Science Springs

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richardmitnick 9:46 pm on September 22, 2017
Permalink (https://sciencesprings.wordpress.com/2017/09/22/from-cern-courier-injecting-new-life-into-the-lhc/)

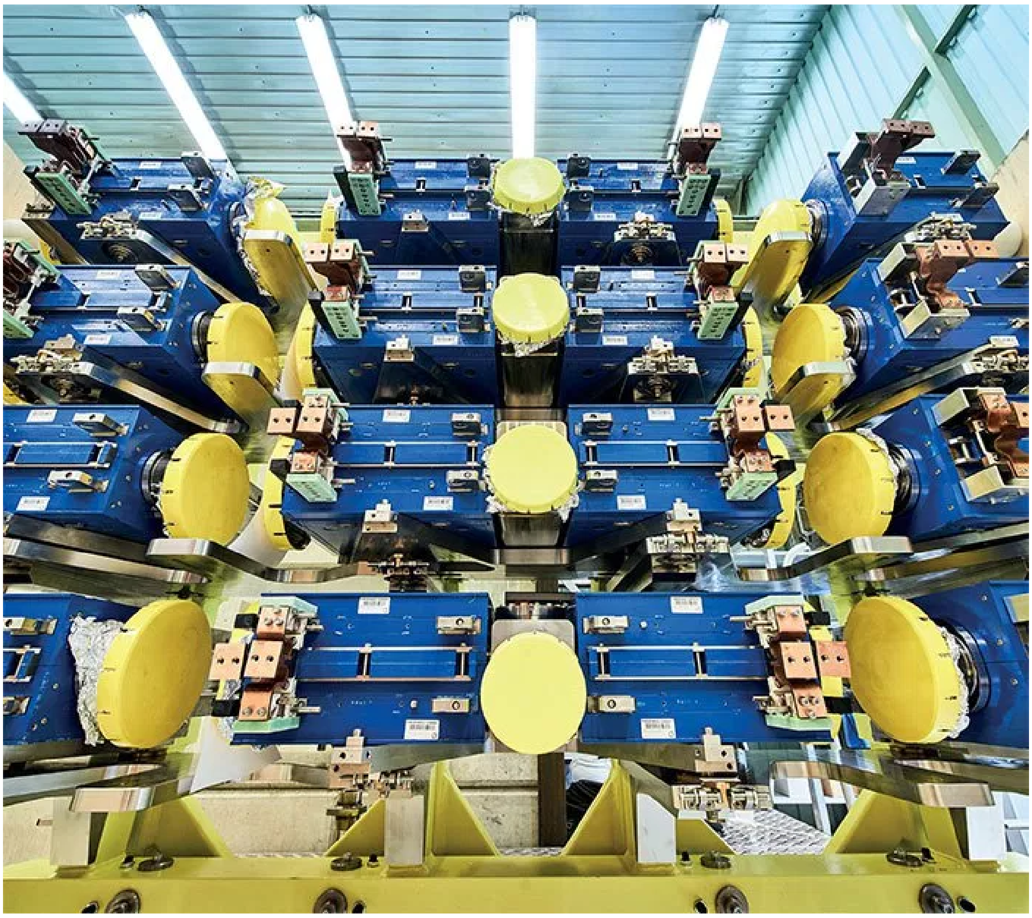
Tags: Accelerator Science (600), Basic Research (7,934), CERN Courier (20), CERN HL-LHC, CERN LHC (170), HEP (889), Other CERN Linacs, Particle Accelerators (732), Particle Physics (1,059)

From CERN Courier: “Injecting new life into the LHC”

CERN Courier

Sep 22, 2017

Malika Meddahi
Giovanni Rumolo

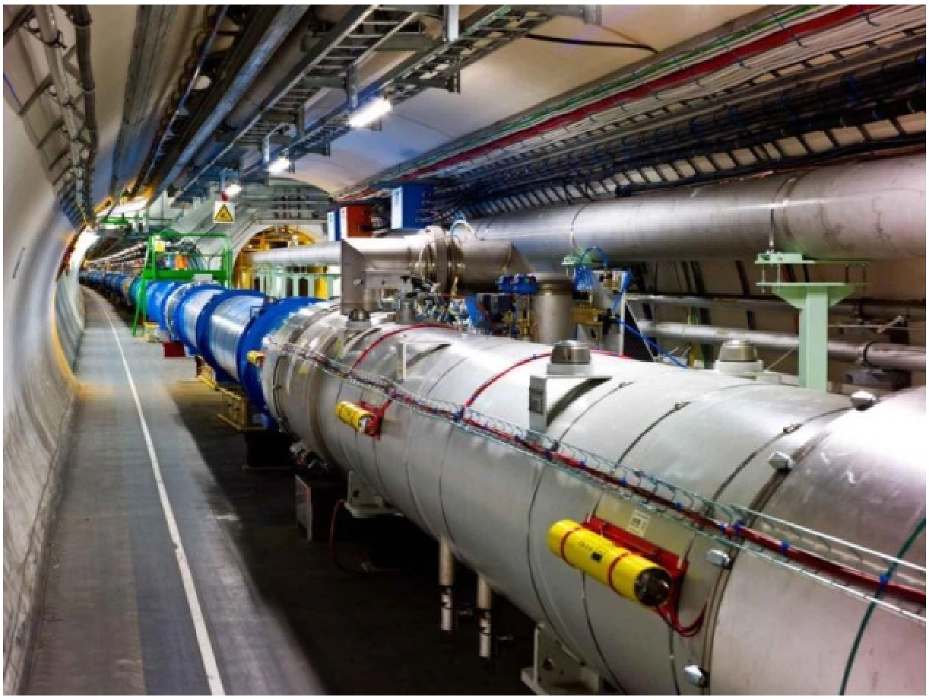


Beam transfer magnets. No image credit

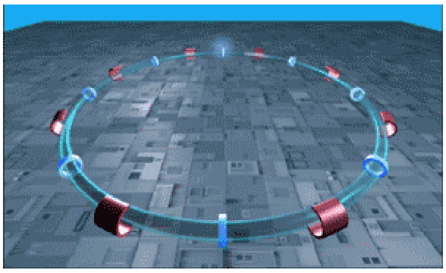
The Large Hadron Collider (LHC) is the most famous and powerful of all CERN’s machines, colliding intense beams of protons at an energy of 13 TeV.

LHC

CERN/LHC Map



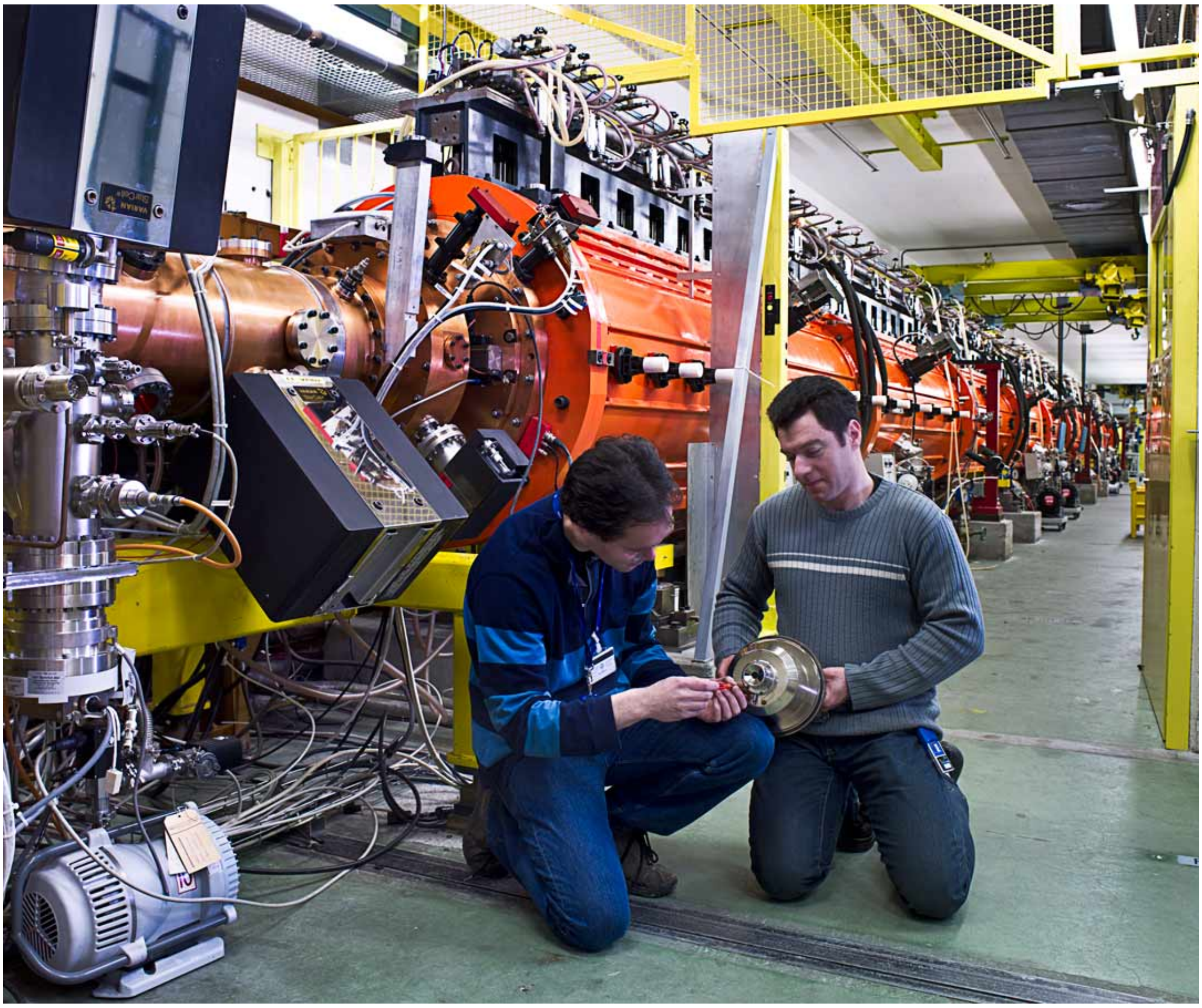
CERN LHC Tunnel



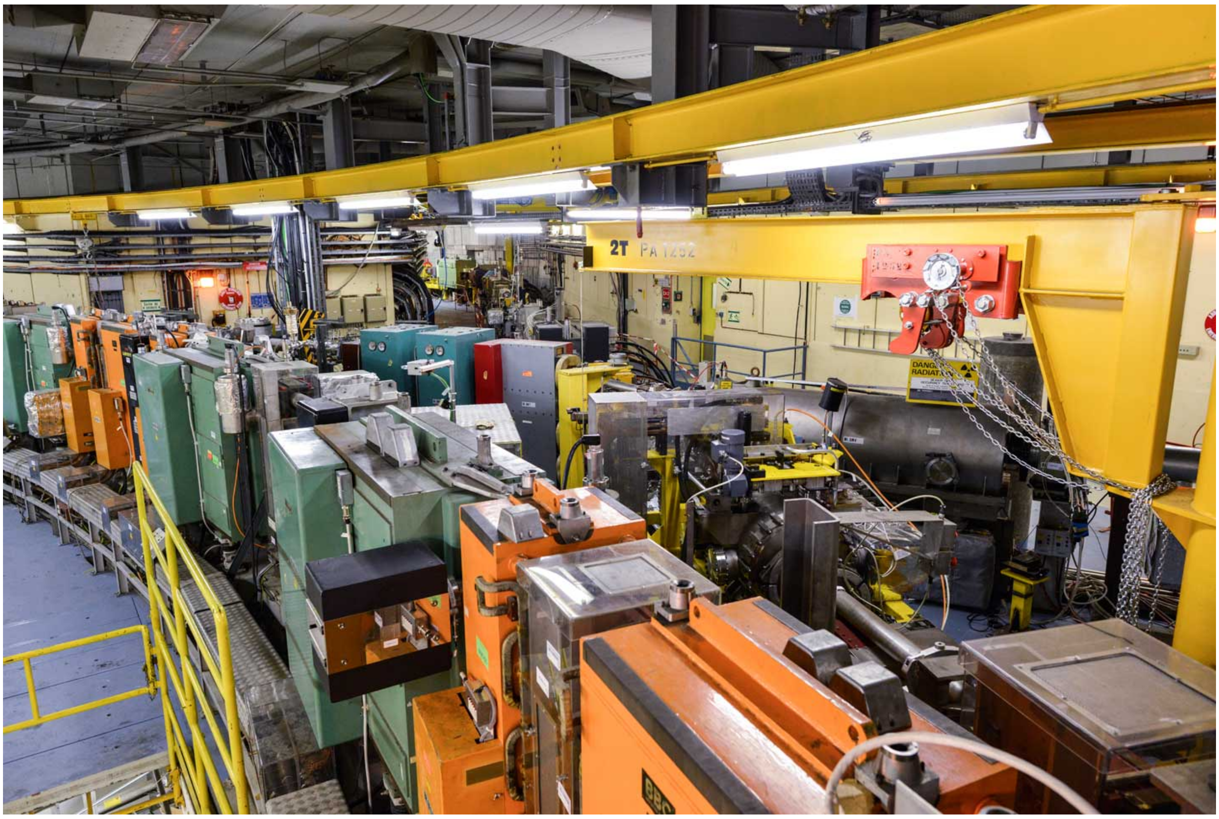
CERN LHC particles

But its success relies on a series of smaller machines in CERN’s accelerator complex that serve it. The LHC’s proton injectors have already been providing beams with characteristics exceeding the LHC’s design specifications. This decisively contributed to the excellent performance of the 2010–2013 LHC physics operation and, since 2015, has allowed CERN to push the machine beyond its nominal beam performance.

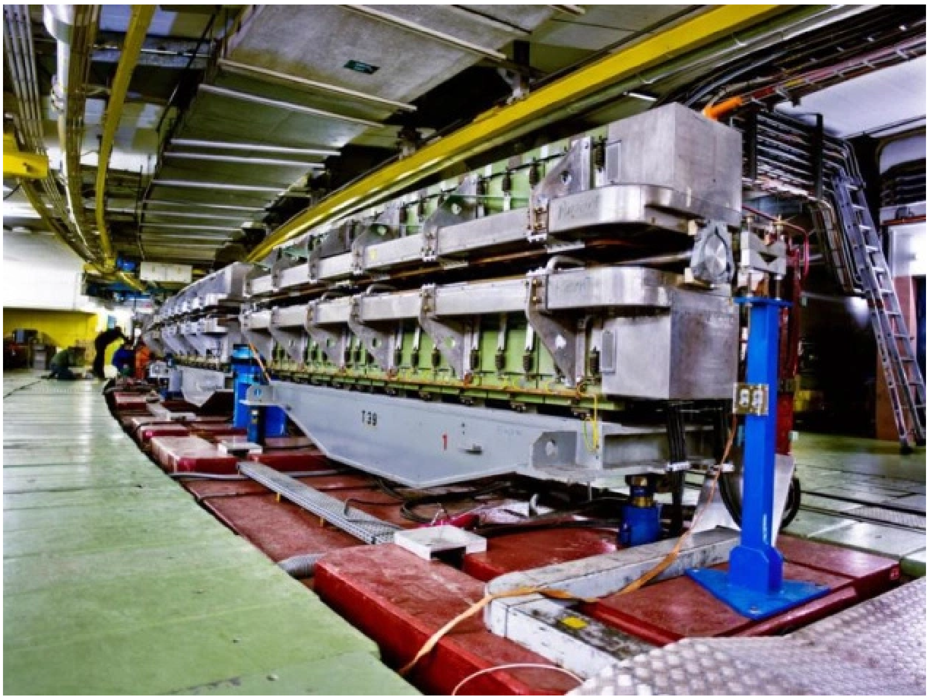
Built between 1959 and 1976, the CERN injector complex accelerates proton beams to a kinetic energy of 450 GeV. It does this via a succession of accelerators: a linear accelerator called Linac 2 followed by three synchrotrons – the Proton Synchrotron Booster (PSB), the Proton Synchrotron (PS) and the Super Proton Synchrotron (SPS).



CERN Linac 2. No image credit



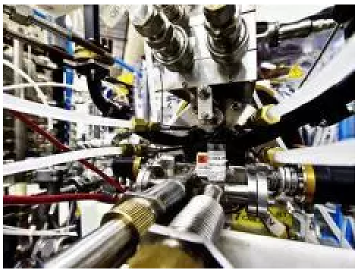
CERN The Proton Synchrotron Booster



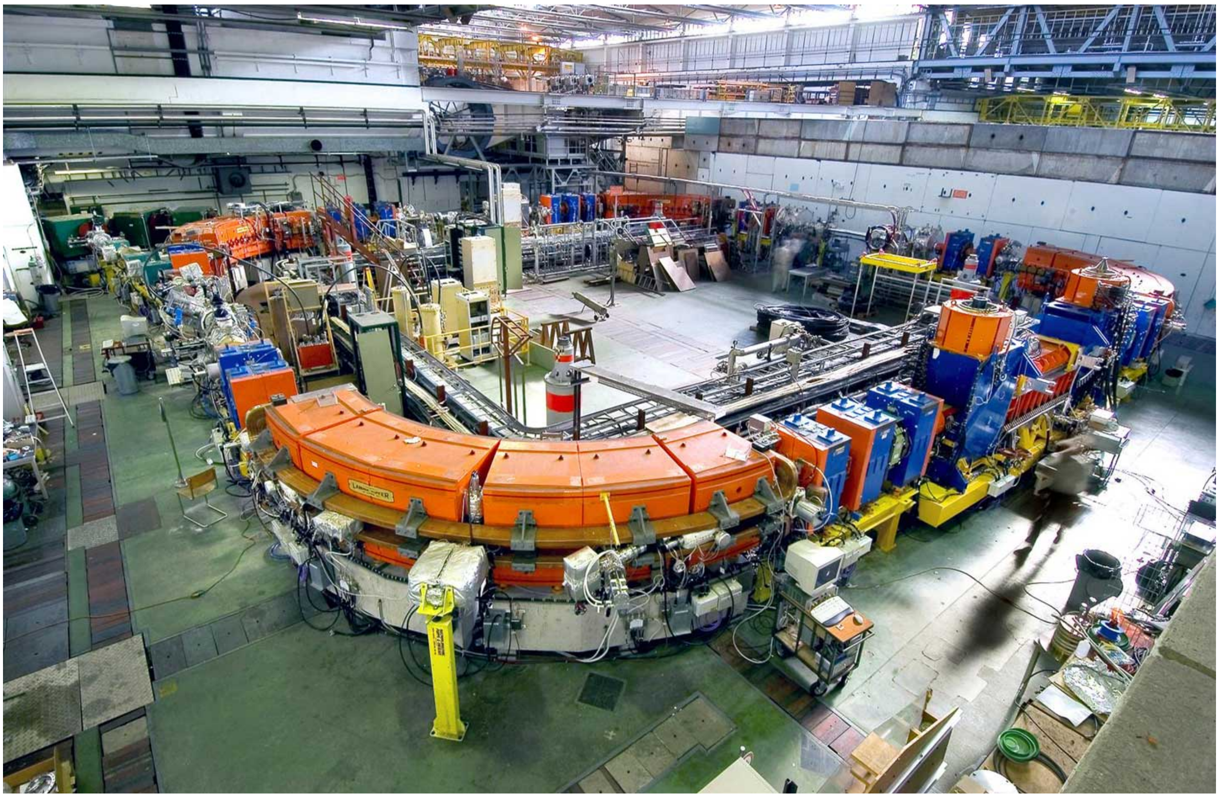
CERN Proton Synchrotron

CERN Super Proton Synchrotron

The complex also provides the LHC with ion beams, which are first accelerated through a linear accelerator called Linac 3 [nand the Low Energy Ion Ring (LEIR) synchrotron before being injected into the PS and the SPS.

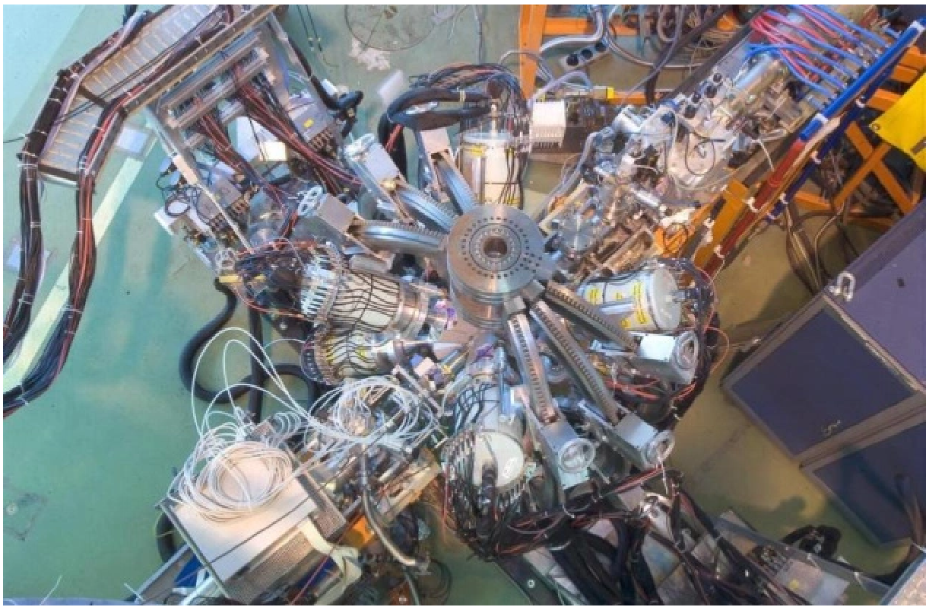


CERN Linac 3



CERN Low Energy Ion Ring (LEIR) synchrotron

The CERN injectors, besides providing beams to the LHC, also serve a large number of fixed-target experiments at CERN – including the ISOLDE radioactive-beam facility and many others.



CERN ISOLDE

Part of the LHC's success lies in the flexibility of the injectors to produce various beam parameters, such as the intensity, the spacing between proton bunches and the total number of bunches in a bunch train. This was clearly illustrated in 2016 when the LHC reached peak luminosity values 40% higher than the design value of 1034 cm–2 s–1, although the number of bunches in the LHC was still about 27% below the maximum achievable. This gain was due to the production of a brighter beam with roughly the same intensity per bunch but in a beam envelope of just half the size.

Despite the excellent performance of today's injectors, the beams produced are not sufficient to meet the very demanding proton beam parameters specified by the high-luminosity upgrade of the LHC (HL-LHC).

High Luminosity LHC

Indeed, as of 2025, the HL-LHC aims to accumulate an integrated luminosity of around 250 fb–1 per year, to be compared with the 40 fb–1 achieved in 2016. For heavy-ion operations, the goals are just as challenging: with lead ions the objective is to obtain an integrated luminosity of 10 nb–1 during four runs starting from 2021 (compared to the 2015 achievement of less than 1 nb–1). This has demanded a significant upgrade programme that is now being implemented.

Immense challenges

To prepare the CERN accelerator complex for the immense challenges of the HL-LHC, the LHC Injectors Upgrade project (LIU) was launched in 2010. In addition to enabling the necessary proton and ion injector chains to deliver beams of ions and protons required for the HL-LHC, the LIU project must ensure the reliable operation and lifetime of the injectors throughout the HL-LHC era, which is expected to last until around 2035. Hence, the LIU project is also tasked with replacing ageing equipment (such as power supplies, magnets and radio-frequency cavities) and improving radioprotection measures such as shielding and ventilation. [See https://sciencesprings.wordpress.com/2017/09/21/from-cern-next-stop-the-superconducting-magnets-of-the-future/%5D

One of the first challenges faced by the LIU team members was to define the beam-performance limitations of all the accelerators in the injector chain and identify the actions needed to overcome them by the required amount. Significant machine and simulation studies were carried out over a period of years, while functional and engineering specifications were prepared to provide clear guidelines to the equipment groups. This was followed by the production of the first hardware prototype devices and their installation in the machines for testing and, where possible, early exploitation.

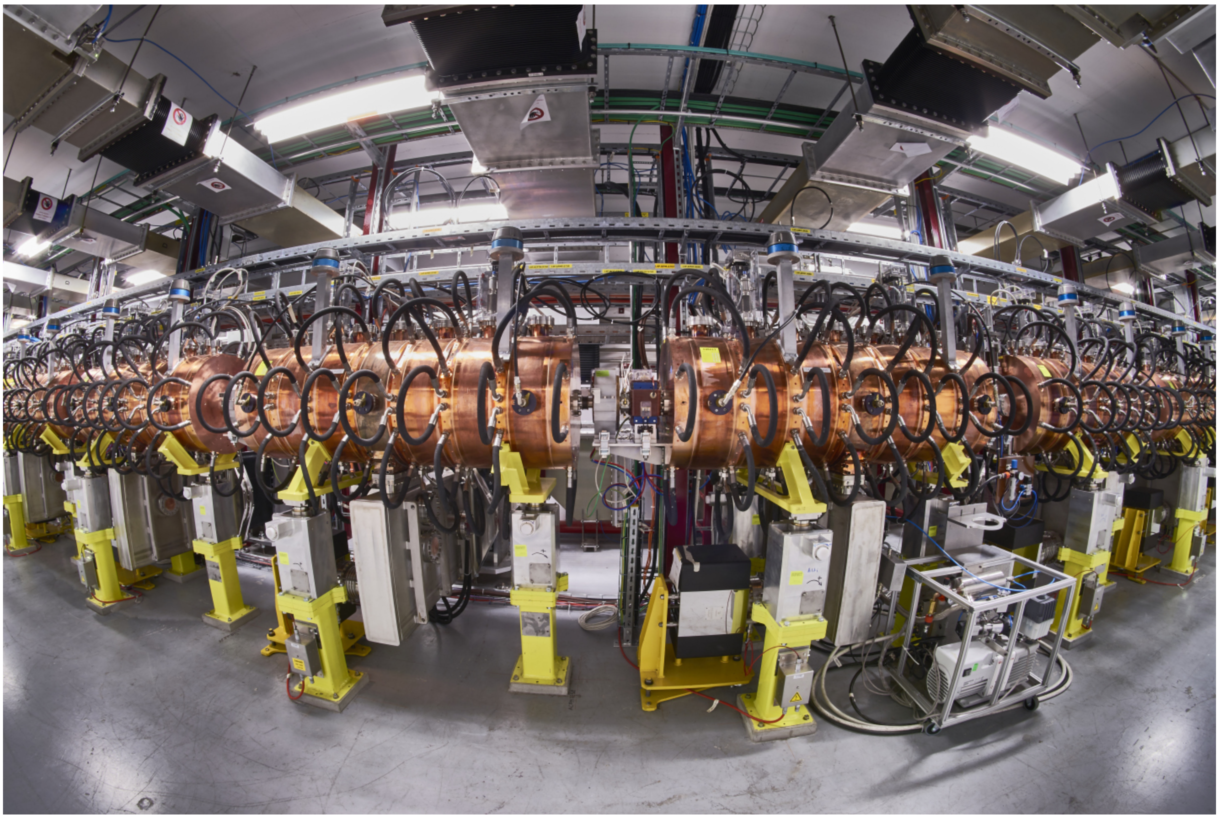
Significant progress has already been made concerning the production of ion beams. Thanks to the modifications in Linac 3 and LEIR implemented after 2015 and the intensive machine studies conducted within the LIU programme over the last three years, the excellent performance of the ion injector chain could be further improved in 2016 (figure 1). This enabled the recorded luminosity for the 2016 proton–lead run to exceed the target value by a factor of almost eight. The main remaining challenges for the ion beams will be to more than double the number of bunches in the LHC through complex RF manipulations in the SPS known as “momentum slip stacking”, as well as to guarantee continued and stable performance of the ion injector chain without constant expert monitoring.

Along the proton injector chain, the higher-intensity beams within a comparatively small beam envelope required by the HL-LHC can only be demonstrated after the installation of all the LIU equipment during Long Shutdown 2 (LS2) in 2019–2020. The main installations feature: a new injection region, a new main power supply and RF system in the PSB; a new injection region and RF system to stabilise the future beams in the PS; an upgraded main RF system; and the shielding of vacuum flanges together with partial coating of the beam chambers in order to stabilise future beams against parasitic electromagnetic interaction and electron clouds in the SPS. Beam instrumentation, protection devices and beam dumps also need to be upgraded in all the machines to match the new beam parameters. The baseline goals of the LIU project to meet the challenging HL-LHC requirements are summarised in the panel (final page of feature).

Execution phase

Having defined, designed and endorsed all of the baseline items during the last seven years, the LIU project is presently in its execution phase. New hardware is being produced, installed and tested in the different machines. Civil-engineering work is proceeding for the buildings that will host the new PSB main power supply and the upgraded SPS RF equipment, and to prepare the area in which the new SPS internal beam dump will be located.

The 86 m-long Linac 4, which will eventually replace Linac 2, is an essential component of the HL-LHC upgrade .



CERN Linac 4

The machine, based on newly developed technology, became operational at the end of 2016 following the successful completion of acceleration tests at its nominal energy of 160 MeV. It is presently undergoing an important reliability run that will be instrumental to reach beams with characteristics matching the requirements of the LIU project and to achieve an operational availability higher than 95%, which is an essential level for the first link in the proton injector chain. On 26 October 2016, the first 160 MeV negative hydrogen-ion beam was successfully sent to the injection test stand, which operated until the beginning of April 2017 and demonstrated the correct functioning of this new and critical CERN injection system as well as of the related diagnostics and controls.

The PSB upgrade has mostly completed the equipment needed for the injection of negative hydrogen ions from Linac 4 into the PSB and is progressing with the 2 GeV energy upgrade of the PSB rings and extraction, with a planned installation date of 2019–2020 during LS2. On the beam-physics side, studies have mainly focused on the deployment of the new wideband RF system, commissioning of beam diagnostics and investigation of space-charge effects. During the 2016–2017 technical stop, the principal LIU-related activities were the removal of a large volume of obsolete cables and the installation of new beam instrumentation (e.g. a prototype transverse size measurement device and turn-by-turn orbit measurement systems). The unused cables, which had been individually identified and labelled beforehand, could be safely removed from the machine to allow cables for the new LIU equipment to be pulled.

The procurement, construction, installation and testing of upgrade items for the PS is also progressing. Some hardware, such as new corrector magnets and power supplies, a newly developed beam gas-ionisation monitor and new injection vacuum chambers to remove aperture limitations, was already installed during past technical stops. Mitigating anticipated longitudinal beam instabilities in the PS is essential for achieving the LIU baseline beam parameters. This requires that the parasitic electromagnetic interaction of the beam with the multiple RF systems has to be reduced and a new feedback system has to be deployed to keep the beam stable. Beam-dynamics studies will determine the present intensity reach of the PS and identify any remaining needs to comfortably achieve the value required for the HL-LHC. Improved schemes of bunch rotation are also under investigation to better match the beam extracted from the PS to the SPS RF system and thus limit the beam losses at injection energy in the SPS.

In the SPS, the LIU deployment in the tunnel has begun in earnest, with the re-arrangement and improvement of the extraction kicker system, the start of civil engineering for the new beam-dump system in LSS5 and the shielding of vacuum flanges in 10 half-cells together with the amorphous carbon coating of the adjacent beam chambers (to mitigate against electron-cloud effects). In a notable first, eight dipole and 10 focusing quadrupole magnet chambers were amorphous carbon coated in-situ during the 2016–2017 technical stop, proving the industrialisation of this process (figure 2). The new overground RF building needed to accommodate the power amplifiers of the upgraded main RF system has been completed, while procurement and testing of the solid-state amplifiers has also commenced. The prototyping and engineering for the LIU beam-dump is in progress with the construction and installation of a new SPS beam-dump block, which will be able to cope with the higher beam intensities of the HL-LHC and minimise radiation issues.

Regarding diagnostics, the development of beam-size measurement devices based on flying wire, gas ionisation and synchrotron radiation, all of which are part of the LIU programme, is already providing meaningful results (figure 3) addressing the challenges of measuring the operating high-intensity and high-brightness beams with high precision. From the machine performance and beam dynamics side, measurements in 2015–2016 made with the very high intensities available from the PS meant that new regimes were probed in terms of electron-cloud instabilities, RF power and losses at injection. More studies are planned in 2017–2018 to clearly identify a path for the mitigation of the injection losses when operating with higher beam currents.

Looking forward to LS2

The success of LIU in delivering beams with the desired parameters is the key to achieving the HL-LHC luminosity target. Without the LIU beams, all of the other necessary HL-LHC developments – including high-field triplet magnets [see above], crab cavities and new collimators – would only allow a fraction of the desired luminosity to be delivered to experiments.

Whenever possible, LIU installation work is taking place during CERN's regular year-end technical stops. But the great majority of the upgrade requires an extended machine stop and therefore will have to wait until LS2 for implementation. The duration of access to the different accelerators during LS2 is being defined and careful preparation is ongoing to manage the work on site, ensure safety and level the available resources among the different machines in the CERN accelerator complex. After all of the LIU upgrades are in place, beams will be commissioned with the newly installed systems. The LIU goals in terms of beam characteristics are, by definition, uncharted territory. Reaching them will require not only a high level of expertise, but also careful optimisation and extensive beam-physics and machine-development studies in all of CERN's accelerators.

See the full article here .

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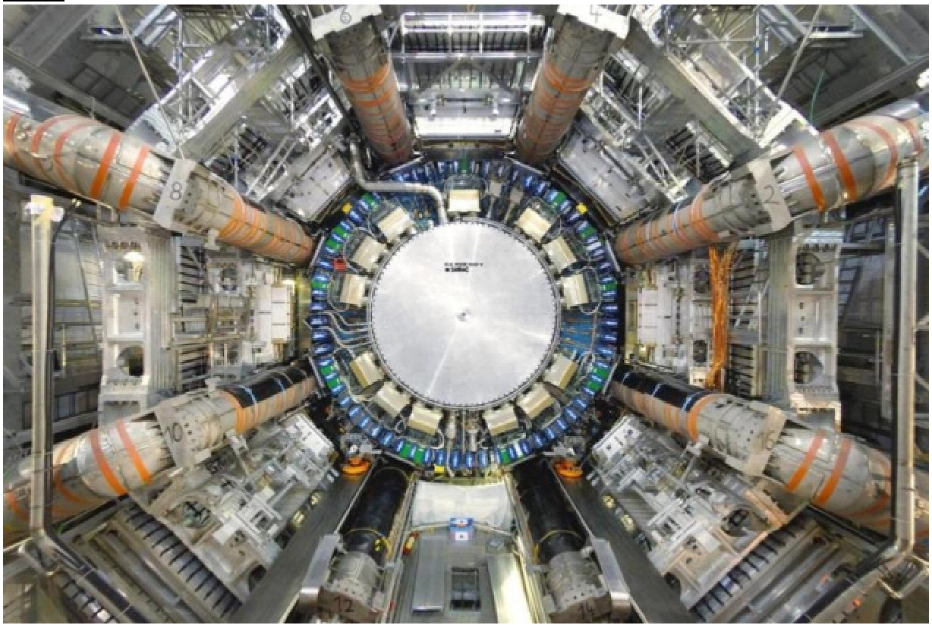
THE FOUR MAJOR PROJECT COLLABORATIONS

ATLAS



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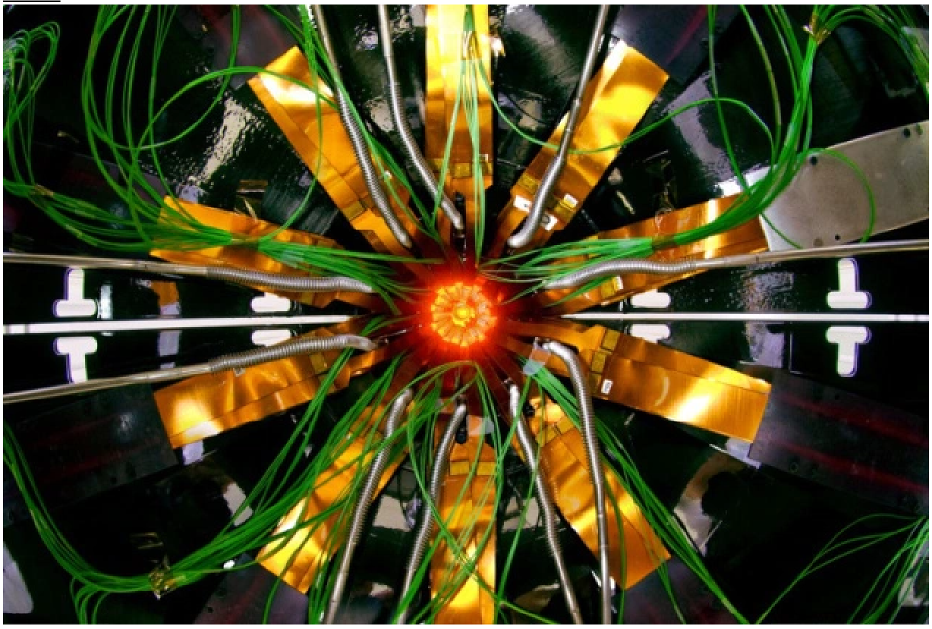

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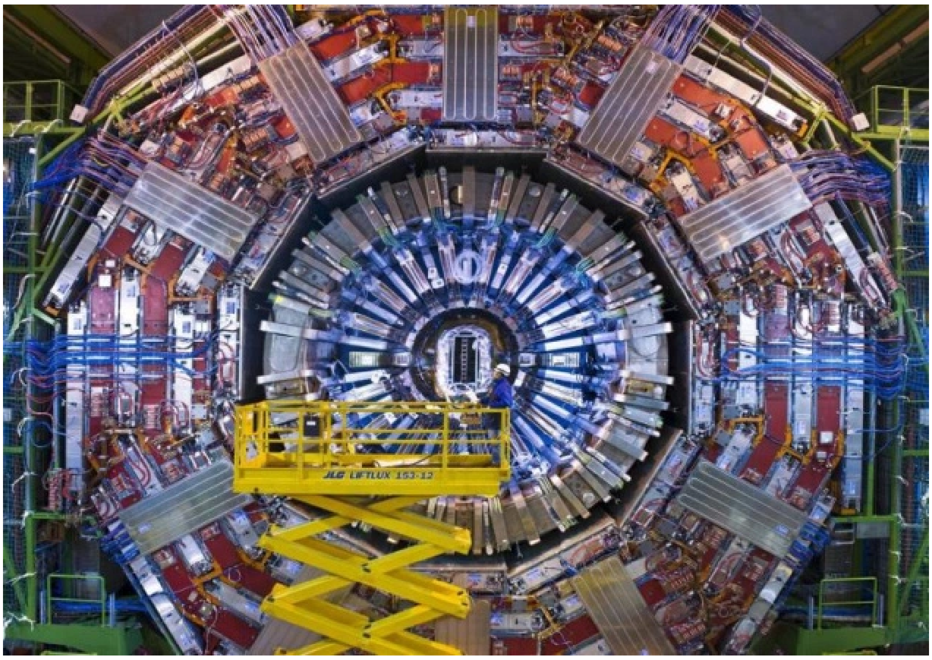
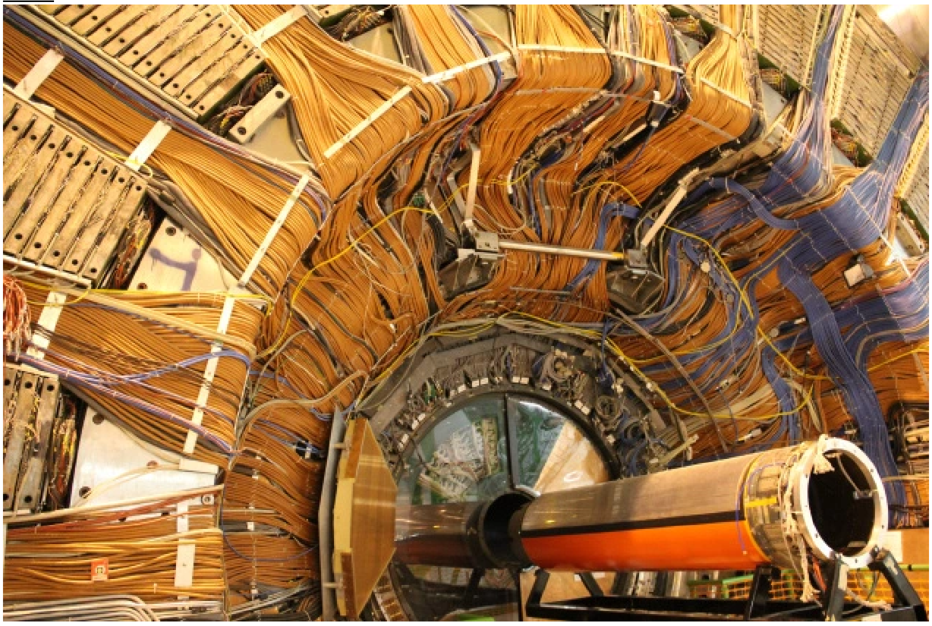
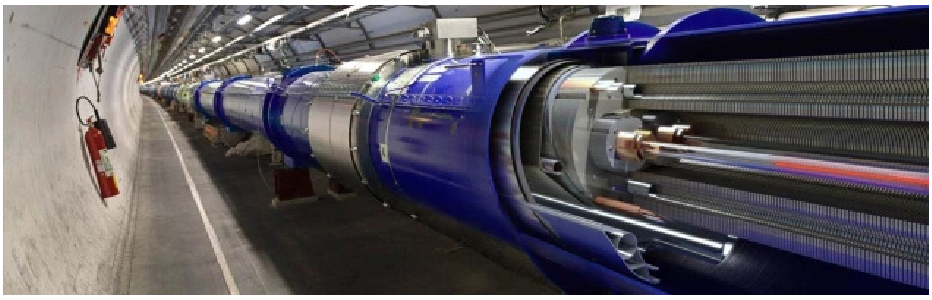
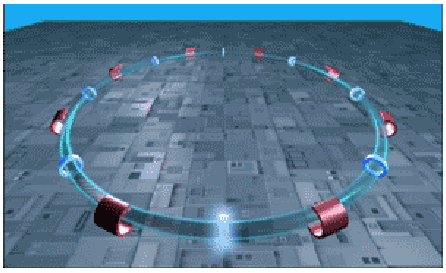


LHCb



LHC





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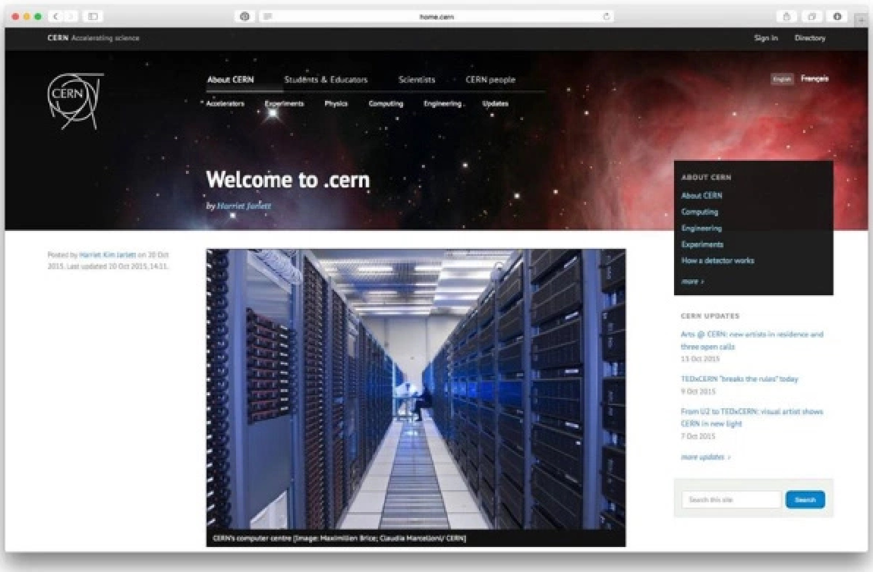
Tags: CEA-Saclay IRFU, CERN (356), CERN HL-LHC, European EuCARD programme, FRESCA2, Future Circular Collider

From CERN: “Next stop: the superconducting magnets of the future”



Welcome to .cern

by Harriet Jarlett

Posted by Harriet Kim Jarlett on 20 Oct 2015. Last updated 20 Oct 2015, 14:11.

CERN's computer centre (Image: Maximilien Brice; Claudia Marcelloni/ CERN)

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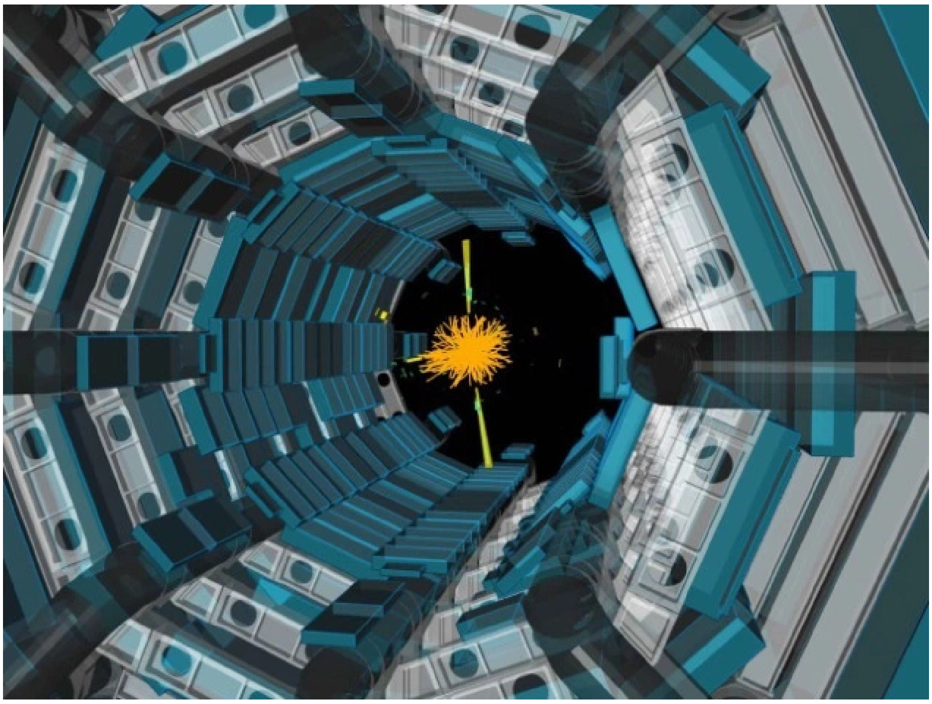

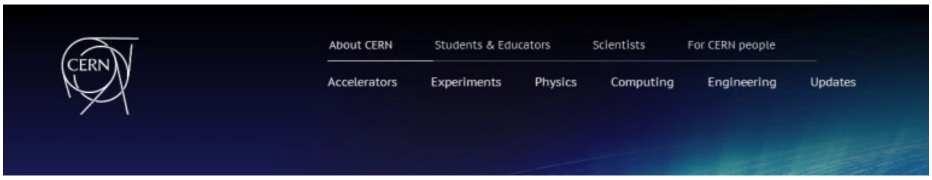

CERN

21 Sep 2017
Corinne Pralavorio

The FRESCA2 cryostat before the insertion of the magnet. (Image: Sophia Bennett)

The superconducting magnets of the future are under development and CERN is on the front line. To increase the energy of circular colliders, physicists are counting on ever more powerful magnets, capable of generating magnetic fields way beyond the 8 Tesla produced by the magnets in the Large Hadron Collider (LHC).

Magnets generating fields of almost 12 Tesla, based on a superconducting niobium-tin compound, are already being manufactured for the High-Luminosity LHC.

High
Luminosity
LHC

But CERN and its partners have also started work on the next generation of magnets, which will need to be capable of generating fields of 16 Tesla and more, for the colliders of the future such as those under consideration in the FCC (Future Circular Collider) study.

To achieve this goal, the performance of niobium-tin superconducting cable is being pushed to the limits.

One of the key steps in the programme is the development of a test station capable of testing the new cables in realistic conditions, i.e. in a strong magnetic field. Such a facility, in the form of a dipole magnet with a large aperture, has been set up at CERN. The magnet, known as FRESCA2, was developed as part of a collaboration between CERN and CEA-Saclay in the framework of the European EuCARD programme.

At the start of August, FRESCA2 reached an important milestone when it achieved its design magnetic field, generating 13.3 Tesla at the centre of a 10-centimetre aperture for 4 hours in a row – a first for a magnet with such a large aperture. By comparison, the current magnets in the LHC generate fields of around 8 Tesla at the centre of a 50-millimetre aperture. The development and performance of FRESCA2 were presented today at the EUCAS 2017 conference on superconductors and their applications.

Testing of the cables under the influence of a strong magnetic field is a vital step. “We not only need to test the maximum current that can be carried by the cable, but also all the effects of the magnetic field. The quality of the field must be perfect,” explains Gijs De Rijk, deputy leader of the Magnets, Superconductors and Cryostats group at CERN. The precision with which the intensity of the magnetic field can be adjusted is an important feature for an accelerator. When the energy of the beams is increased, the intensity of the field that guides them must be increased gradually, without sudden spikes, or the beams could be lost. The fact that the magnets in the LHC can be adjusted with a great degree of precision, keeping their magnetic fields stable, is what allows the beams to circulate in the machine for hours at a time.

The FRESCA2 magnet before the start of the tests. (Image: Maximilien Brice/CERN)

The two coils of FRESCA2 are formed from a superconducting cable made of niobium-tin. Their temperature is maintained at 2 degrees above absolute zero. The magnet they form is much larger than an LHC magner, measuring 1.5 metres in length and 1 metre in diameter. This allows the magnet to have a large aperture, measuring 10 centimetres, so that it can house the cables being tested, as well as sensors to observe their behaviour. FRESCA2 will also be used to test coils formed from high-temperature superconductors (an article on this subject will be published tomorrow).

FRESCA2 is being modified so that by the end of this year it will be able to generate an even stronger field. The station will then be ready to receive the samples to be tested.

See the CEA-Saclay IRFU (*Institute of Research into the Fundamental Laws of the Universe*) article.

See the full article here.

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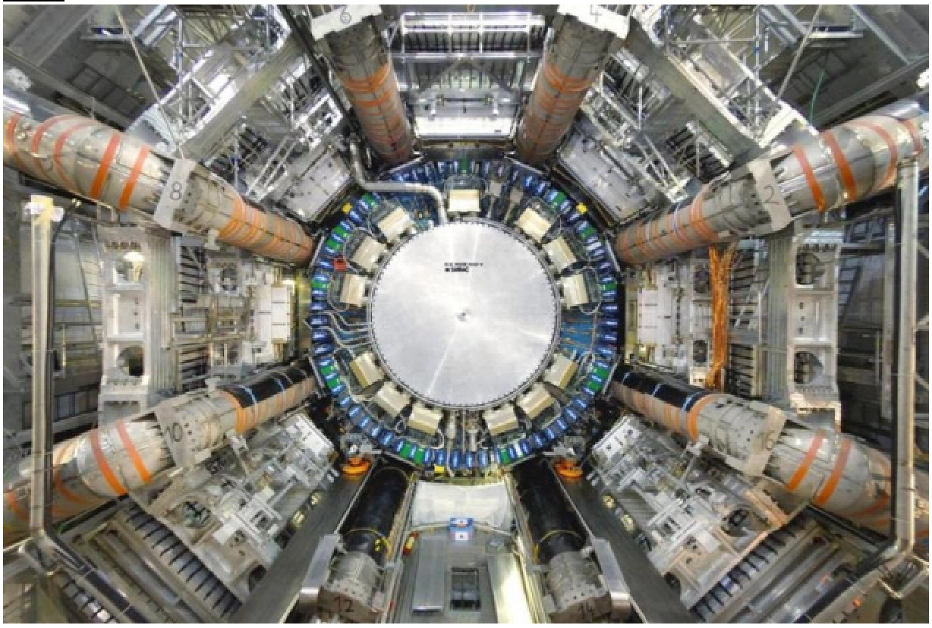

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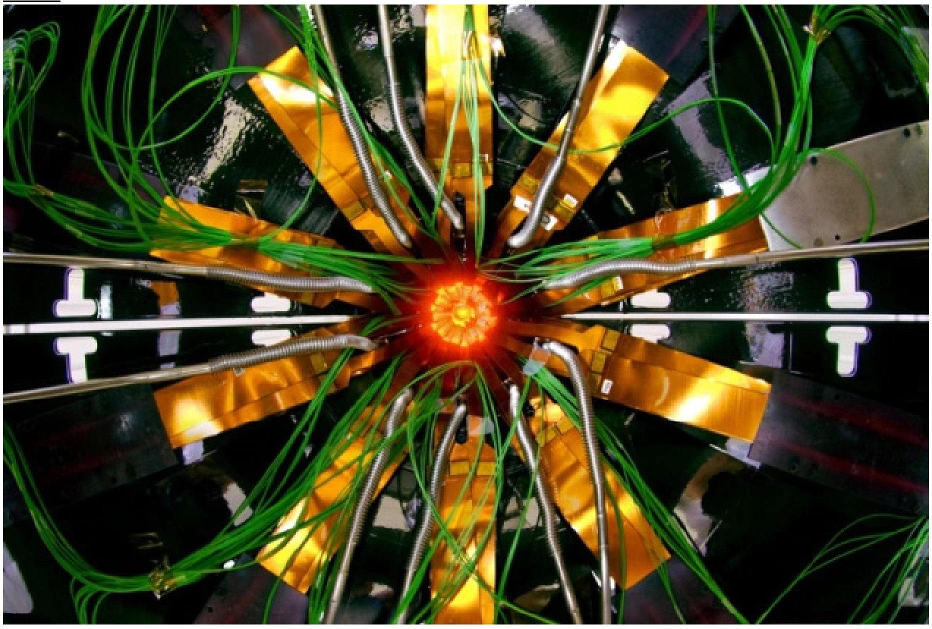

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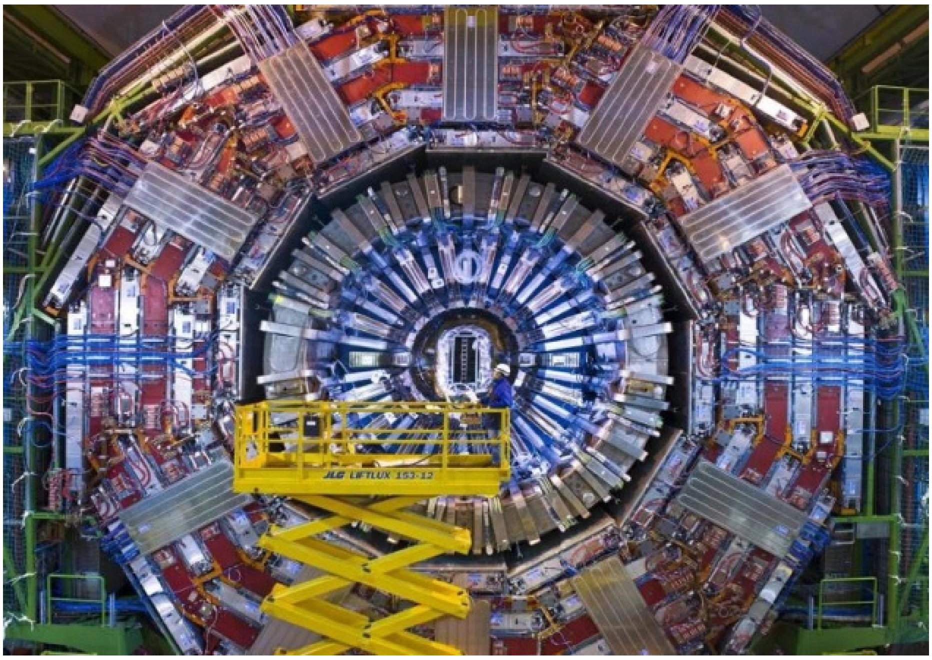

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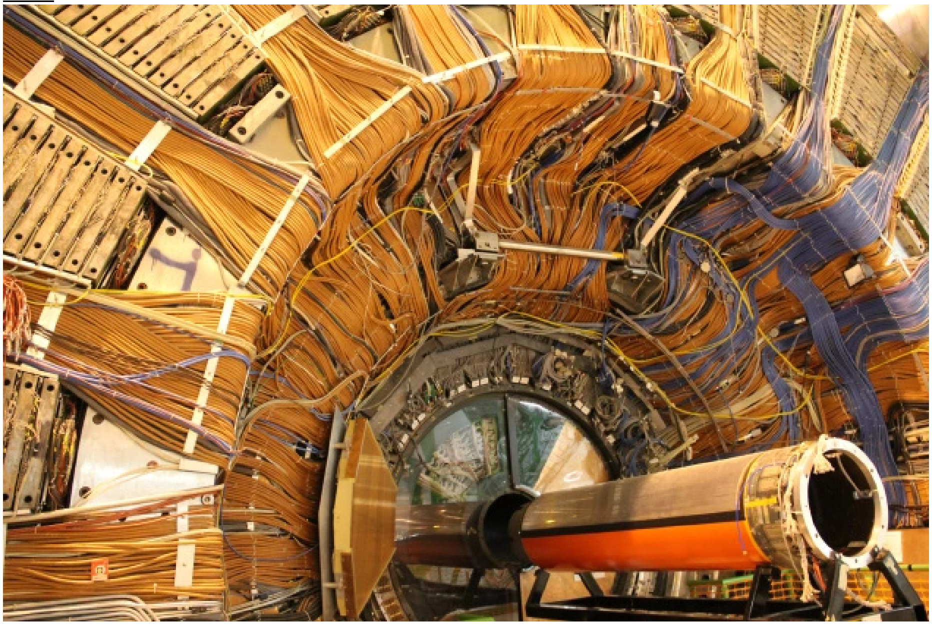
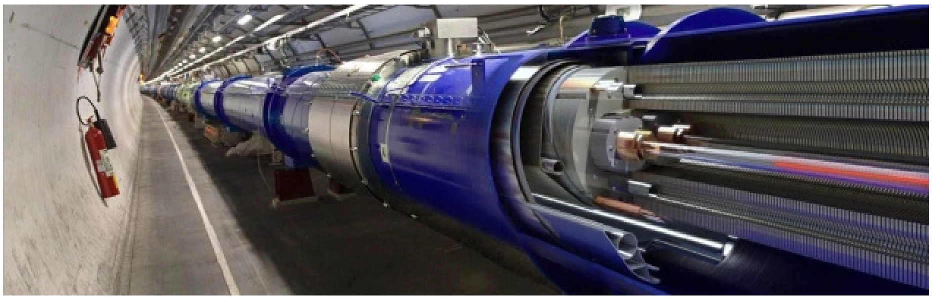
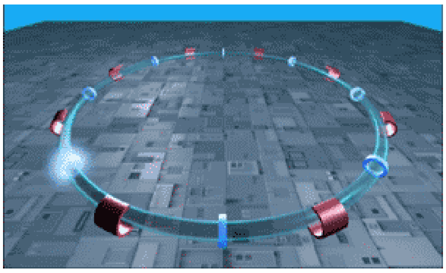


LHC





Quantum Diaries

QUANTUM DIARIES

Thoughts on work and life from particle physicists from around the world.

richardmitnick 3:03 am on September 22, 2017

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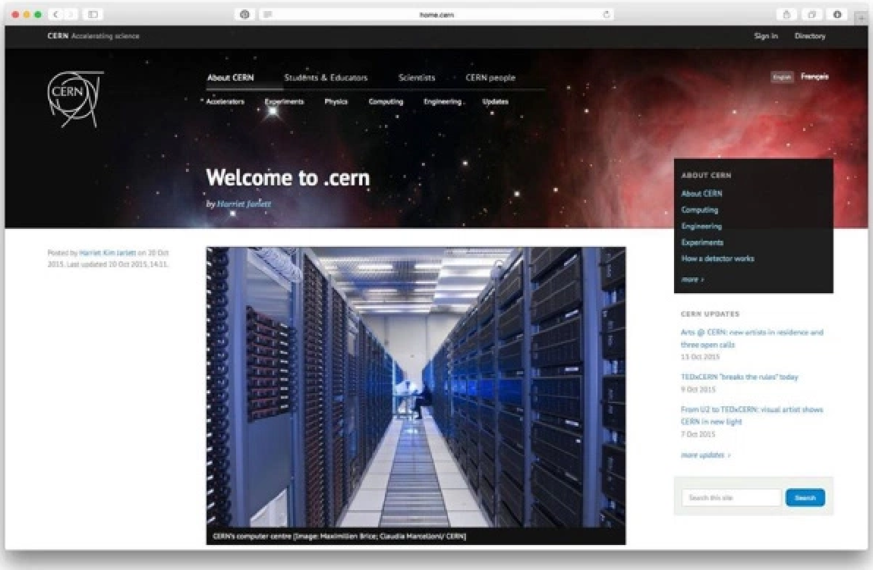
From CERN: “CERN openlab tackles ICT challenges of High-Luminosity LHC “



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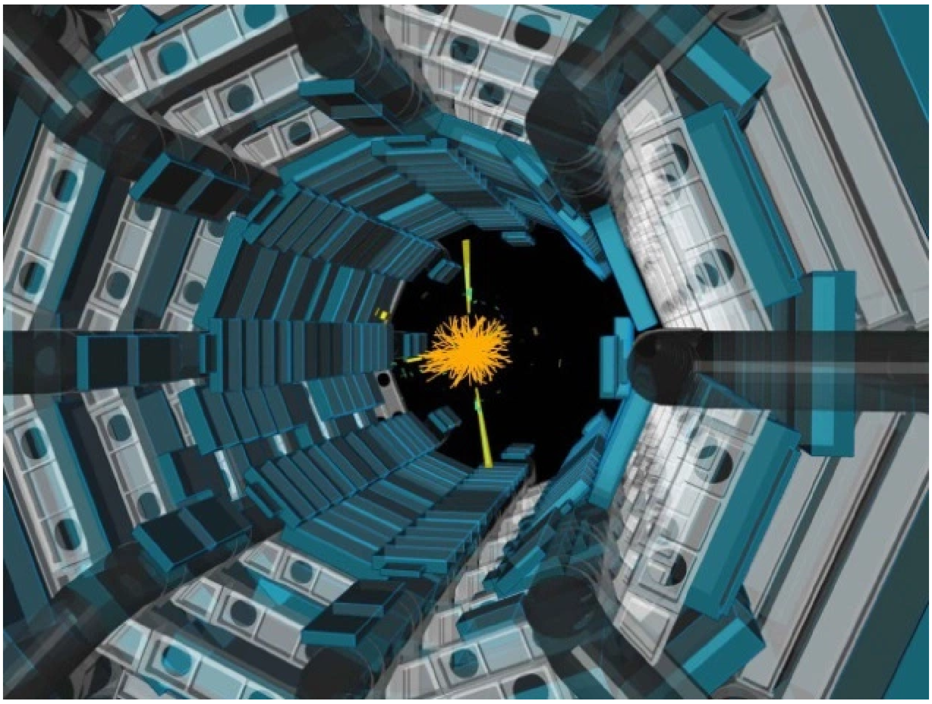
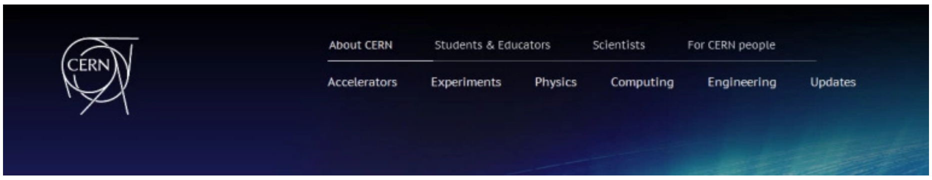


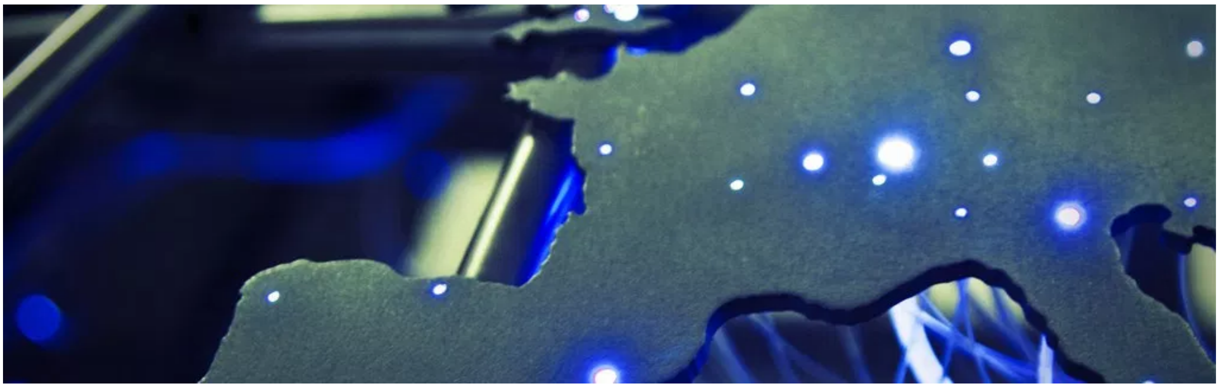


CERN

21 Sep 2017
Harriet Kim Jarlett

CERN computing centre in 2017 (Image: Robert Hradil, Monika Majer/ProStudio22.ch)

CERN openlab has published a white paper identifying the major ICT challenges that face CERN and other 'big science' projects in the coming years.



CERN is home to the Large Hadron Collider (LHC), the world's most powerful particle accelerator. The complexity of the scientific instruments at the laboratory throw up extreme ICT challenges, and make it an ideal environment for carrying out joint R&D projects and testing with industry.

A continuing programme of upgrades to the LHC and the experiments at CERN will result in hugely increased ICT demands in the coming years. The High-Luminosity LHC, the successor to the LHC, is planned to come online in around 2026.

High
Luminosity
LHC

By this time, the total computing capacity required by the experiments is expected to be 50-100 times greater than today, with data storage needs expected to be in the order of exabytes.

CERN **openl**ab works to develop and test the new ICT solutions and techniques that help to make the ground-breaking physics discoveries at CERN possible. It is a unique public-private partnership that provides a framework through which CERN can collaborate with leading ICT companies to accelerate the development of these cutting-edge technologies.

With a new three-year phase of CERN **openl**ab set to begin at the start of 2018, work has been carried out throughout the first half of 2017 to identify key areas for future collaboration. A series of workshops and discussions was held to discuss the ICT challenges faced by the LHC research community — and other 'big science' projects over the coming years. This white paper is the culmination of these investigations, and sets out specific challenges that are ripe for tackling through collaborative R&D projects with leading ICT companies.

The white paper identifies 16 ICT 'challenge areas', which have been grouped into four overarching 'R&D topics' (data-centre technologies and infrastructures, computing performance and software, machine learning and data analytics, applications in other disciplines). Challenges identified include ensuring that data centre architectures are flexible and cost effective; using cloud computing resources in a scalable, hybrid manner; fully modernising code, in order to exploit hardware to its maximum potential; making sure large-scale platforms are in place to enable global scientific collaboration; and successfully translating the huge potential of machine learning into concrete solutions .

"Tackling these challenges — through a public-private partnership that brings together leading experts from each of these spheres — has the potential to positively impact on a range of scientific and technological fields, as well as wider society," says Alberto Di Meglio, head of CERN **openl**ab.

"With the LHC and the experiments set to undergo major upgrade work in 2019 and 2020, CERN **openl**ab's sixth phase offers a clear opportunity to develop ICT solutions that will already make a tangible difference for researchers when the upgraded LHC and experiments come back online in 2021," says Maria Girone, CERN **openl**ab CTO.

See the full article here.

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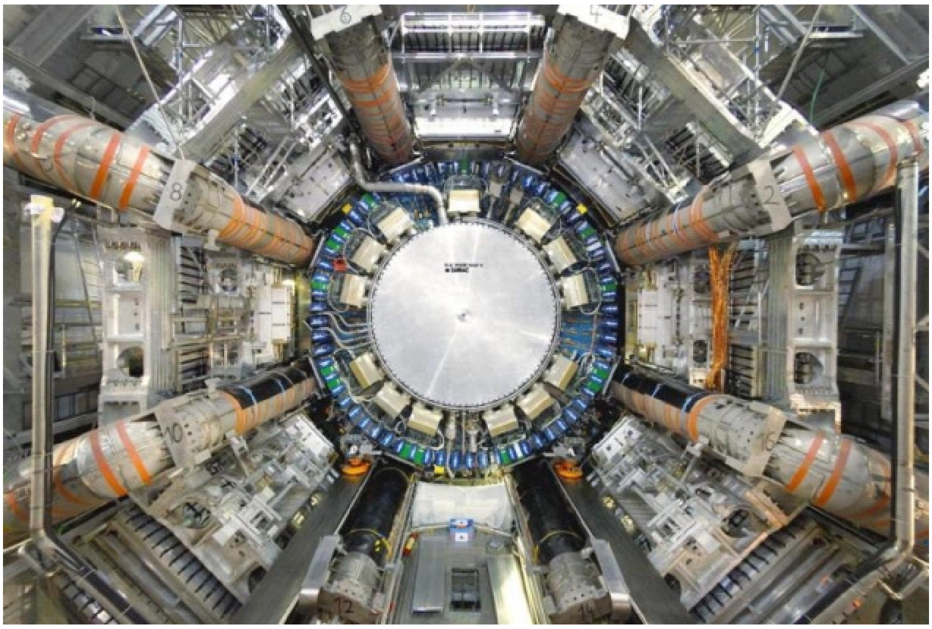
THE FOUR MAJOR PROJECT COLLABORATIONS

ATLAS



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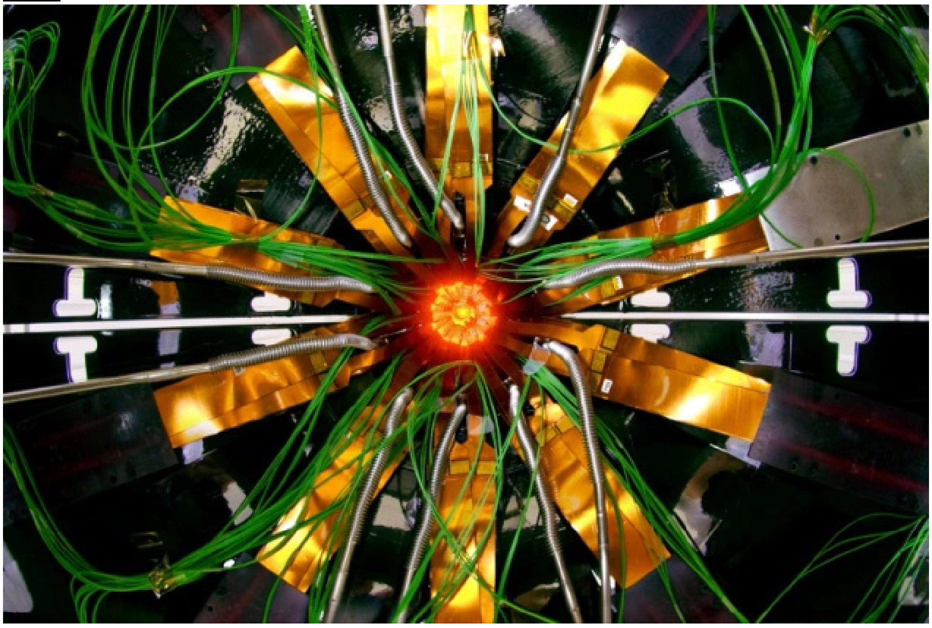

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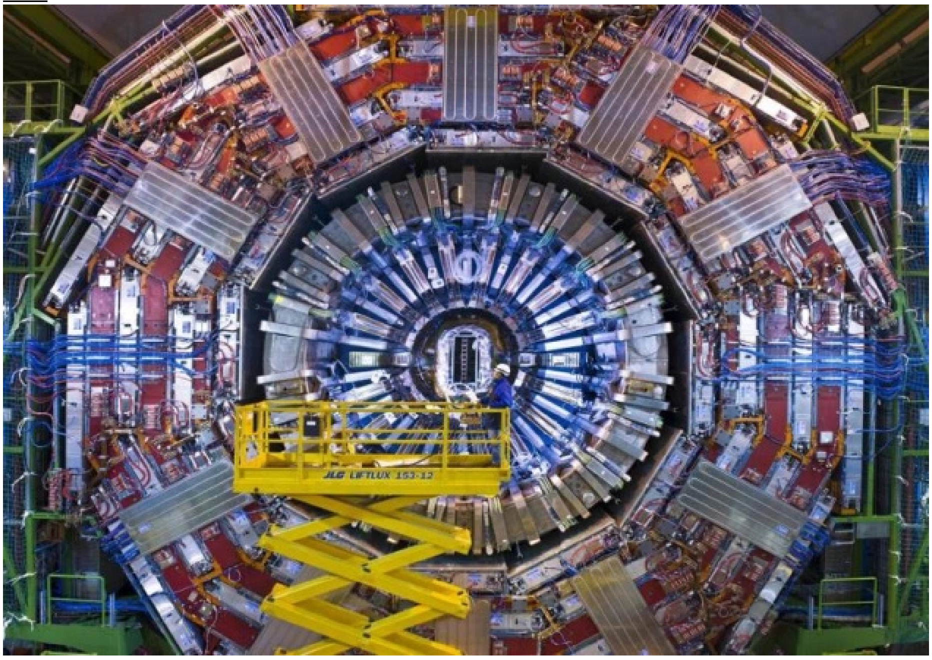

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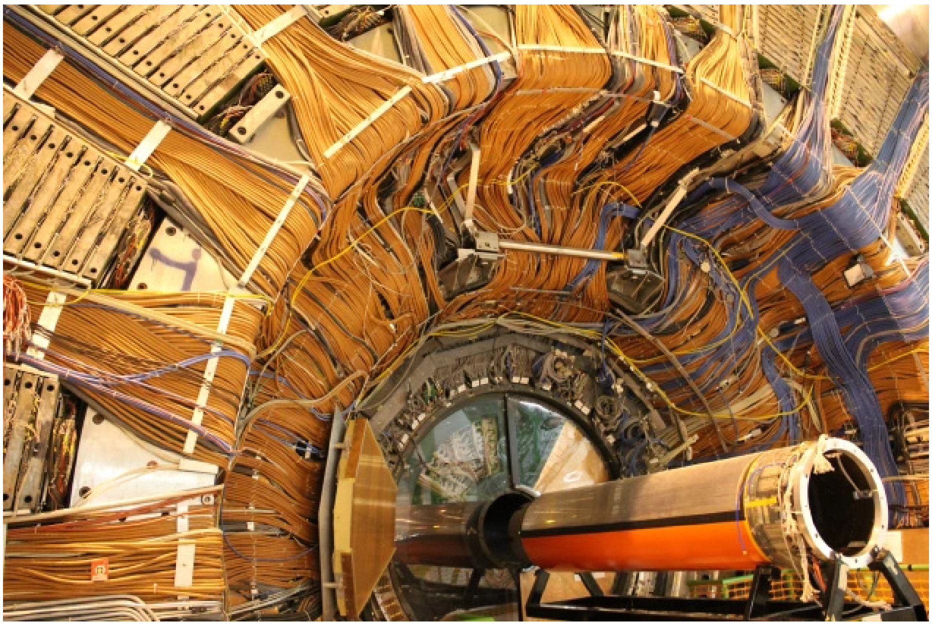
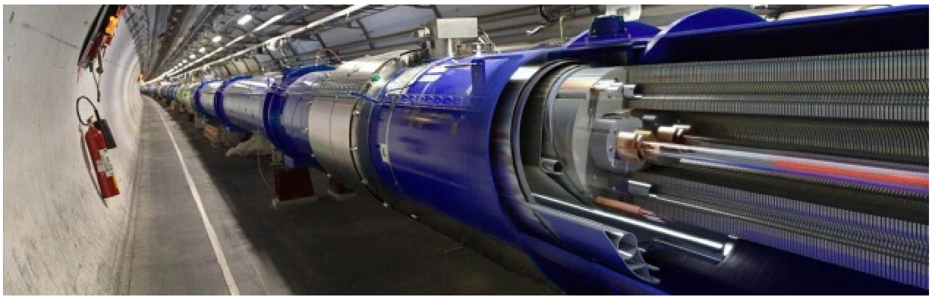
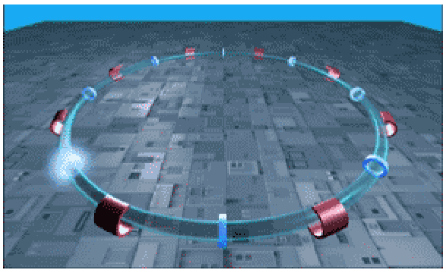


LHC





Quantum Diaries

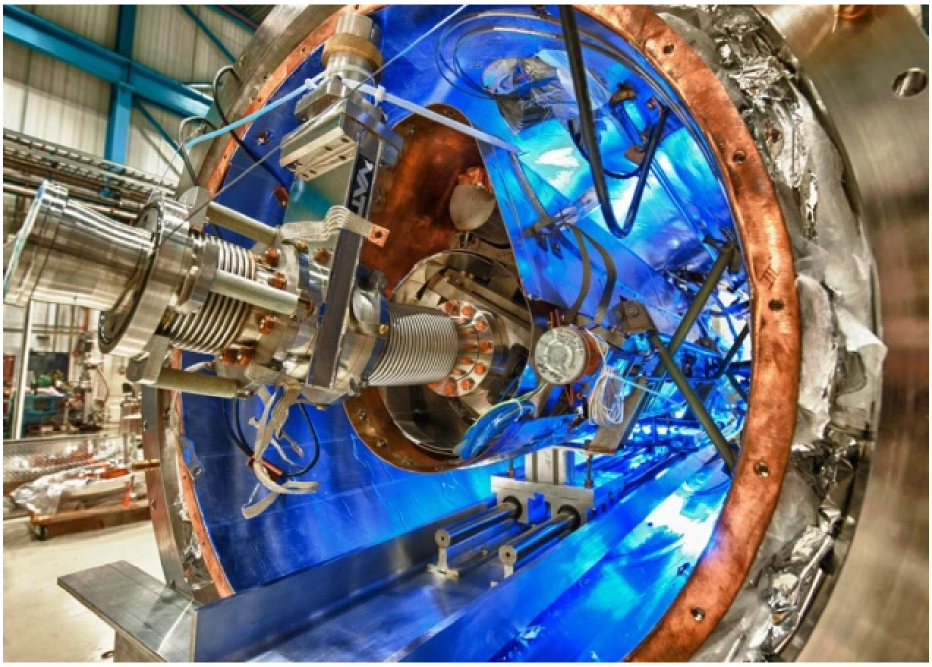
QUANTUM DIARIES

Thoughts on work and life from particle physicists from around the world.

richardmitnick 11:03 pm on May 11, 2017
Permalink (https://sciencesprings.wordpress.com/2017/05/11/from-fnal-new-u-s-and-cern-agreements-open-pathways-for-future-projects/)

Tags: CERN HL-LHC, CERN LHC (170), FNAL (574), Neutrinos (303), SURF (8)

From FNAL: “New U.S. and CERN agreements open pathways for future projects”



FNAL Art Image by Angela Gonzales

Fermilab is an enduring source of strength for the US contribution to scientific research world wide.

May 11, 2017
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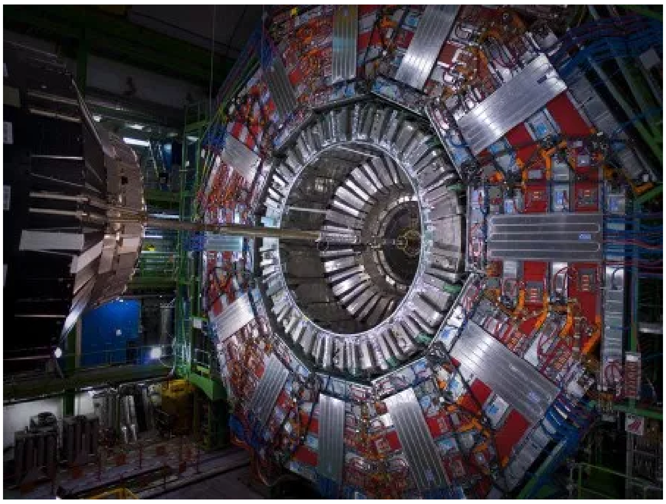


The CMS detector at the Large Hadron Collider at CERN. Photo: CERN

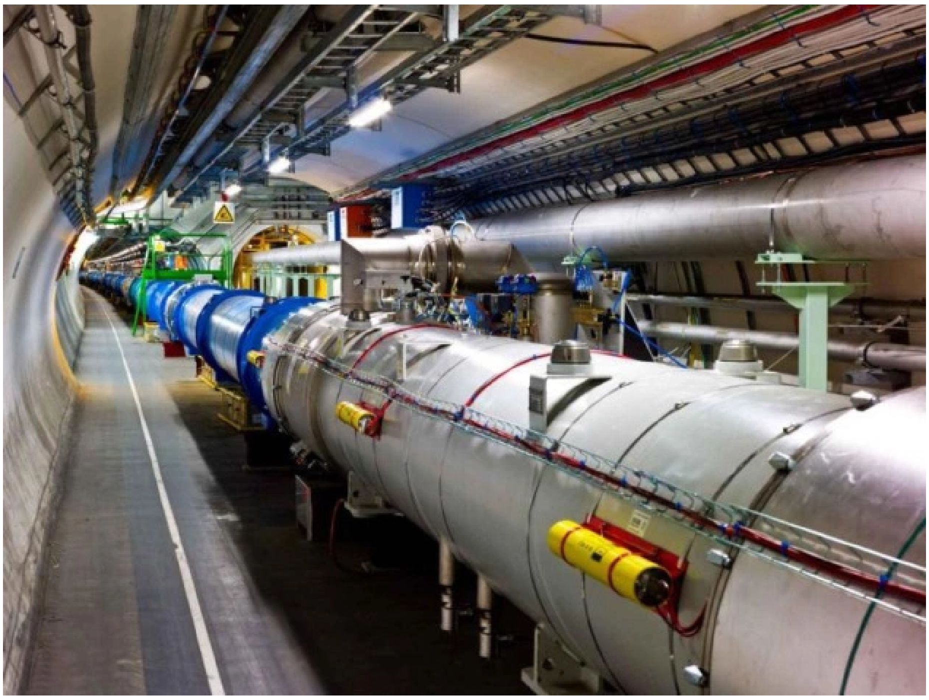
The U.S. Department of Energy and CERN establish contributions for next-generation experiments and scientific infrastructure located both at CERN and in the United States

The United States Department of Energy (DOE) and the European Organization for Nuclear Research (CERN) last week signed three new agreements securing a symbiotic partnership for scientific projects based both in the United States and Europe. These new agreements, which follow from protocols signed by both agencies in 2015, outline the contributions CERN will make to the neutrino program hosted by Fermilab in the United States and the U.S. Department of Energy's contributions to the High-Luminosity Large Hadron Collider upgrade program at CERN.

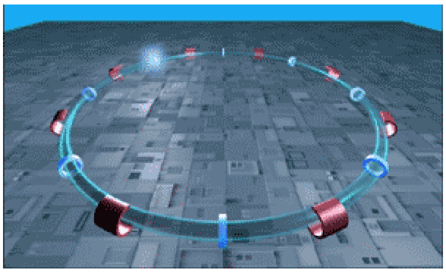
High Luminosity LHC

LHC

CERN/LHC Map



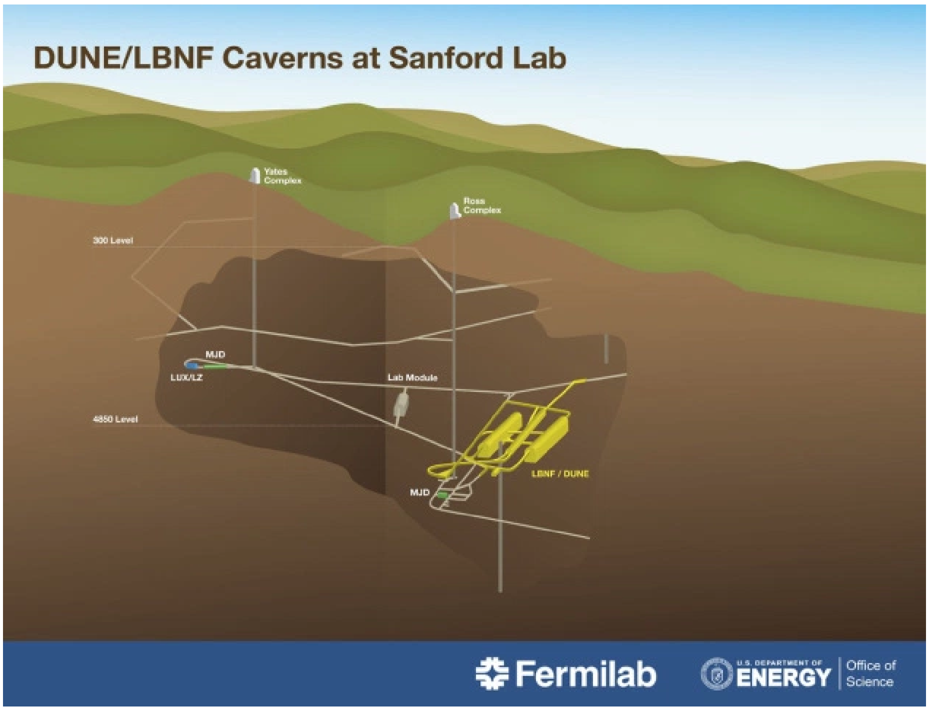
CERN LHC Tunnel



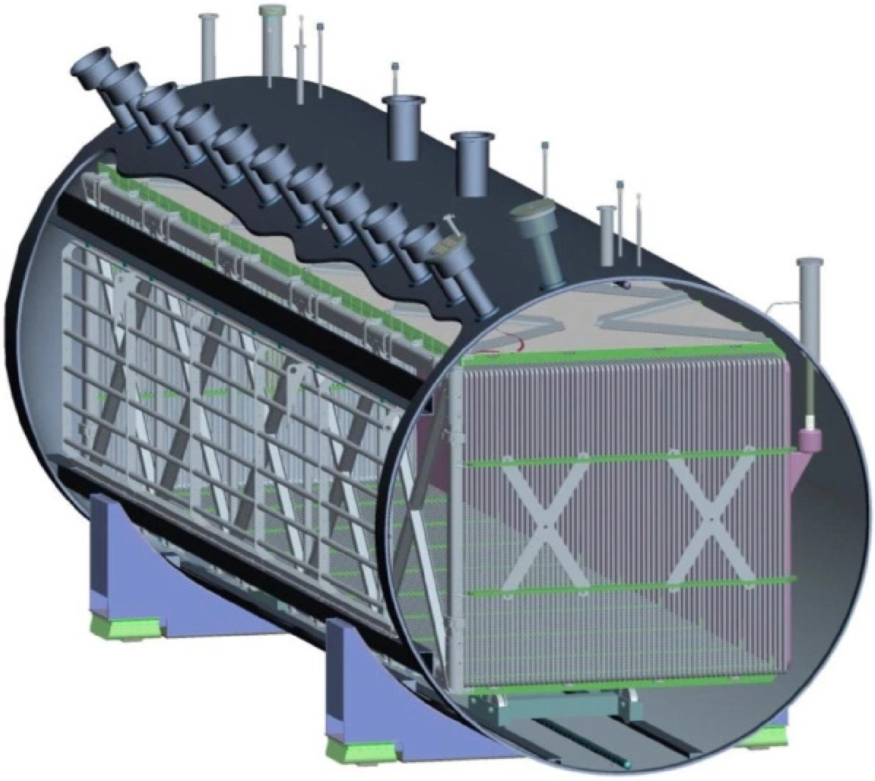
CERN LHC particles

Researchers, engineers and technicians at CERN are currently designing detector technology for the U.S. neutrino research program hosted by Fermilab.

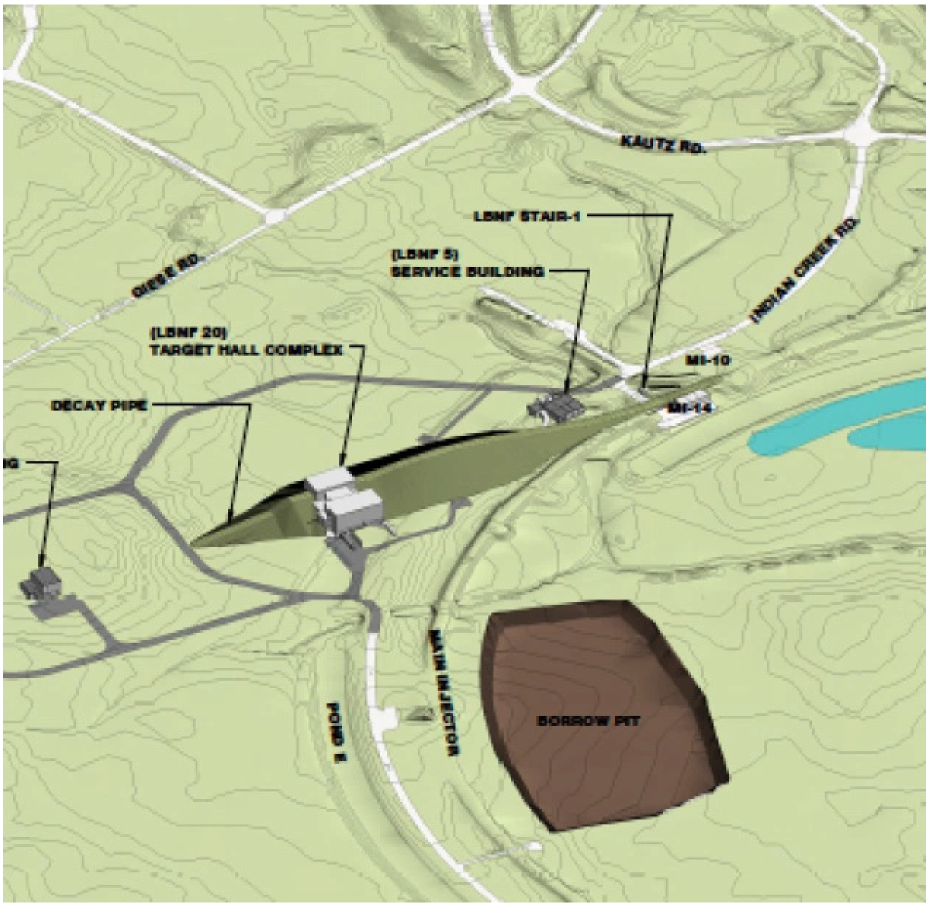
CERN Proto DUNE Maximillian Brice



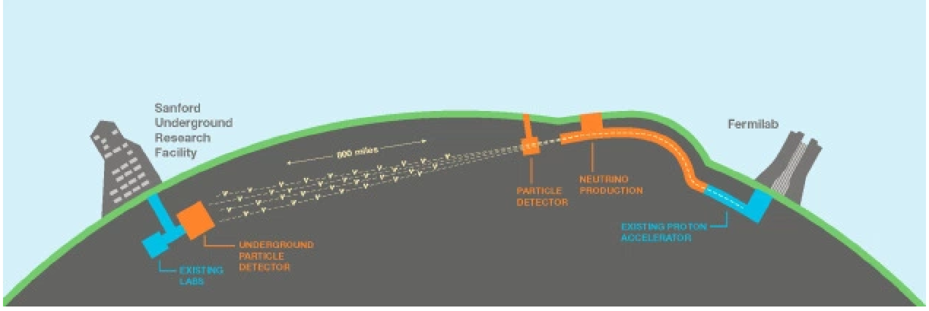
Surf-Dune/LBNF Caverns at Sanford



FNAL DUNE Argon tank at SURF

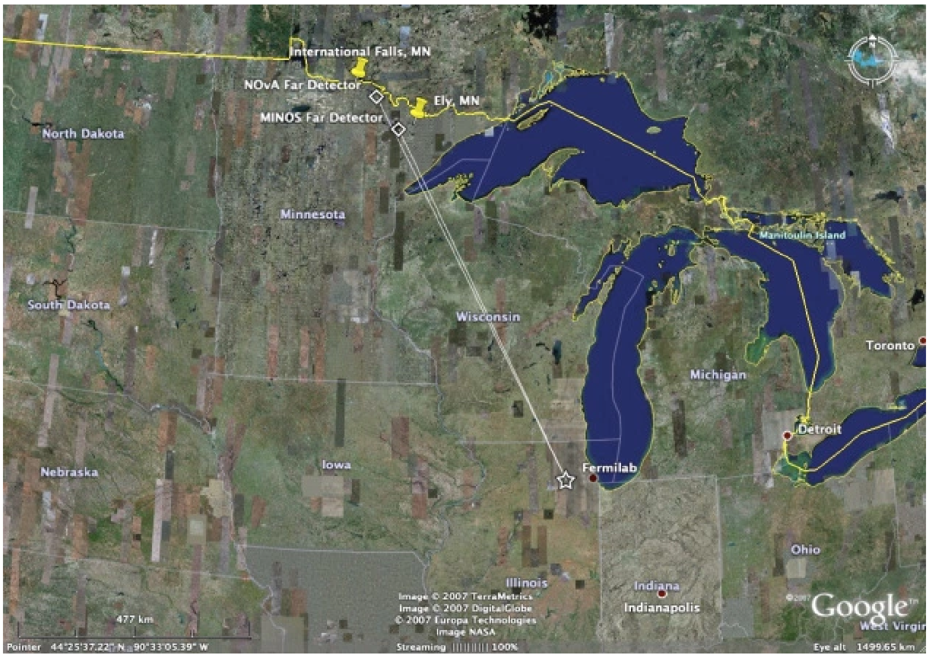


FNAL/DUNE Near Site Layout



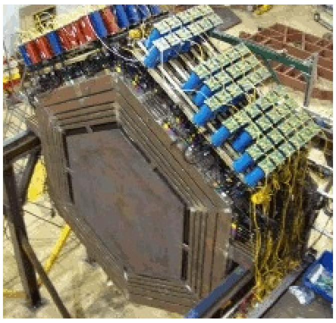
FNAL LBNF/DUNE from FNAL to SURF, Lead, South Dakota, USA

Neutrinos are nearly massless, neutral particles that interact so rarely with other matter that trillions of them pass through our bodies each second without leaving a trace. These tiny particles could be key to a deeper understanding of our universe, but their unique properties make them very difficult to study. Using intense particle beams and sophisticated detectors, Fermilab currently operates three neutrino experiments (NOvA, MicroBooNE and MINERvA) and has three more in development, including the Deep Underground Neutrino Experiment (DUNE) and two short-baseline experiments on the Fermilab site, one of which will make use of the Italian ICARUS detector, currently being prepared for transport from CERN.



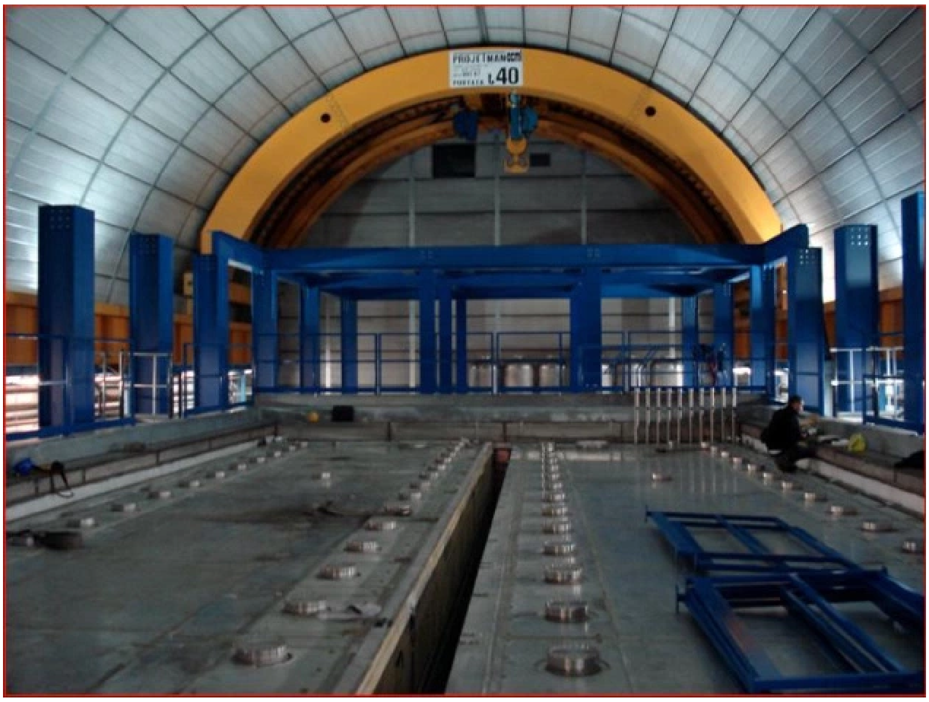
FNAL/NOvA experiment map

FNAL/MicrobooNE



FNAL/MINERvA

FNAL/ICARUS



INFN Gran Sasso ICARUS, since moved to FNAL

The Long Baseline Neutrino Facility will provide the infrastructure needed to support DUNE both on the Fermilab site in Illinois and at the Sanford Underground Research Facility in South Dakota. Together, LBNF/DUNE represent the first international megascience project to be built at a DOE national laboratory.

Sanford
Underground Research Facility
South Dakota Science and Technology Authority

Deep science at the frontier of physics

The first agreement, signed last week, describes CERN’s provision of the first cryostat to house the massive DUNE detectors in South Dakota, which represent a major investment by CERN to the U.S.-hosted neutrino program. This critical piece of technology ensures that the particle detectors can operate below a temperature of minus 300 degrees Celsius, allowing them to record the traces of neutrinos as they pass through.

The agreement also formalizes CERN’s support for construction and testing of prototype DUNE detectors. Researchers at CERN are currently working in partnership with Fermilab and other DUNE collaborating institutions to build prototypes for the huge subterranean detectors which will eventually sit a mile underground at the Sanford Underground Research Facility in South Dakota. These detectors will capture and measure neutrinos generated by Fermilab’s neutrino beam located 800 miles away. The prototypes developed at CERN will test and refine new methods for measuring neutrinos, and engineers will later integrate this new technology into the final detector designs for DUNE.

The agreement also lays out the framework and objectives for CERN’s participation in Fermilab’s Short Baseline Neutrino Program, which is assembling a suite of three detectors to search for a hypothesized new type of neutrino. CERN has been refurbishing the ICARUS detector that originally searched for neutrinos at INFN’s Gran Sasso Laboratory in Italy and will ship it to Fermilab later this spring.

Gran Sasso LABORATORI NAZIONALI del GRAN SASSO

More than 1,700 scientists and engineers from DOE national laboratories and U.S. universities work on the Large Hadron Collider (LHC) experiments hosted at CERN. The LHC is the world's most powerful particle collider, used to discover the Higgs boson in 2012 and now opening new realms of scientific discovery with higher-energy and higher-intensity beams. U.S. scientists, students, engineers and technicians contributed critical accelerator and detectors components for the original construction of the LHC and subsequent upgrades, and U.S. researchers continue to play essential roles in the international community that maintains, operates and analyzes data from the LHC experiments.

The second agreement concerns the next phase of the LHC program, which includes an upgrade of the accelerator to increase the luminosity, a measurement of particle collisions per second. Scientists and engineers at U.S. national laboratories and universities are partnering with CERN to design powerful focusing magnets that employ state-of-the-art superconducting technology. The final magnets will be constructed by both American and European industries and then installed inside the LHC tunnel. The higher collision rate enabled by these magnets will help generate the huge amount of data scientists need in order to search and discover new particles and study extremely rare processes.

American experts funded by DOE will also contribute to detector upgrades that will enable the ATLAS and CMS experiments to withstand the deluge of particles emanating from the LHC's high-luminosity collisions. This work is detailed in the third agreement. These upgrades will make the detectors more robust and provide a high-resolution and three-dimensional picture of what is happening when rare particles metamorphose and decay. Fermilab will be a hub of upgrade activity for both the LHC accelerator and the CMS experiment upgrades, serving as the host DOE laboratory for the High-Luminosity LHC Accelerator Upgrade and the CMS Detector Upgrade projects.

See the full article here .

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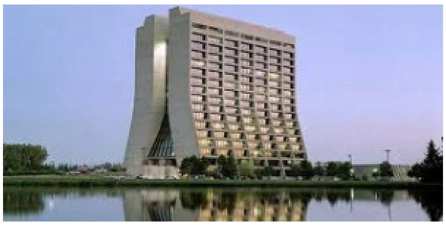

Fermi National Accelerator Laboratory (Fermilab), located just outside Batavia, Illinois, near Chicago, is a US Department of Energy national laboratory specializing in high-energy particle physics. Fermilab is America's premier laboratory for particle physics and accelerator research, funded by the U.S. Department of Energy. Thousands of scientists from universities and laboratories around the world
collaborate at Fermilab on experiments at the frontiers of discovery.

richardmitnick 5:22 pm on March 16, 2017
Permalink (https://sciencesprings.wordpress.com/2017/03/16/from-cern-via-accelerating-news-hl-lhc-project-stimulates-new-collaboration/)

Tags: Accelerator Science (600), Basic Research (7,934), CERN HL-LHC, HEP (889), Particle Accelerators (732), Particle Physics (1,059), Science and Technology Facilities Council (STFC)

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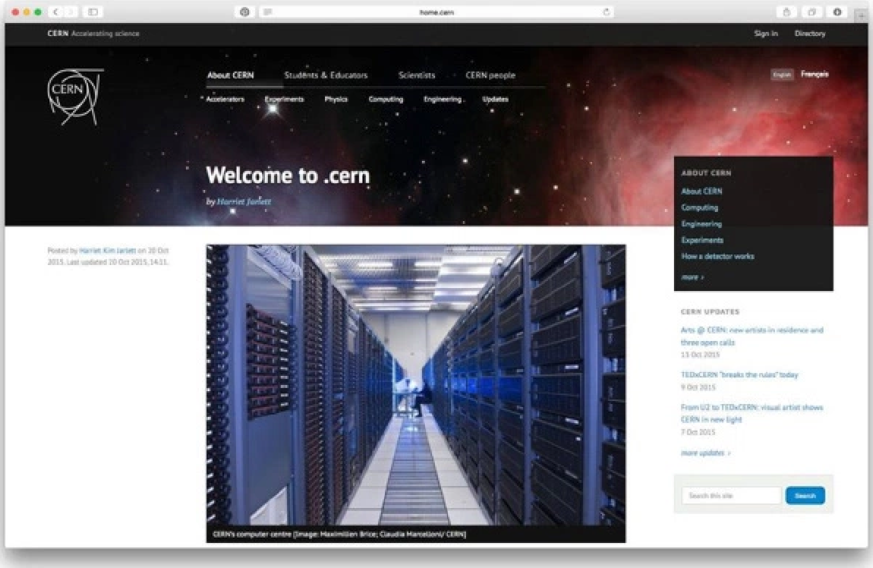

Welcome to .cern

by Harriet Jarlett

Posted by Harriet Kim Jarlett on 20 Oct 2015. Last updated 20 Oct 2015, 14:11.

CERN's computer centre [Image: Maximilien Brice; Claudia Marcelloni/ CERN]

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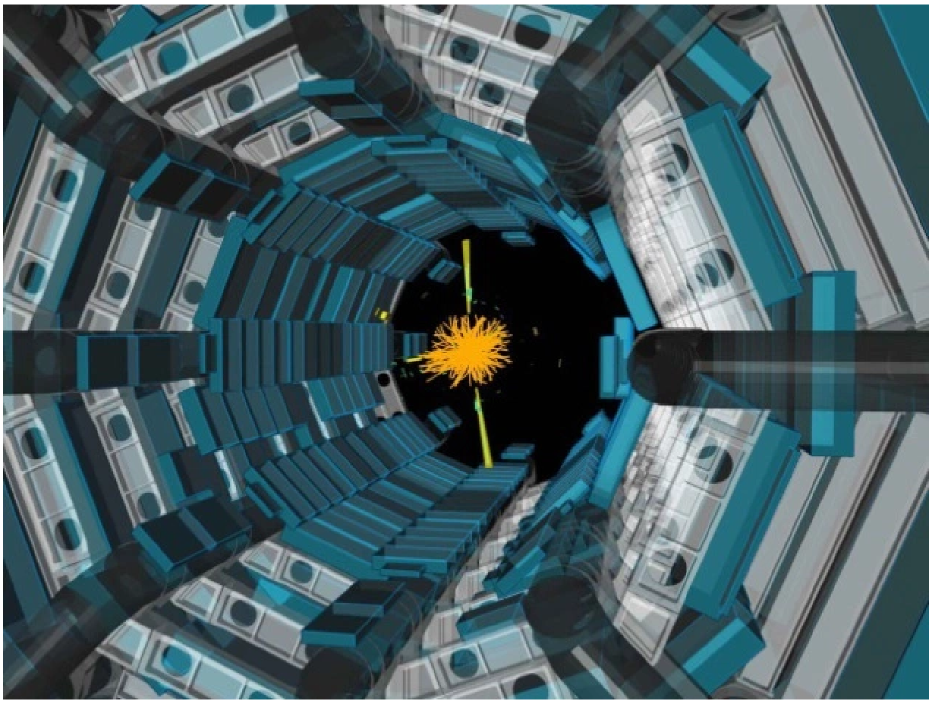

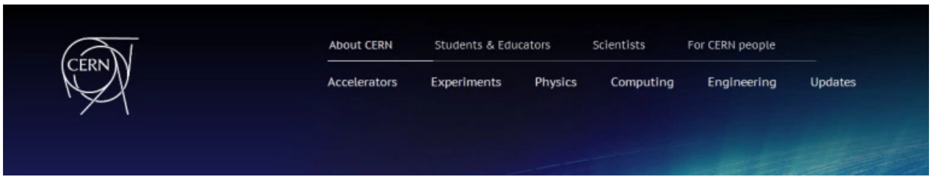

CERN

Accelerating News

View from the LHC tunnel (Credit: CERN)

A new multi-million-pound project between CERN, the Science and Technology Facilities Council (STFC) and six other UK institutions has been launched to contribute to the upgrade of the Large Hadron Collider (LHC) at CERN in Geneva. The world's highest energy particle collider shall be upgraded to the High Luminosity LHC (HL-LHC) in the 2020s through international collaboration.

The challenges of this project are best tackled with input from the project partners from around the world. Several partnerships have already been established with the HL-LHC project and there is room for more potential partnerships in the future. It has now been announced that the UK will make contributions in four areas across the new HL-LHC-UK project among other contributions from UK universities.

The full exploitation of the LHC is the highest priority in the European Strategy for Particle Physics, adopted by the CERN Council and integrated into the ESFRI Roadmap. The full HL-LHC project funding was approved by the CERN Council in June 2016. To extend its discovery potential, the LHC will need a major upgrade around 2025 to increase its luminosity (rate of collisions) by a factor of 10 beyond the original design value (from 300 to 3,000 fb-1). This will enable scientists to look for new, very rare fundamental particles, and to measure known particles such as the Higgs boson with unprecedented accuracy.

Upgrading the LHC calls for technology breakthroughs in areas already under study, and requires about 10 years of research to implement. HL-LHC relies on a number of key innovative technologies, representing exceptional technological challenges. Led by experts from the Cockcroft Institute, the HL-LHC-UK project has now been established to address these challenges.

Within HL-LHC-UK, the partner institutions will perform cutting-edge research and deliver hardware for the LHC upgrade in four areas: 1) proton beam collimation to remove stray halo protons, 2) the development and test of transverse deflecting cavities (“crab cavities”), 3) new methods to diagnose the stored beams including gas jet-based beam profile monitors and, 4) novel beam position monitors, as well as sophisticated cold powering technology needed for the cryogenic systems.

Lucio Rossi, Head of the High-Luminosity LHC project, commented: “In order to make the project a success we have to innovate in many fields, developing cutting-edge technologies for magnets, the optics of the accelerator, superconducting radiofrequency cavities, and superconducting links. We are very excited for the UK to be making key contributions and using their expertise to help deliver this upgrade.”

The HL-LHC-UK project comprises the University of Manchester (Cockcroft Institute), Lancaster University (Cockcroft Institute), the University of Liverpool (Cockcroft Institute), the University of Huddersfield (International Institute of Accelerator Applications), Royal Holloway University of London (John Adams Institute), the University of Southampton and the Science and Technology Facilities Council (STFC). The spokesperson is Rob Appleby (Manchester) and the project manager is Graeme Burt (Lancaster).

More information about the High Luminosity LHC project, its technology and design as well as the challenges ahead can be found in the recently released open access HiLumi LHC book *The High Luminosity Large Hadron Collider. The New Machine for Illuminating the Mysteries of the Universe*.

See the full article here.

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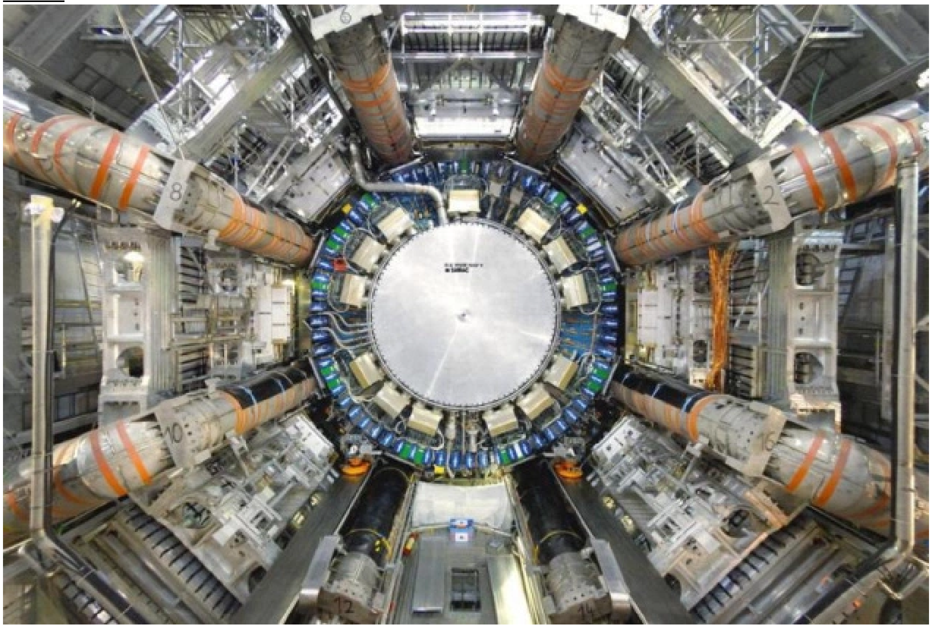

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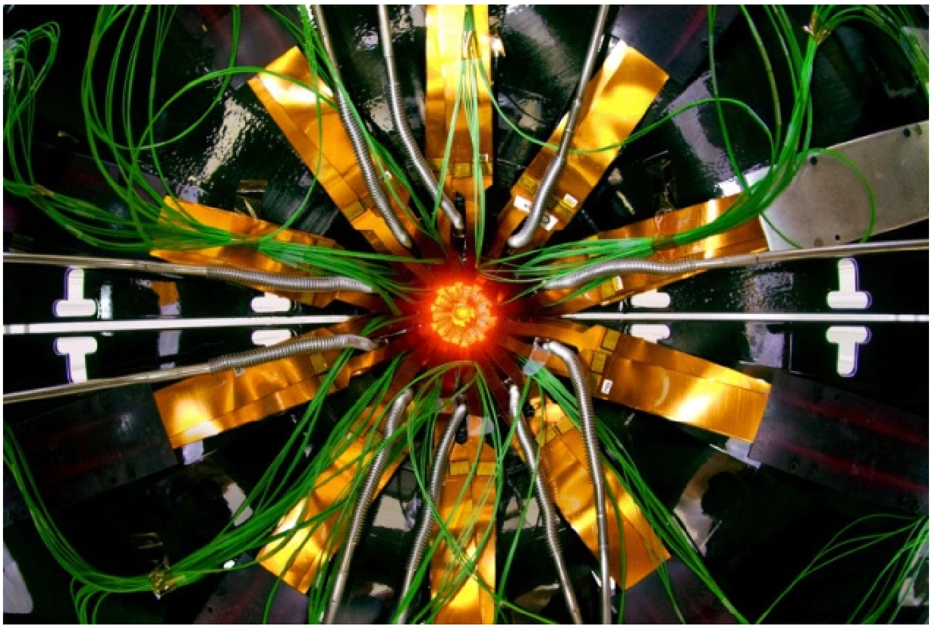

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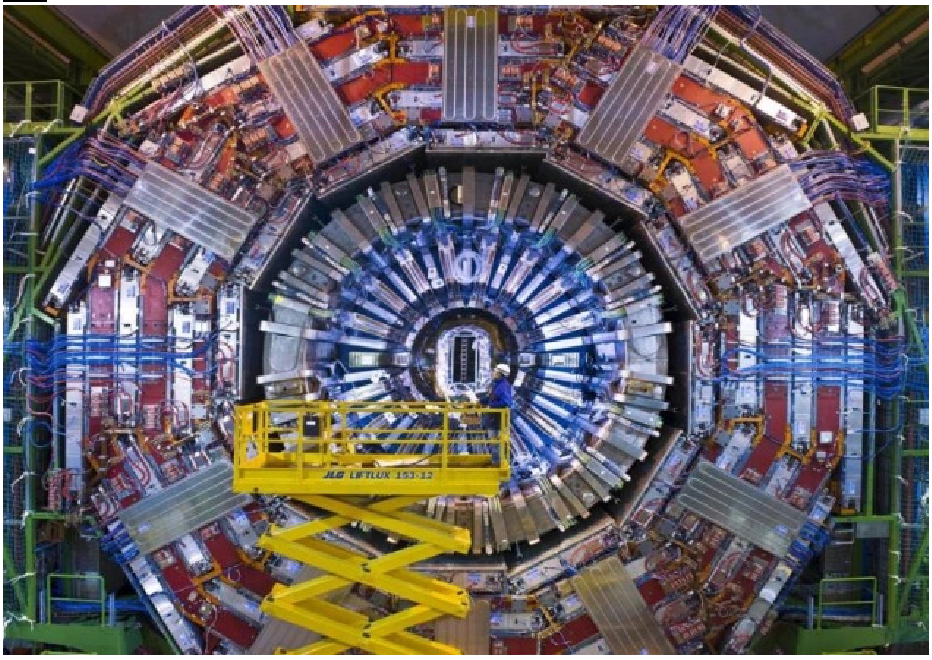

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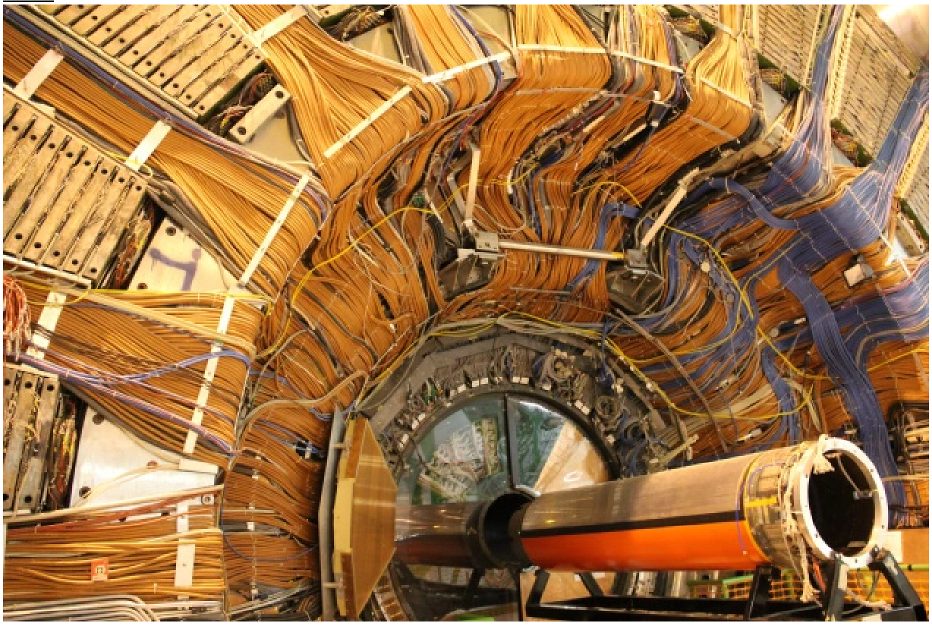
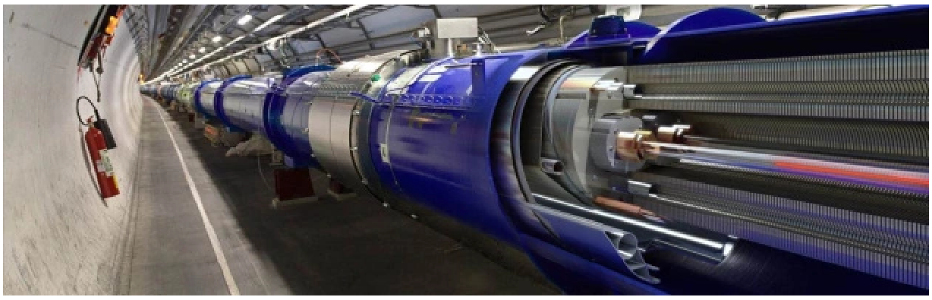
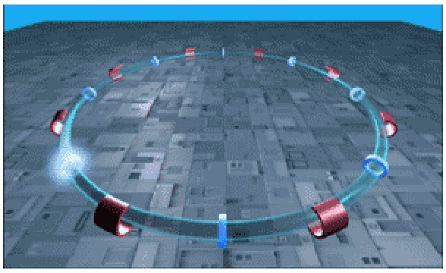


LHC





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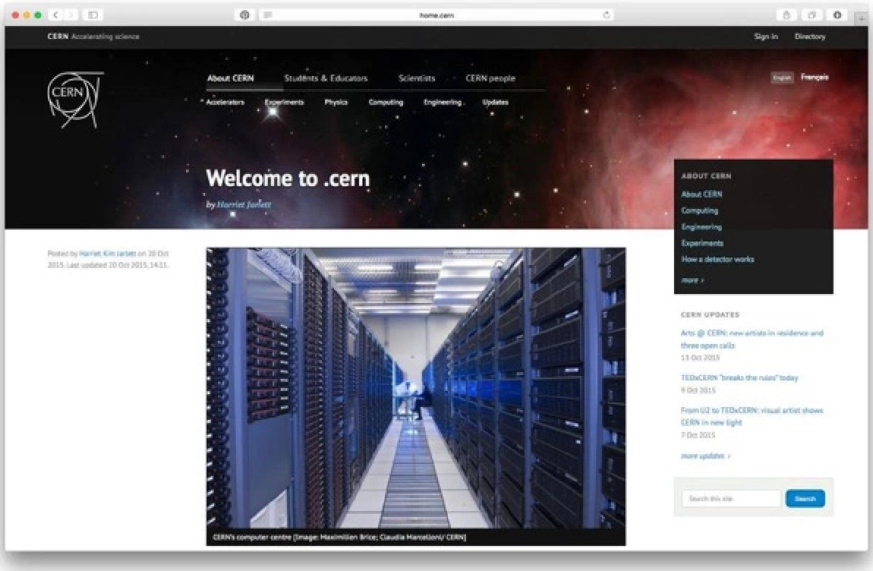
From CERN via Accelerating News: "Progress in the interaction region magnets of HL-LHC"



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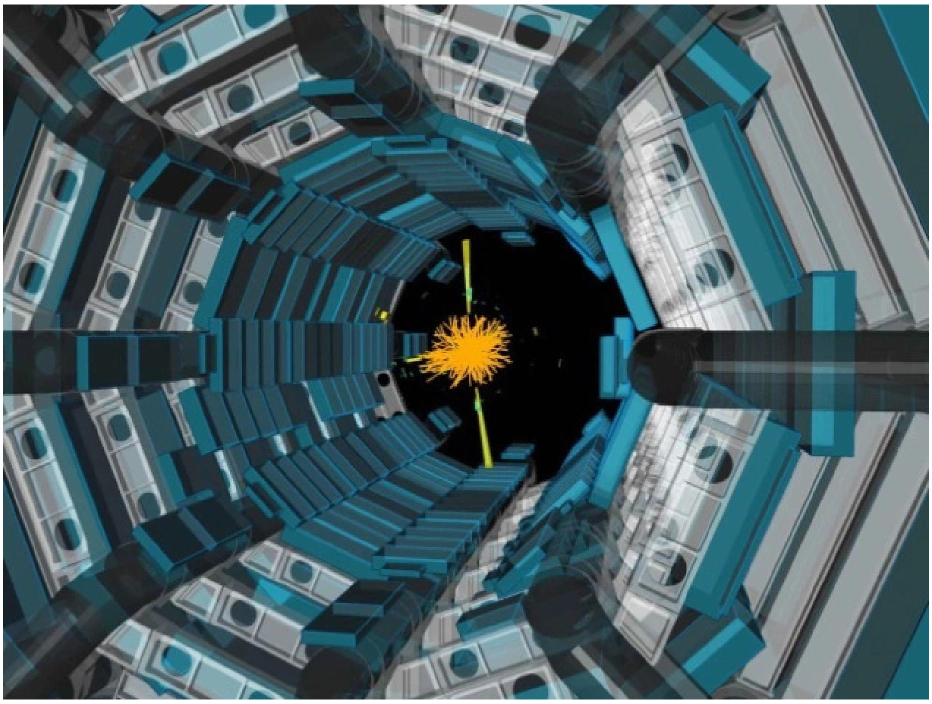

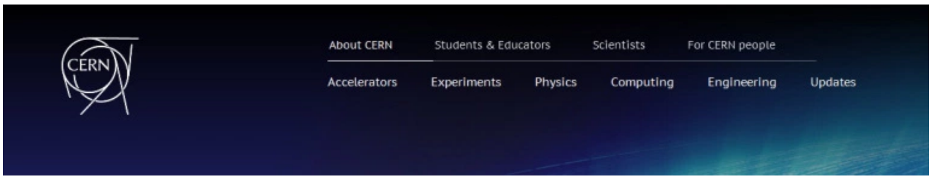

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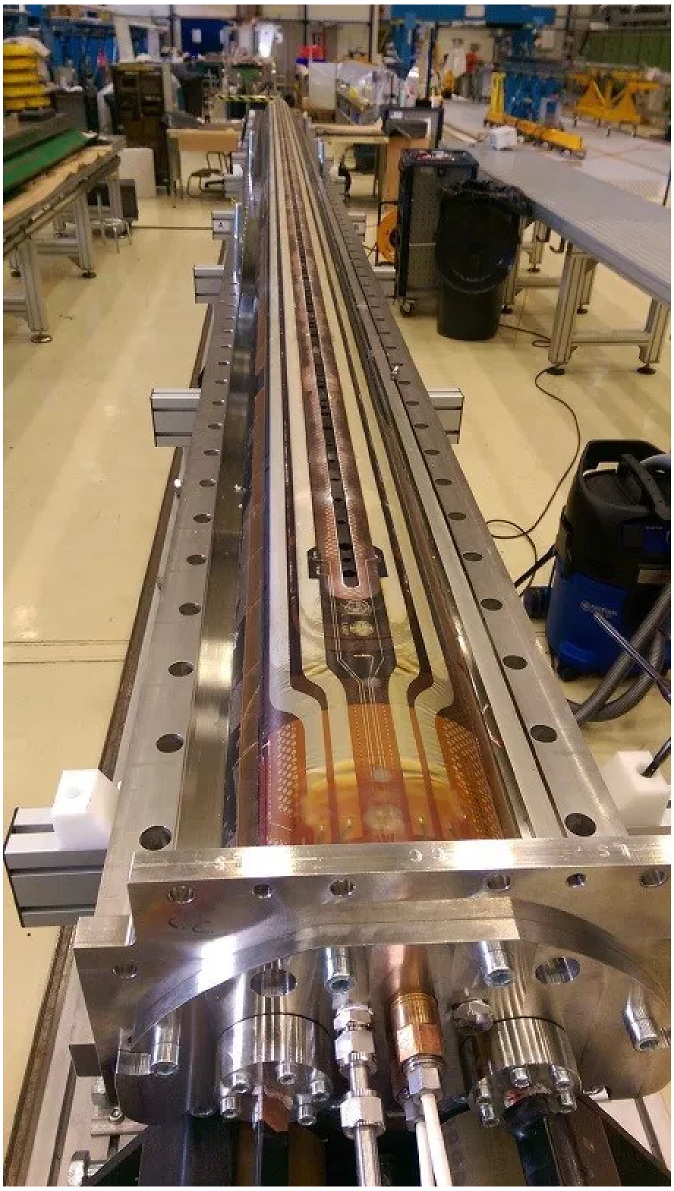
Accelerating NEWS

Accelerator News

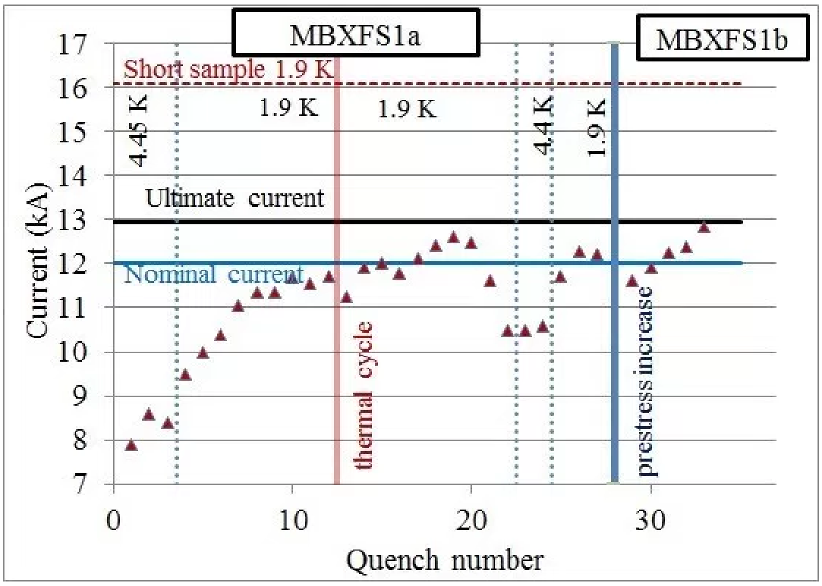
3.16.17
Ezio Todesco (CERN)



Winding of the first 7.15-m-long dummy coil of the triplet quadrupole at building 180 (CERN)

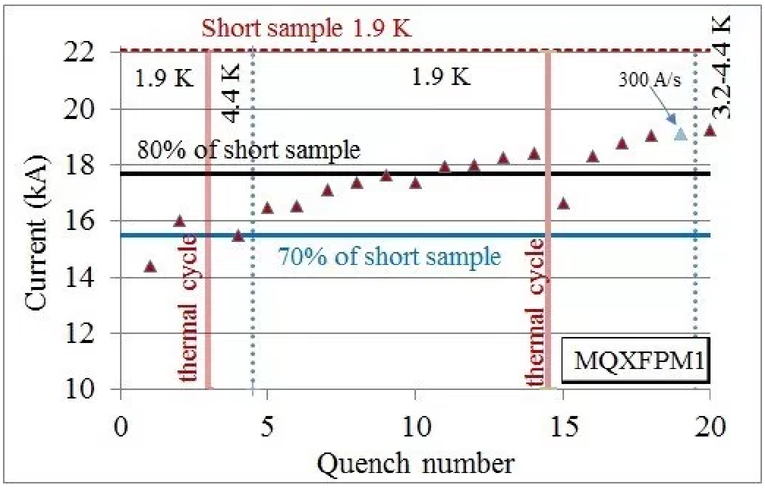
During the past months, significant advancements have been done in the development of the interaction region magnets for HL-LHC.

In KEK, Japan, the short model of the separation dipole D1, that showed insufficient quench performance after the first test, has been disassembled. Significant movements of the coils (up to few mm) were observed in the heads, and a clear evidence of a lack of prestress in the straight part was found. The new assembly took place during winter, and a prestress increase in the straight part of about 35 MPa has been achieved. The magnet was tested in February, reaching nominal current after 2 quenches and ultimate after 5 quenches (see Figure 1). "The magnet performance is now in line with the project requirements – says T. Nakamoto, in charge of the D1 project – we will have a warm-up and cool-down to prove the magnet memory in the next weeks". The short model design is being updated in some features of the iron yoke, and to account for an unexpected contribution to field quality from the coil heads in the strong regime of saturation. A second model will be built in the second part of 2017, and tested in 2018.



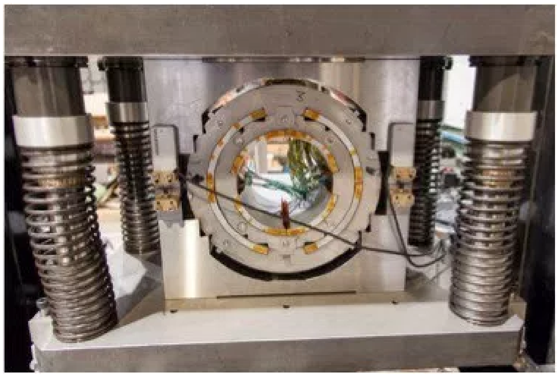
Training of MBXFS1 in KEK: quenches (markers), nominal and ultimate current (solid lines) and short sample limit (dotted line). (Credit: HL-LHC WP3 collaboration)

In the US, the first 4-m-long coil has been tested in a mirror configuration, reaching 85% of short sample limit. “This is the new world record for coil length in Nb3Sn accelerator magnets – says G. Ambrosio, in charge of the US contribution for the triplet – and paves the way to the assembly and test of the first 4-m-long quadrupole, to be done in the second part of the year”. At the same time at CERN the first 7.15-m-long dummy coils are being produced to validate the assembly procedures.



Training of mirror 4-m-long coil in BNL: quenches (markers), 70% and 80% of short sample (solid lines) and short sample limit (dotted line). (Credit: HL-LHC WP3 collaboration)

Furthermore, in CIEMAT, Madrid, the prototype for the nested orbit correctors is entering the construction phase. The concept of double collaring has been validated on a mechanical model with the final design of the collars and a dummy coil made of aluminum (see Figure 4). This is an important step of the validation of the mechanical concept of this magnet, where a mechanical lock between the horizontal and vertical dipoles is required to control the large torque. In particular, the second collaring of the outer dipole on the inner one is critical. “Both collaring operations were in line with our expectations, and we managed to insert pins without any criticality – said F. Toral from CIEMAT, in charge of the Spanish contribution for the orbit correctors – we saw some asymmetries that need more investigations, but given the complexity of the design, this is a very encouraging first step towards construction”.



Double collaring of the nested corrector in CIEMAT

Finally, in LASA, Milano the activity on the high order corrector prototypes is at full speed. After the successful test of the sextupole, the first decapole coil in a single coil configuration has been tested successfully. The coil reached twice the ultimate current with negligible training, thus proving the assembly procedures and tooling concepts. LASA is working in parallel on two magnets: besides the first decapole coil, eigth octupole coils have been completed and will be assembled in the first prototype, and tested in April.

See the full article here.

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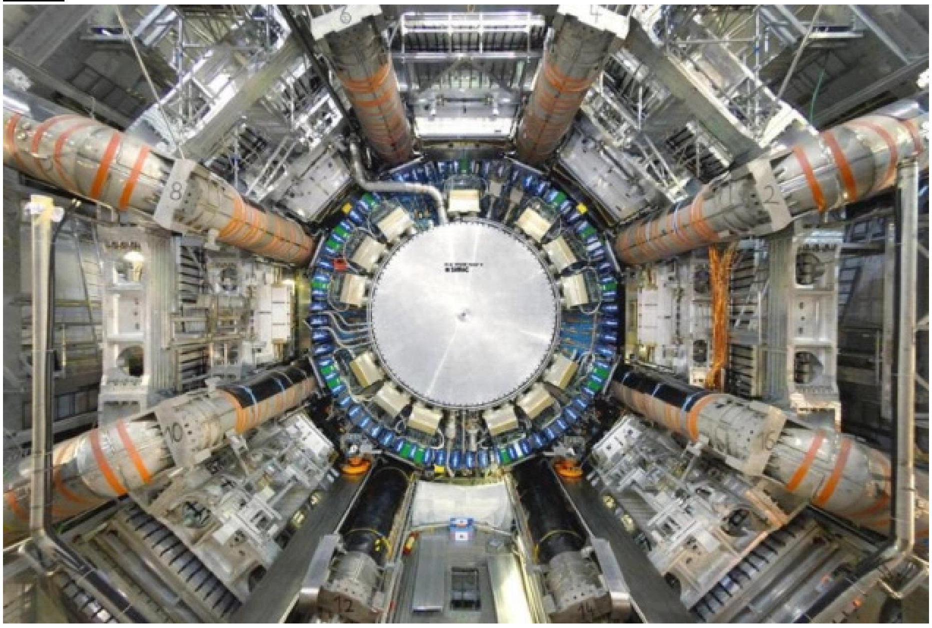

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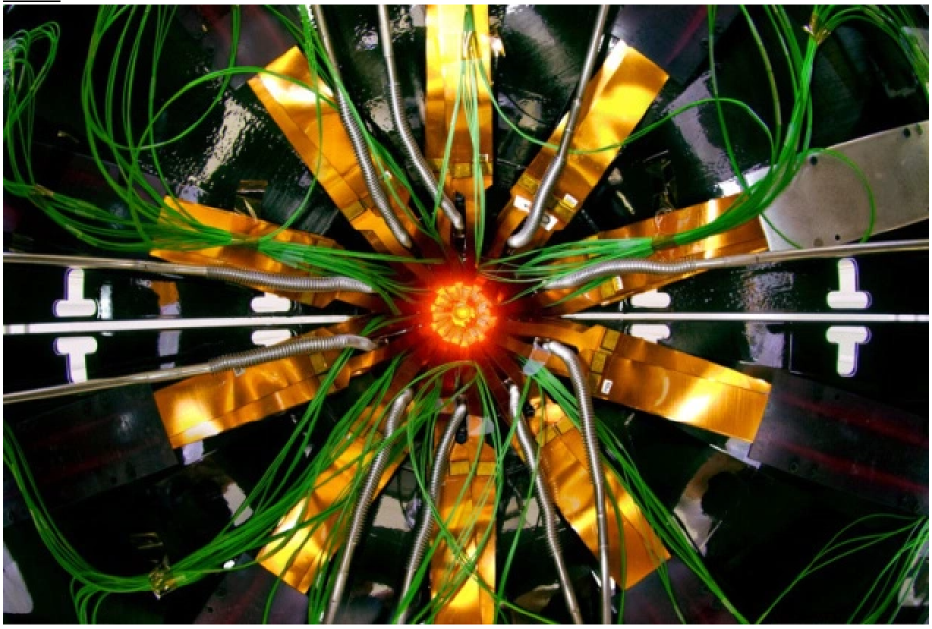

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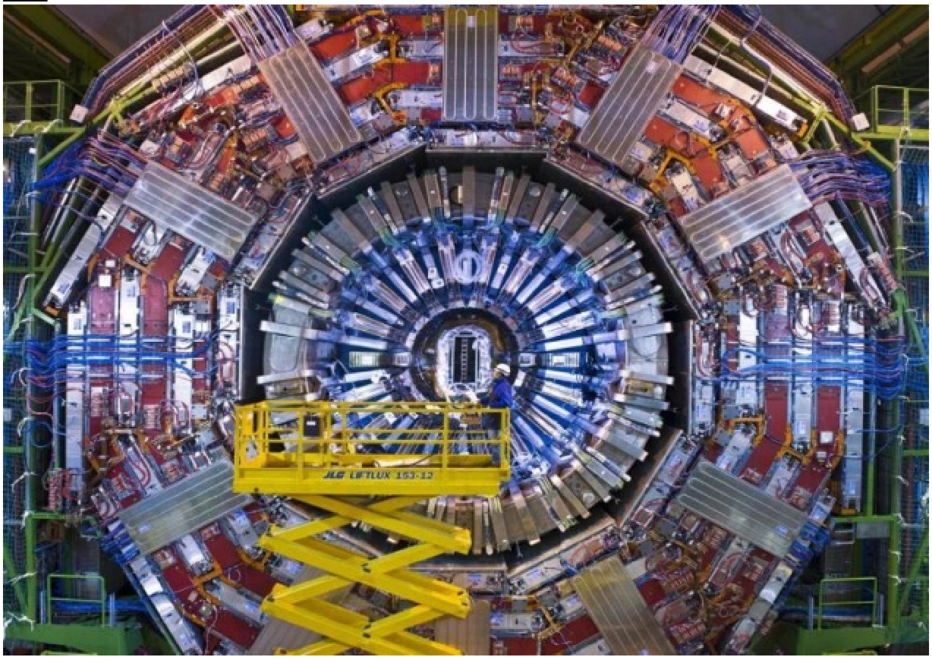

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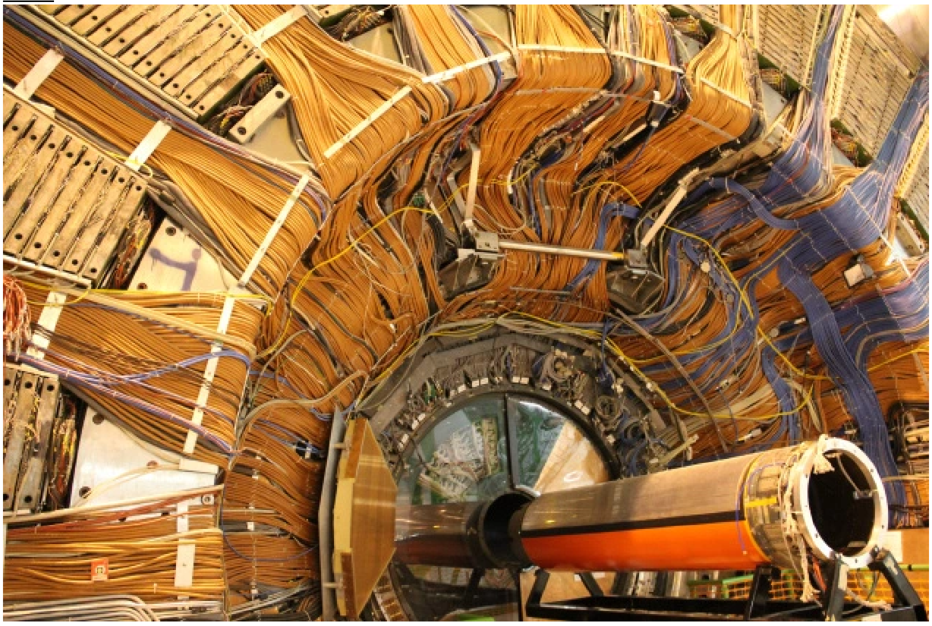
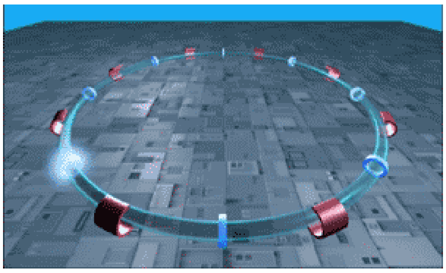


LHC



Quantum Diaries

QUANTUM DIARIES
Thoughts on work and life from particle physicists from around the world.

richardmitnick 12:11 am on October 15, 2016
Permalink (https://sciencesprings.wordpress.com/2016/10/14/from-cern-courier-all-systems-go-for-the-high-luminosity-lhc/)

Tags: Accelerator Science (600), CERN Courier (20), CERN HL-LHC, HEP (889), Particle Accelerators (732), Particle Physics (1,059)

From CERN Courier: "All systems go for the High-Luminosity LHC"

CERN Courier

Oct 14, 2016

Model quadrupole magnet

On 19 September, the European Investment Bank (EIB) signed a 250 million Swiss francs (€230 million) credit facility with CERN in order to finance the High-Luminosity Large Hadron Collider (HL-LHC) project.

High Luminosity LHC

The finance contract follows recent approval from CERN Council, and will allow CERN to carry out the work necessary for the HL-LHC within a constant CERN budget.

The HL-LHC is expected to produce data from 2026 onwards, with the overall goal of increasing the integrated luminosity recorded by the LHC by a factor 10. Following approval of the HL-LHC as a priority project in the European Strategy Report for Particle Physics, this major upgrade is now gathering speed together with companion upgrade programmes of the LHC injectors and detectors. Engineers are currently putting the finishing touches to a full working model of an HL-LHC quadrupole, which will eventually be installed in the insertion regions close to the ATLAS and CMS experiments in order to focus the HL-LHC beam. Built in partnership with Fermilab, the magnets are based on an innovative niobium-tin superconductor (Nb3Sn) that can produce higher magnetic fields than the niobium-titanium magnets used in the LHC.

The contract signed between CERN and EIB falls under the InnovFin Large Projects facility, which is part of the new generation of financial instruments developed and supported under the European Union's Horizon 2020 scheme. It's the second EIB financing for CERN, following a loan of €300 million in 2002 for the LHC. "This loan under Horizon 2020, the EU's research-funding programme, will help keep CERN and Europe at the forefront of particle-physics research," says the European commissioner for research, science and innovation, Carlos Moedas. "It's an example of how EU funding helps extend frontiers of human knowledge."

See the full article here .

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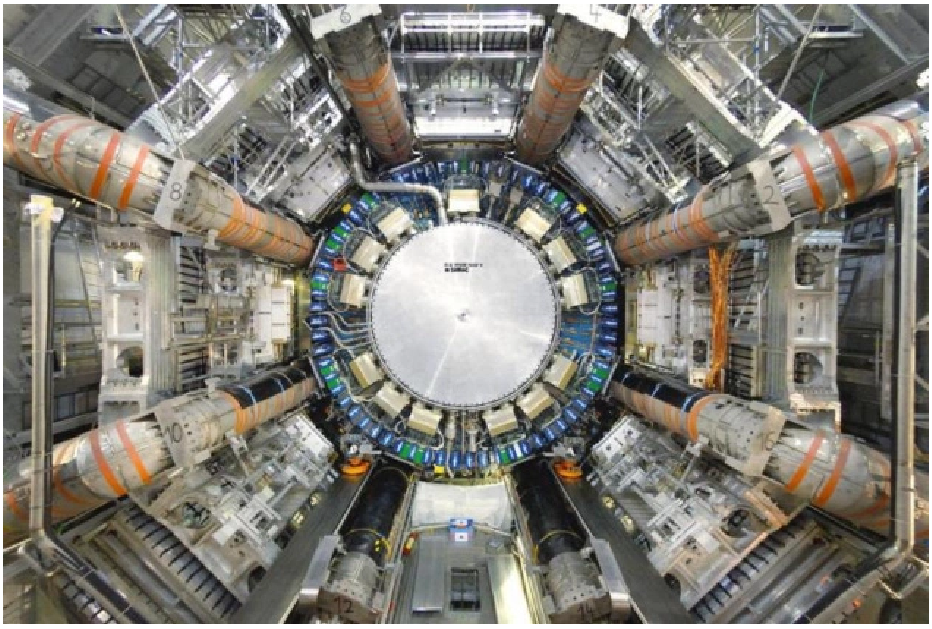

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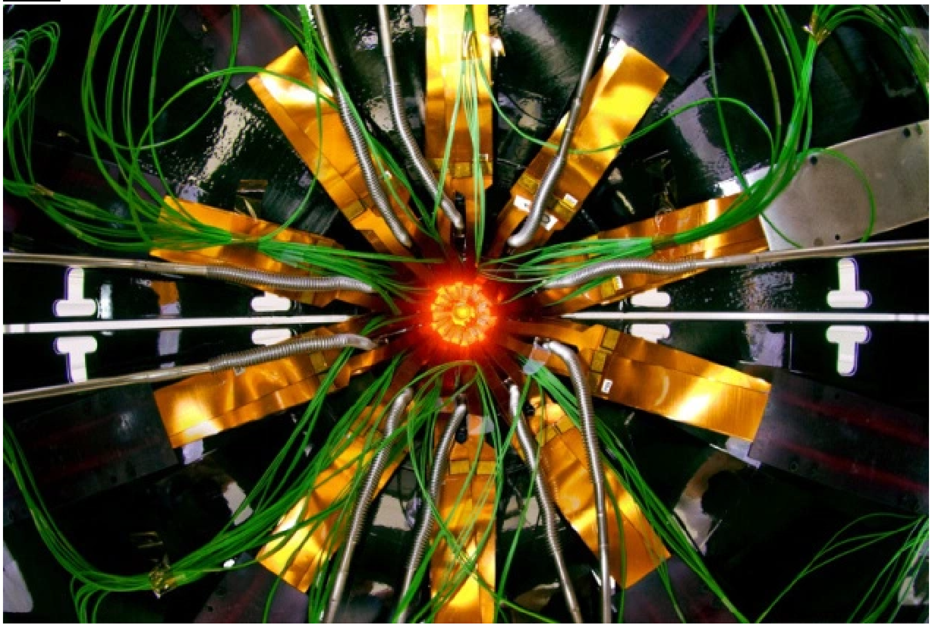

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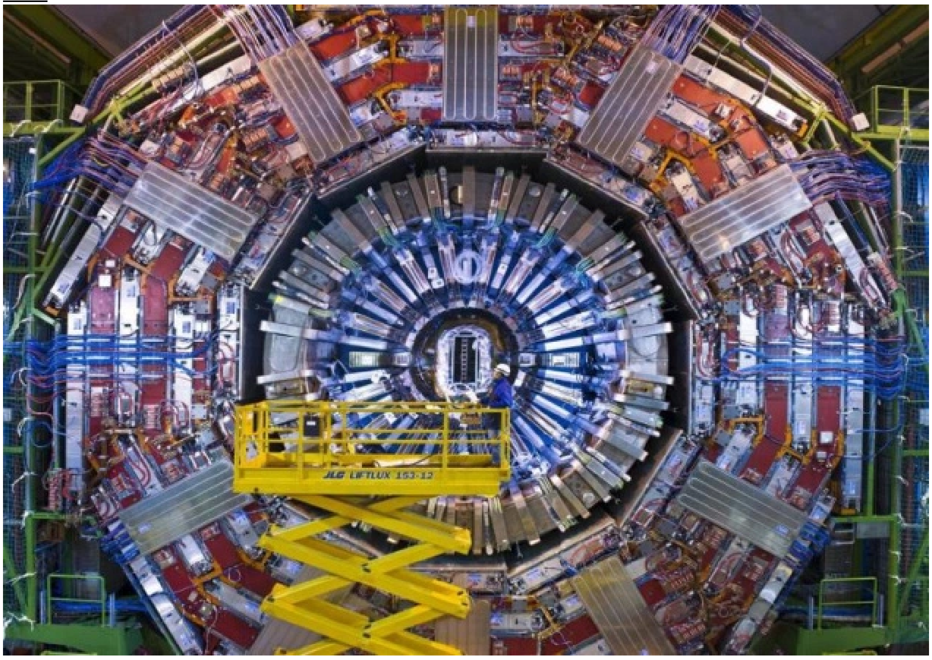
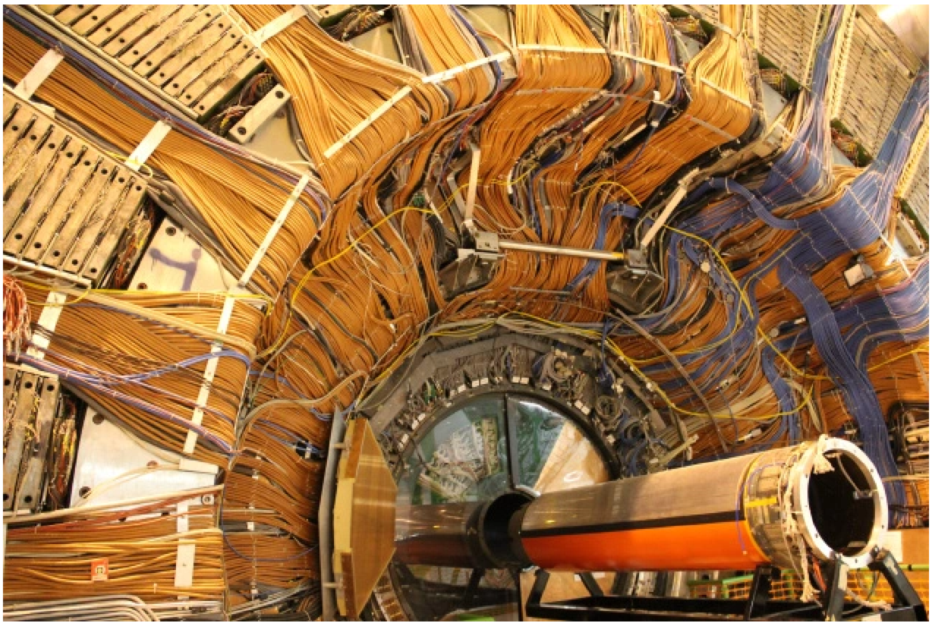


LHCb



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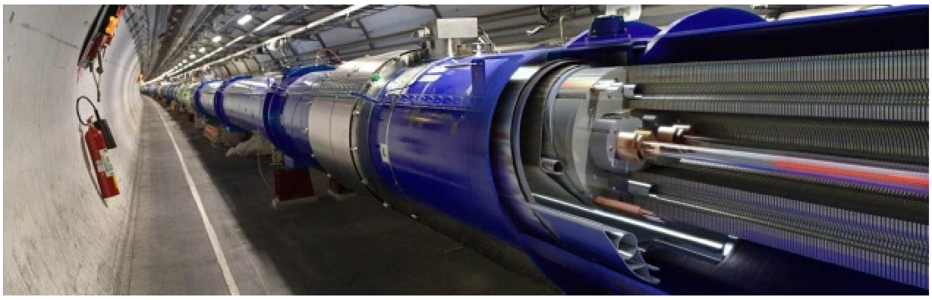
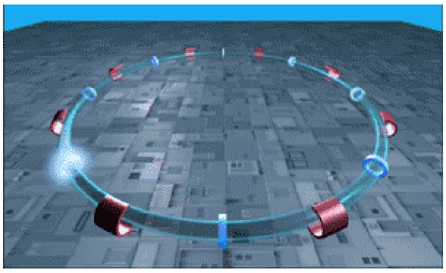
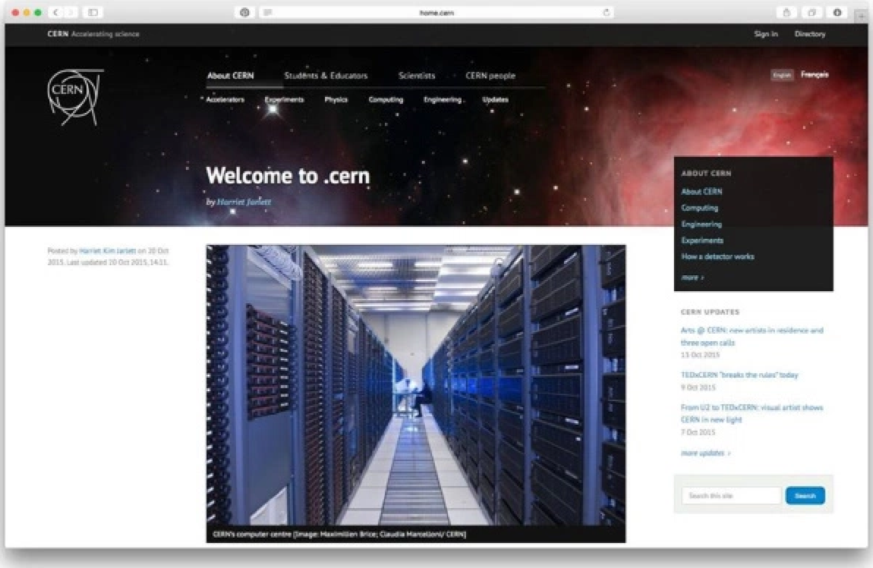




richardmitnick 10:14 pm on August 15, 2016
Permalink (https://sciencesprings.wordpress.com/2016/08/15/from-cern-once-upon-a-time-there-was-a-superconducting-niobium-tin/)

Tags: Accelerator magnets, Accelerator Science (600), Basic Research (7,934), CERN HL-LHC, CERN LHC (170), HEP (889), Niobium-tin (Nb3Sn), Rutherford cable

From CERN: “Once upon a time, there was a superconducting niobium-tin…”



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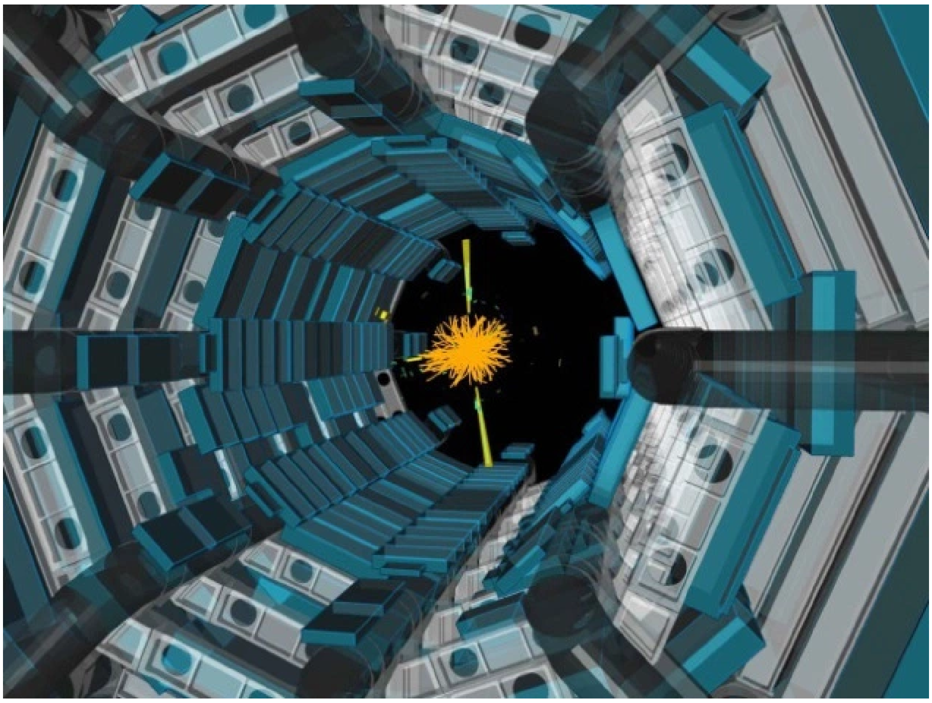
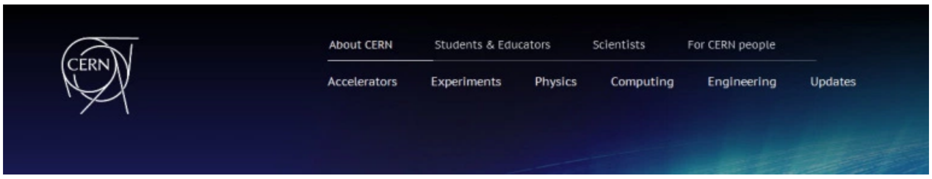
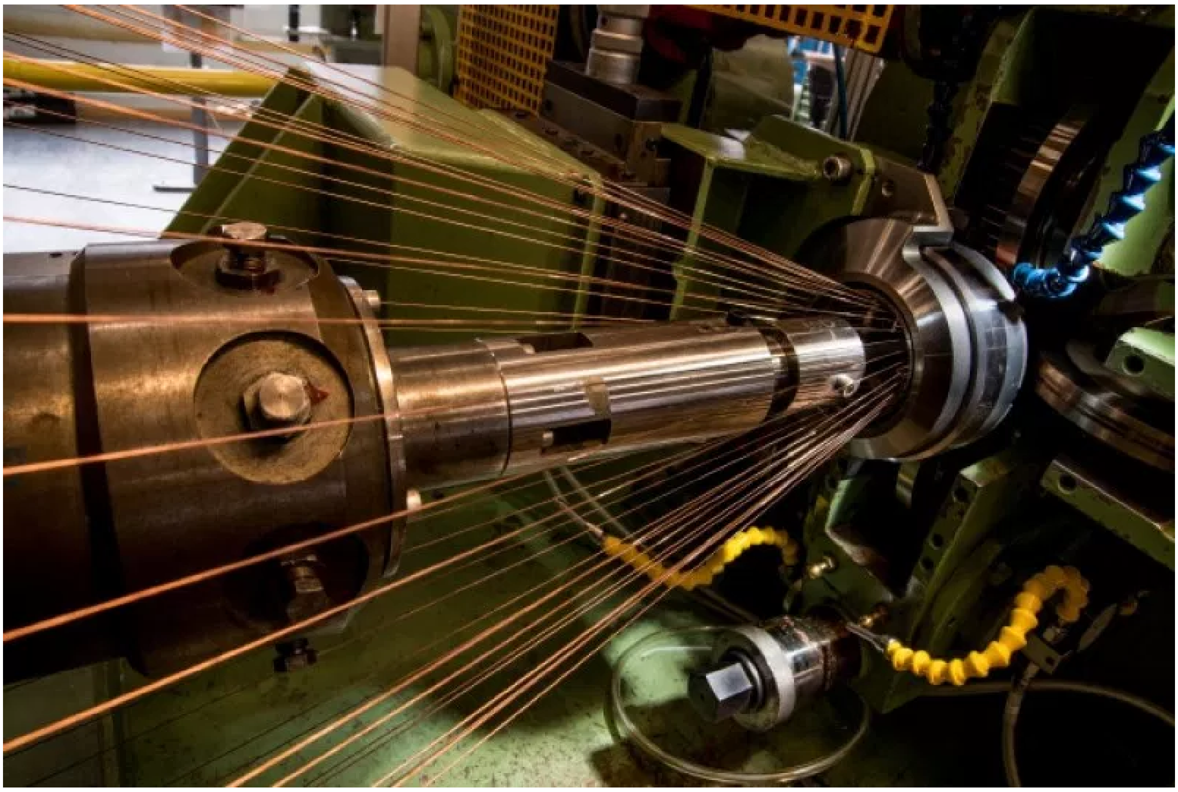




CERN

25 Jul 2016 [Just now in social media.]
Stefania Pandolfi

High
Luminosity
LHC



A Rutherford cabling machine is used to assembly of the high-performance cables, made from state-of-the-art Nb3Sn conductor, for the LHC High Luminosity upgrade. (Photo: Max Brice/CERN)

Extraordinary research needs extraordinary machines: the upgrade project of the LHC, the High-Luminosity LHC (HL-LHC), has the goal of achieving instantaneous luminosities a factor of five larger than the LHC nominal value, and it relies on magnetic fields reaching the level of 12 Tesla. The superconducting niobium-titanium (NbTi) used in the LHC magnets can only bear magnetic fields of up to 9-10 Tesla. Therefore, an alternative solution for the superconducting magnets materials was needed. The key innovative technology to develop superconducting magnets beyond 10 Tesla has been found in the niobium-tin (Nb3Sn) compound.

This compound was actually discovered in 1954, eight years before NbTi, but when the LHC was built, the greater availability and ductility of the NbTi alloy and its excellent electrical and mechanical properties led scientists to choose it over Nb3Sn.

The renewed interest in Nb3Sn relies on the fact that it can produce stronger magnetic fields. In the HL-LHC, it will be used in the form of cables to produce strong 11 T main dipole magnets and the inner triplet quadrupole magnets that will be located at the ATLAS (Point 1) and CMS (Point 5) interaction points.

The Nb3Sn wires that will be used in the coils of the HL-LHC magnets are made up of a copper matrix, within which there are several filaments of about 0.05 mm in diameter. These filaments are not initially superconducting, as they would be too brittle to withstand the cabling process and would lose their superconducting properties Therefore, the unreacted, not-yet-superconducting Nb3Sn wires must first be assembled into cables and the cables then wound into a coil. Finally the coil must be heat-treated at about 650 oC for several days to make it superconducting via a complex reaction and diffusion process.

The cabling of the strands is done in the superconducting laboratory in Building 163 using a machine, which cables together 40 unreacted strands of Nb3Sn into what is known as a Rutherford cable. The Rutherford cable is so far the only type of superconducting cable used in accelerator magnets. It consists of several wires that are highly compacted in a trapezoidal cross section to obtain high current density.

“The Nb3Sn cables for the 11 T dipole magnet series and for the insertion quadrupole magnets have been developed by our section here at CERN,” says Amalia Ballarino, head of the Superconductor and Superconducting Devices (SCD) section of the Magnets, Superconductors and Cryostats (MSC) group in the Technology department. “In the superconducting laboratory, in Building 163, we are now producing the series of cables for the new magnets that will be part of the HL-LHC.”

There are several challenges connected to the cabling of the wires. First of all, the mechanical deformation due to the cabling must have a negligible influence on the shape, and therefore on the electrical performance, of the internal filaments. The deformed wire must be able to cope with the heat treatment without its performance deteriorating. To assure field quality, all the wires must be cabled, with the same tension, into a precise geometry across the whole cable length.

“With the HL-LHC, for the first time there will be Nb3Sn magnets in an accelerator, it’s a big responsibility”, adds Ballarino. “For HL-LHC, we are not in an R&D phase anymore, and this means that we have reached the highest possible level of performance associated with the present state-of-the-art generation of Nb3Sn wires,” points out Ballarino. “Future higher-energy accelerators will require fundamental research on Nb3Sn wire to produce even stronger magnetic fields,” she concludes.

See the full article here.

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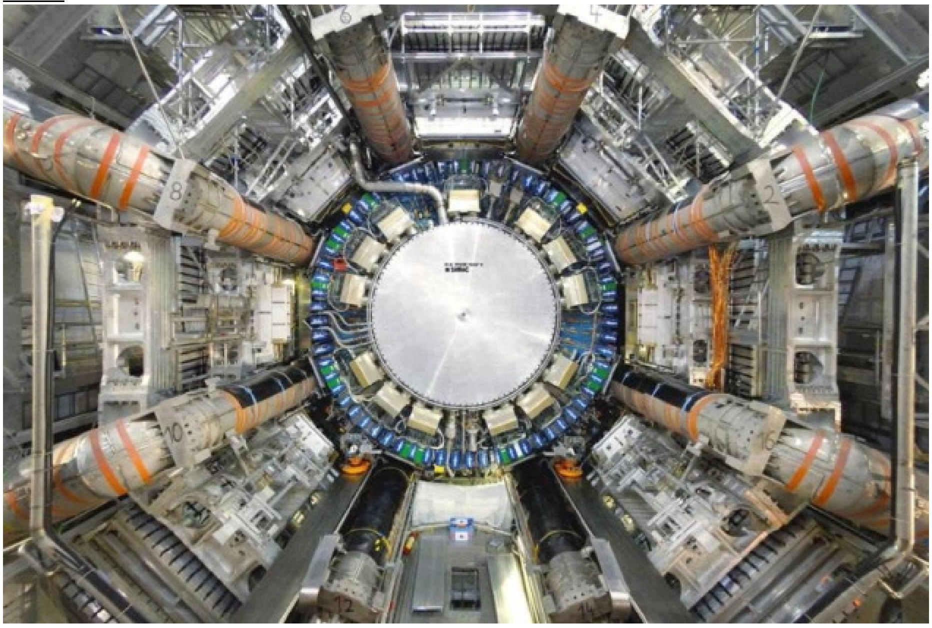

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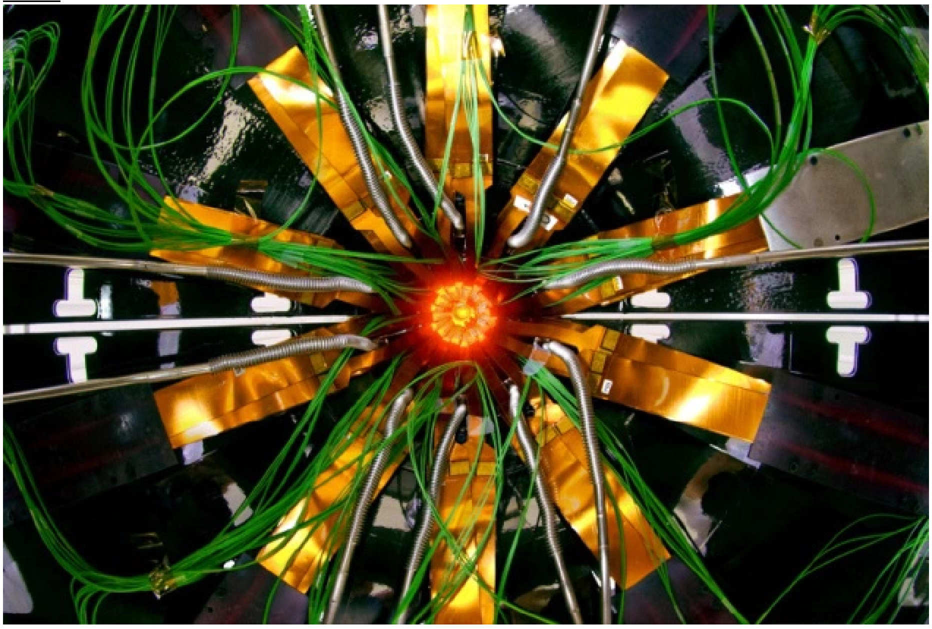
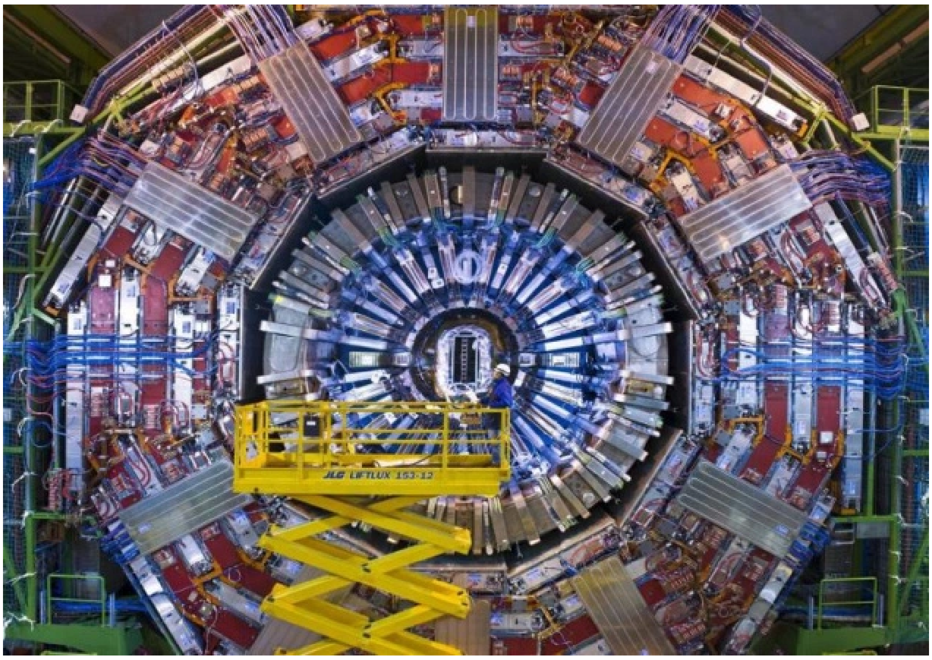
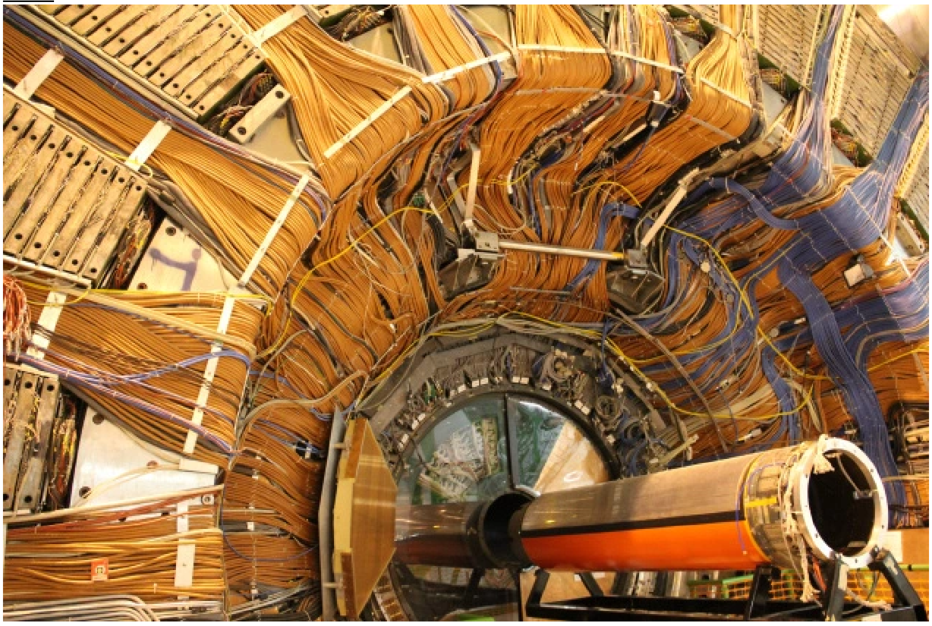


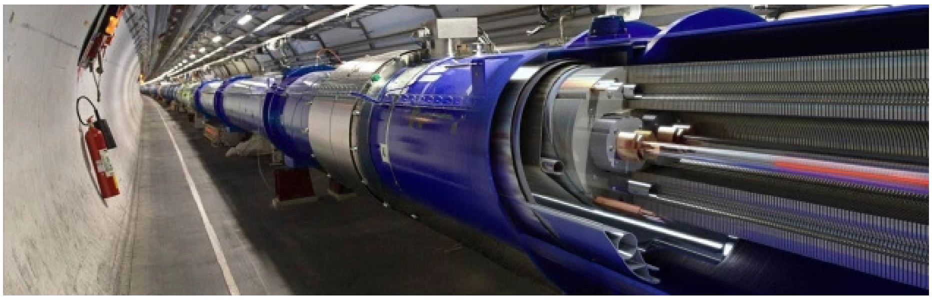
CMS

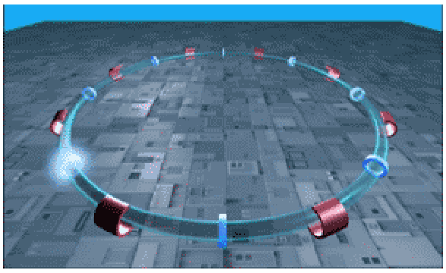


LHCb



LHC





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richardmitnick 6:39 pm on November 27, 2015
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Tags: Basic Research (7,934), CERN HL-LHC, HEP (889), Particle Accelerators (732), Particle Physics (1,059), Superconducting Magnets (8)

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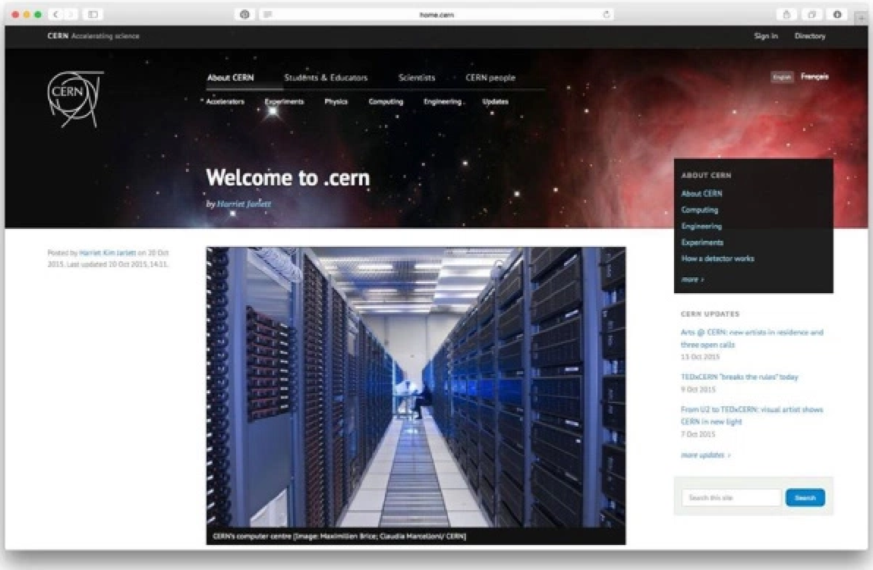

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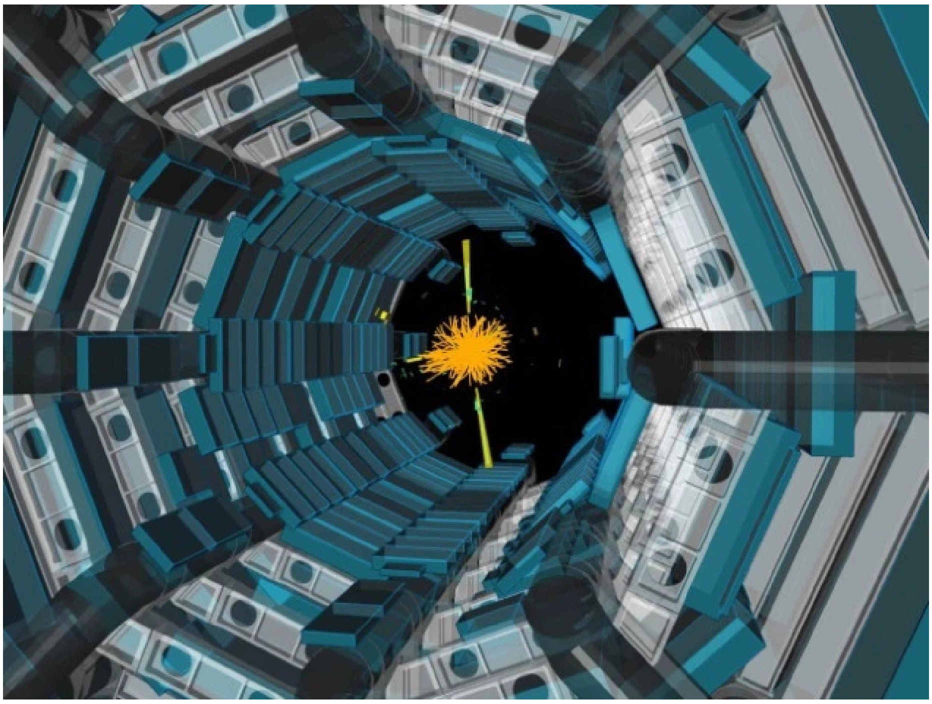
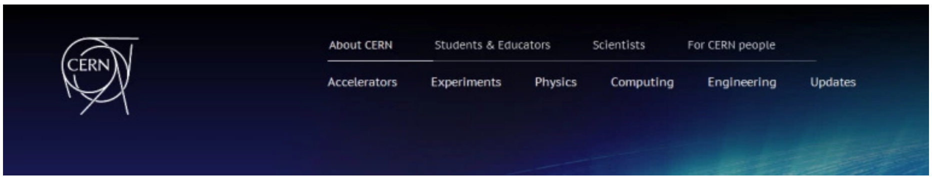
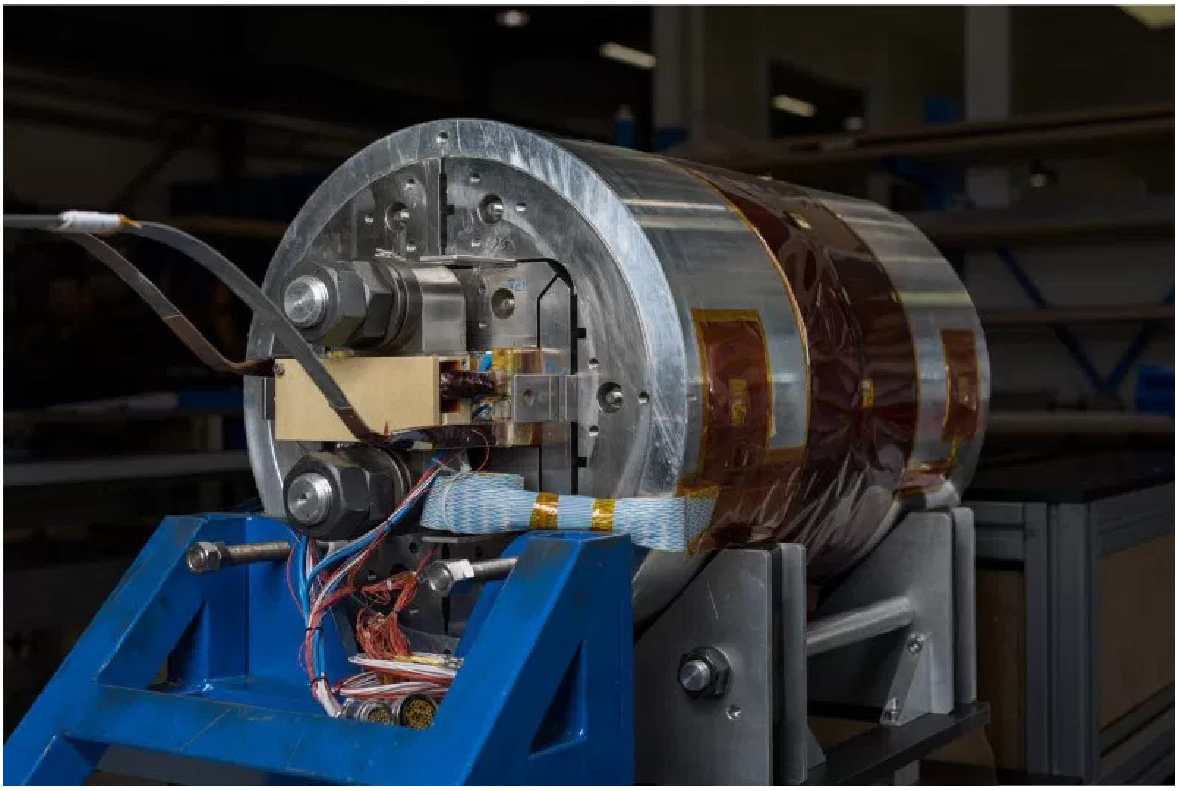




CERN

27 Nov 2015
Harriet Kim Jarlett



The Racetrack Model Coil test magnet (Image: CERN)

A new world record has been broken by the CERN magnet group when their racetrack test magnet produced a 16.2 tesla (16.2T) peak field – nearly twice that produced by the current LHC dipoles and the highest ever for a dipole magnet of this configuration.

The Racetrack Model Coil (RMC) is one of several demonstration test magnets being built by the group to understand and develop new technologies, which are vital for future accelerators.

The shorter magnets are just 1 to 2 metres in length, compared to the 5-7 metre long ones needed for the High-Luminosity LHC.

The tests are needed to prove the feasibility of creating magnetic fields of up to 16 tesla, which are built into the designs of future accelerators.

“The present LHC dipoles have a nominal field of 8.3T and we are designing accelerators which need magnets to produce a field of around 16T – almost twice as much,” says Juan Carlos Perez, an engineer at CERN and the project leader for the RMC.

High-field magnets are crucial to building higher energy particle accelerators. High magnetic fields are needed to steer a beam in its orbit – in the case of dipoles – or to squeeze the beams before they collide within the experiments, which is the case for high-gradient quadrupoles.

The LHC uses niobium-titanium superconducting magnets to both bend and focus proton beams as they race around the LHC. But the RMC uses a different superconducting material, niobium-tin, which can reach much higher magnetic fields, despite its brittle nature.

The world record is a step forward in the demonstration of the technology for the High-Luminosity LHC project, and a major milestone for the Future Circular Collider design study.

“It is an excellent result, although we should not forget that this is a relatively small magnet, a technology demonstrator with no bore through the centre for the beam,” says Luca Bottura, Head of CERN’s Magnet Group. “There is still a way to go before 16 Tesla magnets can be used in an accelerator. Still, this is a very important step towards them.”

The RMC is also using wires and cables of the same class as those being used to build FRESCA2, a 13T dipole magnet with a 100mm aperture that will be used to upgrade the CERN cable test facility FRESCA. FRESCA2 coils are currently under construction and will be ready for testing by summer 2016.

Such fields are only possible thanks to new materials and technologies, and also close relationships between several physics communities. The team worked closely with other European and overseas research and development programmes to break the technology barriers.

Learn more about the technologies and the Racetrack Model Coil read this month’s Accelerating News.

See the full article here.

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CERN ATLAS New

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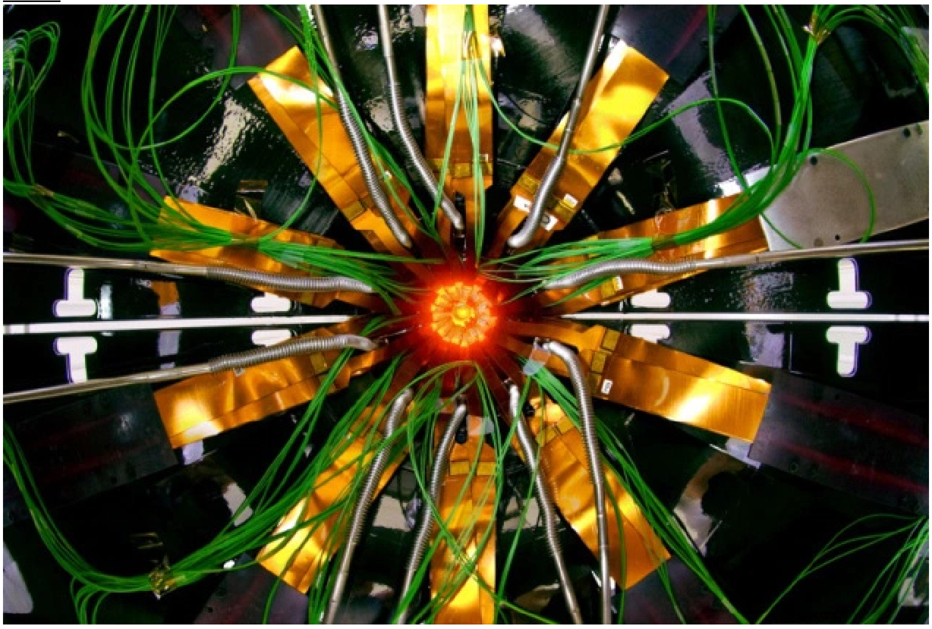
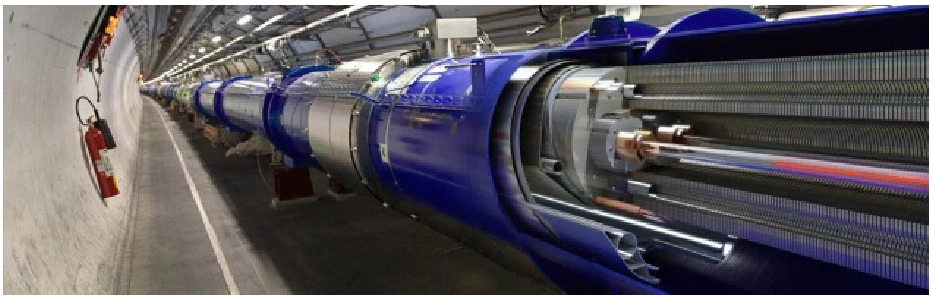


CMS
CERN CMS New

LHCb
CERN LHCb New

LHC

CERN LHC New



LHC particles

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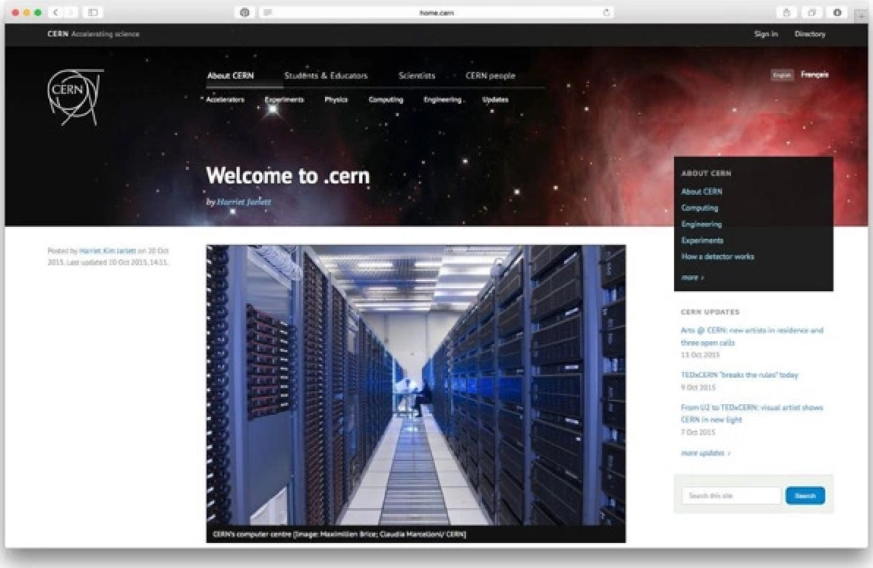
From CERN: “High Luminosity LHC moves forward”



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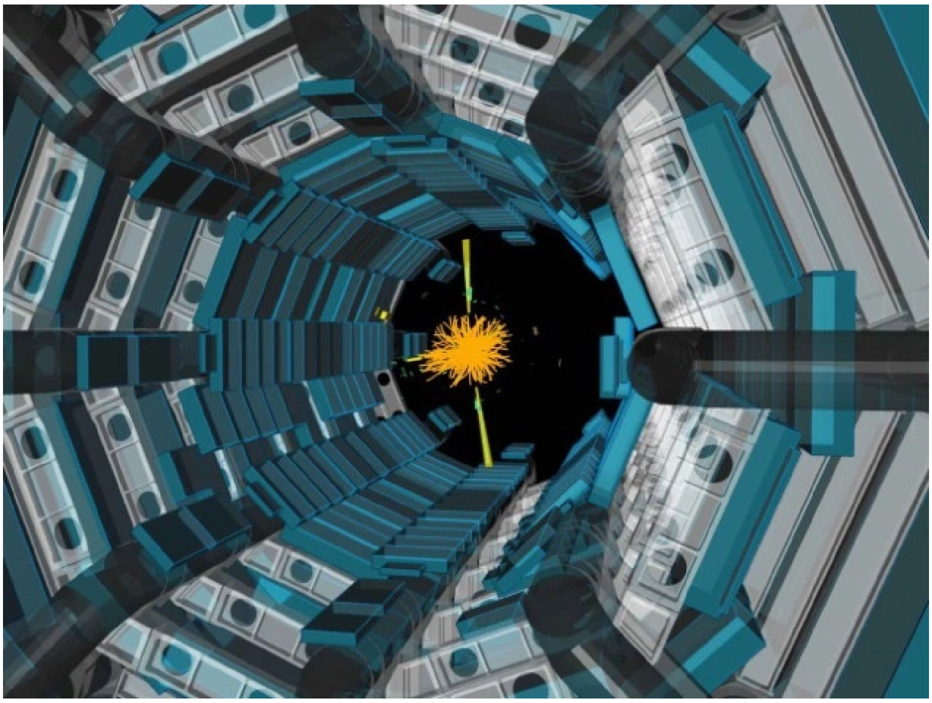
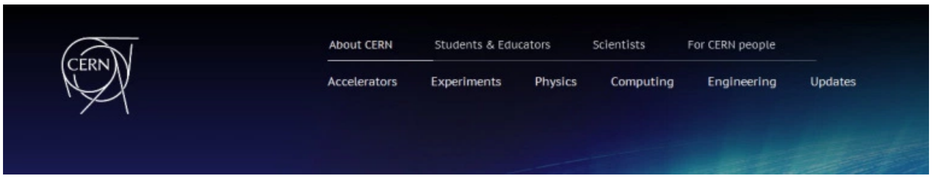




CERN

Nov 13, 2015

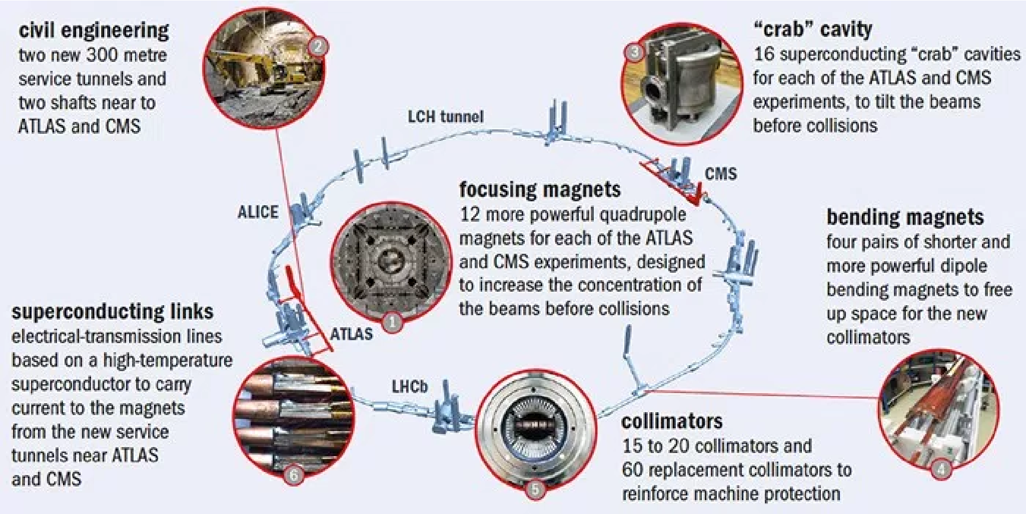
High
Luminosity
LHC

October 2015 was a turning point for the High Luminosity LHC (HL-LHC) project, marking the end of the European-funded HiLumi LHC Design Study activities, and the transition to the construction phase, which is also reflected in the redesigned logo that was recently presented.

So far, the LHC has only delivered 10% of the total planned number of collisions. To extend its discovery potential even further, the LHC will go through the HL-LHC major upgrade around 2025, which will increase the luminosity by a factor of 10 beyond the original design value (from 300 to 3000 fb–1). The HL-LHC machine will provide more accurate measurements and will enable the scientific community to study new phenomena discovered by the LHC, as well as new rare processes. The HiLumi upgrade programme relies on a number of key innovative technologies, such as cutting-edge 12 Tesla superconducting magnets, very compact and ultra-precise superconducting cavities for beam rotation, and 100 m-long high-power superconducting links with zero energy dissipation. In addition, the higher luminosities will make new demands on vacuum, cryogenics and machine protection, and will require new concepts for collimation and beam diagnostics, advanced modelling for the intense beam and novel schemes of beam crossing to maximise the physics output of these collisions.

From design to construction

The green light for the beginning of this new HL-LHC phase, marked by main hardware prototyping and industrialisation, was given with the approval of the first version of the Technical Design Report – the document that describes in detail how the LHC upgrade programme will be carried out. This happened at the 5th Joint HiLumi LHC-LARP Annual Meeting, which took place at CERN from 26 to 30 October and saw the participation of more than 200 experts from all over the world to discuss the results and achievements of the HiLumi LHC Design Study. In the final stage of the more than four-year-long design phase, an international board of independent experts worked on an in-depth cost-and-schedule review. As a result, the total cost of the project – amounting to CHF 950 million – will be included in the CERN budget until 2026.



New technologies

In addition to the project management work-package (WP), a total of 17 WPs involving more than 200 researchers and engineers addressed the technological and technical challenges related to the upgrade. During the 48 months of the HiLumi Design Study, the accelerator-physics and performance team defined the parameter sets and machine optics that would allow HiLumi LHC to reach the very ambitious performance target of an integrated luminosity of 250 fb–1 per year. The study of the beam–beam effects confirmed the feasibility of the nominal scenario based on the baseline β* levelling mechanism, providing sufficient operational margin for operation with the new ATS (Achromatic Telescopic Scheme) at the nominal levelling luminosity of 5 × 1034 cm–2s–1, with the possibility to reach up to 50% more. The magnet design activity, focusing on the design of the insertion magnets, launched the hardware fabrication of short models of the Nb3Sn quadrupoles' triplet (QXF), separation dipole, two-in-one large aperture quadrupole and 11 T dipole for Dispersion Suppressor collimators. Single short coils in the mirror configuration have already been successfully tested for the triplet. The first model of the QXF triplet containing two CERN and two LARP coils was assembled in the US in the summer, and is being tested this autumn, while a short model of the 11 T dipole fabricated at CERN reached 12 T. To protect the magnets from the higher beam currents, the collimation team focused on the design and verification of the new generation of collimators. The team presented a complete technical solution for the collimation in and around the insertions in HL-LHC, providing improved flexibility against optics changes. The crab-cavities activity finalised and launched the manufacturing of the crab-cavity interfaces, including the helium vessels and the cryo-module assembly. All cavity parts stamped in the US will be assembled and surface processed in the US, in addition to electron-beam welding and testing. Last but not least, as part of their efforts to develop a superconducting transmission line, the cold powering activity hit a world-record current of 20 kA at 24 K in a 40 m-long MgB2 electrical transmission line. The team has finalised the development and launched the procurement of the first MgB2 PIT round wires. This is an important achievement that will enable the start of large cabling activity in industry, as required for the production of a prototype cold-powering system for the HL-LHC.

In addition to the technological challenges, the HL-LHC project has also seen an important expansion of the civil-engineering and technical infrastructure at P1 (ATLAS) and P5 (CMS), with new tunnels and underground halls needed to house the new cryogenic equipment, the electrical power supply and various plants for electricity, cooling and ventilation.
A winning combination

Such an extensive technical, technological and civil endeavour would not be possible without collaboration with industry. To address the specific technical and procurement challenges, the HL-LHC project is working in close collaboration with leading companies in the field of superconductivity, cryogenics, electrical power engineering and high-precision mechanics. To enhance the co-operation with industry on the production of key technologies that are not yet considered by commercial partners due to their novelty and low production demand, the newly launched QUACO project, recently funded by the EU, is bringing together several research infrastructures with similar technical requirements in magnet development to act as a single buyer group.

See the full article here.

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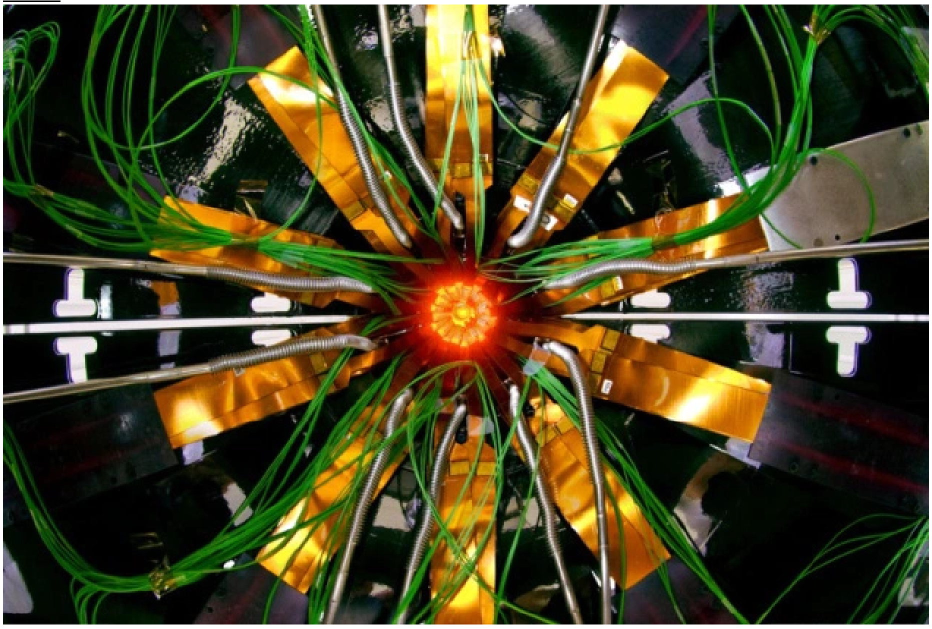

CMS
CERN CMS New

LHCb
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LHC

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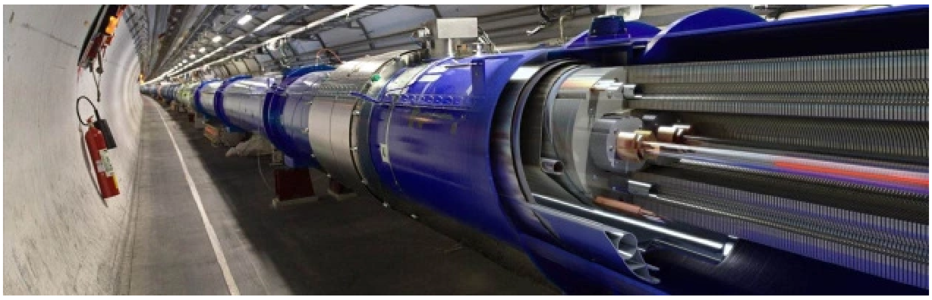

LHC particles

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