THE INTERIM US MARKET FOR SCFR TECHNOLOGIES

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Superconducting Particle Accelerator Forum of the Americas

Superconducting RF Cavity Technology and Industrialization

A Satellite Workshop at IPAC-2010, May 23, 2010

Scope

- Interim market defined as 2010-2015
- Limited to SCRF Accelerators
- Focus on potential US government programs, primarily in discovery science
- Other possible SCFR opportunities from Accelerators America symposium in Washington, DC in Oct 2009

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SPAFOA Overview

- Provide a network for our industry members to interact with government funded SCRF technology
- Provide members current information on the progress and issues related to these programs through newsletters, bulletins and meetings at the National laboratories and in DC.
- Prepare and present briefings and industry position papers on behalf of the forum on specific management and technical issues where relevant industrial capability will benefit the programs.
- Facilitate two-way technology transfer between industry and government funded activities.

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SPAFOA Overview

- Active membership of 20 U.S. and Canadian companies
- Not-for profit, supported by member dues, no financial support from government
- Information and membership information available at www.spafoa.org

U.S. Science Market

The following major SCRF accelerator projects are currently in the U.S. science pipeline:

- Continuous Electron Beam Accelerator Facility (CEBAF), Thomas Jefferson Lab National Accelerator Facility, Newport, News, VA
- Proposed Relativistic Heavy Ion Collider Upgrade (eRHIC), Brookhaven National Laboratory (BNL), Brookhaven, NY
- Facility for Rare Isotope Beams (FRIB), Michigan State University, East Lansing, MI
- Proposed Project X, Fermilab, Batavia, IL
- Big Light, Florida State University
- SNS Upgrade, Oak Ridge National Laboratory (ORNL), Oak Ridge, TN
- LBL FEL

U.S. Market Uncertainties

- Annual Congressional Appropriations
- Technology and project goals and schedules (DOE Order 413.3)
- Laboratory make or buy decision
- Off-shore competition
- Technology transfer
- Post 2015 readiness for the ILC

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CEBAF Upgrade

Upgrade the power of the accelerator from 6 GeV to 12GeV

- Ten new higher-voltage cryomodules, i.e., superconducting radio-frequency (SRF) accelerating elements (five per Linac).
- Ten new RF stations to power the new cryomodules.
- Approximately double the refrigeration capacity.

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Relativistic Heavy Ion Collider Upgrade (PROPOSED) (eRHIC)

- eRHIC project adds a high intensity electron beam with an energy up to 30 GeV colliding with the 100 GeV/n gold beams and 250 GeV polarized proton beams of RHIC.
- The CW electron beam will be accelerated with an Energy Recovery Linac (ERL) to maximize the achievable luminosity.
- Construction start post 2015

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Facility for Rare Isotope Beams (FRIB)

- The new National user facility at Michigan State Univ. to provide intense beams of rare isotopes (short-lived nuclei not normally found on Earth).
- FRIB will provide scientists critical information about the properties of rare nuclear isotopes found in the universe in order to better understand the origin of the elements and the evolution of the cosmos.
- Researchers will also be able to use FRIB to conduct experiments addressing questions of the fundamental symmetries of nature

Project X (Proposed)

- Provides the most powerful beam of high-energy neutrinos for a long-baseline neutrino experiments.
- Will be the world's most intense beams for muon, kaon, and low-energy neutrino physics.
- Develop and exercise the technologies needed for future projects at the energy frontier.

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Cornell Energy Recovery Linac (ERL) (Proposed)

- The ERL proposed to be built at Cornell will serve as an upgrade to the Cornell High Energy Synchrotron Source (CHESS) and will be the first-ever ERL diffraction limited hard x-ray source.

- Cornell is about to start construction of a prototype cryomodule for the ERL.

SNS Upgrade

- The SNS is a neutron science user facility at Oak Ridge National Laboratory
- It is the world's most powerful pulsed neutron source, providing the world's most intense pulsed neutron beams
- Became operational in 2006, SNS performance has ramped-up to 1 MW beam power on target, ~5000 hrs per year and ~85% availability
- Upgrade will double the SNS beam power by Increasing beam energy with 9 additional cryomodules plus other hardware improvements
- Est. construction start FY-12

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High Repetition-Rate Soft X-Ray Facility (Proposed)

- To Produce ultra-fast pulses of X-rays controlled by optical lasers
- Continuous stream at 100 kHz or greater repetition rate
- Concepts under study at LBNL

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ATLAS Facility

- Intensity upgrade of ATLAS accelerator
- DTRA prototypes
- Phase II intensity and energy upgrade

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Big Light - Florida State University

- Construction of a fourth-generation free electron laser light source alongside the lab's world-leading high magnetic field user facility at FSU

- Provide transformational research opportunities in disciplines spanning condensed matter physics, materials science, chemistry, biochemistry, biology and medicine

U.S. SFR Accelerator "Science" Market Estimate Production Orders 2010-2015

Project	**SRF Cavities**	**Cryo-modules**	**Estimated Market $M**
CEBAF JLab	86	10	17
FRIB MSU	336	46	100
PROJECT X FNAL	445	58	87
CORNELL ERL	304	58	87
SNS UPGRADE ORNL	36	9	18
ATLAS ANL	20	3	5
Total	1227	184	314M

ACCELERATOR PRODUCTION OF MOLY-99

- NNSA issued a Funding Opportunity Announcement for the demonstration and production of Moly-99 in March 2010
- Accelerator technology is one option specified for this objective
- Requires cooperative cost sharing agreement with contractor (NNSA contribution capped at $25M)
- Goal is to have a totally commercial venture by Dec. 2013

U.S. Navy FEL Program

- U.S. Navy is studying the application of FEL technology to shipboard missile defense
- Initial R&D performed at JLab FEL user facility
- Two contractors selected to perform preliminary designs (Raytheon and Boeing)
- System will use SCRF accelerator technology
- Decision to select one and possibly proceed with a land based prototype by summer 2010.
- Details of the program are classified

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Emerging Opportunities for Accelerators

- DOE Office of High Energy Physics sponsored a workshop and symposium “Accelerators for America’s Future” in Washington, DC in Oct. 2009

- Working groups identified opportunities for applications of various accelerator technologies in the areas of Energy and the Environment, Medicine, Industry, Security and Defense, and Discovery Science.

- Working groups were comprised of experts from outside DOE’s Office of Science.

- Estimated release of report, June 15, go to www.acceleratorsamerica.org to request a copy

Energy and the Environment

- Accelerator-driven subcritical reactors, accelerator-driven transmutation of spent nuclear fuel, inertial confinement fusion

- High-power hadron accelerators to validate materials for use in advanced nuclear systems

- Low-energy, high power electron accelerators for clean air and water

Medical

- Accelerators with particle energies from 10 to several hundred MeV to produce clinical and research isotopes
- Improvements in beam shaping and delivery designs to maximize the therapeutic efficiency and reducing the dose outside the treatment area.
- Significant reductions in the size and costs of systems

Industrial

- Increase use of accelerator technology to save energy in industrial processes.
- Establishment of a large-scale industry-friendly accelerator user facility.
- Integrate a training program for future accelerator scientists and engineers with the facility.

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Security and Defense

- Compact accelerator systems: low cost, small size, energy efficient, rugged, highly reliable
- Ease of operation in field applications
- Reduction in the use of long-life radioactive isotopes used in current systems

Discovery Science

- Nuclear Physics: High intensity low-loss ion accelerators for the efficient production of radioisotopes
- Particle Physics: Larger accelerator gradients for more compact and lower cost accelerators
- X-ray and Photon Science: Improved in beam loss mechanisms

Industrial Value Added

- Working groups identified several areas beyond increasing higher gradient and beam accuracy of accelerators where industry expertise can add value:
  - Increase the reliability and maintainability of the accelerator system
  - Cost reductions through system engineering
  - More rugged, field deployable systems
  - Operator interfaces, simpler controls
  - User facility for commercial applications

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Conclusions

- U.S. Industry can meet the demands of the domestic SRF market through 2015, however they are reluctant to invest in manufacturing plant and equipment based on risk

- Government (DOE,DOD, and NSF) must look at the overall picture and structure a cooperative industrialization program to fund and jump start these investments

- Meeting the demands of the post 2015 ILC program, estimated at producing 6000 cavities/region, is a major paradigm shift must be treated as a project

  - **Major manufacturing and tooling investment**
  - **One time volume, write off tooling expenses on the ILC alone**
  - **Probability of technology being superseded post 2020**

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