Navigating the Bumpy Road to the ILC

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GDE Workshop - Sendai

3-March-08

Today

- Impacts of UK, US funding actions
- Motivation and strategy for future global ILC R&D and design efforts
- Elements of a global replan. Now called Technical Design Phase I (2010) and Technical Design Phase II (2012)
- CLIC / ILC Collaboration
- Goals of the Sendai Meeting

Impacts – US / UK Funding

- UK ILC R&D Program
  - **About 40 FTEs. Leadership roles in Damping Rings and Positron Source, as well as in the Beam Delivery System and Beam Dumps.**
  - **All of this program is generic accelerator R&D, some of which may be continued outside the specific ILC project, retaining some key personnel.**
- US Program
  - **ILC R&D reduced $60M → $15M for FY08. Planning a reduced level program for FY09 and beyond. US President's FY09 budget proposal is $35M**
  - **Generic SCRF also terminated in FY08, but is expected to be revived in FY09 to $25M. and separated from ILC R&D.**

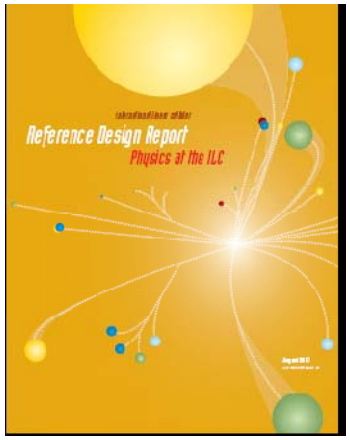
Replanning -- The starting point

- Original charge of the GDE (from ILCSC, ICFA and FALC) was to develop a “global” design. We have succeeded!
  - **Established a baseline for the ILC (0.5 years) This required ~40 critical decisions to agree globally on the key features of a linear collider**
  - **Developed a reference design, including international reviews of design, R&D program and costs (1.5 years)**
- We reached the original goals !!
- We are at a crossroads. Best strategy for future efforts toward a linear collider?

RDR Reports

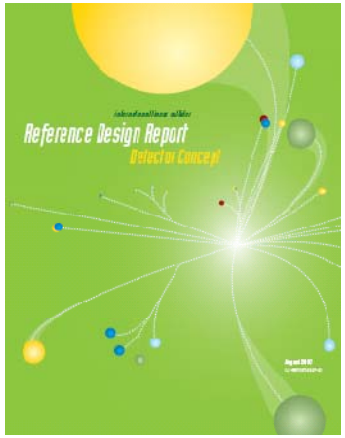
- **Reference Design Report (4 volumes)**

Executive Summary



Physics at the ILC

Accelerator



Detectors

The Broader Context

- **THE SCIENCE !!!**
  - **Nothing has changed.** A linear collider remains the consensus choice as the highest priority long term investment for particle physics
- **The Technology**
  - **Key technical, design & cost issues must be resolved before a serious project can be proposed**
- **Strong Global encouragement**
  - Strong response urging us to forge ahead and find ways to help or replace US and UK efforts.
  - Global commitment to the Common Fund (Spain & India)
  - Offers - visiting appointments, equipment help, travel, etc

Next Phase: Goals and Strategy

- The next phase of the ILC Global Design Effort should produce a technical design of the ILC in sufficient detail that project approval from all involved governments can be sought.
  - **Critical R&D demonstrations complete**
  - **Document the design having reliable costing**
  - **Develop a project plan**
- Timescale: Be prepared when LHC results justify the project
- Central coordination of the GDE is even more essential, if we want to prepare to propose an ILC project
- Recovery plan from UK and US actions developed with reduced goals, strict prioritization & stretched out timescale
- A two stage Technical Design Phase (TDP I 2010 and TDP II 2012 is proposed

Specific Context for our Replan

- Building close collaboration with XFEL. It will provide all SCRF development, except high gradient and ILC scale mass production, including a full systems test in 2013, industrialization, etc.

- We plan to take advantage of alignments and synergies where they will exist with US generic SCRF program, Project X development, etc.

- Undertaking steps to integrate linear collider (ILC and CLIC) R&D efforts, where beneficial to both efforts (meeting on 8-Feb). Examples – sources, damping rings, beam delivery, conventional facilities, detectors

New plan - Technical Design Phase

- The TDP R & D Plan represents a practical balance between:
  - **the R & D priorities as identified during the Reference Design phase;**
  - **the available funding and supporting infrastructure; and**
  - **the interest and skills of a given institution.**

- These three considerations are facilitated through:
  - **the Reference Design Report and the associated value estimate;**
  - **input from the Regional Directors, funding program and institutional managers; and**
  - **responses to a broadly distributed solicitation of 'Expressions of Interest'.**

TDP I -- 2010

- Technical risk reduction:
  - **Gradient**
    - Results based on re-processed cavities
    - Reduced number 540 → 351 (reduced US program)
  - **Electron Cloud (CesrTA)**
- Cost risks (reductions) – Main Cost Drivers
  - **Conventional Facilities (water, hall sizes, etc)**
  - **Main Linac Technology**
- Technical progress (global design)
  - **Cryomodule baseline design is a being developed (e.g. plug compatible parts)**

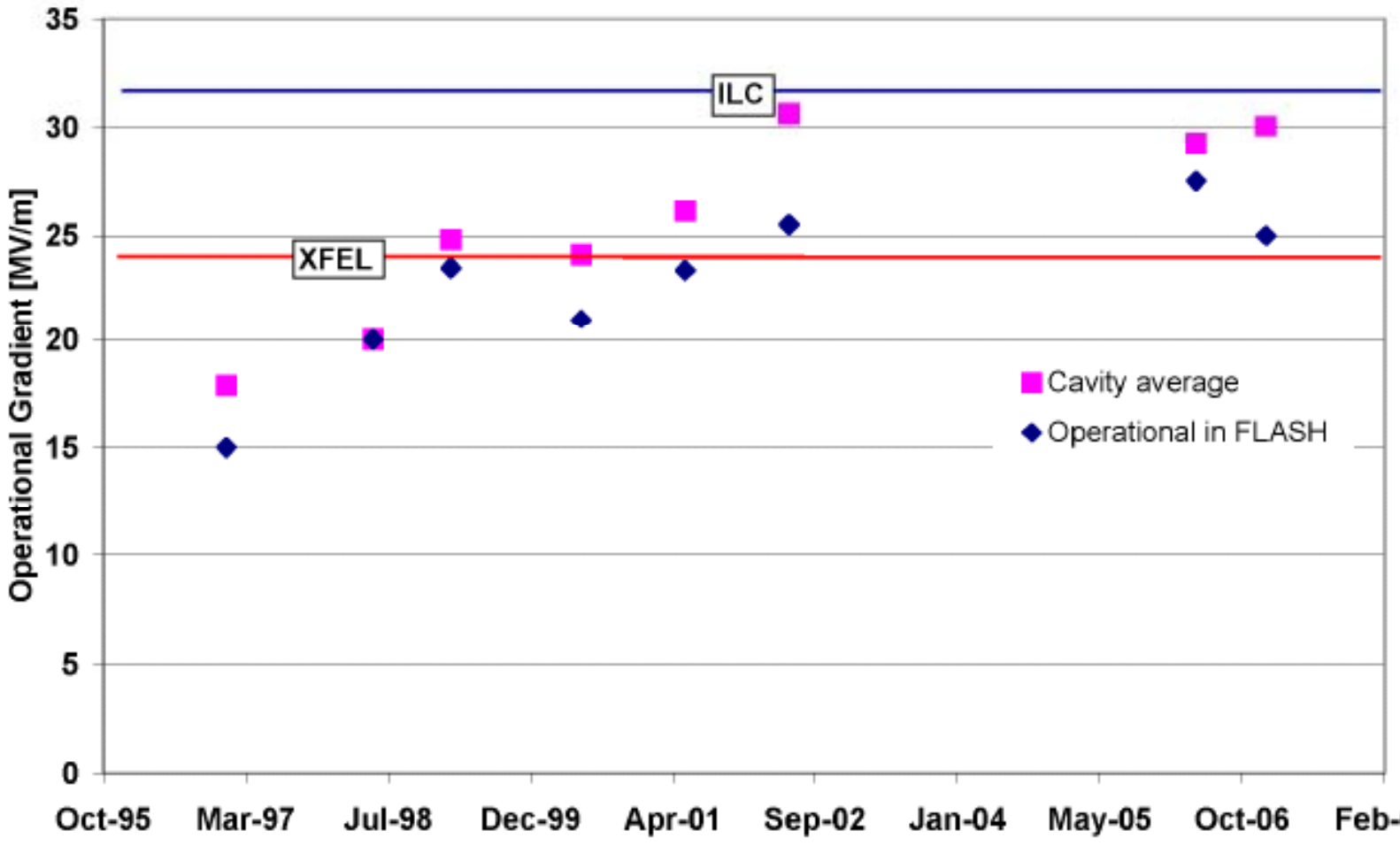
R&D Test Facilities and Program

Test Facility	Deliverable	Date
ATF	Generation of 1 pm-rad low emittance beam	2009
STF	RF Unit demonstration	2011
FLASH	Full 10mA, 1 GeV, high-repetition rate operation	2008
ATF-2	*Final Focus Optics and Stabilisation Demonstration:*	
	Demonstration of compact Final Focus optics (design demagnification, resulting in a nominal 35 nm beam size at focal point).	2010
	Stabilisation of 35 nm beam over various time scales.	2012
STF	RF Unit demonstration	2012
FLASH	Full 9 mA, 1 GeV, high-repetition rate operation	2009
ILC-SLACESA	Energy spectrometer, energy spread and collimator tests	2008
CESR-TA	*Electron cloud mitigation studies:*	
	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

Cavity Gradient

- TD Phase goals for gradient R & D are:
  - **Achieve 35 MV/m in 9-cell cavity in vertical dewar tests with a sufficient yield**
  - **Preparation process and vertical test yield for 35 MV/m at $Q0 = 10^{10}$ should be greater than 50% for a sufficiently large number (greater than 100) of preparation and test cycles by the beginning of CY 2010 (TDP1) and 90 % by CY 2012 (TDP2).**
  - **(includes 20% re-processing fraction)**
- Perform a series of inter-laboratory cavity exchanges and re-test sequences in order to cross-check and compare infrastructure performance
  - **Deliver a gradient recommendation to the TD Project in time to allow the development of a consistent linac design. This should be before the beginning of CY 2012.**

DESY Cryomodule Performance



Development of flexible RF distribution systems will allow higher gradient operation, approaching E_max

Cavity in cryogen tank

Eight in a string

Hang string from support tube

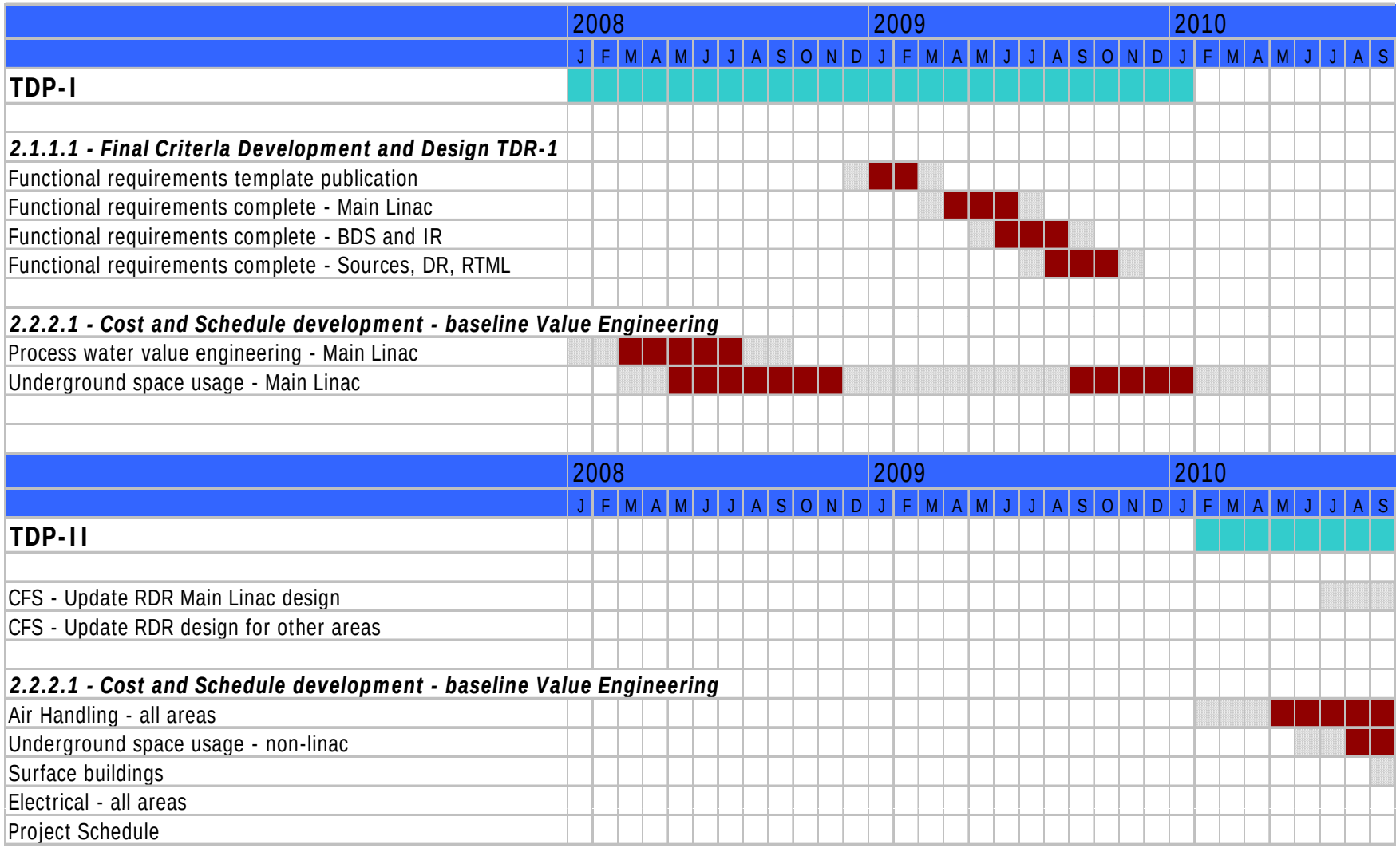
Slide into cryostat

Completed Cryomodule in Fermilab ICB, November 2007

Conventional Facilties Program

- Program of 'Value Engineering', whereby an attempt is made to assure the highest value by delivering all required functions at the lowest overall cost. The TD Phase CFS activities are therefore focused on this activity and are broadly subdivided into three stages:
  - **a preparatory stage, during which the design criteria used to develop the Reference Design are revisited and analyzed;**
  - **a Value Engineering review stage, where the functional requirements are compared one at a time with their respective cost and a small set of prospective improvements are proposed;**
  - **an evaluation and design update stage during which the design is improved through adoption and analysis of the suggestions.**
- Based on expected CFS engineering resources for the TD Phase, stages (1) and (2) above are expected to last about two and a half years.

Value Engineering Milestones



SCRF Global Cavity Program

Americas	FY06 (actual)	FY07 (actual)	FY08	FY09	FY10	TOTAL TDP1	FY11	FY12
Cavity orders	22	12	0	10	10	**52**	10	10
Total 'process and test' cycles		40	5	30	30	**98**	30	30
Asia	**FY06 (actual)**	**FY07 (actual)**	**FY08**	**FY09**	**FY10**		**FY11**	**FY12**
Cavity orders	8	7	15	25	15	**59**	39	39
Total 'process and test' cycles		21	45	75	45	**152**	117	117
Europe	**2004-06 (actual)**	**2007 (actual)**	**2008**	**2009**	**2010**		**2011**	**2012**
Cavity orders	60*			838		**898**		
Total 'process and test' cycles		14	15	30	100	**109**	354	354
Global totals								
Global totals - cavity fabrication	90	19	15	873	25	**1008**	49	49
Global totals - cavity tests	**0**	**75**	**65**	**135**	**175**	**359**	**501**	**501**

TDP II - 2012

- RF unit test – 3 CM + beam (KEK)
- Complete the technical design and R&D needed for project proposal (exceptions*)
  - **Documented design**
  - **Complete and reliable cost roll up**
- Project plan developed by consensus
  - **Cryomodule Global Manufacturing Scenario**
  - **Siting Plan or Process**

Cryomodule Design: Plug Compatible

- TDP 2: RF Unit ≡ 3 each cryomodules
- R&D Priority – High
  - Primary ILC 'High-Tech' component;
  - GDE development and construction plan must account for regional & institutional ambitions
- 6 basic components:
  - Cryostat, internal supports and cryogen plumbing:
  - and 4 interchangeable internal sub-assemblies
    - Cavity + cryogen tank + tuner — 64% CM cost
    - Power input coupler — 12%
    - Quad — 4%
    - BPM — 2%
  - (Cryostat & plumbing/supports — 19%)

Cryomodule Testing Plan

- Development of CM unified design;
  - fabrication in at least two labs – provides a test facility
  - Project X plans to adopt this design
- R&D goal:
  - A cryomodule (of any type) with operational MV/m gradient 31.5MV/m
- Testing to be completed: TDP2:
  - KEK /STF – full beam test RF unit in 2012; CM testing from 2009
  - Fermilab – NML – CM testing from 2009

Goal of S1

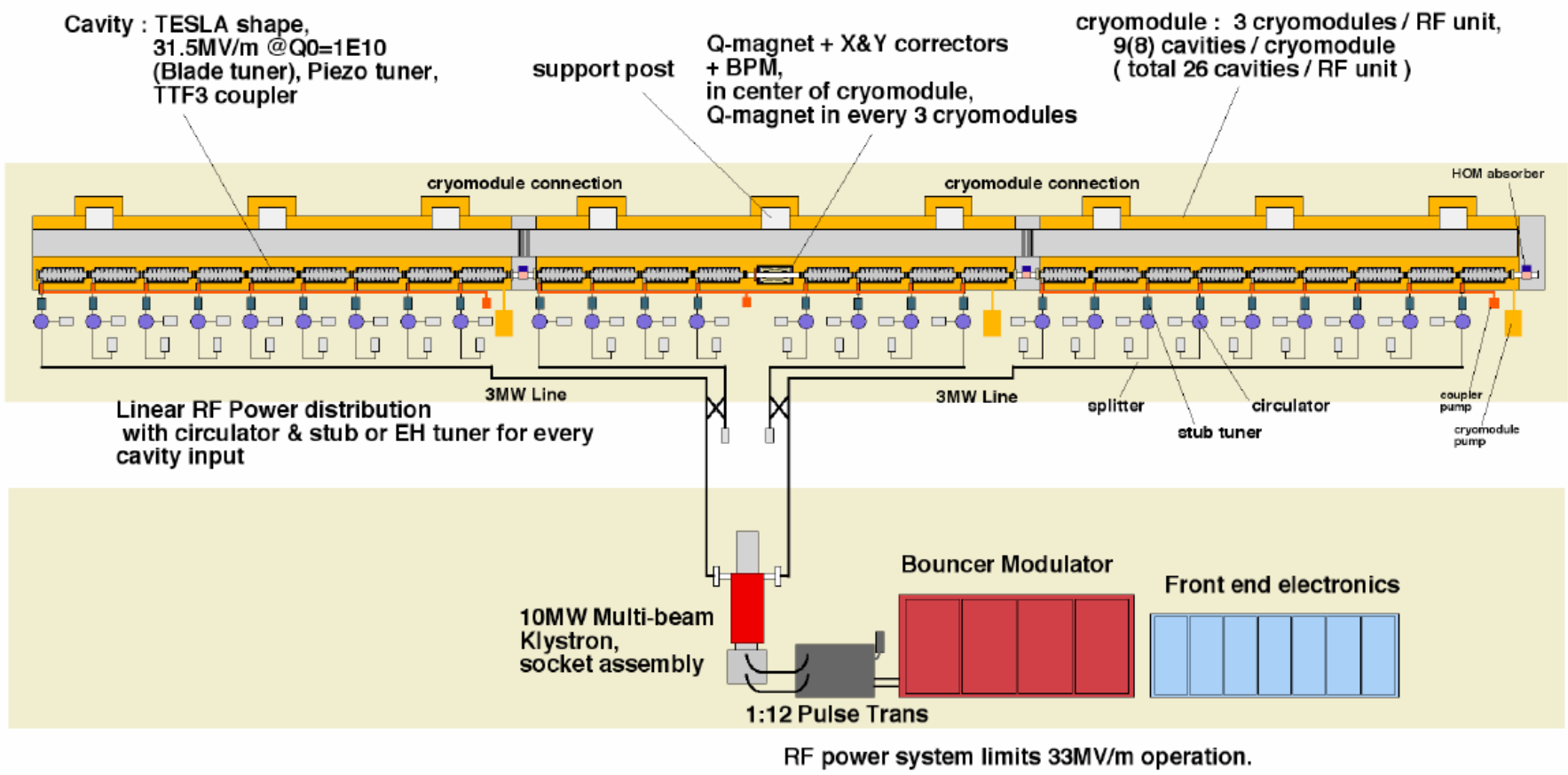
Ultimate Goal;

31.5MV/m@Q_0=1x10^{10} as operational gradient at least 3 cryomodules include fast tuner, etc

Intermediate goal: ***to achieve by single cryomodule with tweaking WG-config***

Final goal: use of 'S0' passed cavities, operation of a few weeks

ILC Main Linac RF unit



RDR configuration

TDP II 2012
what won't be done?

- Detailed Engineering Design (final engineering, drawings, industry, etc) will follow before construction.
- Global CM industrial plant construction
- Some other unresolved issues
  - **Positron Source ???**
  - **Damping Ring Design work?**

CLIC/ILC Collaboration

Introduction

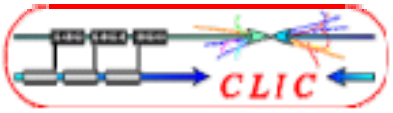
- review selected subjects and define tasks which serve common interests –
  - **ILC and CLIC studies.**
  - **(or which are close enough to yield useful direct exchange)**
- Once defined, nominate contact persons for each subject (convenors)
  - **Who prepared the discussions for today's meeting**
  - **And will follow-up afterwards on listed tasks**

CLIC/ILC Collaboration

CLIC – ILC Collaboration Strategy

- Components – working together on pieces
  - **There will be much in common – starter projects kept definitively small.**
- What can ILC bring to CLIC?
  - **Use the same cost basis. – develop a credible comparison**
  - **ILC could even help in the costing of CLIC.**
- CLIC to ILC:
- CERN expertise helpful to solve.
  - **There may not always be a point to point balance.**
- Line up tasks and skill-sets!
- The big picture may (will) be harder to arrange.
- *The credibility of each, through the broader community, will be facilitated through communication.*

CLIC/ILC Collaboration



Conclusions - CFS

- Interaction Area is obvious area where resources can be shared
- Civil Engineering models can be worked on 'in parallel' for ILC & CLIC.
- Other possible areas of collaboration in the TS area : Ventilation, Electricity, Handling….
- Resources to be defined, if limited, then perhaps Joint 'Value Engineering' exercises could be the way forward, rather than full blown studies…..
- First milestone : At Sendai meeting develop deliverables for 2008 for ILC Value Engineering and ILC/CLIC common efforts
- Identify link persons for highlighted areas
- CFS Video meetings will continue with possible CLIC input on specific subjects

TILC – Working Groups

- WG-1 Cost Reduction Studies

APPROACH

- **Review and evaluate RDR design**
- **Re-visit (Caltech) cost reduction lists**
- **Brainstorming**

SPECIFIC TARGETS (Cost Drivers)

- **Staging? / Scope?**
- **Main Linac Technology**
- **CDF -- Scope of halls, caverns, shafts, etc. Two vs One tunnel. Shallow vs Deep sites**

GOALS

- **Sendai – establish cost reduction goals**

NOTE

- **NO CHANGES OF PHYSICS SCOPE WITHOUT ENGAGING EXPERIMENTAL COMMUNITY**

TILC – Working Groups

- WG-2 Superconducting RF

APPROACH

– **Establish credible SCRF design, ready for production**

SPECIFIC TARGETS

– **Demonstrate gradient and yield**
– **Cryomodule design issues**
– **RF System test**

GOALS

– **Complete S0 goals (35MV/meter and 90% yield by 2012 with intermediate goal of validating gradient with 50% yield by 2010.**
– **Plug compatible cryomodule plan**
– **RF Unit Test at STF (also Fermilab?)**

TILC – Working Groups

- WG-3 Beam Delivery System

APPROACH

- Design and value engineering for BDS
- ILC-CLIC joint issues

SPECIFIC TARGETS for Sendai

- ATF-2 status and planning
- MDI issues
- joint sessions with detector people

GOALS

- IR integration planning and discussion on cost-reduction.

TILC – Working Groups

- WG-4 Damping Rings

APPROACH

– **Demonstrate electron cloud mitigation and evolve the design**

SPECIFIC TARGETS for Sendai

– **Acceptance of baseline lattice (workshop deliverable)**
– **ATF, e-cloud status**
– **Planning CESR-TA two year program**

GOALS

– **Sendai – review status and define the program and goals for TDP- I**
– **Define strategy for implementation**

Other Issues

- Publication of TD (phase I & II) R&D plan
  - **Update and release present document (following Sendai)**
  - **WP and global resource consolidation**
  - **(Confirm/Modify plan at Sendai)**
- EDMS and related
  - **Implementing ILC-EDMS**
  - **RDR documentation (descoping consolidation)**
  - **Establishing the baseline**
  - **(Re-)establishing VALUE traceability**
- VALUE estimate
  - **Tools for maintaining VALUE estimate**
  - **Plans for implementation**
  - **(links up with previous bullet point)**

Conclusions

- A plan to recover from UK and US actions is proposed with reduced goals, strict prioritization and stretched out timescale
- A two stage ILC Technical Design Phase (TDP I 2010 and TDP II 2012 is proposed)
- **Cost reduction and producing a robust design and implementation plan on the time scale of LHC results must remain our primary goals.**