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An innovative small angle slot divertor concept for long pulse advanced tokamaks

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A new Small Angle Slot (SAS) divertor is being developed in DIII-D to address the challenge of efficient divertor heat dispersal at the relatively low plasma density required for non-inductive current drive in future advanced tokamaks. SAS features a small incident angle near the plasma strike point on the divertor target plate with a progressively opening slot. SOLPS (B2-Eirene) edge code analysis finds that SAS can achieve strong plasma cooling when the strike point is placed near the small angle target plate in the slot, leading to low electron temperature T_e across the entire divertor target. This is enabled by strong coupling between a gas tight slot and directed neutral recycling by the small angle target to enhance neutral buildup near the target. SOLPS analysis reveals a strong correlation between T_e and D_2 density at the target for various divertor configurations including the flat target, slanted target, and lower single null divertor. The strong correlation suggests that achievement of low T_e may reduce essentially to identifying the divertor baffle geometry that achieves the highest target gas density at a given upstream condition. The SAS divertor concept has recently been tested in DIII-D for a range of plasma configurations and conditions with precise control of slot strike point location. In confirmation of SOLPS predictions, a sharp transition is observed when the strike point is moved to the critical outer corner of SAS. A set of Langmuir probes imbedded in SAS show that the T_e radial profile, which is peaked at the strike point when it is located away from the SAS corner, becomes low across the target when the strike point is located near the corner. With further increase in density, deep-slot detachment occurs with T_e 1 eV, measured by the unique DIII-D divertor Thomson Scattering diagnostic. Work supported by US DOE under DE-FC02-04ER54698.