FY19 Rutherford Appleton Laboratory Report on Omega Laser Facility Experiments

Evaluation of New Laser Direct-Drive Pulse Shapes on OMEGA

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The laser direct-drive approach to inertial fusion employs complex pulse shapes that are shaped in time. This temporal shaping dictates many implosion parameters including the implosion "adiabat" (ratio of the pressure to the Fermi pressure), the velocity, the growth rate of the Rayleigh–Taylor instability, etc.

HYADES[1] simulations of a large OMEGA DT cryo data set show very good agreement to a wide range of experimental implosion parameters, despite being limited to one spatial dimension (D) as shown in Fig. 1. A surprising finding from this work is that, according to *HYADES*, the low-adiabat, triple-picket pulse shapes that were originally designed to be highly performing would not perform well even in 1-D. The *HYADES* code was used to design a new high-performing pulse shape. The evaluation of this new pulse shape was the primary goal of this experiment. A secondary goal was the evaluation of a novel hot-electron divergence measurement methodology using a buried Cu fluor layer within the target.

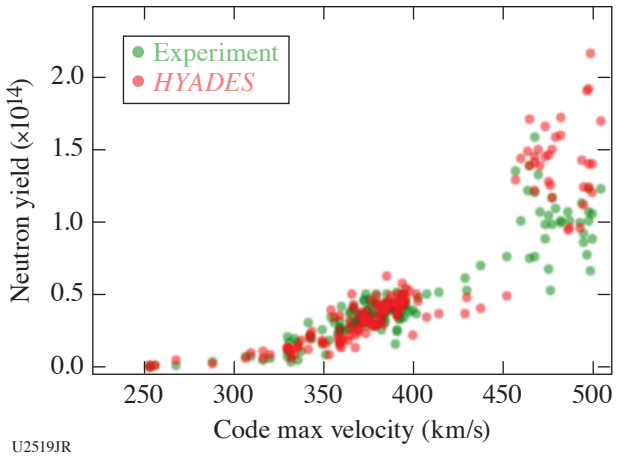

Figure 1
Experimental neutron yield (green points) versus *HYADES* predicted yields. The *HYADES* predictions show a good predictive capability up to ~475 km/s.

The targets employed were 860-μm-outer-diam CH shells with 27-μm wall thickness. Some of the targets also had a 1.5-μm-wide, 4% (by atom number) Cu dopant layer offset 1 μm from the shell's inner surface. In all cases the targets were filled with 20 atm of deuterium gas.

By varying the initial picket amplitude and the delay between the picket and foot of the pulse, the calculated adiabat of the implosion was varied. Yield over clean (YOC) is defined as the experimental yield divided by the 1-D yield. In this experiment we found a strong scaling of YOC with calculated implosion adiabat, with the highest adiabats having a YOC of 0.89. Although analysis of this work is ongoing, this initial experiment indicates that were an implosion to be fielded on an OMEGA DT cryogenic implosion employing this new pulse shape, it would exceed current performance levels.

Generally, the OMEGA laser performed excellently. The major issue on the day was that we lost a number of targets, apparently due to vibrations in the target insertion system. Diagnostics performed excellently except for the gated spherical crystal imager, which could not be timed and therefore yielded no data.

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1. Cascade Applied Sciences Inc., Longmont, CO 80503, http://casinc.com/index.html.