ILC / GDE Report


ATF-2 Final Doublet System

Barry Barish
HEPAP – Wash DC
13-Nov-08

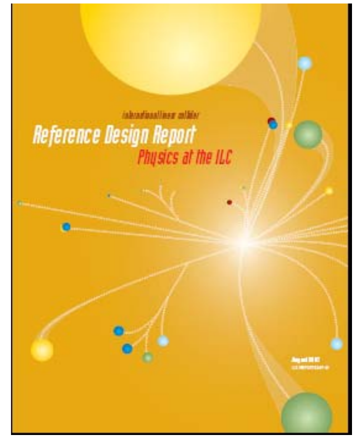
ILC / GDE Report

- Present status of global effort
- Global plans for 2009 and beyond
- Status of the global R&D programs
- Minimum Machine design studies
- Project Implementation Plan
- ILC/CLIC Collaboration
- The U.S. ILC R&D Program

ILC RDR – A Complete Concept

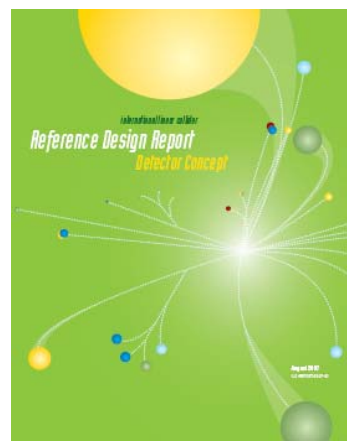
- **Reference Design Report (4 volumes)**

Executive Summary



Physics at the ILC

Accelerator



Detectors

Next: Technical Design Phase

- Complete crucial R&D to reduce technical risk
  - **SCRF gradient; final focus; electron cloud**
- Optimize the ILC design for coherence, simplicity and cost / performance
  - **Minimum Machine Concept**
- Develop capability to industrialize, construct ILC worldwide and develop international model for governance
  - **Project Implementation Plan**

BLACK DECEMBER 2007

- Without warning, severe budget cuts in the USA and the UK
  - In UK, we preserved support for key scientists and their teams, but lost broader program (40 FTE to ~ 15 FTE)
  - In US, budget reduced FY98 to $15M, essentially already spent last December. The US program has effectively been on hold for 9 months.
- Global Program has impressively moved on in the face of these devastating problems
  - The reason: 1) core of our program is focused on large R&D facilities; 2) global coordination & collaboration increased toward prioritized goals

R&D Plan - Technical Design Phase

ILC Research and Development Plan for the Technical Design Phase

Release 2

June 2008

ILC Global Design Effort

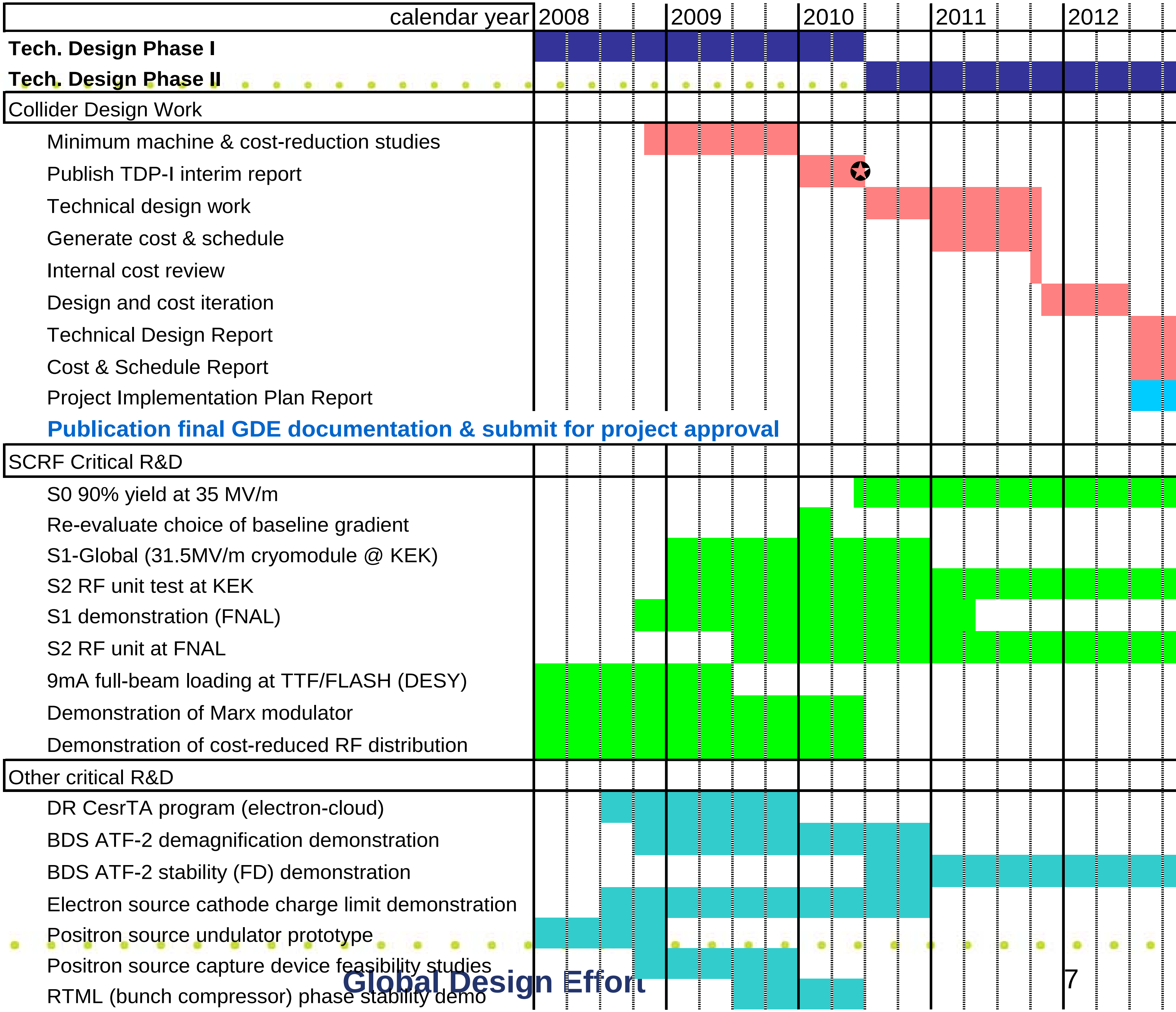
Director: Barry Barish

Prepared by the Technical Design Phase Project Management

Project Managers: Marc Ross, Nick Walker, Akira Yamamoto

- First Official Release June 08
- A 50 page document with details of all programs and schedules
- Next review and release: December 08

TDP Schedule – 2008 to 2012



Status of 9-Cell Cavity R&D

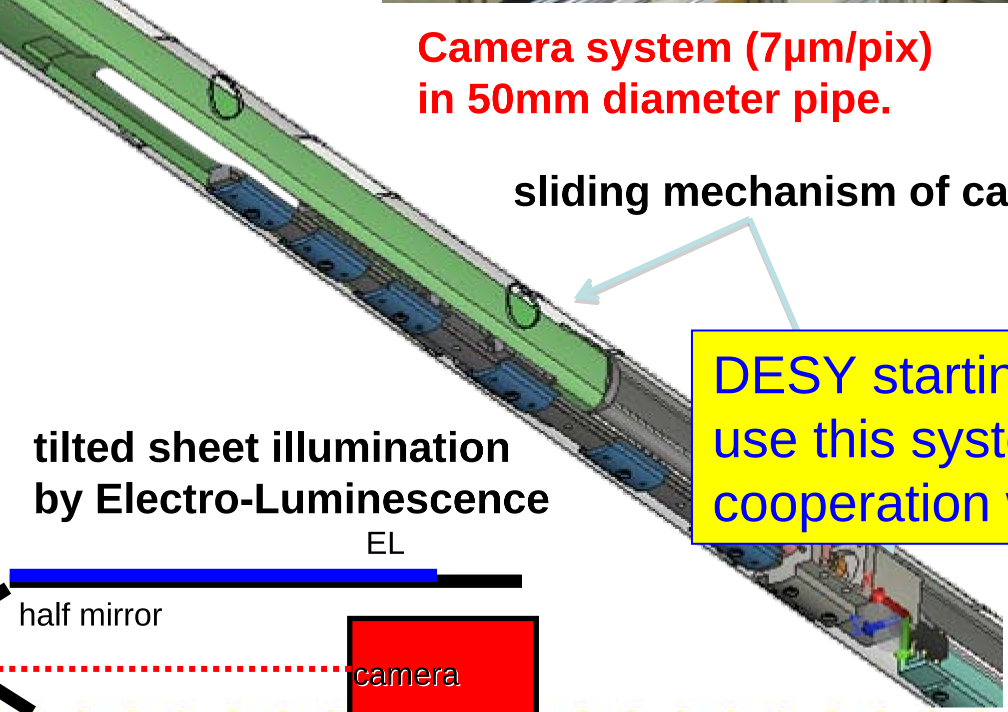
- **Europe**
  - **"Gradient" improved (<31.5> MV/m) with Ethanol rinse (DESY):**
  - **Industrial (bulk) EP demonstrated (<36> MV/m) (DESY)**
  - **Large-grain cavity (DESY)**
  - **Surface process with baking in Ar-gas (Saclay)**
- **America(s)**
  - **Gradient distributed (20 – 40 MV/m) with various surface process (Cornell, JLab, Fermilab)**
  - **Field emission reduced with Ultrasonic Degreasing using Detergent, and "Gradient" improved (JLab)**
- **Asia**
  - **"Gradient" demonstrated, 36MV/m (LL, KEK-JLab), and 28 MV/m (TESLA-like in cryomodule, KEK)**

High gradients achieved in all regions but still with variable yield

13-Nov-08
HEP Seminar

New -- Optical Inspection System

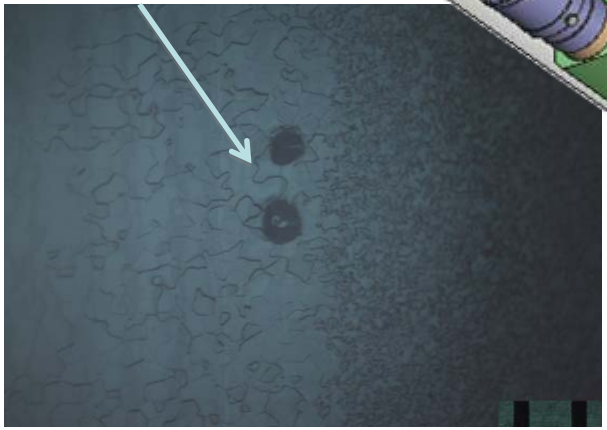
For visual inspection of cavity inner surface.



Iwashita (Kyoto) and Hayano (KEK) et al.

Camera system (7μm/pix) in 50mm diameter pipe.

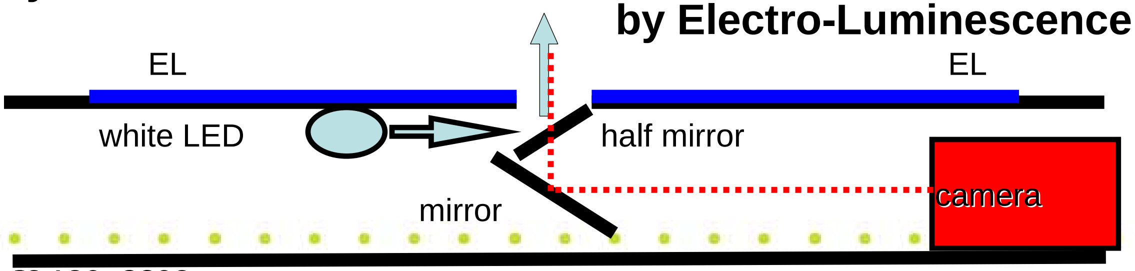
~600μm beads on Nb cavity



DESY starting to use this system in cooperation with KEK

perpendicular illumination by LED & half mirror

tilted sheet illumination by Electro-Luminescence



Global R&D Plan

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)	→ ?

SCRF: Plug Compatibility

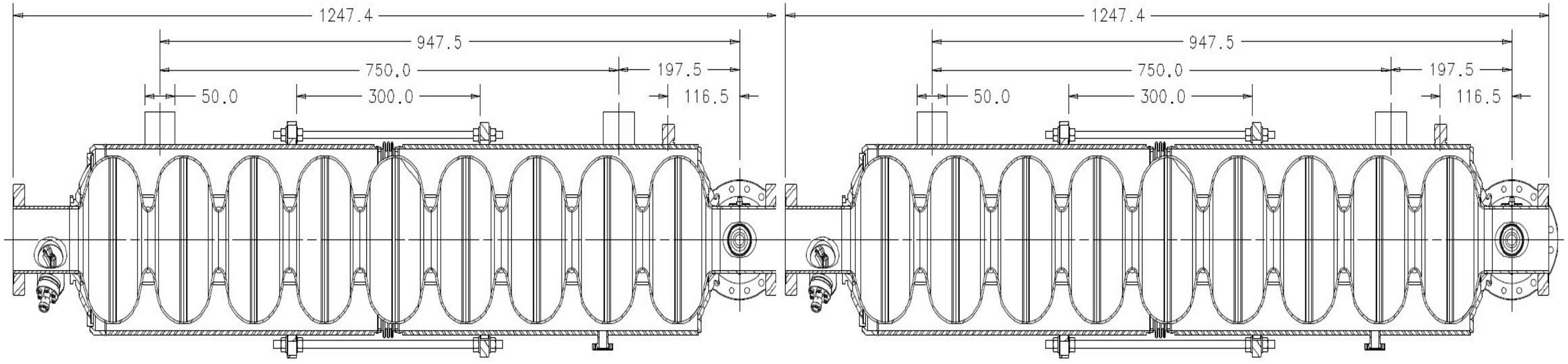
R&D Phase

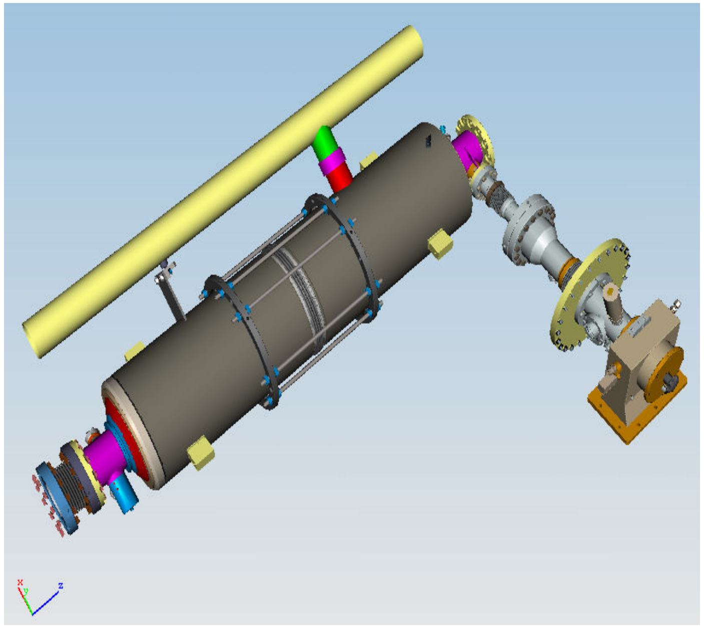
- Need to continue and encourage R&D effort to improve the "gradient" performance,
- "Improvement" comes from "some change", for example,
  - **Cavity Type: Tesla, Low-loss, Re-entrant**
  - **Material: Fine-grain or large grain**
  - **Surface treatment: EP, Rinsing,**
  - **Tuner type: Blade, Jack, etc.,**
  - **Input-coupler: how to simplify the assembly**

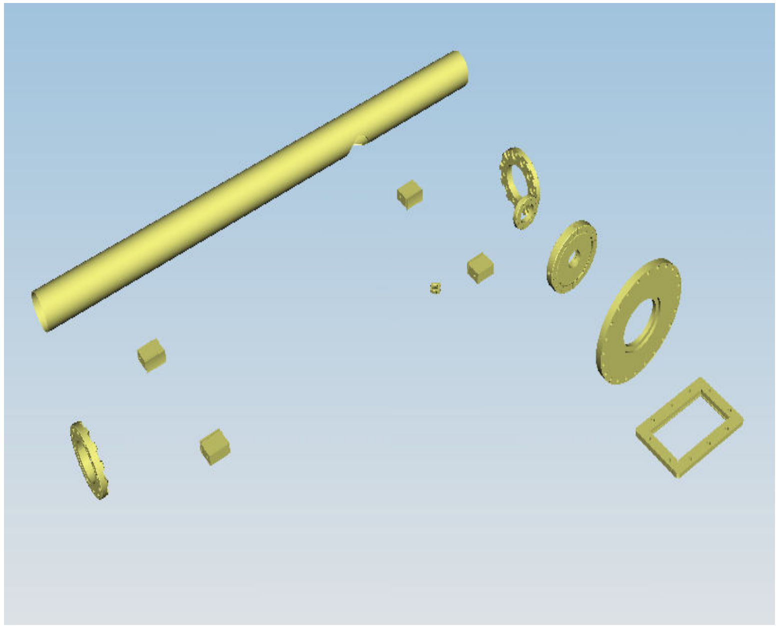
Construction Phase

- Need to keep multiple, regional participation and industrial competition

Plug-compatibly of Cavities



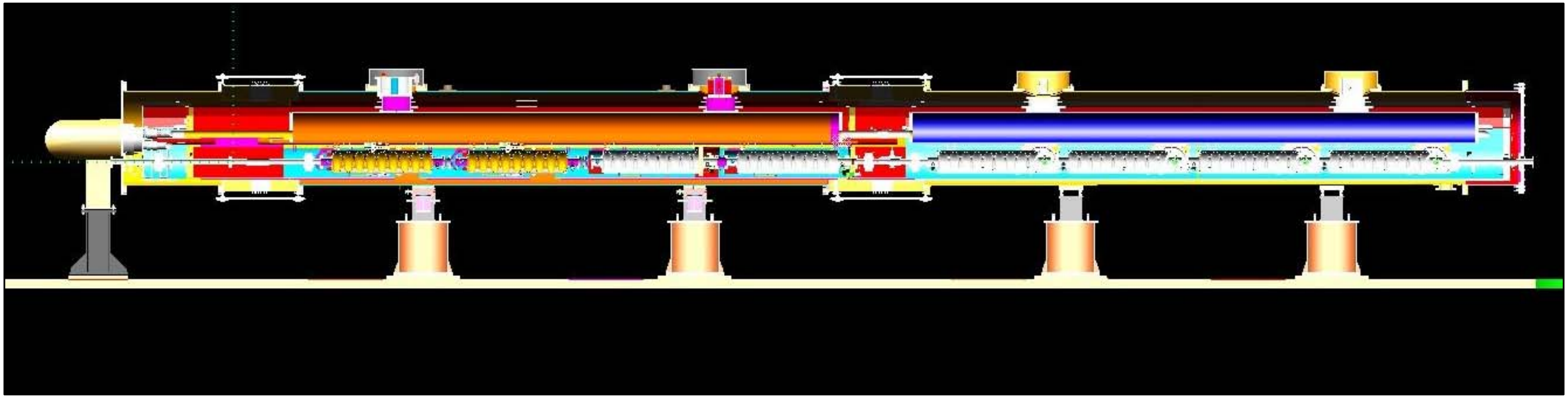




Plug-compatible interfaces need to be established

S1 Global Tests

- Cavity integration and the String Test globally organized with tests to be done at KEK STF facility
  - 2 cavities from DESY and Fermilab
  - 4 cavities from KEK
  - Each half-cryomoducle from INFN and KEK



Global R&D Plan
Consensus in SCRF-TA

Calender Year	2007	2008	2009	2010	2011	2012
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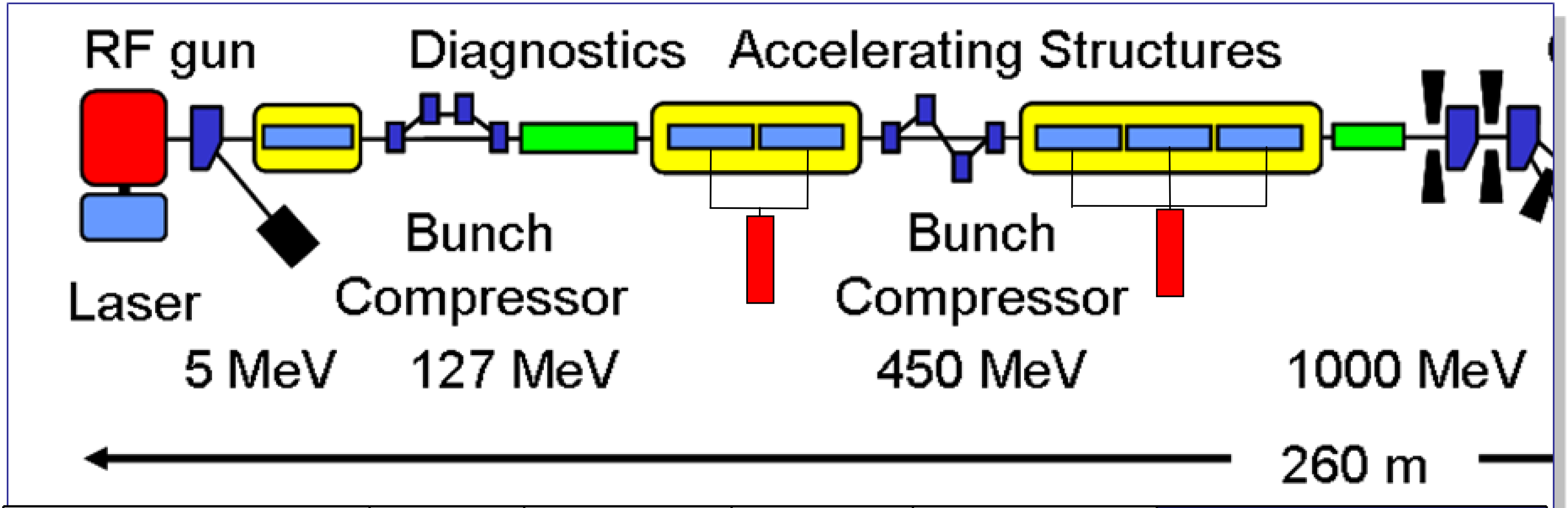
9mA Experiments in TTF/FLASH



		XFEL X-Ray Free-Electron Laser	ilc	FLASH design	FLASH experiment
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

Goals of 9mA test

- Demonstrate energy stability <0.1% (LLRF) with high beam-loading
  - **Bunch to bunch**
  - **Pulse to pulse**
  - **Over many hours**
- Evaluate operation close to cavity limits
  - **Quench limits**
  - **Impact of LFD, microphonics etc.**
- Evaluate LLRF performance
  - **Required klystron overhead**
  - **Optimum feedback / feedforward parameters**
  - **Exception handling (development)**
  - **Piezo-tuner performance *etc.***
- Evaluate HOM absorber (cryoload)
- Controls development
  - **Software & algorithm development for ATCA (XFEL) LLRF system**

Global R&D Plan
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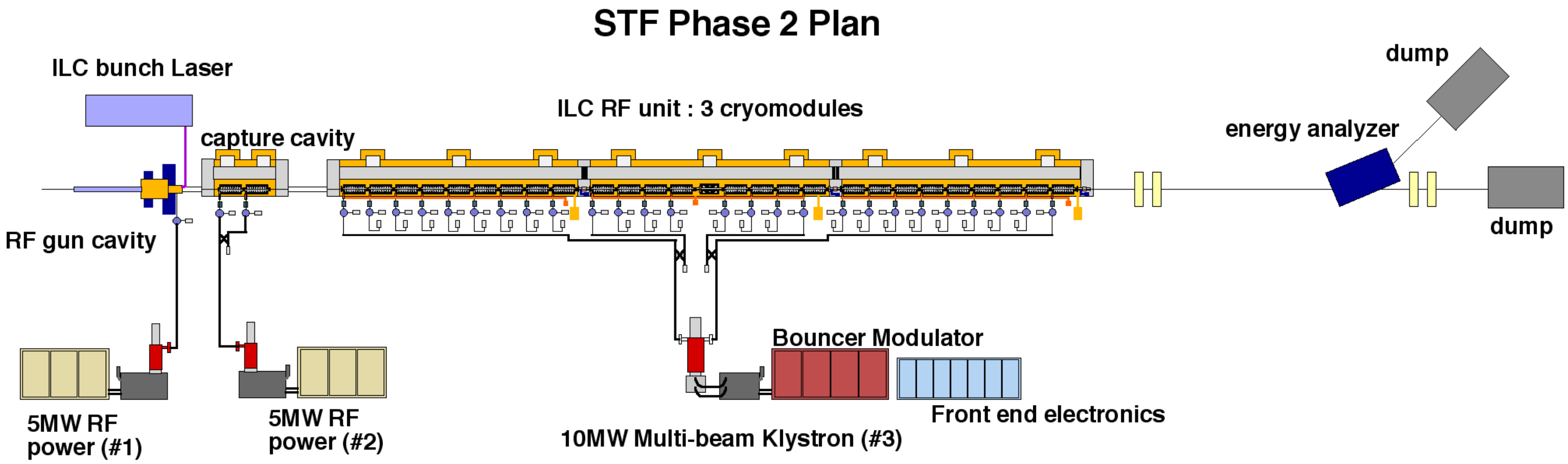
STF phase 2 Accelerator Layout

cavities: 2 capture cavities with short ILC-cross-section cryomodule
+ 26 cavities for ILC cryomodules

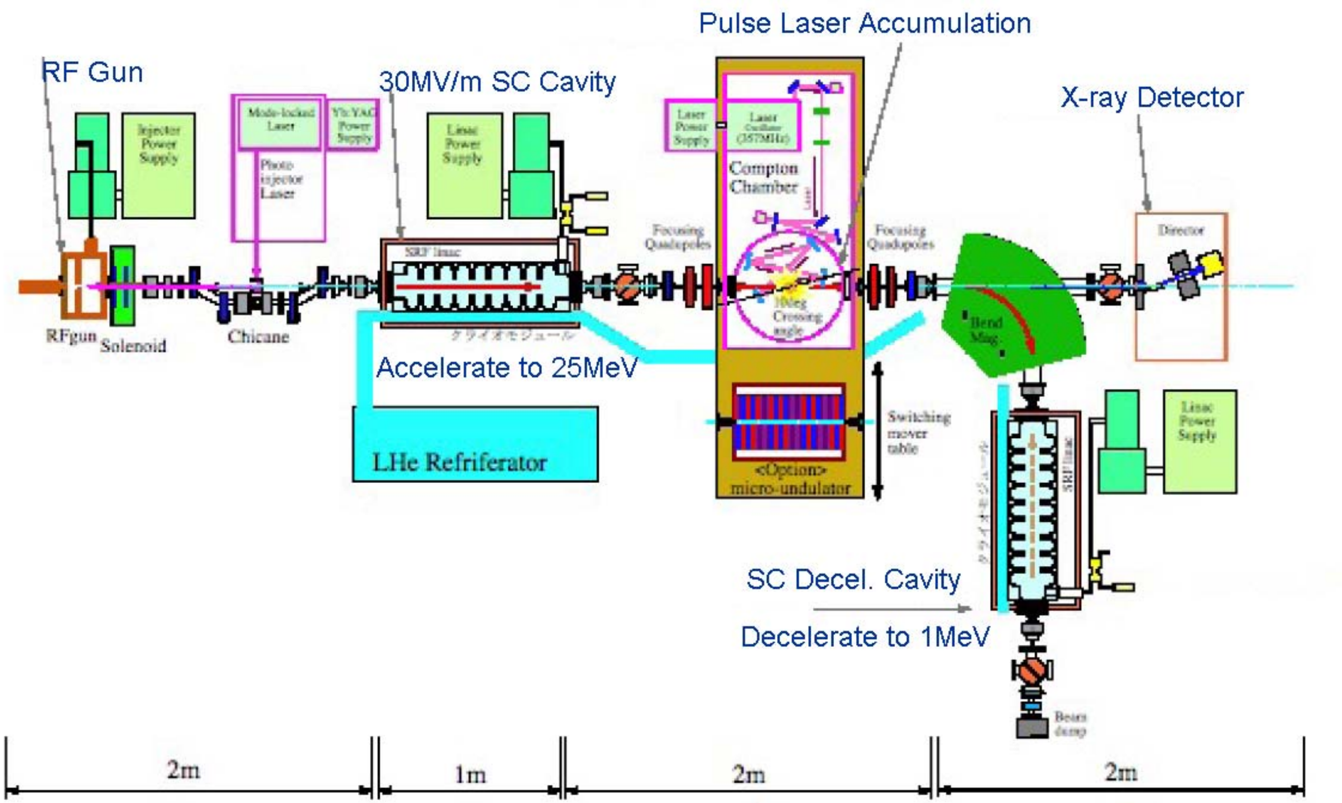
cryomodule: 3 ILC cryomodules,
9 cavities,
8 cavities with SC-Quad+correction dipoles+BPM,
9 cavities

power source: 10MW MBK + bouncer modulator + Linear PDS + ATCA base LLRF

e- beam by FNAL RFgun + IAP laser : 3.2nC x 2625 bunches, 9mA, 5Hz,
will be accelerated up to 850MeV

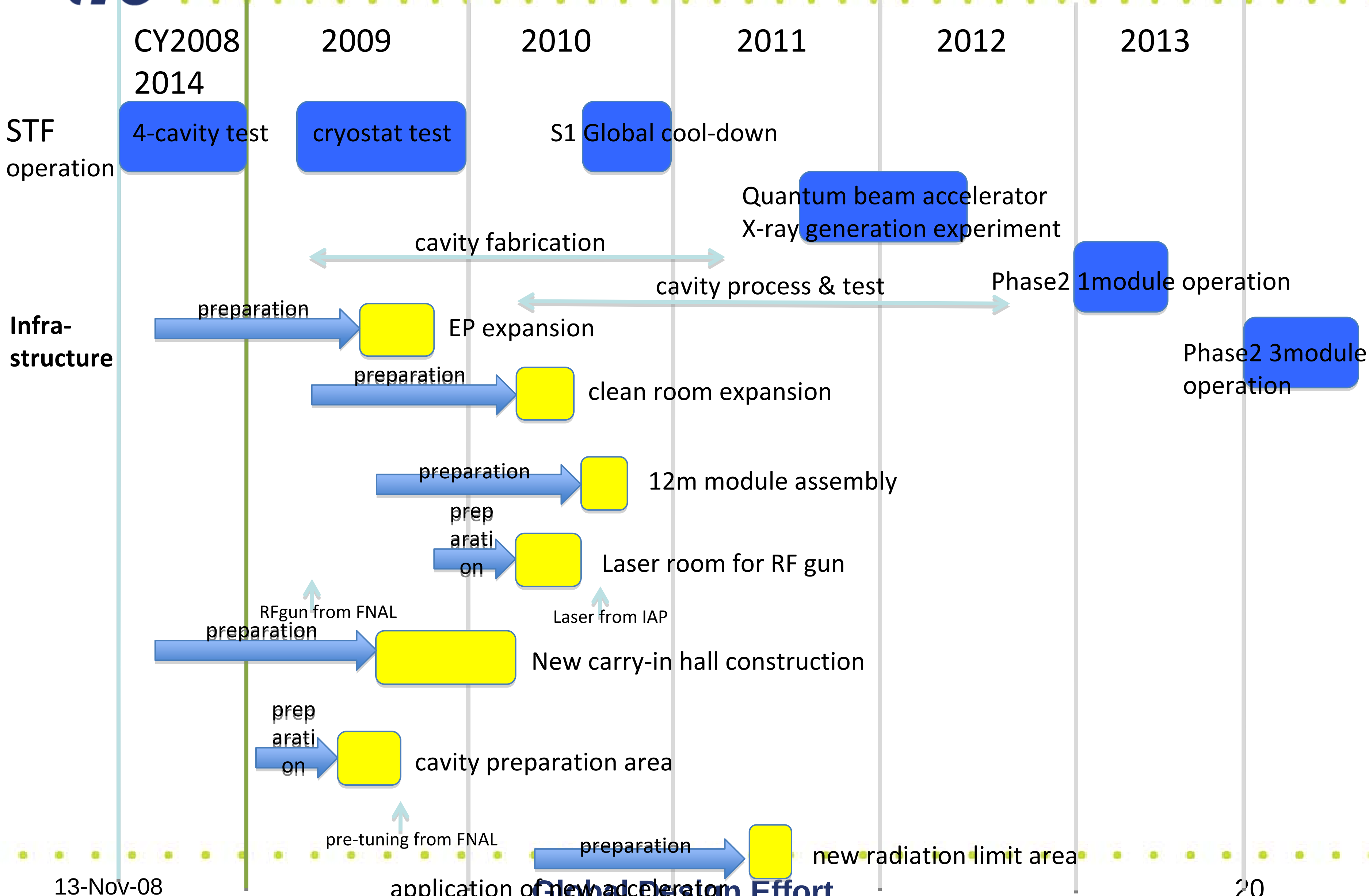


High-Intensity Compact X-ray Source



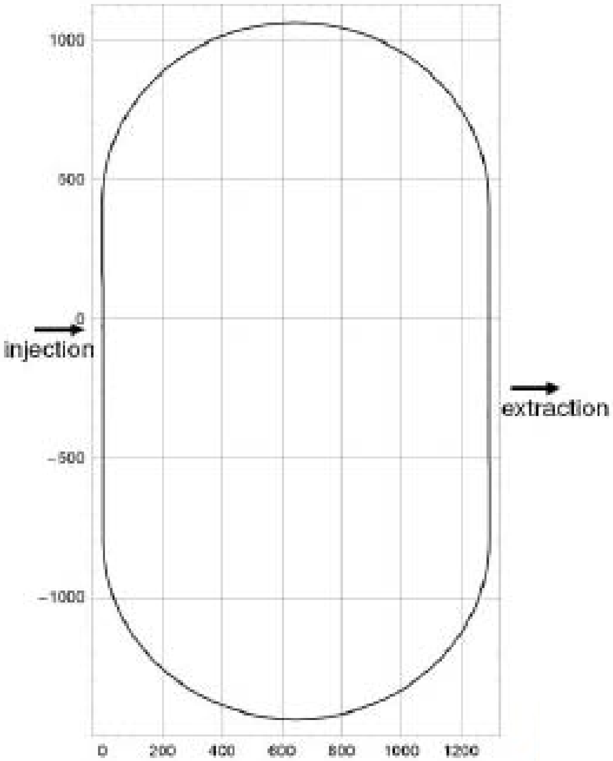
- Must be demonstrated by JFY2012
- Includes 25 MV SC acceleration and deceleration (but perhaps, deceleration can be omitted)
- Beam current (9mA) and pulse length (1ms) same as ILC, but bunch distance factor of ~50 smaller

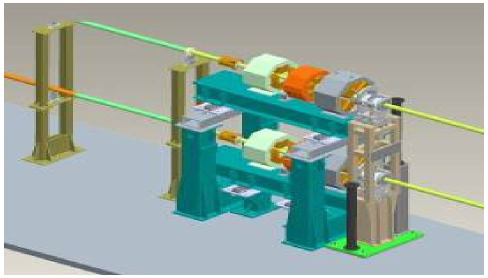
Most Optimistic S2 Schedule



Damping Ring R&D

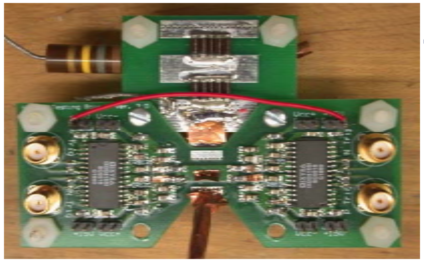
- DR has a flexible race track design
  - 6.4 km Circumference with >1 km straights, which contain, RF, Wigglers, Chicanes, Injection/ Extraction Systems
- There are two critical components which require a successful demonstration in TDP1
  - Fast Inj/Ext Kickers
  - Suppression of electron cloud in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



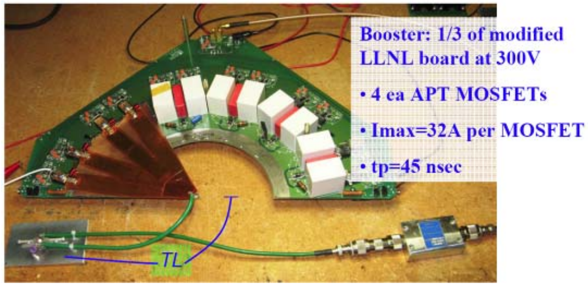


Fast Kicker R&D Program

- 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 in DAΦNE and ATF** are driven by machine upgrade plans (efficient beam injection for DAΦNE and 30~60 multi-bunch train to ATF2 beam line), but are directly relevant for the damping rings R&D program.
- So far, machine tests of fast kickers have relied on commercial (FID) pulser technology.



Tests of MOSFET-based pulser show promising performance.

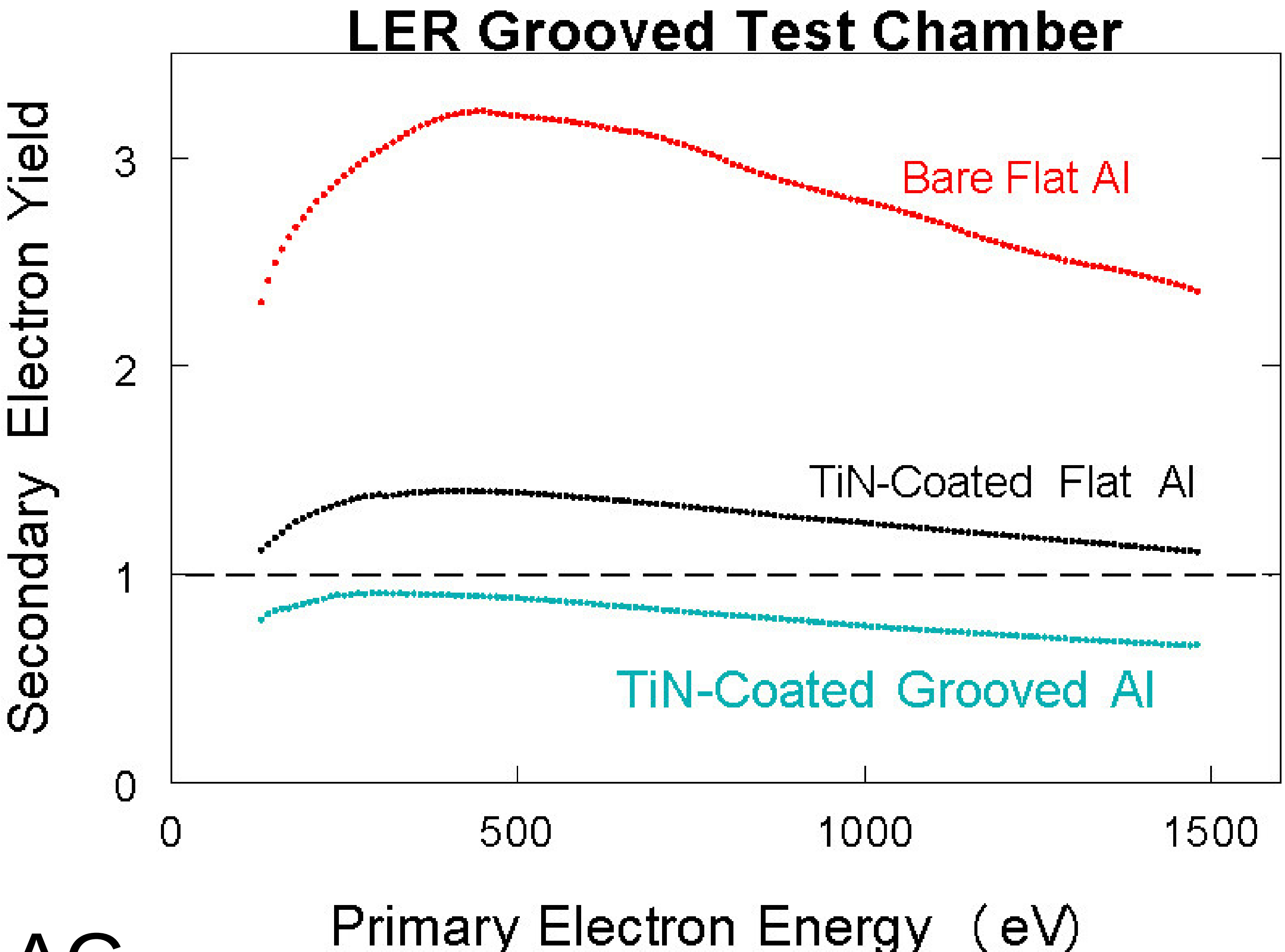


Tests of DSRD-based pulser using board based on LLNL design (for MOSFET inductive adder). Performance is limited by board design and components.

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)**

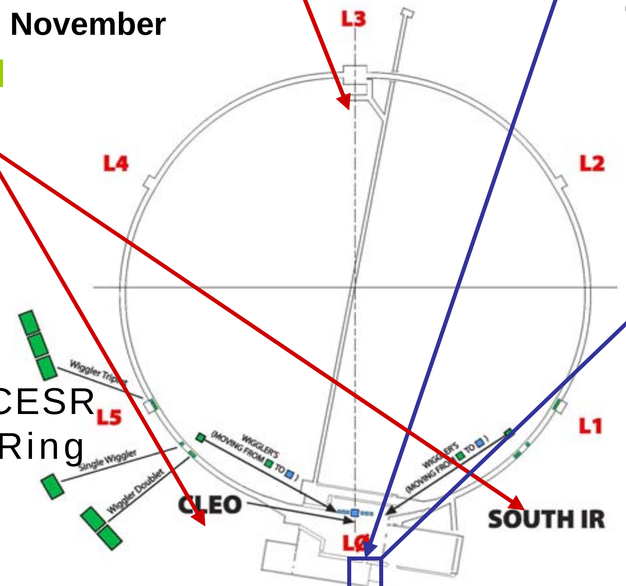
Electron Cloud – Simulation Results

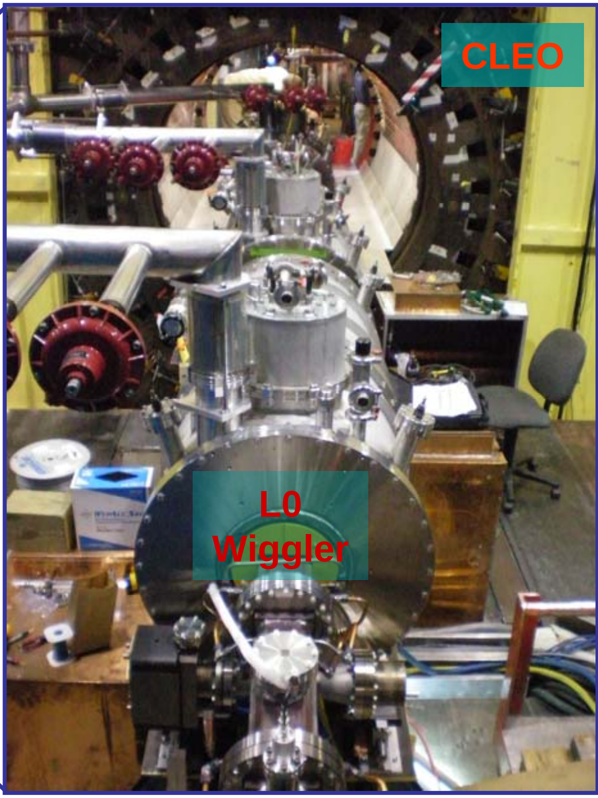


SLAC

Tests at CESR -- Reconfiguration

- **Electron Cloud Diagnostics**
  - L3 region prepped for arrival of PEP-II EC hardware including diagnostic chicane
    - **Hardware being removed at SLAC**
    - **Delivery to Cornell in November**
  - New EC experimental regions in arcs w/ locations for collaborator VCs
  - L0 region reconfigured as a wiggler straight
    - **Instrumented with EC diagnostics**
    - **Wiggler chambers with retarding field analyzers (fabricated at LBNL) - scheduled for installation ~Oct 23rd**
    - **Chambers with EC mitigation (TiN coatings by SLAC)**





Re-commissioning for operations through Oct 27th

CesrTA dedicated experiments: Oct 27-Nov 10

Electron Cloud Experiments, Low Emittance Operation, X-ray Beam Size Monitor

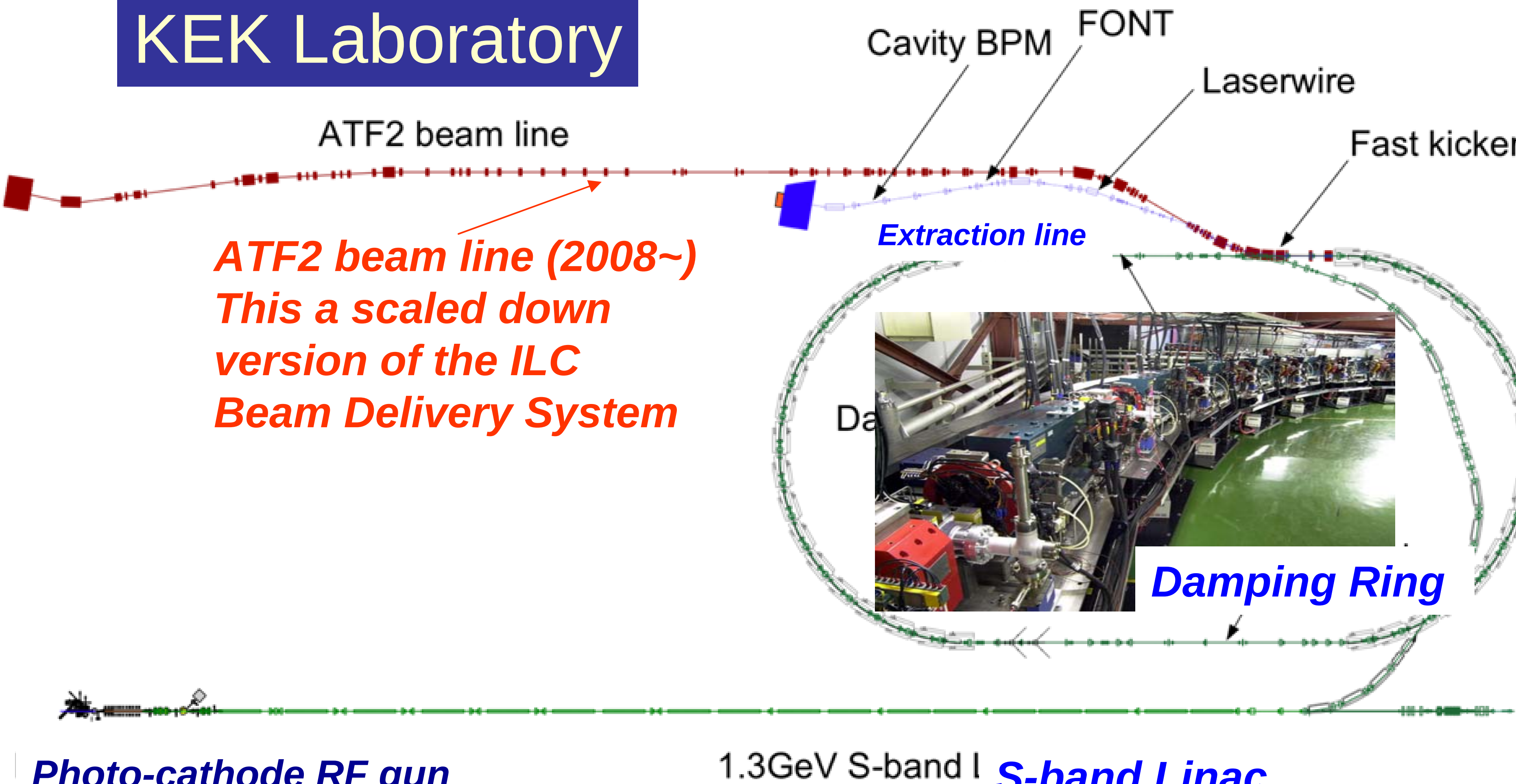
Electron Cloud Goals at CesrTA

- ***Understand cloud buildup*** **in drift, quadrupole, dipole and wiggler sections of CesrTA, with different cloud suppression techniques.**
- ***Understand interaction of the cloud and the beam*** **in CesrTA, including instabilities and emittance growth.**
- ***Validate cloud buildup and cloud dynamics simulations using CesrTA data*****, in order to develop confidence in the application of these simulations to predict cloud behavior in the ILC damping ring.**
- ***Demonstrate cloud suppression techniques*** **suitable for use in the ILC damping ring.**

A very full program with a multinational team

Accelerator Test Facility – ATF/ATF2

KEK Laboratory



ATF2 beam line (2008~)
This a scaled down version of the ILC Beam Delivery System

Extraction line

Damping Ring

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

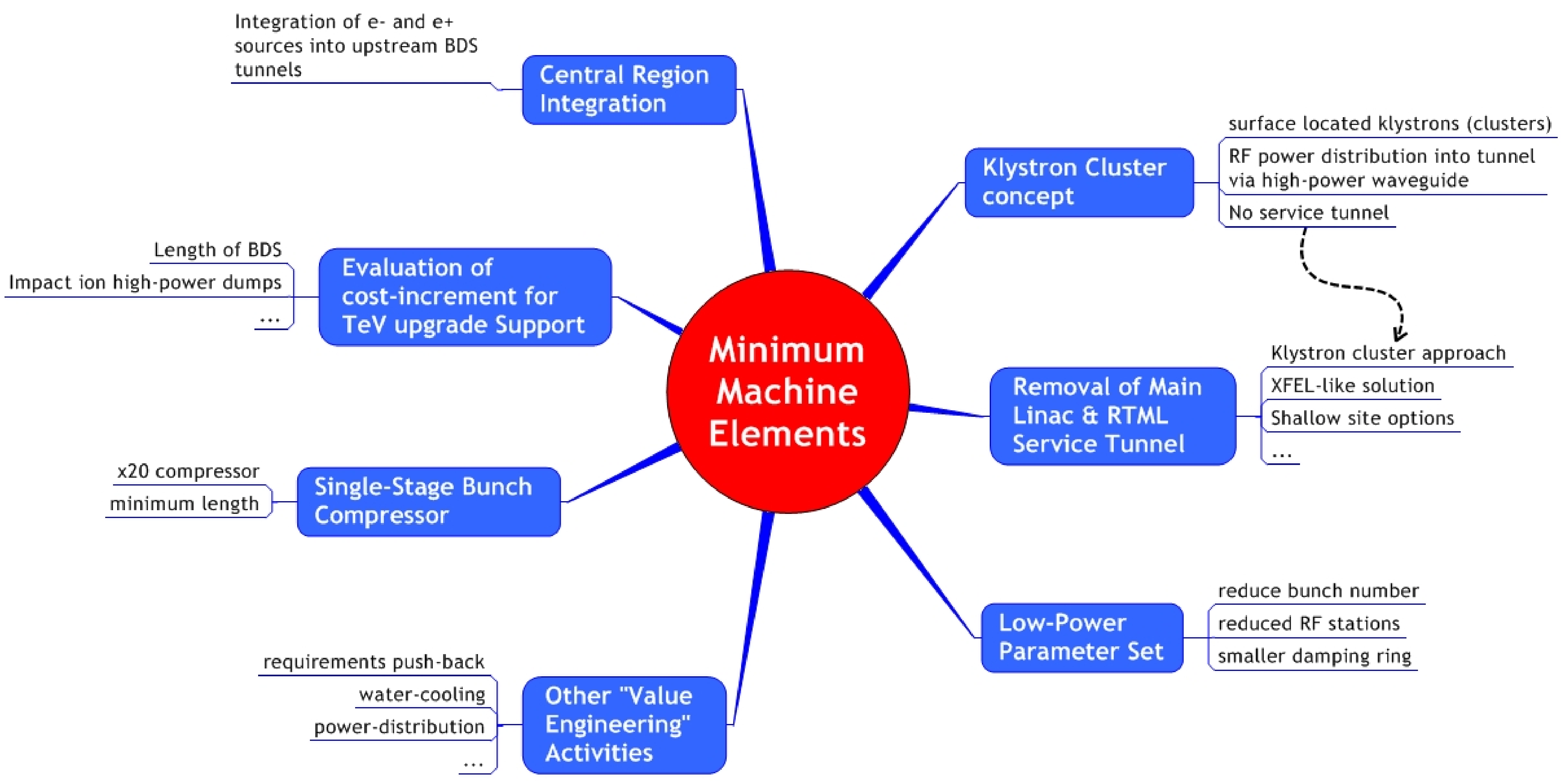
Commissioning this fall

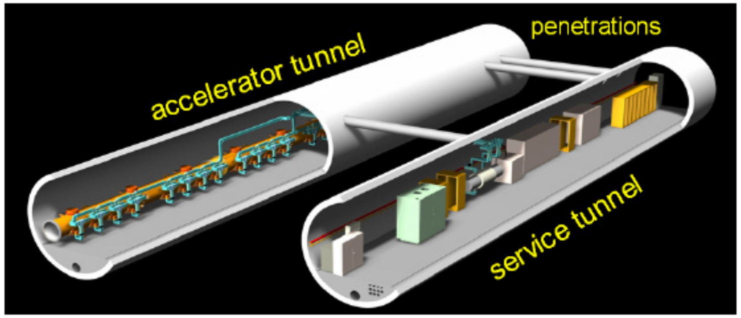
Minimum Machine Design Effort

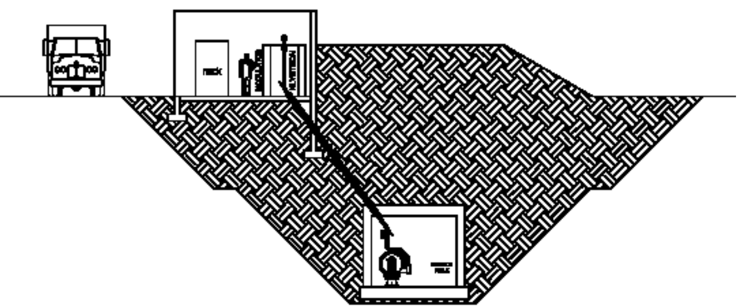
- "Minimum Machine" refers to a set of identified options (*elements*) which may simplify the design and be cost-effective

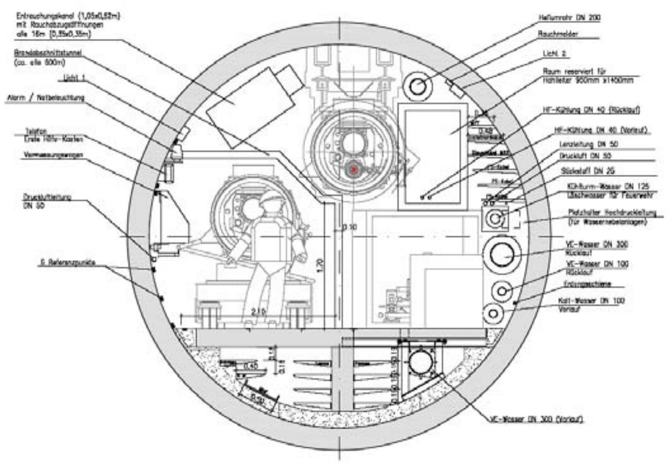
1. **Klystron Cluster concept**
2. **Central region integration**
3. **Low beam power option**
4. **Single-stage compressor**
5. **Quantify cost of TeV upgrade support**
6. **"Value engineering"**
7. **Single-tunnel solution(s)**

Identified Minimum Machine Elements





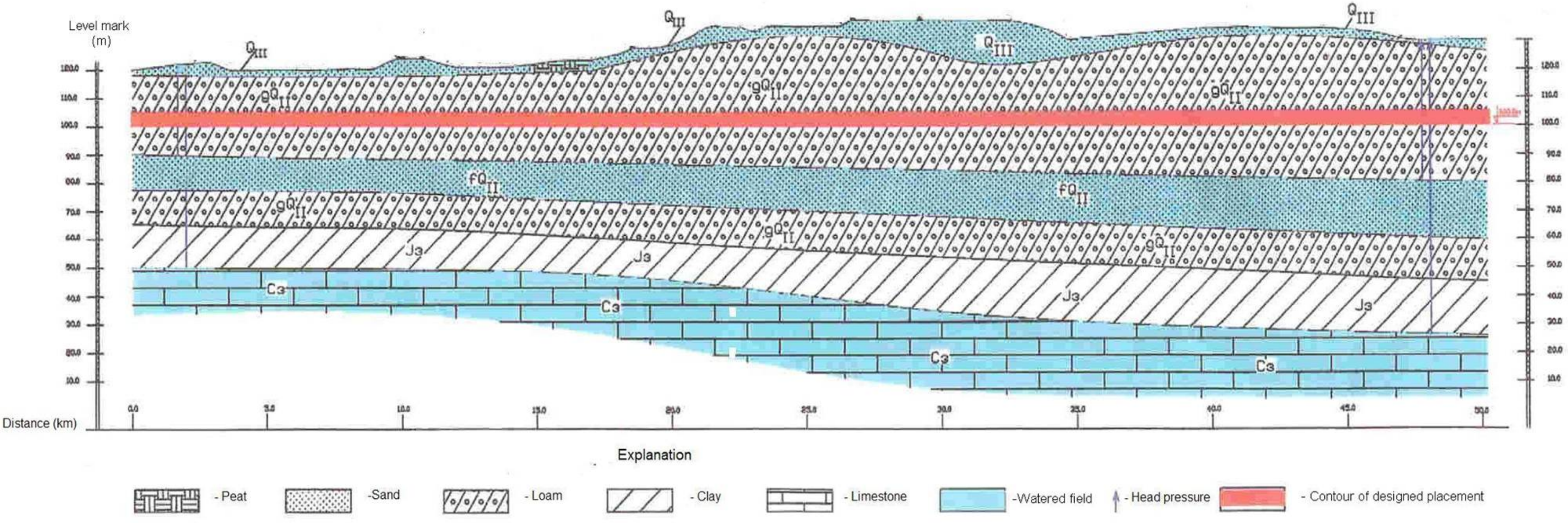




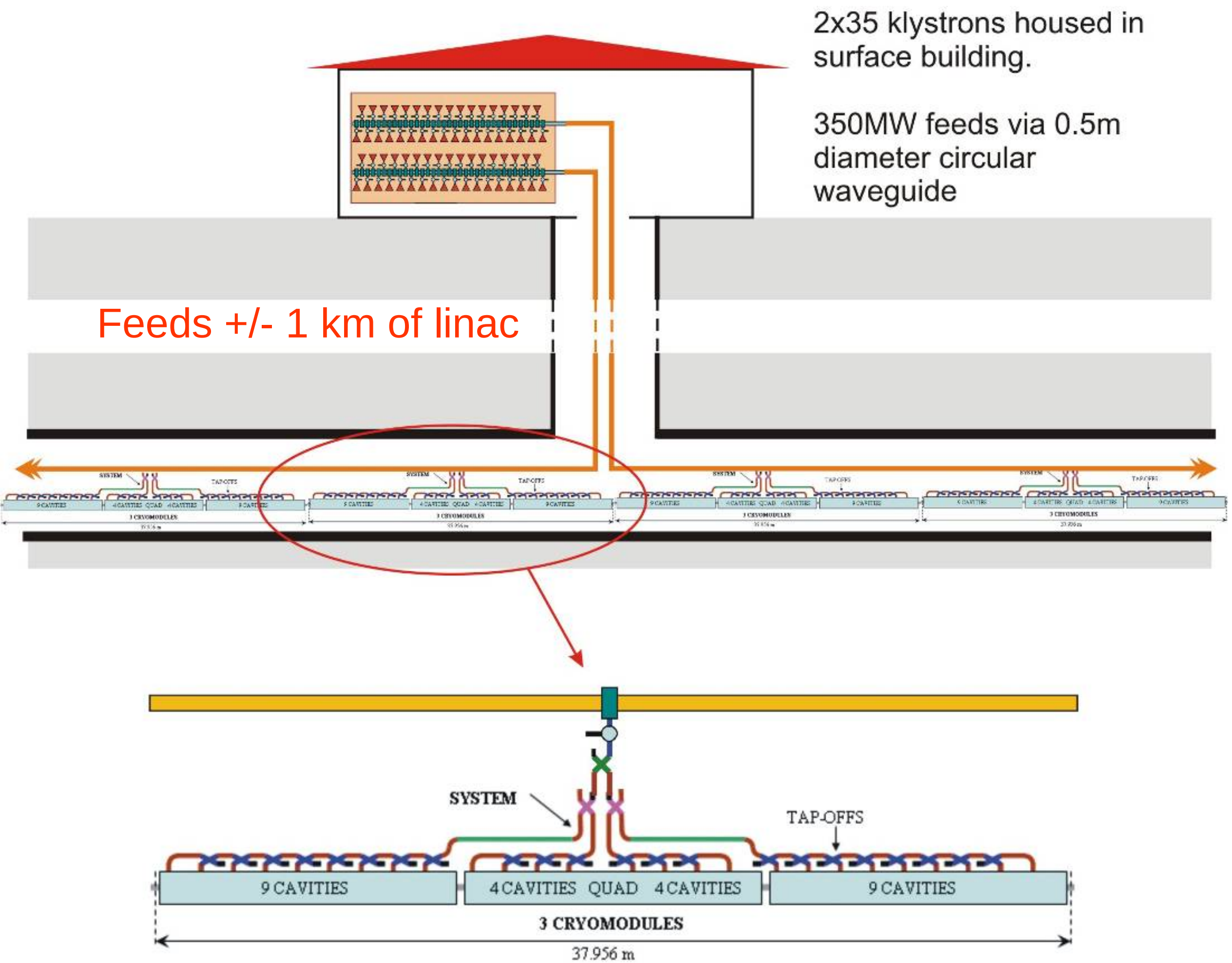
- RDR (two-tunnel)
  - **Access to equipment during ops**
    - Reliability/availability
- Shallow sites
  - **Cut and cover like solutions**
  - **“service tunnel” on the surface**
- Single tunnel
  - **European XFEL-like solution**
    - availability / reliability

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.



Klystron Cluster Concept



Each tap-off from the main waveguide feeds 10 MW through a high power window and probably a circulator or switch to a local PDS for a 3 cryomodule, 26 cavity RF unit (RDR baseline).

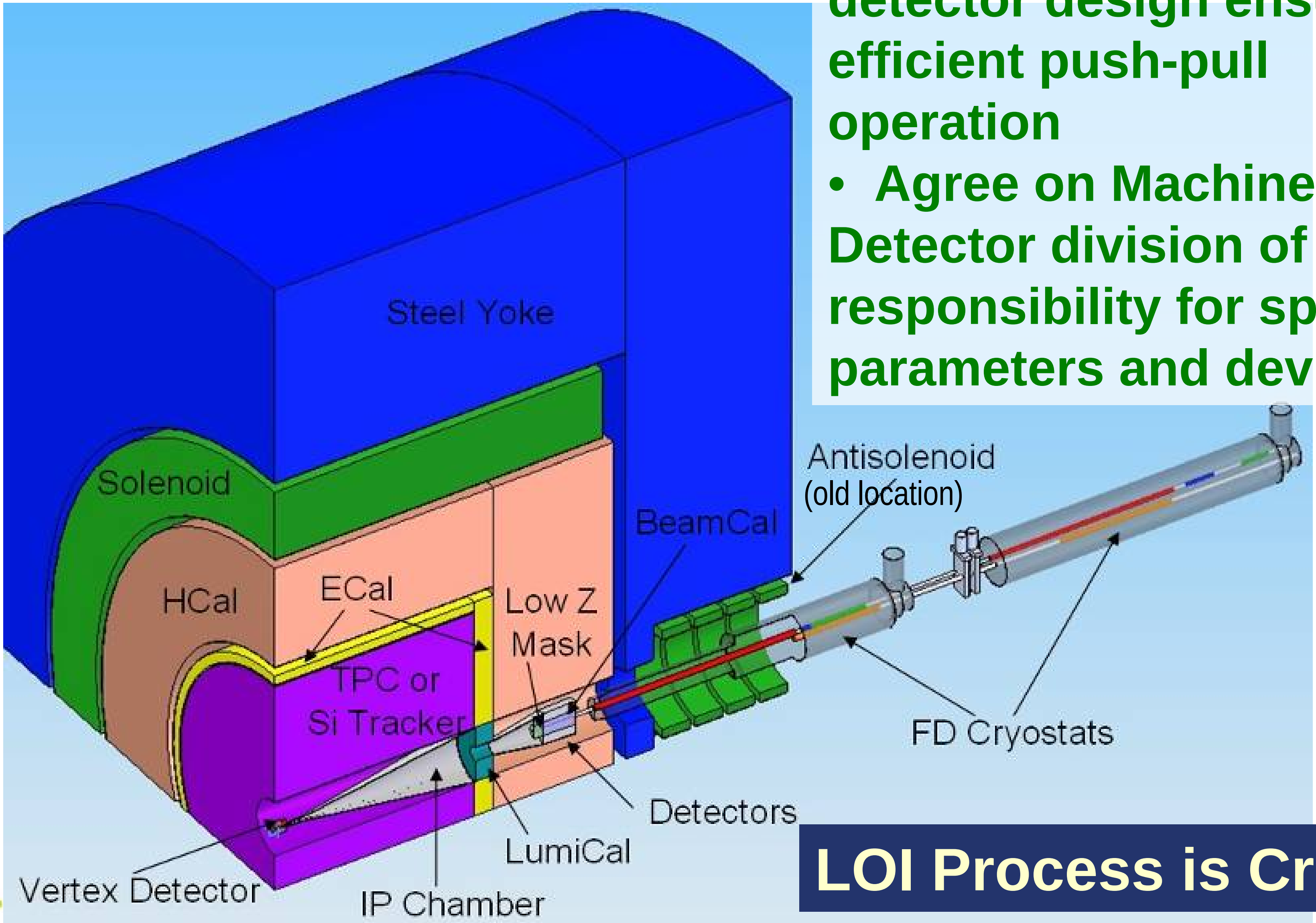
- RF power "piped" into accelerator tunnel
- Removal of service tunnel
- Access to klystrons & modulators maintained
- R&D needed to show power handling
  - Planned (SLAC, KEK)

SLAC

IR Integration

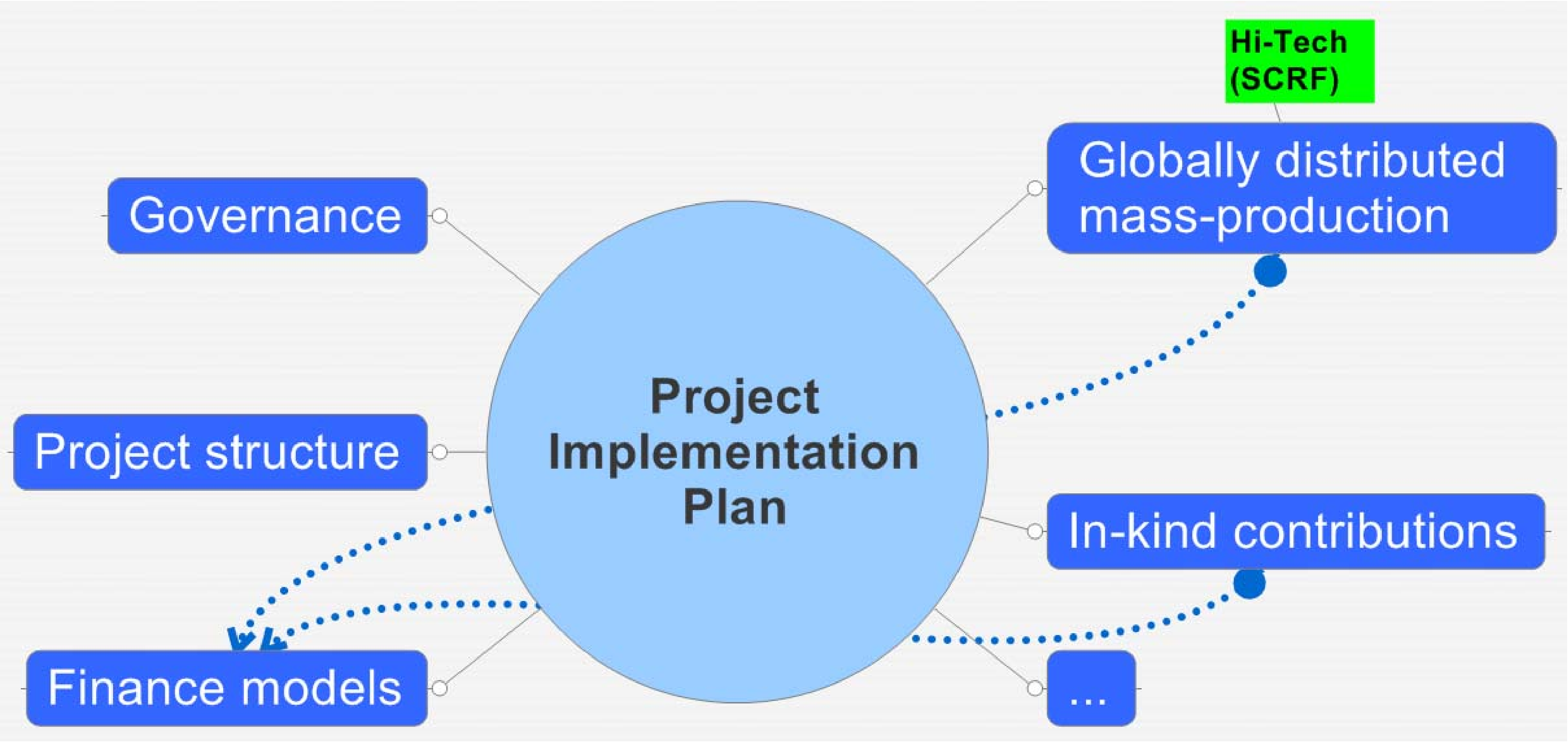
CHALLENGES:

- **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

Project Implementation Plan



Joint ILC/CLIC R&D Areas

- ILC-CLIC working groups formed in 2008. Goal is to optimize use of resources in areas of common or overlapping interests.

  - 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
  - Beam Dynamics: A.Latina/FNAL), Kiyoshi Kubo (KEK), D.Schulte/CERN, Nick Walker (DESY)
  - Cost & Schedule: John Carwardine (ANL), Katy Foraz/CERN, Peter Garbincius (FNAL), Tetsuo Shidara (KEK), Sylvain Weisz/CERN

Project progress reports given at workshops such as

CLIC08 14-17 Oct,08 and ILC08 15-20 Nov,08

Two new groups are being added, E+ sources, Damping Rings

US Program --- P5 Report

- ***"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 – continuing resolution)

US ILC Status

- Following the P5 recommendations, the ILC R&D program the US ILC FY09 baseline budget was established at $35.3M
- This was reduced to $29.5M due to the CR. This is an effective rate of 84% which is equal to the overall reduction in OHEP funding. This is sufficient to restart.
- Guidance at this level was send out at the start of FY09 and work is now ramping up at the national labs. We had managed to maintain the CESR TA program with NSF funding, a skeleton SRF gradient program, and certain elements of the GDE .
- Current CR planning is assuming that the CR goes away in March.
- With the resumption of funding we are starting to work on the US program for the balance of the R&D phase (2010 -> 2012)

FY09 Allocations - $35.3M (& CR)

Institution	$K
SLAC	11913
Fermilab	11697
JLAB	2097
BNL	2100
Argonne	1436
LLNL	200
LBL	260
Cornell	2724
GDE	976
Contingency	1916

Institution	$K
SLAC	10460
Fermilab	10270
JLAB	1840
BNL	1850
Argonne	1260
LLNL	200
LBL	260
Cornell	2400
GDE	976
Contingency	0

CR Plan - Impact

- **Fermilab: hold labour and reduce M&S by $1.3M**
  - Delay some CFS consultant contracts
  - Delay some cryomodule parts purchases
  - Remove S1 global dressed cavities – in principle (if the CR goes away in 6 months) there is no impact to this change
  - Nickel and dime
- **SLAC: slow down and/or delay manpower ramp up and reduce M&S**
  - ATF2 (at KEK) fully supported
  - HLRF system development slowed down
  - Slow down accelerator physics and tilt towards CESR TA support
  - Nickel and dime

Final Remarks

- The global ILC R&D program has proven resilient to the budget crisis
- We are now in the technical design phase, which will culminate in 2012 with completion of crucial R&D and optimized cost / performance / risk design
- The US ILC program is being re-integrated, but we need to develop a long range strategy for the US program
- Collaborative work with CLIC is strengthening our effort and will help prepare us toward an ILC proposal if the science case is justified by LHC