ENTSO-E Research, Development, and Innovation Committee (RDIC) WG5 (Digitalization) Meeting

# Welcome to CERN

European Network of Transmission System Operators for Electricity

Enrico Chesta

Knowledge Transfer
*Accelerating Innovation*

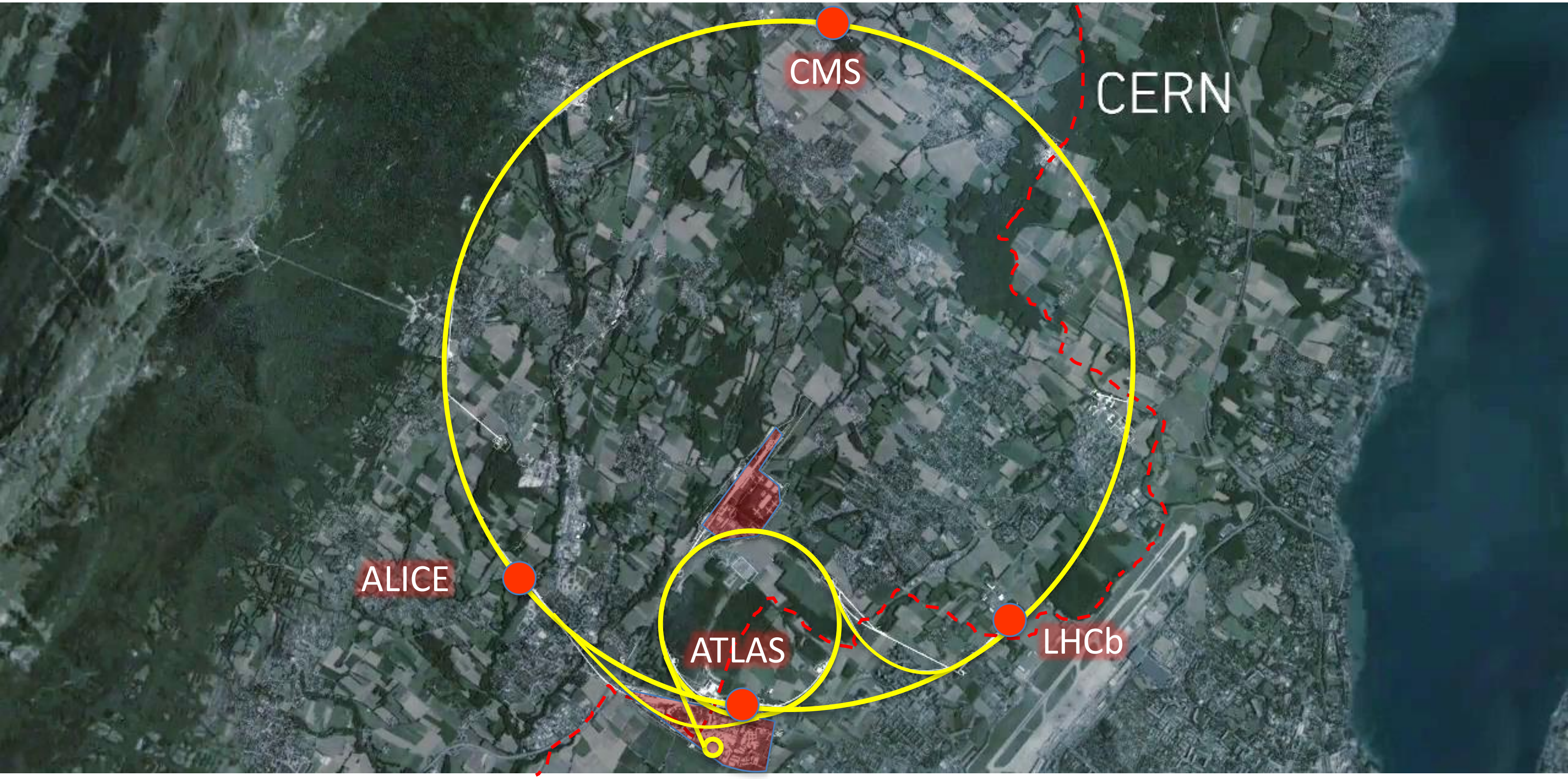
CIPEA CERN Innovation Programme on Environmental Applications

12/09/24

# A (short) introduction to CERN

Enrico Chesta

# CERN at a glance...



# What does « CERN » stand for?

European
Council for
Nuclear
Research

Conseil
Européen pour la
Recherche
Nucléaire

# What does « CERN » stand for?

European
Organization for
Nuclear
Research

# A world collaboration

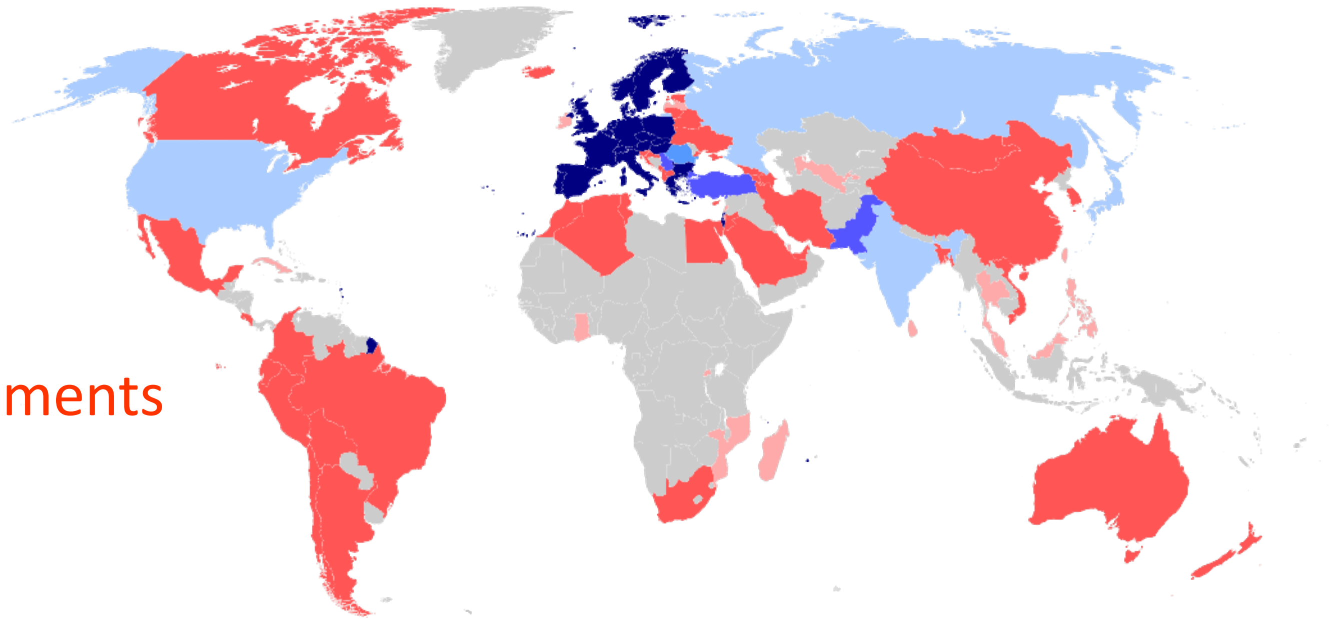
24 members

10 associates

Observers

Cooperation agreements

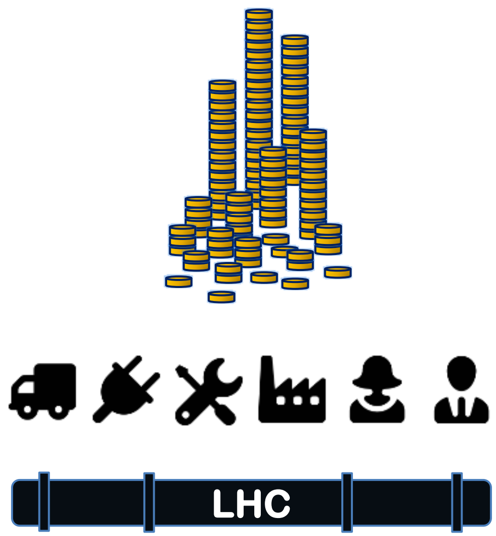
Scientific contacts



**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 and United Kingdom.
**Associate Member States in the pre-stage to Membership**:
Cyprus, Slovenia.
**Associate Member States**:
Brazil, Croatia, India, Latvia, Lithuania, Pakistan, Turkey and Ukraine.

# Budget

ca 1 Bn CHF

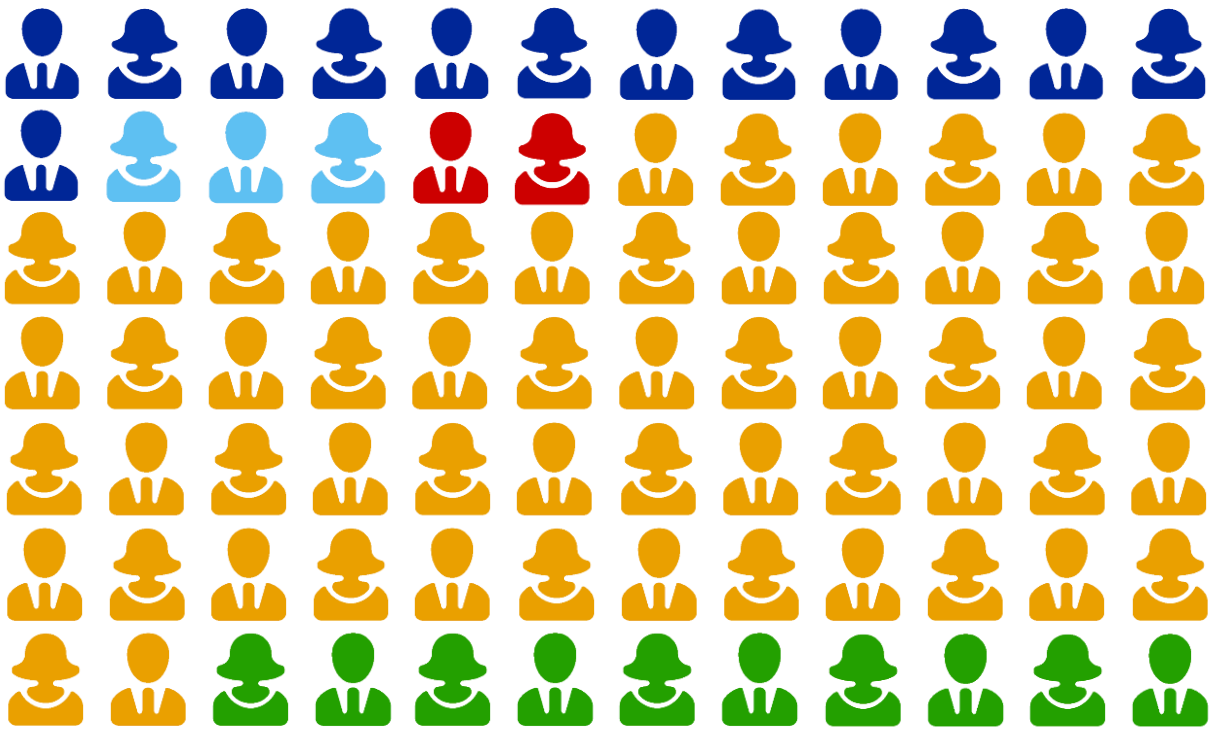



| | |
|---|---|
| Germany | 20.27% |
| France | 15.39% |
| United Kingdom | 13.88% |
| Italy | 11.48% |
| Spain | 8.28% |
| Netherlands | 4.60% |
| Switzerland | 3.64% |
| Belgium | 2.78% |
| Poland | 2.66% |
| Sweden | 2.61% |
| Norway | 2.55% |
| Austria | 2.22% |
| Denmark | 1.76% |
| Greece | 1.64% |
| Finland | 1.39% |
| Portugal | 1.20% |
| Israel | 1.19% |
| Czech Republic | 1.03% |
| Hungary | 0.65% |
| Slovakia | 0.50% |
| Bulgaria | 0.28% |

(2015 data)

# How many persons?

# +15’000!



2’500 staff

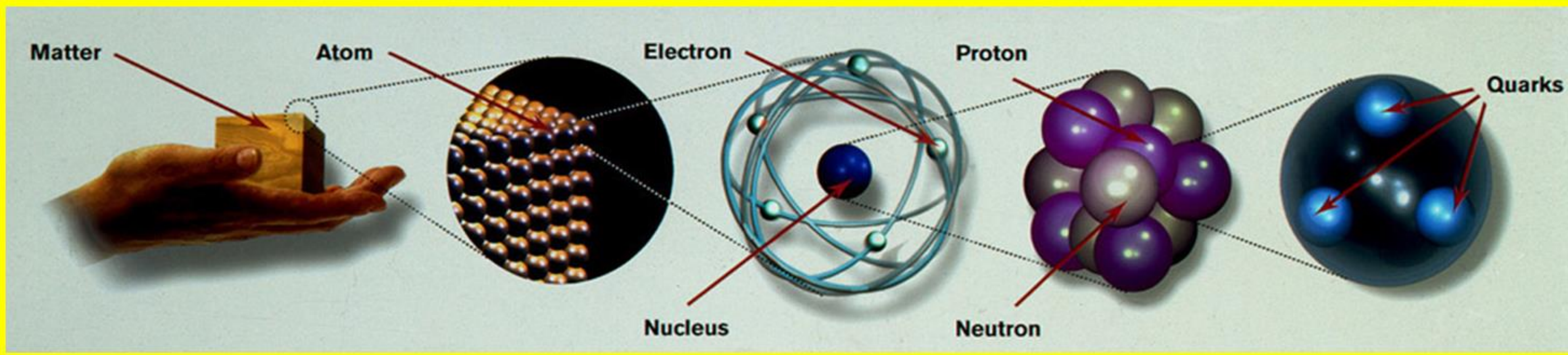
600 fellows & apprentices

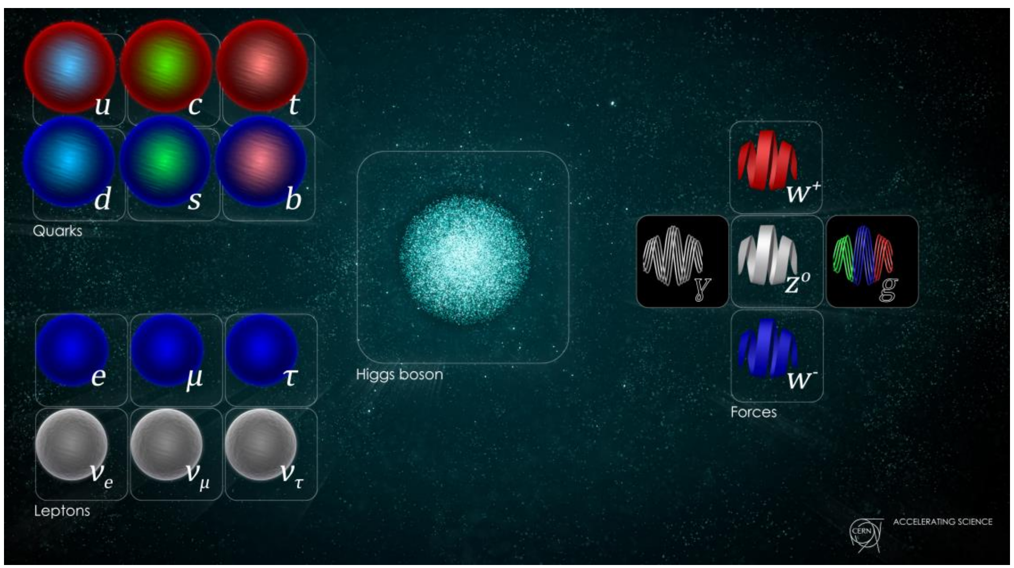
500 students

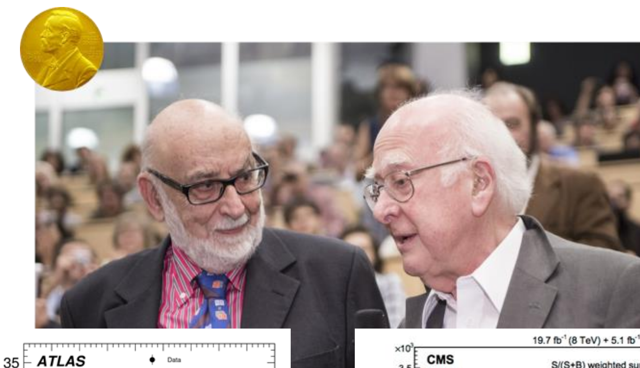
11’000 users

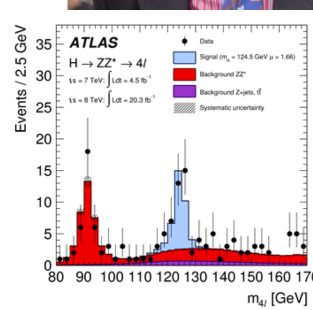
2’000 external companies

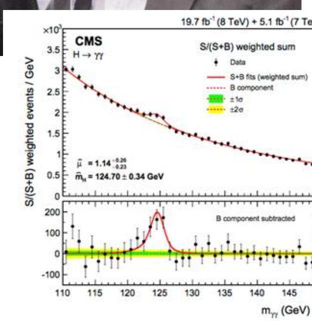
# CERN main mission: fundamental physics





# Answering questions…

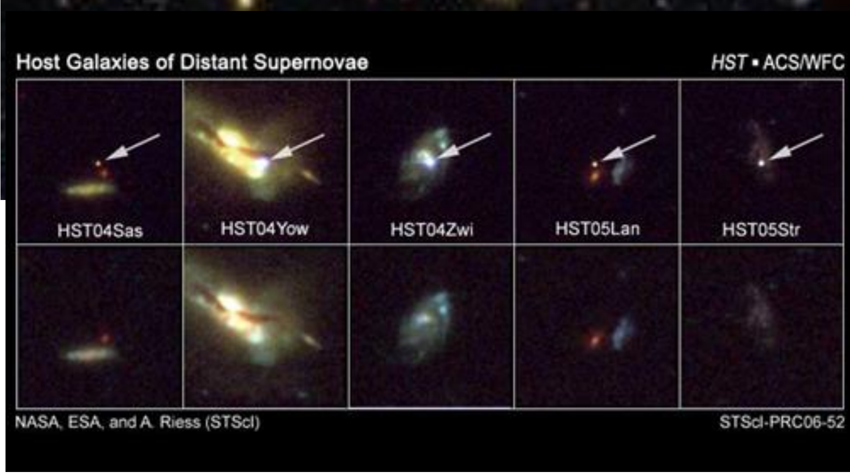

*What lays beyond the Standard Model?*

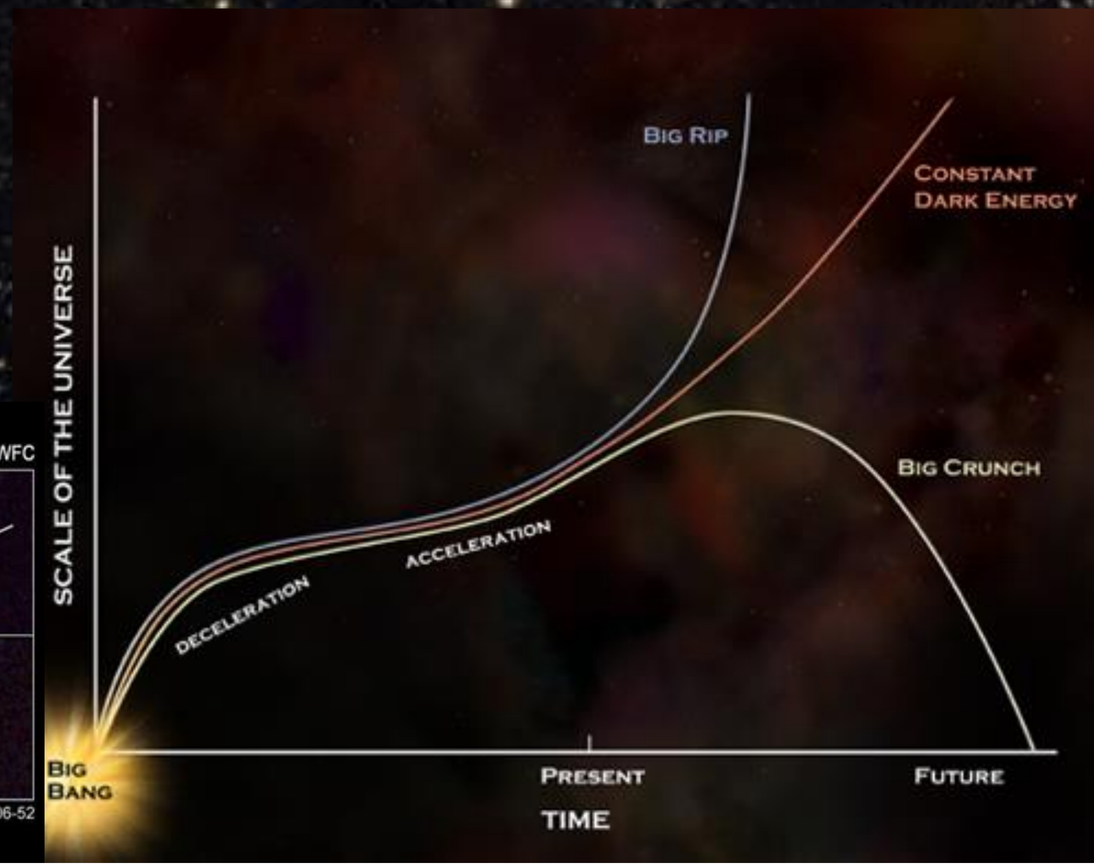
# Answering questions…


*What is dark matter?*

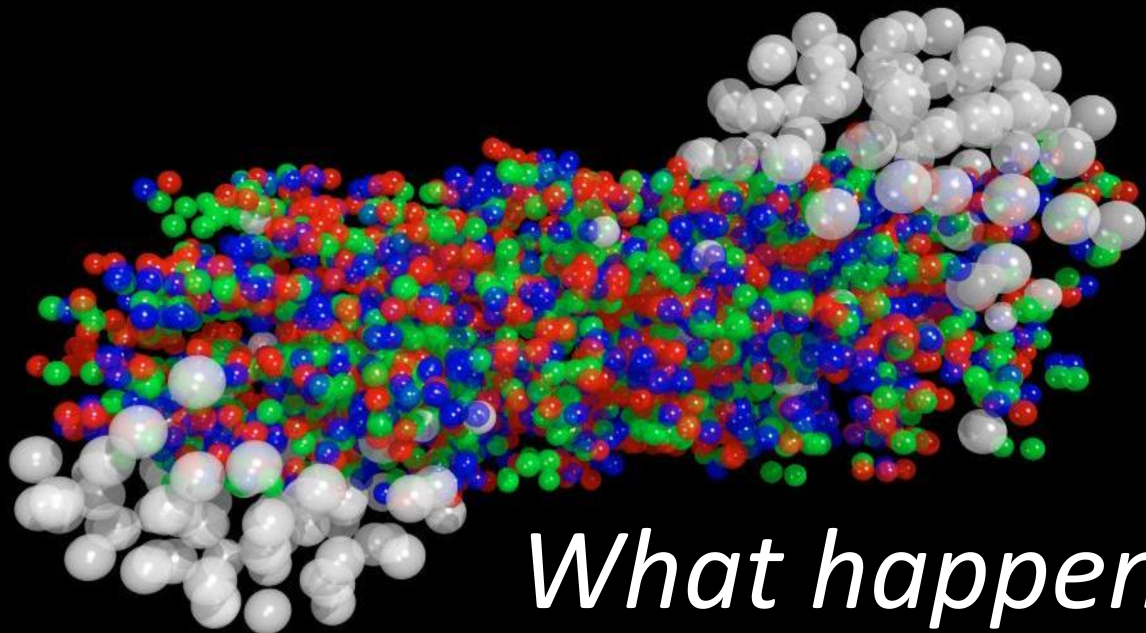
# Answering questions…

*What is dark energy?*

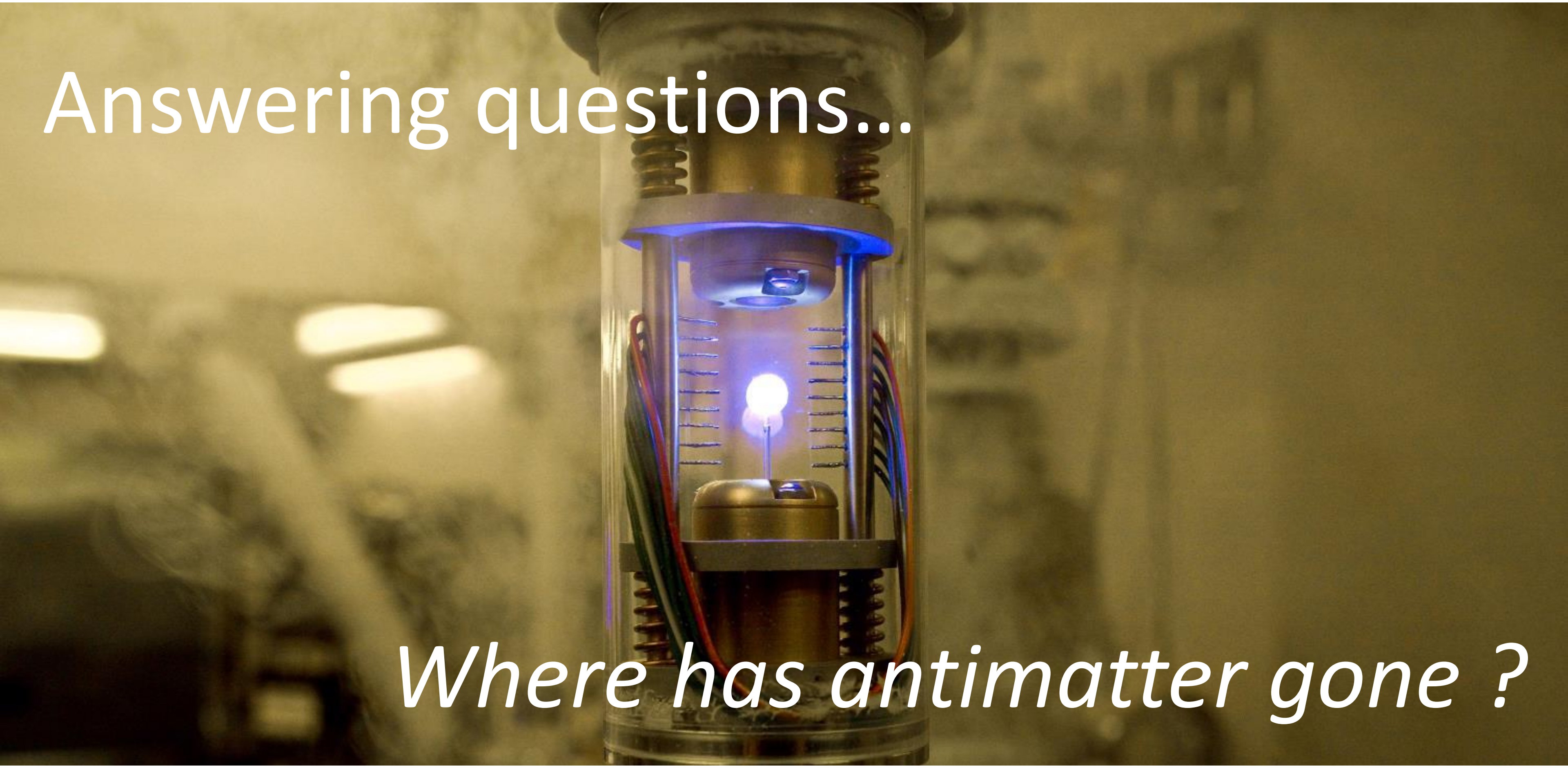


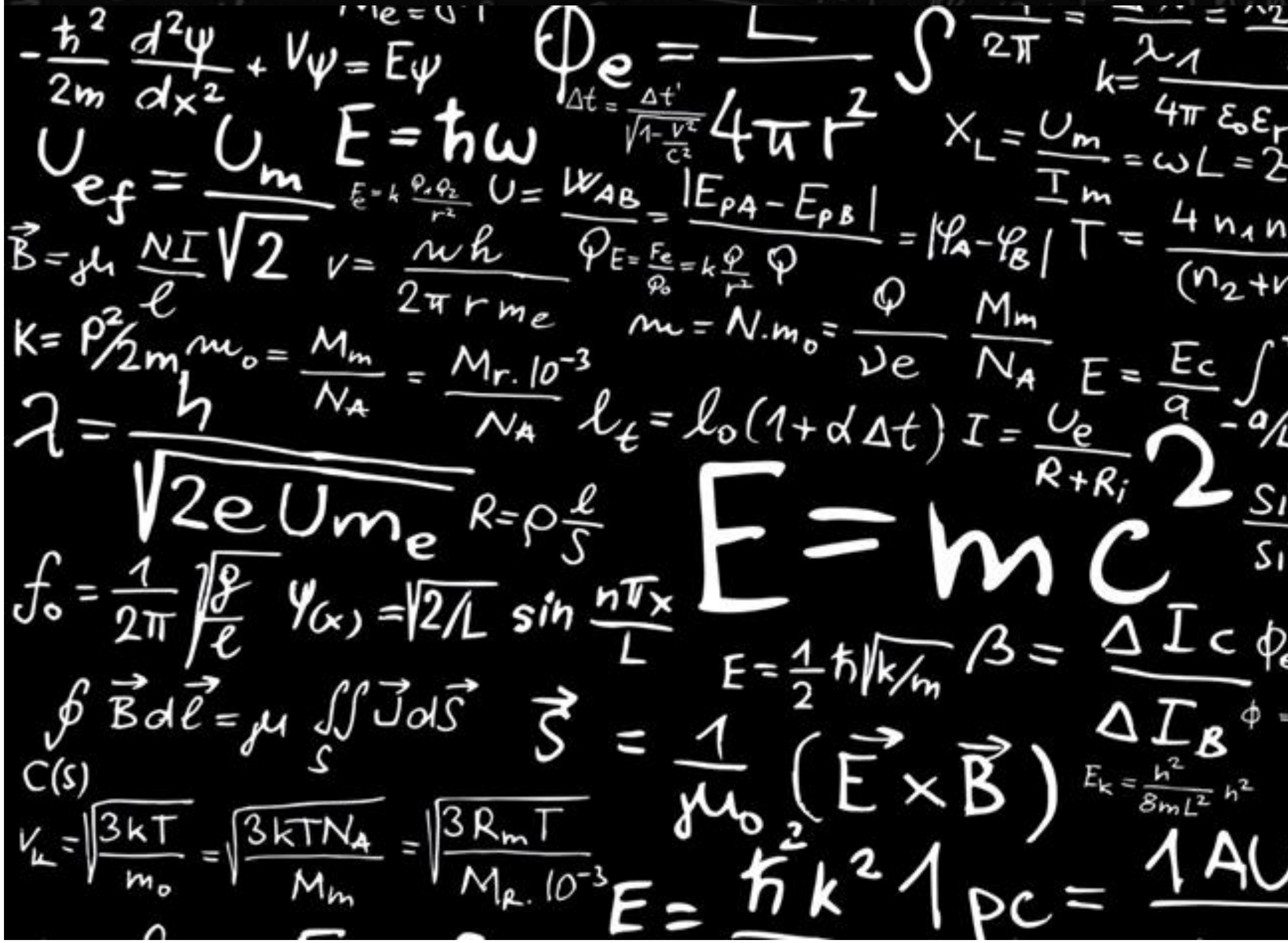
# Answering questions…



*What happened short after the Big Bang?*


Answering questions…
*Where has antimatter gone ?*

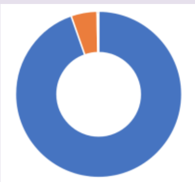
# Transforming energy into matter, i.e. …




# … Transforming energy into data

## CERN Energy Consumption

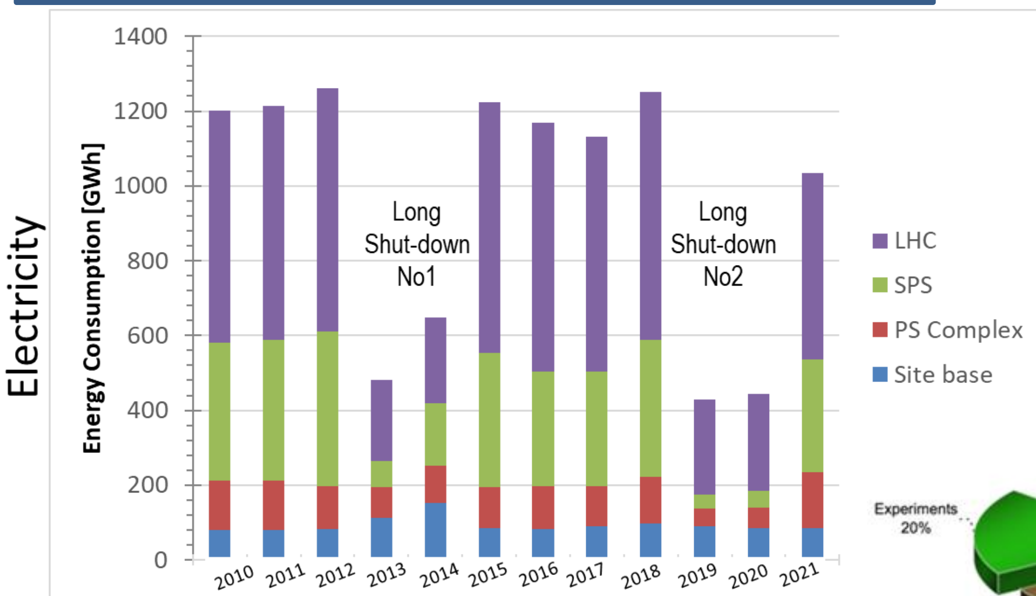
Yearly average

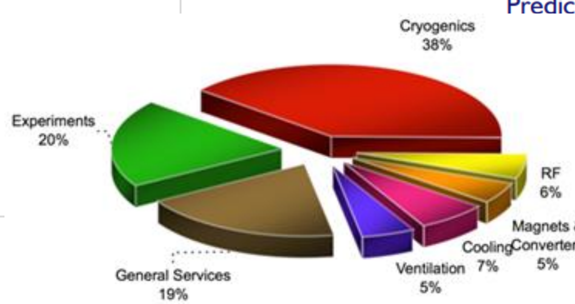


Fuel: 4 GWh, 0.3 %

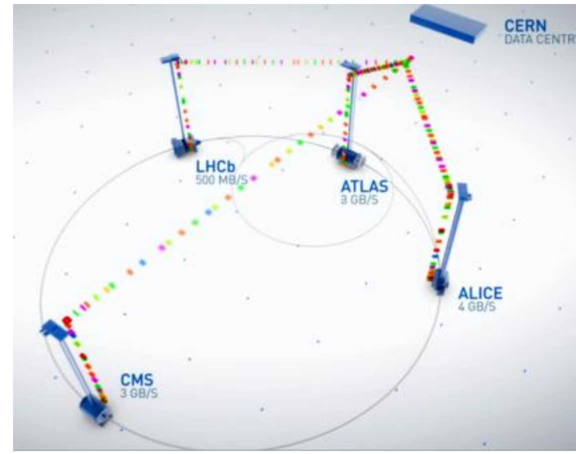
Gas: 67 GWh, 5.2%

Electricity: 1'220 GWh, 94.5%

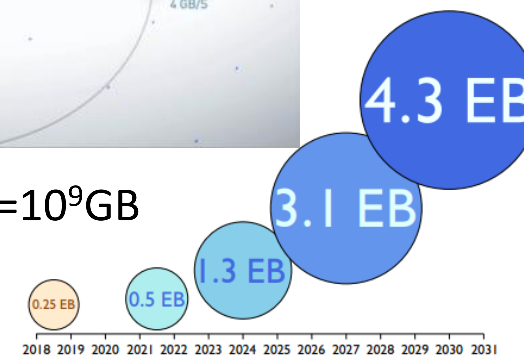



## CERN Data Production




1EB=$10^9$GB

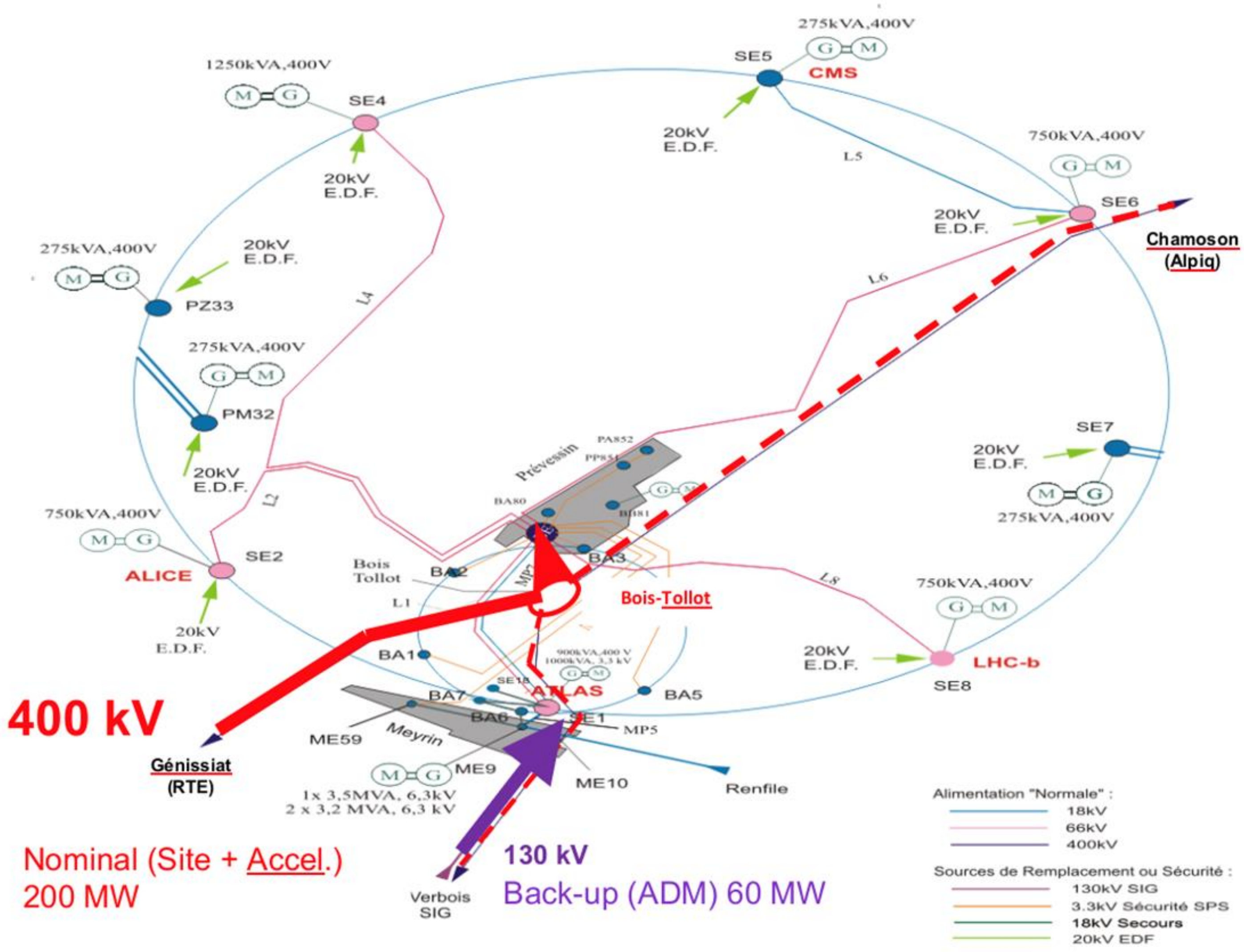



Predicted T0 Tape Archival Storage Needs

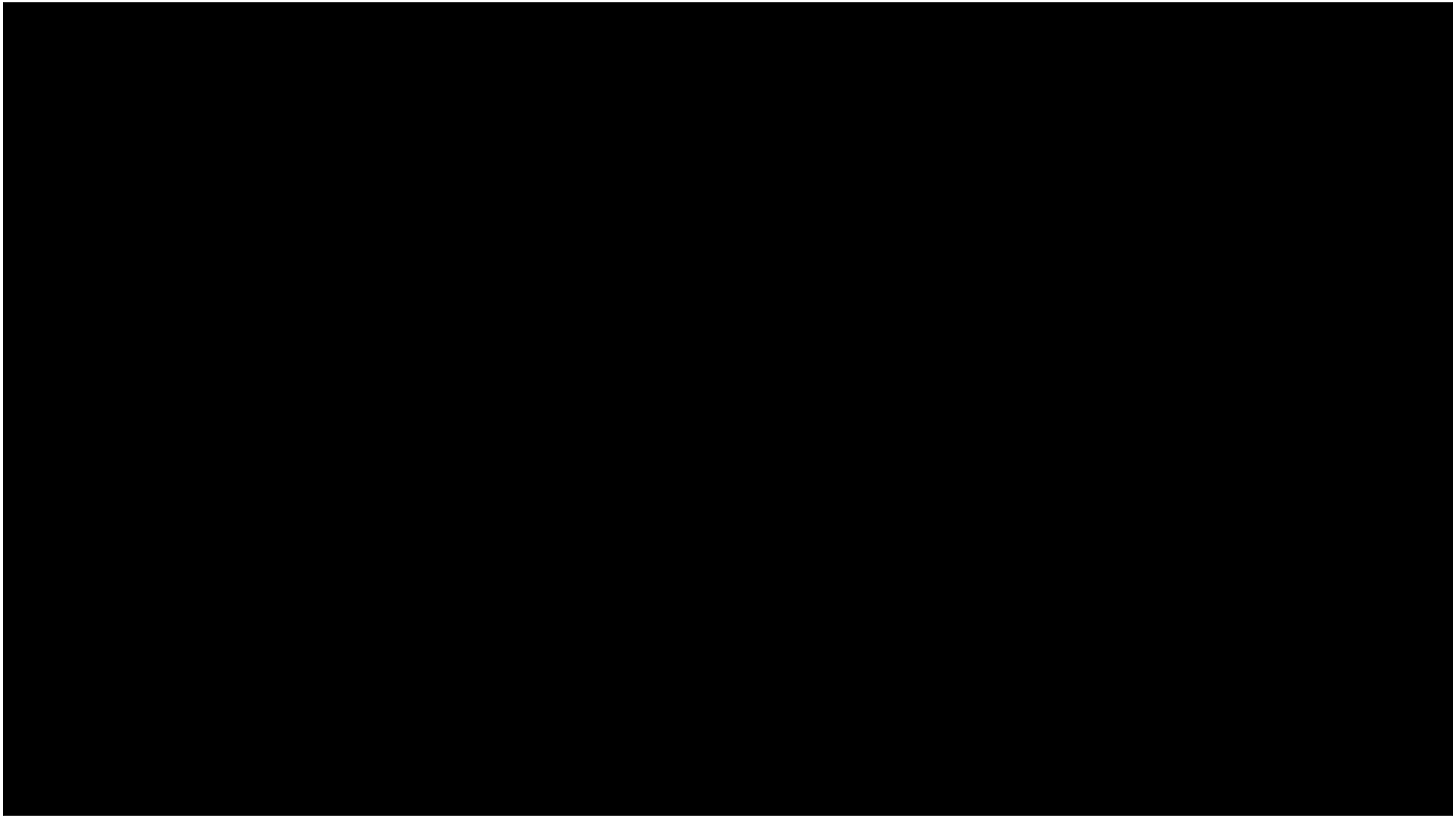
# Electrical distribution at CERN

Main feeding point from a 400kV line (interconnection F-CH)

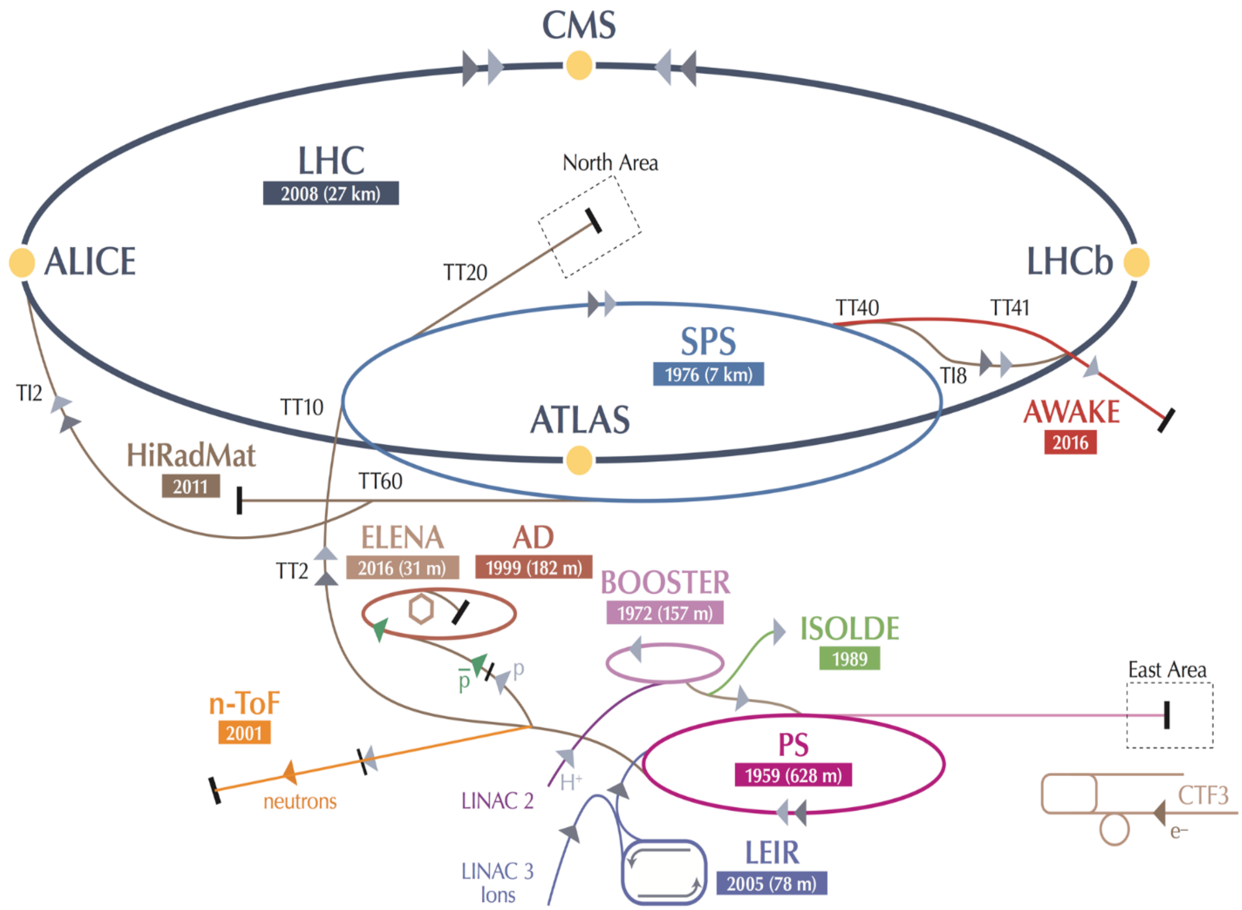
Back-up from 130kV (limited capacity)



# CERN data processing and storage



# Full accelerator chain and experimental capabilities




**AD:** Antiproton Decelerator for antimatter studies

**AWAKE**: proton-induced plasma wakefield acceleration

**CAST, OSQAR**: axions

**CLOUD**: impact of cosmic rays on aerosols and clouds → implications on climate

**COMPASS**: hadron structure and spectroscopy

**ISOLDE**: radioactive nuclei facility

**NA61/Shine**: ions and neutrino targets

**NA62**: rare kaon decays

**NA63**: radiation processes in strong EM fields

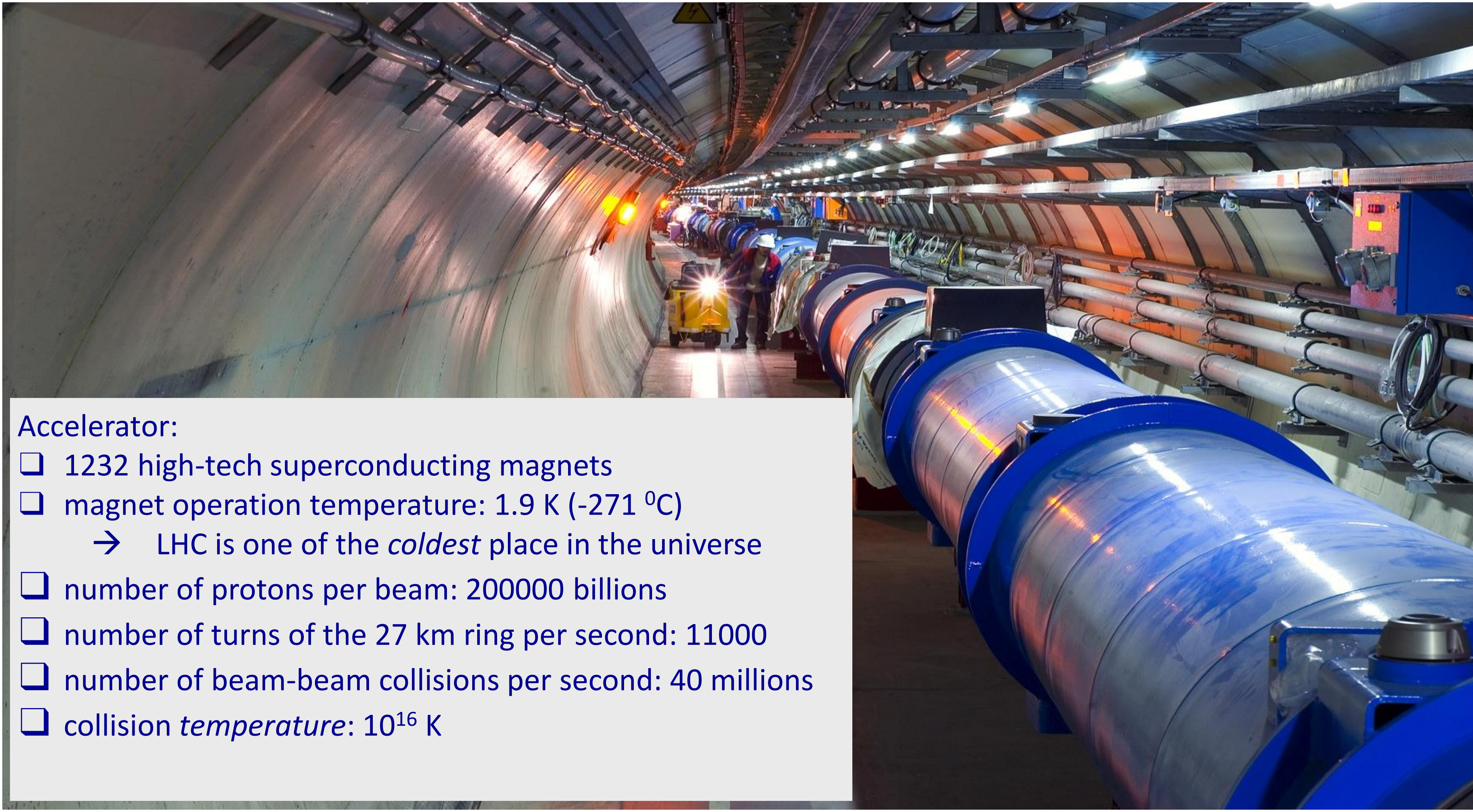
**NA64**: search for dark photons

**Neutrino Platform:** ν detector R&D for experiments in US,Japan

**n-TOF:** n-induced cross-sections

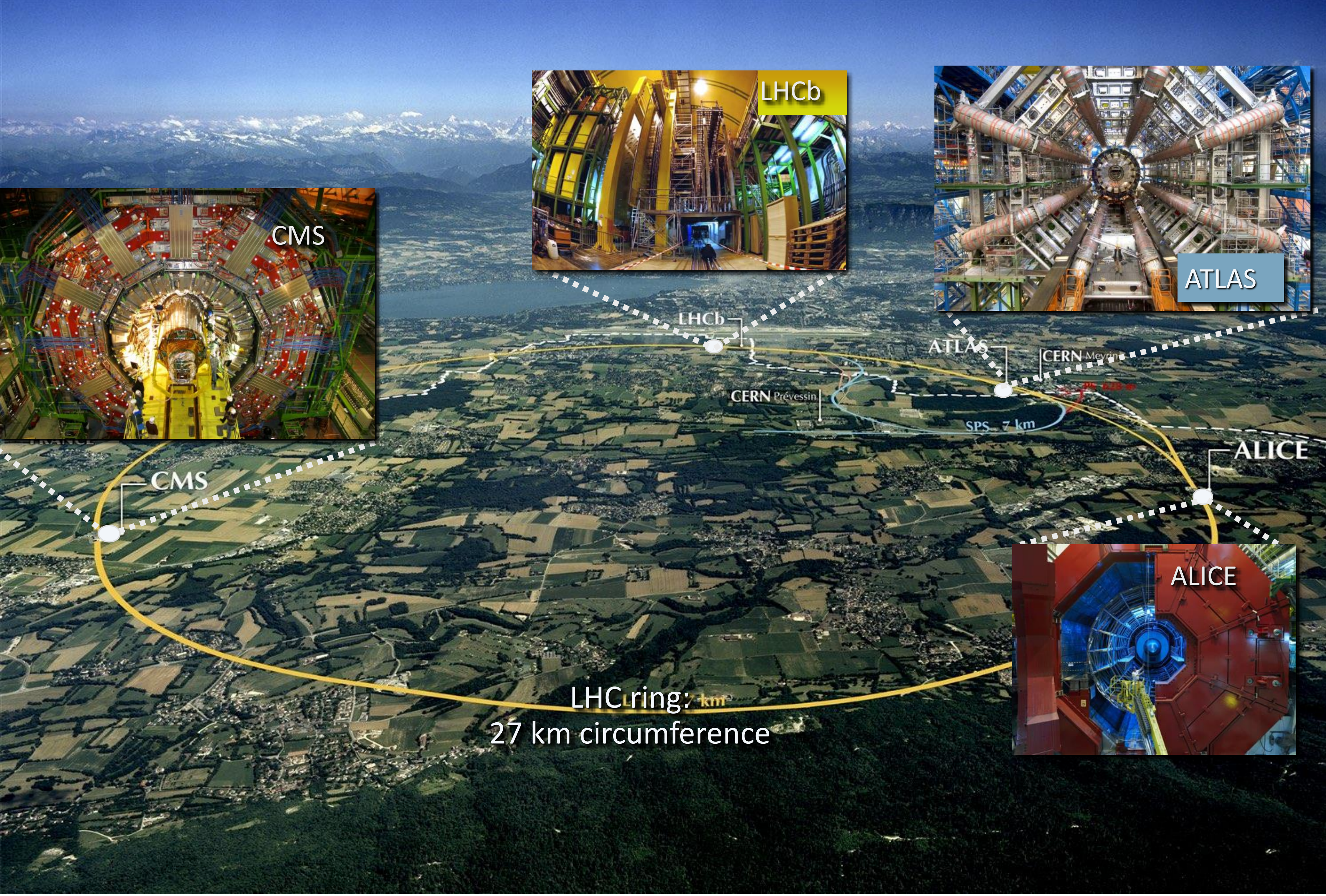
**UA9**: crystal collimation

# Accelerating particles: the LHC

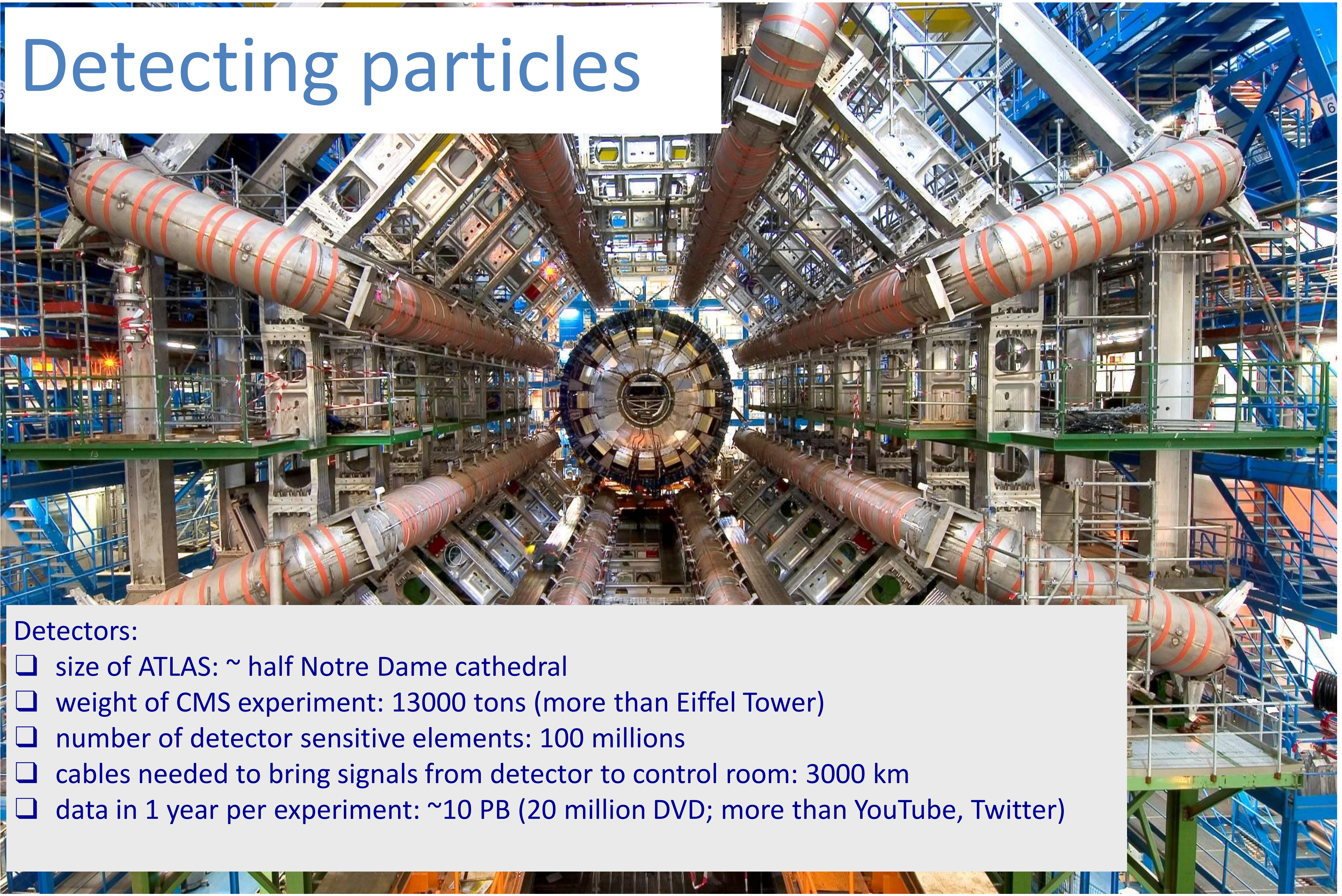


Accelerator:

- ❑ 1232 high-tech superconducting magnets
- ❑ magnet operation temperature: 1.9 K (-271 $^0$C)
  - → LHC is one of the *coldest* place in the universe
- ❑ number of protons per beam: 200000 billions
- ❑ number of turns of the 27 km ring per second: 11000
- ❑ number of beam-beam collisions per second: 40 millions
- ❑ collision *temperature*: $10^{16}$ K

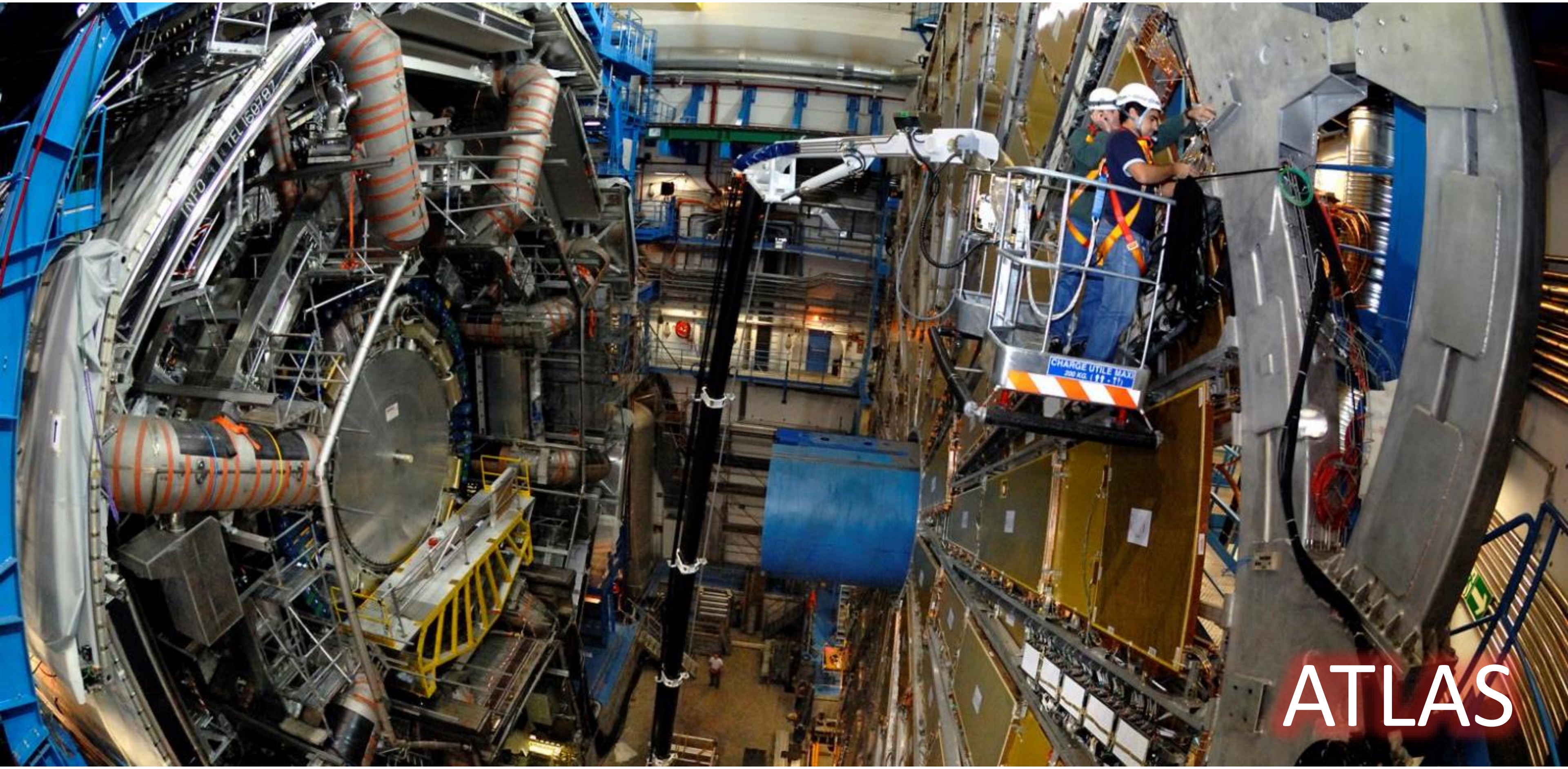

LHCb
ATLAS
CMS
ALICE
LHCb
ATLAS
CERN Meyrin
CERN Prévessin
SPS 7 km
ALICE
CMS
LHC ring:
27 km circumference

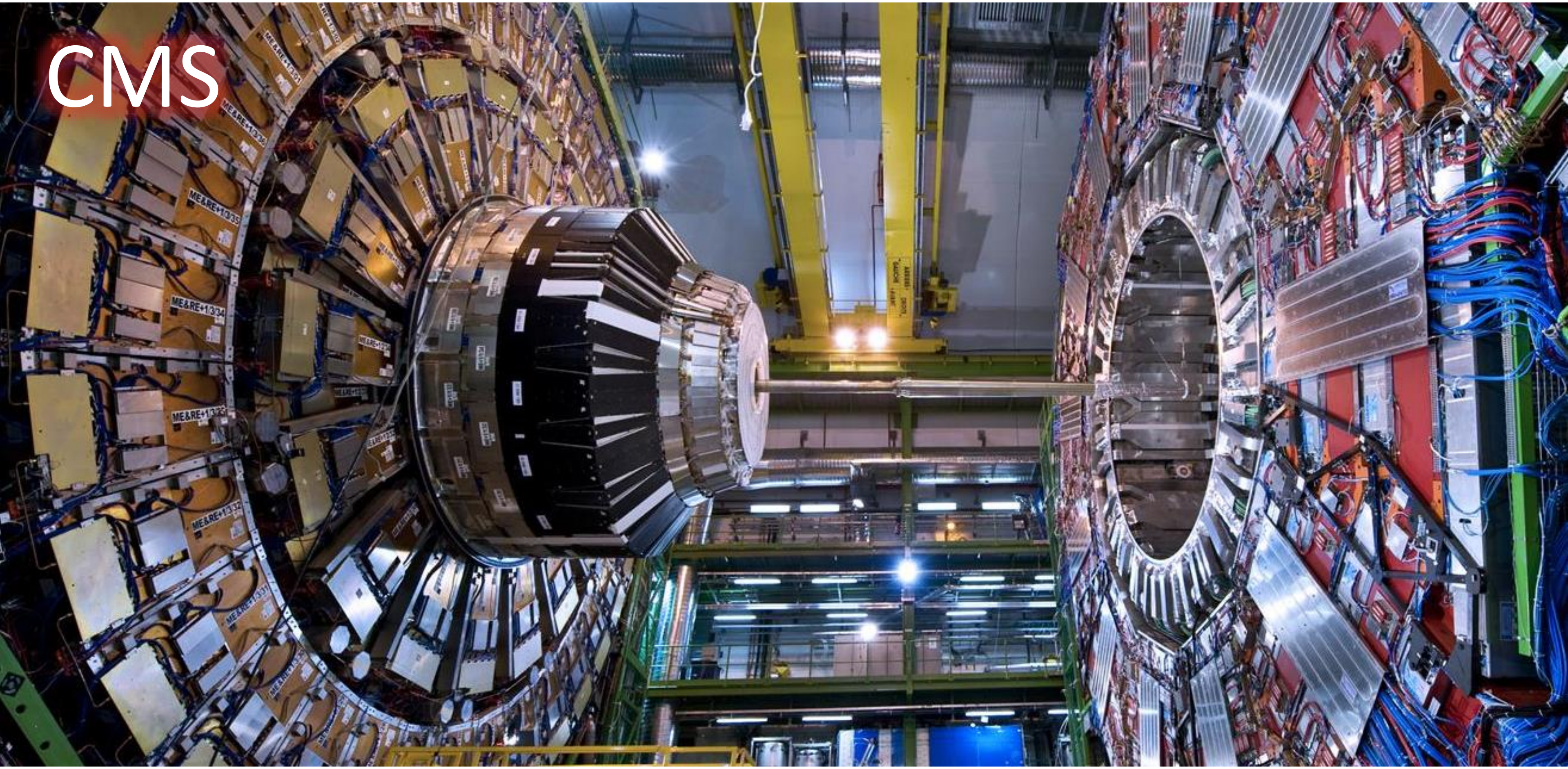
# Detecting particles

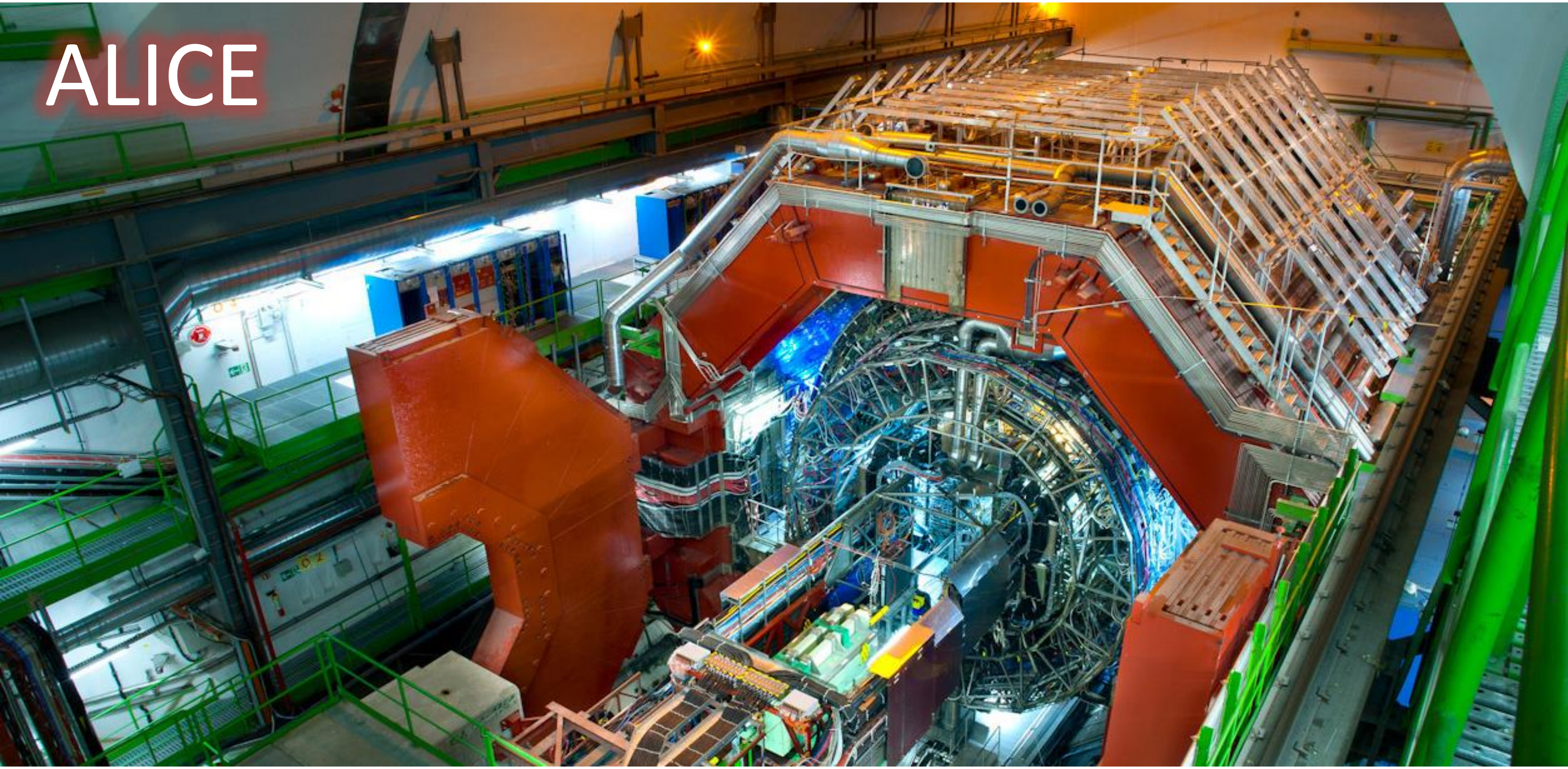


Detectors:

- size of ATLAS: ~ half Notre Dame cathedral
- weight of CMS experiment: 13000 tons (more than Eiffel Tower)
- number of detector sensitive elements: 100 millions
- cables needed to bring signals from detector to control room: 3000 km
- data in 1 year per experiment: ~10 PB (20 million DVD; more than YouTube, Twitter)

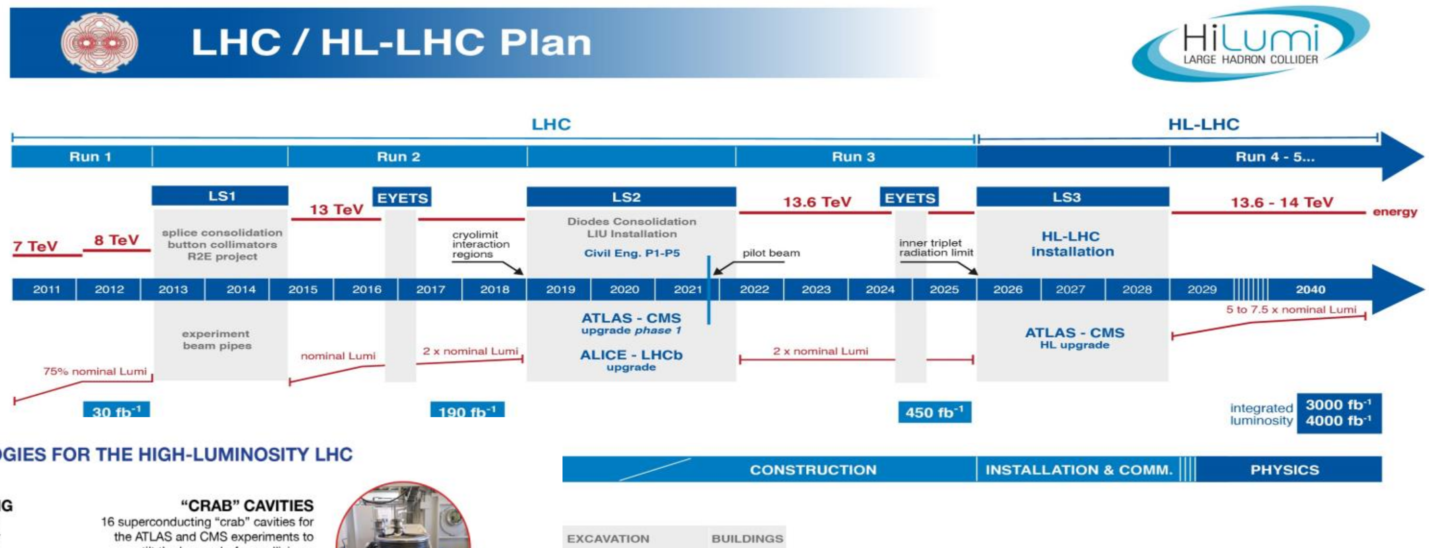

ATLAS

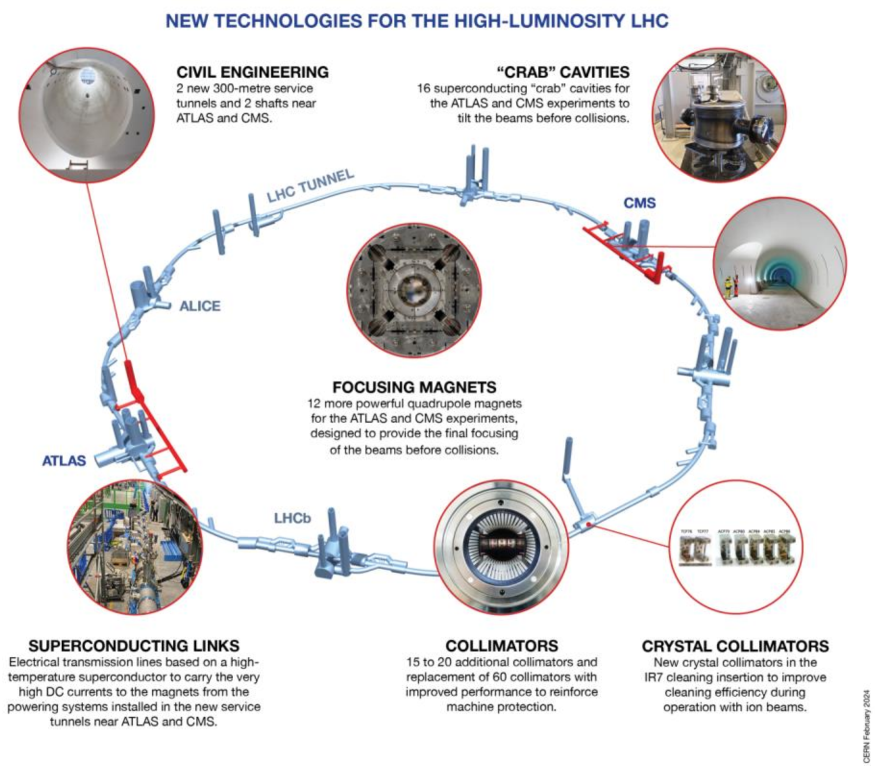

CMS


ALICE


LHCb

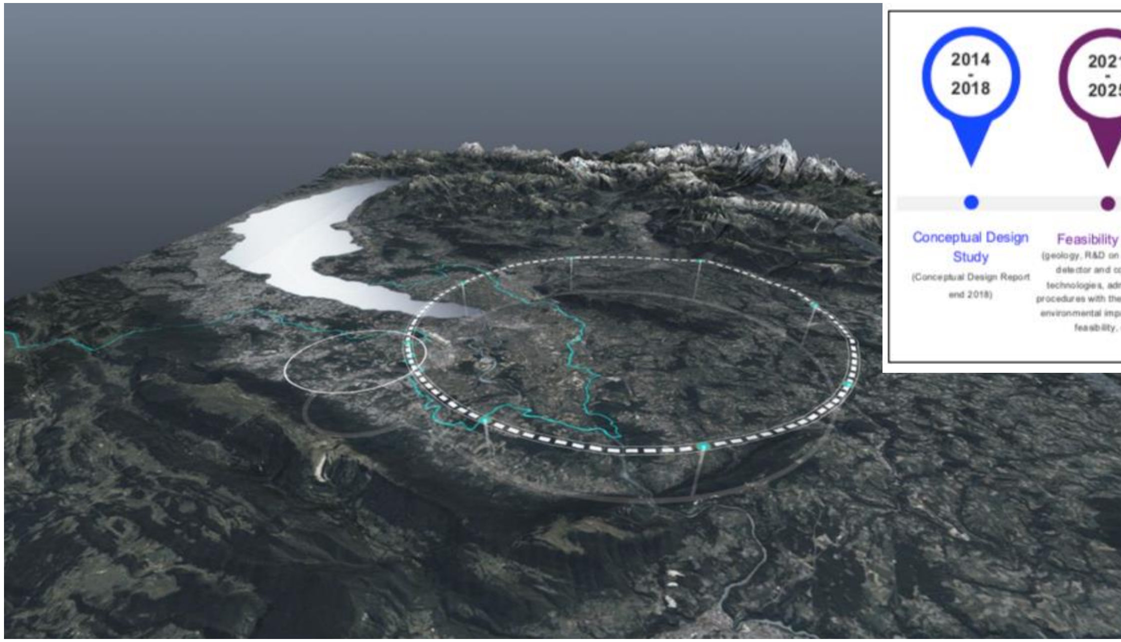
# Medium term future: HL-LHC

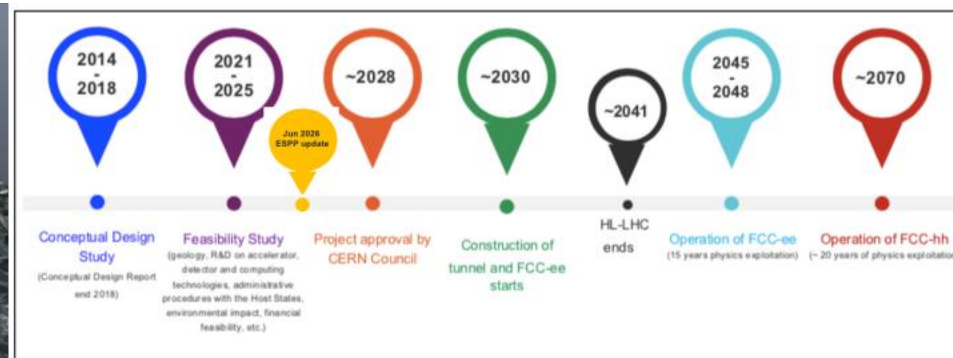


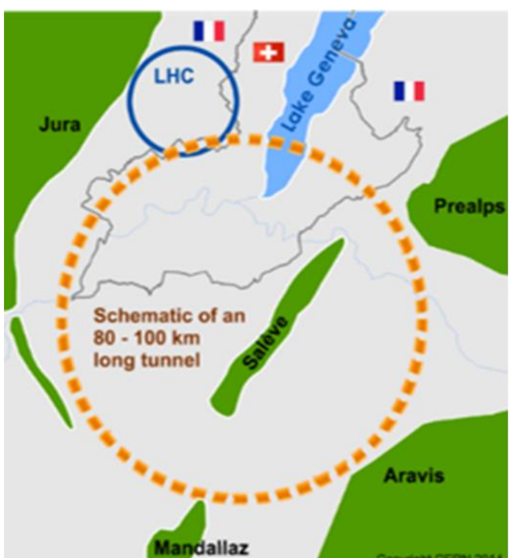

The High-Luminosity LHC will increase the number of collisions by a factor of between 5 and 7.5 with respect to the nominal LHC design and will produce more than 250 inverse femtobarns of data per year ($1fb^{-1}$ of integrated luminosity equates to 100 million million collisions)

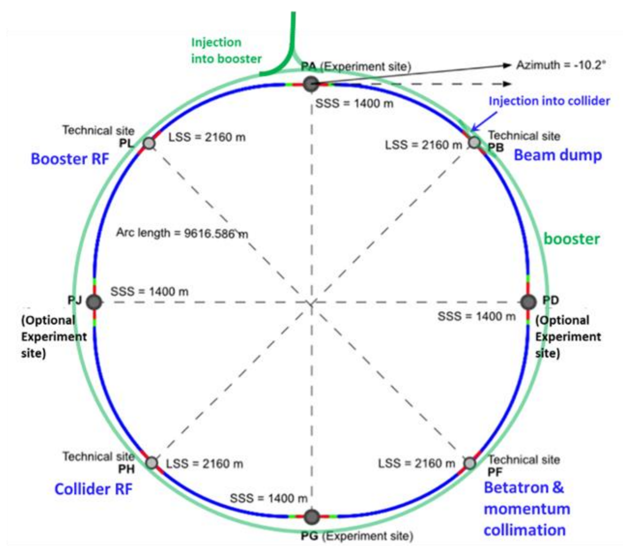
# Long term future: FCC-ee and FCC-hh

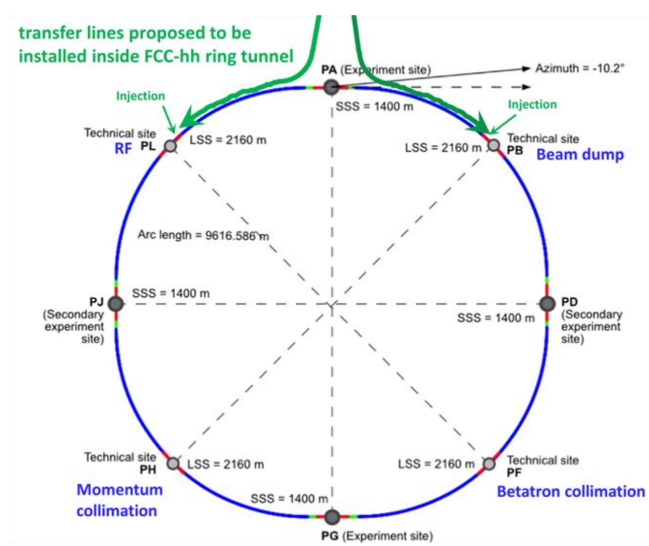





**1st stage collider FCC-ee**:
electron-positron collisions 90-360 GeV:
electroweak and Higgs factory
**2nd stage collider FCC-hh**:
proton-proton collisions at ~ 100 TeV

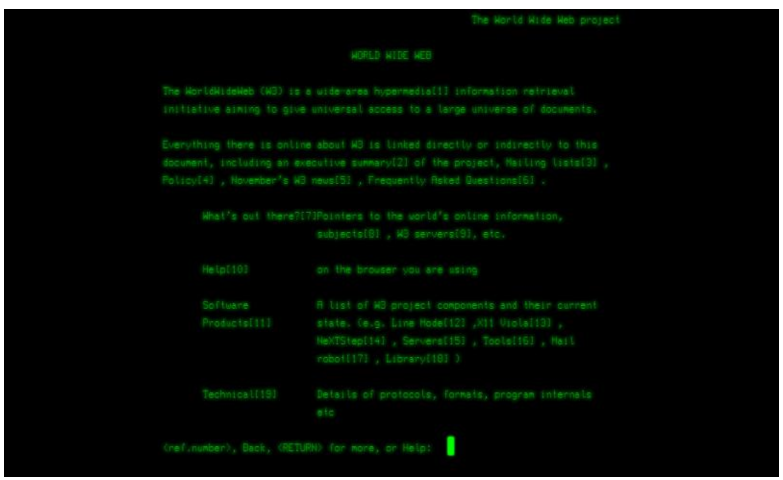


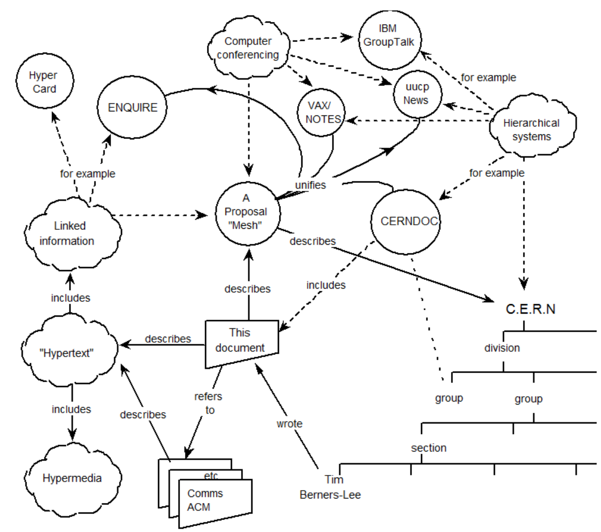



# How can CERN have an impact beyond fundamental physics?

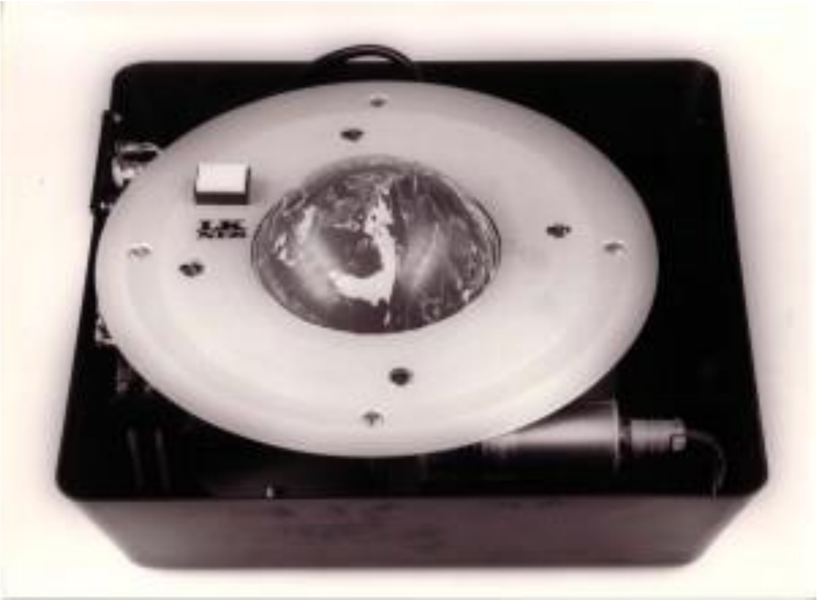
# Where the World Wide Web was born



# Not always a trivial process…

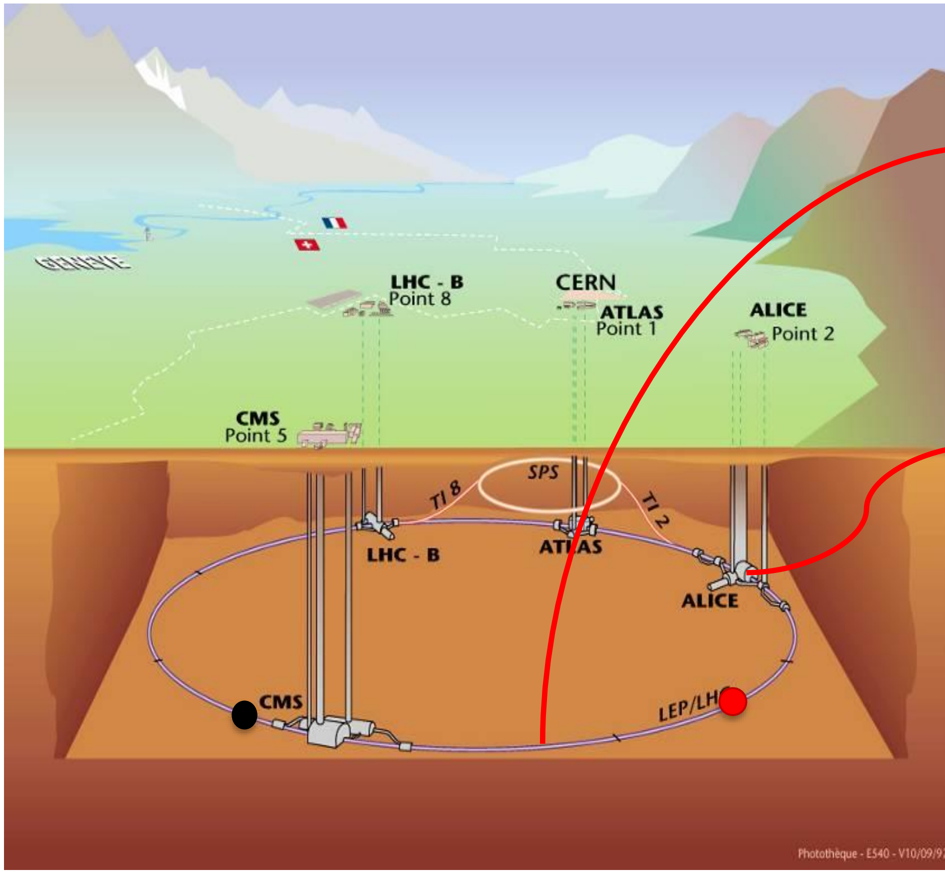
First «Touch-Screen»



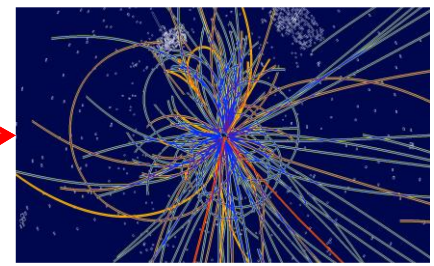
First «Mouse»

# CERN – Knowledge Transfer Ecosystem

# Key competences in cutting edge technologies for extreme environments



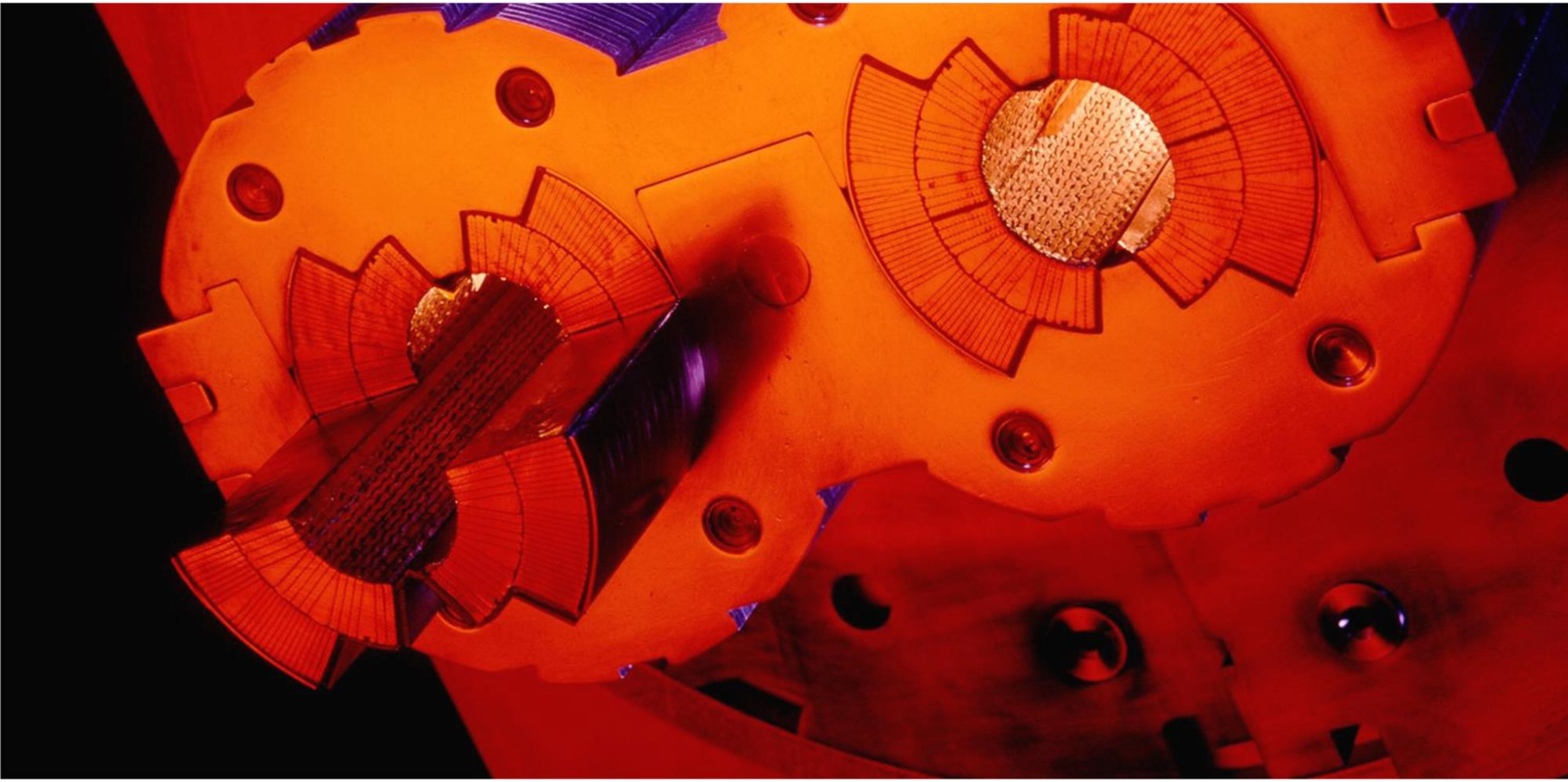

Accelerating particle beams



Detecting particles

Large-scale computing (Grid)

# Very high vacuum

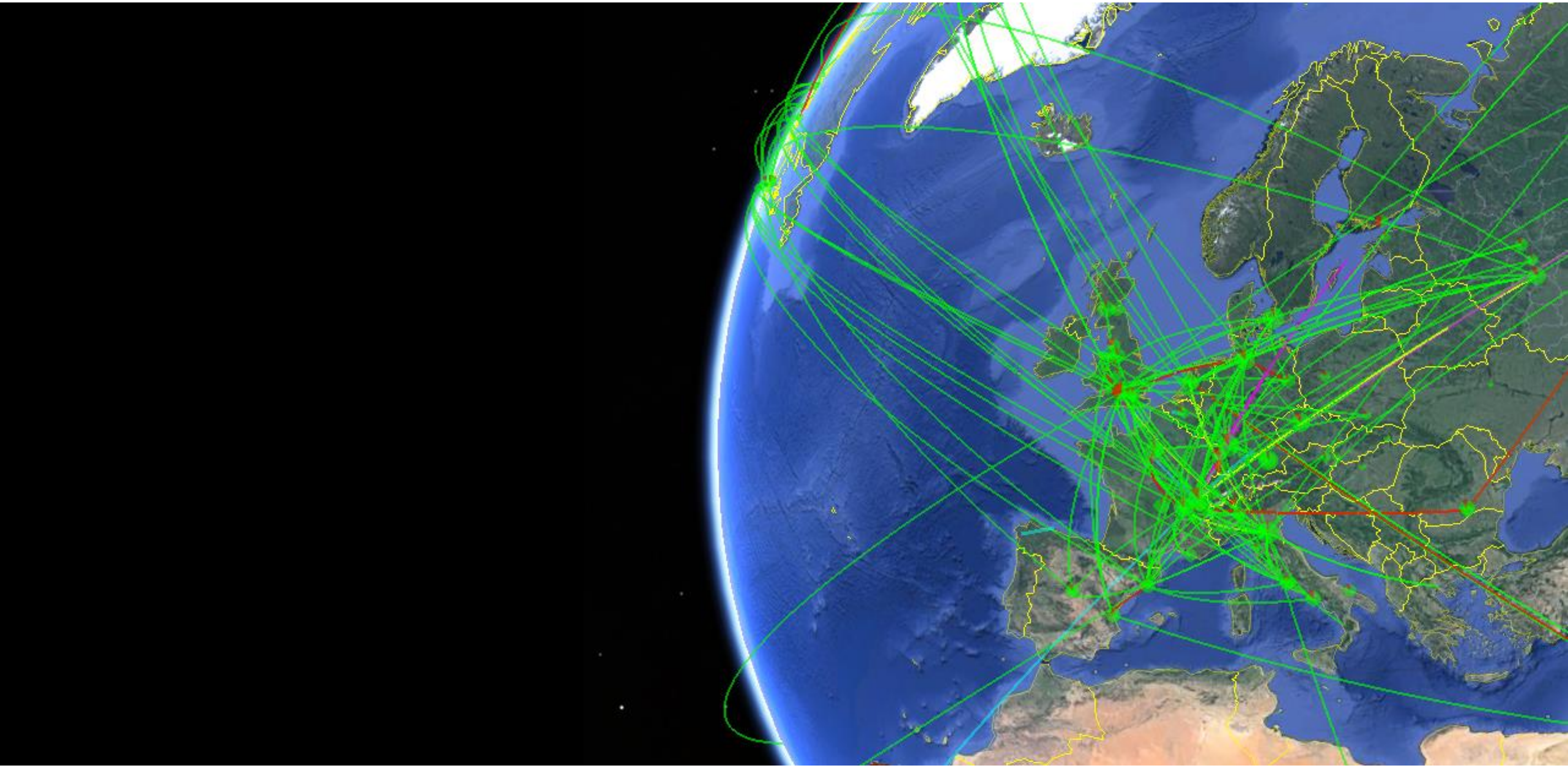


# *Extreme temperatures*

# Radiations

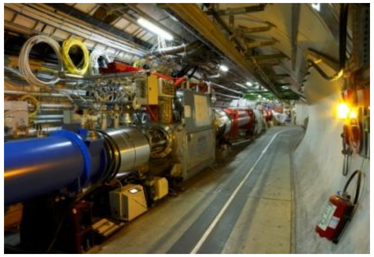

RADIATION
ZONE
SURVEILLÉE
SUPERVISED
AREA
Dosimeter obligatory
Dosimètre obligatoire
Radiation Protection
Radioprotection
72504

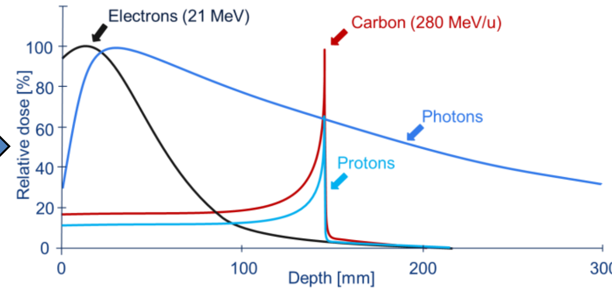
# *Big data*

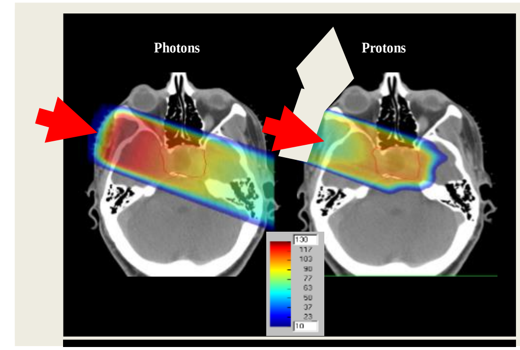


# Medical Applications

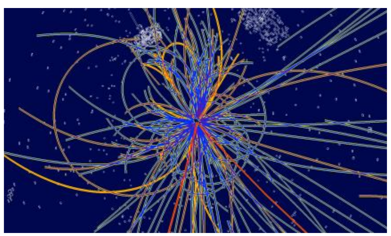
## Particle accelerators for hadron therapy

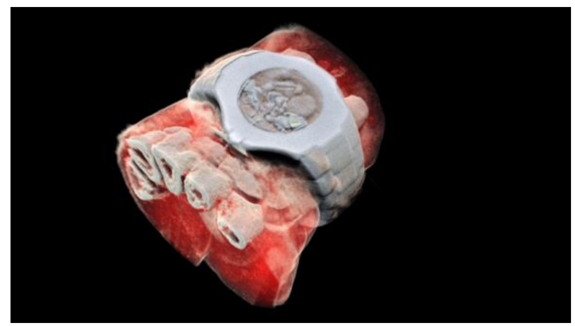


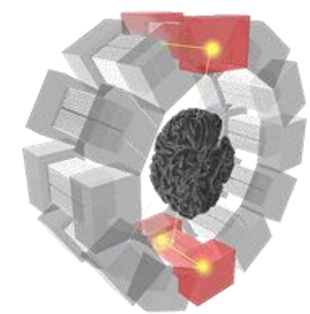


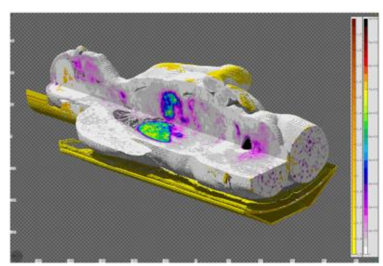

## Particle detectors for medical imaging

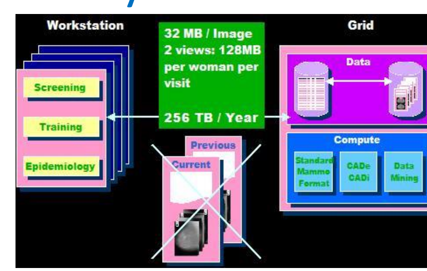




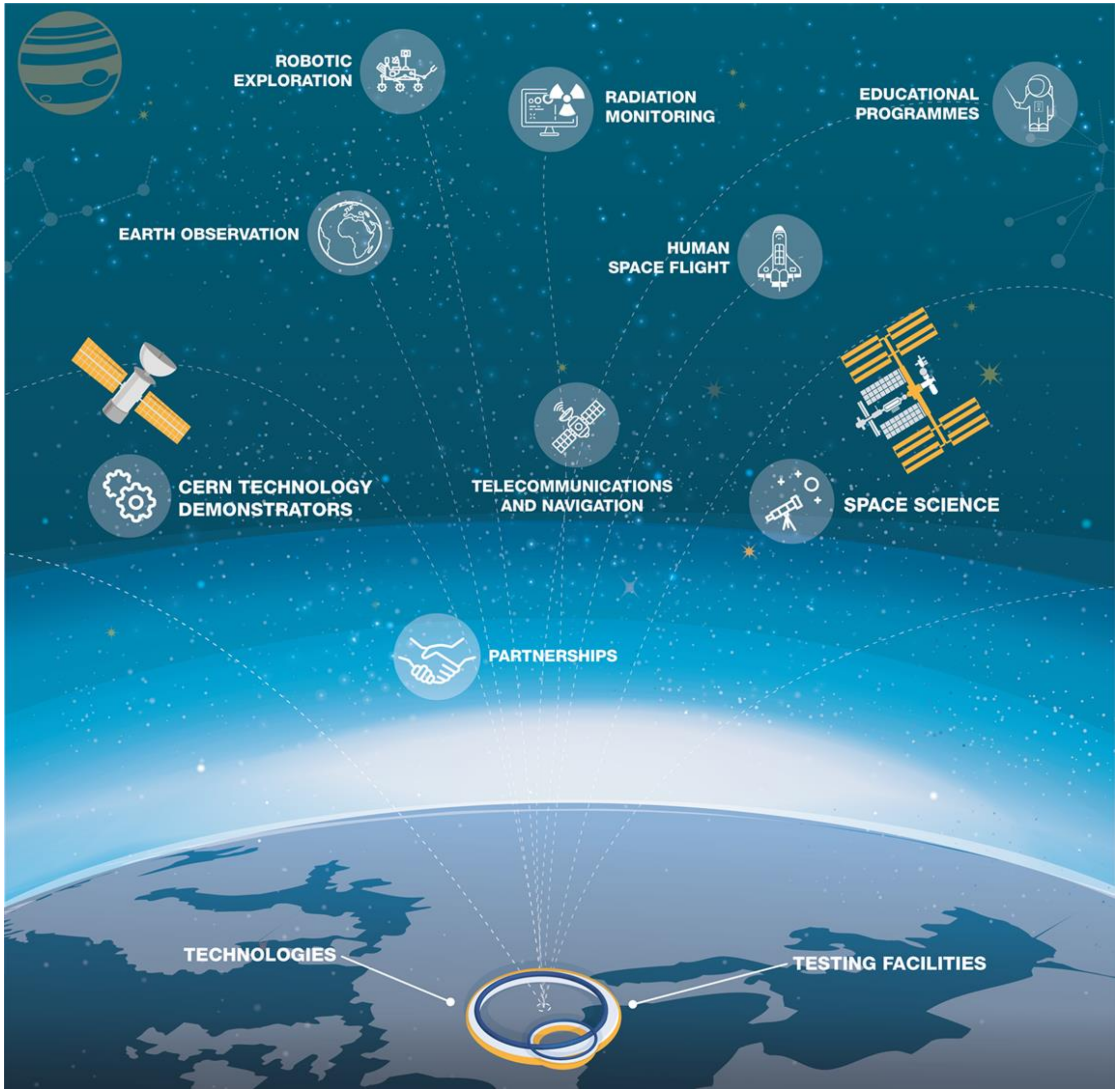


## Computing for simulations and medical data management and analysis

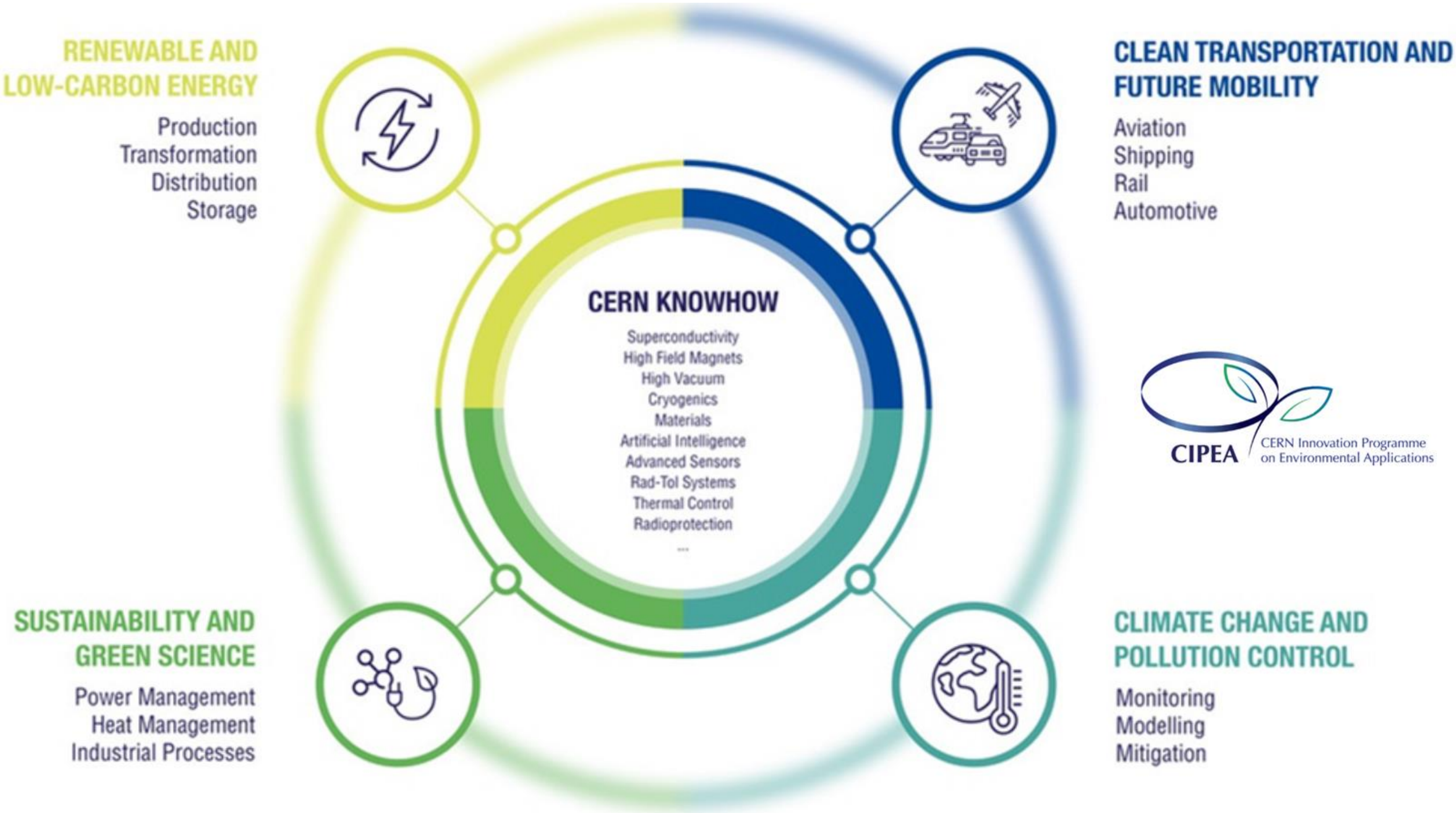




# Aeropace Applications



# Environmental Applications



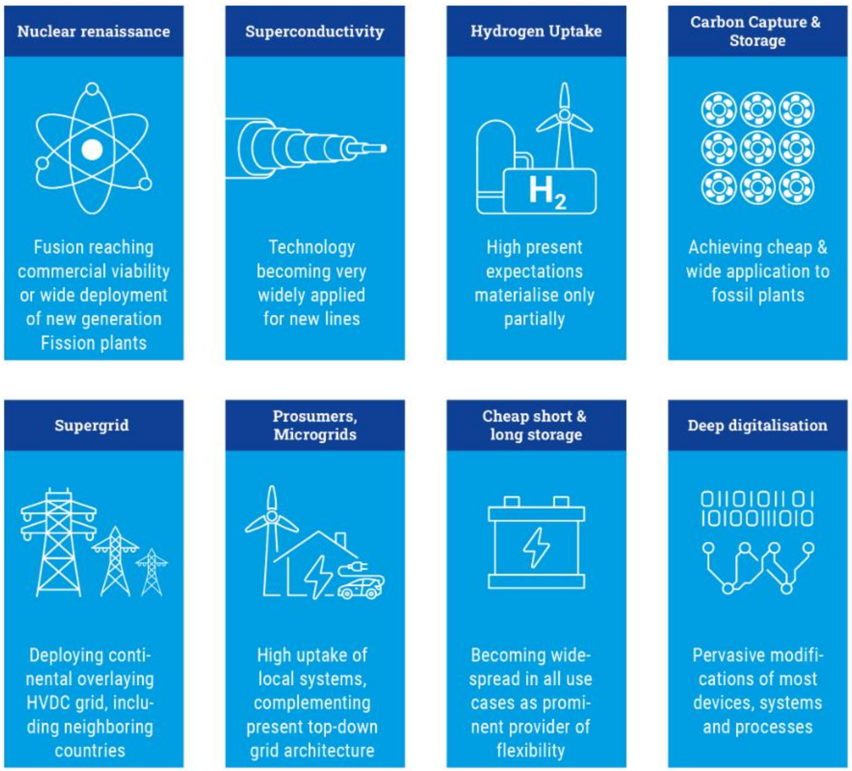
# Highest Priority CERN Poles of Competence in Environmental Applications

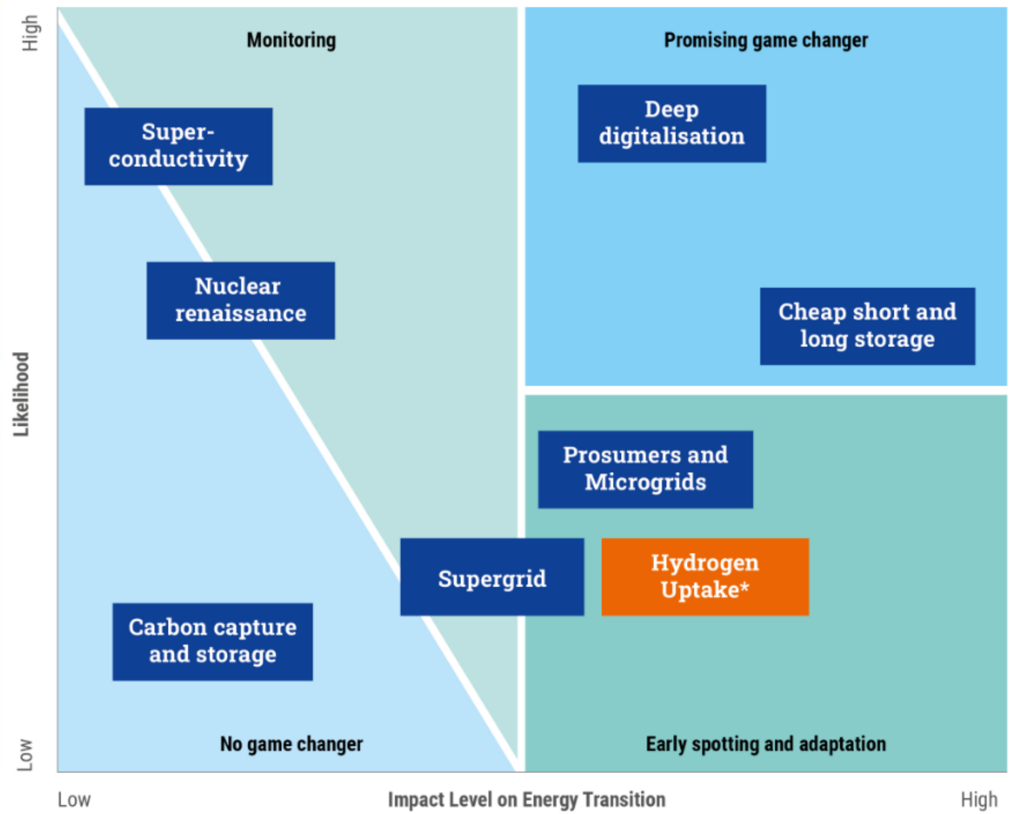
| | |
|---|---|
| **Compact Magnetic Confinement Fusion Energy Systems** | **SC Lines for On-board and Grid Power Distribution** |
| Accelerator Driven and Advanced Nuclear Reactors | Liquid Hydrogen Storage and Handling Systems |
| **Engineering Systems Optimized for Low Emissions and Energy Efficiency** | **Instruments and Facilities for Remote and In-situ Environmental Monitoring** |
| Fast, Low-power Computing Techniques based on AI | AI Platforms for Global Phenomena Modelling and Climate Simulations |

CIPEA
CERN Innovation Programme on Environmental Applications

# ENTSO-E Vision: A Power System for a Carbon Neutral Europe

entsoe



Entso-E Research, Development, and Innovation Committee (RDIC) WG5

12–13 Sept 2024
CERN
Europe/Zurich timezone

Enter your search term

# CERN contributions to the agenda

White Rabbit

SCADA Modular

Digital Twins

Web Energy


Statnett
The future is electric

# Thanks for your attention!

https://kt.cern/


https://knowledgetransfer.web.cern.ch/news/news/knowledge-sharing/statnett-and-cern-collaborate-embrace-innovative-energy

CERN Knowledge Transfer
Accelerating Innovation

CIPEA CERN Innovation Programme on Environmental Applications