Asteroid Prospection Explorer (APEX) CubeSat for Hera Mission

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APEX Science

Asteroid Prospection Explorer (APEX) is a 6U CubeSat developed for Hera mission being part of ESA-NASA AIDA (Asteroid Impact & Deflection Assessment) project. APEX features a unique set of instruments designed to provide a global characterization of the Didymos system – target of the joint ESA-NASA Asteroid Impact and Deflection Assessment (AIDA) mission. The instrument set includes ASPECT (Asteroid Spectral Imager), ACA (Asteroid Composition Analyzer), and MAG (Magnetometer).

Scientific objectives

1. Map the global composition of the Didymos asteroids
   - Result: Mineral composition and homogeneity of the Didymos asteroid surface
   - Result: Elemental composition of the Didymos asteroid surface
   - Result: Constrains FeNi amount from induced component of the magnetic field
2. Determine the internal structure and evolution of the Didymos system
   - Result: Mineral and elemental composition differences between Didymos I and II
   - Result: Detection and origin of the magnetization of the Didymos asteroid material
   - Result: Size of building blocks of the Didymos asteroids inferred from their remanent magnetic signature
3. Determine surface roughness or regolith grain size of the Didymos asteroids
   - Result: Surface particle size distribution and composition for Didymos I and II
4. Evaluate space weathering effects on Didymos II by comparing mature and freshly exposed material
   - Result: Optical and possible elemental differences between mature and freshly exposed material
5. Identify local shock effects on Didymos II caused by DART impact based on spectral properties of crater interior
   - Result: Determine optical properties of the material within crater
   - Result: Determine elemental composition on surface: differences inside and outside the crater
   - Result: Determine magnetic signature of the crater
6. Map global fallback ejecta on Didymos I and II
   - Result: Detailed global mapping of fallback ejecta on both Didymayn and Didymoon
7. Characterize interaction of Didymos system with interplanetary environment
   - Result: Magnitude of interaction of the Didymos system with interplanetary magnetic fields, detection of temporary magnetosphere
   - Result: Determine the magnitude of solar wind ion disturbances/interaction with the binary asteroid (Didymos system)
8. Determine mass of Didymos I and II from APEX orbit perturbations
   - Result: Mass of Didymos I and II
9. Determine strength of the near-surface material from APEX landing
   - Result: Surface material strength

AIDA scenario

The joint ESA-NASA AIDA 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 APEX 6U CubeSat. This arrangement opens up a possibility for secondary scientific experiments. ASPECT aims to study the composition and internal structure 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
- Primary (Didymain) diameter 780 m, 2.1 g/cm³
- Secondary (Didymoon) diameter 180 m
- S-type composition
- Distance between centers 1.2 km
- Orbital period 12 h
- Apollo type NEA (Near-Earth Asteroid)

Conclusions

APEX is a deep space CubeSat with a VIS-MIR hyperspectral imager, magnetometer, and secondary ion spectrometer. The project is done under ESA GSTP contract and is partly supported by Academy of Finland and ERC. Main science objectives are to characterize target surface, composition, and internal structure.

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