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High Energy Density Physics with the Texas Petawatt Laser and a Look Toward Exawatt Lasers

TODD DITMIRE, University of Texas

Using a combination of high peak power chirped pulse amplification technologies we are developing a unique petawatt peak power laser at the University of Texas. One of the new frontiers opened by a lasers like the Texas Petawatt is in high energy-density (HED) science. The Texas Petawatt will deliver 100 fs pulses with energy of over 200 J. In this talk I will discuss some of the recent experiments in high energy density science we have conducted using existing high intensity short pulse lasers with illustrative examples that point to applications on the Texas Petawatt. These areas of HED investigation include exotic physics such Gbar pressures in heated solids, radiative hydrodynamics and nuclear fusion. I will, for example, discuss experiments on isochoric heating of solid targets for high temperature and pressure equation of state measurements. I will examine some of the ways that plasma and hydrodynamic regimes of astrophysical significance can be accessed with petawatt-class lasers. I will also discuss applications in the generation of ultrafast, bright bursts of radiation including hard x-rays, protons and fast neutrons. Finally, I will discuss how the technology being implemented in the Texas Petawatt could be scaled to the exawatt peak power level in a straightforward way.