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Degradation of Neutral Beam heating & current drive by Alfvénic instabilities

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Neutral beam injection in tokamaks results in a population of energetic particles (EP) that can drive instabilities in the Alfvén frequency range. In turn, instabilities can lead to redistribution or loss of EPs, thus affecting the controllability and predictability of quantities such as neutral beam (NB) current drive efficiency and radial profile of the non-inductive current fraction. In this work, examples from NSTX and NSTX-U discharges featuring robust Alfvénic activity are discussed to investigate the reduction of NB current drive by instabilities. Recent improvements to the tokamak transport code TRANSP enable quantitative, time-dependent simulations of NB-heated plasmas in the presence of EP-driven instabilities. In particular, a new physics-based model has been implemented in TRANSP to account for the resonant interaction between EPs and instabilities, which results in more reliable simulations than previously achieved using a simple, ad-hoc diffusive model. Results show that instabilities can strongly affect the EP distribution function. Modifications with respect to 'classical'EP behavior (i.e., in the absence of instabilities) propagate to macroscopic quantities such as the profiles of NB-driven current and of the local EP power transferred to the thermal plasma species through thermalization. For scenarios with multiple unstable EP-driven instabilities, the computed reduction in NB current drive efficiency can be as high as 40% with respect to classical simulations.

Eligible for student paper award?

No

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