Single Cell Cavity Program for the XFEL

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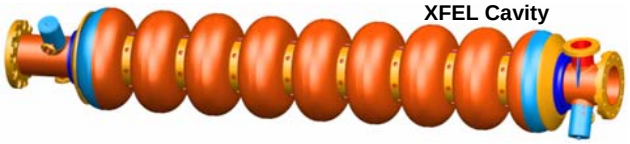
XFEL X-Ray Free-Electron Laser

DESY



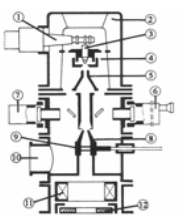
XFEL Cavity

Abstract:

The future European X-ray Free Electron Laser (XFEL) is based on 1.3 GHz 9-cell Nb cavities mainly identical to the proven TTF cavity design. In order to establish the fabrication process of approx. 1000 cavities for the XFEL a test cavity program was initiated at DESY. The program consists of fabrication, preparation and RF testing of approx. 30 single-cell cavities. Design, documentation and qualification of the whole DESY internal fabrication are established. The first single-cell cavities are produced and successfully tested.

DESY Electron Beam Welding Machine

Voltage:	70 - 150 kV
Beam power:	max. 15 kW
Beam current:	0 -100 mA
Chamber size:	3300 x1400 x 1600 mm (ca. 7,4 m³)
Vacuum:	> $5x10^{-6}$ mbar (ca. $2x10^{-8}$ mbar)
Pumping time:	ca. 20 min = 3x10-6 mbar
2 Cryogenic - Pumps:	ca. 2 × 10.000 l/s
Displacement along the X-Axes	ca. 1400 mm



Main objectives

1. Qualifying of new Nb suppliers
   - Cabot (USA)
   - GIREDMET (Russia)
   - Plansee (Austria)
   - Ningxia Orient Tantalum Industry Co. (China)
2. Rework the specification for fabrication of 9- cell cavity
   - Check the eight hours rule etc.
3. Rework the Nb specification:
   - Nb with high thermal conductivity (RRR 700-900)
   - Check the Ta content
4. Cavity from ingot with very large grain

First step: qualification of the DESY EB welding device

large grain ingot discs

Nb disc from large grain ingot

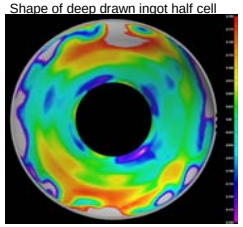
Shape after deep drawing

Deep drawing by one flexible tool

Optical 3D measurement of the half cell shape
(accuracy ca. 20 µm)

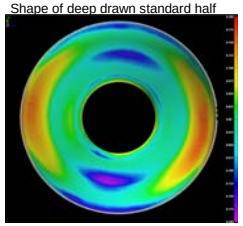
tolerance of shape 0.4 mm in the colored area

Shape of deep drawn ingot half cell

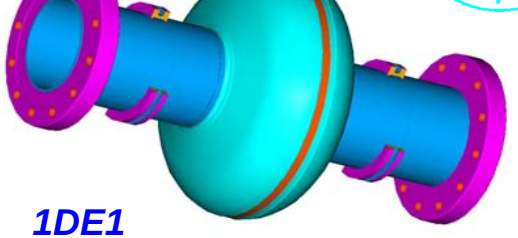


half cell no. GK1

Shape of deep drawn standard half



Half cell no. C_16

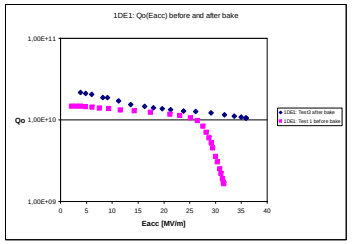


1DE1

First Cavity of DESY in-house fabrication successful

E_{acc} = 36 MV/m @ Q_0 = 1 ·10^{10}

no FE limited by BD

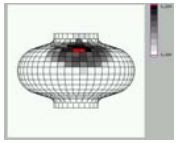


Preparation sequence

- 150µm EP@Henkel,
- 800C
- 130µm EP@Henkel,
- HPR + bake
- add. HPR (after bake necessary due to field emission)

Detailed history

- Cavity made of Heraeus sheets; production 1999
- Deep drawing of cups at Zanon Co.
- Complete machining and electron beam welding at DESY
- All electropolishing at Henkel Co.
- Assembly, HPR and tests at hall NO



T-Map at 35 MV/m at 1.8K during quench
Quench location far away from the equator

Latest Result 1DE2

E_{acc} = 30 MV/m @ Q_0 = 2,2 ·10^{9}

FE > 25 MV/m limited by BD