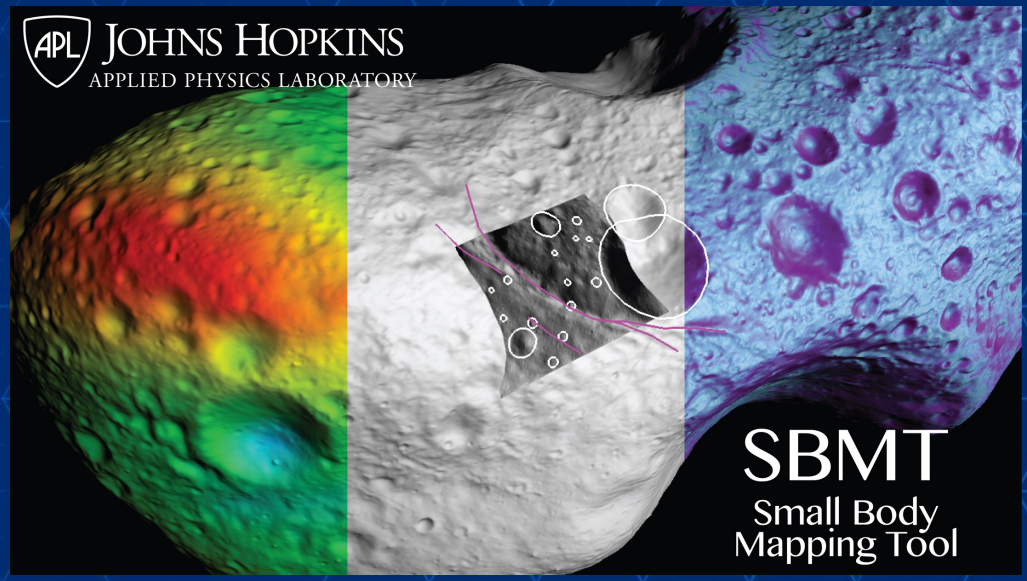
The Small Body Mapping Tool (SBMT) For Accessing, Visualizing, and Analyzing Spacecraft Data in Three Dimensions: 2022 Update



Josh Steele
Senior Scientific Applications Software Engineer
Josh.steele@jhuapl.edu

The Small Body Mapping Tool

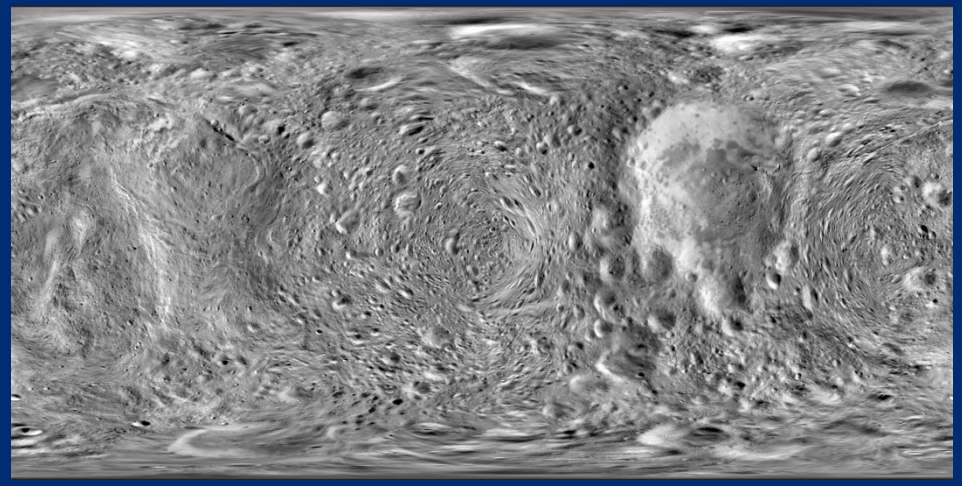
Background

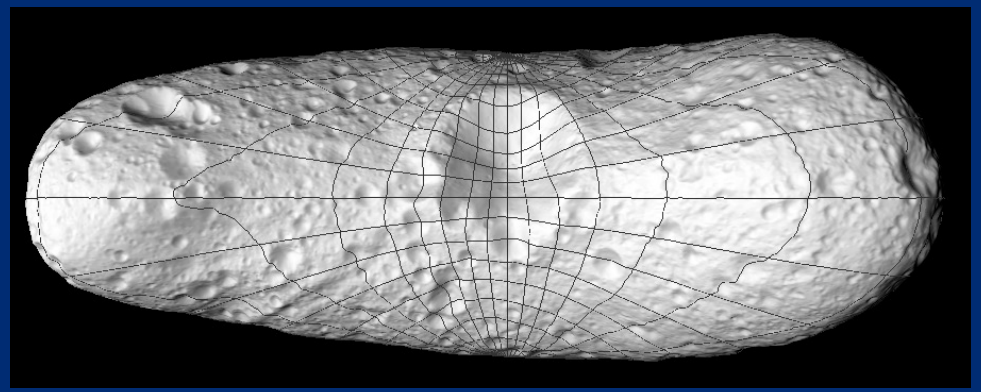
Spheres are Easy(?)

- 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?

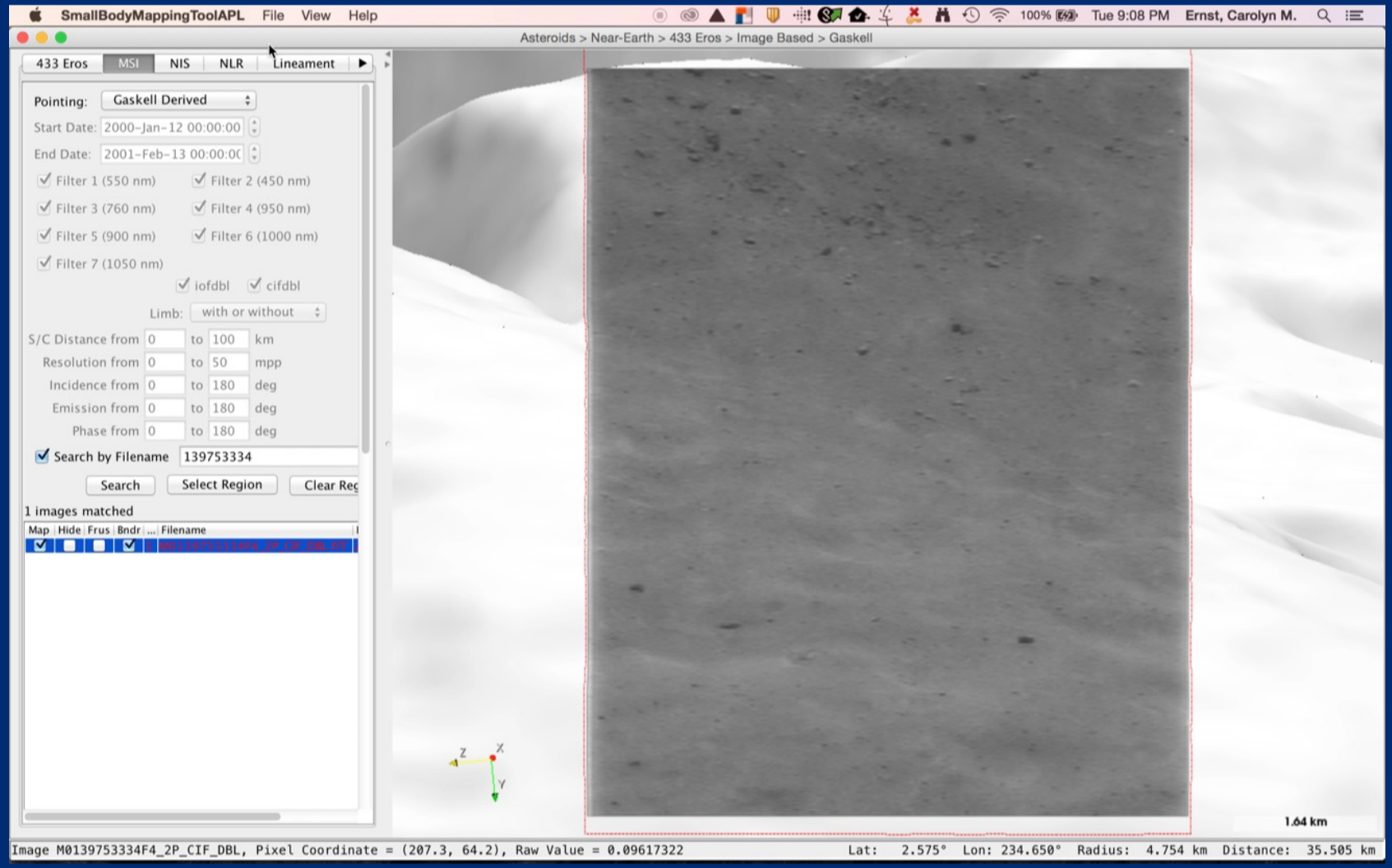
Difficulties of Irregular Bodies

- 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.

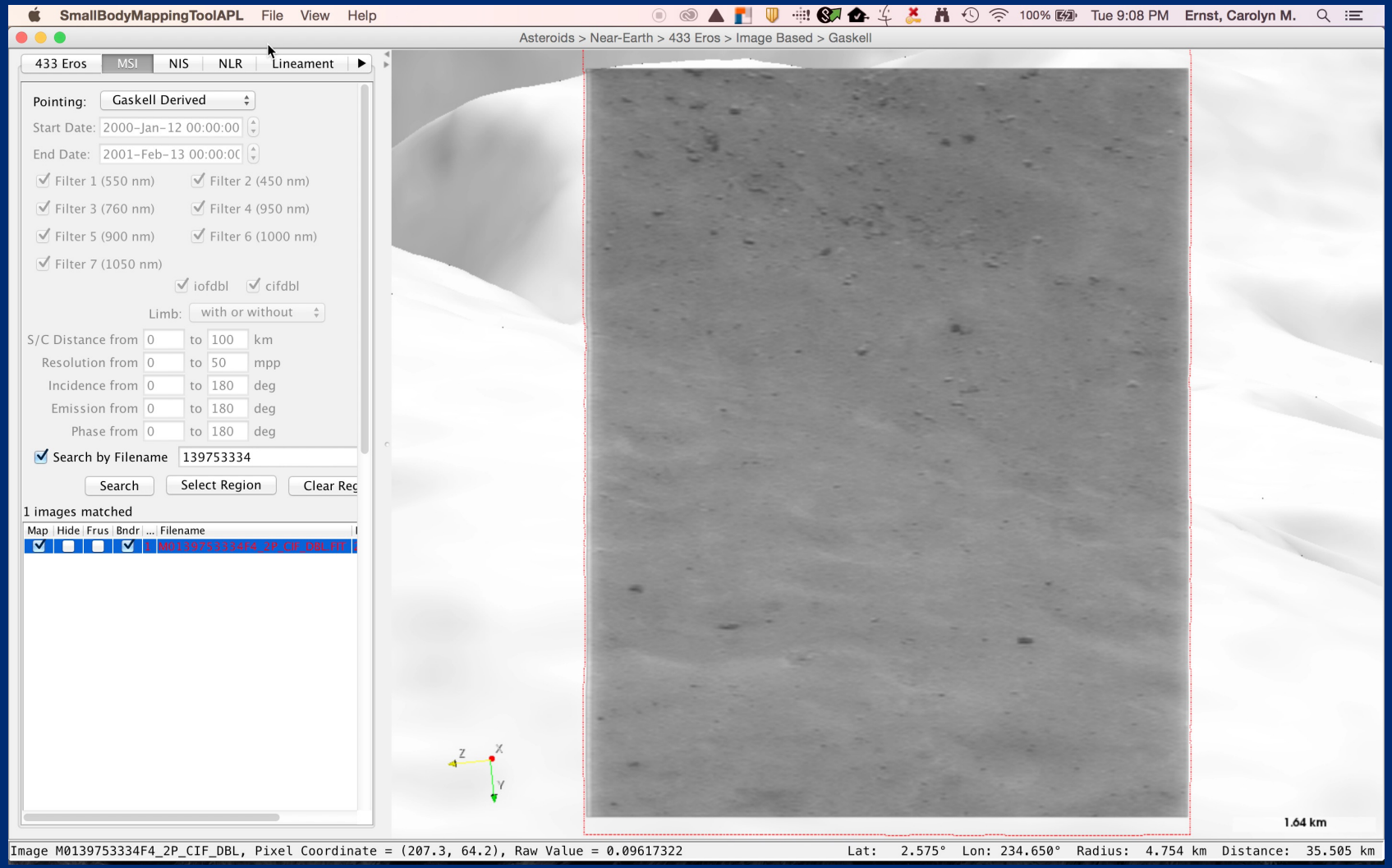




Difficulties of Irregular Bodies



Difficulties of Irregular Bodies



The Small Body Mapping Tool

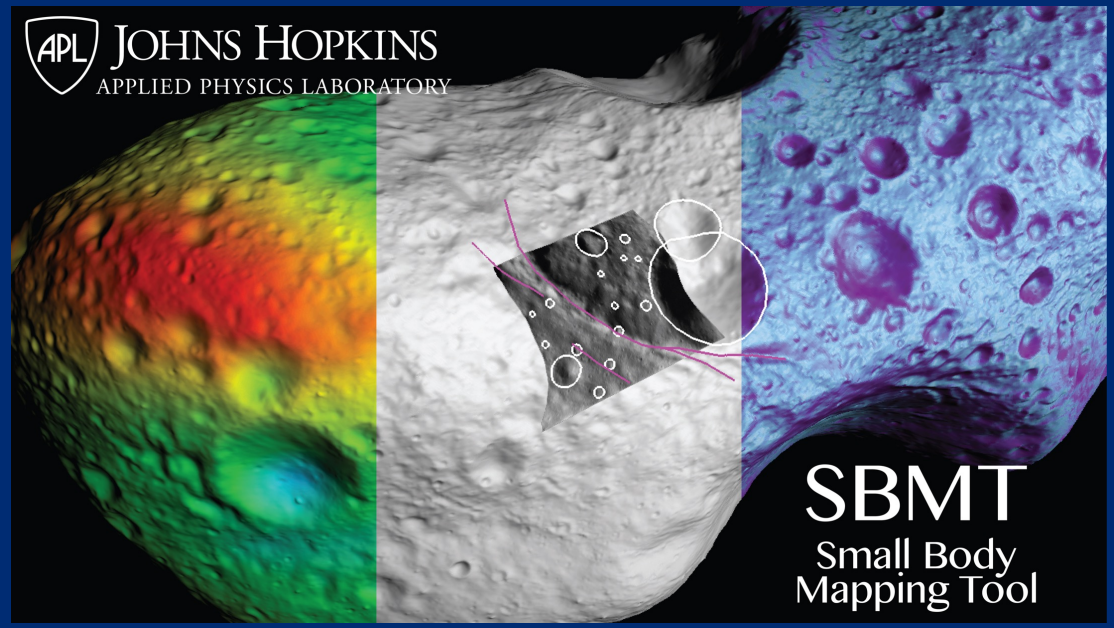
What is the SBMT?

What is the SBMT?

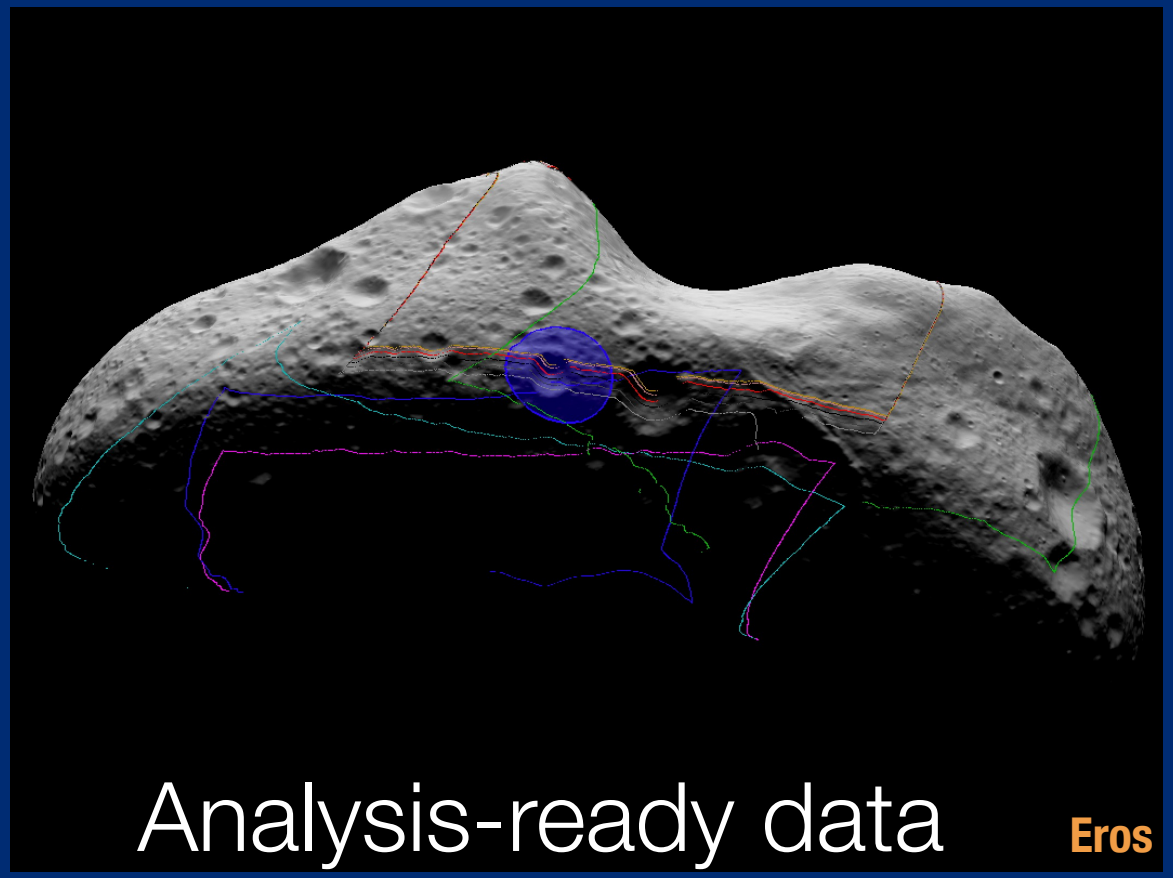
- Developed at APL

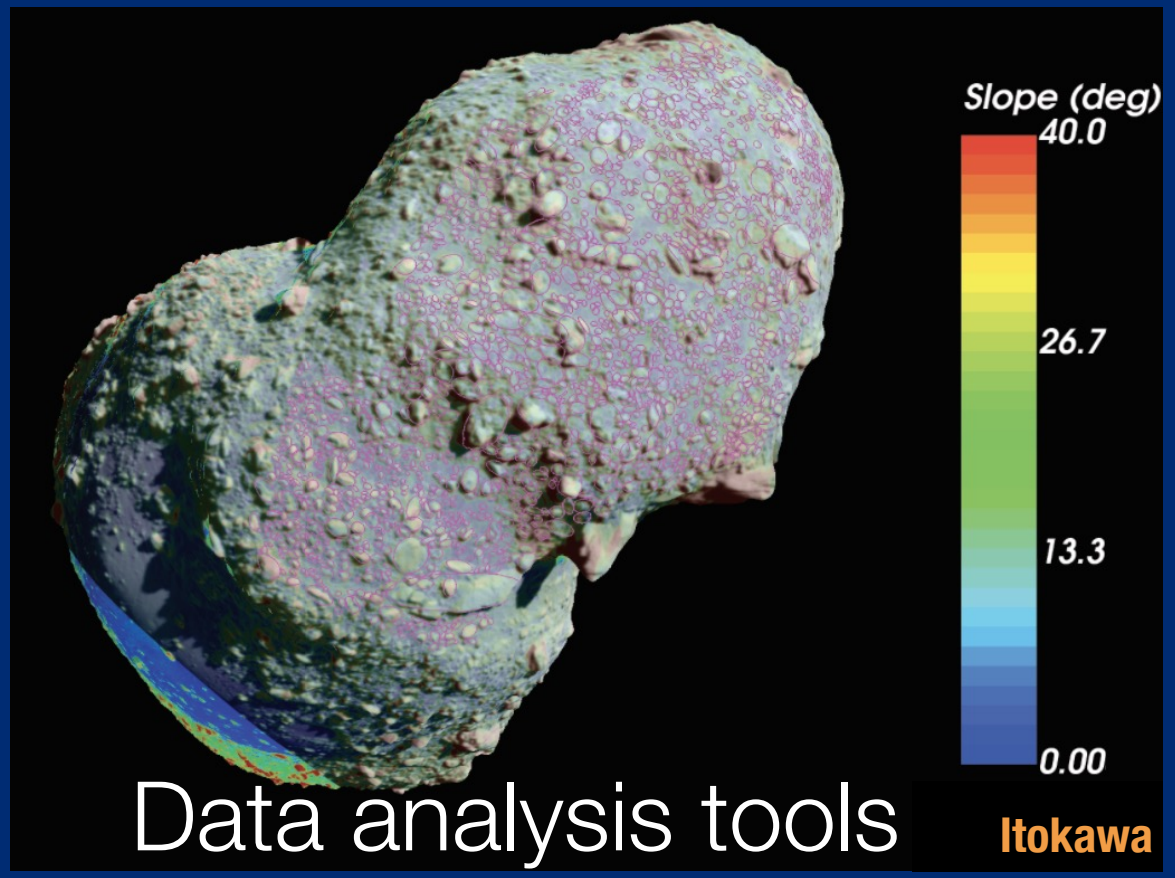
- Interactive 3D visualization tool specialized for use with irregularly shaped solar system bodies
  - Search for data
  - Visualize data on a shape model
  - Map and analyze features

- 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

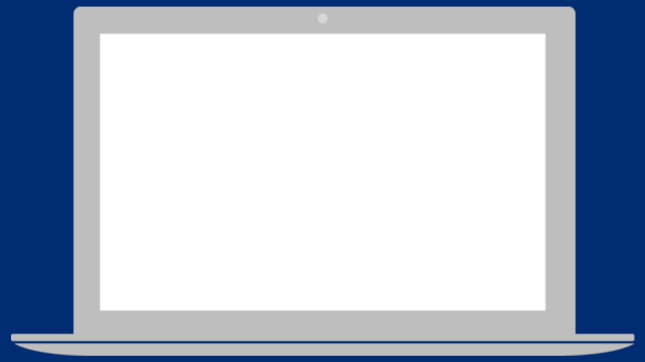


Finding and analyzing the right data





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)

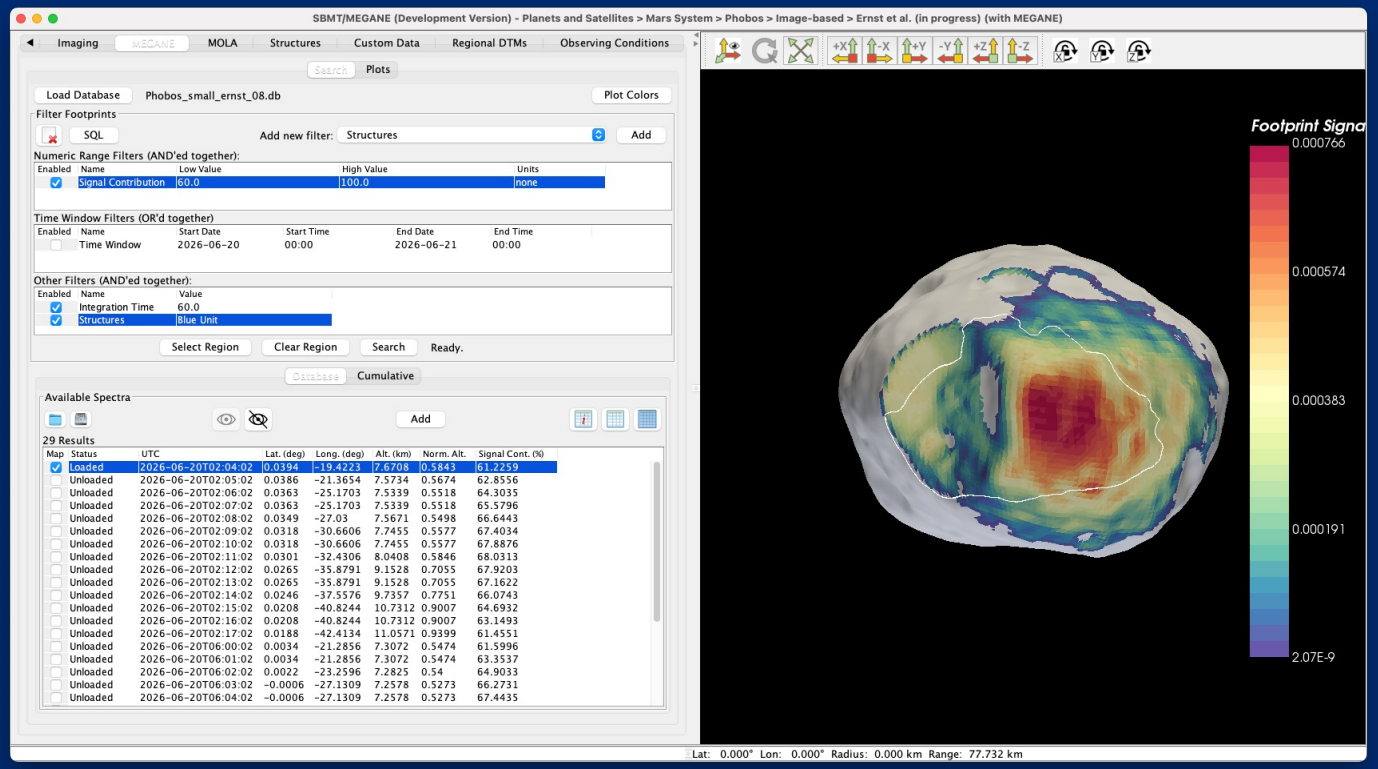
The Small Body Mapping Tool

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

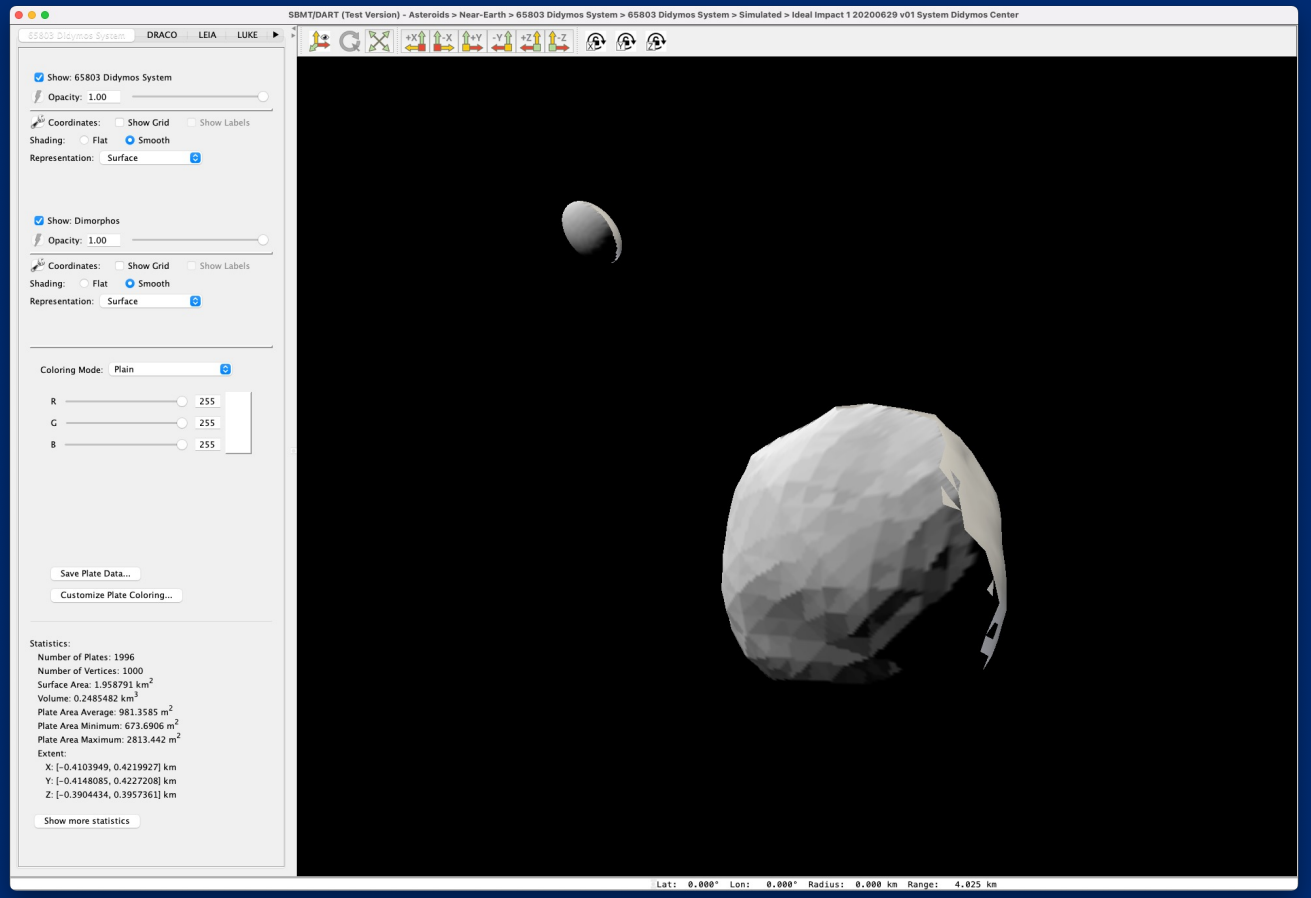


Simulated MEGANE Footprints displayed on a Phobos model (signal strength defined as projected area over the square of the spacecraft range)

DART Multiple Bodies

Beta

- 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

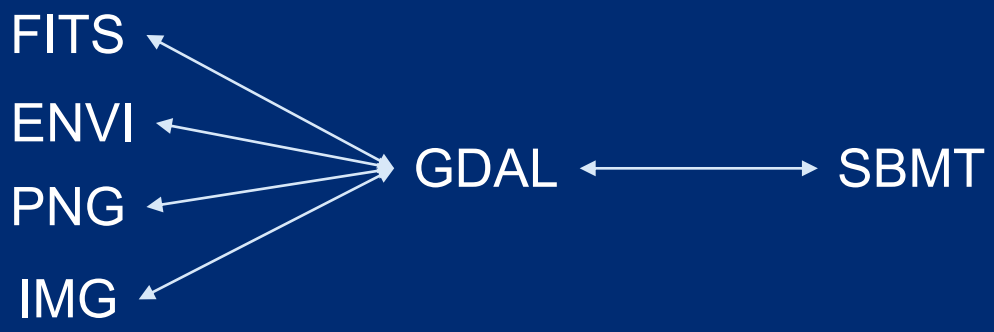


Simulated image data draped on multiple bodies

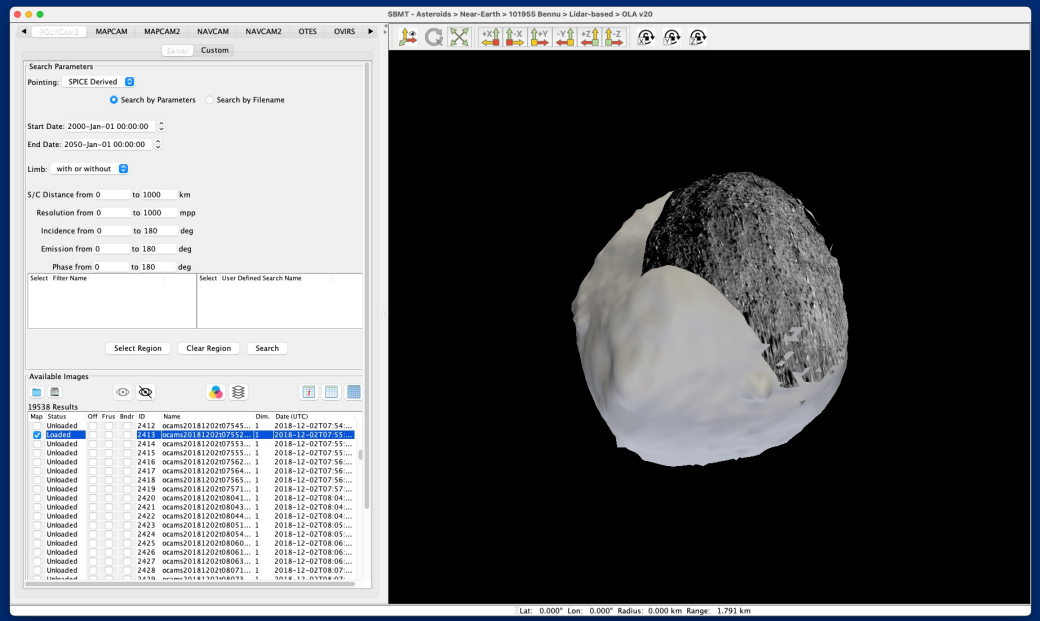
Imaging Framework Updates

Beta

- 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

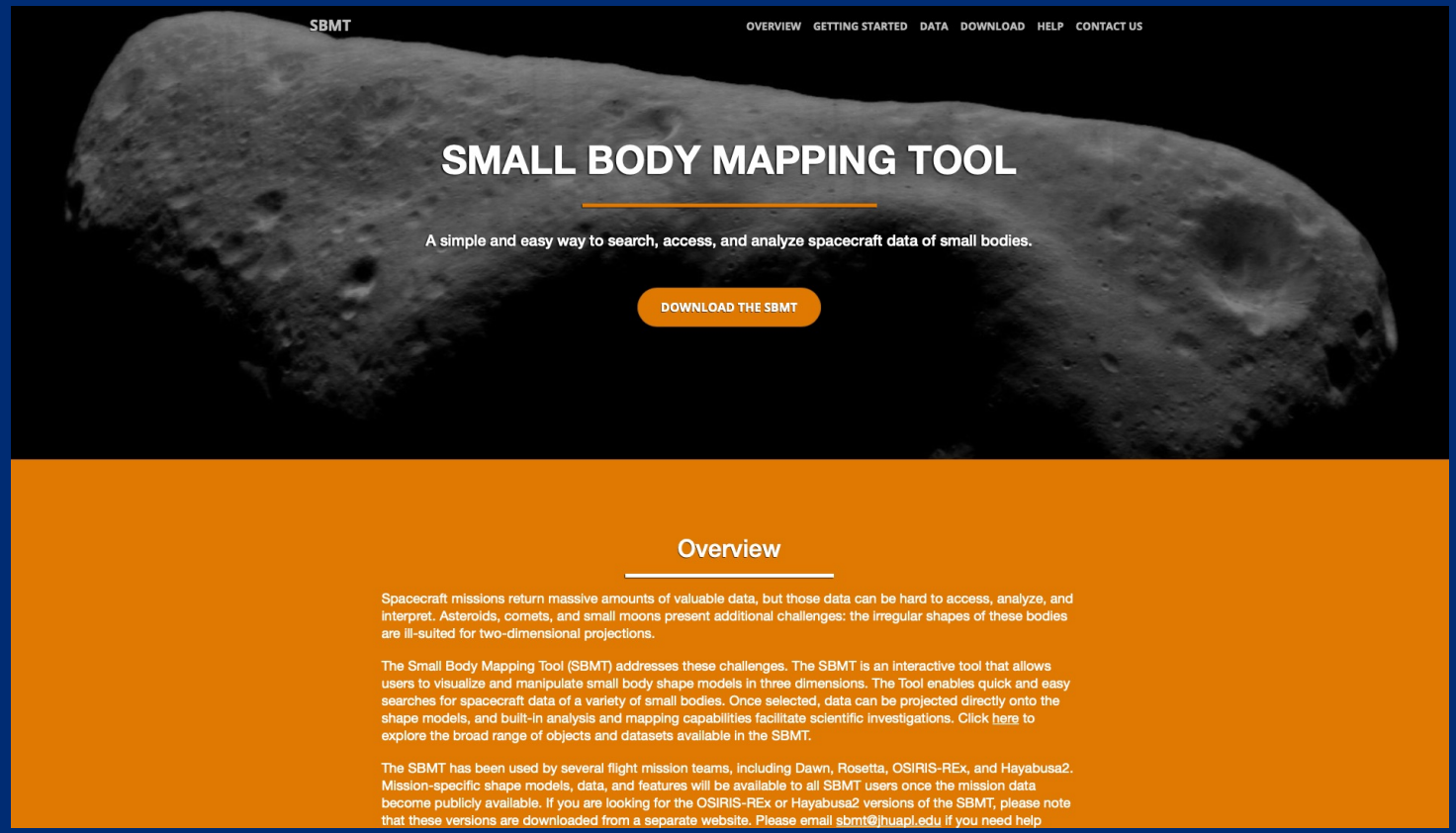
Special Thanks

- Science Team
  - Carolyn Ernst
  - Olivier Barnouin
  - Terik Daly
  - 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



JOHNS HOPKINS
APPLIED PHYSICS LABORATORY