

13th International Stellarator Workshop

Plasma thermal energy dependence on field ripple and direct orbit losses*

A. F. Almagri, D. T. Anderson, C. Deng, S. Gerhardt, J. N. Talmadge.

University of Wisconsin-Madison

Plasma in the helically symmetric experiment (HSX) is generated by a 28 GHz, 200kW gyrotron system operated in the x-mode second harmonic at 0.5 T. HSX can operate in many regimes. The main operating regime is the “QHS mode” where the magnetic spectrum is dominated by the helical term and the magnetic structure has helical symmetry. Another operational regime is called the “Mirror mode”. In this mode of operation, an additional set of magnet coils, “Aux. coils”, are energized to produce a spectral component that has a poloidal mode number $m = 0$ and a toroidal mode number $n = 4$. These coils introduce a symmetry breaking term into the magnetic spectrum. With these coils on, with 10% ripples in the mod(B), the HSX magnetic spectrum resembles a conventional stellarator.

The energy content of HSX plasma is measured with a unique diamagnetic diagnostic consisting of a flux loop and a compensating coil. This set of loops allows the measurement of energy without modeling the effects of eddy currents or the coil current redistribution. A set of three Surface Barrier Diode (SBD) detectors with different Be filters is used to measure the soft X-ray emission along the same line of sight to determine the central electron temperature as a function of time.

In the experiments described here, the resonance location was varied from the inboard side to the outboard side, during both regimes of operation, with approximately 50 kW of launched power. In the Mirror mode, the plasma energy strongly depends on the resonance location. There is a large asymmetry in energy content of the plasma as a function of the resonance location. However, in the QHS mode, the plasma energy exhibits a symmetric dependence on the location of the ECH resonance. When the magnetic field is adjusted such that the resonance is in the inboard side, the energy content is similar in both regimes of operation. This is consistent with the reduced fraction of trapped particles with inboard heating. However, when the resonance is located in the outboard side, the energy content strongly depends on the mode of operation. In the QHS mode, the plasma energy can be as high as 45 joules whereas in the Mirror mode, the energy content can be as low as 5-10 joules. These results are consistent with direct orbit losses.

The plasma energy is observed to increase with plasma density in the Mirror mode. However, plasma energy decreased with density in the QHS mode of operation. For the Mirror case, at the low-density end the direct orbit losses are important as a result plasma energy is low. As plasma density is increased more trapped particles become untrapped and stay confined resulting in a higher energy content. These mechanisms may be responsible for the increase in plasma energy as the density is increased.

The magnitude of the field ripple, Mirror mode, has been varied from 0 up to 10 % to study how the plasma energy content depend on this magnitude. Plasma energy decreases with ripple amplitude. The results of these studies of plasma energy dependencies on resonance location and on the magnetic field ripples will be presented.

* Work supported by the US DoE under grant DE-FG02-93-ER54222.

Topic : (2) Transport and confinement improvement
Poster is preferred : NO
Email : aalmagri@facstaff.wisc.edu