



Highlights

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Dear friends of low energy antimatter and ion physics,

The **LEAP conference** will take place in Paris all of next week. As the main gathering of the low energy antimatter physics community, it will showcase progress made in the recent past, present ideas for new experiments and be an ideal platform for discussion with like-minded colleagues from around the world. It will be the first time that AVA will be part of this conference – no less than 8 of our Fellows will be attending and a talk on Thursday afternoon will give an overview of our project's ambitious plans. I look forward to meeting everyone in Paris!

Registration for our first School on Antimatter Physics at CERN this June is now open. I think we have a fantastic line-up of speakers, a good mix of lectures, tutorials and seminars. Please help spread the word and encourage in particular PhD students and Postdocs to join; several scholarships will be available – note the early application deadline.

I am also delighted to announce that our first Topical Workshop will take place in Vienna between 15th – 17th October. It will cover detectors and diagnostics and will focus on the current challenges in monitoring antimatter beams in rings, beamlines and experiments. Registration will open soon via the [AVA homepage](#).

Finally, make sure you watch the AVA project video. I believe our Fellows have done an amazing job in describing this new European network. It was great to see their enthusiasm in drawing up the storyline, filming at MediaCityUK and going through every step of professional video production. Many thanks to our partner Carbon Digital – your guidance and friendly collaboration was second to none.

All but one Fellowships in AVA have now been filled and our presentation of Fellows' background continues in this issue of MIRROR. All research projects are starting to run at full steam. From the next edition onwards, our newsletter will focus on R&D results and latest progress made across all of our scientific work packages. We are also keen to report on progress made in the wider antimatter physics community; thus if you have news you would like to share via the MIRROR, simply drop me an email.

Prof. Carsten P. Welsch,
Coordinator

Antiprotons to go

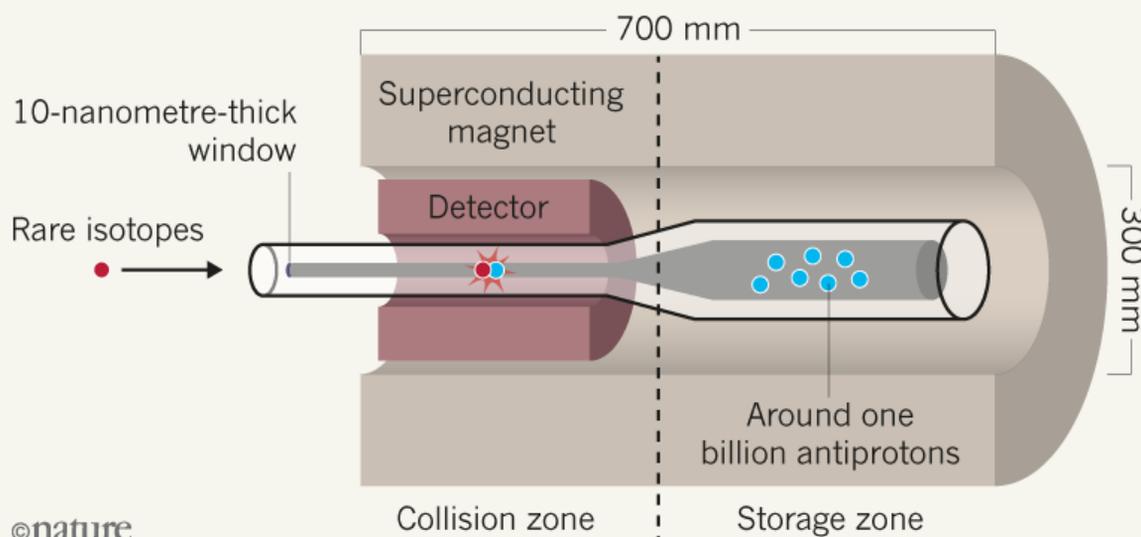
Dr Alexandre Obertelli, who leads the PUMA (antiProton Unstable Matter Annihilation) project at Technical University Darmstadt, has begun a project that will enable antiprotons to be transported from one facility to another for experimental research. Antiproton research aims to provide better understanding of fundamental processes from those inside atomic nuclei to those in the interiors of neutron stars. However, the volatility of antimatter and its readiness to annihilate with any other matter in encounters means that so far, it can only be studied at the place it is produced, CERN. The ability to transport antimatter

to other test facilities – even those located on the CERN campus – will open up completely new areas of research to the antimatter community.

Dr Obertelli and his collaborators hope to create a trap that can store up to a billion antiprotons — more than 100× as many as have been stored in any existing experiments. They will then transport the antimatter to another CERN experiment, ISOLDE, that produces rare radioactive atomic nuclei that decay too quickly to be transported anywhere themselves.

ANTIMATTER TO GO

To reveal the surface structure of atomic nuclei, physicists send ions of rare isotopes into a bottle 700 millimetres long — where they annihilate with antiprotons stored in the trap.



©nature

Source: PUMA

The main difficulties will be storing antiprotons for meaningful lengths of time, at <4K and in high vacuum. Developing and testing technology for the portable trap will take around four years; the first measurements at ISOLDE are scheduled for 2022.

If the trap works, scientists from outside CERN's antiproton source will finally be able to study and use this elusive material.

Source: [Nature 554, 412-413 \(2018\)](#)

Network News

AVA Fellows take part in series of training events

At the very heart of the AVA network is a series of established and bespoke training events. In January 2018, AVA fellows attended a Skills School at the University of Liverpool. They were joined by fellows from the [LIV.DAT](#) network, which focusses on big data generation and manipulation. Wherever possible, training events combining different training networks are encouraged. Such a collegiate approach has two distinct advantages: the advantages of scale brings otherwise unaffordable opportunities to more ESRs and it brings together ESRs from a variety of disciplines to develop personal networks and start lifelong collaborations.



Impressions: Complementary Skills School.

The Skills School at Liverpool followed a programme developed through previous training networks and is recognized as best practice by the European Commission. It focused on skills essential for early stage researchers and included workshops on Project Management, Peer Review and IPR. A workshop on presentational skills held at The Cockcroft Institute, Daresbury included video recording fellows' presentations with feedback from both fellows and trainers. Each of the individual workshops related to a team-based competition that ran throughout the week, to develop a proposal and presentation for a €10k outreach event. This competition encouraged

fellows to take an active part in the workshops, work both independently and in groups and deliver their group proposals and presentations in a competitive environment that was new to many of them.



Indrajeet, Tricia, Ronald, Phillip and Robert – The Winning Team!

The following week the AVA fellows attended a bespoke Media Skills Training School at [MediaCityUK](#), one of the UK's premium creative hubs. Throughout their career, all successful researchers will need to use professional media techniques to promote and advertise their research and this programme offered the opportunity to develop these skills by producing their very own [project video](#). The video had over 6000 YouTube views in its first month and can be seen here:



[Watch the video!](#)

The week began with an overview of the creative process by hosts [Carbon Digital](#) before preproduction started. Storyboards were created and professional voice-over artists recorded scripts. The fellows learned about camera techniques and green screen filming and everyone had the opportunity to film and be filmed before the fellows decided amongst themselves who should star in the final cut. The postproduction process can be as intense and creative as preproduction and production combined. It offers dynamic opportunities to change the storyboard, soundscape and visuals. The fellows actively engaged in postproduction to refresh & refine the film's message.

Sue McHugh from Carbon Digital said, *"It has been inspiring to see researchers from across the world come together to create such a high quality final film. This is an example of successful industry-academia collaboration which can only help improve the overall employment prospects of the researchers."*



Impressions: Media Training.

The AVA fellows are looking forward to meeting up again at CERN for their School on Low Energy Antimatter Physics, 25th – 29th June 2018. More details of this school can be found here: <https://indico.cern.ch/event/677170/>

Second AVA Steering Committee Meeting held at CERN

The AVA Steering Committee, responsible for overall network strategy and operating decisions, met for the second time at CERN on 21st February 2018 to discuss the project's progress and future events.



Discussions initially focused on a review of AVA's international recruitment campaign. Of the 15 ESRs

to be recruited, only one position (at COSYLAB, see vacancies sections of this newsletter) remains to be filled. Wider project communications were also reviewed, including the AVA leaflet, which provides an overview of the project's goals and R&D and the upcoming project brochure to be presented at IPAC'18.

An important part of the network's wider strategy is to establish links to other major training networks and to this end, AVA fellows were joined at their Researcher Skills Training in Liverpool by fellows from the LIVDAT project. Future events including the School on Antimatter Physics, Topical Workshops and the joint Symposium (June 2019) were planned. All future events will be announced via the AVA website and the MIRROR in the future. CERN was an ideal location for the meeting and it was agreed the next Steering Committee meeting would also be held at CERN during the [International School on Low Energy Antimatter Physics](#) in June 2018.

Meet our AVA Fellows (cont.)

Below we present the Fellows that have recently started work in their host institutions, with other Fellows to be introduced in the next issue.

Welcome to AVA!



Siara Fabbri graduated from the Department of Physics and Astronomy at the University of California Los Angeles (UCLA) in spring of 2017.

During her bachelors, Siara conducted research in the Particle Beam Physics Laboratory (PBPL) at UCLA. In her first project at PBPL, she designed and constructed an RF deflecting cavity to streak ultrafast diffracted electron beams as well as perform beam diagnostics. During this time, she simultaneously worked closely with graduate student Emma Curry to demonstrate a guided-THz inverse free-electron-laser technique to compress a 6 MeV 100 fs electron beam by nearly an order of magnitude and develop a longitudinal profile diagnostic. The final project she took part in involved efficient energy extraction from a relativistic electron beam in a strongly tapered undulator.

In summer 2016, Siara further investigated previous research at PBPL on ultrafast electron diffraction microscopy at Lawrence Berkeley National Laboratory. Working on the High Repetition-rate Electron Scattering (HiRES) beamline, she explored novel, high strength focusing techniques to enable the study of nanoscale processes.

Siara is based at the University of Manchester / CERN, where she will develop a project on the “Optimization of Degradation Integration, Beam Injection and B-field Measurements”.



David Haider finished his master's at the Vienna University of Technology (TU Wien) with a growing passion for experimental antimatter physics that led him to become part of AVA. During his studies, he worked at the Institute of High Energy Physics (HEPHY) in Vienna on the analysis of weak decays within the data of the BELLE experiment at KEK, Japan. For his diploma thesis he joined the Stefan Meyer Institute for Subatomic Physics (SMI) in 2016. There David became involved in the AEgIS experiment at the Antiproton Decelerator at CERN. He worked on a scintillating fiber detector designed to verify the production of antihydrogen. More specifically, he established a precise characterization of the Multi Pixel Photon Counters used within the detector for a successful operation during the first antihydrogen production with AEgIS this year.

In 2017, David joined the Beam Instrumentation Research & Development group at GSI/Darmstadt, Germany to work on the next generation of beam intensity monitoring. The ambition is to characterize and to operate an advanced Cryogenic Current Comparator to be implemented in accelerators of the future.





Markus Wiesinger studied physics at the Vienna University of Technology (TU Wien), where he received a bachelor's and a master's degree in physics, both with distinction. During his studies, he spent time at the Max Planck Institute for Plasma Physics in Munich, working on his bachelor's thesis, and at the ETH in Zurich, attending lectures and working on a scintillating fibre detector for the Mu3e experiment. For his master's thesis Markus worked at the Stefan Meyer Institute in Vienna and at CERN in Geneva on the Hbar-HFS experiment, an experiment to determine the hyperfine splitting in antihydrogen. His work primarily focused on tests of the hyperfine spectroscopy apparatus for antihydrogen atoms with hydrogen atoms.

Markus was recruited as AVA Fellow by the Max Planck Institute for Nuclear Physics in Heidelberg. He is based at the proton g-factor experiment in Mainz and will be a member of the BASE collaboration. His work will focus on advanced cooling techniques for protons and antiprotons in penning traps.

As protons or antiprotons do not have transitions suitable for laser cooling, sympathetic cooling by coupling to laser-cooled beryllium ions will be attempted. A successful application of this technique promise improved measurements of the proton and antiproton magnetic moment.



Partner News

Marie Curie celebrations join institutions across Europe

The 7th November 2017 was the 150th anniversary of the birth of Marie Curie Skłodowska Curie. To celebrate her life and achievements, as well as the EU funding program that bears her name, fellows from the [AVA](#) network joined a simultaneous event at the University of Liverpool, [CERN](#) in Geneva and the [Ludwig Maximilians University](#) in Munich. Prof Carsten Welsch, AVA Coordinator, said; *"The event was an enormous success. We had hundreds of school children, students and researchers participate across the three sites, as well as more than half a Million people who read about the event via internet and social media on the day."*

In Liverpool, high school students attended a series of activities at the University. They started their day at the Leggate Theatre in the historic Victoria Gallery & Museum with an introduction by an actor

playing Madame Curie, followed by a live-streamed [talk from CERN by Dr Marco Silari](#) about the international impact of Marie Skłodowska Curie Actions (MSCAs). The students then moved to the Central Teaching Laboratory, where they enjoyed hands-on demonstrations on radioactivity and a



High school students taking part in hands-on activities.

poster session about our MSCA-funded research and training activities with contributions from AVA fellows. The children also participated in their own poster competition about “Women in Science”. The morning activities finished with a [talk by Prof Welsch](#) about Researcher Training that was also live-streamed.



A film contributed by the European Commission's DG EAC, Martine Reicherts.

A film contributed by the [European Commission's DG EAC](#), Martine Reicherts, provided additional background information and the view of the EU.

[Prof Katia Parodi from LMU Munich](#) gave a talk on the impact of MSCAs on education and research in ion beam cancer therapy.



AVA Fellows Bianca Veglia and Volodymyr Rodin at the poster sessions

A special motivation for organizing this celebration were the pan-European training networks including AVA but primarily, Marie Curie remains an inspirational figure who paved the way for many women in science and today, 150 years on from her birth, still continues to inspire a new generation of scientists.

More information, including Fellows' individual profiles and videos of all talks, can be found on the event home page:

<http://www.marie-curie-day-2017.org>.

Physics of Star Wars – Fact or Fiction?

Can the light side and the dark side of The Force be explained by the latest antimatter research? To coincide with the 40th anniversary of the original Star Wars film and the launch of 'The Last Jedi', AVA fellows took part in an outreach event for schoolchildren, undergraduates and PhD students exploring the 'Physics of Star Wars'.

In his lecture, Prof Welsch selected iconic scenes from the movies and used real world physics to explain what is possible and what is fiction. For example, lightsabres would not be possible according to the laws of physics, but many exciting applications are possible, such as laser knives for high precision surgery controlled by robot arms and adaptive manufacturing using lasers for creating complex structures in metals.



AVA Fellow Bianca Veglia.

The light and dark side of The Force in Star Wars was an ideal opportunity to talk about the matter and antimatter interactions we are exploring in [AVA](#).

After the lecture, participants had the opportunity to understand the science behind Star Wars through numerous hands-on activities including laser gravity, augmented reality experiments and two planetariums that immersed the participants into the world of Star Wars.



Schoolchildren learning about the Physics of Star Wars.

Professor Welsch and the AVA fellows who joined him on the day had the kind permission of Lucasfilm to use film excerpts; these were complemented by Lego Star Wars models, a real

cantina as found in the movie, stormtroopers and even Darth Maul himself! [CORDIS News](#), [BBC Focus Magazine](#), the [Warrington Guardian](#), [Physics World](#) and many more have reported the event bringing the AVA project to the attention of hundreds of thousands throughout the galaxy.

Many photographs from the exciting day can be found on Twitter at <https://twitter.com/livuniphysics> (#physicsofstarwars).

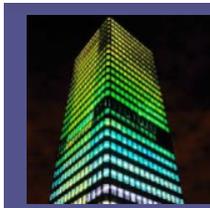


Stormtrooper inspecting LEGO display.

This was not an official Disney/Lucasfilm event, but planned, organised and run by Liverpool staff and students.

Upcoming Events

Low Energy Antiproton Physics Conference, March 2018



Low Energy Antiproton Physics Conference 2018

Jussieu Campus of Sorbonne University, Paris, March 12th to 16th, 2018

The **13th Low Energy Antiproton Physics (LEAP) Conference** will be held in Paris from **12th - 16th March, 2018** at the **University Pierre and Marie Curie in Paris**. Conference topics will include Antihydrogen, Probing the Standard Model and Fundamental Symmetries, Gravity and

Antimatter, Matter-Antimatter Interactions, Hadron and Nuclear Physics with Antiprotons, Exotic Atoms and Applications of Antiprotons. A talk about AVA will be given on Thursday afternoon.

More details are available at: <http://leap2018.lkb.upmc.fr/>

The 9th International Particle Accelerator Conference, April 2018

IPAC'18 will be held in Vancouver, from 29th April to 4th May, 2018.

IPAC is the main international event for the worldwide accelerator community and industry. Attendees will showcase cutting-edge accelerator R&D results and gain the latest insights into accelerator facilities across the globe. Over 1200 delegates and 70 industry exhibits are expected to attend. Fellows and partners from AVA will be at IPAC'18 presenting talks and posters and we look forward to meeting you all at **Booth 400** in the main exhibition hall.

More details are available at: <https://ipac18.org/>



PSAS2018, May 2018

The international conference on precision physics of simple atomic systems will be held from the 14th – 18th May 2018 in Vienna by the Stefan Meyer Institute.

This will be the 10th conference in a series established in 2000 by Savely Karshenboim with topics spanning precision spectroscopy of matter

and antimatter atoms, QED, precision measurements and fundamental constants.

More details are available at www.psas2018.at.



International School on Low Energy Antimatter Physics, June 2018



A week-long International School on Low Energy Antimatter Physics will be held at CERN on 25th – 29th June 2018. It will cover the challenges in antimatter facility design and

optimization, beyond state-of-the-art beam diagnostics and advanced detectors, as well as novel antimatter experiments.

In addition to lectures by research leaders, there will be study groups, a poster session and a dedicated industry session. There will also be opportunities for discussion and networking at evening events and a tour of CERN's unique accelerator facilities.

Several scholarships for early stage researchers from outside of the AVA network are available.

More details are available at: <https://indico.cern.ch/event/677170/>

The registration deadline is 30th April 2018.

Quantum Leap towards the Next Generation of Accelerators, July 2018



The **EuPRAXIA** consortium will be holding a Symposium 'Quantum Leap towards the Next Generation of Accelerators', on 6th July 2018, at ACC Liverpool, UK.

A new technology has emerged that may reduce dramatically the size and cost of particle accelerators, facilitating the access of hospitals and universities to these tools and multiplying its applications. Plasma accelerators, using high-power laser or electron beams, can generate several billion volts of electricity in a gas cell, accelerating electrons to near the speed of light in just a few millimetres.

Whether you are a scientist, a manufacturer, or a student, you can now be part of the future of particle accelerators.

World-renowned scientists will present research highlights on the next generation of accelerators and their enormous impact on science and society. They will be joined by scientists from the EuPRAXIA network and relevant industries who will present their innovations and share their fascination for science.

More information and how to register can be found here: <https://indico.cern.ch/event/695176/>

Position Vacancies

Early Stage Researcher Fellowship within the AVA project at Cosylab d.d.

'Development of a versatile control system'

More information can be found here: <https://www.liverpool.ac.uk/ava/projects/cosylab/>

PhD positions at the University of Liverpool

including a project on the ALPHA experiment

More information can be found here: <https://www.liverpool.ac.uk/quasar/vacancies/vacancies/>

AVA Project Manager

If you would like to work closely with the AVA coordinator and our Fellows, please contact [Professor Carsten Welsch](#) for more information on how to apply.

News from FAIR

Many of the key components for the future particle accelerator facility FAIR are currently under development or in production.

However, production isn't the only decisive step, because the testing of the individual parts' quality is also crucial. CERN and GSI, where FAIR is currently being built, have just concluded a cooperation agreement for the reliability testing of magnets weighing more than 50 tons each and destined for use in the Superconducting Fragment Separator (Super-FRS). [Find out more.](#)

The usual three-year cycle of the FLAIR (Co) spokesperson will soon be coming to an end.



The current FLAIR Spokesperson, Prof Carsten Welsch from the University of Liverpool, has said that he will not continue in this role and an election will take place in due course.

The collaboration has achieved a lot over the past three years: CRYRING was successfully commissioned at GSI/FAIR, a completely new [FLAIR website](#) was established as main communication platform, regular communication was established via MIRROR, new partners have joined the collaboration and, certainly not least, the [AVA project](#) was successfully established and now forms the largest-ever research and training initiative in low energy antimatter physics.



Events

12 th – 13 th March 2018	1st OMA Topical Workshop - Facility Design Optimization for Treatment, PSI, Switzerland
12 th – 16 th March 2018	Low Energy Antiproton Physics Conference, Paris, France
29 th April – 4 th May 2018	IPAC'18, Vancouver, Canada
14 th - 18 th May 2018	PSAS2018. Stefan Meyer Institute, Vienna, Austria
4 th – 5 th June 2018	2nd OMA Topical Workshop - Diagnostics for Beam and Patient Monitoring, CERN, Switzerland
25 th - 29 th June 2018	International School on Low Energy Antimatter Physics, CERN, Switzerland
6 th July 2018	Symposium: Quantum Leap towards the Next Generation of Accelerators, Liverpool, UK
15 th – 17 th October 2018	Topical Workshop: Detectors & Diagnostics, CIVIDEC, Vienna, Austria

Notice Board

There is now only one Fellowships available within AVA. Please encourage suitable candidates to apply.

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

DEADLINE FOR THE NEXT NEWSLETTER CONTRIBUTIONS: 20th April 2018



www.ava-project.eu

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