Infrared measurements of divertor heat loads during steady state and transient events on MAST

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The power load to the divertor is a key challenge for future devices, such as ITER and DEMO, not only during transient events but also during steady state conditions. Measurements of the power load to the divertor have been performed in MAST using infrared (IR) thermography. The IR system is able to measure at spatial resolution of the order 1.5 mm and with temporal resolution of up to 7.5 kHz. In this work IR measurements in L mode, H mode and during ELMs are reported. Recent measurements of the SOL fall off length have predicted narrow widths for ITER. MAST data has been analysed in both L and H mode to investigate the parametric scaling of the fall off length in an ST. The key scaling quantities are found to be consistent with conventional aspect ratio devices, with a major dependence on the plasma current. The MAST data is consistent with the multi-machine scalings for ITER and predicts an H mode fall off length of 5.1 mm for MAST-U, however, this is likely to be broadened by the power spreading seen at low target electron temperatures. IR measurements in L mode show the filamentary nature of the SOL. The filaments at the divertor show that the radial filament size is of the order 5 mm. The measured target radial width maps, via the equilibrium magnetic field, to a toroidal size at the midplane of order 5 cm. The mapped size is consistent with estimates from visible imaging. The L mode filaments are seen to dominate the outer part of the heat flux profile to the tile, but carry only a small amount of power. ELMs are clearly filamentary in nature. Here, analysis of the heat loads during ELMs and the impact of ELM mitigation via resonant magnetic perturbation (RMPs) are reported. RMPs produce ELM mitigation with the peak heat flux halving for a halving of the ELM energy. Strike point splitting due to RMPs is also seen and measurements compared to predictions from plasma response modelling using MARS-F. IR measurements on MAST-U will be key in assessing the reduction of the divertor power load from the super-X divertor. The design and capabilities of the MAST-U IR system will be outlined, along with plans for future expansion.

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