

an Invited Paper
1996 Meeting of
the American Physical Society

Detached Divertor Plasmas in the DIII-D Tokamak¹

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Spatial profiles of divertor plasma density, temperature, and ionization conditions in which there is a strong reduction in plasma pressure in the scrape-off layer (Partially Detached Divertor). This regime is desirable because it can reduce the heat flux to the divertor by up to a factor of 10 by the increased radiation, thus allowing for higher plasma densities in the core. The data presented here are obtained using a newly developed diagnostic system optimized for measuring the high electron densities and temperatures ($n_e \leq 10^{21} \text{ m}^{-3}$, $0.5 \text{ eV} \leq T_e$). These data are correlated with measurements from laser interferometers, VUV spectrometers, bolometers, and visible-light spectroscopy. The radiation is nearly constant along field lines in attached plasmas, consistent with the observation that the radiation in the divertor increases the plasma radiation and lowers T_e to a value where this temperature is low enough to allow ion-neutral collisions, which play an important role in reducing the electron pressure along the magnetic field lines. At these temperatures, molecules may also be present in significant quantities (Kashennikov, et al., J. Nucl. Mater. 1996). Farther out in the divertor, the radiation is higher than those on the same flux surface at the midplane, so only part of the radiation is captured by the spectroscopy and 2-D images of impurity emission show that the radiation in the upper divertor regions near the X-point, and the uniformity of radiated power density within a factor of 2 along the field lines was obtained. Similar heat flux reduction was observed when the radiation is increased and reduce the energy transport in the SOL plasma. A comparison of the results with simulations with the UEDGE code will also be discussed.

Contract Nos. W-7405-ENG-48 and DE-AC03-89ER51114.