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Recent progress with Diagnostic Neutral Beam at TCV tokamak

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The present status of the 50keV / 3A Diagnostic Neutral Beam Injector (DNBI) at TCV tokamak is described.
In 2024, optical and mechanical inspections of the Ion Optical System (IOS) were performed. A significant deformation of the first (plasma) grid was revealed of the order of ~ 1 mm at the central area. The plasma grid was replaced by a new re-manufactured one with its existing design. The technology and production were performed within SPC-EPFL, and there was the first experience of precise ion optics parts manufacturability. The further re-design of the plasma grid was performed to improve its stability, accounting for the results of deformation measurements and considering IBSimu beam simulations results. The attempt to reduce radial stresses was taken by enlargement of the grid thickness in combination with a compensation of thermal expansion. The possible options for the grid manufacturing technologies and materials, were considered.
Basing on the visual inspection of the plasma source parts after long period of operations, and on the EM analysis of magnetic field distribution between cathode and anode, the most impacted elements of the arc-discharge channel were re-shaped to increase the DNBI beam pulse duration, as well as the plasma source lifetime.
After over 20 years of use, most of the DNBI Power Supply (PS) elements worked at their limit. A new Power Supply set for DNBI was proposed after the analysis of a beam current up to 3-3.5A and extended beam shot duration up to 2-2.5s. The PS set is built using standard industrial components, with some further customization, especially for modulated beam regime, increasing the frequency of rectangular pulses up to 300-500Hz.
The new multichannel beam optical diagnostics was recently implemented for spectral profiles scanning, as well as providing the evaluation of the beam species composition. The non-invasive tool is used either for the beam conditioning tests or during its normal operation with TCV CXRS.

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