Accelerating Innovation

From CERN Technology to Society

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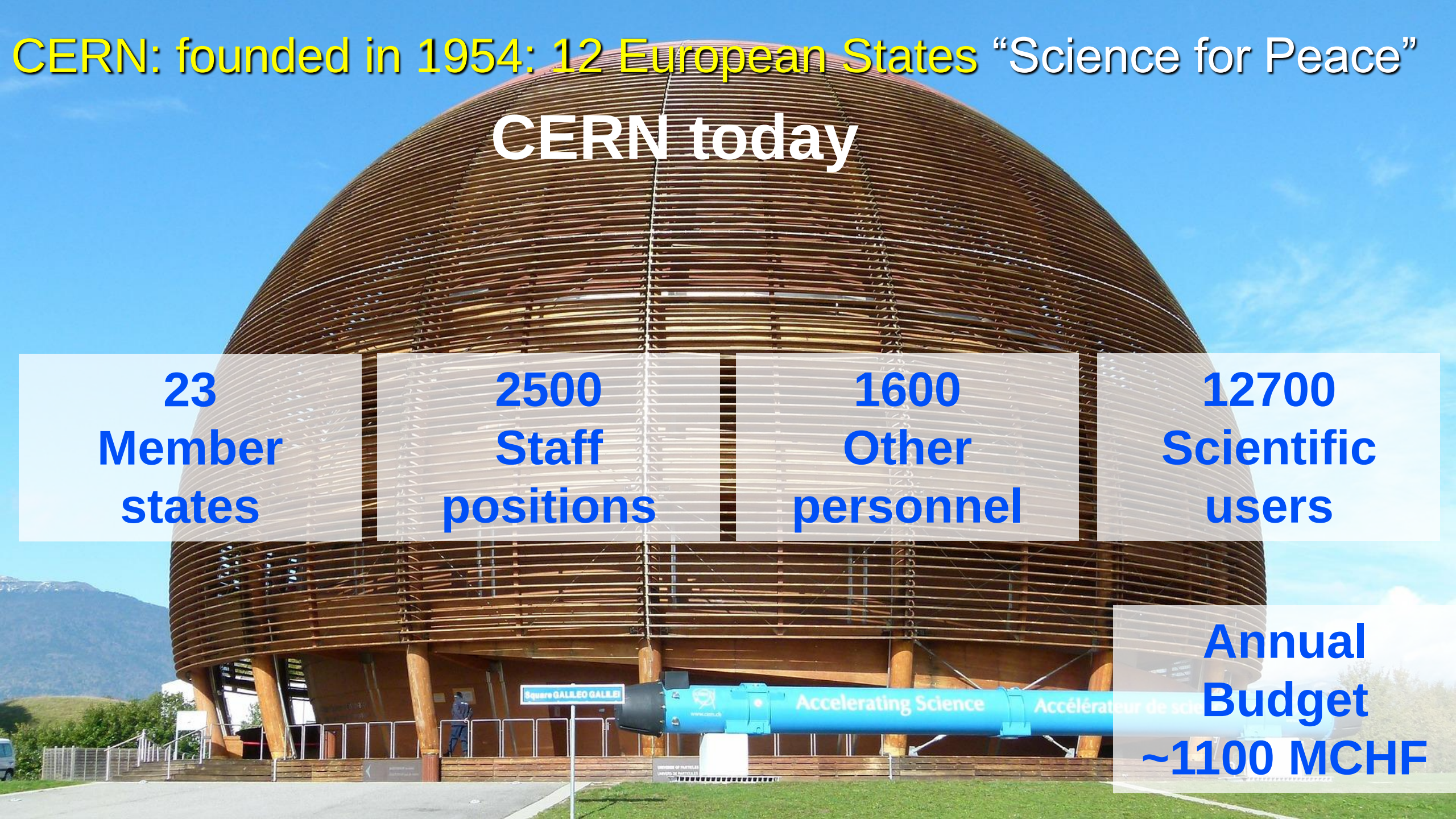
CERN: founded in 1954: 12 European States “Science for Peace”



CERN today

23
Member states

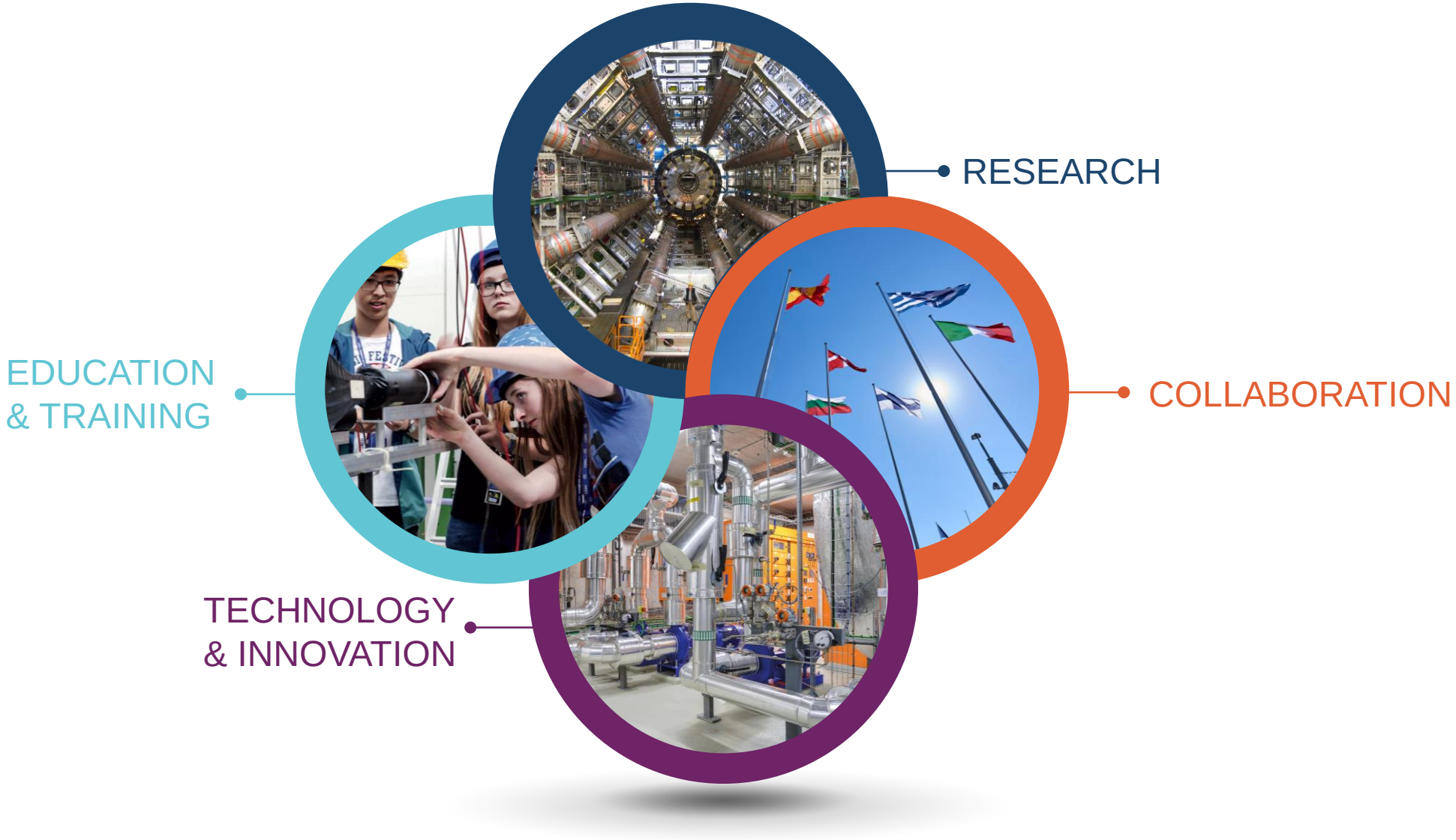
2500
Staff positions

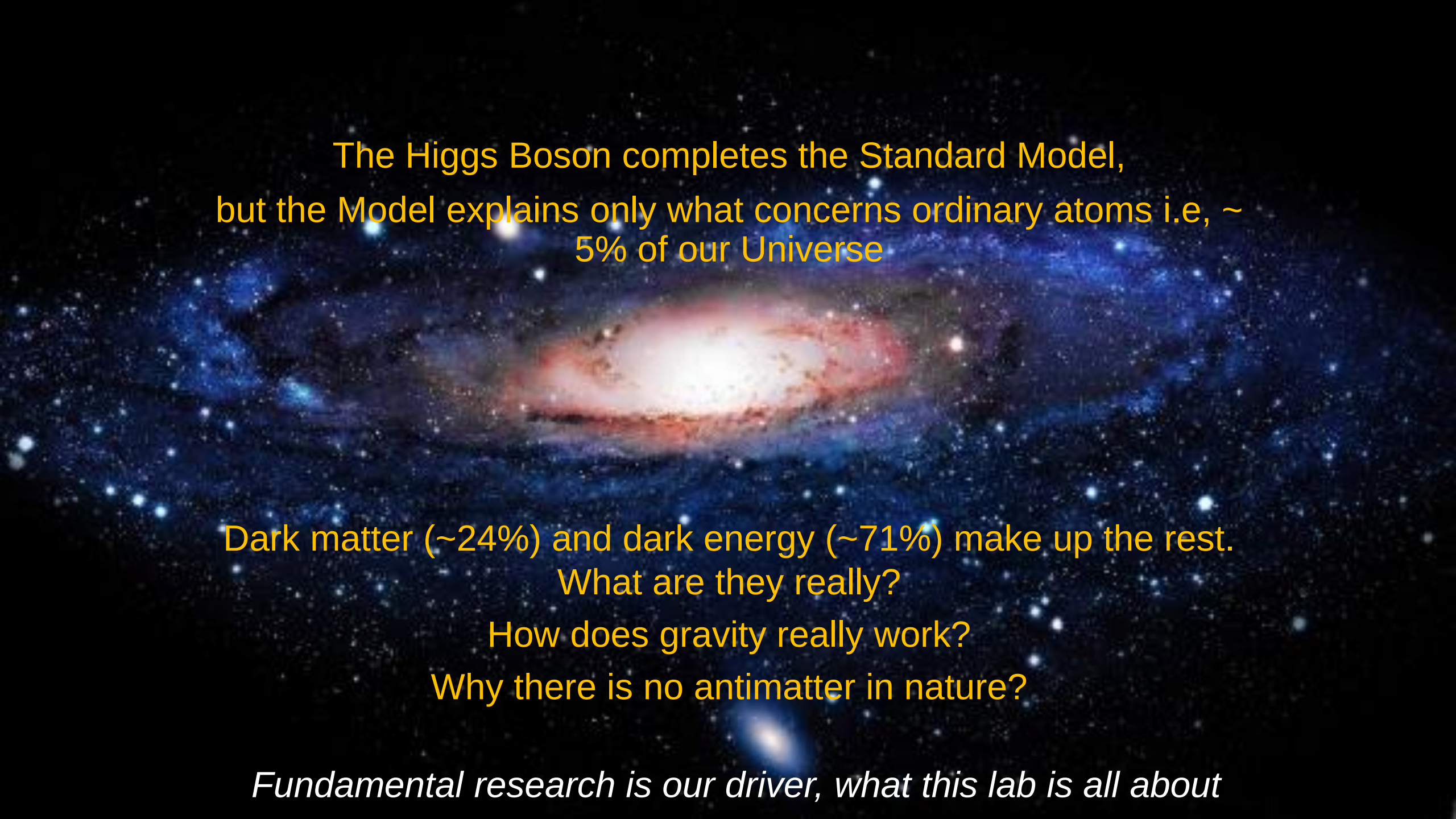
1600
Other personnel

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?

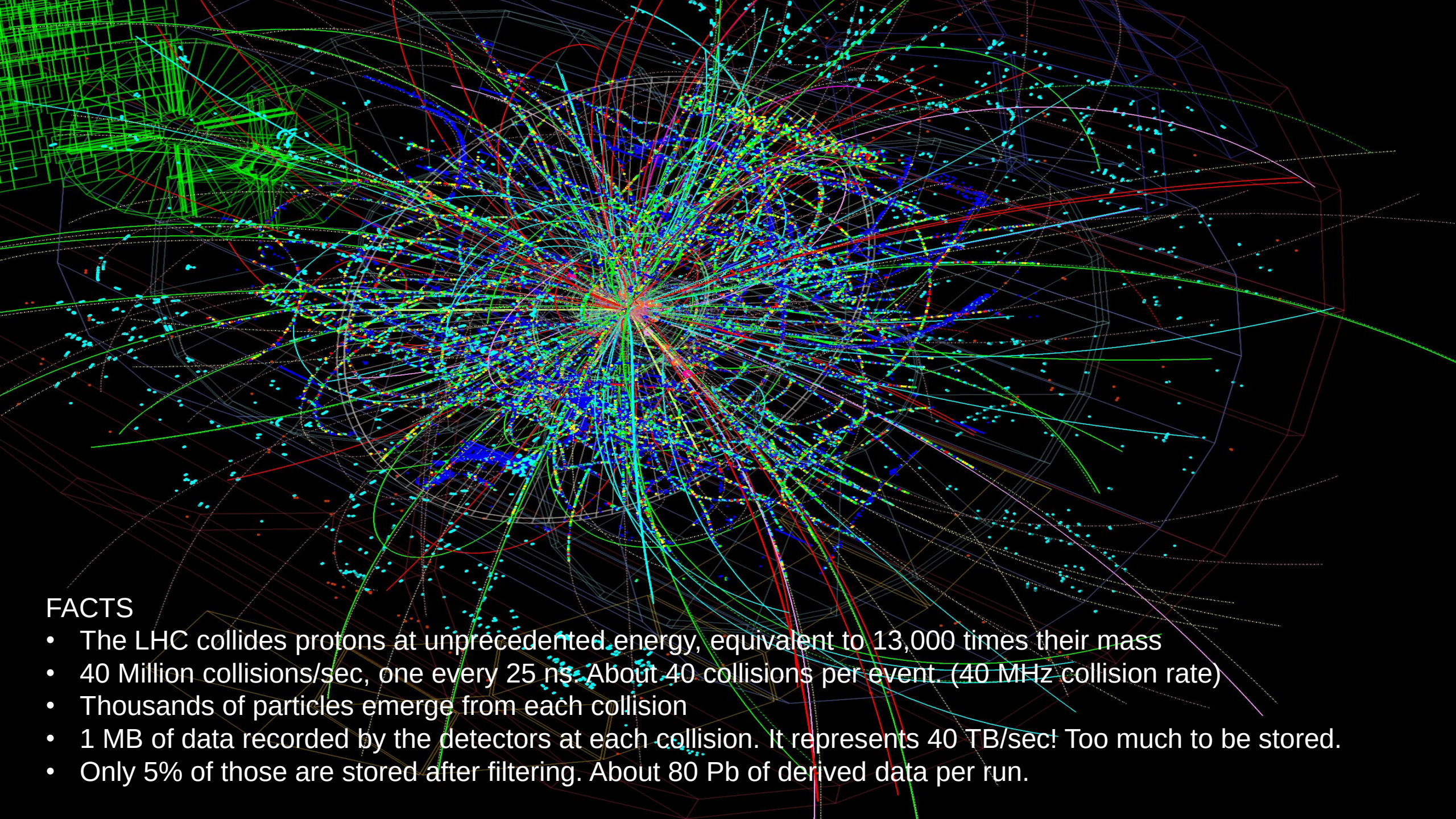
Why there is no antimatter in nature?

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


Accelerators


Detectors

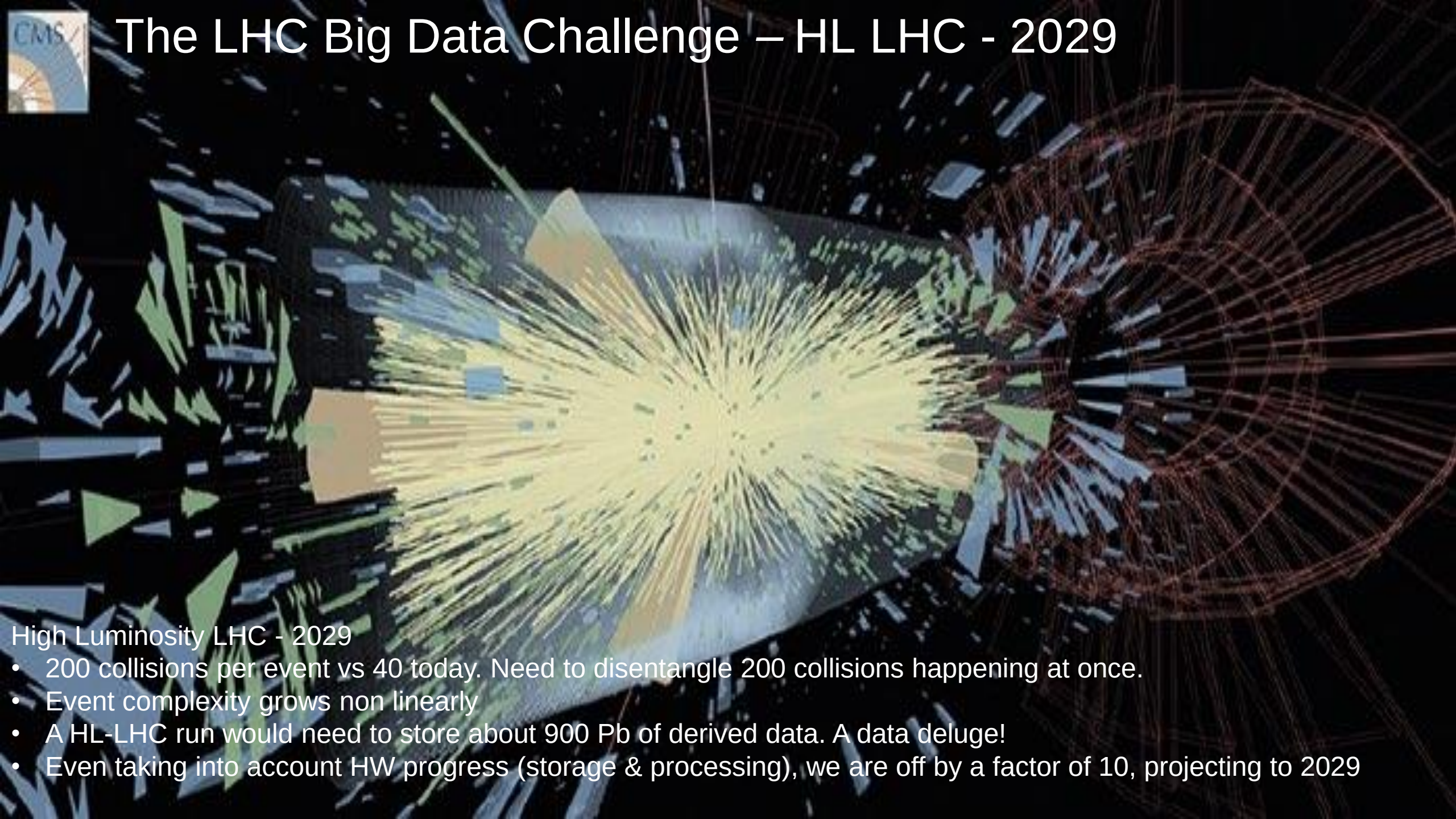

Computing



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. (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

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

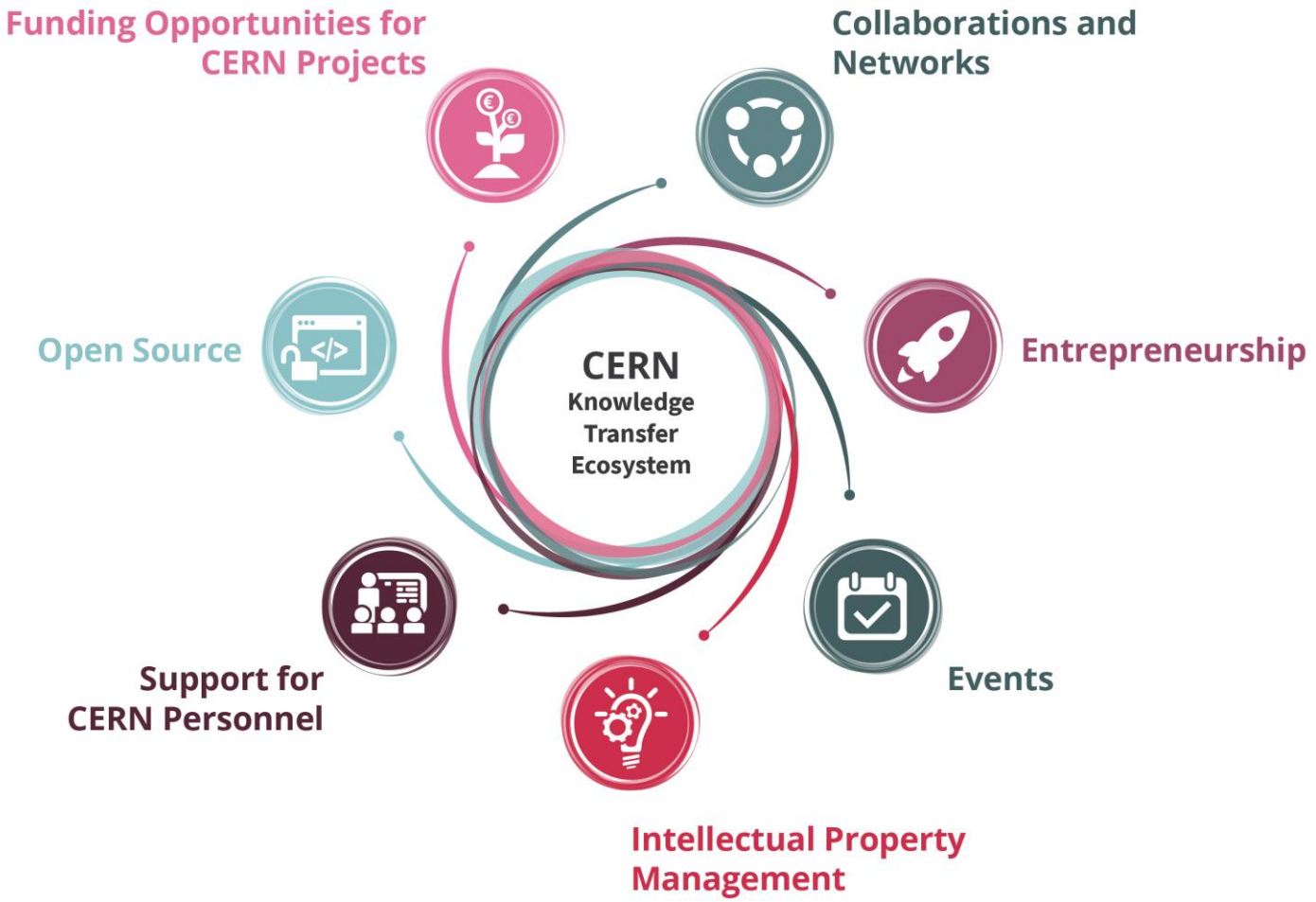
Robotics

Collaboration Tools

Radio Frequency Technology

Manufacturing and Mechanical Processes

Our toolbox to accelerate innovation



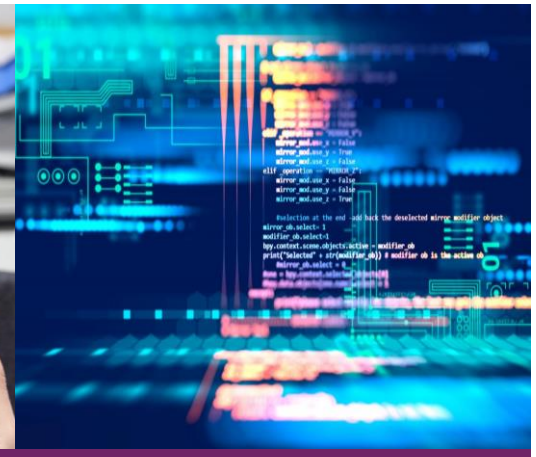
CERN as trusted non-commercial innovation partner

HEALTHCARE

ENVIRONMENT

DIGITAL

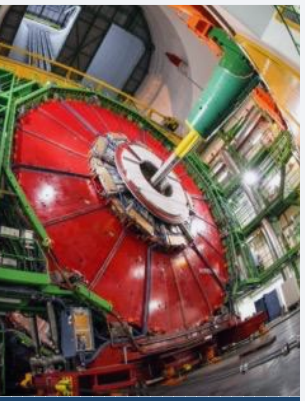
AEROSPACE



QUANTUM

Hybrid strategy: tech push & market pull


ACCELERATORS


DETECTORS


COMPUTING

- Mobilize tech experts
- Create tech and IP dossiers
- Scout for technologies

- Mobilize innovation partners
- Create value propositions
- Search unmet needs


HEALTHCARE

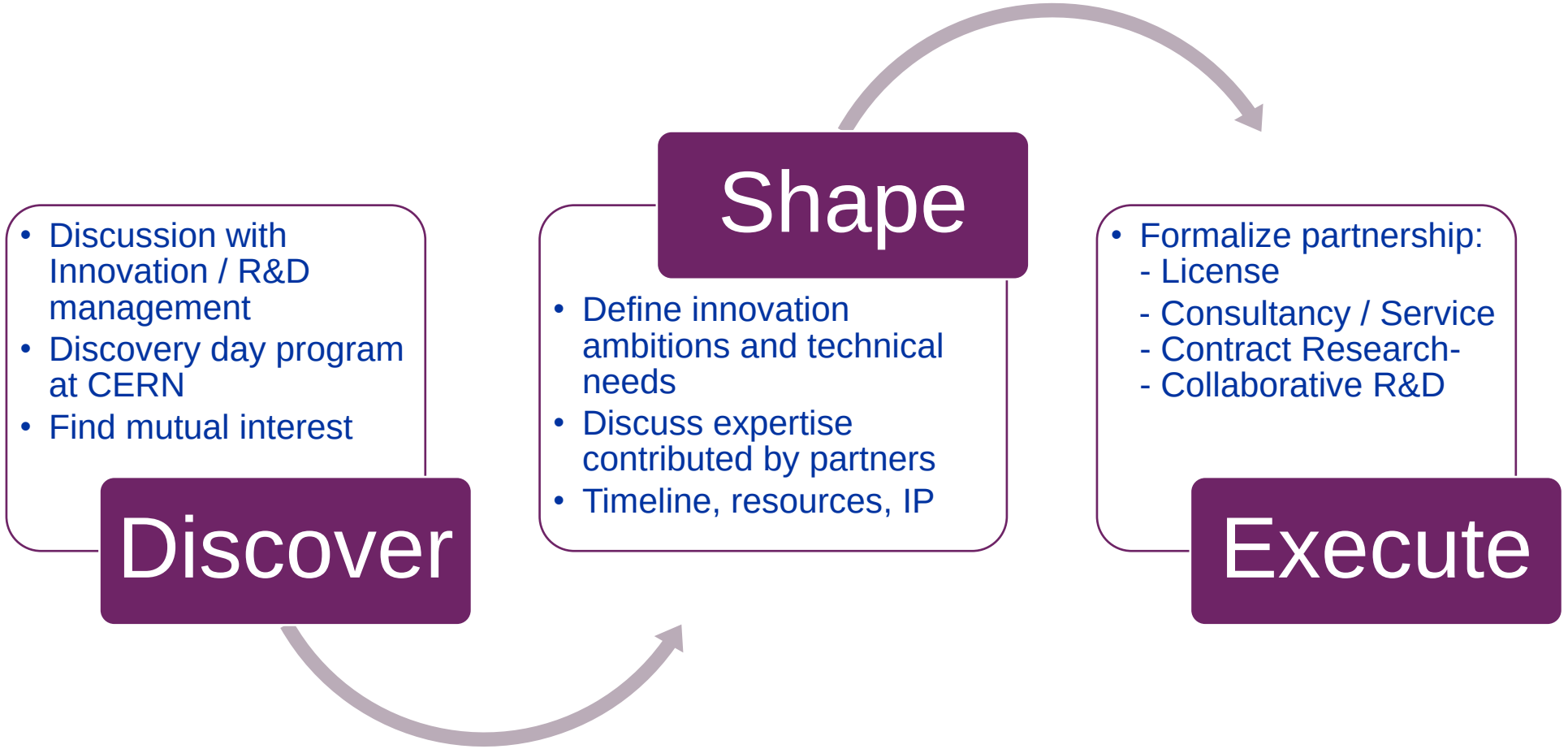

ENVIRONMENT


DIGITAL


AEROSPACE


QUANTUM

Shaping innovation partnerships



Licence	Consultancy/Service	Contract research	Collaborative R&D
• Access to existing solution • Support to implement	• Specific issue • Time of experts • Time of facilities	• Specific solution • Outsource its development to CERN	• 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

License

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

Successful EU Project Submission

Edge SpAIce

Space AI monitoring marine plastic litter

AGENIUM SPACE

CERN

ENDUROSAT

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

Sensors & Historical Data

AI & ML to produce ROMs

Simulation Files

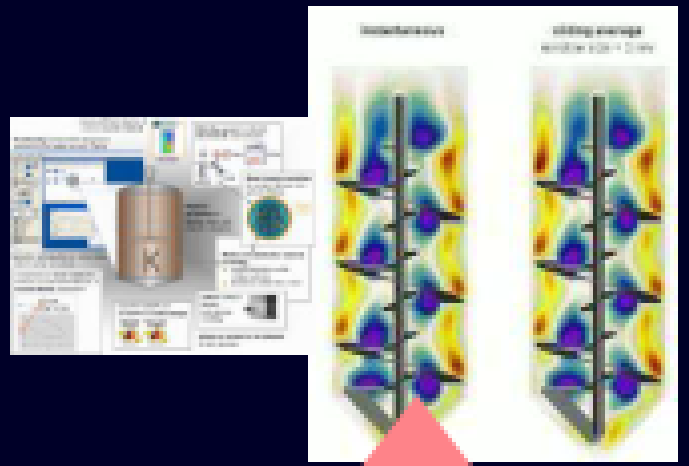
Physics-based Simulation Models

Real Plant

Data

Prediction

Executable Digital Twin



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.

Contract research

SCIENCE & EXPLORATION

juice

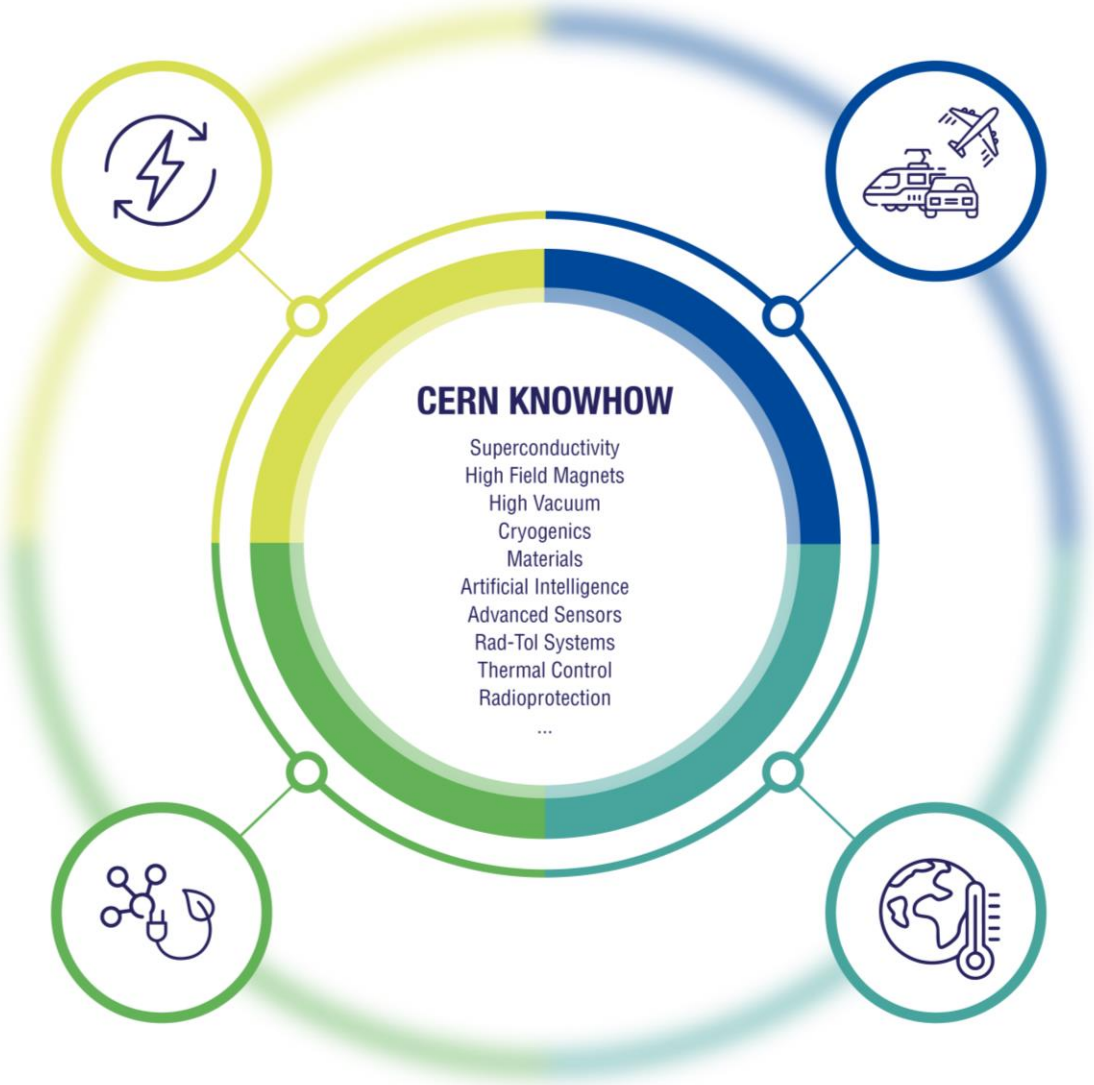
Jupiter Icy Moons Explorer

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.

CIPEA CERN Innovation Program on Environmental Applica

RENEWABLE AND LOW-CARBON ENERGY

Production
Transformation
Distribution
Storage



CLEAN TRANSPORTATION AND FUTURE MOBILITY

Aviation
Shipping
Rail
Automotive

SUSTAINABILITY AND GREEN SCIENCE

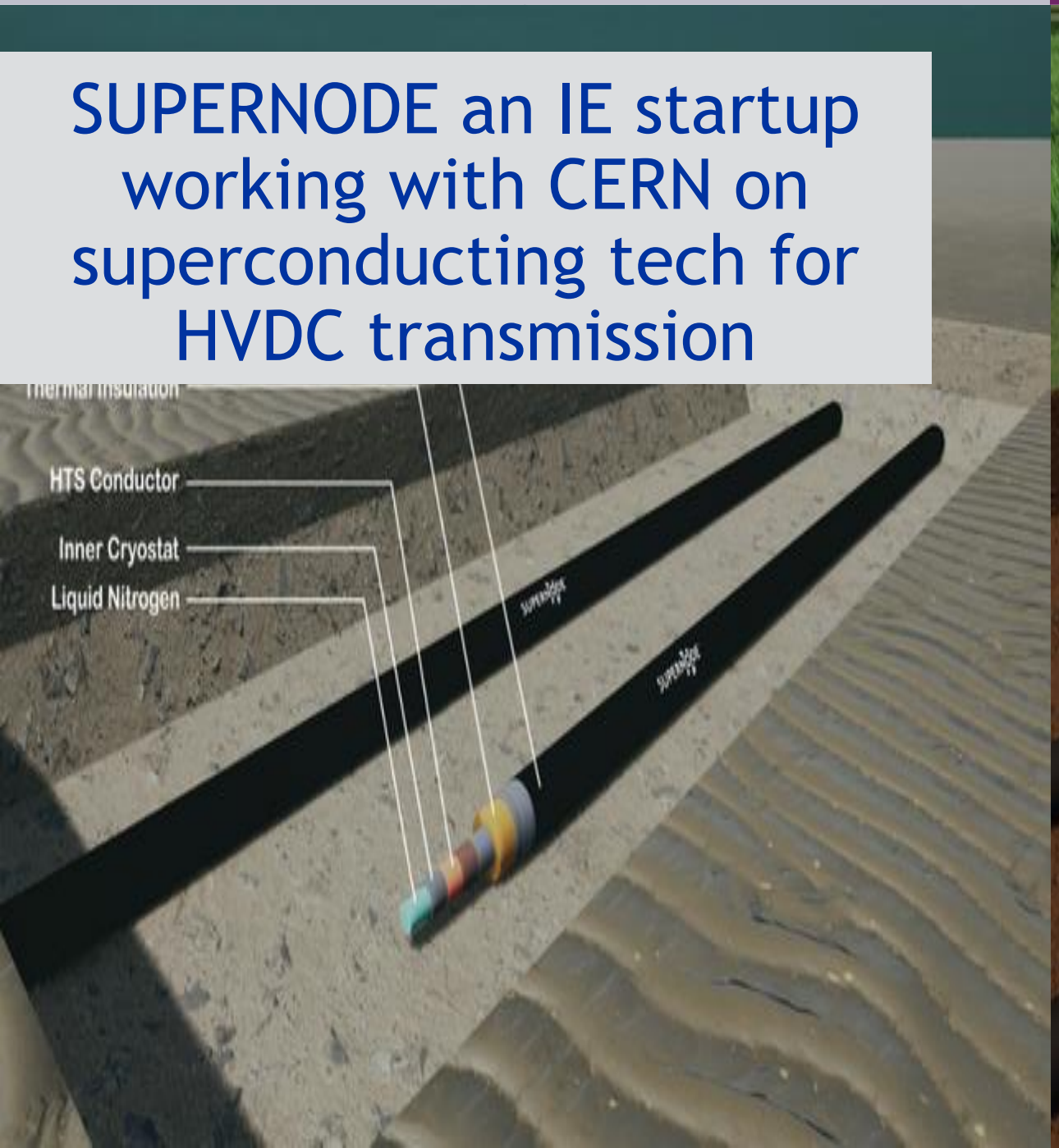
Power Management
Heat Management
Industrial Processes

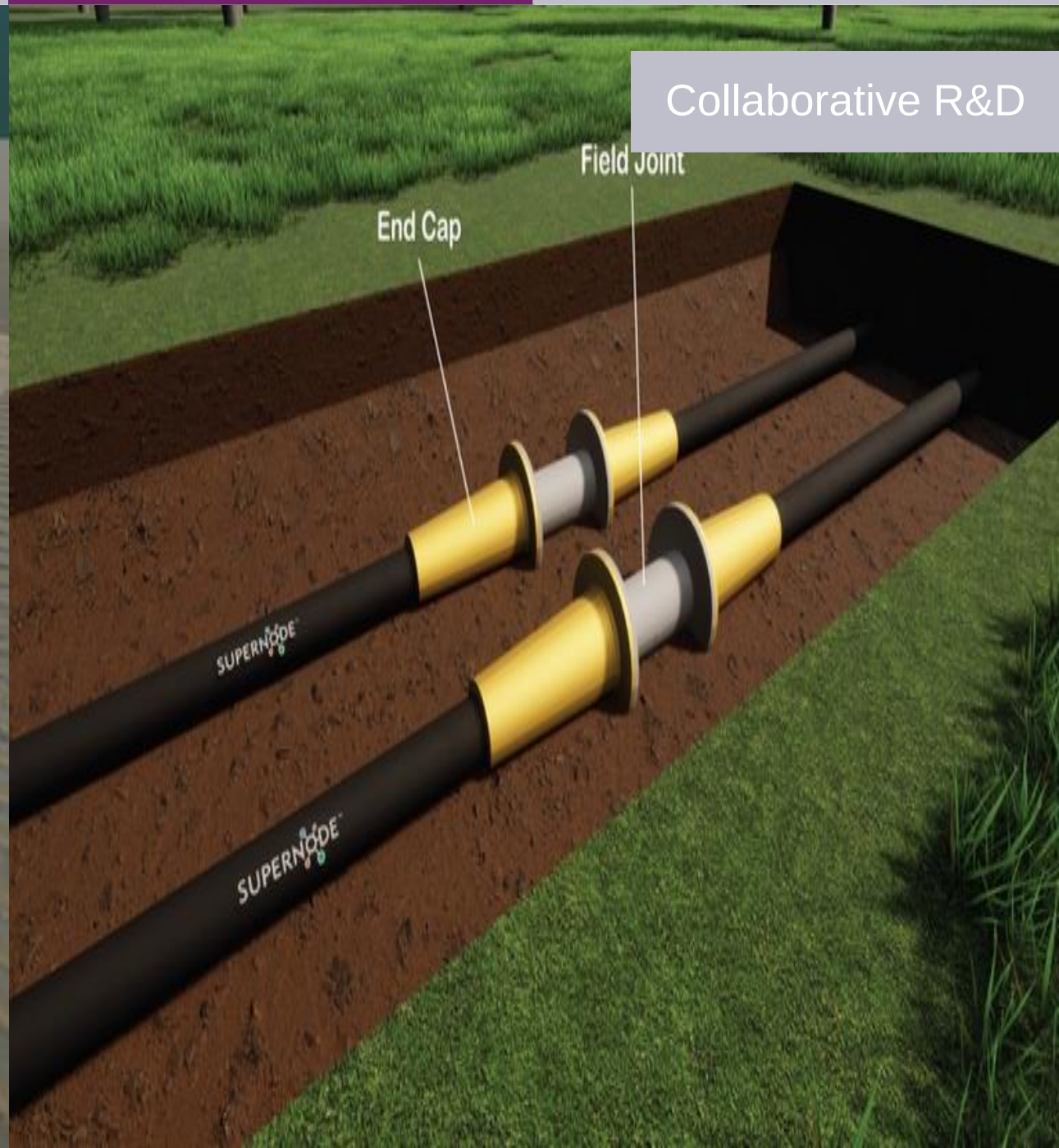
CLIMATE CHANGE AND POLLUTION CONTROL

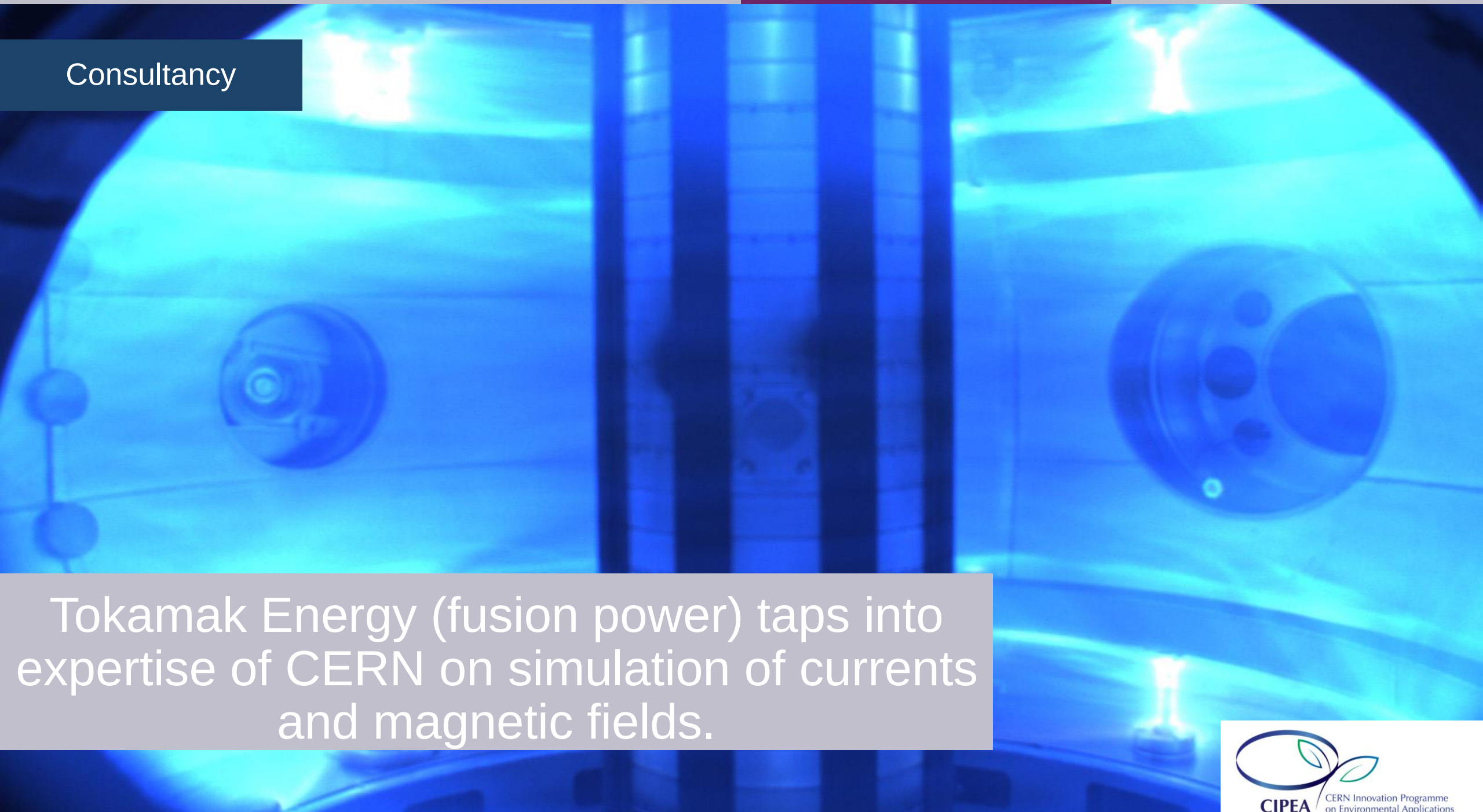
Monitoring
Modelling
Mitigation

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

Collaborative R&D







Consultancy

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

CIPEA CERN Innovation Programme on Environmental Applications

Collaborative R&D

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

CIPEA CERN Innovation Programme on Environmental Applications

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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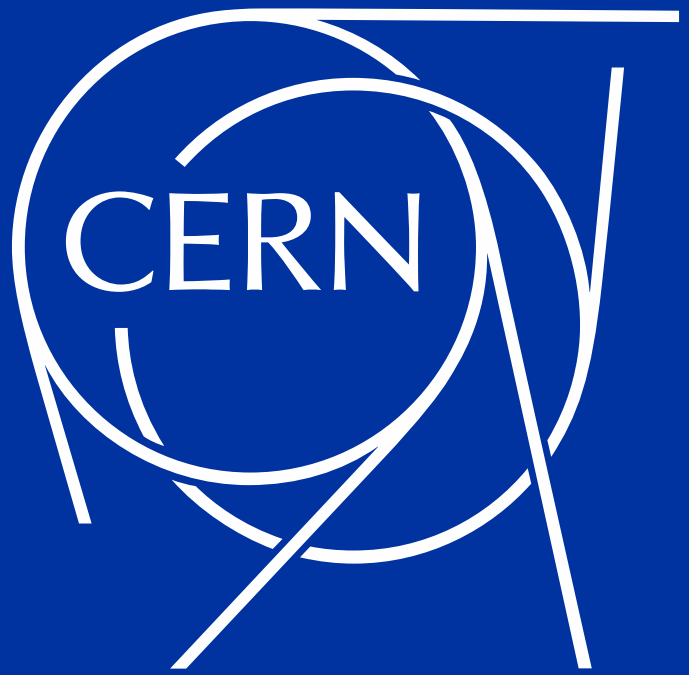
CERN