NEWS letter

MIRROR

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Highlights

Dear friends of low energy antimatter physics,

Earlier this year the AEgIS collaboration announced that Positronium laser cooling was successfully demonstrated. This breakthrough-result opens the door to a whole range of precision studies that have not been possible up until now. In this MIRROR, we present this exciting result and the expected impact on the wider experiment and field. Big congrats to the entire team for this excellent result!

I was delighted to participate in the 2024 KoWi Annual Conference on EU Research & Innovation Funding, held from June 4-6 in Munich and attracting around 350 participants. The event provided an excellent platform for exchanging insights on EU Research and Innovation Funding. Having served on the KoWi Advisory Board since 2016, I found this event an ideal way to engage with experts and the broader community of EU advisors. It was a particular pleasure to participate in a high-level panel on knowledge valorisation, where we discussed the pathway to a European Innovation Area and the importance of knowledge transfer in research policy. This allowed me to report on the experiences we made in our AVA network, which in turn led to many interesting discussions.

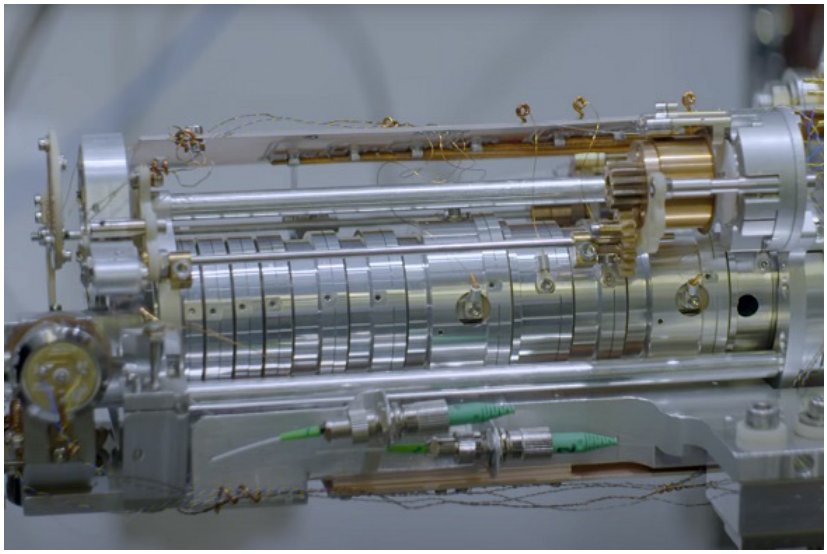
High quality science communication is key to informing the wider public about the latest research outcomes. Last week, I joined the Swiss NCCR Spin for their annual conference and gave a talk about the Do's and Don'ts of efficient science communication - and how one can analyze and understand the feedback provided by participant to further enhance existing outreach activities. Our AVA Fellows were strongly committed to outreach and their legacy lives on through these discussions, encouraging the next generation of scientists and engineers to follow in their footsteps.

Finally, the 2024 call for MSCA networks was just launched and the application deadline is in November this year. To me, MSCA networks are one of the best funding schemes available. They allow to re-imagine the best way of training cohorts of students, and to adapt structured training to the ever more quickly changing research landscape. If you would like to apply, you can find more information here.

Prof Carsten P Welsch, Editor

Research Updates

Unlocking the Mysteries of Antimatter: Positronium Laser Cooling Breakthrough



Photograph of the AEgIS antimatter trap (Credit: University of Liverpool)

The AEgIS experiment at CERN has made a groundbreaking advancement by successfully demonstrating laser cooling of positronium (Ps), an exotic atom composed equally of matter and antimatter.

This significant development, published in a paper in Physical Review Letters ,marks a pivotal moment in the exploration of the fundamental symmetries of the universe.

Positronium, a unique atom made of an electron and its antimatter counterpart, the positron, stands out due to the absence of a hadronic nucleus, allowing for extremely precise numerical calculations of quantum states and transitions.

The transient nature of positronium, with its constituents usually annihilating each other in few hundred nanoseconds, along with their high velocities, has traditionally posed a formidable challenge to scientists attempting to experimentally study its properties.

The recent breakthrough by the AEgIS collaboration overcomes these challenges by employing broadband laser cooling. This technique, which involves the transfer of momentum from specifically tailored laser light to the positronium atoms, allows for the cooling of the entire positronium ensemble in the direction of the laser. This approach differs from more selective narrow-band Doppler cooling methods and represents a significant innovation in the field.

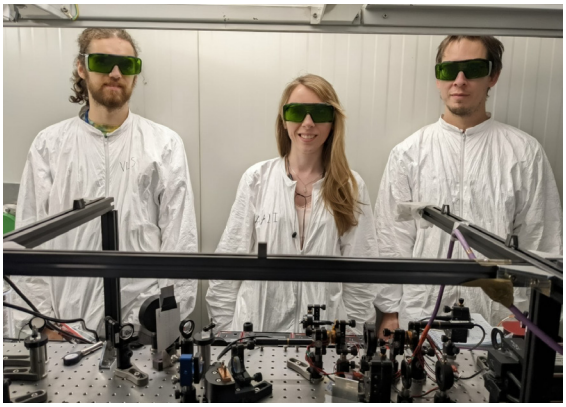
Dr Benjamin Rienäcker, newly-elected AEgIS Physics Coordinator from the University of Liverpool's QUASAR Group, said: “The implications of this achievement extend beyond the technical success of laser cooling positronium. It paves the way for more accurate measurements, crucial for advancing our understanding of antimatter and its role in the universe. I expect this breakthrough to enable new experiments, offering fresh insights into the cosmic matter-antimatter imbalance and the fundamental building blocks of the universe.”

The successful laser cooling of positronium significantly enhances the AEgIS experiment's efforts towards antihydrogen formation as well as opening up entirely new pathways for precision experiments in Quantum Electrodynamics and tests of the Equivalence Principle with positronium. Furthermore, it enables the formation of positronium beams and the exploration of Bose-Einstein condensates, expanding the scope for inertial tests and studies on macroscopic quantum objects.

Dr Ruggero Caravita, spokesperson for the AEgIS collaboration, has been awaiting this result for almost a full decade: “When I witnessed the first atomic excitation of positronium at AEgIS back in 2015, I knew we could be the ones to achieve this more than thirty years old dream of antimatter physicists. It has now become reality, thanks to the efforts of everybody involved.”

Professor Carsten P Welsch, who leads the University of Liverpool contribution to AEgIS, added: “By exploring the properties and behaviour of exotic atoms like positronium, we are advancing our knowledge of fundamental physics at the same time as opening doors to technological innovations with potentially much wider applications. This fantastic result is testament to the excellent teamwork and collaboration within AEgIS.”

More information can be found in the **full article**.



From right to left, Benjamin Rienäcker, Natali Gusakova and Valts Krumins, three of the main authors of this study, standing by the alexandrite-based Q-switched pulsed laser used to cool positronium. (Credits: Antoine Camper)

Full article:
Positronium Laser Cooling via the 13𝑆-23𝑃 Transition with a Broadband Laser Pulse, L. T. Glöggler et al. (AEgIS Collaboration),Phys. Rev. Lett. 132, 083402 – Published 22 February 2024 https://doi.org/10.1103/PhysRevLett.132.083402

Complex performance test at low temperature: test setup of a SIS100 section delivers successful results

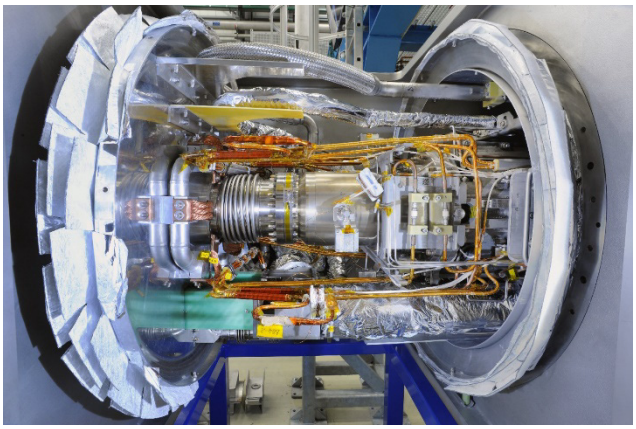
Recently, ground-breaking progress has been made at the large FAIR ring accelerator SIS 100: A section of the cryogenic part of the SIS100 was built at the STF series test facility on the GSI/FAIR campus and then tested for the first time at the required operating temperature of -269 degrees Celsius. This decisive step, the so-called string test, marks an important final milestone in the construction of large superconducting circular accelerators.

It is mainly used to test the interfaces and the smooth interaction of various components, especially in the interconnection area of the cold masses. The string test is the most important milestone for design verification and performance before the actual installation begins.

The setup now realized at the STF corresponds to a continuous section of the SIS100 arc, consisting of two dipole modules and a one quadrupole module. Other important and technically sophisticated cryogenic components of the local cryogenic system, such as the bypass lines and the end boxes that terminate each arc, are also part of the setup.

Cryogenics plays a crucial role in the FAIR project. Superconducting magnets are used in the SIS100 ring accelerator to guide the extremely fast particles and at the same time create an extremely low residual gas pressure (vacuum) in the beam tube. Superconductivity can only be achieved with the aid of highly developed cryogenic technology. For operation, it must maintain the required ultra-low temperature along the magnet chains in the entire ring system of the SIS100.

All modules include technologically highly advanced, cutting-edge components. In particular, the electrical current used to generate the beam-guiding magnetic fields passes through special superconducting cables. To cool these cables and the so-called cold magnetic masses, liquid helium is transported via a hydraulic system and distributed in parallel cooling circuits. Near the operating temperature of -269 degrees Celsius the electrical resistance in the cables collapses and superconductivity is established. Therefore, a key question to be investigated in the string test is whether the cooling in the parallel circuits is sufficient to maintain superconductivity in every operating state. Similar balancing is required in the parallel cooling circuits as in a conventional heating system. The hydraulic resistance must be set so that a sufficient mass flow is guaranteed in each of the parallel cooling circuits without the pressure in the overall system decreasing too much.



End cap: Connection area of the bypass line with the superconducting magnet system (credit: GSI/FAIR)

Each individual unit was tested extensively by the manufacturers and approved by the SIS100/SIS18 sub-project at GSI/FAIR. Only the interconnection areas of the large superconducting modules established with the assembly of the string test could not be tested in advance.

These interconnection areas are exposed to high forces and stresses. Particularly at the required test pressure of 28 bar, high lateral forces are exerted on the process lines, which must be absorbed by suitable supporting structures. The length contraction of the cold masses of the single modules also has an effect in the connecting areas and must be adequately taken into account in the design in order to prevent damage to the components.

During the assembly of the string test, the various work steps were carried out and documented for the first time. The processes that will also be crucial for installation in the SIS100 tunnel include, for example, welding the process lines, closing the cryogenic vacuum system and soldering the superconducting cables. Each of these work steps was documented on the basis of the string test setup in the form of work instructions, test plans and test protocols for the subsequent tunnel assembly. The assembly was carried out in collaboration with engineers experienced in accelerator assembly from the Institute of Nuclear Physics at the Polish Academy of Sciences (IFJ PAN) in Krakow.

The string test setup has led to numerous important findings with regard to the assembly capability of the units and their design. The findings are used for final design optimization. Even in the first thermal cycle (test run with regular temperature changes, heating and cooling), it was possible to supply all magnets with power as intended in the SIS100 in the future. Even when operating at full power (maximum ramp rate and electrical current), stable operation of the superconducting magnets was observed without quenching (sudden, undesired transition of a superconductor to the normal conducting state).

Other key design requirements and cooling concepts were also demonstrated for the first time in a larger vacuum area. The chamber walls of the ultra-high vacuum system, cooled to -263 °C, functioned as planned as a "super pump" and were able to generate a pressure of less than 10^{-12} mbar by freezing out the residual gas particles.

The string will be analysed in detail over the next few months in many thermal cycles. The so-called cross-talk between the individual circuits of the main magnets also plays an important role. The interaction of the circuits via their electromagnetic fields must be sufficiently small so that the precise course of the currents in the acceleration process is not disturbed. Even with the planned rapid current changes (ramp rate of up to 29,000 amperes/second) and electrical currents of up to 13,000 amperes, the precision of the currents must not deviate from the target value by more than 0.01 per cent at any time.

The available results suggest that the SIS100 can be set up as planned. The expert MAC (Machine Advisory Committee), responsible for advising on the technical design and operation of the FAIR facility, has classified the completion of the string test as an important step forward in the project.

This article is based in an article published on the GSI/FAIR website. The original article can be found here

News from the Antimatter Community

CAS40 - A look back at forty years CERN Accelerator School

The CERN Accelerator School turned 40. (Credit: CERN)

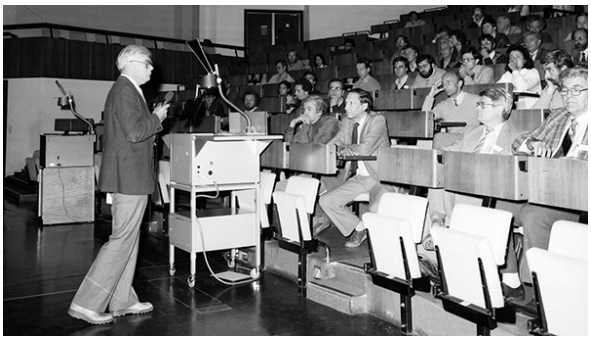
Research infrastructures require the world to work together on the design, construction, operation and subsequent optimization of these facilities to fully exploit their discovery potential. Scientists and engineers are working together across country borders, research disciplines, building bridges also between cultures, genders and generations. Sharing knowledge enables collaborations among researchers, leading to the formation of new ideas and research projects.

These are the ideas that brought up the first course of the CERN Accelerator School (CAS) forty year ago, in October 1983. Held at CERN, the course had the purpose of the communication of deep knowledge and the cultivation of teamwork during an era when significant progress could still be achieved by a single inventive scientist.

Four decades ago, the landscape of accelerator physics was vastly different from today's high-tech reality. Communication relied on telephones, faxes, and letters, with information primarily found in published books or conference proceedings.

Lectures at that time were based on hand-written transparencies, sometimes pictures and sketches, or transparency copies from books.

A key factor to the school's success has been its innovative educational approach and the flexibility to adapt to new learning processes. Participants attend lectures delivered by selected lecturers, including some of the world's foremost experts in accelerator physics, who willingly share their knowledge and insights in an engaging and accessible manner.



The first CAS course in October 1983 "Antiprotons for colliding beam facilities" being introduced by Kjell Johnson, with Simon van der Meer in the front row. (Credit: CERN PhotoLab 300-10-83)

CERN celebrated this special anniversary with a special CAS40 Week in September 2023, which featured a diverse range of activities. The central point of engagement was the CAS stand, strategically positioned in Restaurant 1, which showcased the school's history, achievements, and its mission to advance accelerator technology education. This visual display was not only informative but also served as a conversation starter for attendees interested in the world of particle accelerators and their applications. A particularly exciting highlight of CAS40 Week was a special concert scheduled for the 14th of September during lunchtime. This concert, organised in collaboration with the CERN Music Club, promised to be a celebration of both the school's milestone and the power of networking within the CERN research community.

Another event in January 2024 honoured the dedicated lecturers, hands-on professionals and collaborators that come to CAS from CERN and from various institutes worldwide who have contributed all these years. A special award went to Piotr Kowina, from GSI and to Massimo Ferrario, from INFN.

Many of the current lecturers at CAS were once students and newcomers themselves. Now, they are recognised professors with successful careers and continue supporting the school and its specialised group of lecturers.

Prof Carsten P Welsch, AVA Coordinator and Head of the Accelerator Physics Cluster at the University of Liverpool, said: "I had the pleasure of joining several CAS at the start of my career, before becoming a CAS lecturer years later. The fantastic atmosphere found at each School made it much easier to learn the, at times very difficult, material. The schools were undoubtedly key for fascinating me for the world of accelerators. A number of the friendships I made at CAS have become excellent scientific collaborations and large-scale projects. Happy birthday, CAS!"

Over CAS' 40 year-long history, more than 6000 accelerator students and professionals have been trained, over a hundred accelerator schools have been held, and over forty publications have been carefully and rigorously compiled. Many of its alumni have gone on to play crucial roles in the development, construction, and operation of particle accelerators around the world.

Today, any new accelerator is the result of international collaborations featuring many individual contributions. CAS promotes this development concept by fostering collaboration right from the start of the initial courses, ensuring that students engage in teamwork and maintain the connections forged during the courses throughout their careers.

Benjamin Rienäcker becomes AEgIS Physics co-ordinator

At the AEgIS collaboration meeting in December 2023, Benjamin Rienäcker was appointed as the Physics Coordinator for the AEgIS collaboration.

Of the 50-person AEgIS collaboration, a team comprising approximately of one-fifth is present on average on the CERN-site all of the year talking data. As the Physics Coordinator, Benjamin will play a role in managing the antiproton beam time that lasts for half a year, during which all antiproton physics endeavours must be executed. Drawing from past experience, Benjamin emphasizes the importance of clearly defined physics goals and a good understanding of measurement procedures. This approach allows sufficient time for apparatus debugging and, more intricately, analysis of measurement backgrounds.

This challenging role demands solid knowledge of the experimental apparatus, extensive experimental experience, and a deep understanding of the data analysis process. Proficiency in reading signals and signal-to-noise ratios is crucial for extracting meaningful physics insights. Benjamin underlines the significance of teamwork and organisational skills needed, with the right team members available when needed throughout the year. Managing diverse physics goals, including the antiprotonic ion program, antihydrogen beam and gravity objectives, as well as R&D activities, are key aspects of the role.

Reflecting on more than eight years of experience at AEgIS, Benjamin acknowledges the varying approaches of past Physics Coordinators. He sees the role as an intriguing challenge to coordinate the Physics Programme for the collaboration, fostering team spirit and meeting the expectations of both the collaboration and the broader scientific community.
Benjamin said: "I am excited about the opportunity to lead and communicate effectively within this dynamic and diverse collaboration. I am committed to giving my best, facilitating growth as a leader, and contributing to the continued success of AEgIS."

Dr Benjamin Rienäcker

Bridging Science, Philosophy, and Faith at Liverpool Cathedral

The panel members at the 'Beyond Boundaries: A Dialogue on Science and Faith'.

The University of Liverpool and Liverpool Cathedral hosted the public event 'Beyond Boundaries: A Dialogue on Science and Faith' at the famous Liverpool Cathedral on 5th March 2024.

The event also celebrated the Liverpool Cathedral's centenary since its consecration as a place of worship in 1924.

The event formed part of the next large collider project at CERN, the Future Circular Collider (FCC). The goal of the FCC is to push the energy and intensity frontiers of particle colliders, with the aim of reaching collision energies of 100 TeV, in the search for new physics. The FCC study is an international scientific collaboration of more than 130 institutes, including the University of Liverpool, and is led by CERN.

Accelerator physicists, particle physicists and theologians got together to discuss the common ground between science, philosophy, and religion. This event was open to all people and was not restricted to any particular faith.

On the panel was Revd Canon Scientist Dr Mike Kirby, a medical physicist at the University of Liverpool who balances his work in cancer therapy with his work as a priest at Liverpool Cathedral. "We are delighted to be hosting this Science and Faith event again, after the inaugural one in 2022. Organised by Liverpool University Physics Department and ourselves, it is a great opportunity to bring together world renowned scientists and theologians, as well as local experts; people of faith and none in conversation on topics which are of interest and an inspiration for all of us to encounter."

Further panel members included Professor John Ellis from Kings College London, Alex Bainbridge, physicist from STFC/ASTeC, Dr Kate Shaw from the University of Sussex and Professor Andy Beavis from Vertual Ltd., alongside Father Andrew Pinsent, Research Director at the Ian Ramsey Centre for Science and Religion, University of Oxford, and Professor Elaine Howard Ecklund, Director of the Religion and Public Life Program in Rice's Social Sciences Research Institute.

Revd Canon Dr Mike Kirby and Professor Andy Beavis during the discussion.

The discussion was moderated by distinguished scientist and STFC Council member, Professor Carsten P Welsch, head of the accelerator physics cluster at the University of Liverpool, based at Cockcroft Institute. Prof Carsten Welsch explained: “When you look up into the night sky you then realise how tiny we are and at the same time there is 95% of the universe where fundamentally we have no idea what is going on. So, we have concepts like dark matter, dark energy but really in the end of the day we do not have a full understanding of nature and the big question of what is driving us as humans everyday”.

The panel discussion explored amongst others how attitudes towards the intersection of science and religion vary across different cultures and societies and the role that scientists and religious leaders should play in building trust in science among religious communities.

The panel members during the discussion.

The audience had the opportunity to ask the panel stimulating questions and generated a lively and thoughtful discussion.

Earlier in the day more than 100 school children had the opportunity to visit the Liverpool Cathedral and participate in the physics education event: ‘Shining a Light on Particle Physics and Accelerators’. Scientists from STFC, the University of Liverpool, the University of Manchester and the NHS gave talks and showcased demonstrations of particle accelerators and radiotherapy systems. Alex Bainbridge from STFC presented an insightful talk through a virtual tour of the CLARA particle accelerator in Daresbury. There was also a live virtual tour of the UKRI-STFC Boulby Underground Laboratory which is located over 1 km underground!

A video of the panel discussion is available on YouTube: https://youtu.be/xIX0VU5WYq8

Klaus Blaum elected new member of the Leopoldina

The Presidium of the "German Academy of Sciences Leopoldina - National Academy of Sciences" has elected Prof Dr Klaus Blaum, Director at AVA partner the Max Planck Institute (MPI) for Nuclear Physics and Head of the "Stored and Cooled Ions" Department, as a member in recognition of his scientific achievements and personality.

As a director at the MPI for Nuclear Physics, Klaus Blaum heads the department "Stored and Cooled Ions" and is a member of the Faculty of Physics and Astronomy at Heidelberg University. From 2020 to 2023, as one of three Vice Presidents of the Max Planck Society, he was responsible for the Chemical-Physical-Technical Section.

Prof Dr Klaus Blaum (© Stefanie Aumiller / Max-Planck-Gesellschaft)

He has received numerous awards for his groundbreaking scientific work with a focus on precision experiments on stored and cooled ions. These include the Lise Meitner Prize of the European Physical Society in 2020 and the Otto Hahn Prize of the City of Frankfurt am Main, the Society of German Chemists and the German Physical Society in 2021. He has twice gained an Advanced Grant from the European Research Council. In 2019 he was accepted as an external member of the physics class at the Royal Swedish Academy of Sciences and in 2022 he was admitted to the Heidelberg Academy of Sciences.

The Leopoldina originated in 1652 as a classical scholarly society and now has 1,600 members from almost all branches of science. In 2008, the Leopoldina was appointed as the German National Academy of Sciences and, in this capacity, was invested with two major objectives: representing the German scientific community internationally, and providing policymakers and the public with science-based advice.

The Leopoldina champions the freedom and appreciation of science. It promotes a scientifically enlightened society and the responsible application of scientific insight for the benefit of humankind and the natural world. In its interdisciplinary discourse, the Academy transcends thematic, political and cultural boundaries. It is also an advocate of human rights.

It is the role of the Leopoldina, in co-operation with other national and international organisations, to identify and analyse scientific issues of social importance. The Leopoldina presents its policy recommendations in a scientifically qualified, independent, transparent and prospective manner, ever mindful of the standards and consequences of science.

This article is based on an original article on the Max-Plank-Institut für Kernphysik Heidelberg website and can be found here

Professor Welsch contributes to APS March meeting

AVA Coordinator and QUASAR Group leader Professor Carsten P Welsch gave an invited talk on the *Physics of Star Wars* at the American Physical Society's (APS) March Meeting 2024.

The annual APS March meeting is one of the largest physics conferences. It brought together more than 13,000 physicists from around the world in Minneapolis between 3 – 8 March 2024. Participants showcased their work, connected with others, and discovered ground-breaking physics research. It was a very special meeting this year as attendees joined to celebrate the 125th anniversary of APS.

Professor Welsch giving his talk, credit: Christine Darve, ESS.

Professor Welsch's talk was part of a session on Science Communication and International Public Impact on Thursday 7th March, chaired by CMS Spokesperson Patricia McBride from Fermilab. The talk showcased how the iconic films were used to explain the application of particle accelerators to science, society and commerce. The session also included presentations on CERN's 70th anniversary communication activities, the social media activities of the ATLAS experiment, the highly successful APS *Physics Matters* colloquia, and the non-profit organization *Investing In People* in the Democratic Republic of Congo and the broader Central African region as examples of best practice.

In his talk, Professor Welsch described how each of his events reached hundreds of people on the day, and Millions around the world through media coverage. He gave an insight into the structure of his highly successful outreach events, presented the impact they have had and how this was assessed, and showed how the events have helped improve public awareness and understanding of accelerator technology.

By tapping into the universal appeal of Star Wars, Professor Welsch made complex physics concepts more relatable and inspired attendees to view the world around them through a lens of scientific inquiry. Over the years, the *Physics of Star Wars* events have had a significant impact on promoting public engagement with science. Through events, hands-on activities, material for science teachers and public lectures, Professor Welsch and his QUASAR Group have reached a diverse audience, from young students and aspiring scientists to lifelong fans of science fiction.

The talk was very well received by the international audience and Professor Welsch already received follow-on invitations to speak at the African School of Physics, the WOMAD Festival in the UK, and the Swiss National Centre of Competence in Research on Spin Qubits in Silicon.

More information about *Physics of Star Wars* can be found here.

Particle Physics and Accelerators Masterclasses 2024 at Daresbury Laboratory and Beyond

Daresbury Laboratory and the Cockcroft Institute (CI) have hosted the highly successful annual Particle Physics and Accelerators Masterclasses (APPMC), one of their flagship annual outreach events, for many years. The event aims to inspire and encourage future generations to pursue careers in physics, engineering, technology, clinical sciences, and therapeutic radiography.

This year marked a pioneering move as they expanded to host one event at Daresbury and another in partnership with the Science and Technology Facilities Council (STFC), the QUASAR Group from Liverpool University's Physics Department, and Liverpool Cathedral, introducing cutting-edge Physics research and development to the renowned Liverpool Cathedral. The Cathedral, celebrating the hundredth anniversary since its consecration in 1924, serves as a symbol of convergence—a site where worship, education, and presently, the exploration of scientific knowledge, intertwine.

Prof Carsten P Welsch presenting 'Why Anti-Matter matters'.

On March 5th, the educational physics event titled "Shining a Light on Particle Physics and Accelerators" took place, offering 100 sixth form students from schools and colleges across the region the chance to explore Liverpool Cathedral and learn about cutting-edge research and development in Particle Physics and Accelerators.

This unique initiative aimed to create a world-first experience – a Physics Masterclass conducted within the historic and inspiring environment of a cathedral.

Members of the QUASAR Group demonstrated key principles of accelerator physics and components.

The day's schedule was structured to offer a comprehensive learning experience, commencing with a welcome and introduction by the Revd Canon Dr. Mike Kirby, a Senior Lecturer in Radiotherapy Physics and Canon Scientist at Liverpool Cathedral. The Masterclass featured presentations from experts such as Prof Fred Loebinger, Prof Julia Handley, and Prof Carsten Welsch, covering topics ranging from the basics of sub-atomic particles and the application of Proton and Ion Beam Therapy all the way to research into antimatter. Additionally, the day included online tours, hands-on group activities, and virtual reality exploration of Radiotherapy using the VERT system. Attendees had ample opportunity to engage with experts, pose questions, and gain insights into the latest advancements in physics research.

This event, in addition to the Masterclass at Daresbury Laboratory, was strategically situated in the core of the Northwest and Merseyside regions, guaranteeing accessibility for schools and colleges in the vicinity.

The Masterclass in the morning was followed by the public event titled 'Beyond Boundaries: A Dialogue on Science and Faith', organized by the QUASAR Group. Accelerator physicists, particle physicists and theologians got together to discuss the common ground between science, philosophy, and religion. This event was fully booked and open to all people and not restricted to any particular faith.

Live virtual tour of the UKRI-STFC Boulby Underground Laboratory. (Image: QUASAR Group)

The feedback from the event was incredibly positive. Over 90% of the participants indicated that they would be interested in attending similar events in the future. One participant remarked, "I was not aware of many things that were discussed. This event was an eye opener for me and gave me more curiosity on everything relating to physics and the FCC." Another attendee added, "The discussions gave me a pause for thought on my scepticism towards scientists with deep religious faith. This caused me to consider looking at my own prejudices."

The second part of the APPMC was held on 12th March at Daresbury Laboratory and the Cockcroft Institute (CI). This year was the first time that this event was hosted on site since the start of the COVID-19 pandemic.

The CI welcomed more than 100 students and teachers from seven local schools to the lab. The day began with an opening talk by Dr Alex Bainbridge on the history and development of particle accelerators at Daresbury, followed by a talk on the science of electromagnetism. Live links followed with Boulby Underground Laboratory to learn about the experiments being conducted there. Students were then treated to guided tours of the CLARA particle accelerator, the VISTA laboratory, and the Dune detector manufacturing facility. They also participated in hands-on demos of vacuum science, superconductivity, and electrostatic acceleration and had the chance to discuss their future career options with graduates and apprentices.

The day was finished by a pair of quick-fire talks delivered by Dr Andy Blackett-May (on cryogenics) and Dr Calum Tollervey (on lasers), and a talk from guest lecturer Prof Fred Loebinger, who recounted the story of how quarks, gluons and the Higgs boson were discovered.

The masterclass was organised by Dr Alex Bainbridge (ASTeC) with support from Wendy Cotterill (Daresbury public engagement) as well as many volunteers from across the Cockcroft Institute.

Slovenia is ready for full CERN membership – and so is Cosylab!

The Chamber of Commerce and Industry of Slovenia (CCIS) is the national focal point for CERN and also the facilitator of Slovenian company cooperation with CERN.

At the Chamber, the group met with high-tech industry representatives, including those from AVA partner Cosylab, the world specialist in control systems and integration for particle accelerators.

Interestingly, Slovenian researchers' participation in CERN dates back to the 70s, during the time of the Yugoslav state, which was also one of the founders of CERN. Now, finally, Slovenia is in the process of upgrading its status as an associate member of CERN,the intergovernmental organisation that operates the world's largest and highest-energy particle collider, the Large Hadron Collider (LHC).

A working group from CERN visited the Slovenian government and research institutions to see whether Slovenia is ready for full membership.

Twenty Slovenian firms, with Cosylab among them, have already worked or procured for CERN, and interest is rising: the year 2023 was the most successful so far, with almost four–fifths of all Slovenia's CERN membership fee — approximately 1.7 million Swiss francs – returning to Slovenia in the form of contracts with Slovenian companies.

Charlotte Lindberg Warakaulle, Director of international relations at CERN, emphasised the importance of cooperation between industry, science and CERN, which can be a complex balancing act for new full-member states.

Rok Šabjan, Deputy COO of Cosylab, added, "Traditionally, in our country, the scientific and research part of participation with CERN was always strong. On the other hand, many commercial organisations did not recognise the advantages of collaborating with CERN. This is now changing for the better! As a global Big Science services and solutions provider for more than two decades, Cosylab recognised the business opportunities at CERN early on. For us, the main challenge now is increasing the share of Slovenian high value-added, complex services to CERN."

This article is based on an original article on the Cosylab website ad can be found here

The Globe at CERN. (Image: CERN/S.E. Bennett)

AEgIS Collaboration Meets in Poland

Delegates at the AEgIS collaboration meeting

The AEgIS collaboration recently held a successful meeting in Toruń, Poland, from May 6th - 9th, 2024. The meeting focused on updates and discussions on various research efforts.

The startup of all apparatus for the 2024 measurement campaign went rather smoothly, except for a minor misalignment issue with the electron gun flange. Positronium production remains lower than expected, potentially due to a strong magnetic field at low temperatures. This issue is being investigated. Also, a synchronisation error on the microsecond timescale was discovered in the method of setting the pbar-positron timing. This error likely hampered production in 2023 and points towards a much increased formation rate in 2024.

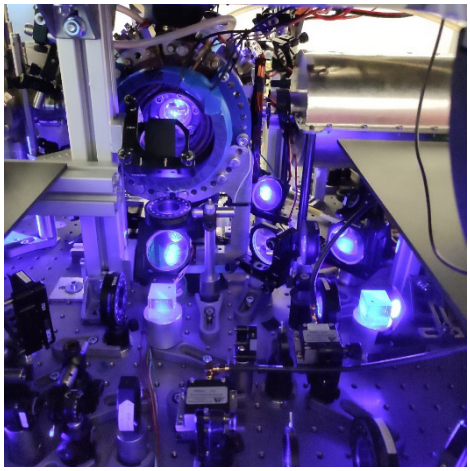
A new PhD student, Tassilo Rauschendorfer, who has previously been working as a Master's student with AEgIS, is now coming back to explore the application of machine learning in AEgIS research. Another new group, lead by Prof Christoph Hugenschmidt from the TU Munich and the research Reactor FRM-II, was also welcomed to the collaboration.

On the second day, Benjamin Rienacker outlined the AEgIS work packages of 2024, receiving positive and valuable feedback. Discussions on alternative ion cooling methods were held after encountering issues with the current iodine ion approach. Talks focused on the search for sexaquarks, portable pbar traps, and the Borealis project for future pbar cooling using C2- ions. Luca Penasa's presentation on 20kV high-voltage switches for improved pbar catching sparked significant interest.

This day concluded with a lab visit to the ion and atom labs at Toruń which fostered collaboration among postdocs and PhD students. Training sessions were also held on frequency combs, a crucial tool for precision spectroscopy in research.

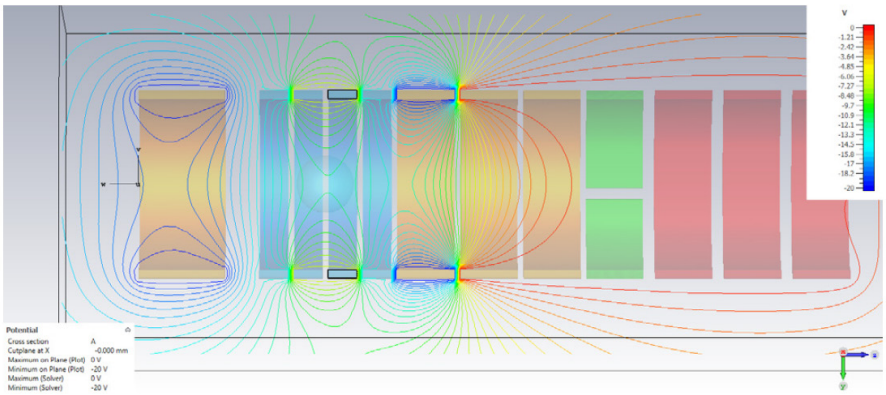
On the final day Stefan Haider presented an update on the Moire deflectometer project. Discussions were also held on magnetic field gradient cancellation techniques and an anti-gradient coil and ideas were presented for 1S-2S Ps spectroscopy.

The AEgIS collaboration meeting in Toruń proved to be a productive event, addressing technical challenges, highlighting research progress, and fostering collaboration within the team. The flagship goal of 2024 was set to achieve an intense antihydrogen beam leaving the apparatus towards the future Moire deflectormeter module outside the magnetic field. Alongside that, six journal publications about this progress are planned from the collaboration in 2024.



1000 cold glowing strontium atoms hovering in a trap.

Liverpool Researchers Contribute to IPAC24 with Antiproton Confinement Study



Simulation of field distribution in the AEgIS trap.

The 15th International Particle Accelerator Conference (IPAC'24), was held from 19th – 24th May 2024 in Nashville, Tennessee. The Music City Center hosted the prestigious event, bringing together the global particle accelerator community. IPAC is the world's largest conference dedicated to particle accelerator science and technology. This year's edition attracted over 1,200 attendees and 80 industry exhibitors, showcasing cutting-edge research in the field. The conference provided a platform for scientists and engineers to discuss the latest breakthroughs and challenges in particle accelerators.

The AEgIS collaboration was represented at the conference with a poster and paper prepared by Dr Bharat Rawat and colleagues from the QUASAR Group, University of Liverpool.

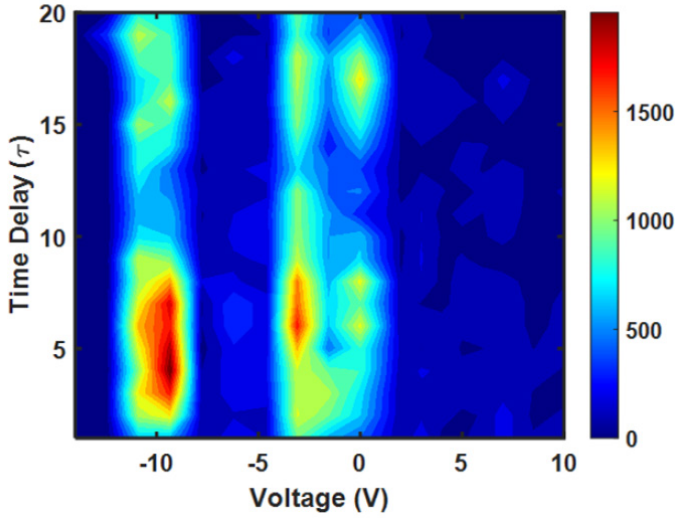
The AEgIS (Antimatter Experiment on Gravity, Interferometry and Spectroscopy) project, based at CERN's Antiproton Decelerator (AD) facility, has undergone significant enhancements, capitalizing on the increased quantity of colder antiprotons made available by the new Extra Low Energy Antiproton Ring (ELENA) decelerator. These improvements aim to create a horizontal beam and enable a direct investigation into the impact of gravity on antihydrogen atoms. This exploration seeks to probe the Weak Equivalence Principle for antimatter.

The study described the design and optimization of circular ring electrodes and an axial magnetic field used to trap antiprotons within the AEgIS experiment. The team utilized a series of electrostatic particle-in-cell (PIC) simulations to study the behaviour of trapped antiprotons. These simulations allowed them to generate a parabolic potential well to effectively confine the antiprotons, essential for subsequent experimental procedures.

The work involved creating a 3D model of the electrostatic trap and simulating the antiproton behaviour under different bias voltage settings applied to the electrodes. The researchers demonstrated that adjusting the potentials of the inner electrodes could control the density and stability of the trapped antiprotons. The results indicated zones of stable operation for effective antiproton trapping.

The findings of this research are important for setting and optimizing the operating conditions of the AEgIS trap, ensuring a stable and cold population of trapped antiprotons for creating antihydrogen atoms, required to pave the way for future research into the gravitational behaviour of antimatter.

The full paper is available via the following link: https://www.jacow.org/ipac2024/doi/jacow-ipac2024-wepr75/index.html



Maximum stable areas for different values of voltages and time delays.

Upcoming Events

Low Energy Antiproton conference announced

The next International Conference on Exotic Atoms and related topics and Conference on Low Energy Antiprotons (EXA/LEAP 2024) has been announced.

The conference, organised by the Stefan Meyer Institute of the Austrian Academy of Sciences, will run from 26th – 30th August in Vienna, Austria. This is the first joint conference of the LEAP and EXA series but both are established conferences attracting many researchers from around the world.

This conference will be an opportunity for the low energy antimatter community to come to together to discuss topics including Hadronic Physics with Antiprotons, Physics with Antihydrogen: CPT and Gravity, Exotic hadronic and leptonic atoms, Kaon-nucleus interaction and strangeness in nuclei, Exotic hadrons, Antimatter in the Universe and New Techniques, Instrumentation and Facilities.

Registration can be found at the conference Indico site here. Registration deadline is 1st August 2024.

ÖAW AUSTRIAN ACADEMY OF SCIENCES

Low Energy Antiproton conference announced

Following the success of the second Early Career Conference in Trapped Ions (ECCTI) in June 2022, a third edition of the conference series is being organised from the 7th to the 12th of July 2024 in Innsbruck, Austria.

The conference is aimed at early career researchers (PhD students and post-docs within 5 years of finishing a PhD) working with trapped ions, giving them an opportunity to present their work to a supportive international audience of peers.

The conference will focus on Atomic Clocks, Quantum Information & Computation, Quantum Simulation, Quantum Technologies, Antimatter Physics, Precision & Molecular Spectroscopy and Nuclear Physics

The conference will host a lecture by Nobel prize laureate, David Wineland, who received the prize for his pioneering work on ground state cooling of trapped ions and for opening the door to the experimental study of the interaction between light and matter.

More information about the conference is available here.

III rd EARLY CAREER CONFERENCE in TRAPPED IONS

Position Vacancies

Open positions at the University of Liverpool/The Cockcroft Institute:

The QUASAR Group offers several ***Fellowships and PhD positions*** over a range of projects.

Find out more

Events

7th – 12th July 2024	Early Career Conference on Trapped Ions (ECCTI), Innsbruck, Austria
25th – 30th Aug 2024	LINAC24, Chicago, USA
26th – 30th Aug 2024	EXA/LEAP 2024, Vienna, Austria
9th - 30th Sep 2024	13th International Beam Instrumentation Conference (IBIC24), Bejing, China
27th Oct – 1st Nov 2024	13th International Workshop on Positron and Positronium Chemistry (PPC13), Kanazawa, Japan
7th - 11th Sep 2025	14th International Beam Instrumentation Conference (IBIC25), Liverpool, UK

Notice Board

Help us communicate interesting events, updates and latest R&D in antimatter physics and send us your news and updates.

MIRROR – A newsletter for friends of antimatter physics

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