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Diagnostics for characterization of neutral beams parameters at TCV

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The TCV tokamak is equipped with three neutral beams injectors. The low power 50keV, 80kW DNBI together with the CXRS system is used for measurements of plasma ion temperature, velocity, and carbon impurity density since 2000. The 1.3MW/28keV NBI-1 has been operated on TCV from 2015 providing the direct ion heating. The second 1MW/52keV high-energy NBI-2 was installed on TCV in July 2021 and extended the TCV capability for ion heating and fast ion studies.

TCV heating beams are equipped with a similar set of standard diagnostic tools: beam acceleration voltage, ion current, voltage and current of suppression grid, current of bending magnet, power of RF plasma sources are measured in power supplies; neutral beam profile on calorimeter and distribution of ions on the ion dump are monitored by thermocouples as well as the temperature of beam duct elements; the temperature of the beam dump (shine-through) is monitored by pyrometers and TCs, etc. The Doppler shift spectroscopy looking along a single view-line intersecting beam axis used for measurement of the beam energy composition.

A new multichord beam spectroscopy diagnostic has been developed and implemented in 2024. The measurement of Hα (Dα) emission spectra along several view lines aligned either along or across beam allow to evaluate density profiles across beam, as well as to estimate parallel and perpendicular velocity spread for each energy fraction.

Minimization of the beam size and power losses in the beam transmission line from injector to tokamak is essential for TCV with relatively narrow ports. The in-house built device, to assess the 3D NB power density distribution, was implemented for TCV NBIs. This device featured an actively cooled tungsten tile inclined at 45° with respect to the beam. An IR camera records the surface temperature rise, which is near proportional to the 2D beam power distribution. The device can be moved along the beam axis for evaluation of beam divergences and focal lengths.

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