Scoping study: high-efficiency X-ray sources for STARBRIGHT

Joseph McLaughlin, August 1, 2023, DSTI 2023

Lawrence Livermore National Laboratory; University of Oregon

The STARBRIGHT HED campaign seeks to develop an efficient means of generating X-ray sources for asteroid defense applications. Recent NIF and OMEGA experiments demonstrate that this platform can deliver necessary efficiencies (≥ 50% laser conversion). We utilize HYDRA codes to model the X-ray conversion efficiency of a Cu foam cylinder. In this work we develop a quantity of interest (QOI) to describe X-ray conversion efficiency and optimize the thickness of the foam to optimize this metric.

An accurate model for ground coupling

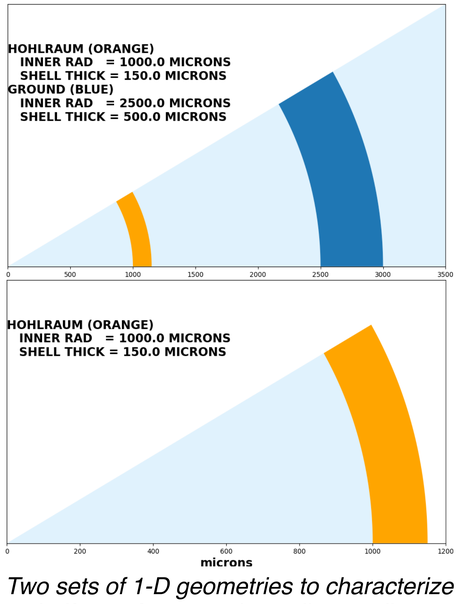
– Ground coupling experiments for asteroid defense typically utilize hydro energy dominate explosives.

– In contrast, nuclear detonations are X-ray energy dominated.

– NIF VISAR targets with a Cu foam for X-ray conversion demonstrate a real scaled analogue to nuclear devices for ground coupling curves.

– This study models the ideal size and composition a Cu foam cylinder for optimal X-ray energy conversion.

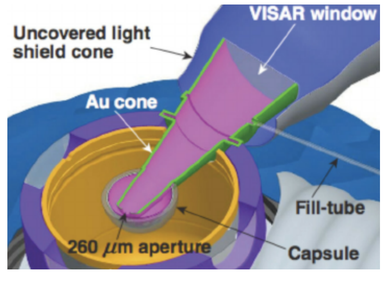
1-D HYDRA simulation



Two sets of 1-D geometries to characterize halfraum for ground coupling studies.

– Our scoping study begins with a 1-D assembly of the problem instrumented using HYDRA codes.

– Two Models to understand burn-through: SiO2 ground surrogate and groundless model.

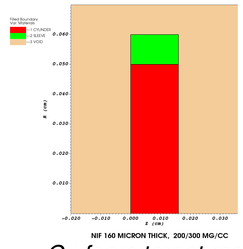


NIF VISAR visualization.

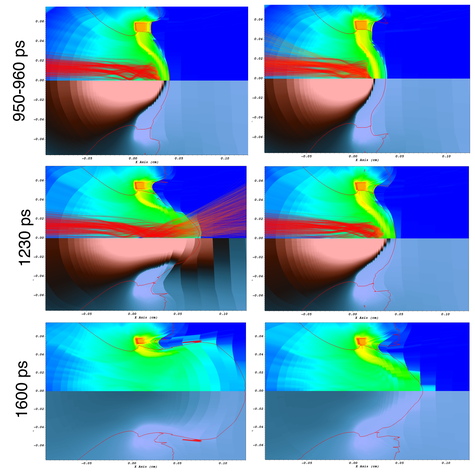
Burn-through degrades X-ray conversion

– Prior ARES simulations demonstrate laser burn-through with a 10 kJ laser below a threshold Cu foam density.

– Our study optimizes over foam density, thickness, and inner radius, to maximize X-ray conversion efficiency without allowing laser burn-through.



Cu foam target model.

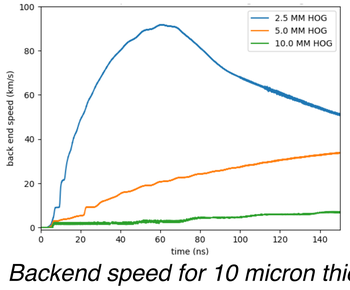


ARES 2-D simulations illustrating burn-through.

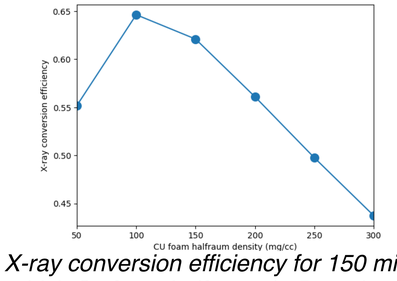
Candidate QOIs for X-ray conversion efficiency

– Backend speed for ground surrogate target.

– Sum of zonal X-ray energy deposited onto ground surrogate.



Backend speed for 10 micron thick ground surrogate target (1-D analogue).



X-ray conversion efficiency for 150 micron thick Cu foam halfraum (1-D analogue).

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