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Ionization dynamics in CH plasmas at Gbar pressures

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The ionization balance in multi-species plasmas at extreme densities, as e.g. found in the interiors of brown dwarfs and stars as well as in technological applications such as potential energy production by inertial confinement fusion, plays a key role for the physical properties of these states of matter. Indeed, the amount of bound or free electrons crucially defines how energy in form of radiation and heat can be transported in such environments. However, even for single-species plasmas, theoretical model predictions of the ionization balance result in strong discrepancies, due to the lack of conclusive experiments. Here we show spectrally resolved X-ray scattering measurements of the ionization dynamics in an imploding CH capsule up to peak electron densities of 10^25 cm^-3 and temperatures around 150 eV resulting in pressures of ~2 Gbar. At these conditions, we find the carbon ionization to be substantially larger than predicted by several state-of-the art plasma models, which suggests that the ionization potential depression description for dense plasmas needs to be revisited, in particular for dense multi-species plasmas, which are of particular relevance for stellar environments and inertial fusion energy approaches [1-6].

References

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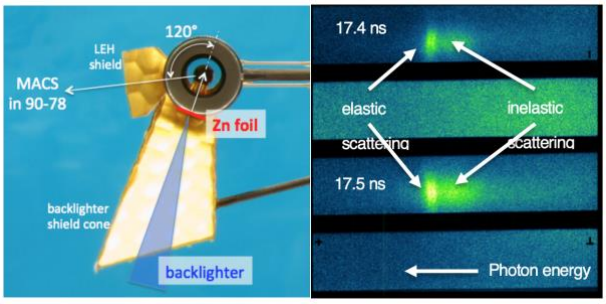

Figure 1. Target design of the experimental platform to perform spectrally resolved X-ray scattering on the National Ignition Facility and raw data of collected spectra. The elastic scattering is a direct measurement of the electron-ion correlations while the inelastic scattering allows for constraining density and temperature.