P 21: Magnetic Confinement II

Time: Thursday 11:00–12:55 Location: b302

Invited Talk P 21.1 Thu 11:00 b302

The behavior of helium in fusion plasmas — •Athina Kappatou[1], Rachael M. McDermott[1], Clemente Angioni[1], Thomas Pütterich[1], Ralph Dux[1], Michael G. Dunne[1], Rudolf Neu[1], Alexander Lebschy[1,2], Eleonora Viezzer[1], Marco Cavedon[1,2], the EUROfusion MST1 Team[3], and the ASDEX Upgrade Team[1] — [1]Max-Planck-Institut für Plasmaphysik, Garching, Germany — [2]Physik-Department E28, TU München, Garching, Germany — [3]See http://www.euro-fusionscipub.org/mst1

The presence of helium is fundamentally connected to the performance of a fusion reactor. The energetic α-particles produced by the D-T fusion reactions will heat the plasma through collisions. However, the thermalised helium content in the plasma core should be minimized as it dilutes the fusion fuel. Hence, understanding the transport of helium is indispensable, as is the availability of experimentally validated theoretical tools, to predict the helium density profile in future machines.

Helium transport investigations have been undertaken in dedicated experiments at ASDEX Upgrade. The experimental helium density profiles, measured with charge exchange spectroscopy, are compared with the theoretical predictions, obtained from gyrokinetic simulations. The comparison revealed features, which indicate a missing piece in the current understanding of low-Z impurity transport. In addition, while it is well known that the confinement in helium plasmas is lower than in deuterium plasmas, recent experiments show that helium deteriorates plasma confinement even at low concentrations. The efforts to shed light on the physics behind this detrimental effect will be presented.

Invited Talk P 21.2 Thu 11:30 b302

Energy and Particle Core Transport in Tokamaks and Stellarators compared — •Marc Beurskens, Clemente Angioni, Craig Beidler, Andreas Dinklage, Golo Fuchert, Matthias Hirsch, Thomas Puetterich, and Robert Wolf — Max-Planck-Institut für Plasmaphysik, 17491 Greifswald/85748 Garching, Germany

The paper discusses expectations for core transport in the Wendelstein 7-X stellarator (W7-X) and presents a comparison to tokamaks. In tokamaks, the neoclassical trapped-particle-driven losses are small and turbulence dominates the energy and particle transport. At reactor relevant low collisionality, the heat transport is limited by ion temperature gradient limited turbulence, clamping the temperature gradient. The particle transport is set by an anomalous inward pinch, yielding peaked profiles. A strong edge pedestal adds to the good confinement properties. In traditional stellarators the 3D geometry cause increased trapped orbit losses. At reactor relevant low collisionality and high temperatures, these neoclassical losses would be well above the turbulent transport losses. The W7-X design minimizes neoclassical losses and turbulent transport can become dominant. Moreover, the separation of regions of bad curvature and that of trapped particle orbits in W7-X may have favourable implications on the turbulent electron heat transport. The neoclassical particle thermodiffusion is outward. Without core particle sources the density profile is flat or even hollow. The presence of a turbulence driven inward anomalous particle pinch in W7-X (like in tokamaks) is an open topic of research.

Fachvortrag P 21.3 Thu 12:00 b302

Mikrowellenheizung und -diagnostik: Leistungsstarke Werkzeuge zum Betrieb von Wendelstein 7-X — •Torsten Stange, Hans-Jürgen Hartfuss, Matthias Hirsch, Udo Hoefel, Heinrich Peter Laqua, Stefan Marsen, Dmitry Moseev, Robert Wolf und The W7-X Team — MPI für Plasmaphysik, Greifswald

Die Nutzung von Mikrowellen hat sich in den letzten Jahrzenten zu einem der wichtigsten Instrumente für die Erzeugung und Heizung von Fusionsplasmen oder für Transportuntersuchungen und Messung von wichtigen Plasmaparametern entwickelt. Die Effektivität der Elektronen-Zyklotron-Resonanz-Heizung (ECRH) sowie die mittlerweile erlangte Souveränität beim Umgang mit Hochleistungsmikrowellen führt dazu, dass der größte Stellarator, Wendelstein 7-X (W7-X), mit einem 140GHz-Heizsystem in Betrieb gehen wird, das in der Lage ist mehrere MW im Dauerstrichbetrieb bereit zu stellen. In der ersten Operationsphase (OP1.1) von W7-X werden insgesamt 6 Gyrotrons zur Verfügung stehen, die einer absorbierten Leistung von bis zu 5MW im Plasma entsprechen. Um bei der Inbetriebnahme eine schnellere Plasmazündung zu erreichen, wird in den ersten Wochen von OP1.1 mit Helium als Entladungsgas gearbeitet. Die Optimierung der Zündung sowie des weiteren Plasmaaufbaus erfolgt mit Hilfe verschiedener Mikrowellendiagnostiken. Innerhalb von 2s werden bei einer absorbierten Leistung von 1MW und einer Elektronendichte von $5{\cdot}10^{19}\mathrm{m}^{-3}$ stabile Elektronen- und Ionentemperaturen von über 2keV erwartet.

P 21.4 Thu 12:25 b302

Impact of Lithium on the plasma performance in the all-metal-wall tokamak ASDEX Upgrade — •P.T. Lang[1], R. Moreno Quicios[1], R. Arredondo Parra[1], B. Ploeckl[1], R. Maingi[2], D.K. Mansfield[2], A. Diallo[2], R. McDermott[1], R. Neu[1], E. Wolfrum[1], and ASDEX Upgrade Team[1] — [1]MPI für Plasmaphysik, Boltzmannstr. 2, 85748 Garching, Germany — [2]Princeton Plasma Physics Laboratory, Princeton, NJ 08543, USA

Several tokamaks reported improvement in key plasma parameters concurrent with the presence of lithium in the plasma. At ASDEX Upgrade explorative experiments have been performed to find out if such effects can be observed when operating with an all-metal-wall. A gas gun launcher was developed capable to inject pellets containing about 1.6×10^{20} Li atoms at 2 Hz. The speed of about 600 m/s is sufficient to achieve core penetration and to create a homogeneous Li concentration of up to 10 %. With a typical sustainment time on the order of 100 ms, only transient Li presence without any pile up was achieved. Deposition of Li on plasma facing components, which remained for several discharges after injection, was observed. This short lived wall conditioning showed beneficial effects during plasma start-up. However, the accompanying surface contamination negatively impacted some diagnostics. The Li impact on the confinement was investigated in a dedicated plasma scenario with a proven sensitivity to nitrogen and helium. In phases with N seeding enhancing the confinement by about 30 %, Li injection resulted in a very modest, transient loss of confinement (about 5 %). No Li impact was found for pure Deuterium plasmas.

P 21.5 Thu 12:40 b302

2D Heat Flux Pattern in ASDEX Upgrade L-Mode With Magnetic Perturbation — •Michael Faitsch, Bernhard Sieglin, Thomas Eich, Albrecht Herrmann, Wolfgang Suttrop, and the ASDEDX Upgrade Team — Max-Planck-Institute for Plasma Physics, Boltzmannstr. 2, D-85748 Garching, Germany

A future fusion reactor is likely to operate in high confinement mode (H-mode). This mode is associated with a periodic instability at the plasma edge that expels particles and energy. This instability is called edge localized mode (ELM). External magnetic perturbation (MP) is one technique that is thought to be able to mitigate or even suppress large ELMs in next step fusion devices such as ITER, where the ELM induced heat load for unmitigated ELMs might limit the lifetime of the divertor. Applying an external magnetic perturbation breaks the axisymmetry and leads to a 2D steady state heat flux pattern at the divertor. The ASDEX Upgrade tokamak is equipped with 16 perturbation coils, 8 above (upper row) and 8 below (lower row) the outer mid plane, toroidal equally distributed. A high resolution infra red system is measuring the heat flux at the outer target at a fixed toroidal position with a resolution of around 0.6 mm. In order to measure the 2D structure a slow rotation of the MP field was applied (1 Hz) with a toroidal mode number n=2. The differential phase between the upper and lower row was changed to investigate the effect of the alignment with the field lines at the edge. The density was varied to study the density dependence of the heat transport with applied external MP and compare it to the axisymmetric scenario.