Exploration of the Equilibrium and Stability Properties of Spherical Tokamaks and Projection for MAST-U


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ABSTRACT

- The disruption event characterization and forecasting (DECAF) code is utilized to map disruptions in MAST; VDEs were not found to be common.
- Equilibrium reconstructions work well for MAST, inclusion of rotation was tested, and procedures are set up for MAST-U, including a 3D wall model.
- A machine learning algorithm for stability calculation developed for NSTX was applied to MAST plasmas; warning levels have been calculated.
- Projections of MAST-U stability indicate a region of high β operational space where new passive stabilization plates stabilize ideal kink modes.

BACKGROUND

- The MAST-U experiment, an upgrade of the MAST device, recently began plasma operations and is entering its first physics campaign.
- In preparation for MAST-U high β₀ operation, research was performed on the existing database of MAST discharges on the topics listed above.
- Recent publications [1,2] outline the progress in MAST-U equilibrium and stability. This poster/paper summarizes that work, with new details.

DISRUPTION EVENT CHARACTERIZATION AND FORECASTING

THE DECAF CODE

The DECAF code identifies chains of events that lead to disruptions and the specific physics elements that comprise those chains [3]. The code can generate diagrams showing the probability of a DECAF event occurring within a given parameter space of tokamak operation.

VERTICAL DISPLACEMENT EVENTS

The DECAF code declares that a VDE event has occurred when axis position (|Z|), axis velocity (|dZ/dt|), and Z dZ/dt pass threshold levels set by the user. The region of κ, l, parameter space where the VDE event was detected in DECAF can be quite different from where plasmas end up at the disruption (DIS) event. One possible explanation for the relative lack of VDE events found for MAST is that MAST had (and MAST-U has) close fitting internal coils that were used for active vertical control.

CONCLUSIONS

In preparation for MAST-U, equilibrium and stability properties of plasmas in the MAST database, as well as projections for MAST-U, were explored. DECAF analysis showed low VDE levels. Equilibrium reconstruction works well for MAST and is set up for MAST-U. ML stability tools progress further, and projections show a region of potential high beta stability in MAST-U.

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