High resolution global mode structure measurements via multichannel reflectometry in NSTX*

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Global modes play a critical role in many aspects of fusion plasma performance. For instance, kinks can modify equilibrium profiles and can eventually lead to plasma disruption. Energetic particle modes and Alfvén eigenmodes (AE) can significantly impact fast-ion transport in neutral beam heated plasmas, and are predicted to be important in alpha-heated burning plasmas such as ITER. The investigation of global modes in the National Spherical Torus Experiment (NSTX) is routinely aided by an array of fixed-frequency quadrature reflectometers used to determine the radial density perturbation structure of a variety of modes. The recently upgraded reflectometer array has 16 channels spanning the frequency range 30 – 75 GHz (n_{cutoff} = 1.1 – 6.9 x 10^{19} m^{-3} in O-mode). The upgrade allows structure measurements with higher spatial resolution and also allows access to the core of high density plasmas, including in particular high power (up to 6 MW) beam-heated H-mode plasmas. The new capabilities of the array have been exploited to obtain structure measurements (both amplitude and phase) of several types of global modes. Measurements of global AE (f > ~ 350 kHz) structure have been obtained in the core of high density (n_0 ~ 7 x 10^{19} m^{-3}), beam-heated H-mode plasmas in an experiment to study global AE-induced electron thermal transport. Toroidicity-induced AE (f ~ 50 – 250 kHz) structure has been measured with unprecedented spatial resolution for future comparison with the predictions of codes such M3D-K and NOVA-K. Notably, the observed toroidicity-induced AEs exhibit signficant radial phase variation. The structures of kinks and energetic particle modes (f < ~ 30 kHz) have also been measured with high spatial resolution. These initial results from the upgraded reflectometer array illustrate the potential for significantly improving our understanding of a wide array of global modes on NSTX through detailed comparison of structure measurements with theoretical/code predictions.

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