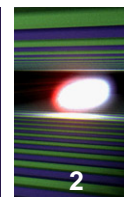


# European XFEL Accelerator Status Report

LCWS13, 11-15 November 2013  
At the University of Tokyo

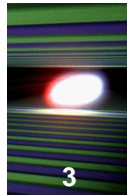
W.-D. Möller for all WG's of the XFEL Collaboration



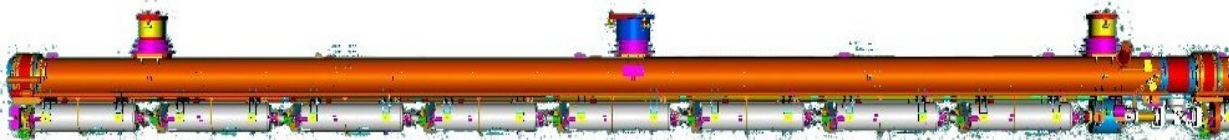


1. XFEL accelerator overview
2. Status of selected components and infrastructure
  - AMTF (Accelerator Module Test facility)
  - SC cavities, fabrication, first test results
  - RF power coupler
  - Cryostats and cold mass
  - Module assembly, first test results
  - RF power systems
  - Cavity tuner, HOM absorber and feedthroughs
  - Cold magnets
  - Beam diagnostic
  - Cryogenics
3. Tunnel installation
  - Injector, Linac
4. XFEL schedule

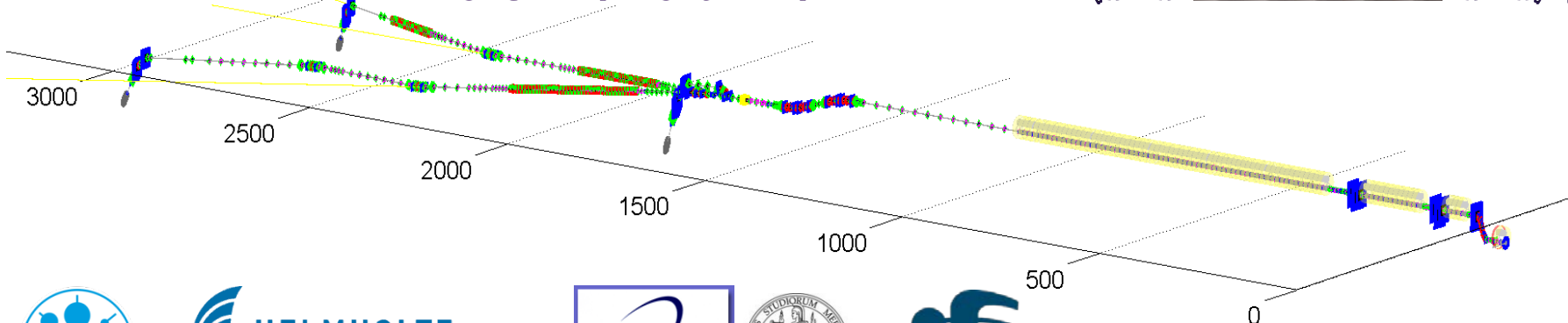
# Contributors to the XFEL Accelerator



## 100 accelerator modules



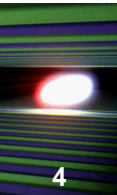
## 800 accelerating cavities 1.3 GHz / 23.6 MV/m



Wroclaw University of Technology

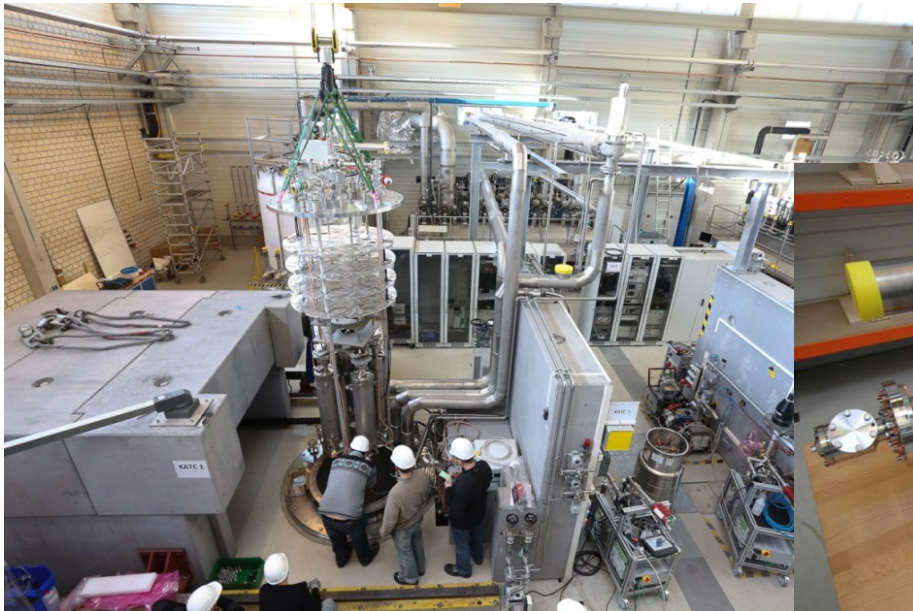


## AMTF, vertical cavity test stands



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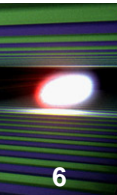
- Two vertical test cryostats
- Six inserts with four cavities with tank
- Four cavities are measured during one cool down, one after the other
- Capacity for >10 cavity measurements / week
- Facility under full operation



- Three module test stands, one is ready for the first module test, XM-2 is assembled, RF test starts now
- Second one is under cryogenic commissioning
- All RF power stations are ready for use
- Second and third will be ready for module tests by end of 2013



## SC cavities, Niobium material

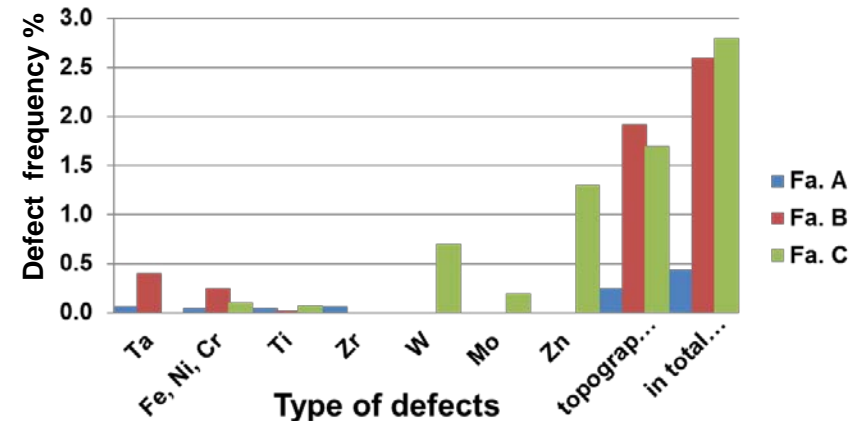


6

- In total 14420 semi finished Nb parts where ordered and delivered to DESY by three companies:

- Heraeus (ca. 95% SFP for end groups)
- Tokyo Denkai (52% sheets)
- Ningxia OTIC (30% sheets, 100% NbTi)
- PLANSEE (18% sheets)

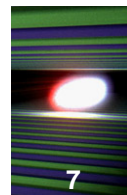
Defects found by eddy current scanning of sheets



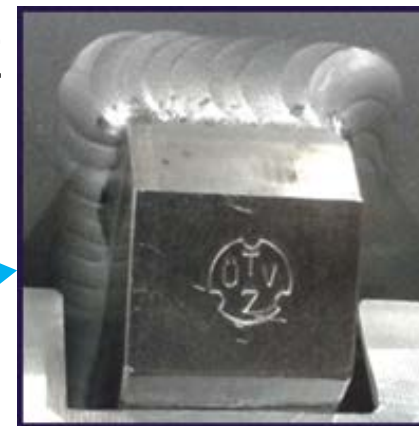
- All parts are quality inspected at DESY:

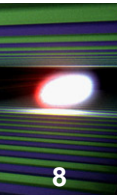
- certification of the material producers for PED (Pressure Equipment Directive)
- independent QC for required parameter (RRR, interstitial impurity (H, N, O, C), metallic impurities, metallography, tensile test, hardness, HV, surface roughness)
- Eddy-Current scanning of all sheets
- documentation using the DESY EDMS (guarantee of traceability for pressure bearing parts)

- Final delivery in Dec. 2013



- Module B (EC type-examination), contracted by DESY
  - examination of design, FEM calculation
  - qualification of welding processes (welding parameters, welders)
  - qualification of another relevant processes (annealing, deep drawing)
  - production of test pieces 2 pieces/company (qualification of each EBW machine) and destructive tests
  - supervising the production qualification of the each company (Dummy cavities and Reference cavities)
  - Supervising the production on first 8 cavities per company (pre-series cavities)
- Module F (product verification), contracted by RI and EZ
  - visual inspections and control of documents
  - pressure test for each cavity
  - Finally we got this approval / stamp on every cavity →



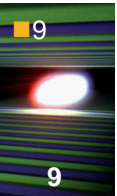


- cavities are delivered ready for vertical test
- total number of delivered cavities Nov. 2013 about 175 (from two companies)
- average delivery during Sept. & Oct. was 7.5 per week, during Oct. 8.25 per week
- 30+ new cavities still to be tested (now two shifts)
  - still some non-conformities, < 10% rejected cavities
  - re-treatment at DESY very successful (mostly only High Pressure Rinse)
  - done for all cavities showing some gradient potential, (even if XFEL specs. are met)
- approx. 60 cavities delivered to CEA Saclay for module assembly; → average usable gradient is 27 - 30 MV/m



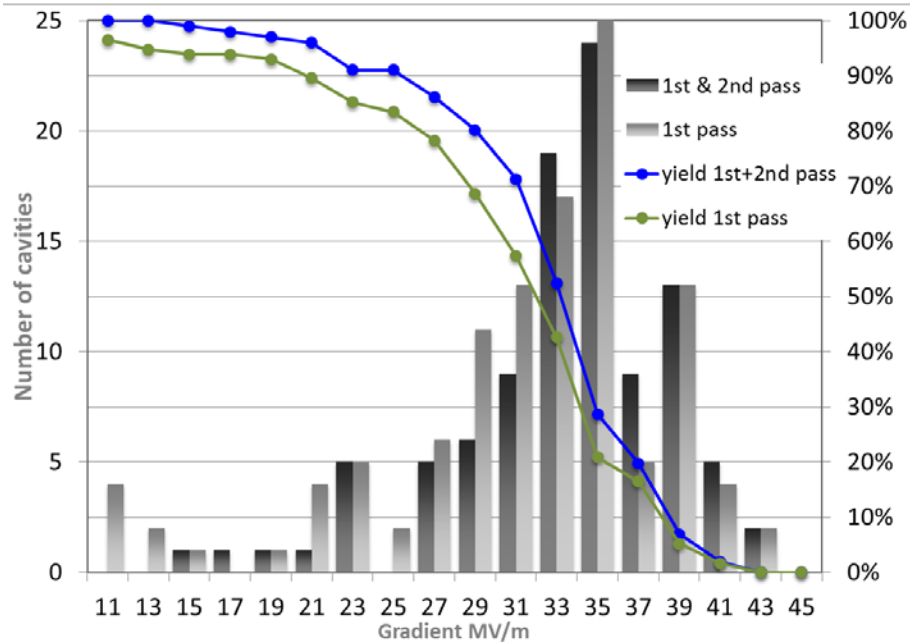


## SL cavities, first test results (Oct. 2013)



- Yield of usable and maximum gradient of 100 cavities (2.pass):  
73 cavities passed in 1.pass + 27 cavities after re-treatment

(Usable gradient = Quench, field emission >  $1 \times 10^{-2}$  mGy/min,  $Q_0 < 1 \times 10^{10}$ )

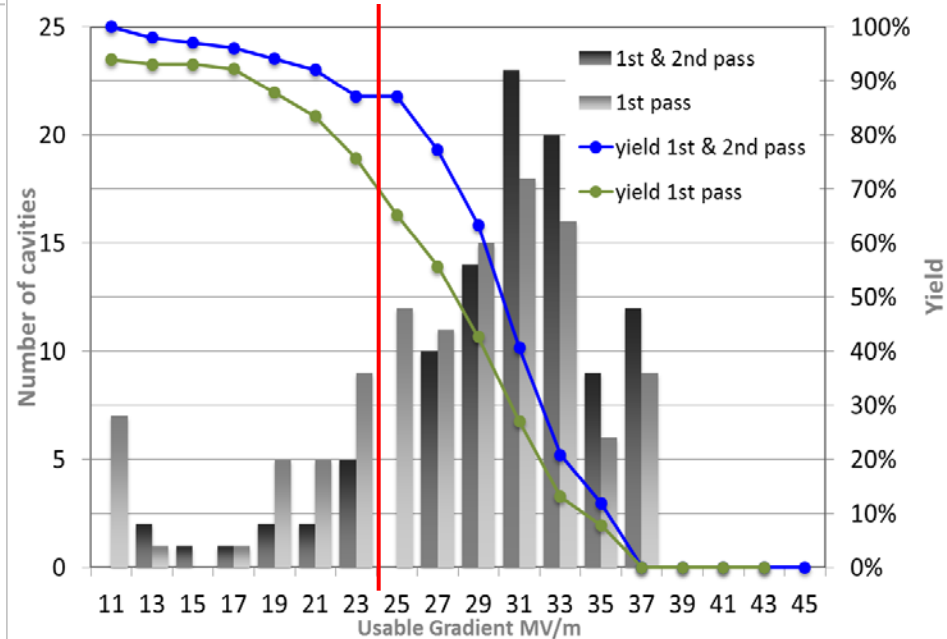


Average maximum gradient:

**$(31.9 \pm 5.5)$  MV/m**

EZ:  $(30.1 \pm 5.2)$  MV/m

RI:  $(34.5 \pm 4.7)$  MV/m

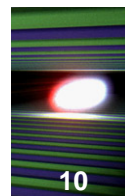


Average usable gradient:

**$(28.8 \pm 5.2)$  MV/m**

EZ:  $(27.8 \pm 5.1)$  MV/m

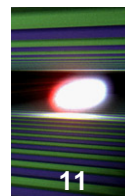
RI:  $(30.2 \pm 5.0)$  MV/m



- First 16 couplers for two modules have been
  - produced (THALES/RI consortium),
  - conditioned (LAL) and
  - delivered to IRFU, Saclay for module assembly
- Delivery rate of 6 per week was reached in Sept. 2013
- Infrastructure at companies and labs is ready for 8-10 couplers per week
- Still problems with copper plating quality, the rejection rate is too high!
- Power coupler delivery is one of the most critical items for the overall schedule

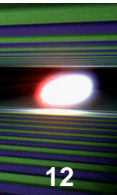


# Cryostats and cold mass



- 25 cryostats & cold masses delivered by E. Zanon
  - some minor re-work of Zanon units will take place at CEA Saclay
- 20 cryostats & cold masses delivered by IHEP
  - 7 need re-work due to non-conformities
- overall delivery schedule ok



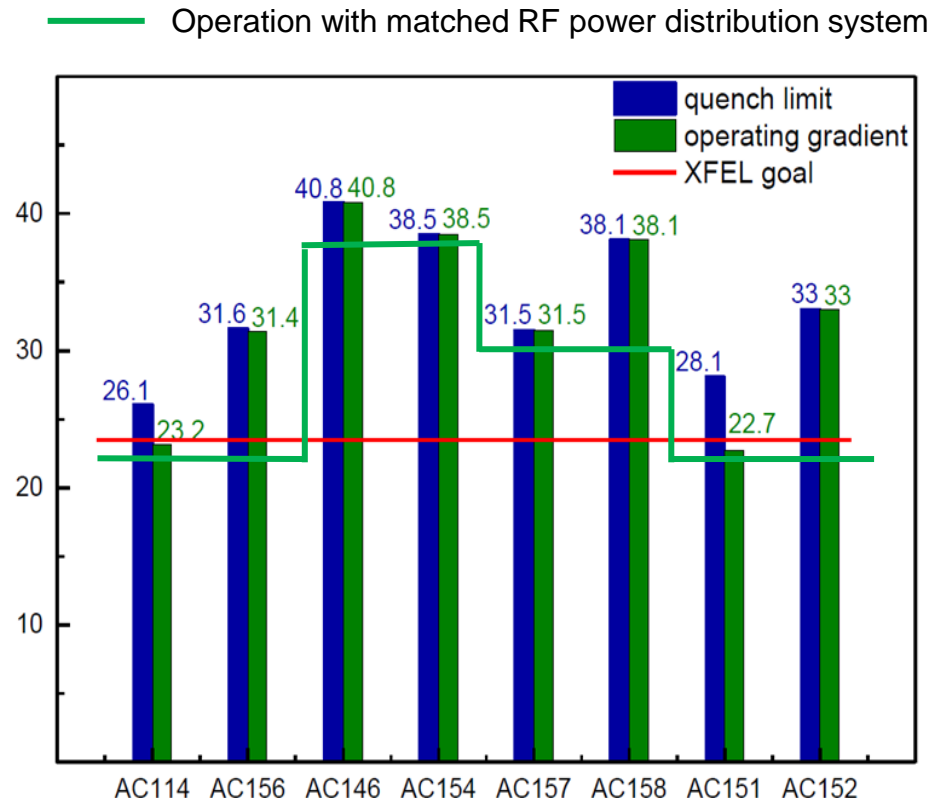


- The overall production of 103 accelerator modules is organized in 3 phases.
  - Phase 1: the observation phase which covers the assembly of XM-3 by CEA with ALSYOM staff as observers.
  - Phase 2 : the pre-series production phase which covers the assembly of XM-2 and XM-1 by mixed CEA-Alsyom teams (co-activity or transfer of knowledge)
  - Phase 3: the series production phase which covers the assembly of XM1 till XM100 by Alsyom with an adequate ramp-up included
- Phase 3 has started, but stopped for the moment because of welding problems related to the pressure vessel code

XM-1 and XM1strings in front of CEA clean room



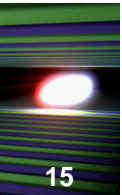
- XM-3 (first pre-series module assembled at CEA) was tested successfully
- average gradient of 33.5 MV/m (quench limited)
- average operable gradient of 32.4 MV/m (due to field emission)
- With matched power distribution system:  $E_{acc} = 27$  MV/m
- This is well above the XFEL design gradient of 23.6 MV/m



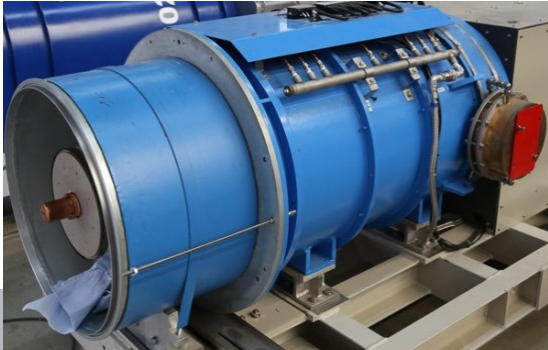
- delivery status of major components
  - 8 klystrons
  - 14 modulators
  - 16 pulse transformers
  - 22 connection modules
  - 100% HV pulse cables installed in tunnel
  - all 30 preamplifiers
  - continuous delivery of waveguides, e.g. 250 circulators



# RF power systems

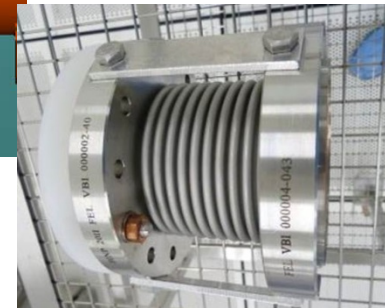
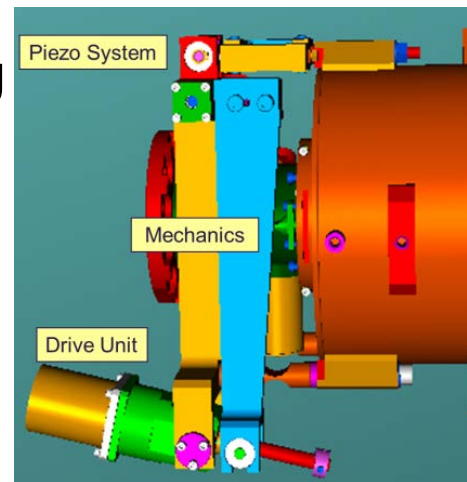


■ One Toshiba Klystron was on board of this vessel... and is finally lost; replacement by Toshiba within schedule is possible.

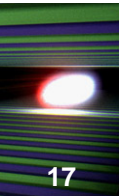


# HOM absorber and feedthroughs, cavity tuner,

- HOM feedthroughs / cables
  - Approx. 85% available
  - 100% expected for end 2013
- Beam Line Absorber
  - 25 @ DESY, another 38 expected for end 2013
  - Difficult to reach specs for remaining 45 ceramics (need new supplier)
- Frequency tuner
  - Ramp-up successful; regular deliveries
- Cold vacuum
  - Regular deliveries of parts



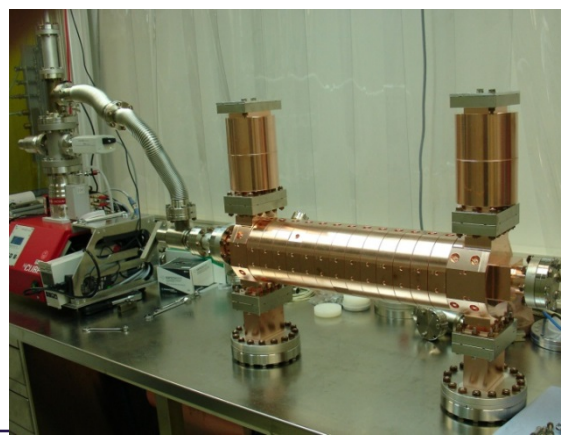
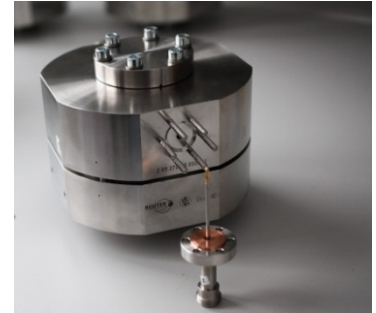
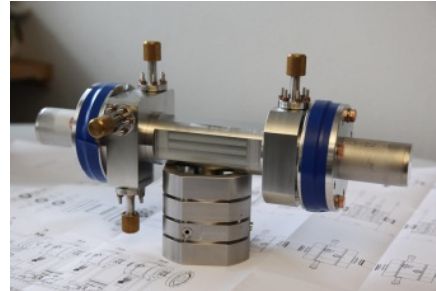
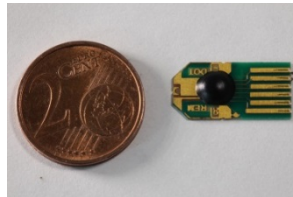




- 55 magnets delivered (CIEMAT IKC)
- 45 cold tested at DESY (IFJ-PAN IKC)
- 39 current leads (DESY IKC) tested
- special magnet for 3.9 GHz module exists
- 14 magnet packages are assembled



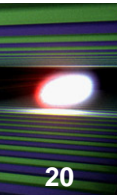
- Cold BPMs fabrication is finished
- Warm BPM Fabrication on schedule
  - Prototype tests @ FLASH of all types are successful
- Many others are under prototype test or fabrication and in time:
  - Current transformer
  - Dark current monitor
  - Beam loss monitor
  - Beam halo monitor
  - Dosimetry
  - Screen stations
  - Wire Scanners
  - Many more....



- Test hall (AMTF) installation is finished
  - Refrigerator commissioning has started: first cool down of one cold box and valve box in September
  - Commissioning of ‚2K-box‘ will start in November
- 
- Basic design of linac tunnel boxes (feed- & end caps, string connection boxes) and linac transfer lines is approved
  - Installation of injector transfer line will start after RF gun test Jan. 2014



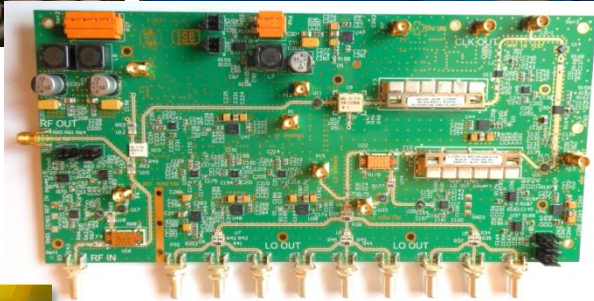
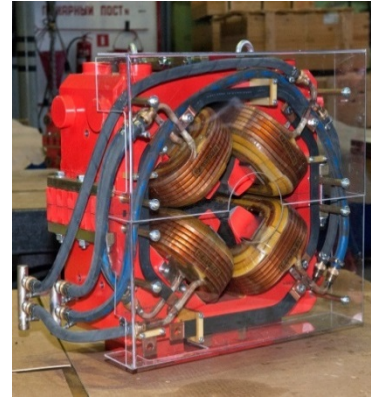
# Many other components are on their way



■ correctors



■ XQE



PCB version of the local oscillator module

European XFEL WP34 – Modulator Hall XHM

Delete this text and put in here: The title of your talk

2

- Installation of power supply, water cooling and ventilation done



Injector-like LLRF racks in FLASH tunnel



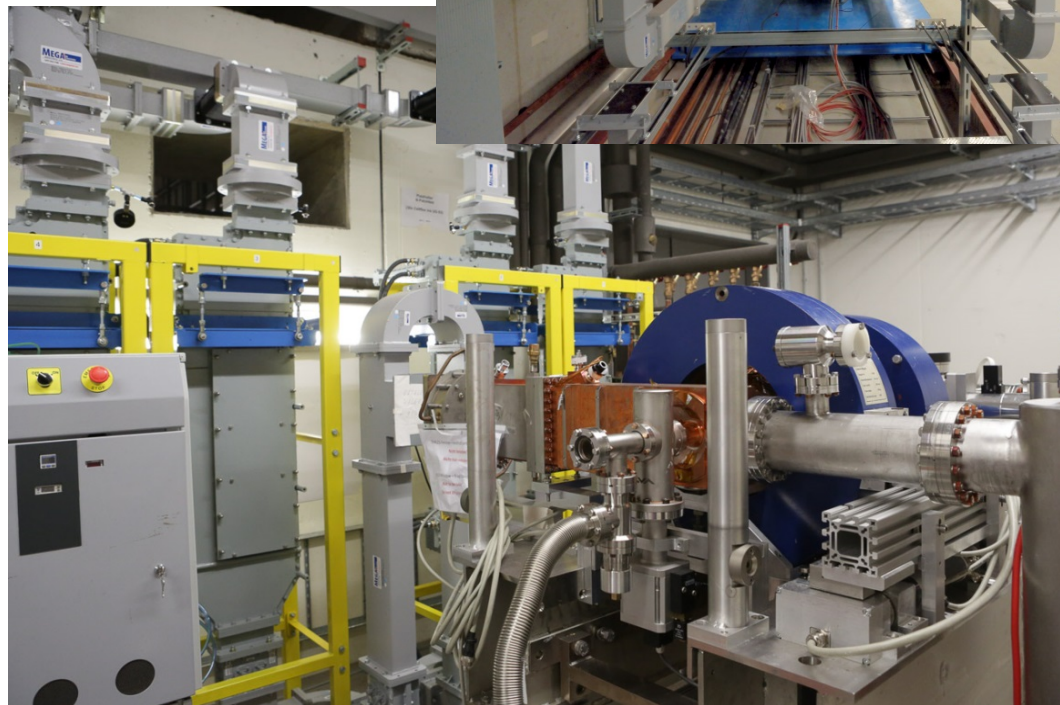
Dump window



Water pumps and pipes in XHMP

October 2013  
Jensen, DESY –MKK-

- Person safety interlock system is ready
- Gun klystron is under test
- The gun is installed in the injector
- Gun commissioning will start in Dec. 2013



Installation finished:

- All HV pulse cables for the klystrons
- Water cooling pipes
- Electrical installation

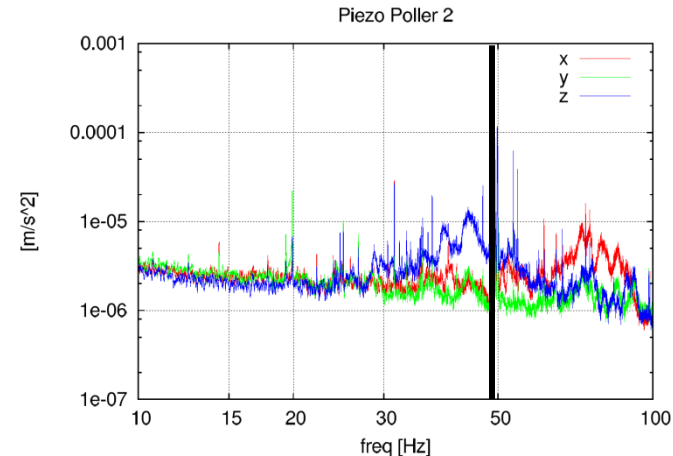
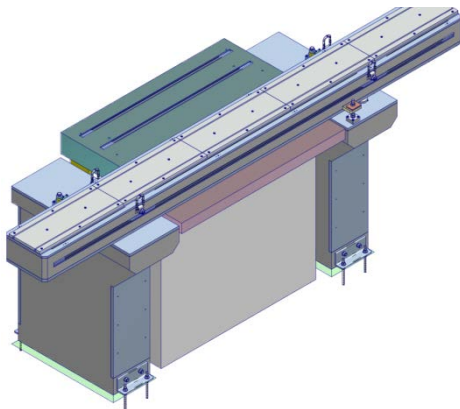
Ongoing:

- ~400 of 800 brackets welded to tunnel ceiling
- first frame welded to tunnel ceiling



# Linac tunnel installation supports for warm sections

- Vibration studies (numerical and experimental) were carried out to ensure that resonance frequencies of pillars, girders, magnet support and interconnections are above 50 Hz.
- Example: different grouts were tested for optimal and easy to handle fixation of pillar to floor, preferred fixation method selected.



- Only long. Components > 50 Hz





- Thanks for the tremendous work, done by many WG's from the different collaborating institutions, in-kind contributors and at DESY.
- Thanks to the big effort of the companies to deliver in time and at high quality.
- Many slides are taken from Hans Weise's report to the XFEL MAC – thank you.