Innovation: knowledge transfer at CERN

Photo: CERN

Photo: CNAO treatment room

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CERN Knowledge Transfer Group

Knowledge Transfer
Accelerating Innovation

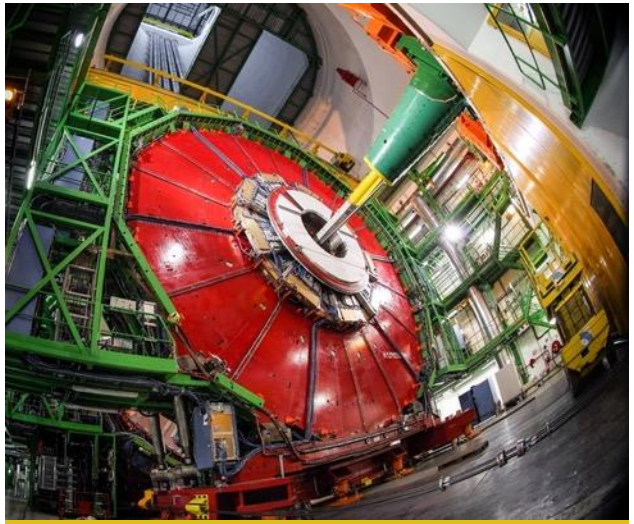
CERN: where the Higgs boson was discovered

François Englert and Peter Higgs. With Robert Brout, they proposed the mechanism in 1964.


WHERE THE
WEB
WAS BORN

We develop technologies in three key areas

ACCELERATORS



DETECTORS

COMPUTING

Over **70 companies and institutes produce accelerators for industrial applications**; these organizations sell more than **1,100 industrial systems per year** — almost twice the number produced for research or medical therapy — at a **market value of $2.2B**.

Over **$1B** of this amount is generated by the sales of accelerators for **ion implantation** into materials — primarily semiconductor devices — whose worldwide value of production is about $300B.

Hamm,R.andHamm,M.(2012).Industrial accelerators and their applications. World Scientific Publishing Co.

As of 2014 there were **42,200** accelerators worldwide:
27,000 (64%) in industry,
14,000 (33%) for medical purposes
1,200 (3%) for basic research.

These figures exclude electron microscopes and x–ray tubes, and the security and defense industries.

Chernyaev, A. P. and Varzar, S. M. (2014). Particle accelerators in modern world. Physics of Atomic Nuclei, 77(10):1203–1215.

Some updated figures in Doyle, McDaniel, Hamm, The Future of Industrial Accelerators and Applications, SAND2018-5903B

Machine Learning and Deep Learning

Industrial Controls and Automation

Data Analytics

Metrology

High and Ultra High Vacuum Systems

Health, Safety and Environment Management

Cryogenics

Optoelectronics and Microelectronics

High Volume Data Management & Storage

Superconducting Magnets

Particle Acceleration and Control

Radiation Protection and Monitoring

Particle Tracking and Calorimetry

Sensors

Material Science

Cooling and Ventilation

Robotics

Collaboration Tools

Radio Frequency Technology

Manufacturing and Mechanical Processes


sound reproduction
data management
testing satellite components
astronauts' radiation exposure
understanding turbulence
food sterilization
medical implants
finding oil, gas, water
geological dating
homeland security
scientific linux
curing of epoxies and plastics
medical imaging
x-ray diffractometry
spacecraft shielding
radiology
medical equipment sterilization
medical radioisotopes
non-destructive testing
nuclear waste transmutation
ion implantation
shrink wrap
radiotherapy
rad-hard electronics
PET
terrestrial reproduction of space radiation
simulations
industry 4.0
digital data preservation
optimised irrigation systems
drug development
safety
open hardware
www
powering complex biological simulations
industrial control systems
power transmission
analysis of satellite data
treatment planning systems
volcano tomography
space applications
sealing food packages
autonomous vehicles
isotope production
smoke detectors
hadron therapy
cultural heritage
MRI
cleaner air and water
ink curing
cargo screening
computer chips manufacturing
studying the retina
medical dosimetry
material science

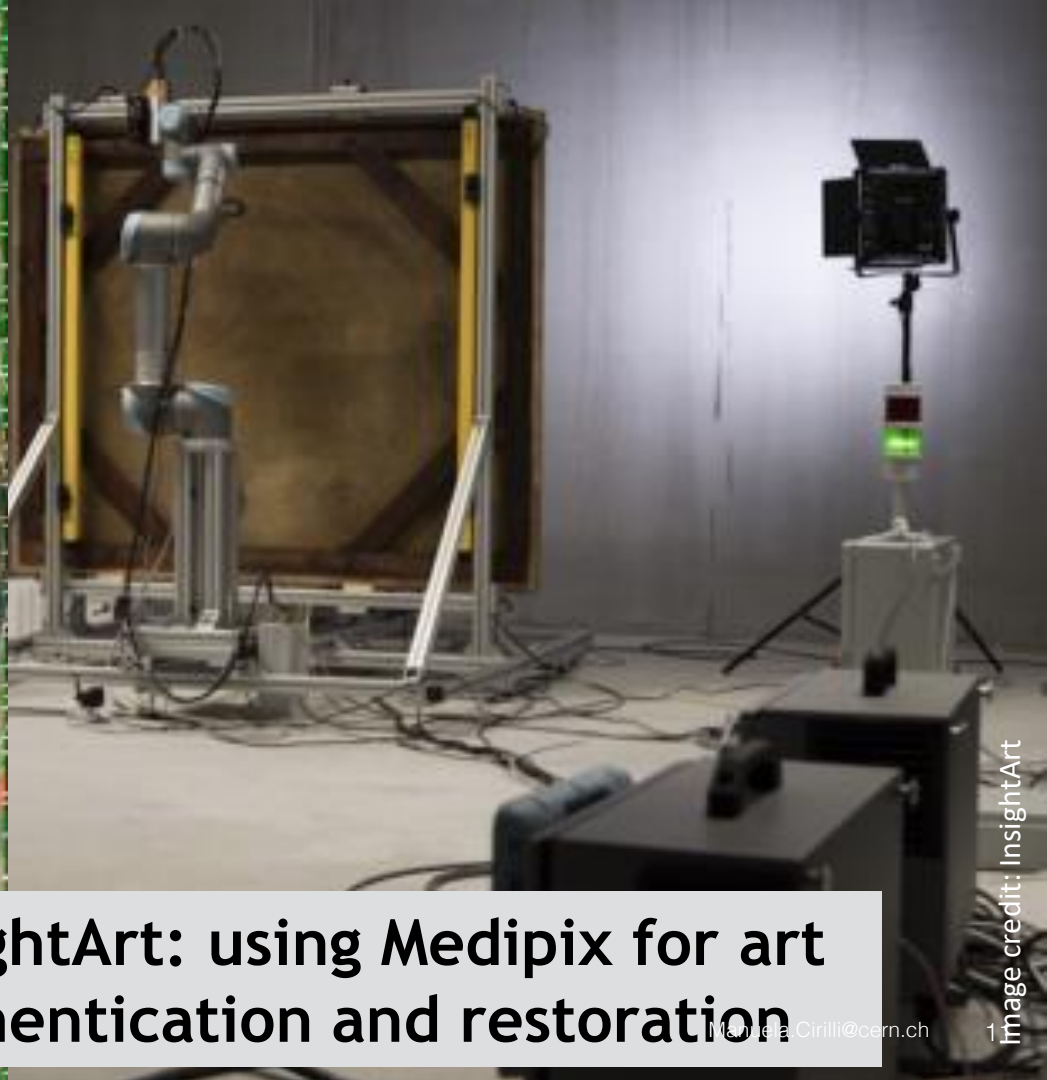
Knowledge Transfer's Mission

- **Maximise** the technological and knowledge return to society, in particular through Member States industry
- **Promote** CERN as a centre of excellence for technology and innovation
- **Demonstrate** the importance and impact of fundamental research investments

The Medipix Collaboration

Medical imaging, space dosimetry, education, and material analysis


mars



InsightArt: using Medipix for art authentication and restoration

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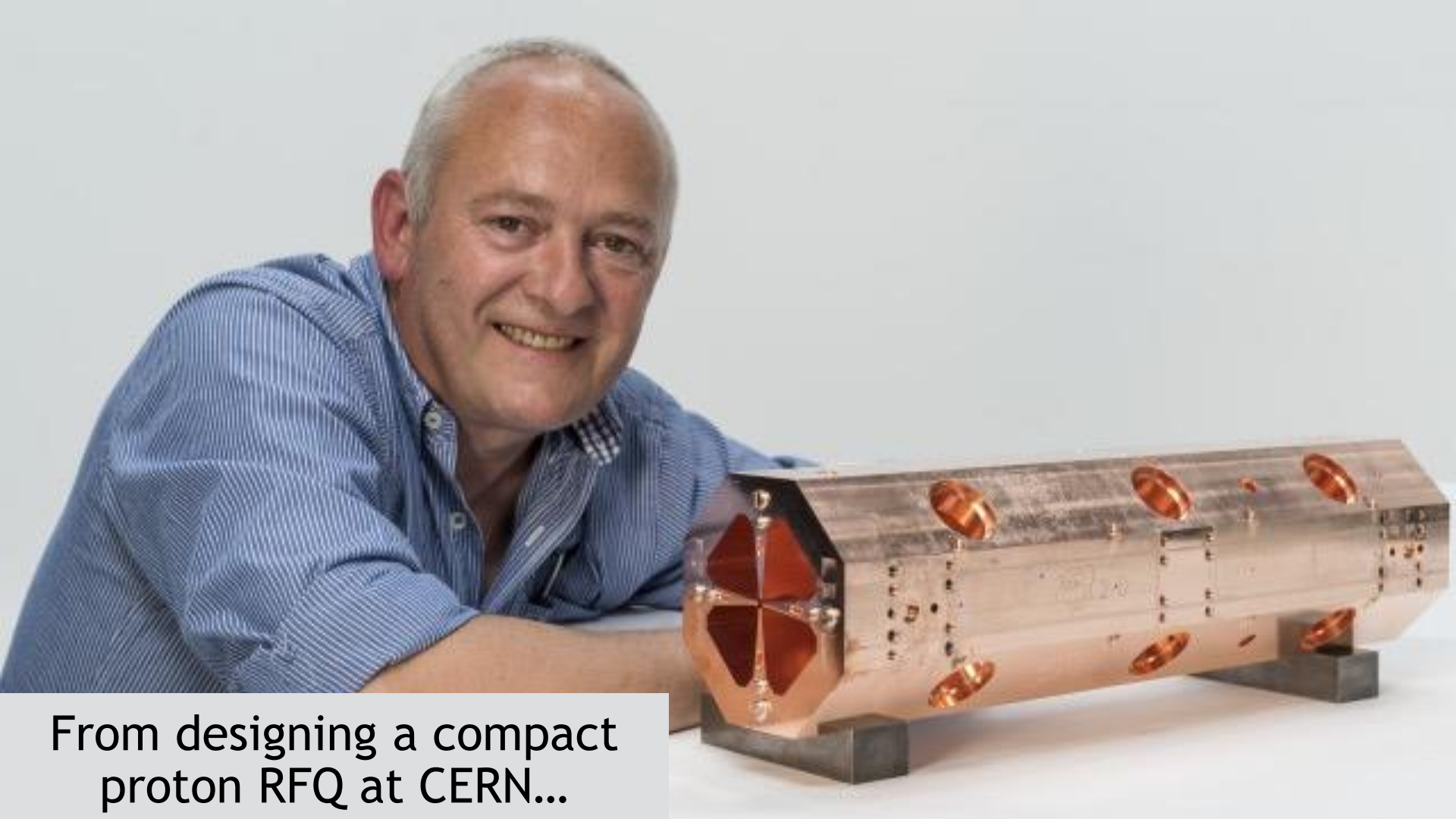
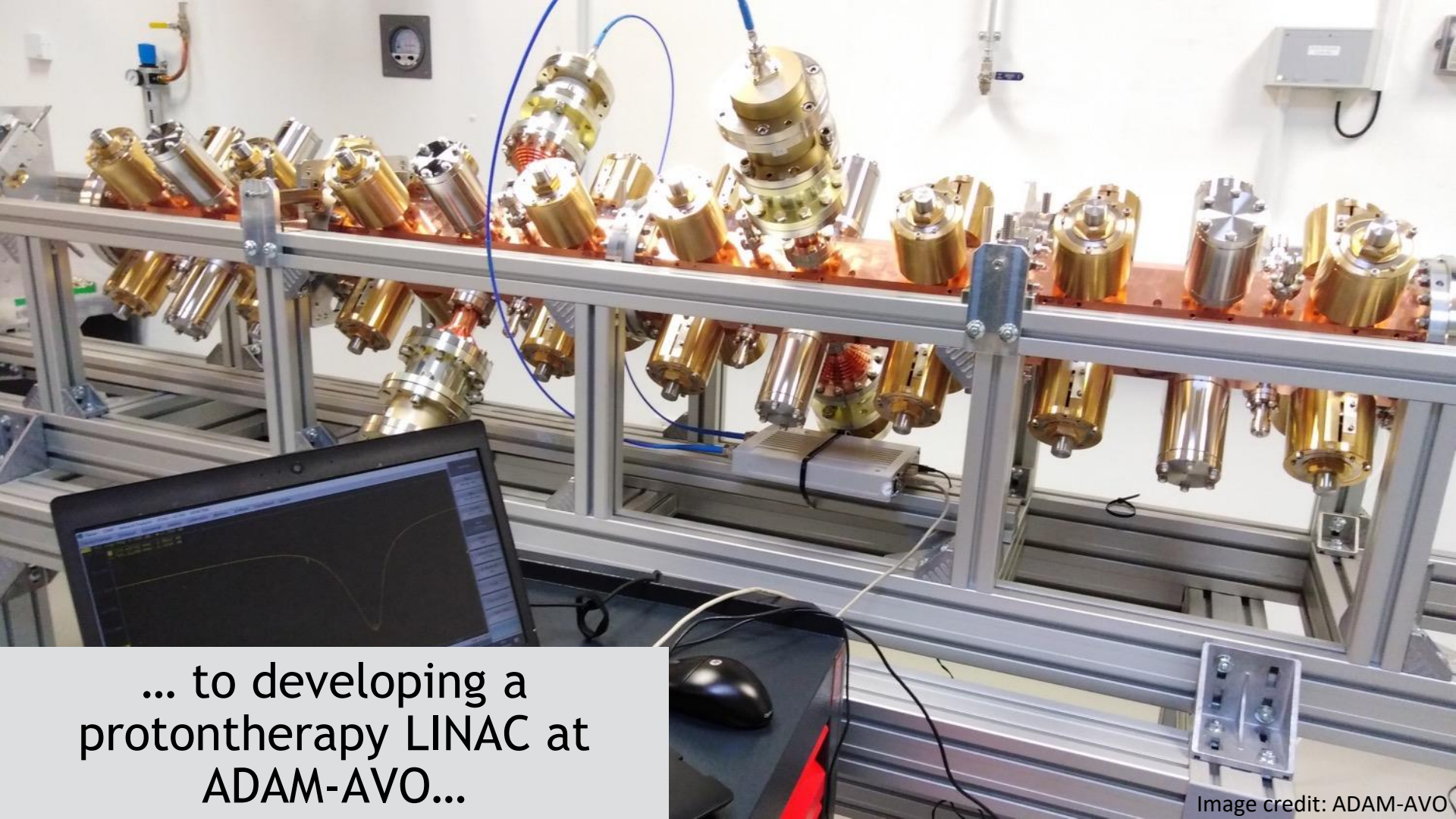
Image credit: InsightArt

NASA astronaut Megan McArthur in the International Space Station - along with the HERA detector (Image: NASA)

CELESTA: the first CERN-driven miniaturized satellite



From designing a compact proton RFQ at CERN…



… to developing a protontherapy LINAC at ADAM-AVO…

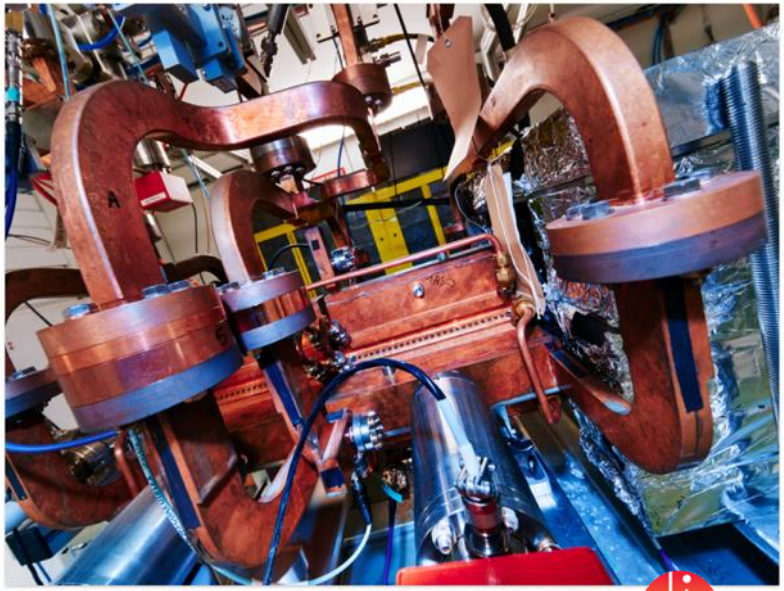
Image credit: ADAM-AVO

Image credit: INFN

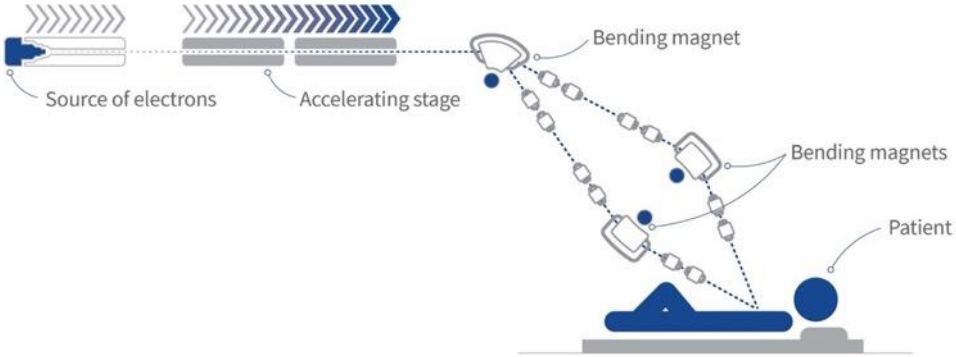
… and to developing MACHINA with INFN: a LINAC for cultural heritage

CERN, CHUV and THERYQ collaboration on FLASH VHEE therapy

CLIC technology for a FLASH VHEE facility being designed in collaboration with Lausanne University Hospital CHUV



Close-up of the Compact Linear Collider prototype, on which the electron FLASH design is based (Image: CERN)



An intense beam of electrons is produced in a photoinjector, accelerated to around 100 MeV and then is expanded, shaped and guided to the patient.

The design of this facility is the result of an intense dialogue between groups at CHUV and CERN.

Jean Bourhis from CHUV:
“The clinical need that we have really converges with the technological answer that CERN has.”

01 December 2022

Innovation

Airbus and CERN to partner on superconducting technologies for future clean aviation

Two European pioneers at the heart of disruptive technology

"PARTNERING WITH CERN WILL HELP PUSH THE BOUNDARIES OF RESEARCH, AS WE WORK TO MAKE SUSTAINABLE AVIATION A REALITY."

Ludovic Ybanez, Head of superconducting technologies demonstrator at Airbus UpNext.

CERN and Airbus UpNext, a wholly owned subsidiary of Airbus, are exploring the potential use of superconducting technologies developed by CERN in the electrical distribution systems of future hydrogen-powered aircraft.

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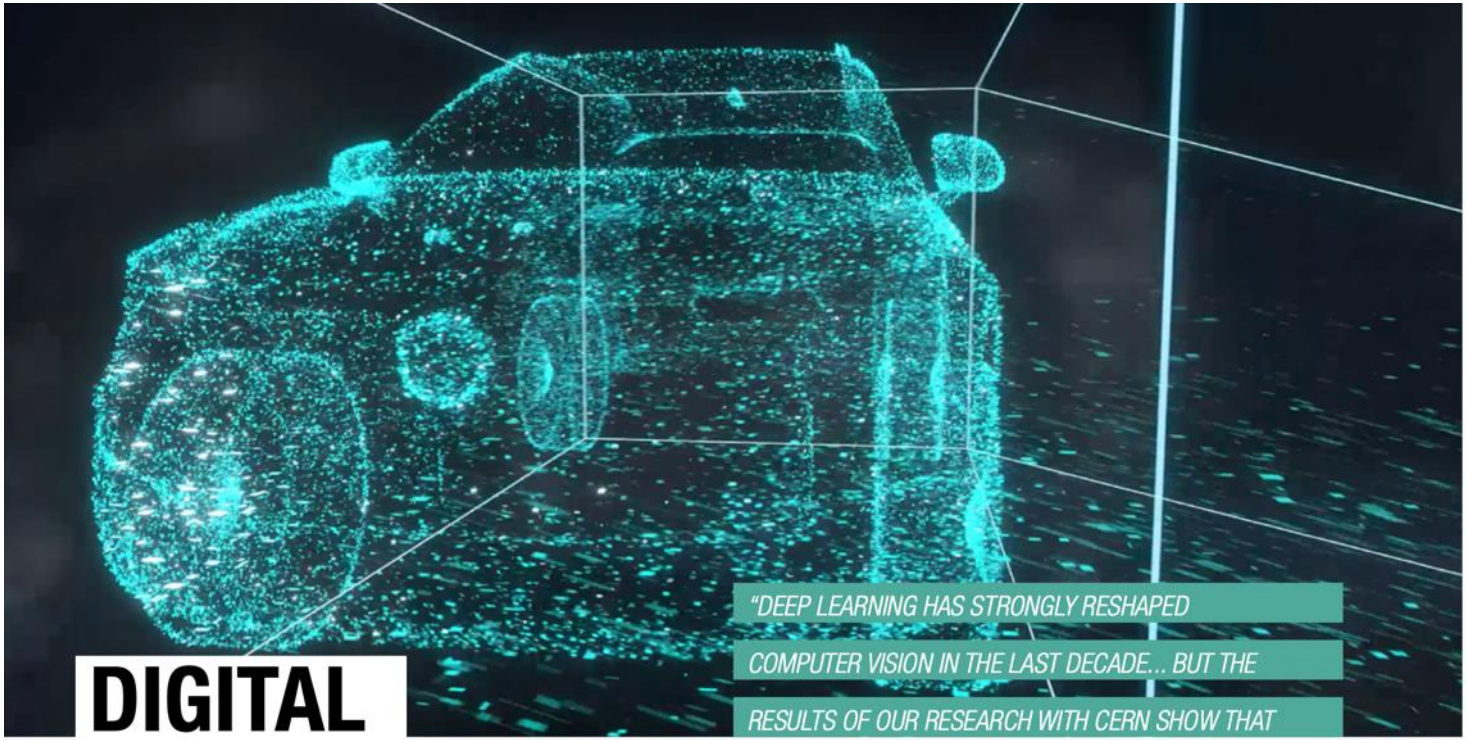

DIGITAL

"DEEP LEARNING HAS STRONGLY RESHAPED COMPUTER VISION IN THE LAST DECADE... BUT THE RESULTS OF OUR RESEARCH WITH CERN SHOW THAT THERE'S STILL ROOM FOR IMPROVEMENT WHEN IT COMES TO AUTONOMOUS VEHICLES."

Christoffer Petersson, research lead at Zenseact.

APPLYING MACHINE LEARNING FOR FAST DECISION-MAKING IN SELF-DRIVING CARS

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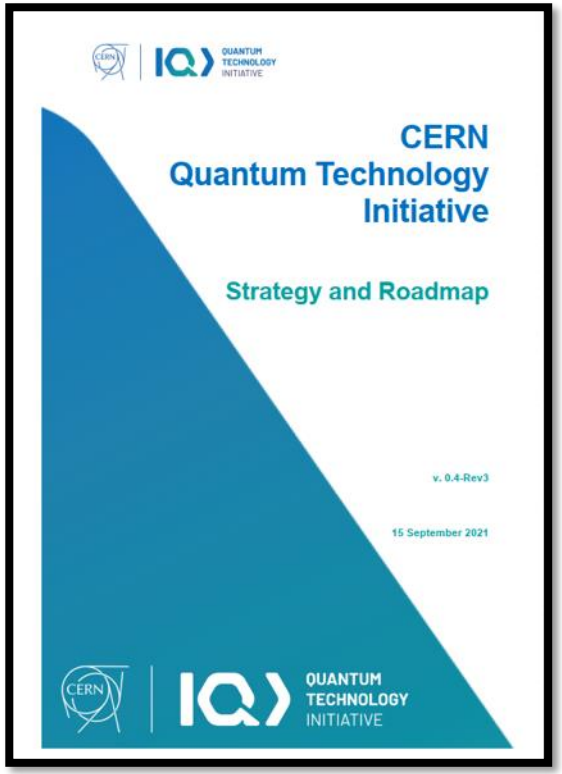
Bundesdruckerei (Berlin) works with CERN on next generation ideas for identity management and cryptography and data handling

Quantum Technology Initiative



https://doi.org/10.5281/zenodo.5553774

- Picosecond Synchronisation – White Rabbit
- Superconducting RF cavities
- Laser devices
- AI on FPGAs
- LLRF control
- Radiation Testing
- Measurement & Control systems
- Magnet design
- Material Characterisation
- Vacuum systems
- Cryogenic systems
- Thin film coating

https://kt.cern/competences/cern-tech-quantum-systems

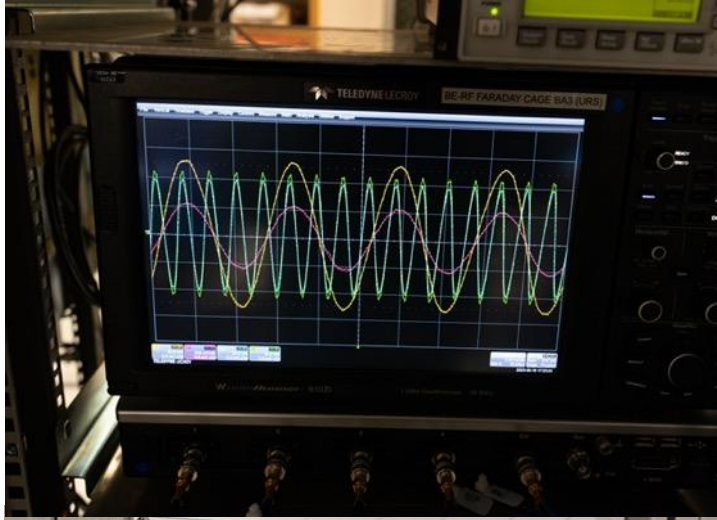
White Rabbit

A novel time- synchronisation system that offers sub-nanosecond accuracy and precision of a few picoseconds.

Fully open hardware and software

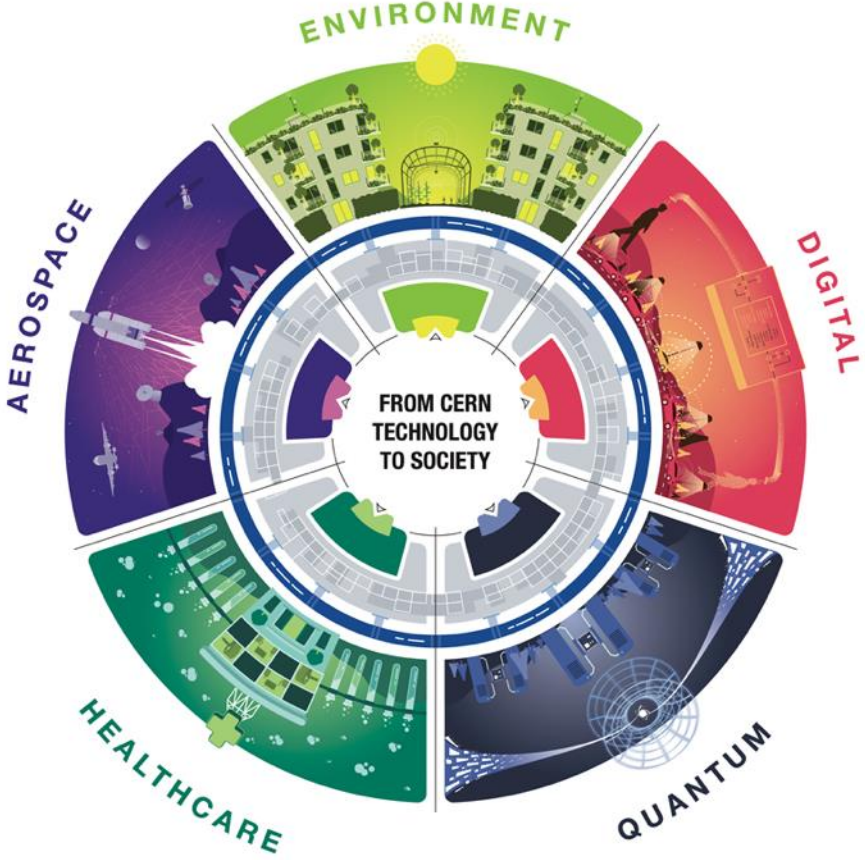
Since 2020, included in the worldwide IEEE industry standard called Precision Time Protocol (PTP)

CERN Open Hardware Licence




Intellectual Property Management
Licence, service & consultancy agreements
Open Hardware Licence & Open Source Software
R&D Collaborations
Knowledge Transfer in EC co-funded projects
Knowledge Networks (Links with Member States Institutional Relations)
CERN Knowledge Transfer Ecosytem
Knowledge Exchange (KT events & Seminars)
CERN Knowledge Transfer fund
CERN Medical Applications budget
CERN Technology Impact fund
Formal & practical training in business & KT
Financial, legal, business & intellectual property support
Entrepreneurship

Licence	Consultancy/Service	Contract research	Collaborative R&D
• Access to existing solution • Support to implement	• Specific issue • Time of experts • Time of facilities	• Specific solution • Outsource its development to CERN	• General issue • Jointly find solution • Jointly develop solution


ENVIRONMENT
DIGITAL
QUANTUM
HEALTHCARE
AEROSPACE
FROM CERN
TECHNOLOGY
TO SOCIETY

CIPEA CERN Innovation Programme on Environmental Applications

RENEWABLE AND LOW-CARBON ENERGY

Production
Transformation
Distribution
Storage

CLEAN TRANSPORTATION AND FUTURE MOBILITY

Aviation
Shipping
Rail
Automotive

SUSTAINABILITY AND GREEN SCIENCE

Power Management
Heat Management
Industrial Processes

CLIMATE CHANGE AND POLLUTION CONTROL

Monitoring
Modelling
Mitigation

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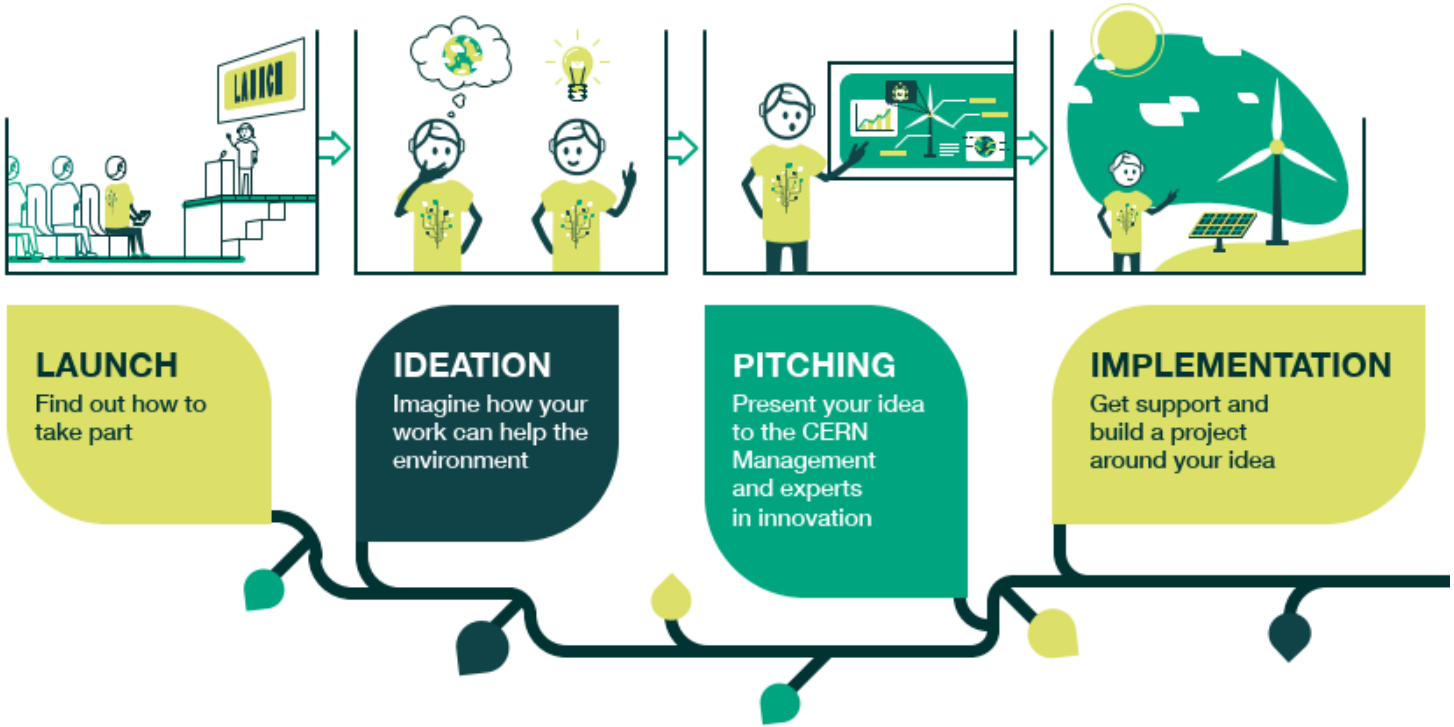
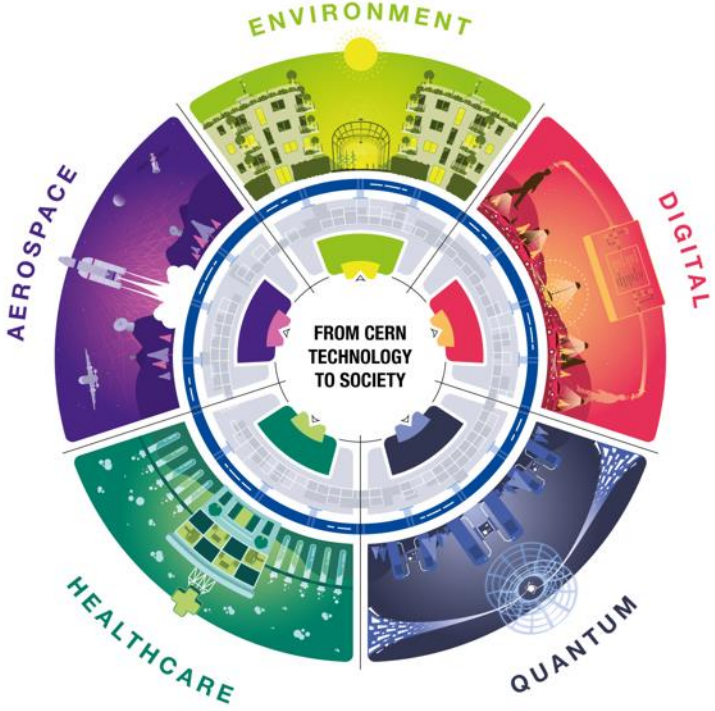
CERN Innovation Programme for Environmental Applications



CERN Technology Impact Fund



SUSTAINABLE DEVELOPMENT GOALS

"The CERN Technology Impact Fund has the ambition to increase CERN's contribution to the common good. It is particularly appropriate to launch this initiative in Geneva, where most of the international organisations in charge of building a better world are based."

Olivier Coutau

Delegate representing the Geneva Canton to International Geneva and member of the CERN & Society Foundation Board

CERN & Society Foundation

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Visit kt.cern

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