Project Summary

Funds are requested for a 28-node computing cluster and 6 TByte of storage to support cooperating research programs in nuclear physics, astrophysics, and computer science at the University of Richmond, making faculty more productive and helping train students in modern data mining techniques, simulation, and high-performance computing.

Intellectual Merit: The nuclear physics research centers on unraveling the structure of the nucleon and the nature of quark confinement. This project involves extracting the distribution of charge and current in the neutron, and measuring the properties of the nuclear force via the breakup of the simplest nucleus, the deuteron. It is supported by DOE. Additional users will include senior personnel in nuclear physics at Ohio University, Virginia Tech, and Union College, who with PI Gilfoyle are responsible for the operation of a large particle detector at the Thomas Jefferson National Accelerator Facility (JLab). The NSF-funded astrophysics research led by Co-PI Bunn focuses on simulations of MBI, a new cosmic microwave background polarimeter being built by researchers at Brown University and the University of Wisconsin, as well as EPIC, a NASA-funded concept study for a future space-borne telescope. In computer science Co-PIs Szajda and Lawson have NSF support to study ways to provide measurably reliable computations and develop novel hierarchical platforms for distributed volunteer computing, in order to develop robust and reliable methods of exploiting underused machines on the internet for scientific research.

Computing limitations threaten to limit the productivity of these projects. Analyzing the nuclear data sets collected at JLab means working with event files that occupy hundreds of gigabytes and conducting simulations that can take weeks to run on existing equipment. Simulations of the MBI/EPIC polarimeters, which are necessary for the design and optimization of the instruments, similarly require a cluster of this size if they are to be completed in a reasonable time. The computer science simulations of algorithms for securing distributed volunteer computations can now take many days to complete. The cluster will open new opportunities for each of these projects and will enable us to use the physics computations as a test bed for the computer scientists. PI Gilfoyle will serve as administrator of the new cluster, which will be maintained with the assistance of a Linux support specialist on the Richmond staff and supported with an extended warranty. The University of Richmond is committed to $10,000 per year in software and hardware support for the proposed instrument after the grant expires.

Broader Impacts: The proposed equipment will enhance the engagement of undergraduates in these cutting-edge projects, by reducing the extended processing times that are a barrier to learning and meaningful undergraduate student research involvement. It will also give students experience with the design and execution of large-scale projects. Each of the four PIs has funding to support undergraduate researchers during the summer; in the past 4 years 7 physics students have presented 14 talks at national meetings including the American Physical Society and the American Astronomical Society and two computer science students have appeared on peer-reviewed papers. These are especially important opportunities for the underrepresented students our summer research program attracts, like the 4 women and 3 African American students who were part of the nuclear physics and computer science labs over the past two summers. Adding the computer cluster to the Universitys research infrastructure will help sustain the faculty collaborations with investigators at research institutions, where the commitments of senior personnel to the project will also make the equipment available to undergraduate, graduate, and postdoctoral researchers there.