



CERN: Bridging the gap between science and business

Han Dols

CERN Knowledge Transfer | Section Business Development





CERN's mission

Research

Seeking and finding answers to questions about the universe

Technology

Advancing the frontiers of technology

Collaborating

Bringing nations together through science

Education

Training the scientists of tomorrow

Council meeting in
Amsterdam when the
CERN convention was
signed (1953).



Geneva is chosen for its
central location and the
neutrality of Switzerland.
Building starts in 1954.



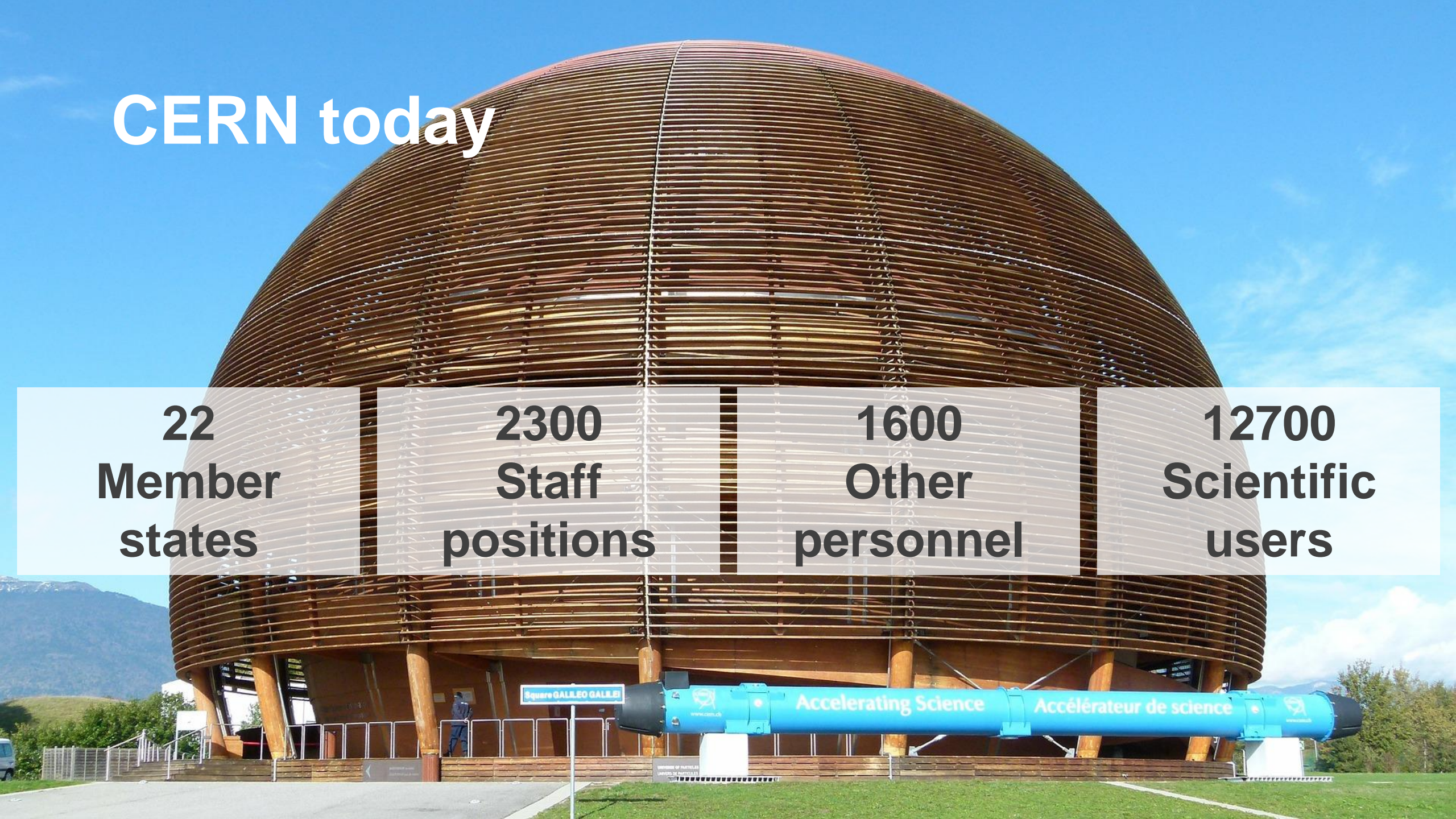
CERN today

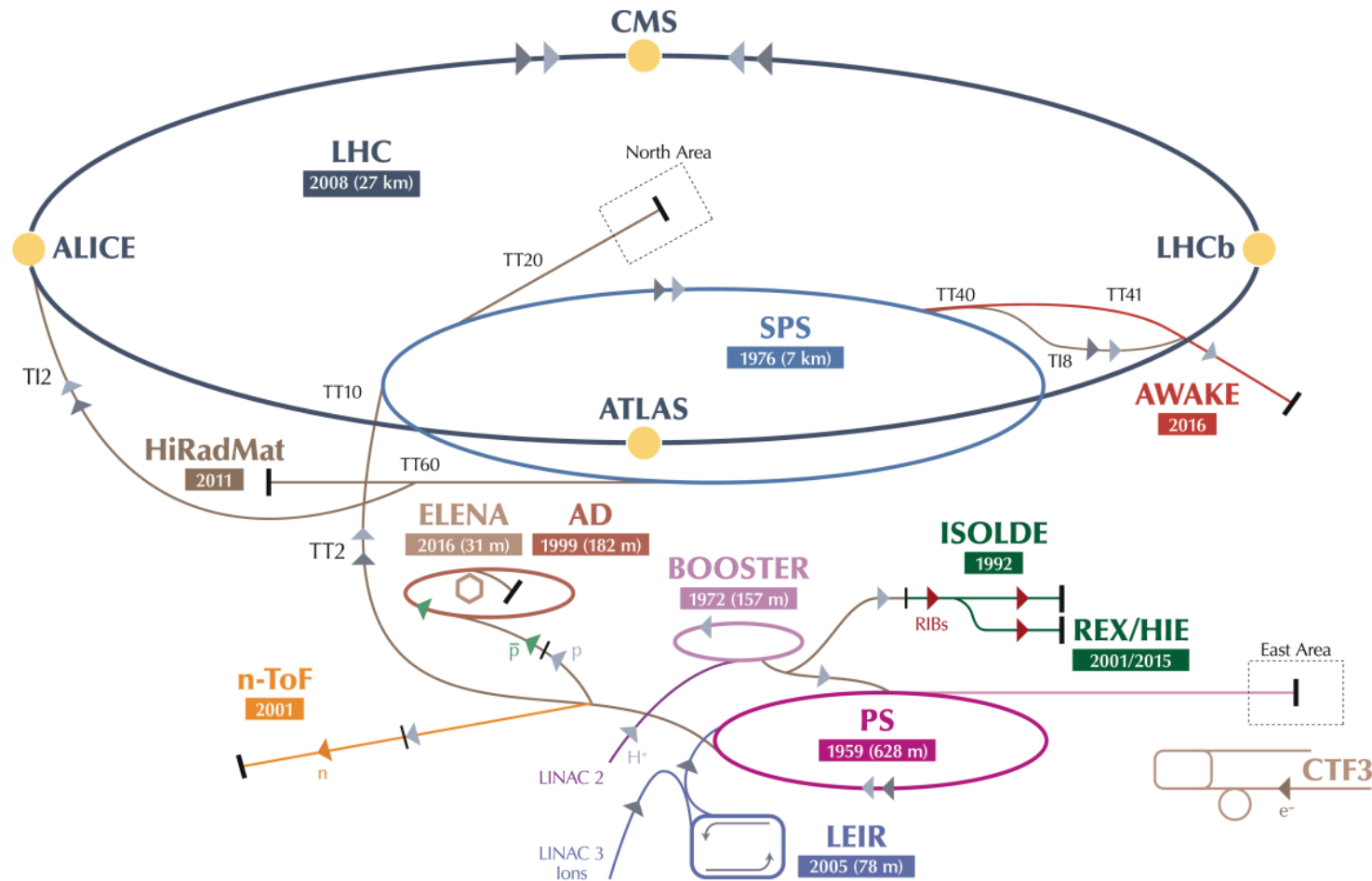
22
Member
states

2300
Staff
positions

1600
Other
personnel

12700
Scientific
users





▶ p (protons) ▶ ions ▶ RIBs (Radioactive Ion Beams) ▶ n (neutrons) ▶ \bar{p} (antiprotons) ▶ e^- (electrons) ▶ \leftrightarrow proton/antiproton conversion ▶ \leftrightarrow proton/RIB conversion

LHC Large Hadron Collider SPS Super Proton Synchrotron PS Proton Synchrotron AD Antiproton Decelerator CTF3 Clic Test Facility

AWAKE Advanced WAKEfield Experiment ISOLDE Isotope Separator OnLine REX/HIE Radioactive EXperiment/High Intensity and Energy ISOLDE

LEIR Low Energy Ion Ring LINAC LiNear ACcelerator n-ToF Neutrons Time Of Flight HiRadMat High-Radiation to Materials



The Large Hadron Collider (LHC)



SUISSE
FRANCE

CMS

LHCb

CERN Prévessin

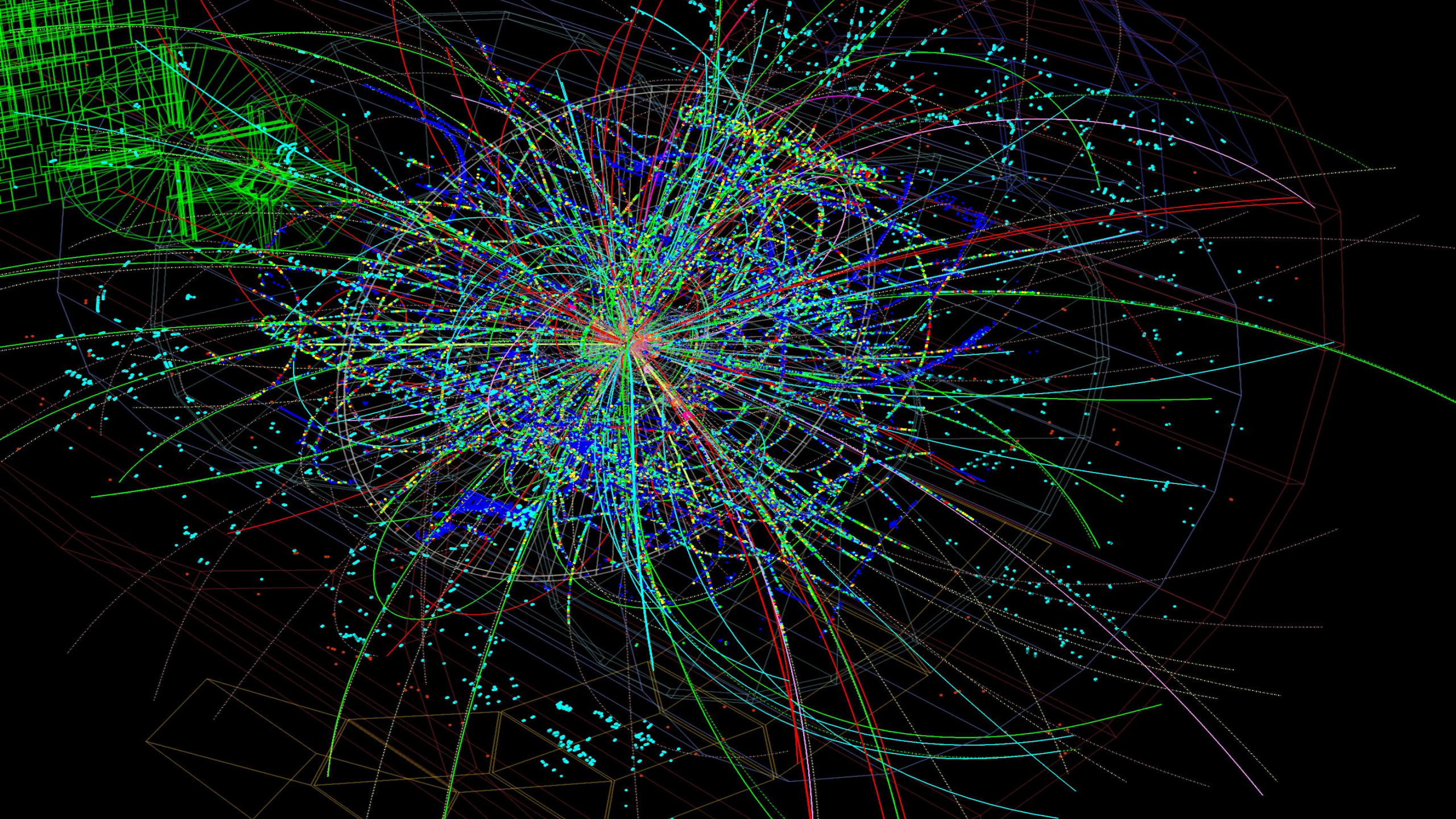
ATLAS

CERN Meyrin

SPS 7 km

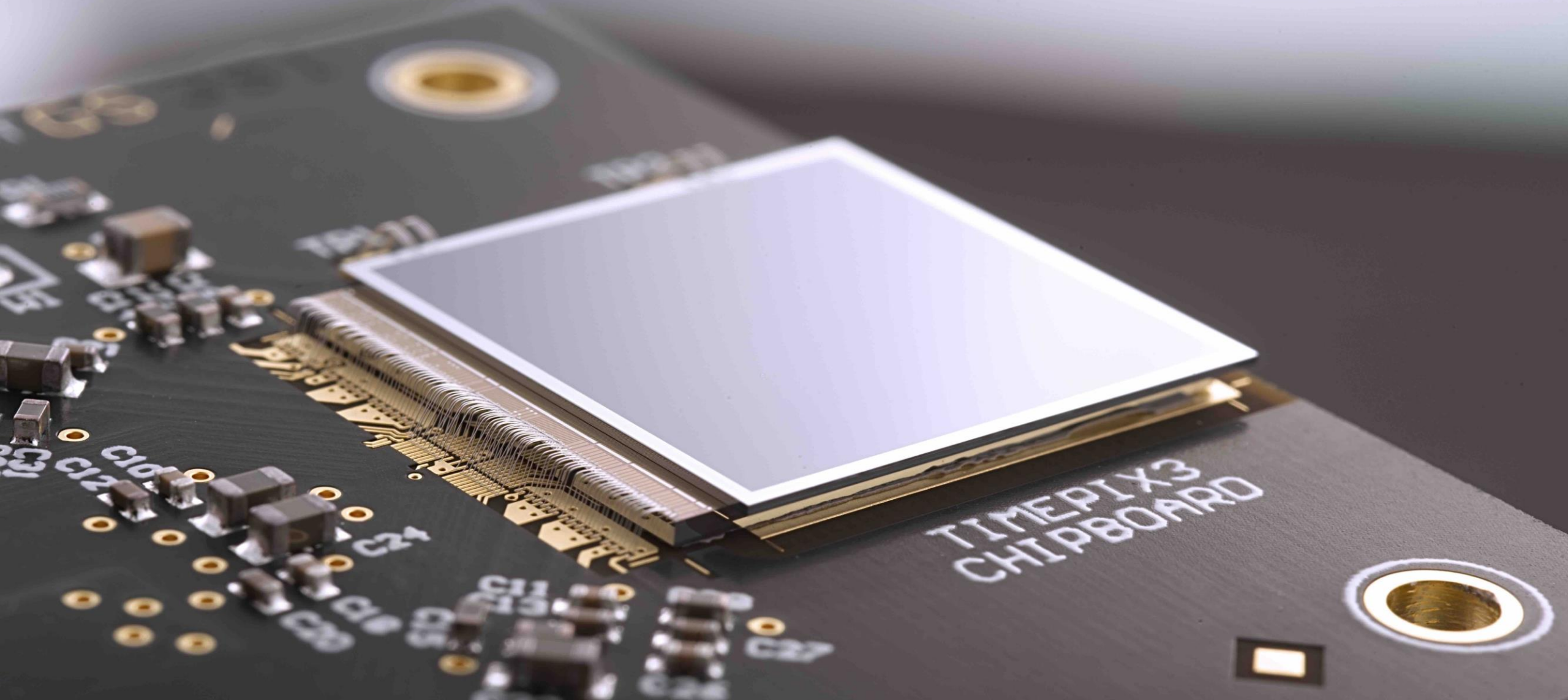
ALICE

LHC 27 km



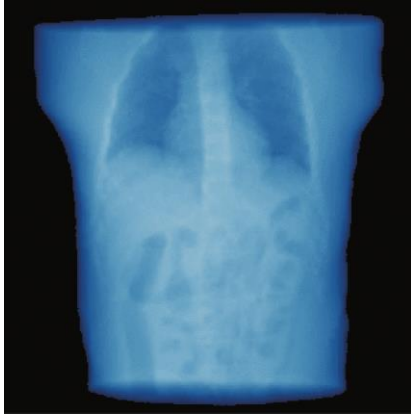
The mission of CERN's Knowledge Transfer Group is to maximise the impact of CERN technology and know-how in society, in particular thru industry in the member states.





Accelerating Innovation

Examples of 2016



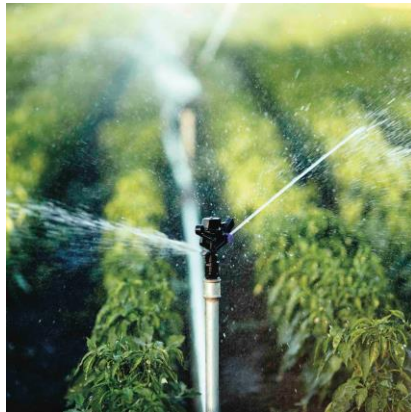
TIGRE: open source software for medical imaging



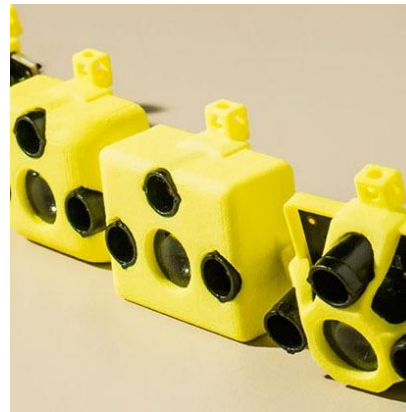
VESPER maiden test for jupiter environment



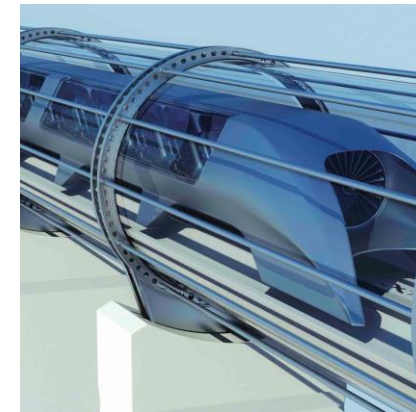
Kryolize: novel cryogenic safety software



FOSS4I: help with water shortage

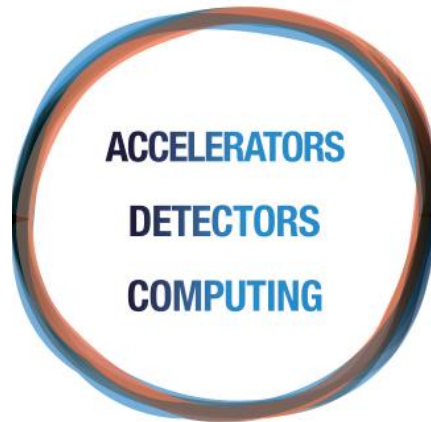


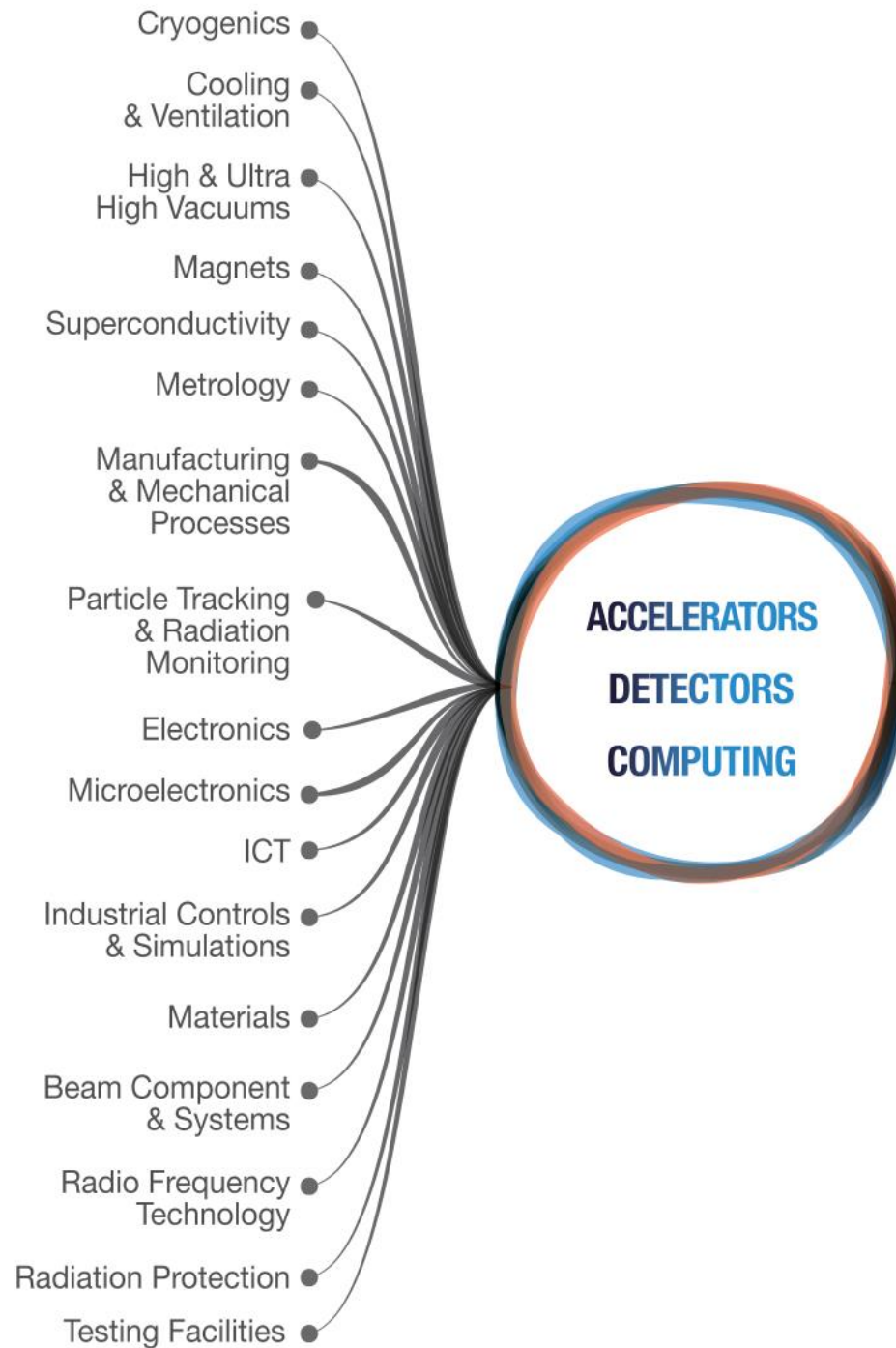
Sensor technology on drones



Hyperloop: sonic speeds in high-vacuum tubes

The core of CERN







Medical & Biomedical Technologies

MEDICAL & BIOMEDICAL PHYSICS RESEARCH

Medical researchers, clinicians & patients rely on novel particle **detectors** for radiation

Radiobiology studies and innovative radioisotope production can be performed in special **accelerator** facilities

Computing & big data challenges in particle physics can provide solutions for biomedical research

BIOMEDICAL TECHNOLOGIES

Tools and techniques for particle physics find applications in **biomedical** technologies

IMAGING & DIAGNOSIS

Medical imaging relies on particle **detectors**, some directly resulting from fundamental research

The analysis of medical images requires sophisticated **computing** tools

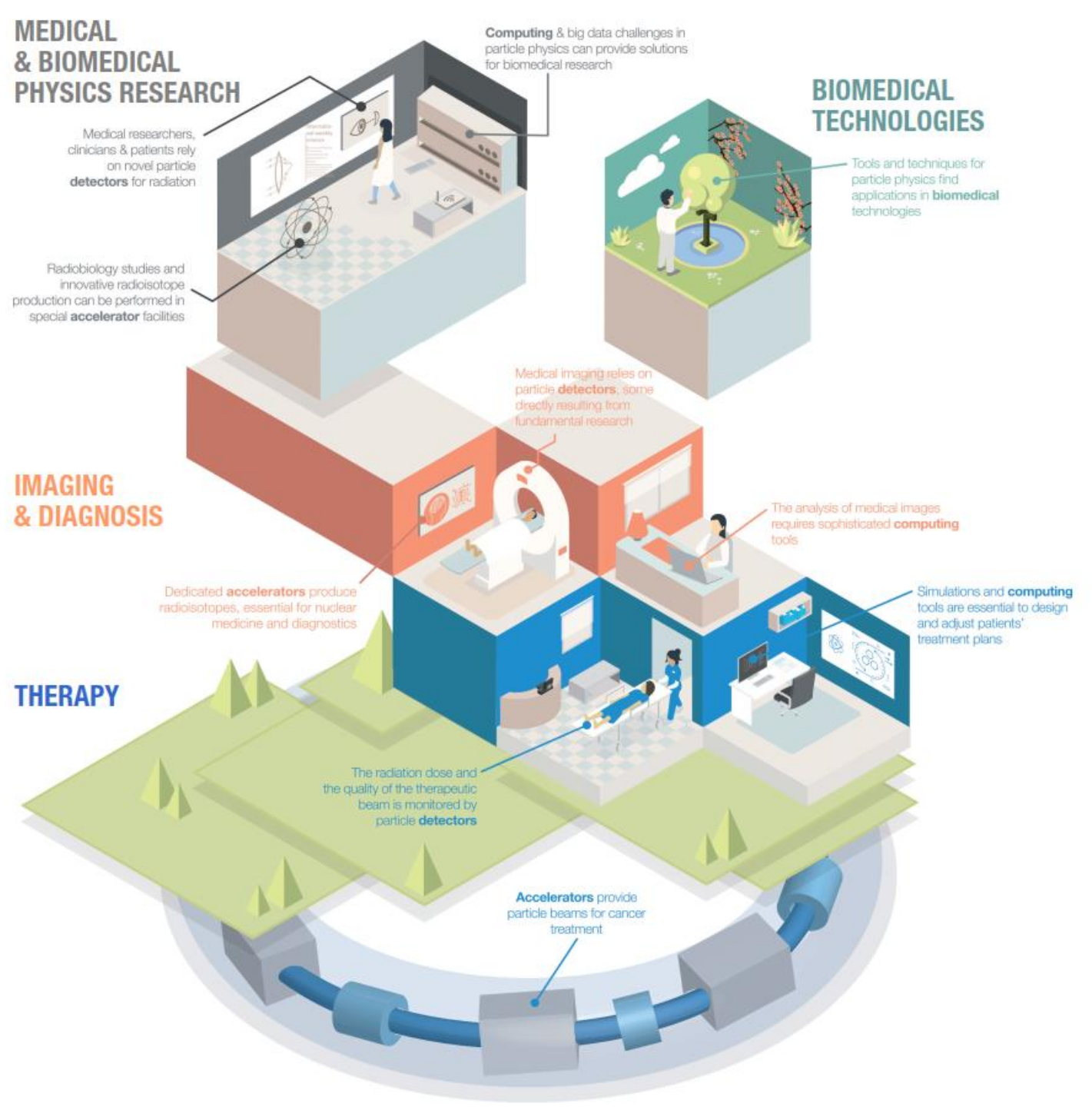
Dedicated **accelerators** produce radioisotopes, essential for nuclear medicine and diagnostics

Simulations and **computing** tools are essential to design and adjust patients' treatment plans

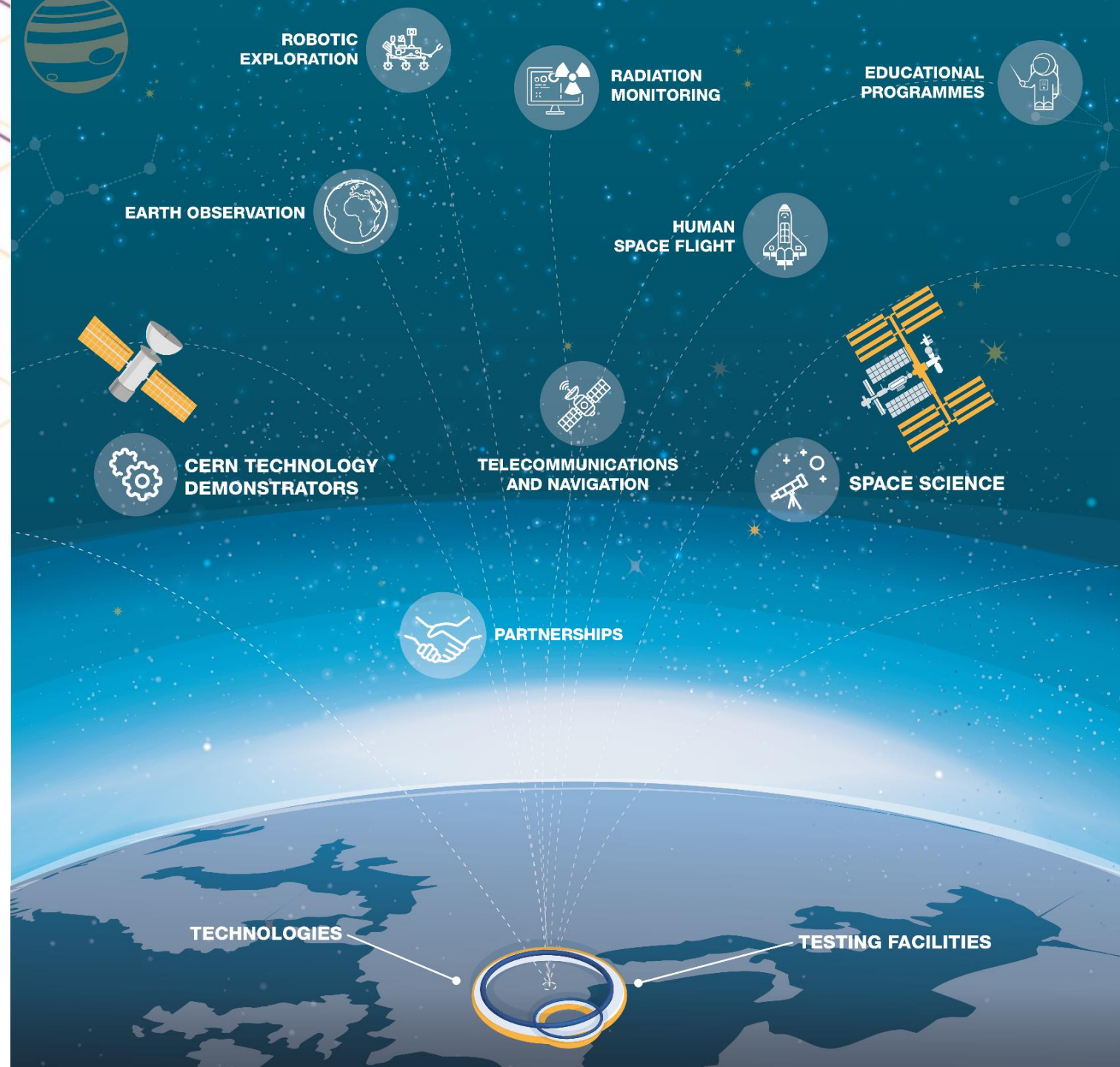
THERAPY

The radiation dose and the quality of the therapeutic beam is monitored by particle **detectors**

Accelerators provide particle beams for cancer treatment

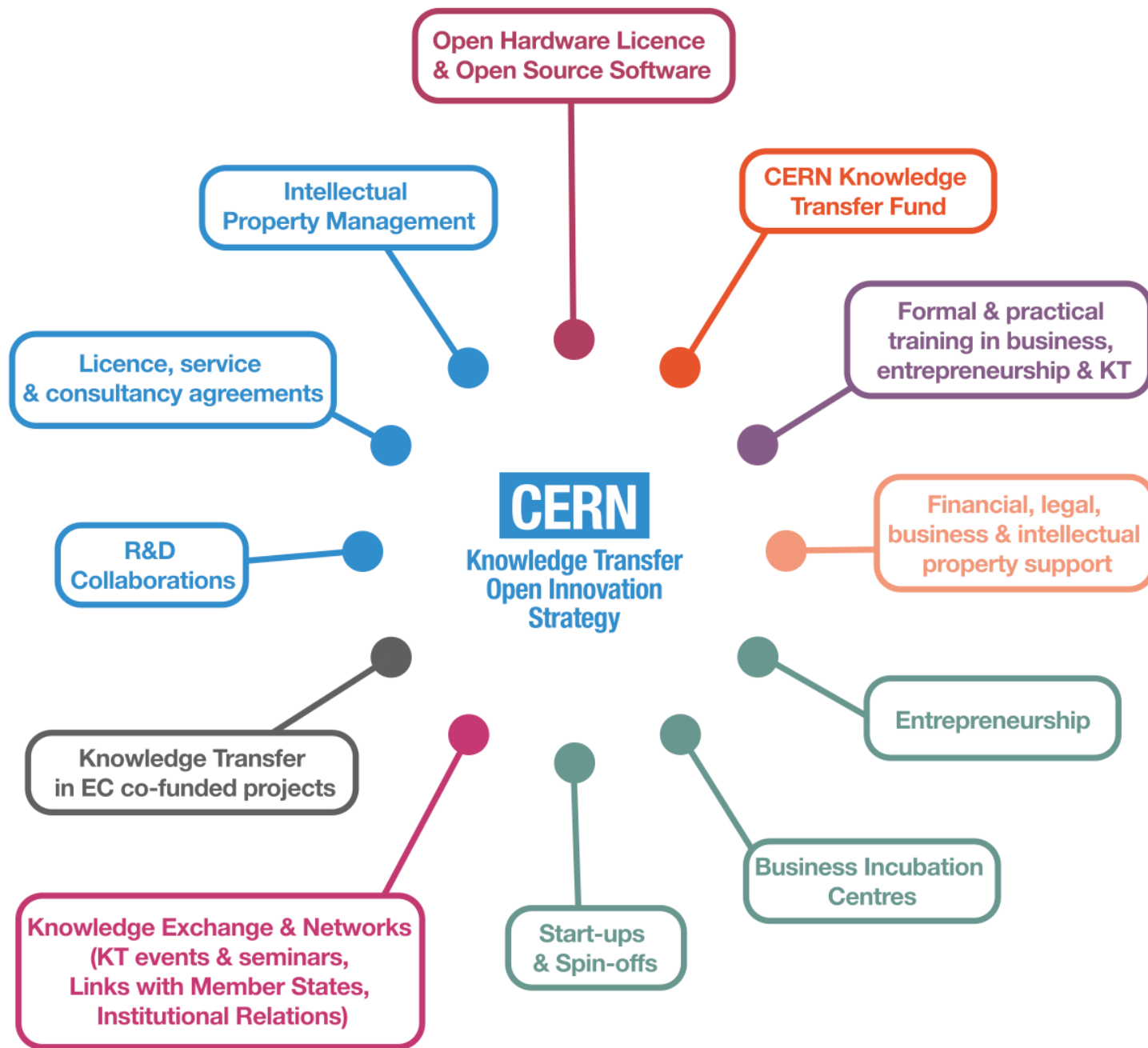


Aerospace Applications





How?



KNOWLEDGE TRANSFER SEMINARS

on entrepreneurship

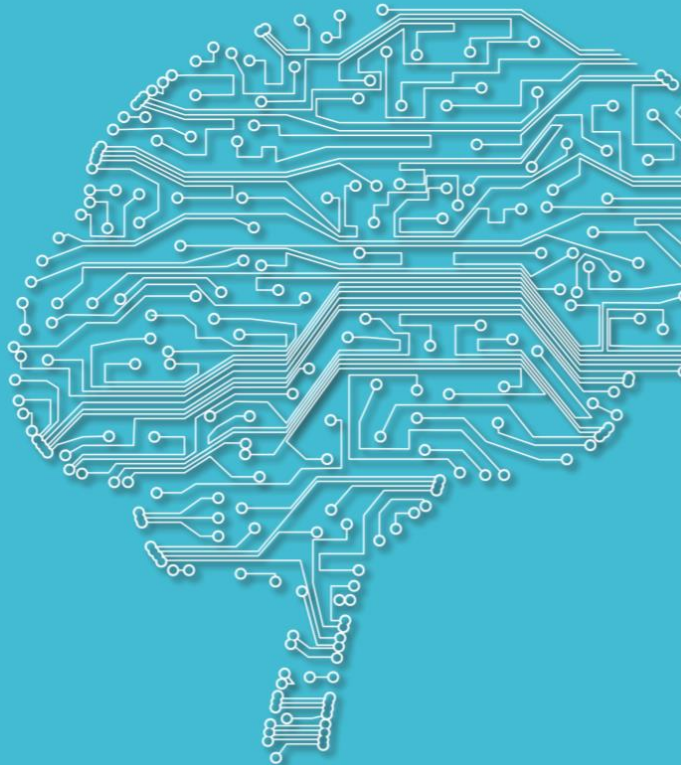
Séminaires transfert de connaissances sur l'entrepreneuriat

From CERN engineer to company founder: my journey

Julio Lucas

Technical Director and
co-founder of Elytt Energy
Former CERN engineer

26th September 16h30
CERN Main Auditorium
indico.cern.ch/event/565706/



Knowledge Transfer
Accelerating Innovation

KNOWLEDGE TRANSFER SEMINARS

on medical applications

Séminaires transfert de connaissances sur les applications médicales

Neurospin: From the Proton to the Human Brain

Neurospin: du proton au cerveau humain

Prof. Denis Le Bihan

Director of Neurospin, CEA Saclay

9th December 14:00 Main Auditorium

Join us for coffee afterwards!

<http://indico.cern.ch/event/574545/>

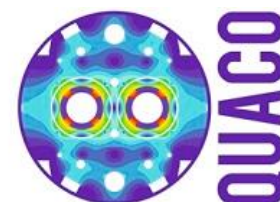


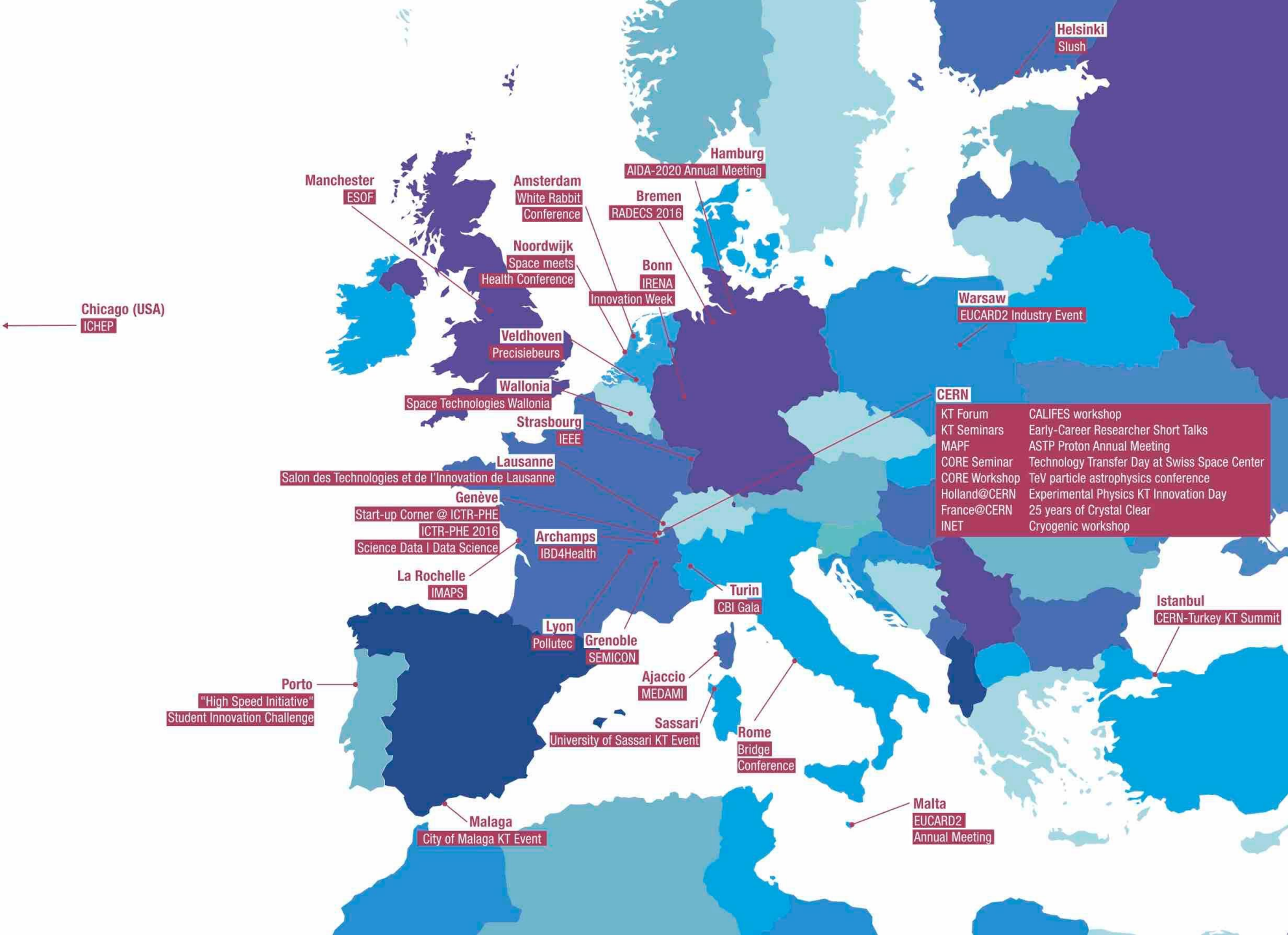
Knowledge Transfer
Accelerating Innovation



MAIN AUDITORIUM

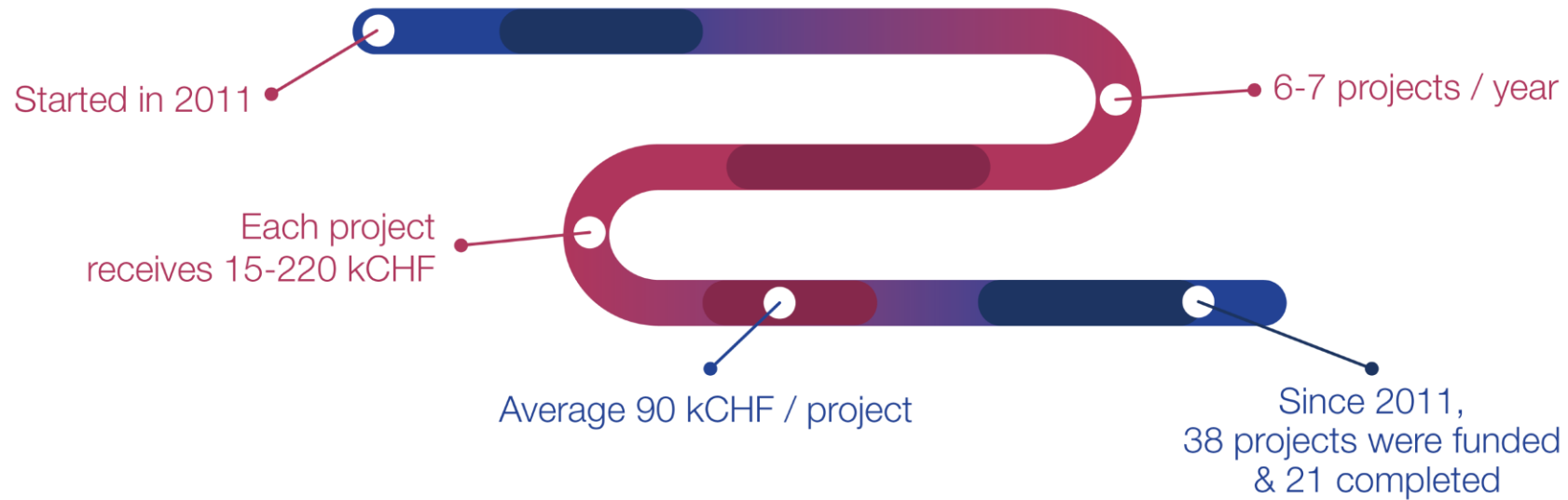
European Union Projects & Networks



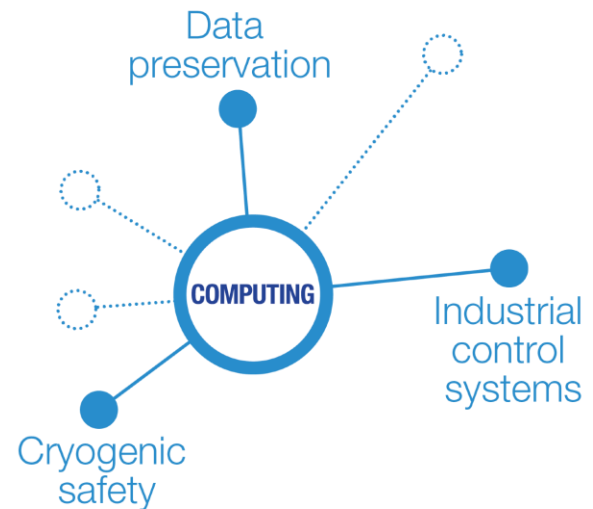
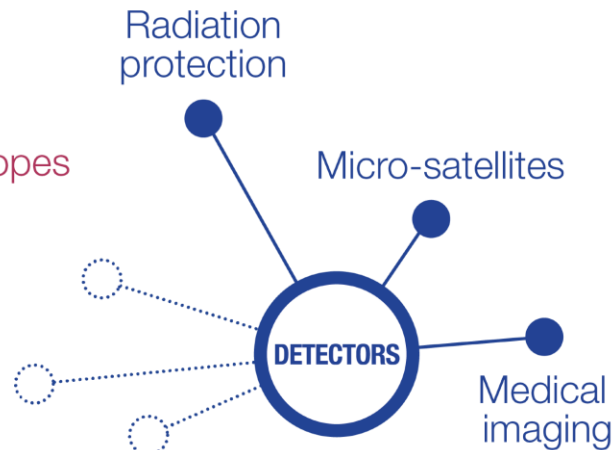
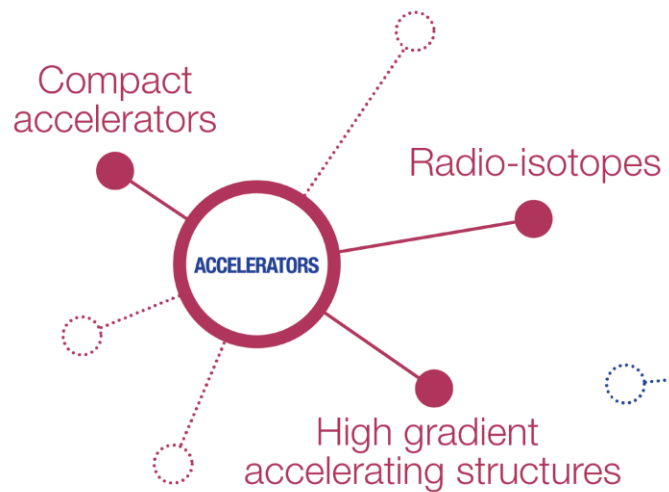


Conferences in 2016 with KT activities from CERN

CERN Knowledge Transfer Fund



PROJECT DIVERSITY



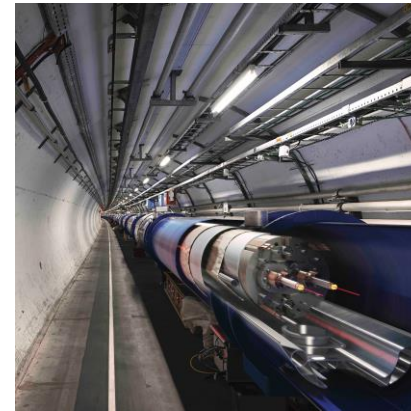
CERN KT Fund Projects Selected in 2016



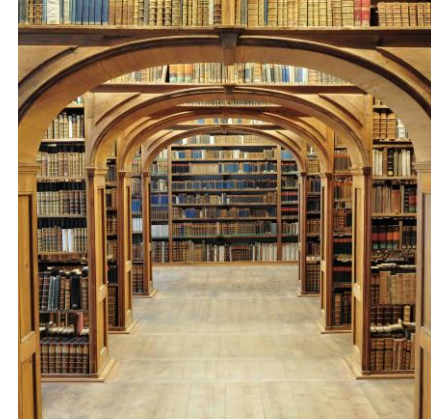
Thermal Management
in space applications



Very large scale
software distribution



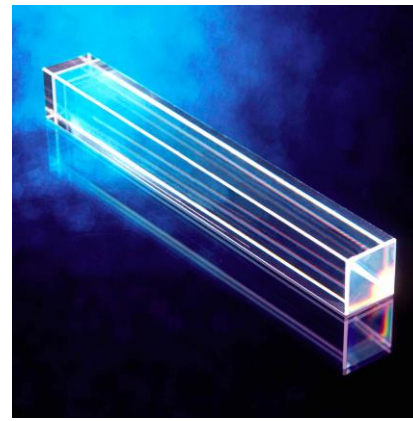
Optical fibre radiation &
temperature sensor



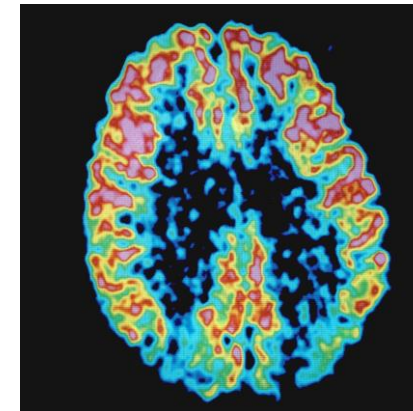
Long-term preservation
for digital libraries



Automated formal
verification of PLC code

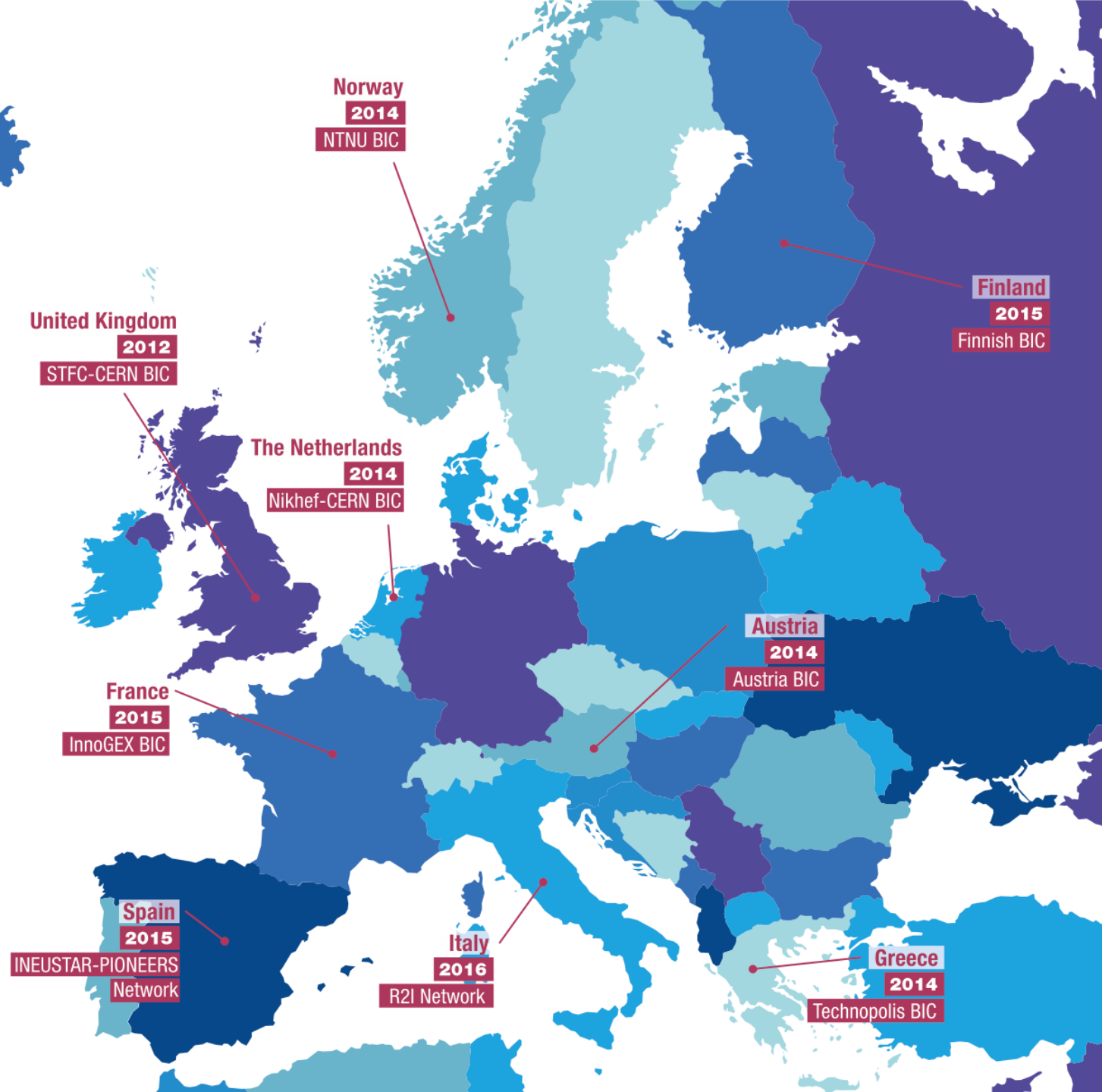


Improving crystal detectors
for PET scanners



Read-out chips for HEP
& medical technologies





Nine Established Business Incubation Centres



Growing a culture of entrepreneurship

Entrepreneurship @CERN

Social
Entrepreneurship THE
PORT

Entrepreneur Mixer

Global
Entrepreneurship
Week

Entrepreneurship
Meet-Ups

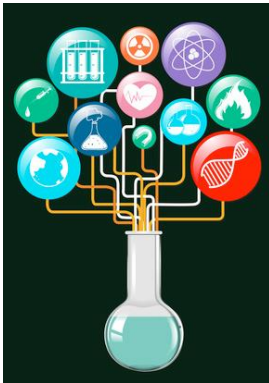
CERN-NTNU
Screening Week

Challenge Based
Innovation



Start-ups using CERN Technologies

Accepted into BIC in 2016



Camstech Ltd



Current BIC Incubatees

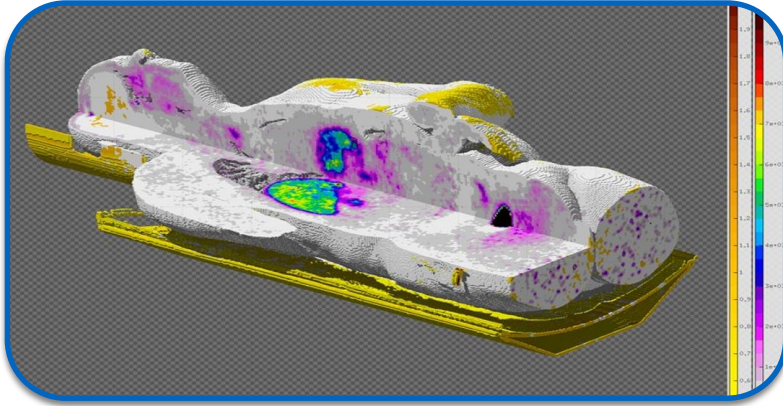


18 start-ups & spin-offs using CERN technology



Examples of CERN technologies available for licensing

Simulator for particle interaction with matter



WHAT

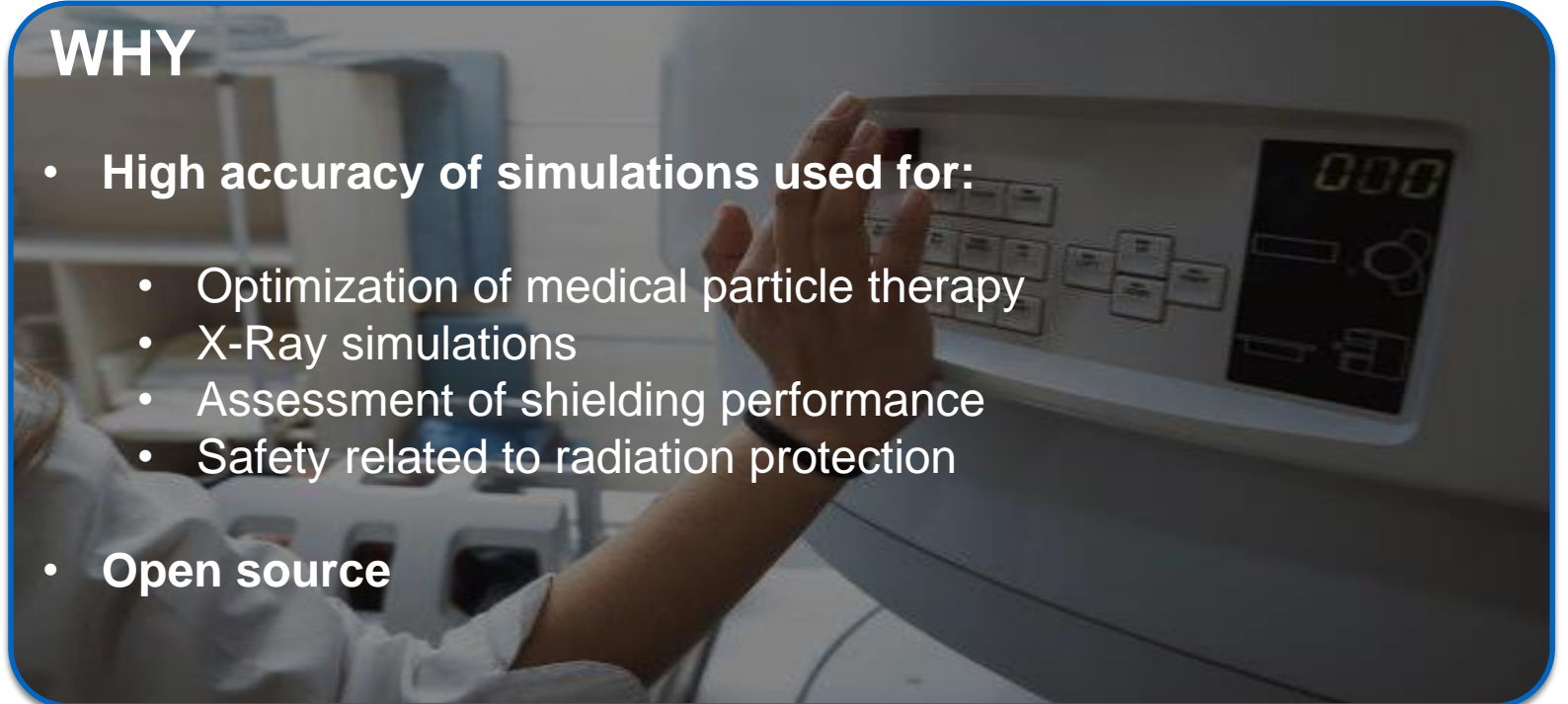
FLUKA (Fluctuating Cascade) is a general purpose tool for calculations of particle transport and interactions with matter. FLUKA can simulate the interaction and propagation in matter of about 60 different materials with high accuracy. FLUKA can handle very complex geometries and yields very accurate simulations.

HOW

- Can simulate photons and electrons from 1 keV to >1000 TeV, neutrinos, muons, hadrons,...
- Can track charged particles even in the presence of magnetic or electric fields
- Possible to describe a complex geometry in terms of "voxels"

WHY

- **High accuracy of simulations used for:**
 - Optimization of medical particle therapy
 - X-Ray simulations
 - Assessment of shielding performance
 - Safety related to radiation protection
- **Open source**



Long Distance Sharp Laser



WHAT

The Long-Distance Structured Beam is a new technology referred to as non-diffractive beams. It has the potential to greatly improve a number of mainstream applications using laser beams. Its most prominent feature is having both a very small spot size and very low divergence, which has until now been a trade-off for lasers.

HOW

- Bessel-like beam with rings
- Sustains an extremely compact spot size over long distances (>100m)
- Approx 1mm at 100 m
- Normal laser as input
- Self-reconstructs after obstacles
- Works for any wavelength (visible, IR, UV)

WHY

- **Potential new applications not possible today**
- **Better and new products in metrology**
 - Surface alignment
 - 3D scanning
- **New opportunities in for example communications, space**

Train Inspection Monorail

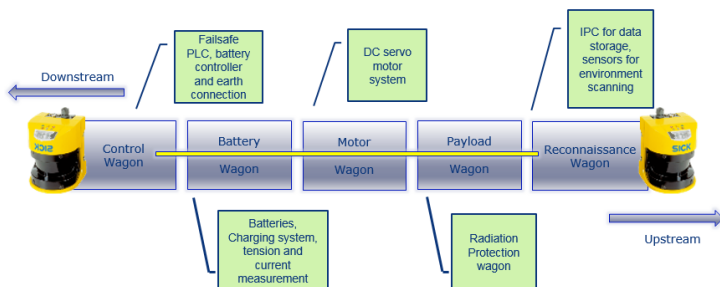


WHAT

The Train Inspection Monorail is an autonomous and versatile vehicle monitoring the 27-km long LHC tunnel and moving along a track suspended from the tunnel's ceiling. Packed with sensors for visual inspection, the robot can be programmed to perform real-time inspection intervention missions.

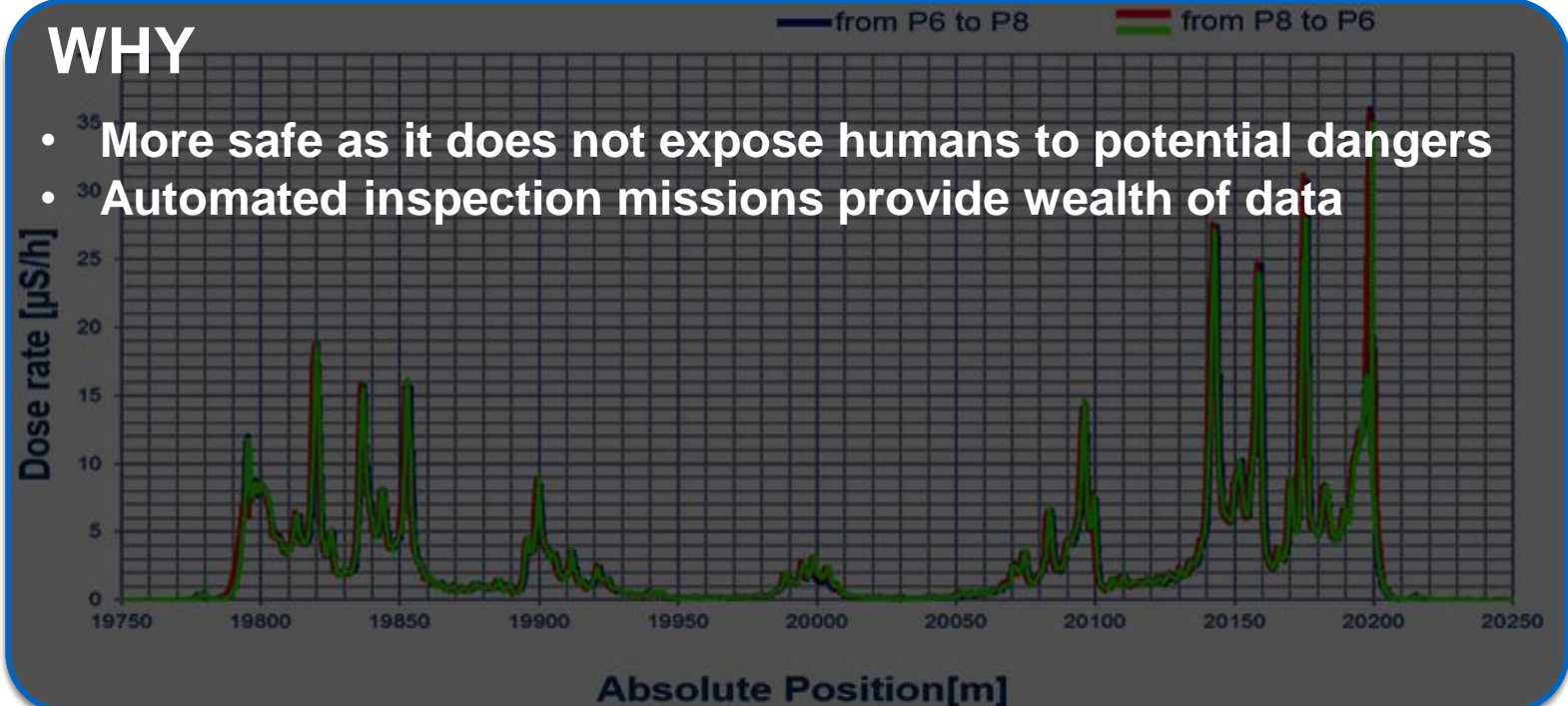
HOW

- Autonomous vehicle control
- Modular design
- Automated visual inspection
- Different sensors packages
- Handling robotics on board

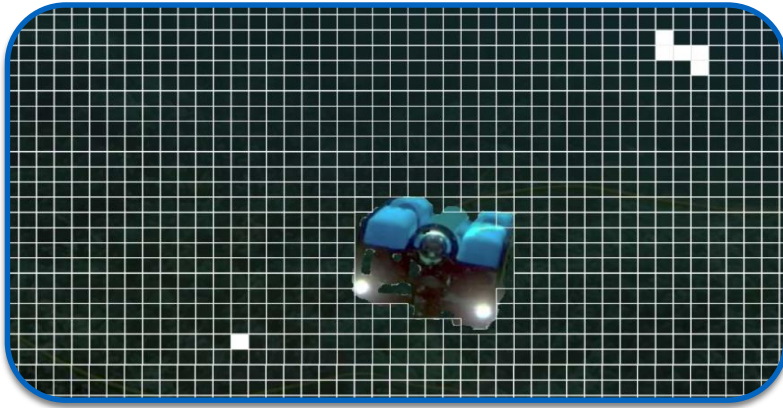


WHY

- **More safe as it does not expose humans to potential dangers**
- **Automated inspection missions provide wealth of data**



Data compression algorithm



WHAT

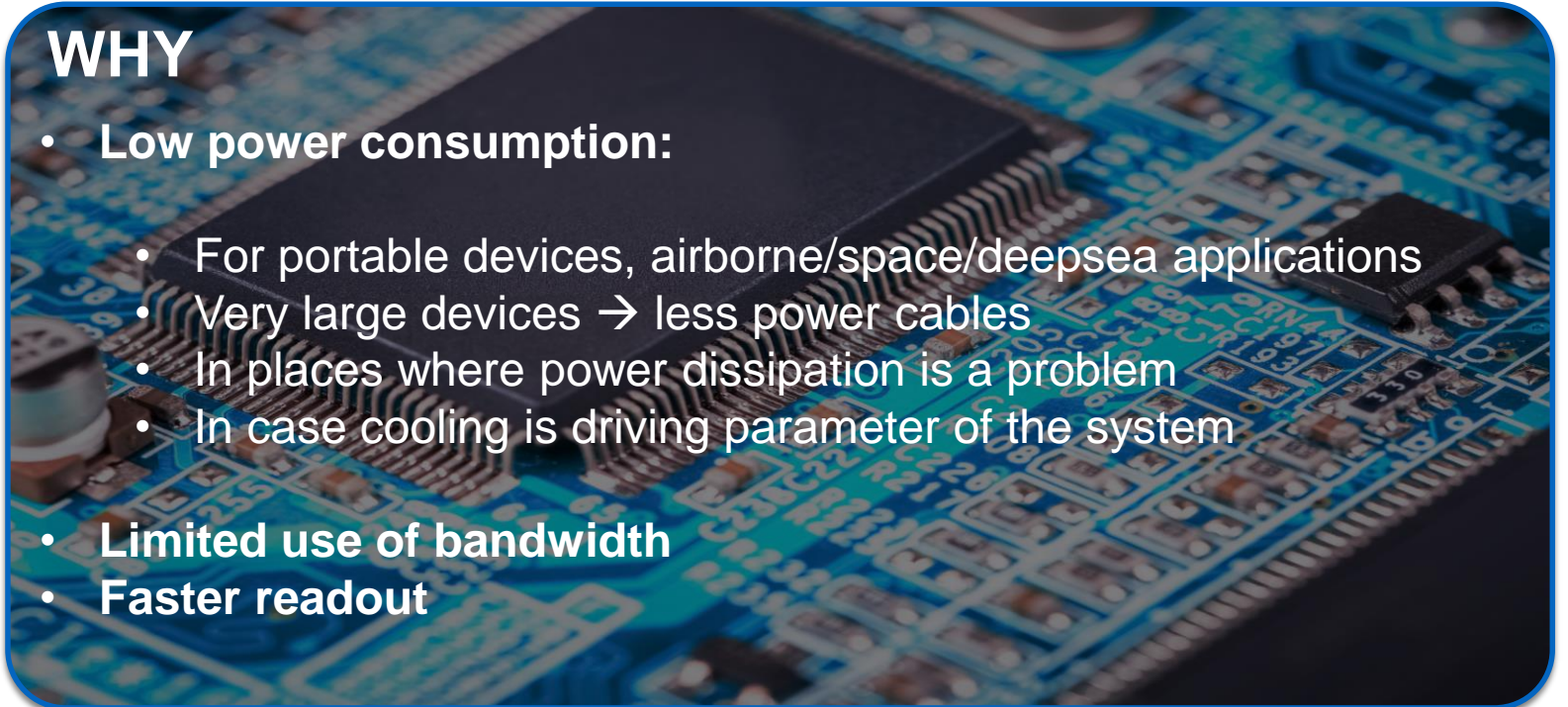
OrthoPix is a method and system for compressing data arranged in a data array and readout circuits of detectors. By reducing the total amount of data to be extracted from the detector, the proposed technology allows to increase the frame rate of the same amount, given a constant data bandwidth capability.

HOW

- Software algorithm which can be included in any chip for sparse data processing
- New method of reducing the data from a detector from $N \times N$ to $4N$, regardless of the number of hits.
- Compression of $N/4$

WHY

- **Low power consumption:**
 - For portable devices, airborne/space/deepsea applications
 - Very large devices \rightarrow less power cables
 - In places where power dissipation is a problem
 - In case cooling is driving parameter of the system
- **Limited use of bandwidth**
- **Faster readout**



Compact Universal Cutter



WHAT

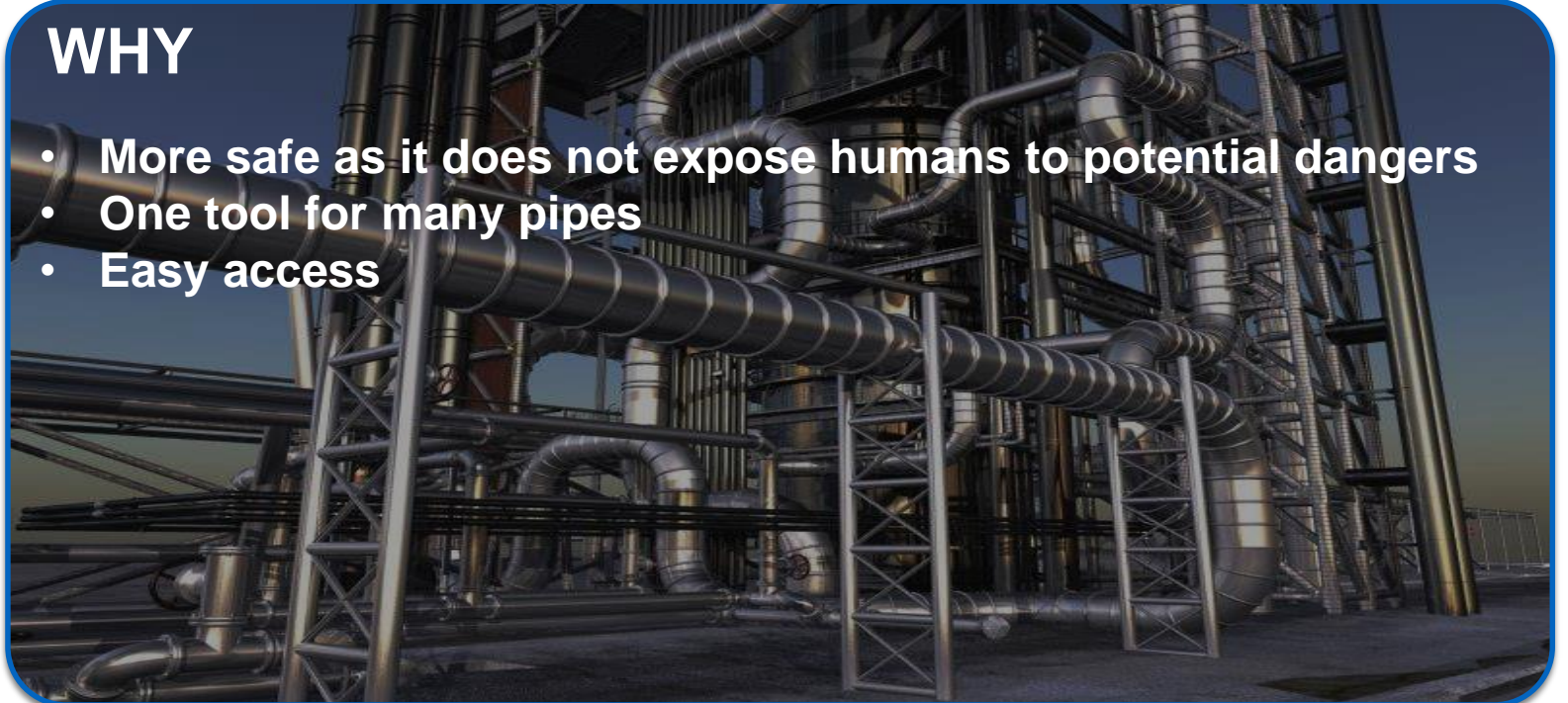
This orbital cutting machine has been designed to cut a broad range of pipes of different diameters and materials located in places which are particularly difficult to access. Once mounted on a pipe, the cutter operates autonomously without manual assistance, making it suitable to cut pipes which present health hazards.

HOW

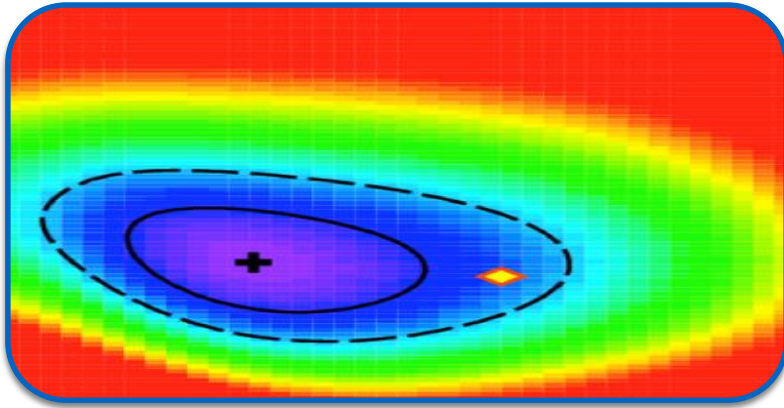
- Autonomous cutting
- Driven by hydraulic motor
- From 100 to 1200 mm
- Adaptable circular saw
- For different thicknesses
- For different materials

WHY

- **More safe as it does not expose humans to potential dangers**
- **One tool for many pipes**
- **Easy access**



Big Data & Machine Learning Software



WHAT

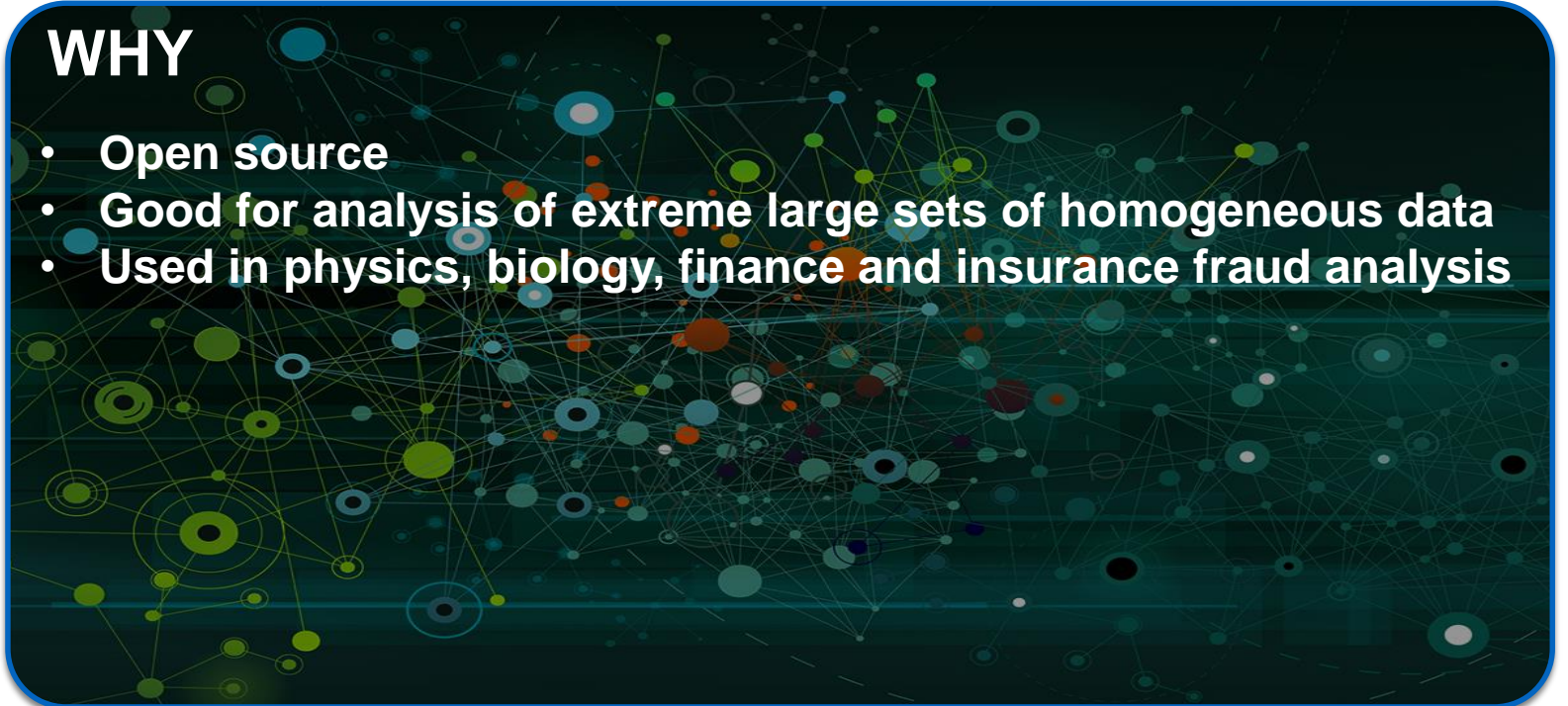
ROOT / TMVA is a modular big data software framework, providing the functionalities needed to deal with big data processing, statistical analysis, visualisation and storage. It is mainly written in C++ but integrated with other languages such as Python and R. Integrated machine learning environment.

HOW

- Artificial neural networks
- Rectangular cut optimisation
- Projective likelihood estimation
- Multidimensional estimations
- Linear discriminant analysis
- Function discriminant analysis
- Boosted/bagged decision trees
- Predictive learning
- Support Vector Machine

WHY

- **Open source**
- **Good for analysis of extreme large sets of homogeneous data**
- **Used in physics, biology, finance and insurance fraud analysis**



Conductive and dust free furniture



WHAT

An industrial grade production process for high pressure laminates with controlled resistivity. The material is made of paper and resin and the correct selection of materials is allowing to secure a controlled volume and surface resistivity. The technology is implemented in low cost material used in normal furniture covering.

HOW

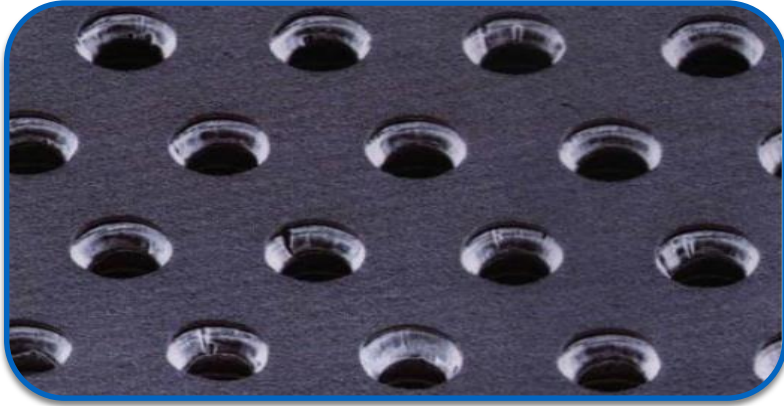
- Injection of conductive layers in a controlled shape possible
- Can be applied on wood like and other furniture material
- Possible control of the thickness from 1mm up to a few cm according to the application

WHY

- **Could be used to make dust-free applications**
 - Furniture
 - Cleanroom environments
 - Hospitals
- **Can embed conductive patterns in surface**



Chemical process to make microvias



WHAT

Making microvias often involves complex technologies such as laser, plasma or photo imaging. Chemical Via is a new method to make microvias, typically for high density printed multilayer circuits. Microvias are used to interconnect adjacent layers and consist of a small diameter hole with a thin metallic deposit.

HOW

- Chemical method, no lasers needed
- Microvias of any size are made possible (microns to cm)
- Initial fabrication investment to use method is low
- Vias of any shape (circle, star, square, etc)
- Compatible with standard PC assembly lines

WHY

- **Added value for microelectronics and printed circuit boards**
- **Any application that requires patterns of small openings...**
 - Ultrasensitive biochemical sensors
 - Used for water pollution measurement

Extreme high resolution photon sensor



WHAT

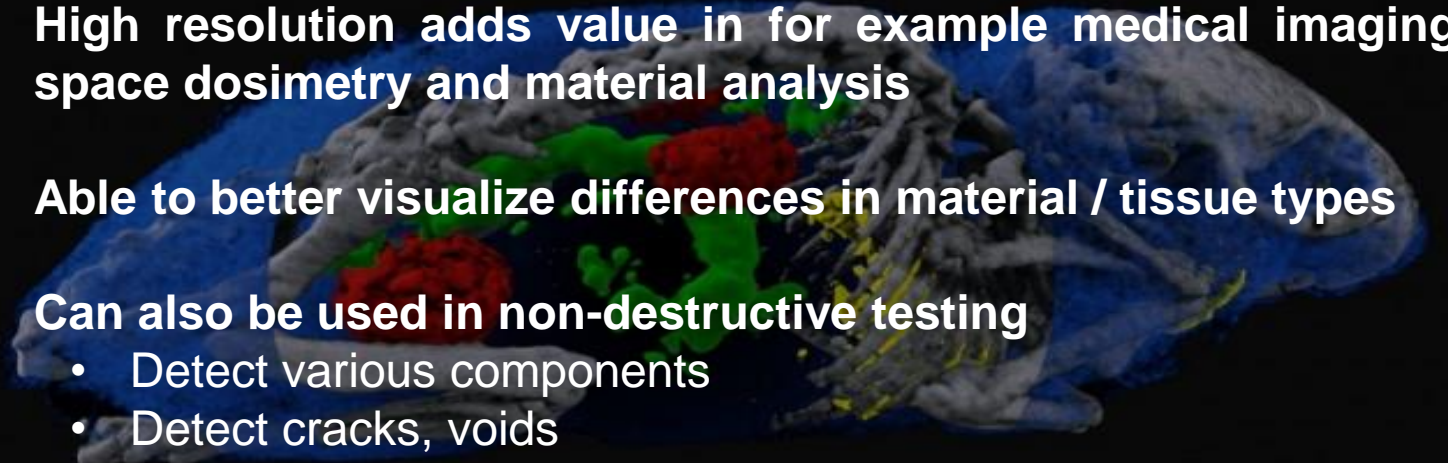
Medipix is a family of read-out chips for particle imaging and detection. The original concept of Medipix is that it works like a camera, detecting and counting each individual particle hitting the pixels when its electronic shutter is open. This enables high-resolution, high-contrast, noise hit free images – making it unique for imaging applications.

HOW

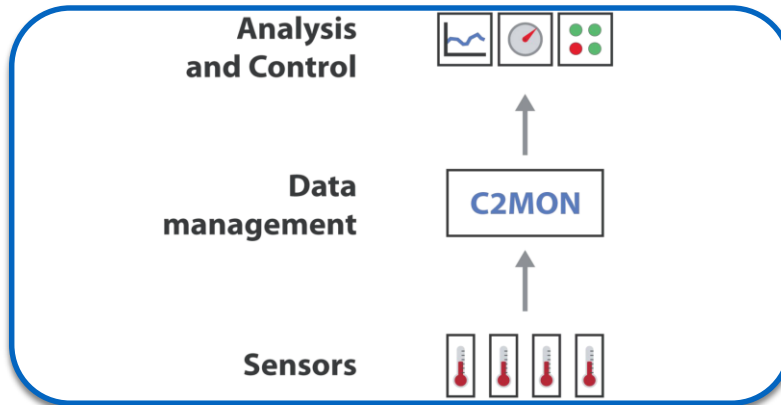
- “Clever” pixel electronics capable of processing every detected photon.
- Capable to record continuous stream of data, not just one frame
- Colours to indicate different energy levels of the photons

WHY

- **High resolution adds value in for example medical imaging, space dosimetry and material analysis**
- **Able to better visualize differences in material / tissue types**
- **Can also be used in non-destructive testing**
 - Detect various components
 - Detect cracks, voids
 - Detect contamination



Control and monitoring platform



WHAT

A modular Java framework called C2MON for large-scale industrial monitoring and control solutions. It has been developed for CERN's demanding infrastructure monitoring needs and is based on more than 10 years of experience. All core functionalities of a monitoring system are available and adaptable to a wide variety of monitoring systems.

HOW

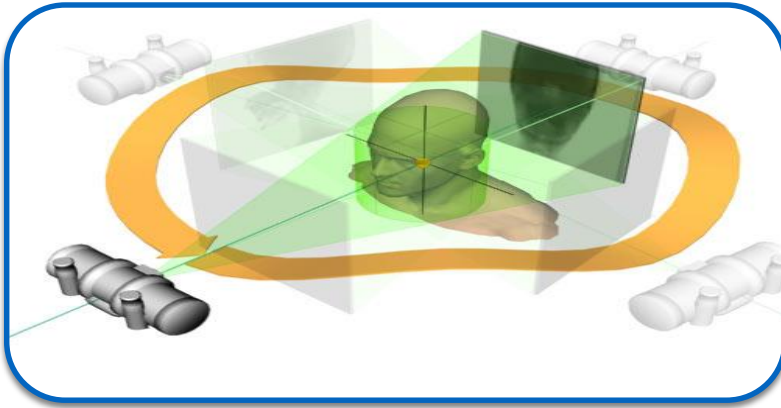
- A modular and three-tier architecture: Data Acquisition, Server and Client API
- Decouples functionality and allows modular development
- Made to handle sudden and unforeseen machine breakdowns
- Integrated history browsing for industrial dashboards

WHY

- **Designed to use in large and complex control & monitoring environments with diverse infrastructure**
- **Robust, reliable and scalable open source architecture for many applications, like for example**
 - Grid operators
 - Oil & gas industry
 - Chemical industry
 - Patient monitoring
- **Modern HTML5 web interface for easy navigation**



Fast 3D reconstruction based on 2D images



WHAT

TIGRE is an open source toolbox allowing the creation of fast & accurate 3D X-ray image reconstruction with applications in medical imaging for cancer diagnosis and treatment. It offers a simple and accessible way to improve imaging and potentially reduce radiation doses for patients, as the software processes the images 1000x faster.

HOW

- Based on Cone Beam Computed Tomography.
- TIGRE incorporate algorithms from four reconstruction families: FDK, SART, CGLS and ASD.
- This software even runs on a laptop fitted with a fast gaming graphics processor

WHY

- **Up to 1000x faster construction of 3D images allows for shorter 'recording' times.**
- **Allows to compare 3D reconstructions using different algorithms.**
- **Can make high quality 3D reconstruction with fewer 2D images, potentially reducing radiation with factor 10.**
- **Could be used outside the medical field too...!**

Thank you!

