CERN SRF ASSEMBLING AND TEST FACILITIES

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Abstract

CERN is currently upgrading and refurbishing its RF and cryogenic facilities in the SM18 assembly hall with the aim of testing SRF cavities and cryo-modules of various provenience. They concern new and spare cavities for the HIE-Isolde upgrade, SPL study and LHC collider. These projects require a redistribution of space, refurbishment of cleanrooms, modification of SRF test stands, of vertical cryostats and of all cryogenic lines. This article presents the specifications of the refurbished facility and the technical choices required for the assembling, processing and testing of superconducting RF cavities.

INTRODUCTION

CERN concentrates on the SM18 building final test operations of accelerator components. From the training of the LHC spare magnets to the assembling and test of the RF cavities, the SM18 building is thus divided in three parts, each of them attributed to the main discipline of super conducting accelerator technology: magnets, RF cavities and cryogenics. Within the RF activities, such as LHC, HIE Isolde and SPL cavities, some improvement and refurbishment of the facilities has been decided. This paper will present the actual facilities dedicated to RF cavities within the SM18 building, from the assembly to the test of the cavities and cryomodules, the upgrades currently in progress and the refurbishment plans.

SRF ACTIVITY OVERVIEW

Four SRF projects are currently running within the RF area in SM18 (Figure 1). Three new LHC spare cavities (400.8 MHz) need to be manufactured, tested and assembled to the one already detained in the purpose of giving to CERN a second spare cryomodule. Moreover, all the facilities remain ready in case of problems with the LHC accelerator cavities.

The HIE Isolde project comprises 32 quarter wave cavities (101.28 MHz) with a nominal gradient of 6 MV/m each, which need to be built and tested, resulting an assembly and tests of 6 cryomodules [1].

The SPL study requires the manufacturing of 4 cavities (5-cell cavities running at 704.4 MHz). These cavities will then be assembled into one short cryomodule. Due to the high gradient of these cavities, 25 MV/m, some improvement of the facilities, especially the cleanroom, need to be done to guarantee the cleanliness of the cavities.

Finally, the quadrupole resonator activity is dedicated to material surface studies (bulk niobium, niobium deposition on copper plate ...). This resonator operates at three frequencies: 400, 800 and 1200 MHz [2].

RF ACTIVITY OVERVIEW

In addition to SRF activities, two normal conducting RF projects use the SM18 facilities: the CLIC Test Facility 3 (CTF3) for which the assembly of their cavities is done in a cleanroom environment, and the LINAC4 project for the RF test inside the SM18 bunker.

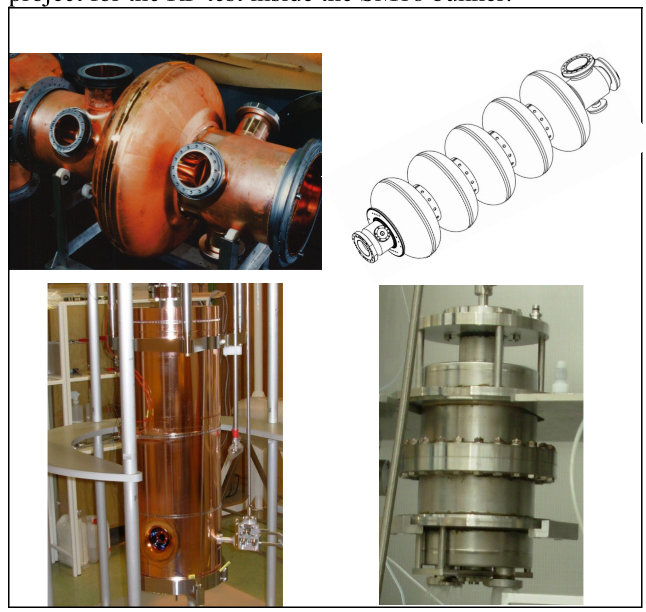

Figure 1: LHC cavity (top left), SPL cavity (top right), HIE Isolde cavity (bottom left), and quadrupole resonator (bottom right).

CLEANROOM FACILITY

Current Facility

The main cleanroom originally designed for the LEP cavity assembly, is composed of three parts, each 15 m long by 4 m large (Figure 2):

- A loading bay allows the positioning of the cryomodule and cavities on the rail system.
- A first class ISO 7 cleanroom (class 10’000), for the cleaning and preparation of the different elements and for the assembling of the CTF3 cavities.
- An assembling room, class ISO 4 (class 10), where cavity assembly into a cryomodule ant the mounting of the power coupler is done (LHC cryomodule).
- Entrance to the assembling room via an air shower.

Next to the main cleanroom, a “baldaquin” (softwall cleanroom), class ISO 5 (class 100), is used for the conditioning of elements that should enter into the main cleanroom, and for the assembly of the HIE Isolde cavity on its test stand.

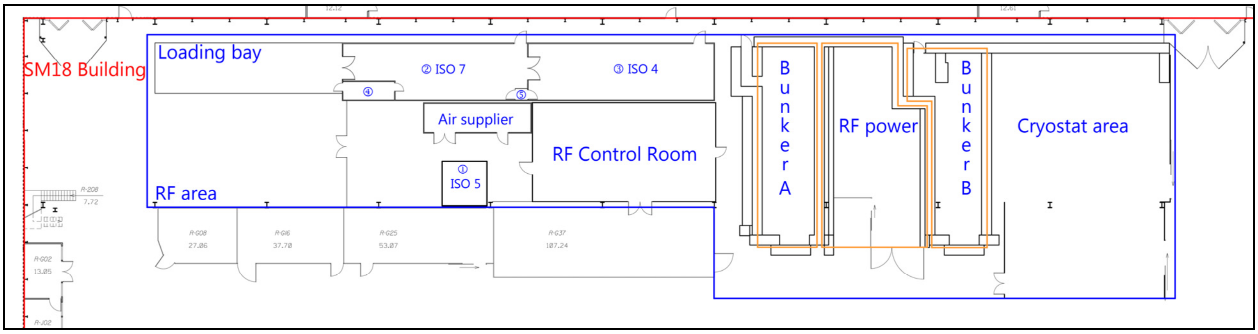

Figure 2: RF area within the SM18 building (①softwall cleanroom, ②preparing area, ③assembling room, ④personal access, ⑤air shower).

Cleanroom Upgrade Plan

To achieve the manufacturing of high gradient cavities (> 20 MV/m) for the SPL study, other and future applications, CERN decided the refurbishment of its cleanrooms. The aim of the plan is to better control the cleanliness, a critical parameter for high gradient cavities. To do so, cleaning and assembling operation need to be grouped into one single building. An increase of the cavity performance is also expected. The upgrade plan recommend thus to [3]:

- increase the cleanliness of the preparing room from ISO7 to ISO 5 in a spirit of reducing the cleanliness gap with the assembling room.
- build a new personal access, to increase the working space inside the preparing room.
- build a new ISO 5 room dedicated to the cleaning and the conditioning of the cryomodule elements.
- install of a new high pressure water rinsing system connected to the cleaning room, and therefore install an ultra pure water production system.
- improve the dust particle monitoring of the cleanroom.

To complete the upgrade plan for high gradient cavities, CERN will acquire an optical inspection system developed by KEK/Kyoto University. Moreover all this modifications will benefit the existing projects.

Finally, the installation of an additional ISO 5 “baldaquin” has been decided to allow the assembling of the HIE Isolde cryomodule. Due to the height needed for the operation, 5 m high, and to permit the use of crane, the baldaquin will be equipped with horizontal laminar flux (Figure 3).

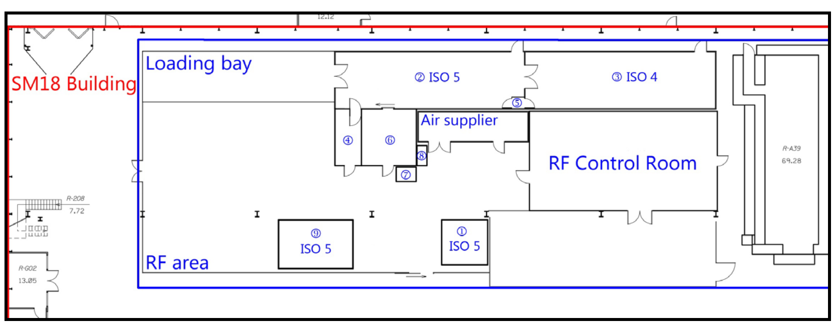

Figure 3: SM18 top view, delimited in blue the new cleanroom space as proposed in the last refurbishment plan (①softwall cleanroom, ②preparing area, ③assembling room, ④personal access, ⑤air shower, ⑥cleaning and rinsing space, ⑦ultra pure water production, ⑧high pressure rinsing, ⑨softwall cleanroom).

SRF CRYOSTAT

The SM18 SRF area is equipped with four vertical cryostats, from 2.5 m to 4 m deep. Each of them is dedicated to one activity and runs at different cooling temperatures:

- LHC cavities at 4.2 K
- HIE Isolde cavities at 4.5 K
- Quadrupole resonator at 2 K
- SPL cavities at 2 K

As the quadrupole resonator reaches the end of its current study and will be moved into the Cryolab outside of the SM18 area, it has been decided to refurbish its cryostat for the use of the LHC spare cavities or for the HIE Isolde cavity production for the end of summer 2011. If the second option is chosen, it will allow to compare the impact of the cleanliness onto the design of the HIE Isolde cavity (common vacuum for cavity and cryostat), as the actual cryostat is isolated from the assembly hall atmosphere by a clean structure.

RF BUNKERS AND RF POWER UPGRADE

Two RF bunkers are located, next to the cryostat area and allow the testing and conditioning of complete and large cryomodule. One is fully dedicated to LHC cryomodules and should be modified to allow the test of the HIE Isolde cryomodule in 2014. The second bunker will be refurbished for operation at 2 K and will be used for the SPL cryomodule test. Moreover, this bunker will be used as well for the test of the LINAC4 cavities.

Between the two bunker, the RF power supply area has been modified to facilitate the component integration of the new projects (SPL and LINAC4), such as the large SPL 50 Hz modulator, the LINAC4 modulator and the SPL klystron (Figure 4). Therefore the LHC high voltage bunker has been moved and refurbished to allow a better integration of the SPL 50 Hz modulator [4].

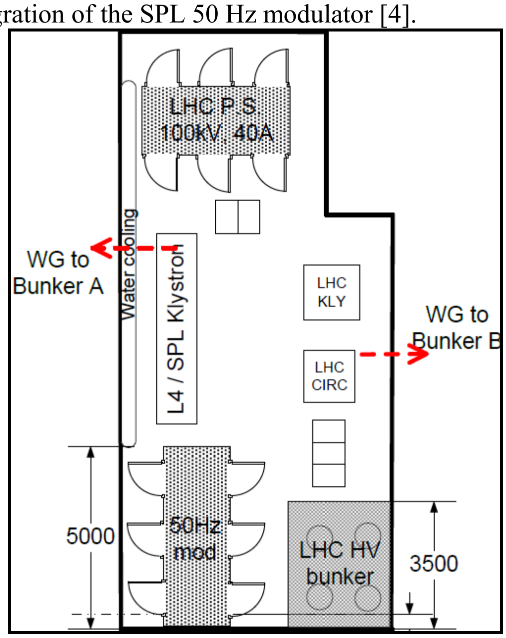

Figure 4 : RF power area, new configuration.

HIE ISOLDE CLEAN SPACE

Because vacuum of the HIE Isolde cavities is common with the cryomodule isolation vacuum due to the open beam hole, the cleanliness of the cavities have to be guaranteed when moving them from the cleanroom to the vertical cryostat. To do so, we used at first two mobile laminar air flow cabinets which were used to spread clean air on top of the cryostat when inserting or removing the cavities. However, the efficient clean area was small, and the laminar air flow was very sensitive to air turbulences. An improvement has been made by isolating the HIE Isolde cryostat area under a metallic structure, closed with PVC curtains (Figure 5). The laminar flow, still covering the cryostat, injects fresh and clean air inside this clean space, and therefore increases the general cleanliness by diluting the particle concentration. First particle measurements show an improvement by an order of magnitude from 100 to 1000 for the particle concentration and lead to a cleanliness level close to ISO5.

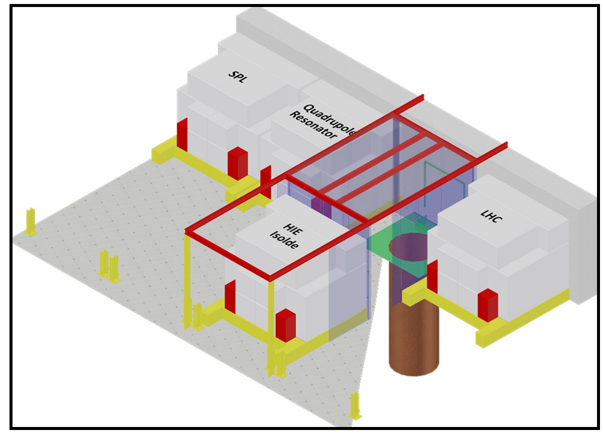

Figure 5 : schematic view of the vertical cryostat area with the clean space.

CRYOGENIC LINE UPGRADE

Originally designed for the LEP cavities, the cryogenic line operates at a temperature of 4.5 K. It was possible to cool cavities down to 2.5 K but only for short periods for diagnostics. An upgrade of the cryogenic line has therefore been decided to allow continuous testing at 2 K. The line, the cryostat and the interface in between, will be completely redesigned. The 2 K operating cryostats will thus be equipped with non flexible line and side connection. The two last cryostats, on the front (Figure 6), will keep their flexible line with a top connection.

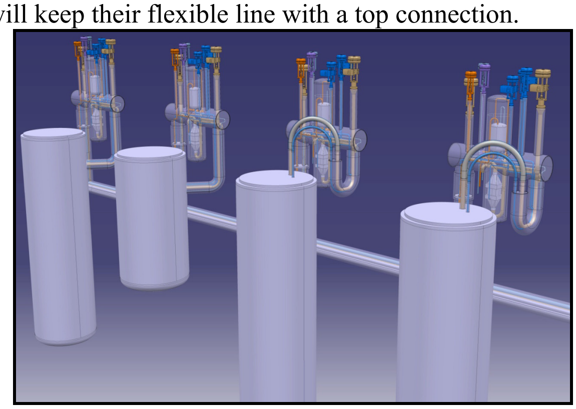

Figure 6: new design of the cryostat-cryoline interfaces around the vertical cryostats (two on the left for 2 K operation, two on the right for 4.5 K operation).

REFERENCES

[1] Matteo Pasini, SRF2011, *HIE-ISOLDE quarter wave Nb/Cu cavity,* CERN, SRF2011, Chicago, IL USA.

[2] Tobias Junginger, SRF2011, *Review of RF-Sample-Test-Equipment and Results,* CERN, SRF2011, Chicago, IL USA.

[3] Janic Chambrillon, *Cleanroom refurbishment in SM18 within the SPL project frame*, feasibility study, sLHC Project Note 0026

[4] O. Brunner, *High power RF tests places at CERN*, 4th SPL Collaboration Meeting jointly with ESS