Contribution ID: **95** Type: **Oral (Plenary Session)**

Non-linear 3D hybrid kinetic-MHD simulations of ELMs in the ASDEX Upgrade tokamak with MEGA

Wednesday, 4 September 2019 12:00 (25 minutes)

A strong interplay between edge perturbations, such as edge localized modes (ELMs) and fast-ions has been observed experimentally [1]. Furthermore, beam-ion acceleration during an ELM was observed for the first time in the ASDEX Upgrade tokamak [2]. All these findings indicate that kinetic effects of fast-ions should be considered in ELM modelling. For this purpose, non-linear hybrid kinetic-MHD simulations of an ASDEX Upgrade reference case [3] have been performed using the code MEGA [4]. First, large type I ELMs are simulated with the code MIPS [5], the MHD component of MEGA, utilising both standard and extended MHD models in a fully 3D and realistic X-point geometry. Standard MHD simulations reveal a linear phase in which medium n ballooning modes are the most unstable. In the non-linear phase, lower n modes grow due to non-linear coupling between different harmonics until a saturated phase is reached [6]. During this phase, heat flux and particle transport towards the scrape-off layer (SOL) is enhanced. On the other hand, extended MHD simulations including diamagnetic, toroidal and the recently implemented neoclassical flows, show a stabilizing effect on the ballooning modes obtained with the standard MHD model. Preliminary results on the interaction between fast-ions and ELMs will be presented.
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Session Classification: Plenary

Track Classification: Multiscale Physics and Instabilities in Burning Plasmas