

# **IOP** | Institute of Physics **Plasma Physics Group**

## **UK Plasma Physics News – Winter 2016/2017**

*Welcome to the UK IOP Plasma Physics Group (PPG) e-newsletter. If you have items for inclusion in future newsletters, please send these to [p.browning@manchester.ac.uk](mailto:p.browning@manchester.ac.uk) – meeting announcements, research achievements, new appointments, facilities, projects, buildings etc.*

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### **COMMITTEE NEWS**

The Group AGM will be held as part of the 44<sup>th</sup> Annual Conference at Oxford (see below), and will be announced in due course. A number of committee positions may be available, including the Chair. Please start thinking about standing for these positions, or nominating colleagues.

### **RECENT MEETINGS**

#### **The 14th UK Technological Plasma Workshop**

The Technological Plasma Workshop was held in Coventry alongside the Vacuum Symposium at the Vacuum Expo at the Ricoh Arena, on the 12th and 13th of October 2016. The Technological Plasma Workshop (TPW) is principally a UK-based international forum in science and technology of plasmas and gas discharges. The conference programme consisted of 3 invited talks, 9 oral talks and many poster presentations from a mixture of UK institutes. TPW 2016 was themed on energy and environment with three invited talks on plasma-catalysis as a promising solution for gas clean-up and fuel and chemical synthesis, non thermal plasma for pollution control, and advanced oxidation processes for efficient water treatment. Two related talks were given one on the abatement of nitrous oxide from diesel engine exhausts using non-thermal plasma and silver alumina catalysts, and the use of oxidative species in plasma to breakdown lignin to enable the extraction of ethanol from biomass. Other presentations covered diverse topics ranging from surface activation of substrates for thin film photovoltaics using atmospheric pressure plasmas, the degradation of chemical solutions exposed to surface dielectric barrier discharges, computational methods for ion source design and the use of micro-discharges for the production of high current density electron beams for the generation of THz radiation. For material processes new developments in the field of highly ionized physical vapour deposition using inductively coupled impulse scattering and the use of high power microwaves for sintering of powders used in solid state lasers crystals were presented. The best student poster prize supported by the Vacuum Symposium was awarded to Alex Shaw of the University of Loughborough for his work on reaching beyond the surface in plasma treatment.



The support of IoP Plasma Physics Group, the IOP Dielectric and Electrostatic Group and the Vacuum Expo which had over 120 delegates presenting at the symposium enabled no registration fee to be set for this two day conference. The workshop based within the wider Vacuum Symposium was used as a form for exploring collaborative opportunities between the academic and industrial communities. The Ricoh Arena is an excellent venue with high quality attendees and provided the ideal meeting place for the next generation of researchers in this field to engage with leading researchers in both academia and in the wider plasma and vacuum based industries.

We look forward to seeing you at **TPW 2017 at the Ricoh Arena, Coventry UK on the 11th and 12th of October 2017.**

### **EPSRC NetworkPlus 2016-19 on 'Emergence and Physics Far From Equilibrium'**

The launch meeting for the EPSRC NetworkPlus 2016-19 on 'Emergence and Physics Far From Equilibrium' happened on 14th and 15th December 2016 hosted by The University of Manchester. The NetworkPlus seeks to engage scientists working on Emergence and Physics Far From Equilibrium in various disciplines so that ideas can be exchanged and common approaches understood. Topics covered at the launch meeting included epigenetics, and run and tumble random walkers. The NetworkPlus may be able to help with the cost of a workshop looking at how Plasma Physics can contribute to this topic. If you would like to become a member of the NetworkPlus please contact [networkplus@manchester.ac.uk](mailto:networkplus@manchester.ac.uk).

### **FORTHCOMING MEETINGS**

#### **44<sup>th</sup> IOP Plasma Physics Conference, Oxford, April 3<sup>rd</sup> -6<sup>th</sup> 2017**

The 2017 IOP Plasma Physics Group Conference will be held at Worcester College, Oxford 3<sup>rd</sup> to 6<sup>th</sup> April 2017. Worcester is a beautiful college with 26 acres of grounds including a lake. It boasts medieval and neoclassical architecture and a chapel partly designed by Hawksmoor. It is also located very near to Oxford railway station. The College is building a new conference facility, the Nazrin Shah building, and the conference will be one of the first events held in the building. The conference will cover the usual topics from high temperature fusion plasmas to laser plasma interactions and from solar and astrophysical plasmas to low temperature plasmas.

The deadline for contributed abstracts is **18<sup>th</sup> January 2017**.

An outreach event will be held on the evening of Tuesday 4 April called '*Plasma Science takes 5'*'. It will feature around 10 members of the community giving 5 minute public outreach talks on a plasma science topic of their choice. This is a new initiative and an exciting opportunity to explain your research to the general public. If you are interested in giving one of these talks, email [Christopher.ham@ukaea.uk](mailto:Christopher.ham@ukaea.uk) by January 30<sup>th</sup>.

For more information, see the website: <http://plasma2017.iopconfs.org>

The **MAST-U research forum** will be held straight after the Conference at the same venue, more details on this to follow.

Picture: Worcester College, Main Quad



**44<sup>th</sup> European Physical Society Conference on Plasma Physics. Belfast, June 26<sup>th</sup> - 30<sup>th</sup> 2017.**

Organised by the Plasma Physics Division of the European Physical Society, this annual conference covers a broad range of plasma science falling under the following headings:

- Magnetic Confinement Fusion Plasmas
- Basic, Space, and Astrophysical Plasmas
- Inertial Fusion and Beam Plasmas
- Low Temperature and Dusty Plasmas

This year's conference will be hosted in association with the Centre for Plasma Physics at Queen's University Belfast and will be held in the Waterfront Hall [www.waterfront.co.uk](http://www.waterfront.co.uk) on the cityside bank of the river Lagan. With the Harland and Wolff shipyard of Titanic ([visitbelfast.com/things-to-do/member/titanic-belfast](http://visitbelfast.com/things-to-do/member/titanic-belfast)) fame providing a historical backdrop to the east, this venue is situated in the heart of Belfast city centre, a vibrant shopping and entertainment district with plenty of restaurants, bars and hotels. The city has a mixture of traditional and modern culture and is renowned for its warm and welcoming atmosphere.

Abstract submission opens February 1<sup>st</sup>, closes February 28<sup>th</sup>. Early registration closes May 13<sup>th</sup>. For further information please visit the conference website at <http://go.qub.ac.uk/eps2017>. For all enquiries please contact either Brendan Dromey (Chair, Local Organising Committee) or Brian Reville at [eps2017@qub.ac.uk](mailto:eps2017@qub.ac.uk).



### **Developments in Nuclear Fusion joint meeting**

A one day meeting is planned between the Plasma Physics, Nuclear Industry, Nuclear Physics and History of Physics IoP groups to provide a historical overview of fusion development in the UK and the future of research in the form of ITER and beyond. The meeting is currently being planned for June 2017 with confirmed dates to follow and will be hosted at the University of Birmingham.

### **Space weather and the heliosphere – processes and forecasts. International Astronomical Union Symposium**

University of Exeter, UK, from 17 to 21 July 2017.

[www.exeter.ac.uk/iaus335](http://www.exeter.ac.uk/iaus335)

Space Weather is increasingly recognised as an international challenge faced by several communities. The ability to understand, monitor and forecast the space weather of the Earth and the heliosphere is of paramount importance for our high-technology society. The Symposium will bring together approximately 250 scientists from across the world, aiming to further our understanding of Space Weather by linking research from a number of disciplines in Space Plasma Physics. In addition, the Symposium will operate an Outreach programme to inspire and educate children and members of the public.

### **Solar-Tokamak Workshop II**

A second Workshop promoting interactions between tokamak and solar plasma physics is proposed to be held at the University of Warwick in 2017. Details will be circulated in due course.

*The PPG Committee is always keen to receive offers from members to organise one day meetings, especially on topics which bring together different areas of research. Joint meetings with other IOP Groups are especially welcome. We have a small amount of funding available to support such meetings, and can assist with publicity, finding speakers etc.*

## **PRIZES AND AWARDS**

### **Rutherford Plasma Physics Communication Prize (sponsored by STFC Central Laser Facility)**

The IOP Plasma Physics Group would like to remind you that nominations for the 2017 Rutherford Plasma Physics Communication Prize are open. The award recognises those who exemplify excellence in outreach to the general public through the communication of plasma physics to those that are non-experts.

The prize is open to ALL members of the plasma physics community, whose application will be judged by a distinguished panel of scientists and communicators (to include one plasma physicist, one non-plasma physicist and one non-physicist). The winner will be announced during the 2017 IOP Plasma Physics Conference dinner and will receive £500.

The application procedure requires evidence of excellent communication skills and discussion of the impact of the activity. Past applications have seen examples such as creating a website, giving a talk or lecture, writing an essay or an article in magazine, blogging or producing a podcast or video. Anything that communicates our plasma science will be considered - the more creative the better!

Nominations and self-nominations are welcome.

Nominees must be members of the IOP Plasma Physics Group.

For more information and an application form, please email [ceri.brenner@stfc.ac.uk](mailto:ceri.brenner@stfc.ac.uk)

**Deadline for submissions: 12:00, 10 February 2017.**

## COMMUNITY NEWS

### NEWS FROM CCFE

#### Ian Chapman takes over as CEO

Professor Ian Chapman's job as the new CEO of UKAEA and Head of Culham Centre for Fusion Energy officially started on 1 October after farewell events for his predecessor Steve Cowley. Steve Cowley has now taken up a post as President of Corpus Christi College, Oxford.

Ian's long-term focus is clear; "We must deliver fusion; it will be an essential part of the portfolio of energy sources that the world will need as the global population continues to expand and develop. Delivering fusion is undoubtedly a big challenge, but one that mankind must overcome, and the work we are doing at Culham is at the international forefront of tackling this challenge."



Steve Cowley (left) and Ian Chapman (right) the new CEO of UKAEA

#### MAST-U

The latest major milestone has been achieved in the construction of the MAST Upgrade fusion device, with installation of the 10-tonne upper end plate on 16 November. The plate – effectively the top lid of MAST Upgrade's hi-tech steel can – was lifted into place and successfully sealed to the vacuum vessel.

Since the beginning of MAST Upgrade construction in late 2013, the Upper End Plate had been in its own dedicated assembly tent where it has been painstakingly built up into a brand new configuration, complete with three divertor magnetic coils, numerous embedded diagnostics and graphite armour; all told amounting to well over 40,000 individual components.

Project Leader Joe Milnes commented: "The successful installation of the upper end plate marks a major landmark for the project: the effective completion of the tokamak boundary and installation of well over 90% of the internal systems."

The next crucial steps to look forward to are the installation of the centre column, the addition of the port flanges and the installation and connection of all the external systems required to pump down, bake, then operate the tokamak in 2017.

MAST-U is targeting pump down in early 2017, with commissioning and restart taking place in mid-2017. The first MAST-U research forum will be held at Worcester College, Oxford on the 6 and 7th of April, following the IOP Plasma Physics Conference. We welcome your participation in the experimental programme and look forward to your ideas and contributions to the MAST-U experiment.





The installation of the MAST-U upper end plate which was craned into place in November and marks a major milestone in the MAST-U project.

### **Successful JET operations**

The latest JET experiments, which came to an end on 15 November, have met all expectations – achieving the best results in the past five years of high power operation.

The excellent machine reliability and routine high heating power (around 25 MW) in the experimental campaign was pleasing for the JET engineering team, and was also very good news for European fusion physicists.

In recent years, there has been painstaking development of two plasma scenarios that will be the standard for ITER operation: a baseline scenario which relies on the increase of plasma current to achieve high performance, and a hybrid scenario that relies on higher plasma pressure to achieve similar performance but at lower plasma current. Until now, these scenarios had not been tested with such high heating power with JET's 'ITER-like' inner wall of beryllium and tungsten; initial results from the latest campaign showed excellent plasma confinement, high stored plasma energy (over 9 MJ) and significant neutron yield.

All of this was very reassuring for researchers, demonstrating their scenarios could sustain high plasma performance with the ITER wall materials without showing excessive accumulation of beryllium and tungsten in the plasma. This provides confidence that JET's eagerly anticipated deuterium-tritium campaign in 2019/20 is on track to be a success and that ITER plasma development – based closely on these two scenarios – is also well developed.

**NEWS FROM AWE**

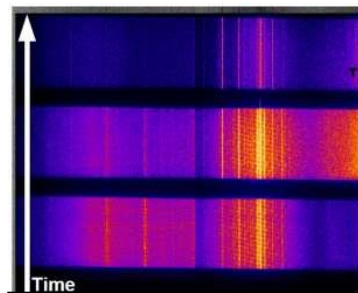
**AWE's Orion facility update**



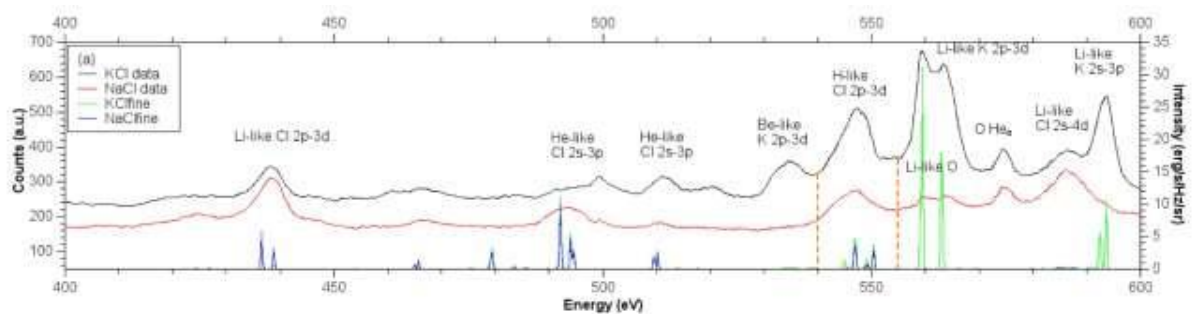
Orion, the multi-kilojoule, multi-petawatt laser plasma interaction facility situated at AWE, has recently upgraded its ultra-high power capability. The 720mm diameter 2 $\omega$  off-axis parabola has been installed in the target chamber within Orion. This optic is the final component in the 2 $\omega$  upgrade programme, a project to double the available energy in this high-contrast mode of operation, from 100J to 200J delivering up to 400TW of power to target. The previous 2 $\omega$  beam was limited to a 300mm diameter

because of the size of available frequency doubling KDP crystal. The upgrade uses two 300mm square crystals, one above the other, and their associated transport mirrors, to create two beamlets from the incident infrared beam. These beamlets are incident on the new parabola, which brings them to a common focus. The new mirror mounts can correct small beam path differences in the beams, to control the phase of the two beamlets at focus to achieve the best possible focal spot.

Following preliminary measurements in 2013, the first dedicated attempt was made on the Orion Laser to observe line coincidence photopumping – the enhancement in population of an atomic level brought on by absorption of X-rays from a different emitting ion. The two lines are said to be resonant, or close enough in energy, such that line emission from one can be absorbed by the other, promoting an electron to a higher state. This then decays via intermediary states to the ground. It is the characteristic signal of this decay that we look for. Many coincident pairs can be found. The scheme chosen uses the two line coincidences between potassium Ly- $\alpha$  and chlorine Ly- $\gamma$  and then potassium He- $\alpha$  and chlorine Ly- $\beta$ . We measure enhancement in the H-like chlorine 3d-4f and 2p-3d transitions as evidence of this effect. Detection relied upon use of the XUVGS (X-ray Ultra-Violet Grating Spectrometer), covering the 120 to 1200 eV energy range. This was coupled to a gated X-ray detector using four strip-lines. By gating the emission temporal blurring is reduced and the lines are clearer on the spectrum. We also get an insight into the evolution of the plasma. High temperature and low density are required to give a significant population of H-like chlorine at the



An image taken by the XUVGS coupled to a gated X-ray detector. The dark line in the centre is caused by the carbon edge from the spectrometer's



KCl (black) and NaCl (red) compare scenarios where pumping could and could not occur. The dashed lines indicate the position of the output for single temperature and density KCl and NaCl are added to guide the

correct optical depth to see pumping. To this end, up to eight of Orion's long pulse beams were used to heat the tamped potassium chloride targets. This was varied over the six shot days to provide a range of conditions. There is a clear signal from the 2p-3d line in chlorine and evidence will now be collated to assess enhancement compared to a scenario where no pumping occurs. Further shots are planned for March 2017, where we will use smaller, thinner targets, reducing gradients within the plasma and increasing the relative population of H-like chlorine and potassium.