ASPECT RATIO EFFECTS ON NEOCLASSICAL TEARING MODES FROM COMPARISON BETWEEN DIII-D AND NSTX

R.J. La Haye[1], R.J. Buttery[1], S.P. Gerhardt[2], S.A. Sabbagh[3], and D.P. Brennan[4]

[1]General Atomics, P.O. Box 85608, San Diego, California 92186-5608, USA

[2]Princeton Plasma Physics Laboratory, P.O. Box 451 Princeton, New Jersey 08543 USA

[3]Columbia University, 2960 Broadway, New York, New York 10027-6900 USA

[4]University of Tulsa, 800 South Tucker Drive, Tulsa, Oklahoma, 74104 USA

ABSTRACT

Neoclassical tearing mode islands are sustained by helically perturbed bootstrap currents arising at finite beta from toroidal effects that trap a fraction of the particles in non-circulating orbits. DIII-D and NSTX are here operated with similar shape and cross-sectional area but almost a factor of two difference in inverse aspect ratio a/R. In these experiments, destabilized $n=1$ tearing modes were self-stabilized (reached the "marginal point") by reducing neutral-beam power and thus beta. The measure of the marginal island gives information on the small-island stabilizing physics that in part (with seeding) governs onset. The marginal island width on NSTX is found to be about three times the ion banana width and agrees with that measured in DIII-D, except for DIII-D modes closer to the magnetic axis, which are about two times the ion banana width. There is a balance of the helically perturbed bootstrap term with small island effects with the sum of the classical and curvature terms in the Modified Rutherford Equation (MRE) for tearing-mode stability at the experimental marginal point. Empirical evaluation of this sum indicates that while the stabilizing effect of the curvature term is negligible in DIII-D, it is important in NSTX. The mode temporal behavior from the start of neutral-beam injection reduction also suggests that NSTX operates closer to marginal classical tearing stability; this explains why there is little hysteresis in beta between mode onset, saturation and self-stabilization (while DIII-D has large hysteresis in beta). NIMROD code module component calculations based on DIII-D and NSTX reconstructed experimental equilibria are used to diagnose and confirm the relative importance of the stabilizing curvature effect, an advantage for low aspect ratio; the relatively greater curvature effect makes for less susceptibility to NTM onset even if the classical tearing stability index is near marginal.