Contribution ID: **509** Type: **Oral Presentation**

# EX/9-3: Disruptions in the High-beta Spherical Torus NSTX

*Friday, 12 October 2012 11:25 (20 minutes)*

Disruptions in next-step tokamak devices, whether at conventional or low aspect ratio, must be rare, predictable, and have minimal consequences for the plant. This paper addresses these issues using data the National Spherical Torus Experiment (NSTX). The disruptivity increases rapidly for $q^*<2.5$, but does not show a strong dependence on $\beta N$; more complicated physics such as kinetic stabilization plays a role in determining the disruptive $\beta N$ limit. The lowest disruptivity is at higher-$\beta N$, where the large bootstrap current prevents the current profile from evolving to a kink/tearing unstable state. Many disruption precursors have been investigated from a database of >2100 disruptions, including direct measurement of MHD signals, confinement indicators, and parameters of the equilibrium evolution. Disruptive thresholds on these quantities have been defined, often using physics based 0-D models of the plasma behavior. Compound disruption warnings are formed from the weighted sum of binary threshold tests. These compound tests can be used to detect ˜99% of disruptions with at least 10 ms warning time, with a false-positive rate of ˜8%. Missed disruptions are often driven by resistive wall modes, while the false positive count is dominated by modes that slow and often lock, but do not disrupt.

Once a disruption begins, the NSTX plasma typically becomes vertically unstable, and halo currents are observed to flow. Halo current fractions >30% have been observed, with the largest currents typically in Ohmic and L-mode plasmas; large halo currents often occur in cases with the largest current quench rates. Both the final disruption onset and the growth of large halo currents typically correspond to the edge q dropping to 2, although some currents are observed during the phase of the VDE with higher edge-q. The halo current patterns are not toroidally symmetric, and the non-axisymmetry is observed to rotate toroidally up to 7 times, with typical rotation frequencies of 0.5-2 kHz, although the rotation is often non-steady. The rotation frequency is anti-correlated with the halo current amplitude. The non-axisymmetric part of the halo current typically decays before the $n=0$ part, and modeling indicates that the loss of the $n\neq0$ current corresponds to the time when the last closed magnetic surface vanishes.

This work was supported by the U.S. DOE.

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**Session Classification:** Disruptions & Post-Deadline Papers

**Track Classification:** EXS - Magnetic Confinement Experiments: Stability