
Open data

In November 2014, CERN launched its Open Data Portal that allows the LHC experiments to share their data with a dual focus: firstly for the scientific community, including researchers outside of the CERN experimental teams as well as citizen scientists, and secondly for the purposes of training and education through specially curated resources. All data is in the public domain under the Creative Commons “zero” license, a first in CERN’s long history, and can be cited in scientific discourse using a unique digital object identifier.

In 2015, the CERN Open Data Portal has been ramped up with further data and code releases. This last year has seen increased use of these resources, and, in the spirit of open science, unexpected applications of the data, such as training in big-data analytics and data mining. CERN’s Open Data team has transferred experience and inspired many teams around the world by participating in conferences and online forums.

Science in the cloud

CERN is working towards building a European Open Science Cloud using the experience gained through various major projects together with the Helix Nebula initiative – a public-private partnership. The work of Helix Nebula instigated CERN to lead a Horizon 2020 project to create a procurement network of public research organisations, named PICSE (Procurement Innovation for Cloud Services in Europe), interested in making use of commercial cloud services to support their research programmes. In 2015, PICSE investigated the feasibility of a cross-border PCP (pre-commercial procurement) for shared procurement across public organisations. The European Commission decided to contribute funding to the HNSciCloud (Helix Nebula – The Science Cloud) PCP project led by CERN, which started in January 2016.

Education and sharing

Since the early seventies, the CERN School of Computing has been promoting advanced learning and knowledge exchange in scientific computing among young scientists and engineers involved in particle physics or other sciences. It is made up of three separate schools, each of them having a particular flavour and focus. In 2015, the Main School – which lasts two weeks and acts as a summer university, providing a series of lectures and hands-on exercises – took place at Kavala in Greece. Of the 76 participating students from 47 institutes, 68 passed the exam and received six ECTS credits.

The Meyrin and Wigner Data Centres together host around 15 000 servers, which are renewed every four to five years as they become obsolete for the purposes of CERN’s research. However, they remain suitable for less demanding applications. In March 2015, 224 servers and 30 switches were donated to the COMSATS Institute of Information Technology in Islamabad, Pakistan, to be used by scientists working on the ALICE experiment at the LHC. A few months later, in August 2015,

384 servers, 24 switches and 26 racks were donated by CERN to institutes in Mexico, which are using them for a variety of scientific and educational projects in the fields of physics, mathematics, energy and environmental sciences. To date, servers and switches have been donated to nine countries, namely Bulgaria, Egypt, Ghana, Morocco, the Philippines, Senegal, Serbia and now Mexico and Pakistan.

New phase for CERN openlab

In January 2015, CERN openlab entered its fifth three-year phase. Through this unique public-private partnership, CERN collaborates with leading ICT companies and research institutes to accelerate the development of cutting-edge solutions for the LHC community worldwide. Huawei, Intel, Oracle, and Siemens are all partner companies, Brocade, Cisco, IDT, Rackspace, and Seagate are contributors, and Comtrade and Yandex are associate members. For the first time, other public research organisations – the European Bioinformatics Institute (UK), the GSI Helmholtz Centre for Heavy-Ion Research (Germany) and Newcastle University (UK) – also joined as members. The topics selected for this new phase include next-generation data-acquisition systems, optimised hardware and software-based computing platforms for simulation and analysis, scalable and interoperable data storage and management, cloud-computing operations and procurement, and data-analytics platforms and applications.

CERN openlab held two new events in 2015: a first-of-its-kind open day in June 2015, and the CERN openlab “Innovation and Entrepreneurship” event in October, organised in collaboration with CERN’s Knowledge Transfer group and IdeaSquare. In addition, the CERN openlab Summer Student Programme continued to go from strength to strength, with forty students representing 27 nationalities coming to CERN.



TEDx CERN speakers included CERN's Edda Gschwendtner showcasing the AWAKE experiment and describing how her passion for science ignited at a young age. (CERN-PHOTO-201510-198-13)

Making an impact

Welcome to CERN

In 2015, CERN welcomed around 107 000 visitors from more than 70 countries on guided tours, 46% of whom were school pupils. From July onwards, visitors had the chance to discover the revamped *Microcosm* exhibition before it was fully opened in January 2016. The new layout uses real objects, 1:1 scale audio-visual supports and high-definition photography to take visitors on a journey through CERN's key installations, the network of CERN's accelerators and on to particle collisions inside vast experiments.

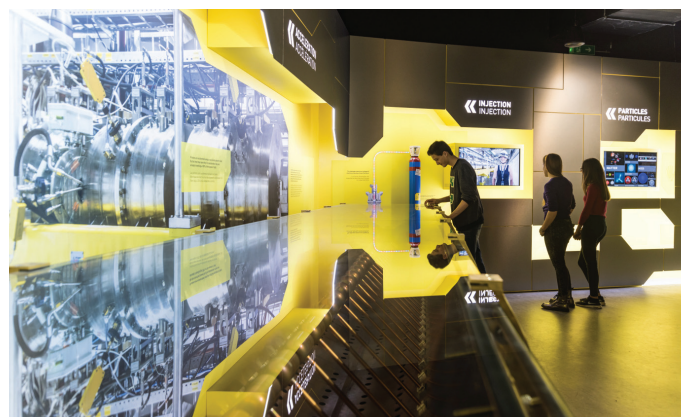
The travelling exhibition *Accelerating Science* was shown in the CosmoCaixa science museum in Barcelona, from October onwards. The "Interactive LHC tunnel" – a high-tech audio-visual installation allowing the audience to play with LHC proton collisions or visualise the Brout-Englert-Higgs field – has become a popular attraction in science museums and fairs. It has been shown, together with the *CERN in Images* poster exhibition, with great success at ten different locations in seven countries.

The third edition of TEDx CERN was held in October, with a local audience of 600 and an online audience of more than 10 000, including viewing parties at 23 institutes. Two TEDx CERN 2015 videos have been republished on TED.com, where videos have an average viewing figure of one million per talk. In addition, CERN organised a new CERN FameLab competition as well as the joint French, Swiss and CERN Masterclass and the Swiss final. Participants went on to succeed at the FameLab International Finals at the Cheltenham Science Festival – the overall winner had won the Swiss final and the runner-up had won the CERN competition. Concluding a two-year initiative, CERN organised the PopScience event for European Researchers' Night with activities at a large, local shopping centre and its cinema complex. The aim was to meet people who would not have come to a laboratory of their own accord and the event saw 500 visitors attend cinema showings for schools, with 700 attending the public cinema showings.

In collaboration with the University of Geneva, the French *Ministère de l'Éducation nationale* and Geneva's *Département*



The new S’Cool LAB at CERN welcomed more than 4000 school students and teachers in its first full year of operation. Its hands-on experiments include cloud chamber construction and visualising X-rays using pixel detectors. (OPEN-PHO-LIFE-2016-003-17)



The new *Microcosm* exhibition takes visitors on an interactive journey through CERN, following the path of particles from the bottle of hydrogen onwards to discovery. (CERN-PHOTO-201603-050-1)

de l’instruction publique, CERN organised another round of its “Be a Scientist” initiative in which more than 750 children from primary schools took part, discovering the process of scientific research. As well as this, in February, more than 600 pupils from local schools visited the CMS detector. Screenings of the movie *Particle Fever* were shown, including one at Saint-Genis-Pouilly in collaboration with the French mission to the UN in Geneva. CERN was also present at the *Cité des Métiers* exhibition in November, which demonstrated the variety of CERN’s and International Geneva’s professions to thousands of visitors.

A thirst for learning

The programmes for secondary-school teachers continued with 36 one-week national language programmes taking place for a total of 1067 teachers from 41 countries. The three-week international High School Teacher programme, in English, welcomed participants of 40 different nationalities, and a special course for teachers of engineering disciplines was held for participants from Bulgaria.

A one-week programme for school students and teachers from the SESAME members – Bahrain, Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, the Palestinian Authority and Turkey – was held in September 2015. The course brought together 28 teachers and students from the Middle East, who came to know each other and learn about CERN as a model for scientific and human collaboration, regardless of political or cultural differences. The programme also prepared the ground for a continuing future collaboration between schools in the SESAME members.

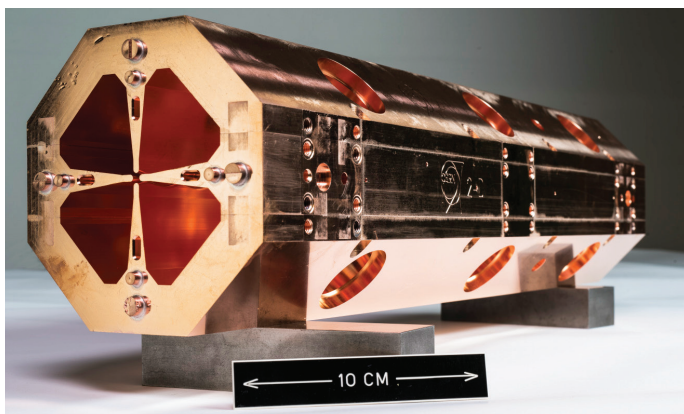
After the success of the first edition in 2014, CERN repeated the Beamline for Schools (BL4S) competition in 2015, with the help of external sponsorship via the CERN and Society Foundation. Teams of high-school students proposed experiments and winning teams were invited to come to the Laboratory and

perform their experiments on a fully equipped beamline in collaboration with CERN scientists. Of the 119 submitted proposals, two teams, from Florence, Italy, and Johannesburg, South Africa, made the biggest impression on CERN experts and were invited to the Laboratory for ten days in September (see p. 11).

Read all about it

The CERN-initiated SCOAP³ consortium – the Sponsoring Consortium for Open Access Publishing in Particle Physics – is a global partnership of more than 3000 libraries, funding agencies and research institutions in 47 countries. By 2015, SCOAP³ has supported more than 8000 open access articles in high-quality peer-reviewed high-energy-physics journals. Thanks to SCOAP³, authors retain intellectual property rights to their work, and permissive Creative Commons licences allow immediate redistribution and reuse of the publications’ content, free of charge, for any purpose, provided they are duly attributed to the authors. To date, about 20 000 authors from some 90 countries have enjoyed these benefits at no cost. Furthermore, CERN implemented its Open Access Policy in 2015. Thanks to SCOAP³ and bilateral agreements with key publishers, more than 96% of CERN’s particle physics results were published on an open-access basis in 2015. In comparison, other research institutes of a similar size publish on average about 10% of their articles open access. In the spirit of open science, the LHC experiments began sharing their data in the public domain in 2014 with the CERN Open Data Portal. In 2015, the portal was augmented with further data and code releases. Data have been used in many applications, such as training in big-data analytics and data mining.

In 2015, CERN doubled the number of albums of its historical photo archives available to the public, digitising them and adding 120 000 images distributed across 14 000 albums: the entire black and white collection from the founding of the Organization



A miniature accelerator for health

With the experience gained at Linac4, a linear accelerator under development (see p. 25), CERN engineers developed a miniature version of one of its components, the radio-frequency quadrupole. This mini linac was conceived to match the needs of medical accelerators for treating certain forms of cancer with particle beams, and for producing medical isotopes.

The resulting compact accelerator will be just two metres long, and offers an attractive alternative to the much larger circular machines that have traditionally been used in this role. Tests should get under way in 2016, and, in the meantime, the first licence to use this technology has already been granted. CERN's brand new linear accelerator, in miniature form, could be about to start appearing in hospitals, making a solid contribution to health.

The first of the four modules that will make up the miniature accelerator developed to be used for treating certain forms of cancer. (CERN-PHOTO-201506-138-3)

through to 1986. As well as archive images, new ways of seeing CERN emerged when photographers were invited to the Laboratory as part of the Global Particle Physics Photowalk. For Arts@CERN, partnerships were organised with international cultural organisations including ADMAF from the United Arab Emirates, Ars Electronica from Austria and the Rupert Centre for Art and Education from Lithuania, as well as governmental bodies such as the Pro Helvetia Swiss Arts Council, the Canton and the City of Geneva, the Ministry of Culture of Taiwan and the Federal Chancellery of Austria. The programme welcomed Collide@CERN Pro Helvetia artists "Fragment.In" from Switzerland and Collide@CERN Ars Electronica arts collective "Semiconductor" from the UK for three-month residencies at CERN, as well as curating visits for eight other artists – 15 artists in total in 2015.

CERN's Press Office welcomed around 400 media visits and registered more than 180 000 press cuttings throughout the year. Seven million unique visitors looked at CERN's core websites, and in October CERN moved its homepage to <http://home.cern> after receiving its own top-level domain. Social media users mentioned CERN and the LHC 1.2 million times, with notable peaks around April's LHC restart and June's 13 TeV collisions, as well as when CERN's Star Wars-themed joke was published for April Fools' Day (see p. 9) In March, CERN was awarded the Best Swiss Twitter Page 2015 at the WorldWebForum in Zurich, beating the Twitter accounts of Swiss tourism, luxury brands and tennis champion Roger Federer.

Transferring the knowledge

2015 saw the launch of CERN's Knowledge and Technology Transfer Network for SMEs and a growing network of Business Incubation Centres (BICs). The BIC initiative that began in 2012 now has eight centres in Austria, Finland, France, Greece, Norway,

the Netherlands, Spain and the UK. The French incubation centre was launched in the framework of the quadripartite partnership between CERN, France, the Department of Ain and the Community of Communes of the Pays de Gex that was put in place in 2014. These centres hosted nine fledgling companies in 2015, covering technologies ranging from sensors for robotics and automation to nanocoatings for applications in electricity generation and cooling.

IdeaSquare made significant progress during its first year of operation, organising or hosting some 40 events. The facility connects detector R&D with cross-disciplinary teams working on societal challenges. Events included several Challenge-Based Innovation (CBI) courses for MSc-level students, workshops on R&D for industry and private investors, and weekend hackathons such as THE Port. IdeaSquare currently also hosts two large EU co-funded detector projects, TALENT and EDUSAFE.

The strong interest at CERN in participating in the EU Horizon 2020 (H2020) programme continues, and a number of proposals involving CERN were submitted. Out of the 12 new H2020 projects selected for funding in 2015, five are coordinated by CERN. Their range of fields and activities includes: laser spectroscopy for radionuclides (EIBT-LS), ultrafast imaging sensors for medical applications (ULTIMA), development of novel quadrupole magnets for the High-Luminosity LHC (QUACO), a private-public partnership for cloud computing (HNSciCloud), and smart sensor technologies for radiation-enhanced applications and measurements (STREAM). In addition, the EC's Marie Skłodowska-Curie Actions provided funding for more than 190 young researchers to work at CERN in 2015.