Contribution ID: **67** Type: **Invited (Plenary Session)**

Energetic particle transport in NSTX/NSTX-U multi-mode scenarios through integrated simulations

Thursday, 5 September 2019 09:15 (35 minutes)

In magnetically confined plasmas, energetic particles from Neutral Beam injection, fusion reactions or RF acceleration are susceptible to enhanced transport by several classes of instabilities, thus potentially leading to degraded plasma performance. Depending on its properties (e.g. frequency, mode number spectrum and radial structure), each type of instability can affect the fast ion population differently, for instance in terms of modification of the radial vs energy gradients. This work investigates modifications of the fast ion distribution in NSTX/NSTX-U scenarios featuring simultaneous low-frequency MHD (kink and fishbones) and Alfvénic modes (AEs) such as Toroidal and Reversed-shear AEs. Interpretive analysis is performed through the TRANSP tokamak transport code, enhanced by the reduced-physics 'kick model'for fast ion transport by instabilities [M. Podestà et al., Plasma Phys. Control. Fusion **59** (2017) 095008]. It is shown that the different instabilities can affect each other's evolution through modifications of the fast ion distribution function, which in turn affects the mode drive and overall stability. For example, core-localized kink modes can redistribute fast ions outward and either reduce or enhance the drive for AEs, depending on the relative reduction of the fast ion pressure and increase in its gradient around the AE location. Marginally stable kinks can also undergo three-wave coupling with AEs, thus favoring the synchronized evolution of the AE mode amplitude in large bursts (or *avalanches*) with enhanced fast ion transport. An important result of this "multi-mode"analysis is the necessity to retain all relevant time scales in the simulation, from the rapid AE growth to the NB ion slowing down that replenishes the fast ion distribution. In general, it is concluded that accounting for the evolution of the fast ion distribution over (at least) a slowing down time is critical for quantitative simulations of mode stability/saturation and resulting fast ion transport. As a consequence, estimates of the expected unstable AE spectrum based on linear AE stability analysis from single time slices can result in inaccurate predictions, since the results are extremely sensitive to any prior relaxation of the fast ion distribution in both energy and real space. *(Work supported by the US Department of Energy, Office of Science, Office of Fusion Energy Sciences under contract number DE-AC02- 09CH11466).*

Country or International Organization

United States

Primary author: PODESTA, Mario (Princeton Plasma Physics Laboratory)

Presenter: PODESTA, Mario (Princeton Plasma Physics Laboratory)

Session Classification: Plenary

Track Classification: Transport of Energetic Particles