The special role of XFEL for ILC

Many slides are contributed by H. Weise, S. Suehl, L. Hagge and others!

Thomas Hott (DESY)
XFEL Technical Coordinator

The special role of XFEL for ILC

- **Both projects must master to a large extent similar technologies**
- **Both projects must master to a large extent similar organisational challenges**
- **A working XFEL is the best overall proof ILC can ever get about systems & concepts**

ILC is invited to follow and learn in close contacts the XFEL approaches

The special role of XFEL for ILC

Both projects must master to a large extent similar technologies

- **SCRF**
- **Underground facilities & technical infrastructure**
- **Control systems**
- **Timing Systems**
- **Cryogenics systems**
- **Vacuum systems**
- **Simulations**
- **Etc.**

XFEL considers its technologies to be basically mature

-> Proven by FLASH

-> Future challenges:

- **Large scale productions at reasonable yields/costs**
- **Assembly, installation, commissioning, operation**
- **Transfer of knowledge**

The special role of XFEL for ILC

Both projects must master to a large extent similar organisational challenges

International project -> Master the highly distributed environment
(Locations, cultures, tech. capabilities & platforms, ideas & aims, needs, ...)

Project preparation

- **Intergovernmental agreements**
- **Defining contributions on governmental & institutes level**
- **Keeping the 'Budget Line' when it comes to real money**
- **Bridging the time financially until funding gets granted**
- **Etc.**

Project management

- **Planning & Follow-up (skills, processes, tools)**
- **Quality Management**
- **Logistics**
- **Etc.**

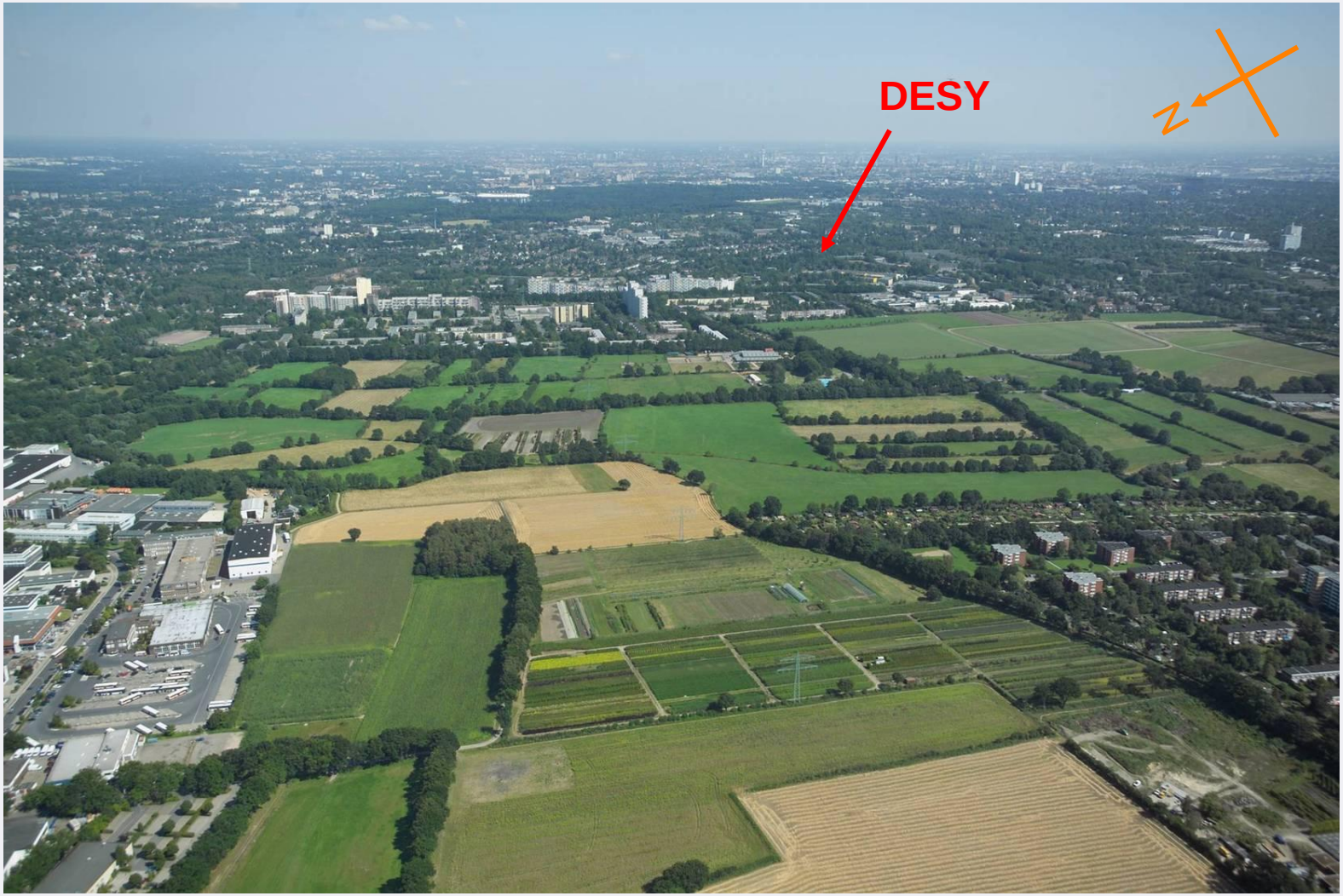
The special role of XFEL for ILC

ILC is invited to follow and learn in close contacts the XFEL approaches

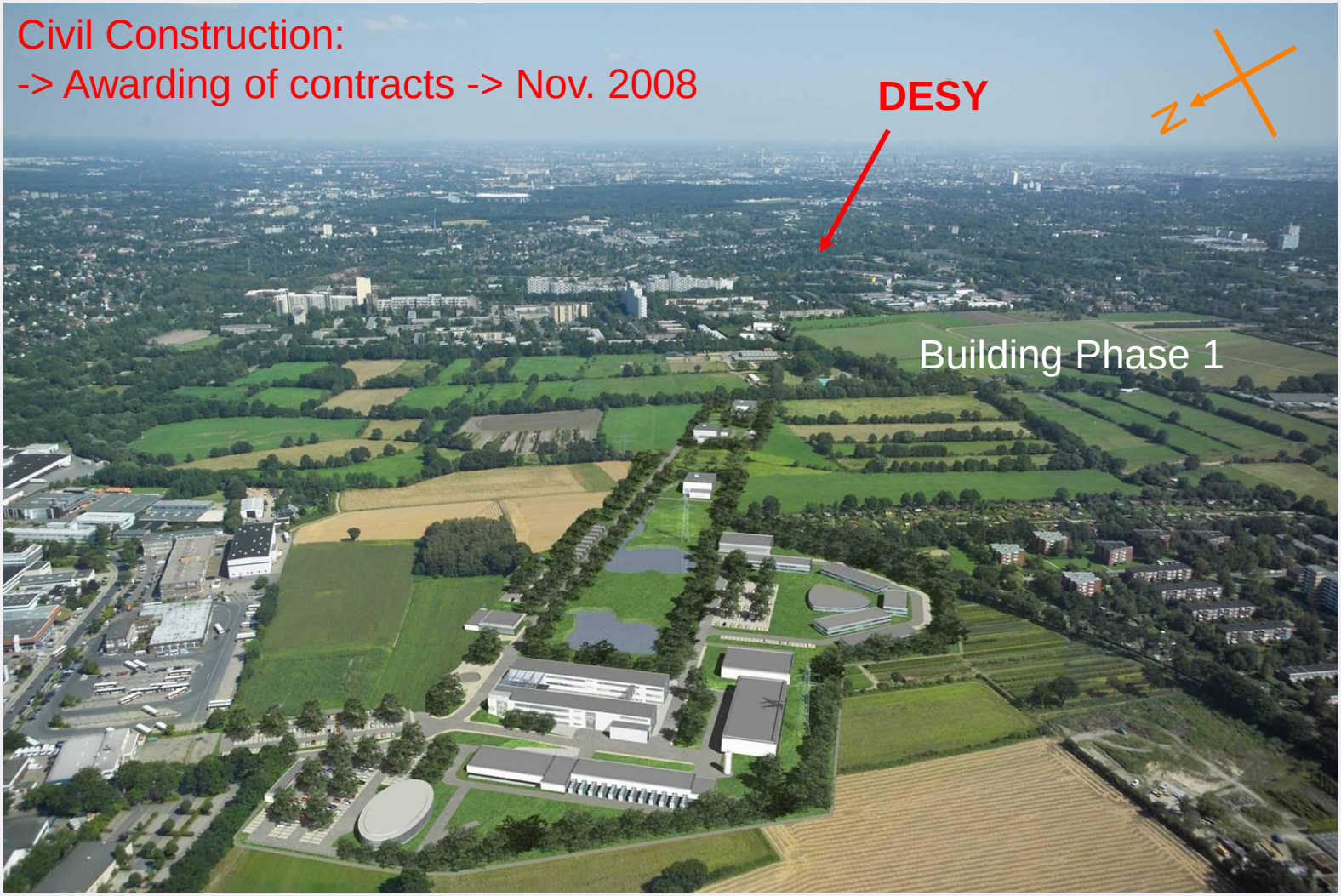
-> XFEL will benefit from the large expertise, which assembles in ILC, and which offers competent ‘outsider views’

Update on general project status

XFEL Site in Hamburg/Schenefeld

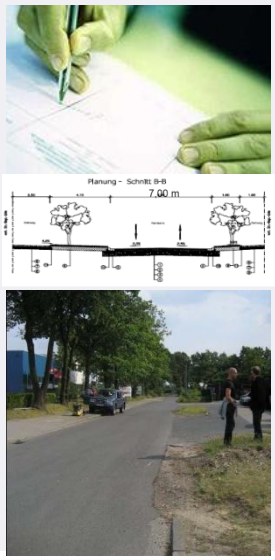


… after construction *(computer simulation)*

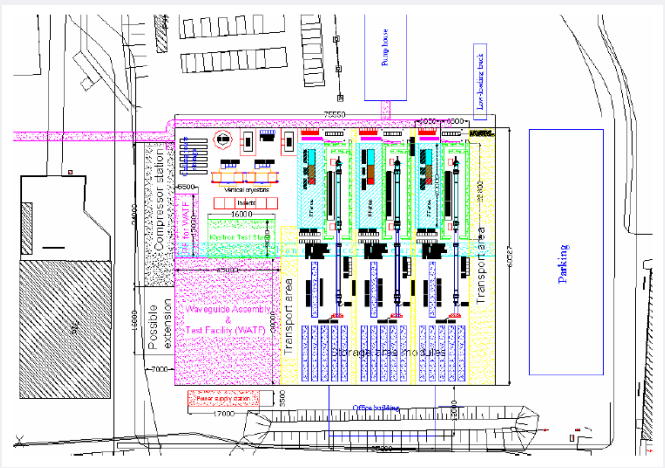


Civil Construction

- Everybody busy with doing the last steps to **place the orders for all lots in the second half of November.**
- Several **access routes** ger already improved.
- The **conservation of evidence** for other **neighbouring streets** started recently.
- First (surevey) **reference pillars** were constructed.
- **Electricity for civil construction sites** under preparation.
- **AMTF call for tender (construction) close to be issued**



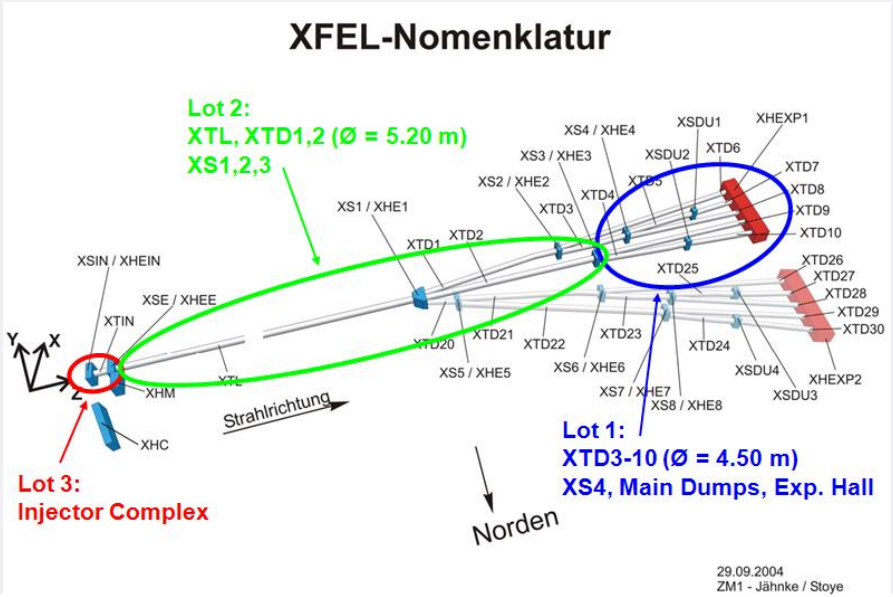
Conservation of evidence at ‘Flottbeker Drift’



Layout of the Accelerator Module Test Facility – call for tender to be started asap.

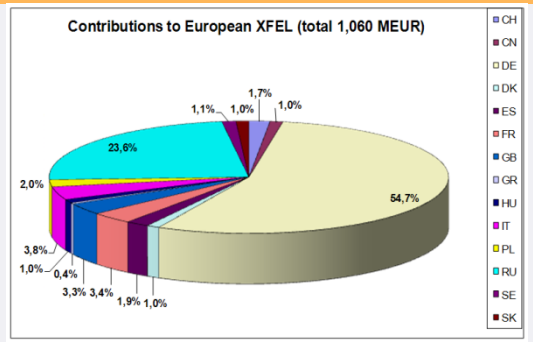
Civil Construction

- **fixing boundaries** of the sites
- establishing of the last 9 **survey reference pillars**
- early **surveying** as foundation to start with the buildings by the contractor
- **Dec. 2008 --> start construction** of lot 1, lot 2 and lot 3
- strengthening of baseplate of pylon Nr. 1067
- prepare to save the sewer pipe along the street ‚Am Osdorfer Born'
- modifications of wells in the trail of the tunnels



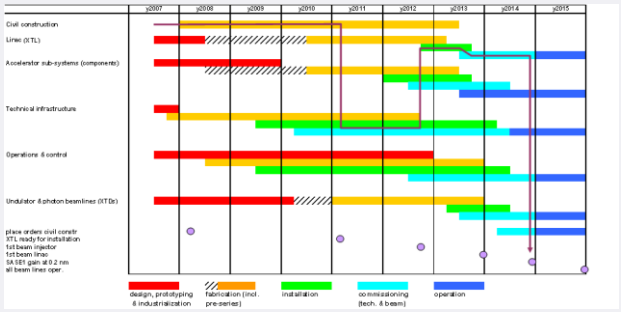
Funding & XFEL GmbH & Negotiations & Schedule & …

The overall financial contribution is basically unchanged. The rules are described in the XFEL convention which unfortunately is not yet signed. **Escalation and risk budget is still a topic.**



The **foundation of the XFEL GmbH is expected** asap after all legal documents are signed. This is expected **for February 2009.**

With some partners the negotiations about in-kind contributions are not yet conclusive. Will they replaced by an increased cash-contribution which then could be used by the XFEL GmbH to finance the not assigned components?



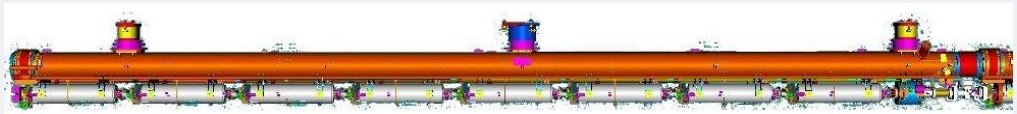
Generating an overall project schedule, which links the important milestones of the individual production schedules (WPs) as well as the envisaged overall installation workflow turned out to be very difficult

--> Requires in-depth understanding of many concurrent dependencies

Update on SCRF

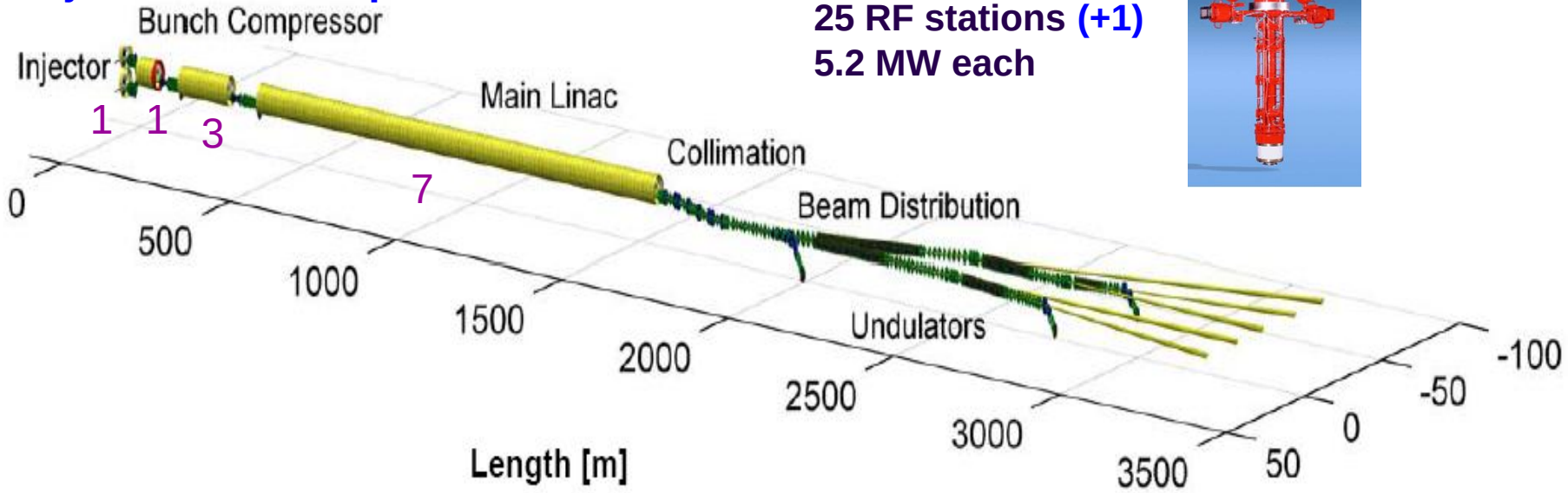
Accelerator Complex & LINAC Technology

100 accelerator modules (+1)



800 accelerating cavities (+8)
1.3 GHz / 23.6 MV/m

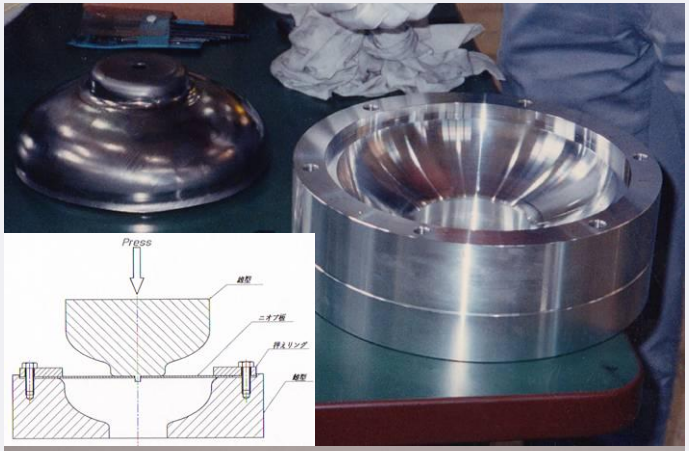
1 Injector at start-up

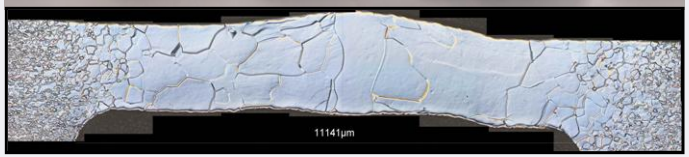


25 RF stations (+1)
5.2 MW each

12 cryogenics/vacuum sections

XFEL Cavities



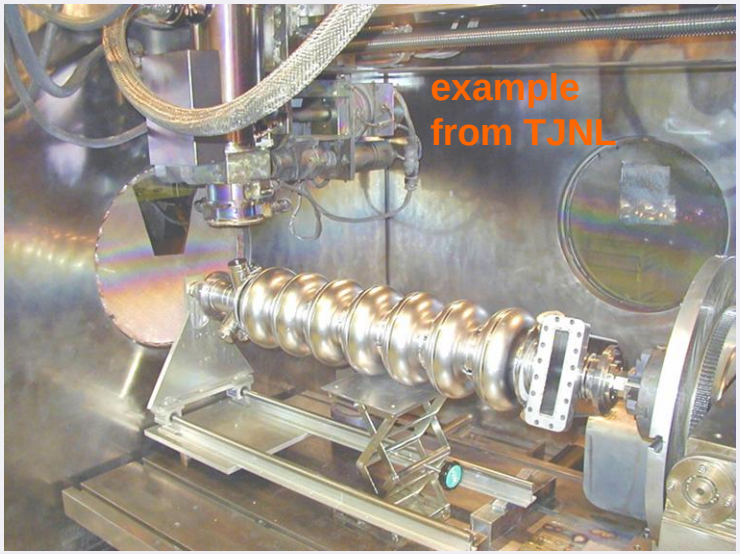


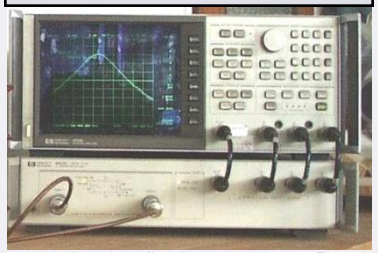
Half cells are produced by **deep drawing**.

Annealing is next to achieve complete re-crystalisation.

Dumb bells are formed by **electron beam welding**.

RF measurements support visual **inspection**.





After proper **cleaning** eight dumb bells and two end group sections are assembled in a precise fixture.

All **equator welds** can be done **in one production step.**

Engineering Data Management Systems (EDMS) is used for the **documentation of the cavity fabrication process (-> QA/QC)**.

Nb Sheets -> Qualification of 3 vendors

Delivered:

AC116 – AC129	**Tokyo Denkai** Material	(15 cavs to study industrial EP)
Z130 – Z144	Tokyo Denkai Material	(15 cavs to study industrial EP)
AC150	Tokyo Denkai Material	(from rest material)
AC159	Tokyo Denkai Material	(small XFEL design change)
AC115	**Plansee** Material	(qualification of new vendor)
AC149	Plansee Material	(qualification of new vendor)
AC146 - AC148	Ningxia Material	(qualification of new vendor)

Under fabrication:

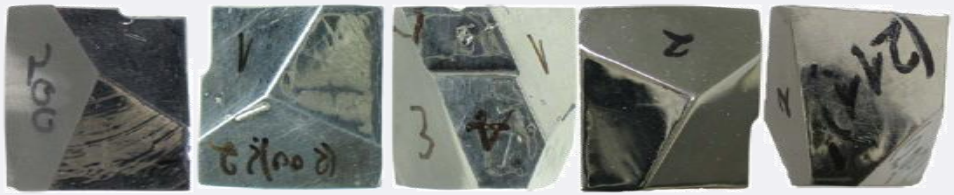
AC151-AC158	Heraeus Material	(8 cavs large grain)

Fa. ACCEL:	10 cavs. successfully EP polished (110 - 140µm), finally treated and RF tested at DESY
Fa. HENKEL:	10 cavs. successfully EP polished, finally treated and RF tested at DESY 4 more cavities in EP polishing at ACCEL
PLANSEE:	**is qualified** (9 cell cav. fabricated at ACCEL from PLANSEE niobium reached > 40 MV/m
NINGXIA:	three 9 cell cavities fabricated at ACCEL delivered to DESY, preparation and RF test scheduled for Q4/2008

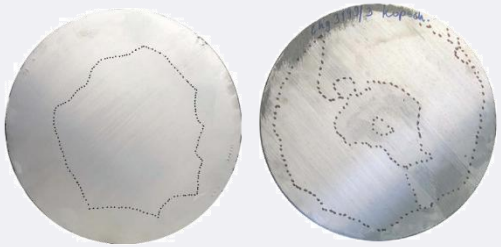
Large Grain Cavities

Results of the **DESY / W.C. Heraeus Collaboration** on large grain material

- **Positive experience**
  several large grain ingots were produced
  large grain crystals are growing in axial direction
- **Disappointing**
  transition phase from start crystal to continuously growing crystal is critical
  quite a few of the well prepared start crystals were destroyed



different start crystals produced by W.C. Heraeus



the goal and the problem

not a stable process
no reproducible growth of the required 150 mm diameter central grain
→ **the XFEL unfortunately can no longer support this interesting program**

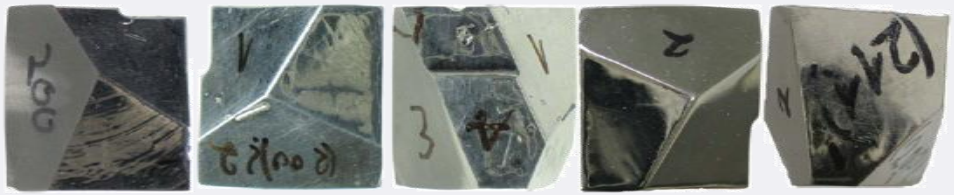
Large Grain Cavities (cont.)

Large grain cavities **AC151-AC158 under fabrication** at ACCEL and to be delivered before end of 2008.

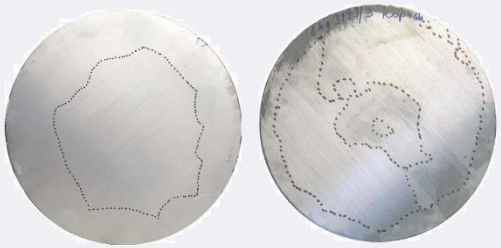
Additional **reshaping of dumb bells** was required due to an oval-shaped equator area; special tools were necessary.

Finally **fabrication problems** were solved, but additional costs.

The welding of 8 LG cavities is now possible.



different crystal orientation gives different deep drawing results, i.e. shape deviations especially in the equator area



the goal and the problem

A certain 'Large Grain Cavities' program continues at DESY

Pending Decision: with He Vessel or without He-Vessel

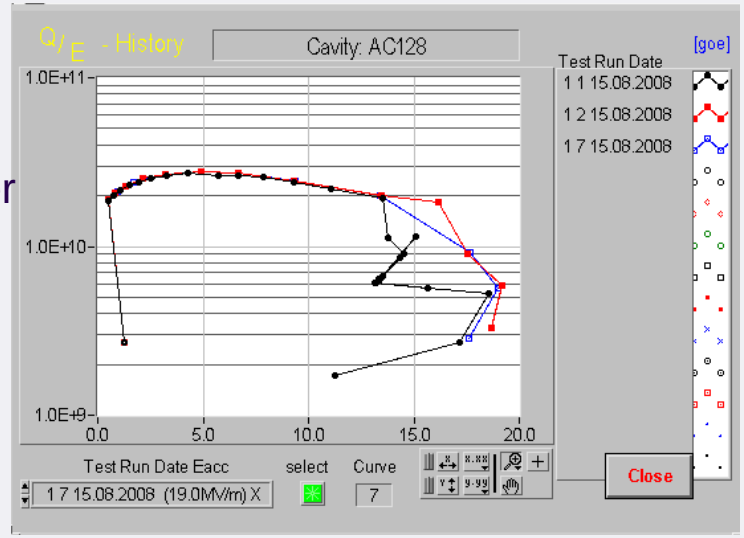
On the way to **minimize cost and effort** a question came up:
Should the cavity vertical test be done with the He tank already welded onto the cavities? Also HOM pick-ups would be assembled.

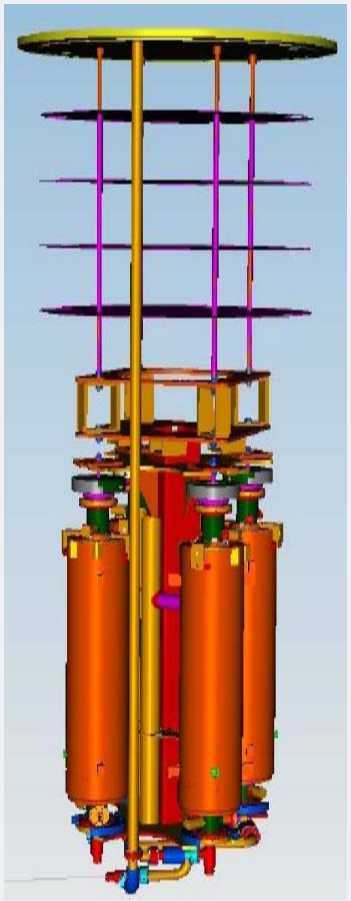
Findings:
- No problems for RF test and RF performance.
- Installed HOM pick-ups do not allow full mode measurement
- T-mapping is not possible anymore

In several cases a Q-switch was observed during cw RF test!?!?!

• Removal of the HOM pick-up installed next to the main RF power coupler eliminated the Q-switch.

• Special test program in order to understand this phenomena is in preparation; some hint to mistakes during feedthrough production.





XFEL Cavity Preparation Test Cycle 9 2775

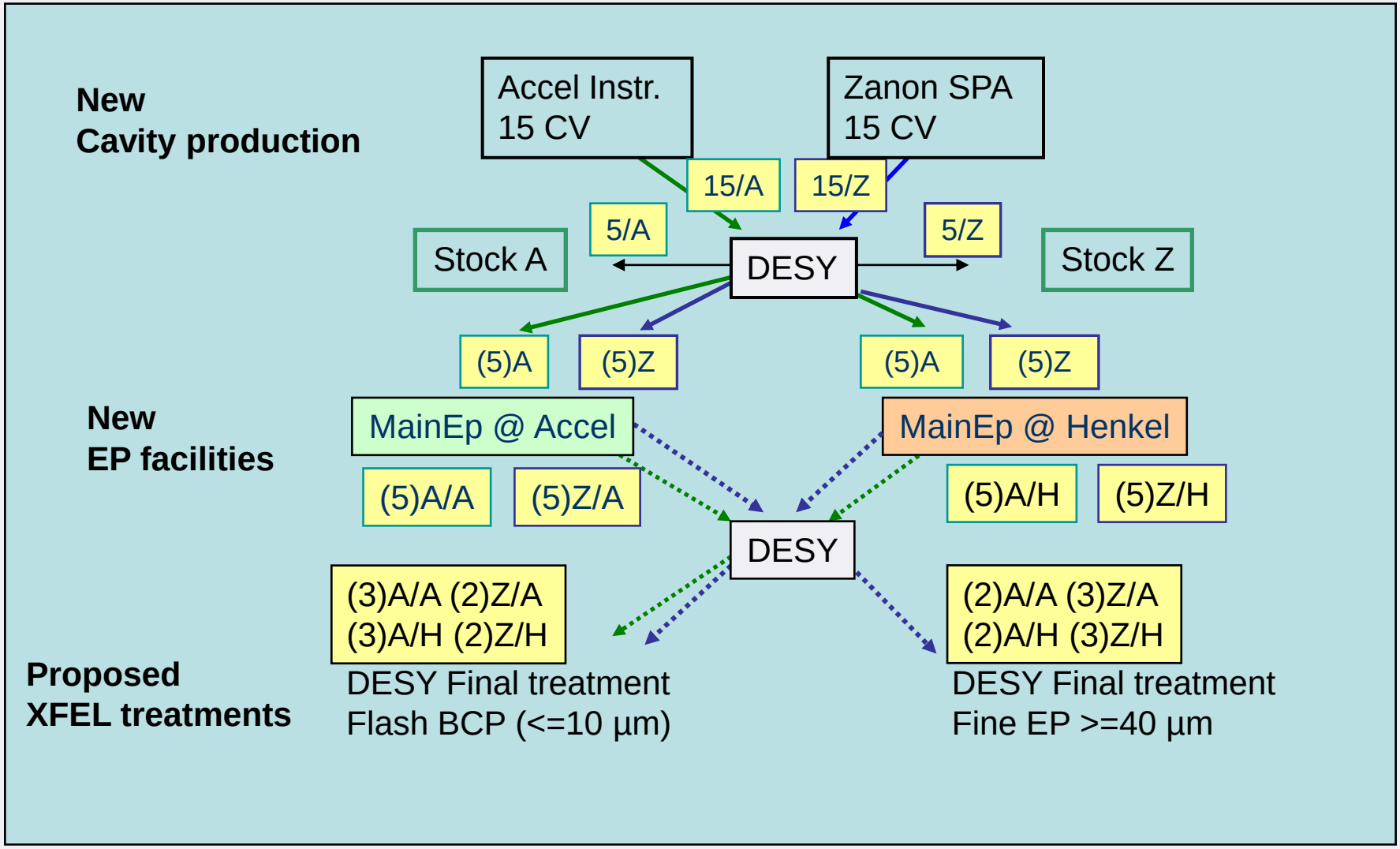
Proposal for **minimum cost:** One RF Test @ 2K only
Minimum manipulations on CV after 2K test (ready for module assembly)

Final EP:
Tuning
Final EP (40 µm)
HPR
Installation of FMS**
TI-cone rings welding
FM control/ tuning
Tank welding
Removal of FMS**
Installation of probes
HOM /Pick Up
HQ Antenna (Fixed coupling)
HPR
120 C bake
Acceptance test @ 2K
Ready for module

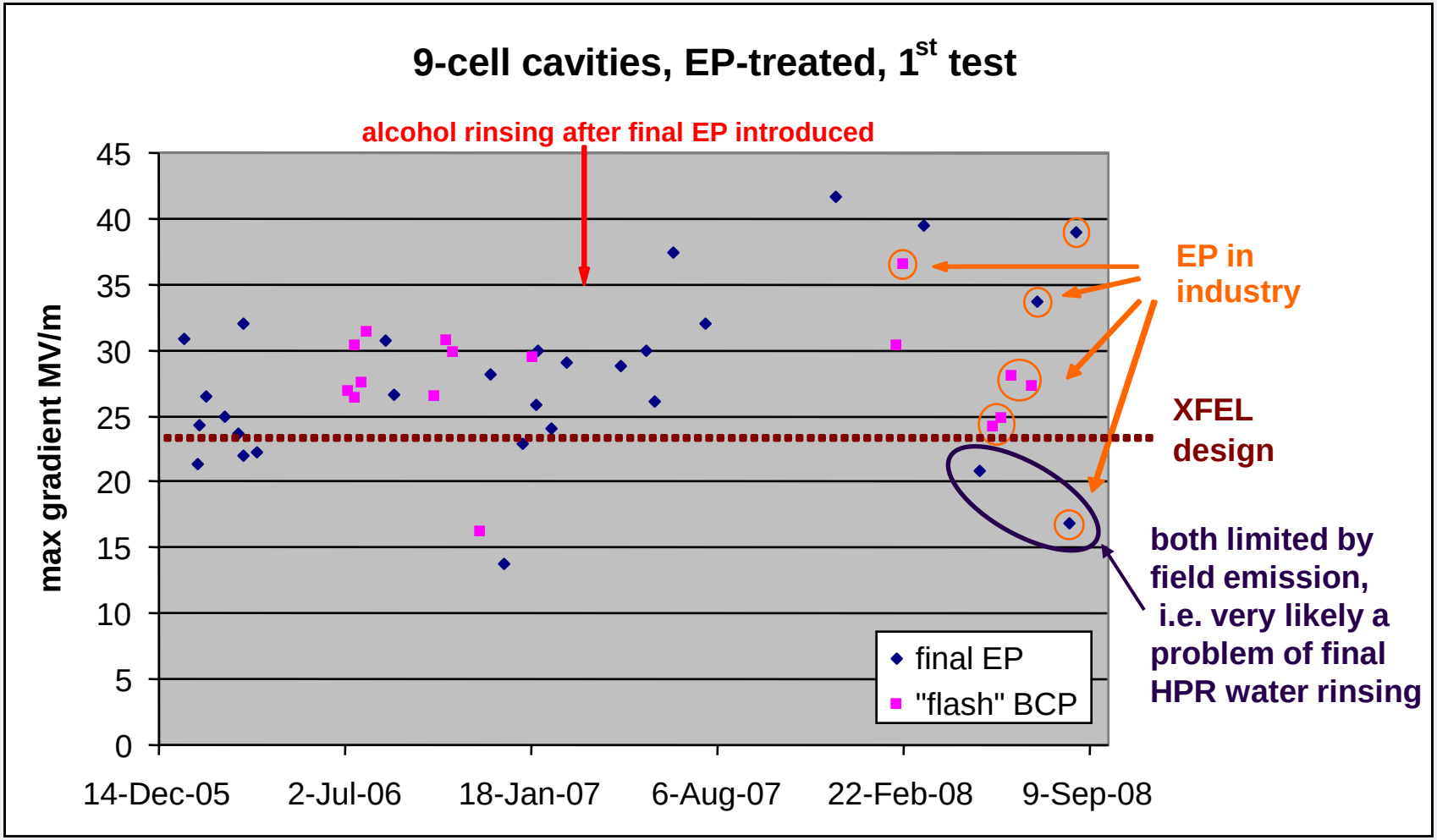
Flash BCP:
Tuning
Installation of FMS**
TI-cone rings welding
FM control/ tuning
Tank welding
Removal of FMS**
Flash BCP (10 µm)
Installation of probes
HOM /Pick Up
HQ Antenna (Fixed coupling)
HPR
120 C bake
Acceptance test @ 2K
Ready for module

** FMS= field profile measurement system

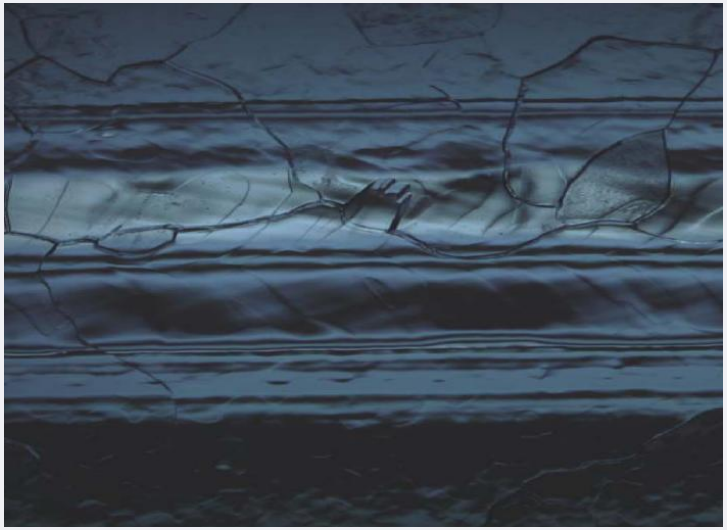
Cavity Preparation at DESY

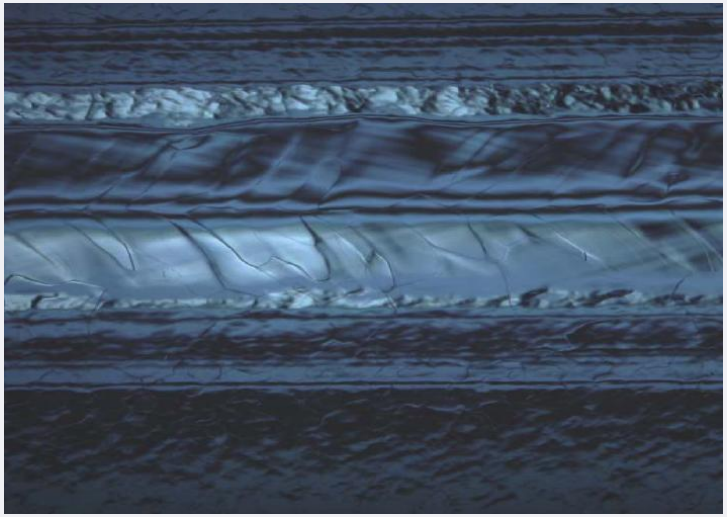


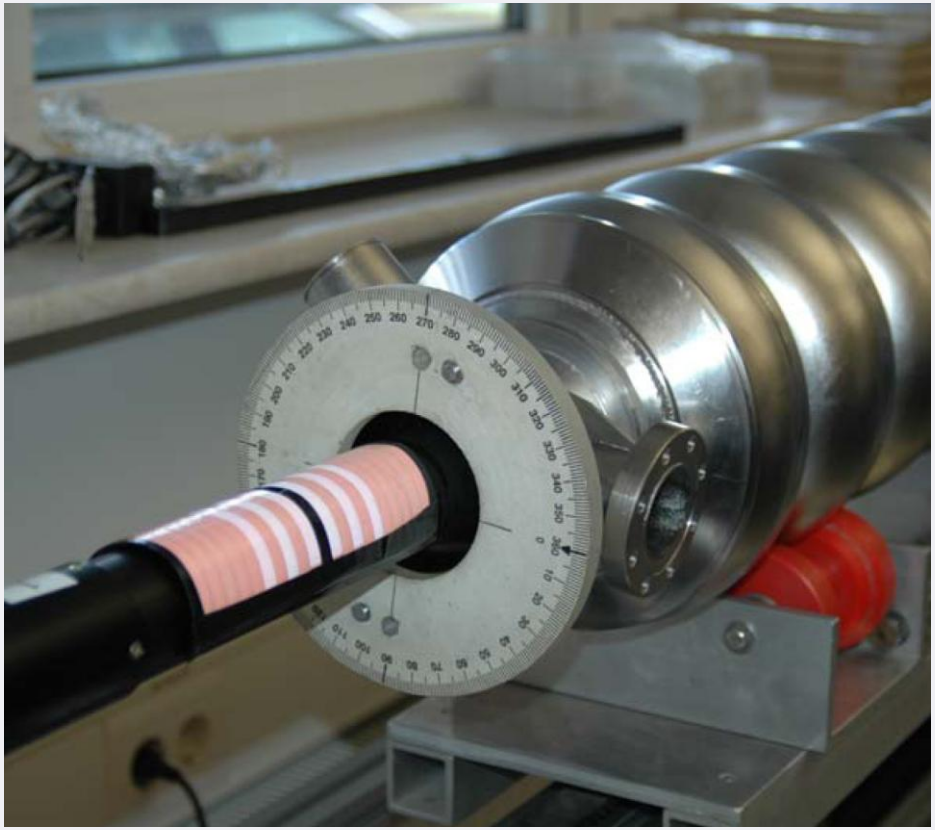
Cavities since Jan 2006, 1st test



Cavities – High Resolution Kyoto Univ. Camera

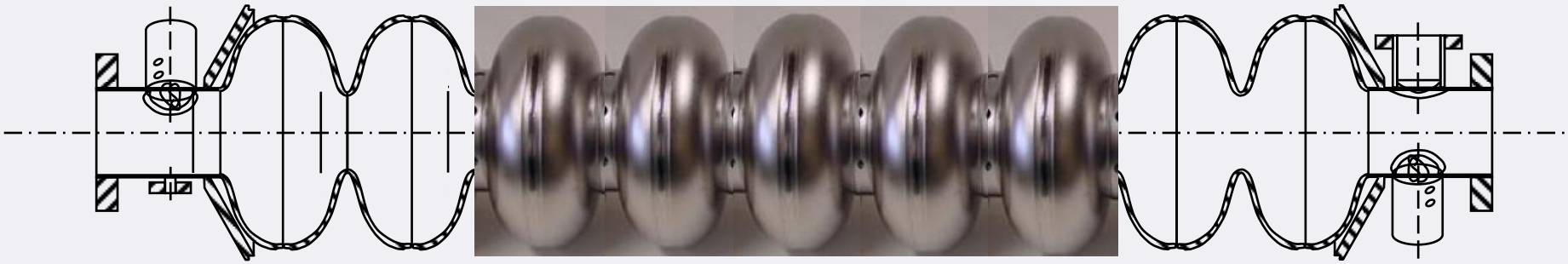






The high resolution Kyoto -Camera was adapted to support the optical inspection being part of the quality control & incoming inspection at DESY. **First pictures were taken and quench location studies are under way**

Cavities – Next Steps



Until end of 2008:

Finalize specification for:
- Cavity fabrication
- He vessel
- Cavity treatment with He vessel

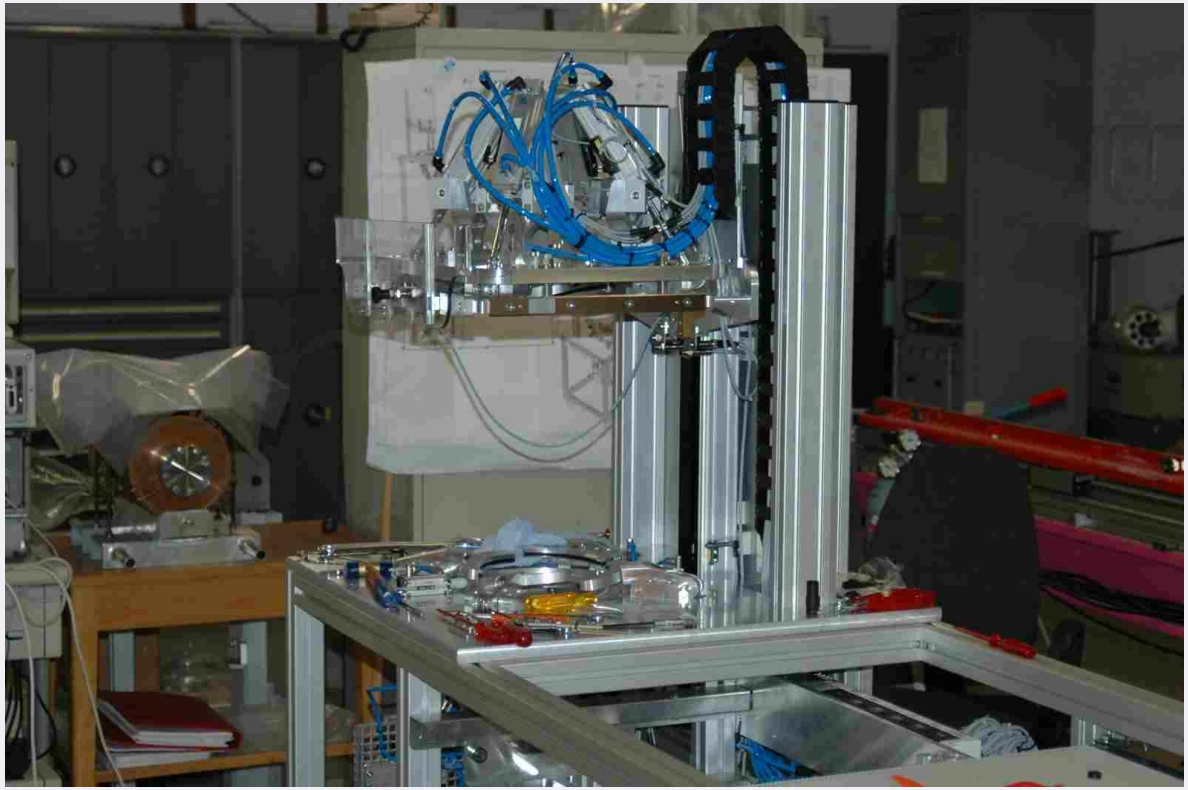
Until Q2 / 2009:

Purchase material (sheets, tubes etc.) for 30 pre-series cavities

And organisational issues:

Finalize Annex to the Accelerator Consortium Agreement (ACA)
- make the cavity work package including the relevant CFTs a **common DESY-INFN enterprise**
- update the **project plan (MSPE)** based on linked project milestones

HAZEMEMA (machine for RF measurement of dumb bells etc.)



Equipments for RF measurement of half cells, dumb bells and end groups

- **prototype has been tested** at ACCEL and ZANON during fabrication of last 30 cavities
- some improvements in design were done
- main parts for **two units** are ordered
- final assembly to be done at DESY
- **ready end of 2008**

Niobium Scanning

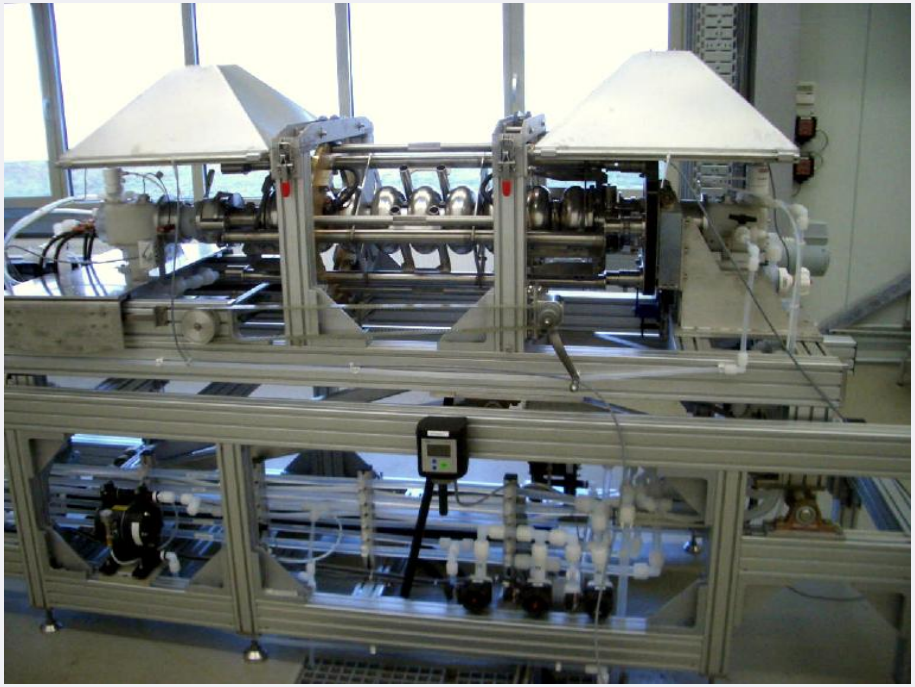
DESY eddy current apparatus

- Niobium for the pre-series (ca. 30 cavities) will be scanned on the existing prototype equipment at DESY
- equipment will be **renovated** for that purpose
- order of **new equipment** is not time critical -> planned for **2009**

Field Flatness Tuning

- 4 tuning machines are under construction in collaboration with FNAL and KEK, **two of them for XFEL**
- final assembly and commissioning as well as certification at DESY
- project should be **completed in Q2 2009**

Electro-polishing in industry



courtesy of Henkel Elektropoliertechnik

courtesy of ACCEL

2 facilities are available in industry

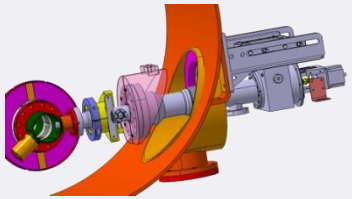
Cavity String & Module Assembly

Using experience gained at DESY and results of industrial studies, the **assembly facility** for all 100 XFEL modules **will be set up at** the **CEA-Saclay** site.

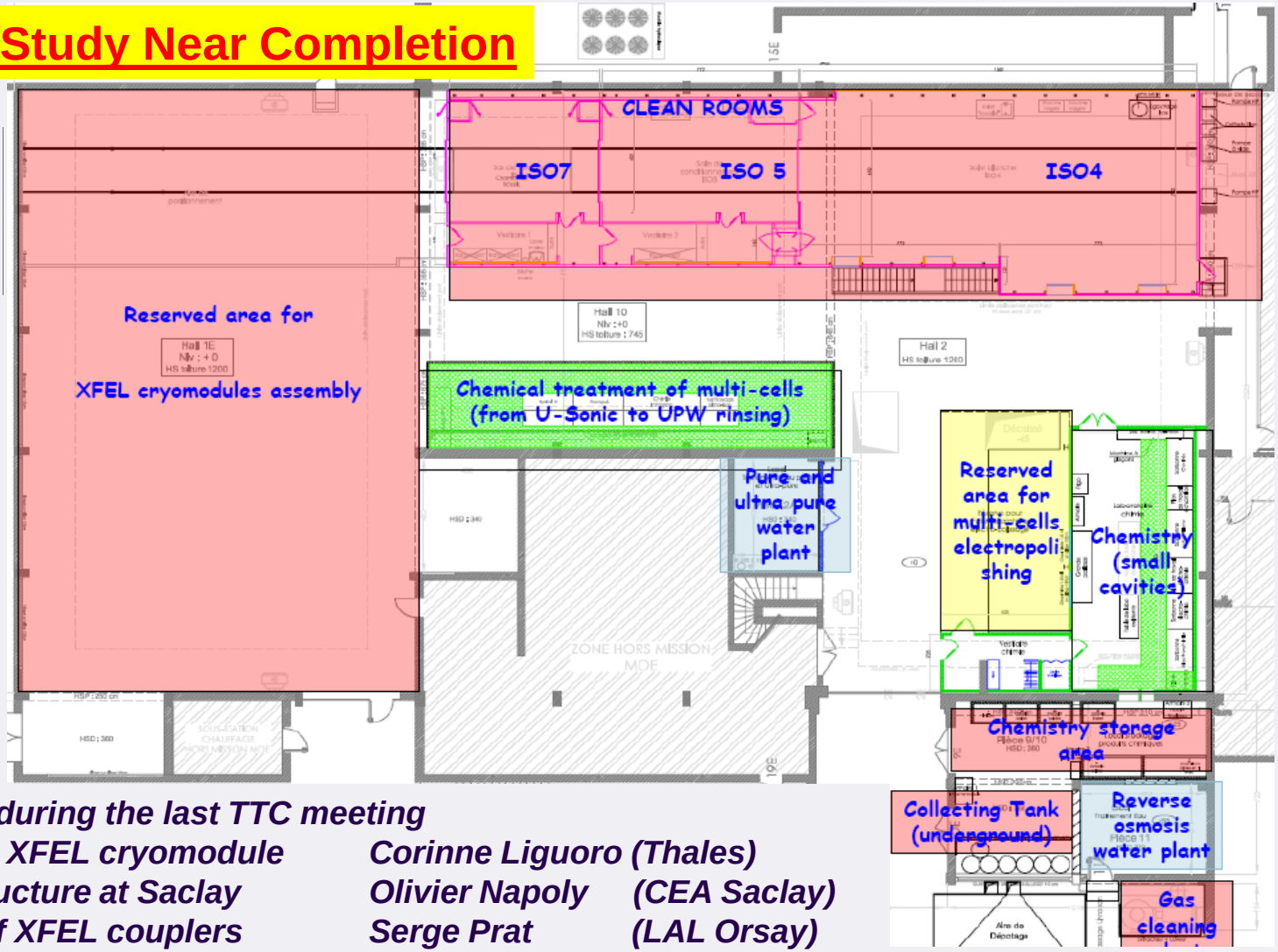
CEA (IRFU), CIEMAT, DESY, INFN-Milano, LAL Orsay, Swierk take the responsibility for the cold linac.

Assembly Facility at CEA Saclay (with Spiral2)

–> Industrial Study Near Completion



RF coupler processing facility under preparation at LAL Orsay



More was reported during the last TTC meeting

- ***Assembly plan for XFEL cryomodule*** — ***Corinne Liguoro (Thales)***
- ***Assembly infrastructure at Saclay*** — ***Olivier Napoly (CEA Saclay)***
- ***Industrialization of XFEL couplers*** — ***Serge Prat (LAL Orsay)***

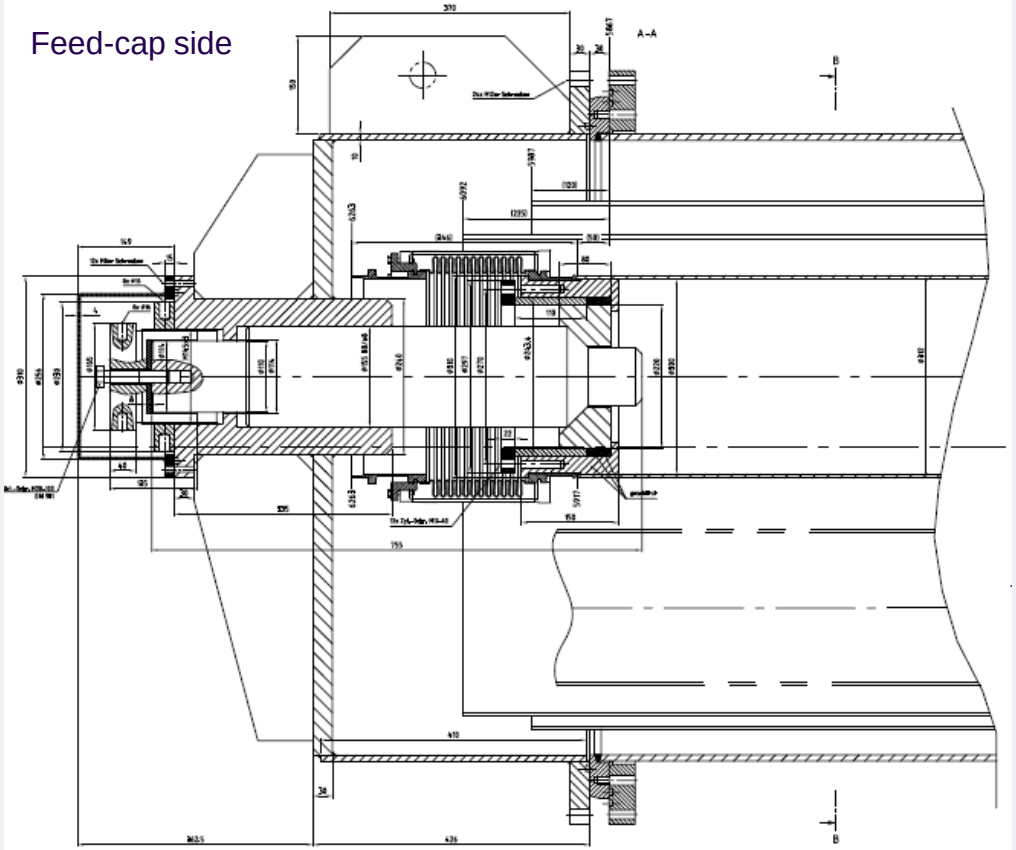
Module Transport Frame

- The Frame is equipped with two **Data Loggers** EnDal Curve 1111
- INFN equipped the Frame and the Module with **additional sensors and** uses **3 geophones** inside of the module (2 on the magnet and 1 on the coldmass' center)
- The INFN electronic will also **readout the vacuum gages** on the beam pipe and coupler pump line and the is permanently checking all RF main input couplers with respect to a short circuit.

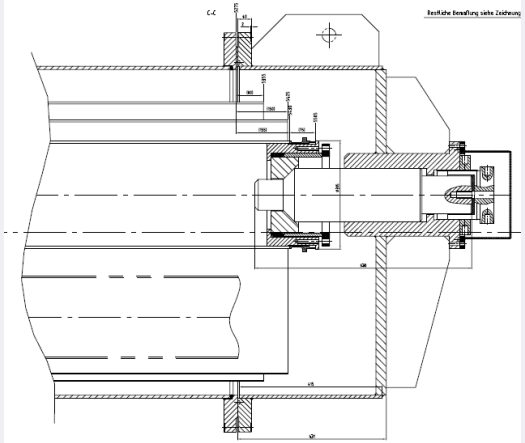
- ***DESY-SACLAY-DESY***
- ***re-test at CMTB in end of November '08***

Coldmass fixed by Vacuum Vessel Caps

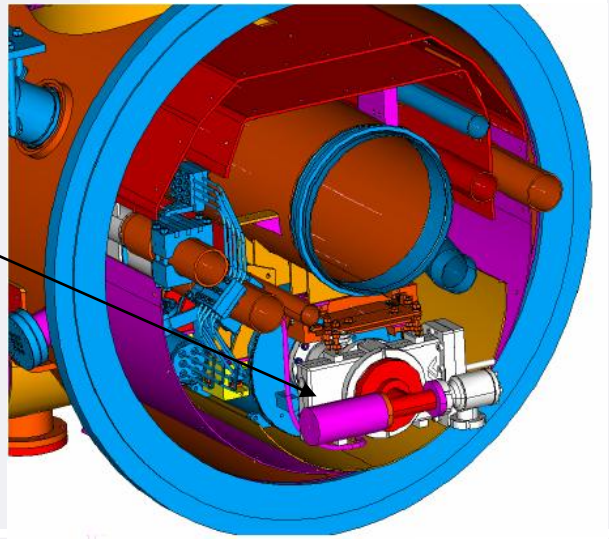
Feed-cap side



End-cap side



Beam pipe
Vacuum gage
End-cap

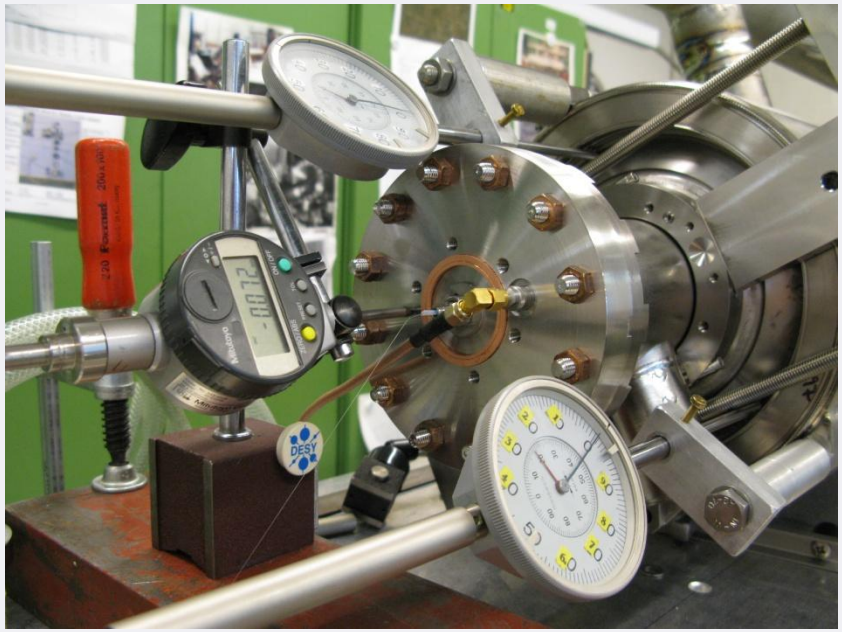


Let's go!

Pressure Test of Cavity and He Vessel

Motivation:
Development of a pressure test for the 800 XFEL cavities as part of a safety acceptance.

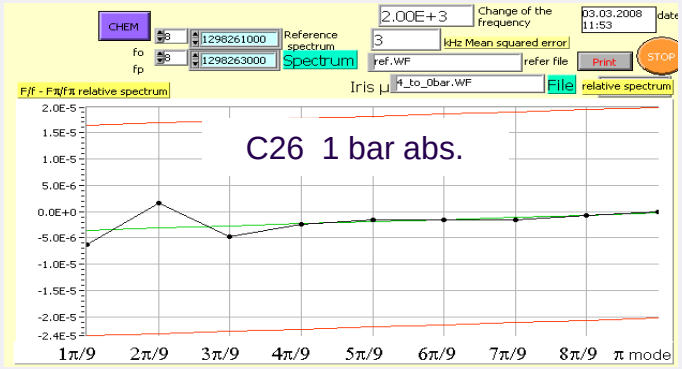
- max. possible pressure inside He vessel is 4 bar rel.
- pressure vessel regulations require 4 x 1.43 = 5.72 bar
- pressure test with 1 bar abs. in the cavity requires 6.72 bar, i.e. 7 bar abs. during a test



Goal:
Do the pressure test with water at warm temperature and check for plastic deformation of cavities.

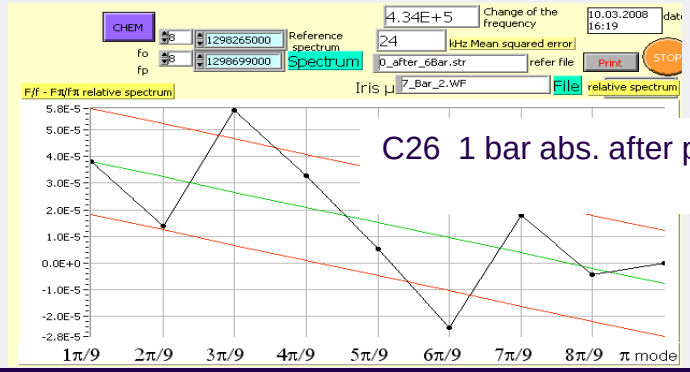
Two cavities were tested:
C26 1350 ºC oven treatment
Z97 800 ºC oven treatment
wall thickness of both cavities is 2.5 mm

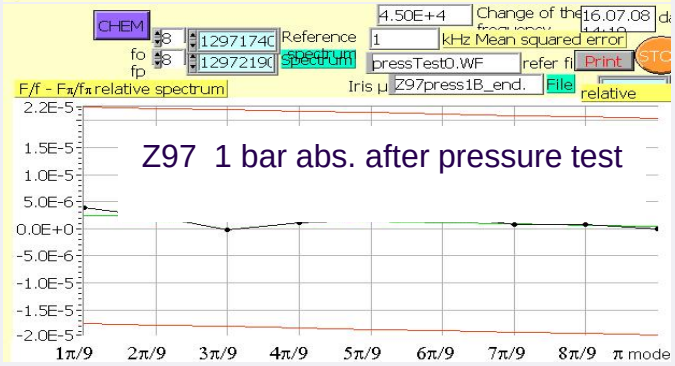
Does the Pressure Test causes Plastic Deformation?



C26 1350 ºC oven treatment
clear deformation after pressure test

Z97 800 ºC oven treatment
no deformation after pressure test
modes unchanged
field flatness unchanged

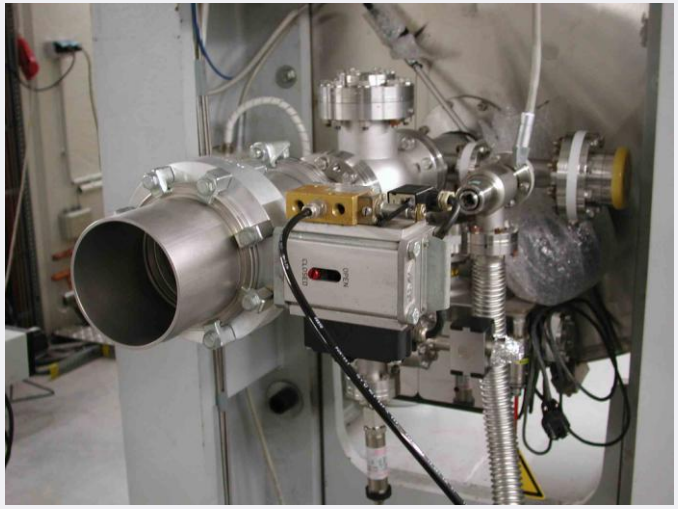




Accelerator Module 3* at CMTB

Venting of Cold Coupler, Cavity and Iso-vacuum

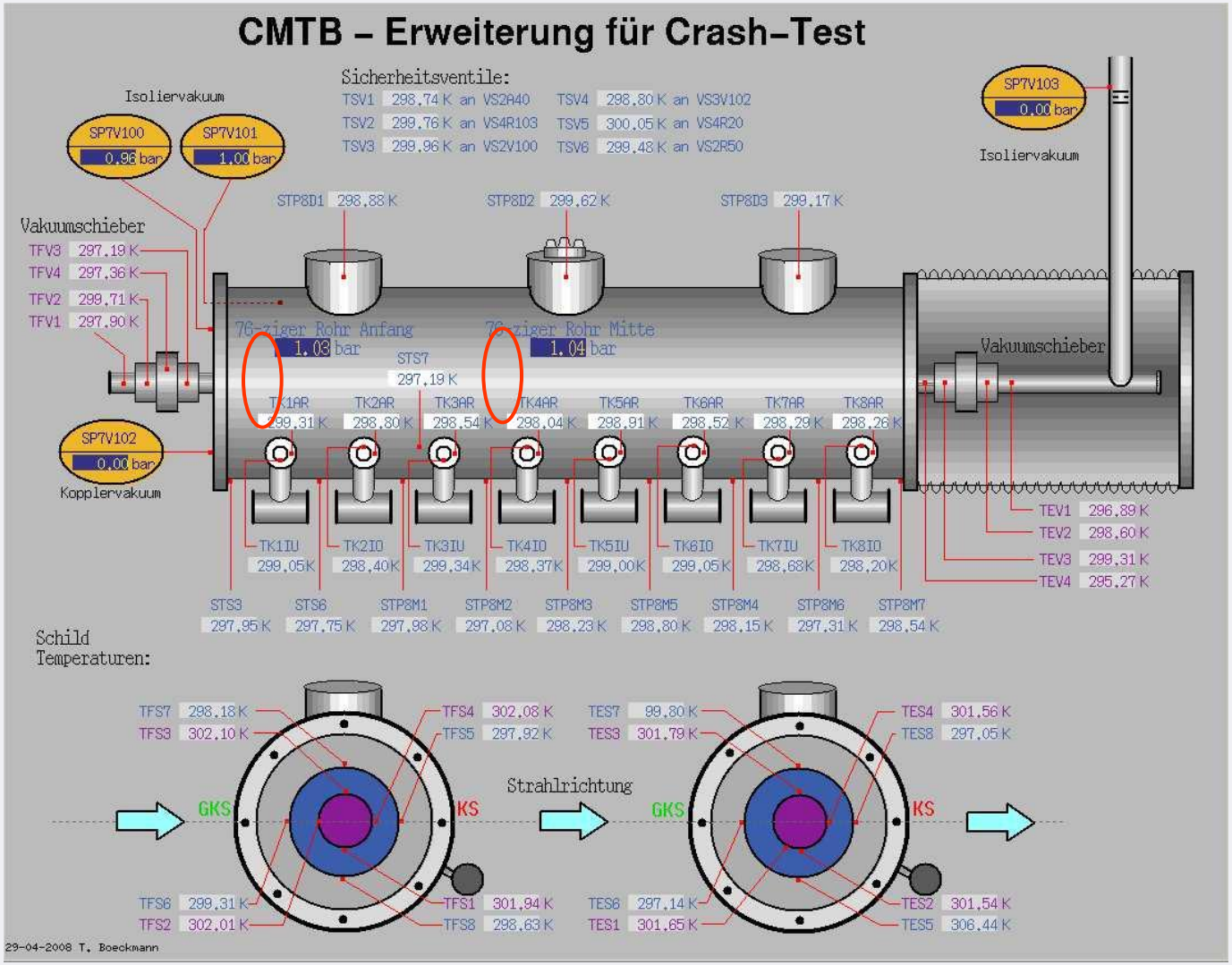
Venting system
beam-pipe-vac DN 100



Venting system **coupler-vac** DN 100

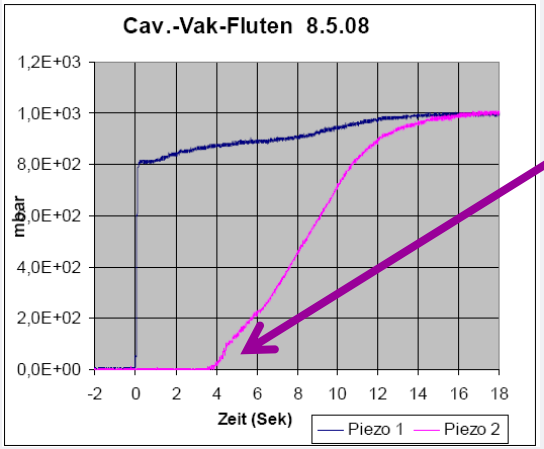
Venting system **Iso.-vac** DN 100

Additional Sensors Installed for M3* *'crash-test'*



Conclusions from *'crash-test'*

- The **calculated values** of pressure drops in the He-circuits during venting the beam pipe and insulation vacuum **are confirmed**
- The cavities' frequency and **field flatness was unchanged**
- A venting of the beam pipe seems to be "relaxed" because the pressure wave needs almost **4 sec** over the length of one single accelerator module, i.e. there is sufficient time to close gate valves.



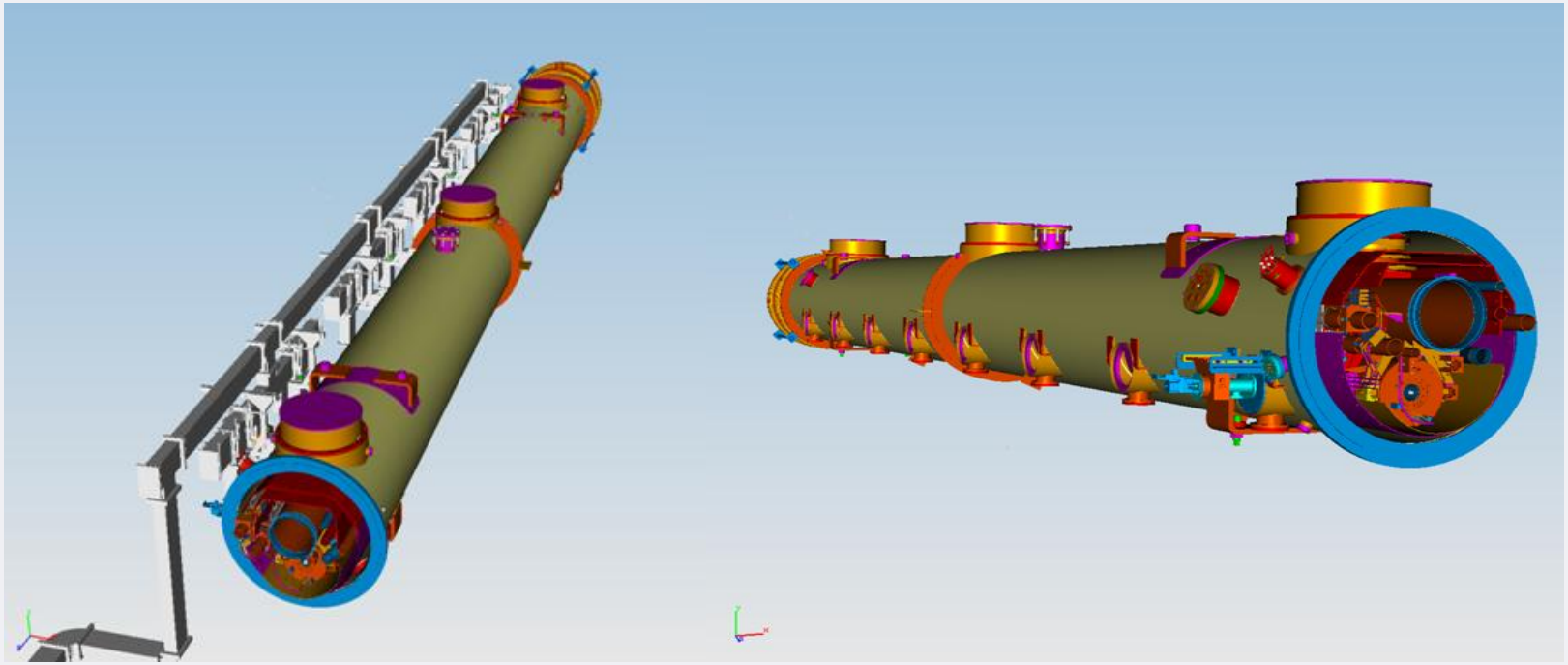
Pressure front in beam-vacuum takes ~4s(!) through module (12 m length)

- After a venting of the **insulation vacuum** followed by pump down (no warm-up) the module was operated under 'normal' conditions (rf and cryo-wise)
- The **frequency tuners' drive system** still works
- The venting of an XFEL unit's (12 modules) insulation vacuum is much more relaxed as compared to the CMTB test because the volume is factor ~12 larger, i.e. the pressure blast is less critical.

70 K Shield inspected during Disassembly

The XFEL Cryomodules are very robust and will cause no conflicts with the 'European Pressure Equipment Directive'

XFEL Cryodules Prototypes -> 3 Companies

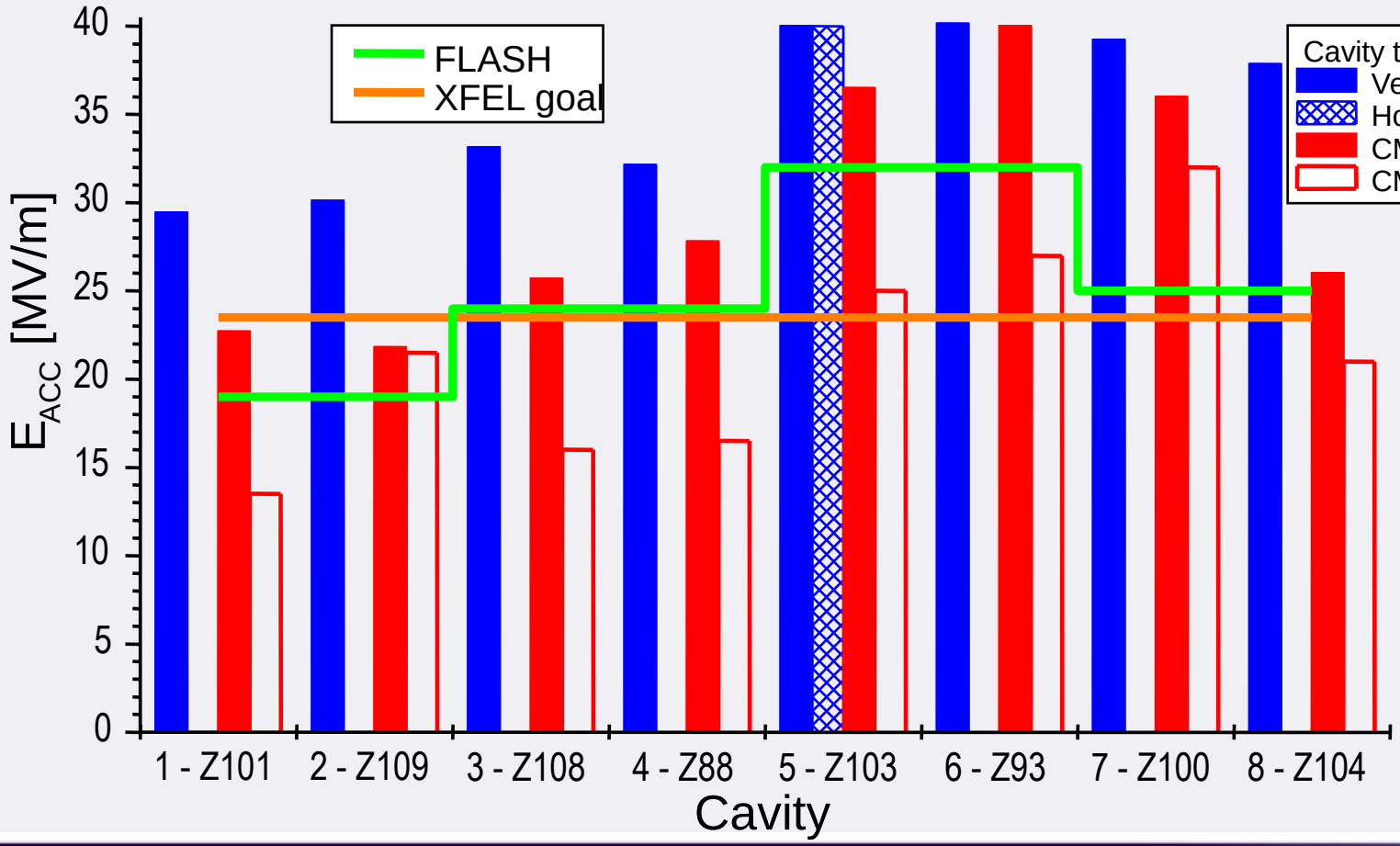


One cryomodule, i.e. vessel & cold mass, each from …

- **Thales / Phoebe (France) delivery expected for December 2008**
- **FCM (Spain) expected for January 2009**
- **IHEP / Aerosun (China) expected for February 2009 (?)**

Module #8 test results

Module 8 was a test vehicle for an **out-sourced module assembly**
The **two groups of four cavities** each were assembled by **two different teams**



Transfer of knowledge

Module 8: Lessons learned

Module 8 was a test vehicle for an **out-sourced module assembly**

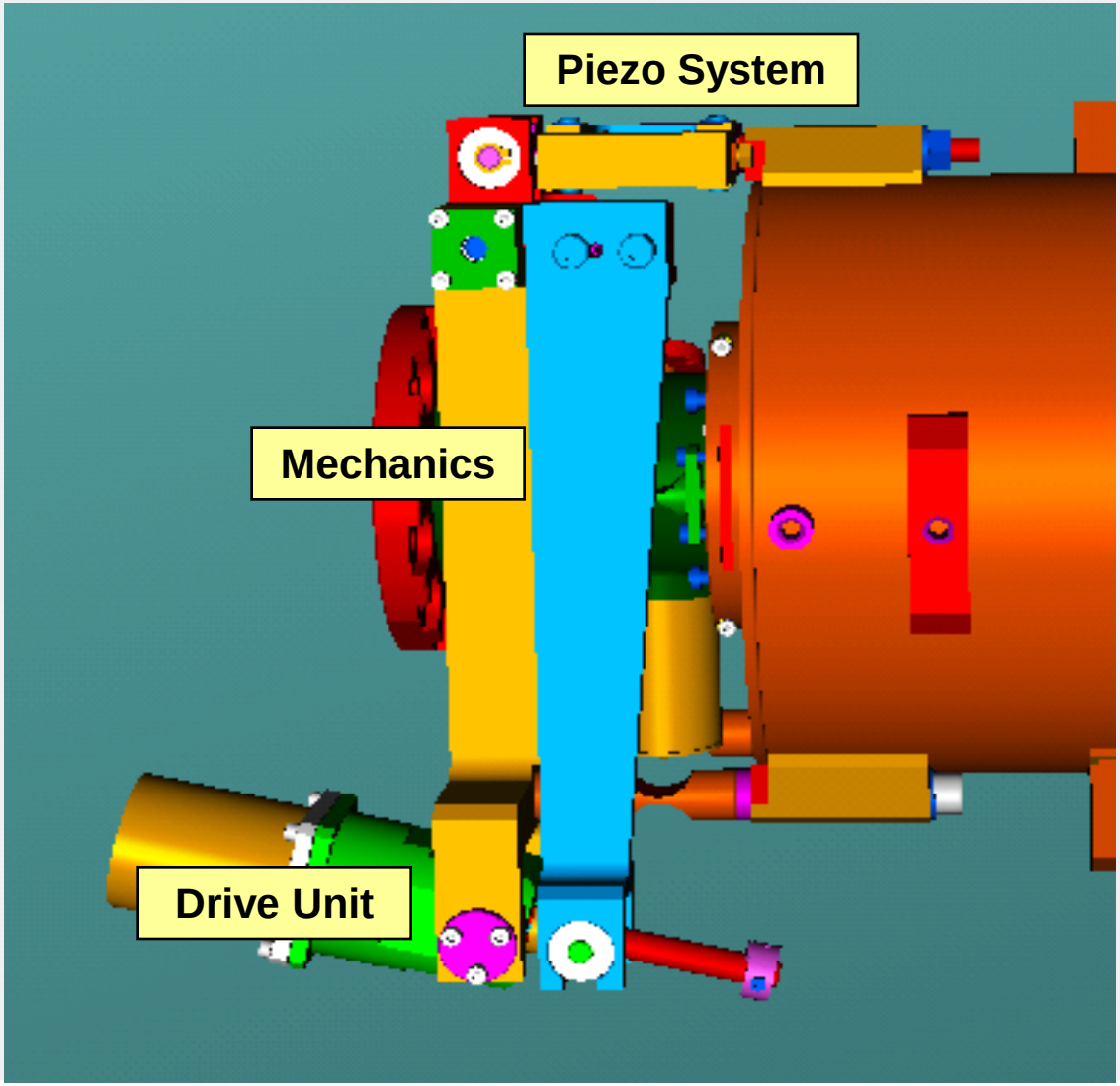
The **two groups of four cavities** each were assembled by **two different teams**

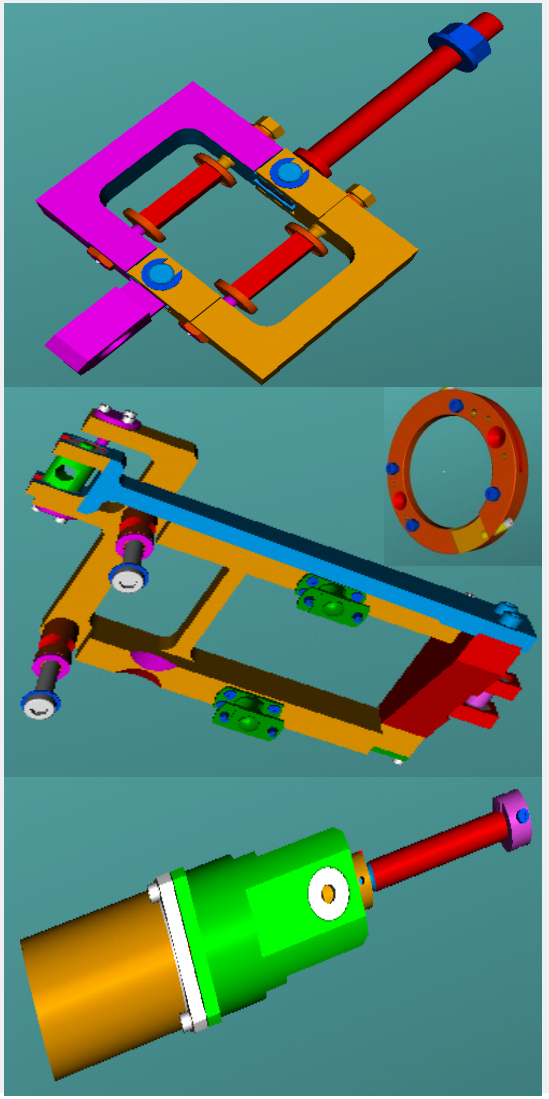
Findings:

- the actual work was done with **slightly different ‚respect‘**
- we were **unable to identify** or describe **obvious differences**
- there is the **suspicion that the single cavity venting** was done with either different care **or** just different **due to an aged venting equipment**; we are going to replace the system
- cavity 8 probably suffered from a **too fast venting** of the string during a quick repair / exchange of an HOM feed-through

Transfer of knowledge

Frequency Tuner - Overview





Frequency Tuner – Ongoing Work

- **Tests**
  - M3*: Motors survived crash test
  - M8: Is done, final acceptance of piezo fixture and choice of pre-tuning
- **Mechanics**
  - Qualification of vendors
    - Need 24 prototypes for M10-M12
- **Drive unit**
  - Found vendors to deliver full drive unit
  - Coated ball bearings seem problematic wrt. life time
  - Vendor qualification is underway
- **Piezo system**
  - Beginning installation of permanent FLASH setup
  - Tested piezo for breakdown under He atmosphere (INFN)
- **Work on specifications and procedures**
  - Detailed assembly steps are available (INFN, DESY)
  - Development of a semi-automatic test system for verification during installation

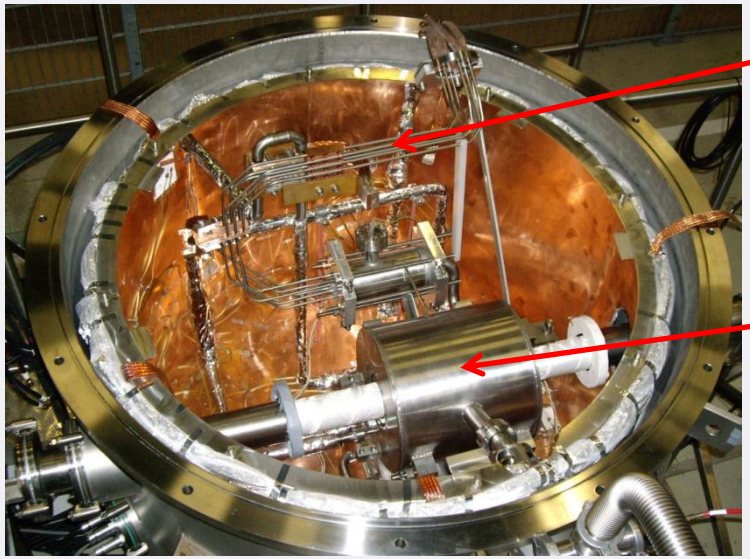
Frequency Tuner - Detailed tuner assembly steps

Goal:

- Verification of current procedure
- Very detailed description, e.g. for training purposes
- for both, the piezo and the mechanical system

Transfer of knowledge

Superconducting Magnet Tests



Test stand at DESY completed in Nov. 08

Klystron and Modulator Prototyping

Toshiba E3736H at Toshiba, Japan

- Factory Acceptance Test in Nasu successfull on August 22/23, 2007
- Klystron arrived at DESY on 18th Sept.
- **Site Acceptance Test at DESY successfull!**

Prototypes from two more manufacturers in near future

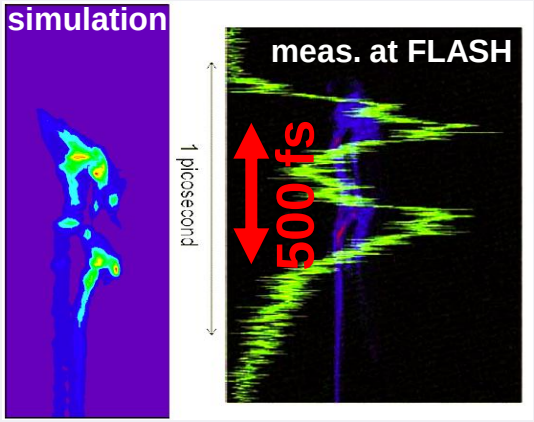
Test stand @ DESY, Zeuthen

Prototype from 1st of two companies recently arrived – test program started

Other important XFEL R&D at DESY

- **Injector R&D at PITZ**
  → small emittance, dark current reduction
- **Extensive S2E simulations**
  → Slice emittance at undulators < 1 mm*mrad
- **FEL simulations**
  → SASE1: 0.1nm with wakefields
- **Slice emittance diagnostics**
  → different methods tested at FLASH
- **Timing / synchronisation**
  → diagnostics in fs-regime
- **Beam distribution**
  → Fast intra-train feedback system
  (DESY & PSI cooperation)

Injector R&D at PITZ



Slice emittance diagnostics

The future challenges

The future challenges

The XFEL future challenges are now by far larger on the organisational / managerial side then on the technological

- **Complexity must be mastered -> become reality**
- **The distributed environment must be mastered**
- **The financial frame is tight and must be kept**
- **The time frame is tight and must be kept**
- **Users expect promised design performance from the beginning on**

Users may go somewhere else if the project delays too much

--> This is a new situation

-> Coordination needs must be identified & satisfied

Identifying & Satisfying Coordination Needs

XFEL has particularly therefore set-up a:

- **Project Management**
- **Project Office**
- **Photon Systems Coordination**
- **Cold Linac Coordination**
- **Machine Layout Coordination**
- **Technical Coordination**
- **WP40: Information & Process Support**

Identifying & Satisfying Coordination Needs

1st Workshop on the XFEL Collaborative Design Effort

(23 & 24 Sept. 2008, DESY-HH)

Thomas Hott
XFEL Technical Coordination

Lars Hagge
WP40 Information & Process Support

1st WS on the XFEL Collaborative Design Effort

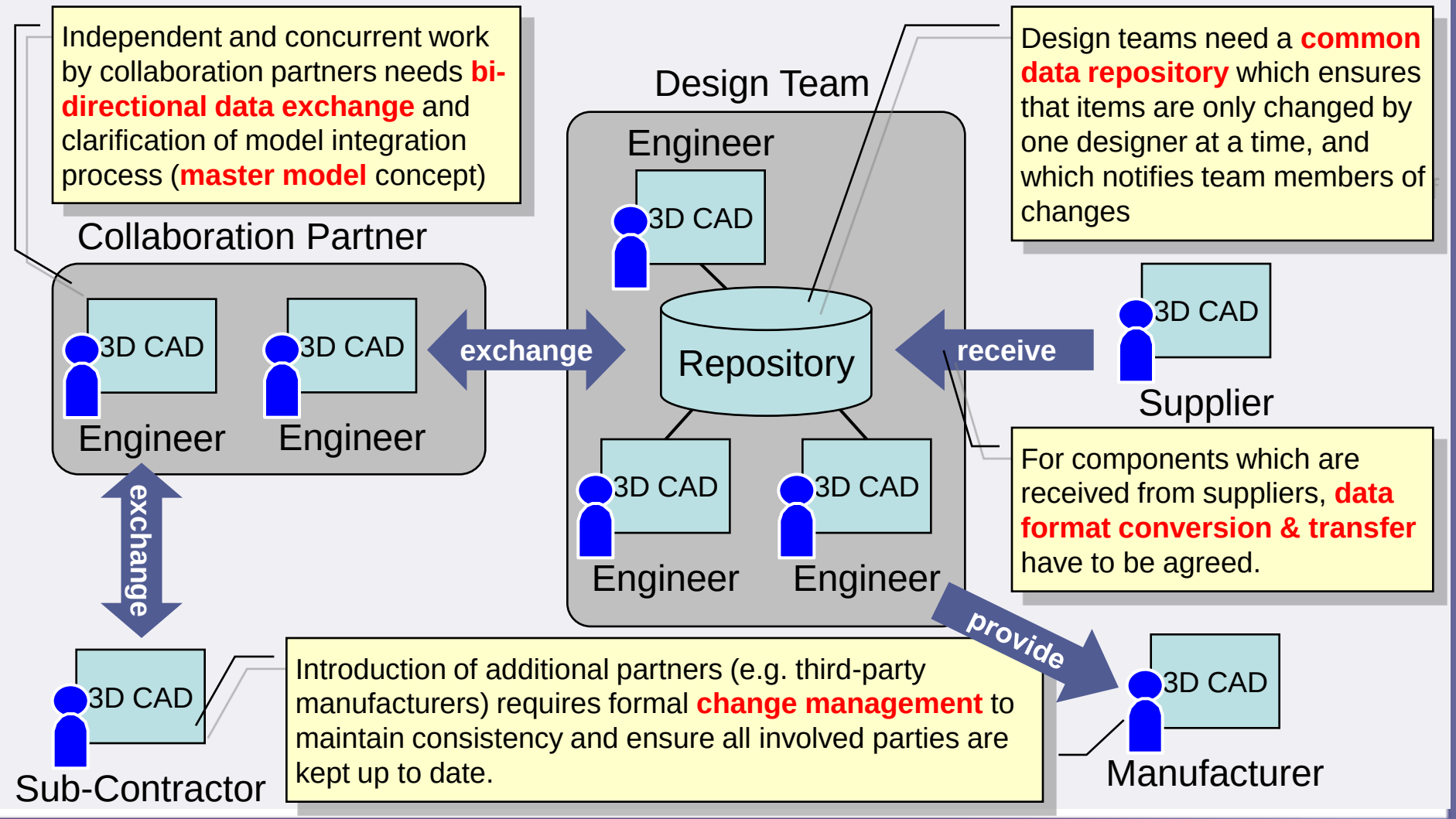
Tuesday 23 September 2008

11:00	**Welcome** (10')	Thomas Hott
11:10	**Update on company & collaboration creation** (20')	Massimo Altarelli
11:30	**'Systems Integration' strategy & mandatory 3D-models and documentation** (15')	Thomas Hott
11:45	**Introduction into collaborative design & data management demands** (20')	Lars Hagge
12:15	**3D-Cad Integration: demo of the process established at the XFEL** (45')	Stefan Suehl
13:00	Lunch Break (1h00')	
14:00	**Design & collaboration process within work packages** (20')	Lars Hagge
14:30	**Data management & data exchange** (20')	Norbert Welle
15:00	**Tools: CAD systems, EDMS (Engineering Data Management System), 3D viewing** (20')	Stefan Suehl
15:30	Coffee Break (30')	
16:00	**Design standards & rules at XFEL, QA procedures** (20')	Norbert Welle
16:30	**Policies: Approval, Change Management, Data Access Control ...** (20')	Lars Hagge
19:00	Dinner at DESY Bistro	

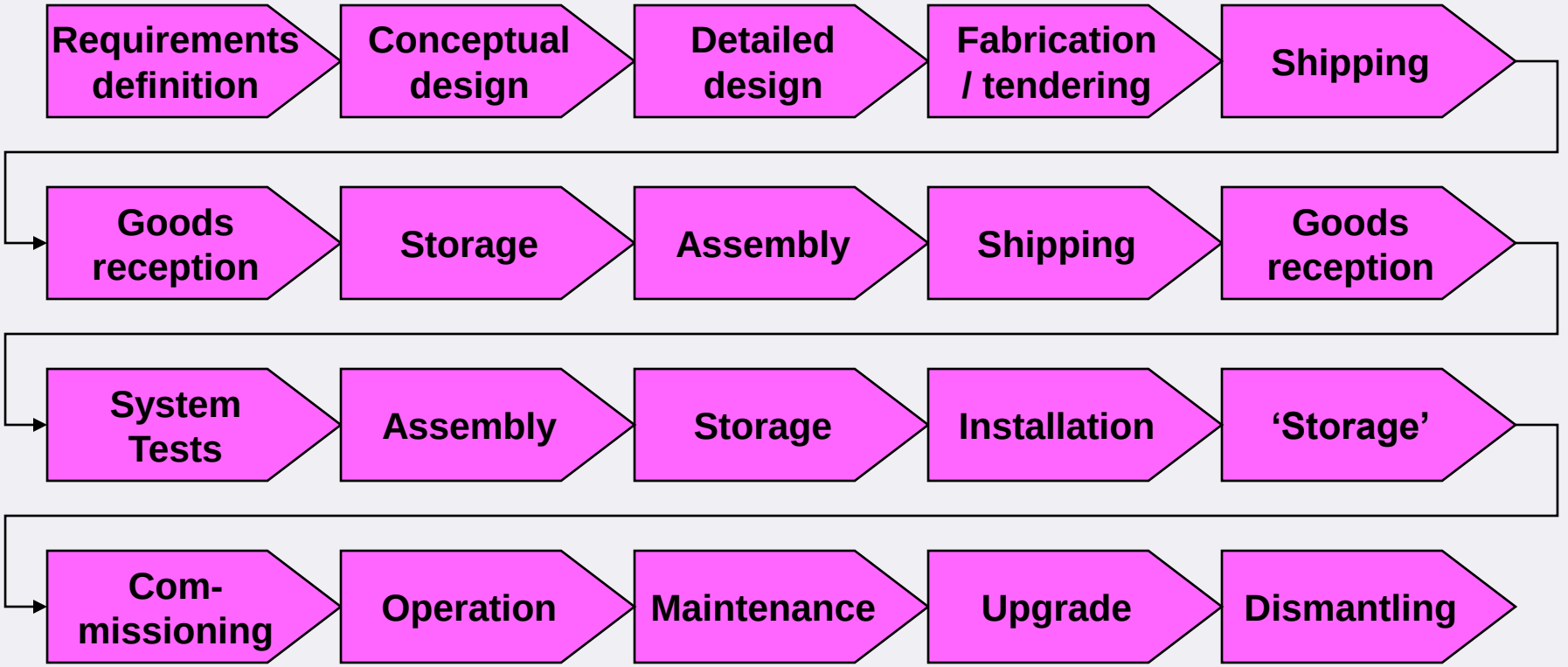
Wednesday 24 September 2008

09:00	**Introduction into case analysis procedure** (15')	Lars Hagge
09:30	**Group work -> Case analysis** (1h30') The individual collaborations (e.g. cold linac, vacuum, dumps, cryogenics, undulators, photon detectors) will analyse their situations and future intentions based on the information provided during the previous day. The organisers will provide prepared materials therefore.	
11:00	Coffee Break (30')	
11:30	**Findings, agreements & open issues** (1h00') Each working group / collaboration will give a brief presentation of their case analysis	
12:30	**Final discussion, conclusions & outlook** (30')	
13:00	End Of Meeting	

3D CAD Topics in Distributed Environments



Lifecycle generates Information & QA/QC 'needs'

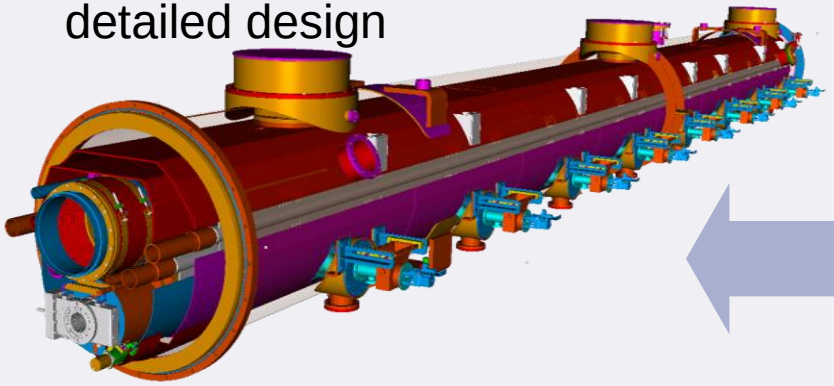


Each phase / activity requires input information and generates new information
-> To be approved, distributed, processed and archived.

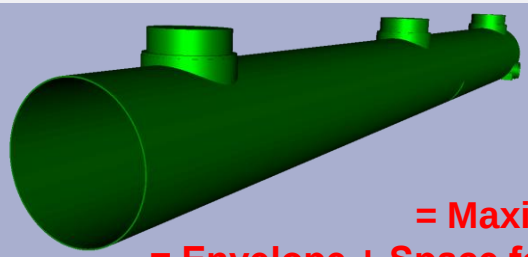
Most phase are sources of requirements (tech. capabilities & constraints, org.)
They must be identified and fulfilled -> Requires QA planning & QC for each phase

The Placeholder Concept & Strategy

detailed design



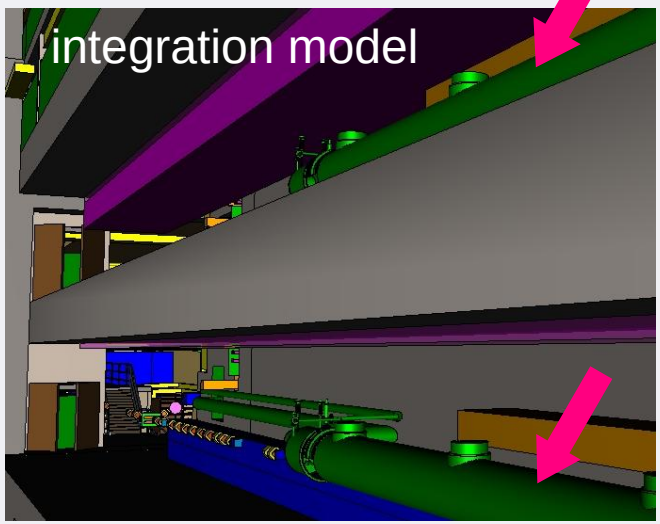
- WPs create **detailed design** as basis for fabrication



Placeholder
= Maximum part dimensions
= Envelope + Space for Tolerances, Tools …

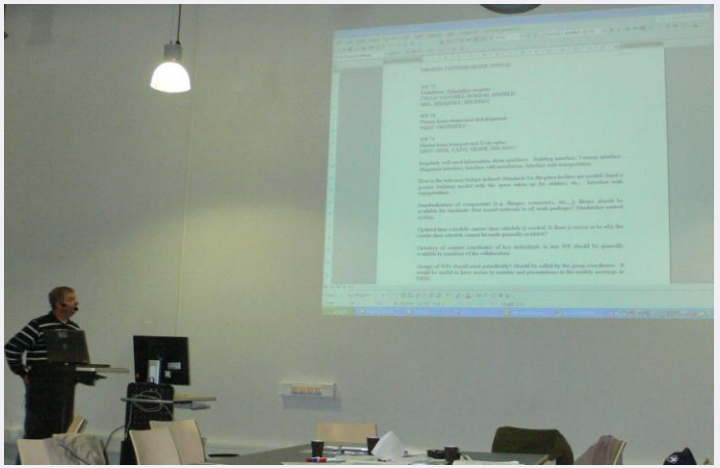
- **Placeholders** are (de-) coupling activities of WPs and Central Integration
  - WPs must ensure detailed designs fit into placeholders

integration model



- TC creates **integration model** to ensure that deliverables from different WPs integrate without collisions

1st Workshop on XFEL Collaborative Design



Impressions from Group Work

Conclusions from the group work -> Actions for TC

More central support is desired in many project fields

- Standards
- QA/QC
- Logistics
- Planning & scheduling
- Safety
- Racks

Organisational issues need to be fixed, between WPs and between WPs & TC

- Mandates
- Interfaces
- Workflow (who does what when how = process)

More project guidelines are desired (Quality Management)

- How to deal with tolerances
- How to design placeholders
- Which standards shall/can be used

XFEL Coordination Activities -> Structure

Section Coordination

Activities	Sections
Conceptual Systems Integration	Injector Beam Line(s)
Section-QA Responsibility	BC1,2
Change management Leadership	Cold Linacs (XTL)
Installation Workflow Development	Warm e-BLs (XTL, XTD1-5)
Installation Supervision	Undulator Sections
	Photon BLs XTD6-10
	Exp. Hall
	Injector Complex
	Shafts XS1-4 Main Dumps

3D-CAD Integration

Activities	Sections
Placeholder integration	Inj. Complex, BCs, Cold Linacs
CAD-QA/QC	Warm e-BLs Und.Sections Main Dumps
3D Installation Feasibility Studies	Photon BLs Exp. Hall
3D Interface Studies	
Standard Parts	

WP40

General Support

Activities	
QA/QC Coordination	Schedule Coordination
Logistics	Review Coordination
Racks & Cabling	
Change Management	**Project Office**
Safety & Health Coordination	
Web Pages	
Radiation Mapping & Rack Shielding	

End