

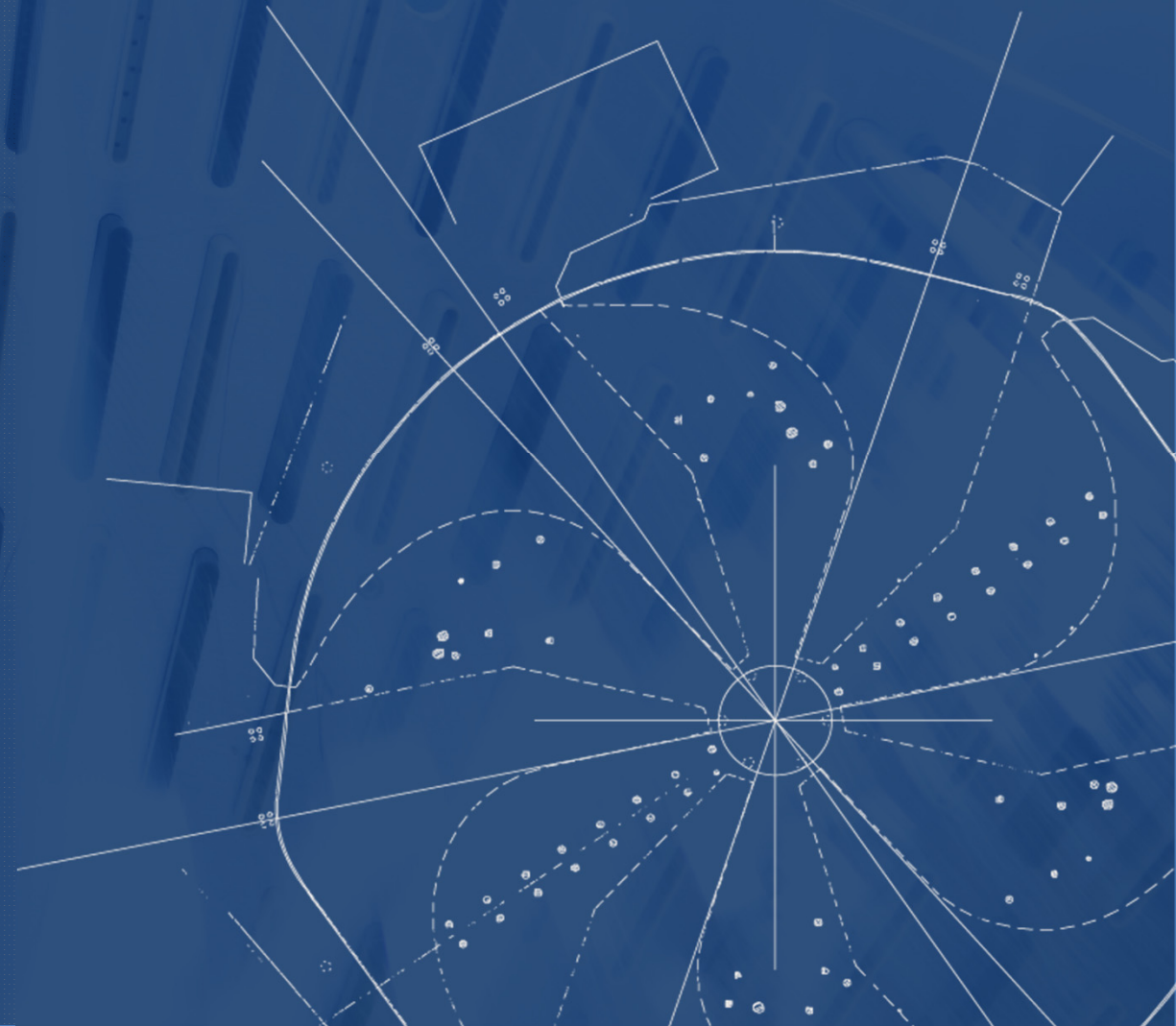


Canada's national laboratory
for particle and nuclear physics
and accelerator-based science

Technology Transfer and Research Projects

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IPAC, May 11, 2016

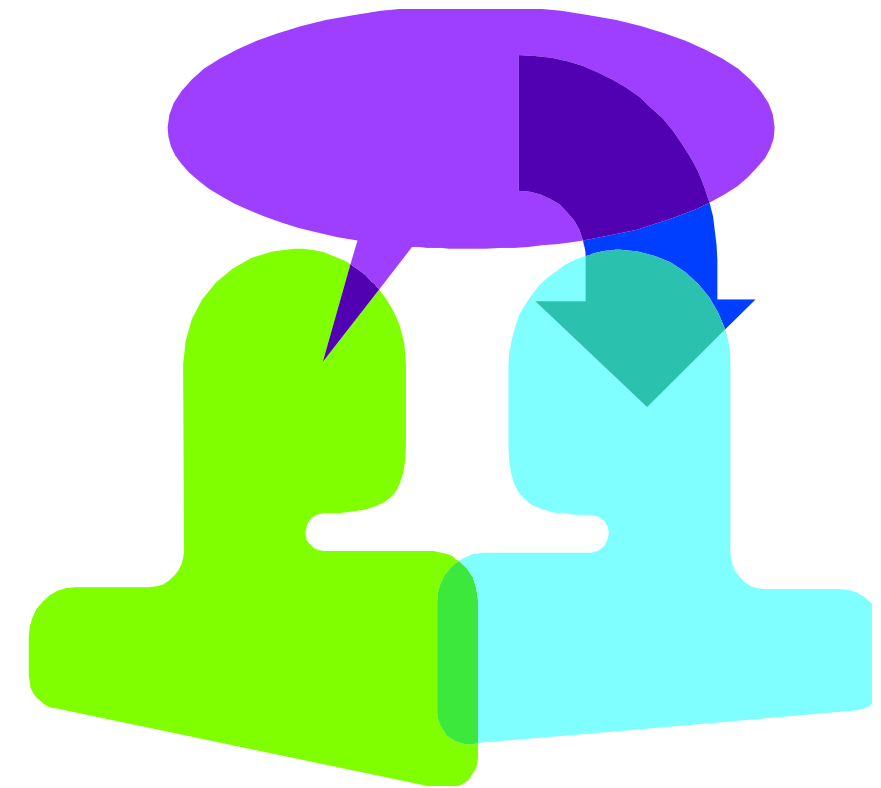


- Introduction
 - Tech transfer – what, how and why
- Examples
 - Europe
 - Asia
 - North America
- Final thoughts



Technology Transfer

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.

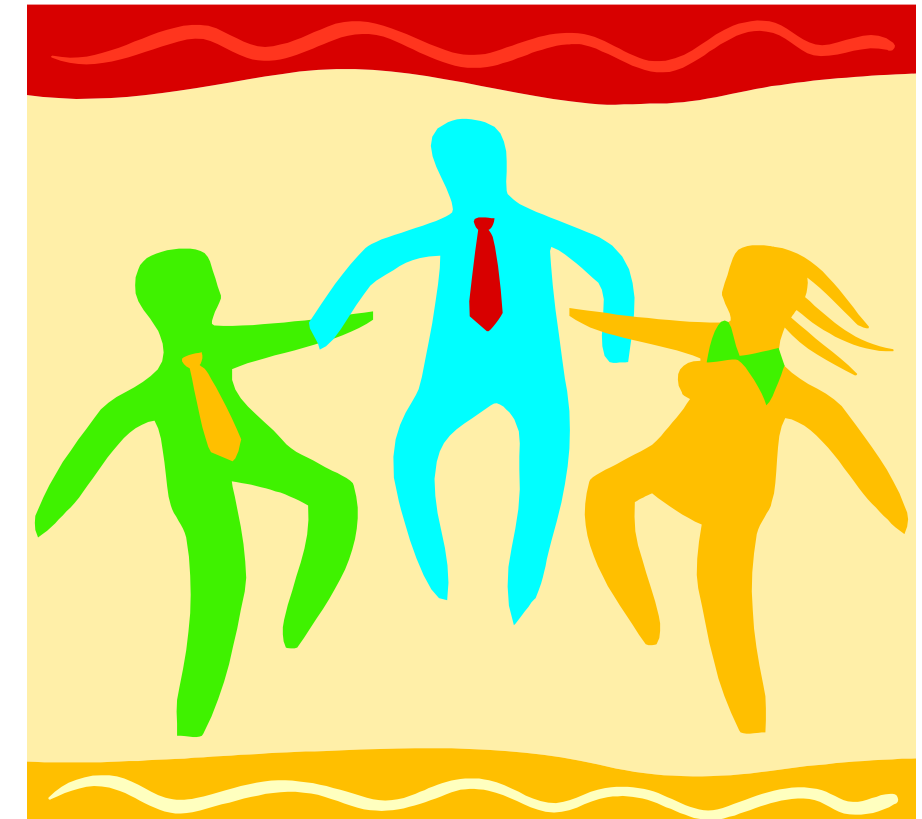


Mode of technology transfer	Metrics
Non-commercial transfer - seminars, informal contacts, publications, staff exchange and training – open source and open hardware agreements	- Not easily metered
Commercial transfer - collaborative research, contract research, consulting, licensing and sale of intellectual property and technical services	- \$ back to the institute - \$ growth of industry - # of agreements
New company generation - direct spin-offs, indirect spin-offs and technology transfer companies	- # of companies - \$ growth of industry

Nilsen, V., Anelli, G., Knowledge transfer at CERN, Technol. Forecast. Soc. Change (2016), <http://dx.doi.org/10.1016/j.techfore.2016.02.014>

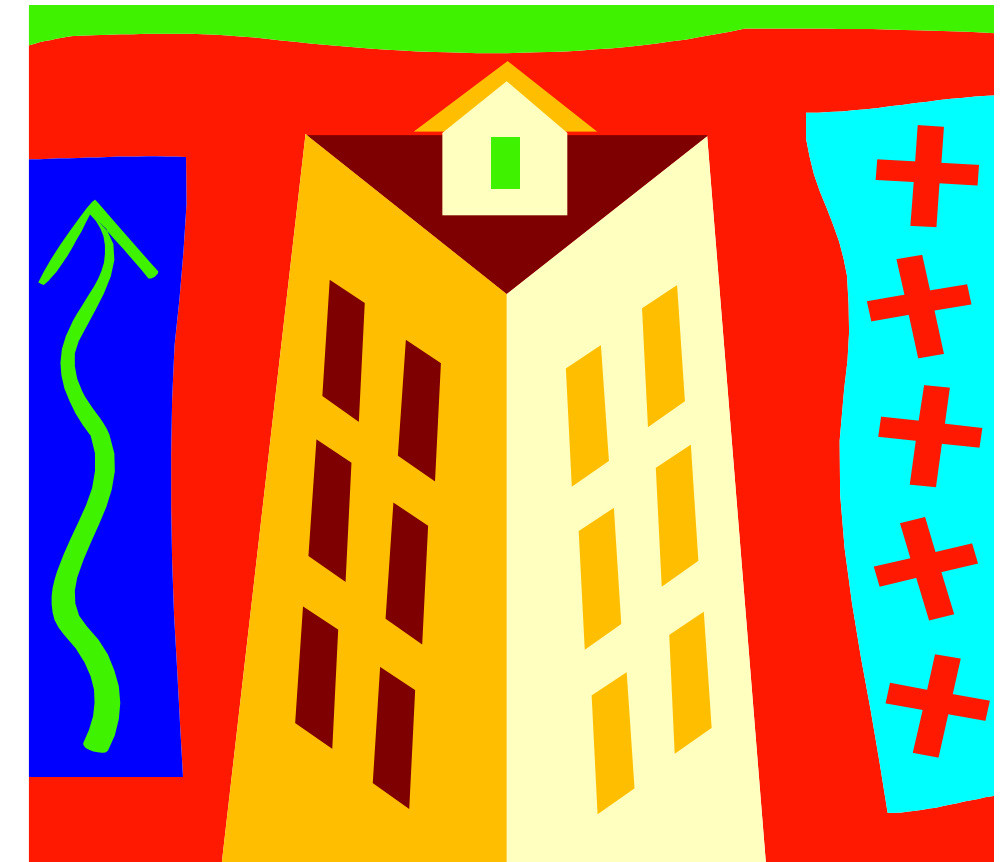
Academic and research institutions engage in technology transfer to:

- Utilise and promote a core competence
- Attract and retain a talented faculty and/or students through enhanced community awareness
- Create local social or economic benefit
- Co-develop new capabilities to support project goals
- Attract government or industrial research support
- Result in licensing revenue to support further research and education



Industry engages in tech 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



- Tech transfer can come directly from the pursuit of a project
 - Lab wants to develop new accelerator technology or capability → industrial partner gets access to know-how and/or IP and commercialization rights
- Tech Transfer activity can come about as by-product of the lab's main mission.
 - Researcher wants to find applications of lab IP → industrial partner wants to develop new product line
 - Industry wants to incubate idea requiring R&D → lab wants to expand core competence, get revenues



- It is clear that each party has different motivations and assumes certain risks
- The company wants to expand its technical base in a new technology but without incurring financial hardship
 - Consider government incentive programs
- The institute wants to grow a supplier or capability without risk to the project in terms of quality, schedule or reputation
 - For large projects consider parallel development paths (multiple concepts/vendors), schedule realistically

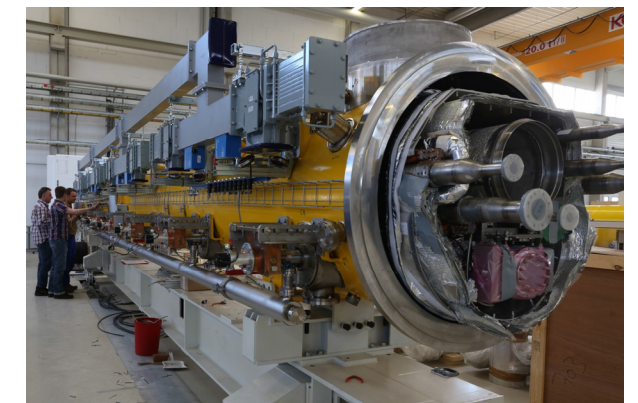
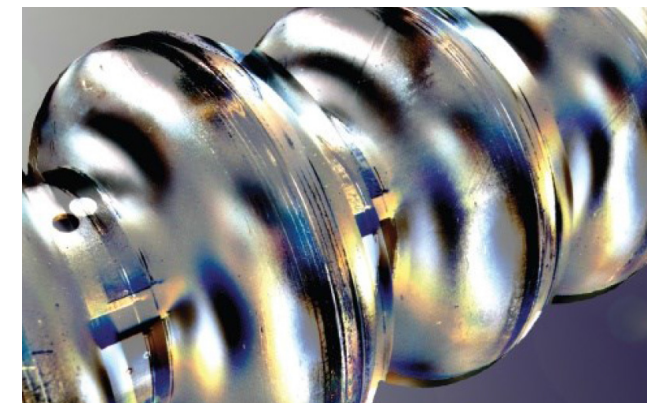


Successful tech transfer does not happen by osmosis – it takes time and active engagement from experts on both sides

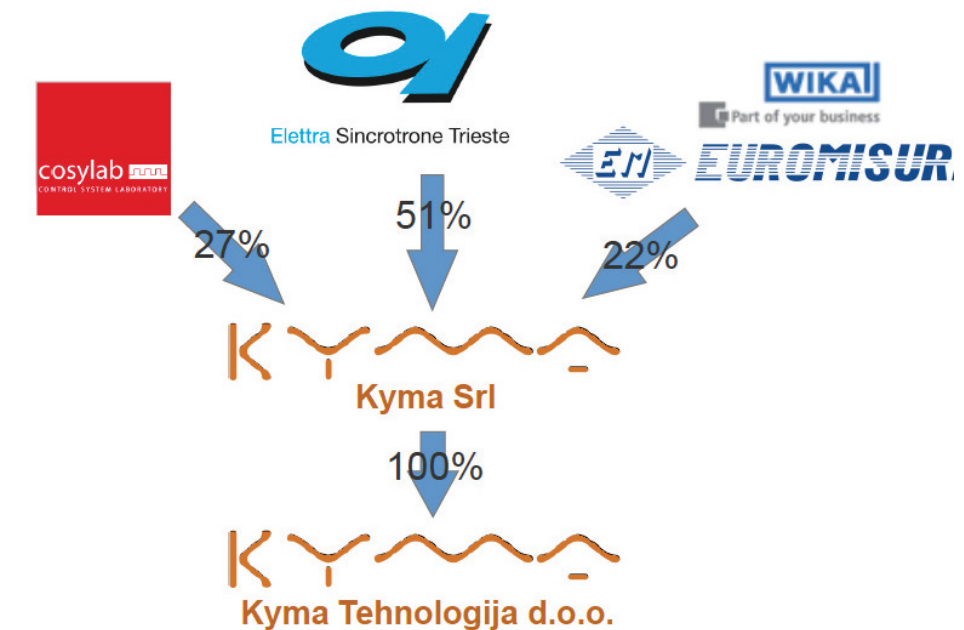
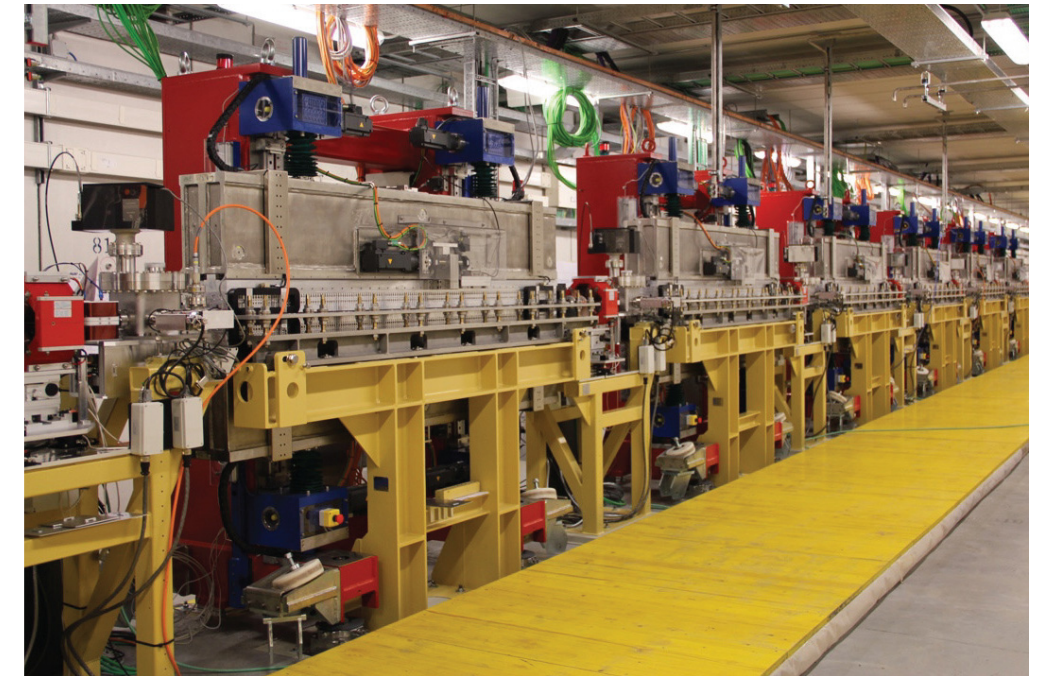
Europe

- XFEL requires 100 CMs and 800 cavities
- XFEL worked with European partnering countries to develop industrial production to meet the needs of the project
- CMs – CEA Saclay – ALSYOM
 - Facility built at Saclay (IRFU) – ALSYOM provided manpower
- Cavities
 - Facilities expanded at RI and Zanon with XFEL guidance
 - Certified machines were developed and given to industry
 - Close oversight by DESY and INFN
- Many more industrial components

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. (H. Weise IPAC14)



- Kyma was established in 2007 as a spin-off company of Elettra-Sincrotrone Trieste
 - Design, realize and install 18 undulators for FERMI
 - Significant 'seeding' project was important for success
- Elettra-Sincrotrone Trieste formally transferred know-how and references of Insertion Devices
 - Maintains 51% of the shares with two other industrial partners
- Collaborated with Cornell on new CHESS compact undulators



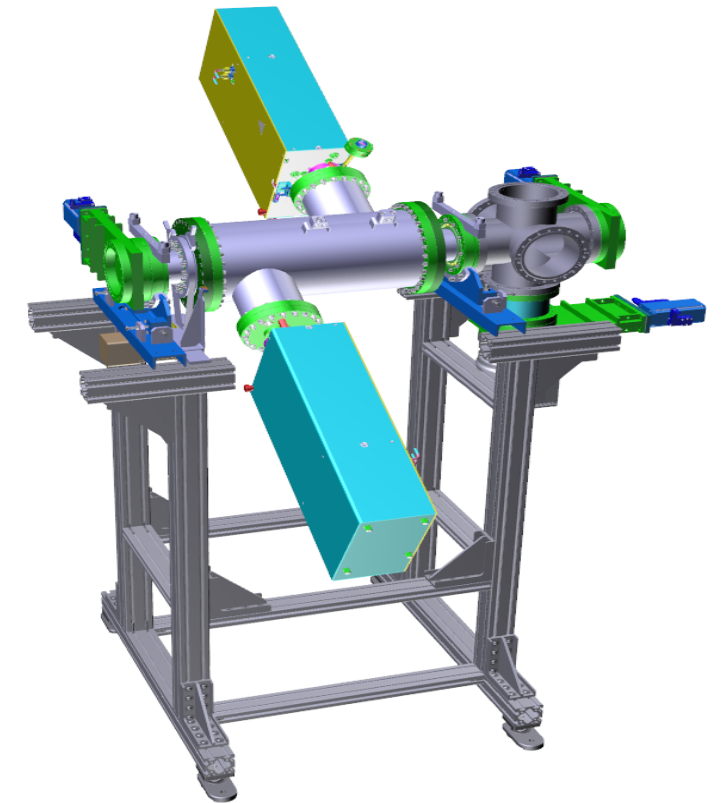
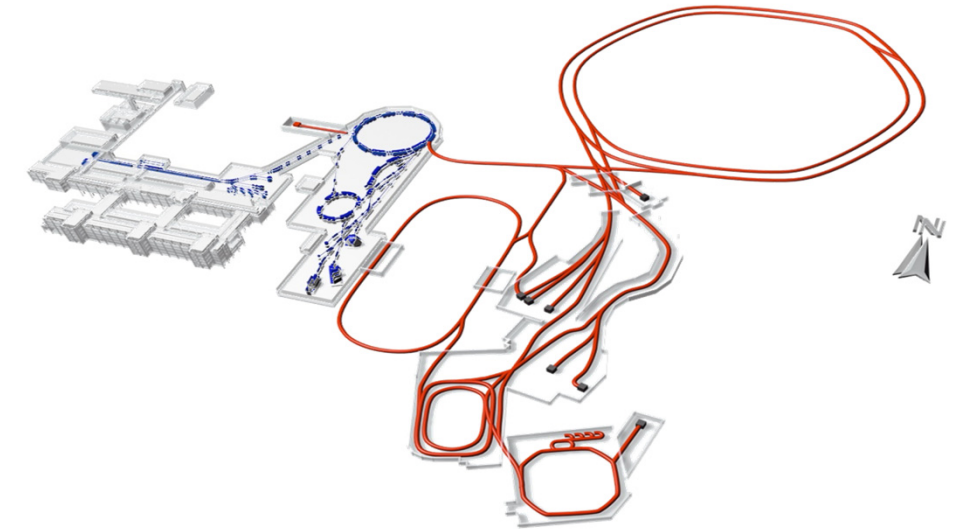
Facts and Figures

- over 650 Property Rights
- over 25 Validation Projects
- over 20 Licensing Procedures
- building the bridge between scientists and industry

Example: ROSE



- **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 approx. 1 hour
- Patent application has been filed in Germany
- TT is currently searching for a validation partner



ESS and tech transfer

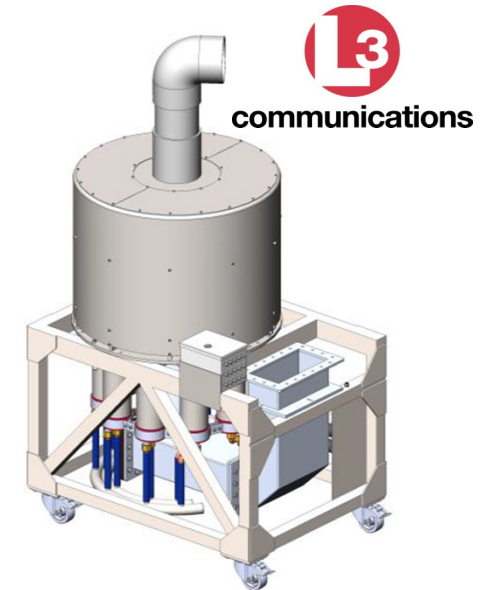
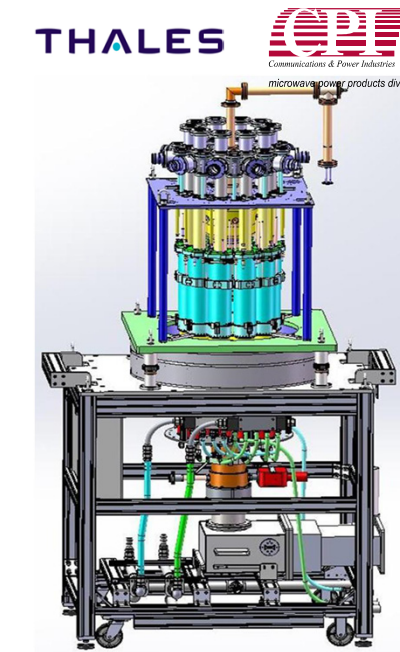
- The in-kind/collaborative nature of ESS has made it difficult to have a protected approach to technology transfer – IP is effectively open source or direct transfer

Pulsed IOT (project drives new technology)

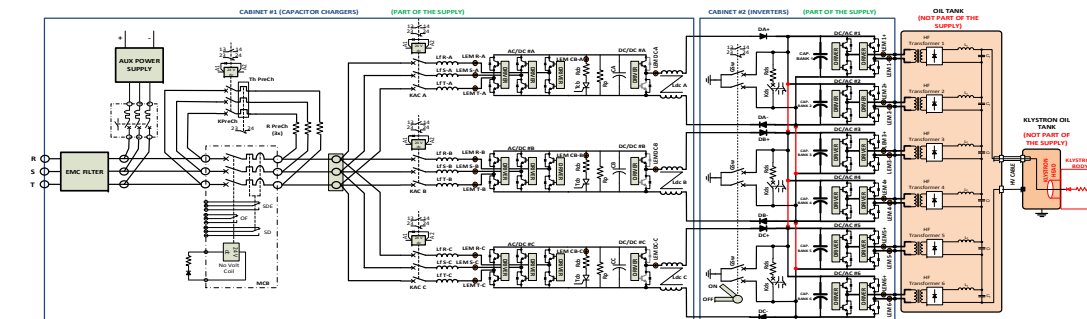
- ESS requires 1.2MW pulsed RF sources
- IOTs potentially offer significant advantages over klystrons:
 - Reduced space, Higher efficiency, Lower voltage**
- Two contracts were placed with industry to design and deliver two multi-beam IOTs as technology demonstrators

Modulator Development (ESS design)

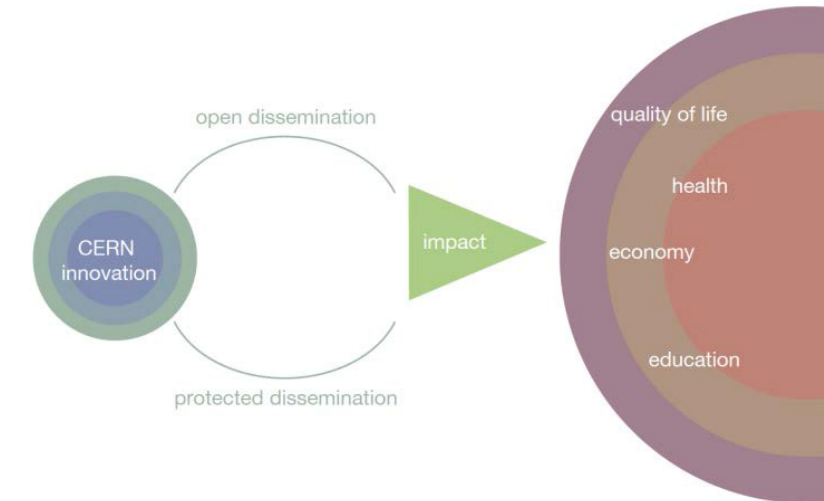
- Stacked multi-level 660kVA - very compact, very high long pulse quality and no disturbances fed back to the power grid
- ESS grants 'In Kind' partner the design free of charge but with non-exclusive rights - ESS to be recognized in promotions for future sales



Parameter		Comment
Frequency	704.42 MHz	Bandwidth > +/- 0.5 MHz
Maximum Power	1.2 MW	Average power during the pulse
RF Pulse length	Up to 3.5 ms	Max Repetition Rate of 14 Hz
Efficiency	Target > 65%	
High Voltage	Low	Expected < 50 kV



- The mission of CERN's Knowledge Transfer 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”
- CERN IP policy states that societal impact shall have priority over revenue creation as a steering principle for KT activities
 - **open vs protected dissemination**
- CERN is therefore increasingly sharing its knowledge through a variety of different commercial and non-commercial modes as well as new company creation.
 - Internally - need to educate scientist and engineers in entrepreneurship
 - Externally - a network of business incubation centres (BICs) of CERN technology – now 8 BICs



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



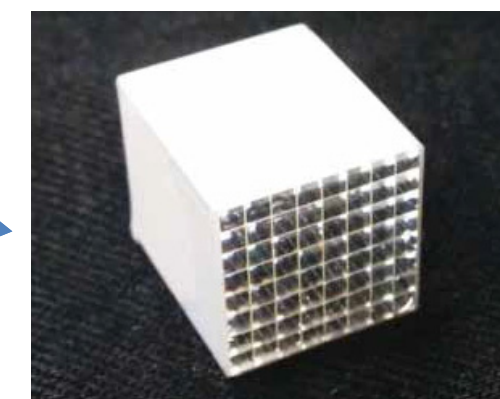
AMIT: a cyclotron small enough to fit into a hospital lift – CERN/CIEMAT collaboration



A SiPM-based detector module for breast imaging Crystal Clear Collaboration, a dedicated PET for breast imaging has been developed: ClearPEM

PicoSEC-MCNet: training on ultrafast photon detectors for medical imaging and high-energy physics - develop 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 – five spin-offs created



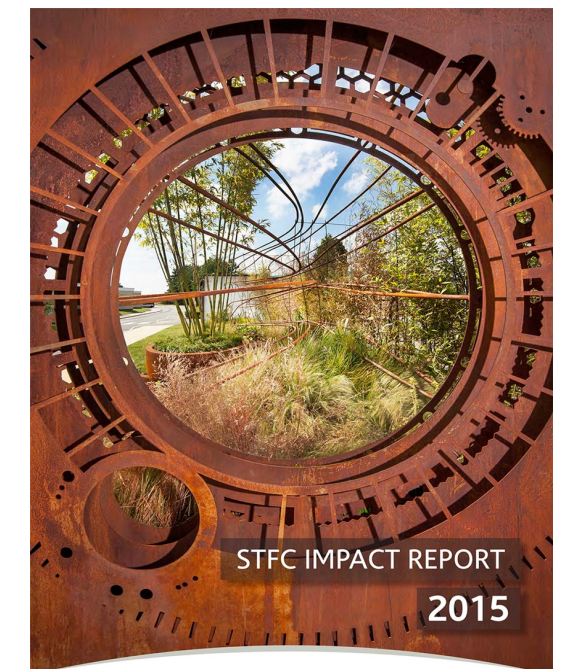
FLUKA simulation code: Commercial license agreements – typically in medical treatment application

CERN MEDICIS: producing radioisotopes for medicine

ENTERVISION: training young researchers in medical imaging techniques



- All STFC grant applications complete a ‘Pathways to Impact’ funding document.
- The STFC also run specific Innovation funding schemes designed especially to encourage academia to work with Industry on “de-risking” new technologies
- Areas of interest
 - Proton beam therapy <http://www.rdmag.com/news/2016/03/proton-imaging-helps-improve-cancer-treatment>
 - Satellite communication <http://gtr.rcuk.ac.uk/projects?ref=ST/N00230X/1>
 - Electron Beam therapy <http://gtr.rcuk.ac.uk/projects?ref=ST/H003703/1>
 - Laser measurement <http://gtr.rcuk.ac.uk/projects?ref=ST/I000526/1>
 - Outreach – Particle accelerators in cultural heritage
- Hosts STFC-CERN BIC
 - domains of 3D manufacturing, heating elements and nano-coatings.



Some examples – Asia

Project

- Construction of **two KEKB-type SCRF modules** for BEPC-II collider at IHEP, China.
- Supported by Core University Program of JSPS (Japan Society for the Promotion of Science)
- Interlab collaboration and IHEP contracted with **MELCO (Mitsubishi Electric Co.) –industry collaboration**

Project

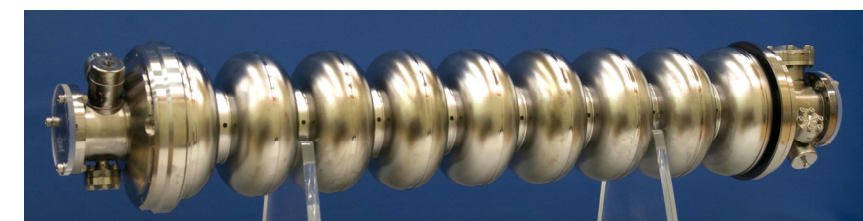
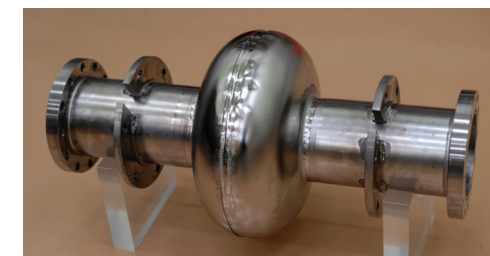
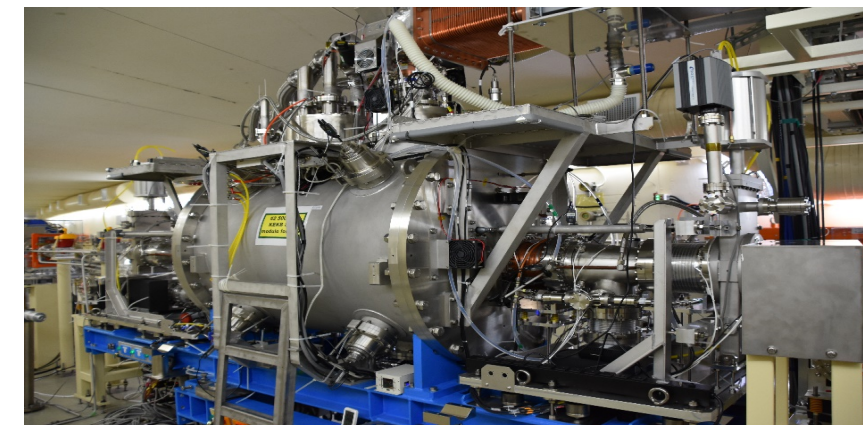
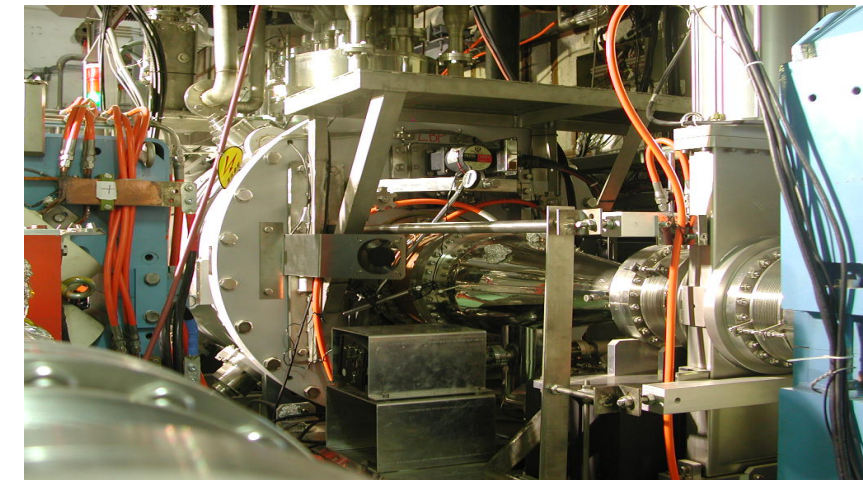
- Construction of **three KEKB-type SCRF modules** for TPS at NSRRC, Taiwan.
- Interlab collaboration and NSRRC contracted with **MHI (Mitsubishi Heavy Industry) – industry collaboration**

Project

- Cavity development for ILC
- Develop new techniques and vendors towards mass production

Project

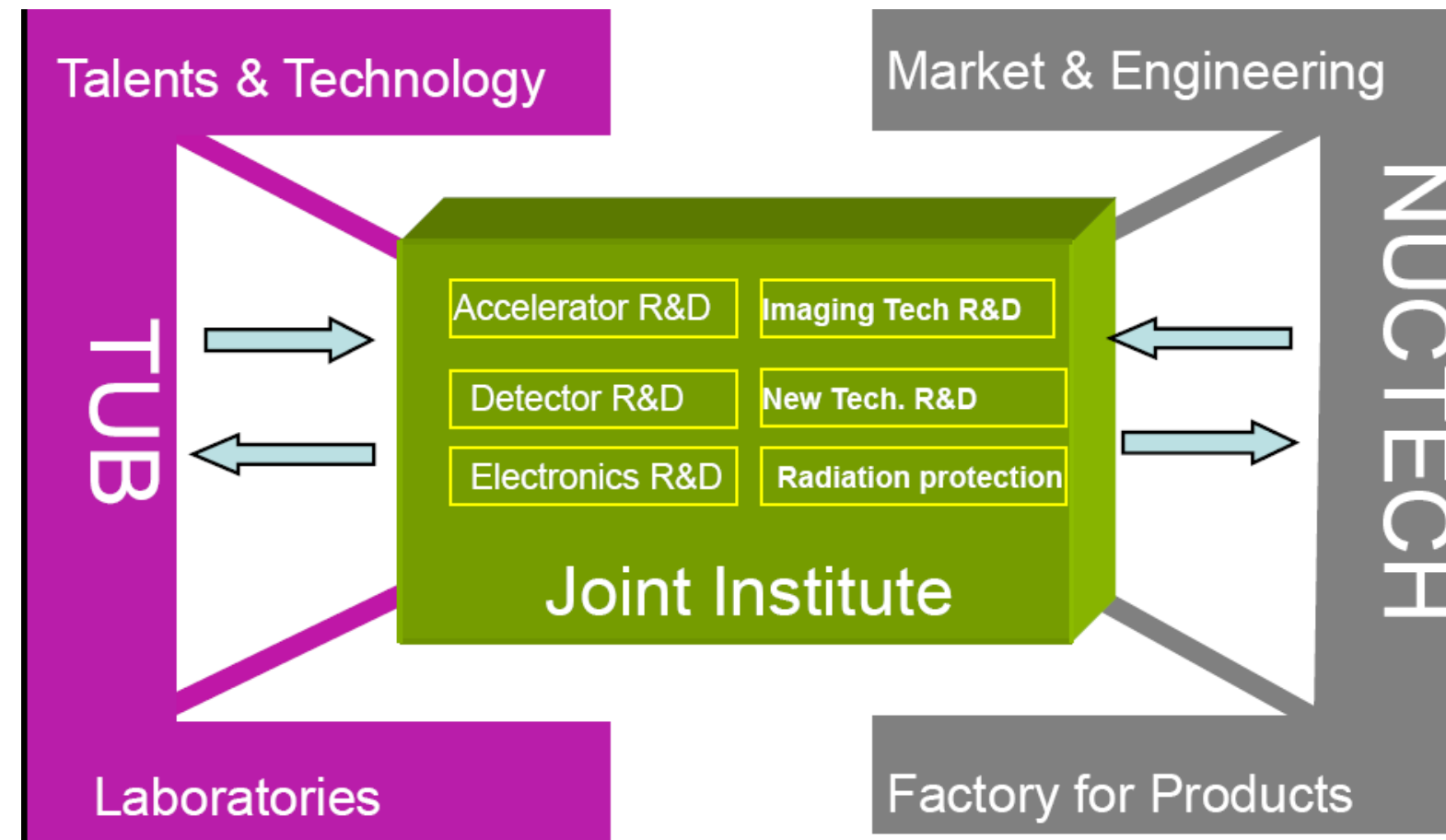
- SC magnet development for SuperKEK-B



The academia and industry establish joint institutes or centres to streamline technology transfer in China.

Example: NUCTECH is a vendor of equipment for cargo inspection.

- 2.5MeV – 9MeV e-Linac systems
- dual-energy cargo inspection system
- material identification of 200-400 units of 40ft containers per hour.



Tsinghua University and NUCTECH collaboration by establishing a joint institute.

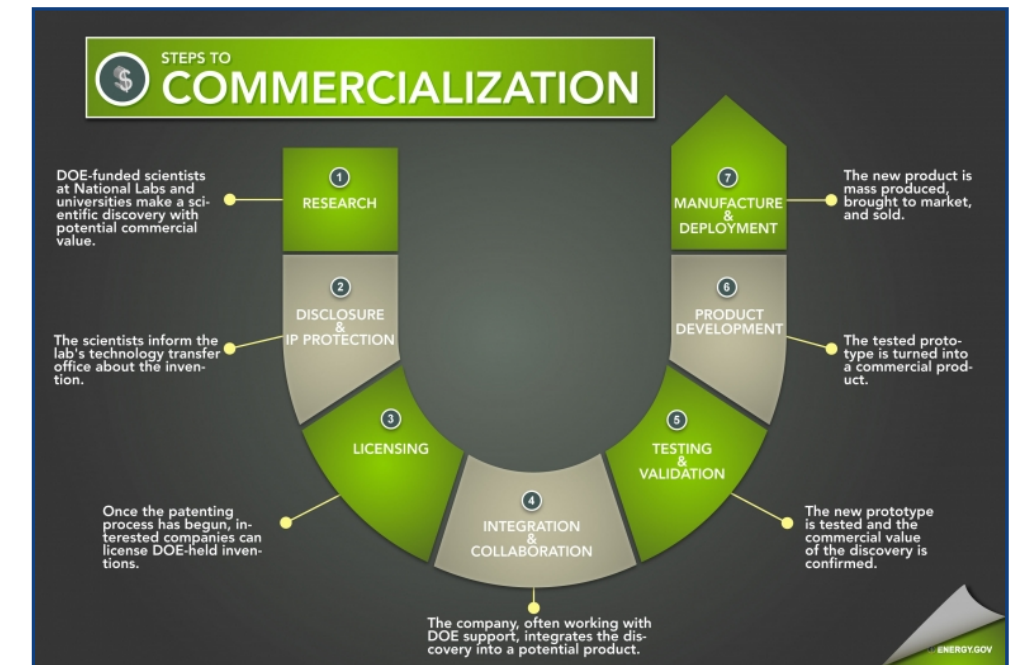
- RISP is a billion-dollar class Korean federal project.
- Superconducting cavity and magnet technologies are considered core technologies to Korean industries.
- RISP and domestic vendors are working collaboratively to master the technologies
- Technology transfer has started to produce positive outcome
 - Domestic SC cavities and magnets exceed specification.
 - RFQ fabrication is almost complete



North America

Commonly use the following mechanisms to partner with industry in USA:

- 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



Sponsored Research Office

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

<http://www.bnl.gov/partner/>

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>

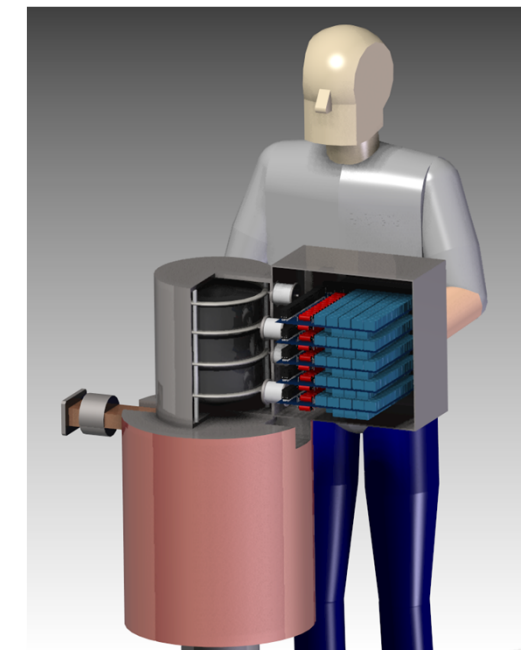
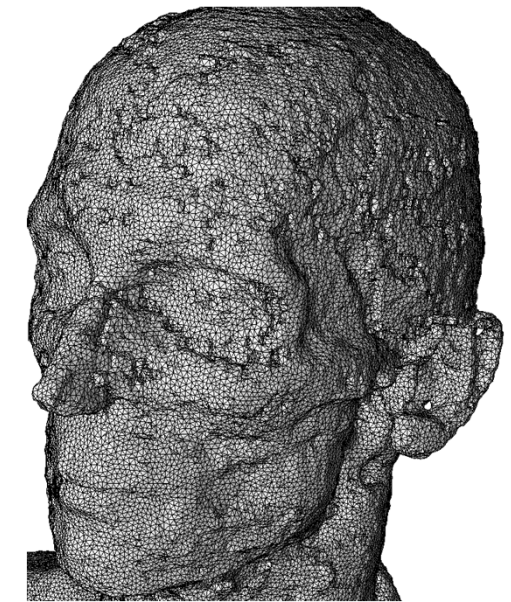


- Specialized expertise in cryogenics extended beyond accelerator domain – cryogenics system for James Webb Space telescope for pre-launch testing
- Boron Nitride nano-tubes - developed from research conducted at JLab's FEL in collaboration with NASA Langley Research Center (LaRC) and National Institute of Aerospace (NIA) - Lightweight, very strong, electrically insulating, thermally conductive



SLAC FY15 Projects

- Electromagnetic modeling for medical applications
 - Simulate electromagnetic propagation for wirelessly powering implanted devices in human body using high performance computing
- GREEN-RF: High efficiency power sources for DOE-SC and industry – 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
 - Goal in 2016 - Fabricate CPI klystron with GREEN-RF technology



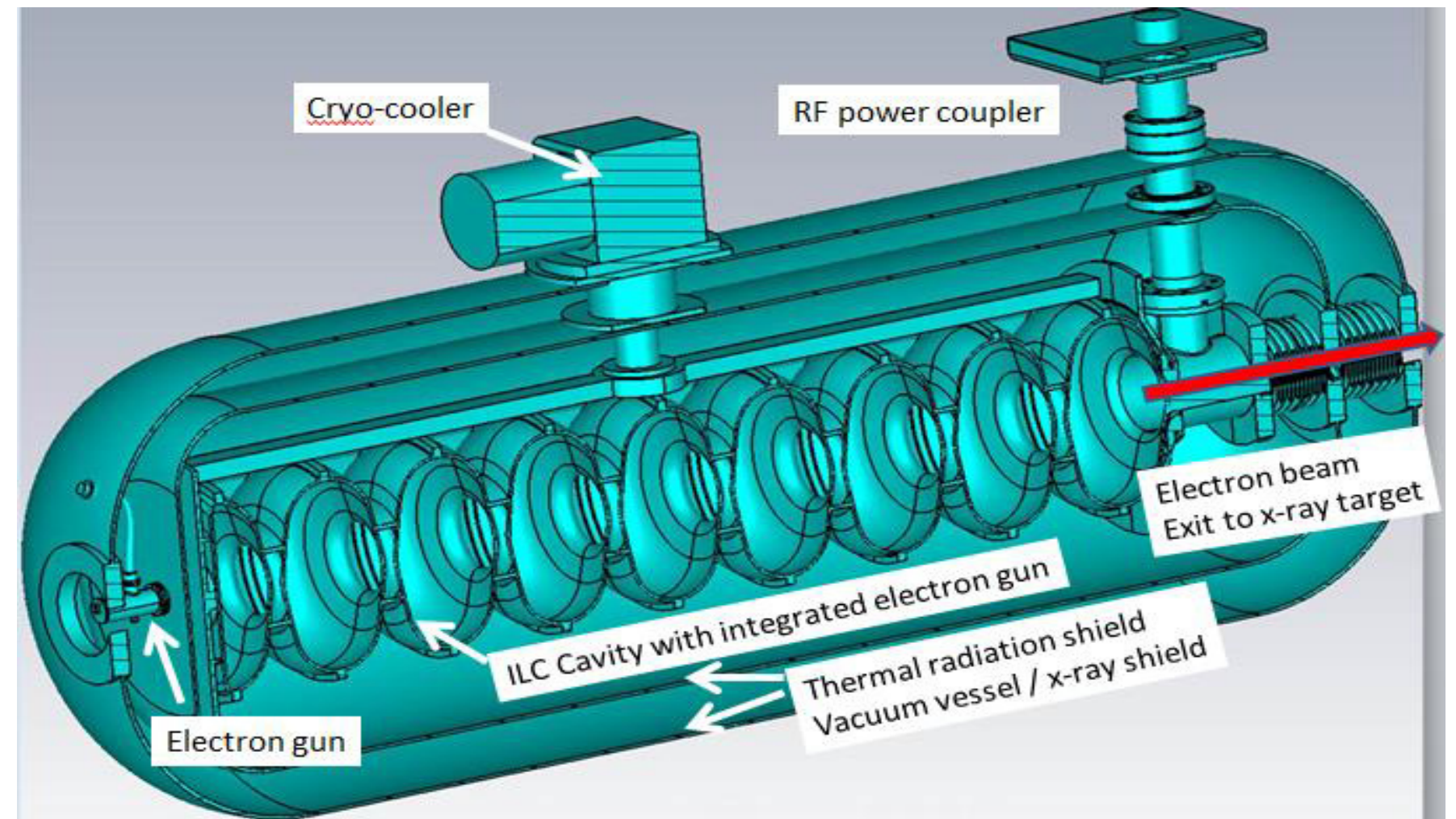


Joint DOE- Illinois DCEO Project

Technology incubator on the FNAL campus to leverage accelerator expertise and technology to create new accelerator applications and decrease the time to market

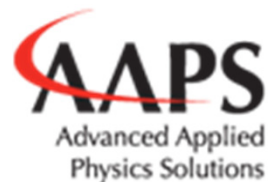
Example: Simple industrial SRF based accelerator

- Industry, mobile, or security applications
- Goal: Simple, turnkey operation, low cost
- A new class of SRF industrial accelerators
- Features
 - 10MeV – 5-50 kW
 - Nb₃Sn for 4K operation
 - 1.3GHz magnetron – cheap rf power
 - Cryocooler – simple operation
 - Integrated electron gun
 - Light weight – 3000 lbs

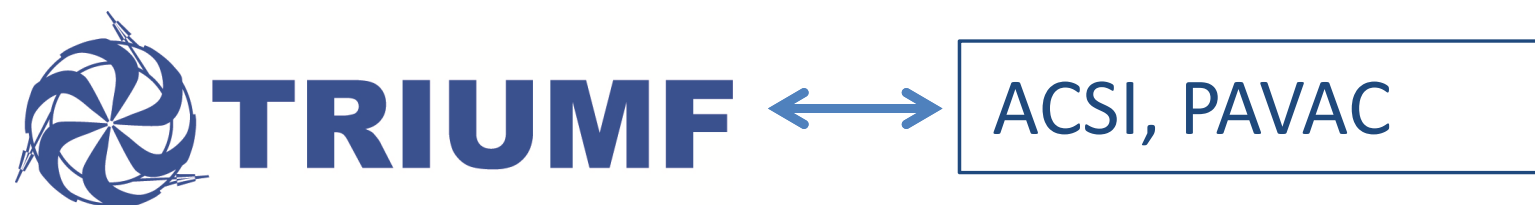




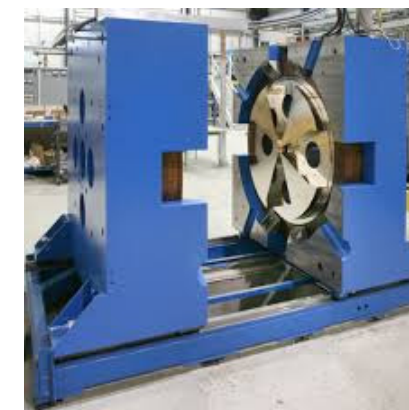
TRIUMF has a commercialization arm (AAPS) and tech transfer policies (guided by the National Research Council and TRIUMF's member universities).



- TRIUMF is Canada's National Laboratory for particle and nuclear physics and accelerator based technology
- Mission:
 - To make discoveries ... 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.
- AAPS is a 100% TRIUMF-owned not-for-profit subsidiary managing and promoting commercial tech transfer
 - AAPS funding is primarily from licensing royalties, revenue from services and industry/government funded projects.



SPIN-OFF
COMPANIES



2009 2011 2012 2013 2014



XRF calibration
standards and DLC
foils



“Shutter” technology
to reduce radiation
exposure



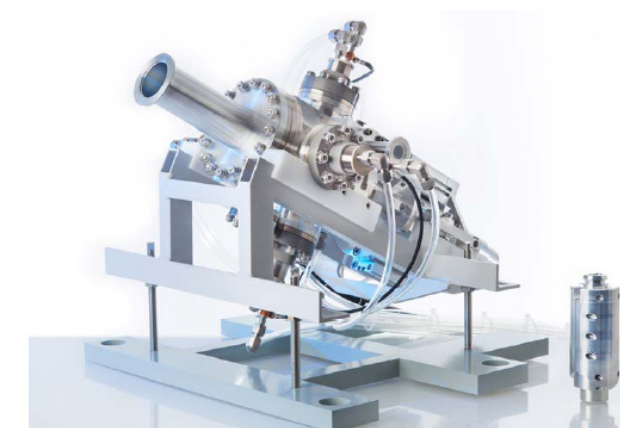
Muon
Geotomography
(mineral
exploration)



Cyclotron
based
Tc-99m
production

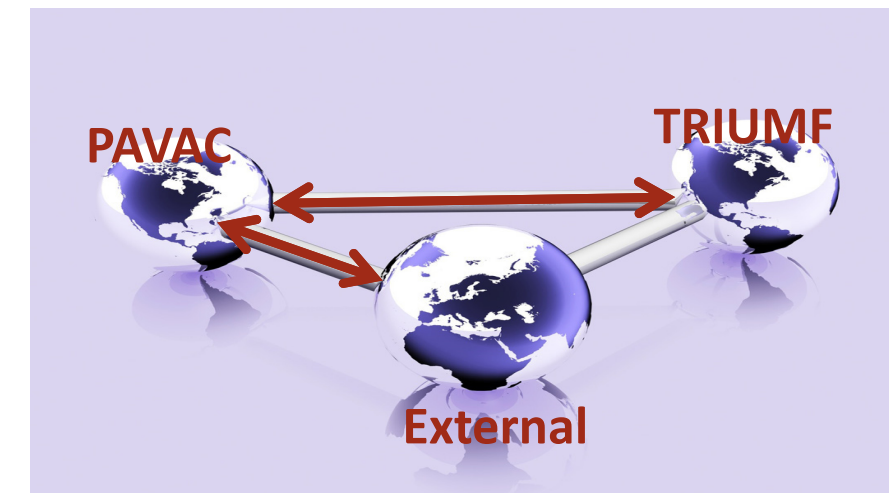
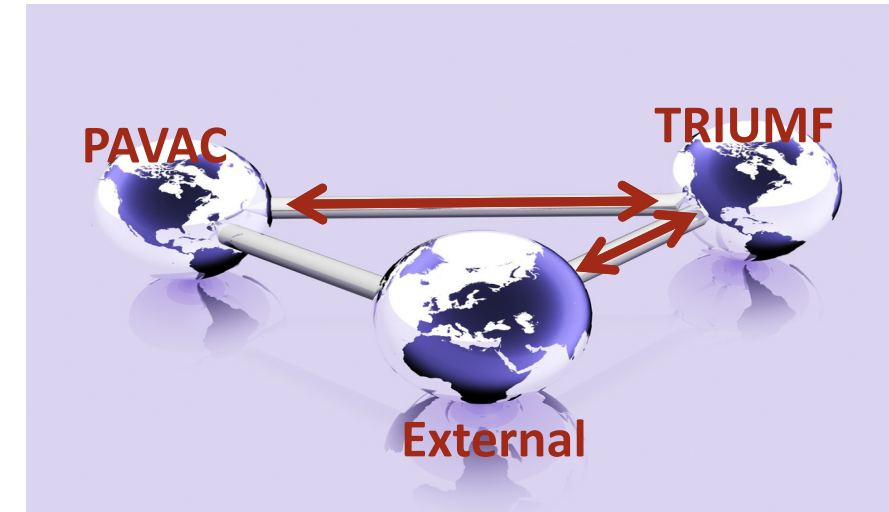


Well-logging
(oil & gas)



TR19 target assembly

- Seeded with order for 20 superconducting cavities for ISAC-II
 - Collaborative transfer of knowledge
- TRIUMF/PAVAC partnership now enables external collaborations – each one an opportunity for expanding knowledge, capabilities and improving quality
- Collaborations are of various types
 - Between TRIUMF and external lab (WFO) - **VECC, RISP**
 - Contract between PAVAC and an external lab with TRIUMF assisting in some capacity – **FNAL, MSU, IHEP**
- Future – transfer TRIUMF cryomodule technology to PAVAC with a licensing arrangement



Final thoughts

- Build a team mentality - take the time to educate industry beyond the metal and welding through workshops and meetings
- Accept the opportunity to learn from each other
- Practise trust - the collaboration between industry and a research lab is like a marriage – plan for the long haul



- 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, collaboration agreements
- 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, ...**



As a community we should be cognizant of the trend to measure success against a limited set of metrics – securing patents or achieving direct payment from license agreements – these do not fully reflect nor necessarily optimize the benefit to society – new metrics may be needed

- Special thanks to :
 - CERN – Giovanni Anelli
 - STFC – Peter McIntosh
 - BNL – Ilan Ben-Zvi
 - Jlab – Andrew Hutton, Drew Weisenberger
 - SLAC – Lia Merminga, Michael Fazio, Mark Kemp
 - FNAL – Bob Kephart
 - ESS – Mats Lindroos, Morton Jensen, Richard Hall-Wilton
 - RISP – DongO Jeon
 - TRIUMF/AAPS – Don Furseth
 - KEK - Akira Yamamoto, Eiji Kako, Masashi Yamanaka, Takaaki Furuya
 - GSI – Oliver Kester, Tobias Engert





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Thank you!
Merci!
감사합니다

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