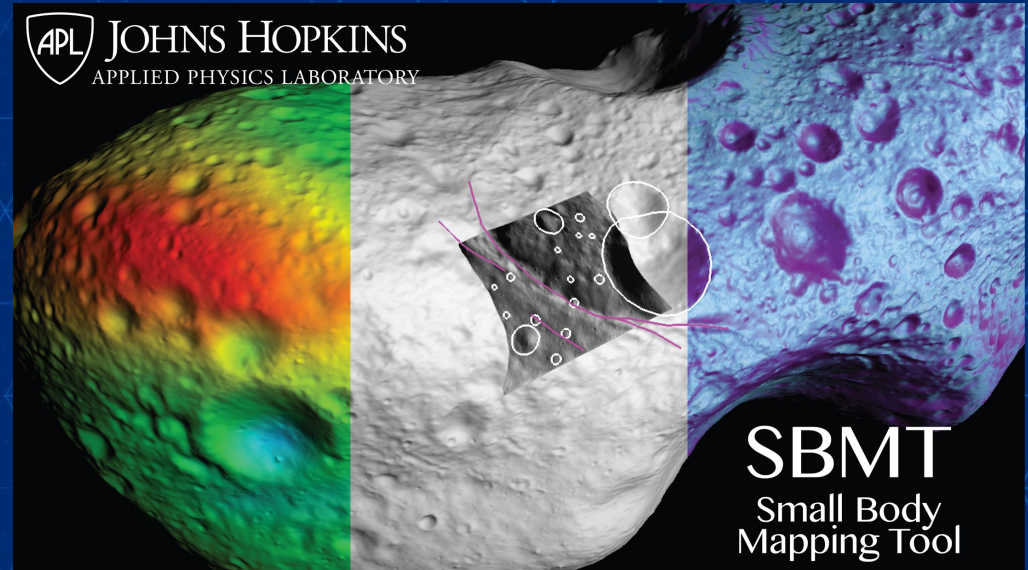


The Small Body Mapping Tool (SBMT) For Accessing, Visualizing, and Analyzing Spacecraft Data in Three Dimensions: 2022 Update



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The Small Body Mapping Tool

Background

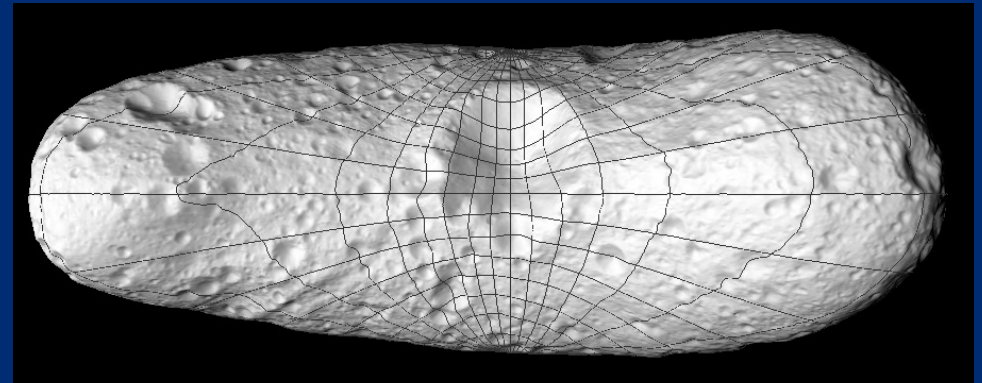
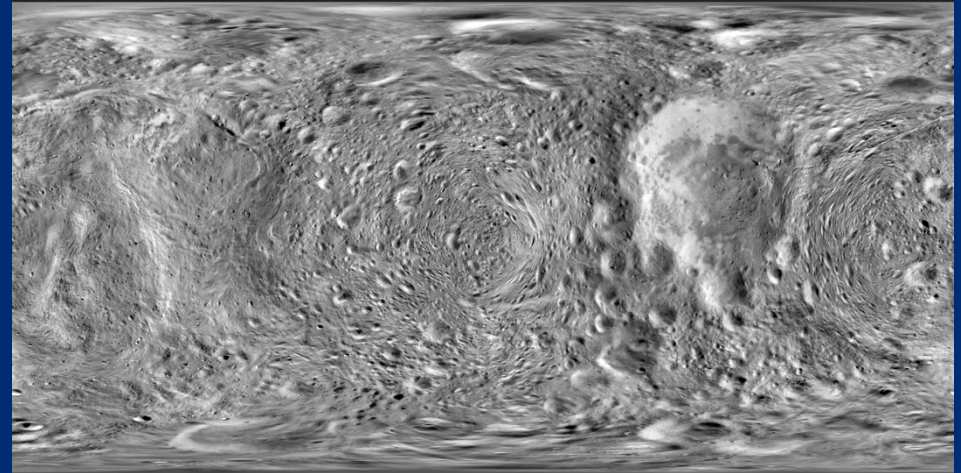
Spheres are Easy(?)

- On Earth well defined and uniform longitude and latitude lines allow us to project data onto a planet with little difficulty
- Map projections are fairly well understood
- But not everything in the universe is a sphere
- Why does that matter?

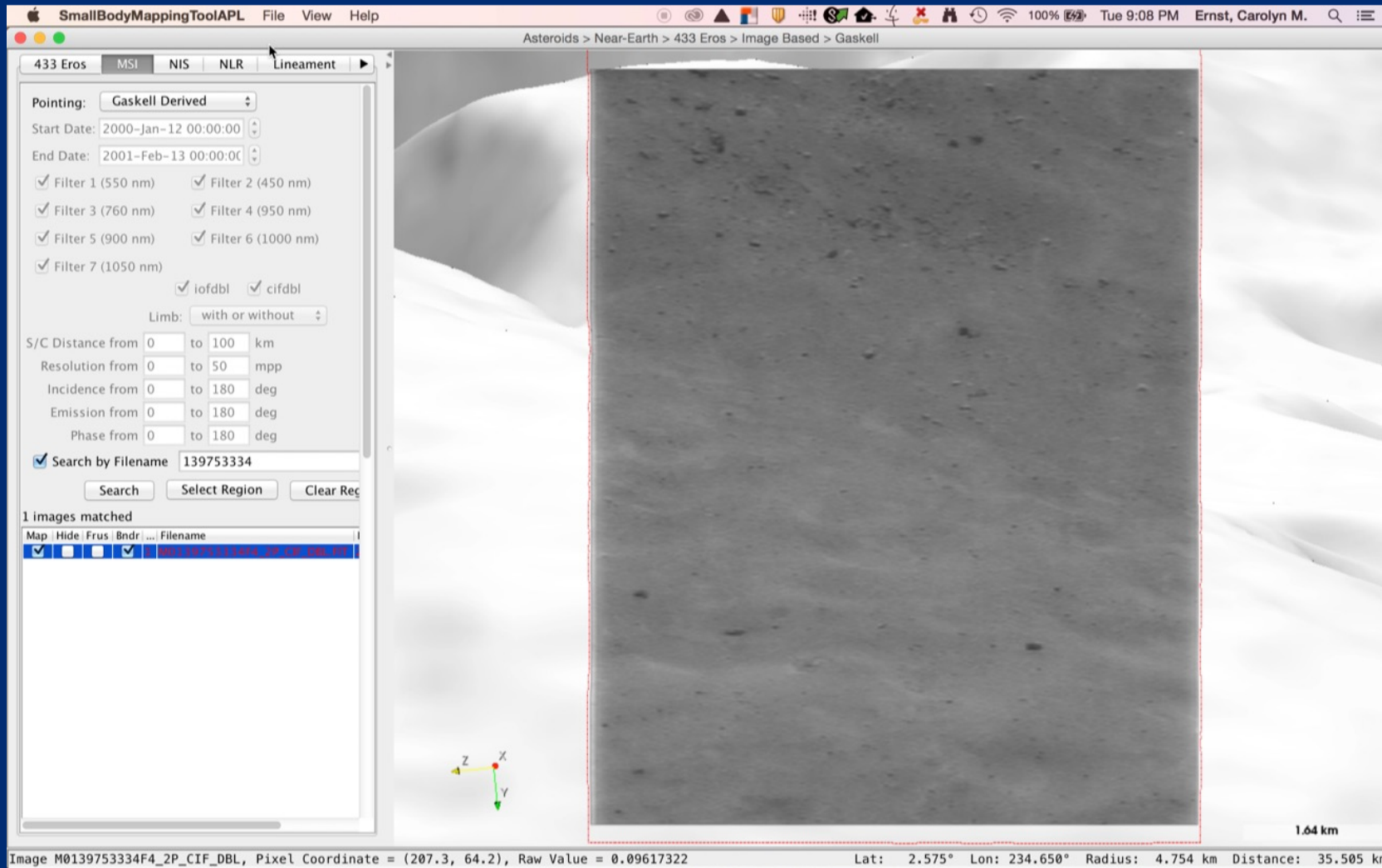


Difficulties of Irregular Bodies

- Visualizing and mapping the surfaces of irregular bodies is difficult.
- Searching for and co-registration of data can be problematic.
- Determining spatial relationships between features can be nearly impossible in a 2-D map projection.



Difficulties of Irregular Bodies



Difficulties of Irregular Bodies

The screenshot displays the SmallBodyMappingToolAPL software interface. The main window shows a search for images of asteroid 433 Eros. The search parameters are as follows:

- Pointing: Gaskell Derived
- Start Date: 2000-Jan-12 00:00:00
- End Date: 2001-Feb-13 00:00:00
- Filters: Filter 1 (550 nm), Filter 2 (450 nm), Filter 3 (760 nm), Filter 4 (950 nm), Filter 5 (900 nm), Filter 6 (1000 nm), Filter 7 (1050 nm)
- iofdbl: checked
- cifdbl: checked
- Limb: with or without
- S/C Distance from 0 to 100 km
- Resolution from 0 to 50 mpp
- Incidence from 0 to 180 deg
- Emission from 0 to 180 deg
- Phase from 0 to 180 deg
- Search by Filename: 139753334

The search results show 1 image matched:

Map	Hide	Frus	Bndr	...	Filename
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		M0139753334F4_2P_CIF_DBL.tif

The main image shows a grayscale view of the asteroid's surface, with a red dashed box indicating the selected region. A scale bar in the bottom right corner indicates 1.64 km. A 3D coordinate system (X, Y, Z) is visible in the bottom left corner of the image area.

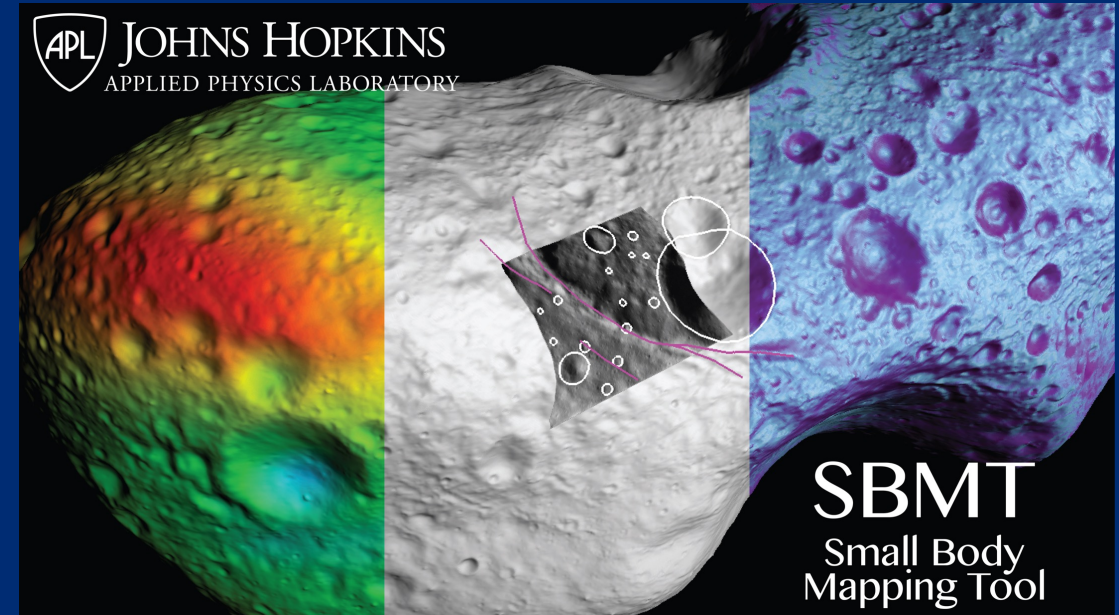
Image M0139753334F4_2P_CIF_DBL, Pixel Coordinate = (207.3, 64.2), Raw Value = 0.09617322 Lat: 2.575° Lon: 234.650° Radius: 4.754 km Distance: 35.505 km

The Small Body Mapping Tool

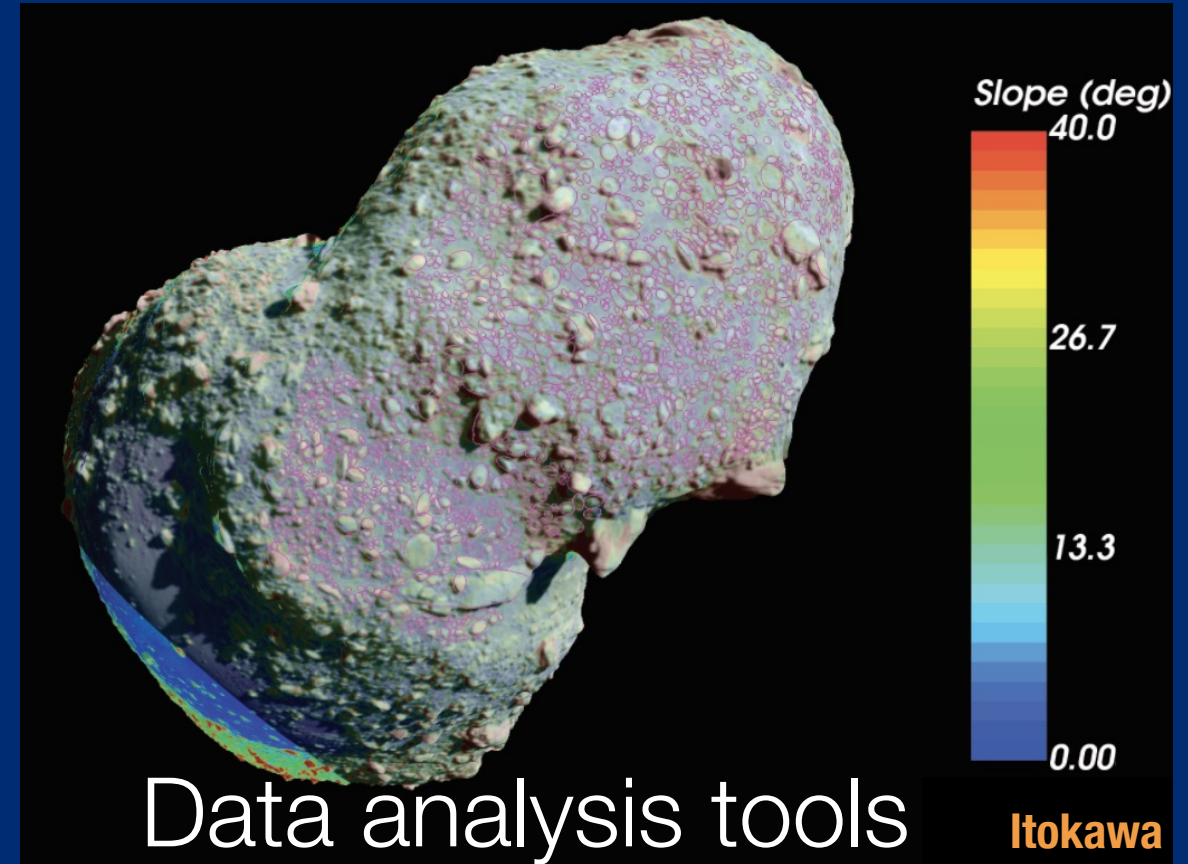
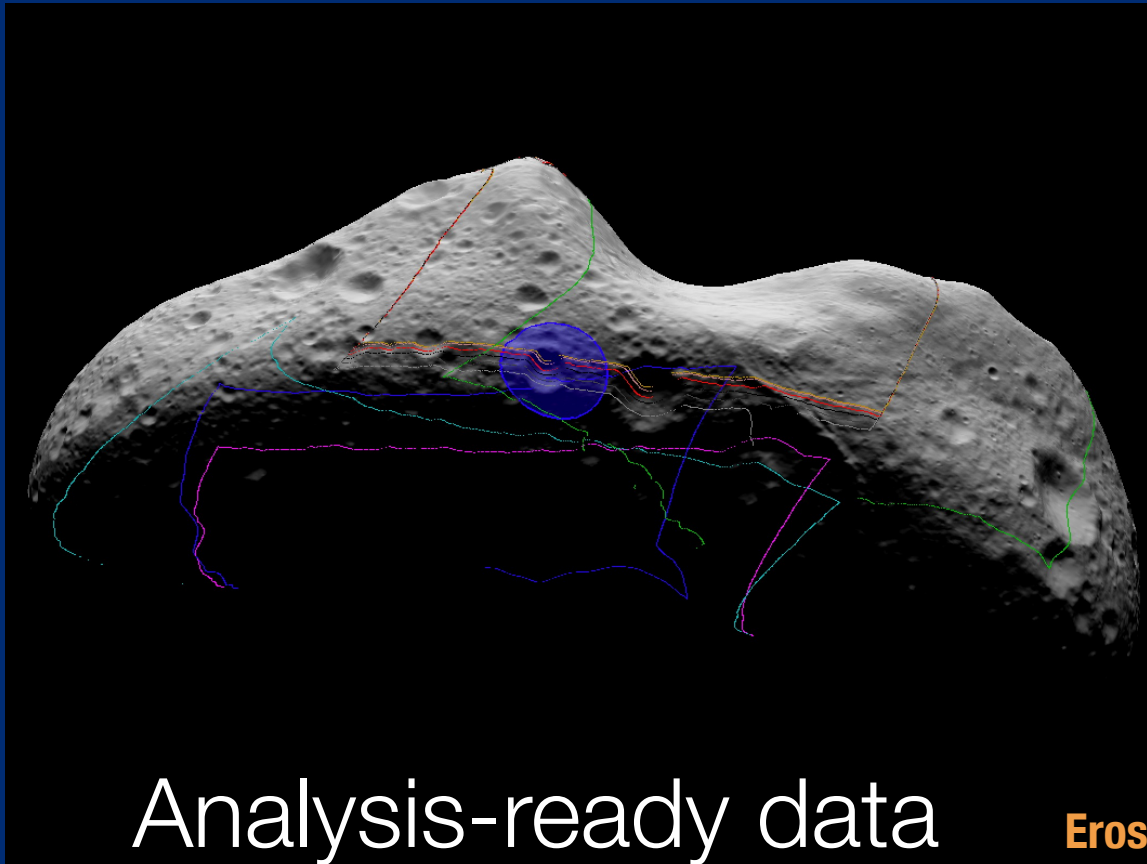
What is the SBMT?

What is the SBMT?

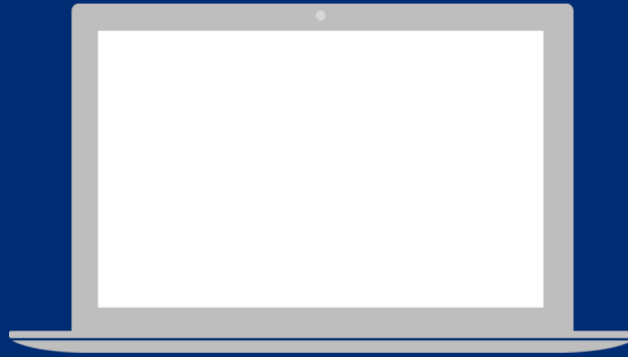
- Developed at APL
- Interactive 3D visualization tool specialized for use with irregularly shaped solar system bodies
 - Search for data
 - Visualize data on a shape model
 - Map and analyze features
- Most recently used to help with OSIRIS-REx tag site selection and visualization
- Previous Missions: NEAR, Dawn, Hayabusa 2, and more!
- Coming soon: MEGANE (MMX), DART



Finding and analyzing the right data



Client Server Architecture



SBMT client runs locally.

- Java 8 based client; runs on Windows, Mac, Linux
 - Upgrade to Java 16 support in Q3 2021
- VTK library (used in Paraview) drives the 3D Graphics
 - VTK 9 upgrade in Q3/Q4 2022
- Local cache allows you to go offline
- User accounts limit access to bodies/data
 - OREx, DART, etc all have restricted model access



Web server hosts data.

- Data hosted on the servers at APL
 - Multiple body models are supported
- Pipelines prepare data for use by the client (for active missions)
 - Pointing information, graphics pre-rendering

Image credits: Wikimedia Commons user Rudloff (top) and icons8.com (bottom)

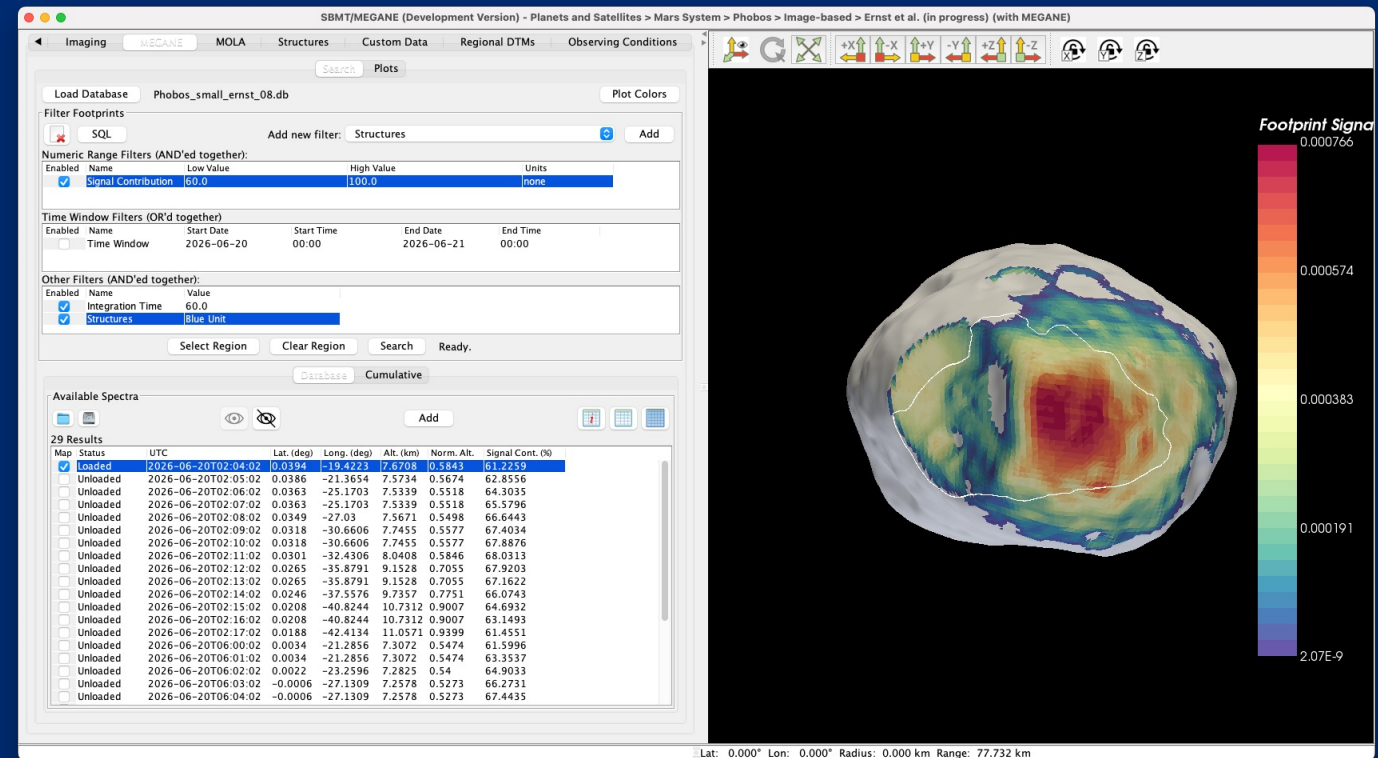
The Small Body Mapping Tool

An Updated Features Tour

MEGANE Footprints

Beta

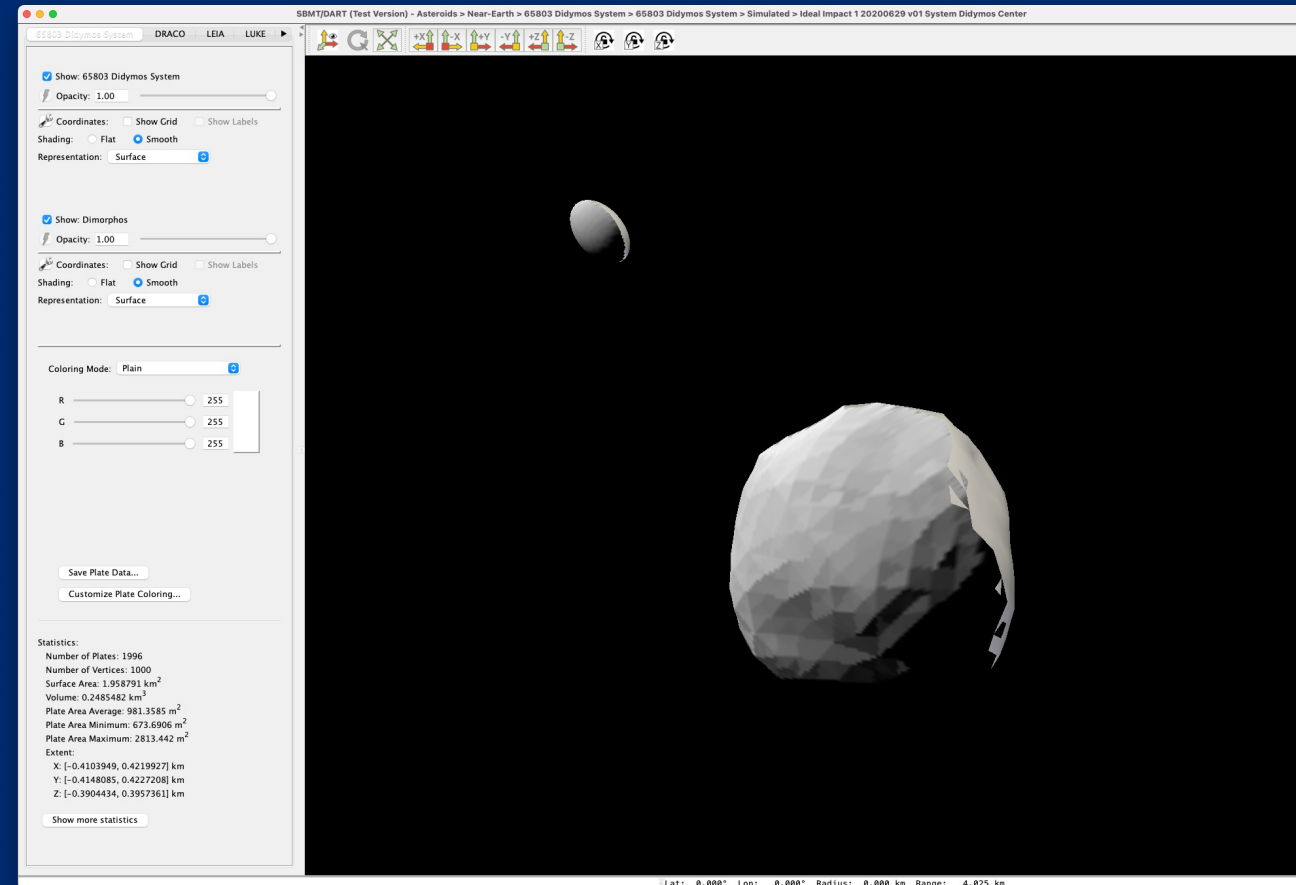
- Facet coloring tools allow GRS/NS instruments to visualize the signal contribution from regions of the surface
- Search capabilities on a prepopulated database (based on spacecraft trajectory and pointing)
- Structures can be used to define geologic units of interest; search within those regions is possible
- Footprints can be added together to visualize body-wide coverage
- Broader feature available in a future release



Simulated MEGANE Footprints displayed on a Phobos model (signal strength defined as projected area over the square of the spacecraft range)

DART Multiple Bodies

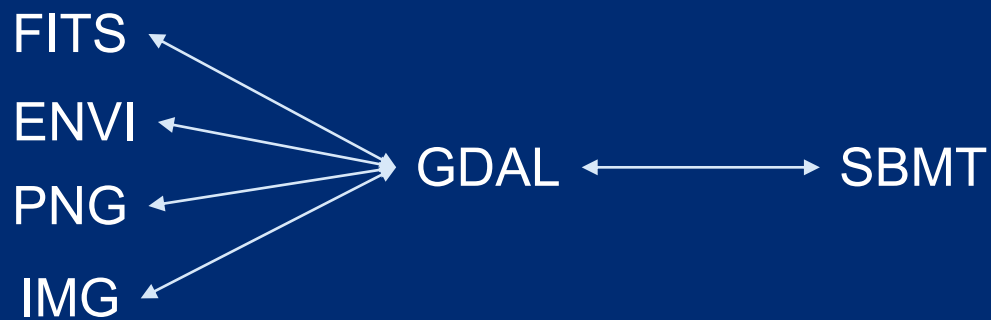
- DART will take images of both Didymos and Dimorphos during the encounter later this year
- SBMT has been updated to support multiple bodies
- Extendable to other multi-body systems (e.g. Pluto-Charon)
- Currently images only, will expand to other datasets in the future
- Broader feature available in a future release



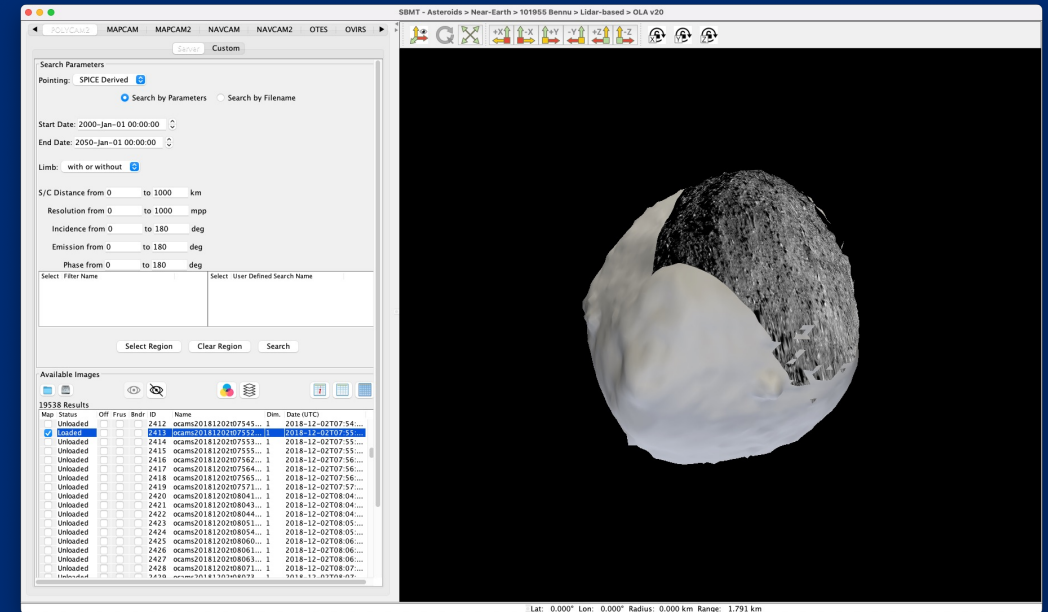
Simulated image data draped on multiple bodies

Imaging Framework Updates

- Currently about halfway through an upgrade of the imaging library in SBMT
- Major Goals:
 - Integrate GDAL
 - Revise the user interface to align with other areas of the tool
 - Expand the support for different image types and image dimensionality (i.e. image cubes, image stacks)
- Hope to release in CY23 (end of PDART support)



GDAL will act as an I/O translation layer for SBMT



A sneak peek into some user interface improvements

The Small Body Mapping Tool

Newest Models

Updated Datasets

- Several datasets are available for internal team use (and will eventually become public):
 - Didymos System
 - Simulated shape models and image of both Didymos and Dimorphos for the DART team
 - Ryugu
 - Shape models and ONC images from Hayabusa2
 - Tempel 1
 - Datasets are getting prepared and will be released in the public tool soon

The Small Body Mapping Tool

Future Plans

Continuing/Future Plans

- Imaging Framework
 - Integration of the GDAL library (via a NASA PDART) to enable higher levels of interoperability with existing tools in the community. This will help the SBMT support more file formats and projection types
 - Improvements in performance, user interface, and overall capabilities are currently being discussed, and will be available in a future release of the SBMT
- MMX/MEGANE
 - Gamma Ray and Neutron Spectrometer data will be introduced to the SBMT via MEGANE on the MMX mission to Phobos
 - Simulated MEGANE footprints (with the new Observing Conditions improvements) have and will continue to assess candidate trajectory/pointing ability to meet science goals
 - Once data have been taken, search and display of flight data will be made available to the team

Future Plans

- Open Source
 - Result of PDART Effort
 - Git repository will be publicized on the SBMT website
- Community Interface
 - Defining interfaces and tools that will enable new users to prepare, validate or import data into the SBMT
- Further Enhancements
 - Ability to perform image searches on spawned DTMs

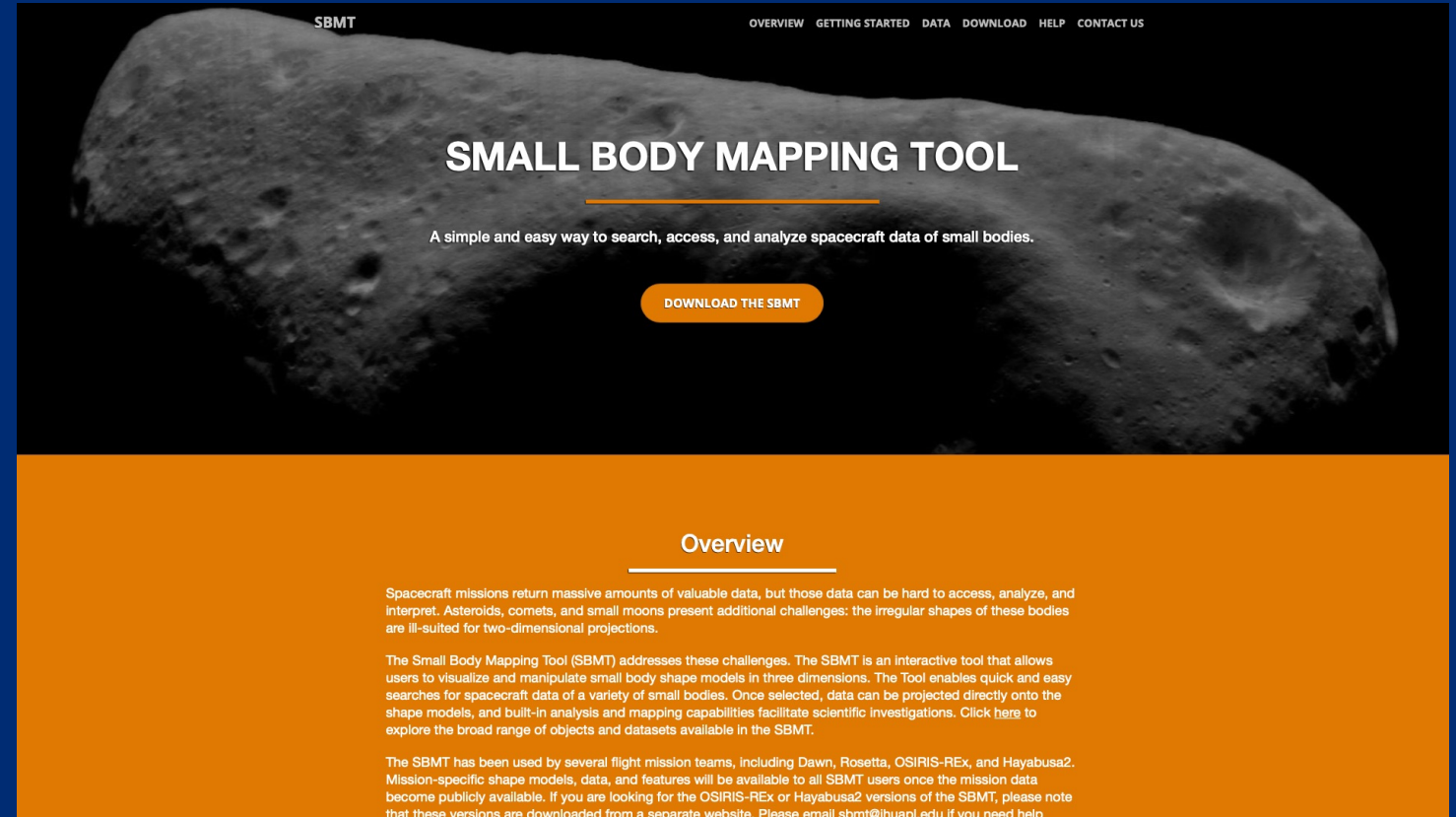
Special Thanks

- Science Team
 - Carolyn Ernst
 - Olivier Barnouin
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 - Anna Martin
 - Many more internal users!
- Software Team
 - Josh Steele
 - James Peachey
 - Norberto Lopez
- Past Software Team Members
 - Russell Turner
 - Colleen O'Shea
 - Mike Zimmerman
- Original Creator
 - Eli Kahn (former APL employee)

Where to get SBMT

Website: <https://sbmt.jhuapl.edu>

Email: sbmt@jhuapl.edu



The screenshot shows the SBMT website homepage. At the top, there is a navigation bar with the following links: SBMT, OVERVIEW, GETTING STARTED, DATA, DOWNLOAD, HELP, and CONTACT US. The main heading is "SMALL BODY MAPPING TOOL" in large white letters, with a thin orange line underneath. Below the heading is a sub-heading: "A simple and easy way to search, access, and analyze spacecraft data of small bodies." A prominent orange button with the text "DOWNLOAD THE SBMT" is centered below the sub-heading. The background of the top half of the page is a high-resolution image of an asteroid. The bottom half of the page has a solid orange background. The word "Overview" is centered in white text with a thin white line underneath. Below "Overview" are three paragraphs of white text providing an introduction to the tool and its capabilities.

SBMT

OVERVIEW GETTING STARTED DATA DOWNLOAD HELP CONTACT US

SMALL BODY MAPPING TOOL

A simple and easy way to search, access, and analyze spacecraft data of small bodies.

DOWNLOAD THE SBMT

Overview

Spacecraft missions return massive amounts of valuable data, but those data can be hard to access, analyze, and interpret. Asteroids, comets, and small moons present additional challenges: the irregular shapes of these bodies are ill-suited for two-dimensional projections.

The Small Body Mapping Tool (SBMT) addresses these challenges. The SBMT is an interactive tool that allows users to visualize and manipulate small body shape models in three dimensions. The Tool enables quick and easy searches for spacecraft data of a variety of small bodies. Once selected, data can be projected directly onto the shape models, and built-in analysis and mapping capabilities facilitate scientific investigations. [Click here](#) to explore the broad range of objects and datasets available in the SBMT.

The SBMT has been used by several flight mission teams, including Dawn, Rosetta, OSIRIS-REx, and Hayabusa2. Mission-specific shape models, data, and features will be available to all SBMT users once the mission data become publicly available. If you are looking for the OSIRIS-REx or Hayabusa2 versions of the SBMT, please note that these versions are downloaded from a separate website. Please email sbmt@jhuapl.edu if you need help.



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