CERN

LHC’s installation makes progress

CERN’s director-general, Robert Aymar praised the immense progress made towards the Large Hadron Collider (LHC) project when he addressed the 135th session of the CERN Council on 16 December 2005. “In one year, we have made great progress,” he said. “The challenge is not over, of course, but we have great confidence of maintaining the schedule for start-up in 2007.”

The LHC is the leading project for the world’s particle-physics community. Experiments performed there will investigate perplexing questions including why fundamental particles have the masses they have, and focus on understanding the missing mass and dark energy of the universe; visible matter seems to make up just 5% of what must exist. Physicists will also explore the reason for nature’s inclination for matter over antimatter, and probe matter as it existed immediately after the Big Bang.

Aymar’s congratulations come after a challenging year with delays imposed by repairing defects in the LHC’s cryogenic-fluid distribution system. These delays are now largely recovered. The cryogenic system is now well advanced and installation of the LHC’s magnets is progressing rapidly. Almost 1000 of the 1232 dipole magnets have been delivered to CERN and more than 200 magnets are already installed in the LHC’s underground tunnel. An average of 20 magnets a week are currently being installed, but this needs to increase to 25 a week in 2006 to reach the 2007 start-up deadline. A review of this schedule is planned for Spring 2006.

Aymar also informed delegates that CERN’s new visitor and networking centre, the Globe of Science and Innovation, opened its doors to the public in September 2005. The Globe is scheduled to host a permanent exhibition about scientific works at CERN, coinciding with the LHC start-up in 2007.

Open-access moves ahead for physics

Eighty representatives from several major physics publishers, European particle-physics laboratories, learned societies, funding agencies and authors from Europe and the US met at CERN on 7–8 December 2005 for the first discussions on promoting open-access publishing. One of the results was the formation of a task-force mandated to bring action by 2007.

Open access is currently a hot topic at universities, publishing houses and governments, as digitized documentation and electronic networking become more mainstream. The particle-physics community has already implemented one of the possible ways for open access to work, whereby institutional libraries, such as CERN’s, make their own information available on the Internet. The other approach is to work directly with scientific publishers to develop open access to the journals.

The aim of open access is to bring greater benefit to society by allowing electronic access to journals to be free to the public, while being paid for by the authors. The time-honoured practice consisted of publishers financing journals through reader subscriptions and ensuring quality by peer review; however, this model favours the wealthier universities and institutions as they can afford the expensive costs of the journals. The challenge for open access is to maintain the quality guaranteed by academic publishers, while broadening access to the information.

The creation of an open-access task-force comes at a crucial time for the world particle-physics community as 2007 brings the launch of a new major facility, the Large Hadron Collider at CERN.

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SUPER-KAMIOKANDE GETS FULL REFIT

Operation of the Super-Kamiokande (SK) II detector in Japan was terminated last October after three years of running to begin a full restoration of the detector. Precise studies on neutrinos will resume next June.

The SK detector consists of a cylindrical tank containing 50 000 tonnes of pure water viewed by about 11 000 photomultipliers (PMTs) of 50 cm diameter. The water tank is 40 m in height and 40 m in diameter, and located 1000 m underground. Neutrinos interact with the water and give rise to Cherenkov light, which provides information about the neutrino energy, direction and type or flavour. In 1998, the collaboration announced that neutrinos change flavour – oscillate – which is possible only if the particles have mass. The evidence came from observing neutrinos created by cosmic-ray interactions in the atmosphere. This was followed in 2001 by evidence for the oscillations of solar neutrinos in the combined data from SK and the Sudbury Neutrino Observatory. More recently, the KEK-to-Kamioka (K2K) experiment, using a man-made neutrino beam from KEK to the SK detector has confirmed the oscillations observed in the atmospheric neutrinos.

Several thousands of PMTs in the detector were destroyed in November 2001, when the shock wave from the implosion of one PMT at the bottom of the tank triggered a chain reaction of implosions in more than half the PMTs (CERN Courier January/February 2002 p6). In 2002, the detector was partially reconstructed using about 5000 PMTs encased in plastic covers to avoid a similar accident. This partial reconstruction was done quickly in only a year in order to continue the K2K experiment. After three years of operation as a shorter exposure in SK-II, with half the original density of PMTs, the long awaited full reconstruction of the detector has now begun. Next June, the detector’s third phase, SK-III, will start to take data again.

The discovery of neutrino oscillations has opened up a new window of research with a variety of subjects for SK to tackle. An experiment using an intense neutrino beam from Tokai – Tokai-to-Kamioka (T2K) – is expected to start in 2009. The beam will be produced by a 50 GeV proton synchrotron being constructed at the Japan Proton Accelerator Research Complex in Tokai (CERN Courier November 2004 p41). SK-III will be the far detector at a distance of 295 km from the beam-production point. The T2K experiment will determine neutrino oscillation parameters precisely and search for effects of the neutrino mixing angle, $\theta_{13}$, which is so far unobserved.

A longer exposure to atmospheric neutrinos will be important in searching for a resonant matter effect in the Earth and may help to resolve the octant ambiguity in the mixing angle $\theta_{23}$. At the lower energies of solar neutrinos, an up-turn in the spectrum is expected as direct evidence for large-mixing-angle solutions and will provide precise oscillation parameters. The higher statistics from several years of exposure should allow this measurement.

SK could also detect several thousand neutrino interactions from a galactic supernova. Such a large number of events would reveal details of the supernova explosion mechanism, as well as information on the properties of neutrinos. The positive identification of electron-antineutrinos in SK could also be possible in future. Neutrons emitted in antineutrino interactions could be detected through the 2.2 MeV gamma-rays emitted by neutron capture on protons and through interactions with gadolinium dissolved in the pure water.

Lastly, the detection of nucleon decay as predicted by grand unified theories has always been one of the primary topics for SK. Sensitivity to the decay mode $p \rightarrow e^+ + p^0$ will soon reach the level corresponding to a lifetime of $10^{34}$ years. Decay modes favoured by supersymmetry, which include K mesons in the final state, will become interesting with a longer exposure in SK-III, and the collaboration hopes to observe the first indication of nucleon decay in the near future.

KEK

BELLE ACHIEVES NEW LUMINOSITY RECORD

By mid-afternoon on 22 November, the Belle experiment at KEK had accumulated an integrated luminosity of 500 fb$^{-1}$ of electron–positron collision data. This integrated luminosity marks a landmark in the progress of the KEKB accelerator and the Belle experiment, which began operation in 1999. It is equivalent to achieving $5 \times 10^{11}$ crossings of electrons and positrons a square centimetre. More than 500 million pairs of $B$ and $\bar{B}$ mesons have been generated in the collisions.

The original challenge for KEKB was to achieve 100 fb$^{-1}$ in 3 years. The total of 500 fb$^{-1}$ in 6.5 years surpasses this goal. The group now aims to achieve even higher records with various upgrades to the machine.
The proposal to create the forum resulted from the considerable industrial interest triggered by several large accelerator projects based on superconducting RF (SCRF) technology, in particular the approved X-ray free-electron laser, XFEL, and the planned International Linear Collider. Both projects use SCRF technology, which has been substantially advanced during the past decade by the TESLA Technology Collaboration. In addition, the TESLA test facility at DESY, built with involvement from European companies, has added to the solid base of expertise in SCRF accelerators in European industry.

Against this background, it was concluded that a forum would further strengthen the excellent position of European science and industry in SCRF technology. Moreover, similar bodies have been established in both the US and Japan.

Members of European research centres and industrial companies decided to found EIFast at a meeting at DESY in April 2005. Its scope includes all systems and components needed for an SCRF accelerator, including supplies and services. Acting as a common voice for European research and industry, the forum will now try to promote the realization of SCRF projects in a coherent way.

The forum aims to bring research institutes either working in the field of SCRF technology or interested in becoming involved together with industrial companies interested in supplying products to projects based on the technology. The main tasks of the forum include generating support for projects at the political level in Europe, ensuring a flow of up-to-date information about projects between institutes and companies, promoting involvement of industry in projects at an early stage, and supporting the members in gaining access to information channels and decision makers otherwise difficult to obtain.

For more information and contacts for EIFast see https://trac.lal.in2p3.fr/SCRF.
COSMIC RAYS

Auger observatory celebrates progress

On 10 November, the Pierre Auger Observatory (PAO) began a major two-day celebration at its headquarters in Malargüe, Argentina, to mark the progress of the observatory and the presentation of the first physics results at the International Cosmic Ray Conference in the summer 2005. One of several experiments connecting particle astrophysics and accelerator-based physics, the PAO studies extensive air showers created by primary cosmic rays with energies greater than $10^{18}$ eV. With more than 1000 of the 1600 surface detectors and 18 of the 24 fluorescence detectors currently installed and operating, the observatory will eventually cover 3000 km² of the expansive Pampa Amarilla.

Over 175 visitors from the 15 collaborating countries attended the celebration, with guests including heads of collaborating institutions, representatives from supporting funding agencies, delegates from Argentinian embassies, local and provincial authorities, plus press and media teams. On the first day, experiment heads Jim Cronin, Alan Watson and Paul Mantsch presented the history and status of the observatory to the assembled visitors in Malargüe’s Convention Center. This was followed by a ceremony on the Auger campus to unveil a commemorative monument made of glass and stone. Ceremony speakers included Malargüe’s mayor and the governor of Mendoza Province. Guests then retired to a traditional asado that featured local cuisine and entertainment by folk musicians and tango dancers. On the second day, attendees toured the vast observatory site, including surface detectors on the pampa and one of the remote fluorescence detector buildings.

As part of the celebration, the collaboration sponsored a science fair in the observatory’s Assembly Building, organized by four local science teachers for teachers and students from high schools in Mendoza Province. Twenty-nine school groups, many travelling long distances to reach Malargüe, presented research projects on topics in physics, chemistry or technology. A team of PAO physicists judged the displays and awarded prizes to the most outstanding young scientists. In March 2006, the opening of a new high school in Malargüe is anticipated, partial funding for which was secured by Cronin from the Grainger Foundation in the US.

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