P 17: Plasma Diagnostics II

Time: Wednesday 14:30–16:35 Location: b305

Invited Talk P 17.1 Wed 14:30 b305

Plasma measurement and control: challenges and recent advances — •Timo Gans — York Plasma Institute, Department of Physics, University of York, UK

Precise measurements and control of plasma properties are equally important for fundamental investigations and the development of next generation plasma technologies. This is particularly challenging in atmospheric pressure plasmas due to small dimensions on micron-scales and pronounced dynamics requiring temporal resolution of picoseconds. This presentation will discuss recent advances using radio-frequency atmospheric pressure plasmas as example. These plasmas are efficient sources for reactive species. The non-equilibrium chemical kinetics is initiated by the electron dynamics. Due to the strongly collisional environment and associated short electron energy relaxation times the electron dynamics can be tailored using multi-frequency power coupling, enabling separate control of key parameters like electron density and electron mean energy. Measurements and predictive simulations of key reactive species are equally challenging due to the strongly collisional environment and their multi-scale nature in space and time. The most promising approach is the exploitation of complementary advantages in direct measurements combined with specifically designed numerical simulations. The employed diagnostic techniques include picosecond laser spectroscopy, synchrotron VUV spectroscopy, UV absorption spectroscopy and nanosecond optical imaging spectroscopy. The presentation will focus on examples of He-O_2-N_2-H_2O mixtures for bio-medical applications.

Fachvortrag P 17.2 Wed 15:00 b305

Endoscope diagnostic for tomography, spectroscopy and thermography on Wendelstein 7-X — •Peter Denner, Olaf Neubauer, Bernd Schweer, and Yunfeng Liang — Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung – Plasmaphysik, 52425 Jülich, Germany

Plasma–surface interaction (PSI) in the divertor region of Wendelstein 7-X (W7-X) will be of great importance for operational phase OP1.2. While the erosion of the divertor will have an impact on its lifetime and is therefore a critical subject of investigation, fundamental PSI studies in the divertor region are in many ways equally significant.

These plasma–wall interactions will be influenced by impurity transport, where the complex 3D magnetic geometry will play a crucial role, but this magnetic geometry could itself be influenced by plasma effects such as Pfirsch–Schlüter and bootstrap currents. Therefore, along with measurements of obvious quantities such as heat flux, PSI research in the divertor region will also require measurements of the temperature in the plasma edge and of the concentration and distribution of different impurities, in combination with modelling of impurity transport.

In order to provide the measurements necessary to address these physics questions, a set of endoscopes has been designed for visible and ultraviolet spectroscopy and tomography of the plasma edge, along with infrared thermography of the divertor tiles. An overview of this endoscope diagnostic system will be presented. Details of the measurements to be taken and their relationship to physics issues such as impurity transport and erosion of the divertor will be discussed.

Fachvortrag P 17.3 Wed 15:25 b305

Magnetic diagnostics at Wendelstein 7-X — •K Rahbarnia[1], T Andreeva[1], A Cardella[2], B Carvalho[3], M Endler[1], D Hathiramani[1], O Grulke[1], U Neuner[1], J Svensson[1], H Thomsen[1], J Geiger[1], and A Werner[1] — [1]Max Planck Institute for Plasma Physics, Wendelsteinstr. 1, 17489 Greifswald, Germany — [2]Former W7-X, presently JT-60SA project, F4E c/o IPP Boltzmannstr. 2, 85748 Garching, Germany — [3]Instituto de Plasmas e Fusao Nuclear Instituto Superior Tecnico, Lisbon, Portugal

An arrangement of magnetic sensors has been installed at the stellarator Wendelstein 7-X (W7-X) including over 300 individual 3D shaped sensors like diamagnetic loops, Rogowski, Saddle and Mirnov coils. Future long pulse operation of up to 1800 s demands an optimization of materials, thermal shielding and signal integration accuracy. The main objectives are the reconstruction of magnetic equilibria and monitoring the diamagnetic plasma energy. Generally, in stellarators a toroidal current drive is not necessary to maintain confinement. Minimization of toroidal currents is in fact one of the major optimization criteria of W7-X. It will be investigated by continuous and segmented Rogowski coils and Saddle coils measuring e.g. bootstrap and Pfirsch-Schlüter currents and their spatial distributions. A set of 125 toroidally and poloidally arranged Mirnov coils will give information on MHD and Alfvén mode activity and edge localized modes (ELMs). A detailed overview of the magnetic diagnostic system is outlined and initial results obtained during the first operation phase of W7-X will be presented.

P 17.4 Wed 15:50 b305

Fotografische Messung der energieabhängigen Wirkungsquerschnitte für Elektronenstoßanregung — •Dirk Luggenhölscher, Xi-Ming Zhu und Uwe Czarnetzki — Ruhr Universität Bochum, Institut für Experimentalphysik V

Die Kenntnis der Wirkungsquerschnitte für Elektronenstoßanregung ist für die quantitative Spektroskopie sowie der Modellierung von Plasmen von großer Bedeutung. Üblicherweise werden diese durch Schwarmexperimente bestimmt. Dabei ist es jedoch schwierig, bei niedrigen Energien nahe der Anregungsschwelle zu messen. Dieser Bereich ist jedoch für Niedertemperaturplasmen mit geringen Elektronenenergien von besonderer Bedeutung. Mit der fotografischen Methode ist auch dieser Bereich gut zugänglich. Hierbei werden mit einem gepulsten UV-Laser Photoelektronen ausgelöst und in einem statischen und homogenen elektrischen Feld mit bekannter Stärke beschleunigt. Durch Stöße mit dem Hintergrundgas werden dessen Atome angeregt und die Fluoreszenz ortsaufgelöst detektiert. Da an jedem Ort die potentielle Energie und somit die der Elektronen bekannt und die gemessene Intensität proportional zum Wirkungsquerschnitt bei dieser Energie ist, kann aus der räumlichen Intensitätsverteilung direkt der relative Wirkungsquerschnitt bestimmt werden. Durch die Auswahl geeigneter Spektrallinien ist die gezielte Vermessung einzelner Übergänge möglich und erste Ergebnisse an Neon und Helium werden präsentiert. Verfälschendende Kaskadenprozesse können durch die sehr schnelle Anregung und Detektion jeweils im ns-Bereich vermieden werden, bzw. deren Einfluss kann durch Variation der Detektionszeit gezielt untersucht werden.

P 17.5 Wed 16:05 b305

Experimental determination of EEDF and He_2^* Rydberg-state density by Thomson scattering in a ns-pulsed atmospheric micro-discharge. — •Christian-Georg Schregel, Dirk Luggenhölscher, and Uwe Czarnetzki — Institute for Plasma and Atomic Physics, Ruhr-University Bochum, 44780 Germany

An open question of major importance for the investigation of atmospheric micro plasmas is the shape of the EEDF. This has been addressed by using incoherent Thomson scattering as a non-invasive diagnostic. The technique has been applied to measure the temporal evolution (Δt=20 ns) of the EVDF for a pure Helium plasma between two plane molybdenum electrodes, 0.95 mm apart. The plasma is pulsed with a repetition rate of 5 kHz at 0.7 bar. Measurements were done by a 532 nm Nd:YAG laser and a triple grating spectrometer with a gated ICCD for detection. The setup allows for detection of electron energies between 0.5 eV and 12 eV with up to three orders of magnitude in the dynamic range. Additionally, time resolved optical emission spectra where recorded and the Helium metastable was density probed by laser absorption. With the different diagnostic data combined, variation of laser energy used in Thomson scattering could additionally be utilized as a probe for the absolute Helium Excimer Rydberg-state density, allowing a unique determination of absolute density values in the early stages of the afterglow. Peak electron densities of $2 \cdot 10^{20} m^{-3}$ with a peak electron temperature of 2 eV have been observed.

P 17.6 Wed 16:20 b305

Measurement of molecular argon ion density at atmospheric pressure — •Torsten Gerling, Markus Becker, Christian Wilke, and Klaus-Dieter Weltmann — INP Greifswald, Deutschland

By observing fast oscillation on the current signal we are able to determine the ion density at an atmospheric pressure plasma source. The discharge is a transient spark with currents up to 2 A and a halfwidth of only 10 ns. This discharge shows oscillations in the current decay phase, which have a declining frequency from 250 MHz down to 50

MHz. This presentation will discuss the origin of this fast oscillation as an ion acoustic wave. We will present the solution of the dispersion relation for these conditions. Based on the solution the limits of observation are computed and the dependencies for the existence discussed. Finally the present possibilities and limitations of this method will be summarized.