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Development and First Experimental Tests of a Small Angle Slot Divertor on DIII-D

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A Small Angle Slot (SAS) divertor has been installed on the DIII-D tokamak to further evaluate the role of divertor closure in achieving efficient heat dispersal for steady-state tokamaks. Initial experiments have shown a significant reduction of the electron temperature (T_e) across the divertor target and access to dissipative divertor operation at lower H-mode operational densities while maintaining high core plasma confinement. The SAS configuration features a small (glancing) angle target and a narrow slot progressively flaring out from the strike point to amplify both neutral and impurity dissipation of power in the divertor. Experiments with closely matched H-mode discharges in DIII-D have demonstrated that SAS achieves dissipative divertor conditions with T_e < 10 eV at a lower main plasma density than in an open (horizontal) divertor configuration, based on target Langmuir probe measurements. In addition, SAS can extend plasma cooling into the far Scrape-Off Layer (SOL), in contrast to the vertical target configuration which usually achieves partial detachment with low T_e in the near SOL only. SAS also achieves improved confinement with a confinement enhancement factor H_98Y2 ~ 25% higher than the open divertor at the onset of detachment. SAS also widens the high performance H-mode operating window through detachment onset at lower density and X-point MARFE formation at higher density. Detailed transport and pedestal stability analyses find that the confinement improvement with SAS are associated with higher pedestal temperature and pressure, which are primarily due to an increased pedestal width, consistent with previous divertor closure experiments on DIII-D. These results were obtained with the ion grad-B drift away from the SAS divertor. Further research will be conducted to establish the role of drifts in a closed slot divertor and results will also be presented.

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Primary author: Mr GUO, Houyang (General Atomics)

Co-authors: Mr HYATT, Al (General Atomics); Mr KELLMAN, Arnie (General Atomics); Ms MOSER, Auna (General Atomics); Mr COVELE, Brent (General Atomics); Mr SANG, Chaofeng (Dalian University of Technology); Mr MURPHY, Chris (General Atomics); Mr THOMAS, Dan (General Atomics); Mr WANG, Huiqian (General Atomics); Mr WATKINS, Jon (Sandia National Laboratories); Mr LAO, Lang (General Atomics); Mr HOLLAND, Leo (General Atomics); Ms CASALI, Livia (General Atomics); Mr SHAFER, Morgan (Oak Ridge National Laboratory); Mr STANGEBY, Peter (University of Toronto); Mr OSBORNE, Tom (General Atomics); Mr LEONARD, Tony (General Atomics); Mr TAYLOR, Tony (General Atomics)

Presenter: Mr GUO, Houyang (General Atomics)

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