

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

UK Plasma Physics News – Summer 2017.

Welcome to the UK IOP Plasma Physics Group (PPG) e-newsletter. If you have items for inclusion in future newsletters, please <mailto:b.graham@qub.ac.uk> any meeting announcements, research achievements, new appointments, facilities, projects, buildings etc.

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COMMITTEE NEWS

The IOP Plasma Physics Group 2017 AGM was held on 5th April 2017 during the 44th Annual Group Conference at Worcester College Oxford. The work of the committee and particularly that during the very successful three year tenure of the outgoing Chair and Secretary, Philippa Browning and Chris Ham respectively, was acknowledged by the enthusiastic applause from all those attending. The committee and members of the Group elected Bill Graham (Queen's University Belfast) to follow Philippa as Chair and Josie Coltman (AWE) was elected to follow Chris as Secretary. The full committee membership can be found at http://www.iop.org/activity/groups/subject/pla/committee/page_40392.jsp.

RECENT MEETINGS

44th IOP Plasma Physics Conference

The 44th Plasma Physics Conference was held at Worcester College, Oxford, April 3rd – 6th 2017. Delegates enjoyed the excellent facilities of a newly built conference centre, in the beautiful environment of Worcester College with its historic buildings and famous gardens. Around 100 delegates participated, enjoying an excellent programme of invited talks covering all aspects of plasma physics including magnetic confinement, lasers, space plasmas and technological plasmas, as well as contributed talks and two poster sessions. Many delegates participated in a tour of CCFE, including the new MAST upgrade.

An innovative public outreach event "Plasma takes 5" attracted a large and lively audience. This event involved 11 plasma physicists – ranging from a new PhD student to a retired professor – giving 5-minute talks about the area of plasma physics that they researched. The event was fast moving and exciting, with strict time limits being strictly applied to speakers by the session chair Chris Ham! We thank Chris and Claire Garland (IOP) for all the hard work they put in to organising this very successful meeting. We are also very grateful to CCFE, STFC and AWE for financial support, without which the meeting could not take place.



International Conference on Women in Physics (ICWIP) 2017 July 16th – 20th



Josie Coltman (from AWE and Secretary of the IOP PPG committee) attended the 6th IUPAP International Conference on Women in Physics (ICWIP 2017) held at the University of Birmingham from July 16th – 20th, as part of the UK team.

This was the first time the conference had been held in the UK and there were approximately 200 delegates from 60 countries including Germany, Uganda, Canada, South Korea, Australia, India, USA, and Egypt. The aim of the conference was to agree a set of resolutions to be presented at

the IUPAP General Assembly, as well as to network and be inspired by female physicists from around the world. Recommendations from the conference will be sent to physics institutions and professional bodies worldwide.

Josie presented posters on diversity and inclusion (D&I) at AWE, and also on her physics research 'Modelling Charged Particle Stopping Power Experiments on Orion'.

It was recommended that delegates attend just one workshop theme throughout the week. Josie attended the Gender Studies and Intersectionality workshops, which looked at what intersectionality is (a point at which gender, race, class, age, culture, religion, and other categories meet and create unique circumstances for each individual) and whether we should be tackling this, as well as gender equality to attract and retain diverse and highly-qualified physicists.

Jocelyn Bell Burnell (who discovered pulsars and now has an IOP early career medal (since 2016) named after her) gave a fascinating talk on her life and was awarded the IOP President's Medal during the conference.

During the conference there was also a piano concert by a very talented 15-year-old girl (Lauren Zhang) who has already won several awards and has appeared as a soloist with the University of Birmingham Philharmonic Orchestra and the Birmingham Conservatoire Junior Symphony Orchestra. Delegates also attended a Gala Dinner where sponsors Northrop Grumman gave a talk on the James Webb Telescope and how it will hopefully be used to see the first light of the universe, watch galaxies collide, see stars and planets being born, find and study exoplanets and study our own galaxy. Julia Higgins (the IOP president-elect) also gave a speech during the Dinner. On the final day there was even a surprise visit and talk by Malala Yousafzai (Nobel Peace Prize laureate and activist for female education).

It was a very inspiring conference with lots of female role models, as well as lots of country posters showing that the UK is not alone in trying to get more diversity in physics and other STEM subjects.

If you would like to see/find out more of what went on at the conference, then you can see lots of tweets sent by delegates during the conference using #ICWIP2017 on twitter. There is also a blog entry by Sarah Tesh on ICWIP 2017 at physicsworld.com and a couple of news articles (Malala Yousafzai and Jocelyn Bell Burnell) on the IOP homepage

FORTHCOMING MEETINGS

15th Technological Plasma Workshop (TPW 2017) Ricoh Arena, Coventry 11-12 October 2017

The Technological Plasma Workshop (TPW) is a UK-based forum in the science and technology of plasmas and gas discharges and delegates from all countries are very welcome to participate. Since the EPSRC Technological Plasma Initiative in 1997, technological plasmas have found new applications in diverse fields ranging from nano-science, through biomedicine and environment, to space exploration. Collaboration between academic and industrial communities is now the norm and there are new and exciting career prospects for younger scientists and engineers. To support a full realisation of these opportunities, TPW aims to foster academic-industry collaboration and to engage young plasma scientists with a scientific programme anchored by leading plasma scientists. The scope of the workshop includes all areas of technological plasmas, and this year the workshop will have a session dedicated to “Plasmas and Liquids: Sources, diagnostics, modelling and applications.”

The invited speakers are Dr. Petr Lukes, IPP, Czech Republic on “Chemistry induced by atmospheric plasma in aqueous liquids” and Dr. Kristian Wende, INP, Germany on “Plasma medicine - beyond the long lived species”.

Early bird registration fee: £30/£25 (academic/student)

45th IOP Plasma Physics Conference, Oxford, April 9th - 12th 2018

The 2018 IOP Plasma Physics Group Conference will be held at Queen’s University Belfast from the 12th April 2018. The conference will be on the main University Campus just south of the city centre. It is easily reached from the airport by taxi or rail connection. The lectures will be delivered in the Emeleus lecture theatre, named after a renowned plasma physicist of his day, and which is part of the Lanyon building designed by Sir Charles Lanyon. The conference chair is Professor Dave Riley. The usual topics, from high temperature fusion plasmas to laser plasma interactions and from solar and astrophysical plasmas to low temperature plasmas will be covered. The community will be invited to make nominations for invited speakers in due course (likely for September 2017). The deadline for contributed abstracts will be in January 2018.

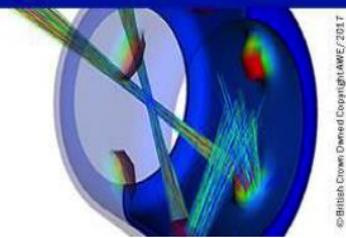


Picture: The Lanyon building at Queen’s University Belfast

IOP Institute of Physics

Computational Plasma Physics Conference

20–22 November 2017, University of York, York, UK



Organised by the IOP Computational Physics Group and IOP Plasma Physics Group and sponsored by CCP-Plasma and AWE. The conference, at the University of York, aims to provide a snapshot of the state-of-the-art; examining the development, testing and optimisation of numerical techniques which are not only accurate but also fast, efficient and scalable on modern supercomputing platforms – as well as ready for the architectural shift currently underway at the cutting edge of high performance computing. It will also be a forum for those developing and using plasma physics codes in academia and industry and an introduction to the algorithms, tools, codes and supporting infrastructure available to researchers new to the field. The focus of the meeting will be on applications to laboratory plasmas. However, the approaches to fundamental problems in plasma physics, and the computational strategies and techniques employed, have clear impact and utility beyond laboratory problems. The first morning of the conference will feature a series of introductory lectures in computational plasma physics delivered by subject matter experts covering the fundamentals of common models, methods, applications and research software development in general. Thereafter there will be a series of plenary sessions and a full programme of invited, oral and poster presentations.

Travel and accommodation bursaries, supported by the CCP-Plasma, are available for PhD students wishing to attend the meeting.

The abstract submission deadline is the 4th September and early registration deadline is the 9th October.

Details of these and key dates can be found on the website <http://cppc2017.iopconfs.org>.

Joint workshop with Accelerators and Beams Group (ABG) in 2018

We have been in contact with the ABG to plan a joint workshop between the groups on the topic of 'Next-generation Accelerators: plasma-based acceleration and novel beams concepts'. This will be a 1-day meeting in 2018 and will focus on knowledge transfer between the accelerator communities with a focus on updating each community on the latest advances in next-generation accelerator technology. It is hoped that this will foster more collaborative working between the communities. If you would like to be involved in the planning of this meeting then please get contact Ceri Brenner ceri.brenner@stfc.ac.uk

PRIZES AND AWARDS

Rutherford Plasma Physics Communication Prize

This year's prize has been awarded to Dr Melanie Windridge for her popular science book, *Aurora: in search of the northern lights*, published by William Collins in 2016. The judging panel had a tough job this year choosing a winner with diverse range of communication methods to compare. The panel were unanimous in their decision however to recognise Melanie for her achievement in publishing a book that sits as comfortably in the travel/adventure section of a book shop as it does popular science, thus expanding the reach to new audiences. The book contains a detailed introduction for the layperson to plasmas and specifically to aurora plasma formation, fusion and the physics of solar wind. The impact of the book has been boosted by articles featured in Wired magazine, VICE Motherboard, Sidetracked magazine, Sky at Night and Astronomy Now as well as over 30 public talks across the world. As described in the blurb 'Aurora explores the visual beauty, ancient myths and science of the northern lights and challenges the popular theory of how the lights are formed.'

Plasma physicist Melanie Windridge explains the extraordinary and evocative phenomenon, a scientific marvel unlike any other in which the powers of astronomy, geology, magnetism and atomic physics combine to create one of the wonders of the natural world’.

Culham Thesis Prize

Also congratulations to the 2016 Culham Thesis Prize prizewinner Dr Jason Cole of Imperial College London, for his thesis entitled "Diagnosis and Applications of Laser-Wakefield Accelerators". Jason presented an excellent invited talk on this work at the Annual Conference. His prize was generously sponsored by CCFE.

IOP medals 2017

Cecelia Payne-Gaposchkin Medal and Prize

Congratulations to Prof Steven Schwartz on being awarded the Cecelia Payne-Gaposchkin Medal and Prize for contributions to plasma, solar or space physics. Steven was awarded the prize for his many contributions to shock waves, particle acceleration, and fundamental plasma phenomena in the Sun’s atmosphere, interplanetary medium, near-Earth environment and wider astrophysical contexts. Full citation here: http://www.iop.org/about/awards/subject/astrophysics-and-plasma/payne-gaposchkin-medallists/page_69643.html

Clifford-Paterson Medal

Congratulations to Dr Ceri Brenner on being awarded the IOP’s Clifford-Paterson Medal 2017 for early career contributions to the application of physics in an industrial or commercial context. Ceri was awarded the prize specifically for driving the development of laser-driven accelerators for applications and for leading collaborative partnerships between academia and industry vital for the transfer of this technology to tackle global challenges. Full citation here: http://www.iop.org/about/awards/early-career/paterson/medallists/page_69685.html

All 2017 medal recipients can be listed here: http://www.iop.org/about/awards/page_69701.html

COMMUNITY NEWS

AWE News

Royal Society Summer Science Exhibition 2017



After months of planning researchers from AWE, the University of Oxford and Imperial College London presented their exhibit 'How to Make a Supernova' at the Royal Society Summer Science Exhibition 3rd–9th July 2017.

The exhibit focused on how Orion has been used for academic access experiments for laboratory astrophysics led by Gianluca Gregori, Oxford, and Francisco Suzuki-Vidal, Imperial. The many thousands of visitors to the Royal Society Summer Science Exhibition, young and old, were able to try to create a 'shock wave' using a vortex cannon made from a dustbin, bask in the power of plasma globes conducting electricity with their bare hands and have a look at some tiny experimental targets, made with high-precision engineering that are used in real laser

experiments to create tiny supernovae in the laboratory.

Josie Coltman, from AWE and Secretary of the IOP PPG committee, was there the day before it opened to the public when it was just media and school groups. She said: 'This was a great day as I, along with the other volunteers, was able to show school aged children why physics is important and how much fun it can be! We even inspired some teachers with fresh ideas for the classroom. There was a lot of media interest too, with lots of photos being taken, Jena Meinecke (a Junior Research Fellow from Oxford University) being interviewed, and the air cannon even got featured on BBC Click. "It was a fantastic day and I did not want to leave, and I would love to do it again! Would have been there more during the week, if I could have sorted out childcare!"

Colin Danson, the AWE exhibit sponsor, said: 'We were very excited to be at the Royal Society showcasing some of the cutting-edge research undertaken by preeminent scientists through the AWE Orion academic access programme. The collaborative effort of the three institutions allowed over 40 people to act as exhibitors through the week.'

Prof. Andrew Randewich, AWE Head of Physics, was invited as a Royal Society VIP guest to one of the evening soiree sessions and said: 'The stand looks wonderful, and a great deal of thought and effort has clearly gone into developing it. The presenters from AWE, Oxford and Imperial were all enthusiastically engaging the customers, and the numbers being drawn in were very pleasing, although I can only imagine how tired the team must be after a shift. This has been a great opportunity to advertise our capabilities and our collaborations, well done to all involved.'

The Royal Society's Summer Science Exhibition was a week-long festival of cutting-edge science from across the UK, featuring 22 exhibits which gave a glimpse into the future of science and technology. Visitors met the scientists who were on hand at their exhibits, took part in activities and live demonstrations and attended talks. There are plans for the exhibit to be presented at other events including New Scientist Live in September. For further information on the exhibit follow the team on [@MakeASupernova](#).



Orion Academic Access Campaign a Great International Success

In a campaign to explore laser driven ion beams to heat matter to extreme conditions an international team led by University of Strathclyde (P McKenna, R Gray, A Higginson) used the unique capabilities of the Orion laser. Researchers from University of California San Diego (C McGuffey, F Beg), Universität Darmstadt (M Roth, G Schaumann, J Ohland), Queens University Belfast (T Hodge) and General Atomics (MS Wei) joined to use the two powerful short pulse beams of Orion together with up to four long pulse beams to explore focusing laser driven ion beams into a small sample.

The team used the TNSA acceleration mechanism to drive proton beams off the rear side of a hemispherical target into a guiding cone structure and onto small samples of copper with different initial densities. The detailed analysis is on-going, but first results indicate the Orion laser to be capable of driving proton currents of more than 100 kA into a test object, thereby creating extreme conditions that would be similar to planetary interiors. The power of Orion led to proton energies above 60 MeV from these complex targets indicating an efficient energy transfer from the laser into the ion beam.



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Part of the experiment team: Colin Danson, Steve James, David Neely, Markus Roth, Adam Higginson, Ross Gray, Thomas Hodge, Gabriel Schaumann, Steve Gales, Graham Cooper and Jonas Ohland

The temporal evolution of the experiment was monitored using the second beam of Orion to operate as a driver for proton radiography with picosecond temporal resolution. Finally, first successful tests were conducted using up to four additional long pulse laser beams to create a plasma on the outside of the guiding cone structure to mimic the conditions in a possible fast ignition scenario in inertial confinement fusion. The campaign targeted the use of powerful short pulse lasers for laboratory astrophysics and was also the latest step in an international integrated Fast Ignition experimental effort with the collaborators mentioned above extending prior experiments on LFEX (Japan) and OMEGA EP led by Dr. Chris McGuffey (UCSD) (US).

CCFE contribution, Summer 2017

New Programme Director at CCFE

Professor Howard Wilson of the University of York is to be the Programme Director for the UK Atomic Energy Authority (UKAEA), which includes CCFE's fusion research work, from 1 October 2017. Professor Wilson will take up the role part-time and retain his chair at the University of York, continuing to be Director of the York Plasma Institute and the Fusion Centre for Doctoral Training. This joint appointment will utilise his background in academia to further strengthen the relationship between CCFE's R&D programmes and its university partners.

MAST-U Research Forum

As the lead up to experiments on MAST Upgrade begins, the MAST Upgrade Research Forum was held after the IOP Plasma Physics Conference at Worcester College, Oxford to discuss experimental plans and machine capabilities. More than 70 researchers attended the meeting, from CCFE, UK universities and overseas. The Forum comprised talks from the MAST Upgrade Topic Leaders reviewing the 79 experiment proposals they have received. In addition, Jon Menard, Program Director of US spherical tokamak NSTX-U, presented an invited talk, "Progress and plans for research on NSTX Upgrade" and Hendrik Meyer, EUROfusion's MST1 Task Force Leader, gave an invited talk on MAST Upgrade's role in the European Medium Sized Tokamaks programme. MAST Upgrade Programme Leader Andrew Kirk commented: "There was a good deal of interaction between the presenters and the audience and there was a clear feeling that the start of MAST Upgrade operations is now very close.

Funding for MAST Upgrade enhancements announced

MAST Upgrade is to receive funding to tackle one of the hottest issues in fusion energy research – plasma exhaust. EUROfusion, the European consortium for fusion R&D, approved the first phase of its contribution to a £21 million programme of enhancements to MAST Upgrade. Funding for the enhancements, which will be phased from now to 2022, will come jointly from EUROfusion and the



UK's Engineering and Physical Sciences Research Council. The controlled exhaust of power and particles from a very hot tokamak fusion plasma, through the divertor area of the machine, is arguably the biggest challenge facing a future fusion powerplant. The extreme power loadings (>10 megawatts per square metre – higher than that on a spacecraft re-entering Earth's atmosphere) in a conventional divertor will

require regular replacement of reactor components and adversely affect the economics and cost of electricity. It is no surprise, then, that divertor and exhaust physics is a major part of EUROfusion's reactor design work as part of their EU Roadmap to the Realisation of Fusion Energy.

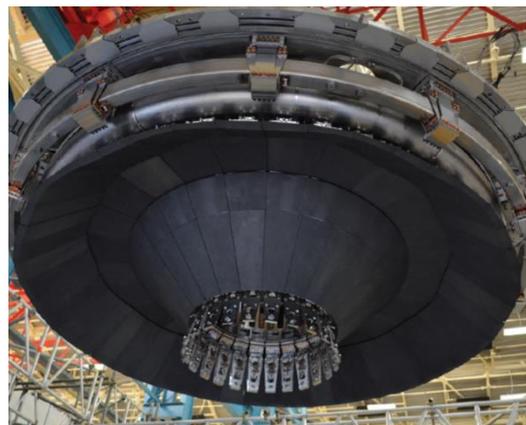
MAST Upgrade's flexible divertor design is already focussed on studying a range of configurations – from conventional designs to snowflake, double decker and the new Super X divertor concept. The Plasma Exhaust funding will give MAST-U an unrivalled capability over the coming years by:

- increasing Neutral Beam heating power from 5 to 10 megawatts;
- installing a cryoplant for the divertor and Neutral Beam cryopumps;
- improving plasma fuelling with additional gas valves and a high frequency pellet injector;
- upgrading plasma control hardware and software;
- additional plasma exhaust diagnostics.

MAST Upgrade Programme Leader, Andrew Kirk, was responsible for putting together the funding bid: "MAST Upgrade provides a uniquely flexible test bed for plasma exhaust physics in all divertor configurations," he said. "This significant extra funding is very exciting – it will enhance our capabilities yet further, enabling MAST Upgrade to play a key role in assessing alternative divertors for use in the first DEMO power plants."

MAST Upgrade

Since the last newsletter, a significant number of steps have been made on the MAST-U build. In February, the upper endplate of the vacuum vessel was installed. The upper endplate is the lid of the machine onto which the upper portion of the poloidal field coils and divertor tiles are attached. In total, there are over 40000 individual components in the endplate which weighs 10 tonnes. Installation involved lifting the assembled endplate, turning it over as it was constructed upside



down and then craning it into place on top of the vacuum vessel. Following the endplate, in March another major step forward was taken with the lifting and positioning of the centre column into the heart of the machine.



The five metre long centre column is a key component for operating MAST Upgrade. The column is a nested assembly of the toroidal field limbs five poloidal field coils one of which is the solenoid – a 324 turn coil of 110m-long copper conductor. To meet the step up in performance from the original MAST device (an increase in magnetic field from 0.52 to 0.78 Tesla and pulse length from 0.5 to 5 seconds), the centre column had to be completely re-manufactured. One of the key features of this new assembly is its use of an insulation matrix of cyanate ester rather than epoxy resin, to increase the insulation mechanical strength and raise the maximum operating temperature from 70°C to around 100°C. The column was lifted into place in a five-hour operation. One of the main challenges was to fit the column in the rather tight space within the centre tube, with an error margin as little as a couple of millimetres in a few locations.

Following the successful installation of the upper end plate and centre column but prior to the installation of the final diagnostic ports, a trail pump down was performed to check the major vacuum seals not used since MAST stopped operating in 2013. The pump down was successful with MAST-U reaching rough vacuum pressure and the machine let up to air for the installation of the final diagnostic flanges. Work is now underway on preparing for the second pump down.

NET news

The government has announced that, subject to the EU extending the UK's contract to host JET beyond 2018, to underwrite its share of running costs for the facility. Business Secretary Greg Clark said: "JET is a prized facility at the centre of the UK's global leadership in nuclear fusion research, which is why the government is taking every possible step to secure its future and to maintain highly-skilled jobs in the UK.

The UK's contract to maintain and run JET is managed by UKAEA and is due to end in December 2018. The UK's commitment to continue funding the facility will apply should the EU approve extending the UK's contract to host the facility until 2020. A discussion will then take place on the appropriate funding split. Ian Chapman, UKAEA CEO, said: "The ITER fusion project is the largest scientific endeavour mankind has ever undertaken and JET is undoubtedly the best place in the world to prepare for ITER's successful operation. We are pleased that the UK government is committed to exploiting JET as we prepare to break fusion records in the next few years."