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Overview of progress in European Medium Sized Tokamaks towards an integrated plasma-edge/wall solution

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Progress in tackling the edge challenge within the new European Medium Size Tokamak Task Force (EU-MST) will be reported. EU-MST coordinates research on ASDEX Upgrade, MAST and TCV supported by the local teams. The challenge is approached from two directions. On the one hand plasma regimes reducing the transient heat loads whilst trying to maintain high confinement are developed with active ELM control techniques and natural small ELM scenarios. On the other hand divertor solutions with detachment control and advanced magnetic configurations are studied. The type-I ELM energy flux is found to never exceed a value proportional to the pedestal top pressure times the minor radius and is never lower than 1/3 of this maximum value. Interestingly the actively controlled type-I ELMs with resonant magnetic perturbations on MAST and AUG also fit well into this operational band and so to reduce heat loads well below the ITER material limits a change of ELM regime is likely required. Such RMP aided small ELM regimes have been found at low and high density, although the low density, low collisionality regimes are often accompanied by an unacceptable drop in confinement. For the high-density regimes, also accessed without RMPs, evidence is mounting that a high scrape-off layer (SOL) density is a key parameter. The RMP ELM control has been found to be transferable to He plasmas. New data from TCV on ELM control with vertical kicks and edge ECRH will also be presented. Partial detachment of the divertor and its control is also a part of the integrated solution. The X-point radiation in N seeded discharges at high P/R has now been identified as a suitable control parameter. The studies of detachment have been extended to advanced divertor configurations experimentally on TCV and theoretically on MAST. Here target heat loads are reduced by geometrical means as well as by volumetric processes. Predicted impurity trapping between the two X-points of a snowflake configuration could further aid the heat flux reduction. SOL flows and filamentary transport become important in understanding the power distribution between the different strike zones. With RMPs, lobe structures form that locally increase the heat load and may influence the divertor radiation. The access to a wide parameter space, new concepts and integration within EU-MST is instrumental for progress in this area.

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