Linear Collider Challenges and ILC-HiGrade

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e^+e^- Linear Collider

- HEP community has long agreed that the next large project following the successful commissioning of the Large Hadron Collider will be an e^+e^--collider
  - Initial energy range from LEP II up to 500 GeV cms and extendable up to 1 TeV
  - It should provide a luminosity of 500 fb^{-1} in a period of 4 years
  - Technology decision has been taken to built the LC in superconducting RF technology; ITRP in 2004.
  - Such a machine could be built today – the ILC
    - Design optimisations are being carried out that improve performance and reduce risk and cost.

Challenges for a Linear Collider

- There will only be one such collider

No global institute in place.

  - Global project from the start

- The footprint of the machine will be >30 km

  - Hosting of the facility in the conventional approach leaves a large fraction of the civil engineering with the host and the high-technology components with the external partners

Who will bid and under which conditions?

- The cost of the machine exceeds 5 bn €

  - ILC in 2007 units: $US 6.7 bn (value estimate)

Same number sometimes "inflated" to >$US 20 bn;

Dependence on accounting schemes.

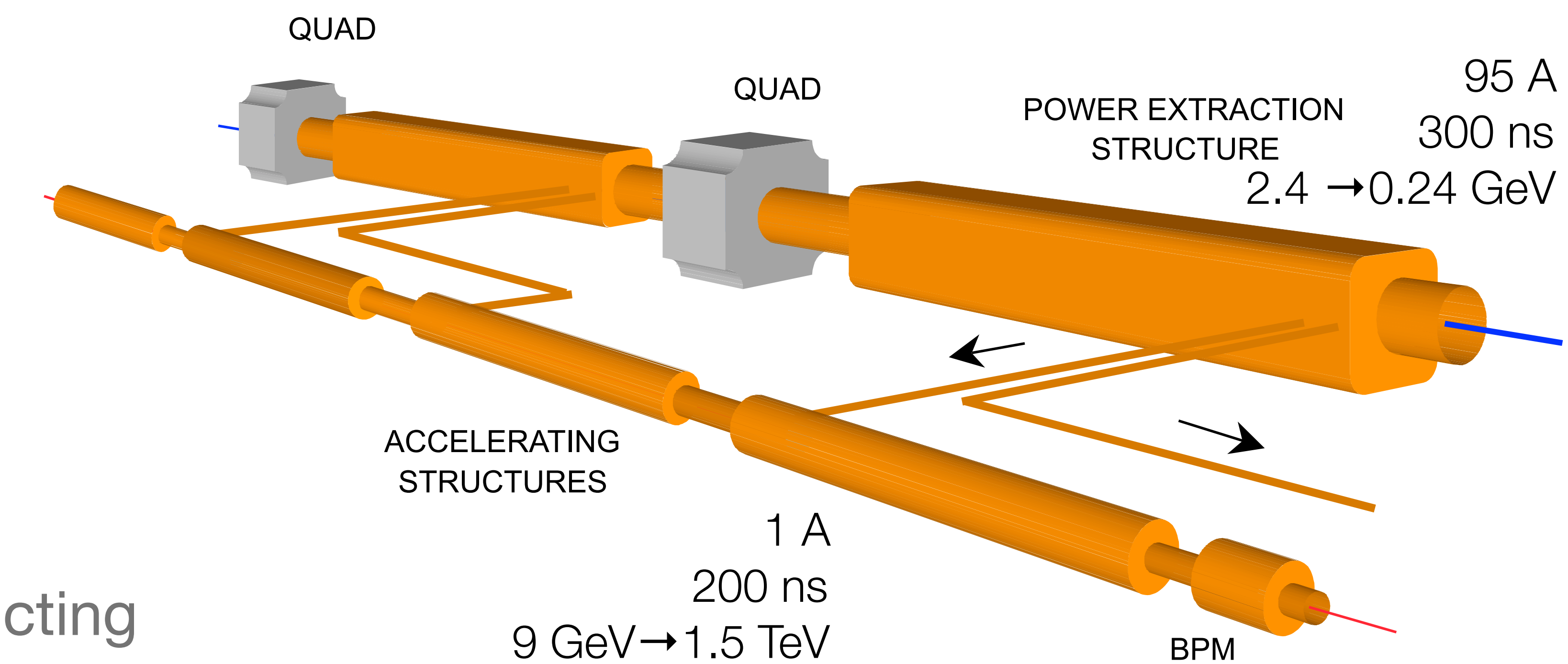
Temporal Constraints

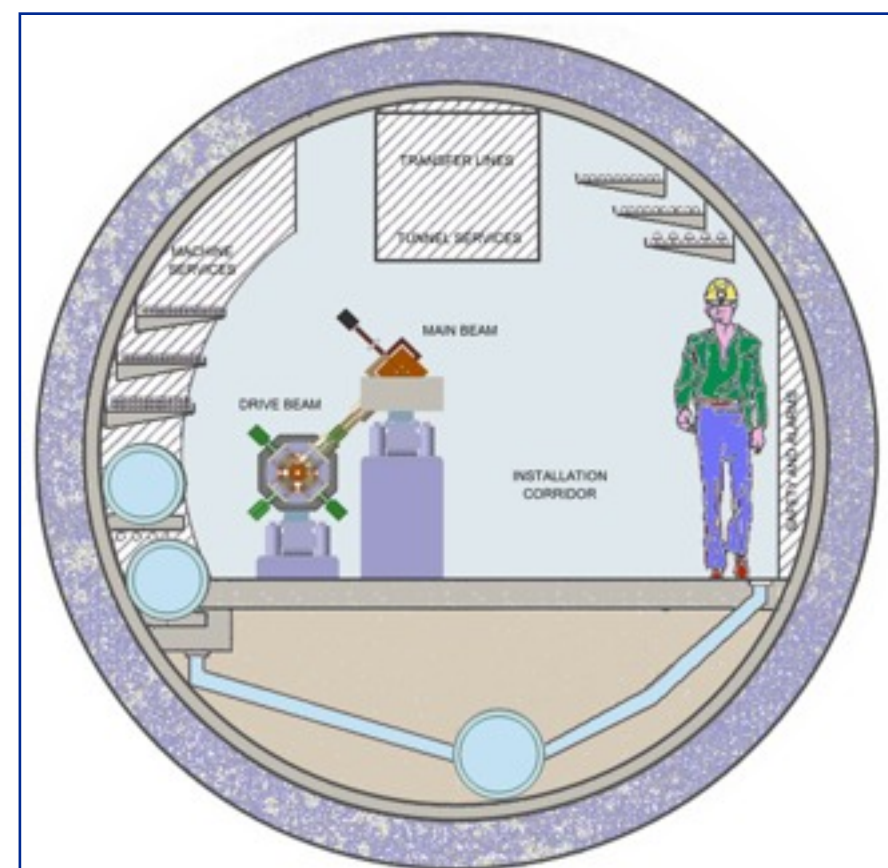
- The LHC started as a European Project.
  However, it has assumed facets of a global enterprise; certainly in the area of detectors
  - It is unlikely that two global projects for the same research field are funded at the same time
  - Delays in the LHC startup hence influence progress in subsequent projects
    - Phase One Upgrades of LHC
    - Uncertainty in longterm LHC schedules
    - Reconsideration of the energy reach for a Linear Collider

Will there be physics guidance from the LHC?

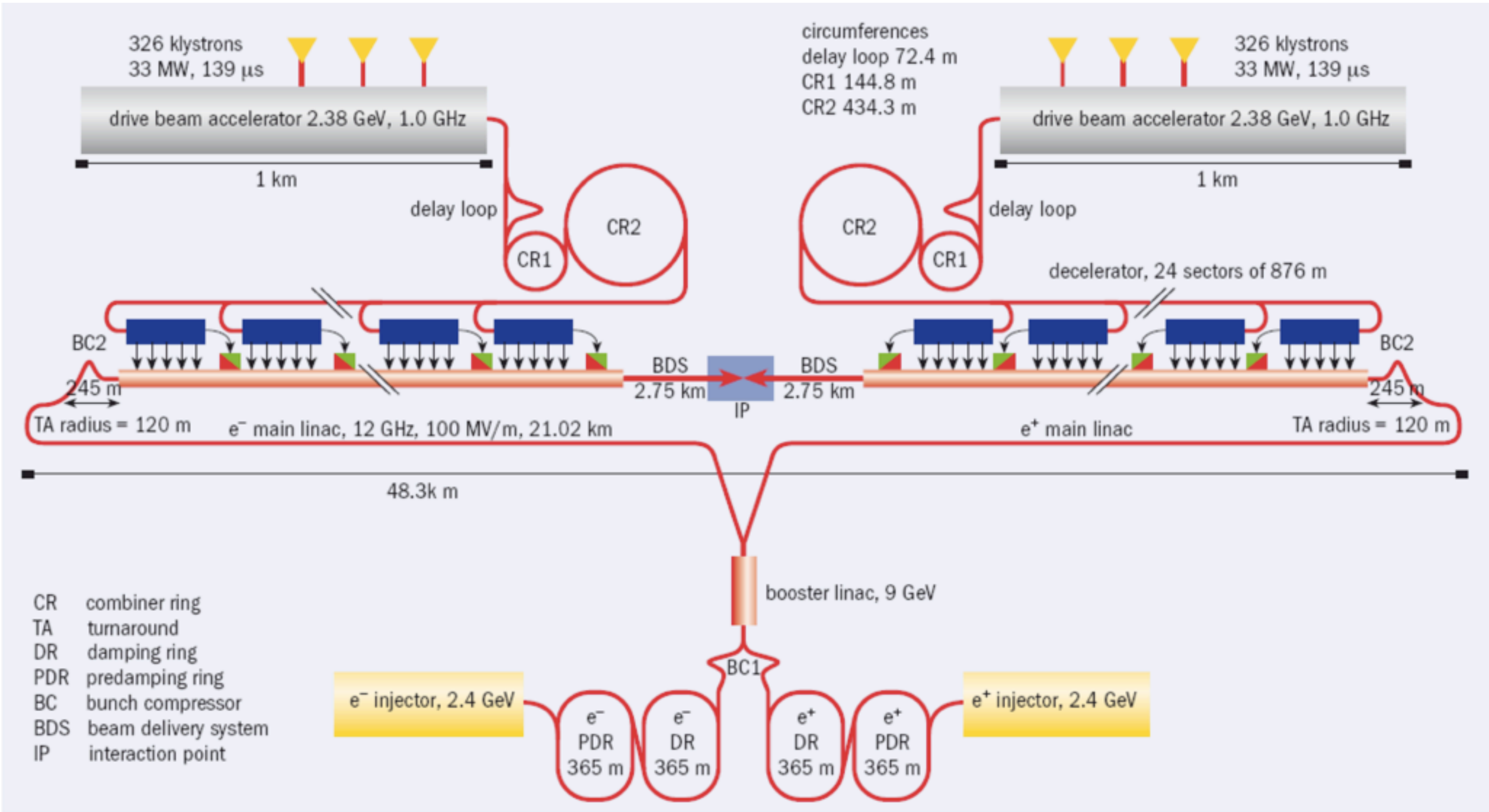
Compact Linear Collider (CLIC)

- Principle
  - High gradient >100 MV/m
  - Compact Collider;
    Length < 50 km for 3 TeV
  - Acceleration in normal conducting structures @ 12 GHz
  - Accelerated by wakefields from a parallel running high current beam.
  - Efficient generation of the drive beam



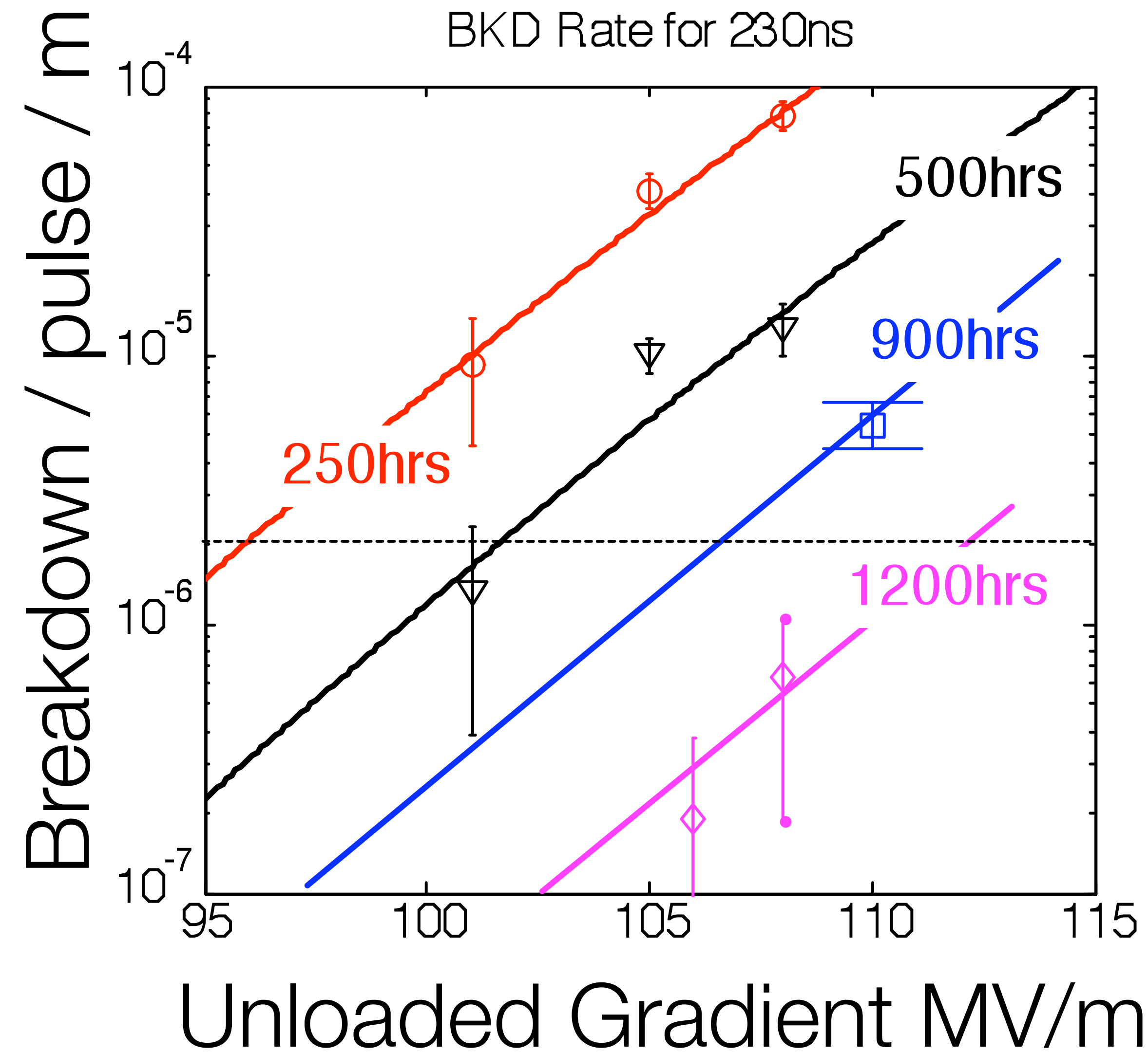


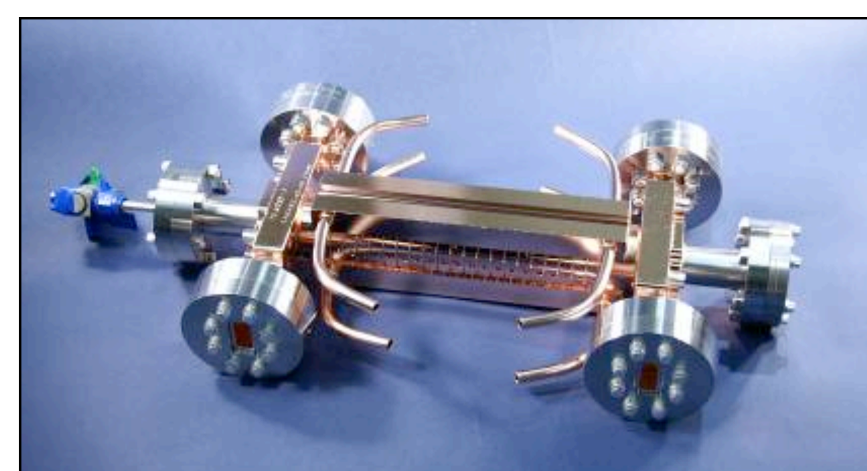
CLIC Layout for 3 TeV



Challenges for CLIC

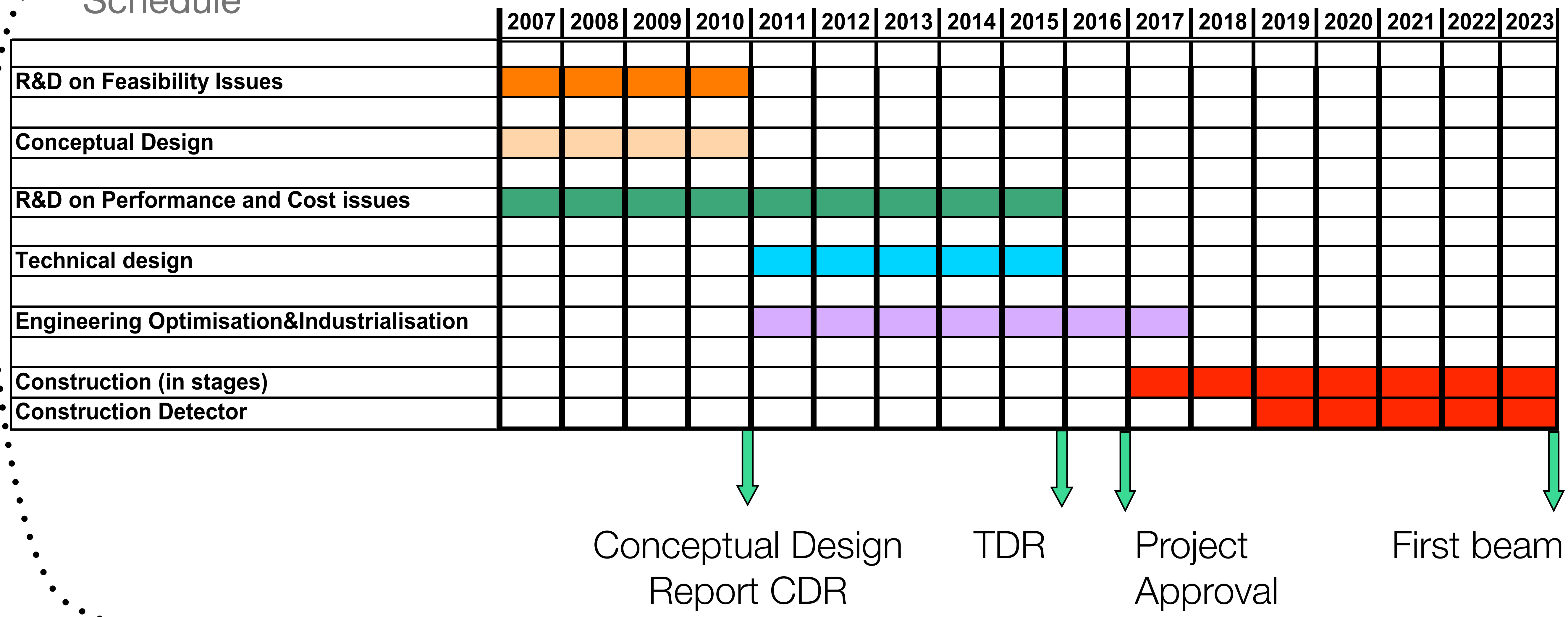
- Stability of acceleration structure:
  - Breakdown rates
- Stability requirements of the accelerator
  - wakefield in small structures
  - nm-accuracy over 50 km
- Path from proof-of-principle to (test-)accelerator unclear





Roadmap for CLIC

- Tentative long-term CLIC scenario Shortest, Success Oriented, Technically Limited Schedule



Assumes the extrapolation from a successful acceleration over a few cm to 2x20 km

ILC-HiGrade

- ILC-HiGrade is the Preparatory Phase project of the European Commission to work towards the realisation of the **International Linear Collider** based on superconducting RF technology.

- The project is one of 30+ projects on the ESFRI list considered technically **mature for construction**. The two HEP projects SLHC-PP and ILC-HiGrade entered via the C.E.R.N. Council strategy list

- In order to reach an early status of readiness for construction ILC-HiGrade addresses

  - a key technical component that affects the cost, i.e.
    SRF gradient with a goal of running the ILC at 31.5 MV/m (a 6% saving over the current state-of-the-art gradient)

  - siting of the ILC and the formation of governance and financial structures in Europe that enable the realisation of the project. The European Commission recognises that this is a process with global implications

ILC-HiGrade in brief

- Participating institutions
  - DESY
  - CEA
  - CERN
  - CNRS
  - INFN Milan
  - University of Oxford
- Start of project: 1.2.2008
- Duration: 4 years
- 8 Work packages (incl. 1 for management)
- Budget: 9.8 M€ incl. 5 M€ support from the European Commission
- Total effort: 571 Person months
- Observers from science politics (on the suggestion of the European Commission)
- Interest from European Commission

ILC-HiGrade Work Packages

1) Management of the Consortium

2) Integration and optimisation of the European contribution within the global GDE organisation as the ILC project moves through the GDE Engineering Design Phase

3) Ensure that the characteristics and importance of the ILC, and its place within the world of science and research, is widely disseminated to the peoples of the European Union, and their governments

4) Investigate features and develop possible schemes of governance for the ILC, exploiting expertise of CERN (LHC) and DESY (HERA) in international projects

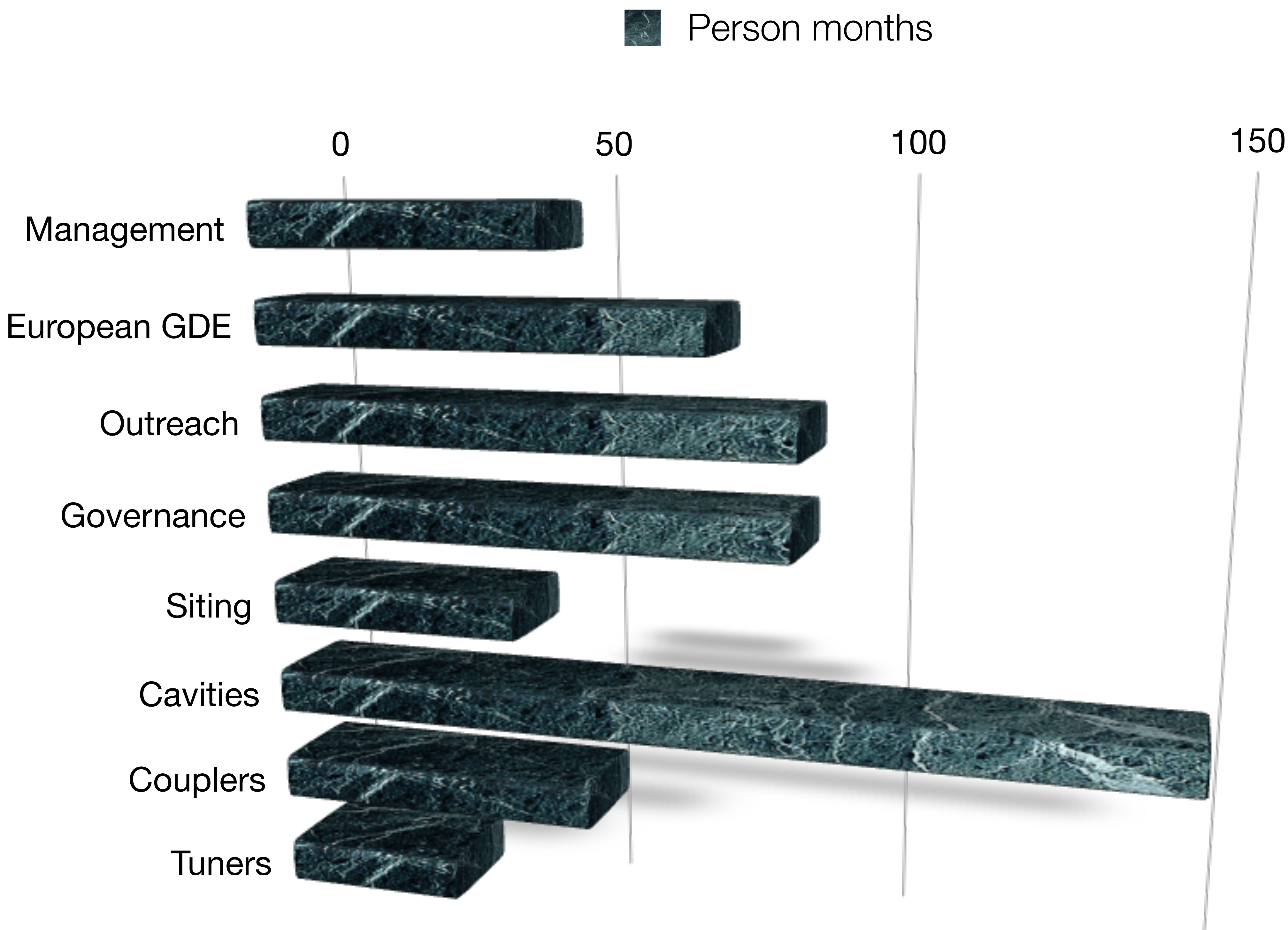
5) Prepare and investigate possible European sites for ILC construction

6) Investigate and monitor the production process that yields high-gradient cavities with high yield. Establish the process in industry

7) Optimisation of the coupler conditioning at reduced cost

8) Demonstrate suitability of tuner design in tests. Establish a cost-effective tuner production

Work Packages

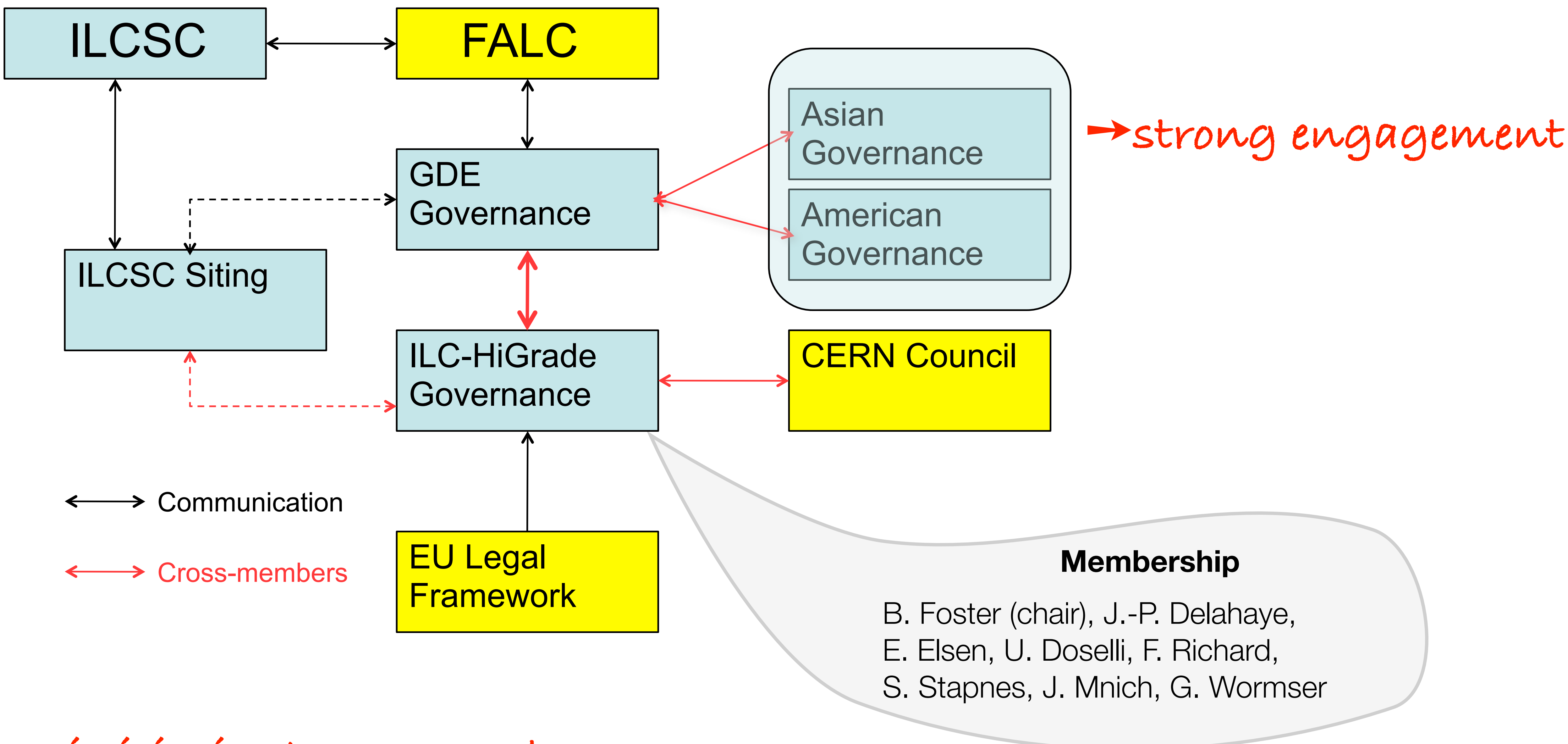


Imbedded in Global Design Effort

- GDE has installed a Study Group for Governance
- Siting is a priority topic for ILC
  - deep vs shallow tunnel
  - single vs twin tunnel
- Cavity gradient is one of two critical research topics
  - global effort with activities in Asia, America and Europe
  - European effort based on XFEL engagement and ILC-HiGrade

Reference Design Report is the basis for the Technical Design

ILC Governance

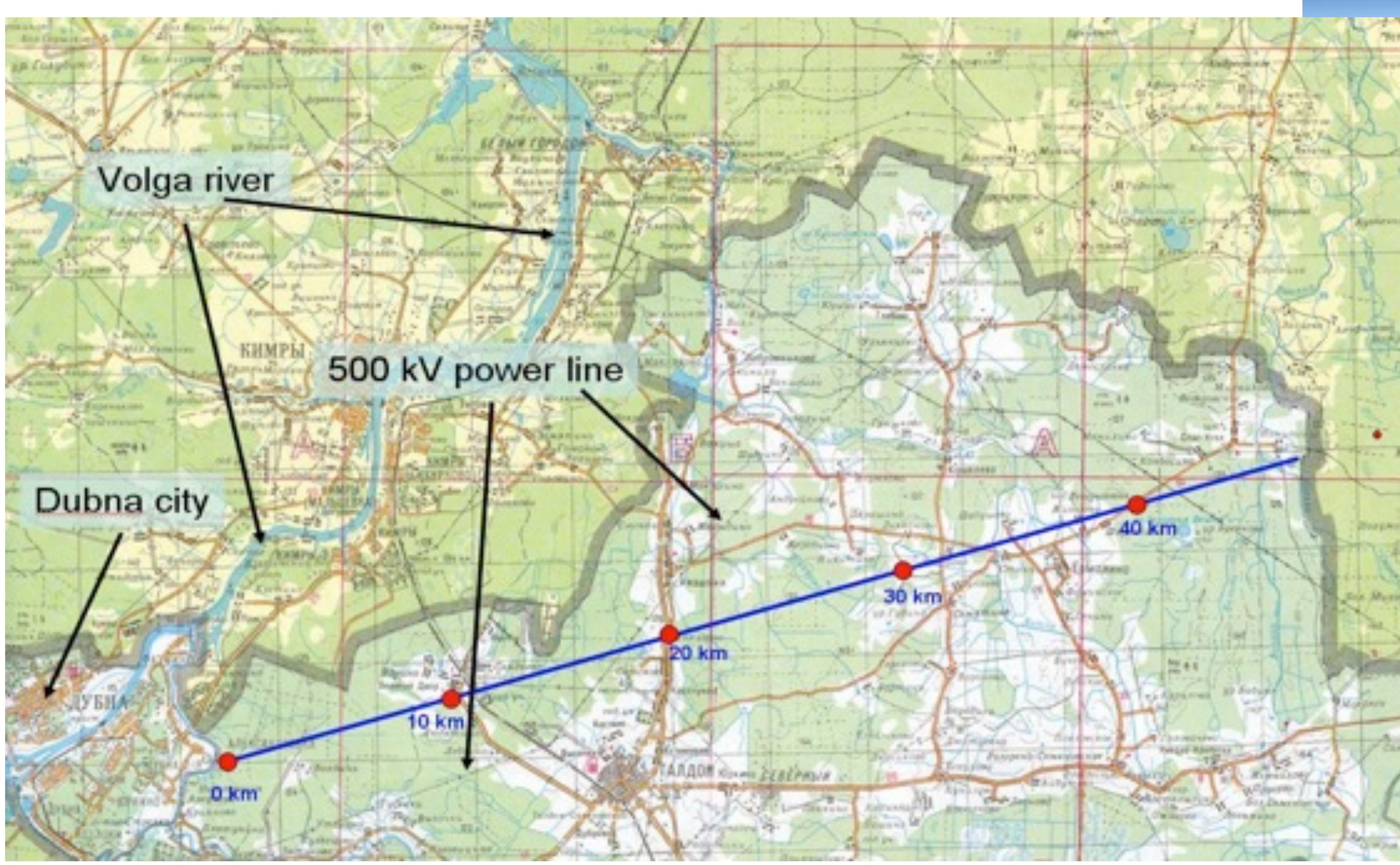


EU initiative has spurred reactions from other regions

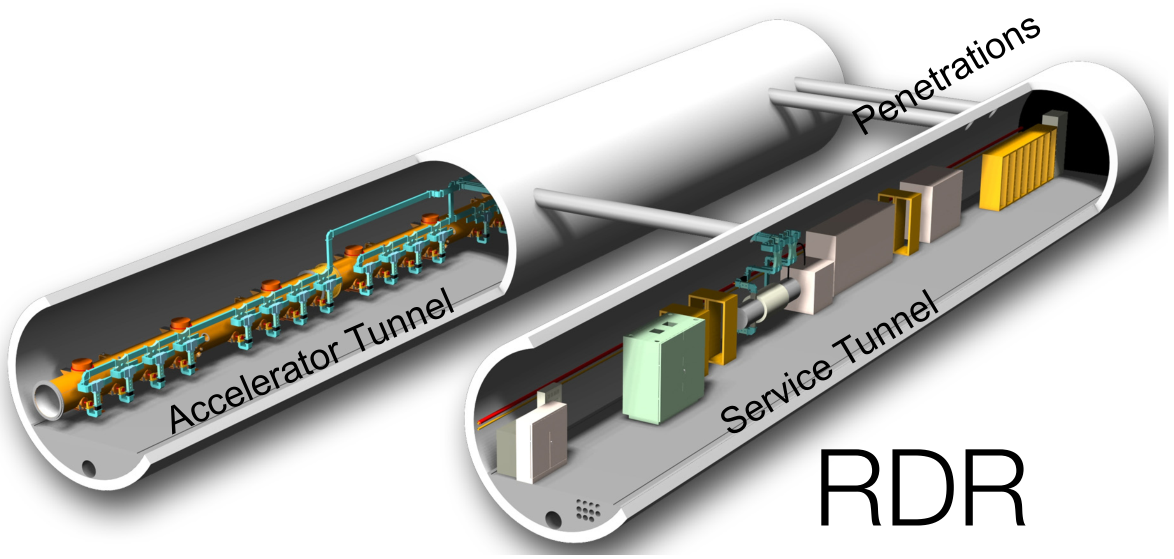
ILC Siting

- Current sample sites in
  - US (near FNAL)
  - EU (CERN)
  - Japan (several locations)

- Dubna offer a location that is particularly suited for shallow tunnel concepts
  - will be used as an example for exploration of cost benefits

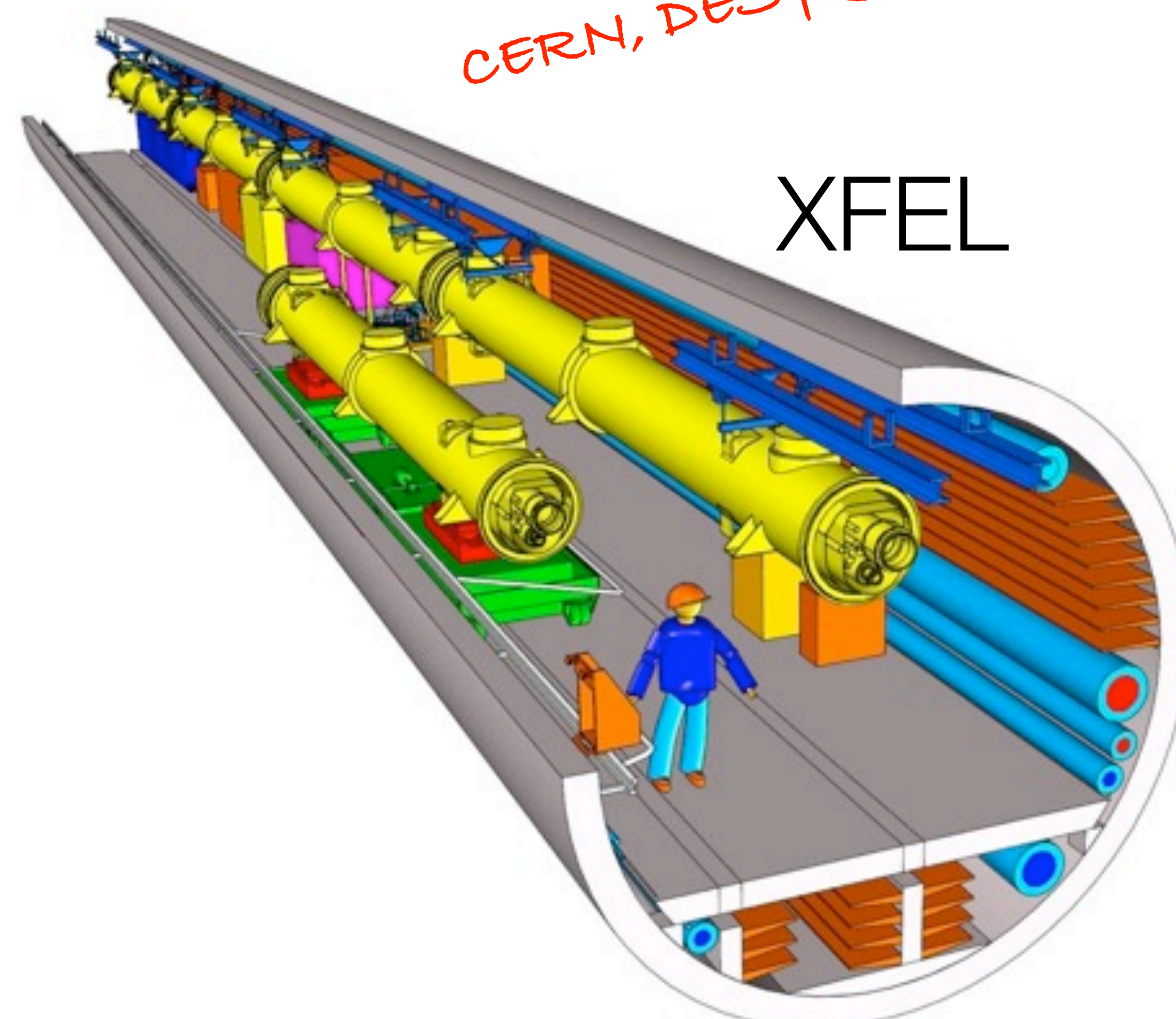


ILC Tunnel



RDR

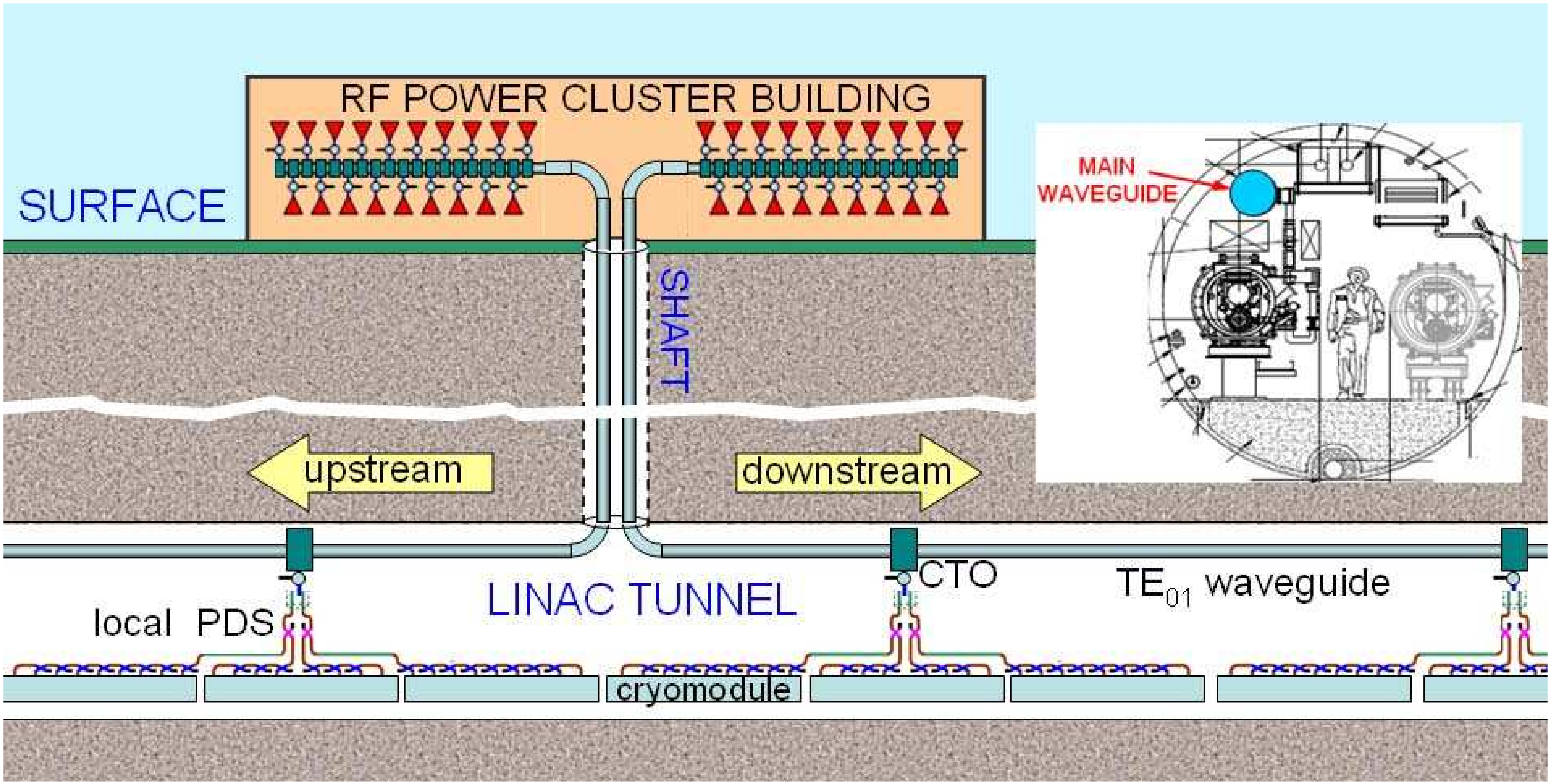
CERN, DESY & LAL



XFEL

- ILC Reference Design Report is based on deep underground twin tunnel design.
- XFEL will give the existence proof for a 1 km single tunnel e^- linac near surface
- LHC & HERA expertise and CLIC planning

ILC Strawman Baseline 2009



Single tunnel powered by klystron cluster

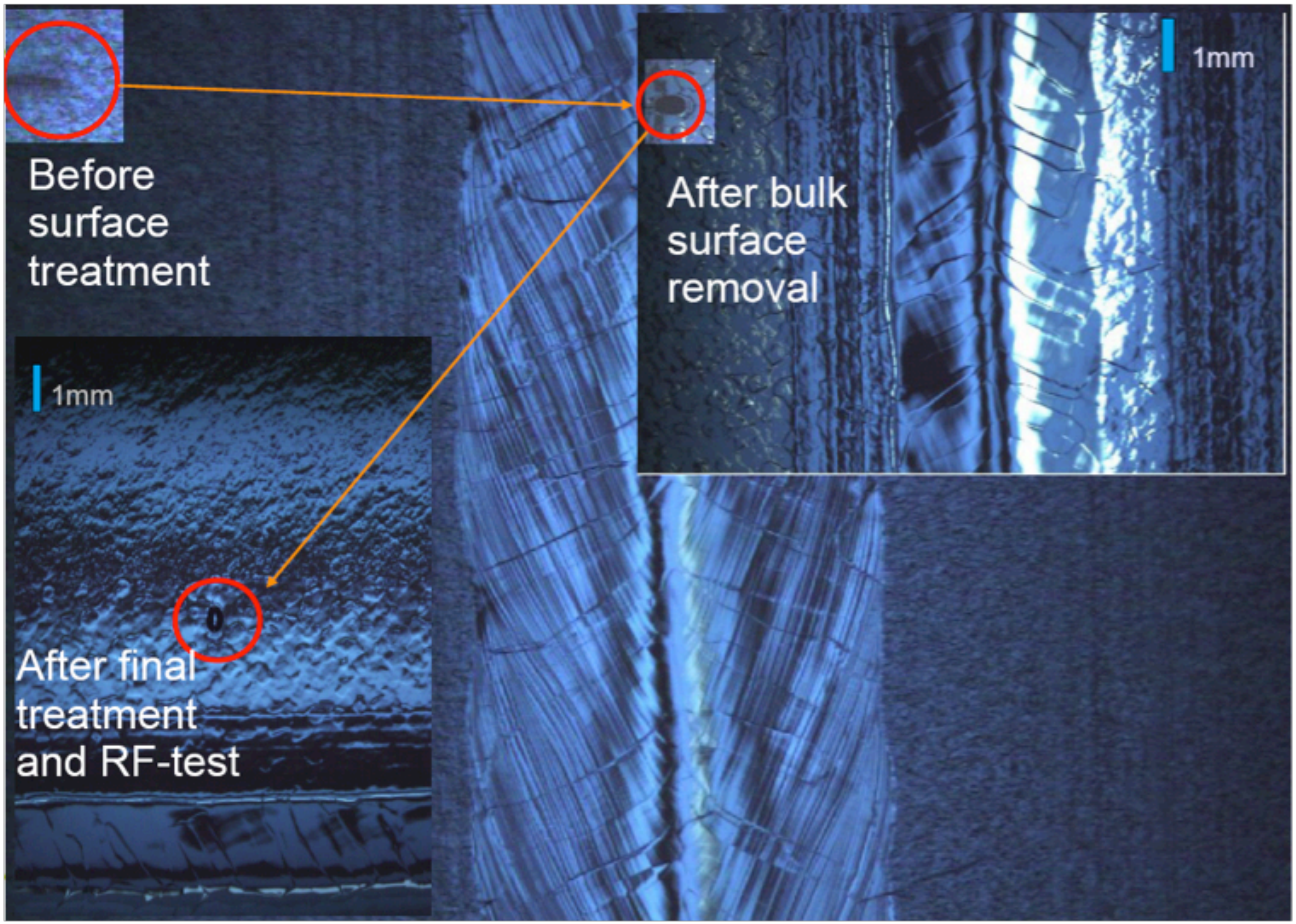
ILC High Gradient Activity

- High gradient cavities @ 40 MV/m have been produced in prototypes
- XFEL will soon order ~800 cavities specified at ~22.5 MV/m
- ILC-HiGrade will add another ~30 cavities from the same industrial production process. They will receive special final treatment according to the findings from the XFEL batch and preseries
- Detailed quality assessment
  - Fast and reproducible cavity processing
  - Example: detailed surface inspection

CEA, DESY

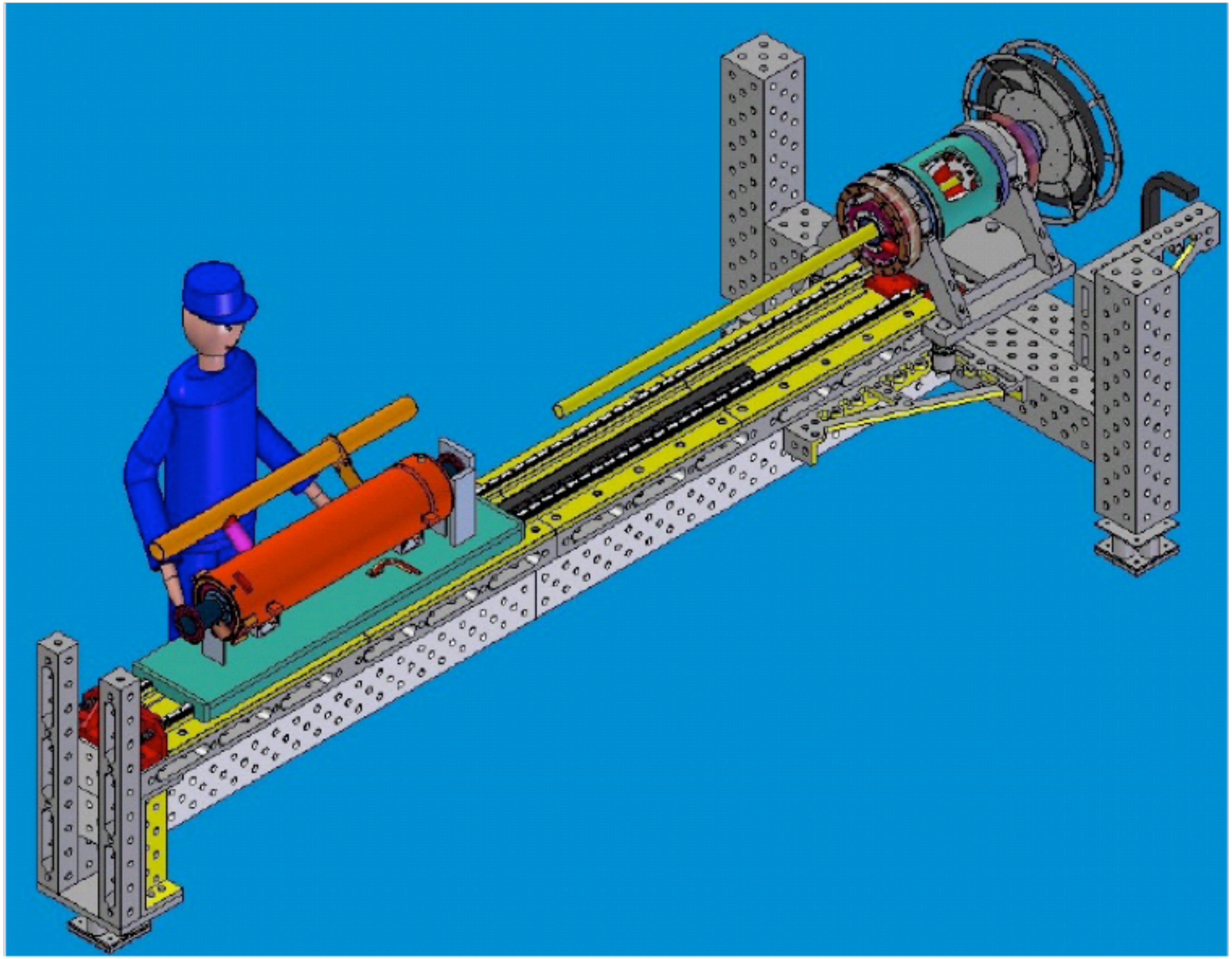
Optical Inspection of cavity inner surface

- Surface features of few 10 μm are seen to cause quenches
- optical inspection is to recognise these defects → feedback on production and post processsing

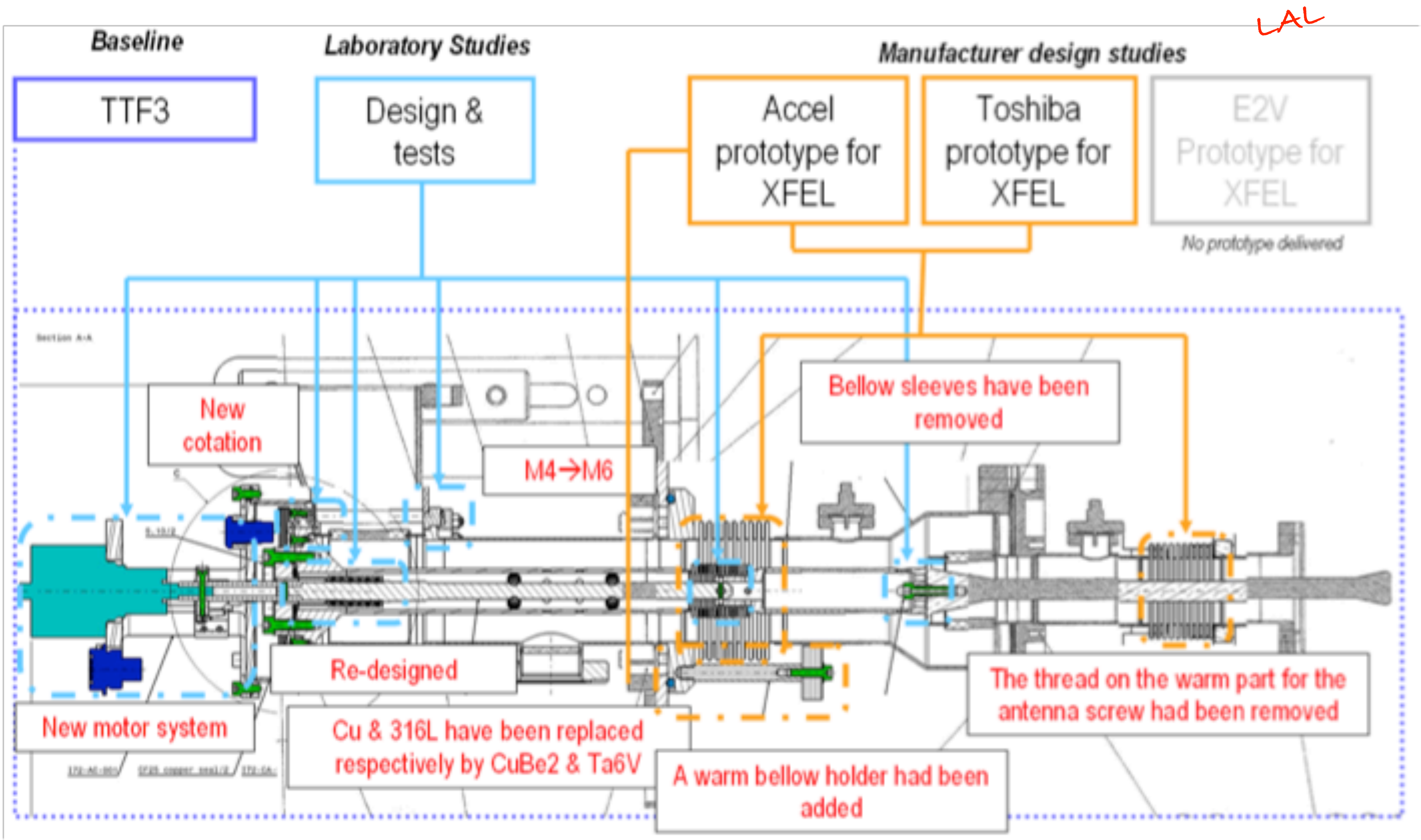


Automating Inspection

- Robot for fast inner surface scanning
    - will reduce time for inspection from 2 d to <3 h
    - prototype is currently being built



Coupler Design



Tuner

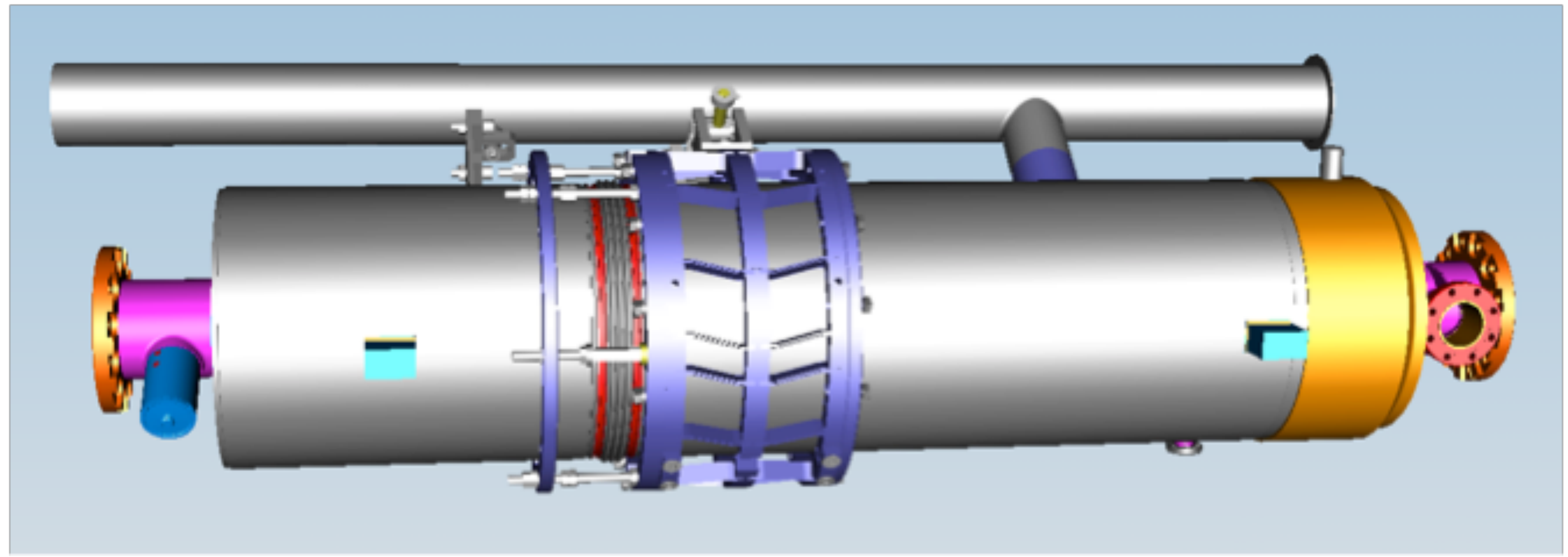
- Blade tuner is one of the variants to compensate for Lorentz force detuning of the cavities

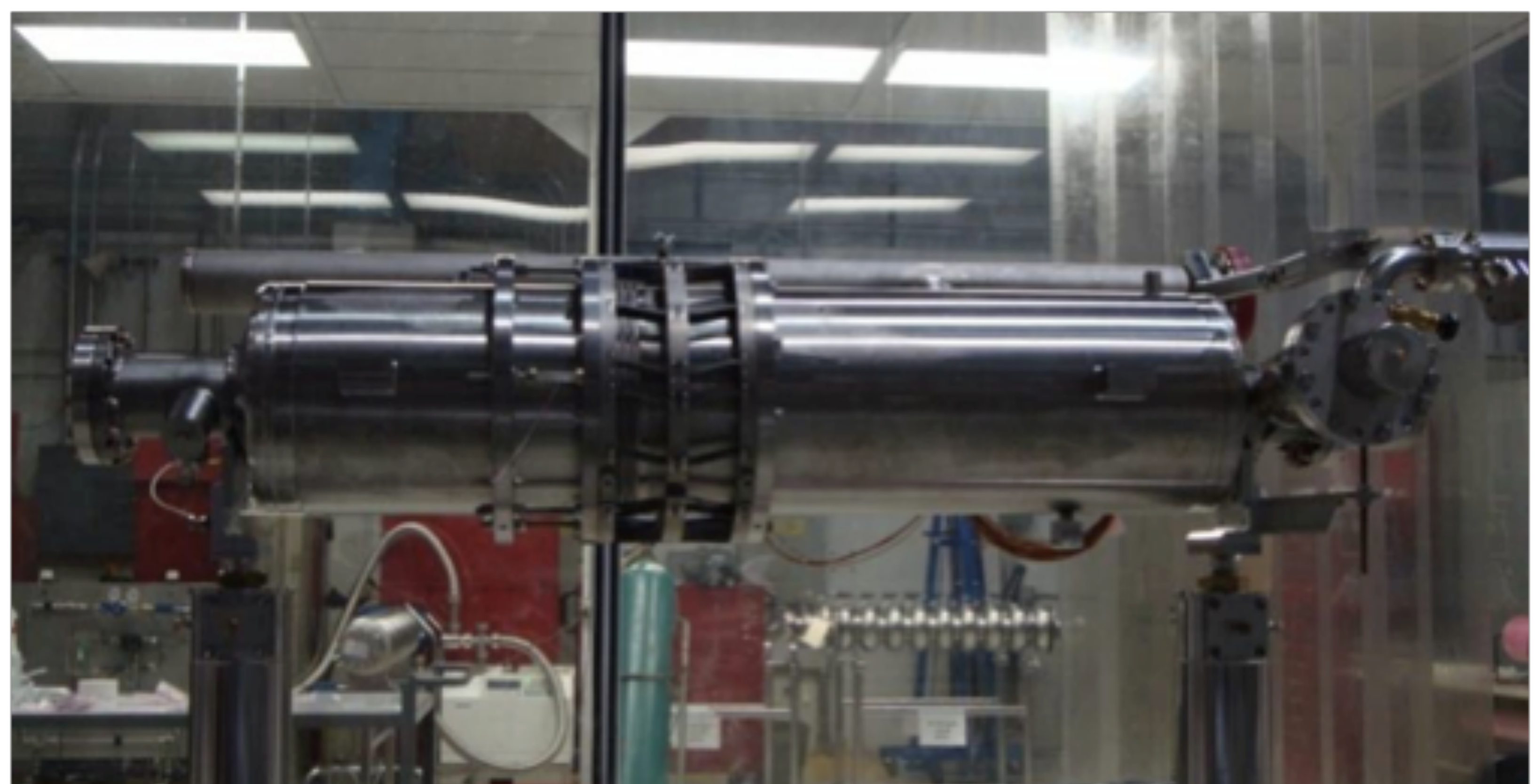
- Successful tests at BESSY

- Prototype tuner installed in FNAL cavity

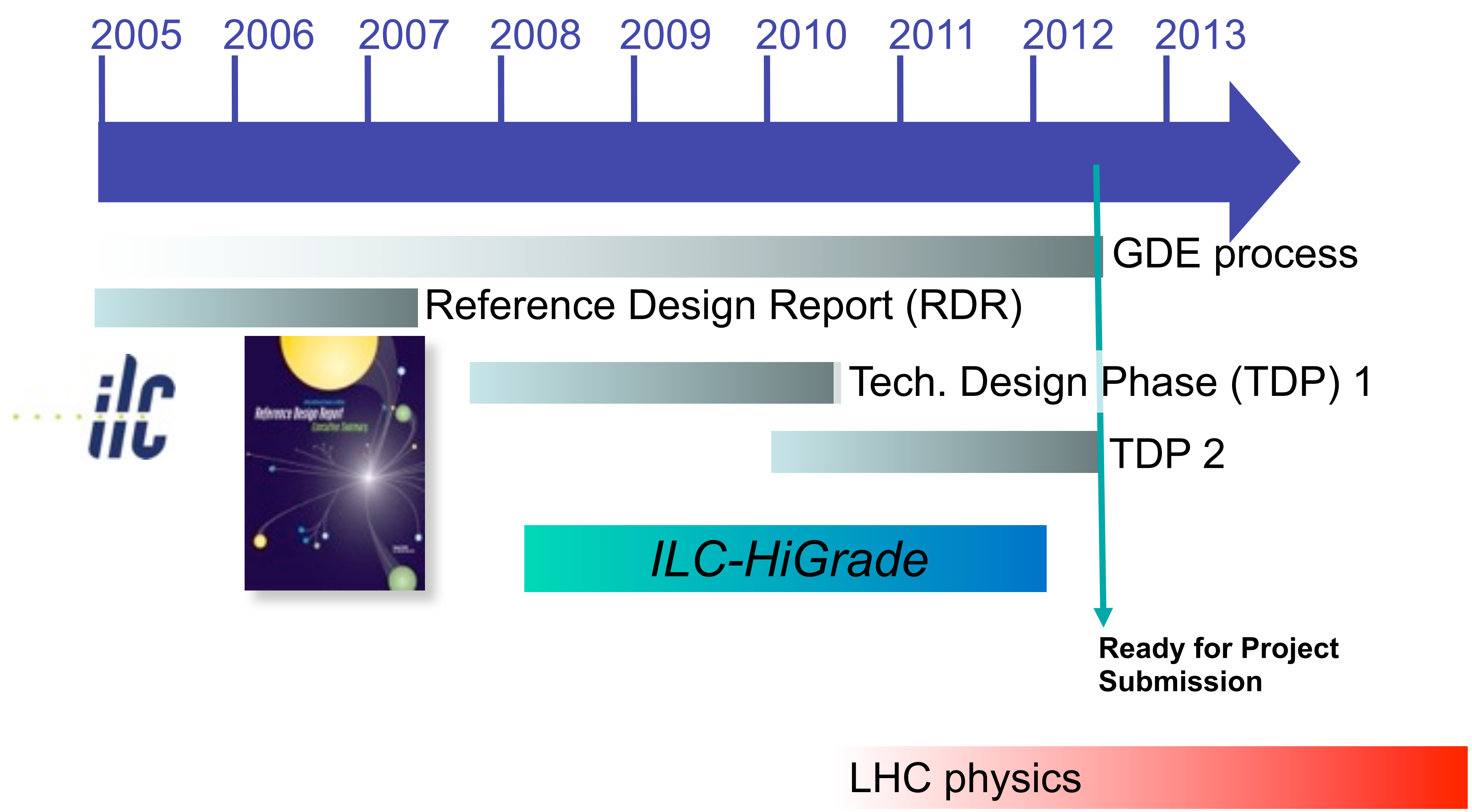
- Design essentially ready

INFN





Summary



- ILC-HiGrade provides a prioritised approach to seeking the implementation and realisation of the ILC well aligned with the global planning