SET UP OF PRODUCTION LINE FOR XFEL BEAM-POSITION MONITOR AND QUADRUPOL UNITS FOR CAVITY STRING ASSEMBLY AT CEA

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Abstract

The super conducting (s.c.) accelerator models of the XFEL consist of eight s.c. resonators, one s.c. quadrupol magnet and one beam position monitor. These components are connected to a so called cavity string under the guidance of the XFEL WP 09 activities inside ISO 4 cleanrooms.

String assembly is done at CEA IRFU while the beam-position monitor and Quadrupol units (BQU) are cleaned and pre-assembled to the "ready for installation " status inside the cleanroom at DESY. The cleaning and assembly of components requires cleanliness of ultra-high-vacuum (UHV) conditions as well as condition of particle free surfaces. The setup of infrastructure, the qualification of processes and transport as well as the ramp up to a delivery rate of 1 BQU per week will be presented.

INTRODUCTION

For the XFEL project activities of the linear accelerator consortium, the assembly of the accelerator module units takes place at CEA Saclay France [1].The Quadrupole Beam position monitor Units (BQU) cleaning and completion is done in a DESY cleanroom. The complete BQU´s are sealed in the DESY ISO 4 cleanroom and send to CEA. For this task activities new improved infrastructure of cleaning and completion of BQU assemblies are developed in the last years. For the XFEL accelerator 102 modules will be installed in the tunnel. Out of the 102 units 70 will be equipped with beam position monitors (BPM) designed by DESY [2], 32 modules will be equipped with a bpm [3] designed and produced by CEA Saclay.

PARTS OVERVIEW

The different parts for the Quadrupole Units are manufactured by collaborating partners and under control of different work packages of the linac consortium. Before handed over to the DESY cleanroom for assembly to a BQU all parts are tested and pre-cleaned by the responsible groups at DESY. The Quadrupoles (QP) produced by TRINOS VACUUM PROJECTS S.L. [4] and ANTEC S.A. [5], and tested for magnetic properties at room temperature and at 2 K by DESY group MKS-4 [6]. After copper plating of the beam tube they are cleaned by ultra-sonic cleaning, rinsed by ultra-pure water rinsing and controlled by vacuum leak check and RGA by DESY group MVS before hand over for installation to the BQU.

PREPARATION OF BQU SUB UNITS

All beam position monitors (BPM) are ultrasonic cleaned, rinsed by ultra-pure water and controlled by vacuum leak check and RGA by DESY group MDI [7]. The gate valves (GV) and vacuum control units (VC) are cleaned and leak checked by DESY MVS group before hand over [8, 9]. At DESY ISO 4 cleanroom there is no additional incoming inspection installed because all parts are prepared and handed over in status "ready for installation". To ensure that quality of cleaning is preserved during internal transports and handling different transport test are made before starting the serial production. For the internal transport at DESY the smaller parts (bpm, gate valve) are double wrapped into cleanroom foil applicable for ISO 4 cleanrooms [10].

The XFEL Cryomodul assembly takes place at CEA Saclay in France, about 1000 km away from the DESY cleanroom. For the quadrupole and the complete BQU (Fig. 1) a platform is designed and tested which allows the transport from cleanroom class ISO 4 to ISO 4 over long distances.

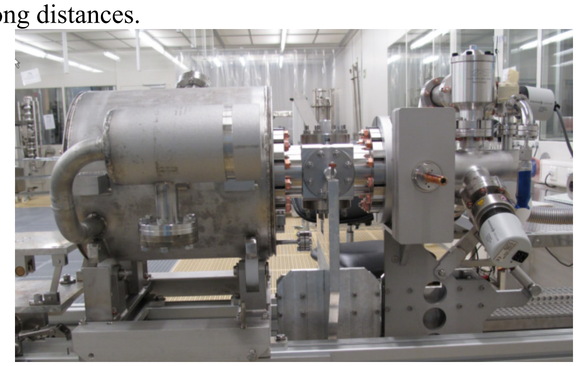

Figure: 1 View on the completed BQU in ISO 4 Cleanroom DESY.

TRANSPORT ACCESSORY

The transport of the BQU is done with a transport system which consists of an inner box for the unit and an outer frame which is able to absorb shocks during the transportation. For the development of the system the most important point was to keep the cleanroom requirements of ISO 4 air quality. The inner box (weight: 250 kg) is made for transport under ISO 4 conditions. Different tests on particle contamination and cleanliness conservation have been done before the first unit was transported.

Inner box:

Before usage the inner surface is cleaned and a particle quality control is done.

Table 1: Test Sequences for Qualification of Inner Transport Box

1.	Store in class ISO 6 for one week.
2.	Store in production hall for one week.
3.	Cleaning the outer surface with car wash (high pressure cleaning with ca. 60bar ultra-pure water).
4.	Load into a transporter, short tour.
5.	Transport to CEA Saclay and back.

With the tests sequences (table 2) it is shown that the transport could not influence ISO 4 cleanliness over the whole distance until BQU is unpacked inside the ISO 4 cleanroom at CEA.

The total weight of the transport system including the BQU installed is about 500 kg. It has to be handled by a fork lifter or cranes. Crane hooks and fork lifter connections are installed on the transport unit. For transport and handling inside the cleanrooms a special carrier is set up (Fig. 2).

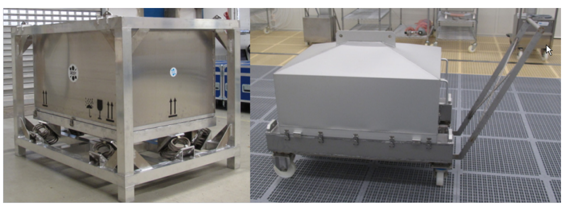

Figure 2: View on the completed BQU in ISO 4 Cleanroom at DESY.

The assembly rate for modules at CEA is one module / week, requesting an assembly and delivery rate of more than one BQU to ensure a minimum hand over rate of one BQU per week and a safety margin in case of transport problems.

The assembly sequence and timetable set up for the assembly rate is given in table 2.

During all assembling steps the ISO 4 cleanness and the alignment conditions could be preserved even though the high weight of the BQU and the used fixture with the risk of particle contamination during handling. A careful handing is essential. Particle check of the beam tube during the final assembly step at DESY, the documentation of the acceleration sensor during transportation and the experiences of the first module assemblies at CEA Saclay have shown that no significant change of cleanness during assembling and transportation occurs. Up to now 12 units are assembled. A production rate of up to 2 units per week in steady state assembly processes is reached.

Table 2: Time Table of the most Relevant Assembly Steps of BQU Assembly inside ISO 4 Cleanroom at DESY

Step	Description	Time
1.	Alignment and fixation of Quad	time
2.	Alignment of BPM in respect to Quad dowel pin	first day
3.	Connect BPM and Quadrupol	first day
4.	High pressure rinsing of unit	first day
5.	Drying of unit	first day
6.	Alignment of the UHV Feedthrough	over night
7.	Leak check of unit	second day
8.	Alignment of gate valve to BPM	third day
9.	Connect BPM/Quad and gate valve	third day
10.	Leak check of unit	third day
11.	Final leak check and transportation	fifth day
12.	EDMS documentation	fifth day
13.	Prepare components for the next assembly	fifth day

FIRST EXPERIENCES ON BQU ASSEMBLY

Up to now 12 units are assembled. It is proven that only four major assembly tools (table 3) are need for a reproducible and successfully work flow.

Table 3: Fixtures and Tooling Applied for BQU Assembly

1.	Horizontal assembly device
2.	Turn device for changing the orientation (necessary to change the orientation for high pressure rinsing)
3.	Wear frame for the HPR system
4.	Transport device to move the different components

TRANSPORTATION OF BQU

In order to ensure that one accelerator module could be assembled per week, it is foreseen that one BQU will be shipped per week. In addition a stock of units will be installed at CEA Saclay. The stock consists of a unit with a Button bpm [7] and a BQU unit with a Reentrant bpm installed to it [10]. Therefore five inner transport boxes and four outer frames are produced (Fig. 3).

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Figure 3: View on the Transport Accessories.

The weekly transfer is done by a commercial truckage company. For highest flexibility and short hand transport the transport frame is designed that it could be shipped by a normal van over night as well (Figure 4).

Figure: 4 View to the Transport Frame for the Transport of BQU´s.

During each transport the vibration to the unit is monitored by a programmable Accelerometer [10]. The same type of accelerometer will be attached to the cavities which are transported with the same truck at the same time. It is currently under investigation, if it is necessary to provide all transported components with individual accelerometers or if monitoring the truck is sufficient. The wake up point (start of data storage) of the shock logger is set to 1,5g. Maximum allowed g force at the BQU is 3g. Above the wake up point data are stored in time resolution of 0,5 sec.

Until now during 6 transports none of the data sets are recorded showed values above 4g, below 3g it is foreseen that the transported components can be used at it is, without any restrictions, only the origin of the shock has to be identified by the GPS control of the truck.

OPEN ITEMS

Vacuum shows reduction from $1*10^{-8}$ mbar as installed at DESY to $1*10^{-2}$ mbar when unit is checked at CEA. Leak test at CEA showed same leak rate of <= $1*10^{-12}$ mbarl/min as detected at DESY. To find origin of degradation of total pressure studies are on the way to see if out gassing of copper plating or commissioning of the multi range gauges are responsible for the reduction of total pressure.

CONCLUSION

Twelve BQU units are assembled in the ramp up phase of BQU assembly at DESY until now. No major problem of the pre-cleaning and hand over of subcomponents at DESY is found. A production rate of more than one BQU per week is shown. Six units are successfully transported to CEA. Three Units BQU 001_C, 005_C and 004_R are assembled to Module XM-3, XM-2 and XM-1.

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