Advances in Measuring and Understanding Neutral Fueling and Pedestal Particle Transport at DIII-D

L. Horvath[1], R. Gerrú[2], S.R. Haskey[1], Q. Pratt[1], A. Bortolon[1], E.D. Emdee[1], G. Wilkie[1], T. Wilks[2], J.W. Hughes[2], F.M. Laggner[3], F. Scotti[4], M.G. Burke[4], J. Balbin-Arias[5], T. Odstrcil[6]

[1]*Princeton Plasma Physics Laboratory, Princeton, NJ, USA*
[2]*MIT Plasma Science and Fusion Center, Cambridge, MA, USA*
[2]*Department of Nuclear Engineering, North Carolina State University, Raleigh, NC, USA*
[4]*Lawrence Livermore National Laboratory, Livermore, CA, USA*
[5]*William & Mary, Williamsburg, VA, USA*
[6]*General Atomics, San Diego, CA, USA*

Understanding the formation of the edge density pedestal is essential for optimizing the performance of ITER and future fusion power plants. In present experiments, the pedestal structure is shaped by the combined effects of neutral fueling and transport mechanisms, with neutral ionization being a dominant factor [1]. Recent advancements at DIII-D, particularly the installation of the Lyman-alpha diagnostic [2, 3] (LLAMA/ALPACA) and the near X-point charge exchange neutral spectroscopy [4] (CENS) systems have significantly improved our ability to measure hydrogenic neutral ionization rates at various locations in the main chamber. These diagnostics, paired with modeling tools like DEGAS2, XGC, and SOLPS-ITER, have provided critical insights into edge particle fueling and transport.

With the direct measurements of poloidal asymmetries in pedestal fueling we extract information to evaluate the flux-surface averaged particle source and enable stricter validation of pedestal transport codes. The new measurements, coupled with numerical analysis, find that these fueling asymmetries strongly correlate with divertor recycling asymmetries and are dependent on drift effects [5, 6], flows in the private-flux region [7], parallel flows in the main SOL [8, 9], rotation [9], magnetic topology and divertor regime. The high temporal resolution of the particle source measurements also allowed to study the particle transport in density modulation experiments through the separation of convective and diffusive contributions and recent studies have shown evidence of an inward particle convection in the pedestal [10, 11].

This contribution will also discuss future need for expansions of neutral diagnostic and modeling capabilities to advance pedestal predictions.

References

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