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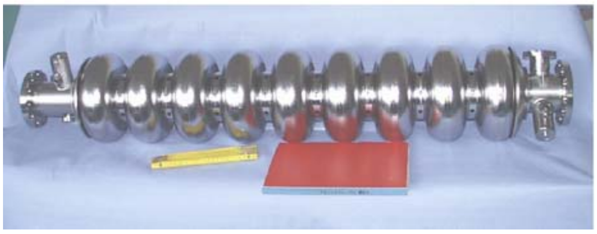

CLEAN-ROOM FACILITIES FOR HIGH GRADIENT RESONATOR PREPARATION

K.Escherich, A.Matheisen, N.Krupka, B.Petersen, M.Schmökel
DESY, Hamburg, Notkestraße 85, 22602 Hamburg, Germany

Abstract

In 1991 a clean room facility to serve for high gradient super conducting cavity treatment- and preparation technique was set up at DESY. Since then several improvements on the infrastructure were made. A total of 88 multi cell TTF / TESLA design resonators with acceleration gradients of up to 39 MV/m [1] have undergone treatments in this facility. We report on experiences of the individual infrastructure components and the flow scheme of cavity preparation. Experiences on infrastructure maintenance procedures and improved quality control of the infrastructure will be presented. Basing on these experiences and the state of art of clean-room technology in 2005 a baseline lay out for an advanced cavity preparation and assembly infrastructure will be discussed.

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Abstract

In 1991 a clean room facility to serve for high gradient super conducting cavity treatment- and preparation technique was set up at DESY. Since then several improvements on the infrastructure were made. A total of 88 multi cell TTF / TESLA design resonators with acceleration gradients of up to 39 MV/m [1] have undergone treatments in this facility. We report on experiences of the individual infrastructure components and the flow scheme of cavity preparation. Experiences on infrastructure maintenance procedures and improved quality control of the infrastructure will be presented. Basing on these experiences and the state of art of clean-room technology in 2005 a baseline lay out for an advanced cavity preparation and assembly infrastructure will be discussed.

INTRODUCTION

Clean-room technology is one of the essential technologies in the preparation of superconducting accelerator technologies. For a project like TTF 2 [2] and the proposed linear accelerators XFEL at DESY [3] and the ILC [4] this technology has to be transferred to an industrial standard. Beside the hardware installation intensive quality control and an optimization of workflow and individual work steps is needed. We report on the experiences gained on the DESY TTF clean-room and present a proposal for an optimized clean-room lay out, adapted to the flow scheme of superconducting resonators. The qualities of process media like ultra pure water, Argon or Nitrogen for cavity ventilation have to fulfill the same standards as the clean room air. Improvements made on the quality control for the TTF clean-room process media are presented.

LAY OUT OF A CLEAN-ROOM FOR CAVITY PREPARATION

The DESY clean-room was installed in 1991 and designed for preparation of a total of 24 resonators [4]. Since then several improvements have been made and the infrastructure is converted in a way that up to 60 new resonators will be processed within the next three years. The general lay out of the DESY clean-room [ref] could not be changed and adopted to the new preparation steps invented during the last decade. Each cavity has to undergo a total of 24 different work steps before the first RF test at 2K (See table 1).

Cavity preparation steps	EP	location
Ultrasonic cleaning		cl 10000
Material Removal of X µm inside	160 (EP)	normal air
Outside chemistry µm	20 (BCP)	cl 10000
800 C annealing	3h	normal air
1400 C post purification		cl 100
Tuning	X	normal air
Ultrasonic cleaning	X	cl 10000
Removal of µm	45 (EP)	normal air
Cleaning for clean-room (USE)	Yes	cl 10000
Exchange of flanges	X	cl 10000
Low pressure rinsing to	18	cl 10000
High pressure rinsing	1 time	cl 10
Drying over night	X	cl 10
Assembly of components	X	cl 10
High pressure rinsing	6times	cl 10
Assembly of antenna	X	cl 10
Rf test at 2K	X	normal air

Table 1:List of major preparation steps applied for preparation of s.c. resonators at DESY

At the DESY clean-room parts of the equipment like pumps, filter units and the high pressure rinsing (HPR) stand are located in a small room in the middle of the clean-room. This room is of so called gray room quality (10000 -100000). The only excess to this room for maintenance is by passing the clean-room class 10000. It can not be avoided that cross contamination appears. For an optimized lay out a U-tube-like arrangement of the different clean-room classes around the maintenance area has to be chosen. The principle lay out of an optimized clean-room infrastructure is shown in figure 1. All infrastructures are lined up according to clean-room classes and it includes all need for cavity preparation and work flow of cavity preparation like in use at DESY.

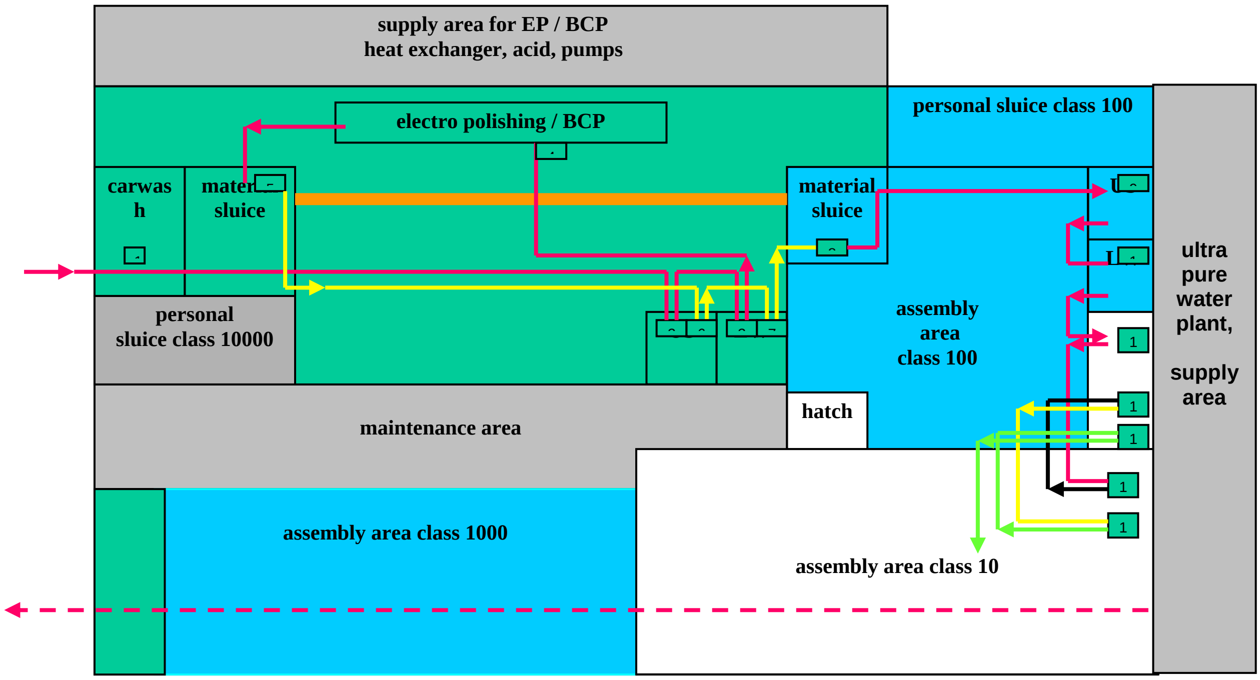

Fig.: 1 Cross section of an optimized clean-room; arrows = flow lines of preparation steps as shown in table 1

RELIABILITY OF THE DESY CLEAN-ROOM INFRASTRUCTURE

During the past decade major problems on reliability of some components turned out. In addition to the reliability the correlated shut down time of the whole infrastructure is implemented in the statistic of Table 2. The chiller of the air conditioning and the HPR equipment turned out to be the major components for the shut down time of the TTF clean-room. A spare chiller was installed and reduced down time to less than 2h. A new HPR stand with improved design and new clean-room infrastructure is under construction. The existing HPR stand will serve for the first rinse after wet surface treatment and as back up system then.

Equipment	Event	origin	Result	recovery
HPR				
Broken diaphragm	1 / 12 years	HP-pump steering	oil in system	16 weeks
Broken filter	6 / 12 years	installation	particle contamination	6 weeks
hardware of HP stand	2 / 12 years	wear out	mechanic blocked	12 weeks
Ultra pure water				
bacteria contamination	1 / 12 years	broken UV lamp	Filter clogged	8 weeks
maintenance on Filter	1 / 1 year	live time	particle contamination	2 weeks

Table.: 2 Reliability of specific components of the TTF clean-room

QUALITY CONTROL AT THE TTF CLEAN-ROOM

In 2003 two new components for quality control have been installed at DESY [4]. Beside basic studies they serve for standard control of the TTF clean-room. The air fog generator allows visualizing the laminar flow in such a way, that components can be modified according to the clean-room standards. Impurities can be discerned during fabrication. The online TOC control allows monitoring the UP water line continuously and serves as quality control check on expendable items like the ion exchanger.

Ultra pure water system

For the ultra sonic cleaning, rinsing of cavities, high pressure rinsing and for rinsing after electro-polishing up to 1 m^3/h of ultra pure water (UP water) are necessary. After an upgrade the DESY UP water system can supply 1,4m^3/h at 18.2 MΩ/cm resistances. A 4 m^3 tank is installed to buffer the consumption and guarantee continuous operation over one 8 hours shift. To prevent bacteria growth a 2, 2 KW ultra violet lamp is installed [4]. As quality control of the UPW main parameters as shown in table 3, are monitored.

Since Jan 2005 the TOC content of the UPW is monitored online. After service on the ion exchangers the

UP water line needs about 24 hours to recover. Typical values during the continuous operation are 0, 5 to 1, 3 ppb of TOC. This TOC measurement is also in use for quality control of suppliers. A resin from a new supplier showed TOC values of up to 500 ppb for several days (Fig.:2). This supplier was rejected from the DESY supplier list.

MEASUREMENT	MONITORING	EQUIPMENT	SEQUENCE
Particles	Online	liquid particle counter	one per weeks
TOC	Online	TOC	once / ?? weeks
Resistance	Online	Resistant meter	on line
Bacteria	Sampling	Millipore filter systems	One per 2 weeks
Rinsing water from HPR stand	Sampling filters	scanning light microscope	every rinse

Table 3: List of quality control steps for the DESY UP water system

During a break down of the UV lamp the TOC content of the DESY UPW system increased from typical 1 to more than 100 within 6 days. The UPW system needed more than 24 hours to recover when the UV light was set back to operation.

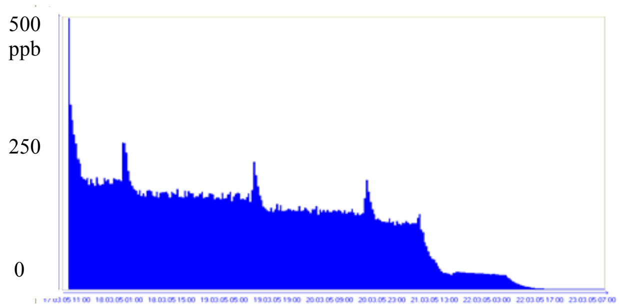

Fig.2: Recovery of TOC after installation of an ion exchanger of a new supplier. X scale= 6 days

Clean-room air

The DESY clean-room is equipped with two central fan units. A Breakdown or maintenance of one fan unit results in turbulences in the laminar flow inside the class 10 and 100 (Fig. 01/02). Particle measurements showed that the clean room air recovers in one hour. Visualization of the air distribution by a fog generator during a fan unit shut down showed that the top to bottom laminar converts

Fig. 3: Influence on laminar flow conditions during fan unit shut down. left: regular laminar flow - right: one fan unit switch off causes horizontal flow in class 100 area

to a horizontal flow towards the class 10 area (Fig.:3). Origin of that behavior is a back stream of particles from the air. This effect appears from exhausting slots in the floor region, the door sealing and overpressure in the class 10000 area (chimney effect).

AUXILLARIES

Gray area

For maintenance on pumps, the ultrasonic bath, the high pressure rinsing stand, liquid particle counters as well as the BCP stand it is necessary to enter the grey area of the clean-room. At that point cross contamination of the class 10000 area can not be avoided. No sluices from class 100 to the grey area are installed.

Air showers and sticking mats, installed inside the grey room reduce the cross contamination. Even with this equipment installed strong contamination of the class 10000 was found after major repairs.

High Pressure Rinsing Equipment

One major tool of cavity preparation is the high pressure rinsing system (HPR stand). Even if the over all reliability of this component is very high, a breakdown results in a re qualification of the system which takes for several weeks. A list of major problems found on the DESY HPR stand is given in table 2.

CONCLUSION

The DESY clean-room is running for 12 years now. New preparation steps for cavity treatments like electro-polishing and a multiplicity of rinsing of cavities by high pressure rinsing after is added to the cavity preparation steps. Partially the DESY infrastructure could be adopted to these needs. A proposal for an optimized cavity preparation clean-room is made. Reliability of components are studied and an intensive quality control of the infrastructure is installed.

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