ILC Report

Barry Barish

SiD Meeting – SLAC

2-March-09

Today

- **General GDE/ILC status and plans**
  - **Updates on our status in key areas**
  - **New version of ILC R&D Plan released**
- **Recent progress**
  - **R&D Demonstrations – Progress on CesrTA (electron cloud); ATF-2 (final focus); and SCRF cavity gradient**
  - **Plug Compatibility concept fleshed-out**
  - **Developed "Minimal Machine" design approach**
  - **Project Implementation Plan – Governance group underway**
- **How to get from here to there?**

R&D Plan - Technical Design Phase

ILC Research and Development Plan
for the Technical Design Phase

Release 3

February 2009

ILC Global Design Effort

Director: Barry Barish

Prepared by the Technical Design Phase Project Management

Project Managers: Marc Ross, Nick Walker, Akira Yamamoto

- "Living Document"
- A 60 page document with details of all R&D programs, schedules and resources.
- **New: Release 3**

- Technical Design Phase
  - **Phase 1 2010 (critical R&D demonstrations; new baseline**
  - **Phase 2 2012 (technical design and implementation plan –> construction proposal ready**

Major R&D Goals for TDP 1

SCRF

- **High Gradient R&D - globally coordinated program to demonstrate gradient by 2010 with 50%yield;**

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.**

Minimum Machine Studies

- **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.

- ~ 70 parts electron-beam welded at high vacuum
  - mostly stamped 3mm thick sheet metal
- pure niobium and niobium/titanium alloy
  - niobium cost similar to silver
- weight ~ 35 kg (less than 10% cryomodule mass)
- 6 flanges

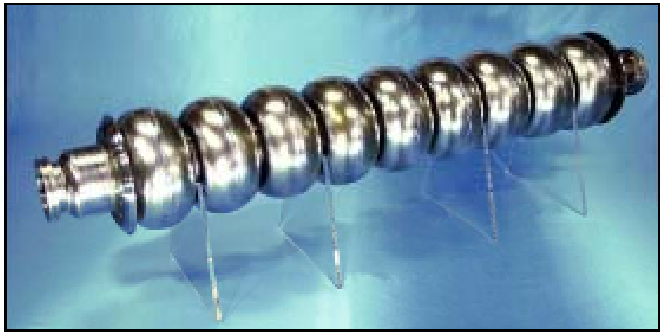
R&D Goal – Achieve High Gradient

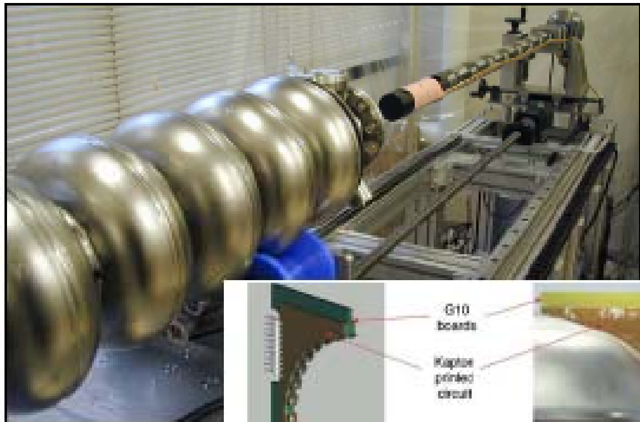
- The *nine cell cavity* 'building block' is the main R & D focus
  - Gradient
  - Production yield
  - Cryogenic losses
  - Radiation
  - System performance

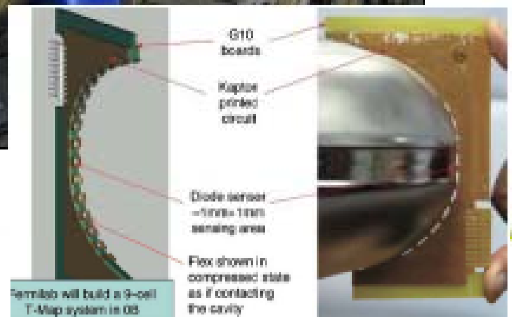
- Goal: 35 MV/m in vertical test with low cryogenic loss and low radiation
  - 90% production yield by 2012

Fabrication and Process

- Niobium Sheet metal cavity
- Fabrication:
  - Forming and welding (electron beam weld)
- Surface Process:
  - Chemical etching and polishing
  - Cleaning
- Inspection/Tests:
  - Optical Inspection (warm)
  - Thermometry (cold)







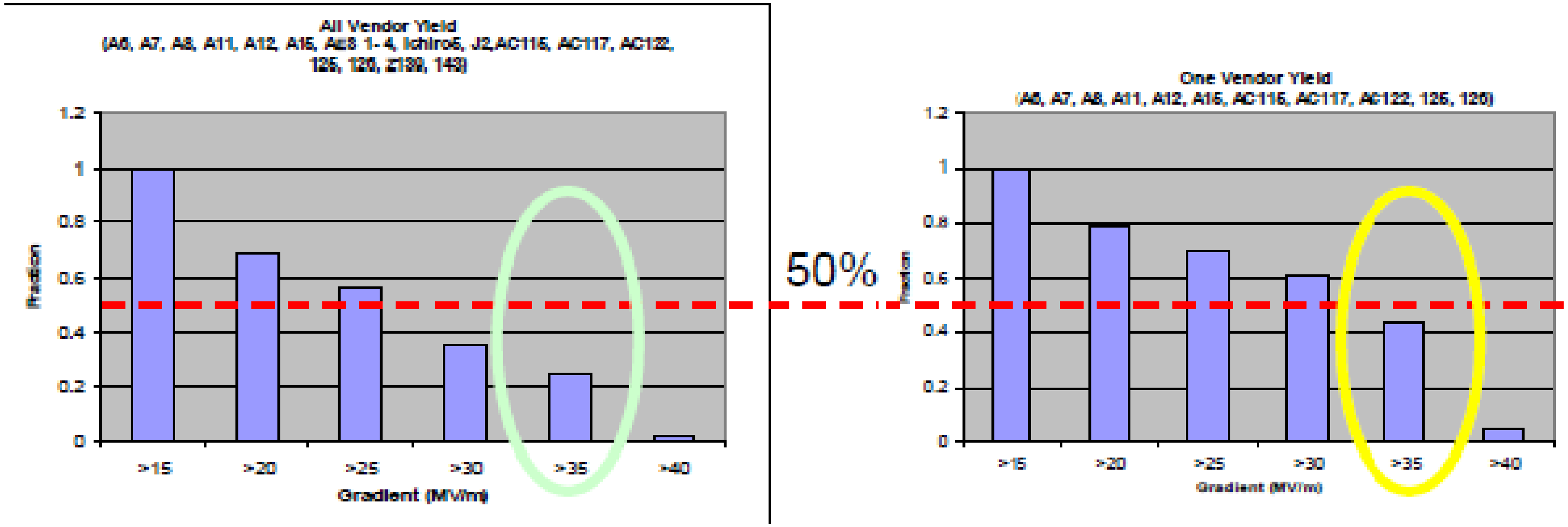
Status of 9-Cell Cavity R&D

48 Tests, 19 cavities

ACCEL, AES, Zanon, Ichiro, Jlab

23 tests, 11 cavities

One Vendor



Yield 45 % at 35 MV/m being achieved by cavities with a qualified vendor !!

Plan for High Gradient R&D

1: Research/find cause of gradient limit

high resolution camera

surface analysis

2: develop countermeasures

remove beads & pits,

establish surface process

3: verify and integrate countermeasures

get statistics

Plan - Industrial Visits

- Learn technical status and progress at vendors, through tour of the factory, technical presentations and discussions with technical staff at the (factory) working site,
- Inform TD-Phase R&D Plan, and necessary boundary conditions, “plug-compatibility”, in the word-wide R&D stage,
- Ask and expect further effort for R&D, particularly to improve “field gradient” and “system engineering” to prepare for the industrialization,
- Establish appropriate communication and confident relationship between ILC-GDE and vendors.

Cavity in cryogen tank

Eight in a string

Hang string from support tube

Slide into cryostat

Completed Cryomodule in Fermilab ICB, November 2007

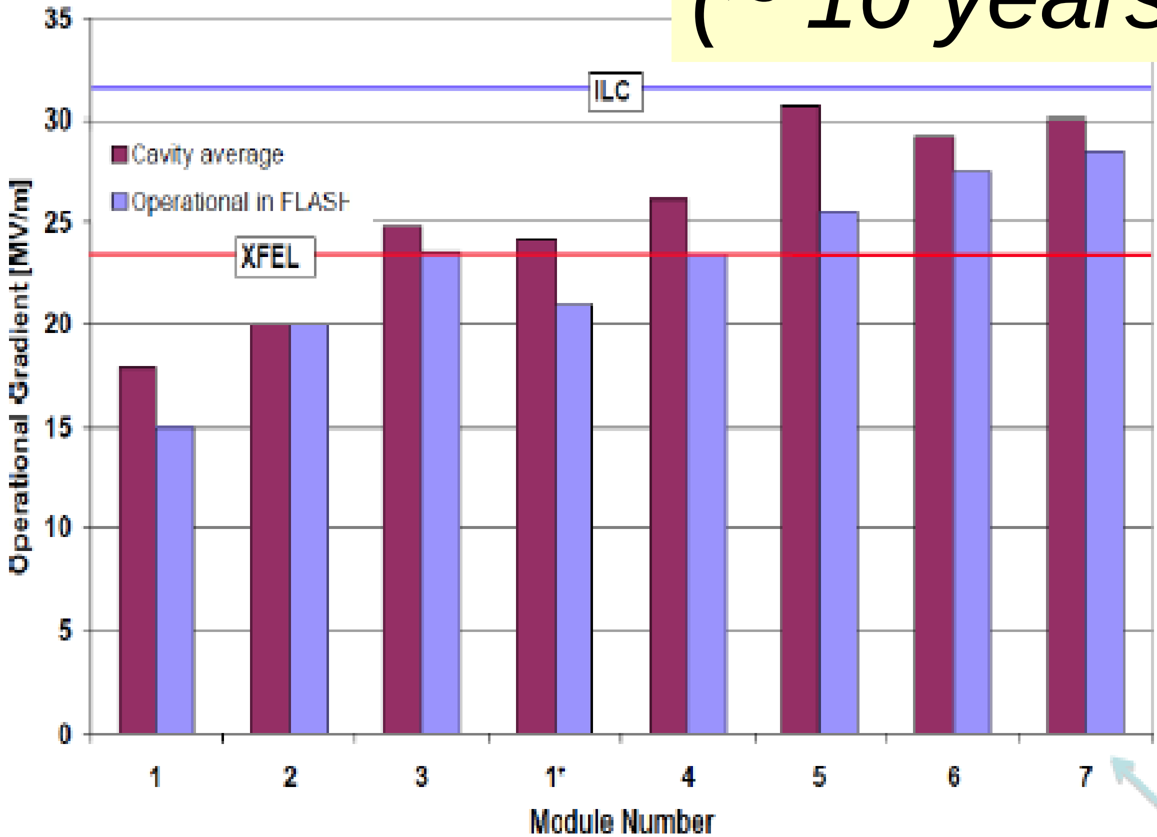
Cryomodule Assembly

Plug Compatible Approach

Cryomodule costs (RDR)	fraction	sum
Cavity Fabrication	36%	36%
Power Couplers	10%	46%
Helium Vessel Fabrication	8%	54%
Magnetic Package (Quad)	7%	61%
Tuners	7%	68%
Assembly, Testing, Transport	5%	72%

(Next 7 items – to 1% level (22%)– Vacuum vessel, shields, interconnect, processing, dressing, pipes, supports, instrumentation)

Cryomodule Gradient Progress
(~ 10 years)



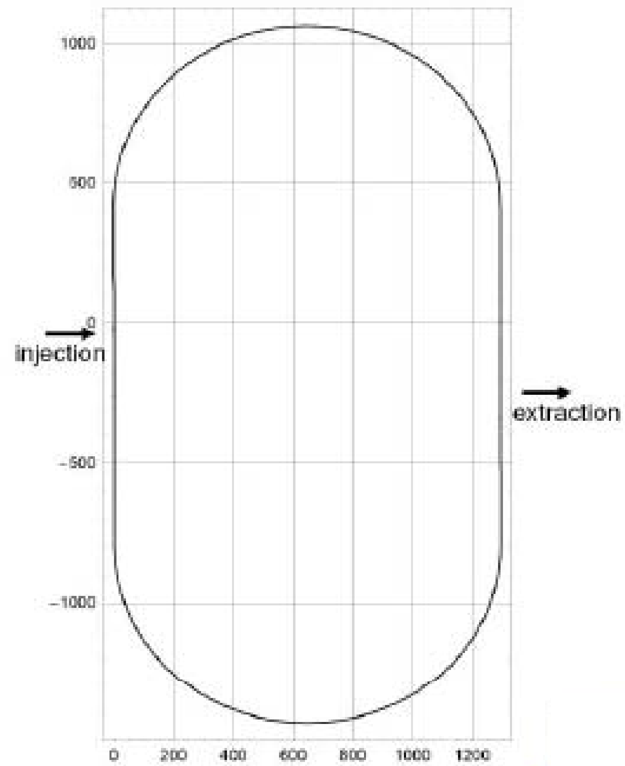
ILC operation :

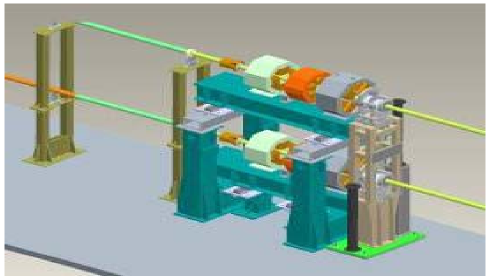
- <31.5> MV/m spec
- (27 MV/m achieved at DESY/FLASH)
- (29 MV/m achieved DESY test stand)

•20 % improvement required for ILC

Damping Ring R&D

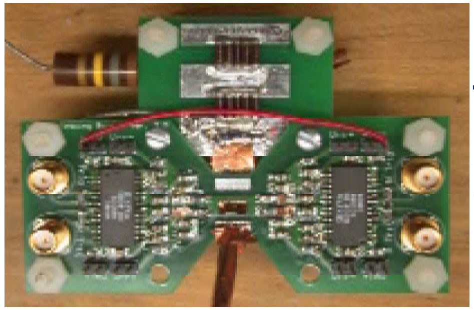
- DR has a flexible race track design
  - **6.4 km Circumference with >1 km straights, which contain, RF, Wigglers, Chicanes, Injection/ Extraction Systems**
- There are two critical components which require a successful demonstration in TDP1
  - **Fast Inj/Ext Kickers**
  - **Suppression of e- Cloud in the e+ ring**



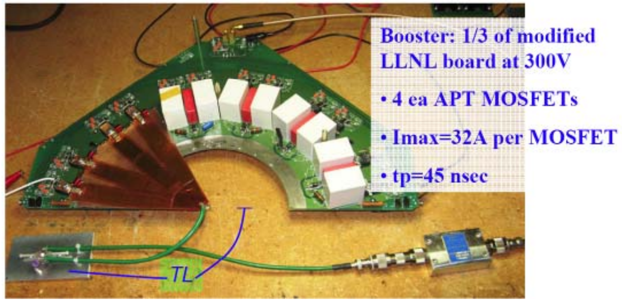


Fast Kicker R&D Program

- There are presently four strands to the R&D program:
  - **SLAC/LLNL**: Development of fast high-power pulsers based on MOSFET technology.
  - **SLAC/DTI:** Development of fast high-power pulsers based on DSRD (drift step recovery diode) technology.
  - **INFN-LNF:** Tests of fast kickers in DAΦNE.
  - **KEK:** Tests of fast kickers in the ATF.



Tests of MOSFET-based pulser show promising performance.

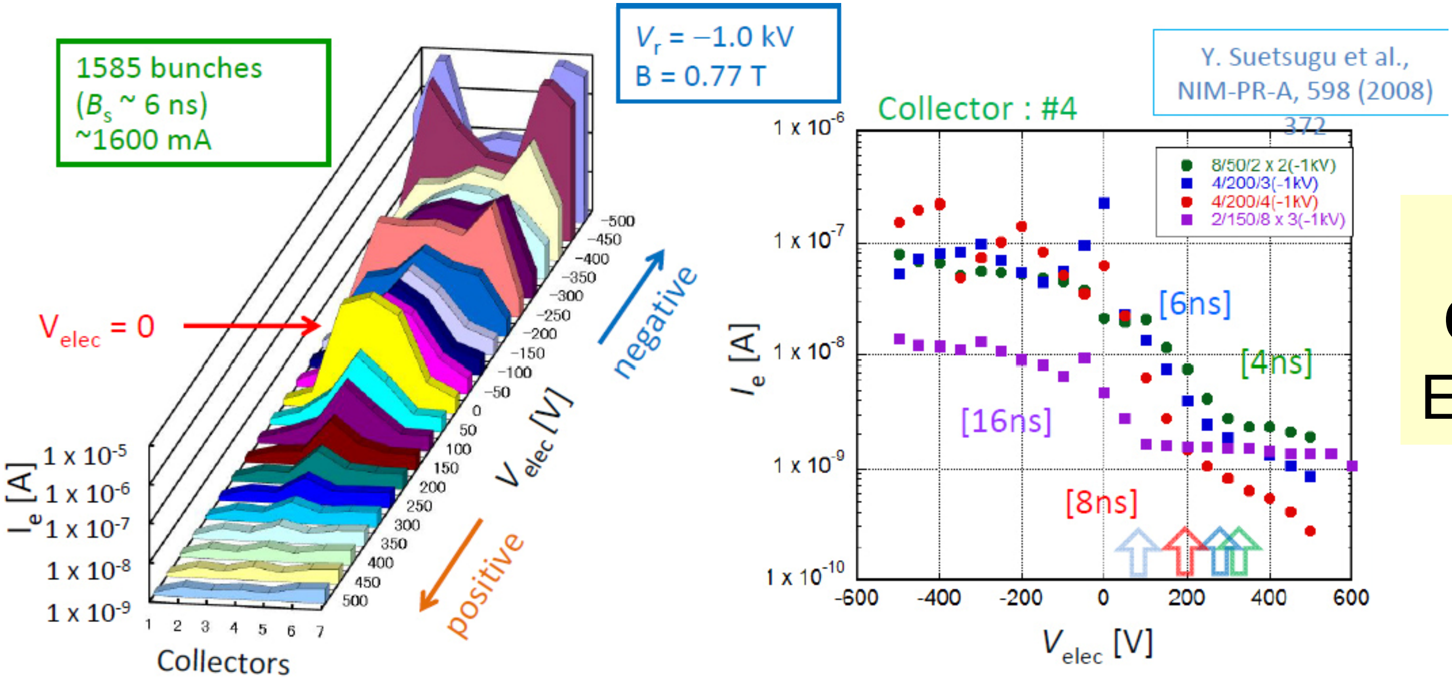


Tests of DSRD-based pulser using board based on LLNL design (for MOSFET inductive adder). Performance is limited by board design and components.

Electron cloud – Goal

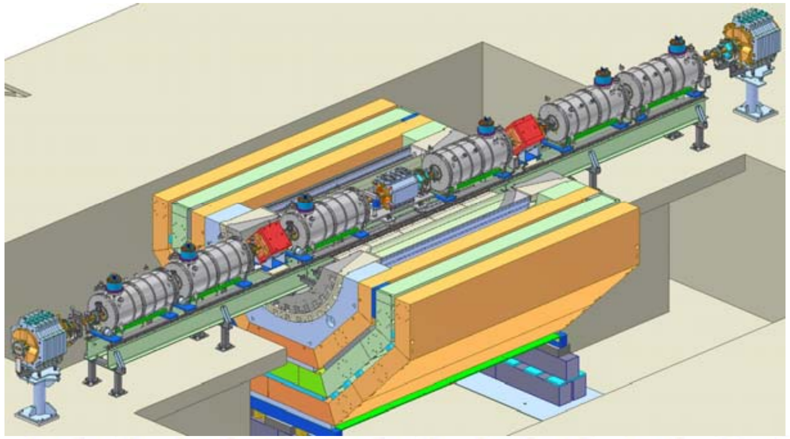
- In electron or proton storage rings, low energy electrons are accelerated by the high energy beam into the wall of the vacuum chamber where more electrons are emitted leading to the formation of an electron cloud.
- For ILC damping ring, need to ensure the e- cloud won't blow up the e+ beam emittance.
  - **Studied through simulations**
  - **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)**

Electron Cloud – KEK-B Results



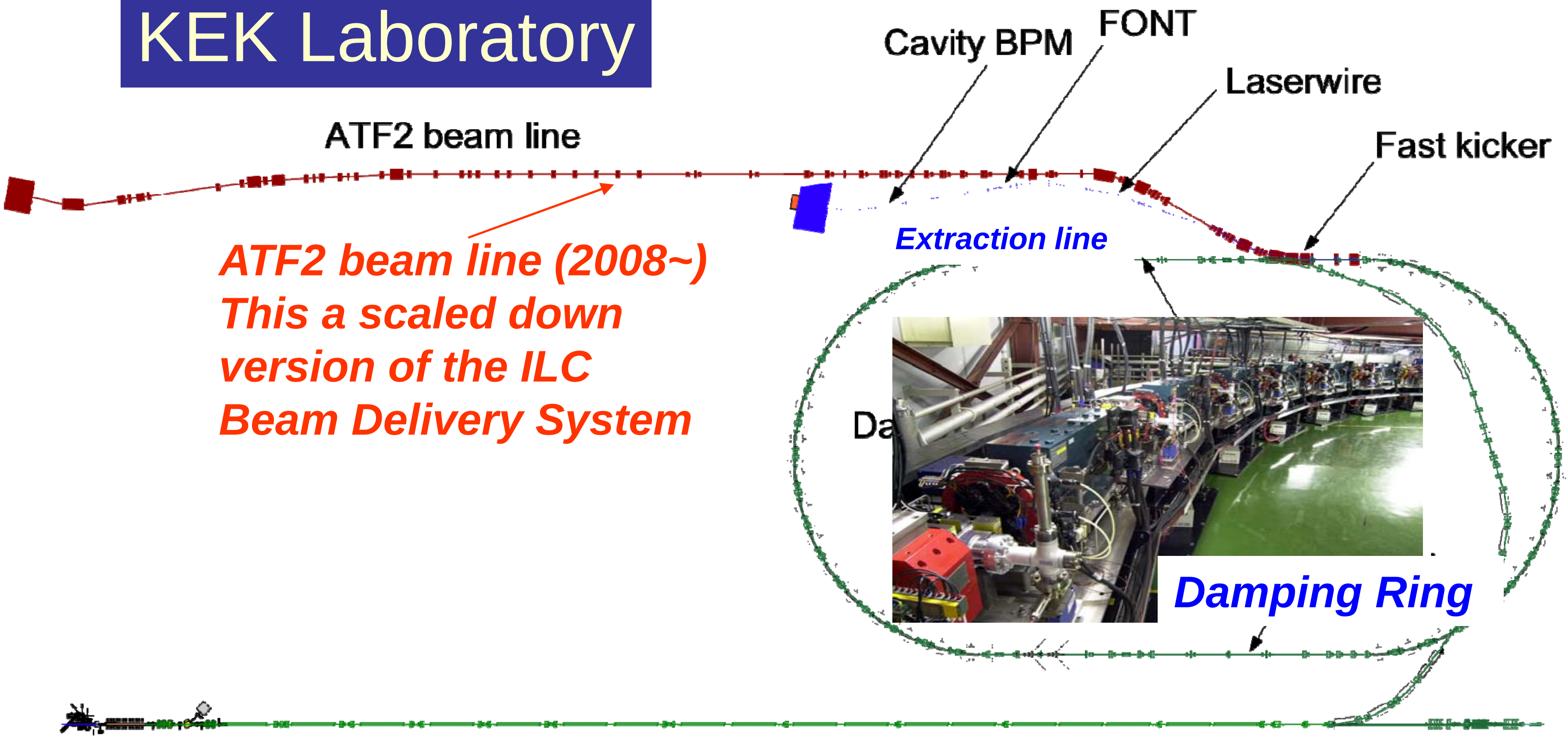
KEK-B Clearing Electrodes

CESR reconfigured to have 12 damping wigglers located in zero dispersion regions for ultra low emittance operation.



Accelerator Test Facility – ATF/ATF2

KEK Laboratory



1.3GeV S-band l

Photo-cathode RF gun (electron source)

S-band Linac

Δf ECS for multi-bunch beam

ATF / ATF2 R&D Program and Goals

- Beam delivery system studies
  - **Demonstrate ~ 50 nm beam spot by 2010**
  - **Stabilize final focus by 2012**
- Broad international collaboration (mini-ILC) for equipment, commissioning and R&D program

ATF2 Beam Line vacuum pipe connected in October

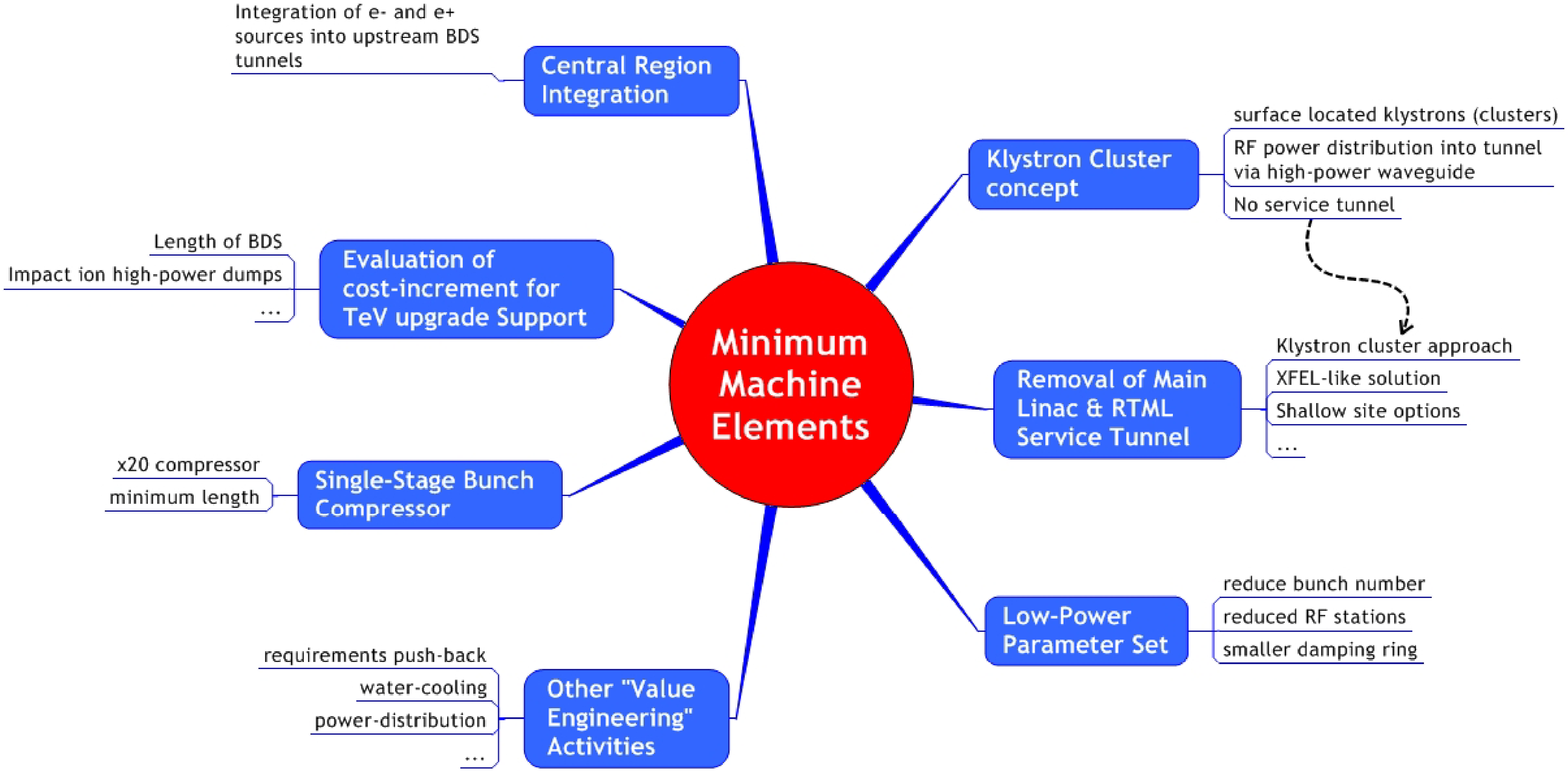
Commissioning underway

Minimum Machine Design Effort

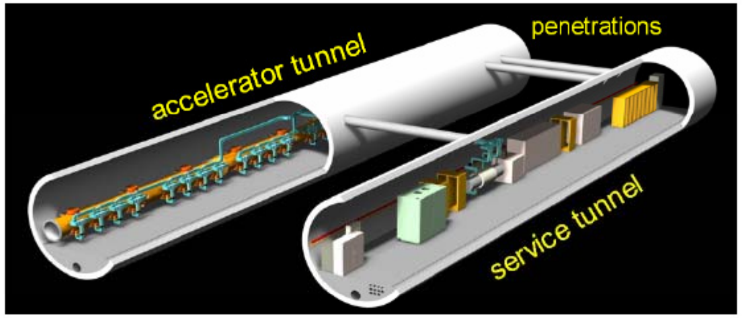
- "Minimum Machine" refers to a set of identified options (*elements*) which may simplify the design and be cost-effective

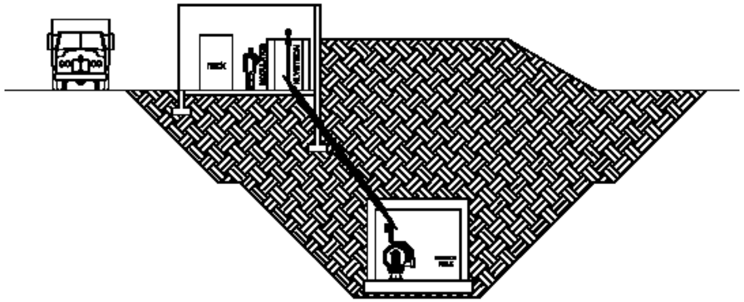
  1. **Klystron Cluster concept**
  2. **Central region integration**
  3. **Low beam power option**
  4. **Single-stage compressor**
  5. **Quantify cost of TeV upgrade support**
  6. **"Value engineering"**
  7. **Single-tunnel solution(s)**

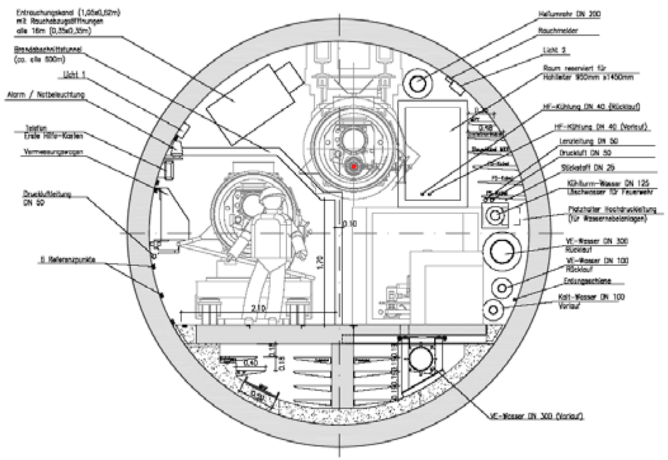
Identified Minimum Machine Elements



Main Linac & Support Tunnel





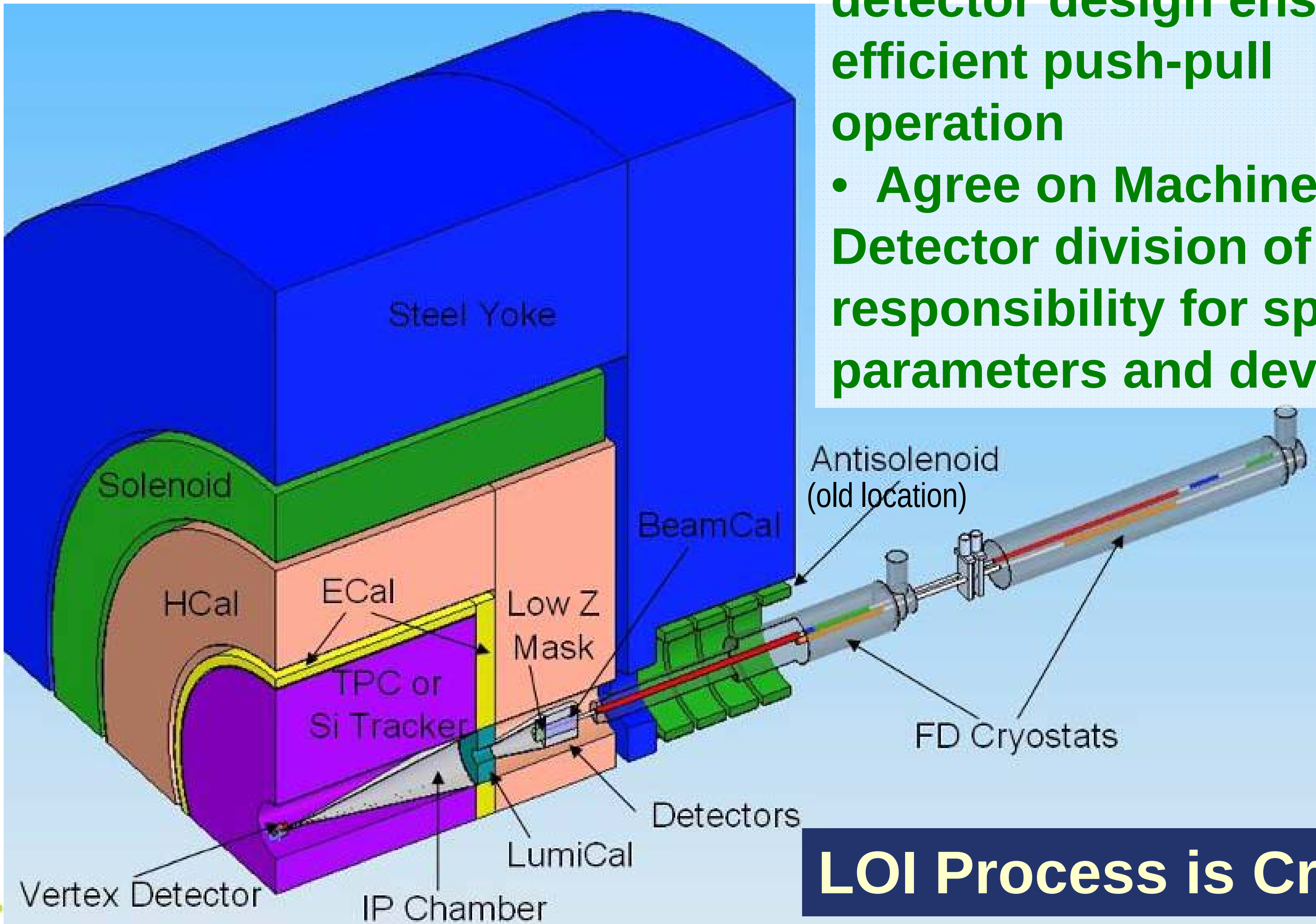


- RDR (two-tunnel)
  - **Access to equipment during ops**
    - Reliability/availability
- Shallow sites
  - **Cut and cover like solutions**
  - **“service tunnel” on the surface**
- Single tunnel
  - **European XFEL-like solution**
    - availability / reliability

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**



LOI Process is Crucial

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.**

CLIC / ILC Joint Statements
27 October 2008

Purpose of these statements:

The CLIC and ILC Collaborations agree to work together, within the framework of the CLIC / ILC Collaboration, to outline comparative statements to be used in presenting their respective projects. The Collaboration members agree to limit statements made about each other's projects to specifically agreed upon statements such as those listed below:

• Project design

The CLIC and ILC projects both plan to release design documents in the coming years. The CLIC Conceptual Design Report is to be published in 2010. If the CLIC technology is demonstrated to be feasible, a CLIC Technical Design will then be launched for publication in a CLIC TDR by 2015. The ILC TDR will be published in 2012. The design reports are intended to summarize the R&D and project planning at that time and will serve as indicators of project readiness. Both TDRs are intended to be submitted to governments and associated funding agencies in order to seek project approval.

• Test facilities and system tests

The CLIC and ILC projects both have test facilities either in operation or under construction for the purpose of demonstrating the performance of key technical components or to allow system engineering and industrialization. For each project, R&D priorities and schedules have been defined and it is anticipated that milestones and progress will be reviewed and reported on by members of the community. The XFEL project, with the same technical basis as the ILC, although at a lower accelerating gradient, and 7% of the energy of one of the ILC linacs, is a large-scale system test and demonstration of the industrialization of the ILC linac technology. The CERN- based CTF3 project is a demonstration of the CLIC two beam technology, although at a lower beam power.

• Technology maturity and risk

The collaborations agree that the ILC technology is presently more mature and less risky than that of CLIC. There are plans to demonstrate, by 2010, the feasibility of CLIC technology and to reduce the associated risk in the future. The ILC collaboration will focus on consolidation of the technology for global mass-production. Both collaborations consider it essential to continue to develop both technologies for the foreseeable future.

• Costing

Project planners from the CLIC and ILC projects are developing common methodologies and tools with the intention of enabling the development of similarly-structured project planning and costing documents for each of the two projects. The two collaborations agree to make no public statements about the comparative cost numbers of the two machines until these project planning and costing documents are complete.

Barry C. Barish

Barry C. Barish
ILC-GDE Director

J-P. Delahaye
CLIC Study Leader

CLIC / ILC Collaboration

- Working Groups with joint leadership

- Accelerator Tech Areas
- Physics / Detectors
- Costing

- First progress reported last fall

LOI Follow-on: Study extrapolation to multi-TeV

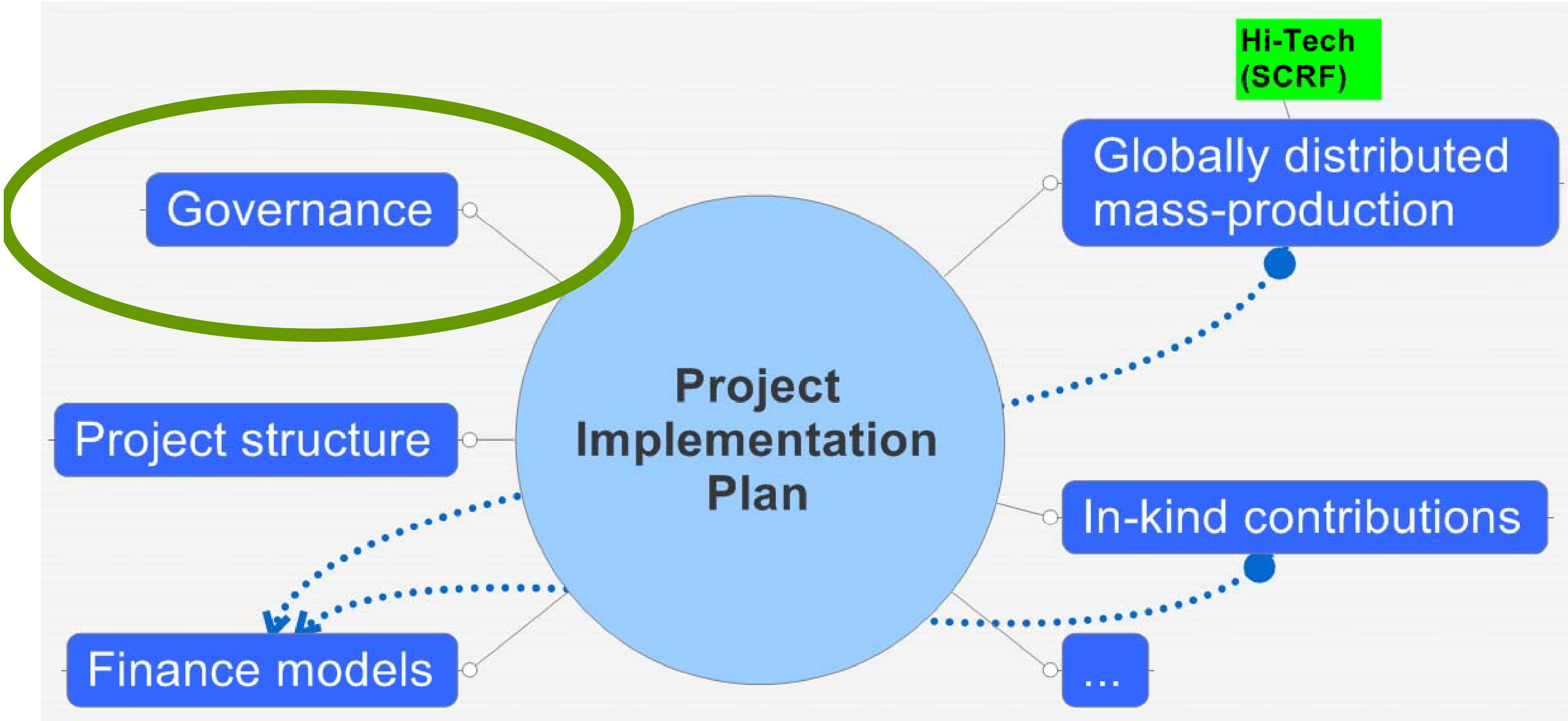
Collaboration Working Groups

	CLIC	ILC
Physics & Detectors	L.Linssen, D.Schlatter	F.Richard, S.Yamada
Beam Delivery System (BDS) & Machine Detector Interface (MDI)	D.Schulte, R.Tomas Garcia E.Tsesmelis	B.Parker, A.Seryi
Civil Engineering & Conventional Facilities	C.Hauviller, J.Osborne.	J.Osborne, V.Kuchler
Positron Generation (new 11/08)	L.Rinolfi	J.Clarke
Damping Rings (new 11/08)	Y.Papaphilipou	M.Palmer
Beam Dynamics	D.Schulte	A.Latina, K.Kubo, N.Walker
Cost & Schedule	H.Braun, K.Foraz, P. LeBrun	J.Carwardine, P.Garbincius, T.Shidara

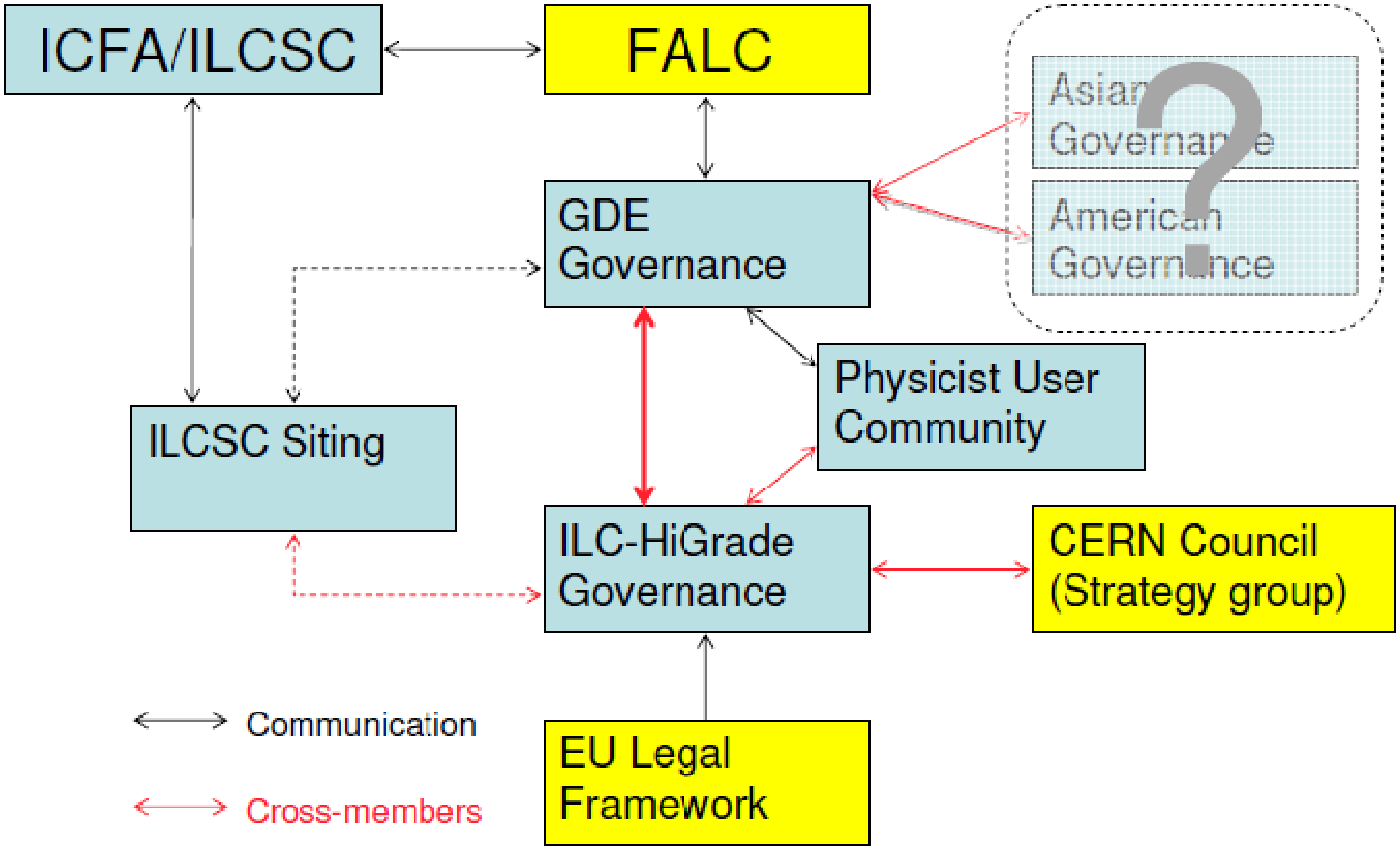
Working Group Mandates

- Each Working Group identifies topics for their work plan (mandate) which:
  - **are practical**
  - **exhibit strong overlap**
  - **enhance inter-project communication**
- “an exclusive, pragmatic approach”
  - **example: Conventional Facilities (Civil Engineering)**
    - exclusive and selective
  - ***example: BDS and Beam Dynamics***
    - *inclusive and (nearly) comprehensive*
- The collaboration must manage both

Project Implementation Plan



Coordinated Effort ?



GDE – Initial Studies

- Examining the main recent projects approved/in preparation: ALMA, FAIR, ITER, SKA, XFEL…
- Contact made with key individuals in projects. Information gathered and presented.
- E.g. on funding - 2 main models for funding: Host (~50%) + regional contributions (2 x~25%) or Host (~50%)+member states (n x~10%) (ITER). Balance of in-kind/cash?

Comments on US Funding

- Serious recession: many fronts – banks, cars, housing, employment
- Economic recovery: strategy is short term stimulation (jobs, credit, etc) + longer term invest in areas for economic growth (clean energy, technology and **science**)
- Science in stimulus: NIH ($10B); NSF ($3B); DoE Office of Science ($1.6B, incl. $300M HEP)
- FY09 Omnibus Bill and FY10 Budget: FY09 fully restored increase for HEP and $35M for ILC R&D; FY10 President's budget invests in science.
- Impacts on ILC: Indirect, except for some opportunities (SCRF investment at Fermilab, MRI and grants at NSF, Detector R&D at HEP, etc.

Final Remarks

- R&D demonstrations are at the center of our program (high gradient; small beam spot; electron cloud). The strength and focus of this program has been key to our "survival" and progress in the past year.
- Preparations for construction proposal (~ 2012)
  - **We are optimizing the Technical Design for cost to risk to performance (minimum machine). Any impacts on physics/detector performance will be considered jointly.**
  - **We are developing a Project Implementation Plan on the same time scale (2012). So far, aspects working on aspects of siting; governance; (will extend to industrialization; financing; etc)**

A last thought ….

With apologies ….

I leave you with a nautical metaphor, unfortunately one popularized in recent time by Reagan and then more recently by Bush (wrt Iraq)

Nevertheless, I think it is very appropriate slogan as we move forward ….

"stay the course!"