P 13: Magnetic Confinement IV & Helmholtz Graduate School IV

Time: Thursday 14:00–15:45 Location: H4

Invited Talk P 13.1 Thu 14:00 H4

How turbulence sets boundaries for fusion plasma operation — •Peter Manz[1], Thomas Eich[2], and the ASDEX Upgrade Team[2] — [1]Institut für Physik, Universität Greifswald — [2]Max-Planck-Institut für Plasmaphysik, Garching

The operational space for safe and efficient operation of a tokamak is limited by several constraints. Well known examples are the Greenwald density limit and the accessibility of high confinement. Their extrapolation to reactor machine size is based on empirical scalings. Both phenomena are related to turbulent transport. Large turbulent transport can lead to a transition to low confinement or trigger events finally leading to a disruption (the L-mode density limit). The strength of turbulent transport in the plasma edge depends on the competition between rather gentle drift-wave and the rather violent resistive ballooning turbulence. The operation boundaries are derived in terms of a combination of dimensionless parameters describing interchange-drift-Alfven turbulence without any free adjustable parameter. This way, the disruptive density limit is related to a transition from the electrostatic to the electromagnetic resistive ballooning regime. At the L-H transition, drift-wave dominated turbulence is suppressed by a combination of flow shear, diamagnetic and beta stabilization. The derived boundaries are compared to about 300 discharges and agreement within experimental error bars.

P 13.2 Thu 14:30 H4

Multi-class disruption prediction at JET using a shapelet based neural-network. — •Victor Artigues[1], Frank Jenko[1], and JET Contributors[2] — [1]Max Planck Institute for Plasma Physics, Boltzmannstr. 2, 85748 Garching, Germany — [2]See the author list of 'Overview of JET results for optimising ITER operation' by J. Mailloux et al. to be published in Nuclear Fusion Special issue: Overview and Summary Papers from the 28th Fusion Energy Conference (Nice, France, 10-15 May 2021)

Disruptions, the very fast, uncontrolled, termination of plasma experiments in tokamaks, remain to this day an unsolved issue on the path towards fusion-based power plants. Due to the their complex nature, disruptions have been very hard to investigate with physics-based approaches. In recent years, progress has been made with data-driven methods to build disruption detection systems, but many questions remain open such as disruption type identification, or transfer between tokamaks.

We propose a Shapelet based neural-network for the task of multi-class disruption prediction, and compare it to two approaches from the literature, trained on our data: stacked Support-Vector Machines (SVM), and a Long Short-Term Memory (LSTM) neural-network. Two datasets of discharges from the Joint European Torus (JET) tokamak, have been compiled. One containing stable discharges and 7 different disruption types, before the installation of the ITER-Like Wall (ILW). The second, with fewer shots and binary classification, from the more recent C36 campaign with ILW. Using the binary and multi-class classification results on the different datasets, we report on the performance of the three models and discuss the advantages of our method.

P 13.3 Thu 14:55 H4

Alpha particle dynamics and Alfvenic instabilities in ITER post-disruption plasmas — •Andrej Lier[1], Gergely Papp[1], Philipp Lauber[1], Stefanie Braun[2], George Wilkie[3], and Ola Embreus[4] — [1]Max Planck Institute for Plasma Physics, D-85748 Garching, Germany — [2]Department of Physics, Chalmers University of Technology, SE-41296 Gothenburg, Sweden — [3]Princeton Plasma Physics Laboratory, Princeton NJ 08540, USA — [4]Department of Physics, Chalmers University of Technology, SE-41296 Gothenburg, Sweden

Fusion-born alpha particles in ITER disruption simulations are investigated as a possible drive of Alfvenic instabilities. The ability of these waves to expel RE seed particles is explored in the pursuit of a passive, inherent RE mitigation scenario in synergy with built-in RE mitigation systems. An analytical model is introduced that is able to compute the spatiotemporal evolution of the alpha particle distribution in a mitigated thermal quench. We use a linear gyrokinetic stability code to calculate the Alfven spectrum and find that the equilibrium is capable of sustaining a wide range of modes. The natural radial anisotropy of the alpha population provides free energy to drive Alfvenic modes during the quench phase of the disruption. The self-consistent evolution of the mode amplitudes and the alpha distribution is calculated utilizing wave-particle interaction methods. Intermediate mode number Toroidal Alfven Eigenmodes (TAEs) are shown to saturate at an amplitude of up to dB/B ~ 0.1% in the spatial regimes crucial for RE seed formation.

P 13.4 Thu 15:20 H4

2.5 MeV and 14 MeV neutron rate measurements on ASDEX Upgrade and predictions for Wendelstein 7-X — •Jan Paul Koschinsky[1], Christoph Biedermann[1], Sergey A. Bozhenkov[1], Joona Kontula[2], Simppa Äkäslompolo[1,2], Monika Koleva[3], Giovanni Tardini[3], C. F. B. Zimmermann[3], Ralf Nolte[4], Elisa Pirovano[4], Andreas Zimbal[4], G. A. Wurden[5], Robert C. Wolf[1], the W7-X Team[1], and the ASDEX Upgrade Team[3] — [1]Max-Planck-Institut für Plasmaphysik, Wendelsteinstraße 1, D-17491, Greifswald, Germany — [2]Aalto University, Espoo, Finland — [3]IPP, Garching — [4]PTB, Braunschweig — [5]LANL, US

Fast-ion confinement is crucial for realizing burning fusion plasmas, both in tokamaks and stellarators, as fast fusion-born alpha particles are meant to provide the self-heating of the plasma. Therefore, the possible application of a scintillating fiber neutron detector, SciFi, for studying fast ions in future deuterium plasmas of the Wendelstein 7-X stellarator, is investigated here.

In deuterium plasmas, 2.5 MeV neutrons and 1 MeV tritons are generated via two equally probable fusion channels, respectively. Depending on confinement and slowing-down processes, produced tritons will fuse with surrounding deuterons and give birth to 14 MeV neutrons. A time-resolved study of this triton burn-up process is attainable with SciFi, which can discriminate between 14 MeV and 2.5 MeV neutrons.

Triton burn-up studies with SciFi on the ASDEX Upgrade tokamak are presented. Moreover, predictions of neutron rates in W7-X and the resulting performance of SciFi are discussed.