

Asteroid Spectral Imaging Mission CubeSat to Characterize Asteroid Surfaces

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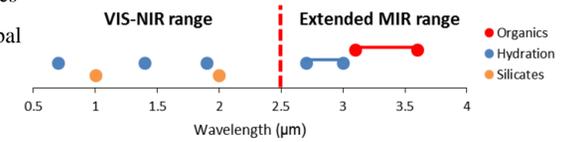


ASPECT

Science and ISRU

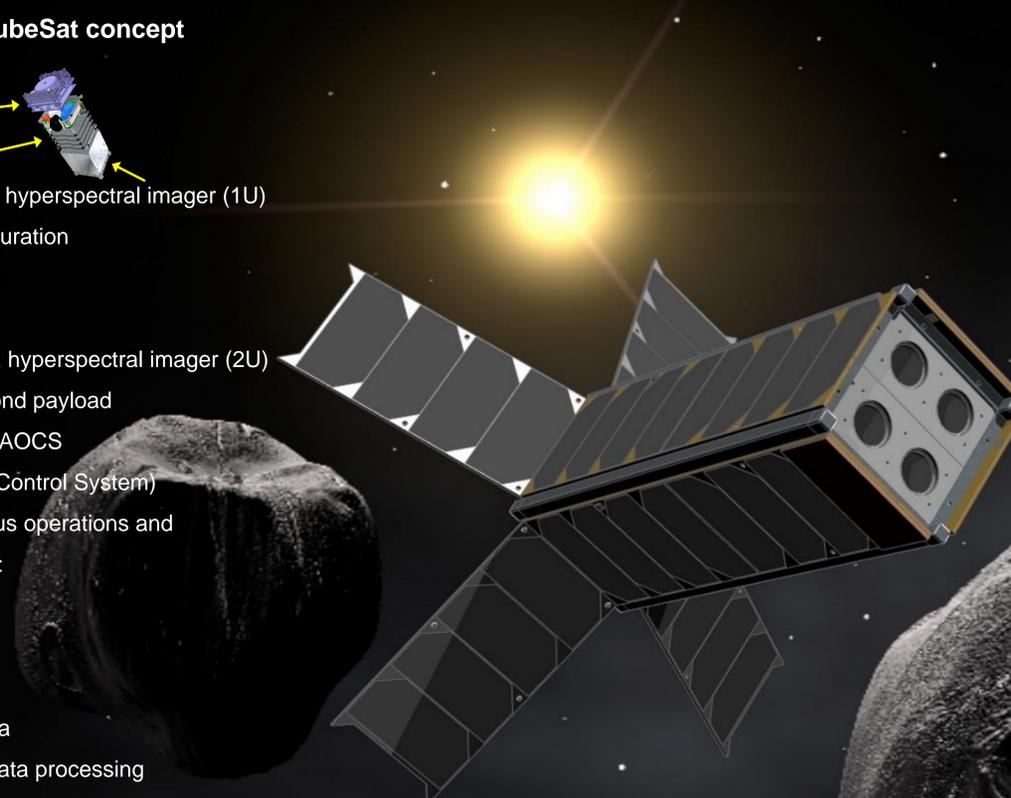
Asteroid Spectral Imaging Mission (ASPECT) is a 3-6U CubeSat with a visible – mid-infrared (VIS-MIR) hyperspectral imager. The concept was initially developed for ESA-NASA AIDA (Asteroid Impact & Deflection Assessment) project. Currently, participation in other small body missions is being investigated. ASPECT can be deployed on an asteroid orbit to characterize the composition of its surface with sub-meter spatial resolution. It can work in tandem with its mothercraft or fleet of other CubeSats to provide complex insight into asteroid properties.

The prospecting objectives of ASPECT are based on the capabilities of the VIS-MIR hyperspectral imager. The payload allows for global imaging and compositional mapping of dry and hydrated silicates, water, and organics. Imaging at varying phase angle allows for estimation of the surface roughness.



ASPECT CubeSat concept

- 3U configuration:
 - AOCS (1U)
 - Avionics (1U)
 - Payload: VIS-NIR hyperspectral imager (1U)
- 6U extended configuration
 - AOCS (1.5U)
 - Avionics (1.5U)
 - Payload: VIS-MIR hyperspectral imager (2U)
 - Provision for second payload
- New interplanetary AOCS (Attitude and Orbit Control System) for semi-autonomous operations and navigation includes:
 - Propulsion
 - Reaction wheels
 - LIDAR
 - Navigation camera
- Onboard payload data processing



Scientific and prospecting objectives

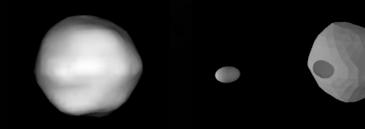
1. Map the surface composition of the target
 - Result: Composition and homogeneity of the target surface
 - Result: Identification and distribution of volatiles, organics, ice
2. Photometric observations and modeling of the target under varying phase angle and distance
 - Result: Surface roughness / particle size distribution
3. Evaluate space weathering effects on the target comparing mature and freshly exposed material
 - Result: Information on the surface processes on airless bodies due to their exposure to the interplanetary environment
4. Identify local shock effects in crater interiors and map impact ejecta
 - Result: Information on the processes related to impacts on small Solar System bodies
5. Characterize possible landing sites
 - Result: Detailed composition and surface roughness information on potential landing sites
5. Evaluate surface areas and objects suitable for sample return or ISRU
 - Result: Identification of areas and objects with desired properties

AIDA scenario

The joint ESA-NASA AIDA (Asteroid Impact & Deflection Assessment) project to binary asteroid Didymos consists of Hera (ESA) and DART (Double Asteroid Redirection Test, NASA). DART is targeted to impact Didymos secondary component (Didymoon) and serve as a kinetic impactor to demonstrate deflection of potentially hazardous asteroids. Hera will serve as an observational spacecraft to evaluate the effects of the impact and resulting changes in the Didymos dynamic parameters. The Hera mission will also carry the 6U ASPECT CubeSat. This arrangement opens up a possibility for secondary scientific experiments. ASPECT aims to study the composition of the Didymos binary asteroid, effects of space weathering, and DART impact crater and ejecta distribution, in order to gain understanding of the formation and evolution of the Solar System.

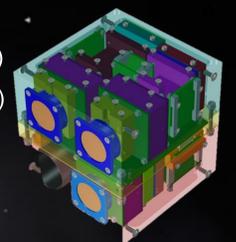
AIDA target –binary asteroid Didymos

- Apollo type NEA (Near-Earth Asteroid)
- S-type composition
- Primary (Didymain) diameter 780 m, 2.1 g/cm³
- Secondary (Didymoon) diameter 160 m
- Distance between centers 1.2 km
- Orbital period 12 h

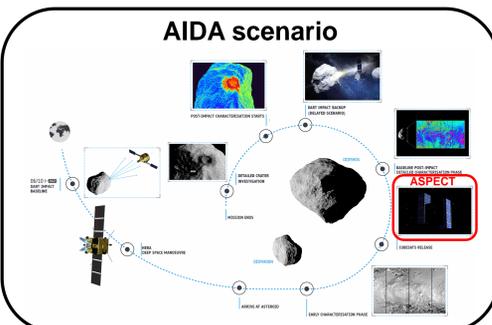


VIS-MIR hyperspectral imager

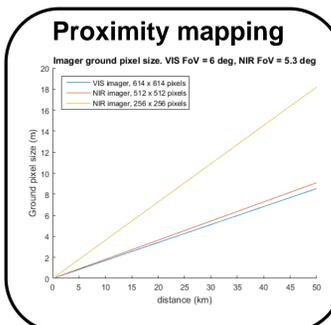
- 4 independent measurement channels:
 - VIS (500–900 nm) spectral imager (614 x 614 pixels)
 - NIR1 (900–1600 nm) spectral imager (256 x 256 pixels)
 - NIR2 (1600–2500 nm) spectral imager (256 x 256 pixel)
 - MIR (2500–4000 nm, under development)
- Fabry-Perot Interferometer spectral separation
- Overall TRL 5 (VIS TLR 9 and NIR1 TLR 7)
- 45 nm spectral resolution
- Better than 2 m spatial resolution (pixel size) from 4 km orbit



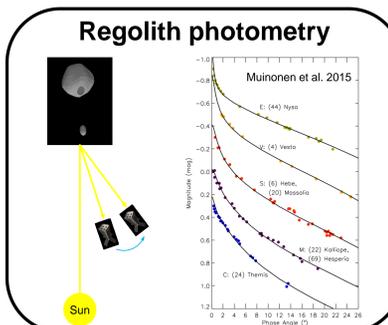
AIDA scenario



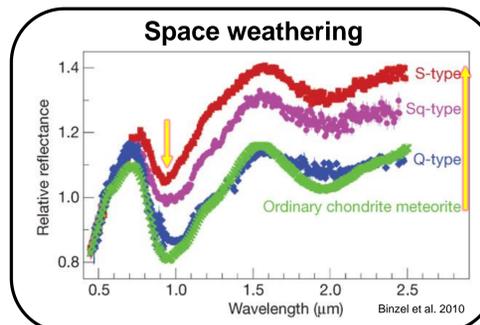
Proximity mapping



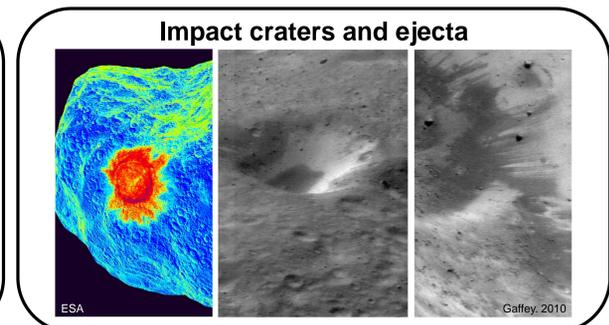
Regolith photometry



Space weathering



Impact craters and ejecta



Conclusions

ASPECT is a deep space CubeSat with a VIS-MIR hyperspectral imager. Main science objectives are to characterize target surface and to evaluate areas for future sampling or ISRU.

Acknowledgments

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