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Progress Toward Stabilization of Low Internal Inductance Spherical Torus Plasmas in NSTX[1]

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Steady-state spherical torus plasmas for fusion applications, such as a component test facility or demonstration power plant, target operation with high non-inductive current fraction. These broad current profile targets have low values of plasma internal inductance, li, less than 0.4, near to the lower end of present NSTX operation. A key significance of this operation is that it approaches the purely current-driven ideal kink limit, which by definition exceeds the no-wall stability limit for all values of plasma normalized pressure (beta). In this regime, passive or active kink and resistive wall mode (RWM) stabilization is critical. Experiments on NSTX have recently approached this condition, evidenced by a significant reduction of the n = 1 no-wall stability limit computed by DCON. This limit drops from normalized beta of 4.2 – 4.6 at li $\sim$ 0.6, to 3.4 at li $\sim$ 0.5, to below 2.8 for li $\sim$ 0.4. Nevertheless, passive and active RWM control has produced high toroidal beta up to 28 percent, and normalized beta up to 6.5 (nearly double the no-wall limit), closely following a record normalized beta to li ratio of 13 between li = 0.4 - 0.5. Non-inductive current fraction reaches 0.5 in these high normalized current plasmas. However, the disruption probability of these plasmas increases significantly, with about half of the discharges suffering terminating instabilities. Alteration of n = 1 RWM control system parameters, plasma rotation profile, and the role of beta feedback is examined to potentially improve mode stability. Ion precession drift and bounce frequency resonance stabilization is examined for these plasmas and compared to the identified stabilization reduction at intermediate plasma rotation and higher li.[3]

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[2]In collaboration with S.P. Gerhardt, J.W. Berkery, J.M. Bialek.

[3]J.W. Berkery, et al., Phys. Rev. Lett. 104, 035003 (2010).