Development of an inertial confinement fusion platform to study nuclear reactions relevant to nuclear astrophysics

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Thermonuclear reaction rates and nuclear processes have traditionally been explored by means of accelerator experiments, which are difficult to execute at conditions relevant to stellar or big bang nucleosynthesis. High energy density (HED) plasmas generated using lasers, e.g., such as the inertial confinement fusion platform at the NIF and OMEGA laser facilites, more closely mimic astrophysical environments in several ways, including with thermal distributions of reacting ions as opposed to mono-energetic ions impinging on a cold target; stellar-relevant plasma temperatures and densities; and neutron flux densities not found anywhere else on earth [1-3].

A wide range of diagnostics available at the laser facilities enable the exploitation of this platform for nuclear astrophysics-relevant experiments [4]. This talk will discuss available charged-particle diagnostics used to study charged-particle-producing low-Z reactions relevant to stellar and big bang nucleosynthesis and to plasma screening effects [5]; neutron diagnostics to characterize neutron emission spectra; radiochemistry diagnostics to study radioactive reaction products e.g. from neutron capture reactions relevant to stellar slow and rapid processes that produce heavier nuclei above iron; and platform characterization diagnostics to understand the plasma conditions in which the relevant reactions are taking place [6]. Future enabling diagnostics required for using this platform to answer outstanding questions on plasma effects on nuclear reactions will also be discussed, including low-energy neutron spectrometry and high-efficiency gamma ray detectors.

The work was supported in part by the US DOE, NSF, LLE, and LLNL.

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