Measurements of Injected Impurity Transport in TEXT Using Multiply Filtered Soft X-Ray Detectors

by

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Abstract

Aluminum was injected into TEXT to study trace, non-recycling impurity transport. A 92-channel, three array x-ray imaging system was constructed and installed to measure temporally-resolved density profiles of the three highest charge states. A novel krypton filter in one array discriminated between the He-like and H-like resonance lines, and a hard filter responded mostly to the fully stripped charge state.

The impurity confinement time scaled approximately as $\tau_c \sim \bar{n}_e Z_{eff} \sqrt{m_i/Z_i}/l_P$ ($i$ denotes the background gas). Aluminum density profiles averaged over a sawtooth period were measured in several different discharges. Profile changes during sawtooth crashes were also measured for a few discharges. Sawteeth strongly enhanced the inward impurity flow immediately following injection, when the density was still peaked near the plasma edge. Those discharges with the longest sawtooth period obtained the most peaked aluminum density profiles; thus sawteeth were also important in ameliorating impurity accumulation on the tokamak axis. The charge state balance of the aluminum ions obtained from the measured profiles was compared to predictions of coronal equilibrium. Somewhat surprisingly the aluminum ions were close to coronal, except in those discharges with very short sawtooth periods or very large inversion radii. Preliminary evidence of up-down asymmetric density profiles was also found.

Numerical simulations of aluminum transport were performed. The effect of sawtooth oscillations was taken into account with a simple flattening model. The data disagreed with a constant $D$ anomalous model except in the plasma center; enhanced outward transport was required. The experiments did not agree with neoclassical simulations, because the theory had outward convection that was too large.

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