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Application of Physics-Based Profile Control Approach to KSTAR

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Advanced tokamak operations, promising candidates for DEMO operations, require control of plasma profiles to establish and to sustain the enhanced energy confinement and the non-inductive current fraction. The safety factor (q) profile and the electron temperature (Te) profile control have to be controlled to access and maintain the advanced operation modes and to improve controllability of the q profile as well as to keep the high plasma pressure [1], respectively. The KSTAR experiments have been initiated aiming at establishing a real time control system of multiple plasma profiles (Te and q profiles) using multiple actuators (NBI and EC) and to validate applied physics-based control models [2]. The real-time Te profile control has been firstly demonstrated in KSTAR experiments for four specific topics: application of the physics-based control models to the time-varying control target in a single discharge, simultaneous application of multiple actuators (NBI and EC), profile control demonstration in the presence of an external disturbance, and real-time update of the physics-based plasma response models. The q profile control system is currently being developed using real-time the Motion Stark Effect (MSE) diagnostic in KSTAR. Implementation of the q profile response model and its validation has been conducted by performing off-line analysis of KSTAR discharges, prior to its application to real KSTAR experiments. Once the q profile control is additionally demonstrated, the combined control of multiple plasma profiles will contribute to exploring the advanced operation regimes in KSTAR and also for addressing the control issues on MHD instabilities.

Reference
[1] Kim, H.-S, Ph. D. Dissertation, Seoul Nation. Univ. (2015).
[2] Kim, S.H., et al., Nucl. Fusion 52 (2012) 074002

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