EuCARD-2

Enhanced European Coordination for Accelerator Research & Development

Newsletter

Accelerating News Issue 18

Charitos, Panagiotis (CERN)

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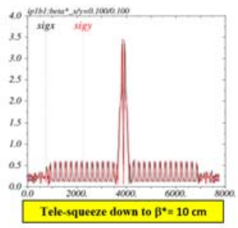

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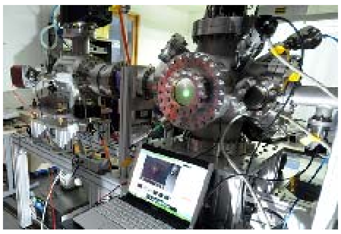

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Accelerating News, Issue #18 - Letter from the Editor

Issue 18 of Accelerating News covers the ongoing R&D activities for the High Luminosity upgrade of the LHC and future accelerator projects.

The approval of the ARIES proposal has been a great success. ARIES will develop new key technologies for present and future accelerators, significantly improving the European accelerator infrastructure as well as broadening global collaboration in the field. Building on the success of EuCARD and EuCARD-2, ARIES aims to boost innovation and strengthen ties with the industry that will maximize the societal impact of fundamental R&D in accelerator technologies.

Another important topic this summer was the formal approval of the High Luminosity LHC project, HL-LHC. This comes as extremely good news not only for CERN, but also for particle physics globally.

In this issue you will also read about the "Achromatic Telescopic Squeezing" scheme, a new optical scheme which will be a key solution to the various challenges of the HL-LHC upgrade, and a necessary ingredient for a possible energy upgrade to the HE-LHC, as explored by the FCC study.

Moreover, you can find more about the milestone of 25T for high-field magnets, the first steps of the QUACO project, as well as news from the plasma accelerator consortium following their latest meeting in Pisa. This summer also saw the completion of the first stage of the HIE-ISOLDE project with the installation of the first two superconducting modules. This post-accelerator will open new physics opportunities for the ISOLDE community at CERN.

Finally, we have a word from Carlos Moedas, the European Commissioner for Science, Research and Innovation. In his opening speech to the EuroScience OpenForum that took place in Manchester, UK in July, Moedas discussed his vision of a new republic of letters that will rise in the coming future, emphasising the relationship of trust between scientists and citizens and the use of open data.

I wish you pleasant reading.

Panos Charitos

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ARIES approved by European Commission

by Jennifer Toes (CERN)

The ARIES project has been approved by the European Commission under the Horizon 2020 Framework Programme for Research and Innovation and will receive €10M in EU funding as requested in its proposal.

The full title of the project is Accelerator Research and Innovation for European Science and Society. It will serve as the spiritual successor to the EuCARD-2 Integrating Activity project, which is due to end in April 2017. The start date for ARIES is yet to be agreed upon, but is foreseen for May 2017, to allow a smooth transition between the two projects.

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The total budget of the project will be €24.8M over the four-year study period, which includes the EU contribution and €14.8 M from the involved beneficiaries. The overall evaluation score of ARIES was 14.5 out of 15. This is the highest score compared with previous EU funded accelerator R&D projects such as CARE, EuCARD and EuCARD-2.

ARIES aims to develop novel concepts and improve existing accelerator technologies; to provide access to top-class accelerator research and test infrastructures to European researchers and industry; to further integrate the European accelerator community; and to develop a joint strategy towards sustainable accelerator S&T.

ARIES will bring together 41 beneficiaries from 18 different European countries, one International European Interest Organization (CERN) and one European Research Infrastructure Consortium (ESS). The beneficiaries are based in the following 18 countries: Austria, Belgium, France, Germany, Hungary, Italy, Latvia, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

The evaluators of the project highlighted the clarity of the project's innovation strategy, the integration such a large variety of partners, the extent of the Transnational Access programme, the intended creation of an e-learning course, the proof-of-concept fund, and the development of compact accelerators as particular areas of interest within the proposal.

During its grant preparation, the Project Coordinator, Maurizio Vretenar (CERN), will agree on a start date for the project with the European Commission and a kick-off meeting for all project collaborators will be arranged.

ARIES EuCARD-2 European Commission proposal grant preparation funding

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Commissioner Carlos Moedas on the new "Republic of Letters"

by Panos Charitos (CERN)

Speaking in the opening ceremony of Euroscience Open Forum 2016, Carlos Moedas, the European Commissioner for Research and Innovation offered his vision of science and the role of the commission in policies and programmes. In his inspiring talk he explained the principles that should guide research and emphasized the need for scientists to engage more with citizens in solving research challenges.

In the new "Republic of Letters" science plays a key role in advancing our fundamental knowledge about nature but also in answering to some of the most pressing problems that Europe is facing in the light of the 21st century. However, to realise this new "Republic of Letters" scientists have to regain the trust of citizens and engage them throughout their research. Toward this direction, Cssr Moedas emphasized the need for open access with open data been deemed the "default mode" for the next set of Horizon 2020 calls.

By continuing investing in research, Europe can strengthen its place in the global research area,

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continue leading innovation and secure its global competitiveness. The development of science and technology is necessary for a sustainable development and guarantees a brighter future for our societies. In an inspiring speech, given at the EuroScience Open Forum conference in July 2016, Carlos Moedas described the rise of the new Republic of Letters:

> If you were a European intellectual during the Enlightenment, the chances are you were a citizen of the Republic of Letters, a community of scholars and literary figures that included the likes of Benjamin Franklin, Goethe and Voltaire.
>
> In Voltaire's correspondence alone, there were nearly 19,000 letters. Voltaire wrote most often to his contemporaries in France, but he also wrote to many others in Germany, Italy, Russia and Switzerland. Across Europe, as universities began publishing academic journals, as royal societies provided patronage to the natural sciences, and as new ideas spread from the salons of the nobles to the coffee houses of the bourgeois, the blueprint for modern science was formed.
>
> Within the Republic of Letters, natural philosophers shared and critiqued each other's ideas. They sent articles and pamphlets to one another and worked towards the expansion of their community, by introducing each other and increasing their networks of correspondence. This was a community that transcended national borders, that experimented and debated across disciplines, and that pursued progress and societal advancement by means of rationalism.
>
> But, though open-minded and meritocratic for the times, the Republic of Letters was a small and privileged community that few people had the means to access. The public was excited by the scientific discoveries of the age, but could play no active role in the process. The Republic of Letters was open science for the few.
>
> By the 19th century, the abundance of new areas of scientific exploration required an overall term for 'men of science' and the word 'scientist' emerged. The industrial revolution and urbanisation had brought science into the public consciousness. National governments were funding science. School children were mastering the rudiments of physics, chemistry and biology in schools and books on science became bestsellers among increasingly literate populations.
>
> Science was now discussed in the laboratory and the lecture hall. Science had succeeded in reaching the professional classes, who could marvel at great exhibitions in their leisure time. So the 19th century enabled more people to take part in science, but, for the most part, science was still closed to ordinary people.
>
> The 20th century, was about nations. Individual nations conquered Everest, achieved space flight and navigated to the poles. Science was defined by one nation's sprint to the finish line after the other and scientific institutions and their funding were organised accordingly. Science was a matter of national pride and national security. More people were attending university than ever before and broadcasting had brought science into people's living rooms. But still, the public remained an audience to be instructed, rather than an active participant in the scientific debate.
>
> In the 21st century, science can no longer be distant to the public. It requires public support to

succeed. I think of it in terms of a triangle between the public, scientists and data, with the public firmly at the centre.

It is my view that we are entering a new era of global and open science. This will return us to some of the founding principles of science. So the 21st century is not about one nation's sprint to the finish line.

As I said, in the 18th century the Republic of Letters was open science for the few. The 21st century will become the Republic of Letters for the many. Rather than being an elite activity, concentrated in a few countries in Europe, 21st century science will involve tens of thousands of scientists working collaboratively across the globe.

Equally as important, the relationship with the general public will define science. Because, unlike in the past, each of us now commands more information in our pockets than any scientist could ever read in their lifetime. This information overload requires public trust in scientists to determine fact from fiction. Trust that will be built on the integrity and objectivity of scientists, and that will depend on good communication. Therefore, the persistent historical division between the "intellectual" and the "non-intellectual", which I described earlier, is one that every scientist and every politician should be worried about.

Though globalisation provides the international integration that makes it possible for countries to work together on global challenges, such as climate change and migration, in its current form it has fallen short of benefitting the majority of people.

A scientist can explain how renewable energy can help to combat climate change, but how does that help someone who cannot afford to heat their home? A politician can explain the net benefits of migration, but how does that help someone who cannot get a doctor's appointment?

The current lack of public and political engagement in fact-based decision-making even has people asking, have we have entered a "post-factual" era of democracy? One in which the public identifies with populist rhetoric and decisions are made based on fears and assumptions, because people feel science and politics have left them behind.

So what do we do about this? How do we build trust? How can we be clear and transparent? How do we ensure progress in this triangle of the public, scientists and data? I believe many of the answers lie in open science. Open access to data needs trust and transparency. Public acceptance requires research integrity and citizen science brings scientists closer to people.

Let's start with open access to data and research integrity.

The future of our knowledge economy will rely on public access to data, so that 1) the European public can take part in the scientific debate and 2) the public can directly access scientific evidence on the issues they care about.

You have to show how data can change lives. Recently in San Francisco, with the help of data in a deep learning system, the system detected cancer in more cases than cancer experts.

But with greater availability of scientific data, comes the need to ensure the integrity of what is being shared. The public needs to know that research results are not falsified, fabricated or plagiarised.

This is why we're putting more focus on research integrity in Horizon 2020 model grant agreements. And today, I can announce that the grant agreements for Horizon 2020 have been updated. They will include clearer rules on Research integrity, making sure that all researchers and research institutions know their obligations.

Citizen science.

We also need to find ways for the European public to take part in the processes behind scientific discovery 1) to help decide the priorities for public research funding and 2) so the European scientific community can crowdsource solutions with the volume and diversity to provide new insights.

Take, for example, the potential of gaming to help scientists multiply the number of brains working on a single problem at any given time.

Five years ago, gamers famously resolved the structure of an enzyme that causes an Aids-like disease in monkeys. Scientists had been working on the problem for over a decade. By using an online puzzle game, gamers solved the structure in just three weeks.

So, to ensure Europe leads the way on open science, I can announce that, from today, the Commission has made open data the default for all Horizon 2020 projects. Moreover, we have now approved the next set of calls under Horizon 2020. Fifty calls, worth around 8.5 billion euro in 2017, in areas ranging from food security, to smart cities, to understanding migration.

For all projects funded by these calls, we will expect the data generated to be open access.

In addition, I am currently working with colleagues in the Commission on our proposed revisions to EU copyright law. The aim is to introduce a research exception in copyright that will apply across all Member States, and which will provide a predictable legal framework for Text and Data Mining.

The trends towards open science and open data are not something we can stop, So we should lead change, rather than adapt to it later.

Of course, talking about Horizon 2020 here in the UK, I know that there is a great deal of uncertainty about what the future holds. I have heard concerns about British organisations being dropped from EU projects. There are concerns about staff from other EU member states still being able to work in British research institutions.

I wish I could give you all the answers, but for now I can make two clear statements: First, for as long as the UK is a member of the European Union, EU law continues to apply and the UK retains all rights and obligations of a Member State. This of course includes the full eligibility for funding under Horizon 2020. Second, Horizon 2020 projects will continue to be evaluated based on merit and not on nationality. So I urge the European scientific community to continue to choose their project partners on the basis of excellence.

I would like to conclude with this message: By continuing to allow the gap between public perception and scientific ambition to increase, we risk, at best, apathy and, at worst, complete distrust at a crucial juncture.

Europe should not only be part of a Global Research Area that embraces open science, we should lead the way to this new Global Research Area.

Following the agreement by EU science ministers in May, Europe is the first region of the world to make open access the norm for all scientific publications, and now the largest research funding programme in the world to introduce open data as a default for all projects.

So let's create a new Republic of Letters: one that is inclusive, one that values its people as much as progress and one that restores trust and confidence in science."

Carlos Moedas | European Commission | ESOF | republic of letters | European science | issue 18

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New milestone for High Temperature Superconductors at UNIGE

by Carmine Senatore & Panos Charitos

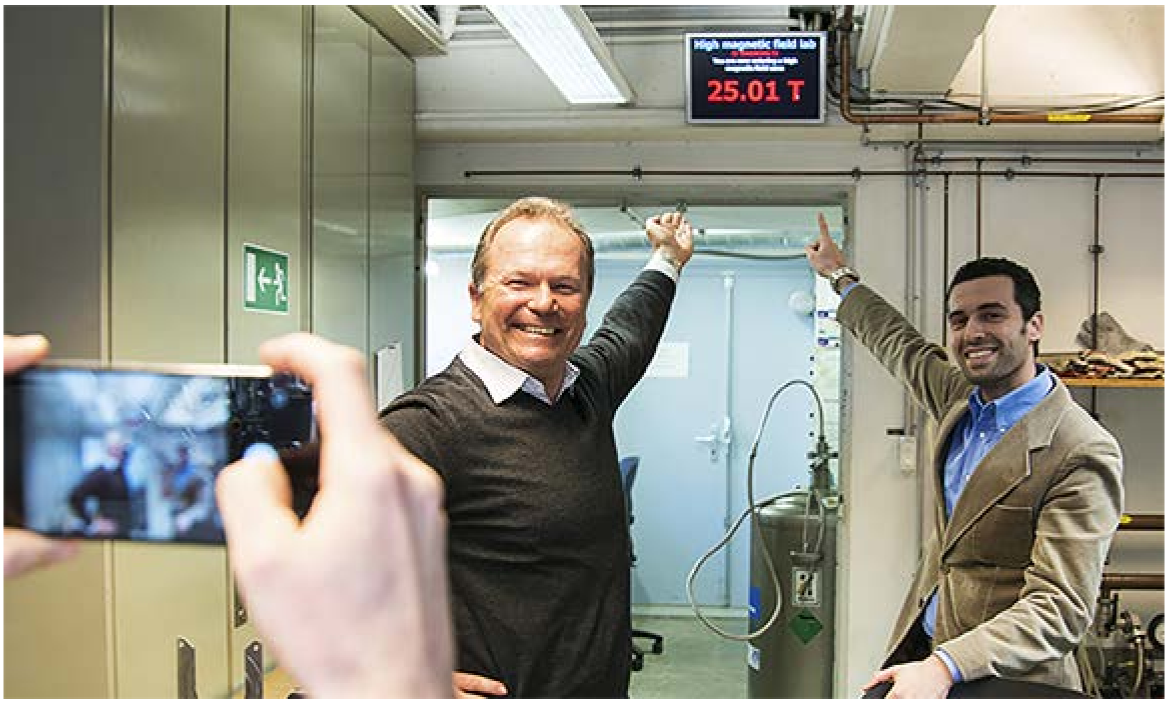
Details of the innovative superconducting coil, conceived and manufactured by researchers from UNIGE and Bruker BioSpin. (Image: © L. Windels, UNIGE)

High field superconducting magnets are the enabling technology for particle colliders, modern magnetic medical imaging, magnetic resonance spectroscopy and fusion reactors. To further push the boundaries of science, enhancing resolution or energy, these devices call for ever increasing magnetic fields. However, solenoidal coils built with the Low Temperature Superconductors (LTS) NbTi and Nb3Sn are limited to around 23.5 T while accelerator dipole magnets based on LTS will most likely reach their ultimate performance at about 16 T.

Recent progresses in the technology of High Temperature Superconductors (HTS) and, in particular, in REBa2Cu3O7-x (REBCO, RE = rare earth) coated conductors (CCs) have paved a way for the development of all-superconducting solenoids capable of generating fields in the range of 30 T, i.e. well beyond the limits of the present technology. However, the development of REBCO magnets still poses several fundamental and engineering challenges.

Carmine Senatore, Professor at the University of Geneva (UNIGE) is actively working in the study of applied superconductivity and through EuroCirCol is working for the development of high-field magnets for a future circular collider based on Nb3Sn under the scope of the FCC Study and EuroCirCol project. Senarore, also works on the development of HTS magnets. He is deputy leader of one of the working packages of EuCARD2 (WP 10.2) exploring different HTS conductor concepts and aiming to manufacture conductor prototypes to feed the HTS accelerator magnet demonstration program, which is the scope of WP10.

Recently his research group in the University of Geneva achieved the goal of generating a magnetic field of 25 T and, thus, obtaining the European record of highest superconducting generated magnetic field. Researchers at UNIGE worked closely with Bruker BioSpin to combine a Bruker laboratory magnet producing 21 T, already installed at UNIGE, with an innovative superconducting insert coil that allowed to increase the field by an additional 4 T. This means that in total, a field well beyond the 23.5 T reachable with conventional superconducting coils could be generated.



Piotr Komorowski, R&D engineer at Bruker and Professor Carmine Senator (UNIGE) pointing to the record field of 25T (Credits: UNIGE)

Concerning the scope of the project, Senatore says: «high magnetic fields are an indispensable tool for research in physics and material science as well as medical applications. This technological need represents the driver for the development of HTS, as they are the only means to generate fields well above 20 T». Riccardo Tediosi, manager of Bruker BioSpin's Superconducting Technologies group adds: "the successful test of the 25 T coil represents a positive test-bench of ideas that we are developing for the next-generation HTS-based NMR magnets. We see that commercial breakthroughs in this field are at reach and 2017-2018 is going to be a very exciting period for Bruker and the NMR community."

The REBCO tapes used to achieve the 25 T in the solenoidal magnet are also studied under EuCARD-2 to build a dipole demonstrator able to generate 5 T in standalone configuration. It is then planned to use the same dipole demonstrator in a background field allowing to reach fields of up to 20 T. The 20 T target in the dipole compared to the 25 T reached in the solenoid should not generate confusion. Compared to solenoids, accelerator magnets are different "animals": they need compact windings for reason of efficiency and cost, very high currents to ease protection, and they experience large forces transverse to the cable. Simple electromagnetics tells us, they require the double of ampere-turns to generate the same field.

However, there is much in common between the 25 T development based on REBCO coils and the goals of EuCARD-2. Senatore explains: We investigated the electrical, mechanical and thermo-physical properties of commercial REBCO tapes from all over the world. The results of these studies guided the choice of the commercial tape to be used for our insert coil and at the same time provided important inputs to the development of the conductor for the dipole prototype of EuCARD-2. The EuCARD-2 dipole will use these tapes in the form of a Roebel cable, a century old technology used for electrical machines. First winding tests have been performed, in various geometries, and a small coil is presently in test at CERN to validate the manufacturing process that will be used for the final magnet, planned for 2017.

high field magnets | HL-LHC | EuroCirCol | EuCARD-2

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Higher energies for ISOLDE's radioactive ion beams

By Athena Papageorgiou Koufidou (CERN)

HIE-ISOLDE cryomodule with five copper RF cavities and one solenoid magnet assembled at the SM18 clean room. (Image: Maximilien Brice, CERN)

On 28 September, the members of the ISOLDE collaboration and major stakeholders came together in a well-deserved celebration. The first phase of the facility's high energy and intensity upgrade (HIE-ISOLDE) is now complete and a promising future is in sight as experiments started on 9 September.

ISOLDE is the oldest facility still in operation at CERN and one of the most successful. It currently occupies a leading position in the field of radioactive ions research, producing the largest range of isotopes worldwide (over 1300 isotopes of more than 70 elements), which are used in multiple fields of physics: nuclear and atomic physics, astrophysics and fundamental interactions. A key element of ISOLDE's success is the wealth of technical expertise it has accumulated over the decades, especially in the construction of target ion source units. The secret to the facility's longevity, however, is its vibrant international collaboration and its ability to adapt to the changing physics landscape.

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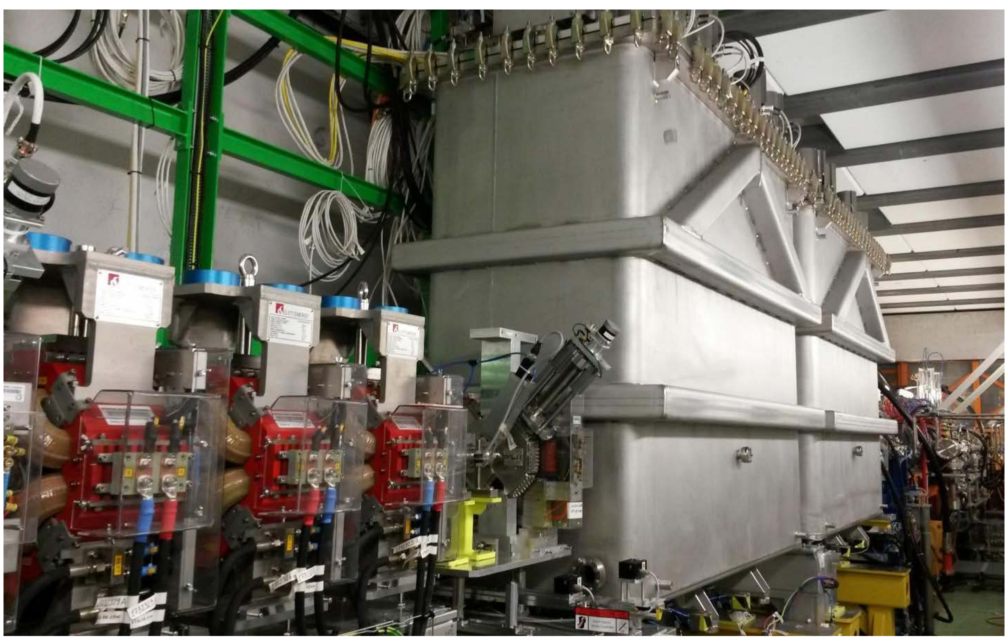
An impressive team is behind HIE-ISOLDE, comprising leading physicists, engineers and other experts in accelerator and beam technologies. Another essential ingredient of the workforce are early stage Marie Curie researchers, who acquire valuable skills in the area of advanced accelerator technologies, reflecting the commitment of ISOLDE on training the next generation of experts.

Taking beam energy and intensity to new heights

The production of radioactive ion beams at ISOLDE begins when a high energy proton beam from the PS Booster hits the facility's target, resulting in a wide variety of reaction products. These are ionised in a surface, plasma or laser ion source and separated according to mass, producing the beam of the preferred element. An RFQ cooler and buncher lowers the temperature of the radioactive beam, thus significantly reducing emittances and energy spreads. The beam is then delivered to the low-energy experimental stations or charge bred and post accelerated at the REX accelerator.

The energy upgrade of the facility entails the construction of a superconducting linear accelerator (HIE-linac) to increase the energy of radioactive ion beams, a high energy beam transfer line to bring the beam to the experiments, as well as new beam diagnostic tools. The intensity upgrade aims to improve the target and ion source, the mass separators and charge breeder.

HIE-linac takes advantage of many cutting edge cryogenics and radiofrequency technologies that were originally developed for the LHC. It is equipped with superconducting radiofrequency cavities made of copper coated with niobium and operating at 101.29 MHz. They are cooled by liquid helium at 4.5 K in ultra high vacuum conditions. In the first phase of the energy upgrade, two high beta cryomodules, each containing five cavities and one superconducting solenoid magnet, were coupled to REX-linac and commissioned, thus increasing energy to 5.5 MeV per nucleon. Two more cryomodules with the same configuration will be added in the second phase, allowing beams to be accelerated to 10 MeV per nucleon; one is currently in the SM18 clean room, awaiting installation in 2017, and the other is scheduled to be assembled and installed in 2018. In the third and final phase, two low-beta cryomodules, containing six cavities and two solenoids each, will be manufactured and installed in replacement of the 7-gap and 9-gap normal conducting structures of REX, allowing beams to be decelerated to 0.3 MeV per nucleon.



The tunnel at HIE-ISOLDE now contains two cryomodules – a unique set up that marks the end of

phase one for the HIE-ISOLDE installation. By Spring 2018 the project will have four cryomodules installed and will be able to reach higher energy up to 10 MeV/u. Image credits: Erwin Siesling/CERN.

After post-acceleration in HIE-linac, radioactive ions enter the high energy beam transfer line (HEBT), which is specially designed to preserve emittances. Then, the beam is delivered to the different experimental stations through one of two beam lines that have been in operation since 2015. A third one will be installed in early 2017.

The PS Booster upgrade and the operation of Linac 4 after LS2 are expected to increase the primary proton beam intensity at ISOLDE to 6.7 μA, allowing more exotic isotopes to be produced and more precise measurements to be obtained. However, the new experimental conditions create a set of challenges that necessitate ISOLDE's intensity upgrade. Higher radiation levels limit the lifetime of the target, thus options for new target materials with a focus on radiation resistance are explored, while materials that are presently used undergo extensive radiation tests. The laser ion source (RILIS) has also been upgraded, improving selectivity and developing new ionisation schemes. Finally, the improvement of the mass separators will reduce isobaric contamination.

HIE-ISOLDE is currently the only next generation radioactive beam facility available in Europe, while SPIRAL-2 and SPES are still under construction,and the most advanced isotope separation on-line (ISOL) facility in the world.

New physics opportunities

HIE-ISOLDE creates a wealth of opportunities for research in many aspects of nuclear physics, astrophysics, as well as solid state physics, because it can produce a wide variety of exotic nuclei at different energies. The upgrade was welcomed by the international nuclear physics community and is in line with the recommendations of the Nuclear Physics European Collaboration Committee. Over thirty experiments have already been approved and are now at the preparation stage.

Nuclear physics

Scientists have been studying the atomic nucleus for more than 100 years, starting with Ernest Rutherford in 1911, yet many open questions remain: What is the nature of nucleonic matter? What happens if we change the energy, momentum, or temperature of the nucleus? Studying radioactive ion beams allows researchers to dig deeper into these questions, as radioactive nuclei often behave differently than stable ones and can reveal certain aspects of nuclear behaviour that their stable counterparts cannot. Accelerating these exotic nuclei to higher energies provides new physics possibilities, matching the innovative theoretical developments of the field. Many of the approved experiments plan to use Coulomb excitation, including studying the physics of super-heavy nuclei, which could reveal the next magic numbers in the very heavy systems. Other experiments will investigate transfer reactions, which may allow physicists to unravel the evolution the structure of the nucleus's energy levels, also known as its 'shell structure'.

Nuclear astrophysics

HIE-ISOLDE also paves the way for advances in nuclear astrophysics, a field that explores the abundance of chemical elements in the Universe. Hydrogen and helium, which were produced seconds after the Big Bang, comprise 74% and 24% of ordinary matter in the Universe, while most other elements were created inside stars much later. Astrophysicists have extensively studied how elements up to the iron region are produced, but the processes by which nuclear reactions produced elements with a higher atomic number remain largely a mystery.

Although we know that these heavy elements were created by stellar explosions and nuclear processes in stars, matching specific events to the observed distribution patterns poses a considerable challenge. The higher intensity, reduced emittance and possibility for beam deceleration at HIE-ISOLDE will enable astrophysics experiments to shed light to this problem. Some research teams plan to investigate neutron-rich nuclei that form in the crust of neutron stars, while others will study the proton-capture process that occurs during X-ray bursts or explosions of white dwarves, research the production of chemical elements in the collapsed core of supernovae and address the problem of lithium-7 abundance in the Universe.

Solid state physics

The solid state programme at ISOLDE encompasses materials science, biophysics and biochemistry, complementing nuclear physics research. It would greatly profit from the high purity and intensity ion beams of HIE-ISOLDE, as well as from the modernisation of the facility. Such research can have considerable social benefits as well, because it yields a wide range of applications — from nanomaterials and superconductors to advances in cancer diagnosis and therapy.

A flying start for HIE-ISOLDE

On 9 September, the first exotic beam at HIE-ISOLDE marked the start of operations for the new facility. The experiment investigated charge states of tin isotopes, using transfer reactions and Coulomb excitation of an 110-Sn-26+ beam, post accelerated to 4.5 MeV per nucleon. Besides demonstrating the experimental capabilities of the upgraded facility, this successful first run validated the technical choices of the HIE ISOLDE team and provided a fitting reward for eight years of rigorous R&D efforts.

Almost half a century after the first ion beams bombarded the ISOLDE target, the facility is thriving and, thanks to the energy and intensity upgrade, continues to create new opportunities for radioactive ions research. The upgrade team and the users are now looking forward to an exciting, intense period.

Loading

From biomedical applications to nuclear astrophysics, physicists at CERN's nuclear physics facility, ISOLDE, are probing the structure of matter. To stay at the cutting edge of technology and science, further development was needed. Now, 8 years since the start of the HIE-ISOLDE project, a new accelerator is in place taking nuclear physics at CERN to higher energies. With physicists setting their sights on even higher energies of 10 MeV in the future, with four times the intensity, they will continue to commission more HIE-ISOLDE accelerating cavities and beamlines in the years to come.

You can find more information about ISOLDE here.

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EUP **Plasma Accelerator Consortium met in Pisa**

by Prof. Carsten Welsch (University of Liverpool)

EuPRAXIA and EuroNNAc members gather for the meeting in Pisa, Italy (Image courtesy of EuPRAXIA)

Particle accelerator experts from around the world joined experts from the laser and novel accelerator communities to discuss the design of an innovative European plasma accelerator within the framework of the EuPRAXIA and EuroNNAc projects.

The workshop took place between June 29th and July 1st at the Area della Ricerca in Pisa, Italy and was hosted by the Istituto Nazionale di Ottica – CNR.

The local organiser, Leo Gizzi said: "It has been an absolute pleasure to see the vibrant discussions amongst participants. The definition of the key parameters of such an international facility with global reach and impact is one of the most exciting things a researcher can be part of. The event gave us the opportunity to reflect on the state-of-the-art and at the same time outline the R&D programme required to reach our goals by the end of the design study."

The design and science cases of advanced plasma accelerators are subject of intense studies around the world. Progress in proof-of-principle experiments has led to the expectation that ground-breaking applications of plasma accelerators will become available in the next few years.

Ralph Assmann gives a speech to attendees at Pisa meeting (Image courtesy of EuPRAXIA)

More than 120 delegates discussed the parameters and technical specifications required at the interfaces between lasers and plasmas, plasmas and particle beams, as well as particle beams and other applications such as Free Electron Lasers, High Energy Physics detectors and ultra-compact X ray devices. Discussions also covered the specific requirements in beam diagnostics, laser technology and underpinning simulation codes.

The aim of the meeting was to collect the input from all interested parties in order to define a full parameter set that will be used as the core of a conceptual design for a European plasma accelerator with industry beam quality that shall now be developed by the project partners until the end of 2019. Targeted workshops will now be organised by each of the EuPRAXIA work packages in order to build up on the Pisa discussions and further refine all parameters.

All presentations and further information can be found on the workshop's indico page. For more information about EuPRAXIA, please refer to the project website.

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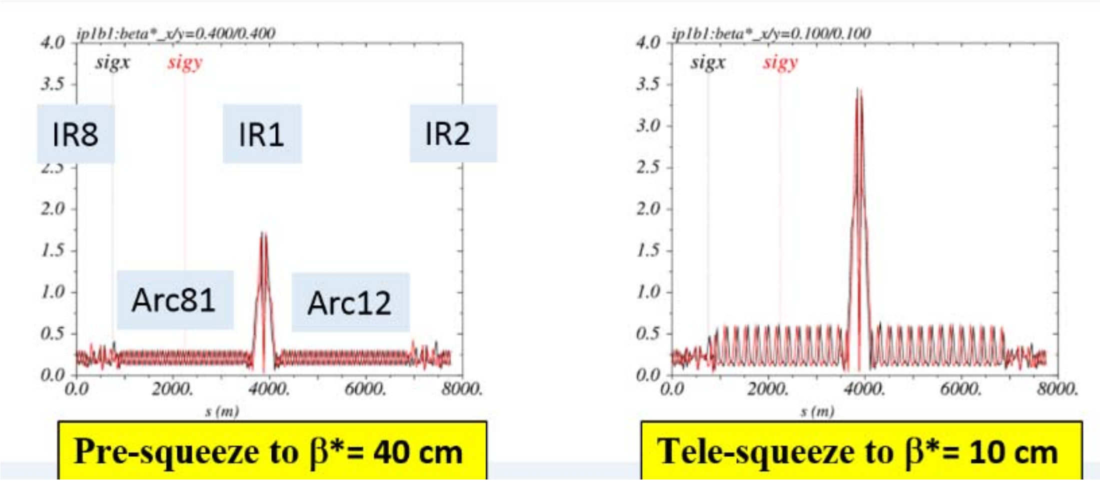
A novel optics scheme to meet the HL-LHC targeted performance

by Stephane Fartoukh and Panos Charitos



Beam sizes [mm] along a quarter of the LHC ring. The interaction point (IP) of the ATLAS experiment is exactly in the centre. In the end of the Tele-squeeze the spot size is no larger than 5 microns at the IP, thanks to the ATS scheme transforming 7km of machine into a giant final focus system with natural embedded chromatic correction sections in Arc81 and Arc12. (Image: Stephane Fartoukh)

Upgrading the luminosity of a circular collider means increasing the number of interactions between the two counter-rotating particle beams. The goal is to maximise the potential of observation (or discovery) of rare (or unexpected) events, and to improve the measurement accuracy of already known phenomena.

An important ingredient to reach this goal is to increase the density of particles colliding at the interaction point (IP), in particular decrease the transverse beam spot size at the IP, that is quantified in accelerator science with the so-called beta* parameter. Like light rays, however, a strong focusing assumes a certain lever arm, that is also and mainly a certain distance, between the incoming beam and its focus point. When this distance is fixed, increasing the number of lenses (the role of the quadrupole magnets in particle accelerators) and increasing their strength is the only way forward. But this presents obvious limits in terms of integration and maximum possible field for new magnets.

This is the case for the long straight sections of the LHC, which host the machine experiments. Here the geometry is fixed by the existing LEP tunnel, and no modifications are expected for the LHC luminosity upgrade project (HL-LHC) or its possible energy upgrade (HE-LHC), one of the scenarios explored under the FCC design study.

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In order to address this challenge, Stephane Fartoukh, who works in CERN's beam department came up with the idea of a novel optics scheme inspired by the classical principle of a telescope in light optical systems. The LHC is a ring with a 27 km long circumference where 8 long-straight sections, or "insertions", are evenly distributed along the ring. Half of the insertions are for special services (such as collimation) and the others host high-energy physics experiments, in particular the two high luminosity insertions ATLAS and CMS.

In the new scheme designed by Stéphane, the beam focusing is achieved in two stages. The first stage, called "Pre-squeeze", is confined to the high luminosity insertions proper (see Fig. 1 left) until limits of strength are reached in the matching quadrupoles. This is the common approach followed by modern colliders. In order to gain an additional beta* squeezing factor, which is of vital importance for the HL-LHC program, the second stage, called "tele-squeeze", involves quadrupole magnets which are located in the two insertions 3.5 km downstream and upstream on either side (see Fig.1 right). The two stages are part of a scheme called ATS, short for "Achromatic Telescopic Squeeze".

The term "Achromatic" reflects the second novelty of the technique. As is the case in light optics, particles with slightly different energies are focused differently, inducing chromatic aberrations, in particular chromatic distortions of the beam spot at the IP, which increase violently for very strong focusing, rendering it inefficient after a certain point. Special magnets called sextupoles are located in the LHC arcs between two consecutive insertions in order to compensate for this effect. Stephane explains: "Contrary to conventional optics squeezing techniques, these magnets are run at constant strength and therefore cannot exceed any field limits in the second, telescopic, part of the ATS, because they are made more efficient when the beam becomes bigger in the arcs." He adds, "Otherwise it would have been quite a copious effort to build and replace more than 500 lattice sextupoles for the HL-LHC".

This concept required fully new optics deployed in all parts of the LHC ring, from injection to collision energy. A detailed study program has been setup with dedicated beam time allocated in the LHC schedule. The first stage of the ATS has been successfully tested, and first collisions with nominal specific luminosity have been established.

"The heart of the HL-LHC is already beating in the LHC. We are now ready to enter in what one could call the telescopic era of the LHC, and prove with beam the reliability of the overall scheme, with the High Luminosity LHC and High Energy LHC as medium and long term objectives for the ATS scheme," Stephane concluded.

For more information on the ATS scheme, please see a detailed report from June 2016 (submitted to the ICFA Beam Dynamics Newsletter of Vol. 70).

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First international superconducting magnet test facilities workshop

by Marta Bajko (CERN) and Panos Charitos (CERN)

Overview of CERN's Large Magnet Hall (Image Credit@CERN)

Within the HL-LHC project about 100 superconducting magnets will be produced in the next years up to 2024. Magnets of different type and size will use NbTi or Nb3Sn technology. The design of the superconducting magnets is well advanced at CERN, and other collaborating institutes and for most of them plan to build a model and a prototype magnet during the period 2016-2018. From13-14th of June CERN hosted the 1st International Workshop on Superconducting Magnet Test Facilities where the status of different facilities was presented along with the needed steps to meet the needs and the rising interest on superconductors.

For the design of new high-field magnets for HL-LHC and for the scenarios explored under the FCC study, there are several institutes together with CERN. working on the testing of the models, prototypes and even the series magnets. Some institutes are equipped with adequate infrastructure while others are completing their installations during the next coming years.

The test of a superconducting magnets is part of the QA process to assess the soundness of the construction and the suitability for machine operation. In addition, tests are important also during construction/building of magnets, as an integral part of the construction chain. One has to get timely feedback to take corrective actions during the construction process. In that sense test is a key milestone for triggering acceptance and passage of responsibility between firms and institutes (in case of industrial orders) or among institutes (in the case of in-kind contribution). For the readiness of the test stands and for achieving a a good coherence between the facilities and planned test, it is essential

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to coordinate the activities with the magnet production managed by WP3, WP6 and WP11 of HL LHC (MSC group at CERN and collaborating Institutes).

The SMTS Workshop contributes to the above mentioned coordination and assessment of the needs and readiness. The main goal of the SMTS workshop is to verify that all test stand will be ready in time and able to perform measurements that will meet the HL-LHC standards. Through regular meetings we to create an active network between the test stands allowing them to exchange methods, techniques, and experience on equipment, data and finally expertise when and where needed. Presently test stations for the HL-LHC magnets exist in the following laboratories: FNAL (USA), BNL (USA), CERN (Switzerland), KEK (Japan), KEK (Japan), CEA Saclary (France), Freia (Sweded), INFN (Milano), LBNL (USA) and Nafassy (Italy)

Most of the test stands for superconducting magnets are in collaboration with CERN for the HL-LHC project but we would like to welcome those working in this area as well independently if they will or not test magnets for HL-LHC or future collider projects. Therefore the above mentioned list has been extended and now also includes GSI (Germany), PSI (Switzerland), JINR (Russia).

This workshop provided a forum for potential users of the Trans National Accesses (TNA) supported by FP7 Eucard2 project and Aries (presently under evaluation). More than 60 participants were registered for the one and a half days of presentations followed by an interactive visit to CERN test facility in SM18. OnAt that occasion 20 experts, mainly from CERN, were sharing their knowledge with the workshop participants during 2 h.

Further events will cover subjects linked to specified areas of measurements as magnetic or mechanical measurements while protection and detection systems will also be treated in detail. The connection to the final IT STRING test will be covered, too. The safety and the interlock systems used by the different test stands will be presented with the goal to optimise the stands and improve where possible the safety of the personnel and the equipment.

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Antimatter research boosted by EU funding

by Alexandra Welsch

In 1928, British physicist Paul Dirac wrote down an equation that combined quantum theory and special relativity to describe the behaviour of an electron moving at a relativistic speed. The equation posed a problem as it could have two solutions: One for an electron with positive energy, and one for an electron with negative energy.

Today we know that for every particle that exists, so does a corresponding antiparticle, exactly matching the particle but with opposite charge. When matter and antimatter come into contact, they annihilate each other – disappearing in a flash of energy. In theory, the big bang should have created equal amounts of matter and antimatter. So why is there far more matter than antimatter in the universe?

The AVA project logo

This question and a number of other equally fundamental questions about the laws of nature are being addressed at CERN's unique Antiproton Decelerator facility. Efforts to answer these questions, the Accelerators Validating Antimatter (AVA) project was created and has been selected for funding by the European Union.

Professor Carsten Welsch, Head of the University of Liverpool's Department of Physics who is based at the Cockcroft Institute and coordinator of AVA, said: "Antimatter experiments are at the cutting edge of science, but they are very difficult to realize. This year the new Extra Low Energy Antiproton ring (ELENA) is being commissioned at CERN and will be a critical upgrade to the unique AD facility. In addition, there are also exciting long-term prospects through opportunities a future low energy antimatter facility might provide as part of the FAIR research centre in Germany."

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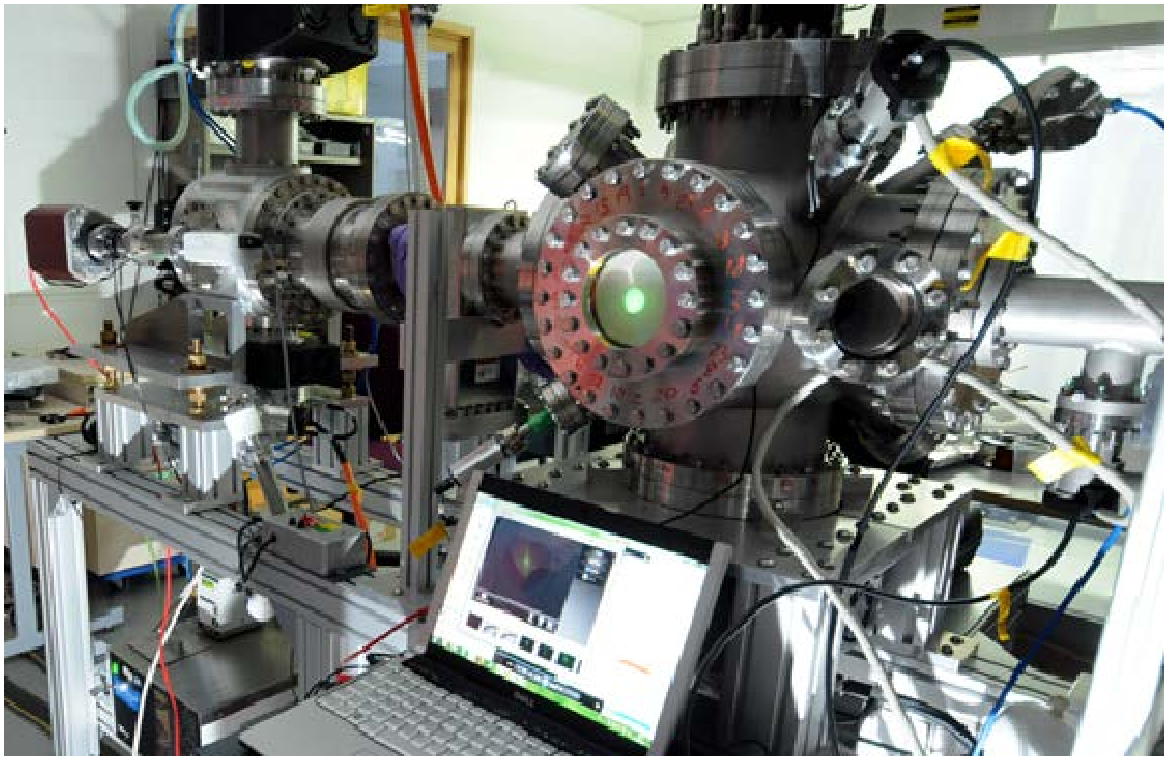

A gas jet experiment. (Image courtesy of University of Liverpool/Cockcroft Institute)

AVA is an Innovative Training Network within the H2020 Marie Skłodowska-Curie actions which will enable an interdisciplinary and cross-sector program on antimatter research. The network comprises a lot of the European expertise in this research area, and joins five universities, eight national and international research centers, and 13 industry partners.

Within AVA, the project partners will carry out research across three scientific work packages. These cover facility design and optimization, advanced beam diagnostics and novel low energy antimatter experiments. A total of 15 Fellows will be recruited and become part of larger scientific teams. A structured combination of local and network-wide trainings will also be offered within AVA. This includes hands-on training on accelerator facilities, as well as an international training programme consisting of Schools, Topical Workshops and Conferences that will be open to all Fellows, as well as the wider scientific community.

The network will recruit its Fellows for start in spring/summer 2017. The deadline for applications is 31st January 2017. More information about the project can be found on the project home page: http://www.ava-project.eu.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 721559.

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QUACO companies ready for announcement

by Isabel Bejar Alonso (CERN) & Panos Charitos (CERN)

The QUACO project logo (Image: CERN)

The four companies that will participate in phase 1 of the QUACO project are expected to be announced on the 29th September 2016. QUACO is a Pre Commercial Procurement (PCP) Project (Grant Agreement 689359) with scope to procure two pilot 3.8 m quadrupole magnets with two 90 mm apertures, an integrated gradient of 440 T with 120 T/m in the transverse plane, and which will have an operational temperature of 1.9 K. The magnets will be installed in the matching sections.

PCP is the European Union's Horizon 2020 COFUND instrument for purchasing R&D services for the development of innovative products, services or processes. One of the biggest advantages of PCP is that it allows all involved parties, both public buyers and private suppliers, to share opportunities as well as risk. As such, public purchasers are able to acquire innovative solutions to satisfy challenging needs. In addition, the project supports the R&D of enterprises, with particular benefits for small and medium enterprises (SMEs) which are encouraged to grow their competitive capital.

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Leading companies in the field of magnet production attended the first QUACO meeting to provide an impression of present needs and share feedback with CERN experts (Image: CERN)

The QUACO project draws together four research infrastructures with similar technical requirements in magnet development. By pooling efforts on technological requirements and using their experience from prior procurements, the partners in QUACO act as a single buyer group with sufficient momentum for potential suppliers to consider the phased development of the requested magnets.

The four QUACO partners are:

- Commissariat à l'Energie Atomique et aux Energies alternatives (CEA), France,
- European Organization for Nuclear Research (CERN), Switzerland,
- Centro De Investigaciones Energeticas, Medioambientales Y Tecnologicas (CIEMAT), Spain,
- Narodowe Centrum Badan Jadrowych (NCBJ), Poland

CERN acts as the lead procurer coordinating and leading the joint procurement in the name and on behalf of the aforementioned organisations.

The project began on 1 March 2016 and will come to an end in February 2020. It is divided into three phases: solution design, prototyping and pilot deployments, with intermediate evaluations after each phase that will progressively select the best competing solutions.

The QUACO Open Market Consultation was held at CERN on 30 March 2016. Leading companies in the field of magnet production attended the meeting to provide an impression of present needs and share feedback with CERN experts. The meeting covered a range of topics, from technical aspects, such as the current status of the Q4 magnet, its technical scope and requirements; to more legal and administrative matters, such as the legal and contractual framework in which the procurement will be executed. Moreover, CERN engineers demonstrated several examples of tools and fabrication methods that might be used in the frame the project. The project tooling requirements were explained, and the market availability and areas for development were identified.

Pre-commercial procurement is a unique and novel procurement method in the field of accelerator components, and QUACO aims to demonstrate its full potential for success in this field.

HL-LHC magnets industry