OPTIMIZATION OF THE COOLING CIRCUIT AND THERMO-MECHANICAL ANALYSIS OF THE EXTRACTION GRID OF ELISE

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Negative ion sources will be the basis of the neutral beam systems for the next generation of magnetic fusion devices. For the production of negative hydrogen ions, inductively coupled RF ion sources have been successfully developed at IPP Garching.
The new test facility ELISE (Extraction from a Large Ion Source Experiment) will have an extraction area with the same width and half the height of the ITER source, acceleration up to 60 kV, for 10 seconds, every 3 minutes and plasma generation up to 1 hour.
The Extraction Grid extracts the negative hydrogen ions and accelerates them toward the next acceleration stage. Due to the same polarity electrons are co-extracted and suppressed on the grid surface. To obtain this electron suppression magnets are embedded in the grid in order to bend the electron trajectories, while the heavier H^- ions are left almost undisturbed. Co-extracted electrons, with energy in the order of 10 keV, are deflected on the extraction grid surface, causing many hot spots with high localized power density (in the order of 20 MW/m^2) near the grid apertures. This results in high temperature and thermo-mechanical stress that make the extraction grid one of the most critical components in the negative ion source. Up to 200 kW of deposited heat load per grid segment is removed by a water circuit inside the grid. Steady state heat removal must be guaranteed due to the small thickness of the grid and the high power load density involved.
Modeling and analyses have been conducted using the finite element package ANSYS, while fluid dynamic simulations have been performed using CFX. It has been shown that a significant reduction in maximum temperature and thermo-mechanical stresses is obtained with the ELISE design respect to the ITER reference design, providing a larger operational margin in particular during conditioning.
This paper presents the optimization of the cooling circuit and the thermo-mechanical analysis of the Extraction Grid of the RF negative ion source ELISE considering maximum grid temperature, mechanical stresses and grid deformation.