

Progress in IFE Technology: October-November 1999

Laser Interactions and Final Optics Studies:

M. S. Tillack, F. Najmabadi, D. Blair, Z. Wang
UC San Diego

- ® A new laboratory for IFE laser chamber research has been established at UC San Diego. Up-to-date information regarding this laboratory can be found at <http://aries.ucsd.edu/IFE/>
- ® A 10 Hz, 2-J pulsed YAG laser (purchased with UCSD internal funds) provides the primary energy source. The laser is equipped with harmonic generator crystals providing laser light at 1-, 1/2-, 1/3- and 1/4-micron wavelengths. The laser arrived recently and has been installed and tested. A class-100 clean room environment has been installed to allow optics testing near the damage threshold with controlled surface impurities.
- ® A variety of other equipment and diagnostics was acquired during the past three months (see <http://aries.ucsd.edu/IFE/equipment.shtml>). The principal diagnostics will include pulse energy, spatial and temporal beam profile, wavefront characterization and post-test interferometric microscopy. Most of the diagnostics are "off-the-shelf" with the exception of a Shack-Hartmann wavefront sensor, which is being assembled on site due to cost considerations.
- ® Near-term experiments are being planned on bare metal surfaces at normal and grazing incidence for comparison with model predictions.

Integration, Safety & Environment, Final Focus Magnet Shielding:

W. R. Meier, J. F. Latkowski, R. W. Moir, S. Reyes
Lawrence Livermore National Laboratory

- ® LLNL organized and conducted a conference call at the end of October to discuss the funding situation and R&D priorities for FY00. Many from the IFE technology community and representatives from the various driver groups (HI's, DPSSLs, KrF) participated. A summary of community input was compiled and forwarded to DOE OFES.
- ® An analysis of the impact of target gain, driver efficiency and driver cost on IFE cost of electricity was completed for presentation at the Japan/US Workshop on Laser-Driven IFE. Increasing target gain was found to have the highest leverage for improving plant economics.
- ® The latest iteration of heavy ion final focus magnet shielding calculations suggest that new, high-T_c superconductors (BSCCO-2212 and -2223, for example) offer great promise for reducing magnet refrigeration requirements and neutron activation concerns while maintaining shielding thicknesses at reasonable levels.
- ® Modifications were made to the CHEMCON code, which is used for long-term heat transfer calculations related to safety analyses, to enable it to simulate the oxidation of carbon composite structures in the SOMBRERO design. With the modifications, CHEMCON now correctly follows the propagation of the oxidation front.

Target Fabrication, Injection, and Tracking:

D. Goodin, R. Petzoldt, and A. Nobile
General Atomics, Lawrence Berkeley National Laboratory, and Los Alamos National Laboratory

- ® An initial draft of the System Design Description for the new experimental target injection and tracking system was prepared. System functions and design requirements were defined.

Dry Wall Target Chamber Dynamics:

R. R. Peterson, G. Kulcinski
University of Wisconsin at Madison

- ® Initial shock tube experiments confirm loading on simple cylinders as predicted by the RAGE 3-D radiation-hydrodynamics code. Additional shock tube experiments and RAGE calculations for more complicated geometries are planned.
- ® Wall erosion due to thermal evaporation has been studied for graphite under SOMBRERO conditions.
- ® Experimental data for the thermal conductivity of graphite shows reduced neutron damage effect at expected (SOMBRERO) irradiation temperatures. Based upon this data, it appears that the required thermal conductivity of 115 W/m-K should be achievable.

Thick-Liquid Protection:

P. Peterson, N. Morley, and M. Yoda
UC Berkeley, UC Los Angeles, and Georgia Tech.

- ® Fluid mechanics and inertial fusion energy (IFE) researchers from LLNL, LBNL, Georgia Tech., UCLA and UC Berkeley met on November 19 at UC Berkeley to discuss the use of thick-liquid blankets for protection of IFE target chambers.
- ® The presentations and discussion focused on the three primary goals for hydraulics research for thick-liquid protection in the next 4 years: 1) Demonstration of pocket formation via single jet optimization, 2) Demonstration of pocket disruption and droplet clearing, and 3) Support of integrated final-focus system design.
- ® Based on the productivity of the workshop, it was agreed to arrange a video-conference workshop in approximately 4 months to continue collaboration, and to arrange another workshop prior to the Oct. 15-20, 2000 Fusion Topical Meeting in Park City, Utah. This workshop would include both liquid hydraulics and chamber dynamics presentations.

Use of the National Ignition Facility for Inertial Fusion Science and Energy Development:

P.F. Peterson, R. Petzoldt, K. Schultz, and M. Tillack
UC Berkeley, Lawrence Berkeley National Laboratory, General Atomics, and UC San Diego

- ® A workshop for exploring Frontier Science at the National Ignition Facility (NIF) was held October 4-6 in Pleasanton, CA. NIF will play a central role in IFE development. Most importantly, the demonstration of ignition and gain on NIF addresses the most important feasibility and scientific issues for IFE. Furthermore, NIF will provide additional unique capabilities for target physics, target systems, and chamber dynamics and condensation experiments.

Recent Publications and Presentations:

L. C. Elwell, J. A. Collins, M. Yoda, and S. I. Abdel-Khalik, "Dynamics of obliquely oscillated turbulent free rectangular jets," American Physical Society Division of Fluid Dynamics Annual Meeting, New Orleans, LA (Nov. 1999).

D. Goodin, "IFE Target Injection and Tracking," Presented at the Japan/US Workshop on IFE, Osaka, Japan (Nov. 1999).

D. Goodin, "Mass Production of Inertial Fusion Energy Targets," Presented at the Japan/US Workshop on IFE, Osaka, Japan (Nov. 1999).

D. A. Haynes, "Radiative Properties of Hot, Dense, and Homogeneous Matter," Presented at the National Ignition Facility Science Users Workshop, Pleasanton, CA (Oct. 1999).

J. Hoffer, "Alternative Fuels for ICF targets," Presented at the 13th Target Fabrication Meeting, Catalina, CA (Nov. 1999).

P. A. House, "Beam line and first vessel wall shielding in HYLIFE-II," UCRL-UCID-136107, Lawrence Livermore National Laboratory (Nov. 1999).

G. L. Kulcinski, "Electricity Production from Laser Fusion Reactors: Technology Aspects of Power Conversion Chambers," Presented at the International Forum on Advanced High Power Lasers and Applications, Osaka, Japan (Nov. 1999).

G. L. Kulcinski, "Non-Electrical Power, Near Term Applications of Fusion Energy," Presented at the 18th IEEE/NPSS Symposium on Fusion Engineering, Albuquerque, NM (Oct. 1999).

G. L. Kulcinski, "Realizing the Benefits of Fusion Energy in Our Lifetime," Presented at Fusion Power Associates Annual Meeting, Washington DC (Oct. 1999).

J. F. Latkowski, B. G. Logan, L. J. Perkins, W. R. Meier, R. W. Moir, S. Atzeni, and J. Sanz, "Safety and Environmental Advantages of Using Tritium-Lean Targets for Inertial Fusion Energy," Presented at the First International Conference on Inertial Fusion Sciences and Applications, Bordeaux, France (Sep. 1999).

J. F. Latkowski, R. W. Moir, and P. A. House, "Nuclear Heating, Radiation Damage, and Waste Management Options for the HYLIFE-II Final Focus Magnets," Presented at the First International Conference on Inertial Fusion Sciences and Applications, Bordeaux, France (Sep. 1999).

J. F. Latkowski, D. E. Cullen, and J. Sanz, "Evaluation of HYLIFE-II and SOMBRERO Using 175- and 566-Group Neutron Transport and Activation Cross Sections," Presented at the First International Symposium on Fusion Nuclear Technology, Rome, Italy (Sep. 1999). Submitted to Fusion Engineering and Design.

J. F. Latkowski, "Thoughts on Expanding International Energy Agency Tasks on Radiation Damage in Fusion Materials to Include Activities in Inertial Fusion Energy," Presented to the International Energy Agency's Executive Committee on Radiation Damage in Fusion Materials, Colorado Springs, CO (Oct. 1999).

W. R. Meier, "Inertial Fusion Energy Technology - Current Activities and Future Plans," Invited talk presented at the 18th IEEE/NPSS Symposium on Fusion Engineering, Albuquerque, NM (Oct. 1999).

W. R. Meier, "Laser IFE Economics - Importance of Target Gain, Driver Efficiency and Driver Cost," Presented at the Japan/US Workshop on IFE, Osaka, Japan (Nov. 1999).

W. R. Meier and K. R. Schultz, "IFE Program - Technology Development Activities and Plans," Presented at the 13th Target Fabrication Meeting, Catalina, CA (Nov. 1999).

R. W. Moir, "Grazing incidence liquid metal mirrors (GILMM) for radiation hardened final optics for laser inertial fusion energy power plants," Presented at the First International Symposium on Fusion Nuclear Technology, Rome, Italy (Sep. 1999). Submitted to Fusion Engineering and Design.

R. W. Moir, "Liquid walls for fusion reaction chambers," Submitted to Comments on Plasma Physics and Controlled Fusion (Sep. 1999).

R. W. Moir and P. A. House, "Pocket geometry options," Presented at the Liquid Protection Workshop, Berkeley, CA (Nov. 1999).

R. R. Peterson, G. L. Kulcinski, E. A. Mogahed, and J. F. Santarius, "Target Chamber Issues for Direct-Drive Targets," Presented at the IFE Direct-Drive Workshop, General Atomics, San Diego, CA (Sep. 1999).

R. R. Peterson, T. W. L. Sanford, R. E. Olson, R. C. Mock, W. Matuska, R. P. Weaver, and M. L. Gittings, "Diagnostic Hole Closure Calculations for Z-Pinch-Driven Hohlraums on Z," Presented at the 1999 Meeting of the Division of Plasma Physics of the American Physical Society, Seattle WA (Nov. 1999).

R. Petzoldt, "Target Injection and Tracking for IFE," Presented at the Symposium on Fusion Engineering, Albuquerque, NM (Oct. 1999).

R. Petzoldt, D. Goodin, and N. Siegel, "Status of Target Injection and Tracking Studies for Inertial Fusion Energy," Poster presentation at the 13th Target Fabrication Meeting, Catalina, CA (Nov. 1999). Paper submitted to Fusion Technology.

S. Reyes, J. F. Latkowski, and W. R. Meier, "Radiation Damage and Waste Management Options for the SOMBRERO Final Focus System and Neutron Dumps," Presented at the First International Conference on Inertial Fusion Sciences and Applications, Bordeaux, France (Sep. 1999).

J. Sanz, P. Yuste, S. Reyes, and J. F. Latkowski, "Efficient Modeling for Pulsed Activation in Inertial Fusion Energy Reactors," Presented at the First International Symposium on Fusion Nuclear Technology, Rome, Italy (Sep. 1999). Submitted to Fusion Engineering and Design.

M. E. Sawan, R. R. Peterson, S. Yu, "Shielding Analysis for a Heavy Ion Beam Chamber with Plasma Channels for Ion Transport," Presented at the First International Symposium on Fusion Nuclear Technology, Rome, Italy (Sep. 1999). Submitted to Fusion Engineering and Design.

M. S. Tillack and N. Basu, "Simulation of gas dynamic behavior in dry-wall inertial fusion energy chambers," Presented at the 18th IEEE/NPSS Symposium on Fusion Engineering, Albuquerque, NM (Oct. 1999).

M. Yoda, L. Elwell, J. Collins, and S. Abdel-Khalik, "Stationary and obliquely oscillated liquid sheets for IFE reactor first walls," Presented at the Liquid Protection Workshop, Berkeley, CA (Nov. 1999).

Various members of the IFE community made presentations at the workshop for Frontier Science at the National Ignition Facility. Presentations were made by M. Tabak and D. Callahan-Miller of LLNL (target physics), P. Peterson of UCB and M. Tillack of UCSD (target chambers), D. Eder of LLNL (NIF target chamber capabilities and constraints), S. Reyes of LLNL (safety and neutronics), and R. Petzoldt of LBNL and K. Schultz of General Atomics (target fabrication and injection).