Contribution ID: **956** Type: **Poster**

Suppression of Alfvén modes through additional beam heating

Friday, 21 October 2016 14:00 (4h 45m)

The International Tokamak Experimental Reactor (ITER) will have a large population of non-thermal, energetic ions consisting of fusion generated alphas and beam ions injected for current profile control. Potential redistribution and/or loss of those non-thermal ions is thus of concern as it will modify heating profiles, current profiles, and losses could lead to unacceptable local heating of plasma facing components. Redistribution and losses of fast ions have been documented as resulting from multiple Alfvénic modes, Toroidal Alfvén Eigenmodes and energetic particle modes (fishbones) on many smaller plasma devices. This paper presents experimental evidence that some fast ion driven instabilities can be suppressed by modifying the fast-ion distribution function. The experimental results were modeled using the HYM code and provide a valuable validation of our theoretical understand of fast-ion-driven instabilities. ITER will necessarily have a large population of fusion-generated super-Alfvénic alphas, and like the beam ions in NSTX-U, these alphas will excite a variety of beam-driven instabilities. Neither NSTX-U, nor any other operating tokamak can simultaneously match all relevant fast-ion parameters to those expected for ITER, so predictions of fast-ion driven modes on ITER will rely on well-developed and validated theory. NSTX-U, which sees a broad spectrum of modes excited by the neutral beam ions, provides a laboratory to improve our understanding of this physics and to develop tools to control these instabilities, or to predict their affect on ITER.

Paper Number

PDP-3

Country or International Organization

USA

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Session Classification: Poster 8

Track Classification: EXW - Magnetic Confinement Experiments: Wave–plasma interactions; current drive; heating; energetic particles