NEWS letter

MIRROR

Issue 17 September 2020

Highlights

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- Single-pass non destructive electronic detection of charged particles
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Dear friends of low energy antimatter and ion physics,

This summer has probably been the quietest one our campus here at the University of Liverpool has ever known, but at the same time it has also been the busiest. It has really been a heroic effort by academic staff to get everything ready for the fall semester which will start in only a few weeks. Hybrid teaching, an engaging teaching mix delivered both on campus and remotely, is now part of the teaching approach that most universities around the globe have chosen. Similarly, COVID-19 required our project to postpone some events or find alternative methods of delivery and, importantly, our Fellows to progress their research in this new working-from-home environment.

We had originally planned to hold an international conference (jointly with EXA) in Vienna this autumn, however, current travel restrictions unfortunately made this impossible. As always, the health and safety of our staff and Fellows had highest priority. In close discussion with the EXA Programme Committee and our EU Project Officer, the AVA Steering Committee decided to hold a Supervisory Board meeting instead in 2020 to give our Fellows an international platform to present the outcomes of their projects. In addition, our network will hold a dedicated careers workshop - just for our Fellows - to help with them transition into new roles after the end of their Fellowship. The conference is now planned to take place in 2021 and we hope that many of our Fellows will be able to join us then and there.

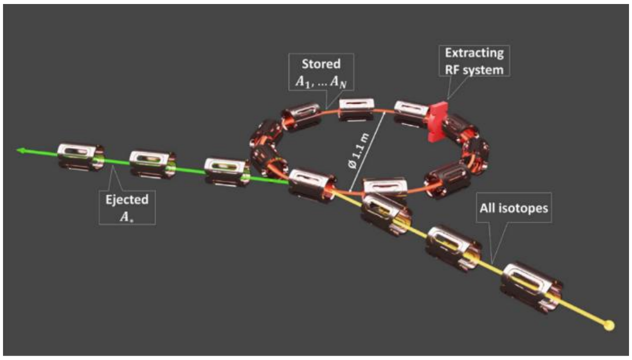
I hope you will enjoy this issue of MIRROR and look forward to your future contributions!

Prof Carsten P Welsch, Coordinator

Research News

Novel and compact superconducting recoil separator for radioactive isotopes

AVA Fellow Volodymyr Rodin is analyzing 3D beam transport using different simulation approaches and has applied the techniques that he developed specifically for the AD/ELENA antimatter facilities now to a different low energy facility. Here, his work on simulations helped confirming a new concept on storing, and performing experiments with, heavy ions.



Conceptual FFAG ring layout for a compact recoil separator.

In a paper recently published in Nuclear Instruments and Methods, Cristian Bontoiu, Javier Resta-López, Volodymyr Rodin, and Carsten Welsch, together with Ismael Martel, from the University of Huelva, have presented a new concept of a compact ring spectrometer that can provide superior resolution. The recent development of radioactive beam facilities, such as the HIE-ISOLDE facility at CERN, has significantly expanded the capabilities for investigating the structure of the atomic nucleus and the nuclear interaction. However, the unambiguous identification of medium and large mass reaction fragments becomes particularly challenging and require an efficient and high-resolution recoil separator.

The team has designed a versatile recoil separator for radioisotopes that can meet those requirements. The spectrometer is based on a compact superconducting (SC) Fixed-Field Alternating-Gradient (FFAG) mini-ring of approximately 1m diameter. This machine would be able to store a number of light/heavy radioisotopes simultaneously and separate them from the main beam by radiofrequency gymnastics. It also presents the advantage of significantly reducing the size with respect to standard non-SC recoil separator configurations.

Although this concept has mainly been designed to address the challenges in the context of HIE-ISOLDE, it can easily be updated and applied to other radioactive beam facilities, such as SPIRAL2 at GANIL (Caen, France), FRIB at MSU (East Lansing, USA) and SPES at INFN-LNL (Legnaro, Italy).

C. Bontoiu,…,V. Rodin et al., Conceptual design of a novel and compact superconducting recoil separator for radioactive isotopes, Nuclear Inst. and Methods in Physics Research, A 969 (2020) 164048
https://doi.org/10.1016/j.nima.2020.164048

Single-pass non-destructive electronic detection of charged particles

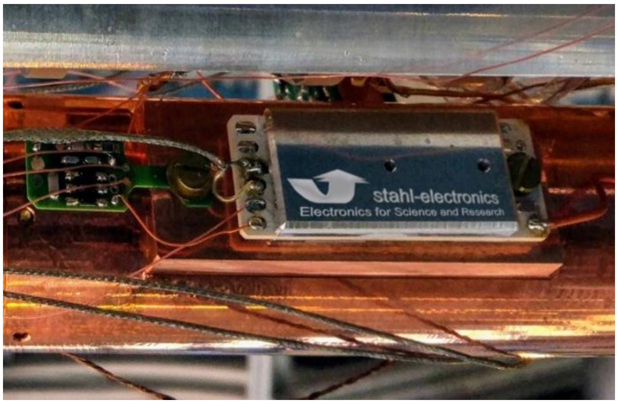
AVA Fellow Ilia Blinov is based at Stahl-Electronics (Germany). As part of a wider collaboration he works with the Atomic Physics group at nearby GSI/FAIR. His project focuses on the provision of a novel detection system, which will be easier to operate, rugged under adverse conditions as found at ELENA and FLAIR and feature much higher detection sensitivity, down to single particles.

A highly sensitive and ultralow noise CX4 amplifier by Stahl-Electronics.

Within the framework of AVA, this collaboration has setup a charge sensitive amplifier for the HILITE experiment currently operated at GSI/FAIR. The results from this work have now been published in a paper co-authored by Ilia. The authors present an experimental method and apparatus for the simultaneous non-destructive determination of the absolute ion number of charged particles. The detector system uses a highly sensitive and ultralow CX4 amplifier from Stahl-Electronics which has been especially developed for the purpose of deep-cryogenic operation and very low input voltage and current noise density. The goal of this part of the setup was designed to detect ion bunches in a non-destructive way, before they enter a Penning Trap. The amount of charge can be calculated by the standard method of electrostatic calculations.

In order to non-destructively detect passing particles, an induced charge is picked up by an electrode. This detection electrode is connected to Stahl-Electronics' low-noise amplifier and read out by an oscilloscope. By calibrating the sensitivity of the device, absolute ion numbers can be determined. The analysis procedure does not require high computational effort to infer the desired ion bunch parameters from the acquired signal.

The accuracy of the measurement of ion number and ion energy is limited by the experimental conditions of the setup. In the present configuration, the minimum detectable number of Ar^{13+} ions in a bunch is about 480 at a temperature of 100 Kelvin. At a temperature of 4 Kelvin, around 95 ions can be detected. Currently, two of these CX4 amplifiers are mounted to both ends of the HILITE trap and form an integral part of the ion detection system.
This new sensor has been fully characterized, has demonstrated superior performance and was found to be a versatile product for a wide range of applications.



The CX4 amplifier (Stahl-Electronics) connected to the to the detection electrode.

M. Kiffer, …, I. Blinov, et al., Single-pass non-destructive electronic detection of charged particles, Review of Scientific Instruments 90, 113301 (2019)
https://doi.org/10.1063/1.5110988

Network News

New Fellow joins AVA

The AVA network welcomes new Fellow Vassilis Vrettakos who has joined the project as a Marie Curie research Fellow in June 2020.

Vassilis Vrettakos, AVA Fellow at CIVIDEC.

Vassilis studied applied Mathematics at the National Technical University of Athens (Greece). He followed the orientation of mathematical modeling and he obtained his bachelor degree in 2014. He then followed the master courses "Analysis-Modeling-Simulation" of the University Paris - Saclay in Paris (France). He finished his master degree in 2016 on and he did an internship at ENSTA ParisTech where he studied the use of the finite elements method at Maxwell's equations.

At CIVIDEC Instrumentation GmbH, Vassilis will be analysing experimental data, which was taken during beam tests with a prototype in 2017-18 at the AEGIS experiment at CERN. He will be studying the interaction mechanisms of antimatter with matter and will the design an ultra-thin, vacuum compatible diamond membrane detector and the related front-end electronics for antimatter research.

Welcome!

AVA Steering Committee Meeting

The AVA Steering Committee held a special COVID meeting on 25th June 2020. With travel restrictions still in place, the group met online using the video conferencing tool Zoom. The meeting was attended by Dr Michael Doser, Prof Eberhard Widmann, Prof Erich Griesmayer, AVA Fellow representative Milena Vujanovic, AVA Project Manager Dr Theun van Veen, and the network coordinator, Prof Carsten P Welsch

The group reviewed impact of the corona pandemic on project progress and training opportunities for each individual Fellow. It also discussed the impact on all 2020 AVA events with the AVA School on Precision Studies held as an online event and the final AVA conference, as part of the established EXA conferences series, postponed to 2021. Networking opportunities for all Fellows, which this conference would have provided during the lifetime of the AVA Project, will now be realised by a dedicated careers workshop for the Fellows that will be held in autumn 2020. The Committee was impressed by how the Fellows and their supervisors had been actively managing the impact of the pandemic.

For the foreseeable future all meetings will be held online and it was hence agreed that the next Steering Committee meeting would be held in conjunction with the final Supervisory Board meeting which is scheduled to take place on Wednesday, 14 October 2020.

AVA Online Fellows Meeting

A snapshot of the online Fellows Meeting. (Image credit: University of Liverpool)

In March this year the Fellows met during the School on Precision Studies. This was supposed to be an excellent opportunity for the Fellows see each other again and catch up in Prague (Czech Republic) at the beginning of the final year of the AVA Project. However, this turned out to be very different as a result of the corona pandemic and it was the start of online meetings and virtual catch-ups. The School was held online instead and successfully allowed speakers and participants to connect and share information in a way that was not done before within the AVA Network.

To give AVA Fellows a chance to connect again in an online setting, and update them about the final stage of the project, AVA set up a Zoom meeting in July. Here, the Fellows shared their experiences of working under lockdown conditions in the various European countries where they are based. Some of them have been working solely from home whereas for others it was still possible to work partly on site. In general, it was a good moment to hear about everyone's experiences under these challenging circumstances.

During the meeting various topics were discussed including the final AVA conference (part of the established EXA conferences series), publications, secondments, the final report to which each Fellow will contribute and a dedicated careers workshop tailored to the Fellows' interests will be held in autumn 2020.

The final conference is an excellent moment for the Fellows to present their AVA research. And while this has been postponed to 2021, the Fellows will now also get the opportunity to present their research in an online format to the AVA Supervisory Board this year. This will be an excellent opportunity for the Partners to see all AVA Fellows together and how they have progressed in their projects.

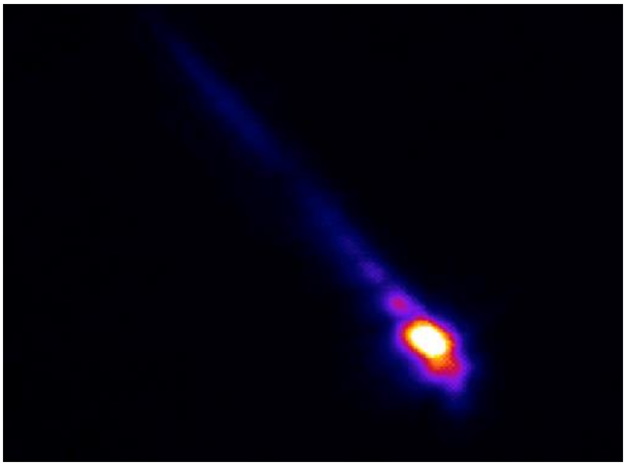
We look forward to seeing everyone again at our online events this autumn!

Fellows Activity

Remote access to optical synchrotron radiation imaging at Diamond

Whilst the world has been figuring out how to conduct business as usual remotely, experts from the University of Liverpool, based at the Cockcroft Institute, and Diamond Light Source, the UK's national synchrotron in Oxfordshire, have taken this a step further and conducted a series of remote access beam measurements. Amongst these are measurements related to the project of AVA Fellow Milena Vujanovic.

Milena's project focuses on the development of new optical imaging techniques for the characterization of charged particle beams. Currently, she is focusing on performing high dynamic range (HDR) beam imaging, using a digital micro-mirror device (DMD). Milena was supposed to take data as part of her PhD project at Diamond Light Source. Access to the facility was not possible, so an alternative approach had to be made.



3 GeV Diamond beam image using optical synchrotron radiation.

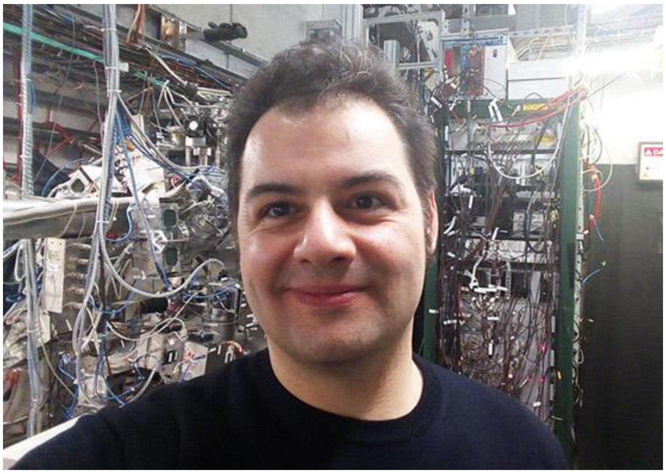
Together with one of her supervisors, Dr Joseph Wolfenden, remote access to a previously installed optical synchrotron radiation (OSR) imaging system in the 3 GeV ring at the synchrotron was gained and used for data taking.

The installed OSR system has been developed at the Cockcroft Institute, and was originally designed to be operated from ~400 m away from the source in the Diamond control room. However, thanks to VPN connection and video conferencing software, the experiment could now be operated from ~200 miles away!

With many of the synchrotron light sources around the world closed due to the pandemic, there was no guarantee that beamtime would be available at Diamond. Thanks to the world-leading COVID-19 research being conducted at Diamond, the facility was still in operation. Several X-ray beamlines have been able to continue operation remotely throughout lockdown. These beamlines have been able to make significant contributions to the ongoing research into COVID-19, providing a deeper understanding of the virus, which could lead to the development of new therapies or treatments.

Milena's measurements were completely non-invasive and did not alter the beam at all. A series of OSR experiments have been undertaken by Milena and her colleagues from the University of Liverpool, which aim to characterize the imaging capabilities of the existing diagnostic beamline, and will hopefully shine a light on beam halo effects. Once the data has been fully analyzed, the monitor will be used to develop a single shot emittance and phase space monitoring system.

AVA Fellow Mattia Fanì obtained his PhD in Physics



Mattia in the AEgIS experimental zone at CERN.

Earlier this year, AVA Fellow Mattia Fanì who was based at CERN earned his PhD at the University of Genova (Italy). His thesis is titled *Pulsed antihydrogen production for direct gravitational measurement on antimatter* and a brief intro into is work can be found below. After finishing his Fellowship, Mattia took up a position with the Neutrino Team at the Los Alamos National Laboratory (USA) which performs sterile neutrino and dark matter searches at Fermilab, America's particle physics and accelerator laboratory.

One of the biggest efforts of the antimatter community is to measure gravity on a neutral antimatter system for a direct test of the validity of Einstein's Weak Equivalence Principle. Electrically neutral antimatter systems are expected to behave in exactly the same way as their matter counterparts. To date, however, the question of whether antimatter falls in the Earth's gravitational field with the same acceleration g as ordinary matter does not yet have a direct experimental answer. Antihydrogen is the bound state of an antiproton and a positron. It is the simplest antimatter atom - and the only one ever synthesised. In AEgIS, antihydrogen is formed through charge-exchange reaction between cold trapped antiprotons and a cloud of Rydberg-excited positronium. Positronium (Ps) is a purely leptonic hydrogen-like bound state composed of an electron and a positron.

As part of his thesis, Mattia presented the first pulsed formation of antihydrogen, achieved in AEgIS as a core topic of his work. He was a member of the AEgIS Collaboration and part of the AEgIS Antiproton Group. Pulsed antihydrogen production is the crucial achievement to validate the AEgIS experimental approach to perform the gravity measurement on antimatter. This achievement opens up the possibility to measure the atoms' time-of-flight, unavailable from currently available trap-based methods. The AEgIS Antiproton Group is responsible for the trap system; the main system of the experimental apparatus. The electronics of all the other systems depend on that of the trap system. Mattia strongly contributed to the developments on antiproton manipulation procedures and related detection techniques. Among the results of his thesis, an outstanding antiproton plasma compression was obtained, allowing the movement of antiproton clouds into the production trap in suitable conditions for the formation of antihydrogen and its detection. […] A full summary about Mattia's work as part of his AVA Fellowship can be found on the AVA website.

Indrajeet Prasad's outreach receives India-wide media attention

AVA Fellow Indrajeet Prasad, originally from India, is based at FOTON in the Czech Republic. There, he studies high stability, rampable power supplies for keV ion beams. Aside from his work for AVA, Indrajeet mentors' students from both his native and host country about studying abroad. Indrajeet is well placed to do this as, after graduating from the West Bengal University of Technology (India), he went on to complete a Master at the Wroclaw University of Technology (Poland), worked as a Researcher on a Marie Curie Project at the University of Brasov (Romania) and attended a short educational program at MIT (USA).

Indrajeet mentors Indian & Czech students. (© I. Prasad)

His excellent initiative to help students hasn't gone unnoticed and media in his home country India have published about his work. Amongst these are CNN-News18 India, Hindustan Times, The Statesman and Yahoo India. All these media show how much Indrajeet's work is appreciated:

"*Indrajeet is not your regular NRI based in Prague but he continues to make his country proud by mentoring Indian & Czech students and helping them find the best research opportunities in Europe. This humanitarian step to aid young students to pursue an education abroad comes from Indrajeet's innate desire to see brilliant young minds employed in the right direction*" – Hindustan Times

"*Through his work on social media, Mr. Prasad is providing a powerful platform for free information that is helping Indian students to accelerate their careers in the right direction*" – Yahoo India

Indrajeet mentors Indian & Czech students to find the best research opportunities under EU research programs and provides guidance to Indian students wanting to study abroad. To connect with the students, Indrajeet has an active presence on social media platform Instagram. Via his Instagram account, where he reaches over 100,000 accounts a month, he holds LIVE-Q&A session to talk about the challenges and benefits of studying abroad. Furthermore, he helps the students connect with scholarships and provides useful information for those pursuing research opportunities in Europe.

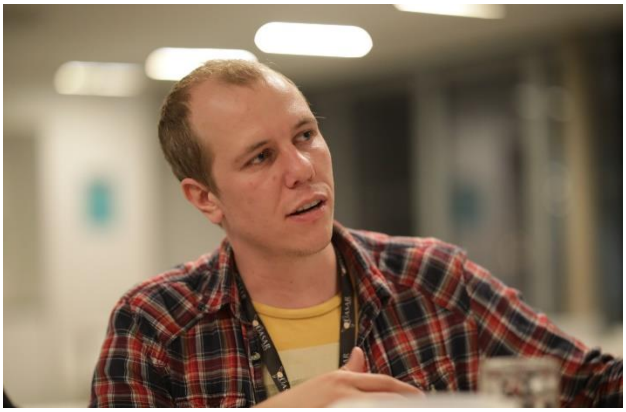
As part of a Live Webinar Series where industry influencers inform students in India on careers and entrepreneurships, organized by The Taruna & Co. (India) and which took place last month, Indrajeet presented a Webinar 'Career Talk' on Scholarships and Admissions Abroad.

With his Fellowship being supported via the Marie Skłodowska-Curie Actions, Indrajeet also speaks at many public events about Marie Curie Fellowships and he has been an invited speaker at events organized by various career counseling agencies in India.

Public engagement is an important and integral part of the training of all AVA Fellows and Indrajeet has shown how to do this very effectively using social media.

Miha Červ on his time as an AVA Fellow

Miha Červ recently finished his AVA Fellowship. During his time with AVA he worked on novel diamond-based detector for beam characterization. In particular, Miha studied the use of µm ultra-thin diamond layers as beam position and profile monitors in low energy antiproton beam lines. He is now working as an FPGA developer at MedAustron, a cancer treatment facility in Wiener Neustadt, near Vienna. Now he has started a new chapter in his career, we look back on his time as an AVA Fellow.



Miha Červ during the AVA School on Low Energy Antimatter Physics at CERN (© I. Prasad)

It was just over three years ago, when Miha started working at CIVIDEC as an AVA fellow. CIVIDEC is a Vienna-based company that specializes in the production of diamond detectors. His main role there was as an FPGA developer. Field-Programmable Gate Arrays (FPGA) are integrated circuits designed to be configured after manufacturing and have found their place in particle physics experiments because of their adaptability, efficiency and possibility of parallel real-time signal processing. Here, Miha had to opportunity to apply everything that he learned at the university into practice.

He found his time at CIVIDEC very valuable. Besides gaining new knowledge about detectors and an insight into the world of particle physic, he also gained important soft skills. Working at CIVIDEC was his first employment and he learned there what it was to work together within a team. He said: "*That also taught me the importance of good communication within the team, and to rely on other people to work together.*"

Miha found that the Fellows were an important aspect of the AVA Network. When he saw how good everyone was at what they were doing, it made him very motivated to do well in his work. He also mentioned: "*One of the aims of the project, as I understand it, is to build a network of scientists, but the side effect of this was also to build friendships. I really enjoyed spending time together and I always looked forward to all the workshops and schools we attended. We still have one more AVA event lined up at some point in the near future, and I really hope we stay in touch even after the AVA project is finished*."

Miha (middle) with AVA Fellows Dominika Alfs (left) and Mattia Fanì (right) during a training day with Stahl Electronics. (© I. Prasad)

His experience of being a part of AVA was a very positive and valuable one and he mentioned that wherever he will go in life, it is his time at AVA that will influence the next steps in his professional career.

Partner News

The Physics of Star Wars: Creative Teaching in Times of Lockdown

Han Solo, Princess Leia, and Luke Skywalker, might have understood very well how oppressive it feels to be under lockdown when they found themselves trapped inside a trash compactor in Star Wars Episode IV: A New Hope. The unprecedented situation created by the pandemic has changed dramatically our ways of working and going about our daily lives. In particular, the closure of schools during the lockdown has challenged parents and teachers to find innovative ways to keep children active, and many of them have turned to online resources in order to minimise the disruption to the students' education.

The Head of the Quasar Group and coordinator of the AVA network, Prof Carsten P Welsch, has stepped up to the challenge by sharing online the educational materials created for the celebrated series of Physics of Star Wars events. The ideas were published in Teaching Times, an online magazine popular among education professionals, where teachers can find classroom resources.

Feeling the electrostatic force around a Van de Graaff generator.

In the article, Professor Welsch, a declared Star Wars fan, explains how Star Wars fiction can help students to better understand the developments happening in accelerator science: "*The Physics of Star Wars provides a strong theme for engaging students with advances in accelerator science, and provides an opportunity to explore what is science and what is fiction in the famous films.*"

Based on the experiences of the Quasar group with schools in the North West, the article shares their ideas and resources to help others to explore a number of areas in the curriculum using the Star Wars theme. The aim is to show students in years 7-9 how futuristic technologies, brought to life in the movies, may potentially become possible with current developments in accelerator science.
The activities use the topics of space travel, light sabres and droids to explain concepts like the speed of light, sound propagation, and machine learning. The learning and teaching materials are described in detail so that teachers can take these ideas directly into the classroom. These include a salad-bowl accelerator, the augmented reality accelerator app *acceleratAR*, and the egg-drop challenge. Additional information explain in more depth how these fundamental concepts relate to accelerator research.

The demonstrations and science content can be easily adapted to different year groups and adjusted to various class sizes – small groups benefit from giving all pupils the opportunity to gain hands-on experience, whilst larger groups are shown the demonstrations and are then engaged in discussions.

Professor Welsch says: "*I hope that these suggestions for science lessons with a Star Wars spin will prompt teachers to find exciting new ways to engage their pupils with this emerging area of science discovery.*"

The article can be found here:
https://www.teachingtimes.com/the-science-of-star-wars-creative-physics-learning-in-a-galaxy-that-isnt-far-far-away/

Cosylab to provide the control software of Australia's first proton therapy unit

AVA partner Cosylab has spent the last four years actively developing, fine-tuning and integrating the Treatment Delivery Control System and the Motion Control System for the Radiance 330 Proton Therapy System in close collaboration with ProTom International.

The new Australian Bragg Centre in Adelaide, which is the first proton therapy unit in Australia, has now chosen ProTom's Radiance 330 device as its functional core and, with it, Cosylab's embedded systems-software. The Australian Bragg Centre will treat an estimated 600 to 700 patients each year when it becomes fully operational at the end of 2024.

The Radiance 330 PT system utilizes an integrated imaging and control system, and advanced pencil-beam scanning technology. The latter is one of the most advanced forms of proton therapy treatment, as it enables the system to apply superior dose sculpting and higher beam efficiencies than other methods of proton therapy. Pencil-beam scanning technology also reduces the adverse side-effects to patients and improves their long-term outcome and quality of life.
Thus Cosylab has participated in the successful development of one of the smallest and lightest proton therapy systems on the market which is based on a very compact synchrotron particle accelerator.

Professor Klaus Blaum appointed Vice President at the Max Planck Society

Prof Dr Klaus Blaum from the MPI For Nuclear Physics, supervisor of AVA Fellow Markus Wiesinger, has been appointed Vice President of the Max Planck Society Chemistry, Physics and Technology Section.

Other newly appointed Vice Presidents are Dr Asifa Akhtar and Prof Ulman Lindenberger and together they are now part of the Executive Board, which advises President Martin Stratmann and prepares important decisions for the Society.

As Vice President, similar to his predecessor Ferdi Schüt, Klaus also wants to get involved in technology transfer and Cyber Valley, Europe's largest research consortium in the field of artificial intelligence with partners from science and industry. Another area of focus for him, as he has been maintaining close scientific cooperation in the Asian region, is to contribute to the exchange between the Max Planck Society and the Chinese Academy of Sciences. Furthermore, he is very much interested in digitization and sustainability within the Max Planck Society.

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

Position Vacancies

Silicon Detector Physicist (CERN)
Are you an applied physicist expert in silicon detector? Do you wish to contribute to the start-up of the brand new ALICE silicon tracking detector and to the R&D for the future evolution of this experiment? This could be the opportunity for you! Take part!

As silicon detector physicist, you will take a leading role in the commissioning and operation of the ALICE ITS detector. This includes: participation in the finalisation and validation of detector readout software; participation in the detector integration and data validation for the ALICE global commissioning; participation in the detector operation, also as on-call expert; leading role in the study of the ITS detector performance during first operation with beams.

Qualifications: PhD or equivalent relevant experience in the field of Physics and more particularly in experimental particle physics, with specialization in particle detectors, or a related field.

Experience: Proven, successful post-doctoral experience in the development of silicon detectors. Expertise in the assembly, integration and testing of silicon detector systems based on monolithic CMOS sensors is considered an asset; experience with hardware and software for semiconductor detectors, including detector control, data acquisition and data analysis; experience with semiconductor detector simulations, in particular with monolithic CMOS sensors; proven experience in coordinating multi-disciplinary teams of physicists, engineers and technicians.

Technical competencies: Knowledge and application of solid-state based particle detection technologies; assembly and integration of detectors; simulation, design and development of (parts of) detectors; analysis and optimization of detector performance; operation of experiments.

Application Deadline: 29th September 2020 – **Job reference:** (EP-AID-DT-2020-106-LD)
Full details via https://careers.cern/alljobs

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Notice Board

DEADLINE FOR THE NEXT NEWSLETTER CONTRIBUTIONS: 20th November 2020

www.ava-project.eu

Project Coordinator
Prof Carsten P Welsch
carsten.welsch@cockcroft.ac.uk

Project Manager
Dr Theun van Veen
t.vanveen@liverpool.ac.uk

Newsletter Editor
Alexandra Welsch
alexandra.welsch@cockcroft.ac.uk

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