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Role of fueling versus transport in determining the core density profile

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A multi-machine database shows that density peaking and collisionality are inversely correlated [1]. As such, the fusion performance prediction of future machines always assumes that the density will peak as long as one operates at low collisionality. However, recent non-dimensional collisionality scaling experiments in DIII-D and JET show that the increase in peaking at low collisionality is the result of an increase in neutral beam fueling at lower collisionality [2,3]. In this paper we will present the first results linking the dimensionless changes in collisionality to the changes in density peaking, fueling, turbulence and perturbed transport measurements. A 3-point dimensionless collisionality scan in DIII-D H-mode plasmas shows that the particle pinch is directed outward for all collisionality regimes over the whole radius except at the highest collisionality, where the pinch becomes inward around mid-radius. Inside mid-radius the pinch for all 3 cases has fairly similar magnitude and is slowly decreasing in size outward. The outward diffusion is nearly a factor 3 higher for the low collisionality discharge in comparison to the mid- and high collisionality discharges. At the same time, we also measure a strong increase in density fluctuations at the ion-scale with the BES. This direct dimensionless scan indicates that the multi-machine database correlation between collisionality and density peaking is hiding other factors that can influence particle transport. Purely relying on low collisionality to get a peaked density profile for ITER or other future burning plasma devices, might be too optimistic an assumption. We will discuss how other factors such as an increase in turbulence drive [4], turbulence type (ITG to TEM) [5,6] and neutral beam fueling can influence the results from the database to build a more comprehensive predictive picture of particle transport.

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