Reactor-relevant quiescent H-mode operation using torque from non-axisymmetric, non-resonant magnetic fields

K.H. Burrell[a], A.M Garofalo[a], W.M. Solomon[b], M.E. Fenstermacher[c], T.H. Osborne[a], J.-K. Park[b], M.J. Schaffer[a], and P.B. Snyder[a]

[a] *General Atomics, P.O. Box 85608, San Diego, California 92186-5608, USA.*
[b] *Princeton Plasma Physics Laboratory, Princeton, New Jersey, USA.*
[c] *Lawrence Livermore National Laboratory, Livermore, California, USA.*

Abstract. Results from recent experiments demonstrate that QH-mode sustained by magnetic torque from non-axisymmetric magnetic fields is a promising operating mode for future burning plasmas. Using magnetic torque from $n = 3$ fields to replace counter-I_p torque from neutral beam injection (NBI), we have achieved long duration, counter-rotating QH-mode operation with NBI torque ranging from counter-I_p to up to co-I_p values of 1-1.3 Nm. This co-I_p torque is 3 to 4 times the scaled torque that ITER will have. These experiments utilized an ITER-relevant lower single-null plasma shape and were done with ITER-relevant values of ν^*_{ped} and β_N^{ped}. These discharges exhibited confinement quality $H_{98y2} = 1.3$, in the range required for ITER. In preliminary experiments using $n = 3$ fields only from a coil outside the toroidal coil, QH-mode plasmas with low $q_{95} = 3.4$ have reached fusion gain values of $G = \beta_N H_{89} / q_{95}^2 = 0.4$, which is the desired value for ITER. Shots with the same coil configuration also operated with net zero NBI torque. The limits on G and co-I_p torque have not yet been established for this coil configuration. QH-mode work to has made significant contact with theory. The importance of edge rotational shear is consistent with peeling-ballooning mode theory. Qualitative and quantitative agreement with the predicted neoclassical toroidal viscosity torque is seen.

PACs: 52.30.Ex, 52.30.Cv, 52.25.Fi, 52.55.Fa