CHAMBER DESIGN AND TECHNOLOGY FOR LASER INERTIAL FUSION ENERGY (LIFE)

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The National Ignition Facility (NIF), a laser-based Inertial Confinement Fusion (ICF) experiment designed to achieve thermonuclear fusion ignition and burn in the laboratory, was completed in May 2009 at the Lawrence Livermore National Laboratory. Experiments are underway and will culminate in the first attempts at ignition in the fall of 2010, using laser energies of 1-1.3 MJ. Fusion yields of the order of 10-35 MJ are expected soon thereafter, and we anticipate that fusion yields >150 MJ per pulse could ultimately be obtained with NIF-based indirectly-driven targets.

Laser Inertial Fusion-based Energy (LIFE) could use NIF-like targets in a repetitive fashion to provide gigawatts of carbon-free electric power [1]. Such power plants could be operated as either a pure fusion system or as a subcritical fusion-fission hybrid to provide additional energy gain and waste incineration. Both systems require a robust source of fusion power (the fusion engine) with challenges that include the need for high-efficiency and high average power lasers, automated target fabrication, target injection, tracking and engagement, and tritium production and recovery.

Here we focus on the design, technology and performance of the chamber for a pure fusion power plant. LIFE utilizes a gas-protected, dry-wall first wall concept. Without gas protection, the short-range emissions from the target (x-rays and ions) would cause an unacceptably high temperature spike in the first wall. The chamber gas stops target ionic emissions and substantially attenuates the x-ray flux. The heated gas then re-radiates the energy over a timescale that is compatible with conducting the heat away from the first wall. Thus, the chamber gas acts as a buffer to protect the first wall and final optics. Several design options are being considered and evaluated for the first wall material and configuration, blanket design, coolant, breeding material and power conversion cycle. We describe the chamber design and related technology development needs. We also discuss the performance and economic implications of design choices, e.g., how the use of advanced structural materials capable of higher temperature improve power cycle efficiency but may or may not decrease the cost of electricity depending on their cost.

[1] E.I. Moses et al., "A Sustainable Nuclear Fuel Cycle Based on Laser Inertial Fusion Energy," *Fusion Science and Technology* **56**, 2 (2009) 547-565.

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