Final Design of the Dispersion Interferometer for the Wendelstein7-X Stellarator

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Continuous electron density measurements with high time resolution will be performed on the Wendelstein 7-X (W7-X) stellarator using a single channel interferometer. These are required for discharge control, and will be used for cross-calibration of the density profiles measured with Thomson scattering.

Vibration compensation tests clearly show that 2-colour Mach-Zehnder interferometers are much more sensitive to vibrations and thermal movements than dispersion interferometers (DI). Thus, we set up a DI in laboratory and optimized its design for the installation on W7-X. The system consists mainly of two frequency doubling crystals, an acousto-optical modulator and a detector. All optical components will be positioned on a vertical Basalt bench except the corner cube reflector on the other side of the plasma, outside of the vacuum vessel. At the corner cube the beam is reflected back, parallel to the incoming beam with a distance of 32 mm avoiding feedback to the laser, thus improving the laser stability. A second doubling crystal in the beam returning from the CCR simplifies the alignment procedure reaching a maximal contrast of the interference signal at the detector. Using an acousto-optical modulator (AOM, f=50 kHz), the determination of the electron density is not sensible to the power of the laser as long as it is constant over a period of the modulation, a requirement easily satisfied. The data acquisition and density determination is performed by a FPGA board. It was demonstrated in laboratory tests that the thermal movements of the corner cube reflector can be compensated by a laser beam positioning control system consisting of a diode laser (637 nm) parallel to the infrared laser beams, two tuning mirrors and two 4-quadrant diodes. By using back reflections of the visible laser from the ZnSe optics and the AgGaSe doubling crystal onto the 4-quadrant diodes, no additional dichroitic mirrors are needed, thus minimizing the number of optics in the interferometer.