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Castellated tiles as the beam-facing components for the diagnostic calorimeter of the negative ion source SPIDER

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Operation of the thermonuclear fusion experiment ITER requires additional heating via injection of neutral beams from accelerated negative ions. In the SPIDER test facility, under construction in Padova, the production of negative ions will be studied and optimised. The STRIKE diagnostic (Short-Time Retractable Instrumented Kalorimeter Experiment) will be used to characterise the SPIDER beam during short pulse operation (several seconds) to verify the degree of attainment of ITER requirements about the maximum allowed beam non-uniformity (below $\pm 10\%$). The major components of STRIKE are 16 tiles, corresponding to the SPIDER beam arrangement, which are observed on the rear side by a thermal camera. The main requirements of the tiles are: to preserve the thermal pattern throughout the heat conduction from the front to the rear side; to tolerate very high and localised heat loads and the consequent thermo-mechanical stresses.

This contribution describes a solution for tiles made of an essentially homogeneous and isotropic material like graphite, machined in such a way that heat is forced to propagate mostly in one direction (castellated tiles). In order to assess the reliability and the diagnostic capabilities of the tiles under high power irradiation, suitable finite element thermo-mechanical analyses were undertaken in the conditions expected of the SPIDER beam; moreover experimental tests on a prototype exposed to a high power beam were performed in the GLADIS facility at IPP (Max-Planck-Institut für Plasmaphysik) Garching. The results of these studies are described as well as the numerical simulations of the data measured when the size of the thermal camera pixels is comparable to the typical dimension of the elements of the castellated tiles for SPIDER.

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