Gyrokinetic Turbulent-Neoclassical Projection of the Divertor Heat-Flux Width from Present Tokamaks to ITER*,**

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The total-f edge gyrokinetic code XGC1 –with blobby electrostatic turbulence, neoclassical dynamics and neutral particle transport– shows that the divertor heat flux width λ_q in the ELM-free period of H-modes in two representative types of present tokamaks (DIII-D like plasma for conventional aspect ratio and NSTX like plasma for tight aspect ratio) is set mostly by the ion neoclassical orbit spread, which is proportional to $1/I_p$, while the blobby turbulent spread plays a less significant role. This explains the $1/I^{\gamma}_p$, with γ~1, scaling of the heat flux width observed in the present-day tokamaks. On the other hand, the XGC1 studies for ITER H-mode like plasmas show that λ_q is mostly set by the blobby turbulent spread, with the heat flux width being about 5X wider than that extrapolated from the $1/I_p$ scaling. Gyrokinetic ions, drift-kinetic electrons and Monte-Carlo neutral particles are simulated in realistic diverted edge geometry. This result suggests that the achievement of cold divertor plasmas and partial detachment required for power load and W impurity source control may be more readily achieved and be of simpler control issue than what was predicted on the basis of the $1/I_P$ scaling. A systematic validation study of the XGC1 results is on-going using experimental data from three major US tokamaks[a] as part of the DOE-OFES 2016 National Theory/Simulation Performance target, including the cross-verification activity of edge turbulence with another participating code BOUT++[b].

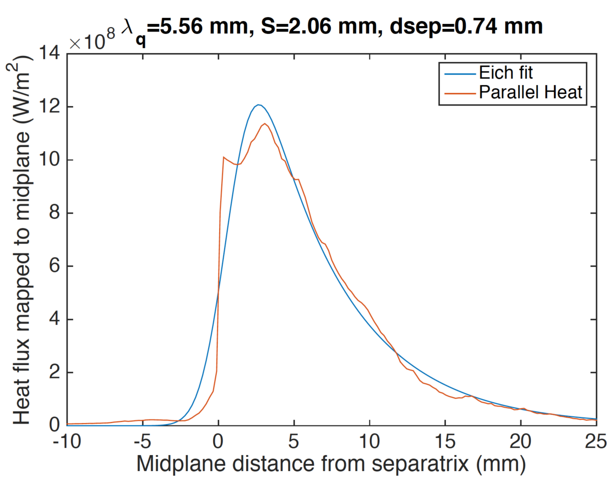

Fig. 1. Heat-flux footprint from XGC1, mapped back on the outer divertor plate, in a model ITER plasma edge. At 15MA, λ_q is ~5.6mm, which is ~5X wider than what was predicted from the $1/I_p$ scaling.

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