Research and Development Resources

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Based on:
'ILC Research and Development Plan for the Technical Design Phase'
Published February 2009

R & D Resources for ILC GDE Technical Design Phase (TDP)

- **Role of R & D in support of GDE TDP**
  - 'In-kind' R & D
- **Key TDP Deliverables**
  - Technical R & D
  - Beam Test Facility results
  - Design and Integration
  - Project implementation plan
- **Resource base – examples**
- **Resource summary tables**
  - (TDP R & D Plan)

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

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

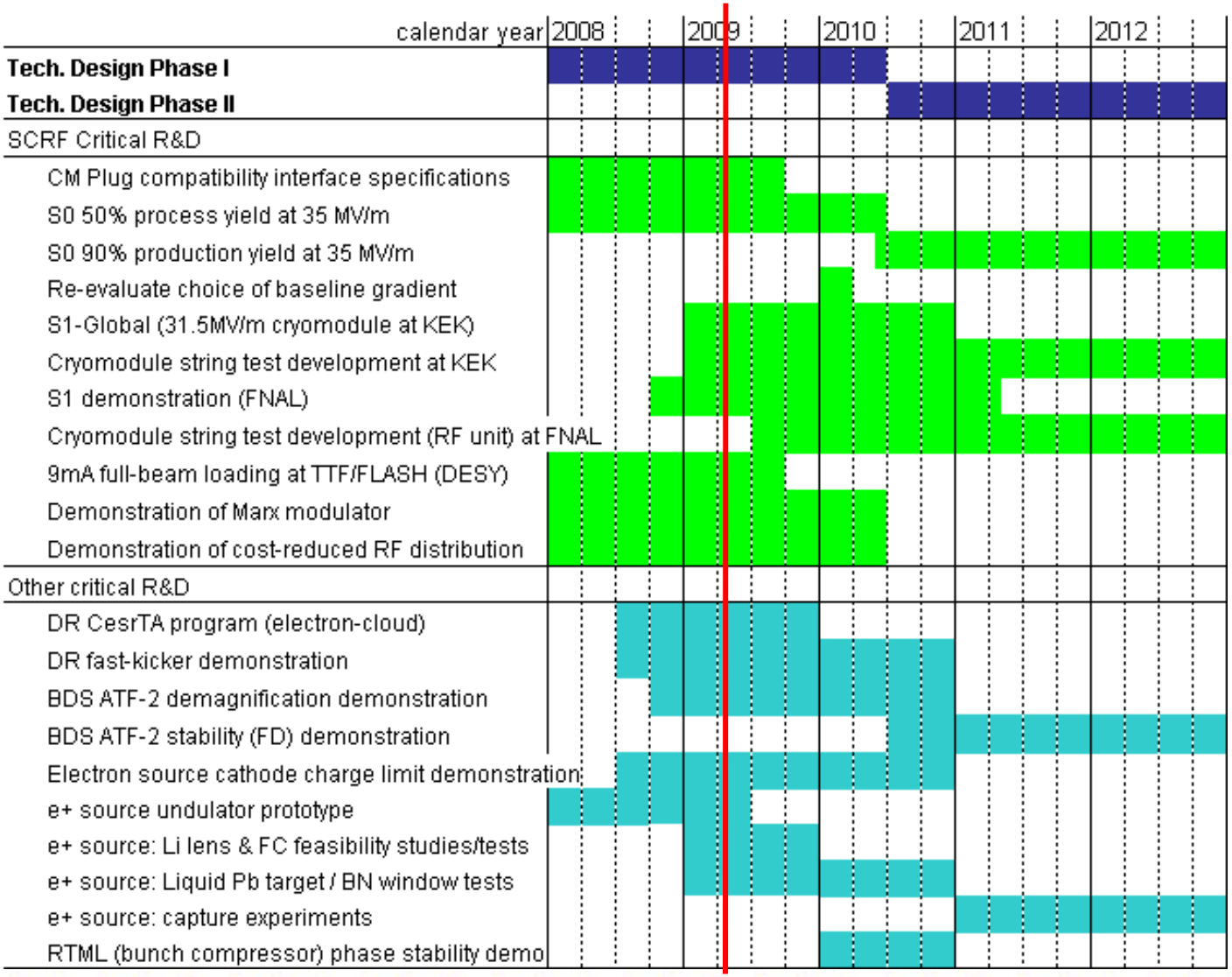
- **(and combinations of the above)**

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

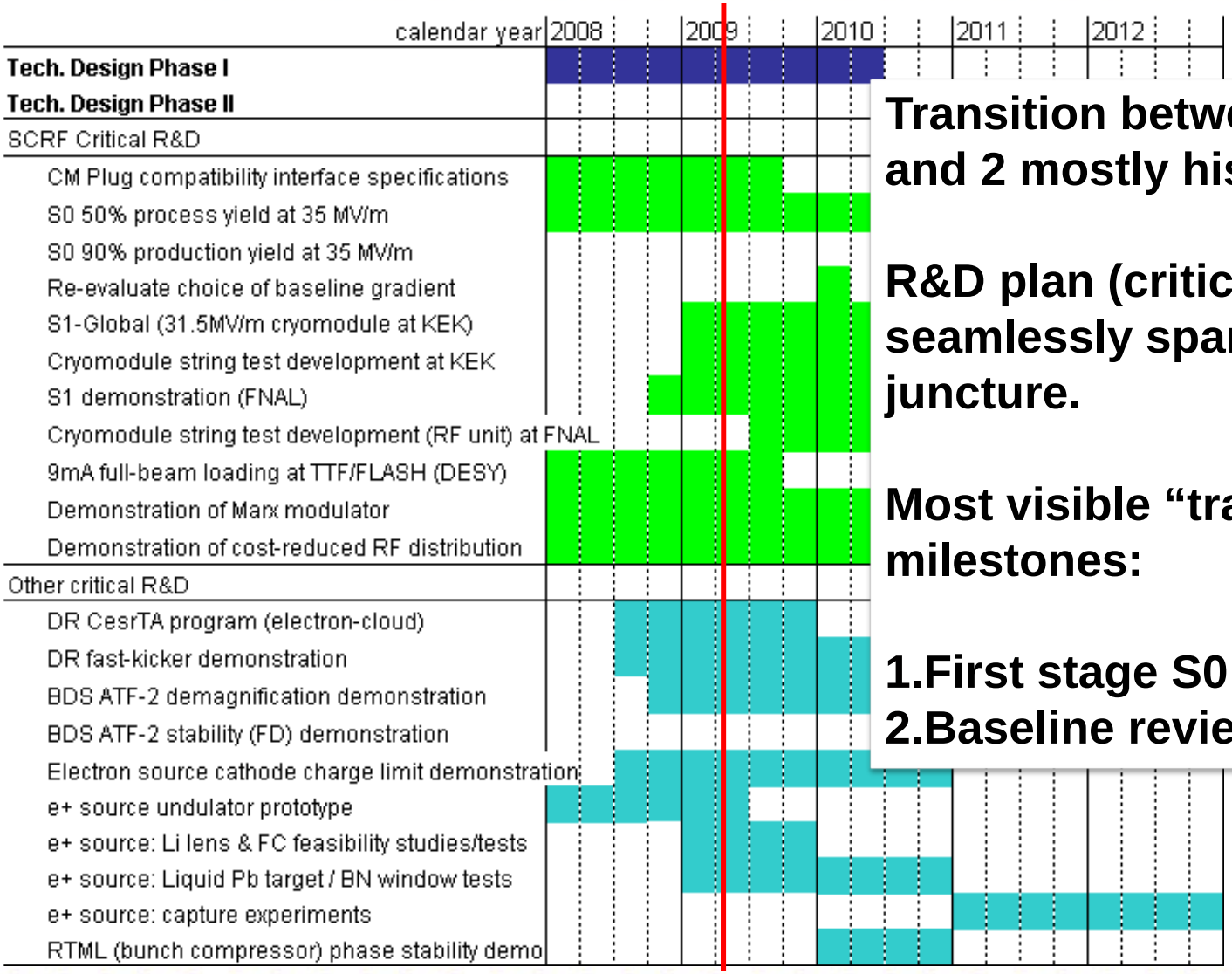
‘In-Kind’ R&D

- **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
- **More than 80 ILC papers at USPAC - 09**

TDP R&D Plan Milestones



TDP R&D Plan Milestones



Transition between phase 1 and 2 mostly historical.

R&D plan (critical R&D) seamlessly spans this juncture.

Most visible "transition" milestones:

1.First stage S0 goals
2.Baseline review

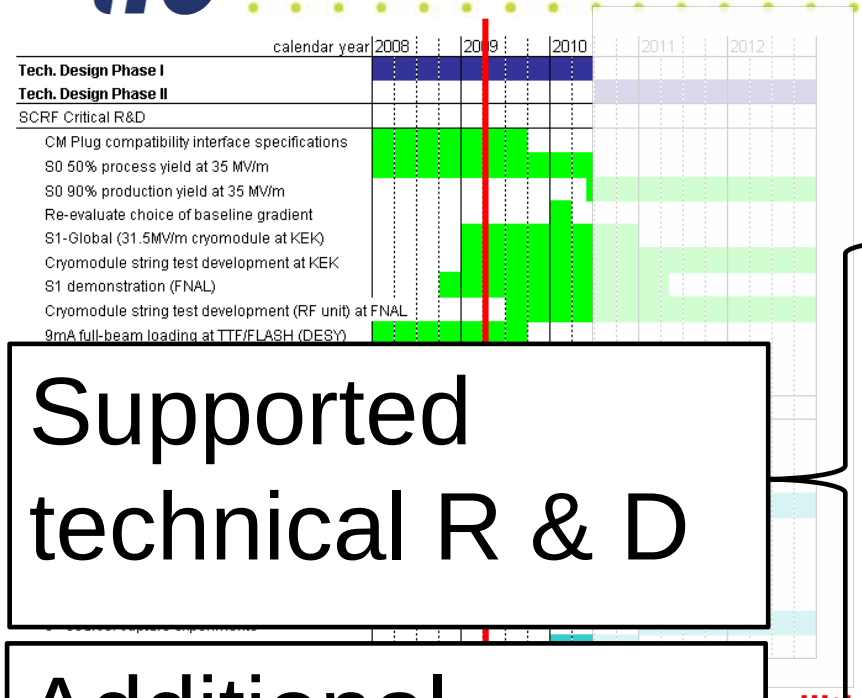
Report to ILCSC – Feb 2008:

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?

- **Still true!**
- **(Add S2 string test delay)**

TDP R&D Plan Milestones



Supported technical R & D

Additional resources needed

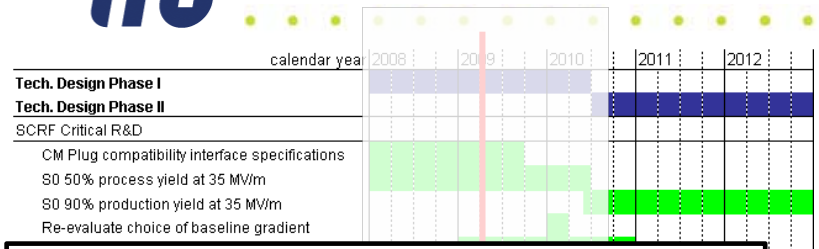
TDP-1 specified high-level milestones (examples)

- **S0 50% process yield**
  - **Will be based on ~60 cavities**
- **CM interface specification**
  - **"plug compatibility"**
- **9mA full beam loading demo.**
- **CesrTA programme (e-cloud mitigation)**
- **Marx modulator demonstration**
- **RF distribution system demonstration**
  - **"circulator-less"**

- **Positron source SC undulator**
- **Positron source Li lens / FC feasibility studies**
- **…**

- **Baseline review (not shown)**

TDP R&D Plan Milestones



Supported technical R & D – (schedule a concern for S2 KEK and FNAL)

Additional resources needed

TDP-2 specified high-level milestones (examples)

- **S0 90% production yield**
- **S1-G 31.5 MV/m average cryomodule**
- **FNAL high-performance cryomodule**
- **FNAL string-test – S2**
  - **Narrowly within TDP time-frame**
- **STF string-test – S2**
  - **Not within TDP time-frame**

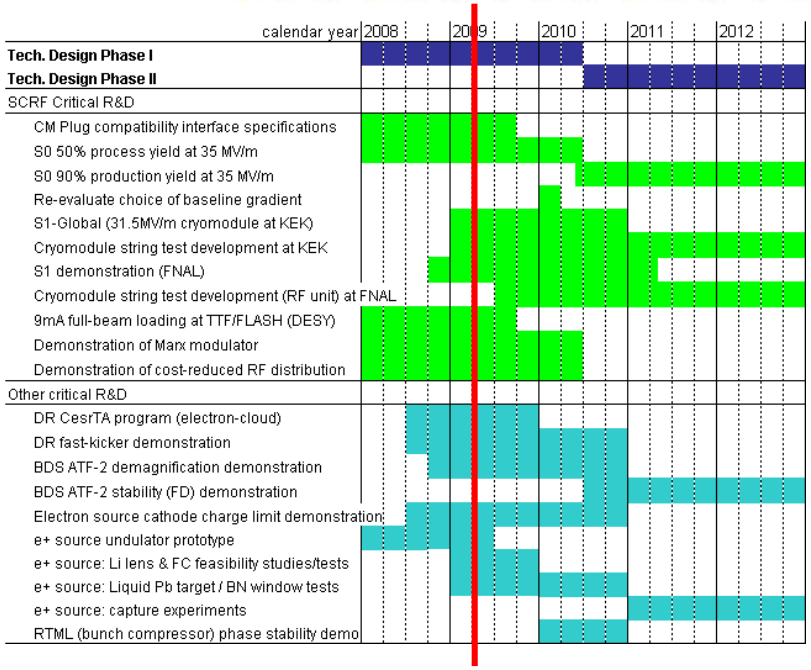
acilities

- **Demonstration of ATF2 demagnification**
- **Demonstration of ATF2 beam stabilisation**
- **Demonstration of SC final doublet prototype (ATF2)**
- **Demonstration of 2pm DR emittance (ATF)**

- **Li Pb target demonstration; BN window**

- **TDR design & cost work (incl. PIP).**

TDP R&D Plan Update



- **Will continue to update R&D plan with more detail**
  - **Every six-months**
- **Will continue to look for options to help with identified under-resourced areas:**
  - **e.g. positron source**
  - **CF & S**
- **Look for opportunities to extend programmes at BTF**
  - **Further work at TTF/FLASH**
  - **CesrTA**
  - **…**

Resource Basis – Summary:

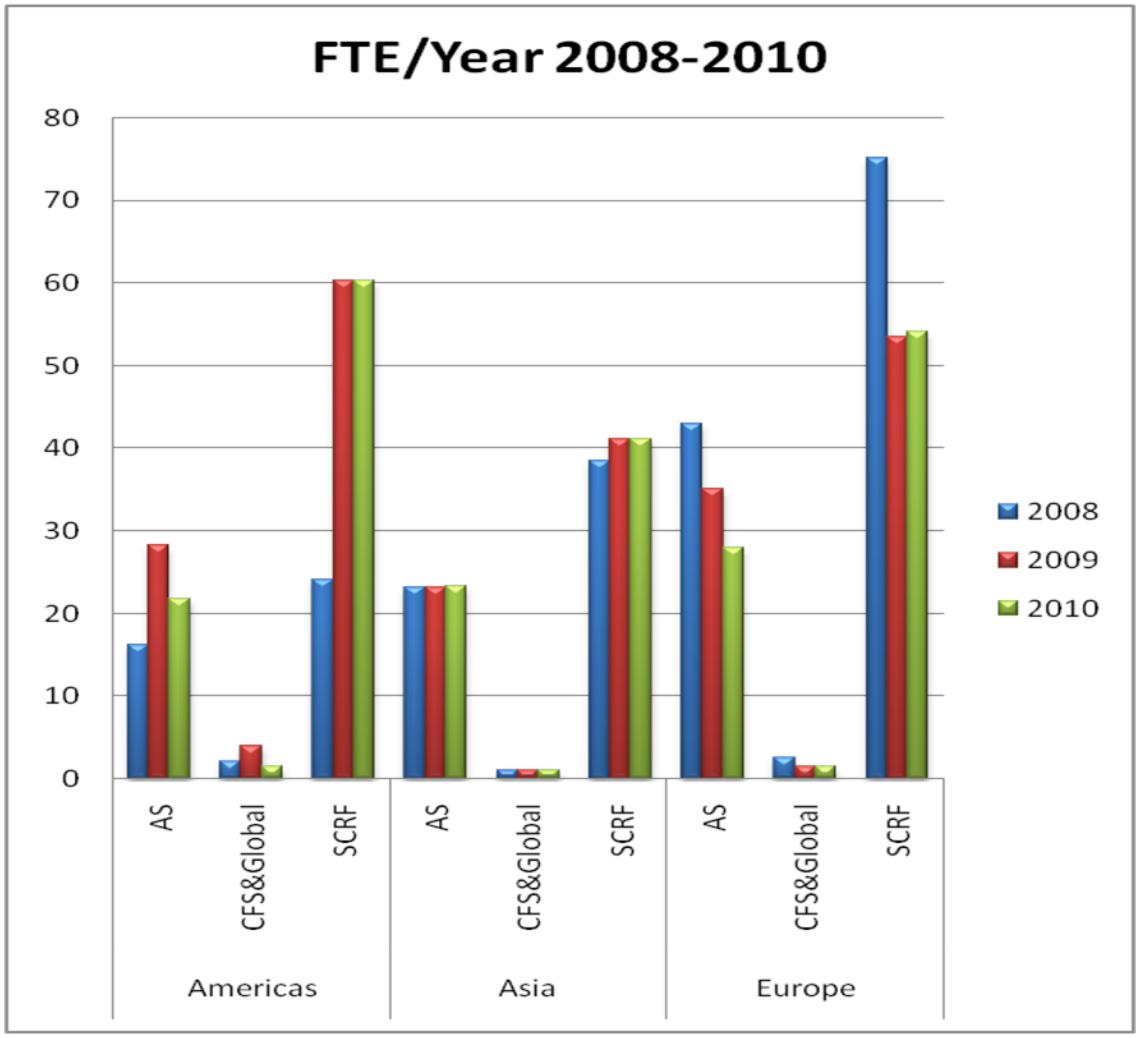
1. **ILC project preparation-specific funding**
   - **support for design and cost/risk reduction studies for the TDR**
   - ***GDE has substantial control***
2. **other project-specific funding (XFEL etc)**
   - **Resources defined through 'overlap' and 'synergy'**
   - ***Can be used effectively for technical R & D topics***
3. **generic R&D**
   - ***Resources targeted for the development of specific technologies***

1. Project Specific Support

- **Americas**
  - 'Regional Team' (ART): 35 M$/year
    - (consists of 1/3 M/S, 1/3 Labor, 1/3 Overheads)
- **EU**
  - FP7:10 M € (4 years)
    - ILC HiGrade – specific program sub-element
  - (only part of EU ILC program)
  - UK: ILC GDE leadership support
    - 11 FTE
- **Asia**
  - KEK: ~ 16M$ / year M/S (1.62 B Yen)

Each region provides ~ roughly equivalent resources

FTE Summary



- **Project – specific and 'synergetic' resources**
  - From each of above 3 basis categories
- **Includes "In-kind" R&D contributions**
  - No direct control in many cases
- **Totals (2010):**
  - SCRF 155
  - AS 73
  - CFS 4
- **CFS sub-critical**

The US ART program contains:

High gradient cavity development (JLAB/Fermilab/Cornell)
Cryomodule design and fabrication (Fermilab)
Electron cloud experimental program (Cornell +……)
Beam Delivery system design (SLAC)
Final focus & MDI (BNL, SLAC)
RTML (Fermilab)
Positron production (ANL, LLNL)
Electron source development (SLAC, JLAB)
Beam Test Facilities ATF2, FLASH (SLAC, ANL)
Conventional Facilities (Fermilab)

The ART R&D program is based on a $35M/yr constant effort budget and is planned through 2012 in conjunction with the GDE Technical Design Phase

Cavity Inventory

Americas

Tesla-shape nine-cell cavities		
Description	**No. Cavities**	**Status**
AES 1-4	4	tested
AES 5-10	6	received; testing in progress
AES 11-16	6	due Oct 2009
Accel 6-9	4	tested
Accel 10-17	8	received Mar 2008; testing in progress
Accel 18-29	12	due May 2009
Jlab fine-grain 1-2	2	fabrication complete; testing in progress
Niowave-Roark 1-6	6	due Oct 2009
Stimulus Procurement	xx	still in the planning stages; assume first cavities ~April 2010
Total	**48**	
Already Received	24	
Tesla-shape single-cell cavities		
Description	**No. Cavities**	**Status**
AES 1-6	6	tested at Cornell; further testing in progress
Accel 1-6	6	received Dec 2008; testing in progress
Niowave-Roark 1-6	6	received Jun 2008; testing in progress
PAVAC	4	requisition in progress
Total	**22**	
Already Received	18	

ART DOE FY09 Funding by System ($35M)

Americas

Program Element	$M	%
GDE & Lab Management	4.76	13.6
Electron Source	0.94	2.7
Damping Rings	2.61	7.5
Beam Delivery	4.69	13.4
Accelerator Physics	1.63	4.7
Global systems	1.73	4.9
RF Technology (SRF + systems)	16.81	48.0
Conventional Facilities	1.08	3.1
Contingency	0.44	1.2

Nominally ~ 100 FTE's

10 M € - 4 years

ILC-HiGrade Work Packages

EU

- WP1: Management of the Consortium 4%
- WP2: Integration and optimisation of the European contribution within the global GDE organisation as the ILC project moves through the GDE Engineering Design Phase 8%
- WP3: 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 8%
- WP4: Investigate features and develop possible schemes of governance for the ILC, exploiting expertise of CERN (LHC) and DESY (HERA) in international projects 9%
- WP5: Prepare and investigate possible European sites for ILC construction 4%
- WP6: Investigate and monitor the production process that yields high-gradient cavities with high yield. Establish the process in industry 40%
- WP7: Optimization of the coupler conditioning at reduced cost 14%
- WP8: Demonstrate suitability of tuner design in tests. Establish a cost-effective tuner production 11%

KEK JFY2009 – M/S

Asia

- **(Apr.2009-Mar.2010)**
  - Cavity-related 37%
  - HLRF/LLRF 27%
  - Other SCRF 17%
  - ATF/ATF2 10%
  - Management 10%

  Total 16.17 * 10^8 Yen

- **Note:**
  - Includes budgets for generic accelerator R&D
  - Expect (at high possibility) supplement budget within this FY

2. Other projects:

- **EU – XFEL**
  - Substantial overlap with GDE objectives
  - 101 cryomodules
    - Order to be processed starting 2009
  - Very close to ILC spec
  - Operational in 2013 - 2014
  - Conventional work underway
  - ~ 700 M € project

2. Other projects

- **Asia – 'Quantum Beam Project'**
  - Development of compact light source using SCRF
  - Substantial overlap
  - 2.7 M / year for 5 years
- **America – Project X at Fermilab: R&D only**
  - Substantial overlap
  - 5.4 M / 32 FTE-years
  - 4 years 2009 – 2012

3. Generic SRF R & D Resources

- **US ‘SRF’ program**
  - Specific goals with direct connection ‘string test’ program
  - ~25 M / year
- **KEK infrastructure development**
  - Strong, direct support for ILC string test goals
- **EU ‘CARE / EUCARD’ FP7 program**
  - 8 M € for 4 years
  - Largely academic, varied
  - Not directly linked to ILC goals and schedule

FNAL SRF Program

Americas

Mission:

- **Develop SRF infrastructure at FNAL and perform R&D to master the technology for future accelerator projects (e.g. ILC or Project X)**

Goals:

- **Master fabrication & processing of cavities & cryomodules**
- **Build SRF infrastructure that is difficult for industry to provide**
  - Large cryogenic & RF systems, cavity & cryomodule testing systems, etc.
- **Operate facilities to acquire required expertise**
- **Transfer SRF technology to U.S. industry**
- **Participate in national & international collaborative SRF R&D**

SRF R&D Scope of Work

Americas

- **Develop & Operate SRF infrastructure**
  - Joint ANL/FNAL Processing Facility
  - Vertical Test Systems (VTS)
  - Cavity & Cryomodule Assembly Facility (CAF)
  - Horizontal Test Systems (HTS)
  - RF unit Beam Test Facility (ILCTA_NML)
  - Stand-alone Cryomodule Test Stand (CTS)
- **Purchase cavities (ILC only provides cryomodule parts)**
- **Provide infrastructure for generic SRF Material R&D**

- **FNAL SRF infrastructure plan reviewed by DOE in Feb 07**
  - Focused on infrastructure for ILC 1.3 GHz elliptical cavities
  - Changing scope… now support industrialization of SRF
  - Revised U.S. HEP priorities include Project X @ FNAL and ILC on a slower time line… but large overlap of Px and ILC goals
-

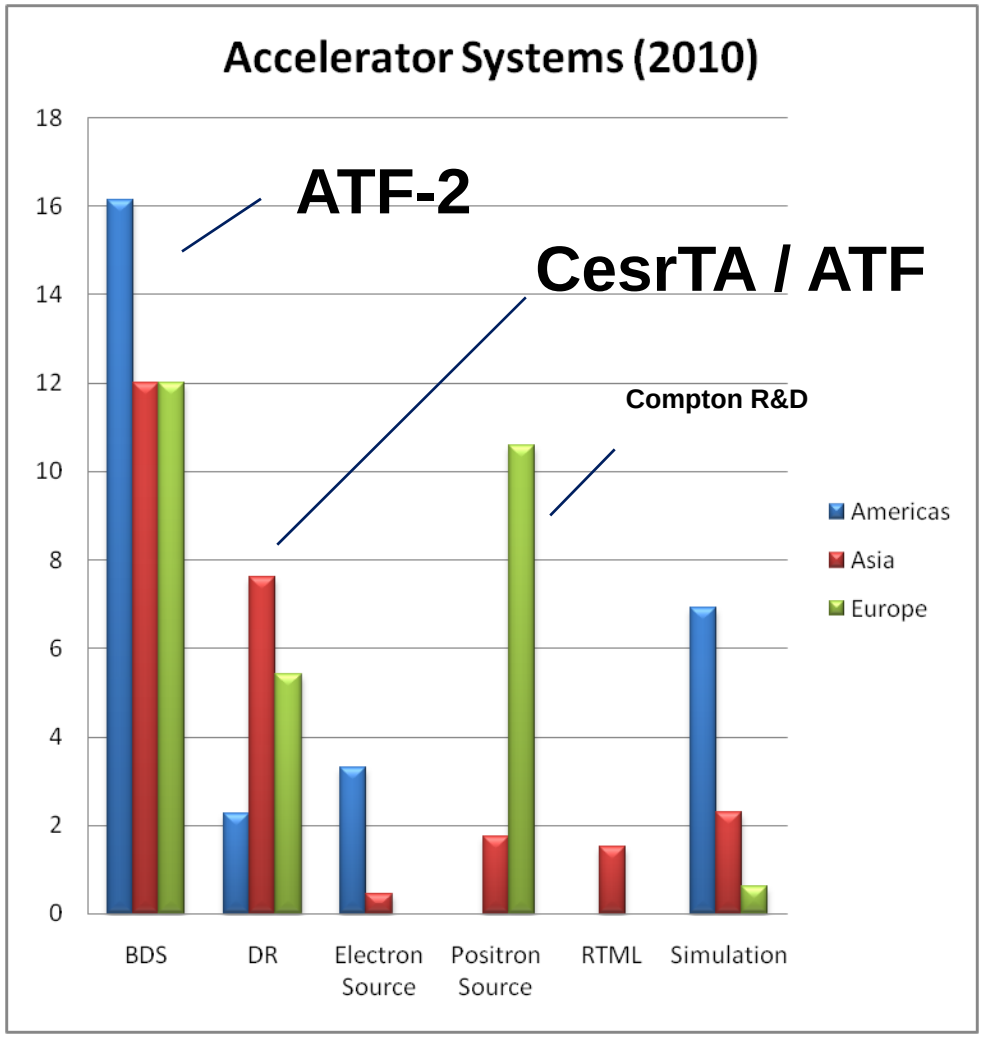
- **Related SRF programs include Project X, HINS, and 3.9 GHz R&D**

Infrastructure Resources – Testing and Processing

- **Asia**
  - STF Processing Facility
  - ATF / ATF2 Beam Test Facility
- **EU**
  - DESY Processing Facility +
    - (XFEL Production facilities – CEA and IN2P3)
  - TTF2 / FLASH
- **Americas**
  - JLab, Cornell, FNAL / ANL Processing Facility
  - Cesr Test Accelerator →

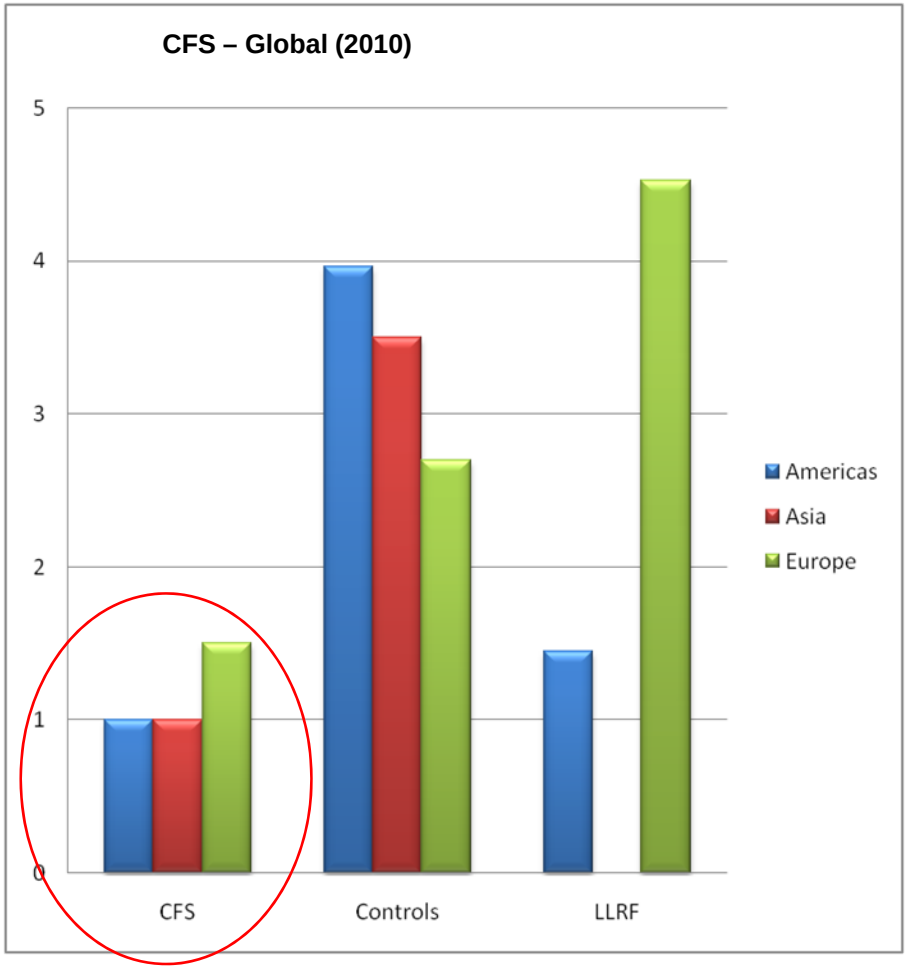
Each region has ~ roughly equivalent infrastructure in use or under development

Accelerator Systems



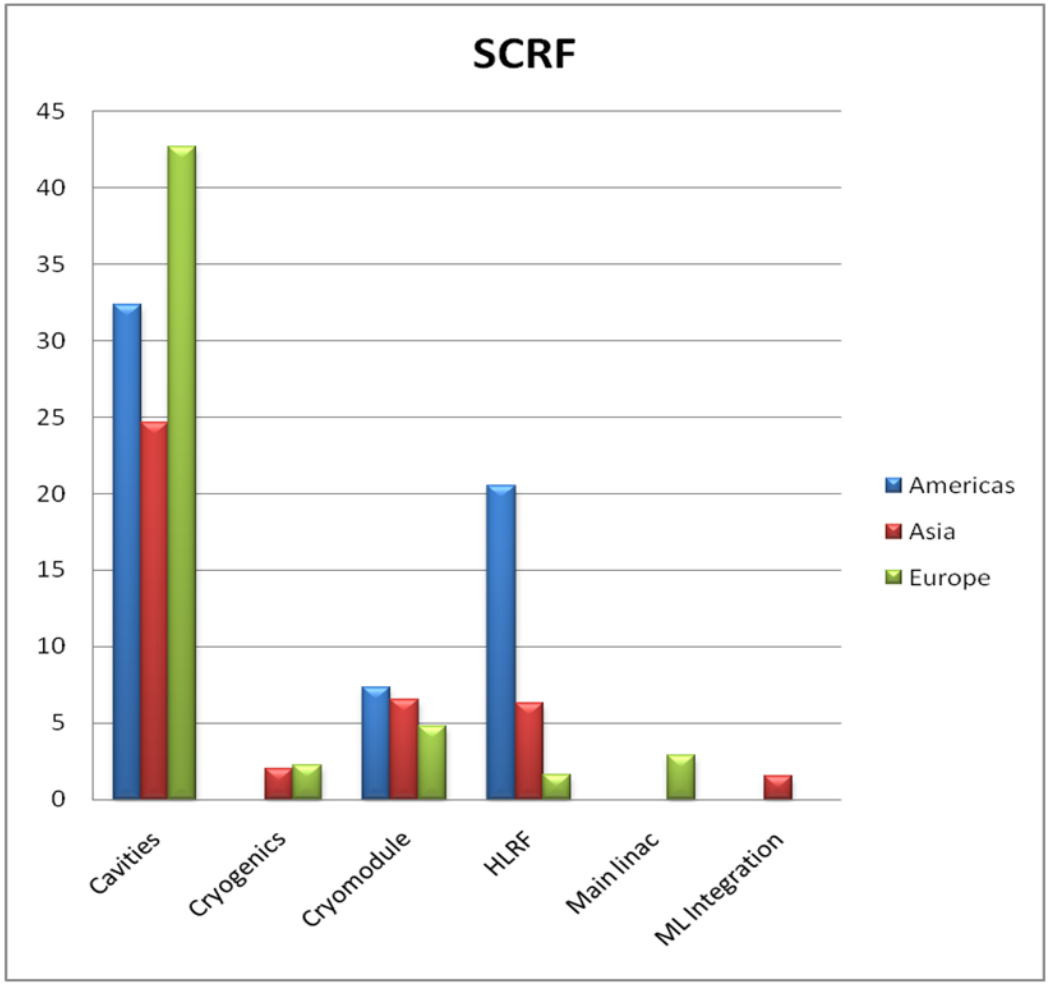
- **AS systems dominated by R&D**
- **Beam Test Facilities are focus**
  - Stated TD Phase priorities
- **Design and Cost Estimating resources?**

CFS & Global



- **CFS probably our biggest resource challenge**
  - US M&S funds available for consultants
    - Not indicated on this plot
    - Additional ~4 FTE
- **Note: major cost driver**
  - VALUE Engineering for cost reduction

SCRF (2010)



- **SCRF resource dominant across all regions**
- **Focused on on-going R&D programmes**
  - Cavity R&D dominates
- **Primary cost driver. Cost update for TDP-2 critical**
  - Understand how we work towards updated estimate
    - Plug compatibility
    - Mass production models
    - Regional industrial input
    - (XFEL update from Europe)

R & D Resources Summary (1/2)

- **Best knowledge of ILC resource base in given in R&D Plan tables**
  - (last release Feb 2009 – to be updated June 2009)
- **In many cases numbers are inclusive and reflect our 'in-kind' R&D contributions philosophy**
- **This is OK for current TDP activities**
  - Important to keep as large as possible R&D community linked to ILC GDE effort

- ***Critical-path activities are covered (S0, e-cloud etc.)***

- ***Positron and CFS notable exceptions***

R & D Resources Summary (2/2)

- **Assuming "flat" global resources 2010 and beyond**
- **Planned critical R&D will continue to absorb most of this**
- **Design, Integration and Costing activities for updated design:**
  - Important management task for TDP1 to evaluate available "design" resources
  - Will need to 'restore' RDR technical groups at some level
- ***Will have impact on TDP (TDR) scope.***
  - *Must depend on RDR basis of estimate*
  - But existing data will be reviewed
  - Migrating to new cost tools (ICET)

Challenge:

- ***Managing resources not fully within project control***

Key points:

1. **Base for technical R & D is strong and growing**
   - And well aligned with lab activities
     - Overlap / Synergy discussions difficult (but not impossible)
   - Facilitated in part through ‘plug – compatibility’
2. **We must balance technical R &D with ongoing project – specific activities**
3. **Two time scales define the task:**
     - TDR in 2012 → well defined milestone
     - Project start → ?