Energetic Knock-on Deuteron and Triton Fluences in NIF Capsules

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We present results from experiments aimed at using NIF cryogenic capsules to make simultaneous measurements of reaction-in-flight (RIF) neutrons and charged particle radiochemistry (Radchem), both of which are nuclear reactions induced by energetic knock-on D and T ions, with energies up to about 10 MeV. These reactions are very sensitive to the plasma conditions because they are controlled by the stopping power of the plasma. A main goal of the experiments is to determine whether these two diagnostics (RIFs and Radchem) are consistent with one another, and whether the measured reactions yields can be reproduced by current simulation codes. To measure these reactions we implemented two new diagnostics at NIF: (1) the construction and installation of a new clover detector at LLNL in order to measurement of the shape of the RIF spectrum, and (2) a new normalized $^{12}C(d,n)^{13}N$ diagnostic enabled by the NIF Riadiochemical Analysis of Gaseous Samples (RAGS) facility. The experiments provide the first measurement of the shape of RIF spectra in an ICF plasma, and the spectrum is found to be unusually hard in energy. Calculations show that this reflects the quantum degenerate state of the compressed cold fuel that surrounds the capsule hotspot, and the analysis allows the first extraction of stopping powers in degenerate ICF plasmas. The RAGS $^{12}C(d,n)^{13}N$ signal is found to be consistent with the RIFs , provided that the knock-on fluence and stopping power are calculated accurately, which requires that the density of the cold fuel be simulated correctly.

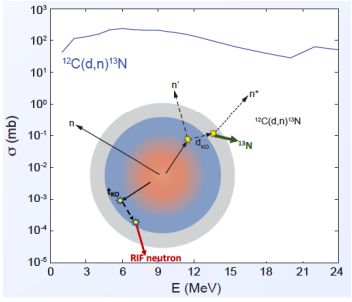

Figure 1: The RIF and 13C(d,n)13N reactions require meV knock-on D and T Ions

References

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