3D Equilibrium Reconstruction with Islands

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There are many situations where the nested flux surface topology of fusion plasmas break. When resonant magnetic perturbations (RMP) for edge localized mode control are applied nested magnetic surfaces can tear resulting in magnetic islands. During disruptions, equilibrium surfaces can break down to the point of stochastic field lines. The normal operation of tokamaks and advanced stellarators break the nested surfaces at the last closed flux surface to control the exhaustion of hot plasma. Equilibrium reconstruction has played an important role in determining unknown quantities and setting the basis for advanced modeling. To understand scenarios like these, it is critical to be able to reconstruct equilibria with arbitrary topologies.

Until recently, 3D reconstruction using V3FIT[1], which is based on VMEC[2], has been limited to plasmas with closed nested flux surfaces. V3FIT has been extended to include SIESTA[3] as an equilibrium solver allowing for non-nested or stochastic magnetic topologies. Using a VMEC equilibrium as background coordinates, SIESTA tears the nested magnetic surfaces by applying resonant magnetic perturbations. Reconstruction determines the strength of these magnetic perturbations along with other equilibrium quantities by matching synthetic signals to physical measurements.

Experiments show that measured temperature profiles flatten inside magnetic islands. Using this signal information the first ever reconstruction of a non-nested equilibrium topology was performed on the DIII-D experiment[4]. This presentation will highlight the methods used to reconstruct non-nested topologies and show preliminary results of reconstructing island diverter cases using the new free boundary SIESTA[5].

References

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