Development of High Average Power Lasers for Inertial Fusion

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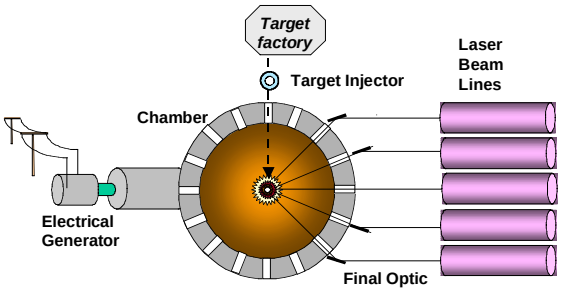
Scientists at the Naval Research Laboratory and Lawrence Livermore National Laboratory, along with researchers at other national labs, universities, and industry, have established a plan to develop high energy repetitively pulsed lasers for a wide range of DOE and DOD missions. The program plan concentrates on two types of lasers: krypton fluoride lasers (KrF) and diode pumped solid state lasers (DPPSL) and includes development of complementary technologies to optimize the potential uses of these lasers.

A principal application for this development is for inertial fusion energy (IFE). The laser would be used to symmetrically and directly illuminate a cryogenically cooled target that has been injected into a chamber. The target is compressed and heated to undergo thermonuclear burn, and the released energy is converted to electricity. Recent advances in target design, target experiments, lasers, and other fusion technologies give this approach great promise. A projected inertial fusion energy power plant is shown below. It consists of an array of identical laser beam lines, a chamber, a target factory, a target injector, a set of final optics, and the electrical generator. This modular and separable nature of laser IFE significantly reduces its development costs.



The first step will be a "Phase I" effort that will perform the cutting edge R & D necessary to evaluate and develop this approach. The most critical science and technologies for the various components will be developed in concert with one another to ensure a coherent approach. Phase I should take about five years. The goal is to develop the technologies required to build an Integrated Research Experiment (IRE) in Phase II. This is envisioned to be an integrated demonstration that the components can operate together with the required efficiency and precision. Phase III would be a full-scale test reactor.

Average power laser development has important applications for DOE and DOD defense missions. These laser systems would complement high-energy single-shot facilities and allow an inexpensive means to explore detailed properties of matter that are relevant to DOE. The laser technology is generally relevant to materials processing and directed energy applications for DOD. This program has significant short-term defense benefits as well, including the development of advanced, robust, efficient pulsed power systems, advanced ultra-short pulse lasers, and coatings and optics for the NIF and other high power, high energy laser systems. In addition, because of its small and innovative nature, this effort will attract the next generation of researchers.

A suggested first-year allocation for Phase I is shown below. It is based on the funding level for high average power lasers recommended by the Fusion Energy Sciences Advisory Committee. This does not include target design, as that is part of the DOE Defense Program in Inertial Confinement Fusion.

Suggested allocation, Rep-Rate Laser resources

Lasers – KrF	$ 9,275,000
Lasers-DPPSL	$ 9.275,000
Chambers	$ 1,450,000
Target Fabrication	$ 1,600,000
Target Injection	$ 1,400,000
Optics/coatings	$ 1,000,000
Other Laser Development	$ 1,000,000
TOTAL	$25,000,000