P 12: Magnetic Confinement / Plasma Wall Interaction I

Time: Wednesday 14:00–15:30 Location: P-H12

P 12.1 Wed 14:00 P-H12

Experimental observation and modelling of heat loads in W7-X and implications for transport — •David Bold, Felix Reimold, Holger Niemann, Yu Gau, Marcin Jakubowski, Carsten Killer, and the W7-X team — Max-Planck-Institut für Plasmaphysik, Greifswald, Germany

Modelling the scrape-off layer of a stellarator is challenging due to the complex magnetic 3D geometry. The here presented study analyses simulations of the scrape-off layer (SOL) of the stellarator Wendelstein 7-X (W7-X) using the EMC3-EIRENE code. Comparing with experimental observations, the transport model is validated.

Based on the experimentally observed strike line width, the anomalous transport coefficients, used as input to the code are determined to around $0.2\,\mathrm{m}^2/\mathrm{s}$. This is however in disagreement with upstream measurements, where such small cross-field transport leads to temperatures higher than measured experimentally. Agreement can be improved by using spatially varying transport coefficients.

Even with spatially varying transport coefficients, differences remain, for example the toroidal heat flux distribution or the hollow temperature profile is not reproduced. Some of the differences could be explained by drifts. The future implementation of drifts into the transport model is expected to help overcome the discrepancies, and thus the development of SOL transport models including drifts is a necessary next step to study the SOL transport of the W7-X stellarator.

P 12.2 Wed 14:15 P-H12

Scaling Behavior of the Weakly Coherent Mode in ASDEX Upgrade I-mode Plasmas — •Manuel Herschel[1,2], Tim Happel[1], Joey Kalis[1,3], Gregor Birkenmeier[1,3], Michael Griener[1], Klara Höfler[1,3], and The ASDEX Upgrade Team[1] — [1]MPI für Plasmaphysik, Garching, Germany — [2]Universität Ulm, Germany — [3]Physik Department E28, TUM, Garching, Germany

Improved confinement regimes are fundamental in the operation of current and future fusion devices. Among these regimes, the I-mode combines the beneficial properties of an H-mode like energy confinement with the absence of ELMs. The physical origin of the I-mode is still not fully understood, but the so-called weakly coherent mode (WCM) dominant in the turbulence spectrum at the plasma edge is often considered to be a key player for I-mode.

To investigate the WCM in detail, turbulence measurements from multiple diagnostics (Doppler reflectometry, thermal helium beam emission spectroscopy) on ASDEX Upgrade are combined in order to characterize the mode better. These measurements include the radial localization, frequency and wavenumber of the WCM, along with important local plasma parameters such as the magnetic field strength, density and temperature.

To ensure statistical significance and enable comparisons over multiple discharges, these measurements are collected in a database consisting of various I-mode plasmas. With this database, the scaling of parameters of the WCM depending on typical plasma variables is examined and compared with proposed theories.

P 12.3 Wed 14:30 P-H12

Post mortem ion beam analysis of the 13C tracer experiment at Wendelstein 7-X — •Christoph Kawan[1], Sebastijan Brezinsek[1], Timo Dittmar[1], Sören Möller[1], and W7-X Team[2] — [1]Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, Partner of the Trilateral Euregio Cluster (TEC), 52425 Jülich, Germany — [2]Max-Planck-Institut für Plasmaphysik, D-17491 Greifswald, Germany

Future fusion reactors will operate under extreme thermal conditions. A key challenge for preserving a safe operation and low maintenance is the mitigation of erosion, transport and deposition of wall material and impurities. To analyze the deposition and transport of impurities, two dedicated experiments were carried out at the end of Wendelstein 7-X campaign 1.2b. $1.1*10^{21}$ molecules $^{13}CH_4$ were injected in standard magnetic divertor configuration through a dedicated gas puff head attached to the multi purpose manipulator directly into the plasma island structures. In the second part, $4.2*10^{22}$ molecules of $^{13}CH_4$ have been injected from a divertor gas injection system at a position where the magnetic island intersects with the horizontal target plate. After the experiment, the wall components were changed and parts of the test divertor unit (TDU) target elements cut for post-mortem analysis. In this work, the deposition of ^{13}C in different locations of W7-X via 1 MeV deuteron ion beam analysis is reported.

P 12.4 Wed 14:45 P-H12

Double-pulse laser ablation molecular isotopic spectroscopy with picosecond laser pulses: Swan band analyses for ^{13}C-^{12}C distinction in graphite — •Erik Wüst, Jannis Oelmann, and Sebastijan Brezinsek — Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, 52425 Jülich, Germany

Laser-based methods for spatially and depth resolved measurements of material composition are well-established. Laser ablation molecular isotopic spectroscopy or spectrometry (LAMIS) is a technique for the determination of isotope concentrations in material mixtures. A laser-induced plasma on the material's surface is used to derive the material isotope composition by optical emission spectroscopy (OES). In double-pulse LAMIS (DP-LAMIS) a second laser pulse is focussed into the laser-induced plasma to enhance the plasma's emission and thus improve the limit of detection for isotopes with smaller concentrations. Laser pulses from a Nd:YAG-laser with 35 ps pulse duration were used to induce the plasma and a second laser pulse from the same laser was used to enhance the plasma's emission. Both laser pulses arrive at the sample with a relative delay of 50 ns. A Littrow spectrometer (focal length: f=750 mm, spectral resolution at 473 nm: A=6000, étendue: $E=62\,\frac{\mu\ \mathrm{m}^2}{\mathrm{sr}}$) was used to analyse the band structure. The analysed materials were graphite either with only natural amounts of ^{13}C or coated with a ^{13}C rich layer. The isotopic composition was determined with the aid of the C_2 molecule's Swan band with $\Delta v=1$ at 473.7 nm.

P 12.5 Wed 15:00 P-H12

Investigation of hydrogen retention in beryllium and beryllium-tungsten alloys — •Meike Flebbe, Timo Dittmar, and Christian Linsmeier — FZJ, Jülich, Germany

ITER will use beryllium (Be) as first wall material and tungsten (W) as divertor material. Alloys can form due to erosion of beryllium and tungsten particles and their redeposition elsewhere. In the course of the plasma-wall interaction, tritium from the plasma can be deposited in the plasma facing material. For safety and for tritium breeding and economy considerations, the understanding of hydrogen retention in Be-W-alloys is of central importance for the fusion research in order to be able to realize a fusion reactor.

Fundamental experiments are required to understand the processes involved in hydrogen retention in Be-W-alloys. These can be executed with the help of in-situ ion beam experiments. A suitable system for this is ARTOSS, a high vacuum device from the FZJ, in which Be-W-alloys can be produced, loaded with deuterium and examined using analysis diagnostics like thermal desorption spectroscopy (TDS) and ion beam analysis (IBA). Recent studies have shown a low temperature desorption peak at around 400 K for beryllium, which shows a splitting into a fine structure from a threshold fluence of $1 \cdot 10^{21}\ \mathrm{m}^{-2}$ with a sufficiently high resolution. The mechanism behind this split is still unknown. To test whether hydrides are the reason for the fine structure, ramp-and-hold TDS experiments are used.

In this contribution, I will show ramp-and-hold experiments with beryllium and will give an outlook on Be-W experiments.

P 12.6 Wed 15:15 P-H12

Application of a spatially resolved emission model to sputtered tungsten atoms at the linear plasma device PSI-2 — •Marc Sackers, Oleksandr Marchuk, Stephan Ertmer, Philippe Mertens, Arkadi Kreter, and Sebastijan Brezinsek — Forschungszentrum Jülich GmbH - Institut für Energie- und Klimaforschung - Plasmaphysik, Partner of the Trilateral Euregio Cluster (TEC), 52425 Jülich, Deutschland

Highly charged atomic species in the core of a fusion plasma are detrimental to the successful operation of the reactor because they lead to significant cooling of the plasma due to radiation losses. For example, at ITER, the divertor will consist of tungsten blocks [1]. The main erosion channel of these blocks is physical sputtering, which needs to be understood at a fundamental level to estimate tungsten concentration in the plasma core for different operating scenarios.

In this work, the PSI-2 plasma-surface interaction test-bed provides divertor-like conditions. Its plasma source is an arc discharge between a hollow ring-shaped cathode and anode. This geometry allows the acquisition of high-resolution emission spectra ($\lambda/\Delta\lambda \approx 7 \cdot 10^5$) for lines of sight parallel and perpendicular to the surface normal of a target exposed to the plasma. A spatially resolved emission model was fitted to spectra of the 498.26 nm neutral tungsten line obtained during sputtering of mono- and polycrystalline tungsten targets. The angular and energy distribution were derived for bombardment with argon ions from 40 eV to 160 eV.

[1] R.A. Pitts *et al.*, J. Nucl. Mater. 2011, **415**, S957-S964