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# Velocity Imaging for Understanding Particle Transport in the Boundary of Magnetically Confined Plasmas

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Ion velocity imaging is carried out on the DIII-D tokamak to understand the interplay between pressure balance and particle transport along open magnetic field lines in both axisymmetric and 3D magnetic configurations. The large number of forces at play and capacity for the flows themselves to influence momentum transport in feedback loops complicates our existing picture of particle transport in the scrape-off-layer (SOL) especially for impurity species. Two absolutely calibrated Doppler Coherence Imaging Spectroscopy (CIS) diagnostic systems are employed on DIII-D for direct measurement of ion flows using a combination of fast-imaging and interferometry [1]. Similar systems have recently been employed on the W7-X stellarator [2], the MAST spherical tokamak [3], and the ASDEX-U tokamak [4] for investigating the complex behavior of ions flowing along field lines.

Recently on DIII-D, the formation of large coherent n=1 magnetic islands has been shown to modify parallel pressure gradients generating regions of positive and negative ion acceleration throughout the SOL; this measurement confirms long-standing EMC3-EIRENE modeling predictions. The islands are directly responsible for altering boundary plasma parameters, principally due to the modification of radial temperature profiles across the islands and the cross-field momentum loss from adjacent regions of counter-streaming flows. Initial data also suggests the presence of 3D flows on the high-field-side of n=2 RMP ELM-suppressed discharges. RMP ELM-suppressed discharges are predicted to have significant separatrix perturbations generating flow-reversal in lobe structures throughout the divertor, which may pose a potential issue for divertor impurity retention.

For benchmarking 2D fluid modeling, comparisons with UEDGE simulations have been used to understand the competing roles of ion- and electron- dominated forces in determining momentum balance in the divertor [5]. These simulations allow us to test modeling predictions of impurity entrainment in main-ion flow and estimate the role of ExB drifts in determining parallel ion velocity.

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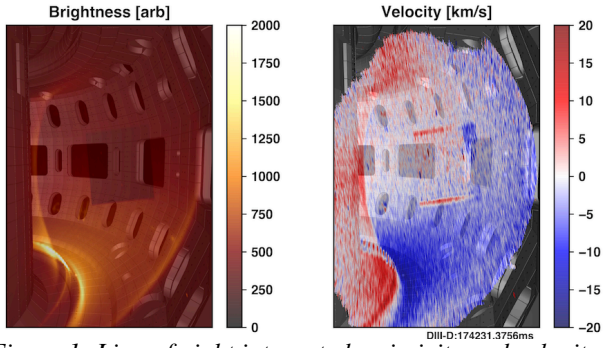


*Figure 1: Line-of-sight integrated emissivity and velocity of $C^{2+}$ impurity ions in the DIII-D SOL and divertor. Note: data is overlaid onto CAD representation of vessel wall with a partial-transparency.*



References

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