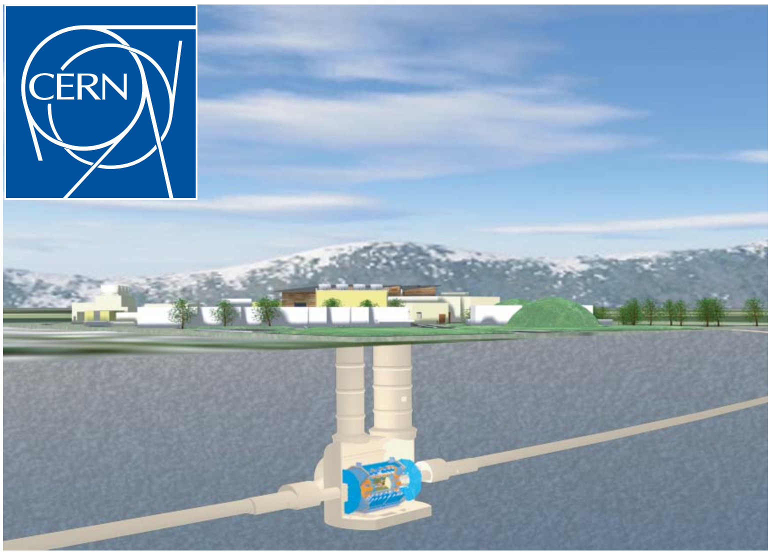
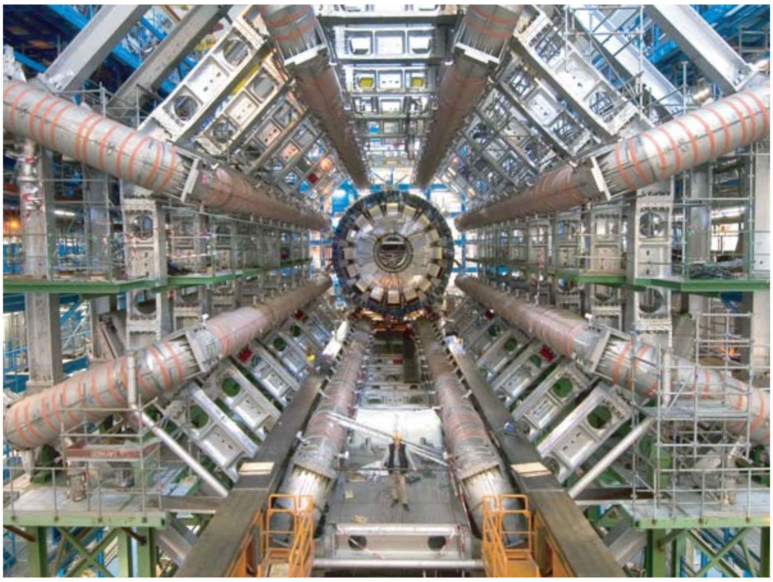




From Fundamental Science to Everyone's Life

The ATLAS Experiment

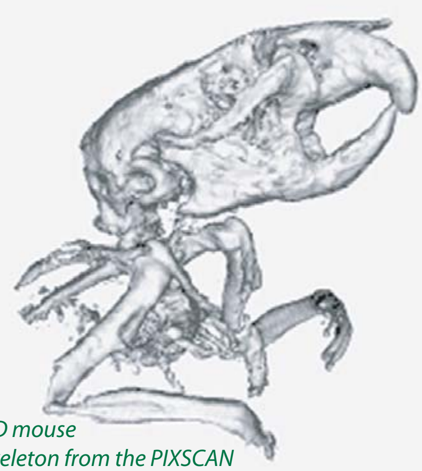
The ATLAS experiment at the CERN laboratory in Geneva is a basic research project that uses state-of-the-art instruments to explore the outer reaches of our understanding of the universe. At the same time as they pursue these fundamental developments, ATLAS scientists are taking the knowledge they have gained in their ATLAS work and applying it in other fields.

Studies have demonstrated that the transfer of knowledge from fundamental research enables high-tech companies to remain on the cutting edge of innovation and generates a variety of social and economic benefits. It also has an important impact on our culture and education. This brochure highlights several examples that show how work on ATLAS is being applied elsewhere.

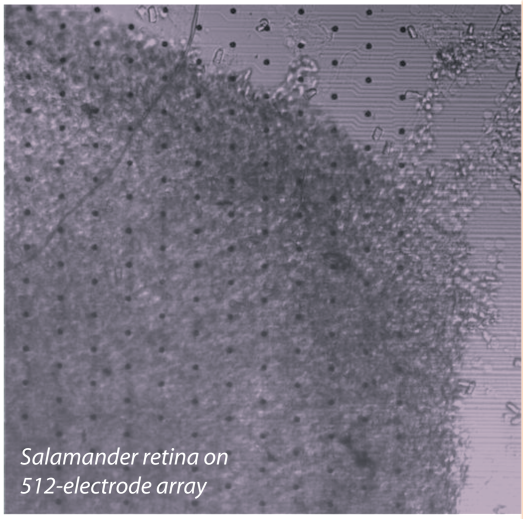
Medical

New, miniature electronic silicon chips have been designed for the ATLAS experiment to track elementary particles close to the collision point of the incoming proton beams. These small pixel semiconductor detectors are characterized by high detection efficiency and low noise, making them ideally suited for X-ray imaging in radiography, protein crystallography and material science. They can detect individual X-ray photons with high spatial precision over a broad energy range with extremely short readout times.

Pixel Matrix with 18 x 160 pixel cells. For comparison a part of a match is shown.



3D mouse skeleton from the PIXSCAN



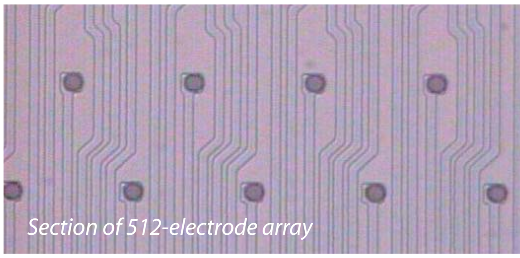
Salamander retina on 512-electrode array

Multi Picture Element Counters

The innermost layers of the ATLAS experiment will be composed of silicon pixel detectors. Close to 100 million individually amplified detector cells are able to determine and trace the exact position of the charged particles produced in a proton-proton collision. The same type of pixel detector can be used for biomedical imaging when a high spatial resolution is needed, for instance in mammography. The detector simply counts the absorbed X-ray quanta individually, via tiny counters implemented in every pixel. *The method gives a truly digital image of the absorbed X-ray dose.* The radiograph is visible in real time, eliminating the use of a film. Hence, a relatively small modification of the ATLAS pixel detector has led to digital radiography.

Computer Tomography

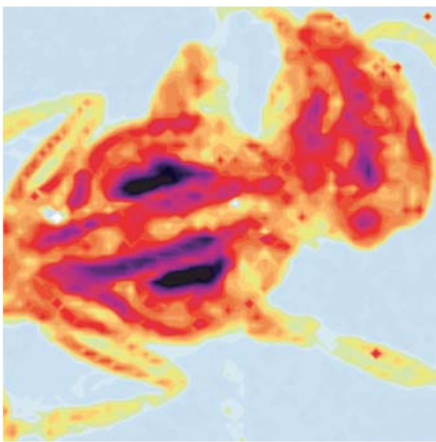
PIXSCAN is a new method for Computer Tomography (CT). It uses the XPAD, a photon counting detector based on the ATLAS pixel chip. *PIXSCAN improves the contrast for soft tissues and produces up to 400 images in two seconds.* A first prototype has been developed for the examination of small animals. Given the small size of the animal, an extremely high spatial resolution is required. First tomographic images prove the quality of the new techniques. The extremely thin detector can also be used in combination with Positron Emission Tomography (PET). While PET gives the position of the tumour tissue only, the CT image shows the whole organ.



Section of 512-electrode array

Retina Project

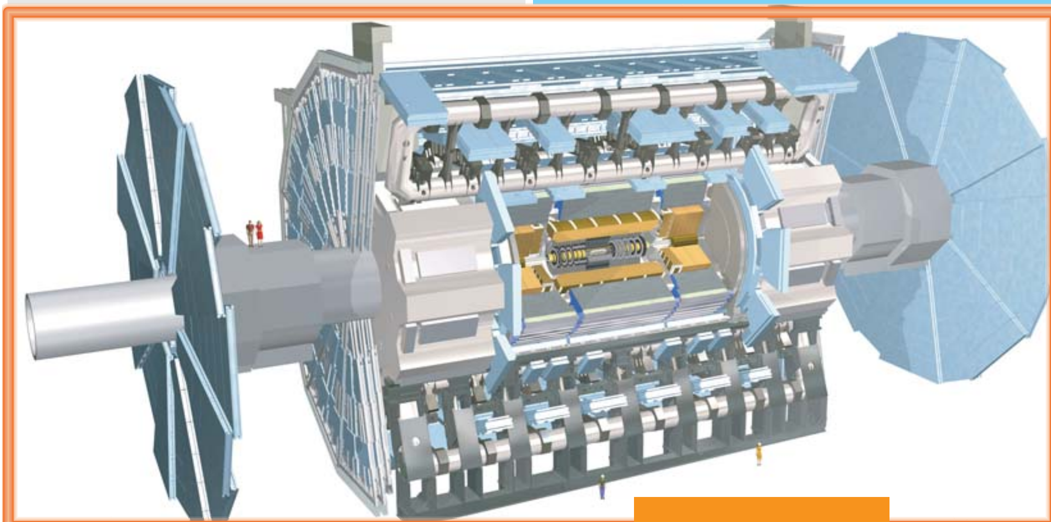
Together with neurobiologists, ATLAS physicists have studied the information that is transmitted from the eye to the brain. The retina is a sophisticated biological pixel detector that converts a visual image into electrical signals, called "spikes". These spikes act as a neural code and communicate the features of an image to the visual centre of the brain. To crack this code, live retinal tissue is examined and a recording system for large-scale neural activity has been developed based on the silicon microstrip detector technology used in the ATLAS experiment. *These experiments help neurobiologists to understand how living neural systems process and encode information and could one day give artificial sight for the blind.*



Digital radiograph of a hornet

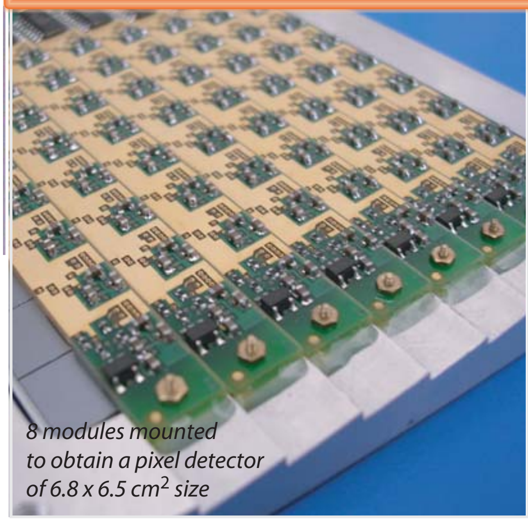
Technical

All parts of the ATLAS detector are highly sophisticated instruments in which the technology and required performance often exceed the available industrial know-how. Technologies developed for the purpose of research activities produce improvements in many fields and make our daily environment more functional.



Schematic diagram of the ATLAS detector.

The ATLAS detector is about the size of a five story building.



8 modules mounted to obtain a pixel detector of 6.8 x 6.5 cm^2 size

X-Ray Detector

XPIX is an X-ray detector using the XPAD chip developed for ATLAS. It is adapted to a new generation of high-intensity X-ray sources. This radiation is used for the study of the structure of proteins and solid state material. A first prototype detector of 6 x 6 cm^2 is in use at the European Synchrotron Radiation Facility in Grenoble (France). *First results using XPIX detectors show that the image quality improves substantially and the exposure time is reduced considerably, thus avoiding destruction of the material by the radiation.*

Ultrasound Gas Analysis

In ATLAS an ultrasonic analysis technique has been developed to measure the fluorocarbon vapours in the cooling system of the inner detector. This technique has also been used to analyse the gas mixtures in semiconductor production, where often the amounts of heavy elements have to be controlled. The composition of the mixture is determined with a precision better than 1 part in 100 000. *An application in clinical anaesthesia has been tested successfully, indicating that typical clinical anaesthesia mixtures can be resolved with high precision.* The analysis of hydrocarbons in oil refinery operations has also employed this technique.

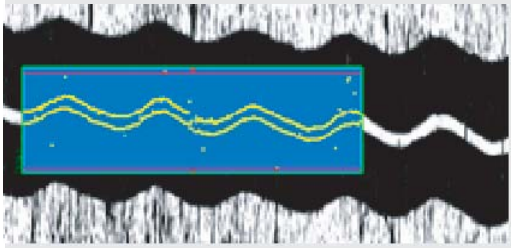
Emergency Personnel Location

A system for finding and rescuing people in case of an accident in the ATLAS area has been conceived by ATLAS members. A large number of infrared sensors installed at the experiment site will allow an operator in the Control Room to follow the movements of all persons in the ATLAS cavern. The system can be installed at very low costs in virtually all types of environments and is suitable in large areas such as mines where people are often difficult to find. In case of emergency, especially if smoke or fog is present, it helps a rescue team to locate persons in danger.

Culture

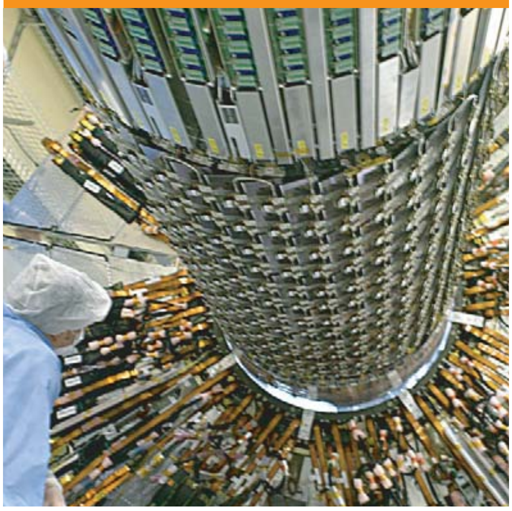
Particle physics and cosmology teach us how the interior of matter works and how the universe started and developed into what we can now see all around us. This desire to extend our knowledge and go beyond the present limits is part of our heritage and cultural life. ATLAS makes these modern physics ideas publicly available at various levels via the ATLAS Web site and via informational material including live and animated films.

Mechanical sound recordings can be reconstructed using optical techniques



DataGrid aims to enable access to geographically distributed computing power and storage facilities belonging to different institutions.

Assembling the ATLAS SemiConductor Tracker (SCT) which consists of approximately 16 000 silicon microstrip detectors with 6.3 million readout channels, built into 4088 modules



Sound Reproduction

Precision optical image processing methods were used by ATLAS members to measure and align each of the 16 000 individual silicon detectors of the ATLAS SemiConductor Tracker. Inspired by this approach the same strategy was applied to measuring precisely the shape of the groove on mechanical sound carriers such as phonograph discs and cylinder records. To analyse the shape of the grooves and extract the audio information, a data reduction and fitting strategy similar to finding and reconstructing particle tracks in the ATLAS detector was used. The sound could be reconstructed with high fidelity and significantly reduced noise level. *As there is no physical contact with the material, the method can be used to restore and preserve delicate or damaged samples and historical sound recordings.* The technology is now under development for use in the major recorded sound archives and collections.

Grid Computing

The ATLAS collaboration is taking part in the development of a global computing Grid for data storage and analysis. When the Large Hadron Collider (LHC) starts to operate, the experiments will produce several million gigabytes of data annually. Via the computing Grid, data from ATLAS and the other LHC experiments will be distributed around the globe and be accessible to all the 5000 scientists of the LHC experiments located all over the world. *The World-wide LHC Computing Grid (WLCG) project operates the computing Grid for the LHC experiments, including more than 100 different sites. It collaborates and interoperates with other major Grid projects.* In 2006 over 20 applications are already running on this infrastructure, including Earth observation, climate prediction, petroleum exploration and drug discovery.

Education

In participating institutes worldwide, graduate and undergraduate students as well as high school teachers and students are involved in the development, construction and testing of parts of the new detectors. *This work provides experience in modern laboratory work, state-of-the-art research, cooperation in international teams, and complex problem solving. Such an education prepares students for a wide spectrum of professions in science and industry as well as in education and administration.*

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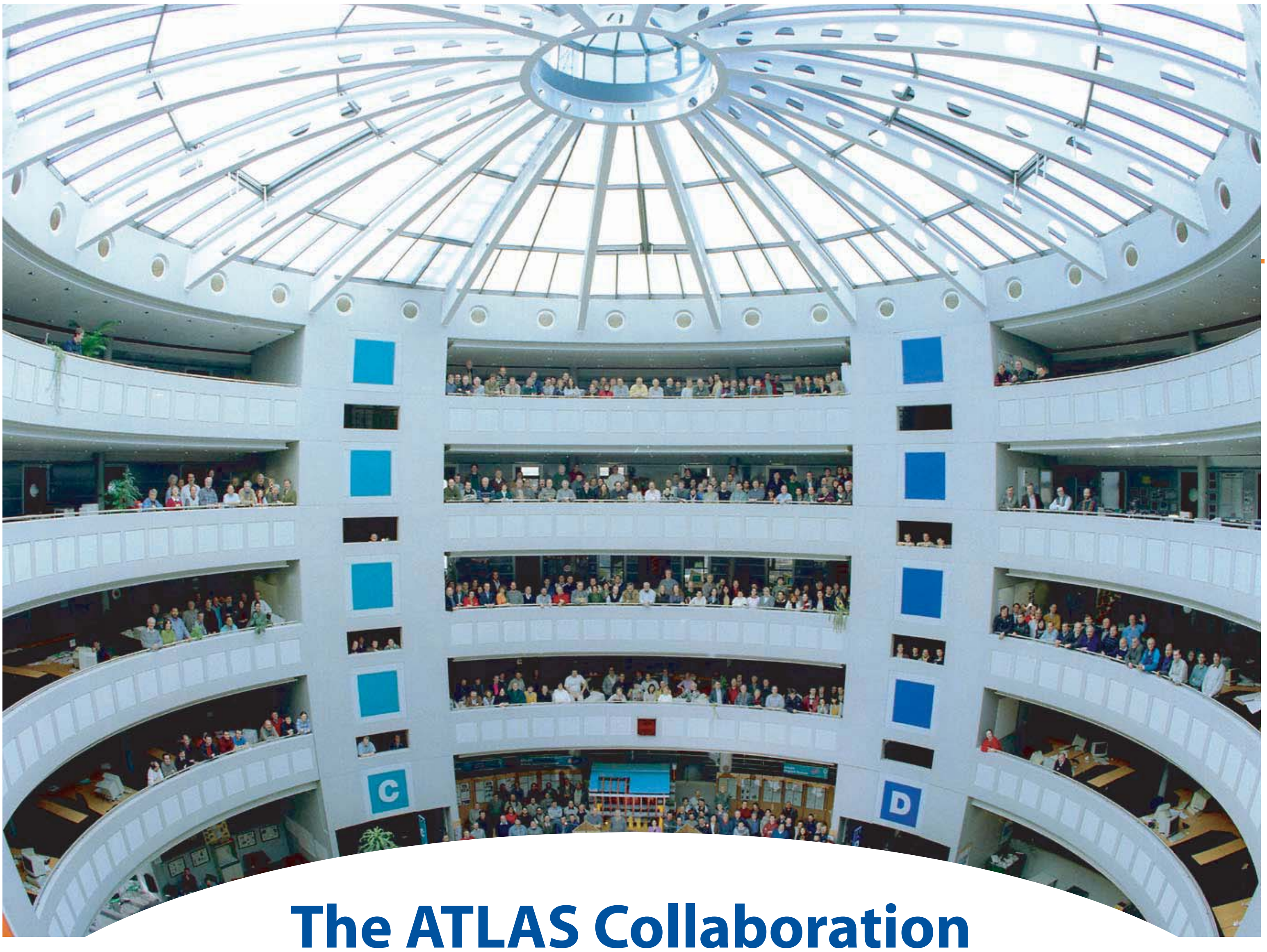

The ATLAS Collaboration

In order to explore the fundamental nature of matter and the basic forces that shape our universe, high energy particle collisions are studied in the laboratory. Protons are accelerated in the Large Hadron Collider (LHC), an underground accelerator ring 27 km in circumference at CERN, the European particle physics laboratory outside Geneva. The particle beams are steered to collide in the middle of the ATLAS detector. Examination of the debris of these collisions reveals information about fundamental particle processes.

The energy density in these high energy collisions is similar to the collision energy of particles in the early universe, less than a thousandth of a billionth of a second after the Big Bang.

The ATLAS detector is one of the largest and most complex physics experiments ever conducted. This endeavour is made possible thanks to the dedicated work of 1700 scientists including 400 students from more than 160 universities and laboratories in 35 countries that take part in the world-wide ATLAS collaboration.