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10.23 Measurements of the effective electron density in an electron beam ion trap using extreme ultraviolet spectra and optical imaging

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In an electron beam ion trap, ions are not confined to the electron beam, but rather oscillate in and out of the beam. To determine the time-averaged effective electron density n_e,eff that the ion experiences, the size of the electron beam, the nominal electron density n_e, and the ion cloud size must all be measured. We use imaging techniques in the extreme ultraviolet (EUV) and optical to determine both. In particular, the electron beam width is measured using 3d-3p transitions from Fe XII and XIII around 200 Å. These transitions are fast and the EUV emission occurs only within the electron beam. The resulting spatial emission profile and the measured electron current yields n_e, and we find values on the order of 1010-1012cm-3. We determine the size of the ion cloud using optical emission from metastable levels of the ions with lifetimes longer than the ion orbital periods. The resulting emission maps out the spatial distribution of the ion cloud. We find cloud radii on the order of 300 μm. This gives an effective electron density, n_e,eff experienced by the ions of 109-1011 cm-3. This work is supported in part by NASA H-TIDeS grant NNX16AF10G. Work at LLNL is performed under the auspices of the U.S. DoE under contract No. DE-AC52-07NA27344.

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