

A long, complex particle accelerator tunnel with various pipes and machinery. The tunnel is illuminated by overhead lights, and the machinery is primarily blue and silver. The perspective is from the side, looking down the length of the tunnel.

# *Accelerating Innovation*

From CERN Technology to Society

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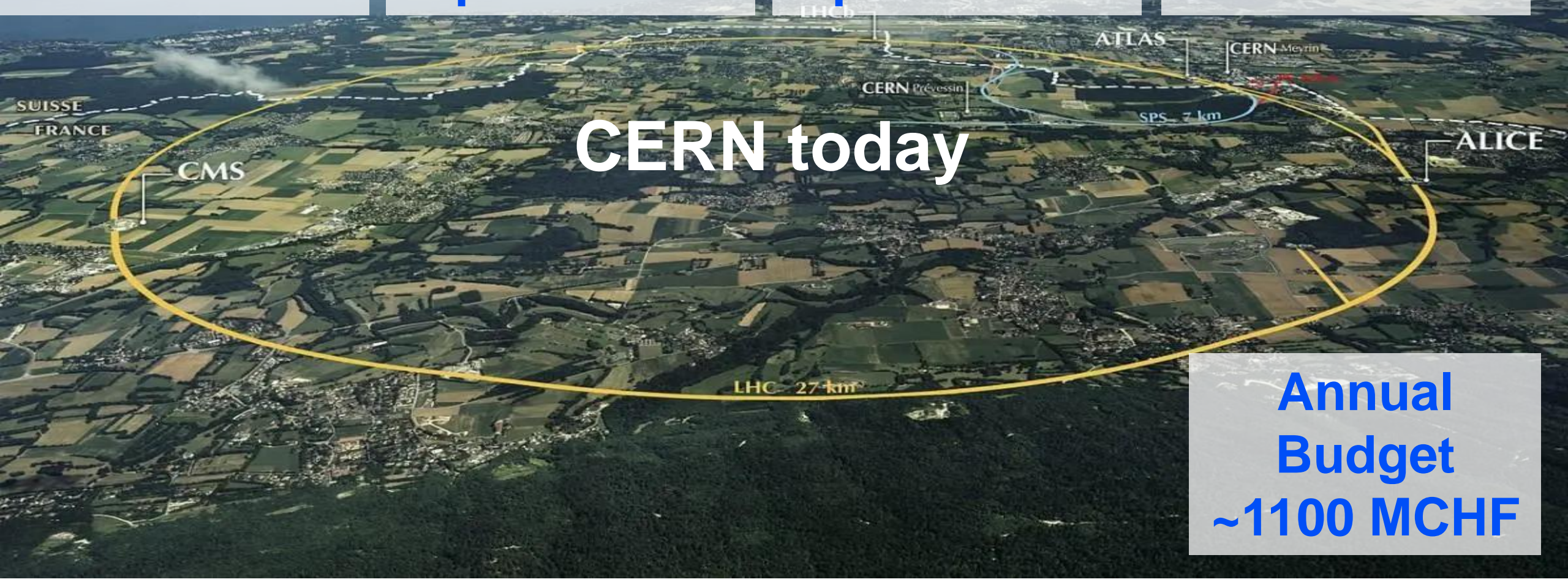
# CERN: founded in 1954: 12 European States “Science for Peace”

**23**  
**Member**  
**states**

**2500**  
**Staff**  
**positions**

**1600**  
**Other**  
**personnel**

**12700**  
**Scientific**  
**users**



**CERN today**

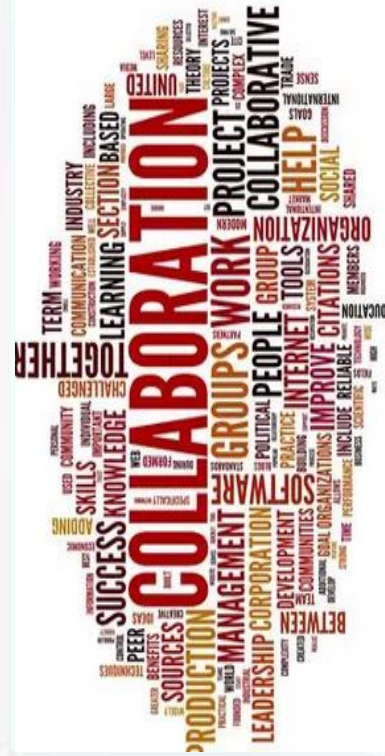
**Annual**  
**Budget**  
**~1100 MCHF**



# Four pillars underpin CERN's mission



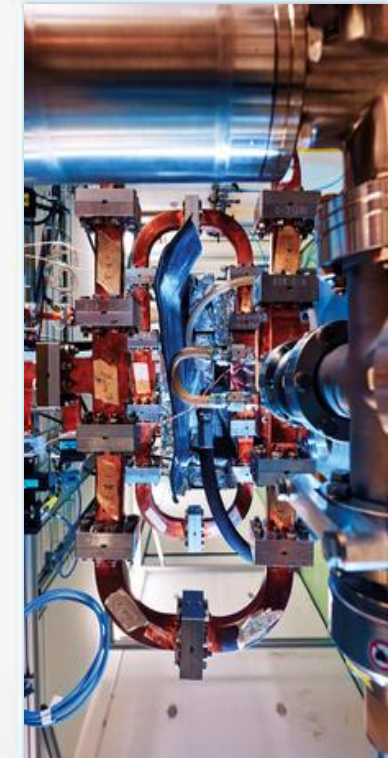
RESEARCH



COLLABORATION



EDUCATION & TRAINING



TECHNOLOGY & INNOVATION





The Higgs Boson completes the Standard Model,  
but the Model explains only what concerns ordinary atoms i.e, ~  
5% of our Universe

Dark matter (~24%) and dark energy (~71%) make up the rest.  
What are they really?

How does gravity really work?

Why there is no antimatter in nature?

*Fundamental research is our driver, what this lab is all about*





*Accelerators*

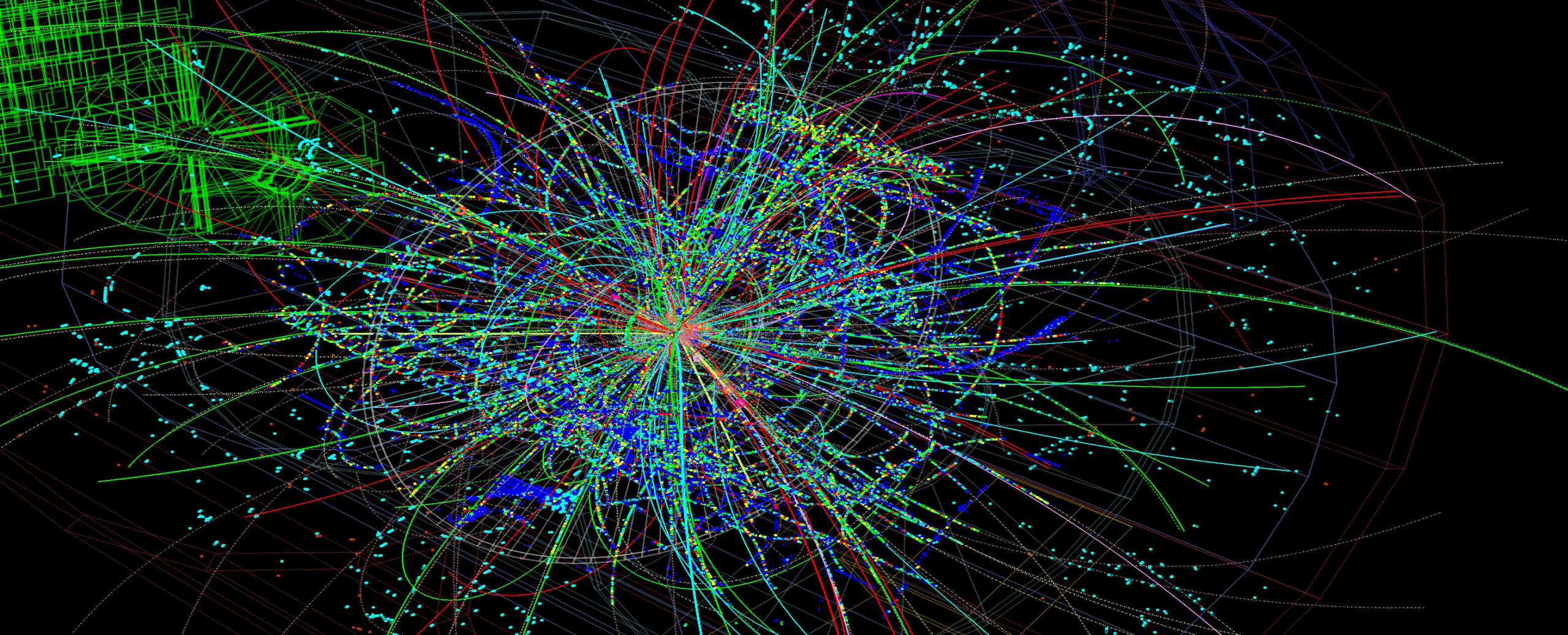


*Detectors*



*Computing*





## FACTS

- The LHC collides protons at unprecedented energy, equivalent to 13,000 times their mass
- 40 Million collisions/sec, one every 25 ns. About 40 collisions per event. (40 MHz collision rate)
- Thousands of particles emerge from each collision
- 1 MB of data recorded by the detectors at each collision. It represents 40 TB/sec! Too much to be stored.
- Only 5% of those are stored after filtering. About 80 Pb of derived data per run.





# The LHC Big Data Challenge – HL LHC - 2029

## High Luminosity LHC - 2029

- ~200 collisions per event vs ~40 today. Need to disentangle 200 collisions happening at once.
- Event complexity grows non linearly
- A HL-LHC run would need to store about 900 Pb of derived data. A data deluge!
- Even taking into account HW progress (storage & processing), we are off by a factor of 10, projecting to 2029

# 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**

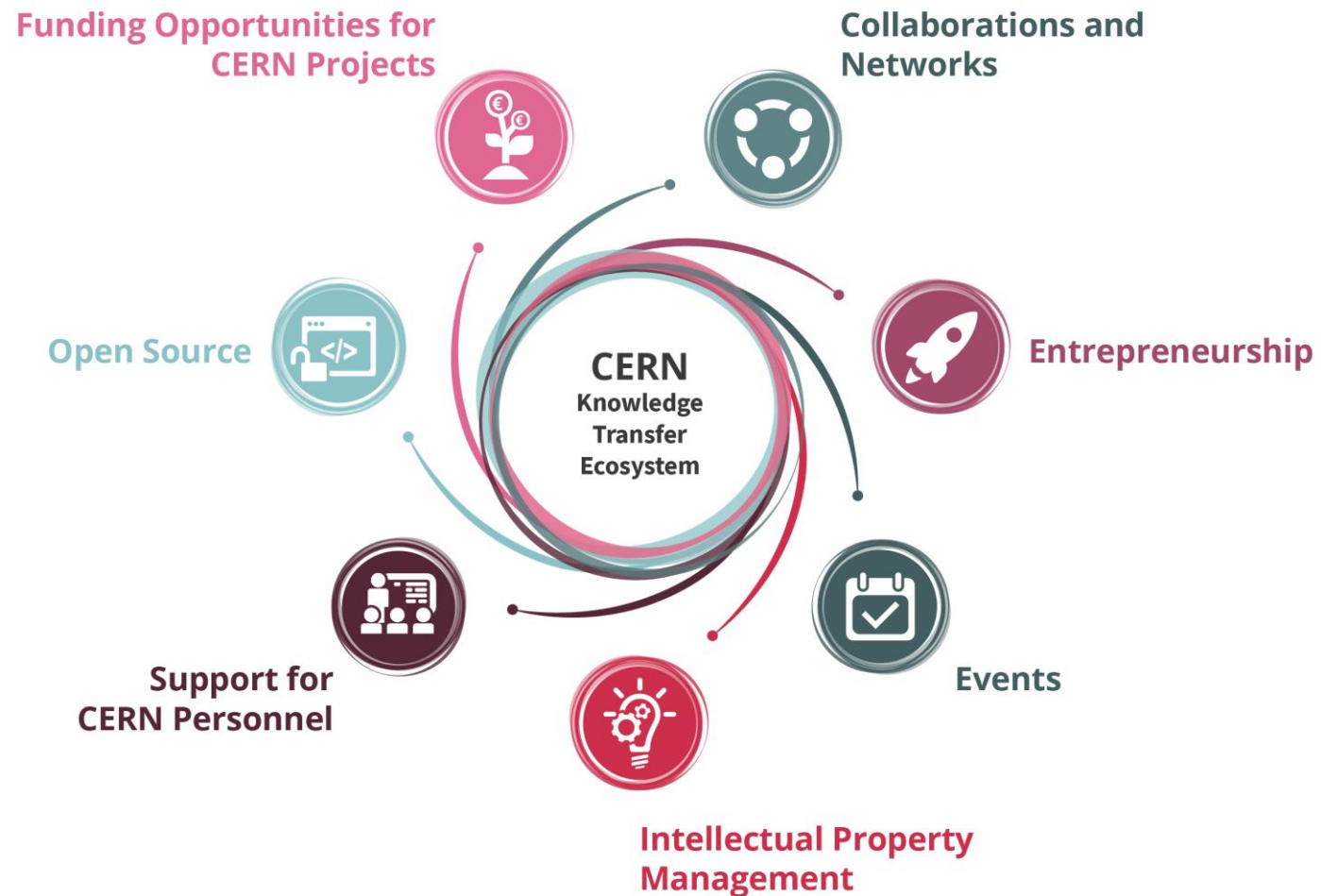
Robotics **Sensors** **Material Science** **Cooling and Ventilation**

**Collaboration Tools** **Radio Frequency Technology**

**Manufacturing and Mechanical Processes**



# Our toolbox to accelerate innovation





# CERN as trusted non-commercial innovation partner



HEALTHCARE



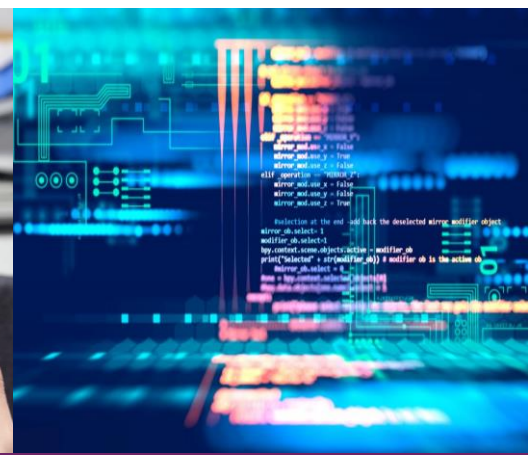
ENVIRONMENT



DIGITAL



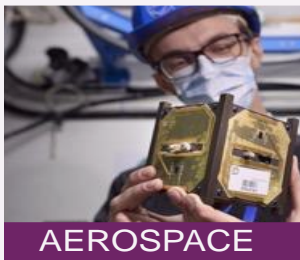
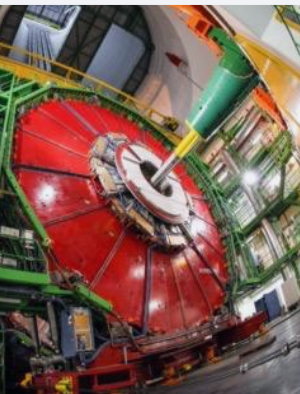
AEROSPACE



QUANTUM



# Hybrid strategy: tech push & market pull



Mobilize tech experts

Mobilize innovation partners

Create tech and IP dossiers

Create value propositions

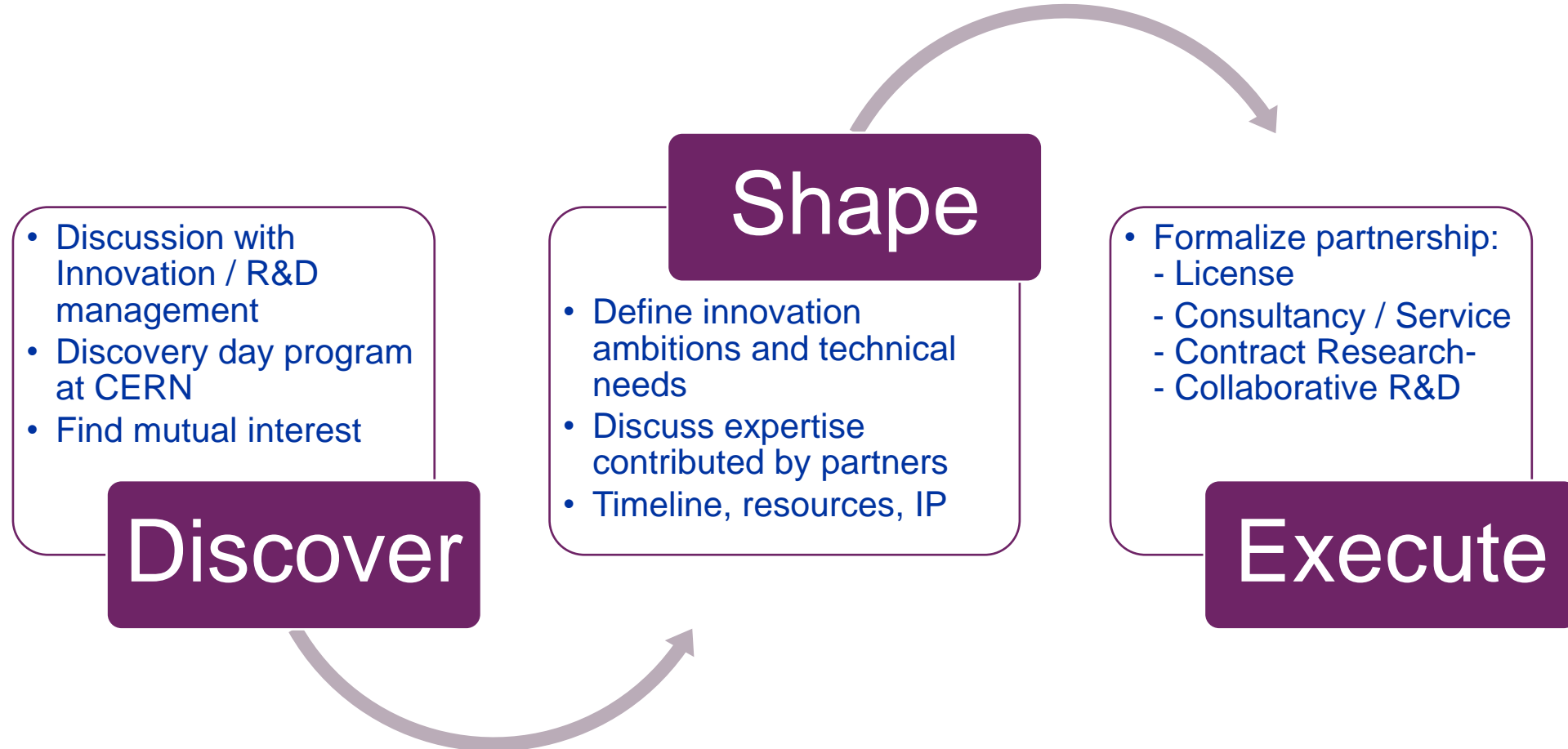
Scout for technologies

Search unmet needs





# Shaping innovation partnerships





## Licence

- Access to existing solution
- Support to implement

## Consultancy/Service

- Specific issue
- Time of experts
- Time of facilities

## Contract research

- Specific solution
- Outsource its development to CERN

## Collaborative R&D

- General issue
- Jointly find solution
- Jointly develop solution



How much time does it take to  
create a R&D Partnership?

What is the % of partnerships that  
typically make it to the execution  
phase?





Collaborative R&D

MedAustron and CNAO offer hadron therapy using CERN technology.



Collaborative R&D



MedAustron and CNAO offer hadron therapy using CERN technology.



License

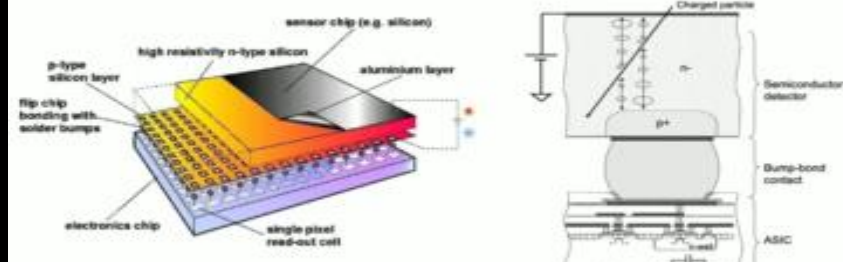


MEDIPIX Read-out chips for particle imaging



MARS Bio Imaging:  
next generation X ray  
finally in color using  
CERN chips

### Hybrid Silicon Pixel Detectors





ZENSEACT (Volvo Cars Company) teams up with CERN on extremely fast machine learning/deep learning using FPGAs.



CEVA and CERN joined R&D on neural network weight and activation compression algorithms aiming make them run more efficiently. Wireless comms & computer vision applications

Collaborative R&D

- Jointly develop solution



Machine learning/Deep learning



EU Funded project

The Project ▾

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AGENIUM  
SPACE



# Edge SpAIce

A stylized blue satellite icon with solar panels and a central payload, positioned to the right of the main title.

NOVEL EDGE-AI SYSTEM FOR ACCURATE AND NEAR REAL-TIME  
PLASTIC DETECTION AND MONITORING  
IN MARINE ENVIRONMENT

Machine learning/Deep  
learning

On board inference of Earth Observation images:  
Application: Detection of plastic litter at sea.  
Next generation EO applications

# Real-time Digital Twin example

## AI enhanced autonomous condition monitoring for Septa magnets, using Digital Twins

### Real Plant



Sensors & Historical Data

AI & ML to produce ROMs

Simulation Files

### Physics-based Simulation Models

### Executable Digital Twin

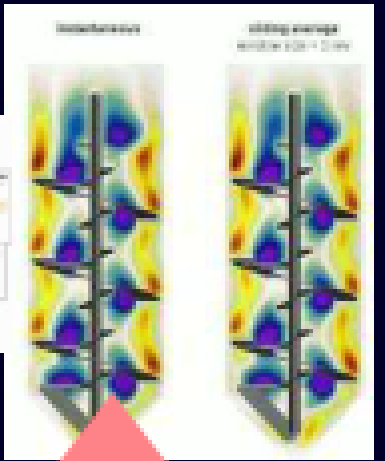
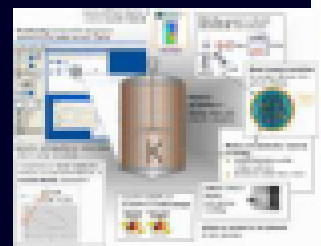


- Virtual Sensor(s)
- Model Predictive Control

Data

Prediction

### Model Fitting / Validation







## Contract Research

- Use case and requirements by the company
- Code contributed to the OS project
- Development @CERN, benefit for HEP applications

ROCHE is using CernVM-FS for application and library distribution worldwide.

Contract Research for a Company in the financial services sector. JumpTrading has strong interest in this tech for fast reliable worldwide file distribution.





Collaborative R&D

Collaboration with CORMEC and WUR to support national banks and regulators to detect trading anomalies in stock market.



Specialised Facilities

Collaborative R&D

SCIENCE & EXPLORATION

# juice

## Jupiter Icy Moons Explorer

High energy beam for testing radiation hardness with ESA.

Before embarking on its journey, critical components of ESA's interplanetary mission were tested in the only facility on Earth capable of replicating Jupiter's harsh radiative environment.

### RENEWABLE AND LOW-CARBON ENERGY

Production  
Transformation  
Distribution  
Storage

### SUSTAINABILITY AND GREEN SCIENCE

Power Management  
Heat Management  
Industrial Processes



### CLEAN TRANSPORTATION AND FUTURE MOBILITY

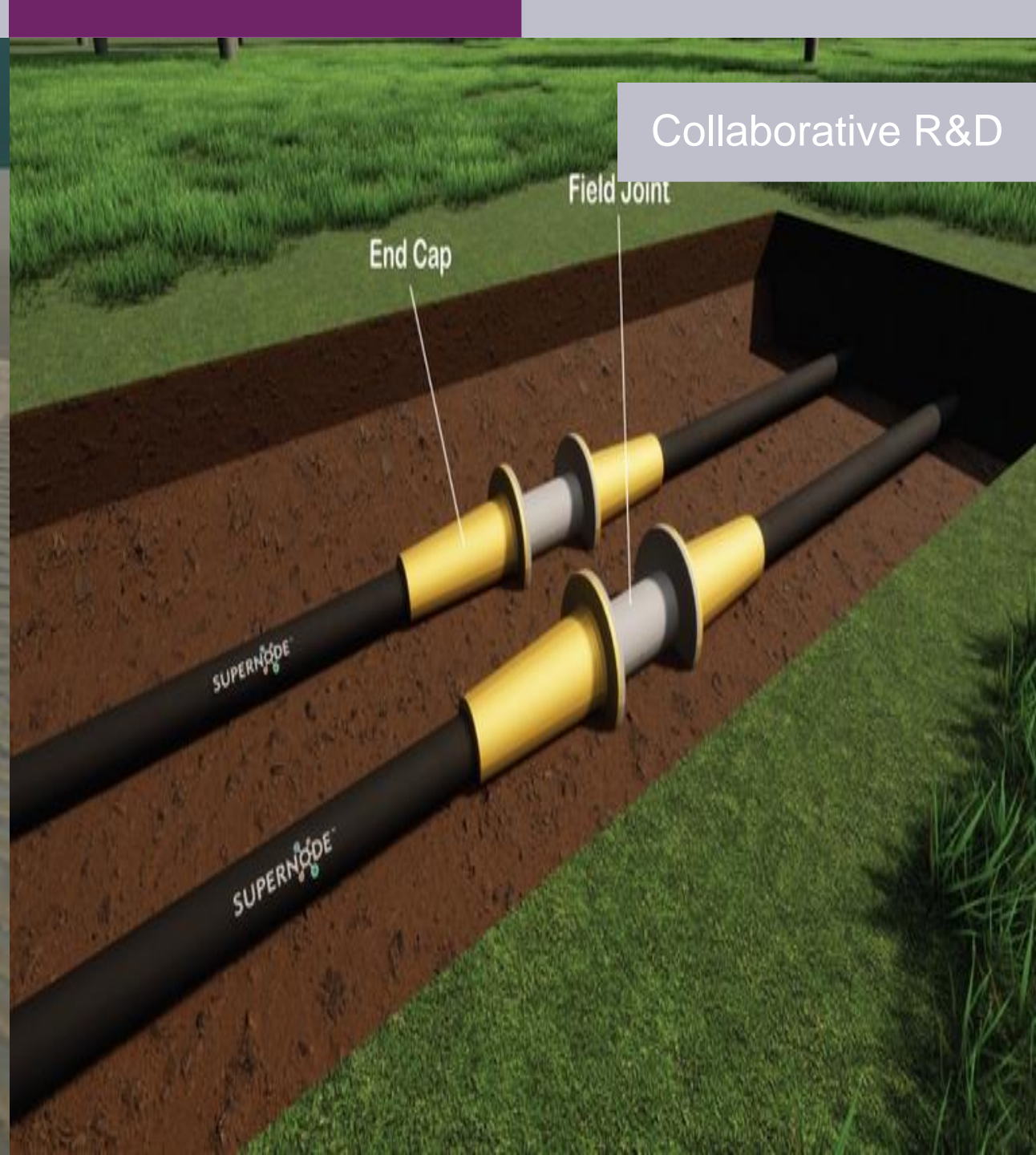
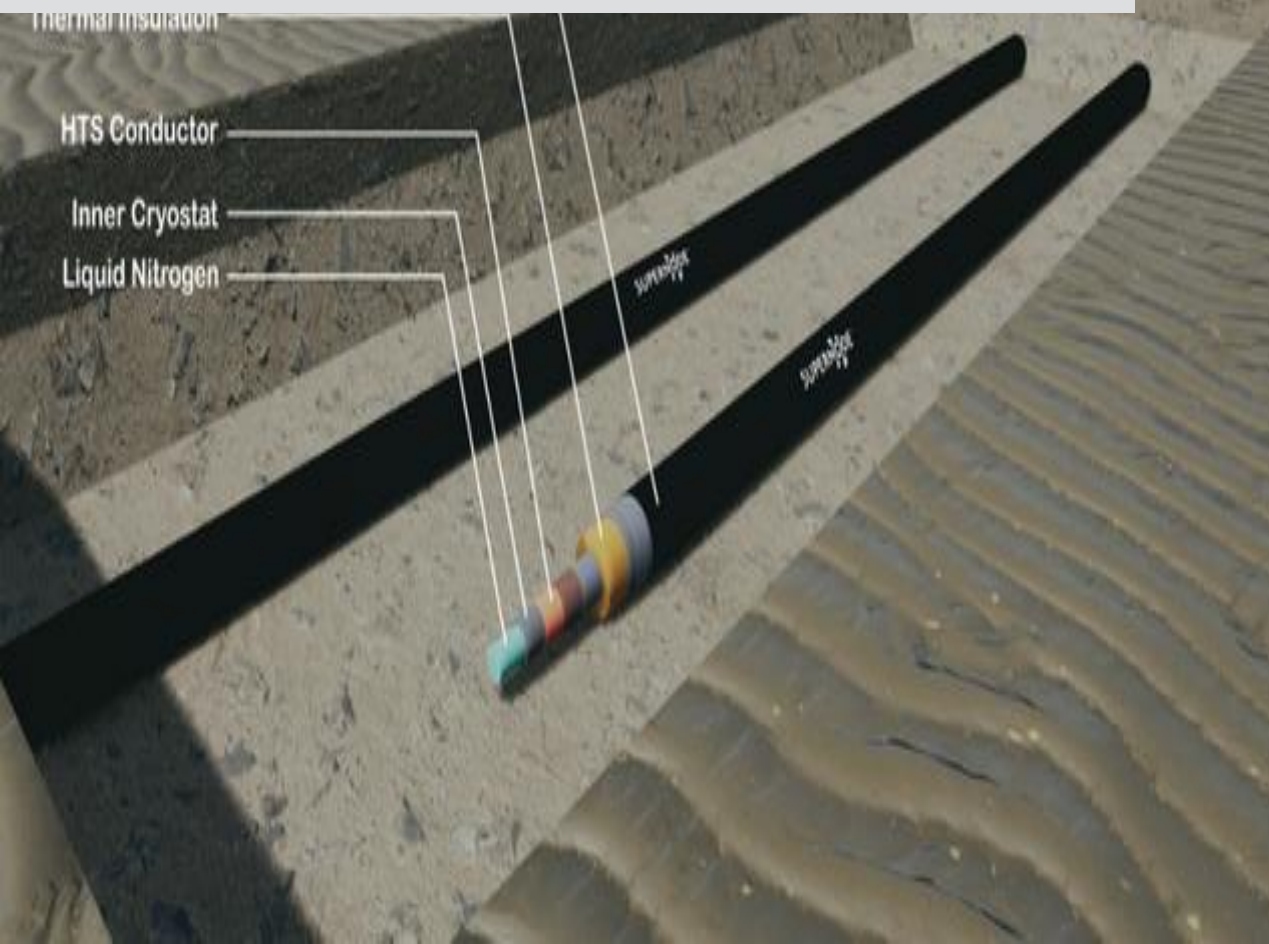
Aviation  
Shipping  
Rail  
Automotive

### CLIMATE CHANGE AND POLLUTION CONTROL

Monitoring  
Modelling  
Mitigation



# SUPERNODE an IE startup working with CERN on superconducting tech for HVDC transmission





Consultancy

Tokamak Energy (fusion power) taps into expertise of CERN on simulation of currents and magnetic fields.



Collaborative R&D

CERN and ABB team up on reducing electricity in cooling and ventilation.



# Key lessons learned when innovating with Industry

- CERN is strong in the 'extremes' of the technology scale
- You need passionate experts on both sides to succeed
- Need to identify a concrete project & clear business case
- Keep in mind differences in culture, language, and pace
- Driving deep tech innovation requires courage, commitment & time

But, results can be way beyond expectations!





**Thank you for your attention**

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kt.cern**







**WHAT IF WE BUILD A STEM EDUCATION PROGRAM FOR HIGH SCHOOLS, USING OUR PIXELATED RADIATION DETECTORS?**

**4** QUALITY  
EDUCATION





