Scale-selective Turbulence Reduction in H-mode Plasmas in the TJ-II Stellarator / Design of a new Doppler Reflectometer Transceiver Front End for the ASDEX Upgrade Tokamak

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The TJ-II Doppler reflectometer [1, 2] (frequency hopping Q-band, $f_0 = 33 – 50$ GHz) uses a steerable ellipsoidal mirror to change the measured turbulence scale between $k_\perp = 3 – 15$ cm$^{-1}$ on a shot-to-shot basis. This possibility has enabled the investigation of the scale-dependence of turbulence reduction from L- to H-mode. Wavenumber spectra have been obtained with radial resolution, and a preferential reduction of turbulence close to the shear layer of the radial electric field is observed. Power laws – identified in both L- and H-mode spectra – are slightly more pronounced in the H-mode. Turbulence reduction in the H-mode is scale-selective, a comparison with the L-mode spectra shows that intermediate scales are preferably reduced. This effect can be interpreted in the framework of zonal flow generation through Reynolds stress [3], while turbulence decorrelation by sheared flows [4] might not play a central role.

Furthermore, the design of a new transceiver front end for the W-band Doppler reflectometer of ASDEX Upgrade is presented. The microwave backbone of the existing system [5] (frequency hopping synthesizer, $f_0 = 75 – 105$ GHz) is used. The new bistatic system consists of smooth-bore circular oversized waveguides (to minimize microwave power loss) from the microwave oscillators up to the in-vessel smooth-wall horn antennas (side lobes $<-25$ dB). A combination of two mirrors and one common ellipsoidal mirror – which serves to focus the beam to the cutoff layer to obtain optimum spectral resolution – will be used to control the tilt angle of the beam in the direction perpendicular to the magnetic field. This allows for a perpendicular wavenumber measurement range of $k_\perp = 5 – 25$ cm$^{-1}$. The mirror movement can be stepped by a piezo controller, allowing for several beam tilt angles during one discharge.