name	***Sensor / Actuator type***	***PID name***	***Serial number***	***Electrical value (µF) (before shipment)***	***C / NC***
LC04	Actuators	PZ10		14,01	C
		PZ11		14,25	C
		PZ20		13,95	C
		PZ21		14,06	C

After delivery @ UU

Measured values (Ω)	C / NC
2,8	C
3,2	C

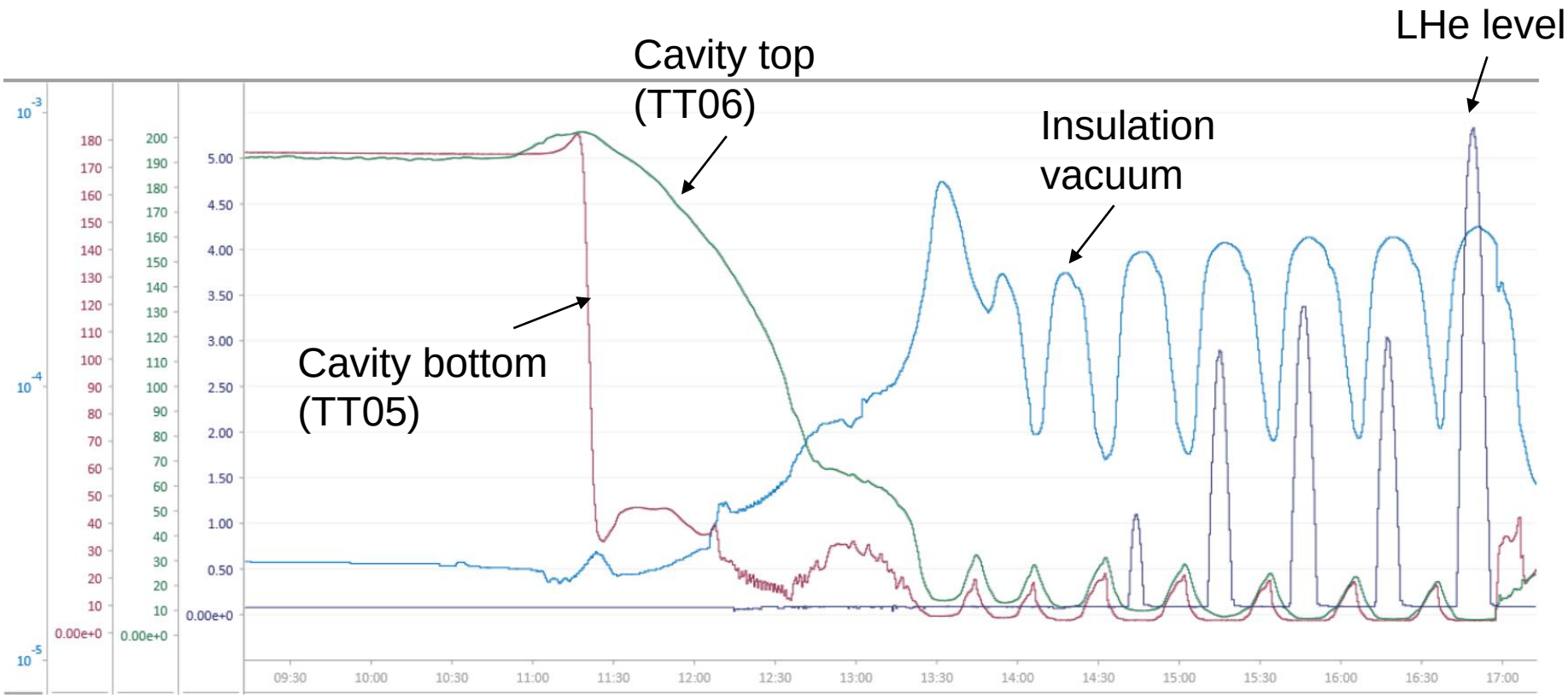
VACUUM GAUGE OF CAVITY STRING AT UU

Date	Time	Pfeiffer TPG2020 (mbar	Limit	Name of controller
2022-02-10	14:50	2,00E-03	1,00E-01	C. Svanberg
2022-02-11	09:00	1,90E-03	1,00E-01	C. Svanberg
2022-02-14	08:45	2,00E-03	1,00E-01	C. Svanberg
2022-02-15	08:50	2,10E-03	1,00E-01	C. Svanberg
2022-02-16	09:00	2,10E-03	1,00E-01	C. Svanberg

Part I: leak found in CM08 at cold

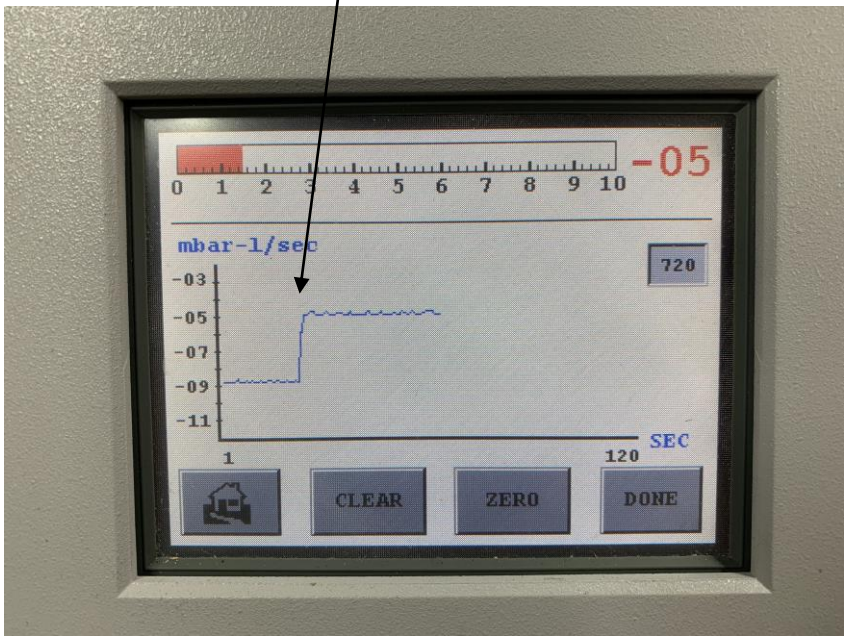
Observation

- Leak (1e-4 --1e-3 mbar) was observed in insulation vacuum
- The leak seems correlated to the bottom temperature and LHe level inside the cryomodule

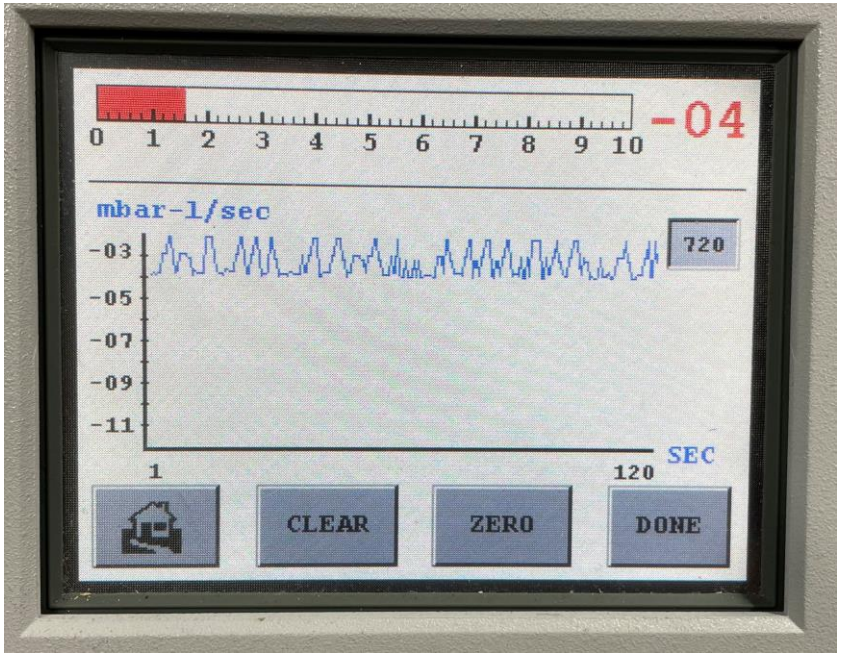


helium signal by the leak detector (at cold)

Open the angle valve between the leak detector and insulation vacuum



After while
Max leak 1e-3 mbar*L/sec

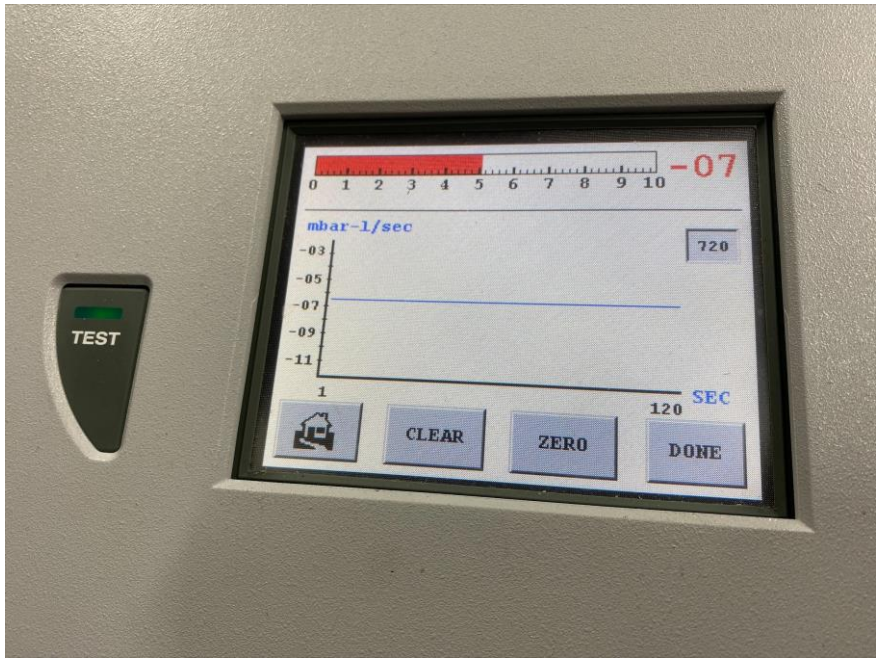


(He circuit **1100 mbar; 4K cooling phase**)

→ We decided to warm up the module

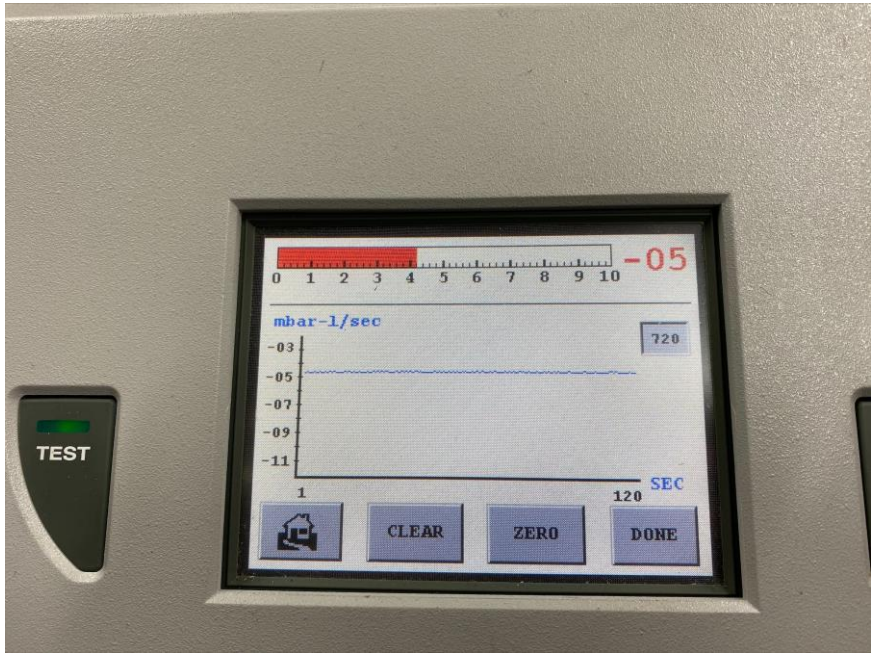
Small He leak confirmed at warm

He circuit **30 mbar**
insulation vacuum 1e-4 mbar



Leak 1e-7 mbar*L/sec

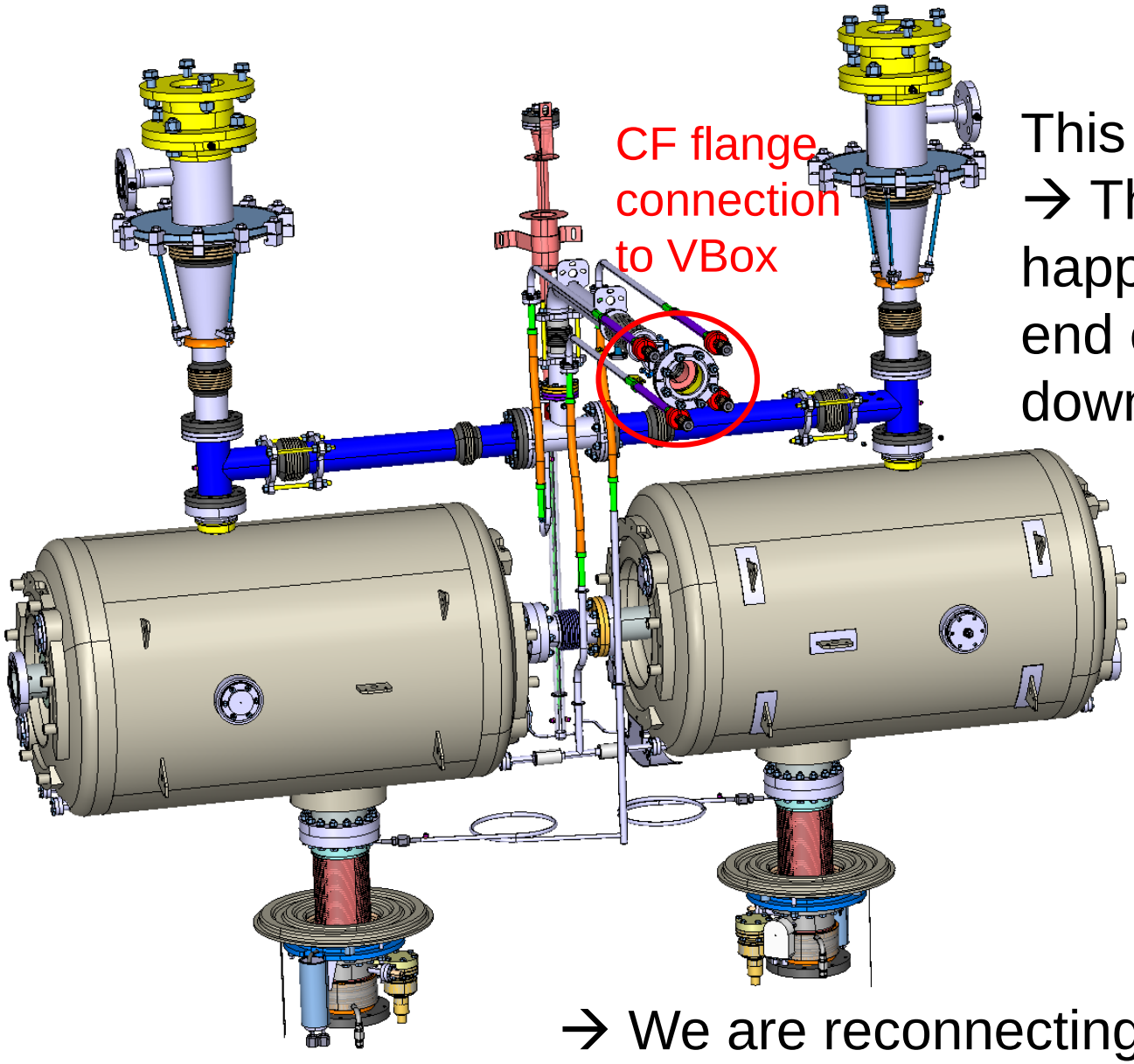
He circuit **1175 mbar**
insulation vacuum 1e-4 mbar



Leak 1e-5 mbar*L/sec

Leak rate is smaller (1e-3 → 1e-5 mbar*L/sec) than at cold but it is proportional to the differential pressure
→ Leak exists also at warm

Where was the leak?



This is GHe exhaust
→ Thermal shrinkage happens at the very end of the cooling down process

→ We are reconnecting this part

Procedure: leak test before cooling down

Connect beam vacuum

↓

Check with a leak detector

↓

Open the angle valve

↓

Connect cryogenic lines

↓

Pressurize the He circuit
- Check beam vacuum via RGA
- Check pressure drop in the He circuit

↓

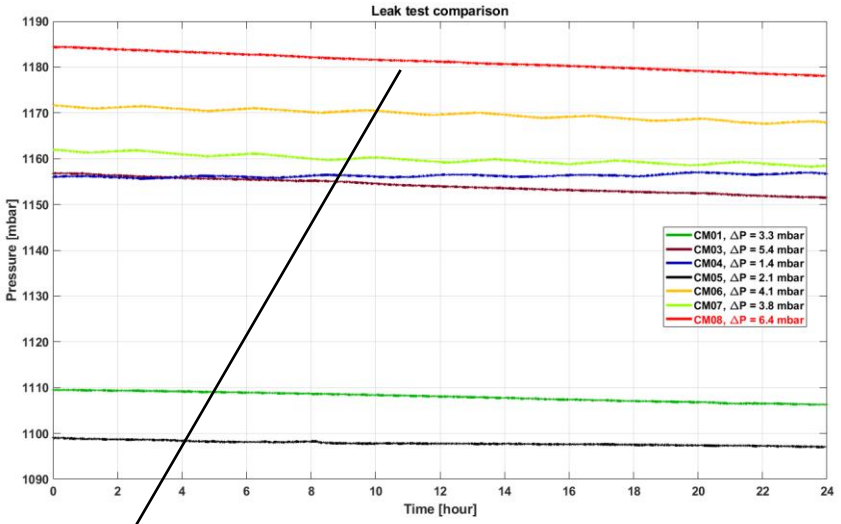
Close the bellows and pump the insulation vacuum

↓

Continue pumping to remove humidity and reach <1e-4 mbar

↓

Start LN2 cooling



Pressure drop in CM08 was larger than other modules but was not that much

← Usually dominated by leaky valves and insulation vacuum is still not closed at this stage

← Humidity contaminated our leak detector so we decided not to use it here. Instead, we judge no leak just by the vacuum reach

Add leak detection phase

Connect beam vacuum

Check with a leak detector

Open the angle valve

Connect cryogenic lines

Pressurize the He circuit
- Check beam vacuum via RGA
- Check pressure drop in the He circuit

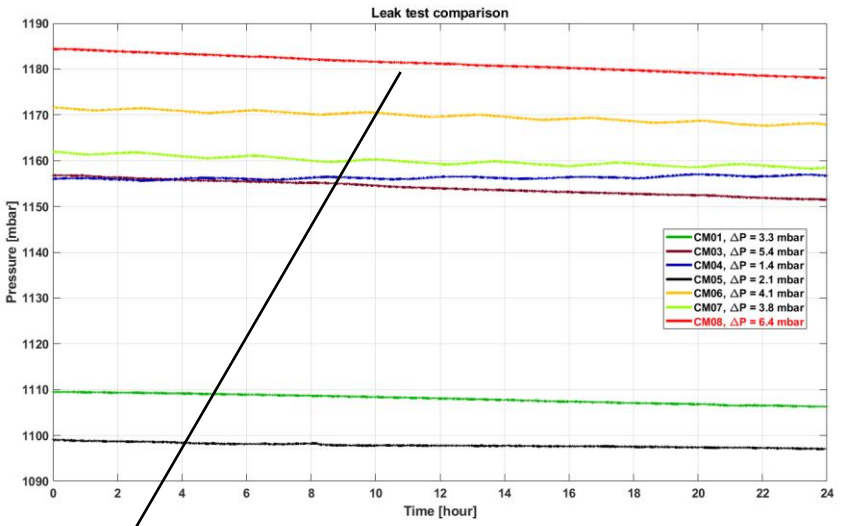
Close the bellows and pump the insulation vacuum

Continue pumping to remove humidity and reach <1e-4 mbar

~2-3 days

Connect the leak detector to the insulation vacuum

Start LN2 cooling



Pressure drop in CM08 was larger than other modules but was not that much

← Usually dominated by leaky valves and insulation vacuum is still not closed at this stage

No impact to the planning (W08, 09, 10)

week		W08															
date		MON		TUE		WED		THU		FRI		SAT		SUN			
		21-feb		22-feb		23-feb		24-feb		25-feb		26-feb		27-feb			
		m	a	m	a	m	a	m	a	m	a						
present CM	**CM08**	LHe cooling		4K filling	coupler conditioning	2K pumping	RF calibration & interlock setup	CTS		MP conditioning	heat load	warming up					
next CM	**CM09**	doorknob mounting															
next next CM	**CM10**	preparation at Orsay															

We might need to work on Saturday

week		W09															
date		MON		TUE		WED		THU		FRI		SAT		SUN			
		28-feb		01-mar		02-mar		03-mar		04-mar		05-mar		06-mar			
		m	a	m	a	m	a	m	a	m	a						
previous CM	**CM08**	warming up completed / open the bunker		disconnect cryogenics	swap modules	N2 filling		out going test		out going test		waiting in the box					
present CM	**CM09**					connect cryogenics		connect vacuum pumps		pumping vacuum							
next CM	**CM10**	preparation at Orsay								departure from Orsay		transport					

week		W10															
date		MON		TUE		WED		THU		FRI		SAT		SUN			
		07-mar		08-mar		09-mar		10-mar		11-mar		12-mar		13-mar			
		m	a	m	a	m	a	m	a	m	a						
previous CM	**CM08**	waiting in the box		departure to ESS		preparing report		publish report									
present CM	**CM09**	coupler warm conditioning								purging		N2 cooling					
next CM	**CM10**	transport from Orsay						arrival at UU		reception test							

Part II: TH595A in DB stations

Two broken tubes in the DB station (Sep 2021)

DB-A
595A 907196
4800 hours with filament ON
Since March 2020

DB-B
595A 901204
4800 hours with filament ON
Since September 2019

- Few crowbar events happened from the beginning of the series CM tests (Nov 2020)
- Crowbar became more and more frequent over time (typically after May 2021)
- Crowbar became permanent without RF only with HV (Sep 2021)
- Crowbar logic was shared by the sections and we could not identify which one was first
- We first replaced 901204 in DB-B with a virgin new spare 912223
  → Crowbar in was still there but less frequent
- We also replaced 907196 in DB-A with a virgin new spare 916278
  → Crowbar in has never happened again

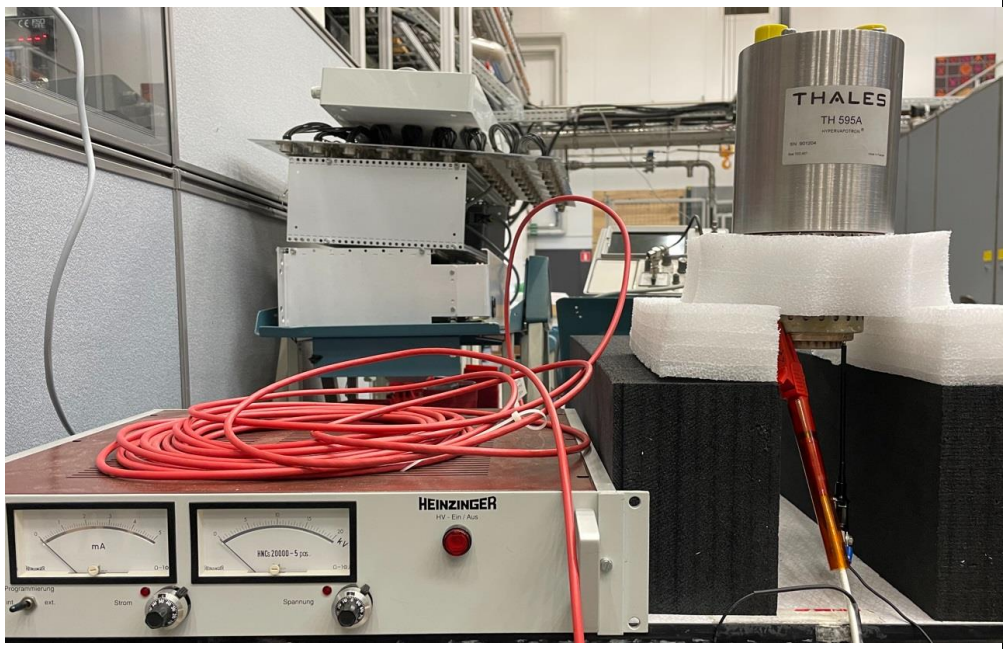
→ **Conclusion: both were dead**

901204 test @ FREIA outside the station

Capacitance

	THALES	This test
K-G1	117 pF	126.2 pF
G1-G2	246 pF	259.0 pF
G2-A	19 pF	23.2 pF

No problem
(constant off-set from our multimeter)



HV test at room temperature

	THALES*		This test	
	HV	current	HV	current
K+/G1-	2 kV	<1 uA	2 kV	0
G1+/G2-	1.5 kV	< 6 uA	**1 kV**	**> 400 uA**
G2+/A-	20 kV	12 uA	20 kV	0

*from TH595 755307 test report

Conditioning

Several cycles of applying HV in G1-G2 max 1.5 kV for 3 hours

→ **Dark current in G1-G2 disappeared (<10 uA)**

→ The tube was sent back THALES

901204 test @ THALES

	THALES	
	HV	current
K+/G1-	2 kV	<5 uA
G1+/G2-	**1.5 kV**	**< 5 uA**
G2+/A-	35 kV	<10 uA

← THALES reproduced our results ***after*** the conditioning

They forgot water cooling and destroyed the tube during the filament test

→ No test with HV + filament ON + RF

<u>Conclusion</u>

- THALES reproduced our results after the conditioning
- We did not have a chance to check if the conditioning was also effective with filament ON + HV + RF
- The conditioning might just hide the issue only at cold

→ Systematic and careful test is required

907196 test @ FREIA outside the station

Capacitance

	THALES	This test
K-G1	128 pF	126.9 pF
G1-G2	243 pF	244.9 pF
G2-A	20.5 pF	22.5 pF

No problem

HV test at room temperature

	THALES*		This test	
	HV	current	HV	current
K+/G1-	2 kV	<1 uA	800 V	0.5 uA
G1+/G2-	1.5 kV	< 6 uA	**600 V**	**58.3 uA**
G1-/G2+	-	-	**800 V**	**0**

*from TH595 755307 test report

- Polarity dependence observed
- Dark current slowly decreased with constant HV
- We stopped the test to avoid conditioning of this tube

→ The tube still preserves the problematic status

Agreement with THALES

- The FREIA lab team was glad to receive this clarification and their concerns are now clearer. It is our mutual conclusion, that there wasn´t any issues with the returned tube ref. 901204:
  - FREIA applied a conditioning (hi-pot) on the tetrode which could explain that Thales doesn't identified any defect
  - Thales has observed no cracks on the ceramic and the coma stains disappeared after Thales cleaning. The stains are probably due to a metallic contact (maybe during the installation of the tetrode?)
  - Only one arc observed on the top of G2 grid, but the root cause is probably the crowbar firing (FREIA) or the disjunction on the equipment failure (Thales). This arc root cause is not due to a potential tetrode defect
  - FREIA said that a second tetrode have the same kind of issue. Freia will test the tetrode (HV insulation test) and will send the results to Thales. A discussion will be conducted (Thales/FREIA) and the decision will be discussed concerning a potential treatment (conditioning)

- The report was sent to THALES on Feb 4th 2022 but they have not answered yet
- My suggestion is to check everything as much as we can at FREIA before transportation to THALES and add more witnesses (from ESS)
- We have not applied extensive conditioning yet because it might just hide the issues at cold
- However, we could also perform the conditioning and mount the tube back to DB station and see what happens
  - If the crowbar issue does not happen, this conditioning can be a solution

→ We need a strategical decision making among ESS, THALES, and FREIA