TRAINING EARLY CAREER SCIENTISTS IN FLIGHT INSTRUMENT DESIGN THROUGH EXPERIENTIAL LEARNING: NASA GODDARD'S PLANETARY SCIENCE WINTER SCHOOL. L. V. Bleacher[1], B. Lakew[1], J. Bracken[1], T. Brown[1] and R. Rivera[1]. [1]NASA Goddard Space Flight Center, Greenbelt, MD 20771 (Lora.V.Bleacher@nasa.gov).

Introduction: The NASA Goddard 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. Currently in its third year [1], the PSWS is an experiential training program [2] for scientists interested in participating on future planetary science instrument teams. Inspired by the NASA Planetary Science Summer School [3], Goddard's PSWS is unique in that participants learn the flight instrument lifecycle by designing a planetary flight instrument under actual consideration by Goddard 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 develop a science traceability matrix and design the instrument, culminating in a conceptual design and presentation to the PI, the IDL team and Goddard management. By shadowing and working alongside IDL discipline engineers, participants experience firsthand the science and cost constraints, trade-offs, and teamwork that are required for optimal instrument design.

Each PSWS is collaboratively designed with representatives from SSED, IDL, and the instrument PI, to ensure value added for all stakeholders. The pilot PSWS was held in early 2015, with a second implementation in early 2016. Feedback from past participants was used to design the 2017 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.

Participant Selection, Roles, and Deliverables:

Participant selection. 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 and a letter of recommendation from their advisor or supervisor. Participants are required to 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 prework 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 and to gauge its success.

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

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

Deliverables. 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 work alongside their discipline engineer mentor to provide an overview of the conceptual design to the customer team. The participants also lead and deliver a "science impact" report that addresses how any design trades that were made will impact the instrument's science return.

Participant Feedback: A feedback survey is issued to participants at the conclusion of each PSWS, with the results used to refine and improve the next PSWS implementation. Changes from the 2015 pilot to 2016 included using an internal wiki site to host documents prior to the study week (at which point participants received access to the IDL server), having a previous PSWS participant serve as Project Manager to guide participants in setting up pre-study meetings, requiring a science trade report at the conclusion of the study, and doubling up on some roles so that there is not as much downtime for participants during the study.

2016 survey results. Survey results indicate that the experience of the 2016 participants was positive. When asked, "*Before* participating in the GSFC PSWS, how would you have described your interest in being on a spaceflight instrument team as a PI or Co-I?" 43% of participants indicated that they were *very interested*. When asked the same question *after* the PSWS, 100% indicated that they are *very interested*. In addition, 100% of the participants *strongly agreed* "I have a better understanding of the engineering drivers in spaceflight instrument design *after* having completed the PSWS than I did before the PSWS." This is an improvement over the 2015 pilot, after which only 88% of participants *agreed to strongly agreed* that their understanding improved.

2016 participant quotes. "The PSWS experience not only opened my eyes to how a mission evolves from concept to reality, it also revolutionized my way of thinking, from science-driven/thinking of ROSES proposals to mission-driven/thinking of new mission ideas. I'm hoping to return to the IDL as a customer – a well-prepared and flexible customer!"

"It has given me more confidence to propose a mission/instrument, now that I better understand the process and the engineering help and expertise that can be provided by GSFC."

What's new for 2017*?* Changes to the 2017 PSWS, currently underway, include giving participants access to a folder on the IDL server ahead of the study week for easier file storage and transfer of pre-study information from the IDL team, holding the study week later in the winter to (hopefully) reduce the number of times participants are impacted by winter weather and illness, allowing more time between participant selection/kick-off and the start of the study week, holding a "meet and greet" with discipline engineers earlier so that participants have more time to reach out to them ahead of the study week if needed, having discipline engineers and IDL staff give more detailed presentations on the responsibilities of each discipline engineer at the meet and greet, and trying to better manage participant expectations regarding the time commitment and pace and initial requirements for the first day of the study week.

Conclusion: The PSWS is successful in inspiring and preparing postdoc and early career planetary scientists to design and propose planetary flight instruments, based on both survey results at the conclusion of each Winter School and the professional successes of past participants. Participants of both the 2015 and 2016 Winter Schools indicate that the experience has positively impacted their professional lives. Participants have formed new collaborations, leading to successful ROSES and GSFC Internal Research and Development proposals. Participants have also collaborated on proposals, with selections yet to be announced, that will take them back into the IDL and/or GSFC's Mission Design Lab. Two participants cite the knowledge and experience gained during their respective PSWS as helpful in acquiring and establishing their new Civil Service positions at two different NASA centers.

We hope to continue to offer this opportunity to GSFC's postdoc and early career planetary scientists beyond 2017, pending funding.

References: [1] Bleacher L.V. et al. (2016) *LPS XLVII*, Abstract #2069. [2] Kolb, D. A. (2015), Experiential learning: Experience as the source of learning and development. NJ: Pearson Education, Inc. [3] Budney C. J. et al. (2014) *LPS XLV,* Abstract #1563.