MedTech @ CERN

Sandra Muhr

Knowledge Transfer Officer - Medical Applications
Knowledge Transfer Group
CERN

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

CERN was founded in 1954 with 12 European Member States

23 Member States

Austria – Belgium – Bulgaria – Czech Republic
Denmark – Finland – France – Germany – Greece
Hungary – Israel – Italy – Netherlands – Norway
Poland – Portugal – Romania – Serbia – Slovakia
Spain – Sweden – Switzerland – United Kingdom

3 Associates Member States in the pre-stage to membership

Cyprus – Estonia – Slovenia

7 Associate Member States

Croatia – India – Latvia – Lithuania – Pakistan – Turkey – Ukraine – Brazil

5 Observers

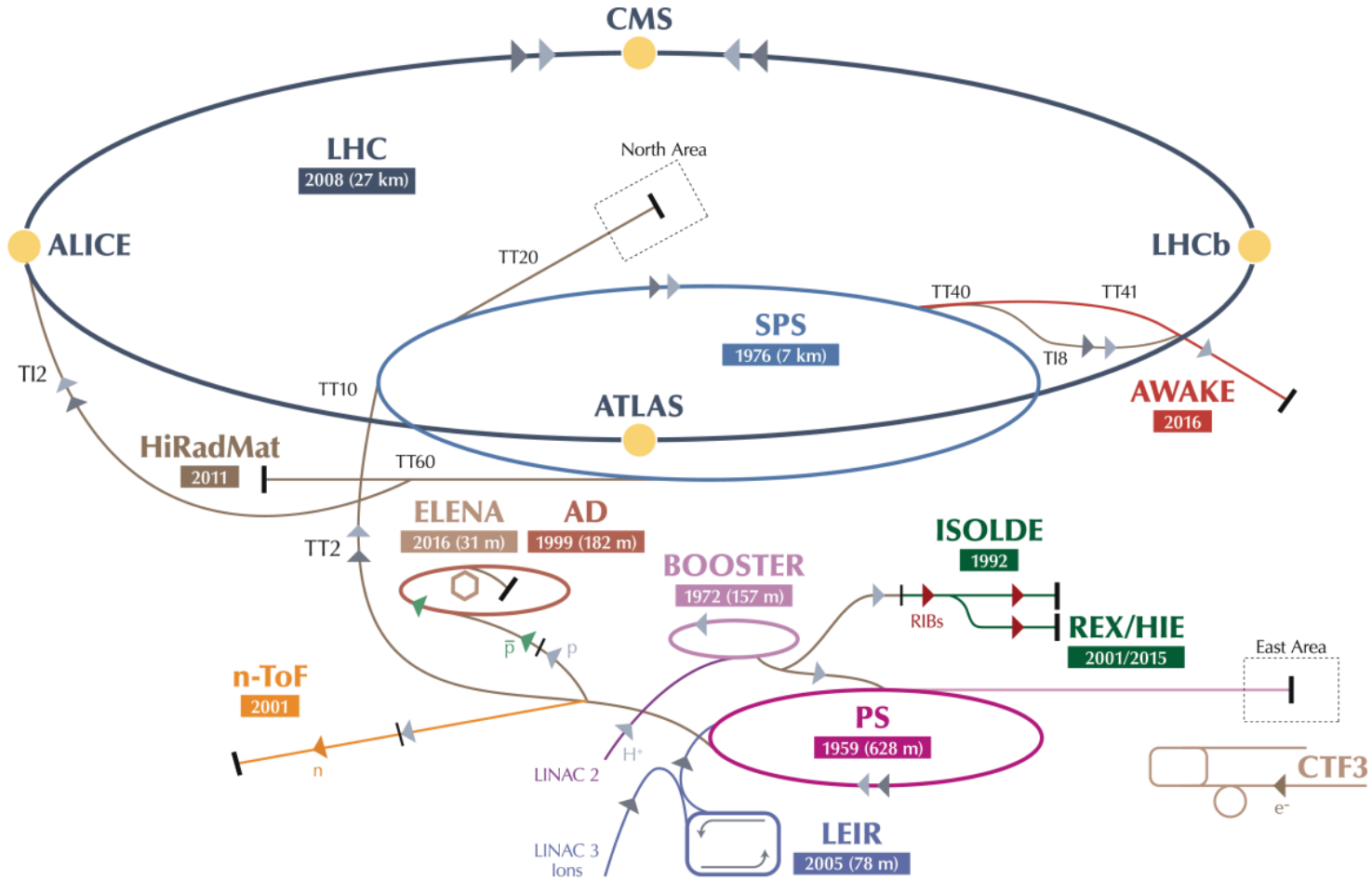
Japan – USA
European Union – JINR – UNESCO

CERN's annual budget is 1200 MCHF (equivalent to a medium-sized European university)

As of 31 December 2020
Employees:
2635 staff, **756** fellows

Associates:
11 399 users, **1687** others

Geographical & cultural diversity
Users of **110 nationalities**
~ 23% women



p (protons) ions RIBs (Radioactive Ion Beams) n (neutrons) p̄ (antiprotons) e⁻ (electrons) proton/antiproton conversion proton/RIB conversion

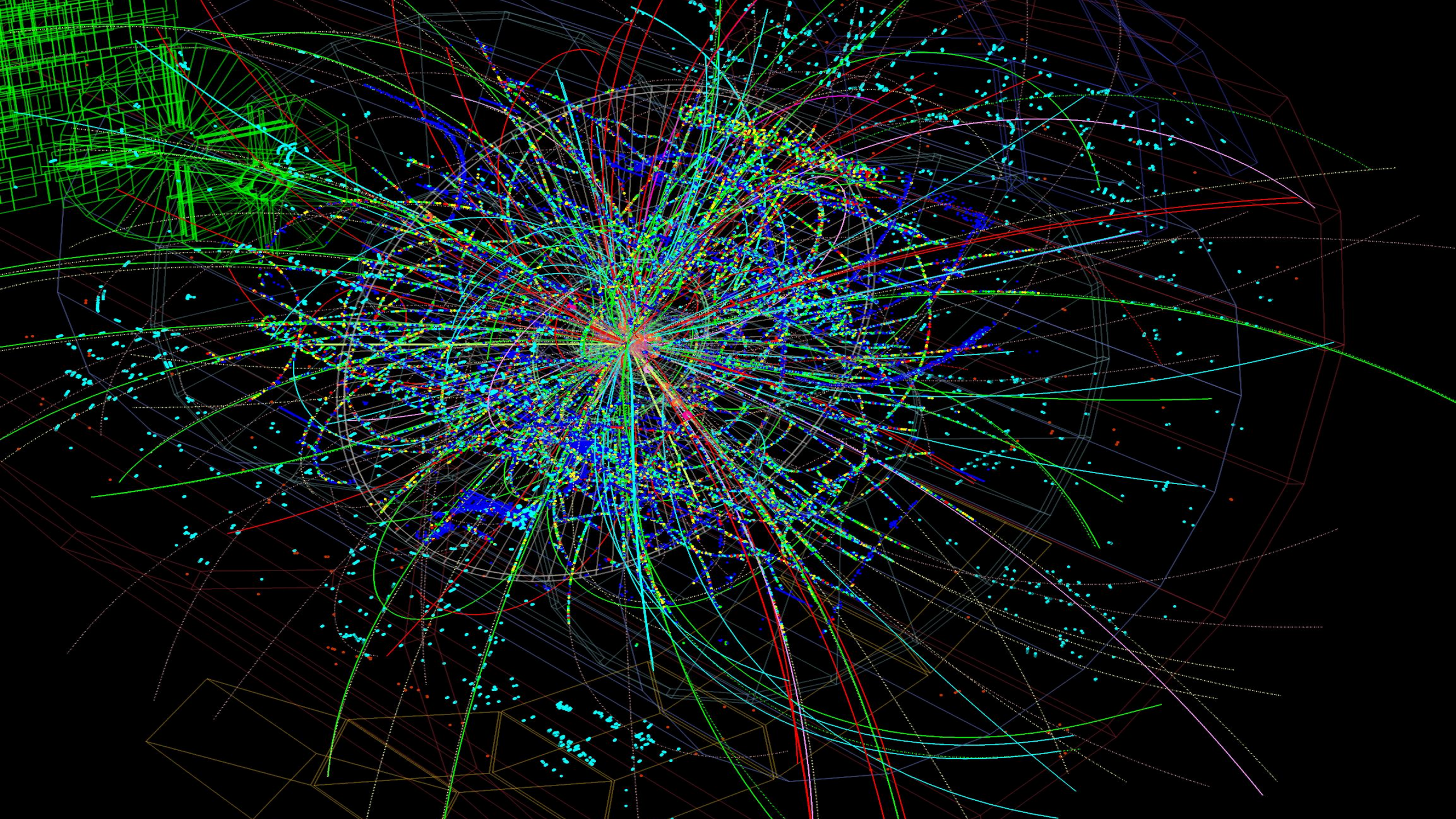
LHC Large Hadron Collider SPS Super Proton Synchrotron PS Proton Synchrotron AD Antiproton Decelerator CTF3 Clic Test Facility

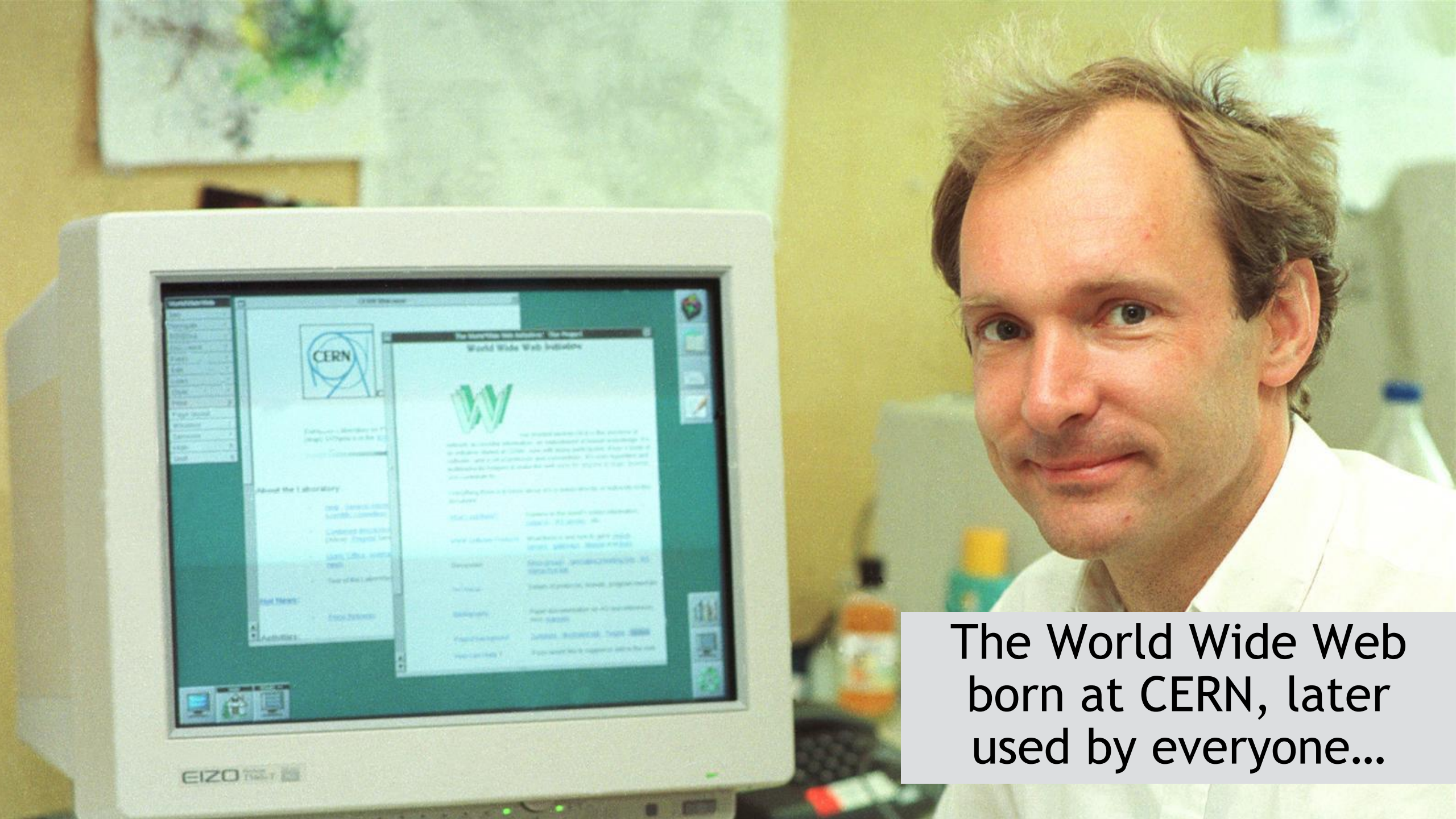
AWAKE Advanced WAKefield Experiment ISOLDE Isotope Separator OnLine REX/HIE Radioactive EXperiment/High Intensity and Energy ISOLDE

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

The Large Hadron Collider (LHC), 27km long, 100m deep.

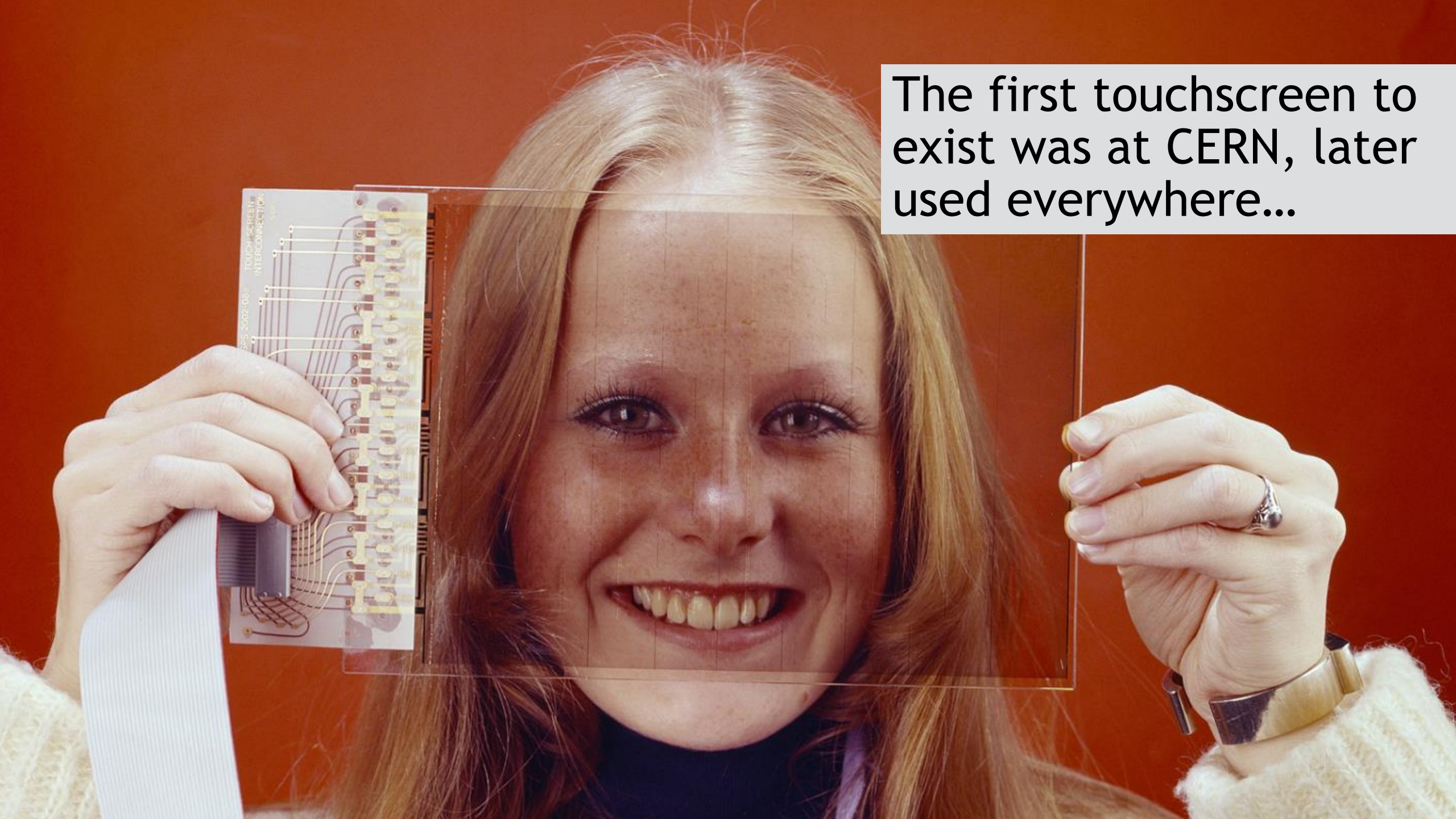

LHCb
ATLAS
CERN Meyrin
CERN Prévessin
SPS 7 km
SUISSE
FRANCE
CMS
ALICE
LHC 27 km





The World Wide Web born at CERN, later used by everyone…

Trackball with optical encoders, used later in the mouse of a PC…


The first touchscreen to exist was at CERN, later used everywhere…

Competences

Machine Learning and Deep Learning

Industrial Controls and Automation

Metrology

High and Ultra High Vacuum Systems

Data Analytics

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

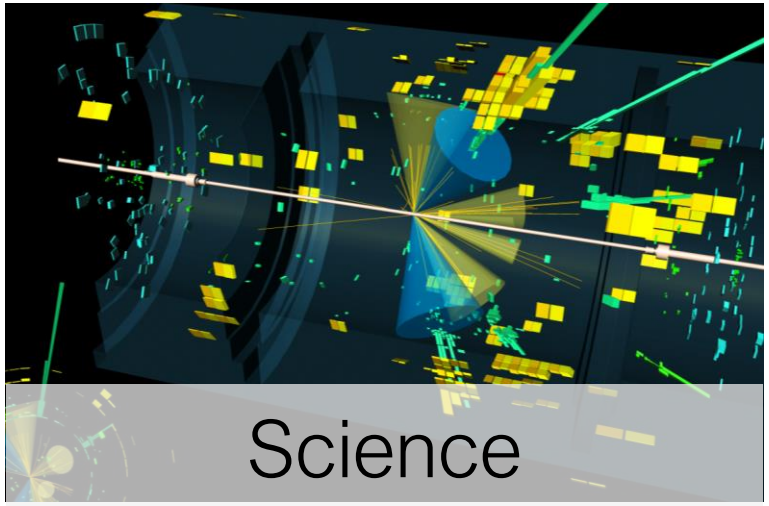
Robotics

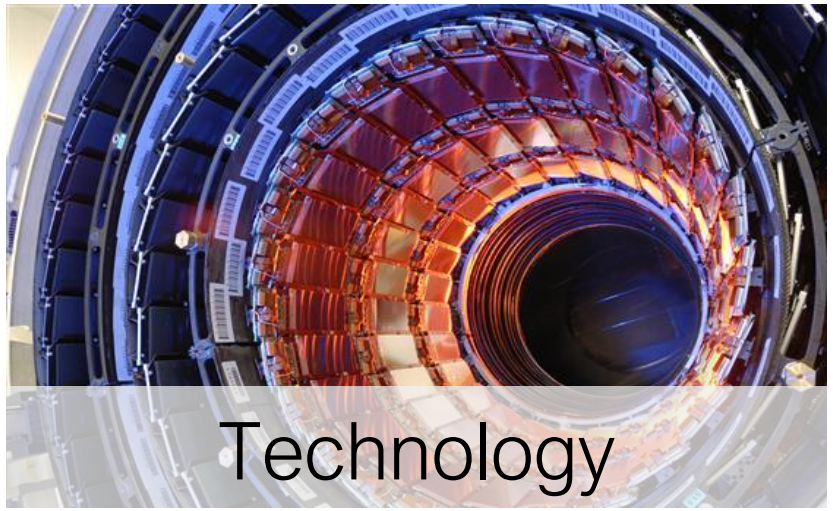
Collaboration Tools

Radio Frequency Technology

Manufacturing and Mechanical Processes

CERN's Mission

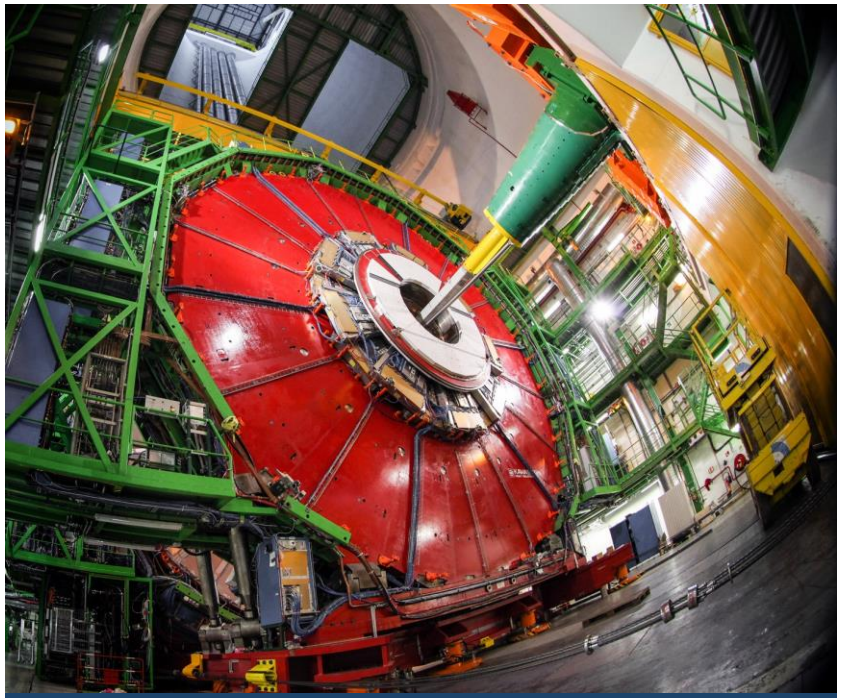




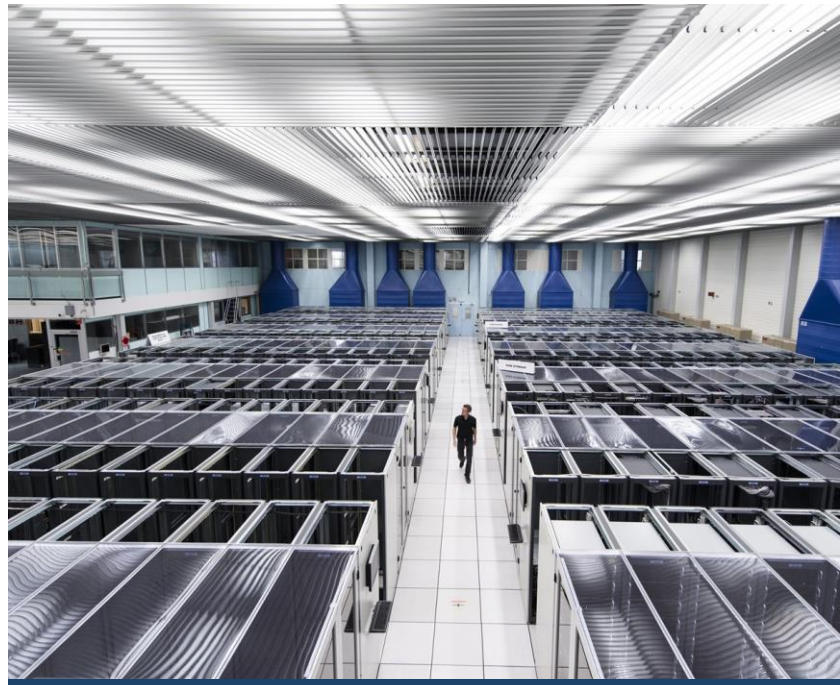
To summarize…

- We build the largest machines to study the smallest particles in the universe
- We develop technology to advance the limits of what is possible
- We perform world-class research in theoretical and experimental particle physics

ACCELERATORS

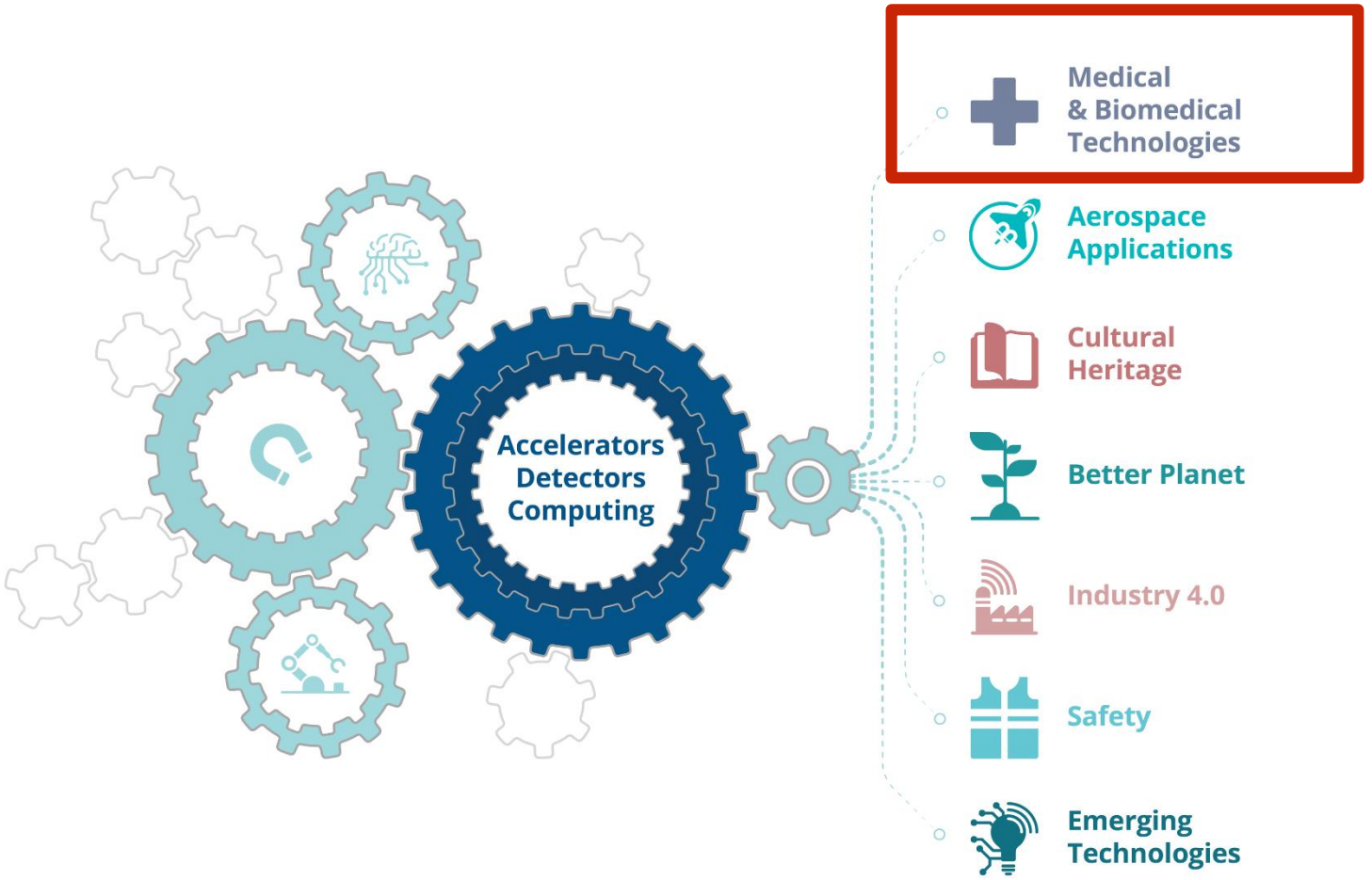


DETECTORS



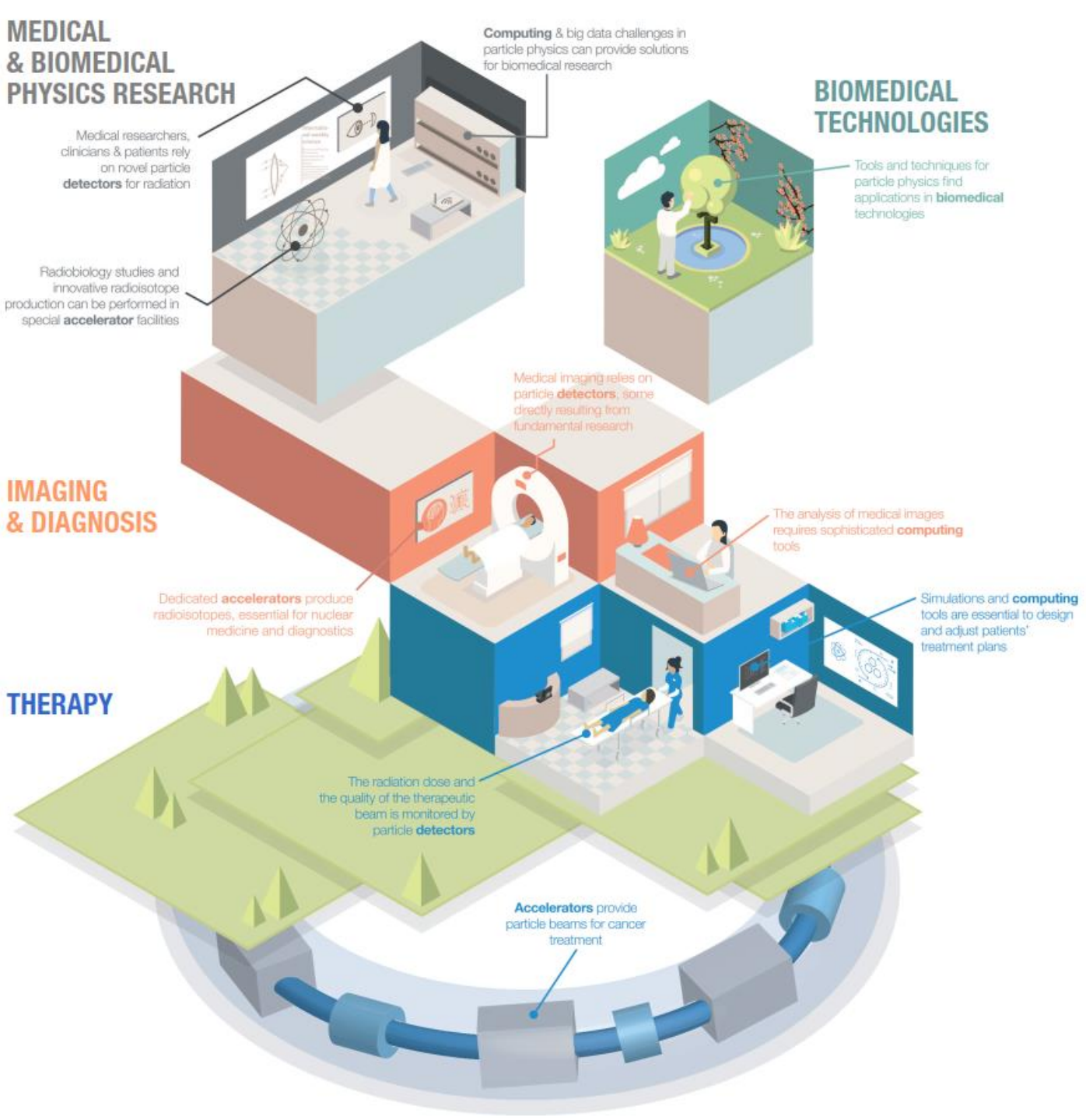
COMPUTING

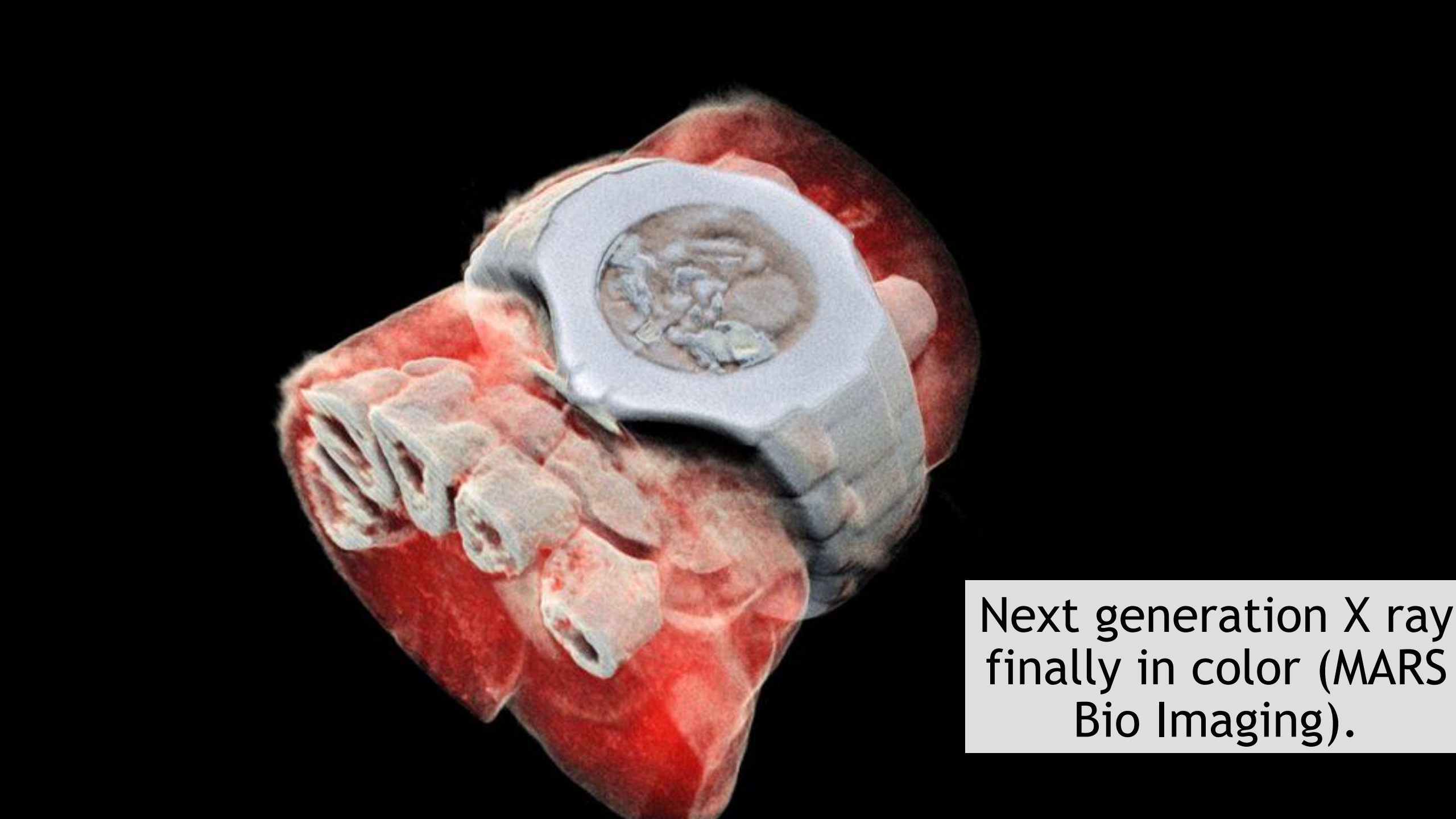
From CERN Technologies...



… to Society

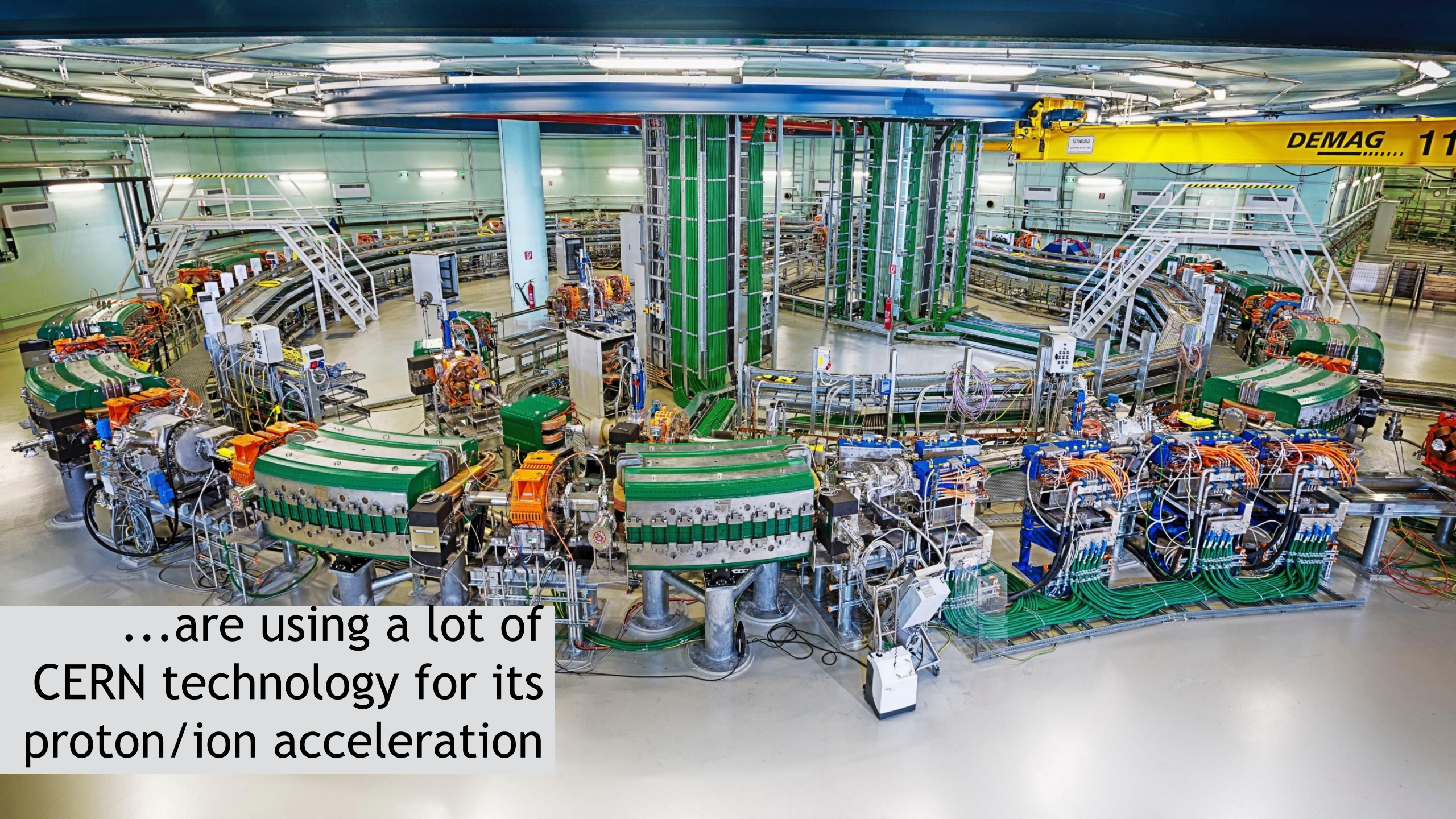
Medical & Biomedical Technologies





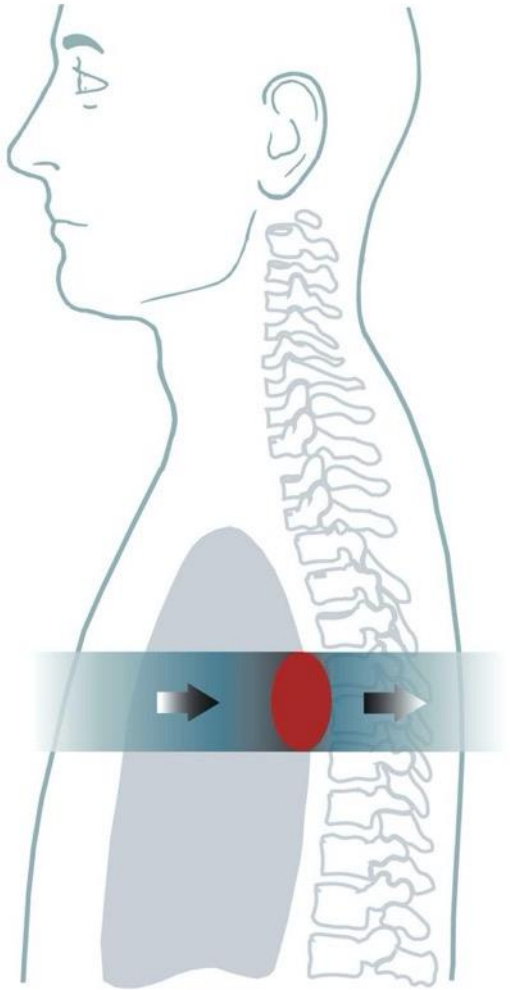
Next generation X ray finally in color (MARS Bio Imaging).

Particle Therapy Centers...

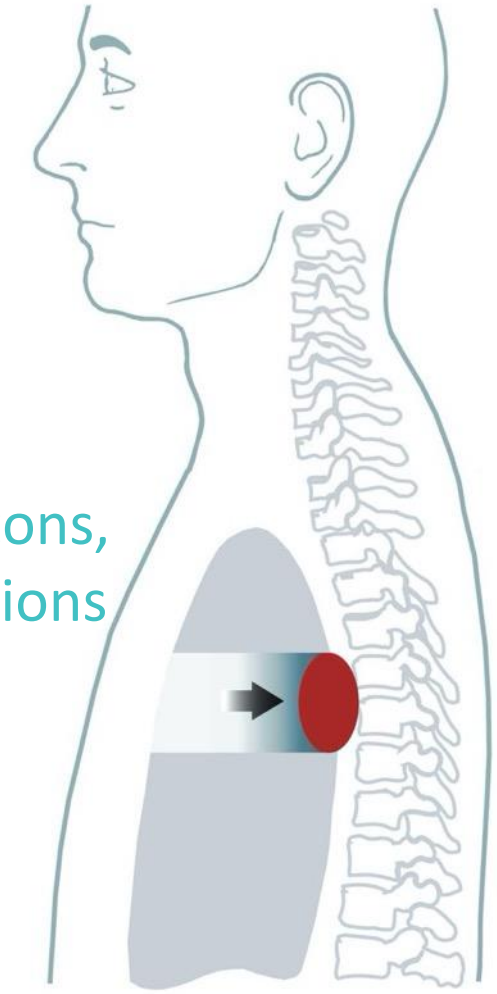


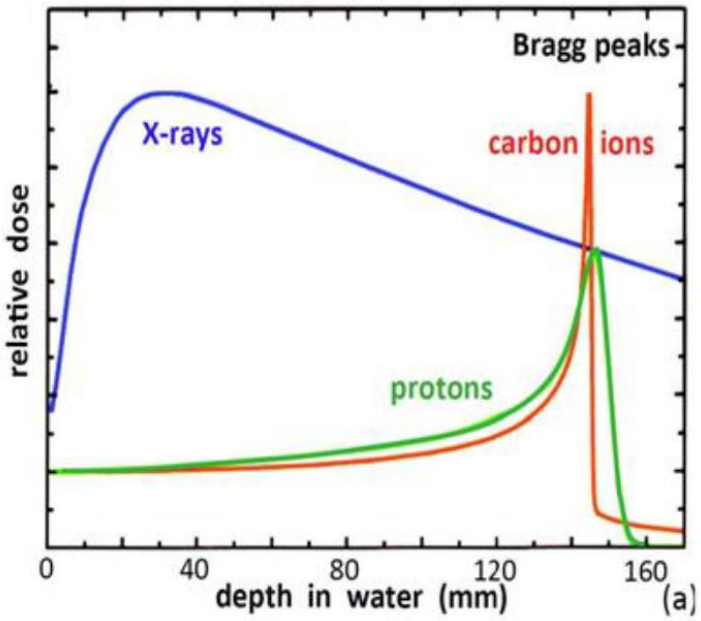
...are using a lot of CERN technology for its proton/ion acceleration

X rays

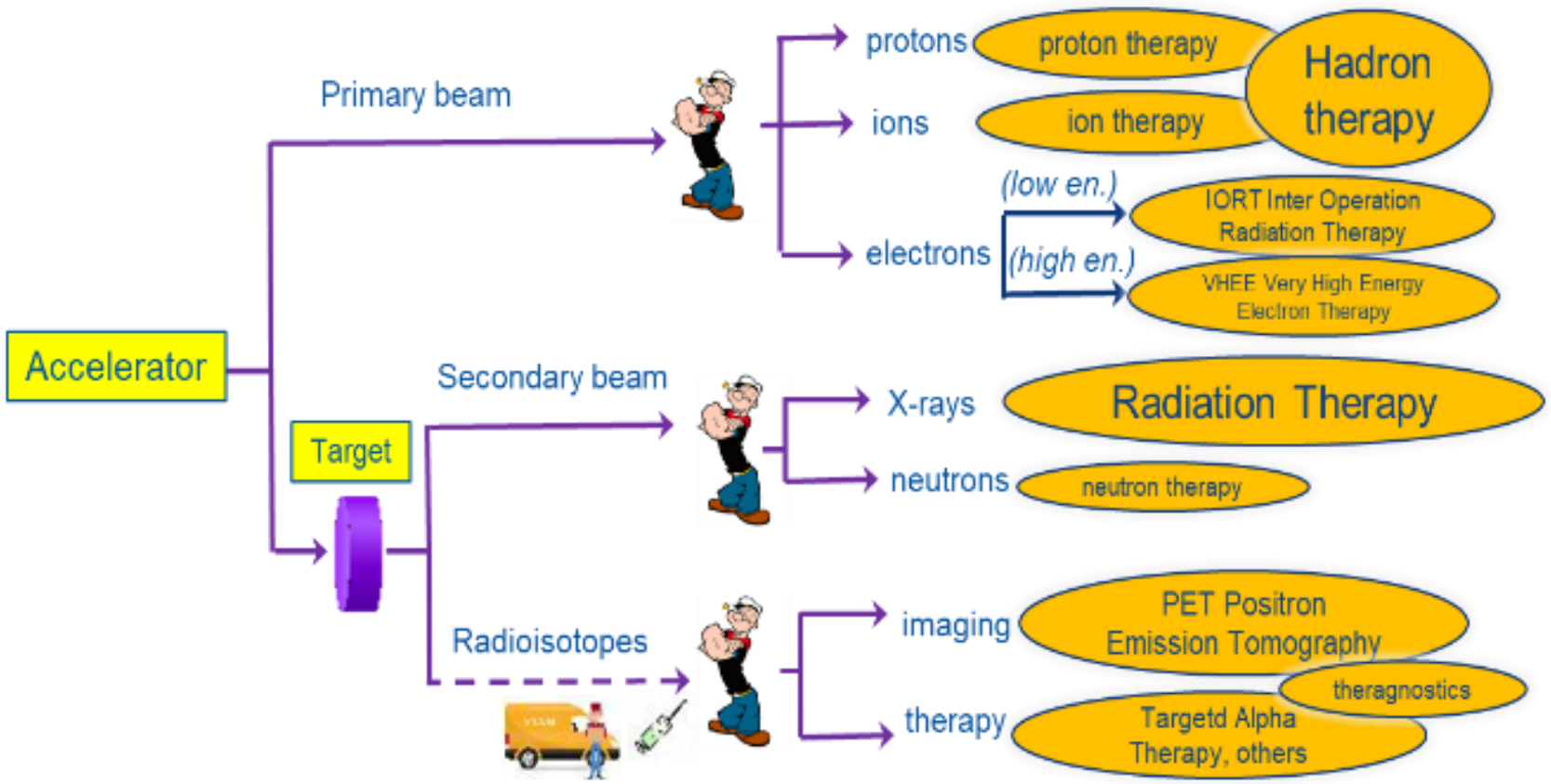


Protons, ions





Particle accelerators: a formidable tool for medicine



Nuclear medicine:

application of radioactive substances in the diagnosis and treatment of disease

Radiation therapy:

therapy using ionizing radiation, generally as part of cancer treatment to control or kill malignant cells

≈ 30'000 particle accelerators operating worldwide
16'000 in medicine, for cancer therapy and imaging

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
CERN - PS DIVISION

CERN/PS 2000-007 (DR)

PROTON-ION MEDICAL MACHINE STUDY (PIMMS) PART II

Accelerator Complex Study Group*
supported by the Med-AUSTRON, Onkologie-2000 and the TERA Foundation
and hosted by CERN

ABSTRACT

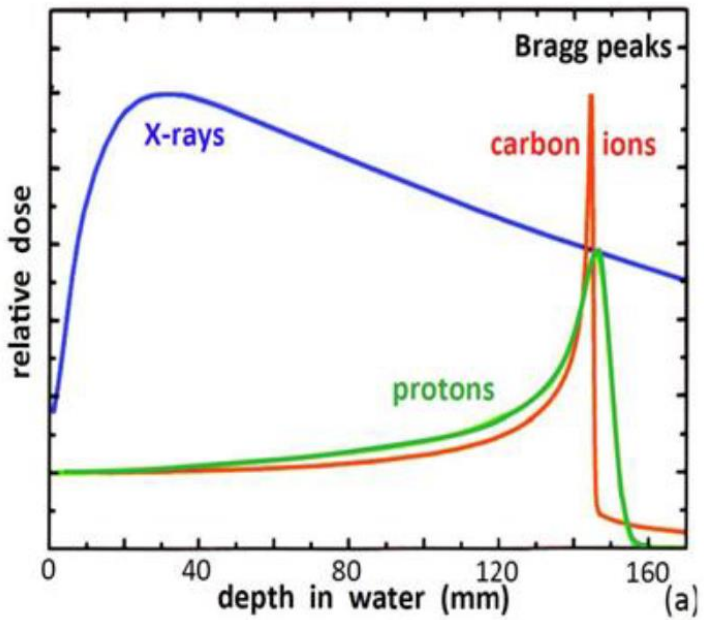
The Proton-Ion Medical Machine Study (PIMMS) group was formed following an agreement between the Med-AUSTRON (Austria) and the TERA Foundation (Italy) to combine their efforts in the design of a cancer therapy synchrotron capable of accelerating either light ions or protons. CERN agreed to support and host this study in its PS Division. A close collaboration was also set up with GSI (Germany). The study group was later joined by Onkologie-2000 (Czech Republic). Effort was first focused on the theoretical understanding of slow extraction and the techniques required to produce a smooth beam spill for the conformal treatment of complex-shaped tumours with a sub-millimetre accuracy by active scanning with proton and carbon ion beams. Considerations for passive beam spreading were also included for protons. The study has been written in two parts. The more general and theoretical aspects are recorded in Part I and the specific technical design considerations are presented in the present volume, Part II. An accompanying CD-ROM contains supporting publications made by the team and data files for calculations. The PIMMS team started its work in January 1996 in the PS Division and continued for a period of four years.

*Full-time members: L. Badano[1], M. Benedikt[2], P.J. Bryant[2] (Study Leader), M. Cresc
A. Maier[2]+[4], M. Pullia[1], S. Reimoser[2]+[4], S. Rossi[1],
Part-time members: G. Borri[1], P. Knaus[1]+[2]
Contributors: F. Gramatica[1], M. Pavlovic[4], L. Weisser[2]
1) TERA Foundation, via Puccini. 11, I-28100 Novara.
2) CERN, CH 1211 Geneva-23.
3) Oncology-2000 Foundation, Na Morani 4, CZ-12808 Prague 2.
4) Med-AUSTRON, c/o RIZ, Prof. Dr. Stephan Korenstr.10, A-2700 Wr. Neustadt.
5) Sommer & Partner Architects Berlin (SPB), Hardenbergplatz 2, D-10623 Berlin.

Geneva, Switzerland
May 2000

CNAO
The National Center for Oncological Hadrontherapy

MedAustron



HITRI plus

Heavy Ion Therapy Research Integration

EU FRAMEWORK PROGRAMME
FOR RESEARCH AND INNOVATION (2014 – 2020)
"HORIZON 2020"

MedAustron

CNAO

The National Center for Oncological Hadrontherapy

UKGM

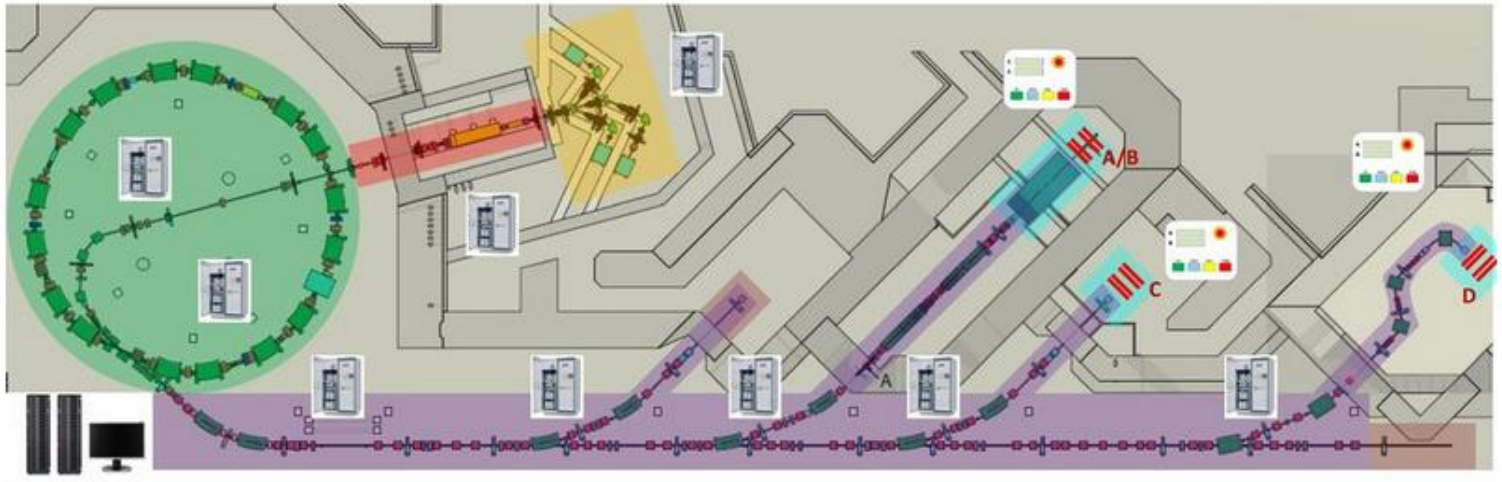
UNIKLINIKUM GIESSEN UND MARBURG

HIT

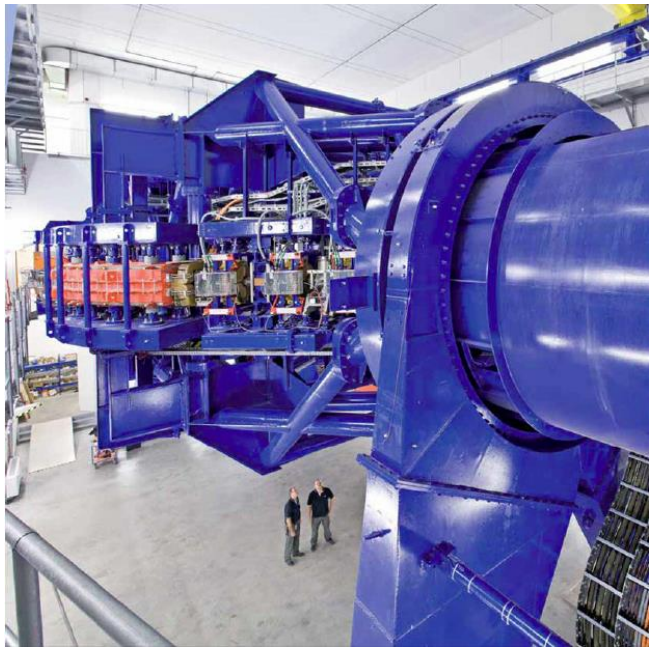
Heidelberger Ionenstrahl-Therapiezentrum

Hadron Therapy Center:

Ion Sources
Linear Accelerator
Synchrotron
Beam Distribution System
Beam outlet for non clinical research
Accelerator Control System
Power Supplies
Dose Delivery System (part of medical front-end - MF)
A/B Clinical beam outlet IR2 horizontal (A) uand vertical (B)
C Clinical beam outlet IR3 horizontal (C)
D Clinical beam outlet Gantry (D)
MAPTA Treatment Control Panel (part of MF)

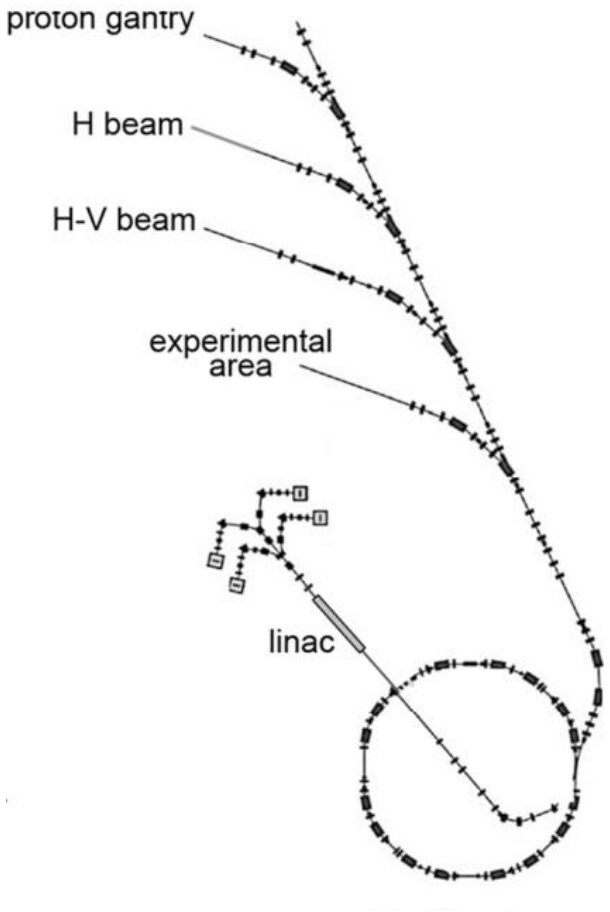


Total area: ca 22 500 m^2

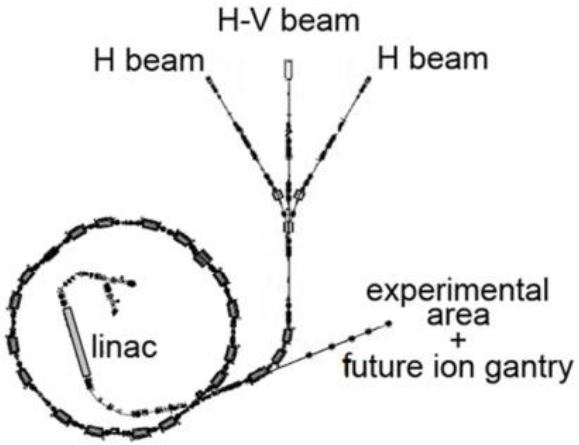


Gantry – 600 tons

X-ray therapy system: 2-3 M€
Proton therapy center: 23-140 M€
Ion therapy center: 150-200 M€



MedAustron

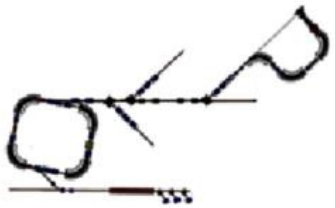


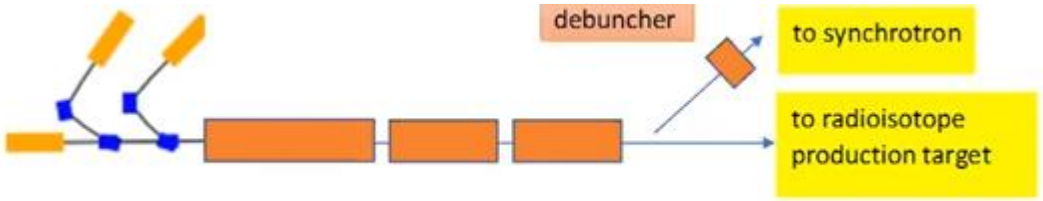
CNAO

The National Center for Oncological Hadrontherapy

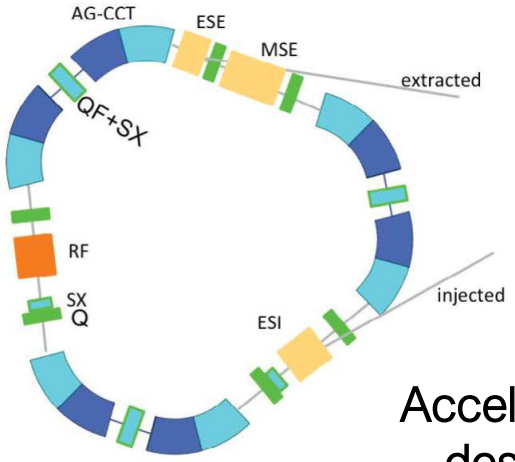
New Strategy:

The aim is to
- Reduce **Costs**
- Reduce **Dimensions**

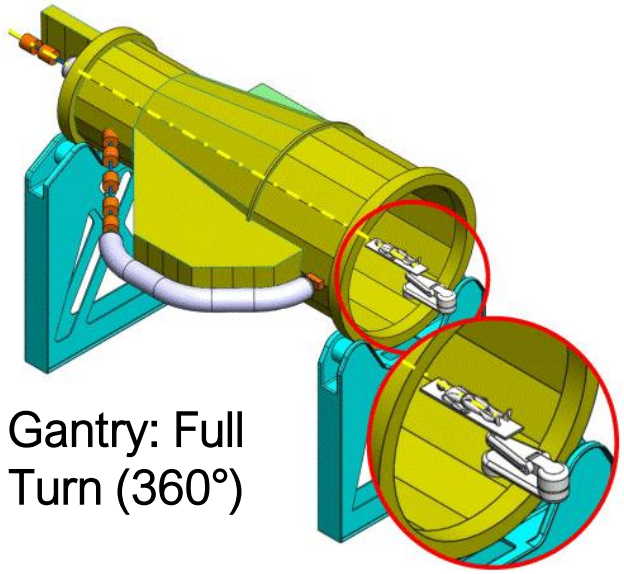




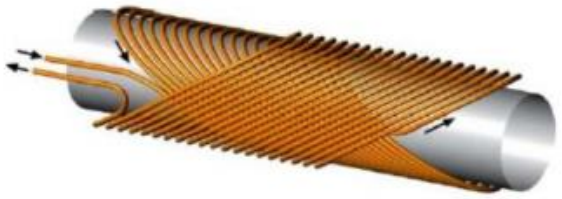
LINAC



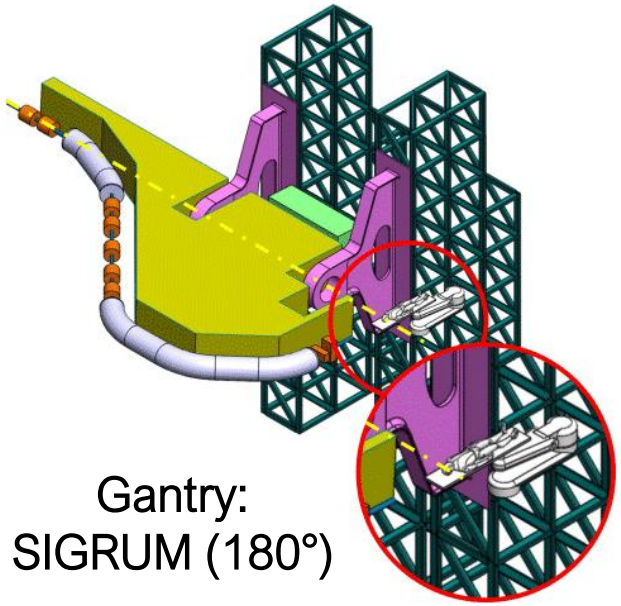
Accelerator design: Synchrotron



Gantry: Full Turn (360°)



Superconducting Magnets

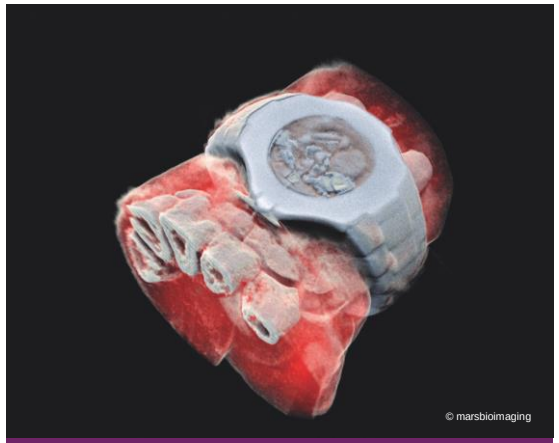


Gantry: SIGRUM (180°)


D. Kaprinis, Kaprinis
Architects

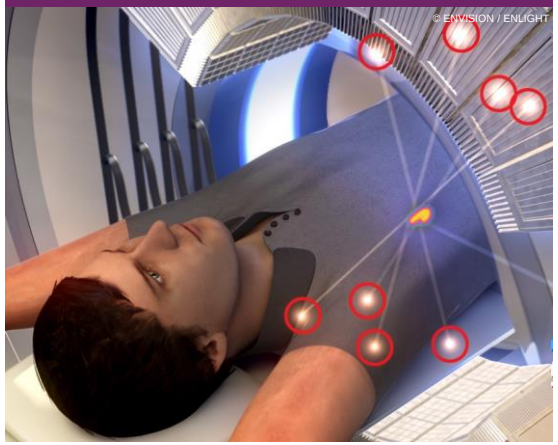
CERN’s technological innovations have important applications in medicine and healthcare

Technologies applied at CERN are also used in PET, for medical imaging and diagnostics.



CERN produces innovative radioisotopes for nuclear medicine research.

Accelerator technologies are applied in cancer radiotherapy with protons, ions and electrons.



Pixel detector technologies are used for high resolution 3D colour X-ray imaging.

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

Entrepreneurship @CERN

Social Entrepreneurship THE PORT

Entrepreneur Mixer

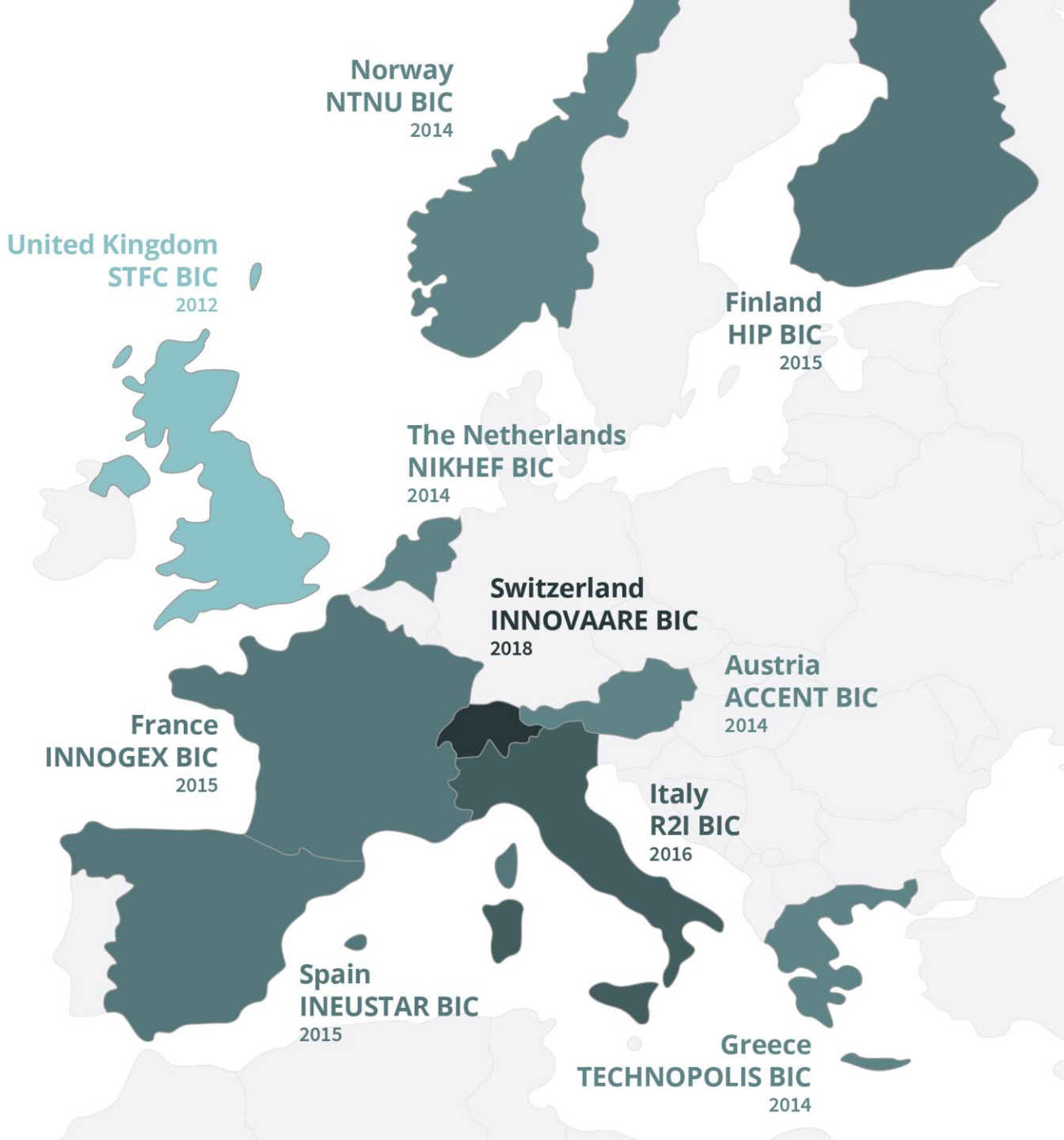
Global Entrepreneurship Week

Entrepreneurship Meet-Ups

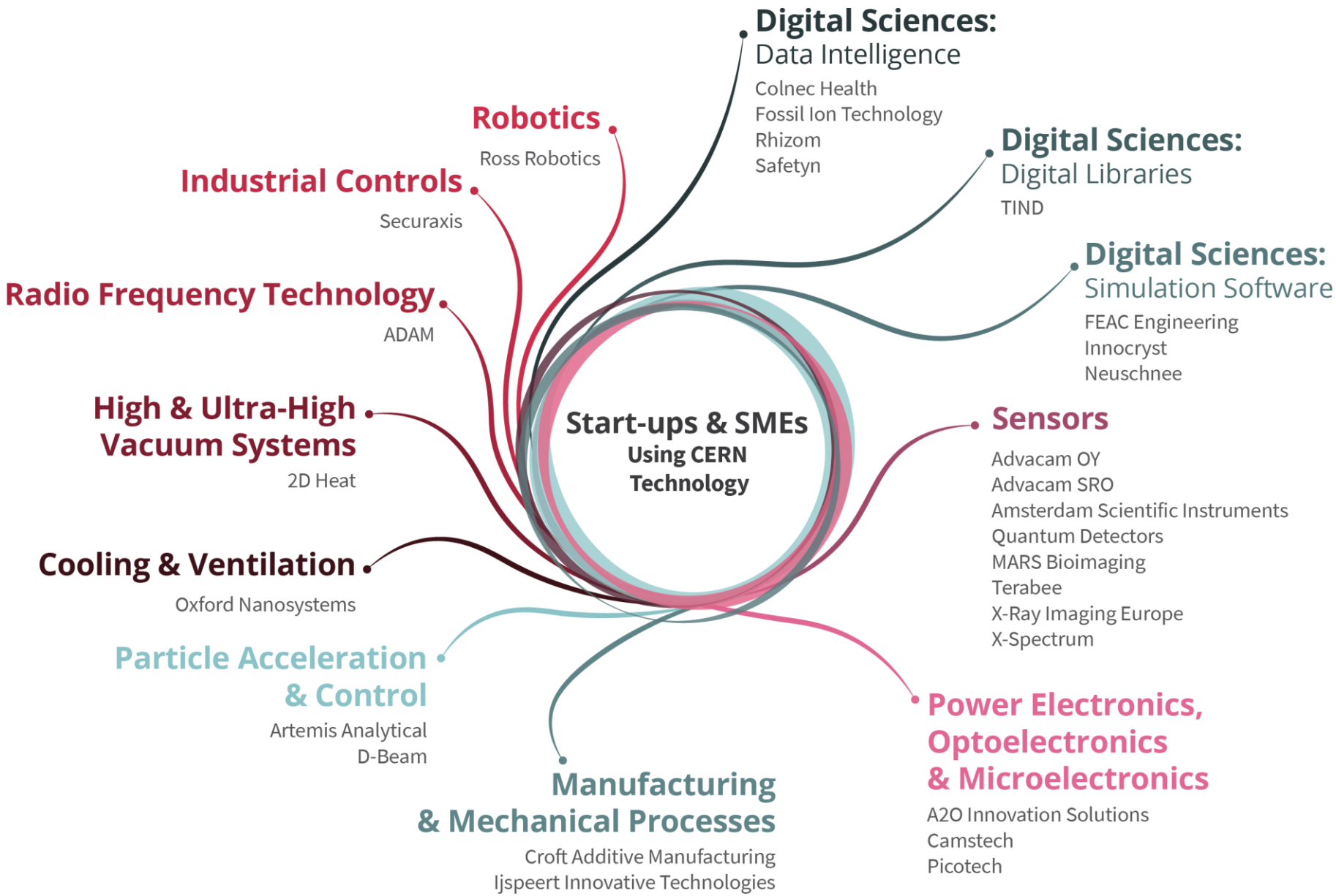
CERN-NTNU Screening Week

Challenge Based Innovation

Our network of Business Incubation Centers (BICs) help accelerate innovation in the CERN Member States.



Many local initiatives organized by BICs to help (create) startups with CERN technology


Start-ups & SMEs
Using CERN
Technology
Digital Sciences:
Data Intelligence
Colnec Health
Fossil Ion Technology
Rhizom
Safetyn
Digital Sciences:
Digital Libraries
TIND
Digital Sciences:
Simulation Software
FEAC Engineering
Innocryst
Neuschnee
Sensors
Advacam OY
Advacam SRO
Amsterdam Scientific Instruments
Quantum Detectors
MARS Bioimaging
Terabee
X-Ray Imaging Europe
X-Spectrum
Power Electronics,
Optoelectronics
& Microelectronics
A2O Innovation Solutions
Camstech
Picotech
Manufacturing
& Mechanical Processes
Croft Additive Manufacturing
Ijspeert Innovative Technologies
Particle Acceleration
& Control
Artemis Analytical
D-Beam
Cooling & Ventilation
Oxford Nanosystems
High & Ultra-High
Vacuum Systems
2D Heat
Radio Frequency Technology
ADAM
Industrial Controls
Securaxis
Robotics
Ross Robotics

Lessons learned for making industrial strategic collaborations aiming to accelerate innovation.

- A strong local CERN ‘ambassador’ / BIC is important
- Start with a concrete project and business need
- Passionate experts needed on both sides
- Mind the gap – in language, culture, goals
- Knowledge transfer is hard work and fun

- Be aware… magic may happen!

THANK YOU!

Find out more at kt.cern