Numerical Modelling for the Juventas Radar (JuRa) investigation: Analysis of simulated full-wave scattering data for test fragments in time domain

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Juventas Radar (JuRa) [1] will perform a tomographic radar inverstigation as a part of European Space Agency's coming planetary space mission HERA [2], which will rezdenvous its target asteroid 65803 Didymos in 2027. JuRa's goal is to find out the internal structure of the 160 m diameter Dimorphos, the asteroid moon of Didymos.

In collaboration with Institut Fresnel (IF), Aix-Marseille University, France, Institute for Astrophysics and Planetary Sciences Grenoble (IPAG), University Grenoble Alpes, France, and the 5GLab of Technical University Dresden, Germany, we have obtained preliminary results on modelling full-wave radar signals in time domain [3] for numerical test fragments that have been designed to match the parameters of the JuRa investigation. Due to the payload limitations and other mission constraints the wavelength is relatively short compared to the diameter of the target while the measurement point configuration is might be sparse.

Full-wave modelling is important to minimize any modelling errors which can significantly affect the inferences made based on sparse data. When a full-wave model is applied, the relatively short wavelength, however, sets a challenge from the viewpoints of the computational cost and accuracy of the numerical simulation.

The results suggest that the 60 MHz center frequency and 20 MHz bandwith of JuRa can be applied in a volumetric time-domain numerical simulation when a state-of-the-art computing cluster and an appropriate level of parallelization are applied. Large-memory GPUs provide a potential solution to perform the simulations effectively for a large number of time points. These preliminary results have been obtained in collaboration with the HERA workgroups preparing the mission.

[1] Herique, Alain, et al. "JuRa: the Juventas Radar on Hera to fathom Didymoon." European Planetary Science Congress. 2020.

[2] Michel, Patrick, et al. "European component of the AIDA mission to a binary asteroid: Characterization and interpretation of the impact of the DART mission." Advances in Space Research 62.8 (2018): 2261-2272.

[3] Sorsa, Liisa-Ida, et al. "Bistatic full-wave radar tomography detects deep interior voids, cracks, and boulders in a rubble-pile asteroid model." The Astrophysical Journal 872.1 (2019): 44.

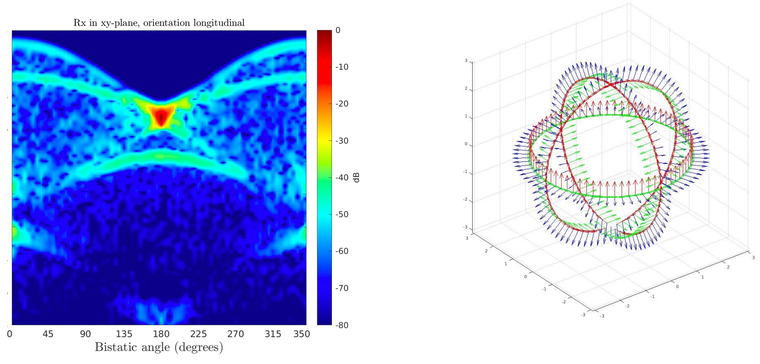

Figure 1: Full-wave scattering of a spherical fragment.

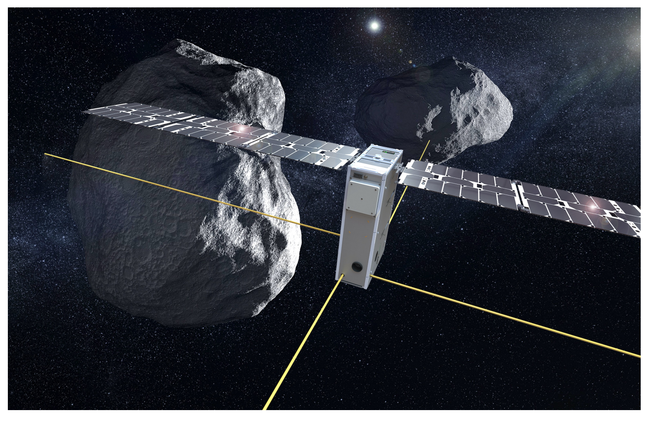

Figure 2: Juventas cubesat with JuRa.