P 12: Poster Session: Magnetic Confinement

Time: Tuesday 16:30–19:00 Location: Empore Lichthof

P 12.1 Tue 16:30 Empore Lichthof

Electron cyclotron emission measurements at the stellarator TJ-K — •Gabriel Sichardt[1], Alf Köhn[2], and Mirko Ramisch[1] — [1]Institut für Grenzflächenverfahrenstechnik und Plasmatechnologie, Universität Stuttgart — [2]Max-Planck-Institut für Plasmaphysik, Garching

Electron temperature (T_e) measurements in the magnetised plasmas of the stellarator TJ-K are currently performed by means of Langmuir probes. The use of these probes is restricted to relatively low temperatures and the measurement of temperature profiles requires the acquisition of the local current-voltage characteristics which limits strongly the sampling rate. As an alternative, T_e can be measured using the electron cyclotron emission (ECE) that is generated by the gyration of electrons in magnetised plasmas. Magnetic field gradients in the plasma lead to a spatial distribution of emission frequencies and thus the measured intensity at a given frequency can be related to its point of origin. The T_e dependence of the intensity then leads to a temperature profile along the line of sight for Maxwellian velocity distributions. A diagnostic system for T_e measurements using ECE is currently being set up at TJ-K.

When non-thermal electrons are present the emission spectrum changes dramatically. Therefore, the ECE can also be used to investigate the contribution of fast electrons to previously observed toroidal net currents in TJ-K. Simulations are used to examine the role of electron drift orbits in generating these currents.

P 12.2 Tue 16:30 Empore Lichthof

Trapping of Electron Bernstein Waves in a inhomogeneous magnetic field of the plasma experiment FLiPS — •Rumiantsev Kirill, Holzhauer Eberhard, Köhn Alf, and Kasparek Walter — Institut für Grenzflächenverfahrenstechnik und Plasmatechnologie, Universität Stuttgart

Heating and diagnostics by Electron Bernstein Waves (EBW) is an important topic in fusion research. EBW are purely kinetic waves and appear in the treatment of plasma waves only when thermal effects are properly included. The absence of the high-density cutoff and the strong absorption at the cyclotron resonance harmonics make EBW a good candidate for plasma heating. It has been shown theoretically that inhomogeneities in the magnetic field can trap EBW within a narrow space creating a wave channel similar to a waveguide. The dedicated experiments are planned to be done at a linear device FLiPS. Its flexible magnetic field is well suited for fundamental studies. The investigation is relevant for fusion research due to FLiPS's dimensionless plasma parameters that are similar to those that are found in the edge of fusion plasmas.

The trapping has been investigated using ray-tracing and full-wave simulations for various magnetic field configurations. The consequences of the effect for heating and diagnostics are being discussed. Preliminary experimental results will be shown.

P 12.3 Tue 16:30 Empore Lichthof

Influence of neutral-plasma interactions on 3D scrape-off layer filaments — •David Schwörer[1,2], Nick Walkden[2,3], Ben Dudson[3], Fulvio Militello[2], Huw Leggate[1], Turlough Downes[1], and Miles Turner[1] — [1]Dublin City University, Ireland — [2]Culham Center of Fusion Energy, UK — [3]York University, UK

Filaments are field aligned density and temperature perturbations, which can carry a significant amount of particles and heat from the last closed flux surface to the far scrape-off layer (SOL). This transport mechanism is highly non diffusive. It is important to understand and predict the motion of filaments, as they can cause a significant heat load onto first wall materials. This is especially of interest in regard to the design of future fusion devices.

Recent experiments have shown that the density of the SOL can have a significant influence on the dynamics of filaments.

We have carried out non-linear, three-dimensional simulations, including neutral-plasma interactions, implemented in BOUT++. By selectively including neutral-filament interactions, direct interaction with neutrals are decoupled from indirect ones, where neutrals affect the filaments through a change in background profiles. The heat and particle influx is varied, generating self-consistent profiles that reproduce both sheath limited and high recycling regimes. These profiles are used as a background for full three-dimensional fluid simulations of the filament. A systematic increase of neutral model complexity is carried out, from static neutral background to full neutral fluid evolution. This will help to understand and interpret the results of experimental measurements.

P 12.4 Tue 16:30 Empore Lichthof

Moden-Wechselwirkung unter Plasmabiasing am TJ-K — •Til Ullmann[1], Bernhard Schmid[1], Peter Manz[2] und Mirko Ramisch[1] — [1]Institut für Grenzflächenverfahrenstechnik und Plasmatechnologie, Universität Stuttgart — [2]Technische Universität München, Garching

Scherströmungen spielen in magnetisch eingeschlossenen Fusionsplasmen für den Übergang in ein besseres Einschlussregime eine wichtige Rolle. Durch Plasmabiasing können poloidale ExB Strömungen gezielt aufgeprägt werden. Wie sich diese Strömung auf die Wechselwirkung zwischen der Driftwellen-Turbulenz und natürlichen Zonalströmungen auswirkt, wird in dieser Arbeit untersucht. Daher wurde am Stellarator TJ-K die Hintergrundströmung in limitierten Plasmen auf zwei verschiedene Weisen durch Biasing verändert. Zum einen wurde eine ringförmige Elektrode im Einschlussbereich positioniert. Bei der anderen Biasing Variante wurden die poloidalen Limiter positiv vorgespannt. Für die Analyse des Hintergrunds wurden mit drei Langmuir-Sonden Plasmapotential, Dichteprofil und Elektronentemperatur radial aufgelöst. Zur Untersuchung der Turbulenz wurden mit einem Kranz aus 128 Langmuir-Sonden, aufgefächert auf vier Flussflächen, die Floatingpotentialfluktuationen gemessen. Mit der Ringelektrode können starke Strömungen dem Plasma aufgeprägt werden. Die Dichte nimmt innerhalb der Elektrode zu, was mit steileren Gradienten einhergeht. Das Limiter-Biasing induziert eine Scherströmung im Plasmarandbereich. Der Einfluss dieser Scherströmungen und die Abhängigkeit der Moden-Wechselwirkungen im k-Raum vom angelegten Bias wird dargestellt.

P 12.5 Tue 16:30 Empore Lichthof

Dependence of intermittent density fluctuations on collisionality in TJ-K — •Kyle Reuther[1], Stephen Garland[1], Peter Manz[2], and Mirko Ramisch[1] — [1]Institut für Grenzflächenverfahrenstechnikund Plasmatechnologie, Universität Stuttgart — [2]Physik-Department E28, Technische Universität München, Garching

Particle and heat transport losses due to edge turbulence are well known phenomena commonly seen in toroidal magnetic confinement devices. Furthermore in the scrape-off layer (SOL), turbulent density fluctuations are often observed to be intermittent and dominate particle transport to the vessel walls. In the adiabatic limit (small collisionality), of the two-field Hasegawa-Wakatani model, simulated turbulent density fluctuations are observed to couple to potential fluctuations and exhibit Gaussian behavior. However, in the hydrodynamic limit (large collisionality) the density and potential decouple. As a result, the density becomes passively advected, evolves towards the vorticity, and exhibits intermittent behavior.

The relationship between collisionality and intermittency is investigated experimentally at the stellarator TJ-K. To vary the plasma collisionality, which is related to electron density and temperature, parameters such as gas type, neutral gas pressure, magnetic field, and heating power are varied. Radial profiles of plasma density, temperature, floating potential, and vorticity are recorded via a scanning 7-tip Langmuir probe array. First results will be presented.

P 12.6 Tue 16:30 Empore Lichthof

Calibration and Usecases of the Electron Cyclotron Emission diagnostic at Wendelstein 7-X — •Udo Höfel, Matthias Hirsch, Karsten Ewert, Hans-Jürgen Hartfuss, Heinrich Peter Laqua, Torsten Stange, Robert Wolf, and the W7-X Team — Max-Planck-Institut für Plasmaphysik, Greifswald

The world's largest stellarator, Wendelstein 7-X (W7-X), is equipped with a 140 GHz electron cyclotron resonance heating (ECRH) system providing up to 5 MW absorbed power in the first operation phase OP1.1. The foreseen X2-heating scenario uses the high absorption of the second harmonic extraordinary electron cyclotron waves, which leads on the other hand to a black body electron cyclotron emission (ECE) being proportional to the local electron temperature. ECE is one of the fundamental operating diagnostics and is planned to yield

the electron temperature profile from the very first discharges onwards. Unlike most other ECE diagnostics, the 32 channel ECE radiometer diagnostic (with additional 16 channels with higher radial resolution) at W7-X is absolutely calibrated. It is planned to use this diagnostic for intensive studies on electron heat transport in the upcoming operational phases of W7-X. Simple switch-off experiments for the determination of the energy confinement time should already be possible within the first plasma shots. Due to the high temporal and radial resolution the ECE will be used also to determine the power deposition by modulation of the heating gyrotron. If reasonably equilibrated plasma conditions could be generated in the first operational phase (OP 1.1), first studies on electron thermal diffusivity could also be possible.

P 12.7 Tue 16:30 Empore Lichthof

Progress toward the creation of magnetically confined pair plasmas — •Haruhiko Saitoh[1,6], Uwe Hergenhahn[1], Holger Niemann[1,2], Norbert Paschkowski[1], Thomas Sunn Pedersen[1,2], Juliane Stanja[1], Eve V. Stenson[1], Matthew R. Stoneking[1,3], Christoph Hugenschmidt[4], Christian Piochacz[4], Sebastian Vohburger[4], Lutz Schweikhard[2], James R. Danielson[5], and Clifford M. Surko[5] — [1]Max-Planck-Institut für Plasmaphysik — [2]Ernst-Moritz-Arndt-Universität Greifswald — [3]Lawrence University — [4]Technische Universität München — [5]University of California, San Diego — [6]The University of Tokyo

The PAX (Positron Accumulation eXperiment) and APEX (A Positron Electron eXperiment) projects aim to experimentally study the unique wave propagation and stability properties of pair plasmas. We plan to accumulate a large number of positrons in a multicell-type trap system (PAX) and to confine them with electrons in APEX, a levitated dipole or stellarator configuration, operated at the NEPOMUC facility, the world's most intense positron source. In this contribution, we report on recent results from PAX and APEX. We have conducted electron experiments with a 2.3 T Penning-Malmberg trap; confinement for more than 1 hour and observation of a collective mode were demonstrated. At NEPOMUC, we have characterized the positron beam for a wide energy range. In a prototype permanent-magnet dipole trap, efficient (38%) injection of the remoderated 5 eV positron beam was realized using ExB drifts. Based on these results, design studies on the confinement of pair-plasmas in a levitated dipole trap are ongoing.

P 12.8 Tue 16:30 Empore Lichthof

Spectroscopic Impurity Survey in Wendelstein 7-X — •Birger Buttenschön[1], Rainer Burhenn[1], Henning Thomsen[1], Wolfgang Biel[2], Jochen Assmann[2], Klaus-Peter Hollfeld[2], and the Wendelstein 7-X Team[1] — [1]Max-Planck-Institut für Plasmaphysik, Wendelsteinstr. 1, 17491 Greifswald, Deutschland — [2]Forschungszentrum Jülich GmbH, Jülich, Deutschland

The High Efficiency eXtreme ultraviolet Overview Spectrometer (HEXOS) has been developed specifically for impurity identification and survey purposes on the Wendelstein 7-X stellarator. This spectrometer system, consisting of four individual spectrometers, covers the wavelength range between $\lambda = 2.5$nm and $\lambda = 160$nm, observing the intense resonance lines of relevant Mg-, Na-, Be- and Li-like impurity ions as well as the high-Z W/Ta quasi-continua.

During the first operation phase of W7-X, commissioning of HEXOS was finished by providing an in-situ wavelength calibration. The permanently acquired spectra are evaluated to monitor the overall impurity content in the plasma, and serve as an indicator for unintended plasma-wall contact possibly leading to machine damage.

HEXOS results from the first operation phase of W7-X are presented and discussed with respect to future scientific exploitation of the available data.

P 12.9 Tue 16:30 Empore Lichthof

Determination of the Stochastic Layer Width Induced by Magnetic Perturbations via Heat Pulse Experiments in ASDEX Upgrade — •D. Brida[1,2], T. Lunt[1], M. Wischmeier[1], G. Birkenmeier[1], P. Cahyna[3], M. Faitsch[1], Y. Feng[4], R. Fischer[1], B. Kurzan[1], M. Schubert[1], B. Sieglin[1], W. Suttrop[1], E. Wolfrum[1], and the ASDEX Upgrade Team[1] — [1]Max-Planck-Institut für Plasmaphysik, 17491 Greifswald, Germany — [2]Physik-Department E28, Technische Universität München, 85747 Garching, Germany — [3]Institute of Plasma Physics CAS, v.v.i. Prague, Czech Republic — [4]Max-Planck-Institut für Plasmaphysik, 17491 Greifswald, Germany

Magnetic Perturbations (MP) are studied on a number of tokamaks, due to their mitigating effect on Edge Localized Modes (ELMs), which pose a serious risk for the plasma facing components. MPs can lead to the creation of a stochastic layer in the plasma edge. Theory predicts, however, that the plasma screens the MP field, but the measurement of this screening effect remains elusive. In this contribution we present an experimental approach to measure the stochastic layer width, by the localized deposition of Electron Cyclotron Resonance Heating pulses in the edge region. Simulations with the 3D transport code EMC3-Eirene for ASDEX Upgrade (AUG) indicate that the propagation time to the target decreases with decreasing screening. A corresponding heat pulse L-mode experiment on AUG was carried out where no decrease of the propagation time between the case with and without MPs could be measured within the error bars, indicating strong screening.

P 12.10 Tue 16:30 Empore Lichthof

Measurement of plasma edge profile on Wendelstein 7-X — Philipp Drews[1], •Yunfeng Liang[1], Olaf Neubauer[1], Peter Denner[1], Michael Rack[1], Shaocheng Liu[1], Nunchao Wang[1], Dirk Nicolai[1], Olaf Grulke[2], Klaus Hollfeld[1], Guruparan Satheeswaran[1], and W7-X Team[2] — [1]Forschungszentrum Juelich, IEK4, Jülich — [2]Max-Planck-Institut für Plasmaphysik, Greifswald

Wendelstein 7-X (W7-X), currently under commissioning at the IPP Greifswald, will be the world*s largest stellarator with modular superconducting coils, which will enable steady-state-like plasma operation of up to thirty minutes in order to explore the reactor relevance of this concept. The first operation phase of W7-X will employ a limiter configuration. It will be used primarily for setting up the diagnostics and testing the magnetic configuration. In conjunction with the multipurpose manipulator, a fast reciprocating probe is installed. The combined probe head will be used to measure the radial distribution of the magnetic field using magnetic pick-up coils; the plasma temperature and density profiles and the radial electric field using Langmuir pins; and the plasma flows using a Mach setup. As a quasi-isodynamic stellarator, it has been predicted that not only neoclassical but also turbulent transport will be comparable to or possibly even lower than that of tokamaks. Edge plasma profile measurements, especially those of the electron temperature and density, will play a key role in validating this performance in comparison to the tokamak and hence the viability of a stellarator fusion reactor. The edge plasma profile measurements using the combined probe head will be presented.