P 26: Magnetic Confinement II - Helmholtz Graduate School V

Time: Thursday 14:00–16:30 Location: A 0.112

P 26.1 Thu 14:00 A 0.112

Improved Measurements of Satellite Modes in 140 GHz Wendelstein 7-X Gyrotrons: An Approach towards an Electronic Stability Control — •Fabian Wilde[1,2], Torsten Stange[1], Hans Oosterbeek[1], Stefan Marsen[1], Heinrich Laqua[1], Konstantinos Avramidis[2], Ioannis Pagonakis[2], Stefan Illy[2], Manfred Thumm[2], Gerd Gantenbein[2], John Jelonnek[2], Robert Wolf[1], and W7-X Team[1] — [1]Max-Planck Institute of Plasmaphysics, Wendelsteinstraße 1, 17491 Greifswald, Germany — [2]Institute for Pulsed Power and Microwave Technology, Karlsruhe Institute of Technology, 76131 Karlsruhe, Germany

The stellarator Wendelstein 7-X (W7-X) uses electron cyclotron resonance heating (ECRH) by high-power microwave sources (gyrotrons). At the limit of operational stability, the stray radiation level in the gyrotron is increased due to excitation of parasitic and satellite modes, often resulting in a mode loss. The stray radiation by those modes is proposed as a mode-loss precursor. The hysteretic gyrotron behavior after a mode loss was investigated to demonstrate the feasibility of an automated mode recovery. The satellite modes around 137.3 GHz and 142.5 GHz were identified as possible mode-loss precursor candidates in shot spectrograms of the stray radiation at the gyrotron relief window. The activity of the latter was measured with a 142 GHz highpass filter and upto two RF detectors. In order to improve the signal stability, an overmoded setup was evaluated, using a satellite mode bandpass, realized as a dielectric disc filter in an overmoded waveguide and a resonator volume with upto five RF detectors.

P 26.2 Thu 14:25 A 0.112

Development of Heating Scenario to Reduce the Impact of Bootstrap Currents in Wendelstein 7-X — •Priyanjana Sinha, Hauke Hölbe, Joachim Geiger, Yuriy Turkin, and Thomas Sunn Pedersen — Max-Planck-Institut für Plasmaphysik, Greifswald, Germany

Wendelstein 7-X is a low-shear stellarator with 10 modular island divertor units designed for particle and heat exhaust. For the proper working of the island divertor concept, the edge magnetic field topology has to have a certain resonant structure, so-called magnetic islands, at the boundary of the plasma .The bootstrap current (BSC), affects strongly the location of the edge islands thus changing their interaction with the divertor plates. Previous studies have predicted an overload problem due to the evolving BSC near the pumping gap of the divertor. A new plasma-facing component referred to as scraper element (SE) has been proposed to mitigate this overload problem. However, calculations predict a drop in pumping efficiency which may result in a degraded divertor performance. Therefore, to avoid the necessity of the SEs, alternative experimental scenarios are investigated where the critical range of BSC is reached and exceeded at reduced heating power levels. For this study, the numerical tools used are the Variational Moments Equilibrium Code (VMEC) and the EXTENDER-code to calculate the magneto-hydrodynamic equilibrium field produced by the plasma and the external coils in the entire vacuum chamber. The plasma currents are calculated self-consistently by iterating between various codes until changes are negligible.

P 26.3 Thu 14:50 A 0.112

Microwave beams in plasmas: numerical study of scattering and reflections in the semiclassical limit. — •Lorenzo Guidi[1,2], Omar Maj[1,2], Antti Snicker[1,3], Alf Köhn[1,4], Hannes Weber[1], Caroline Lasser[2], and Emanuele Poli[1] — [1]Max-Planck-Institut für Plasmaphysik, D-85748 Garching (DE) — [2]Technische Universität München, D-85748 Garching (DE) — [3]Institute of Interfacial Process Engineering and Plasma Technology, Univeristy of Stuttgart, D-70569 Stuttgart (DE) — [4]Department of Applied Physics, Aalto University, FI-00076 Aalto (FI)

Due to the large use of microwaves in nuclear fusion related experiments, fast and reliable numerical simulations of their behaviour are crucial to both understand present devices (e.g., ASDEX Upgrade) and guide the design of future ones (e.g., ITER). We will show how in the short-wavelength approximation (semiclassical limit) one can build rigorously such for the following two problems:

1. The problem of scattering induced by fluctuations of the plasma density can be formulated by means of the so called wave kinetic equation, whose solution provides the average effect of fluctuations on the beam. We designed a Monte-Carlo scheme for it, and implemented it in a code - WKBeam - which can simulate realistic ITER scenarios.

2. In the framework of reflectometry studies, the asymptotic methods routinely used in the fusion community generally fail to describe the beam in the neighborhood of turning points. We show how we can solve this issue by reconstructing the beam from an opportunely initialized wave packet.

P 26.4 Thu 15:15 A 0.112

ICRH heating and antenna performance in magnetically perturbed 3D tokamak plasmas — •Guillermo Suarez Lopez[1,2], Roman Ochoukov[1], Matthias Willensdorfer[1], Volodymyr Bobkov[1], Mike Dunne[1], Helmut Faugel[1], Helmut Funfgelder[1], Jean-Marie Noterdaeme[1,3], Erika Strumberger[1], Wolfgang Suttrop[1], Hartmut Zohm[1,2], ASDEX Upgrade team[1], and EUROfusion-MST1 Team[1] — [1]Max Planck Institute for Plasma physics, Garching b. Munchen, Germany — [2]Ludwig Maximillians University, Munich, Germany. — [3]University of Ghent, Ghent, Belgium

Ion Cyclotron resonant heating (ICRH) is an efficient process in which an antenna excites the fast magnetosonic acoustic wave in a magnetically confined plasma in order to increase the energy of the plasma ions via wave damping. The fast wave is, however, evanescent in low-density plasmas, such as the one in the edge region of a tokamak, where such an antenna is usually installed. This means that only a fraction of the total power sent to the antenna is coupled to the plasma wave. Analytically, the amount of power that can be coupled is very well understood for simple cases, such as a one-strap antenna radiating to a uniform plasma. More complex problems require the use of numerical computations. In this work, we study the coupling of the fast wave in an intrinsic 3D geometry, namely, a tokamak plasma with applied magnetic perturbations (MP). Both experimental data and numerical MHD simulations are presented. A relation between applied MP phasing, plasma 3D displacement, and ICRH coupling is found.

P 26.5 Thu 15:40 A 0.112

New insights into fast ion induced turbulence stabilization — •Alessandro Di Siena, Tobias Goerler, Hauke Doerk, Emanuele Poli, and Roberto Bilato — Max Planck Institute for Plasma Physics, Boltzmannstr.2, 85748 Garching, Germany

The beneficial effect of fast ions on plasma turbulence has been observed in several experimental discharges and in different tokamak devices, e.g. ASDEX Upgrade and JET. Such energetic particles, usually created by auxiliary heating systems such as external neutral beam injection (NBI) and ion cyclotron resonance heating (ICRH) may strongly suppress plasma turbulence, possibly increasing the performance of future fusion reactors. Although, these findings have been reproduced in numerical gyrokinetic simulations the physics of the significant fast ion stabilisation is still mostly unknown and usually highlighted as nonlinear electromagnetic stabilisation. In the contribution at hand, a wave-energetic particle resonance stabilising mechanisms is presented with both gyrokinetic GENE simulations and a reduced Vlasov-Poisson theoretical model. Key parameters controlling the role of the fast ions are identified and various ways of optimising their beneficial impact are explored. Experimental evidences of this effect are shown and ITER extrapolations are drawn.

P 26.6 Thu 16:05 A 0.112

Development and evaluation of a synthetic helium beam diagnostic for Wendelstein 7-X — •Wladimir Zholobenko[1], Michael Rack[1], Detlev Reiter[1], Motoshi Goto[2], Bettina Küppers[1], and Petra Börner[1] — [1]Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, Partner of the Trilateral Cluster (TEC), 52425 Jülich, Germany — [2]National Institute for Fusion Science, Toki 509-5292, Japan

Helium beam emission spectroscopy is an established diagnostic for the determination of temperature and density in the edge region of magnetically confined plasmas. It is also applied for the study of the divertor plasma at Wendelstein 7-X. However, its applicability in the whole possible parameter range and 3D geometry is still debated [1].

Our approach is to implement a synthetic diagnostic in the established 3D Monte Carlo transport code EMC3-EIRENE to study the propagation of the helium beam into a divertor plasma and its emission. The first step was to upgrade the He collisional-radiative model in EIRENE with the more recent one from M. Goto [2], which contains an internationally evaluated data set. Numerical investigation shows the importance of the often neglected higher excited states.

The extended diagnostic module enables simulation of HeI emission patterns in complex geometries in a few seconds computing time. Detailed evaluation of given (simplified) atomic models allows improvement of the diagnostic for the experiment and parameters of interest.

[1] M. Krychowiak et al., Plasma Phys. Control. Fusion 53, 035019 (2011)
[2] M. Goto, J. Quant. Spectrosc. Radiat. Transfer 76, 331-344 (2003)