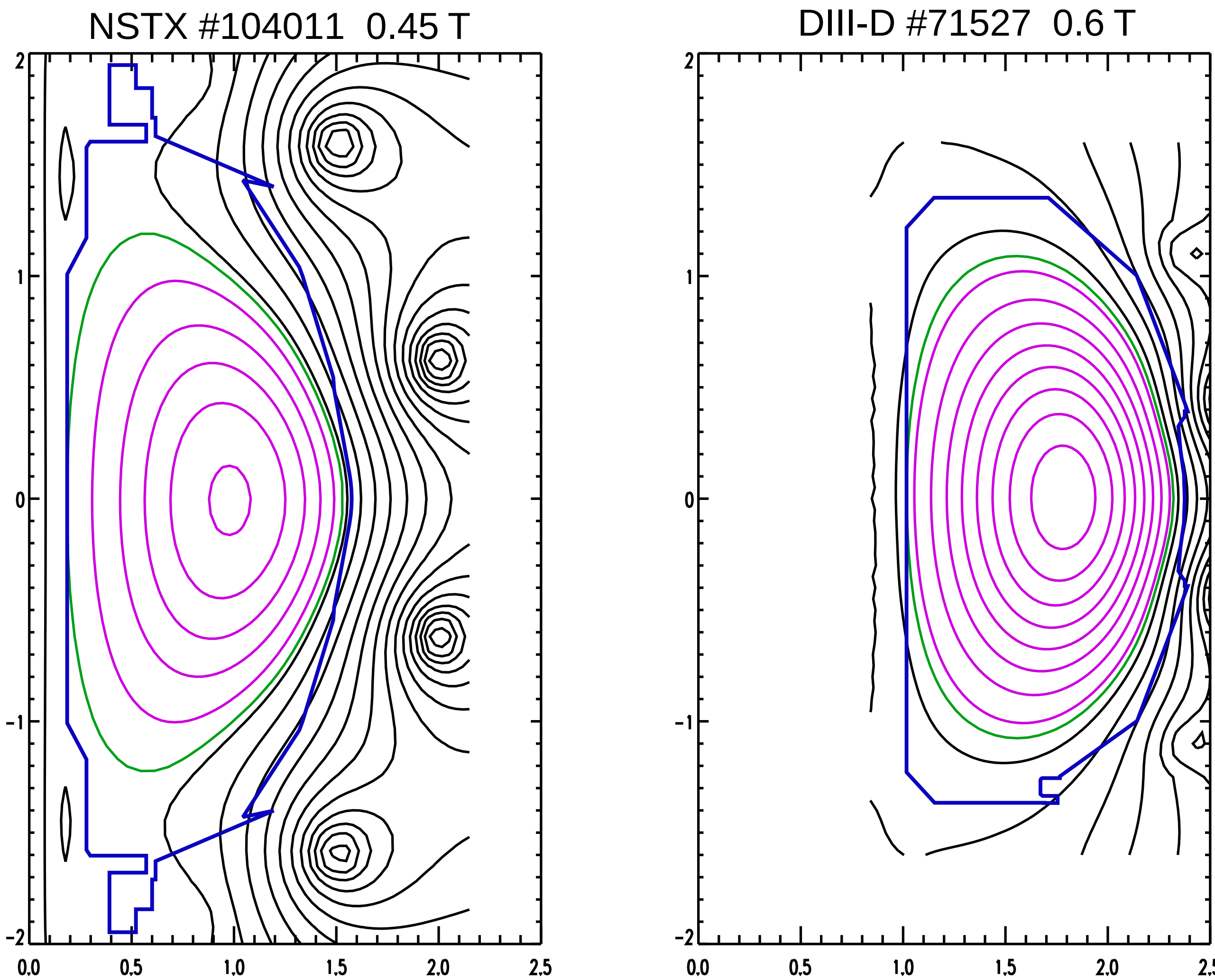
NSTX/DIII-D Alfven Mode Similarity Experiment

W.W. Heidbrink et al.



@ NSTX and DIII-D can match shapes and toroidal fields.

@ Both use 80 keV co-injected, deuterium beams.

=> Can match all Alfven mode parameters and study effect of toroidicity.

Primary Experimental Goals:

1) Compare the stability thresholds for TAE/EPM (and CAE).

2) Measure the toroidal mode number of the most unstable mode.

Motivation:

@ Larger gaps in the Alfven continuum in the ST. Is it more unstable? Does the transition to EPM occur at higher beta?

@ Kinetic effects. Effect of larger value of diamagnetic drift frequency : Alfven frequency. More field variation alters resonances?

@ Major radius scaling of most unstable mode--important for prediction of a "sea" of unstable modes in a burning plasma experiment.

@ Necessary to avoid Alfven modes in a thermal confinement similarity experiment.

Notes on First Slide (EFITs)

1. One day in the 2002 campaign is already allocated on DIII-D.

2. The shapes of the illustrated efits do not match perfectly because these are actual plasmas that have already been made on the respective machines. The figure is meant to show that a close match is feasible.

3. Officially, NSTX can operate with a toroidal field of 0.6 T (although it hasn't yet). In 1991, we operated DIII-D with some difficulty at 0.6 T for Alfven mode studies. Since the PCS does a better job of controlling the field null at startup, I'm told that 0.4 T is now feasible and actually happened accidentally once.

4. Since the injection energy, density, and toroidal field can be close, the ratio of beam speed to Alfven speed v_b/v_A will be well matched.

5. Another issue is the fraction of beam ions that are on circulating or trapped orbits. This can be matched by using the "A" and "B" sources on NSTX and the "Right" sources on DIII-D.

6. The central q value is important. In DIII-D discharge 71527, sawteeth-related instabilities had a large effect on the beam population. It is desirable in this experiment to run at higher elongation to raise q and to inject earlier.

Notes on Second Slide (Motivation)

1. The stability threshold is found by "stair-stepping" the beams.

2. Magnetics are the primary diagnostic but reflectometer measurements are also important and are feasible on both machines. DIII-D does not currently have a magnetics diagnostic suitable for CAE measurements at 6 kG but an effort to acquire data up to 5 MHz is planned.

3. Both the toroidicity-induced and the beta-induced gap are larger in an ST.

4. Theoretically, the frequency of the TAE moves toward the lower continuum as beta increases. The "BAE" (EPM) transition is more likely to occur when the frequency hits the continuum.

5. Theoretically, the ratio of ω_{*pi}/ω_A is important for the coupling of sound waves and Alfven waves. It scales with aspect ratio.

6. To some extent, these theoretical effects of low-aspect ratio may already explain some peculiarities of DIII-D observations relative to TFTR and other higher-aspect ratio tokamaks. In other words, this experiment helps us understand *AE in conventional tokamaks.

7. There are differing theoretical predictions for the scaling of the most unstable mode with major radius.

8. A similarity experiment to study thermal confinement is also of interest and will piggyback on the DIII-D stability experiment. The thermal confinement study cannot be conducted unless a regime with weak Alfven activity is found.