Report from the EPS Plasma Physics Division Board, Summer 2024

Board meetings

The Board met in-person twice in 2023, on July 2 in Bordeaux (France) and on December 5-6 in Heidelberg (Germany).

Operation of the Division

Kristel Crombé (ERM/KMS and Ghent University, Belgium) continues as Chair (2022-2026) of the Division, and Ken McClements (UKAEA, UK) continues as Secretary. The Board members coordinating the 2023 EPS-PPD Prizes were: Alfvén, Andreas Dinklage (Max Planck Institute for Plasma Physics, Greifswald, Germany); Landau-Spitzer, Vladimir Tikhonchuk (University of Bordeaux); Innovation, Eva Kovačević (Orléans University, France); PhD Research Award, Monica Spolaore (CNR, Padua, Italy). In 2024 a new prize has been established, the EPS-PPCF Sylvie Jacquemot Early Career Prize, coordinated by Mervi Mantsinen (Barcelona Supercomputing Centre). Further information is available at http://plasma.ciemat.es/eps/board/.

Bordeaux EPS Plasma Physics Conference 2023

The 49th annual EPS Plasma Physics Conference took place at the Bordeaux Congress Centre in Bordeaux from July 3-7 2023, hosted by the University of Bordeaux. This was the first in-person EPS plasma conference since 2019. The Local Organising Committee (LOC) was chaired by Alexis Casner (University of Bordeaux, France). The Programme Committee was chaired by Sébastien Le Pape (LULI, France) and comprised:

- MCF: T. Bolzonella (IT – sub-chair), R. Bilato (DE), T. Estrada (ES), F. Felici (CH), S. Henneberg (DE), J. Hillairet (FR), M. Kubkovka (PL), V. Moiseenko (UKR), S. Pinches (ITER), P. Rodrigues (PT), A. Sen (IN), I. Voitsekovitch (UK)
- BPIF: G. Lehman (DE – sub-chair), A. Debayle (FR), R. Florido (ES), D. Hinkel (USA), J. Metzkes (DE), E. Gelfer (CZ), L. Antonelli (UK)
- BSAP: T. Passot (FR – sub-chair), C. Palmer (UK), C. Pfrommer (DE), O. Alexandrova (FR), B. Cerutti (FR)
- LTDP: J. Bradley (UK – sub-chair), A. Borras (ES), J. Trieschmann (IL)

Proposals from the plasma research community for invited and plenary speakers were received through an open forum, from the American Physical Society and from the Association of Asia Pacific Physical Societies, which kindly contributed representatives to participate in Programme Committee and EPS-PPD Board meetings during 2023. There were 740 paying delegates, of whom 78 paid the EPS member rate. This is a healthy number, comparable to the typical number of paying attendees at EPS plasma conferences before the COVID19 pandemic, and the financial outturn was positive. The LOC organised the submission of 4-page papers linked to contributed orals and posters. PPD Board Member Basil Duval assisted the LOC in bringing these papers to publication: they are available online at 49th EPS Conference on Plasma Physics - 3 - 7 July 2023 (epfl.ch) and constitute volume 47A of the Europhysics Conference Abstracts series. Some of the invited talks led to refereed journal articles published in a special issue of *Plasma Physics and Controlled Fusion*, available online at IOPscience - Special Issue Featuring the Invited Talks from the 49th EPS Conference on Plasma Physics, 3 - 7 July 2023.

Salamanca EPS Plasma Physics Conference 2024 (Home - EPS PLASMA 2024)

The 50th annual EPS Plasma Physics Conference will take place in Salamanca, Spain, from July 8-12 2024, hosted by the Centro de Láseres Pulsados (CLPU). The Local Organising Committee is chaired by Luca Volpe (Universidad Politécnica de Madrid). The programme Committee is chaired by John Kirk (DE) and comprises:

- MCF: S. Ratynskaia (SE – sub-chair), M. Chernyshova (PL), R. Dumont (FR), G. Fuchert (DE), J. Harrison (UK), A. Järvinen (FI), P. Lauber (DE), I. Pusztai (SE), A. Sen (IN), E. Solano (ES), M. Tardocchi (IT), J.L. Velasco (ES)
- BPIF: P. Neumayer (DE – sub-chair), F. Consoli (IT), D. Doria (RO), F. Fiuza (US), A. Grassi (FR), J. Honrubia (ES), C. Palmer (UK), P. Raczka (PL)
- BSAP: A. Araudo (CZ – sub-chair), S. Servidio (IT), F. Spanier (DE)
- LTDP: A. Granier (FR – sub-chair), F. Greiner (DE), E. Thomas (US), J. Walsh (UK)

At this Annual Conference, the EPS Plasma Physics Division will recognise researchers who have achieved outstanding scientific or technological results, reflecting and reinforcing excellence in plasma physics.

The **2024 EPS Hannes Alfvén Prize** for outstanding contributions to plasma physics is awarded jointly to **Tünde Fülöp** (Chalmers University of Technology, Sweden) and **Per Helander** (Max Planck Institute for Plasma Physics, Greifswald, Germany) for outstanding contributions to theoretical plasma physics, yielding groundbreaking results that significantly impact the understanding and optimization of magnetically confined fusion plasmas.

Tünde Fülöp has been a leader in the field of disruptions and relativistic "runaway" electrons associated with these events. She has systematically explored the physics of runaway electrons in tokamaks and beyond, and conducted unprecedented modelling efforts applicable to both existing experiments and future devices. As part of this endeavour, Professor Fülöp has investigated various facets of the problem, including runaway-electron-driven electromagnetic instabilities, the impact of different collision types, radiation reaction effects, and the role of partially ionized impurities on runaway electron dynamics. Additionally, she has evaluated and optimized disruption mitigation strategies involving external magnetic perturbations and massive material injection. Furthermore, Professor Fülöp has played a crucial role in overseeing the development of several open-source, state-of-the-art runaway modelling tools and synthetic diagnostics. These tools have gained widespread use in the scientific community, reflecting her commitment to advancing collective knowledge in the field.

Per Helander has obtained seminal results in the theory of stellarator plasmas by systematically exploring the question of how the properties of magnetically confined plasmas depend on the geometry of the magnetic field. In most such plasmas, turbulent transport caused by micro-instabilities arising from plasma density and temperature gradients poses a significant challenge. Professor Helander foresaw a crucial development, the absence of the most important density-gradient-driven instability in certain types of magnetic fields. This prediction is believed to underpin the remarkable record plasma performance achieved in the Wendelstein 7-X stellarator. In addressing long-standing concerns about neoclassical impurity accumulation in stellarators, Professor Helander demonstrated a possible route to avoiding it in collisionality regimes relevant to reactors. Furthermore, he identified important differences between stellarators and tokamaks concerning plasma rotation. On large scales, it is relatively slow in stellarators and governed by neoclassical processes even in the presence of turbulent transport, and on small scales zonal flows behave differently. These and other revelations have shaped the general understanding of stellarator plasmas and the burgeoning field of stellarator optimization.

The **2024 EPS Plasma Physics Innovation Prize** for technological, industrial or societal applications of research in plasma physics is awarded to **Anthony Murphy** (Commonwealth Scientific and Industrial Research Organisation, Australia) for outstanding thermal plasma R&D with significant impact on industry and research, including critical contributions to the first commercial plasma waste treatment process, development of arc welding software for manufacturers, and calculation of thermophysical properties adopted worldwide in computational models of industrial plasma processes.

Anthony Murphy is a recognised leader in atmospheric-pressure plasma R&D, particularly thermal (arc) plasmas. His work has been highly influential, as demonstrated by his high citation rate (>13,000 in the Web of Science, >19,000 in Google Scholar), the highest of any thermal plasma researcher, present or past. As well as their significant impact on the research community, Dr Murphy's scientific advances have been instrumental in ensuring the uptake of his R&D by industry. Three examples demonstrate the industrial impact of his work and its relation to his research results:
Development of the Plascon (now Pyroplas^{TM}) waste-treatment process, used worldwide to destroy ozone-depleting substances, greenhouse gases and toxic liquids. Dr Murphy's computational model of the Plascon process was the first thermal plasma model to include fluid-dynamic, magnetohydrodynamic and detailed chemical-kinetic phenomena. He applied the model to identify the unwanted recombination reactions that

occurred when destroying ozone-depleting substances, which led to the redesign of the process to add steam to the reactants. This modification has been used on all five Plascon plants (in Australia, UK, USA and Mexico) that destroy ozone-depleting substances and trifluoromethane.
Development of the "ArcWeld" welding simulation software package for use in industry. The software has been transferred to General Motors, USA and CRRC (China Rail and Rolling Stock Corporation) for use in the automotive and rail industries. Dr Murphy's approach is unique in capturing all the important physical processes occurring in the arc plasma, electrode and weld pool in three dimensions. A critical innovation in the model is the inclusion of the influence of metal vapour, which cools the arc because of its strong radiative emission, leading to a ~50% reduction in the depth of the weld. This built on Dr Murphy's pioneering work on understanding the effect of metal vapour in thermal plasmas. The innovations mean the model can reliably predict weld properties for a wide range of welding parameters with minimal benchmarking.
Calculation of the thermophysical properties of thermal plasmas for industry. Dr Murphy's thermophysical data have been adopted by over 80 research groups and companies in over 25 countries and are widely used as a benchmark. Moreover, his combined diffusion coefficient method transformed the computational modelling of thermal plasmas in gas mixtures by allowing species (molecules, atoms, ions, electrons) to be grouped into their parent gases, greatly reducing the complexity of the problem. Dr Murphy's data have been applied by companies such as Siemens, Pfiffner and Sensata Technologies for circuit breaker development, CFX Berlin for use in commercial CFD software, Boeing for modelling the influence of lightning on aircraft, and LS Electric (Korea) for the development of circuit breakers in novel insulating gases to replace SF_6 (a strong greenhouse gas). His data have also been used by collaborators in Asia and Europe for projects funded by companies such as Kobe Steel, Yumex, and Nissan Tanaka Corporation to develop improved arc welding and plasma cutting processes, circuit breakers and arc lamps.

The inaugural (**2024**) **EPS-PPCF Sylvie Jacquemot Early Career Prize** has been awarded to **Varchas Gopalaswamy** (University of Rochester, USA) for the development of statistical modelling to achieve accurate predictions of laser fusion experiments, thereby improving implosion performance and achieving record values of the Lawson triple product for direct-drive on the OMEGA laser system.

Designing implosions with optimised performance is challenging because the available design tools cannot be used to predict fusion yields to better than a factor of 2. As a result, codes alone could not be used to optimise implosions and match experimental results. To address this issue, **Varchas Gopalaswamy** developed a prediction framework employing novel statistical mapping of experimental outcomes from the OMEGA implosion database onto a 1D simulation database. This work was published in *Nature* in 2019 and presented in several invited talks at major conferences. Dr Gopalaswamy demonstrated that despite the inaccuracies of the codes, it is possible to construct a nonlinear mapping relation to correct the code predictions using past experiments and statistical manipulations. When applied to both test data and new experiments, he showed that the predictions are now accurate to within ±10% of the experimental results. This new predictive capability enabled an experimental campaign at the University of Rochester Laboratory for Laser Energetics (LLE) to make rapid progress by increasing the fusion yield from 100 J in 2016 to about 1 kJ in 2023. The most recent direct-drive implosions on OMEGA have led to core conditions that scale to a burning plasma at the MJ laser energies used at the US National Ignition Facility. These results are described by Dr Gopalaswamy in a recently-published (2024) *Nature Physics* paper.

The winner of the **2024 EPS-APS Lev D. Landau and Lyman Spitzer Jr. Award for Outstanding Contributions to Plasma Physics** is the team comprising **Anna Grassi** (SLAC, USA), **Hye-Sook Park** (LLNL, USA), **Frederico Fiuza** (SLAC, USA) and **George Swadling** (LLNL, USA) for critical advancement in the understanding of acceleration physics in astrophysically-relevant shocks through theoretical analysis and experiments at the National Ignition Facility, made possible by an established and continuing partnership between Europe and the USA.

The **2024 EPS Plasma Physics Division PhD Research Awards** were judged by a small external committee of referees, comprising Mats Andre, Guy Bonnaud, Francesco Paolo Orsitto and Gabriella Saibene, who examined all the submitted theses in a process co-ordinated by Monica Spolaore representing the EPS-PPD Board. This year's awards go to (in alphabetical order of surname): Toby Adkins (University of Oxford, UK) for his thesis "Electromagnetic instabilities and plasma turbulence driven by the electron-temperature gradient", nominated by Alex Schekochihin; Baptiste Frei (École Polytechnique Fédérale de Lausanne, Switzerland) for his thesis "A gyrokinetic moment model of the plasma boundary in fusion devices", nominated by Paolo Ricci; Mathias Hoppe (Chalmers University of Technology, Sweden) for his thesis "Runaway-electron model development and

validation in tokamaks", nominated by Tünde Fülöp; and Lucas Rovige (Institut Polytechnique de Paris, France) for his thesis "Optimization, stabilization and optical phase control of a high-repetition rate laser-wakefield accelerator", nominated by Jérôme Faure. For further information, please see PhD Research Award | European Physical Society – Plasma Physics Division (ciemat.es).

The winner of the **2024 PPCF Outstanding Paper Prize** is "Magnetohydrodynamic simulations of runaway electron beam termination in JET" by V Bandaru and co-workers: see Magnetohydrodynamic simulations of runaway electron beam termination in JET - IOPscience.

The winners of the **2024 PPCF/EPS/IUPAP Student Poster Prizes** will be determined during the conference and announced during the closing session.

Future Conferences

A central objective of the EPS-PPD Board is to establish a multi-year pipeline of future venues for our conference. This is essential if we are to continue to host these meetings in appropriate and affordable facilities (primarily located in major population centres), and at the optimum time of year for our community. The challenge of organising the conference requires careful long-term planning by organisations with greater financial resources than those at our disposal. We are therefore extremely grateful to institutions that are able and willing to provide this service. Local organisation for forthcoming EPS plasma physics conferences will be provided in 2024 by the Centro de Láseres Pulsados (Salamanca, Spain), in 2025 by C-IN and Vilnius University (Vilnius, Lithuania), and in 2026 by the United Kingdom Atomic Energy Authority (Edinburgh, UK). Looking further ahead, the EPS-PPD Board is in discussions with the École Polytechnique Fédérale de Lausanne, Switzerland for 2027.

Elections to the EPS-PPD Board

Elections for a fresh tranche of Board members will be initiated in 2024. Please consider whether you are willing to stand for election to this role, which involves attending two Board meetings each year and contributing throughout the year to the work outlined in this Report. The term is four years, renewable once, and the electorate comprises all Individual Members of EPS who are affiliated to EPS-PPD. After this year, the next opportunity to stand or vote will arise in 2028.

Kristel Crombé, Chair

on behalf of the EPS Plasma Physics Division Board

30th May 2024