Overview of Recent Results from HSX

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In the quasi-helically symmetric (QHS) configuration, significant reductions in direct loss orbits, parallel viscous damping and neoclassical thermal transport are predicted compared to a conventional non-symmetric stellarator. The quasi-symmetry can be broken in HSX through the introduction of a toroidal mirror term in the magnetic field spectrum. The mirror term phased to give the highest trapped-particle fraction at the ECH launch (so-called antiMirror) gives poor power absorption and low stored energies. The opposite phase mirror gives absorption and stored energies not significantly different from the QHS case. Experiments on 2nd harmonic ECH at B=0.5 T have been extended to up to 100 kW injected power. For QHS plasmas, T_{e0} measured by Thomson scattering rises linearly with heating power to 600 eV at 100 kW of launched power and a central line-averaged density of 1.5 x 10^{12} cm^{-3}. At lower densities (0.7 x 10^{12} cm^{-3}) electron temperatures as high as 1000 eV have been measured. The highest stored energies have been achieved in QHS discharges at densities of 0.4 x 10^{12} cm^{-3} when using a gas valve location that has the largest distance from the plasma edge to the magnetic axis. 2-D DEGAS simulations are used in conjunction with multichord H_α measurements to estimate the neutral distribution. Flows induced with a biased electrode have been measured with a Mach probe in the QHS and mirror configurations. Measurements show damping is dominated by ion-neutral friction in the QHS case, with parallel viscosity leading to faster damping with broken symmetry. Doppler spectroscopy on carbon and oxygen impurities has been used to non-invasively look at flows in unbiased plasmas. Little flow is seen in QHS plasmas (<1 km/s), in agreement with Mach probe data. In mirror plasmas, the magnitude of the flow is increased, and the flow reverses direction when the magnetic field is reversed. Under these conditions large negative potentials are observed on plates located in the electron grad-B drift direction at the ECH launcher. Identical plates located 180 degrees toroidally away from the launcher show little signal and no asymmetry.

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