Technology Transfer at CERN and the LHC developments.

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Abstract

Developments for the LHC, and electronics in primis, constitute a continuous technological challenge. A direct by-product of this activity is the transfer of the know-how to industry and to society at large. This, beyond being an unquestionable tool for progress, allows a return to the scientific environment, which triggered the transfer. In the last years, CERN has consolidated its long lasting tradition of technology transfer and a more coordinated and fruitful approach has been put in place. An overview of the importance of this activity and of its associated operational tools and results will be given, with emphasis on electronics.

I. Why Technology Transfer?

Much is being said about Technology Transfer (TT), though its actual realization is somewhat more challenging than what one could normally expect. The rationale behind doing TT relies on some ethical and practical justifications:

- It is not ethical for scientists to keep their discoveries for themselves.
- Discoveries must be realized and the results must be disseminated to Society at large
- Technology Transfer is a potential source of revenues that can help the financing of more physics research
- There should be a balance between fundamental Research that must be publicly funded to remain unbiased and Applied R&D that can be Society/Industry driven.
- Technology Transfer is a compromise that can benefit both Research and Society.

The development of technologies and technological projects at CERN can be sketched according to Fig. 1, which stresses the different stages in the process, and for each stage individuates the source of funding. This aspect is quite relevant in order to correctly separate the commitments of the different parties involved, and to prevent inappropriate utilization of research funds, which are received from the Member States for carrying out the "core business" of CERN, namely High Energy Physics (HEP).

The fact that the Member States themselves are quite keen on seeing a fall-out of their fundamental research investments while at the same time being very cautious on the use of their research funds requires a subtle handling of the process.

As Fig. 1 shows, all the TT activities which are carried out at CERN originate only from HEP R&D or from Technical developments required to support HEP R&D, and this clearly shows a coherent non-disperse approach. The HEP R&D and the technical development required for HEP are funded by HEP. No TT funds are required. The intermediate step in which this R&D is steered towards specific domains in view of developing demonstrators or prototypes in view of gaining proofs-of-principle, is where the TT Group activity and TT funds are required. In some cases where there is common interest for HEP and industry, some of the technical R&D development costs can be shared.

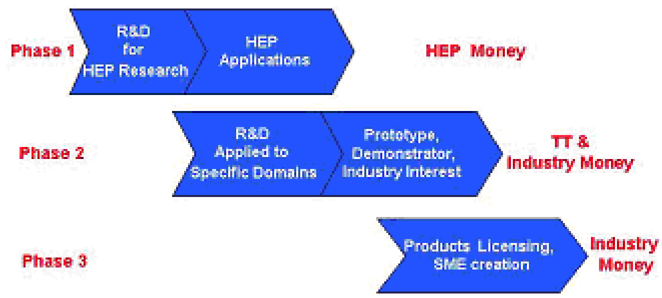

Fig. 1: Stages in development of technologies and projects

II. TT objectives and process at CERN

The main objectives of the TT activity at CERN cover issues ranging from the direct management of the funding to the dissemination of information, to the training of people. They can be itemized as follows:

- To manage, promote and license the CERN patent portfolio to industry,
- To support TT oriented collaborations with partner laboratories and industries,
- To maintain and update the CERN technology database,

- To establish a TT internal and external network to identify, assess, promote and transfer CERN technologies to industry,
- To create a TT program based on the training of personnel at CERN and promote connection with industry,
- To seek resources for Technology Transfer activities, in particular in the framework of the European Union program.

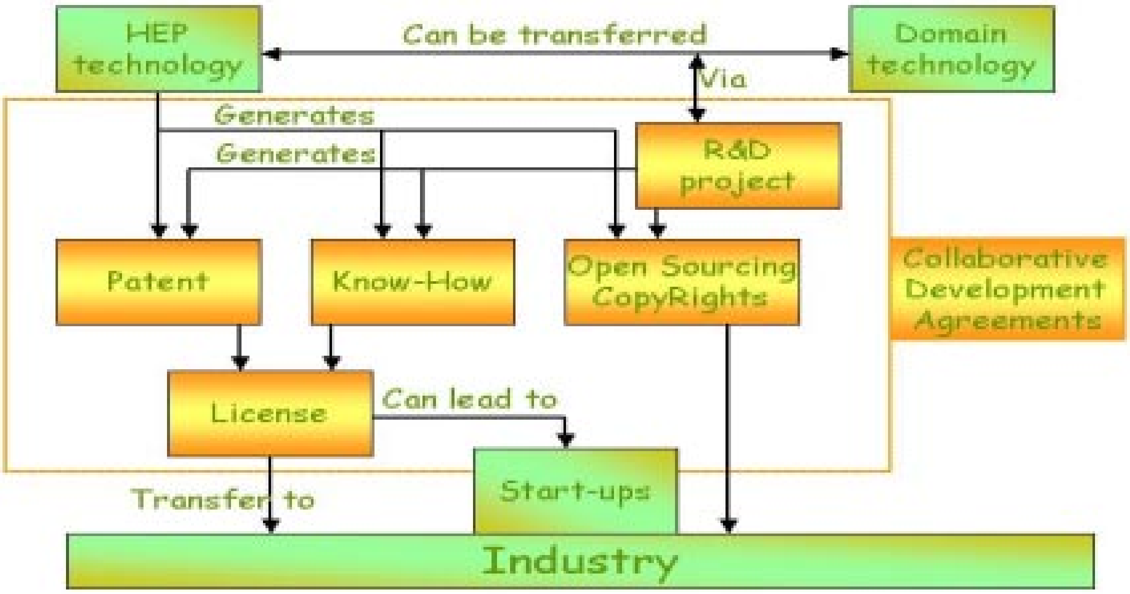

Fig. 2: The TT process at CERN

Fig. 2 gives a closer view on how the TT process works at CERN. While the HEP technology can generate by itself know-how (eventually protected through patenting) and consequently can lead to revenue-prone licensing to industry, the mechanism through which domains other than HEP can trigger a potential TT activity is through the establishment of R&D projects mostly externally financed.

The more recent projects are mandatorily regulated by formal agreements, and the TT Group is catching up with existing de facto collaborations from the past. An important reason for this approach relies on the need of carefully protecting the Intellectual Property (IP) of CERN and of the partners involved, since these activities most probably will lead to licenses to industry.

CERN has only quite recently started to set-up a coordinated TT activity, though TT has someway always taken place in the past.

The structures related to TT handling set-up by the recently formed ETT Division are:

- A Technology Transfer Group, in charge of carrying on all the TT activities
- A Technology Advisory Board, in charge of advising the DG on TT matters and of preparing strategy and policy recommendations
- An Internal TT Network, formed by a Divisional contacts with the task of identifying and promoting
- An External TT Network, formed by contacts in the Member States for TT promotion

One important tool, used both for dissemination to the external world and as a working instrument of the TT Group itself (which has a privileged access to it) is the Technology Transfer Database, which is a compendium of the TT activities of CERN [1].

As part of the learning and optimization process, the TT group makes a dedicated effort to explore how the issue is dealt with in other countries or in other research laboratories in the world, as well as by successful applied research companies.

One remarkable example of the former group, which is being carefully studied, is the one of the Weizmann Institute in Israel. There, the declared scope of the TT activity is to neatly separate the fundamental research from commercialization. To this end, a “non profit” company has been founded (more than 40 years ago!) charged with finding the right industrial partners to take the Institute’s discoveries through the critical steps from the laboratory to the marketplace. This company, to which the IP is transferred, optimizes revenues, though with certain constraints (e.g. never sell a patent, only license it). After cost deduction, the remaining profit returns to the Institute for funding further R&D activities.

An example of the latter group is a company next to CERN, GenProt, which originated as a start-up spawned by the University and Hospital of Geneva, funded entirely by external capitals (mainly pharmaceutical industries and computer manufacturers). All the results of the scientific research non commercially and readily exploited by the investors are publicly released. Start-up companies' creation is one of the tools for transferring to industry, as seen in Fig.2, though one not yet easily exploited at CERN.

III. OVERVIEW ON CERN TECHNOLOGIES

The TT Database contains more than 160 technologies presently being developed at CERN, which are in different phases of advancement. The patent portfolio includes more than 20 patents at present. Fig. 3 gives a view of how the technologies are distributed among the different domains.

It is remarkable that about one quarter are related to Information Technologies, but even more the fact that accelerators, magnets, vacuum, cryogenics and RF account for about 40% of the total: this is a clear indication of the impact of accelerator related developments, i.e. of the LHC effort, on the achievement of a proficuous technology transfer.

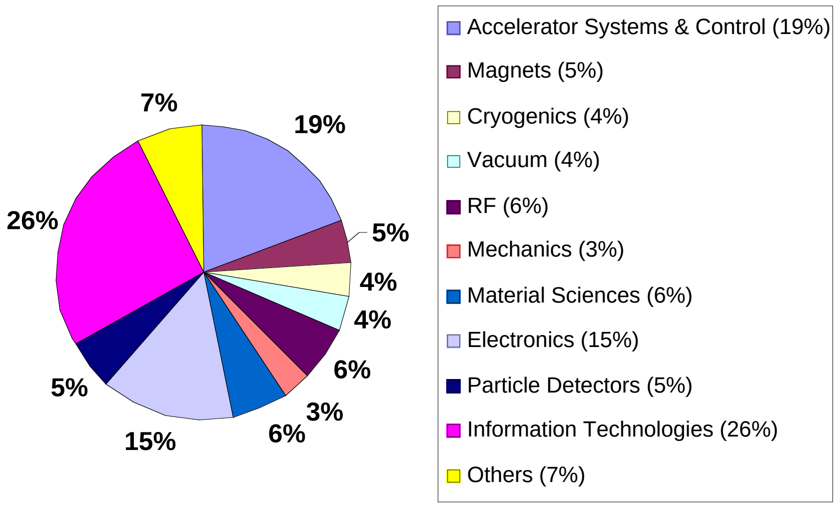

FIG. 3: DISTRIBUTION OF CERN TECHNOLOGIES

IV. SOME EXAMPLES

A close view at the different technologies would bring out of the scope of this paper, only few illustrative examples can be given.

Regarding patents, one concerns the Cryogenic Optical Fiber Temperature Sensor (realized by Walter Scandale of CERN Accelerator Division), a very cheap method based on the use of Brillouin scattering to measure temperatures down to 1.4 °K on thousands of measuring points utilizing a single optical fiber. This is a typical example of a technology originated by the work on LHC magnets and readily applicable to any other industrial field.

The LHC-driven research for improving the detectors, in this case the scintillators, has brought to a patent on the use of innovative LuAP crystals which can be directly applied also to PET scanners, thus providing an improved image sharpness. Around this work, in view of achieving a more effective transfer of the technology, a Europe-wide collaboration (Crystal Clear) has been formed, which joins the knowledge of many institutes beyond CERN in fields like electronics, data acquisition software. This collaboration is charged of handling all the CERN activities related to the development of PET scanners, and has already licensed some of its results to industry.

Examples of licensing of inventions include:

- the Neutron Driven Element Transmuter, conceived by Nobel Laureate and former CERN DG Carlo Rubbia, a method for production of radio-isotopes for Nuclear Medicine which can be implemented locally in Health Care sites and has been licensed to three European companies
- the Bath Electro-polishing of Titanium (by J.Guerin): it originated again from the needs of the accelerator construction, but has found applications in domains as

varied as polishing of turbine blades, of spectacle frames and orthopedic devices.

- the Non Vaporizable Getter (by C.Benvenuti), originated by the need of achieving very high vacuum in the accelerator pipes, and which has found application in domains as flat screen displays, cathode ray tubes, energy transportation and the like.

Electronics accounts for a large part of TT, and has always been a cutting edge activity at CERN. As for the detector developments (scintillators, gas and solid state), in the recent years our electronic circuits raised interest in non-HEP applications, which are mostly related to Medicine and Biology. Several collaborations formed around CERN groups owning the know-how for advanced electronics developments.

One of these is the Medipix collaboration, already acting since several years, which has spawned the use of VLSI single photon counting pixel detectors in mammography, general radiography and tomography. One chip (a 64x64 170 µm squared pixels device with controllable threshold and 15-bit counter) is already being used by industry in medical prototypes, an improved version (a 256x256 55 µm squared pixel device) is under test. At present, 15 Institutions work closely with CERN: while the IP on the electronics resides with CERN, the external institutes carry on the work on the associated detector design and characterization, and manage the transfer to industries in their home countries. The revenues to CERN from these activities have already allowed the funding of further developments.

Another R&D recently undertaken inside the EP Division is the development of Monopix, which aims at achieving single particle/photon detection with extremely low noise factors in a monolithic IC. This development has been covered by a patent since its inception, and was triggered by the needs of forthcoming second generation LHC experiments. The approach relies on the use of A-Si:H deposited on the ASIC, it aims at a low cost target, opens the possibility of wafer scale integration for large area detectors, has intrinsically high radiation hardness, and allows very thin implementations essential for vertex detectors in HEP. The potential spin-off of such a development has immediately become clear, covering domains like space (ultra sensitive 2D single photon imager), medical (X-ray detectors, biosensors) and industrial (material research).

V. LHC AND TECHNOLOGY TRANSFER: HOW EACH OTHER IMPACT

It has already been stated the importance of the LHC regarding the potential for technology transfer to industry and society in general. The examples given are just a few of a multitude.

One delicate aspect of the problem is however if the TT activity could affect the LHC and the core business of the Laboratory, which is HEP. To this end, a very clear policy is being followed, with respect to the funding and to the engagement of personnel. Namely:

- The R&D projects are accepted only if they prove to be synergic with LHC and future accelerators developments
- The TT activities can be carried on if cost free or if they bring revenues
- The existing staff personnel is mostly employed on supervision tasks, subject to Divisional approval
- Funds from external sources are to be used for material and extra manpower hiring

Care is also paid not to get involved in works which could configure themselves as an implicit competition with external industries: CERN is in no way a commercial service provider. And this reflects in the careful exploitation of the CERN tools, which have been acquired for research purposes only. A typical example is the use of the electronics design tools.

VI. FUNDING

Just to understand where some of the above mentioned CERN projects are with respect to funding and development activities, and referring to the diagram in Fig. 1, one can say that Monopix is in Phase 1, with an opening on research applied to specific domains but still funded mostly inside the HEP field, Medipix is in the middle of Phase 2 type of projects, where funds come from industry and partly form TT at CERN, while for example the Neutron Transmitter is entirely in Phase 3, being the object of exploitation by Industry and of start-up creation: all funding comes from industry.

As a rule, no HEP money is used for TT, and when this happens it is refunded. Sources of funding are revenues from licensing and collaborative agreements. It must be stressed that in the recent years a much more constructive policy has been undertaken by CERN to exploit funding from The European Commission (EC).

This has had the most important example with the DataGRID project, and continues today with the TT spawned MammoGrid project (an application to Medicine), and with the effort put in drafting Expressions of Interest (EoI) for the EC Sixth Framework Program.

One of them, in which CERN is a technical partner, relates to the realization of Ion-Therapy centers in Europe. This derives directly from the highly successful work made by CERN on the field of Hadron-Therapy (the PIMMS study).

The Laboratory has submitted two other EoIs. One of them (EGEE) is a natural consequence of the great GRID related effort of CERN, the other one (EuroMedIm), originated by the TT Group itself, supported by the EP Division and patronized by the DG, aims at constructing a Europe-wide Integrated Project tackling advancements in Medical Imaging instrumentation, based on ongoing R&D projects centered at the Laboratory.

This EoI has been co-signed by almost 80 institutions in Europe, 30% of which are industries. The very fact that all this happened is a proof of the overlap between HEP and TT developments, of the close relationship between European institutions and CERN, and of the relevance which industries attach to technological R&D carried on in a highly motivated and scientifically outstanding environment like CERN has always been.

VII. CONCLUSIONS

The ETT Division of CERN, through its groups among which the TT one, is trying to address issues like transfer of technologies to industry, dissemination of information among the people, making of tangible benefits to society.

These are ambitious tasks, and much has still to be improved and even learnt on how to proceed. But the actors in this game believe that a road has to be paved to a better world also through these tools. They trust that CERN, and the whole HEP community, want to be at the lead of this activity.

VIII. REFERENCES

[1] http://dbnetra01.cern.ch:9000/pls/ttdatabase/display.main