P 4: HEPP II

Time: Monday 16:30–18:35 Location: CHE/0091

P 4.1 Mon 16:30 CHE/0091

CO_2 dissociation using a microwave plasma torch - a study on industrially relevant parameters — •Christian Karl Kiefer[1], Rodrigo Antunes[1], Ante Hecimovic[1], Arne Meindl[1], and Ursel Fantz[1,2] — [1]Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany — [2]University of Augsburg, 86159 Augsburg, Germany

Under laboratory conditions, microwave plasma torches are known to be an energetically highly efficient CO_2 conversion technology, for pressures ranging from 100 mbar up to atmospheric pressure. However, issues relevant for industrial application such as the wall-plug energy efficiency, including the energy consumption of peripheral equipment, the performance for impure CO_2 streams directly from carbon capture facilities and the stability at long-term operation are usually not addressed. To fill that gap, the wall-plug energy efficiency of a lab-scale microwave plasma torch was determined reaching values up to 17.9%, corresponding to an electrical power consumption of 19.6 kWh per produced Nm^3 of carbon monoxide. The effect of Ar, N_2, O_2 and air admixture to the CO_2 feed gas stream was investigated. Experiments show that small amounts of nitrogen can even increase energy efficiency whereas the most detrimental effect on CO_2 dissociation was found for air admixture. Finally, a durability test over 29 h was performed, demonstrating that microwave plasma torch operation is very reproducible and stable in all figures of merit with short ramp-up times, making it a promising technology for intermittent operation.

P 4.2 Mon 16:55 CHE/0091

3D Monte Carlo PIC modeling of particle extraction from negative ion sources — •Max Lindqvist[1,2], Dirk Wünderlich[1], Serhiy Mochalskyy[1], Adrien Revel[2], Tiberiu Minea[2], and Ursel Fantz[1] — [1]Max-Planck-Institut für Plasmaphysik, Garching, Germany — [2]Université Paris-Saclay, CNRS, LPGP, Orsay, France

Negative H^- or D^- ions for the ITER NBI system are produced in RF ion sources, mainly by surface production, and accelerated through a multi-aperture grid system. One of the main limiting factors during operation of such ion sources is the amount of co-extracted e^-, in particular during operation with D. For a correct description of the particle dynamics close to the Plasma Grid (PG) where a 3D magnetic field is present, self-consistent 3D PIC-MCC modeling is needed. The 3D PIC-MCC code ONIX has been used to simulate one PG aperture in the ELISE ion source, a half-size ITER-like ion source in IPP Garching. The impact of plasma parameters on the co-extraction of e^- is presented. A higher T_e has a strong impact on the amount of co-extracted e^-. The original code was improved by adding a plasma generation module that allows modeling the biasing of the PG w.r.t. the source walls. By increasing the PG bias above the floating potential, the amount and temporal instability of co-extracted e^- are strongly decreased, in agreement with experiments. ONIX was coupled with the beam code IBSimu to allow the correlation of particle properties from the plasma to the beam, and to study the extraction probability and beam divergence of negative ions during different configurations of PG biases and geometries to give insights into grid optimization.

P 4.3 Mon 17:20 CHE/0091

Non-local neoclassical PIC simulations for the radial electric field in stellarators. — •Michał Kuczyński, Ralf Kleiber, and Håkan Smith — Max-Planck-Institut für Plasmaphysik, Greifswald, Germany

Transport in fusion plasma devices can be classified as either turbulent or neoclassical. While turbulence is responsible for the majority of particle and heat losses in both, tokamaks and optimised stellarators the theory of neoclassical transport should not be disregarded. Its applications, for example the prediction of the bootstrap current, are of great importance in fusion research. This talk focuses on the neoclassical radial electric field in stellarators.

For a quasi-neutral plasma in a thermodynamic equilibrium, commonly, the electric field is negative throughout the plasma vessel. This is called an ion root. However, when electrons are much hotter than ions, the electric field takes a positive value. This electron root and can be achieved with, for example, ECRH heating. As correctly predicted by the local neoclassical transport theory, this is a consequence of the ambipolarity condition on the ion and electron fluxes. However, the theory meets its limitations when there is a transition between the two solutions. Moreover, since the electric field switches the sign during the transition, the strongly sheared ExB flow is likely to affect turbulence. To understand the physics of this phenomenon we must resort to simulations of global neoclassical transport. We present the first self-consistent global neoclassical radial electric field simulations performed using a particle-in-cell code - EUTERPE.

P 4.4 Mon 17:45 CHE/0091

Suppression of Diocotron Drift Modes and Increased Transfer in a Multicell Trap — •Martin Singer[1,3], James R. Danielson[2], and Lutz Schweikhard[3] — [1]IPP Greifswald, Germany — [2]Department of Physics, UCSD, USA — [3]Institut für Physik, Universität Greifswald, Germany

The A Positron Electron eXperiment (APEX) will accumulate large quantities of positrons for a positron-electron (pair) plasma which are an excellent candidate to test basic plasmas physics. To this end we have designed and constructed a new multicell Penning-Malmberg trap (MCT). It includes a master-cell, and three prototype storage cells (one on-axis, and two off-axis). With this device we will test and improve the plasma transfer to the off-axis cells and the stacking of multiple plasma pulses to create large space-charges. We will develop suitable protocols to achieve these key goals, for the use of a MCT at the NEPOMUC positron source in Munich.

In this contribution, we will discuss the dynamics during the transport to the off-axis cells. These are dominated by competing diocotron drift modes. We developed techniques to suppress these modes to mitigate losses and to center the plasma in the off-axis cells. Furthermore, we demonstrated an improved transfer and consecutive transfer to multiple off-axis cells. This enabled the first simultaneous confinement in two different off-axis storage cells. The work was funded by DFG (Grant Nos. SCHW 401/23-1, Hu 978/15-1 and PE 2655/1-1) and ERC (Grant No. 741322). JRD is funded by U.S. DOE (Grant No. DE-SC0019271).

P 4.5 Mon 18:10 CHE/0091

Characterization and identification of MHD-like fluctuations of core electron temperature transitions in W7-X plasmas — •Juan Fernando Guerrero Arnaiz[1,2], Andreas Dinklage[1,2], Axel Könies[2], Carolin Nührenberg[2], Alessandro Zocco[2], Matthias Borchardt[2], Christian Brandt[2], Neha Chaudhary[2], Joachim Geiger[2], Matthias Hirsch[2], Udo Höfel[2], Ralf Kleiber[2], Kian Rahbarnia[2], Sara Vaz Mendez[2], Alexei Mishchenko[2], Jonathan Schilling[2], John Schmitt[3], Henning Thomsen[2], Marco Zanini[2], and W7-X Team[2] — [1]Universität Greifswald, Greifswald, Germany — [2]Max-Planck-Institut für Plasmaphysik, Greifswald, Germany — [3]Auburn University, Auburn AL, United States

Previously unexpected spontaneous transitions to higher core-electron temperatures preserving plasma pressure were detected in low-iota configuration W7-X plasmas. Transitions occurred at stationary plasma conditions at fixed heating power and line integrated density but with evolving plasma currents. Here we report on low frequency activity preceding the transitions. To gain insight on the transition mechanism, this activity is characterized. This is done through experimental and numerical modelling, shedding light on the nature of the underlying MHD instability. The rational iota-values and the impact of radial electric fields on the mode activity and the transition to enhanced core electron temperature are examined. As for now, the instability is narrowed down to GAM oscillations and zonal flow activity, both of which were found to potentially exist according to systematic simulations.