

RUI Impact Statement

1. Siena College

Siena College, founded in 1937, is a coeducational, independent, liberal arts college with a Franciscan tradition that serves approximately 3000 undergraduates. It is located in Loudonville, New York, in the center of New York State's Capital District.

Siena College provides a unique array of outstanding scientific, reference, and research facilities for a small liberal arts college. The Morrell Science Center, opened in September 2001, is a 55,000 square foot science center with 24 research labs, 10 teaching labs, and three support areas on three floors. There is also a small machine shop for manufacture of prototype parts and lab apparatus. Another relatively recent addition is the J. Spencer and Patricia Standish Library. This 72,000 square foot building provides access to 100 computer workstations, 500 Internet connections, a computer laboratory, and a 40-seat screening room. A collaborative exchange agreement between Siena, Rensselaer Polytechnic Institute (RPI), and the State University of New York at Albany provides additional access to first-rate research libraries.

In August 2014 Siena completed construction of the Stewarts Advanced Instrumentation & Technology (SAInT) Center with the goal of establishing Siena as a leader in undergraduate education in scientific instrumental resources and training. The SAIInT Center houses multiple mass spectrometers, an atomic force microscope, a scanning electron microscope, and other analytic equipment. In September 2013 Siena College established its High Performance Computing Center (HPCC). The HPCC cluster has 252 2.3 GHz Intel Xeon (E5-2630) cores and 20.5 TB of global storage. Each worker node has 500 GB of local storage and 32 GB of RAM. A full suite of software tools and compilers are available on the cluster, which is used for both research and as a classroom resource.

Over the past several years, Siena College has undergone an academic transformation in response to its exponential growth in sponsored research grants and faculty-student collaborations. The administration at Siena College has been fully supportive of faculty research efforts, willingly reducing the normal teaching load from 12 to 9 contact hours per semester for faculty actively pursuing research. As of Fall 2015, there are active grants in the School of Science totaling \$6.5M, and integrated over the last 10 years, the faculty have brought in a sum total of \$12.5M. A significant number of students are engaged in research under the supervision of a faculty member with funding from organizations committed to advancing the sciences (i.e., NSF, NASA, DOE). In addition, during the summer months, a large cohort of students from across all disciplines participate in undergraduate research as part of the *Siena Summer Scholars Program*.

To ensure adequate oversight, management, and recognition of all faculty-student collaborative activities, in Fall 2008 the College established the Center for Undergraduate Research and Creative Activities (CURCA). The impetus for this center came from a workshop held by the Council of Undergraduate Research that was attended by three Siena faculty (one of whom is PI Finn) and our Sponsored Research officer. The mission of CURCA is to foster a campus-wide culture in which all undergraduates are engaged in inquiry or investigations conducted in collaboration with a faculty mentor which makes an original intellectual or creative contribution to a discipline or the community. The goal of these research experiences is to increase the level of student engagement, and to better prepare students for post-baccalaureate opportunities, including graduate school. In 2011, CURCA was endowed with a \$1.5 million gift to ensure long-term success and sustainability. Since 2008, the number of students participating in an undergraduate research experience has more than tripled. To manage the growing volume of research across campus, the college appointed its first undergraduate research director on in June 2012.

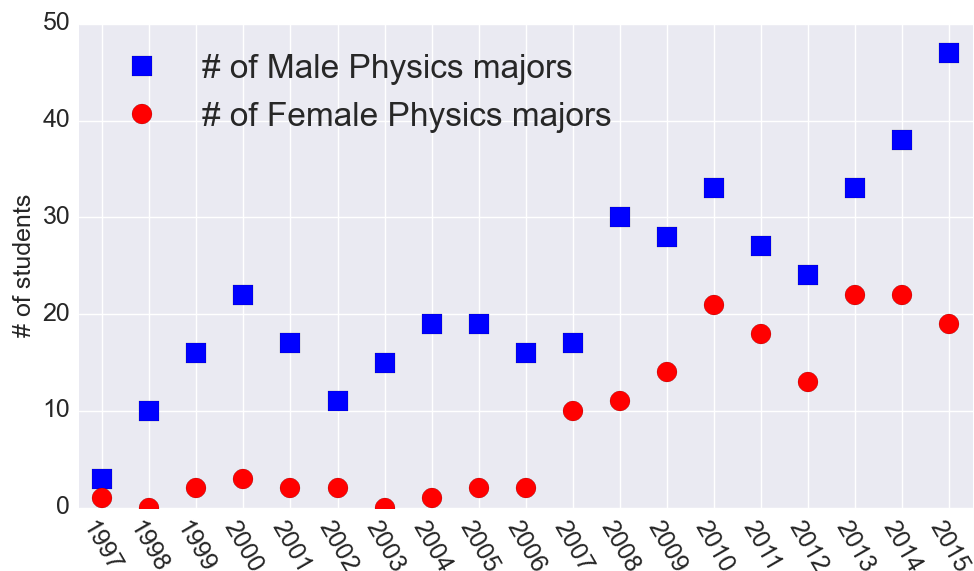


Fig. 1.— The growth of the Physics department, particularly among women, has been striking over the last 10 years. This is due in part to the high-level of engagement that the faculty have in involving students in research projects and in proactively recruiting and retaining young women scientists.

2. Department of Physics & Astronomy

The Department of Physics & Astronomy aims to develop in its students a comprehensive grasp of the principles of physics. The program emphasizes the concepts and techniques that have led to our present state of understanding of the physical universe. Placed in the context of a liberal arts environment, the generality and applicability of the physics curriculum give physics majors three broad options upon graduation. Students are well-prepared to pursue graduate study in physics, astrophysics, or a related field; to embark immediately upon a professional career in science; or to enter one of the numerous careers which require or are enhanced by a broad knowledge of science in today’s technological society.

The department also offers a curriculum for students interested in teaching, minors in astrophysics and computational science, and a 3/2 Engineering Program through an articulation agreement with Clarkson University, Rensselaer Polytechnic Institute (RPI), and Binghamton University. The 3/2 program leads to a B.S. in Physics and a B.E. in electrical, mechanical, civil, biomedical, aeronautical, nuclear or materials engineering. Programs leading to a Masters degree are also available through RPI and Clarkson University’s Schenectady campus (formerly Union Graduate College).

The Department of Physics & Astronomy plays a central role in sustaining the vitality of the School of Science. According to several metrics, the department has led Siena College in upgrading its national profile and improving the quality of student achievement. The number of physics majors has grown steadily over the last decade (see Figure 1), and the department was recently recognized by the American Institute of Physics as one of the few undergraduate colleges nationwide to graduate an average of more than 10 physics majors per year. Importantly, the percent of women majors has grown from nearly zero to 30 – 40%, and we currently exceed the national average for the fraction (20%) of undergraduate women in physics. The department excels due to a multi-pronged approach that improves the educational experience of our students: we strive to involve

all students in independent research projects as early as their first semester; we introduce student-centered learning techniques at all levels of our curriculum; we diversified our course offerings for both non-science students and physics majors; and we recently established an astrophysics minor. The astrophysics minor was established as part of an NSF CAREER grant (PI Finn).

Because of these and other efforts, the department has experienced an exciting period of growth and revitalization, including five new faculty members in the last seven years. The result is a fairly young, active faculty who are leading exciting research programs in astrophysics, biophysics, computational physics, physics education research, biophysics, and atomic and particle physics. An immediate benefit of the increase in the level of faculty research is a corresponding increase in student engagement in these research endeavors.

Siena is a small liberal arts college that emphasizes teaching excellence, small class sizes, and close student-faculty connections. Unlike many comparable schools, Siena's Physics & Astronomy Department also has a very strong research program, with many federally funded projects. Dr. John Cummings, the current Dean of Science, is funded by the NSF to work on neutrino physics at Daya Bay, China (NSF PHY-0901954); Dr. Rose Finn is an NSF CAREER Fellow (Award AST-0847430) and has been funded through the Spitzer Space Telescope Observer Program; Dr. Matt Bellis is funded by the NSF to search for new physics using data from the LHC/CMS detector; Dr. John Moustakas recently received an NSF grant to study the stellar mass content of dark matter halos (AST-1616414), and Dr. Graziano Vernizzi is funded to work on a variety of computational biophysics problems through the Department of Defense. In addition, Drs. Larry Medsker, Rose Finn, and Allan Weatherwax shared an NSF S-STEM grant (DUE 0728452), and Dr. Medsker and Dr. Michele McColgan share an NSF Robert Noyce Teacher Scholarship Program grant (DUE-1136322). Finally, Drs. Finn and Medsker completed a Clare Boothe Luce grant which provided scholarships for women majoring in STEM areas.

The transformation of Physics & Astronomy at Siena College is a testament to strategic vision, research-intensive faculty who love teaching, a focus on undergraduate research, and the critical importance of NSF funding for basic research and undergraduate STEM education.

3. Impact of Prior NSF Support

PI Finn was the recipient of an NSF CAREER award, and that had considerable impact on our department and students. Over the entire tenure of this grant, Finn supervised 24 undergraduate physics students for a total of 6,300 hours of research. This was the first research experience for 23 of these students, 16 of whom are female, and 13 of whom had just completed their freshmen year. The grant supported high-impact student experiences including trips to Arecibo Observatory, Kitt Peak National Observatory, and meetings of the American Astronomical Society. This positive early experience with research has been shown to increase retention in STEM fields, and these opportunities have contributed to the rise in the number of physics majors at Siena College from a total of 41 at the start of this grant to 93 overall as of fall 2015. The student researchers who have graduated have all remained in STEM fields including graduate school and/or employment in engineering, medicine, the air force, astronomy graduate school, computer science, an environmental science.

As part of the CAREER award, we developed an assessment for Electricity and Magnetism that is aligned with college-level calculus-based introductory physics. While other assessment tests exist, the pre and post-test scores on these exams are typically very low. We adjusted the level of the difficulty so that post-test scores are comparable with other widely used assessments such as the Force Concept Inventory. After five testing and revision cycles, we have converged on a final version

of the assessment, and we have distributed it on PhysPort (www.physport.org). It has been adopted by one instructor at George Washington University.

In each July since the start of the CAREER award, we have held a one-week workshop for local-area high school physics teachers. Darren Broder runs each workshop and is given a stipend from the NSF grant. This year's workshop focused on the wave unit of the Modeling Physics curriculum. During the tenure of the grant, the workshops were attended by over 40 high school teachers.

4. Impact of this proposal

Successful funding of this proposal would have a significant impact on the PI's ability to continue to offer cutting-edge research experiences to undergraduates, and on the department and College's ability to recruit a diversity of talented students. Many of these opportunities would not normally be available to a student at a small liberal arts college.

The interest in research opportunities among the students is significant, even among freshmen and sophmores. Every spring the faculty give presentations to the students about current research opportunities, and there is always far more demand than available resources, although many students are frequently willing to gain experience through unpaid opportunities.

Students supported by this grant will move on to the next phase of their careers more prepared for scientific and technological challenges. Whether they pursue astrophysics in graduate school or move on to technical careers, they will have gained a wide range of practical skills which will serve them for life.