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An International Exchange Framework for Research in Beam Physics and Accelerator Technology: A Letter of Interest for Snowmass 2021*

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The exchange of scientists and young researchers between accelerator institutions worldwide plays an invaluable role in maintaining unique capabilities, in developing new technologies, and in training the next generation of accelerator physicists and engineers. Contacts between research groups, collaboration in the design of beam physics experiments, access to control rooms during commissioning of apparatus, the common development of theoretical models and numerical simulations are all activities that have been very fruitful, both in the short term and in the long term.

For instance, the LHC Accelerator Research Program (LARP) [1], funded by the US Department of Energy in the period 2003–2018, enabled the development of accelerator-quality Nb_3Sn superconducting magnets, crab cavities for hadron colliders, wide bandwidth feedback systems, and novel collimation techniques, including active beam halo control with hollow electron lenses. As part of the LARP program, the post-doctoral Toohig Fellowship supported collaborative, multi-laboratory research for 14 physicists [2]. Many of them have taken leadership positions at international laboratories, educational institutions or in industry and are continuing to advance the accelerator field. Personnel exchange in general was recognized as one of the highlights of LARP.

Another example is the Europe-Japan Accelerator Development Exchange Programme (E-JADE) [3] funded by the European Union. It promotes exchanges of accelerator scientist to advance research in critical areas of development for hadron and lepton colliders (HL-LHC, FCC, and ILC/CLIC).

One of the main challenges in our field is the diagnostics and control of high-intensity and high-brightness beams dominated by space charge and self fields. These studies rely on the interplay between solid experimental foundations, theoretical understanding of complex phenomena, and realistic numerical simulations that take advantage of progress in computer technology.

As accelerator beam time is a precious resource, efforts to collaborate on beam physics experiments are very valuable. Recently, for example, colleagues from CERN participated in experiments to understand space-charge dynamics and beam losses in the Fermilab Booster [4]. We are also seeing a growing interest in doing research at the Fermilab Integrable Optics Test Accelerator (IOTA) and at the FAST superconducting electron linac [5, 6].

Several other examples of international, multi-institutional accelerator research exist. Laboratories worldwide are facing similar challenges and close collaboration on approaches and proposed solutions is vital. Well-established collaborations help ensure that the proposed framework will be relevant and efficient.

We envision a program focused both on current short-term needs of the high-energy-physics community and on long-term research goals. Priorities are to be determined by the community and by the funding agencies. It is expected that goals will be evaluated and revised regularly.

In the near future, examples of priority areas may include participation in experiments at FAST/IOTA

(nonlinear integrable optics, optical stochastic cooling, radiation from single electrons), studies of space-charge and losses at the Fermilab Booster, support for PIP-II, beam delivery to neutrino and muon experiments, commissioning of HL-LHC systems, and contributions to the Electron-Ion Collider, together with the technological development of particle sources, high-power targets, superconducting magnets, and accelerating cavities. Longer term projects include PIP-III, neutrino factories, FCC, and the Muon Collider.

We propose the following program scope:

- Sponsor 1–3 post-doctoral fellowships per year.
- Support the exchange of junior researchers, senior scientists and engineers through visits ranging in duration from 2 weeks to 1 year. These include exchanges among US national laboratories and universities as well as mutual exchanges with international institutions.
- Partially fund personnel salaries for research and for mentoring.
- Provide resources for small-scale hardware development and prototypes.

This initiative complements and integrates well with the international accelerator schools (JUAS, CAS and USPAS, mentioned in separate Snowmass letters) and with existing internships for undergraduate and graduate students.

Collaboration and education are areas where a small investment generates long-lasting benefits: knowledgeable people, scientific results, and new technologies. Beyond high-energy physics, there is a demand for trained accelerator physicists to provide high-quality beams and energy-efficient technologies for medicine and other applications. We encourage the high-energy-physics community to set up a permanent framework through which these goals can be pursued.

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[1] The US LHC Accelerator Research Program (LARP), uslarp.org.

[2] Toohig Fellow profiles, www.slac.stanford.edu/ jdfox/ToohigFellowProfilesV5.pdf (2017).

[3] The Europe-Japan Accelerator Development Programme (E-JADE), www.e-jade.eu.

[4] June 2019 Booster studies capstone event, indico.fnal.gov/e/21000.

[5] The Fermilab Accelerator Science and Technology (FAST) facility, fast.fnal.gov.

[6] The IOTA/FAST Scientific Committee (ISC), cdcvs.fnal.gov/redmine/projects/ifsc/wiki.