"I believe that if we stop doing research, then we're actually not human beings anymore."
Rolf-Dieter Heuer, Director General of CERN

New Exhibition

ORIGIN – INVESTIGATING THE BIG BANG

Opening August 5, 2011 / Ars Electronica Center Linz

(Linz, August 4, 2011) In the beginning was … what, actually? Since time immemorial, humankind has been wrestling with origins—our own and that of the universe as a whole. And our answers to this, The Ultimate Question, have forever been a matter of controversy. CERN, the European particle physics laboratory, represents the possibility of gaining real insights into the genesis of time and space and matter. Approximately 10,000 scientists from all over the world work at this international research facility in an effort to solve the puzzle of the Big Bang. Serving as their laboratory is the largest piece of scientific equipment humankind has ever built: the Large Hadron Collider (LHC). The Ars Electronica Center's new exhibition takes a close-up look at CERN—its history and organization, the everyday activities and ambitious goals of its global research project. This showcase is a plea on behalf of pure science; at the same time, it focuses on a quintessentially human quality: the unbridled passion and boundless enthusiasm with which we go about discovering new things. "ORIGIN – Investigating the Big Bang" opens on August 5, 2011 at the Ars Electronica Center.

CERN – A Research Project of Superlative Dimensions

Initiated in 1954 to provide for the future of European science after the continent had been torn apart by war, CERN took up research in fields in which its scientists had been pre-eminent prior to World War II: atomic nuclei and the forces that hold them together. Right from the start, staff members were recruited worldwide. Long before the fall of the Iron Curtain, scientists from West and East were working together here. With a crew of 10,000 researchers and support personnel from 80 countries and an annual budget of a billion Swiss Francs, CERN is now one of the world's largest research facilities.

The Large Hadron Collider – The World's Largest Piece of Scientific Equipment

CERN is best known for its particle accelerator. And the LHC truly is a machine for which only superlatives will do. The world's highest-performance particle accelerator runs through a 26.659-kilometre underground tunnel in which two proton beams travelling in opposite directions at an incredible 99.9999991% of the speed of light cross paths in four detectors. The results are particle collisions that produce concentrations of energy the likes of which

With queries, please contact
Christopher Ruckerbauer
Tel: +43.732.7272-38
christopher.ruckerbauer@aec.at
www.aec.at/press

existed for only fractions of a second after the Big Bang. These protons race through the 27-kilometre concrete ring more than 11,000 times per second, kept on course by giant magnet coils that have to be cooled to -273.1° Celsius (1.9 Kelvin) and are thus colder than outer space! So that's the "Large Hadron Collector Ring," the largest piece of scientific equipment humankind has ever constructed.

The ATLAS Experiment

The designation ATLAS was originally an abbreviation of A Toroidal LHC ApparatuS. Now, it's simply the name of one of the four major experiments being conducted using the LHC. ATLAS is a particle detector meant to provide first-ever proof of the existence of the Higgs boson that is essential to the explanation of mass. Another objective is to examine the substructures of what are now considered the smallest building blocks of matter, leptons and quarks. The detector is a 46-metre-long, 7,000-tonne cylindrical colossus with a diameter of 25 metres. It is thus half as big as Notre Dame Cathedral in Paris! ATLAS is installed in a subterranean cavern that is 53 meters long, 35 meters high and 30 meters wide. The ATLAS project alone involves some 3,000 researchers from 173 universities in 40 countries.

The CMS Experiment

CMS stands for Compact Muon Solenoid. The mission of this major experiment is similar to that of ATLAS. The CMS detector has a cylindrical shape, is 21 metres long, 16 metres in diameter and weighs about 12,500 tonnes—about as much as 30 jumbo jets. Around 3000 scientists, engineers and students from over 180 institutions in 38 countries are working on the CMS experiment. They seek the Higgs boson, but are also searching for evidence of so-called supersymmetry and studying the collision of heavy ions.

The ALICE Experiment

ALICE stands for A Large Ion Collider Experiment. The ALICE detector is about 25 metres long and 16 metres wide. It weighs about 10,000 tonnes. This experiment is designed to simulate the state of matter immediately after the Big Bang. For a few millionths of a second after the Big Bang, the universe went through a phase of extremely high density and temperature, a quark-gluon plasma. Collisions of lead nuclei are designed to briefly replicate this state. The ALICE staff includes 1,000 physicists, engineers and technicians.

The LHCb Experiment

Some 650 scientists from 47 institutions in 145 countries are working on the Large Hadron Collider beauty (LHCb) experiment. The detector is 21 metres long, 10 metres high, 13 metres wide and weighs 5,600 tonnes. The experiment focuses on the asymmetry between matter and antimatter. The theory now generally accepted is that identical quantities of matter and

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Tel: +43.732.7272-38
christopher.ruckerbauer@aec.at
www.aec.at/press

antimatter were produced out of the energy initially available. However, there are heavy elementary particles, so-called B mesons, in which a tiny difference becomes apparent when they decay into other particles. The proof of this difference is gathered in a complex detector system in which the researchers attempt to filter out the products of the decay of B mesons, whether matter or antimatter. It is hoped that these detailed investigations will help scientists understand the surplus of matter in the universe.

The Worldwide LHC Computing Grid (WLCG)

15 petabytes (15 million gigabytes) is the inconceivably vast amount of data that will be produced annually by the LHC over a period of 15 years. Compiling all the data generated by ATLAS would fill 100,000 CDs per second, a rate that's equivalent to 50 billion simultaneous telephone conversations. In order to be able to view and analyze this enormous quantity, CERN created the world's largest computing grid. This network of computers working together encompasses 160 institutions in 33 countries and more than 100,000 processors. In CERN's own data processing centre, there are more than 5,000 PCs with 20,000 processors, 8 petabytes of disk storage and 18 petabytes of tape storage capacity.

In Search of the Higgs Boson …

With their experiments using the LHC, CERN physicists are completing an odyssey that began about 340 years ago with Isaac Newton and the description of gravity. Every one of us is familiar with gravity and its effect on mass. But why we even have mass remains a mystery. According to the theory of British physicist Peter Higgs and others, the explanation calls for a particular particle that has been named after him. If the existence of this particle can actually be confirmed, then one of the basic postulates of physics will have been proven. If not, then the generally accepted standard model of physics will have to be fundamentally called into question. So what's the story with this particle?

The Higgs Boson or Albert Einstein Attends a Cocktail Party

Picture this: Albert Einstein accepts an invitation to a cocktail party. Needless to say, the other guests who've arrived before him can hardly wait to meet the brilliant thinker in person and chat with him for a while. And then the big moment arrives: He is here! Albert Einstein walks in and suddenly every single one of the guests who had been distributed evenly throughout the room starts moving in his direction. More and more people crowd around him, and the group gets bigger and bigger. Wherever he goes, he's surrounded by his entourage of admirers. You could almost say he was taking on more and more weight… The very same phenomenon that an appearance by the famous Albert Einstein sets off on the part of his many fans is what the Higgs boson triggers among elementary particles. Accordingly, mass is said to be the outcome of reciprocal interaction.

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www.aec.at/press

CERN Sidesteps: The Retinal Project

CERN's main mission is basic research but there's a place for applied research here too. Together with neurobiologists, ATLAS physicists have been studying the information that is forwarded from the eye to the brain. The retina is actually a biological pixel detector that transforms a visual image into electrical signals called spikes. These spikes serve as a code and communicate the properties of an image to the visual centre of the brain. In order to break this code, the retinal tissue was studied and a system to detect large-scale neuronal activity was developed. The ATLAS experiment's silicon microstrip detector technology serves as the basis for this. The aim of this research is to explain how our neuronal systems work. If it succeeds, blind people could be able to (re)gain the ability to see.

A CERN "waste product": The World Wide Web

At CERN, lots of things happen as incidental spinoffs. The most famous one is the World Wide Web. It was invented by Tim Berners-Lee, a Briton working as a computer scientist at CERN, as a convenient way for colleagues to share research results. The method they used entailed "interweaving" or "interlinking" scientific articles. What gradually emerged was a network of data in which everything could be interlinked with everything else. The Web came into existence in 1990 as a CERN project. On April 30, 1993, CERN put the web in the public domain, ensuring that it would remain an open standard for all. We are all familiar with the rest of the story…

CERN: http://public.web.cern.ch/public/
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christopher.ruckerbauer@aec.at
www.aec.at/press