Results from parametric studies of thin liquid wall IFE chambers

D. A. Haynes, Jr.
Fusion Technology Institute
University of Wisconsin, Madison
We present results from a set of BUCKY simulations of the response of a thin liquid wall chamber to the threat spectrum of the C/C HIB target. Parameters considered were wall material (Pb or FLiBe), vapor composition (Xe or vapor from the liquid) and vapor pressure. All variations considered lead to acceptable chambers from the point of view of ion deposition, vaporization thickness and condensation rates, though these simulations do not include the effects of splashing or aerosolization.

- Wall material (Pb or FLiBe)
- Vapor pressure (10mTorr or 1000mTorr)
- Vapor composition (Xe or wall material)
- Conclusions and future work
- Old business: dry wall strawman results
Wetted-Wall Chamber Physics Critical Issues Involve Target Output, and First Wall Response

- **Target Output**
  - Simulations (BUCKY, etc)
  - Target Disassembly
  - Energy Partition

- **Liquid Dynamics**
  - Simulations (BUCKY)
  - X-ray Deposition
  - Vaporization
  - Self-Shielding
  - Shocks in Liquid

- **Chamber Recovery**
  - Simulations (1-D: BUCKY, 2, 3-D TSUNAMI, ?)
  - Re-condensation
  - Substrate Survival

- **Vapor Mass Impulse**
- **Beam Transport Criteria**
- **Vapor Opacity**

- **Low T, Hi \( \rho \) Opacity**
- **Target Design**
- **Wall Design**
- **Liquid Properties**
- **Rep-Rate**
This talk concentrates on the effects of the threat from the closely coupled HIB target. The threat is predominantly from the soft x-rays produced by the interaction of capsule output and the massive hohlraum output x-ray spectra.

Target output x-ray spectra

Though this target is not currently being emphasized by the HIB target community, its threat spectrum should be grossly similar to the more likely contenders. As this target is the only one for which we have detailed threat spectra, we use it as a representative.
We have generated relevant FLiBE opacity and equation of state

Calculations performed using DTAOPA, a detailed transition accounting, NLTE version of EOSOPA
FLiBe is considerably more transparent to the target x-rays than is Pb. This leads to more volumetric heating of the liquid, and less shielding by the chamber vapor and the superheated vapor.

As of 0.1ms after implosion:

- X-ray energy absorbed in vapor:
  - FLiBe: 36MJ
  - Pb: 114MJ

- Energy re-radiated to the wall:
  - FLiBe: 16MJ
  - Pb: 60MJ
A hybrid design using both a chamber gas chosen for beam transport and a thin liquid wall chosen to protect the first wall is conceivable: 1000mTorr Xe

As of 0.1ms after implosion:
• X-ray energy absorbed in vapor:
  • FLiBe wall: 78MJ
  • Pb wall: 111MJ

(Blow-off is treated as vapor for this purpose. Note that the Pb created early in the pulse better shields the wall from the end of the pulse.)

• Energy re-radiated to the wall:
  • FLiBe wall: 25MJ
  • Pb wall: 31MJ
Different driver transport beam transport methods require different pressure of chamber gas. Last meeting we looked at 1mTorr. Here, we look at 10mTorr and 1000mTorr.

- The lower Pb chamber pressure actually results in less vaporized mass at the end of 0.1ms. This is due to the effect of soft, re-radiated energy due to ions and x-rays absorbed in the chamber gas.

- Re-radiated energy:
  - 10mTorr: 36MJ
  - 1000mTorr: 60MJ
BUCKY does not include the effects of aerosol formation nor splashing. We have handed off early time, post flash chamber conditions to Phil Sharpe, who will report on his analysis of aerosol issues later this meeting.

Plan of attack from last meeting:

• “Homogenize” chamber, converting bulk kinetic energy into thermal energy.

• Start condensation run from these conditions.

• Geometry dependent uncertainty: how long does it take to homogenize, and will there be any x-ray pulse produced by stagnation on axis?
Re-establishment of conditions suitable for target injection: do drops of aerosol remain?

- We need to decide on the parameters space in which we want to identify operating windows, and what constitutes an acceptable design:
  - Target Output
  - Driver/Transport Method
  - Radius
  - Liquid
  - Wall temperature

Vapor density and temperature are suitable for beam transport and target injection?

Protecting liquid is re-established?

t ~ 100-500 ms
Summary/Conclusions

• For the 4.5m radius chamber assaulted by the C/C HIB target:
  • All of the combinations of chamber gas, pressure, and wall considered lead to 10s of kilograms of mass vaporized at the end of 0.1ms.
  • Based on results presented last time, and absent splashing and aerosolization, recondensation should proceed quickly enough to maintain a 5Hz rep. rate.
  • More vapor does not necessarily provide more protection to the first wall, due to soft re-radiation with no time of flight spreading.

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Dry Wall Strawman Results

BUCKY simulations for the LY DD, HY DD, and ID Target 1 have been performed. Protective gas requirement, armor temperature and evaporation rates are reported.

DAH, UW-FTI
Dry Wall Strawman Results

- ID1: 500 mTorr
- DDLY: 10 mTorr
- DDHY: 28 mTorr

N.B.: The effect of ion implantation is an important outstanding issue.

Is brief melting acceptable? Desirable?

No mass loss due to vaporization from thermal response.