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Michigan Institute for Plasma Science and Engineering

Wednesday
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3:30 pm
Room 1005 EECS

Dr. John Edwards

Lawrence Livermore National Laboratory

In Pursuit of Ignition at the National Ignition Facility - Progress and Challenges

The Inertial Confinement Fusion Program (ICF) at the Lawrence Livermore National Lab has been conducting experiments at the National Ignition Facility (NIF) since 2009 with the goal of igniting a DT plasma. This requires the 1.8MJ in the 192 laser beams of NIF to compress BB sized capsules containing DT fuel to form a central “hot spot” with conditions similar to those at the center of the Sun. Under these conditions DT fuses to produce a 14MeV neutron, which escapes and a 3.5 MeV alpha particle, which deposits its energy in the hot spot provided it has sufficient density (>0.2 g/cm^2). If this self-heating is strong enough it will outstrip cooling and the plasma temperature will rapidly bootstrap to ignition. For the first time in the lab, alpha heating has been demonstrated resulting in a doubling of fusion yield to ≈26 kJ from DT hot spots with densities ≈50,000 Kg/m^3 and temperatures ≈50 million Kelvin corresponding to pressures ≈200 billion atmospheres. Ignition, however, will require even better implosions with roughly 2x higher pressures that can amplify yield by ≈100X. Making the implosions more spherical is an important though not straightforward step towards this goal. Ignition capsules on NIF must converge by more than a factor of ≈30 at speeds exceeding ≈350 km/s while remaining largely spherical. The NIF attempts to do this by directing its 192 laser beams inside a pencil eraser sized cylindrical x-ray oven, a “hohlraum”, creating a thermal x-ray bath of more than 300 million Kelvin. The x-rays ablate the outer surface of the capsule generating the ≈100 million atmospheres of pressure that must be uniform to better than ≈1% to spherically compress the fuel. In this presentation we will discuss the key physics of x-ray driven ICF on the NIF and the status of current understanding (and some mysteries) gleaned from the NIF data. We will also discuss some of the lines of investigation that are being pursued to improve our understanding and hopefully also target performance.

About the Speaker: Dr. John Edwards is the Inertial Confinement Fusion (ICF) Program Director in Weapons and Complex Integration (WCI) Directorate at Lawrence LIvermore National Lab with nearly 30 years experience in the application of laboratory drivers to explore the physics of ICF and high energy density (HED) matter. He earned his Ph.D. in 1990 from Imperial College, London. He was a group leader at UK’s Atomic Weapons Research Establishment responsible for research in HED science. He joined the WCI Directorate at LLNL in 1998, helping to lay much of the foundation for today’s HED laser program. He then focused on ICF, leading groups exploring most aspects of the target physics. In his current role he is responsible for the direction of the ICF program at LLNL. Dr. Edwards received the 2014 Fusion Power Associates Leadership Award.