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Small Bodies Missions and Technologies (Part 1) (4A)

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HERA GNC SUBSYSTEM AND ITS MODIFICATIONS TOWARDS RAMSES

Abstract

On 13 April 2029, Apophis, an asteroid deemed potentially hazardous, is projected to approach Earth at a distance of less than 32,000 kilometers, rendering it visible to the naked eye. Positioned closer than satellites orbiting in the Geostationary ring, Apophis presents a perfect opportunity for a new potential Planetary defence action using a small-satellite/fast-track mission, just following the experience of HERA, which has just started its two years journey towards its target system, Dydimos, one week ago.

The RAMSES (Rapid Apophis Mission for SEcurity and Safety) mission, currently being in phase A/B, has identified Apophis as its target and intends to rendezvous with it approximately one and a half months prior its close encounter with Earth. The mission aims to conduct a detailed characterization of the asteroid both pre and post the encounter, to be able to assess the effects of the tidal forces exerted by the Earth during the close passage. This endeavor will provide sufficient data to analyze and predict the likelihood of a potential impact with Earth in 2069.

In order to make possible the RAMSES mission within the applying severe programmatic (mostly short time to mission), technical and financial constraints, the team has to strongly relay on what developed for HERA, both as overall system level and at GNC/AOCS one.

Within this paper, GMV intends to recall the high level features and lesson learned of the HERA Guidance, Navigation, and Control (GNC) subsystem and conceptualize its evolution towards the RAMSES mission.

A primary difference between the RAMSES and Hera missions is the more constrained dry weight of the SC, as RAMSES needs considerably greater Delta-V for its deep space trajectory. Accordingly, a significant effort has been made to minimize the overall weight of the SC, influencing both the sensor suite available, and the fuel budget during the proximity operations. Consequently, the redundancy philosophy has been revisited leading to the removal of redundancies for specific units, which leads to the implementation of functional redundancies. Furthermore, the proximity operations have been designed to minimize the Delta-V consumption while easing the operations. As key difference, Hovering has been proposed aiming the minimization of the operational costs and ground effort, and benefiting from an increased AOCS/GNC autonomy.

Last but not least, and most likely the most severe challenge, is the need of designing a full mission in less than 4 years.