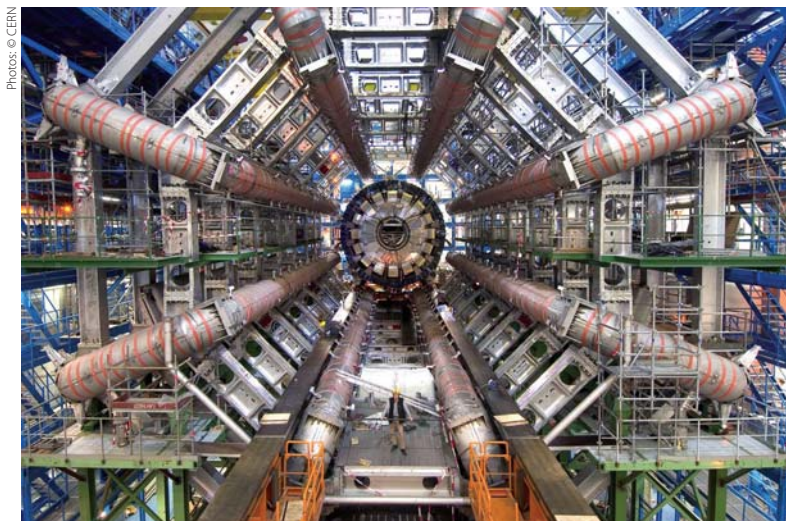


CERN AND INNOVATION

The Heart of the Matter



Eight toroid magnets surround the calorimeter that is placed into the middle of the detector to measure the energies that the particles produce when protons collide.



The LHC spans the border between France and Switzerland about 100 meters underground.

A freezing, 27-kilometer, underground ring, colder than outer space, producing temperatures from collisions a hundred thousand times hotter than the sun, in a vacuum where the pressure is ten times lower than on the Moon... it is no wonder that CERN's Large Hadron Collider (LHC) has captured the world's imagination. Thousands of scientists and engineers from over 60 countries worked for over 20 years to produce a machine of unequalled scientific artistry and technical complexity that will delve deep into our origins, seeking out the infinitesimal particles that are the building blocks of the universe.

The challenges were enormous. More than 9,000 magnets, cooled to a frigid minus 271.3°C using 10,080 metric tonnes (t) of liquid nitrogen and nearly 60t of liquid helium, control two beams of trillions of hadrons that race around the accelerator ring in opposite directions at over 11,000 circuits a second – almost the speed of light. When they are allowed to intersect, 600 million collisions take place every second, simulating the conditions of the Big Bang. Gargantuan detectors measure the speed of the debris particles to a few billionths of a second and their location to millionths of a meter.

The September launch of the LHC created a buzz across the planet. We were clearly witnessing something momentous – definitely a “milestone in scientific history” – but what would it mean to us as individuals and how might it impact our lives?

Aside from the research insights it promises, the mere building of the LHC is a tremendous achievement, stretching the boundaries of technical know-how and generating major breakthroughs and applications that are already impacting on research and business practices in fields from medicine to micro-electronics and solar energy to computer modeling. The conceptualization and development of the equipment which enables the pure research that is CERN's *raison d'être* has, therefore, also made it a seedbed for technological innovation, the potential applicability of which can sometimes take years to understand and develop.

How does CERN share this knowledge with the world? What is its approach to intellectual property (IP) and to patents – tools designed to enhance dissemination of technical knowledge and encourage technological development? Is there a role for IP in the world of pure science, where the focus is knowledge as opposed to commerce? Does IP figure in one of the largest scientific collaborations in the world, and, if so, in what way?

To answer some of these questions, and to get a better idea of CERN's approach to technology transfer, WIPO Magazine sat down with Jean Marie LeGoff, who heads CERN's Technology Transfer Office (TTO).

CERN in a nutshell

CERN, the European Organization for Nuclear Research, is one of the world's largest centers for scientific research. Its focus is fundamental physics, finding out what the universe is made of and how it works. At CERN, the world's largest and most complex scientific instruments are used to study the basic constituents of matter – the fundamental particles. By studying what happens when these particles collide, physicists learn about the laws of nature.

The instruments used at CERN are particle accelerators and detectors. Accelerators boost beams of particles to high energies before they are made to collide with each other or with stationary targets. Detectors observe and record the results of these collisions.

Founded in 1954, the CERN Laboratory sits astride the Franco-Swiss border near Geneva. It was one of Europe's first joint ventures, and now has 20 Member States.

Source: <http://public.web.cern.ch>

An open science policy

LeGoff began by clearly underscoring CERN's strong orientation toward an "open science" policy, which favors making the methodology, data and results of experiments freely available. CERN also uses open source in the development of software. According to LeGoff, it is the only valid approach for the highly collaborative environment in which CERN operates as, "no company, not even Microsoft, would be able to develop software projects of the scale and sophistication required for CERN's experiments at an affordable price."

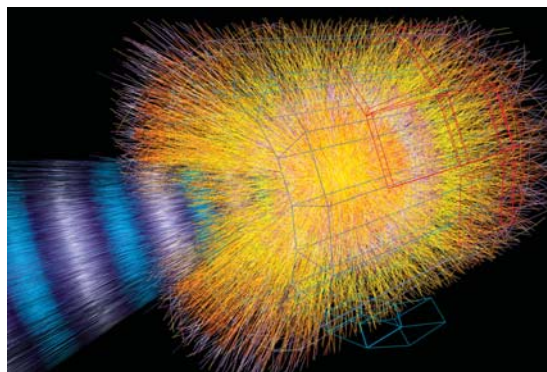
However, he notes that IP does have a significant role to play in this environment. Not least, the patent system ensures that a research lab like CERN is able to stake its claim and be recognized as the inventor of a wide range of technologies. As LeGoff explains, "We would like to make sure that it is known that a particular idea comes from CERN, so patenting helps in traceability. Typically, for a patent relating to the fundamental concept of a new accelerator where the application for industry was limited, we would not seek protection in many countries."

The patent system also allows CERN to monitor the broader impact of its activities – both in catalyzing technological development and in subsequent commercialization – through, for example, licensing.

While CERN's use of IP might be considered somewhat unconventional – focusing more on the recognition than on the reward aspect of the system – it provides an interesting illustration of the pragmatic use of patenting within a non-commercial environment.



The CERN theory group plays a vital role in imagining new aspects of physics that can then be tested by designing and running experiments.



A simulation of a lead ion collision.

CERN and industry – technical symbiosis

As far back as the 1970s, CERN began to recognize the broader impact of its research activities. As most of CERN's ground-breaking instruments do not exist in the market place, it falls to the scientists themselves to develop "proof of concept" and to demonstrate the functionality of much of the equipment they require. Industry is then contracted to manufacture and assemble the required parts. As CERN takes full responsibility for performance and outcomes, industry can participate



IP Rights in Commercial Partnerships

Partnerships with industry are an important part of CERN's technology transfer endeavor. Such arrangements create an opportunity to build prototypes from spin-off CERN technologies for commercial application. While industry bears the financial costs, CERN's aim is to facilitate assessment of the commercial viability of a given technology. Once a commercially promising technology is identified, then CERN establishes a partnership agreement that includes IP rights.

Commercial partners usually have exclusivity over the results of R&D projects within their own market and have access to CERN's background IP in order to exploit the results. Royalty rates are calculated on the basis of the relative value of the background IP to the resulting technology. Similarly, CERN has access to the IP of the results of joint R&D projects for their own research purposes. Also, whenever possible, CERN will seek to license these results in other domains of application in order to maximize the diffusion and impact of its technologies.

in developing new technologies and gain cutting-edge knowledge and expertise without the associated commercial risks of development. From CERN's viewpoint, LeGoff noted, this helps minimize costs of developing these technologies as contractors do not feel the need to factor in security margins, which could result in "a multibillion Euro machine costing two or three times more."

This creates a potentially fruitful situation for industry, where companies are able to gain expertise and know-how from their association with a cutting-edge project without any real commercial risk. As LeGoff notes, "it is well known among the companies that contract with CERN that it is not a profitable market. That said, these companies acquire a wealth of expertise and in some cases, contracting with CERN offers an opportunity to further develop their R&D."

Recently, CERN studied the impact of high-tech contracts, worth some one billion Euros, granted to 630 companies involved in the LHC construction. Of the 178 companies that replied, 30 percent said they had developed new products not related to high-energy physics, 17 percent had established new markets and 14 percent had set up new business units. "Quite a finding" LeGoff remarked, "illustrating the impact of CERN's fundamental research and how it can generate innovation that can directly impact on society."

Technology transfer and patents – indicators of excellence

According to LeGoff, CERN's technology transfer activities, including those underpinned by patents, are fuelled by a desire to consolidate its position as a center of technological excellence.

However, while the impact of its fundamental research on society is of far greater importance than any technology transfer aimed at a commercial return, he noted, "you can't get one without the other." He explains, "You know, patenting is something that is not essential to an open science environment, but it is something that absolutely is needed by industry to develop products and bring them to market. We don't develop products, we develop technologies and some of these are just too advanced, too costly and too far removed from daily life for there to be market interest. So, it is a question of timing." LeGoff explained, "if we believe there is commercial potential in specific markets then we will seek patent protection in those countries. Patent protection is important to us because, although it can take around 10 years for a CERN technology to reach the market, it enables us to establish licensing agreements with industry, to diffuse the technologies and to generate a return on the licenses for the life of the patent and to minimize the financial burden on the Organization."

A number of CERN technologies are of great relevance to society, particularly in the field of medical imaging. LeGoff noted, "Those fantastic devices, now regularly used for cancer treatment (see box page 13) derived from our research had to be developed by industry, which had to invest a considerable amount of money and time to bring them to market." They are now of immediate benefit to doctors and their patients as well as creating financial benefits for industry and the wider economy. Spin-off products, such as these, also clearly help to demonstrate the significant impact of investments made by governments into pure scientific research. CERN's member states take a keen interest in technology transfer, which is now a key part of its mission.

Spin-off Technologies

The spin-off technologies from CERN's experiments have revolutionized medical imaging. For example, technology combining computed tomography (CT) for imaging human structure and anatomy with positron emission tomography (PET), for biochemical functions and metabolism – developed from a prototype built by two CERN scientists in 1977 – today gives physicians close to 20/20 vision for diagnosing and planning treatment of cancer.



Pet Scans are one of many spin-off technologies from CERN experiments.

While such technologies seem extraordinarily advanced, to CERN scientists they are, in fact, out-of-date. Bridging the gap between the worlds of scientific research and business is a lengthy process. LeGoff notes that "From the technologies we produce, it takes approximately 10 years to get to a commercial device that can be manufactured and is cost-effective and affordable. Those machines that are state-of-the-art for clinicians today were developed from high energy physics technologies in the late 1970s, and in our view, they are rather old because they are not using the technologies from the LHC, for example, which were developed in the 1990s."

LHC technologies, which require fast and high-precision measurement of particle (photon electrons) energy, momentum and time, will, undoubtedly, continue to enhance medical and molecular imaging enabling increasingly better detection, and more targeted treatment, of small tumors raising cancer survival rates.

LeGoff believes that the challenges involved in building the next accelerator, a very powerful electron linear collider, will produce major developments in the fields of nanotechnology and microelectronics, opening up unprecedented opportunities for dedicated patient treatment, for example, and "allowing us to address the nano world at the nano level!"

CERN's patent portfolio

All IP generated by its employees, belongs to CERN. Typically, the organization has joint ownership of any breakthrough technology developed together with a partner institute.

With a growing sense of the potential for industrial application of its technologies, CERN's technology transfer strategy has expanded to explicitly include IP. CERN filed its first patent application in 1996, and currently holds 230 patents corresponding to 35 patent families, using WIPO's Patent Cooperation Treaty (PCT) as a cost-effective route to protect its technologies internationally. According to LeGoff, CERN is "very cautious in only patenting those technologies that are believed to have market potential." He added, "in an open science environment, the PCT allows us to buy time, to attract industry interest and on the basis of that to decide where to patent our technologies before the patenting process becomes prohibitively expensive."

More than 60 percent of CERN's patent portfolio is licensed. In 2007 the commercialization of IP – licenses, services and consultancies – generated some 1.5 million Swiss francs. This is just a fraction of CERN's budget, but it is in line with CERN's policy of "favoring dissemination as opposed to income." Preferential terms are offered to licensees, particularly research institutes. Bridging the technology gap between the worlds of science and industry clearly represents a significant challenge and one that CERN's technology transfer team is tackling head-on. "It is now our job to make the relevance of these advanced technologies and their potential for the next generation of innovation known to industry," he notes.

Creating a patent culture

Within a fundamental research community such as CERN, scientists typically race to publish their findings. This can destroy the novelty of a technology, which is a basic requirement of the patenting process. How does CERN tackle this problem?



Sifting for digital gold

CERN is at the forefront of networking technology. As befits the home of the World Wide Web, the organization is leading some of the most ambitious IT projects in the world.

At full capacity, the LHC will produce roughly 15 petabytes (15 million gigabytes) of data annually. To put this in some perspective – if we say that one byte (which equals one letter) is a grain of rice then a petabyte is the equivalent of 80 bowls of rice for every person on the planet or enough to cover central London in a meter of rice (thanks to managed networks for working this out <http://blog.managednetworks.co.uk/tag/petabyte/>). The LHC Computing Grid (LCG) will store and process huge amounts of data globally and transfer it at rates in excess of one gigabyte/second! The LCG will enable thousands of scientists around the world to access and analyze this data. For these scientists, it has been said that using the LCG will be “like sifting for digital gold.”

In addition to its own LCG, CERN heads the Enabling Grids for E-science. This is used by the wider research community (from biomedical science to astrophysics), who share a common infrastructure connecting and harnessing the power of over 20,000 computers into a seamless whole.

These grids are useful for a wide range of research applications involving large amounts of data. The WISDOM project, for example, is using grid computing to speed drug discovery for diseases, such as malaria and the bird flu virus (H5N1). The MammoGrid (with which CERN is associated) is using grid technologies to build a pan European database of mammography images. This will allow the sharing of data and resources in analyzing mammograms to improve breast cancer treatment and reduce the risk of misdiagnoses.

CERN's TTO has been actively cultivating the idea that there is no fundamental incompatibility between the need to publish scientific results for academic purposes and IP protection, in spite of the need to safeguard novelty for patenting purposes. “In fact, there is increasing evidence that scientists' own research is enriched through exposure to the patenting process which forces them to examine the prior art. While this is common practice in industry, it is rather new in the world of fundamental research,” he explained.

In its drive to raise IP awareness among its scientists, the TTO explains that patents are important to CERN because they increase the probability of technology transfer, they enhance the value of technologies and they ensure that CERN is recognized as the originator of an exceptional invention. LeGoff believes that “the idea that IP and fundamental research are compatible is taking root.” Emphasizing again that “It is a question of timing – timing is key.” LeGoff expects that IP consciousness among CERN's scientific community will expand as the pressures leading up to the LHC's launch ease.

Attitudes to IP, he thinks, have been influenced by a number of factors. First, researchers have been exclusively focusing on the enormous technical challenge of creating the LHC and not necessarily on the broader application of its technologies. Second, there are fears that IP protection will threaten research freedom. And third, there is a general lack of understanding within the research community about the role of patenting and IP generally.

CERN's technology transfer strategy is clearly evolving and IP is playing a role in its technology transfer mission. CERN is using the IP system to expand its options, to confirm its role as a center of excellence in its field and to be recognized as a technology innovator and a leading hub for technology transfer.

That said, there is a strong sense that the jury is still out as to whether the IP system, in all its complexity, will, in the future, be the best vehicle for CERN to maximize the impact of its research on society.