ILC Status and CLIC-ILC collaboration

FLASH TESTS

One shift Operation 2100:0600 20-21.09.2009

Barry Barish

CLIC Workshop – CERN

12-Oct-09

Today

- ILC Design R&D Status
- Evolving the ILC "Baseline"
- Key R&D Program and Milestones
- Technical Design (2012)
- CLIC / ILC Collaboration
- Moving toward a Linear Collider project

ICFA: e+e- Linear Collider

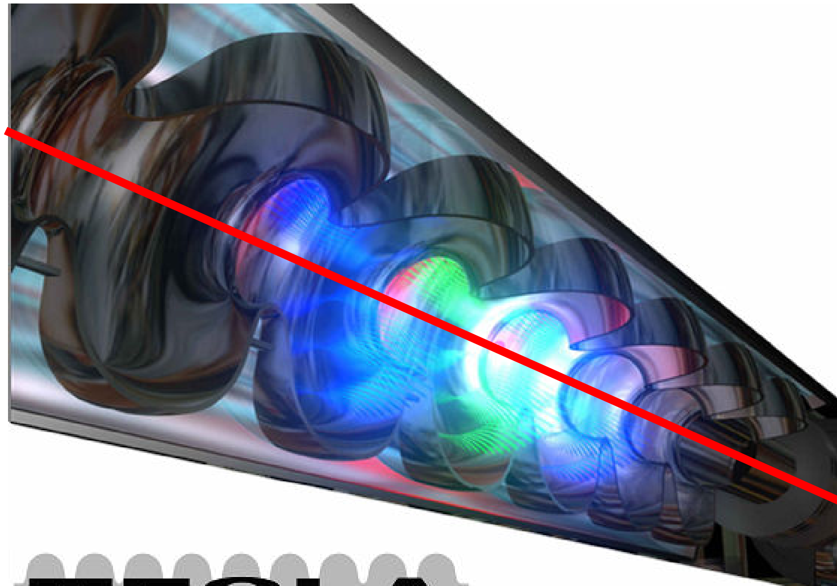
- Physics Parameters
  - **International subcommittee report**
- Technology
  - **Superconducting RF**
- International Design Team
  - **Global Design Effort (2005)**

ILC Collider Parameters
ICFA Report

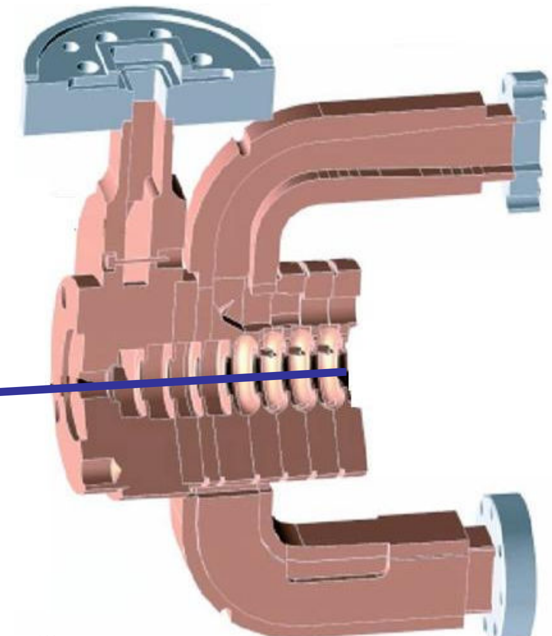
- E_{cm} adjustable from 200 – 500 GeV
- Luminosity → $\int L dt$ = 500 fb^{-1} in 4 years
- Ability to scan between 200 and 500 GeV
- Energy stability and precision below 0.1%
- Electron polarization of at least 80%

- The machine must be upgradeable to 1 TeV

ILC Competing Technologies



Evolution from: SLAC & SLC



TESLA

1.3 GHz - Cold

Evolution: CEBAF & LEPII
+ TRISTAN, HERA, etc.

NLC JLC

11.4 GHz - Warm

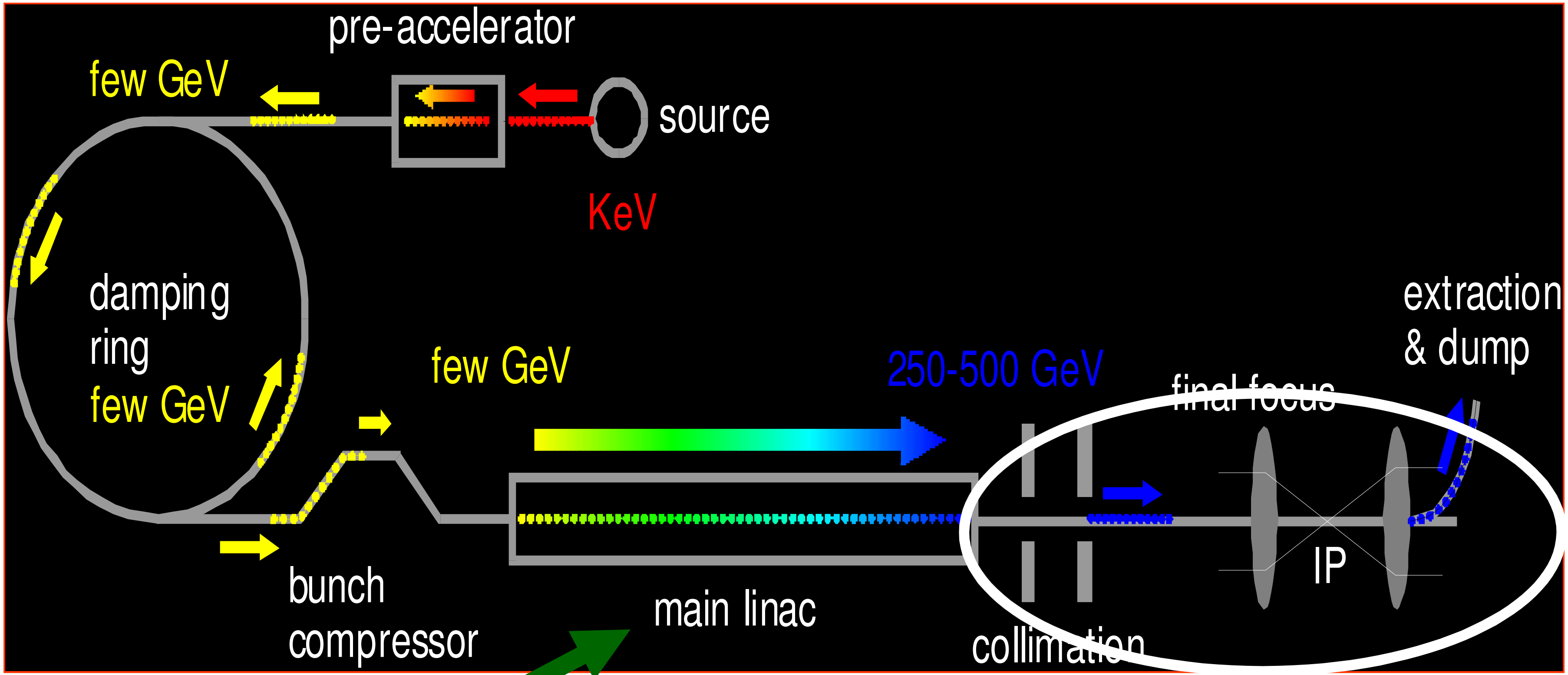
The ILC SCRF Cavity

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

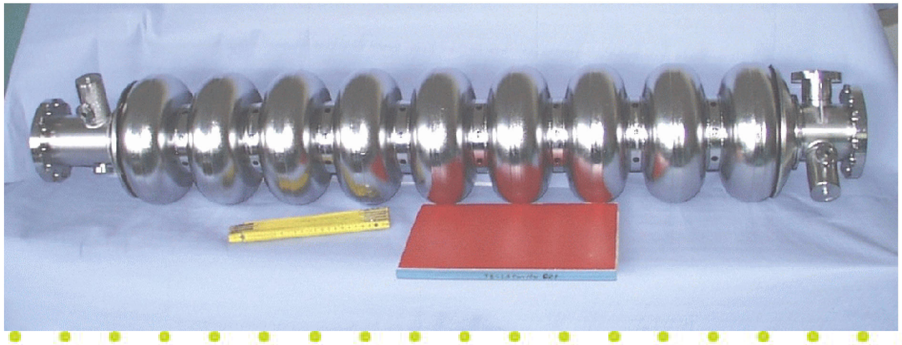
- Achieve high gradient (35MV/m); develop multiple vendors; make cost effective, etc

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

Designing a Linear Collider

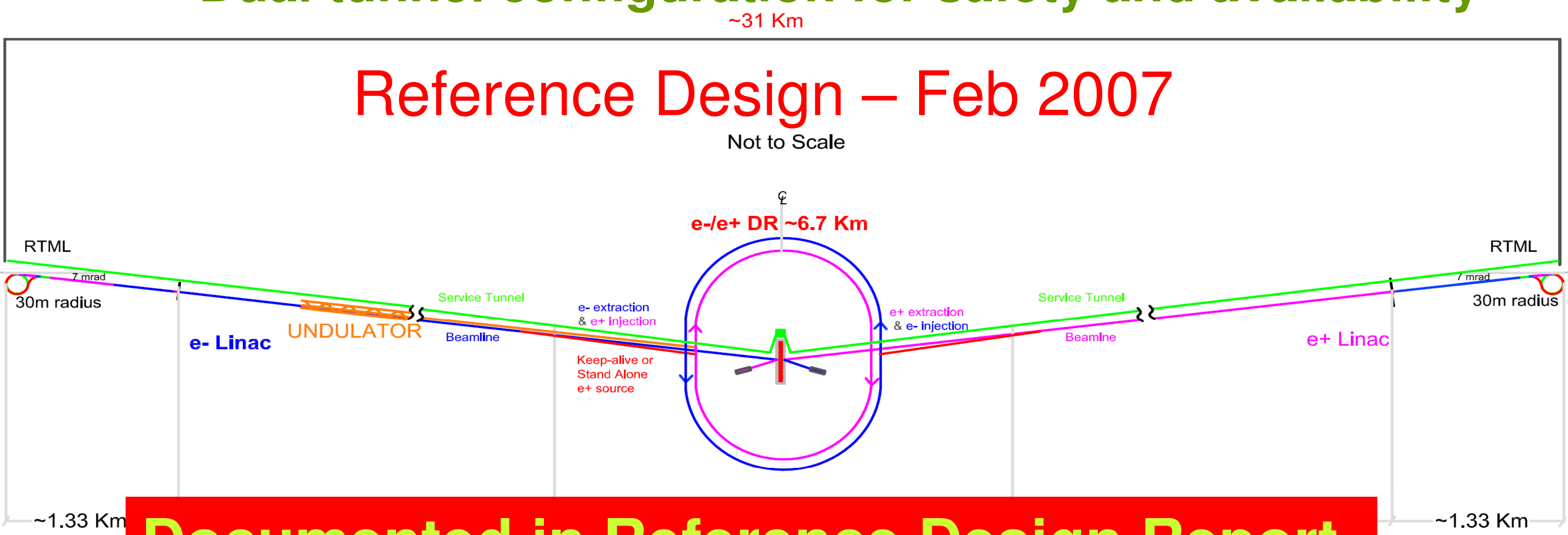


Superconducting RF Main Linac



ILC Reference Design

- 11km SC linacs operating at 31.5 MV/m for 500 GeV
- Centralized injector
  - Circular damping rings for electrons and positrons
  - Undulator-based positron source
- Single IR with 14 mrad crossing angle
- Dual tunnel configuration for safety and availability



Documented in Reference Design Report

RDR Design Parameters

Max. Center-of-mass energy	500	GeV
Peak Luminosity	~2×10^{34}	$1/cm^2s$
Beam Current	9.0	mA
Repetition rate	5	Hz
Average accelerating gradient	31.5	MV/m
Beam pulse length	0.95	ms
Total Site Length	31	km
Total AC Power Consumption	~230	MW

RDR Design & "Value" Costs

The reference design was "frozen" as of 1-Dec-06 for the purpose of producing the RDR, including costs.

It is important to recognize this is a snapshot and the design will continue to evolve, due to results of the R&D, accelerator studies and value engineering

The value costs have already been reviewed three time

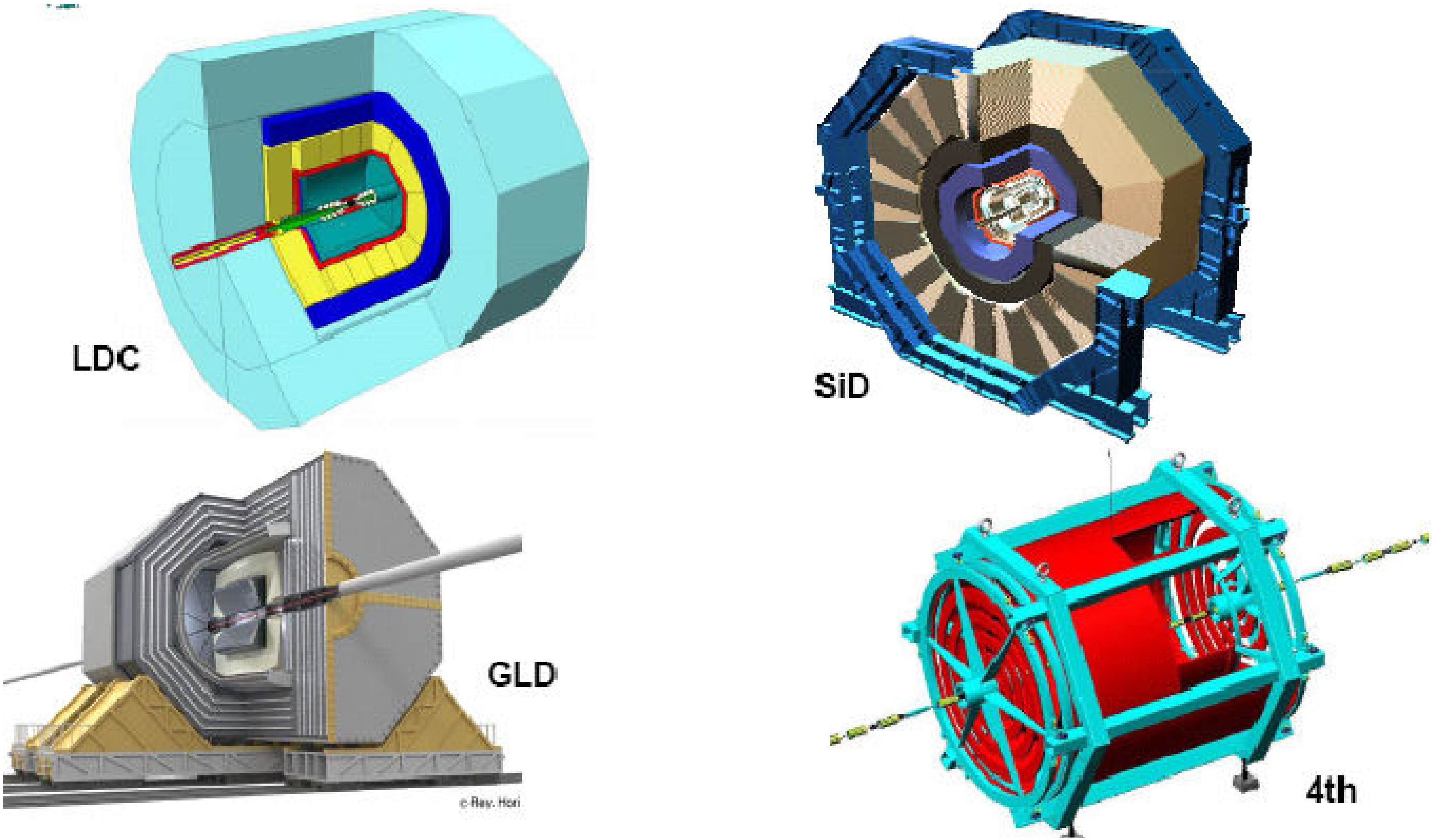
- **3 day "internal review" in Dec**
- **ILCSC MAC review in Jan**
- **International Cost Review (May)**

Σ Value = 6.62 B ILC Units

Summary
RDR "Value" Costs

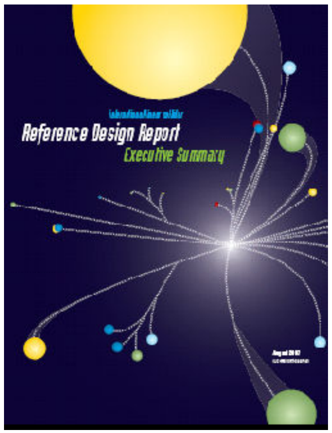
Total Value Cost (FY07)
4.80 B ILC Units Shared
+
1.82 B Units Site Specific
+
14.1 K person-years
("explicit" labor = 24.0 M person-hrs
@ 1,700 hrs/yr)
1 ILC Unit = $ 1 (2007)

Detector Concepts Report

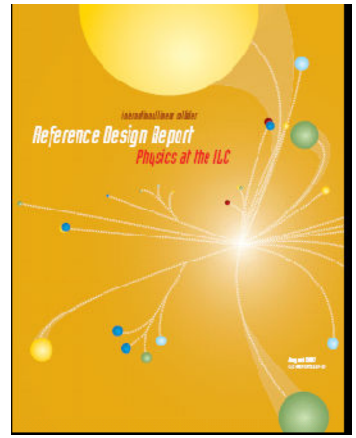


RDR Complete

- **Reference Design Report (4 volumes)**



Executive Summary



Physics at the ILC

Accelerator

Detectors

ILC R&D / Design Plan


ILC Research and Development Plan for the Technical Design Phase

Release 4

July 2009

ILC Global Design Effort

Director: Barry Barish

Prepared by the Technical Design Phase Project Management

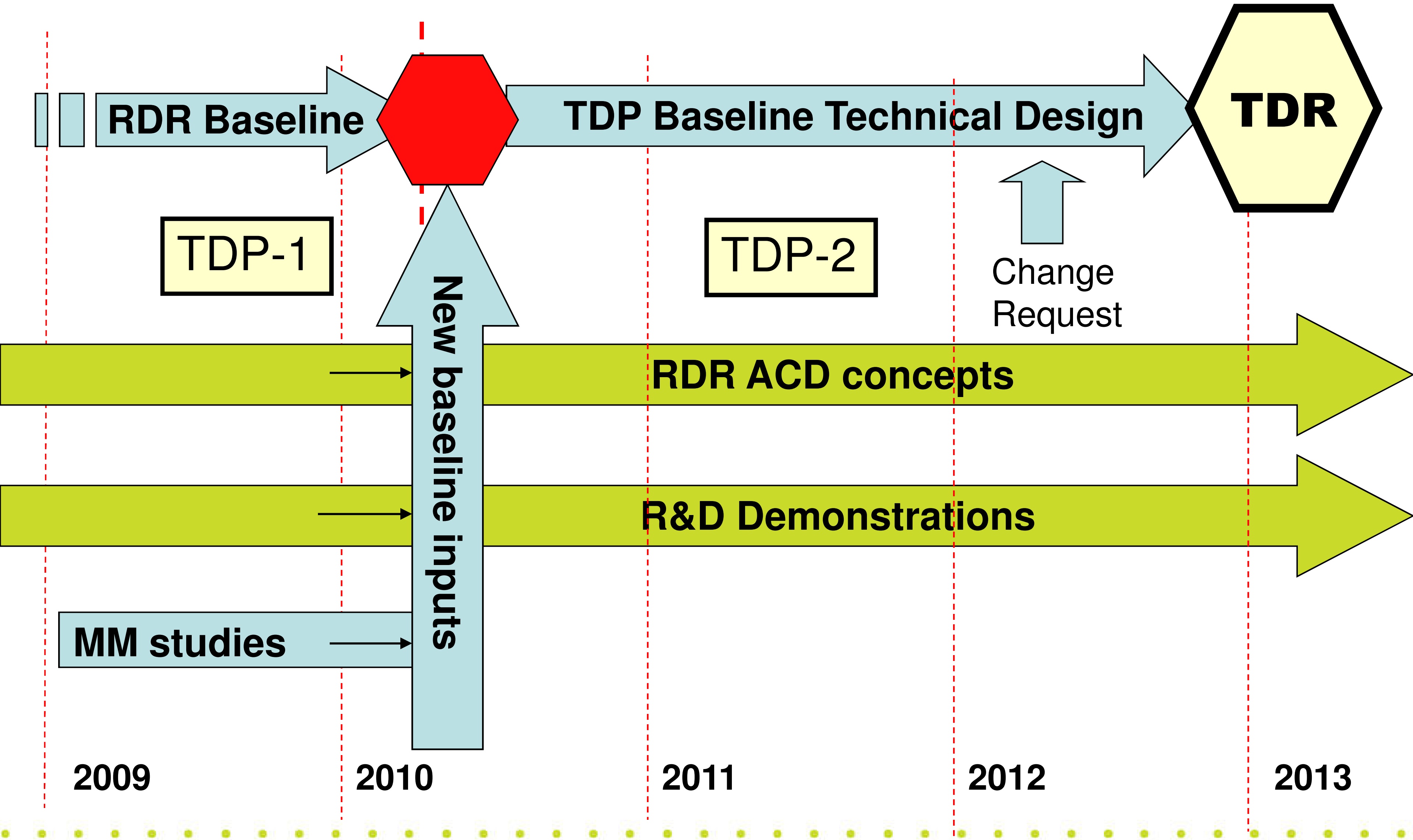
Project Managers: Marc Ross, Nick Walker, Akira Yamamoto

Major TDP Goals:

- **ILC design evolved for cost / performance optimization**
- **Complete crucial demonstration and risk-mitigating R&D**
- **Updated VALUE estimate and schedule**
- **Project Implementation Plan**

Updated every six months
A “living document”

Technical Design Phase **and Beyond**



Major R&D Goals for TDP 1

SCRF

- **High Gradient R&D - globally coordinated program to demonstrate gradient by 2010 with 50%yield**
- **Preview of new results from FLASH**

TODAY

ATF-2 at KEK

- **Demonstrate Fast Kicker performance and Final Focus Design**

Electron Cloud Mitigation – (CesrTA)

- **Electron Cloud tests at Cornell to establish mitigation and verify one damping ring is sufficient.**

Accelerator Design and Integration (AD&I)

- **Studies of possible cost reduction designs and strategies for consideration in a re-baseline in 2010**

The ILC SCRF Cavity

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

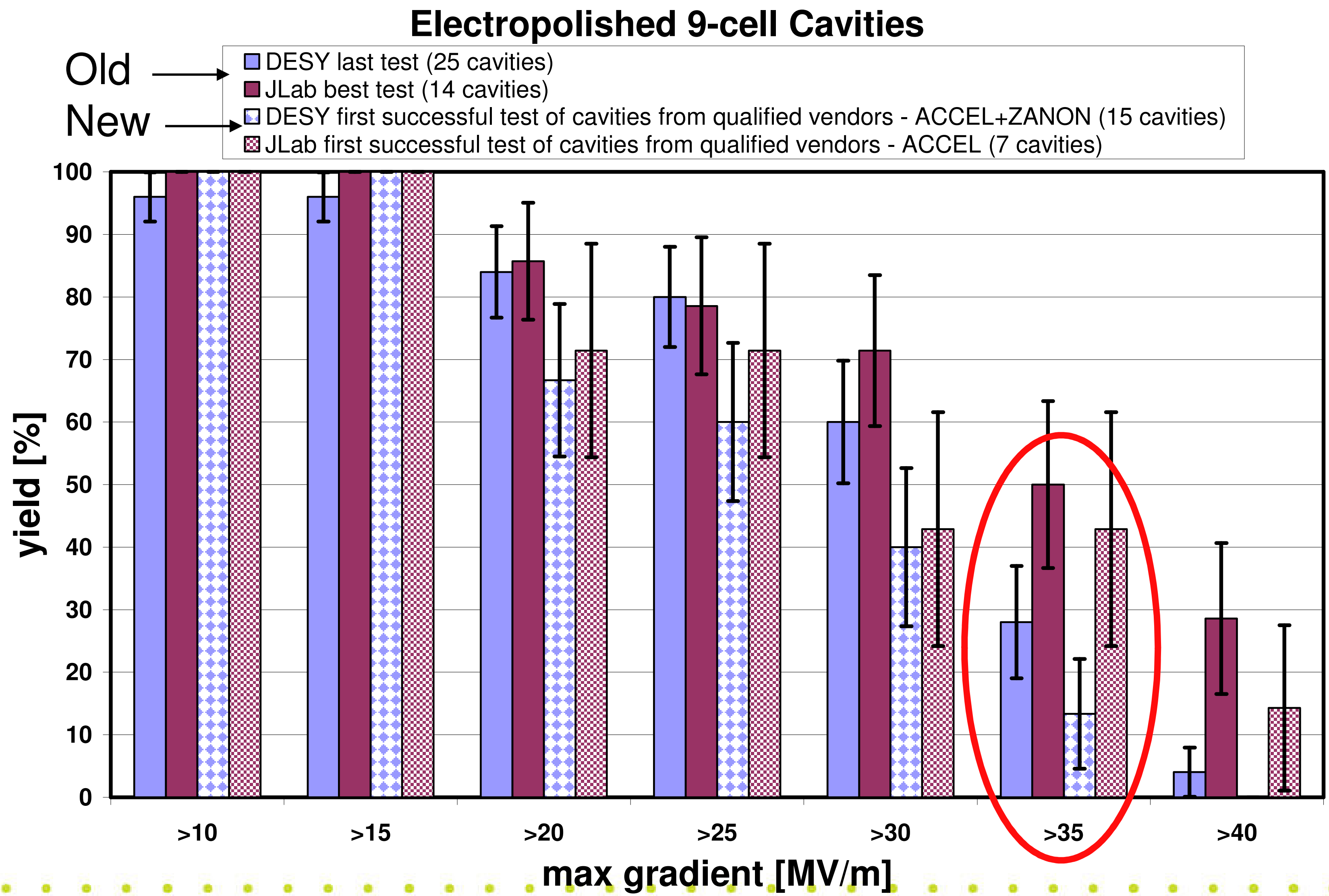
- Achieve high gradient (35MV/m); develop multiple vendors; make cost effective, etc

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

Standard Process for Yield Plot

	Standard Cavity Recipe
Fabrication	Nb-sheet (Fine Grain)
	Component preparation
	Cavity assembly w/ EBW (w/ experienced venders)
Process	1st Electro-polishing (~150um)
	Ultrasonic degreasing with detergent, or ethanol rinse
	High-pressure pure-water rinsing
	Hydrogen degassing at > 600 C
	Field flatness tuning
	2nd Electro-polishing (~20um)
	Ultrasonic degreasing or ethanol
	High-pressure pure-water rinsing
	Antenna Assembly
	Baking at 120 C
Cold Test (vert. test)	Performance Test with temperature and mode measurement (1st / 2nd successful RF Test)

Gradient Goal

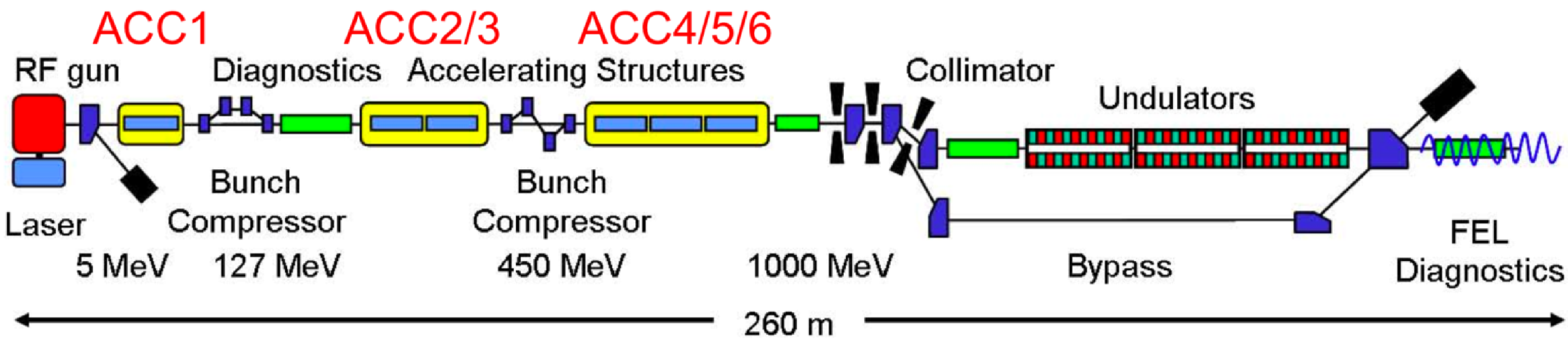


Global Plan for SCRF R&D

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 plug-compatible string (DESY, FNAL, INFN, KEK)				
System Test with beam acceleration		FLASH (DESY)			NML (FNAL) STF2 (KEK)	
Preparation for Industrialization			Mass Production Technology R&D			

TTF/FLASH 9mA Experiment

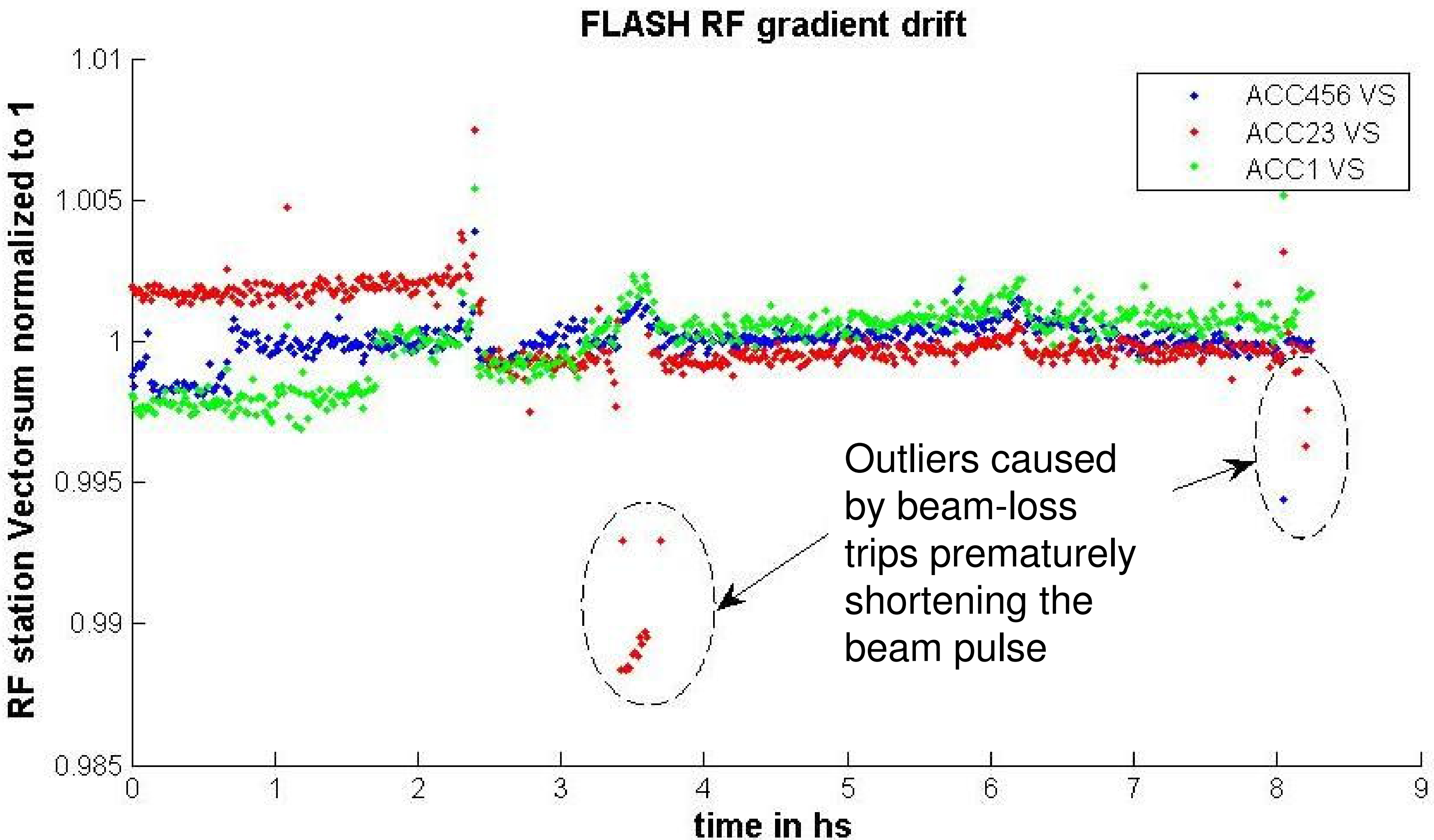
Full beam-loading long pulse operation → “S2”



		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

RF Gradient Long-Term Stability



Example Result

Major R&D Goals for TDP 1

SCRF

- **High Gradient R&D - globally coordinated program to demonstrate gradient by 2010 with 50%yield**
- **Preview of new results from FLASH**

ATF-2 at KEK

- **Demonstrate Fast Kicker performance and Final Focus Design**

Electron Cloud Mitigation – (CesrTA)

- **Electron Cloud tests at Cornell to establish mitigation and verify one damping ring is sufficient.**

Accelerator Design and Integration (AD&I)

- **Studies of possible cost reduction designs and strategies for consideration in a re-baseline in 2010**

Rationale for Re-baseline

- Cost constraint in TDR
  - **Updated cost estimate in 2012 ≤6.7 BILCU**
  - **Need margin against possible increased component costs**
- Process forces critical review of RDR design
  - **Errors and design issues identified**
  - **Iteration and refinement of design**
  - **More critical attention on difficult issues**
- Balance for risk mitigating R&D
  - **Majority of global resources focused in R&D**
  - **Important to prepare / re-focus project-orientated activities for TDP-2**
- **Need for design options and flexibility**
  - **Unknown site location**

SB-2009 Proposal

1. A Main Linac length consistent with an optimal choice of average accelerating gradient
   – RDR: 31.5 MV/m, to be re-evaluated

2. Single-tunnel solution for the Main Linacs and RTML, with two possible variants for the HLRF
   – Klystron cluster scheme
   – DRFS scheme

3. Undulator-based e+ source located at the end of the electron Main Linac (250 GeV)
   – Capture device: Quarter-wave transformer

SB-2009 Proposal (cont)

4. Reduced parameter set (with respect to the RDR)
   – n_b = 1312 (so-called “Low Power”)

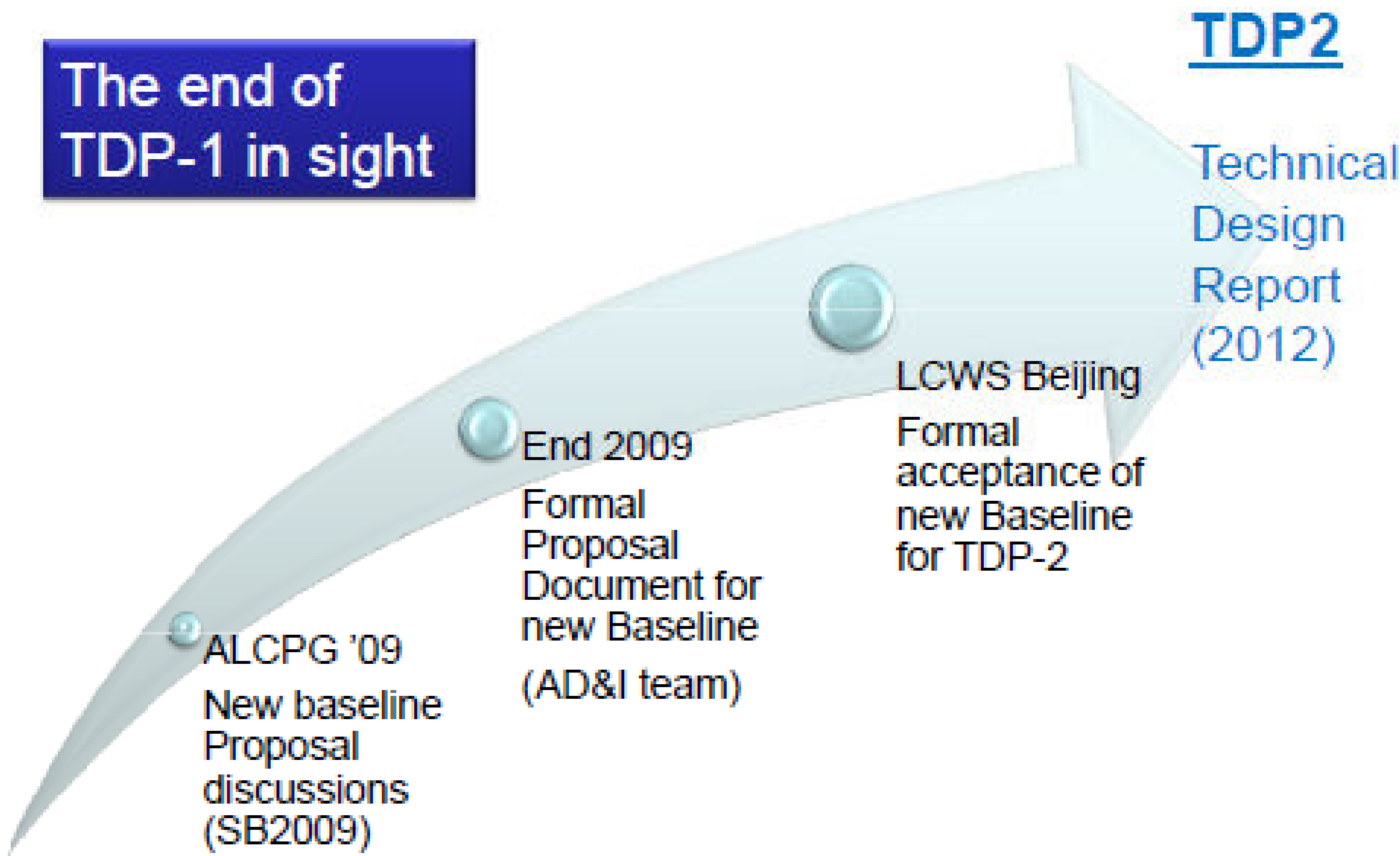
5. Approx. 3.2 km circumference damping rings at 5 GeV
   – 6 mm bunch length

6. Single-stage bunch compressor
   – compression factor of 20

7. Integration of the e+ and e- sources into a common “central region beam tunnel”, together with the BDS.

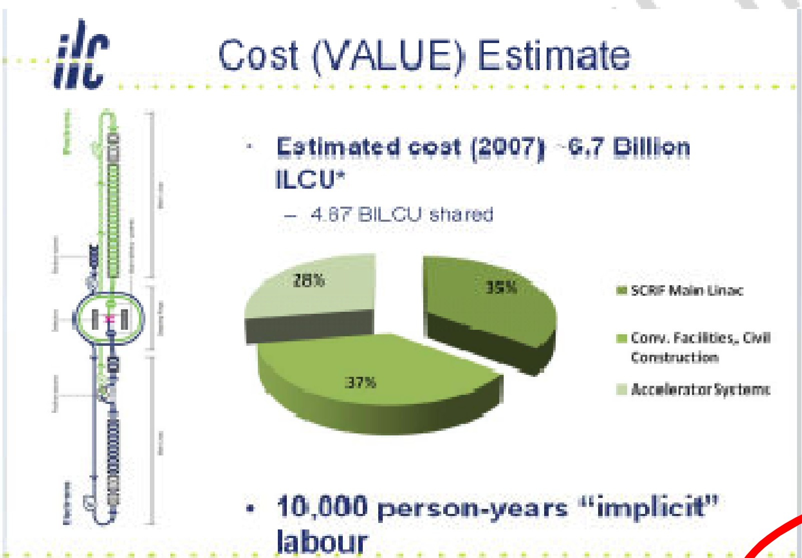
Timeline

The end of TDP-1 in sight



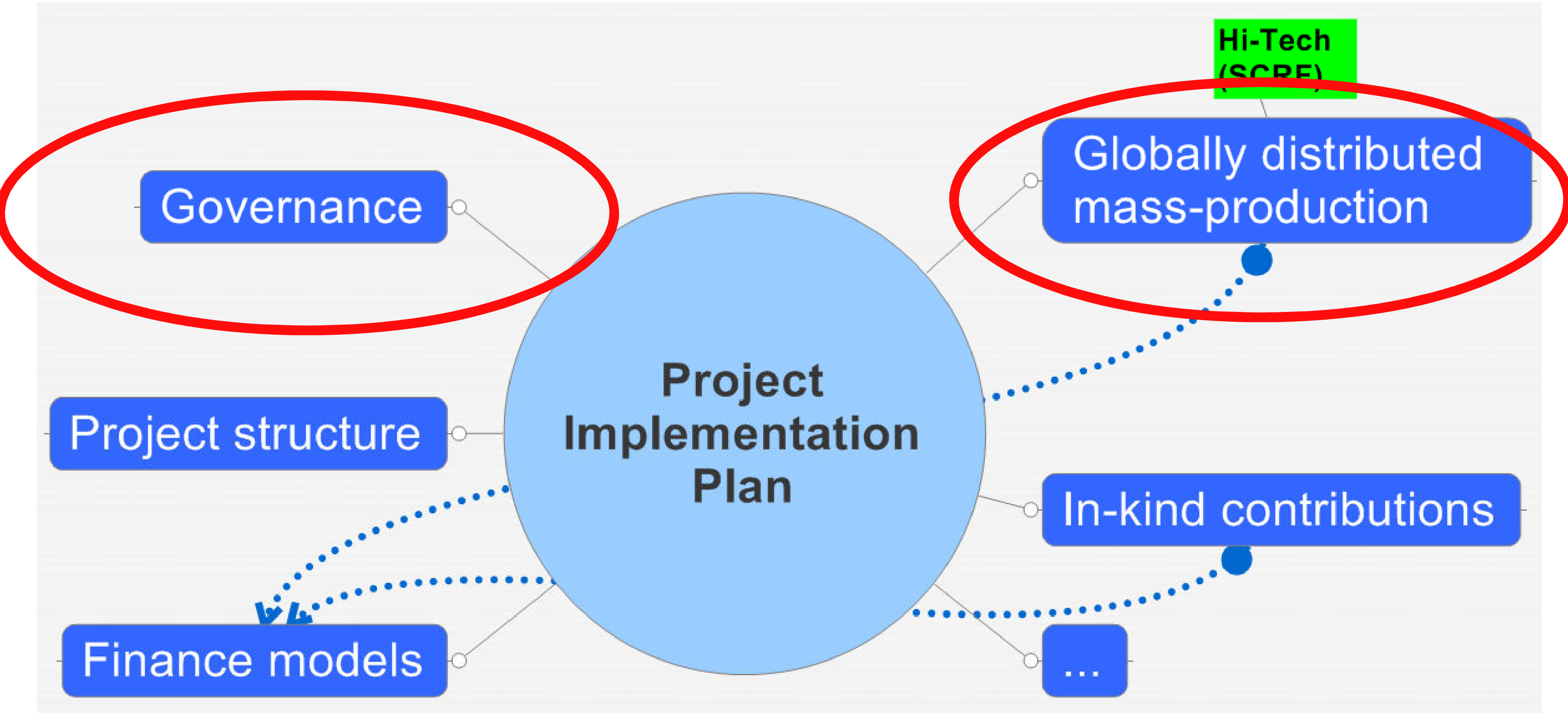
Cost Increments
(Rough Estimates from 10.2008)

- Main Linac (total) ~ 300 MILCU
- Low-Power option ~ 400 MILCU
- Central injector Integration ~ 100 MILCU
- Single-stage compressor ~ 100 MILCU



- VERY preliminary: better estimates will be made (end 2009)
  - But still based/scaled from RDR value estimate
- Elements *not* independent! Careful of potential double counting!
- **Cost vs Performance vs Risk**: important information for making informed decisions in 2010

Project Implementation Plan



ILC- CLIC Collaboration

- CLIC – ILC Collaboration has two basic purposes:
  1. **allow a more efficient use of resources, especially engineers**
     - **CFS / CES**
     - **Beamline components (magnets, instrumentation…)**
  2. **promote communication between the two project teams.**
     - **Comparative discussions and presentations will occur**
     - **Good understanding of each other's technical issues is necessary**
     - **Communication network – at several levels – supports it**
- Seven working groups which are led by conveners from both projects

Collaboration Working Groups

	CLIC	ILC
Physics & Detectors	L.Linssen, D.Schlatter	F.Richard, S.Yamada
Beam Delivery System (BDS) & Machine Detector Interface (MDI)	L.Gatignon D.Schulte, R.Tomas Garcia	B.Parker, A.Seriy
Civil Engineering & Conventional Facilities	C.Hauviller, J.Osborne.	J.Osborne, V.Kuchler
Positron Generation	L.Rinolfi	J.Clarke
Damping Rings	Y.Papaphilipou	M.Palmer
Beam Dynamics	D.Schulte	A.Latina, K.Kubo, N.Walker
Cost & Schedule	P.Lebrun, K.Foraz, G.Riddone	J.Carwardine, P.Garbincius, T.Shidara

ILC / CLIC – Future Directions

- A recent management meeting at CERN reviewed collaborative status and looked at possible areas for additional co-operation.

- Conclusions from that meeting include:
  - **The existing working groups were deemed a success and we added two more (damping rings & positron production)**
  - **Jean Pierre Delahaye (CLIC Study Leader) has joined the GDE EC, and Brian Foster (European Regional Director) has joined the CLIC steering committee.**
  - **We plan to hold joint ILC/CLIC management meeting,**
  -

- There was discussion about creating a joint linear collider program general issues subgroup encompassing both the ILC and CLIC programs. A joint statement has been endorsed by ILCSC and the CLIC Collaboraton Board.

CLIC / ILC Joint Working Group on General Issues

- ILCSC has approved formation of a CLIC/ILC General Issues working group by the two parties with the following mandate:
  - Promoting the Linear Collider
  - Identifying synergies to enable the design concepts of ILC and CLIC to be prepared efficiently
  - Discussing detailed plans for the ILC and CLIC efforts, in order to identify common issues regarding siting, technical issues and project planning.
  - Discussing issues that will be part of each project implementation plan
  - Identifying points of comparison between the two approaches .
- The conclusions of the working group will be reported to the ILCSC and CLIC Collaboration Board with a goal to producing a joint document.

Final Remarks

- The central frontier of particle physics is and will continue to be the energy frontier!
- The LHC will open a new era at that frontier and its discoveries will motivate the next machine --- a lepton collider.
- That machine could be the ILC or CLIC (or maybe a muon collider). Science must dictate the choice of machines, informed by the realities of technical performance, readiness, risk and cost for each option
- It is our jobs (ILC and CLIC design teams) to make sure our R&D and design work will enable the best informed decision for our field.