A Place Where Ideas are Born

Technology Transfer from CERN

In the quest to find out what matter is made of and how its different components interact, high-energy physics needs very sophisticated instruments using technologies and requiring performance that often exceed what is available to industry. New technologies are developed to solve specific needs at CERN, but these technologies are often applicable outside the physics laboratories. The most well known technology coming from CERN is the World Wide Web (WWW), originally developed to solve the information sharing need between physicists and laboratories. This technology was made freely available to everyone and is today part of the everyday modern communication.

Technological developments most often require the involvement and interaction of experts in a large variety of domains such as information technology, microelectronics, superconductivity, vacuum, material sciences, and surface treatments, thereby resulting in technological cross-fertilization. Today CERN is the world's largest particle physics laboratory with 3400 staff members, fellows and associates, and about 5300 users from Member States and about 3000 from non Member States. By bringing together the creativity of so many scientists from different nationalities, backgrounds and technical fields of research, CERN has been and continues to be a source of knowledge creation and knowledge transfer. The research being carried out at CERN is expensive so in order to justify these expenses CERN is striving to transfer knowledge and technologies to other areas than particle physics.

There are different ways of doing Technology Transfer (TT) in order to fuel innovation to Member States' industry. One is through procurements and this has been the conventional model used by CERN since its foundation. Technologies and prototypes that have been developed at CERN are transferred to industry, usually in order to let the industry do the industrial production. However, in order to promote a more active TT, CERN introduced a proactive TT policy in 2000 to identify, protect, promote, transfer and disseminate its innovative technologies in the European scientific and industrial environment. In addition to a conventional licensing model for transferring technologies CERN goes into R&D partnership with industry to strengthen its dissemination outside the domain of particle physics. For promising technologies with a long time to market large R&D collaboration with partners from research institutes, universities and often also industry are established due to long development time and high costs. Another type of CERN technology transfer to industry, institutions and society comes implicitly through the transfer of knowledge or know-how of people. Each year hundreds of young people join CERN as students, fellows, associates or staff and work at CERN for a limited period of time. When they finish their jobs at CERN they bring their gained knowledge elsewhere. Experience shows that 2/3 of particle physics students end up in fields outside particle physics research, while for technologically minded students the fraction is even larger.

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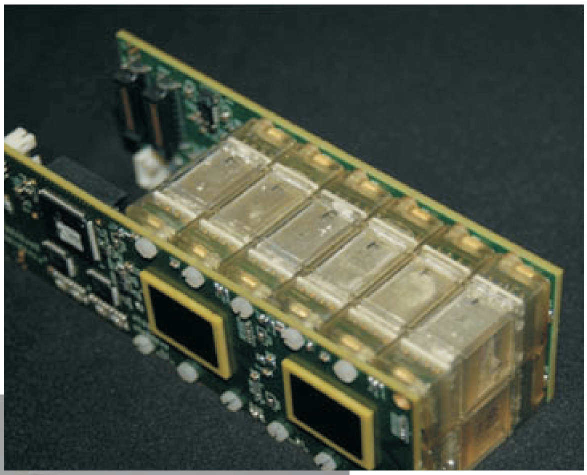
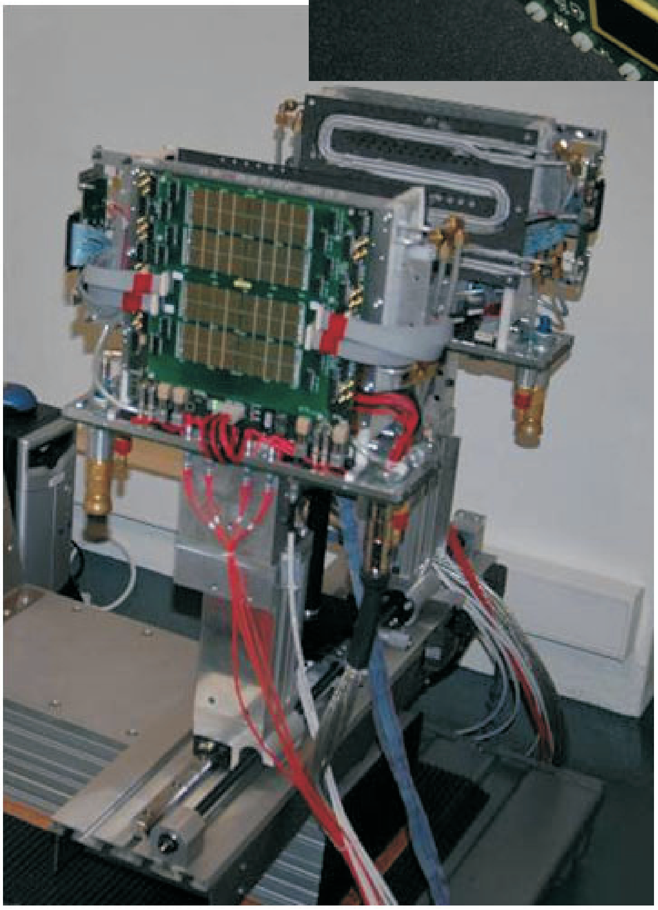
Examples of Technology Transfer from CERN:



Figur 1

ClearPEM: Scintillating crystal detector



Figur 2 Assembled GClear PEM prototype

Medicine

Many concepts and developments from particle physics find applications in health care. High-quality detector, accelerator, and beam technologies are essential for particle physicists to achieve their quest. These developments may be applied for better diagnostic tools and for providing tailored radiation treatment of disease, in particular in the fields of hadron therapy, isotopes, and medical imaging.

Hadron Therapy

Hadrons, the subatomic particles that are influenced by the strong nuclear force and made up of quarks, such as the neutron and proton, were immediately identified as more appropriate particles for radiotherapy of deep-seated tumors due to the dose distribution in tissues. Compared to traditional radiation therapy this technology can destroy the tumor with much higher precision and thereby reduce the risk of destroying healthy tissue. Pioneering studies were carried out at CERN in the late 1960s. Nowadays many centers worldwide are using proton or carbon ion therapy. So far some 35 000 patients have been treated with protons and many new centers are under construction. CERN physicist Ugo Amaldi strongly promoted the developments of new proton-ion accelerators; and in 1999 CERN, GSI (Gesellschaft für Schwerionenforschung) in Germany, Med-Austron in Austria, Oncology 2000 and TERA (TErapia con Radiazioni Adroniche) in Italy realized a study to design an ion synchrotron (PIMMS) optimized for medical applications. A treatment centre based on an improved version of the PIMMS synchrotron, called CNAO (Centro Nazionale di Adroterapia Oncologica) is now being built in the north of Italy, by the CNAO Foundation, which is composed of five large hospitals and TERA.

Detection and Imaging

Particle physicists regularly use collisions between electrons and their antiparticles, positrons, to investigate matter and fundamental forces at high energies. At low energies, the electron–positron annihilations can be put to different uses, for example to reveal the functioning of the brain using PET (Positron emission tomography).

Clear PEM

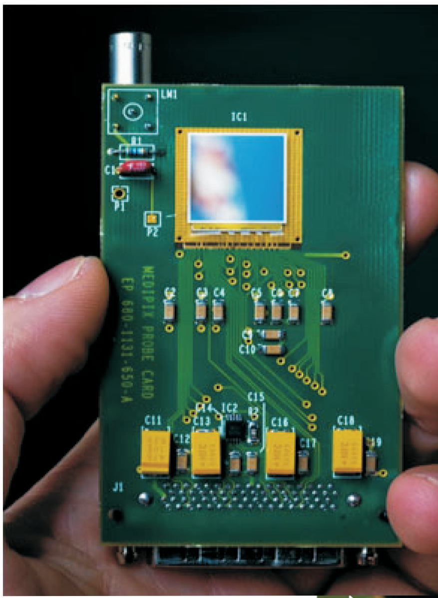
Today PET is a common scanning technique in medical diagnostics. PET allows, for instance, detailed viewing of the functioning of distinct areas of the human brain at work while the patient is conscious and alert. It is possible to study the chemical processes involved in the functioning of healthy or diseased organs in a way previously impossible. A first image from a PET camera was made at CERN in 1977. Thirty years later, a combined PET / CT scanner has been advocated as the path to true image fusion. Examples of ongoing CERN developments are the developments for a brain PET scanner based on photodiodes, being carried out in collaboration with the Cantonal Hospital of Geneva; the Compton Prostate Probe from the CIMA (Compton Imaging for Medical Applications) collaboration; and a Positron Emission Mammography (PEM) prototype using crystals (ClearPEM) under development by the PEM Collaboration in the framework of the Crystal Clear Collaboration (CCC) with the aim of improving early-stage breast cancer diagnostic. The purpose of the CCC is to develop new scintillating crystals, used as detectors, and associated readout with fast electronics for high-energy physics applications and medical imaging.

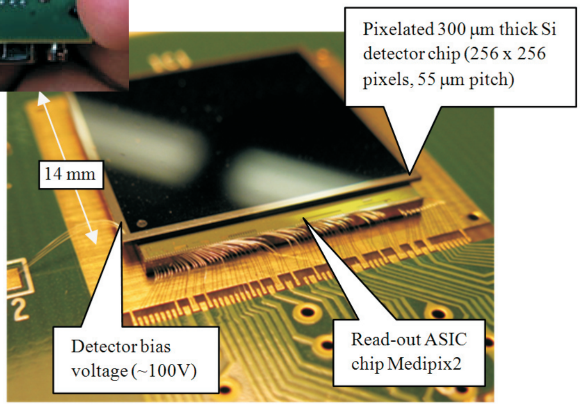
The Medipix System

The Medipix system is another example of a technology whose development was driven by the requirements of high-energy particle physics finding its way out of the Laboratory and into medical and industrial applications. Hybrid pixel detectors are a technology developed to enable physicists to make sense of the complicated interactions as revealed in CERN detectors. The Medipix Collaboration adopted the same technique to count and image X-rays whose energy falls within a given window. This novel X-ray imaging technique eliminates the background noise associated with more traditional X-ray imaging approaches and provides energy information that was previously lost.

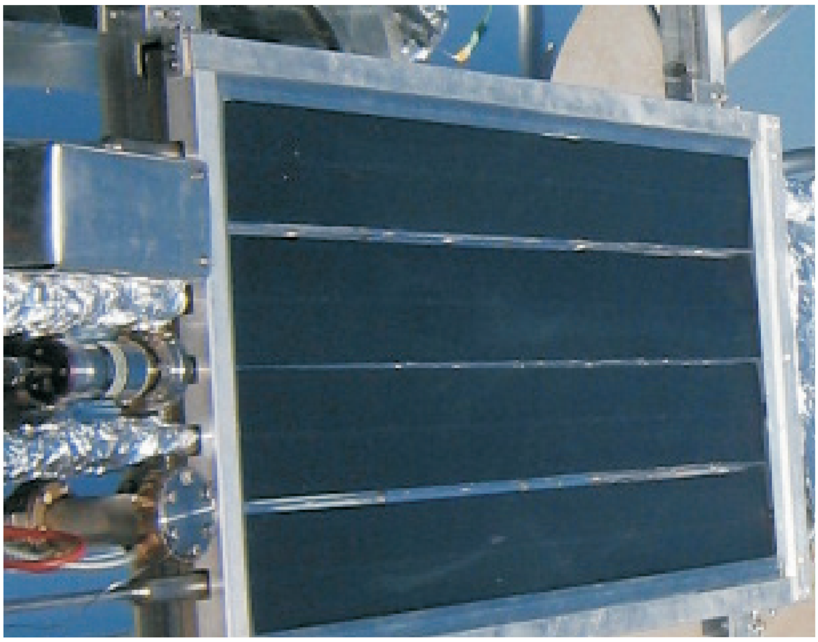
Energy

Energy consumption in the industrialized world tends to increase together with economic development. Energy is another crucial domain where high-energy physics technology can provide new solutions. One example is an innovation in the field of solar energy. Solar energy as such has appealing qualities: it is environmentally friendly; it is virtually infinite and free of charge. However, its low power density requires wide collecting areas to reach reasonable power ranges. CERN has thanks to the mastering of ultra-high vacuum technology, built an evacuated flat panel solar collector. This solar collector can achieve an equilibrium temperature of 350°C with 900 Wm-2 of incident solar power without using focusing mirrors. This is about 100°C better than the best technology currently available on the market.





The Medipix system. The pribciple and the complete card.



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