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Notes on NSF 24-551 Grant Solicitation

Title: HSI:ELPSE (Enriching Learning, Programs, and Student Experiences)

Introduction

This is a program designed to enhance STEM educational outcomes at HSIs. The HSI program within NSF has two overarching goals: increase student recruitment, retention, and graduation rates, and enhance the quality of undergraduate STEM education.

This program is designed to enhance STEM courses, degree programs, academic departments, and divisions within institutions.

We are targeting the Educational Instrumentation (EI) Track. Proposals in this track are subject to a maximum budget of $200,000, and 2 years duration.

We must submit our eligibility letter as an HSI as a supplemental document.

There are two core principles at work in the design of the program's themes and tracks: (1) Each HSI is unique, and student outcomes are shaped by the nature of the institution. (2) Enriching the student experience by supporting learning depends on the lived experiences and intersecting characteristics of students.

The idea is to broaden HSI-student participation in STEM fields by enriching their education at HSIs.

Program Description

Two main themes: (1) courses, curricula, and pedagogy, and (2) institutional structures and pathways. We will focus on (1). There are two well-defined tracks. Of these, we are selecting the Educational Instrumentation (EI) track, within theme (1): courses, curricula, and pedagogy. Below is a list of relevant courses that can be enhanced in interesting ways if we received an EI-track grant:

- *computational physics (PHYS325, Prof. Hanson)*
- *digital signal processing (COSC360, Prof. Hanson)*
- *computational chemistry (Prof. Peterson can elaborate)*
- *electromagnetic theory (PHYS330, Prof. Hanson)*
- *machine learning (COSC370, Prof. Park)*
- *numerical analysis (MATH350, Prof. Park)*
- chemistry research (CHEM496, various)
- physics research (PHYS396, various)
- biology research (BIO496, various)
- *Structural biology (Prof. Ochoa can elaborate)*
- Molecular genetics (BIOL381, Prof. Link)

Each of these courses could include research projects in software design and algorithms, simulations, and computational modeling. We therefore seek to purchase a high-performance computing system (HPC) that would serve these courses and associated undergraduate research. Specifically, the EI-track is designed for proposals that "increase access" to the computing resources needed for high-quality undergraduate education in STEM. **The HPC must be centered on courses and course-based research experiences, and undergraduate research.** For example, the HPC cannot be

designated solely for the research group of a single PI. The emphasis is on a user-base that extends to multiple disciplines and research areas.

Notes on our Project Description: The project description is limited to six (6) pages, so we must concisely demonstrate that an HPC would benefit the listed courses and programs. Our project description must also address recruitment, retention, and graduation rates. At a minimum, we must:

- **Demonstrate need for the equipment.** Examples:
  - (Prof. Park) Our primary machine learning researcher and instructor for our Machine Learning course is currently without a top-end GPU-enabled HPC. This blocks our students' access to implementing machine learning algorithms like advanced neural networks in the course and in research projects.
  - (Prof. Hanson) Our Electromagnetic Theory course should be enhanced with computational electromagnetism (CEM) projects. CEM projects of sufficient complexity require HPC systems with large numbers of cores, and 1 GB of volatile memory per core. This enables computational parallelism that ensures projects are completed in reasonable timescales.
  - (Prof. Hanson) Our Computational Physics course is currently designed to rely on student laptops and classroom workstations, which prevents us from conducting large-scale simulations (like CEM calculations) with our students.
  - (Prof. Hanson) We have recently created a Digital Signal Processing course that would benefit from handling large-scale datasets, hardware accelerated computations, and parallelism. Topics include audio and image processing, and applications of neural networks
  - (Prof. Peterson) We are creating a computational chemistry and remote sensing course that incorporates atmospheric simulations enabled by an HPC
  - (Prof. Ochoa) We seek to add structural biology to our curriculum, and an HPC system would allow students to learn protein-folding algorithms
  - (Prof. Park) Our numerical analysis course is an upper-division mathematics course that would benefit from an HPC. For example, an HPC could serve numerical analysis students by providing a code environment configured with modules for numerical solution of differential equations.
  - (Prof. Link) We have recently created a molecular genetics course that would benefit from an HPC that can process microbiome data.
  - Research for Credit Courses (various): we have many forms of research for credit courses. These opportunities in biology, chemistry, and physics would be greatly enhanced by a shared HPC. An HPC would facilitate student research projects that would advance them closer to their career goals in STEM.
- **Demonstrate benefit to students, and estimate numbers of students benefited.** Examples:
  - Based on a five-year average, calculate the numbers of students in the regular courses mentioned above
  - Based on a five-year average, calculate the numbers of students in the research for credit courses mentioned above
  - Add in typical numbers for Fletcher Jones Foundation Fellows and Ondrasik-Groce Fellows
- **Describe courses and programs impacted**
  - Regular courses mentioned above
  - Research courses mentioned above
  - The Artemis Program: research and recruitment program for young women from local area high schools
    - *This item is especially important because it goes towards recruitment from our local community*
  - Degree programs impacted: 3-2 Eng/Physics, 3-2 Eng/Computer Science, 3-2 Eng/Mathematics, 3-2 Eng/Chemistry, ICS/Physics, ICS/Math, ICS/Economics, ICS/Political Science, Physics and Astronomy, Mathematics, Chemistry, and Biology
- **Maintenance plan and consumables**

    - We do not anticipate significant maintenance beyond work we already perform on our other equipment
    - We have 3+ years of experience with running an HPC desktop from System76
        - Includes installation and maintenance of Linux operating system
        - Includes hardware repair
        - Includes hardware upgrades
- **Discussion of Progress Assessment, Documentation of Outcomes, Project Goals**
    - We can quantify numbers of student users and use cases by semester, and set reasonable targets
    - We can quantify the number of courses that implement learning modules on the HPC, and set a reasonable target
    - We can quantify the number of summer research students, and set a reasonable target
    - We can keep a log of projects that meet a reasonable threshold of completeness and peer review, and store them on Poet Commons
    - From all forms of participation, we can set broad goals on (a) peer-reviewed publications led by undergraduates that involved the HPC (b) new learning modules within courses that utilized the HPC, and (c) student-led course-based research projects that were completed with the HPC

There are restrictions on project funding:

- No instrumentation for a specific faculty group
- No building infrastructure upgrades or construction
- No general purpose computer labs or software not dedicated to undergraduate STEM research
- We can use a maximum of 10% of the the budget on compensating faculty for training others to use the HPC (Prof. Hanson)

Finally, focus on these three words often: *recruitment, retention, completion.*