A Summary of Nuclear Diagnostics at the National Ignition Facility

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The newly-commissioned National Ignition Facility (NIF) provides a unique laboratory for the study of nuclear processes occurring within high energy density plasmas. Driven by up to 1.8 MJ of laser power, an imploding NIF capsule can produce average plasma densities of several hundred g/cm^3 at temperatures from 1-100 keV for confinement times of tens to hundreds of picoseconds. With ignition of fusing deuterium and tritium fuel, as many as 10^{19} 14-MeV neutrons will be produced over the ~30 μm implosion, corresponding to fluences of 10^{23} n/cm^2 or fluxes of 10^{34} $n/cm^2/s$ over the rapid burn time. This unique laboratory environment offers opportunities to study nuclear processes not accessible by traditional accelerator facilities, such as reactions on short-lived excited states, low cross section measurements, nuclei in thermal equilibrium with the plasma environment, and other plasma-nuclear interactions. To perform these experiments, a robust suite of debris collection and capsule performance diagnostics is planned or has already been developed and implemented. In addition, capsules must be designed to introduce nuclei of interest into the plasma environment. I will present an overview of methods for measuring nuclear reactions in the near-instantaneous implosion including neutron activation, neutron time-of-flight, gamma-ray Cherenkov detection, magnetic recoil spectroscopy, neutron/x-ray imaging, and debris collection.

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