INSTITUTE OF PHYSICS

IOP Institute of Physics
Particle Accelerators and Beams Group

IOP PAB GROUP NEWSLETTER

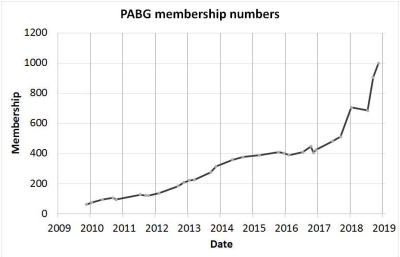
Issue 18

December 2018

Editorial

Welcome to the December 2018 edition of the IoP's Particle Accelerator and Beams Group Newsletter. The world of science in the UK is in a state of change on many fronts. Can anyone really say with any clarity or certainty where we will be by the time our next Newsletter is published in the Summer of 2019? Possibly not. The two main factors are of course Brexit and the UKRI's research and innovation infrastructure roadmap. UKRI's FAQs attempt to answer some of the questions which they readily admit is 'a challenging task as the UK has never undertaken a road mapping exercise of this breadth and scale'. The extent to which the STFC Accelerator Strategic Review, which was reported on in our last Newsletter, will have any influence will become clearer next Spring when the UKRI report on their strategy. As for predictions of how Brexit will affect our area of science, well I think we'll just have to wait and see…

I am glad to report that the PABG, however, is progressing well in supporting our members. Our membership has been growing at an impressive rate, nearly doubling to just below 1,000 in the last two years. I think that you would agree that the topics and progress reported upon in this Newsletter show that our members are internationally at the top of their game. Many new joint events with other IoP Groups are being planned for the future, so keep an eye open for these, or follow us on Twitter at @PartAccelBeams where these and other items of interest are announced.



One disturbing issue that has recently come to the fore is the sexual coercion and harassment of women in science – see *e.g.* this article in Physics World. The PAB Group feels this requires a strong and fast response by the IoP to firstly establish the facts and then to take appropriate actions to address them. Our women members expect and must receive nothing less. As a Group, we are making representation to the IoP leadership and Council to help ensure that this happens.

We would like to note our congratulations and thanks to Kay Dewhurst, a PhD student at the University of Manchester and the Cockcroft Institute, who was elected to serve on the PAB Group Committee. Kay is a Physics graduate of the University of Manchester and has a PGCE in Secondary Education from Manchester Metropolitan University. Her PhD research focuses on beam line designs, with the aim of transporting electrons from a Laser Wakefield Accelerator for use in light sources.

Nominations are now open for the PAB Group Prize for Outstanding Professional Contributions (see also page 4 of this Newsletter).

Any feedback, comments questions, please contact me. Brian McNeil, Group Chair.

Inside this issue:

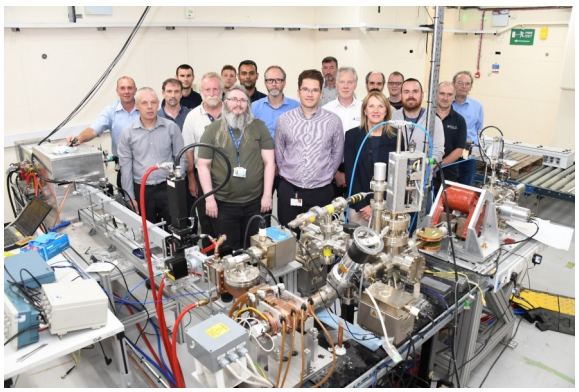
News from the Laboratories — Daresbury

Daresbury Security Linac Achieves 3.5 MeV

A small scale particle accelerator for security X-ray scanning, designed and commissioned at STFC Daresbury Laboratory and the Cockcroft Institute has successfully accelerated an electron beam to 3.5 MeV.

The linac, designed by Lancaster University and STFC Accelerator Science and Technology Centre (ASTeC) and Technology Departments, is optimised for X-ray screening of aviation cargo. These small particle accelerators are designed to fit on the back of a truck and can provide mobile security checkpoints. The new linac can vary its energy between 1-3.5 MeV and has a smaller footprint than other similar linacs. The beam can produce a peak current of 100 mA, and is pulsed at 200 Hz with 5 µs pulses. The linac operates at S-band and utilises a 17 keV thermionic electron gun and an S-band magnetron from Teledyne e2v. The RF linac structure utilises a pi mode where every accelerating cell is used, rather than the standard side-coupled design where every 2nd cavity is empty, to reduce the physical transverse dimensions thereby minimising the diameter of the shielding required. X-rays are produced by firing the beam onto a tungsten target to produce bremsstrahlung radiation. An important part of the project is to make a linac with simple controls and feedback, so that the energy and beam dose can be varied by operators at the airport without the need for accelerator scientists, and work in the next few months will be focused on implementing techniques to accomplish this mode of operation. The linac has similar requirements to radiotherapy linacs and the team are now also looking at similar compact accelerators for medical applications.

Dr Graeme Burt from Lancaster University and the Cockcroft Institute, who led the linac design, said 'Particle accelerators are important to the lives of everyone, but most people are unaware of how important they are. R&D into small industrial, medical and security accelerators is vital to making progress in the field of accelerator engineering and ensuring new research in HEP machines is properly exploited in other areas'.



The Compact aviation cargo scanning linac commissioning team.
(Credit: STFC)

After completion, the prototype will be turned into a user facility for industrial and university users to access small industrial type electron beams for research into industrial, security, medical and environmental applications of accelerators run by STFC at Daresbury Laboratory.

This facility perfectly complements the existing suite of accelerators at Daresbury including the existing 5 MeV VELA beam which delivers high quality, short pulse, low emittance beams for industrial and academic exploitation purposes.

Facility development was funded by the STFC challenge led applied systems programme.

Anyone wishing to utilise the facility should contact Donna Pittaway.

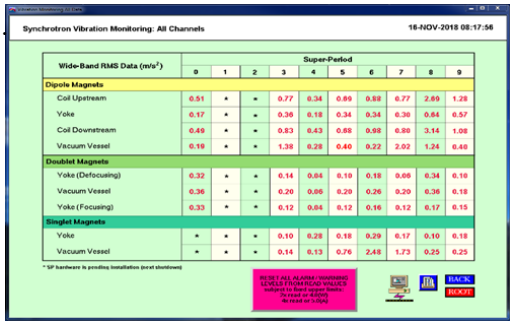
News from the Laboratories — RAL

A New Vibration Monitoring System for the ISIS Synchrotron

The ISIS synchrotron uses large AC dipole and quadrupole magnets to steer and focus the proton beam as it is accelerated around the ring. Since ISIS began operation in 1984, staff have employed a simple form of manual vibration monitoring to assess magnet health before each machine cycle, involving an insulated rod and sensor attached to a vibration meter. However, this method is only a one off measurement, is rather subjective and involves staff having to enter the synchrotron under controlled access while the magnets are fully energised.

Magnets in the ISIS ring.
(Credit: STFC)

In 2016, the ISIS Performance Improvement (PI) Group, in collaboration with the Institute of Sound and Vibration at Southampton University put forward a proposal to develop and install a fully automated vibration monitoring system with data available 24/7 and visible to the ISIS operations crew. The accelerometers utilised are of the charge-mode piezoelectric type and are radiation hardened, enabling real-time vibration monitoring during operation with beam.



Synchrotron Vibration Monitoring: All Channels 16-NOV-2018 08:17:56

Wide-Band RMS Data (m/s²)	Super-Period									
	0	1	2	3	4	5	6	7	8	9
Dipole Magnets										
Coil Upstream	0.51	*	*	0.77	0.34	0.89	0.88	0.77	2.69	1.28
Yoke	0.17	*	*	0.36	0.18	0.34	0.34	0.30	0.64	0.57
Coil Downstream	0.49	*	*	0.83	0.43	0.88	0.98	0.80	3.14	1.08
Vacuum Vessel	0.19	*	*	1.38	0.28	0.40	0.22	2.02	1.24	0.48
Doublet Magnets										
Yoke (Defocusing)	0.32	*	*	0.14	0.04	0.10	0.18	0.06	0.34	0.10
Vacuum Vessel	0.36	*	*	0.20	0.06	0.20	0.26	0.20	0.36	0.18
Yoke (Focusing)	0.33	*	*	0.12	0.04	0.12	0.16	0.12	0.17	0.15
Singlet Magnets										
Yoke	*	*	*	0.10	0.28	0.18	0.29	0.17	0.10	0.18
Vacuum Vessel	*	*	*	0.14	0.13	0.76	2.48	1.73	0.25	0.25

* SP hardware is pending installation (next shutdown)

RESET FAIL ALARM / TOGGLE ALARM LEVELS FROM RMS VALUES (subject to fixed upper limits: 2x (read or 400m) 4x (read or 1.5m))

BACK ROOT

Vibration monitoring control screen.
(Credit: ISIS)

All data is visible within the ISIS control system, so operational events (including failures) can be visualised, logged and analysed. In addition a parallel LabVIEW application stores a one-week rolling buffer of raw data. This provides a window for bulk post-processing for detailed analysis in the event of a failure. Such post-processing can be in the time or frequency domain, with many standard analysis techniques easily accessible in LabVIEW. The data acquisition (DAQ) system was built using National Instruments (NI) PXIe hardware and NI 449x sound and vibration modules.

During development, care was taken to ensure conformance with standard ISIS practices, resulting in a low noise wiring system and charge mode amplifiers housed outside active areas. The LabVIEW system uses the same hardware and software as other ISIS diagnostic systems. Data is carried from the magnets in the outer synchrotron using an MXI fibre link via the standard fibre patch panel.

So far the new system has been installed in 90% of the synchrotron, with the remaining 10% to be installed during the ISIS shutdown in January 2019. Thereafter no more manual measurement will be required as the system becomes fully automated.

Fibre patch panel.
(Credit: ISIS)

Julian Brower
Asim Yaqoob

IoP Particle Accelerators and Beams Group Prize

The Particle Accelerators and Beams Group of the IoP is seeking nominations for the 2019 Prize for Outstanding Professional Contributions. This will recognise the contribution made by an individual to the field of accelerator science and technology in the UK or Ireland whilst also enhancing the public profile of the subject. Previous recipients of the prize are Richard Walker (2018), Andy Wolski (2017), Mike Poole (2016), Chris Prior (2014), Ian Gardner (2013) and Neil Marks (2012).

The Prize can be awarded to a person of any nationality although the nomination must be made by an IoP member. The identified personal contributions should be demonstrated to have had significant impact on major scientific or technological advancement, or alternatively to have promoted important educational or outreach activities.

2018 prize recipient Richard Walker

A maximum two page summary case must be submitted, together with a small amount of ancillary material, including major citation evidence (where relevant). Up to three letters of support for the candidate may also be included. The material must be submitted to the PAB Group Secretary, Aled Jones by the nomination deadline of 1 March 2019.

A Prize Committee has been appointed and will meet to determine the award winner. The recipient will be presented with a certificate at the PAB Group Annual Conference on 26 April 2019 at STFC Rutherford Appleton Laboratory and will be invited to give the prize lecture at the PAB Group Annual Conference 2020.

Aled Jones

New leadership at the John Adams Institute

Professor Philip Burrows became Interim Director of the John Adams Institute effective June 2018. He succeeds Professor Andrei Seryi, who has taken up the post of Associate Director for Accelerator Operations, Research and Development at the Thomas Jefferson National Laboratory in the USA.

Phil Burrows

Phil has been Professor in the Physics Department at Oxford University since 2006 and Associate Director of the JAI. His own research is focused on advanced beam feedback systems characterised by low latency (order 10-100 ns), high-resolution, high-power, and high-bandwidth response. His Feedback On Nanosecond Timescales (FONT) research group has built pioneering closed-loop feedback and feed-forward systems that have been deployed at the NLC Test Accelerator at SLAC, the Accelerator Test Facility (ATF/ATF2) at KEK, and the CLIC Test Facility (CTF3) at CERN. These systems have been developed in the context of beam control for next-generation high-energy electron-positron colliders. So far 20 students have done PhDs in the FONT group.

Phil was Chair of the IoP PAB Group between 2012 and 2016. He is Spokesperson of the Compact Linear Collider (CLIC) accelerator Collaboration and is currently Guest Professor at CERN.

Phil Burrows

The National Vacuum Electronics Conference 2018 (NVEC 2018)

The National Vacuum Electronics Conference (NVEC) is a UK conference focusing on early career researchers and staff members at PhD student and PDRA level. It is dedicated to vacuum electronics, RF and accelerator science, engineering and innovation. This year NVEC 2018 was hosted on 10 September 2018 by the John Adams Institute for Accelerator Studies at the Department of Physics, University of Oxford. The conference was attended by 45 participants from 19 different institutes, universities and industrial partners.

Rupa Basu (Lancaster University) talks about design of G-band travelling wave tube for a wireless high data rate link.
(Credit: John Adams Institute)

The conference was introduced by the Head of the Department of Physics, Prof. Ian Shipsey, and 18 presentations were delivered including 10 by young researchers and graduate students, and 6 by conference supporting industrial partners. The conference organisers would like to thank the industrial partners who provided strong support for the conference, allowing the event to remain registration fee free and proving generous with coffee and biscuits. The conference industrial, research and other partners COMSOL Ltd, Tech-X UK, CST GmbH, Anritsu, the Cockcroft Institute, the John Adams Institute and the IoP Particle Accelerators and Beams Group are acknowledged for their sponsorship.

Ivan Konoplev

The Future and Next Generation Capabilities of Accelerator Driven Neutron and Muon Sources

On Tuesday 14 August 2018, the Rutherford Appleton Laboratory hosted a joint meeting organised by two groups from the Institute of Physics – the Particle Accelerators and Beams Group (PABG) and the Neutron Scattering Group (NSG). This was a one day event aimed at bringing important communities involved in neutron and muon facilities together – accelerator physicists and engineers, instrument scientists and users. The intention was to highlight recent advances and showcase future opportunities, particularly in the context of generating user support for the science case for the next iteration of neutron and muon facilities. The meeting was co-sponsored by the Institute of Physics and the ISIS Neutron and Muon Source.

Mike Plum from SNS talks about the forthcoming Proton Power Upgrade. (Credit: John Thomason)

Following some introductory remarks from John Thomason (ISIS and PABG) and Felix Fernandez-Alonso (ISIS, University College London and NSG), Zoë Bowden, the Deputy Director of ISIS, took over as chair for the morning session dedicated to accelerators and targets for neutron and muon production.

In the opening talk John Thomason described the development of the 'ISIS-II Roadmap', intended to allow an appropriate period of feasibility, design studies and R&D to evaluate options in order to make a fully informed decision on what a successor to ISIS should look like. Ciprian Plostinar from the European Spallation Source (ESS) then provided some honest insight into progress on the construction of what will take over from the Spallation Neutron Source (SNS) in the USA as the world's most powerful spallation source. Work on the Proton Power Upgrade project at SNS in preparation for building a second target station was presented by Mike Plum.

After a coffee break Philip King from ISIS gave an overview of the Target Station One (TS-1) Project, which will replace the ISIS TS-1 target, reflector and moderator assembly along with the entire contents of the target services area during a long shutdown which is due to commence in 2020. Alain Menelle from CEA Saclay then gave a very interesting summary of Compact Accelerator-driven Neutron Source (CANS) development in Europe, and went on to describe plans for a new CANS, Sonate, at Saclay. The session concluded with another talk from John Thomason, this time on recent commissioning work on the China Spallation Neutron Source – the newest kid on the spallation block.

Alain Menelle from CEA Saclay talks about CANS. (Credit: Suzie Sheehy)

Over lunch it was gratifying to see lots of accelerator and neutron science people talking to each other and obviously enthused by the meeting – job done! There was also the chance for non-ISIS attendees to see the ISIS synchrotron, with tours led accelerator physicists Ben Pine and Bryan Jones from the Synchrotron Group.

The afternoon session was dedicated to new opportunities in neutron and muon science, and was chaired by Fabrizia Foglia from King's College London.

ISIS's Jeff Penfold and Rob Dalgliesh gave the first two talks, presenting an overview of possibilities for future science at ISIS, and thoughts on how to optimise neutron and muon instruments to 'be the best'. David Barlow from King's College London followed with a fascinating description of the part neutrons have to play in the global effort to counter antibiotic and antifungal resistance – Drugs, Bugs and Neutrons.

Lucy Clark, Sarah Youngs, Steve Hull and Fabrizia Foglia.
(Credit: John Thomason)

Sarah Youngs from ISIS explained the importance of deuteration in neutron science and the continued development of new deuteration methods. Lucy Clark from the University of Liverpool talked about the role played by neutrons and muons in studying quantum materials for quantum technologies and finally Steve Hull from ISIS described how neutrons benefit next generation battery systems. All of the talks for the day can be found here.

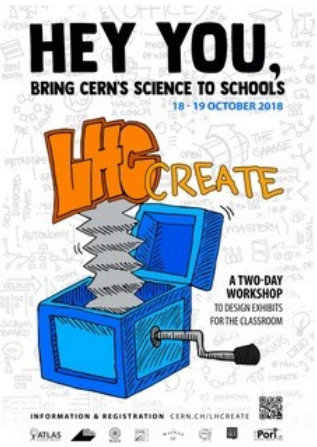
Overall, the event was a great success and attracted a total of around 90 attendees. Feedback at the end of the sessions emphatically endorsed the idea of holding such joint meetings and there was agreement that there should be more in future.

Special thanks go to Trudi Gurney, Sara Fletcher and Dan Harryman from ISIS for their help in organising this meeting.

And the last word goes to Ian Tucker, chair of the NSG. Ian was one of the prime movers in the conception and organisation of this event and had intended to be co-chair, but was unfortunately indisposed and unable to attend on the day.

John Thomason
Felix Fernadez-Alonso

CERN LHCreate Outreach Hackathon



How to have fun, learn new things and do outreach at the same time? LHCreate is the perfect event for that. This year, Helena Pikhartova participated in this CERN organised event.

LHCreate is a 2-day outreach hackathon and workshop. The aim is to create an exhibit showing off what CERN does and how in a fun and creative way. This year's edition took place 18 – 19 October 2018 at the CERN IdeaSquare, a unique space dedicated to knowledge transfer and experimental innovation.

The central theme of this 4th edition of LHCreate was to take CERN science to classrooms. The goal was to design the prototype of a science exhibit which could be rebuilt by 12 to 18 year old students in their classroom and used to explain scientific concepts.

A total of four teams entered the competition, each made up of six people having different professional backgrounds (including physicists, engineers, design students) with a wide diversity of gender and nationality. The teams were given 33 hours to brainstorm ideas and put together a working prototype. Mentors were available for support at all times during the competition. Mentors were teachers from local schools, electrical experts, physicists, machinists and others.

Royal Holloway was represented at LHCreate by Helena Pikhartova, a 2nd year PhD student in accelerator physics, currently based at CERN. Helena contributed to the victory of her team which designed the 'Synchro CERN Game'.

The Synchro CERN Game team, with Helena second from the right.
(Credit: CERN)

The Synchro CERN game is based on the operation of a real synchrotron (a type of particle accelerator where a particle beam travels around a fixed circular path). The game involves up to six people (one controller and five operators) each in command of one control station. Each station is responsible for different parameters that drive the virtual synchrotron. The players must work together in order to collide particles successfully and potentially achieve a physics discovery. The different parameters controlled by the players are the system temperature, the

beam pipe pressure, the acceleration gradient, the bending magnet strength and the focusing magnet strength. As the total power of the whole system is limited, these parameters must be fine tuned individually at different times during the course of a game. The synchrotron beam collides when the players find the ideal combination of parameters. Upon success, a holograph located on top of the machine shows a diagram of the particle collisions.

At the end of the design phase, the participating teams presented their prototypes to the public and to a panel of judges. The projects were rated on the basis of the scientific content, suitability as an exhibit, product design and reproducibility.

As a winning project, the story of the Synchro CERN Game is far from finished. The prototype will be rebuilt by professionals and will be available to visitors at CERN. A construction manual targeted at classrooms will also be written.

The Synchro CERN Game.
(Credit: CERN)

So if you plan on visiting CERN in the future, make sure you keep your eyes open and maybe enjoy playing the Synchro CERN Game!

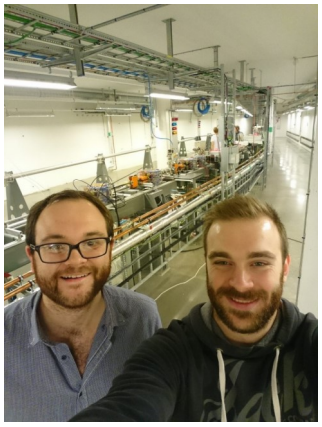
Helena Pikhartova

Successful Measurement Programme at MAX IV

A group of PhD students from the Cockcroft Institute have recently returned from an extremely successful measurement program at the MAX IV synchrotron in Lund, Sweden. Joe Wolfenden (University of Liverpool), Bill Kyle (University of Manchester), and Tom Pacey (University of Manchester) have been working at the centre of a new collaboration with MAX IV on a new diagnostic for their 'Short Pulse Facility'.

Joe's research focuses on new imaging-based techniques for particle accelerator diagnostics. His work uses radiation generated by a charge particle beam, and spans both transverse and longitudinal measurements for the next generation of machines. Bill's research is based on simulating and measuring the interactions between radiation generated by a charged particle beam and the beam itself. He hopes to measure the effect of these interactions and compare them with the results of a novel simulation model. One of Tom's research interests is on the development of diagnostics which work in a specific frequency range known as terahertz (THz). He can use these techniques to measure the properties of a charged particle beam after it has passed through metallic and dielectric structures.

Their measurements at MAX IV were actually a special type of imaging, just as anyone else would do with a digital camera. However, the average digital camera captures optical light with a wavelength around 0.5 μm, whereas here the focus was on much longer wavelengths – up to 3000 μm! This light was made by an electron beam, by either hitting a target or bending its path with a magnet. It is known as coherent radiation, because its wavelength is comparable in length



Joe and Bill at MAX IV.
(Credit: Cockcroft Institute)

to the length of the electron beam that produced it. Imaging this coherent radiation showed that it was possible to tell how long the electron beam was from the properties of the image they found. The measurements went extremely well and data is currently being analysed. First results are looking very promising and the group is already planning to head back to MAX IV for more measurements in early 2019!

The students had a fantastic time in Lund and want to say a massive thank you to Erik Mansten and Sara Thorin from MAX IV for all their help and enthusiasm, and for inviting them in the first place!

Joe Wolfenden

The Cockcroft Institute of Accelerator Science and Technology

AWAKE Achieves Electron Acceleration to 2 GeV for the First Time

In a recent paper published in the journal Nature [1], the AWAKE Collaboration reported for the first time ever the successful acceleration of the electrons using the plasma wakefields driven by high-energy proton beams.

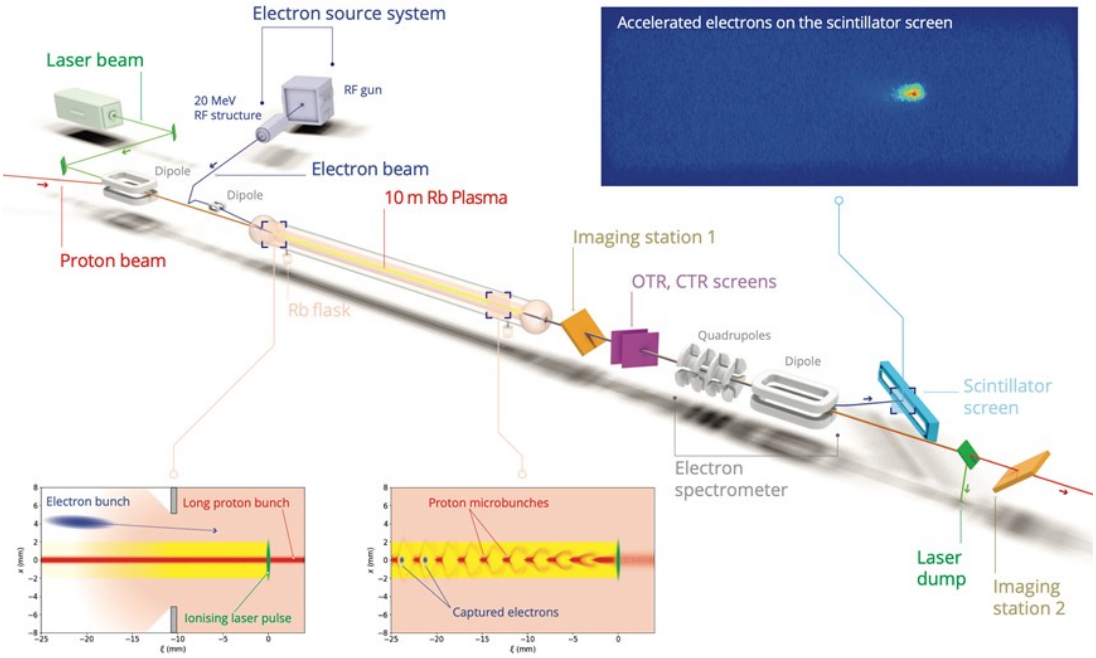
AWAKE stands for the Advanced Wakefield Experiment. It is the world's first proof-of-principle experiment investigating the use of plasma wakefields driven by a high-energy proton bunch to accelerate charged particles.

AWAKE utilizes the high-energy proton beams extracted from the Super Proton Synchrotron (SPS), one of the last LHC injectors, to provide a 400 GeV proton beam to excite plasma wakefields, as the layout shown in Figure 1. In the AWAKE experiment, the proton bunch and laser pulse propagate from left to right through a 10 m column of rubidium (Rb) vapour. The laser pulse ionizes the Rb to form a plasma (yellow) which then interacts with the proton bunch (red, bottom left image). This interaction modulates the long proton bunch into a series of micro -bunches (bottom right image) which then drive strong wakefields in the plasma. Electrons generated using a radio frequency (RF) source propagate a short distance behind the laser pulse and are injected into the wakefields by crossing at an angle. Some electrons are captured in the wakefields and accelerated to high energies.

In the recent experiment, the AWAKE collaboration successfully accelerated witness-electrons for the first time – electrons injected into AWAKE at relatively low energies of 19 MeV. These electrons were injected in the right phase of the plasma wave and were accelerated by a factor of around 100 to an energy of almost 2 GeV over a length of 10 m. The acceleration gradient demonstrated was about 200 MeV/m, which is about 10 times higher than the accelerating field in current radiofrequency cavities.

[1] E. Adli *et al.*, Acceleration of Electrons in the plasma wakefield of a proton bunch, Nature, 561, 363-367 (2018).

The AWAKE project got approval in 2013 and afterwards construction was started. The first proton beams were then guided to the plasma cell in late 2016. During the 2016 – 2017 run the plasma wakefields generated by the self-modulated proton beams were successfully observed and studied in detail. In 2018, electrons were accelerated for the first time in the plasma wakefields driven by the proton bunch.



The layout of the AWAKE experiment.

The advantage of the AWAKE scheme lies in the fact that it utilises the available very high-energy proton bunch as the drive beam. The beam energy of one proton bunch is about three orders of magnitude higher than that from the highest energy electrons beams or lasers available nowadays. Hence, the proton bunch can penetrate into the plasma for a longer distance and bring an electron bunch to the energy frontier in a single stage of acceleration. This will eliminate the complex issues such as staging, synchronization and alignment posed by the multiple acceleration stages required using electrons or lasers as drive beams instead.

AWAKE is an international scientific collaboration made up of 18 institutes and involving over 80 engineers and physicists. Several groups from UK universities are taking leading roles in the AWAKE project, including University College London, Lancaster University, Liverpool University and the University of Manchester. Key contributions from the UK include a 1 m long S-band travelling wave structure energy booster, the energy spectrometer and the pepper-pot emittance instrumentation.

The AWAKE collaboration is currently preparing for AWAKE Run II, which is after the LHC long shutdown. The aims of AWAKE Run II will include the demonstration of 10 GeV electron acceleration with preserved beam emittance. For the long-term future, a fixed-target experiment and compact colliders will be designed based on the AWAKE scheme. The AWAKE experiment will pave the way towards future compact colliders based on plasma technology.

Guoxing Xia

International Calendar

10th International Particle Accelerator Conference (IPAC 19)
Melbourne, Australia, 19 - 24 May 2019
https://ipac19.org/

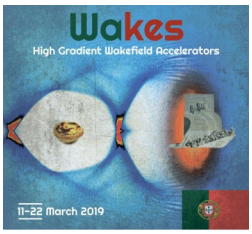
19th International Conference on RF Superconductivity (SRF2019)
Dresden, Germany, 30 June - 5 July 2019

39th International Free Electron Laser Conference (FEL 2019)
Hamburg, Germany, 26 - 30 August 2019
https://www.fel2019.org/intro/

8th International Beam Instrumentation Conference (IBIC 2019)
Malmö, Sweden, 8 - 12 September 2019
http://www.ibic2019.org/

63rd ICFA Advanced Beam Dynamics Workshop on Energy Recovery Linacs (ERL2019)
Berlin, Germany, 15 - 20 September 2019
https://www.helmholtz-berlin.de/events/erl19/index_en.html

Upcoming schools



CERN Accelerator School — High Gradient Wakefield Accelerators
Sesimbra, Portugal, 11 - 22 March 2019
http://cas.web.cern.ch/schools/sesimbra-2019

CERN Accelerator School — Advanced Accelerator Physics
Slangerup, Denmark, 5 - 19 June 2019
http://cas.web.cern.ch/schools/slangerup-2019

CERN Accelerator School — Introduction to Accelerator Physics
Vysoke-Tatry, Slovakia, 8 - 21 September 2019
http://cas.web.cern.ch/schools/vysoke-tatry-2019

PAB Group & UK Events

Annual General Meeting of the PAB Group
Visitor Centre (R112)
STFC, Rutherford Appleton Laboratory, 26 April 2019

Useful Links

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

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

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

www.diamond.ac.uk

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

http://www.linearcollider.org/newsline/

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

http://www.jacow.org/

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IoP Particle Accelerators and Beams Group

IoP PAB Committee

***Chair*: Dr. Brian McNeil (Strathclyde)**

***Secretary*: Mr. Aled Jones (AWE)**

***Treasurer*: Dr. Jonathan Smith (Tech-X UK)**

Dr. Graeme Burt (CI Lancaster)

Miss Kay Dewhurst (CI Manchester)

Dr. David Dunning (STFC Daresbury)

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

Dr. Andrew Rossall (Huddersfield)

Prof. Susan Smith (STFC Daresbury)

Dr. John Thomason (STFC RAL); *Newsletter*

Dr. Melissa Uchida (Cambridge)

Dr. Peter Williams (STFC Daresbury)

Deadline for submissions to the next newsletter is
31 May 2019