Global Design Effort

Overview

Barry Barish

PAC - Paris

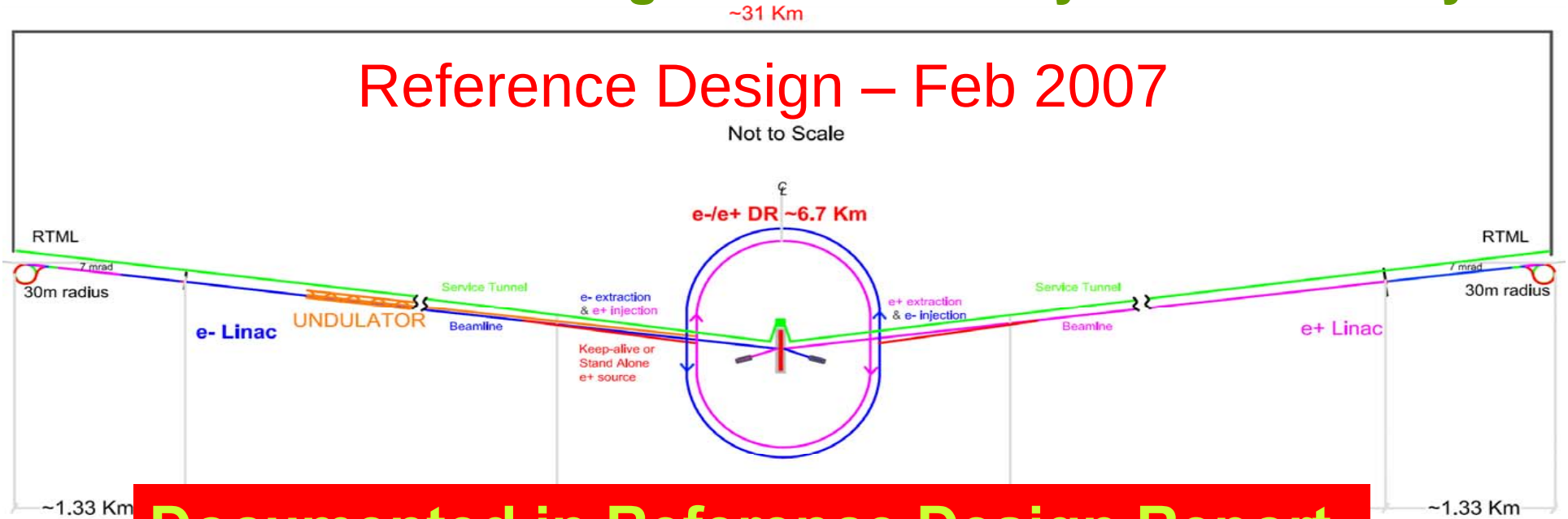
19-October-08

Status and Plans

- What have we accomplished?
  - **A reference design was completed and accepted by FALC (July 07), ILCSC and ICFA (Aug 07)**
- Where are we going? (The plan for the GDE)
  - **Technical Design Phase (TDP)**
    - **TDP1 – 2010; TDP2 – 2012**
- What do we plan to accomplish in TDP?
  - **R&D Goals: ATF2; SCRF; CesrTA (test facilities)**
  - **The Minimum Design - Optimizing cost to performance; new baseline and technical design**
  - **Project Implementation Plan**

TDP Starting Point: ILC RDR

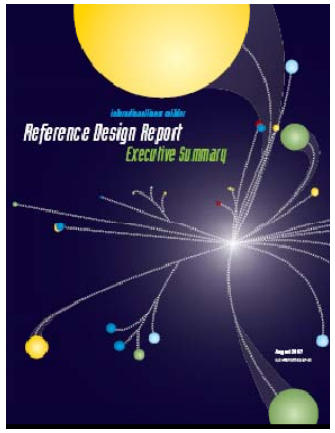
- **11km SC linacs operating at 31.5 MV/m for 500 GeV**
- **Centralized injector**
  - Circular damping rings for electrons and positrons
  - Undulator-based positron source
- **Single IR with 14 mrad crossing angle**
- **Dual tunnel configuration for safety and availability**



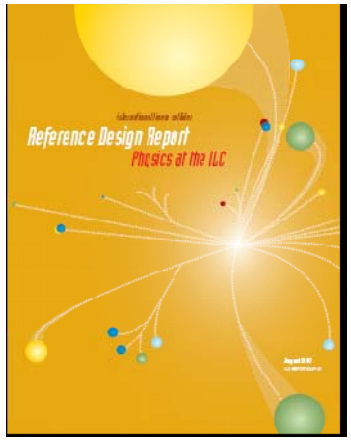
Documented in Reference Design Report

ILC Reference Design

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

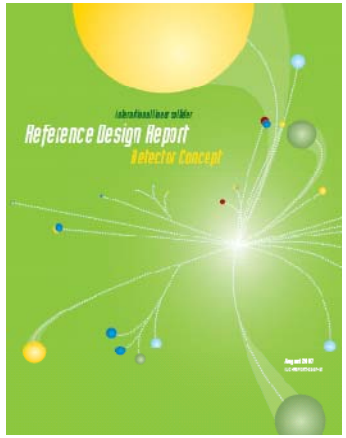


Executive Summary



Physics at the ILC

Accelerator



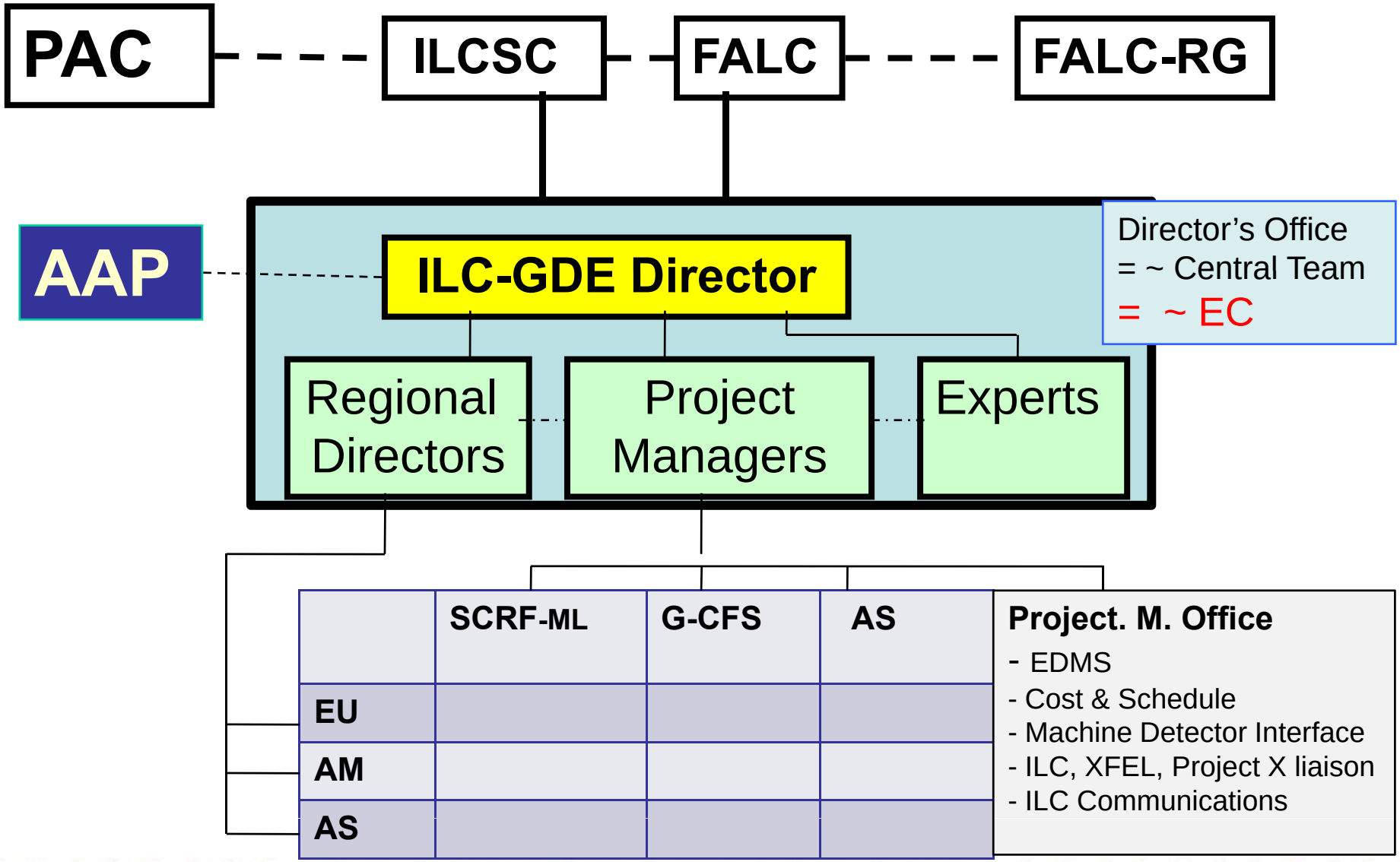
Detectors

How do we propose to move forward?

*Our General Theme is **RISK REDUCTION***

- We will re-examine the ILC RDR design to optimize for cost to performance.
- This will perform aggressive studies of the major cost drivers, including reducing scope, staging, etc. We will do this openly and in full coordination with experimentalists.
- We will develop the technical design, such that the major technical questions (gradient, electron cloud, etc) are positively resolved
- We will develop the technical design toward a construction proposal (plug compatible designs, value engineered concepts, etc.)
- Finally, we will develop an attractive, realistic and flexible Project Implementation Plan

ILC-GDE Organization Chart



Top Level Organization/Roles

Sunday 19 October 2008

8:30. Executive Session
9:30. Welcome
9:35. GDE Overview. B. Barish (50+10)
10:35. Break
10:50. Accelerator Advisory Panel (AAP). E. Elsen (35+10)
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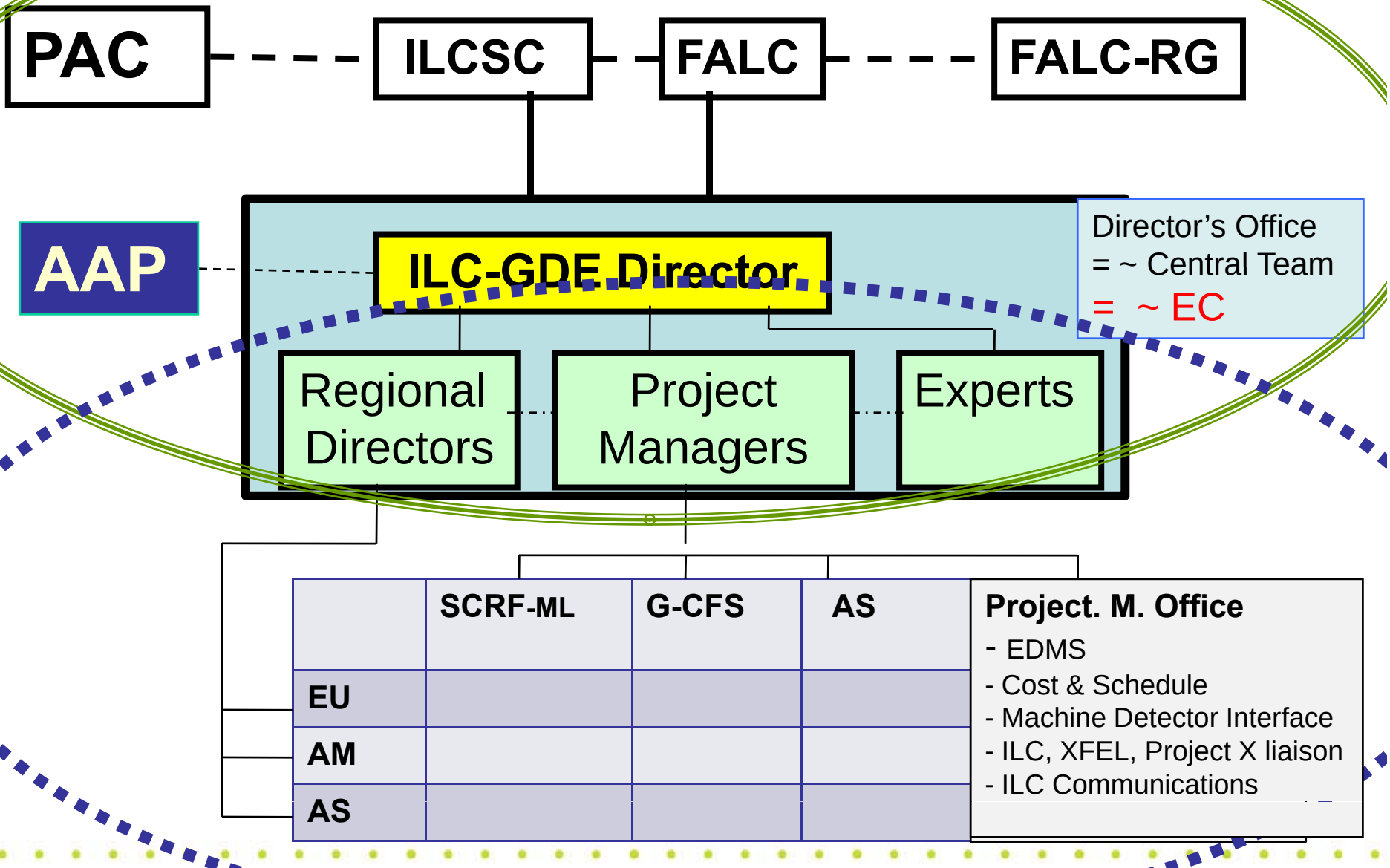
GDE Overview - Barish



Role of FALC

- **Special Role for the ILC: <u>There is no host laboratory for the ILC development</u>;**
  - FALC crucial for project / fiscal / resource advice
    - ILSCS for scientific, technical and performance advice
    - FALC for resource advice and planning
  - ILC R&D plan reviewed and endorsed by FALC RG (Give legitimacy to global plan when dealing with individual agencies countries and agencies)
    - Enables understanding of where and how ILC R&D support in any country fits into the global picture
    -
  - Guidance needed in developing funding models and an implementation plan
    - Governance; funding; siting; industrialization etc. How to put together a realistic plan for partner countries

FALC – Terms of Reference

- To consider the wider picture of particle physics research, to understand the priorities and constraints in each region and to provide information and guidance to governments for planning and coordinating large particle physics facilities.
- To improve the possibilities for international co-operation by understanding the planning processes in the funding agencies.
- To provide a forum to prepare for, and report, decisions about funding arrangements for future particle physics facilities.
- To provide a forum to promote knowledge of the applications of the technologies to be developed for large colliders, both in other scientific areas and in industry.
- Recognising ICFA as the scientific reference point, to receive reports from ICFA (and its subsidiary bodies as appropriate), on the status of programmes for future particle physics facilities.
- To exchange information on R&D projects being carried out for future particle physics facilities requiring international cooperation.
- To encourage global cooperation in the R&D programmes for existing projects (such as the LHC and J-PARC), promote coordination for projects in the R&D and design phase (such as the ILC) and share information on possible future technologies and projects (such as CLIC and a neutrino factory).
- To promote for the ILC specifically, the coordination of resources and the conduct of an R&D programme for the engineering design phase, and to work towards an appropriate organisational structure for the engineering design phase.
- To produce a public annual report, including a scientific report from ICFA and information on the global picture of R&D for future particle physics facilities.
- These Terms of Reference will be reviewed no later than 2010.

ECFA Governance Study

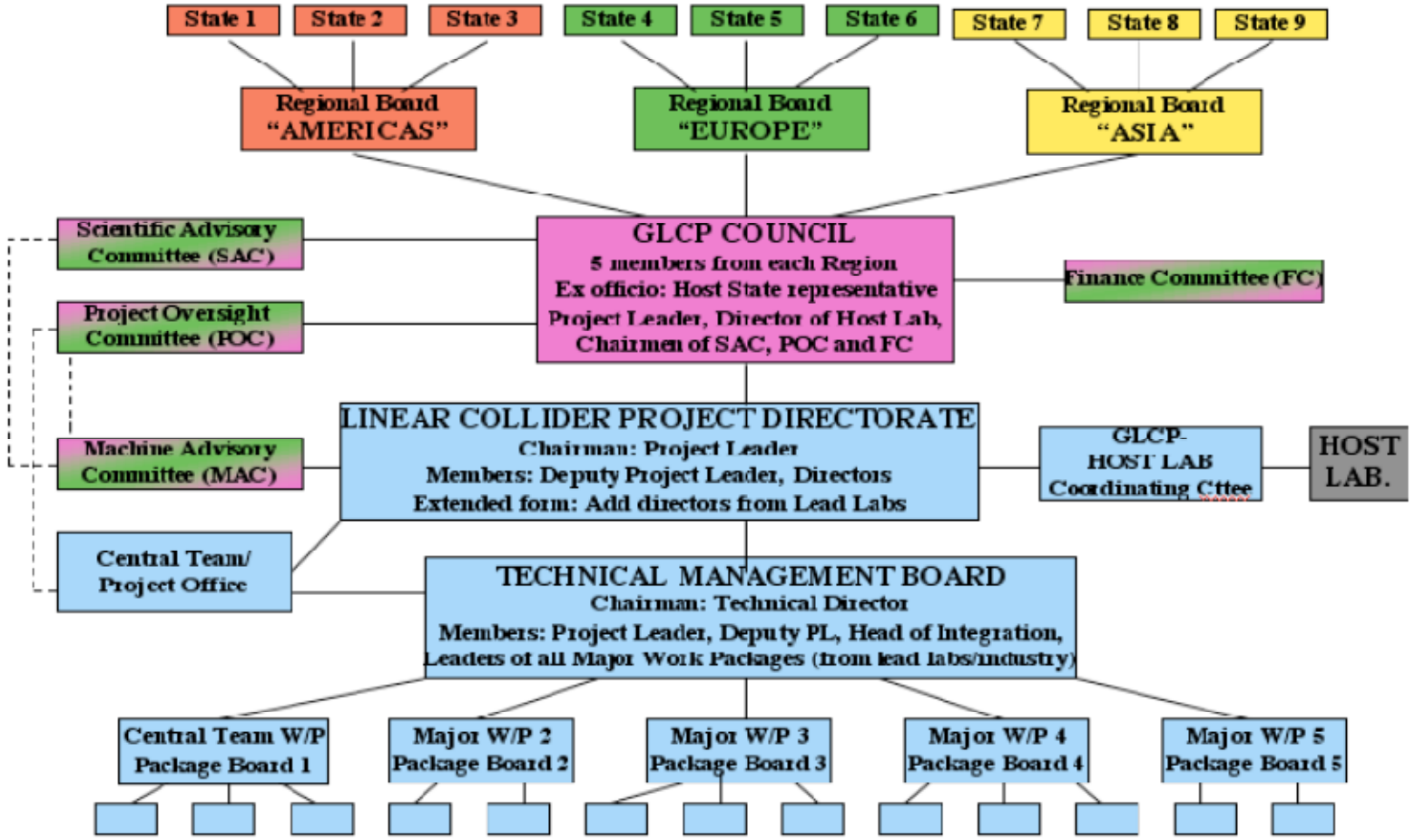


Fig. 1 Governance (GLCP Council and above), Management (Light blue boxes below GLPC Council) and Monitoring (Bi-coloured boxes) structure of the GLCP

ILC Governance & FALC Role

- Plan must be customized to satisfy requirements of host country and agency
- Plan must contain sufficient partner role in management, priorities and decision making to satisfy global partners
- Governance document by 2012 – Study group headed by Brian Foster to work out approaches to governance with FALC
- This may be our most important need from FALC in the coming few years.

ILCSC – Siting of the ILC

- GDE will understand practical considerations like the timelines for siting, including environmental studies, geological surveys, tunneling, etc
- GDE will technically evaluating siting options, including shallow vs deep siting; two tunnels vs one tunnel and optimization of the siting
- ILCSC will lead the effort to develop a strategy for soliciting siting.
- GDE and ILCSC will work together on models for host country responsibility etc

From Annex to ILCSC MOU

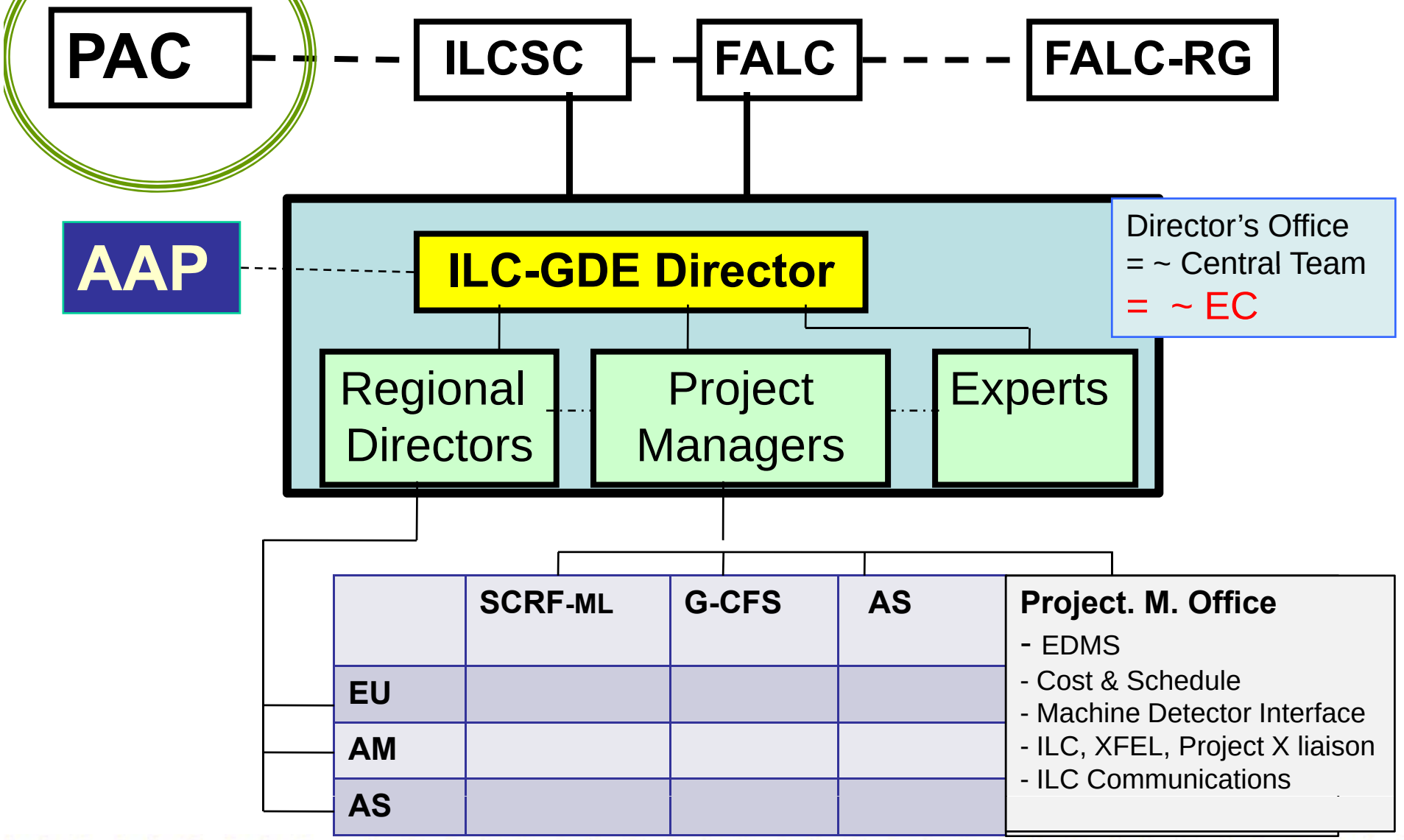
- **3. Composition of the Central Team**

3.1 The Central Team shall be led by the Central Team Director, who shall be selected and appointed by the ILCSC, having received recommendations from the Regional Steering Committees.

3.2 The Central Team Director shall appoint three Regional Directors, each nominated by the Regional Steering Committee of his or her region. Each Regional Director shall become a member of the Central Team and shall facilitate the GDE in his or her region.

3.4 The Central Team shall have its own staff, including (a) Project Manager(s), who shall assist the Central Team in the execution of its duties.

The Project Advisory Committee



ILCSC - PAC Mandate

- **ILC Project Advisory Committee (PAC) Mandate**
  - 1. The International Linear Collider Steering Committee (ILCSC) is responsible for the oversight of the Global Design Effort (GDE) activities and of the ILC experimental program.
  - 2. PAC will assist ILCSC in this function and report to the ILCSC.
  - 3. PAC will review the GDE accelerator activities and, in addition, the ILC detector activities.
  - 4. In its review activity, PAC will examine the overall consistency and realism of the project, in relation to physics, technical design, cost, and schedule.
  - 5. PAC shall comprise about nine members, appointed by the ILCSC for terms of two or three years, and will meet a few times per year until the completion of the Technical Design Phases I and II.
  - 6. The PAC Chair will be appointed by the ILCSC, normally for a two-year term.

Accelerator Advisory Panel (AAP)

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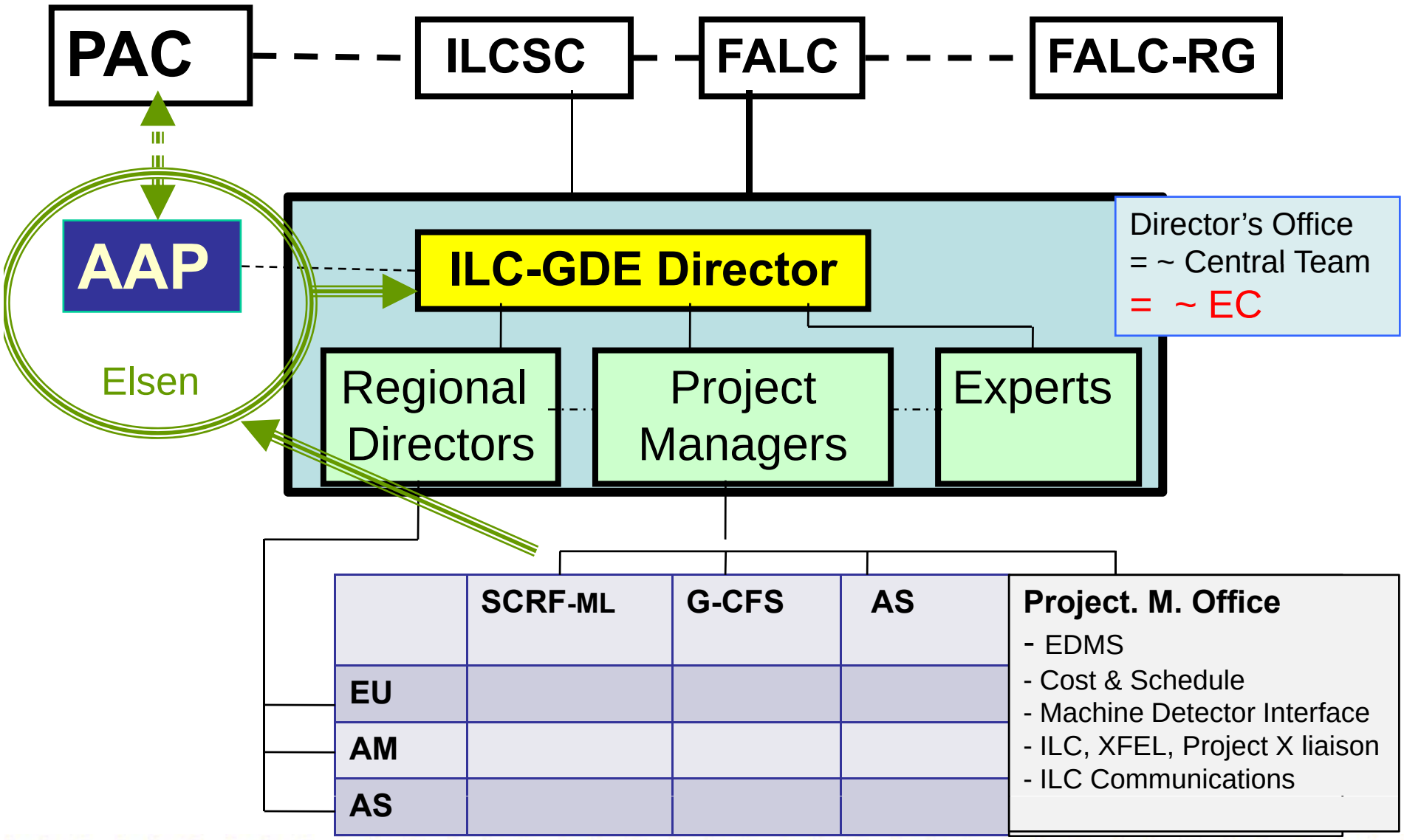
AAP – Elsen


PAC
ILCSC
FALC
FALC-RG
AAP
Elsen
ILC-GDE Director
Director's Office
= ~ Central Team
= ~ EC
Regional Directors
Project Managers
Experts
SCRF-ML
G-CFS
AS
EU
AM
AS
Project. M. Office
- EDMS
- Cost & Schedule
- Machine Detector Interface
- ILC, XFEL, Project X liaison
- ILC Communications

Project Coordination/Management

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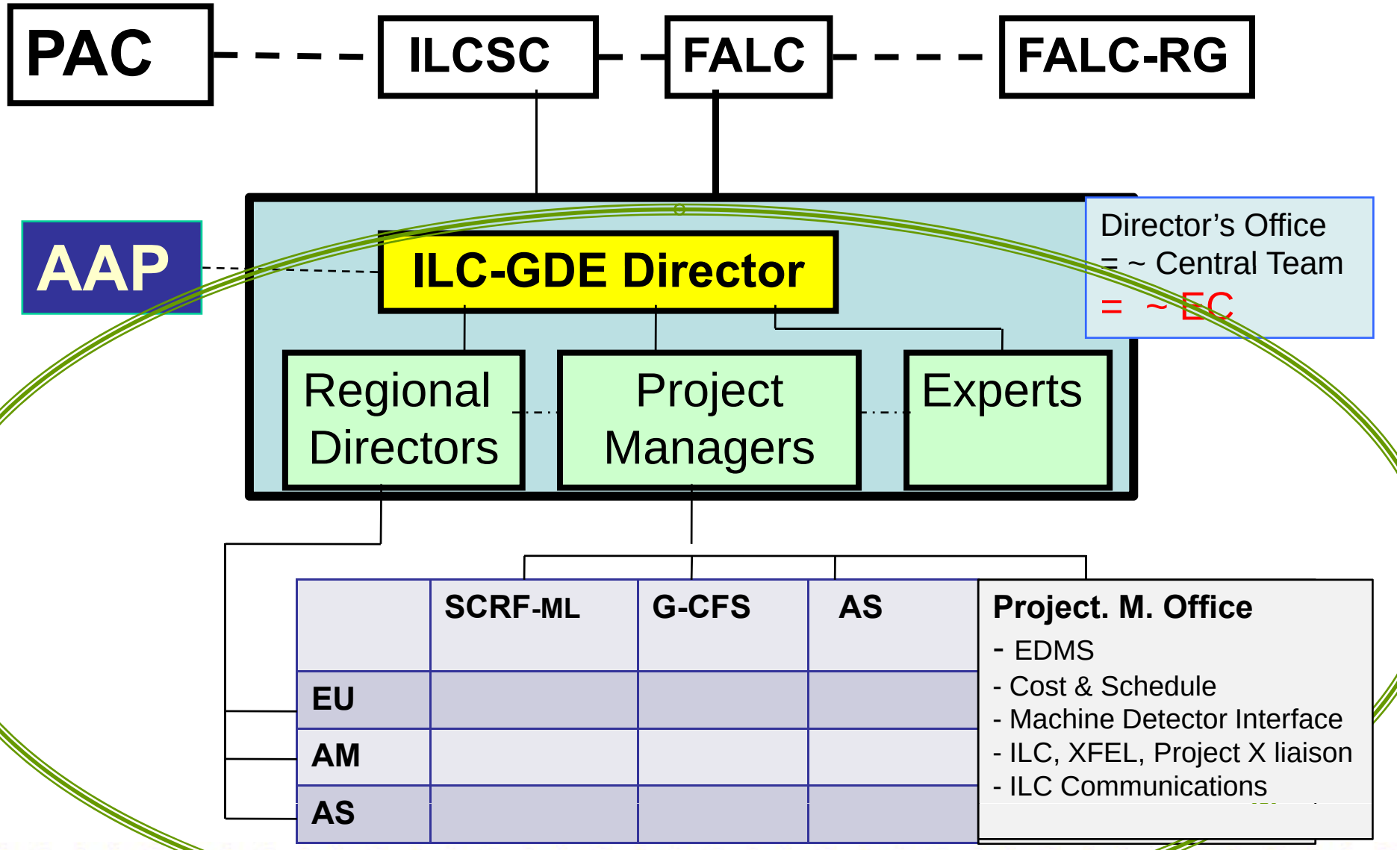
Project Coordination/Management - Ross



Managing/Coordinating the Program

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

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

Resources

- Regional Directors work with governments / agencies / laboratories on regional resources and priorities

- Reconcile program priorities with the GDE Director, PMs and EC

US / UK Funding Actions

- UK ILC R&D Program
  - **Before: About 40 FTEs. Leadership roles in Damping Rings and Positron Source, as well as effots on Beam Delivery System, Beam Instrumentation and Beam Dumps.**
  - **After: Program is now generic accelerator R&D, that retains key personnel and leadership roles.**
- US Program
  - **ILC R&D reduced $60M → $15M for FY08. Planning a reduced level program for FY09 and beyond. US President & Congressional FY09 budgets = $35M**
  - **Generic SCRF also terminated in FY08, but is proposed to be revived in FY09 to $25M. and separated from ILC R&D.**

P5 Report: ILC Recommendation

- ***"The panel recommends for the near future a broad accelerator and detector R&D program for lepton colliders that includes continued R&D on ILC at roughly the proposed FY2009 level in support of the international effort. This will allow a significant role for the US in the ILC wherever it is built."***

Proposed FY2009 Budget = $35.3M

(caveat – after US election and a continuing resolution)

Technical/Planning Major Goals

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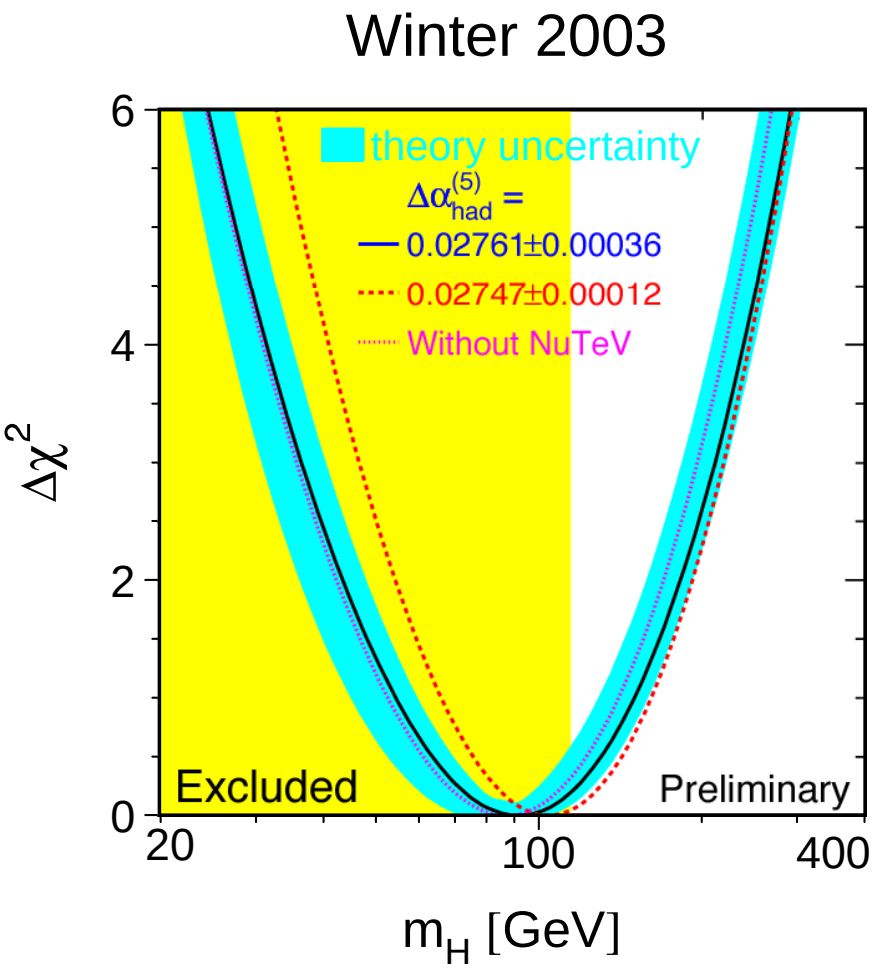
LHC Results and GDE Program?

- **We are presently planning a Technical Design Phase program, where we will be ready to propose the project in 2012**

- **The science guidance for a linear collider has not changed. We have strong reason to anticipate that the energy reach and luminosity of the SCRF ILC will be well matched to the goals.**

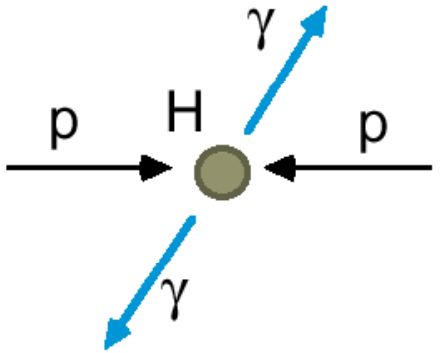
- **Nevertheless, the GDE program and linear collider proposal must be informed by LHC timescale and results.**

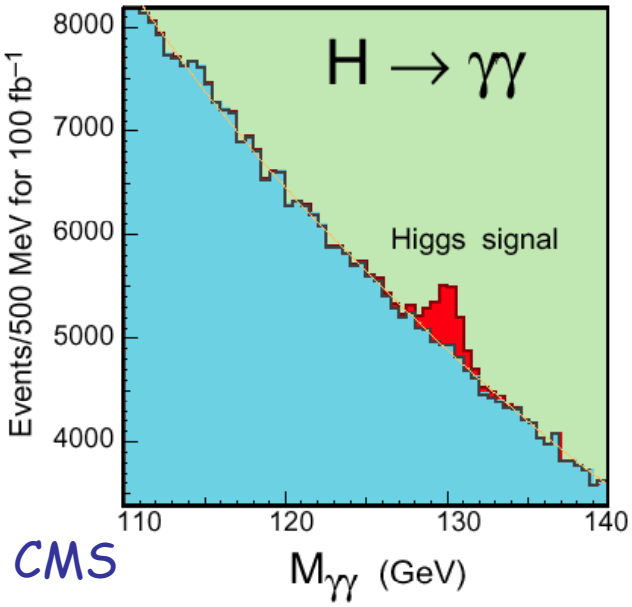


LHC: Low mass Higgs

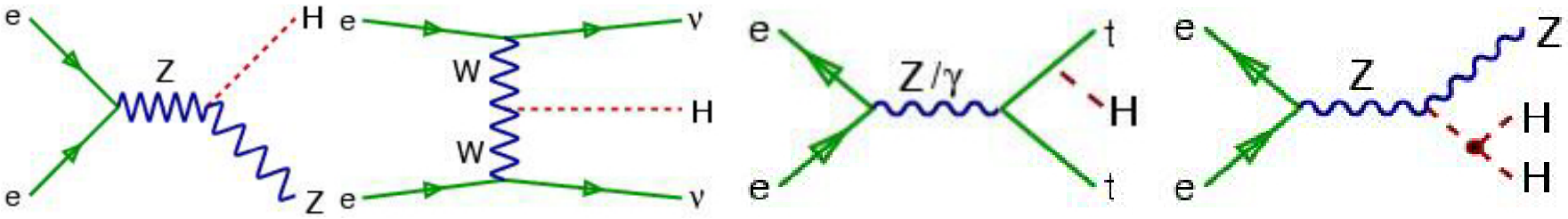
$H \rightarrow \gamma\gamma$ $M_H < 150\ GeV/c^2$

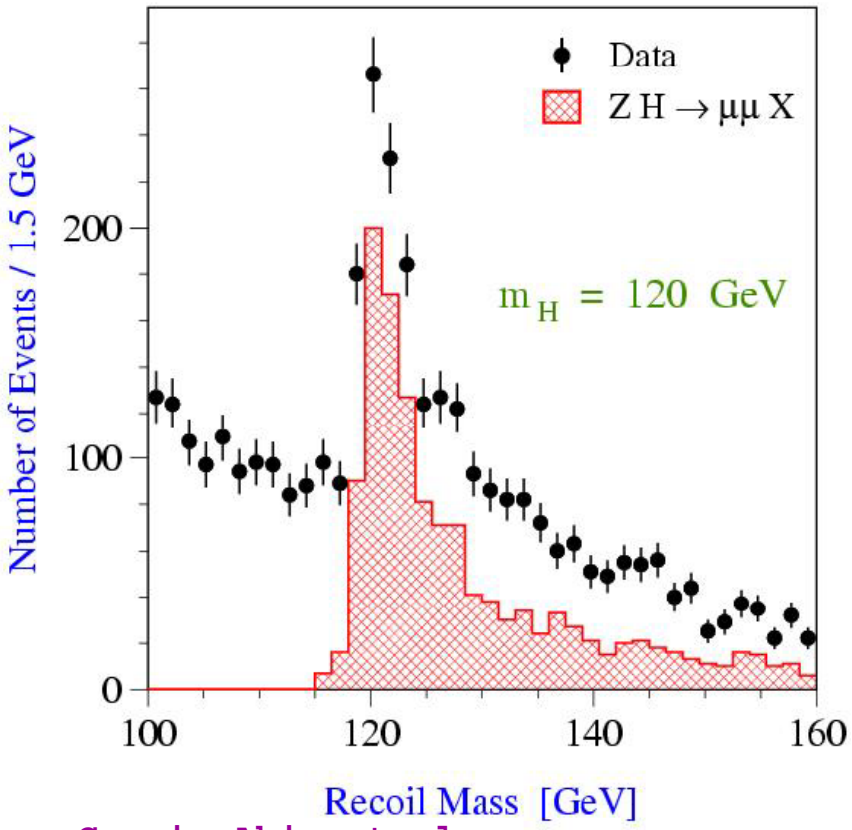
- Rare decay channel: BR ~ 10^{-3}
- Requires excellent electromagnetic calorimeter performance
  - acceptance, energy and angle resolution,
  - γ/jet and γ/π^0 separation
  - Motivation for LAr/$PbWO_4$ calorimeters for CMS
- Resolution at 100 GeV: $\sigma \approx 1$ GeV
- Background large: S/B $\approx$ 1:20, but can estimate from non signal areas





ILC: Precision Higgs physics





Garcia-Abia et al

- **Model-independent Studies**
  - **mass**
  - **absolute branching ratios**
  - **total width**
  - **spin**
  - **top Yukawa coupling**
  - **self coupling**
- **Precision Measurements**

Parameters for the ILC

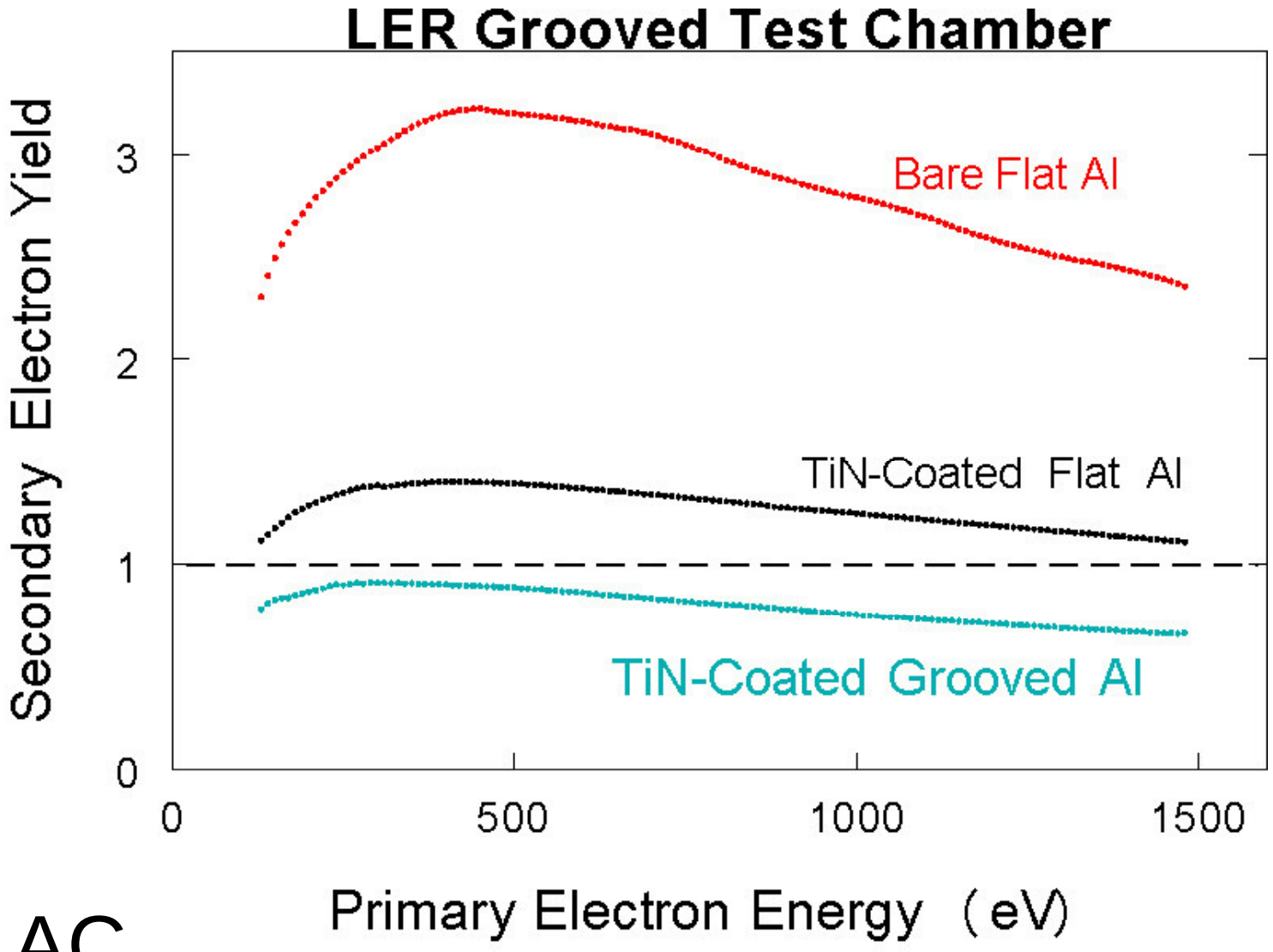
- E_{cm} adjustable from 200 – 500 GeV
- Luminosity → $\int L dt$ = 500 fb^{-1} in 4 years
- Ability to scan between 200 and 500 GeV
- Energy stability and precision below 0.1%
- Electron polarization of at least 80%

- **The machine must be upgradeable to 1 TeV**

GDE Plan – Major Elements

- GDE R&D program for the next phase will follow the *"Technical Design Phase R&D Plan"*
- A two stage ILC Technical Design Phase (TDP-1 2010 and TDP-2 2012 is proposed
  - **R&D program to demonstrate gradient, electron cloud, RF unit, etc.**
  - **Minimal Machine Approach to make cost effective design**
  - **Conventional Facilities Cost Drivers (1 vs 2 tunnels, shallow vs deep siting, technical drivers like water systems.**
- Develop a Project Implementation Plan

E Cloud – Results



SLAC

Electron cloud – Goal

- Ensure the e- cloud won't blow up the e+ beam emittance.
  - **Do simulations (cheap)**
  - **Test vacuum pipe coatings, grooved chambers, and clearing electrodes effect on e-cloud buildup**
  - **Do above in ILC style wigglers with low emittance beam to minimize the extrapolation to the ILC.**
  - **Test program is underway at CESR Cornell (CesrTA)**

TD Phase 1

- Timescale: Interim report mid 2010
- Major theme: High-priority risk-mitigating R&D
  - **R&D demonstrations**
  - **Minimum design -- top down cost/performance optimizaton to develop a new baseline by 2010**
  - **Studies of governance**
  - **Development of a siting plan with ILCSC**

TD Phase 2

- Timescale: Produce report mid-2012
- **First goal:** New baseline design
  - **SCRF – S1 Test of one RF unit**
  - **Detailed technical design studies**
  - **Updated VALUE estimate and schedule**
  - **Remaining critical R&D and technology demonstration**
- **Second Goal:** Project Implementation Plan.

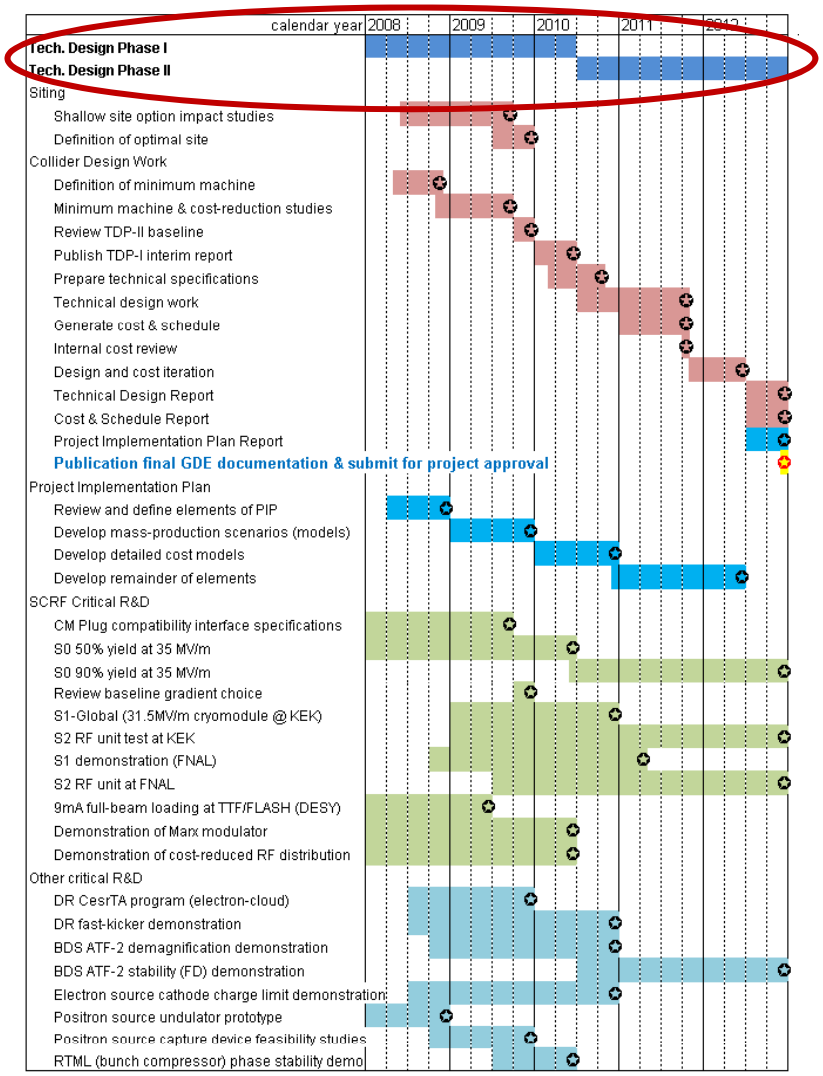
ILC R&D Major Test Facilites

Test Facility	Acronym	Purpose	Host Lab	Operation start	Organized through:
Accelerator Test Facility	ATF	Damping Ring	KEK	1997	ATF Collaboration
Cornell Test Accelerator	CESR-TA	Damping Ring	Cornell	2008	Cornell
Superconducting RF Test Facility	STF	Main linac	KEK	2008	KEK
TESLA Test Facility/ Free Electron Laser Hamburg	TTF FLASH	Main linac	DESY	1997	TESLA Collaboration, DESY
ILC Test Accelerator	ILCTA-NML	Main Linac	FNAL	2009	Fermilab
Beam Delivery Test Facility	ATF-2	Beam Delivery	KEK	2008	ATF Collaboration
End Station A (program terminated 2008)	ILC-SLAC ESA	Machine – Detector Interface	SLAC	2006	SLAC

R&D Test Facilities Deliverables

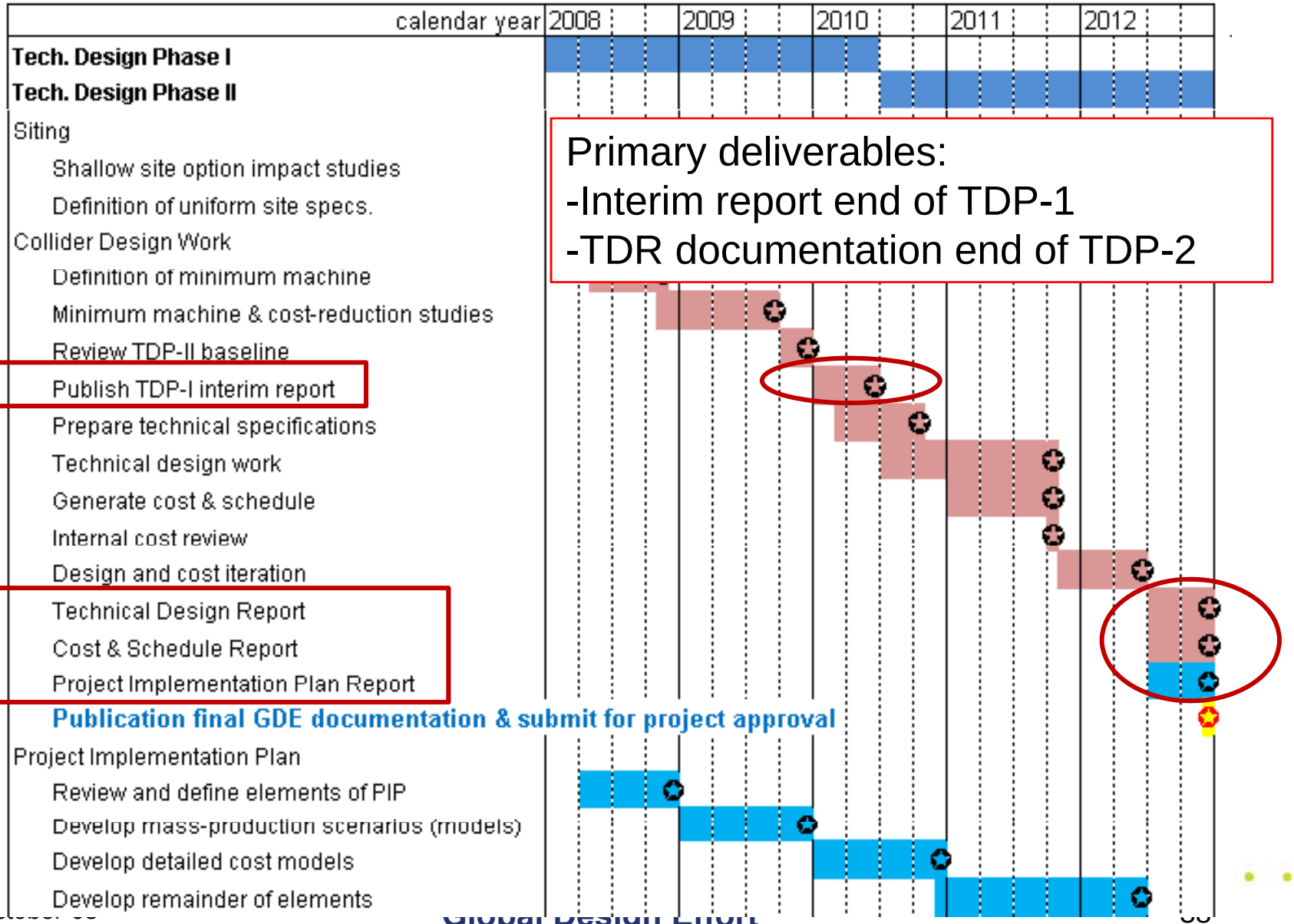
Test Facility	Deliverable	Date
Optics and stabilisation demonstrations:		
ATF	Generation of 1 pm-rad low emittance beam	2009
ATF-2	Demonstration of compact Final Focus optics (design demagnification, resulting in a nominal 35 nm beam size at focal point).	2010
	Demonstration of prototype SC and PM final doublet magnets	2012
	Stabilisation of 35 nm beam over various time scales.	2012
Linac high-gradient operation and system demonstrations:		
TTF/FLASH	Full 9 mA, 1 GeV, high-repetition rate operation	2009
STF & ILCTA-NML	Cavity-string test within one cryomodule (S1 and S1-global)	2010
	Cryomodule-string test with one RF Unit with beam (S2)	2012
Electron cloud mitigation studies:		
CESR-TA	Re-configuration (re-build) of CESR as low-emittance e-cloud test facility. First measurements of e-cloud build-up using instrumented sections in dipoles and drifts sections (large emittance).	2008
	Achieve lower emittance beams. Measurements of e-cloud build up in wiggler chambers.	2009
	Characterisation of e-cloud build-up and instability thresholds as a function of low vertical emittance (≤20 pm)	2010

Our Plan with goals and dates

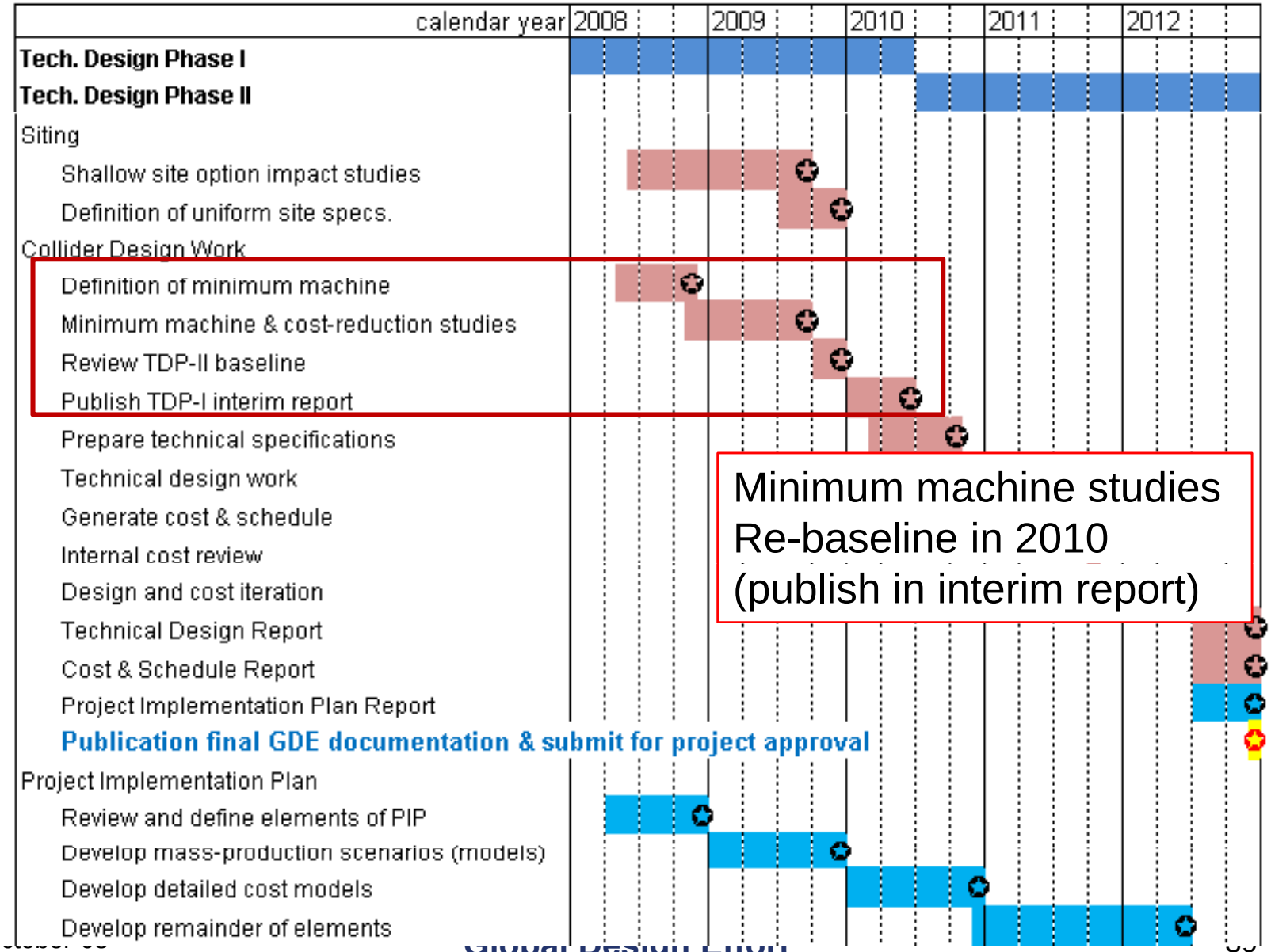


- Basic time-scale
  - **Phase 1: July 2010**
    - **Paris meeting already scheduled**
  - **Phase 2: end of CY 2012**
    - **Not previously well-defined**
    - **Fits with current SCRF planning (S2 for example)**
- Encapsulates the PMs strategy and vision for the next four years
  - **Critical R&D**
  - **Cost reduction / machine design**
  - **Project Implementation Plan**

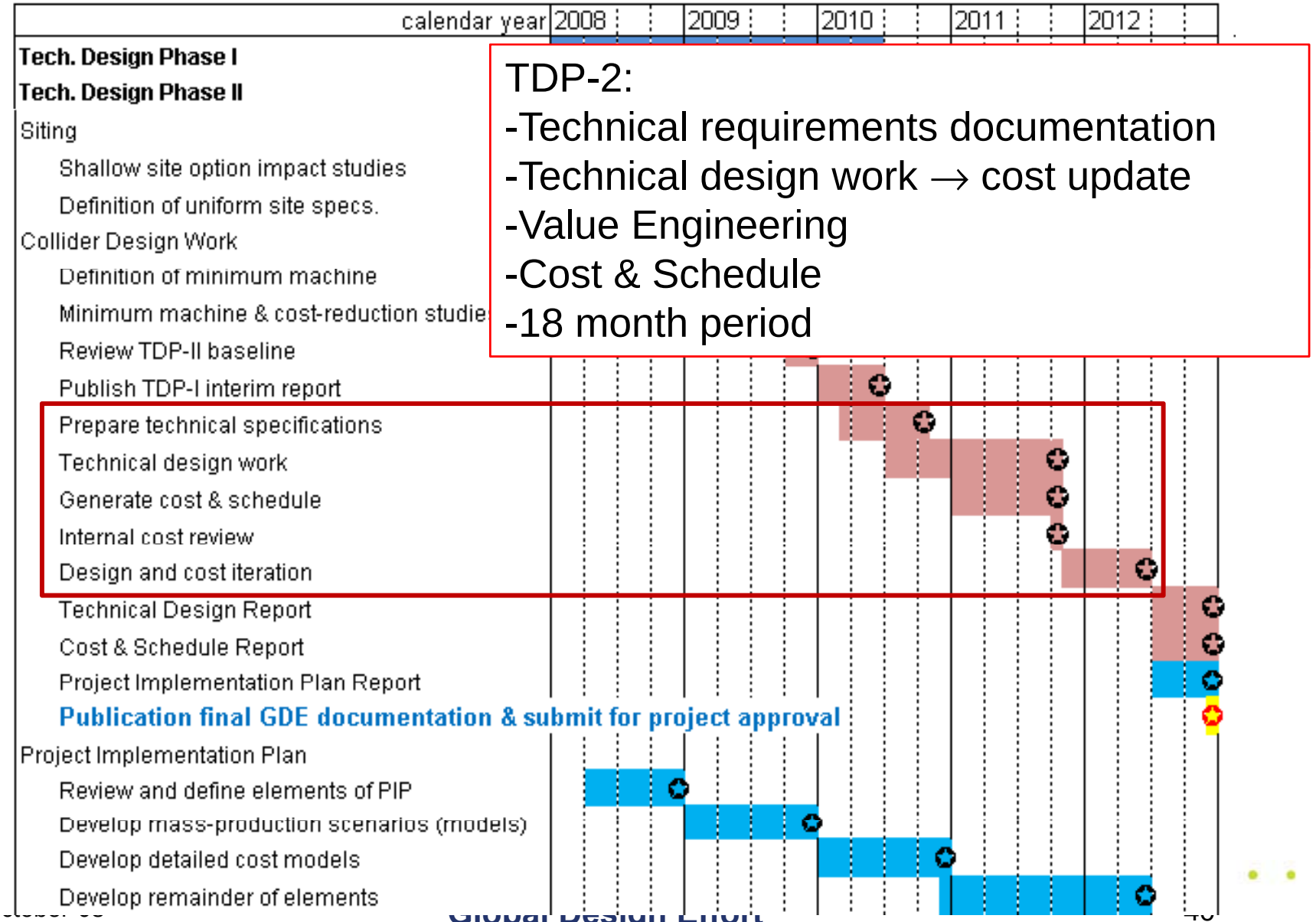
Design / Cost Reduction / PIP



Design / Cost Reduction / PIP

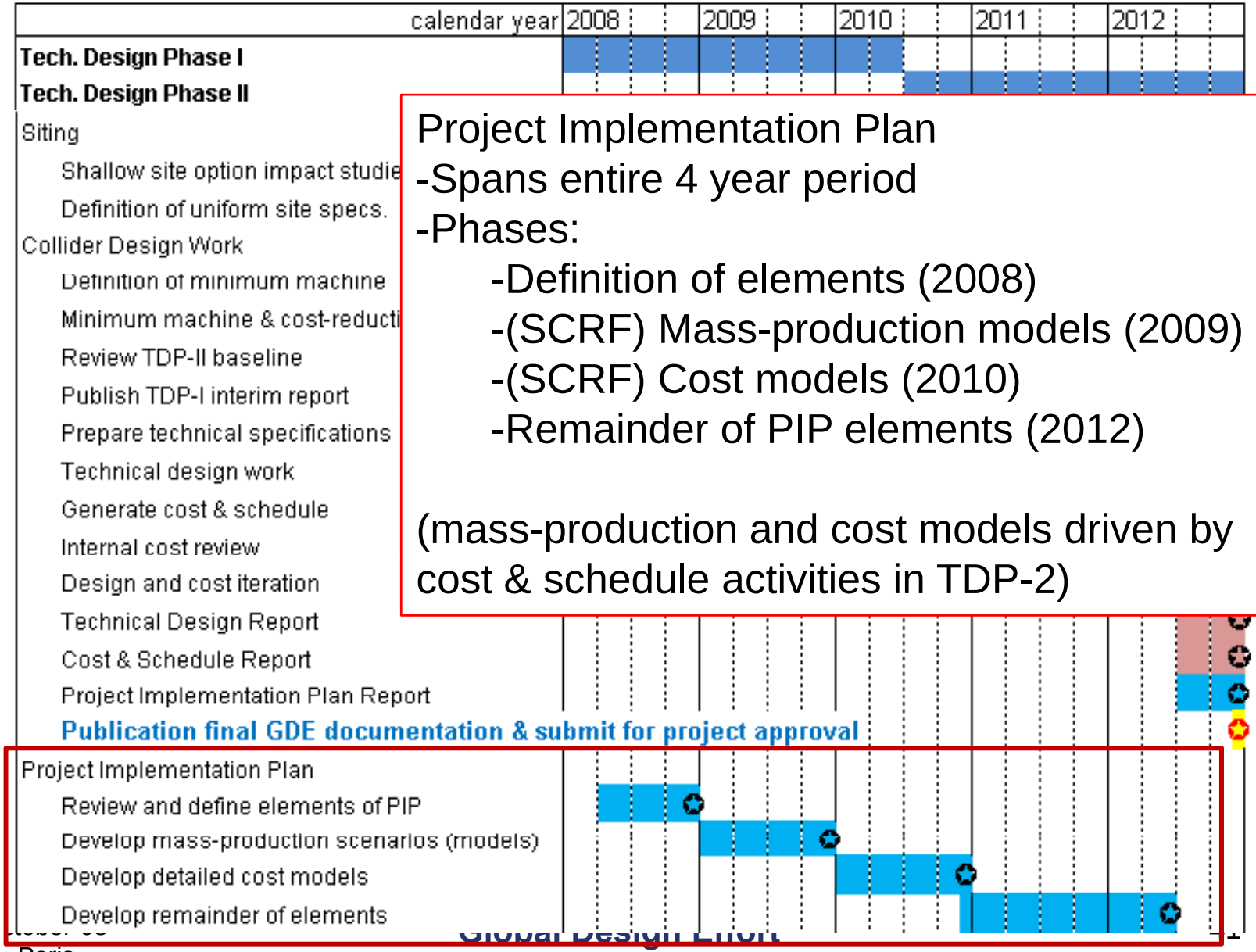


Design / Cost Reduction / PIP



TDP-2:
-Technical requirements documentation
-Technical design work → cost update
-Value Engineering
-Cost & Schedule
-18 month period

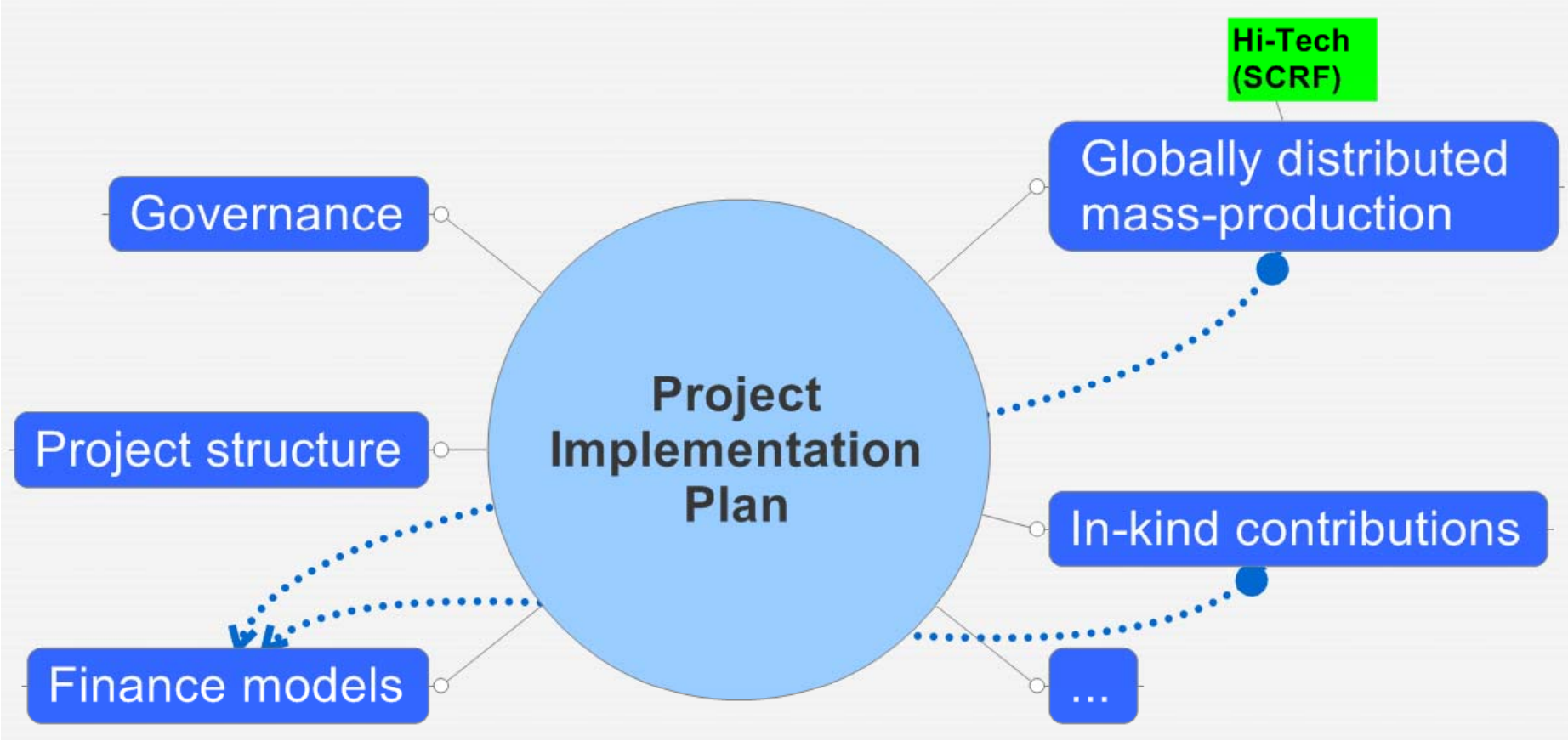
Design / Cost Reduction / PIP



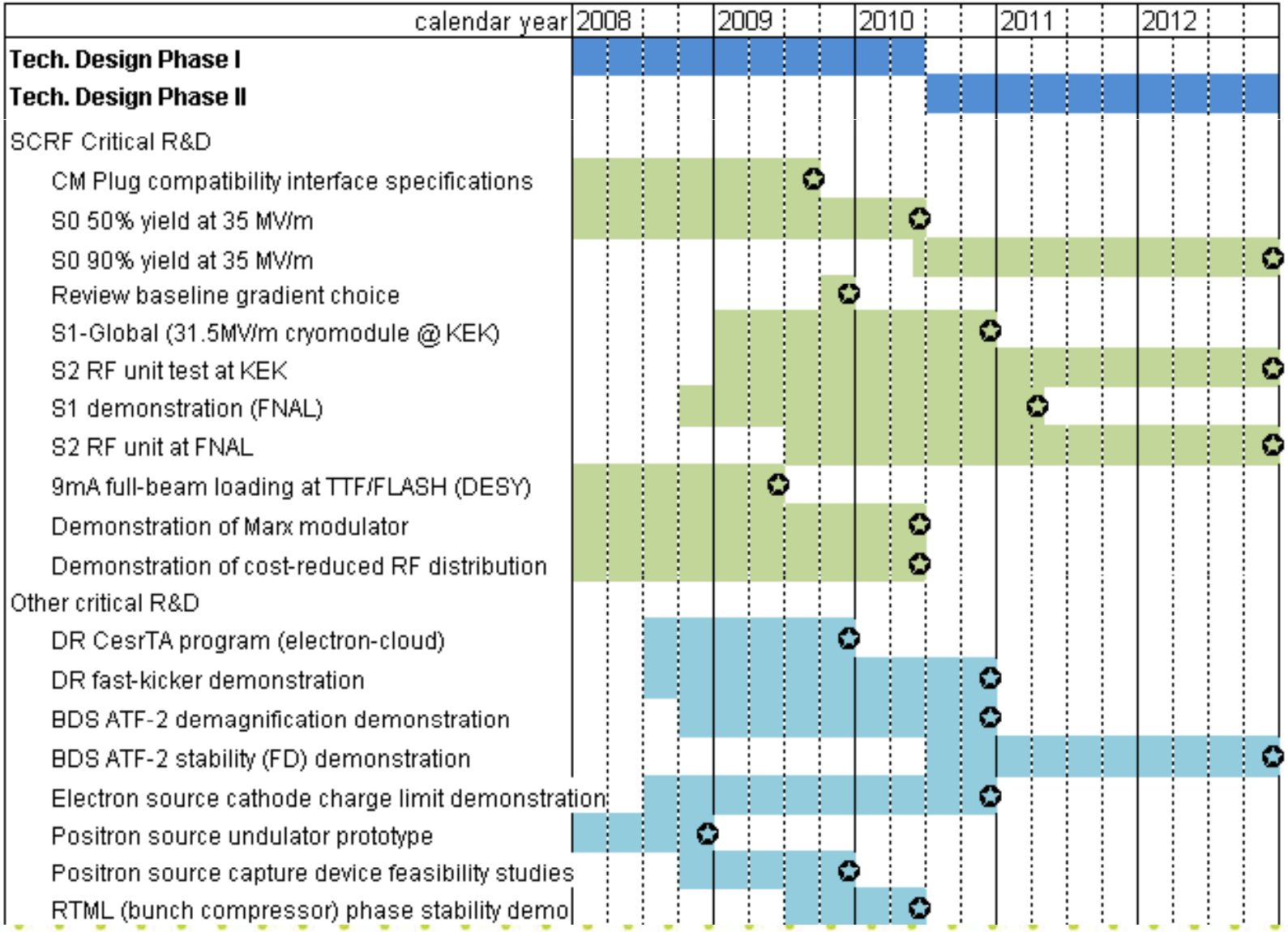
Project Implementation Plan
-Spans entire 4 year period
-Phases:
- -Definition of elements (2008)
- -(SCRF) Mass-production models (2009)
- -(SCRF) Cost models (2010)
- -Remainder of PIP elements (2012)

(mass-production and cost models driven by cost & schedule activities in TDP-2)

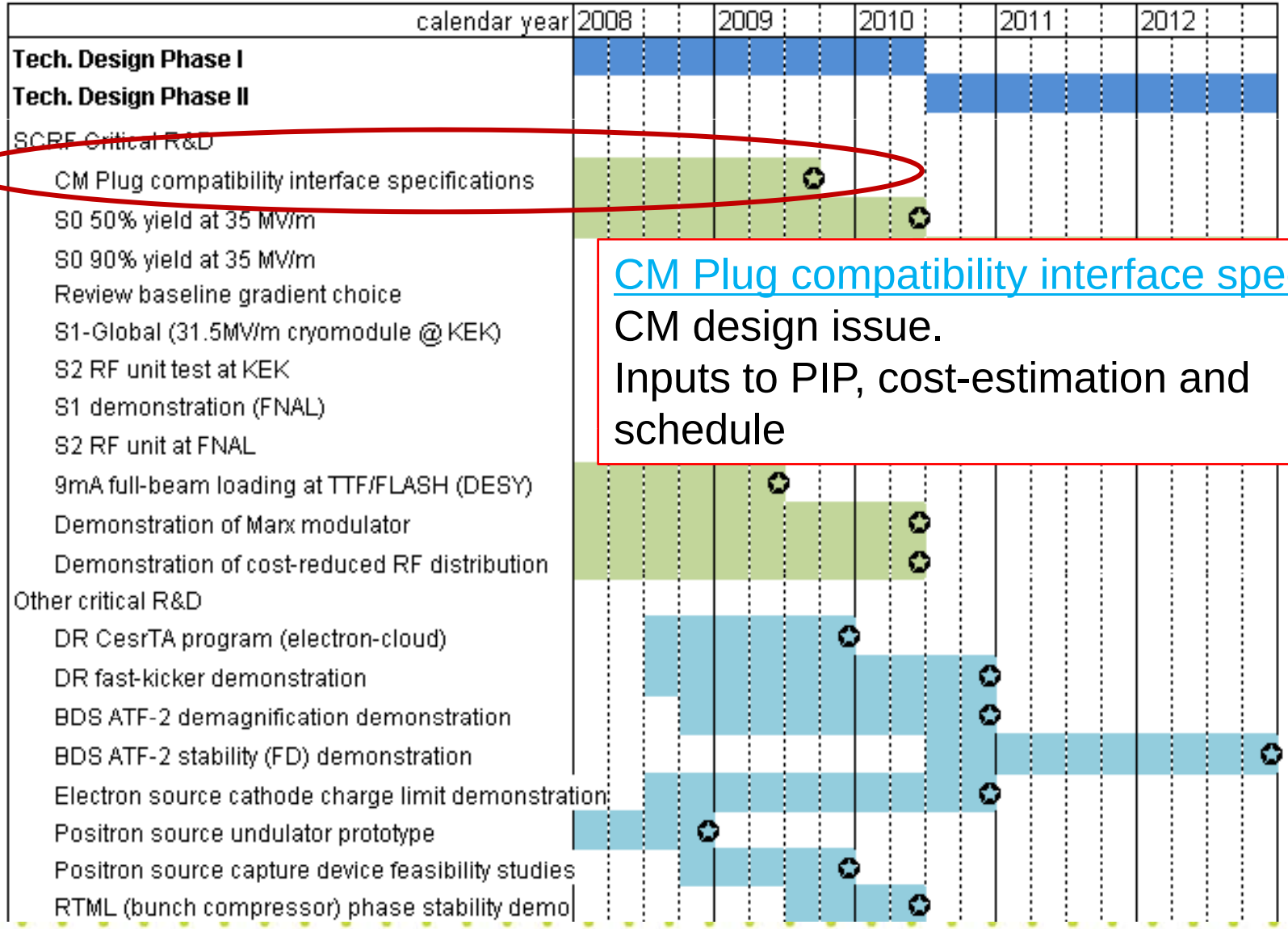
Project Implementation Plan



Critical R&D

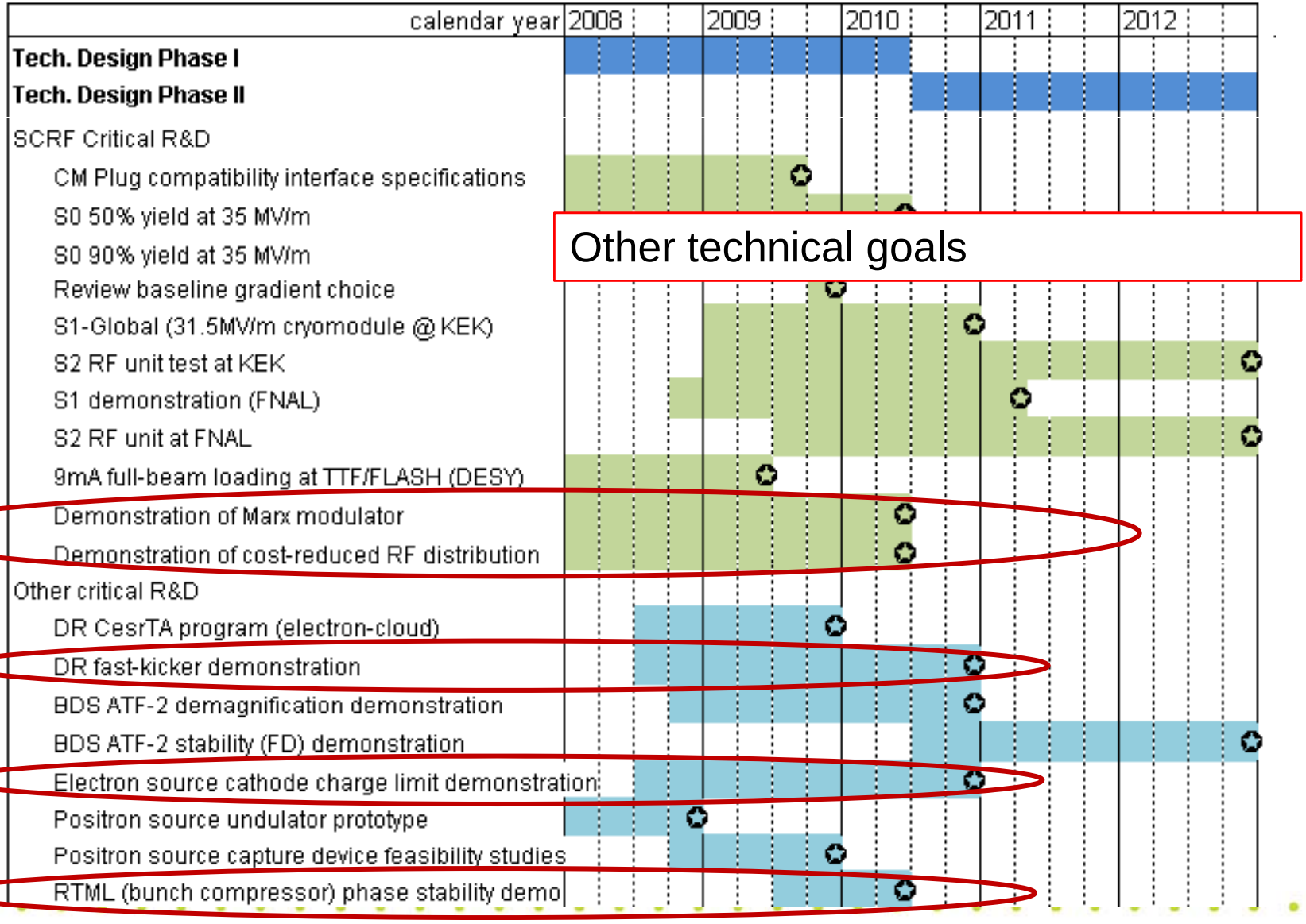

calendar year
2008
2009
2010
2011
2012
Tech. Design Phase I
Tech. Design Phase II
SCRF Critical R&D
CM Plug compatibility interface specifications
S0 50% yield at 35 MV/m
S0 90% yield at 35 MV/m
Review baseline gradient choice
S1-Global (31.5MV/m cryomodule @ KEK)
S2 RF unit test at KEK
S1 demonstration (FNAL)
S2 RF unit at FNAL
9mA full-beam loading at TTF/FLASH (DESY)
Demonstration of Marx modulator
Demonstration of cost-reduced RF distribution
Other critical R&D
DR CesrTA program (electron-cloud)
DR fast-kicker demonstration
BDS ATF-2 demagnification demonstration
BDS ATF-2 stability (FD) demonstration
Electron source cathode charge limit demonstration
Positron source undulator prototype
Positron source capture device feasibility studies
RTML (bunch compressor) phase stability demo

Critical R&D



CM Plug compatibility interface specs.
CM design issue.
Inputs to PIP, cost-estimation and schedule

Critical R&D


calendar year
2008
2009
2010
2011
2012
Tech. Design Phase I
Tech. Design Phase II
SCRF Critical R&D
CM Plug compatibility interface specifications
S0 50% yield at 35 MV/m
S0 90% yield at 35 MV/m
Review baseline gradient choice
S1-Global (31.5MV/m cryomodule @ KEK)
S2 RF unit test at KEK
S1 demonstration (FNAL)
S2 RF unit at FNAL
9mA full-beam loading at TTF/FLASH (DESY)
Demonstration of Marx modulator
Demonstration of cost-reduced RF distribution
Other critical R&D
DR CesrTA program (electron-cloud)
DR fast-kicker demonstration
BDS ATF-2 demagnification demonstration
BDS ATF-2 stability (FD) demonstration
Electron source cathode charge limit demonstration
Positron source undulator prototype
Positron source capture device feasibility studies
RTML (bunch compressor) phase stability demo
Other technical goals

SCRF Major Goals

High-gradient cavity performance at 35 MV/m according to the specified chemical process with a yield of 50% in TDP1, and with a production yield of 90% in TDP2	2010 2012
Nominal Cryomodule design to be optimized: - plug-compatible design including tune-ability and maintainability - thermal balance and cryogenics operation - beam dynamics (addressing issues such as orientation and alignment)	2009
Cavity-string performance in one cryomodule with the average gradient 31.5 MV based on a global effort (S1 and S1-global)	2010
An ILC accelerator unit, consisting of three cryomodules powered by one RF unit, with achieving the average gradient 31.5 MV/m (S2)	2012

Global R&D Plan

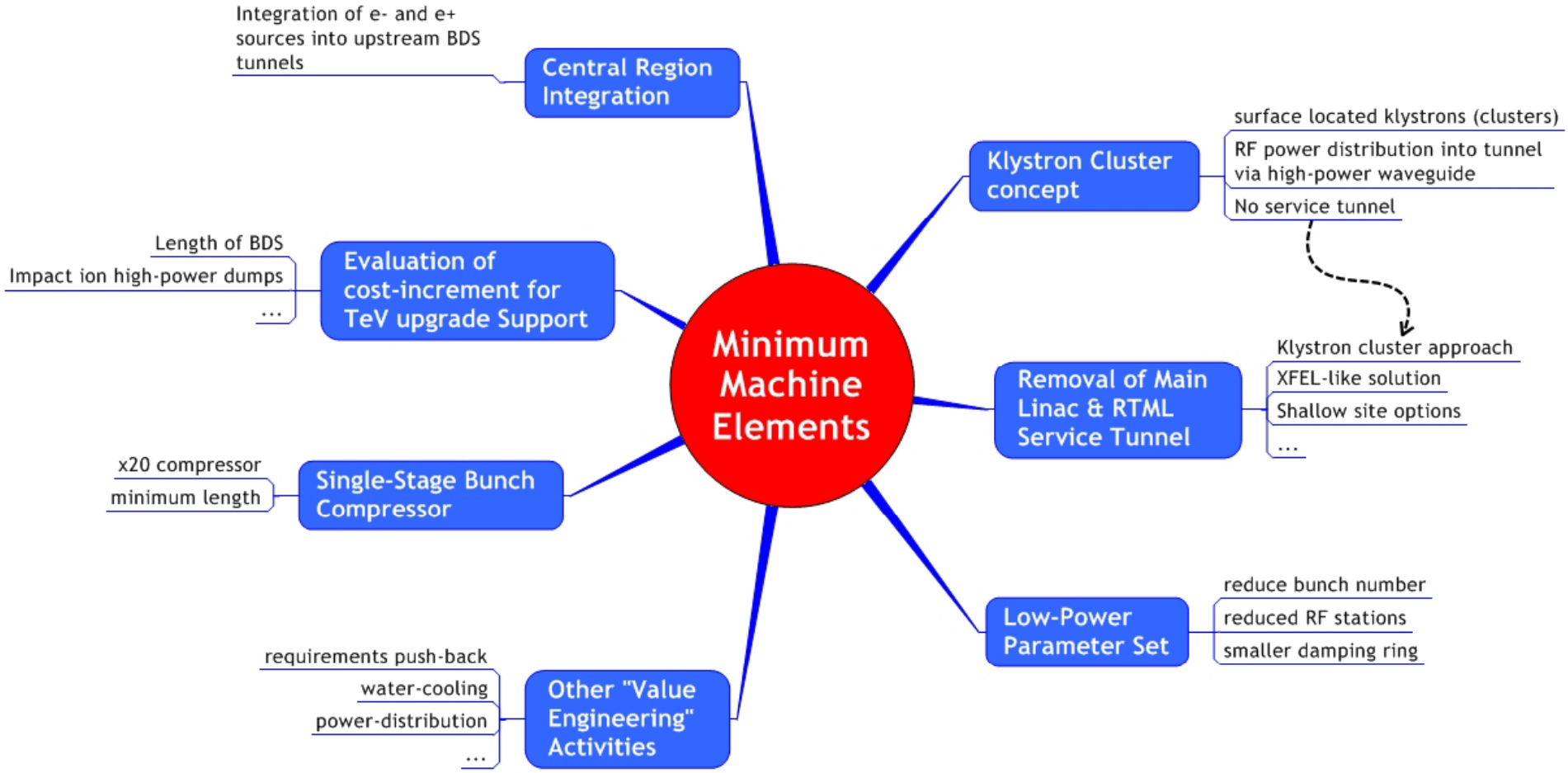
Consensus in SCRF-TA

Calender Year	2007	2008	2009	2010	2011	2012
Technical Design Phase	TDP-1				TDP-2	
Cavity Gradient R&D to reach 35 MV/m		Process Yield > 50%			Production Yield >90%	
Cavity-string test: with 1 cryomodule			Global collab. <31.5 MV/m>			
System Test with beam 1 RF-unit (3-modulce)		FLASH (DESY)			STF2 (KEK) NML (FNAL) → ?	

The Minimum Machine Philosophy

- **The concept of the "minimum machine" is the corner-stone of the cost-reduction strategy for Phase 1 of the Technical Design Phase:**
  - **Define the basic parameters and layout for a "minimum machine configuration to study cost-performance trade-offs begins by 2009**
  - **Evaluate estimated cost and performance parametric studies by end 2009, leading to possible options for the re-baseline.**
  - **Evaluate cost-reduction studies and status of critical R&D, leading to an agreed to re-baseline of the reference machine by the end of TD Phase 1, 2010**
- **Adopting a new baseline in 2010 will be for the purposes of producing a new defendable updated VALUE estimate for the TDR in 2012 – a primary GDE deliverable.**

Identified Minimum Machine Elements



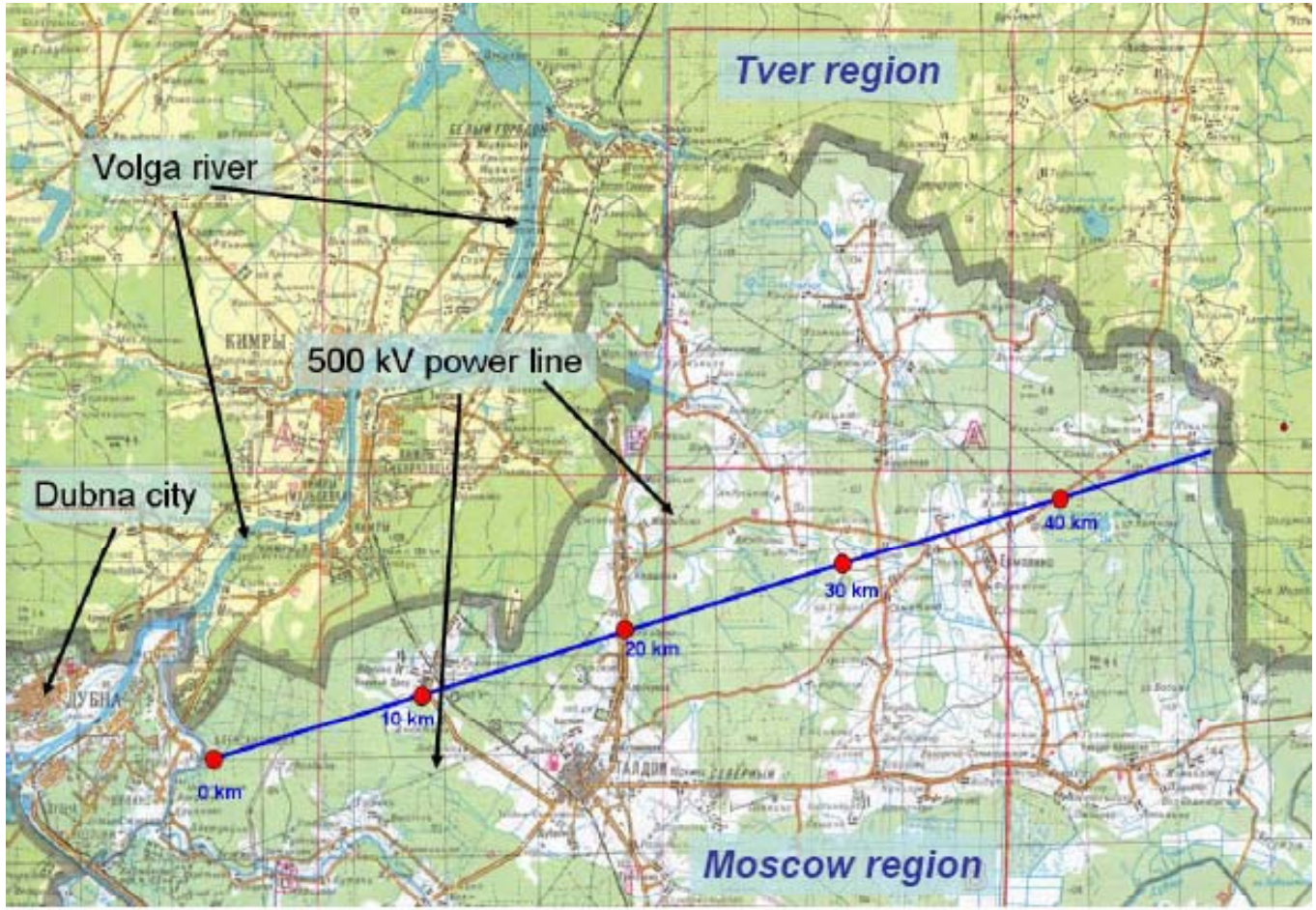
TD Phase - Conventional Facilities

Design Approach

- Examine CFS requirements for ILC Reference Design
- Develop models for cost scaling to various alternative Sites and CFS configurations, in particular for shallow sites and single-tunnel options
- Examine the conventional facilities of the machines with particular attention to the cost drivers (process cooling water etc.), and understand the impact with respect to the choice of site configuration
- Evaluate alternative layouts to minimize cost and to understand the cost / performance trade-offs

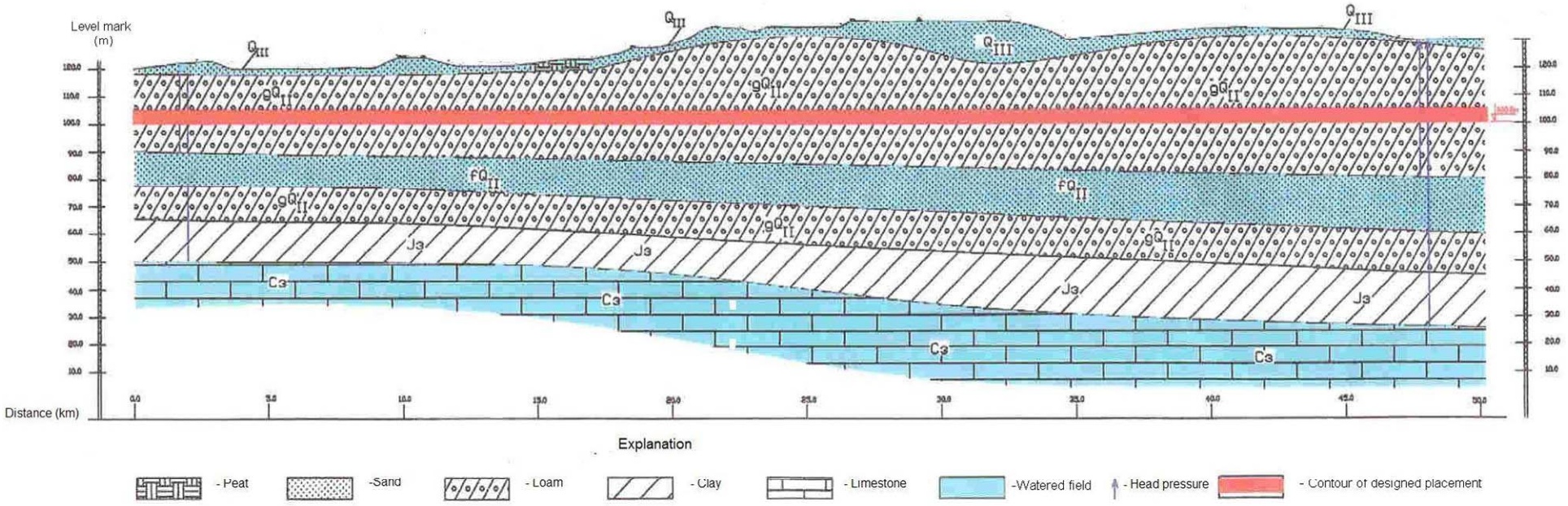
Russian Site

- ***Unique shallow site – thick loam layer near the surface.***



Russian Site

The ILC linear accelerator is proposed to be placed in the drift clay at the depth of 20 m with the idea that below the tunnel there should be impermeable soil preventing from the underlying groundwater inrush. It is possible to construct tunnels of the accelerating complex using tunnel shields with a simultaneous wall timbering by tubing or falsework concreting.



Interface with Detectors - Seryi

Monday 20 October 2008

8:30. Executive Session

9:00. Research Director Overview. S. Yamada (60+15)

10:15. Break

10:30. International Detector Advisory Group (IDAG). M. Davier (30+10)

11:10. Machine-Detector Interface. A. Seryi (15+5)

11:30. Cooperation with CLIC Physics and Detectors. F. Richard (15+5)

11:50. Executive Session

12:30. Lunch

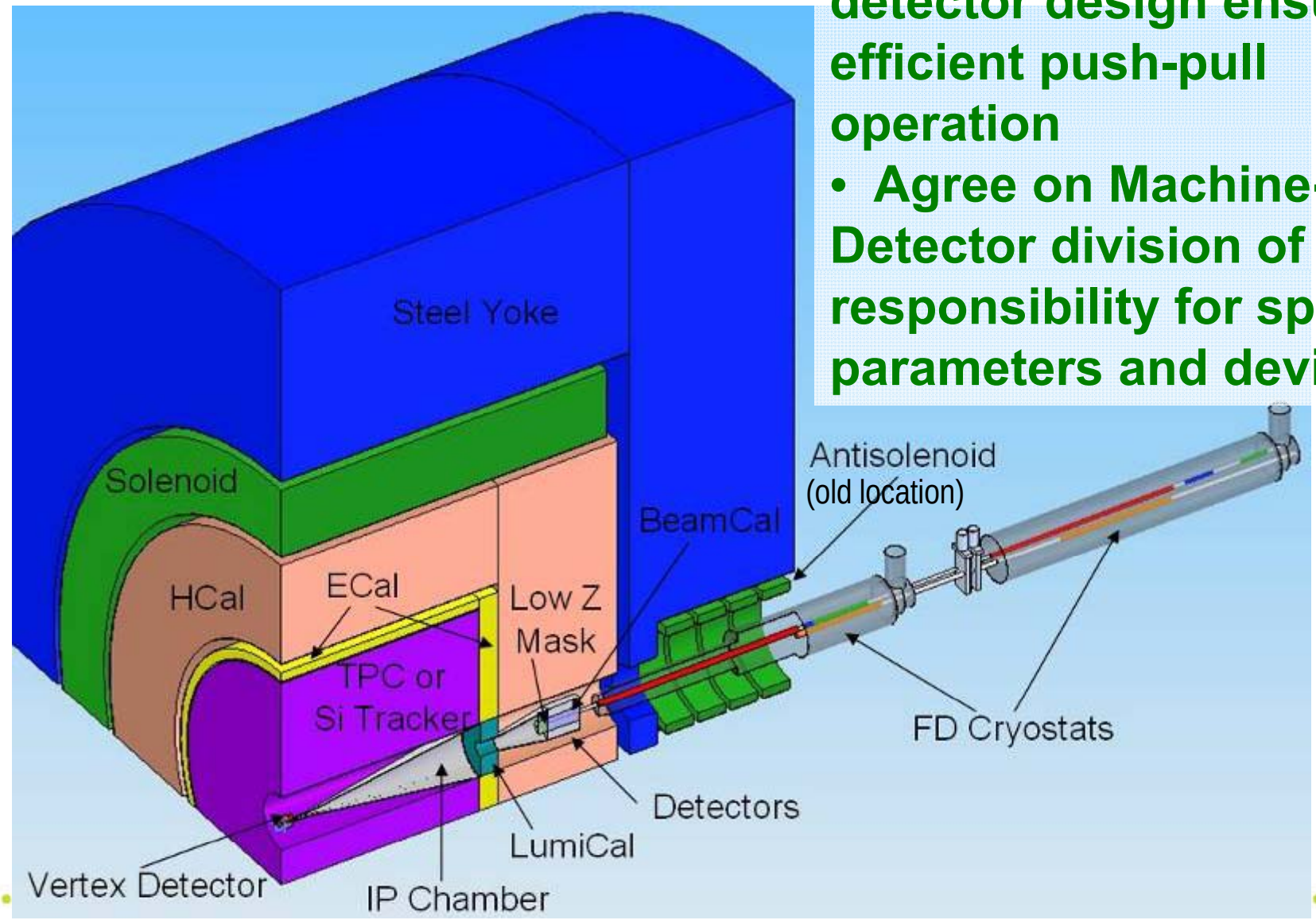
13:30. Executive Session

14:30--15:15. Closeout

IR Integration

Challenges:

- **Optimize IR and detector design ensuring efficient push-pull operation**
- **Agree on Machine-Detector division of responsibility for space, parameters and devices**



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Initiating Joint ILC/CLIC R&D Areas

- **Co-conveners of the CLIC-ILC working groups**
  - **Civil Engineering and Conventional Facilities (CFS): Claude Hauviller/CERN, John Osborne/CERN, Vic Kuchler (FNAL)**
  - **Beam Delivery Systems and Machine Detector Interface: D.Schulte/CERN, Brett Parker (BNL), Andrei Seryi (SLAC),, Emmanuel Tsesmelis/CERN**
  - **Detectors: L.Linssen/CERN, Francois Richard/LAL, Dieter.Schlatter/CERN, Sakue Yamada/KEK**
  - **Cost & Schedule: John Carwardine (ANL), Katy Foraz/CERN, Peter Garbincius (FNAL), Tetsuo Shidara (KEK), Sylvain Weisz/CERN**
  - **Beam Dynamics: A.Latina/FNAL), Kiyoshi Kubo (KEK), D.Schulte/CERN, Nick Walker (DESY)**
- **Two new groups being formed – (positrons and damping rings)**

Conclusions

- We have developed a “realistic” plan for the next phase of the R&D and design of the ILC
  - **A two stage ILC Technical Design Phase (TDP-1 2010 and TDP-2 2012 is underway**

- Overall Goals: Cost / Performance optimization through R&D program, developing a new baseline; complete a technical design and implementation plan on the time scale of LHC results

- SCIENCE remains the key to our ultimate success; as well as a solid design/cost/implementation plan to propose for construction