P 9: Magnetic Confinement I

Zeit: Dienstag 8:30–10:10 Raum: HS 2010

Hauptvortrag P 9.1 Di 8:30 HS 2010

Summary of the Edge Physics Results from the First Operation Phase of the Wendelstein 7-X Stellarator — •Ralf König and W7-X team — Max-Planck-Institute for Plasma Physics, Wendelsteinstr.1, 17491 Greifswald, Germany

Wendelstein 7-X (W7-X) is the largest and most optimised superconducting stellarator world-wide, which aims at demonstrating high heating power steady state plasma operation. In its first operation phase (OP1.1), most of the in-vessel graphite wall armor had not yet been installed and instead of the 10 discrete island divertor modules only 5 inboard limiters were used. Plasma purity and wall outgassing were continuously improved by ECRH and GDC wall conditioning. Low ECR heated plasmas of up to 6 s (0.6 MW, 1 gyrotron) were created, as were shorter-lived higher power discharges (4.3 MW, 6 gyrotrons). Te > 8 keV, Ti > 1.5 keV and ne = 3 10^{19} m^{-3} were achieved simultaneously. The power loads to the limiters reached up to 5 MW/m^2 in steady state (< 60% ECRH input power), with toroidal asymmetries up to a factor 2. The SOL widths were on the order of 1-2 cm. Langmuir probe arrays integrated into one limiter showed significant top/bottom asymmetries in Te and ne, as did IR camera measurements in the power load distribution across the limiters, which suggest ExB drifts at the plasma edge. IR camera observations revealed indications for enhanced transport due to frequent bursts with poloidal mode numbers of about 15 seen on the limiter surface, while fast video camera images show filamentary structures elongated along the magnetic field lines, which rotated poloidally, consistent with the ExB drift velocity.

Hauptvortrag P 9.2 Di 9:00 HS 2010

Physics of heat and momentum transport changes in ohmically confined tokamak plasmas — •Rachael McDermott[1], Alexander Lebschy[1,2], Ivan Erofeev[1], Clemente Angioni[1], Emiliano Fable[1], and the ASDEX Upgrade Team[1] — [1]Max-Planck-Institut für Plasmaphysik, Garching, Germany — [2]Technische Universität München, Garching, Germany

In Ohmically confined tokamak plasmas the energy confinement time is observed to increase linearly with the plasma density up to a critical density above which it saturates. These two regimes, below and above this critical density, are referred to as linear and saturated Ohmic confinement (LOC and SOC) and are ubiquitous to tokamak experiments. In the same general parameter regime, dramatic changes in the core plasma toroidal rotation are also observed, with the rotation actually flipping sign from the co-current to the counter-current direction. These changes in both energy and momentum transport have long been ascribed to changes in the plasma turbulence, which is expected to transition from trapped electron mode (TEM) driven to ion temperature gradient (ITG) driven as the electron density, and hence collisionality, is increased. While recent modelling work does display a gradual TEM-ITG transition throughout the plasma as the density grows, the critical densities of the LOC-SOC transition and the rotation reversals do not correspond to any sudden modification of the global turbulence regime. Rather, the LOC-SOC transition can be related to the increase in ion turbulent transport, which is higher when ITG is dominant.

Fachvortrag P 9.3 Di 9:30 HS 2010

Control of Edge-Localized Mode in Magnetically Confined Fusion Plasmas — •Yunfeng Liang — Forschungszentrum Jülich GmbH, Jülich, Germany

A great challenge for fusion energy research and technology is to confine burning plasma while maintaining tolerable steady state and transient heat and particle fluxes on plasma-facing components. When tokamak plasmas operate in a high-confinement (H-mode) regime, a significant increase in the plasma energy confinement time is observed. However, as a consequence, a steep plasma pressure gradient and an associated increased current density at the plasma edge could exceed a threshold value to drive magnetohydrodynamic instabilities referred to as edge-localized modes (ELMs). ELMs lead to quasiperiodic expulsions of large amounts of energy and particles from the confined region, which in turn could result in serious damage to plasma-facing components. The next generation fusion machines, like ITER and DEMO, will need a reliable method for controlling or suppressing large ELMs.

In this paper, several newly developed ELM control methods on EAST and JET tokamaks including low n (1, 2) resonant magnetic perturbations (RMP) [Phys. Rev. Lett. 117, 115001 (2016), Phys. Rev. Lett. 105 , 065001 (2010)], Lower Hybrid Waves (LHW) [Nature Physics, 9, 817-821 (2013), Phys. Rev. Lett. 110, 235002 (2013)], Li pellets injection and Li powder [Phys. Rev. Lett. 114, 055001 (2015)] will be presented. In addition, the role of magnetic topology in accessing ELM suppression will be discussed.

P 9.4 Di 9:55 HS 2010

Comissioning of the soft X-ray tomography system (XMCTS) in the Wendelstein 7-X stellarator — •Christian Brandt, Henning Thomsen, Torsten Broszat, Ralph Laube, Mirko Marquardt, Mathias Schülke, Thomas Sieber, Sven Weissflog, and and the W7-X Team — Max-Planck-Institute for Plasma Physics, Wendelsteinstr. 1, 17491 Greifswald, Germany

The soft X-ray multi-camera tomography system (XMCTS) has been assembled and installed inside the W7-X vacuum vessel. The commissioning is scheduled for the upcoming operation phase (OP1.2a). Twenty pinhole cameras aligned on a poloidal circumference measure the plasma radiation in the soft X-ray range (> 1 keV) with 18 lines-of-sight each (360 in total). The preamplifier electronics is located directly behind the silicone photodiode arrays within the actively water-cooled camera housings. By tomographic reconstruction the radiation distribution of the poloidal cross section inside the LCFS will be obtained with a spatial resolution of ≈ 2 cm. The foreseen sample frequency of 2 MHz enables the detection of MHD modes up to 800 kHz. In addition the XMCTS will provide insights into the spatiotemporal dynamics of impurities and the quality of the plasma confinement (Shafranov shift). Ongoing work is the preparation of the control and data acquisition systems. The data rate will be 1.6 GB/s and for the later planned long pulse plasmas ≈ 3 TB per 30 minutes.