NEWS letter

MIRROR

Issue 20 September 2021

Highlights

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- Two-trap cooling by BASE promises antimatter precision
- AVA Fellow Interviews
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Dear friends of low energy antimatter and ion physics,

I am delighted to report that our final project report has been accepted by REA and that this brings the AVA project to a successful close. The Project Officer and our previous officers praised the work done in the project as *"very successful"* and said that they were *"very happy with the work done by the ESRs through their research projects."* Our project has been a wonderful journey and efficient frame for collaborative R&D. It has also set improved standards for the training of early-stage researchers as highlighted in the latest issue of *Accelerating News*. We will continue our wider communication activities for at least 2 more years and will also try to organize additional events to bring the antimatter community together once international travel will be back to normal levels, so watch this space!

ELENA is back in action. The ELENA ring at CERN has started delivering antiprotons at an energy of 100 keV to all low energy antiproton experiments. I am already looking forward to the exciting results coming from this run – they will certainly feature in our MIRROR. You can watch ELENA in action in this short video: https://youtu.be/BNd2c8tVWjw.

Bringing AVA science into the classroom: Based on our very successful outreach events, two articles have just been published in "Science in School" – the European journal for science teachers. The Physics of Star Wars highlights how cutting-edge science can be explained in an engaging format, whilst Build your own virtual accelerator allows students to gain a hands-on, immersive understanding of how particle accelerators work. Please feel free to share these resources more widely and help inspire the next generation of researchers.

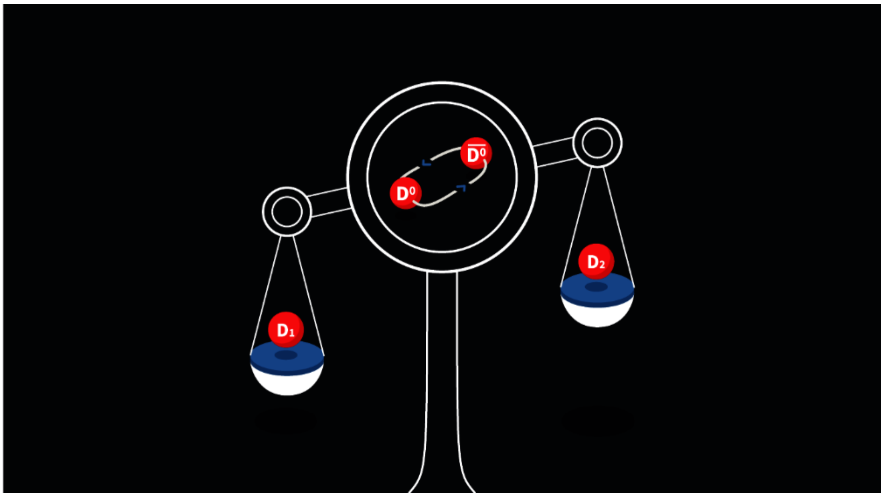
Enjoy this MIRROR and please do continue to send us your contributions!

With my very best wishes,

Prof Dr Carsten P Welsch
AVA Coordinator

Research News

Particle seen switching between matter and antimatter at CERN



The LHCb collaboration has measured the tiny mass difference between the D1 and D2 mesons, which are a manifestation of the quantum superposition of the D0 particle and its antiparticle. (Image: CERN)

Physicists have proved that a subatomic particle can switch between matter and antimatter, in a new discovery revealed earlier this summer. The extraordinarily precise measurement was made by UK researchers using the Large Hadron Collider beauty (LHCb) experiment at CERN. It has provided the first evidence that charm mesons can change into their antiparticle and back again.

Within Accelerators Validating Antimatter physics (AVA), the Innovative Training Network focuses on new scientific and technical developments in antimatter research. The pan European network, via 16 Fellows based at universities, industry and research facilities such as CERN and GSI, has enabled world-class research with low energy antiprotons.

For more than 10 years, scientists have known that charm mesons, subatomic particles that contain a quark and an antiquark, can travel as a mixture of their particle and antiparticle states. It is a phenomenon called mixing. However, this new result by the LHCb collaboration shows for the first time that they can oscillate between the two states.

Antimatter is sort of the “twin” of normal matter, but it’s surprisingly similar – in fact, the only real difference is that antimatter has the opposite charge. That means that if ever a matter and antimatter particle come into contact, they will annihilate each other in a burst of energy. To complicate things, some particles, such as photons, are actually their own antiparticles. Others have even been seen to exist as a weird mixture of both states at the same time, thanks to the quantum quirk of superposition. That means that these particles actually oscillate between being matter and antimatter.

And now, a new particle has joined that exclusive club – the charm meson. This subatomic particle is normally made up of a charm quark and an up antiquark, while its antimatter equivalent consists of a charm antiquark and an up quark. Normally those states are kept separate, but the new study shows that charm mesons can spontaneously switch between the two.

LHCb is one of the four large experiments at the LHC at CERN in Geneva, and is designed to study decays of particles containing a beauty quark. The primary goal of LHCb is to investigate matter-antimatter asymmetry known as the ‘CP violation’. Mesons are part of the large class of particles made up of fundamental particles called quarks, and contain one quark and one antimatter quark. The D0 meson consists of a charm quark and an up antiquark, and its antiparticle, the anti-D0, consists of a charm antiquark and an up quark. This measurement was made using LHCb’s Vertex Locator (VELO) subdetector. The design and construction of VELO was funded by Science and Technology Facilities Council, and led by physicists at the University of Liverpool.

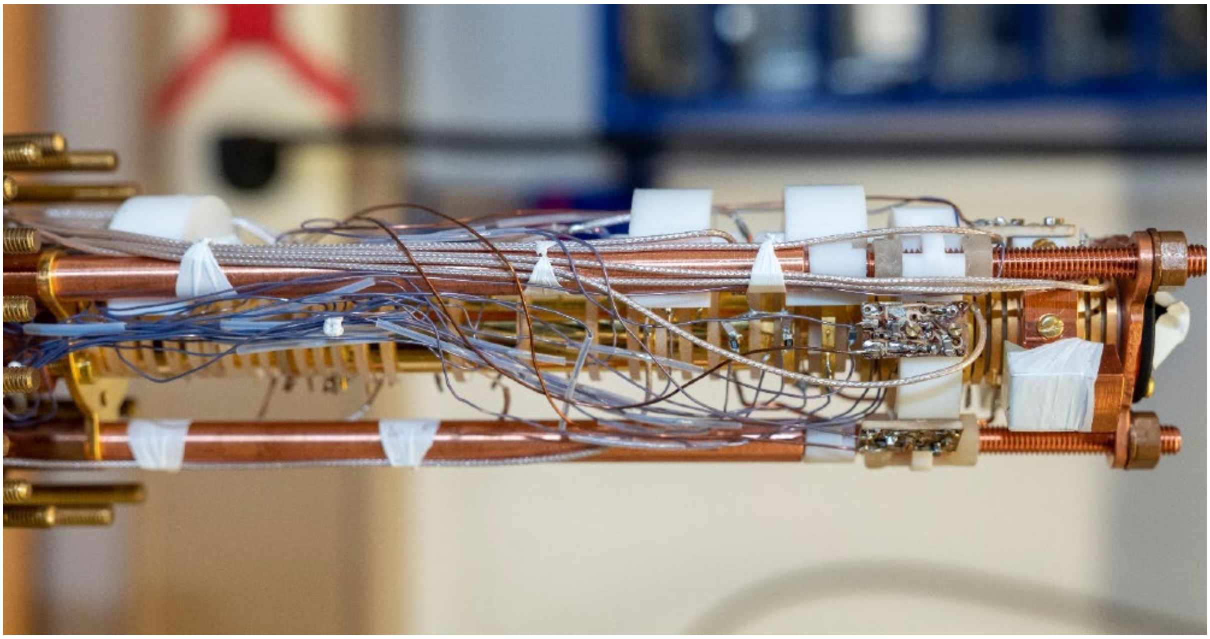
Using data collected during the second run of the Large Hadron Collider (LHC), researchers from the LHCb collaboration, with major contributions by physicists based at the Universities of Oxford and Warwick, measured a difference in mass between the two particles. There was a difference of 0.00000000000000000000000000000000000001 (1×10-38) grams. A measurement of this precision and certainty is only possible when the phenomenon is observed many times. Charm mesons are produced at the LHC in proton-proton collisions, and normally they only travel a few millimeters before they decay into other particles. By comparing the charm mesons that tend to travel further versus those that decay sooner, the team identified differences in mass as the main factor that drives whether a charm meson turns into an anti-charm meson or not. As the measurement is extremely precise, the research team ensured the analysis method was even more so.

This discovery of oscillation in the charm meson particle opens up a new and exciting phase of physics exploration. Researchers now want to understand the oscillation process itself, potentially a major step forward in solving the mystery of matter-antimatter asymmetry. A key area to explore is whether the rate of particle-antiparticle transitions is the same as that of antiparticle-particle transitions. And specifically, whether the transitions are influenced or caused by unknown particles not predicted by the Standard Model.

The result is a milestone in the study of how a particle known as a D0 meson changes from matter into antimatter and back. The research has recently been submitted to Physical Review Letters and is already available on arXiv. Further information can be found via the CERN website.

Further information:
Observation of the mass difference between neutral charm-meson eigenstates, LHCb collaboration, arXiv:2106.03744 [hep-ex]
https://arxiv.org/abs/2106.03744

Two-trap cooling by BASE promises antimatter precision



Cool experiment — The BASE collaboration's Penning trap where individual protons are cooled in the new two-trap cooling apparatus (Image: Stefan F. Sämmer/JGU)

In a significant technological advance for antimatter research, the BASE (Baryon Antibaryon Symmetry Experiment) collaboration has used laser-cooled ions to cool a proton more quickly and to lower temperatures than is possible using existing methods. The new technique, which introduces a separate Penning trap, promises to reduce the time needed to cool protons and antiprotons to sub-Kelvin temperatures from hours to seconds, potentially increasing the sample sizes available for precision matter-antimatter comparisons by orders of magnitude.

Within the AVA Network, R&D into beyond state-of-the-art beam handling, storing and analysis techniques paves the way for the design of novel low energy antimatter experiments. For example, AVA Fellow Markus Wiesinger's project focussed on the *Sympathetic Cooling of Antiprotons* where he worked on advanced cooling techniques for (anti)protons in Penning traps with the aim of improved measurements of the proton and antiproton magnetic moment. Both Markus and his supervisor Stefan Ulmer are members of the BASE collaboration.

This new technique, as recently reported in Nature, is an important milestone in precision Penning trap spectroscopy and the test setup at the University of Mainz also reached temperatures approximately 10 times lower than the limit of the established resistive-cooling technique. With optimised procedures the collaboration expects that they should be able to reach particle temperatures of the order of 20-50 milli Kelvin (mK), ideally in cooling times of the order of 10 seconds. Previous methods allowed them to reach 100 mK in 10 hours.

The speedy new two-trap cooling procedure promises a huge increase in the statistics that are available to experimenters. It is also a game-changing development for the study of BASE's main particle of interest: the antiproton. Conventional cooling techniques are difficult to apply to antimatter because it is highly challenging to put matter and antimatter in the same trap. Applying the new technique should allow a significant improvement on BASE's already world-leading measurements of fundamental properties of antiprotons. Such measurements have the potential to shed light on one of the biggest unanswered questions in fundamental physics: the unexplained surfeit of matter over antimatter in the universe.

The BASE collaboration's vision is to continually improve the precision of the matter-antimatter comparisons to develop a better understanding of the cosmological matter–antimatter asymmetry. The newly developed technique will become a key method in these experiments, which aim to measure fundamental antimatter constants at the sub-parts-per-trillion level.

Full report via the CERN Courier magazine.

Full Article in Nature (Open Access):
Bohman, M., Grunhofer, V., Smorra, C. *et al.*, Sympathetic cooling of a trapped proton mediated by an LC circuit. Nature **596**, 514–518 (2021) https://doi.org/10.1038/s41586-021-03784-w

Fellows Activity

AVA Fellow Bianca Veglia presented at IPAC'21

AVA Fellow Bianca Veglia was selected to give a contributed talk at the 12th International Particle Accelerator Conference – IPAC'21. The conference was organized by the Brazilian Center for Research in Energy and Materials (CNPEM), Campinas (Brazil), and took place online 24-28 May. IPAC is the main international event for the worldwide accelerator community and industry. Attendees are presented with cutting-edge accelerator research and development results and gain the latest insights into accelerator facilities across the globe.

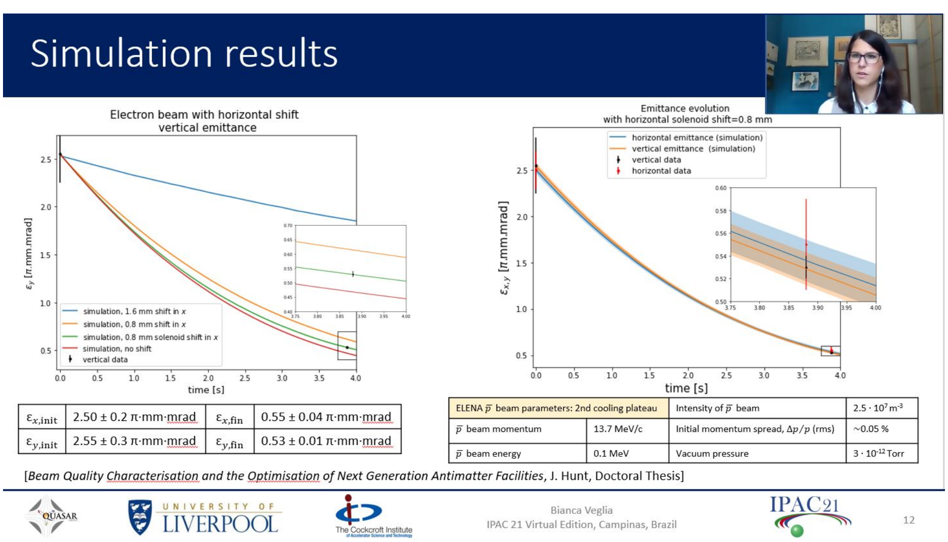
Based at the Cockcroft Institute/University of Liverpool (UK), Bianca has been studying antimatter experiments on beam stability and life time in low energy storage rings. Within her AVA project, Bianca developed realistic models for beam transport, storage, deceleration and cooling from storage rings through beam lines to experiments.

On receiving the invitation to speak at IPAC'21, Bianca said: *"I was thrilled to be asked to give a contributed talk at this year's (unfortunately again) virtual IPAC. It is the largest accelerator physics conference and definitely the widest audience I ever had to give a talk to. So my excitement was also accompanied by some hints of terror. I heard somebody saying in a movie once: 'The number one fear of people isn't dying, it is public speaking'. For this, the virtual format makes it a bit easier, even if it meant that I had to endure the intense pain of watching myself over and over trying to present my slides."*

Oral presenters were required to prerecord their talk which was then made available online (it still is, actually) for participants to watch at their convenience, as the conference covered all time zones from Tokyo (Japan) to Campinas (Brazil) and San Francisco (USA). Bianca's talk titled *The Effect of Electron Beam Velocity Distribution on Electron-Cooling at ELENA* focused on electron cooling dynamics for the Extra Low Energy Antiproton (ELENA) ring, specifically the effect of different electron beam distributions and cooler geometry imperfections on the antiproton beam evolution.

The talk presented simulation results of a dynamic model for the ELENA electron cooler using an accurate description of the cooling process based on realistic distribution of electrons. For this study, BETACOOL simulations of the ELENA antiproton beam phase space evolution were performed using uniform, Gaussian and "hollow beam" and parabolic electrons velocity distribution. Unfortunately, it is impossible to have a direct observation of the electrons inside the cooler. Therefore, G4beamline was used to simulate the interaction of an initially Gaussian electron beam with the magnetic field measured inside the electron cooler assembly: a transverse shift of the center of the electron distribution along the cooler interaction chamber was observed. Introducing this misalignment in the simulations, interpreted as a geometry imperfection of the drift solenoid, a very good agreement with measured data was found, validating the model.

On presenting her talk, Bianca said: *"I was broadly satisfied with the outcome: I received some nice feedbacks and was involved in very interesting discussions that ultimately helped me to progress with my thesis. Often the eye of somebody not involved in the project can help to observe the subject from a new perspective and suggesting new approaches. For sure the distressing time I used to prepare was well spent and I really hope to have the chance to present at this fantastic conference again in the future, possibly in front of a live audience."*



Bianca presenting her results at IPAC'21.

Siara Fabbri successfully completes PhD

Siara Fabbri, AVA Fellow based at the University of Manchester and CERN, successfully passed her PhD viva on *Optimization of Antiproton capture and delivery for ALPHA Antihydrogen experiment.* Siara joined the AVA project in 2017 and has been a member of the ALPHA collaboration for which her supervisor Dr William Bertsche is the deputy spokesperson. A brief introduction into the subject of her PhD thesis is given below.

Siara Fabbri

The ALPHA (Antihydrogen Laser PHysics Apparatus) collaboration at CERN is testing Charge-Parity-Time (CPT) symmetry through precise measurements with antihydrogen atoms and in the future will measure antihydrogen's free fall acceleration in Earth's gravitational field. The antihydrogen atoms are created by slowly merging cold plasmas of antiprotons and positrons. The production rate is highly sensitive to the parameters of these plasmas and typically only a few atoms have been available at a time for measurements. A limit is placed early on in the achievable number of trapped antihydrogen by the inefficiency when capturing antiprotons from the Antiproton Decelerator (AD). Historically, over 99 % of antiprotons are lost during the capture process as a result of the 5.3 MeV initial kinetic energy of the delivered beam. ELENA is a new storage ring coming online in 2021 which will lower this initial kinetic energy of the beam to 100 keV, improving the capture efficiency of antiprotons for ALPHA and other experiments.

To accommodate for ELENA, it will be essential to upgrade the ALPHA antiproton Catching Trap (CT) and in particular the antiproton degrading apparatus which is responsible for slowing down the incoming beam to trappable energies. Following these upgrades, it is expected that the antiproton capture efficiency will increase from less than 1% to upwards of 50%. To effectively utilize the anticipated larger number of trapped antiprotons and translate this to a gain in antihydrogen production, new plasma manipulation and delivery techniques need to be developed. This thesis describes those upgrades and associated techniques which optimize the capture of antiprotons from ELENA, as well as the preparation and delivery of the antiprotons for antihydrogen creation.

In Siara's thesis, first the development of the new antiproton degrading apparatus to slow antiprotons delivered by ELENA is presented. A combination of semi-analytic models and Monte Carlo particle tracking simulation techniques are used to design the new degrading apparatus. Next, numerical simulations of a technique for non-destructively characterizing the parameters of the antiproton plasmas are described, and these are compared against theory. Finally, a method for extracting controlled, reproducible beams of antiprotons from the CT is discussed. A combination of theoretical models and numerical simulations are assembled into a framework for understanding and modeling the extraction of these beams.

Congratulations!

Indrajeet Prasad successfully completes MBA

Indrajeet Prasad

In Spring 2021, Indrajeet Prasad, AVA Fellow based at FOTON, s.r.o. completed the Master of Business Administration (MBA) degree at the Prague University of Economics and Business (Czech Republic). Indrajeet joined the AVA project in 2017 and as part of his Fellowship he successfully completed this International Executive MBA in Business & Entrepreneurship.

The Prague University of Economics and Business (VŠE) was Indrajeet's first choice when he decided to move his career from only technical responsibilities towards tech business and entrepreneurship. VŠE's executive MBA program is designed especially for highly skilled professionals with industry experiences seeking to expand their knowledge of business & management, and deepen their management and entrepreneurial skills to enable the successful realization of their next career move. In 2020, VŠE was awarded the title of best Business School in Eastern Europe at the annual Eduniversal ranking.

During his MBA studies, Indrajeet participated in various business case studies, business presentations and he also wrote several papers. Being a Fellow within the AVA Network, an EU Horizon 2020 project, he was in a prime position to use his gained knowledge of business and his Fellowship experience during his MBA. Here, Indrajeet was able to use topics related to his work for AVA with disseminations on *"European Commission's HORIZON 2020- Marie Skłodowska-Curie Actions (MSCA) - A Perspective on Career development for Researchers"* and *"Project Management Frameworks used for large scale research projects at CERN: Their advantages and disadvantages"*.

As part of the Fellowship, Indrajeet has done a large number of (entrepreneurial) outreach activities for students in his home country India. His dedication to these activities and his love for business and entrepreneurship was one of the reasons to concentrate his final MBA dissertation on "Edtech Startups in India – Success factors". When he successfully completed his studies, Indrajeet started as a Project Estimator ii at Honeywell (Czech Republic) and also co-founded a tech start-up called PaMaKid.com.

Congratulations!

AVA Fellow Interviews – A look back and into the future

Now the formal period of the project has come to an end, this is a good moment to look back at the Fellows' time with AVA. We have asked the Fellows a few questions as part of the AVA Spotlight Interview series; this will give you a more personal insight into their motivation, achievements and outlook.

Spotlight on Vassilis Vrettakos

Vassilis Vrettakos at his office at home

Vassilis Vretakos joined the AVA Network at CIVIDEC Instrumentation, Vienna (Austria), for the final 7 months of the project. CIVIDEC, an internationally operating R&D company born from the cutting-edge technology of CERN, focuses on technological solutions for fast and precise beam diagnostics for particle accelerators and on neutron detection for resolving the issue of Helium-3 replacement. For his project, Vassilis has been working on the analysis of experimental data taken at the AEGIS experiment in 2017-18 at CERN. He has continued working for CIVIDEC beyond AVA.

What did attract you to the AVA network? Has it fulfilled your expectations?

"I always had a strong interest about antimatter research. The idea to be part of the AVA network was very attractive. The fellowship helped me to improve my skills in several fields such as programming, data analysis, detector physics and working as a member of a big team. Furthermore, everyone in the AVA network was willing to help, the environment was very friendly and my project was super interesting. So, my expectations were completely fulfilled."

Why did you choose to go to CIVIDEC?

"My goal was to combine my curiosity/interest for the antimatter research with my studies in Mathematics. CIVIDEC offered me this opportunity. Now, after the end of my fellowship, I feel that I made the best choice. I worked in a top level environment with the best people in the fields of detector physics and electronics. I learned a lot of things from my colleagues and the cooperation with them was more than perfect."

Can you explain in a few words what your project was about and what have you achieved?

"The objective of my project was to analyze data obtained at CERN from the AEGIS experiment. The purpose was to investigate the possible application of a diamond membrane detector for antimatter research. More precisely, a synthetic chemical vapour deposition (sCVD) diamond detector was used in order to detect low energetic antiprotons (p-) via the detection of the products of their interaction with matter. The results are very promising. It is shown that the reaction products from the antiproton annihilation can be detected by a diamond detector. The analysis and the results of this project can be used for further antimatter research. They prove that diamond detectors can be used for this kind of science."

What has AVA provided you professionally?

"Being part of AVA helped me in several ways. I improved my skills, I learned a lot of new things and I worked as a member of a great team. I met wonderful people and I worked with them in very interesting projects. Furthermore, as an AVA Fellow, I started work at CIVIDEC which is my current employer."

Can you say something about your next career move?

"I continue working for CIVIDEC. I work in the field of data analysis and I participate in several projects for their customers."

What will be your most cherished memory from AVA?

"My experience in AVA network lasted only for 7 months (from 06/2020 to 12/2020). Due to covid restrictions I have not had the opportunity to participate in schools, conferences etc. I met everybody via the communication tools. So, I cannot distinguish a single moment but I keep all my experience in AVA team as a very good memory."

Spotlight on Mattia Fanì

Mattia at the Palace of Governors in Santa Fe (USA)

For this interview we have spoken with Mattia Fanì who was based at CERN during his AVA Fellowship. Here, he worked on the *Instrumentation and Detector Beam Line and Test Stand*. As part of his work Mattia also studied for a PhD at the University of Genoa which he successfully completed last year before he then took the next step in his career to start a new role in the United States. Found out more about Mattia and his journey in this Spotlight Interview.

What did attract you to the AVA network? Has it fulfilled your expectations?

"I was one of the first Fellows to be selected. I didn't know about the AVA network before, but it turned out to be a great surprise. I responded to a call for an application on the CERN website that fully matched with my background, interests, and expectations. Not all the frontiers of Physics lie at the frontier of high energies. A number of attempts to formulate quantum theories of gravity or to unify gravity with other forces lead to the possibility of a non-identical gravitational interaction between matter and antimatter. Antihydrogen spectroscopy as well as a direct test of the Equivalence Principle in General Relativity will allow new pieces in the puzzle of the Baryon Asymmetry as well as to advance in understanding towards great unification theories. The AVA call for application was perfect for me. It was about a low-energy antiproton beam line and a dedicated test stand. The goal was to study the properties of a low-energy antiproton beam and measure the response of several detectors to the interaction with low-energy antiprotons. The knowledge and skills I would have developed to achieve those goals would have come in extremely handy.

At that time, I had just started my PhD program at the University of Genoa in the AEgIS experiment working on low temperature antiprotons towards the first pulsed production of antihydrogen, then achieved as one of the accomplishments of my fellowship. The next natural step will be to use antihydrogen for a measurement of the gravitational interaction of neutral antimatter. I am extremely happy with this experience. AVA exceeded my expectations. I achieved all the goals for my project, I have contributed heavily to laying a milestone in antimatter physics and I have acquired skills that are still crucial after moving to a different field of Research in Physics."

Why did you choose to go to CERN?

"CERN is the world's largest particle physics laboratory and the unique place in the world where antimatter can be created at low temperature and studied. CERN was a very natural choice at that moment."

Can you explain in a few words what your project was about and what have you achieved?

"My research in AVA developed in three main topics. First, I worked on the detector beam line and test stand for low-energy antiprotons available in the AEgIS experimental area, submitting in good time the two deliverables required. Then, I focussed on the pulsed production of antihydrogen, subsequently achieved at the end of the antiproton runs as a milestone towards the first consistent measurement of the interaction between globally neutral antimatter and the Earth gravitational field. I presented the results in antiproton plasma manipulation at an international conference, and I got my proceedings published as a selected paper. Finally, I worked on the characterisation of a new scintillating material for improved sensitivity in the detection of positronium in the magnetic field in the AEgIS apparatus, obtaining promising results and submitting a draft of a paper."

What has AVA provided you professionally?

"The schools and training provided in the network were of very high quality. Those events typically took an entire week, but that time turned out greatly fruitful. Low-energy antiproton school, hands-on courses, precision studies school, and all the other training have all been beneficial for the work. But I'd like to mention the public presentation courses and the management courses as some of the most valuable I received. The management course provided insight into the management of a project of any kind, from one's doctoral thesis to the world's largest physics experiment. Understanding the requirements of a project, correctly estimating the resources needed, defining a mitigation strategy for all the risks, figuring out how to prioritize the work became even more relevant to me since I moved to the next step of my career. Another thing I greatly appreciated was the freedom I had in selecting my additional training. This allowed me to participate in an international school of my interest and acquire technical skills that turned out to be crucial for my present work."

Can you say something about your next career move?

"Sure. I'm currently working as a Postdoctoral Research Associate in Experimental Neutrino Physics at the Los Alamos National Laboratory (LANL), in the United States where I am leading the effort for building the main calibration system of the Deep Underground Neutrino Experiment (DUNE), the next generation long baseline experiment aimed at measuring charge-parity (CP) violation in the neutrino sector. In fact, leptogenesis could be the key of the baryonic asymmetry riddle, as a possible process treating matter and antimatter differently. The final detector will consist of four Liquid Argon Time Projection Chambers of unprecedented dimensions and technical challenges. Two large scale prototypes of DUNE, called ProtoDUNEs are currently built at CERN."

"So far, I enabled the first data taking campaign from a deuterium-deuterium pulsed neutron generator on ProtoDUNE and led the installation, commissioning and data taking from the device. I successfully installed, tested, and validated a proposed tilt-meter system for monitoring the stability of the designed detector ports for the calibration system. "In addition, I developed a full simulation tool from scratch reproducing all the relevant detectors' details to answer some of the critical design parameters. Currently, I am building the main calibration system both for the main experiment and for the two prototypes currently at CERN, where I will lead the installation, commissioning, and operation of the calibration system at the beginning of next year. In parallel, I am working on one aspect of hadron interaction with liquid argon based on ProtoDUNE data."

What will be your most cherished memory from AVA?

"This is a hard question. Every day spent with the other fellows would deserve to be mentioned here. Unfortunately, the covid-19 outbreak didn't allow us to attend the last AVA events all together. Hopefully, we will have more opportunities to meet in the future."

Spotlight on Indrajeet Prasad

Indrajeet Prasad at one of his many outreach activities during his AVA Fellowship

For this interview we have spoken with Indrajeet Prasad who joined the AVA network at FOTON, s.r.o. (Czech Republic) in June 2017. His project focused on the development of high stability, rampable power supplies for accelerator applications, and the trap experiments in particular. For this, he worked closely with many AVA Partners.

What did attract you to the AVA network? Has it fulfilled your expectations?

"There are actually a few strong reasons for me to join the project. One of the most important reason that attracted me to this interesting project was the ability to contribute to a project involving the European Union and CERN. Every time I visited CERN, GSI, or one of the other Partners for my experiments and secondments, it gave me goosebumps to be a part of such an amazing R&D project. By joining the network, I became part of an amazing group of researchers from all around the world, including some of the most senior scientists from the best organizations in the world. Now, I can confidently write to any of the Fellows and senior scientists to ask for guidance regarding career or any R&D aspects. I feel that this is also a very valuable aspects of the AVA network. Another aspect is the excellent training opportunities a large network like this one gives: it is a great chance to gain knowledge from partner institutions. I am happy that I was able to follow the timelines and training provided by the network in different organizations. It indeed fulfilled my expectations and It will be one of the best choices I made in my career."

Why did you choose to go to FOTON, s.r.o.?

"I choose FOTON because of the R&D project that was offered via AVA: "High Stability, Rampable Power Supplies for keV Ion Beams". FOTON is a company specialized in designing and manufacturing of advanced scientific instrumentation and has many links with the other institutes and companies in the particle accelerator field. Together, this was a great opportunity that aligned with my own research and development aspirations and an excellent way to learn more about the activities of these scientific partners. In addition, by doing my project at FOTON, it allowed me to also do secondments to CERN and GSI which were highlights of my time with AVA."

Can you explain in a few words what your project was about and what have you achieved?

"Critical for beam storage and energy ramping in a storage ring and efficient beam transport from a ring to the experiments are power supplies that have a stability of better than 10-4, can be ramped over more than one order of magnitude in output voltage in 1s over a linear ramp and that can be smoothly integrated into the accelerator control system. During my research work at FOTON, I first developed a power supply requirement table of all trap experiments, such as at the ELENA beamlines (CERN) as well as FLAIR rings (GSI). After this, I continued my work with CERN, GSI and Cosylab on defining a suitable interface for their seamless integration into the respective accelerator control system. The next and final phase was the design, build, and test of the power supply prototype at FOTON. This was successfully completed in collaboration with Fellows and other partners in the Network."

What has AVA provided you professionally?

"AVA provided me with a lot of opportunities to get training in the biggest research laboratories in the world. I had a great time doing my experiment work, secondments, and training at partner institutions. AVA also provided soft skills training, experimental schools, and a lot of travel opportunities. One of the best things that AVA provided was also to connect with the best professionals in the field. Thanks to AVA and the support of my supervisor, I also completed my MBA during the Fellowship.."

Can you say something about your next career move?

"Since I completed my Fellowship, I have started as a Project Estimator ii at Honeywell in Czech Republic. Earlier this year I co-founded a tech start-up called PaMaKid where I am also the Chief Marketing Officer. PaMaKid.com is an AI & Data Science driven Learning Experience Platform for kids to discover Strengths, weaknesses & new interests in a fun way."

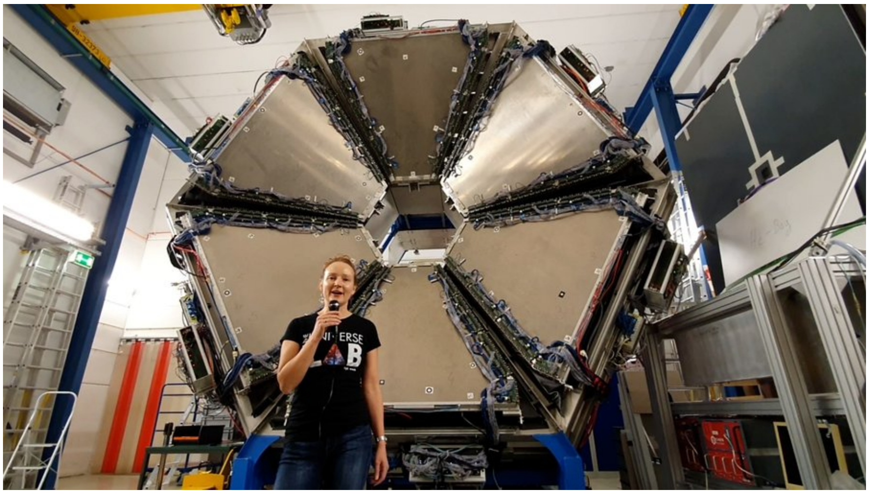
What will be your most cherished memory from AVA?

"That is a difficult on one…! I loved everything about the AVA network. Having said that, visiting CERN for the first time is definitely my cherished moment of the AVA project."

AVA Fellows at CERN

Partner News

Online visits to GSI and FAIR



Screenshot from the video tour – large detector HADESS (Image: GSI)

AVA Partner GSI - Helmholtz Centre for Heavy Ion Research, based in Darmstadt is the German national center for heavy ion research and hosts a large accelerator facility where high beam intensities for heavy ions are accelerated up to several GeV/u. Next to the GSI-complex, a worldwide unique accelerator facility is currently being constructed for heavy ions and antiprotons, the Facility for Antiproton and Ion Research (FAIR). The facility is designed for first class research in the field of atomic, nuclear and plasma physics, material sciences and biophysics and will be used to create and study matter in the laboratory that otherwise only occurs in the universe. GSI hosted AVA Fellows David Haider and Jeffrey Klimes during their research projects as well as many Fellows during their secondments.

Due to the Corona pandemic measures, visits to GSI's campus were not possible. Instead, they have organized online tours so that GSI and FAIR could be visited virtually. These tours have proven to be very popular!

The live moderated events offered a comprehensive insight into current research and the experimental facilities at GSI/FAIR and allowed individual questions to be asked, which were answered by the presenters. Also included in the tour was an exclusive view at the mega construction site for the future accelerator center FAIR, one of the largest construction projects for research worldwide.

Following an introductory lecture, a guided video tour took the participants to several research sites and facilities on campus: Among other things, the participants could visit the 120-meter-long linear accelerator UNILAC or the main control room online and learnt a lot about the unique research at GSI and FAIR. Interesting facts informed about the construction of components for the international accelerator center FAIR, currently being built at GSI.

AVA Partners work together to improve beam control at the COSY accelerator at FZJ

The COoler SYnchrotron accelerator and storage ring (Image: FZJ)

Forschungszentrum Jülich (FZJ) and Cosylab d.d. have been working together on a project to improve the beam control at the COoler SYnchrotron (COSY), a particle accelerator and storage ring at the Institute of Nuclear Physics (IKP) based at FZJ. Both Cosylab and FZJ are partners of the AVA Network and have hosted Fellows Adélaïde Grimaud and Dominika Alfs, respectively.

During AVA, Adélaïde at Cosylab helped develop a versatile control system using the Experimental Physics and Industrial Control System (EPICS) framework to handle the power supply developed within the Network. Dominika worked at FZJ on the search for polarization effects of antiprotons produced in pA collisions for which she analyzed the existing data from the beamtimes performed at the T11 beamline (CERN). This resulted in a very good understanding of the measurement conditions and design of an improved measurement setup. Currently the test measurements with the improved setup are ongoing at COSY.

COSY provides polarized and unpolarized proton beams in the energy range between 45 and 2700 MeV for basics science experiments. Alternatively, it can provide deuteron beams between 90 and 2100 MeV. The particle beam can be cooled if required to improve beam quality.
This project to improve beam control had several goals. The engineers were to make the Beam Control for the COSY machine faster and include enhanced tune-measurement tools. They also were to upgrade various parts of the control system and beam instrumentation hardware. The EPICS framework was to be utilized to allow upgraded access to beam instrumentation devices, orbit control and quadrupole-magnets control. A number of these improvements include: routine delivery of sub-mm rms orbit deviation; high brilliance beams, produced with beam cooling; numerous beam diagnostic systems seamlessly integrated into the EPICS-based control system.

To learn more about all the improvements, please follow this link.

AVA member stars in Spark! Podcast on 'Experimental AI' at CERN

AVA Steering Committee member Dr Michael Doser explores using "unsupervised learning" to reveal nature's mysteries in SPARK! Podcast

At the end of last year, we reported on the launch of a new and multidisciplinary science innovation forum and public event called Sparks! Serendipity forum at CERN. The goal of this forum is to foster a new community and develop a platform to spark innovation in issues related to science, technology, engineering and mathematics that are relevant to society, necessary for CERN, and that further CERN's mission of science for peace.

CERN is the world's largest particle physics laboratory which acts as a focal point for European physics and technology collaborations. It has a very strong track record as a European training centre and it has great experience in tutoring and mentoring of early stage researchers as well as in the transmission of complementary skills. CERN has been an AVA Partner since the launch of the AVA Network in 2017.

A Podcast Series around the theme '*Future Intelligence*' is leading up to **Sparks! Forum on 17-18 September and a Public Event 18 September**, the latter will be webcast live online. Invited participants to the forum will be selected AI professionals, along with neuroscientists, psychologists, philosophers and ethics experts who together will brainstorm solutions, match problems to answers, and prepare some of the content of the second day. The Public Event will consist of a series of short talks and debates about the current and future trends that will define the field of AI and how it will impact our society as we know it. The talks will be given by a number of AI experts participating in the Sparks! forum.

Episode 4 of the Podcast Series titled '*Experimental AI'* has recently been released and hosts AVA Steering Committee member and Fellow supervisor Michael Doser, who is a seasoned experimental physicist at CERN's antimatter factory. He is joined by Maurizio Pierini, an innovative experimental physicist implementing AI techniques at the Large Hadron Collider. Together they explore using "unsupervised learning" to reveal nature's mysteries. To listen to their discussion, tune in here.

Further details, including information about the entire podcast series and the upcoming Public Event, can be found here: https://sparks.cern. This website also provides the possibility to re-watch the virtual launch event that took place on 26 November 2020.

Upcoming Event

MSCA Networks - Training the next generation through collaborative programmes

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

The QUASAR Group, based at the University of Liverpool / The Cockcroft Institute, has an exceptional track record in the coordination of MSCA networks through leadership in the DITANET, oPAC, LA^{3}NET, OMA and AVA projects. In combination, the Group has been in charge of the training of almost 100 Fellows and has coordinated the research and training at more than 100 partner organizations.

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

The event is free of charge and will be hosted online by the University of Liverpool on 29th September 2021. Advance registration is required and can be done via the following link: https://indico.ph.liv.ac.uk/event/358/

Registration deadline: 19th September 2021

More Events

10th International Beam Instrumentation Conference - IBIC 2021

The virtual IBIC 2021 will be held 13th - 16th September 2021, organized by PAL, Korea.

IBIC brings together the world community of experts in instrumentation for particle accelerators, to explore the physics and engineering challenges of beam diagnostics and measurement techniques for charged particle beams. The conference program will include tutorials on selected topics, invited and selected talks, as well as poster sessions.

For registration and more information visit: https://www.indico.kr/event/22/page/18-welcome

IBIC 2021
International Beam Instrumentation Conference

International Conference on Exotic Atoms and Related Topics - EXA2021

EXotic Atoms (EXA) is a series of international conferences on muonic, pionic, kaonic, and antiprotonic atoms and related topics. It takes place every 3 years and was scheduled to be held in Vienna, Austria, in September 2020. Due to the coronavirus pandemic, the conference EXA2021 will now take place as an online meeting from 13-17 September 2021 and is being organised by AVA Partner Stefan Meyer Institute for Subatomic Physics of the Austrian Academy of Sciences.

The AVA project is supporting EXA2021 and encourages all of its Fellows and partners to make contributions to this important conference.

More information can be found here: https://indico.gsi.de/event/9289/

13th International Workshop COOL'21

The bi-annual 13th International Workshop COOL'21 will be held 1st - 5th November 2021 in virtual mode using ZOOM organized by Budker Institute of Nuclear Physics SB RAS. The workshop will be focused on the various aspects of the cooling methods and technics of charged particles.

Deadline for Delegate registration – 25th Oct 2021

Deadline for Abstract submission – 15th Sept 2021

The workshop Topics:

- electron cooling
- stochastic cooling
- muon cooling
- cooled beam dynamics
- new concepts and theoretical advancements in beam cooling
- facility status updates and beam cooling reviews

More information can be found here: https://indico.gsi.de/event/9289/

Position Vacancies

Open position at Friedrich Schiller University/GSI:

PhD Position in Accelerator Physics – Ultra-sensitive Beam Intensity Measurement
In the frame of a Collaboration supported by the BMBF (German Ministry of Research), extensive investigations on a superconducting SQUID based Cryogenic Current Comparator (CCC) for intensity measurements down to the nA range have been performed. This device measures the beam intensity via the beam magnetic field (fT-range), which requires meticulous shielding. The results from the prototype measurements led to the design of an advanced CCC for FAIR, which was successfully tested in the Cryring@ESR facility. At the GSI beam instrumentation group new diagnostics devices are permanently developed to match the requirements of the upcoming Facility for Antiproton and Ion Research (FAIR) at GSI/Darmstadt, Germany.

The focus of the PhD work can to some extend be defined according to the inclination of the candidate. However, the goal is the setup, commissioning of an ultrasensitive and reliable diagnostics device for FAIR, as well as its optimization and comparison with other diagnostic schemes.

Application deadline: 15th September 2021

Full details here

Open positions at CERN:

Doctoral Student Programme This is a chance to work on your thesis while spending up to 36 months at the forefront of science. Whether you've already chosen a subject or are still making your decision, if your specialism is Applied Physics, Engineering or Computing, this is an invitation to further your knowledge in a truly unique organisation. In fact, it's an invitation to get involved in world-famous experiments of unprecedented scale and scope. An invitation to join an environment like nowhere else on Earth.

Full details: https://careers.cern/alljobs

Accelerator Physicist (BE-ABP-INC-2021-103-LD) Are you an Accelerator physicist or Engineer with experience in beam dynamics, and, in particular, incoherent multi-particle effects, combining academic excellence and technical coordination skills? Are you interested in taking an active role in the performance optimization of the Large Hadron Collider (LHC) and its High Luminosity upgrade (HL-LHC)? Join a dynamic team of applied physicists and have an impact in the integrated luminosity of the LHC, guide its upgrade and contribute to studies for future particle colliders. Work at the heart of beam physics and operation, at the largest particle physics laboratory in the world: CERN.

Full details: https://careers.cern/alljobs

Open positions at University of Liverpool/The Cockcroft Institute:

Postdoc on Monte Carlo studies and detector design and optimization (2 years initially)

The University of Liverpool is seeking to recruit a postdoctoral researcher who will work with academics across the accelerator science, nuclear and particle physics clusters on developing, testing and evaluating innovative detector technologies for a range of applications from high flux reactor physics experiments to detectors for medical imaging. You will develop and deliver Monte-Carlo models for a chosen set of detectors as basis for a range of applications across the three clusters. You will also lead detector development work, and use the existing laboratory, clean room and workshop infrastructure to characterize prototypes and benchmark their performance against existing technologies.

Application deadline: 22nd September 2021

Full details here

Project Manager to work across national and international projects (3 years initially)

We are recruiting an experienced project manager to work on the Centre for Doctoral Training in Data Intensive Science (LIV.DAT), several large-scale research projects in accelerator science and technology, and on communication activities for the Cockcroft Institute for Accelerator Science and Technology with Professor Carsten P Welsch.

You will be responsible for the day-to-day management of several projects, including ensuring efficient implementation of the projects, building strong links with project partners, event organisation and international communication of all project outcomes. Establishing good media links and embedding project communication into the wider activities of the group and physics department will be very important.

Application deadline: 15th September 2021

Full details here

For more details please contact Prof Carsten Welsch c.p.welsch@liverpool.ac.uk

Events

13th – 16th Sept 2021	10th International Beam Instrumentation Conference (IBIC 2021), online event
13th – 17th Sept 2021	International Conference on Exotic Atoms and Related Topics (EXA2021), online event
29th Sept 2021	MSCA Networks - Training the next generation through collaborative programmes, online event
1st – 5th Nov 2021	13th International Workshop COOL'21, online event
12th – 17th June 2022	13th International Particle Accelerator Conference (IPAC'22), Bangkok, Thailand
28th Aug – 2nd Sept 2022	International Linear Accelerator Conference 2022 (LINAC 2022), Liverpool, UK

Notice Board

This newsletter is published on a quarterly basis. Help us keep it interesting by providing your news and updates.

DEADLINE FOR THE NEXT NEWSLETTER CONTRIBUTIONS: 30th November 2021

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