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# Particle and power exhaust studies in non-resonant divertors using EMC3-EIRENE

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The removal of heat and neutral particles are key challenges for stellarator power plants. Divertors are used to facilitate this process. Several divertor candidates have been proposed including the non-resonant divertor (NRD) [1].

NRDs are characterized by strikelines which show little structural change when the rotational transform of the magnetic field is altered, in contrast to island divertors which rely on the position of a specific magnetic resonance value. This resilience is particularly important for quasi-symmetric stellarators which can develop higher amounts of bootstrap current [2]. Such resilient behavior persists despite the chaos in the plasma edge and has been quantified via connection lengths and Lyapunov exponents taking advantage of chaotic edge structures [3]. To further quantify this resiliency, the relationship between the connection length and the minimum radial penetration helps to determine within the resilient behavior if the configuration is NRD-like, or rather an "island divertor"-like [4].

In this contribution, the EMC3-EIRENE plasma edge code [5] is used to study the particle and heat exhaust problem in non-resonant divertors. EMC3-EIRENE solves the Braginskii equations in the plasma edge while the neutral source terms are obtained by solving the Boltzmann equation. In the Helically Symmetric eXperiment (HSX), such NRD behavior appears in the "standard" configuration which is quasi-helically (QH) symmetric optimized.

Recent work has shown that the inclusion of baffle plates leads to an increased neutral pressure near the strikeline of HSX. Placement of these baffles, however, must be carefully selected due to the 3D edge field structure as intersections with plasma-carrying flux tubes can lead to a reduction in neutral pressure [3].

Besides such mechanical baffling, the effect of different magnetic topologies on the presence and importance of neutral processes is studied. By changing the included neutral reactions in the EIRENE input file, their importance and the contribution of atoms and molecules to the total neutral pressure in a particular configuration is studied.

Apart from particle exhaust, heat exhaust in NRDs is an important open question. Heat exhaust is mainly established due to injecting impurities and in that way changing the amount of radiated power. For HSX, the radiated power in the QH configuration is analyzed and compared with the radiation in configurations with larger edge islands which behave "island divertor"-like. Carbon is used in the simulation as the only impurity species meaning that the radiation is either coming from carbon, or from hydrogen.

Towards intermachine comparison, magnetic configurations with NRD-like behavior are identified in W7-X and were run in the most recent experimental campaign. We study the neutral and radiation behavior using EMC3-EIRENE simulations. Where the neutral behavior is compared to experimental data, the radiation behavior is different due to the used heating scheme (NBI only heating) causing ion root plasma conditions and high impurity confinement times [6]. This leads to core radiation rather than edge radiation which would be achieved if ECRH heating is used. The later situation is considered for the EMC3-EIRENE simulations.

We use such EMC3-EIRENE simulations to quantitatively assess the advantages and difficulties of NRDs with respect to power and particle exhaust. The combination of EMC3-EIRENE simulations of W7-X and HSX enables the broader study of the neutral and radiation behavior and ensures that the observations are not machine dependent.

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