Edge Radial Electric Field Structure in Quiescent H-mode Plasmas in the DIII-D Tokamak*

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Experimental results from DIII-D in the past four years have demonstrated a new operating regime, the quiescent H-mode regime, which has the advantages of H-mode confinement but without the potentially deleterious effects of edge localized modes (ELMs) [1–3]. Quiescent H-mode operation is ELM-free and yet has good density control and constant radiated power for durations up to 3.8 seconds or 26 Tau_E, limited only by neutral beam pulse length. The presence of substantial edge pedestals in electron density and temperature and in ion temperature and rotation clearly demonstrates that these discharges are in H-mode. The key factors in creating the quiescent H-mode are neutral beam injection in the direction opposite to the plasma current (counter injection) plus cryopumping to reduce the density.

In addition to the absence of ELMs, a unique feature of the QH-mode is the presence of an extremely deep radial electric field (Er) well at the edge of the plasma. The location is essentially identical to that of the standard H-mode Er well, but the depth is about -100 kV/m while the standard H-mode Er well is usually about -20 to -30 kV/m. This Er well is associated with a unique profile in the edge toroidal rotation. The rotation inside the separatrix at the top of the edge pedestal is in the direction of the neutral beams at a speed of about 100 km/s while the rotation just outside the separatrix is in the direction opposite the beam direction with a speed of about 20 km/s. This oppositely directed rotation develops slowly over a period of several hundred milliseconds during the time that the ELMs cease and the edge harmonic oscillation (EHO) develops.

We have investigated the structure of the Er well and the edge rotation under a variety of conditions. These include operation at various different edge densities and with different mixes

*Work supported by U.S. Department of Energy under Contract Nos. DE-AC03-99ER54463, W-7405-ENG-48, DE-AC02-76CH03073, DE-AC05-00OR22725, DE-AC04-94AL85000 and Grant Nos. DE-FG03-01ER54615, DE-FG03-97ER54415, DE-FG03-96ER54373.

of neutral beams, which significantly modify the edge fast ion orbit loss. Results of these studies will be presented.

References:

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