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H-mode divertor target heat load measurements on KSTAR

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Divertor target heat loads in future long pulse, high power tokamak reactors such as ITER or DEMO will impose major operational constraints. Detached divertor operation and suppression or substantial mitigation of Edge Localized Modes (ELMs) will be mandatory. One of the most promising ELM mitigation methods to be applied on ITER is the use of 3D magnetic perturbations (MPs). This technique substantially modifies the divertor SOL structure and can lead to non-axisymmetric power loading on the targets [1]. The study of this 3D heat deposition under highly dissipative, H-mode conditions is a key research area for ITER. The KSTAR tokamak is equipped with an extensive set of in-vessel magnetic perturbation (MP) coils. A state-of-the-art infra-red (IR) thermography system has also recently been installed, viewing the lower, outer divertor target from the top of the main chamber. The power density on the target is set by the scrape-off layer (SOL) power width, λ_q. A recent multi-machine scaling for the H-mode λ_q based on high resolution IR finds an expected value of λ_q ~ 1 mm for the ITER H-mode baseline scenario [2]. It has been found that the first inter-ELM λ_q values obtained in the KSTAR H-mode plasmas are in good agreement with the multi-machine scaling. Furthermore, ELM suppression/mitigation is a priority research area on KSTAR [3], but until the installation of the new thermography system, it has not been possible to observe the target heat loads during MP application. However, in the last year, it has been clearly observed that the application of the 3D MPs can induce the splitting of the outer divertor heat striking point. A clear evidence of different strike point splitting pattern seen on the target between the two different coil perturbations was also found. This paper presents an overview of the first experimental studies of divertor power loading, with emphasis on the characterization of inter-ELM heat load widths in the absence of MPs and on the non-axisymmetric divertor heat loading arising from the application of MPs.

[1] O. Schmitz et al., 2013 Journal of Nucl. Materials 438 S194
[2] T. Eich et al., 2013 Nucl. Fusion 53 09031
[3] Y. M. Jeon et al., 2012 Physical Review Letters 109 035004

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