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

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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
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preparation and assembly infrastructure will be discussed.

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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).

<table>
<thead>
<tr>
<th>Cavity preparation steps</th>
<th>EP</th>
<th>location</th>
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</thead>
<tbody>
<tr>
<td>Ultrasonic cleaning</td>
<td>160 (EP)</td>
<td>cl 10000 normal air</td>
</tr>
<tr>
<td>Material Removal of X µm inside</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside chemistry µm</td>
<td>20 (BCP)</td>
<td>cl 10000</td>
</tr>
<tr>
<td>800 C annealing</td>
<td>3h</td>
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</tr>
<tr>
<td>1400 C post purification</td>
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<tr>
<td>Tuning</td>
<td>X</td>
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<tr>
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<tr>
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<tr>
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<td>cl 10</td>
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<tr>
<td>High pressure rinsing 6times</td>
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<td>cl 10</td>
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<td></td>
<td>cl 10</td>
</tr>
<tr>
<td>RF test at 2K X</td>
<td></td>
<td>normal air</td>
</tr>
</tbody>
</table>

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.
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.

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 m³/h of ultra pure water (UP water) are necessary. After an upgrade the DESY UP water system can supply 1,4m³/h at 18.2 MΩ/cm resistances. A 4 m³ 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.

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.

**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.

**REFERENCES**


[4] International linear collider;
http://www.linearcollider.org


[6] Proceedings of the 12th workshop on RF-superconductivity 2005, Cornell, USA, N.Krupka et all ; to be published