Topic: EX-D

Divertor heat and particle flux profile modification during 3-D field application in NSTX

J-W. Ahn[1], J. Canik[1], R. Maingi[1], T.K. Gray[1], B. Leblanc[2], A. Mclean[1], J.-K. Park[2], and V. Soukhanovskii[3]

(email: jahn@pppl.gov)

[1] Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA
[2] Princeton Plasma Physics Laboratory, Princeton, NJ 08543, USA
[3] Lawrence Livermore National Laboratory, Livermore, CA 94551, USA

The externally applied 3-D fields have been used to suppress [1] or trigger [2] ELMs and are considered to be used in the International Thermonuclear Experimental Reactor (ITER). It is found that the non-axisymmetric magnetic perturbations modify the heat and particle flux profiles at the divertor surface in NSTX H-mode plasmas [3]. It produces multiple strike points radially separated, formed by the so-called 'lobe' structure. A modest level of strike point (SP) splitting in both profiles is observed even before the application of 3-D fields due to the intrinsic error fields, *i.e.* the 'intrinsic' SP splitting. Divertor profiles become broadened when the plasma enters the intrinsic SP splitting phase, with the peak values at the separatrix largely unchanged. The intrinsic SP splitting is further perturbed by the externally applied 3-D fields. This 'perturbed' SP splitting by the applied 3-D fields was simulated by a field line tracing code and was compared with the measurement for n=1 and n=3 cases. It is found that the location and spacing of the simulated split strike points agree well with the observation. The inclusion of plasma response inside the separatrix in the field line tracing did not alter the predicted footprints at the divertor targets substantially. Time response of the formation of the perturbed SP splitting is as fast as 3-4ms, which is consistent with the field line penetration time through the vacuum vessel. The pedestal electron temperature and density profiles show quick (<15ms) reduction by the applied 3-D fields but the electron collisionality (ν^*_e) is not found to change substantially. The SP splitting observed in the heat flux profile in NSTX occurred in the pedestal collisionality of ν^*_e=1-2, which is consistent with the DIII-D result, where it is only observed for ν^*_e >0.5 [4]. Understanding the effect of 3-D fields on the divertor profiles and the underlying physical mechanism of the profile modification is crucial for the development of effective control tools for the divertor heat and particle handling. This is particularly important for the future spherical and conventional tokamaks because of the extremely high heat load onto the divertor plates expected for those machines.

This work was funded by the US Department of Energy, contract numbers DE-AC05-000R22725, DE-AC52-07NA27344, and DE-AC02-09CH11466.

References:

[1] T. E. Evans, *et al, Nature Phys.* **2** (2006) 419-23
[2] J. Canik, *et al, Phys. Rev. Letts.* **104** (2010) 045001
[3] J-W. Ahn, *et al*, submitted to *Nucl. Fusion* (2009)
[4] M.W. Jakubowski, *et al, Nucl. Fusion* **49** (2009) 095013