
CERN

Driving Innovation through Collaborative Public-Private R&D

OPUS Project: Industry and Open Science Workshop, 9th April 2025

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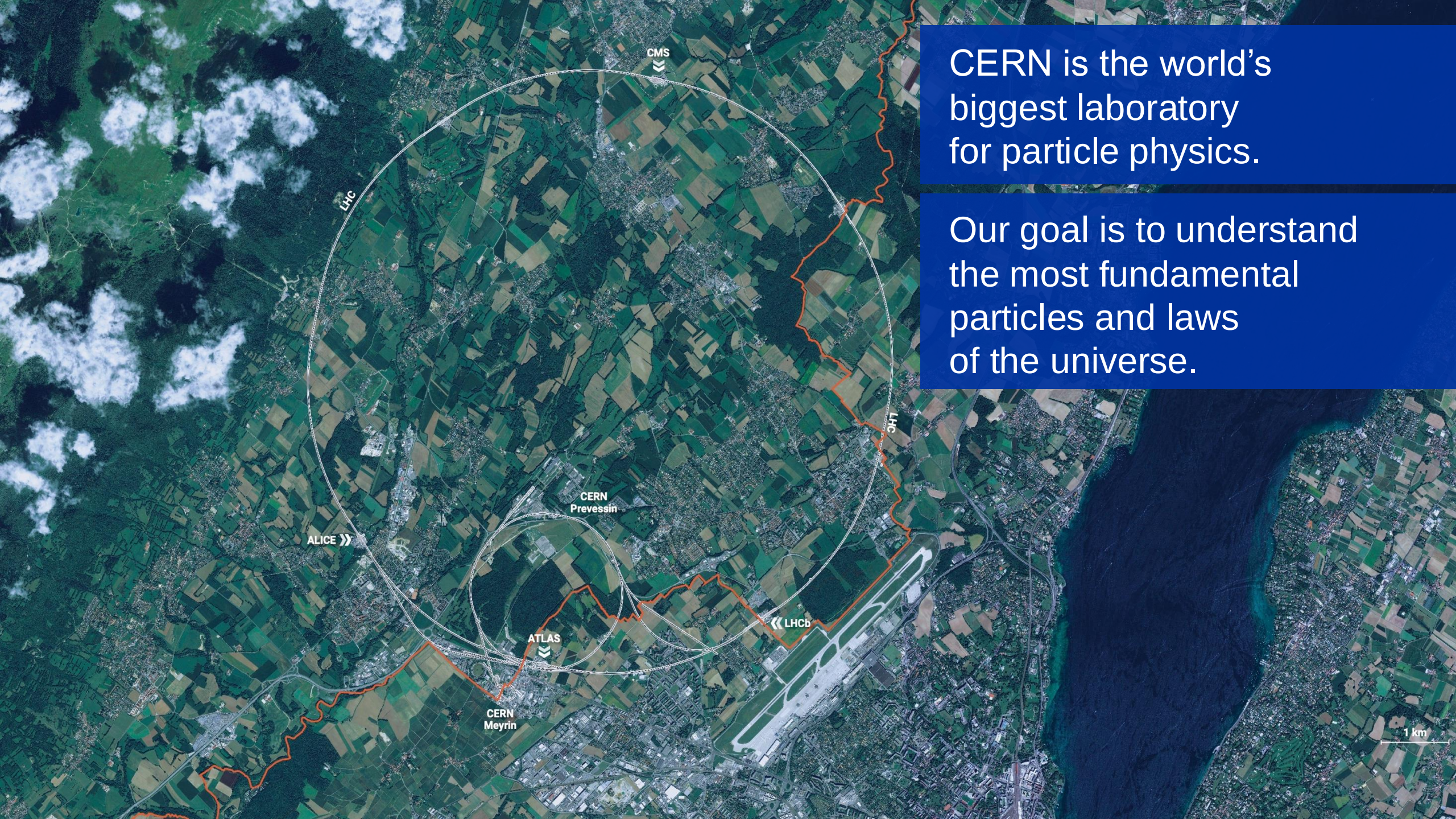
Outline

- Intro to CERN
- CERN Fundamental Challenge
- Technology Innovation
- Examples
- Impact & Mutual Benefits



CERN is the world's biggest laboratory for particle physics.

Our goal is to understand the most fundamental particles and laws of the universe.

Science for peace

CERN was founded in 1954 with 12 European Member States

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

As of 31 December 2023
Employees:
2666 staff, **1002** graduates
Associates:
12 370 users, **1513** others

24 Member States

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

10 Associate Member States

Brazil – Croatia – Cyprus*– India – Latvia – Lithuania
Pakistan – Slovenia* – Türkiye – Ukraine

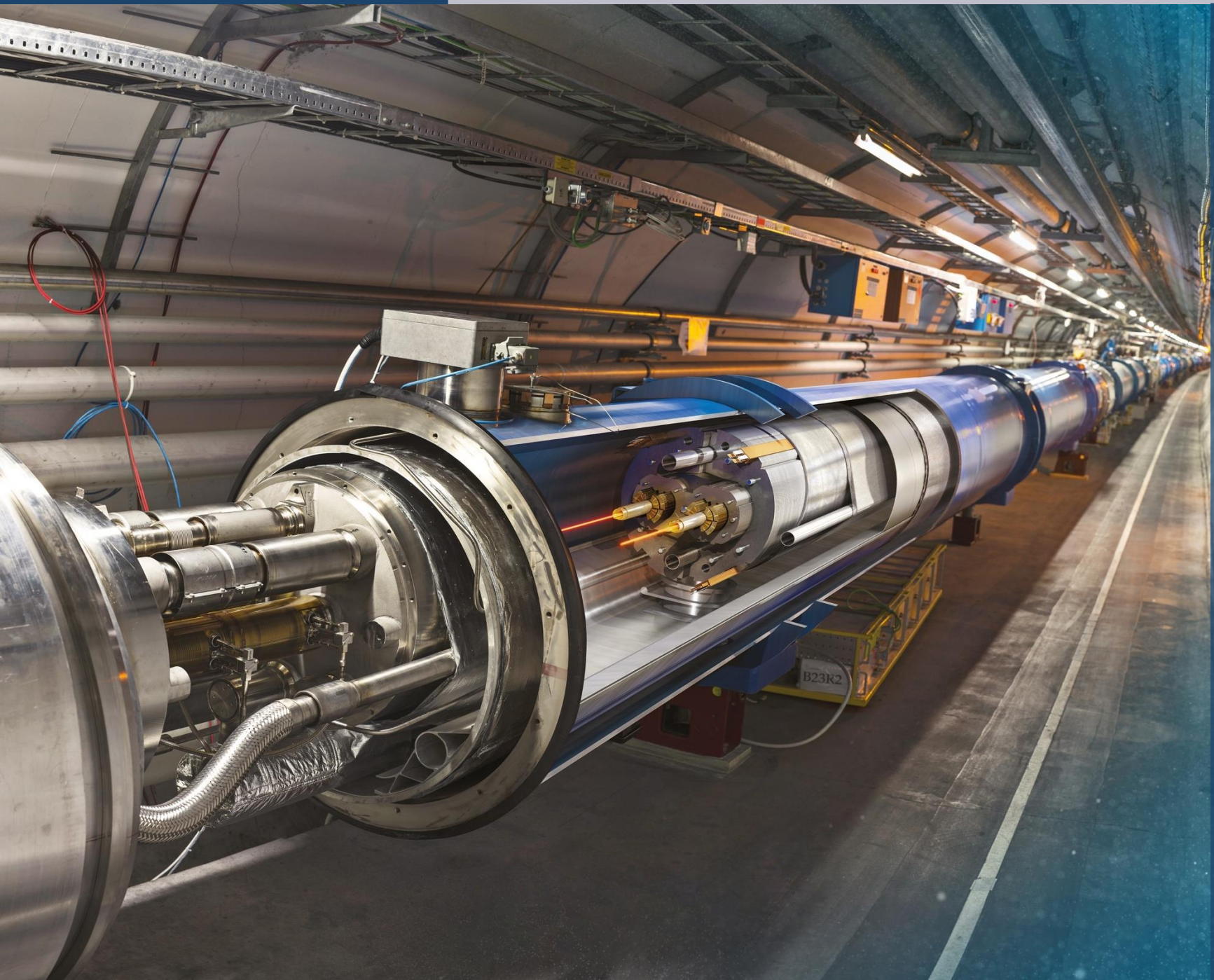
4 Observers

Japan – USA – European Union – UNESCO

* Associate Member State in the pre-stage to Membership

~ 50 Cooperation Agreements

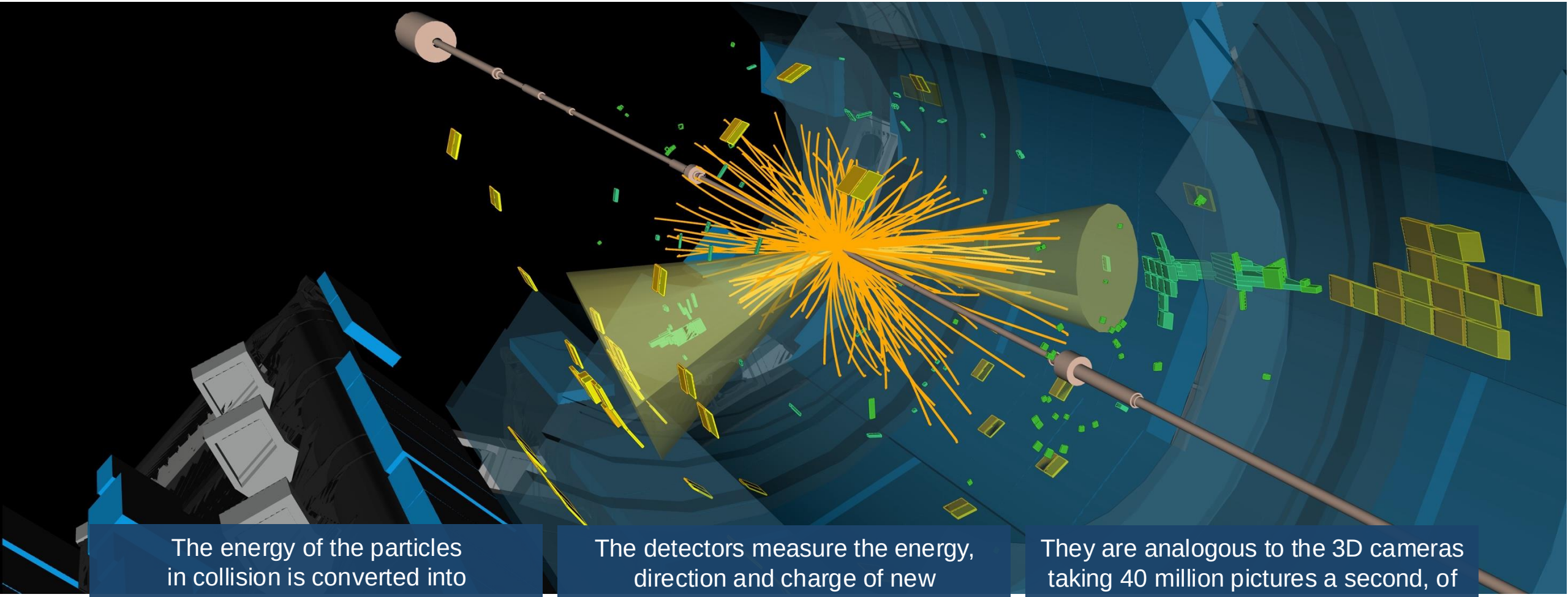
Albania – Algeria – Argentina – Armenia – Australia – Azerbaijan – Bahrain – Bangladesh – Bolivia – Bosnia and Herzegovina
Canada – Chile – Colombia – Costa Rica – Ecuador – Egypt – Georgia – Honduras – Iceland – Iran – JINR – Jordan
Kazakhstan – Lebanon – Malta – Mexico – Mongolia – Montenegro – Morocco – Nepal – New Zealand
North Macedonia – Palestine – Paraguay – People's Republic of China – Peru – Philippines – Qatar – Republic of Korea
Saudi Arabia – South Africa – Sri Lanka – Thailand – Tunisia – United Arab Emirates – Uruguay – Vietnam



Large Hadron Collider (LHC)

- 27 km in circumference
- About 100 m underground
- Superconducting magnets steer the particles around the ring
- Particles are accelerated to close to the speed of light

The LHC produces more than 1 billion particle collisions per second

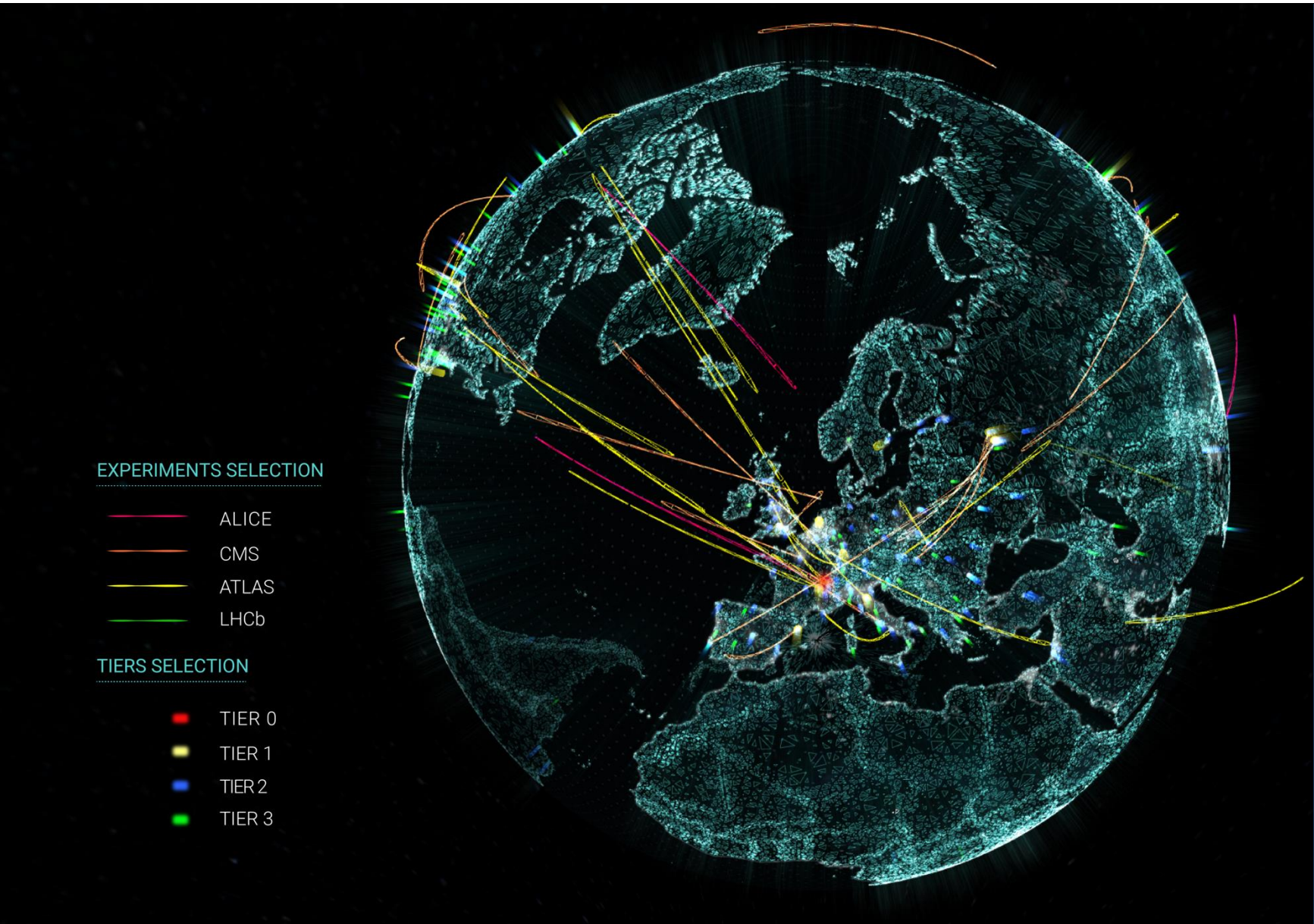


The energy of the particles in collision is converted into new particles.

The detectors measure the energy, direction and charge of new particles formed.

They are analogous to the 3D cameras taking 40 million pictures a second, of which 1000 are selected and recorded.

The Worldwide LHC Computing Grid (WLCG)



WLCG

- Stores, distributes, processes and analyses LHC experiments' data.
- 1.4 million processing cores in 170 data centres and more than 40 countries.
- 1500 Petabytes of CERN data stored world-wide.

CERN’s technological innovations have applications in many fields…

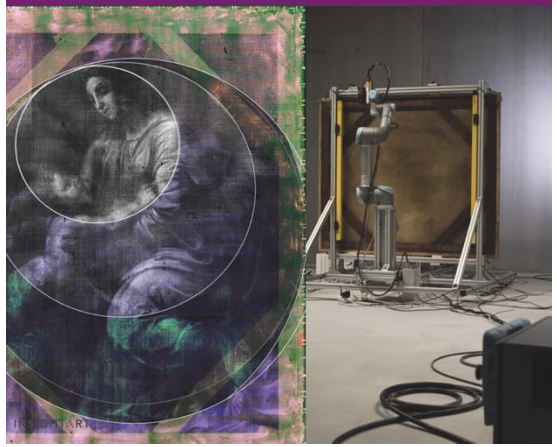
CERN is the birthplace of the World Wide Web

…and have an important impact on society

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

Cultural Heritage
InsightART

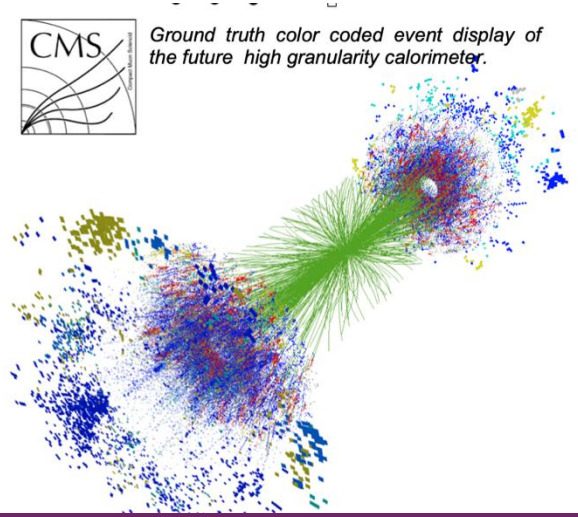
Measuring the DNA of your art.



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

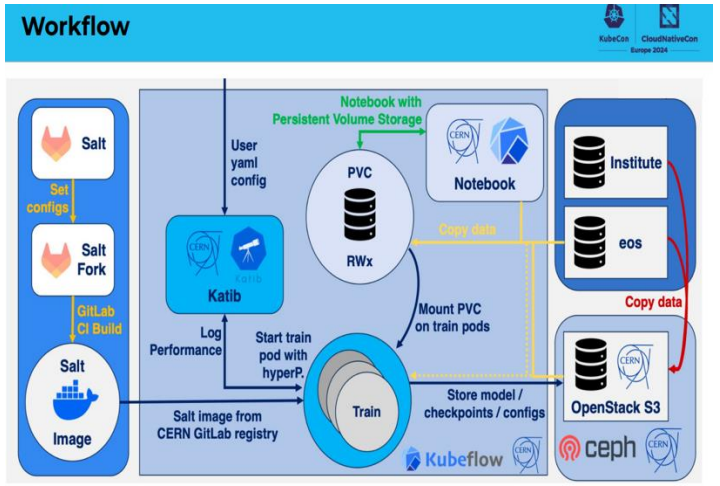
Developing machine learning software for autonomous driving.

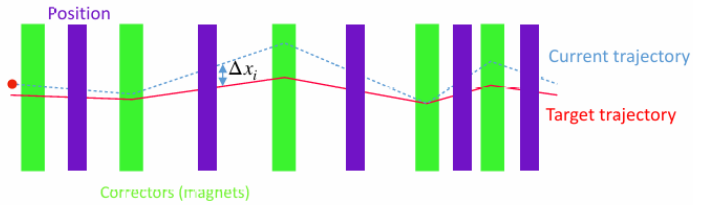
AI @ CERN



Machine Learning is used today at any level of the HEP experiments data processing flow. Recent advancements in Generative AI and Large Language Models are being explored to support controls and operations, clerical assistants to improve efficiency.

CERN is prototyping dedicated AI/ML services together with industry in the Member States and the experimental collaborations, based on hybrid scalable architectures including on-premise, cloud and HPC





Reinforcement Learning algorithms are used to optimise particle beams steering
But also collaborations include several non-physics related projects in the healthcare domain (European network of Clinical Centres), cancer research (IARC), and medical supply chains (WHO).

INNOVATION with INDUSTRY: Examples

Example 1: ARCHIVER Project

Focus: Archiving and Data Preservation Services at scale for the European Open Science Cloud (EOSC)

European Commission

Buyers Group (BG) - Public organisations committing funds to contribute to a joint-R&D-procurement, research data use cases and R&D testing effort.

PHOTON-NEUTRON SCIENCES

ASTROPHYSICS & COSMOLOGY

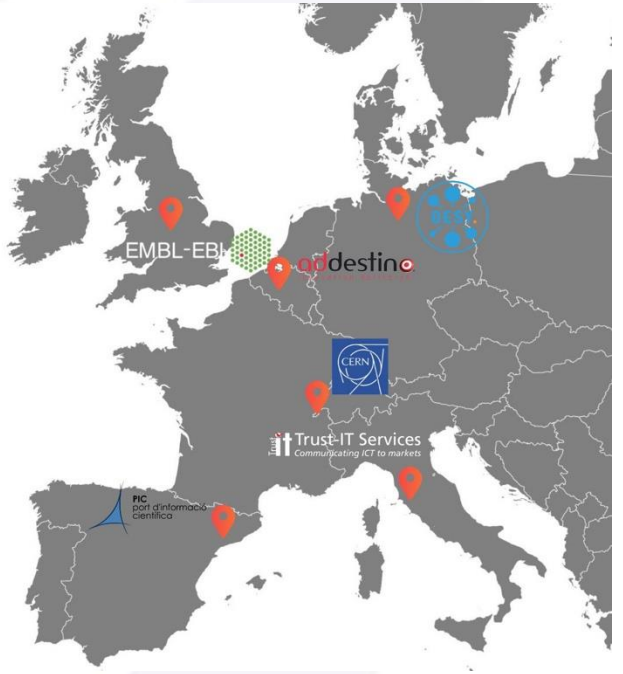
LIFE SCIENCES

HIGH ENERGY PHYSICS

LONG TAIL OF SCIENCE

Buyers + Experts → Consortium

Experts - Partner organisations bringing expertise in requirement assessment and promotion activities



Innovation R&D Scope

Layer 4 Advanced services	**High level services: visual representation of data (domain specific), reproducibility of scientific analyses, etc.**
Layer 3 Baseline user services	**User services: search, discover, share, indexing, data removal, etc. Access under Federated IAM**
Layer 2 Preservation	**OAIS conformant services: data readability formats, normalization, obsolesce monitoring, files fixity, authenticity checks, etc. ISO 14721/16363, 26324 and related standards**
Layer 1 Storage/Basic Archiving/Secure backup	**Data integrity/security; cloud/hybrid deployment PB range; high, sustained ingest data rates in Gb/s. ISO certification: 27000, 27040, 19086 and related standards. Archives connected to the GEANT network**

EMBL

PIC port d'informació científica

CERN

DESY.

- EMBL 1 – FIRE
- EMBL 2 – Cloud Caching
- PIC 1 – Large File Storage
- PIC 2 – Mix File Storage
- PIC 3 – Data Distribution
- CERN 2 – CERN Open Data
- CERN 3 – CERN Digital Memory
- DESY 1 – Individual Scientist
- DESY 2 – Petra III Experiment
- DESY 3 – EUXFEL Experiment

Scientific use cases deployments documented at: https://www.archiver-project.eu/deployment-scenarios

ARCHIVER "current state of the art" report in the context of the EOSC: https://doi.org/10.5281/zenodo.3618215

ARCHIVER Resulting Services

arkivum

Bringing archived data to life

libnova

ARCHIVER White Paper: https://doi.org/10.5281/zenodo.7691976

ARCHIVER Award Winning Project

The International Council of Archives Award for Collaboration and Cooperation

Example 2: CERN Quantum Technology Initiative

How can future quantum technologies contribute to CERN's scientific mission?

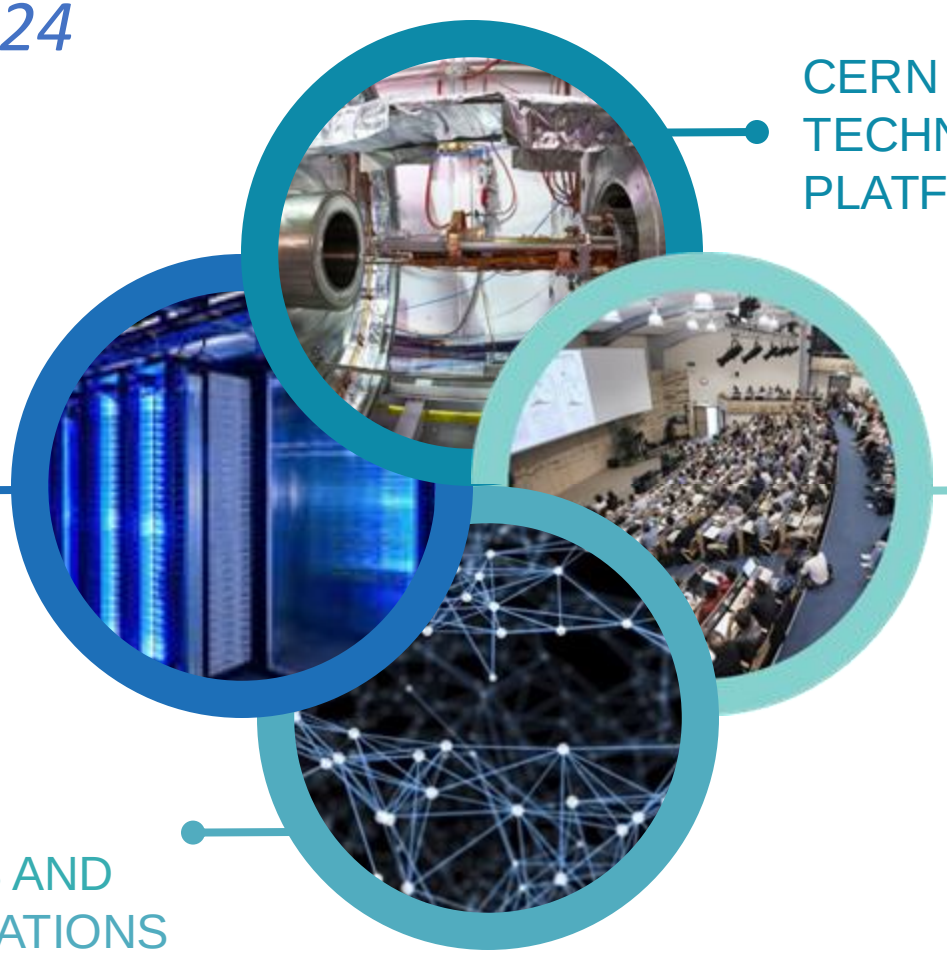
How can CERN's technologies and expertise contribute to the quantum revolution?

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

https://quantum.cern

CERN QTI Phase 2

Launched in January 2024



CERN QUANTUM TECHNOLOGY PLATFORMS

HYBRID QUANTUM COMPUTING AND ALGORITHMS

COLLABORATION FOR IMPACT

QUANTUM NETWORKS AND COMMUNICATIONS

CERN | QUANTUM TECHNOLOGY INITIATIVE

5-years Research Plan

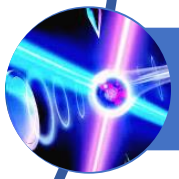
The QTI Hub: A collaboration framework for Quantum Technology

The QTI Hub creates projects with partners in the public and private sectors, investigating the different areas of quantum technologies.

Enable **access to diverse quantum technology and services**

Provide a **unified framework for all collaborative projects** QTI with multiple partners.

Establish a clear **separation between commercial relationships and R&D collaborations with the private sector**



Facilitate the follow-up and ensure **more efficient coordination of projects** also across several CERN areas and departments.

Allow for **multiples approaches to IP protection in agreement with** CERN policies.

Benefits of Open Innovation

- for the Private Sector:
  - Access Cutting-Edge Research: Tap into fundamental discoveries, reducing R&D costs & timelines
  - Boost Innovation: Leverage a diverse pool of ideas for new products, processes, and markets
  - De-risk and accelerate Time to Market: Speed up the R&D into commercial products/services

- for Public funded “Big Science”:
  - Drive Real-World Impact: Translate fundamental research into practical societal applications
  - Enhance Technology Transfer: Facilitate knowledge flow to stimulate economic growth
  - Address Societal Challenges: Contribute scientific expertise to solving major issues

- Mutual Benefits & Outcomes:
  - Dynamic Knowledge Exchange: Foster cross-pollination of ideas and expertise
  - Build Innovation Ecosystems: Hubs connecting researchers and entrepreneurs
  - Tackle Global Problems: Combine resources to address complex challenges

Thank You!