Knowledge and technology transfer @CERN

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The electronic version of this HiLumi LHC Publication is available via the HiLumi LHC web site <http://hilumilhc.web.cern.ch> or on the CERN Document Server at the following URL: <http://cds.cern.ch/search?p=CERN-ACC-SLIDES-2014-0093>
KT: one of CERN’s missions

Knowledge Transfer

- Push back the frontiers of knowledge in nuclear research
- Develop new technologies for accelerators and detectors
- Train scientists and engineers of tomorrow
- Unite people from different countries and cultures

CERN

Research

Innovation

Education

uniting people

Matter
Molecule
Atom
Nucleus
Proton
Electron
Quarks
CERN’s areas of excellence

- Accelerating particle beams
- Detecting particles
- IT technologies
CERN Core Competences

- Superconductivity (13kA, 7MJoules)
- Vacuum (10^{-12} Torr)
- Cryogenics (1.9 K)
- Magnets (10 T)
- Very high performance detectors and electronics

Data processing
KT happens in many ways

Licensing
- CERN Open Hardware License
- CERN Easy Access IP

Service and consultancy

R&D Collaborations
- A network of Business Incubator Centers in the Member States
- EU Projects

KT through procurement

KT through People

The KT group helps making KT happen, and choosing the best dissemination channel.
CERN’s Technology Portfolio
NEG

Non-Evaporable Getter thin film coatings

Used to create and maintain ultra-high vacuum in accelerators by absorbing gas molecules in vacuum chambers

Have multiple other applications in addition to accelerators
Neg

Licenses to:

- SAES, which has developed the product IntegraTorr based on the NEG technology
- Italian company
Gas Electron Multipliers GEMs

- HV
  \[ R \]
  Copper
  Kapton
  Window
  Drift Region
  GEM Foil
  Induction Region
  Readout Strip
  Readout
Gas Electron Multipliers GEMs

- HV

R

Window

Drift Region

GEM Foil

Transfer Region

GEM Foil

Induction Region

Readout Strip

Readout

Knowledge Transfer | Accelerating Innovation

Italy@CERN, 08.10.2014
Gas Electron Multipliers GEMs

Invented by F. Sauli at CERN in 1997

The main advantages are high amplification gains and performance to a low cost

R&D Licenses to:
- INFN
- Laboratori Nazionali di Frascati
- ENEA
CDS – CERN Document Server

INVENIO
- Digital library or repository system

INDICO
- Software for planning meetings, workshops or conferences, and to store minutes

2 Licenses and 1 Service and Consultancy agreement in Italy
HPTDC

HPTDC
- **High Performance Time to Digital Converter**
- Precise time-tagging of electronic signals

CAEN - Costruzioni Apparecchiature Elettroniche Nucleari S.p.A
- Holds a licence to and has developed 3 different Time to Digital converters based on the HPTDC
Roxie

Routine for the Optimization of magnet X-sections, Inverse field calculation and coil End design

License to:
• INFN - Laboratori Nazionali di Frascati
Magnetic Measurement

Technology for measurement of quadrupole magnets with the rotating coil principle

Ansaldo Superconduttori SpA holds a license to the technology

Ansaldo developed and supplied magnets to among other CERN and CNAO

Measurement of quadrupole magnet
Recent cases

Collimator Material Collaboration
- Collaboration with company
- R&D on the processing, manufacturing, characterization and testing of advanced thermal management materials with high structural and thermal properties

Linac4 Drift Tubes
- License to LNL-INFN for the linac4 drift tube linac design and related patent
- Purpose of the agreement is for LNL-INFN to be able to manufacture drift tube linac for the European Spallation Source ESS

Large monolithic SiPMs with excellent timing
- Shared patent between CERN and INFN

Portable Radiation Survey Meter
- Joint ownership agreement between CERN and Politecnico di Milano
CERN Open Hardware Licence

A legal framework to facilitate knowledge exchange across the electronic design community.

In the spirit of knowledge and technology dissemination, the CERN OHL was created to govern the use, copying, modification and distribution of hardware design documentation, and the manufacture and distribution of products.
CERN OHL: it is making an impact!

- CERN OHL v1.1 Launched in 2011, great interest from the worldwide community
- More than 50 hardware designs licensed under CERN OHL
- More than 20 companies are using it
- The license is being used by people outside our community as well (and for any kind of hardware)
- Thanks to the interactions with the community, we improved the license and prepared v1.2
CERN Easy Access IP is a new opportunity to benefit of CERN’s Intellectual Property. The scheme involves making some of CERN’s technologies available free of royalties, released only to partners who can best develop them to benefit the economy and society. If you would like to know more about CERN Easy Access IP or other technology transfer opportunities, please contact CERN’s Technology Transfer Office.

The following technologies are available under the CERN Easy Access IP scheme:

**3D Magnetic sensor calibrator**

This is an innovative device for calibrating magnetic field with high resolution. The technology measures all three axes of the magnetic field, by performing a scan over the full unit sphere, independent of its orientation relative to the magnetic field. [read more]

**RF Waveguide Vacuum Valve**

This device enables low-loss RF power transmission in a waveguide across a gap, where a liftable instrument is positioned. [read more]

**Thermally insulatable vessel**

The Thermally insulatable vessel is a simple container system for hot substances, incorporating a temperature display within the vessel’s cap or lid.

The key element in this technology is an integrated infra-red thermometer developed with Micro-Electro-Mechanical systems on a common silicon substrate through micro fabrication technology. [read more]

**Multifunctional detector**

A multifunctional, versatile position-sensitive detector for measuring characteristics of a beam of particles. The technology consists of a microwire-based monolith that allows measuring non-destructively the spatial profile, divergence, and intensity of UV, x-ray, and charged particle beams, including antiparticles. [read more]

**Cryogenic optical fiber temperature sensor**

The technology consists in a simple and relatively cheap cryogenic temperature sensor, composed of an optical fiber and a Brillouin spectral analyzer for measuring one or more temperature dependent Brillouin scattering parameters. [read more]

Easy Access IP was first trialled by Easy Access Initiative®, a collaborative project between the University of Glasgow, King’s College London and the University of Bristol.

CERN Easy Access IP Exclusive Licence agreement
CERN Easy Access IP Non-Exclusive Licence agreement
Collaboration on Hadron Therapy

![Graph showing relative dose vs. depth for different particles: Electrons (21 MeV), Carbon (280 MeV/u), Photons, and Protons.](image-url)
Hadron Therapy
Hadron Therapy

Hadron beams are more effective than X-rays in destroying tumors while sparing healthy tissues nearby.

New treatment opportunities for deep-seated tumors
CNAO

CNAO started treating patients with proton beams in September 2011

Ion Beam Therapy and Research Center

Protons ($^1\text{H}^+$) and carbon ions ($^{12}\text{C}^{6+}$)
CNAO– CERN Contributions

PIMMS - Proton-Ion Medical Machine Study
- 1996-2000
- MedAustron and TERA Foundation (Italy) study on design of cancer therapy synchrotron hosted by the PS Division at CERN and also collaborating with GSI.

CERN participated in the design and construction of the CNAO accelerator complex, notably with the magnets, the radiofrequency cavity, dipole measurements and beam diagnostics.
ENLIGHT
CERN philosophy into health field

- Common multidisciplinary platform
- Identify challenges
- Share knowledge
- Share best practices
- Harmonise data
- Provide training and education
- Innovate to improve
- Lobbying for funding

Coordinated by CERN

> 150 institutes
> 400 people
> 25 countries
(with >80% of MS involved)
ENLIGHT platform projects

• Marie Curie Initial Training Network
  • 12 institutions
  • 29 trainees

2008-2012

• R&D on medical imaging for hadron therapy
  • 16 institutions

2010-2014

• Infrastructures for hadron therapy
  • 20 institutions

2009-2014

• Marie Curie ITN
  • 12 institutions
  • 16 trainees

2011-2015

Knowledge Transfer | Accelerating Innovation
KT implementation ways

- Transfer to Existing Companies
- Creation of New Companies

Pull vs. Push:
- Market Pull
- Technology Push

Spin-Off Support
Knowledge Transfer | Accelerating Innovation

CERN Business Ideas Accelerator

CERN Pre-Incubator

- CERN STFC BIC
- NIKHEF CERN BIC
- NATIONAL BIC
- NATIONAL BIC
- NATIONAL BIC
Knowledge Sharing under FP7

7th Framework Programme for Research and Technological Development

CERN has taken part in 28 and coordinated 18 FP7 projects with partners from the Italy.

These projects have had 45 Italian participants, taking part in an average of 2 projects each.

INFN was the most active participating in 25 projects.
Knowledge Sharing under FP7

For FP7 projects where CERN is a coordinator or partner Italian beneficiaries got 41M euro in funding from the commission and provided matching funding of 28M euro.

- From the European Commission 41M€
- Matching funds from the partners 28M€
Knowledge Sharing under FP7

EuCARD² Enhanced European Coordination for Accelerator Research & Development

EuCARD-2 is an Integrating Activity Project (IAP) for coordinated R&D on Particle Accelerators. It will contribute to positioning European accelerator infrastructures at the forefront of global research.

The project has 40 partners from 15 European countries, including Russia.

Politecnico di Torino and INFN are Italian partners in EuCARD-2
Knowledge Sharing under FP7

HiLumi LHC is part of an overall project that will federate efforts and R&D of a large community towards the ambitious HL-LHC luminosity upgrade of the Large Hadron Collider.

The project has 15 beneficiaries, 13 from Europe, one from Russia and one from Japan, in addition there are several associated partners from the US.

INFN is the Italian beneficiary in this project.
Knowledge Sharing under FP7

In the frame of these projects new composite materials are being developed, with industry, to achieve unprecedented thermo-mechanical and electric properties.

Brevetti Bizz and CERN has developed new materials with:
- Very high Melting Point
- Low Density
- Outstanding Thermal Conductivity
- Very low Thermal Expansion
- Good electrical conductivity
- Fair Mechanical strength
Potential applications of these new materials are:

- Thermal management for high power electronics
- Solar energy applications
- High temperature aerospace applications
- Advanced braking systems
- Fusion engineering
Long MgB$_2$ electrical transfer line

In the frame of Hilumi-LHC, CERN and Columbus Superconductors, located in Genova, have developed record breaking electrical transmission lines.

The superconducting transmission lines produced by Columbus obtained a world record current of 20 kA at 24K in two 20m long cables made of MgB$_2$.

This result makes the cables a potential viable solution for long-distance power transmission.
Long MgB$_2$ electrical transfer line

Partly performed in the frame of a collaboration agreement between CERN and IASS (Institute for Advanced Sustainability Studies) in Potsdam

One work package in the FP7 project Best Paths that is starting soon will focus on this application of the SC links of HiLumi

The main partners in this WP are: KIT (DE), IASS of Potsdam (DE), Columbus Superconductors (IT), Nexans (FR) and RTE (FR)
Knowledge Transfer through Procurement

Results from a survey of companies involved in technology-intensive procurement contracts with CERN. 178 questionnaires analyzed, related to 503 MCHF procurement budget.

Results:

- 44% indicated technological learning
- 42% increased their international exposure
- 38% developed new products
- 36% indicated market learning
- 13% started new R&D teams
- 52% would have had poorer sales performance without CERN
- 41% would have had poorer technological performance
Knowledge Transfer through People

Every year, hundreds of students come to CERN to contribute to our research programs.

An opportunity for young people to learn in a multicultural environment.

Not only for physicists! Also engineers, computer scientists, administrative students…
Students and fellows selected from Italy
National Teacher Programmes

One week on high-energy physics and applications for high school teachers at CERN

Provided in language of the participants

Bringing particle physics and modern research closer to schools

5 sessions of the Italian teacher programme have been arranged, training a total of 234 teachers

Participants in the CERN teacher programme observe particle trajectories in a cloud chamber they have built
More info / Contacts

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