Fast ion and and thermal helium transport experiments in Alcator C-Mod

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Transport of fast and thermal helium ions are topical issues, both being addressed in Alcator C-Mod. Our charge exchange recombination spectroscopy (CXRS) measurements allow us to follow fully stripped helium from the plasma core all the way to the edge and to follow fast ions as they transport through the plasma. We measure trace impurity ^{4}He and ^{3}He temperature, density, and velocity profiles. The transport of helium can be compared to an extensive database of boron profiles and to neoclassical and turbulence theories. The data is relevant to ITER ash measurements. The measurements also assist understanding of RF deposition in heating and mode conversion regimes dependent on ^{3}He concentration.

Fast ion experiments are being conducted for both H minority and ^{3}He minority ICRF heated plasmas. Fast ion charge exchange spectroscopy (FICXS) is being tested for both minority species. FICXS is one of several fast ion diagnostics and complements the fast ion loss detectors to give a complete empirical description of fast ions.

Measurement in the 4686Å region serves a dual purpose to measure fast ions in D (^{3}He) minority heated plasmas and He impurity profiles in general plasmas via CXRS. Alternatively, measurement in the 6563Å region will measure fast ions in D (H) minority heated plasmas. In this case, there are more limitations due to the need to eliminate background spectra.

The beam-enhanced emission from the 4686Å He II line or the H 6563Å line is observed with a high throughput spectrometer from 30 poloidal and toroidal views with spatial separation of about 1.2cm. The spectra are detected with a camera with 20 ms temporal resolution. To measure H fast ions, a blocking bar was developed for blocking the bright emission from the deuterium fueling species.

The capabilities of the diagnostic are explored through simulation of the spectrum and measurements of the emission background. For C-Mod, the diagnostic is uniquely capable of detecting fast ions in the plasma core and thus contributing to RF physics as well as to fast ion transport. Expected signal-to-noise will be presented.

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