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Overview of Physics Studies on ASDEX Upgrade

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The ASDEX Upgrade (AUG) programme, jointly run with the EUROfusion MST1 task force, continues to enhance significantly the physics base of ITER and DEMO. Here, the full tungsten wall is a key asset for extrapolating to future devices. The high overall heating power and flexible heating mix and comprehensive diagnostic set allows studies ranging from mimicking the scrape-off-layer (SOL) and divertor conditions of ITER and DEMO at high density to fully non-inductive operation (q95=5.5, betaN<=2.8) at low density. Higher ECRH heating power <=8 MW, new diagnostics and improved analysis techniques have enhanced the capabilities of AUG. Stable high-density H-modes with Psep/R<=11 MW/m with fully detached strike-points have been demonstrated. The ballooning instability close to the separatrix has been identified as a potential cause leading to the H-mode density limit. Density limit disruptions have been successfully avoided using a path-oriented approach to disruption handling and progress has been made in understanding the dissipation and avoidance of runaway electron beams. ELM suppression with resonant magnetic perturbations (RMP) is now routinely achieved reaching HH98(y,2)<=1.1 giving new insight into the field penetration physics, in particular with respect to plasma flows. Modelling agrees well with plasma response measurements and and a helically localised ballooning structure observed prior to the ELM is evidence for the changed edge stability due to the RMP. Fast measurements of Ti and Er show that the dominantly neoclassical character of Er holds through the ELM recovery. Good agreement of 3D nonlinear MHD modelling with measured ELM crash dynamics is achieved. As type-I ELMs (even mitigated) are likely not a viable operational regime in DEMO studies of no ELM regimes have been extended. Stable I-modes up to n/nGW<=0.7 have been characterised using beta feedback. Despite the sub-Alfvenic beam energy nonlinear energetic particle modes have been observed allowing modelling comparisons under burning plasma conditions. First measurements of the eddy tilt angle of ne fluctuations using correlation Doppler reflectometry as well as the radial correlation and cross-phase angles of Te fluctuations have been achieved, showing good agreement with Gyrokinetic simulations. Dedicated matches of H, D and He discharges (core/edge) highlight important isotope physics.

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Primary author: Dr MEYER, Hendrik (UK Atomic Energy Authority)

Presenter: Dr MEYER, Hendrik (UK Atomic Energy Authority)

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