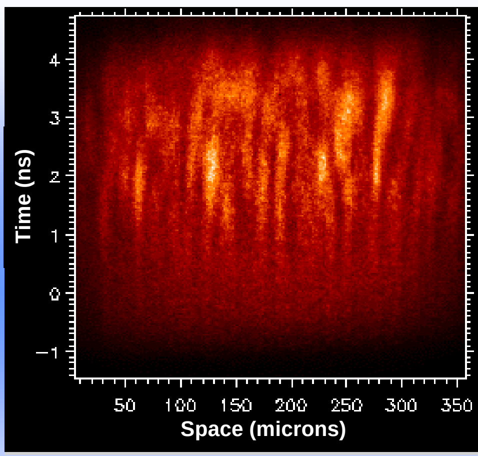
NRL LASER FUSION PROGRAM

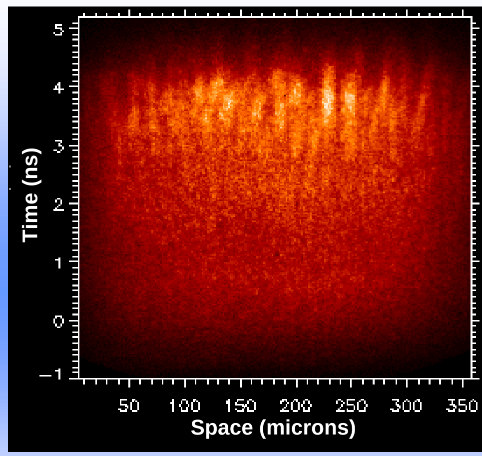
Bimonthly Highlights

July-August 2001

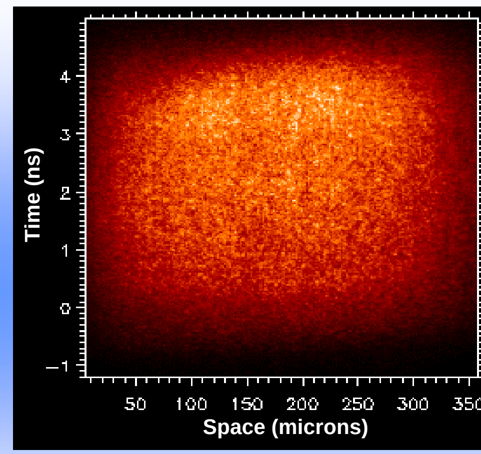
Effects of thin high-Z layers on the hydrodynamics of laser-accelerated plastic targets



1 beam foot pulse
Bare CH



40 beam foot pulse
Bare CH



1 beam foot pulse
120-nm Pd layer

We have considered the benefits of thin high-Z layers towards reducing hydrodynamic instability in laser accelerated targets. We studied Rayleigh-Taylor (RT) amplified laser imprint in ablatively accelerated flat plastic targets with and without thin metal layers (Au, Pd, and Al). The Nike KrF facility was employed using a laser pulse that had a low-intensity few-ns foot pulse followed by a 4-ns main pulse. This pulse-shaping mimics that needed for high gain targets where a long foot compresses the pellet and reduces the shock heating from the main pulse. The areal mass nonuniformity in our laser-accelerated targets was measured by x-ray backlighting using spherical crystals to image the target onto streak and framing cameras. We found that the RT-amplified laser imprint can be substantially reduced with gold or palladium layers of suitable thickness (500-800 Å). The reduction can be equivalent to more than a factor of 6 times improvement in the uniformity of the laser illumination (see the figures above). The soft x-radiation from thin gold and palladium layers during the foot pulse ablates additional material that can greatly increase the separation between the laser absorption and the ablation layers, thereby smoothing laser nonuniformity. The high-Z layer in the blow-off plasma effectively dissipates with the arrival of the higher intensity main pulse and the target acceleration history is similar with or without the high-Z layer. Studies of Rayleigh-Taylor growth using grooved targets indicate that while there is some reduction in total growth with the high Z-layers, the primary beneficial effect is caused by reduction in the laser imprint during the foot pulse rather than target preheat. This effects will be useful in developing more robust high-gain direct-drive targets. One dimensional simulations of direct-drive pellet implosions (using the NRL FAST code) indicate that one can add such high-z layers to pellets without penalty in the gain.

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