**1. NAME OF INITIATIVE:** Superconducting RF Module Test Facility (SMTF)

*List of major collaborating institutions (including non-US partners).*

The list below includes US institutions that have participated in the two SMTF meetings that have been held at ANL in February and May 2004. In order for these institutions to collaborate they must have resource support from their funding agencies or through this initiative. As the formation of the collaboration is just now underway, the interests, roles and responsibilities of the individual labs has yet to be defined. Major collaborating institutions would be likely to be the present US TESLA collaborators (ANL, Cornell, Fermilab, JLab, MIT) and DESY.

US institutions:
  Fermilab, Cornell University, ANL, BNL, JLab, LANL, LBNL, MIT, MSU, SNS.

Non US institutions:
  DESY, other TESLA Collaborators.

**2. SCIENTIFIC JUSTIFICATION:**

*Physics goals. How does it fit into the global physics goals for the entire field.*

Physics goals

The goal of the SMTF is to establish in the US a superconducting RF module test facility with capabilities beyond that present at any US lab. Such a facility could be used as a R&D test bed for future SRF projects. In particular the SMTF would allow for development of SRF technology for the Fermilab SRF based Proton Driver and for a cold International Linear Collider (if that technology is chosen). It could also provide as a further step, a test bed for research and development of CW SRF technology that is key to many future DOE and NSF proposals.

The consensus from the two meetings held at ANL was that there could be considerable advantage for constructing a superconducting cryomodule test facility or SMTF in the US.

Major sub-areas of common R&D interest across many proposals that were identified during the meetings are:

1) Demonstrate 35 MV/m at 1% duty factor with high beam loading at 1300 MHz.
2) Demonstrate >15 MV/m high duty factor operation at beta~0.5 at Q>5E9. Multiple cavities should be fed from one klystron.
3) Demonstrate 20 MV/m CW operations at Q values > 2E10.
4) Operate at 20 MV/m at a Qext > 10E7 for low beam loading applications. (Necessary in order to keep CW RF power demands within reasonable bounds.)

These goals encompass research and development topics critical for continued iteration and evolution of SRF LC linac systems, for development of cost effective medium and high beta linac sections needed for proton/ion linacs (Proton Driver), and for the development of CW operation for the many upcoming light source applications,.

Global Perspective

There is a strong technical base for Superconducting RF technology (SCRF) in the US. A variety of projects are being planned in particular physics, nuclear physics, basic energy sciences like condensed matter physics, and biological physics that propose to use SCRF linac technology. These projects are distributed across many of the major US laboratories funded by DOE and NSF. Many are on the DOE 20 Year Roadmap.

We list several possible future projects that will use RF Superconductivity.

1) The Rare Isotope Accelerator (RIA) (located at Argonne or MSU) would use a SCRF linac. RIA will help drive the development of SCRF in US industry.
2) Fourth generation light sources at ANL, BNL, Cornell, JLAB, LBL, and MIT using SCRF as a Linac, ERL or FEL.
3) Brookhaven plans to use ERLs for electrons colliding with RHIC heavy ion beams (E-RHIC) and for electron cooling of the RHIC beams.
4) Upgrades (12 GeV) to JLAB electron linac, the extensions of the FEL and the proposed ELIC (Electron Light Ion Collider).
5) SNS upgrades to achieve higher beam power ~ 4 MW.
6) Proton driver at Fermilab and BNL.
7) International Linear Collider (ILC) if "cold" technology is chosen.

All these projects have common or similar systems and developments that could benefit from coordinated efforts. Many could benefit directly from a common module test facility not available in the US at present.

A specific proposal is in preparation and expected to be available in the fall of 2004.

## 1. VALIDATIONS FOR SCIENTIFIC JUSTIFICATION:

*Examples of recommendations and supporting statements from the committees, panels, and the community at large.*

DOE and NSF hosted a joint workshop in July 2003 to explore the opportunities for collaboration between the laboratories. More meetings are planned.

The summaries and presentations from the ANL meetings can be found at:

http://www.aps.anl.gov/asd/SMTF/SMTF.html.

Presentations by the US "Cold LC" group to the ILC International Technology Recommendation Panel (ITRP) can be found at:

http://www.ligo.caltech.edu/~donna/ITRP_mt5.htm

In addition nine labs have responded to ITRP questions 33 and 34.

33) Describe the effect upon your laboratory of a) the warm vs. cold decision, and b) choice of site.
34) Discuss the support of the accelerator community for your technology and to what ever extent your technology has outreach into other accelerator areas.

## 2. DESIRED SCHEDULE:

*List major milestones (month & year) such as design complete, construction start, construction complete, etc.*

Schedule considerations at this time focus on the development of the infrastructure and test facility necessary for Proton Driver and LC technology development. These two efforts have much common and overlapping development needs, and they are based directly on TESLA technology. CW module R&D uses much of the same infrastructure but would require different module design and RF systems to develop the CW capability of major interest for a number of future proposals.

Three main phases in development of the PD or LC module test bed part of SMTF are: 1) Bring into operation one TESLA like module with RF and cryogenics, and with the goal of demonstrating 35 MV/m. (This may take more that one iteration.) 2) Bring into operation one "RF unit" of 3 or 4 modules (32-36 cavities) and an injector so that beam measurements can be carried out. 3) Bring into operation an X% ILC demonstration linac/ Proton Driver. In this 3rd phase, the last 85% of an 8 GeV Proton Driver linac could serve as an ~ 1% ILC demonstration and facilitate low rate industrial production of the linac for a LC. The phase 2 development (modules and injector) could be used further as an electron injector to the beta =1 modules of the proton driver. What we describe here as phase 3, except for the electron source, would be covered by a Proton Driver Project.

It is expected that Phase 1 would take ~2 - 2.5 years (e.g. 2005-2006+), Phase 2 ~ 2.5years (2006-2008) with overlap in 2006 and transition to Phase 3 in 2008.

## 3. ROUGH ESTIMATE OF COST RANGES:

*Whatever the best information available (e.g. $M +/-30~50%, $150~250M, etc.). Total cost range including non-DOE funding (if any other funding sources are assumed and if known, state from where and how much. Also indicate remaining R&D cost to go.*

Rough estimate 40$M +/- 50% (~10M$/y). Considered to be R&D and Capital Equipment (Cryoplant). Major technical assistance, but not funding, is anticipated from DESY. A rough estimate of manpower for the SMTF initiative is ~50FTE/y. Labor would be mostly from engineering departments and with technician support. Accelerator and RF physicists would be required to guide the effort.

## 4. DESIRED NEAR TERM R&D:

*Major activities needed to be completed before start construction.*

We do not consider this to be a construction project but rather an evolutionary R&D program in SRF technology. The desired near term program would be to establish the necessary infrastructure for Phase 1, including assembly and test of a first cryomodule. The infrastructure includes: preparation of building space (Meson Hall), cryogenics, RF, and SRF specific infrastructure. It also includes migration/upgrade of the FNPL (A0) photoinjector to the new location.

## 5. BRIEF DESCRIPTION OF LABORATORY'S ANTICIPATED ROLE:

*Expected unique capabilities to be provided by lab. Rough estimate of human resources from lab (#FTE in what type labor).*

Fermilab is pursuing linear collider and Proton Driver R&D in parallel. The Superconducting Module Test Facility (SMTF) is the key vehicle for carrying out that R&D in either area (assuming a cold LC technology choice, however we anticipate pursuing Proton Driver R&D independent of the technology choice.).

Fermilab has long term cryogenic and superconducting magnet experience in design fabrication and operation. It has growing expertise in SRF and has been a major collaborator in TESLA since its inception. Fermilab is in a unique position as a HEP lab to lead a US SRF collaboration. In the event of a cold LC decision Fermilab would be ready and able to assume the leadership role in establishing a US collaboration to push SRF development under the aegis of an international LC organization. This leadership role will involve further building of the US SRF collaboration (initiated as SMTF), developing plans for SRF linac development and testing in the US, and in coordination with TESLA and Japan, bringing industrial participation to the activity.

Also refer to Linear Collider and Proton Driver Initiatives.