ILC Status

Impacts of US/UK Budget Actions
Replan for GDE Technical Design Phase

Barry Barish

SiD Workshop - SLAC

28-January-08

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.

- **US Program**
  - ILC R&D is basically terminated for FY08, but we are planning for a reduced level restored program in FY09.   Broad based program.
  - Generic SCRF also terminated in FY08, but expected to be revived in FY09 separated from ILC R&D. Primarily builds US SCRF capability

Impacts – US / UK Funding

- **Fermilab (ILC and other reductions)**
  - Consequences include layoffs, lab wide furloughs and reassignments for many personnel
  - ILC program - most activities suspended for FY08. Some support for 1.3GHz program.
- **SLAC (ILC and other reductions)**
  - Staff reductions and reassignments for FY08
  - ILC program only within related accelerator R&D for FY08
- **GDE**
  - Continued support for common fund and key personnel.
  - Loss of R&D support for FY08 ~ 40% of global total

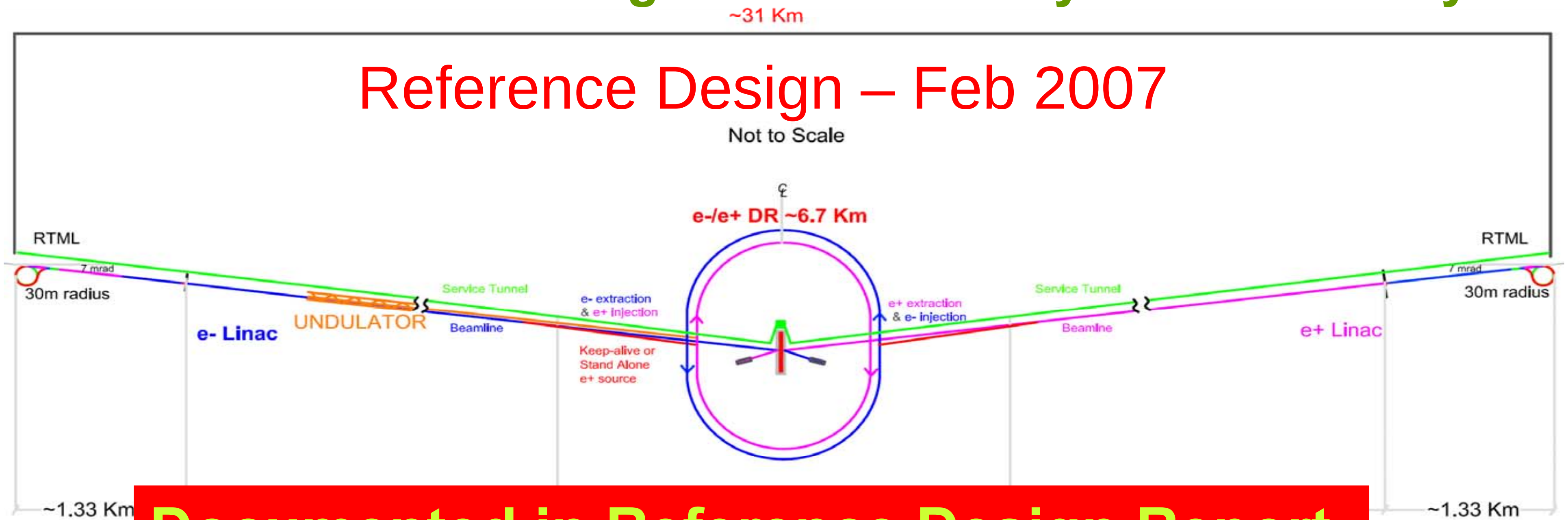
So, where are we?

- **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 (6 months) 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 have reached the original goals !!
- **We are at a crossroads. Best strategy --- move on or revert to laboratory driven R&D programs?**

ILC Reference Design

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

Reference Design – Feb 2007



Documented in Reference Design Report

RDR Design Parameters

Max. Center-of-mass energy	500	GeV
Peak Luminosity	$\sim 2\times10^{34}$	$1/cm^2s$
Beam Current	9.0	mA
Repetition rate	5	Hz
Average accelerating gradient	31.5	MV/m
Beam pulse length	0.95	ms
Total Site Length	31	km
Total AC Power Consumption	~230	MW

RDR Design & "Value" Costs

The reference design was "frozen" as of 1-Dec-06 for the purpose of producing the RDR, including costs.

It is important to recognize this is a snapshot and the design will continue to evolve, due to results of the R&D, accelerator studies and value engineering

The value costs have already been reviewed twice

- 3 day "internal review" in Dec
- ILCSC MAC review in Jan

Σ Value = 6.62 B ILC Units

Summary
RDR "Value" Costs

Total Value Cost (FY07)

4.80 B ILC Units Shared

+

1.82 B Units Site Specific

+

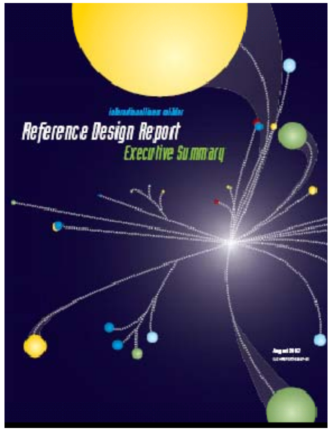
14.1 K person-years

("explicit" labor = 24.0 M person-hrs @ 1,700 hrs/yr)

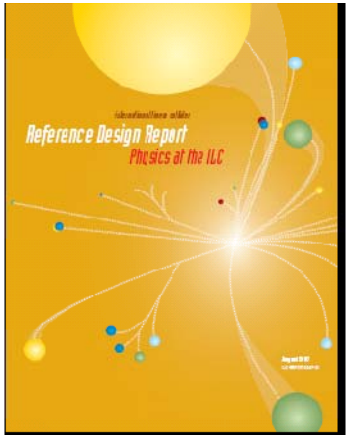
1 ILC Unit = $ 1 (2007)

RDR Reports

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

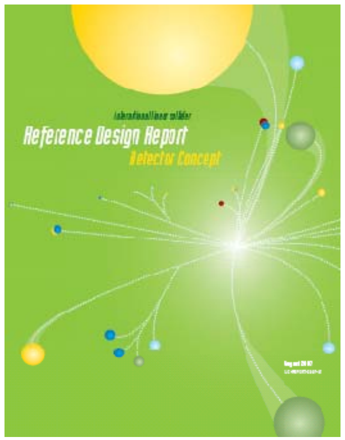


Executive Summary



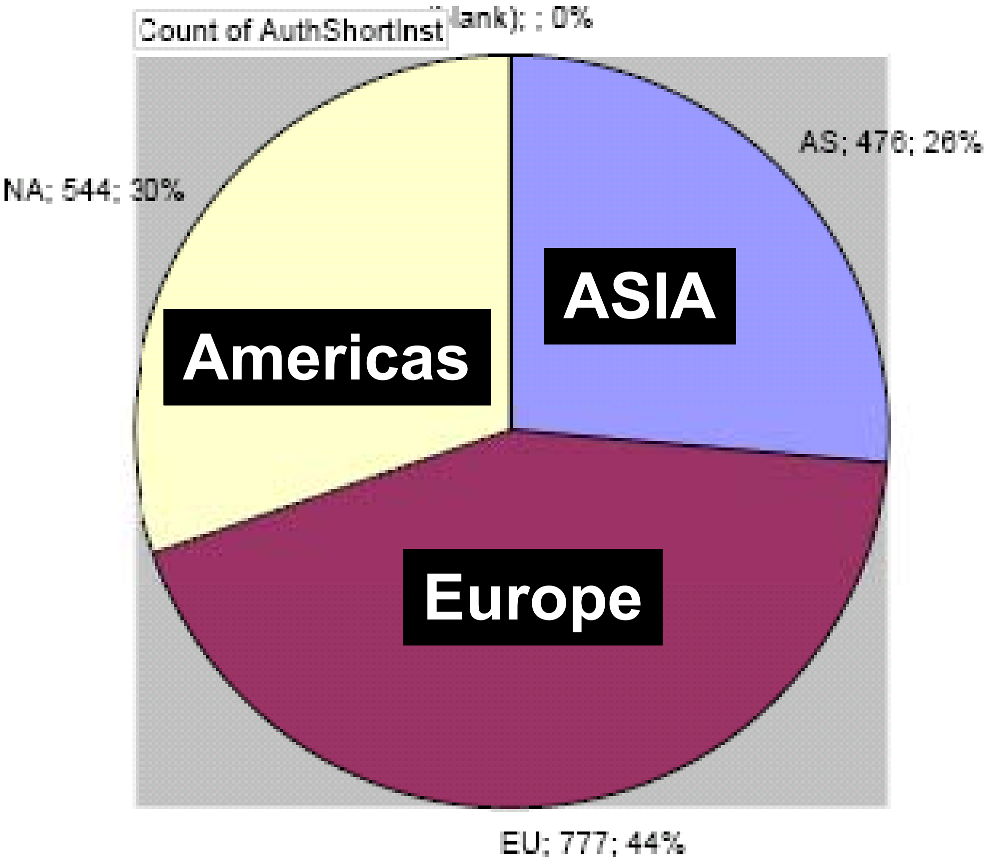
Physics at the ILC

Accelerator



Detectors

RDR Author List

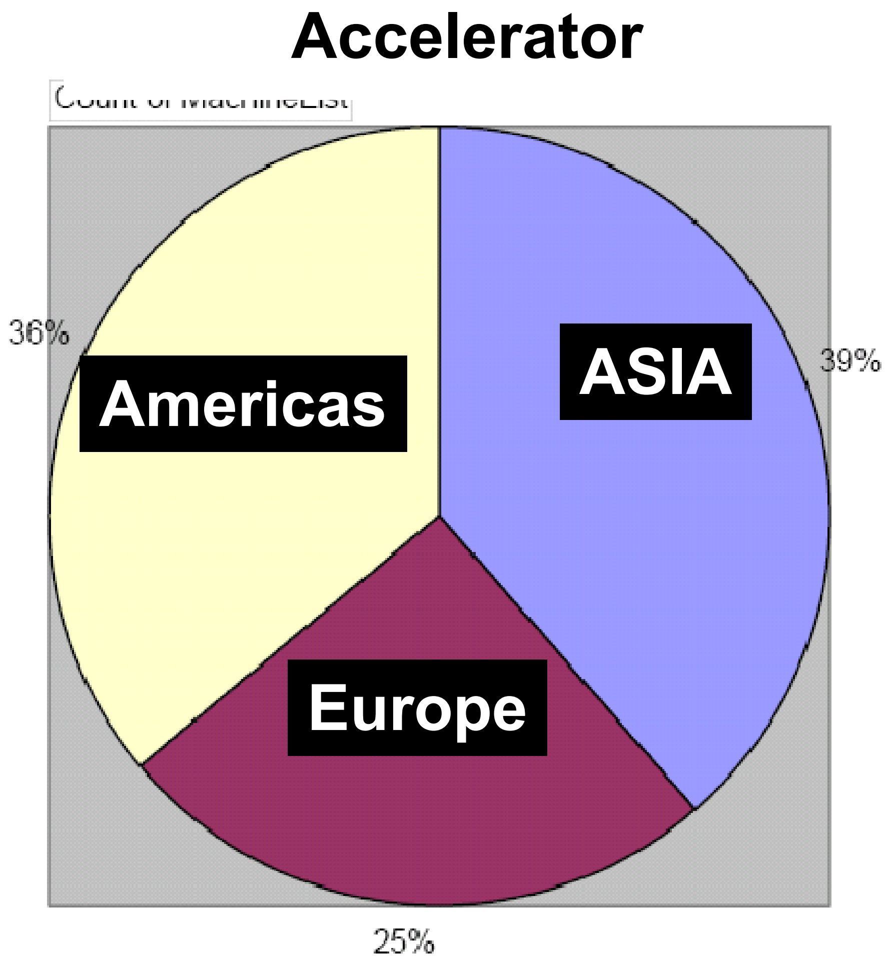


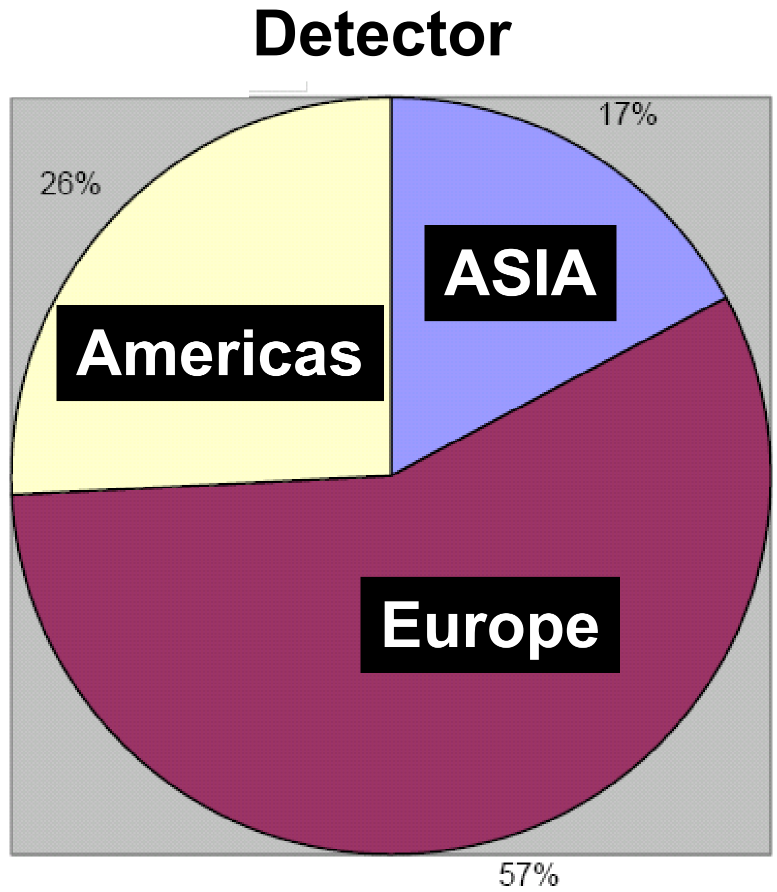
- **Asia 476**
- **Americas 544**
- **Europe 777**

- **TOTAL 1797**

Ties Behnke

RDR Author List





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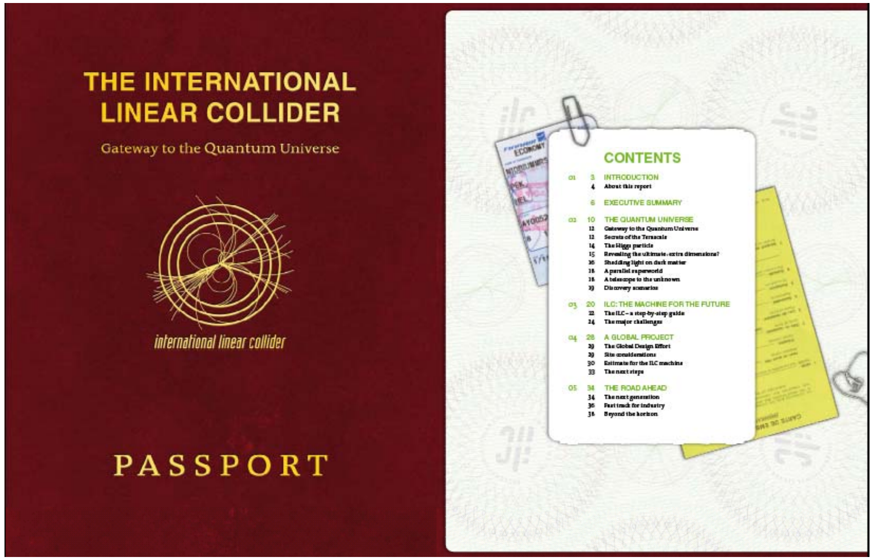
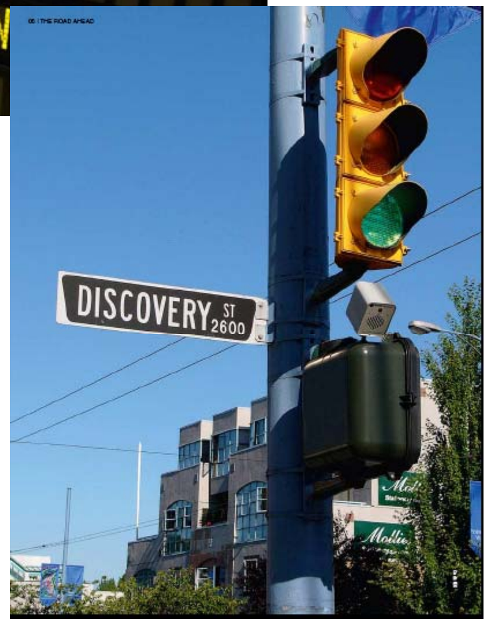
Gateway to Quantum Universe

Last piece: Companion Document for broad circulation, including translations to eight languages over the coming year.





http://www.linearcollider.org/gateway/

What's next and why?

- **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)
  - Offers - visiting appointments, equipment help, travel, etc

The Elements of a New Plan

- ILC R&D program must be more focused and strictly prioritized to achieve critical R&D, so project can be proposed, once LHC results justify.

- Build a 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.

- 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, etc. (Maybe also directly in CLIC R&D).

- Develop analysis of siting considerations (GDE) and process for siting <u>after</u> 2010 (ILCSC/GDE)

Next Steps: The GDE

- **Build on Successes of GDE, RDR and DCR**
  - **Be ready to make solid funding proposal whenever scientific results from LHC justify.**

- **Plan**
  - Re-structure and strengthen GDE to incorporate a more traditional project management structure, engineering strength and project tools.
  - R&D program to mid-~~2010~~ to develop and ~~Design Report~~ that develops RDR through value engineering, completed crucial R&D demonstrations, reliable costing, and a project implementation plan

Technical Design Phase

2012

Essential Elements of EDR

- **Global Project Tools (common funds)**
  - Primivera and other costing tools will be implemented
  - ~~An earned value system will be employed during EDR~~
  - We are implementing an EDMS system for carrying out and documenting the design

- **Supporting R&D Program (priorities)**
  - High Gradient R&D - globally coordinated program to demonstrate gradient for EDR by 2010
  - Electron Cloud Mitigation – Electron Cloud tests at Cornell to establish mitigation and verify one damping ring is sufficient.
  - Final Beam Optics – Tests at ATF-2 at KEK

SCRF Technology

Cost / MeV → superconducting accelerator base cost

- **Goal:**
  - Assess yield of nominal (35 MV/m) cavities
  - Recommend EDR gradient and preparation process in late 2010
- **Strategy:**
  - Vertical dewar tests of nine-cell cavities
  - Minimize resource needs by repeatedly processing and testing cavities on hand
  - Development of test infrastructure and diagnostics
- **Partnerships:**
  - ~~Rely on process infrastructure in all three regions~~

Superconducting RF cavities

- **Projected:**
  - Cavities available
  - Test cycles anticipated
- **2006 – 2012**

Americas	FY06 (actual)	FY07 (actual)	FY08	FY09	FY10	TOTAL ED-R	FY11	FY12
Cavity orders	8	12	18	40	40	108	40	40
Total 'process and test' cycles		40	60	90	115	276	120	120
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	2004-08* (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	76	19	33	903	55	1065	79	79
Global totals - cavity tests	0	75	120	195	260	538	591	591

-150

380

Developing SCRF Units

- Full gradient RF Unit (3 cryomodule) demonstration (post TDP- I)
- Cost effective design of the integrated cryogenics system
- Optimization of the cryomodule design, component layout & transport
  - beam dynamics
  - quadrupole magnets
  - beam monitoring systems;
- Cost effective design of the RF power and distribution system

CERN?

XFEL
Saclay Collaboration

BY 2012
STF KEK

Conventional Facilities

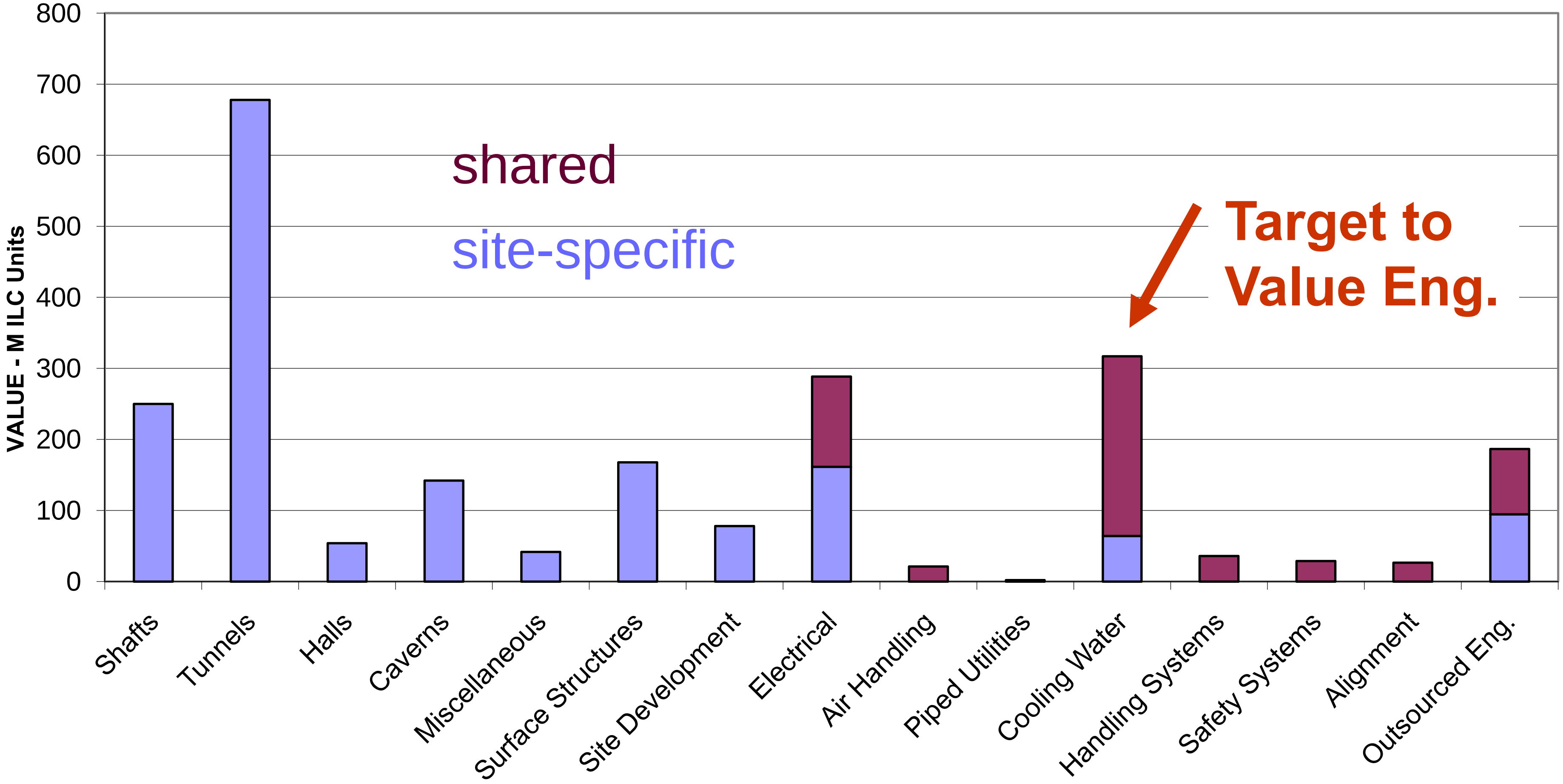
Develop most effective design of underground space and utilities – power and water

20 deg to 30 deg? (joint with CLIC)

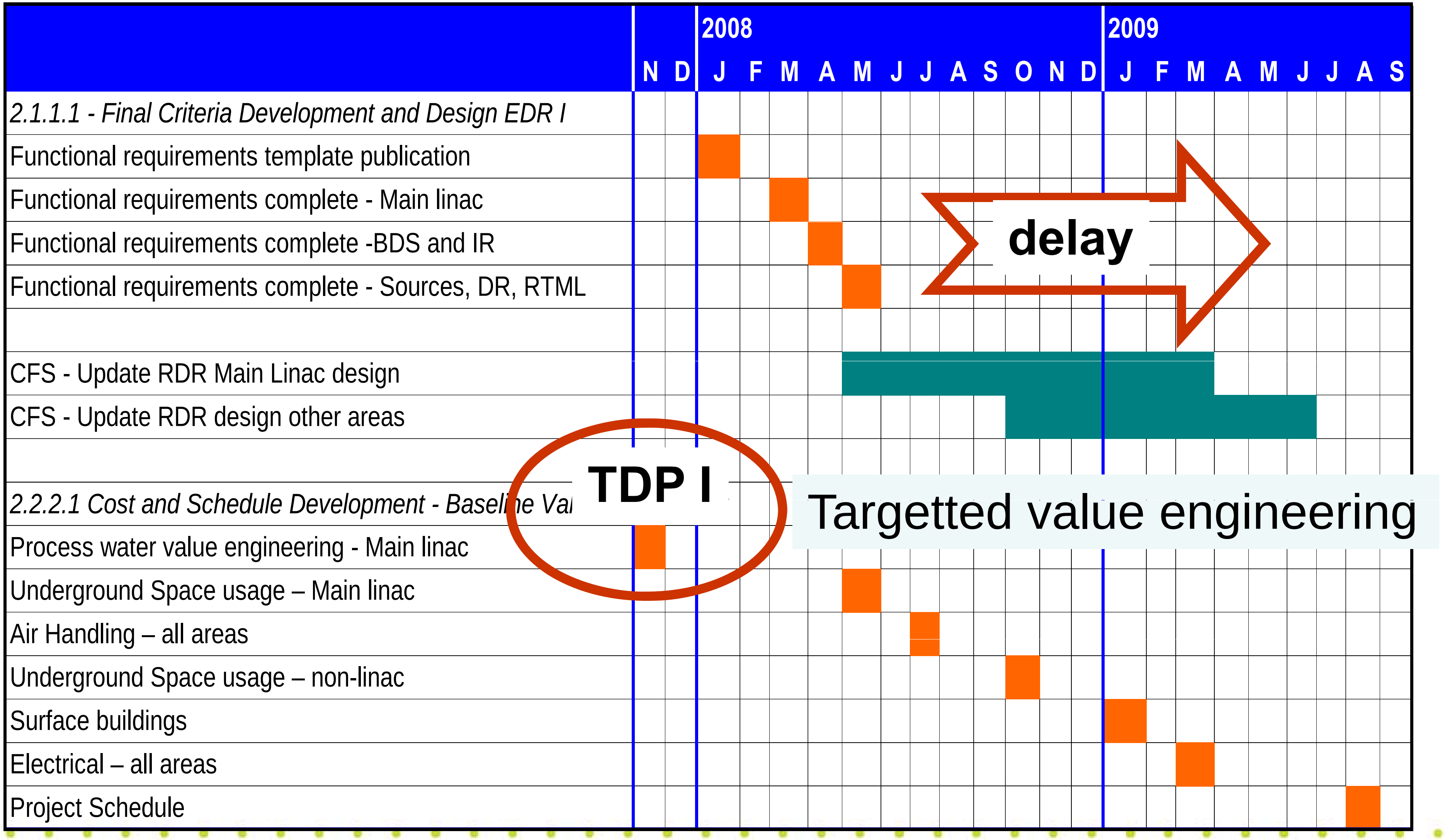
- **Goal:**
  - Evaluate basis of RDR estimates and analyze trade-offs --value engineering and component R & D
  - Two tunnels; shallow vs deep; etc
- **Strategy:**
  - Focus on top 5 costs:
    - **Underground construction, water cooling, air handling, surface buildings and electrical power distribution**
  - Analyze and derive basic requirements
- **Partnerships:**
  - Design and analysis of conventional facilities designs by large labs

Conventional Facilities

Americas Site – 2006 estimate for illustration only



Target Value Engineering Milestones, some deferred



Beam Test Facilities

Reduce technical risk through beam-based demonstrations

- **Goal → Demonstrate:**
  - **Control of electron instability – Damping Ring**
  - **Control of 10 mA beam – Superconducting Linac**
  - **Generation and measurement of precision beams – Beam Delivery**
- **Strategy:**
  - **Based on existing or planned test facilities**
- **Partnerships:**
  - **CESR-TA – Cornell University**
  - **TTF / FLASH – DESY**
  - **ATF2 – KEK**

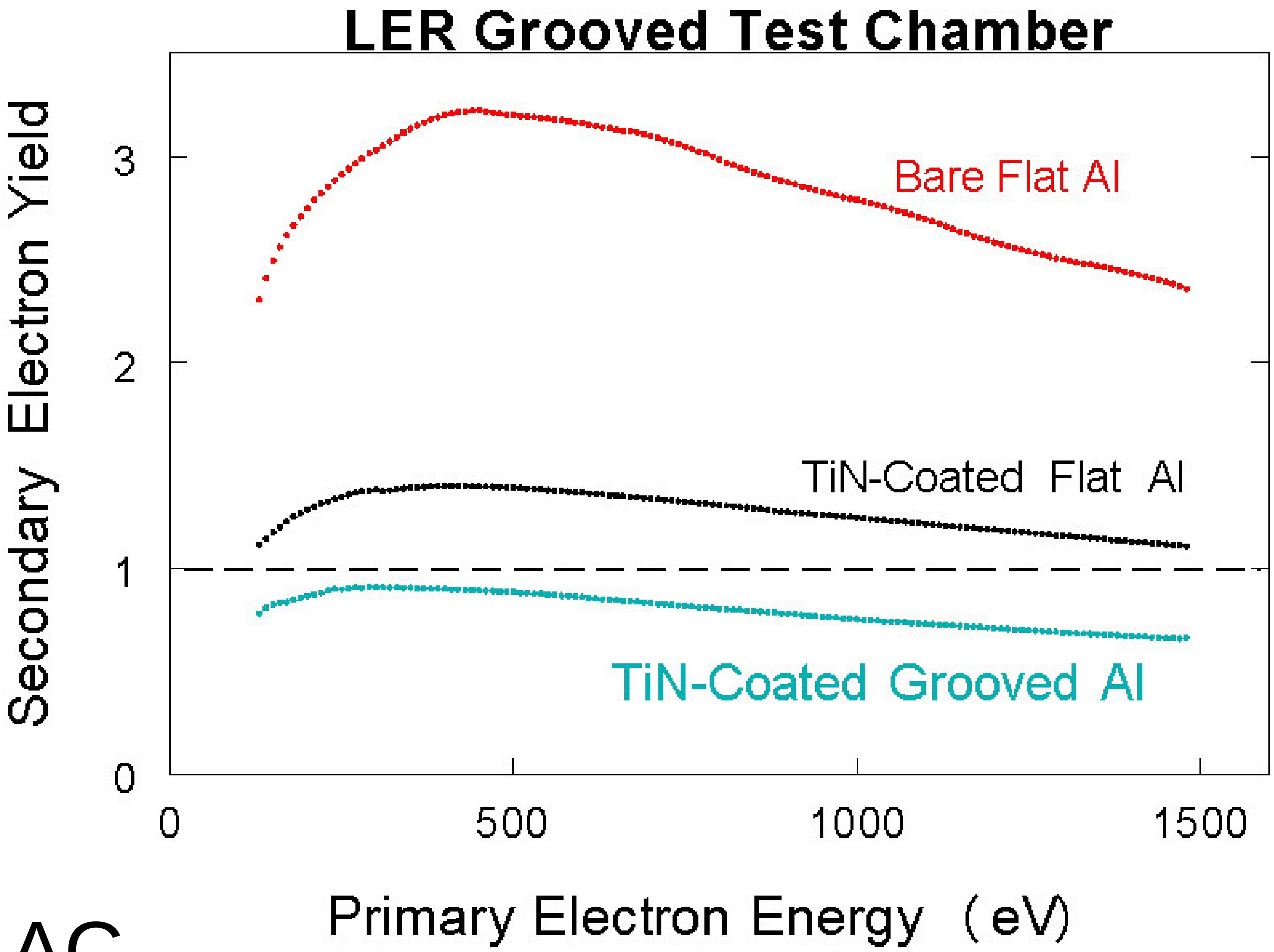
Beam Test Facility Deliverables and Schedule

Test Facility	Deliverable	Date
ATF	Generation of 1 pm-rad low emittance beam	2009
ATF2	35 nm beam size	2010
STF	RF Unit demonstration	2011
FLASH	Full 10mA, 1 GeV, high-repetition rate operation	2008
~~ILC-SLACESA~~	~~Energy spectrometer, energy spread and collimator tests~~	~~2008~~
~~ILCTA-NML~~	~~RF Unit demonstration~~	~~2012~~
CESR-TA	Electron cloud mitigation tests	2010

Electron cloud – Goal

- Ensure the e- cloud won't blow up the e+ beam emittance.
  - Do simulations (cheap)
  - Test vacuum pipe coatings, grooved chambers, and clearing electrodes effect on e- cloud buildup
  - Do above in ILC style wigglers with low emittance beam to minimize the extrapolation to the ILC.
- Electron cloud problem goes well beyond ILC
- Experimental program at CesrTA crucial

Electron Cloud – Results



SLAC

TDP I -- 2010

- **Technical risk reduction**:
  - **Gradient**
    - Results based on re-processed cavities
    - Reduced number 540 → 390 (reduced US program)
  - **Electron Cloud (CesrTA)**
- **Cost risks (reductions) – Main Cost Drivers**
  - **Conventional Facilities (water, etc)**
  - **Main Linac Technology**
- **Technical progress ? (global design & US??)**
  - **Cryomodule baseline design defined**

TDP II - 2012

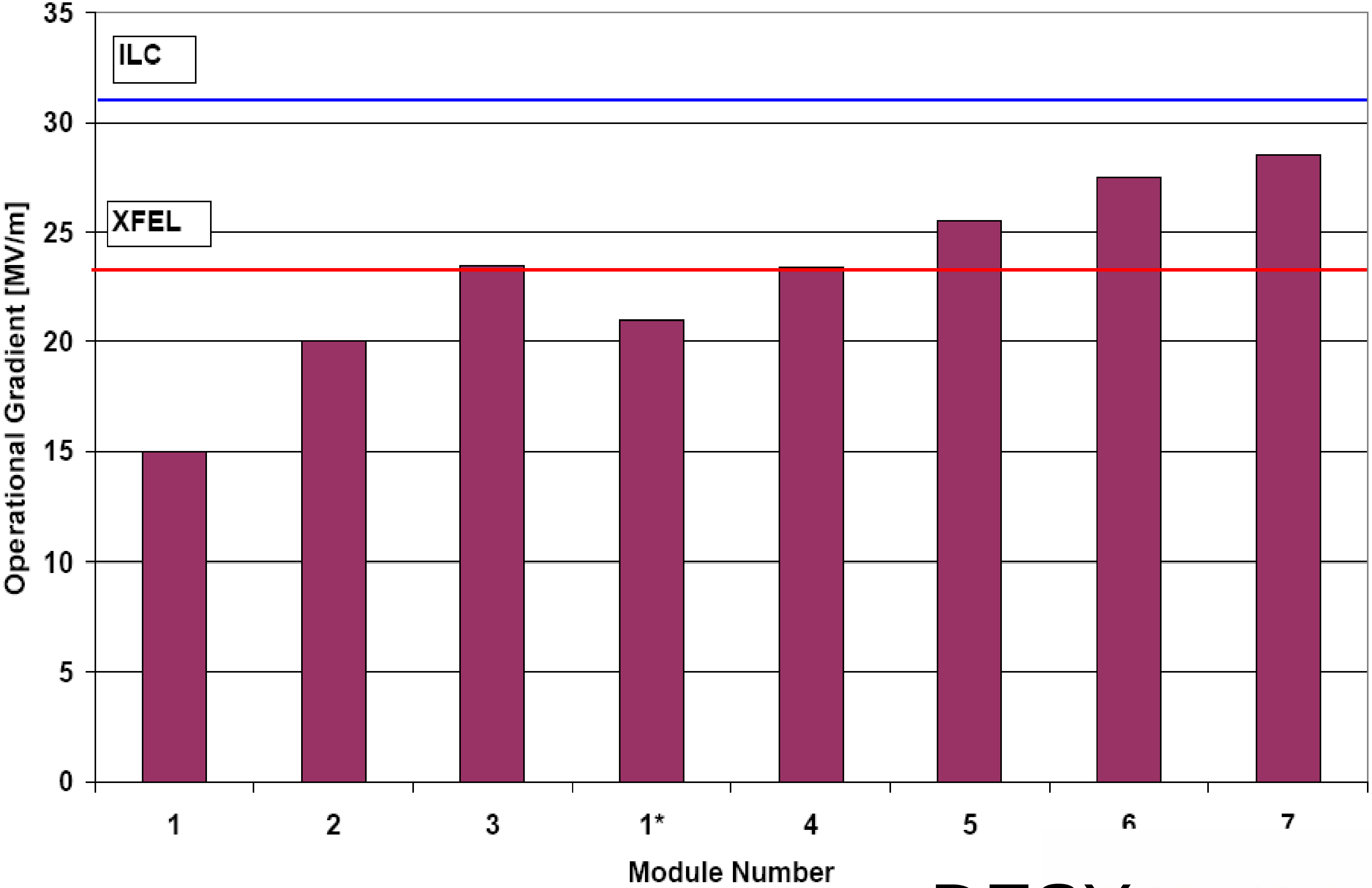
- RF unit test – 3 CM + beam (STF)
- Complete technical design and R&D needed for project proposal (exceptions*)
- Documented design
- Complete and reliable cost roll up

- Project plan developed by consensus
- CM Global Manufacturing plan
- Siting Plan or Process

SCRF Module Test – Goal

- **Intermediate goal**
  - Achieve 31.5 MV/m average operational accelerating gradient in a single cryomodule as a proof-of-principle. In case of cavities performing below the average, this could be achieved by tweaking the RF distribution accordingly.
  - Auxiliary systems like fast tuners should all work.
- **Final goal**
  - Achieve > 31.5 MeV/m operational gradient in 3 cryomodules.
  - The cavities accepted in the low power test should achieve 35 MV/m at $Q_0 = 10^{10}$ with a yield as described above (80% after first test, 95% after re-preparation).
  - It does not need to be the final cryomodule design

Module Test – Results



DESY

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**
- **Other Unresolved Issues**
  - **Positron Source ???**
  - **Damping Ring Design work?**

Conclusions

- Central coordination by the GDE is even more essential, if we want to prepare to propose an ILC project
- The will is there!
- A plan to recover from UK and US actions appears possible with reduced goals, strict prioritization and stretched out timescale
- A two stage Technical Design Phase (TDP I 2010 and TDP II 2012 is proposed
- We must have the support of FALC, P5, ILCSC and ICFA to continue with this plan