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EX/P4-33: Observation of Edge Harmonic Oscillation in NSTX and Theoretical Study of its Active Control Using HHFW Antenna at Audio Frequencies

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Edge localized modes (ELMs) can generate unacceptable heat loads to plasma facing components in a reactor scale tokamak or spherical torus, and therefore ELM control is a critical issue in ITER. ELM control using non-axisymmetric (3D) fields is a promising concept, but the 3D coil requirements are demanding in cost and engineering. An alternative means may be to use internally driven 3D field oscillations such as edge harmonic oscillations (EHOs), but the relevant operational window is possibly more limited than the external 3D field applications. The disadvantages of each approach can be mitigated if the external and the internal drive of 3D fields can be constructively combined. This paper presents two important topics for this vision: Experimental observations of edge harmonic oscillations in NSTX (not necessarily the same as EHOs in DIII-D), and theoretical study of its audio-frequency drive using the high harmonic fast wave (HHFW) antenna as 3D field coils. Edge harmonic oscillations were observed particularly well in NSTX ELM-free operation with low n=1 core modes, with various diagnostics confirming n=4-6 coherent oscillations in 2-8kHz frequency range. These oscillations, which share some characteristics with the n=1 dominated modes observed in small-ELM regimes in NSTX [1], seem to have a favored operational window in rotational shear, similarly to EHOs in DIII-D QH modes. However, in NSTX, they are not observed to provide particle or impurity control, possibly due to their weak amplitudes, of a few mm displacements, as measured by reflectometry. The external drive of these modes has been proposed in NSTX, by utilizing audio-frequency currents in the HHFW antenna straps [2]. Analysis shows that the HHFW straps can be optimized to maximize n=4-6 while minimizing n=1-3. Also, IPEC calculations show that the optimized configuration with only 1kAt current can produce twice larger displacements than the observed internal modes, ~ 6mm vs. 3mm. The possibility of implementing a drive system will be examined in NSTX-U first, and successful application may provide a pathway for future devices, including ITER.

[1] A. C. Sontag, J. M. Canik, R. Maingi et al., Nucl. Fusion 51, 103022 (2011)
[2] J.-K. Park, R. J. Goldston, Presented at the 16th MHD Mode Control Workshop (2011)

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