Contribution ID: **80**

Type: **Oral Presentation**

IFE/1-4: Inertial Fusion Energy with Direct Drive and Krypton Fluoride Lasers

Thursday, 11 October 2012 09:30 (20 minutes)

We are developing the science and technologies needed for a practical fusion energy source using direct drive targets driven by electron beam pumped krypton fluoride (KrF) lasers. The direct drive approach: 1) allows higher target energy gain, 2) simplifies target fabrication, and 3) reduces the complexity of target material recycling.

The advantages of KrF include: A) very uniform target illumination, thus reducing the seeds for hydrodynamic instability; B) shorter wavelength, which allows higher ablation pressures and helps suppress laser-plasma instabilities; and C) ready capability for zooming, to decrease the diameter of the focal spot to follow the imploding pellet and thereby improve the coupling efficiency by as much as 30%.

Simulations indicate the unique qualities of KrF should substantially reduce the laser energy required to obtain the high gains needed for fusion power plants. High resolution 2-dimensional simulations predict directly-driven shock ignited designs can achieve gains above 150 with KrF energies at and possibly below 1 megajoule. Present research is evaluating the effects of the deeper UV. Experiments on the Nike KrF laser are consistent with the theoretically expected increase in 2-plasmon decay threshold.

We have similarly advanced the laser technology. We predict, based on demonstrations with the individual components, that a KrF laser should have the efficiency needed for a power plant. We have run the Electra as an integrated laser for long runs at 5 Hz. And we have built an all solid state sub scale demonstrator pulsed power supply that has operated for 11,000,000 shots continuously at 10 Hz (319 hours) with an efficiency exceeding 80%. The Orestes KrF physics code, has been developed and benchmarked against experiments on Nike, Electra, and other KrF experiments. Based on this, we have a predictive capability to design future KrF systems, including the required pulse shape.

We will discuss progress in all these areas and our vision for a path forward to develop fusion energy based on this approach.

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Session Classification: Inertial Fusion Experiments and Theory

Track Classification: IFE - Inertial Fusion Experiments and Theory