P 8: Diagnostics I

Time: Tuesday 10:30–12:00 Location: SPA HS201

Invited Talk P 8.1 Tue 10:30 SPA HS201

Coherence imaging spectroscopy: A new method for measuring plasma dynamics — •Oliver P. Ford[1], John Howard[2], Matthias Reich[1], Jakob Svensson[1], and Robert Wolf[1] — [1]Max-Planck-Institut für Plasmaphysik, Greifswald/Garching, Germany — [2]Plasma Research Laboratory, Australian National University, Canberra, Australia

In mangetic confinement fusion plasmas, diagnosis of the magnetic field is of particular interest as it is critical to the efficiency and stability of the plasma confinement but is created partly from unknown currents in the plasma itself. High plasma temperatures restrict core diagnostics to observation of emitted radiation and magnetic field direction is typically inferred through the polarisation of Hydrogen Balmer-α emission, split by the Stark and Zeeman effects. This simultaneous spectroscopy and polarimetry usually requires complex hardware for a small number of measurements. Coherence imaging is a new technique which, with a few small crystal plates and a CCD camera, acquires images of the plasma, modulated with interference patterns that encode the spectral and polarisation information. These diagnostics are substantially simpler, more flexible and provide an order of magnitude more data than traditional systems. The basic principle of coherence imaging will be explained and measurements from the prototype Imaging Motional Stark Effect (IMSE) diagnostic recently installed on the ASDEX Upgrade Tokamak will be presented. Additionally, ion temperature and velocity measurements by Doppler coherence imaging on other small plasma devices will be presented.

P 8.2 Tue 11:00 SPA HS201

Electron beam based space charge measurement of intense ion beams — •Said El Moussati[1], Dieter Hoffmann[1], Serban Udrea[1], Dmitry Varentsov[2], and Karin Weyrich[2] — [1]TU Darmstadt, Germany — [2]GSI, Darmstadt, Germany

To determine the transverse intensity distribution of intense ion beams, an electron beam diagnostic device has been developed at the HHT experimental area of the GSI Helmholtzzentrum für Schwerionenforschung in Darmstadt. This method is based on the deflection of the electrons after passing through the electric field of the ion beam.

In this contribution the theoretical model how to determine the space charge of ion beams is described and some numerical calculations, by which we can define the range of this theoretical model, are presented. Furthermore a first experiment, which has been done with low energy cw ion beam ($^4He^+$, 13.5keV, ~1mA) at the FRANZ-accelerator facility at the Goethe University Frankfurt, will be presented.

P 8.3 Tue 11:15 SPA HS201

Measurements of spectral line intensity by classical spectroscopic methods — •Marina Lisnyak[1], Dmitry Kalanov[2], Sergej Gorchakov[1], Yuriy Golubovskii[2], and Klaus-Dieter Weltmann[1] — [1]INP Greifswald e.V., Felix-Hausdorff-Str. 2, 17489 Greifswald — [2]St. Petersburg State University, Ulyanovskaya 1, 198904 St. Petersburg, Russia

Optical emission spectroscopy (OES) is widely applied for plasma diagnostics. Evaluation of plasma parameters from the results accessed by the optical measurements has to be analysed taking into account the geometry of the plasma and the type of detector in order to avoid inaccuracy and mistakes by results interpretation. Especially, it should be taken into account that the plasma is a volumetric light source. The contribution discusses the applicability of particular OES methods for typical plasma sources and gives a methodological background that is important for plasma diagnostics. The analysis of the plasma domains from which the emitted light enters to the spectral device, taking into account the form of instrumental function, is presented. Correct optical arrangement for measurements with sufficient spatial resolution on a volumetric plasma source is suggested. Experimental results of the emission measurements using different detectors - iCCD, SMOS cameras and photomultiplier - are discussed focussing on advantages and disadvantages of each device. It is shown that the mistakes in optical arrangement can lead to critical mistakes and wrong interpretation of the results.

P 8.4 Tue 11:30 SPA HS201

Plasma Diagnostics Using K-Line Emission Profiles of Silicon — •Yiling Chen, Andrea Sengebusch, Heidi Reinholz, and Gerd Röpke — Universität Rostock, Rostock, Deutschland

Modifications of K-line profiles due to a warm dense plasma environment can serve for plasma diagnostics. We focus on Si K_α emissions. A high enough temperature is necessary to produce the plasma and ionize the greater part of atoms. The plasma consists of ions, atoms and free electrons with densities in the order of $10^{23}\ cm^{-3}$. Thus, x-ray energies are necessary to penetrate the Si sample. In our work we focus on pure Si using LS coupling. For the isolated ions, the wave functions as well as ionization energies, binding energies and relevant emission energies are calculated using the chemical ab initio code Gaussian03. Plasma effects are considered using a perturbative approach to the Hamiltonian. Using RHF wave functions we calculate the screening effect within an ion-sphere model [1] which leads to a plasma screening shift. These energy shifts of the spectral lines are considered with respect to electron-ion and electron-electron interaction. The different excitation and ionization probabilities of the electronic L-shell and M-shell lead to a non-equilibrium charge state distribution [2]. Using this distribution we calculate spectral line profiles depending on the plasma parameters which can be used to evaluate experimental data [3].

[1] Yu. B. Malykhanov, S. V. Evseev,*et al.*, J. Appl. Spectrosc., **79**, 1 (2012). [2] J. Rzadkiewicz, O. Rosmej, *et al.*, High Energy Density Phys. (HEDP) **3**, 233-236 (2007). [3] J. Rzadkiewicz, A. Gojska, *et al.*, Phys. Rev. A **82**, 012703 (2010).

P 8.5 Tue 11:45 SPA HS201

Rekonstruktion der Elektronendichte mit Hilfe von Emissionsspektroskopie am Neutralstrahl — •Alexander Lebschy, Ralph Dux, Rainer Fischer, Rachael M. McDermott und das ASDEX Upgrade Team — Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching

Die Abschwächung des hochenergetischen Neutralteilchenstrahls, der zur Heizung des Plasmas verwendet wird, geschieht durch Ladungsaustauschprozesse und Ionisationsstöße mit Teilchen im Plasma. Die Stärke der Abschwächung wächst mit steigender Plasmadichte. Die Messung der Balmer Strahlung an verschiedenen radialen Positionen, ermöglicht die Abschwächung zu detektieren und damit Informationen über das Profil der Elektronendichte zu erhalten.

Typischerweise, werden die Messungen verschiedener Diagnostiken - Interferometrie und Lithiumstrahl am Tokamak ASDEX Upgrade - im Rahmen der integrierten Datenanalyse kombiniert, um die Elektronendichte im gesamten Plasma zu rekonstruieren. Fehlende Information im Plasmazentrum führt zu einer großen Unsicherheit über das Profil der Elektronendichte. Die Emissionsspektroskopie am Neutralstrahl liefert durch geschickte Anordnung der Sichtlinien Informationen über die Elektronendichte im Plasmazentrum und verringert die Unsicherheiten im Plasmazentrum.

Dieser Vortrag stellt die physikalischen Grundlagen der Emissionsspektroskopie vor, zeigt die Anforderungen an die Genauigkeit der Messung auf und vergleicht Ergebnisse der Rekonstruktion der Elektronendichte.