ECRH Plasma Experiments at B=1 T in HSX

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The HSX program has focused on understanding the potential benefits, as well as any possible negative effects, of quasihelical symmetry (QHS) on confinement. To achieve this goal, we have concentrated on heating electrons to the low collisionality regime with a 28 GHz gyrotron at a magnetic field in HSX of 0.5 T, and recently at 1.0 T. Tests of quasisymmetry are made by comparing experimental results to a configuration in which the symmetry is degraded and the neoclassical transport is increased (Mirror mode of operation). To date, we have shown that in the QHS configuration there are reductions in particle, momentum and heat transport compared to a conventional stellarator: reduced drifts of passing particles from flux surfaces, reduction of direct loss orbits of deeply trapped electrons, decreased parallel viscous damping and larger driven flows, more peaked density profiles and higher central electron temperatures.

At a magnetic field of 0.5 T, transport analysis was performed on discharges in which the power was adjusted for the two configurations such that the density and temperature profiles roughly matched. The results show that the experimental thermal diffusivity is significantly reduced in the core of the QHS plasma (2.5 m^2/s in QHS, compared to 4 m^2/s in Mirror) due to the decrease in the neoclassical transport. Throughout most of the Mirror plasma and all of the QHS plasma, anomalous thermal conductivity dominates. First reflectometry results show a difference in core turbulence levels between configurations, with a single coherent mode in the QHS configuration and a broad spectrum at significantly higher level to the core turbulence when the symmetry is broken. Using a model that combines neoclassical plus anomalous transport due to the trapped electron mode, good agreement with HSX profiles has been obtained.

This work is now being extended to the 1 T magnetic field and with an improved quasi-optical transmission line to deliver more power to the torus. For ordinary mode heating at higher density and power than at 0.5 T, the nonthermal contribution to the stored energy that we observed at the lower field is now greatly reduced. With an input power of 100 kW and a line-average density of 5×10^{12} cm^{-3}, we have measured central electron temperatures of 2.5 keV in QHS and 1.5 keV in Mirror. Also, we have begun looking at differences in the equilibrium currents between the symmetric and nonsymmetric configurations. These results show the expected reduction in magnitude of these currents commensurate with the high effective transform in HSX. Additionally, the helical nature of the Pfirsch-Schlüter current due to the lack of toroidal curvature has been confirmed. The latest results from HSX will be presented.