Infra Red thermography of ELM divertor target interactions on TCV

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If reliable mitigation methods cannot be devised or plasma scenarios developed in which they will be absent, Type I Edge Localised Modes (ELMs) represent a serious threat to the erosion lifetime of the ITER divertor targets [1]. In recent years, significant progress has been made in characterising the ELM induced transient heat loads arriving at divertor target plates in a number of tokamaks, leading to physics-based empirical scalings by which the energy loads to be expected in ITER can be estimated. This contribution presents the first such measurements from the TCV tokamak, providing further data for the scaling database.

A new fast, snap-shot type infra red (IR) camera has been installed on TCV viewing the vacuum vessel floor from the top of the machine. This region acts as the outer divertor target for many single null lower configurations and offers a particularly simple viewing geometry of the polycrystalline flat graphite tiles covering the target area. The camera is built around a 256x256 CMT detector operating in the wavelength range 1.5 - 5.1 μm with a maximum full frame rate of 880 Hz and up to 25 kHz in sub-array mode. Heat fluxes are derived from the spatio-temporal IR surface temperature measurements using the 2D finite difference THEODOR code [2], taking into account the effect of surface layers covering the target tiles (due to boronisation/redeposition processes).

Results will be presented for the ELM transient heat flux rise time, the profile width during and in-between ELMs and the integral deposited energy for Type III ELMs obtained in ohmic H-modes and for larger ELMs obtained in H-modes heated with third harmonic ECRH. In the former case, the plasma energy loss due to ELMs, ΔW_{ELM}, is only a few 100 J, whilst values of ΔW_{ELM} reaching several kJ are observed in the presence of additional heating. In the case of these larger ELMs, clear evidence has been found for a filamentary structure, similar to that first reported from ASDEX-Upgrade [3], in the target power deposition. The power flux contained in these subsidiary peaks is only of the order of a few percent of that found at the strike point, also consistent with the ASDEX-Upgrade findings.

[1] G. Federici et al., Nucl. Fusion 41 (2001) 1967

[2] A. Herrmann et al, ECA Vol. **25A** (2001) 2109-2112

[3] T. Eich et al., Phys. Rev. Lett 91 (2003) 195003