The Path to Develop Laser Fusion Energy*

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We are developing the science and technology for fusion energy with laser direct drive targets and solid wall chambers. The modular nature of this approach and the inherent engineering advantages reduces both the cost and risk of development. These factors, plus the recent scientific and technical advances, make laser fusion an increasingly attractive path to a practical fusion energy source. This talk will present the program development philosophy, an overview of the technical progress, and the path to laser fusion energy.

Technology development is carried out through The High Average Power Laser (HAPL) program, a multi-institutional, multi-disciplinary effort that follows two core beliefs: 1) The research should be guided by the end goal of a practical power plant. 2) The main components should be developed in concert with one another to ensure they are developed as an integrated system. These components are: the lasers [krypton-fluoride (KrF) and diode-pumped solid-state laser], chamber, final optics, target fabrication and target injection. This work is coordinated with the direct drive target designs carried out largely through the DOE/ICF program.

Significant advances have been made in all major areas: High-resolution 2-D simulations of target designs predict gains greater than 150, which is sufficient for net power generation with laser fusion. Both types of lasers now run repetitively pulsed and have the potential for meeting the durability and efficiency requirements. Grazing incidence aluminum mirrors have been shown to meet the needed reflectivity and laser damage threshold. A target injector has been brought to operation. The foam shells needed for the targets have been made in batch quantities with the proper dimensions. Experiments show DT ice grown over a foam underlay both exceeds the smoothness requirements and is thermally robust. And finally, progress has been made in the materials needed for the chamber first wall. Other talks in this HAPL session will discuss some of these advances in detail: the lasers, the first wall, and a chamber dynamics model to study how fast the chamber clears itself between shots. Other presentations at this conference will discuss target fabrication, target injection, and materials development.

We propose to develop and demonstrate laser fusion energy in three phases. The present Phase I program includes HAPL and is developing the critical science and technologies. Phase II would develop and integrate full size components. Phase III, the Engineering Test Facility (ETF), would have three functions: 1) optimize laser-target and target-chamber interactions, 2) develop materials and components; and 3) generate net electricity fusion. We could be technically ready to start construction of the ETF within the next decade and start operations by 2020. This development could allow construction of pilot commercial plants well before 2050.

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*This is a summary of work performed by researchers from over 20 institutions. For a detailed list of collaborators, see: J.D. Sethian, et al, “Fusion Energy Research with Lasers, Direct Drive Targets, And Dry Wall Chambers,” Nuclear Fusion, **43**, 1693-1709 (2003).