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Didymos Gravity Science Investigations through Ground-based and Inter-Satellite Links Doppler Tracking

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The Asteroid Impact and Deflection Assessment (AIDA) is an international collaboration supported by ESA and NASA to assess the feasibility of the kinetic impactor technique to deflect an asteroid, combining data obtained from NASA's DART and ESA's Hera missions. Together the missions represent the first humankind's investigations of a planetary defense technique. In 2022, DART will impact Dimorphos, the secondary of the binary near-Earth asteroid (65803) Didymos. After 4 years, Hera will follow-up with a detailed post-impact survey of Didymos, to fully characterize and validate this planetary defense technique. In addition, Hera will deploy two CubeSats around Didymos once the Early Characterization Phase has completed, to augment the observations of the mother spacecraft. Juventas, the first Cubesat, will complete a low-frequency radar survey of the secondary, to unveil its interior. Milani, the second Cubesat, will perform a global mapping of Didymos and Dimorphos, with a focus on their compositional difference and their surface properties. One of the main objectives of Hera is to determine the binary system's mass, gravity field, and dynamical state using radio tracking data in combination with imaging data. The gravity science experiment includes classical ground-based radiometric measurements between Hera and ground stations on Earth by means of a standard two-way X-band link, onboard images of Didymos, and spacecraft-to-spacecraft inter-satellite (ISL) radiometric tracking between Hera and the Cubesats. The satellite-to-satellite link is a crucial add-on to the gravity estimation of low-gravity bodies by exploiting the Cubesats' proximity to the binary, as the range-rate measurements carried out by the inter-satellite link contain information on the dynamics of the system, i.e., masses and gravity field of Didymos primary and secondary.

We will describe the updated mission scenario for the Hera radio science experiment to be jointly

carried out by the three mission elements, i.e., Hera, Juventas and Milani. To conclude, our updated analysis and latest results, as well as the achievable accuracy for the estimation of the mass and gravity field of Didymos and Dimorphos, are presented.