The Small Body Mapping Tool (SBMT) For Accessing, Visualizing, and Analyzing Spacecraft Data in Three Dimensions: 2022 Update

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Introduction: Spacecraft missions return massive amounts of valuable data, but those data can be hard to access, visualize, and analyze. Most asteroids, comets, Kuiper Belt Objects, and small moons present additional challenges because two-dimensional map projections severely distort features on irregularly shaped bodies. The Small Body Mapping Tool (SBMT), developed at the Johns Hopkins University Applied Physics Laboratory, addresses these challenges [1].

The SBMT allows users to find, access, and analyze spacecraft data in three dimensions, directly on small body shape models. The Tool includes a diverse suite of bodies and data types (images, spectra, altimetry data, see "Available Data"). Much of the data in the Tool is already co-registered, but the Tool also supports additional co-registration of data products. It has been or is being used by multiple mission teams, including Dawn, Rosetta, OSIRIS-REx, Hayabusa2, DART, and MMX.

The SBMT is publically available as a free download at sbmt.jhuapl.edu. It works on Mac, Linux, and Windows operating systems and has an easy-to-use graphical user interface that has been refined and improved over the past several years. The SBMT is written in Java and uses the Visualization Toolkit (VTK), an open-source, freely available software system for 3D computer graphics, rendering, and visualization [2]. Although datasets and functionality specific to active missions may be temporarily restricted to team members, such data and features become publicly available once the data have been published or archived with the PDS.

New Features: The basic features of the SBMT have been discussed in previous publications [1,3]. Here we discuss recent improvements to the Tool.

GRNS Footprints: Gamma Ray and Neutron Spectrometer (GRNS) instruments, such as MEGANE on the MMX mission to explore Phobos, see large footprints of the surface, so the signal strength varies significantly with the orientation of the spacecraft. To produce accurate compositional results, the irregular shape of Phobos and its proximity to Mars must be taken into account during the analysis of MEGANE data. The SBMT now has the ability to visualize such footprints, and provides users the ability to search footprints from a database that match certain criteria. Figure 1 shows expected signal strength over the footprint, defined as the projected area over the square of the range of the spacecraft. [4].

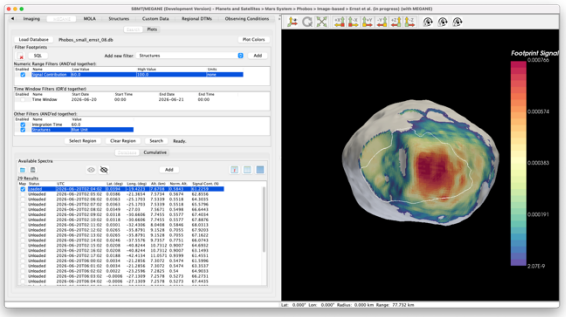

Figure 1: Visualizing GRNS Footprints in the SBMT

DART: The SBMT now has the capability to project images that contain multiple bodies onto multiple shape models in a scene, which will be required by the DART team when the spacecraft visits the Didymos system later in 2022.

GDAL: The first of two phases of integration of the GDAL library into the SBMT is complete. GDAL will allow a higher level of integration with other community image processing tools. This integration is part of an effort to bring the Imaging tab in line with updates to other sections of the Tool made in recent years.

Available Data: All data from the OSIRIS-REx mission are now publicly available in the SBMT. These new datasets complement the previously existing bodies, which include spacecraft data for several asteroids (e.g., Ceres, Vesta, Lutetia, Eros, Itokawa) and moons (e.g., Phobos, Deimos, Dione, Mimas, Phoebe, Thethys).

Conclusion: The SBMT is a powerful, easy-to-use tool for accessing, visualizing and analyzing data from small bodies. We continue to release new datasets and functionality. Visit sbmt.jhuapl.edu to download the Tool and subscribe to the SBMT mailing list. We invite everyone in the community to reach out and discuss collaborations.

References: [1] Ernst et al., 2018, *LPS 49*, #1043. [2] http://vtk.org [3] Steele et al., 2021, 5th Planetary Data Workshop. [4] Chabot et al., "MEGANE Investigations of Phobos and the Small Body Mapping Tool", *Earth, Planets and Space,* 2021