ILC Technical Design Phase Overview

presented by Marc Ross - for the ILC Project Managers:

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Nick Walker - (DESY),

Akira Yamamoto – (KEK)

Based on:
'ILC Research and Development Plan for the Technical Design Phase'
Published June 2008
and
'ILC Project Management Plan for the Engineering Design (ED) Phase'
Published October 2007

TDP Overview

- ***Mission and Deliverables***
- **Basis and Oversight**
- **Resources and the role of R & D**
- **Schedule and Status – technical activities**
- **Regional Developments**
- **Project Preparation**
- **Conclusion**

3 main aims:

slide taken from LCWS07 – DESY June 2007

- **In order to achieve our goals we must:**

1) ensure that the internal momentum of the GDE continues to grow and that the tasks the GDE sets itself allow scope for the enthusiasm and commitment of the *international ILC community* to continue to grow;

2) produce the *technical information* required and agreed by the contracting governments as necessary to proceed to approval of the project implement design, preparation for procurement

3) coordinate the *world-wide R&D programme* to give the optimum return on the investment of the contracting governments.

Goal for Technical Design Phase:

- **The Technical Design (TD) Phase of the ILC Global Design Effort will produce a technical design of the ILC in sufficient detail that project approval from all involved governments can be sought.**

- **The TD phase will culminate with the publication of a Technical Design Report (TDR) in 2012.**

Technical Design Report (TDR):

- **The key elements of the TDR will be:**
  - • A complete and updated technical description of the ILC in sufficient detail to justify the associated VALUE estimate.
  - • Results from critical R&D programmes and test facilities which either demonstrate or support the choice of key parameters in the machine design.
  - • One or more models for a Project Implementation Plan, including scenarios for globally distributed mass-production of high-technology components as “in-kind” contributions.
  - • An updated and robust VALUE estimate and construction schedule consistent with the scope of the machine and the proposed Project Implementation Plan.
- **The report will also indicate the scope and associated risk of the remaining engineering work that must be done before project construction can begin.**

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Basis for our activity:

- TD Phase R & D is coordinated by the TD Phase Project Management Organization.
- The effort is subdivided into fifteen functional Technical Area Groups grouped into three Technical Areas
  - **Superconducting RF Technology,**
  - **Conventional Facilities & Siting and Global Systems,**
  - **Accelerator Systems.**
- Each Technical Area Group has a Group Leader who reports to a Project Manager.
- The Group Leader is responsible for soliciting, collecting and interpreting Expressions of Interest statements that indicate the contribution a given individual or institution would like to make toward the goals of that Technical Area.

The GDE Organizational Roles:

- **Project Managers report directly to Project Director**
- **Project Managers (PM) are responsible for**
  - setting technical direction and executing the project for realization of the ILC,
  - day-to-day execution
- **Regional Directors (RD) and Institutional managers are responsible for:**
  - promoting, funding and authorizing the cooperative program,
  - using a framework consistent with Institutional and Regional priorities
  - periodic review
- **Project Manager and Regional Director roles are complementary and balanced**

The Organizational structure should serve to facilitate a balance between regional interests and resources and global technical direction

GDE Organization – Practical Aspects

- **Technical objectives are developed by PM with support of Technical Area Groups**
  - Based on *Reference Design Report* Risk Assessment
    - For example: Gradient R&D, electron cloud,
  - PM ←→ RD communication through Central Team (Executive Committee)
  - Using PM-coordinated collaborative teams
- **Institutional objectives and matching Resource plans are developed by RD and Institutional Managers**
  - PM and Technical Area Group Leaders develop and manage detailed objectives within these plans
- ***Process forms the basis for a three-way consensus***
  - *Project Managers*
  - *Regional Directors*
  - *Institutional Managers*

Oversight

- **Project Advisory Committee**
  - commissioned by ICFA / ILCSC
  - Chair: Jean-Eudes Augustin (LPHNE)
- **Accelerator Advisory Panel**
  - commissioned by GDE Project Director
  - Chair: Bill Willis (Columbia) / co-chair Eckhard Elsen (Desy)
  - Panel members linked to Technical Areas to ensure steady communication
    - they receive updates concerning ongoing program
    - they provide advice on strategic direction, etc
  - Formal, traditional-style review annually (TDP1 Interim - April 2009)
- **Regional / Institutional / Programmatic reviews managed through RD and Institutional Managers**
  - e.g. : Annual Americas Regional Team DoE/NSF Review

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Resources:

Basis: *institutional and regional support for science ILC will provide.*

ILC development effort utilizes:

1. **ILC project preparation-specific funding**
   - support for design and cost/risk reduction studies for the TDR
2. **other project-specific funding (XFEL etc)**
3. **generic R&D**
   - support for the development of specific technologies
4. **combinations of the above**
   - beam test facility support

- **Support for the science ILC will provide complements a strong interest in emerging technologies**

‘In-Kind’ R&D

- **provides return for regions/institutions investing resources for technical development**
- **To ILC:**
  – Beam Studies
  – Infrastructure usage
  – Engineering and Testing
- **To contributing Institute / Region:**
  – Technology transfer between partner ILC institutions
  – Infrastructure development and qualification
  – Community connection mechanisms

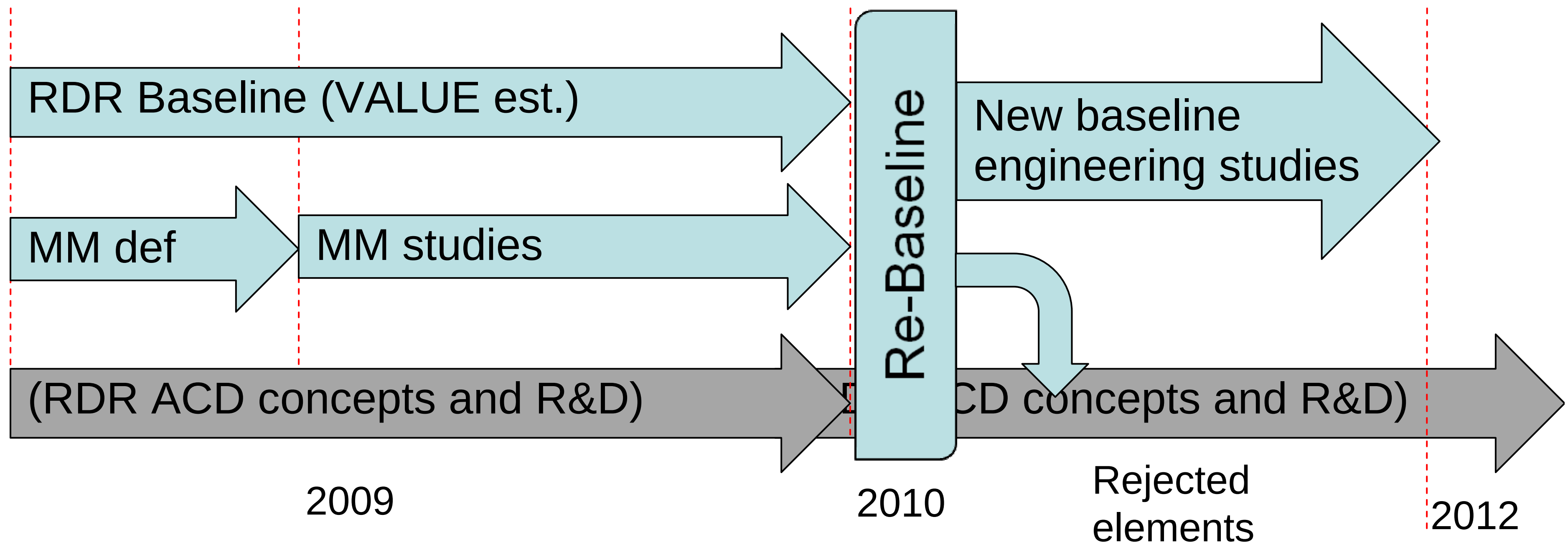
The role of R&D:

- **in support of a *mature, low risk design***
- **take advantage the ongoing, increasing global investment in SRF**
  - the big impact of the ITRP decision
  - Improve performance, reduce cost, challenge limitations, develop inter-regional ties, develop regional technical centers
    - Both a 'project-based' and a 'generic' focus

The ILC has:

- **A *Baseline Design*; to be extended and used for comparison (RDR)**
  - But ready for deployment
- **Research and Development activities on Alternates to the Baseline**
  - Engages the community → venue for cost-saving / risk-reduction actvities
- **Plug – compatibility / modularity policy → flexibility between the above**
  - The critical role of associated projects – XFEL, Project X, SNS, JLab12, ERLs, …
- **Models of 'project implementation'**
  - The transition from R&D to a real project
  - The link between Technical Phase R&D and the project political process

Towards a Re-Baselining in 2010



- **Process**
  - – RDR baseline & VALUE element are maintained
    - Formal baseline
  - – MM elements needs to be studied/reviewed internationally
    - Regional balance in the AP&D groups involved
    - Regular meetings and discussions
  - – Formal review and re-baseline process beginning of 2010
    - Exact process needs definition - closeout
    - Community sign-off mandatory

MM – Minimum Machine

RDR ACD – Alternate Configuration

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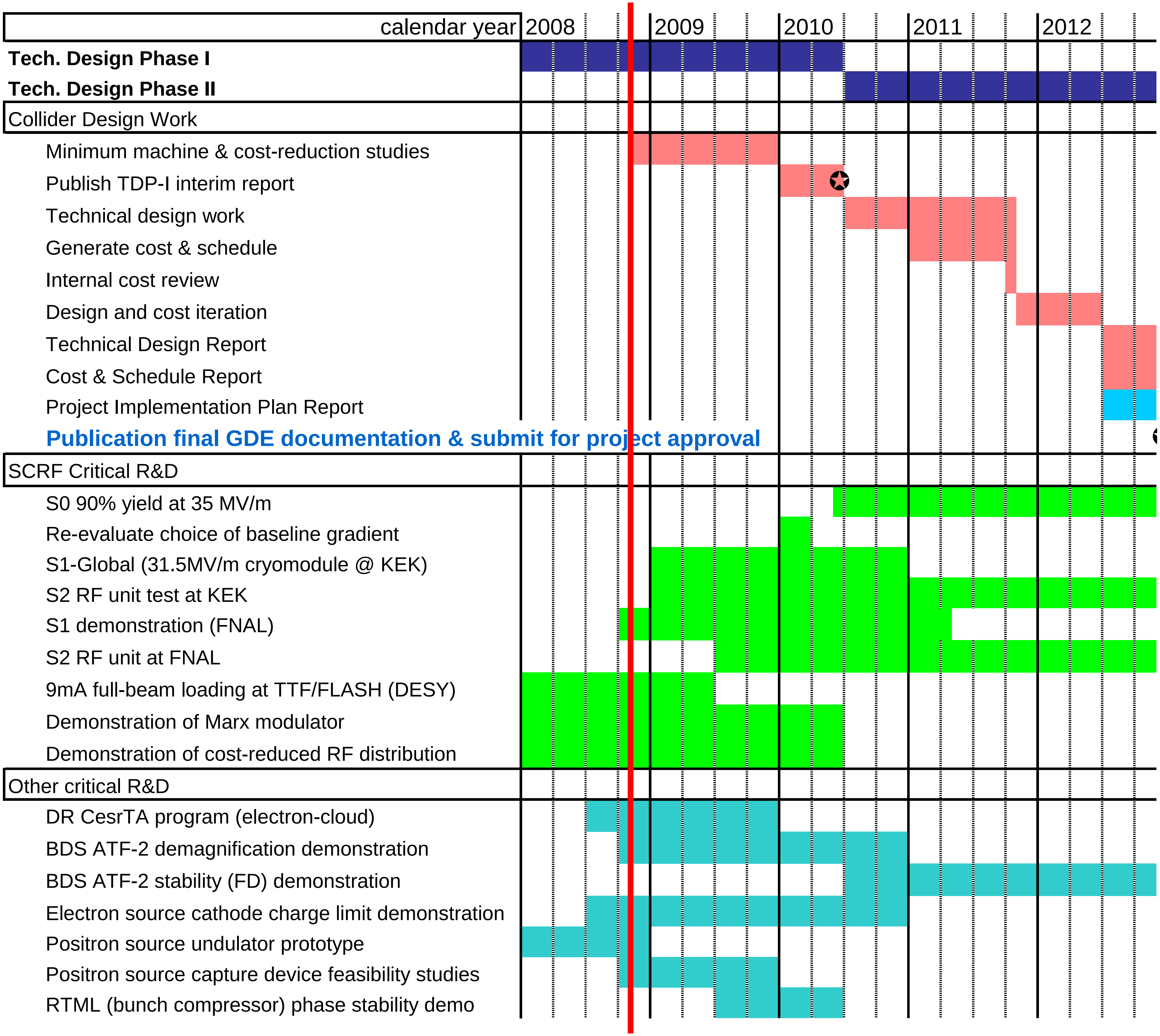
TDP Schedule – 2008 to 2012

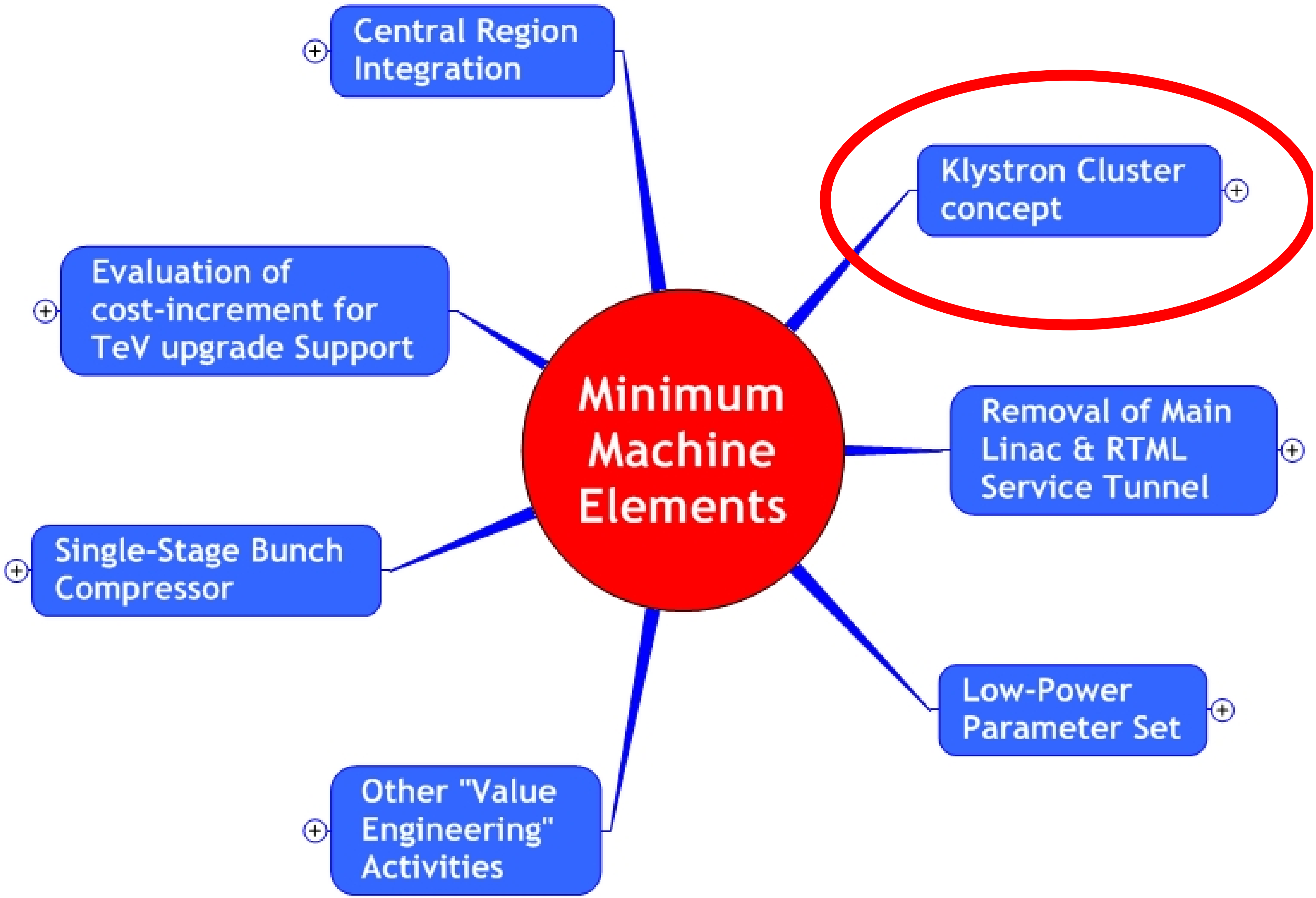


2008 Milestones

- **Collider design – beyond the RDR**
  - the 'global value engineering' process:
  - the MINIMUM MACHINE INITIATIVE → *study Cost - Performance Tradeoffs*
    - a core theme of ILC08 / LCWS08
  - CF/S study of alternates
- **Superconducting RF Technology:**
  - Gradient (S0)
  - Cryomodule Demonstration → Plug Compatibility (S1)
  - Cryogenic Linac Systems (S2) :
    - XFEL (EU),
    - ILCTA/NML (FNAL),
    - STF (KEK)
- **Beam Test Facility construction / operation**
  - TTF/FLASH (DESY),
  - ATF2 (KEK),
  - CesrTA (Cornell)

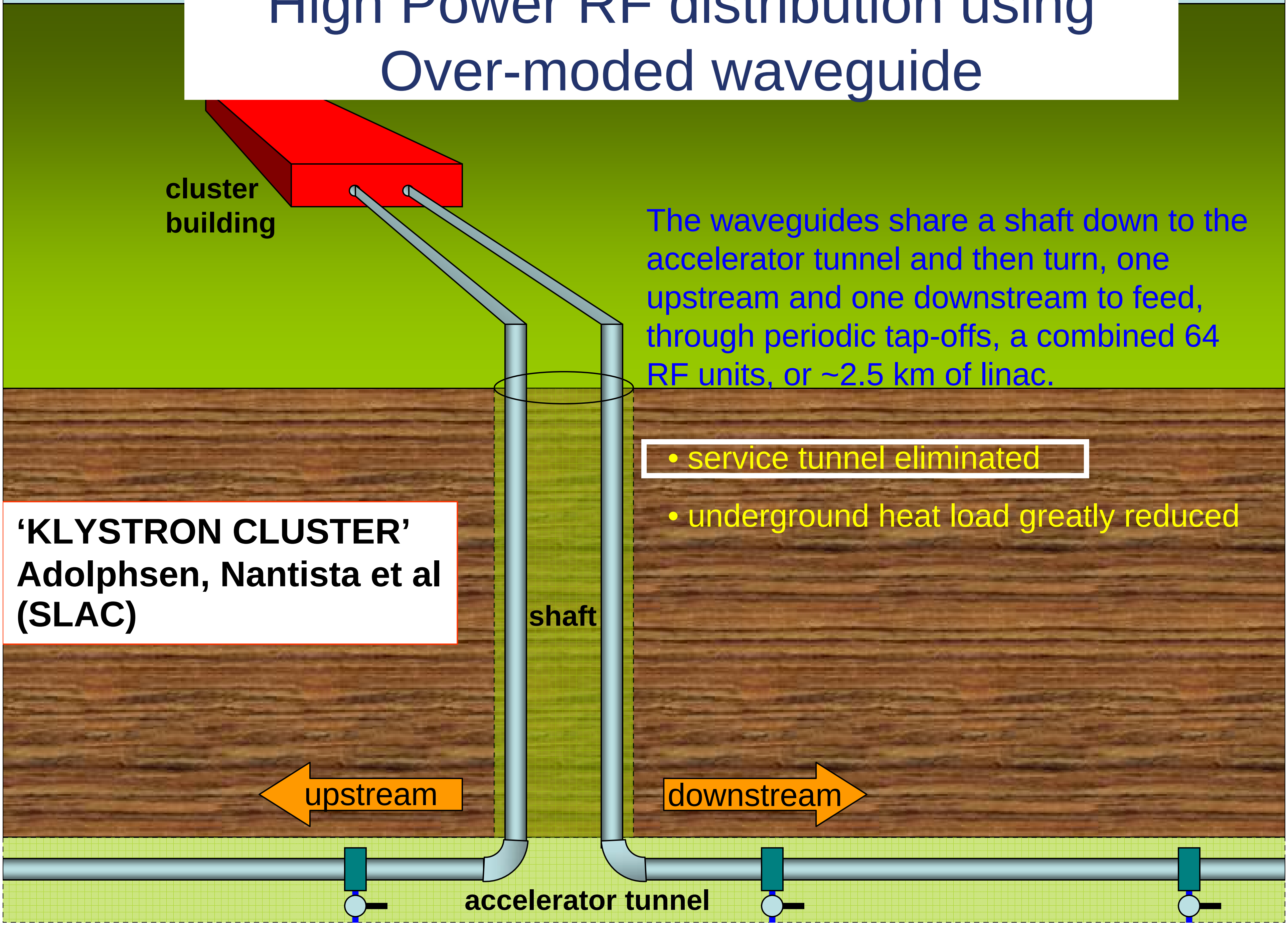
The Minimum Machine Philosophy

- **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.**



Minimum Machine Elements
Central Region Integration
Klystron Cluster concept
Evaluation of cost-increment for TeV upgrade Support
Removal of Main Linac & RTML Service Tunnel
Single-Stage Bunch Compressor
Low-Power Parameter Set
Other "Value Engineering" Activities

High Power RF distribution using Over-moded waveguide



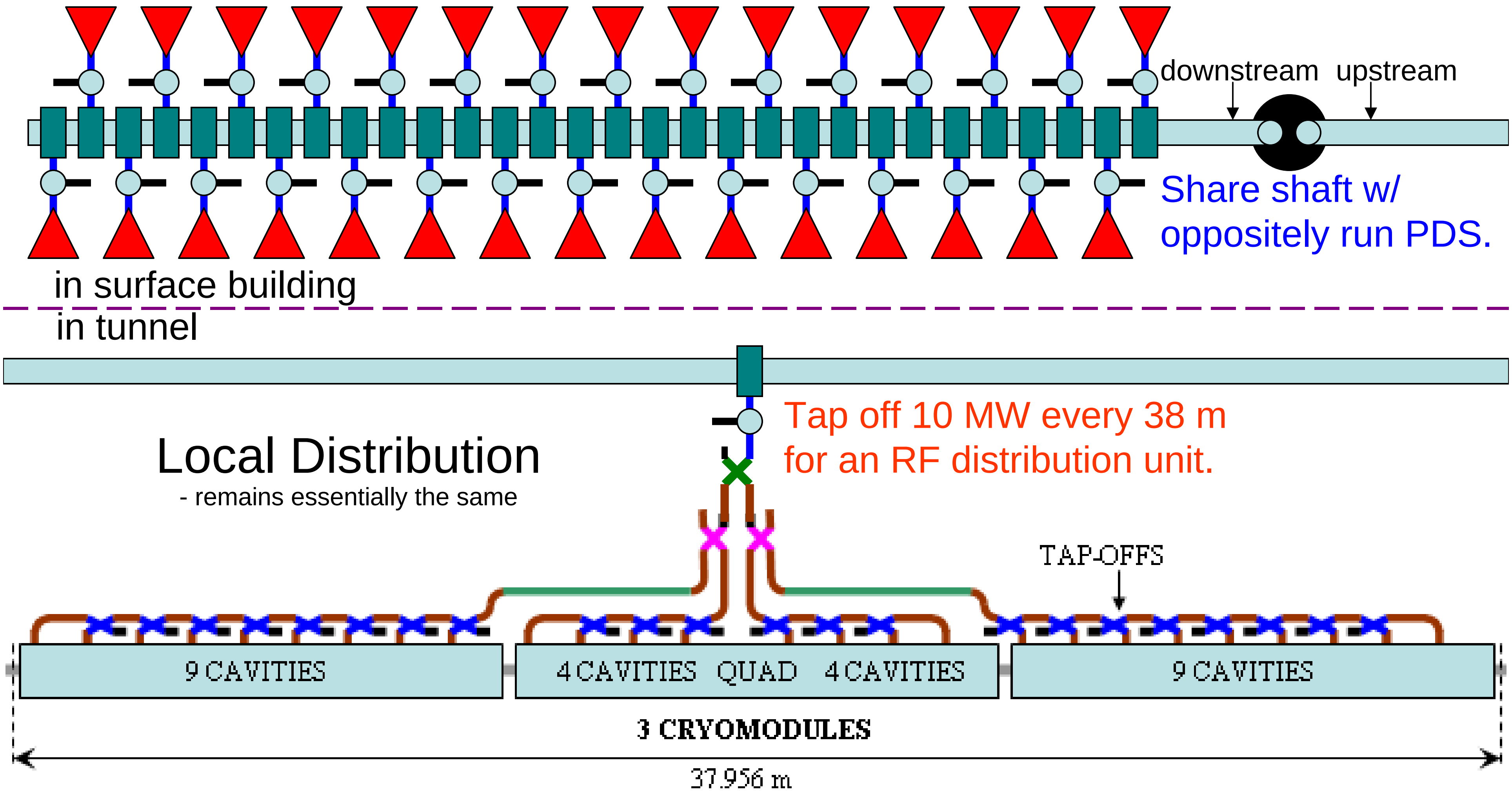
The waveguides share a shaft down to the accelerator tunnel and then turn, one upstream and one downstream to feed, through periodic tap-offs, a combined 64 RF units, or ~2.5 km of linac.

- service tunnel eliminated
- underground heat load greatly reduced

‘KLYSTRON CLUSTER’
Adolphsen, Nantista et al (SLAC)

Klystron Layout – Overmoded WG system

Combine 300 MW from thirty 10 MW klystrons into one circular TE_{01}-mode evacuated waveguide on the surface.



With extra transmission loss, feeds ~27 RF units = 1.026 km. (shaft serves 2.052 km)

CFS

- **project-specific resources support CFS activity**
  - (ILC, XFEL, CLIC…)
- **focus of June Dubna GDE workshop –**
  - a ‘single-tunnel’ sample site; all RDR sample sites deep/dual tunnel sites
- **2008 / 2009:**
  - Use existing designs (LHC) and ongoing design work (XFEL, CLIC and Project X) to compare with RDR
  - finding overlap and exploiting diversity of approaches

Value Engineering: CFS Application

- **Study of variants / alternates with a global basis**
- **(Monday AM CFS session)**

SUMMARY

DRAFT- as of noon 11/14/08- DATA IS STILL BEING ADJUSTED

E. Huedem DRAFT 11/14/08

Impact / Issues (by others)
Cost to be added (could be by others?)
Major IMPACT/ Issues?
SS=Sch 10 304 Stainless in Tunnel only; CPVC=Sch 80 CPVC plastic pipe; CS= Std Sch (40) Carbon Steel

		ILC																			
		25C ΔT (45F ΔT)									40C ΔT (72F ΔT)							Kly Cluster- Aug 2008	CLIC	XFEL	Project X
RF Water Delta T		Scheme 5			Scheme 6			Scheme 7			Scheme 5			Scheme 6			Scheme 7				
		SS	CPVC	CS	SS	CPVC	CS	SS	CPVC	CS	SS	CPVC	CS	SS	CPVC	CS	SS	SS			
Overall Water Delta T	$^{\circ}\Delta$C	16.7			16.5			18.1			20.3			19.6			22.4	22.1			
	$^{\circ}\Delta$F	30.1			29.7			32.6			36.5			35.2			40.4	39.8			
"First-Cost" Savings in % - Process/Air Treatment WBS 1.7.3. & 1.7.5		-35%	-37%	-38%	-30%	-32%	-33%	-38%	-40%	-40%	-38%	-40%	-39%	-34%	-36%	-35%	-42%	-47%			
RF Loads and Circulators reduced flow																					
RF Modltrs and Plse Transfm-flow/temp																					
Watercooled wvgde cooling design (by others)																					
Kly Clstr's RF Pipe Cooling by others																					
High Space Temperature ok?		~45°C (113°F)									~45°C (113°F)										
Equipment Insulations??																					
50% reduction in air heat load possible?																					
Finalize HLRF Heat Load table? Collector issue?																					
Rack chiller impact ok? / Rework rack arrngmt??																					
Confirm reduced Heat load from racks?																					
Pump Recirc loop at Collector~ **$2M??**																					
Pump Recircloop (modul/P.Transfmr)~ **$2M ??**																					
Electrical Reduction		~ (- 2.3 MW)																			
Operational cost reduction		~ (- ??)																			
Electrical addition					~ + 3 MW			~ + 1 MW													
Operational cost addition					+ ??			+ ??						+ ??			+ ??				
Pipe Press & Temp limit issues																					
"Clean Water" Compatibility Issue																					

Main Linac Water Cooling
Huedem, Hammond, et.al.
(Fermilab)

CFS Strategy

- **For the CF/S, we would like to study sites with *contrasting characteristics*,**
  - the basis of 'value engineering'
  - namely shallow (Dubna) and single tunnel (Xfel)
  - to the point where we may rank cost drivers
  - and then iterate the Rdr deep tunnel designs
- **Most importantly, we will do the technical R&D so that the value estimates from the different sample sites are not substantially different.**
- **Thus no one site would be a-priori disqualified even though the machine layouts (and technical components) may be different.**

- **This strategy facilitates consensus on our CFS development a siting activities**

SCRF Critical R & D

0. Pursuit of High Gradient: Vertical (CW) Test

- Goal: 90% yield 35 MV/m vertical test
- Fabrication
  - 4 industrial fabricators world-wide (1 US, 2 EU, 1 Japan)
  - (more coming – 2 AM)
- Surface Process and Vertical Test
  - DESY, KEK, JLab, Cornell, ANL/FNAL
  - Successful industrial processing in EU
- Vital role TESLA Technology Collaboration (TTC)

1. Defining and implementing modularity within the Cryomodule

2. Development of infrastructure and linac system 'tests'

- (misnomer: system 'tests' are scientific tools and can have substantial value for their field)
- XFEL and 'Quantum Beam'

High Gradient R&D (S0): *Initial Concept*

- **2006:**
  - Field emission was considered the most important limitation
  - Statistics were thought to be required to demonstrate control of field emission → meant building and testing a lot of cavities
  - S0 plan based (in part) on the need for 'statistics'
  - TTC – authored recommendation (January 2006)
- **2007:**
  - The recommendation proved 'on-target'
  - Field emission greatly reduced (15% of total – Geng, JLab; also Reschke, DESY) – directly proven with very limited statistics
  - Thermal Quench now considered the most important limitation!
  - BUT: gradient limit increased only a little AND gradient limit spread remained
- **Re-evaluate 'initial' 2006 strategy →**

Develop and deploy diagnostics:

- **for the *low* gradient-limit portion of the distribution:**
  - optical inspection / thermal monitoring shown to directly identify performance-limiting defects in the equator weld ‘Heat Affected Zone’ (HAZ)
  - below ~ 25 MV/m, these defects are ~ > 0.3 mm radius
- **New Strategy (April 2008):**
  - understand details of this reproducible, fundamental, problem (Develop fixes)
  - Study > 25 MV/m quench-limited cavities
  - (a reasonable number of cavities to be obtained and processed with some chosen for further study)
- **This is where we are.**

S0 in 2009:

- **Understand the HAZ; electron beam weld (EBW) parameters**
  - each manufacturer does it differently. (PM to visit fabrication companies)
- **‘Close the loop’ on the defects before full chemistry (KEK)**
  - implementation of optical inspection QC cycle for XFEL industrial production?
- **Identify quench-causing defects >25 MV/m**
  - equator EBW HAZ? radius? crystallography / impurities (US plan…)
- **Study interaction between EBW / annealing / weld strength / RRR (residual resistance ratio – impurities)**
- **Present plans provide adequate cavities and treatment cycles →**
  - studies and recommendations are a top priority (another request to TTC?)

Goals:

Bob Rimmer, (JLab)

Eradicate field emission up to 35 MV/m
Increase the maximum gradient to > 50 MV/m
Reduce spread in quench gradient to ±5% of mean

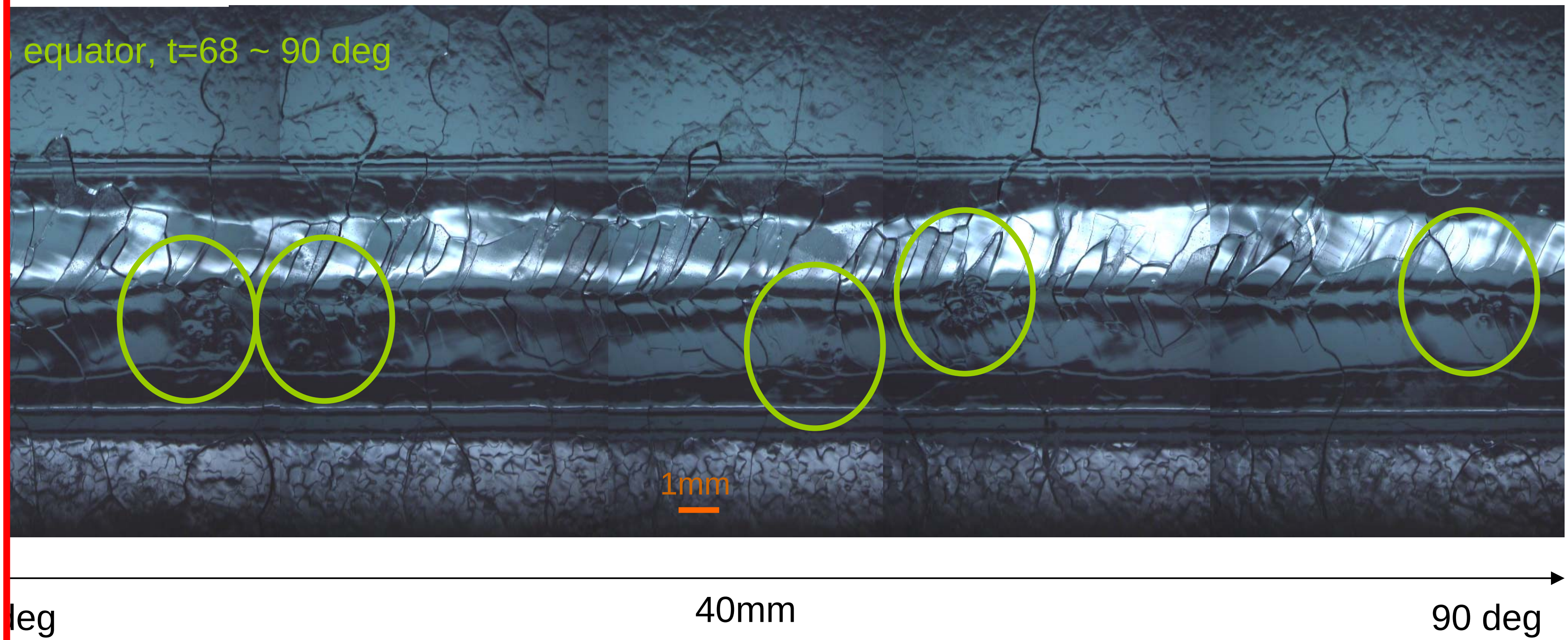
- ILC high gradient program pushes in these areas. Jlab is providing the bulk of the "S0" data for the Americas region
  - Improved cleaning and assembly practices
  - Electro-polishing process optimization
  - Quench fault location via temperature mapping
  - High-resolution optical inspection
  - Emphasis on gaining knowledge from every test
- Aim is to improve process yield through understanding
  - ILC funding shortfall significantly slowed the program in FY08
  - Need stable funding in order to staff program
- Jlab actively promoting alternatives to the baseline
  - Direct-from-ingot large grain material with BCP
  - Alternative processes (vertical EP, Buffered EP, plasma etching)
  - Superconducting joint, alternative fabrication methods
  - Interesting test of Atomic Layer Deposition (ALD at ANL)

Optical Inspection – *Electron Beam Weld under scrutiny*

- **'Kyoto Camera System'**
  - *a major success of 2008*
  - telescope–based system in use at Cornell and JLab
  - now in use at DESY; on order for FNAL
- **16 nine cell cavity optical inspections tabulated**
  - ~ five with > 30 MV/m limit
  - about ½ inspected at KEK and ½ at JLab
  - about ½ thermally mapped; several different styles
  - correlation excellent if:
    - thermal quench ; equator region
    - gradient limit < 25 MV/m
    - (mcr)
- **(Monday morning – Main Linac WG)**

Z110: group of spots (1)

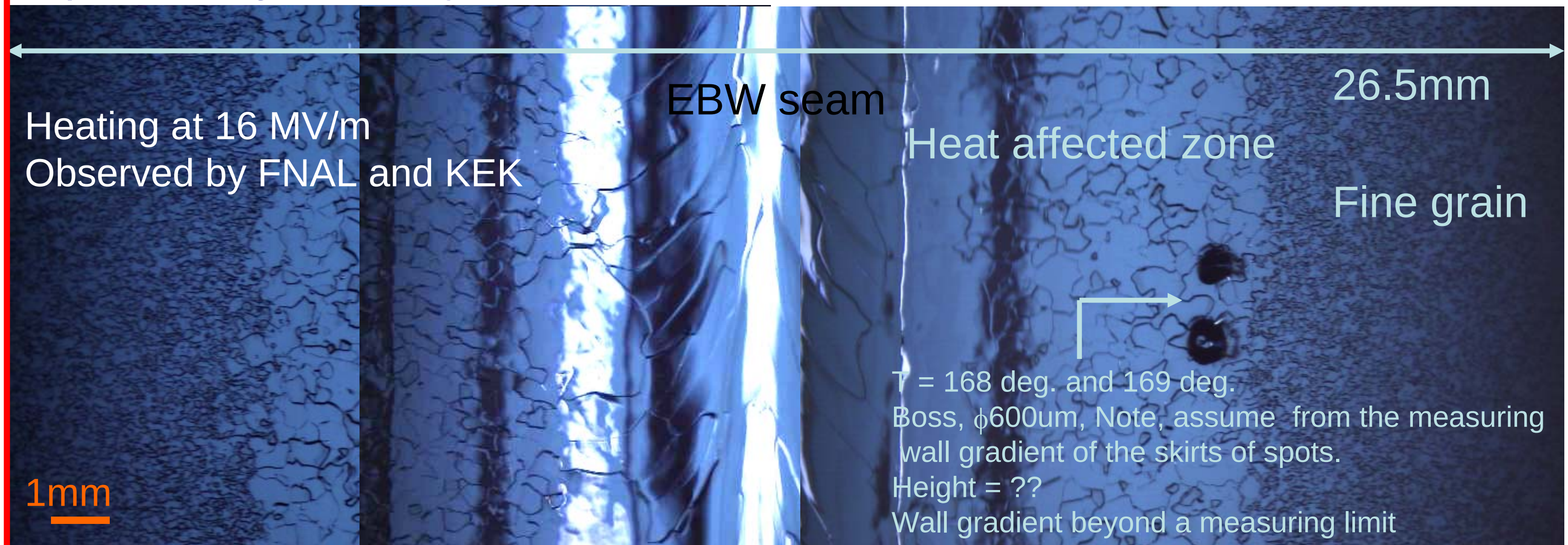
Cavity Equator Welds – all four global fabricators



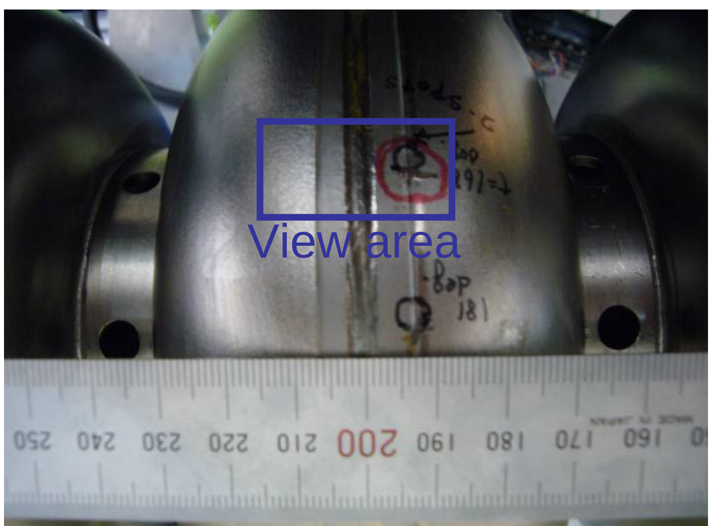
Five groups of spots within 22 degrees of EBW bead.

AES#001 #3 cell equator

Cavity Equator Welds – all four global fabricators



Z-axis



Z-axis

Twin spots were observed on the heat affected zone (HAZ).
EBW seams were very smooth at all cell equators.

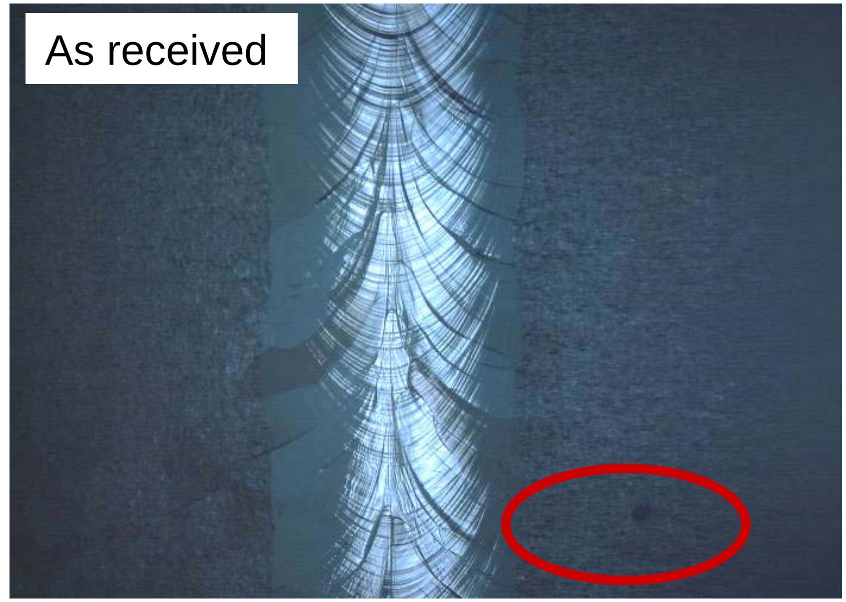
Other spots position : #3 cell equator, t = 181 deg on the HAZ.
(Boss, diameter = 400, height = 42 um)

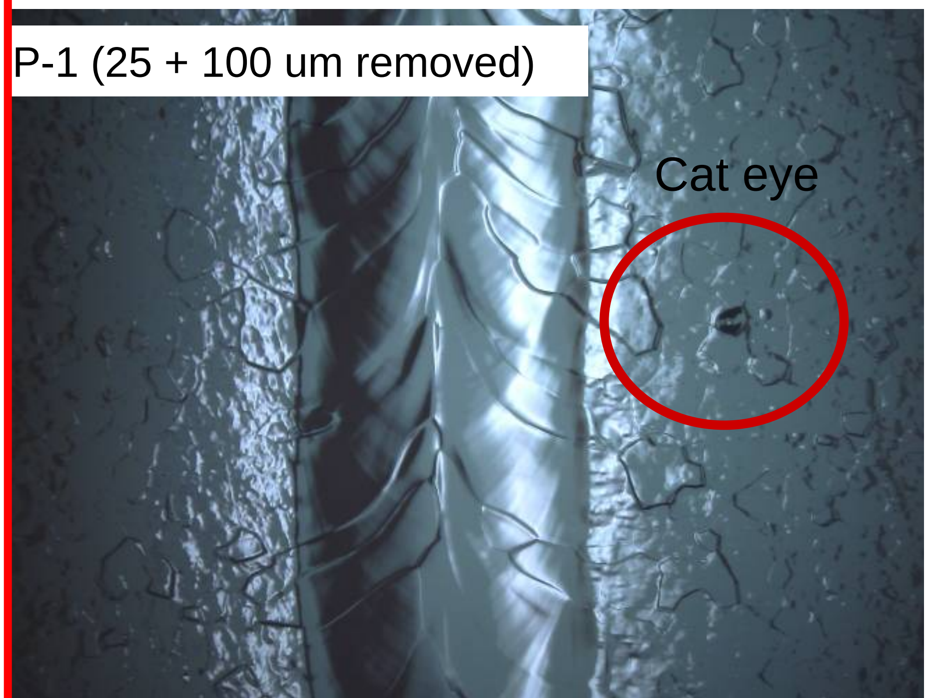
#7 cell equator, t = 325 deg on the HAZ.
(Pit, diameter = 500 um, depth = 28 um)
Max Eacc = 16 MV/m, But no heating.

STF BL cavity #5 : #4 cell equator

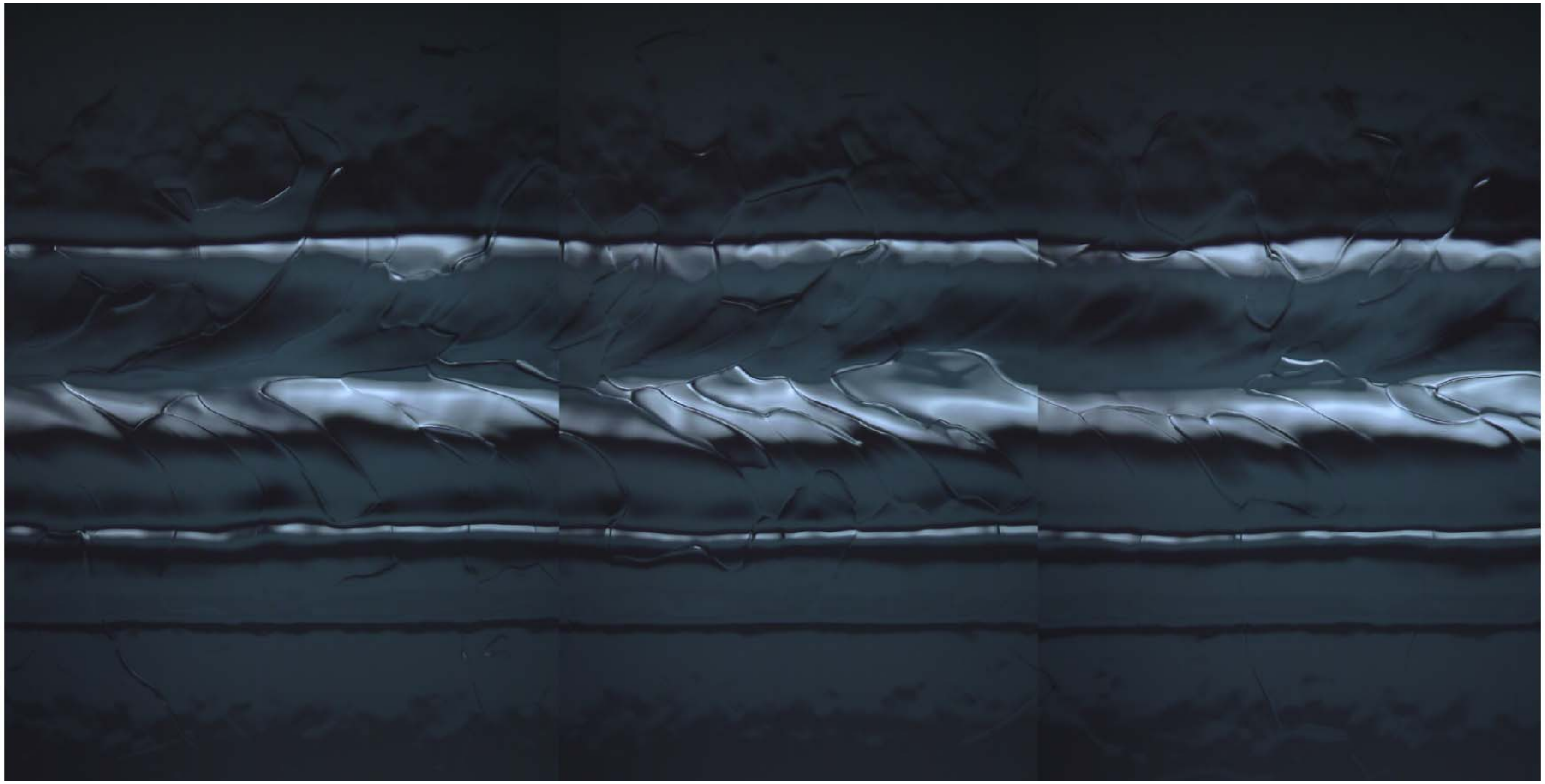
Cavity Equator Welds – all four global fabricators

The cat eye can find after EP-1 process (25 + 100 um removed), and can measure a shape of spot.





AC 80



- Limiting Gradient ~> 21 – not in this cell.
- smooth weld

RRR near EBW

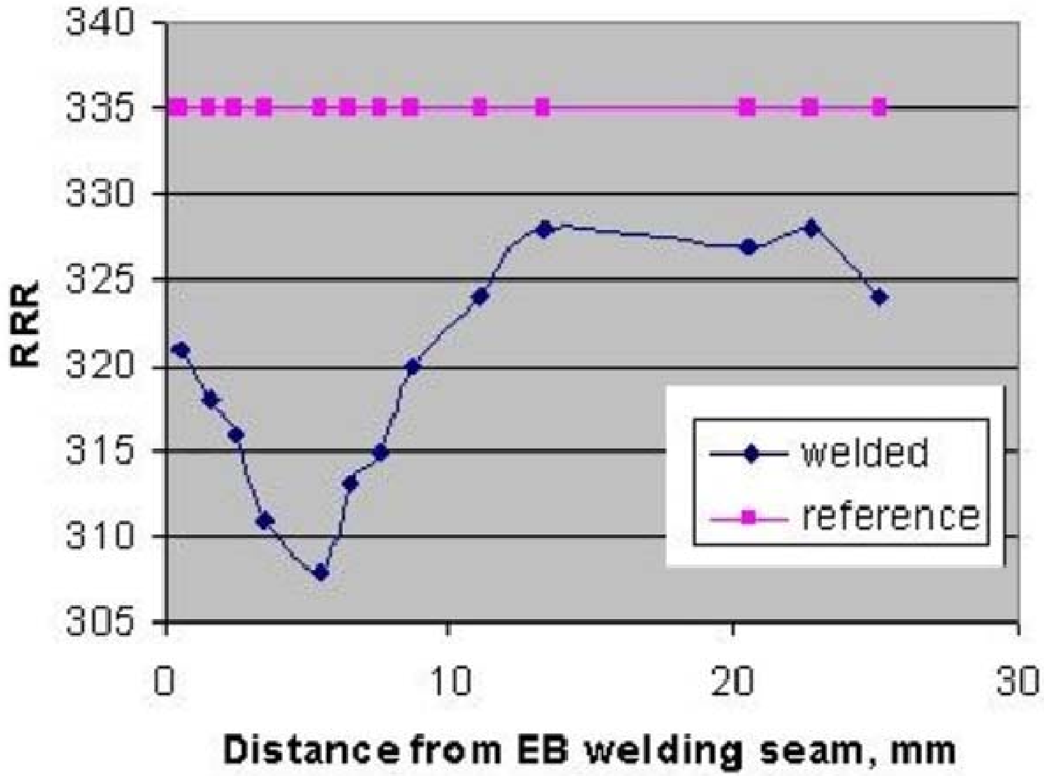


FIGURE 5. RRR in the welding seam versus distance from the welding seam (welded at pressure 2×10^{-5} mbar, ACCEL 1996)

Impurities can concentrate on either side of the weld seam

fundamental to weld process

- **TESLA Note (2003) Singer et al.**
- **The HAZ morphology is complex –**
  - superficial explanation of defects

High Gradient R&D Plan in TDP

- Projected Cavity Orders and Process and Test Cycles in each region
  - **(June 2008 R & D Plan)**

Americas	US FY06 (actual)	US FY07 (actual)	US FY08	US FY09	US FY10	TDP-1 Totals**	US FY11	US FY12
Cavity orders	22	12		10	10	**52**	10	10
Total 'process and test' cycles		40	5	45	30	**113**	30	30
Asia	**JFY06 (actual)**	**JFY07 (actual)**	**JFY08**	**JFY09**	**JFY10**		**JFY11**	**JFY12**
Cavity orders	8	7	8	25	15	**44**	39	39
Total 'process and test' cycles		21	40	75	45	**147**	117	117
Europe	**CY06 (actual)**	**CY07 (actual)**	**CY08**	**CY09**	**CY10**		**CY11**	**CY12**
Cavity orders	60	8		834		**902**		
Total 'process and test' cycles		14	18	26	30	**73**	380	406
Global totals								
Global totals - cavity fabrication	**90**	**27**	**8**	**869**	**25**	**997**	**49**	**49**
Global totals - cavity tests		**75**	**65**	**135**	**175**	**333**	**501**	**501**

Inventory of Tesla-shape cavities procured through Fermilab

Fermilab

Tesla-shape nine-cell cavities		
Description	**No. Cavities**	**Status**
AES 1-4	4	tested
AES 5-10	6	due Nov 2008
AES 11-16	6	due Sep 2009
Accel 5-9	5	tested
Accel 10-17	8	received Mar 2008; testing in progress
Accel 18-29	12	due Dec 2008
Jlab fine-grain prototype	1	tested
Jlab large-grain 1-2	2	tested
Jlab fine-grain 1-2	2	fabrication complete; testing in progress
Niowave-Roark 1-6	6	due Sep 2009
Total	**52**	
Already Received	22	
Tesla-shape single-cell cavities		
Description	**No. Cavities**	**Status**
AES 1-6	6	tested at Cornell
Accel 1-6	6	due Nov 2008
Niowave-Roark 1-6	6	received Jun 2008; testing in progress
Total	**18**	
Already Received	12	

Note that 5 nine-cell cavities were produced by Jefferson Lab.

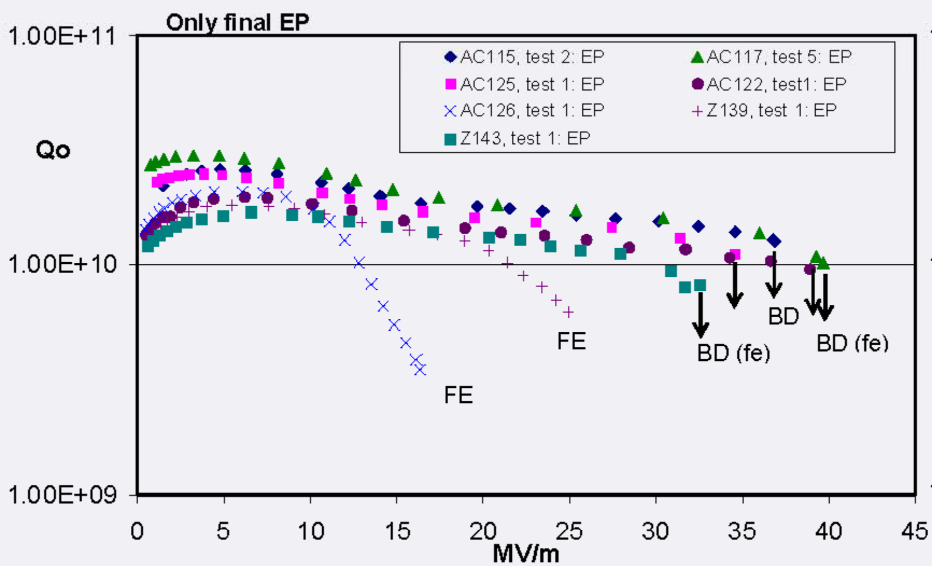
Mark Champion (FNAL)

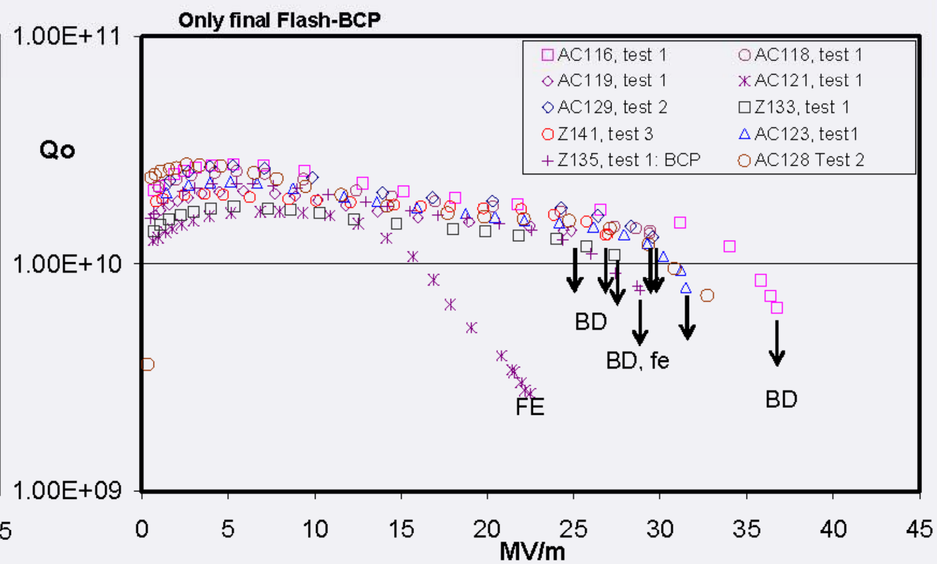
2009 – XFEL Cavity Fabrication

- **2007: DESY reported '4th production' results 30 cavities**
  - (development of rinsing process to counter field emission)
- **2008: DESY '6th production' - also 30 cavities**
  - (8th production - 8 large grain cavities)
  - industrial EP; multiple vendors
  - optical inspection process starting
  - 'First test' results; quench limit
- **XFEL will order 800+ cavities in 2009**
- ***Likely to use optimum treatment process – EP / Ethanol rinse***
  - Processing / testing starts 2010
- ***Initial DESY 2008 / Accel cavity / final EP-Ethanol rinse results very promising:***
- ***36 MV/m average for 5 cavities; first EP test***

6th cavity production: Results

- Available data: 7 (of 10) final EP cavities; 10 final short BCP cavities





=> Flash BCP shows some Q-slope after bake

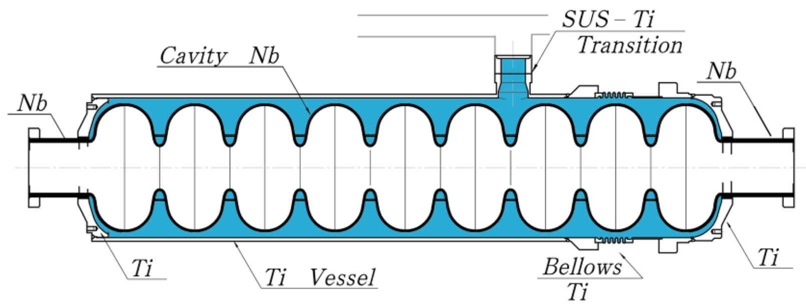
=> FE is still a problem !!

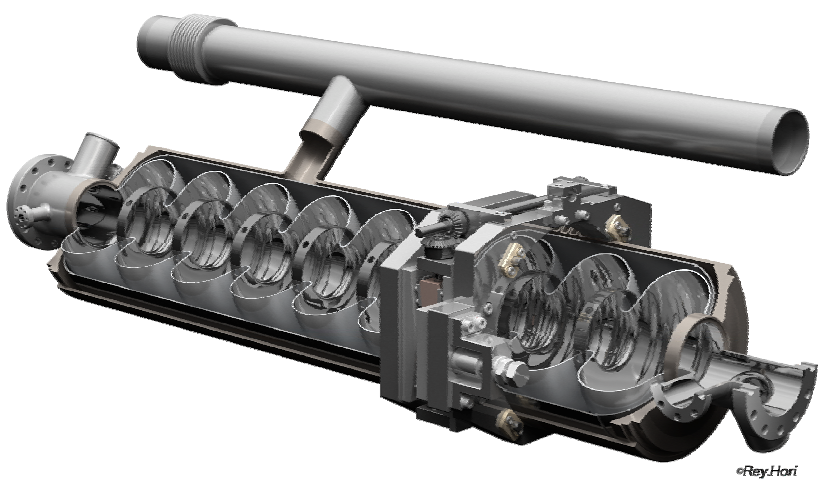
- FE loaded cavities will be HPR re-rinsed => in preparation
- 3 more EP cavities follow soon

Cavity-string test in one cryomodule

- **Goal (S1):**
  - A set of eight dressed cavities qualified through the high-gradient effort will be installed into a cryomodule and tested to demonstrate the ILC operational gradient of 31.5 MV/m on average
- **Plan:**
  1. An international cooperation program, S1-Global, is planned to realize the cavity-string performance test as a global effort using the test facility at KEK (STF).
     - Two cavities each will be provided by the American and European effort, with the remaining four cavities being provided by the Asian effort.
  2. Fermilab will work towards this goal using eight cavities from the US production stream.
  - above plans are redundant
  - To-date, DESY has achieved an average gradient of nearly 30 MV/m.
     - Plans to construct an ILC-spec. cryomodule at DESY during the XFEL production are under discussion.
- ***Plug Compatibility – The S1 Global Cryomodule***

Plug compatibility: Cavity package definition





Item	Can be flexible	Plug-compatible
Cavity shape	**TeSLA/ LL/RE**	
Length		**Required**
Beam pipe dia		**Reuuired**
Flange		**Required**
Tuner	**0**	
Coupler flange		**Required**
He –in-line joint		**Required**
Input coupler	**TBD**	**TBD**

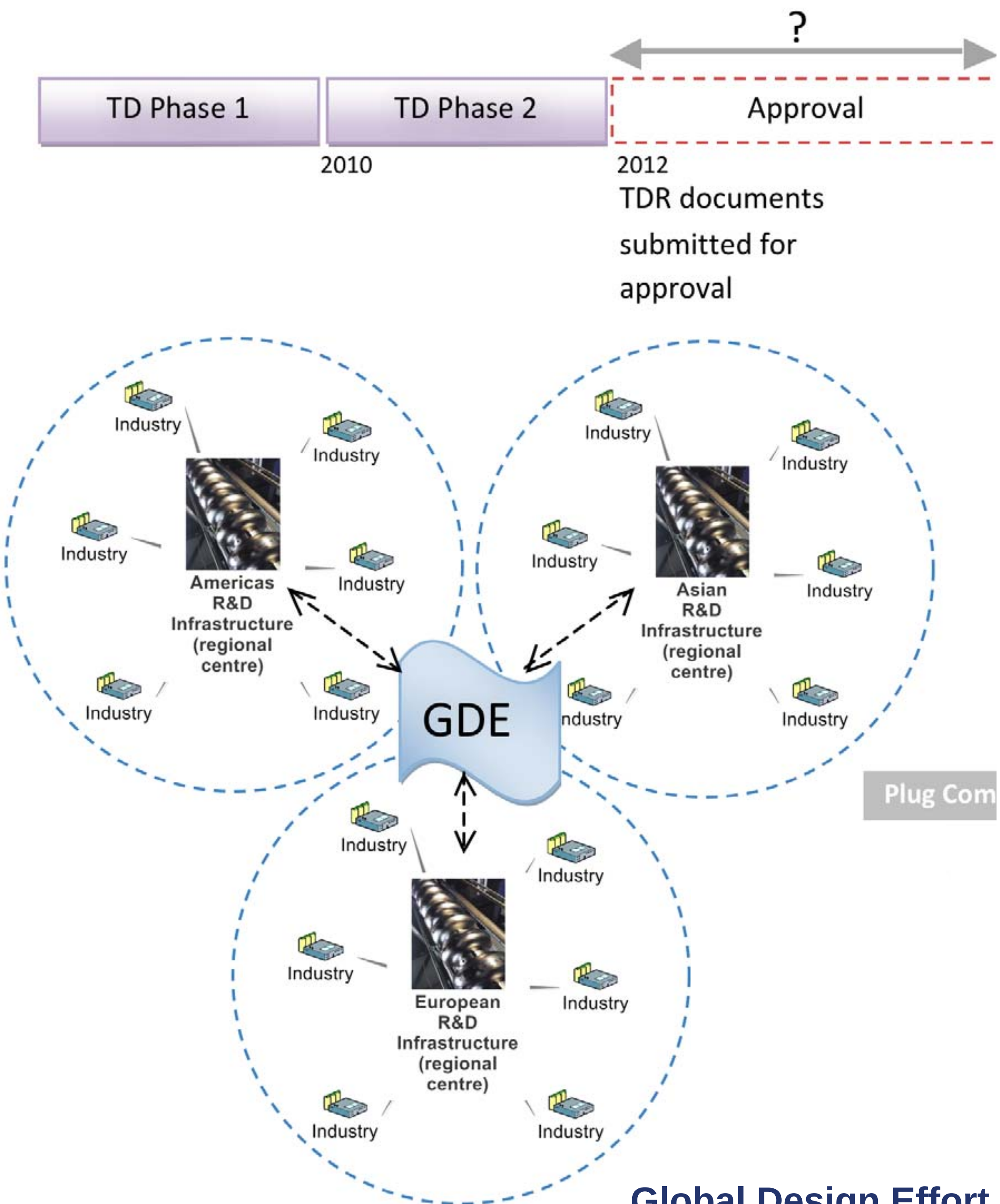
(work in progress)

Why and How Plug-compatibility ?

- Cavity
  - **Necessary "extended research" to improve field gradient,**
  - **Keep "room" to improve field gradient,**
  - **Establish common interface conditions,**
- Cryomodule
  - **Nearly ready for "system engineering"**
  - **Establish unified interface conditions,**
  - **Intend nearly unified engineering design**
  - **Need to adapt to each regional feature and industrial constraint**
- **Descriptive document to be distributed – ILC08**

Plug-compatibility
in R&D and Construction Phases

- R&D Phase
  - **Creative work for further improvement with keeping replaceable condition,**
  - **Global cooperation and share for intellectual engagement**
- Construction Phase
  - **Keep competition with free market/multiple-suppliers, and effort for const-reduction, (with insurance)**
  - **Maintain "intellectual" regional expertise base**
  - **Encourage regional centers for fabrication/test facilities with accepting regional features/constraints**

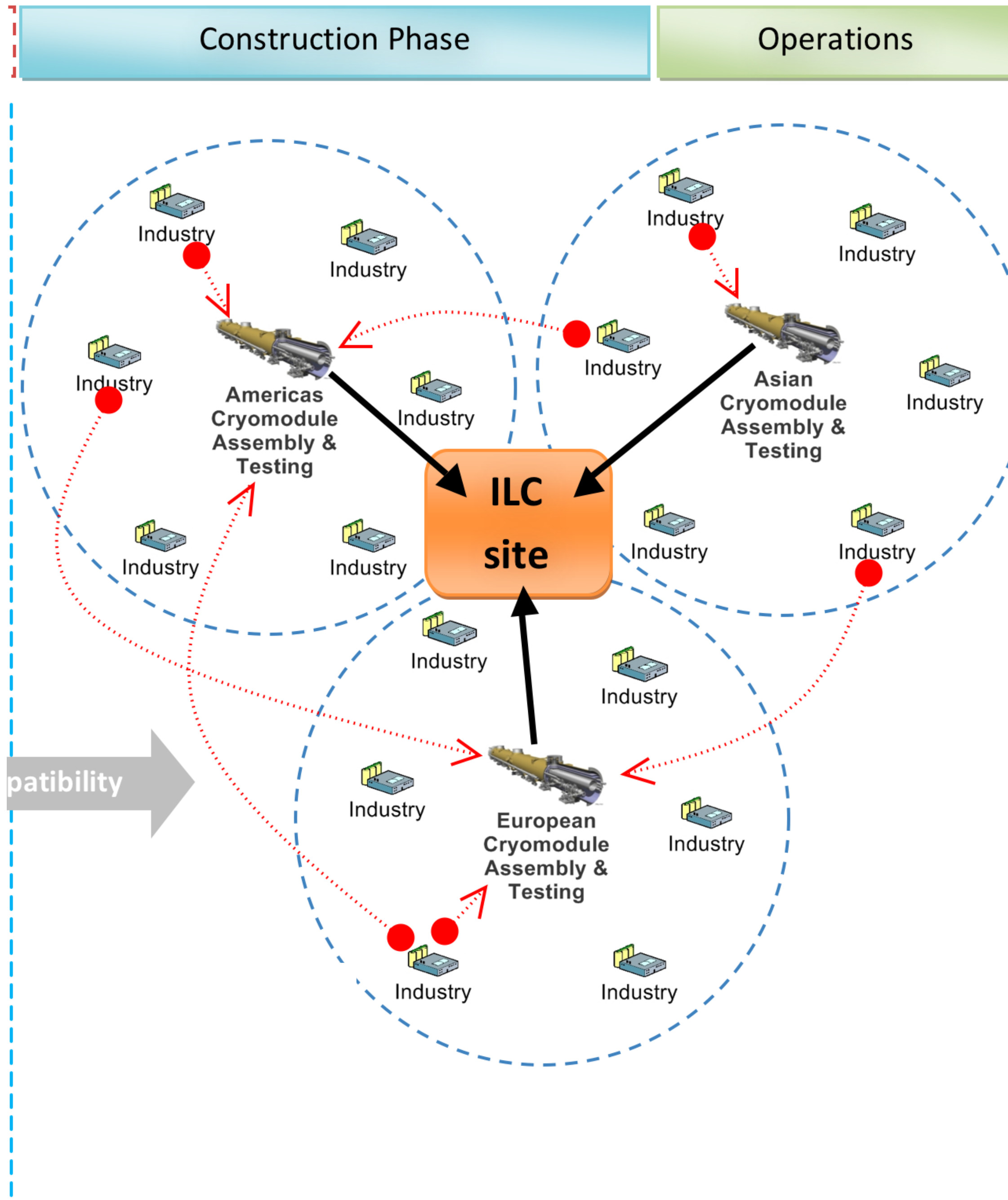


Global Cooperation: Plug-compatible Design and R&D

- Cost driven R & D process
- Technology transfer to Industry
- Innovation
- Intellectual engagement
- Expert base

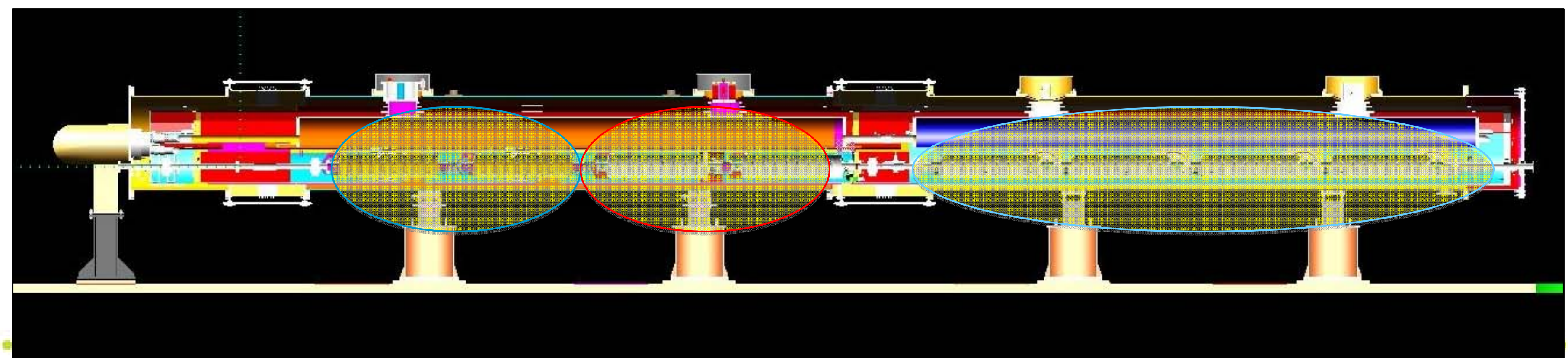
Global Production: Plug-Compatible Production

- Testing (QA/QC)
- Free 'global' market competition (lowest cost)
- Maintain intellectual regional expertise base



Cavity and Cryomodule Test with Plug Compatibility

- **Cavity integration and the String Test to be organized with:**
  - 2 cavities from EU (DESY) and AMs (Fermilab)
  - 4 cavities from AS (KEK (and IHEP))
  - Each half-cryomodule from INFN and KEK
- **A real-world test of 'plug compatible' interfaces**



System Test – ‘S2’

- **Global R&D Board Report**
- **An S2 Task Force, chaired by Hasan Padamsee and Tom Himel, was commissioned in June 2006**
- **Their report includes a table of ‘possible reasons’ for system tests**
  - includes general comments on which tests can/will be done at FLASH (XFEL)
  - Now in EDMS
- **Key concepts:**
  - how many critical modifications distinguish the ‘ILC’ cryomodule from the XFEL cryomodule?
    - what ‘system tests’ are required to test such modifications?
    - and on what time scale?
  - (second phase system test ‘scale’ is linked to industrialization strategy)

To be done prior to industrialization (1):

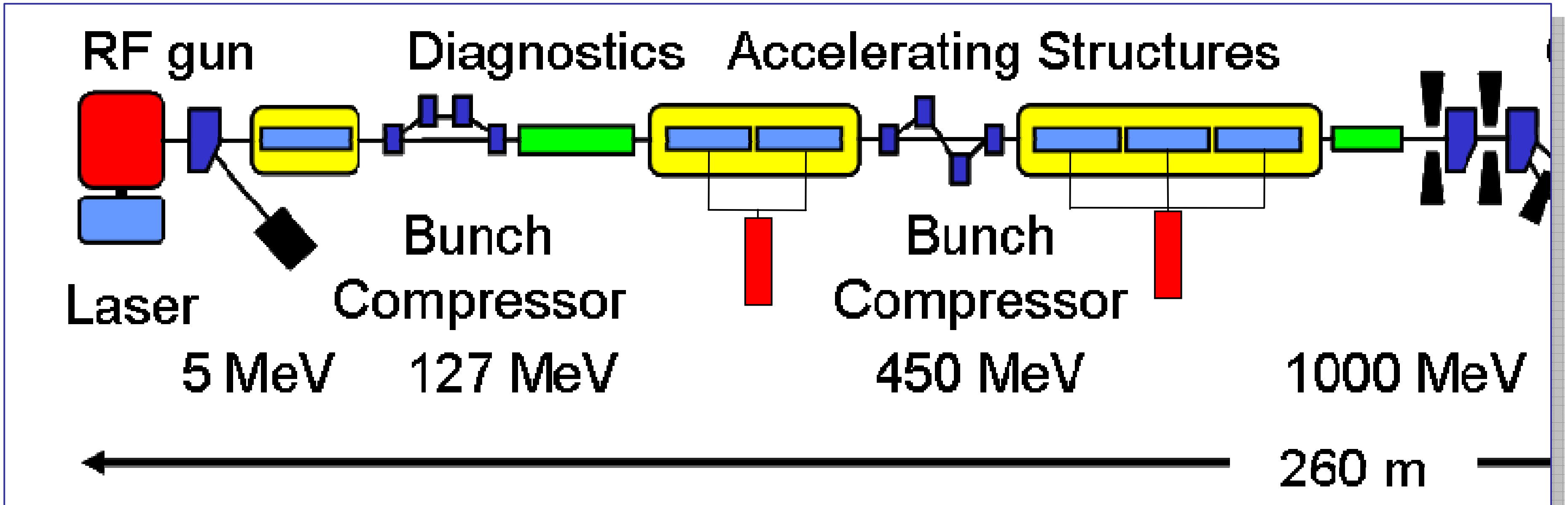
Reliability test of sub-components	SRF TAG
beam-based feedback and controls	Global System TAG
‘Crash-test’ – ***done 2008 at DESY***	SRF TAG
RF ‘fault-recognition’ software	Global System TAG

Quench rates and recovery times	SRF TAG
Dark current	SRF TAG
Gradient spread – ***now better understood; seen to indicate required power overhead***	SRF TAG
Long Term CM Testing	SRF TAG

To be done prior to industrialization (2):

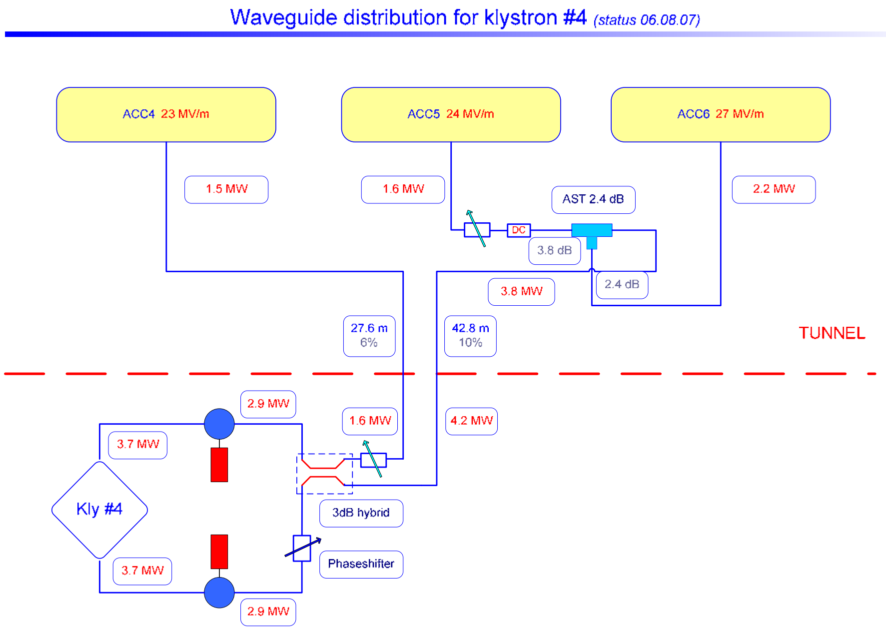
HOM heating	SRF TAG
radiation dose rate environment	SRF TAG
Produce a 'spec RF Unit'	SRF TAG
CM Thermal cycling	SRF TAG
Vibration due to piezo operation	SRF TAG
Quad vibration due to cryo-system	SRF TAG
Provide / deploy a LLRF Test facility	SRF/GS TAG
Build a mock-up for design / integration	SRF TAG

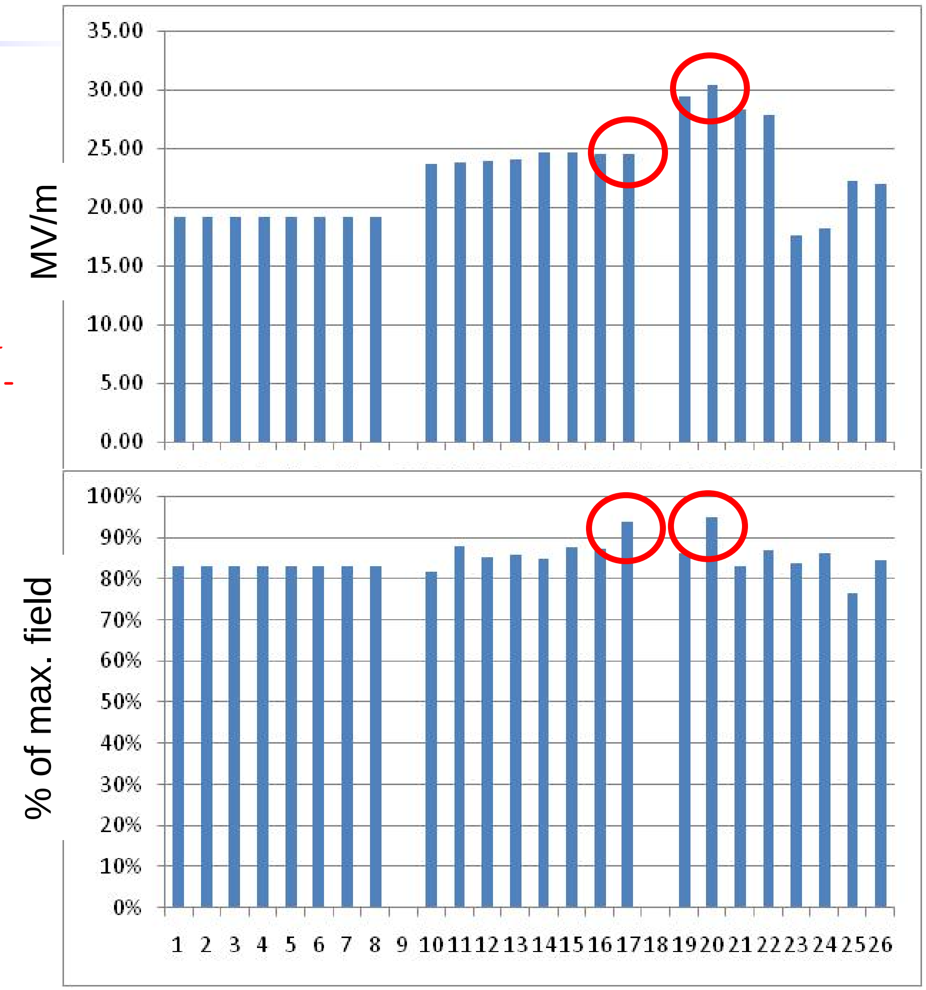
9mA Experiments in TTF/FLASH – S2



		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

TTF Flash “RF Unit”





- Aim for stable 9mA running at this limit
  - 5% below quench limit
  - Klystron power ~6 MW

Goals of 9mA test

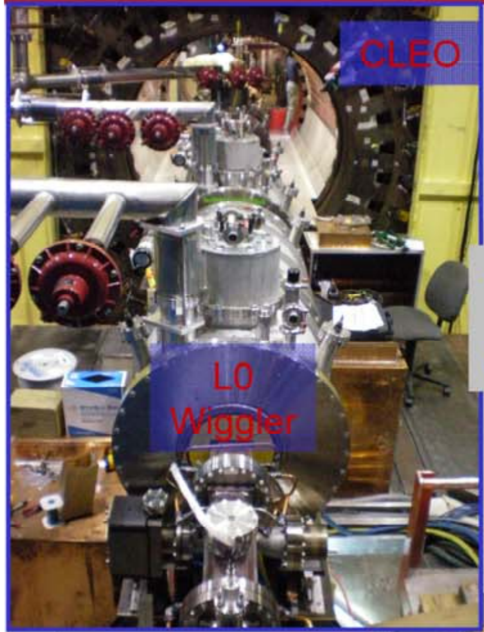
- Demonstrate energy stability <0.1% (LLRF) with high beam-loading
  - Bunch to bunch
  - Pulse to pulse
  - Over many hours
- Evaluate operation close to cavity limits
  - Quench limits
  - Impact of LFD, microphonics etc.
- Evaluate LLRF performance
  - *Required klystron overhead*
  - Optimum feedback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

Test Facilities

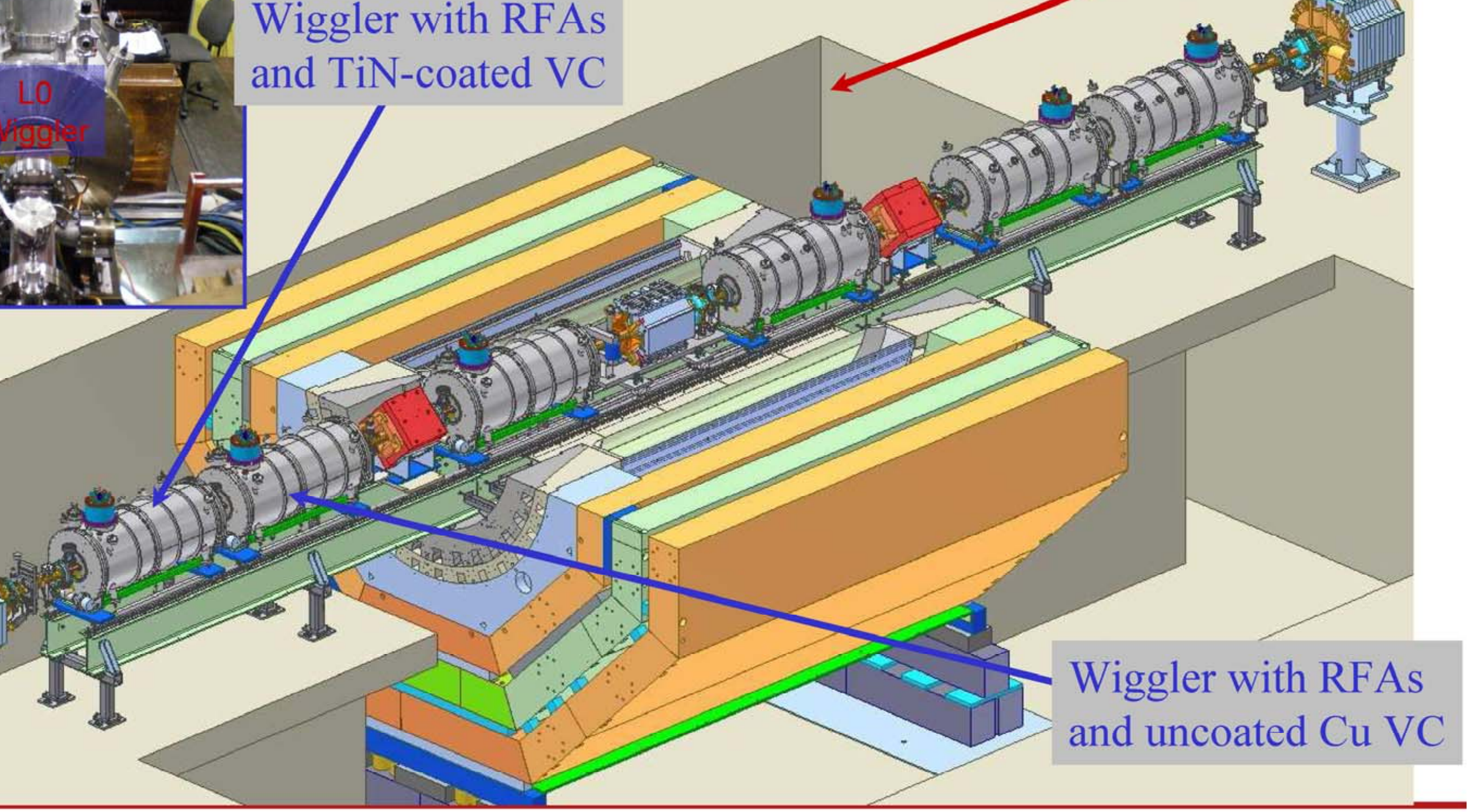
- **CesrTA**
  - Commissioning run completed
  - Goals:
    - Electron Cloud studies
    - Optics / Low emittance tuning
    - Beam Instrumentation testing
  - ‘Retarding Field Analyzer’ -RFA
- **ATF2**
  - Installation complete
  - Commissioning tasks / groups planned
  - Goals:
    - precision beam tuning

Cornell University
Laboratory for Elementary-Particle Physics

Wiggler Straight

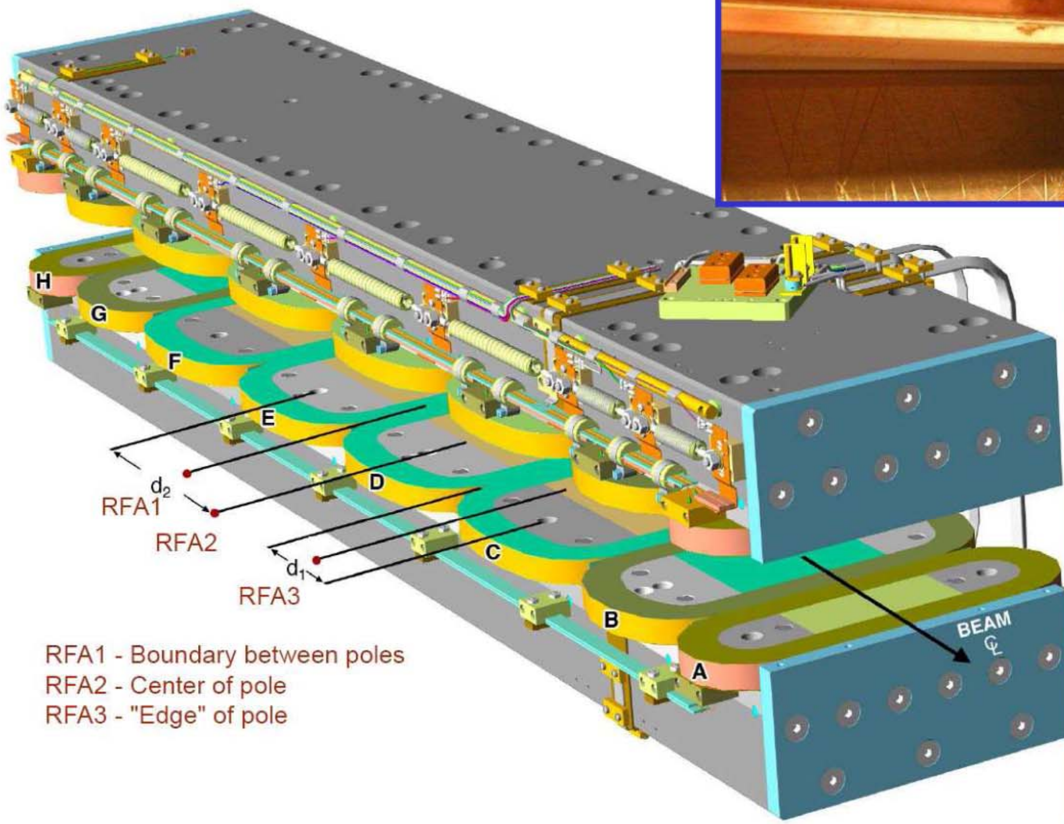


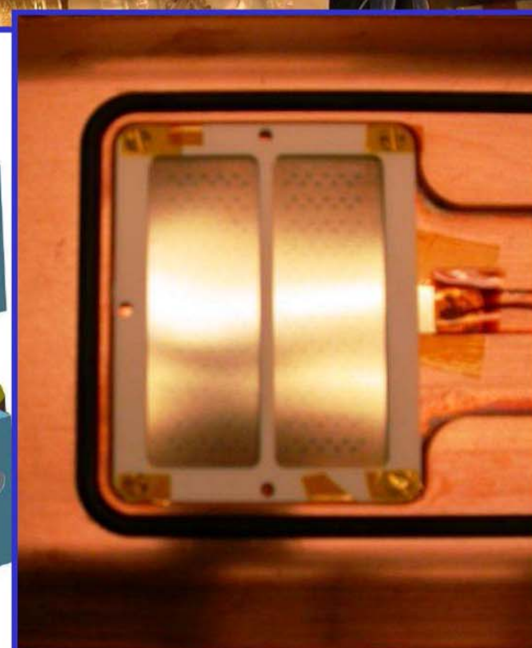
- Zero dispersion straight for low emittance
- Wiggler experimental region – local EC measurements
  - Retarding Field Analyzers
  - TE Wave Transmission Experiments



Wiggler RFAs

- RFA chamber during assembly and locations of detectors in superferric wiggler. 3 RFAs in each vacuum chamber at different field locations. (CU/KEK/LBNL/SLAC)



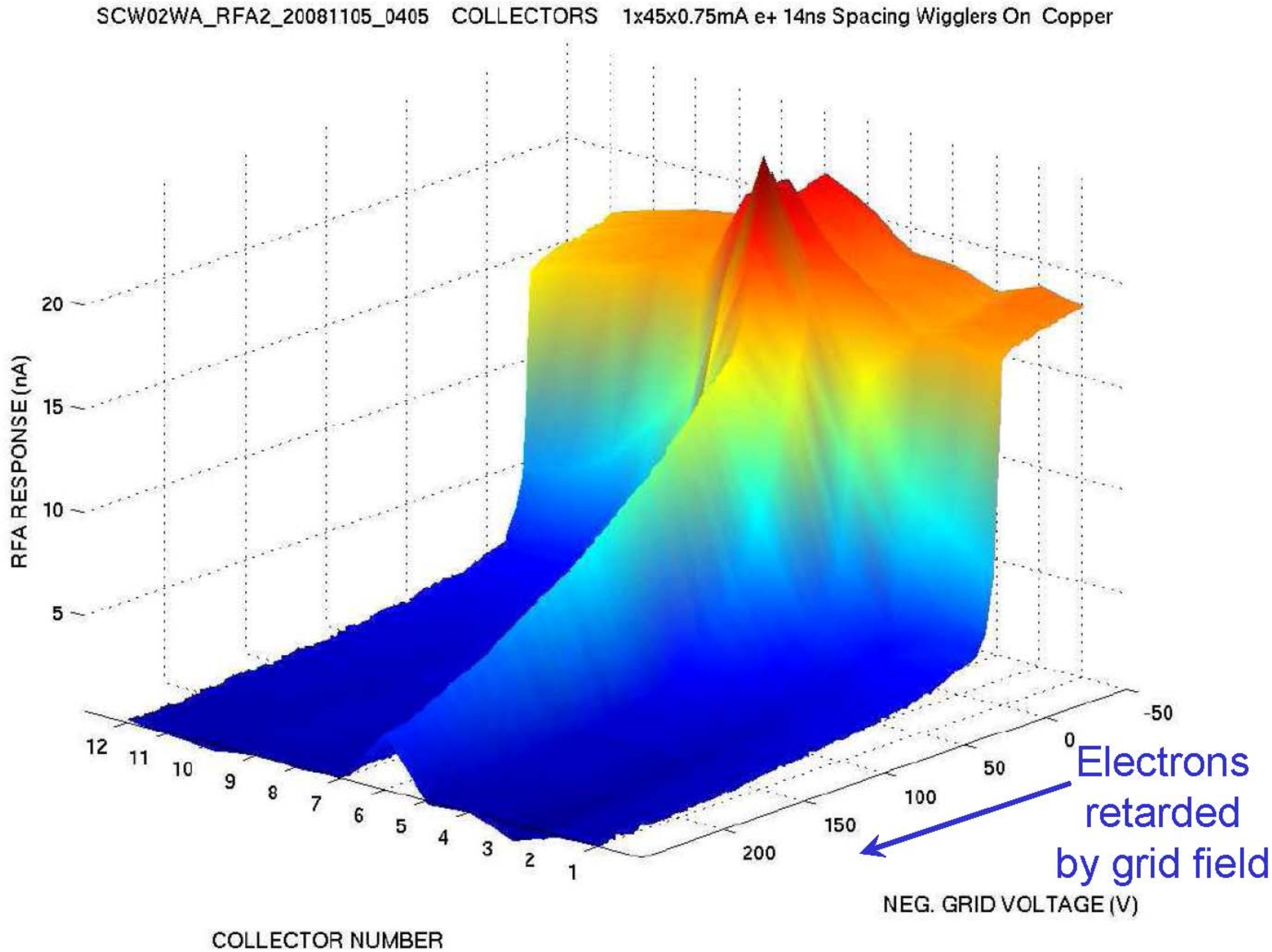


12 collectors across top of vacuum chamber

1 retarding grid spans the 12 collectors

RFA Data

- 1 Train, 45 bunches, 1.2×10^{10} positrons/bunch



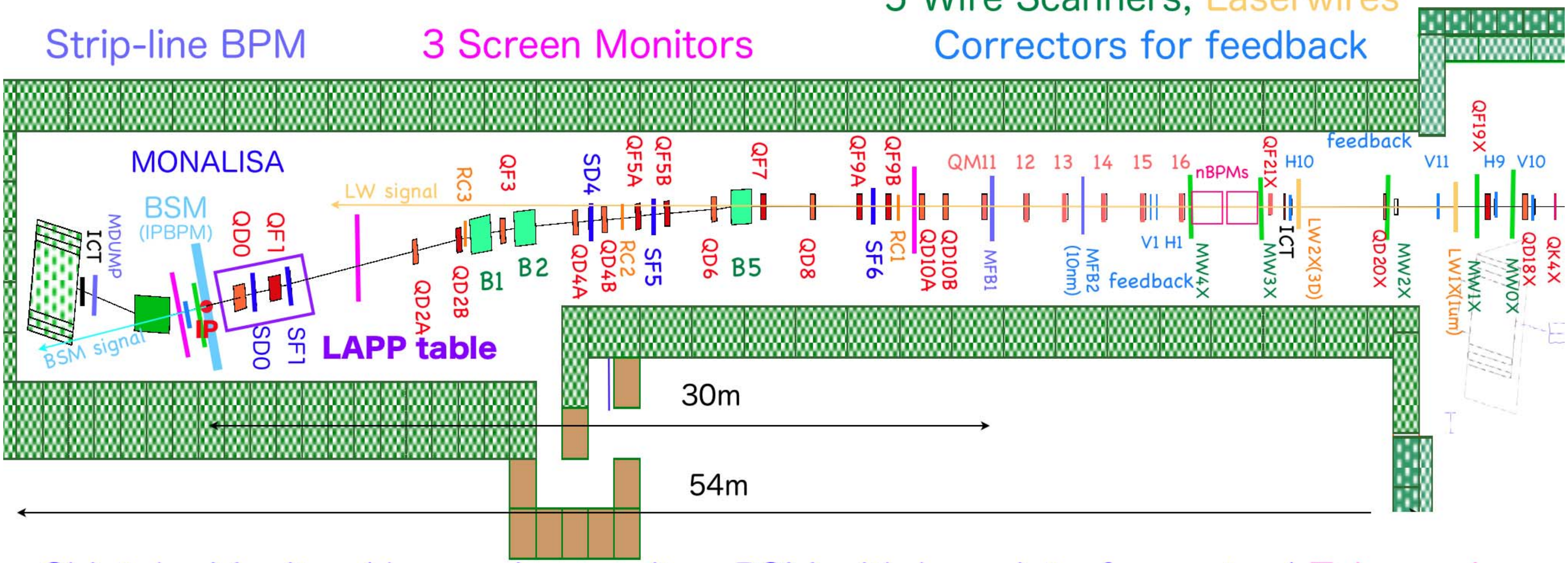
Hardware system at ATF2

22 **Q**uadrupoles, 5 **S**extupoles, 3 **B**ends in downstream of QM16
(IHEP, China, MOPP014) (SLAC) (SLAC, IHEP)

All Q- and S-magnets have cavity-type beam position monitors(QBPM, 100nm).
(PAL, Korea)

5 Wire Scanners, Laserwires

Strip-line BPM 3 Screen Monitors Correctors for feedback



Shintake Monitor (beam size monitor, BSM with laser interferometer):Tokyo univ.

MONALISA (nanometer alignment monitor with laser interferometer):Oxford univ.

Laserwire (beam size monitor with laser beam for 1 μm beam size, 3 axies):RHUL

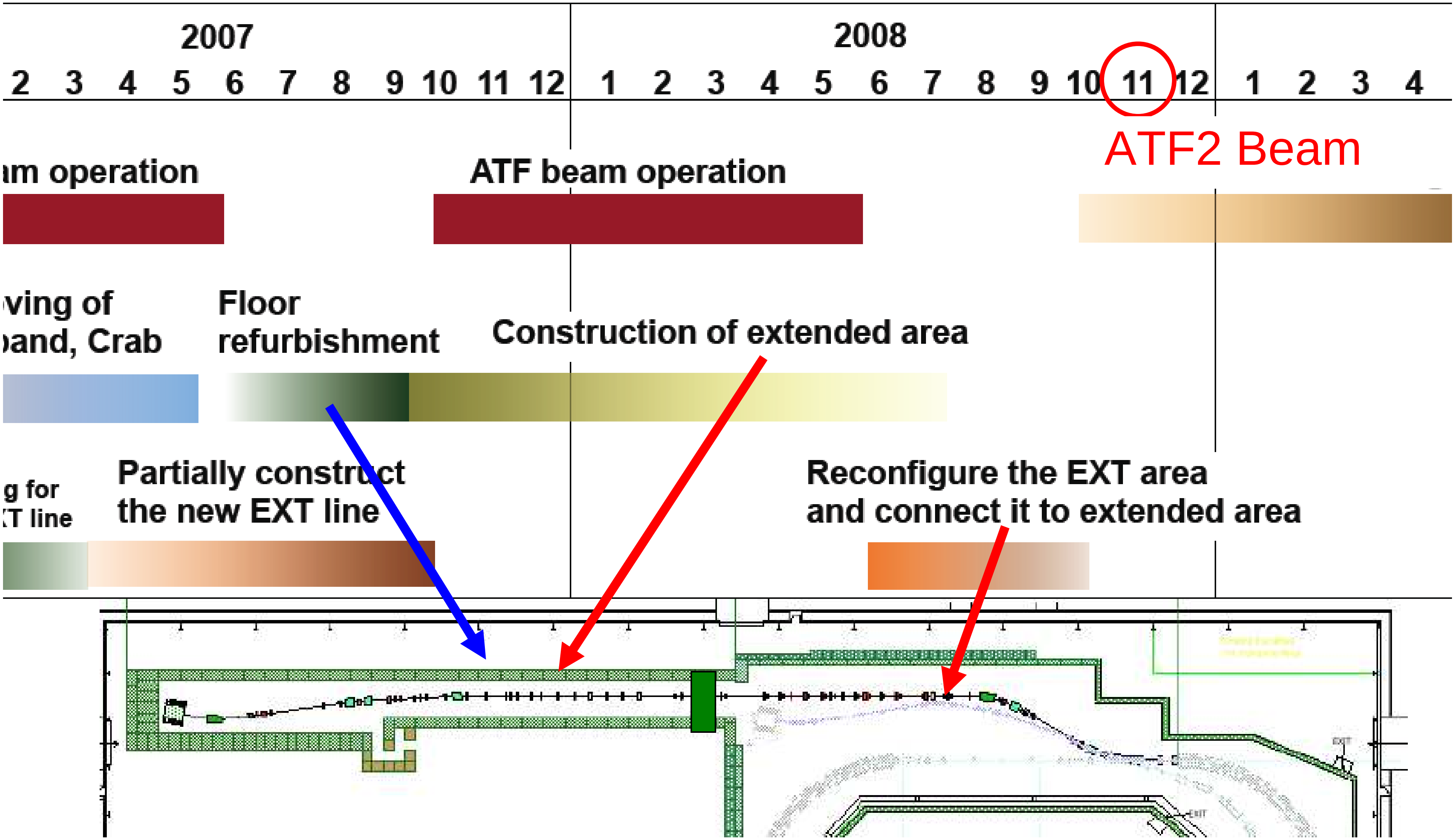
IP intra-train feedback system with latency of less than 150ns (FONT):Oxford univ.

Magnet movers for Beam Based Alignment (BBA):SLAC - MOPP039

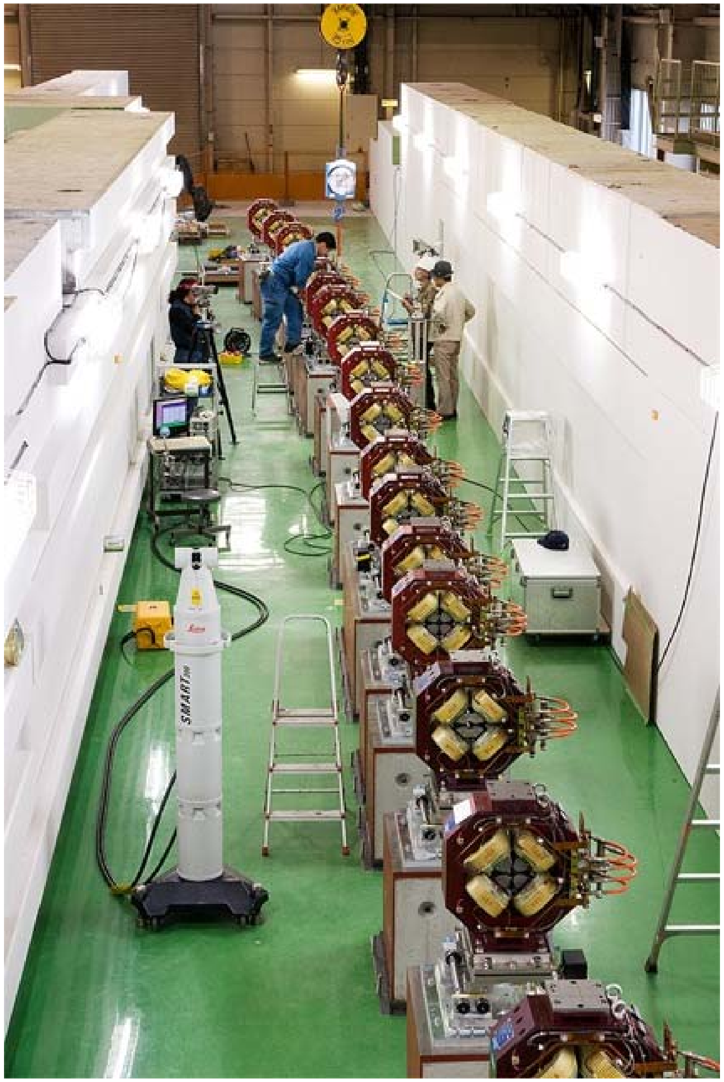
High Available Power Supply (HA-PS) system for magnets:SLAC

T.Tauchi, EPAC08

ATF2 Construction Schedule



ATF2 construction



2008/2

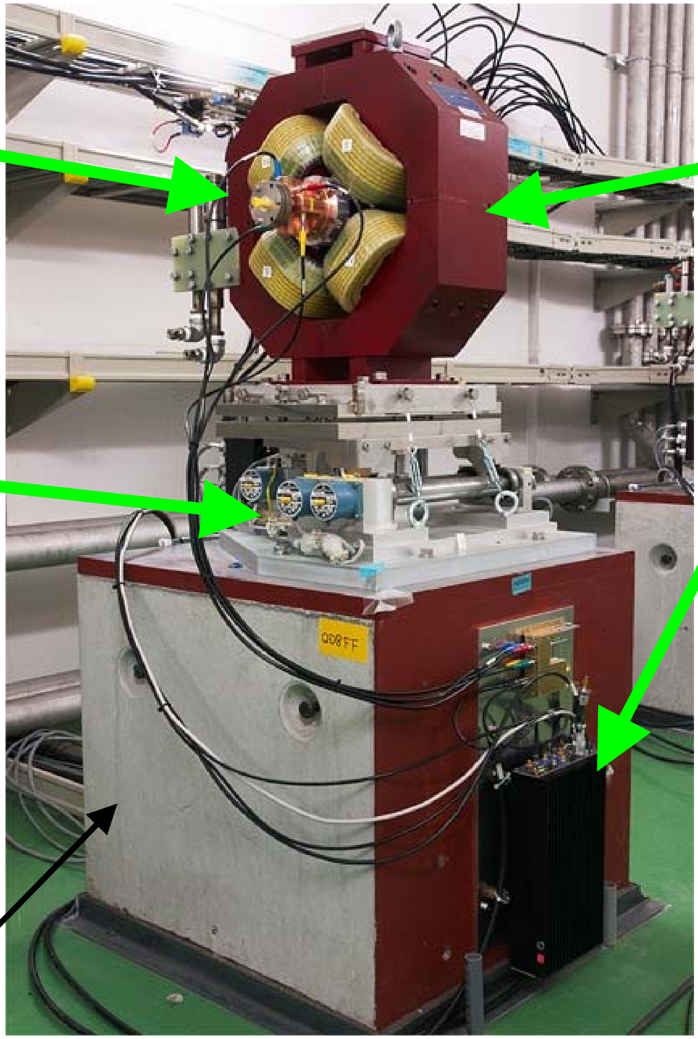
2008/5

2008/9: new EXT

International Contribution (1)
ATF2 Q-magnet Setup

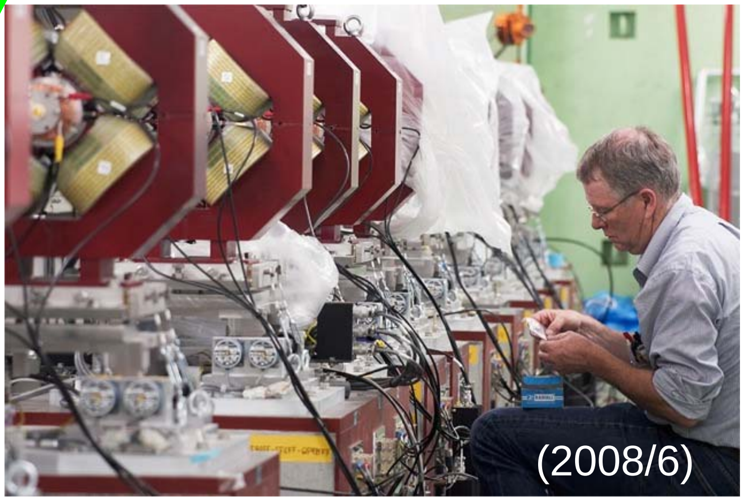
QBPM
(Cavity BPM)
(KEK,PAL)

Q magnet
(KEK,SLAC,IHEP)



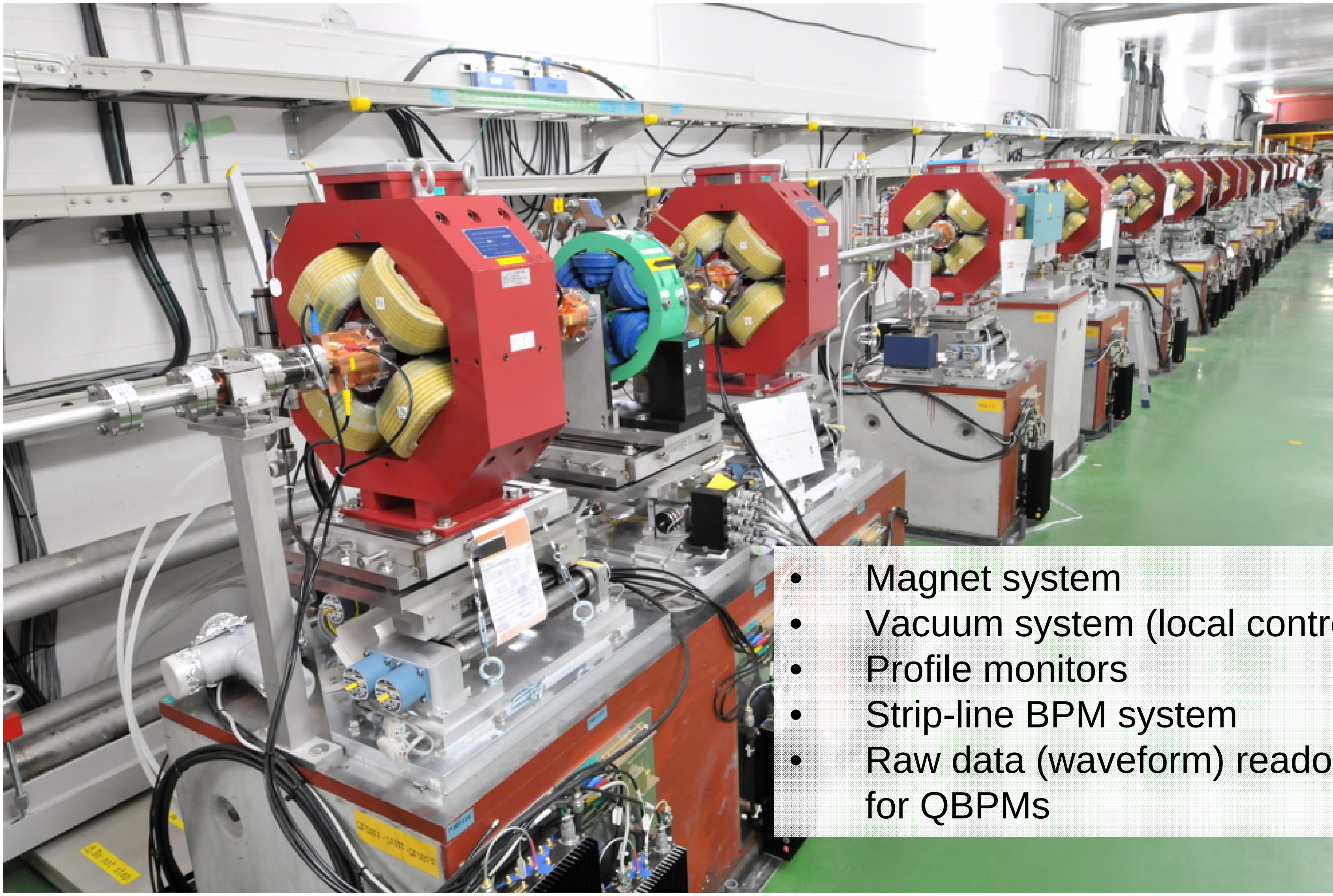
FFTB mover
(SLAC)

QBPM electronics
(SLAC)



Concrete Base Stand (KEK)

Finished works for ATF2 beamline



- Magnet system
- Vacuum system (local control)
- Profile monitors
- Strip-line BPM system
- Raw data (waveform) readout for QBPMs

TDP Overview

- **Mission and Deliverables**
- **Basis and Oversight**
- **Resources and the role of R & D**
- **Schedule and Status – technical activities**
- ***Regional Developments***
- **Project Preparation**
- **Conclusion**

Regional Developments

Asia (Japan)

- Formation of two ILC / Accelerator Tech. Promotion Groups
- ‘Tail-wind’

Europe

- **(European Commission); Seventh Research Framework Programme (FP7)**
  - ILC – Higrade:
    - ILC specific; DESY leadership
    - four year (08-11); six institution; 10 M € direct
  - European Coordination for Accelerator Research and Development (EUCARD):
    - generic; CERN leadership
    - four year (09-12); 37 institution; 30 M € direct (~30% ILC-relevant)

Americas (US)

- P5

Collaboration Council for Promoting Advanced Accelerator Technology (no official English name)

- Established on Jun.11.2008
- For accelerator technology of the next generation with LC as the core model
- Base of collaboration industries ←→ academy
- >60 industries, >30 institutes and universities
- Headed by CEOs of 4 big industries (Mitsubishi Heavy Industry, Mitsubishi Electric, Toshiba, Hitachi)

- Technology subgroup meetings already held 4 times (so far mostly ILC tutorials on ILC general design, CFS, cavity, RF)

Activity: A Series of Seminars

- A series of technical seminars in progress as the first step to close communication with Japanese industries

Dates	Subjects	Lectured by
Aug. 29	General Introduction and discussions	A. Yamamoto
Spt. 16	Introduction on Advanced Accelerators ILC, Superconducting Accelerator System	J. Urakawa H. Hayano
Oct. 8	Experiences on Accelerator Civil Engineering ILC, Accelerator civil engineering requirements	M. Yoshioka, M. Miyahara A. Enomoto
Oct. 29	Introduction to Superconducting Cavities Development of superconducting cavities	T. Furuya T. Saeki, S. Noguchi
Nov. 12	Intoduction to High Power RF Pulse Power Supply, Klystron, LLRF	S. Fukuda, M. Akemoto, S. F., S. Mizhizono
Dec. 18	Adv. Accelerators and Synchrotron Radiation Science/Applications	To be held
Jan. 14	Cryomodules and cryogenics	To be held
Feb.	Adv. Accelerators and Neutron Science/Applications	To be held

Federation of Diet Members for Promotion of the ILC Project

- First established Jun.2006 as a group of ~50 diet members of LDP (Liberal Democratic Party)
- After several meetings, published 1st summary report in Nov.2007
- Reformulated as a supra-partisan group in Jul.31.2008 including all the parties

Chair: Mr.Yosano (Minister of State for Economic and Fiscal Policy)

Secretary: Mr.Kawamura (Chief Cabinet Secretary)

European Commission FP7:

ILC-HiGrade – what is it anyway?

- ILC-HiGrade is the Preparatory Phase project of the European Commission to work towards the realization of the **International Linear Collider** based on superconducting RF technology.

- The project is one of 30+ projects on the ESFRI list considered technically **mature for construction**. The two HEP projects SLHC-PP and ILC-HiGrade entered via the C.E.R.N. Council strategy list

- In order to reach an early status of readiness for construction ILC-HiGrade addresses
  - a key technical component that affects the cost, i.e.
    SRF gradient with a goal of running the ILC at 31.5 MV/m (a 6% saving over the current state-of-the-art gradient)
  - siting of the ILC and the formation of governance and financial structures in Europe that enable the realization of the project. The European Commission recognizes that this is a process with global implications

ILC-HiGrade Work Packages

1) Management of the Consortium
2) Integration and optimisation of the European contribution within the global GDE organisation as the ILC project moves through the GDE Engineering Design Phase
3) Ensure that the characteristics and importance of the ILC, and its place within the world of science and research, is widely disseminated to the peoples of the European Union, and their governments
4) Investigate features and develop possible schemes of governance for the ILC, exploiting expertise of CERN (LHC) and DESY (HERA) in international projects
5) Prepare and investigate possible European sites for ILC construction
6) Investigate and monitor the production process that yields high-gradient cavities with high yield. Establish the process in industry
7) Optimization of the coupler conditioning at reduced cost
8) Demonstrate suitability of tuner design in tests. Establish a cost-effective tuner production

European Commission FP7: EuCARD

Research Activity Work Packages 7 - 11:

- Superconducting High Field Magnets
- Collimators and materials
- Technology for normal conducting linear accelerators
- Superconducting RF technology for proton accelerators and electron linear accelerators
- Assessment of novel accelerator concepts

- **Overlap with ILC baseline / alternate R & D:**
  - Superconducting Undulators
  - LLRF at FLASH
  - Beam Delivery Instrumentation

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

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Development of the ILC Project:

- **Making the transition from collegiate-style R & D to a 'project'**
- **intensely political and review-based process**
- **For ILC:**
  - Written reports
    - RDR, TDR including Project Implementation Plan (PIP)
  - Internal review
  - External review
    - ILCSC (ICFA)
  - Funding Agency involvement;
    - direct and through 'FALC'

Our Project Implementation Plan includes:

- **Project structure**
- **Component acquisition**
- **Financial models**
- **Industrialization**
- **Governance**

Example PIP

DoE Project Execution Plan Table of Contents

Table of Contents

Role of FALC(1)

- **FALC crucial for project / fiscal/resource advice**
  - ILCSC for scientific, technical and performance advice
  - FALC for resource advice and planning
- **ILC R&D plan reviewed and endorsed by FALC RG**
  - Gives 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

Role of FALC(2)

- **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
  - 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 - there is no point in presenting something that will be dead on arrival in 2012.**
  - Thus we need an iterative approach with the GDE & FALC, with comments & guidance at each step during the TDP phase

Project Tools

- **(Supported through 'Common Fund')**
- **Electronic Document Management System (EDMS) 'Teamcenter (UGS)'**
  - Managed through DESY (Lars Hagge)
  - Intended for
    - accelerator design documents → e.g. 'Decks'
    - complete 'placeholder CAD' entire complex
    - engineering 'CAD' models / drawings → e.g. CM model
    - cost estimation material → e.g. RDR Value Estimate basis
- **Project Management System**
  - 'TRIAD' Project Management System Company ← Contractor
  - Managed through Fermilab (Peter Garbincius)
  - from September 2008

ILC GDE Meetings & Reporting

- **Two Plenary meetings / year**
  - one involving entire community; one focused (e.g. AAP review)
  - additional two or three thematic meetings
- **Four week cycle of Technical Area and Project Management tele-conference meetings**
  - Entry level meeting for new partners; connection point for institutional management
- **Monthly published report to the community based on the above**

ILC08 / LCWS08

Goals:

- Review current status of global ILC R&D and future plans, for both the baseline configuration and alternative designs;
- Review and plan activities in and around Test Facilities (both existing and proposed);
- Identify and prioritize critical R&D milestones for TDP-1 and beyond.
- Promote and improve collaboration between groups working on ILC related R&D:
  - **To encourage a broader participation from active groups around the world;**
  - **To attract new researchers to the field;**
  - **Refine proposed schedule, milestones, deliverables etc.**

2009 – 2010

Proposed meetings and reviews:

- **AAP TDP1 Interim Review, Tsukuba – April 17-21, 2009**
- **ALCPG fall 2009**
- **ILC Baseline update – January 2010**
- **AAP TDP1 Review, April 2010**
- **ECFA Workshop, CERN – April 2010**
- **TDP1 presentation, Paris - July 2010**

First Review – Coarse Schedule

<table>
<tr><th>Friday
Day 0</th><th>Saturday
Day 1</th><th>Sunday
Day 2</th><th>Monday
Day 3</th><th>Tuesday
Day 4</th></tr>
<tr><td rowspan="3">Plenaries</td><td>Management</td><td>Acc. Facilities
ATF, FLASH</td><td>e-cloud</td><td rowspan="3">Plenaries</td></tr>
<tr><td rowspan="2">Conventional Facilities & Siting</td><td rowspan="2">SRF</td><td>Accelerator Systems</td></tr>
<tr><td>ILC Project</td></tr>
</table>

- The review will concentrate on TD phase 1 in its technical scope.

Look back: 2004

- **International Technology Recommendation Panel (ITRP) Report:**
  - (released during LINAC 2004 Conference, Lubeck)

The superconducting technology has features, some of which follow from the low rf frequency, that the Panel considered attractive and that will facilitate the future design:

- The large cavity aperture and long bunch interval simplify operations, reduce the sensitivity to ground motion, permit inter-bunch feedback, and may enable increased beam current.
- The main linac and rf systems, the single largest technical cost elements, are of comparatively lower risk.
- The construction of the superconducting XFEL free electron laser will provide prototypes and test many aspects of the linac.
- The industrialization of most major components of the linac is underway.
- The use of superconducting cavities significantly reduces power consumption.

Basis of the ITRP decision; basis of our progress since then rests in large part on EU – XFEL project

Backup Material

Global Resource base 2007-2010: SRF Tech

Region	Country	FTE-Years: Cavities	Cryomodule	HLRF	Cryogenics	ML Integ.	total FTE-Years	total M&S: Cavities	Cryomodule	HLRF	Cryogenics	ML Integ.	total M&S	
Americas	Canada	18					**18**	1050					**1050**	k$
	USA	73	24	68	5	14	**183**	9169	3960	5909	134	362	**19535**	k$
Asia	China	12	8	8	4	1	**33**	1371	1371	1371	686	137	**4936**	k$
	India	24	12				**36**	1560	900				**2460**	k$
	Japan	45	6	11	4	5	**72**	19867	4125	4036	1607	9992	**39627**	K$
	Korea	13		5			**18**	1619		264			**1883**	K$
Europe	EU (CERN)				1	4	**5**					190	**190**	k$
	France	94					**94**	14785					**14785**	k$
	Germany	51	10	7	7	9	**83**	2506	531			35	**3071**	k$
	Italy	38	8		1	1	**48**	1738	235				**1973**	k$
	Russia	2	20				**22**	20					**20**	k$
	Spain		3				**3**		13				**13**	k$
		370	**90**	**99**	**21**	**34**	**615**	**53685**	**11136**	**11581**	**2427**	**10715**	**89542**	

- **Notes:**
  - XFEL project specifically excluded where possible
    - → Estimate 65% of France FTE / 80% France M&S is XFEL project-related
    - Other EU does not include XFEL
    - DESY XFEL R&D ~ 155 FTE 2007 -2009
  - EU funding includes: CERN, European Commission Research Framework Programme 7 / 6 (5 contracts), National funding agencies (IN2P3, STFC, INFN, BMBF,…)
    - ILC project-specific and Generic R&D
  - Currency conversion based on 01.01.2008

Global Resource base 2007-2010: CF&S and Global Systems

		FTE-Years			total M&S			
		CFS	Controls	total FTE-years	CFS	Controls	total M&S	
Americas	USA	12	18	30	1397	1098	2495	k$
Asia	China		8	8		137	137	k$
	Japan	3	5	8				
	Korea	1	1	2	0.04		0.04	k$
Europe	EU (CERN)	2					0	k$
	France		18	18		451	451	k$
	Germany	3	14	17		92	92	k$
	Italy		4	4		118	118	k$
	Poland		20	20		365	365	k$
	Russia	2		2	58.8		59	k$
	Switzerland		3	3		132	132	k$
	(mixed)		11	11		139	139	k$
		23	102	112	1456	2531	3987	

- **Notes:**
  - 90% of FTE / 65% M&S is in Controls Global System and supports Test Facility activity
  - ‘mixed’ includes EU funding for Test Facility Controls

Global Resource base 2007-2010: Accelerator Systems

		FTE-Years							total M&S							
		Elec. Source	Posi. Source	Damping Rings	RTML	Beam Delivery	Simulations	total FTE-years	Elec. Source	Posi. Source	Damping Rings	RTML	Beam Delivery	Simulations	total M&S	
Americas	Canada			5				**5**			20				**20**	k$
	USA	11	8	28	1	48	16	**113**	617	144	7174	3	3847	190	**11975**	k$
Asia	China			12	4	20	2	**38**		69	686	14	27	14	**809**	k$
	Japan	2	7	16		23	4	**52**			6447		3348		**9795**	k$
	Korea			2	2	4	3	**12**			28	28	217	28	**301**	k$
Europe	EU (CERN)			2		1	4	**7**			10		3	13	**26**	k$
	France		11		5	12		**27**		573			9		**582**	k$
	Germany		22	3		4	4	**33**		47	10		53	20	**129**	k$
	Italy			17				**17**			441				**441**	k$
	Spain					2		**2**								k$
	Sweden				2	2		**3**								k$
	UK		10	11		85		**106**		70	124		3069		**3263**	k$
		13	**57**	**97**	**14**	**201**	**33**	**415**	**617**	**903**	**14939**	**44**	**10574**	**264**	**27342**	

- **Notes:**
  - Test facilities account for ~80%
    - ATF2 effort regionally balanced
  - UK effort greatly reduced
    - 2009 and 2010 ~ 20% of total
    - Non ILC-specific 09 and 10 R&D (instrumentation etc) not included
  - Positron Source includes R&D on Compton ‘alternate’
  - Currency conversion based on 01.01.2008