Some Implications of Recent DIII–D Experiments on Future Tokamak Divertor Designs

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Advanced tokamaks use shaped (D-shaped cross-section) plasmas to optimize fusion performance. In turn, the divertor (which handles heat and particles) must operate efficiently in these shaped plasmas. In this paper, we report on recent experiments at the DIII–D National Fusion Facility which compare the advantages/disadvantages of double-null (DN) versus single-null (SN) configurations, open versus tightly baffled divertors, and particle pumping at low and high density**.** We find that: *(1) heat flux balance between the upper and lower divertors of the DN does <u>not</u> occur at magnetic balance, (2) power sharing at low density, attached divertor conditions between the inboard and outboard legs for SN or DN diverted plasmas differs markedly* (e.g., inner:outer = 1:2 for SNs and 1:10 for DNs), and *(3) the scrape-off length of the ion temperature in DIII–D can be 2–3 times that of electron temperature*. From observation (1) it is clear that optimal heat handling in a DN requires a slight degree of magnetic imbalance. Observation (2) suggests that, because so little of the power flows to the inboard divertors relative to the outboard divertors under DN operation, “passive” cooling of divertor armor under the inboard legs may be a practical alternative to “active” cooling. From observation (3), it is clear that designers should be aware that energetic ions deep in the scrape-off layer can produce sputtering on the downstream divertor structure, when they consider how “open” or “closed” the divertor should be. We also report on an added design flexibility for positioning the divertor strike points for efficient particle pumping, if the plasma is maintained at a higher operating density. Modeling these behaviors in DIII–D using state-of-the-art edge transport codes (e.g., UEDGE) and the prospects for using these codes to accurately predict the plasma behavior of next generation tokamaks will also be presented.

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