FNAL SCRF Program Overview

Robert Kephart

Outline

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- Review Organization
- FNAL strategic plan
- Role of SRF technology
- Global SRF Landscape
- The Charge
- Goals for SRF infrastructure
- Organization and Management
- FY06 Funding and Technical Accomplishments
- FY07, FY08, and beyond
- Required Funding
- Conclusion

Review Organization

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Addressing the Questions in the Charge:

1. …key R&D issues ? M Ross
2. …scope of facilities ? S Mishra (ILC), G Apollinari (HINS)
3. …infrastructure… adequate ? S Mishra
4. …collaboration ? M Ross
5. ….U.S. industry ? P Pfund (break out)
6. …prioritized ? R Stanek

I will touch on all of these questions in this talk… plus Management & funding

- History of SRF Activities @ FNAL: Helen Edwards
- RF unit test facility: Sergei Nagaitsev
- Details of infrastructure: breakout sessions
- Tour tomorrow
- Talks and Documentation: Review Indico site:

  http://ilcagenda.linearcollider.org/conferenceDisplay.py?confId=1347

FNAL Strategic Plan

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- The Science Strategy described by Pier envisions a plan in which FNAL remains the US center for accelerator-based High Energy Physics and a pre-eminent international HEP center.
- The major Program Elements are
  - Energy Frontier Physics
  - Neutrino Physics
- ILC is the primary Energy Frontier goal
  - in parallel with a strong participation in LHC
- The next priority is a world-leading neutrino program
  - Scope adjustable depending upon the fate of the ILC.
  - New multi MW SRF linac based proton source is a key
- FNAL's plans for both the energy frontier (ILC) and neutrinos revolve around machines that employ SRF technology.
- Advanced Accelerator R&D is another key long term goal

Role of SRF Technology

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- Superconducting Radio Frequency (SRF) Technology has emerged as an important "enabling" accelerator technology
  - In many ways "like SC magnets in 1980's"
- Many SRF based accelerators exist or are under const.
  - ATLAS (ANL)
  - CEBAF (TJNL)
  - SCRF cavities for LEP, KEK b factory, etc
  - SNS (ORNL)
  - TTFII/FLASH, XFEL (DESY)
- Remarkable improvements in the achievable accelerating gradients (~ 5→35 MV/M) over the last ~ decade or so
- ➔ SRF is the chosen technology for the International Linear Collider, the next new global High Energy Physics facility
- It is being considered for many other applications

Role of SRF Technology

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- The uses of SRF go far beyond the ILC
  - High Intensity Neutrino (ie proton) Sources (HINS)
  - Front end of neutrino factories or Muon Colliders
  - Spallation neutron sources (e.g. like SNS)
  - Light Sources (e.g. XFEL)
  - Energy Recovery Linacs
  - Rare Isotope Accelerators (RIA)
  - Medical Accelerators
  - Proton linacs to drive sub-critical reactors
- High Energy Physics has developed much of the accelerator technology used by Nuclear Physics & Basic Energy Sciences
- As the only National Laboratory (after 2009) dedicated to HEP, it should be FNAL's role to be a steward of SRF technology for HEP
- Moreover, if FNAL wishes to be a viable host for ILC, we must strive to become a leader in SRF development

Global SRF Landscape

- **Europe**
  - DESY/INFN developed world leading SRF expertise and infrastructure as it built the Tesla Test Facility in support of the TESLA proposal.
  - Infrastructure is being expanded to support the XFEL
  - Strong industrial vendors involved: ACCEL, Zanon in cavity fabrication; some in processing
  - Previous experience with LEP SRF cavities at CERN
- **Japan**
  - Several decades of SRF R&D at KEK (K. Saito & others)
    - New cavity shapes and processing techniques
  - Experience with SRF cavities for KEK B factory
  - Major effort to build STF facility for ILC (CM cold this year)
  - Traditional strong working relationship with Industry

U.S. SRF

- **U.S. experience and capability:**
  - ATLAS machine at ANL
  - CEBAF and SNS experience at TJNL and ORNL
  - RIA R&D (ANL, MSU, TJNL); APT R&D (LANL)
  - SRF work was at labs and Universities (e.g. Cornell)
  - No significant industrial participation
- **FNAL**
  - Small SRF program as part of TESLA collaboration ~ 10 yrs
    - Built A0 FNPL photo-injector in parallel (twin of TTF I)
    - Supplied components to DESY (modulators, cryo parts)
    - Working to complete 3.9 GHz 3rd harmonic cavities for DESY
  - Until 2005 this was a ~ $1-2 M/yr program
- **U.S. was focused on the warm technology for ILC**

U.S. SRF

- **Change! After August 2004 ILC technology choice**
  - **SRF program at FNAL began to expand… but requires significant "up front" funding**
- **In Feb 2005, the U.S. SRF community, with strong leadership from FNAL assembled the SMTF proposal**
  - **It proposed broad expansion of U.S. SRF infrastructure**
  - **Supported multiple projects that cut across laboratories, and the HEP, Nuclear, and BES offices in the Office of Science**
  - **Requested much of the infrastructure we are discussing today**
  - **This was not supported**
- **FNAL started building SRF infrastructure in FY05 using laboratory core funds**
- **Some pieces are near completion… and precede the "charge" and the funding requested…**
- **More on the history from Helen…**

Charge 1: What are the key R&D issues faced by the U.S. accelerator community in the area of SCRF?

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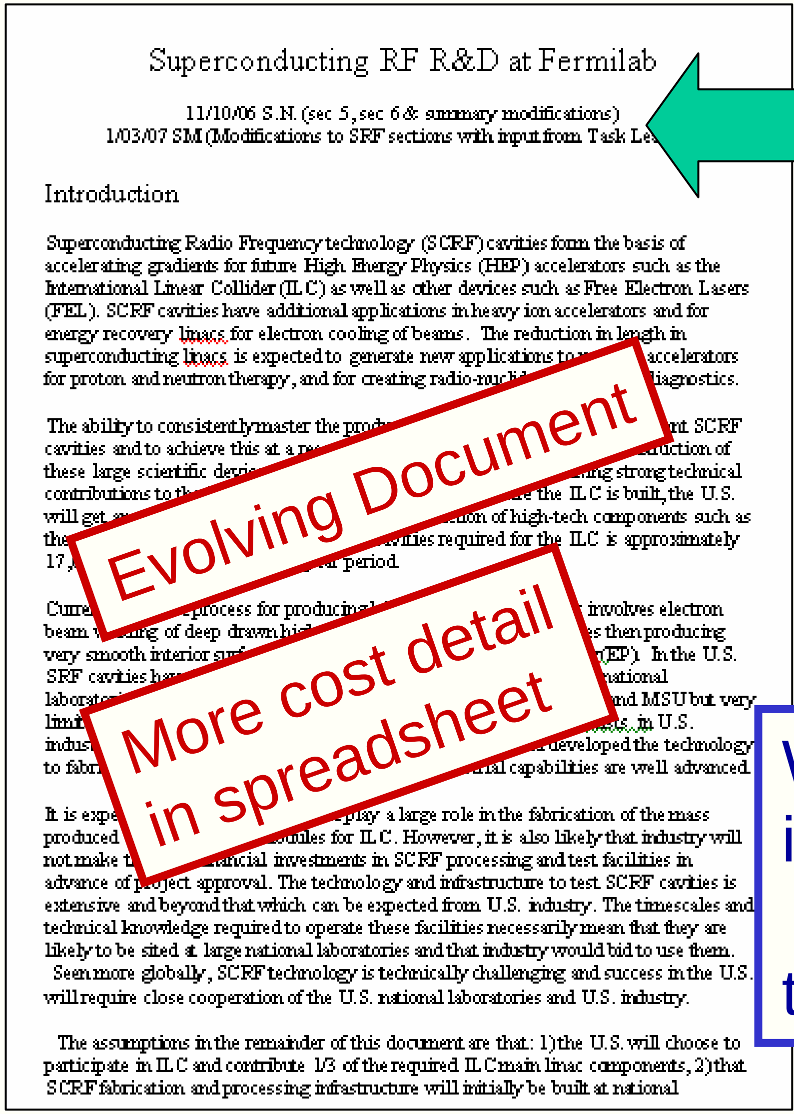
- **To perfect U.S. fabrication & processing of SRF cavities and modules and to demonstrate performance**
  - **Develop ILC design / processing / assembly techniques**
  - **Establish process controls to reliably achieve high cavity gradient**
  - **Test cavities and cryomodules at the component level and systems test to demonstrate yield, reproducibility and beam performance**
- **To facilitate commercial production of SRF components**
  - **Develop lab base to transfer SRF technology to US industry**
    - **Similar to SC cable and magnet technology transfer**
- **To participate in SRF Research and Development**
  - **To prepare FNAL as a viable host site for the ILC**
  - **Provide training for construction and operation of future accelerators**

Carry out this work within US/international collaborations to develop the kind of relationships needed for a project like ILC

Charge 2: What is the scope of facilities required at FNAL to address these key issues including those questions key to the success of the ILC?



Superconducting RF R&D at Fermilab

11/10/06 S.N. (sec 5, sec 6 & summary modifications)
1/03/07 SM (Modifications to SRF sections with input from Task Le[illegible]

Introduction

Superconducting Radio Frequency technology (SCRF) cavities form the basis of accelerating gradients for future High Energy Physics (HEP) accelerators such as the International Linear Collider (ILC) as well as other devices such as Free Electron Lasers (FEL). SCRF cavities have additional applications in heavy ion accelerators and for energy recovery linacs for electron cooling of beams. The reduction in length in superconducting linacs is expected to generate new applications to [illegible] accelerators for proton and neutron therapy, and for creating radio-nucli[illegible] diagnostics.

The ability to consistently master the prod[illegible] nt SCRF cavities and to achieve this at a re[illegible] ruction of these large scientific devic[illegible] ing strong technical contributions to th[illegible] re the ILC is built, the U.S. will get [illegible] tion of high-tech components such as the [illegible] vities required for the ILC is approximately 17,[illegible] ar period.

Curre[illegible] process for producing [illegible] involves electron beam w[illegible] ing of deep drawn hig[illegible] es then producing very smooth interior sur[illegible] (EP). In the U.S. SRF cavities ha[illegible] national laborato[illegible] nd MSU but very limi[illegible] s in U.S. indus[illegible] developed the technology to fabri[illegible] al capabilities are well advanced.

It is expe[illegible] play a large role in the fabrication of the mass produced [illegible] dules for ILC. However, it is also likely that industry will not make t[illegible] nancial investments in SCRF processing and test facilities in advance of project approval. The technology and infrastructure to test SCRF cavities is extensive and beyond that which can be expected from U.S. industry. The timescales and technical knowledge required to operate these facilities necessarily mean that they are likely to be sited at large national laboratories and that industry would bid to use them. Seen more globally, SCRF technology is technically challenging and success in the U.S. will require close cooperation of the U.S. national laboratories and U.S. industry.

The assumptions in the remainder of this document are that: 1) the U.S. will choose to participate in ILC and contribute 1/3 of the required ILC main linac components, 2) that SCRF fabrication and processing infrastructure will initially be built at national

Main Infrastructure

- Cavity Fabrication
- Cavity Processing Facility
- Vertical Cavity Test Facility
- Horizontal Test System
- Cryomodule Assembly Facility
- Cryomodule Test System
- RF Unit Test at NML

We explicitly did NOT address issues of infrastructure at other U.S. SRF institutions (but did consider their capabilities)

Charge 2: What is the scope of facilities required at FNAL to address these key issues including those questions key to the success of the ILC?

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- **Cavities and CM are a major cost driver of ILC**
- **The best cavity fabrication and surface processing can yield outstanding cavity performance (> 40 MV/m Eacc)**
  - **But the process yield is low for 9 cell cavities (cost !!!)**
  - **Evidence points to one or more uncontrolled variables**
  - **Particulates at the micron level on Nb surfaces lead to field emission, defects of 10s of microns lead to quenches**
- **Need adequate lab infrastructure to build, process, and test a large number of cavities to track down the sources of variability.**
  - **S0 ILC goal: 200 cavity process/test cycles/region/year**
  - **TJNL ~ 30-40/yr, Cornell ~ 10/yr: both institutions have other plans beyond 2008 for their facilities**
- **Clear: new large U.S. facilities are needed**

Charge 3: Will the laboratory SCRF infrastructure started in FY06 and planned for FY07 and beyond be adequate to address these key issues, and on what time scale. ...cost effective?

- Yes, the infrastructure plan we present is designed to addresses the most pressing issues identified by the ILC Research Board and by the HINS R&D program
- The time scale depends on the level of funding the program receives.
- The timeline in our plan is driven by the aggressive GDE timeline for ILC
- The proposed solutions reuse a lot of existing FNAL infrastructure and resource base → we believe they are effective in terms of cost and schedule

Charge 4: Does the laboratory make effective use of collaboration and existing SCRF assets at other laboratories and universities?

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- **Yes, our plan is built to leverage existing SCRF assets at other labs and universities**
- **Major Ramp up in SRF collaborative efforts !**

- **ANL: EP development and cavity processing**
- **Cornell: Cavity processing & test, materials R&D**
- **DESY: 3.9 GHz, cryomodule kit, TTF**
- **KEK: Cavity R&D, ATF II**
- **MSU: HPR, Cavity vendor development and cost**
- **TJNL: EP cavity processing and test**
- **INFN: tuners, HTS, NML gun cathodes**
- **Penn/Triumf: cavity tuners**
- **SLAC: RF power, klystrons, couplers**
- **CERN, DESY, KEK, INFN, etc: Type IV CM design**
- **India: Design, couplers, cavities, etc**
- **NW,UW/NHMFL, Cornell, DESY, KEK: Materials etc…**

More from Marc

Charge 5: Does the SCRF plan for FY08 and beyond make use of and develop U.S. industry at an appropriate level?

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- Not yet
- Encouraged the formation of the Linear Collider Forum of America (LCFOA) … consortia of U.S. ILC industries
- Developing U.S. cavity vendors (and one processing vendor)
- Current efforts are limited by our own ability to guide industry
- …and by available funding

Cryomodule Process	Starts with	Transitions to
Cavity Fabrication	Lab/Industry Collaboration →	**Industry**
Cavity Processing	Lab/Industry Collaboration →	**Industry**
Low Power Test (VTS)	Laboratory →	Laboratory
Cavity Dressing	Lab/Industry Collaboration →	**Industry**
High Power Test (HTS)	Laboratory →	Laboratory
Cryomodule Fabrication	Lab/Industry Collaboration →	**Industry**
Cryomodule Test (CTS)	Laboratory →	Laboratory

More from Phil Pfund

Charge 6: Is the FNAL SCRF plan configured and prioritized in a such a way that it can be sensibly scaled back should all of the requested funds not be available?

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- **Yes, however rate of progress is paced by available funding**
- **Priorities and scope largely set by the needs of the ILC R&D program and FNAL's desire to host the machine**
- **The GDE has proposed a timeline for ILC R&D and project development that we have used to prepare our plan**

- **Can we scale back ? Sure… but … we are already playing "catch up" with other parts of the world on SRF technology**
- **Management structure:**
  - **Already adapted to changes in the level of available funding**
  - **Have plans for several possible levels of funding**

More from Rich Stanek

ILC cavity goals

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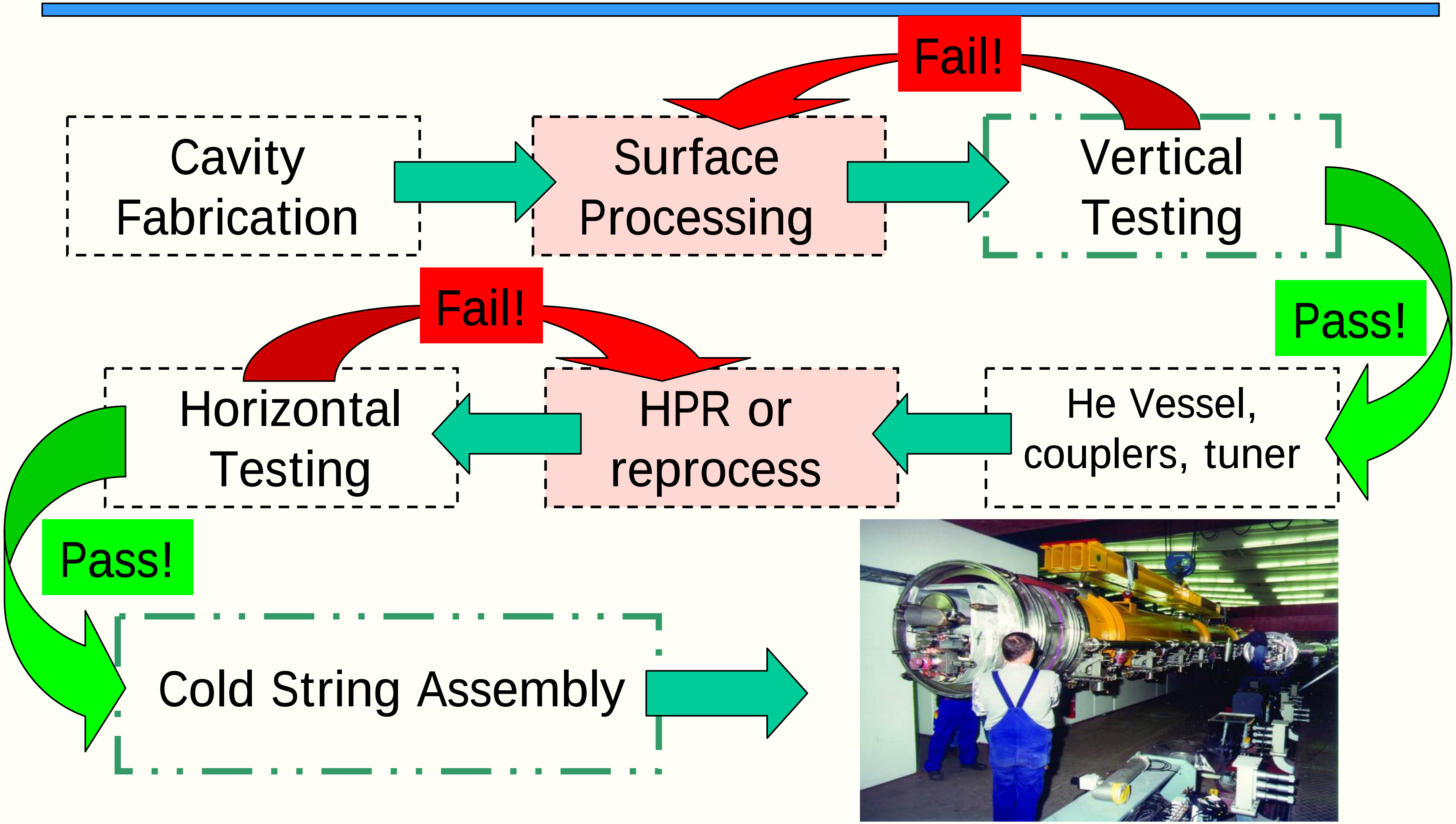
- A primary ILC R&D goal is to rapidly advance the intellectual understanding of SRF surface physics and establish process controls to reliably achieve high gradient (35 MV/M) SRF cavity operation needed for ILC (usually referred to as GDE S0 goal)
- Approach: Establish so called "tight loop" processing and test infrastructure
- Tight loop elements:
  - Cavity fabrication capability (U.S. vendors)
  - BCP & Electro-polish facilities
  - High purity water and High pressure rinse
  - Vertical test facilities
  - SRF experts & materials program to interpret results
- Note: Giorgio will address HINS goals and needs

Cavity process and testing



Plan… Develop in labs then transfer technology to industry

SCRF Infrastructure

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- **This process requires extensive infrastructure**
- **Bare cavities**
  - Fabrication facilities (Industry: Electron beam welder, QC, etc)
  - Surface treatment facilities BCP & Electro-polish facilities (EP)
  - Ultra clean H_20 & High Pressure Rinse systems
  - Vertical Test facilities (Cryogenics + low power RF)
- **Cavity Dressing Facilities (cryostat, tuner, coupler)**
  - Class 100 clean room
  - Horizontal cavity & Coupler test facilities (RF pulsed power)
- **String Assembly Facilities**
  - Large class 10/100 clean rooms, Large fixtures
- **Cryo-module test facilities**
  - Cryogenics, pulsed RF power, LLRF, controls, shielding, etc.
  - Beam tests ➔ electron source (RF unit test facility at NML)
- **It is this infrastructure that we propose to build**

Funding types

- It is important to recognize that FNAL SRF efforts are funded from 3 different sources
- ILC R&D (ILC B&R… GDE recommends)
  - Funds actual machine design effort
  - ILC cavity fabrication, processing, CM parts, etc.
  - Only funds the most crucial ILC infrastructure
- HINS R&D (lab core funds)
- SRF infrastructure (lab core funds)
  - Funds the bulk of the generic infrastructure
  - Funds operations and efforts that serve to “train” staff… e.g. 3.9 GHz effort with DESY
- This review is focused on the last category…
- However, we must note that ILC often sets the scope of the required infrastructure & ILC R&D funds sometimes have paid for significant parts of it (must consider the whole program)

An R&D program

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- Today we will show you a concrete plan for infrastructure fabrication… this is a long-term R&D "campaign"
  - The process steps and equipment to reliably produce high gradient cavities and CM are expected to evolve
  - So will the costs and milestones… they are dependent on the outcome of the R&D, project timelines, and project decisions (e.g. ILC ACD options)
- Of course a campaign must be well planned and managed !
- ➔ We are implementing appropriately tailored project management principles (and tools)
  - For example, scope definition, work breakdown structure, cost estimates, cost and effort tracking, and schedule planning
- Management structure next… (and more in Rich's talk)

Management Issues

- For the next few years FNAL must deliver on the existing program (especially Run II) while building an ILC and SRF effort
- We also recognize that success on the ILC requires the full resources of the laboratory
  - Technical, business, HR, FESS, etc.
  - Hence ILC is not organized as a project in a division
- In FY06 Pier chose to organize ILC and <u>all SRF efforts</u> by creating an office in the Directorate
- My job: ILC Program Director
  - Full budget authority for ILC/SCRF program
  - matrix management org drawing resources from the entire lab

FNAL ILC/SCRF organization

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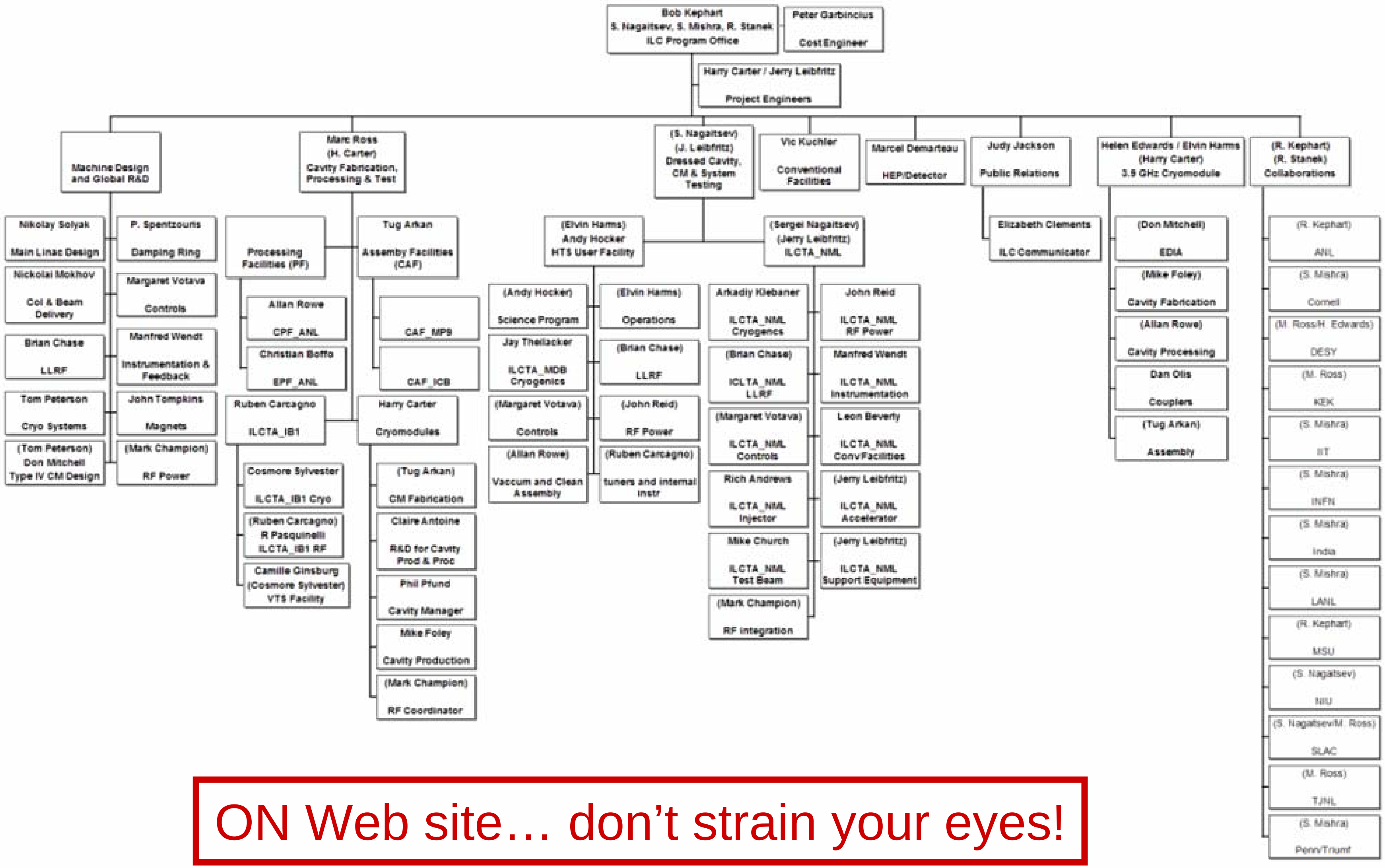
- Deputies
  - Shekhar Mishra
  - Sergei Nagaitsev
- Resource Manager – Rich Stanek
- Leaders in the Divisions and Sections
  - AD Sergei Nagaitsev
  - TD Marc Ross (as of Feb 1)
  - PPD Marcel DeMarteau
  - CD Steve Wolbers (new)
  - FESS Vic Kuchler
- Detailed organization chart (see indico site + Rich's talk)
  - Task Leaders responsible for deliverables
  - Workers may come from more than one Division
  - SWF in Division (labor agreement), M&S in Directorate
- Evolving… eg new strong additions (e.g. Ross,Wolbers, M Champion)
- Full WBS (Project 18 in FNAL financial system)
- Technical and Financial tracking in place

Organization



ON Web site… don't strain your eyes!

Financial Management

- **Full WBS breakdown of tasks**
  - **ILC Division Leaders organize efforts in each Division**
    - **Task managers responsible for budget & technical progress**
  - **SWF is assigned to Divisions for scope of work**
    - **Essentially a scope of labor agreement**
    - **High level assignments made by Division Heads in consultation with ILC Director and Division leader**
  - **M&S and management reserve held in Directorate**
    - **Division Leaders & Task leaders have signature authority**
- **Need to be flexible**
  - **Tasks change in response to R&D results & ideas**
  - **M&S available in FY06 changed 7 separate times due to incremental funding by DOE**
- **But rigorous**
  - **Fence off GDE funds dedicated to ILC R&D (separate B&R)**
  - **Directorate level "change control" in place (ie not open loop)**

Financial Management

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- Role of ILC Resource Manager (Rich Stanek)
  - Interacts with Task Managers on budget and resource issues
  - Monitors ILC (GDE) vs. SCRF Infrastructure split to assure it is done correctly (Multiple funds transfers➔Serious Issue!)
  - Oversees MOUs and financial transfers to outside institutions
  - Produces monthly financial reports (with Budget Office)
  - With Program Engineers (Harry Carter & Jerry Leibfritz)
    - Developing a resource loaded schedule & milestones
    - Produce GDE quarterly technical & financial reports
  - With input from task managers, produce summary cost estimates for FNAL SCRF program in future years
- Everything I just describe to you is NEW since Jan 06 !

GDE directed ILC R&D

- The vision of the GDE is that the ILC R&D program be proposal driven, prioritized, and optimized across the globe
  – U.S. DOE has asked the GDE Americas Regional Team (ART) Director for R&D funding recommendations
- In the U.S. in FY06 and FY07 U.S. labs and universities made proposals for ILC R&D efforts
- The ART Director (Dugan now, soon Harrison)
  – Received guidance from OHEP on available funding
  – GDE research board assigned relative priority to tasks
  – Work packages include some infrastructure
- GDE is very supportive of the proposed FNAL infrastructure (not clear how much $ we will get)

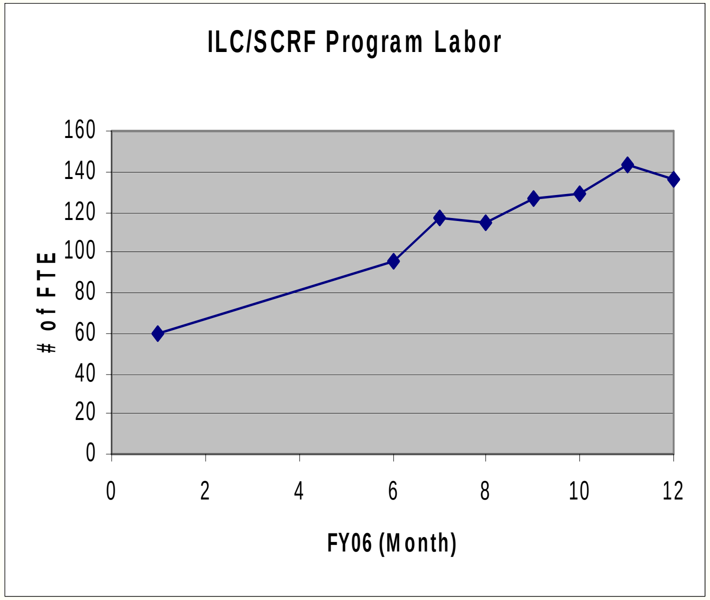
FY06 Funding

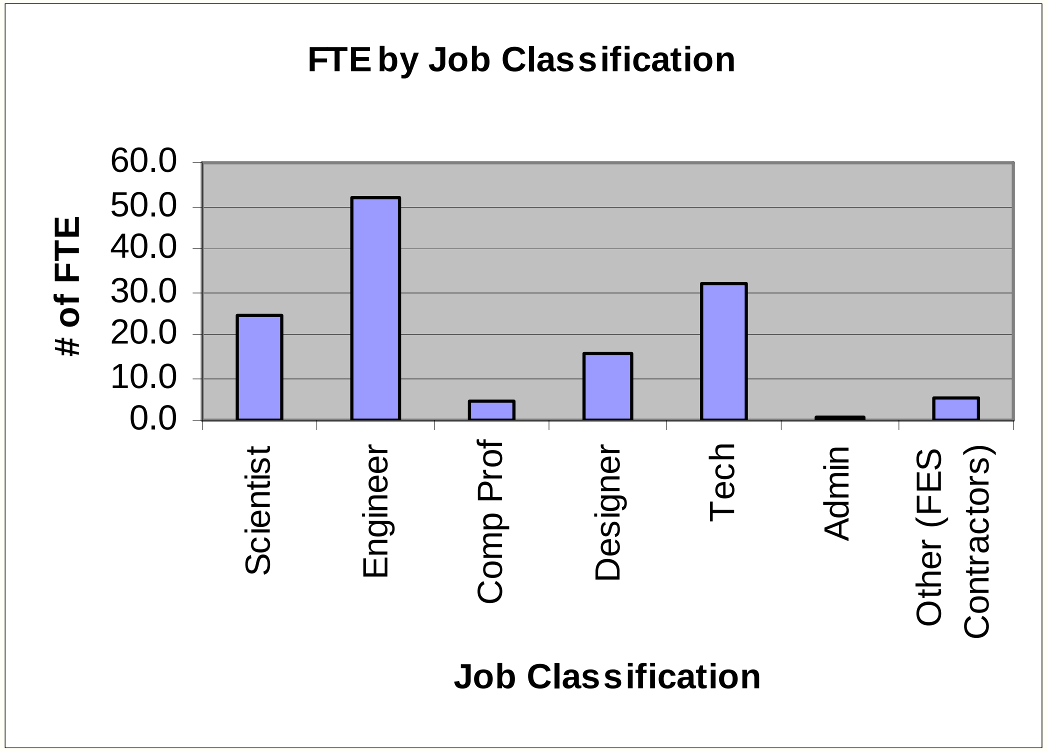
- FY06 national funding for ILC R&D was $ 30 M
  - GDE recommended ILC R&D funding to FNAL was $ 13 m
  - Some of this funded the RDR work, but part funded cavity development and infrastructure of the highest priority to ILC
  - FNAL added $ 19 M in core funds to develop generic SCRF capability & infrastructure (includes ~$3 M for DESY collaboration)
- FNAL's total FY06 ILC/SRF effort was $ 32 M
  - The numbers above include salaries and overhead
- In FY06 the FNAL workforce (ILC + SRF) ramped from 60 FTE to 150 FTE by year end
  - ie, a major increase in emphasis and effort
  - Rapidly evolving workforce and capability

FY06 Funding

- **Total "direct" spending on ILC/SRF in FY06 was $ 25,545 K**
- **Labor: FY06 spending on SWF was $ 12, 943 K**
  - Steady growth of workforce through the fiscal year (next slide)
  - Workforce increased from 60 FTE to 150 FTE at EOY
  - 72% of this labor worked on SRF R&D and building infrastructure
- **M&S: FY06 spending in was $ 12,603 K**
  - 2/3 of this went into the SRF R&D program and infrastructure
  - I'll tell you what infrastructure we built in a few slides…
- **We ended the year holding several million dollars worth of req's**
- **Our progress continued to be paced by available funding.**

FY06 Workforce





ILC/SCRF Program (SWF)			
	SWF Budget		SWF Actual
	Guidance	Revised	
AD	5250	4620	4719
CD	848	1217	1182
DIR	410	488	488
FES	0	0	9
PPD	2131	2226	2324
TD	4409	4228	4221
TOTAL	13,048	12,779	12,943

- **All Divisions contributing**
- **Full effort reporting in place**
- **Note: FES is chargeback organization so CFS work shows up as M&S expense**

FY06 Accomplishments

What did we do with the money ?

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- **ILC Design:**
  - FNAL made a large contribution to ILC RDR machine design and cost estimate
- **DESY 3.9 GHz Collaboration**
  - Fabricated, processed, & tested first 3.9 GHz cavities
  - Completed design of the CM and ordered parts
- **Capture Cavity II**
  - DESY supplied high gradient cavity
  - Repackaged @ FNAL for NML RF unit test facility
  - Extensive modifications the MDB cryogenic system were completed and demonstrated 1.8 K operations
  - 300 KW klystron, LLRF, etc installed/commissioned
  - Successfully operated the cavity at 31.5 MV/M
  - A great success !

FY06 Accomplishments

- **Cavities:**
  - Purchased & received 4 TESLA cavities from ACCEL (Europe)
  - Ordered 4 TESLA cavities from AES a U.S. vendor
    - first step in qualifying them to make ILC cavities,
  - Ordered single cells from Roark/Niowave (new companies)
  - Ordered two standard TESLA cavities from TJNL
    - experienced cavity fabricators…as a bench mark
  - Large Grain: Ordered two large-grain TESLA cavities from TJNL to explore BCP processing as an alternative
  - Late in the year ordered another 15 cavities (9 ACCEL, 6 AES)

  - 27 cavities ordered… 5 in our hands…

FY06 Accomplishments

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Cavity Processing:

- **Cornell: in collaboration**
  - Use existing BCP facilities to process cavities
  - 1st ACCEL cavities 26.5 MV/M achieved
  - Building a vertical EP system; FNAL personnel @ Cornell
- **TJNL: in collaboration to upgrade TJNL facilities to EP process and test TESLA cavities; FNAL personnel @ TJNL**
  - 2nd ACCEL cavity achieved 29.5 MV/ M
  - 3rd ACCEL cavity achieve 40 MV/M
  - TJNL will soon process 1st AES cavities (just received)
- **ANL: Extensive plans for future close collaboration**
  - Collaboration to process 3.9 GHz cavities.
  - Completed a joint EP/BCP processing facility @ ANL
  - Collaborative design of EP system for 1.3 GHz cavities @ANL
- **Strong collaborations with experienced SRF institutions**

FY06 Accomplishments

Started to build SRF infrastructure !

- **Vertical Test System (1st of 3 planned for IB1)**
  - Tests bare 1.3 GHz cavities
  - Design and civil work complete, components ordered
  - Operational by Summer 07
- **Horizontal Test System (MDB)**
  - RF system Ready
  - Cryo connections in MDB and Cryostat almost done
  - Operational by Summer 07
- **Cryomodule Assembly Facility (MP9 and ICB)**
  - Buildings cleaned out
  - Large clean room ordered and installed
  - Extensive fixtures designed and procured (DESY copies)
  - Should be operational to assemble 1st cryomodule kit from DESY in spring-summer 07

FY06 Accomplishments

Started to build RF unit test facility

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- RF unit test facility (ILCTA_NM)
  - Extensive Facility Design work in progress
    - Electron source design
    - Building Layout, Dump and shielding design
    - RF systems, instrumentation, controls, etc
  - Cleaned out New Muon Lab, including removal of 2500 Ton CCM magnet and began building refurbishment
  - Established collaborations
    - DESY (rf gun, LLRF);
    - INFN-Milano (photo-cathode system);
    - NIU (injector design);
    - Rochester University (laser);
    - Argonne (controls);
    - SLAC (rf power, crab-cavities, controls);
    - The Cockcroft Institute – Daresbury (crab-cavities)
    - KEK (klystron, gun)
  - Began installation of satellite refrigerator
- More on all of this in Sergei's talk

Infrastructure MAP

FY07: A key year for ILC R&D

- **Cavity R&D:**
  - Need to purchase enough cavities to measure yield (~25-50)
  - Need to process and test cavities and put them in CM
- **Cryomodule R&D:**
  - Assemble 1st Cryomodule in the U.S.
  - Purchase parts for 2nd Cryomodule (1st with U.S. cavities)
  - Improve design and work on cost reduction (involve US Industry)
- **SRF Infrastructure:**
  - Need to build and make operational cavity processing and test infrastructure: EP processing, VTS, HTS, dressing facility
  - Finish the Cryomodule fabrication infrastructure
- **RF Unit Test:**
  - Prepare ILCTA_NM infrastructure to test DESY CM (ie RF & cryogenics)
- **EDR Launch: Opportunity to take a major leadership role in ILC**

FY07 Funding

- **Assuming $ 60 M funding for ILC in FY07, the GDE recommendation for FNAL is $22.7 M**
  - **A big increase, but far less than the $ 56 M (180 FTE) program we requested, insufficient to support the existing workforce**
  - **Doesn't support site specific civil work or industrialization**
  - **Recommended additional support of staff & infrastructure from other funds (depends on availability of lab's core funds)**
- **But no FY07 budget...Continuing resolution…delay**
  - **Now expect about $ 42 M for the program**
  - **$22.7 M ILC & $20 M SRF core funds (with indirects)**
- **At this funding level about $ 14 M M&S (direct) would be available for <u>both</u> ILC R&D activities and SRF infrastructure**
  - **ILC: travel, cavity purchase, processing, EDR, etc**
  - **SRF R&D program: 3.9 GHz, materials program, etc**
  - **SRF Infrastructure: (this review)**

FY08 and beyond

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- Presidents FY08 budget = $ 60 M for ILC and $ 23.5 M for SRF
- ➔ no increase in funding
- How do current funding levels compare to the required scope of SRF infrastructure required ?
  - DESY spent ~ $150 M of M&S to build TTFII and infrastructure.
  - The infrastructure we plan in the next ~ 3 years is comparable in scope to TTFII expenditures at DESY
  - But… ILC facilities needed are more advanced… higher gradients (cleaner) and higher cavity/CM throughput
  - But… many pieces of infrastructure exist at FNAL that we can be exploited (buildings, refrigerators, A0 photo injector parts, etc)
- Our infrastructure proposal has $ 73 M of M&S one has to add to that the cost of cryomodules to populate ILCTA_NM
- At ~ $ 14 M of M&S/yr (direct) it will take many years to complete these facilities and carry out the planned the R&D

Required Funding

Infrastructure	M&S		SWF		Total with Indirect	
Cavity Fabrication Infrastructure	$	3,000	$	675	$	4,380
Cavity Processing Facilities	$	11,100	$	4,590	$	18,945
Vertical Test Stand (VTS 2 & 3)	$	2,625	$	1,845	$	5,475
Horizontal Test Stand (HTS 2)	$	1,220	$	1,057	$	2,805
Cavity/Cryomodule Assembly Facilties (CAF_MP9 & ICB	$	690	$	270	$	1,158
NML Facility (ILCTA_NML)	$	18,270	$	23,220	$	51,700
Cryogenics for Test Facilities	$	10,690	$	950	$	13,692
Cryomodule Test Stand	$	5,400	$	2,970	$	10,180
Material R&D	$	870	$	722	$	1,960
Illinois Accelerator Research Center	$	20,000	$	4,050	$	28,605
Grand Total ($k)	**$**	**73,865**	**$**	**40,349**	**$**	**138,900**

- **We envision the required infrastructure to be built in stages over the next 3-4 years with the pace limited by funding**
- **Rich Stanek's talk will address the issue of funding profiles and the associated schedule and milestone impacts**

Conclusions

- I have described to you the importance of SRF as and "enabling" technology for HEP.
- In the talks that follow we will:
  - Address the questions in the charge in more detail
  - Identify the key issues for SRF R&D
  - Describe plans for the needed generic infrastructure
  - Present details of the estimated cost and schedule
- Our aim is to convince you that this crucial enabling technology urgently needs significant investments at FNAL (AND at other U.S. SRF institutions)
- We also hope to convince you that we have a well thought out and managed R&D program that leverages existing U.S. expertise and infrastructure and is appropriate in its scope for an HEP laboratory like FNAL

End

- **Questions ?**

Why is this not just an ILC R&D expense?

After all, the ILC in many ways “sets the bar” for the needs

Answer:

- ILC fund the Project R&D (cavity purchase, processing, test, etc)
- ILC also funds some critical infrastructure
- …but ILC is a global project.
  - The GDE steers ILC R&D funds at the most pressing issues for the benefit of “project”
  - ➔ ILC has used existing U.S. SRF institutions to get “quick” answers it needs to make project decisions
  - With little SRF infrastructure FNAL has been at a disadvantage to seriously engage in this activity

Why is this not just an ILC R&D expense?

Fermilab

- Generally acknowledgement that existing U.S. SRF infrastructure is inadequate in terms of throughput, process control, etc
  - The GDE does not have the responsibility for building generic SCRF capability at any laboratory or in any region
  - This responsibility belongs to the labs and the DOE
- Also: HINS or other U.S. SRF projects will benefit from improved infrastructure and from successful SRF R&D so the costs should not all fall on ILC
- In this review we will present our best estimate to complete needed FNAL infrastructure over the next few years regardless of the funding source