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DEFLECTION OF A SMALL OBJECT USING A KINETIC IMPACTOR

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ABSTRACT

Near-Earth objects (NEOs)---asteroids and comets---pose a low-probability yet potentially high-consequence risk to Earth and its inhabitants. We simulate mitigation techniques, including the kinetic impactor spacecraft, to deflect asteroids and comets in preparation for responding to future threats. The efficacy of the kinetic impactor technique is dependent on the impacting spacecraft (mass and velocity) as well as the physical characteristics of the target asteroid or comet. We use an Adaptive Smoothed Particle Hydrodynamics (ASPH) code, Spheral, to simulate kinetic impactors of varying mass and velocity impacting a small target object at varying

locations. This work uses a three-dimensional shape model of the comet 67P/Churyumov-Gerasimenko, a bilobate shape scaled down from its original multi-kilometer size to ~200 m across the longest axis (total volume equivalent to a sphere with a radius of 63.5 m). Impact masses and encounter velocities have been calculated using trajectory analysis methods for deflecting this object from a realistic Earth-impacting orbit. This study is part of a NASA-NNSA interagency collaboration to explore end-to-end mitigation of various representative NEOs; previously published work focused on the deflection of a simulated asteroid modeled after an actual asteroid named Bennu [1]. In this paper, we will report the material and parameter selections in Spheral, as well as the momentum multiplication factor, β, observed in the simulation results for the different spacecraft impactor masses, velocities and impact locations on the target object. This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. LLNL-ABS-762638-DRAFT.

[1] Barbee, B. W. et al. Options and uncertainties in planetary defense: Mission planning and vehicle design for flexible response. Acta Astronautica 143 (2018), 37-61.

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