# ART and the SLAC program

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SLAC

# Linear Collider R&D

SLAC has been working towards a Linear Collider for more than 30 years

The science case for a Linear Collider to complement the LHC remains compelling

SLAC is committed to a next-generation LC, pursuing many options with different levels of risk and cost

- ILC: only near term option, lowest risk but high cost
- High gradient klystron: medium risk with significant cost savings
- Drive-beam microwave: higher risk with probably greater savings
- Dielectric or Plasma acceleration: much higher risk but with potential for much lower costs

SLAC has strong R&D programs on these different options

# SLAC ILC Effort 2007 > 08

For the RDR, SLAC was the US lead on 5 of 6 area systems & several technical systems

AS: Electron & Positron sources, Bunch compressors, Main Linac and Beam Delivery Systems

TS: RF power sources, Dumps & Collimators, Commissioning & Operations, Installation

+ contributions to Damping ring design & lead on e-cloud R&D

For 2008, the plan was to narrow focus to e- source, linac & BDS areas + accelerator physics and system integration

—> e+ source, BCs, most DR effort transferred to others

TS: large effort on RF sources, smaller efforts on e-cloud R&D and other TS , incl: HA controls & power supplies

+ major ramp up of engineering design effort

# Impact of 2008 Budget

Without ILC funding Q2-4, we continued any generic R&D synergistic with other projects that could be supported on other funds

Stopped ILC specific design work and cut back engineering effort

down ~ 10 engineers/eng. physicists + cancelled 5 ME reqs

Overall reduction of ~ 40 ILC supported FTEs, counting other depts

In 2008, we continued R&D on e- source, linac & BDS areas

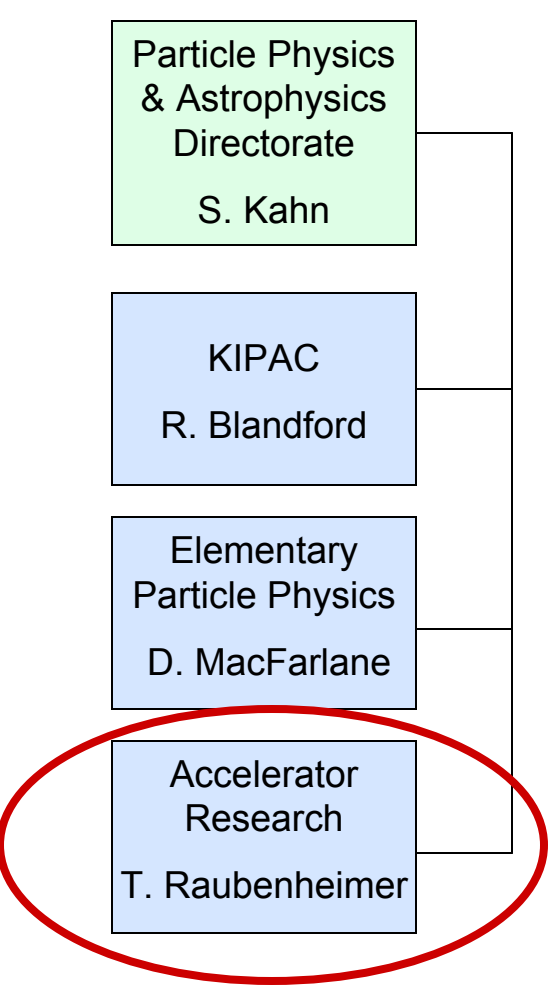
TS: slowed effort on L-band RF sources (but FY08 ~same as FY09 level)

stopped PEP-II e-cloud R&D early (PEP-II shutdown)

slowed HA controls, cut CFS and Installation engineering

SLAC progress on LC R&D in FY08 was made possible because it was embedded in a broad ARD research program and through increased DOE support for accelerator development and science @ SLAC

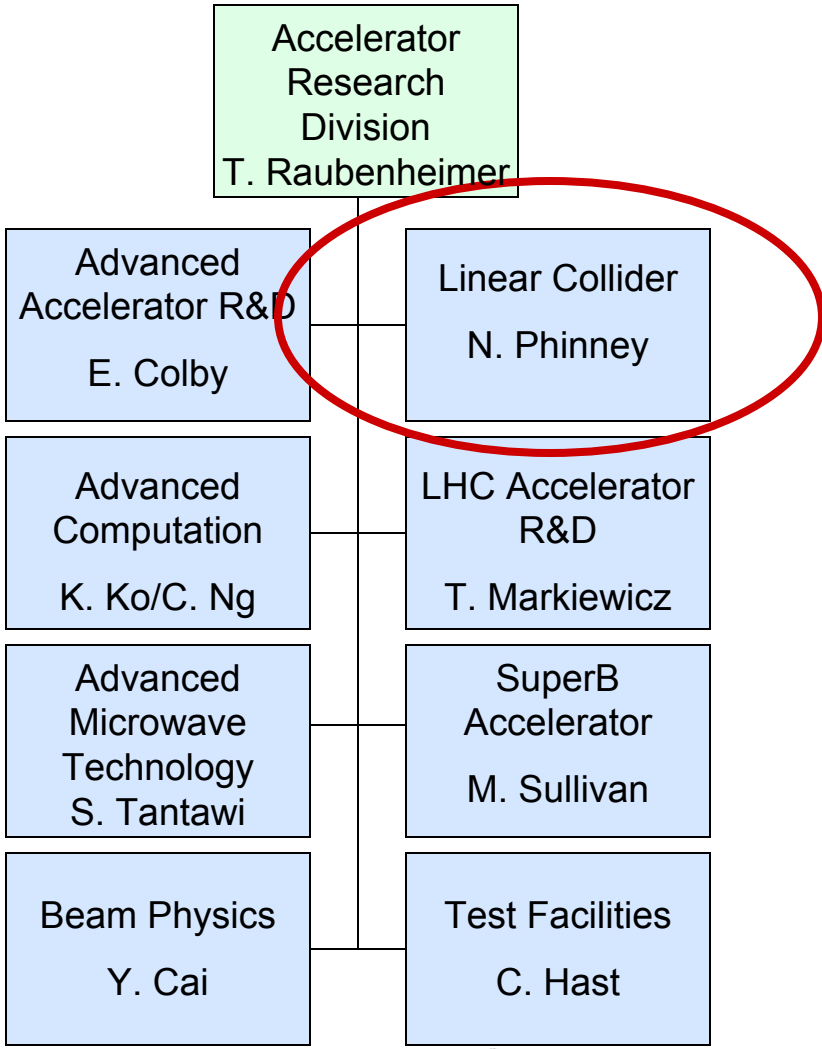
# ILC in SLAC Organization




ARD - Accelerator Research Division

in Particle Physics and Astrophysics Directorate

Linear Collider is the largest department In ARD (21 people)



# Accelerator Research Division (ARD)

ARD supports a broad program of accelerator research

- ILC & Accelerator Science each roughly 1/3
- rest is Accelerator Development, LARP, SciDAC, other projects

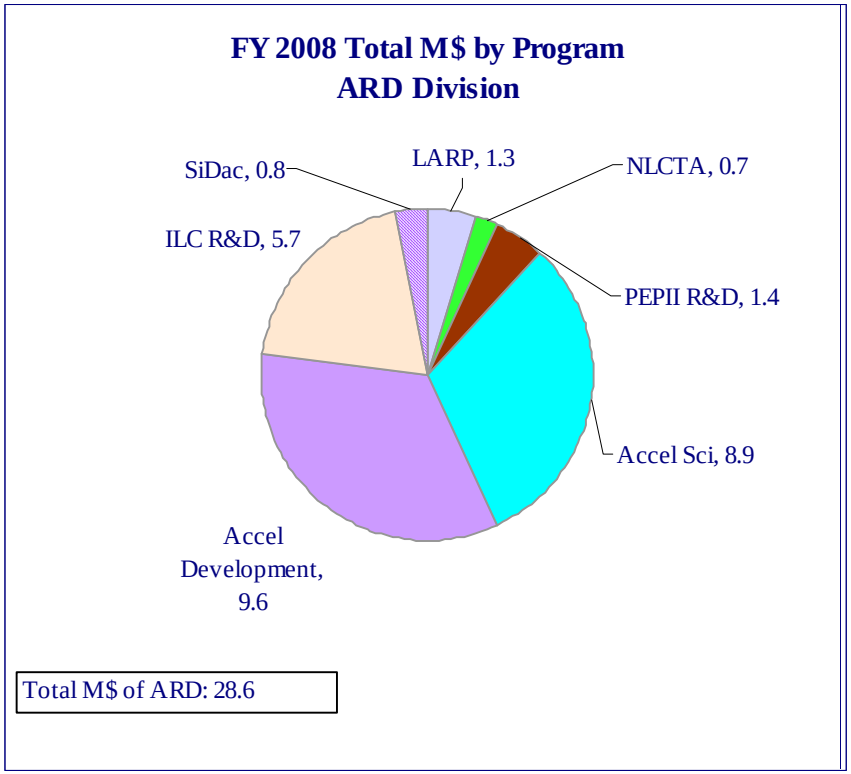
Accelerator Science includes High Gradient, Direct Laser & Plasma Wakefield Acceleration, Beam Physics, Advanced Computation

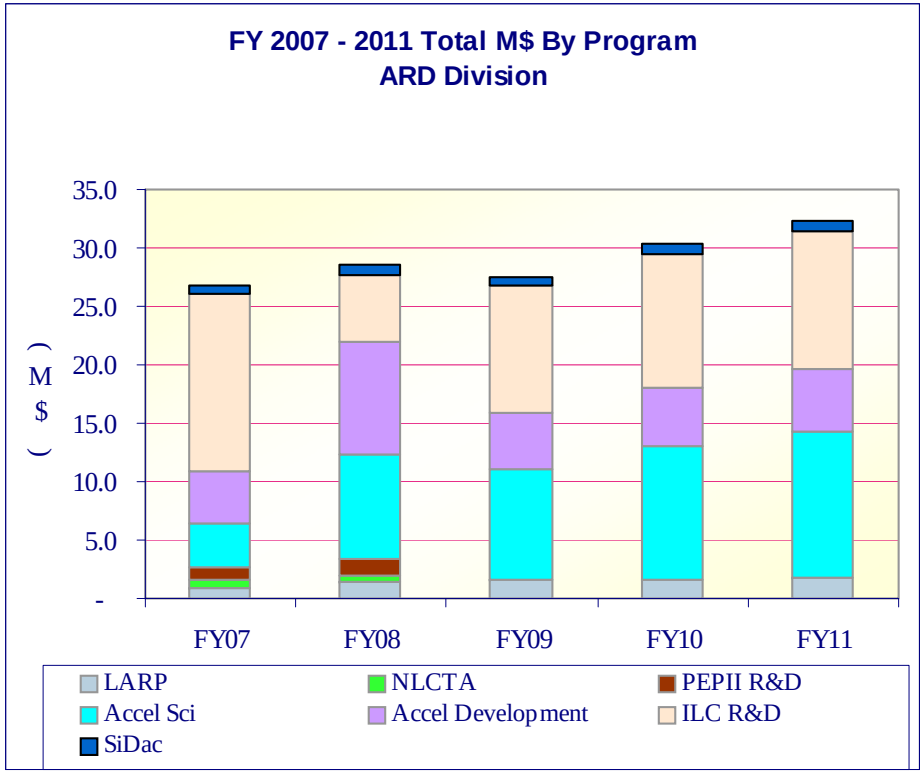
Accelerator Development includes work on LHC, CLIC, SuperB & ProjectX, generic LLRF and Feedback

LHC/LARP work includes Phase-II rotatable collimators, beam-beam simulations, crab cavity design, crystal collimation experiments, LLRF modelling, e- cloud tests and fdbk design

SciDAC funds development of massively parallel computing

# ARD Budget FY2008 & plans




FY07-08 are actuals, FY09 is CR budget, others are projections

Large increase in Accelerator Development in FY08, after ILC cuts

# FY08 Actuals (ILC Q1, Other Q2-4)

| | FY08 Q1 ILC Funds | FY08 Q2-4 Accelerator Development Funds | FY08 Total |
|---|---|---|---|
| 1.1 Management | $300 | $502 | $802 |
| 1.2 Electron Source | $255 | $404 | $659 |
| 1.4 Damping Ring | $563 | $260 | $823 |
| 1.5 Accelerator Physics | $345 | $278 | $623 |
| 1.6 Beam Delivery Systems | $566 | $989 | $1,555 |
| 1.8 Global Systems | $454 | $136 | $590 |
| 1.9 HLRF Systems | $3,200 | $2,887 | $6,087 |
| Other | $255 | $55 | $310 |
| Total | $5,937 | $5,510 | $11,448 |

Q1 funds included ~2M$ carry-in from FY07, expected budget $21M$
Q2-4 funds were almost exclusively salaries, M&S to cover earlier commits
Commits costed in Q2-4 on ILC funds, included in Q1 (klystron, clean room)

# FY09 Budgets & Q1/Q2 Actuals

| | FY09 Budget | FY09 CR Budget | FY09 Q1+Q2 Actuals | % of CR Budget | |
|---|---|---|---|---|---|
| 1.1 Management | $1,057 | $950 | $389 | 41% | |
| 1.2 Electron Source | $560 | $470 | $348 | 74% | |
| 1.4 Damping Ring | $203 | $300 | $189 | 63% | |
| 1.5 Accelerator Physics | $820 | $400 | $165 | 41% | |
| 1.6 Beam Delivery Systems | $2,991 | $2,600 | $708 | 27% | |
| 1.8 Global Systems | $382 | $350 | $147 | 42% | |
| 1.9 HLRF Systems | $5,924 | $5,390 | $3,198 | 59% | |
| 1.10 Cavity & Cryomodule | $166 | | | | included in 1.9 |
| Total | $12,102 | $10,460 | $5,143 | 49% | |

Q1-2 spending matched to CR budget, now need to ramp up

HLRF up - SBK parts & fab, RF distribution & couplers > FNAL

DR budget needed increase to support CESR-TA

BDS down due to staffing problems, new reqs just posted

# FY06-08 Actuals & FY09 Budgets

| | FY06 Actuals | FY07 Actuals | FY08 Actuals | FY09 Budget |
|---|---|---|---|---|
| 1.1 Management | $2,257 | $1,744 | $802 | $1,057 |
| 1.2 Electron Source | $713 | $502 | $659 | $560 |
| 1.4 Damping Ring | $937 | $114 | $823 | $203 |
| 1.5 Accelerator Physics | $729 | $415 | $623 | $820 |
| 1.6 Beam Delivery Systems | $3,191 | $2,771 | $1,555 | $2,991 |
| 1.8 Global Systems | $402 | $331 | $590 | $382 |
| 1.9 HLRF Systems | $4,295 | $6,537 | $6,087 | $5,924 |
| Other | $3,382 | $2,490 | $310 | $166 |
| Total | $15,905 | $14,903 | $11,448 | $12,102 |
| Year-end Commits | $114 | $1,687 | $0 | |

Even including supplemental FY08 funds for “generic” ILC-related R&D, available funds dropped significantly in FY08, slight increase in FY09.

The emphasis changed as some areas were dropped and focus was R&D rather than engineering

# SLAC ILC R&D Effort

L-Band RF power source R&D
- Modulators
- Klystrons
- RF distribution and couplers
- Klystron cluster concept

} Synergistic with Project-X R&D and other SC applications

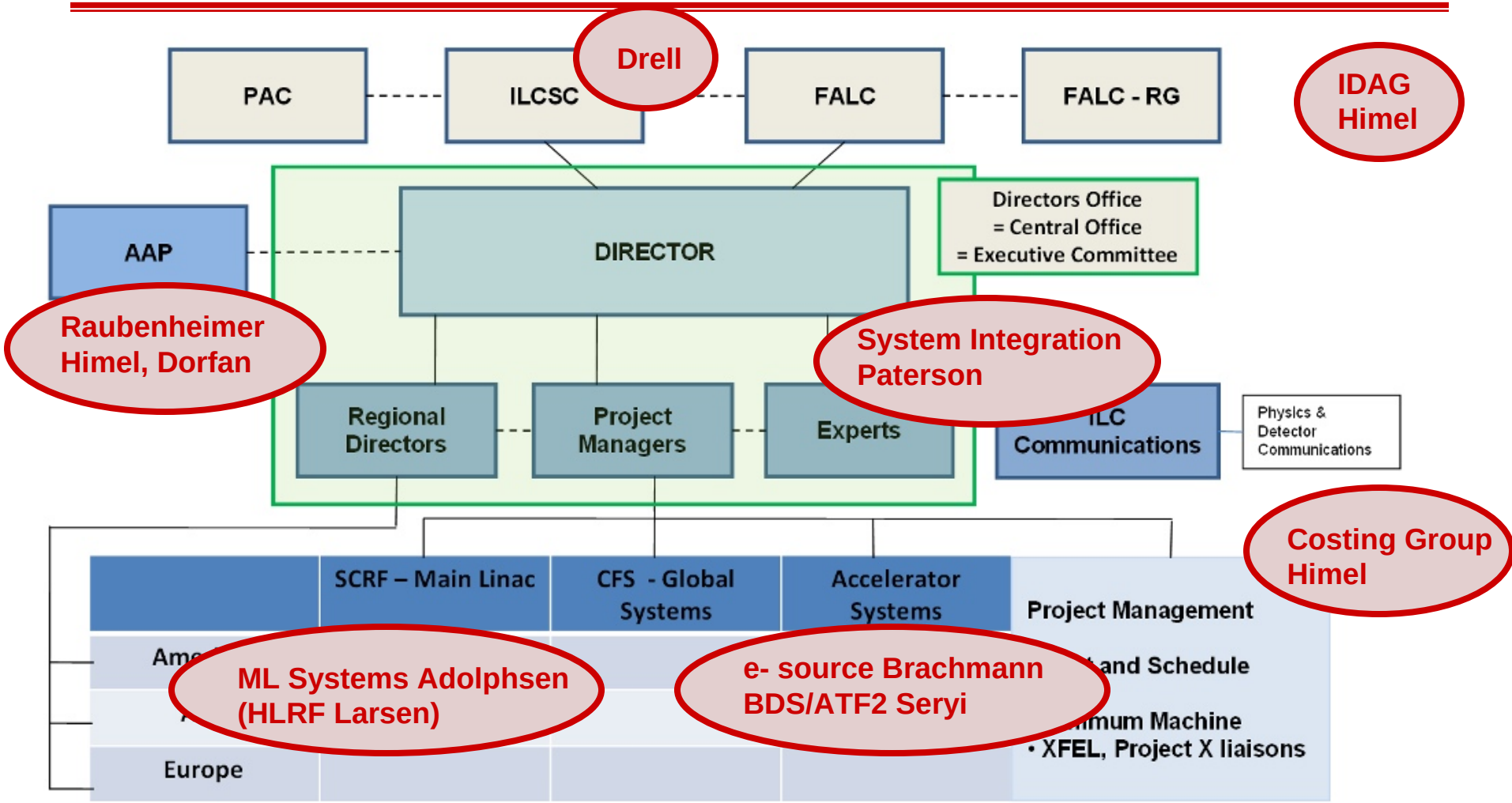
Electron source R&D
- Laser and Photocathode development

Beam delivery system R&D
- FFS optics and tuning design
- Collimation and beam dump design
- MDI design with FD and crab cavity
- ATF / ATF2 Test facility

Accelerator Physics & e-cloud R&D

System Integration & High Availability Hardware

# SLAC in the GDE Organisation



# FY08-09 Accomplishments

## L-Band RF Power Sources

- Marx Modulator Prototype operational, installed in ESB
- Toshiba MBK klystron purchased, installed in ESB
- RF distribution prototype tested successfully, full CM system > FNAL
- Clean room purchased for Coupler assembly and processing, begun
- L-band positron capture structure built & tested

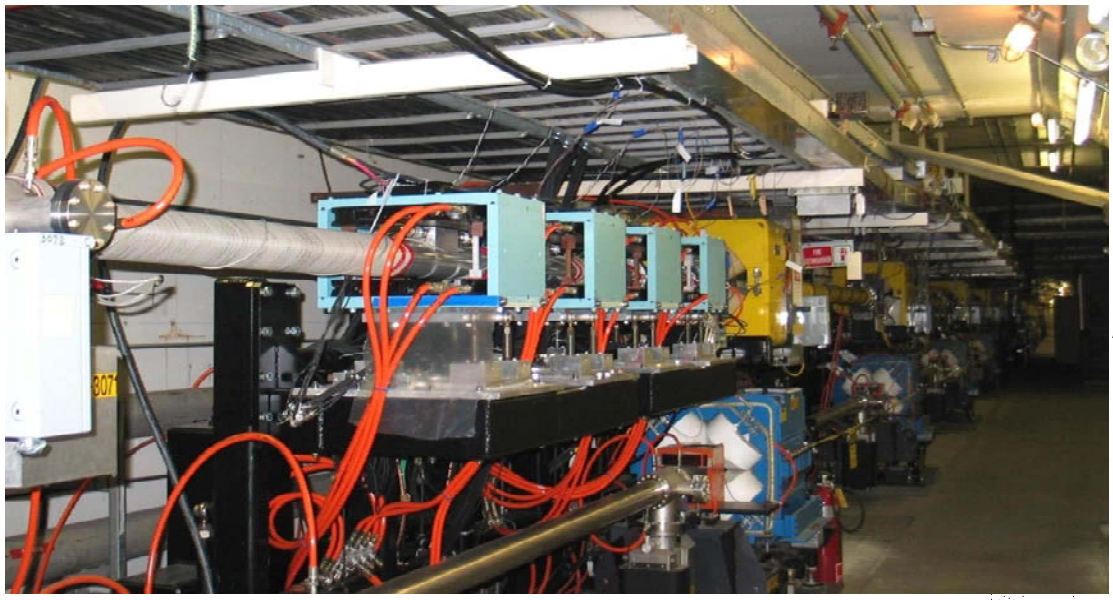
## Beam Delivery

- ATF2 hardware complete & tuning software developed
- High power dump engineering design (with BARC, India)
- MDI Interface document
- Crab cavity design

## Electron source and DR Electron cloud

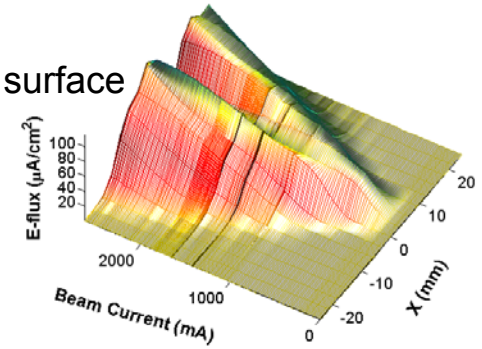
- Laser purchased, Gun test lab refurbished after 3 years
- E cloud experiments successfully completed in PEP-II

# Electron cloud mitigation tests @ PEP-II

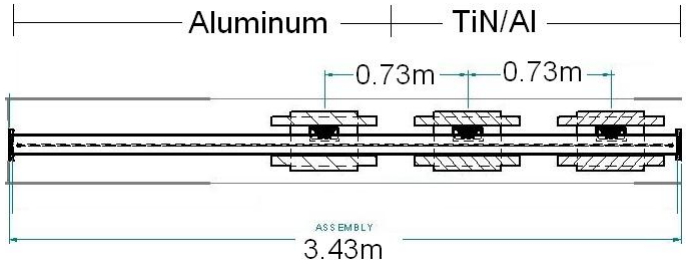


Mitigation tests
in ILC magnetic field

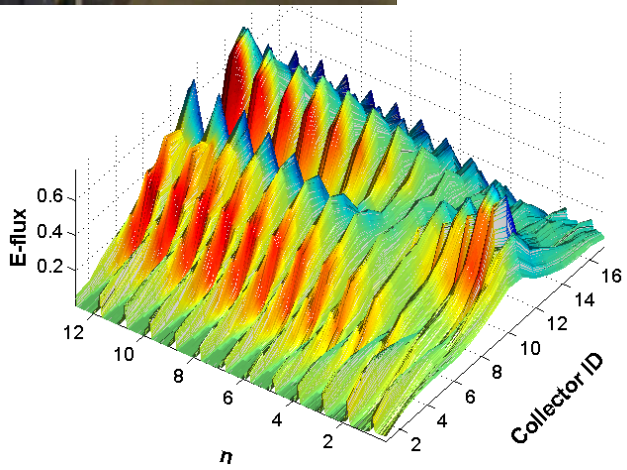
Aluminum surface



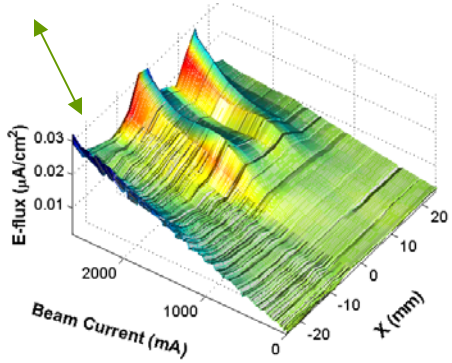

New 4-dipole chicane in the PEP-II LER




Test chamber Al and TiN-coated




Observed new resonance: Electron current peaks at defined B values (*n*)




TiN surface much reduced signal with respect to Al

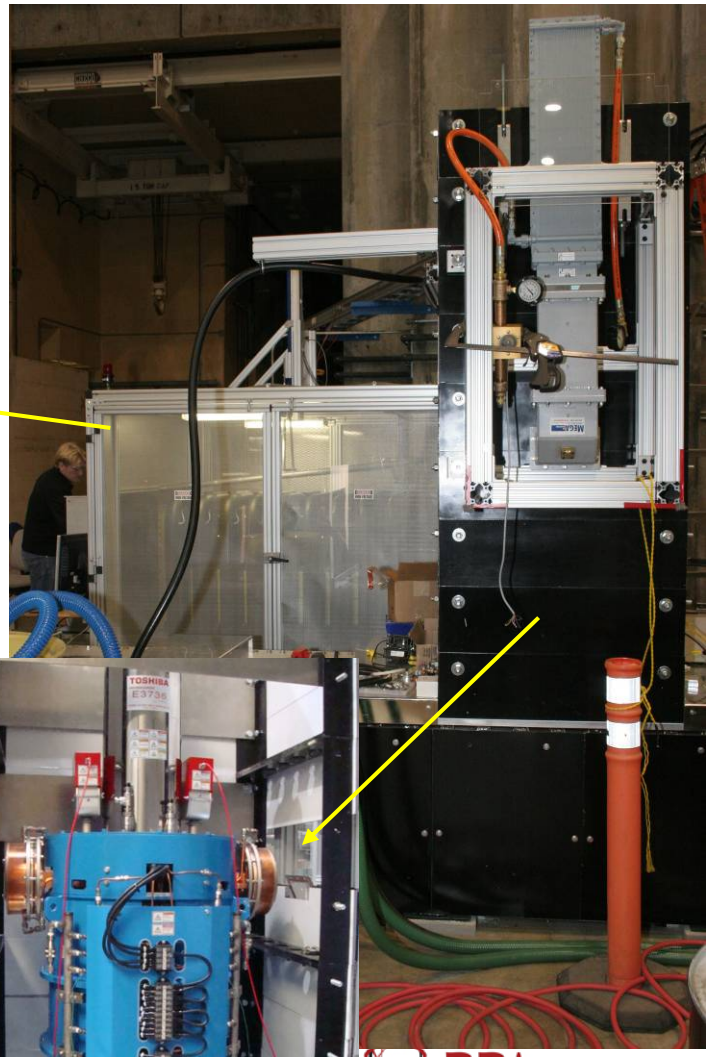


NATIONAL ACCELERATOR LABORATORY

Particle Physics & Astrophysics

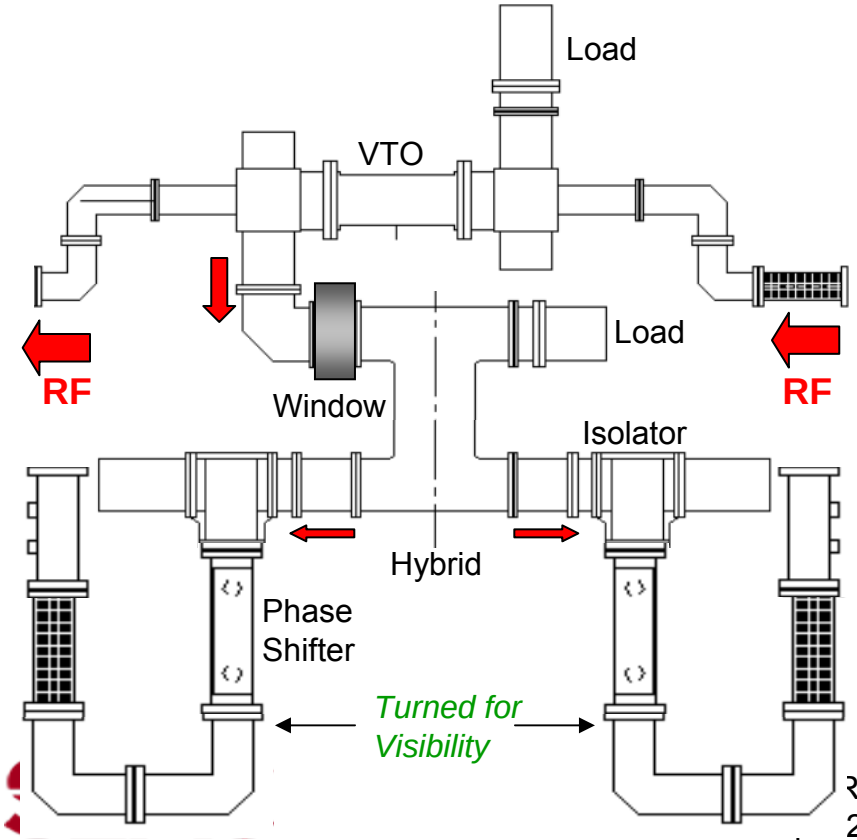
# New L-Band Station at ESB: Marx Modulator and 10 MW Toshiba Multi-Beam Klystron

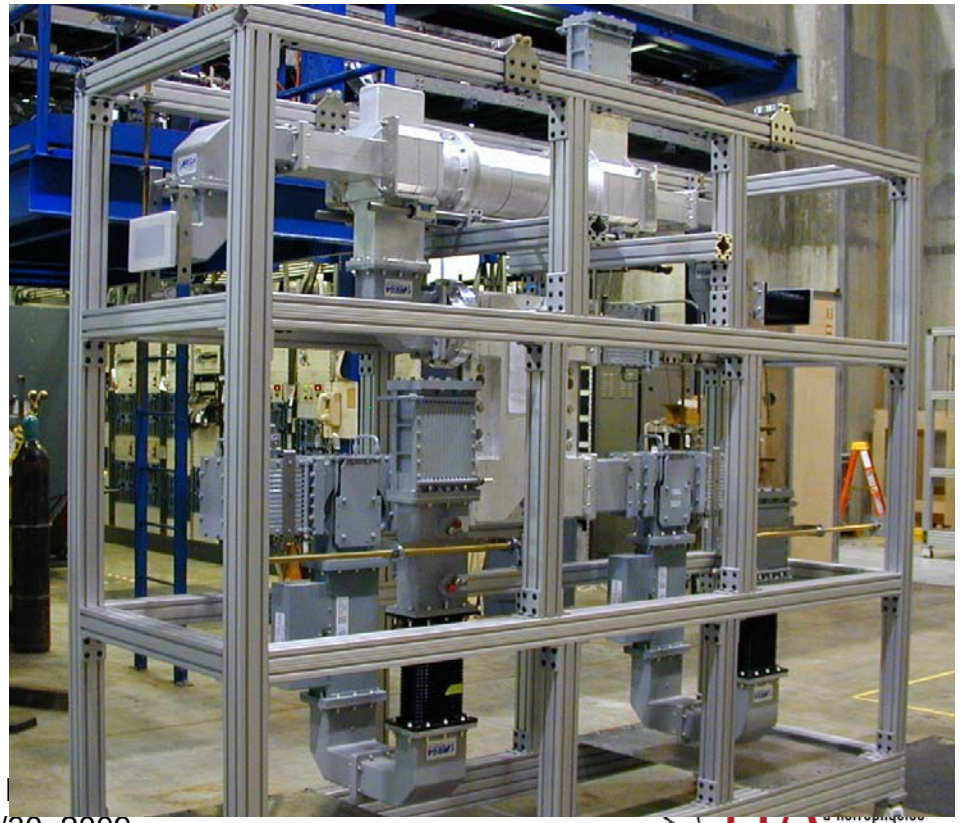
See Adolphsen Talk

# RF Distribution Modules

Four, two-cavity distribution modules were individually high power tested and then shipped to FNAL



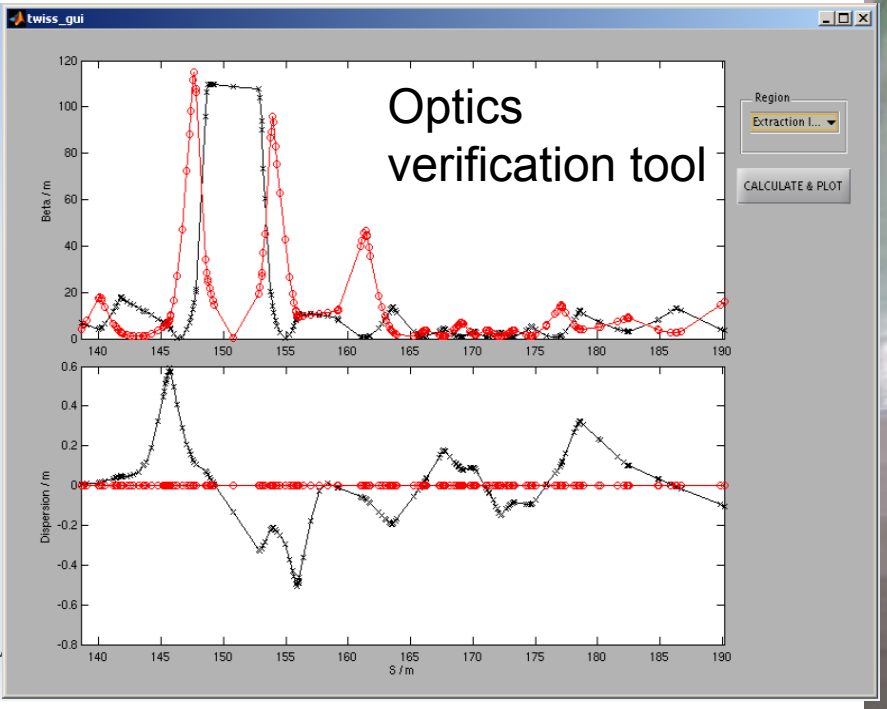



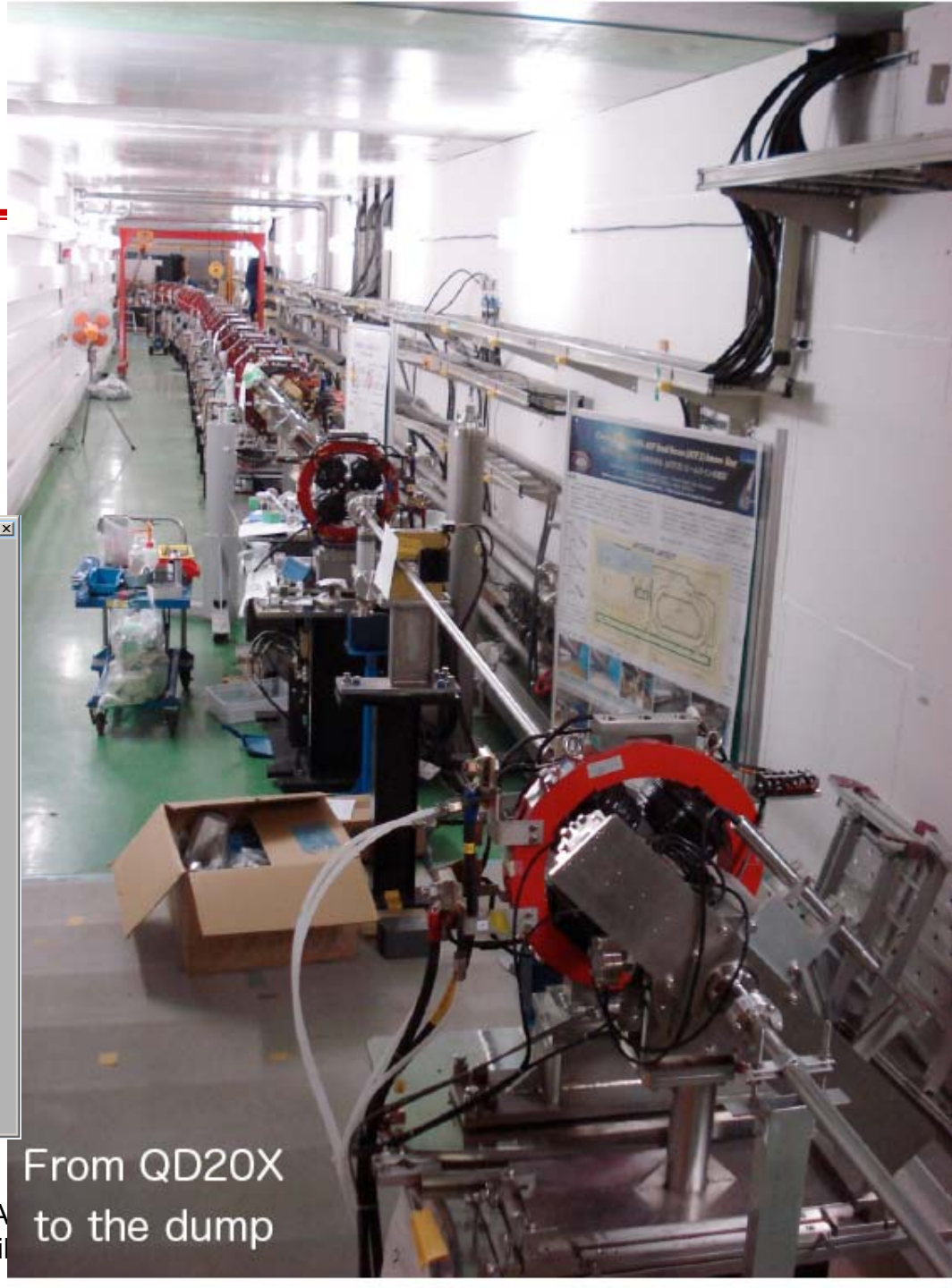
# Coupler Assembly in SLAC Class 10 Cleanroom

# ATF2 @ KEK

SLAC provided magnets, movers, BPMs, diagnostics

and has led the tuning software development effort



# FY09 Milestones

| WBS System | Milestones (FY09 only) | Institution | Forecast | Actual |
|---|---|---|---|---|
| 1.2 Electron Sources | Laser bunch pattern demo | SLAC | Q1 | **Q1** |
| | Full Laser system demo | SLAC | Q4 | |
| 1.4 Damping Rings | Grooved coated chambers for Cornell and KEK | SLAC | Q3 | |
| | transfer e-cloud expts PEP II -> CESR TA | SLAC | Q1 | **Q1** |
| 1.6 Beam Delivery | Redesigned BDS layout for new baseline machine | SLAC | Q4 | |
| | Complete ATF2 hardware | SLAC | Q1 | **Q1** |
| | MDI IR interface document | SLAC/BNL | Q2 | **Q2** |
| 1.8 Global systems | VME adapter prototype | SLAC | Q3 | |
| | L-Band test stand controls demo | SLAC | Q3 | |
| 1.9 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 | |
| | Klystron cluster POP - stage 1 | SLAC | Q4 | **FY10Q1** |
| | 10 couplers to Fermilab | SLAC | Q3 | |

# Planning for FY10

DOE guidance is for level funding for FY10 and beyond

SLAC will continue to lead e- source, BDS, and RF power source R&D
- with increased effort on accelerator physics & system integration
- and smaller efforts on ecloud, HA kickers & controls

HLRF details depend on progress, supplemental funding, Project X
- 2nd prototype Marx modulator speed up w extra funds
- Sheet beam klystron – Go-NoGo decision end of CY09
- RF distribution & couplers paced by FNAL schedule

New funding for cluster klystron POP expected

BDS will continue major role in ATF2, support for TDP-1

# Alignment with GDE/ILC Goals

SLAC focus is largely complementary to efforts elsewhere

- HLRF R&D ~ unique within GDE
- e- source laser and photocathode R&D also unique
  - complements gun R&D at Jlab
- System integration effort centered at SLAC
- BDS effort collaborative with UK
  - SLAC has major role in ATF2 int'l collaboration
  - also a leader in MDI design efforts
  - SLAC took lead in dumps, collimators after UK cuts
  - using SLAC RF modelling expertise for crab cavities
  - UK is leading BDS optics design efforts for new baseline
- e- cloud – SLAC led past expt'l effort, now collaborating w CESR, KEK

All efforts negotiated with ART and GDE management

# Coordination with GDE/ART

Within SLAC

Weekly meetings of BDS/ATF2 and Linac groups

Weekly ARD R&D talks (topics rotate)

Bi-weekly meetings with group leaders (with TR, NP)

Within ART

Quarterly visits from ART director (+ phone meetings)

Semi-annual visits from DOE program

With GDE

Weekly EC Webex meetings, plus quarterly face-to-face

Monthly meetings with PMs (MR @ SLAC, NW & AY  phone/Webex)

International GDE meetings (+ periodic special topic meetings)

# Recovery from FY08 Cuts ?

ILC Program emphasis and funding profile has changed irrevocably, and will not recover, until the project begins to move forward

In major ILC R&D efforts, SLAC was able to continue through FY08 at a slower pace, so recovery is adiabatic

With FY09 CR budget, M&S spending was resumed

Rebuilding workforce is more problematic. Key staff moved onto other projects, and cannot shift back quickly. Morale and lack of confidence in ILC future and in SLAC's future role in ILC is a major impediment.

DOE guidance was to stop engineering and it will not quickly recover

Overall, SLAC "Recovery" so far is reasonable given budget uncertainties

and we have just had approval for a few new hires

# Summary

SLAC remains committed to a future Linear Collider

SLAC continues to play a key role in ILC

- e- source, Beam Delivery, L-Band RF systems, e cloud
- Accelerator Physics, System Integration, HA Controls

SLAC is well integrated into the GDE effort

- many SLAC efforts are unique

SLAC was able to maintain significant effort on ILC related R&D through FY08 and through the FY09 CR.

Now ramping up to full FY09 budget.