Dependence of the divertor heat flux profiles on the plasma boundary shape in the National Spherical Torus Experiment*

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Spherical tori (ST) face the prospect of high heat flux at the plasma facing components (PFC), owing to their compact nature and design as high power density systems. The peak heat flux at PFCs is intimately tied to the downstream profile widths on both the scrape-off layer (SOL) and private flux region sides, which in turn is related to cross-field transport and the upstream midplane widths. Near term research in this area at the National Spherical Torus Experiment (NSTX) is driven by U.S. DoE multi-machine joint research milestone in 2010. We report the first set of results from those studies in two papers: this paper focusing on the effect of boundary shape, and an accompanying paper focusing on the effect of engineering and externally controllable parameters.

In this paper, we report the dependence of the midplane SOL heat flux widths (λ_q^{mid}, magnetically mapped from the divertor profiles obtained from thermography) on the magnetic balance between the two X-points as measured at the outer midplane (δ_r^{sep}), the magnetic flux expansion, and the X-point radius/triangularity. In general, the λ_q^{mid} is independent of δ_r^{sep}, leading to power sharing between the lower and upper divertors in going from lower-single null configuration to double-null configuration. Very close to balanced double-null with δ_r^{sep} ~ 0, a reduction of λ_q^{mid} is sometimes observed, probably correlated with the drop in parallel connection length. At constant triangularity, the λ_q^{mid} is constant at ~ 8-10mm, relatively independent of the magnetic flux expansion in the range of 10-40, leading to a strong reduction of the peak heat flux wth increasing flux expansion. Finally the λ_q^{mid} is relatively independent of the X-point triangularity in the range of 6-9mm. Details of the experiments and implications for future devices will be presented.

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