Accelerating Innovation

Han Dols

CERN Knowledge Transfer | Section Business Development

Mission of CERN?

Research

Seeking and finding answers to questions about the universe

Technology

Advancing the frontiers of technology

Collaborating

Bringing nations together through science

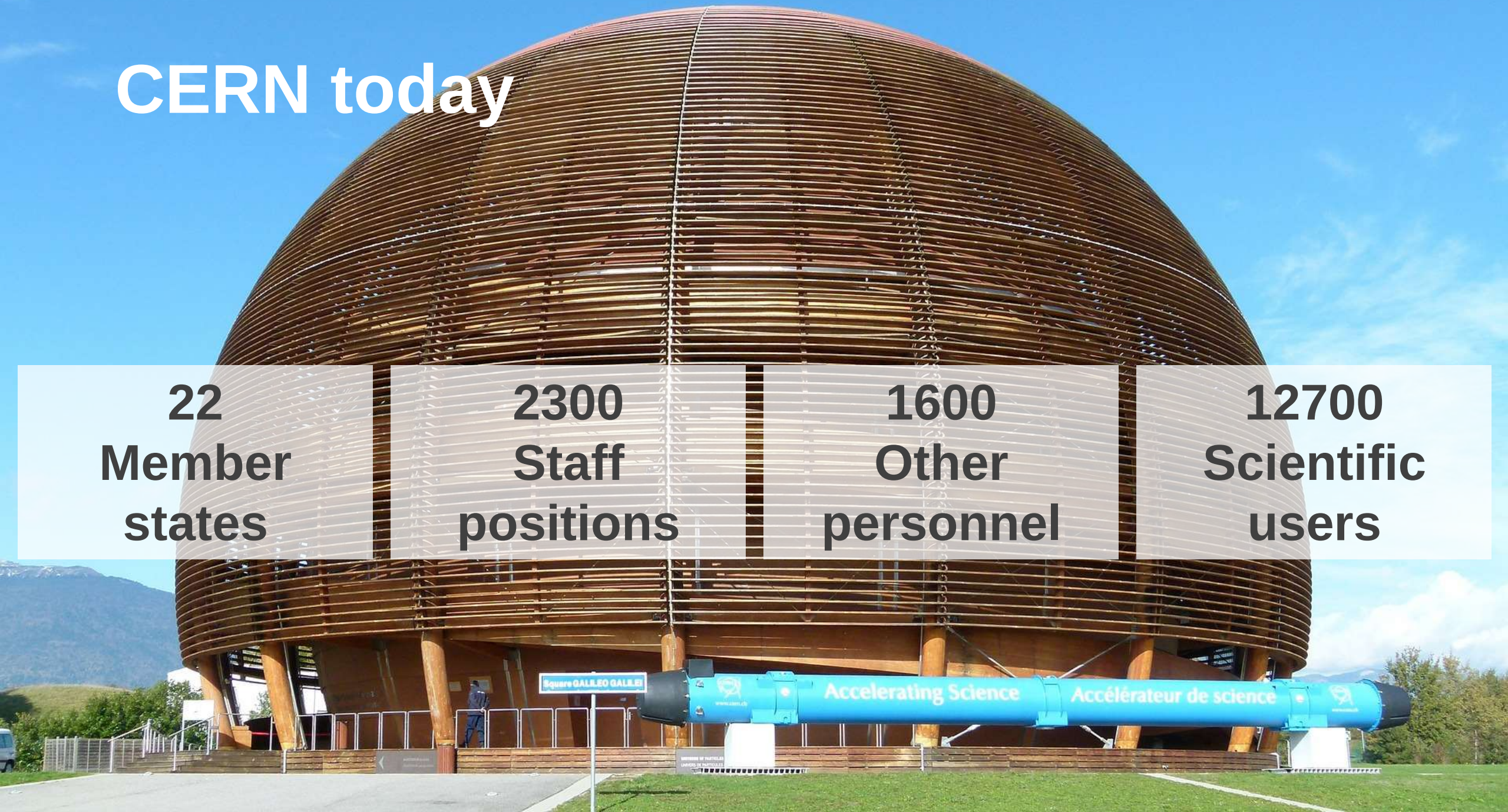
Education

Training the scientists of tomorrow

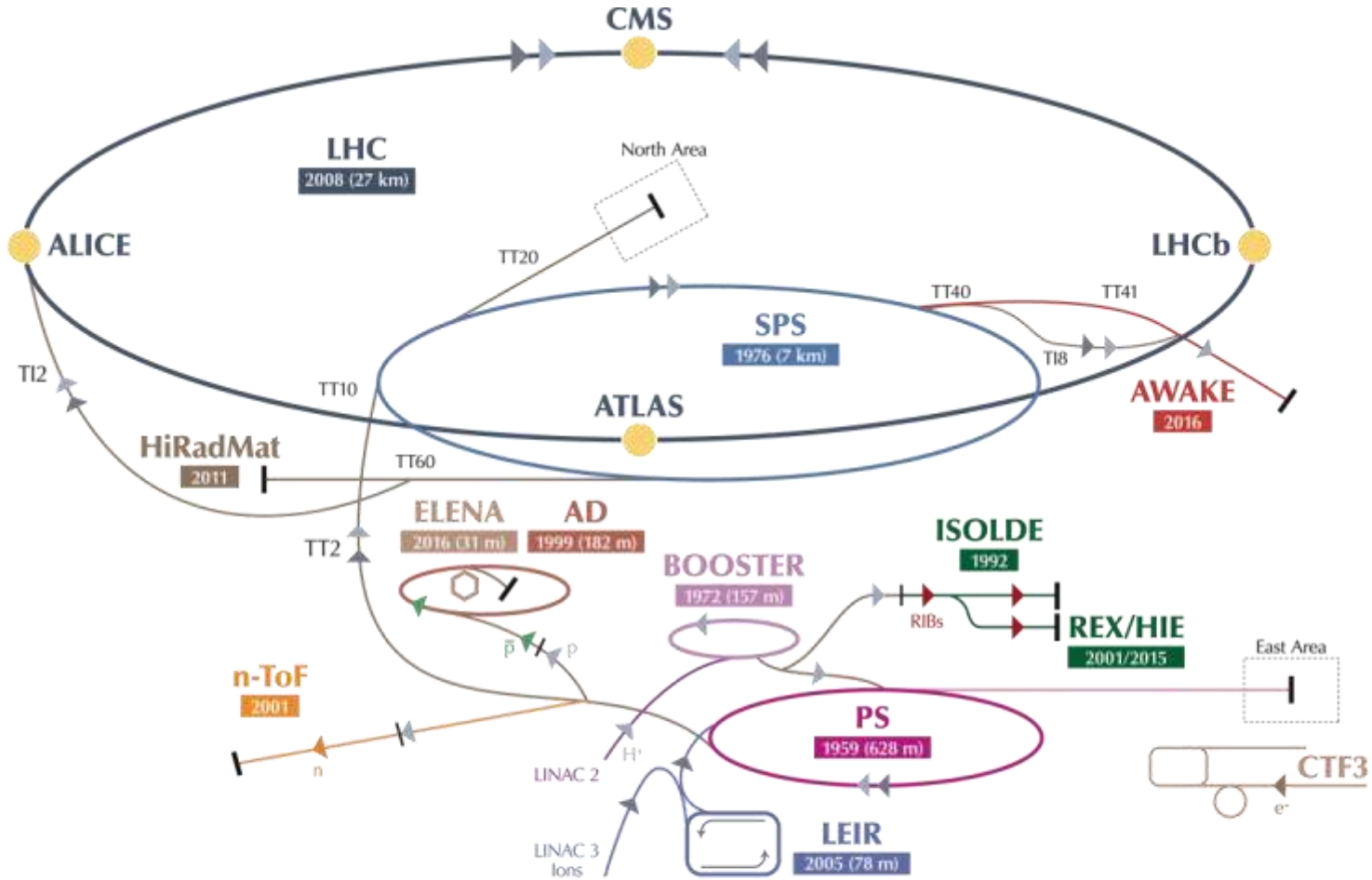
Council meeting in Amsterdam when the CERN convention was signed (1953).

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) proton/antiproton conversion proton/RIB conversion

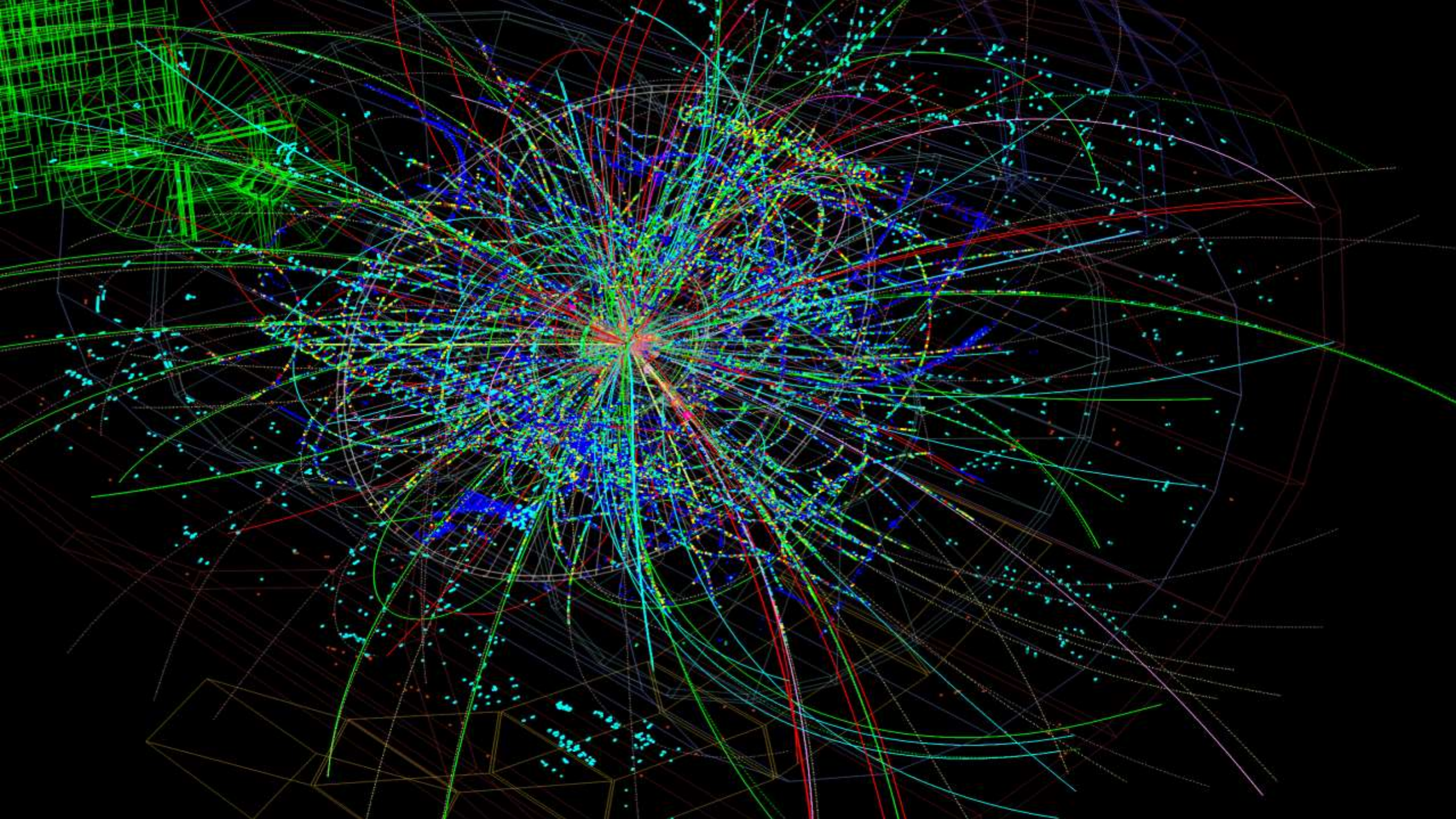
LHC Large Hadron Collider SPS Super Proton Synchrotron PS Proton Synchrotron AD Antiproton Decelerator CTF3 Clic Test Facility

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)

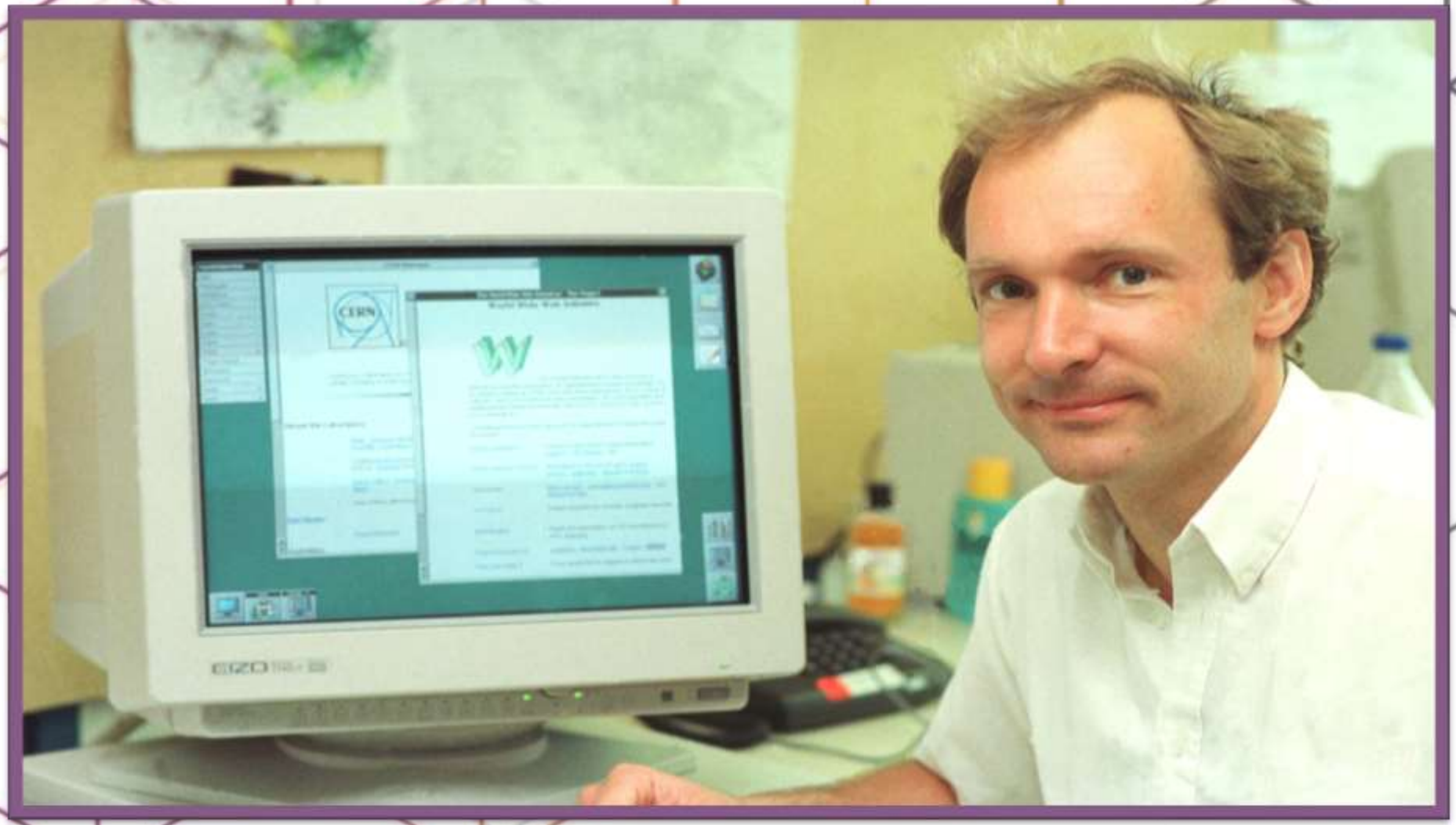

LHCb
ATLAS
CERN Meyrin
CERN Prévessin
SPS 7 km
SUISSE
FRANCE
CMS
ALICE
LHC 27 km



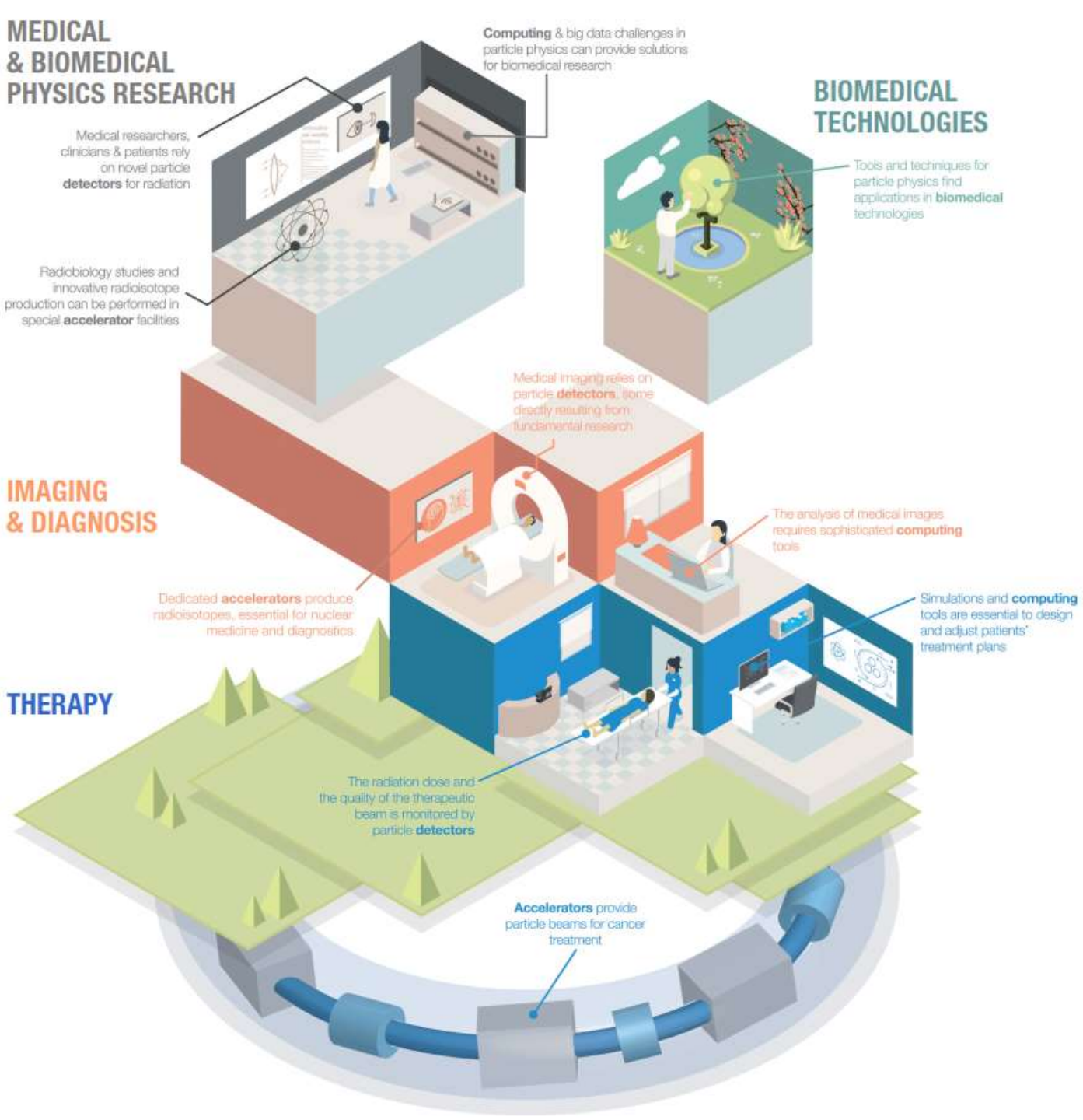
Why Knowledge Transfer?

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.

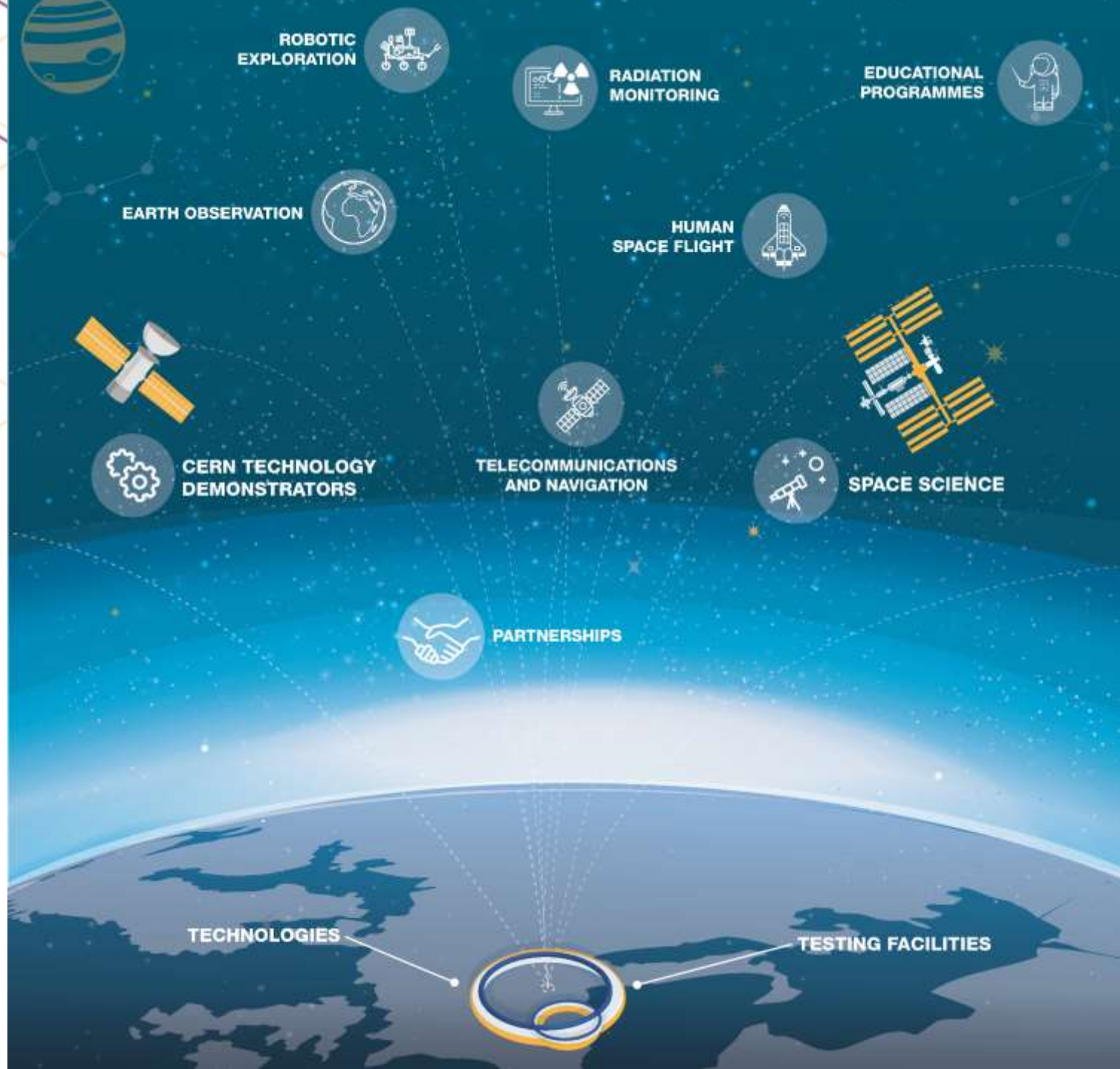
Accelerating Innovation


CERN

Medical & Biomedical Technologies



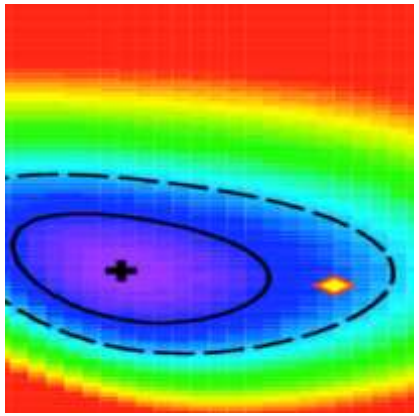
Aerospace Applications



Acceleration in many surprising directions

TIGRE: open source software for medical imaging

VESPER maiden test for jupiter environment

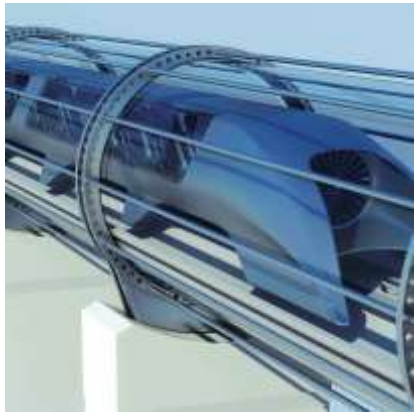


ROOT/TMVA: big data and machine learning software

HPL: high pressure laminates with anti-dust properties

FOSS4I: help with water shortage

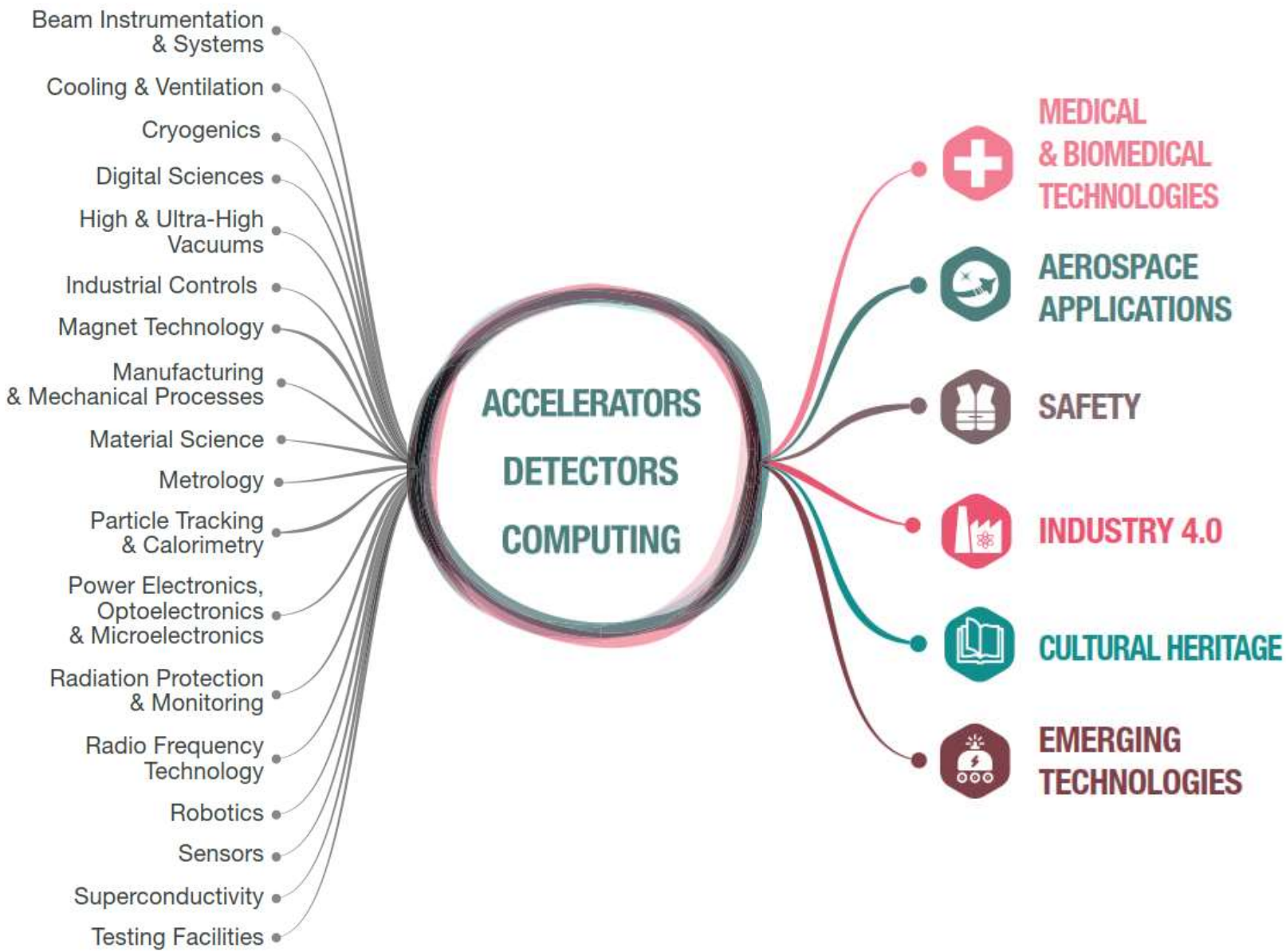
Sensor technology on drones

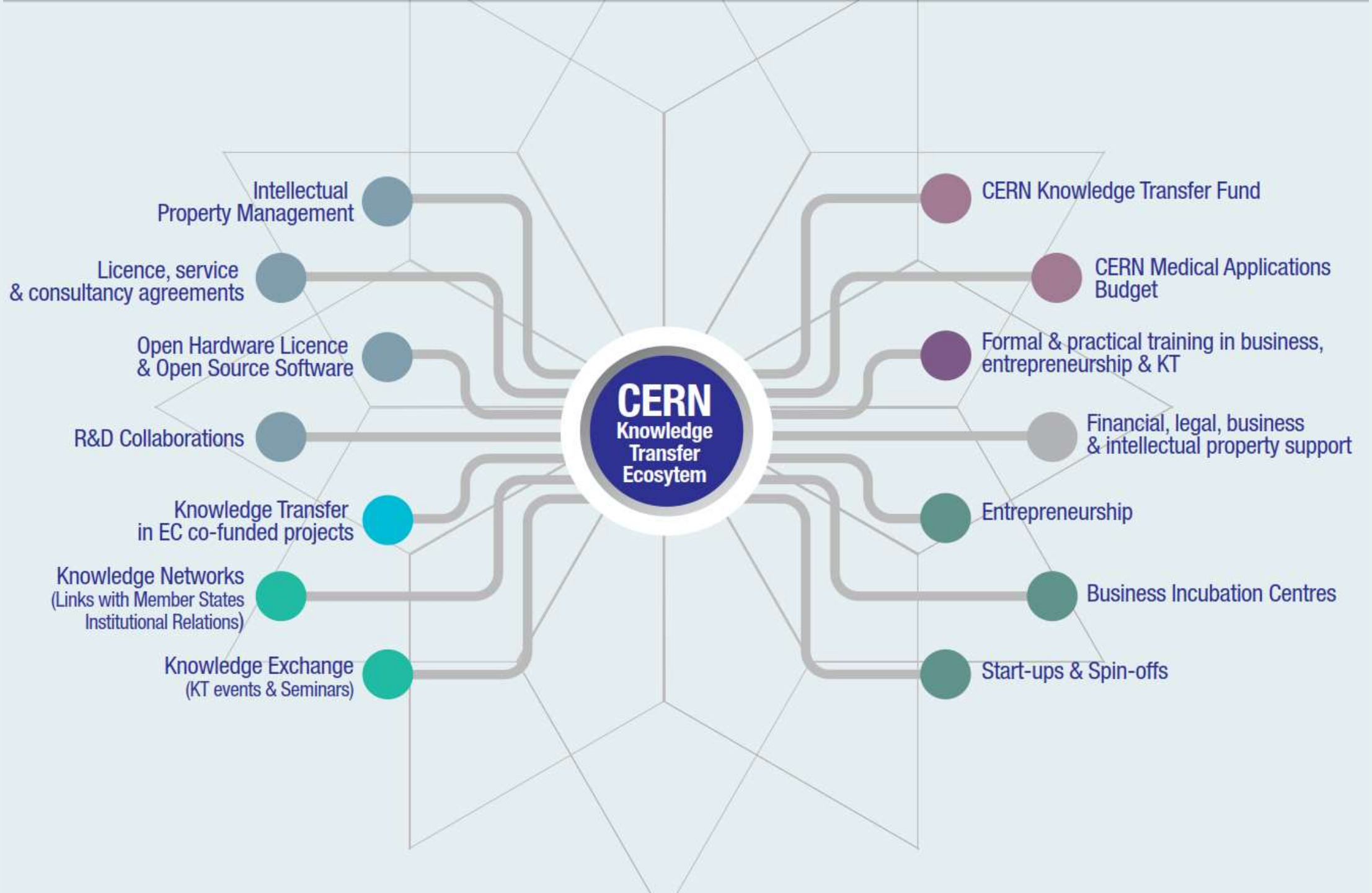


Hyperloop: sonic speeds in high-vacuum tubes

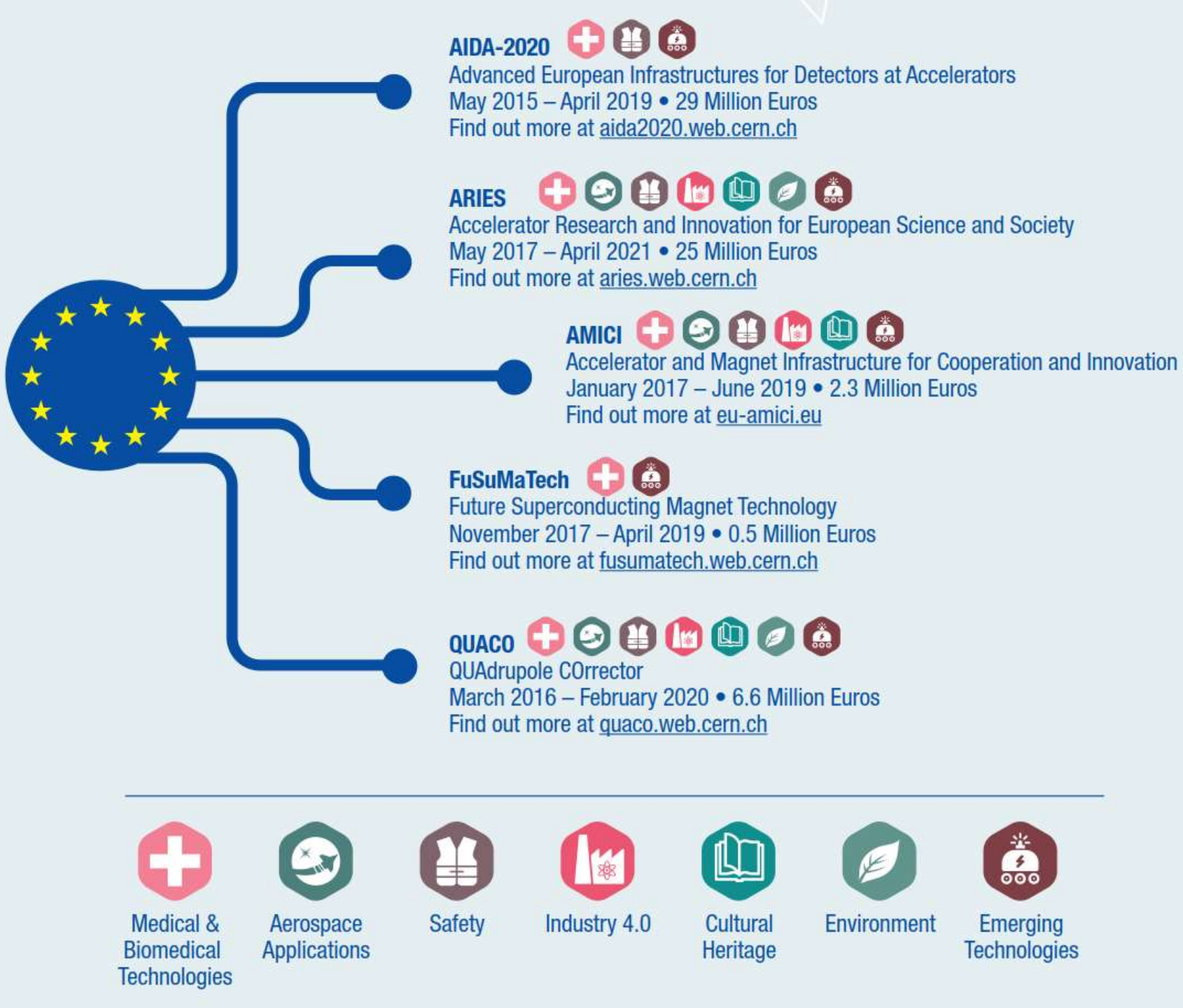
TIM: autonomous safety monitoring system

How?


Beam Instrumentation & Systems
Cooling & Ventilation
Cryogenics
Digital Sciences
High & Ultra-High Vacuums
Industrial Controls
Magnet Technology
Manufacturing & Mechanical Processes
Material Science
Metrology
Particle Tracking & Calorimetry
Power Electronics, Optoelectronics & Microelectronics
Radiation Protection & Monitoring
Radio Frequency Technology
Robotics
Sensors
Superconductivity
Testing Facilities
ACCELERATORS
DETECTORS
COMPUTING
MEDICAL & BIOMEDICAL TECHNOLOGIES
AEROSPACE APPLICATIONS
SAFETY
INDUSTRY 4.0
CULTURAL HERITAGE
EMERGING TECHNOLOGIES


CERN
Knowledge
Transfer
Ecosytem
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)
Knowledge Exchange
(KT events & Seminars)
CERN Knowledge Transfer Fund
CERN Medical Applications
Budget
Formal & practical training in business,
entrepreneurship & KT
Financial, legal, business
& intellectual property support
Entrepreneurship
Business Incubation Centres
Start-ups & Spin-offs

EU co-funded projects with universities, institutes, labs, industry



Growing a culture of entrepreneurship

Entrepreneurship @CERN

Social Entrepreneurship THE PORT

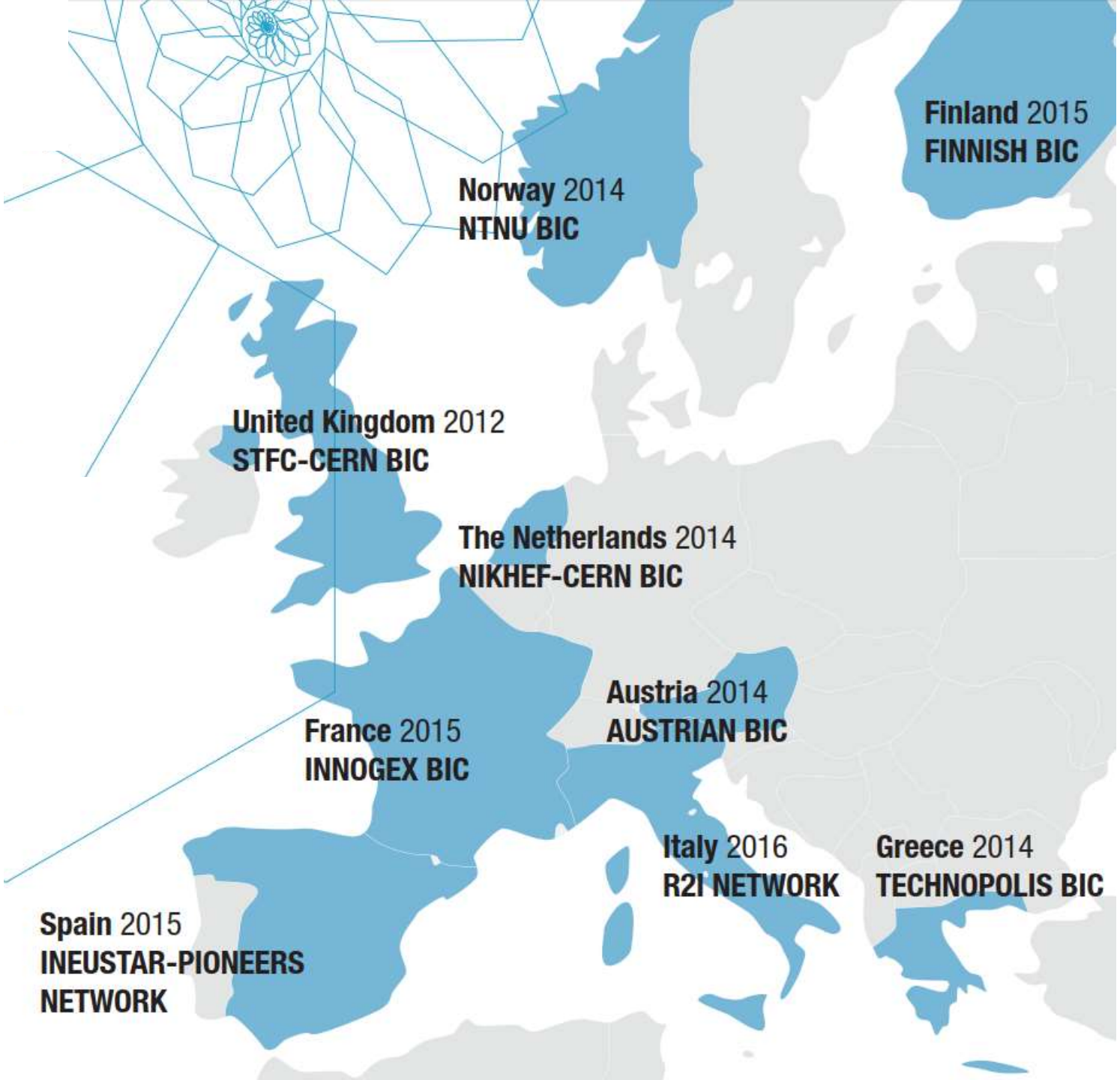
Entrepreneur Mixer

Global Entrepreneurship Week

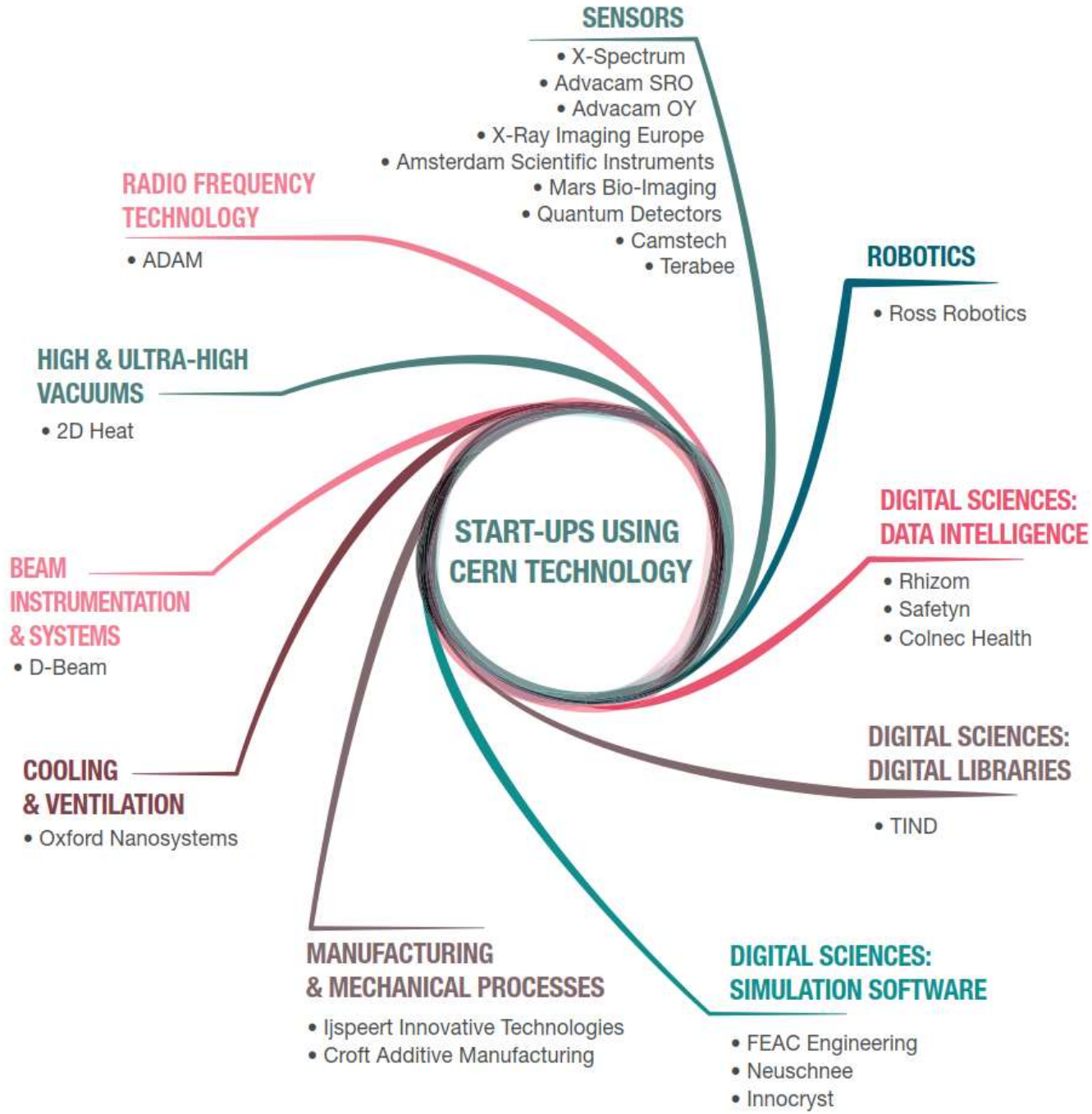
Entrepreneurship Meet-Ups

CERN-NTNU Screening Week

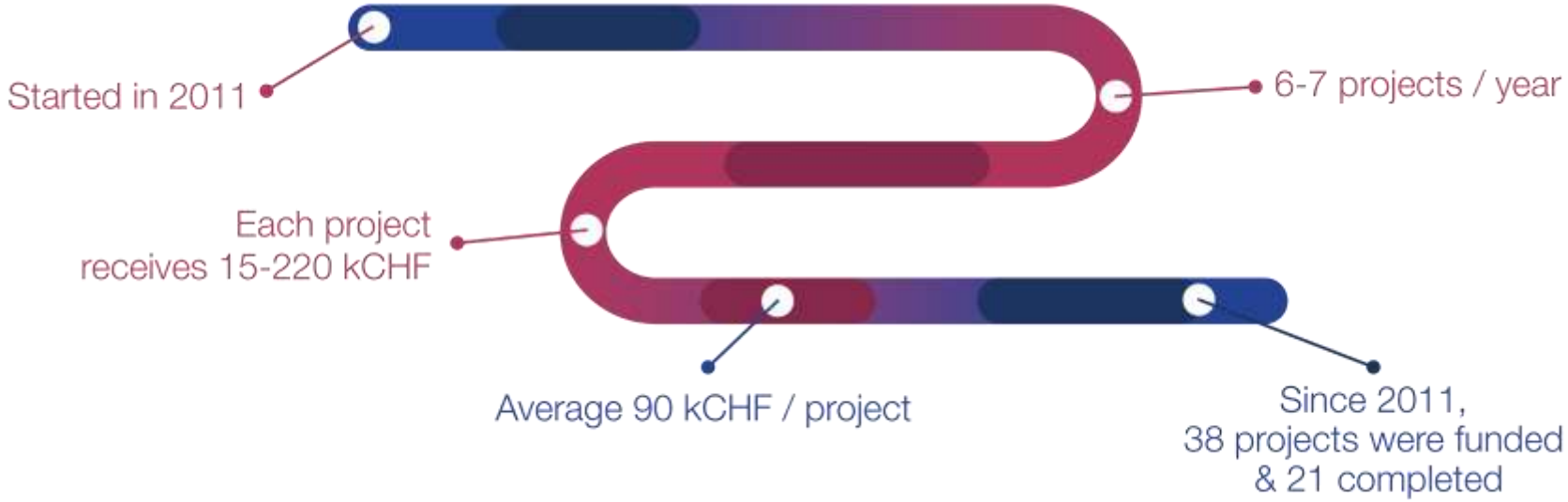
Challenge Based Innovation



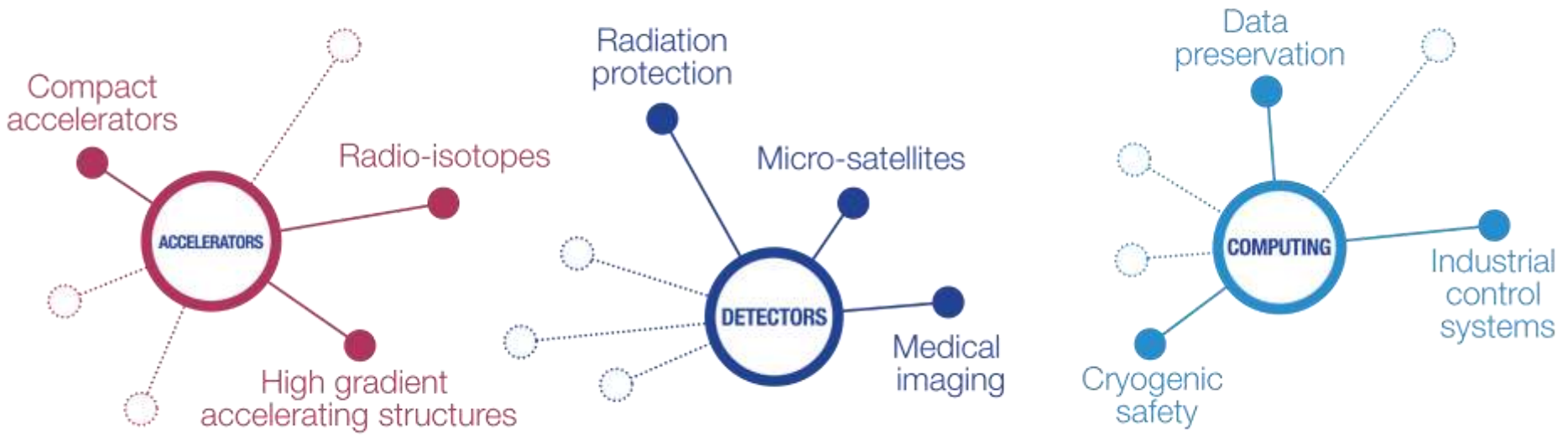
Nine Established Business Incubation Centres in the Member States


SENSORS
• X-Spectrum
• Advacam SRO
• Advacam OY
• X-Ray Imaging Europe
• Amsterdam Scientific Instruments
• Mars Bio-Imaging
• Quantum Detectors
• Camstech
• Terabee
RADIO FREQUENCY TECHNOLOGY
• ADAM
ROBOTICS
• Ross Robotics
HIGH & ULTRA-HIGH VACUUMS
• 2D Heat
START-UPS USING CERN TECHNOLOGY
DIGITAL SCIENCES: DATA INTELLIGENCE
• Rhizom
• Safetyn
• Colnec Health
BEAM INSTRUMENTATION & SYSTEMS
• D-Beam
COOLING & VENTILATION
• Oxford Nanosystems
DIGITAL SCIENCES: DIGITAL LIBRARIES
• TIND
MANUFACTURING & MECHANICAL PROCESSES
• Ijspeert Innovative Technologies
• Croft Additive Manufacturing
DIGITAL SCIENCES: SIMULATION SOFTWARE
• FEAC Engineering
• Neuschnee
• Innocryst

CERN Knowledge Transfer Fund



Project Diversity



Example of projects supported by KT fund

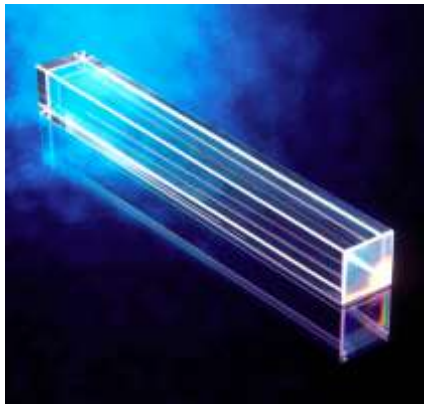
Thermal Management
in space applications

Very large scale
software distribution

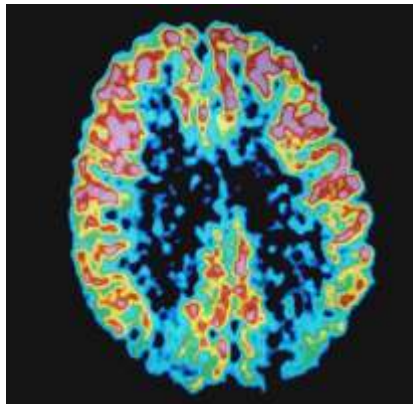
Optical fibre radiation &
temperature sensor

Long-term preservation
for digital libraries

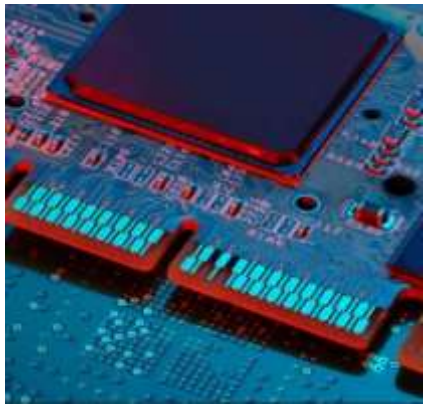
Automated formal
verification of PLC code



Improving crystal detectors
for PET scanners



Read-out chips for HEP
& medical technologies



NDT: 3D characterization of
semiconductors

Examples of industry collaborations?

Advise / 2ND Opinion / Tech Challenge from CERN Expert team

Collaborative R&D / Co-development agreements on specific topic of mutual interest

Challenge Based Innovation program with CERN Experts and/or universities to address specific issue

Using CERN labs / openlab for prototyping, benchmarking and testing of equipment

Licensing of CERN technology for commercial use / Support or training on using Open Source Hardware / Software

Facilitation of Knowledge Exchange by sponsoring PhD / Allocation of company resource at CERN / Use of Alumni Network

…is testing electronic components at CERN to assure space missions reliability

…is licensing software from CERN to enhance the safety in complex cooling systems

…is licensing machine learning software developed at CERN for improving vaccine production

…Intel teams up with CERN openlab on the Modern Code Developer Challenge to team up with the best coders in the world

…is using CERN readout chips to improve material analysis for applications in food, pharma, oil and nanomaterials

…is using CERN middleware to for enhanced factory automation across their plants

…is using CERN software for machine-to-machine communication

…is using CERN detectors to help advance art restauration and authentication

…is using technology derived from one of the big experiments in CERN for advanced headlights in cars

…is part of the CERN openlab to work together on advancing Automation and Control technology

What we hear from industry

Improved our Innovation Capability

- Helped us see where technology is going and what is around the curve
- Great challenge for our technology and R&D roadmaps and strategies
- CERN helped to address some of our biggest challenges with a fresh view
- In contact with a great talent pool of technical experts and engineers

Provided Fast Learning of Technology

- Various licensing options and great training on tech available for (open) license
- Discovered new opportunities for joint R&D and on-site knowledge exchange
- We learned technology from CERN that also has helped us in other applications
- Great benchmarking facilities helped to quickly identify design issues

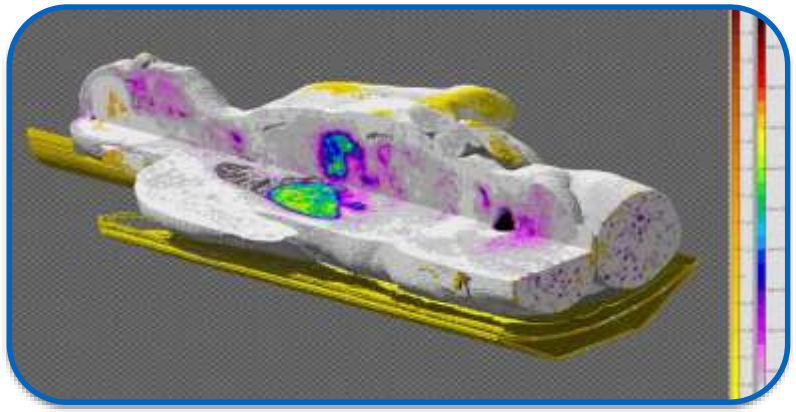
Endorsed our Brand

- CERN Brand endorsement increased buyer confidence
- CERN associated with latest cutting edge technology helped position us better
- Strong international reputation far beyond just science community
- Using CERN technology has helped us get funding for scaling up


Thank you!
Square GALILEO GALILEI
Accelerating Science
Accélérateur de science

ANNEX: 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**

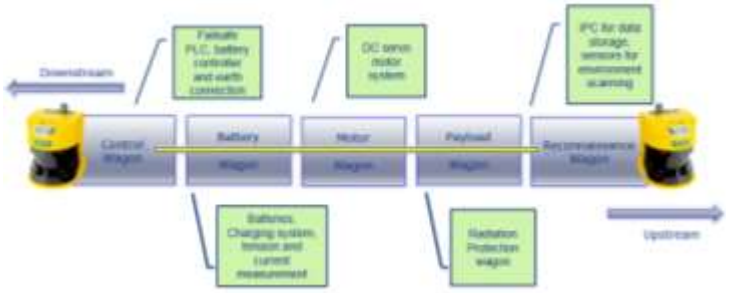
Train Inspection Monorail

WHAT

The Train Inspection Monorail is 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.

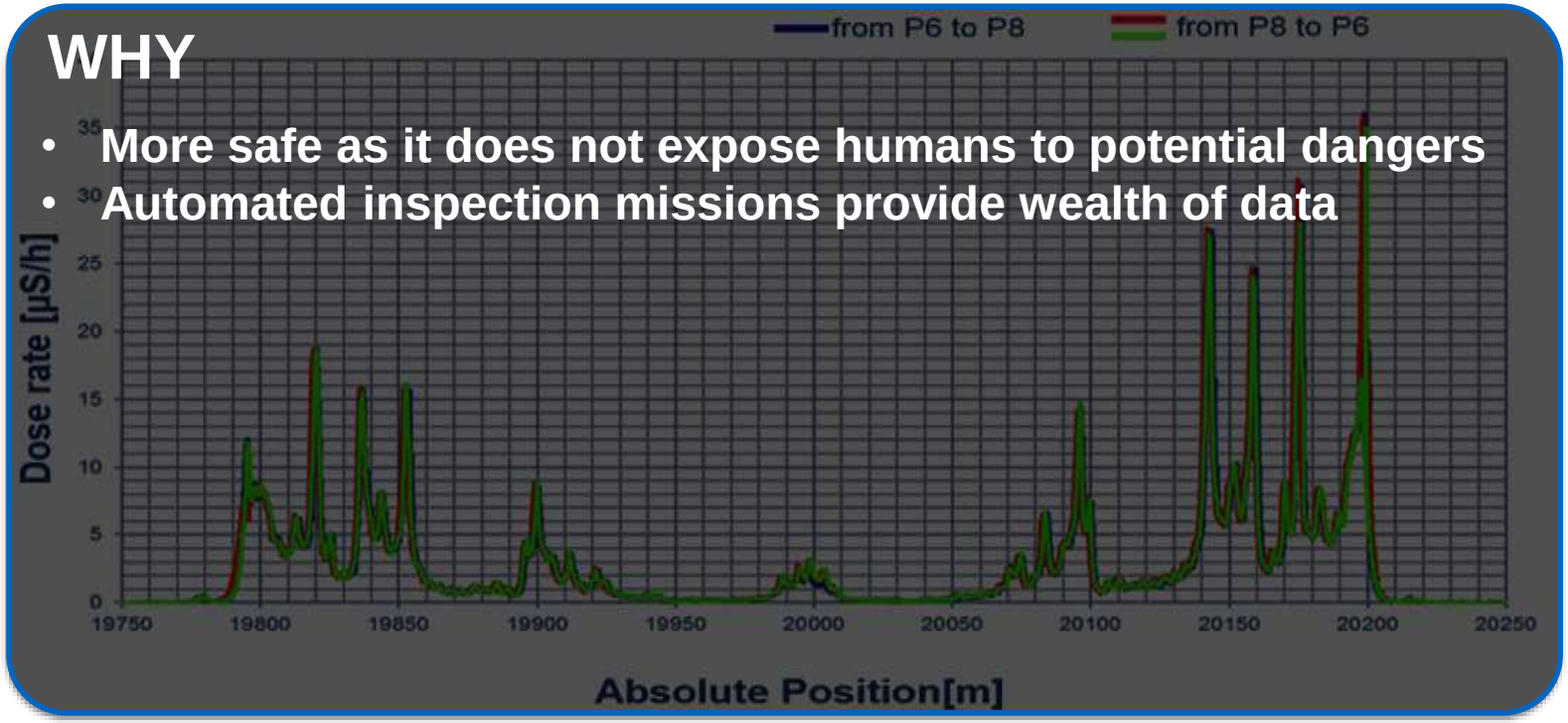
HOW

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

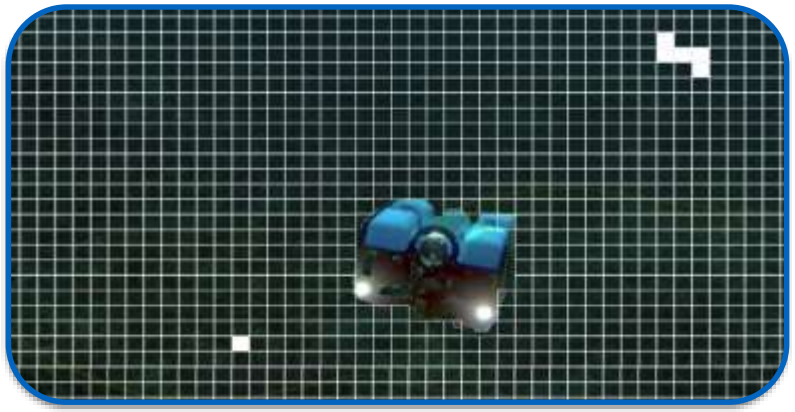


WHY

- **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 NxN 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 → 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.

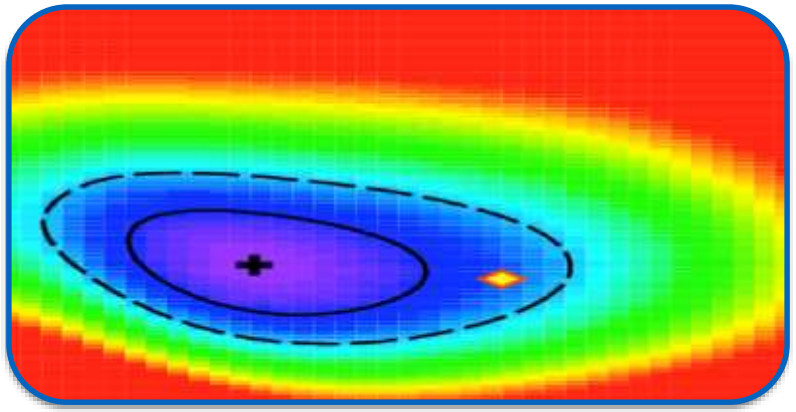
HOW

- 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.

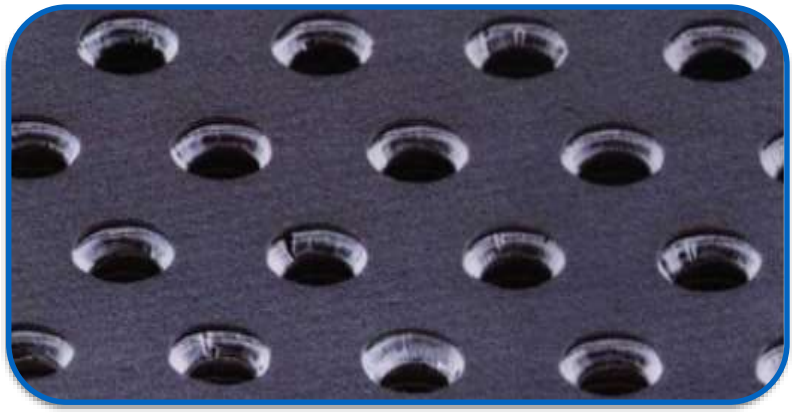
HOW

- 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

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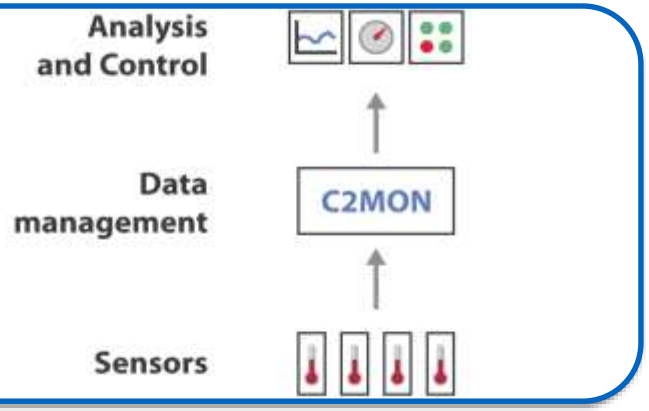
- Compatible with standard PC assembly lines

WHY

- **Added value for microelectronics and PCB industry**
- **Any app**
- **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.

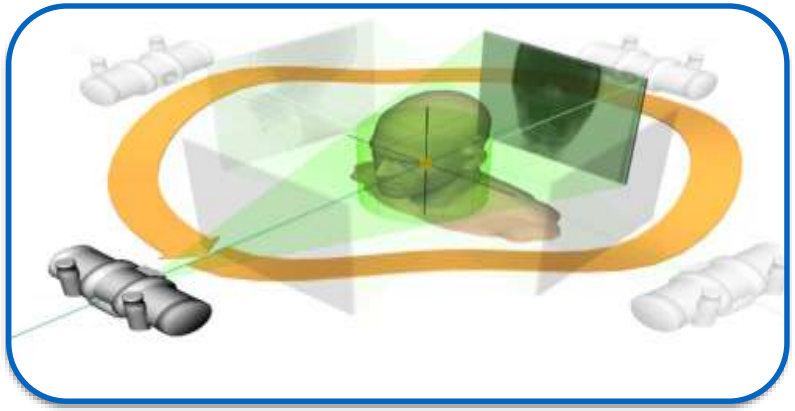
HOW

- 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…!**