GDE Report

One shift Operation 2100:0600 20-21.09.2009

Barry Barish

PAC

Pohang, KOREA

2-Nov-09

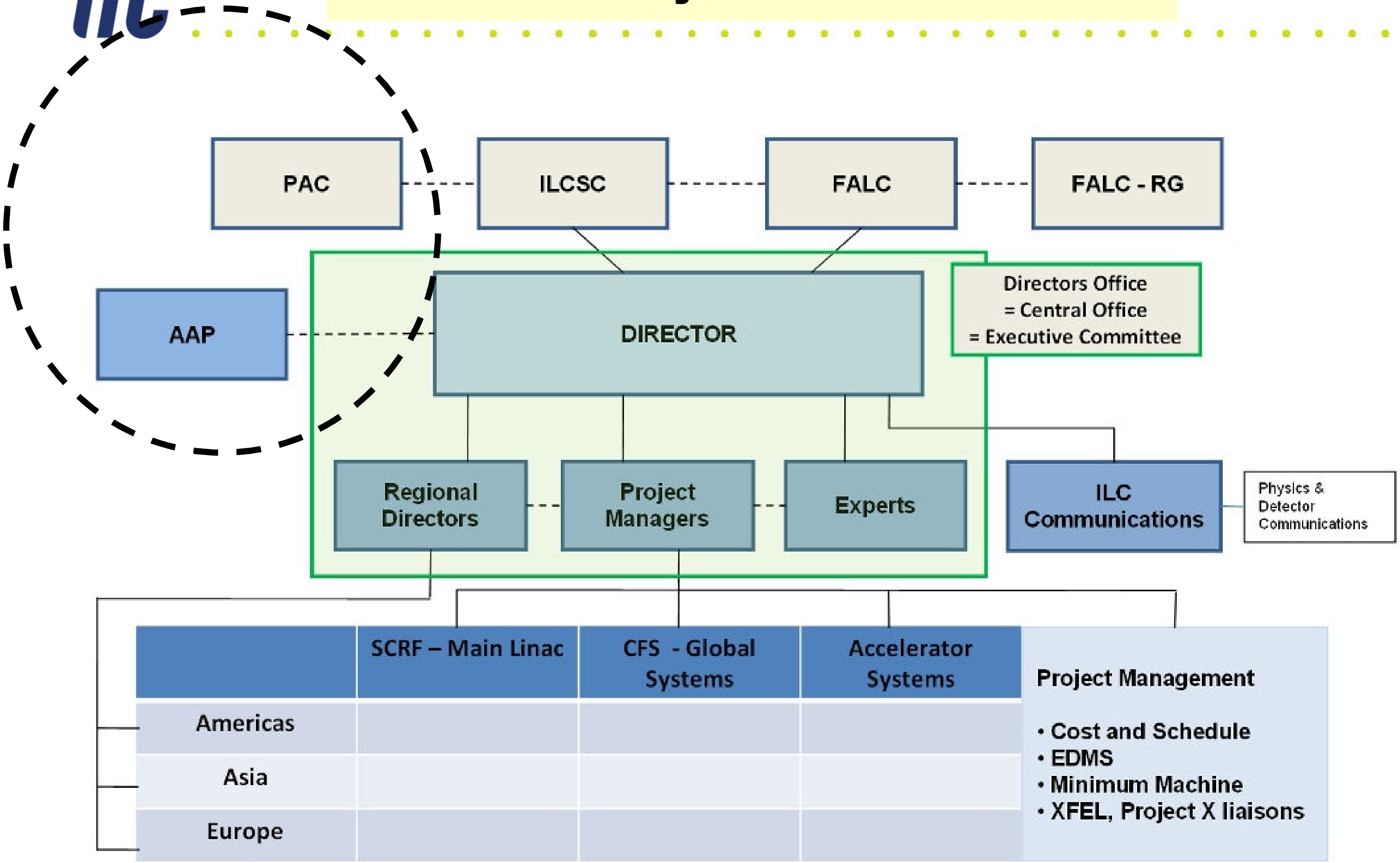
Today

- PAC and AAP Reviews - Responses
- R&D Plans and Resources
- Key R&D Efforts
  - SCRF
  - ATF2
  - CesrTA
- Proposed New Baseline (SB2009)
- ILC / CLIC Collaboration
- TDR and PIP (2012) and beyond
- Final Remarks

Today

- **PAC and AAP Reviews - Responses**
- R&D Plans and Resources
- Key R&D Efforts
  - SCRF
  - ATF2
  - CesrTA
- Proposed New Baseline (SB2009)
- ILC / CLIC Collaboration
- TDR and PIP (2012) and beyond
- Final Remarks

GDE Project Structure



Technical Reviews

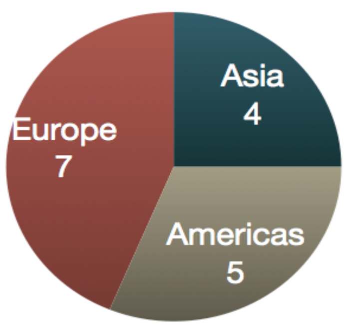
- Accelerator Advisory Panel (Willis & Elsen)
  - On-going reviews by assigned AAP members to particular systems (attend meetings, etc) Example result: Questions regarding plug compatibility have resulted in studies, report
  - Technical Review – first one 3.5 days at TILC09 in April. Internal + 4-5 external reviewers. Yearly through TDP phase with continuity. First review: Overall coverage + focus areas
- ILCSC PAC Review:
  - 1.5 days (1 day GDE); higher level review and will use AAP review as input.

AAP Review

- **The Accelerator Advisory Panel review addressed the superconducting RF program, conventional facilities, electron cloud R&D, test facilities operation and project management.**

AAP Reviewers

- Regular Members
  - C Damerell
  - J Dorfan
  - E Elsen
  - T Himel
  - M Kuriki
  - O Napoly (*)
  - K Oide
  - H Padamsee
  - T Raubenheimer
  - D Schulte
  - W Willis



- External Members
  - N Holtkamp (*)
  - L Rossi (*)
  - T Tajima
  - M Uesaka
  - F Zimmermann

(*) apologies received

- F Lehner served as the scientific secretary for this meeting

AAP Review - highlights

- Understanding e-cloud

See Yokoya Talk

The AAP notes that once the current rounds of measurements are completed and the modeling software has been updated to incorporate what has been learned from the measurements, the impact of the e-cloud must be reevaluated for the 12 ns and 6 ns bunch spacings in the damping ring designs. This will provide an updated assessment of the risk to damping ring performance from the effects of the e-cloud. Should the risk factor be too high, the AAP observes that a lower-current ILC machine with half the number of bunches in the 6-km configuration, i.e. 12 ns bunch spacing would operate in a safer regime with regard to electron cloud. Reducing the positron ring circumference to 3-km may risk losing this back-up solution.

The AAP would like to see a plan laid out showing how the damping ring group plans to arrive at a decision for the viability of the ILC damping ring choice with respect to electron-cloud immunity. A clear set of criteria for the vacuum system should be developed that will lead to the choice of a baseline solution. Alternates along with required R&D can also be specified. A schedule for establishing the criteria and the baseline should be shown.

Project Planning cont'd & Conclusion

- Preparation for 2012
  - some technical goals will have to be pursued beyond the timeline
    - gradient development and string test
  - LHC will be running
    - time is ripe for a decision
    - Have to prepare pro-actively
      - plan for success
      - develop a long-term strategy

The AAP suggests asking ILCSC to consider displaying and arbitrating the use of laboratory resources more formally. Proper orchestration of the in-kind contributions is mandatory to advance the likelihood of implementation of the ILC. Sudden changes in commitment should be avoided and, if necessary, should be communicated in the ILCSC.

Laboratory Commitments to ILC R&D

- The system with work packages and associated laboratory based MOU's became obsolete during the 2008 funding interruption in the UK & US.
- This system has been replaced by an ad-hoc series of bilateral agreements with the GDE and the national labs for work scope or facility access e.g. FP7 projects such as Hi-Grade in the EU, ATF2 at KEK, ART program in the US, which are embedded in a variety of management structures. A common R&D program has also been established with Project X at Fermilab.
- This has given rise to situations where internal lab priorities have had the result of moving critical personnel away from the GDE program.
- Both the AAP and the PAC flagged this issue and suggested it be discussed at ILCSC, which contains several lab directors.

AAP Review

- The full report was circulated to ILCSC, who endorsed the report
- The next AAP review will take place in Oxford, UK in January 2010.
- The focus of this review will be an in-depth review of the proposed new machine baseline for the TDR

PAC Review – May 09, Vancouver

- **"Satisfactory progress is being made towards a Technical Design Report in 2012. At some time in the future, ILCSC guidance will be needed for activities beyond that date."**
- **"The PAC supports the GDE Director's AAP process, and endorses the conclusions of the AAP's recent review. It looks forward to seeing the response to the AAP's recommendations."**
- **"There is some concern by the PAC on whether there will be enough cavities available to obtain meaningful statistics on the yield, and more information on the needed statistics would be helpful. Some help on this may be forthcoming from the XFEL, Project X and Quantum Beam projects."**

See Yamamoto talk

PAC Review – May 09, Vancouver (continued)

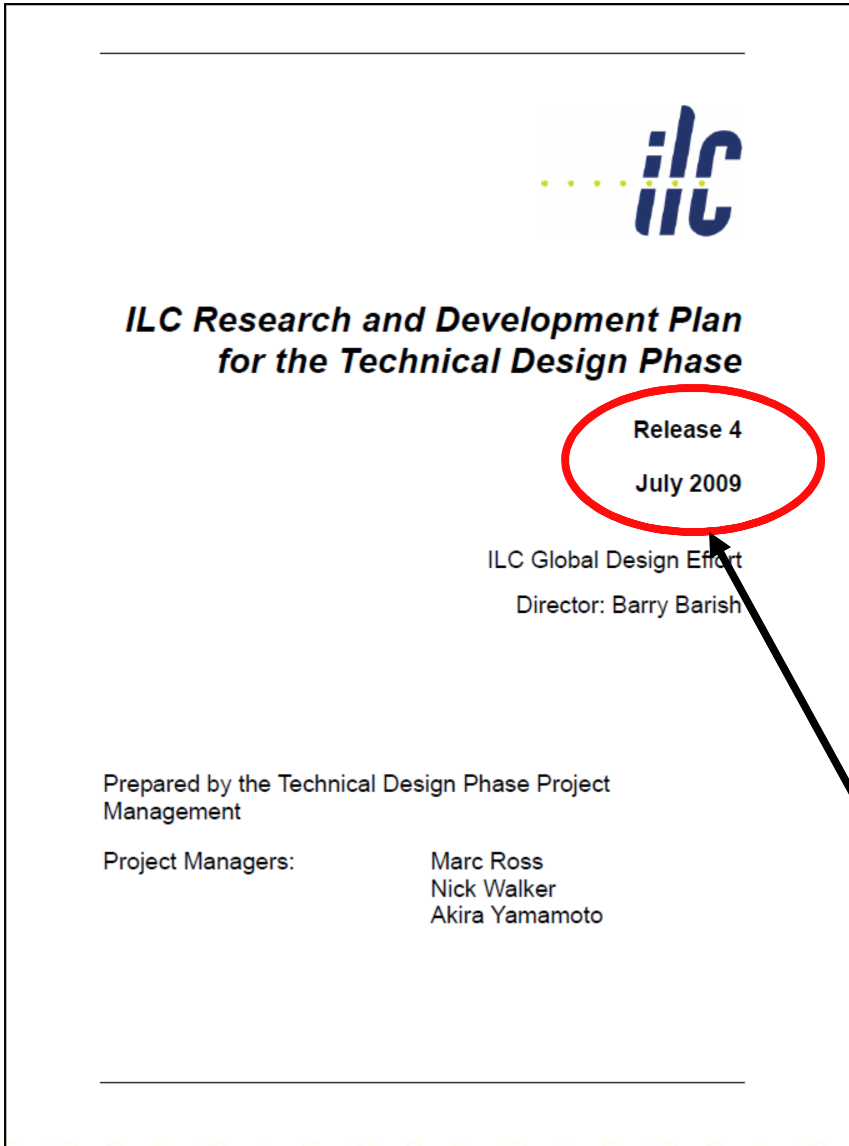
Renamed
"Accelerator Design and Integration" (AD&I)

- **"The PAC supports the "Minimum Machine" activities to carefully review the RDR design ……... The Committee believes that this activity should not compromise the existing ILC physics goals, and reiterates its belief that the 1 TeV upgrade option should be maintained."**
- The full report was acceped by the ILCSC at their meeting in Aug 2009.
- The AD&I process has led to the SB2009 re-baseline proposal

Today

- PAC and AAP Reviews - Responses
- **R&D Plans and Resources**
- Key R&D Efforts
  - SCRF
  - ATF2
  - CesrTA
- Proposed New Baseline (SB2009)
- ILC / CLIC Collaboration
- TDR and PIP (2012) and beyond
- Final Remarks

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 (PIP)

Updated every six months
A "living document"

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**

R & D Plan Resource Table

- Resource total: 2009-2012

FTE	SCRF	CFS & Global	AS	Total
Americas	243	28	121	392
Asia	82	9	51	142
Europe	108	17	64	189
	433	55	236	724
MS (K$)	SCRF	CFS & Global	AS	Total
Americas	18080	2993	6053	27126
Asia	23260	171	5260	28691
Europe	9890	921	530	11341
Total	51231	4085	11843	67158

- Not directly included:
  - **There are other Project-specific and general infrastructure resources that overlap with ILC TDP**

2009 – 2012: Resource Outlook

- Flat year-to-year resource basis
  - **Focused on technical enabling R & D**
  - **Limited flexibility to manage needed ILC design and engineering development**

- Well matched between ILC technical and institutional priorities with some exceptions:
  - **Positron system beam demonstrations**
  - **Conventional facilities optimization and site development**

Today

- PAC and AAP Reviews - Responses
- R&D Plans and Resources
- Key R&D Efforts
  - SCRF
  - ATF2
  - CesrTA
- Proposed New Baseline (SB2009)
- ILC / CLIC Collaboration
- TDR and PIP (2012) and beyond
- Final Remarks

The ILC SCRF Cavity

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

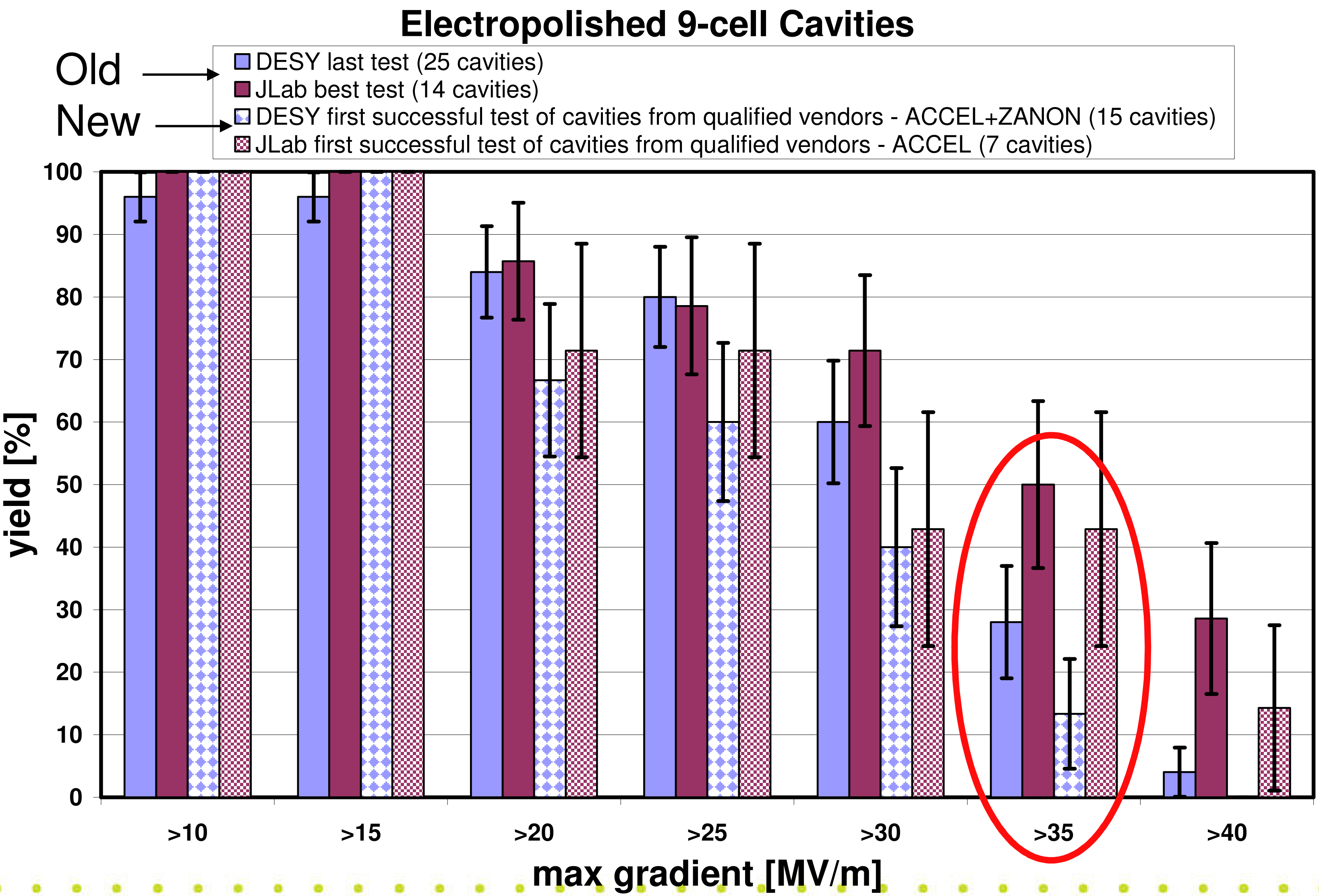
- Achieve high gradient (35MV/m); develop multiple vendors; make cost effective, etc

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

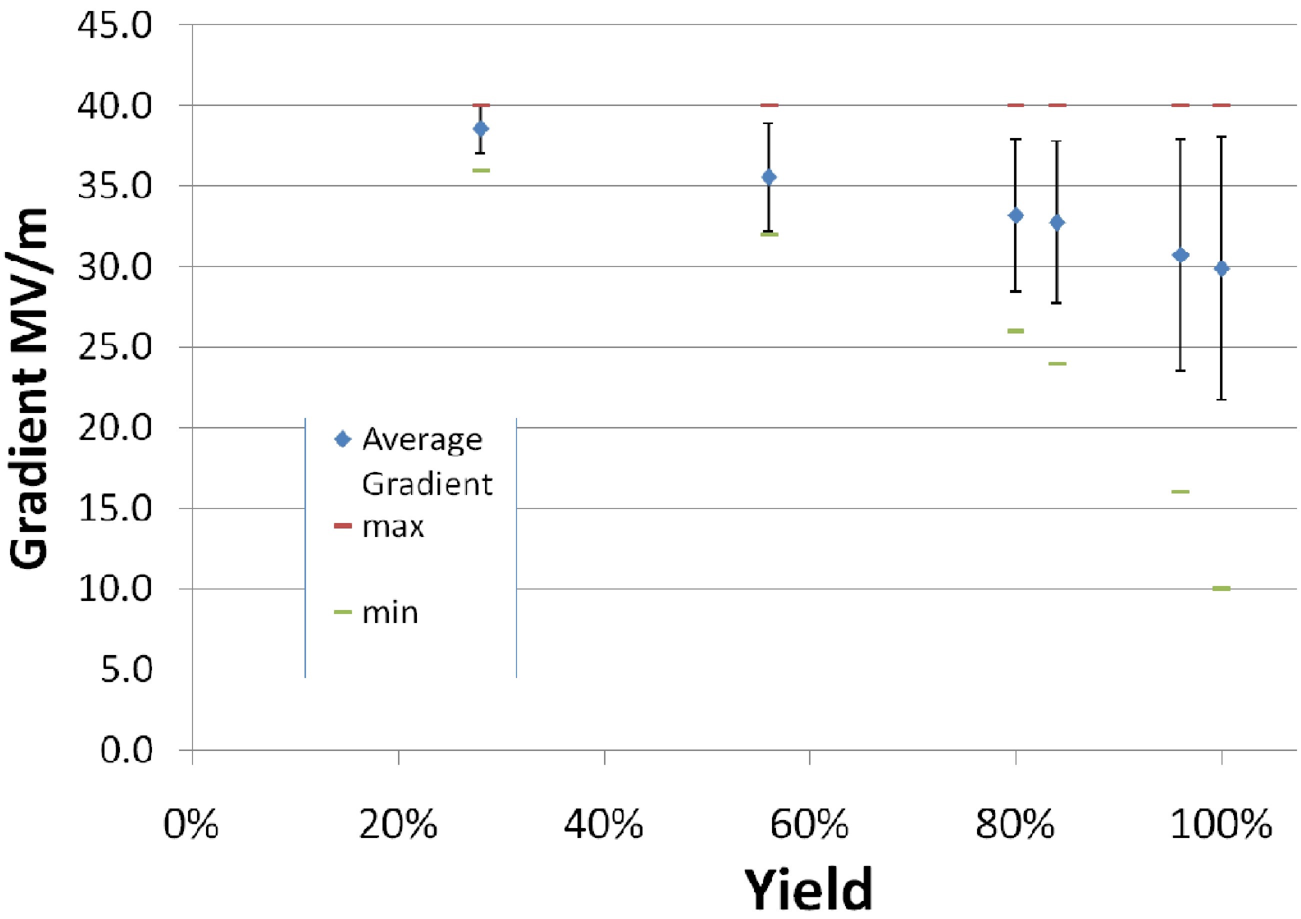
Standard Cavity Process/Recipe

	Standard Cavity Recipe
Fabrication	Nb-sheet purchasing
	Component preparation
	Cavity assembly with EBW
Process	Electro-polishing (~150um)
	Ultrasonic degreasing with detergent, or ethanol rinse
	High-pressure pure-water rinsing
	Hydrogen degassing at > 600 C
	Field flatness tuning
	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

Gradient Goal



Alternate Yield Definition



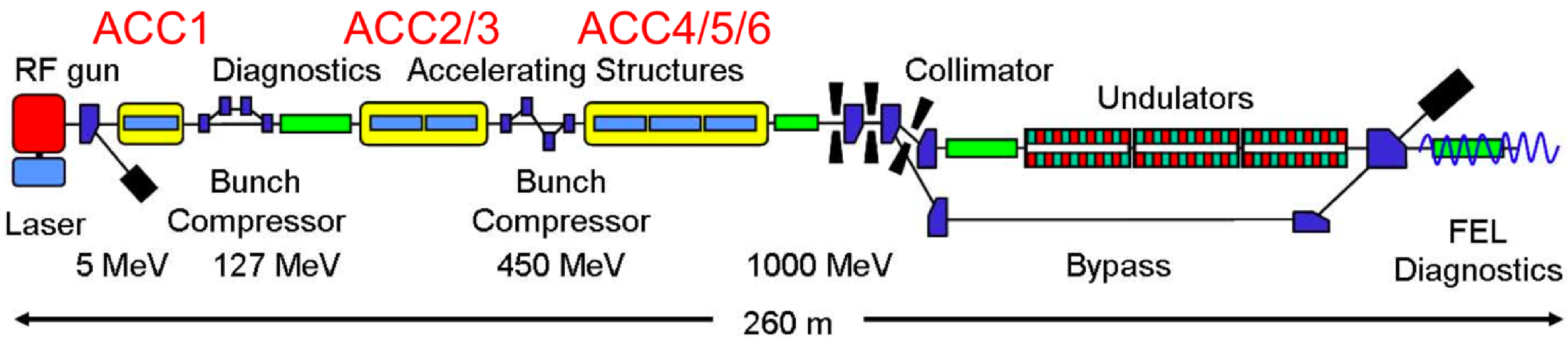
- Allowing for gradient spread
- Additional RF power needed to compensate
- 20% spread seems reasonable

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 string assembly and test (DESY, FNAL, INFN, KEK)				
System Test with beam acceleration		FLASH (DESY) , NML (FNAL) STF2 (KEK, extend beyond 2012)				
Preparation for Industrialization			Mass-Production Technology R&D			

TTF/FLASH 9mA Experiment

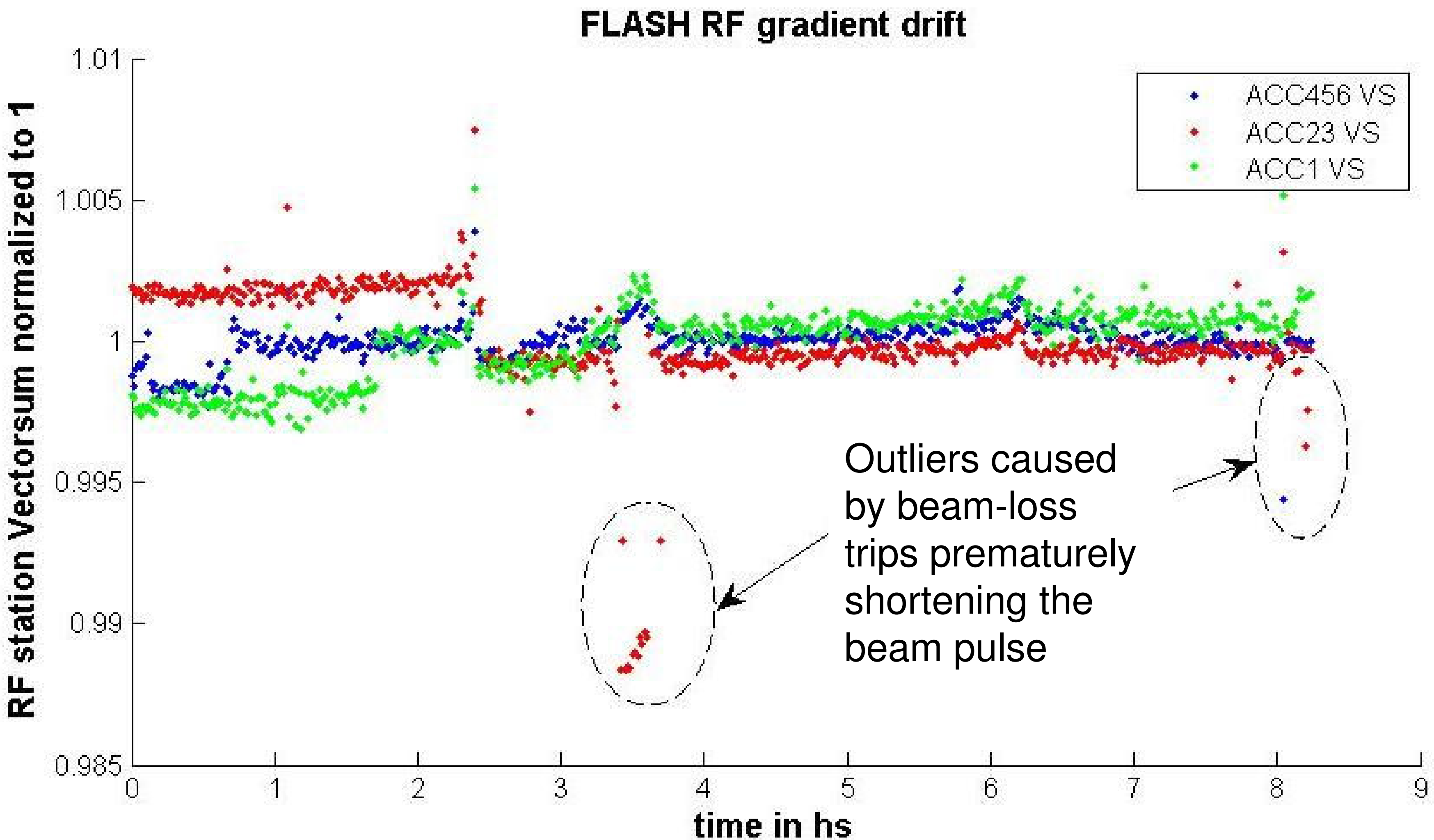
Full beam-loading long pulse operation → “S2”



		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

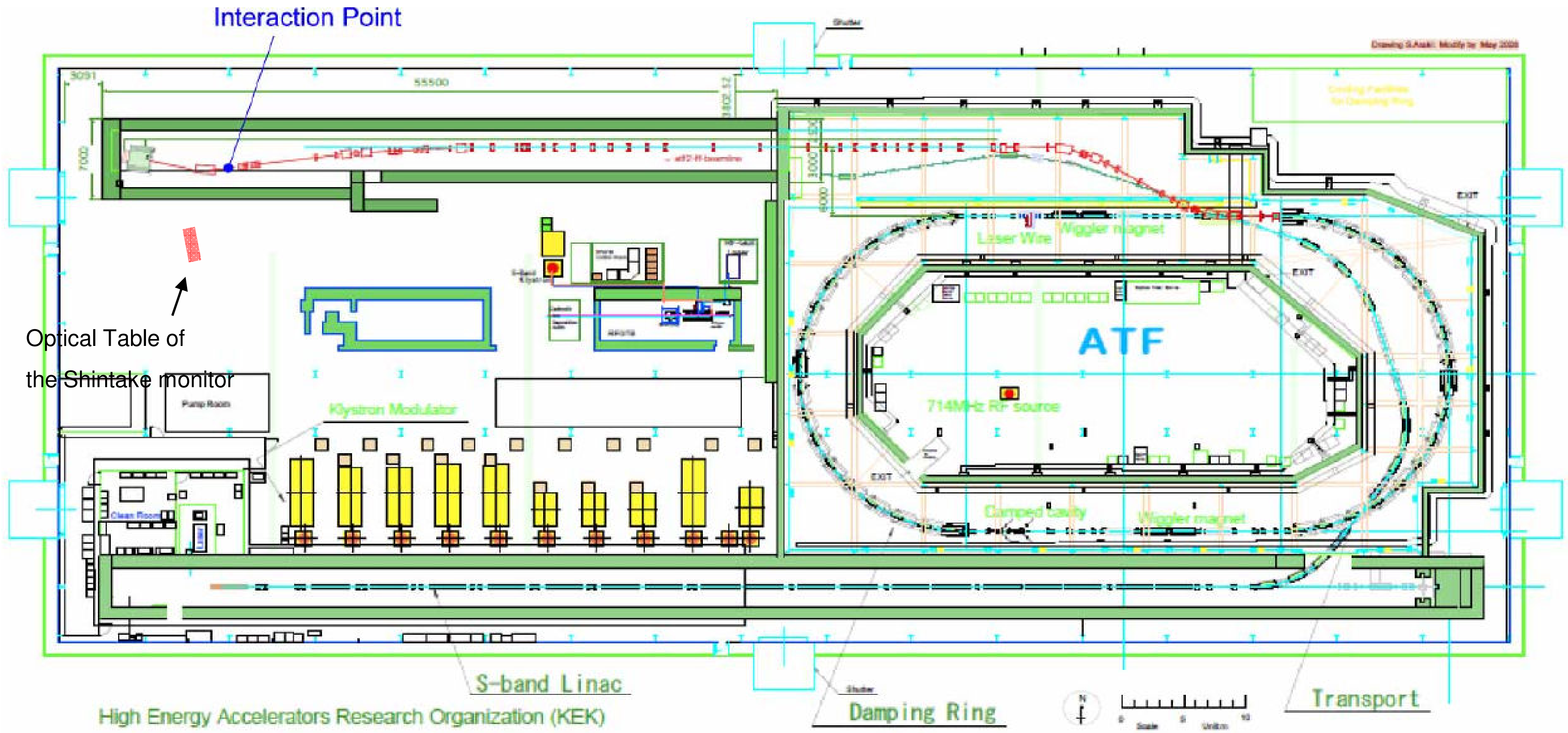


Example Result

Today

- PAC and AAP Reviews - Responses
- R&D Plans and Resources
- Key R&D Efforts
  - SCRF
  - ATF2
  - CesrTA
- Proposed New Baseline (SB2009)
- ILC / CLIC Collaboration
- TDR and PIP (2012) and beyond
- Final Remarks

ATF/ATF2



ATF2 Goals

- **Test fast kicker magnet**
- **Focus the electron beam to 35 nm in vertical**
- **Stabilize the vertical beam position with 2 nm resolution**

ATF/ATF2 Layout

Today

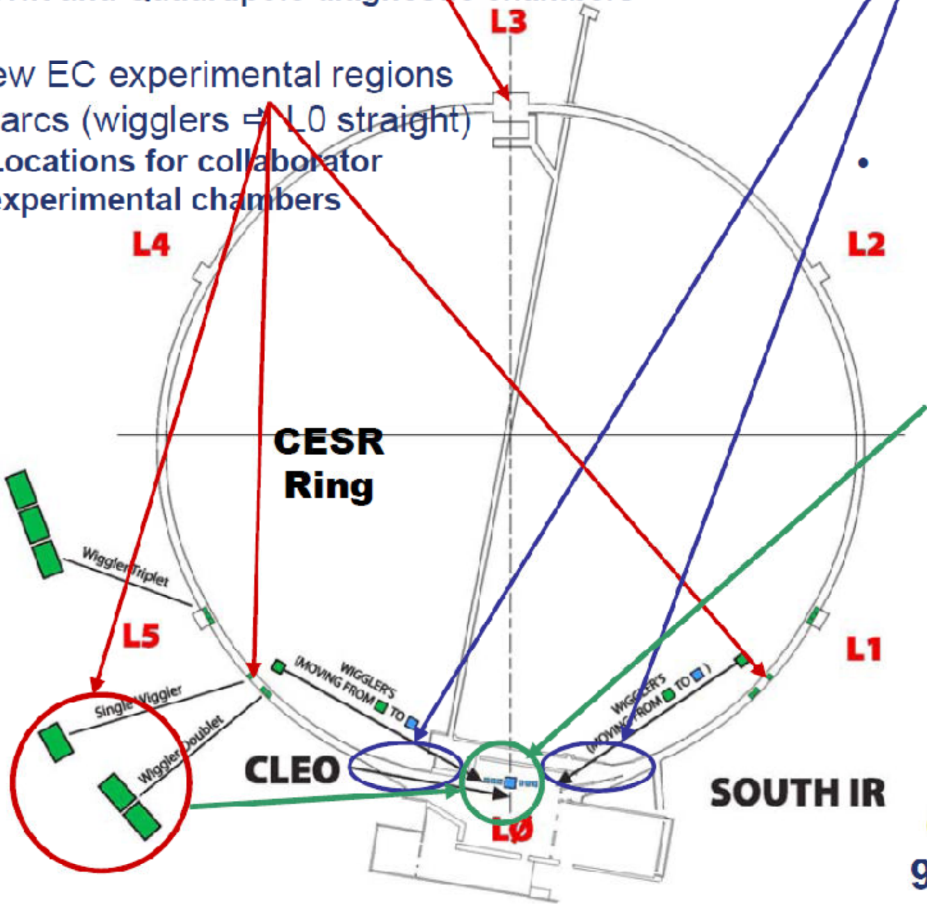
- PAC and AAP Reviews - Responses
- R&D Plans and Resources
- **Key R&D Efforts**
  - SCRF
  - ATF2
  - **CesrTA**
- Proposed New Baseline (SB2009)
- ILC / CLIC Collaboration
- TDR and PIP (2012) and beyond
- Final Remarks

CESR Reconfiguration

- L3 EC experimental region
  PEP-II EC Hardware: Chicane, upgraded SEY station (coming on line in May)

  Drift and Quadrupole diagnostic chambers

- New EC experimental regions in arcs (wigglers ⇒ L0 straight)
  Locations for collaborator experimental chambers



- CHESS C-line & D-line Upgrades
  Windowless (all vacuum) x-ray line upgrade

  Dedicated optics box at start of each line

  Detectors share space in CHESS user hutches

- L0 region reconfigured as a wiggler straight
  CLEO detector sub-systems removed

  6 wigglers moved from CESR arcs to zero dispersion straight

  Region instrumented with EC diagnostics and mitigation

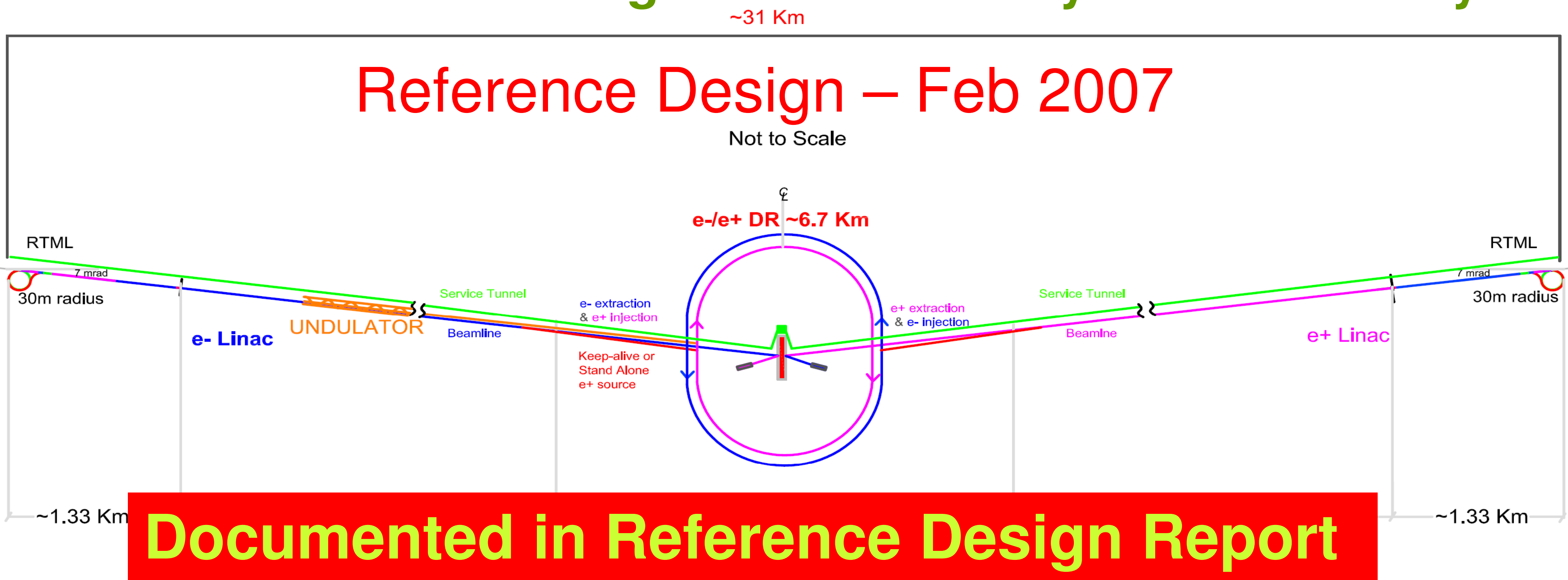
  Wiggler chambers with retarding field analyzers and various EC mitigation methods (fabricated at LBNL in CU/SLAC/KEK/LBNL collaboration)

Today

- PAC and AAP Reviews - Responses
- R&D Plans and Resources
- Key R&D Efforts
  - SCRF
  - ATF2
  - CesrTA
- **Proposed New Baseline (SB2009)**
- ILC / CLIC Collaboration
- TDR and PIP (2012) and beyond
- Final Remarks

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

International Costing

- “Value” Costing System: International costing for International Project
  - **Provides basic agreed to “value” costs**
  - **Provides estimate of “explicit” labor (man-hr)]**
- Based on a call for world-wide tender:
  - **Lowest reasonable price for required quality**
- Classes of items in cost estimate:
  - **Site-Specific: separate estimate for each sample site**
  - **Conventional: global capability (single world est.)**
  - **High Tech: cavities, cryomodules (regional estimates)**

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

Total Value Estimate = 6.62 B$ (US 2007)

(+ 24M person-hours explicit labor ~ $1.4 B U.S.)

- ILCSC MAC review
- International Cost Review

Total ~ 8.0 B 2007$

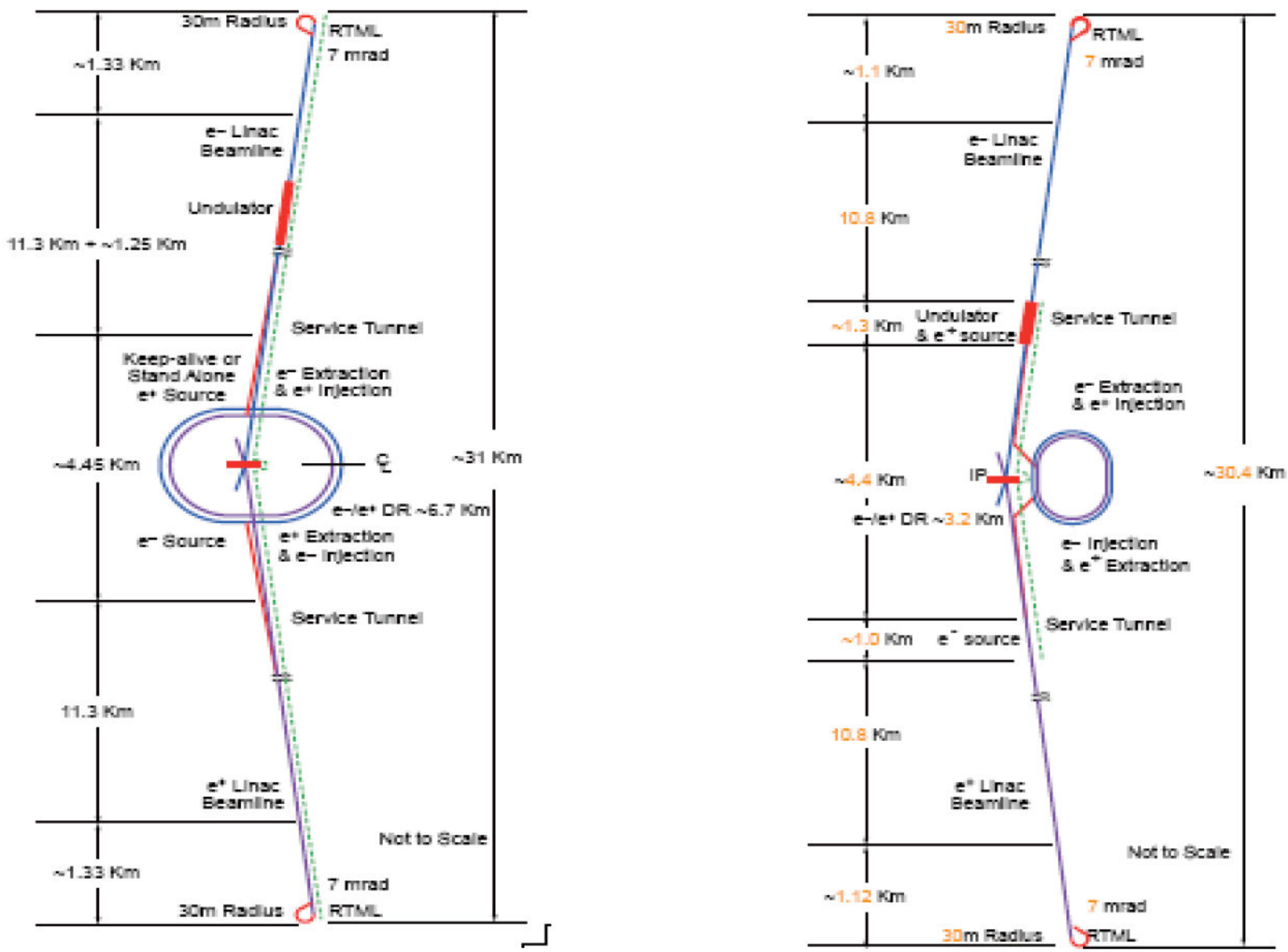
Translating to "U.S. Costs"

- <u>No official or detailed translation has been performed</u>
- What are the factors?
  - Add some contingency (note GDE estimates include some, but not all (DoE) contingency. It needs to be done item by item. (conservatively + 20%) [$8B → ~$10B]
  - Escalation to "then year dollars." This is the big factor that people use – escalating for ~ 15-20 years would be ~ 200%
  - For the total project, this gives **~$20B+** (then year $$)
- Comments:
  - US costs will only be a fraction of total project costs (off shore or on shore).
  - Thinking in "then year" $$ in the far future can be quite misleading. (Wages, GDP, etc also scale with inflation; Japan no inflation, etc)

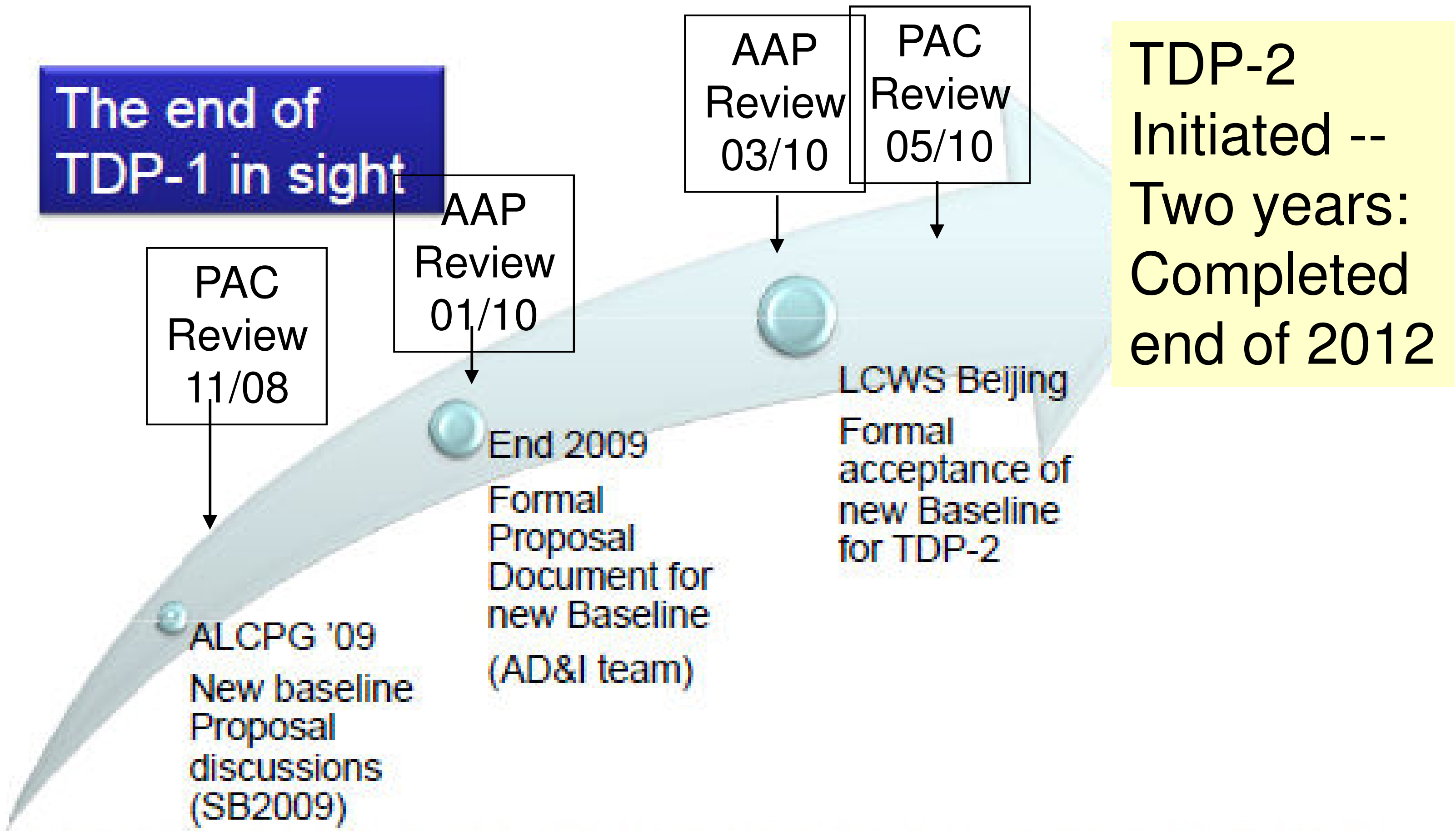
Rationale for Re-baseline

- 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**

Layouts: RDR vs SB2009



Timeline


The end of TDP-1 in sight
PAC Review 11/08
AAP Review 01/10
AAP Review 03/10
PAC Review 05/10
TDP-2 Initiated -- Two years: Completed end of 2012
ALCPG '09
New baseline Proposal discussions (SB2009)
End 2009
Formal Proposal Document for new Baseline
(AD&I team)
LCWS Beijing
Formal acceptance of new Baseline for TDP-2

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.

Today

- PAC and AAP Reviews - Responses
- R&D Plans and Resources
- Key R&D Efforts
  - SCRF
  - ATF2
  - CesrTA
- Proposed New Baseline (SB2009)
- **ILC / CLIC Collaboration**
- TDR and PIP (2012) and beyond
- Final Remarks

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

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

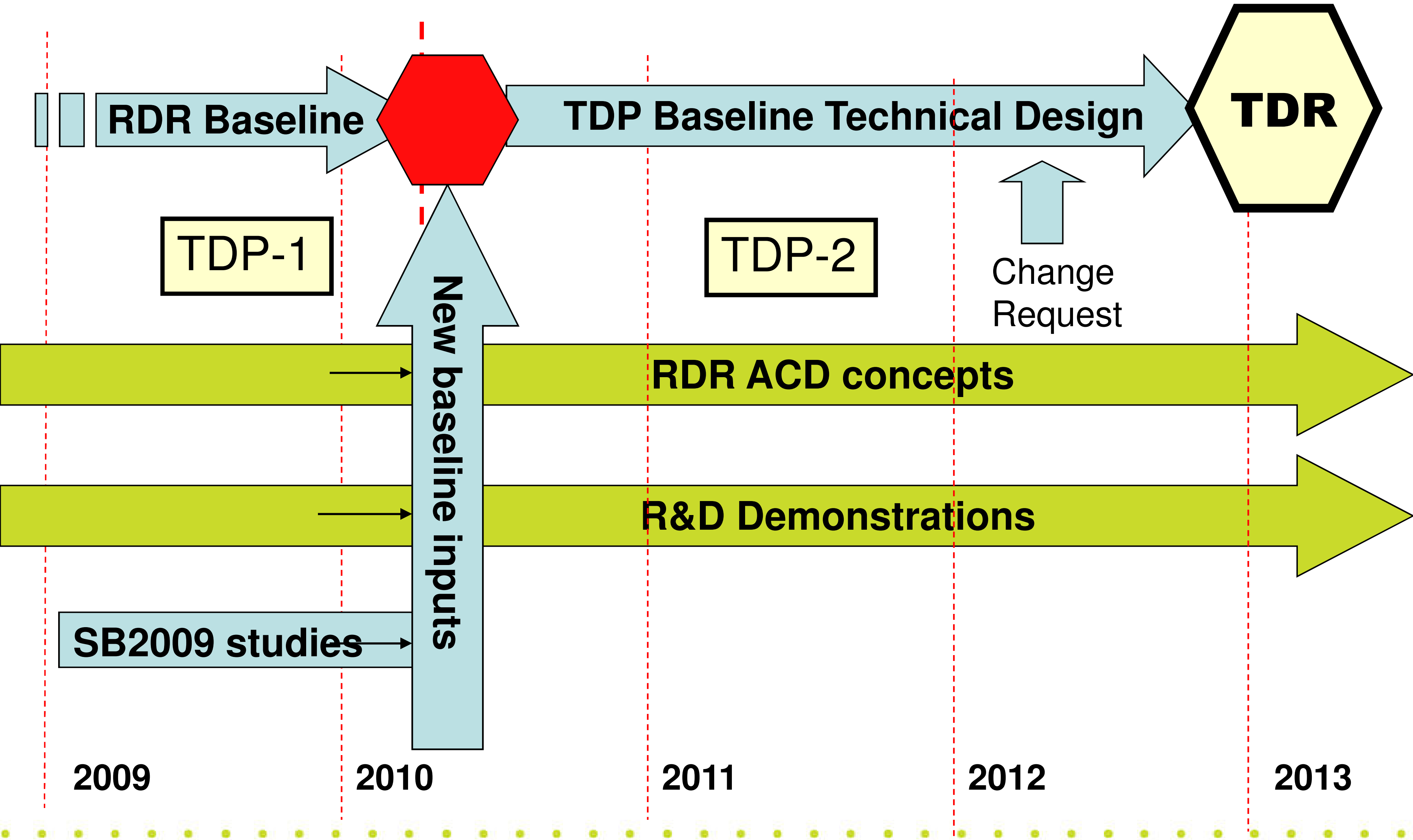
- ILCSC has approved formation of a CLIC/ILC General Issues working group by the two parties with the following mandate:
  - **Promoting the Linear Collider**
  - **Identifying synergies to enable the design concepts of ILC and CLIC to be prepared efficiently**
  - **Discussing detailed plans for the 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.

- The committee has been appointed:
  - **P.LeBrun (co-chair), D.Schulte, K.Peach [CLIC]**
  - **M.Harrison (co-chair); E.Elsen; K.Yokaya [ILC]**

Today

- PAC and AAP Reviews - Responses
- R&D Plans and Resources
- Key R&D Efforts
  - SCRF
  - ATF2
  - CesrTA
- Proposed New Baseline (SB2009)
- ILC / CLIC Collaboration
- **TDR and PIP (2012) and beyond**
- Final Remarks

Technical Design Phase and Beyond



What happens after 2012?

- Technical Design and Costs (by end 2012)
  - ILC Design optimized for cost / performance / risk
  - R&D program completed for major technical risk issues (SCRF gradient/yield, electron cloud mitigation, etc)
  - Value Costs well established
  - Safety, reliability and other project issues addressed.
- After 2012 ?
  - Global plans are being developed.
  - Main elements – Continuing SCRF R&D, especially systems tests and industrialization; Selective design efforts (e.g. positrons); siting; etc

Timescale for ILC (Project Case)

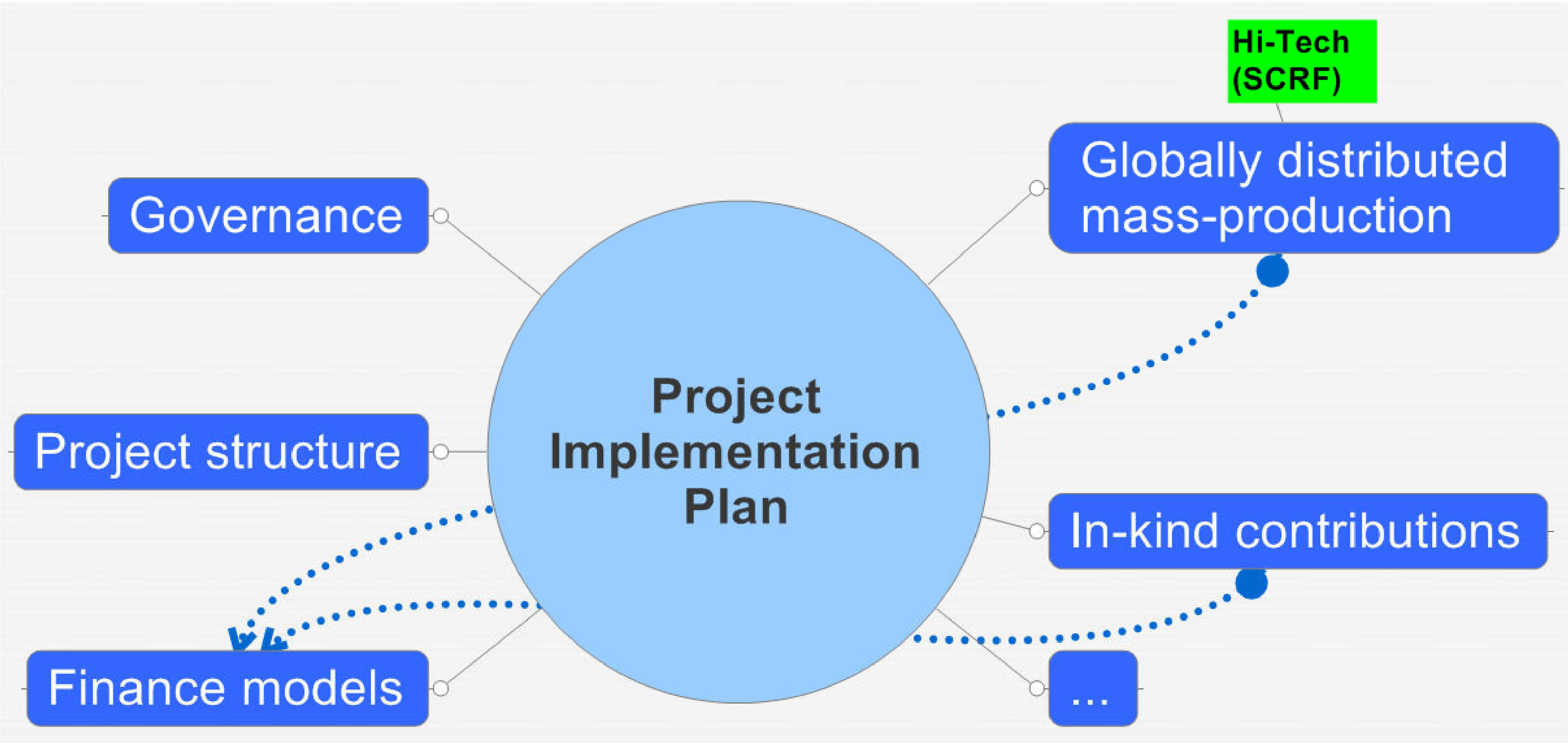
- Technical Design and Costs (by end 2012)
  - **ILC Design optimized for cost / performance / risk**
  - **R&D program complete for major technical risk issues (SCRF gradient/yield, electron cloud mitigation, etc)**
  - **Industrialization advanced toward worldwide production**
  - **Value Costs well established**
  - **Safety, reliability and other project issues addressed.**

Timescale for ILC (Science Case)

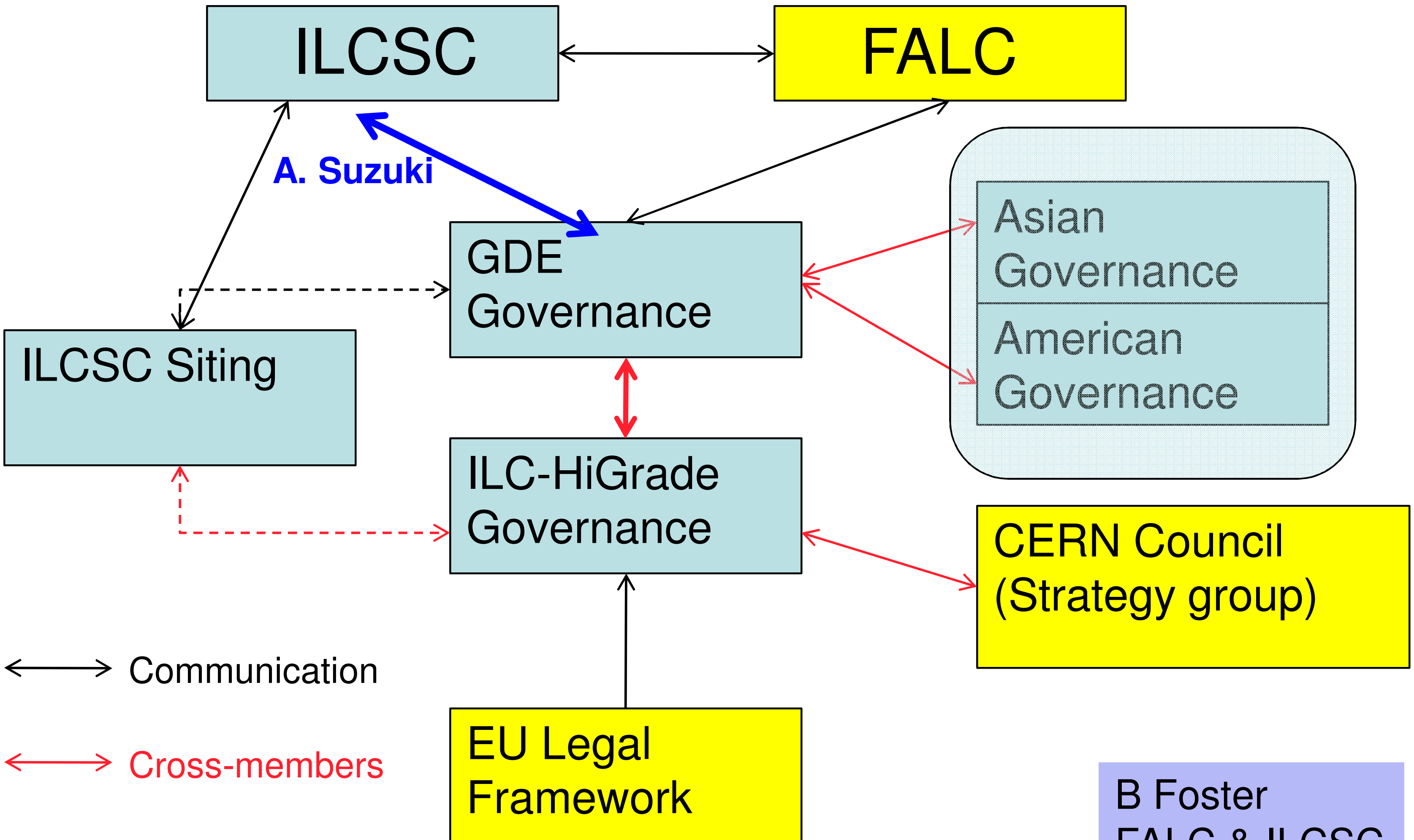
	July	LHC	
8 TeV	2010	3 pb ^{1}	min bias, QCD
	2011	300 pb^{-1}	$\tilde{q}$ at 600 GeV, MET at 2σ, l+l+ at 3σ Z' at 1.5 TeV stable $\tilde{l}$- at 200 GeV
14 TeV	2012	1 fb^{-1}	$\tilde{q}$,$\tilde{g}$ at 1 TeV, MET, ll, lll at 5σ Higgs at 300 GeV in ZZ
	2013	10 fb^{-1}	Higgs at 140 GeV in ZZ*
	2014	30 fb^{-1}	Higgs at 120 GeV in $\gamma\gamma$ $t\bar{t}$ resonance at 3 TeV
	2015	100 fb^{-1}	strong WW scattering unexpected Q at 2 TeV
	2016	200 fb^{-1}	strong ZZ scattering unexpected Q at 3 TeV

M Peskin

Project Implementation Plan



Governance



B Foster
FALC & ILCSC

Today

- PAC and AAP Reviews - Responses
- R&D Plans and Resources
- Key R&D Efforts
  - SCRF
  - ATF2
  - CesrTA
- Proposed New Baseline (SB2009)
- ILC / CLIC Collaboration
- TDR and PIP (2012) and beyond
- **Final Remarks**

Implications SB2009
Physics/Detectors

Initial Comments from the RD's SB2009 Working Group

Working Group Members: Mark Thomson, Tom Markiewicz, Karsten Buesser, Akiya Miyamoto, Keisuke Fujii, Jim Brau

Concerns:

- The main concern is the impact of SB2009 on the potential physics programme of the ILC. In particular the possibility of studying a low mass Higgs boson at the optimal centre-of-mass energy of sqrt(s) ~ 250 GeV. Understanding the nature of the Higgs boson is central to the ILC and reduced luminosity at low energies could significantly damage the physics reach of the ILC.
- Increased beamstrahlung reduces the useful luminosity at given centre-of-mass energy.
- Beam energy spread is also important; in the Higgs recoil mass analysis, this is the limiting factor for the LoI studies (RDR parameters).
- Increased backgrounds will impact on detector performance, e.g.
  - **may imply moving VTX inner radius out to 20mm, which will degrade (somewhat) flavour tagging performance and may have a large impact on the ability to reconstruct the charge of displaced vertices.**
  - **increased background levels may result in moving the inner acceptance of the forward calorimeters (LumiCAL/BCAL) which will reduce the hermeticity of the detector.**

Implications SB2009

Physics/Detectors

- The above effects will degrade the physics reach of the ILC; we are concerned about the impact on the competitiveness of the ILC compared to the LHC and CLIC.
- There are concerns about the impact of the reduction of the size of the damping rings on possible upgrade options for the ILC.
- The narrowed margin for performance raises concerns regarding the risk for delivering the design luminosity; concerns include kicker jitter, collimation tolerances & jitter, traveling focus feasibility, and others.
- There were also questions about the economics of cost saving on the machine and longer ILC operation to reach the same integrated luminosity.

\+ Specific Questions …….

We have just received the concerns (and questions). They will be addressed as part of the decisions on SB2009

Conclusions

- **We are on course to carry out our R&D plan, including critical R&D, technical design based on new baseline by end of 2012 and a project implementation plan.**
- **Earliest start for a construction project is ~ 2015, assuming science case, funding, siting, etc are in place**
- **CERN (see Sept *Physics World*) has stated its intent (or desire) to host a linear collider (either ILC or CLIC). This must be considered a serious possibility, with earliest start ~ 2018**
- **Other possibilities remain viable on a shorter timescale. We will support keeping the options as open as possible.**