APPROACHES TO REDUCE HYDRO AND LASER PLASMA INSTABILITY FOR LASER DIRECT DRIVE

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The laser fusion program at the Naval Research Laboratory has been exploring and developing several means to reduce the hydro and laser plasma instabilities that impede achievement of high performance laser fusion. If implemented on a MJ class implosion system, the krypton-fluoride (KrF) laser's combination of (a) deeper UV light, (b) broad bandwidth ISI-smoothed beams and (c) capability for multi-stage zooming would significantly alleviate these instabilities. Here we discuss two instability mitigation techniques that are applicable to both frequency tripled Nd:glass and KrF lasers.

Experiments on the Nike KrF facility and simulations at NRL have shown that the addition of a thin gold or palladium coating on the laser illuminated surface of plastic targets can dramatically reduce laser imprint that seeds subsequent hydrodynamic instability [1, 2]. Similar effects have been observed in OMEGA experiments [3]. This configuration creates an early time x-ray drive of the target from the high-Z layer. The separation distance between the laser absorption in the high-Z plasma layer and the x-ray driven substrate target prevents imprinting by the shorter spatial wavelength laser illumination non-uniformity. Eventually the laser burns through the layer and direct drive commences. Simulations indicate that use of still thicker high-Z layers delays this burn-through and thus extends the duration of the x-ray drive. This could further inhibit hydro-instability and might also delay onset laser-plasma instability near quarter critical density.

Extreme laser bandwidth is predicted to inhibit laser plasma instability by theory and this suppression of instability by bandwidth has been observed in microwave-plasma interaction experiments [4]. We have been conducting plasma fluid and PIC simulations that are exploring what bandwidths would be needed to suppress laser-plasma instability near quarter critical density. The simulations indicate that bandwidths greater than 3 THz can significantly reduce the instability growth. This bandwidth is several times larger than that which can be directly obtained with current ICF lasers. We are investigating several means for obtaining such bandwidths on both KrF and Nd:glass laser systems.

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