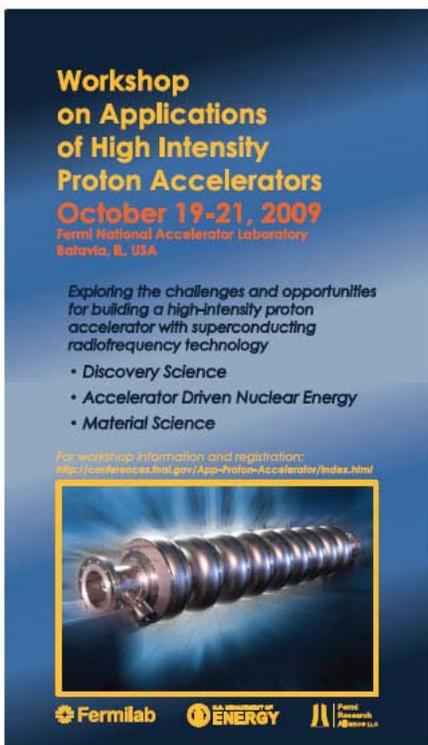


Workshop on Applications of High Intensity Proton Accelerators

October 19-21, 2009

Fermi National Accelerator Laboratory, Batavia, IL, USA

<http://conferences.fnal.gov/App-Proton-Accelerator/index.html>



Recent advances in superconducting radiofrequency technology have made it possible to construct high-intensity proton accelerators with 10 Milliamps of current or higher and energies exceeding 1 GeV. Fermilab is developing a design of a High Intensity Proton Linac, known as Project-X, to support future High Energy Physics Programs. The workshop proposes to bring together researchers working in areas as diverse as:

- Production of high intensity proton beams for neutrino, muon and kaon physics and a proposed muon collider and neutrino factory
- Accelerator-based solutions for nuclear energy
- Nuclear and material science and material production

Fermilab's future accelerator R&D program is focused on an SRF linac for the proposed Project-X, International Linear Collider and any other future machine. The present design of the Project-X linac will provide 2 Megawatts of pulsed beam power at 8 GeV. The workshop will cover topics related to challenges in the design of high-power continuous wave and pulsed linear accelerators.

The purpose of the workshop is to explore the possibility of diversifying and maximizing the utilization of the proposed upgrade to the Fermilab accelerator complex and applying the technology developed for Project X to other areas of science.

The workshop is divided into working groups focused on high energy physics, nuclear energy applications, and nuclear and material science and materials production. An accelerator working group will capture all the requirements of the SRF Linac for Project X that arise from the needs of the other groups.

The present requirement parameter tables for all of the possible applications of the Project X linac are diverse. The working groups are charged with examining the required parameters in light of the linac design for Project X and associated upgrades.

The following section outlines the plans for the working groups:

Science:

■ **WG1: SRF Linac for Neutrino, Muon and Kaon Physics**

Investigate the use of a multi megawatt proton linac for neutrino, muon and kaon physics. SRF proton linac technology, such as the concepts now being explored with Project-X, has the potential to make enormous strides in the pursuit of ultra-rare decays and novel neutrino experiments. Working Group 1 will focus on the following issues relevant for next generation muon, kaon, and neutrino research programs, driven with an SRF linear accelerator:

- 1) Beam requirements for muon, kaon, and neutrino experiments driven with low-energy protons.
 - a) Beam energy and power requirements.
 - b) Beam timing requirements.
 - c) Comparative study of extracted beam power scaling between SRF linacs and synchrotrons.
- 2) Design issues for high-power low-energy targets.
 - a) Low-Z targets
 - b) High-Z targets
- 3) Particle production simulation tools and data benchmarking.
LAQGSM
GEANT-4
- 4) Understanding the physics reach and accelerator requirements of "super-beam" linacs that directly drive low energy neutrino experiments.
- 5) Questions and issues to carry to the Project-X physics workshop on Nov. 8-10.

■ **WG2: SRF Linac for Muon Collider and Neutrino factory**

Investigate the use of a multi-megawatt proton linac to target, phase rotate and collect muons to support a future muon collider and neutrino factory. Several speakers will summarize the driver requirements for a muon collider, review status of design studies, and discuss critical issues. About half the time will be devoted to discussions, with the goal of defining a set of linac parameters that satisfy the charge and match the capability of an SRF-equipped linac.

- 1) Neutrino Factory / Muon Collider proton beam requirements:
- 2) ISS/IDS proton source related studies, including discussion on the motivation for the design choices:
 - a) Rapid Cycling Synchrotron Options
 - b) Linac + Rings Solutions
 - c) C.W. Linac options
- 3) Pion production for neutrino factories and muon colliders

Focus on the substantial progress in the last decade with data (HARP etc.), production models (event generators), targetry, and understanding of energy dependence of pi/mu yields at the end of a decay channel.

- 4) Rebunching ideas/considerations.
 - a) How do we rebunch a 4 megawatt beam into 3 nanosecond-long bunches?
 - b) Charge exchange injection in a synchrotron during a very large number of turns (laser stripping considerations)
 - c) Making few very short and intense bunches: accumulation and bunch rotation schemes (1 ring? 2 rings?), keeping emittances small, beam stability (collective effects)
- 5) Target station requirements and studies (Joint discussion with WG 1)
- 6) Muon Collider R&D Test Area at Project X: Initial thoughts

Energy:

- **WG3: SRF Linac driven subcritical systems (ADS)**

This WG will work out the parameters of a proton linac that is suitable for Accelerator Driven System applications. Investigate pulse structure, beam power, accelerator reliability issues. This group will hear reports of work on ADS being conducted throughout the world. It will specify the parameters of the SRF Linac solution needed to make the first gigawatt ADS system and the power and reliability requirements of the accelerator. The group will examine the changes that need to be made to the proposed Project X and an alternate design to make it feasible to build an ADS-quality linac. The group will examine the material and remote handling requirements in an ADS level accelerator.
- **WG4: SRF Linac driven subcritical core**

Examine target issues, reactor design options, feedback to the accelerator, core safety issues and core power. The working group will address the different technical aspects of the driven subcritical core.

 - 1) Liquid and solid spallation targets (concepts, performance, technical issues, R&D needs)
 - 2) Subcritical concepts for different missions – transmutations, energy production, testing, neutron source facility (concepts, performance, technical issues, R&D needs)
 - 3) Target/Subcritical interface
 - 4) Accelerator design requirements for driven systems
 - 5) Fuel cycle options for energy and transmutation missions
 - 6) Current and future demonstration projects
 - 7) Subcritical/Accelerator interface and safety issues
 - 8) The group will report on the current world activities, the ongoing and planned developments, and the accelerator requirements for the different missions.

Nuclear and Material Science and Material Production:

- **WG5: Nuclear and Material Science and Material Production**

This working group will investigate the use of a high-intensity proton accelerator for nuclear and material science and isotope production. Presentations related to these topics will be arranged into sub-topics. The working group will attempt to clarify the open issues that are driving future developments in these fields. The necessary facilities and beam requirements that are desirable to enable these developments at a future high power proton driver linac will also be discussed.

The tentative session sub-topics for this working group are:

- 1) Isotope production
- 2) Nuclear science (including an ultra-cold neutron capability and an ISOL facility – both aimed at research in fundamental symmetries)
- 3) Measurements of the properties of irradiated materials (as required for future high power targets and accelerator facilities, including specifically requirements for ADS)
- 4) Developments related to future high power targets (including infrastructure and remote handling requirements) with discussion of measurements with both continuous wave (2 GeV?) and pulsed (8 GeV?) beams.

Accelerator:

- **WG6: Project X SRF Linac parameter working group**

This WG will investigate common accelerator parameters for all the working groups. It will capture all the requirements for the SRF linac for Project X arising from the needs of the other groups. There are no planned presentations for the group. Instead the members of this working group will interact with all of the other groups.

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