SOFE05-111

MODULAR COIL DESIGN FOR THE ULTRA-LOW ASPECT RATIO QUASI-AXIALLY SYMMETRIC STELLARATOR MHH2*

L. P. Ku and the ARIES Team
Princeton Plasma Physics Laboratory, PO Box 451, Princeton, NJ 08543-0451
lpku@pppl.gov

During the course of ARIES-CS reactor studies, we discovered a family of 2 field-period stellarator configurations, MHH2, in which the magnetic field structure was optimized to be nearly toroidally symmetric and the plasma aspect ratio was only ~2.5. They have very low field ripples, resulting in good confinement of α particles (energy loss <10%). This raises the prospect of them being the candidate for compact power producing reactors able to operate in a steady state at high β with low recirculating power and minimal disruptions. However, their attractiveness as compact, smaller sized reactors can only be realized if coils can also be designed with sufficient compactness and with good engineering properties. In particular, for a reactor, sufficient space between the plasma and coils must be provided to accommodate the blanket for tritium breeding. Radiation shielding must also be in place for the coil protection. If the ratio of the major radius to the plasma-coil separation gets too small, the shape of the coils may become too complex to be attractive. If the ratio gets too large, the size of the machine may become too big to be compact, irrespective of the compactness of the plasma. In addition, the maximum magnetic field, hence the power density, in the plasma, is limited by the maximum allowable field in the coil body, which in turn depends on the complexity of the coils. Coils must also have adequate separation among themselves to allow for ease of port installation, machine assembly and remote maintenance.

In this paper, we present recent results in designing modular coils for this ultra-low aspect ratio family of configurations. The design optimization is made more challenging because the low aspect ratio makes the real estate inside the donut hole more precious. We found designs with sixteen coils that are able to produce plasmas with good quasi-axial symmetry and low α loss. These coils have large separation from the plasma, with the major radius to minimum separation ratio <5.5, hence reactors of major radii ~8 m become possible. These coils are also reasonably smooth with large bend radii and moderate maximum fields in the conductor body relative to the field in the plasma.

*Work supported by U.S. DOE Contract No. DE-AC02-76CH03073.