Conclusions

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Importance of SRF

- **Hopefully we have convinced you that SRF is a significant enabling technology likely to be used in almost ANY new HEP facility**
  - **and that FNAL as the ONLY U.S. HEP lab after 2010, must have command of this technology, especially if it wishes to be a viable host for ILC**
- **We have presented the scope of facilities and infrastructure we believe is appropriate for FNAL as it pursues and SRF R&D program with national and international partners to address the key questions**
- **We have presented the priorities and estimated costs for supporting infrastructure**
  - **ILC (Drives the scope)**
  - **HINS, Muon Collider front ends, AARD, etc all benefit**

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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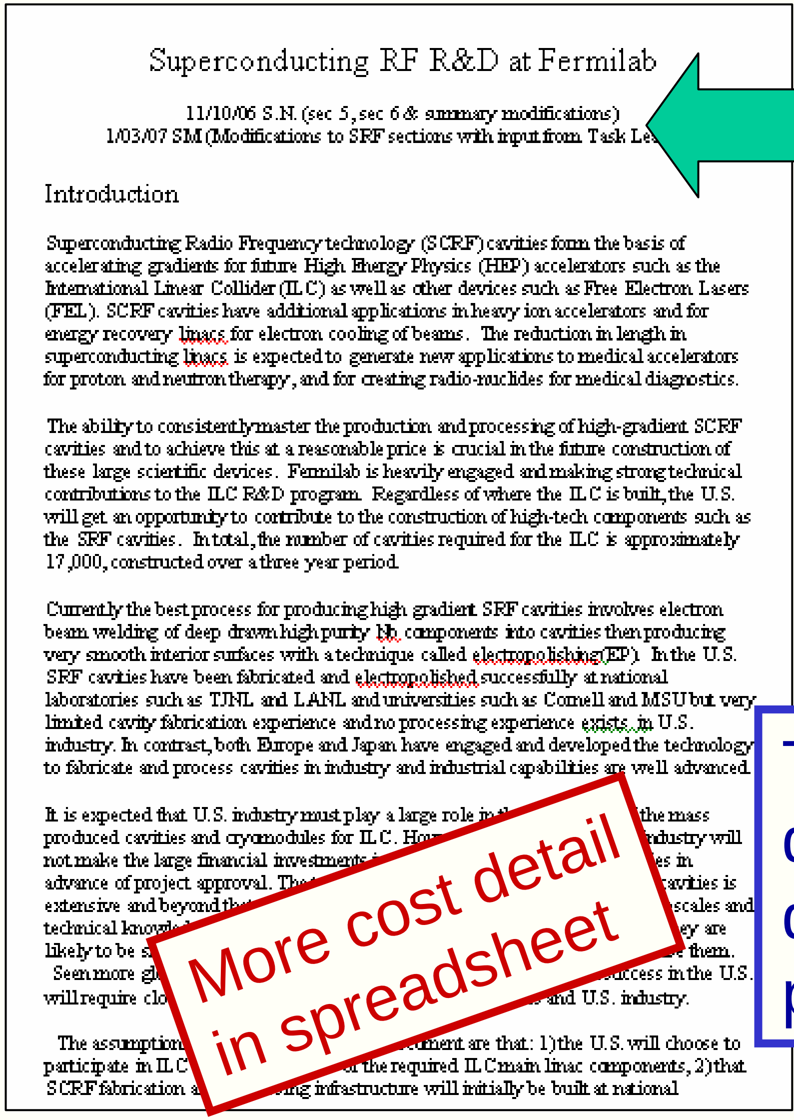
- **To perfect U.S. fabrication & processing of SRF cavities and modules and to demonstrate performance**
  - **Develop ILC design / processing / assembly techniques**
  - **Establish process controls to reliably achieve high cavity gradient**
  - **Develop SRF spoke resonators for HINS and RIA**
  - **Test cavities and modules at the component level and in a 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**
- **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**

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...

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 medical accelerators for proton and neutron therapy, and for creating radio-nuclides for medical diagnostics.

The ability to consistently master the production and processing of high-gradient SCRF cavities and to achieve this at a reasonable price is crucial in the future construction of these large scientific devices. Fermilab is heavily engaged and making strong technical contributions to the ILC R&D program. Regardless of where the ILC is built, the U.S. will get an opportunity to contribute to the construction of high-tech components such as the SRF cavities. In total, the number of cavities required for the ILC is approximately 17,000, constructed over a three year period.

Currently the best process for producing high gradient SRF cavities involves electron beam welding of deep drawn high purity Nb components into cavities then producing very smooth interior surfaces with a technique called electropolishing (EP). In the U.S. SRF cavities have been fabricated and electropolished successfully at national laboratories such as TJNL and LANL and universities such as Cornell and MSU but very limited cavity fabrication experience and no processing experience exists in U.S. industry. In contrast, both Europe and Japan have engaged and developed the technology to fabricate and process cavities in industry and industrial capabilities are well advanced.

It is expected that U.S. industry must play a large role in ... the mass produced cavities and cryomodules for ILC. How... industry will not make the large financial investments ... es in advance of project approval. The ... avities is extensive and beyond th... scales and technical knowl... ey are likely to be ... them. Seen more gl... ccess in the U.S. will require clo... and U.S. industry.

The assumption... ment are that: 1) the U.S. will choose to participate in ILC ... the required ILC main linac components, 2) that SCRF fabrication a... ing infrastructure will initially be built at national

More cost detail in spreadsheet

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**

The scope of facilities has been described in the talks with more detail provided in the " white paper" provided to the committee

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**
  - **This is a major cost driver for ILC**
- **Need adequate lab infrastructure to build, process, and test a large number of cavities to track down the sources of variability.**
  - **S0 ILC goal: > 100 cavity process/test cycles per year**
- **Proposal is for a new large facilities at FNAL coupled to an R&D program based upon national and international collaboration**

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?

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- Yes, the infrastructure plan we propose will allow us to addresses the key SRF issues in a timely way
- 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 ➔ we hope we have convinced you that they are both cost effective and expedient

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

Fermilab

- **Yes, our plan is built to leverage existing SCRF assets at other labs and universities**
- **Many collaborative SRF efforts**

- **ANL**: EP development and cavity proc... g
- **Cornell**: Cavity processing & test, ...als R&D
- **DESY**: 3.9 GHz, cryomodule ki...
- **KEK**: Cavity R&D, ATF II
- **MSU**: HPR, Cavity vend... ...elopment and cost
- **TJNL**: EP cavity pr... ...g and test
- **INFN**: tuners, H... ...L gun cathodes
- **Penn/Trium**... ...y tuners
- **SLAC**: ... ...er, klystrons, couplers
- **CER**... ...SY, KEK, INFN, etc: Type IV CM design
- **India**: Design, couplers, cavities, etc
- **NW,UW/NHMFL, Cornell, DESY, KEK**: Materials etc…

We are not trying to do this all ourselves

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

- **Not yet**

- **Current efforts are limited by:**
  - **Our own ability to guide industry (tech transfer)**
  - **Available infrastructure**
  - **Available funding**

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 timeline for ILC project 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
- Contingency ?
  - We have not included explicit contingency… but we established priorities
  - the pace of progress is set by available funding so the contingency is the schedule

Management

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- The program has existed a little more than one year
- We described our technical accomplishments
- We have described the FNAL ILC/SCRF organization and management structure
- We presented our plans for new infrastructure
  - appropriate to support the goals and objectives of the ILC and other future SRF projects in the U.S.
- We have a full WBS breakdown of the tasks
- Work agreements with FNAL divisions and sections
- MOU's with collaborating institutions
- Financial and effort reporting … all in place
- We are working on a resource loaded schedule

What do we want from this review ?

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- We want your recommendation that the DOE fund an SRF program at FNAL at about $ 40 M/yr

  (ie twice the current $ 20 M/yr level)
- These funds are in addition to ILC, HINS R&D funds
- This would mean that ~$ 25 M/yr of M&S would be available allow construction of needed FNAL infrastructure
- We also would like you to recommend that the DOE improve infrastructure at other U.S. SRF institutions