A Comparison of Plasma Performance Between Single-Null and Double-Null Configuration During ELMing H–mode*

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Differences in core plasma and divertor plasma behaviors have been observed in comparison among up-down symmetric double null divertors (DN), single null divertors with their ∇B drift toward the X-point (SNT), and single null divertors with their ∇B drift away from the X-point (SNA).No divertor (or core) MARFEs have been observed for balanced DN and SNA discharges, even as their H–L back transition was approached at higher densities. This observation contrasts with SNT cases, where "divertor" MARFEs are observed with line-averaged densities as low as ~0.6 × Greenwald density limit $\bar{n}_{e,G}$. Moreover, high density ($\geq 2\times 10^{20}$ m^{-3}), low temperature (< 5 eV) plasma *inside* the separatrix adjacent to the X–point ("core" MARFEs) is often observed during gas puffing near the H–L back transition in SNTs, but core MARFE formation during the ELMing H–mode has never been observed in any high density DN and SNA. We have found that it is easier to achieve higher density during H–mode operation in the balanced DN than in either SNA and SNT discharges. The above results might be partially explained by how the different configurations respond to fueling via gas puffing. For example, the lower power flow along the inboard separatrix in DNs leads to complete detachment of the inboard legs, which in turn allows recycled neutrals to escape the private flux region and fuel the core plasma along the entire inboard side of the core plasma; this leads to a more uniform and efficient fueling. The fueling rates for comparable gas puff rates are ~2× higher in DNs than SNs. In both SNA and SNT discharges, the detachment of the inboard leg requires a considerably higher amount of injected neutral gas than in DNs. Neutrals (and plasma) build up in the private flux region to much higher levels in SNA and SNT plasmas, since their (attached) inboard leg reduces the chances of escape from the private flux region and the high recycling regions adjacent to it. A more localized (and less efficient) fueling of the core region results.

The differences in divertor and scrapeoff layer regions impact the core plasma performance, such as the operating density range and the H-mode energy confinement quality. Typically, the H–L back transition is 10-20% higher for SNT discharges than for comparable SNA discharges, and is ~10% higher for balanced DNs than for comparable SNTs. For all cases, the energy confinement at the back transition, however, is ≤ 30% above the ITER89 L–mode. Although the approach to the H–L back transition for SNs and DNs may be very different, there appears to be a commonality in the proximate cause of the H–L back transition at high density. In the SNT, DN, and SNA configurations we have examined, we have found that the pedestal electron temperatures are quite similar (within 10%) at the H–L back transitions. Edge electron pressure was also comparable for the SNT, DN, and SNA configurations near their respective H–L high density back transition.

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