NASA GODDARD INSTRUMENT FIELD TEAM: A FACILITY ENABLING PLANETARY SCIENCE FIELD TESTING OF NEW INSTRUMENT DESIGNS. J. E. Bleacher[1], C. W. Hamilton[2], D. P. Glavin[1], A. C. McAdam[1], J. L. Eigenbrode[1], K. E. Young[1,3], W. B. Garry[1] A. D. Rogers[4], T. D. Glotch[4], D. B. Eppler[5], N. E. Petro[1], J. C. Stern[1], M. G. Trainer[1], P. G. Conrad[1], S. D. Guzewich[1]. [1]NASA Goddard Space Flight Center, Greenbelt, MD, 20771 (jacob.e.bleacher@nasa.gov), [2]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721, [3]CRESST/University of Maryland, College Park, MD, [4]Department of Geosciences, Stony Brook University, Stony Brook, NY 11794, [5]Exploration Science Office, Code XI4, NASA JSC, Houston, TX, 77058.

Introduction: The collection of scientific data during planetary exploration involves a broad range of measurements via instrument technologies developed inside and outside of NASA. Different measurements often require access to highly valuable resources throughout the lifecycle of a mission. The nature of planetary exploration causes instruments with different needs to be bundled onto a single spacecraft or surface vehicle, bound by a drive to address high level mission goals. Although each instrument is motivated to address the defined mission objectives, individual instrument teams are also motivated by the potential for additional science that pushes limits of the design of their instrument and the vehicle to which they are mounted. Instruments are designed and built at a range of government and non-government laboratories and institutions and often instrument teams are not focused on their integration with other instruments until a mission is defined and instruments are selected, or indeed well after launch. Once working together on a mission the unique capabilities of each instrument can often be used in a complementary manner to provide enhanced science value above individual instrument results alone. Here we discuss a facility at NASA's Goddard Space Flight Center called the Goddard Instrument Field Team (GIFT). The primary goal for GIFT is to enable planetary science relevant field testing and integration of measurement philosophies early in the instrument development cycle.

Facility Description: Goddard Space Flight Center's (GSFC) Science and Exploration Directorate (SED) includes four Divisions covering Planetary Science, Earth Science, Heliophysics and Astrophysics. All four Divisions develop instruments for missions focused on their scientific field. The Planetary and Earth Science Divisions also host personnel who actively conduct field campaigns as a means of ground truthing orbital and airborne instruments and conducting surface studies to support comparative planetary research. GIFT was developed in 2009 as a means of integrating instrument design teams across the divisions with field research teams.

Early on GIFT acted to identify and document upcoming funded field excursions that were to be conducted by GSFC personnel (and their external collaborators both within and outside NASA). As these field campaigns were identified GIFT would subsequently communicate this information to instrument teams across the SED to identify opportunities for field testing and validating other GSFC-led instrument design and definition efforts where field testing was not otherwise planned.

Initially this effort was focused on field testing on planetary science relevant field sites to demonstrate an individual instrument's ability to measure in situ, real materials and provide critical insight into science questions that are of interest to NASA. As GIFT continued to grow the team recognized an ability to not only test an individual instrument's capabilities in the field but begin testing the philosophy of integration of instrument suites at a very early stage of instrument design and definition. Additionally, synchronous testing of multiple instruments enables evaluation of field operations. Field operations can be carried out in a terrestrial setting by field geologists, or by astronauts on planetary surfaces. GIFT looks to determine the operational implications of deploying these instruments to assist human explorers as well as robots.

GIFT has subsequently grown beyond a Goddard- or NASA-focused effort. GIFT has routinely identified benefits for integration between existing field campaigns and instrument technologies outside of Goddard and NASA. Likewise, GIFT field operations have grown to include hardware other than science instruments. The motto adopted by GIFT is "From Field to Flight". Examples of interactions enabled through the GIFT facility are presented in the following sections.

VAPoR: The Volatile Analysis by Pyrolysis of Regolith instrument (VAPoR) instrument is a simplified version of its predecessor Sample Analysis at Mars (SAM) [1], and enables compositional and isotopic measurements of water and other volatiles in planetary atmospheres and exospheres and released from solid surface samples using pyrolysis mass spectrometry on airless bodies including the Moon, asteroids and comets, and the icy moons of the Outer Planets. With the addition of a miniature turbo pump like the one on SAM, VAPoR could also operate in higher pressure planetary environments including Mars and Titan [2]. GIFT efforts enabled the successful participation of VAPoR during the 2010 Desert Research And Technology Studies (DRATS) field test [3]. During this field campaign simulated crew traverses across the northern AZ volcanic fields enabled the collection of a number of geologic samples to be studied with laboratory techniques. The inclusion of VAPoR enabled crew timeline information to include concepts for a portable laboratory instrument that might be mounted on the human operated rover. VAPoR was able to demonstrate its ability to operate within a human exploration architecture, which also provided more realistic sample collection Concept of Operations (ConOps) for the overall field campaign as the crew were forced to enact sample collection procedures that did not contaminate the samples in a manner that disrupted VAPoR measurements. In this way the participation of an instrument that was in development for planetary exploration was a mutually beneficial process for the DRATS field campaign and the instrument team.

Multi-View Stereo Photogrammetry: High spatial resolution (< 1 m/pixel) topographic data are highly desirable for planetary exploration. If orbital laser altimeters do not provide high enough resolution for detailed morphometric studies of small scale features, stereo-derived Digital Terrain Models (DTMs) can be produced using data from cameras such as the High Resolution Imaging Science Ex-periment (HiRISE) or Lunar Reconnaissance Orbiter Camera Narrow Angle Camera (LROC NAC). In order to enable comparisons between terrestrial DTM datasets of comparable resolutions to HiRISE and LROC the GIFT team has worked with partners to evaluate the use of Multi-View Stereo Photogrammetry (MVSP) to produce local DTMs at resolutions appropriate for the scientific question at hand [4]. Images are collected from a low altitude airborne platform such as a kite or motorized vehicle. Using this technique, images taken from above can be combined with surface images to provide data for areas that are difficult to image from the air, for instance below overhangs [5]. A partnership between researchers at the University of Arizona and GIFT has enabled testing of this capability a several planetary analog sites in both a science application and as an asset within a human exploration architecture to provide reconnaissance of ongoing EVA activities.

Instrument Suites for Mineralogy Studies: Recent work has shown the utility of using miniaturized and portable planetary-relevant instruments during geologic exploration [6]. For example, geochemical techniques such as x-ray fluorescence (XRF), x-ray diffraction (XRD), and multi-spectral imaging are now available in a field portable format. The integration of these instruments into EVA operations, however, has not been widely tested. GIFT collaboration with researchers at Stony Brook University and the Johnson Space Center have focused on how these individual instrument ConOps can be integrated in the most efficient and scientifically beneficial manner. For instance, off-the-shelf portable XRF units can provide useful geologic information within several minutes, thereby helping streamline the sample collection process. However, coupling XRF spot measurements with qualitative views of the multispectral data can provide a quick-look ground truth to the broader field of view spectral camera information. None of these approaches can replace the accuracy obtained by laboratory analyses (XRF) or through post processing and analysis (multi-spectral data) but the real-time use of these instruments together might produce an operational approach that enables quick high grading and decision making during either human missions or low latency telerobotic missions when quick responses are of value [7,8].

Conclusions: The Goddard Instrument Field Team facility works to integrate instruments teams with existing field research campaigns. The field testing in relevant planetary science sites enable instrument teams to validate their technology while facilitating an interaction with field researchers who help to push the technology and its ConOps in directions that are most efficient and scientifically beneficial. Exploring the combination of measurement types during field campaigns prior to instrument selections for missions helps to identify potential conflicts between instrument requirements while enhancing complementary aspects of instrument operations. The science community is invited to contribute suggestions for field campaigns and/or instruments that are mature enough for field testing.

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