PIRE preliminary proposal Project Summary

Title: **PIRE: Calorimetry for the International Linear Collider**

NSF program area: Mathematical and Physical Sciences (MPS); Specialization: High-Energy Physics.

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Summary of intellectual merit

Beyond the projects that are currently in operation or already approved, the International Linear Collider (ILC) is the mainstay of the worldwide road map for High Energy Particle Physics (HEP). It is anticipated that the Large Hadron Collider (LHC), scheduled to be commissioned at CERN (Switzerland) in 2007, and the ILC will together usher in a new era in our understanding of nature at both the smallest scale (fundamental particles and their interactions) and the largest (structure and evolution of the universe). The ILC is a truly international project involving a scale of investment similar to that of the recently approved international fusion energy project ITER: several billion dollars, and nearly two decades of research and development. The R&D is already under way, with the aim of commissioning in 2015, and operating for two decades or more after that. Realization of the full scientific potential of this unique machine will require equally unique detectors for studying the outcome of the high-energy particle collisions. This proposal seeks funding for a comprehensive R&D program, based on simulations and prototyping, for the design of a key component of the detector, namely, the calorimeter, which is used for measuring the energies of individual particles as well as collimated "jets" comprised of many particles. Eventually, the calorimeter is expected to cost upward of $200M, about a third of the total detector. Therefore, it is vitally important that its design be carried out with utmost care. The proposal encompasses all aspects of ILC calorimeter design, construction, and testing: technology hardware, development of integrated read-out electronics, geometry optimization through detailed simulation, prototype construction, prototype testing with controlled particle beams, and algorithm development.

The scale of the ILC makes it impractical for any single nation to undertake entirely on its own. Thus, by necessity, the proposed activities are fundamentally international in nature. In addition to the four universities listed above, and three US national laboratories, we will collaborate on this project with five national laboratories and five university groups from six countries in Europe and Asia. A model of international collaboration has been established. The very long time-line demands involvement of young students and post-doctoral researchers. The requested funding will help us attract and train them to work on future large-scale scientific adventures that must be played on the worldwide stage. This will be achieved through exchange programs of working at unique laboratory facilities around the world, and attendance of international workshops/conferences under the auspices of an established global organization.

Broader impact of the proposed PIRE program

Both the ILC machine and its detectors will push the respective technologies well beyond the current state of the art on many fronts. Invariably, such technologies find practical applications in many areas to improve the quality of human life. Examples include medical imaging and radiation therapy, radiation sensing (for security), high-end computing (e.g. GRID-based distributed computing, simulation), and financial markets (complex pattern-recognition algorithms). The proposed project will invigorate research in Silicon Photo-Multipliers (SiPM) - a new type of solid-state photon detectors that are poised to open up new possibilities in radiation sensing, medical imaging, and other applications in basic research than the one proposed. High-resolution imaging of interactions of high-energy particles with matter will improve modeling of such processes, which find application in many areas of radiation sensitivity. Beside technology R&D, students and post-doctoral researchers with good training in Experimental HEP often move to those areas and make important contributions. Last, but not the least, experimentation with new models to improve collaboration and information-sharing across the globe (the worldwide web was born at CERN, the European international HEP laboratory), training the youth in rigorous methods of scientific investigations, and dissemination of the insights gained to the general public are among the core objectives of the proposed PIRE program.

Keywords: International Linear Collider, Calorimetry, Particle-Flow Algorithms