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P5.1035 Comparison of H-mode pedestal characteristics in SAS and open divertor configurations on DIII-D

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The Small Angle Slot (SAS) divertor installed on DIII-D combines high closure with small incidence angle to achieve detachment over the entire divertor at low density. Experiments on DIII-D comparing divertor detachment and other divertor characteristics of the SAS configuration to an otherwise identical open divertor configuration also revealed differences in the H-mode pedestal characteristics and overall plasma performance. Density scans in otherwise matched discharges in the SAS and open divertor configurations were obtained over a range of neutral beam heating powers with the Bx∇B drift direction both toward and away from the X-point.
With the Bx∇B drift away from the X-point, SAS discharges showed improved energy confinement at a given pedestal density, n_e^PED, with higher temperature and reduced thermal diffusivity from the top of the H-mode pedestal inwards, compared the open divertor configuration. At a given n_e^PED, pedestal density profiles are similar in the two divertor configurations, but the SAS discharges have wider and higher temperature pedestals with the top of the temperature pedestal shifted inwards relative to the density pedestal. For this Bx∇B drift direction, the pedestal pressure increases with density in the SAS configuration while it is reduced with density for the open divertor. Both configurations show a strong decrease in pedestal temperature and pressure above a density where a high radiation zone reaches the X-point region, although the density at which this occurs is significantly higher for the SAS case.
With the Bx∇B drift toward the X-point the SAS and open divertor have similar pedestal structure with pedestal pressure increasing with density. In comparison to the other Bx∇B drift direction pedestal temperature profiles are higher and wider and separatrix density is reduced.
These discharges have relatively weak shaping and high density and as a result lie along the ballooning mode branch of pedestal peeling-ballooning stability. In this regime the critical pressure gradient is strongly affected by the level of diamagnetic stabilization making the pedestal stability limit sensitive to the relationship between the pedestal density and temperature profiles. In the open divertor case with Bx∇B drift away from the X-point the diamagnetic stabilization is weakened with increasing density resulting in the reduced critical gradient and pedestal pressure while in the SAS case diamagnetic stabilization improves with density. This affect was dramatically demonstrated in a SAS discharge in which Ne injection improved the core ion confinement resulting in a strong increase in pedestal ion temperature resulting in improved ballooning mode diamagnetic stabilization and critical pressure gradient. Although significant differences were seen in the pedestal pressures for a given density in the different divertor configurations and Bx∇B drift directions the fact that plasma shape and other discharge characteristics where matched resulted in the usual form for the EPED1 model[1] predicting similar pressures for all cases. However the pedestal widths were consistent with the scaling used in EPED1 indicating that the model would predict the results if the relationship between the pedestal density, temperature, and impurity profiles were included.

[1] P.B. Snyder, et al., Nucl. Fusion 51 (2011) 103016

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