Tomographic inversion of Wendelstein 7-X stellarator plasmas

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In the operational phase OP1.2a (Aug-Dec 2017) of the Wendelstein 7-X (W7-X) stellarator experiment the soft X-ray tomography diagnostic (XMCTS: soft X-ray multi camera tomography system) has been commissioned. Soft X-ray tomography systems are powerful diagnostics for high temperature plasmas measuring spatiotemporal X-ray emissivity profiles. The XMCTS consists of 20 poloidally arranged pinhole cameras at one toroidal location observing a triangular shaped up-down symmetric plasma cross section. X-ray radiation is mainly emitted in the hot plasma core (electron temperatures $> 1\,\mathrm{keV}$). In the pinhole cameras the plasma radiation is filtered by a beryllium foil of $12.5\,\mu\mathrm{m}$ thickness being transmissible for X-ray radiation above $1\,\mathrm{keV}$. Taking into account the detector silicon thickness of $100\,\mu\mathrm{m}$ the detectable energy range is limited to approximately $1-10\,\mathrm{keV}$. With 18 available cameras in OP1.2a the soft X-ray emissivity has been recorded along 324 lines-of-sight with a time resolution of $0.5\,\mu\mathrm{s}$.

The presentation concentrates on the preparation and first results of the tomographic inversion. For correct calculation of the tomograms, both, the knowledge of the exact geometry of the lines-of-sight and the sensitivity of each photodiode are of crucial importance. The as-built coordinates of the cameras have been measured after the in-vessel installation. The deviations from the designed lines-of-sight are smaller than 1°. Changes of the lines-of-sight geometry according to mechanical deformations of the vacuum vessel in the pumped down state and its systematic effects on the tomography are discussed. The amplitude responses of all cameras measured before and after in-vessel installation are considered. The tomography code used bases on the regularization applying a minimum Fisher constraint. First tomography results of selected discharges from OP1.2a are discussed.