AccelNet-Implementation: HSF-India - Research Software Networks in Physics

HSF-India is a US National Science Foundation (NSF) funded project that begins October 1, 2022. HSF-India will join collaborative networks in India to networks in the U.S. and Europe in order to build the international research software collaborations required to reach the science goals of next-generation particle, nuclear and astroparticle physics experiments including the high-luminosity Large Hadron Collider at CERN, the Deep Underground Neutrino Experiment at Fermilab, and the Electron Ion Collider at Brookhaven National Laboratory. To fully realize their discovery potential a new generation of software algorithms and approaches is required. Building these research software collaborations is challenging and inherently international matching the international nature of the experimental undertakings themselves. HSF-India will provide students, postdocs and early career personnel significant experience in international team science through engagement in a diverse research community.

HSF-India activities will include:

1. **Training events** that will build upon the curriculum being actively developed and used today by the HSF and IRIS-HEP. This will include an introduction to the current analysis, deep learning and data science ecosystem, software development/engineering skills, and best practices for collaborative work. Practical sessions and group "hackathons" will develop team connections. We aim to engage 150 students per year and have funds to assist with instructor travel costs and networking events. Our project includes funding for instructor travel and a network building event during each training .
2. **Mentoring and co-mentoring** of early-career researchers across the networks. This will include curating a catalog of possible software-related projects of various sizes, including those sized for summer or semester-long projects as well as larger projects which are suitable to be the subject or a part of a student thesis. We plan to engage with the HEP Software Foundation and other groups that engage students in summer projects to make a broadly useful project database.
3. **Fellowship programs** for students that have participated in our training programs, or have equivalent experience. Fellows will be based at their home institute (or elsewhere as convenient) and interact remotely with their mentors on software projects. Projects will nominally have two mentors, both for practical reasons (holidays, busy schedules, etc), and to bring different perspectives, from different networks, to the problem. We also aim for projects where two Fellows from different countries work together under the same mentors on a project. We aim to support approximately 10 students per year for a three month fellowship in a fashion similar to the Google Summer of Code program.
4. **Researcher exchanges** organized and funded between the U.S. and India. While short in-person visits for training events, workshops and con- ferences can reduce barriers to communication, longer visits are critical to building and sustaining durable longer-term relationships. We aim to provide travel support for 10 early-career researchers per year

to participate in a researcher exchanges. Like the fellowship program, this program will be open to researchers in both India and U.S.

5. **Virtual Topical Meetings** to allow participants to periodically present the status of their projects as well as invited external speakers with relevant software activities.
6. **Annual Project Meeting** to facilitate collaboration amongst HSF-India participants. Our project includes funding for some international travel and on-site networking events.

HSF-India has three three broad research themes:

1. **Analysis Systems:** Tools and techniques enabling next-generation analysis approaches to realize the maximum scientific potential of the data in the least time. The final stages of data analysis for our science are topically diverse and highly collaborative within small subsets of the experiment collaborations. Increasingly, researchers are working with the broader data science and machine learning communities resulting in scalable, efficient and easy to use tools required for the complex datasets of the largest future facilities.
2. **Novel simulation techniques** are critical tools for the increasingly complex questions being asked by current and planned experiments, and touch all aspects of experimental work in nuclear and particle physics. Traditional Monte Carlo methods face large gaps with respect to needs for next-generation experiments. These can be closed through research that enables the efficient use of new computing technology; the application of machine learning approaches and more broadly emerging techniques such as simulation based inference and differentiable programming.
3. **Tools for Open Science** ensure that researchers benefit from, and contribute to, the innovation of the broader data science community. This includes openness of the software, as well as the development of corresponding open datasets to enable further software evolution. An open science approach is a key enabler of international and multidisciplinary collaborations. Tools generalized to work across many experimentswill also find applications beyond our own science.

HSF-India will focus on opportunities for early-career researchers and establish mentoring and co-mentoring relationships with more senior researchers across the networks. By engaging with the data-science, artificial intelligence and broader computer science communities the project will foster bottom-up alliances around research software, for physics and beyond. HSF-India aims to establish an environment where researchers with diverse backgrounds, skill sets and interests can come together and build innovative collaborations that sustain novel tools and techniques while bridging research gaps to enable future scientific facilities.

HSF-India is an National Science Foundation (USA) funded project lead in the U.S. by David Lange (Princeton University), Peter Elmer (Princeton University), Rafael Coelho Lopes de Sa (University of Massachusetts, Amherst), Verena Martinez Outschoorn (University of Massachusetts, Amherst), and Heidi Schellman (Oregon State University).