Cryogenic Planar Ablation: Testing and Fabrication

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Physics Goal

MEASURE ABLATION AND SHOCK PROPAGATION USING HETEROGENEOUS MEDIA

-Future HED and nuclear survivability platforms will use macroscopic 2pp lattice materials for cryogenic liquid-hydrogen-wetted-lattice ablator targets. Average EOS and shock spatial non-uniformity measurements are needed as a function of lattice properties
-Measure shock speed of mixed warm and cryogenic targets driven by uniform and non uniform ablators to compare with simulation results
-Measure shock nonuniformity of a Deuterium filled 2PP lattice

EXPERIMENTAL DESIGN

-1-2 um thin HDC front window
-Various 2pp lattice structures filled with aerogel foam to mimic cryogenic deuterium filled lattices as closely as possible
-Warm target design to mimic cryogenic platform

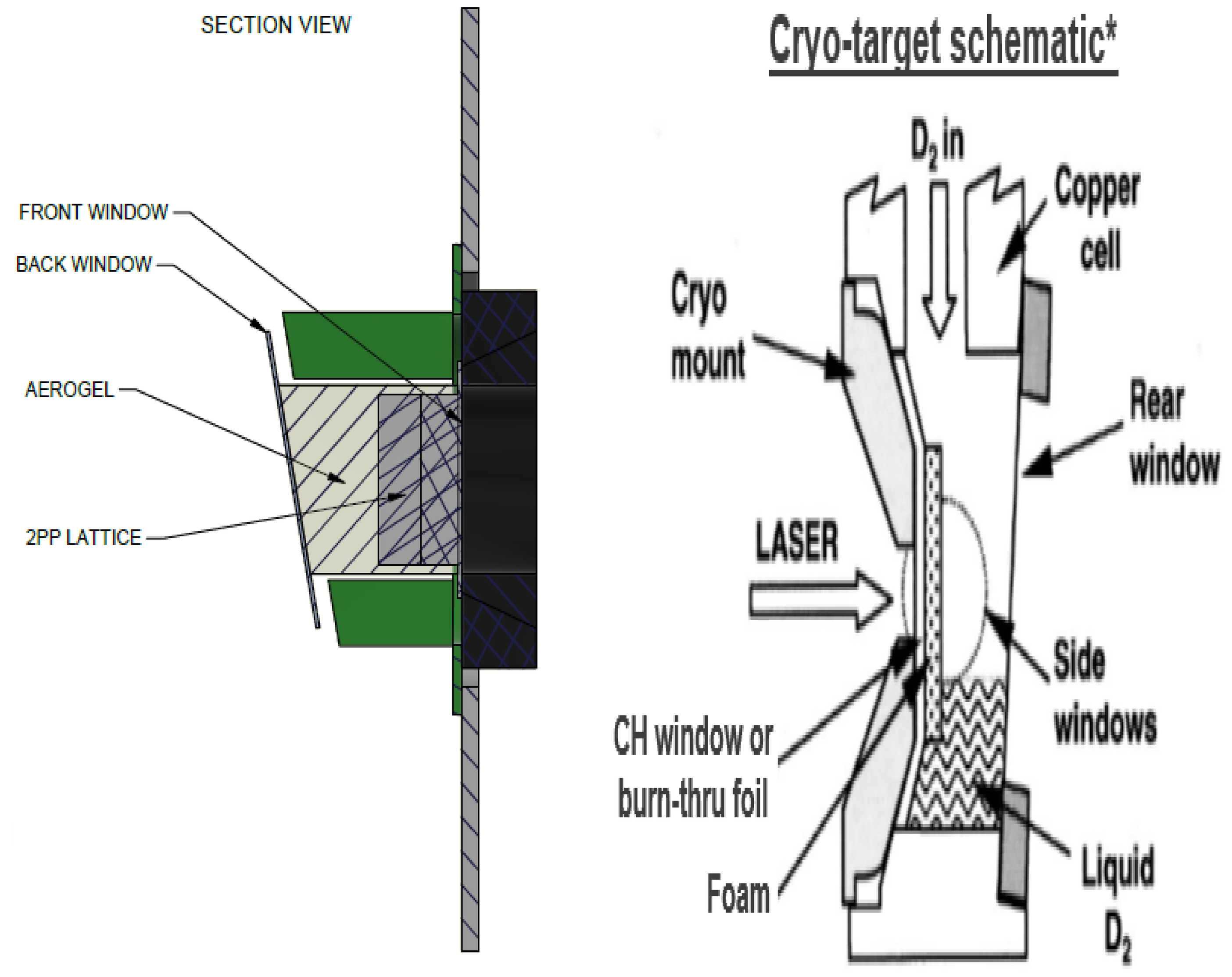


Diagram 1. Warm target design (left) and cryogenic target design (right)

Feasibility Testing

PRESSURE TESTING FRONT WINDOWS

-Cryo targets will be subjected to internal pressures of 32 psi for roughly 30 minutes
-Pressure testing was designed and conducted on thin windows to ensure survivability of 32 psi pressure differential

-Results showed failure at the following pressure differentials
-1um HDC window at 1.5 psi
-2um HDC window at 47 psi
-2um HDC window was able to sustain 32 psi pressure differential for roughly 27.5 minutes

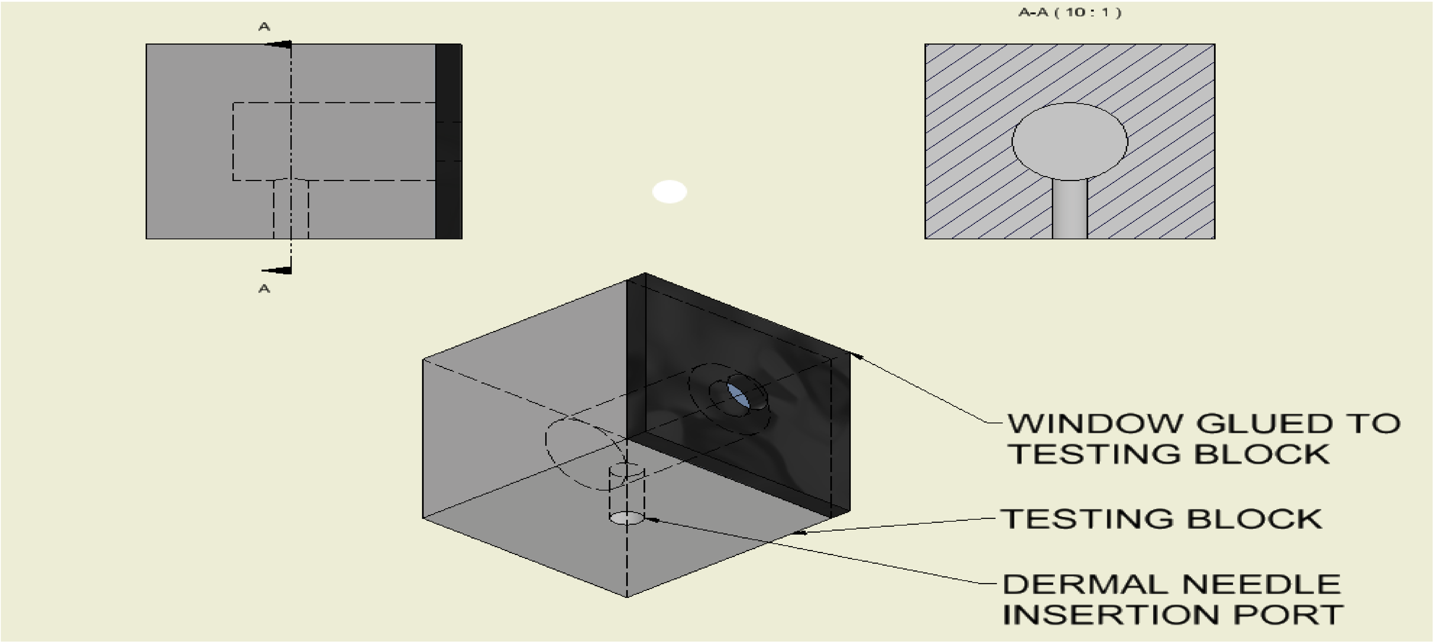


Diagram 2. Pressure testing apparatus

2PP PRINTING DIRECTLY TO DIAMOND WINDOWS

-Experimental design benefitted from direct contact of diamond window and 2pp lattice
-Effort was tested using Nanoscribe Photonic Professional GT+
-Failed due to inability to find printing interface without conductive coating

Saturating 2PP Lattice with Aerogel

CASTING AEROGEL INTO LATTICE VIA MOLD

-Casting aerogel into a lattice via a mold would be ideal
-Mold replicated internal chamber of cryo targets to mimic as. closely as possible
-Mold had drainage channels to allow for flow of liquids and gasses
-During drying process, aerogel exhibited significant shrinkage, destroying the lattice

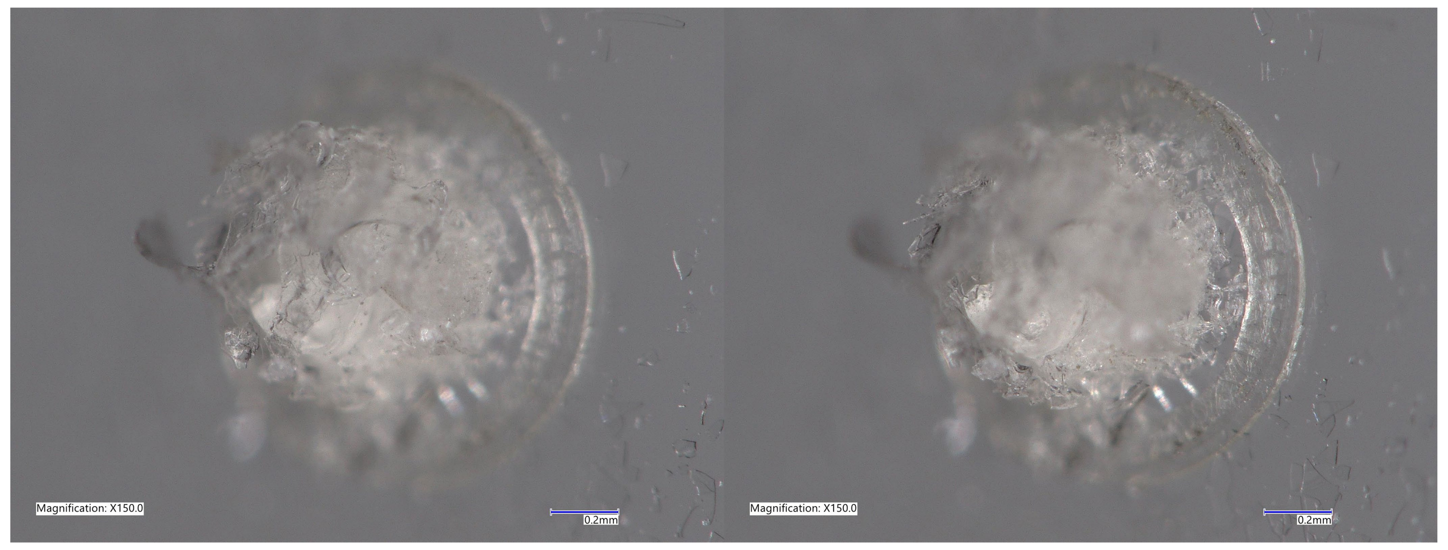


Diagram 3. Lattice destroyed after drying in mold

MACHINING LATTICE OUT OF BULK AEROGEL

-2PP lattices were suspended in bulk aerogel solutions with the hope that local shrinkage would be minimal
-After drying the aerogel, the bulk pieces were aligned with and mounted to a mandrel
-Mandrel was custom made to allow for centering on lathe
-Were unable to CT the part, but visually the lattice was filled

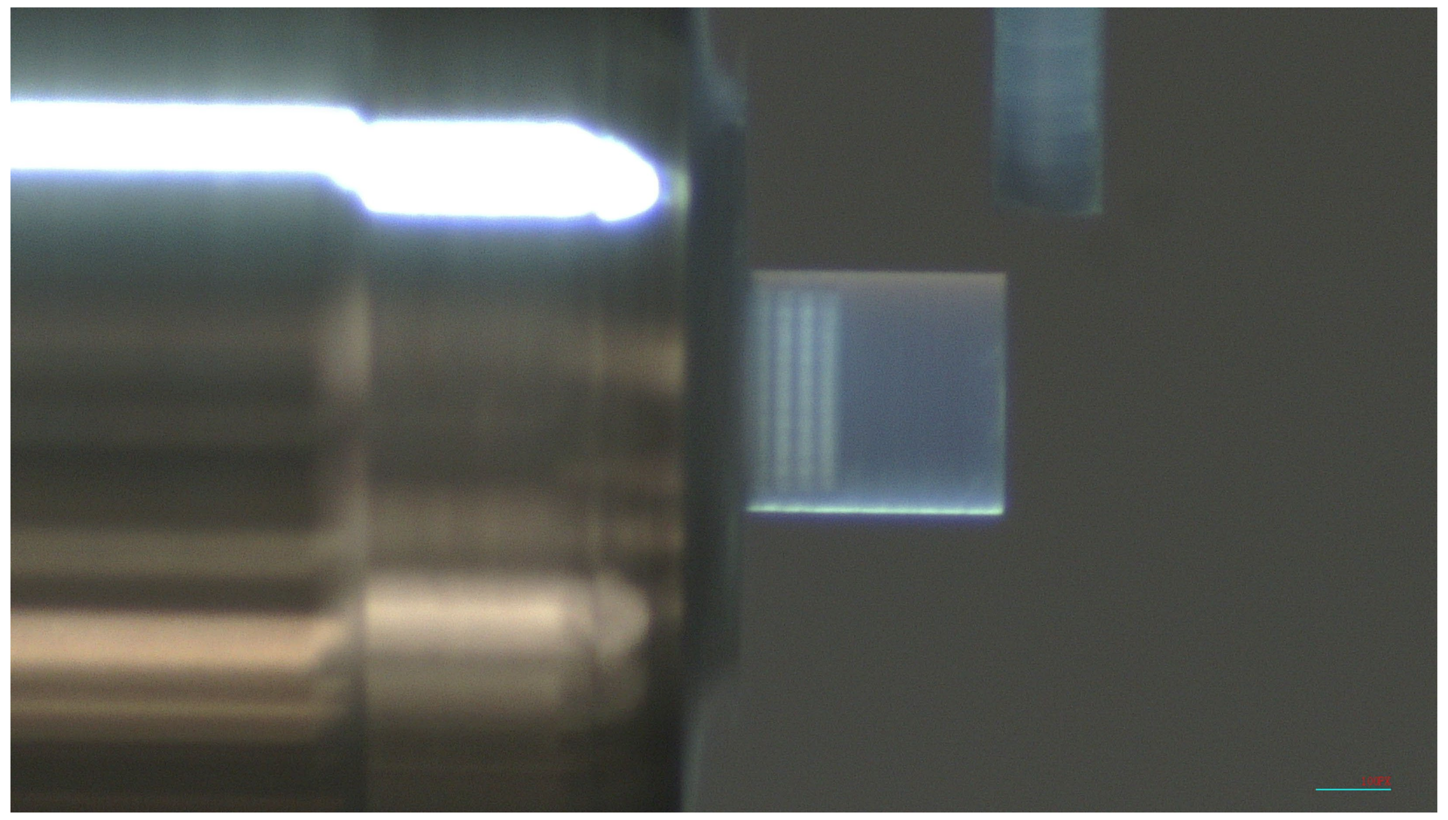
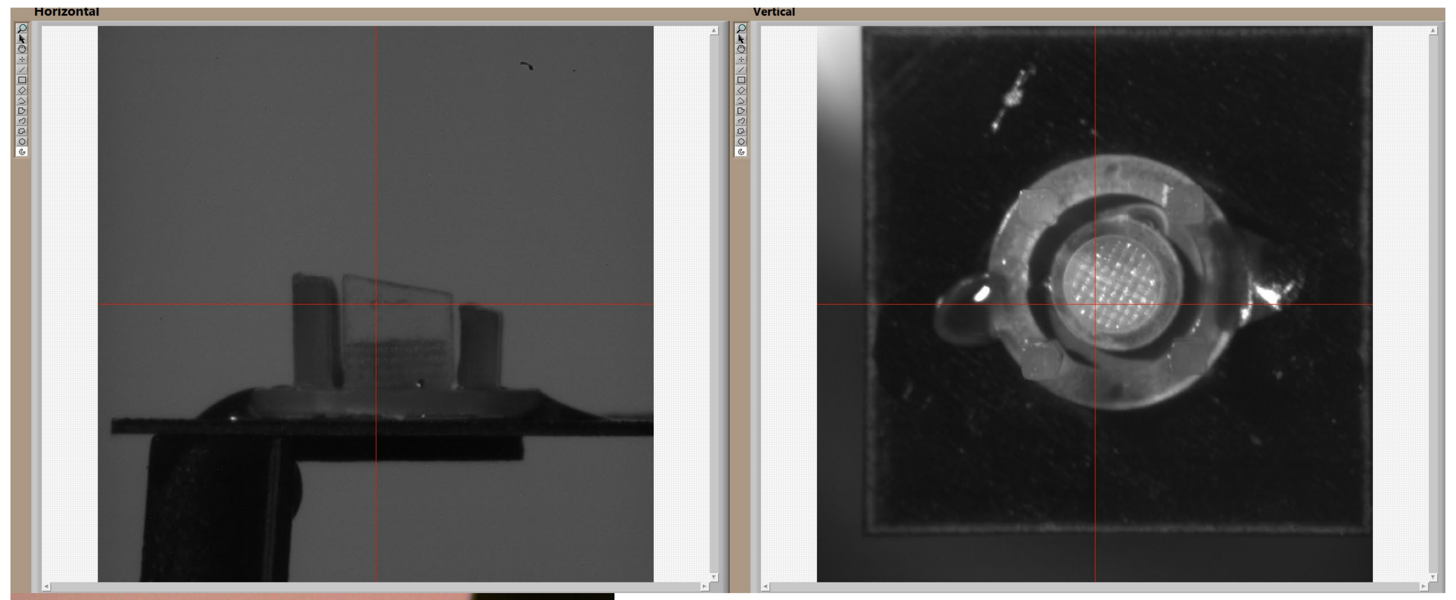


Diagram 4. Foam in lattice during machining

Warm Target Assembled

TARGET ASSEMBLED USING MST-7 TRIPLE THETA

-Front window is mounted to a washer to allow for easier handling and assembly
-SL printed supports are glued around the foam to allow indirect glueing of the back window
-Package is mounted to a SL printed rapid and stalk



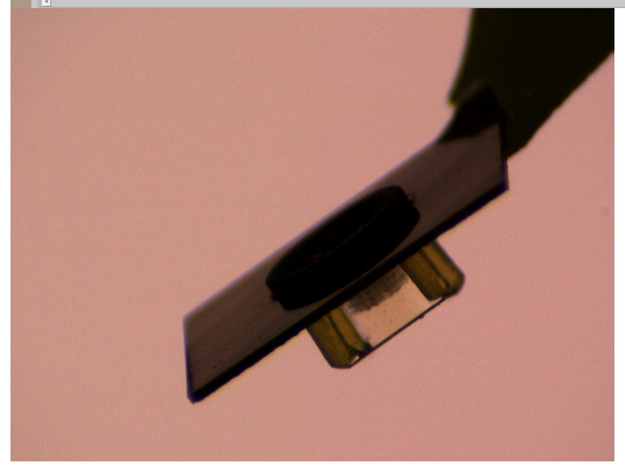


Diagram 5. Lattice in foam during assembly (upper right and left) and the target as viewed from tim6 (bottom left)

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