Experiments and 3D simulations of hot VDEs and halo currents in ASDEX Upgrade

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During hot vertical displacement events (VDEs), the plasma column moves into the surrounding structures at the resistive wall time, still carrying its initial thermal and magnetic energy, until it finally disrupts. This is one of the most threatening events for machines due to the associated large forces and heat loads. Additionally, non axisymmetric features can lead to horizontal and potentially rotating forces. To invstigate the consequences of hot VDEs, dedicated experiments with varying plasma current and q95 were carried out in ASDEX Upgrade (AUG), where a VDE was intentionally triggered. Large halo currents with a halo fraction of up to 30% have been observed, comparable to previous observations in this machine [1]. The poloidal and toroidal coverage of the divertor with shunt measurements allows to analyze the halo width and toroidal asymmetries. Additionally, measurements of the halo current by grounded Langmuir probes were carried out in one sector to compare the halo with the ion saturation current density measured by neighboring biased probes. Based on these shots, simulations were carried out with JOREK [2] using the realistic conducting structures of AUG in the thin wall approximation and realistic plasma parameters (in terms of resistivity, anisotropic diffusion, etc.). An extended MHD model including neutral particles and sheath boundary conditions [3] was used, allowing a fully self-consistent description of the halo current evolution. Results are compared to experimental data including the halo current magnitude, its width and non-axissymmetric features as well as the vessel forces (experimentally inferred from oscillation measurements). Results increase confidence that the established non-linear MHD models are able to capture the full experimental dynamics.

References

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