Cryogenic Settings for Testing of the Fully Equipped ESS’ Double Spoke Cavity Romea

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Settings for Run 8 (Romea with FPC and CTS)

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1 Background

This report gives the details about Romea’s sensors, heaters, etc. for this run, from 23rd February to 29th May 2017.

For over a year there has been no run in HNOSS. In January 2017 we got a double spoke prototype equipped with a fundamental power coupler (FPC) and a cold tuning system (CTS) to be tested. This cavity is Romea, manufactured by Zanon and labeled ZA 01. The reason not to have Germaine any more is because after the final chemical treatment IPNO found a leak between the beam vacuum and the helium vessel, very close to where the first one appeared but was repaired by SDMS. This cavity is thus not suitable anymore for cryostat experiments.

Pictures from the installation of Romea in HNOSS can be found in [201701_Romea to HNOSS], and before closing the cryostat in [20170223_Closed HNOSS].

In between run 7 and run 8, three heaters in the 4K tank have been replaced by new ones after it was discovered that they had burnt [logbook entry 09/12/16 at 14:14].

Also during this time, TL001 and the ICB have been shipped and received back from Cryo Diffusion to check and repair the LN2 and LHe leaks that were seen in past runs. The LN2 leak seems to have come from a selfa valve on the ICB; the steam above FV401 valve had a small crack and, although not evident, the same was happening to the other selfa valves on the ICB top flange. Only FV401 has been worked on: this valve is completely bypassed by having welded together the inlet of this valve directly to its outlet [logbook entry 21/12/16 at 08:26].

Regarding the LHe leak, there are indications that this leak might have come from the VCR connectors between the LHe dewar and the ICB: the copper gasket had signs of not having sealed properly due to scratches and glue remnants on the connector itself (see Figure 1). This being the cause of the LHe leak in the ICB gets stronger since Cryo Diffusion could not find any leak in the LHe circuit.
Regarding the leak between the LHe and the ScHe circuits in HX300 (see run #6A and/or #7), discussions with Jean-Pierre Thermeau revealed that the problem comes from having defined a too low leak rate for the ScHe circuit. This heat exchanger has been manufactured with a leak rate of $10^{-4}$ mbar l/s for both circuits instead of having specified $10^{-6}$ mbar l/s for the ScHe one. This means that the leak in HX300 is not a manufacturing problem, but it has to be taken care of if we take the VB out at some later point for other repairs.

![Figure 1: Scratches and glue remnants on the LHe pipe VCR connector between TL000 and the ICB.](image)

**Important**: the naming of the cavities as "cavity 1" and "cavity 2" has been reversed for this and future runs due to the position of the ScHe pipes inside HNOSS.

## 2 Modifications

The modifications done for this run are shown in Figure 2:

a) TT129 is a Cernox sensor connected between SV101 and the 2K tank’s branch (in past runs it was TT304). Was placed there to check for Taconis effect.

b) Since there is no table inside HNOSS the outlet from CV101 has been directly connected to the 4K tank exhaust and the prior outlet (connected to the 2K tank exhaust) blinded. This has changed since last run (where outlet of CV101 was just blinded) because during the past run we saw that having this valve just plugged was not working well: it gave many problems when starting to cool down the 4K tank.

c) CV102’s and CV103’s outlets have been merged into one to connect to Romea.

d) The ScHe pipes’ input and output for Cavity 2 are directly connected to each other but in between there is a heater glued to a copper plate and inside the pipe there is a copper braid to increase the flow resistance. The heater glued on the ScHe pipe has its output in the control cabinet: loose cables on the floor marked EH(HX). This is the same as in previous runs.

e) The ScHe pipes input for Cavity 1 goes to the FPC and the outlet inside HNOSS is blinded. Since the outlet of the FPC is outside HNOSS there is an extension pipe from this port back to the ScHe circuit for Cavity 1 after PT301 and before TT310 (Figure 3)
Figure 2: Modifications done inside HNOSS for run #8.
f) TT305 is sitting outside HNOSS (Figure 6(c)). It is connected to the control cabinet via cable 01-021 connector 1. This cable is then connected in the control cabinet to the original pins, i.e. XC3 pins 16-19.

g) TT01x to TT09x and TT306 are connected to the CTS (see Figure 7).

h) All sensors pertaining to Cavity 2, i.e. TT105, TT116, TT126 and TT118 have also been placed in Romea, in the same position as described in the GUI. TT104 is siting on the cavity while TT105 is at the inlet of the cooling pipe (Figure 5(d)).

i) The tee in the pipe for the liquid helium level probe has been removed since only one cavity is in place.

j) FT550 is now operating and is a Brooks thermal flowmeter with capacity 60 m$^3$/h but the data is only available through EPICS.

### 3 Cavity

Only Romea is inside HNOSS for this run, placed to the east (cavity 1) and on tie-beams, as shown in Figure 4(a). The connection to the 2K tank is via CF63 bellow, CF63-CF40 adapter, CF40 90 degree bend and a CF40 below connecting to the top of the cavity (Figure 4(b)). To avoid movements during cooldown and/or pumping that could put stress on the FPC, two clamps with three rods each have been attached to the bellows.
and tightened to keep the cavity’s position as fixed as possible.

The level probe is connected to the furthermost CF16 port from the thermal shield on the side opposite the CTS and the cooling line (outlet from CV102 and CV103) is connected to the closest CF16 port to the thermal shield below the CTS.

3.1 Sensors

Romea’s temperature sensors and heaters are shown in Figure 5 [20170116_Romea sensors installation]. The Cernox sensors’ supports are glued to the cavity while the heaters are glued onto copper plates that have been previously pre-formed on the cavity’s surface. These heaters (three in total) have then been fastened to the cavity with kapton tape and three straps. The corresponding Pt100 sensors have been placed on the copper sheets by using cryogenic grease and kapton tape.

For the FPC, one heater (EH107) and its associated Pt100 sensor (TT147) have been attached in the same way as for the cavity (Figure 6(a) and 6(b)). For the ScHe circuit in the FPC, both temperature sensors are shown in Figure 6(c) and 6(d).

For the CTS, ten extra sensors have been attached according to Figure 7, where
TT02x monitors the Noliac piezo and TT03x the PI.

Figure 5: a) and b) show the position of Romea’s sensors on the sides, c) on the top and d) on the inlet for the cooling line, below the CTS.
Figure 6: Position of Romea’s a) heater and b) temperature sensor in the FPC and the Cernox sensors in the ScHe circuit c) outside and d) inside HNOSS.
Figure 7: Temperature sensors placed on the CTS.
3.2 Helium Level Probe Distances

An overview of the placement of Romea wrt the LHe probe is sketched in Figure 8. This distance is needed in order to calculate at what percentage is the cavity already filled with LHe. This level is ca. 41% for LT101, calculated for an active length of the probe of 1500 mm.

![Figure 8: Distances for the LHe probe and some calculated volumes for the 2K tank LT101.](image-url)

" indicates measured in-situ
3.3 Vacuum Gauges

Because Romea has only a penning gauge IKR060 attached to control the pressure in the FPC, it was decided to use an existing pirani TPR018 for switching to the penning gauge. This pirani gauge used is sitting on the beam vacuum pumping group after the gate valve and, for its use together with the penning gauge, the card in TPG300-4 unit CP300 T11 has been exchanged for CP300 C10. The details are given in Figure 9.

![TPG300 back connections](image)

*Figure 9: TPG300 connections for run #8 with changes in purple.*