

# Experimental Studies of Ion Charge Equilibrium in the Warm Dense Matter Regime Using Laser-Based Plasma

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In the WDM regime, the charge equilibrium and stopping power of particles differs significantly from that of both cold matter and ideal plasma due to free electron contributions, plasma correlation effects and electron degeneracy. The creation a WDM state with a temporal duration consistent with the particles used to probe it has been extremely difficult to achieve experimentally. Advantageously, the short-pulse laser platform allows the potential to produce WDM[5,6] along with relatively short bunches of protons compatible of such measurements. Using ion carbon beams generated by high intensity short pulse lasers we perform measurements of single shot mean charge equilibration in cold or isochorically heated solid density aluminum matter. We demonstrated that plasma effects in such matter heated up to 1 eV do not significantly impact the equilibration of carbon ions with energies 0.045–0.5 MeV/nucleon. Furthermore, these measurements allow for a first evaluation of semiempirical formulas or ab initio models that are being used to predict the mean of the equilibrium charge state distribution for light ions passing through warm dense matter. Also, we made measurements of the proton energy loss within the material compared to the measured medium density profile allows the stopping power to be determined quantitatively. The results from heated matter show that the stopping power of 450 keV protons is dramatically reduced within heated hydrogen plasma.

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