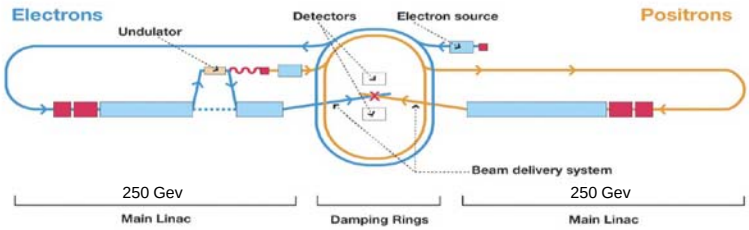
Americas

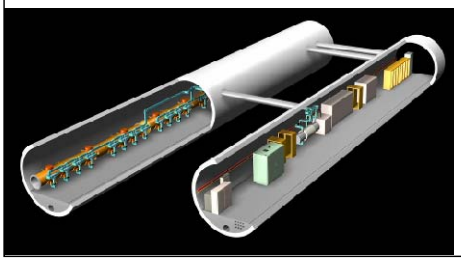
ART Program Overview

- US Program
  - ART Program Goals
  - ART Management/Strategy
  - GDE Role
- ART Program – FY09 -> 2012
  - R&D Plan deliverables
  - FY08/09 status
  - FY10
- Synergies
- Issues
- Charge & Agenda
- Conclusions

Americas

ILC Baseline Design





e+ e- Linear Collider

Energy	250 Gev x 250 Gev
Length	11 + 11 km
# of RF units	560
# of cryomodules	1680
# of 9-cell cavities	14560

2 Detectors push-pull
2e34 peak luminosity
5 Hz rep rate, 1000 -> 6000 bunches per cycle
IP spots sizes: σ_x 350 – 620 nm; σ_y 3.5 – 9.0 nm

Particle Physics Project Prioritization Panel (P5) – Strategic 10 year plan, June 2008

"Whatever the technology of the future linear collider, and wherever it may be located, the US should plan to play a major role. For the next few years the US should continue to participate in the international R&D program for the ILC. This R&D will position the US for an important role should the ILC be the choice of the international community"

- **"The panel recommends for the near future a broad accelerator R&D program for lepton colliders that includes continued R&D on the ILC at roughly the proposed FY2009 level in support of the international effort"**

This is about as close to a mission statement that ART possesses. On the basis of this recommendation the ART budget for FY09 was established at $35M

ART Program Strategy

- The US ART program should be optimized to:

1. Support the Global Design Effort (GDE) goals (international collaboration)
2. Position the US optimally to make contributions consistent with the US HEP community priorities (future program)
3. Consistent and synergistic with our US lab plans & programs (intrinsic merit)

Not what one would term a completely crisp or consistent set of criteria. More like a virtual lab rather than a 'project'. An interesting management situation.

The ART program is integrated into the GDE Technical Design Phase which runs until 2012 and has the goal of Project Proposal.

Americas

ART Program contributions to the GDE

The US ART program contains:

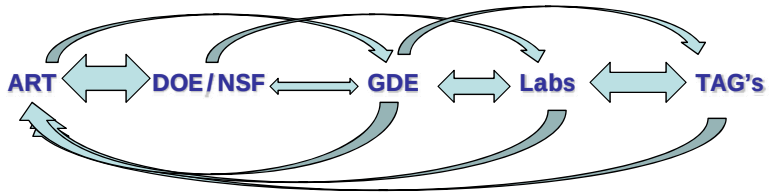
- High gradient cavity development (JLAB/Fermilab/Cornell)
- Cryomodule design and fabrication (Fermilab)
- Electron cloud experimental program (Cornell +……)
- Beam Delivery system design (SLAC)
- Final focus & MDI (BNL, SLAC)
- RTML (Fermilab)
- Positron production (ANL, LLNL)
- Electron source development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

Americas

ART Program – Program Development

Recent ART Program development has relied on an iterative process



Difficult to be precise about exactly how the priorities are established in ART but it involves multi-lateral discussions at several levels

Program management (cost & schedules etc..) follows the lab line management with ART (and then agency) oversight

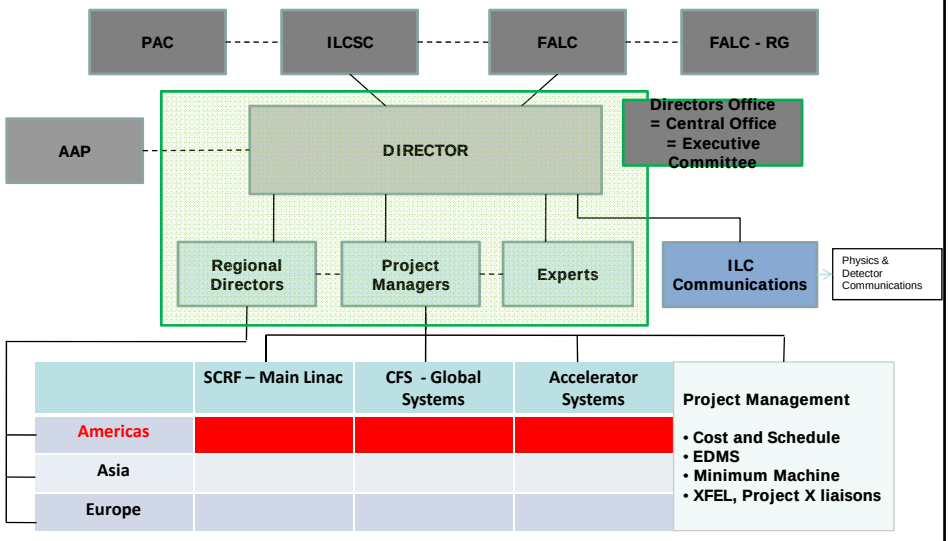
Americas

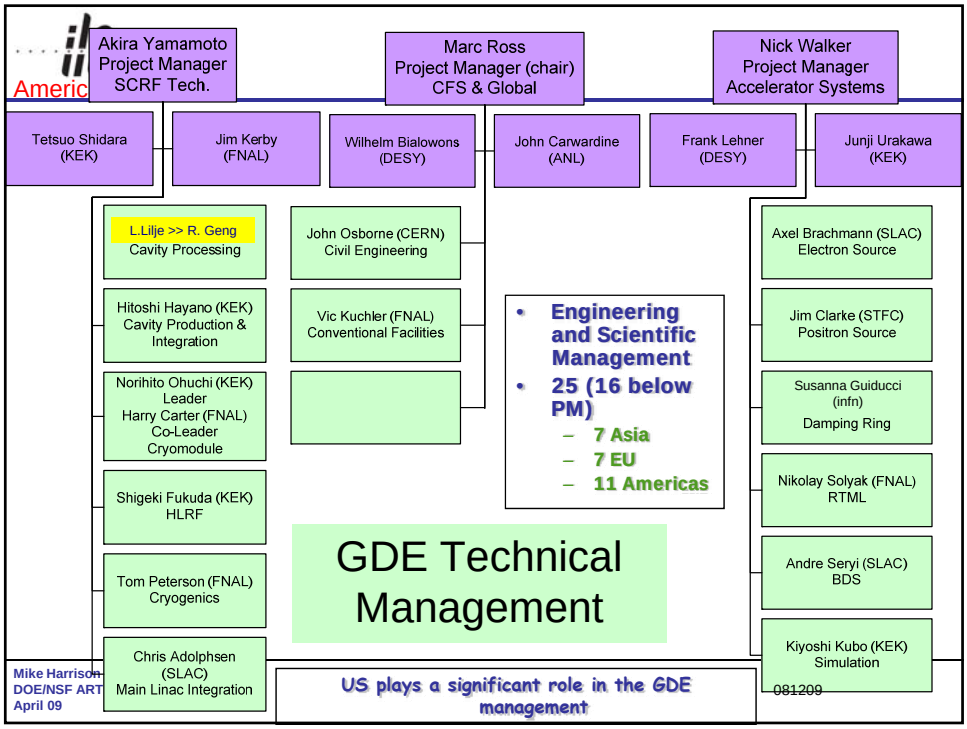
ART Management Process

- Annual program scope documented at the lab level together with milestones at the beginning of the fiscal year i.e. goals for this year. This is in the context of a multi-year US R&D plan. The detailed program is determined on an annual basis.
- SRF Cavity program co-ordinated nationally (Mark Champion)
- Monthly (ish) conference calls with the national lab senior managers
- ART Face-to-Face meetings at the GDE bi-annual meetings
- Labs visits by ART management (MH) + Marc Ross when possible. These discussions are both technical and management. Fermilab (ANL) – monthly, SLAC – quarterly, JLAB – biannual, BNL - monthly, Cornell – biannual. TRIUMF – annually.
- Weekly GDE Executive Committee conference calls. EC face-to-face meeting every few months
- Bi-annual reports from the labs
- Germantown meetings every ~ 2 months with OHEP, NSF briefings bi-annual.

Americas

GDE Global Organisation





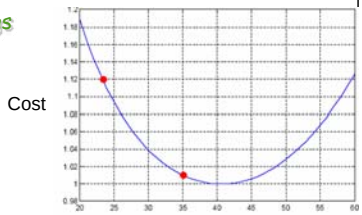
ILC Global R&D Program

What are the drivers for the global program ?

Cost Risk
- Main Linac RF systems (cavity gradient & yield, cryomodules, HLRF etc..
- Conventional construction/facilities

Technical Risk
- Electron cloud effects in the damping rings
- Beam delivery system (small beams)

Production Risk (industrial involvement)
- Technology transfer
- Volume production



Optimize the baseline design

GDE: meetings include bi-annual project (LCWS, ALCPG09), topical (TTC) & programmatic.

Mike Harrison
DOE/NSF ART Review
April 09

The ART Program – High Level

The present US program:

- SRF Development(~50% of total effort, R&D & technology)
- Beam Delivery System (~14%)
- Damping rings (~8% thru FY10 + NSF for Cornell Ops)
- Accelerator physics, Electron Source, CFS, Controls (~15%)
- GDE & lab management (14%)

There is no ART organisation chart per sec, we are matrixed into the national labs. The ART management team:

SLAC:	Nan Phinney
Fermilab:	Bob Kephart
JLAB:	Bob Rimmer
ANL:	Rod Gerig
LBNL:	John Corlett
BNL:	Brett Parker
LLNL:	Jeff Gronberg
Cornell:	Mark Palmer

US ART Program – SRF technology

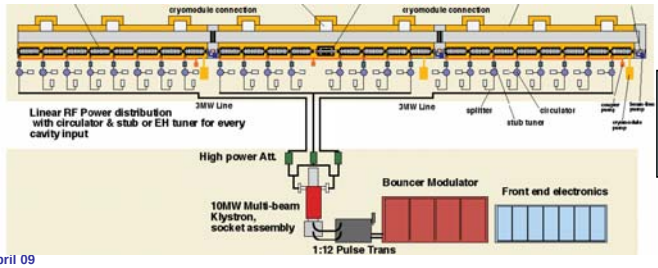
- Cavities – Fermilab, ANL, JLAB, Cornell
- Cryomodules – Fermilab
- HLRF Systems – SLAC
- LLRF Systems – Fermilab, ANL, SLAC

Americas

ART R&D Program Deliverables (2012)

The highest priority activity in the ART program is SRF development which represents 50% of the total effort. In collaboration with Fermilab Project X, the deliverables are:

- High gradient cavity fabrication (35 MV/m, yield 80%) tech transfer to at least 2 North American vendors completed
- Cryomodule type 4 design, fabrication and horizontal testing completed for 3 cryomodules
- Marx modulator, tunable power distribution system
- LLRF control
- String test of a complete, high gradient, RF unit; installed & operation started



ILC RF Unit: 3 CM, klystron, modulator, LLRF

Americas

ART R&D Program Deliverables (2012)

Electron Sources:

Prototype source demonstration: 3MHz micropulse at 5Hz (2800 bunches at 3 10^{10}, 80% polarisation) requires:

- Laser development (3 MHz)
- Polarised photocathode development (5 A peak, 6A/cm^2)
- DC gun development (>300KV)

Damping Rings (2010)

- Conclude electron cloud growth and stability studies at CESR TA
- Develop low emittance techniques & demonstrate low emittance beams (<20 pm vert) at CESR TA
- Develop low emittance x-ray beam size monitor

Accelerator physics

- Level of effort which includes positron production studies, CESR TA support, bunch compressor/emittance dilution, & main linac dynamics

ART R&D Program Deliverables (2012)

Americas

Beam Delivery System

- Build and test prototype final focus magnet cold mass
- Demonstrate BDS optics, diagnostics and feedback systems at ATF 2 (global collaboration milestone)
- Machine – Detector Interface design complete

Global systems

- Demonstrate high availability control system components
- Cryogenic system design with heat load analysis

Conventional Facilities

- Level of effort support for the re-baseline design and associated cost estimate

GDE: All system groups will be involved in updating the baseline design and associated cost estimate for the 2012 project proposal.

ART - The Americas - TRIUMF

Americas

- TRIUMF (Vancouver) is a member of ART. Their 5 year plan calls for a high intensity SC electron linac (50MeV, 1-10mA) (50kW-0.5MW) as a second driver to produce radioactive ion beams via photo fission
- E-driver could use 1.3GHz technology in-line with the global effort for technology to support the ILC.
- While TRIUMF has significant experience with low-beta cavities they are interested in collaboration in 1.3 GHz structures
- They are involved with a local vendor (PAVAK) who represents the 3rd potential North American vendor.
- They project ~$400K/yr M&S for SRF development.
-

ART Program FY08

- The FY08 omnibus spending bill capped US DOE FY08 ART funding at $15M (SRF $5M). Since we were 3 months into the fiscal year with a $60M CR guidance this was tantamount to a 'cease work' for the balance of FY08. NSF Cornell support was minimally impacted.
- All spending was halted ~ 1 Jan and a count of funds remaining at the labs indicated an unobligated balance of ~ $2.5M under the cap. A skeleton program continued in FY08.
  - GDE Common Fund ($400K)
  - GDE Collaboration management (4 FTE's: Barish, Ross, Harrison, Carwardine) + some travel for meetings
  - CESR TA support ($1m)
  - 'Keep alive' SRF program (~$1.5M)
- There was some level of 'generic' support through the FY08 base program
- The ART program was re-scoped from $60M to $35M, many elements were cut

ART Program FY09

- ART was resuscitated in FY09 with a presidents budget of $35.3M. This endured to be a baseline budget. As usual the FY09 was delayed and a continuing resolution (CR) was enacted. Under normal CR protocol this would have frozen the budget at the FY08 level. Since the budget was zeroed in FY08 this would have effectively killed the ART program. It was decided that since the CR reduced the nominal OHEP FY09 budget by 16% then the ART program would be reduced by this amount. We were funded at a rate equivalent to $29.5M. Work was restarted. The lab funding allocations were reduced from their baseline amounts by 16% i.e. we made no programmatic changes based on the CR. Since many of the lab programs had been suspended this was not a major dislocation. That had taken place 9 months earlier.
- The funding was fully restored to $35M with the final FY09 budget in March. This represents the first time in the 4 year history of the project where we have received more than 60% of the budget guidance used for planning. Thank you DOE !!

Americas

ART Program FY09 Milestones

WBS System	Milestones (FY09 only)	Institution	Forecast	Actual
L2 Electron Sources	Laser bunch pattern demo	SLAC	Q1	Q1
	Full Laser system demo	SLAC	Q4	
L4 Damping Rings	Grooved coated chambers for Cornell and KEK	SLAC	Q3	
	Transfer e-cloud expts PEP II -> CESR TA	SLAC	Q1	Q1
	CESR TA low emittance lattice	Cornell	Q2	Q2
	Complete final CESR TA machine hardware installation	Cornell	Q3	
	Evaluate CESR TA damping ring configuration	Cornell	Q4	
	Specialized vacuum chambers to Cornell	LBNL	Q3	
L5 Accelerator Physics	Evaluate positron yields	ANL	Q4	
L6 Beam Delivery	Redesigned BDS layout for minimal machine	SLAC	Q4	
	Complete ATF2 hardware	SLAC	Q1	Q1
	MDI IR interface document	SLAC/FNAL	Q2	Q2
	Final focus prototype coil vertical testing	BNL	Q4	
	ATF2 FF coil winding start	BNL	Q3	
L7 Conventional Facilities	Complete water & HVAC VE	FNAL	Q4	
	Main Linac tunnel alternative	FNAL	Q4	
	Minimum machine CFS conceptual design	FNAL	Q4	
L8 Global systems	VME adapter prototype	SLAC	Q3	
	L-Band test stand controls demo	SLAC	Q3	
	FLASH phase 1 report	ANL	Q4	
L9 HLRF	2nd generation Marx design	SLAC	Q4	
	Sheet beam klystron beam tester	SLAC	Q3	
	Fabricate RF distribution system for Fermilab CM testing	SLAC	Q2	Q2
	RF test stand - Marx prototype 1500 hrs	SLAC	Q4	
	Cluster klystron POP - stage 1	SLAC	Q4	
	18 couplers to Fermilab	SLAC	Q3	
L10 Cavities & Cryomodules	Complete & commission ANL/Fermi processing facility	ANL/FNAL	Q2	Q2
	First dressed 1.3 GHz cavity tested	FNAL	Q3	
	Start testing Cryomodule 1 at FNAL	FNAL	Q3	
	All Cryomodule 2 components available	FNAL	Q4	
	Complete 8 dressed cavities	FNAL	Q4	
	30 EP/VTR test cycles (15 Q2 + 15 Q4)	JLAB	Q2/Q4	
	Complete 2 9-cell large grain cavities	JLAB	Q4	
	Test vertical EP system prototype	JLAB	Q4	

Americas

ART DOE FY09 Funding by System ($35M)

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

Americas

ART FY09 Allocations - from $35.0M total

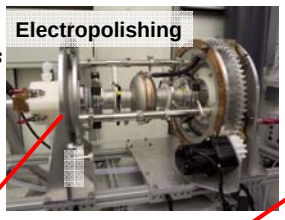
Institution	$M
SLAC	12.1
Fermilab	11.2
JLAB	2.4
BNL	2.0
Argonne	1.4
LLNL	0.4
LBL	0.4
Cornell	2.8 + ~ 5 (NSF)
GDE (mostly Fermilab)	1.7

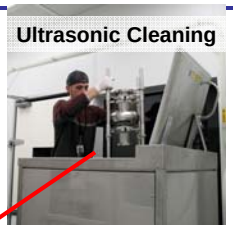
I have the detailed budgets for FY09 if anyone is interested

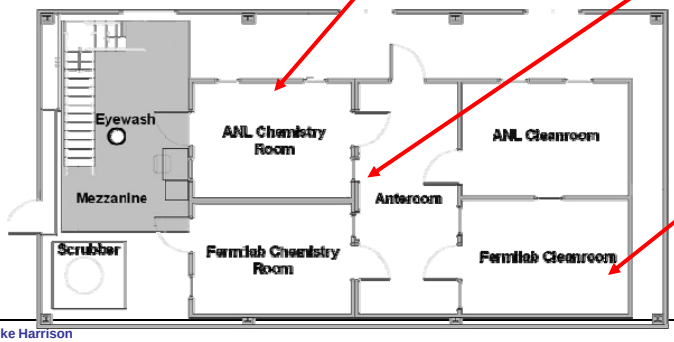
Americas

The ART FY09 Program Highlights - Joint ANL/FNAL Superconducting Cavity Processing Facility at ANL

- 2000 ft² facility complete as of March 2009
- Full capability for single- and nine-cell cavities
- Seven electropolishing procedures performed since Jan. 09
- Five single cells with E_{ACC}>35 MV/m
- 12 additional cavities (mostly 9-cell) in '09

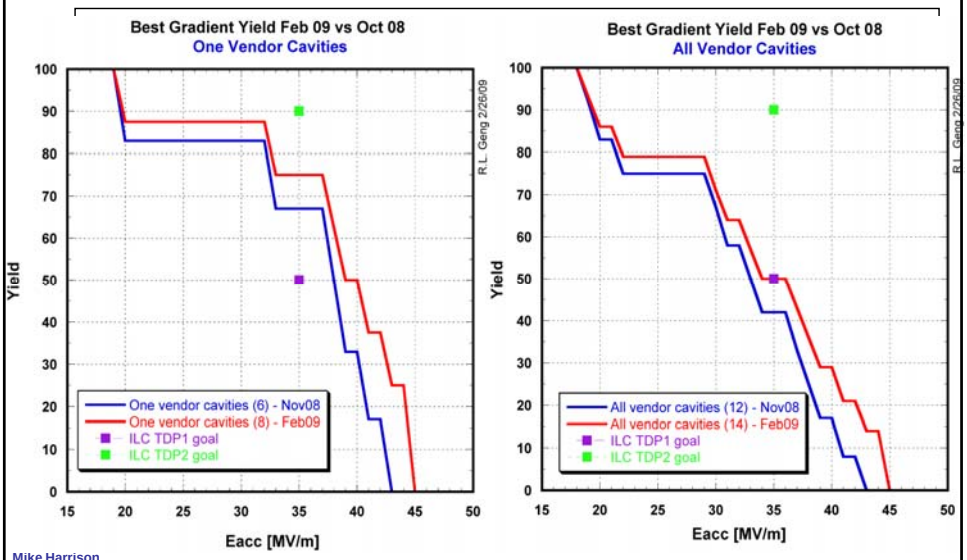






Americas

The ART FY09 Program Highlights – Cavities



Americas

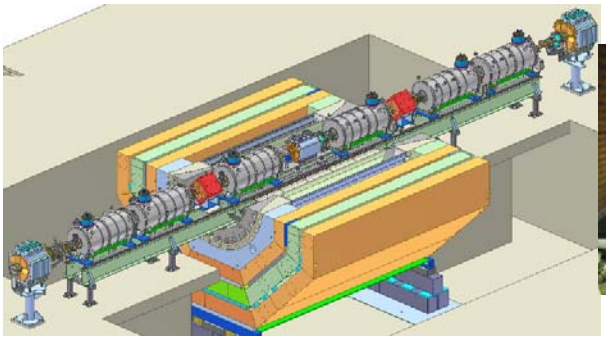
The ART FY09 Program Highlights – HLRF

New L-Band Station at ESB: Marx Modulator and 10 MW Toshiba Multi-Beam Klystron

- Long term testing of a solid state modulator. This is potentially cheaper (~33%) than a conventional modulator. We still must demonstrate reliability, and pulse shaping

Americas

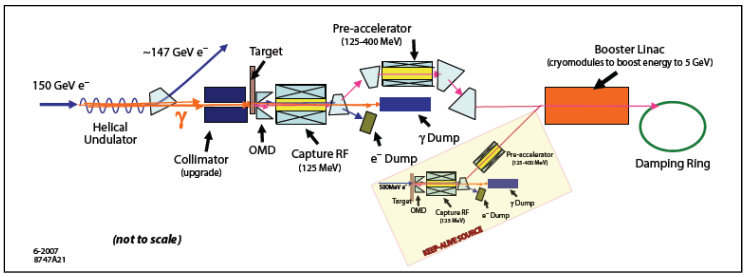
The ART FY09 Program Highlights – CESR TA



- Major CESR ring modifications complete, wiggler straight in place, specialised RFA analysers completed (SLAC, LBNL).
- Low emittance lattice demonstrated
- Several data runs completed as scheduled
- Active collaboration in simulation & analysis

Americas

The ART FY09 Program Highlights – Accelerator physics



- Simulation of ILC positron source from undulator to damping ring:
  Positron production, capturing, polarization and activations.
- Undulator radiation modeling:
  Optimizing undulator parameters for MM, Simulating RDR undulator under different working conditions.
- Evaluating different OMD:
  Quarter wave transformer, AMD, Flux concentrator, Lithium lens
- Evaluating different targets:
  Titanium target, Tungsten target, Liquid lead target.
- Simulating laser Compton scheme positron source for ILC/CLIC

Americas

Global Systems – Controls Standard Platform Development

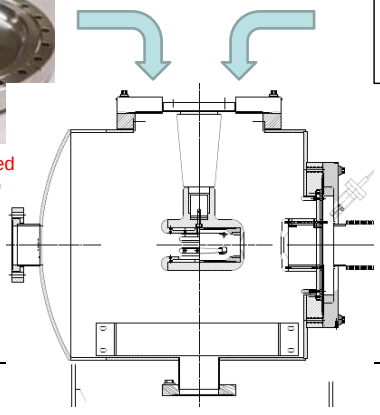
- **ATCA-VME Adapter Module**
  - Goal: Demonstrate in RF Interlock System
  - First boards completed, in test at SAIC (Intelligent Platform Mgmt section)
  - SLAC responsible to make operational under EPICS
  - Slipping due to lack of SW manpower at SLAC, being addressed
- **MicroTCA**
  - Goal: Spinoff activity to SLAC Linac Controls Upgrade
  - Software support for Commercial Fast ADC for RF in collaboration with DESY under MOU
- **xTCA for Physics Coordinating Committee under PICMG Industry Group**
  - Goal: Develop Physics Applications Standard Extensions
  - Committee Formation Sponsored by SLAC, DESY, FNAL, IHEP, FZJ, Cypress Research, Performance Technologies
  - Organized and operating since 03/10/09
  - New HW, SW Working Groups initiated 04/22/09
  - 44 companies, 65 members
  - Physics community Requirements Survey initiated
  - *Goals: New AMC card designs for physics, software & firmware protocol guidelines by 12/31/09*
- **Workshops**
  - 2nd WS @ Dresden Oct 2008; 3rd @ IHEP May 2009, 4th @ IEEE NSS Oct 2009

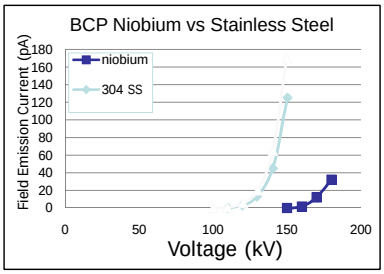
Americas

The ART FY09 Program Highlights – Electron Source (JLAB)

New design: expected operation June 2009

Replace conventional ceramic insulator with "Inverted" insulator:
•Less metal at HV
•Field emitted electrons more likely to hit grounded chamber walls
•No SF_6



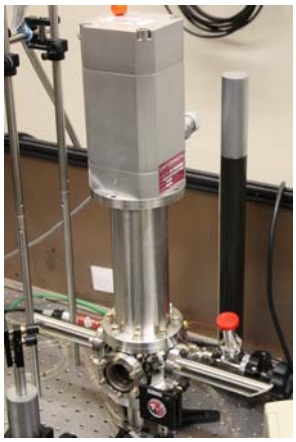


Stainless Steel limited to 5MV/m

ILC Gun features:
•Inverted insulator
•Goal: eliminate field emission to 10MV/m
•Niobium looks promising: no diamond paste polishing
•400C bake to minimize outgassing
•Testing ion pump limitations
•Need to start designing cathode/anode appropriate for ILC beam

The ART FY09 Program Highlights – Electron Source (SLAC)

- **Source laser system**
  - 3 MHz cryogenically cooled amplifier system
  - Pulse train generation is complete (seed for amplifier)
  - Amplifier development in progress
- **Photocathode optimization**
  - Address Surface Charge limit
    - Optimization of cathode design
    - Alternative materials



The ART Program – FY10

- The FY10 program will not see any major changes to the program elements. Continuity was a goal of the planning process. Detailed FY10 planning in progress.
- The funding will be either be flat or cost-of-living. The difference is not trivial: $1.4M. We are seeing upward pressure of lab indirect charges that are greater than cost-of-living. Taken together if we receive flat funding then this will be an issue.
- Evolutionary changes include the completion of cryomodule design work, enhanced accelerator physics effort at Fermilab, and the possibility of increased cavity processing & testing from stimulus funding supplied cavities.
- FY10 will be the final year of the CESR TA program, this will have an impact in FY11.
- We will perform a technical review of the sheet beam klystron program in FY10 Q1.

The ART Program– Synergies

- The most obvious synergy is with Fermilab & Project X. The cryomodule and associated RF systems are essentially identical. Presumably at some point minor differences will emerge but at present the PX & ART SRF development program for the $\beta = 1$ elements are the same program.
- With the obvious exception of the main linac technology the many elements of the CLIC design benefit from the GDE program. In the context of ART the beam delivery system, electron source, positron production, and damping rings all have relevance for CLIC. (Note PX + CLIC = ILC)
- In regard to National Lab programs
  - JLAB – SRF, electrons
  - LLNL - lasers & specialised software
  - Cornell – CESR, SRF
  - BNL – direct wind magnets
  - SLAC – RF systems, BDS (SLC collisions), beam dynamics, electrons
  - ANL – SRF, undulator simulations

The ART Program– Issues

- Resources: Probably the biggest issue at this time is access to resources. Manpower is not fungible and in FY08/09 we went from 200 FTE's -> 15 -> 106 (FY09 average). This caused Fermilab into furloughs & short time operation, SLAC into layoffs, and manpower at the other labs to be dispersed. The uncertainties of the CR in FY09 did not help either in the ramp up. Into this difficult situation came the rags-to-riches problems associated with the ARRA funding which 'must be spent quickly'.
- Communications: The world is rarely black and white but it can be argued that a national R&D program involving 2 large & 6 smaller lab efforts might have a few more shades of gray than desirable. Combine that with a completely global, collaborative, project structure and it creates a challenge to remain coherent.
- Project Ambiguity: The ILC remains an unapproved project with an uncertain schedule. This creates a certain level of diffuseness
- Constant effort v's a flat budget
- CESR TA program evolution

The ART Program – The Committee Charge

The review should consider the ongoing ILC R&D effort by the Americas Region Team (ART) by generally evaluating

- the quality and structure of the organization and management of the program,
- the scientific and technical merit of the R&D plan,
- the achievements in the past twelve months,
- feasibility of the milestones for FY2009 and FY2010, and
- the match between funding and manpower requirements and the availability of these resources in FY 2009 and FY 2010.

The ART Program – The *explicit* Committee Charge

- Is the program well integrated managerially and technically into the GDE Technical Design Phase (TDP)? Is the R&D program well integrated into the TDP?
- Has management instituted effective mechanisms to ensure the goals of the TDP are met?
- Has the coordination of the national R&D plan with the individual laboratories been effective?
- Has the program efficiently recovered from the sudden reduction in funding due to the fiscal year 2008 appropriation for DOE High Energy Physics? Are there further steps to be taken?
- Does the R&D plan ensure the U.S. will have a leading role in the ILC program?
- What are the broader impacts of the program?

The ART Program – Agenda

Americas

DOE/NSF ART Program Review - Wednesday April 29

Item	Speaker	Start Time
Executive Session		8.00
ART Program Overview	Harrison	8.30
GDE Global Program	Ross	9.30
ART and the SLAC program	Phinney	10.00
break		10.30
ART and the Fermilab Program	Kephart	11.00
Gradient R&D	Champion	11.30
Cryomodule production	Carter	12.15
Lunch (working lunch for the committee)		12.45
HLRF R&D	Adolphsen/Hast	13.30
CESR TA	Palmer	14.15
Conventional Facilities	Kuchler	14.45
Break		15.15
Beam Delivery Systems	Seryi	15.45
Beam tests at FLASH	Carwardine	16.15
Summary	Harrison	16.35
Executive Session		17.00
End		18.00
Thursday April 30		
Break out sessions		
Program management	Harrison, Ross, Kephart, Phinney	8.30
Main Linac RF systems (possible tour)	Adolphsen, Hast, Champion, Carter	8.30
Accelerator systems	Seryi, Palmer, Brachmann, Kuchler, Larsen, Carwardine	8.30
Break		10.30
Executive session (includes working lunch)	Committee	10.45
Close-out	All	14.30
End		15.30

The ART Program – Conclusions

Americas

- The ART program has survived the budgetary roller coaster of FY08 and has restructured (along with the GDE) with an R&D plan which runs through 2012.
- The US plays a significant role in the global program
- Budget guidance for the this R&D plan is ~$35M/yr. The plan is consistent with this level of resources.
- Resources are provided (matrixed) through the national labs
- Program development is done in conjunction with all the stakeholders (DOE, GDE, Labs, ART). Management via the national lab line management.