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Numerical Predictions of Divertor Power Sharing in Conceptual High Power Double Null Tokamaks

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SOLPS-ITER is used to investigate power sharing between the upper and lower outer divertors in a balanced double null magnetic configuration, revealing that asymmetric divertor conditions drive SOL power flows which can result in a large power sharing imbalance between divertors. Double null (DN) or near double null magnetic geometries are potential configurations for a future tokamak reactor due to advantages such as more efficient fueling, favorable energy confinement, and shared power loads in two outer divertors which may justify DN configuration despite the reduction of available core plasma volume. Simulations of a compact high field tokamak (B_T = 6 T, R = 1.5 m, P_SOL = 4 to 50 MW) show that when one outer divertor is attached and the other is detached, power flows dominantly toward the attached divertor regardless of ion grad B direction. However, when both outer divertors are attached or both detached, power flows toward the divertor in the ion grad B direction.

These results challenge the DN concept of designing one outer divertor for dissipation and the other divertor for density control using pumping, because the resulting asymmetric divertor conditions create an unfavorable power sharing imbalance that favors the less dissipative pumped divertor. In order to achieve a desired level of power sharing, magnetic balance control will be critical in order to compensate for symmetry-breaking effects such as divertor shape asymmetries, pumping, and drifts.

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