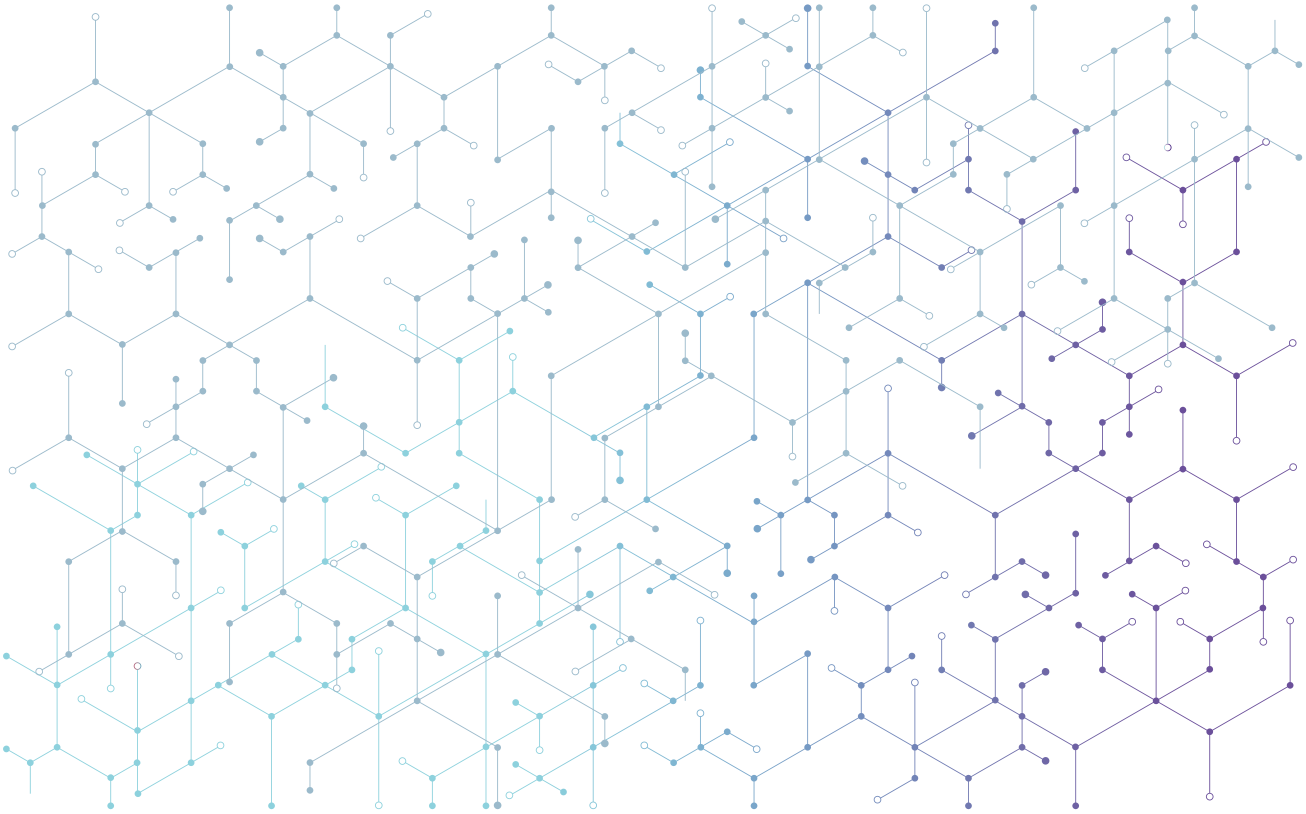
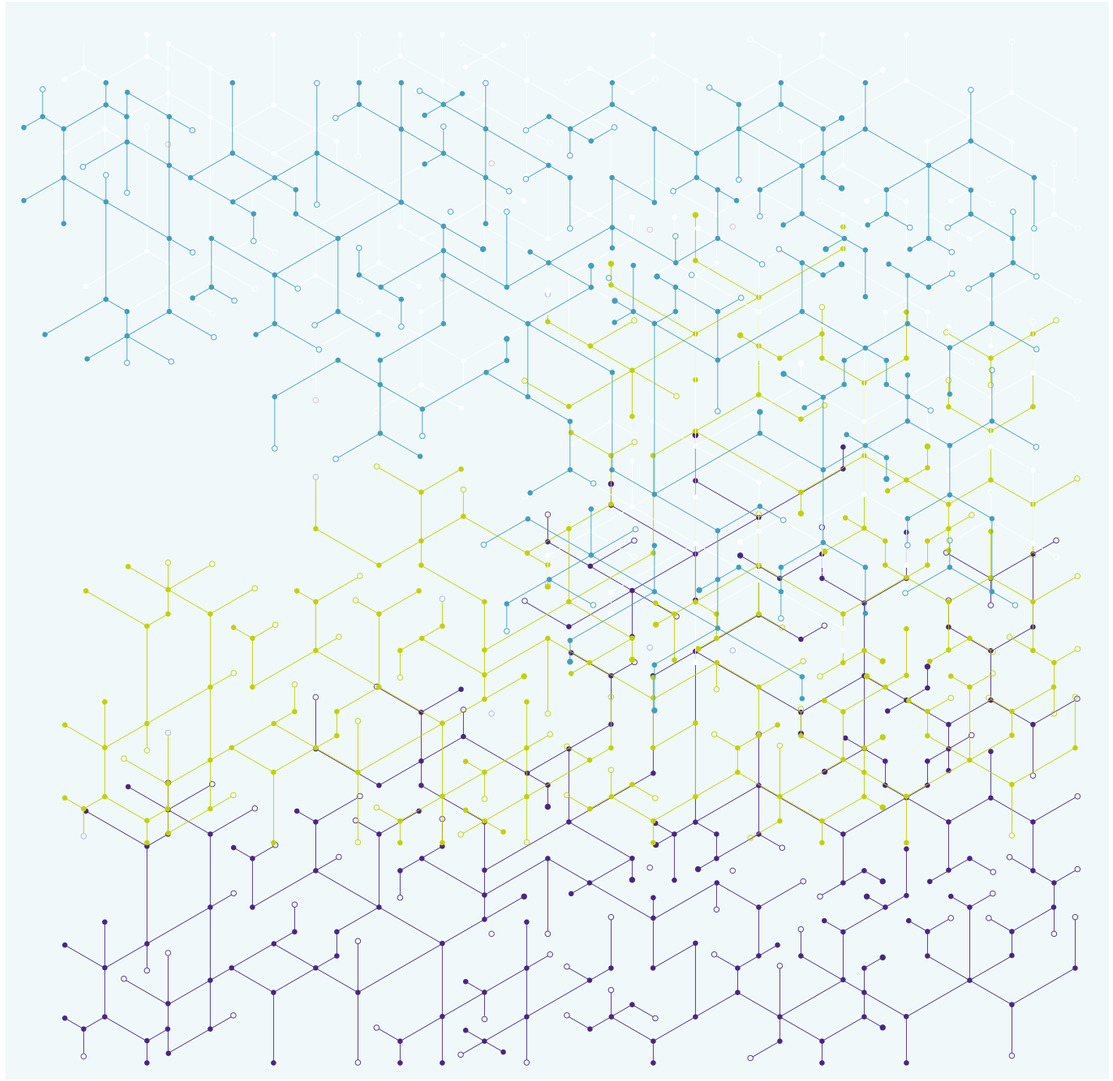


Knowledge Transfer
2021 Highlights

CERN



A word from Fabiola Gianotti, CERN Director-General

CERN operates at the cutting edge of technology. This is not only vital for the tools that enable our research, but also for the knowledge that we transfer to our Member and Associate Member States, providing important input to industrial innovation in many fields, and benefits to society at large.

In 2021, as the pandemic continued to wreak havoc around the world, the role of science remained crucial, and CERN played its part. One key development is the COVID Airborne Risk Assessment tool, CARA, which was key to enabling CERN personnel to come back on-site safely, and also lead to a collaboration with the World Health Organization (WHO). CERN has joined an international WHO working group to develop an algorithm quantifying the risk of airborne virus transmission indoors.

CERN's work in medical technology made significant advances in 2021. Funding was pledged for construction of the Lausanne University Hospital's FLASH radiotherapy cancer-treatment facility, based on CERN technology, while a collaboration with Spain's CIEMAT produced the first of four modules of a Radio Frequency Quadrupole (RFQ) for a carbon-ion therapy facility. The complete RFQ will be tested at CERN in 2023.

Another major knowledge-transfer strand in 2021 was the launch of a new initiative related to the environment. The CERN Innovation Programme on Environmental Applications (CIPEA) will encourage innovative ideas from CERN experts to apply the Laboratory's technologies, know-how and facilities to addressing major environmental challenges. The best ideas will be supported to develop impactful projects in collaboration with external partners. CERN has also reinforced its efforts to reduce electricity consumption, and is developing an Energy Performance Plan enabling it to align with best practice in terms of energy management and re-use. Meanwhile the CERN spin-off PlanetWatch increased the number of air-quality sensors it deploys around the world to over 32 000.

This report provides details of these and other exciting developments, showcasing the societal impact of CERN's innovation.

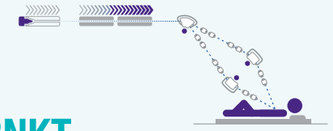
Fabiola Gianotti

CERN KNOWLEDGE TRANSFER
IN NUMBERS 2021

ACCELERATING INNOVATION
FROM CERN TECHNOLOGIES
TO SOCIETY

CERN'S KEY APPLICATION DOMAINS

- Aerospace
- Better Planet
- Industry 4.0
- Safety
- Cultural Heritage
- Emerging Technologies
- Medical and Biomedical



#CERNKT
#ACCELERATINGINNOVATION

INTELLECTUAL PROPERTY AND LICENSING

CONTRACTS BY TYPE

- 15 Collaborative R&D
- 4 Contract research
- 21 Licence
- 3 Service & Consultancy
- 4 Other

14
New technologies disclosed internally

47
Knowledge Transfer contracts signed

CONTRACTS BY PARTNER

- 12 Institute/Laboratory
- 18 Industry
- 4 Hospital or biomedical research institution
- 14 University
- 9 Other

#CERNIMPACT

CERN TECHNOLOGY IMPACT FUND

SUSTAINABLE DEVELOPMENT GOALS

EVENTS

1.2k
People attended Knowledge Transfer seminars either in person or virtually

10+
Discovery Days with CERN to innovate with industry

EUROPEAN UNION CO-FUNDED PROJECTS

6
New projects with a strong knowledge-transfer component started in 2021

70 MEUR

ATTRACT2
AIDAinnova
HITRI*plus*
I.FAST
PRISMAP
RADNEXT

ENTREPRENEURSHIP

- Meet-Ups
- Business Incubation Centres (BICs) for CERN Technologies
- New deep-tech program

50+
Participants

- *CERN ENTREPRENEURSHIP*
- *STUDENT PROGRAMME (CESP)*
- *CERN-NTNU SCREENING WEEK*
- *CERN-BIC SCREENING WEEK*

FUNDING OPPORTUNITIES

2
Projects funded by the Knowledge Transfer fund

6
Projects funded by the Medical Applications budget

37kCHF-900kCHF
Range of funding received per project

1.86 MCHF
Total funding allocated for projects taking CERN tech into society

with Knowledge Transfer partners @ CERN: IdeaSquare, CERN openlab, CERN & Society Foundation and CERN Quantum Technology Initiative

EXECUTIVE SUMMARY

CERN's unique technologies and the know-how of our experts are at the heart of each initiative featured in this report. We can observe how internal knowledge paired with external expertise transforms research into innovation. These mutually beneficial collaborations allow the transfer of cutting-edge ideas from the Laboratory into the real world, all by having in mind future solutions to benefit humanity.

For instance, 2021 marked 30 years of the Crystal Clear Collaboration at CERN, exploring scintillating crystals for high-energy physics and medical applications (p. 9). Additionally, the MARS Bioimaging 3D colour X-ray scanner arrived in Switzerland to undertake clinical trials that will lead to its medical use (p. 11).

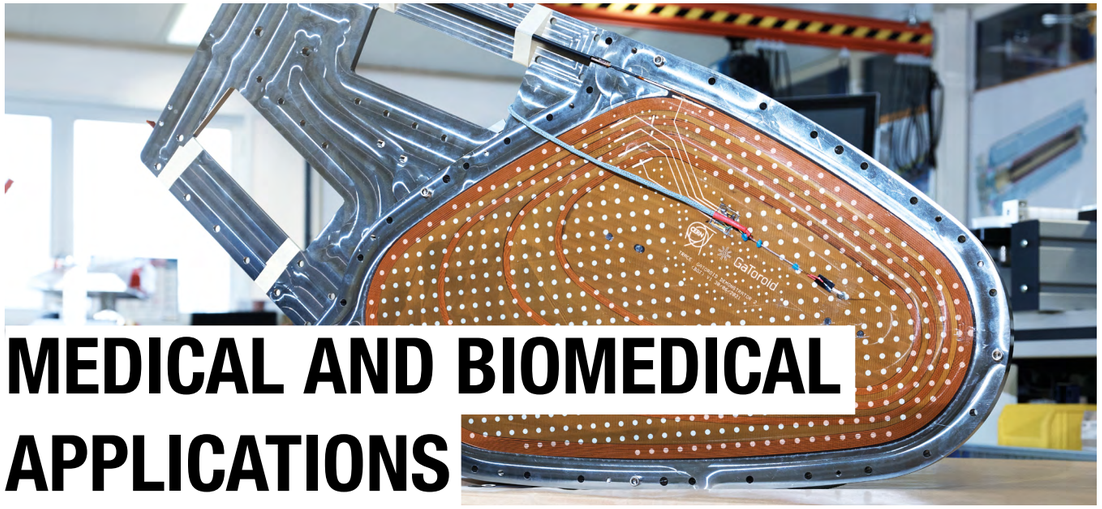
Committed to minimising its environmental impact, CERN partnered with ABB Motion to reduce the Organization's electricity consumption, while helping the company apply its connectivity solutions on a large scale, and share the learnings openly (p. 15). A new partnership began with the startup Transmutex, opening doors towards building safer nuclear energy production systems (p. 15).

First publications stemmed from CERN's ROOT technology being used in research to help protect financial markets from fraud (p. 18). Further fuelling the entrepreneurial engine of the new economy, the Laboratory proudly supports the three new startups accepted into the network of Business Incubation Centres of CERN technologies during 2021 (p. 20-21). Moreover, CERN and INSEAD, one of the world's leading business schools, jointly developed a new deep-tech programme for their Executive MBA (p. 21).

Despite the pandemic, new horizons for knowledge transfer continued to be fuelled through talks, seminars, innovation days with industry, entrepreneurship programmes, and new co-funded EU projects (p. 23-25).

This report shares a collection of many more CERN developments that are benefitting society beyond the Organization's core mandate of fundamental physics.

The applications of CERN technologies extend beyond high-energy physics to a vast range of areas such as aerospace, medical & biomedical, industry 4.0, cultural heritage, safety and towards a better planet.



MEDICAL AND BIOMEDICAL APPLICATIONS

A prototype coil of GaToroid, a compact non-rotating gantry for cancer therapy.

ONCOLOGY TREATMENTS OF TOMORROW

FAST TRACK FOR VERY HIGH-ENERGY ELECTRON TREATMENTS

CERN and Switzerland's Lausanne University Hospital (CHUV) continued work on an innovative facility for FLASH radiotherapy. This facility, based on the CLIC (Compact Linear Collider) accelerator technology developed at CERN, will use very high-energy electrons (VHEE) to treat deep-seated tumours in less than 200 milliseconds. Treating tumours in such short times exploits the so-called FLASH effect, giving equivalent control while producing fewer side effects. In 2021, CHUV secured a large donation for the construction of the facility with CERN. Moreover experiments at CERN's CLEAR test facility demonstrated how VHEE beams can be focused onto deep-seated tumours and measured the performance of dose diagnostics for short irradiation times.

SOLUTIONS FOR ION THERAPY

The NIMMS (Next Ion Medical Machine Study) activities have continued to progress in the development of technologies for cancer therapy with ion beams. CERN and the South East European International Institute for Sustainable Technologies (SEEIIST) have produced a design report of an innovative facility based on a conventional room-temperature synchrotron. The collaboration between CERN and Spain's CIEMAT for a future carbon-ion therapy linear accelerator has reached a milestone with the completion of the first out of four modules of a radio frequency quadrupole. CERN also completed the assembly of the first high-temperature superconductor prototype coil for GaToroid, a novel concept of a non-rotating gantry for ion therapy.

NOVEL RADIOISOTOPES FOR NUCLEAR MEDICINE

MEDICIS, CERN's facility designed to produce non-conventional radioisotopes for medical research, produced its first samples for targeted alpha therapy, a promising new field of radionuclide therapy. Its mass purification capabilities enabled scientists from the MEDICIS collaboration to successfully complete a new proof-of-concept study with animal models.

30 YEARS OF CRYSTAL CLEAR COLLABORATION

2021 marked 30 years of the Crystal Clear Collaboration at CERN exploring scintillating crystals for exciting new avenues not only in high-energy physics, but also in innovative medical applications like positron emission tomography (PET).

NEW IMAGING APPLICATIONS WITH PET FOR ORGAN-ON-A-CHIP

In 2021, a new project with Inselspital Bern was launched to explore applications in biological imaging. CERN is supporting the development of a PET for an organ-on-a-chip, a type of artificial organ system which simulates its processes. This PET would help analyse metabolic processes for an organ-specific context using radiotracers.

TOWARDS A FIRST FULL-SCALE PROTOTYPE FOR NON-INVASIVE DOSE MONITORING

TERAPET, a Swiss startup, aims to commercialise innovative solutions for safer, more precise and time-saving therapies for cancer treatment. Its technologies enable non-invasive monitoring of the delivered proton therapy dose. The startup will benefit from CERN's expertise in scintillating crystals through a project started in 2021, funded by the Swiss Innovation Agency Innosuisse, to support the development of the first full-scale prototype.

LEAPING ONTO BREAKTHROUGH INNOVATION

Looking to the future, a project on fast heterostructure scintillators aims to drastically improve the coincidence time resolution of PET, bringing it down to 10 picoseconds from today's state of the art of 200 picoseconds. This could improve image quality while reducing the time spent in the scanner and the dose administered to the patient.

EUROPEAN PROJECTS FOR MEDICAL INNOVATION

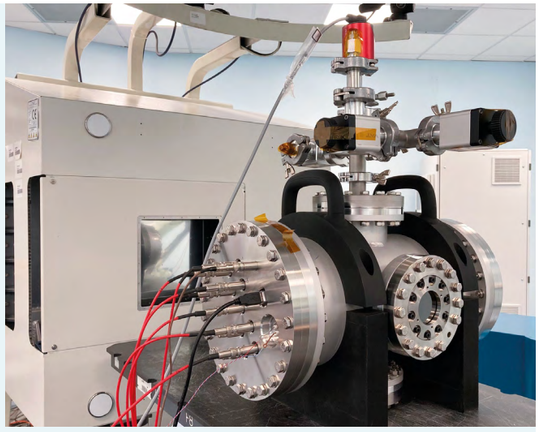
CERN participates in and leads projects co-financed by the European Union. From the new co-funded projects starting this year, many will help CERN translate its technological developments to have impact in medical and biomedical fields.

The CERN-coordinated European isotope programme, PRISMAP, federates a consortium of the key intense neutron sources, isotope mass separation facilities (including CERN-MEDICIS) and high-power accelerators and cyclotrons, with leading biomedical and healthcare research institutes. The goal is the active translation of emerging radionuclides into medical diagnosis and treatment. CERN also coordinates two newly-started projects, I.FAST and AIDAinnova, which are aimed respectively at the development and innovation in accelerators and detectors. Both carry a strong potential for future medical applications.

CERN is a key partner in two projects entirely dedicated to the development of medical technologies: HITRI*plus* is strongly connected to the CERN NIMMS (Next Ion Medical Machine Study) and aims at fostering biophysics and medical research on cancer treatment with ions, and at developing next-generation instruments for it; GAMMA-MRI will develop a breakthrough imaging technology combining the high sensitivity of gamma ray detection and the high resolution and flexibility of magnetic resonance imaging (MRI). In both cases, the application for funding was strengthened by the preliminary work made possible by seed money from the CERN budget for knowledge transfer to medical applications.

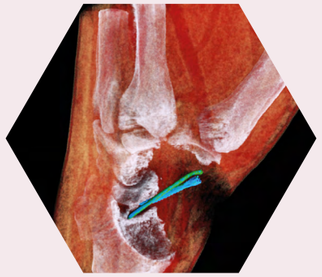
PORTABLE DETECTORS FOR MICRODOSIMETRY AND ION THERAPY

The new GEMTEQ detector developed at CERN could be used to improve the effectiveness of cancer treatments. The detector is based on GEMPix, which combines two CERN technologies, Gas Electron Multipliers and Timepix, both used for detection of ionising radiation. It will be used in microdosimetry, which studies the absorbed dose in biological matter at cell level, for a better understanding of radiation effects in human tissue. To further increase portability, a sealed and low-pressure version of the GEMTEQ was designed, assembled and made fully operational at CERN. It was then successfully used for measurements with protons and carbon ions at CNAO (The National Center for Oncological Hadrontherapy) in Italy, one of the few centres in Europe treating cancer patients with carbon ions.



GEMPix at CNAO for the latest measurements in October and December 2021

MARS Bioimaging scanner at Lausanne University Hospital (CHUV); on the right is a 3D colour wrist X-ray made possible by the scanner.

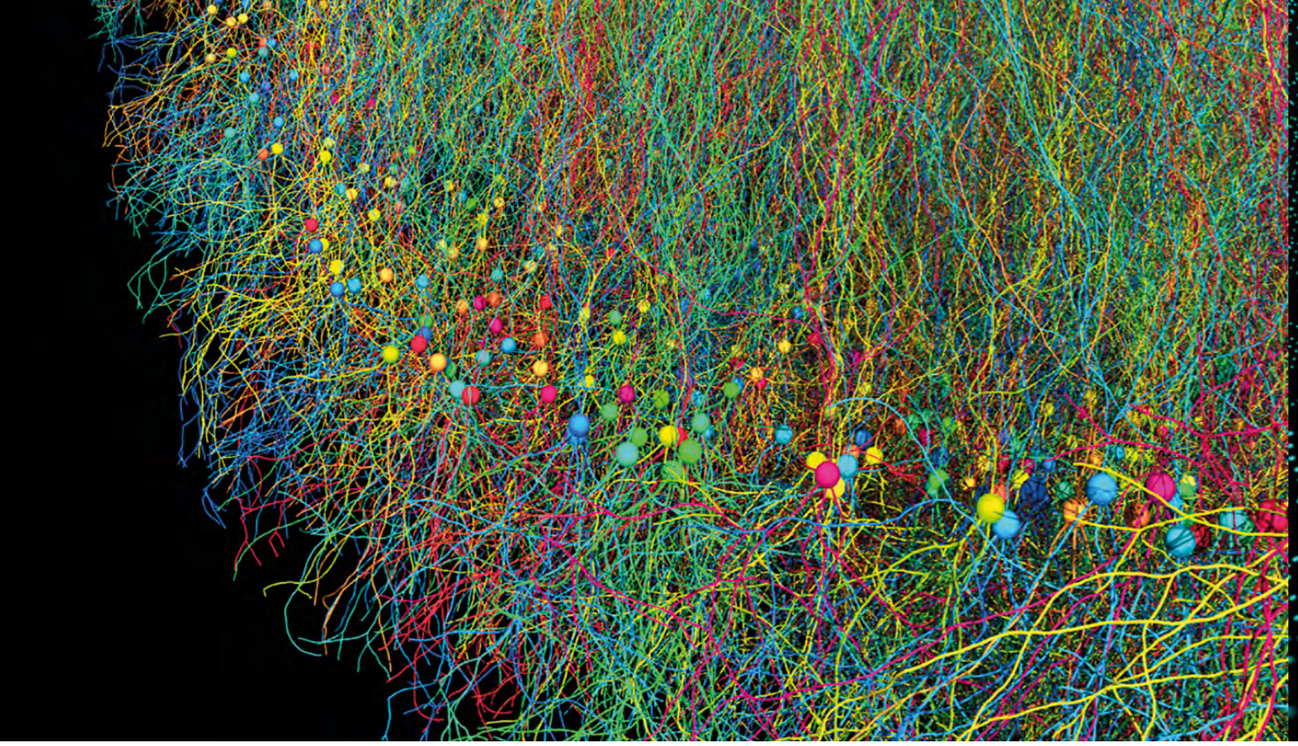


NEW STRIDES IN MEDICAL IMAGING WITH A 3D COLOUR X RAY SCANNER

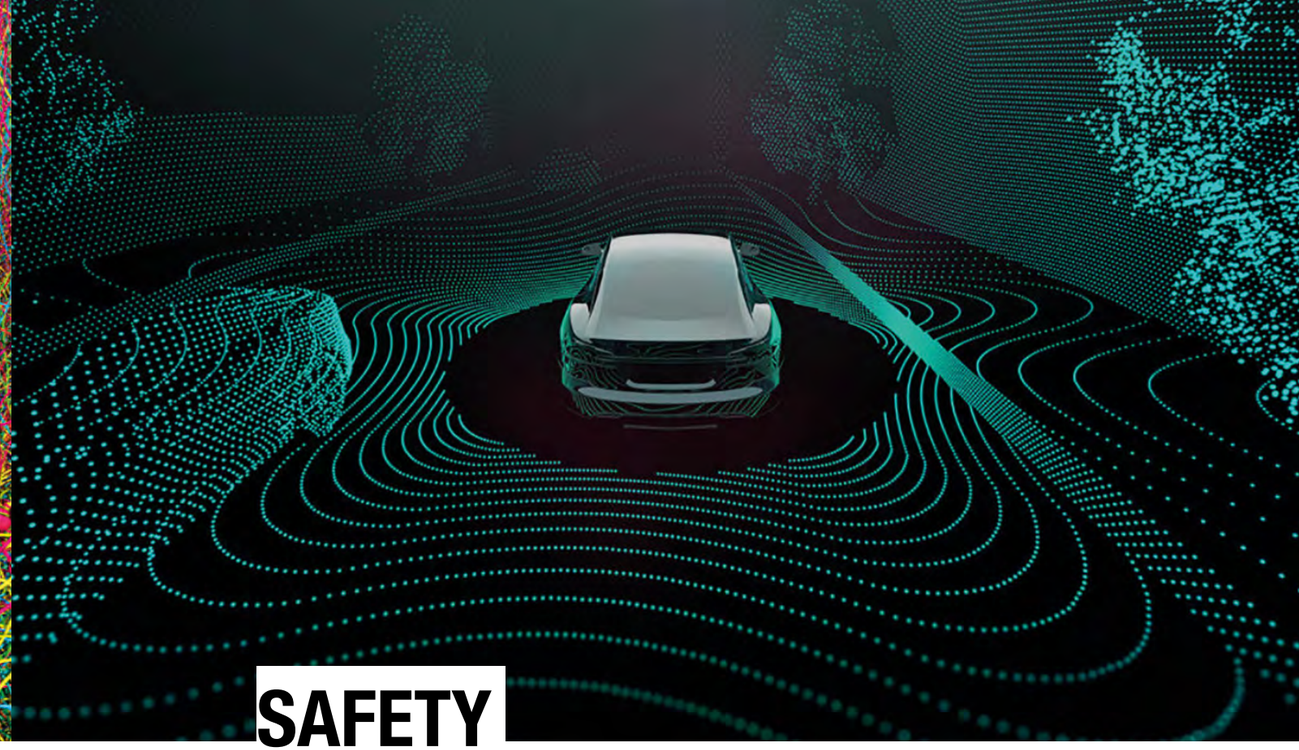
CERN and MARS Bioimaging have been working together for a long time to develop a 3D colour X-ray scanner based on technology developed by the CERN hosted Medipix3 collaboration. After years of development in New Zealand, where MARS Bioimaging is based, the scanner finally arrived in Europe in 2021 at the Lausanne University Hospital (CHUV) in Switzerland to undertake clinical trials that will lead to its medical use. The technology is a leap from the world of black and white to high resolution colour imaging, and can enable significant progress in diagnosing bone fractures and monitoring the healing process.

CREATING IMPACT WITH CERN'S COVID AIRBORNE RISK ASSESSMENT (CARA) TOOL

CERN developed the COVID Airborne Risk Assessment (CARA) software as an additional tool to assist CERN office managers to evaluate the risk of COVID-19 infection in enclosed spaces and adopt appropriate measures. In 2021, following numerous requests from global health players and research institutes, CARA was released as open source. The software was used, for example, by specialists in infectious diseases to evaluate the effectiveness of different measures to limit SARS-CoV-2 aerosol transmission in schools. CERN was also invited by the World Health Organization to bring the CARA expertise into ARIA, an international expert working group focused on developing standards for airborne transmission of respiratory pathogens. CARA is continuously validated by experts in health science and is now used by researchers, advisory bodies and facility managers worldwide.



Large-scale simulation of neural development using BioDynaMo.



SAFETY

Machine learning for autonomous driving.

VERSATILE LARGE-SCALE DATA MODELLING

Based on CERN's experience in large-scale computing, BioDynaMo, an open-source agent-based simulation software, has been helping scientists model the behaviour and spread of the SARS-CoV-2 virus. Having started as a CERN openlab project, it is gradually becoming a more versatile tool for wider applications. In the near future, thanks to a collaboration with Statistics Netherlands, BioDynaMo will help perform large-scale data modelling on socio-economic parameters by creating a digital twin of the Netherlands. The resulting observations will help policy makers in fighting socio-economic inequities.

LOW-COST VENTILATOR SOLUTIONS

In light of the growing COVID-19 pandemic, a team of physicists from CERN first prototyped the High Energy Ventilator (HEV) in 2020. It was designed as a fully functional, high-quality medical ventilator for use in and out of intensive care for patients with severe breathing difficulties.

In the past year, a team of scientists in the United Kingdom and Brazil, coordinated by the Daresbury Laboratory of the Science and Technology Facilities Council (STFC), started work to redesign the HEV and to adapt it for manufacture and clinical use in low- and middle-income countries. This new prototype is called the High Performance Low Cost Ventilator (HPLV).

DEVELOPING MACHINE LEARNING SOFTWARE FOR AUTONOMOUS DRIVING

CERN's unique environment combining various types of radiation, extremely low temperatures, ultra-high magnetic fields and very high voltages, naturally lends itself to the creation of innovative solutions to ensure a high level of safety. Zenseact, a company based in Sweden, owned primarily by Volvo Cars, is dedicated to making autonomous driving safer. With CERN, Zenseact has been exploring how CERN's machine learning algorithms, so adept at studying collisions in the Large Hadron Collider, can be applied to other fields including avoiding collisions in autonomous vehicles. Together, the aim is to enable specialists to design hardware-optimised machine learning algorithms, which can be applied to autonomous vehicles, allowing them to take fast decisions and make predictions more quickly.

TECHNOLOGIES FOR A BETTER PLANET

DEFINING A ROADMAP FOR CERN'S ENVIRONMENTAL APPLICATIONS

CIPEA CERN Innovation Programme on Environmental Applications

Acknowledging global environmental challenges, CERN is taking steps to move from serendipity to a conscious effort to harness CERN's unique skillset to contribute to a more sustainable planet. As a first step, the Organization has endorsed the new 'CERN Innovation Programme on Environmental Applications'. It is a crucial starting point in building a roadmap to maximise CERN's positive environmental impact.

Four priority areas have been identified: renewable and low-carbon energy, clean transportation and future mobility, climate change and pollution control, and sustainability and green science. In its initial stage, the programme intends to engage CERN experts in proposing innovative ideas to address these challenges using CERN's expertise – which may give rise to impactful projects in collaboration with external partners.

Find more information at kt.cern/environment.

PlanetWatch's network allows for monitoring air quality in real time.

SOLUTIONS FOR AIR QUALITY MONITORING

PlanetWatch, a CERN spin-off company in the blockchain arena set up by a CERN alumnus, is building a global real-time citizen network to monitor air quality. The data is streamed by sensors deployed by residents, local authorities and partners, who, in return, are rewarded with utility tokens (PLANETS).

While based in France, PlanetWatch's global network grew to 32k+ connected sensors worldwide in 2021, and is rapidly expanding with hundreds of sensors being installed every day. The company received a $10M investment by Borderless Capital, and started partnerships with ClimateTrade, a leading blockchain-enabled carbon credit marketplace, and Treedom, a platform that allows people to plant trees anywhere in the world.

A segment of CERN's cooling and ventilation infrastructure.

ENABLING DIGITAL SOLUTIONS FOR SUSTAINABLE SCIENCE

Committed to minimising its environmental impact, CERN partnered with ABB Motion with the aim of reducing the Organization's electricity consumption, while helping the Swedish-Swiss company apply its connectivity solutions on a large scale. ABB will equip CERN's cooling and ventilation (C&V) infrastructure with diagnostic devices, collecting information to create digital twins of the ventilation system to identify energy saving scenarios. The goal is to apply these scenarios to CERN's C&V systems and to share the learnings publicly, inspiring industries and large-scale facilities around the world to become more energy efficient.

TOWARDS CLEANER AND SAFER NUCLEAR ENERGY

In February 2021, CERN partnered with Transmutex SA to help it uptake technologies originating from CERN's accelerator-driven systems to build innovative and safer nuclear energy production systems. The Swiss startup aims to reinvent nuclear energy to make it inherently safe, free of long-lived waste and cost competitive, with the plan to deliver a pilot plant within a decade. CERN has started supporting the startup in setting up a network of international collaborations.

"AS HUMANS VENTURE INTO SPACE, THE RADIATION LEVELS INCREASE, AND SO DOES THE NEED FOR RELIABLE DOSE MONITORING."

Florence Clément, project manager of the Lumina experiment, CNES/CADMOS

AEROSPACE

Astronaut Thomas Pesquet with Lumina, at the International Space Station.

CERN-TESTED OPTICAL FIBRES NOW ON THE INTERNATIONAL SPACE STATION

The International Space Station (ISS), just like the Large Hadron Collider at CERN, is a complex radiation environment that requires bespoke dosimetry devices. Optical-fibre-based technologies can provide radiation dose measurements with high precision to protect the crew and hardware of future spacecraft.

In August 2021, ESA (European Space Agency) astronaut Thomas Pesquet activated the Lumina experiment inside the ISS. Developed under the coordination of the French Space Agency (CNES) and with the involvement of CERN, Laboratoire Hubert Curien and iXblue, this project uses two several-kilometre-long optical fibres as active dosimeters to measure ionising radiation with very high sensitivity.

Building on its experience of studying radiation effects on electronics and developing optical sensing solutions, CERN contributed to the theoretical model of the dosimeter and carried out the low- and high-dose irradiation tests needed to calibrate the instrument.

The Lumina experiment is part of the CERN-CNES bilateral collaboration framework and is supported by CERN's Radiation to Electronics (R2E) Project.

QUANTUM COMPUTING AND ARTIFICIAL INTELLIGENCE FOR EARTH OBSERVATION

A rapidly growing field of research and application, quantum technologies have the potential to revolutionise the way we do Earth observation by solving previously intractable problems. Partaking in this research boom, CERN strengthened its strategic partnership with ESA in the field of quantum technology and artificial intelligence models for Earth observation (QUAI4EO). Expected to last three years, this collaboration intervenes in the context of CERN's Quantum Technology Initiative and ESA Φ-lab programme on Earth observation.

QUAI4EO will explore models for Earth observation.

A FUTURE ESA-SUPPORTED FACILITY FOR HIGH PENETRATION HEAVY IONS TESTS AT CERN

Radiation testing is a major topic of the partnership between CERN and ESA. As both space and high-energy physics applications increasingly rely on complex and heavily packaged commercial off-the-shelf components, it is important to characterise their radiation tolerance. In order to reach the active and radiation-sensitive semiconductor die of the component, high-energy ion beams are necessary.

As the availability of this type of beam is scarce, ESA has decided to support two studies in the frame of the CHIMERA project, which aims at adapting the CHARM irradiation facility at CERN for the arising needs of both the accelerator and the aerospace community.

"THE COLLABORATION WITH CERN HAS STIMULATED NOVEL RESEARCH METHODS AND INSIGHTS ON IDENTIFYING MANIPULATIONS IN FINANCIAL MARKETS, THAT WERE UNTHINKABLE BEFORE."

Joost M.E. Pennings,
Professor at the Wageningen University

EMERGING TECHNOLOGIES

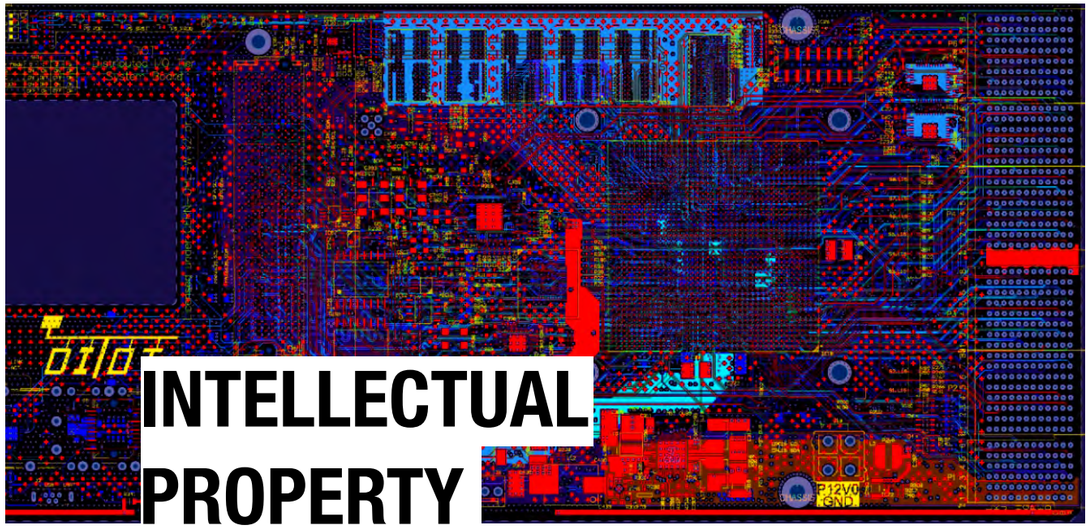
Data corridor at the CERN Data Centre.

FROM PHYSICS TO FRAUD DETECTION

The Wageningen University in the Netherlands, the Commodity Risk Management Expertise Centre (CORMEC) and CERN are collaborating to help protect commodity and financial markets from fraud. CERN's expertise and tools in big data storage, processing, analysis, and visualisation are being leveraged to advance anomaly detection techniques in order to help identify irregularities in financial markets. The collaboration has resulted in the first publications in 2021, where CERN's open-source data-analysis tool ROOT was used to reconstruct and visualise future markets. This novel approach complements existing research methods, improving identification and interpretation of market manipulation.

SCALING CERN'S GLOBAL SOFTWARE DISTRIBUTION SYSTEMS TO NEW HEIGHTS IN FINANCE AND HIGH-ENERGY PHYSICS

CERN Virtual Machine File System (CERNVM-FS) is a reliable, scalable and low-maintenance global software distribution service. This service is at the core of CERN's computing environment for data analysis, and high-energy physics (HEP) collaborations rely on CERNVM-FS for worldwide software deployment.
The unique capabilities of this open source software convinced Jumptrading, a leading global quantitative research company to adopt it for various internal uses, including software distribution and market data archive access. Thanks to a new agreement, CERN and Jumptrading have partnered up to improve speed and scalability and add interesting features to the software. Improvements in the software will also benefit the HEP community and the wider open source community using it.



INTELLECTUAL PROPERTY

A Printed Circuit Board (PCB) layout, including a CERN OHL v2 licence notice in its silk screen layer.

THE OPEN SOURCE INITIATIVE (OSI) ENDORSED THE CERN OPEN HARDWARE LICENCE 2.0

In January 2021, the Open Source Initiative (OSI) approved as OSI compliant the CERN Open Hardware Licence 2.0; a family of licences that governs the use, copying, modification and distribution of hardware designs.
Version 2 of the Open Hardware Licence (OHL) uses simpler terminology than its original version, introduces three variants of the licence, and adapts the licence to cases such as application-specific integrated circuits (ASICs) and field-programmable gate arrays (FPGAs). It can even be used to license software.
The endorsement by OSI will ultimately make the selection and application of the licences easier, as they are now included in the list of OSI-approved licences, a concept widely understood in the open source community.

"OPEN HARDWARE GIVES DESIGNERS AND USERS THE FREEDOM…THAT ENABLES COLLABORATION AMONG ENGINEERS, SCIENTISTS, RESEARCHERS, HOBBYISTS AND COMPANIES."

Javier Serrano, Engineer at CERN and
Open Hardware Repository (OHR) founder

ENTREPRENEURSHIP

Startups built on emerging technologies have impacted every sector of our lives – from novel vaccines to space exploration. CERN wants to support these visionary entrepreneurs who aspire to revolutionise the world.

DEEP-TECH STARTUPS: FROM THE LAB TO THE MARKET

Three new startups entered the Business Incubation Centres of CERN technologies in 2021.

Researcher at Delta Biosciences running experiments.

DELTA BIOSCIENCES

Delta Biosciences, a Lithuanian startup, is developing a next-generation screening platform to accelerate new drug discovery. CERN's cutting-edge know-how in micro-engineering is particularly pertinent to the company's advances in microscale detection systems. A novel way to manufacture highly-customisable microvias, useful in electronics applications, was invented by experts at CERN. This technology is helping the startup further miniaturise its screening capabilities, which is essential on the road to discovering novel therapies.

Transmission electron microscope setup provided by condenZero.

CONDENZERO

CondenZero, a Swiss startup, specialises in instrumentation for ultra-high vacuum and cryogenic conditions. Current state-of-the-art technology in transmission electron microscopy allows samples to be held at cryogenic temperatures for measurement only for 15 minutes. CondenZero has developed sample-holders that allow measurement for up to 24 hours, thus revolutionising cryo-electron microscopy (Cryo-EM). CERN's expertise in designing cryostats can help condenZero's pursuits to improve Cryo-EM.

A semiconductor wafer for optical communication under test by Lumiphase.

LUMIPHASE

Lumiphase, a Swiss startup, aims to build optical communication chips using Barium Titanate (BTO) to help network equipment vendors and cloud providers manage the ever-increasing data traffic. The underlying technology was developed at IBM Research Zurich by the founding team and led to the spin-out company.
CERN's irradiation facilities can help assess the impact of radiation on Lumiphase products for optical data transmission in harsh environments. The results will also help assess the applicability of these products for CERN's detectors, CERN's accelerators, and in space.

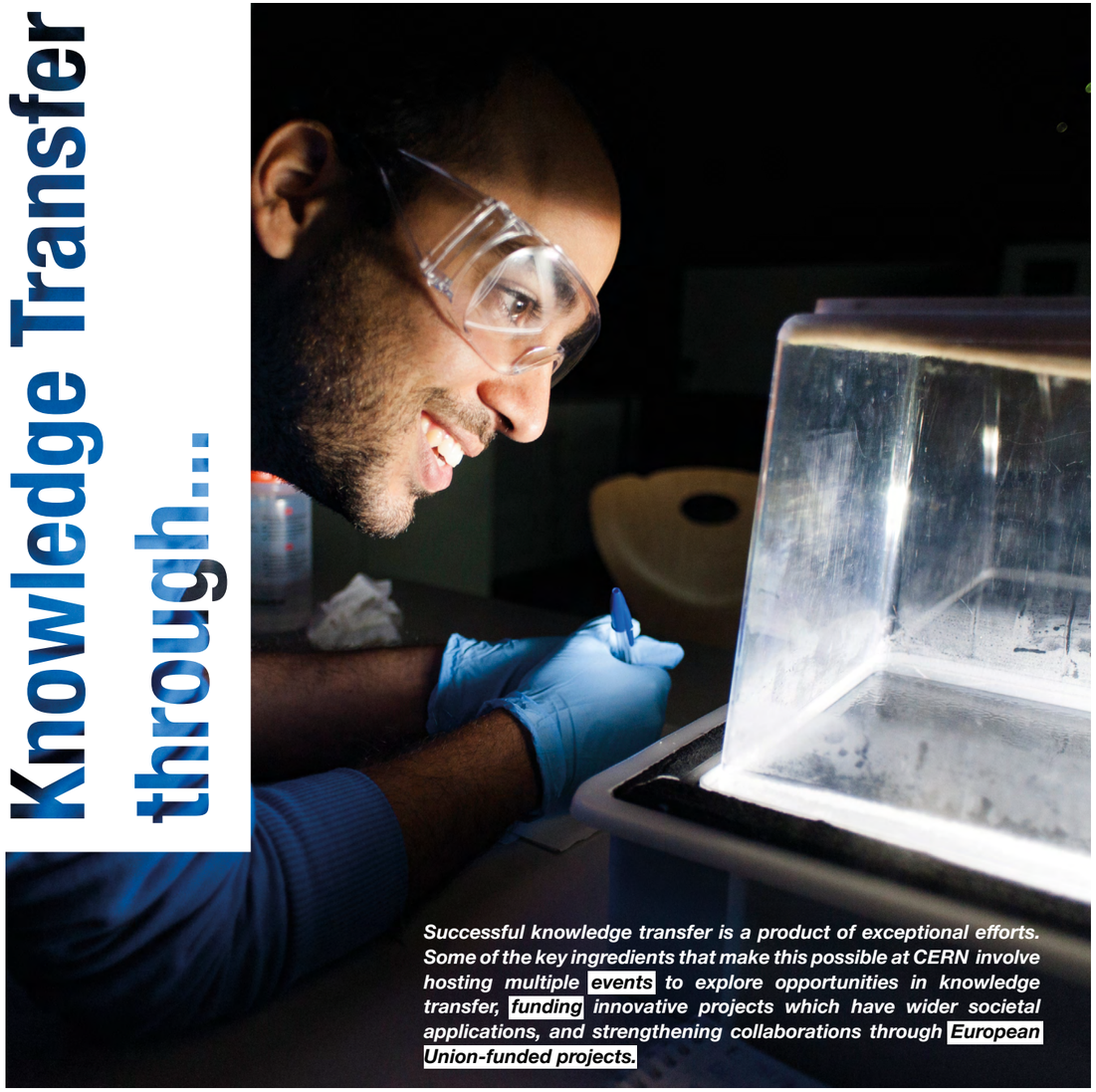
CERN's entrepreneurship programmes support the next generation of technical entrepreneurs.

ENTREPRENEURSHIP TRAINING AND SUPPORT: GLOBAL AND DIVERSE

In 2021, CERN and INSEAD, one of the world's leading business schools, jointly developed a new deep-tech programme for their Executive MBA. The teams of MBA students scouted potential market applications for CERN technologies through projects which varied from blockchain analysis for money laundering using CERN ROOT technology, clock timing for security in power plants using CERN's White Rabbit technology to portable imaging using CERN's Medipix chipsets.

CERN's entrepreneurship programmes with technical and industry experts also helped students from countries all over the world including Norway, India, Mexico, Canada, North Macedonia, and Lithuania navigate their entrepreneurial journey.

Knowledge Transfer through...



Successful knowledge transfer is a product of exceptional efforts. Some of the key ingredients that make this possible at CERN involve hosting multiple events to explore opportunities in knowledge transfer, funding innovative projects which have wider societal applications, and strengthening collaborations through European Union-funded projects.

Knowledge-transfer opportunities arise through discussions, networking and targeted events. Throughout 2021, despite the pandemic, the CERN Knowledge Transfer (KT) group continued organising talks, seminars, visits, and events virtually or in person where possible while ensuring safety.

CERN DISCOVERY DAYS TO INNOVATE WITH INDUSTRY

Discovery Day events are an effective way to showcase CERN technologies and explore how the Organization's unique know-how can help industries solve their problems. In 2021, two Discovery Day events were held at a country level with Member States (Denmark and the United Kingdom). Besides this, ten other Discovery Days were organised with individual companies to explore new opportunities. An 'Innovate in healthcare' event with BioAlps, a diversified life-sciences cluster in Switzerland brought the spotlight on medical innovation.

5
Entrepreneurship Meet-Ups

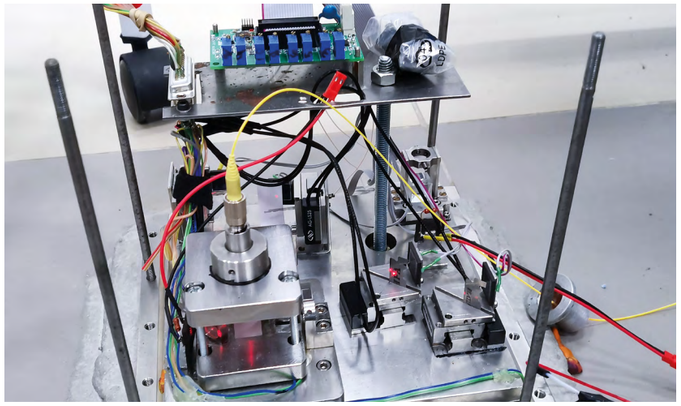
5
CERN Knowledge Transfer seminars

10+
Discovery Days to innovate with industry

In 2021, different activities like KT seminars and Entrepreneurship Meet-Ups (EMUs) contributed to fostering a culture of knowledge-transfer and entrepreneurship within and beyond the Organization.

Before the pandemic, the EMUs often took place at IdeaSquare; the innovation space at CERN where early stage ideation prototyping for many future knowledge-transfer innovation projects happens. Adapting to the global health measures, the events traditionally held at IdeaSquare had to move online apart from a joint presentation to the Finance Committee that took place in 2021, with a virtual visit of IdeaSquare and CERN facilities involved in knowledge transfer.

Funding mechanisms like the CERN Knowledge Transfer (KT) fund, help support CERN experts take their research from the lab to wider applications in society. On top of this, the CERN Medical Applications (MA) budget focuses on nurturing technologies with the potential for applications in medical or biomedical fields. In 2021, the KT fund and MA budget financed eight projects with a total funding of 1.86 MCHF.



The Compact Precision Laser Inclinometer (CPLI) provides a cheaper portable alternative to common seismometers.

A NEW FUND FOR IMPACT

In March, the CERN Technology Impact Fund was launched, a new tool to bridge the gap between the technology developed for research at CERN and its potential applications to address societal challenges. The fund was launched with help from the CERN & Society Foundation, which is actively seeking external donors.

Financial backing provided by the fund will enable CERN technologies to contribute to the 17 Sustainable Development Goals (SDGs) adopted by all United Nations Member States.

The first technology selected by the fund is the Compact Precision Laser Inclinometer (CPLI), originally intended for measuring ground movements around CERN's ATLAS detector. The technology can be adapted as an extremely sophisticated early-warning system for seismic events, helping rescue operations in regions prone to such natural disasters.

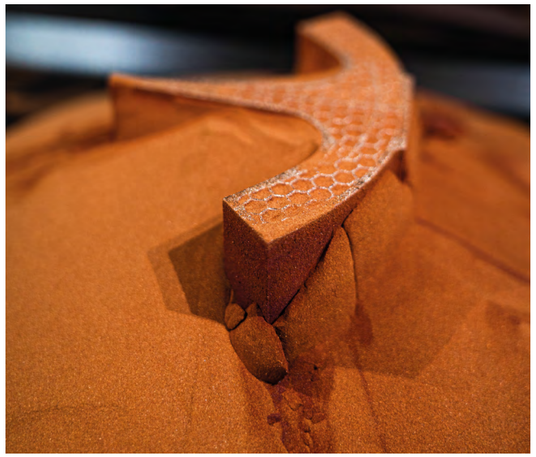
Scan the QR code to learn more about the AIDAinnova project.

As the leading European particle physics organisation, CERN participates actively as a partner and/or coordinates projects co-financed by the European Union (EU) under research and innovation programmes such as Horizon 2020 and Horizon Europe. Among the 57 EU projects running at CERN, six, with a strong knowledge-transfer component, started in 2021. CERN coordinates five of them. The total EU funding for all six projects (PRISMAP, HITRIplus, ATTRACT2, I.FAST, AIDAinnova, RADNEXT) amounts to EUR 70 million and is distributed among the participating institutes and companies.

ADDITIVELY MANUFACTURED COPPER COMPONENTS FOR LINEAR ACCELERATORS

Over 30 000 accelerators are currently in use worldwide, the large majority of which are used for healthcare, environment and industry. 3D printing, also known as additive manufacturing is one way to make them more accessible to users.

In 2021, through the CERN-coordinated I.FAST project, researchers succeeded for the very first time to additively manufacture an accelerator quadrupole component essential to linear particle accelerators. Made out of pure copper powder, this component has a hollow structure which helps save both material consumption and manufacturing time. This achievement was made possible by Fraunhofer IWS in Germany together with CERN, Latvia's Riga Technical University and Politecnico di Milano in Italy, all partners of I.FAST.



Component for accelerators made from copper powder using 3D printing for the first time.

ATTRACT ENTERS PHASE 2

During its Phase 1, the ATTRACT project supported 170 breakthrough technology concepts in the domain of detection and imaging technologies across Europe. Implementing its Phase 2 in 2021, it launched three open funding calls for:

1. The most promising opportunities arising from ATTRACT Phase 1, for a smooth transition from the lab to the market;
2. Young innovators from universities developing ideas and prototypes for social innovation in collaboration with professional researchers within the ATTRACT ecosystem;
3. Professional scholars undertaking a socio-economic study of the ATTRACT initiative.

CREDITS

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Find out more at kt.cern

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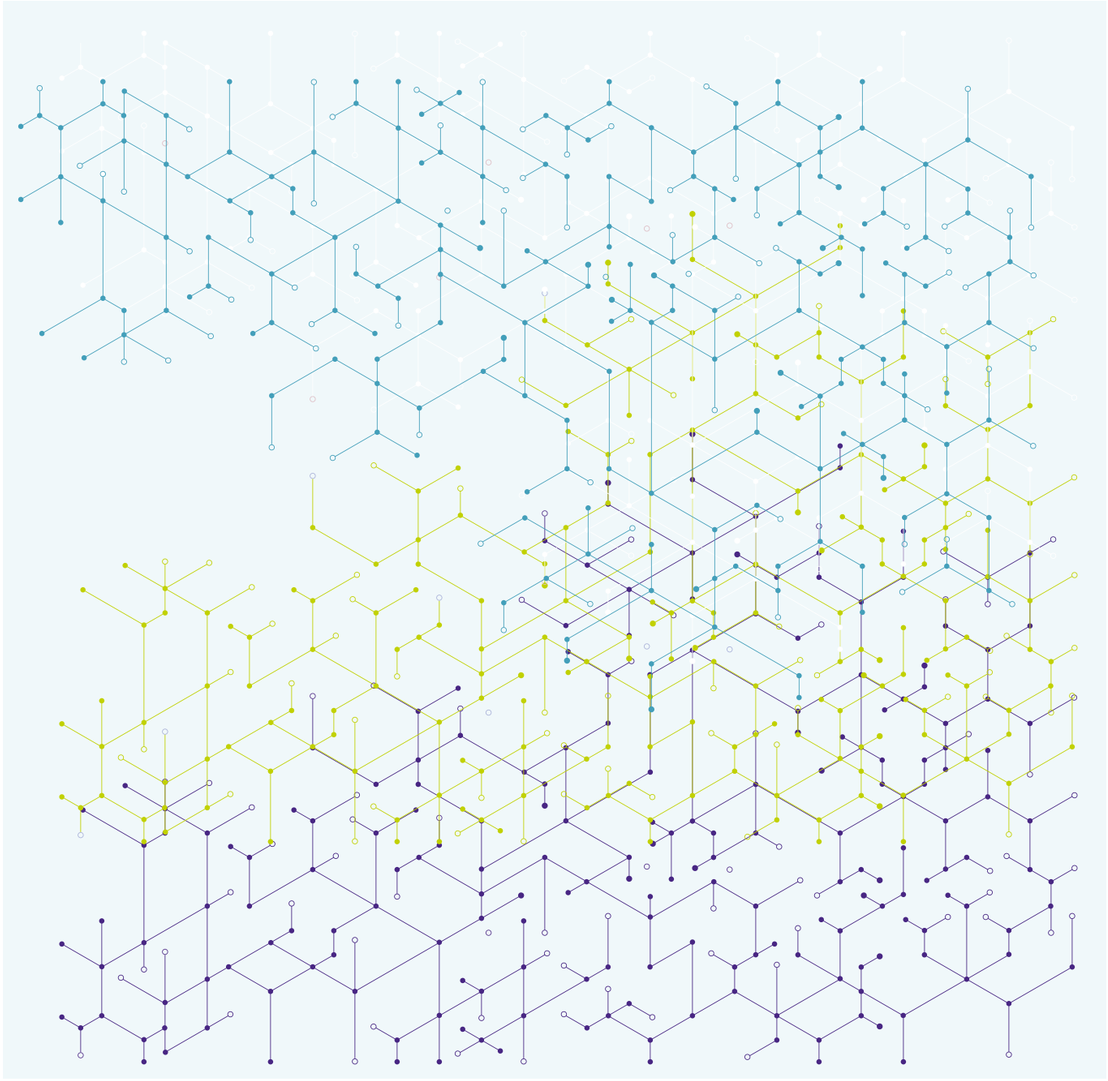
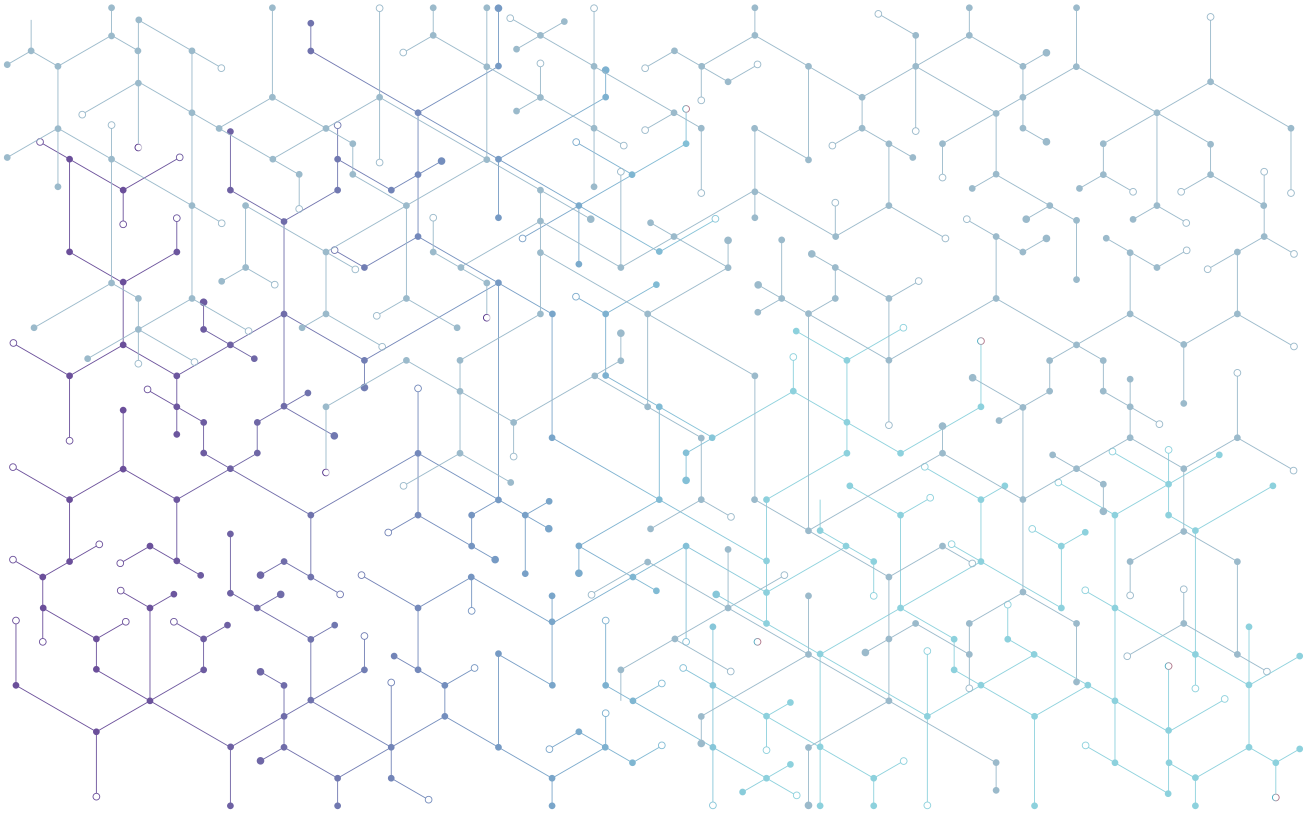
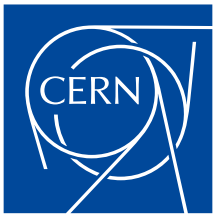
- All partners who have collaborated with CERN on knowledge -transfer activities.
- Everyone who has contributed to the content and production of this report

Scan the QR code to access the digital version of the CERN Knowledge Transfer Highlights 2021 on your device. You can also find links to individual projects on the digital version.



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