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Measurements of Ion Stopping around the Bragg Peak in High-Energy-Density Plasmas[1]

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Over the last few decades, ion stopping in weakly- to strongly-coupled High-Energy-Density (HED) plasmas has been subject to extensive analytical and numerical studies, but only a limited set of experimental data exists to check the validity of these theories. Most of these experiments also did not probe the detailed characteristics of the Bragg peak (peak ion stopping) where the ion velocity is similar to the average thermal electron velocity. To the best of our knowledge, only one exploratory attempt to do this was conducted by Hicks et al.,[2] who were able to describe qualitatively the behavior of the Bragg peak for one plasma condition. The work described in this presentation makes significant advances over previous experimental efforts by quantitatively assessing the characteristics of the ion stopping, ranging from low-velocity stopping, through the Bragg peak, to high-velocity stopping for different HED plasma conditions. This was achieved by measuring the energy loss of DD-tritons, D^3He-alphas, DD-protons and D^3He-protons, with distinctly different velocities, and the results indicate that the stopping power varies strongly with T_e and n_e. This effort represents the first experimental test of state-of-art plasma-stopping-power theories around the Bragg peak, which is an important first step in our efforts of getting a fundamental understanding of DT-alpha stopping in HED plasmas, a prerequisite for understanding ignition margins in various implosion designs with varying hot spot areal density at the National Ignition Facility.

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[2]D. G. Hicks et al., Phys. Plasmas 7, 5106 (2000).