Challenges in SRF Module Production for the European XFEL

Detlef Reschke / DESY
100 accelerator modules

800 cavities + power couplers
1.3 GHz / 23.6 MV/m

25 RF stations
5.2 MW each
Introduction - Module

- Cavities incl. He-tank:
  - material, fabrication, preparation, acceptance test
- Cold Mass and Vacuum Vessel
  - fabrication
- Coupler
  - fabrication, conditioning
- String and Module assembly
- Tuner
- Cold Magnet + BPM
- HOM
Introduction

- **Knowledge transfer** to industry (especially new vendors) and collaboration partners!
- Experiences with:
  - Infrastructure
  - Procedures (incl. cleaning)
  - Handling
  - Tools
- Establish **procedures adapted to series production**
- Additional tasks taken over by DESY

- No discussion of budget + schedule aspects
Original, first CFT included:

- **Full material procurement** + quality assurance by contractor
- Vendors responsible for performance ("**performance guarantee**")
  “…Therefore cavities with a measured accelerating gradient value of <18 MV/m or Q value Q<1x10^{10} at E_{acc} < 18 MV/m will be rejected, this already taking into account a measurement accuracy of ±10%.”
- Three stages of pre-series cavities (4 + 4 + 4) by each vendor

After first offer and negotiations with vendors:

*Details about cavity procurement in talk WEOB04*
Research Instruments and E. Zanon were contracted to produce each

- **4+4 pre-series cavities** => 4 next pre-series cavities included in series cavities
- **280 XFEL type series cavities**
- **12 HiGrade cavities**, first used for quality assurance, later available for further investigations & treatments (high gradient R&D towards ILC)
- **Additional 80 cavities** as an option to be placed after the evaluation of the successful start of the series production
- **First series cavities beginning of 2012**; all cavities to be delivered within two years; He-vessels for RI cavities to be supplied by DESY

- **Nb / NbTi to be supplied by DESY**
- Production precisely following the specifications which also include the exact definition of infrastructure to be used ("build-to-spec")
- **No performance guarantee by the vendors**, i.e. the risk of unexpected low gradient or field emission is with DESY (responsibility for re-treatment); goal: average usable XFEL gradient 23.6 MV/m
DESY ordered Nb / NbTi material + supplies to companies

DESY is responsible for:
- **infrastructure incl. man power** for quality assurance and logistics
- incoming visual inspection
- dimension checks
- Eddy-current scanning
- documentation using the DESY EDMS (guarantee of **traceability for pressure bearing parts**)
- definition of numbering system and marking
- delivery to companies (including **risk of delays**)

EZ: Titanium parts for He-tank and He-tank fabrication included
RI: Titanium parts will be supplied by DESY
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Cavities – Niobium / NbTi II

- Eddy current scanning of XFEL niobium sheets at DESY
- Equipment for tactile 3D dimension measurement
- First sheets, tubes and other parts arrived at DESY (ca. 3,500 of 19,500 pcs)
- Entrance checks started
- First delivery to EZ + RI in-time end of July
- Poster THPO053
Cavities – Fabrication according to PED

- Cavity fabrication according to **Pressure Equipment Directive** (PED 97/23/EC)
- “Transfer of Identification” from material to final cavity
- PED process with **Notified Body** (“TÜV Nord”):
  - Identification: classification of pressure equipment
  - **conformity assessment procedure** => choice of adequate procedure
    => modules B + F of PED to be applied
  - “module B”: EC **“type examination”** of all relevant documents, companies, procedures, includes **test piece for weld qualification**
  - “module F”: **“product verification”** for series; based on results of module B
    e.g. pressure test of individual cavities required (not contracted yet)

Courtesy of RI
Both machines in commissioning to be used at the companies (CE certified).

Machines can be operated basically by Non-RF-Experts.

Considerably shorter measurement / tuning time.

Automation and documentation guaranteed.

DESY has to ensure maintenance.
Two schemes for the final surface treatment:
- EZ: BCP Flash
- RI: Final EP

- 4 dedicated Cv’s for set-up of infrastructure at companies each
- 4 dedicated Cv’s for commissioning of infrastructure each

- Close supervision of infrastructure, processes, procedures and handling by DESY + INFN Milano required

- No performance guarantee results in:
  - the risk of unexpected low gradient or field emission is with DESY
  - responsibility for re-treatment at DESY
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RI Germany

DESY Germany

IRFU /CEA France

EZ Italy

Transport tests done

Poster TUPO050

- DESY takes care of installation / dismounting of cavities into / from test insert
- Transport to CEA in transport boxes as well
- Accelerator Module Test Facility
- New Infrastructure for vertical acceptance test and module test
  - two cryostats for test of 4 cavities in parallel + 3 module test stands
  - WATF: assembly + test of customized waveguide distribution
  - new software development for vertical and horizontal test
  - training of new team
  - modification + extension of cavity data base
LAL Orsay has taken over the responsibility for the XFEL RF power coupler production.

Conditioning of the couplers will take place at LAL Orsay in new cleanroom infrastructure.

Direct delivery to assembly site at CE Saclay

Coupler interlock system developed and contributed by DESY.

Contract for the production of 640 couplers placed at a consortium of THALES & Research Instruments.
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String and Module

Detlef Reschke, DESY
String assembly is crucial for the cavity performance

String + power coupler assembly for all modules will take place at CEA Saclay site

Commissioning of infrastructure and training of CEA staff with prototype modules ongoing

Knowledge transfer to executing company to be done after placing of order
All cavities with He tank, the coupler cold parts and the quadrupole-BPM units will be cleaned and dried externally before entering ISO4 area.
Three XFEL prototype modules built and tested => in use for technology transfer

Now four qualified vendors for cold mass / vac vessel

Assembly procedures improved during training with new teams

Contracts for 83 modules placed (25 EZ, 58 IHEP with subcontractors)

ACC39 by INFN Milano + assembly at DESY
Module Assembly

- Module assembly facility for all modules is set up at CEA Saclay site
- Commissioning of infrastructure and training of CEA staff with prototype modules ongoing
- Knowledge transfer to executing company to be done after placing of order
- Several assemblies, transports and tests of prototype modules ongoing
Module: Transport

- All 83 (+20) assembled modules must be **transported** on road from CEA Saclay to DESY about a distance of approx. 1000km.
- Allowed max. impact to the modules during the transport 1.5g
- The **transport frame** is equipped with electronic shock loggers and GPS
- Until now 5 transports took place
- Before start of the series assembly ~4-5 further transport with additional alignment checks after arrival @ DESY are foreseen.
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Refurbished DESY Clean Room

- Assembly training
- Prepared for **routinely assembly of Quad/BPM**
- Future re-treatment of cavities

- State-of-the-art air distribution + condition
- Increased ISO4 assembly area
- Chemistry and cleaning infrastructure now in ISO6/5 instead of ISO7/6
- New rotational clean room airlock

See Poster TUPO018
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The end