Symposium 09

Recent NIF experiments with record levels of fusion self-heating

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Thermonuclear fusion in the laboratory is a scientific grand challenge, a highly compelling problem because the fusion reactions can self-heat the fuel and continue the burn. Predominantly approaches use the fusion of deuterium and tritium nuclei, which generates 17.6 MeV of energy released in a neutron and alpha particle. The alpha particle, which carries 1/5 of the energy, can heat the plasma. A plasma in which the alpha self-heating is greater than external heating is termed a ‘burning plasma’, and one in which the self-heating dominates over all loss mechanisms, leading to a run-away increase in temperature, is termed ‘ignited’. Inertial confinement fusion (ICF) has pursued these scientific milestones using large laser drivers, notably the National Ignition Facility (NIF) at LLNL. Here we use the laser energy, up to 1.9MJ, to generate a hot x ray bath, which creates ablation pressures of hundreds of Mbar at the outer surface of a fuel-containing capsule. The ablation pressure implodes the capsule, with fuel pressures of several hundred GBar generated as the fuel stagnates at the center. The combination of these extreme pressures and inertial confinement times from the surrounding material can lead to burning and ignited plasmas. Recent experiments on NIF in the last year have generated 25x higher fusion yields than previous records, up to 1.3MJ. The physical basis for this increase in performance relative to previous NIF results, as well as the scientific implications, will be discussed.

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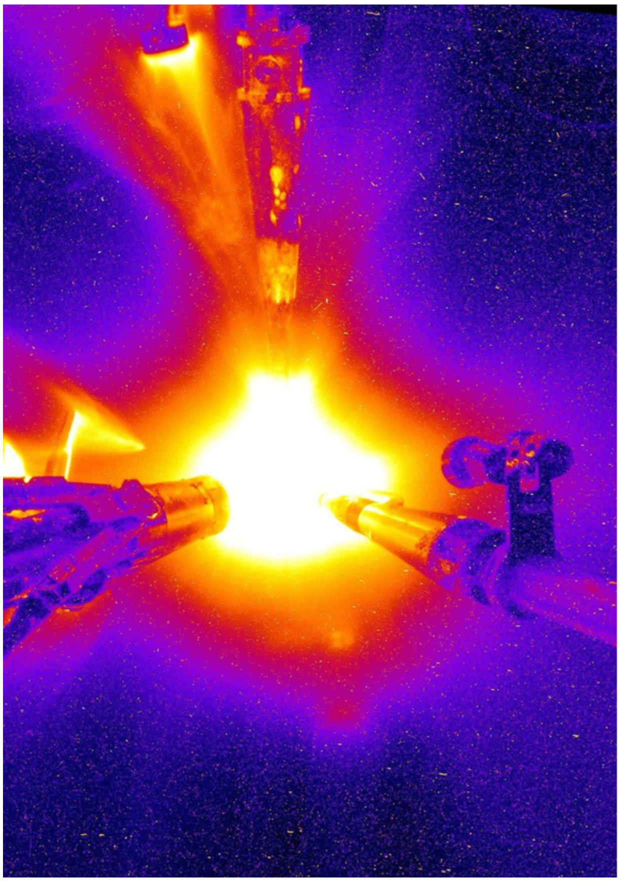

Figure 1: Photograph of a NIF experiment.