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C3PL1-01: Overview of the fabrication of cryogenic hydrogen fuel ice layer for nuclear fusion ignition experiments

Wednesday 12 July 2023 08:00 (45 minutes)

The National Ignition Facility (NIF) houses the world's most energetic laser which can deliver over 2MJ of energy at the 500TW level of power of 351nm UV light. This immense optical energy is focused on a small 'target'that can create such high energy densities that the unique physics underlying this extreme regime can be explored. One of the primary goals of the NIF has been to explore controlled nuclear fusion where the energy from the laser is used to compress hydrogen (specifically, its isotopes deuterium and tritium or DT) to about 100 billion atmospheres at which point temperatures reach about 100 million Kelvin, conditions where the atoms can overcome Coulombic repulsion and fuse. This grand challenge of ignition where the nuclear fusion energy out was greater than the optical energy in was successfully achieved on December 5, 2022 in a landmark experiment. This is expected to usher in a new age of nuclear fusion research with diverse and far-reaching goals.
Of the many, one of the challenges of this experiment is the formation of a hollow spherical ice layer off the DT fuel at ˜19K with extremely high dimensional precision. In this presentation, we will start with a brief overview of the key aspects of the complex and multifaceted system needed to carry out these experiments. We will then focus on the design and engineering done to fabricate targets which can reproducibly meet these stringent sub-milli Kelvin thermal control requirements. We will also discuss the technique used to make and characterize the exquisite smooth and uniform hydrogen ice crystal formed by transporting the fuel using a fill-tube with an inner diameter of 1µm.
NIF and Photon Science (llnl.gov)

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