Back to: Understand Asteroid Geology, Dynamics, and Spectroscopy
Back to: Level-2 Requirements

Summary of Requirement

MRD-147 (2.12.4) Measure the integrated spectral properties of detected satellites and compare them to those of Bennu.

This requirement applies to contingency observations in the event that one or more satellites resolvable by the spectrometers are detected at Bennu.

The requirement is verified by establishing that SAWG has developed and tested the requisite algorithms for converting OVIRS and OTES L2 pipeline products into I/F and emissivity spectra, respectively. These are the minimum processing steps required to compare the spectral properties of any satellite(s) to the spectral properties of Bennu.

Data Products Required

OVIRS: OVIRS calibrated radiance from the Detailed Survey phase, resampled and processed to remove the thermal excess, then converted to I/F using a standard solar spectrum.

OTES: OTES calibrated radiance from the Detailed Survey phase, processed to emissivity.

No other dependencies exist for these products.

Ability/Availability of the System to Generate Sufficient Observations

Details of spacecraft orientation for instrument pointing and spacecraft trajectories will depend on the characteristics of the satellite(s), and hence, will not be decided until such objects have been detected. Characterization of any phases on the satellite(s) surface(s) is on a best-effort basis, with no requirement for minimum detection by the spectrometers. If the satellite(s) is/are sufficiently large to obtain adequate signal-to-noise spectra from the spectrometers, the spectra will be converted to I/F (OVIRS) and emissivity (OTES) for comparison with comparable Bennu spectra.

Minimum Success Criteria

The spectrometers can make observations of the space encompassing the satellite(s) but successful characterization will depend on the size and in the case of OTES, surface temperature, of the satellite(s), which cannot be predicted in advance. If the satellite(s) do not fill a sufficiently large portion of the instruments' fields of view, or is/are not hot enough to produce resolvable spectral features in either the OVIRS or OTES (or both) dataset, characterization will nonetheless have been accomplished.

Dependencies by Mission Phase

The search for satellites using OCAMS will occur during the Approach phase. The characterization of any identified satellites will take place after the satellite search campaign, during the Contingency Phase associated with a satellite detection.

Adequacy of the DRM

These observations will only take place in the event that one or more satellites are detected; to the degree that the DRM sets aside time for the characterization observations during Detailed Survey (even if they are not yet planned), the mission profile is adequate. The response to a satellite detection is specified in the relevant Contingency Plan.

Data Products per Mission Phase

Data products will be produced either in contingency mode (not in the DRM now) or early in the Detailed Survey phase.

OVIRS: The output product is one or more I/F spectra.

OTES: The output product is one or more emissivity spectra.

Overview of Processing

OVIRS:

- I/F from OVIRS L2 calibrated radiance is obtained using SAWG scripts for resampling, thermal tail removal, and ratioing to the solar spectrum; these scripts run in the IDL environment.
    - These scripts have been delivered to the SPOC.
    - The solar spectrum has been delivered to the SPOC.

OTES:

- Emissivity from OTES L2 calibrated radiance spectra is obtained using a SAWG script referred to as the emissivity-temperature separation algorithm (emissivity.dvrc); this script runs in the Davinci environment.
    - emissivity.dvrc has been delivered to the SPOC.

Provenance of Algorithms, Software and Techniques

OVIRS: The resampling, thermal tail removal, and I/F processing steps can all be considered common knowledge. The specific scripts delivered by the SAWG were written expressly for the SAWG.

OTES: The emissivity-temperature separation script for the Davinci environment is an update to code used for analysis of thermal infrared spectra on prior spaceflight missions (Mars Exploration Rovers, Mars Odyssey, Mars Global Surveyor) and has been used extensively for OTES data processing through instrument-level testing and ATLO. Script version control is included.

Expected/Simulated Data

Data representative of what would be produced are available as the CMWG-provided input spectra for the CMWG/SAWG Blind Test, available at this link: (SEE SCIENCE TEAM WIKI)

Analysis & Verification Methods

See Provenance of Algorithms, above.

Existing or Potential Liens

Lien-SPEC-2 has closed. The database search, input, and output currently implemented in the JSON database at the SPOC for meeting the MRD Requirements on spectral data processing(MRD-118, MRD-140, MRD-143, MRD-147, MRD-154, MRD-159 and MRD-540), are ready for operations. These database uses have been completed, validated, verified and used successfully by SAWG and TAWG scientists during the first Science Operations Proficiency Integrated Exercise (SOPIE-1). The SAWG and TAWG teams demonstrated that the database IO is complete -- by correctly using it to create data products during the SOPIE-1 exercise. Only minimal support was required from Sanford Selznick (Director of Science Data Processing) and his staff to use the database structure to download datasets and upload higher level data products. The software and database structures for extracting L2 OTES and OVIRS data from the database, and handing them off to the various data processing algorithms, then returning them to the database, has been completed (i.e., science database tables have been implemented), and Lien-SPEC-2 can be closed.

Closure on Lien-SPEC-2: Lien on the SPOC: The second lien on successfully meeting this requirement is the implementation of needed database access and data processing linkages at the SPOC. SAWG has delivered individual algorithms for conducting the required analyses, but there is currently no defined procedure for SAWG to extract L2 OTES and OVIRS data from the database, and hand it off to the various algorithms, then return it to the database (i.e., science database tables have not been implemented). Removing this lien will require work on both the part of the SPOC and the SAWG to generate algorithms and update existing algorithms once a process is defined.

There are currently no known liens on the DRM, the OVIRS and OTES instruments, or spacecraft system that would preclude successfully collecting the data needed to meet this requirement.

SPOC Requirements

SPOC must produce OVIRS and OTES instrument L2 products, enable these to be fed to the SAWG algorithms for resampling, thermal excess removal, and calculation of I/F (OVIRS), as well as emissivity-temperature separation (OTES), and enable the return of the derived products and ancillary information to the SPOC database. Geometric information (solar distance) is required for calculation of I/F, but is not required for derivation of emissivity.

The SPOC-Spectral Analysis ICD is posted on ODOCS: \OSIRIS-REx Ground Systems\9.4 SPOC\9.4.2 Systems Eng\ICDs\WG ICDs\

The Spectral Analysis flowchart is in draft form, undergoing active revision (as of 15 May 2016) and will be linked here when it is finalized.

External Interfaces

There are no external interfaces for spectral characterization of satellites.