P 2: Magnetic Confinement I/HEPP I

Time: Monday 11:00–13:10 Location: CHE/0091

Invited Talk P 2.1 Mon 11:00 CHE/0091

Deuterium-Tritium Plasmas at JET with ITER-like Wall and the Role of Isotope Mass and Transport for H-mode Access — •Gregor Birkenmeier[1,2] and JET Contributors[3] for the JET L-H Transition Team-Collaboration — [1]Max Planck Institute for Plasma Physics, Garching — [2]Physik-Department, Technical University Munich, Garching — [3]See J. Mailloux et al 2022 Nucl. Fus. 62 042026

More than 20 years after the last deuterium-tritium (D-T) experiments in magnetic confinement fusion research, the largest operating tokamak in the world, the Joint European Torus (JET) in Culham, UK, was operated with the reactor relevant D-T fuel mixture during the 2020/2021 experimental campaign. The experiments demonstrated that reactor relevant plasma scenarios can be successfully operated in metallic wall conditions and the record of controlled fusion energy production of 59 MJ was achieved in a steady plasma over five seconds. The experiments confirmed simulations of reactor-relevant plasma performance building confidence, that next step devices like ITER will perform as predicted. In addition to experiments maximizing the fusion power, further experiments in tritium containing plasmas allowed to study isotope effects in unprecedented detail. As one striking example, it was found that the power threshold to access the high confinement regime, which is considered as being mandatory for a sufficient performance of a reactor plasma, shows an unexpected isotope dependence in isotope mixtures. After the presentation of the highlights of recent D-T experiments, an explanation for the observed isotope effects is given and its impact on modelling is discussed.

P 2.2 Mon 11:30 CHE/0091

Experimental and numerical investigation of helium exhaust at the ASDEX Upgrade tokamak with full-tungsten wall — •Antonello Zito[1,2], Marco Wischmeier[1], Athina Kappatou[1], Arne Kallenbach[1], Francesco Sciortino[1], Volker Rohde[1], Klaus Schmid[1], Edward Hinson[3], Oliver Schmitz[3], Marco Cavedon[4], Rachael McDermott[1], Ralph Dux[1], Michael Griener[1], and Ulrich Stroth[1,2] — [1]Max-Planck-Institut für Plasmaphysik — [2]Physik-Department E28, Technische Universität München — [3]University of Wisconsin-Madison — [4]Dipartimento di Fisica "G. Occhialini", Università di Milano-Bicocca

An efficient removal of helium ash by active pumping in future fusion devices is necessary to avoid fuel dilution and not degrade plasma confinement. Therefore, a deep understanding of the underlying physics mechanisms is mandatory. Helium recycling and pumping has been experimentally investigated at the ASDEX Upgrade tokamak. The time evolution of helium following a small injection during otherwise steady-state deuterium discharges was measured spectroscopically both in the core plasma and in the neutral exhaust gas. The exhaust efficiency was found to improve with increasing divertor neutral pressures, but to degrade with detachment. A multi-reservoir particle balance model was developed to interpret the observed exhaust dynamics. The limited performance of the pumping system and an efficient helium storage capability of the tungsten wall were identified to have a strong impact on the exhaust dynamics. The SOLPS-ITER code was used to interpret the observed He transport towards the divertor.

P 2.3 Mon 11:55 CHE/0091

Introduction and Uncertainty Quantification of Kinetic Models in the Integrated Data Analysis Framework — •Michael Bergmann[1], Kislaya Ravi[2], Rainer Fischer[1], Clemente Angioni[1], Klara Höfler[1], Pedro Molina Cabrera[3], Tobias Görler[1], Roberto Bilato[1], and Frank Jenko[1,2] — [1]Max- Planck-Institute für Plasmaphysik — [2]TUM (CIT) — [3]École Polytechnique Fédérale de Lausanne, Switzerland

Using a combined analysis of multiple diagnostics as well as Bayesian probability theory the Integrated Data Analysis (IDA) infers elec- tron density and temperature profiles of ASDEX Upgrade plasmas and is the standard against which simulations are validated. As the diagnostics do not cover the entire plasma or may be unavailable IDA considers a variety of non-physics-based priors. The resulting profiles may not be in accordance with theories best expectations e.g. may have gradients which drive too high turbulent transport. Using the transport solvers ASTRA coupled with the quasi-linear turbulence code TGLF we have created a loop in which simulated profiles are fed back into IDA as another prior thus providing constraints about the physically reasonable parameter space. For now the uncertainty of the simulation is given by the user, however we will discuss several ideas for a more complete uncertainty quantification such as input error propagation and comparison to the high-fidelity turbulence solver GENE.

P 2.4 Mon 12:20 CHE/0091

Analysis and modeling of momentum transport based on NBI modulation experiments at ASDEX Upgrade — •Benedikt Zimmermann[1,2], Rachael McDermott[1], Clemente Angioni[1], Basil Duval[4], Ralph Dux[1], Emiliano Fable[1], Antti Salmi[3], Ulrich Stroth[1,2], Tuomas Tala[3], Giovanni Tardini[1], Thomas Pütterich[1], and the ASDEX Upgrade Team[5] — [1]Max Planck Institute for Plasma Physics, 85748 Garching, Germany — [2]Physik-Department E28, Technische Universität München, 85747 Garching, Germany — [3]VTT, P.O. Box 1000, FI-02044 VTT, Finland — [4]EPFL, Swiss Plasma Center, CH-1015 Lausanne, Switzerland — [5]see the author list of U. Stroth et al. 2022 Nucl. Fusion 62 042006

Understanding momentum transport is crucial to reliably predict the plasma rotation profiles in future fusion devices. At ASDEX Upgrade, momentum transport studies are used to validate theoretical models and transport codes. An advanced momentum transport analysis framework uses NBI modulation to extract the contribution of diffusion, convection, and intrinsic torque to momentum transport within the core plasma. Recent work focused on a possible mass dependence by comparing hydrogen and deuterium plasmas. Both momentum transport coefficients were found to be the same within error bars indicating no significant mass dependence. Gyrokinetically predicted Prandtl number and pinch number agree with the experimental results. Furthermore, a robust error analysis quantified the uncertainties of the assessed coefficients and the uniqueness of the determined solution in the scanned parameter range.

P 2.5 Mon 12:45 CHE/0091

Neutral gas pressure gauges for current and future fusion devices — •Bartholomäus Jagielski[1,2], Uwe Wenzel[1], Dirk Naujoks[1], Felix Mackel[1], Thomas Sunn Pedersen[1], and and the W7-X team[1] — [1]Max Planck Institute for Plasma Physics, Germany — [2]Universität Greifswald, Institut für Physik, Greifswald, Germany

Pressure gauges emplyoing helical tungsten-wire emitters suffer from the Lorentz force in strong magnetic fields. In consequence, for fusion devices, conventional pressure gauges do not work reliably, or at all when operated within specified duration of plasma operation. As an alternative, rod shaped emitters are more robust in strong magnetic fields and may sustain long-pulse operation.

We report on the performance of the ionization gauges, equipped with lanthanum hexaboride, zirconium carbide or tungsten emitter, tested in a purpose built laboratory and operated in the stellarators W7-X and LHD. During the second Wendelstein 7-X campaign, 18 manometers equipped with LaB6 cathodes are used to measure the neutral gas pressure at different positions. Early experiments show robust operation up to 900s. The gauges reveal a magnetic field dependence of the ion current and sudden jumps of the electron- and ion current limit the operation over the whole pressure region from 10^{-7} mbar to 10^{-2} mbar. Along with a basic characterization of the latter, measurements under new record conditions and the impact of limitation on the design of the instruments are discussed. Operation in different magnetic field strengths and working gases are examined.