Towards a 3D-GIS for Hera

Synergistic mapping of Didymos and Dimorphos

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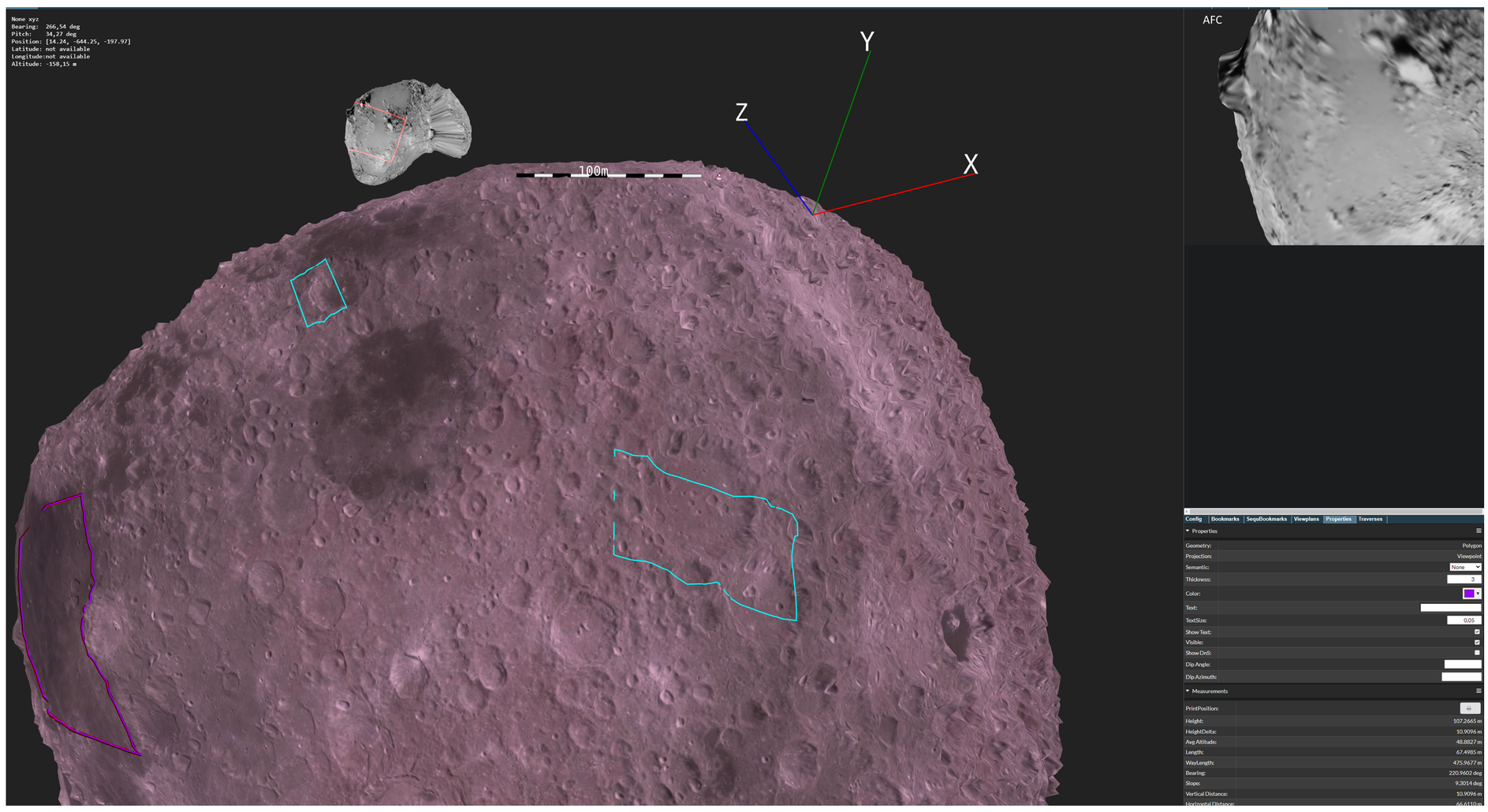

PRo3D, displaying simulated binary asteroid system (left) and instrument view (top right and its footprint annotated in red in the main view), as well as simple annotations such as a coordinate system, polygons circumventing Regions of Interest, and a scale bar.

3D Data and need for 3D-GIS

- The Hera Mission will rendezvous with the binary asteroid system Didymos in 2027, to perform a detailed post-impact survey of the orbiting Moonlet Dimorphos, after NASA's DART impact on 2022-09-26
- Hera carries remote sensing instruments to characterize Dimorphos' surface during half-year approach, observation and experimental phases.
- Imaging in the visible and infrared range is complemented by hyperspectral images, a laser altimeter, radio science, and CubeSats.
- Laser altimetry and imaging in various phases will enable 3D models for:
  - analyses of global properties, shape, volume, geomorphology
  - optical and thermal properties, space weathering, composition
  - debris and dust distribution
  - particular focus on the DART impact crater and its properties
- Medium-level products and layers:
  - Albedo map, thermal inertia map, color and hyperspectral texture
  - Instruments' footprints, observation conditions (shadows, sun exposition, incident angles)
  - (spatially distributed) knowledge about observations
- Target Science Cases requiring 3D context & multi-cue representations:
  - Composition (albedo + spectra + shape)
  - Evolution (maps of morphological features + shape + roughness)
  - Effects of the DART impact (ejecta distribution, surface changes)

3D-GIS Functionalities

The **spatio-temporal maintenance** of the medium-level data products (including links to their raw data origins) on top of the asteroids' models – which are emerging as Hera approaches – is **key for a holistic understanding of the science return.**

The **definition and localization of targets and regions of interest** on (different versions of) the shape models, the ability to annotate and analyze the geomorphologic properties in a quantitative way (measure distances, angles, areas, volumes and derived statistics), and the ability to maintain different versions of the named entities are further requirements that lead to the decision to provide a **3D Geographic Information System (3D-GIS)**, being able to represent the necessary functionalities.

Hera 3D-GIS: PRo3D

PRo3D (The Planetary Robotics 3D Viewer) is the ideal tool for Hera 3D-GIS extensions – it already has some preliminary GIS functionality.

It shall ingest **geometry and texture layers** describing medium-level products and cues.

It allows **interactive 3D geometry and texture display** (see Figure above), **manipulation and arbitrary combinations** thereof, enables **annotations and quantitative 3D analysis** and, by means of an underlying data base, supports the **reference between observations and to raw data products** and their observation conditions.

A target and Region-of-Interest maintenance capability is within the set of requested functions, similarly the analysis of 3D surface changes.

PRo3D 3D-GIS capability is currently under development, using simulated data, tailored to the Hera use case.

Further design discussions are primarily involving the Hera Working Group 4 ("Data Analysis, Exploitation, Interpretation").

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