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LHC and particle physics: latest results and new challenges

Press conference

Monday 25 July 2011, Grenoble, France

PRESS KIT

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PRESS INVITATION I PARIS I 11 JULY 2011

Press conference – LHC and particle physics: latest results and new challenges

Monday, 25 July 2011 at 1.30 pm (French time)
in Grenoble
Alpexpo / Espace Alpes Congrès
Access by Tram A (station: Pôle Sud / Alpexpo)

What new secrets have neutrinos revealed? What are the latest discoveries on dark matter and the Higgs boson? After more than a year in operation, it is time for the first review of the LHC. In the 3-month period up to mid-June of this year, the number of LHC experimental collisions exceeded 70 million million, in other words the objective set for the whole of 2011. This performance bodes well for further advances over the coming months, while the future of the LHC and the initiation of new projects are being discussed: what strategy should be adopted in Europe today for the particle physics of tomorrow?

These themes will be explored at the International Europhysics Conference on High Energy Physics - HEP 2011 - which is expected to gather more than 700 physicists from around the world. A not-to-be-missed event in the high energy physics calendar, the conference is organized this year by the High Energy and Particle Physics Division of the EPS (European Physical Society), with the support of the French scientific community (CNRS and CEA). The press conference which is attended during the symposium will give a preview of the latest particle physics results in 2011 as well as the outlook for the future.

- **Introduction** by **Fabio Zwirner**, Chair of the High Energy Physics Division of EPS (European Physical Society).
- **Presentation of the latest results of the LHC** by **Rolf Heuer**, Director General of CERN[1].
- **The LHC and other projects: what strategy should Europe adopt for particle physics?** by **Michel Spiro**, President of the CERN Council and CNRS Scientific Director for the Alpes region.
- **Astroparticles in Europe: the latest advances and forthcoming challenges** by **Stavros Katsanevas**, Deputy Coordinator of ASPERA[2] and Deputy Scientific Director of IN2P3[3]-CNRS for astroparticles and neutrinos.

[1] CERN (European Organization for Nuclear Research), Particle Physics Research Laboratory, has its headquarters in Geneva. Its main accelerator is the LHC (Large Hadron Collider).

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The press conference, which will be held in English and simultaneously translated into French, will be followed by refreshments.

Live on Webcast:
The press conference will be filmed and broadcast live on Webcast (accessible on the Internet) : http://webcast.in2p3.fr/live/HEP2011. Questions could be asked to the speakers during the webcast by sending them on twitter (please contact us to receive the Twitter user name).

Necessary accreditation: *If you wish to attend the symposium and/or press conference, please register with the CNRS press office before 22 July 2011 (cf. contacts below).*

To find out more about the HEP 2011 conference : http://eps-hep2011.eu/
(The scientific plenary sessions will be filmed and broadcast live on Webcast: http://webcast.in2p3.fr/live/HEP2011).

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[2] ASPERA (AStroParticle European Research Area) is the European network of national government agencies responsible for coordinating and funding national research efforts in astroparticle physics : www.aspera-eu.org
[3] CNRS's National Institute of Nuclear and Particle Physics

Press release CERN, 21 July 2011

LHC experiments present their latest results at Europhysics Conference on High Energy Physics

Geneva, 21 July 2011. The first of the major summer conferences for particle physics opens today in Grenoble. All of the LHC experiments will be presenting results, and a press conference is scheduled for Monday 25 July. The conference follows an extremely successful start to LHC running in 2011, and results are eagerly awaited.
“So far we’ve collected as much data as was planned for the whole of 2011 and that’s already a great achievement for the LHC,” said CERN Director General Rolf Heuer. “While it’s still too early for the biggest discoveries, the experiments are already accumulating interesting results.”

The LHC experiments will present measurements with increased precision on known processes of the current model of particle physics, the Standard Model. They will also provide new measurements and limits on sought-after phenomena and particles, such as the Higgs boson.

“Discovery or exclusion of the Higgs particle, as predicted by the Standard Model, is getting ever closer,” said CERN's Director for Research and Scientific Computing, Sergio Bertolucci. “Both occurrences will be great news for physics, the former allowing us to start the detailed study of the Higgs particle, the latter being the first proof of the incompleteness of the Standard Model, requiring new phenomena to be happening within the reach of the LHC.”

The speed with which the experiments have been able to analyse the data is unprecedented. The Worldwide LHC Computing Grid, which links up computer centres around the world, has proved itself well up to the task, routinely processing up to 200,000 physics analysis jobs concurrently.

“With the data we have analysed already, and building on our extensive measurements of Standard Model processes, we are beginning to explore much of the available mass range for the Higgs and many scenarios of new physics”, said ATLAS spokesperson Fabiola Gianotti.

“We’re taking our first steps in this new physics landscape,” underlined Guido Tonelli, spokesperson of the CMS experiment, “and it is great to see how fast we are producing new results. I am confident that soon there will be only a few regions left where the Higgs boson, as postulated by the Standard Model, might still be hiding.”

Among the announcements to be expected at the conference are reports from the LHC collaborations on intriguing observations by the CDF and D0 experiments at Fermilab in the US. For instance, in the realm of b-quark decays, the D0 experiment has observed a difference in the behaviour of matter and antimatter, while CDF very recently announced measurements of a rare process that appear to disagree with the Standard Model and could indicate new physics.

“The LHC experiments are getting closer and closer to pinning down whether these are real signals or not,” said LHCb spokesperson Pierluigi Campana. “In particular, LHCb is now surpassing the sensitivity of previous experiments on some key measurements in b-quark physics and is rapidly closing in on others.”

These first results are just the beginning, with much more to come. Discovery in particle physics is often a long and painstaking process, requiring large quantities of data to be carefully sifted for rare processes. The LHC data target for 2011-2012 was chosen to allow the experiments to explore new physics accessible to the LHC at its current operating energy of 3.5 TeV per beam. So far a tenth of this total amount of data has been collected.

The conference begins today with parallel sessions that run through the weekend, to be followed by plenary sessions starting on Monday. At 13:30 CEST on Monday 25 July a press conference will be held at which: Fabio Zwirner, Chair of the High Energy Physics Division of EPS (European Physical Society), will announce the European Physical Society’s 2011 high-energy physics prizes; CERN’s Director General, Rolf Heuer, will discuss the latest results from the LHC; President of CERN Council, Michel Spiro, will talk about European strategy for particle physics; and Stavros Katsanevas, the Deputy Director of the French national institute for nuclear and particle physics (IN2P3) of CNRS, will present the latest advances in astroparticle physics in Europe.

To follow the Press Conference, or for more information, visit: http://www2.cnrs.fr/en/1879.htm
For information about the Europhysics conference on high energy physics, visit: http://eps-hep2011.eu/
Webcast link: http://webcast.in2p3.fr/live/HEP2011

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CERN, the European Organization for Nuclear Research, is the world's leading laboratory for particle physics. It has its headquarters in Geneva. At present, its Member States are Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom. Romania is a candidate for accession. India, Israel, Japan, the Russian Federation, the United States of America, Turkey, the European Commission and UNESCO have Observer status.

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Speakers

Professor **Fabio Zwirner** has been chairing the High Energy and Particle Physics Division of the EPS (European Physical Society) since 2009. He obtained his Ph.D. at SISSA, the International School for Advanced Studies in Trieste, in 1987. In the following decade, he carried out his researches in the theoretical physics groups of the University of California at Berkeley, of INFN (Italian National Institute for Nuclear Physics) in Padua and of CERN. In 2000 he was appointed to a chair at the University of Rome, in 2005 he moved to his present institution, the University of Padua. His scientific work has focused on the theory and the phenomenology of the fundamental interactions. In particular, he has explored several models that aim at going beyond the standard theory of particle interactions, including some based on supersymmetry and/or extra spatial dimensions, and their possible experimental tests. He has served in several international scientific committees and editorial boards and is the current chairman of the CERN Scientific Policy Committee.

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Professor **Rolf-Dieter Heuer** has been CERN Director General since January 2009. He obtained his Ph.D. at the University of Heidelberg in 1977. Most of his scientific work has focused on the study of electron-positron reactions, the development of experimental techniques, as well as the construction and operation of large detector systems. From 1984 to 1998, Prof. Heuer was a staff member at CERN, working for the OPAL experiment at the electron-positron storage ring LEP. During his 15 years at CERN Prof. Heuer occupied the highest managerial positions in the OPAL experiment and was the OPAL's spokesperson in 1994-1998. In 1998, Rolf-Dieter Heuer was appointed to a chair at the University of Hamburg. Then, he set up a working group to prepare experiments at an electron-positron Linear Collider that quickly became one of the leading groups in this field worldwide.
From 2004 to 2008, Prof. Heuer was research director for particle and astroparticle physics at the DESY laboratory, a member of the Helmholtz association. Prof. Heuer has been a member of many scientific committees and advisory bodies where he has acquired a great deal of expertise in reviewing projects as well as in assessing and promoting people.

Elected Chair of the CERN Council in December 2009, **Michel Spiro,** 63, is also CNRS Scientific Director for the Alpes region. He was formerly Director of the CNRS National Institute of Nuclear and Particle Physics, French scientific representative on the CERN Council from 2003 to 2010 and Chair of CNRS's TGE (Very large-scale research facilities) Committee from 2005 to March 2011. Previously, he was Chair of the Scientific Experiments Committee at the LEP (CERN's Large Electron-Positron Collider) from 1998 to 2001. A graduate of the Ecole Polytechnique, Spiro completed his PhD at the CEA (French Atomic Energy Commission) in Saclay, which he joined in 1970. In 1991, he was promoted to the position of Director of the SPP (Particle Physics Department) at Dapnia (now CEA's IRFU[4]), which he headed until 1999. He was then appointed project leader (Chargé de Mission) at the CEA and Deputy Scientific Director of IN2P3/CNRS, in charge of astroparticles and neutrinos.

In 2002, he was appointed head of Dapnia. His initial research in particle physics led him to participate in the discovery of the intermediate W and Z bosons (the UA1 experiment). He then turned to the study of particles from the cosmos and participated in the Gallex experiment for the detection of solar neutrinos and in the Brown Dwarf experiment, which then evolved into the Eros project for the search for dark matter. He has received many awards for his exceptional research: the Prix Joliot-Curie of the SFP (French Physics Society) in 1983, the Prix Félix Robin of the SFP in 1999 and an award from the Association Française pour le Rayonnement International in 2000.

[4] Institut de Recherche sur les Lois Fondamentales de l'Univers.

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Stavros Katsanevas, 58, has been a Professor at the Université Diderot-Paris 7 since 2004. He has also been Deputy Scientific Director of the National Institute of Nuclear and Particle Physics/CNRS since 2002. At the same time, he has been directing CNRS's "Astroparticle" interdisciplinary program. In 2006, he became the first coordinator of ASPERA (Astroparticle Physics European Research Area), the European network of national government agencies responsible for funding research efforts in astroparticle physics. He held this position until 2009, when he was named deputy coordinator of the network. ASPERA produced the first roadmap of European Astroparticle Physics in 2008. In addition, Katsanevas chairs the Council of the European Gravitational Observatory (EGO) and is also a member of the steering committee of ApPEC (Astroparticle Physics European Coordination) and the OECD Astroparticle Physics International Forum (APIF). He has been one of the principal investigators of the Institute for the Physics and Mathematics of the Universe in Tokyo since 2007.

Born in Athens, where he obtained a PhD in Physics in 1985, he taught at the University of Athens before being appointed Professor at the Université Lyon 1 in 1996. He worked on accelerator physics at Fermilab, the Fermi National Accelerator Laboratory, a high-energy physics laboratory located near Chicago in the United States, where he studied quantum chromodynamics Then, at CERN, he worked on quark-gluon plasma physics, the Standard Model and supersymmetry. At CERN's large electron-positron collider (LEP), he occupied several responsible scientific positions as part of the DELPHI experiment. Finally, some of his research work has focused on neutrino (neutrino oscillation experiments) and astroparticle physics (neutrino telescopes).

Winners of the Division of High Energy Physics of the European Physical Society (EPS)

The EPS High Energy Physics Division announces the winners of its 2011 prizes, which will be awarded at the Europhysics Conference on High-Energy Physics (EPS-HEP 2011), Grenoble (FR) 21-27 July 2011.
http://eps-hep2011.eu/

The 2011 High Energy and Particle Physics Prize for an outstanding contribution to High Energy Physics in experimental, theoretical or technological area is awarded to Sheldon Lee Glashow, John Iliopoulos and Luciano Maiani "For their crucial contribution to the theory of flavour, presently embedded in the Standard Theory of strong and electroweak interactions."

The Giuseppe and Vanna Cocconi Prize for an outstanding contribution (experimental or theoretical) to Particle Astrophysics and Cosmology to Paolo de Bernardis and Paul Richards "For their outstanding contributions to the study of cosmic microwave background anisotropies with the balloon-borne experiments BOOMERanG and MAXIMA.

The 2011 Gribov Medal for outstanding work by an early career physicist in Theoretical Particle Physics and/or Field Theory is awarded to Davide Gaiotto "For the uncovering of new facets of the dynamics of four-dimensional supersymmetric gauge theories. In particular, for discovering a large class of four-dimensional superconformal theories and for finding with others important intricate relations between two-dimensional theories of gravity and fourdimensional gauge theories."

The 2011 Young Physicist Prize for outstanding work by one or more early career physicists in the field of Particle Physics and/or Particle Astrophysics is awarded to Paolo Creminelli "For his contributions to the development of a solid fieldtheoretical approach to early-universe cosmology and for his studies of nongaussianities in the cosmic microwave background"; and to Andrea Rizzi "For his contributions to the reconstruction software and physics program of the CMS experiment at the LHC".

The 2011 Outreach Prize for outstanding outreach achievement connected with High Energy Physics and/or Particle Astrophysics is awarded to Christine Kourkoumelis and Sofoklis Sotiriou "For building educational resources to bring the research process in particle physics and its results to teachers and students, both nationally and across Europe"

Press release EPS, 17 June 2011

Physicists who showed how new quark could solve longstanding puzzles to be awarded prestigious prize

The High Energy and Particle Physics Prize of the European Physical Society has been awarded for 2011 to three theoretical physicists: Sheldon Lee Glashow (Boston University, USA), John Iliopoulos (Ecole Normale Supérieure, Paris, France) and Luciano Maiani (University of Rome La Sapienza, Italy). In 1970, they discovered a compelling argument for the existence of a yet undiscovered particle - the "charm" quark - to solve a number of problems that particle physicists were facing at the time. Their proposal, now called "GIM mechanism" from the initials of the three authors, was spectacularly confirmed four years later, when particles containing the charm quark were finally discovered.

The award ceremony will take place at the EPS-HEP 2011 conference in Grenoble on July 25, see http://eps-hep2011.eu/

In 1970 it was already understood that the microscopic constituents of matter are quarks and leptons (such as the electron and neutrinos), but there was evidence for only three types of quarks. It was also known that whereas the weak interactions can change the type, or "flavour", of a quark, not all "flavour-changing" processes were observed. Processes associated with "neutral currents" were not observed, as if they were forbidden, or at least strongly inhibited, by some unknown mechanism.

The three physicists showed that the introduction of a fourth quark, the “charm” quark, that was undiscovered at the time, would generalize the unified description of the weak interactions previously introduced by N. Cabibbo, in a way that would permit flavour-changing neutral currents only via tiny quantum effects: to explain the observed rarity of such transitions, the charm quark mass should be at most a couple of times the proton mass.

The rest is history. Neutral weak currents without flavour-changing and charmed particles were discovered in the mid-70s. The GIM mechanism became a cornerstone of the Standard Theory of Strong and Electroweak Interactions (for the electroweak part of which Sheldon Glashow shared the 1979 Nobel Prize with Abdus Salam and Steven Weinberg), and is at work also in the modern version with three families of quarks and leptons.

At present another feature of the Standard Theory is under intense scrutiny at the Large Hadron Collider at CERN, which will soon tell whether the predicted Higgs boson indeed exists or is replaced by some new physics. It is remarkable that the presence or the absence of a builtin GIM mechanism has been one of the most severe censors of the many models of new physics proposed so far, under suggestive names such as technicolor, supersymmetry or extra dimensions.

Professor Paris Sphicas, the current secretary of the EPS-HEPP Board, from the University of Athens and CERN, said "The GIM mechanism was a bold step, which required nothing less than the existence of a new particle, a fourth quark that was unknown at the time. Forty years after its inception, it remains an essential and inspiring topic for any course on particle physics."

Doctor Yves Sirois, a member of the EPS-HEPP Board from the Ecole Polytechnique in Palaiseau and CNRS Research Director, added "The invention of the GIM mechanism was a decisive breakthrough, allowing a model of leptons interacting with photons and weak bosons, to become what is known today as the 'Standard Model' of the fundamental interactions for the elementary constituents of matter, the leptons and quarks".

Source and contact: Prof. Fabio Zwirner, chair of the EPS-HEPP Board, fabio.zwirner@pd.infn.it

For further reading: http://www.scholarpedia.org/article/Glashow-Iliopoulos-Maiani_mechanism

Original publication: S.L.Glashow, J.Iliopoulos and L.Maiani, ``Weak Interactions with Lepton-Hadron Symmetry'', Phys. Rev. D2 (1970) 1285.

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The LHC in brief

The LHC (Large Hadron Collider), which produced its first collisions in November 2009, is the world's most powerful particle accelerator. The LHC lies in a 27-kilometer ring buried 100 m underground at the Franco-Swiss border, near Geneva. Its principle is as follows: two beams of very high energy protons (or ions) circulating around the ring in opposite directions are made to collide with each other, in order to find clues about **supersymmetry**, the nature of **dark matter** and the origin of the **mass of elementary particles**.

In most of the ring, the beams travel in two separate lines under vacuum, but at four interaction points they collide within the four main experimental detectors, known as **Atlas, CMS, Alice** and **LHCb**. The energy of the protons (or ions) is transformed at the instant of collision into a myriad of particles, which these four highly sophisticated detectors trace with great precision. The detectors will be able to track up to 600 million collisions per second to spot the signs of extremely rare events. Grid computing technology allows hundreds of computing centers scattered across the world to pool their computing power and storage capacities so as to be able to process some 15 million billion octets a year.

LHC's scientific perspectives

The LHC and its particle detectors will make it possible to improve knowledge of the infinitely small and infinitely large aspects of nature. It is a formidable machine for traveling back in time in a bid to understand the very first instants of the Universe.

In the 1960s-70s, the Standard Model of particle physics was elaborated and it provides the best description to date of the elementary constituents of matter and the forces that reign between them. In this model, elementary particles are classified into particles of matter, also known as fermions (including quarks and leptons) and force mediating particles, known as bosons.

According to current knowledge, matter is described via twelve particles of elementary matter (six quarks and six leptons) classified into three families. Each family comprises two quarks and two leptons, one charged (such as the electron or the muon) and its associated neutrino.

Twelve particles of elementary matter, classified into three families:

	1	**2**	**3**
Quarks	up (u)	charm (c)	top (t)
	down (d)	strange (s)	bottom or beauty (b)
Leptons	neutrino électronique	neutrino muonique	neutrino tauique
	électron	muon	tau

All matter particles also have an antimatter equivalent, a form of matter that is in a way "reversed", and whose characteristics, such as the charge, are reversed. This makes a total of 24 particles.

The four fundamental interactions are conveyed by their "intermediate" bosons: the photon for electromagnetic interaction, W and Z bosons for weak nuclear interaction and the gluon for strong nuclear interaction. Gravitation is conveyed by the graviton, but it cannot be described with the present quantum formalism.

The Standard Model also employs a certain number of parameters that define the coupling between these different particles. Only quarks have never been observed individually, but in association with two other quarks (baryons, such as the proton or the neutron), with another quark or with an antiquark (mesons, such as the pion or the kaon).

The major questions in particle physics

Since 1973, the Standard Model has been borne out by numerous experiments and has never been disproved. However, theoretical physicists consider it incomplete as many questions remain unanswered and some of their potential responses may lie beyond the Model:

What is the origin of the mass of particles?
The Standard Model possesses a mechanism known as "symmetry breaking", which gives mass to the elementary particles that we know. This mechanism reveals a particle known as the Higgs boson, the missing piece in the Standard Model. The LHC should make it possible to observe this hypothetical particle and to measure its mass. However, demonstrating within the LHC that the Higgs boson does not exist would probably have just as big an impact, which would revolutionize our current vision of the infinitely small.

Why is antimatter so rare?
At the beginning of the Big Bang, matter and antimatter were present in equal quantities, but today antimatter seems to be very rare. The study of particular processes in particle collisions at the LHC will provide a better understanding of the events that could explain this imbalance. One of the LHC experiments is dedicated to this area of research.

Can the primordial soup of the Universe be explained?
In the very early Universe, temperature and densities were extremely high. The LHC is capable of recreating these conditions in which elementary particles (quarks and gluons) are no longer confined but can move about freely in a new state of matter known as "quark - gluon plasma".

Do supersymmetric particles exist?
At energies that largely exceed those that can be reached at the LHC, electroweak and strong interactions may only constitute a single interaction… At present, supersymmetry theories that predict symmetry between the elementary particles making up matter and interaction mediators, known as "supersymmetry", could lead to such unification. In this case, the elementary particles currently known should have partners: "supersymmetric" particles, the lightest of which should be observed in proton collisions within the LHC.

What is dark matter?

Astrophysical observations indicate that a large part of the Universe could be composed of “dark matter”, a type of matter that does not emit electromagnetic radiation. Although its presence can only be inferred through gravitational effects, particle physicists have in their supersymmetry theories a particle known as “neutralino”, which could explain the origin of this “dark matter”. This particle could be produced in high-energy collisions.

Does space-time have more than four dimensions?
The major theories that allow the unification of gravitational interaction with all other interactions are principally based on “superstring” theory, but this requires many more space-time dimensions than the four considered until now, in other words a Universe of ten dimensions.

CNRS, CEA and universities are the French players involved in the LHC project

Physicists and engineers from CNRS, CEA and the universities have been at the forefront of particle physics research for many years, whether at CERN or in other research facilities throughout the world. French researchers from CNRS and CEA have contributed from the outset to the genesis and development of the LHC detectors. They play a significant role in the collection and interpretation of data. France is also at the forefront in the emergence of the computing grid concept and in the definition and setting up of the data analysis infrastructure, including in particular the Centre de Calcul de l’IN2P3 du CNRS and the LCG computing grid.

A total of 210 physicists and 230 engineers and technicians from CNRS and the CEA are involved in the LHC program. These experiments also provide an ideal and competitive framework for many students as part of their research training.

CNRS participates in the scientific programs of the four main detectors, namely Atlas, CMS, Alice and LHCb and contributes to the development of the LHC's computing grid. The CNRS laboratories and research infrastructures involved are:

- The Centre de Calcul de l’IN2P3 du CNRS (CC-IN2P3) in partnerership with the CEA
- The Centre de Physique des Particules de Marseille (CNRS/Université Aix-Marseille 2)
- The Institut Pluridisciplinaire Hubert Curien à Strasbourg (CNRS/Université Strasbourg 1)
- The Institut de Physique Nucléaire de Lyon (CNRS/Université Lyon 1)
- The Institut de Physique Nucléaire d’Orsay (CNRS/Université Paris-Sud 11)
- The Laboratoire de l’Accélérateur Linéaire à Orsay (CNRS/Université Paris-Sud 11)
- The Laboratoire d’Annecy le Vieux de Physique des Particules à Annecy (CNRS/Université Chambéry)
- The Laboratoire Leprince-Ringuet à Palaiseau (CNRS/Ecole Polytechnique)
- The Laboratoire de Physique Corpusculaire de Clermont-Ferrand (CNRS/Université Blaise Pascal-Clermont-Ferrand 2)
- The Laboratoire de Physique Nucléaire et de Hautes Energies à Paris (CNRS/UPMC)
- The Laboratoire de Physique Subatomique et de Cosmologie à Grenoble (CNRS/Université Joseph Fourier /INPG Grenoble)

- The Laboratoire de Physique Subatomique et des Technologies Associées à Nantes (CNRS/Ecole des mines de Nantes/Université de Nantes)

The CEA is involved in the scientific programs of three (Atlas, CMS and Alice) of the four major detectors installed on the LHC, as well as in the development of the LHC's computing grid. The laboratories concerned include CEA/IRFU and the CEA's Service des Basses Températures (Inac: Institut Nanosciences & Cryogénie, Grenoble).

Press release Cern, 17 June 2011

LHC achieves 2011 data milestone

Geneva, 17 June 2011. Today at around 10:50 CEST, the amount of data accumulated by LHC experiments ATLAS and CMS clicked over from 0.999 to 1 inverse femtobarn, signalling an important milestone in the experiments' quest for new physics. The number signifies a quantity physicists call integrated luminosity, which is a measure of the total number of collisions produced. One inverse femtobarn equates to around 70 million million1 collisions, and in 2010 it was the target set for the 2011 run. That it has been achieved just three months after the first beams of 2011 is testimony to how well the LHC is running. "It's great to have delivered this amount of data in time for the main summer conferences," said CERN's Director for Accelerators and Technology, Steve Myers. "When we set ourselves the objective of achieving one inverse femtobarn in 2011, it was for good reason: that amount of data could well give us access to exciting new physics."

The LHC experiments are now working hard to get results ready for the main summer physics conferences: the European Physical Society's High Energy Physics conference, which will be held in Grenoble from 21 to 27 July, and the Lepton-Photon conference, this year hosted by the Tata Institute in Mumbai from 22 to 27 August.

Among the new physics the LHC experiments are searching for are the Higgs mechanism and supersymmetry. The Higgs mechanism, and its associated particle, is the last missing ingredient of the so-called Standard Model of particle physics that explains the behaviour and interactions of the fundamental particles that make up the ordinary matter from which we and everything around us are made. The Higgs mechanism gives rise to the masses of certain particles.

Ordinary matter, however, appears to be only around 4% of what the Universe is made of. Supersymmetry is a theory that goes beyond the Standard Model. It is a more elegant theory of ordinary matter, and could also explain the mysterious dark matter that makes up about a quarter of the universe. With one inverse femtobarn there's a real chance that, if these theories are correct, they will start to manifest themselves in the data.

"This is a superb achievement, which demonstrates the outstanding performance of the accelerator and of the operation team," said Fabiola Gianotti, spokesperson for the ATLAS experiment. "It's really great to have such a large amount of data in time for the main summer conferences. The ATLAS physicists, in particular students and post-docs, are working hard and with great enthusiasm to produce exciting results, from precise measurements of the known particles to searches for the Higgs boson and other new phenomena. It's really a gorgeous moment!"

"With the LHC running at much higher intensity than initially foreseen, signals of new physics might appear any moment in our data," said CMS spokesperson Guido Tonelli. "Hundreds of young researchers all over the world are actively searching for new particles such as the Higgs boson, supersymmetric particles or new exotic states of matter. If nature is kind to us, we could have major breakthroughs even before the end of this incredibly exciting year"

A third LHC experiment, LHCb, requires less data than ATLAS and CMS, but has also exceeded its expectations for the year. "LHCb is currently taking data at a rate almost double that previously expected, thanks to the fantastic performances of LHC machine," said Pierluigi Campana, LHCb spokesperson. "We are chasing the rarest events and the new possible asymmetries of nature that could show up in the decays of beauty quarks. The amount of data we are collecting will put LHCb in the position to unveil the flavour of new physics. This an exciting time for everybody, in particular for our youngest colleagues, who have a leading role in this scientific adventure." Although recording data with proton beams, the fourth major LHC experiment, ALICE, is specifically designed for physics with lead-ion beams, which will come during the last four weeks of the LHC's 2011 run.

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1. 70 million million = 70 x 1012
2. CERN, the European Organization for Nuclear Research, is the world's leading laboratory for particle physics. It has its headquarters in Geneva. At present, its Member States are Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom. Romania is a candidate for accession. India, Israel, Japan, the Russian Federation, the United States of America,Turkey, the European Commission and UNESCO have Observer status.

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European particle physics strategy

During an exceptional session on Saturday afternoon, the particle physics community launched the update of its roadmap as part of the European strategy. The previous edition had been voted in Lisbon in 2006. The new edition is scheduled for the autumn 2012 and should be presented in Brussels.

The European strategy *for particle physics*

Particle physics stands on the threshold of a new and exciting era of discovery. The next generation of experiments will explore new domains and probe the deep structure of space-time. They will measure the properties of the elementary constituents of matter and their interactions with unprecedented accuracy, and they will uncover new phenomena such as the Higgs boson or new forms of matter. Long-standing puzzles such as the origin of mass, the matter-antimatter asymmetry of the Universe and the mysterious dark matter and energy that permeate the cosmos will soon benefit from the insights that new measurements will bring. Together, the results will have a profound impact on the way we see our Universe; *European particle physics should thoroughly exploit its current exciting and diverse research programme. It should position itself to stand ready to address the challenges that will emerge from exploration of the new frontier, and it should participate fully in an increasingly global adventure.*

General issues

1. European particle physics is founded on strong national institutes, universities and laboratories and the CERN Organization; *Europe should maintain and strengthen its central position in particle physics.*

2. Increased globalization, concentration and scale of particle physics make a well coordinated strategy in Europe paramount; *this strategy will be defined and updated by CERN Council as outlined below.*

Scientific activities

3. The LHC will be the energy frontier machine for the foreseeable future, maintaining European leadership in the field; *the highest priority is to fully exploit the physics potential of the LHC, resources for completion of the initial programme have to be secured such that machine and experiments can operate optimally at their design performance.* A subsequent major luminosity upgrade (SLHC), motivated by physics results and operation experience, will be enabled by focussed R&D; *to this end, R&D for machine and detectors has to be vigorously pursued now and centrally organized towards a luminosity upgrade by around 2015.*

4. In order to be in the position to push the energy and luminosity frontier even further it is vital to strengthen the advanced accelerator R&D programme; *a coordinated programme should be intensified, to develop the CLIC technology and high performance magnets for future accelerators, and to play a significant role in the study and development of a high-intensity neutrino facility.*

5. It is fundamental to complement the results of the LHC with measurements at a linear collider. In the energy range of 0.5 to 1 TeV, the ILC, based on superconducting technology, will provide a unique scientific opportunity at the precision frontier; *there should be a strong well-coordinated European activity, including CERN, through the Global Design Effort, for its design and technical preparation towards the construction decision, to be ready for a new assessment by Council around 2010.*

6. Studies of the scientific case for future neutrino facilities and the R&D into associated technologies are required to be in a position to define the optimal neutrino programme based on the information available in around 2012; *Council will play an active role in promoting a coordinated European participation in a global neutrino programme.*

7. A range of very important non-accelerator experiments take place at the overlap between particle and astroparticle physics exploring otherwise inaccessible phenomena; *Council will seek to work with ApPEC to develop a coordinated strategy in these areas of mutual interest.*

8. Flavour physics and precision measurements at the high-luminosity frontier at lower energies complement our understanding of particle physics and allow for a more accurate interpretation of the results at the high-energy frontier; *these should be led by national or regional collaborations, and the participation of European laboratories and institutes should be promoted.*

9. A variety of important research lines are at the interface between particle and nuclear physics requiring dedicated experiments; *Council will seek to work with NuPECC in areas of mutual interest, and maintain the capability to perform fixed target experiments at CERN.*

10. European theoretical physics has played a crucial role in shaping and consolidating the Standard Model and in formulating possible scenarios for future discoveries. Strong theoretical research and close collaboration with experimentalists are essential to the advancement of particle physics and to take full advantage of experimental progress; *the forthcoming LHC results will open new opportunities for theoretical developments, and create new needs for theoretical calculations, which should be widely supported.*

Organizational issues

11. There is a fundamental need for an ongoing process to define and update the European strategy for particle physics; *Council, under Article II-2(b) of the CERN Convention, shall assume this responsibility, acting as a council for European particle physics, holding a special session at least once each year for this purpose. Council will define and update the strategy based on proposals and observations from a dedicated scientific body that it shall establish for this purpose.*

12. Future major facilities in Europe and elsewhere require collaborations on a global scale; *Council, drawing on the European experience in the successful construction and operation of large-scale facilities, will prepare a framework for Europe to engage with the other regions of the world with the goal of optimizing the particle physics output through the best shared use of resources while maintaining European capabilities.*

13. Through its programmes, the European Union establishes in a broad sense the European Research Area with European particle physics having its own established structures and organizations; *there is a need to strengthen this relationship for communicating issues related to the strategy.*

14. Particle physicists in the non-Member States benefit from, and add to, the research programme funded by the CERN Member States; *Council will establish how the non-Member States should be involved in defining the strategy.*

Complementary issues

15. Fundamental physics impacts both scientific and philosophical thinking, influencing the way we perceive the universe and our role in it. It is an integral part of particle physics research to share the wonders of our discoveries with the public and the youth in particular. Outreach should be implemented with adequate resources from the start of any major project; *Council will establish a network of closely cooperating professional communication officers from each Member state, which would incorporate existing activities, propose, implement and monitor a European particle physics communication and education strategy, and report on a regular basis to Council.*

16. Technology developed for nuclear and particle physics research has made and is making a lasting impact on society in areas such as material sciences and biology (e.g. synchrotron radiation facilities), communication and information technology (e.g. the web and grid computing), health (e.g. the PET scanner and hadron therapy facilities); *to further promote the impact of the spin-offs of particle physics research, the relevant technology transfer representatives at CERN and in Member states should create a technology transfer forum to analyse the keys to the success in technology transfer projects in general, make proposals for improving its effectiveness, promoting knowledge transfer through mobility of scientists and engineers between industry and research.*

17. The technical advances necessary for particle physics both benefit from, and stimulate, the technological competences available in European industry; *Council will consolidate and reinforce this connection, by ensuring that future engagement with industry takes account of current best practices, and continuously profits from the accumulated experience.*

Unanimously approved by the CERN Council at the special Session held in Lisbon on 14 July 2006

www.cnrs.fr

energie atomique • energies alternatives

Astroparticles: a talking point in 2011

- CNRS, le journal.

April 2011, « Giant detector heads for space »

- Press release.

15 June 2011, « Neutrinos oscillation caught in the act »

Astrophysics The AMS detector should soon be installed in the International Space Station to track down the most mysterious components of matter in the Universe.

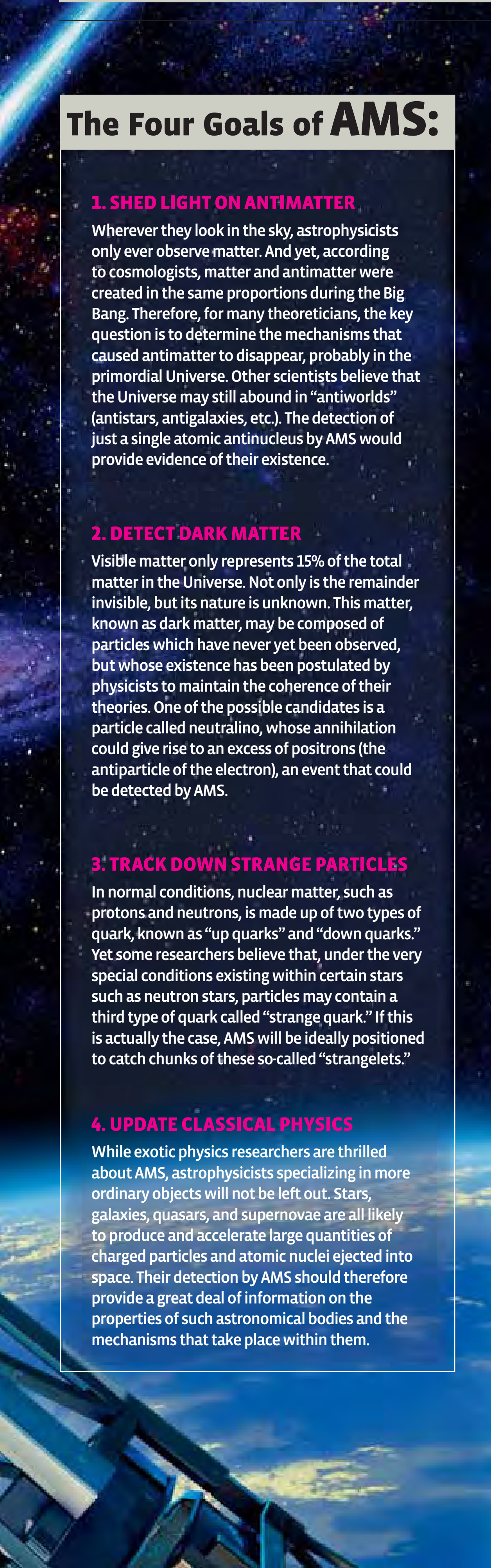
Giant Detector **Heads for Space**

THE INTERNATIONAL SPACE STATION

Orbiting at an altitude of around 360 kilometers, the International Space Station (ISS) is the result of a collaboration between space agencies worldwide, including the US, Russia, Canada, and Europe. Following on from the old Soviet space station Mir, its first module was placed in orbit by Russia in 1998. Since then, a handful of astronauts have continuously been present on board. One of their missions is to carry out scientific experiments that require reduced gravity or a lack of atmosphere.

THE AMS DETECTOR

To identify the high-energy particles present in cosmic rays, AMS boasts equipment comparable to the most powerful particle detectors on Earth. Until the end of the experiment, between 2020 and 2028, this technology-packed detector will seek to shed light on the origin of these particles which constantly bombard our planet from space.



The Four Goals of AMS:

1. SHED LIGHT ON ANTIMATTER

Wherever they look in the sky, astrophysicists only ever observe matter. And yet, according to cosmologists, matter and antimatter were created in the same proportions during the Big Bang. Therefore, for many theoreticians, the key question is to determine the mechanisms that caused antimatter to disappear, probably in the primordial Universe. Other scientists believe that the Universe may still abound in "antiworlds" (antistars, antigalaxies, etc.). The detection of just a single atomic antinucleus by AMS would provide evidence of their existence.

2. DETECT DARK MATTER

Visible matter only represents 15% of the total matter in the Universe. Not only is the remainder invisible, but its nature is unknown. This matter, known as dark matter, may be composed of particles which have never yet been observed, but whose existence has been postulated by physicists to maintain the coherence of their theories. One of the possible candidates is a particle called neutralino, whose annihilation could give rise to an excess of positrons (the antiparticle of the electron), an event that could be detected by AMS.

3. TRACK DOWN STRANGE PARTICLES

In normal conditions, nuclear matter, such as protons and neutrons, is made up of two types of quark, known as "up quarks" and "down quarks." Yet some researchers believe that, under the very special conditions existing within certain stars such as neutron stars, particles may contain a third type of quark called "strange quark." If this is actually the case, AMS will be ideally positioned to catch chunks of these so-called "strangelets."

4. UPDATE CLASSICAL PHYSICS

While exotic physics researchers are thrilled about AMS, astrophysicists specializing in more ordinary objects will not be left out. Stars, galaxies, quasars, and supernovae are all likely to produce and accelerate large quantities of charged particles and atomic nuclei ejected into space. Their detection by AMS should therefore provide a great deal of information on the properties of such astronomical bodies and the mechanisms that take place within them.

BY MATHIEU GROUSSON

AMS, short for Alpha Magnetic Spectrometer, weighs 7.5 tons, is 4 meters high, 5 meters wide, and worth $2 billion. The expected performance of this massive detector places it in the same category as those lurking deep inside particles accelerators like the Large Hadron Collider (LHC) in Geneva. Yet what makes AMS rather special is that it will be hitching a ride on the US space shuttle's last flight to the International Space Station (ISS), scheduled for April 2011. AMS will become the first-ever giant particle detector to be placed in orbit. Its mission is to track down any possible signs of the existence of the most mysterious components of matter in the Universe, including antimatter, strange matter, and dark matter.

LIVE FROM SPACE

For theoreticians, such signs might be found in the cosmic rays that continuously bombard the Earth. Cosmic rays are particles—electrons, protons, atomic nuclei of every kind, positrons (antielectrons), or antiprotons—whose energy is often far greater than that of the particles observed in accelerators. When they enter the atmosphere, these particles produce large showers of secondary particles. Instruments like the Auger Observatory in Argentina, an international collaboration including seven laboratories from CNRS's IN2P3 Institute,[1] can detect these secondary particles and reveal some characteristics of the cosmic rays that gave rise to them. But this is only indirect detection. The best method for direct detection is to place a powerful particle detector in orbit. And this is precisely what AMS is: a powerful circular magnet, 1.15 m in diameter, used to bend the path of particles entering it and steer them towards a stack of detectors. AMS should be able to detect all the particles passing through it up to an energy level of around one teraelectronvolt (10^{12} electron-volts), and spot a single positron among a million protons. This represents a 100 to 1000-fold increase in performance compared with the Pamela satellite, which was placed in orbit in 2006.

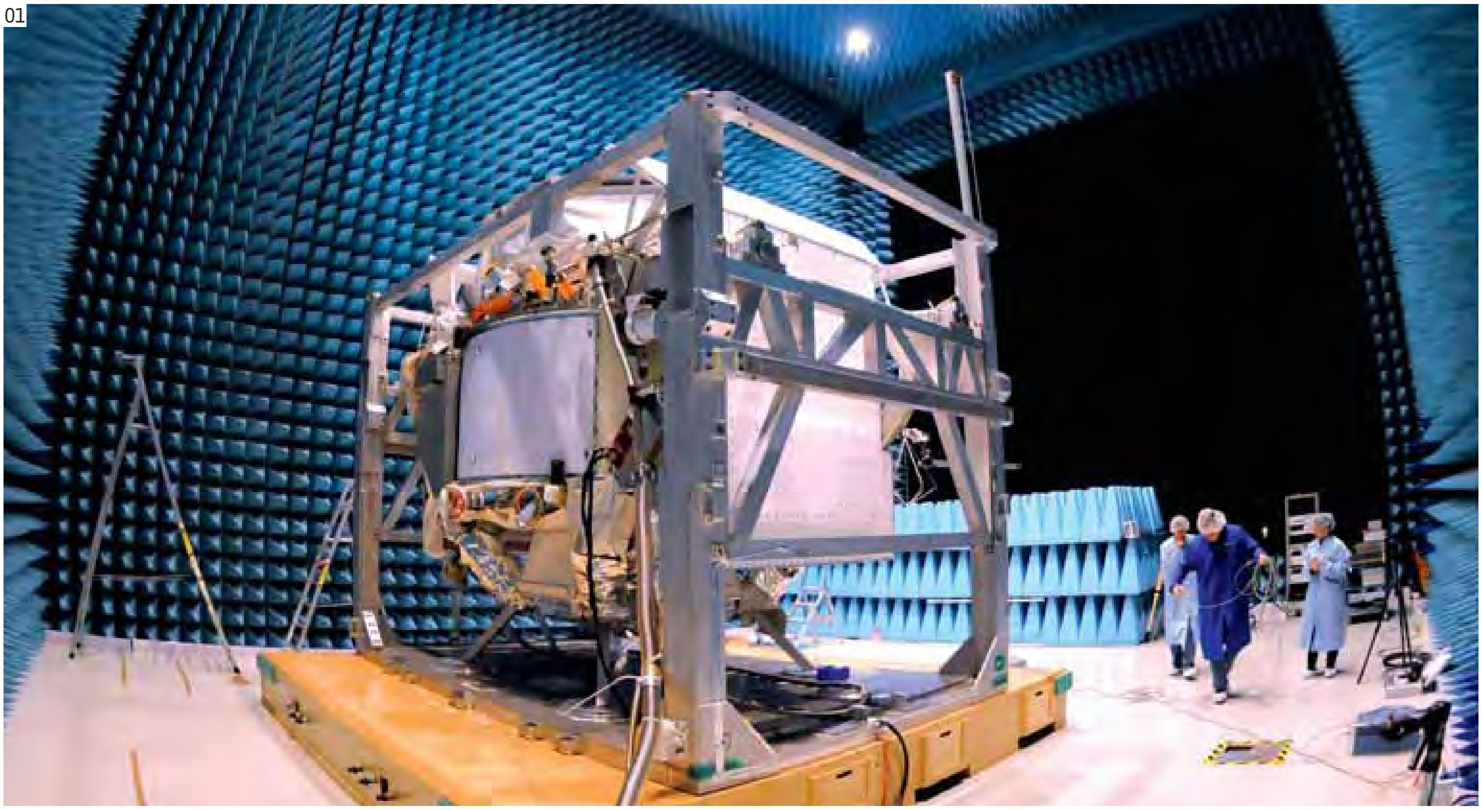
A UNIQUE EXPERIMENT

"Using AMS, we will be able to compare the characteristics of all the charged particles that bombard the Earth," enthuses Jean-Pierre Vialle, researcher at the LAPP.[2] "This should give us an indication of whether dark matter really exists. Although never detected, dark matter is believed to make up 85% of all matter in the Universe. Furthermore, if no antinuclei are detected, we will be able to conclude that there is no antimatter in the entire observable Universe."

AMS, which is about to become the only physics experiment onboard the ISS, fills astroparticle specialists with excitement. It is one of the most ambitious projects aboard the space station, which was sometimes criticized for its low scientific output. Yet it has come a long way. Initiated in 1994, the project produced its first detector in 1998. It stayed twelve days in orbit aboard the space shuttle Discovery, in order to provide proof of principle. "It was a real success," Vialle recalls. "Although it was purely a test mission, it led to the publication of five scientific papers." As a result, plans for the current version of AMS began a year later.

Unfortunately, the 2003 Columbia disaster called into question the entire US shuttle program, and the AMS project was shelved. "This was followed by a fierce political battle whose successful outcome owes a great deal to the efforts of the experiment's spokesman, physics Nobel Laureate Samuel Ting." It ended with the 2008 vote by the US Congress to place the detector in orbit. Though AMS is obviously tied to US space policy, it is

01



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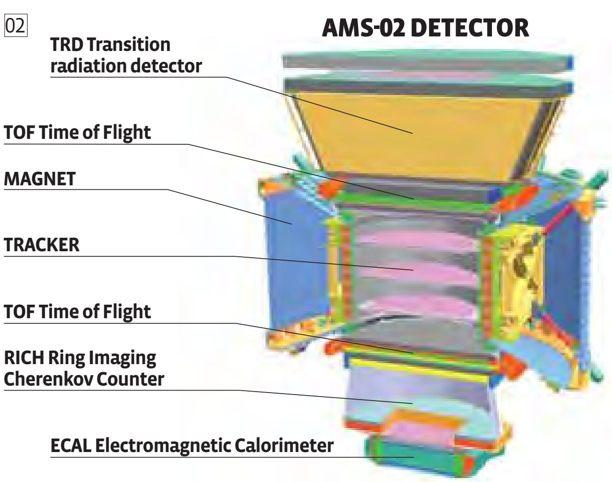
also an international project involving 600 researchers from some 50 organizations, including three laboratories of the IN2P3 institute of CNRS, across 16 countries.[3] "Officially, AMS is a project led by the US Department of Energy (DOE)," Vialle adds. "But 95% of the instrumentation comes from Europe and Asia." Indeed, the AMS control center, which will collect the data sent by the Space Center in Houston, will be located at CERN, in Geneva, the European Mecca of particle physics. This is no coincidence. AMS may be an astronomical observatory, but it is also an experiment that has

01 The AMS detector (inside the cage at the center of the image) underwent a battery of tests in this chamber. The chamber's walls are designed to absorb radiation to facilitate the interpretation of results.
02 Diagram of the various components that make up the AMS detector.

02



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truly been designed along the lines of particle physics.

AN EXTENDED MISSION

One of the implications is that whereas the information collected by a scientific observation satellite usually falls into the public domain after one year, the AMS data will remain the property of the collaboration, like all data gathered by an accelerator. Similarly, while the construction of most scientific satellites is entrusted to industry, AMS was entirely designed and assembled in laboratories, as is the case for large ground-based particle detectors.

This may be why it was possible to make a last-minute adjustment to the detector as a result of turnarounds in US policy. In spring 2010, after AMS had undergone all the validation tests in Geneva and the Netherlands, the ISS mission was extended to 2020, and possibly to 2028. As Vialle explains, the problem was that "the lifespan of the AMS superconducting magnet matched that of the space station as initially planned, and was therefore designed to operate for two to three years. Consequently, we took the decision to bring the detector back to CERN, dismantle it completely, and replace its magnet by a permanent one that has a much longer lifespan."

READY FOR LIFT-OFF

As a result, AMS underwent a final series of tests in the Geneva-based accelerator's particle beam last summer, just in time to be loaded on August 26, 2010, onto a US Army C5 aircraft, and head for the Kennedy Space Center, in Cape Canaveral (Florida) to board the space shuttle.

Once in orbit, the giant detector, after a ten-year wait, will look up to the stars at last. The showers of particles that it will gather may then reveal some of the secrets of the Universe, weaving new connections between the infinitely large and the infinitely small.

01. Institut national de physique nucléaire et de physique des particules.
02. Laboratoire d'Annecy-le-Vieux de physique des particules (CNRS / Université de Savoie).
03. Laboratoire de physique subatomique et de cosmologie de Grenoble (CNRS / Université Joseph-Fourier / Grenoble INP), Laboratoire d'Annecy-le-Vieux de physique des particules (CNRS / Université de Savoie), and Laboratoire univers et particules de Montpellier (CNRS / Université Montpellier-II).

ONLINE
› www.ams02.org

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PRESS RELEASE I PARIS I 15 JUNE 2011

Neutrino oscillations caught in the act

Physicists at the T2K experiment in Japan, including scientists from CNRS[1] and CEA/IRFU, have announced that, for the first time, they have most likely detected the transformation of muon neutrinos into electron neutrinos. With a probability of over 99%, the observation of this phenomenon will, if confirmed, be a major step towards understanding the physics of elementary particles and will open the way to new research into the asymmetry between matter and antimatter.

Neutrinos exist in three different forms, or 'flavors': electron neutrinos, muon neutrinos and tau neutrinos. The T2K experiment, based in Japan, is studying the oscillation mechanism of these particles, in other words their ability to change flavor while traveling through space. The experiment is designed to observe neutrino oscillations over a distance of 295 km, between the Tokai site, where the muon neutrinos are produced using the J-PARC[2] particle accelerator on Japan's east coast, and the Super-Kamiokande detector, a cylindrical tank of water 40 meters in diameter and 40 meters in height, located 1 000 meters underground, near the west coast (hence its name T2K, which stands for "Tokai to Kamiokande").

Analysis of the data collected between the beginning of the experiment in January 2010 and March 2011 (the experiment was suspended as a result of the 11 March earthquake) shows that, over the period, the Super-Kamiokande detector recorded a total of 88 neutrinos, of which six were electron neutrinos that probably result from a change of muon neutrinos into electron neutrinos. The remaining 82 neutrinos are thought to be mainly muon neutrinos that underwent no transformation between their production to their detection. Measurements by GPS confirm that the neutrinos identified by the Super-Kamiokande detector were indeed produced on the east coast of Japan. The physicists therefore estimate that the results obtained point to a 99.3% probability that electron neutrino appearance was detected.

The T2K experiment will resume at the end of the year. Although located in a seismic zone near the epicenter of the earthquake of 11 March 2011, the J-PARC laboratory and T2K's near detectors were fortunately only slightly damaged. T2K's next goal is to confirm the appearance of electron neutrinos with further data and, even more importantly, to measure the 'mixing angle', a parameter of the Standard Model which would open the way to studying the asymmetry between matter and antimatter in our Universe.

The T2K collaboration brings together over 500 physicists from 62 institutions across 12 countries (Japan, a number of European countries and the US). The teams from CNRS and CEA/IRFU developed some of the measuring instruments used in the near detectors (located 280 meters from the neutrino production target, and used to monitor the experiment). The researchers also took part in the calibration of the Super-Kamiokande detector and helped to analyze the data.

[1] Laboratoire de physique nucléaire et de hautes énergies (CNRS / Université Pierre et Marie Curie / Université Paris Diderot-Paris 7), Institut de physique nucléaire de Lyon (CNRS / Université Lyon 1), Laboratoire Leprince-Ringuet (CNRS / École Polytechnique).
[2] Japan Proton Accelerator Research Complex

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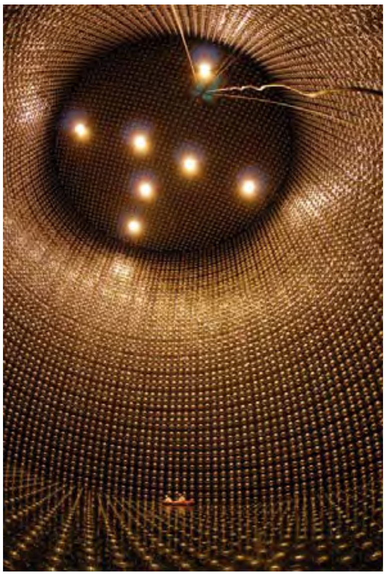

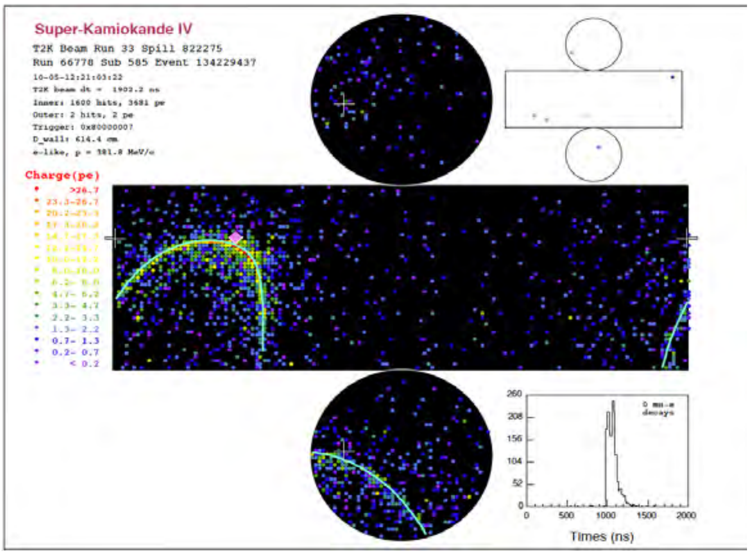

View of the huge Super-Kamiokande detector, which had already been used to study 'natural' neutrinos coming from the Sun as well as those produced by cosmic rays in the upper atmosphere. At the bottom of the image, a team can be seen inspecting the detector while it is still empty.
Credit: Kamioka Observatory, ICRR, University of Tokyo.

View of a T2K electron neutrino appearance event at the Super-Kamiokande far detector. The dots show where Cherenkov radiation is detected by photomultipliers located on the walls of the huge tank. The circle shows where an electron was produced due to the interaction of the incident electron neutrino with the water in the tank. This event was perfectly synchronous with the production of the muon neutrino at JPARC. Credit: T2K collaboration.

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HEP 2011

The international "EuroPhysics Conference on High Energy Physics" - HEP 2011 – will be held in Grenoble from 21 to 27 July 2011. Initiated in 1971, it is one of the most important high-energy physics conferences in the world and is held every other year, in alternation with ICHEP (organized in Paris in 2010). As in 1993, France has once again the privilege of organizing and hosting this conference this year.

The objective is to bring together specialists in high-energy physics from across the world. HEP 2011 will serve as a forum for all subjects more or less closely related to the study of the most elementary components of our Universe and their interactions. More than 700 participants are expected to attend. Numerous personalities, including Nobel Prize winners and directors of international laboratories, will be present to discuss the most recent advances in fundamental physics and innovative technology.

Numerous personalities will be attending

This year, the High Energy Physics Division Prize of EPS is being awarded to Sheldon Lee Glashow, Jean Ilioupoulos and Luciano Maiani[5] for their contribution to the theory of quark flavor. In total, ten physicists will be presented with an award and all of them will attend the ceremony scheduled on Monday 25 July, from 9 am.

Three Nobel Prize winners will be attending the conference:
- **George Fitzgerald Smoot**: winner of the Nobel Prize in Physics, 2006, jointly with John C. Mather for their discovery of the blackbody form and anisotropy of the cosmic microwave background radiation and currently Academic at the Université Paris Diderot in the "Astroparticule et Cosmologie" laboratory (CNRS/Université Paris Diderot/CEA/Observatoire de Paris).
- **David Jonathan Gross**: winner of the Nobel Prize in Physics, 2004, with his two former students Frank Wilczek and David Politzer, for their shared discovery of asymptotic freedom in quantum chromodynamics (he currently works mainly on string theory).
- **Sheldon Lee Glashow**: winner of the Nobel Prize in Physics, 1979[6], Professor of the Arthur G.B. Metcalf Chair of Physics at the University of Boston, mainly recognized for his significant contributions to electroweak interaction theory.

[5] Jean Iliopoulos, former Senior Researcher at CNRS and Luciano Maiani were awarded the Prix Dirac 2007: http://www2.cnrs.fr/presse/communique/1159.htm
[6] Co-laureate with Abdus Salam and Steven Weinberg

Public events (open access, free of charge)

Organized by CNRS and the Université Joseph Fourier, with the support of the Grenoble-based CCSTI.

Tuesday 19 July: Particles concert

The Mazalda group presents the Turbo Clap Station music show, a skilful mixture of electrified traditional music and current popular music.

Wednesday 20 July: The night of particles

A special gala event, open to the general public, will be held on the university campus of Saint-Martin d'Hères. Organized under the artistic direction of the Scalène choreographic company, this night of particles is an encounter between art and science, between artists and scientists and between scientists and the public. It is an invitation to witness a surprising dialogue, that of dance and science. This encounter is the beginning of a voyage that will take you to a strange world. Your guides are both physicists and dancers. Together, they will tell you particle stories.

Wednesday evening:

7.30 pm – Welcome and visit of the "Particles fair" –visual artist: Laurent Mulot, dance: the Scalène company: see cie-scalene.com

8.30 pm – Dancing conferences – 3 physicists: Aurélien Barrau, Lucia di Ciaccio and Richard Taillet, moderator Laurent Chicoineau, director of the CCSTI Grenoble, dance the Scalène company

9.30 pm - Spectacle "The dance of particles" - dance the Scalène company and Attrape-corps

HEP 2011 main partners

This conference, organized by the European Physical Society, has benefited from widespread support, in particular from CNRS, CEA, the Université Joseph Fourier à Grenoble, the Université de Savoie and the Université Claude Bernard de Lyon. Local players are also heavily involved in this prestigious event, especially the city of Grenoble, the Communauté d'Agglomération Grenoble-Alpes Métropole (the Metro), the Communauté d'Agglomération d 'Annecy and the Région Rhône-Alpes.

To find out more about the HEP 2011 conference: http://eps-hep2011.eu/

Lexicon

• Standard Model
The theory that describes the Universe as being constituted of elementary particles of matter, known as fermions. They interact through the exchange of particles known as "messengers", gauge bosons. This theory is remarkably precise in its field of application, but it is known to be incomplete and limited.

• Fermions
Fermions are: 3 charged leptons (electron, muon and tau); 3 neutral leptons (neutrinos associated with charged leptons) and 6 quarks (up, down, strange, charm, bottom and top).

• Higgs boson
The Standard Model predicts the existence of another particle, which has never been observed, the Higgs boson. Its role could be fundamental in understanding why particles have mass and why it differs depending on the type of particle.

• CP symmetry
CP symmetry corresponds to the product of two symmetries: charge conjugation symmetry, C, which associates a particle with its antiparticle, of same mass but opposite charge, and parity symmetry P, which transforms a particle into its mirror image.

• CP symmetry violation
When the Big Bang occurred, the Universe contained as much matter as antimatter. Today, the Universe only contains matter. Differences in behavior between matter and antimatter – a violation of CP symmetry– could be responsible for this discrepancy which has established itself, over the history of the Universe, between the proportions of matter and antimatter.

• Dark matter and energy
Astronomical observations have shown for a long time the existence of “dark” matter, whose influence but not radiation can be seen. Recent cosmological measurements have revealed that this matter constitutes 23% of the energy of the Universe. Surprisingly, 72% comes from “dark matter” of a totally unknown nature. “Ordinary” matter, described by the Standard Model, only accounts for 5 % of the energy of the Universe. This new enigma is probably linked to other questions of particle physics.

• Beyond the Standard Model
Numerous theories have been proposed to complete the Standard Model and resolve some of its problems, including Supersymmetry and Supplementary Dimensions. The discovery of a particle or an effect confirming one of these theories would open up an entirely new era for physics.

Visual displays and videos available

LHC – vidéos and animations (FR/EN) ©CERN

CERN HD Stockshots 2011 / Rushes du CERN en haute définition 20111

- 3D Animations / Animations en 3D : http://cdsweb.cern.ch/record/1324096
- ATLAS experiment / expériences Atlas : http://cdsweb.cern.ch/record/1324131
- ALICE experiment / expériences Alice : http://cdsweb.cern.ch/record/1324129
- CMS experiment / expérience CMS : http://cdsweb.cern.ch/record/1324132
- LHCb experiment /expérience LHCb : http://cdsweb.cern.ch/record/1324133
- The Grid / La Grille : http://cdsweb.cern.ch/record/1324556
- LHC Tunnel and CERN Control Centre / Tunnel du LHC et centre de contrôle : http://cdsweb.cern.ch/record/1324843

General CERN LHC stockshots / Rushes du CERN concernant le LHC
In Standard Definition http://cdsweb.cern.ch/record/1103799
In High Definition http://cdsweb.cern.ch/record/1105930
The script is here (le script est ici, en anglais) http://cdsweb.cern.ch/record/1105930/files/script.pdf

LHC First Physics :

- 30 March 2010 - First proton collisions in the LHC experiments / Premières collisions proton-proton à une énergie de 7 TeV
    - ATLAS: http://cdsweb.cern.ch/record/1255875
    - CMS: http://cdsweb.cern.ch/record/1256538
    - LHCb: http://cdsweb.cern.ch/record/1258212

- 8 Novembre 2010 - First lead collisions in the LHC experiments / Premières collisions plomb-plomb à une énergie de 287 TeV par faisceau.
    - ATLAS : http://cdsweb.cern.ch/record/1309872
    - CMS : http://cdsweb.cern.ch/record/1305408?ln=fr et http://cdsweb.cern.ch/record/1305409?ln=fr

Autres animations (science)
- From Bottle to Bang http://cdsweb.cern.ch/record/1125472
- De la bouteille d'hydrogène au LHC (sous-titré en français) http://cdsweb.cern.ch/record/1179452

Journey to discover the nature of matter (Higgs field): http://cdsweb.cern.ch/record/1128122
Journey to the unimaginably Small http://cdsweb.cern.ch/record/1128123

The Large Hadron collider in 10 minutes / le LHC en 10 minutes (EN/FR/IT/DE)

English: http://cdsweb.cern.ch/record/1129494 - Français : http://cdsweb.cern.ch/record/1129499
Italian: http://cdsweb.cern.ch/record/1134373 - German : http://cdsweb.cern.ch/record/1129502

Ressources « expliqué en 1 minute » « explained in one minute »
- Quarks et gluons
English http://cdsweb.cern.ch/record/1363350 – Français http://cdsweb.cern.ch/record/1363352
- Luminosité du LHC / LHC luminosity
English http://cdsweb.cern.ch/record/1359220 – Français http://cdsweb.cern.ch/record/1359222
- LHC particle speed – La vitesse de particules au LHC
English http://cdsweb.cern.ch/record/1340223 – Français http://cdsweb.cern.ch/record/1340225

LHC : photos

CERN press office photo sélection : http://cdsweb.cern.ch/collection/Press Office Photo Selection

Future accelerator / International linear collider :

Animation : ILC en 1 minute / the ILC in one minute (silent)
http://www.linearcollider.org/about/Press/Images-and-graphics/ILC-animation---The-ILC-in-1-minute

Photos :
http://www.linearcollider.org/about/Press/Images-and-graphics

Astroparticle – Videos and animations (FR/EN)

http://astroparticle.aspera-eu.org/index.php?option=com_content&task=blogcategory&id=29&Itemid=102

AMS

Lancement : http://cdsweb.cern.ch/record/1351130
Vidéo News en français : AMS sur l'ISS http://cdsweb.cern.ch/record/1352406?ln=fr
Video News in English : AMS on ISS http://cdsweb.cern.ch/record/1352408

Toutes les vidéos :
http://cdsweb.cern.ch/search?ln=fr&cc=Videos&sc=1&p=AMS&f=&action_search=Recherche&rm=wrd

PLANCK

vidéos, photos : http://public.planck.fr/multimedia.php

Astroparticle – Photos

Galerie complète :http://astroparticle.aspera-eu.org/index.php?option=com_easygallery&Itemid=6