OVERVIEW OF CERN TECHNOLOGY TRANSFER STRATEGY AND ACCELERATOR-RELATED ACTIVITIES

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Abstract

CERN, the European Organization for Nuclear Research, is actively engaged in identifying technologies developed for its accelerator complex that could be profitably used by partner research organizations or commercial companies in applications with potentially high socio-economic impact beyond pure fundamental physics research.

In the first part of the paper, an overview of CERN current strategy in the field of Technology Transfer and Intellectual Property Management will be presented, with details on the most effective models, implementation tools and processes created by the Knowledge Transfer Group to achieve satisfactory dissemination and development of the knowledge generated within the Organization.

In the second part, CERN's currently available technology portfolio will be described with a focus on cases originating from the Accelerator and Technology Sector. A selection of promising on-going projects embracing a variety of technology fields and application areas will be detailed to showcase technical challenges and possible benefits of initiatives driven by (but not limited to) the needs of CERN scientific programme.

CERN TECHNOLOGY TRANSFER AND IP MANAGEMENT STRATEGY

CERN is well known for its important contributions to fundamental particle physics research and for the development of advanced technologies for high energy hadron accelerator facilities.

It is part of CERN core mission to ensure that the innovation generated in order to achieve its challenging scientific and technological goals is widely disseminated and used by other research centres and commercial partners to benefit society. This impact can be a direct improvement of quality of life, thanks to the availability of useful technologies (e.g. hadrontherapy systems for cancer treatment) or a macroeconomic effect obtained through supporting the competitiveness of partner companies in the Member States (e.g. spin-off company creation based on LHC vacuum technologies).

In order to maximize the chances of fulfilling this mission, a coherent 'Impact Driven' model has been developed, striving to find a delicate balance between 'Open Dissemination' and 'Protected Dissemination' approaches (as schematically represented in Figure 1).

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Open Dissemination is sometimes the best way to achieve wide and long lasting effects, especially when low initial investment is needed to reach an exploitable maturity level. The drawback is the difficulty in ensuring appropriate recognition as originator of the innovation (risk of misappropriation) and the lack of direct financial return for the Organization. A classic example of Open Dissemination is the World Wide Web, born at CERN and diffused rapidly and spontaneously with massive impact and return (in terms of reputation). A dedicated internal task force recently recommended that, whenever possible, software owned in whole or in part by CERN should be made available as open source. This encourages the creation of open collaborations of users who can improve and complement the software and share their enhancements with the entire community, whilst not excluding the possibility to generate business (creating for instance spin-off companies dedicated to service and support). Similarly, CERN has proposed a legal framework to facilitate knowledge exchange across the electronic design community: the CERN Open Hardware Licence ("CERN OHL") created to govern the use, copying, modification and distribution of hardware design documentation, and the manufacture and distribution of products. This model is enjoying remarkable success and is now also being adopted for different types of hardware. Another example of the Open Dissemination approach is given by CERN Easy Access IP initiative, which offers the possibility of obtaining a free exploitation licence for selected technologies from CERN's portfolio. Finally, technologies made available to other institutions for their academic activities do not require IP protection.

Protected Dissemination is the only viable option when a private partner needs to take considerable financial and strategic risk in order to adopt and further develop a technology to reach a competitive new market.

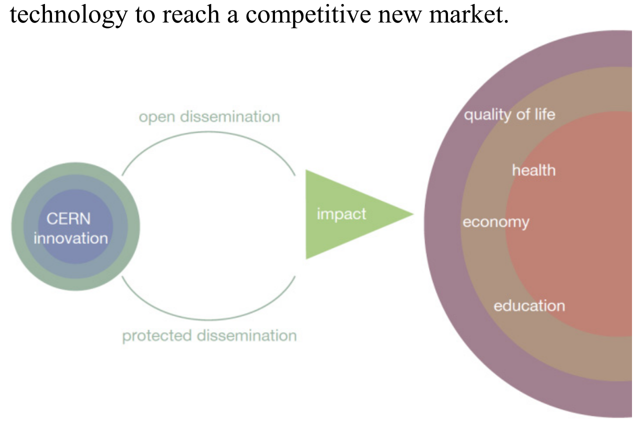

Figure 1: CERN Impact driven innovation approach.

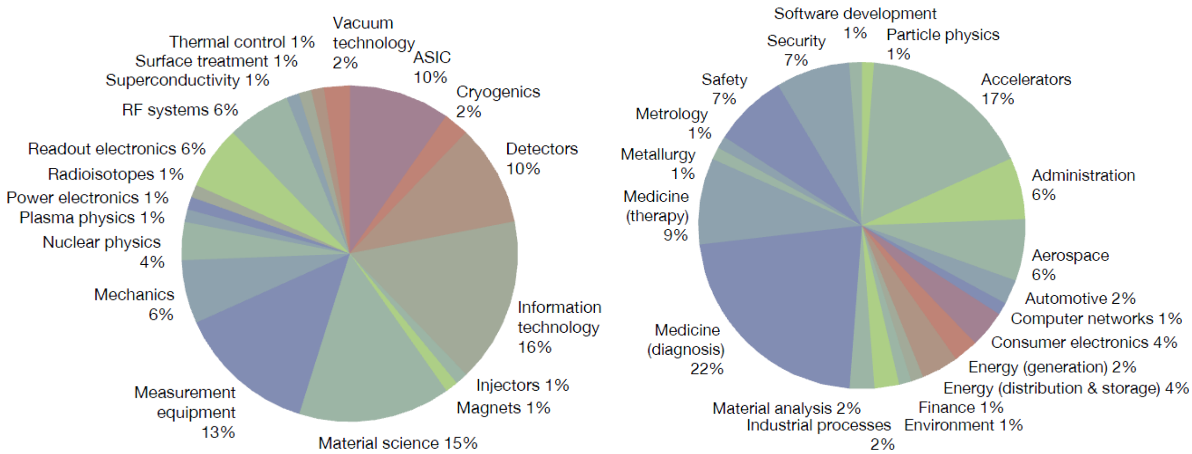

Figure 2: CERN Technology Portfolio classified in terms of Technology Fields (left) and Application Domains (right).

This can be even more important for early stage start-up companies heavily depending on external investments.

Different protection strategies are considered on a case by case basis, but international patent filing is in general the preferred option (when justified) because of the inherent value of the patent document as a powerful knowledge dissemination tool (freely accessible publication) and as a traceable intangible asset for the Organization. Confidentiality is sometimes adopted, for instance for microelectronics designs where reverse engineering is unlikely. Various types of agreements can be established with external partners willing to contribute to the exploitation of CERN's innovation, typically licensing (technology push mode) or R&D collaboration (market pull mode). For licenses, non-exclusivity is the baseline approach, with exceptions being considered only when there is no risk of inducing unfair competition with other companies in the Member States. Although direct revenue generation is not the main driver, a fair-share of the commercial revenues generated by the exploitation of CERN's Intellectual Property is usually requested, typically in form of initial lump sums or royalties. According to the Policy on the Management of IP in Technology Transfer activities at CERN [1], the revenues are then redistributed: 2/3 to the team and department of the inventor (no individual incentive is currently foreseen) and 1/3 to the "KT Fund" (or ½ and ½ in case of overheads related to service or consultancy agreements), a very useful instrument to support new initiatives and projects with technology transfer objectives.

Another example of structural implementation of the impact-driven strategy is the development of initiatives aimed at encouraging entrepreneurship. In particular, the CERN BIA (Business Ideas Accelerator) aims at creating a pre-incubation structure at CERN connected to a network of regional incubators and a network of partner Universities with suitable Entrepreneurship programs.

The classification of current global CERN Technology Portfolio [2], made of about 200 independent identified technology or know-how cases (~50% exploited, in some cases by many partners in parallel) in terms of technology fields and application domains is represented in Figure 2.

TECHNOLOGY TRANSFER ACCELERATOR-RELATED EXAMPLES

A successful technology transfer programme is sustainable only if it can rely upon a collaborative and competent network of internal experts from the technical departments. This has (fortunately) been the case at CERN in recent years, in its three main areas of excellence: accelerators, detectors and IT. The focus of this paper is on technologies originating from the development of CERN accelerator complex, and a few representative examples are described in this section.

NEG – Non Evaporable Getters

NEG thin films were developed at CERN in the late nineties to provide distributed gas pumping in conductance-limited beam pipes. A getter is a material having a chemically reactive surface which can either bind molecules or split them so that the fragments can be absorbed in the volume. The inner walls of vacuum components are completely coated with such materials by magnetron sputtering, so that what is usually a gas source is transformed into an efficient gas pump. After in situ activation at temperatures as low as 180°C, NEG films adsorb most of the residual gas species in ultra-high vacuum (UHV). When the surface is completely covered by the pumped molecules, the getter becomes inactive and must be regenerated. In the case of evaporable getters the regeneration is performed by evaporating a fresh layer of material on top of the aged one. In the case of NEG the activation can be performed thermally, by heating in vacuum, so that oxygen and partly carbon can diffuse into the volume and provide a clean rejuvenated and reactive surface. In addition to distributed pumping, NEG coated surfaces offer two additional advantages compared to traditional materials: when bombarded by particles (electrons, photons, and ions) their gas-molecule desorption and secondary electron yields are much lower. As a result, NEG coatings are the best fitted solution for modern particle accelerators, where limited conductance, high energy and intensity, and photon flux coexist. Several accelerators are already benefiting from the exceptional performance of such materials, notably the

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LHC where about 1400 vacuum chambers are NEG coated amounting to about 7 Km of beam line. In terms of innovation, the real breakthrough was the development of thin film coating with an alloy, TiZrV, which has sufficiently low activation temperature (180 C for 24h heating). This concept has been protected with a patent [3], which today constitutes the best example of CERN's successfully exploited IP: many research institutes and commercial firms have licensed this technology and make use of it, mainly for accelerator vacuum systems and thermal insulation applications. In particular, CERN's spin-off company SRB Energy has successfully applied this technology to produce vacuum insulated flat thermal solar panels, where an internal getter pump driven by the sun is dimensioned so as to maintain the panel internal pressure lower than 10^{-4}Torr for the specified panel life (up to 25 years). The distinctive feature of this panel is the very high temperature it may reach by simple exposure to solar light (over 300°C for 1000W.m^{-2} of incident power). Even higher temperatures may be obtained making use of non-focusing mirrors, which also allow diffuse light to be collected. Several solar plants made with SRB Energy collectors are currently installed and in operation for cooling or heating, for example at Geneva International Airport.

RF Loads for Energy Recovery

This is the first project that has been supported through the KT Fund mechanism. Its purpose is to build a demonstrator of a new type of high power RF absorber designed to provide water or air at temperature and pressure levels capable to meet energy recovery requirements. Two main concepts are currently under assessment. The first one aims to produce water at 150˚C and high pressure, and it is based on stacked waveguide geometry with inside walls coated with a thin layer of ferrite. The second one aims to produce air of temperatures up to 800˚C and is based on a porous silicon carbide block that serves both as microwave absorber and as heat exchanger. The concept may be usefully applied in many particle accelerator facilities, where the dissipation of waste RF power can reach the MW range.

High-gradient Accelerating Structures for Linacs

Over the past years CERN has driven the study of the CLIC normal conducting linear collider, which targets multi-TeV fundamental physics. One of the key technologies which have been developed by the study is very high gradient radio frequency accelerating structures. This technology may be important for a number of other applications, the most promising of which are compact proton and carbon ion linacs for medical therapy. Members of the CLIC study and the TERA foundation are now involved in adapting the technology to this new application, with the support of the KT fund. The target is to double the current state-of-the art accelerating gradient for therapy linacs in order to achieve about 50 MV/m, thus halving the length (and making the development and use of moving gantries viable possibilities). The project will develop two high power prototype 3 GHz accelerating structures (one at low energy - 76MeV, the other at high energy – 213MeV, corresponding to the lowest and highest energy for the main part of a typical proton therapy linac).

Thermal Management Materials

New Metal Matrix Composites (MMC) based on Copper or Molybdenum with diamond or graphite reinforcement are needed for future LHC Collimators. The extreme environmental conditions in which these materials are expected to operate call for cutting edge performances: in particular, high electrical and thermal conductivity and very low coefficient of thermal expansion combined with high operating temperature, strength, robustness and also radiation hardness. The first set of requirements correspond to those of novel thermal management materials needed in a wide spectrum of applications, most notably high-end chipsets (and more in general electronic components generating high heat fluxes). Materials to be developed for these applications may combine metal-based matrices with a variety of reinforcements. The project will consist of the definition, production and characterization of two batches of around 10 proof-of-concept samples of materials with very high thermal conductivity, low thermal expansion coefficient and fair mechanical properties.

CERN-MEDICIS Facility

The CERN-MEDICIS project is an ambitious, long-term initiative to create a dedicated radioisotope production facility at CERN. It will use the wasted proton beam at the ISOLDE facility to irradiate specific targets, generating custom synthesized radioisotope batches for end-users. The main isotopes of interest in the first instance are intended to be those of copper, scandium, terbium and magnesium. It is anticipated that these radioisotopes will be used for both the treatment (targeted alpha therapy) and the diagnosis (through medical imaging) of suitable cancers. KT funds were sought to act as a catalyst to expansion of the project. Partnerships are already in place with local hospitals and universities to carry out radiochemical and biological experiments using isotopes generated by the project. Preliminary bioavailability studies conducted using a 152Tb-labelled compound in tumor-bearing mice showed good localization of the tracer molecule to the site of the tumor, with low toxicity compared to control experiments. This work shows promise for potential clinical use in humans. CERN-MEDICIS project hopes to contribute to the formation of a European network of radioisotope production facilities, providing a full and comprehensive range of isotopes for research and medical science.

REFERENCES

[1] Policy on the Management of IP in Technology Transfer activities at CERN, March 2010, CERN/FC/5434/RA.

[2] http://knowledgetransfer.web.cern.ch/

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