DPP20-2020-000538

Abstract for an Invited Paper
for the DPP20 Meeting of
the American Physical Society

Reactor-friendly core and boundary of DIII-D diverted negative triangularity plasmas with persistent L-mode edge[1]

MAX AUSTIN, University of Texas at Austin

At high heating power DIII-D negative triangularity (NT) discharges are characterized by high confinement ($H_{98y2} \sim 1.3$) and significant $\beta_N \sim 3.0$ while maintaining an L-mode edge and being robustly ELM free. Recent experiments were carried out with a new shape that permitted diverted operation for the first time with strong negative triangularity $\delta_u = -0.4$ in the upper half and neutral triangularity $\delta_l \sim 0.0$ on the lower half. These discharges retained an L-mode edge with up to 14 MW of auxiliary heating power, exceeding the expected L-H transition power by a factor of 5 while still exhibiting H-mode confinement globally ($H_{98y2} = 1.0$). In one shot, an accidental relaxation of δ_u to -0.2 resulted in an H-mode transition at $P_{aux} = 4$ MW. Comparison of the heat flux width of this H-mode edge discharge with the L-mode edge ones indicates the L-mode cases have up to 50% wider divertor heat flux width λ_q. Impurity transport experiments demonstrate that the NT discharges have $\tau_p/\tau_E \sim 1$, as opposed to typical H-modes with $\tau_p/\tau_E \sim$ 2-3. Additional experiments and modeling are giving new insights into the good performance of up-down symmetric NT shape. Nonlinear CGYRO runs confirm experimental observations of reduced energy transport in NT compared to matched positive triangularity (PT) discharges; the H-mode-level confinement is attributable to a combination of shape-related effects and weakened turbulent transport. Both global and perturbative transport analysis indicate improved confinement in NT compared to matched PT cases. The features of the negative triangularity plasma represent significant advantages in achieving core-edge integration via high radiation fraction and provide a simpler technical path to divertor construction in a reactor.

[1]Work supported by US DoE under DE-FC02-04ER54698, DE- FG02-97ER54415, DE-FG02-94ER54235, DE-AC52-07NA27344