Fabrication of the First Lead and Depleted Uranium Laser Entrance Hole (LEH) Inserts for the Viewfactor Campaign

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Background

- The hohlraums used in inertial confinement fusion (ICF) experiments at the National Ignition Facility (NIF) typically utilize two annulus-shaped parts.
- The inner diameter of these annuli functions as the diameter of the LEH, so these components are called LEH inserts.
- Typically, LEH inserts are made of Au to match the hohlraum material. In 2022, the rise to peak power and the Au bubble growth were both studied in a pair of experiments.
- These experiments utilized a Viewfactor target design with an open side and an LEH side. The “open side” faced an xray diagnostic called DANTE-1.
- The other side utilized an LEH insert made from Pb. Au bubble growth was observed through these coated windows.

Slow vs Nominal Rise to Peak Power was Studied in ViewFactor

Gold bubble growth blocks inner beams from reaching hohlraum wall

- The Au bubble forms when outer beams ablate the hohlraum walls
- This bubble blocks inner beam laser energy from reaching the hohlraum wall near its equator
- This ultimately reduces the amount of energy transferred to the capsule
- The Au bubble is typically hard to view using polar diagnostics

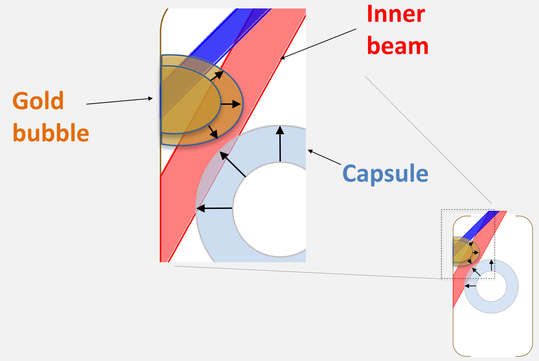
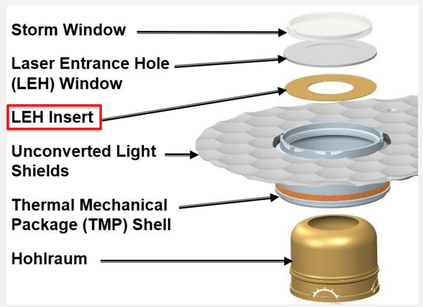


Illustration of gold bubble growth in ICF target

ICF targets typically use Au LEH inserts

- General Atomics fabricates the Au LEH inserts which are used for typical ICF targets
- Gold is used because a high-Z material is needed to prevent loss of xray energy
- The hohlraum’s polar hole diameters are oversized, so physics can tune the LEH size using the Au insert
- For the Viewfactor campaign, a high-Z material which is spectrally different from the hohlraum material was necessary for diagnostics. Pb and DU have been used.



Exploded view of a typical ICF target

Two Identical Targets Were Built in CY22 Using Pb LEH Inserts

Practice build was successfully completed prior to final assembly

- Cantilever beam equations were used to predict how much more Pb foil would deflect under its own weight compared to Au. Assuming identical part geometry, lead components will deflect 3.16 times more under their own eight than gold.
- There was uncertainty in how well the UV cure and Stycast 2850 epoxy would adhere to the Pb, so a test build was deemed necessary. It was successfully completed prior to target assembly.

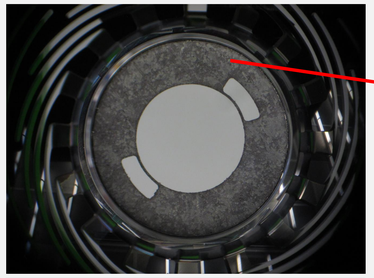
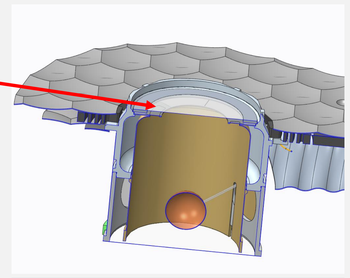
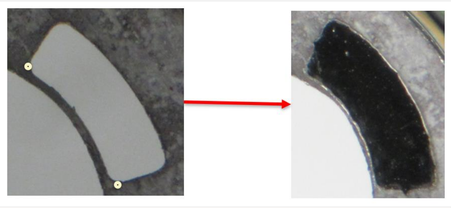


Image of Pb insert glued into TMP subassembly



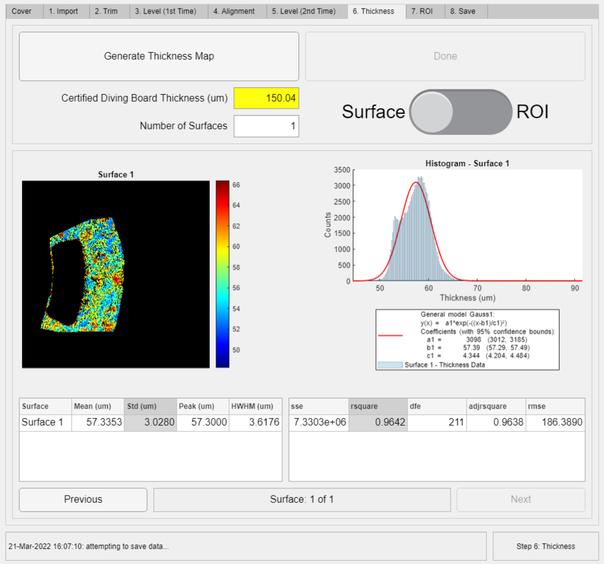
Cross-section view of final target assembly

The Au bubble windows for DANTE needed to be sealed to retain hohlraum internal pressure. A sheet of Mylar was laser cut and coated with Pb to lower xray loss.



Filmstrip instructions for how to glue Pb-Coated Mylar tabs

Pb LEH Insert was carefully measured using a white light interferometer



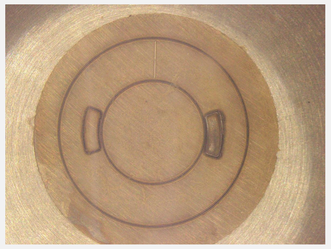
Foil thickness was 7.3um greater than nominal and met physics requirements

CY23 DU LEH Insert and CY22 Experimental Results

One target was built in CY23 using a DU LEH insert

- Cantilever beam equations were used to predict how much more DU foil would deflect under its own weight compared to Au. Assuming identical part geometry, DU components will deflect 2.39 times less under their own eight than gold.
- Target fabrication polished DU foil down to a thickness of 50 um. It was then laser milled to create the LEH insert profile.
- The foil thickness was measured using a Heidenheim touch probe
- A sheet of Mylar was laser cut for the LEH insert tabs. The Mylar was coated in DU. These tabs were then glued onto the LEH insert using Stycast 1266.

Precision polisher used for DU foil

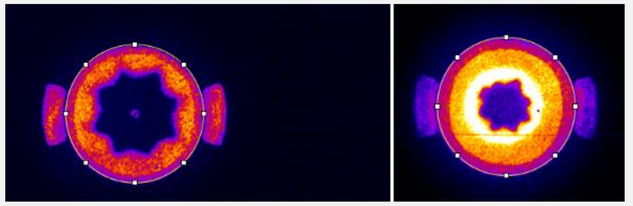


Laser-milled 50um DU LEH insert

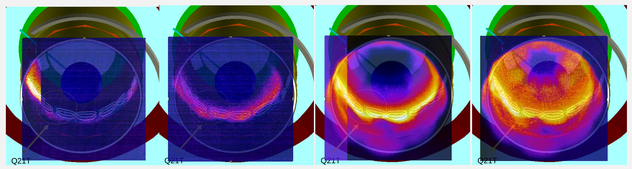
Final Experimental Results

Nominal Rise: N220605-001

Slow Rise: N220605-001



View looking into LEH end from pole



Center (roughly): 1 ns 3 ns 5 ns 7 ns

GLEH-2, looking into OPEN end at 19°, recorded Au bubble growth vs time

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