Calculation of Pedestal Transport Coefficients Using Direct Measurements of Neutral Emissivity on DIII-D

Aaron M Rosenthal[1], Jerry Hughes[1], Alessandro Bortolon[2], Florian Laggner[2], Theresa Wilks[1], Tomáš Odstrčil[1], Francesco Sciortino[1] and Marco A Miller[1]

[1]Massachussets Institute of Technology, Plasma Science and Fusion Center, Cambridge, MA, USA

[2]Princeton Plasma Physics Laboratory, Princeton, NJ, USA

Corresponding Author Email: aaronmr@mit.edu

New Lyman-α measurements have enabled improved radial and temporal measurement of hydrogen and deuterium emissivity profiles on DIII-D allowing for quantitative experimental studies of pedestal particle transport and main chamber neutrals. The diagnostic, an absolutely calibrated pinhole camera measuring deuterium Lyman-α emission, provides a high resolution measurement at previously unsampled poloidal locations on the inboard and outboard pedestal region below the midplane. Lyman-α emission measurements facilitate direct experimental studies of the edge ionization source without relying solely on neutral transport codes. Furthermore, the neutral measurements can serve as a comparison and constraint for advanced edge modeling codes used to simulate future plasma devices, in which particle sources and thermal sinks due to neutral populations are important. Initial data analysis has explored neutral profiles and ionization rate behavior during stationary plasma discharges with increasing outboard gas puff as well as dynamic events such as ELM cycles and applied gas puff modulation. Inferred ionization rates provide radial profile estimates of the transport coefficients in the pedestal region. For stationary discharges, a 1D steady state slab model without poloidal variation is used to estimate the effective diffusion coefficients in the pedestal. Effective diffusion coefficients increase with increased gas puff from 0.01 to 0.04 m^2/s. For gas puff modulation experiments, a poloidally uniform model is used which accounts for the tokomak geometry. Lyman- α measurements allow calculation of the transport coefficients into regions with an edge source. While poloidal symmetry is assumed for initial calculations, inboard-outboard Lyman-α brightness measurements frequently show asymmetries. The inboard side measurement is often an order of magnitude larger than outboard Lyman-α brightness measurement. Furthermore, gas puff modulations are observed to result in delayed response on the inboard side relative to the outboard side.

This work is supported by the US Department of Energy DE-SC0014264, DE-AC02-09CH11466 and DE-FC02-04ER54698