**GENERAL INFORMATION**

- **Program sponsor:** Princeton Environmental Institute
- **Position number:** E1GOL1
- **Project title:** Zero-Knowledge Warhead Verification
- **Organization/research group:** Woodrow Wilson School Program on Science and Global Security
- **Primary location(s) of internship:** Princeton Plasma Physics Laboratory, Princeton, NJ
- **Additional cities and/or countries to be visited (if applicable):** n/a

**Note:** If this internship is located in a country with an International SOS risk rating of High or Extreme, final candidates must participate in a travel review process overseen by the Travel Oversight Group (TOG), and obtain safety guidance prior to departure. The University reserves the right to revoke support and funding for travel at any time there has been a significant deterioration in the safety and security conditions surrounding travel arrangements, or in the sector of the country, or countries, where travel is to occur.

**FACULTY SPONSOR(s)/HOST INFORMATION**

- **Name(s):** Robert J. Goldston
- **University Department(s):** Astrophysical Sciences
- **E-mail:** rjg@princeton.edu
- **Phone:** 609 369 0279
- **Website:**

**INTERNERSHIP/RESEARCH PROJECT INFORMATION**

**Internship/project description:**

There is a paradox at the heart of any agreement on nuclear disarmament: the world wants to be certain that real warheads are being destroyed, but the owner of the warheads does not want to reveal any information about their material composition or design. And no one wants inspectors from states without nuclear weapons to learn how to build their own. At Princeton we have developed a "Zero-Knowledge" protocol to resolve this paradox. It is based on differential measurements between stored warheads and those installed on delivery systems. It should be sufficient to prove that these are all identical to be assured that the stored warheads are real. Then the challenge is to measure differences between objects, without measuring the objects themselves. We have completed a first set of experiments confirming that we can do this with radiography based on 14 MeV neutrons. We plan a high-precision campaign for this summer.

**Student's role and responsibilities:**

An undergraduate student would participate in the final construction, calibration and operation of a new precision collimator and high-count neutron detectors to complete the new campaign. We will also experiment with a new moderation system, to study the effects of using lower-energy neutrons to probe the material content of a test object.
Internship/project learning objectives:
The student will gain experience with the final construction, calibration and operation of a new scientific instrument, learning how we focus on achieving the objectives of the experiment.

PROGRAM REQUIREMENTS

Academic background and any course pre-requisites:
If the student were to take AST 309, they would gain knowledge of the neutronics principles that are exploited in this experiment, as well as learning more about nuclear non-proliferation.

Technical skills:
No special skills are needed.

Additional training(s):
Appropriate safety training will be provided at the Princeton Plasma Physics Laboratory.

Equipment:
Student should bring their own laptop.

Physical demands:
None.

Language abilities/competencies (if applicable):

Additional information about the internship/project:
This is a ground-breaking experiment that ultimately might be deployed as part of the denuclearization of North Korea ... if it really happens. Selected student will need to complete lab safety training prior to the internship beginning.

INTERNATIONAL TRAVEL REQUIREMENTS (if applicable)

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<th>Visa(s) required?</th>
<th>Research permit/pass required?</th>
<th>Immunizations required?</th>
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INTERNERSHIP/PROJECT SUPERVISOR(S)

Name and title of primary supervisor: Robert J. Goldston

Email: rjg@princeton.edu  Phone:

Name and title of additional supervisor, if applicable: n/a

E-mail:  Phone:

PROGRAM DATES AND FUNDING INFORMATION

Weekly Stipend: $500  Number of Positions Available: 1
Tentative Start Date (mm/dd/yyyy): flexible  Number of Weeks: 8-10
Tentative End Date (mm/dd/yyyy): flexible

Note: PEI funding is for full-time work, 35 hours per week minimum, and for a period of at least 8 continuous weeks.

Application Deadline: January 11, 2019