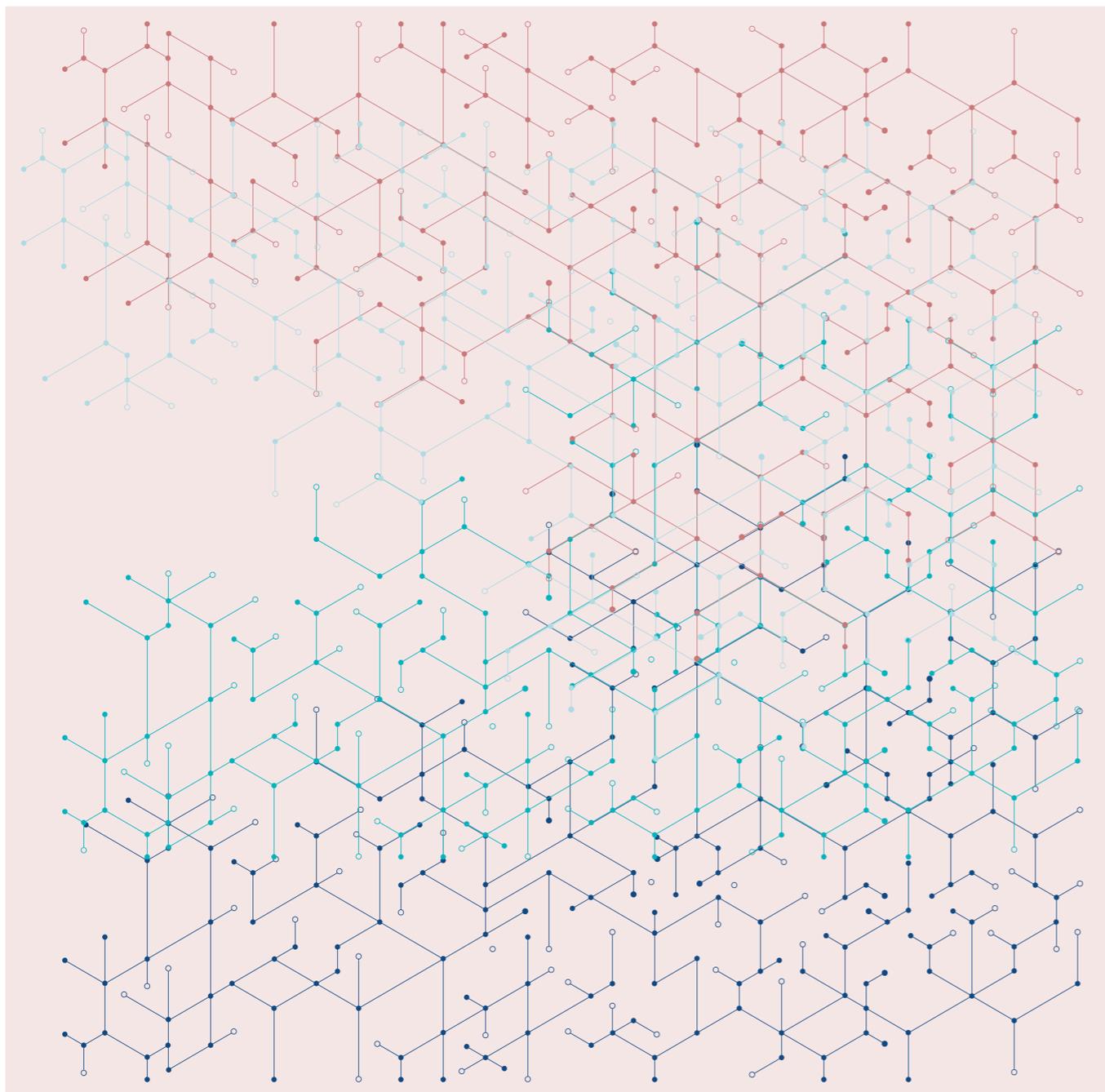


Knowledge Transfer **2019 Highlights**





“THROUGH OUR KNOWLEDGE

TRANSFER ACTIVITY, WE PRO-ACTIVELY

IDENTIFY CERN TECHNOLOGIES WITH

POTENTIAL FOR SOCIETAL IMPACT.”

Fabiola Gianotti, CERN Director-General

A word from Fabiola Gianotti, CERN Director-General



As a publicly funded organisation, it is incumbent on CERN to ensure that society benefits maximally from the work we do. This includes not only fundamental research, which is our primary mission and through which we contribute to the progress of human knowledge, but also the technologies we develop and the young generations we train.

Our convention states that all of our results shall be made generally available. Through our knowledge transfer activity, we take this principle a step further, pro-actively identifying CERN technologies with potential for societal impact, nurturing their development, and bridging the gap between science and society.

In 2019, some 15 nascent projects were supported through the CERN Knowledge Transfer Fund and Medical Applications Budget, bringing the total to 89 since the funds were established. Many projects also benefited from co-funding from industry. Our Business Incubation Centres supported some 26 start-ups based on CERN technologies, some of which are reaching full maturity. One project produces 3D colour X-ray images using the CERN-developed Medipix chip. In 2019, CERN celebrated the 20th anniversary of the second collaboration behind the family of chips. Another project is deploying machine learning techniques from CERN for the development of autonomous vehicles in collaboration with the automotive industry. You can learn more about CERN's Knowledge Transfer activities in the following pages of this report.

Fabiola Gianotti

EXECUTIVE SUMMARY 2019

KNOWLEDGE TRANSFER

ACCELERATING INNOVATION

7
Application fields showcased in 2019



18
Technology domains of CERN expertise

2
Knowledge Transfer Partners @ CERN: IdeaSquare and CERN openlab

ENGAGING WITH EXPERTS
IN SCIENCE, TECHNOLOGY
AND INDUSTRY

#CERNKT

INTERNATIONAL ORGANISATIONS

5
Sustainable Development Goals (SDGs) in which CERN fully contributes within the current mandate



CERN KNOWLEDGE TRANSFER FUND

6
Projects funded in 2019

15-220 kCHF
Range of funding received per project

CERN MEDICAL APPLICATIONS BUDGET

179 kCHF
Average funding received per project

9
Projects funded in 2019

EUROPEAN COMMISSION CO-FUNDED PROJECTS



5
European Commission co-funded projects with a strong Knowledge Transfer component

33.9 MEUR
Total European Commission contribution to Knowledge Transfer related projects

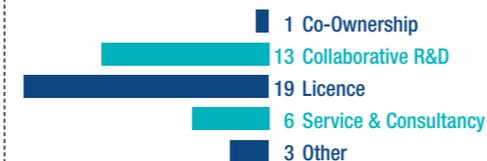
19
ATTRACT projects approved in which CERN participates

INTELLECTUAL PROPERTY AND LICENSING

31
New technologies disclosed internally

42
Knowledge Transfer contracts signed

Contract by Type



Contract by Partner



ENTREPRENEURSHIP

20
Entrepreneurship Meet-Ups

2
Entrepreneurship Programmes

2
Investor events hosted at CERN

9
Member State Business Incubation Centres of CERN technologies

7
Start-ups accepted into BICs

#CERNBIC

COMMUNICATION AND MARKETING

2
Knowledge Transfer contributed as data partner for two reports

GLOBAL INNOVATION INDEX
STATE OF EUROPEAN TECH

17 000 Views

First CERN LinkedIn Live: Moving out of Academia to Entrepreneurship



HUMAN EXCELLENCE AND EDUCATION

3
Training courses for CERN personnel organised by the Knowledge Transfer group

> 2 k
Visiting the Knowledge Transfer Exhibition during the Open Days



EVENTS



>100
Events organised or attended by the CERN Knowledge Transfer group in Member States

SLUSH
WEB SUMMIT
WORLD CONFERENCE OF
SCIENCE JOURNALISTS

18
Number of countries where Knowledge Transfer events were held or visited



8
Knowledge Transfer Seminars

> 1 k
People attended the Knowledge Transfer Seminars in person or via webcast

FLAGSHIP

Launch of CERN Alumni Entrepreneurship group



Medipix2 Collaboration

A new collaboration agreement between CERN and ESA



SUCCESS STORIES

CERN is home to some of the world's most complex scientific instruments, used by physicists to probe the fundamental structure of the Universe. The technologies developed to operate these instruments – and, in general, to pursue CERN's fundamental mission – have applications in areas beyond particle physics. CERN's Knowledge Transfer (KT) group works proactively to maximize the dissemination of these technologies and the impact of CERN in society, by actively scouting for opportunities to accelerate innovation and work with leading industries in the medical field, aerospace, cultural heritage and industry 4.0. The following are only some of the success stories of 2019.

A DATA-ANALYSIS AND SIMULATION PLATFORM FOR LIFE SCIENCES

In response to growing interest from academia and industry, the BioDynaMo consortium was born in 2019. Based on the project with the same name, it aims to establish a high-performance, general-purpose platform, through which life-scientists can easily create, run and visualise complex 3D simulations. Initially, it brought together CERN's expertise in large-scale computing, with the University of Newcastle's algorithmic knowledge of biological tissue dynamics. Immunobrain Ltd., GSI Helmholtz Centre for Heavy Ion Research and the University of Zurich have since joined, broadening the application fields to immunotherapy, tissue damage during radiation therapy, neuron development mapping, and cancer growth studies. The consortium is open to new partners working in related fields.

CERN TECHNOLOGIES FOR NEXT-GENERATION ION THERAPY CENTRES

2019 saw the official launch of the NIMMS (Next Ion Medical Machine Study) project and its approval for funding from the CERN Medical Applications Budget. NIMMS outlines an umbrella R&D programme for CERN accelerator technologies linked to hadron therapy. Following input from world experts in the field, CERN's efforts will concentrate on ion therapy facilities rather than those using protons. In line with CERN's core competences and expertise, superconducting magnets, linacs and gantries were identified as key technologies for this development. NIMMS will provide a toolbox of know-how to be used and adapted by end-users to realise a new generation of more compact and cost-effective ion therapy facilities.



SOFTWARE SOLUTIONS FOR AUTONOMOUS DRIVING

Zenuity, a company developing software solutions for automotive safety and autonomous driving (AD), has become the first to team up with CERN in the fields of fast machine learning. A fundamental challenge in the development of AD cars is the fast interpretation of the huge quantities of data generated in normal driving conditions. CERN has approached this challenge in the context of physics data acquisition, by using Field-Programmable Gate Arrays (FPGAs) hardware that can execute complex decision-taking algorithms in microseconds. The collaboration between Zenuity and CERN aims to leverage this knowledge using FPGAs for fast machine learning applications that allow AD cars to reach fast decisions and make predictions more quickly.

APPLYING PHYSICS TO FINANCIAL MARKETS

In September 2019, CERN, the foundation Commodity Risk Management Expertise Centre (CORMEC) and the Wageningen University signed an agreement to develop new methods for identifying anomalies that can harm the integrity of commodity and financial markets. The detection of anomalies in real-time, in the high-speed, high-volume body of financial transactions requires the exact identification of suspicious signals in massive amounts of data. The ability to detect such signals would generate safer and more stable financial environments, sharpen the surveillance of risk, and enhance regulatory compliance. The collaboration leverages CERN's expertise and tools in big data storage, processing, analysis, and visualisation to tackle new challenges in the financial system.

DEVELOPING SOFTWARE FOR POWER CONVERTERS' CONTROL ENVIRONMENT COMPATIBILITY

Since 2014, the Electrical Power Converters group at CERN has been developing compatibility software to allow its power converter digital controls to be integrated into the more commonly used controls frameworks TANGO and EPICS. CERN's Function Generator/Controllers (FGCs) were originally developed to work within the CERN accelerator control software, so this development opens the door for CERN's FGC and power converters to be deployed in other accelerator facilities. Due to its potential for technology transfer, the project was one of five selected in 2019 to receive funding from the CERN Knowledge Transfer Fund. In 2020, 11 control modules of commercial power converters, installed at the synchrotron SOLEIL (Paris, France), will be replaced by FGCs.



IGLUNA: BUILDING A DEMONSTRATOR MOON HABITAT IN ZERMATT

IGLUNA is an educational project aimed at investigating the realisation of a human habitat on the moon. 18 student teams from all over Europe, coordinated by the Swiss Space Center, built several technology demonstrators for this habitat and tested them in June 2019 in the extreme environment of the Matterhorn

glacier (Switzerland) at 3800 metres. CERN contributed to IGLUNA by hosting the Critical Design Review in IdeaSquare in January 2019 and by providing two high precision radiation-monitoring systems, developed to track on-site radiation levels, such as during the operation of CERN's accelerators. CROME and HEH-Monitors were deployed outside and inside the glacier to measure open-air high altitude cosmic rays and thick ice shielding capability.

APPLYING ACCELERATORS TO ENVIRONMENTAL CHALLENGES WITH ARIES

Horizon 2020 project ARIES aims to improve the performance, availability and sustainability of particle accelerators, transferring its benefits and applications to science and society. In 2018, ARIES launched the Proof-of-Concept innovation fund for industry-oriented activities, awarding funding to four promising projects. One of these projects, coordinated by the RIGA Technical University, proposes to reduce the content of sulphur and nitrogen oxides and of particulate matter in the exhausts of maritime diesel engines using an electron beam accelerator. In 2019, the first measurements confirmed the expected reduction in pollutants. A dedicated project, with the goal of installing and testing a specially designed accelerator on a real cargo ship, requested funding to start in 2020. On the R&D aspect, ARIES also succeeded in producing a high-temperature superconducting (HTS) tape that reached a record current density on a series of samples, thus opening the possibility of scaling-up for industrial production for the future collider machines.

Franco Ongaro, Director of Technology, Engineering and Quality Head of ESTEC, European Space Agency (left) with Eckhard Eisen, CERN Director for Research and Computing.



CERN AND ESA COOPERATING ON RADIATION ENVIRONMENTS, TECHNOLOGIES AND FACILITIES

The collaboration agreement between CERN and ESA, signed in July 2019, addresses the challenge of operating in harsh radiation environments found in both particle-physics facilities and outer space. This first protocol of the CERN-ESA Cooperation Framework concerns radiation environments, technologies and facilities with potential applications in both space systems and particle physics experiments or accelerators. Two projects related to radiation testing in CERN facilities for ESA space missions have already achieved important results. In October 2019, four more projects started, with the aim of addressing assessment strategies for commercial off-the-shelf (COTS), in-orbit technology demonstrators, development of radiation detectors, monitors and dosimeters and simulation tools for radiation effects. These activities will continue and, as new challenges emerge, they will be dealt with under the coordination of the CERN-ESA Committee on Radiation Issues.

MANAGING CERN'S INTELLECTUAL PROPERTY

Intellectual property (IP) lies at the core of successful knowledge transfer at CERN, allowing CERN to manage scientific and technological developments for maximum impact in society. CERN often adopts an open source philosophy, having in place the adequate tools to manage its intellectual property in these cases. One example is the CERN Open Hardware Licence (OHL), a legal framework to facilitate knowledge exchange on hardware design. On the other hand, CERN considers patenting when the patent protection facilitates the technology transfer or makes the invention more attractive to companies. In 2019, two CERN patents were published. The Structured Laser Beam is a new paradigm in the creation of non-diffractive beams (NDBs) with potential to improve the application of laser beams or light beams. The second, GaToroid, is an innovative gantry design, which removes the need to rotate the structure, eliminating any current or movement limitations.

DRIVING POSITIVE IMPACT ACROSS MEMBER STATES

The Knowledge Transfer group at CERN initiated a pilot programme in collaboration with the Israel Innovation Authority (IIA), with the purpose of exploring how cutting-edge Israeli companies and institutes can embrace specific CERN technologies and know-how to fuel innovation and drive positive impact in society. In 2018, four exciting projects, including All-In-Image and ImmunoBrain Checkpoint, were selected by CERN and IIA from a wide range of proposals. In 2019, All-in-Image trained a neural network to identify tumours in MRI images from real patients, using SWAN, a CERN platform for interactive data analysis. The same year, ImmunoBrain Checkpoint joined the BioDynaMo consortium which aims to use the BioDynaMo platform to better predict the effectiveness of immunotherapy applications for the treatment of Alzheimer's disease.

FOSTERING A CULTURE OF ENTREPRENEURSHIP AT CERN

One of the Knowledge Transfer (KT) group's priorities is to foster a culture of entrepreneurship at CERN, by both highlighting the knowledge transfer potential of CERN technology to existing start-ups and by building a community of entrepreneurial-minded individuals to create new ventures. These develop through activities such as the Business Incubation Centre (BIC) network and programmes like the CERN Entrepreneurship Student Programme (CESP) and the NTNU and BIC screening weeks. For the latter, CERN KT invited CERN Alumni who have become entrepreneurs to inspire the next generation. In 2019, more companies joined the CERN BIC network. Arc Power, who develops radiation-resistant electronics for space missions, in the Swiss BIC PARK INNOVAARE; Orvium, who aims to change the scientific publication paradigm, using ZENODO as a document repository, in the Spanish BIC Ineustar; and PlanetWatch, who aims to develop a social network for streaming environmental sensor data, using C2MON as the monitoring software, in the French BIC INNOGEX.



CREDITS

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