Local Gas Injection as a Scrape-off Layer Diagnostic on the Alcator C-Mod Tokamak

by

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Submitted to the Department of Nuclear Engineering on 22 May 1996 in Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

ABSTRACT

A capillary puffing array has been installed on Alcator C-Mod which allows localized introduction of gaseous species in the scrape-off layer. This system has been utilized in experiments to elucidate both global and local properties of edge transport. Deuterium fueling and recycling impurity screening are observed to be characterized by non-dimensional screening efficiencies which are independent of the location of introduction. In contrast, the behaviour of non-recycling impurities is seen to be characterized by a screening time which is dependent on puff location.

The work of this thesis has focused on the use of the capillary array with a camera system which can view impurity line emission plumes formed in the region of an injection location. The ionic plumes observed extend along the magnetic field line with a comet-like asymmetry, indicative of background plasma ion flow. The flow is observed to be towards the nearest strike-point, independent of x-point location, magnetic field direction, and other plasma parameters. While the axes of the plumes are generally along the field line, deviations are seen which indicate cross-field ion drifts.

A quasi-two dimensional fluid model has been constructed to use the plume shapes of the first charge state impurity ions to extract information about the local background plasma, specifically the temperature, parallel flow velocity, and radial electric field. Through comparisons of model results with those of a three dimensional Monte Carlo code, and comparisons of plume extracted parameters with scanning probe measurements, the efficacy of the model is demonstrated. Plume analysis not only leads to understandings of local edge impurity transport, but also presents a novel diagnostic technique.

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