

Panel on Exploration (PEX)

Sciences and Strategic Knowledge for Robotic and Human Exploration (PEX.1)

Consider for oral presentation.

THE RAMSES CUBESAT-1 MISSION TO (99942) APOPHIS

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RCS-1 Team

Tyvak International (prime, platform), Politecnico di Torino (requirements, radiation), Politecnico di Milano (mission analysis, science camera, GNC), HULD (software), EmTroniX (low-frequency radar), Astronika (deployable antennas), and ESA

(99942) Apophis is a potentially hazardous asteroid that will closely approach the Earth on April 13, 2029. Although the likelihood of an impact has been ruled out, this close encounter represents a unique opportunity for planetary science and defense. By investigating the physical and dynamical changes induced by this interaction, valuable insights into asteroid cohesion, strength, and internal structure can be obtained. In light of these circumstances, a fast mission to Apophis holds great scientific importance for understanding potentially hazardous asteroids. To this aim, ESA has proposed the RAMSES (Rapid Apophis Mission for Space Safety) mission, a fast-response initiative designed to rendezvous with Apophis prior to its Earth encounter. RAMSES mission will be launched in 2028 and arrive at Apophis in February 2029. The mission payloads include two 6U-XL CubeSats, one of which is RAMSES CubeSat-1 (RCS-1). RCS-1 will be deployed as part of RAMSES proximity operations and will orbit Apophis in closed stable trajectories to complement the scientific objectives of the RAMSES spacecraft to enhance planetary defense demonstration efforts, to enable multi-point observations, and to facilitate closer and riskier operations. Specifically, RCS-1 aims to i) characterize Apophis internal structure and ii) characterize surface properties, through the use of a scientific optical camera and a low-frequency radar. The onboard optical camera has the aim to capture high-resolution images of Apophis surface, allowing for detailed mapping of geological features, surface roughness, and dust distribution. Meanwhile, the low-frequency radar is designed to penetrate beneath the surface, providing critical data on internal layering, density variations, and structural characteristics. All this data will be used to assess asteroid characteristics pre- and post-encounter and to detect changes induced by the asteroid during its close approach with the Earth.