Edge Pedestal Control in Quiescent H-Mode Discharges in DIII-D Using Co Plus Counter Neutral Beam Injection*

K.H. Burrell, General Atomics

Active control of the edge pedestal transport has been achieved in quiescent H-mode plasmas by using co plus counter neutral beam injection (NBI) to modify the edge toroidal rotation speed. This allows continuous adjustment of the pedestal density and pressure by a factor of ~2 while avoiding edge localized modes (ELMs), thus permitting operation near but below the ELM stability boundary. These plasmas exhibit edge particle transport more rapid than that produced by ELMs while operating at reactor relevant pedestal beta ~1% and collisionality ~0.1; pedestal densities up to 1/2 the Greenwald density have been achieved. The essential feature distinguishing QH-mode from standard ELMing H-mode is the presence of an edge-localized electromagnetic mode, the edge harmonic oscillation (EHO). The EHO provides sufficient particle transport to maintain the edge pressure below the ELM stability boundary. The EHO is spontaneously generated by the plasma itself and requires no external coils to generate a perturbed magnetic field. Experimental observations suggest rotation controls the edge pedestal by altering the EHO-induced particle transport. Calculations using the ELITE code show that the QH-mode operating point is near the peeling stability boundary. Much of the physics of the EHO is consistent with a model in which the EHO is an edge kink-peeling mode destabilized by shear in the edge toroidal rotation at an edge current density slightly below that on the standard ELM boundary. This theory predicts that, given sufficient rotational shear, QH-mode should be achievable with either counter or co rotation. QH-mode was first discovered in counter rotating plasmas; we now have seen QH-mode periods up to 1 second long in co-rotating plasmas.

*Supported by the US DOE under DE-FC02-04ER54698.