"Flow dynamics and plasma heating of spheromaks in SSX"

M. R. Brown, C. D. Cothran, D. Cohen, J. Horwitz, V. Chaplin

Swarthmore College

Swarthmore, PA 19081 USA

doc@swarthmore.edu

We report several new experimental results related to flow dynamics and heating from single dipole-trapped spheromaks and spheromak merging studies at SSX. Single spheromaks (stabilized with a pair of external coils, see Brown, *Phys. Plasmas* **13** 102503 (2006)) and merged FRC-like configurations (see Brown, *Phys. Plasmas* **13**, 056503 (2006)) are trapped in our prolate ($R = 0.2\ m, L = 0.6\ m$) copper flux conserver. Local spheromak flow is studied with two Mach probes ($r_1 \leq \rho_i, r_2 \geq \rho_i$) calibrated by time-of-flight with a fast set of magnetic probes at the edge of the device. Both Mach probes feature six ion collectors housed in a boron nitride sheath. The larger Mach probe will ultimately be used in the MST reversed field pinch. Line averaged flow is measured by ion Doppler spectroscopy (IDS) at the midplane. The SSX IDS instrument measures with 1 μs or better time resolution the width and Doppler shift of the C_{III} impurity (H plasma) 229.7 nm line to determine the temperature and line-averaged flow velocity (see Cothran, *RSI* **77**, 063504 (2006)). We find axial flows up to 100 km/s during formation of the dipole trapped spheromak. Flow returns at the wall to form a large vortex. Recent high-resolution IDS velocity measurements during spheromak merging show bi-directional outflow jets at $\pm 40\ km/s$ (nearly the Alfvén speed). We also measure $T_i \geq 80\ eV$ and $T_e \geq 20\ eV$ during spheromak merging events after all plasma facing surfaces are cleaned with helium glow discharge conditioning. Transient electron heating is inferred from bursts on a 4-channel soft x-ray array. The spheromaks are also characterized by a suite of magnetic probe arrays for magnetic structure **B**(r,t), and interferometry for n_e. Finally, we are designing a new oblate, trapezoidal flux conserver for FRC studies. Equilibrium and dynamical simulations suggest that a tilt-stable, oblate FRC can be formed by spheromak merging in the new flux conserver.

A1, A2, E5, E6