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Simulation of beam profiles from extracted ion current distributions for mini-STRIKE

P. Agostinetti, G. Serianni, P. Veltri

Consorzio RFX, Corso Stati Uniti, 4, I-35127, Padova, Italy

Corresponding author: P. Agostinetti, e-mail: piero.agostinetti@igi.cnr.it

In order to develop ITER heating and current drive neutral beam injectors, two experiments are planned to operate in the next future in the PRIMA testbed facility at Consorzio RFX (Padova, Italy). The experiments are a full-size negative ion source, SPIDER, and a prototype of the whole ITER injector, MITICA.

The STRIKE diagnostic calorimeter will be used in SPIDER to investigate the beam properties. A small-scale version of STRIKE, called mini-STRIKE, has been developed and built to check the performance of this type of diagnostic system in existing experiments. It is made of two CFC tiles directly exposed to the beam, whose temperature profile is measured by a thermal camera providing a fine spatial resolution. The tiles are produced with a special technique that permits to obtain a much higher value of thermal conductivity along the thickness (or beam) direction, with respect to the other two directions (perpendicular to the beam). This results in a well-defined footprint of the beam also on the downstream side of the tiles, where it is acquired by the thermo-camera.

BATMAN is a negative ion beam test facility equipped with a radiofrequency source, operating at IPP (Garching bei München, Germany). Its main aim is to investigate the physics underlying generation and extraction of negative ions in the framework of the activities leading to the construction of SPIDER and MITICA. The mini-STRIKE diagnostic calorimeter has been mounted in BATMAN and used for the investigation of the beam properties.

This contribution describes the adaptation to the negative ion beam of BATMAN of the codes, which are currently used to model the SPIDER and MITICA experiments. In particular, the SLACCAD and EAMCC codes have been used to simulate the beam optics, the NBImag code for the magnetic fields and a dedicated model developed in COMSOL for the temperature distribution on the tile. The latter one is a non-linear, transient, finite element model that calculates the temperature across the downstream surface of the tile during and after the beam pulse, by applying as boundary condition on the upstream side the heat load calculated by the EAMCC code, and taking into account the anisotropy of the thermal conductivity in the CFC.

The current density across the extraction area is influenced by several factors like the source geometry, the magnetic field and the particle drifts inside the source, and the cesium distribution. The main outcome of the present contribution is the development of a minimisation method to estimate the extracted current distribution using the footprint of the beam recorded with the mini-STRIKE diagnostic. First results of the application of the method to the BATMAN beam are given.

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