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IAA-PDC-15-P-53

1D to 3D MAPPING FOR NUCLEAR ENERGY DEPOSITION

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Keywords: *asteroid, comet, deflection, nuclear*

ABSTRACT

When a nuclear explosion is used to deflect a comet or asteroid, energy in the form of X-rays, gamma rays, and neutrons is deposited in the target. Since this takes place in a hard vacuum the radiation does not scatter before reaching the target's surface. At any given point on the surface the angle of incidence and the spectrum of the radiation determine the energy deposition beneath that point. This means that the energy deposition is a one-dimensional problem at each point on the surface. This assumes the surface is "flat" over lengths on the order of the mean free path of the radiation in the target.

We will show how to take 1D deposition calculations and map them onto a 2D or 3D shape. Two approaches can be used. First, the 1D calculations at each angle of incidence, γ, can be approximated by an exponential profile, specified by a characteristic depth (λ), and an albedo, η, (note that for neutrons η can be greater than one). For simple target shapes, given $\lambda(\gamma)$ and $\eta(\gamma)$, the deposition can be written in closed form as a function of the yield, height of burst (HOB), and location inside the target. Second, the tabular deposition versus depth and angle of incidence can be interpolated to find the energy deposition at any point inside the target based on the depth to the nearest surface point. This approach will be used to compare the mapping procedure to a 2D calculation of the deposition on a spherical target. The errors resulting from this process will be presented.

One application of this method is to calculate the HOB that maximizes the volume of melted material. The melted material is a conservative estimate of the mass involved in the blow-off and maximizing this mass should be a good estimate of the HOB that maximizes the imparted momentum. For a spherical target and exponential deposition profiles a semi-analytic solution for the optimal HOB is provided.

Part of this work was funded by the Laboratory Directed Research and Development Program at LLNL under project tracking code 12-ERD-005, performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. LLNL-ABS-665379

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