After transitioning from carbon to metal first wall materials, confinement is typically observed to be lower at the tokamaks JET and ASDEX Upgrade (AUG) due to the required deuterium gas puff[1]. However, a confinement increase of up to 40% has been reported on the metal-walled AUG when nitrogen seeding is applied at constant input power[2]. While this confinement improvement has been observed to take place in the pedestal, the physical mechanism is not known. Smaller ELMs are also associated with nitrogen seeding[3] which, when combined with the high divertor radiation from the nitrogen gas, lead to significantly reduced heat loads on the divertor targets, offering a promising operational regime for future fusion reactors.

This contribution will examine both of these effects from the point of view of leading pedestal evolution theories. The EPED model[4] posits that the gradient-limiting kinetic-ballooning mode arises after the ELM crash. After this, the pedestal width grows at a constant gradient until the peeling-ballooning mode (driven by edge current density and pressure gradient) is triggered. In order to examine this theory in detail, analysis of several parameters is required: the pressure gradient and current density, the evolution of which have been presented in previous contributions[5], and the growth of the pedestal width and height over the ELM cycle.

These pedestal parameters are analysed and the experimental results from AUG improved H-mode discharges, both with and without nitrogen seeding, are presented. ELM size differences between the scenarios play an important role in determining the dynamics of the pedestal gradient and height recovery. The trajectories of the normalised pressure gradient and current density over the ELM cycles are presented for both scenarios. Linear MHD stability analysis is conducted for selected plasmas and compared to this evolution to evaluate the impact of changes in peeling-ballooning stability on plasma confinement.

References