

### **3D Equilibrium reconstruction of Helical Cores in the DIII-D Tokamak**

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Internal helical cores or snake like magnetic axis perturbations are possible solutions to the 3D MHD Equilibrium equations when there is a reverse shear in the  $q$  profile. As the minimum  $q$  approaches a resonance, the VMEC equilibrium solution can bifurcate between an axisymmetric solution and a helical solution. Given some initial perturbation, a helical solution is possible even when the boundary remains axisymmetric. Helical core equilibria have been observed and reconstructed in the RFX-Mod and MST RFPs. In conventional and spherical tokamaks, internal helical cores have been measured and observed but the equilibrium properties have not been reconstructed. Recent experiments performed on the DIII-D tokamak show possible indications of helical core activity on MSE, ECE and SXR diagnostics. 3D equilibrium reconstruction can provide conclusive evidence on actual state of the equilibrium.

To reconstruct helical cores, a number of improvements have been made to the V3FIT reconstruction code including but not limited to new diagnostic signal development and parallelization. Recent work has completed a coupling between an already parallelized V3FIT with a newly parallelized PARVMEC. When exploiting ORNL super computer resources, reconstruction computational time is greatly reduced.

Starting from an EFIT solution, axisymmetric equilibrium results are incorporated into the V3FIT reconstruction via an initial guess and as Bayesian priors. MSE signals contain information on current profile parameters. ECE and SXR diagnostics contain information about the location of the magnetic axis. Combined, these signals should distinguish between an axisymmetric and helical state. This presentation will report on recent V3FIT development, optimal equilibrium model parameterizations and results of reconstructing a DIII-D shot showing initial indications of a helical core.

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