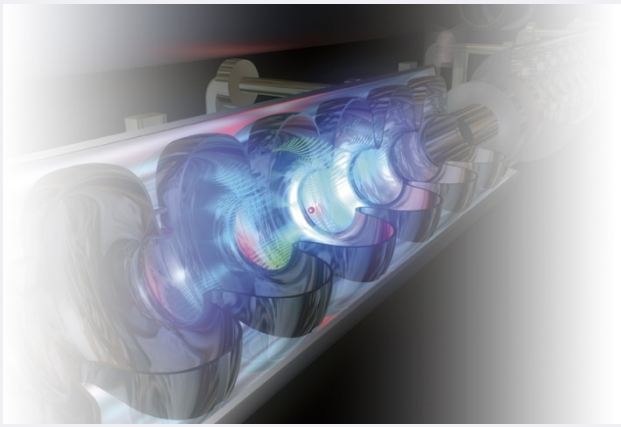
Status XFEL

Hans Weise



TESLA Technology Collaboration Meeting
DESY, January 14th – 17th, 2008

Proposal Made to the XFEL In-kind Review Committee

Common in-kind proposal for the superconducting linac of the XFEL WP3 – WP9 and WP11

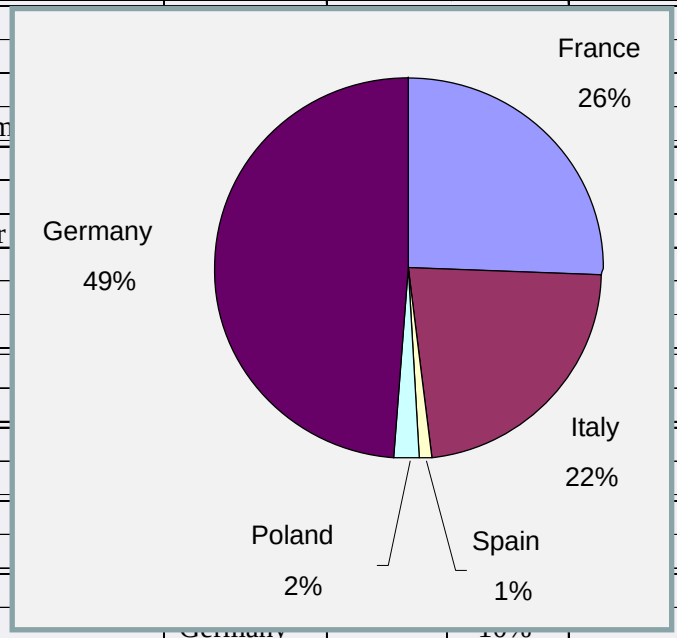
presented to the IKRC

for

CEA Saclay
CIEMAT
DESY
INFN
IPJ Swierk
LAL Orsay

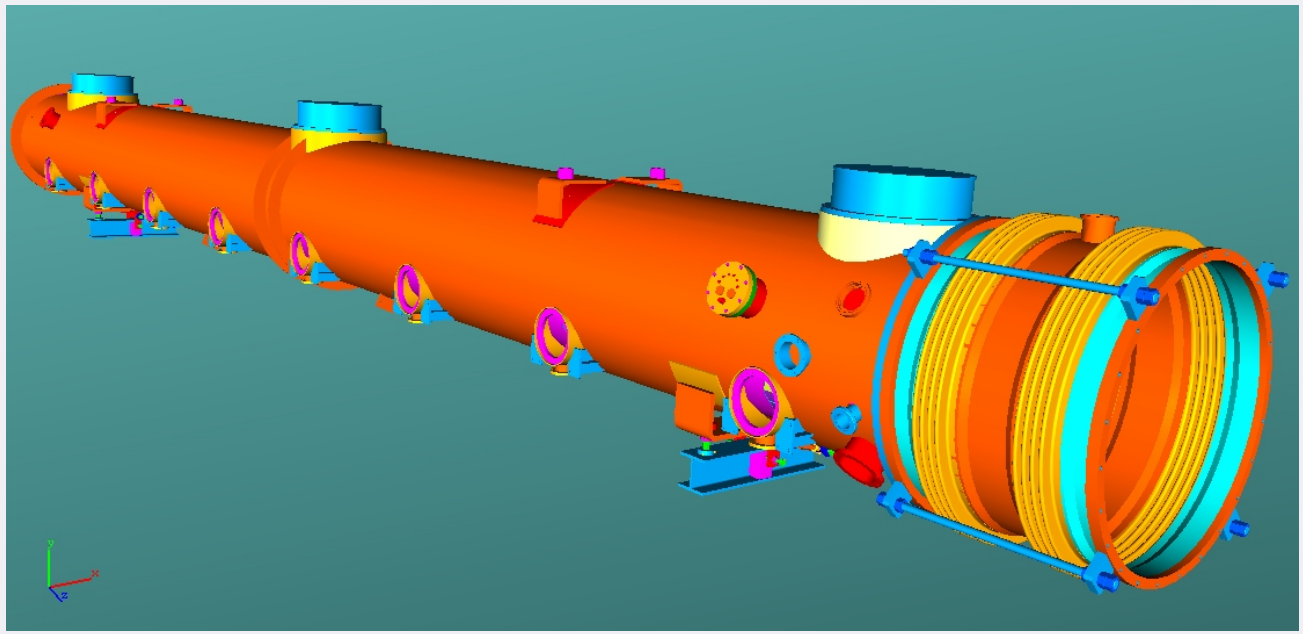
Summary of the in-kind Proposal

		Laboratory	Country	Invest / M€		FTE	FTE / M€	
Accelerator Modules	**WP – 3**	CEA Saclay	France		60%			43%
		INFN	Italy		19%			29%
		DESY	Germany		21%			29%
	sum				***100%***			***100%***
Superconducting Cavities	**WP – 4**	INFN						34%
		DESY						66%
	sum							***100%***
		Received from						
Power Couplers	**WP – 5**	LAL Orsay						52%
		DESY						48%
		or						
		LAL Orsay						100%
		DESY						0%
	sum							***100%***
HOM Coupler / Pick-up	**WP – 6**	IPJ Swierk						100%
	sum							***100%***
Frequency Tuners	**WP – 7**	DESY						100%
	sum							***100%***
Cold Vacuum	**WP – 8**	DESY						100%
	sum							***100%***
Cavity String Assembly / Clean Room Quality Assurance	**WP – 9**	CEA Saclay						51%
		DESY						49%
		Transferred to WP -4						
	sum				***100%***			***100%***
Cold magnets	**WP - 11**	CIEMAT	Spain		56%			10%
		DESY	Germany		44%			90%
	sum				***100%***			***100%***



WP – 3 Accelerator Modules

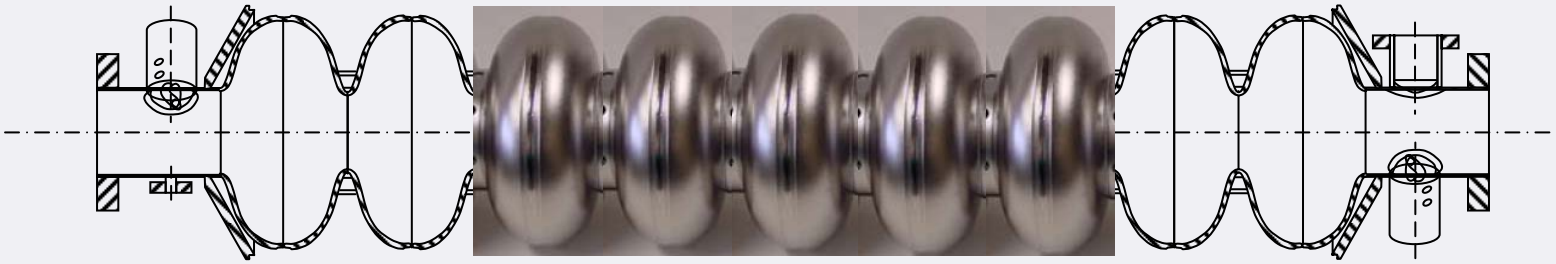
Invest	FTE
60% CEA	43% CEA
19% INFN	29% INFN
21% DESY	29% DESY

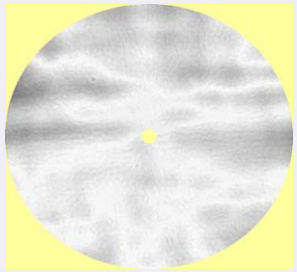
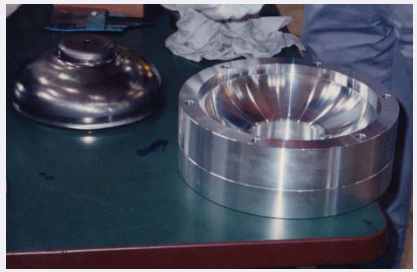


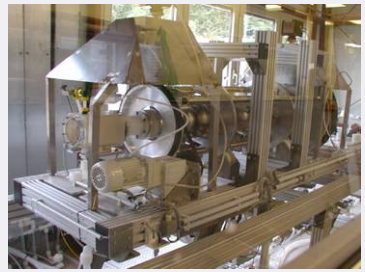
- Fabrication of cold masses (incl. outer vessel)
- module assembly w/o frequency tuner & power coupler; start with assembled string and finish with module installation
- weld connections
- alignment inside modules
- transportation of assembled accelerator modules
- material specifications, safety issues
- define processes for integration / assembly
- magnetic shielding / demagnetization
- sensors inside the accelerator modules
- pre-alignment of cavities and coupler position

WP – 4 Supercond. Cavities

Invest	FTE
50% INFN 50% DESY	34% INFN 66% DESY



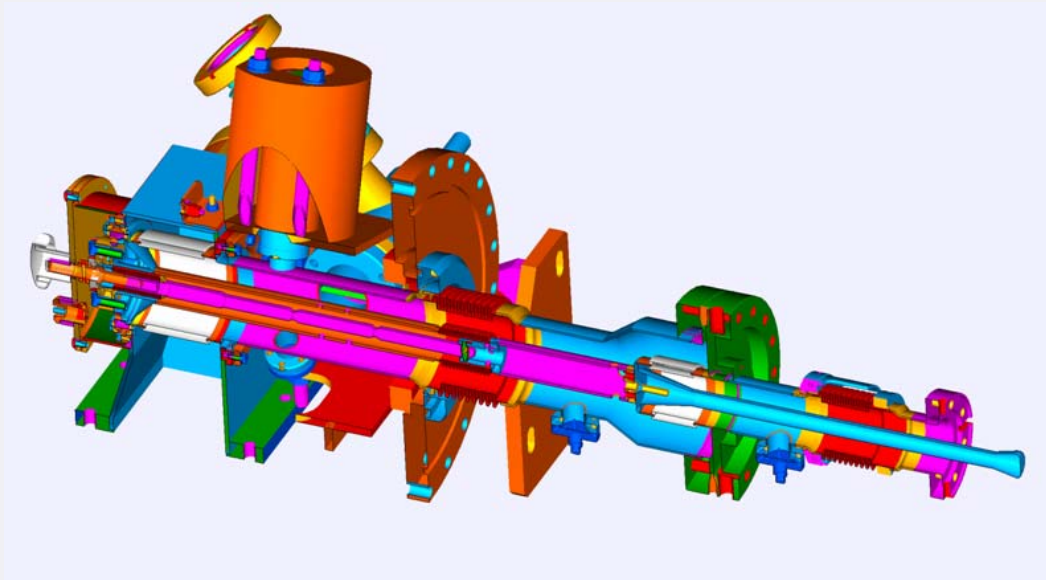


- Procurement of all niobium
- Scanning of NB sheets
- Complete mechanical fabrication of all cavities
- Surface treatment
- Consultant at start up of infrastructure and at full running production

- Data base setup and database running
- EDMS
- Helium vessel incl. Titanium parts (taken over from WP-9)

WP – 5 Power Coupler

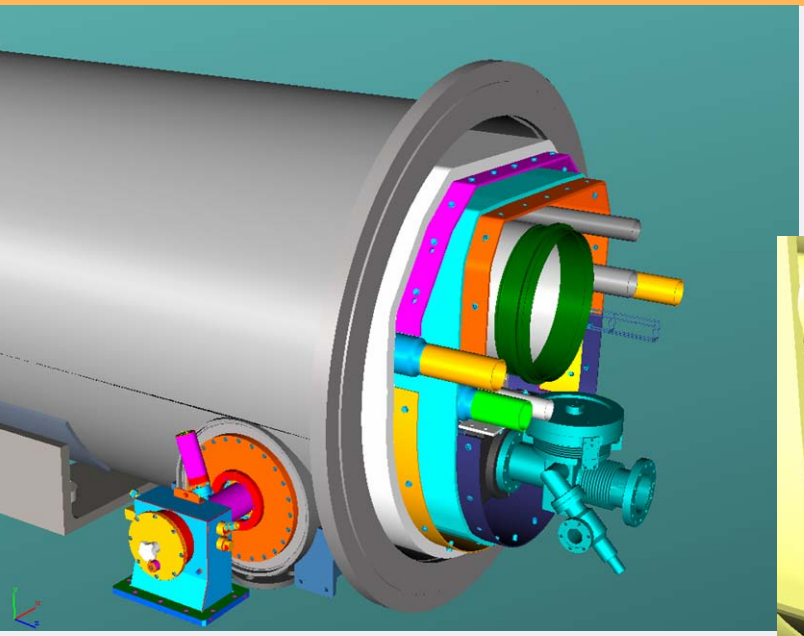
Invest	FTE
73% LAL 27% DESY	52% LAL 48% DESY

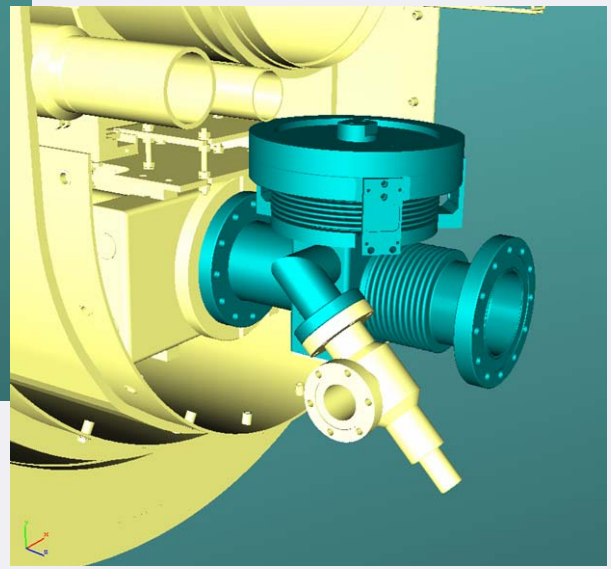


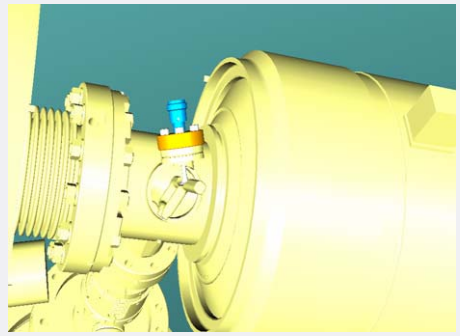
- Coupler production incl. project and industries follow-up
- Coupler conditioning
- Infrastructure required for coupler assembly and conditioning, i.e. clean room and modulator / klystron
- Technical interlock
- Tunnel installation / cabling of technical interlock
- Motor electronics

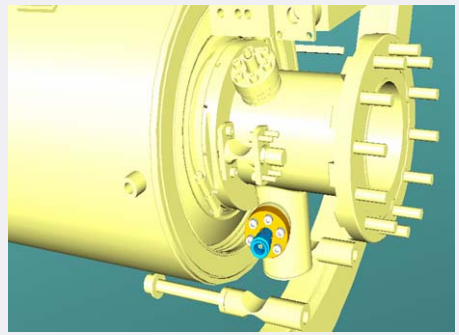
WP – 6 HOM Coupler / Pick-up

Invest		FTE	
	100% Swierk		100% Swierk





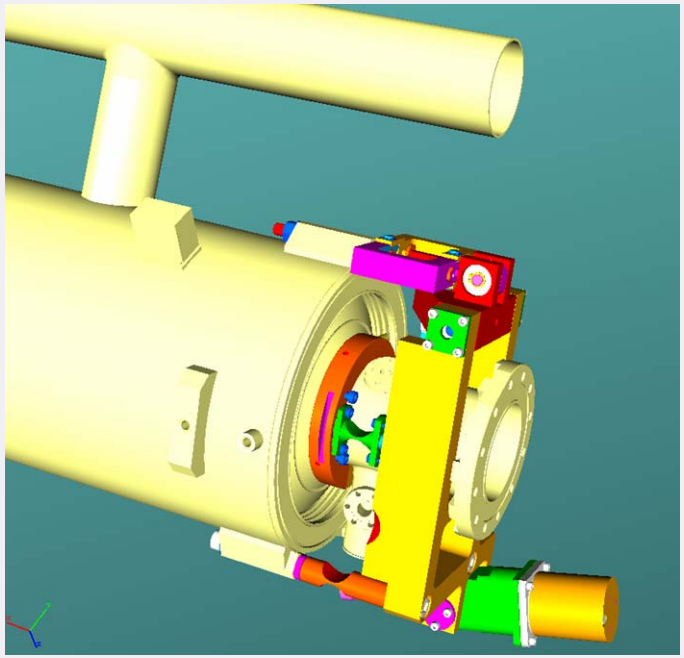


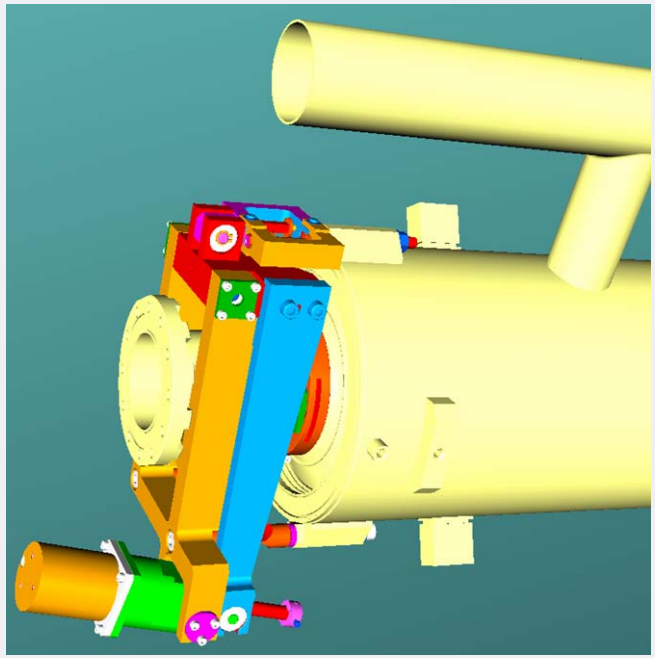


- Fabrication of HOM beam pipe absorbers
- HOM Pick-ups and cables

WP – 7 Frequency Tuners

Invest	FTE
100% DESY	100% DESY

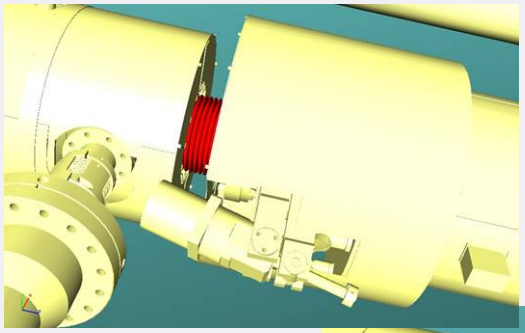


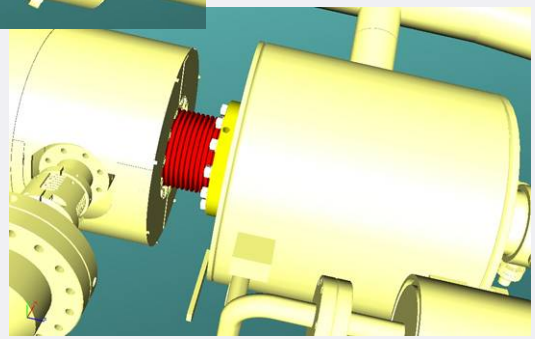


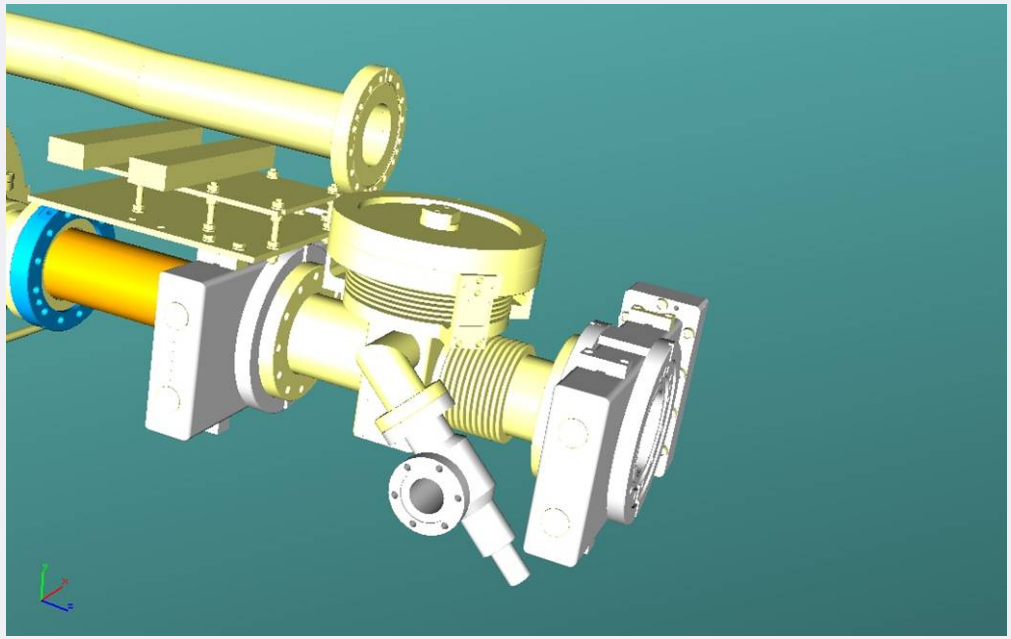
- procurement of motors, gear box, piezo actuators
- fabrication of mechanical tuner parts
- fabrication of drive unit (motor and piezo) electronics
- cabling
- survey of production

WP – 8 Cold Vacuum

Invest	FTE
100% DESY	100% DESY



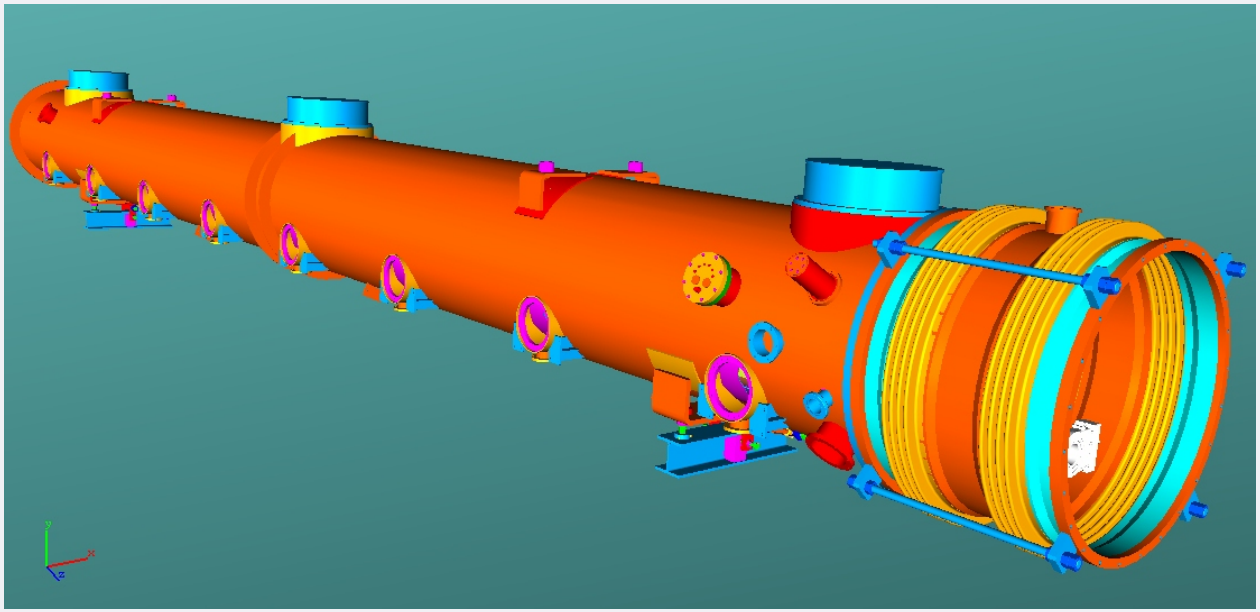




- procurement of all vacuum components within the cold linac, i.e.
  - bellows between cavities
  - cold manual valves at both ends of the cavity strings
  - valves in the module connection
  - isolation vacuum valves
  - ion and TSP pumps incl. power supplies/controllers
  - all vacuum components being part of the cryogenic connection boxes and of the cold-warm transitions
- vacuum components in the injector as well as bunch compressor sections (to be transferred to WP – 19)

WP – 9 Cavity String Assembly / Clean Room Quality Assurance

Invest	FTE
90% CEA 10% DESY	51% CEA 49% DESY

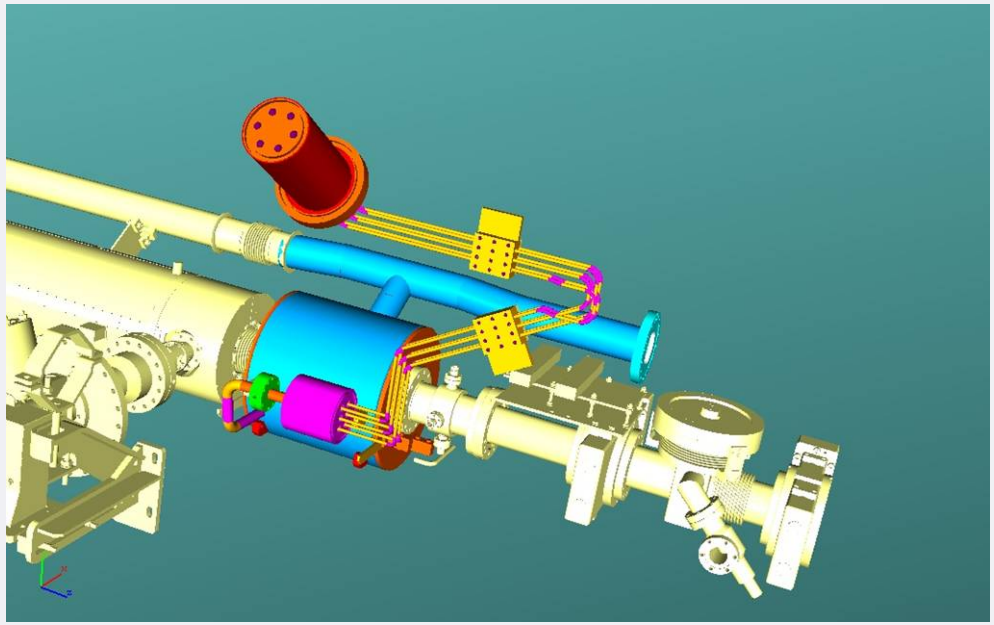


Module assembly see WP-3

- Helium vessel fabrication
- Titanium Tube and 2-phase line
- String assembly
- Knowledge transfer / consultant / training
- Database set-up and running / Quality control of infrastructure
- EDMS

WP – 11 Cold Magnets

Invest	FTE
56% CIEMAT 44% DESY	10% CIEMAT 90% DESY



- fabrication of 2K quadrupole package
- test of quadrupole package

Recommendations of the IKRC – 2nd Meeting September, 24th 2007 at DESY

SC-LINAC Consortium (as presented by H. Weise, DESY)

The committee appreciates that the main contributors to the TESLA technology will form a consortium to provide the SC LINAC for the European XFEL Project. The SC-LINAC consortium is formed by the following partners: CIEMAT (Spain), DAPNIA Saclay and LAL Orsay (France), DESY (Germany), INFN Milano (Italy) and IJP Swierk (Poland). The associated tasks comprise the work packages (WPG) 3-9 and WPG-11 of the XFEL project plan. The IKRC is convinced that the consortium possesses the required know-how to realize the SC-LINAC in the proposed manner and according to the XFEL time planning and cost book figures. The overall task distribution within the consortium seems reasonable, reflecting well the strengths and abilities of the participating partner institutes. Still, the IKRC realizes that there is not much time left to clarify the remaining technical and managerial details between the consortium partners in order to comply with the XFEL time schedule, which foresees the launching of the tendering process with the beginning of 2008. Thus, the IKRC recommends rapid finalization of the production process and collection of the CFT material. During this process, the competence of “newcomers” in the field (namely Russia and China) and their interest of providing specific components and/or qualified manpower should be considered but the leading roles of the partner institutes of the consortium should remain as it was presented to the IKRC.

Although almost all WPGs connected to the SC-LINAC are covered by the consortium the IKRC realizes that the majority of the tasks, components and activities associated with the XFEL accelerator are not yet covered and invites the partner countries of the European XFEL Project and their institutions to actively participate and contribute to the realization of the accelerator facilities.

XFEL Components (the “scrf ones…”)

XFEL needs

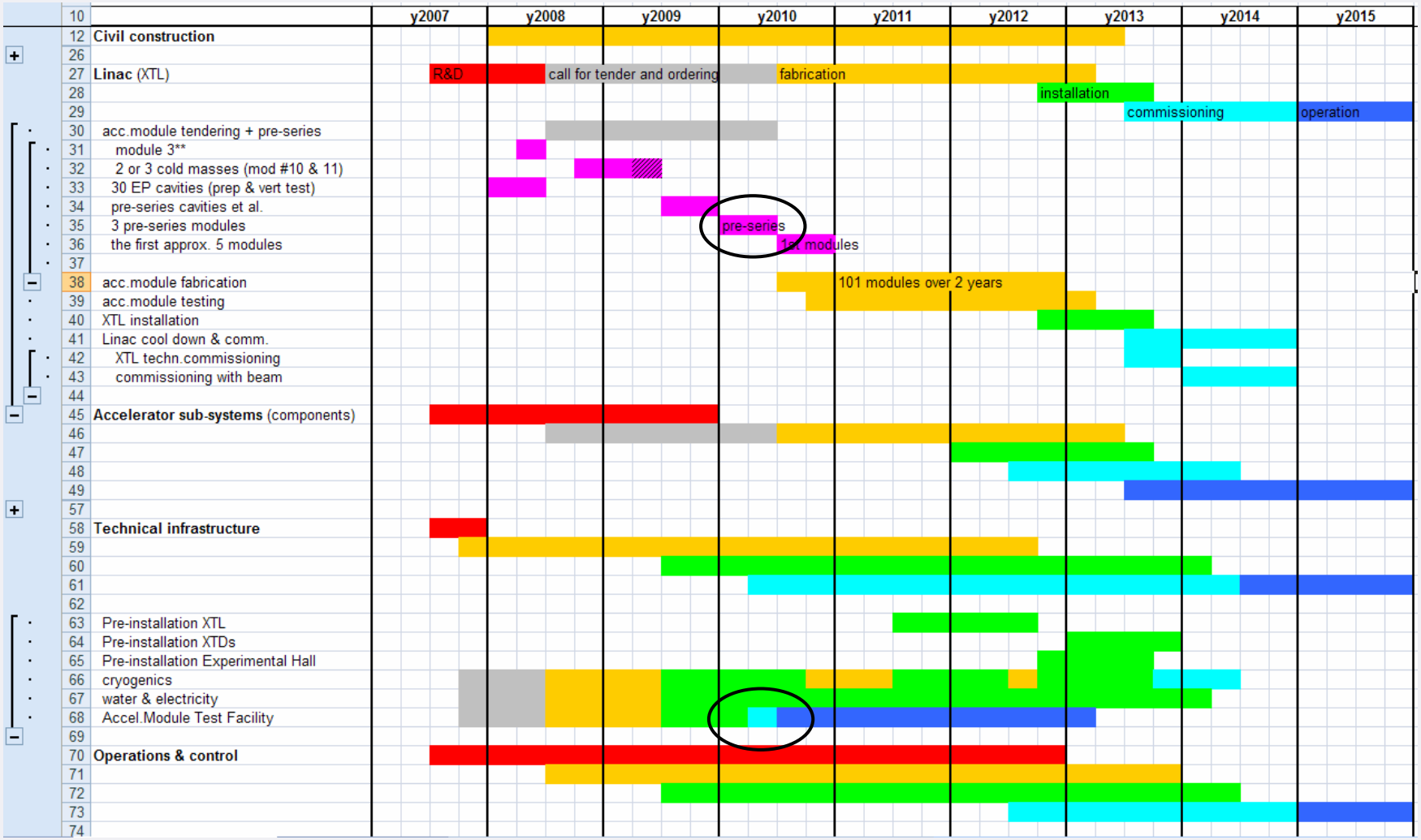
808 cavities for
101 accelerator modules, i.e.
808 frequency tuners,
808 RF main input couplers,
1616 HOM pick-ups,
101 HOM absorbers
etc.

Due to the long leadtime all **components need to be specified in 2008**,

- the call for tender process to be started before end of 2008,
- orders be placed not later than beginning of 2009.

XFEL Overall Schedule as the Basis

XFEL Overall Schedule - First Details



XFEL Overall Schedule - Comments

Module #3* will be 'destructively' tested at the CMTB; therefore it needs to be repaired; additional assembly training possible (old module type!)

Module #8 is going to be tested in Q1/2008; and needed for installation in FLASH in Q1/2009; it will be extensively tested at CMTB, and then be used for a first transportation test of assembled modules; we 'bought' a Return Ticket to Saclay.

We are going to receive the **cold mass** for modules #10 to #11 (or #12?) beginning of Q4/2008; these XFEL type modules offer assembly checks / training (remark: the final 101 module call for tender will not wait for the module assembly!!!)

Three **pre-series XFEL modules** need to be assembled approx. Q4/2009 – Q1/2010; a first check on CMTB should follow, then they are to be used for AMTF commissioning (Q2/2010); all sub-components have to be available.

We expect to see **the first few (≤ 5) assembled modules** at AMTF until end of 2010; after this we have two years time for the remaining 101 – 5 = 96 modules; module tunnel installation starts in Q4/2012

Actual Work: Agenda Last Cold Linac Meeting

Working Group 1	**cavities / He-vessel / cavity tests / HOM pick-up fabrication** **WP-04 / WP-03 / WP-05 / WP-06 / WP-07**
Waldemar Singer	Details / open issues cavity production & preparation schedule Impact of optimized tank welding procedure on cavity production Interface cavity fabrication & preparation with tests Is the preparation of cavities sufficiently well defined?
Wolf-Dietrich Möller	Cavity tests incl. discussion of antenna
Kay Jensch	He-vessel (WP-03 -> WP-04) impact of optimized tank welding procedure vessel type i.e. interface with tuner (WP-07)
Lutz Lilje / Carlo Pagani	Frequency Tuner Open issues / actual status (incl. disc. of blade tuner: results/qualification/schedule/…)
Jacek Sekutowicz	HOM pick ups Fabrication Issues / Schedule Preparation for installation Tests / cold cycles / QA etc. (discussion only, no transparencies)
Working Group 2	**string assembly** **WP-09 / Wp-08 / WP-11 / WP-17 / WP-05**
Bernard Visentin	Cavity String Assembly Cavity String Assembly at Saclay
Axel Matheisen	String assembly inside a class 10 (ASTM) Cleanroom
Axel Matheisen	Specification of string accessories
Helmut Remde	Particle free Pump Down and Venting of UHV Vacuum Systems

Agenda Last Cold Linac Meeting

Working Group 3	**cold BPM / Quad / HOM absorber / cold vacuum** **WP-17 / WP-11 / WP-06 / WP-08**
Dirk Nölle	Open Issues DESY BPM
Claire Simon	Open Issues Saclay BPM
Kirsten Zapfe	Open Issues Cold Vacuum
Jacek Sekutowicz	Open Issues HOM Absorber (discussion only, no transparencies)
Heiner Brück / Fernando Toral	Open Issues Quad (discussion only, no transparencies)
Working Group 4	**module fabrication and assembly** **WP-03 / WP-05 / WP-07 / WP-11**
Olivier Napoly	Module Fabrication and Assembly at CEA-Saclay
Kay Jensch	Module Assembly Procedure & Specification & QA
Summary	
Bernard Visentin	Working Group 2 Cavity String Assembly
Olivier Napoly	Working Group 4 Module Fabrication and Assembly

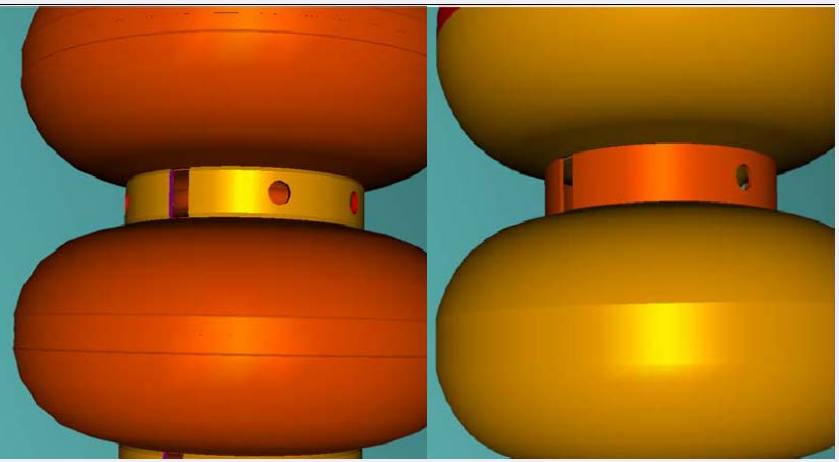
WP 4: Cavities
Items not finished in the XFEL preparation phase

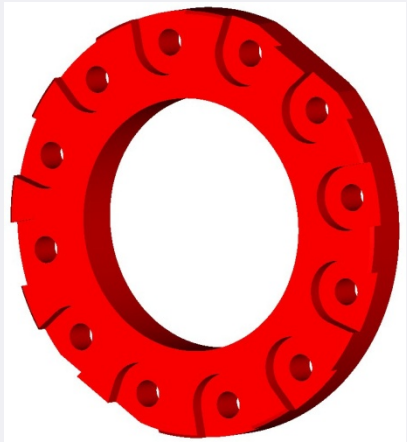
- **Fabrication of 30 cav.** for industrial EP
  ACCEL delivered 15 cav.;
  ZANON delivered 5 cav., rest till end of the year
- Qualifying of **new Nb vendors** on 9 cell cavities
  1 cav. of PLANSEE niobium is in fabrication at ACCEL,
  3 cav. of NINGXIA niobium are in fabrication at ACCEL
- **Industrial study of EP**

  set up of prototype EP and carry out the first step EP (rough EP) of 30 cav.

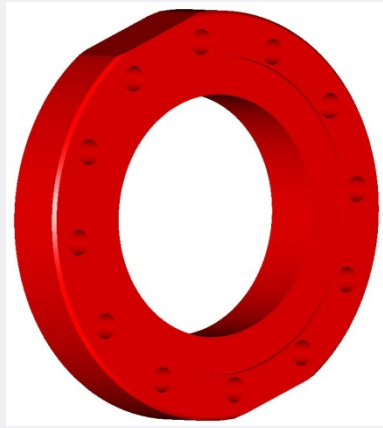
  Fa. ACCEL: EP treatment of first cavities till end of 2007
  Fa. Henkel is also going to start EP treatment now

WP 4: Cavities - Small design changes to reduce cost and simplify fabrication





Short side (machined step under discussion)



Long side

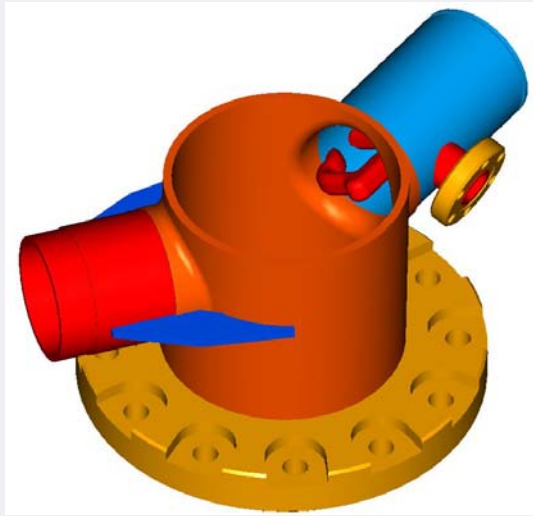
Removal of coupler port stiffener

Reducing of flange machining short side

Removal of outside recess (equator area)

Less holes and thinner the stiffener ring

Review tolerances



No rib

WP 4: DESY will supply companies with following material / equipment and carry out the training

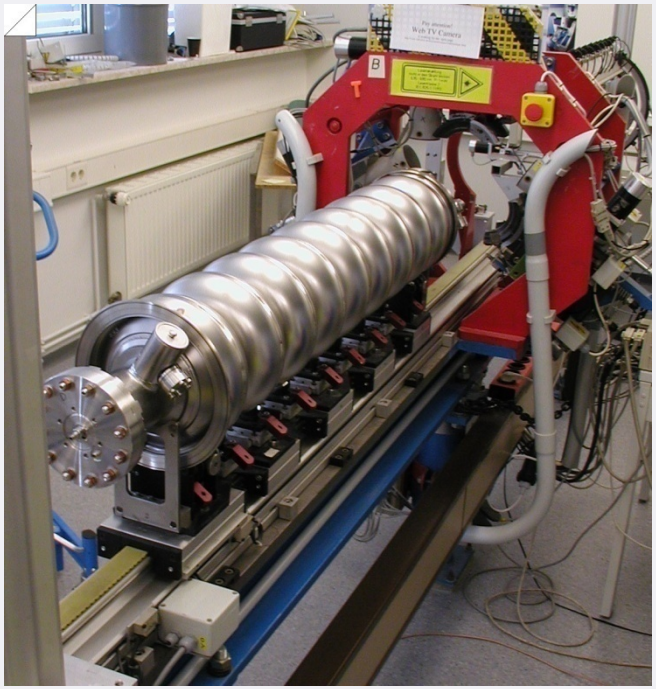
- Niobium for 50 cavities
- Apparatus for scanning of niobium
- Equipments for RF measurement of half cells, dumb bells and end groups
- Equipment for warm tuning (tuning machine)

WP 4: Prototype equipments exist at DESY

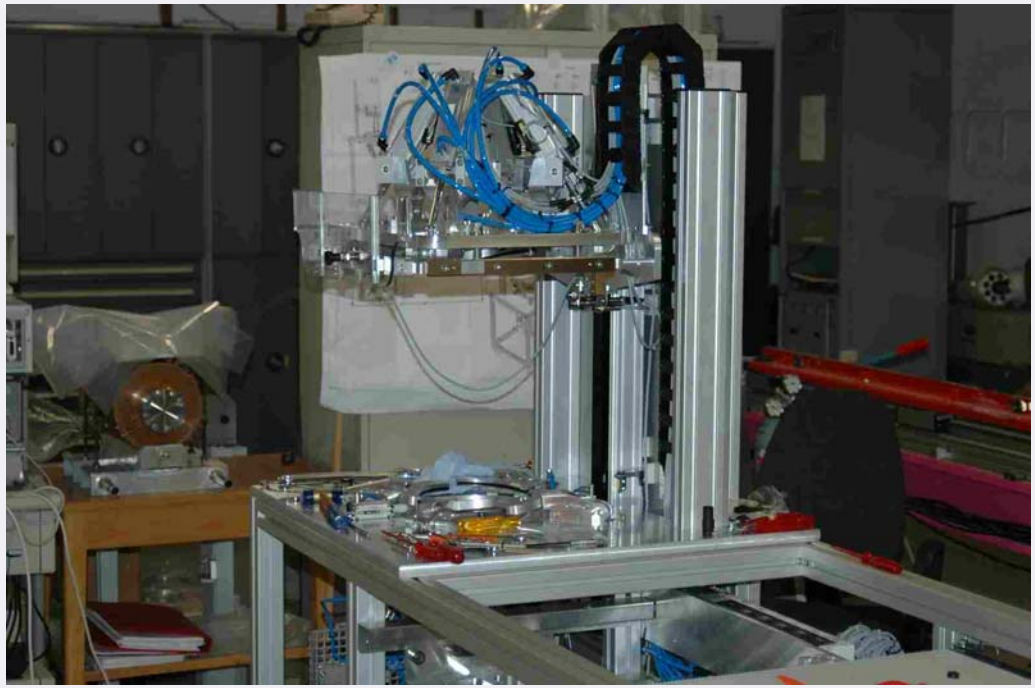
DESY Eddy current apparatus

DESY SQUID apparatus

WP 4: Prototype Equipment Exist at DESY



Equipment for warm tuning (tuning machine)



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

WP 4: Pending Decisions

- Vertical RF test of cavities **with He tank or not**
- Treatment procedure is not finally defined.

  Fine Grain:

  Final EP (with or without ethanol) **or BCP-Flash?**

  Large Grain:

  BCP only or rough EP with final EP (with or without ethanol) or rough EP with BCP-Flash?
- Material scanning: **Eddy Current or SQUID**
- **Niobium for 50 cavities**

  (as ingot material, discs or fine grain sheets??)

WP5 – Interface of Power Coupler with other WPs

WP 1 – Waveguide
- 1.1 Waveguide flange, bolts and nuts
- 1.2 Kapton window

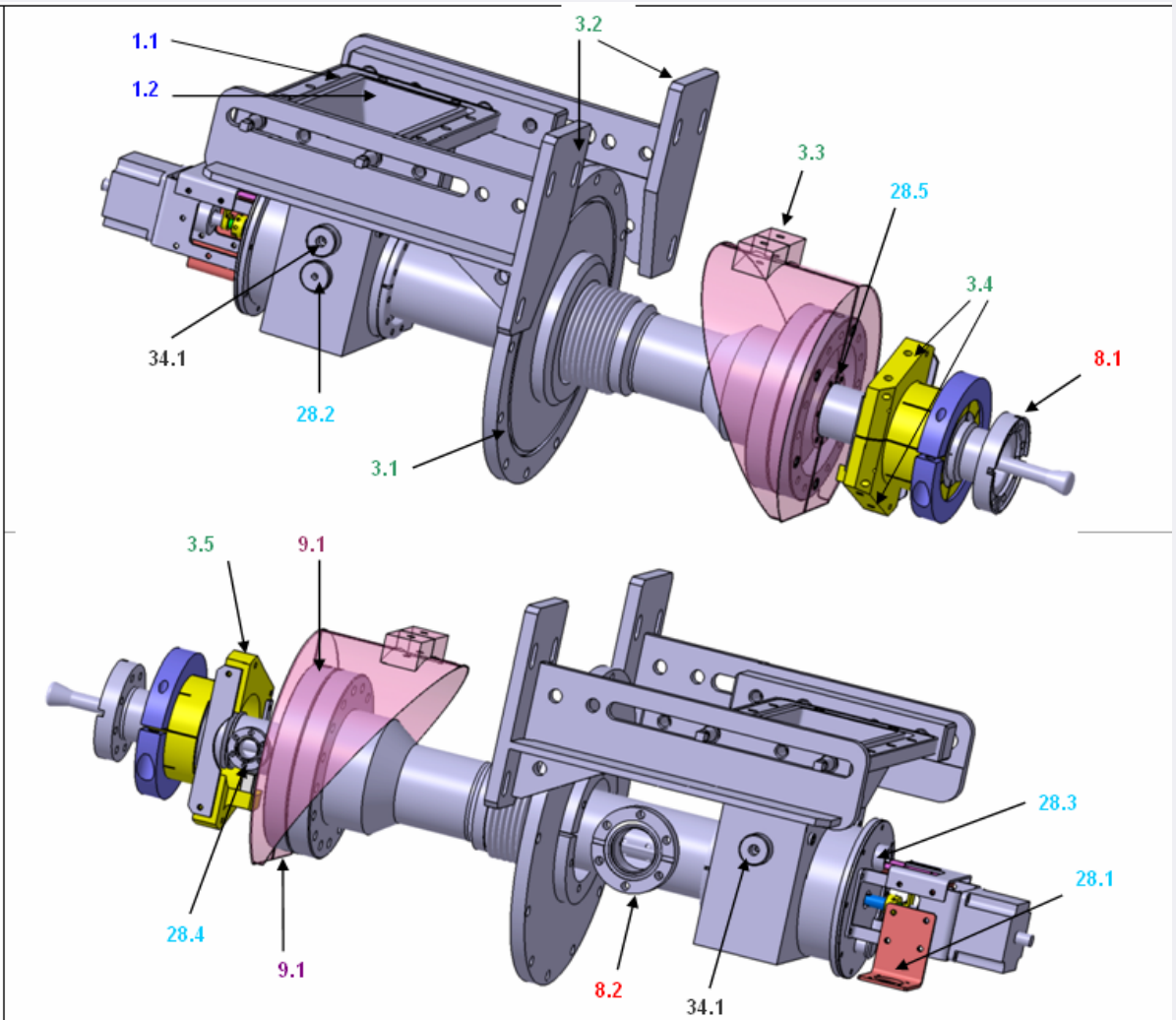
WP 3 – Cryomodule
- 3.1 Flange on vacuum vessel, gasket, bolts
- 3.2 Coupler supports (left & right), bolts
- 3.3 Connection of Cu braids from 80K thermal shield, bolts
- 3.4 Connection of Cu braids from 4K thermal shield, bolts
- 3.5 4 holes in 4K interface for assembly rods
- 3.6 Super insulation

WP 8 – Cavity & vacuum
- 8.1 Cavity flange, gasket, bolts & nuts
- 8.2 Coupler vacuum pumping port, gasket, bolts & nuts

WP 9 – Cavity string assembly
- 9.1 Two holes in big cold flange
- 9.2 Clamp for cold bellows

WP 28 – Control system
- 28.1 Connector for motor, end switches, PT100
- 28.2 Arc detector
- 28.3 HV connector
- 28.4 e- pickup
- 28.5 2 sensors PT100 in 80K zone

WP 34 – Utilities
- 34.1 Two N2 cooling ports
- 34.2 Environmental conditions: T, P, H, radiations



WP5 - Interfaces Workshop on Nov 5 & 6 at DESY

2 successful days of clarification and exchange of ideas

→ very satisfactory & very useful

→ common data base & follow up in future

Physical Interfaces:

- location: CAD models & data exchange with .step files is satisfactory, but still no access to EDMS
- geometry, tolerances
- characteristics: material, surface finish, hardness
- gaskets & bolts: specs, who provides what
- electronics of WP5: to be further analyzed & discussed (DESY / LAL)

Process Interfaces:

- washing with detergent, rinsing (washing machine), active drying
- He leak test
- RGA records: sample of typical spectrum
- RF power line for conditioning: long lead time → place order in 2008
- Conditioning process: validation of several pairs in series or in // is necessary in 2008
- phase between conditioning & assembly on module is unclear: to be clarified between LAL / DAPNIA

Linac schedule Interface:

- WP5 schedule: today ahead of LINAC schedule ~ 0.5 year
- → couplers storage must be foreseen

WP5 – Different Phases in Couplers Production & Assembly

Phase	Responsible	Control	Where
Fabrication	Industries	LAL	2 industrial locations
Operations in clean room: Washing, rinsing, drying, baking, He test		LAL	2 industrial locations
RF Conditioning & reception tests		LAL	1 location is preferred
Transport to cryomodule assembly	LAL	LAL	Assembly hall
Storage until needed	To be clarified		Assembly hall
Dismount from test stand			Assembly hall
Clean & assemble on cryomodule	DAPNIA	DAPNIA / LAL	Assembly hall

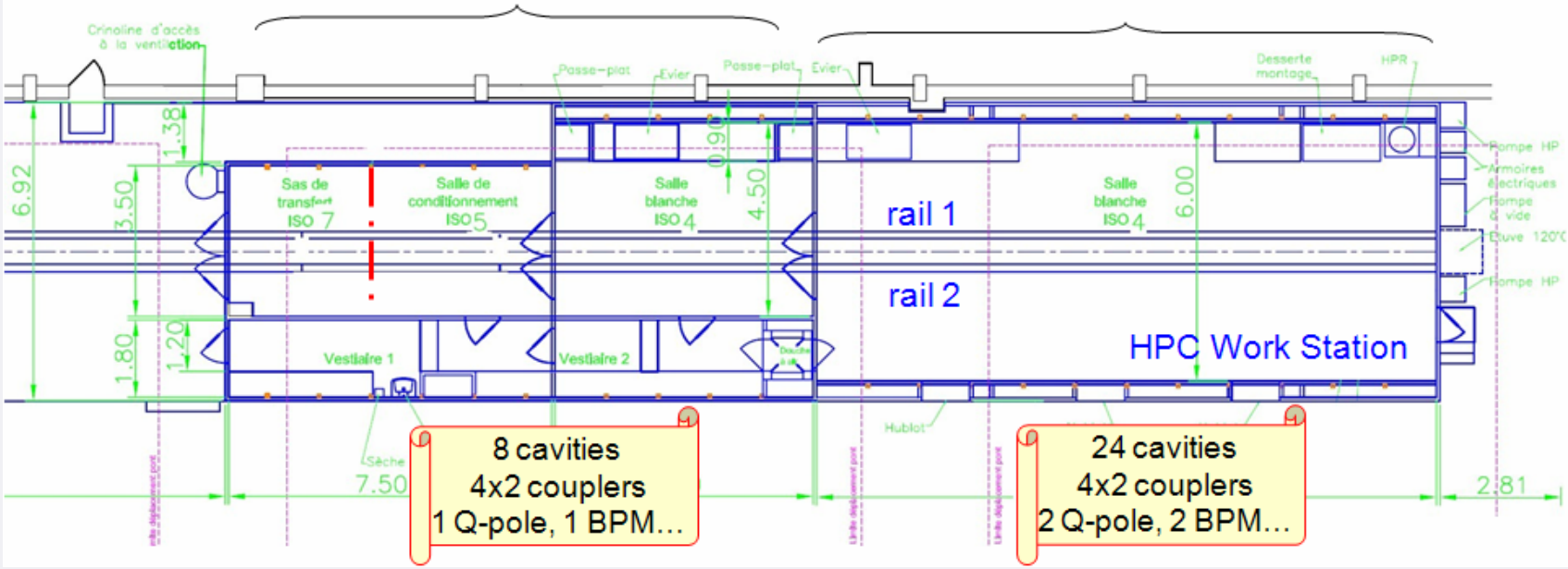
String Assembly Plans at Saclay

Description of expanded clean room

Class 10 (ISO4) : 73.5 m² + 21 m² (dividing curtain - door open)
Class 100/10 000 : 13 m² / 13 m² (fitting wall)

Components
for String N+3
cleaning - storage

String N assembly on rail 1
String N+1 (or spare) equipped with HPC
ready on carrousel to be assembled on rail 2
HPC Work Station : cold part on 8 cavities
for String N+2 → on carrousel



Assembly Procedure Sufficiently Well Defined ?

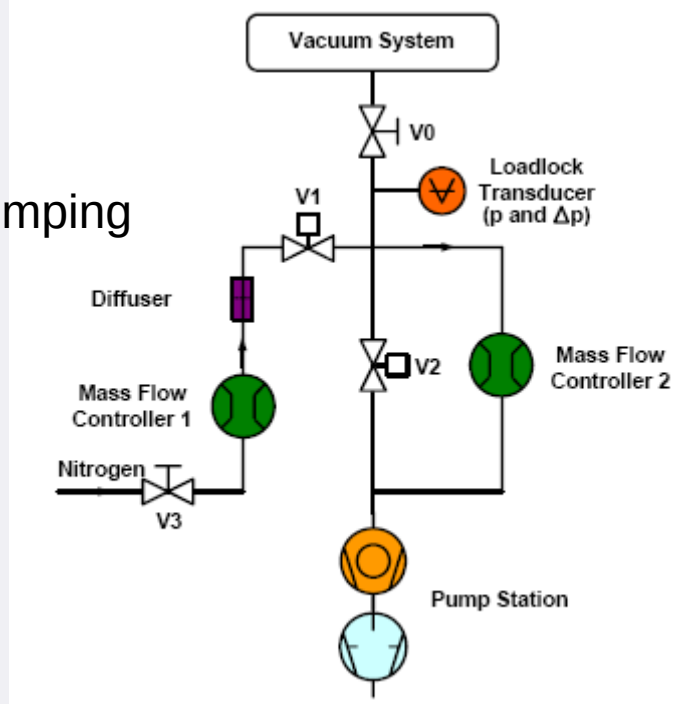
excel file shown used at DESY
(part of EDMS structure)

- Description of different steps for the assembly (check list)
- useful for supervisor, for operators (at the beginning) and for industrial study
- but know-how is not written on it and nothing is better than a good training…
- Some information are reported in file (leak detection rate, particle number measured) useful for QA of assembly
- procedure is sufficiently well defined: it was checked through assembly of several cryomodules at DESY and it was adapted for specific cases (Fermilab is an example)

Venting Procedure Sufficiently Well Defined ?

Similar procedure on an excel file than previous one
(part of EDMS structure)

- not adapted to mass production : different tuning of needle valve for venting and pump down
- new procedure is required
- new set-up has been tested for venting and pumping mass flow controllers and gas diffusers Are used (SRF workshop 2007). More tests are needed for application on string assembly
- automation of procedure will be developed



Delivery specifications

Cavities – Bellows, Flanges, Valves - BPMs – Quad...
Couplers (2 cold parts+connecting box disassembled from warm parts)

oil and grease free – particle free

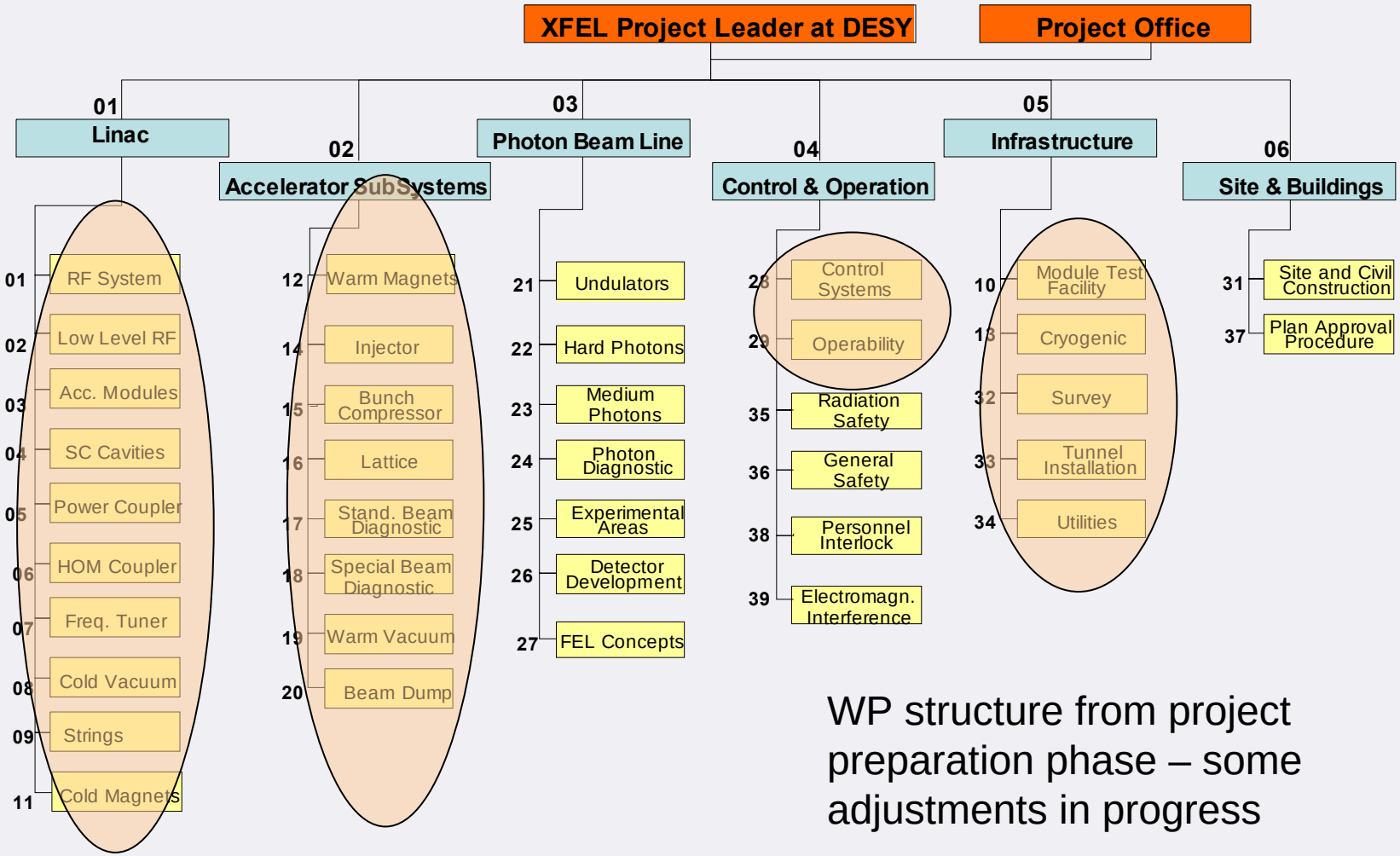
- Degreasing
- CR class 10
- high pressure rinsing (Quad)
- packaging in under double vinyl bag (inflated with N2)

- Controlled by Residual Gas Analyzer (no significant masses beyond 50)
- Leak check ($<10^{-10}$ mbar.l/s)

QA on the production site for company
QC on the assembly area at the reception : if not conform then return to sender

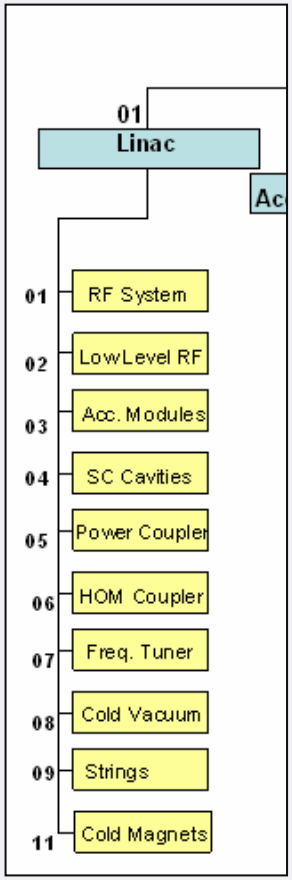
But multiplication of washing machines, clean rooms, control tools…
increased cost if realized in industry
Proposal to create only one site (new WP ?) with devoted clean room
for cleaning elements before sending to assembly

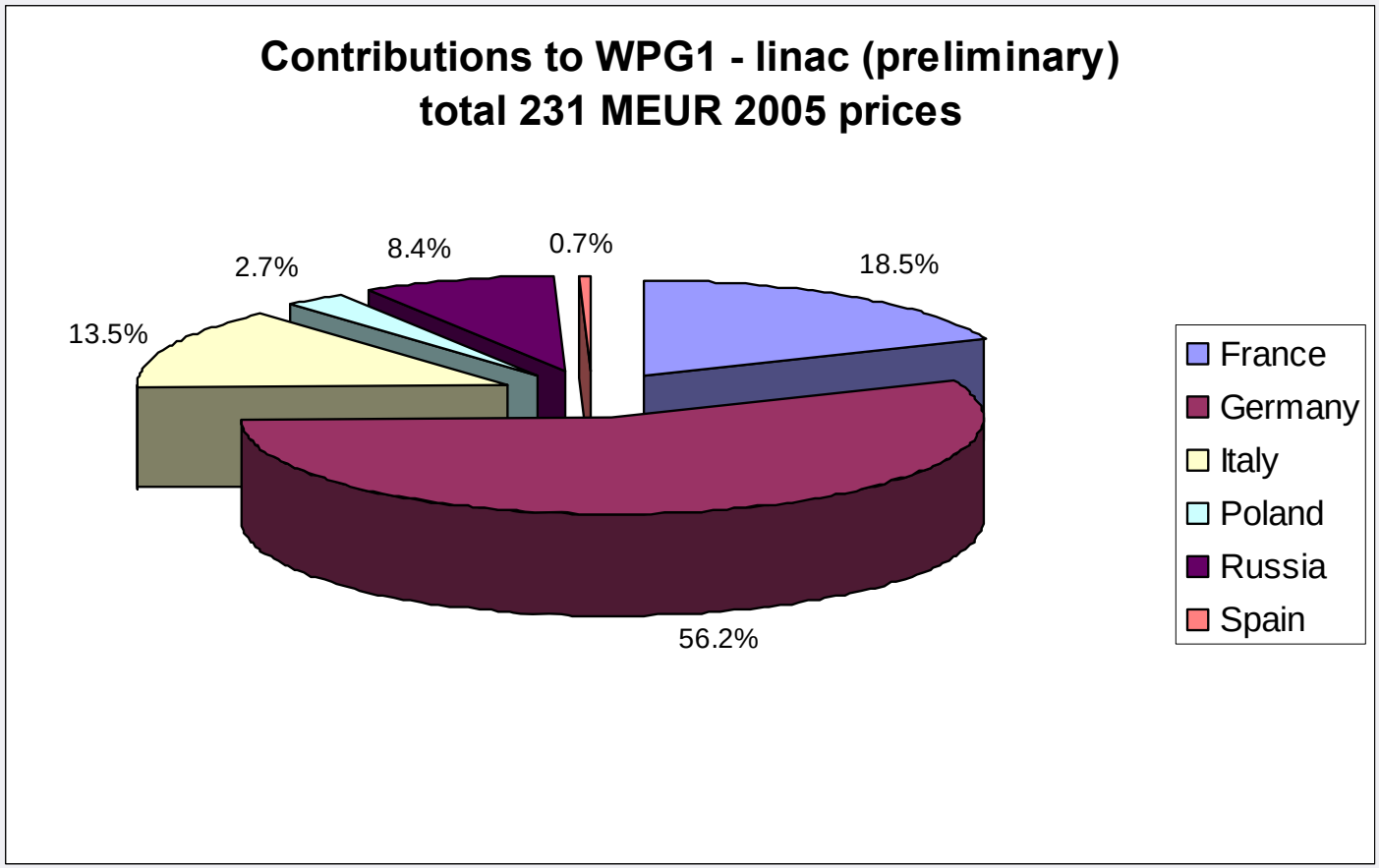
Accelerator Consortium – "in-kind" contribution



WP structure from project preparation phase – some adjustments in progress

WPG1 Linac (WPs 1-9 and 11)





WPG1 Linac (RF and LLRF)

- WP01-RF system
  - BINP/Novosibirsk & IHEP/Protvino waveguide system

    BINP pulse transformers

    DESY everything else

- WP02-LLRF system
  - Joint EoI DESY + Polish institutes presented at last IKRC
  - LLRF-ATCA Review meeting with external reviewers Dec 4, 2007 at DESY

WPG1 Linac ("Cold Linac")

- WPs 3-9 & 11 "Cold Linac"
  - Joint proposal already evaluated by IKRC
  - 4th cold linac meeting scheduled Feb 4&5, 2008 in Milano

- EoIs not yet included:
  - Contribution IHEP/Beijing on cryomodules & cavities
    - Construction of module prototype launched, agreement with DESY to provide support with expertise, evaluate the prototype & if suitable equip with cavities etc. → decision on in-kind contribution Q4/08
    - Not clear yet how to proceed with cavity proposal, discuss with cold linac group
  - Contribution IHEP/Protvino on MLI blankets for cryomodules
  - Contribution IFJ-PAN/Cracow (part of the Manpower EoI), regarding software/database, electrical & mechanical engineering, installation

WPG2 Accelerator sub-systems

- WP12-warm magnets
  - EoI Efremov Inst./St. Petersburg includes ***all*** magnets
  - EoI MSL/Stockholm on quads for undulator sections
  - Possibility of 3rd bid for undulator quads from CIEMAT, as part of EoI for undulator intersections/assembly
- WP14-injector
  - EoI Uppsala Univ. (submitted to last IKRC) for laser heater
  - DESY intends to take main part of injector package
- WP15-bunch compressor
  - 3rd harmonic (3.9 GHz) system to be extracted from WP14 and moved as new WP into WPG1-linac; contributed by DESY
- WP16-lattice & optics
  - Beam stabilization system part of PSI EoI already presented to IKRC
  - EoI by Univ. Aarhus on beam distribution kicker systems – to be done jointly with DESY

WPG2 cont'd

- WP17-standard beam diagnostics
  - BPM systems shared by DESY-PSI-Saclay

    Basic agreement on which types/technology to use; question of how many/where cavity BMPs to be used
  - EoI by IHEP/Protvino on beam profile and beam loss monitor systems

    Discussion at an early state – need to follow up to determine scope of contribution and sharing of work, responsibilities and cost
- WP18-special beam diagnostics
  - EoI JINR/Dubna on optical replica synthesizers
  - EoI INR/Troitsk on deflecting mode cavity bunch slice diagnostics *("LOLA" device at FLASH)*
- WP19-warm vacuum
  - EoI BINP Novosibirsk
- WP20-beam dump
  - EoI IHEP/Novosibirsk on beam dump systems

WPG5 Infrastructure

- WP10-accelerator module test facility & WP13-cryogenics
  - Joint proposal DESY-BINP-IHEP-WUT, covers WP13 completely and includes all cryogenics components for WP10
  - Details → presentation B. Petersen
- WP10-AMTF
  - EoI IFJ-PAN Cracow on manpower
    - Approx. 100 FTE (scientist/engineer/technician) to build & (mainly) operate the test facility
    - Very near finalised proposal, few details regarding sharing of work, schedule for starting the participation
- WP33-tunnel installation
  - EoI initially submitted by IHEP/Protvino, but recent agreement that INR/Troitsk will join
  - Discussions at an early stage, need to follow-up to determine scope, sharing of work & cost, IHEP/INR manpower at XFEL site during installation?, etc.

WPG5 cont'd

- WP34-utilities
  - EoI CIEMAT on s.c. (linac) quad power supplies
  - EoI BINP on warm magnet power supplies

Next steps

- There is still plenty of work necessary to **detail EoIs** towards proposals in ~final shape
- Some partners need to do **cost-checks** and **negotiations** with funding agencies
- Towards setting up the full Consortium:
  - Establish **"Accelerator Executive Board"**
  - **Internationalize WP leadership**
  - In-kind proposals → **Accelerator Construction Agreement** (signed and binding document) between Consortium members and XFEL company
  - Organize **1st General Consortium Meeting** (tentatively late spring/08)

Next steps cont'd

- Issue to be addressed:
  - **Value of in-kind contribution** is fixed according to budget book in year **2005 prices**
  - In-kind contributors handle **deviations due to general price index & unavoidable uncertainties at the time of cost evaluation**
  - There are **exceptional cases** where budget book value is "unfair":
    - Technically necessary design changes (not changing scope of project)
    - Large impact of raw material price escalation
    - (obvious mistakes in the budget book – if any)
  - Two (maybe more?) **ways to handle exceptions**
    - Access to risk budget (included in TDR!) as a "common fund" held by the XFEL company
    - If partner can provide additional funding, value of this WP needs adjustment to properly account the share in the project

Conclusion

We see remarkable progress on our way to put together the XFEL Accelerator Consortium – thanks to the constructive engagement of the colleagues from all partner labs and co-workers at DESY!