PURDUE UNIVERSITY | School of Nuclear Engineering

Nuclear Engineering Seminar

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The long path to ignition: An historical overview

Abstract

This lecture reviews the long journey that culminated in ignition in 2022 using the laser heated indirect-drive approach to imploding DT filled targets at the National Ignition Facility (NIF), located at the Lawrence Livermore National Laboratory. We describe key developments such as the paradigm shifting birth of High Energy Density (HED) studies with lasers, and changes in choice of laser wavelength. Fulfilling the requirements of the multi-faceted Nova Technical Contract was needed for the approval of the NIF, and the end of the Cold War and the cessation of Nuclear Testing, were also catalysts in that approval. The inherent flexibility of the field of laser driven ICF played a huge role in achieving success at the NIF. We describe how the original "point design" target evolved, through the lessons of experiment, in every single way: capsule materials and size; hohlraum materials, sizes, and gas fills; laser pulse shapes. The philosophy to globally optimize performance for stability was also key, as was progress in target fabrication, and in increasing NIF's energy output. The persistence of the research staff was also necessary in this success.

Mordecai D. (“Mordy”) Rosen received a PhD in Plasma Physics from Princeton University. In 1976 he joined the Laser Fusion effort at Lawrence Livermore National Laboratory (LLNL), where he specialized in the physics of a laser heated gold cylinder (a "hohlraum") that surrounds the implosion capsule. He designed and analyzed the first few generations of High Energy Density Physics (HEDP) experiments that used these hohlraums in a wide variety of ways. In 1984 he designed the first successful laboratory x-ray laser. In the 1990’s he led the target design & theory efforts, whose work on LLNL's Nova laser led to the approval to build the 50x larger National Ignition Facility (NIF). Since then, his work has led to more efficient hohlraums, a key development in allowing ignition to finally be achieved in 2022.

He has twice won the American Physical Society (APS) Award for Excellence in Plasma Physics Research. He won the American Nuclear Society Teller Award for his role in establishing the field of HEDP and is a Fellow of the APS. He has won the Department of Energy Award of Excellence 8 times. He has taught Fusion Plasmas at UC Davis and UC Berkeley, and in numerous Summer School Programs across the globe.