Development of Mixed Foams for NIF Hohlraum Wall Heating Campaign

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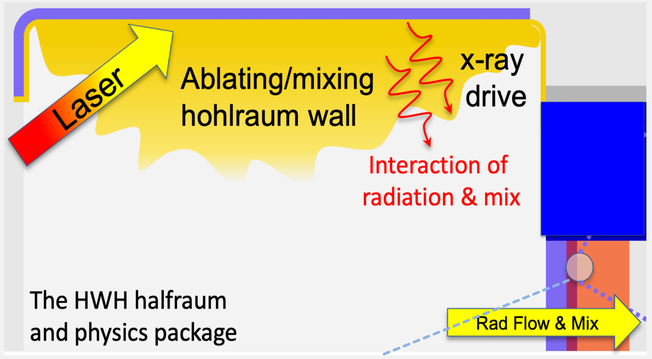
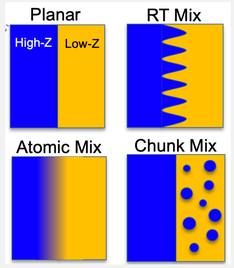
Goals of Hohlraum Wall Heating (HWH) Campaign

Hot and cold packages investigate radiation-mix interaction

- **Motivation**
  - HED/ICF experiments are impacted by uncertainty in the interaction of radiation and mix
  - For example, hohlraums radiate x-rays through an ablating wall mixture, creating drive uncertainty
  - HWH is collecting data to better understand this phenomena, validate our rad-hydro codes, and estimate sensitivity levels across a spectrum of mixing interface types



- **Consider four mixing interface types: planar, Rayleigh-Taylor, Aromic, and Chunk**
  - Baseline shots exhibit transonic radiation flow, heating the mix to ~150 eV
  - Control shots, where radiation flow is subsonic, ensures mix remains relatively cold (~50 eV)
- **HWH has two main goals:**



Bound the effect of mix on radiation transport
Quantify the effect of radiation on mix growth

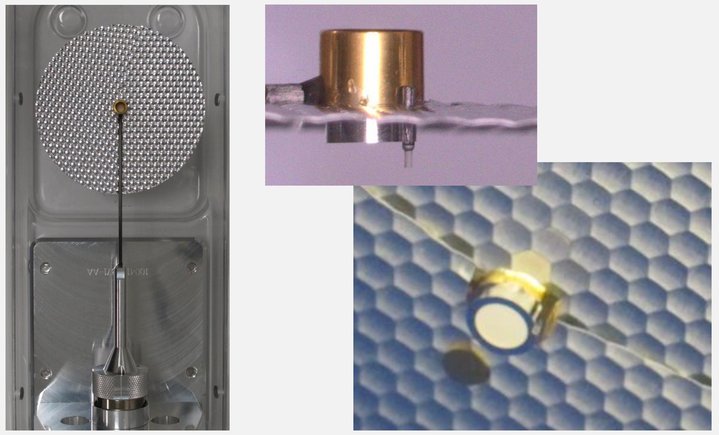
Atomic and Chunk Mix Physics Requirements

- **Mix** is of a high z, high density foam at 20% by vol in a low z, low density foam
  - The high and low z materials should be the same in both mixes
  - Volume fraction of high to low density material should be the same in both mixes
- **Atomic Mix** is a homogenous distribution of the high z foam in the low z foam at *a sub-micron scale*.
- **Chunk Mix** should be a homogenous distribution of the high z foam in the low z foam at a *10-100 micron scale*.

TF Engineering Solutions:

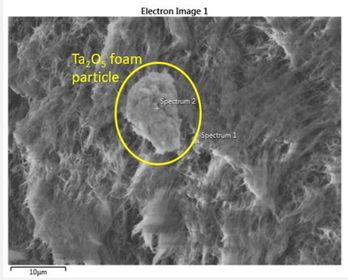
- High Z Tantalum Oxide
  - Known processes to create foam densities in the desired range (200-400 mg/cc)
  - Powder is compatible with CH foam chemistry
  - Precursors for Atomic Layer Deposition (ALD) are available for the Atomic Mix
- Low density carbon based foams between 40-100 mg/cc serve as the substrate
- Particles from fractionated powders will be substituted for spheres.

Target Photo



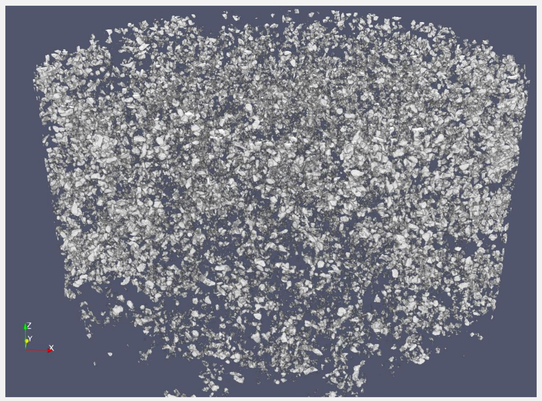
Chunk Mix Development

SEM/EDS analysis identified distinct Ta2O5 chunks in the CH foam matrix.



- Ta_2O_5 foam was milled and particle sizes fractionated using a series of sieves.
- 60 um particles were dispersed in CH foam during formation
- EDS analysis confirmed that the white aggregate is composed of Ta_2O_5

Radiographs illustrate that high z-chunks are dispersed in the low z matrix

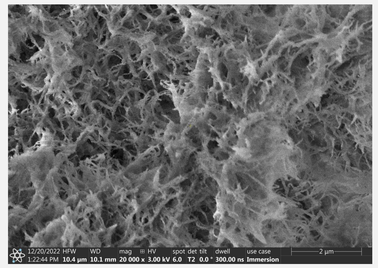


Chunk Mix consisting of 60 um particles dispersed in a 50 mg/cc CH matrix at 20% by volume prior to machining and assembly

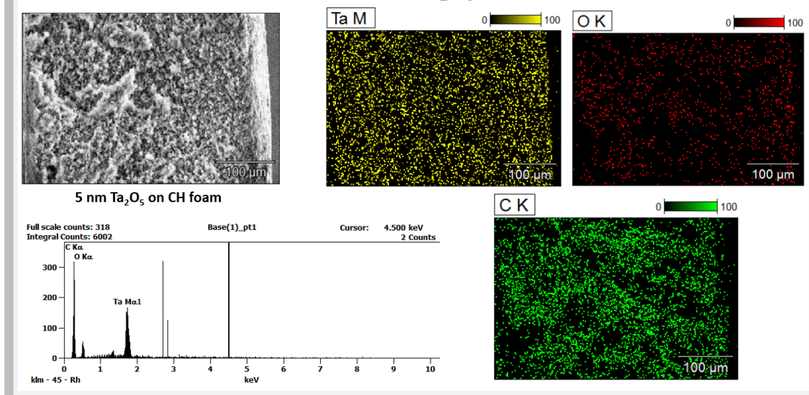
Atomic Mix Development

A series of atomic mix foams were prepared:

- CH foam substrates were fabricated as thin discs (60 mg/cc)
- ALD was used to deposit layers of Ta_2O_5 on the inner surface area of the foam discs
- ALD-treated samples were prepared to determine deposition rate and optimal soak times for each cycle



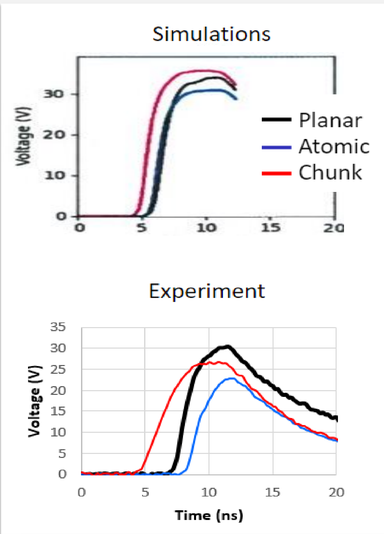
SEM/EDS analysis of CH/Ta_2O_5 Atomic Mix Foam



Using ALD enabled us to match the volume fraction of the Atomic Mix to that of the Chunk Mix foams, a key physics requirement

Target Deliveries Completed and Planned

- **Jan and June 2024 Baseline, Atomic, and Chunk Mix Targets were fielded**
  - Densities appear higher than pre-shot simulations and what was reported from metrology and calculated loading values
- **Shots Planned for FY25:**
  - November 2024, Atomic and Chunk Mix foams of higher vol% along with a RT Mix interface (rippled Ta2O5)
  - January 2025, Atomic and Chunk Mix with a different loading



Higher fidelity density measurements will be delivered for FY25

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