IAEA FEC 2014

Contribution ID: **774** Type: **Poster**

Physical Characteristics of Neoclassical Toroidal Viscosity in Tokamaks for Rotation Control and the Evaluation of Plasma Response

Wednesday 15 October 2014 08:30 (4 hours)

Favorable use of low magnitude (deltaB/B ~ O(10^-3)) three-dimensional (3D) magnetic fields in tokamaks includes mitigation of ELMs and Alfvénic modes, and alteration of the plasma rotation profile to strongly affect the stability of NTMs and RWMs. However, in ITER, these fields can significantly reduce the fusion gain, Q, by increasing alpha particle transport. These effects have been theoretically addressed using neoclassical toroidal viscosity (NTV) theory [K.C. Shaing and C.T. Hsu, Nucl. Fusion 54 (2014) 033012]. NTV magnitude and profile that determines the critical 3D applied field level for Q reduction, or for rotation feedback control, depends on the field spectrum, plasma collisionality, and plasma response to the field. The present work focuses on these critical questions with new analysis of results from NSTX and KSTAR. Experimental angular momentum alteration is directly compared to theoretical NTV torque density profiles, T_NTV, created by a range of applied 3D field spectra and plasma parameters in NSTX including configurations with dominant n = 2 and n = 3 field components. Large radial variations of T_NTV are found in ideal MHD models when the flux surface displacement is derived using an assumption of a fully penetrated deltaB. In contrast, experimentally measured T_NTV does not show strong torque localization. NSTX experiments yield a computed displacement ~ 0.3cm, smaller than the ion banana width, and averaging T_NTV over the banana width more closely matches the measured dL/dt profile. Results from a model-based rotation controller designed using NTV from applied 3D fields as an actuator for instability control are shown. A favorable observation for rotation control, clearly illustrated by KSTAR experiments, is the lack of hysteresis of the rotation when altered by non-resonant NTV. These experiments also show the theoretical scaling of T_NTV with deltaB^2 and ion temperature ~ T_i^2.5. Due to this strong dependence of the T_NTV profile on deltaB, the T_NTV measurements significantly constrain the allowable field amplification. Plasma response models being tested against experiment include the fully-penetrated deltaB model, and various physics models in the M3D-C1 resistive MHD code. Analysis shows that the M3D-C1 single-fluid model produces a flux surface-averaged |deltaB| consistent with the measured T_NTV.

Country or International Organisation

USA

Paper Number

EX/1-4

Author: Mr SABBAGH, Steven (USA)

Presenter: Mr SABBAGH, Steven (USA)

Session Classification: Poster 3