

Accelerating Innovation

A long, complex particle accelerator tunnel, likely the Large Hadron Collider (LHC) at CERN. The tunnel is filled with various pipes, machinery, and structural elements, extending into the distance. The lighting is warm and focused on the equipment.

From CERN Technology to Society

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

CERN today

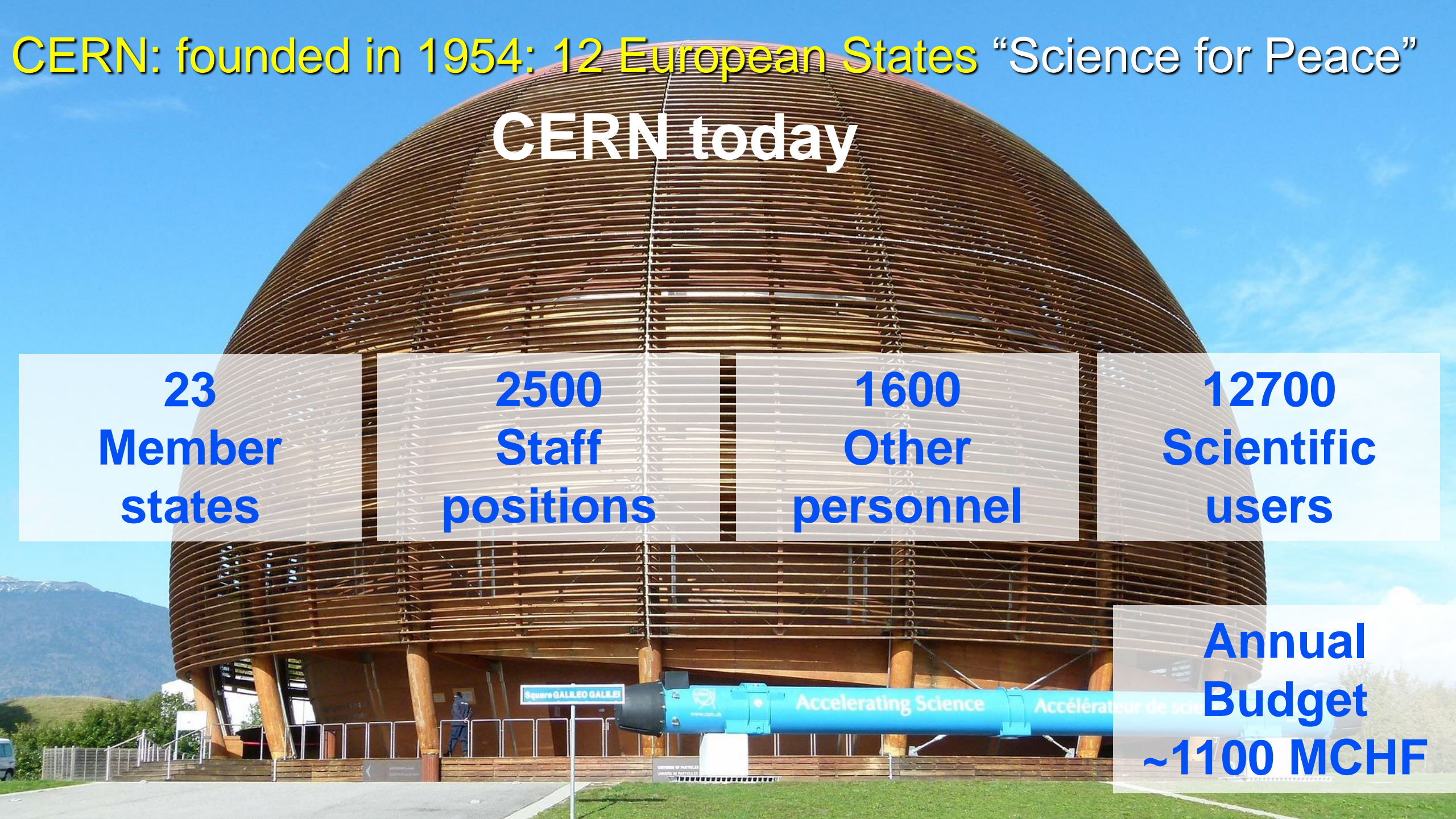
23
Member
states

2500
Staff
positions

1600
Other
personnel

12700
Scientific
users

Annual
Budget
~1100 MCHF



Four pillars underpin CERN's mission





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



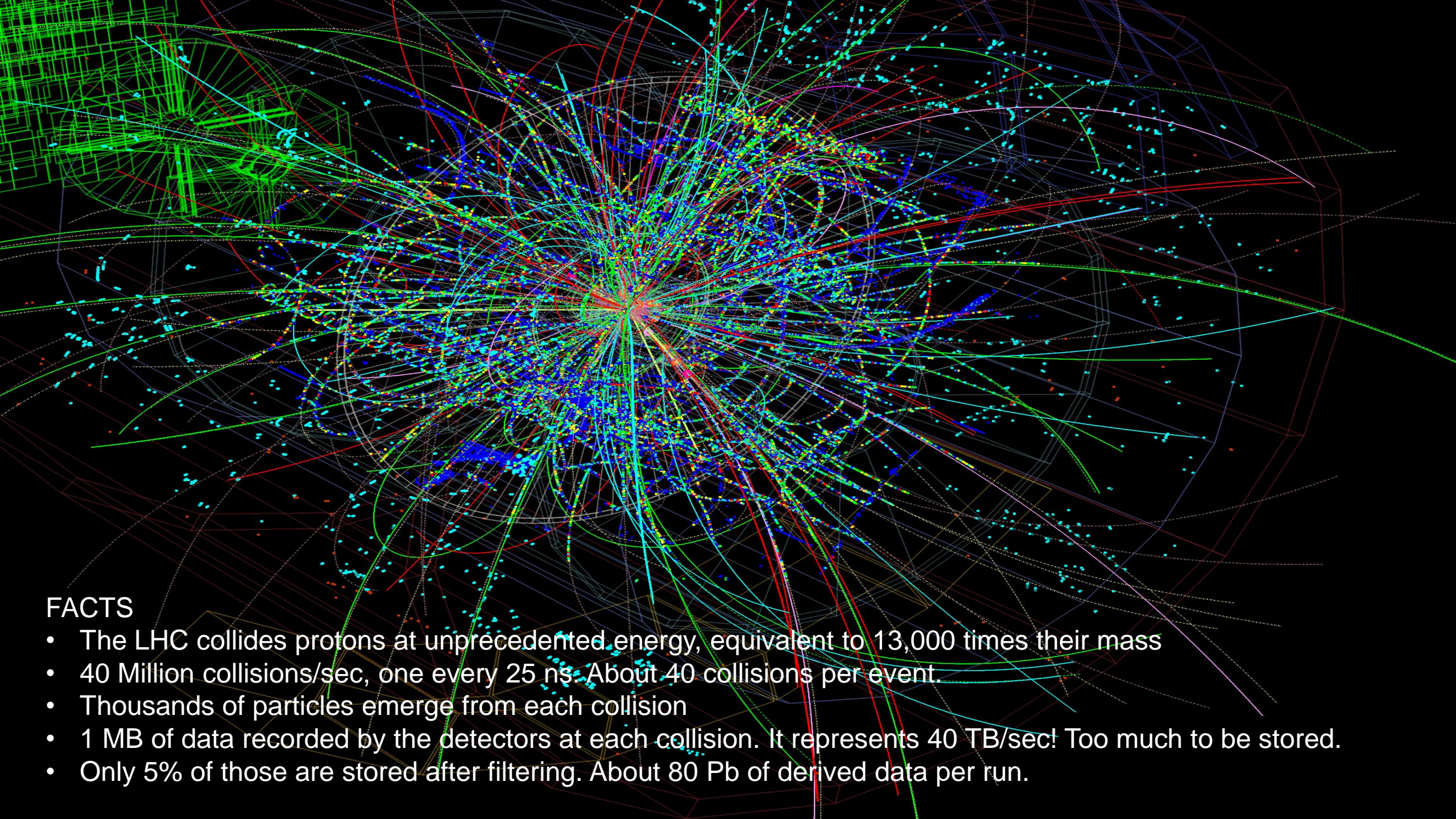
Accelerators



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.
- 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

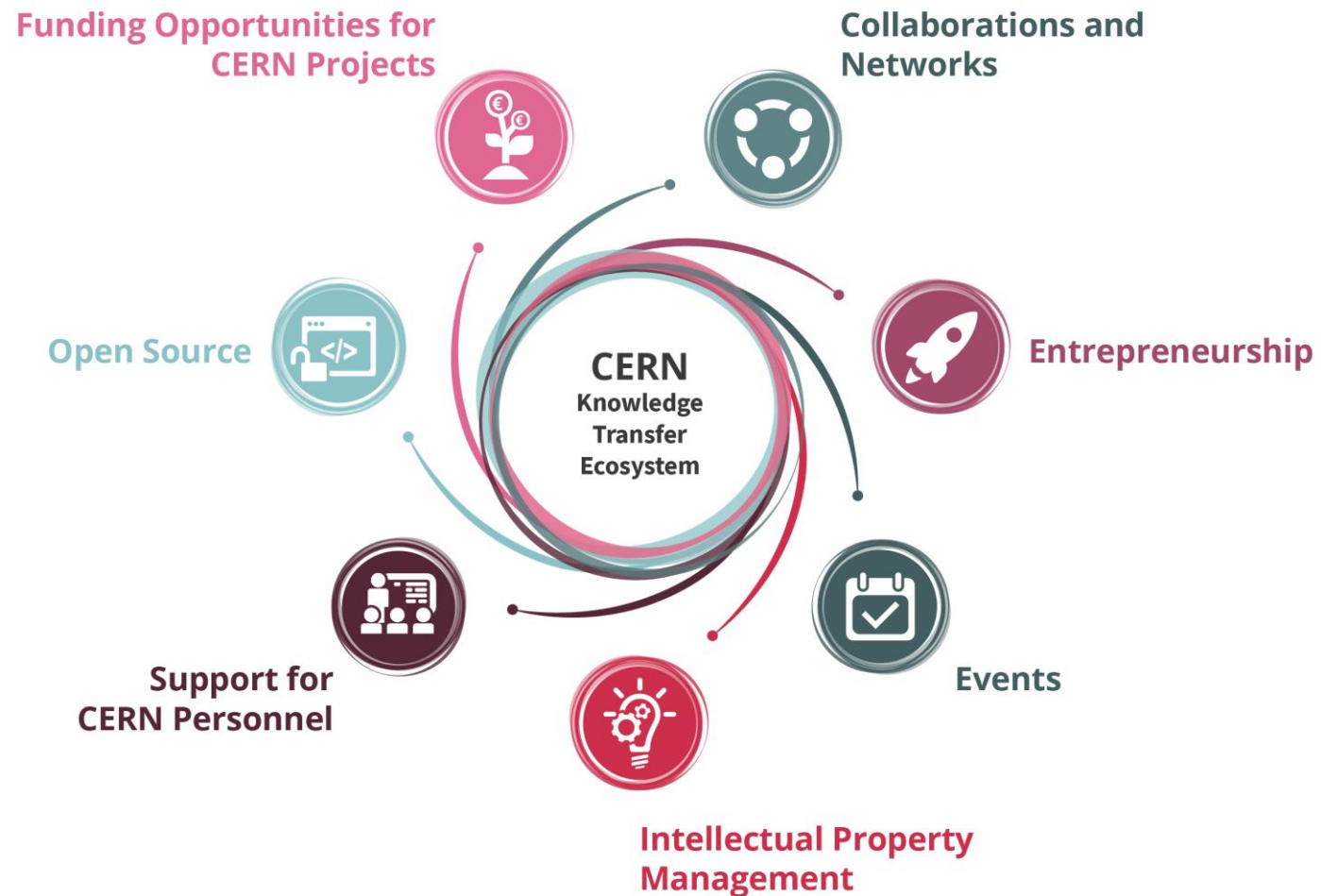
Radiation Protection and Monitoring **Particle Tracking and Calorimetry**

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



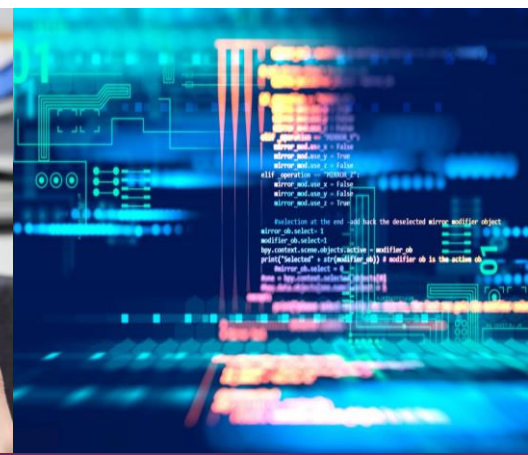
ENVIRONMENT



DIGITAL

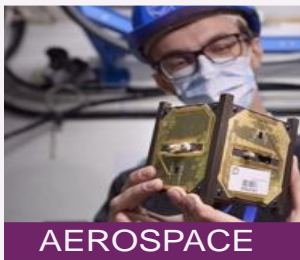
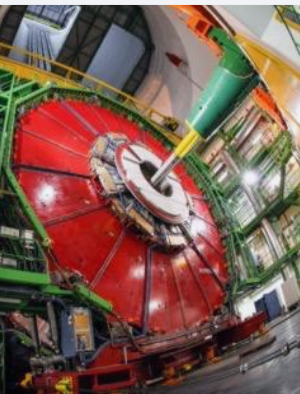


AEROSPACE



QUANTUM

Hybrid strategy: tech push & market pull



Mobilize tech experts

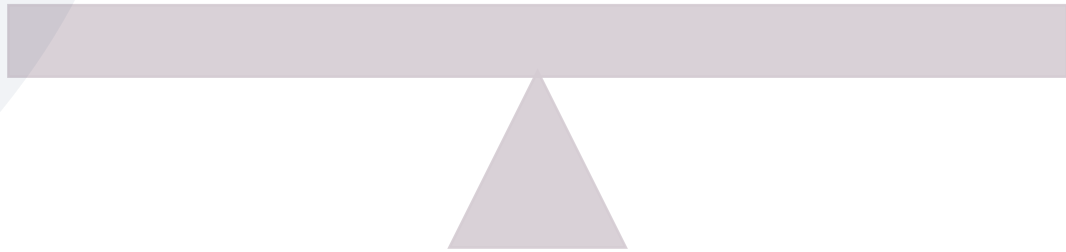
Mobilize innovation partners

Create tech and IP dossiers

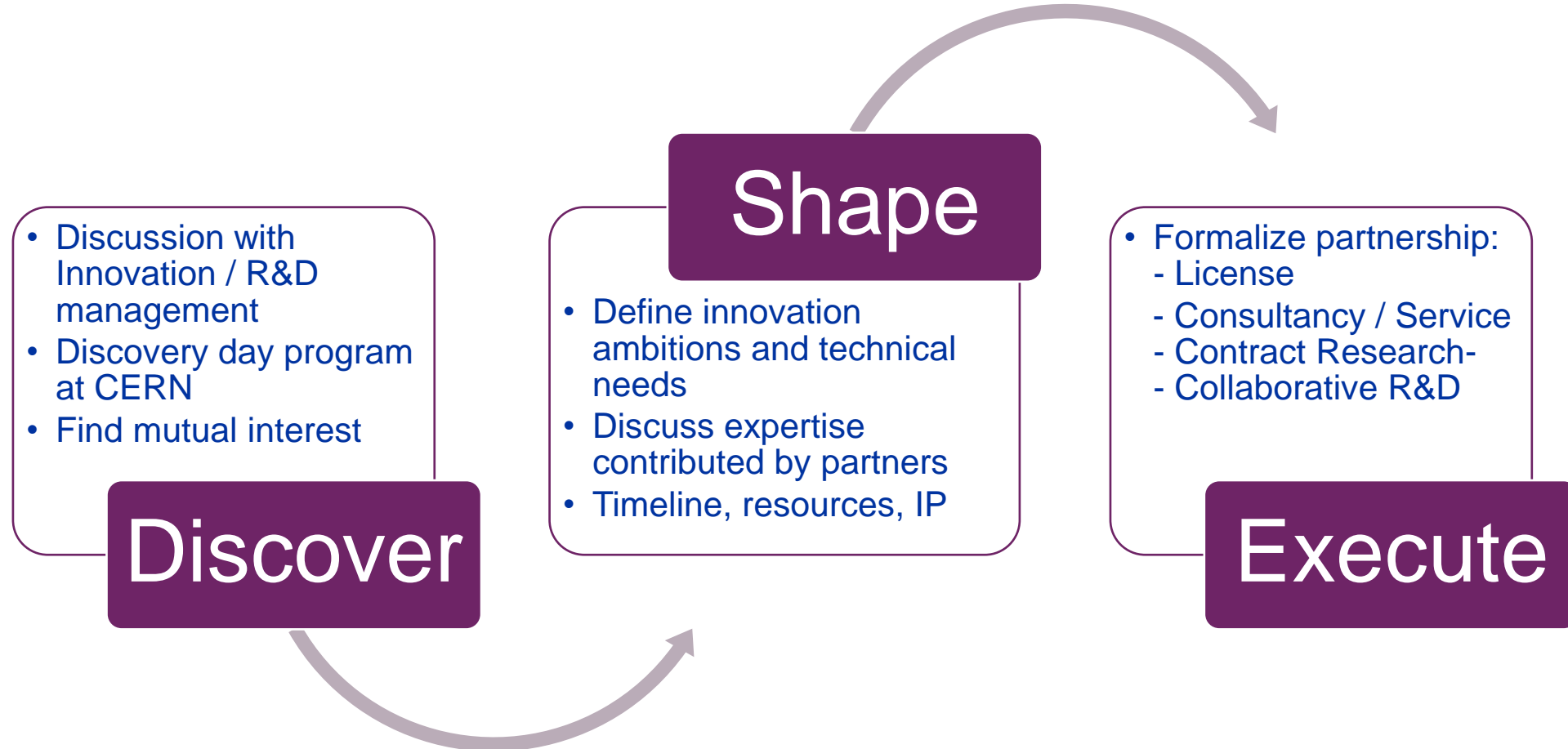
Create value propositions

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.

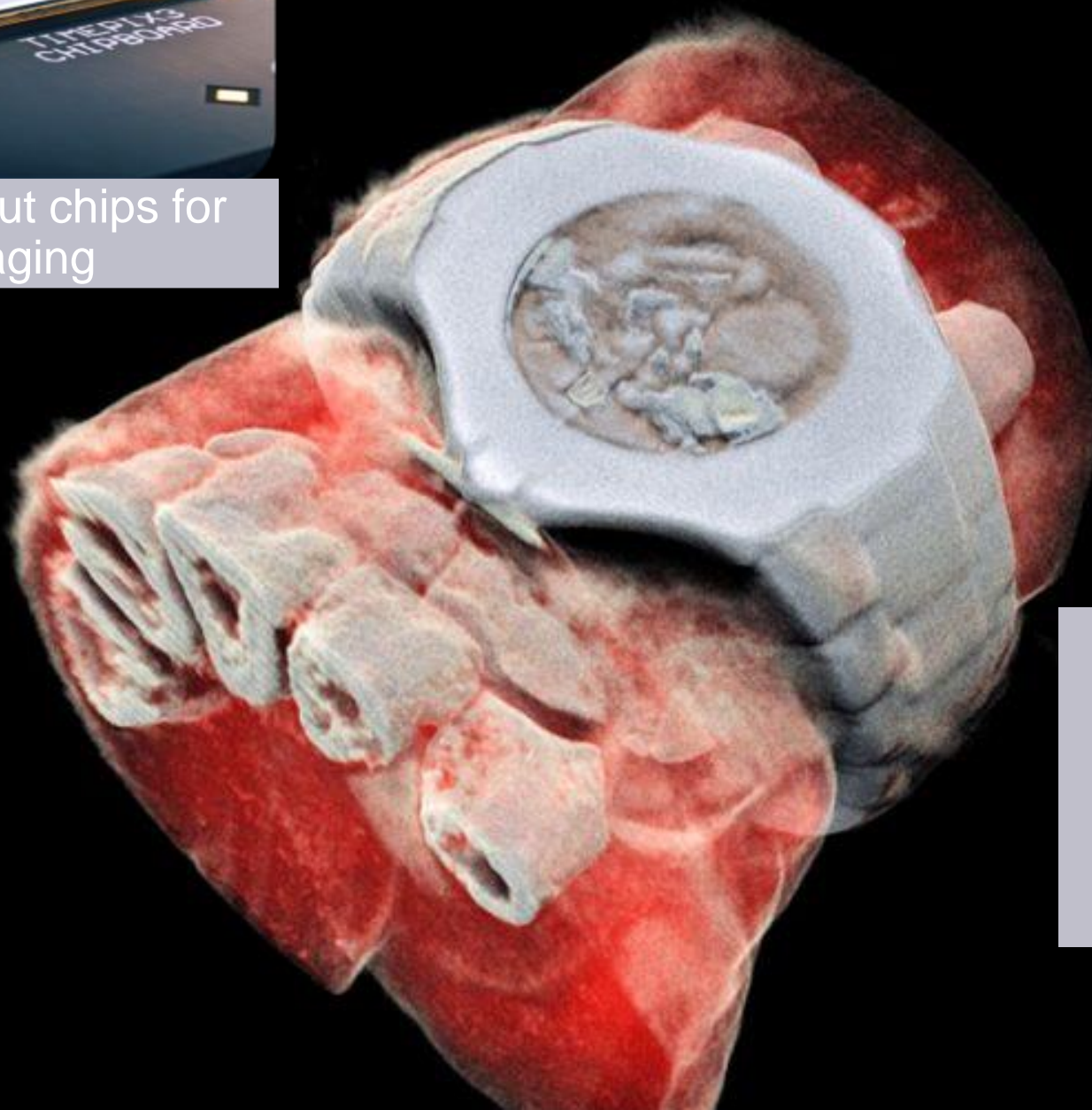
Collaborative R&D



MedAustron and CNAO offer hadron therapy using CERN technology.



MEDIPIX Read-out chips for particle imaging



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

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

Collaborative R&D



Collaborative R&D

- General issue
- Jointly find solution
- Jointly develop solution

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



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.

SCIENCE & EXPLORATION

juice

Contract research

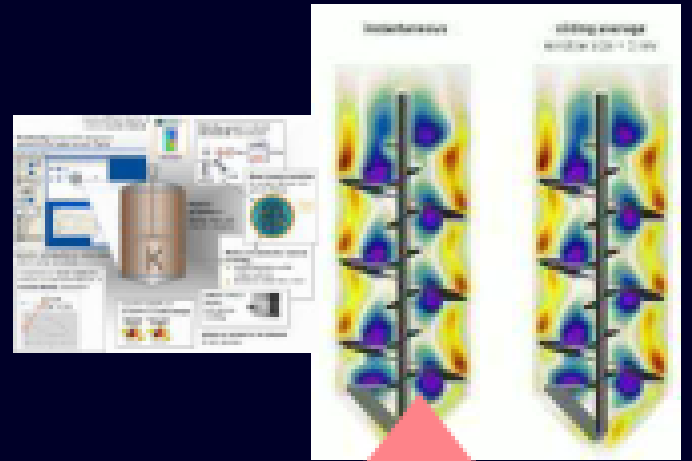
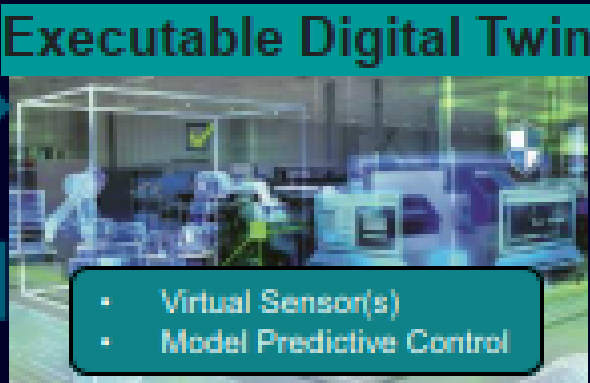
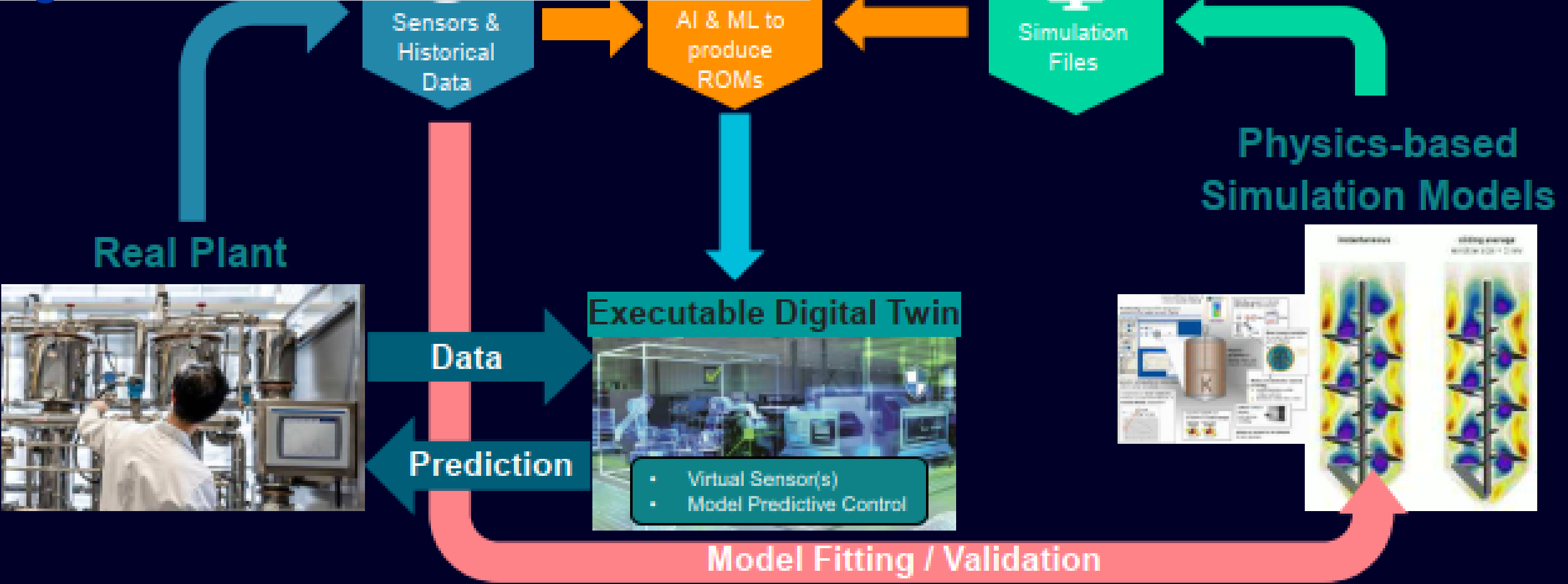
Jupiter Icy Moons Explorer

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.

Real-time Digital Twin example

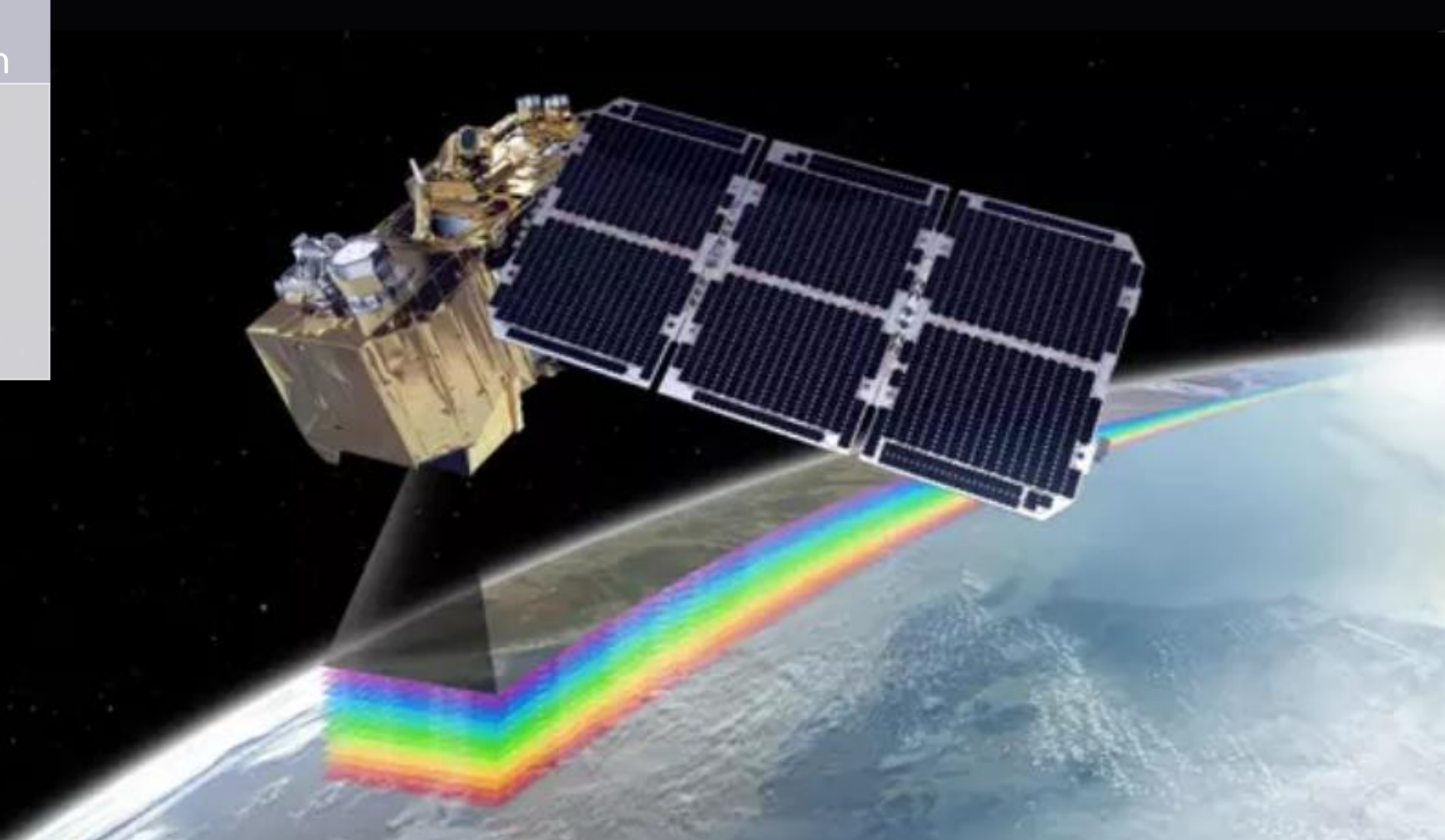
AI enhanced autonomous condition monitoring for Septa magnets, using Digital Twins



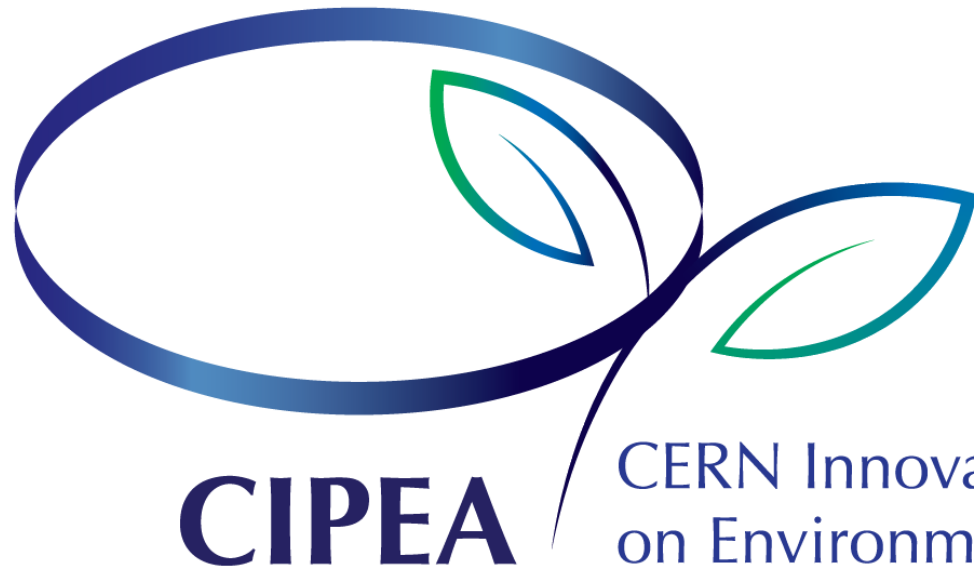
Successful EU Project Submission

Consortium:

- CERN
- Agenium Space
- EnduroSat
- NTUAthens
(Remote sensing)



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



CERN Innovation Programme
on Environmental Applications



RENEWABLE AND LOW-CARBON ENERGY

Production
Transformation
Distribution
Storage



CLEAN TRANSPORTATION AND FUTURE MOBILITY

Aviation
Shipping
Rail
Automotive



CERN KNOWHOW

Superconductivity
High Field Magnets
High Vacuum
Cryogenics
Materials
Artificial Intelligence
Advanced Sensors
Rad-Tol Systems
Thermal Control
Radioprotection
...

SUSTAINABILITY AND GREEN SCIENCE

Power Management
Heat Management
Industrial Processes



CLIMATE CHANGE AND POLLUTION CONTROL

Monitoring
Modelling
Mitigation



Collaborative R&D

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



Consultancy

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

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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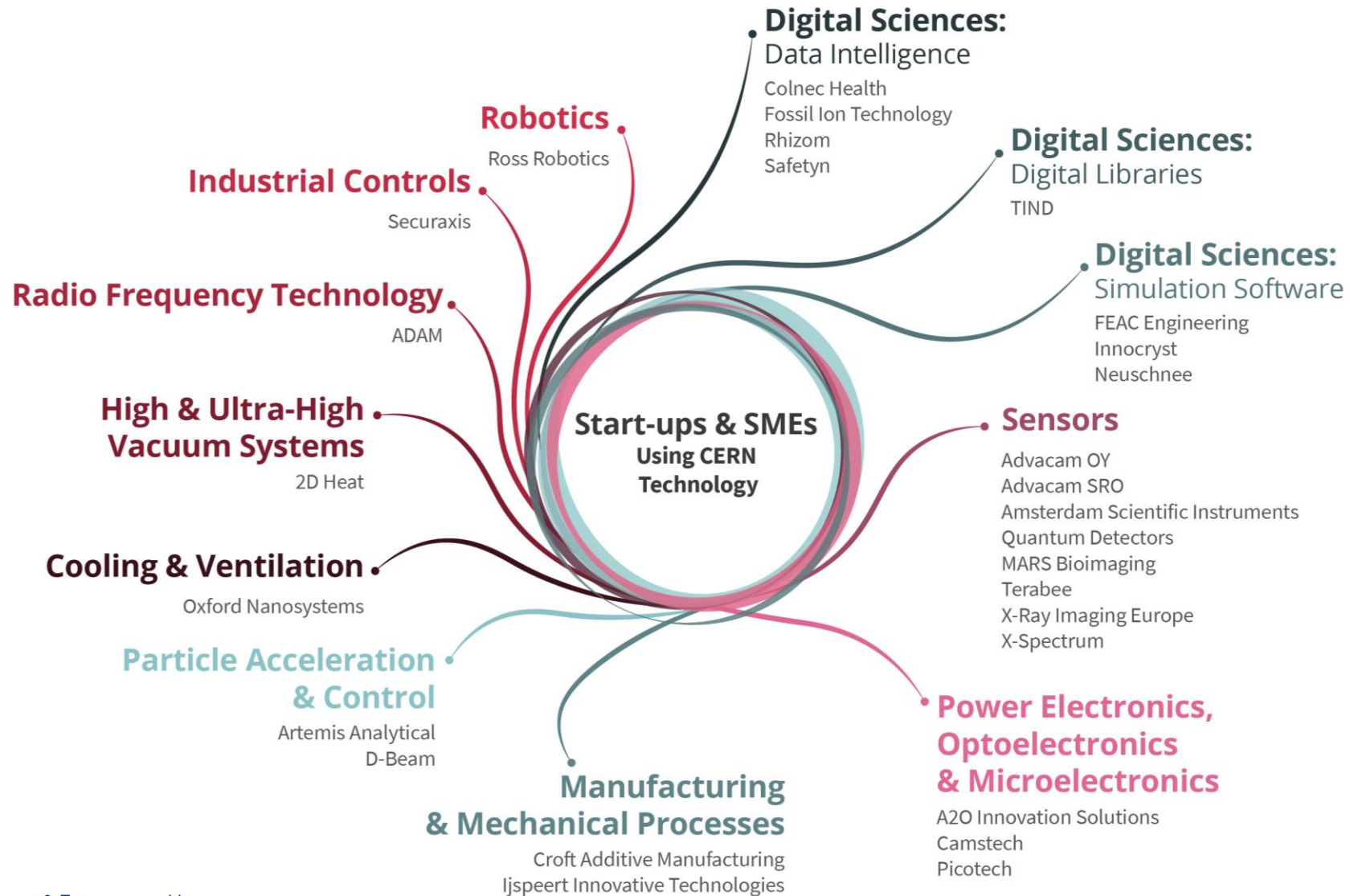




Consultancy

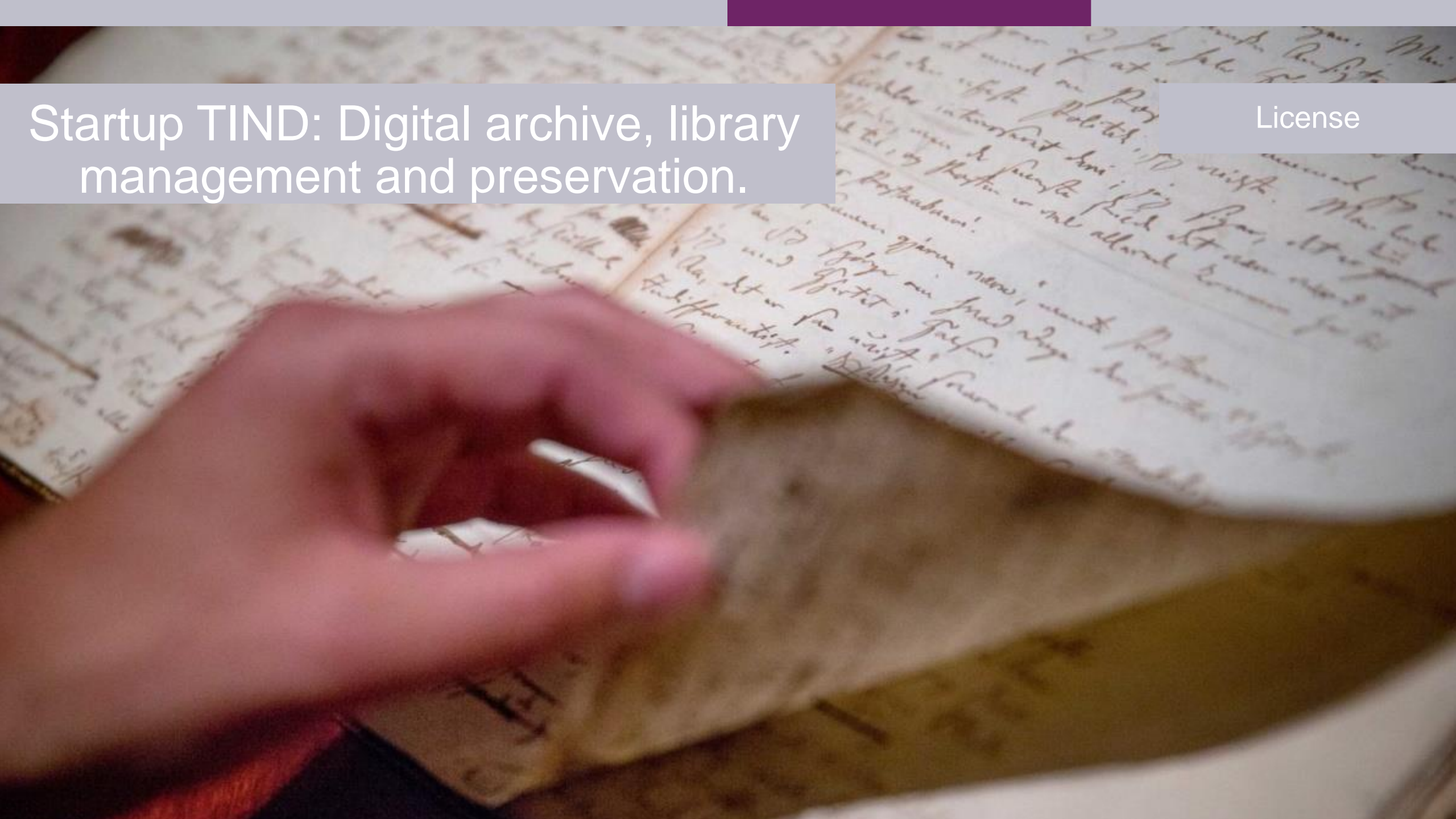
Bundesdruckerei (Berlin) works with CERN on next generation ideas for identity management and cryptography and data handling.

Startups and Spin-offs



Startup TIND: Digital archive, library management and preservation.

License



InsightART: Using CERN
Medipix detector to analyse art.

License





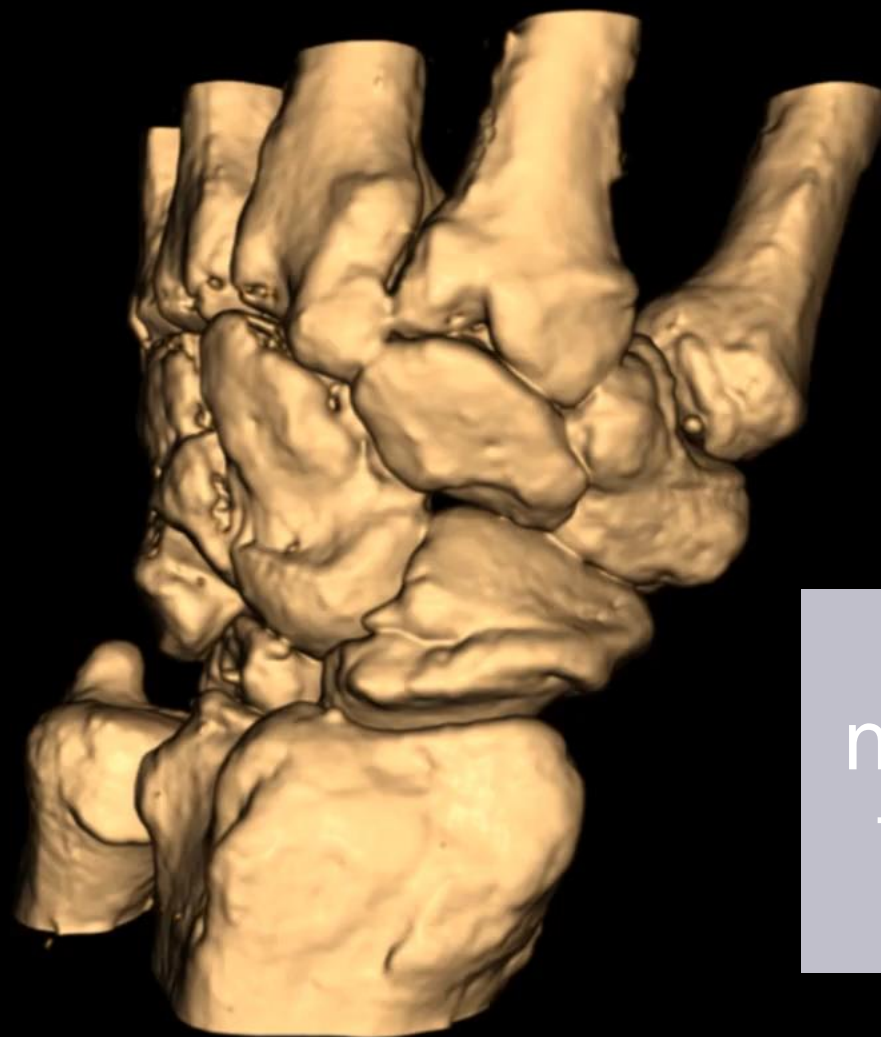
SecurAxis: Real Time Analysis,
Reporting and Localization
with Smart Acoustic Sensors
C2MON monitoring software



A person wearing a blue hard hat with a logo, safety glasses, and a light blue face mask is holding two electronic components. The components are gold-colored printed circuit boards (PCBs) mounted in dark brown frames. One component has a small cylindrical component on it. The other has a label with a barcode and the text 'CR-070238'. The background shows a laboratory environment with blue structural elements and various cables.

Contract research

Development of high energy beam for testing radiation hardness with ESA.



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