Welcome to Issue 19 of our Newsletter. The PAB Group first came into existence at the IoP Council on 27 November, 2008 and was officially launched from 1 January, 2009. I still have the e-mails from Mike Poole from early 2008 onwards who was Director of ASTeC and who put significant effort into setting up the PABG. Thanks Mike! I’m happy to report that we now have over 1,000 members and the Group is providing a real contribution to the community as seen from the great range of talks from across the country at our Annual Meeting held at RAL (p8).

A highlight of the Annual Meeting was a summary of the most recent UKRI-STFC strategy as presented by Grahame Blair, which includes pointers to many of the important strategic works that will affect our research. This also led me to an interesting link on UKRI’s historical interpretation of the Haldane principle which, I think, gives some insight into how their strategy is evolving.

What strikes me in this issue of the Newsletter is the large volume of high quality outreach work that is being done to engage with greater society. For example, this has been recognised by the EPS European Award for Outreach for the Tactile Collider Project organised by Rob Appleby, Chris Edmonds and Robyn Watson (p14). Thanks to you from our community for this great work and many congratulations on the well-deserved recognition!

Another aspect of note is the international reach of our community’s R&D. From assisting Fermilab in the USA with superconducting (SC) RF cavities, to the supply of SC cavities for the European Spallation Source (ESS) in Sweden, to helping to roll out improved radiation therapy treatment systems in sub-Saharan Africa. Our community has a great international impact!

As discussed in our last Newsletter, the PABG continue to push for improved services from IoP to establish facts and take appropriate actions to address issues on sexual harassment in the workplace. We hope to hear of any developments from IoP Council in the not too distant future.

We would like to announce that Andy Smith has been elected to serve as our Group Secretary from this Autumn. Andy is an Accelerator Beam Line Experimental Officer at The University of Manchester’s Dalton Nuclear Institute’s Cumbrian site. We look forward to working with you Andy!

Finally, a great big ‘thankyou’ to our outgoing Group Secretary, Aled Jones. Aled has served the PABG with great diligence during his term of office, making sure everyone is informed of what is happening and keeping the wheels of our committee running smoothly. Nothing happens without a good Secretary, and Aled, you were great!

If there is anything you think we could do better or should know of, please feel free to contact me at b.w.j.mcneil@strath.ac.uk and follow us on Twitter for updates of what is happening in our community @PartAccelBeams
News from the Laboratories — Daresbury

Cavity Developments for CLARA

A new photo-injector cavity, designed by the ASTeC and Technology Departments at Daresbury with the Cockcroft Institute (Lancaster University) and the Institute of Nuclear Research in Moscow is now being integrated into the CLARA accelerator.

The RF cavity has been extensively tested with mW of power, and fitted with a state-of-the-art cathode exchange vacuum system that allows different cathodes to be tested. The cavity is now on the secondary CLARA accelerator beam line at Daresbury and must be conditioned to operate at high power — up to 8 MW pulsing 100 times per second. This level of power will produce 100 MV/m electric fields in the cavity. Currently, the cavity cannot sustain fields at this level without electrical arcing taking place, which would damage the cavity surface. The power must be increased gradually, conditioning the surface by removing contaminants as well as nano-metre scale imperfections that 'grow' from within the copper cavity surface. This conditioning process, when previously performed on lower field RF cavities, has proved laborious and time-consuming, involving trained RF staff having to increase the power manually, whilst observing the pressure rises due to electrical arcing.

Recent research from CERN and KEK in Japan has shown that for high gradient cavities like the new photo-injector cavity, what is important is to avoid too many breakdowns during conditioning. A better strategy is, therefore, to detect the breakdowns very quickly and turn off the RF power before more can occur. The fastest way to detect a breakdown is through the RF signals from the cavity itself. If the power reflected from the cavity increases suddenly, it means there is an arc, but because the power is pulsed 100 times per second it is impossible for a human operator to detect this and switch off the RF.

Scientists at Daresbury lab have designed and written a program that reads in the reflected RF signals and analyses them before the next pulse. The program then turns off the RF immediately, the whole process happening in 0.01 seconds. This prevents the arcs from growing too large and damaging the cavity. The program also automatically ramps the power up, so trained staff are no longer required to spend weeks of time manually conditioning the cavity. Early versions of the program were tested on other CLARA RF structures.

This is all part of a larger drive to automate more of the repetitive processes on the CLARA accelerator. Automation means that tasks are repeatable, user-friendly and that important data is regularly saved.

Emily Baker
Louise Cowie
ASTeC Hosts High Power Radio Frequency Forum Event

On Wednesday 27 February 2019, ASTeC hosted the 7th High Power Radio Frequency Forum (HPRFF) at STFC Daresbury Laboratory.

HPRFF is a special interest group for organisations with a particular interest or involvement in the HPRF environment. Areas of interest include: Defence & Security, Communications (terrestrial & space), Medical, Scientific and others. The aim of the HPRFF is to represent members and generate opportunities for better UK and international business through a joint role in planning with Her Majesty's Government and other relevant bodies, to strengthen a presence in the market through effective branding, activity and relationships.

Michelle Keeley-Adamson

Daresbury supports PIP-II at Fermilab

A team of accelerator science and technology experts at STFC’s Daresbury Laboratory are to play a major role in the development of PIP-II, the Proton Improvement Plan project to enhance proton beam capability at America’s Fermilab. The Daresbury team will provide superconducting Radio Frequency (RF) cavities and assembled cryomodules.

An RF cavity is a metallic chamber that contains an electromagnetic field. Its primary purpose is to accelerate charged particles. The cavities for PIP-II are to be made from very high purity niobium, cooled to cryogenic temperatures (a chilly -150°C or less) and will accelerate particles to almost the speed of light. The cryomodules will keep them at the correct operating temperature.

Daresbury Laboratory is renowned for its world-class accelerator expertise, and the work for PIP-II will be performed as part of the UK’s £65 million investment in the Long-Baseline Neutrino Facility (LBNF)/DUNE and PIP-II.

Michelle Keeley-Adamson
Preparation for SRF Accelerator Delivery to the European Spallation Source

The European Spallation Source (ESS) is one of Europe's largest planned research infrastructures and the world’s leading facility using a 5 MW neutron source. The ESS in Lund, Sweden will bring new insights to the grand challenges of science and innovation. The ESS project is a collaborative project supported by seventeen European countries, which will build capacity and increase capability in scientific research mainly driven by applications related to material sciences. Being a single purpose facility, the design parameters of the accelerator are defined by the high level requirements of neutron users and the design of neutron instruments at ESS, with an unprecedented power of 5 MW, a proton pulse of 2.86 ms and a repetition rate of 14 Hz.

The ESS linac accelerates 62.5 mA of protons up to 2 GeV in a sequence of normal conducting and superconducting accelerating structures. Superconducting RF (SRF) accelerator technology is employed in order to ensure high gradient acceleration for such a long-pulse machine can be achieved efficiently, in a small physical footprint.

Daresbury Laboratory has the responsibility for providing all of the High-β accelerating structures, with each of the 84 cavities requiring testing to achieve the stringent performance requirements for ESS, prior to their shipment to CEA Saclay in France for final stage integration into the 21 operational cryomodules.

In order to achieve the required qualification performance of 19.9 MV/m accelerating gradient and a quality factor of $5 \times 10^{10}$, an extensive amount of SRF testing infrastructure is being implemented. This includes a 2 m diameter vertical test cryostat to house the cavities to be tested, which is cryogenically cooled by a 2K liquid helium liquefier, with a radiation shielding enclosure implemented to perform the SRF cavity tests. In addition, local surface cleaning is also required for those cavities which are initially not able to reach the operational performance targets for ESS. As a result, these cavities will be subjected to a High Pressure Rinse (HPR) cycle using ultra-pure water, which is intended to remove all particulates which may exist on the SRF cavity internal surfaces and which ultimately degrade the achievable performance. All of this will be conducted in a high classification ISO4 cleanroom in order to protect the exposed surfaces of the SRF cavities during the preparation and processing procedure. Once HPR’d the cavities will be reinstated for re-test and qualification.

Currently first integrated system commissioning is underway, utilising a prototype high-β cavity provided by CEA Saclay, which is allowing the Daresbury team to optimise the cryogenic and RF system operation, whilst also giving valuable operational experience for each of the technical delivery specialists.

All production 704 MHz SRF cavities are currently being manufactured at Research Instruments GmbH in Germany. The first pre-series unit has recently been successfully fabricated and is being prepared for qualification tests at DESY in Germany, with first final production cavities expected for testing at Daresbury early in 2020.
ESS High Beta Cavity test Infrastructure at Daresbury
(Credit: STFC/ASTeC)

First UK procured ESS high beta cavity manufactured at Research Instruments
(Credit: Research Instruments)

Peter McIntosh
New High-Sensitivity, Full-Coverage Beam Loss Monitors at ISIS

The ISIS neutron and muon source at the Rutherford Appleton Laboratory provides a high-power proton beam via a 70 MeV drift-tube linac and an 800 MeV rapid-cycling synchrotron. The synchrotron accelerates up to $3 \times 10^{13}$ protons in a 10 ms cycle and delivers beams to two target stations. The operating intensity of the facility is limited by beam loss which can cause component damage or activation which impedes hands-on maintenance and repair. Accurate monitoring and control of beam loss is therefore vital to the continuing operation of the facility.

From first beam in 1984, loss has been detected by argon-filled ionisation chambers distributed around the inside radius of the synchrotron at floor level. These monitors provide a sensitive, fast, but qualitative measurement of evaporation neutrons resulting from beam-machine interactions. However the ionisation monitors are ineffective at measuring losses inside the main dipoles of the synchrotron, which account for 25% of the circumference, as they are shielded by the magnets’ thick steel yokes. Damage to RF screens (wire cage structures which provide a low impedance for beam-induced currents) inside the dipoles has limited the operating beam intensity.

Scintillating beam loss monitors (BLMs) have now been added inside each dipole, outside the vacuum vessel. Six 150×100×3.5 mm blocks of plastic scintillator BC-408, with entirely non-metallic support assemblies to avoid eddy currents, are installed in each dipole. Optical fibres connect each monitor to a photo-multiplier tube and data acquisition system. Data is published at 50 Hz over the site network to allow real-time optimisation of beam parameters. The system provides extremely sensitive loss monitoring to enable better fine-tuning of machine parameters.

The monitors were installed in sections between August 2016 and August 2018. In this time, the average beam loss level in the synchrotron has been reduced by a factor of three, while simultaneously the operating intensity has increased by 10% to 220 μA. Radiation surveys of the synchrotron dipoles at the end of each user cycle have shown a 40% reduction in residual activation between July 2018 and April 2019.
John Adams Institute DPhil Success

Two JAI/Oxford students recently defended their DPhil theses and both have secured new positions in the field based at CERN.

Rebecca Ramjiawan joined the John Adams Institute as a DPhil student in 2015, following an undergraduate degree with the University of Oxford. Her DPhil thesis is concerned with low-latency feedback systems for beam stabilisation in future linear colliders, the title of which is ‘Development of Feedback Algorithms for Future Linear Colliders’. Her DPhil research includes the development of a prototype feedback system at the Accelerator Test Facility (KEK, Japan), which is a contribution towards the goal of stabilising the electron beam to the nanometre level. Another aspect of her research involves simulations of the performance of an intra-train feedback system designed for the interaction point of the International Linear Collider. In July 2019, Rebecca will be taking up a Post-Doctoral Research Assistant position with the John Adams Institute which will be based at CERN. This position will involve the design for an electron beamline for Run 2 of the AWAKE project.

Léon van Riesenhaupt did his undergraduate studies at Imperial College London before joining the John Adams Institute in Oxford, Léon's DPhil thesis explores ‘Advanced Accelerator Interaction Region Optics for LHC Operation and Future Hadron Colliders’ and introduces a novel method that uses the thin lens approximation to find the optimum final focus triplet for a given set of constraints. This method is used to improve the final focus section of the Future Circular Collider and the NICA collider and to design a complete interaction region for the High Energy LHC. The research also includes an improved ballistic alignment optic that was used for LHC commissioning as well as new methods and findings to improve the k-modulation measurements in the LHC's interaction region. Léon will be continuing on the Future Circular Collider Project as a CERN fellow starting in summer 2019 where he will be working on the lepton collider.

Phil Burrows
Particle Accelerators and Beams Group Annual Meeting

On Friday 26 April 2019, the Rutherford Appleton Laboratory (RAL) hosted the Particle Accelerators and Beams Group (PABG) Annual Meeting. The event was held in the new RAL Visitor Centre and attracted a total of around 80 attendees representing the breadth of the UK accelerator community.

After tea, coffee and pastries sponsored by AWE, the meeting began with an overview of recent UKRI and STFC activities from Grahame Blair, followed by updates from the directors of the John Adams Institute and the Cockcroft Institute. Stephen Gibson from RHUL then presented on progress at the LHC, covering High-Luminosity LHC, Future Circular Collider and beyond!

The morning session concluded with a talk by last year’s PABG prize winner, Richard Walker from Diamond Light Source. Richard chose 'Some Episodes in the History of UK Particle Accelerators (1933 - 1959)' as his specialist subject and delighted the audience with his insights into the early days of accelerator development, debunking a few myths along the way and showing an aptitude for detective work.

The lunch break was sponsored by the Cockcroft Institute and featured a student poster competition and the Group AGM. The poster prize was won this year by Jenny Morgan from the University of Strathclyde for her work on orbital angular momentum in an FEL. The AGM included a report on group activities and finances presented by Jonny Smith the group treasurer. Of particular note was a welcome upturn in group membership, which now stands at just above 1,000.

The first speakers of the afternoon session were Catia Costa from the University of Surrey Ion Beam Centre and Andy Smith from the University of Manchester’s Dalton Cumbrian Facility. Their two talks were nicely complementary and provided a comprehensive introduction to ion beam capabilities in the UK. Deepa Angal-Kalinin from ASTeC followed with a summary of the first year of exploitation of CLARA, describing the excellent experimental results that have already been achieved and the potential for CLARA to be a unique test facility not only for the UK, but also for international collaborators.
Graeme Burt from Lancaster University talked about the successful crab cavity testing in the SPS at CERN (some of which was previously reported on in Newsletter Issue 17). Graeme pointed out that the UK led many of the key parts of these experiments, playing to a clear emerging strength.

Following on from the John Adams Institute sponsored afternoon coffee break Laura Corner from the University of Liverpool described laser development for future laser wakefield acceleration. Peter Williams from ASTeC then enthusiastically explained his ideas to use a recirculating linac with energy recovery to combine the best aspects of linacs and rings as the basis for a future X-FEL.

Rebecca Ramjiawan from the John Adams Institute presented her work on very low latency beam-based feedback system development for nanobeam control at ATF2. Kristina Small from the University of Manchester described Very High Energy Electron Radiotherapy experiments on CLARA and finally Öznur Apsimon (also from the University of Manchester) gave an overview of the AWAKE experiment to demonstrate electron acceleration in proton plasma wakefields.

Overall the meeting was a great success, with a number of participants commending the quality of the presentations and choice of speakers. All of the talks for the day can be found here.

The meeting closed with a reception jointly sponsored by ISIS and Diamond in the Atrium of Diamond House, where attendees were able to reflect on a stimulating day while enjoying canapés and a glass of wine (or fruit juice for those with a drive home still ahead of them).

Special thanks go to Trudi Gurney, David Posthuma de Boer, Sara Fletcher, Peter Hicks and Asim Yaqoob from ISIS and Ian Martin from Diamond for their help in organising the meeting.
Liverpool Hosts Symposium on Particle Colliders

Fundamental science benefits society in many ways, from generating knowledge about how our universe works, to enabling unexpected and often transformative applications. Particle accelerators have been at the centre of many of the most advanced research infrastructures for decades.

Future particle accelerators are expected to have a similarly bold impact on science and society. To showcase and discuss the technologies that are currently being developed within the global Future Circular Collider (FCC) study, almost 1,000 researchers and industrialists from across Europe, university students and high school children participated in ‘Particle Colliders – Accelerating Innovation’, an international science symposium that took place in Liverpool on Friday 22 March 2019.

The event, which was co-hosted by the University of Liverpool and CERN together with partners from the Future Circular Collider and EuroCirCol projects, investigated the opportunities that the next generation of colliders can offer to industry, scientists and society.

In January 2019, CERN published the conceptual design report for the Future Circular Collider (FCC), a potential successor to the Large Hadron Collider (LHC), which aims to be four times larger and seven times more powerful, enabling it to reach unprecedented energy levels.

Making the connection between fundamental science and economic value is often difficult to quantify, but the FCC collaboration demonstrates a novel example of how particle accelerator technology is helping to verify the authenticity of honey in its latest film, Busy Bees and Mighty Magnets.

The symposium in Liverpool was live-streamed to institutions across Europe and the talks from world-leading researchers are now available to watch via the event website. The event featured an industry exhibition with dozens of companies exhibiting their latest products, a careers fair exclusively for Liverpool physics undergraduate students and a number of interactive demonstrations for hundreds of high school students.

Left - Dr Michael Benedikt (FCC/CERN) presenting on how the realisation of a next generation of particle collider calls for a major global training, technological and industrial programme. Right - The event featured a number of interactive demonstrations for hundreds school students. (Credit: University of Liverpool)
A highlight for the hundreds of visually impaired (VI) and sighted students attending was a demonstration of the world’s first interactive ‘Tactile Collider’, which uses touch together with real sounds from the LHC to create an immersive experience (see also article on page 14 of this newsletter). There was further support on offer to make the event inclusive for VI children, e.g. through a narrator in the audience who explained all content shown on slides via Bluetooth headsets – the first time this was offered at an accelerator science event. Delegates also had the chance to play proton football and interact with visualisations of themselves in two different universes within CERN’s interactive Large Hadron Collider Tunnel.

A technology-transfer workshop followed in the afternoon for industrialists and researchers from across Europe to develop ideas together to solve global challenges. It further strengthened links between industry and academia, and paved the way for future collaborative projects.

Riccardo Torres

**Manjit Dosanjh appointed Visiting Professor at the John Adams Institute, Oxford Physics Department**

Manjit Dosanjh is Senior Advisor for Medical Applications at CERN. She is an experienced molecular toxicologist in mechanisms of cancer resulting from environmental exposure and damage. She graduated in biochemistry/chemistry and holds a PhD in Biochemical Engineering from the UK. After her post-doctoral position at MIT, she has held positions at LBNL Berkeley, as BEST Professor at Jackson State University, and as visiting professor at the Universities of Padua, Cagliari and Surrey. Since joining CERN in 2000, she has focused on applying the technologies developed for particle physics to the life sciences domain. She played a key role in launching the European Network for Light Ion Hadron Therapy (ENLIGHT), a multidisciplinary platform that takes a collaborative approach to particle therapy research in Europe, and she been the coordinator of the network since 2006.

In addition, she is actively involved in helping non-profit health and science education and gender related organisations in Geneva and is the UN representative for GWI (International Federation of University Women) and a member of the Task Force for NGO-CSW Geneva Beijing+20 Platform. She is on the board directors of International Cancer Expert Corps (ICEC), an NGO working on improving cancer treatment in low and middle-income countries (see article on page 12 of this newsletter).

Prof. Phil Burrows, Interim JAI Director, said: ‘We are thrilled to have Manjit join us in Oxford. She brings immense expertise and experience in radiobiology, not least in accelerator-based delivery. This will strengthen significantly the UK’s capability in both current and future beamline therapy systems for applications both at home and in challenging environments overseas.’
Accelerating the Future: Designing a Robust and Affordable Radiation Therapy Treatment System for Challenging Environments

The 4th Conference to coordinate efforts to design and develop an affordable and robust yet technically sophisticated linear accelerator-based radiation therapy treatment (RTT) system was held in Gabarone, Botswana on March 20 - 22, 2019. The conference was sponsored by STFC with funding from the UK Global Challenges Research Fund (GCRF) and supported by CERN and the International Cancer Expert Corps. Three members of the Cockcroft Institute, Prof Graeme Burt (Lancaster University), Prof Peter McIntosh (ASTeC/STFC) and Dr Deepa Angal-Kalinin (ASTeC/STFC), and two members of the John Adams Institute, Prof Manjit Dosanjh and Dr Suzie Sheehy, attended the workshop.

All too often, conferences related to creating a new programme or technology to improve the care of patients with cancer or other conditions in Low and Middle-income Countries (LMICs) are held in major world cities; New York, Geneva, London. Convening this conference in Gabarone enabled a significant number (over one half of the attendees) of physicians, physicists and staff from Sub-Saharan Africa and other LMICs to attend, present their reports and interact with the scientists working with them in their own region of the world, thereby generating a sense of a global community working toward a common goal. It also allowed participants to visit hospitals, both private and public, in Gabarone to see the conditions under which the robust and modular RTT system will be used. The visiting participants left Gabarone with a much better understanding of the challenges faced by those treating patients with cancer in LMICs and a much stronger commitment to work with their colleagues to develop the new RTT systems that they need. Currently in the lowest income counties within Africa, only 4% of cancer patients that require radiotherapy are actually able to receive it. About 80% of the available machines are found in just six countries: South Africa, Egypt, Morocco, Tunisia, Nigeria and Algeria. The annual global incidence of cancer is projected to rise 25 million cases (13 million deaths) by 2035 with 65 - 70% occurring in LMIC.

This workshop built upon two prior workshops held at CERN in November 2016 and October 2017, and one in Manchester UK in March 2018. LMIC countries with participating representatives included, Botswana, Ghana, Jordan, Kenya, Nepal, Nigeria, Tanzania, Zambia, and Zimbabwe. Expertise included accelerator and medical physicists, engineers, oncologists, and healthcare management representatives.
To set the stage for the discussion to advance the design work, there were background presentations on current linear accelerator treatment systems with a review of the relevant challenges identified in the prior workshops; an overview of radiation therapy treatment techniques and treatment planning systems; an overview of the major sub-systems of medical linear accelerators and their shortfalls, and new developments in artificial intelligence (AI) and machine learning as it can apply to radiation therapy. Opportunities to improve the performance of radiation therapy treatment systems with new technologies were summarised.

As radiation therapy is delivered within a system of care, presentations were given on education, training and technical support needs, the various programmes that were available, and on the continuing unmet needs in these areas, with several sessions focusing on medical physics. Technological solutions to support long distance mentoring and technical support to compensate for shortages of staff and expertise were discussed.

The workshop concluded with a summary of progress, priorities to be addressed, and next steps.

Manjit Dosanjh
Senior Advisor for Medical Applications at CERN and Visiting Professor at the University of Oxford, John Adams Institute.
Tactile Collider Wins EPS European Award for Outreach

The communication of the science and engineering we do in our field has never been more important, with the aim of explaining our scientific progress and involving as many people as possible in our scientific debates. Tactile Collider is an STFC-funded project which has tackled communication to under-represented audiences head-on, creating a new model of scientific communication and a travelling event to teach visually impaired audiences about accelerator physics and the Large Hadron Collider. Tactile Collider was created by Rob Appleby and led by Rob, Chris Edmonds and Robyn Watson, and these three have just won the European Physics Society Outreach prize for 2019. The citation for the award is ‘To Rob Appleby, Chris Edmonds and Robyn Watson for the Tactile Collider Project that brings particle physics to blind and visually impaired schoolchildren through touch and sound’. The Award Ceremony will take place on Monday morning, July 8 during the EPS-HEP Conference in Ghent, Belgium.

In an invited plenary talk at IPAC19 in Melbourne in May 2019, Rob talked about the importance of communication and diversity in our field, and the need for collaborative research. He talked about the new communication model developed by the Tactile Collider Project, which gives a framework to communicate to visually impaired and other under-represented audiences. He pointed out that this model not only helps us reach a VI audience but also improves our communication to all audiences.

Rob Appleby

European Strategy for Particle Physics Update (ESU)

The European particle physics (PP) community is in the process of updating its strategy with a forward look over the next couple of decades. The last strategy update was in 2013 when the two main scientific recommendations with implications for the accelerator field were:

Europe’s top priority should be the exploitation of the full potential of the LHC, including the high-luminosity upgrade of the machine and detectors with a view to collecting ten times more data than in the initial design, by around 2030. This upgrade programme will also provide further exciting opportunities for the study of flavour physics and the quark-gluon plasma.

CERN should undertake design studies for accelerator projects in a global context, with emphasis on proton-proton and electron-positron high-energy frontier machines. These design studies should be coupled to a vigorous accelerator R&D programme, including high-field magnets and high-gradient accelerating structures, in collaboration with national institutes, laboratories and universities worldwide.
Both of these recommendations have been implemented vigorously, and the PP community met in May 2019 in Granada for an open symposium to review the status of the field and discuss the next steps. A number of large accelerator projects are in consideration.

Based on the views expressed in Granada there seemed to be a strong physics-based consensus that the next global PP project should be an electron-positron collider to serve as a factory for producing Higgs bosons and top-quarks. Such a facility would enable precision measurements that can test the Standard Model (SM) at the (sub-)1% level for the majority of Higgs-boson couplings, and, via Higgs, top-quark and other precision measurements, have sensitivity to beyond-SM effects at mass scales of up to many tens of TeV for some new-physics models. There seemed to be consensus that this could be the best way to make progress on elucidating the mass scale of new particles that could then be investigated via direct production at a possible future high-energy proton-proton collider.

There are several e+e- collider options on the table: the International Linear Collider (ILC) proposed for realisation in Japan; the Compact Linear Collider (CLIC) and the Future Circular Collider (FCCee), both proposed for implementation at CERN; the Circular e+e- Collider (CEPC) proposed as an option for realisation in China. Options were also presented for a future hadron collider in Europe (FCCpp) and in China (CppC), involving a 100 km-circumference tunnel, which could also be used to house the FCCee and CEPC respectively. The energy and luminosity capabilities of these machines, their corresponding physics potential, and their cost, were discussed with gusto at the Granada symposium.

Looking even further ahead, discussion included the application of plasma-based, high-gradient wakefield-acceleration techniques towards a very high-energy electron-positron collider. There was also discussion of the intriguing idea of a muon collider that could potentially be housed eventually in the LHC tunnel.

The next step in the ESU process is for the production of the ‘Briefing Book’ that summarises the parameters and status of the colliders listed above, as well as other proposed projects, along with their physics potential. Caterina Biscari, Lenny Rivkin, Frank Zimmerman and I have been charged with producing the accelerator section of the Briefing Book, based on the formal submissions to the ESU and the discussions in Granada. The aim is to have this completed by early September for approval by CERN Council. The Strategy Group, comprising representatives from CERN member and observer states, will then use the Briefing Book as input for their deliberations in Bad Honnef in January 2020. A draft ESU should emerge for formal consideration and ratification by CERN Council in Spring 2020. Watch this space …

Phil Burrows

John Adams Institute Interim Director
Scientific Secretary for Accelerators to the ESU Preparatory Group
**International Calendar**

39th International Free Electron Laser Conference (FEL 2019)  
Hamburg, Germany, 25 - 30 August 2019  

North American Particle Accelerator Conference (NAPAC 2019)  
Lansing, MI, USA, 1 - 6 September 2019  
[https://www.frib.msu.edu/events/2019/napac19/index.html](https://www.frib.msu.edu/events/2019/napac19/index.html)

OMA International Conference on Medical Accelerators and Particle Therapy  
Seville, Spain, 4 - 6 September 2019  
[https://indico.cern.ch/event/803528/](https://indico.cern.ch/event/803528/)

8th International Beam Instrumentation Conference (IBIC 2019)  
Malmö, Sweden, 8 - 12 September 2019  

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](https://www.helmholtz-berlin.de/events/erl19/index_en.html)

22nd International Conference on Cyclotrons and their Applications (CYC 2019)  
Cape Town, South Africa, 22 - 27 September 2019  
[https://indico-jacow.cern.ch/event/14/](https://indico-jacow.cern.ch/event/14/)

International Conference on Accelerator and Large Experimental Physics Control Systems (ICALEPCS)  
New York, NY, USA, 7 - 11 October 2019  
[https://www.icalepcs.org/](https://www.icalepcs.org/)

3rd AVA Topical Workshop: Machine-Experiment Interface  
COSyLAB, Slovenia, 10 - 11 October 2019  
[https://www.liverpool.ac.uk/ava/events/workshops/3rd-ava-topical-workshop/](https://www.liverpool.ac.uk/ava/events/workshops/3rd-ava-topical-workshop/)
7th Accelerator Reliability Workshop (ARW 2019)
Guangzhou, China, 11 - 15 November 2019
https://www.accelerator-reliability.org/workshops-1/arw/

11th International Particle Accelerator Conference (IPAC 2020)
Caen, France, 10 - 15 May 2020
http://www.ipac20.org/

Upcoming schools

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

CAS@ESI: Basics of Accelerator Physics and Technology
Archamps, France, 7 - 11 October 2019
http://cas.web.cern.ch/schools/archamps-2019

Joint-US-CERN-Japan-Russia School on Ion Colliders
Dubna, Russia, 28 October - 7 November 2019
http://cas.web.cern.ch/schools/dubna-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/
IoP PAB Committee

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Dr. Melissa Uchida (Cambridge)
Dr. Peter Williams (STFC Daresbury)

Deadline for submissions to the next newsletter is 29 November 2019

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