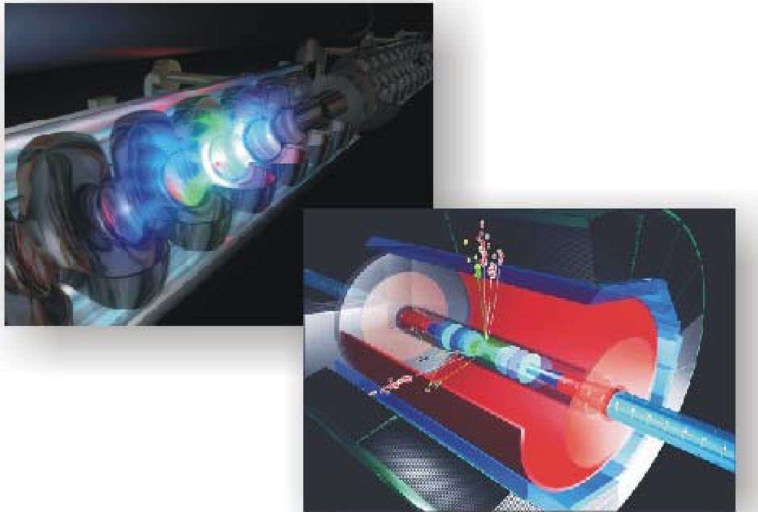
Overview of the ILC

(overview of GDE activities)



Nick Walker (DESY/GDE)

ILC-HiGrade Kick-Off Meeting

28.08.2008

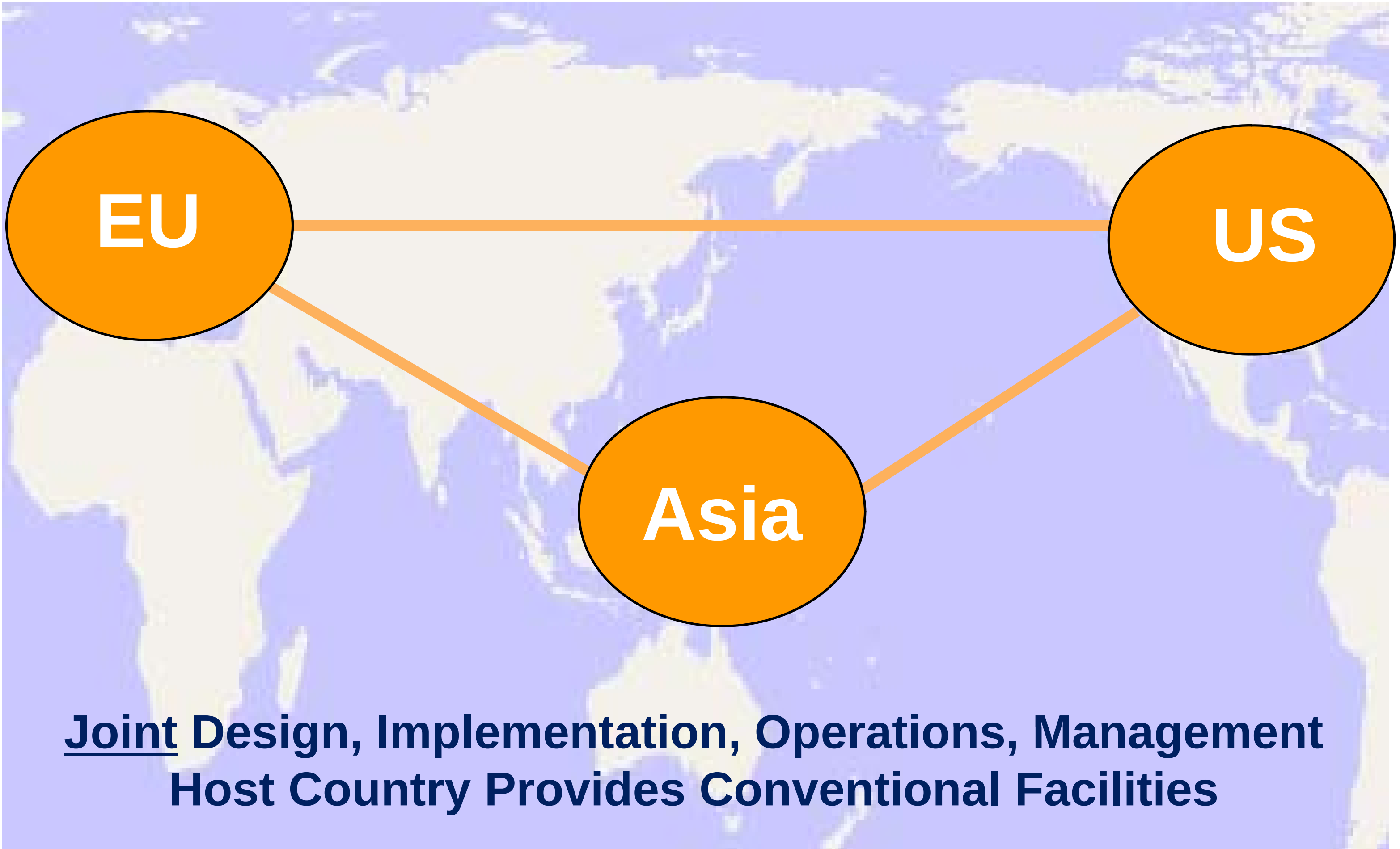
Historical Background

- Over 15 years active international R&D
  - NLC/JLC based on Cu x-band technology (11.4 GHz)
  - CLIC two-beam accelerator (30 GHz)
  - TESLA Superconducting RF (SCRF, 1.3GHz)
- 2002 German BMBF XFEL decision
  - Request to internationalize effort
- 2004 **ITRP** recommends SCRF Linac Technology for the ILC
  - Recommendation later endorsed by ICFA
- 2005 Global Design Effort (GDE) Formed

2001

2006

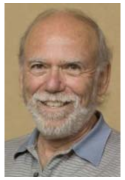
ILC GDE: A Truly Global Effort



<u>Joint</u> Design, Implementation, Operations, Management
Host Country Provides Conventional Facilities

Global Design Effort

- 2005: Formation of the GDE by ICFA
  - Barry Barish – director

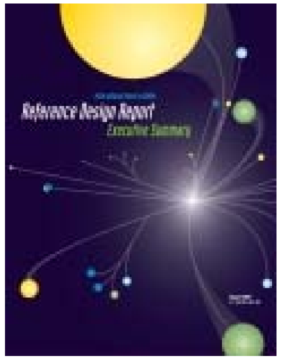


- History
  - Dec 2005 - Definition of baseline design
  - Dec 2006 - Completion of conceptual design with cost estimate (including first iteration cost reduction)
  - Jul 2007 – Publication of 4-volume **<u>Reference Design Report (RDR)</u>.**
  - 2008 - restructuring for <u>Technical Design Phase</u>

2001

2006

2007

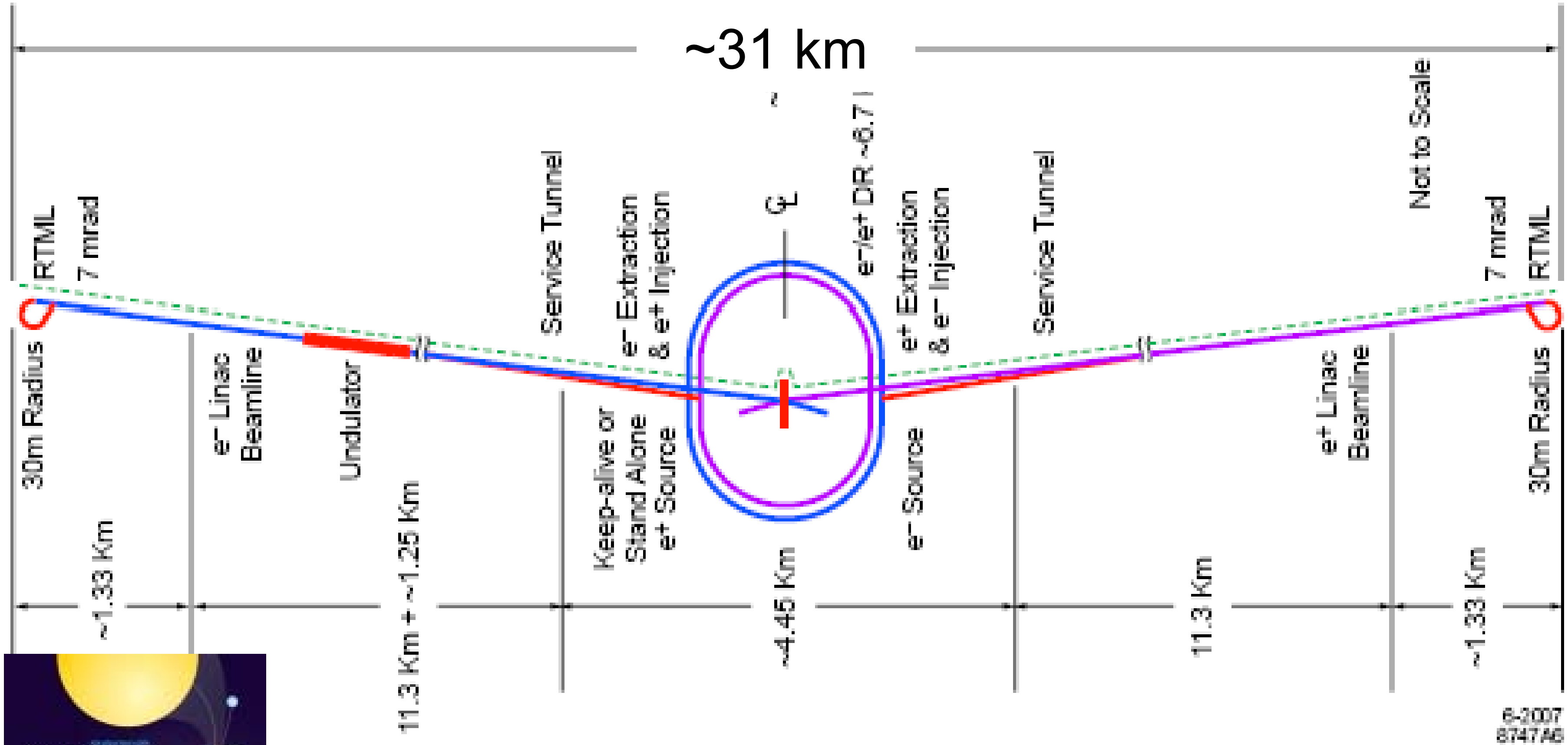


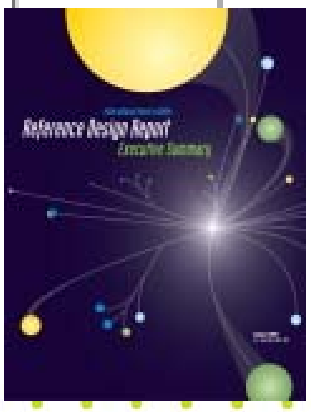
ILC Requirements

ILCSC Parameters group

- E_{cm} adjustable from 200 – 500 GeV
- Luminosity: $\int L dt$ = 500 fb^{-1} in 4 years
  - Peak at max. energy of $2\times10^{34} cm^{-2}s^{-1}$
  - Assume $1/\gamma$ L scaling for <500 GeV
- Energy stability and precision below 0.1%
- Electron polarization of at least 80%
- The machine must be upgradeable to 1 TeV
- Two detectors
  - Single IR in push-pull configuration
  - Detector change-over in not more than 1 week

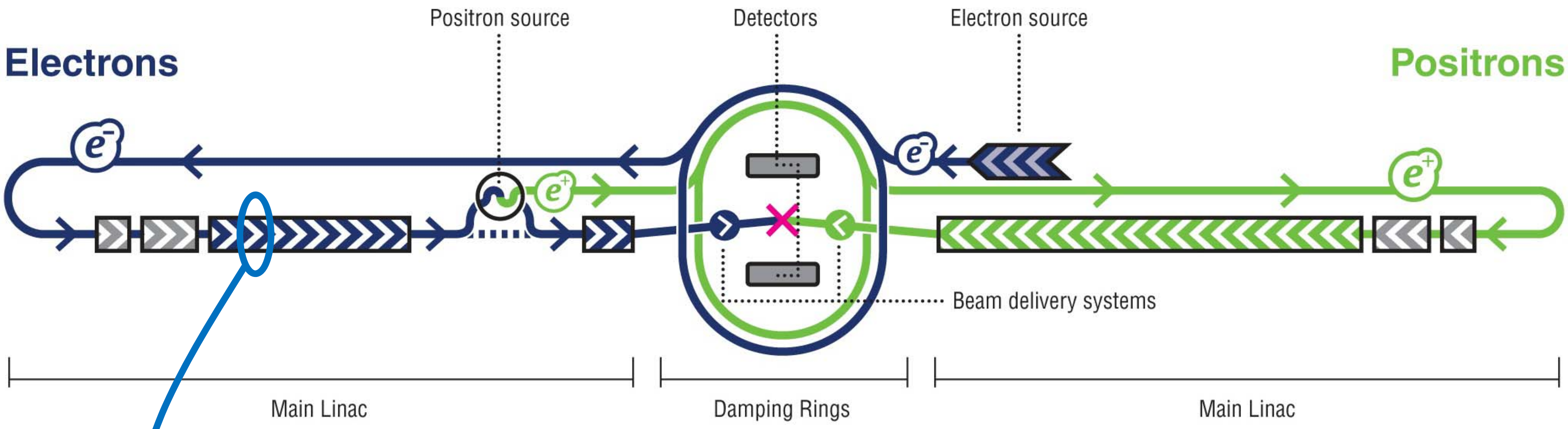
The ILC Reference Design

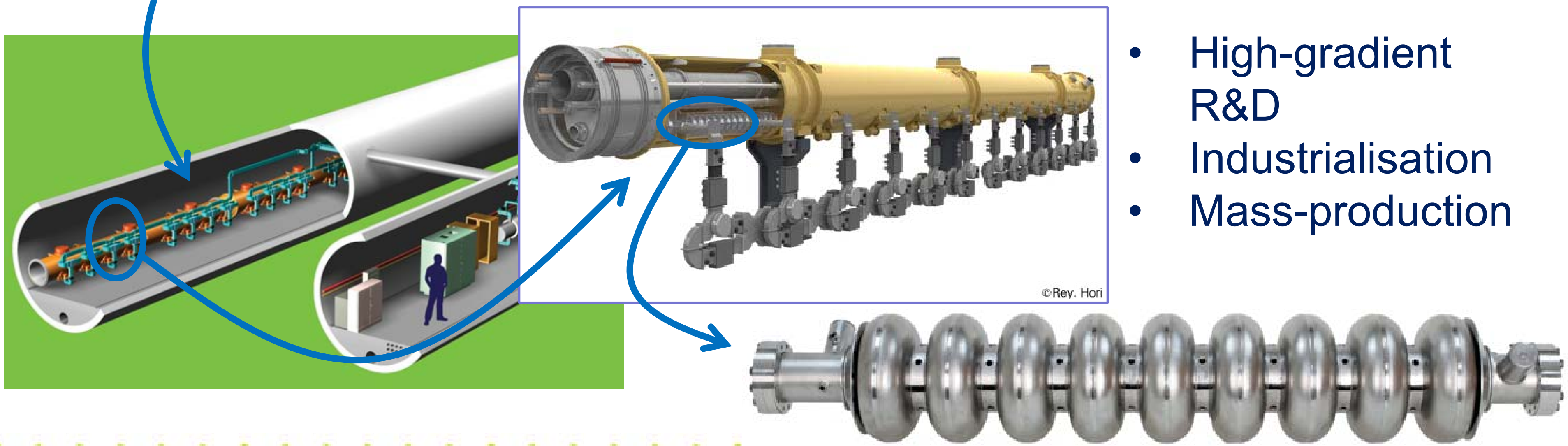




- 200-500 GeV centre-of-mass
- Luminosity: 2×10^{34} cm^{-2}s^{-1}
- Based on accelerating gradient of 31.5 MV/m (1.3GHz SCRF)

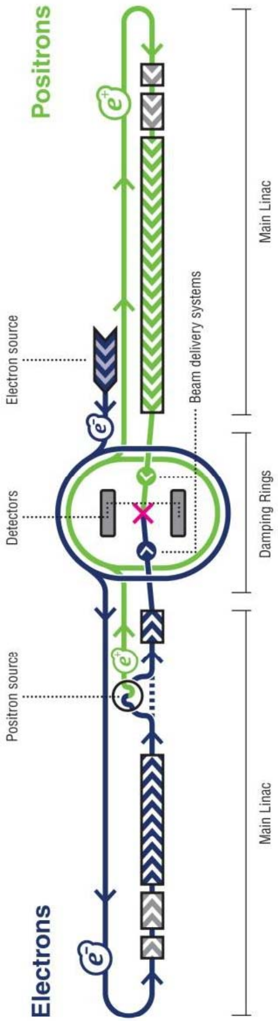
ILC Reference Design



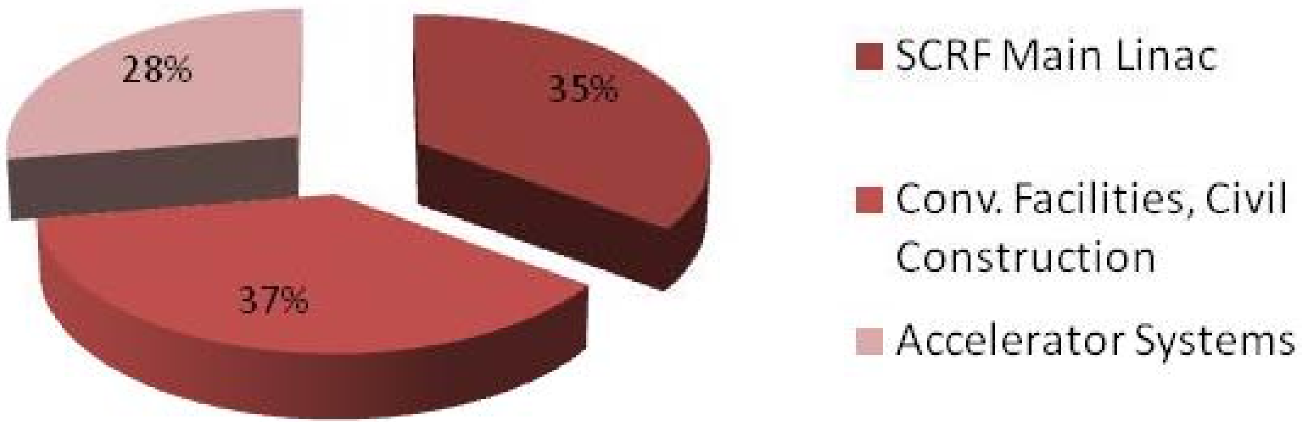


- High-gradient R&D
- Industrialisation
- Mass-production

Cost (VALUE) Estimate



- Estimated cost (2007) ~6.7 Billion ILCU*
  - 4.87 BILCU shared
  - 1.78 BILCU site-specific

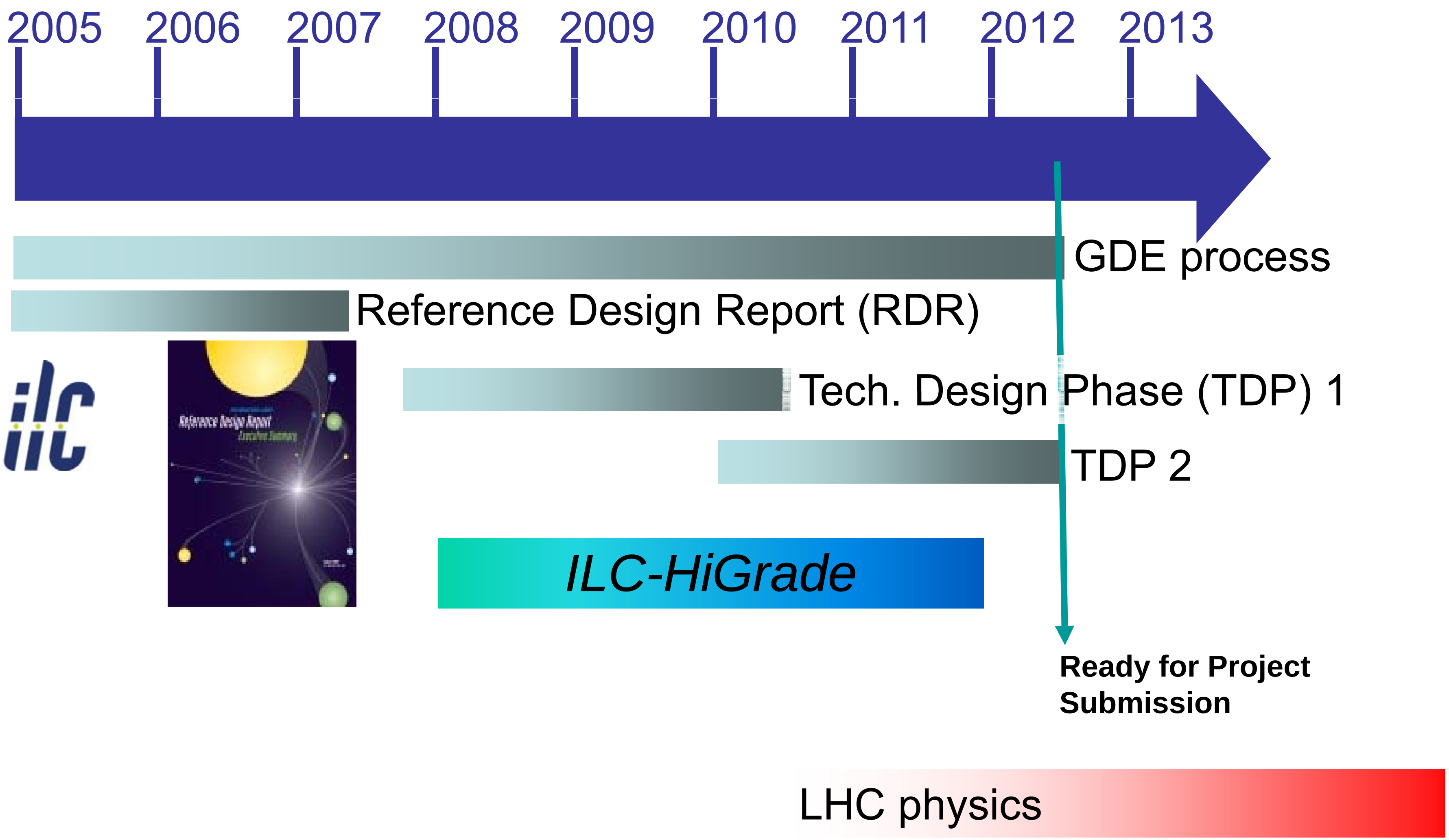


- 10,000 person-years “implicit” labour

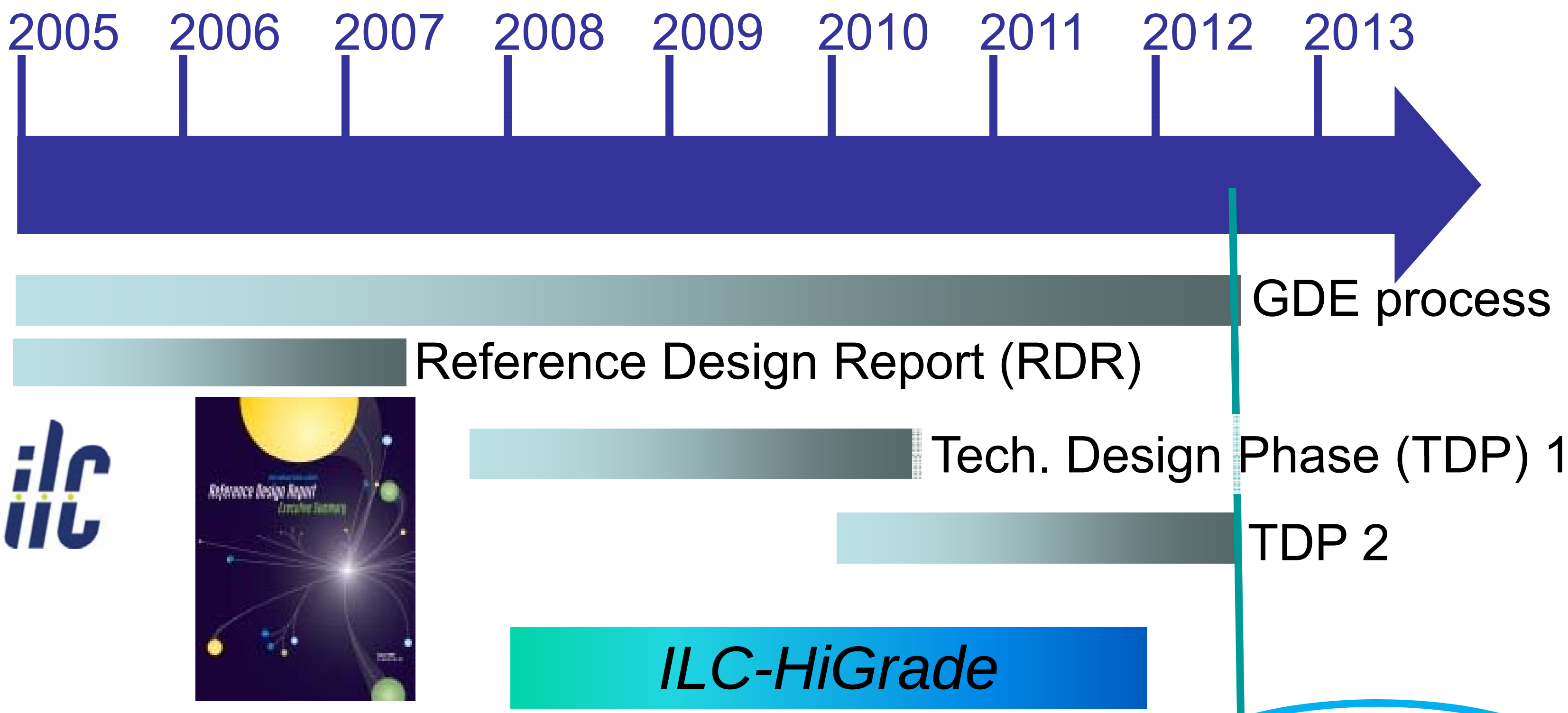
The GDE Post-RDR

- Publication of the RDR was a major milestone
- Analysis of the RDR design/cost → priorities for Technical Design Phase
- Re-structuring of GDE into a more traditional Project Structure
  - Hierarchal org. chart
  - Project Management Team
    - **Ross, Walker, Yamamoto**
- Focus of TDP work:
  - Risk mitigating R&D
  - Overall Cost Reduction / Containment (optimisation)
  - Project Implementation Plan (PIP)

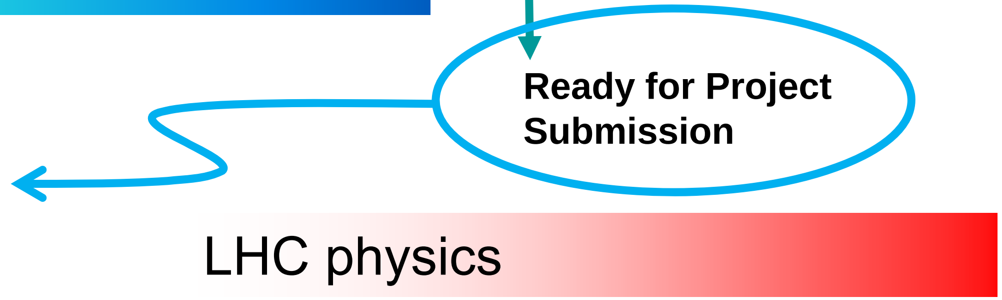
GDE Time Line until 2012



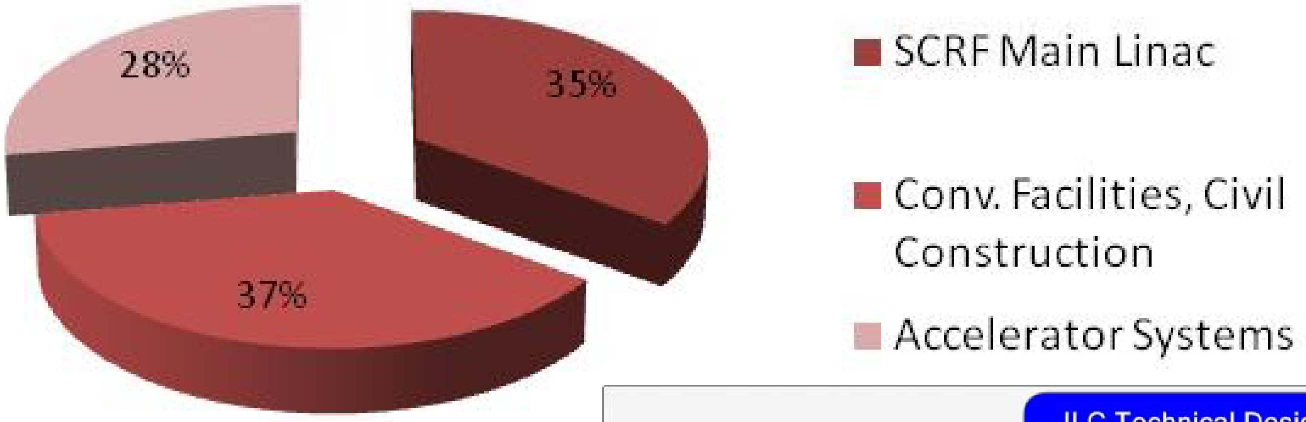
GDE Time Line until 2012



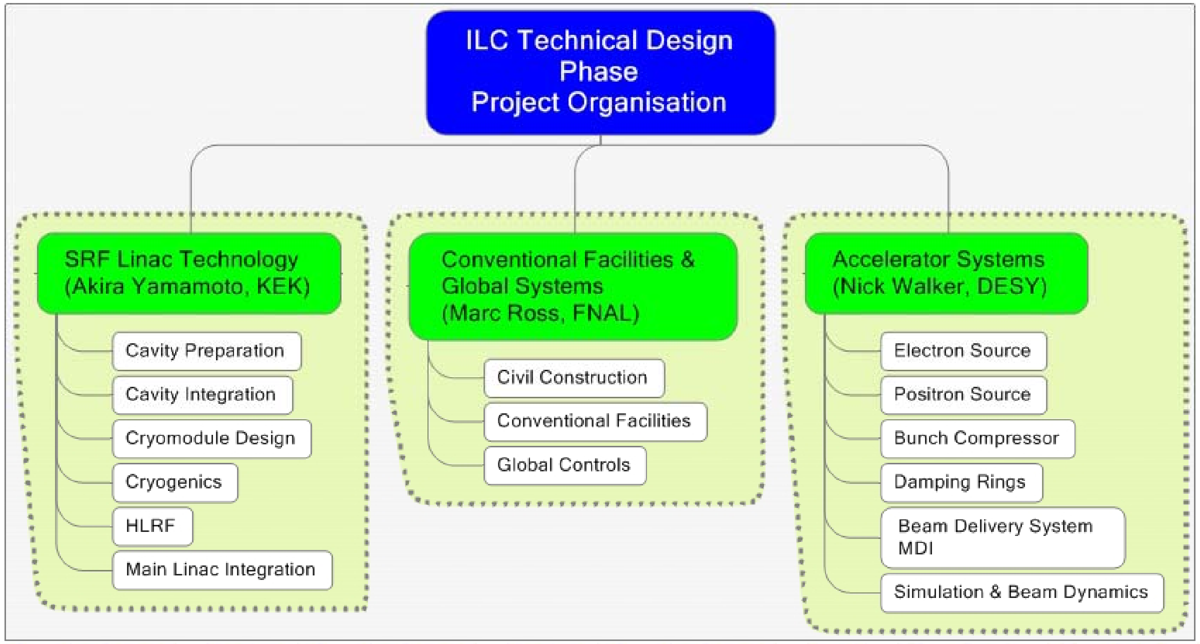
Submission to international funding authorities/agencies
- Updated technical design
- Updated VALUE estimate
- Project Implementation Plan
- (Updated physics case [LHC])



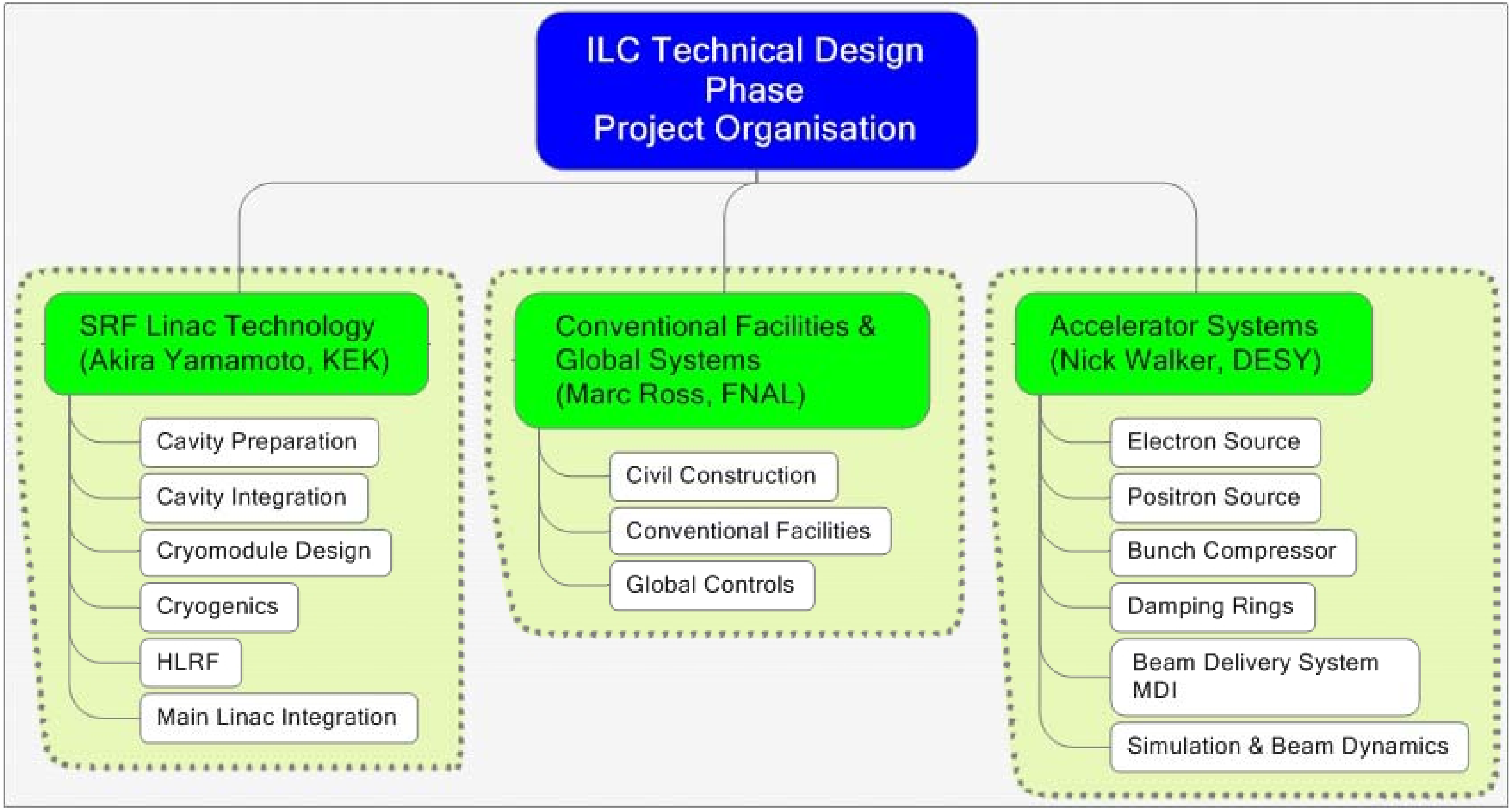
TD Phase Project Structure



Project structure focused on RDR **Cost-Drivers** (Technical Areas)



TD Phase Project Structure



A Global R&D Plan

ILC Research and Development Plan for the Technical Design Phase

Release 2

June 2008

ILC Global Design Effort

Director: Barry Barish

Prepared by the Technical Design Phase Project Management

Project Managers: Marc Ross, Nick Walker, Akira Yamamoto

- Available from: http://ilc-edmsdirect.desy.de/ilc-edmsdirect/file.jsp?edmsid=D00000000*813385

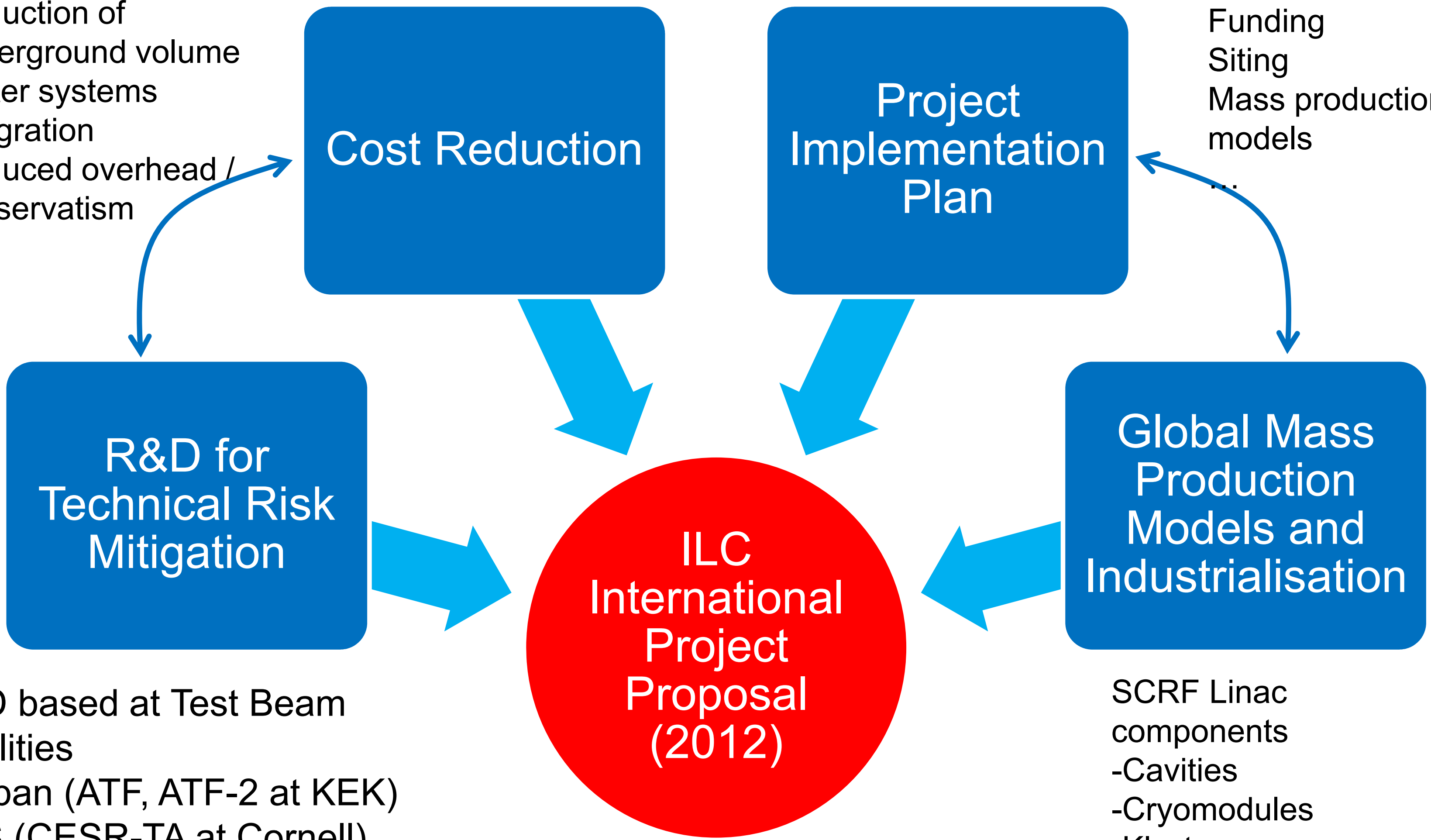
- First Official Release
- Next review and release: December 08

- Contains summary of **Global Resources** available for ILC or ILC-related activites.

TD Phase Priorities

SCRF gradient R&D
Reduction of underground volume
Better systems integration
Reduced overhead / conservatism
…

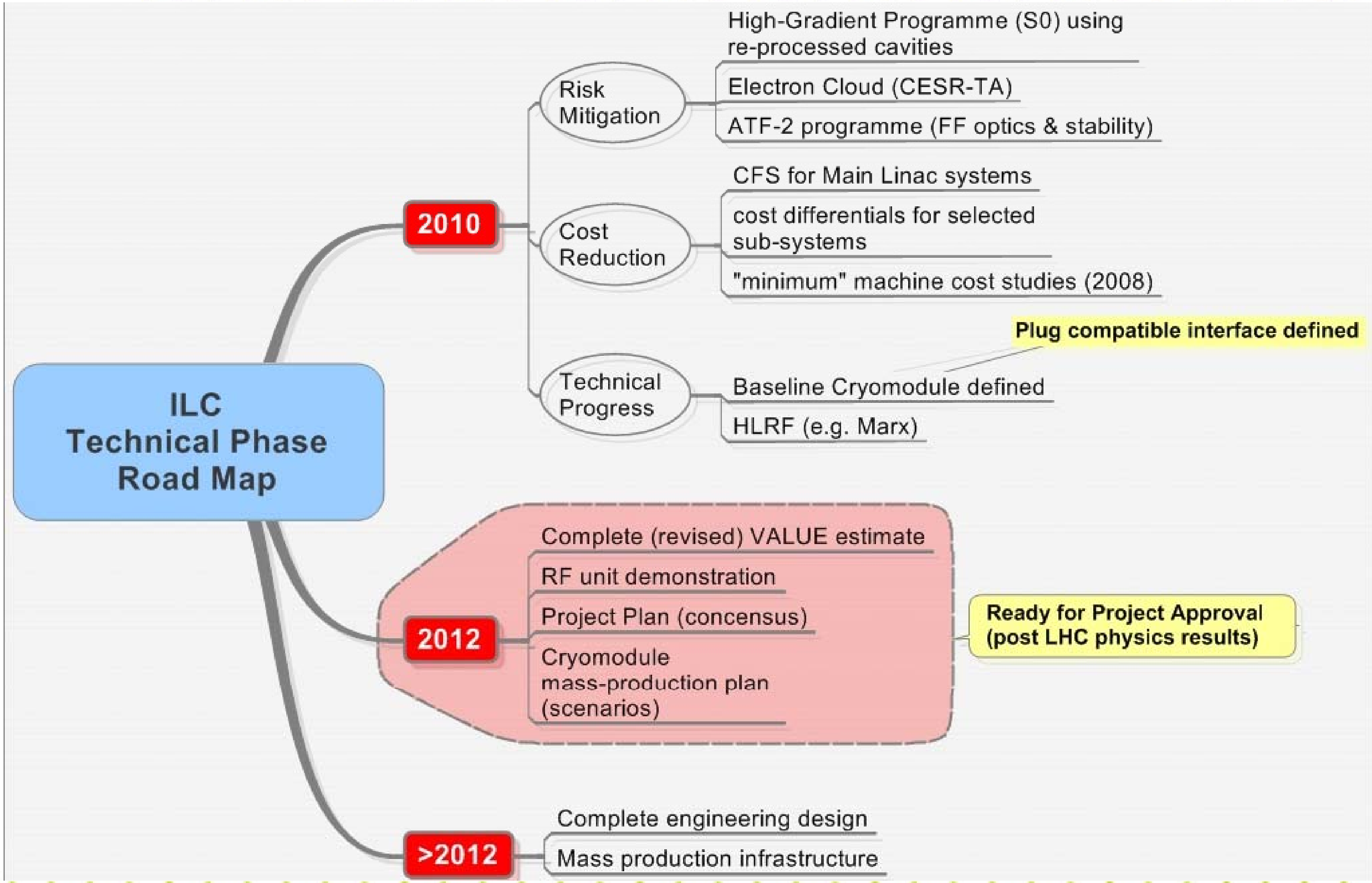
International governance
Funding
Siting
Mass production models
…



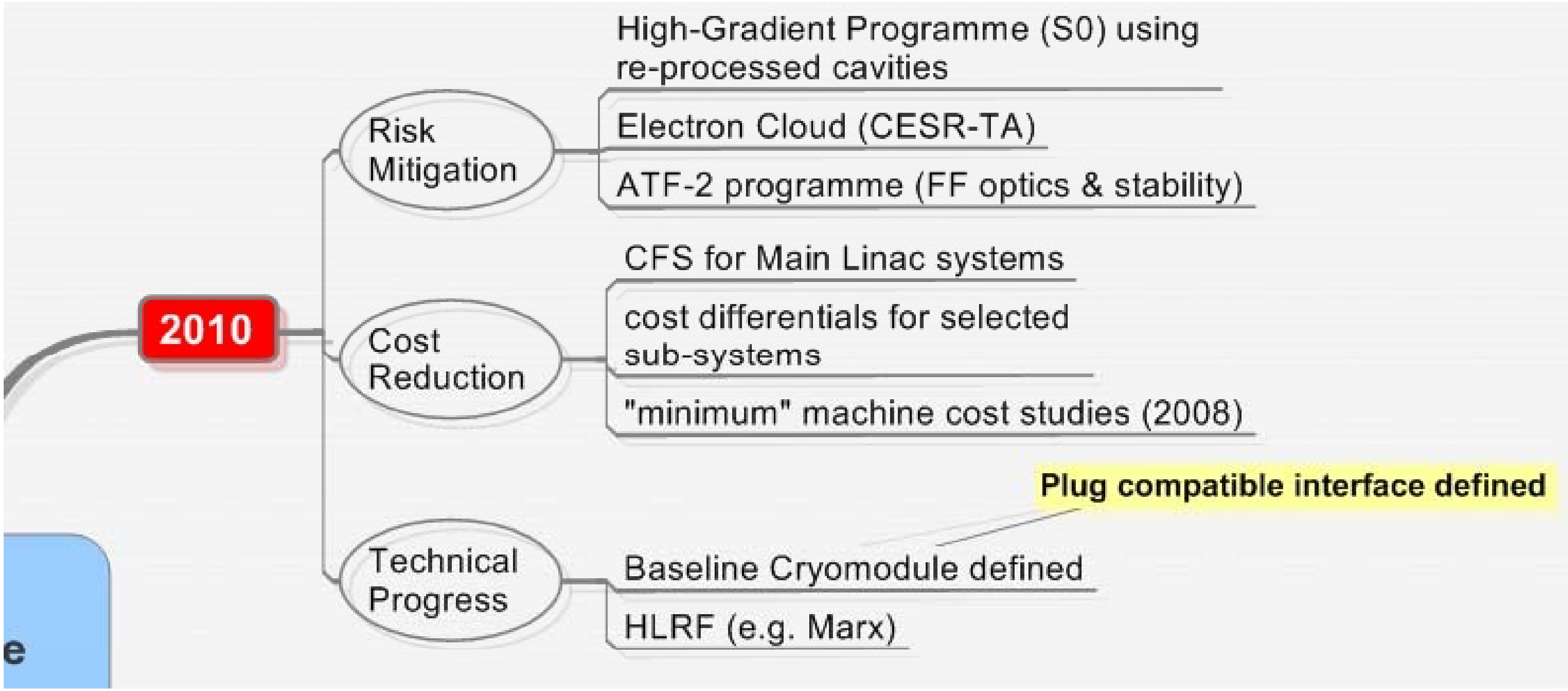
R&D based at Test Beam Facilities
- Japan (ATF, ATF-2 at KEK)
- US (CESR-TA at Cornell)

SCRF Linac components
-Cavities
-Cryomodules
-Klystrons
-…

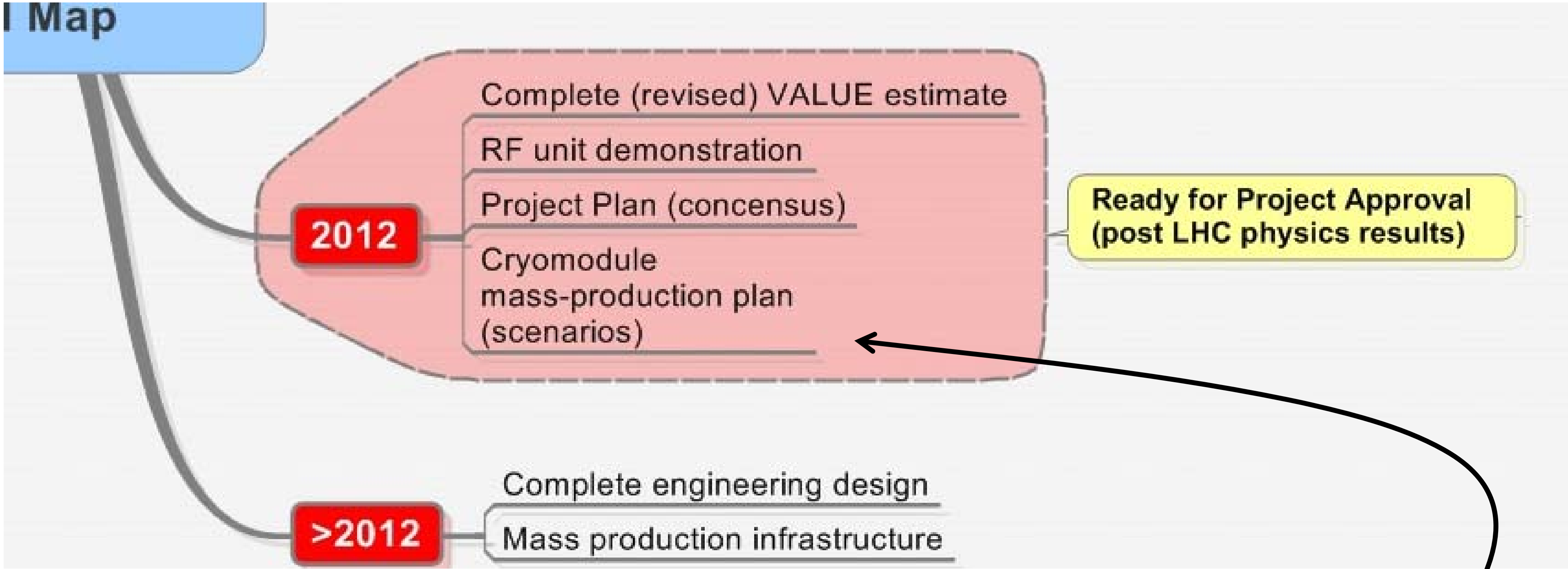
Technical Phase Roadmap



Technical Phase I Roadmap

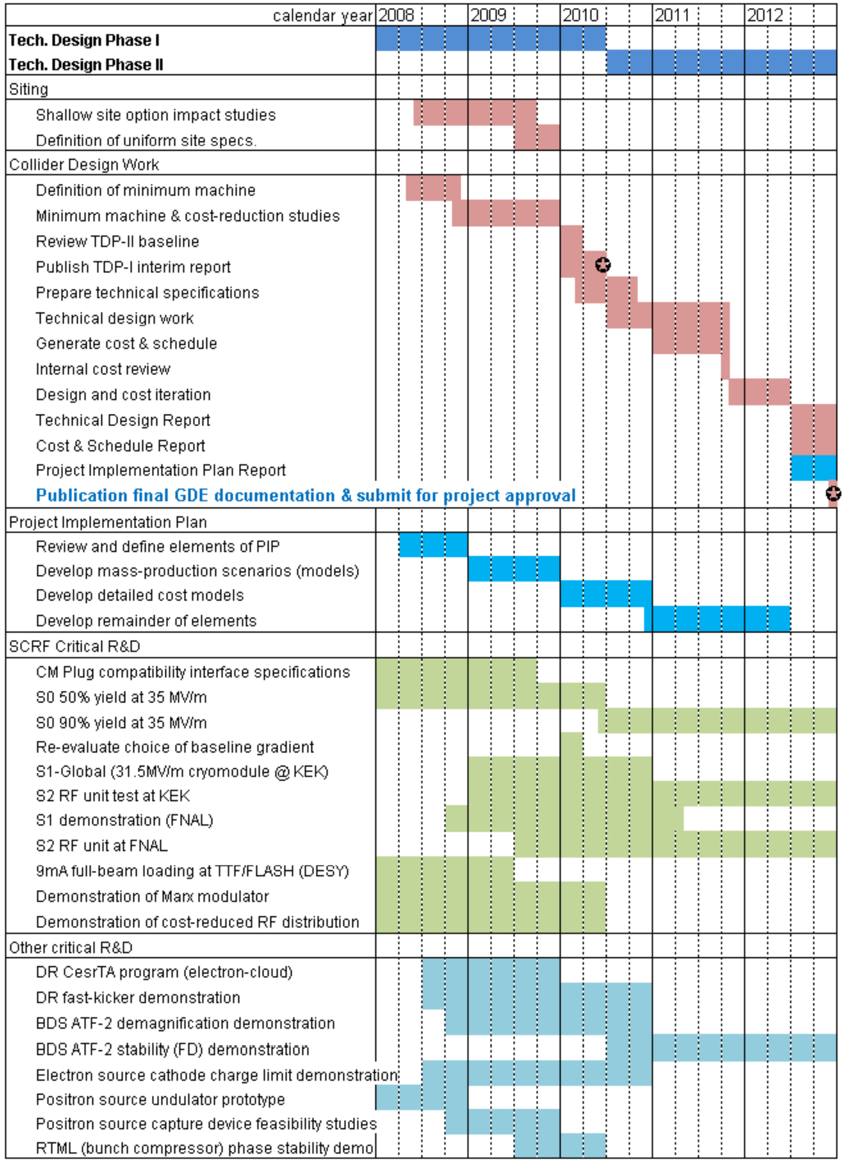


Technical Phase II Roadmap



- Development of "plug compatible" linac components considered critical for global mass-production models
- XFEL (European) planned CM mass-production (in-kind contribution scheme).

PM TD Phase 1 & 2 Schedule



A tentative top-level management plan for TD Phase 1 & 2 now exists

- Published in R&D Plan
- More detailed schedule being updated
  - MS Project

Part of release 2

Encapsulates the PMs strategy and vision for the next four years

- Critical R&D
- Cost reduction / machine design
- Project Implementation Plan

SCRF Cavity Gradient

- R&D priority – **very high**
  - RDR estimate: 10% improvement in gradient reduce ILC cost by 7%
- Goal: Determine production yield at nominal (35 MV/m) gradient
  - TDP1 Goal: 35 MV/m 50% yield
  - TDP2 Goal: 35 MV/m 80% yield
- Progress since technology choice (08/2004):
  - (Primarily at DESY; also J-Lab and KEK)
  - 2006: 50% yield 27.5 MV/m
  - 2008: 50% yield 31.5 MV/m
  - each based on sample population of 15 nine cell cavities
- Recent XFEL Industrial cavity pre-production series look very promising

World-Wide Superconducting Cavities

Table 5.1: Projected number of superconducting RF cavities available in each region and the number of planned tests for the TD Phase (TDP1 is 2004 to mid-2010), and up to 2012.

Americas	**FY06 (actual)**	**FY07 (actual)**	**FY08**	**FY09**	**FY10**	**TOTAL TDP1**	**FY11**	**FY12**
Cavity orders	22	12	0	10	10	**52**	10	10
Total 'process and test' cycles		40	5	30	30	**98**	30	30
Asia	**FY06 (actual)**	**FY07 (actual)**	**FY08**	**FY09**	**FY10**		**FY11**	**FY12**
Cavity orders	8	7	15	25	15	**59**	39	39
Total 'process and test' cycles		21	45	75	45	**152**	117	117
Europe	**2004-06 (actual)**	**2007 (actual)**	**2008**	**2009**	**2010**		**2011**	**2012**
Cavity orders	60*			838		**898**		
Total 'process and test' cycles		14	15	30	100	**109**	354	354
Global totals								
Global totals - cavity fabrication	90	19	15	873	25	**1008**	49	49
Global totals - cavity tests	**0**	**75**	**65**	**135**	**175**	**359**	**501**	**501**

* Thirty European cavities were ordered in 2004.

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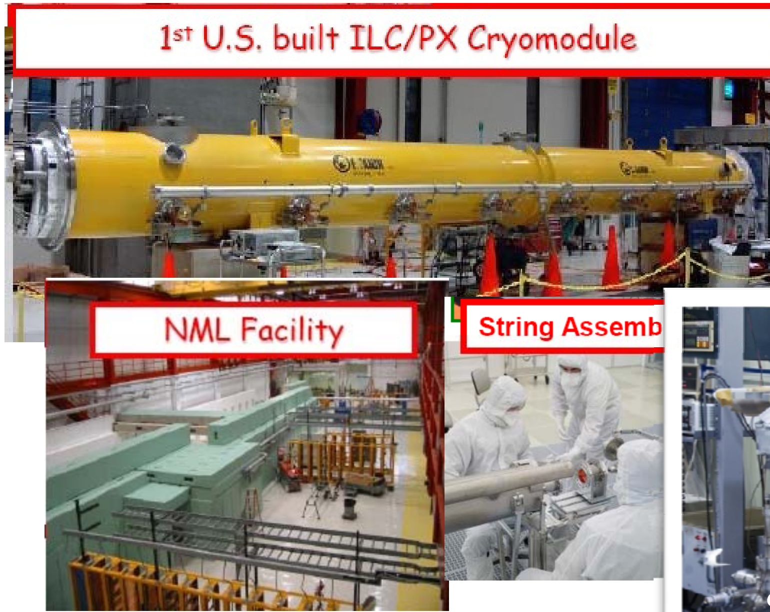
808 XFEL production + ~30 ILC-HighGrade

Global SCRF R&D (Examples)

TTF at DESY

European XFEL at DESY

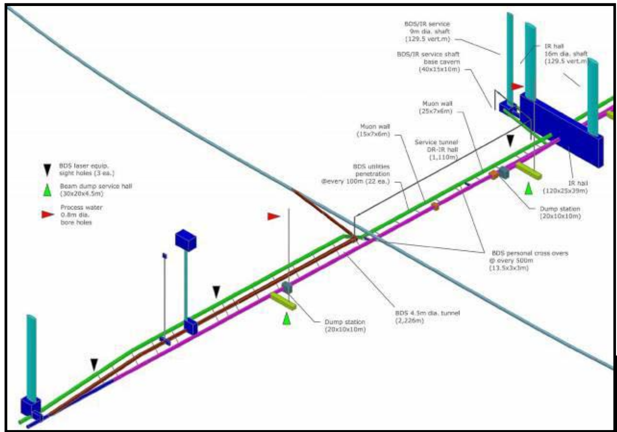


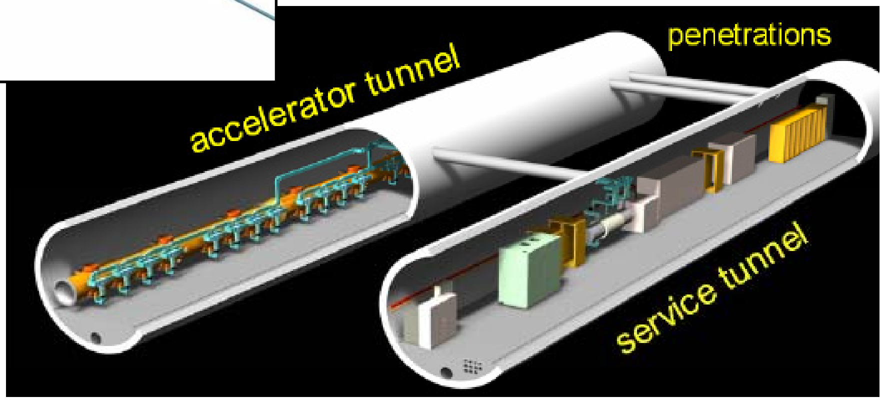
Major SCRF Infrastructure at FNAL (US)

Single cell R&D at KEK

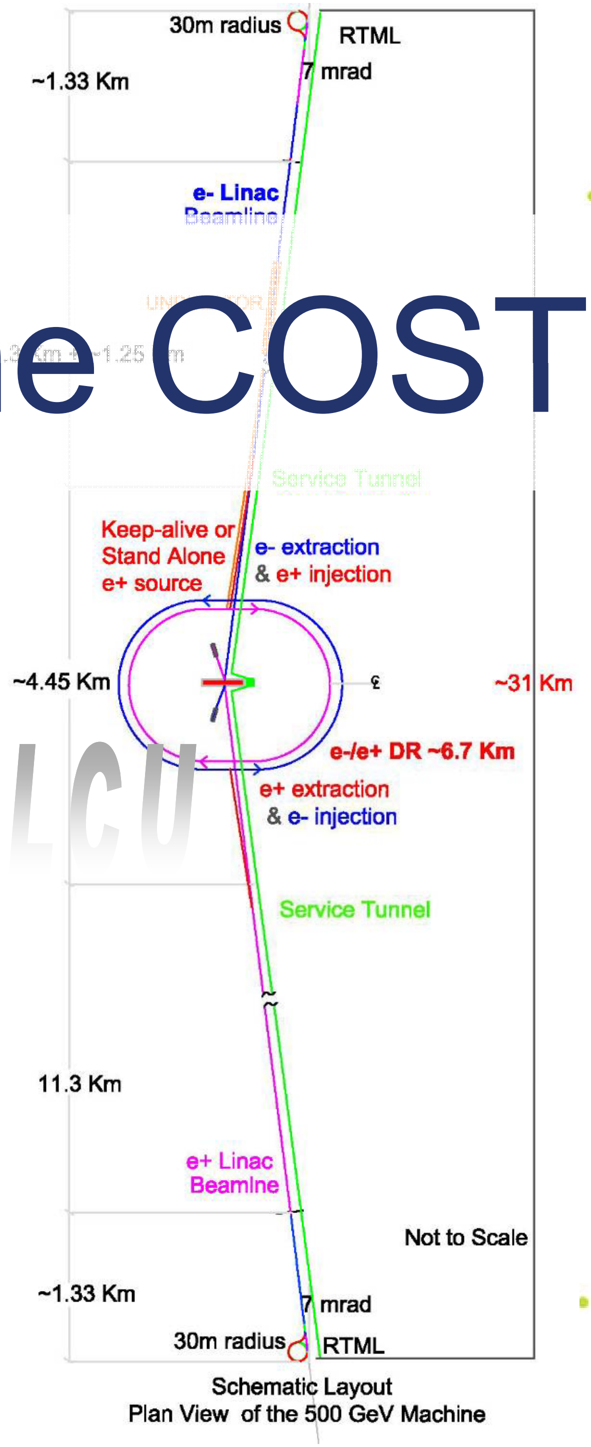
Cryomodule Development at KEK

Reducing the COST





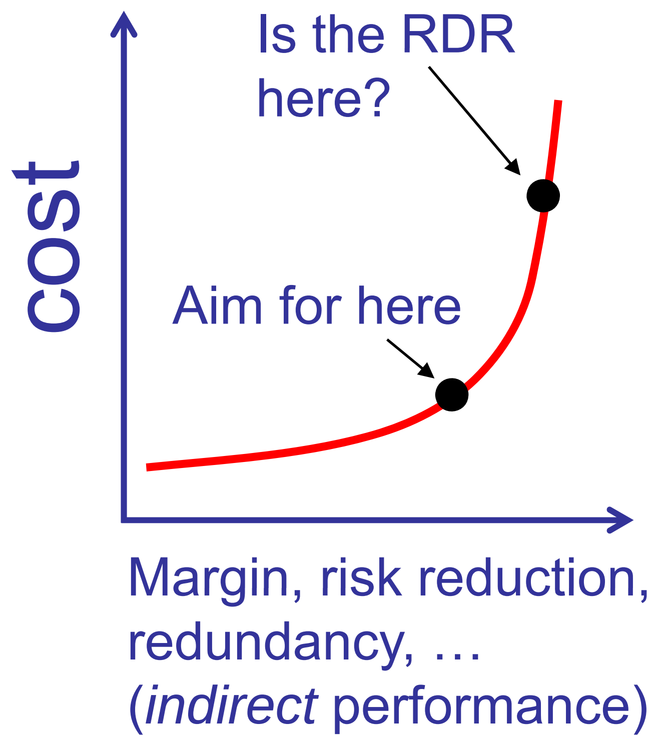
6.7 Billion ILCU

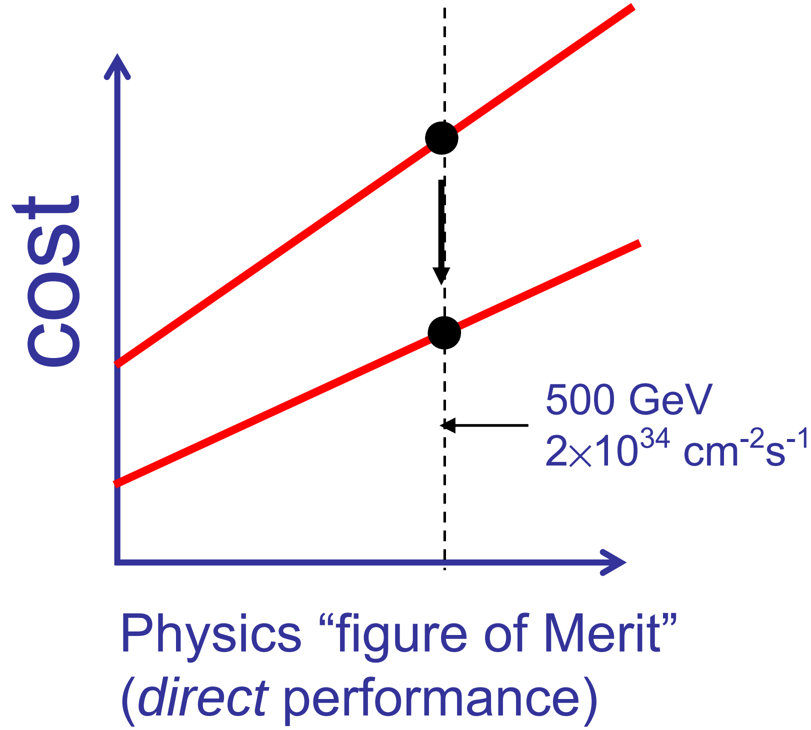


Cost Reduction: A Strategy

- Required engineering resources will be very limited in TD Phase 1
- Use time to take a fresh look at RDR design
  - Perform design/performance iterations that were not completed in RDR phase
- Approach
  - Re-evaluate RDR design with a strong emphasis on COST drivers
  - Specifically, focus on machine layout which could reduce the use of underground volume $\rightarrow$ cost driver
  - Push back on conservatism in Conventional Facilities (i.e. processed water cooling, electrical power etc.) $\rightarrow$ cost driver
  - Evaluate possible shallow site solutions
- As a study tool, develop concept of the *Minimum Machine*

The Minimum Machine Study





Minimum Machine
Understand the performance derivatives

Minimum Machine Concepts

1. Removal of service tunnel
   - XFEL-like solution
   - Surface klystron solutions
2. Integration of e+/e- sources with upstream beam delivery system (same tunnel)
   - Move e+ undulator source to end of linac (250 GeV point)
   - e- source and 5 GeV injector linacs share BDS tunnel
3. Main Linac - Novel high-power RF distribution
   - "klystron-clusters" on surface (30 klystrons/cluster)
   - 300 MW "pipe" distribution over 1 km using over-moded wave-guide
   - (single tunnel solution)
4. Main Linac – adoption of Marx modulator
5. Reduced beam-power parameter set
   - Half klystron/modulators
   - 6km $\rightarrow$ 3km damping ring
6. Two-stage $\rightarrow$ single-stage bunch compressor
7. Remove all support for TeV upgrade
   - Mostly impacts BDS

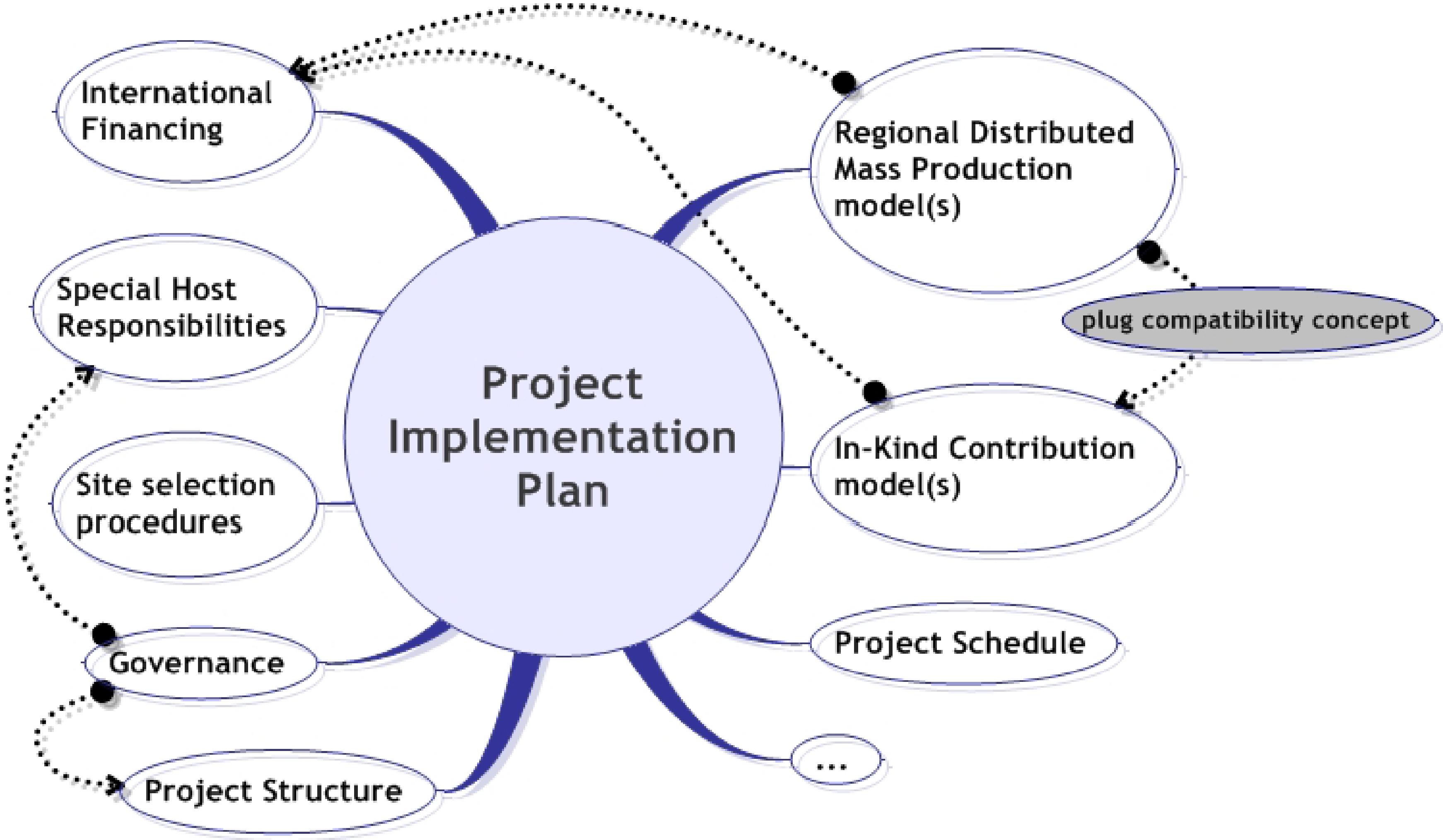
Tentative
under discussion

Potential cost savings primarily via reduced CFS requirements

Minimum Machine Plan

- TD Phase 1
  - Develop 'minimum machine' description as *alternative* to RDR baseline
  - Develop list of issues / studies to evaluate MM comparison with RDR baseline for CY 2009
    - **Including cost saving**
  - Early 2010 (end of TDP1) evaluate MM studies and status of critical R&D (parallel), and
  - Agree on new formal **reference design baseline** for TD Phase 2
- TD Phase 2
  - Engineering and updated value estimate based on adopted reference design

Project Implementation Plan



ilc and the European... XFEL X-Ray Free-Electron Laser

- From the ITRP Executive Summary (rationale for cold decision) 2004:
  - "The construction of the superconducting XFEL free electron laser will provide prototypes and test many aspects of the linac.
  - The industrialization of most major components of the linac is underway."

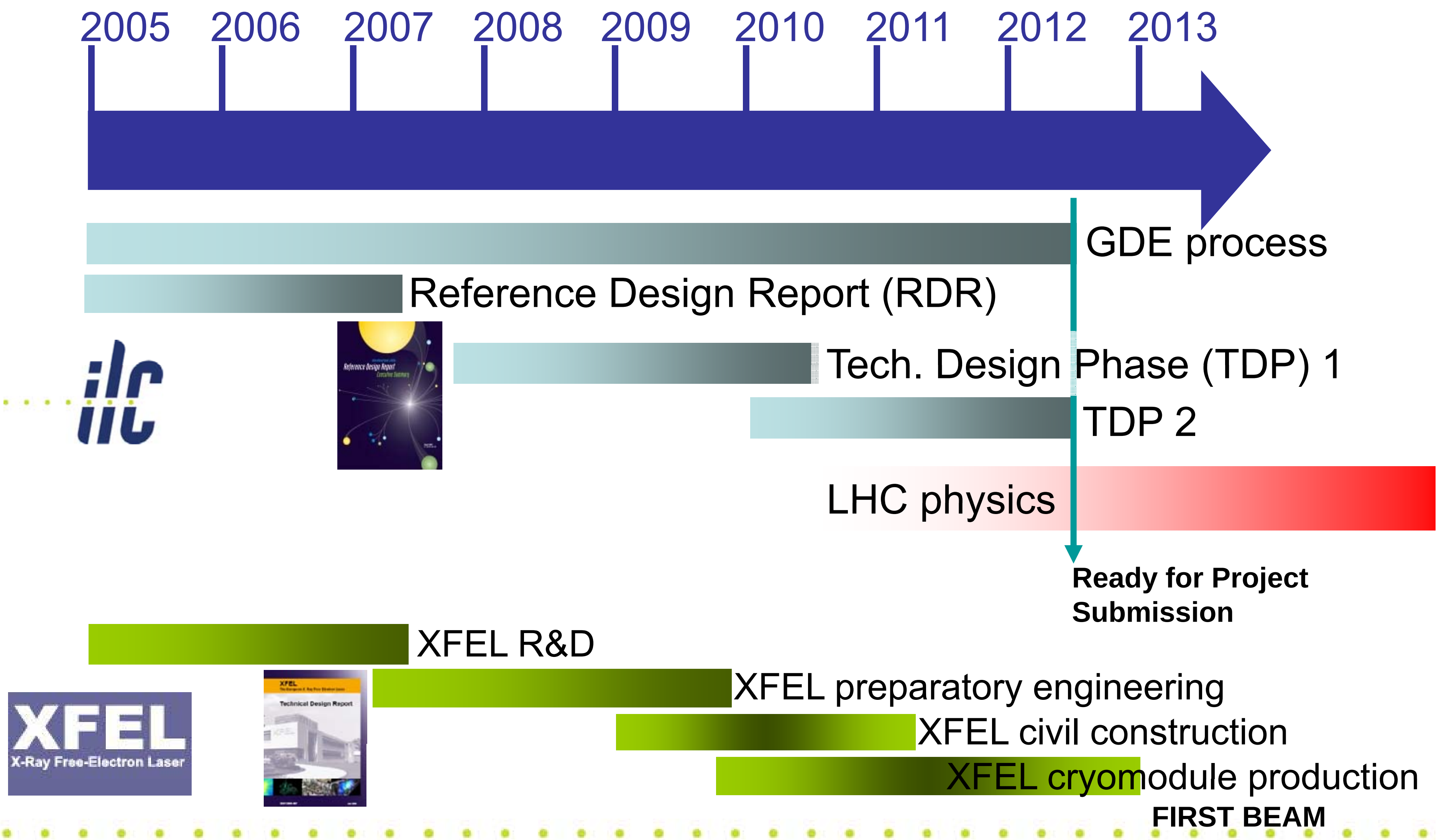
- The European XFEL is Europe's dominant contribution to the ILC

ILC and the European XFEL

- XFEL will mass-produce, install and commission 101 SCRF cryomodules from end 2009 until end 2012.
  - Very similar to ILC cryomodules
    - 808 cavities, HP couplers, tuners *etc*.
  - Operational cavity gradient requirement lower for XFEL
    - XFEL 23.5 MV/m
    - ILC 31.5 MV/m
  - An important systems test for ILC

- XFEL as international “in-kind contribution” project
  - Linac technology supplied by collaboration of Germany (DESY), France (SACLAY, LAL), Italy (INFN), Spain (CIEMAT), Poland.
  - Important experience for International Project Implementation Plan for ILC

GDE ILC and XFEL Timeline



In Summary

- In a truly (perhaps unique) global collaboration, the GDE has successfully produce a design for the ILC and an associated cost estimate
  - Based on a mature linac technology
  - A “low risk” design
- The GDE is now planning a ‘Technical Design Phase’ which will
  - Consolidate the design and reduce the cost
  - Complete risk-mitigating R&D
  - Ramp-up SCRF facilities and expertise and Americas and Asian regions
  - Produce a realistic Project Implementation Plan
    - Together with FALC
- The European XFEL will provide a significant ILC resource!
  - Industrialisation / mass production infrastructure
  - Systems tests (10% ILC linac prototype)
  - Iin-kind contribution model
- Ready for project approval in 2012