IAEA FEC 201

Contribution ID: **718**

Type: **Poster**

GYROKINETIC SIMULATIONS OF TOKAMAK PEDESTALS- PRESENT EXPERIMENTS AND EXTRAPOLATION TO BURNING PLASMAS

Tuesday, 18 October 2016 14:00 (4h 45m)

For the first time, electromagnetic gyrokinetic simulations of pedestal transport are reported (inter-ELM). For the JET-ILW (ITER Like Wall) pedestal, nonlinear simulations show that Micro-Tearing Mode (MTM) turbulence produces the bulk of the transport in the steep gradient region, and the combination of MTM, electron temperature gradient (ETG), ion-scale electrostatic turbulence and neoclassical transport reproduces experimental power balance across most of the pedestal. Pedestals with nustar< *1 are often well into the second stability region, so Kinetic Ballooning Modes do not strongly affect pedestal transport- as indicated by previous linear analysis of JET-Carbon cases [1]. A rho* scan of ITER-like pedestals is performed, keeping other dimensionless parameters constant. Simulations find gyroBohm scaling of transport in the range of rho*of ASDEX/DIIID through low field JET. However, for high field JET and beyond, an insufficiency of velocity shear leads to strong ion scale electrostatic turbulence, and a strong departure from gyroBohm at lower rho** such as ITER. Inclusion of Carbon or Nitrogen greatly reduces this turbulence, so that gyroBohm scaling is reestablished through JET, and the departure at ITER is substantially reduced. Pedestal transport is also strongly affected by the separatrix density, which can be affected by gas puffing. These trends may account for observed differences in pedestal behavior in JET-ILW and JET-Carbon. Unstable electrostatic eigenmodes have an unusual structure in the pedestal, and localize where the velocity shear is low –near the top and bottom. In addition to including low Z impurities, operation with a lower separatrix density can greatly reduce the problem, which may be possible with advanced divertor geometries of Lithium. Finally, initial results indicate that low aspect ratio may have advantages for avoiding shear insufficiency.

1 S. Saarelma et. al., Nucl. Fusion 53 123012 (2013).

Paper Number

TH/P2-30

Country or International Organization

USA

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Session Classification: Poster 2

Track Classification: THC - Magnetic Confinement Theory and Modelling: Confinement