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Elimination of the Non-Axisymmetric inter-ELM Heat Flux Generated by Resonant Magnetic Perturbations in Detached Divertor Conditions

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In DIII-D, measurements show that at high densities, above the onset of divertor detachment, the non-axisymmetric heat flux striations between ELMs created by resonant magnetic perturbation (RMP) fields are eliminated and the heat flux profile is nearly identical to that measured without RMPs. Measurements show that the RMPs continue to affect the particle balance even when there were no measurable perturbations to the heat flux structure. ELM mitigation was seen when the RMPs were applied, but not ELM suppression.
Previous results from DIII-D showing that increasing density can cause heat flux to the striations to increase, [1] as well as results from NSTX showing that heat flux in the striations can remain high during detachment [2], have caused concerns about the compatibility of RMPs and the divertor operation in ITER. In this work, density has been raised beyond that previously used to study RMP effects in DIII-D. It is shown that above the onset of detachment, striations in the heat flux gradually decreased with increasing density and are effectively eliminated at 90% of the Greenwald density. Eliminating these striations could dispense with the requirement that RMP fields on ITER rotate to distribute the non-axisymmetric heat flux.

When RMPs are applied, the density in the main plasma drops and the peak inter-ELM heat flux to the divertor is observed. Peak heat flux generally scales inversely with the plasma density even without RMPs. When gas puffing is used to increase the main plasma density to pre-RMP levels the peak inter-ELM heat flux returns to a value at or below the pre-RMP value. The 3D edge code EMC3-EIRENE [3] is used to explore the relative contributions of changes in particle transport, source and sink effects. Measurements of electron temperature made using divertor Thomson scattering show that a structure similar to that predicted by EMC3-EIRENE appears when RMPs are applied. The structure in the electron temperature generated by the RMPs does not extend to the floor tiles in detached conditions where striations in the heat flux profile were also eliminated.

[1] M.W. Jakuboski, et al., Nuc. Fus., 49, (2009) 095013
[2] J.W. Ahn, et al., PPCF, 56, (2014) 015005
[3] Y. Feng, et al., J. Nuc. Mat., 241-243, 930 (1997)

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