Fabrication & Acceptance Test of cavities for the European XFEL and ILC-HiGrade

E.Elsen

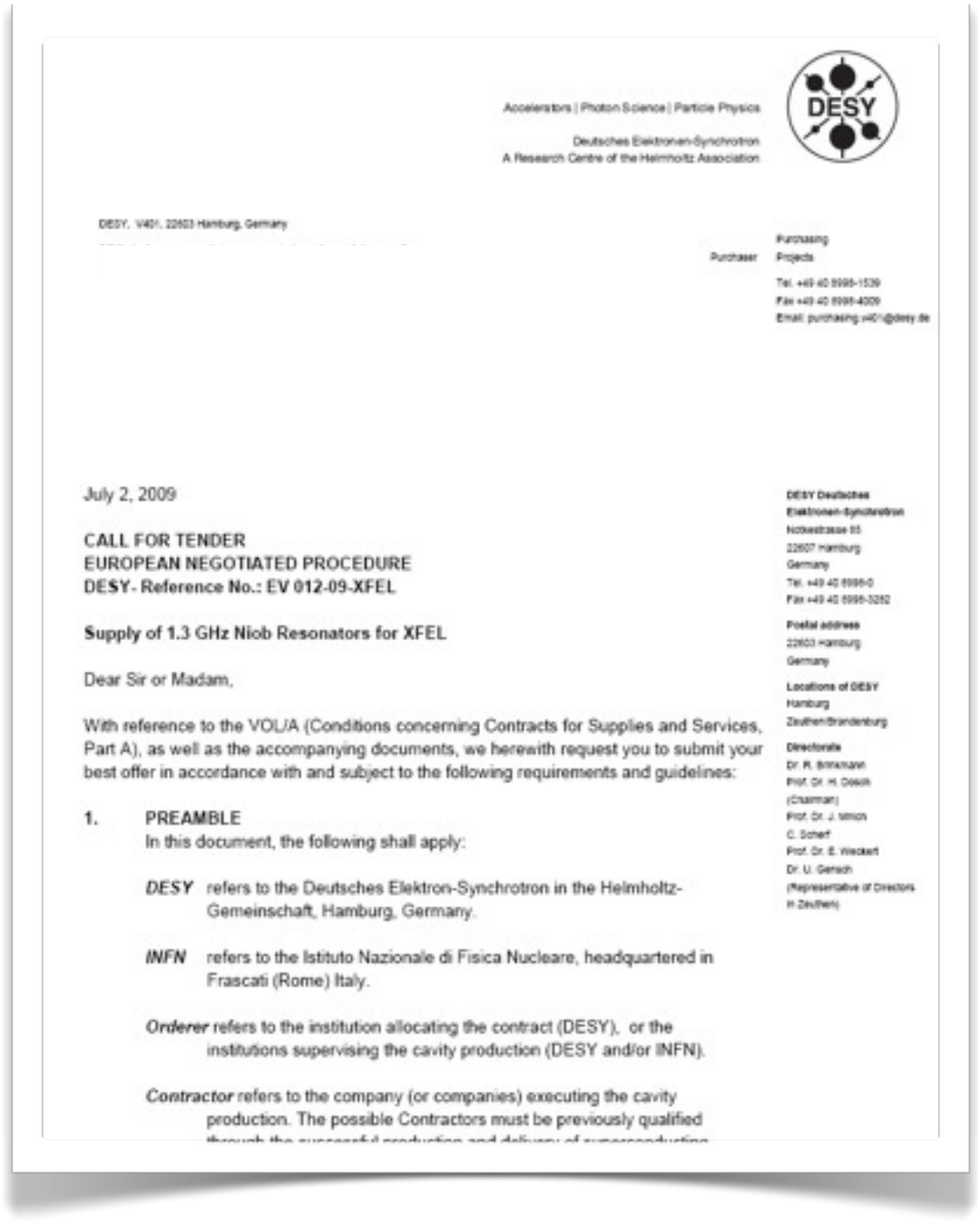
after first 480 m

2nd boring machine

1st Baseline Assessment Workshop, KEK, Sep 7-10, 2010

Call for tender for Cavities

- Production Readiness Review
- Call for tender published July 2, 2009
  - Contracts awarded by DESY
  - Supervision of production by DESY/INFN
- 2nd Iteration after 1st response
- Funding politically involved



Accelerators | Photon Science | Particle Physics

Deutsches Elektronen-Synchrotron
A Research Centre of the Helmholtz Association

DESY

DESY, V401, 22603 Hamburg, Germany

Purchaser: Purchasing / Projects

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July 2, 2009

CALL FOR TENDER
EUROPEAN NEGOTIATED PROCEDURE
DESY- Reference No.: EV 012-09-XFEL

Supply of 1.3 GHz Niob Resonators for XFEL

Dear Sir or Madam,

With reference to the VOL/A (Conditions concerning Contracts for Supplies and Services, Part A), as well as the accompanying documents, we herewith request you to submit your best offer in accordance with and subject to the following requirements and guidelines:

1. PREAMBLE
In this document, the following shall apply:

DESY refers to the Deutsches Elektron-Synchrotron in the Helmholtz-Gemeinschaft, Hamburg, Germany.

INFN refers to the Istituto Nazionale di Fisica Nucleare, headquartered in Frascati (Rome) Italy.

Orderer refers to the institution allocating the contract (DESY), or the institutions supervising the cavity production (DESY and/or INFN).

Contractor refers to the company (or companies) executing the cavity production. The possible Contractors must be previously qualified

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Prof. Dr. J. Mnich
C. Scherf
Prof. Dr. E. Weckert
Dr. U. Gensch (Representative of Directors in Zeuthen)

Cavities Surface Treatment

- Two schemes for final surface treatment were explored
  - Final EP
  - BCP Flash
- using cavities form two vendors
- The preparation strategy for final treatment with mounted He-vessel was optimized and resulted in
  - yield curves for schemes
  - yield curves for vendors
  - two variants for final treatment
- DESY procedures and experience documented in call for tender
  - Specification to be made available to SRF community around end of 2010

Some Tools provided by DESY

RF measurement

Tuner for field flatness

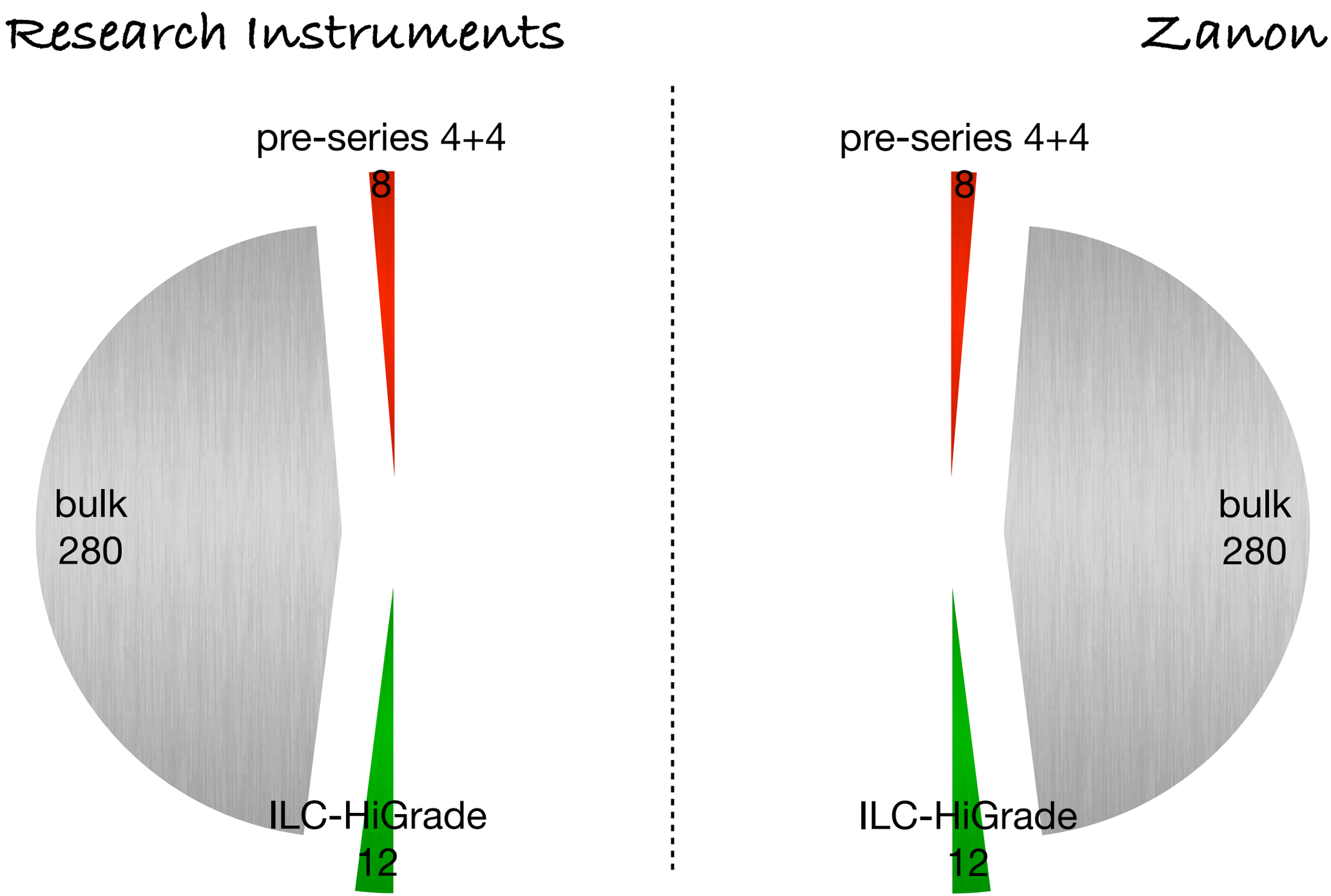
- Both machines ready for use at the companies (CE certified).
- Machines can be operated by non-RF-experts.
- Considerably shorter measurement / tuning time.
- Automation and documentation guaranteed.

The contracts

- Research Instruments and E. Zanon were contracted to produce each
  - 4+4 pre-series cavities
  - 280 XFEL type series cavities
  - 12 ILC-HiGrade cavities, first used for quality assurance, later available for further investigations & treatments (high gradient R&D towards ILC)
- Additional 80 cavities will be ordered after the evaluation of the successful start of the series production (competitive element)
- First series cavities beginning of 2012; all cavities to be delivered within two years; He-vessels for RI cavities to be supplied by DESY

- Contracts have a volume of almost 25 M€ each

The contract split



Cavity Order

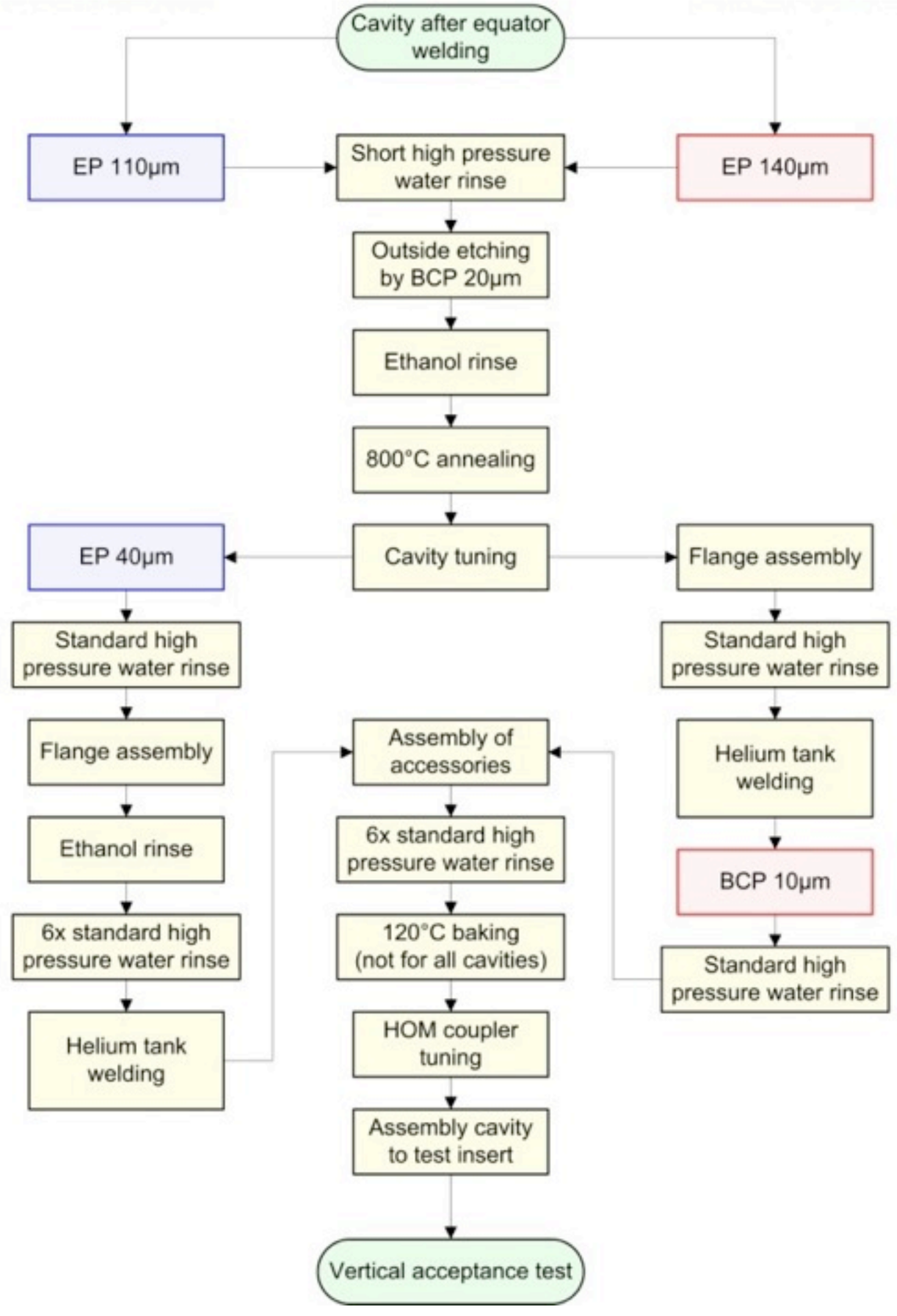
- 300 cavities have been ordered at RI and Zanon each
    - Divided into 280 series cavities, 8 prototypes and 12 ILC-HiGrade cavities
    - ILC-HiGrade cavities will be delivered without He-vessel
- No performance guarantee will be given by the companies, cavities are built to specification
- Option for 40 or 80 additional cavities part of both contracts, based on production success

The contracts

- Nb / NbTi to be supplied by DESY
- Production precisely following the specifications which include the exact definition of infrastructure to be used
- Final treatment after bulk electro-polishing (EP):
    - EP for RI
    - flash BCP for Zanon
- No performance guarantee by the vendors, i.e. the risk of unexpectedly low gradient or field emission is with DESY
    - DESY takes the responsibility for re-treatment of up to 100 cavities in two years; goal: average usable XFEL gradient 24.3 MV/m

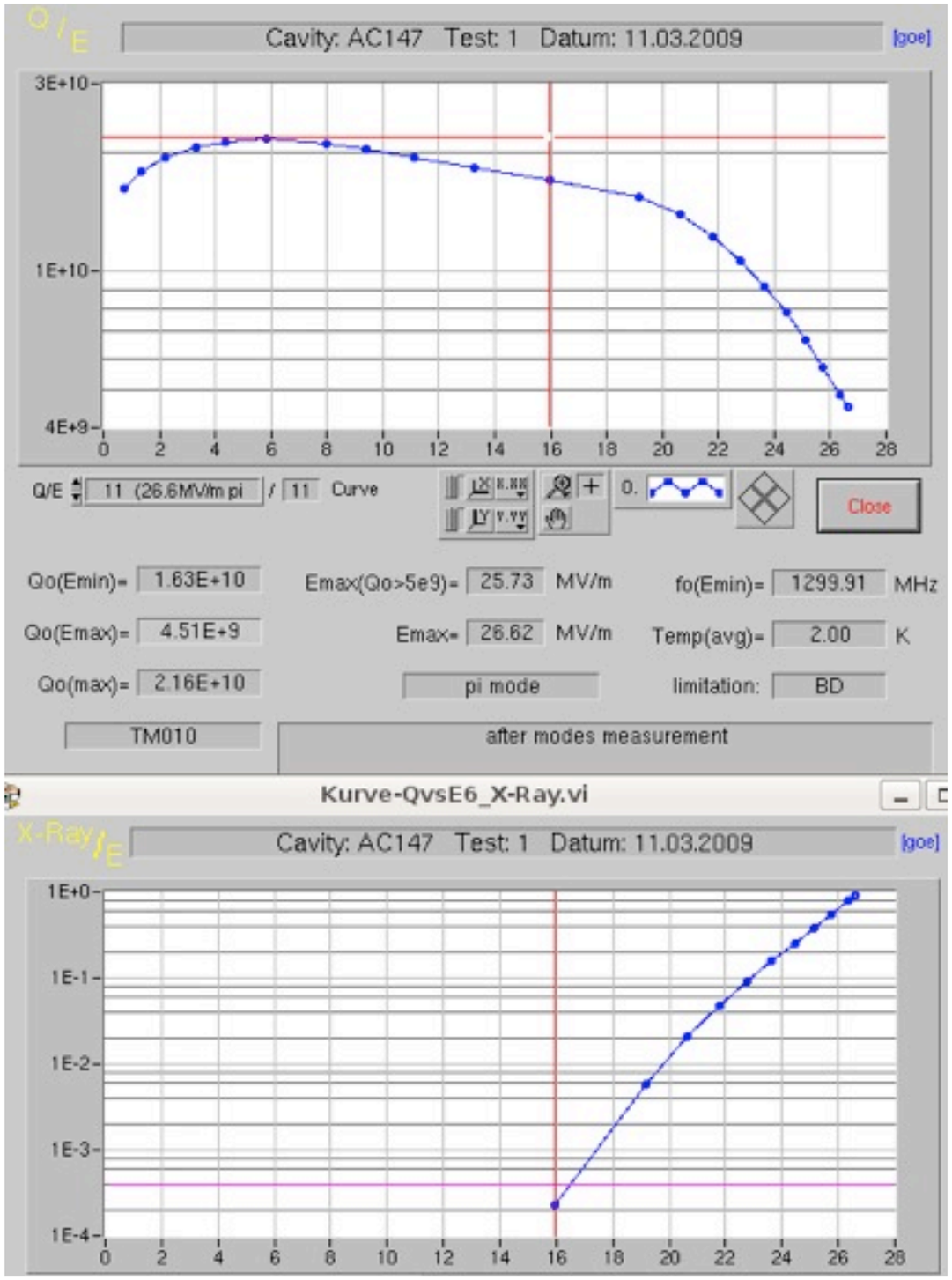
Cavity Surface Treatment

- Final treatment
  - Flash BCP with He-vessel
  - EP w/o He-vessel
- The 12+12 ILC-HiGrade cavities will be delivered without He-vessel

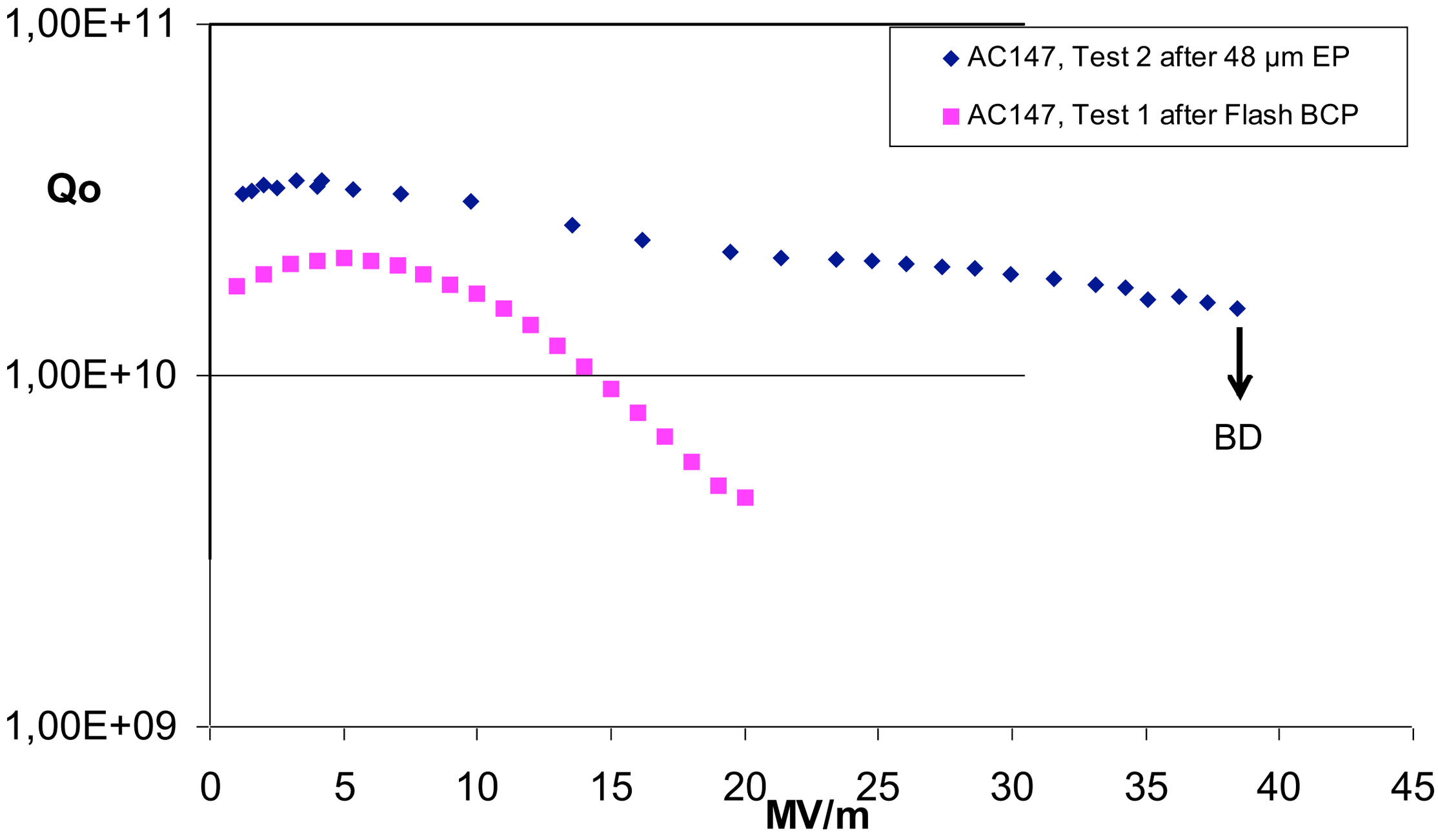


Example:
Tests of AC147, vertical

- Cavity treatment history:
  - Bulk-EP at Henkel: 128 µm
  - 800°C HT
- Flash-BCP at DESY: 10 µm
  - 6xHPR
  - 120°C bake for 48 h
- 1st test (11.3.2009), π-mode
  - Limited by strong FE at 26.6 MV/m
  - 48 µm EP at DESY
- 2nd test (4.8.2010), π-mode
  - Limited at 38.7 MV/m, almost no FE

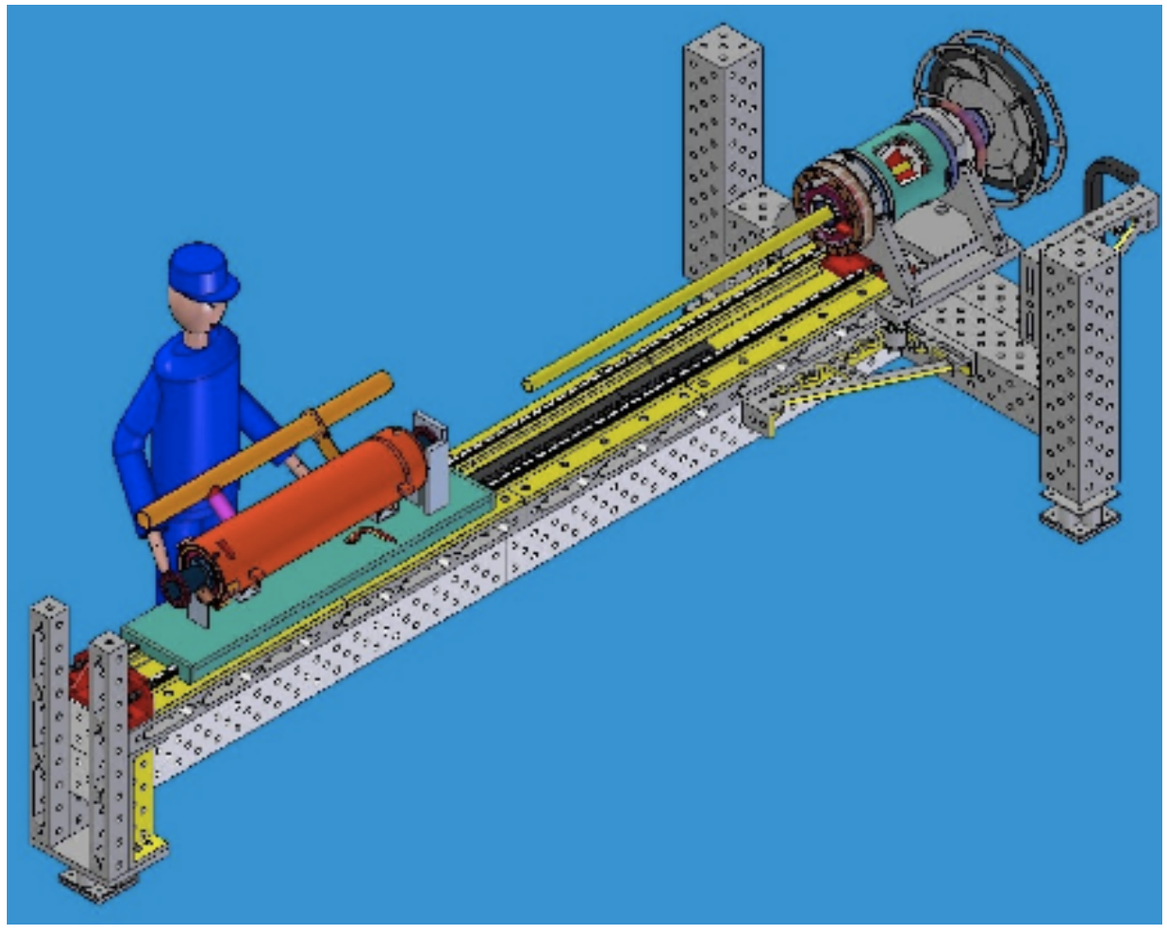


AC147, Comparison 1st and 2nd Test



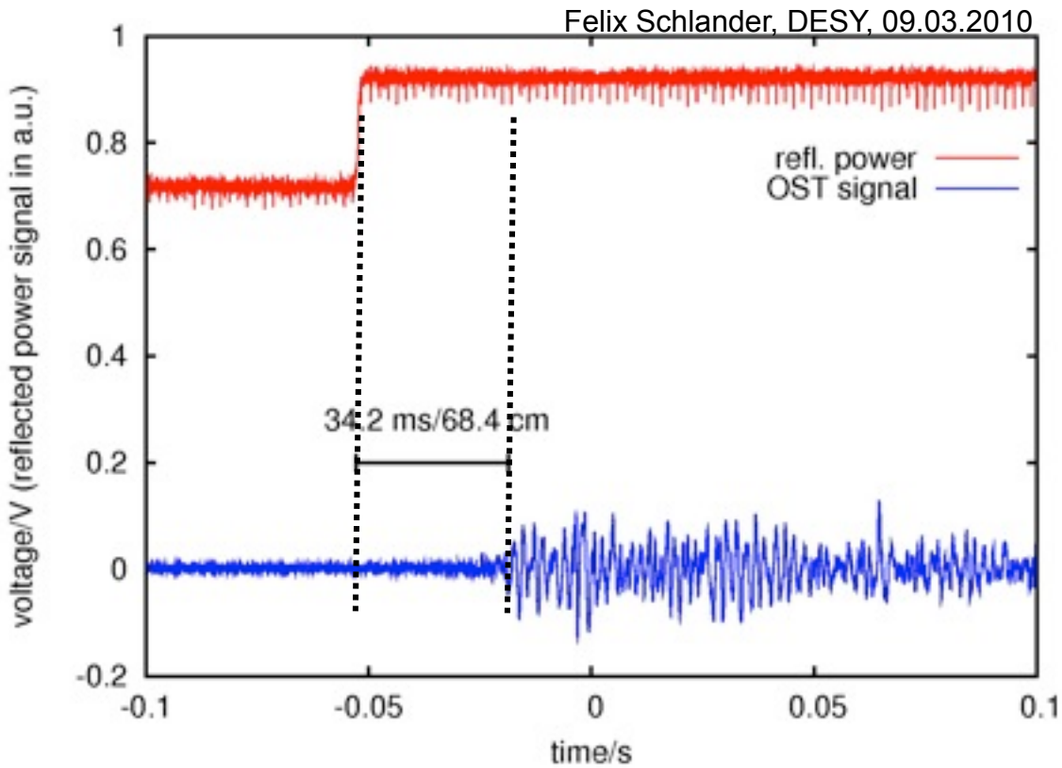
Optical Inspection at DESY

- Kyoto/KEK-camera system in use since August 2008
  - More than 25 cavities inspected
  - Correlation between hotspot in Tmap-measurement and defect found by optical inspection in several cases
- Automated inspection set-up under development
  - Reproducibility, speed, robustness
  - Suitable for application in cavity mass production



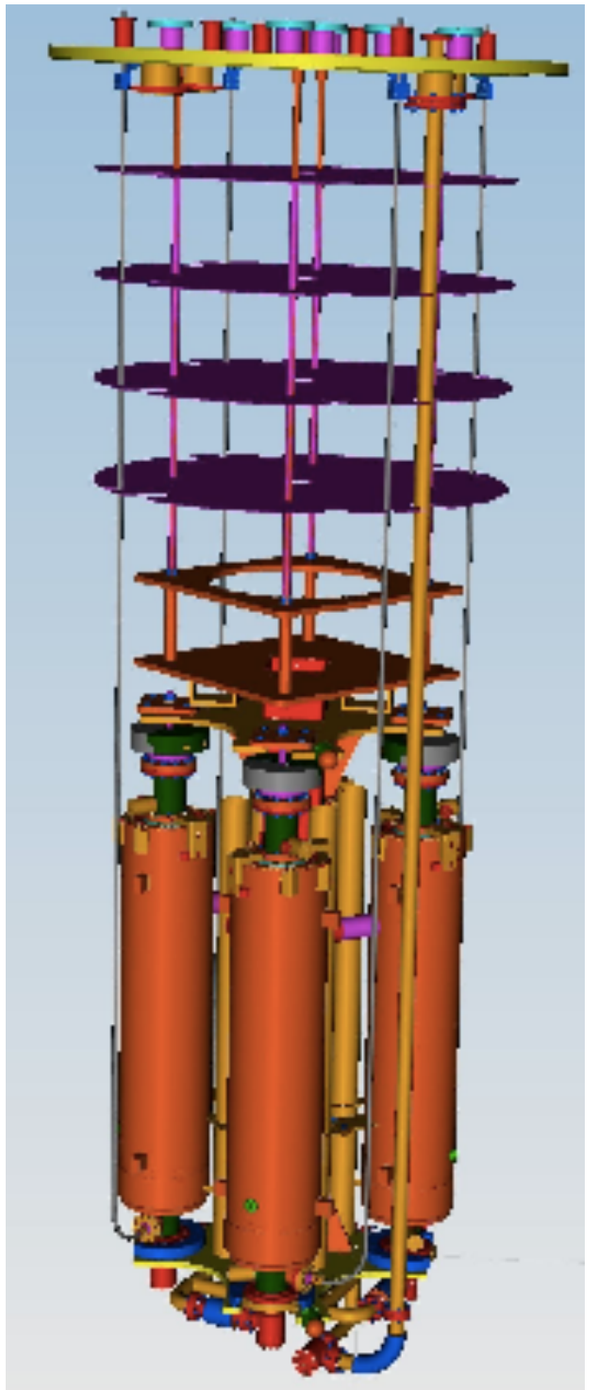
Commissioning of Second Sound System

- 2nd sound observed during test of AC74 in 2/9 π mode at 21 MV/m
  - One OST was producing signals
  - Signal observed over “large” distance
- 8 OST installed and being tested
  - Goal: locating quenches in test stand with minimum installation requirements
- Explore suitability for routine diagnostics



Tools for cavity handling

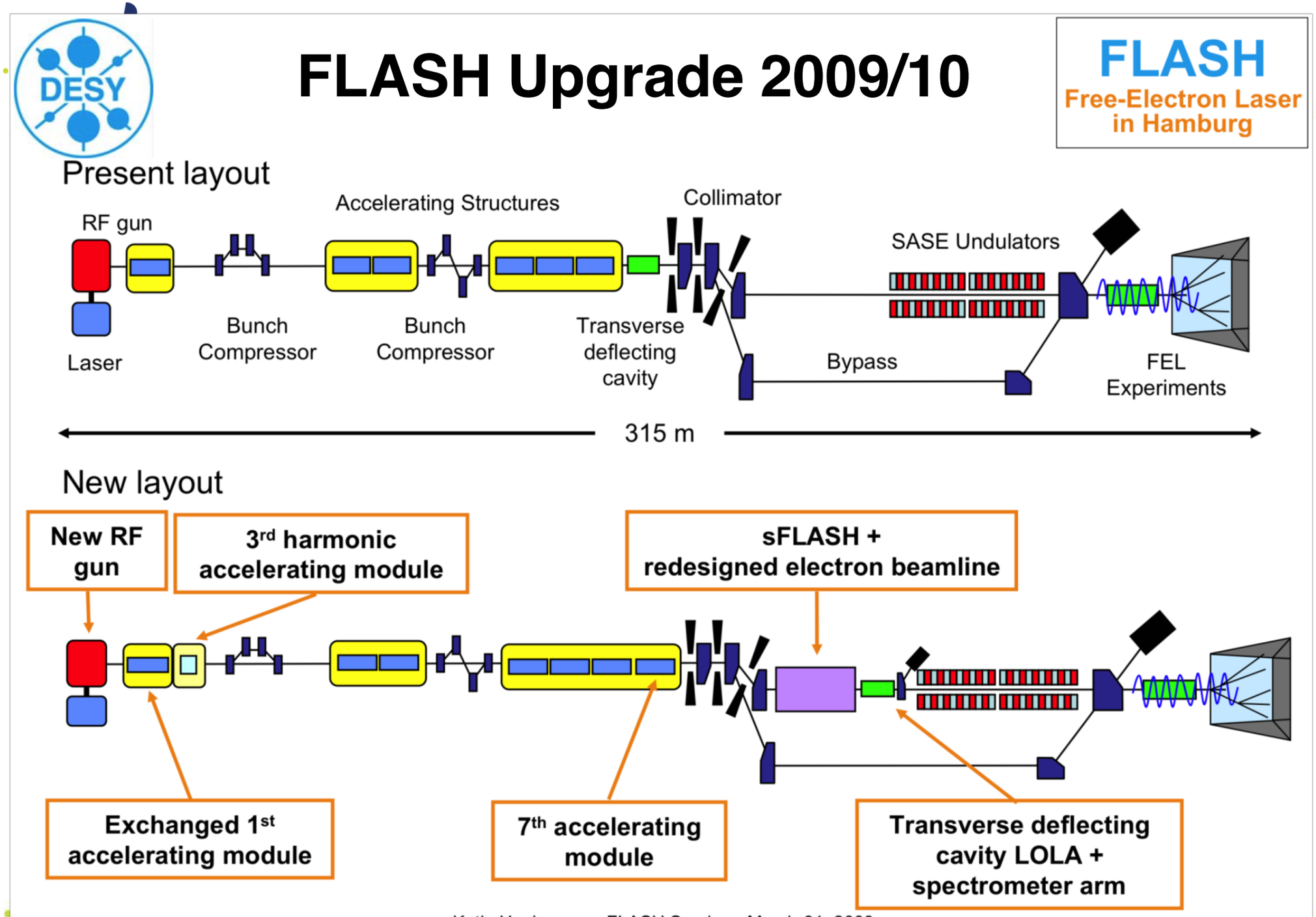
- Vertical insert for AMTF
  - Design has been completed
  - Suitable for cavities with and without He-vessel
- Lower part serves as a transport frame
  - mounted to trolley with shock absorbers
  - detailed transport simulation has been made



Automated vertical test

- Reproducibility
  - No operator intervention
  - auto-calibration
- Increased testing speed
  - automatic determination of phase and frequency
  - parallel measurement of gradient, power and radiation level in one cavity
- Automatic consistency check
- Remote control

S2 Contributions @ DESY = FLASH



see talk of J.Carwardine at this meeting

Summary

- Contracts for cavity mass production are out
    - will gain experience from 300 cavities with a recipe that is probably suitable for the ILC
    - will study 2 x 12 cavities in detail as part of the ILC-HiGrade program
- Quality control and assurance at DESY
    - exploring how to prepare for post-fabrication treatments
- Several new tools will be available