INSTITUTE OF PHYSICS

IOP Institute of Physics
Particle Accelerators and Beams Group

IOP PAB GROUP NEWSLETTER

Issue 23

July 2021

Editorial

Welcome to Issue 23 of our PAB Group Newsletter. As I look though this issue's newsletter items, at the conferences, awards, PhD successes, facility upgrades and physics advances such as the recent g-2 result, I feel a great sense of pride in our community and all we have achieved and continue to achieve during this unique period. Particle accelerators and beams research in the UK and Ireland continues to grow – we now have more PhD students than ever and we remain one of the major players on the international stage. Whether you are an early career scientist or an 'old hand' reading this, we hope you will be inspired by the articles herein.

When I think about our achievements in the last 6 months my mind naturally turns to our prize winners who truly exemplify this. Lydia Hall won the PAB group Student and Early Career Scientist Poster Prize for her poster entitled "Simulating Electron Diffraction for Development of a Relativistic Ultrafast Electron Diffraction Facility". Chris Densham was awarded the PAB group Prize for Outstanding Professional Contributions. Chris was awarded the prize for his holistic and multi-disciplinary approach to high-intensity particle beam target facility design. He has worked on several world-leading HEP experiments including: T2K, NOvA and DUNE/LBNF, and on RADIATE, he has built his group at Rutherford Appleton Laboratory (RAL) into the world's foremost experts on neutrino production targets, and raised the profile of UK accelerator physics internationally. Congratulations to our 2021 prize winners! As always the prizes were awarded at our Annual Conference on April 9th and you can read more about this on page 9 of the newsletter.

In 2022 we are relaunching the IOP PABg Annual Conference as a much larger and more inclusive two day event. This inaugural conference will be held in Liverpool from 19th to 20th April 2022. Alongside an exciting program of invited plenary and prize talks, there will be two sets of two parallel sessions where several shorter talks will be presented. These will be contributed talks from the community and we envisage this being an excellent opportunity for PhD students in their later years and for early career researchers, but everyone is welcome to submit an abstract for consideration. The recent addition of panel sessions has been very well received and these will continue with a new and timely topic each year (suggestions are welcome so do contact us if you have a theme you would like to see discussed). The poster session has long been a highlight of the Annual Conference and in 2022 we plan to make it bigger and better than ever. The poster session will be combined with a drinks reception and held over two hours to allow presenters a chance to mingle and view the other posters in a relaxed atmosphere while still being on hand to tell us more about their work. We encourage any and all contributions, in particular, from our PhD student community (who will also be eligible for the Early Career Poster Prize which is judged on the day). One of the major benefits of a two day event is the chance to bring the community back together and allow us all, irrespective of sub-discipline or career stage, to get to know each other and to network. With this in mind the launch of the conference dinner promises to be an event not to be missed. More details will be coming soon. So bring yourselves, bring you group bring your boss and your students and help us to make the PABg Annual Conference *the* event on the UK and Ireland accelerators calendar!

(continued on the next page)

Inside this issue:

Editorial (continued)

This issue of the newsletter includes a report on tantalising evidence that muons are not behaving in the way they are supposed to according to the Standard Model of particle physics according to recent results from the g-2 experiment. There is an update on the Proton Improvement Plan-II (PIP-II) accelerator, which is to be designed and built by an STFC-Fermi National Accelerator Laboratory collaboration and is currently under construction in the USA. It will eventually enable the world's most powerful high-energy neutrino beam. Major ISIS accelerator upgrades are planned for 2021 and you can read all about this effort on page 3. This year saw many of us attending conferences virtually – Alex Castilla (Lancaster University), Bianca Veglia (University of Liverpool), Chris Rogers (STFC Rutherford Appleton Laboratory) and Joseph Wolfenden (University of Liverpool) tell us about their experiences at IPAC 2021. We also have articles on the National Particle Accelerator Open Day, Workshop on MSCA Networks - Training the next generation through collaborative programmes, and some personal success stories from 2021. I hope you enjoy reading it as much as I have!

If there is anything you think we could do better or should know of, please feel free to contact us at mauchida@hep.phy.cam.ac.uk and follow us on Twitter for updates of what is happening in our community @PartAccelBeams.

News from the Laboratories — RAL

Major ISIS Accelerator Upgrades for 2021

The next ISIS long shutdown began on 21 June 2021. Such shutdowns occur approximately every 5 years to enable the installation of major upgrades to the ISIS facility. The forthcoming shutdown will concentrate on the replacement of the Target Station One neutron production target and associated services and the series of accelerator projects outlined below.

Linac Tank IV Replacement

A previous contribution presented in Issue 17 of this Newsletter (June 2018) described progress with the linac tank IV replacement project. A lot has happened since 2018, prior to and during the present restrictions imposed by the global pandemic. All sections of the newly manufactured, 12 m long, tank IV were reassembled in a dedicated Linac Test Area and conical design drift tube roll out went ahead. A number of manufacturing and processing challenges encountered with the new drift tubes needed to be overcome to deliver the 20+ drift tubes necessary to populate the tank.

Figure 1. Conical drift tubes fitted in the 12 m tank (Credit: ISIS)

Once these had been fitted and surveyed into place, external water, electrical and vacuum services were installed in readiness for first RF being applied. Initially at low level using a bead pull rig, the setting up and 'tuning' of post coupler positions was carried out.

Figure 2. Tank in the Linac Test Area with all services installed (Credit: ISIS)

Subsequently, in January 2021, conditioning the tank to accept full power began using a newly constructed and commissioned RF system (duplicating those used in service on ISIS). Following the addition of radiological block shielding to the test area, the first of two 6-week test periods at full power, each approximately equivalent in length to an ISIS user cycle, began in early March 2021. Apart from a brief interruption due to a feedline insulator issue the tank performed and ran faultlessly for the first 6-week test, maintaining a peak RF power of 1.3 MW at the required 2% duty and concluding toward the end of April 2021.

Figure 3. Linac Test Area RF amplifier system
(Credit: ISIS)

A short break in testing was then programmed to permit several checks and inspections via the tank's service hatches. It was extremely pleasing that this confirmed internal surfaces and seals were behaving and functioning correctly.

With the planned ISIS long shutdown fast approaching the second period of testing commenced in early May, returning the RF level through the conditioning process to 1.3 MW at 2% duty.

Figure 4. Radiological shielding in the Linac Test Area
(Credit: ISIS)

Synchrotron RF Systems Upgrade

After many years of development work, the equipment for a major refit of the swept-frequency RF systems that drive the ISIS synchrotron cavities is ready for installation. Referred to as HPDs or High Power Drives, the original units, based around a pair of Burle (now Photonis) 4648 tetrodes have reached a good time for retirement and are due to be replaced with a similar looking, but much enhanced, design that will use a single Thales TH558 tetrode. Initially the 6 fundamental frequency RF (1RF) system HPDs are to be replaced, but in due course the now standardised HPDs can also be used for the 4 second harmonic RF (2RF) systems, which will receive the same upgrade.

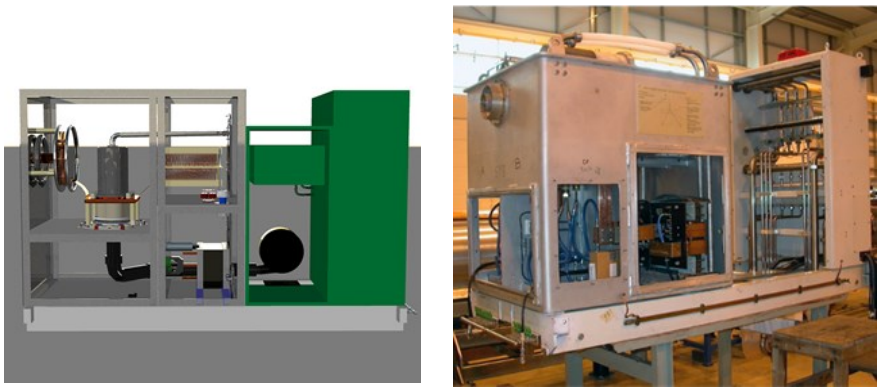


Figure 5. The new High Power Drive in schematic form and as a production unit (Credit: ISIS)

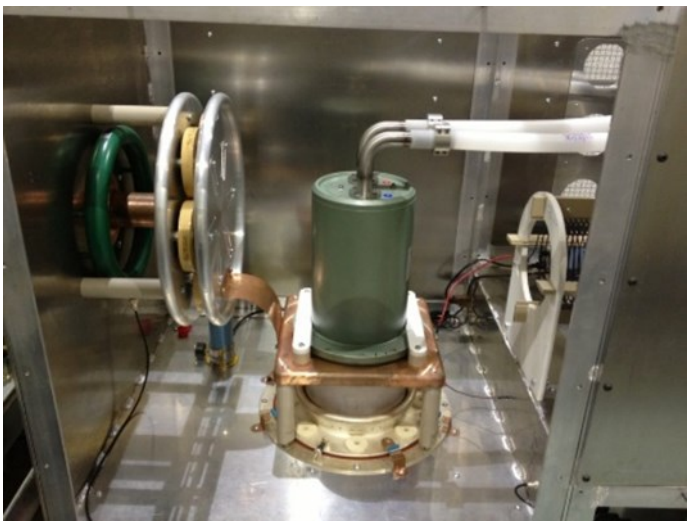


Figure 6. The TH558 tetrode at the heart of the new HPD design (Credit: ISIS)

Prototype TH558 based 1RF and 2RF systems have been operated reliably in a test regime on ISIS for a number of recent user cycles to allow both shake down of any unexpected issues ahead of the full roll out and to provide confidence in the fit and function of the design.

This upgrade work will provide a number of benefits, the primary one being to address obsolescence concerns where parts and components have become difficult and extremely expensive to source.

Muon Collimator Replacement

In addition to the planned upgrades and improvements for the long shutdown, repair work must also be completed. The muon collimator is a pair of copper cylinders positioned along the beamline which absorbs scattered protons after the proton beam has passed through the intermediate target used for generating muons. By absorbing the scattered protons prior to them being intercepted by more sensitive equipment downstream the collimator ensures that the downstream equipment will be less active and can be more readily maintained.

The original muon collimator was built and installed in the late 1980s. In 2014 it developed a leak in a water cooling line which was repaired, but has recently begun to leak again. A temporary repair has been implemented to ensure that ISIS can still operate safely until the long shutdown where more time can be devoted for a full replacement. The leak is in a location that is largely inaccessible due to being surrounded by many layers of steel and concrete shielding, and once extracted the component cannot be repaired as it is too radioactive to work on safely. Instead, a full replacement will be built and installed. The replacement will be identical in form, fit and function, but with some small design improvements to remove the water joint that is leaking and make potential future servicing and repairs easier. The parts being replaced consist of the collimator assembly, 16 tonnes of steel shielding and a trolley assembly for installation and alignment. The parts are currently on order and due to be received and tested just prior to the start of the long shutdown.

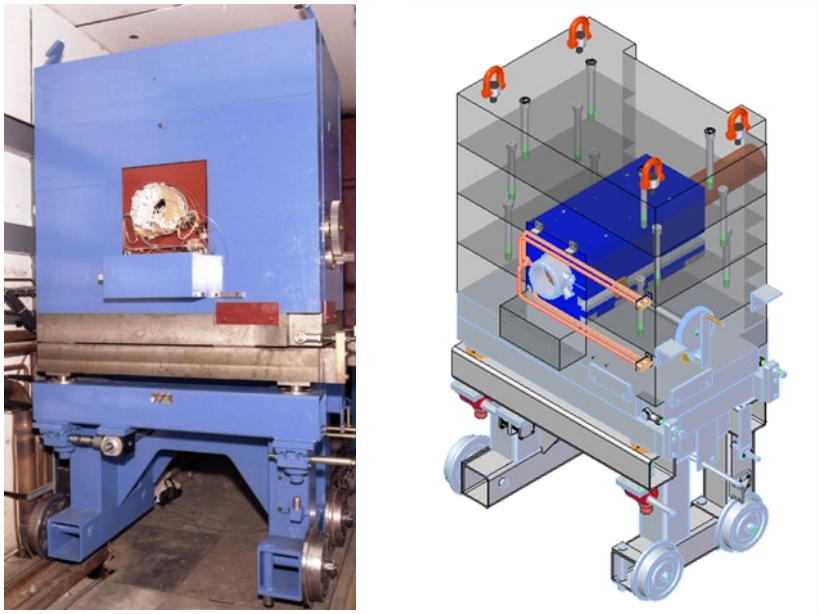


Figure 7. The muon collimator, steel shielding and trolley assembly (Credit: ISIS)

Science and Technology Facilities Council

ISIS Neutron and Muon Source

Mark Keelan

Galen Aymar

News from the Laboratories — Daresbury

UK scientists play vital role in creating world's most powerful neutrino beam

STFC and Fermi National Accelerator Laboratory have agreed to collaborate on building one of the world's most powerful linear accelerators.

Based at the US Department of Energy's Fermilab, the Proton Improvement Plan-II (PIP-II) accelerator, currently under construction, is an essential upgrade to the accelerator complex. Once complete, it will enable the world's most powerful high-energy neutrino beams.

The agreement sets out how the UK will contribute to the PIP-II accelerator project, which will provide the engine for the Deep Underground Neutrino Experiment (DUNE), as well as a suite of other experiments hosted by Fermilab. DUNE is an international flagship science experiment designed to study neutrinos. Results from these studies could potentially revolutionise our understanding of the universe.

STFC's Executive Chair, Professor Mark Thomson and the Director of Fermilab, Dr Nigel Lockyer sign the agreement detailing how the organisations will collaborate to build the one of the world's most powerful linear accelerators. (Credit: STFC)

The agreement was signed by STFC's Executive Chair, Professor Mark Thomson and the Director of Fermilab, Dr Nigel Lockyer. Professor Mark Thomson said: *"Today's agreement further strengthens the UK's collaboration with our US partners in this crucial project, which sits at the heart of a new globally significant facility at Fermilab."*

The UK's involvement in the upgrade has been facilitated through the UK government's £79 million investment in the DUNE experiment, Long-Baseline Neutrino Facility (LBNF), and the new PIP-II accelerator. The investment, delivered by STFC, has given UK scientists the chance to take leading roles in the management and development of the DUNE far detector, the LBNF neutrino beam targetry and PIP-II accelerator.

STFC will design, build and qualify vital elements of the 215-metre-long particle accelerator, which will accelerate the proton beam to its highest energy. The main elements currently being developed at STFC's Daresbury Laboratory are the cryomodules for the superconducting Radio Frequency (SRF) cavities.

SRF cavities accelerate the proton beam, which when fired into a carbon or beryllium target, will produce a high-intensity beam of neutrinos. The cavities are made from niobium, which is both malleable and is superconducting at low temperature. However, it is not an easy material to work with as it reacts with oxygen in the air at high temperatures, especially during the welding process. STFC has been working closely with industry partner, The Welding Institute (TWI) in Cambridge, which has commissioned the UK's first Electron Beam Welder able to weld in vacuum the high-purity niobium cavities.

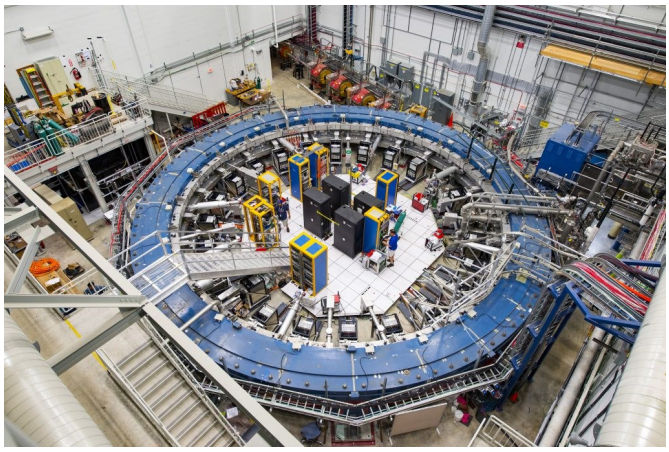
Teams of scientists, engineers and technicians from the Cockcroft Institute and Daresbury Laboratory, working with TWI, will construct three cryomodules, each housing six SRF cavities. Once the cryomodules are built, each of them will need to be safely transported to Fermilab in the US. The transport frame has to protect the cryomodule and all of its high-tech components during transportation.

Professor Peter McIntosh, PIP-II Principal Investigator and Deputy Director of ASTeC at Daresbury Laboratory, said: *"The UK, STFC and Daresbury Laboratory in particular, have a fantastic opportunity to provide cutting-edge accelerator technologies for 'powering the heart' of the international flagship project LBNF/DUNE in the USA. I am immensely proud of how the delivery team at Daresbury, along with our industry partners, have adapted to the challenges faced in developing our leading provision of Superconducting cryomodules for PIP-II."*

Peter McIntosh

Evidence of new physics in muon measurements

News media around the world have been inundated with reports of a recent discovery in Fermilab which could hint to a new revolution in physics. Much-anticipated data from the Muon g-2 experiment provides tantalising evidence that muons are not behaving in the way they are supposed to according to the Standard Model of particle physics. Scientists from the UK have played an important role in the Muon g-2 experiment.



The Muon g-2 ring sits in its detector hall amidst electronics racks, the muon beamline, and other equipment. This impressive experiment operates at negative 450 degrees Fahrenheit and studies the precession (or wobble) of muons as they travel through the magnetic field. (Credit: Fermilab/Reidar Hahn.)

The experiment searches for signs of new particles and forces by measuring the magnetic moment of the muon with unprecedented precision. When placed in a magnetic field, the muon rotates at a certain frequency as a consequence of its magnetic moment, which can be calculated using the Standard Model. However, the g-2 collaboration has measured this rotation to be faster than predicted – providing experimental evidence of Beyond the Standard Model (BSM) physical phenomena. This result has been anticipated for over a decade, since a measurement published in 2006 from an experiment at Brookhaven National Lab stood at odds with the Standard Model. The new result from Fermilab pushes the precision of the experiment into uncharted territory in the quest to confirm or refute that finding.

Muon g-2 is an international collaboration between Fermilab and dozens of labs and universities in seven countries, including the UK. The UK collaboration comprises the universities of Lancaster, Liverpool, Manchester, and UCL as well as the Cockcroft Institute.

Dr Ian Bailey, from the Cockcroft Institute/Lancaster University, who has led the development of novel computer simulations to investigate the motion of the muons said: *"The high sensitivity of the Muon g-2 experiment is achieved by combining precision measurements and simulations from particle physics, accelerator physics and nuclear physics. Simulations developed by the Cockcroft Institute were used to improve the understanding of the distribution and polarization of the muons being injected into the main muon storage ring, and the motion of the muons circulating in the dipole field of the ring and focussed by curved electrostatic quadrupoles. Unlike typical particle collider experiments, these details are essential to calculating the leading systematic uncertainties on the published measurements, and will continue to be important as more data is analysed and the statistical uncertainty on the measurement decreases.*
A new generation of precision experiments, that include the Fermilab Muon g-2, break down the traditional distinction between accelerator physicists and particle physicists, and present exciting challenges for everyone involved."

The Cockcroft Institute Director Professor Peter Ratoff added: *"We are extremely pleased that the Institute has been able to contribute to the tremendous success of the muon g-2 project at Fermilab. The accelerator physics challenges were substantial and it is difficult to identify many other particle physics measurements that have depended quite so directly on the detailed understanding of the beam dynamics of the machine delivering the science".*

These new results were released in a seminar on 7th April, and published in Physics Review Letters.

Alexandra Welsch

Report from the Group's Annual Conference

This year's annual conference was held on the 9th April, and we had an exciting program of panel sessions, plenary talks, a poster session and a drinks reception which was very well attended and a nice way to relax and get to know each other a bit better. It was the second of our annual conferences which was held virtually, nevertheless, there were 137 participants and another opportunity for a Zoom Conference photo which we are all getting so used to now.

We started the day with a 30 minute panel session with the IOP where Claire Aspinall, Rachel Youngman and Sarah Bakewell discussed "How the IOP are Working to Improve Equality and Diversity". This was followed by our second panel session with Mark Thomson, Peter Ratoff and Philip Burrows considering "The Future Funding Landscape and New Directions for Accelerators". Afterwards we had our prize talk, this is where the previous year's winner of the IOP PABg's annual prize for outstanding contribution to the field gives a talk on a topic of their choosing. This year it was Susan Smith with "Around the clock with accelerators at Daresbury", and I don't think I am alone in saying that I found the journey through Susan's career incredibly inspirational.

After lunch we were onto our plenary talks: LhARA – Colin Whyte, How Diamond Light Source is contributing to the global effort to combat Covid – Halina Mikolajek, H- Ion Source Development at ISIS – Olli Tarvainen, Progress with the Diamond-II Storage Ring Lattice – Hossein Ghasem, Caustic Analysis of Accelerators – Tessa Charles and Next-generation Plasma-based Electron Beams Sources for High-brightness Photon Science – Fahim A. Habib each of which was followed by an interesting Q&A session.

We finished the day with a reception, poster session, and IOP Award presentation. This year's poster prize winner was Lydia Hall and our Outstanding Professional Contribution prize went to Chris Densham. You can read more about our prize winners and their work in the Chair's introduction.

In light of the success of our Annual Conference we think it is time to step things up a gear and really highlight the full breadth of the UK program, by improving opportunities for early career researchers to present their work and expanding occasions for networking and discussion. So next year will be all change (Covid permitting). The Annual meeting is moving to a two day event with a much expanded physics program to include: panel sessions, plenary and keynote talks, parallel sessions and our popular 2 hour poster session. There will also be an exciting entertainment program to include a drinks reception alongside the poster session and what promises to be an exquisite conference dinner in an amazing venue. We look forward to welcoming our members at all career stages for next year's meeting on 19-20th April 2022 in Liverpool.

Melissa Uchida

Presenting Virtually at IPAC 2021

For the second successive year the International Particle Accelerator Conference (IPAC) was held virtually, so instead of setting off to Campinas in Brazil, participants took place online from around the world. Here, four speakers from UK institutes (Alex Castilla, Bianca Veglia, Chris Rogers, and Joseph Wolfenden) share their experiences of preparing for and participating in the conference:

Alex Castilla (Lancaster University):

"I guess it is a sort of milestone in the career of someone working in particle accelerators related topics, when an email pops in the inbox with the subject: 'Invitation Letter: invited talk at IPAC…'. In my case, at least, it came with a lot of joy for the honour and a bit of pressure attached. At that point, March 2021, teleworking and virtual attendance to workshops and conferences, due to the current COVID contingency, was already the norm, so no surprise there to be requested to record the talk.

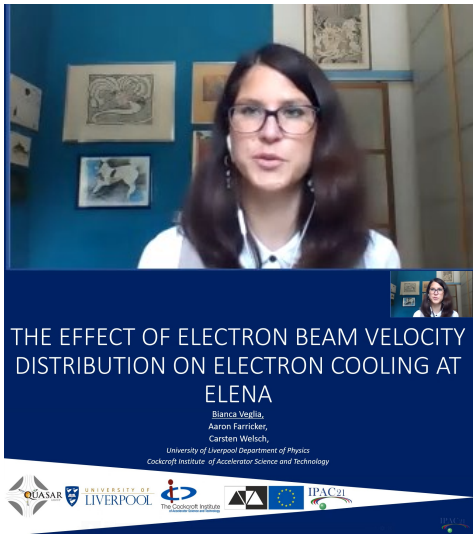
(Credit: Alex Castilla/Lancaster University)

Due to the usual international nature of most collaborations I have had the opportunity to be part of, presenting virtually in any of the different platform flavours, from the good old Skype to the latest hits like Zoom and Teams, does feel to be within what I would call my 'comfort zone'. However, I have to say that doing the recording of the talk was way harder and weirder than foreseen. I kept stumbling on my words and getting the conducting line of the talk all tangled up, much more than usually when presenting virtually. I still wonder if the reason for this is merely a psychological effect of knowing that you can stop and redo the bits and pieces that did not come out right, or if it's something more related to the lack of feedback from colleagues logged into the live session. I ended up spending some extra time shooting again bits where the audio may have failed or my delivery was lacking. Definitely it felt more of a performance than usual, but at the end it worked out fairly fine, and I was happy with it.

The assigned Q&A session for my talk was scheduled for the last day of the conference, which was actually about 20 days after I recorded the talk, so, I had to review my slides a bit before to remind myself about the nitty gritty details I had in. The question session was actually nice, the chairman made it quite easy to get engaged with the questions without feeling rushed, so it was a quite enjoyable experience. I have to say that one of the things that surprised me, in a good way, about the conference setup, was the ability to create this 'Topic chats' that were open for all the assistants. I tried creating a couple of those, with subjects related to my talk, and people engaged quite nicely, some had general questions for the community and some others had comments or even brought to our attention contributions of relevance being presented in the conference. I would not venture as far as to say that this made up for the lack of discussions that usually are spontaneously created from the live interaction between colleagues, but it made for a good way to create a sense of community and interaction. Overall, I had a good experience with this IPAC edition and I still feel stoked to have been able to participate with an invited talk and particularly to do it as Lancaster University PDRA."

News from the Laboratories — RAL

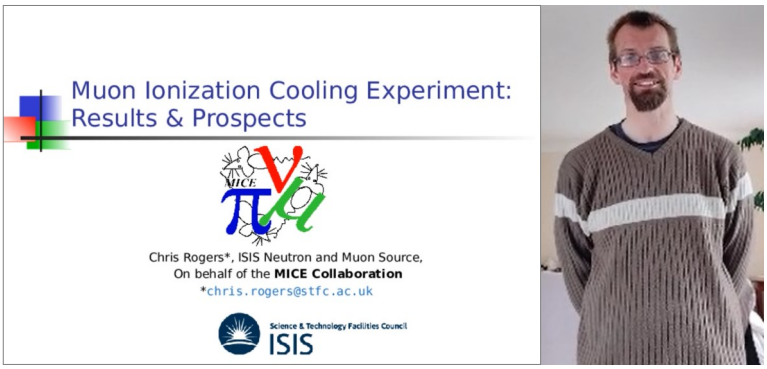
Bianca Veglia (University of Liverpool):



(Credit: Bianca Veglia/University of Liverpool)

"I was thrilled to be asked to give a contributed talk at this year (unfortunately again) virtual IPAC. It is the largest accelerator physics conference and definitely the widest audience I ever had to give a talk for. So my excitement was also accompanied by some hints of terror. I heard somebody saying in a movie: 'The number one fear of people isn't dying, it's public speaking'. For this, the virtual format makes it a bit easier, even if it meant that I had to endure the intense pain of watching myself over and over trying to present my slides. We were required to prerecord our talk that was the available online (it still is actually) for the attendees to watch at their convenience, a smart move if you consider the different time-zones of participants. After many embarrassing attempts, I managed to wrap a video that could make justice to the studies I was presenting. The focus was on electron cooling dynamics for the Extra Low Energy Antiproton (ELENA) ring, specifically the effect of different electron beam distributions and cooler geometry imperfections on the antiproton beam evolution. I was widely satisfied with the outcome: I received some nice feedbacks and was involved in very interesting discussions that ultimately helped me to progress with my thesis. Often the eye of somebody not involved in the project can help to observe the subject from a new perspective and suggest new approaches. For sure the distressing time I used to prepare was well spent and I really hope to have the chance to present at this fantastic conference again in the future, possibly in front of a live audience."

Chris Rogers (STFC Rutherford Appleton Laboratory):



(Credit: Chris Rogers/STFC)

"2020 was a very strange year for me, and not just because of the pandemic. Just having our MICE paper accepted for publication in Nature was an amazing achievement; but the media attention made it even better. The week before publication was a whirlwind of media interviews on the phone and even a visit to the BBC studios in Oxford.

The invitation to 'speak' at IPAC online made things even more exciting, although very different to a normal conference due to the need to pre-record the talk because of the pandemic. As we all know, accelerator physicists need to have a huge range of skills, and I can now add video editing to the list! The video itself was recorded using nothing more than a phone camera - I had recently bought a tripod for my daughter's photography hobby and managed to find a freeware video editing suite.

The nice thing about combining slides and video in an editing suite was that I could edit any last minute things in the slides without having to re-record the audio. It almost made it possible to tweak the look and feel - fading audio in and out as necessary.

IPAC then had a Q&A session during which colleagues were invited to ask questions about the talk. This was a really excellent opportunity to explain some of the details that I didn't have time to go into during the video presentation. I don't think that such a session works as a replacement for the interactions one has at a conference - but nonetheless, it was a really interesting opportunity.

All in all, presenting online was a really interesting experience. However, I am looking forwards to getting back to face-to-face meetings when it becomes possible!"

Joseph Wolfenden (University of Liverpool):

(Credit: Joseph Wolfenden/Univ. Liverpool)

"The invite to give a talk at IPAC this year was an exciting and welcomed surprise; it was also an anxiety inducing shock. During this pandemic, I have discovered that the harmless pinch of perfectionism found in most of us, is amplified within me whenever there is a requirement to record myself. That slight stutter, slip of the tongue, or mumbled word that would otherwise go ignored or simply corrected in the moment in a live presentation, is suddenly unacceptable! So began my tortuous cycle of record, delete, repeat.

Finally, after agonising over the length of my slide transitions and animation speed, I was finished. I could finally look to the actual conference and the vast array of content on display. One of the highlights of IPAC this year was that the virtual format lead to an increased level of participation, with thousands of authors and contributions. From discussions at the conference, I got the feeling that many viewed this as a double-edged sword. The sheer quantity of contributions to work through was a little daunting; there was obviously something extremely different between actively scrolling through posters and casually sauntering through a poster room with coffee and pastry in hand. The Q&A session for my talk was also different. There was something unnerving knowing that people had been given access to it all week, as if they had spent all that time scrutinizing it and preparing questions. In reality, obviously this was not the case, and the session was rather enjoyable; a rare opportunity in recent times to discuss our group's work with members of the accelerator community that I don't interact with on a regular basis.

Given the circumstances, I think this year's conference was a real success. Such a large range of content was given a platform that would have otherwise not been possible, including excellent presentations from the now permanent fixtures of the industrial session and WISE plenary. I think future IPACs would do well to include some of the virtual elements showcased this year. A more hybrid format would allow participants the more traditional elements of a conference, whilst allowing the greater participation and interaction provided by virtual elements. Overall, I think everyone involved in the conference this year, participants and organisers, did a great job despite the challenging circumstances. Fingers crossed for a more "normal" IPAC 2022!"

The recorded talks are presently available and are linked below for our four contributors:

Alex Castilla, Bianca Veglia, Chris Rogers, and Joseph Wolfenden

National Particle Accelerator Open Day

The Cockcroft Institute hosted the 2021 National Particle Accelerator Open Day virtually on Wednesday, 3rd February 2021. The aim of the event was to ensure that the accelerator community gets the opportunity to speak to undergraduate students about accelerators despite the lockdown. The open day had an exciting programme of events including talks and lab virtual tours plus the opportunity for students to talk to UK universities, laboratories and industry at virtual recruitment stands to find out how you can find studentship and employment opportunities in this exciting field. This year the tours were done in a virtual environment with two tours offered: one of the Diamond light source, the UK's flagship synchrotron light source, and one of the Elekta factory, a world-leading producer of radiotherapy machines. Talks on graduate opportunities were given by Laura Corner (Liverpool), Luke Dyks (Oxford), Hayley Cavanagh (ISIS), James Bourne (STFC) and Per Bergfjord (Elekta) providing a good mix of recent graduates, and employers from each sector.

There were 16 employers in attendance, made up of 8 Universities, 5 national labs, 1 hospital and two industry employers. We had around 170 undergraduate students register, over all 4 years of study, and about 78 turned up on the day. The talks and tours went very well with around 25 students for each of the four tour groups. The students who attended were mostly from the UK (54) but also from the USA, Brazil(4), India (3), Ireland (2), Greece, Bulgaria (2), Italy, Spain, Netherlands, Poland, Korea, France, Canada, Germany, Portugal, UAE, and Turkey.

Prof Graeme Burt who chaired the event said *"I'd like to thank all the many staff who gave up their time and effort to make this event a success, I'd particularly like to thank STFC media services who put together a fantastic platform in a very short period of time".*

The Open Day was supported by the IOP Particle Accelerators and Beams Group, STFC and the IET Particle Accelerator Engineering Network and had tours contributed from Diamond and Elekta.

Part of the Diamond virtual tour https://www.diamond.ac.uk/Public/VisitUs/Virtual-Visit.html
(Credit: Diamond Light Source)

Graeme Burt

Another CERN Fellowship for JAI, Oxford

For the last two years Rebecca Ramjiawan has been a Post-Doctoral Research Associate at the John Adams Institute (JAI), Oxford University, based at CERN, working on the AWAKE project. Rebecca joined JAI Oxford in 2015 as a DPhil student; her thesis was on low-latency beam-stabilisation feedback systems for linear electron-positron colliders and she was awarded her DPhil in 2019. Her current research is focussed on design studies for the AWAKE Run 2 proton and electron transfer lines. The challenging requirements for the experiment require the use of novel beamline design techniques, including multi-objective optimisation with genetic algorithms. Rebecca has just been awarded a CERN Fellowship for work on the transfer line designs for future accelerators, which she will start in September. This research will include studies of the FCC beam transfer and safe dump at every stage of the complex, and transfer line proposals for Physics Beyond Colliders projects such as the Beam Dump Facility. Congratulations Rebecca!

(Credit: Rebecca Ramjiawan)

PhD Success and CERN Fellowship

Ewa Oponowicz successfully defended her thesis on 24th March 2021. Her thesis, titled 'Superconducting Gantry for Proton Therapy and Proton Computed Tomography', was the first study of a superconducting gantry capable of delivering protons both at 70-250 MeV for proton-based radiotherapy, and to deliver 350 MeV protons for proton imaging of patients. In her novel design, a cryo-cooled achromat based on straight NbTi shielded superconducting magnets obtains a moderate 5% bandwidth and an overall size similar to existing resistive 250 MeV gantries. An innovative degrader scheme, possibly using boron carbide, allows static fields to be used during multi-layer treatment, overcoming the ramping speed limitation of previous designs. Since completing her thesis, Ewa has won a prestigious CERN Fellowship position and is currently working on superconducting designs for particle therapy.

(Credit: Ewa Oponowicz)

PhD Successes!

(Credit: Kay Dewhurst)

IOP PAB group committee member Kay Dewhurst successfully defended her thesis on 26th March 2021. Her thesis, titled 'Transport of Electrons From a Laser-Wakefield Accelerator to Produce Short-Wavelength Radiation in Undulators', concerned efforts to solve the problem of bunch length control of fs-scale bunches produced by plasma acceleration. Using the 500-1000 MeV SCAPA LWFA facility as a context, Kay developed a unique moving-quadrupole chicane system that allows variable chirp control of ultrashort bunches; this allows one to overcome the intrinsic chirp and lengthening of bunches following their acceleration, and enables generation of coherent undulator radiation into the ultraviolet. It is hoped that an experimental demonstration will be made of this in due course. Since completing her thesis, Kay has continued to work at the University of Manchester.

(Credit: Cockcroft Inst.)

Many congratulations to Strathclyde Physics PhD student Jenny Morgan, who recently passed her PhD viva with flying colours! She made great leaps forward in proposing and modelling new Free Electron Laser output to include Poincaré beams[1] and fast polarisation switching[2].

Poincaré light beams have the interesting property of having a polarisation that varies in the transverse plane. This is the first time that Poincaré output has been modelled in an FEL and, with the ability to control the wavelength, intensity and transverse polarization, could provide a useful tool for applications in material processing, microscopy, and atomic-state preparation, manipulation and detection.

Jenny also developed and modelled a relatively simple method to implement in an FEL that would greatly increase the rate of polarisation switching available in the X-ray by four orders of magnitude! This would allow polarisation switching of high power FEL X-ray output at timescales below the atomic unit of time of 24 attoseconds! (the time it takes an electron in a Bohr hydrogen atom to travel 1 radian around the nucleus.) Such a source potentially opens up a whole new field of science.

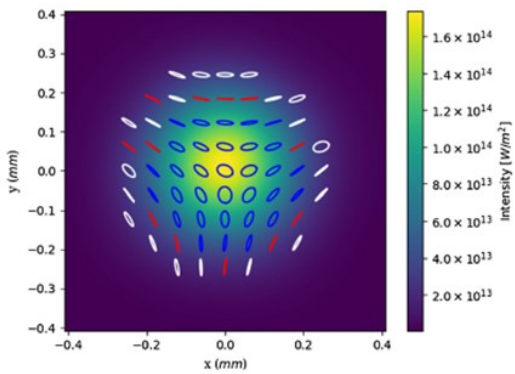


Figure 1: Simulation of Poincare output from an FEL with transverse polarisation dependence[1].

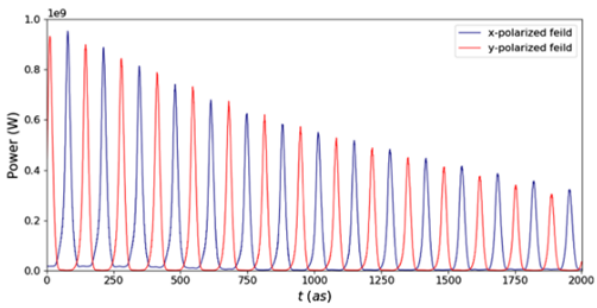


Figure 2: Fast polarisation switching for FEL output[2] at 1.25 nm.

[1]Jenny Morgan, Erik Hemsing, Brian WJ McNeil and Alison Yao, Free electron laser generation of x-ray Poincaré beams, New J. Phys. 22, 072001, 2020

[2]Jenny Morgan and Brian W J McNeil, Attosecond polarization modulation of x-ray radiation in a free-electron laser, Phys. Rev. Accelerators and Beams 24, 010701, 2021

Rutherford Plasma Physics Communications Prize

MPhys student Cara Hawkins and lecturer Dr Laura Corner, both of the University of Liverpool, have been awarded the Rutherford Plasma Physics Communications Prize for their episode on the podcast The Liverpool Scientific.

(Credit: The Liverpool Scientific)

This podcast was started in October 2020 by Cara Hawkins, and is based on the Radio 4 programme 'The Life Scientific'. In the podcast episodes, Cara Hawkins interviews scientists and engineers from across the University of Liverpool, talking about their research and career.

In the prize-winning episode, Cara chats with Laura about her research in plasma-based acceleration at the Cockcroft Institute and the University of Liverpool. They also covered Dr Corner's family tradition of studying physics, how plasma wakefield acceleration works, and how producing a hologram in labs led her into a lifelong career studying laser physics.

The Rutherford Communications Prize is awarded by the IOP Plasma Physics group to scientists who exemplify excellence in outreach to the general public through the communication of plasma physics.

Cara Hawkins and Dr Laura Corner were invited to give the Rutherford prize talk on 9 April at the 47th IOP Plasma Physics Conference.

You can listen to the award-winning episode via the following link:

https://open.spotify.com/episode/4GIz3at4Jc65IuOJltQyMb

Paul McKenna elected Fellow of the Royal Society of Edinburgh

Professor Paul McKenna, a senior member of the University of Strathclyde and Cockcroft Institute has been elected to a Fellowship of the Royal Society of Edinburgh in recognition of his outstanding scientific achievements.


(Credit: Paul McKenna)

Paul is a laser-plasma physicist whose research focuses on ultra-intense laser-plasma interactions and the development and application of laser-driven radiation sources. Paul has been a member of several EPSRC and STFC senior strategic advisory boards and the scientific advisory committees for international high power laser facilities. Following a PhD from Queen's University Belfast he undertook postdoctoral research at the University of Glasgow before moving to Strathclyde upon award of a RSE personal research fellowship in 2002. He was an EPSRC Leadership Fellow from 2012-17 and became Head of the Department of Physics at Strathclyde in 2018.

Paul became a member of the Cockcroft Institute in 2016 and much of his research has been carried out at the UK's Central Laser Facility. He has also been instrumental in the establishment of the SCAPA high power laser facility in Strathclyde.

On being congratulated on his success, Paul replied that *"it is a fantastic honour to be recognised in this way by the Royal Society of Edinburgh. Collaboration is central to my research, and I would like to acknowledge my current and former PhD students and post-docs, as well as the many other researchers I have had the opportunity to work with."*

Alexandra Welsch

Philip Burrows elected to IOP Council

Philip Burrows C.Phys. F.Inst.P. has been elected a Member of the Council of the UK Institute of Physics (IOP).

Burrows is Professor of Physics at Oxford University and Director of the John Adams Institute for Accelerator Science.

The Institute of Physics is the professional body and learned society for physics in the UK and Ireland. Council is the Board of Trustees of the Institute and has ultimate responsibility for directing its affairs, and ensuring that it is solvent, well run, and delivers the charitable outcomes for which it was set up.

Burrows said: *'It is a great honour to have been elected a Member of Council. I joined the IoP when a graduate student and I have been closely involved ever since. I was elected Fellow in 2004 and served as Chair of the Particle Accelerators and Beams Group between 2012 and 2016. It will be a privilege to help advise and steer the Institute as a Member of Council.'*

See also: https://www.iop.org/about/news/result-elections-iop-council#gref

(Credit: Philip Burrows)

Workshop on MSCA Networks - Training the next generation through collaborative programmes

Marie Skłodowska-Curie Actions (MSCA) target the development of excellent researchers through international and cross-sector mobility. MSCA networks support joint doctoral programmes, implemented by European partnerships of universities, research institutions, industry (incl. SMEs) and other non-academic organisations. The research training programmes are intended to provide doctoral students with excellent research skills, coupled with experience outside academia to develop their innovative capacities and employment prospects.

The QUASAR Group based at the University of Liverpool/Cockcroft Institute has an exceptional track record in the coordination of MSCA networks through leadership in the DITANET, oPAC, LA3NET, OMA and AVA projects. These networked covered cutting edge R&D in beam instrumentation, laser accelerators, medical accelerators and antimatter research. In combination, the Group has been in charge of the training of almost 100 Fellows and has coordinated the research and training at more than 100 partner organizations.

This workshop will share best practice and provide participants with a detailed understanding of the opportunities (and challenges) that the scheme offers. It is aimed at staff at academic and non-academic organisations in the UK and abroad, including industry, who are planning to participate in one of the next MSCA Doctoral Networks call.

The event is free of charge and will be hosted at the University of Liverpool on 29 September 2021. Remote connection will be made available and some of the speakers will join online. Advance registration is required and can be done via the following link: https://indico.ph.liv.ac.uk/event/358/

Carsten Welsch

Community Meetings

Do you have an idea for a meeting of interest to the community? See our advert below for details on applying for support from the Group.

IOP Particle Accelerators and Beams Group - Half Day Meetings

The meeting should be of **interest to the community at large**, bringing together experts and non-experts from different areas of the field. (Must use IOP Conference Service.)

You can request up to **£500** to help cover the cost of a half day meeting in any area of accelerator physics.
£750 for a 1 day meeting.
Or £750 (½) £1500 (1 day) shared meeting with another IOP group.

If you have an idea for a meeting and/or would like to discuss it further please email Ben Pine at **yafizicist@gmail.com.**

IOP Institute of Physics
Particle Accelerators and Beams Group

Ben Pine

International Calendar

Given the present circumstances, many events have been postponed or are being replaced by virtual events. Updates are available at: https://www.jacow.org/About/UpcomingEvents

10th International Beam Instrumentation Conference (IBIC 2021)
13-17 September 2021 (Virtual)
https://www.indico.kr/event/22/

18th International Conference on Accelerator and Large Experimental Physics Control Systems, ICALEPCS 2021
16-22 October 2021 (Virtual)
https://indico.ssrf.ac.cn/event/1/

67th ICFA Advanced Beam Dynamics Workshop on Future Light Sources (FLS 2022)
20-25 March 2022, Lucerne, Switzerland
https://indico.jacow.org/event/35/

13th International Particle Accelerator Conference (IPAC'22)
12-17 June, 2022, Bangkok, Thailand
https://www.ipac21.org/

International Linear Accelerator Conference 2022 (LINAC 2022)
28 August – 2 September 2022 , Liverpool, UK
https://linac2022.org/

Upcoming schools

Accelerator schools are similarly affected by the present situation. Information is available at: https://cas.web.cern.ch/ and https://uspas.fnal.gov/.

Useful Links

http://www.scitech.ac.uk/

http://www.cockcroft.ac.uk/

http://www.adams-institute.ac.uk/

http://www.diamond.ac.uk

http://www.desy.de/index_eng.html

http://www.linearcollider.org/

http://home.web.cern.ch/

http://www.jacow.org/

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IOP Institute of Physics
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IoP Particle Accelerators and Beams Group

IoP PAB Committee

***Chair*: Dr. Melissa Uchida (Cambridge)**

***Secretary*: Dr. Andrew Smith (Dalton Cumbrian Facility)**

***Treasurer*: Dr Glenn Christian (Diamond Light Source)**

Dr. Graeme Burt (CI Lancaster)

Dr. Tessa Charles (CI Liverpool)

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Dr. Stephen Gibson (JAI RHUL); *Web Manager*

Dr. Ben Pine (Opera Software)

Mr Malik Salaam (AWE)

Dr. Jonathan Smith (STFC Hartree)

Dr. John Thomason (STFC RAL)

Deadline for submissions to the next newsletter is
3 December 2021