P 16: Helmholtz Graduate School for Plasma Physics I

Time: Wednesday 14:00–16:05 Location: SPA HS202

Topical Talk P 16.1 Wed 14:00 SPA HS202

Transport analysis of high radiation and high density plasmas at ASDEX Upgrade — •L. Casali, M. Bernert, R. Dux, R. Fisher, A. Kallenbach, O. Kardaun, B. Kurzan, P. Lang, A. Mlynek, R. McDermott, F. Ryter, M. Sertoli, G. Tardini, and H. Zohm — Max-Planck-Institut für Plasmaphysik, EURATOM-Assoziation, Boltzmannstraße 2, D-85748 Garching

Future fusion reactors will operate under more demanding conditions compared to present devices. They will require high divertor and core radiation by impurity seeding to reduce heat loads on divertor target plates. In addition, high core densities are required to reach adequate fusion performance. These scenarios are addressed at the ASDEX Upgrade tokamak. Here we present the transport analysis of such scenarios. Plasmas with high radiation by impurity seeding: a non coronal radiation model was developed and compared to the bolometric measurements in order to provide a reliable radiation profile for transport calculations. Power balance analyses taking into account the radiation distribution show no change in the core transport during impurity seeding. High density plasmas with pellets: very good agreement between experimental values and transport calculations is found. Both reveal that τ_E remains constant despite the density increase. Hence the density dependence of ITER98 ($\tau_E \sim n_e^{0.41}$) is not adequate to describe this regime. The kinetic profiles reveal a transient phase at the pellet start due to a slower density build up compared to the temperature decrease. The low particle diffusion can explain the confinement behaviour.

Topical Talk P 16.2 Wed 14:25 SPA HS202

Nitrogen migration and retention in ASDEX Upgrade — •G. Meisl[1], K. Schmid[1], M. Oberkofler[1], K. Krieger[1], S.W. Lisgo[2], L. Aho-Mantila[3], F. Reimold[1], V. Rohde[1], and ASDEX Upgrade Team[1] — [1]Max-Planck-Institut für Plasmaphysik, EURATOM-Assoziation, Boltzmannstraße 2, 85748 Garching, Germany — [2]ITER Organization, FST, Route de Vinon, CS 90 046, 13067 Saint Paul Lez Durance Cedex, France — [3]VTT, FI-02044 VTT

To limit the power load in high-power plasma operation, impurity seeding is mandatory. Nitrogen has been established as optimal choice in ASDEX Upgrade. However, as N is subject to wall pumping, a self-consistent model of the N source flux distribution is required.

N retention in tungsten was studied in laboratory experiments under well-defined exposure conditions. The applicability of the so established model of W-N interaction was tested by experiments in ASDEX Upgrade. W samples were exposed to plasmas with and without N seeding and analyzed by ion beam analysis. Using these data as boundary condition, N transport and re-distribution in the plasma were studied by self-consistent WallDYN-DIVIMP modelling. The dynamic change of the N erosion source at plasma exposed W surfaces was then computed by WallDYN using an improved W-N surface model. First simulations show, in agreement with the experiment, a strong rise of the N re-erosion flux within the first second. By this approach the experimental results from sample analysis, spectroscopy and N pumped by the vacuum system can be interpreted for the first time within a unified self-consistent model.

Topical Talk P 16.3 Wed 14:50 SPA HS202

Non-equidistant Particle-In-Cell for Ion Thruster Plume simulation — •Julia Duras — Ernst-Moritz-Arndt Universität Greifswald, D-17489, Germany

The interaction of ion thrusters and satellites is determined by the plume plasmas. Since the mean free paths are such that the probability for collisions relaxing the distribution functions to Maxwellians is quite low, a correct model of the plume plasma has to be kinetic. Unfortunately, the well-established Particle-In-Cell (PIC) method is only momentum conserving and free of artificial self forces in the case of equidistant meshes. This allows only small domains for the plume due to computational time restrictions. Those simulations suffer from the strong influence of the solution from the boundary conditions at the end of the plume domain.

In the outer plume the densities of electrons and ions decrease by 4-8 magnitudes compared with the thruster channel. This leads to an increasing Debye length, which gives the possibility to enlarge the domain by using a non-equidistant grid. Therefore, momentum and energy conservation in 1D electrostatic PIC codes using non-equidistant grids are studied. A modified two point central difference scheme for non-equidistant grids is suggested, which can be proven analytically and numerically to give the exact solution for the electrical field. In addition a 2D axis-symmetric Poisson solver for non-equidistant grids using the Finite Volume Method is presented.

Topical Talk P 16.4 Wed 15:15 SPA HS202

Algorithm development for safeguarding the Wendelstein 7-X divertor during steady state operation — •A. Rodatos[2], M. Jakubowski[2], H. Greuner[1], G. A. Wurden[3], and T. Sunn Pedersen[1] — [1]Max-Planck-Institut für Plasmaphysik, Boltzmannstraße 2, D-85748 Garching — [2]Max-Planck-Institut für Plasmaphysik, Wendelsteinstraße 1, D-17491 Greifswald — [3]Los Alamos National Laboratory, Los Alamos, NM 87544 USA

The divertor of Wendelstein 7X is designed to withstand steady state heat fluxes of $10\,\mathrm{MW/m^2}$ and $15\,\mathrm{MW/m^2}$ transiently [1]. However higher local heat fluxes are possible. 10 thermographic infrared (IR) observation systems will be installted to monitor the divertor and its center goal is the detection of overheated areas in real time. Besides an increased plasma heat flux, there are at least two potential causes of an elevated diverter surface temperature. First redeposited eroded material forming surface layers with a poor thermal connection to the underlying water-cooled tiles [2]. Second, delaminated CFC tiles will exhibit an elevated surface temperature relative to properly bonded tiles. Using the measured characteristic time scales for the thermal response, gained from experiments at GLADIS[3], we have concluded that it is possible to distinguish between healthy, delaminated, surface-coated and delaminated surface-coated tiles.

[1] H. Greuner, et al., Fusion Technology **Vol. 1** (1998) 249
[2] A. Herrmann, et al., Phys. Scr. **T128** (2007) 234
[3] H. Greuner, et al., J. Nucl. Mater. **367-370** (2007) 1444

Topical Talk P 16.5 Wed 15:40 SPA HS202

Recent progress in studying the dynamics of finite 3D dust clouds — •André Schella, Matthias Mulsow, and André Melzer — Institut für Physik, Ernst-Moritz-Arndt-Universität Greifswald, 17489 Greifswald, Germany

Dusty plasmas had become a versatile model system to study diverse physical concepts at the kinetic level since individual particles can be traced by means of video microscopy. One decade ago, Arp et al. conducted groundbreaking experiments with a finite number of harmonically trapped dust particles in a plasma. Due to their mutual particle-particle interaction and their shell-like structures, these 3D dust clouds are termed Yukawa balls. In these finite ensembles volume effects and boundary related effects are always competing, making a quantitative physical description a challenging task.

In my contribution, I will focus onto recent progress in studying the dynamics of finite dust clouds. Here, laser heating is a generic approach drive these systems to the fluid state. During the last years, not only the associated phase transition, but moreover statistical properties of dust clouds were explored. There, a close relationship between transport and disorder even in finite ensembles was demonstrated. Furthermore, I will emphasize the role of dust clusters in studying the recrystallization process of finite matter by means of experiments.