Investigation of Electron Parallel Pressure Balance in the Scrapeoff Layer of Deuterium-based Radiative Divertor Discharges in DIII-D*

T.W. Petrie, S.L. Allen,† T.N. Carlstrom, D.N. Hill,† R. Maingi,‡ D.G. Nilson,† M. Brown,†
D.A. Buchenauer,# T.E. Evans, M.E. Fenstermacher,† R.A. Jong,† C.J. Lasnier,†
A.W. Leonard, M.A. Mahdavi, G.D. Porter,† M.R. Wade,Δ and W.P. West
General Atomics, P.O. Box 85608, San Diego, California 92186-9784

We investigate electron parallel pressure balance in the scrape-off layer (SOL) of deuterium-generated radiative divertor discharges under both ELMing H–mode and L–mode operating conditions. Electron pressure near the midplane and in the divertor are obtained from Thomson scattering measurements. T_i-profiles are measured only for the midplane SOL.

The partially detached divertor regime (PDD) is established when sufficient cold deuterium gas is injected during ELMing H–mode (or L–mode) operation to trigger the formation of a high density, highly radiative region extending from near the X–point down toward the divertor target. Electron density near the X–point is at least an order of magnitude greater than that found at the midplane or near the divertor separatrix intercept, as was initially *inferred* in Refs. 1,2. In this regime, the electron pressure between the midplane separatrix and the X–point may drop by ~2–3 times. A further reduction in the electron pressure along the separatrix is observed between the X–point and the divertor target (~3–4 times). However, we have observed that the electron pressure appears to *increase* between the midplane and divertor target along flux surfaces farther into the SOL, which suggests that parallel momentum is being transferred radially outward from the separatrix flux surface. The distributions of highest radiated power density and highest electron pressure in the outer divertor leg extend across the magnetic flux surfaces and are roughly coincident with each other. The above results are in contrast to non-gas injected cases, where electron pressure along the separatrix (and in the SOL) may drop by, at most, a factor of two between the midplane and the divertor target.

Low and moderate input power cases (≤ 10 MW) are considered in this paper. In particular, successful PDD operation at low power input (~2 times the L–H mode transition power) is presented and its applicability to an ITER-type device (which could operate in a regime near the L–H threshold) is discussed.

---

*Work supported by the U.S. Department of Energy under Contract Nos. DE-AC03-89ER51114, W-7405-ENG-48, DE-AC04-94AL85000, and Grant No. DE-FG03-95ER54294.
†Lawrence Livermore National Laboratory.
‡Oak Ridge Associated Universities.
#Sandia National Laboratories.
[1] T.W. Petrie, D. Buchenauer, D.N. Hill, *et. al.*, J. Nucl. Mater. **196–198** (1992) 848.
[2] T.W. Petrie, A.G. Kellman, M.A. Mahdavi, Nucl. Fusion **33** (1993) 929.