

Daniel Casey: Exploring a 'little star' on Earth

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In 2010, after a decade of meticulous preparation, Daniel Casey and an MIT team finally ran their experiment. The world's largest laser struck a millimeter-sized target, and in less than a second, it was all over.

Casey, now a postdoc in MIT's Plasma Science and Fusion Center, recalls, "You heard a little pop, but there was no other sight or sound in the control room." Yet if the moment itself proved an anticlimax, the experiment has paid off in spades, yielding data that has opened a window onto extreme conditions found nowhere else on Earth, and starting a new chapter in high energy density physics.

The home for this novel research is the Lawrence Livermore National Laboratory's National Ignition Facility (NIF), which came online in 2009. Casey has devoted his graduate and post-graduate years to designing and refining research related to the NIF, whose goals include reproducing the intense temperatures and pressures inside stars, and illuminating their vast energy-generating processes. Casey's Nuclear Science and Engineering thesis was the very first doctoral thesis to emerge from the NIF — foundational work that will enable the nation to move closer to fusion energy — an endlessly renewable, sun-like power.

To attain this end, scientists must first achieve fusion ignition. Using enormous amounts of energy, researchers hope to trigger a thermonuclear conflagration that will ideally generate energy in excess of that used to start the reaction.

NIF was built for undertaking this grand scientific challenge. In this building three football fields long, 192 laser beams combine to strike a pellet containing hydrogen, achieving temperatures greater than 100 million degrees and pressures greater than 100 billion times Earth's atmosphere — just the kind of conditions thought necessary for fusion ignition and energy gain. MIT is the principal university participant at the NIF, and as "a big player," Casey says, is deeply involved in the planning and execution of a wide range of experiments.

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