

13th INTERNATIONAL STELLARATOR WORKSHOP

Design and Operational Diagnostics of the W7-X Divertor

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Important aims of the W7-X experiment are the studies of energy and particle exhaust under quasi-stationary conditions and the development of a reactor relevant divertor system. Ten divertor units, each consisting of about 130 target elements which are combined to 13 modules have been developed for stationary heat removal. The design of the divertor target plates is related to an expected local power load of up to 10 MW / m². The target elements consist of CFC tiles brazed or welded on water cooled Mo or Cu structures. The temperature of the tile surface exposed to the plasma is expected to raise up to values of 1200 °C with a time constant of some seconds. To guarantee the safety of the machine and monitor the operation mode some basic diagnostics for the divertor components with data evaluation in real time are necessary. In respect of the energy balance the operational divertor diagnostics include instruments for thermography, thermometry, water flow control, measurements of thermo-currents to the divertor modules. Additionally, for the control of the particle balance localised gas feed, mass spectrometry and measurements of gas pressure inside the divertor units have to be provided.

To be able to determine local power deposition, to detect asymmetries of heat load to the targets and to prevent damage of target elements by overheating or mechanical defects a continuous supervision of the whole target surface area by thermography is essential. For the thermography system 10 uncooled microbolometer cameras and infrared optics of about 1.5 m length will be installed. It has to dispose signals indicating anomalous operation scenarios immediately. This requires image acquisition and data transfer at rates of at least 20 Mbytes/s to achieve local and temporal resolution of about 10 mm and 100 ms, respectively. The software must be able to detect invalid values of the measured surface temperature, intolerably hot target areas and strong temperature rises and has to generate control signals indicating tolerable, dangerous and unreliable operation. For thermometry and water flow control about 2000 PT100 temperature sensors and about 100 ultrasonic flow meters will be used. A PROFI bus system (SIMATIC) has been constructed and will record and analyse the data of the thermo--sensors and the flow meters with a refresh time of about 1s. For measuring the electric potential and currents to the target modules the water cooling pipes can be used as shunt resistors. First experiments showed that they have sufficiently high electrical resistance.

Topic: 10 New Devices

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