NUCLEAR SCIENCE RESEARCH WITH DYNAMIC HIGH ENERGY DENSITY PLASMAS AT NIF

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We present an overview of the experimental capabilities for performing nuclear science experiments at the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory (LLNL). A suite of nuclear diagnostics at NIF has been used previously to assess the results from indirect laser-driven inertial confinement fusion experiments. Based on these results, platforms for performing measurements of nuclear data and isotope production have been developed. Previous work resulted in a method for radiochemically determining the areal density ($\rho_r$) of the deuterium-tritium (DT) fuel through the correlation of the isotope ratios from the gold hohlraum ((n,$\gamma$) and (n,2n) products) to the fraction of down-scattered neutrons in the compressed fuel.¹ The post shot debris is collected via the Solid Radiochemistry (SRC) diagnostic. Based on this data, measurement of the $^{197}$Au(n,$\gamma$) cross section at 14 MeV was performed using a low convergence ICF implosion as the neutron source.

First results from the neutron-induced fission of $^{238}$U from the hohlraum will be reported. Gaseous fission fragments are collected and analyzed via the Radiochemical Analysis of Gaseous Species (RAGS) apparatus.² In situ detection combined with post-shot noble gas mass spectrometry and radiation counting are used to measure the independent fission yields of short-lived gaseous fission products. Similarly, solid fragments are collected with the SRC and have been indicated that some degree of fractionation between fission species occurs via condensation of the debris products.² $^{238}$U has also been fielded in a Target Option Activation Device (TOAD) for irradiation at 50 cm from target chamber center.³

Doping of NIF capsules with isotopes of interest for nuclear data measurements is currently under investigation beginning with a plastic symcap with a single layer of $^{238}$U added to the ablator at a distance of 30 microns from the fuel. This capsule will be used to assess collection of capsule debris and to begin to study the effects of the high energy density plasma on nuclear reaction rates. This is also relevant to studies of nuclear astrophysics. Collection of low-Z products (i.e. Be) is currently under investigation for the measurement of $^7$Be production as an indicator of stellar reaction rates.

Current results in nuclear data measurements as well as planned future experiments will be presented. Based on previous work, the ability to perform nuclear cross section measurements in a plasma environment are possible at NIF with existing platforms. This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. This work was funded by the Laboratory Directed Research and Development Program at LLNL under project tracking code 13-ERD-036.