Energetic Particle research on NSTX-U

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Spherical Torii with Neutral Beam (NB) injection typically feature a large fraction of super-Alfvénic fast ions. Those energetic particles (EP) can drive a number of instabilities, which in turn affect the EP population and related quantities such as NB heating and current drive. The resulting deterioration of plasma performance must be addressed while moving forward with the ST programme, e.g. towards a ST-based Fusion Nuclear Science Facility. Experiments on NSTX have resulted in an extensive characterization of EP-driven instabilities over a broad range of frequency, including fishbones and other kink-like modes at low frequency (10's of kHz), toroidal Alfvén eigenmodes (TAEs, near the Alfvén frequency) and Global/Compressional AEs near the ion cyclotron frequency. The effects of those instabilities have been measured, indicating – for example – the deleterious effect of large-amplitude, bursting TAE events on EP confinement. This work will present the latest results from analysis of NSTX data, including modeling of mode stability through linear and non-linear codes, and modeling of the associated fast ion transport. In particular, the development and validation of reduced models for fast ion transport by AEs will be emphasized, focusing on the improvement of predictive capabilities for EP physics that is relevant for both STs and conventional aspect ratio tokamaks. The completion and start of operations of NSTX-Upgrade offer enhanced tools to further improve our understanding of EP physics, e.g. higher toroidal field and plasma current, and an additional set of NB injectors. An overview of the planned experiments for the coming NSTX-U campaign will be given.