

Town Meeting on Liquid Wall Chamber Dynamics

Background and Goals

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ARIES Town Meeting
Hilton Garden Inn, Livermore, CA
May 5-6, 2003

ARIES Town Meetings

- **The ARIES program organizes town meetings to provide a forum for discussions between scientists from R&D programs and power plant studies:**
 - To help guide experimental programs towards solutions that lead to an attractive fusion power plant
 - To help design studies develop concepts that are consistent with the understanding of scientists developing those technologies.
- **Consistent with ARIES mission statement:**
 - Perform advanced integrated design studies of the long-term fusion energy embodiments to identify key R&D directions and provide visions for the program.

Past ARIES Town Meetings Have Proven Very Valuable

Mar. 2-3, 1995	ANL	Workshop on Liquid Target Divertors	<i>Starlite</i>
May 10, 1995	ANL	Starlite Town Meeting on Structural Materials	
Jan. 31, 1996	UCSD	Starlite Town Meeting on Low Aspect Ratio Spherical Tokamaks	
June 19, 1997	UW	ARIES Town Meeting on Designing with Brittle Materials	<i>ARIES-RS</i>
May 6-7, 1998	UCSD	ARIES Town Meeting on ST Physics	<i>ARIES-ST</i>
Jan. 18-19, 2000	ORNL	International Town Meeting on SiC/SiC Design & Material Issues for Fusion Systems	<i>ARIES-AT</i>
Mar. 6-7, 2001	Livermore	ARIES Tritium Town Meeting	<i>ARIES-IFE</i>

Most Recent Town Meetings

SiC/SiC Town Meeting, January 2000

Objective: To bring together the international SiC/SiC design and materials communities to exchange information, identify design-related critical issues, discuss latest R&D results, and provide guidelines to help focus future effort (reference properties, R&D goals, *etc.*)

Organizers: M. Billone, R. Raffray

Attendance: EU (5), Japan (9), US (17)

Major Output: Bring material and design communities up to date with latest developments in the field; identify major material issues from design perspective; recommend most appropriate values of properties to be used in design studies (FED journal article)

<http://aries.ucsd.edu/LIB/MEETINGS/0001-SiCSiC/>

Tritium Town Meeting, March 2001

Objective: To bring together the design and R&D communities to exchange information, identify design-related critical issues, discuss latest R&D results, and provide guidelines to help focus future effort (fuel cycle, safety, blanket and PFC, IFE-specific).

Organizers: D. K. Sze, M. Gouge

Attendance: EU (1), US (21)

Major Output: Update major tritium issues for MFE and IFE; show “similarity” in operating armor parameters between transient MFE conditions and IFE operation and highlight possible R&D synergy for armor thermo-mechanical and tritium issues.

<http://aries.ucsd.edu/LIB/MEETINGS/0103-ARIES-TTM/>

ARIES Integrated IFE Chamber Analysis and Assessment Research

Goals:

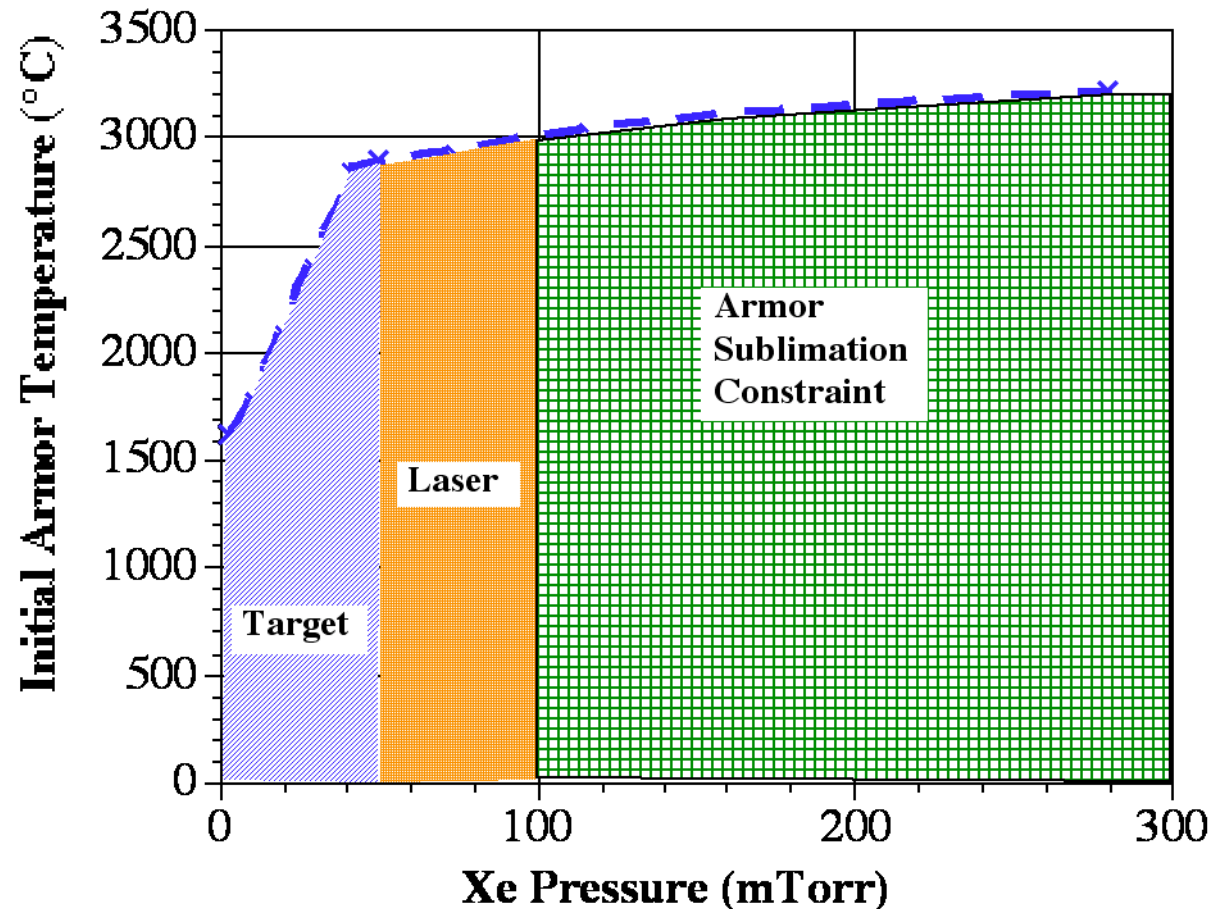
- Analyze & assess integrated and self-consistent IFE chamber concepts
- Understand trade-offs and identify design windows for promising concepts.
The research was not aimed at developing a point design.

Approach:

- Six classes of target were identified. Advanced target designs from NRL (laser-driven direct drive) and LLNL (Heavy-ion-driven indirect-drive) were used as references.
- To make progress, we divided the activity based on three classes of chambers:
 - Dry wall chambers;
 - Solid wall chambers protected with a “sacrificial zone” (e.g. liquid films);
 - Thick liquid walls.
- We researched these classes of chambers in series with the entire team focusing on each concept.

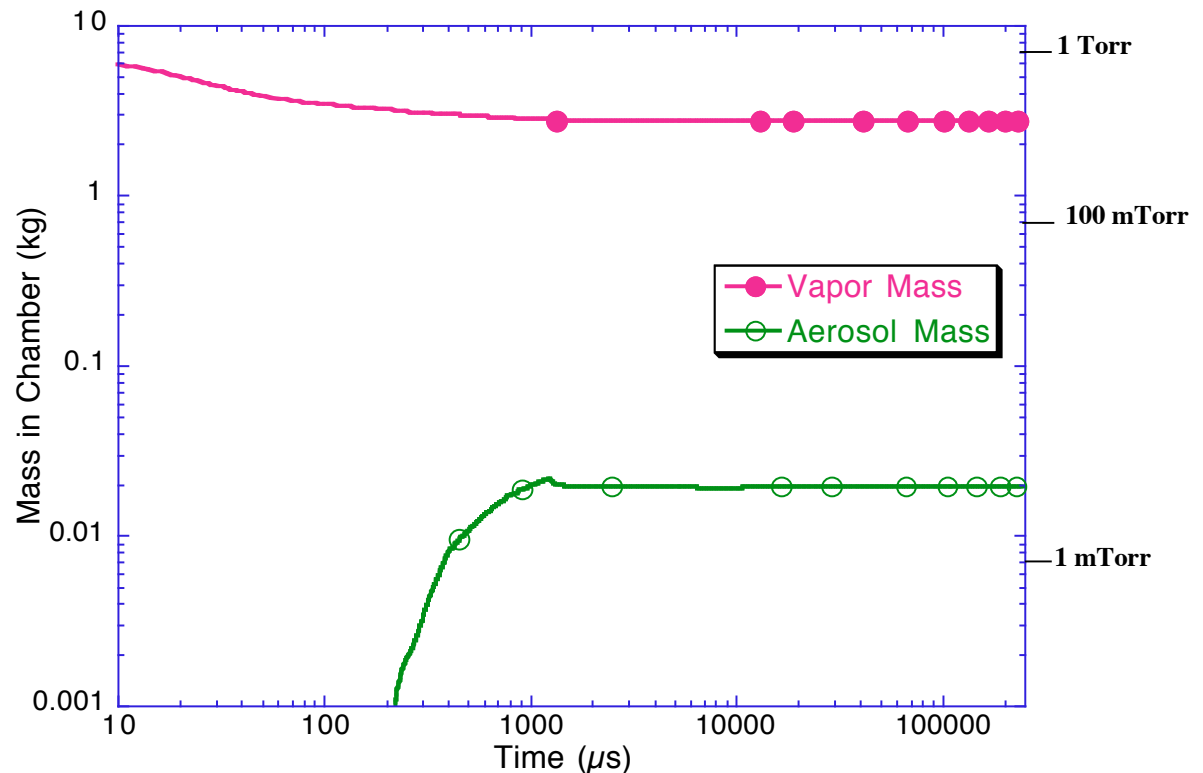
Example Results from ARIES-IFE Effort on Solid Wall Chambers

- Evolution of parametric design window for carbon armor in a 6.5 m radius chamber for the 154 MJ direct drive target
 - Armor survival (including time of flight effect)
 - Laser breakdown constraint
 - Target survival



Example Results from ARIES-IFE Effort on Thin Liquid Wall Chambers

- Vapor and aerosol mass histories for a 6.5 m chamber with a flibe wetted wall exposed to the photon threat spectrum of the 400 MJ indirect-drive target
 - Potentially major effect on choice of mode of transport and focusing of heavy ion driver based on pre-shot chamber gas density
 - Neutralized ballistic transport: <1 mTorr
 - Channel transport: <1 Torr.
 - Self-pinch transport: < 100 mTorr.



ARIES-IFE Effort on Thick Liquid Wall Chambers

Focus on major design: HYLIFE-II

- **Completed**
 - **Structural material assessment** (<http://aries.ucsd.edu/LIB/REPORT/ENG.shtml>)
- **On-going**
 - **Liquid wall behavior under the IFE threat spectra**
 - **Overall clearing process dictating the chamber environment prior to the next shot**
 - **Mechanisms affecting chamber clearing (e.g. aerosol creation, condensation)**
 - **Requirements on chamber environment**
 - **Heavy ion beam propagation and focusing**
 - **Target injection and tracking requirements on chamber environment**
 - **Complex nature of processes involved makes it difficult to arrive at a full understanding of the different mechanisms involved**
 - **Also of interest and studied under VLT-IFE umbrella**

Right time for town meeting

Goals of Town Meeting

- The major objective of the meeting is to bring together experts in the liquid chamber dynamics areas to identify the major issues, share the latest results, understand better the accuracy of (and any differences among) various modeling predictions and, through **discussions**, to help focus future R&D efforts (analyses and experiments).
- **Focus: Liquid Wall Chamber Dynamics**
 - IFE Target Threats
 - Driver and Target Constraints
 - Chamber/Liquid Wall Dynamics Under Threats (short term, $\sim \mu\text{m-ms}$)
 - Liquid wall response to threats and early chamber dynamics
 - Chamber/Liquid Wall Dynamics (long term, to ~ 0.1 s)
 - Chamber clearing mechanisms
 - Liquid re-establishment
- **Organizers: W. Meier/R. Raffray**
- **Proposed publication**
 - “Progress and R&D Priorities for Thick Liquid Wall Chamber Dynamics”