P 2: Helmholtz Graduate School I

Zeit: Montag 8:30–10:35 Raum: HS 1010

P 2.1 Mo 8:30 HS 1010

Topology optimisation of two material structures for plasma-facing component applications — •Alexander von Müller[1,2], Rudolf Neu[1,2], Udo von Toussaint[1], and Jeong-Ha You[1] — [1]Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany — [2]Technische Universität München, 85748 Garching, Germany

An important plasma-facing component (PFC) in future magnetic confinement nuclear fusion devices is the divertor which allows power exhaust and removal of impurities from the main plasma during operation. The most highly loaded parts of a divertor have to withstand intense particle bombardment which in turn leads to severe heat fluxes.

According to the current understanding, tungsten (W) is used as a plasma facing material while copper (Cu) is used as heat sink material in such a component. However, the combination of these materials bears difficulties due to their inherently different thermomechanical properties leading to thermal stresses during heat flux loading.

Up-to-date additive manufacturing technologies offer possibilities to materialise objects with almost any shape. Against this background, the question arises whether a topologically optimised W-Cu structure can be beneficial in order to achieve an improved PFC design.

The contribution addresses this issue by assessing the suitability of topology optimisation techniques regarding the abovementioned two material problem. An approach is presented how such an optimisation can be implemented. Eventually, the practicality of this approach is demonstrated based on a representative test case.

P 2.2 Mo 8:55 HS 1010

Plasma-driven deuterium permeation through tungsten at 300 and 450 K — •Stefan Kapser[1,2], Mitja Kelemen[3], Armin Manhard[1], Sabina Markelj[3], Klaus Schmid[1], Tiago Silva[1,4], Primož Vavpetič[3], and Udo von Toussaint[1] — [1]Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching, Germany — [2]Physik-Department, Technische Universität München, James-Franck-Str. 1, 85748 Garching, Germany — [3]Jožef Stefan Institute and Association EURATOM-MHEST, 39 Jamova cesta, Ljubljana 1000, Slovenia — [4]Instituto de Física da Universidade de São Paulo, Rua do Matão, trav. R 187, 05508-090 São Paulo, Brazil

Deuterium permeation through tungsten under plasma exposure has been investigated for sample temperatures of 300 K and 450 K. Tungsten foils were exposed to deuterium plasma on one side, the permeating deuterium was accumulated in a getter layer on the other side. Subsequently, the deuterium amount in the getter was measured using nuclear reaction analysis (NRA). In addition, the deuterium depth distributions in the tungsten were investigated by NRA. Despite significant differences in the deuterium retention in the subsurface region of the plasma exposed tungsten, the measured permeation flux at both temperatures was similar. The experiments are interpreted based on trap-diffusion simulations. Additionally, microbeam-NRA was used to investigate the influence of the tungsten microstructure on the spatial homogeneity of the deuterium permeation flux.

P 2.3 Mo 9:20 HS 1010

Impact of 3D Magnetic Perturbations on Divertor Heat Load in ASDEX Upgrade — •Michael Faitsch, Bernhard Sieglin, Thomas Eich, Albrecht Herrmann, Wolfgang Suttrop, and the ASDEX Upgrade Team — Max-Planck-Institute for Plasma Physics, Boltzmannstr. 2, D-85748 Garching, Germany

The reduction of transient heat loads due to edge localized modes (ELM) in H-mode is required for the sustained operation of ITER/DEMO. The application of 3D magnetic perturbation (MP) fields is investigated as a method for ELM control and full ELM suppression which has recently been established on ASDEX Upgrade (AUG). However, these 3D fields lead to toroidal asymmetries of the heat load pattern in the divertor that may be problematic for future devices. AUG is equipped with a versatile coil set and a high resolution infrared (IR) camera system to characterize the impact of MPs on divertor heat loads to the highest accuracy. The 2D heat flux with constant divertor conditions in L- and H-mode is studied in AUG with slow rotating (1 Hz) n = 1,2,3 MP fields. In H-mode both ELM and inter-ELM data is obtained.

The resulting 2D heat flux pattern varies for distinct differential phases. The presented data indicate that at least in L-Mode enhanced cross-field transport due to the MP is negligible. With increasing density the characteristic of the 2D heat flux structure is reduced. This is accredited to the increase of the divertor power spreading S. However, ELM filaments and divertor striations lock to the perturbation leading to enhanced sputtering at distinct toroidal locations.

P 2.4 Mo 9:45 HS 1010

Divertor Heat Fluxes with Magnetic Perturbations at High Densities in the Tokamak ASDEX Upgrade — •Dominik Brida[1,2], Tilmann Lunt[1], Marco Wischmeier[1], Matthias Bernert[1], Daniel Carralero[1], Michael Faitsch[1], Till Sehmer[1], Bernhard Sieglin[1], Yühe Feng[3], Wolfgang Suttrop[1], Elisabeth Wolfrum[1], The MST1 Team[1], and The ASDEX Upgrade Team[1] — [1]Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, D-85748 — [2]Physik Department, Technische Universität München, James-Franck-Str. 1, D-85748 Garching — [3]Max-Planck-Institut für Plasmaphysik, Wendelsteinstr. 1, D-17491

Magnetic Perturbations have been the subject of extensive research in the last years, due to the prospect of mitigating harmful edge localized modes (ELMs) in future divertor tokamaks, such as ITER. As an undesireable side effect MPs can create a toroidally non-uniform divertor target heat flux. This has been consistently measured, among others, in the tokamak ASDEX Upgrade (AUG) at low divertor densities. However, currently it is envisaged to operate ITER in a partially detached regime, at high divertor densities, where the impact of transport may be different.

To address this issue a comprehensive set of high density L- and H-mode deuterium discharges with MPs were carried out in AUG. It was found that the target heat flux becomes increasingly axisymmetric as the divertor detaches. Furthermore, a similar tendency has been observed in simulations with the 3D transport code EMC3-EIRENE.

P 2.5 Mo 10:10 HS 1010

Fictitious time-evolution for steady-state strongly non-linear transport equations — •Herbert Oberlin, Marco Restelli, and Omar Maj — Max Planck Institut - IPP , Garching bei München, Deutschland

The solution of nonlinear partial differential equations may often pose difficult challenges in the development of efficient codes for physics simulations. Standard methods usually rely on iterative schemes that, in time-dependent problems are nested into time-stepping iterations. In strongly non-linear cases, convergence of the iterative nonlinear solver imposes prohibitively small values for the time-step. When only the steady state is of interest, this amounts to wasting resources in the uninteresting transient. In this work, we propose new relaxation methods for the computation of steady-state solutions for strongly non-linear systems, based on the dissipation of specific metrics of the system which guarantee better steady-state convergence properties. The main envisaged application is the speeding up of the computational fluid dynamics kernel of the SOLPS (Scrape-Off Layer Plasma Simulation) suite of codes which simulate the outer region of the plasma column in tokamak devices.