TECHNOLOGY TRANSFER AND RESEARCH PROJECTS

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Abstract

The funding scenario seems to improve based on the capability of a laboratory to generate technology that can be transferred to industry, in particular if the technology is of public interest. New research projects may benefit if the technology transfer is considered as an integral part of the project itself. The drawback could be that revenue generated by a successful technology transfer may give the impression that research projects only provide societal benefit by direct transfer through closed protocols. This paper provides an overview of different technology transfer projects worldwide and how different laboratories are dealing with the issue.

INTRODUCTION

Technology transfer is the process of transferring know-how, technical knowledge or technology from one organization to another for the purpose of further development or societal impact including commercialization.

There are three basic modes for technology transfer from public research to the business sector [1]:

- Non-commercial transfer through seminars, informal contacts, publications, secondments and staff exchange and training and open source and open hardware licenses.
- Commercial transfer involving collaborative research, contract research, consulting, licensing and sale of intellectual property and technical services.
- New company generation through direct spin-offs, indirect spin-offs and technology transfer companies.

Of these it is useful to keep in mind that only the latter two are conducive to the application of metrics. Typical metrics are numbers of research agreements, invention disclosures, patent applications, patent grants, licences executed, licence income earned and spin-offs established. Open modes of dissemination are not typically or easily included in these metrics.

Academic and research institutions engage in technology transfer to:

- co-develop new capabilities to support project goals
- utilise and promote a core competence
- attract and retain a talented faculty through enhanced community awareness – attracts students and further opportunities
- create local social or economic benefit
- attract government or industrial research support
- result in licensing revenue to support further research and education

Industry engages in knowledge transfer for similar but different reasons, such as:

- Allows expansion of the product line to reach new markets for economic growth.
- Increases base knowledge and capabilities to increase innovation potential.
- Expands the customer base and so allows new potential customers for core products.
- Allows access to state of the art infrastructures and technical and scientific expertise.

COLLABORATIVE RESEARCH

Collaborative research falls into a two general categories. In the first knowledge transfer can come directly from the pursuit of project or laboratory goals. A solution is to give suppliers access to IP and commercialization rights and in turn the vendor enhances their global competitiveness. In addition it could be advantageous to the laboratory to develop a local supplier of a generic technology like SRF cavity production. This benefits the supplier and the local economy by opening a new product line and future sales but also benefits the lab by creating a synergistic environment by creating a local technology hub that can attract Work for Others (WFO), students and professionals. Interlab WFO can help the lab support a standing army to support `in-house' operation and student education while developing local expertise.

In the second general category the Tech Transfer activity can come about as a by-product of the lab's main mission. Knowledge transfer can be driven by the desire to find applications of intellectual property generated by the lab while pursuing the goals of basic physics research. Researchers can apply for patents which can be promoted and lead to license agreements with industry. In converse industry may approach the laboratory and academia to help develop a raw idea into a product. In this case the lab can negotiate a license with revenue potential on future sales while expanding their core competence and building their reputation. Incubation funds to support the development of the product may be required.

It is clear that each party has different motivations and assumes certain risks and it is useful to keep this in mind. The company wants to expand its technical base in a new technology but without incurring financial hardship. Government incentive programs may help mitigate this risk. The institute wants to grow a local supplier but without risk to the project in terms of quality, schedule or reputation. For larger projects parallel development paths or multiple vendors can be considered. Schedules with realistic development times are required. It cannot be overstated that successful tech transfer does not happen by osmosis – it takes time and active engagement from experts on both sides.

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EUROPEAN ACTIVITIES

XFEL

At the heart of the XFEL project is the largest SRF linac attempted to date, requiring 100 cryomodules and 800 SRF cavities. In order to accomplish the goal XFEL worked with European partnering countries to develop industrial scale production. The cryomodule production was coordinated with CEA Saclay. A facility was established at Saclay (IRFU) and ALSYOM was engaged as a sub-contractor to provide the manpower with oversight by the Saclay experts. The cavities were contracted to two vendors, RI and Zanon. Each vendor upgraded their facilities with oversight from the project. Certified machines for production were developed by the project and given to industry. Throughout production there was close oversight from DESY and INFN. Many other parts required for the cryomodules including couplers and tuners were sourced in similar ways.

The project involves technology transfer between different institutes and also industry. The coordination effort should not be underestimated. The original budget estimate needs to take care of this [2].

Kyma

Kyma was established in 2007 as a spin-off company of Elettra-Sincrotrone Trieste, to design, realize and install all the 18 undulators of FERMI, the seeded FEL, at the time being built at the Elettra lab in Trieste, Italy. For Kyma establishment, Elettra-Sincrotrone Trieste formally transferred to the new company know-how and references relevant to the insertion devices with an estimated value corresponding to 51% of the shares. Kyma has become a well-known partner in the light source community. A notable example is the collaboration with Cornell on the CHESS compact undulators. The design, realization and installation of 18 undulators for FERMI was a significant `seeding' project that was important for the success of the start-up [3].

GSI-FAIR

The FAIR international particle accelerator is set to be one of the largest research facilities in the world. It is being built in a cooperation of an international community of countries and scientists. New challenges for industry and new chances for cooperation between FAIR and industry are being created. The FAIR GSI Industry Forum (FGIF) is a connecting element between the technological demands of research and the High-Tech industry. FGIF will be a marketplace for information concerning the GSI/FAIR-facility and serves for the increase of technology transfer between the partners of the forum and improves the connections to the universities.

Present statistics for GSI tech transfer are over 650 Property Rights, over 25 Validation Projects and over 20 Licensing Procedures have been completed. An example is the beam diagnostic ROSE [4]. ROSE is a standard slit grid emittance scanner. It uses one measuring plane which is rotatable around the beam axis. With a magnetic doublet it allows to determine the full 4d beam matrix in approximately 1 hour. A patent application for ROSE has been filed in Germany and the tech transfer office is currently searching for a validation partner.

CERN

The mission of CERN's Knowledge Transfer (KT) Group is to “maximise the technological and knowledge return to the Member States and promote CERN's image as a centre of excellence for technology”. Further, CERN’s IP policy states that societal impact shall have priority over revenue creation as a steering principle for KT activities [5]. This strikes at the heart of the open vs protected dissemination strategies which are a creative tension in tech transfer discussions in research institutes. CERN is increasingly sharing its knowledge through a variety of different commercial and non-commercial modes as well as new company creation.

Internally there is an emphasis in the need to educate scientists and engineers in entrepreneurship. Externally CERN has promoted a network of business incubation centres (BICs) of CERN technology – now with 8 BICs distributed throughout Europe. A small cross-section of CERN knowledge transfer activities are itemized below:

The miniature linear accelerator is a compact Radio Frequency Quadrupole (RFQ) proton linear accelerator operating at 750 MHz frequency with potential commercialization as part of proton therapy or isotope production system under a licence with CERN.

AMIT: a miniature cyclotron for PET isotope production is a collaboration between CERN/CIEMAT.

A SiPM-based detector module for breast imaging Crystal Clear Collaboration is a dedicated PET detector for breast imaging – ClearPEM.

PicoSEC-MCNet: development of ultra-fast photon detectors, in particular for application in time-of-flight PET and future high-energy physics calorimetry.

Medipix: a hybrid silicon pixel detector with many applications and five spin-offs created to date.

FLUKA simulation code: Commercial license agreements are being created typically in medical treatment applications.

CERN MEDICIS: an initiative developing new isotopes for medicine

ENTERVISION: A program to train young researchers in medical imaging techniques.

STFC – UK

The Science and Technology Facilities Council (STFC) is one of seven UK research councils. STFC was created in 2007 as an inherently cross-disciplinary organisation with a uniquely broad remit. STFC engages with research, business and innovation as part of their mission. STFC’s technology strategy is based around three strategic goals that encapsulate the underlying philosophy for this strategy:

- STFC will develop technology first and foremost to underpin STFC’s science and facilities;

- STFC will manage a technology programme encompassing blue-skies R&D to working systems;
- STFC will support exploitation technology developed for STFC's science and facilities for other applications and through industry.

ASIAN ACTIVITIES

Korea

RISP is a billion-dollar class project funded by Korean tax money. Superconducting cavity and magnet technologies are considered core technologies to Korean industries. RISP and domestic vendors are working collaboratively to master the technologies. Tech transfer has started to produce positive results. Superconducting cavities and magnets fabricated by domestic vendors well exceeded the design specification. RFQ fabrication is almost complete after the prototype was successfully fabricated by a domestic vendor.

China

Academia and industry establish joint institutes or centres to streamline technology transfer in China. NUCTECH is a vendor of equipment for cargo inspection. Fixed (9 MeV, TW or SW linac), relocatable (6 MeV SW linac) and mobile (s-band or x-band 2.5 MeV linac) systems are available. NUCTECH also has developed a dual-energy cargo inspection system capable of the material identification and fast-scan cargo inspection systems, which can scan 200-400 units of 40 ft containers per hour. A diagram of the Joint Iinstitute concept for product nucleation is shown in Fig. 1.

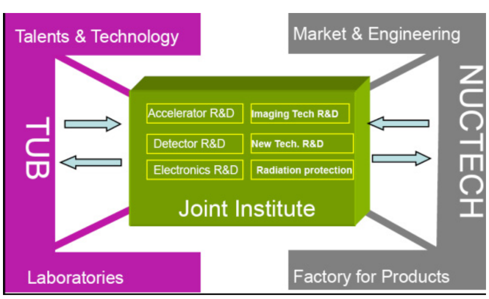

Figure 1: Collaborative joint institute between Academia (TUB) and industry (NUCTECH) in China.

Japan

Japan research projects have a long history of developing technology with Japan industry. Here we highlight a few examples from KEK. The KEK SRF group has recently completed two cryomodule projects in collaboration with IHEP in China and NSRRC in Taiwan. In the former two KEK-B modules have been completed for the BEPC-II collider. The project was supported by Core University Program of JSPS (Japan Society for the Promotion of Science). The collaboration developed under a lab to lab MOU with IHEP contracting with MELCO (Mitsubishi Electric Co.) with expert oversight from KEK. In the latter three KEKB-type SCRF modules have been completed for TPS at NSRRC, Taiwan. The collaboration developed with an interlab MOU, with NSRRC contracting with MHI (Mitsubishi Heavy Industry) to complete the cryomodules. In each case KEK lab infrastructure and expertise were used.

Japan has expressed strong interest in hosting the ILC and KEK is devoting infrastructure in the Cavity Fabrication Facility (CFF) and manpower to SRF developments towards production. The developments consist of benchmarking various techniques designed to reduce the cavity cost including large grain low RRR cavity production from ingot Niobium and hydroforming. They are also developing a new niobium supplier.

NORTH AMERICA ACTIVITIES

Technology transfer and technology partnering are significant mechanisms for DOE laboratories and facilities to engage non-Federal entities to advance technology development and commercialization. These arrangements leverage resources, providing for collaboration and cooperation between DOE and the private sector. Technology transfer includes - technical assistance to solve a specific problem, use of unique facilities, licensing of patents and software, exchange of personnel, and cooperative research agreements. Technology Transfer activities at DOE labs must ensure fairness of opportunity, protect national security, promote the economic interests of the nation, and prevent inappropriate competition with the private sector.

The DOE Accelerator R&D Stewardship Mission facilitates access to national laboratory facilities, develops innovative solutions to critical problems for both the broader user communities and the DOE discovery science community and broadens and strengthen the community that relies on accelerators and accelerator technology.

Laboratories commonly use the following mechanisms to partner with industry:

- Cooperative Research and Development Agreements (CRADAs)
- Strategic Partnership Projects (SPP)
- Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)
- Technical Service Agreements (TSA)
- Memorandum of Understanding (MOU)
- Facility User Agreements (proprietary and non-proprietary)
- Licensing agreements

Brookhaven National Lab

Brookhaven has had a long history of developing innovative technology from superconducting applications (MAGLEV transportation, YCBO fabrication), to medicine breakthroughs (PET reagent, L-DOPA), to thermoelectric power generators. BNL's partnering resources are a good example of support at the DOE laboratories for tech transfer activities and include:

Sponsored Research Office

- Manage Prep and Risk System

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- SPP, CRADA, and ACT proposals, agreements, funding, and contract administration
- Support entire Project Life Cycle from Prep and Risk through project close-out.

Business Operations
- Proposal Support; Point of Contact with BHSO, Budget Development
- Contract Administration, Project Management

Technology Commercialization and Partnerships
- Technology licensing, entrepreneurship and start-ups

Intellectual Property Legal Group
- Invention disclosures, patents, NDAs

Proposal Center
- Assistance in developing proposal strategy and in preparing a high-quality proposals that are responsive to sponsor's funding opportunities

Guide to Partnering with DOE's National Lab
- www.bnl.gov/techtransfer/docs/doing-business.pdf

Licensing Guide and Sample License
- http://techtransfer.energy.gov/LicensingGuideFINAL.pdf

Thomas Jefferson Lab

DOE's contract with JSA, which operates Jefferson Lab, permits Jefferson Lab to conduct research and development work for non-DOE sponsors as long as it is consistent with, and complementary to, DOE's mission. This work must not adversely impact or interfere with execution of DOE-assigned programs or place Jefferson Lab in direct competition with the domestic private sector. The lab has an entrepreneurial leave program that allows Jefferson Lab employees to take temporary leave to advance technology developed at Jefferson to commercialization.

A recent tech transfer project involved JLab's cryogenics group helping NASA scientists design and commission a cryogenics system for the James Webb Space Telescope to ensure that the telescope is fit for its mission. The plant cools the telescope's components to temperatures to within 30 degrees Fahrenheit of absolute zero, triples refrigeration system capacity of the current system and was the first built using the energy-saving floating pressure Ganni Cycle technology, developed at Jefferson Lab. The plant demonstrates a wide range of load temperature and capacity while maintaining peak efficiency and temperature stability.

Boron Nitride Nano-tubes (BNNT) technology has been developed at JLabs through research at the JLab FEL in collaboration with NASA Langley Research Center (LaRC) and National Institute of Aerospace (NIA). BNNT is lightweight, very strong, electrically insulating, and thermally conductive. It maintains strength to > 900^{o}C vs. carbon at 400^{o}C, is fibril with few defects, and no metal catalyst impurities compared to carbon (not fibril). Possible applications include biomedical scaffolding for living tissue, aircraft, aerospace, jet engine parts, fire retardant cabling, electrical insulation, athletic equipment and more.

JLab's nuclear physics detector technology has produced medical imaging capability with applications for breast cancer detection, prostate imaging, live small animal imaging for biological research, climate change research tools and high resolution lung imaging. Dilon Technologies, a start-up company, is producing a new type of mammography camera for global sale.

SLAC

SLAC's tech transfer office is active in pursuing the Accelerator Stewardship Mission of DOE. Two examples of the engagement are the GREEN-RF initiative and ASTFPP: Electromagnetic modeling for medical applications. The GREEN-RF project involves the development of high efficiency power sources for DOE-SC and industry. SLAC is partnering with CPI. GREEN-RF is an energy recovery concept for pulsed RF sources. The 45% SLAC 5045 klystron will be upgraded to over 60% efficiency. The collaboration has completed a conceptual design for radiation-cooled collector. The Goal is to fabricate a CPI klystron with GREEN-RF technology in 2016.

The medical EM modeling project uses high power computing to simulate electromagnetic propagation in human body for wirelessly powering implanted devices. The project combines the efforts of SLAC for parallel finite element electromagnetic modeling code suite ACE3P running on massively parallel computers, Stanford pioneering work in midfield wireless powering for miniature implanted devices and Simmetrix Inc. enabling technology in meshing for complex geometries. Thus far they have built a finite element mesh from CAD model of the whole human body consisting of 22 tissues.

FNAL

A major vehicle for tech transfer at FNAL is the Illinois Accelerator Research Center (IARC). The mission of the facility is to partner with industry to exploit technology developed in the pursuit of science to create the next generation of industrial accelerators, products, and new applications. The goal is to leverage accelerator expertise and technology created in the pursuit of science to create new accelerator applications and decrease the time to market of these new industrial solutions. There is a significant range of applications for electron accelerators in the 10 MeV range. Current industrial linear accelerator technology uses room temperature technology. The machines are by necessity pulsed to reduce wall losses to manageable levels with sizeable rf systems. Low energy (< 10 MeV), high power electron accelerators appear to be in broad need where emerging SRF technology can contribute. High average beam power industrial accelerators can create new capabilities relevant to security and environmental applications.

Dramatic breakthroughs in SRF technology in the last 2-3 years mean that adapting this technology for small, simple industrial accelerators is becoming possible. Advances that could be incorporated are Nb3Sn coated Nb cavities to permit operation of 1.3 GHz cavities at 4 K, conduction cooling from a commercial cryo-cooler to greatly simplify the cryogenics, economical rf power with an injection locked magnetron and a gun integrated into the cryomodule. A sketch of a 10MeV SRF based industrial linac is shown in Fig. 2. The unit could in principle operate at beam powers ranging from 5 kW to 50 kW. FNAL is in the process of patenting the concept.

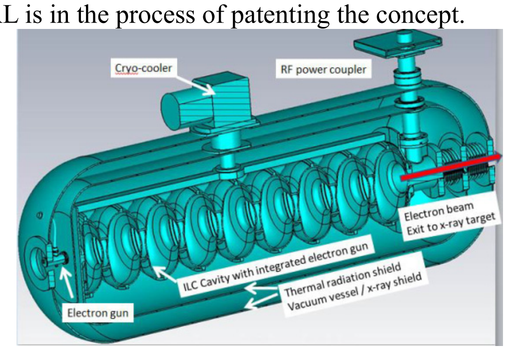

Figure 2: Sketch of a SRF industrial 10MeV linac (FNAL).

TRIUMF

TRIUMF is Canada's National Laboratory for particle and nuclear physics and accelerator based technology. TRIUMF's mission is:

- To make discoveries that address the most compelling questions in particle physics, nuclear physics, nuclear medicine, and materials science;
- To advance particle accelerators and detection technologies;
- To transfer knowledge, train highly skilled personnel, and commercialize research for societal benefit.

TRIUMF has created AAPS as a 100% TRIUMF-owned not-for-profit subsidiary to manage and promote commercial tech transfer. AAPS funding is primarily from licensing royalties, revenue from services and industry/government funded projects. TRIUMF still engages on non-commercial open access exchanges notably the engagement with PAVAC on the transfer of SRF technology. In that case the development of a local supplier of SRF technology was viewed as beneficial for the TRIUMF SRF program specifically and Canada in general. An initial order of 20 cavities for the ISAC-II program was the initial seeding project to launch a successful transfer. The TRIUMF/PAVAC partnership now enables external collaborations, each one an opportunity for expanding knowledge, capabilities and improving quality. Collaborations are of two variants: 1) Between TRIUMF and external lab (WFO) (VECC, RISP) with PAVAC as industrial supplier and 2) Contract between PAVAC and an external lab with TRIUMF assisting in some capacity (FNAL, MSU, IHEP).

AAPS manages the commercial licensing agreements. The commercialization pathways are through three mechanisms: 1) Products & Service – providing the benefits of TRIUMF technology as a service (e.g., irradiation, testing) or product (e.g., irradiated targets), 2) Licensing – Providing IP to companies in return for royalties and/or licensing fees (e.g., Nordion royalties, D-PACE), 3) Spin-offs – Creating a new company to commercialize technology (e.g., ARTMS for cyclotron based Tc-99m production). AAPS has developed five start-up companies since 2009.

FINAL THOUGHTS

Successful knowledge transfer takes effort and patience. A team mentality greatly aids the process. Take the time to educate industry beyond the metal and welding through workshops and meetings. Accept the opportunity to learn from each other. The collaboration between industry and a research lab is like a marriage – plan for the long haul. Assume that there will be problems along the way and be prepared to work together to solve the issues.

Knowledge transfer is still strongly linked to advancing technology to support on-going accelerator projects. Labs are engaging dedicated tech transfer offices and incubation centers to manage and advance the commercialization, IP protocols, licensing, collaborative agreements. There are many examples of open and controlled collaborations between lab, academia and industry: rf sources, diagnostics, detectors/imaging, insertion devices, SC magnet and SRF, industrial accelerators, medicine (therapy, isotopes), new materials, …

And finally as a community we should be cognizant of the trend to measure success against a limited set of metrics such as securing patents or achieving direct payment from license agreements. While easy to chart they do not fully reflect nor necessarily optimize the benefit to society. Our challenge will be to devise new metrics to help us gauge and optimize our real impact as we move forward.

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