Development and validation of a critical gradient energetic particle driven Alfven eigenmode transport model for DIII-D tilted neutral beam experiments

R. E. Waltz\(^1\), E.M. Bass\(^2\), W.W. Heidbrink\(^3\), and M.A. VanZeeland\(^1\)

\(^1\)General Atomics, San Diego, CA  
\(^2\)University of California San Diego, San Diego, CA  
\(^3\)University of California Irvine, Irvine, CA

Recent experiments with the DIII-D tilted neutral beam injection (NBI), which significantly vary the beam energetic particle (EP) source profiles, have provided strong evidence that unstable Alfven eigenmodes (AE) drive stiff EP transport at a critical EP density gradient\([1]\). We hope to identify the critical gradient with the condition that the maximum local AE growth rate falls to the local ITG/TEM rate at the same low-n toroidal mode number. This condition was supported by early nonlinear local GYRO simulations [2]. It is somewhat more optimistic than stiff EP transport at the AE marginal stability gradient used in a recent ITER projection of AE driven alpha confinement losses[3]. The AE and ITG/TEM growth rates are taken from GYRO with comparison of Maxwellian to slowing down beam-like EP distribution with slightly lower critical gradient. The critical gradient condition is to be verified by nonlinear GYRO simulations of the DIII-D NBI discharges with unstable low-n AE modes embedded in high-n ITG/TEM turbulence. The ALPHA EP density transport code[3] combines the low-n stiff EP critical density gradient AE transport at the mid core radii with the Angioni et al [4] energy independent high-n ITG/TEM density transport model which controls the central core EP density profile. For the on-axis NBI heated DIII-D shot 146102, while the net loss to the edge is small, about half the birth fast ions are lost from the central core r/a < 0.5 and the central density is about half the slowing down density. Results are in good agreement with the MHD equilibrium fit NBI fast ion pressure profile.


Acknowledgement: This work was supported by the U.S. Department of Energy under GA-Grant Nos. DE-FG02-95ER54309, DE-FC02-08ER54977, and DE-FC02-04ER54698