Contribution ID: **108** Type: **not specified**

Inverse heat flux evaluation of STRIKE data by neural networks

Monday, 17 September 2018 11:00 (2 hours)

The instrumented calorimeter STRIKE (Short-Time Retractable Instrumented Kalorimeter Experiment) has been designed with the main purpose of characterizing the SPIDER negative ion beam in terms of beam uniformity and divergence during short pulse operations. STRIKE is made of 16 1D Carbon Fibre Composite (CFC) tiles, intercepting the whole beam and observed on the rear side by infrared (IR) cameras.
The front observation presents some drawbacks due to optically emitting layer caused by the excited gas between the beam source and the calorimeter, and the material sublimated from the calorimeter surfaces due to the heating itself. It is then necessary to solve an inverse non-linear problem to determine the energy flux profile impinging on the calorimeter, from the 2D temperature pattern measured on the rear side of the tiles. Most of the conventional methods used to solve this inverse problem are unbearably time consuming, so a ready-to-go instrument to determine the beam condition, while operating STRIKE, is mandatory. In this work, the inverse problem, both in stationary and non-stationary conditions, is faced by using a Neural Network (NN) model, pursuing two different approaches. In the first one, the NN is trained to directly solve the inverse problem, by associating the radiation profile (target) to the measured temperature profile (input). In the second approach, a NN is trained to solve the direct problem, where the input is the radiation profile and the target is the temperature profile. Then, the NN is inverted by determining the input corresponding to a fixed target. Preliminary results show the reliability of the proposed method for STRIKE real time operation.

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Session Classification: P1

Track Classification: Diagnostics