

OSIRIS-REx SCIENCE OPERATIONS PLANNING AND IMPLEMENTATION. H. L. Enos¹, S. Knutson¹, W. V. Boynton¹, C.W. Hergenrother¹, D. S. Lauretta¹ Lunar and Planetary Laboratory, University of Arizona (1415 N. 6th Ave, Tucson, AZ, Email:heather@orex.lpl.arizona.edu)

Introduction: NASA's Origins, Spectral Interpretation, Resource Identification, and Security-Regolith Explorer (OSIRIS-REx) mission successfully launched on September 8th, 2016. During its rendezvous with near-Earth asteroid (101955) Bennu beginning in 2018, OSIRIS-REx will characterize the asteroid's physical, mineralogical, and chemical properties in an effort to globally map the properties of Bennu, a primitive carbonaceous asteroid [1], and choose a sampling location.

OSIRIS-REx science operations planning and implementation is quite different from many other planetary science missions. The unique nature of an asteroid sample return mission creates significant operational challenges. These challenges include accurate spacecraft navigation in the microgravity environment, precision delivery of the spacecraft to the asteroid surface, tight coupling and interdependence between the science team and spacecraft operations, and data product production on a tactical timeline to enable sample-site selection. The OSIRIS-REx ground system, which includes the Science Processing & Operations Center (SPOC), is designed to meet these unique challenges (Figure 1).

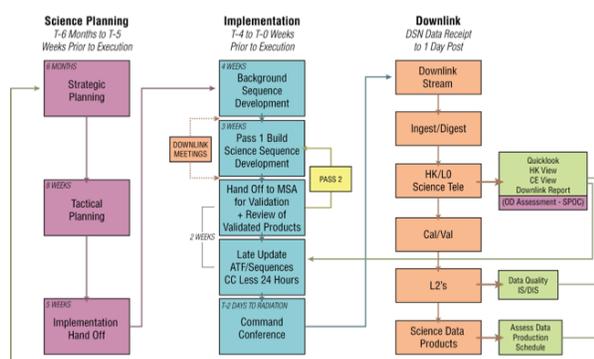


Figure 1

The OSIRIS-REx Science Payload consists of the following instruments; OCAMS (camera suite), OLA (scanning LIDAR), OVIRS (infrared spectrometer), OTES (thermal emission spectrometer) and REXIS (X-Ray imaging spectrometer).

Traditionally science instrument teams have independent science objectives and do not directly support operations. For OSIRIS-REx this is very different. The OSIRIS-REx science instrument teams have one common integrated goal, characterize and select a sample site.

The integrated science operations approach starts with science planning. The OSIRIS-REx Science Operations Planning Group (SOPG) is responsible for developing the science observation activities required to meet the mission science objectives. The SOPG reaches across all elements of the team and includes members from the science team, navigation, mission systems engineering and the spacecraft team. Science planning is done on a mission phase by phase basis. The observations required to obtain the science data necessary to produce the data products critical for sample-site selection have been identified and are contained in the OSIRIS-REx mission plan. As the details for science observation activities are developed, multiple and often conflicting constraints must be taken into consideration. Given the integrated nature of the science observation activities and their interdependence on one another, priority for resources will be given to the instrument activity that provides the most critical data to support phase transitions and sample-site selection data products. Once the SOPG has finalized the detailed science observation activity, they hand the plan off to the Science Operations Implementation Team.

The OSIRIS-REx Science Operations Implementation Team includes members of each of the instrument teams. The implementation process is an integrated process that requires close communication across all project elements and the science team members. The implementation team is responsible for ensuring the sequences required to successfully execute the science observation activity are generated and produce the expected science data output. Operations Engineers, Instrument engineers and Instrument Scientists work

closely together to validate the instrument engineering and science data.

One of the biggest challenges facing the Science Operations Planning and Implementation teams is the substantial uncertainties in the prediction of the spacecraft trajectory and pointing. This challenge also has a significant impact on the navigation team, requiring close coordination and communication with the science planning and implementation team. The OSIRIS-REx operations team developed a sophisticated late-update process to tactically revise planned science and optical navigation observations. Further, the OSIRIS-REx team is maintaining a matrix of all critical science data products and science observations required to produce the products. These multi-tiered processes and tools allow planning and commanding to occur with the flexibility required for an asteroid mission.

References: [1] Lauretta, D. S., et al. *Meteoritics & Planetary Science* 50.4 (2015): 834-849.

Acknowledgments: This material is based upon work supported by NASA under Contracts NNM10AA11C, NNG12FD66C, and NNG13FC02C issued through the New Frontiers Program.