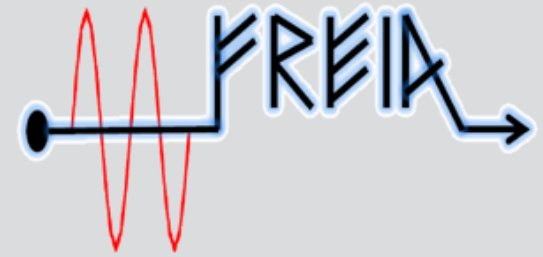


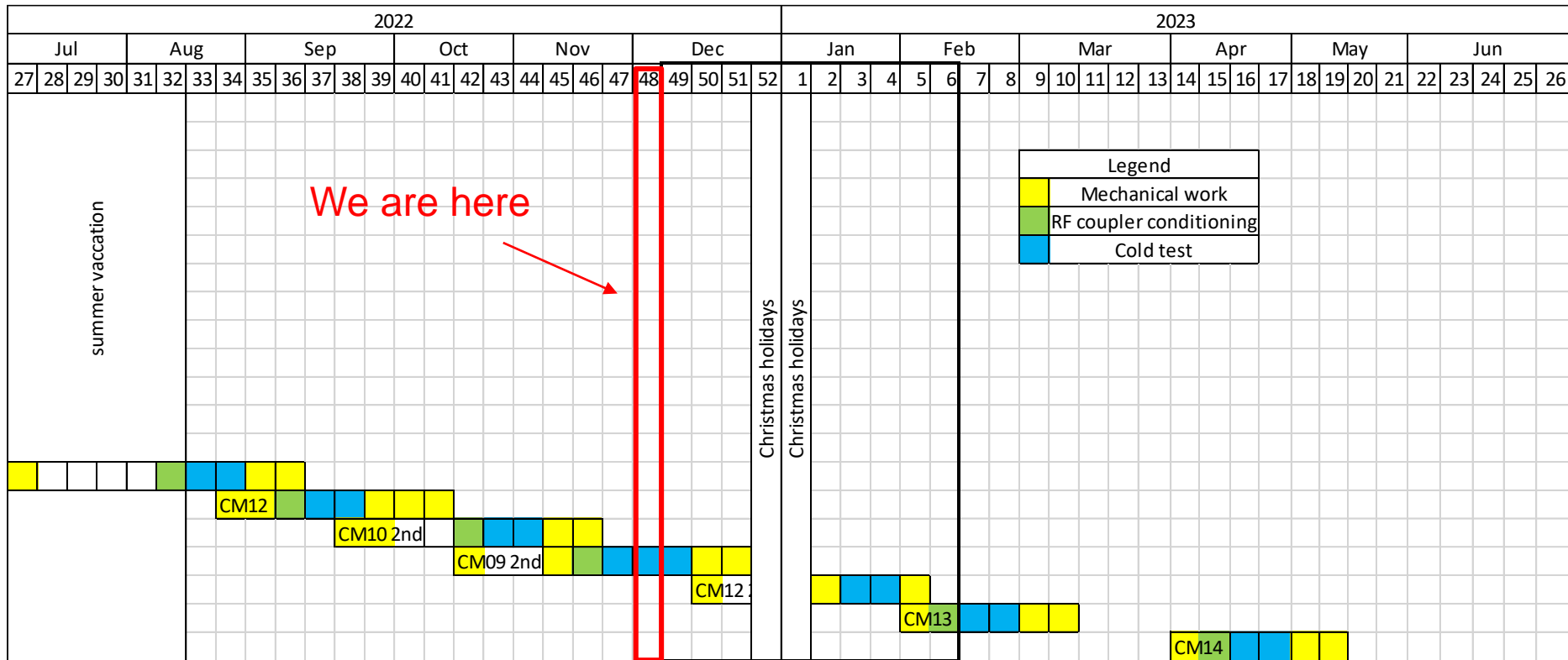


UPPSALA
UNIVERSITET



ESS weekly meeting (2022 W48)

A. Miyazaki et al



- CM09 (2nd) has been prepared for the cold test
 - Coupler conditioning was OK
 - Cooling down to 2 K was OK
- Cryogenics was unstable (low LHe production rate) → decided to do thermal cycle
- The potential leak signal at A/q=4 was identified when the cavities reached 13 K
 - The same signal why we wanted to cool down CM12 again



CM09: progress and planning



week		W46											
date		MON		TUE		WED		THU		FRI		SAT	SUN
		14-nov		15-nov		16-nov		17-nov		18-nov		19-nov	20-nov
		m	a	m	a	m	a	m	a	m	a		
previous CM	CM10		N2 filling	Outgoing test		departure to ESS		report writing	publish report				
present CM	CM09	prepare power stations, RF calibrations		coupler conditioning at warm						LN2 cooling			

week		W47											
date		MON		TUE		WED		THU		FRI		SAT	SUN
		21-nov		22-nov		23-nov		24-nov		25-nov		26-nov	27-nov
		m	a	m	a	m	a	m	a	m	a		
present CM	CM09	start LHe cooling		4K filling		2 K pupming	going to 4K and then standby, LN2 line blocked	standby operation to fill up the 4 K Dewar --> A/q=4 signal found		4 K filling	thermal cycle to confirm A/q=4 signal	standby to fill up 4 K Dewar	

We are here

week		W48											
date		MON		TUE		WED		THU		FRI		SAT	SUN
		28-nov		29-nov		30-nov		01-dec		02-dec		03-dec	04-dec
		m	a	m	a	m	a	m	a	m	a		
present CM	CM09	stand-by operation		4 K filling		ESS's leak detector was connected, background leak rate is being pumped		leak test at cold with ESS' leak detector					

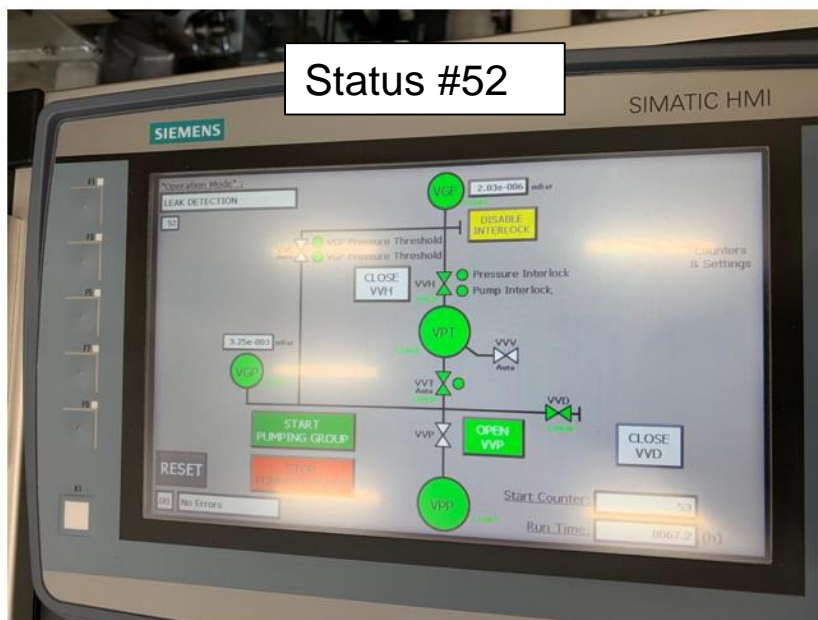
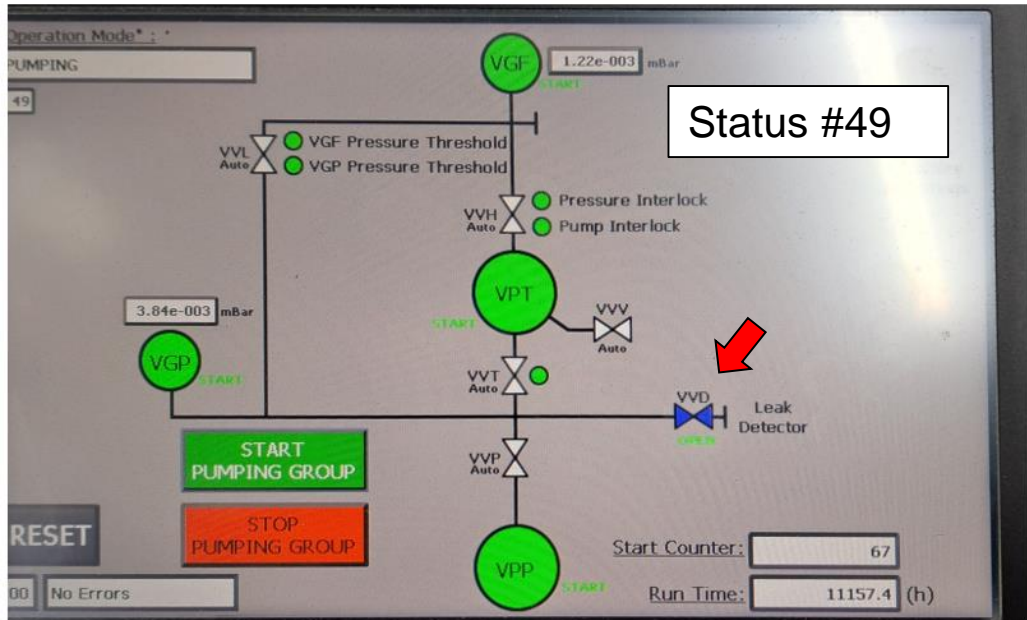
week		W49											
date		MON		TUE		WED		THU		FRI		SAT	SUN
		05-dec		06-dec		07-dec		08-dec		09-dec		10-dec	11-dec
		m	a	m	a	m	a	m	a	m	a		
present CM	CM09	2K pumping	calibration interlock	CTS test		MP conditioning / heat load measurement		start warming up		vent insulation vacuum	warming up		

week		W50											
date		MON		TUE		WED		THU		FRI		SAT	SUN
		12-dec		13-dec		14-dec		15-dec		16-dec		17-dec	18-dec
		m	a	m	a	m	a	m	a	m	a		
present CM	CM09	warming up completed	vacuum cryolines disconnected	docking area		N2 filling		out going test		waiting in the box			
next CM	CM12					departure from ESS (?)		arrival at FREIA (?)					

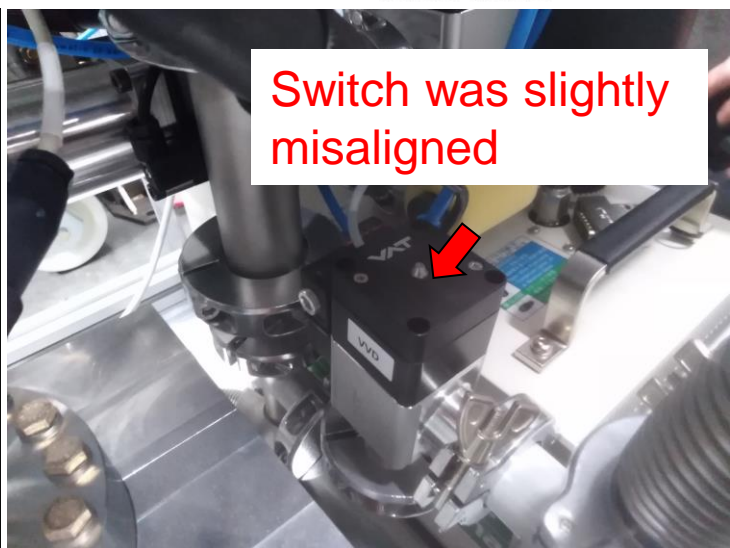
Goal of CM09

week		W51											
date		MON		TUE		WED		THU		FRI		SAT	SUN
		19-dec		20-dec		21-dec		22-dec		23-dec		24-dec	25-dec
		m	a	m	a	m	a	m	a	m	a		
present CM	CM09	departure to ESS (?)		arrival at ESS (?)		report writing		publish report					
next CM	CM12	going to the bunker. Vacuum and cryogenic connections											

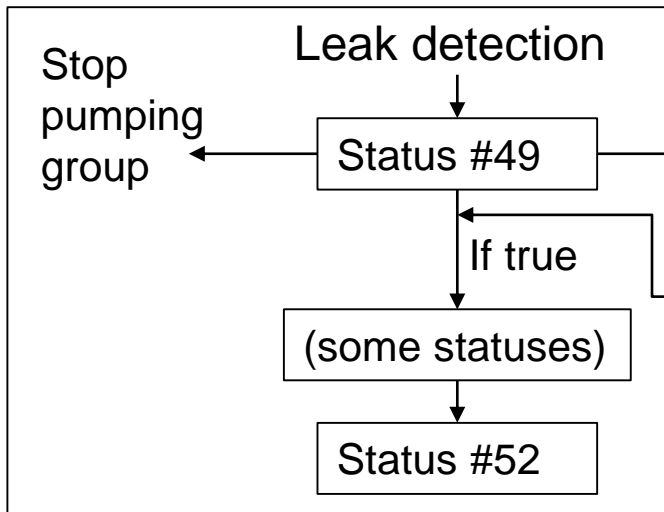
A minor issue in the ESS pumping station



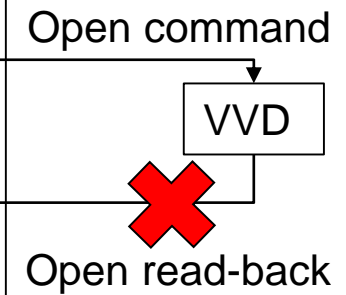
Where we are



Control system



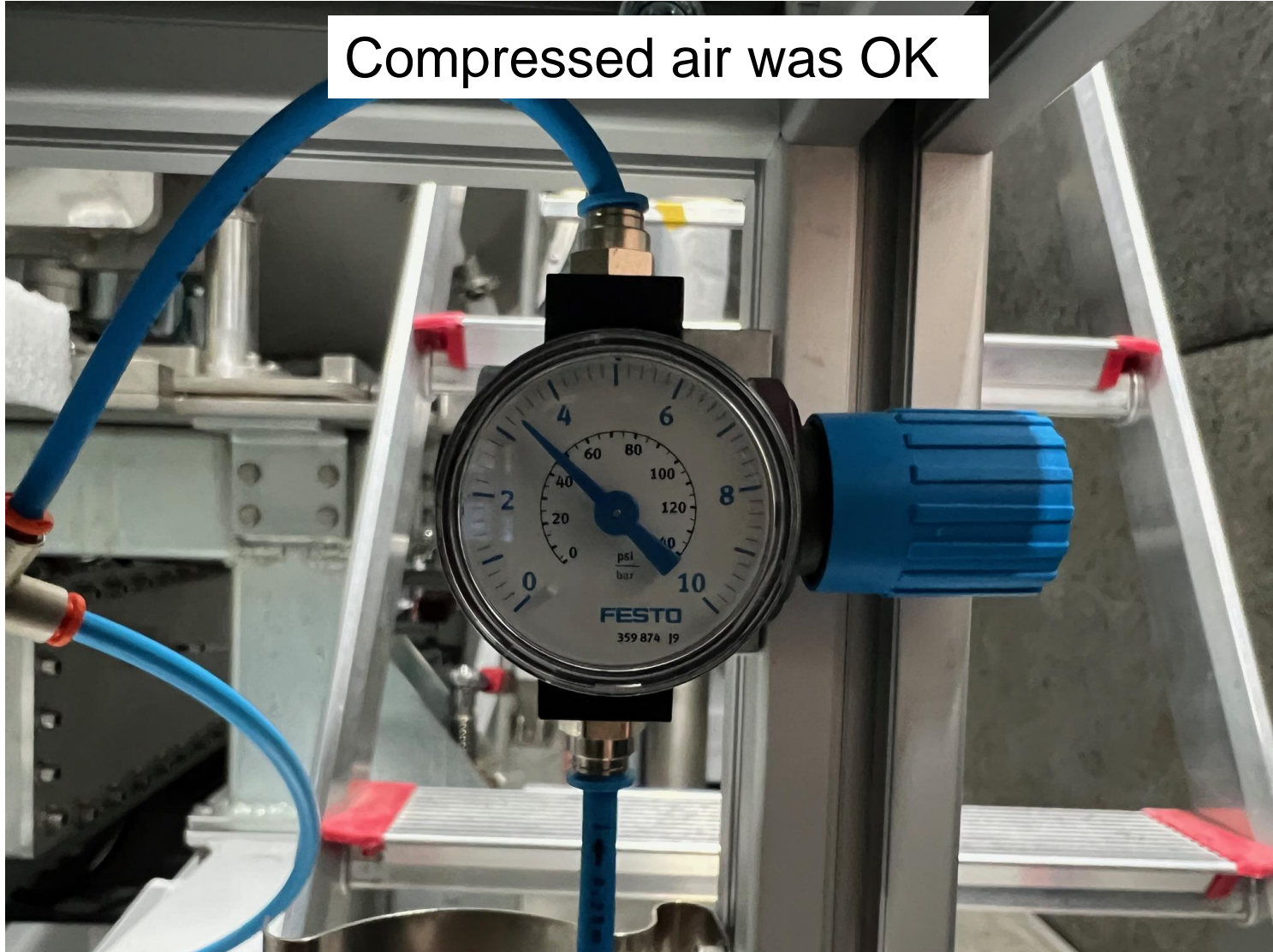
What we want



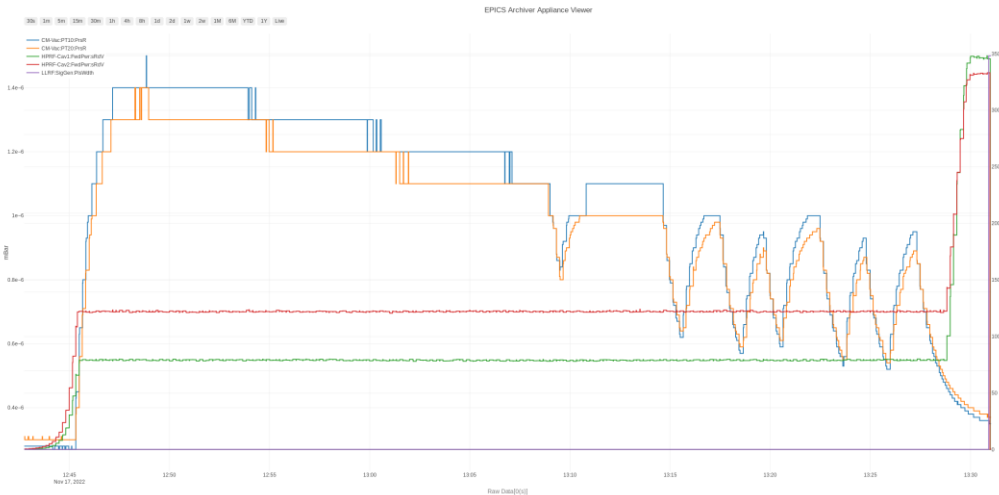
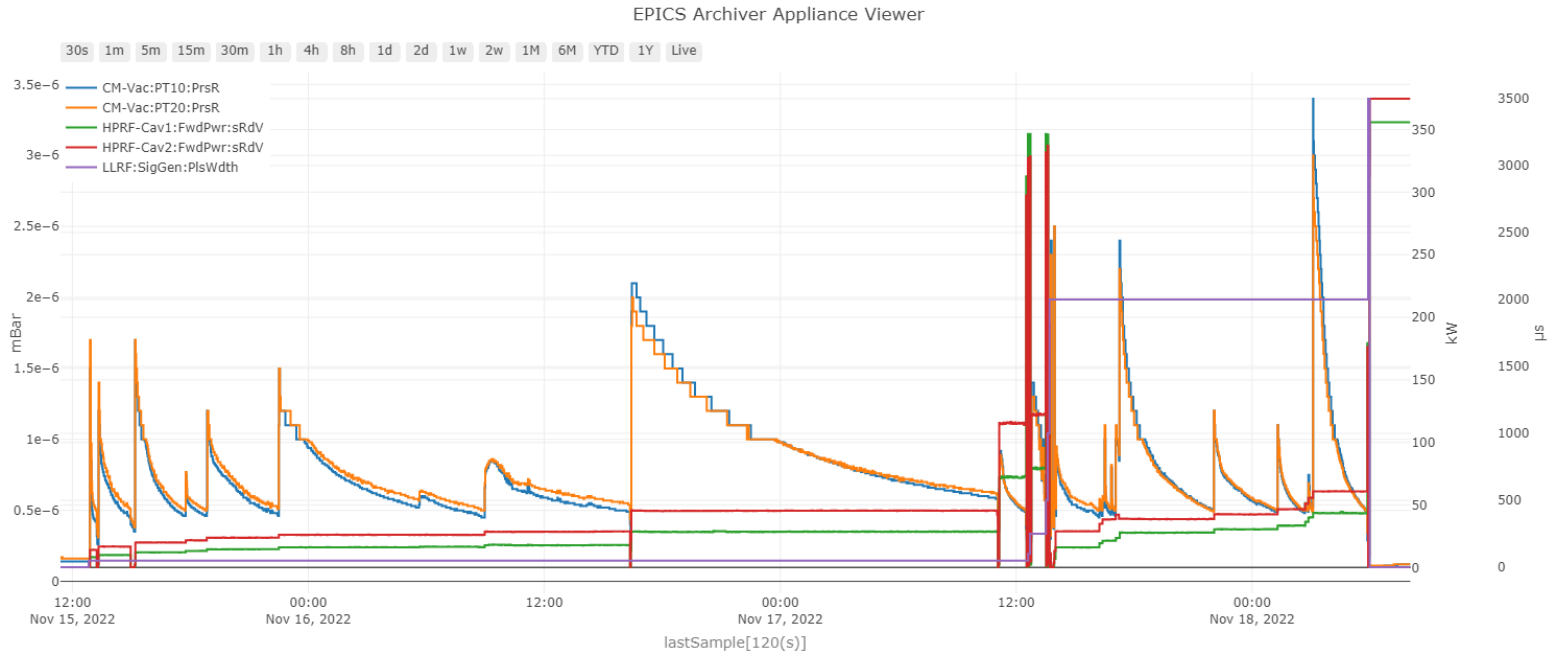
The valve was opened without the read-back



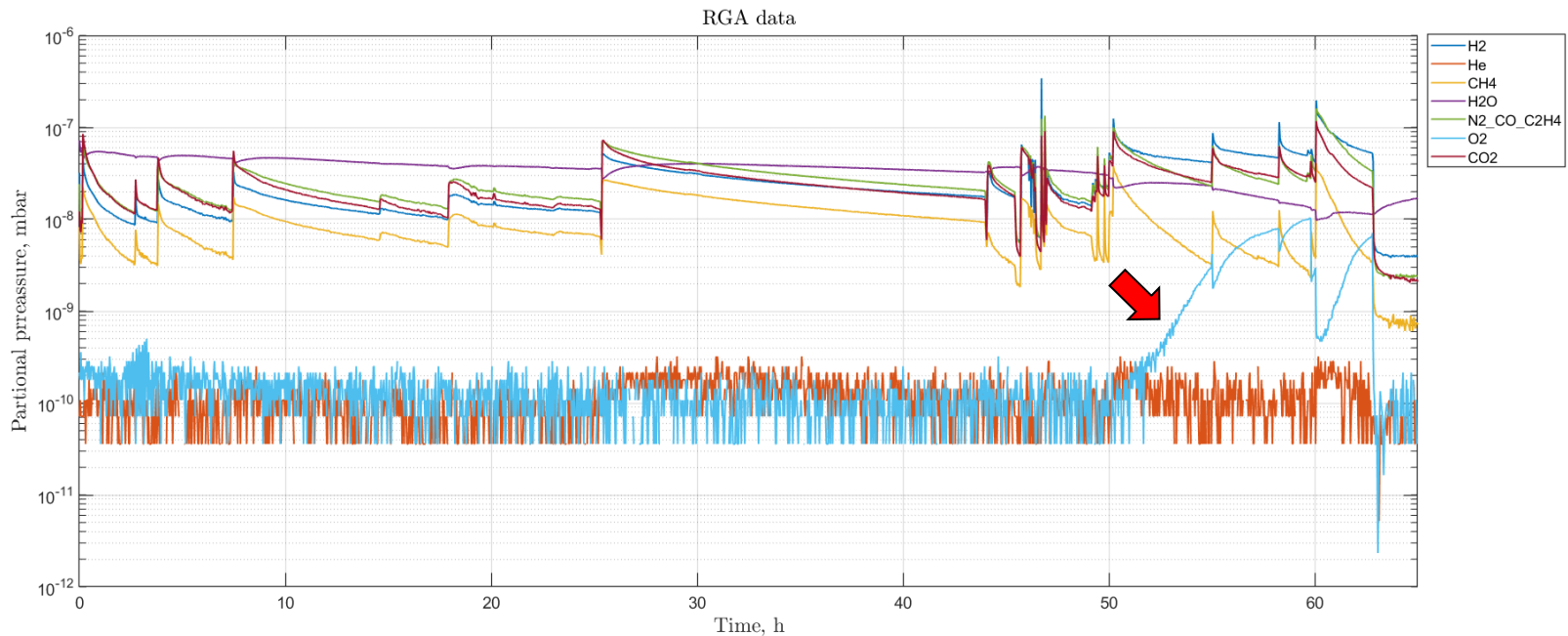
Compressed air was OK



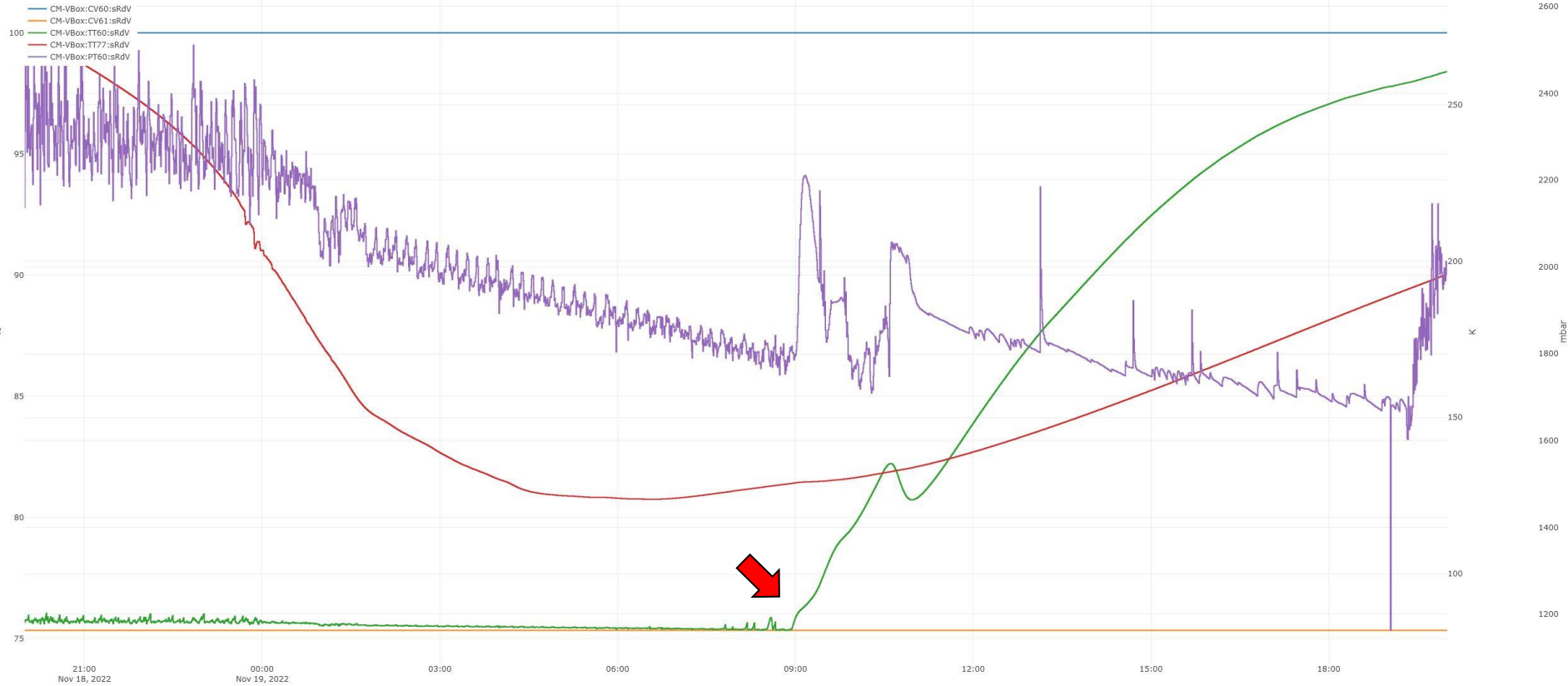
We manually touch the button and corrected the alignment ⁵



- Strange oscillations in the beam vacuum were observed
- Not correlated to RF power

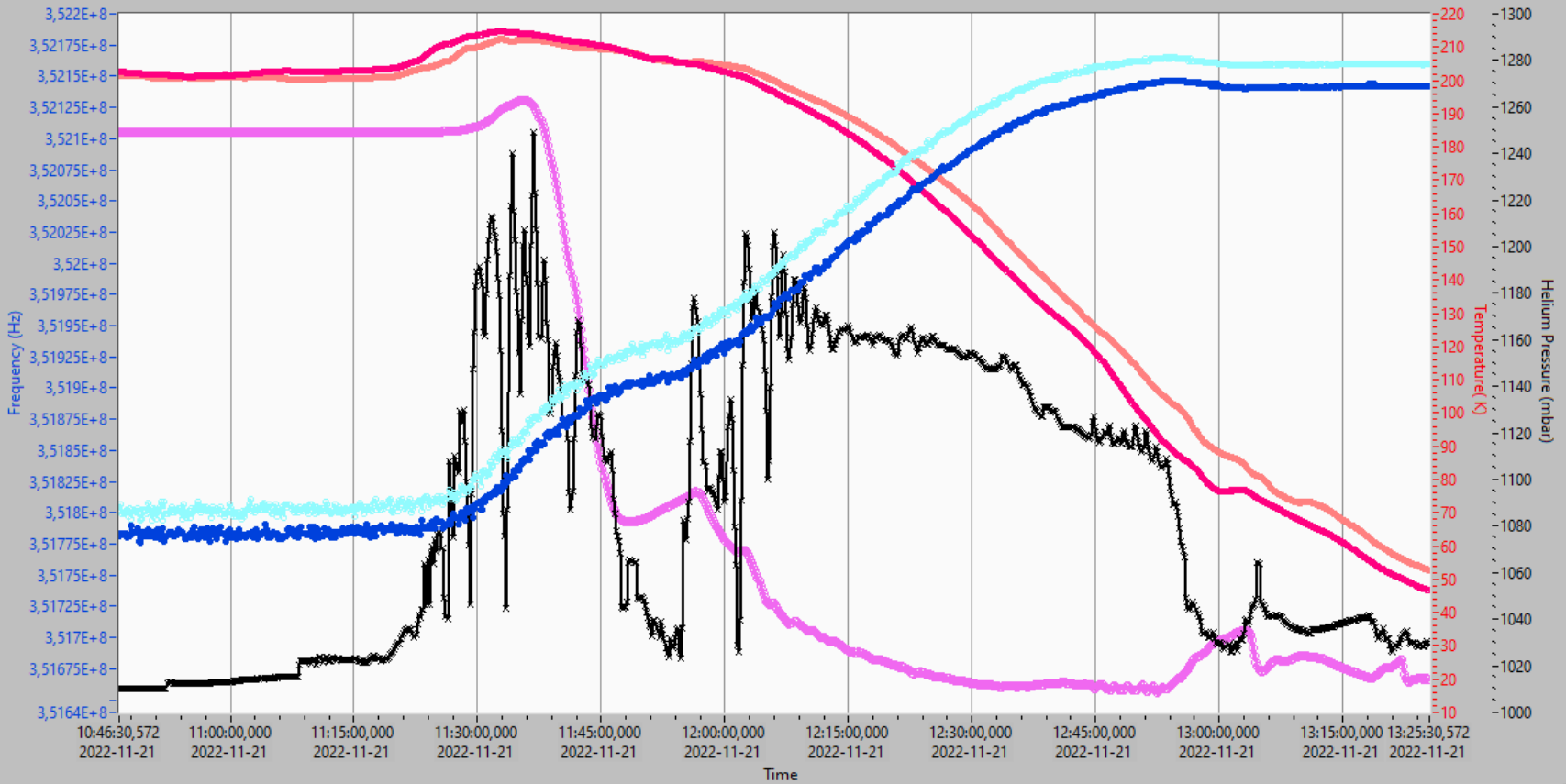
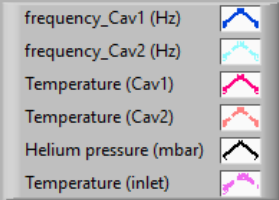
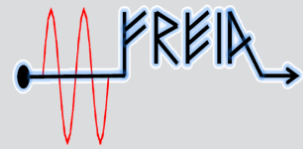


- O2-like signal appeared at longer pulse lengths
- This O2-like signal and H2O signal are anti-correlated to other molecules
- This was observed in some of other modules but the others showed O2-like signal even from the beginning
- (hopefully not a sign of leak opened by RF power...)

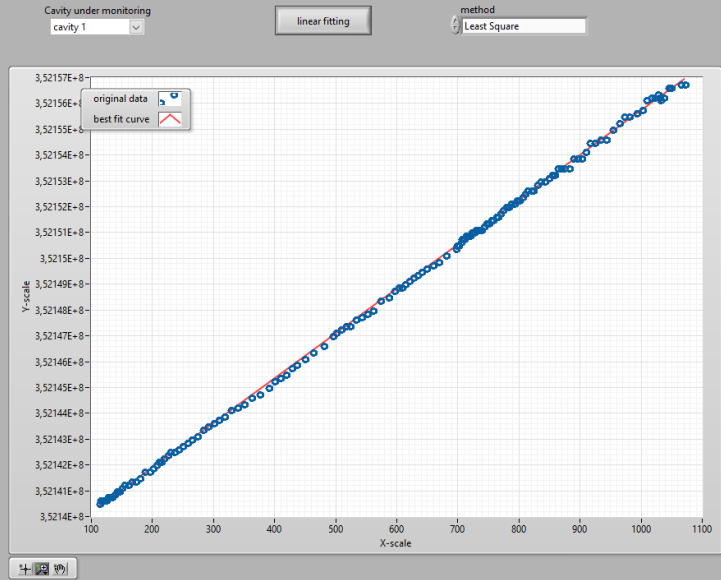
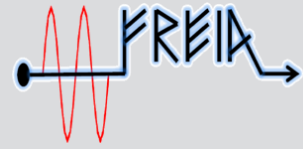


- This is a known issue which sometimes happens
- The LN valve from the external tank is “frozen” and we need to flush a hot water
- Some contamination? → listed for the next maintenance

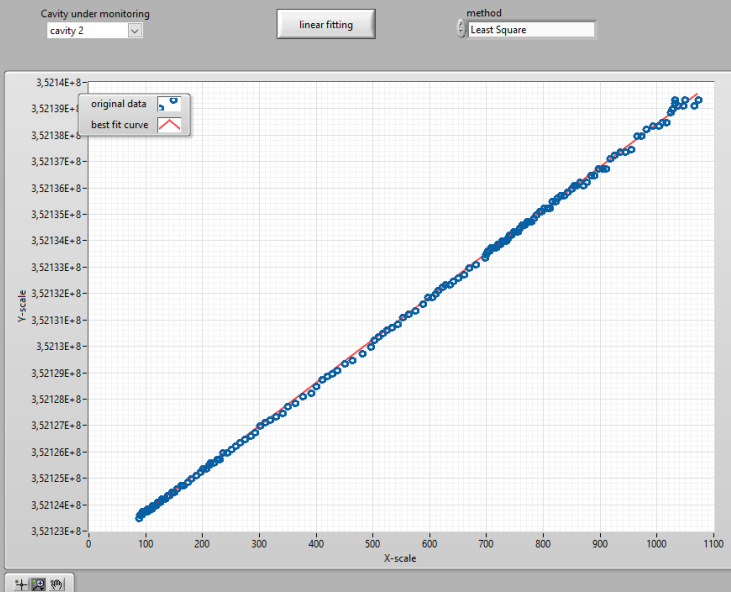
CM09_2: 4K cooling was OK



CM09_2: 2K pumping was OK

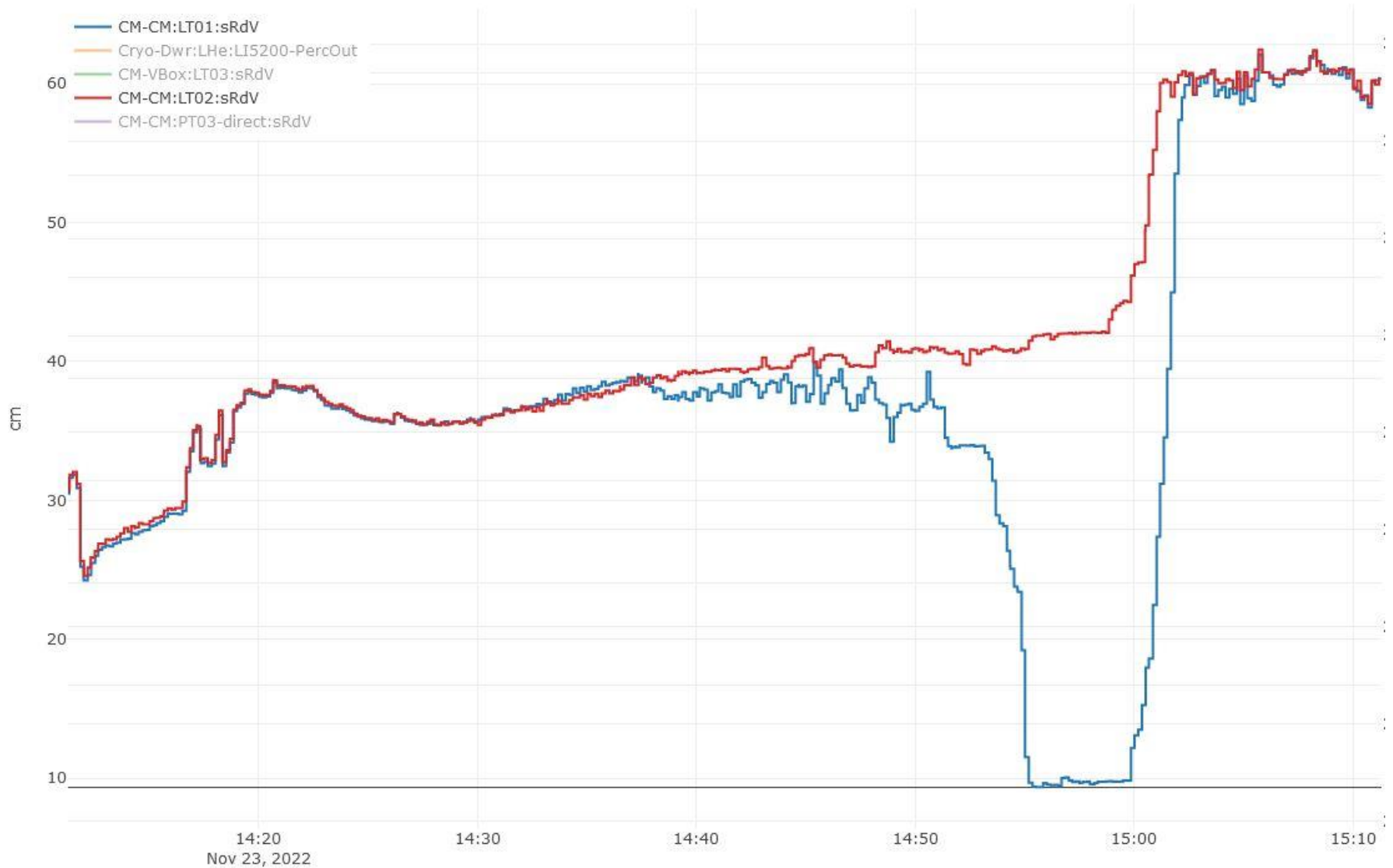
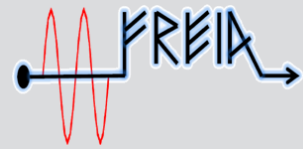


CAVIN 17.3 Hz/mbar

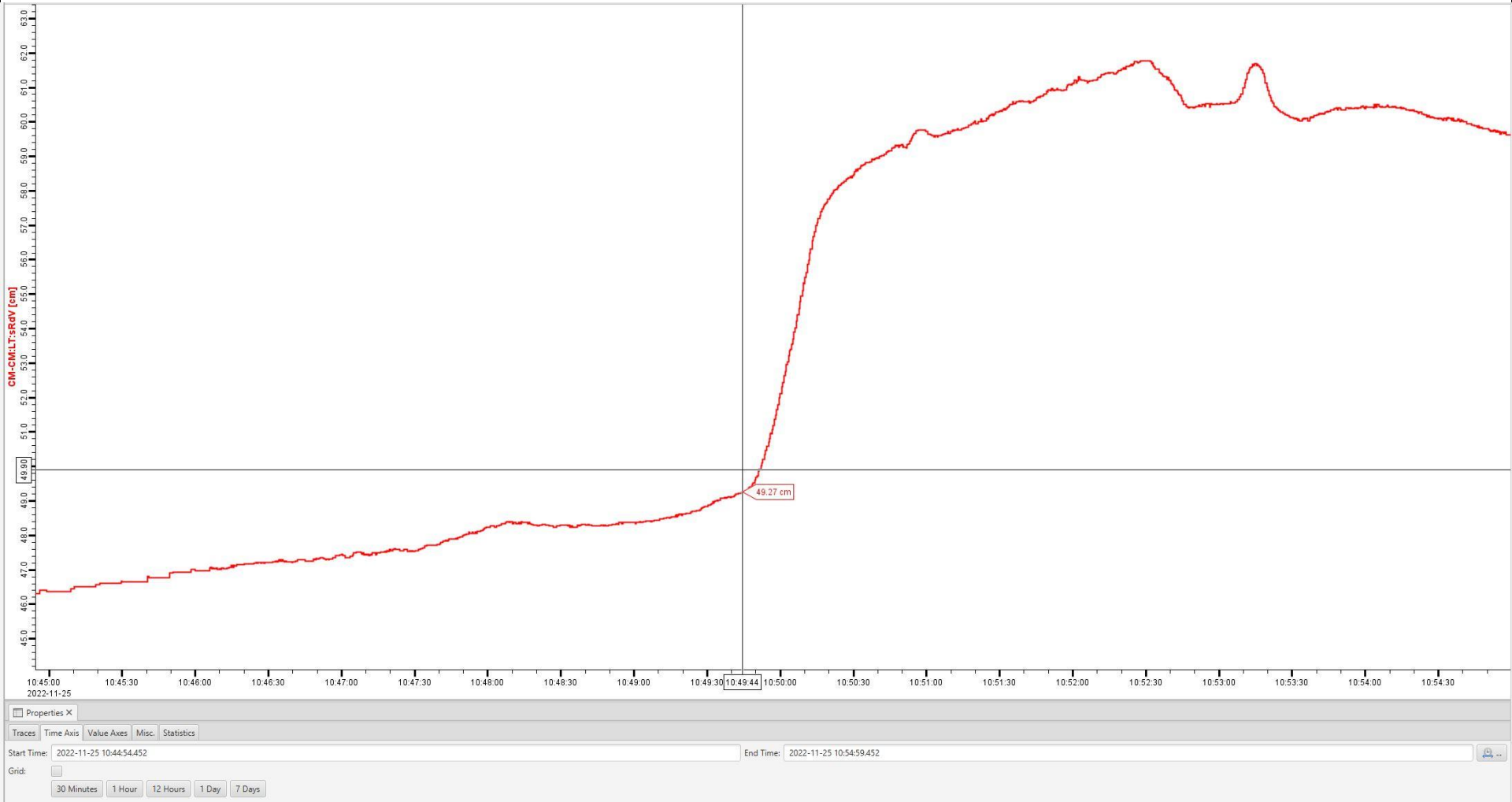


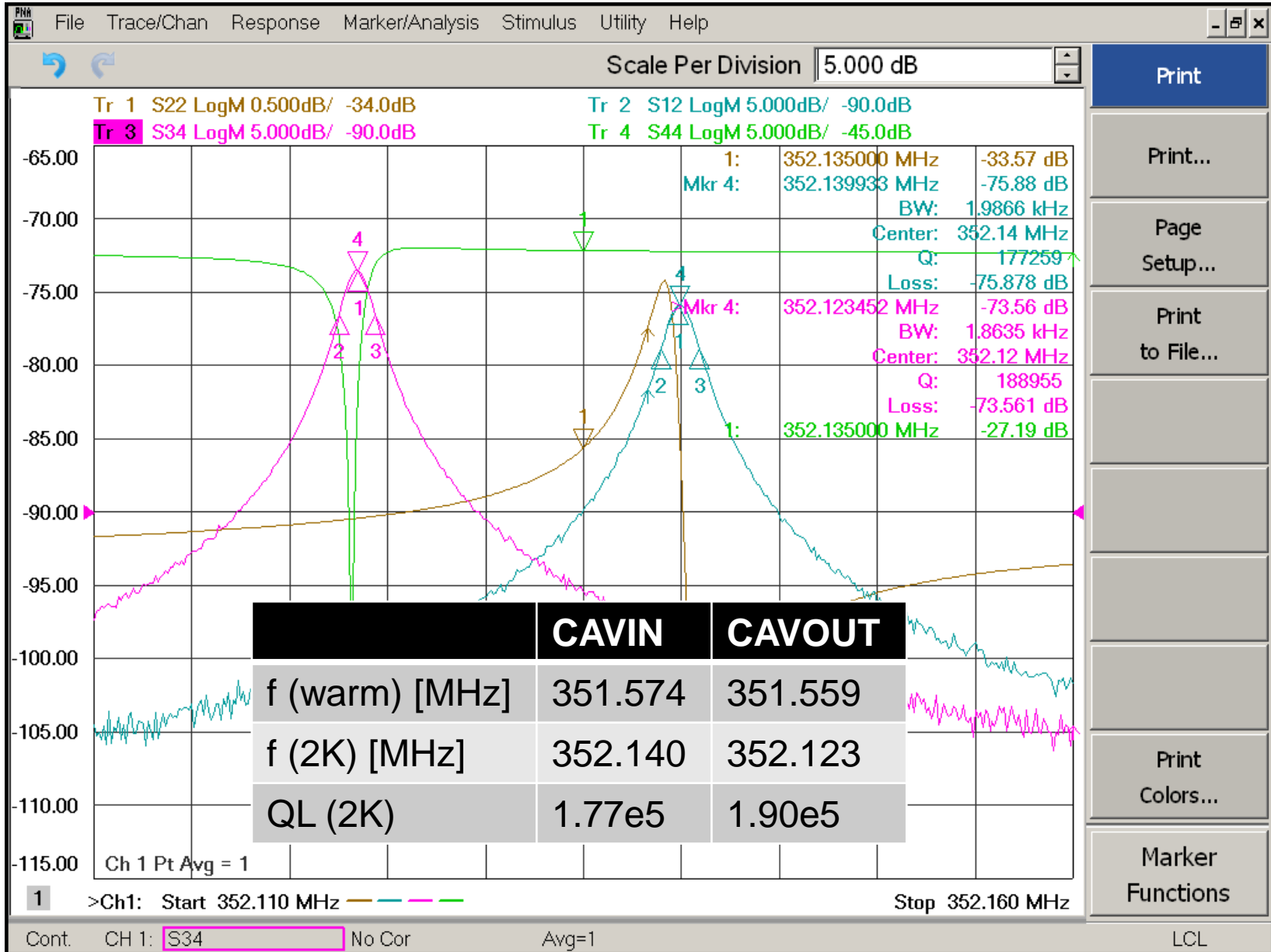
CAVOUT 16.3 Hz/mbar

CM09_2: LT01 behaved strangely once

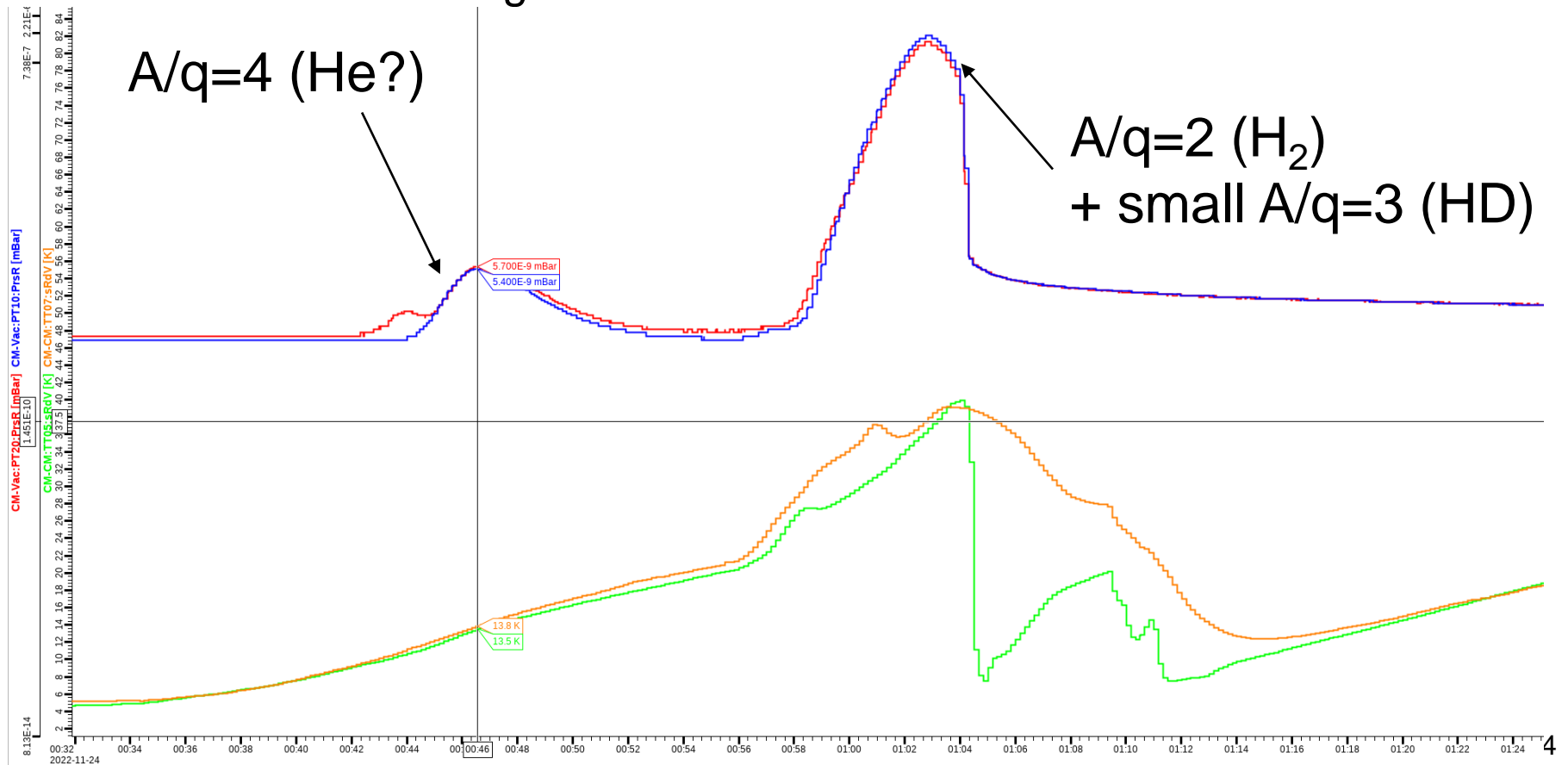


CM09_2: level offset calibration



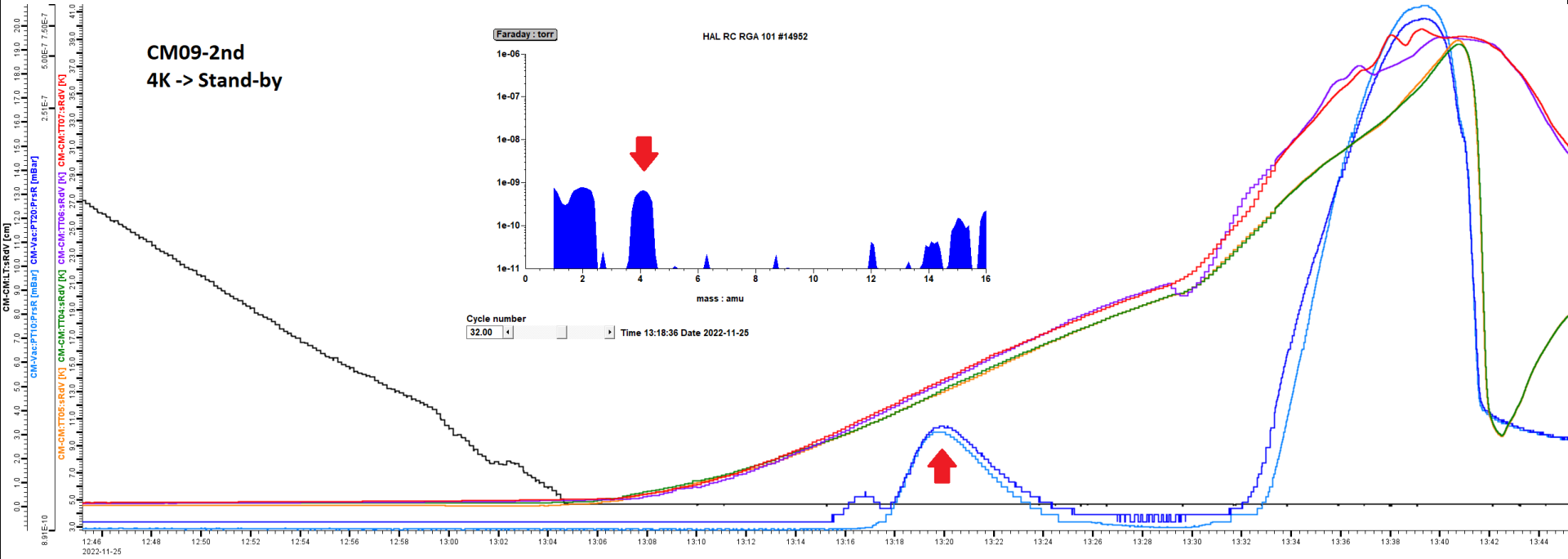


- Liquifaction rate was not sufficient to keep the LHe level in the Dewar
- Decided to go to the standby
 - Of course, LN2 line was frozen ☹️ (thanks, Rocio!!)
- Then, we observed the famous signal of potential leak!
- RGA was not running but the behavior is the same as others





No! The same signal was observed without going to 2 K



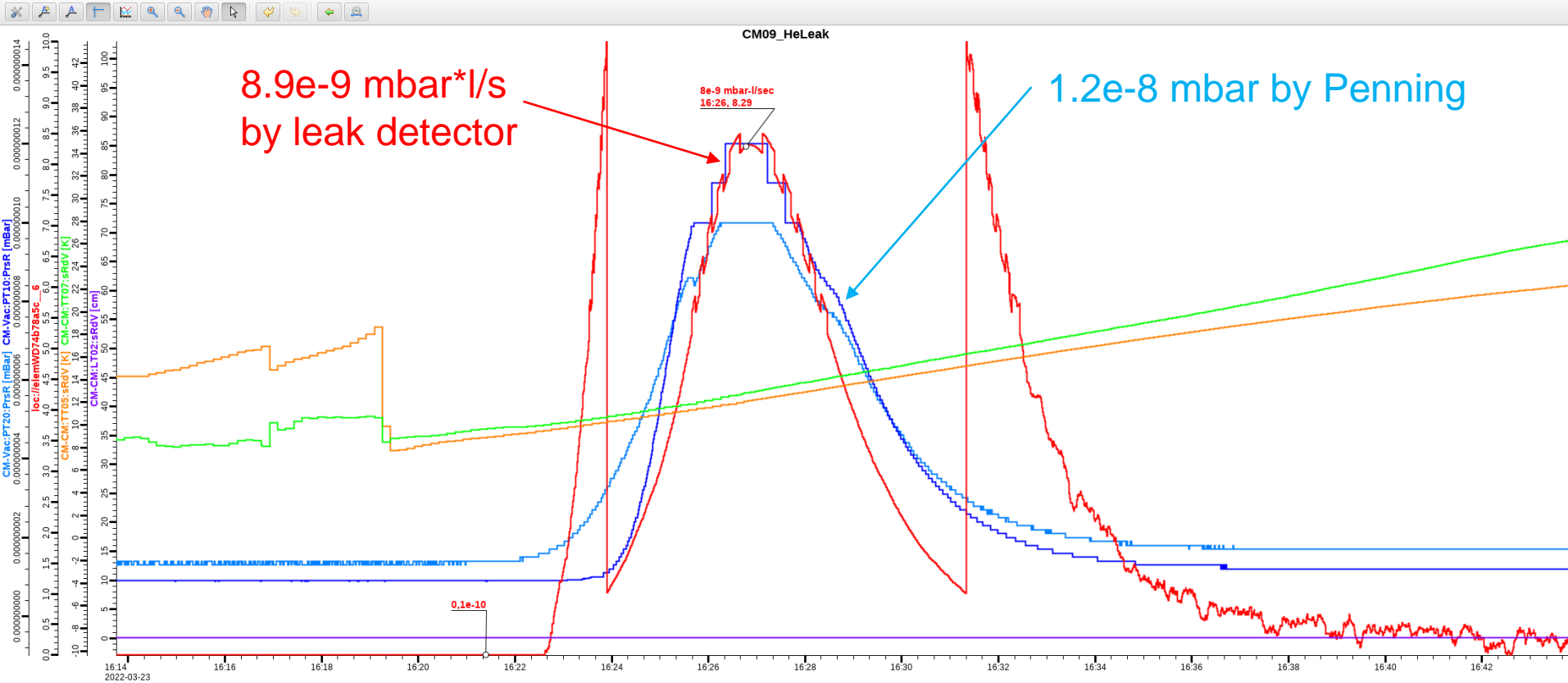
This phenomenon may not be defined as the cold leak that is associated with superfluid



The image shows a control interface for a vacuum chamber and a mass spectrometer. The top left window displays the chamber pressure $p_i: 5.00 \cdot 10^{-4}$ mbar and a large red number $2.49 \cdot 10^{-10}$ mbar-l/s. A 'STOP' button is visible. The main plot shows a pressure trace over time from -240s to 0s. The bottom left window shows 'The Gallery' with 'Leak Detect Mode' selected. The right side of the image shows a multi-trace mass spectrometer plot with various channels (red, black, blue, orange, purple) and a time axis from 03:00 to 14:00. A 'Properties' window is open at the bottom right, showing 'Start Time: 12 hours' and 'End Time: now'.

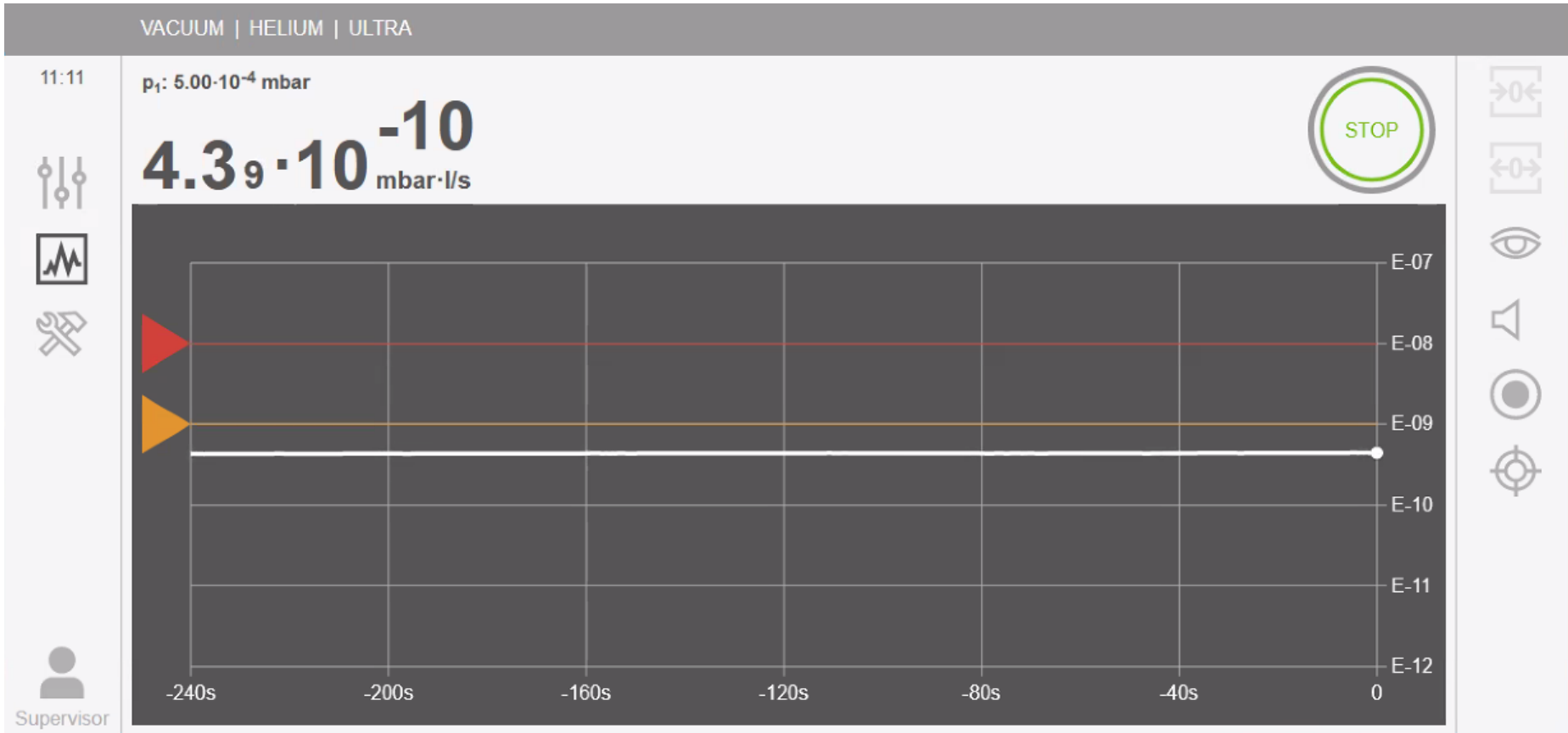
What is the background rate we need to achieve for a sufficient S/N?

1st test of CM09 (different cavities than 2nd test...)



The Penning gauge showed $5e-9$ mbar so we may have a leak rate of higher than $1e-9$ mbar*I/s

Background rate over one night

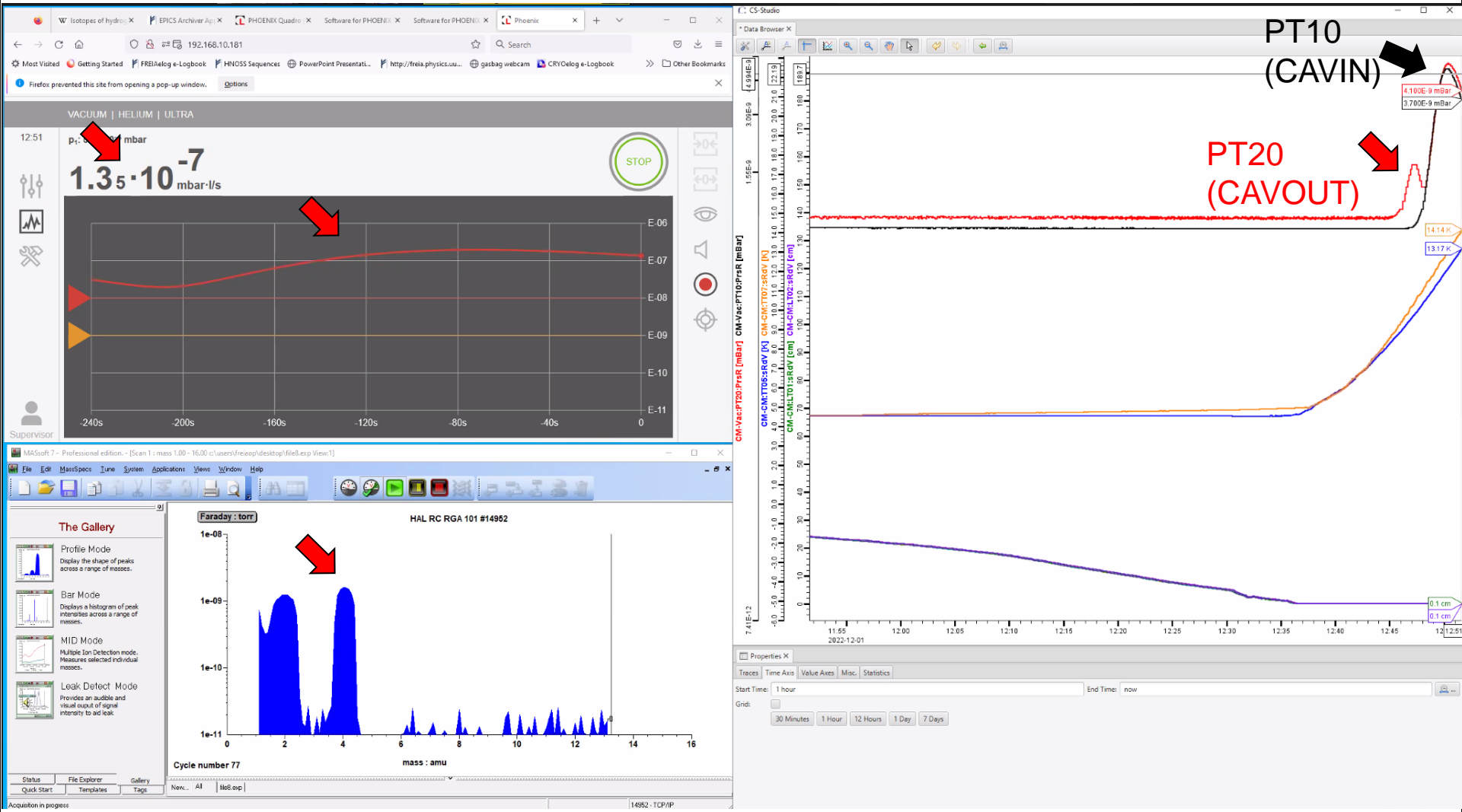


$S > 1e-9$ mbar·l/s

$N = 4.3e-10$ mbar·l/s

$\rightarrow S/N > 2$??

Helium was confirmed in CM09 2nd 😊 or ☹️?



The leak detector is CAVIN side and RGA is at CAVOUT side₁₉



List of facts and hypothesis



- A helium signal ($A/q=4$) appears when cavities reach 13 K
 - Penning gauge observes increase in total vacuum
 - RGA observes $A/q=4$ signal
 - The leak detector observes the helium
- The signal level is increased if the cavities are with LHe for longer time
 - Thermal cycles (10-50K) without having LHe does not show signal
- The signal appears at a thermal cycle after 2 K operation or 4 K operation without going down to 2 K
 - Superfluid is not a necessary condition
- Hypothesis
 - There is a leak between the beam vacuum and the helium circuit and the leaky helium is accumulated in the cavity
 - The leak is not necessarily at the 2 K boundary and can be again at the supercritical helium line of the coupler's double-wall tube
 - CM12 and CM10 probably have the same issue → how about others?₂₀