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Design and first measurements of the divertor Thomson scattering system on ASDEX Upgrade

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On ASDEX Upgrade the plasma in the divertor and around the x-point is of major interest. Therefore, a Thomson scattering diagnostic for this region was always desired. No comparably easy access to this region from outside the vacuum vessel is possible. In-vessel collection and laser beam optics are needed, which complicate the design. These problems could be solved now.

The newly installed divertor Thomson scattering (DTS) diagnostic for the lower divertor has the following features: It has access to three regions of interest: (i) The region above the outer divertor leg, (ii) the x-point, and (iii) the high field side high density region. It is expected that DTS diagnoses plasmas with electron temperatures 1 eV - 100 eV and electron densities 1 x 10^{19} m^{-3}- 1 x 10^{21} m^{-3}.

The DTS diagnostic has a conventional design: As light source a Nd-YAG laser (pulse energy < 0.9 J, repetition rate 20 Hz) is used. Parts of the laser beam line (one mirror and the beam dump) are installed inside the vacuum vessel. The light originating from the scattering volumes is imaged by a collection cell, located behind the outer divertor structure, into optical fibres, which transfer the light to the polychromators. The spatial resolution, determined by the lengths of the scattering volumes and the diameter of the laser is around 1 cm. For each spatial channel a separate polychromator is used. At the start-up of this diagnostic 24 spatial positions are available.

In the polychromators 4 spectral channels are used to analyse the Thomson scattering spectra expected for the specified electron temperature range. In each spectral channel the Thomson scattered light pulses are detected by avalanche photo diodes. The signals of these detectors are sampled by newly developed data acquisition modules (1 GSamples/s, 14-bit resolution), which are tailored to fit for the inhouse data link standard SIO2.

The relative calibration of the spectral channels is done with a wavelength tunable optical parametric oscillator (OPO) laser. For the absolute calibration Raman scattering in nitrogen is used.

DTS is now operated as a standard diagnostic for each plasma discharge. Clearly defined profiles of electron density and temperature are measured e.g. for L mode, or quiescent H mode. In H mode plasmas the transport of particles and heat into the divertor during edge localized modes can be studied.

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