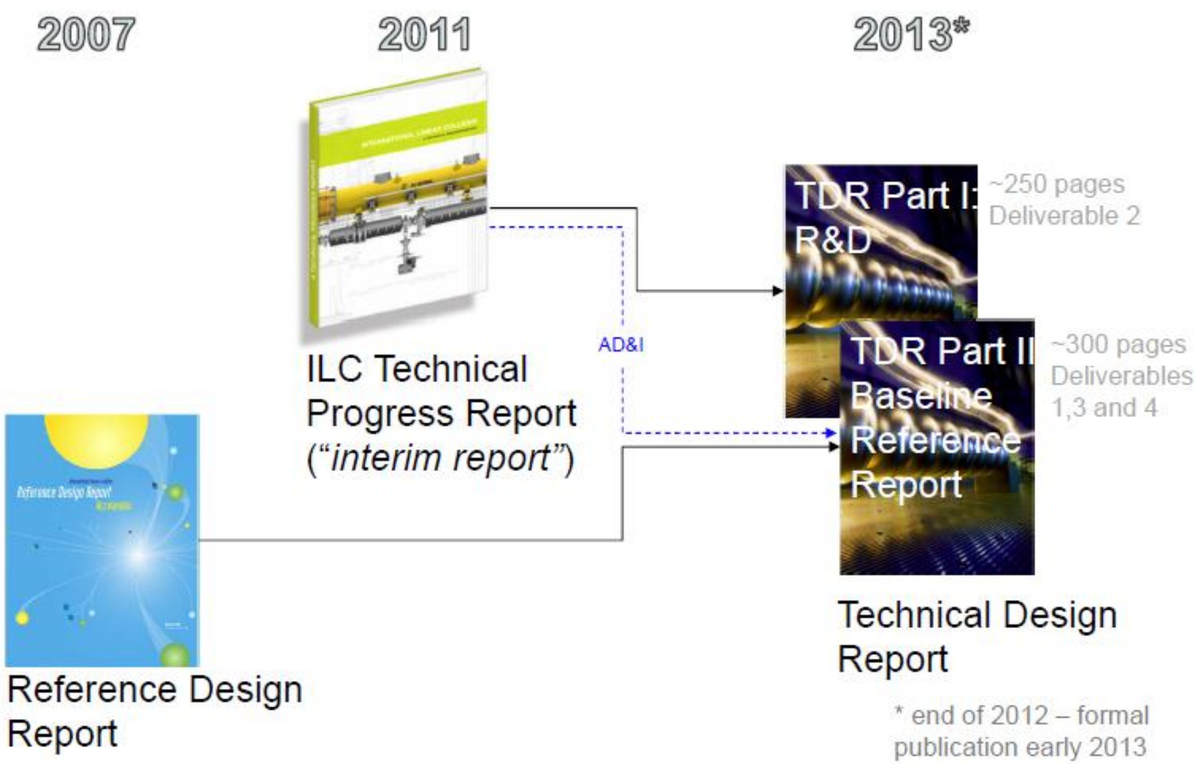
Global Design Effort

Director's Report



Barry Barish

KILC12
Daegu, Korea
23-April-12

GDE Status & Plans

- **Update on ILC accelerator R&D**
- **The Technical Design Report**
  - **Top level changes**
  - **Baseline Technical Reviews ; PM level changes**
  - **TDR Scope and Plans**
  - **Cost Estimate**
  - **Project Implementation Planning**
- **ILC Systems Tests**
- **Japanese candidate sites**
- **Post-TDR planning**

Major R&D Goals for Technical Design

SCRF

- High Gradient R&D - globally coordinated program to demonstrate gradient by 2010 with 50%yield; improve yield to 90% by TDR (end 2012)
- Manufacturing: plug compatible design; industrialization, etc.
- Systems tests: FLASH; plus NML (FNAL), STF2 (KEK) post-TDR

Test Facilities

- ATF2 - Fast Kicker tests and Final Focus design/performance
  Delayed due to EARTHQUAKE RECOVERY
- CesrTA - Electron Cloud tests to establish damping ring parameters/design and electron cloud mitigation strategy
- FLASH – Study performance using ILC-like beam and cryomodule (systems test)
  Future STF (KEK), NML (Fermilab)

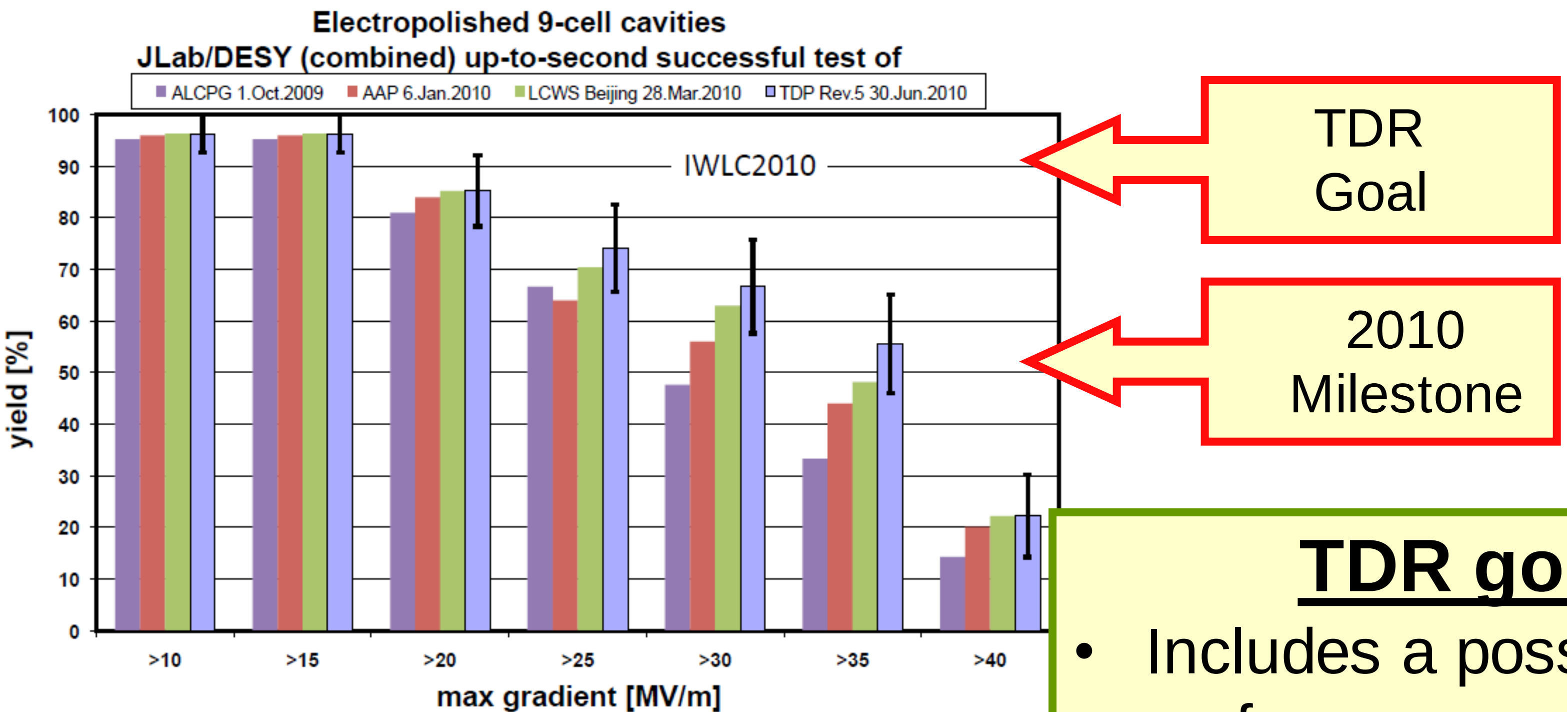
The ILC SCRF Cavity

Figure 1.2-1: A TESLA nine-cell 1.3 GHz superconducting niobium cavity.

- Achieve high gradient (35MV/m); develop multiple vendors; make cost effective, etc

- Focus is on high gradient; production yields; cryogenic losses; radiation; system performance

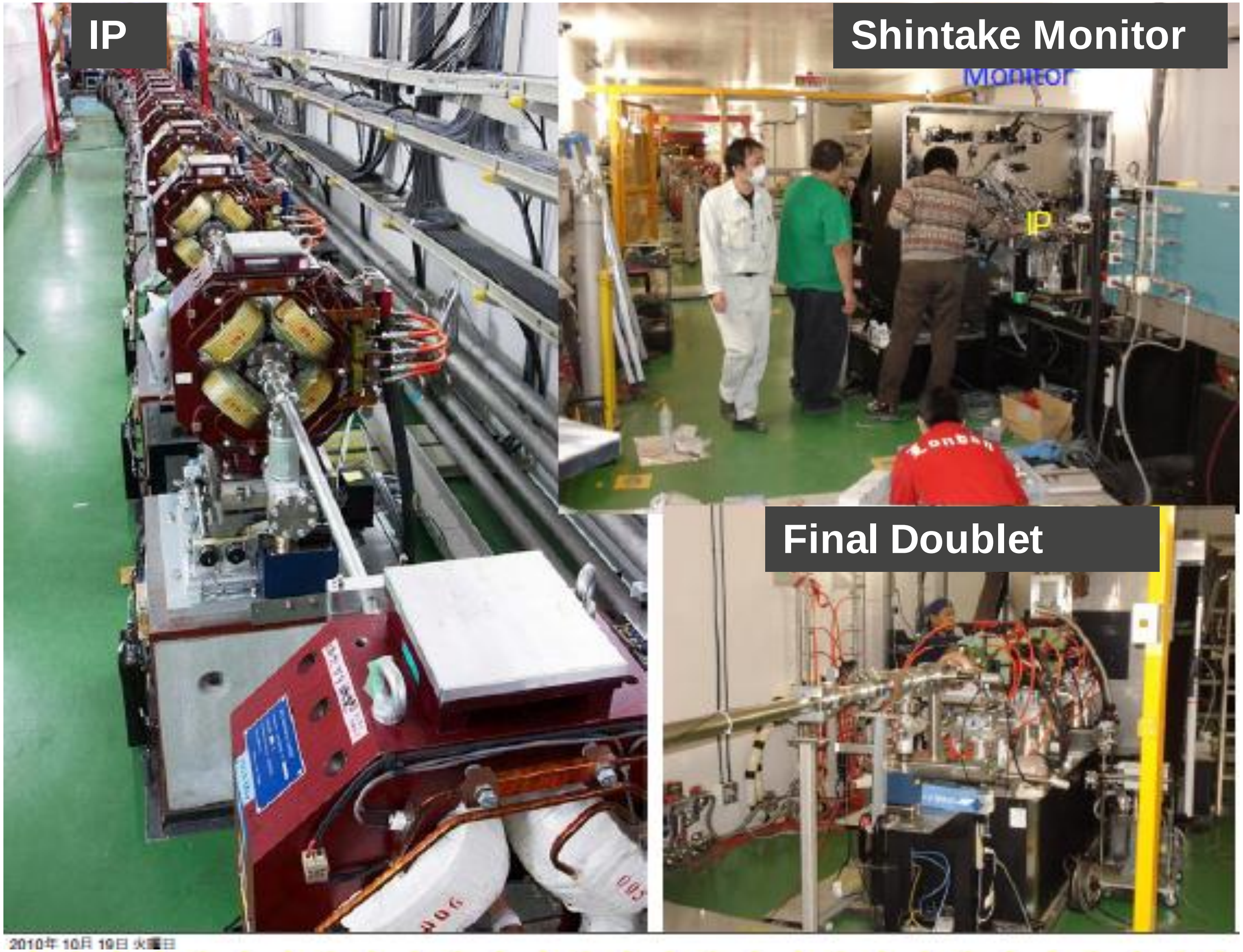
Cavity Gradient Milestone



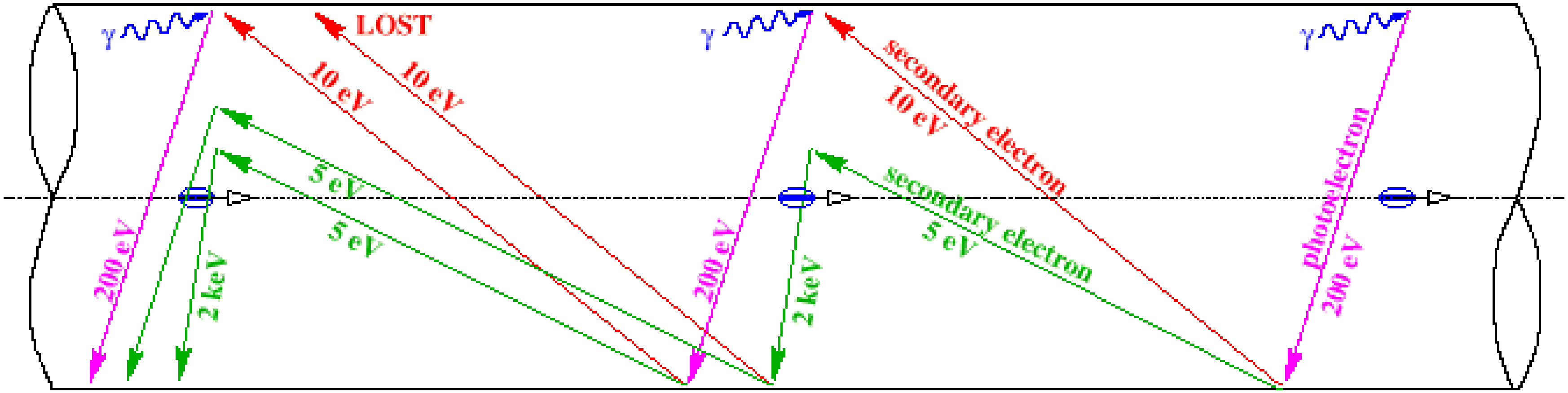
TDR goal

- Includes a possible 2nd surface process
- Surface-process recipes include an optical inspection system, possible tumbling and mechanical repair cycle

ATF2 – Beam size/stability and kicker tests

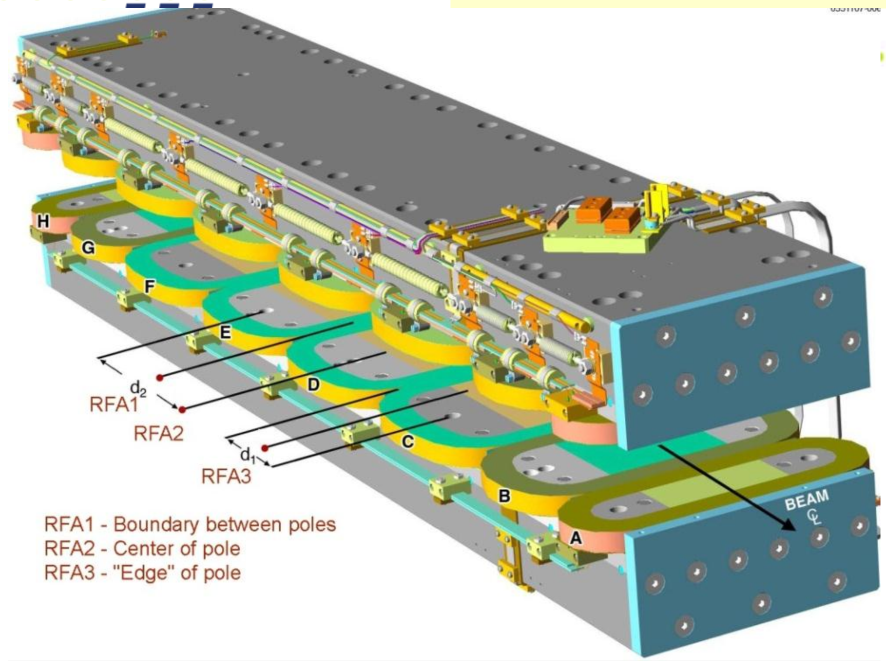


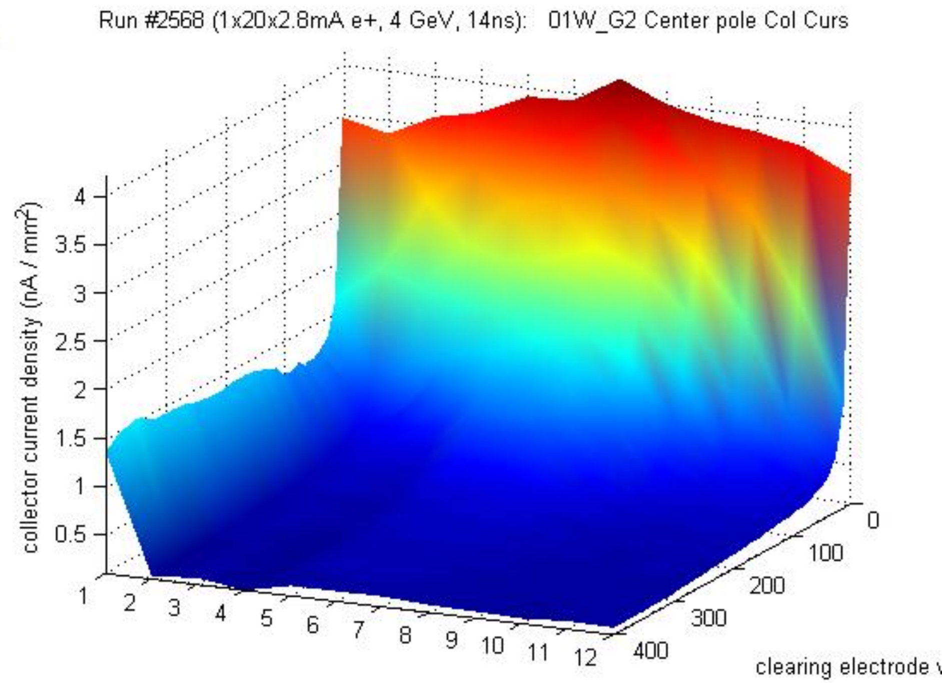
- Mitigating Electron Cloud

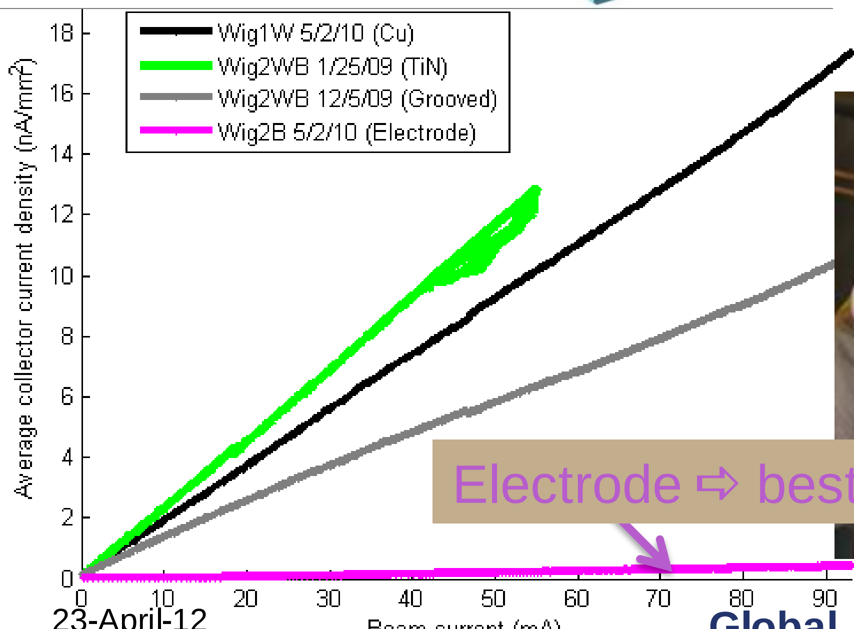


- Simulations – electrodes; coating and/or grooving vacuum pipe
- Demonstration at CESR critical tests

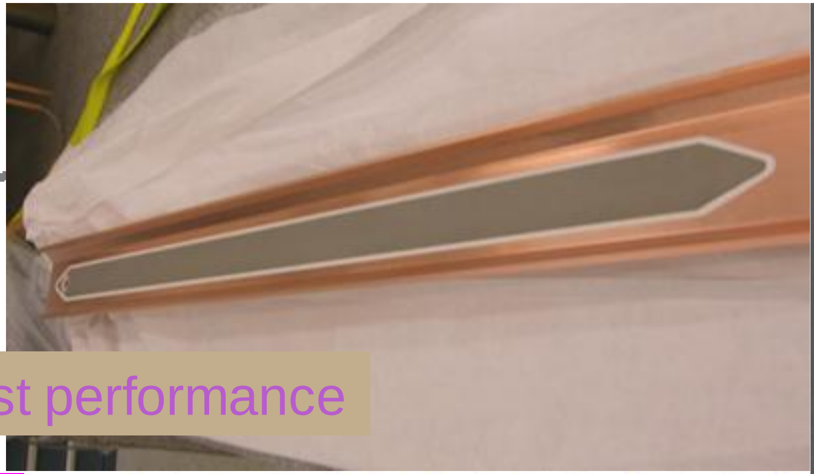
CesrTA - Wiggler Observations







Electrode ⇨ best performance

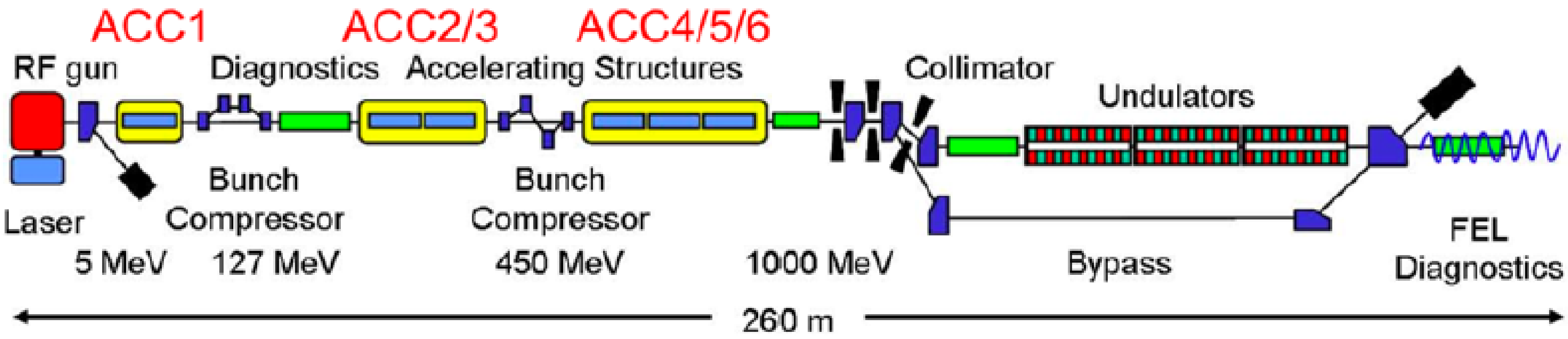


Proposed ILC Mitigation Scheme

Field Region	Baseline Mitigation Recommendation		Alternatives for Further Investigation
Drift*	TiN Coating	Solenoid Windings	NEG Coating
Dipole	Grooves with TiN Coating	Antechambers for power loads and photoelectron control	R&D into the use of clearing electrodes.
Quadrupole*	TiN Coating		R&D into the use of clearing electrodes or grooves with TiN coating
Wiggler	Clearing Electrodes	Antechambers for power loads and photoelectron control	Grooves with TiN Coating

TTF/FLASH 9mA Experiment

Full beam-loading long pulse operation → "S2"

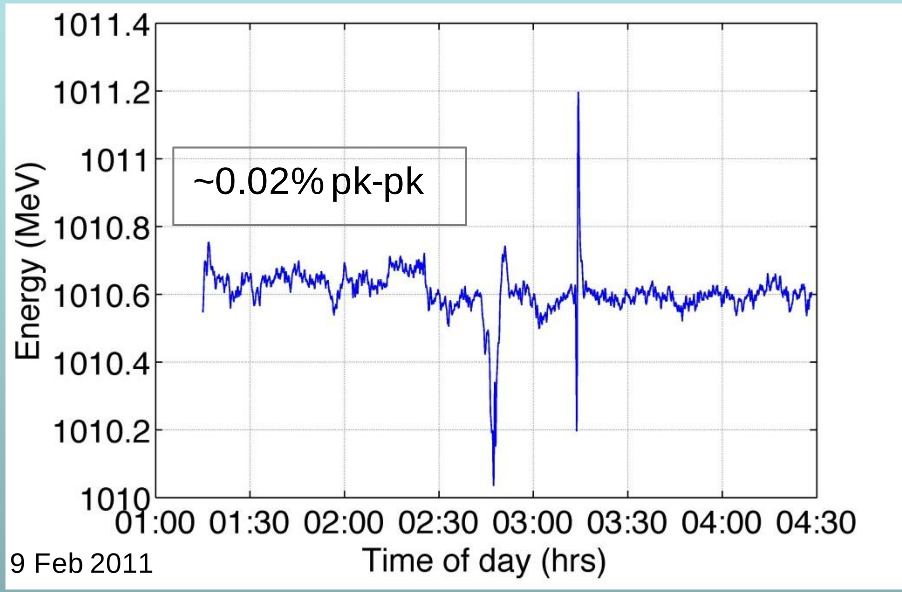


		XFEL	ILC	FLASH design	9mA studies
Bunch charge	nC	1	3.2	1	3
# bunches		3250	2625	7200'	2400
Pulse length	μs	650	970	800	800
Current	mA	5	9	9	9

- Stable 800 bunches, 3 nC at 1MHz (800 μs pulse) for over 15 hours (uninterrupted)
- Several hours ~1600 bunches, ~2.5 nC at 3MHz (530 μs pulse)
- >2200 bunches @ 3nC (3MHz) for short periods

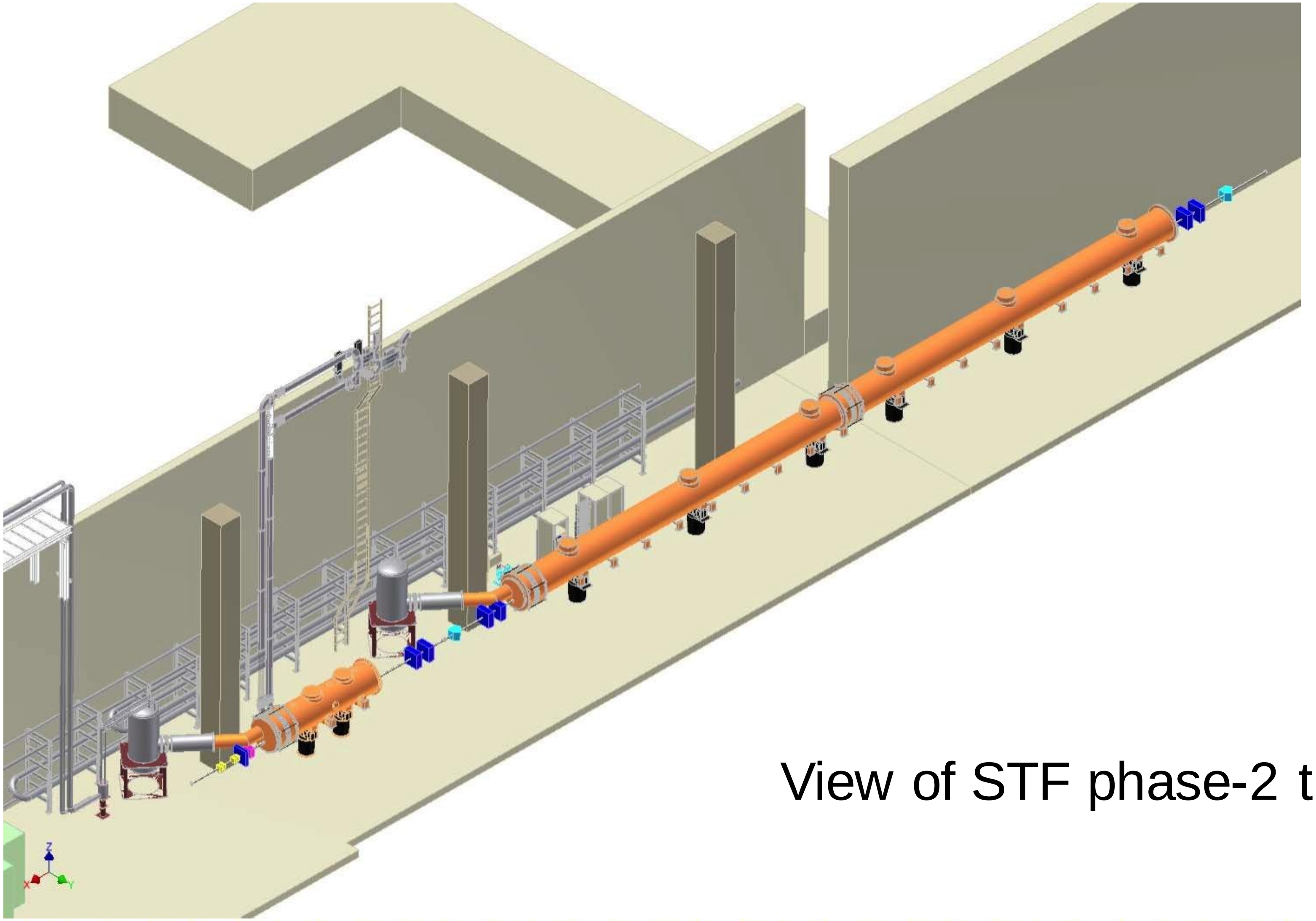
FLASH: Stability

Energy stability over 3hrs with 4.5mA



- 15 consecutive studies shifts (120hrs), and with no downtime
- Time to restore 400us bunch-trains after beam-off studies: ~10mins
- Energy stability with beam loading over periods of hours: ~0.02%
- Individual cavity "tilts" equally stable

STF Systems Tests at KEK



View of STF phase-2 tunnel

Fermilab – NML SRF

Systems Tests

Fermilab NML: RF Unit Test Facility

Establishing Baseline for the TDR

SB2009 Proposal Document

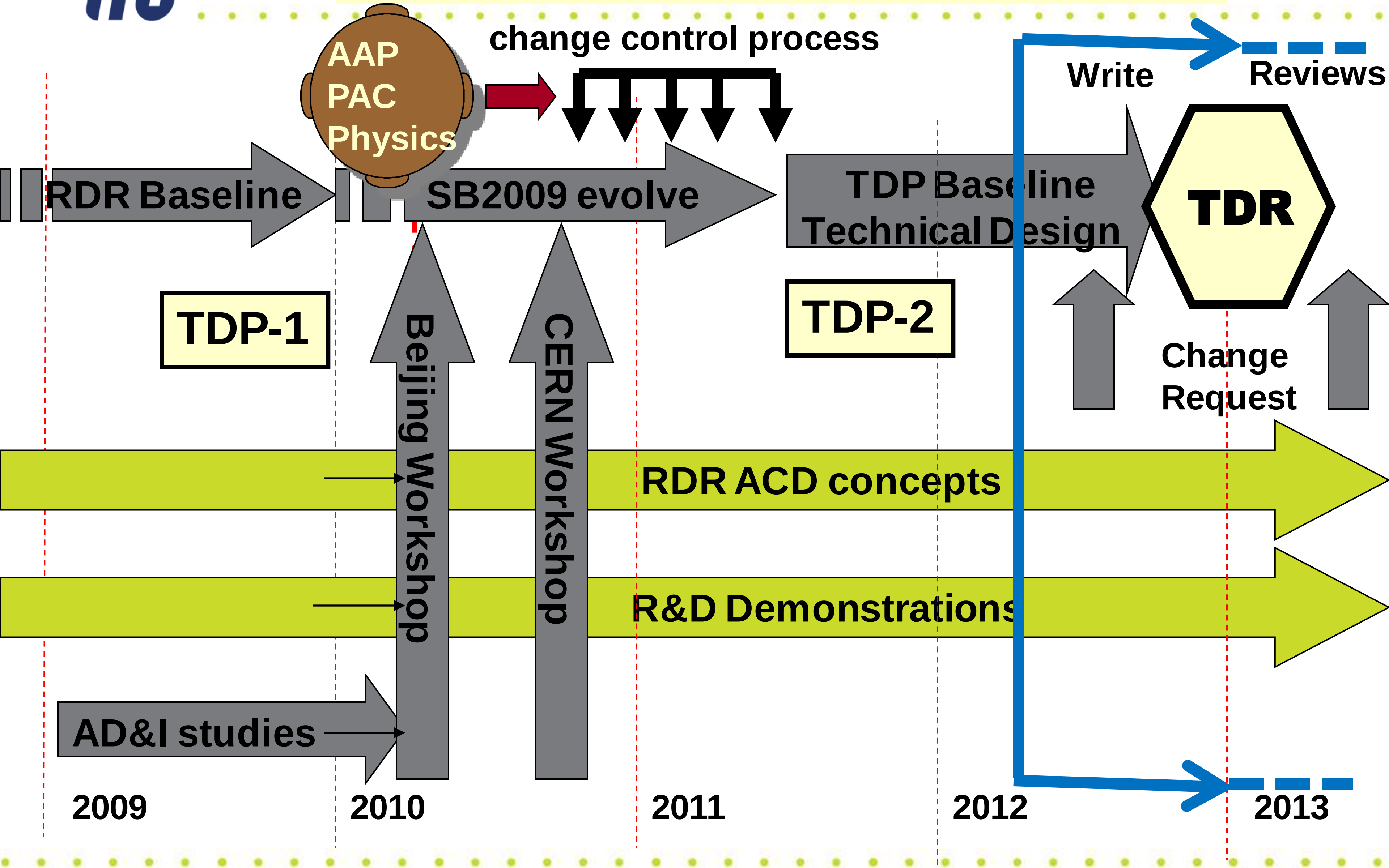
Release 1.1

December 2009

ILC Global Design Effort

Prepared by the Technical Design Phase Project Managers and
the Accelerator Design and Integration Team Leaders

Technical Design Phase



Top Level Change Control Process

Issue Identification

- Planning
- Identify further studies
- Canvas input from stakeholders
- …

Baseline Assessment Workshops

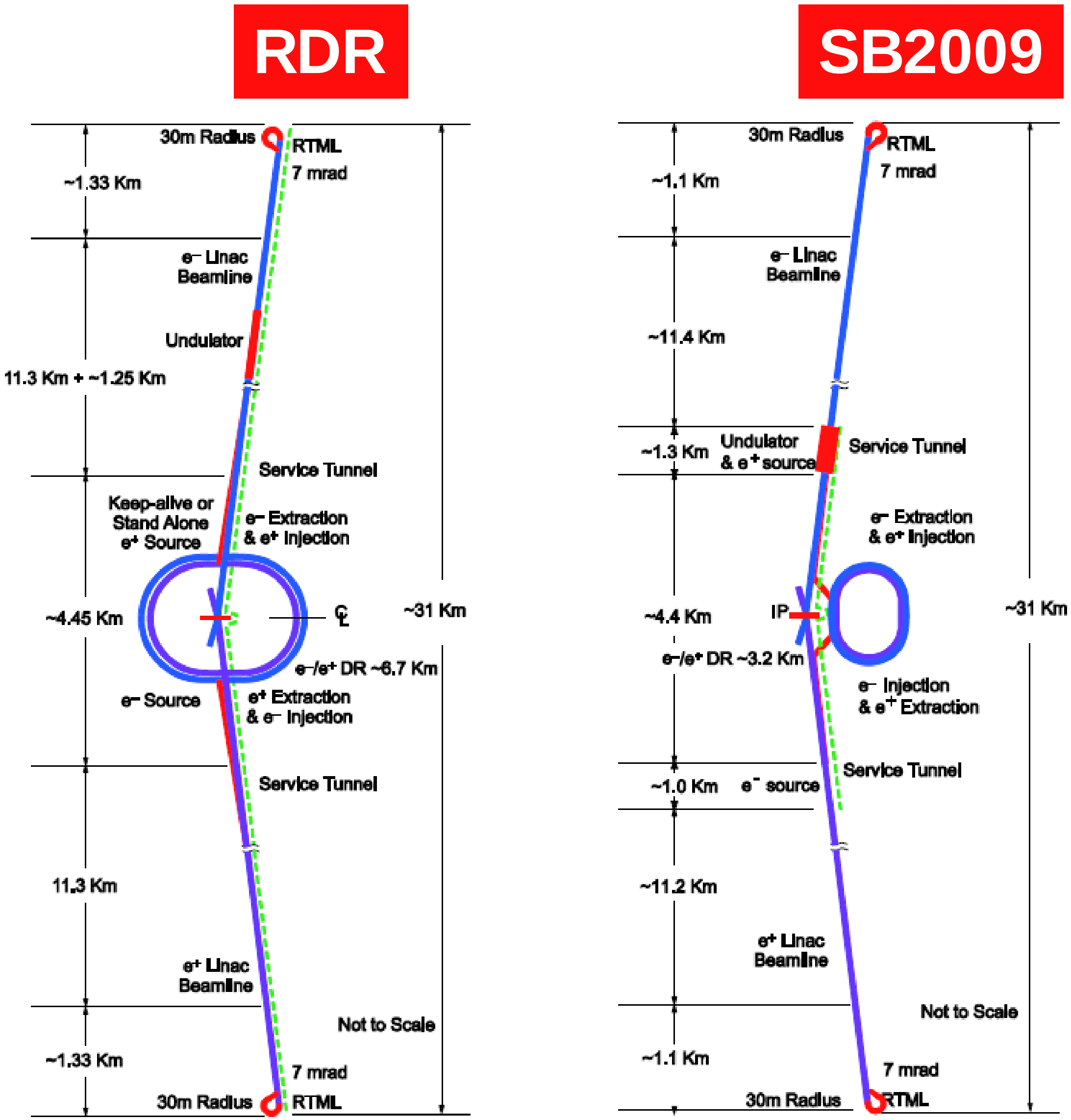
- Face to face meetings
- Open to all stakeholders
- Plenary

Formal Director Approval

- Change evaluation panel
- Chaired by Director

keywords: open, transparent

Proposed Design changes for TDR



- Single Tunnel for main linac
- Move positron source to end of linac ***
- Reduce number of bunches factor of two (lower power) **
- Reduce size of damping rings (3.2km)
- Integrate central region

Impact of Top Level Changes

- RDR estimate = starting point   6,618   Δ
- Caverns, DR & cool Value Eng.   -86   -1.3%
- 1 stage B.C. (not yet considered)   -33   -0.5%
- Alternative RF (1 tunnel for ML, ½ bunches)
  Klystron Cluster/DRFS   -400/-419   -6.2%
- DR (6.4 => 3.2 km, ½ bunches)   -191   -2.9%
- Central Injector Complex   -104   -1.6%
- Sub-total of SB2009 changes estimated   -10.7%
- Did not consider range of cavity gradients nor details of alternating e+ production at 150 GeV

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Evolution from SB2009 to TDR
Baseline Technical Reviews

	Technical Area	Place and Dates
SB2009		Proposed Dec. 2009
BAW-1	1. Acc. Gradient, 2. Single tunnel,	KEK, Sept. 7-10, 2010
BAW-2	3. Reduced RF Power, 4. e+ source location	SLAC, Jan. 17-21, 2011
BTR-1	DR	INFN, July, 7-8, 2011
BTR-2	RTML, Sources, BDS/MDI	DESY, Oct. 24-28, 2011
BTR-3	ML & SCRF	KEK, Jan. 19-20, 2012
BTR-4	CFS	CERN, March 22-23, 2012

Detailed Technical-change Decisions Summary

- ML: lattice design w/ the cavity-string of {9+4Q4+9} = 26 (in KCS) or 1.5x 26 = 39 in RDR-like RF,
- HLRF: KCS w/ flat-land geology, and RDR-like w/ mountain geology
- Cryomodule: RDR-like (9+4Q4+9) w/ SCQ at center, and w/ simplification of 5 K shield
- Cryogenics: 2 x 5 plants, w/ limited tilting, and w/ variation (< 20%) of spacing b/w plants,
- Cavity Integration: Cavity; Tesla + Blade tuner, magnetic shield inside,
- Cavity gradient: 35+/-20% MV/m w/ production yield of 90 %, w. updated recipes and yield definition, resulting operational gradient 31.5 MV/m +/-20 % (with KCS or RDR-like RF and > 12 % RF power overhead)
- Cryomodule col tests: in reasonable rate (1/3 ~ ¼) in cost-balance, and w/ the following overhead,
- ML-CFS: tunnel-extension to keep energy overhead up to ~ 1.4 % (~150 m)
  - Corresponding to 2 x SB2009-RDR-RF units, 2 x 39 cavities per side, (+ 150 m tunnel / linac),
  - If tunnel tilting required, additional length of ~ 100 m / 0.5 % required, and the energy overhead not available,
  - the ML length to be fixed under constraint of balance of timing issues b/w electron and positron,
  - This to be well discussed with detector/physic community and

Global Plan for ILC Gradient R&D

Year	07	2008	2009	2010	2011	2012
Phase	TDP-1			TDP-2		
Cavity Gradient in v. test to reach 35 MV/m	→ Yield 50%			→ Yield 90%		
Cavity-string to reach 31.5 MV/m, with one-cryomodule		Global effort for string assembly and test (DESY, FNAL, INFN, KEK)				
System Test with beam acceleration		FLASH (DESY) , NML (FNAL) STF2 (KEK, test start in 2013)				
Preparation for Industrialization			Production Technology R&D			

New baseline gradient:

Vertical acceptance: 35 MV/m average, allowing ±20% spread (28-42 MV/m)

Operational: 31.5 MV/m average, allowing ±20% spread (25-38 MV/m)

Starting Point is the RDR Costs

- ***6.6 Billion ILC Units*** (2007 US $) ***+ 24 Million hours*** of Institutional Labor (which includes laboratories and universities, but not vendors or contractors)
- TDR will quote estimate in 2012 US $, need consider:
- Difference in Exchange Rates

In 2006-07:	1 $ = 117 ¥	1 € = $ 1.20
1/1/2011:	1 $ = 81.5 ¥	1 € = $ 1.334
now 5/10/2011:	1$ = 80.6 ¥	1 € = $ 1.43

- 4 yr – escalation from 1/1/2007 => 1/1/2011 Index Links
  - US construction, technical goods -2.1%, 8.6%
  - Germany construct., indust. products 10.5%, 5.7%
  - Japan construction, industrial products 3.4%, 1.1%

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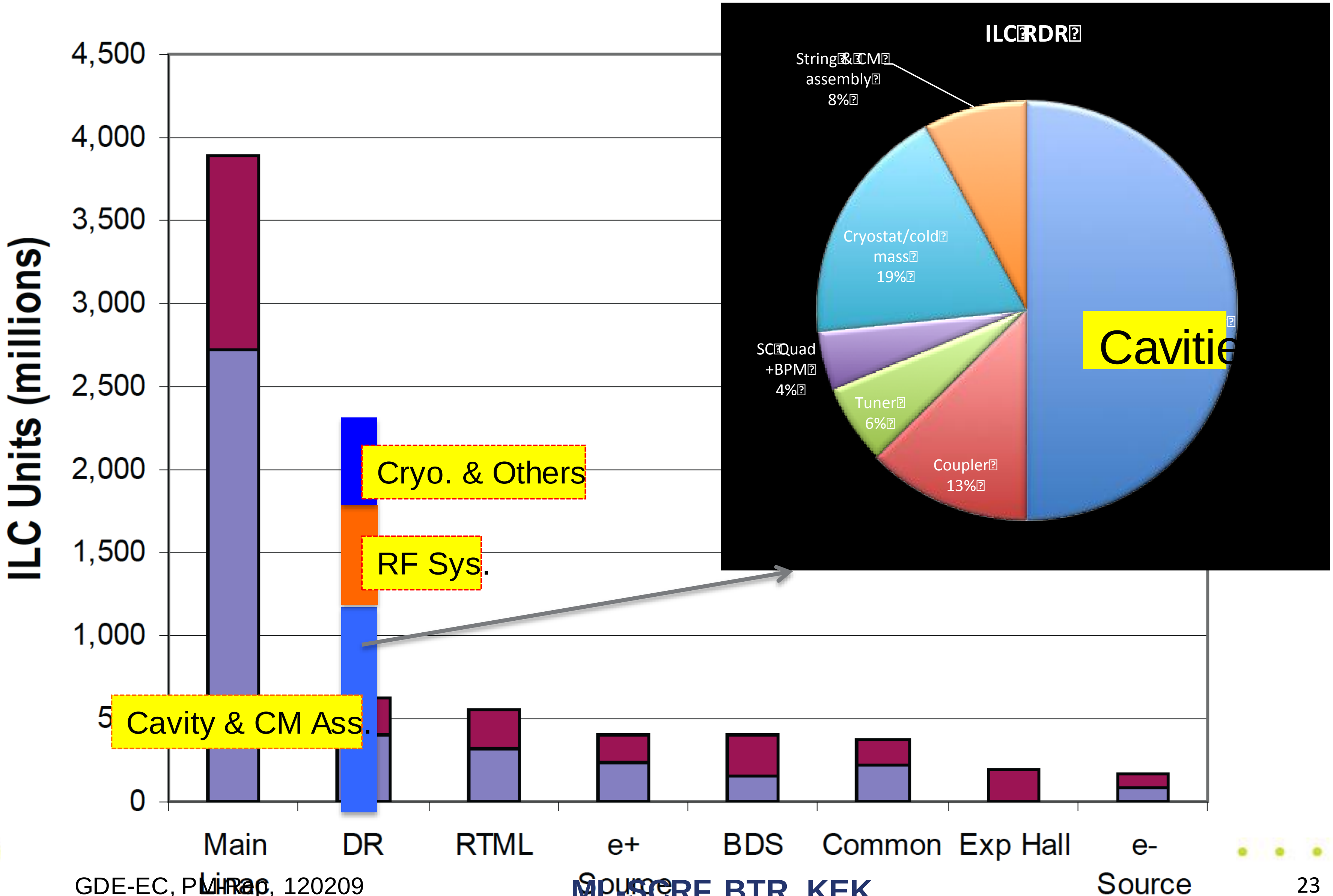
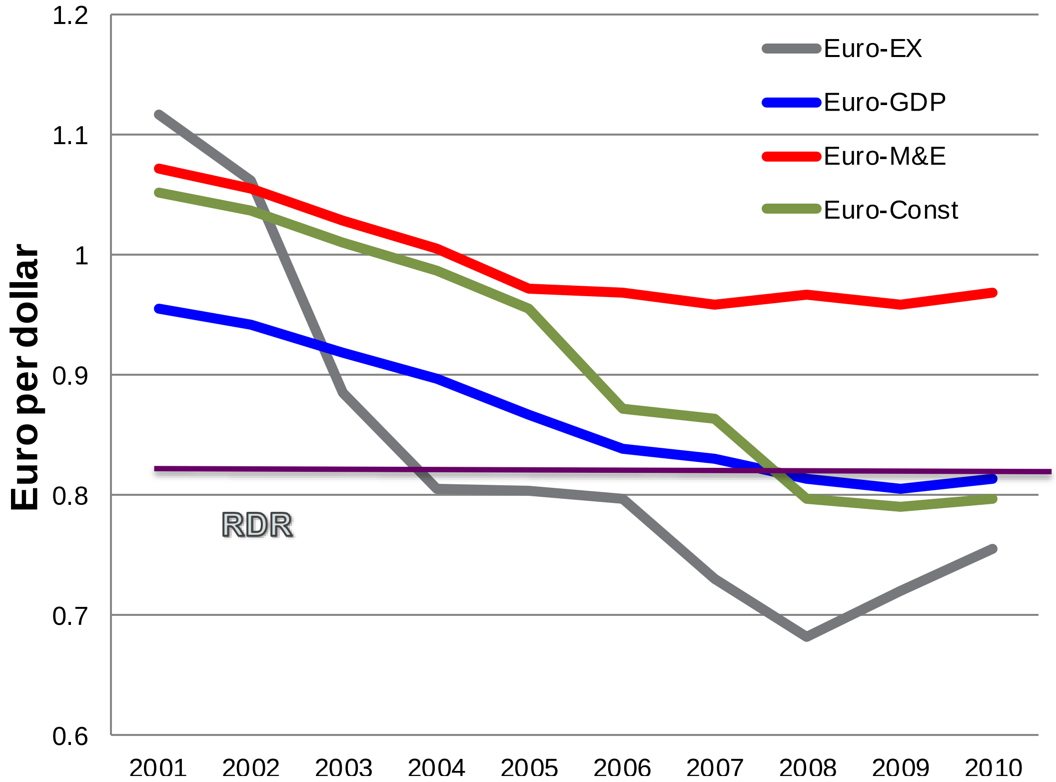
ILC RDR Value Costing



OECD PPP (Yen/USD)-annual average by year

PPP = Purchasing Power Parity



EX-exchange rate
GDP: PPP based on all goods/services in GDP of each region
M&E: PPP based on machinery and equipment
Const: PPP based on civil construction

Full PPP determinations were done for 2005 and 2008; other year points based on GDP inflation rates

TDR Technical Volumes

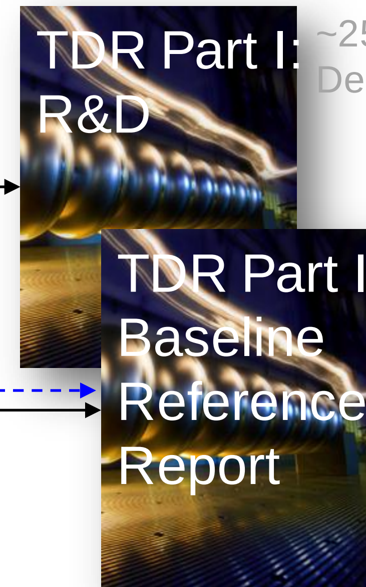
2007

2011

2013*

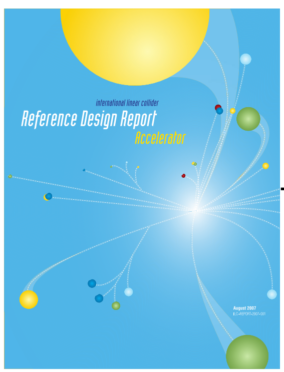
ILC Technical Progress Report (“*interim report*”)

AD&I



~250 pages Deliverable 2

~300 pages Deliverables 1,3 and 4



Reference Design Report

Technical Design Report

* end of 2012 – formal publication early 2013

EDMS & Tech. Design Documentation

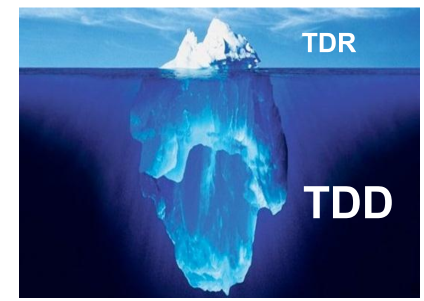
TD Phase Deliverables

- Technical Design Report (TDR)
  
  - Documents primary TDR deliverables
    1. Results and status of Risk Mitigating R&D
    2. Updated Reference Design
    3. Updated VALUE estimate
    4. Project Implementation Plan
    5. Technical risk assessment and future R&D
  - Readable
  - 6-9 months to write
- Technical Design Documentation (TDD)
  - Reference Documentation
  - Structured and linked
  - Basic design documentation
    - Parameter tables
    - Requirements
    - Specifications
    - Design documents
    - Drawings (2D)
    - CAD-3D models
    - ...
  - Cost information → ICET
  - Schedule

Supports

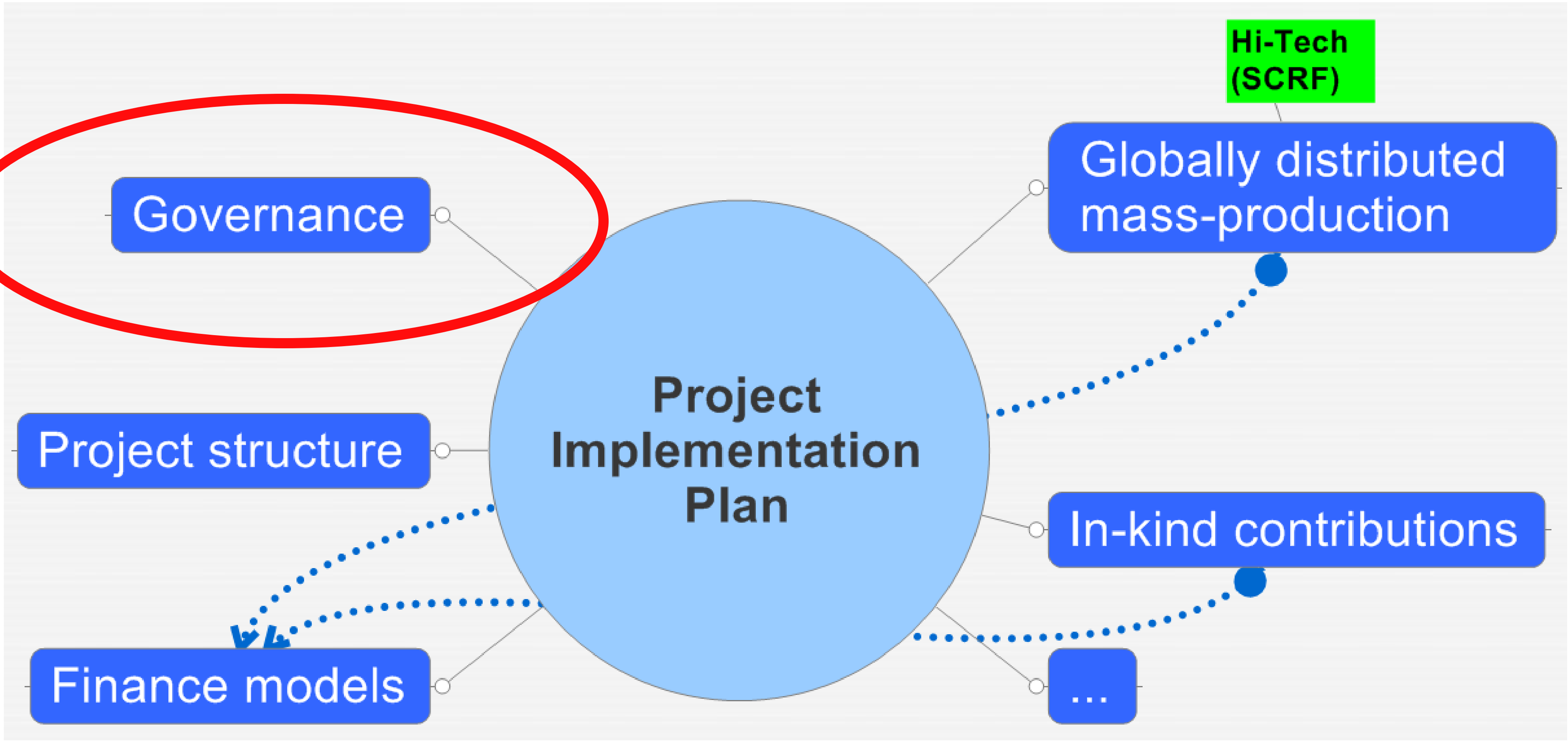
Summarises

ILC-EDMS



Important goal to consolidate all technical documentation in EDMS in a structured fashion

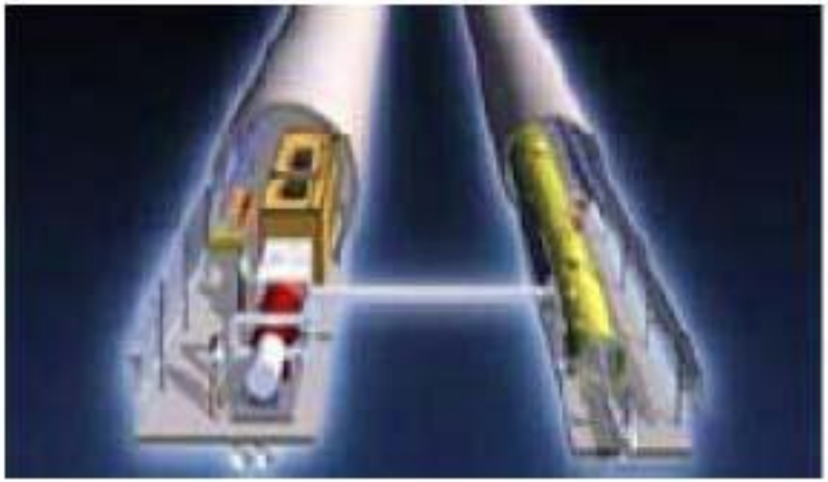
Project Implementation Planning



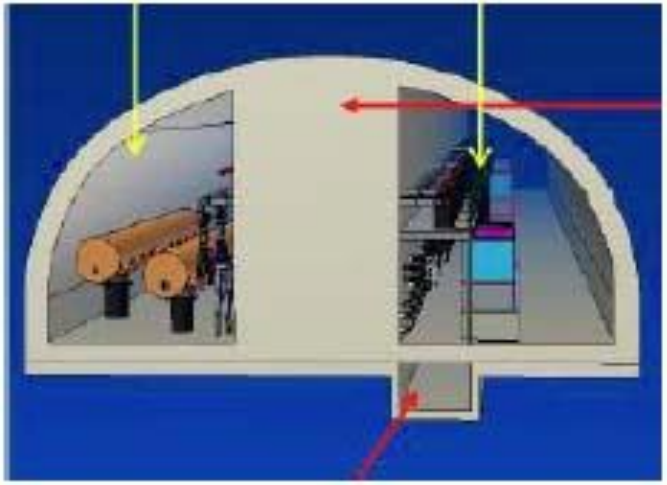
Two Candidate Sites in Asia/Japan

New Tunnel Shape

RDR two tunnel design (2007)



TDR mountain sites



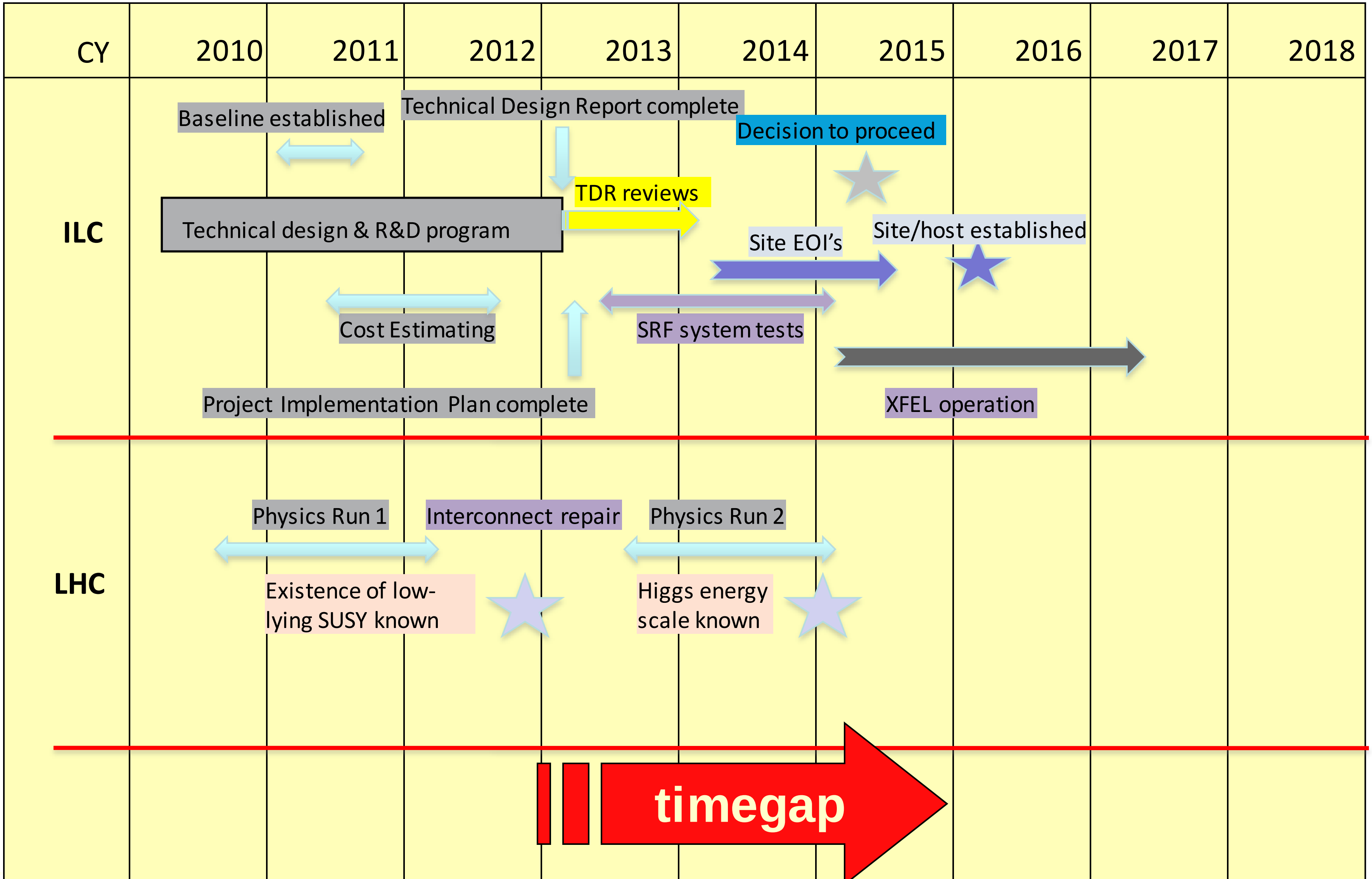
Underground Power Station

Geological Samples

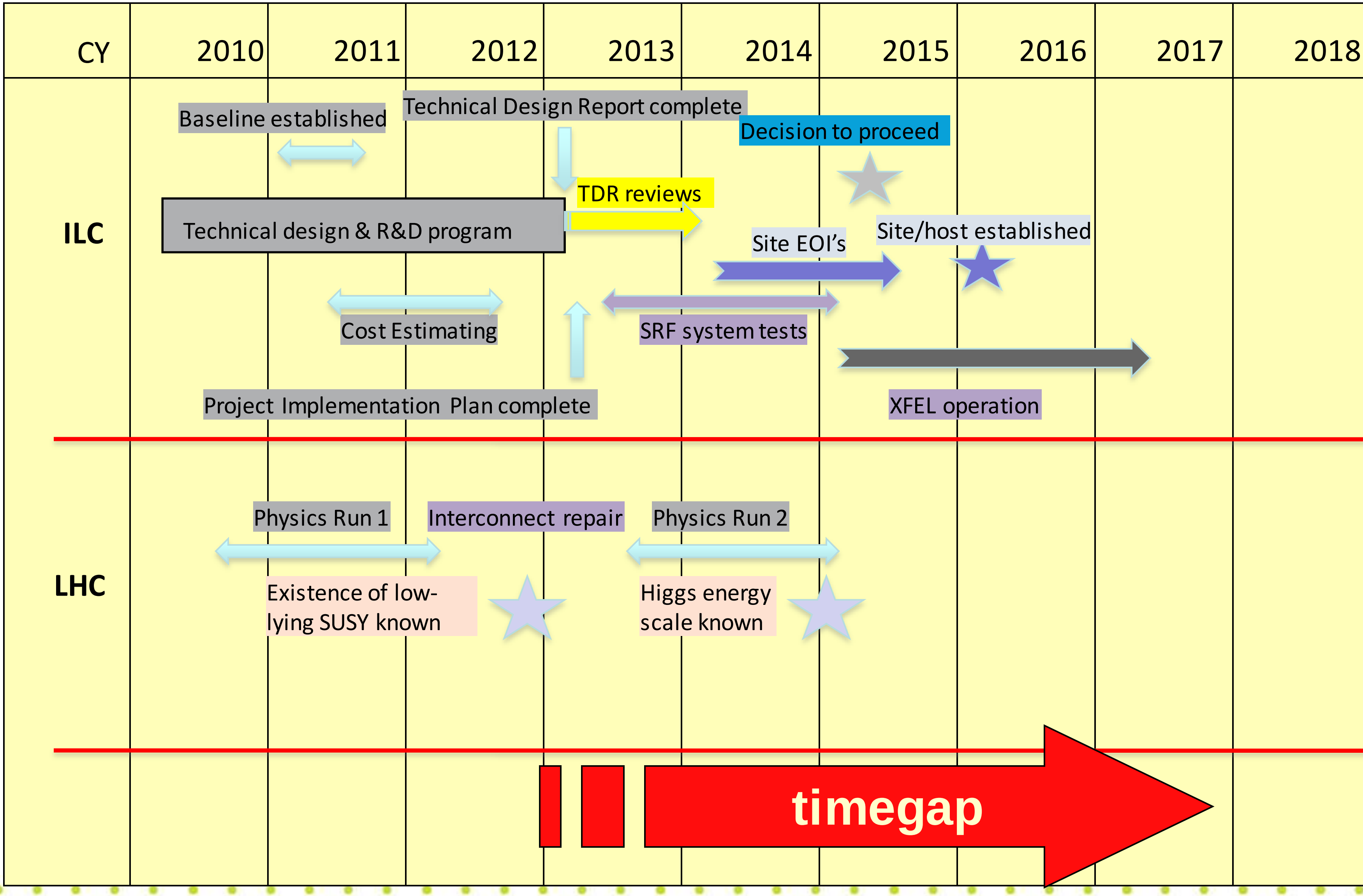
Post TDR

- Extending the energy of the ILC
- Continued R&D – especially SCRF
- Systems Tests
- Organization? (ILCSC)

ILC possible timeline



ILC possible timeline



Extending the reach of the ILC

- **ICFA LC Parameters subcommittee (2003 and 2006)**

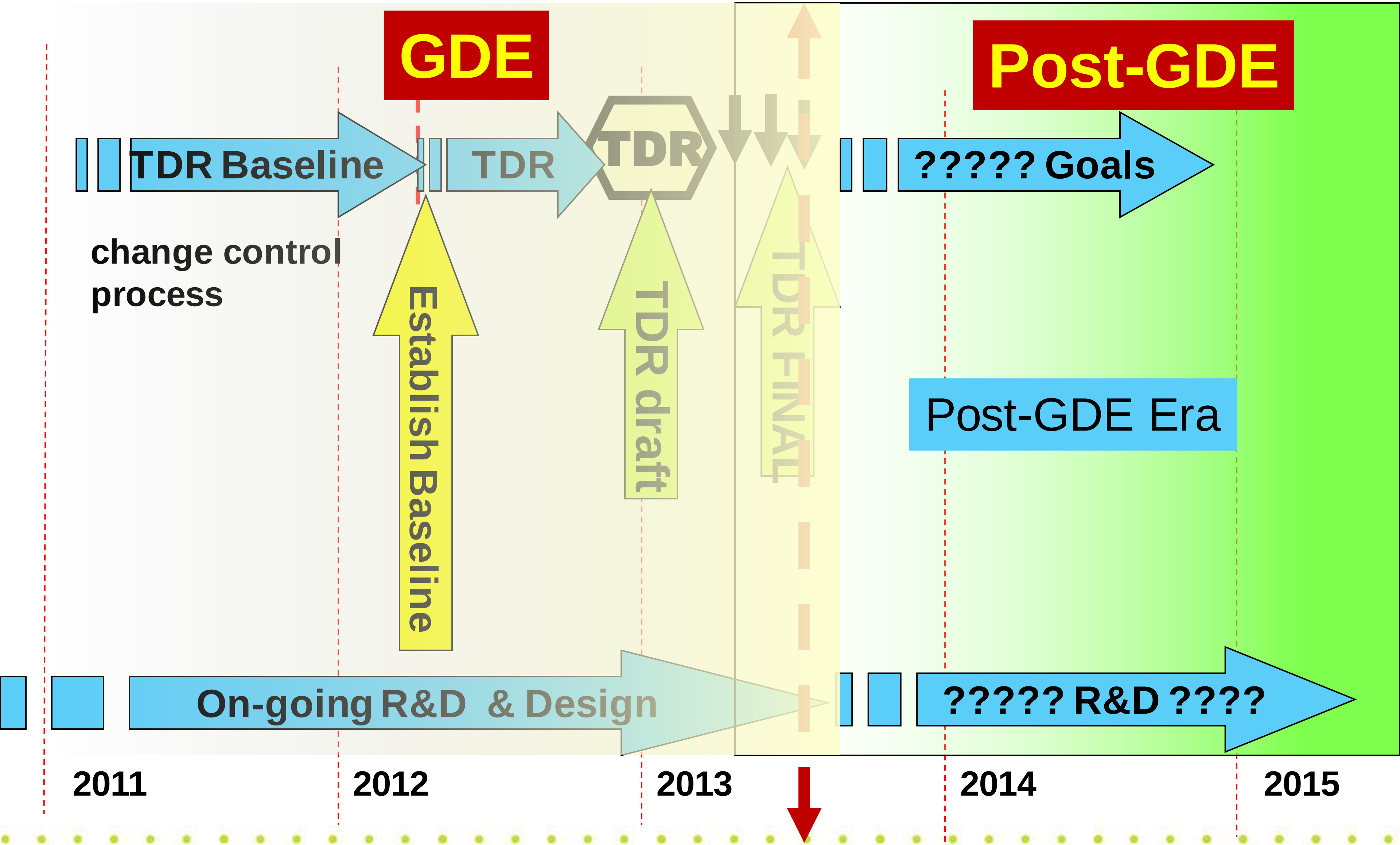
The strong likelihood that there will be new physics in the 500 – 1000 GeV range means that the upgradeability of the LC to about 1 TeV is the highest priority step beyond the baseline.

- The energy of the machine should be upgradeable to approximately 1 TeV.
- The luminosity and reliability of the machine should allow the collection of order of 1 ab^{-1} (equivalent at 1 TeV) in about 3 to 4 years.
- The machine should have the capability for running at any energy value for continuum measurements and for threshold scans up to the maximum energy with the design luminosity ($\sqrt{s}$ scaling assumed).
- Beam energy stability and accuracy should be as stated for the baseline machine.

Post-TDR ILC Interim Goals & Organization

- What should follow GDE (mandate and organization) for an interim 3-5 year period? (ILCSC – Bagger)
- GDE position paper submitted to ILCSC Aug 2011. The paper addresses:
  - **Technical Goals proposed for 2012+ program?**
    - Value engineering; Continued system demonstrations; Increasing energy reach; +
  - **Organizational Issues for 2012+ post GDE?**
    - What are primary GDE assets that should be preserved?
    - What are the primary GDE weaknesses that should be improved?
- FALC common fund budget for GDE is to complete mandate in mid-2013.

ILC Timeline – Post-GDE Transition



GDE Conclusions

- The major R&D milestones for TDR are in-hand
- The TDR will be a self-contained comprehensive R&D report; with a design based on new baseline; a new value costing; and a section on project implementation planning
- Submit: Dec 2012; Reviews of technical design & costs; rewrite as needed; submit to ICFA at LP2013 in June 2013 **(GDE mandate complete)**
- Envision post–TDR ILC program: 1) extend energy reach; 2) systems tests; 3) evolve design based on technology development and LHC results (eg. Higg's Factory?)