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O4.112 Analysis of MHD stability and active mode control on KSTAR for disruption prediction and avoidance

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Long-pulse plasma operation at high normalized beta up to 4 (exceeding the n = 1 ideal MHD no-wall stability limit) in KSTAR is presently limited by tearing instabilities rather than resistive wall modes that are computed to be stabilized by kinetic MHD effects. H-mode plasma operation during the 2018 KSTAR device campaign also produced discharges having strong m/n = 2/1 tearing instabilities at N lower than the idealMHD no-wall beta limit. The magnitude of the strongly unstable mode exceeded 30 G which consequently reduced plasma confinement and toroidal plasma rotation significantly. Mode stability alteration was attempted by varying plasma heating, safety factor, collisionality, and rotation profile. The experiment confirmed that an extended duration of the electron cyclotron heating (ECH) at the initial phase of the discharge plays a critical role in mode destabilization. To study destabilizing mechanisms that affect the mode growth, the stability of the observed tearing modes is computed by using the resistive DCON code and the M3D-C1 code. Equilibrium reconstructions that include constraints from Thomson scattering, charge exchange spectroscopy, motional Stark effect diagnostic data, and allowing fast particle pressure are used as input for reliable computation of stability. The classical tearing stability index, from resistive DCON is compared to modes from significantly higher normalized beta plasmas and the result indicates that their stability is governed by different physical mechanisms. In preparation for long-pulse plasma operation at higher beta utilizing increased plasma heating power in 2019, a resistive wall mode (RWM) active feedback control algorithm has been completed and enabled on KSTAR. To accurately determine the dominant n-component produced by RWMs, an algorithm has been developed that includes magnetic sensor compensation of the prompt applied field and the field from the induced current on the passive conductors. Use of multiple toroidal sensor arrays is enabled by modifying the sensor toroidal angles assumed in mode decomposition to include the effect of varied mode helicities in the outboard region where the mode measurement is made. This analysis on stability, transport, and control provides the required foundation for disruption prediction and avoidance research on KSTAR.
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