UPDATE OF THE DESY INFRASTRUCTURE FOR CAVITY PREPARATION

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Abstract

The clean room, set up in the early 90^{th} of the last century, is the main infrastructure for preparation of superconducting cavities at DESY. This clean room was completely renovated in 2009. The ground plan of clean room class ISO 4 was enlarged from 20 to 53 m² and the areas of ISO 7 of the old clean room were upgraded to ISO 6 and ISO 5 standard. Areas for ultrasonic cleaning, ultrapure water rinsing and chemical surface treatment were upgraded to ISO 4 standards. Multiple vacuum connections were installed to reduce movement of cavities. A 120°C heating chamber was connected to the ISO 4 assembly area and allows the in situ bake out of multi cell super conducting resonators. For industrial cavity production it was shown that a high pressure rinsing unit driven by a turbine pump allows feeding several high pressure rinsing stands in parallel. For cost reduction of ultra-pure water production and for increase of the amount of water in the cavity preparation cycle, a recirculation of rinsing water is under commissioning. Fixtures and tools for the assembly of the Beam position monitor and Quadrupol units (BQU) for the XFEL modules are installed and commissioned.

INTRODUCTION

In the last years an improvement on clean room technology took place. Beside reduction of energy consumption, more homogeneous air distribution by individual filter fan units (FFU) and more effective filters were developed. At DESY, the XFEL project was launched in 2007. Various activities like repair and upgrade of XFEL cavities, assembly of Quadrupol-Beam position monitor packages (QBU) for work package 9 of the linear accelerator consortium and the assembly of a 3.9 GHz module for the XFEL injector will take place in the DESY clean room. For these activities the DESY clean room was upgraded to the standards of 2009 and new improved infrastructure for the tasks within the XFEL project were developed.

UPGRADE OF INFRASTRUCTURE

Cleanroom Air Distribution System

The DESY clean room was built in early 90^{th}. Enlargement of space and upgrade of air quality of this cleanroom was limited by the two central fan units installed. In 2009 the clean room air distribution system and the clean room walls were replaced and the work spaces were adapted to the new activities (Table 1). Filter Fan Units (FFU´s) and an air shower were added and a new energy saving air condition unit was installed (Fig.1). That set up allows a flexible increase of space and air quality as required for the projects.

Table 1: Overview on ground plan and actual installed clean room air quality

Clean room part	Before refurbishing	After, refurbishing
ISO 4	20 m²	53 m²
ISO 5	112 m²	82 m²
ISO 6+7	ISO 7...65 m²	ISO 6…65 m²
Chemistry area	ISO 7...55m²	ISO 5 ...55 m²
Ultrasonic cleaning / UP rinsing	ISO 7	ISO 4
HP rinse 1+2	ISO 4	ISO 4

The FFU´s are self-controlling and can be set individually. These units are controlled by facility management software with online control of the homogeneity of the air flow volumes and distribution as well as air condition parameters. The FFU´s allow regulating and adapting the air volumes to keep the air flow conditions (laminar flow) constant, when air pressure and air distribution are disturbed by opening of doors.

Figure 1: Main clean room area (ISO 4/5) before installation of FFU´s.

Alarms are generated to inform the cleanroom crew when the FFU´s are not able to keep that laminar flow conditions any more. For power saving the air flow can be reduced during night or weekends.

Update of High Pressure Rinsing Stand

In 2007 a new high pressure rinsing stand (HPR 2) was installed [1]. In the last two years more than 340 HP rinses of two hours length each are done. According to the original design of the HPR, the turbine should allow to tune the range of water flow from 1m³/h up to 6 m³/h HPR water at 100 bar without new settings on the pump unit. After a standard 8 nozzle head had been replaced by a head holding 20 nozzles at the time, a flow rate of 2m³/h could be verified. No influence on flow rate or pressure stability during HPR runs of up to 6 hours was observed when changing back from the 20 nozzle heads to the original 8 nozzle head (Fig. 2). As a result, it is shown that the HPR 2 turbine will allow feeding more than one HPR stand in parallel at a time. In addition, reduced cost and vibrations in comparison to piston driven units are observed.

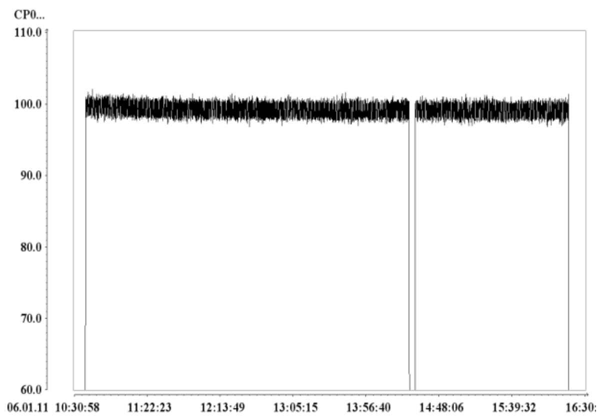

Figure 2: pressure vs. time diagram of HPR 2 runs equipped with 20 nozzles of 0.4 mm ID (water consumption 2 m³/h.

To reduce cost for ultra-pure-water (UPW) and to increase the UPW volumes required, a recirculation of the water of the HPR stand was installed (Fig. 3). TOC values and resistances (R) are controlled in parallel with an on line controller Anatel PAT 700 ® [TR 1]. Monitoring resistance and TOC values in parallel ensures that recirculated water will neither introduce bacteria or hydro carbides nor degrade the resistance of the main UPW system.

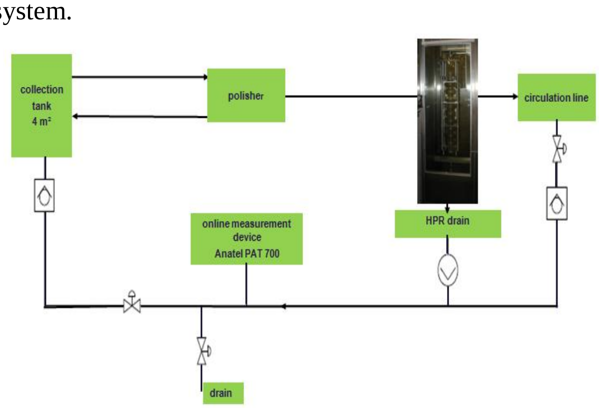

Figure 3: Schematics of the UPW recirculation installed in the DESY High pressure rinsing stand.

As long as the drain water quality does not meet the specified values the water is send to drain. Only, if the defined quality standards are fulfilled the water is returned to the storage tank.

120 °C Insitu Heating Chamber

For improvement of surface resistances at high gradients bake out of cavities (“baking”) is done at 120°C [2,3]. At DESY the bake out procedure is applied to fully equipped cavities under vacuum before vertical test [4]. During 120°C baking the aluminum alloy gaskets tend to become soft and are origin of leaks. Studies in different laboratories have shown that in-situ baking in inert gas or air, without vacuum inside the cavities, reduces the high gradient Q slope with the same efficiency [4,5] In 2011 a new 120°C oven (Table 2) is installed and connected to the DESY cleanroom (Fig. 4). It allows baking of cavities in Argon atmosphere inside the cleanroom right after chemical surface treatment and before the installation of accessories.

Figure 4: View from inside ISO 4 area on the loading area of the 120°C in-situ heating chamber.

The loading area (Fig. 4) is accessible from the ISO 4 assembly area. No influence on air quality and laminar flow conditions of the clean room is observed. The 120°C oven is under commissioning and a test will be done on a 3 - cell reference cavity.

Table 2: Data of the 120°C in-situ heating chamber

Temperature range	RT to 120 – 150°	
Inert gas overlay	Argon	
Oxygen reduction	Pump and purge	
Innert Gas quality	ISO 4 / 99.9999	
Leak rate	$5x10^{-1}$mbarl/s	
Dimensions:	Inside	Outside
Length	1600 mm	3100 mm
Width	600 mm	2100 mm
Heights	600 mm	1400 mm

NEW TOOLS DEVELOPED FOR XFEL PROJECT

BPM and Quadrupole Assembly

Quadrupoles (QP), beam position monitors (BPM), gate valves (GV) and vacuum control units (VC) for the XFEL Cryomodules are manufactured by collaborating partners and under control of different work packages of the linac consortium.

These subunits have to be combined to the beam position monitor and quad unit (BQU) in the DESY clean room. Assembly, alignment and handling, tools are developed that allow this assembly under ISO 4 air cleanliness conditions (Fig. 5). After completion and quality control (QC) the units are handed over to the CEA Saclay, France. In the clean room setup at CEA Saclay the BQU is connected to the accelerator cavities to complete the cavity string for the XFEL.

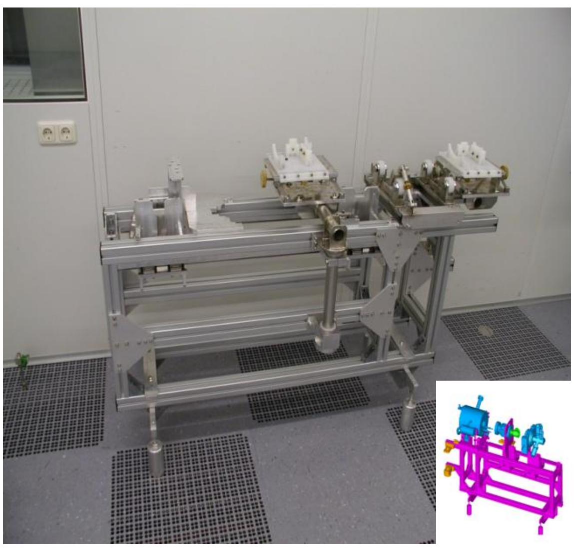

Figure 5: Alignment and assembly tool for the BPM, Quadrupoles and Gate valve assembly in ISO 4 cleanroom.

The vacuum and particle cleanliness of the BQU components have to fulfill the same conditions of cleanliness (ISO 4) as the resonators.

The individual parts of the BQU need to be aligned with very high precision. The precise alignment of BPM and quadrupol is ensured by a dowel pin, while the alignment of the GV has to be ensured by the assembly fixture. The BQU are high pressure rinsed after assembly and leak test. BPM pickup, antennas and button monitors are sensitive against the forces introduced by the HPR and need a very precise adjustment. They are installed after HPR just right before the final leak check.

Table 3: General processing steps for assembly of the XFEL BPM quadrupol units

1	Alignment and fixation of Quad	Horizontal
2	Alignment of BPM in respect to Quad dowel pin	Horizontal
3	Connect BPM and Quadrupol	Horizontal
4	Leak check of unit	Horizontal
5	High pressure rinsing of unit	Vertical
6	Drying of unit	Vertical
7	Alignment of gate valve to BPM	Horizontal
8	Connect BPM/Quad and gate valve	Horizontal
9	Leak check of unit	Horizontal
10	Installation of antennas	Vertical
11	Installation of pressure control unit	Horizontal
12	Final leak check and transportation	Horizontal

For the operations, shown in table 3, the BQU with a total weight of 130 KG has to be turned from vertical to horizontal positions and back several times without influencing the ISO 4 cleanroom conditions or losing the alignment precision. The tools developed were applied successfully on the assembly of the BQU in Module PXFEL 3 and PXFEL 2 [6].

Helium Tank Acceptance Test

For half of the XFEL resonators DESY took over the responsibility of procurement and quality control of the titanium helium vessels. The vessels will be fabricated by subcontractors and handed to the cavity manufactures in industry by DESY. To ensure the quality of all the vessels a test tool was developed (Fig. 6).

Up to six helium tank units per week have to be tested. The intensive quality control has to ensure that all parts will fit to any of the resonators manufactured. First tests on existing Helium tank for flash cavities show that the acceptance test with all parameters controlled can be done by one technician with 20 minutes.

For calibration of different test stations a master piece is fabricated and will be handed over for calibration to different test set ups.

Figure 6: control device with Helium tank installed for quality control.

CONCLUSION

The DESY clean room, which will be used for portions of the XFEL production, was renewed and set up to the state of the art in 2010. A water recirculation for the daring water coming from the high pressure rinsing stand was installed and commissioned.

New fixtures and tools for assembly of Quadrupole-BPM packages were set up and tested.

To reduce risk of leakages during 120°C baking an in-situ heating chamber is connected to ISO 4 clean room area and is under commissioning. To ensure the quality for the Helium vessels for the XFEL Cavities, a test and acceptance tool was installed, commissioned and is now ready for use.

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[TR1] ® Anatel PAT 700