ILC R&D Planning

Timeline, Technical Organization, & R&D goals

Global R&D Planning

Americas Region R&D

BIG R&D program elements

Highly Leveraged (small) R&D program elements

Potential Resources

How to get involved: DOE institutions

How to get involved: NSF institutions

Timeline

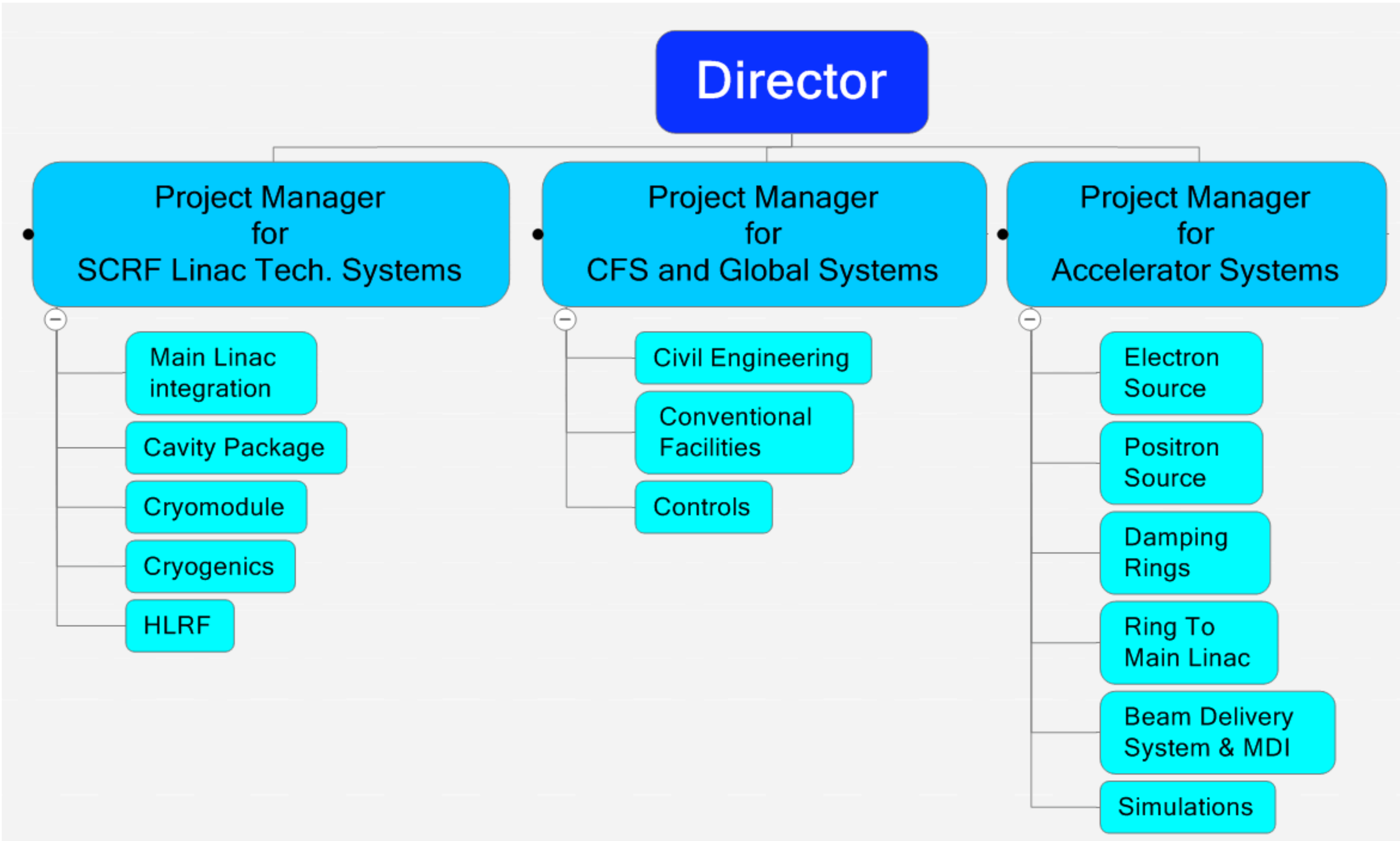
The Reference Design & cost estimate + associated technical reviews has been formally presented to the international funding agencies (FALC 3 weeks ago in Rome) and will be presented to ICFA/ILCSC in August (Korea - Lepton Photon conference). This will end this phase of the project (after 2+ years of work).

The GDE is now in the process of restructuring itself and making plans for the engineering design phase, leading to the completion of the ILC Engineering Design phase in 2010.

- Engineering design report
- R&D Program
- Tech transfer to US industry
- Updated Cost Estimate
- Siting Requirements -> bid to host
- + management elements & value engineering

Consistent with construction start in ~ 2012

Technical Organization



Technical programs determined by L3 managers + Project management troika

R&D Goals - DOE's View (HEP 5 year plan)

- The proposed International Linear Collider (ILC), HEP's highest priority, is expected to provide a far deeper understanding of the unification of forces, the origin of mass, and the character of the dark matter pervading the universe. Its precision would allow a much sharper understanding of discoveries made at the Large Hadron Collider (LHC), now under construction at CERN. The Department has expressed its interest in *siting the ILC at Fermilab* should it be built and the United States be chosen as the host country. *The out-year profile includes support for technology R&D activities aimed at various technical design goals while reducing project risk and cost to support an international decision-making process near the end of this decade.* A future decision to proceed with construction rests on two conditions: *the ILC is deemed a priority and affordable by its international partners; and the anticipated new science at the ILC is supported by clear physics results at the LHC.*

R&D Goals - GDE Americas Region

- Validate the baseline design technical parameters
  - An example of this would be the cavity/cryomodule gradient & yield
  - Damping ring bunch spacing
  - Final focus quads
- Develop alternate designs that lead to improved performance and/or reliability
  - Cavity shapes
  - V4 cryomodule
  - Sheet beam klystron
- Develop alternative designs that lead to lower costs
  - Marx modulator
- Develop designs that lead to an improved accelerator design
  - SC RF photocathode gun

Global R&D Planning

During the Reference design the GDE set up an R&D Board (Bill Willis, chair) and a series of task forces for the various major technical elements:

- S0: Cavities
- S1: Cryomodules
- S2: SCRF System tests
- S3: Damping Rings
- S4: Beam Delivery System
- S5 Positrons
- + …….

As part of the reference design activities the task forces output effectively became an R&D plan. This was reviewed by the ILC MAC. The plan while comprehensive tended to focus on establishing the baseline. There is still room for ideas in the alternate design area & tech development in the baseline.

For example the global SC Cavity Plan

Cavity (S0) Task Force:

–Achieve 35 MV/m in 9-cell cavity in vertical dewar tests (low-power) with a sufficient yield (> 80%)

–Staged approach with intermediate goals to track progress

Task Force Assumptions for regional cavity production

		KEK			US			EU						
		2007	2008	2009	2007	2008	2009	2007	2008	2009	Sum over 2007-2009	Cost Fabrication	Cost Processing	Cost Sum
	pessimistic	8		24	14	20	20	30	20	30	166	12450000	5810000	18.260.000,00 €
	realistic	8		24	14	24	30	30	30	60	220	16500000	7700000	24.200.000,00 €
S0	**optimistic**	10		24	14	24	48	30	30	60	240	18000000	8400000	26.400.000,00 €

Americas Region R&D

- The Americas region is involved with varying degrees of intensity in most aspects of the ILC R&D program.
- The major R&D programs are based at the national labs with Fermilab, SLAC and then everyone else.
- What determines the Americas R&D Program?
  - Alignment with the global R&D program
  - Strategic interest. If we wish to host the ILC then we must demonstrate we have mastery of SCRF technology. This is one major goal of the Fermilab program.
  - Unique capabilities. Things we can do that no-one else can.
  - Global competitiveness. Developing cutting edge industrial capabilities through tech transfer. ACI. Government looks for more than science.
  - Lab & University individual interests and ideas
  - National HEP priorities -'thou shalt do this'
  - Available resources - duh

Americas Region R&D

Main Linac Cavity and Cryomodule

Shekhar Mishra, Hasan Padamsee

(WBS X.9 Managers: Shekhar Mishra, Hasan Padamsee, John Mammosser and Mike Kelly)

Abstract

This document describes the US program for the International Linear Collider (ILC) Main Linac cavity and Cryomodule R&D and related infrastructure development the US plans to carryout in FY08-09. This program has been developed jointly with the American Regional Team (ART) of the Global Design Effort (GDE) and members of the LCSGA Ozaki regional interest panel. The plan is focused on the highest priority ILC R&D as defined by ILC R&D Boards while developing US as a "Credible" and "Qualified host of ILC". The program will be implemented as a collaboration of U.S. institutions already involved in SRF R&D and will expand to include new collaborators. A strong international collaboration with DESY, the TESLA Technology collaboration (TTC), INFN, KEK, STF collaborations is also an integral part of this plan.

US Cavity/Cryomodule R&D planning - April 07

BIG Program elements e.g. CESR - TA

Highest R&D priorities ILC Damping Rings (S3 task force)

- Lattice Design for positron ring
- Lattice Design for electron ring
- *Demonstrate < 2pm vertical emittance* *(CesrTA <5-10pm for positrons)*
- Characterize single bunch impedance driven instabilities
- *Characterize electron cloud build up*
- *Develop electron cloud suppression techniques*
- *Develop modeling tools for electron cloud instabilities*
- *Determine electron cloud instability thresholds*
- *Characterize ion effects*
- *Specify techniques for suppressing ion effects*
- Develop a fast high power pulser

- Goal of GDE to produce Engineering Design Report by 2010 and that depends on outcome of R&D

CESR Facility

CESR Layout / Injector

Cornell University
Laboratory for Elementary-Particle Physics

e+/e- colliding beams 1.5-5.5 GeV

Circumference 768 m

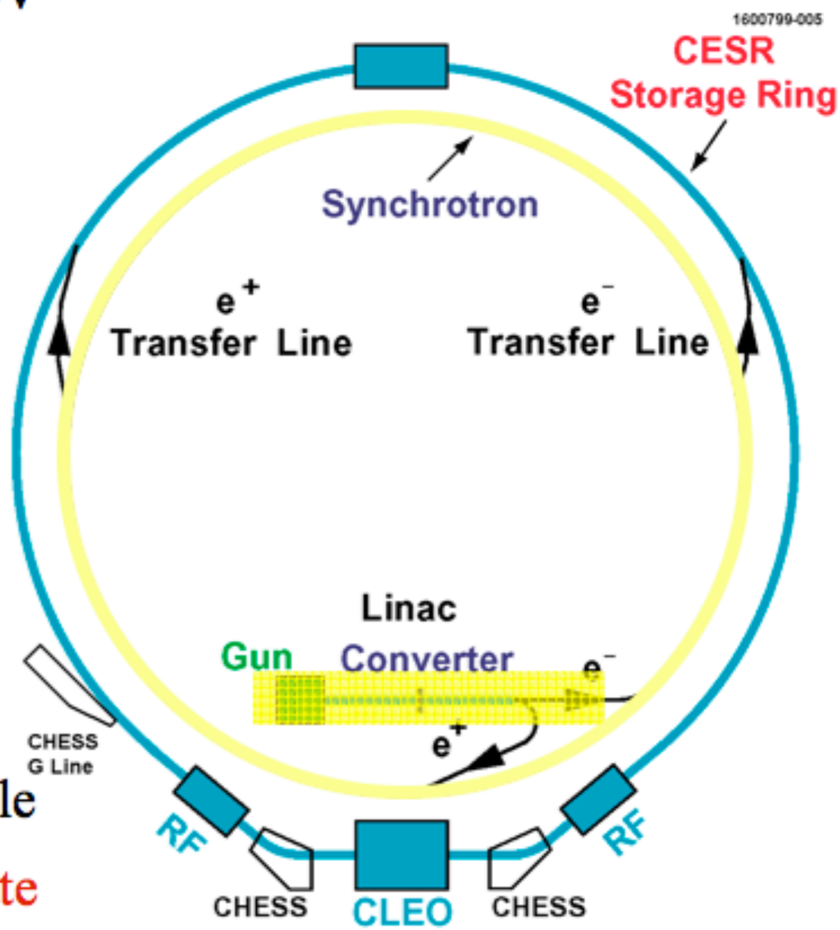
45 bunches/beam in trains, electrostatic separation

Currents in CESR to
2x350 mA @ 5.3 GeV
>1x150 mA @1.9 GeV

120 keV gridded gun
150/300 MeV linac
Full energy synchrotron (60 Hz)

Flexible timing, ~20 bunches/cycle

Filling rates to 100/300 mA/minute



CESR TA Technical Goals

- Propose to address a number of S3 R&D priorities with CESR configured as a test accelerator
  - Characterize electron cloud build up in dipoles, quadrupoles, drifts and especially ILC-like damping wigglers using RFA and collectors
  - Develop and test e-cloud suppression techniques, finned chambers, coatings, clearing electrodes.
  - Test suppression techniques at 5GeV in ILC-like wigglers under ILC-like synchrotron radiation load
  - Measure dependence of tune shift, emittance dilution, dipole instability, etc. on bunch configuration (bunch spacing, bunch charge, train length), beam energy
  - Measure emittance dilution as a function of electron cloud density.
  - Characterize ion effects by comparison of bunch by bunch mode spectra, tune shifts, emittance dilution, etc. for positrons and electrons
  - Test ion suppression techniques
  - Develop beam based emittance tuning techniques

    Demonstrate 5-10pm emittance for both electrons and positrons

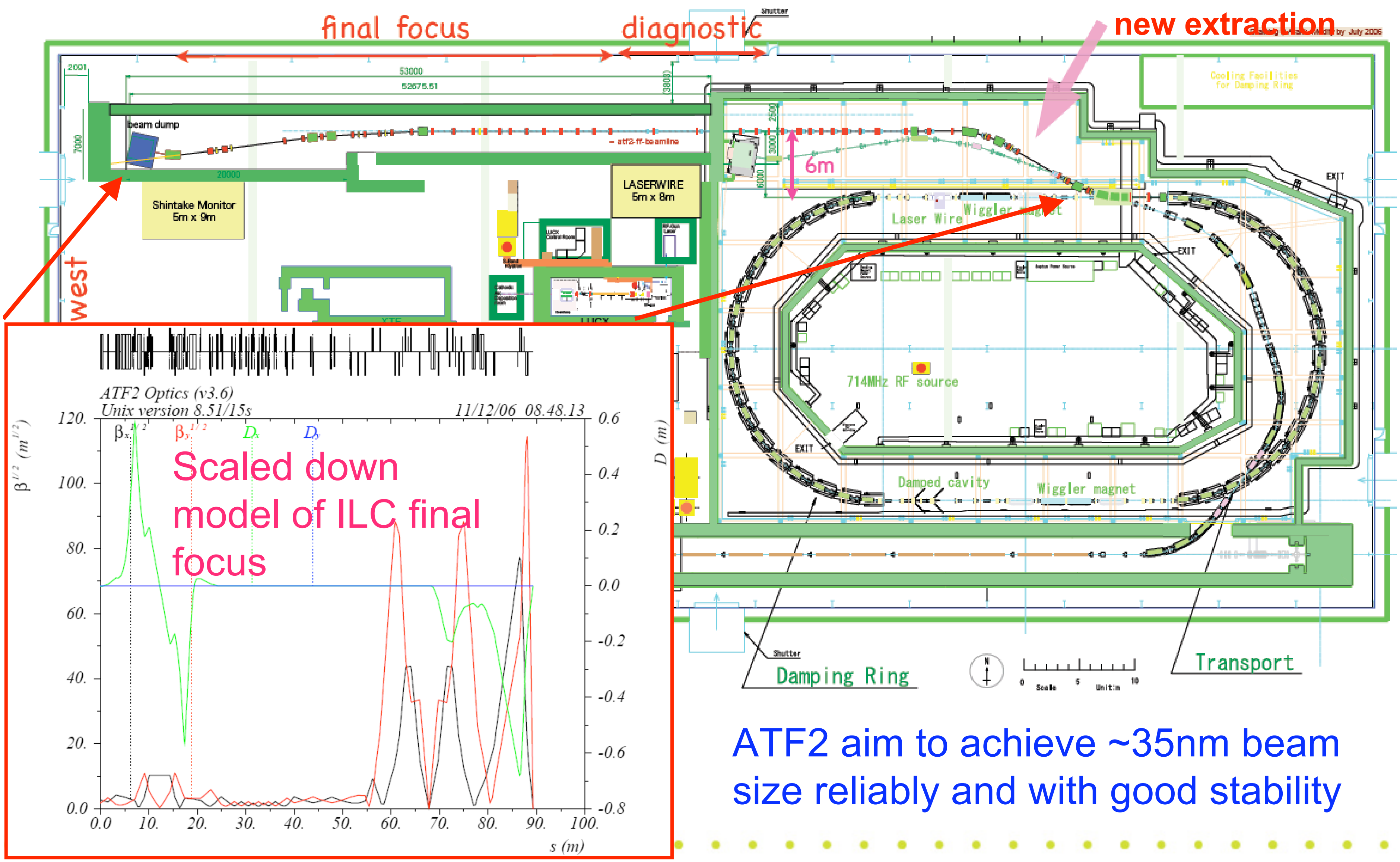
$42M over 4 years

CESR TA Collaborators

Table 4: Present plans for CesrTA collaboration for ILC damping ring research.

Collaborators	Institution	Topic
M. Pivi and L. Wang	SLAC	Electron cloud studies, wiggler chambers for electron cloud suppression
Y. Cai and PEP-II Beam Physics Group	SLAC	Machine correction and ultra low emittance tuning
A. Reichold and D. Urner	Oxford	Alignment and survey requirements and upgrades
S. Marks, R. Schlueter and M. Zisman	LBNL	Wiggler chambers for electron cloud suppression
C. Celata, M. Furman and M. Venturini	LBNL	Simulation of electron cloud in wigglers
A. Molvik	LLNL	Electron cloud measurements
J. Byrd, S. de Santis, M. Venturini, and M. Zisman	LBNL	Wiggler and electron cloud and FII studies
K. Harkay	ANL	Electron cloud measurements
K. Ohmi, J. Flannagan, N. Ohuchi, M. Tobiyama, Y. Suetsugu and K. Shibata	KEK	Electron cloud measurements and simulation
P. Spentzouris, J. Amundsen and L. Michelotti	FNAL	Beam dynamics simulations and measurements
A. Reichold	John Adams Inst.	Automated Survey Techniques
A. Wolski	Cockcroft Inst.	Machine correction and ultra low emittance tuning
R. Holtzapple	Alfred Univ.	Instrumentation and beam measurements
J. Urakawa	KEK	R&D program coordination
L. Schächter	Technion-Haifa	Electron cloud measurements and analysis

Big Program elements e.g. ATF 2



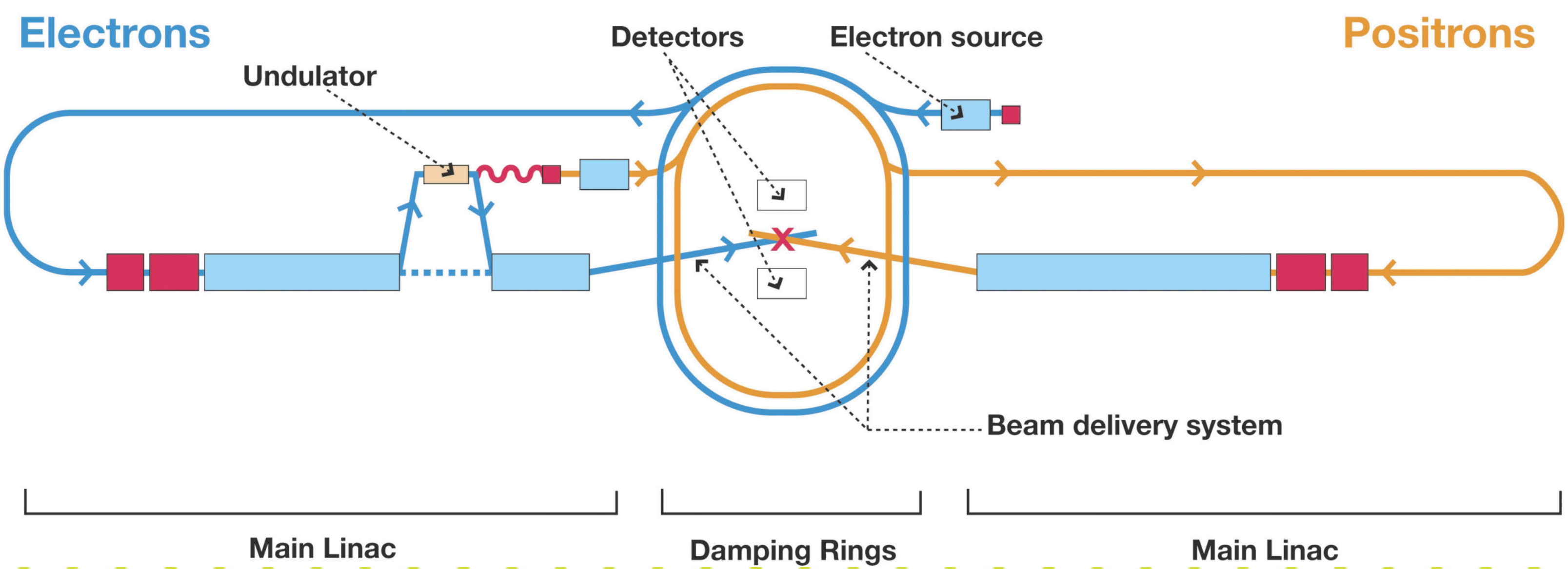
ATF2 aim to achieve ~35nm beam size reliably and with good stability

ILC R&D - Large Collaborations

- ATF2 is a project within ATF collaboration
- ATF MOU already signed by 19 labs and universities from 9 countries
- The ATF2 proposal was authored by 110 people from 25 organizations
- ATF2 will:
  - prototype FF, help development tuning methods, instrumentation (laser wires, fast feedback, submicron resolution BPMs), help to learn achieving small ~35nm size & stability reliably, and be a facility to train experienced accelerator physicists
- ATF2 is a central element of BDS EDR work, as it will address a large fraction of BDS technical cost risk
- ATF2 constructed as ILC model, with in-kind contribution from partners and host country providing civil construction
- ATF2 commissioning will start in Autumn of 2008

ILC R&D: Superconducting RF Electron Gun

Continued gun development over the past several years has resulted in the potentially intriguing (i.e. supported by simulations) possibility of a high brightness-low emittance source. This raises the spectre of replacing the electron damping ring and associated transfer line with a much cheaper & simpler solution.



Superconducting RF Electron Gun

Polarised electron guns require ceasitated Ga-As cathode which extremely sensitive to vacuum environment (< 10-11 torr for good lifetime).

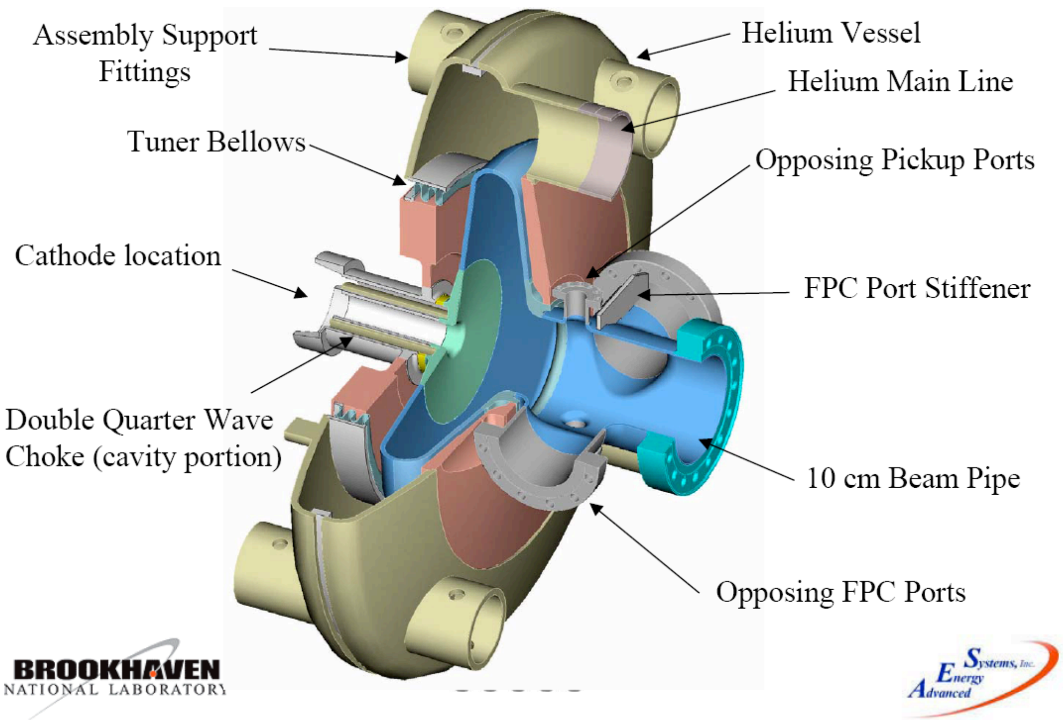
The necessary low emittance & bunch charge for the ILC cannot be produced by a DC gun. RF gun solves this problem by providing a high electric field/energy gain.

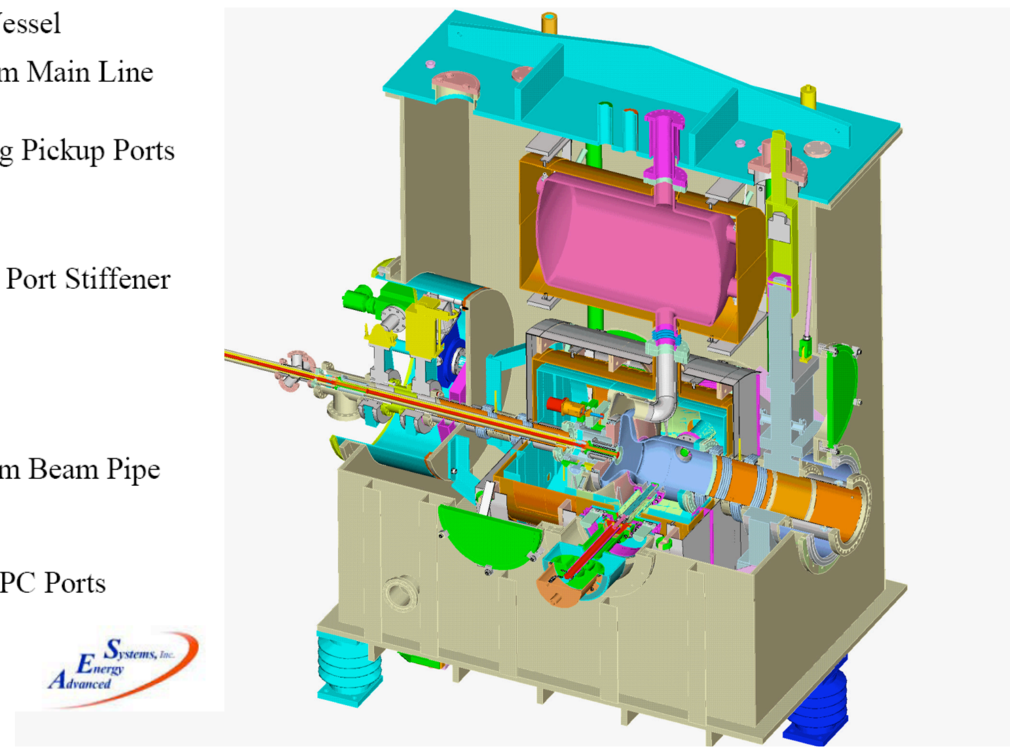
The SC nature of the gun solves the vacuum problem as well as allowing for long pulse train operation. Requires 2K.

Two elements of the R&D program (in order):

1. Vacuum properties
2. High brightness - flat beam (1000:1), bunch intensity, polarization

SC RF gun design





Real work !

Resources: Office of HEP Funding 5-year plan

High Energy Physics (HEP)

	B/A (dollars in thousands)					
	FY 2006 Approp.	FY 2007 Request	FY 2008	FY 2009	FY 2010	FY 2011
User Facility Operations	309,139	308,647	277,000	241,400	215,000	215,000
Construction	—	10,300	18,900	51,200	43,500	26,100
Research	407,555	456,152	489,100	517,400	631,500	733,900
Total, HEP	716,694	775,099	785,000	810,000	890,000	975,000

As always the out year profiles (2010/11) look wonderful

Resources: US ILC Funding

- FY06 $33M
- FY07 $42M (+ SRF generic $~25M Fermlab base)
- FY08 $60M + SRF generic $23M (presidential)
- FY09 OHEP guidance for ILC $90M -> $135M

This is a significant amount of support though only a fraction (~1/3 ?) is R&D spending

Some NSF support via a 3 year R&D program at the level of $250K or so. This program will finish in 2007. We are currently discussing the next phase with NSF.

Phase II SBIR's - up to $900K over 2 years

DEPARTMENT OF ENERGY
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
AND
SMALL BUSINESS TECHNOLOGY TRANSFER PROGRAM
FY 2007 PHASE II AWARDS BY TOPIC

TOPIC: ACCELERATOR TECHNOLOGY FOR INTERNATIONAL LINEAR COLLIDER

Advanced Energy Systems, Inc.
27 Industrial Boulevard
Unit E
Medford, NY 11763

Superconducting RF Photocathode Gun for Low Emittance Polarized ELectron Beams

This project will develop an advanced electron source that should provide substantial cost savings in future linear colliders. It should also hasten the arrival of next-generation light sources for research, security and medical imaging, and industrial processing.

Diversified Technologies, Inc.
35 Wiggins Avenue
Bedford, MA 01730

Fast Kicker Driver for International Linear Collider Damping Rings

The major thrust of this effort is to develop and demonstrate technologies which will move the International Linear Collider into reality - by enabling precise kicker operation needed for bunches of electrons and positrons to compress and then collide. A secondary benefit of this effort will be the development of reliable, solid-state kicker pulsers which can meet the needs of a wide range of existing and planned accelerators and colliders worldwide.

www.science.doe.gov/sbir

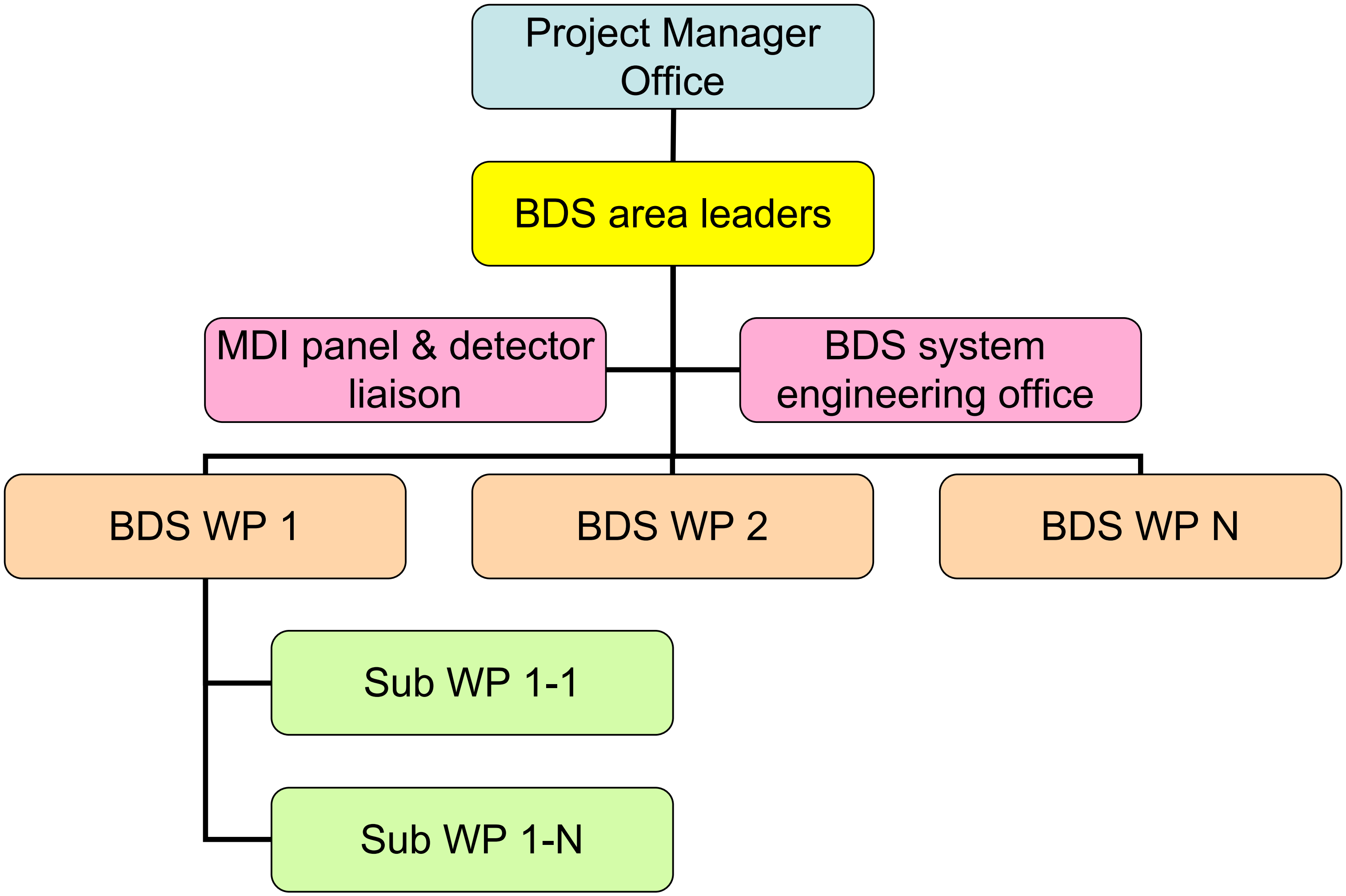
How to get involved

- The Level 3 managers are breaking down the scope of the engineering design phase into a series of work packages. These work packages will include the R&D tasks. Packages will include scope, schedules, milestones and necessary resources.
- Not all work packages are R&D related
- Institutions or collaborations will volunteer for these tasks.

This, of course, sounds easy but isn't. In order to 'volunteer' then there must be an tacit agreement with the GDE L3 and what ever ILC institutional management is in place. Then there needs to be assurance that the task can be funded. This, in most cases, will perforce involve ART management i.e. me. I suspect that this will require a degree of iteration with all the involved parties

- Assigned work packages will be described by an MoU between the institution and the GDE (possibly the agencies in some way).

Work Packages - Example of the Beam Delivery System



Work Packages - Example of the Beam Delivery System

- BDS instrumentation
  - Alignment system design
  - Design deflecting y-t cavity
  - Design OTR monitors
  - Design PMT & ion chamber loss monitors
  - Design polarimeters
  - Design X synch light profile monitor
  - Design of BDS BPMs
  - Design of BPM based energy spectrometer
  - Design of feedbacks
  - Design of laser wires
  - Design of SR based energy spectrometer
  - Study energy spectrometer at ESA
  - Study second.beam eff. on fdbk BPMs at ESA

How to get involved: DOE program

US technical managers have identified the level of manpower needed in the R&D program. The funding to support this manpower is provided through the normal DOE funding channels into the national lab program.

Thus if you are in the staff of a national lab then contact the appropriate technical manager or institutional program lead.

If you are part of a DOE supported university program then it is recommended to collaborate on a national lab work package. (National labs tend to understand accelerator R&D better than universities). Funding would either come as pass-thru from the labs or directly from the DOE.

How to get involved: NSF program

- The NSF has agreed to support the engineering phase R&D activities. They have asked that all ILC machine R&D proposals be bundled into a single request. George Gollin has agreed to act as PI for this umbrella proposal. The time scale for this is ~ October.
- The next steps roughly follow the same process as the DOE ones: talk to L3 managers about the work packages and iterate with the custodians of the resources to make sure that the request is reasonable.
- One assumes that since this is the NSF then there will be some form of technical appraisal before any form of approval.

Summary

- We are planning the ART R&D program for the ILC engineering design phase (now -> 2010)
- This program will be part of the global effort
- Guiding principles involve baseline validation, risk reduction, design improvements and cost reduction
- Technical direction via project management and L3 managers