

A NEW CLEANROOM WITH FACILITIES FOR CLEANING AND ASSEMBLY OF SUPERCONDUCTING CAVITIES AT HELMHOLTZ-INSTITUT MAINZ

F. Schlander*, R. Heine, KPH JGU, Mainz, Germany
 K. Aulenbacher, KPH JGU, Mainz, HIM, Mainz, Germany
 W. Barth, S. Mickat, GSI, Darmstadt, HIM, Mainz, Germany
 V. Gettmann, M. Miski-Oglu, HIM, Mainz, Germany

Abstract

The Helmholtz-Institut Mainz HIM will operate a clean room facility for the assembly and possible re-treatment of superconducting cavities. This is mandatory for several SRF accelerator projects, like the advanced demonstrator for a dedicated sc heavy ion cw-linac at HIM or other projects pursued by research facilities or universities close by. While the installation of the clean room is in progress, the procurement of the appliances is ongoing. The present equipment planned and the current status of the installation will be presented.

INTRODUCTION

Superconducting radio frequency technology is already in use in the Rhine-Main metropolitan area and several further accelerator projects are in progress. A new building for the Helmholtz-Institut Mainz (founded in 2009) - on the campus of Johannes Gutenberg-Universität Mainz is under construction and will be available for moving in in 2016. One of the six research sections is ACID (ACcelerator Design and Integrated Detectors), which deals with accelerator and detector development. The infrastructure for superconducting cavities at Helmholtz-Institut Mainz is mainly dedicated to a new superconducting heavy ion cw-linac [1], but will also provide excellent conditions for assembly and testing of other cavities and cryomodules. Besides a radio frequency performance test bunker and an area for testing of accelerator components, e.g. magnets, a large clean room with staged clean areas up to ISO 4 quality will be available, which will be described in the next section. To allow cleaning and mounting of cavities and cryomodules, devices for cleaning, assembly and quality control must be at hand. The devices to be used and the workflow will be described in the subsequent sections.

CLEAN ROOM

The clean room is located within the experimental hall in the HIM building, including a mounting rail allowing the assembly and sealing of full cavity strings under clean conditions in ISO 4, and to move it outside for further installations. In total, the clean room covers an area of about 155 m², including grey room for built-in appliances, air locks for personnel access and to load single cavities and equip-

ment into the ISO 6 and ISO 4 clean room. An overview of the clean room is displayed in Fig. 1.

It is designed to allow cleaning in stages from regular environmental pollution up to the cleanliness required - as has been proven to be sufficient for SRF - in the ISO 4 area. Air locks and an air shower ensure the boundaries for the staff between the different areas, while the cavities have to pass the HPR system to enter the ISO 4 level sufficiently cleaned. The maximum size of the cavities to be treated is approximately 1400 mm in length and 700 mm in diameter, which is sufficient for the largest type of cavities required for the heavy-ion cw linac project [2]. A summary of the dimensions is given in Table 1.

Table 1: Dimensions of the Clean Room

total length	19.5 m
total width	8 m
ISO 6 area	42 m ²
ISO 4 area	44 m ²

CLEAN ROOM INSTALLATIONS

The clean room will be equipped with all appliances to clean and to assemble superconducting cavities. During the earlier planning and approval phase, it has been refrained from installing a chemical polishing facility due to the high safety requirements. For wet pre-cleaning of the cavities a high pressure washer will be installed in the air lock between grey room and the ISO 6 area. To remove any kind of grease and contaminants, a cleaning station including an ultrasonic bath and a second bath for measuring the water conductance is foreseen to ensure a proper cleaning progress. In particular for the relatively heavy and bulky CH-type cavities, an automated lifting device will be included. A high pressure rinsing cabinet between ISO 6 and ISO 4 allows thorough cleaning of the inner cavity surface, as has been proven to be the treatment of choice to avoid field emission [3]. A furnace designed to either dry the cavity or to do the 120 °C bake, is available.

WORKFLOW

The workflow for cavity handling and the accessories is described separately. A flow chart is given in Fig. 2.

* schland@uni-mainz.de

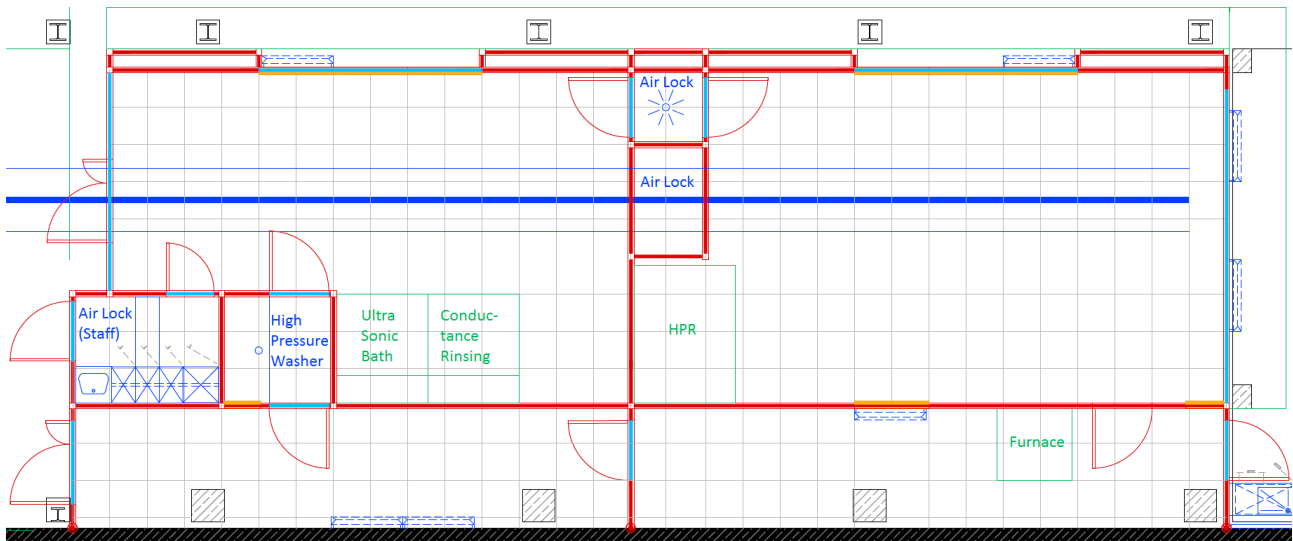


Figure 1: Overview of the clean room area (length 19.5 m; width 8 m). The left area is in ISO 6 standard and the right area in ISO 4 respectively. The corridor on the bottom is the grey room area, which is either used for bringing parts into the clean room or to install auxiliaries for larger appliances, like compressor for the HPR and vacuum pumps. © Dr. Heinekamp

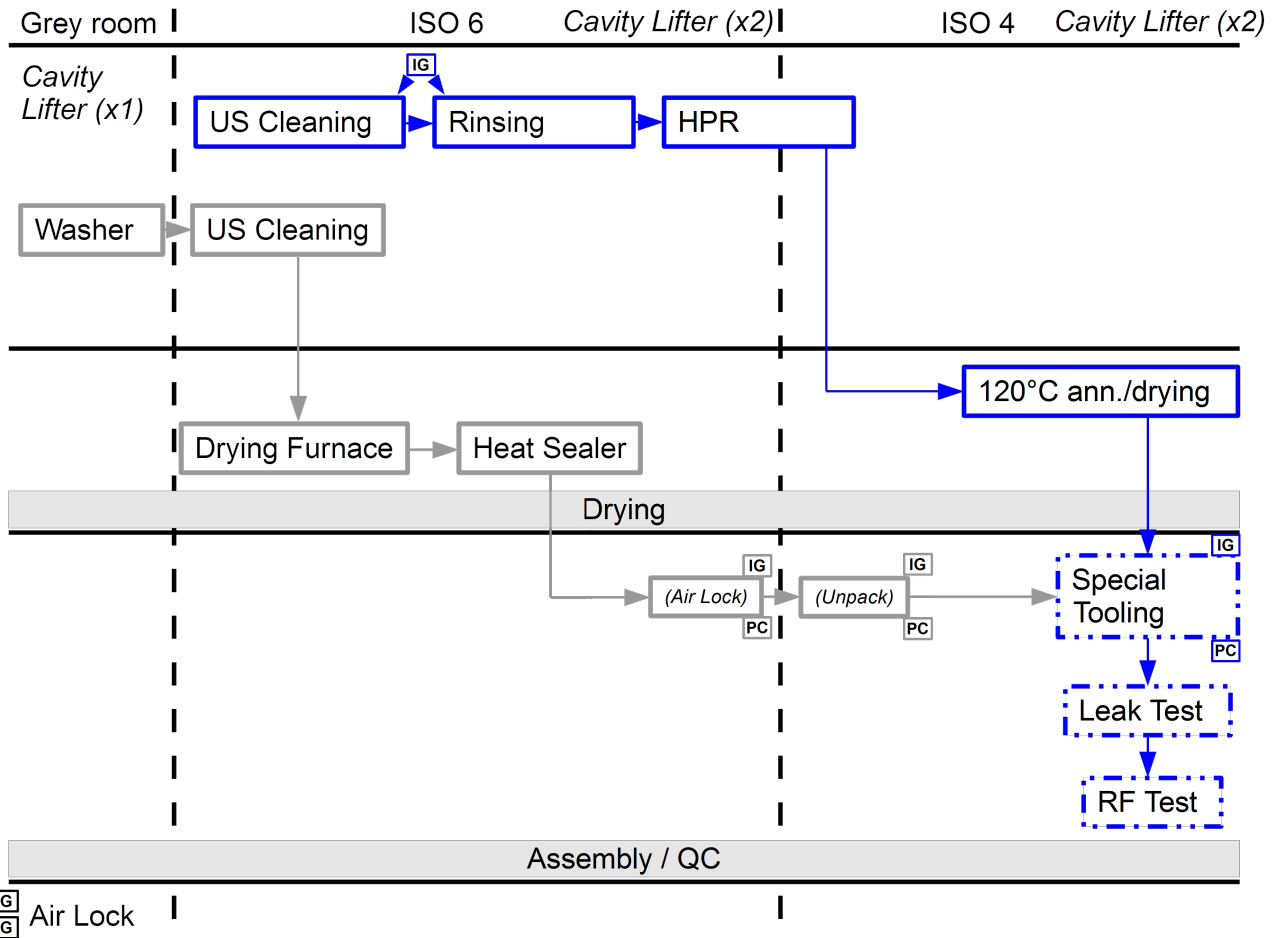


Figure 2: Work flow for cavity assembly and handling of accessories in the clean room. Grey represents the flow for accessories and tools, blue for the cavities (IG: Gun for ionised nitrogen, PC: Particle counter).

Cavities

Depending on the status, either the bare or the fully assembled cavity will be handed over from a lifter in the grey room onto a second one in the first airlock, continued by a thorough exterior cleaning with a high pressure washer. After removal of all detachable parts in the ISO 6 clean room, the cavity is placed in the ultrasonic bath and will be cleaned. Any grease will be removed by the addition of a soapy detergent. After this process, the cavity will be placed in a second bucket, filled with ultra pure water, and rinsed until the conductance of the water reaches an appropriate value.

Any remainders like particles and dust on the interior surface will be removed in a high pressure rinsing system. It consists of a wand with a set of nozzles on top spraying water with approx. 100 bar onto the surface. After the cavity has dripped off, it will be placed in a furnace to dry. Then the assembly of RF couplers and further parts take place. For this purpose, special tooling and control of particles which will be created by tightening nuts and bolts using ionised nitrogen and particle counters is required. After the cavity is fully sealed, a leak test and an RF test conclude the assembly in the clean room.

Accessories

All accessories, nuts, bolts, seals, tools, ... also have to be prepared for the clean environment and clean assembly. The wet cleaning will take place in the grey room area using an industrial washer with deionised water. In the next step the parts will be handed over into the ISO 6 area and receive ultrasonic cleaning. To avoid contamination and to allow storage of these parts, they will be dried in a drying furnace and then heat sealed in two plastic bags.

For assembly, the parts are brought into the ISO 4 area and unpacked. This is monitored by particle counters which will absorb the air flow from the ionised nitrogen guns that are used to clean the bags and the parts. Eventually, the parts and tools are ready to be used for assembly.



Figure 3: Exterior top- and sideview of the clean room: The outer casing is complete, while the installations inside are ongoing (see Fig. 4).



Figure 4: View inside of the clean room (same direction as in Fig. 3), from the ISO 4 area facing towards the ISO 6 and the air-lock area: The double floor is completed, while the installation of the filter-fan units, plumbing and electric installations is ongoing.

CURRENT STATUS

At present (September 2015), the clean room is under construction. Impressions from the construction site are given in Figs. 3 and 4.

Potential vendors for the tools and appliances to be installed and used in the clean room have been determined. The administrative processes for ordering are ongoing.

SUMMARY & OUTLOOK

The Helmholtz-Institut Mainz will provide excellent conditions for superconducting RF development and testing. This includes a large clean room which allows cleaning and assembly of all critical parts.

The construction of the clean room is ongoing and will be completed by end of the year, while the installation of the appliances will take place in 2016.

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