INERTIAL FUSION ENERGY DIRECT DRIVE TARGET WORKSHOP

GENERAL ATOMICS

September 15, 1999

INTERNAL MEMORANDUM

TO: Distribution DTG

IN REPLY
REFER TO: ICFT99/227

FROM: D.T. Goodin

DATE: 17 September, 1999

SUBJECT: Minutes of Inertial Fusion Energy Direct Drive Target Workshop

1.0 Summary

The first IFE Direct Drive Target Workshop was held on September 15, 1999 at General Atomics. The purpose of the workshop was to bring together experts in the areas of target design, target fabrication, layering, injection/tracking, and target chambers. A goal of the workshop was to move towards a practical direct drive target design meeting requirements in all of these areas. The participants identified and discussed issues associated with utilizing the NRL radiation-preheated target design in a dry-wall chamber power plant (e.g., SOMBRERO design).

It was agreed that there are still significant technical issues associated with successfully injecting the proposed target designs into a dry-wall chamber. It was the consensus of the group that approximately one year should be allocated to solving issues for this particular IFE approach before changing to significantly different concepts for the chamber, target, or other plant systems. Action items were agreed upon and are documented in this package. The next workshop was tentatively planned to take place at NRL around February of 2000.

2.0 Introduction

A workshop was held on September 15, 1999 at General Atomics (GA) with attendees from Naval Research Laboratory (NRL), Los Alamos National Laboratory (LANL), General Atomics (GA), Schafer Corporation, University of California, Berkeley (UCB), University of Wisconsin (UW), Lawrence Livermore National Laboratory (LLNL), University of California, San Diego (UCSD), San Diego State University (SDSU), and General Atomics (GA). A list of Attendees and their affiliations is given in Table 1, below. The workshop Announcement and Agenda is included as Appendix A. A list of telephone, FAX, and email addresses of all Attendees is provided in Appendix B.

3.0 Introductory Presentations

The workshop began with introductory presentations in each of the key areas listed below:

Target Design	Jill Dahlburg (NRL)
Target Fabrication	Warren Steckle (LANL) Lloyd Brown (GA)
Target Layering	Don Bittner (Schafer) Jim Sater (Schafer)
Target Injection	Ron Petzoldt (UCB)
Target Chamber	Bob Peterson (UW)

Table 1 List of Attendees and Affiliations

Name	Affiliation
Jill Dahlburg	NRL
John Gardner	NRL
John Sethian	NRL
Warren Steckle	LANL
Don Bittner	Schafer
Jim Sater	Schafer
Ron Petzoldt	UCB
Jerry Kulcinski	UW
Bob Peterson	UW
Wayne Meier	LLNL
John Perkins	LLNL
Farrokh Najmabadi	UCSD
Nathan Siegel	SDSU
Larry Thompson	SDSU
Neil Alexander	GA
Dave Baldwin	GA
Lloyd Brown	GA
Dan Goodin	GA
Wayne Miller	GA

John Sethian provided an introduction and opening remarks (Appendix C), emphasizing the need to look at laser IFE as an integrated system. He noted that we should focus on the issues with the existing reactor concept (i.e., dry wall, spherical illumination) before abandoning the concept for "greener pastures". He also provided NRL's view of an Integrated Research Experiment, discussed the role of NIF in developing direct drive IFE, and an approach to gaining support for laser IFE that was based on good science but directed towards resolving laser IFE issues.

Jill Dahlburg provided the attendees insight into the critical issues involved in designing a high gain target suitable for IFE (Appendix D). She presented five critical issues and discussed code results and experimental results. Potential target designs and the prototype target design for laser fusion energy (the NRL radiation preheated target) were described.

Warren Steckle presented (Appendix E) the status of target fabrication, including foams currently used in targets. He described the density, pore size, dopants, and production features of foams currently used in ICF targets. He described current technologies for producing foams. He described a potential high-volume method of microencapsulation for producing shells and a Be droplet forming technique for producing Be shells.

Lloyd Brown then focussed on methods suitable for mass-production of IFE targets (Appendix F). He contrasted the objectives of current ICF target fabrication with those for IFE, then described potential large-scale foam fabrication methods and foam-coating techniques.

Don Bittner described the current status of IR layering (Appendix G) as applied to ICF targets, and Jim Sater (Schafer) described recent work in the area of beta-layering and Joule heating for enhanced layering (Appendix H).

Ron Petzoldt discussed the issues associated with direct drive target injection and tracking, the work accomplished to date, and current injection requirements. A critical issue with interfaces to other systems is target heating during the injection process. Estimated target heatup curves during injection and heat fluxes at varying chamber gas pressures were presented (Appendix I).

Bob Peterson presented target chamber issues for direct drive IFE targets (Appendix J). He discussed the variables considered and the basis for the xenon chamber gas in the SOMBRERO design. He also presented the experimental needs associated with chamber dynamics in gas-protected chambers.

4.0 Discussion and Action Items

Key interface issues involving all the represented groups were emphasized in the discussions. These include:

- Unacceptable target heating during injection into a gas-filled chamber
- Target designs that reduce the effects of heating during injection
- The asymmetry of heating imposed by chamber gases
- The effects on chamber walls of changing or reducing the chamber gas density
- The ability to provide enhanced layering capability with highly reflective coatings

Participants prepared action items in each of their areas and these were discussed with the rest of the group. A summary of these action items are provided in the sections below.

4.1 Target Design (Jill Dahlburg)

1. Have proposals ready should funding increase (John Sethian)
2. Look at effect of pore size and non-uniformity tolerance on target performance
3. Generate output spectra for x-ray and debris
4. Generate Xe and Kr opacity data for Bob Peterson
5. Evaluate core DT gas temperature and pressure effects on gain
6. Evaluate whether the target dopant can be inside, outside, or throughout
7. Evaluate gain curves as a function of on-target energy (part of the parametric studies of tradeoffs in driver efficiency, chamber temperatures, etc.)
8. NRL would like DT layer spectral distribution for native beta layering, for IR heating, and for Joule heating

4.2 Target Fabrication (Warren Steckle)

1. Evaluate self-skinning foams
2. Evaluate impurities in foams and microenscapsulation techniques
3. Explore new polymers

4.3 Target Fabrication (Lloyd Brown)

1. Investigate whether the Japanese, or others, have ever made "target quality" foam shells and tell NRL what has been done (Wayne Miller)
2. Evaluate fluidized bed coating of capsules (potential IR&D experiment)
3. Consider proof-of-principle demonstration experiments for a single-step formation of a foam shell with integral coating
4. Collect together some examples (viewgraphs) on technologies for real mass-production of high-volume items.

4.4 Target Layering (Don Bittner and Jim Sater)

1. Keep in mind the extra margin needed for IFE targets while studying layers at lower temperatures for ICF
2. Provide any data they can think of on fast-heatup of DT layers

4.5 Target Injection (Ron Petzoldt)

1. Evaluate diffraction effects on target tracking
2. Evaluate gas effects on target including effects of moving and stationary gas on transverse target position
3. Revisit the possibility of frozen gas on target, including asymmetric gas layer (with an orienting target spin)
4. Review the possibility of (random) tumbling target to obtain uniform heating ("comet idea")
5. Look for the possibility of coatings that have high reflectivity to chamber IR but have very narrow transmission slots at frequencies needed to IR layer the DT
6. Evaluate the possibility of injecting a "blocker" to clear area in front of the target ("NASCAR" idea)
7. Revisit the shock-heated target (with external foam) and evaluate filling the foam with neon or deuterium for strength during acceleration and cooling during injection (perhaps wick into foam).

4.6 Target Chambers (Bob Peterson)

1. Should have a 1 year evaluation of these issues to see if Sombrero still hangs together (Kulcinski)
2. Will provide a list of bad-actors for activation, corrosion, and interaction with graphite - for comparison to Jeff Latkowsky's list (Kulcinski)
3. Compare EOSOPA (UTA) opacity values with STA
4. Evaluate re-radiation to try & minimize gas density, and try different species

4.7 Plant Systems (Wayne Meier)

1. Requested direct drive gain curve for use in systems codes
2. Look at activation/safety implications of 1000 Angstrom gold or Al coatings (Latkowsky)

5.0 Conclusions

The workshop was an excellent start to what must be a continuing interaction between key groups involved in making the direct drive target a success. It was agreed that minutes would be prepared for the workshop, and that the next workshop should be held at NRL around February of 2000. It was the consensus of the group that approximately one year should be allocated to solving issues for this particular IFE approach before changing to significantly different concepts for the chamber, target, or other plant systems.

Distribution:

Attendees (see Appendix10)
Roger Bangerter (LBNL)
Gottfried Besenbruch (GA)
Jeff Latkowski (LLNL)
Grant Logan (LLNL)
Per Peterson (UCB)
Ken Schultz (GA)
Mark Tillack (UCSD)
Project File