Abstract

The European XFEL is a 4th generation synchrotron-radiation source, currently under construction in Hamburg. Based on different Free-Electron Laser and spontaneous sources and driven by a superconducting accelerator, it will be able to provide several user stations with photons simultaneously. Due to the superconducting technology in the accelerators modules many components have to operate at liquid helium temperature. This poster will concentrate on high frequency ultra high vacuum feedthrough used for the beam position monitors of the cryogeneric accelerator modules. Main emphasis will be put on the design of these feedthroughs, their material composition and the production process. The capability to be used under these very special conditions was investigated with FEM simulations, as well as with a test procedure. The results of these simulations will be presented; the tests and their results will be explained in detail.

Series production

The serial production described the steps of final changes and fabrication

Steps of mass fabrication

- Tolernances simulation related to real production drawings of suppliers
- Last mechanical design changes if necessary
- New call for price to qualified vendor
- Placing serial production
- Start up meeting at plant of vendor
- Communication “by tour for” and milestones
- Quality check of delivery parts like cleanliness, visual inspection, RF and mechanical properties
- Cryogenic test (3 cycles, mass production procedure)
- Preparation to assembly to BPM bodies
- Finishing quality documents and procedures
- Last vacuum leak check and mass spectrum analysis together with quadrupole units

Test procedures and analysis

Cryogenic tests cycles

- R&D Design properties

- Prototype incl. Leak check

- Assemble test of feedthrough to body with the calculated tightening torque in order to check one of the critical tolerances (deepness of the button into the body)

- Mass production

- FEM-analyses

- Cryogenic analysis

- Assembly tests

- Measure the RF parameters

Prototyping

- Prototypes incl. Leak check

- Assembly test of feedthrough to body

- With the calculated tightening torque in order to check one of the critical tolerances (deepness of the button into the body)

R&D Design properties

Electronic properties:

- Impedance: 50 Ohm
- Highest operating frequency: 2.5 GHz
- Bunch Charge: from 0.1 to 1 nC @ 10 Hz
- max: 1 nC @ 10 Hz
- Spark over voltage: high
- Glass to sealing metal: low E
- Button diameter: 10-30 mm
- Return loss < -10 dB

Mechanical properties:

- Operating temperature: 4K
- Temperature range: 30K - 4K
- Vacuum tightness: 1x10^-10 mbar/la under 4K
- Purity: Cleanroom Class 5 and better
- All materials: permeability < 1,02, non magnetic
- UHV sealing: full metal gasket
- Servicing: removable no welding
- Reliability: very high
- Isolation to metal: matched to RF properties
- and joined by welding, vacuum firing or brazed in an vacuum oven under pressure and high temperatures
- Beam pipe diameter: 78 mm

Conclusions and Outlook

- Mechanical tolernances fulfilled RF simulations results: “Knob” material defined of copper, due to wake loss simulation
- 40 prototypes passed all tests, incl. cryo cycles (titanium and sild flange material)
- And 320 serial items passed just as well all tests
- FEM analysis and practical tests defined the flange assembly process, forces, friction and tightening torques to guaranty the 0.1 mm accuracy
- Due to assembling test a very good correlation between FEM analaysis and practical test to squeezed the diamond aluminium gasket to 0.3 mm
- TiFe 4V alloy-nuts and set nuts (A-4 B 8) are a suitable combination
- Brazing technology to titanium to AlCu2 provided sufficient stability for cryogenic applications
- Suitability for application and cleaning in class 5 and 4 cleanrooms
- Good UHV performance
- Non magnetic and robust design with an N-connector for cabling

- It took 4 years to develop the cryogenic Feedthroughs for E-XFEL, from the idea to the first production, and the first quality checks. Special attention has to be given to the feedthroughs which need to be produced with high precision and high quality in parallel or even before the mechanical design and electronic readout concept is ready

- Based on the experience with the feedthroughs for the cryogenic environment, a second project was started to develop and produce also a custom made feedthrough, especially suited to the requirements of these driven facilities like E-XFEL. These production of feedthroughs went to glass to metal sealing technology in microscope-controlled furnaces. This technology brings more than one advantage, because these glass-ceramics have a better resistivity perpendicularly than aluminas. They have very low porosity, low or negative thermal expansion coefficients, low dielectric loss, high mechanical strength, very high thermal shock resistance and high abrasion resistance to chemical substances.

- Customer designed feedthroughs with very low voltage standing-wave ratio losses and with special mechanical characteristics are possible.