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OVERVIEW OF THE QPS EXPERIMENT

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A quasi-poloidal stellarator with very low plasma aspect ratio ($\langle R\rangle/\langle a\rangle \sim 2.7$, 1/2-1/4 that of existing stellarators) is a new magnetic confinement approach that could ultimately lead to a high-beta ($\langle\beta\rangle = 7$-15%) disruption-free compact stellarator reactor. In this approach the dominant components in the magnetic field spectrum are poloidally symmetric in flux coordinates. The degree of quasi-poloidal symmetry decreases with radius but increases with β. In the plasma core the magnetic energy in non-poloidally symmetric field components is less than 10% of that in the poloidally symmetric field components and rises to 30% at the plasma edge. The quasi-poloidal symmetry leads locally to small B x grad B drifts out of a flux surface over most of the plasma cross section and reduced neoclassical transport at low collisionality. The high degree of quasi-poloidal symmetry and the reduced effective field ripple may also reduce poloidal viscosity, enhancing the naturally occurring E x B poloidal drifts and allowing larger poloidal flows for possible shear damping reduction of anomalous transport. For exact poloidal (θ) symmetry, the canonical angular momentum p_θ would be conserved and: (1) the orbit excursions from a flux surface would be limited to the gyroradius in the *toroidal* magnetic field ρ_T rather than in the *poloidal* magnetic field ρ_p (the banana width) where $\rho_T << \rho_p$; (2) there would be no flow damping in the poloidal direction; and (3) the bootstrap current would be reduced by ι/N where ι is the rotational transform (= 1/q) and N is the number of field periods. The magnetic configuration is relatively insensitive to increasing beta and is similar to that in the W7-X approach, but at 1/4 the plasma aspect ratio. In contrast to W7-X, a self-consistent bootstrap current is included in the configuration optimization and a different physics mechanism is responsible for the reduced neoclassical transport.

The Quasi-Poloidal Stellarator (QPS) experiment [1] is being developed to test key features of this approach. QPS has $\langle R_{plasma}\rangle = 0.9$-1 m, $\langle a_{plasma}\rangle = 0.3$-0.4 m, $\langle B_{axis}\rangle = 1$ T for a 1.5-s pulse, and $P_{heating} = 1$-3 MW. The experiment is designed to study regimes in which either anomalous transport or neoclassical transport is dominant, equilibrium robustness at finite beta, and stability limits at $\langle\beta\rangle \sim 2.5\%$. Kink and vertical modes are stable at $\langle\beta\rangle \sim 5\%$ without feedback or close conducting walls. The poster will address the physics basis for the QPS approach, the relationship with other stellarator concepts, the key features of the proposed QPS experiment, and the connection to higher-beta quasi-poloidal-stellarator configurations.

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[1] J. F. Lyon and the QPS team, "QPS, A Low Aspect Ratio Quasi-Poloidal Concept Exploration Experiment", http://qps.fed.ornl.gov/, April 2001.