



# **Welcome & Introduction to CERN**

## **White Rabbit Collaboration Inauguration**

Dr. Rhodri Jones - Head of the CERN BEAMS Department

Friday 22<sup>nd</sup> March 2024

**13<sup>th</sup> White Rabbit Workshop and White Rabbit Collaboration Launch**

# CERN: Particle Physics, Innovation & Education



- Interfacing between fundamental science and key technological developments



- Driving innovation while educating the next generation of scientists & engineers



Particle Accelerators



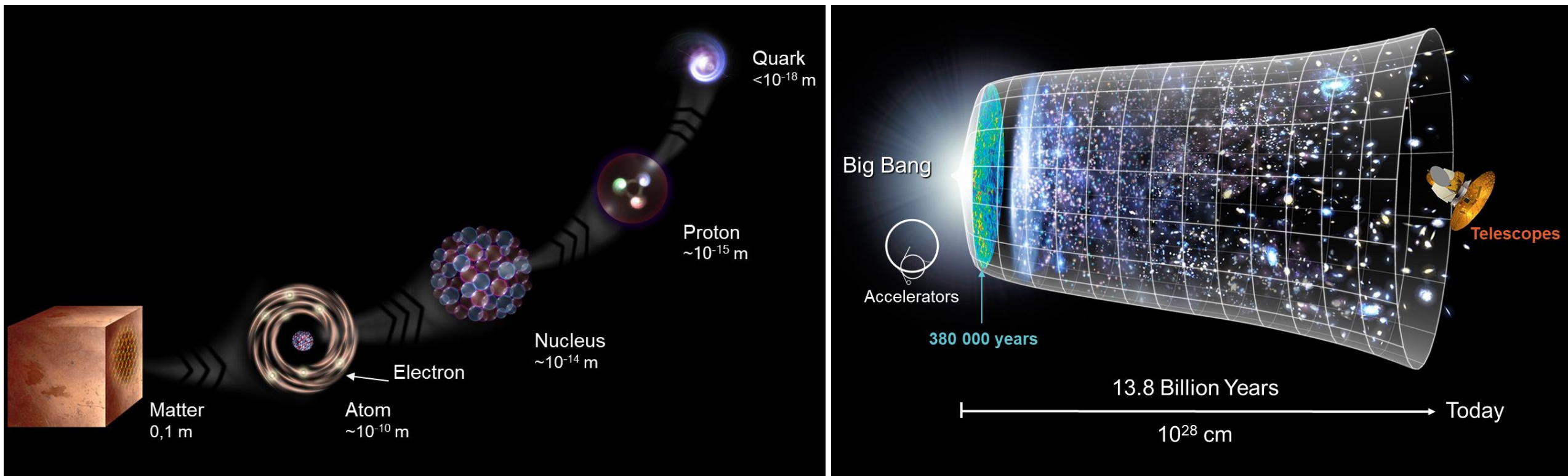
Particle Detectors



Large-scale computing (Grid)

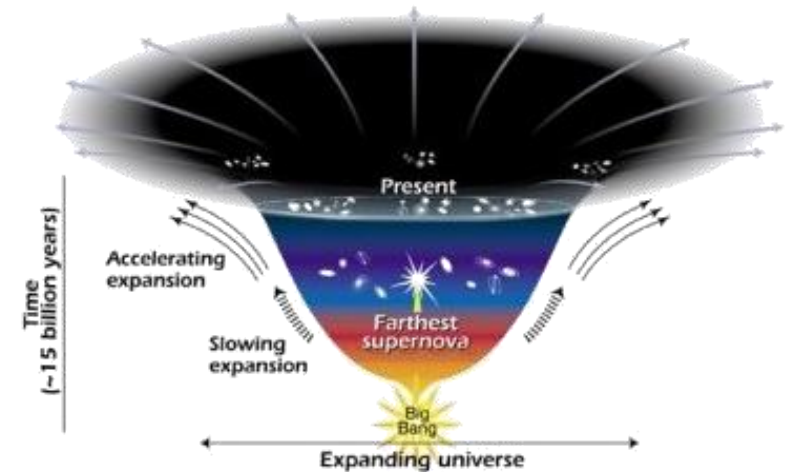
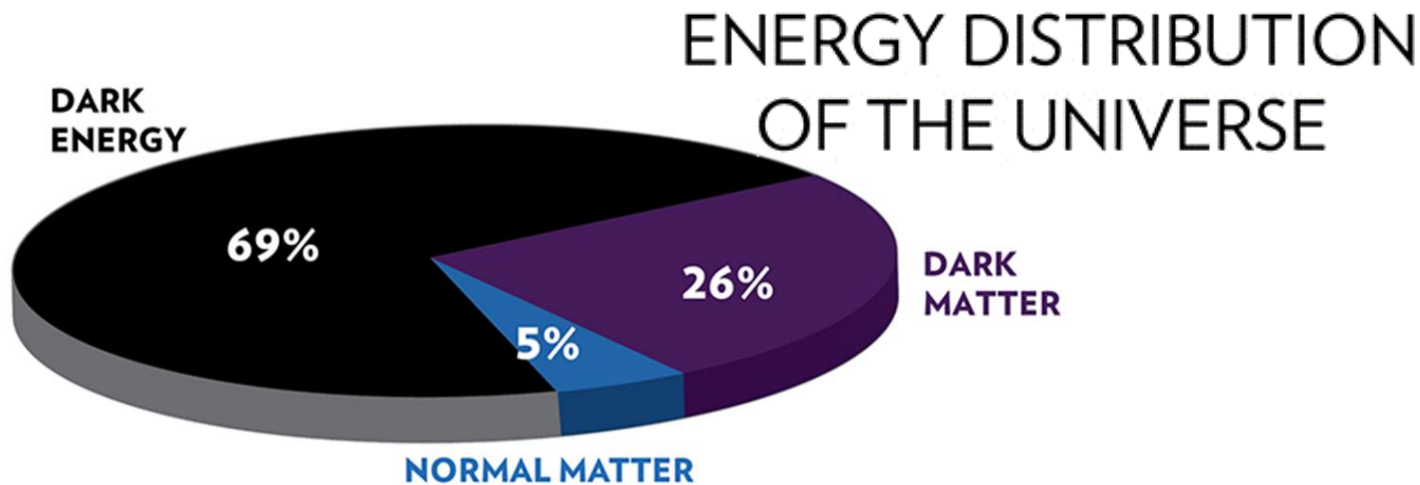
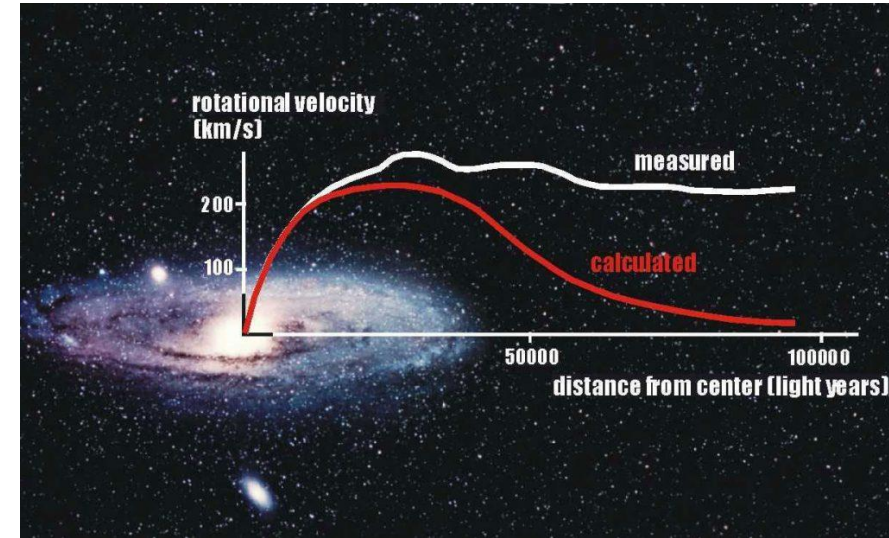
# CERN: Our Mission

- To study the elementary building blocks of matter & forces that control their behaviour
- In so doing we reproduce the conditions a fraction of a second after the Big Bang, allowing us to gain insight into the structure and evolution of the universe



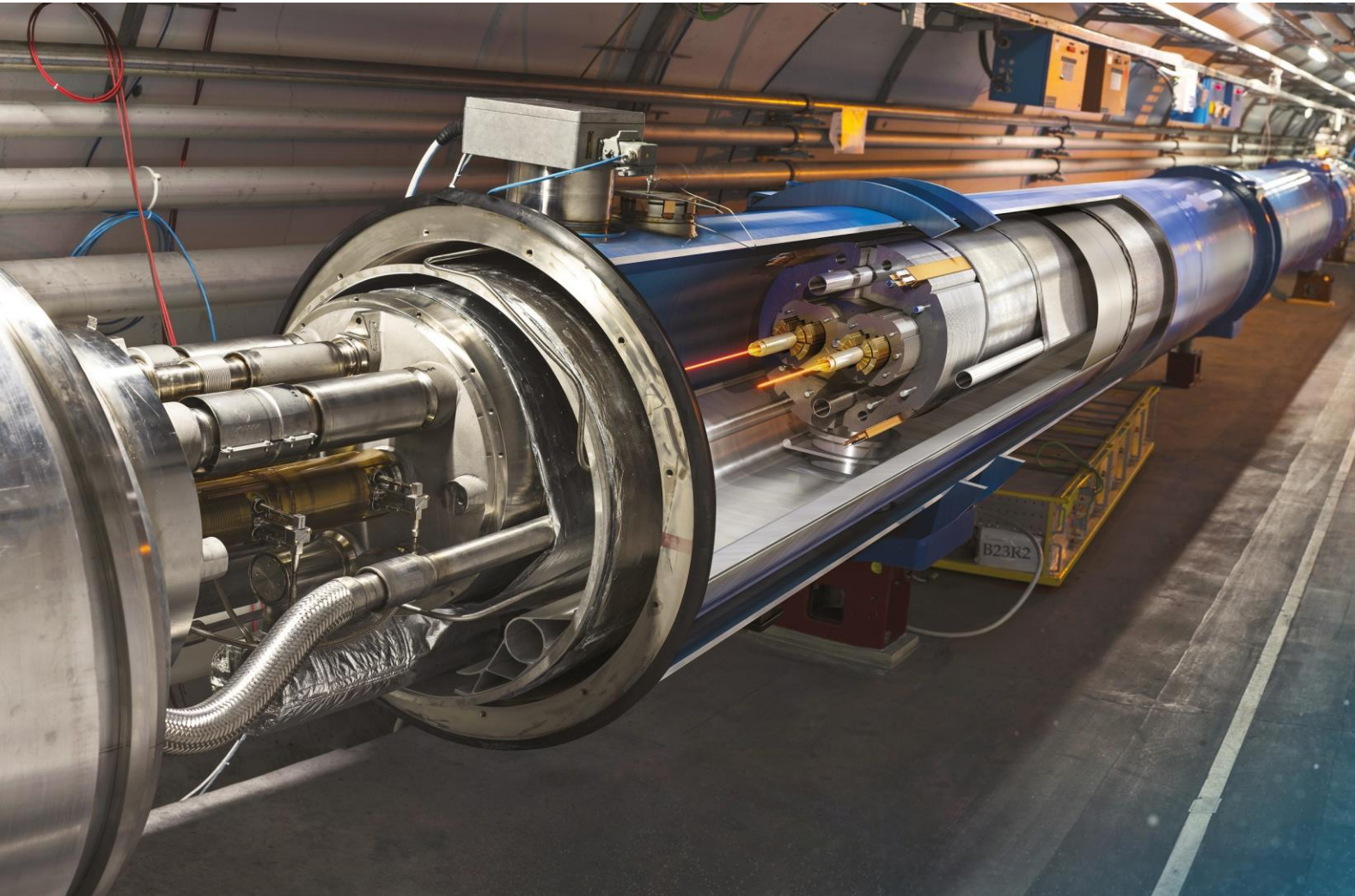
# The Questions we are Trying to Answer

- **What is Dark Matter?**
  - Introduced to explain cosmological phenomena that cannot be explained taking into account only ordinary matter
- **What is Dark Energy?**
  - Introduced to explain accelerating expansion of the universe
- **Why is there a matter / antimatter asymmetry?**



# Particle Accelerators and their Detectors:

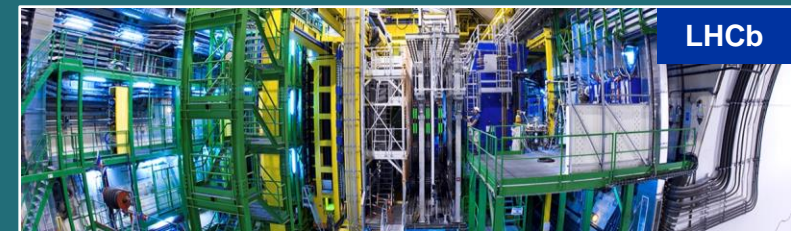
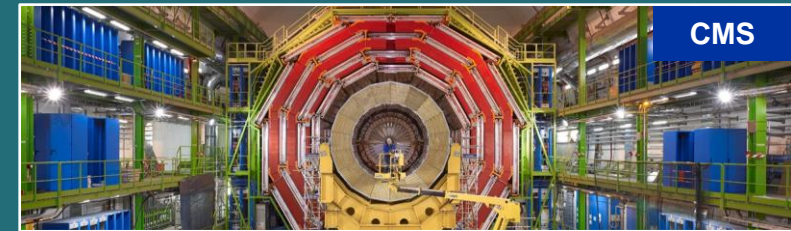
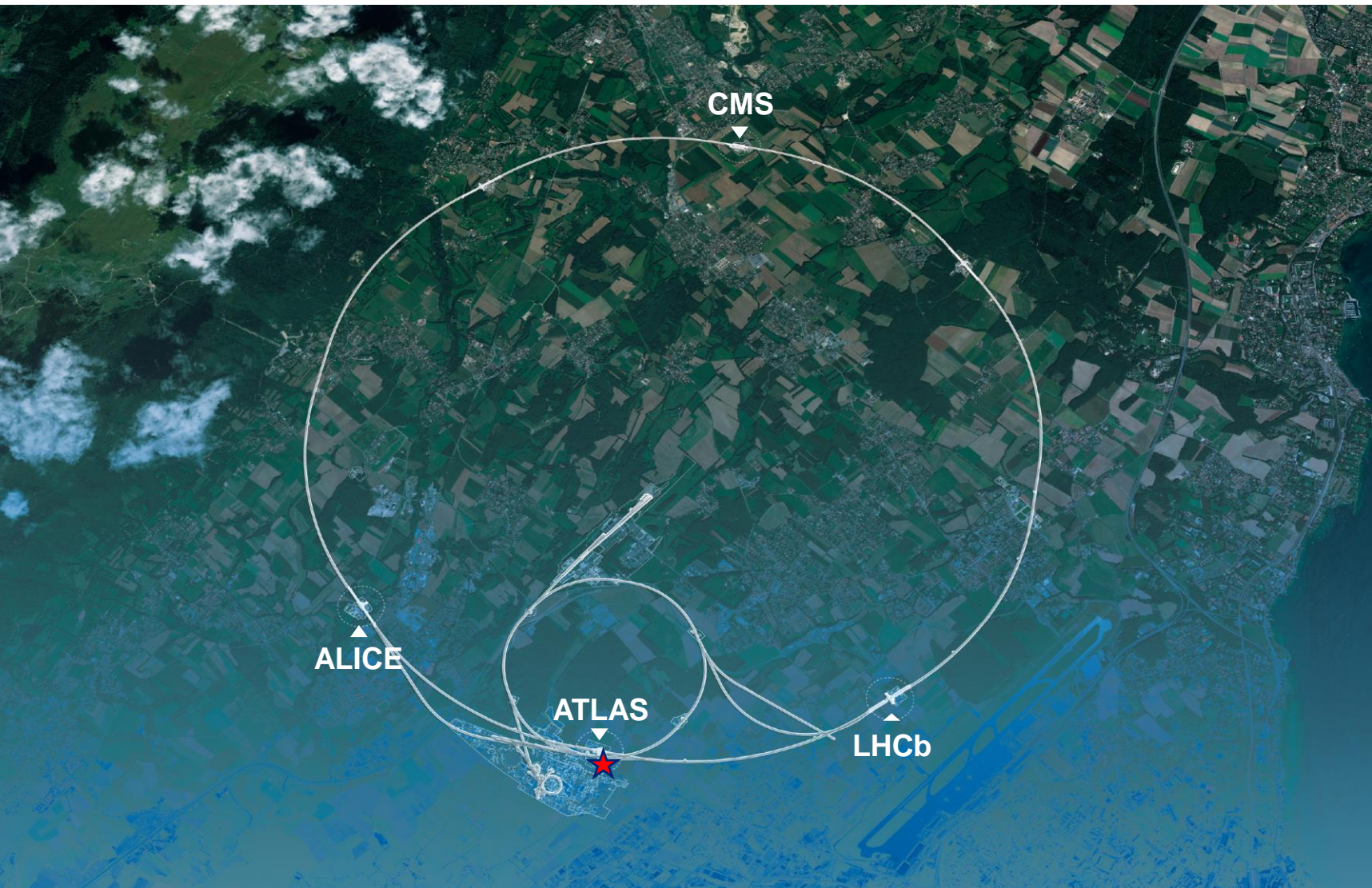
## The tools of choice at CERN to explore these questions



### The Large Hadron Collider

- 27 km in circumference
- About 100 m underground
- 2 beams of trillions of protons travelling at 0.999999991 times the speed of light in opposite directions
- Superconducting radiofrequency system to accelerate the beams
- NbTi Superconducting magnets operating at - 271.3 °C to bend them in a circle
- Largest beam vacuum system worldwide
- Advanced powering, machine protection systems, beam diagnostics & control
- 4 Large experiments

# The LHC and its Detectors

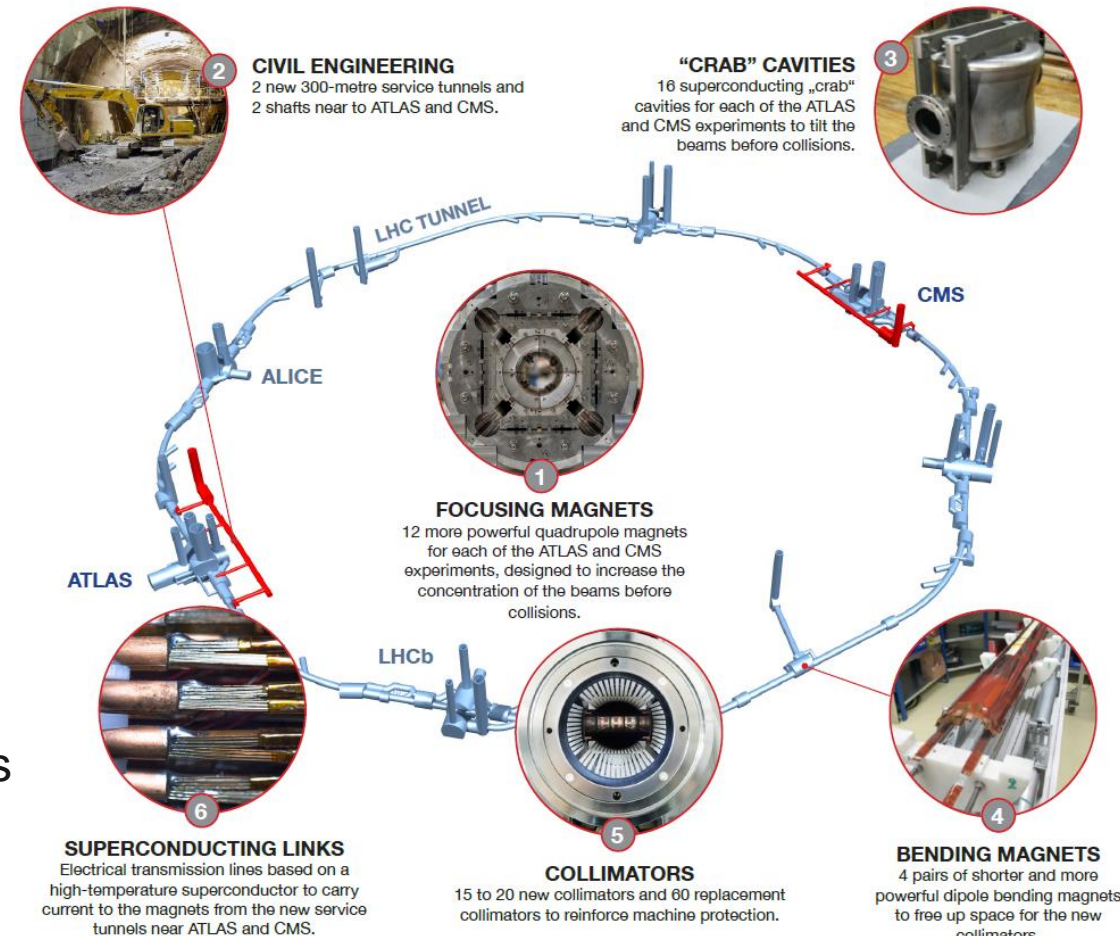


# Beyond LHC – Already Underway



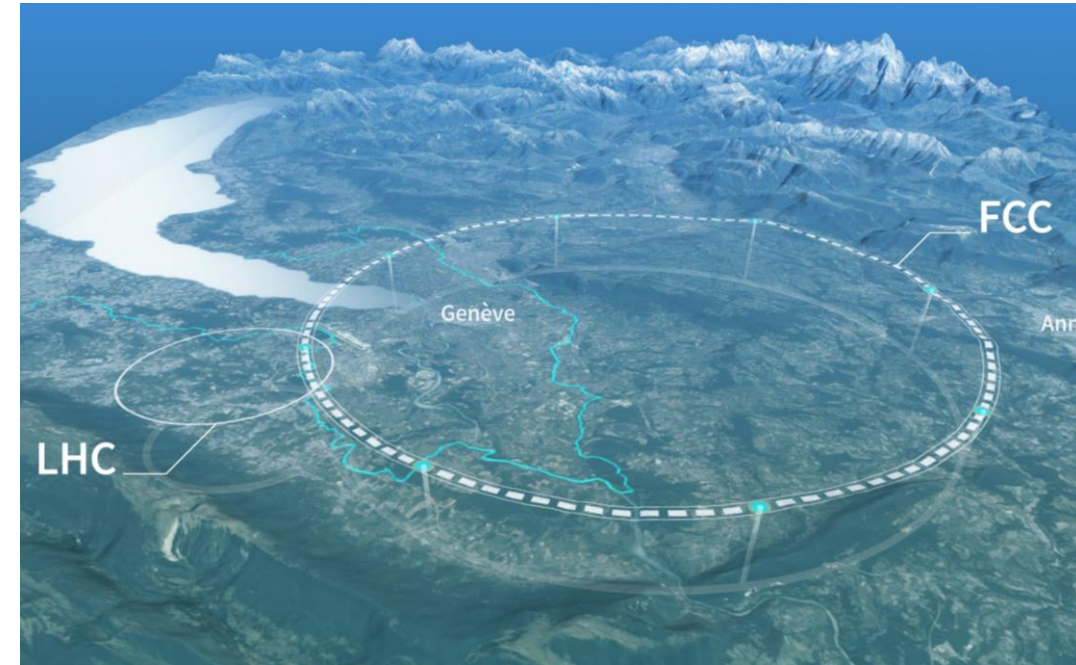
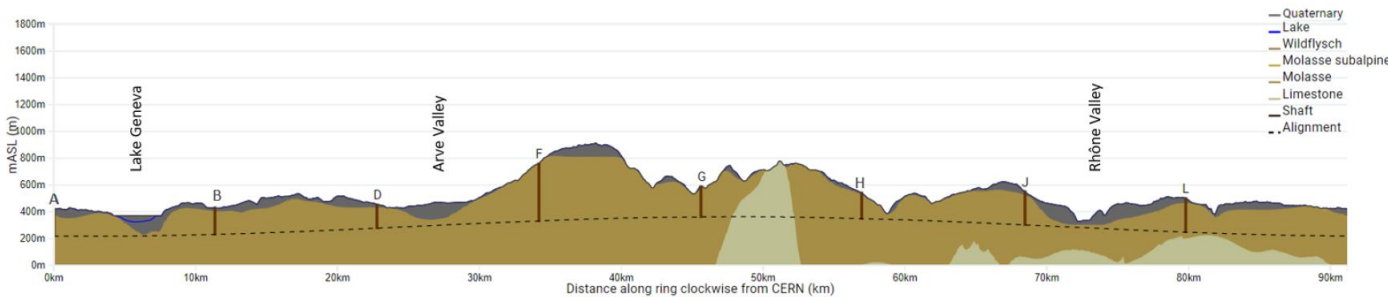
- **The High Luminosity Large Hadron Collider (HL-LHC) – to be completed in 2028**

- A 1 billion CHF upgrade of the LHC to achieve a five-fold increase in the number of instantaneous collisions, enabling the experiments to enlarge their data sample by an order of magnitude compared with the LHC baseline programme
- **Key innovative technologies include:**
  - **Move to White Rabbit timing**
  - Nb<sub>3</sub>Sn superconducting magnets
  - High-power, loss-less superconducting links
  - Compact superconducting radiofrequency cavities
  - New materials & coatings for beam intercepting devices
  - New dual phase CO<sub>2</sub> cooling technology for the experiments



# Beyond LHC – Future Possibilities

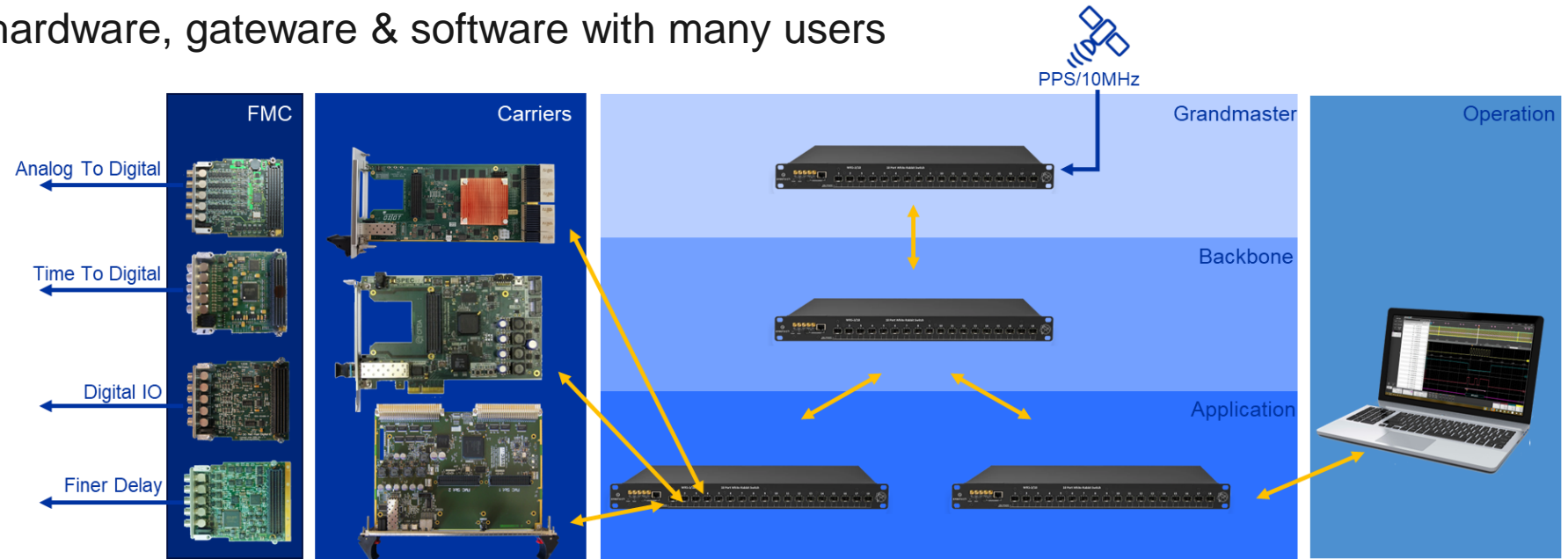
- **A Future Circular Collider – feasibility study underway**
  - Ultimate Goal: to push the energy frontier of particle colliders to reach 100 TeV (LHC at 13.6 TeV)
  - A 91 km ring linking to the CERN accelerator complex
    - First step: an electron positron collider to study the newly discovered Higgs Boson in detail in the 2040s
  - Key engineering challenges include:
    - Sustainable operation
    - Civil engineering for the tunnel & related infrastructure
    - Magnet technology to reach much higher field
    - Improved superconducting radio frequency acceleration





# High Accuracy Synchronised Timing Solutions

- **Sub-nanosecond synchronisation through ethernet – White Rabbit**
  - Developed at CERN and now standardised under IEEE1588
  - Fully open-source hardware, gateway & software with many users



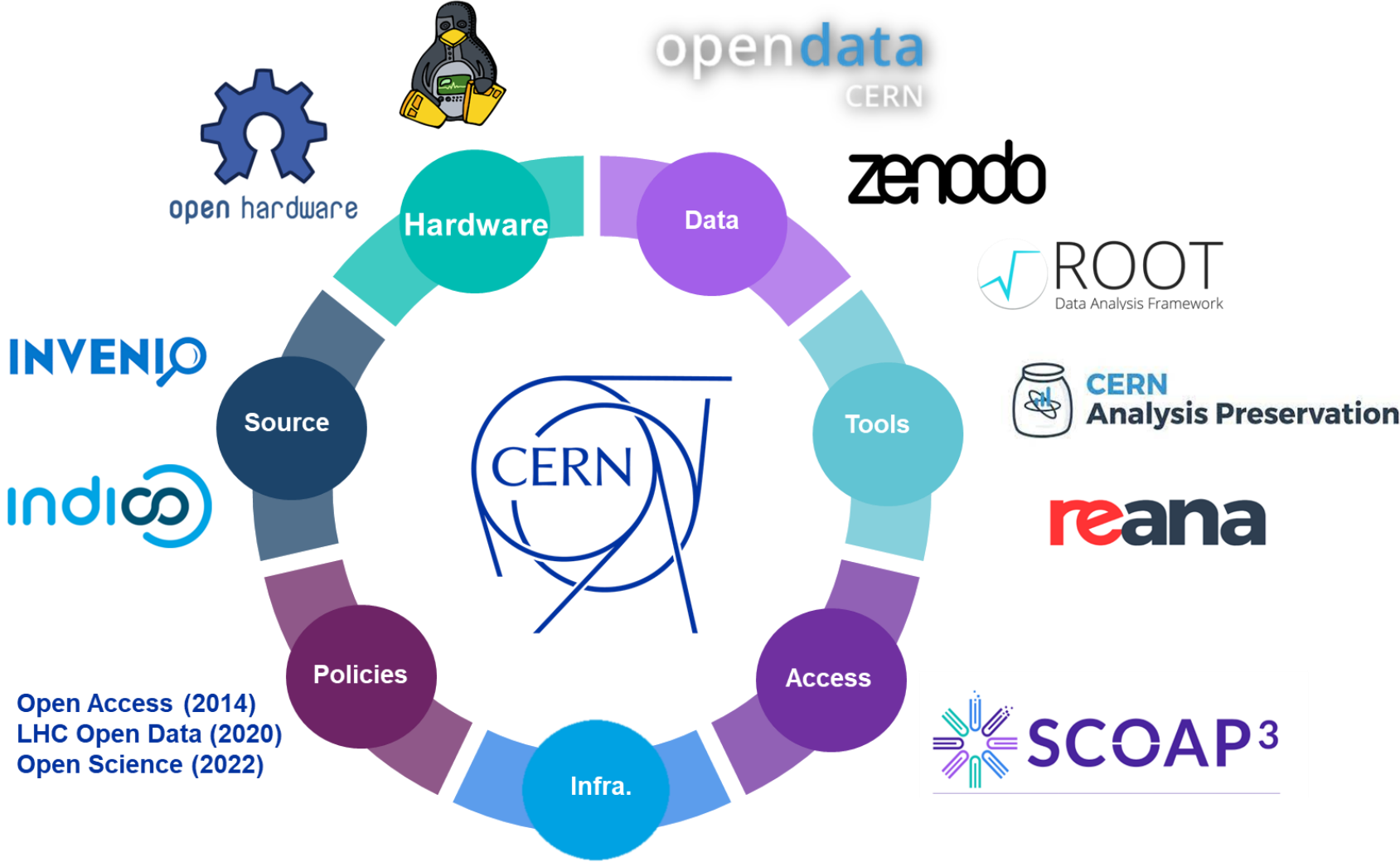
- **Initially developed for application within the accelerator community**
  - General synchronisation, [Radio Frequency](#) signal distribution, [Trigger Distribution](#)
- **Current Development**
  - [New WR switch](#) (v4)

# Open Science @ CERN

This Official Launch of the White Rabbit Collaboration cements White Rabbit as one of the great successes of the CERN Open Hardware Initiative



**White Rabbit**  
COLLABORATION





[home.cern](http://home.cern)