ETpathfinder annual workshop 2026

Vacuum Update

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Interreg
EUROPESE UNIE
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Europees Fonds voor Regionale Ontwikkeling

Overview

3 UHV sections – 14 large turbopumps

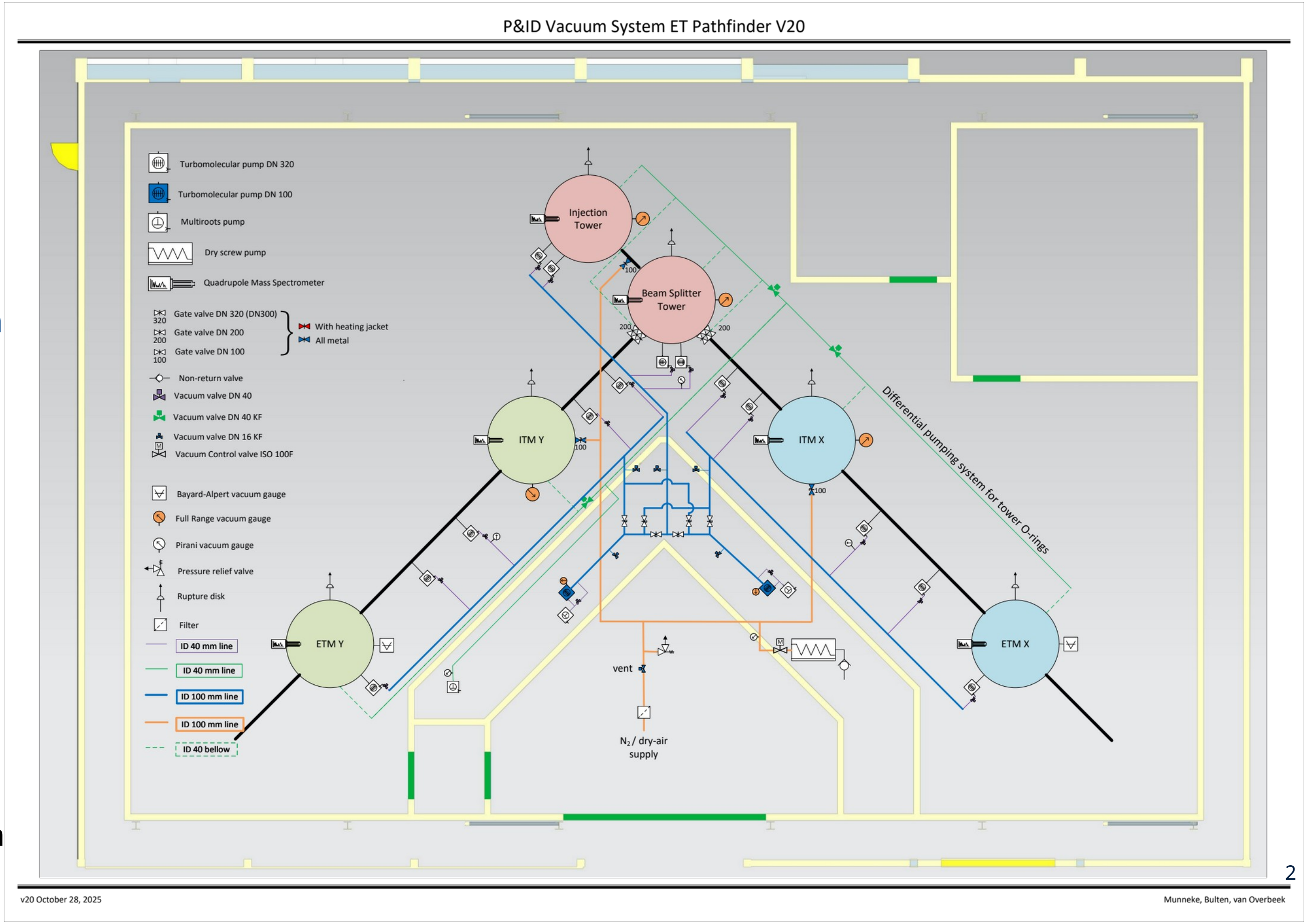
Forevacuum: 2 pumping stations (turbo/multiroots) and a switching manifold in noisy corridor, 100mm all-metal pipes

Differential pumping: 1 multiroots pump to pump on the Orings on all 3 sections

100mm all-metal roughing lines for venting/evacuation
- screw pump and butterfly valve (added recently)

All installed and tested.

2026 – 2027: add vacuum system for cryogenic towers, add dry air venting system.

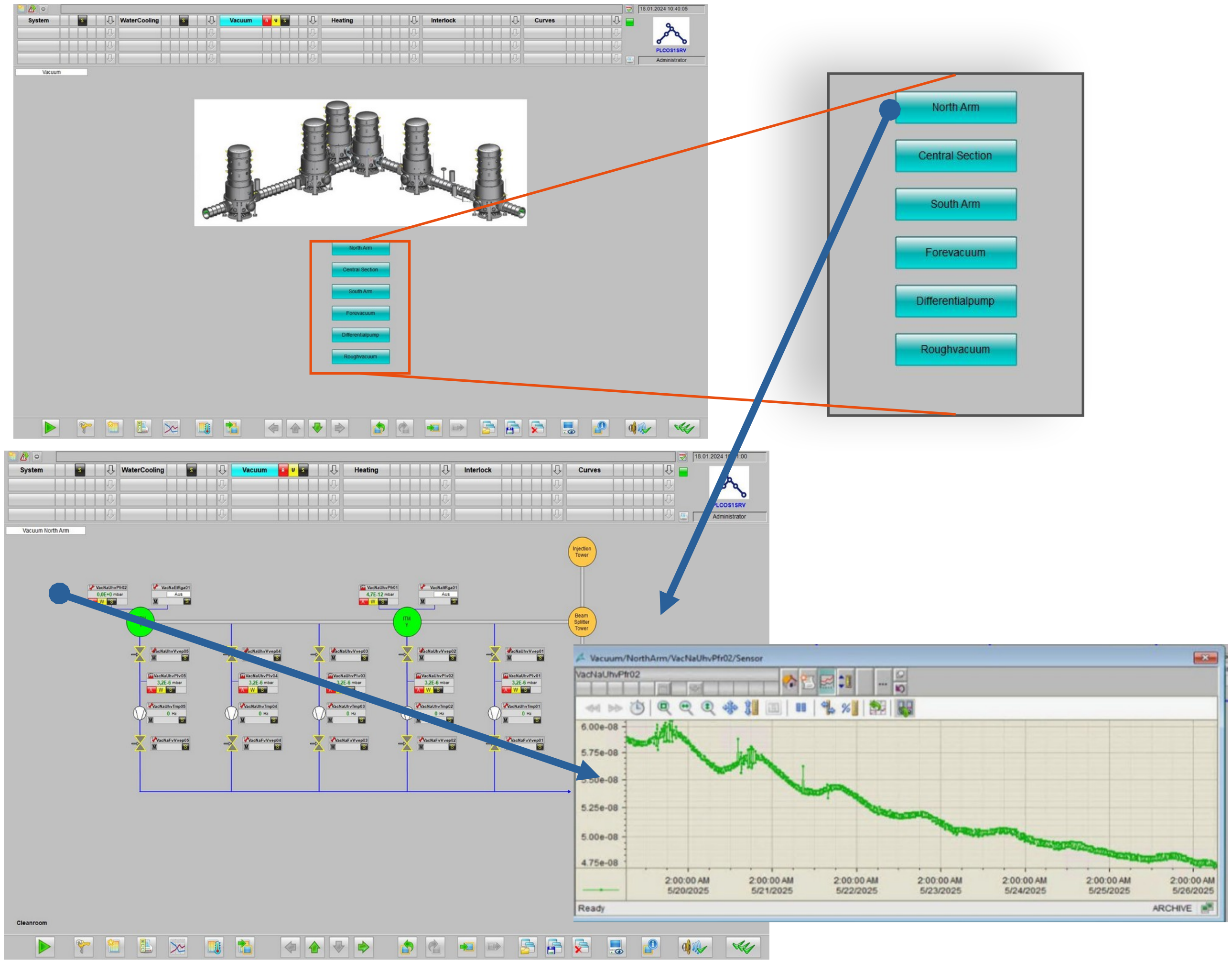


PLC control

KIT designed, implemented and supported our PLC control:
- cooling water
- all valves and pumps except screw pump
- large turbopump heaters

Operators: Thomas Thuemmler, Thomas Hoehn, Eliott Duvieusart
(remote private network to KIT)

For 2026-2027 :
Interface with cryogenics
Vacuum cryogenic towers
Venting system
Automatization of evacuation procedures



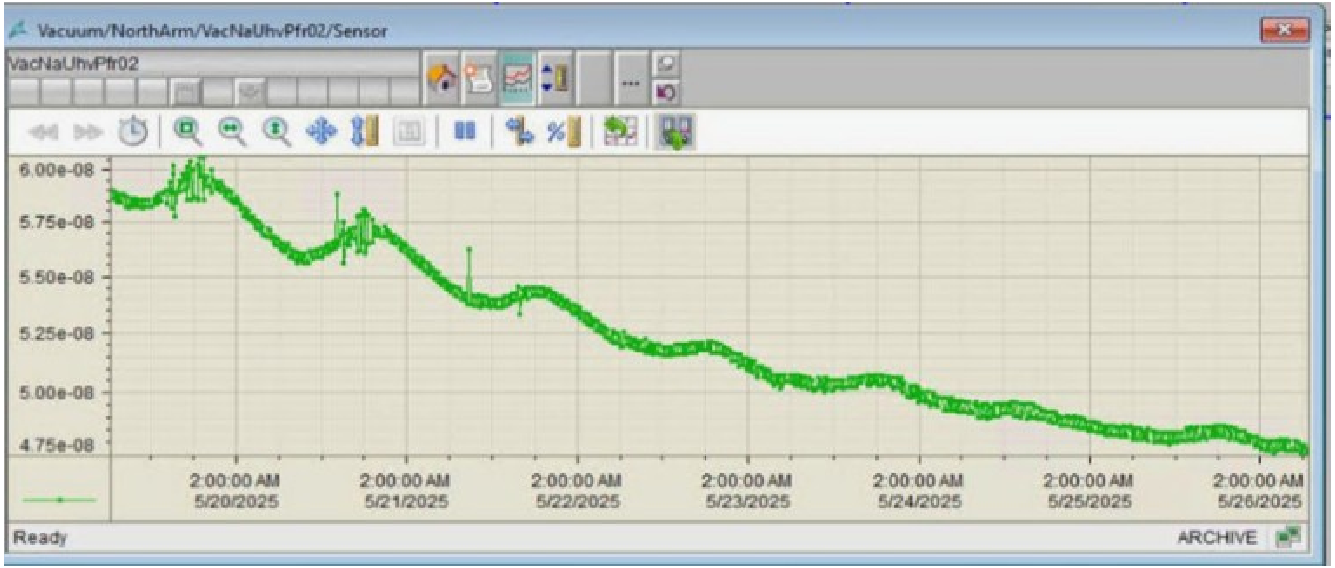
Vacuum : North arm

Evacuated north arm on may 20, 2025

- differential pumping since May 2025, but the O-rings on the connection to the central section are not pumped on.

Initial pressure after 1 day was 6e-8 mbar, after 1 week 4.8e-8 mbar, after 10 months 1e-8 mbar.

- possibly outgassing/permeation O-rings (a 6mm thick O-ring at room temperature is in equilibrium after 2 months)



Initial pressure North arm, May 2025. Note that the daily pressure fluctuations correspond to a half degree temperature shift. The permeation through an O-ring for water doubles every 1.5 deg. C (Nikhef outgas measurements).

Decrease of pressure is slower than 1/t. Possibly a combination of initial outgassing through the O-ring, depletion of the monolayer of water on the tower surfaces, and a constant contribution from permeation. At Nikhef, we measure about 1e-5 mbarl/s of water permeation through 1m of Viton O-ring at 25 deg. C.

Vacuum : North arm

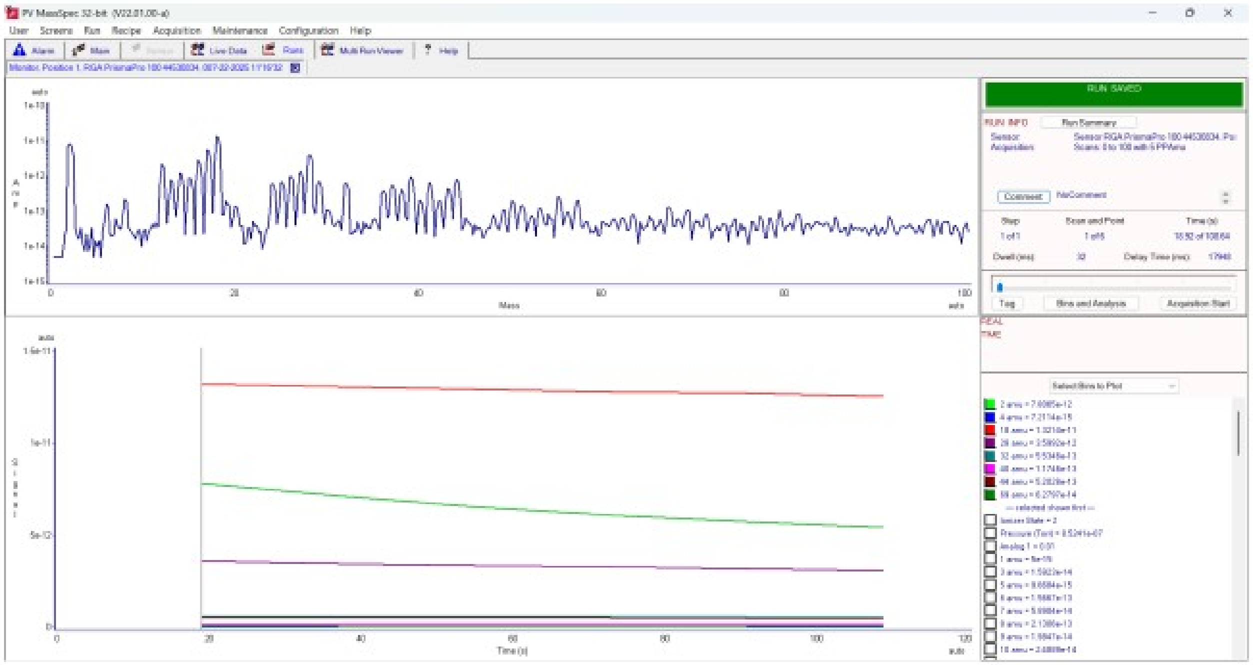
RGA measurements feb 2026.

Note that there is about 10% air present – possibly a small leak in one of the flanges.

Note also that observe about 20% difference in the pressure gauges in NI and NE towers – this may be a difference in pumpspeed, a systematic error in the gauges, or indication of a leak in the tower.

Conductance arm is around 50,000 l/s, pumpspeed pumps around 18,000 l/s

2026: measure and model pumpdown for all UHV sections including RGA spectra, calibrate RGAs, leakchase if necessary.



RGA spectrum Feb 2026 – Emma Prins RGA manual. Note: a little bit of air present.

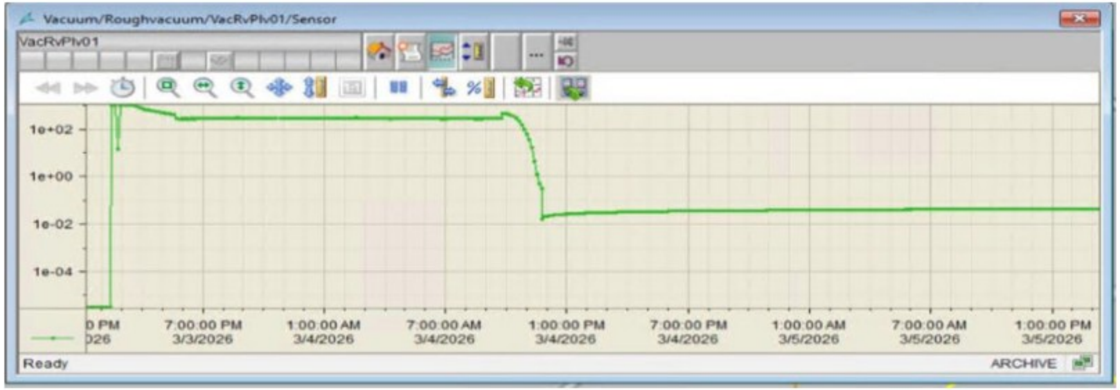
Vacuum : Butterfly valve

Initial pumpdowns: the screw pump was a bit too strong. At atmospheric pressure we want to throttle the airflow to protect the suspended optics in the tower.

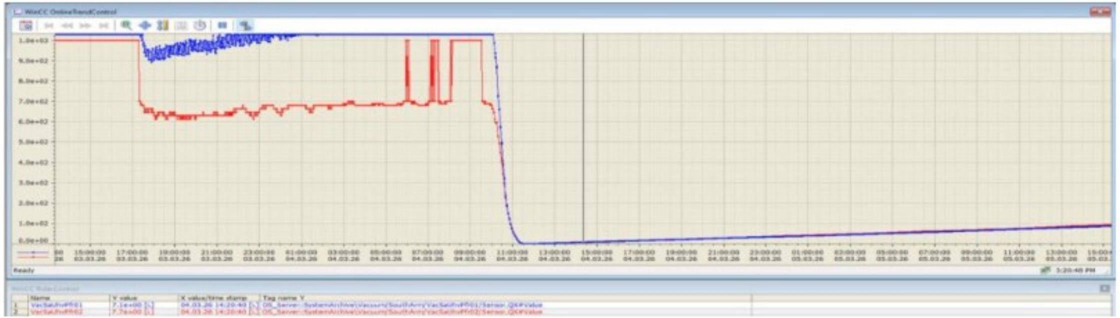
A butterfly valve was installed in front of the screw pump. Thomas and Eliott made an initial calibration of the required settings; at 2% opening the pressure in the arm decreases with about 6 mbar/min.

We assume that that is save, but we should measure the movements/forces on the suspended optics when evacuating the interferometer next year.

Also, we need to program the PLC to have the correct butterfly valve settings during evacuation; currently the evacuation is done manually by the operator.



VacRvPlv01



VacSaUhvPfr01/02

Top: calibrated gauge in front of screw pump. Bottom the South arm penning/pirani combinations. Around 400mbar the south arm gauges start working. Different settings of the butterfly valve in the range 400-200 mbar were used to define the throughput (Thuemmler, labbook 28919)

Vacuum : Cryogenic towers

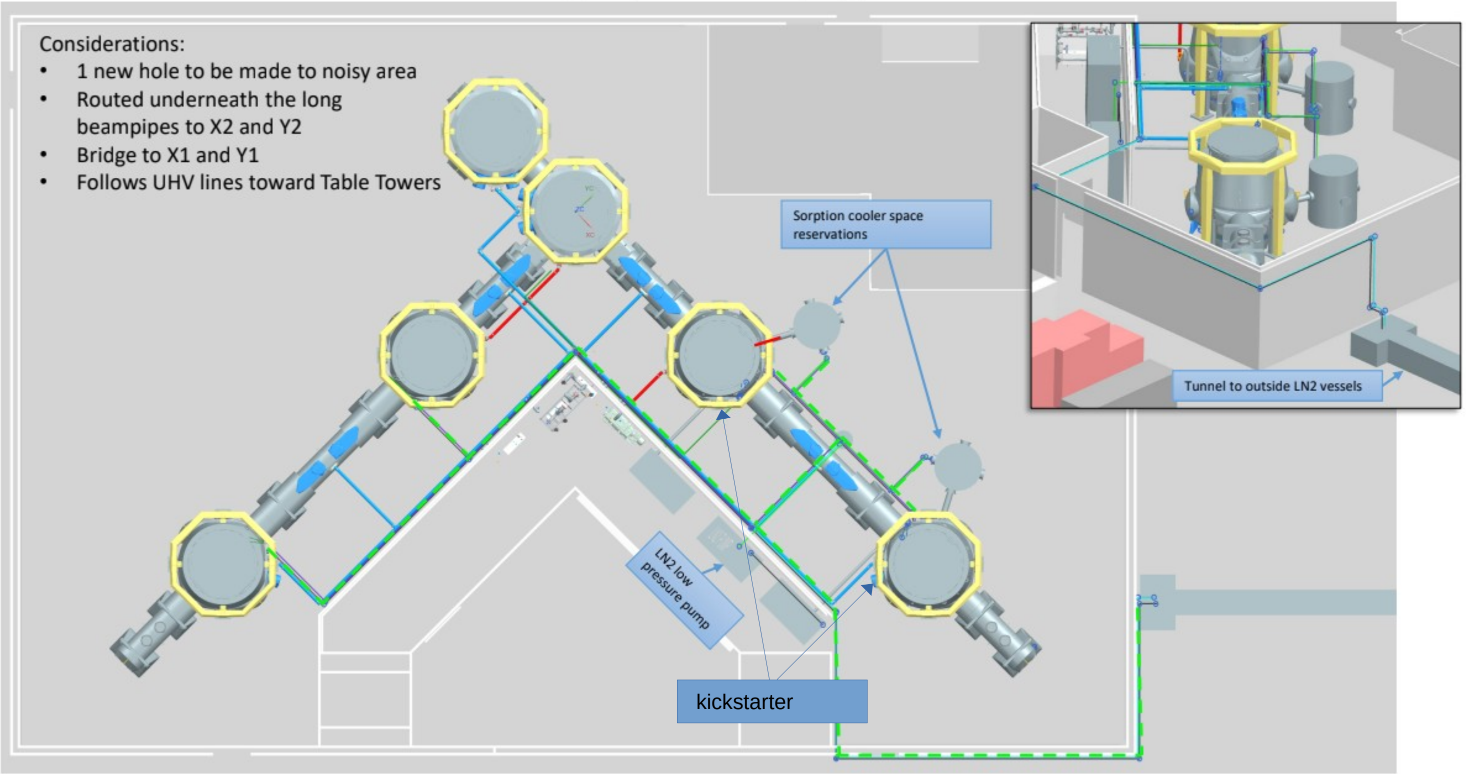
2026 : install cryogenics in south arm.

Vacuum system: 4 additional towers, 2 for the sorption coolers and 2 for the kickstarter (a Helium loop at ~4K).

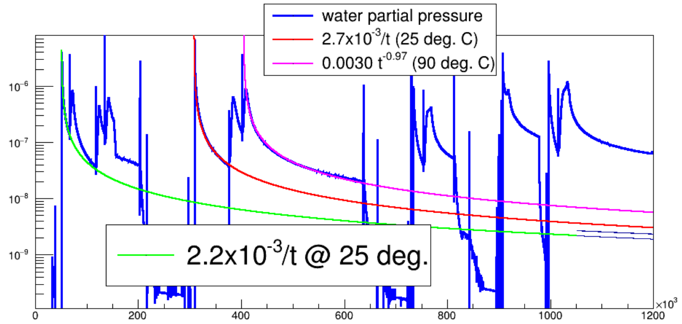
Needs new pumping system. Plan: use 4 small turbo pumps (around 100l/s) per chamber. Extend differential pumping system line for forevacuum of the small turbo pumps.

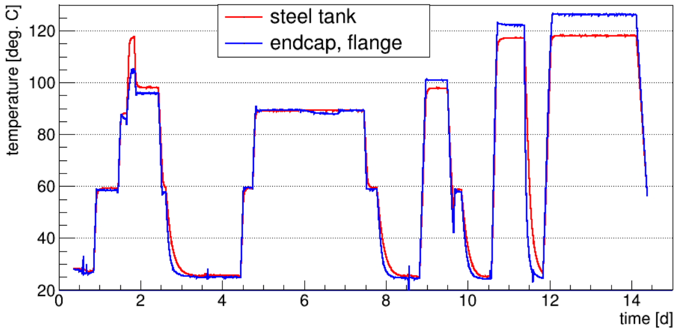
PLC system:
- add cryogenic pumping system (pumps, valves, gauges)
- add interlocks between UHV system and cryogenic system (pressures, temperatures)

Current routing layout – Cryogenic lines



Vacuum system: venting system





Current venting system:

- air from noisy corridor
- filters in front of venting valves

Possible upgrade:

- dehumidifier. Vent with dry air.
- on the open task list

Will reduce pumpdown time after venting, provided the vacuum system is exposed to air for a short time (order 1 hour).

(E.g. measurements at Nikhef for mild steel outgassing: about 3 times more water vapor when exposed to air as compared to venting with mild steel. Bulten, TDS ET-0503A-23)

System	Q(t) =Q_0 [Pam^3/(m^{2}s)]/t[h]	n_adsorbed [m^{-2}]
Empty vessel, moist air, 25 deg	5.4 x10-6	5.3x10^{19}
Empty vessel, inert gas venting, 25 deg. C	2.0 x10-6	1.9x10^{19}
Mild steel samples, both runs, 25d deg. C	(1± 0.5) x10-5	10^{20}

Vacuum system: outlook 2026

Automatization of pumpdown (butterfly valve settings) – test while reading the acceleration of the suspension.

Characterization of pumpdown and outgassing of the whole interferometer.
- including outgassing measurements of all subassemblies. Including RGA calibration during pumpdown. Valuable lessons for ET, especially for ice buildup predictions.

Installation of pumping system for cryogenic towers, and integration into the PLC system

Integration of cryogenic PLC with the vacuum PLC - interlocks for temperatures/pressures

Possibly : add dehumidifier to venting system