Letter of Interest to AF2 and AF7:

US-Japan Collaboration on Accelerator and Beamline Research and Technology Development for High-Power Neutrino Beams

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A US-Japan joint research program for development of advanced technology for neutrino experiments with high power beams has been continued from 2014. Both J-PARC in Japan and Fermilab in the U.S. operate high-power proton accelerators for the production of neutrino beams. The J-PARC facility produces up to 1 MW from its 3 GeV RCS (rapid-cycling synchrotron) and ~520 kW from its 30 GeV MR (Main Ring) for neutrino production. J-PARC is planning upgrades to the RCS to produce 1.5 MW of 3 GeV protons; the MR and T2K neutrino beam will reach its design power of 750 kW in the next few years and has proposed upgrades for achieving 1.3 MW towards Hyper-K era. Multi-MW scenarios are also being considered as long-term plans in Japan. Fermilab's 120 GeV Main Injector presently provides ~730 kW to the NuMI neutrino beam. Near-term upgrades will push this beam power toward 1 MW. Proposed future upgrades will increase this power further to more than 1 MW, and possibly beyond 2 MW.

This US-Japan collaboration is formed of the accelerator and neutrino beamline groups of Fermilab and KEK / J-PARC, as well University of Colorado Boulder which have collaborated with both laboratories. The collaboration is supported by Japan Society for the Promotion of Science, Ministry of Education, Culture, Sports, Science and Technology, and DOE. It allows for the exchanging of experiences and knowledge, which leads to opportunities for further improvement of the accelerators and neutrino beam lines.

The group has identified several major technology issues that could consolidate present high-power operations and enable future improvements for both facilities. The number of collaboration items and fields is gradually increasing every year. The present collaboration covers several topical areas:

- Beam dynamics studies for beam loss reduction
  - Exchanging of experiences and knowledge including, which leads to beam loss reduction and opportunities for further improvement of the accelerator performance.
- Electron cloud studies
  - Electron cloud is a potential concern for all high-power hadron machines. Simulations have begun of electron cloud at higher intensities however, there is a need to benchmark these codes. Fermilab and J-PARC continue to collaborate on simulations as well as discuss an experimental program.
- Beam Monitors
  - Gated ionization profile monitor which has a long life time.
  - New signal acquisition system for high precision beam position measurement

- Laser manipulation of H- beams
  - Present common interest in collaboration is the neutralization of the H^- beam, and it is being extensively studied in both laboratories for application to multiple purposes. At Fermilab, H^- neutralization by using two mirror laser cavity is successfully utilized to produce a time structure in the 0.750 MeV H^- beam (called laser notching). At J-PARC, a Proof-of-Principle demonstration of 400 MeV H^- stripping to proton by using only lasers will be done to make a breakthrough in the conventional H^- stripping injection done by using stripper foil. Laser experts joins the collaboration from University of Electro-Communications.
- LINAC instrumentation
  - Beam diagnostics in the Linac are a challenging part of operation, especially at low energy. Fermilab and J-PARC are going to exchange ideas, share experiences, develop the diagnostics for the LINAC, and conduct beam studies and simulations. J-PARC developed a novel beam interaction scheme which could improve the lifetime and signal-to-noise ratio of a present Bunch Shape Monitors (BSM). Both facilities plan to optimize the BSM design together and integrate them into our regular operation.
- New RCS design for high intensity proton beams
  - The J-PARC RCS have had recent success building high flux accelerators and delivering 1 MW at 3 GeV and plan to increase the beam power in near future. The Japanese expertise coupled with Fermilab's experience in non-linear dynamics and normal conducting RF technologies, will allow significant progress to be made in the RCS development for both laboratories.
- Reinforcements of target facility and secondary beam-line components.
  - The robustness and cooling capability of the components exposed to high-power beam such as target, horn, extracted beam-monitors should be improved. The sharing the operation knowledge, the cooperation on the component design and production and the development of common technique for both laboratories will be made.
  - The understanding of the production mechanism of radio-activated wastes, the handling of the highly radio-activated equipment, the radiation protection of the beam-line components will be studied as common issue for the high-power proton beam facility. The investigation of the behavior of the tritium at the neutrino beam-line, the development of the remote-handling equipment with recent autonomous robotic technologies for the radio-activated target/horns will be done.
- Improvement of the neutrino beam quality
  - The diagnostics and the adjustment of the extracted proton beam is important to improve the precision of neutrino experiments. The development and implementing the less-destructive proton beam profile monitors, and the robust tertiary muon profile monitors will be done.
  - The precise knowledge of production distribution as well as the production cross section of the hadrons which are the neutrino parents is important to predict the neutrino flux and its uncertainty. Measurements of these quantities will be performed in the hadron production experiments at FNAL and CERN.