

"CRYHOLAB", A NEW HORIZONTAL TEST CRYOSTAT FOR SCRF CAVITIES*

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Abstract

The collaboration CEA Saclay/IPN/LAL in the SRF activities has lead the IPN cryogenic group to build a horizontal cryostat to test several designs of equipped cavities and associated components like power couplers. The main aim of this cryostat is the study of the 700 MHz for protons and the 1.3 GHz for electrons (TESLA type) structures.

In this paper we describe the cryostat presently under assembly and the conceptual design of its associated feed box.

1 INTRODUCTION

The aim of "CRYHOLAB" is to provide a tool to measure the performances, at nominal RF power, of SC cavities, of various frequencies, equipped of their Helium vessel and associated components. The both structures design to be tested in "CRYHOLAB" are, mainly, the 1.3 GHz for electrons (TESLA type) and the 700 MHz cavities for protons.

The cryostat is designed and assembled by the IPN cryogenic group. Others features of "CRYHOLAB" like R.F powering and measurements, automatic control, refrigeration system are taken in charge by the CEA and LAL groups. The whole facility is planned to be installed in the CEA Saclay at the "L'Orme des merisiers" laboratory in spring 2000.

2 REFRIGERATION

Cavities in "CRYHOLAB" will be cooled with a superfluid Helium bath at around 1.9 K.

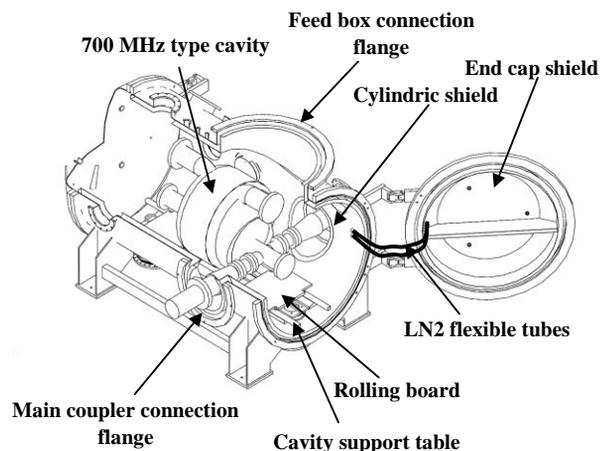
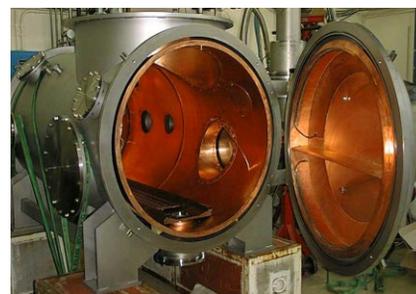
The cryostat will be feed by the cryoplant formerly used for the MACSE accelerator at CEA Saclay. This plant can provide, in liquefaction mode, 120 l/h with a pumping capacity of 8 g/s at 30 mbar while the maximum required power to test the 700 MHz type structures is 60 W at 2K. The main improvement of the cryogenic utilities is the construction of a 30 m vacuum isolated pumping line for the 2 K bath.

3 CRYOSTAT

3.1 General design

The cryostat is designed to operate with cavities, equipped with their Helium vessel, of different sizes. For instance the external diameter of the 1.3 GHz (TESLA type) structure is around 300 mm while a global diameter of around 1 m is needed for the 700 MHz cavity. To cope with this, a table fixed to the vacuum tank may support rolling boards on which are flanged cavities of various dimensions. The design of the rolling boards is mainly related to the connection of the main coupler to the vacuum tank.

Figure 1: General views of the cryostat



Attention was made to make easy and fast the mounting of the tested structures inside the cryostat, thus it is possible, by mean of articulated caps at both ends of the cryostat, to

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open the cryostat without disconnect the vacuum tank and the thermal shield.

3.2 Vacuum Tank

The vacuum tank, made from stainless steel, is roughly 2,5 m long and 1.2 m diameter. It has seven 200 mm flanges for the measurements outputs and two 500 mm flanges for the connection of various main couplers designs. A pumping port of 165 mm faces a blackened baffle on the radiation shield and allows a sufficient evacuation of the vacuum space.

At least the end caps are articulated and can be closed without screws; the pressure applied on it when pumping being sufficient to avoid leaks.

3.3 Radiation heat shield

The radiation shield is cooled by liquid nitrogen circulating in a tube soldered onto a copper cylinder and two caps at the ends of the cryostat. The whole part is covered by 30 layers of MLI, and surrounds the cavity to reduce the radiation thermal losses to about 6 W/m². The cylinder stands on the vacuum tank on four epoxy-glass bases.

The end caps of the shield are clamped to the vacuum tank on three epoxy-fibreglass rods. Flexible elbows make the continuity of the LN2 circulating tube between the cylinder and the caps.

The shield also provides heat sinks at 80 K and is equipped with heaters to warm up the cryostat.

3.4 Cavity support system

Figure 2: Internal view of the cryostat



The support table is cooled at 4.2 K with liquid Helium, and is isolated from the vacuum tank at 300 K by epoxy-glass posts heat sunk at 80 K by the thermal shield.

3.5 Static thermal losses

The calculated values of static thermal losses for different parts of the cryostat are summarised below (with a Helium vessel corresponding to the 700 MHz design, and without taking into account the losses due to power coupler).

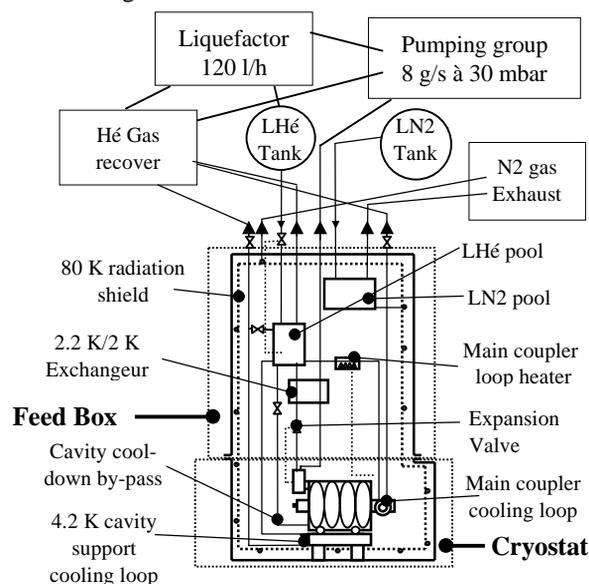
Table 1: Static losses

CRYOSTAT PARTS	NATURE OF HEAT LOAD	THERMAL EXCHANGE TEMP.	LOSSE
80 K THERMAL SHIELD	Radiation Conduction (support, heat sinks, electric leads)	300 K to 80 K	70 W
CAVITY SUPPORT	Radiation Conduction (heat sinks, support, electric leads)	from 300 K and 80 K to 4.2 K	2 W
CAVITY HELIUM TANK	Radiation Conduction (heat sinks, support, electric leads)	from 300, 80 and 4.2K to 1.8K	2 W

4 FEED BOX

A feed box put onto the cryostat provides the cooling of CRYHOLAB at 80 K, 4.2 K and 1.8 K.

Figure 3: Feed box flow scheme



This simplified flow scheme, describes the whole cryogenic installation (Cryostat, feed box, cryogenic plant) at CEA Saclay.

The LHe is siphoned intermittently from the 2000 l liquefactor tank directly to the LHe 100 l pool which the level is maintained with a level controlled valve. LHe from the pool is then divided in 4 flows.

One flow, used for the cavity cool-down, bypasses the 2.2 K heat exchanger. A second flow allows the cooling of the cavity support table at 4.2 K. A third flow passing through a heater that can evacuate a maximum of 60 W, with a temperature variation of 10 K, to cool the main coupler at various temperatures in the range 4.2 K to 60 K. The last flow is first pre cooled at around 2.2 K in the heat exchanger before feeding the cavity helium vessel through the expansion valve and thus, reducing, the flashing losses during expansion to 16 mbar. The expansion valve is controlled by a level probe inserted inside the feeding pot of the cavity Helium vessel.

LN₂ is siphoned intermittently to the LN₂ pool which feeds the 80 K radiation shield of the cryostat. This pool, annular shaped, surrounds the 4.2 K parts of the feed box and acts itself as a 80 K radiation shield.

5 PRESENT STATUS (OCTOBER 1999)

The cryostat, currently under assembly, is to be cooled and tested at 1.8 K, at IPN Orsay, before the end of the year.

The feed box is being studied. A test of the whole cryogenic feature (Cryostat, feed box, and refrigeration system) is planned for April 2000.