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EX/P2-07: Investigation of Plasma Rotation Alteration and MHD Stability in the Expanded H-mode Operation of KSTAR

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Initial H-mode operation of the KSTAR has been expanded to higher normalized beta, betaN, and lower plasma internal inductance, li, moving toward design target operation. As a key supporting device for ITER, an important goal for KSTAR is to produce physics understanding of MHD instabilities at long pulse with steady-state profiles, at high betaN and over a wide range of plasma rotation profiles. Instability characteristics in the present expanded H-mode operational space, the influence of varied plasma rotation, and methods to access ITER-relevant low plasma rotation are presently investigated. Equilibria have reached new maximum values in key parameters betaN = 1.9, stored energy of 340 kJ with an energy confinement time of 171 ms in 2011. These results mark substantial progress toward the n = 1 ideal no-wall stability limit, most closely positioned at betaN = 2.5, li = 0.7. Rotating MHD modes are observed with perturbations having tearing parity as determined by Mirnov and ECE measurements. Modes with m/n = 3/2 are triggered during the H-mode phase at 0.5 < betaN < 1 but and do not substantially reduce plasma stored energy. In contrast, 2/1 modes to date are only observed when both the confinement and plasma rotation profiles are lowered after H-L back-transition, and mode locking creates a repetitive crash of betaN by more than 50%. A correlation is found between the 2/1 amplitude and local rotation shear from an X-ray imaging crystal spectrometer, and additionally, 2/1 modes appear to onset only below ~1,200 km/s/m of local rotation shear. Plasma rotation alteration by applied n = 1, 2 fields and the associated neoclassical toroidal viscosity (NTV) induced torque can be used as a rotation profile alteration tool, but also to study the collisionality dependence and steady-state behavior of NTV. Initial success in non-resonant alteration of the H-mode rotation profile in KSTAR were made by using an n = 2 applied field. Analysis is pending to determine if the observed stronger rotation damping by n = 1 braking is resonant or non-resonant. The implications of kinetic RWM stability using the measured KSTAR rotation profiles and their variations are presently being evaluated using the MISK code to further examine the initial theoretical guidance that showed unfavorable RWM stability for projected device target plasmas using projected rotation profiles.

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