NASA Goddard's Planetary Science Winter School: Training Goddard's Early Career Planetary Scientists in Flight Instrument Design through Experiential Learning. L. V. Bleacher[1], B. Lakew[1], S. D. Guzewich[1,2], J. Bracken[1], T. Brown[1] and R. Rivera[1]. [1]NASA Goddard Space Flight Center, Greenbelt, MD 20771 (Lora.V.Bleacher@nasa.gov), [2]CRESST and Universities Space Research Association, Columbia, MD 21046.

Introduction: The NASA Planetary Science Winter School (PSWS) is a Goddard Space Flight Center-sponsored training program, managed by Goddard's Solar System Exploration Division (SSED), for Goddard-based postdoctoral fellows and early career planetary scientists. Taking inspiration from the NASA Planetary Science Summer School [1], the PSWS is a training program for scientists interested in participating on future planetary mission teams. While participants of the Planetary Science Summer School develop a mission concept study, Goddard's PSWS is unique in that the program is an experiential learning opportunity - participants learn the flight instrument lifecycle by designing a planetary flight instrument under actual consideration for proposal and development. They work alongside the instrument Principal Investigator (PI) and engineers in Goddard's Instrument Design Laboratory (IDL; idc.nasa.gov), to design the instrument, culminating in a preliminary design and presentation to the PI, the IDL team and Goddard management. By shadowing and working alongside IDL discipline engineers, participants experience first-hand the science and cost constraints, design trade-offs, and teamwork that are required for optimal instrument design.

Prospective participants at Goddard must complete an application for consideration that includes a description of how their career goals will be advanced through their participation in the PSWS. Upon selection, participants sign a confidentiality agreement due to the competition-sensitive nature of the instrument concept and IDL facility and process. Participants are expected to participate in all aspects of the PSWS, including all pre-IDL meetings, each day of the IDL study week, and a study wrap-up. Participants also agree to provide feedback at the conclusion of the PSWS to inform the design and implementation of future Winter Schools.

The pilot PSWS was held in early 2015. It was collaboratively designed with representatives from SSED, IDL, the instrument PI, and prospective participants to ensure value added for all stakeholders. Feedback from the participants was used to design the 2016 PSWS, which is underway as of the writing of this abstract.

PSWS Goals: 1) To develop a conceptual instrument design that: Meets the overall mission objective as described by the PI and science team; Includes all instrument support subsystems as identified by the discipline engineers; Includes heritage hardware solutions that reduce risk and improve cost confidence; Can be parametrically costed for a credible, defensible proposal. 2) To create an awareness of the engineering drivers in spaceflight instrument design for participants by pairing them with discipline engineers to: Reveal the rationale and methodology to collaborative instrument design; Provide a detailed explanation into the total resource needs for the target science measurement; Provide an overview of the parametric costing process during formulation. 3) To introduce participants to collaborative engineering: The IDL is a unique instance of rapid collaborative design of flight instrument hardware.

Possible Roles: Upon selection, participants are presented with the instrument concept and associated IDL discipline engineer roles, at which time they will be asked to justify and prioritize their preferences for shadowing. These preferences will be taken into account as much as possible. Some participants may be required to take on a second role during the second half of the IDL week as needed to ensure active participation during all phases of the study.

- Contamination/Planetary Protection
- Costing
- Data/Communications
- Detectors
- Electrical
- Flight software
- Mechanisms
- Materials (consult)
- Mechanical systems
- Mechanical design (CAD)
- Optics
- Power
- Radiation (consult)
- Reliability
- Science PI
- Structural Analyst
- Systems Engineering
- Thermal

After the instrument concept is presented and roles chosen, participants develop a Science Traceability Matrix and identify science drivers for their particular focus area. On the last day of the IDL, participants deliver a "science impact" report that addresses how any trades that were made will impact the instrument's science return.

Participant Feedback: Survey results from the 2015 participants indicated that the pilot PSWS met its goals. 88% of participants somewhat agreed to strongly agreed with the statement: "I have a better understanding of the engineering drivers in spaceflight instrument design after having completed the PSWS than I did before the PSWS." The number of participants indicating that they were somewhat interested to very interested in being on a spaceflight instrument team as a PI or Co-I increased from 88% to 100% after the PSWS. In addition, the PI indicated that the resulting design was a better product than it may have been otherwise due to the additional scientist viewpoints in the room.

Quotes from 2015 participants: "It really was a fantastic exercise to see how an idea can become a solid, proposable concept in such a short time window! …I feel prepared to embark on my own proposal writing effort!" "I have a much deeper appreciation of the costing, reliability, and especially electrical support for a mission. I think I have a better feel now for how mature an idea has to be before it is ready for flight."

Despite the success, participant feedback indicated areas for improvement. For example, participants indicated that the number and topics of the pre-IDL meetings needed to be refined to ensure that they accomplished relevant purposes in an efficient manner. Another suggestion was to develop a secure library of relevant journal articles and instrument heritage documents, if applicable, for easy access by participants so that they did not duplicate effort by finding these documents individually. A third finding was that some engineer roles required less activity than others, particularly early in the IDL study week, resulting in those associated participants being less engaged.

This feedback was taken into account when designing the 2016 PSWS currently underway. We rethought the needed engineer/participant roles to ensure sustained engagement of all participants, reduced the number of pre-IDL meetings and developed more focused goals and agendas for each, and developed a secure library for useful documents and presentations. We also recruited a participant of the 2015 pilot to act as a Project Manager and mentor for the 2016 participants.

Summary: The NASA Goddard-sponsored PSWS provides an experiential learning opportunity for postdoctoral fellows and early career scientists while also producing a proposable instrument design. Feedback from participants of the 2015 pilot, as well as the instrument PI, suggests that the pilot PSWS achieved its goals. An unintentional but additional welcome outcome of the PSWS is that new collaborations were fostered among the 2015 participants, leading to at least one ROSES proposal and an internal Goddard research and development proposal. We look forward to a successful 2016 PSWS as well.

References: [1] Budney C. J. et al. (2014) *LPS XLV,* Abstract #1563.