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P2.072 Thermo-mechanical analysis of unidirectional carbon-carbon composite for thermal imaging diagnostic of a particle beam

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Unidirectional carbon fiber-carbon matrix (CFC) composite tiles can be used to diagnose the main features of a particle beam such as its power, its divergence and uniformity. The diagnostic calorimeter STRIKE will be used with such aim for the negative hydrogen ion beam produced by the ITER ion source prototype SPIDER, starting operation at Consorzio RFX (Padova, Italy) in 2018. By exposing the tiles to the beam and recording their temperature with infra-red cameras the beam energy flux can be retrieved by calorimetry.
The observation of the front surface is not advisable due to the erosion of the carbon surface and to the plasma which forms in front of the tiles due to beam-gas interaction. The necessity to perform rear observation led to the choice of a very anisotropic material as CFC, which limits the broadening of the temperature profile.
The SPIDER beam heat load on each tile is constituted by 80 beamlets, carrying a total power up to 300 kW. The beamlet width depends on their divergence and the beam power density may have peaks up to 20 MW/m2, inducing large thermo-mechanical stresses. Since STRIKE is not actively cooled, beam pulse duration is limited.
In the present work a transient non-linear parametric finite element model developed in ANSYS and already validated on the basis of data collected in other test facilities is used to predict the operational limits of STRIKE, i.e. at which performance (in terms of beam power, divergence and pulse duration) SPIDER may operate when the beam is dumped onto STRIKE without the induction of cracks in the tiles themselves. By affecting the heat transfer within the tiles in fact, such cracks would at least compromise their future diagnostic capability. The effects of different configurations for the STRIKE setup on the thermo-mechanical stresses are also discussed.

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