

Particle Physics, CERN and the Large Hadron Collider

Juan Rojo

St Aloysius Catholic Primary School
Oxford, 11/03/2015

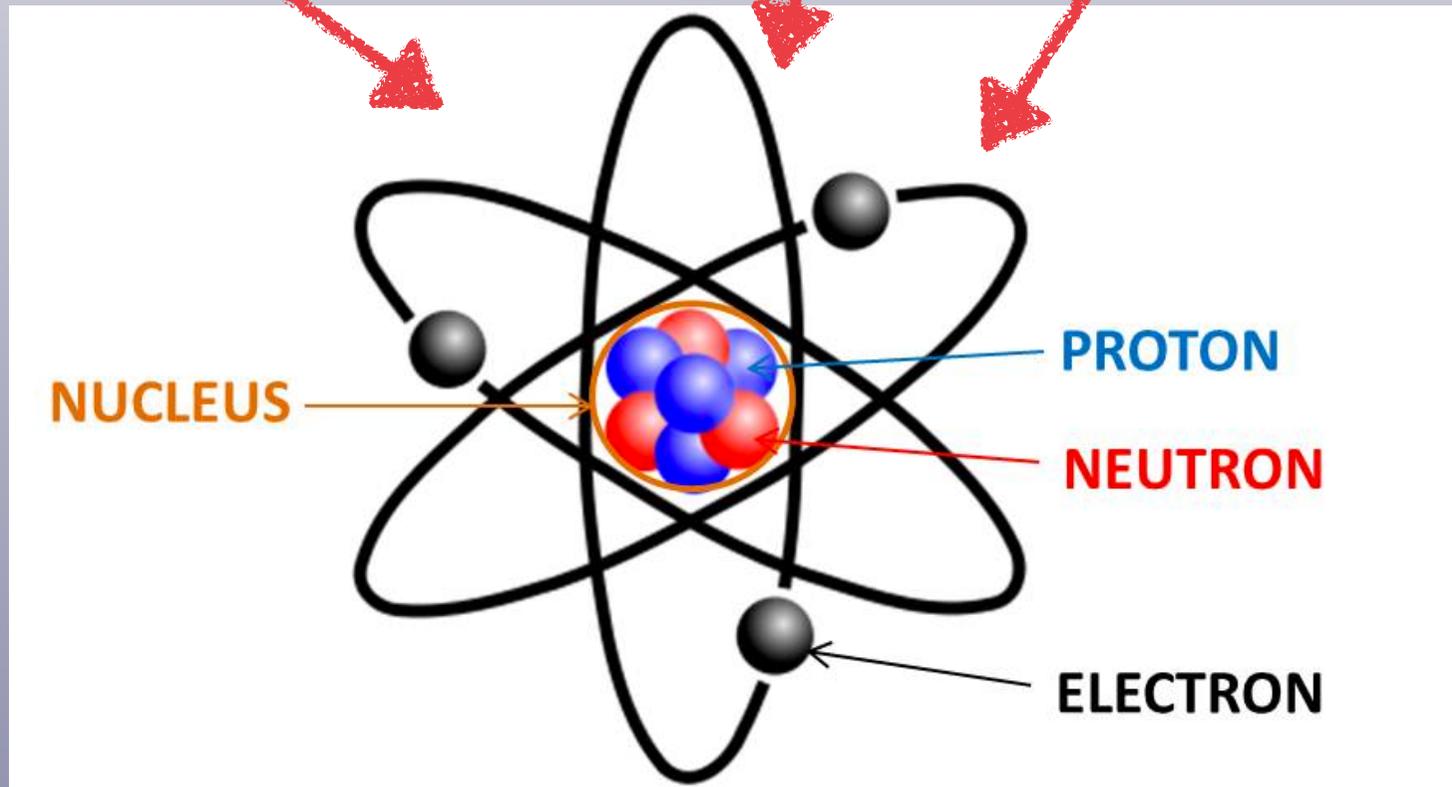
The Stuff of Matter

- ☑ A **table**, a **cell phone** and a **squirrel** look very different ... but ultimately, they are composed by the **same kind of building blocks**: we call them **atoms**



The Stuff of Matter

- ✓ A **table**, a **cell phone** and a **squirrel** look very different ... but ultimately, they are composed by the **same kind of building blocks**: we call them **atoms**



How small are atoms?



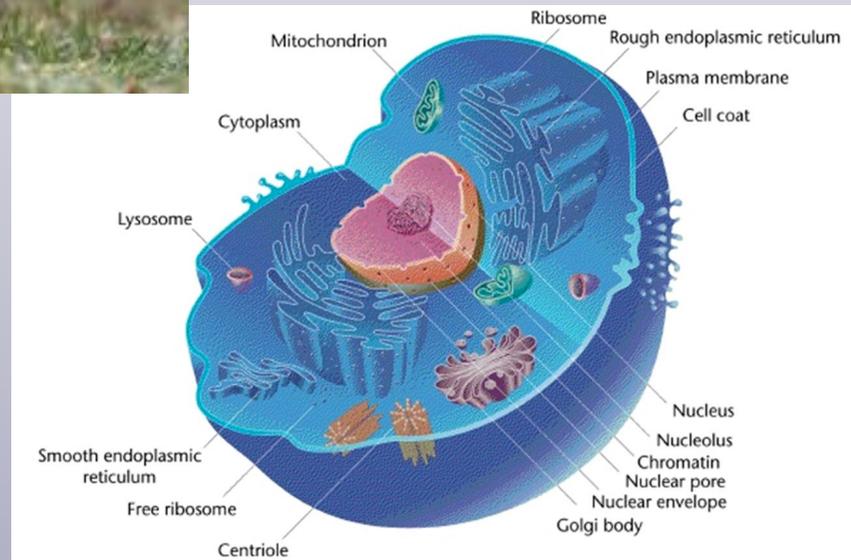
A squirrel has a length of **10 centimeters**

How small are atoms?



A squirrel has a length of **10 centimeters**

All animals are composed by **cells**, of size **10 micrometers: 10000 times smaller**

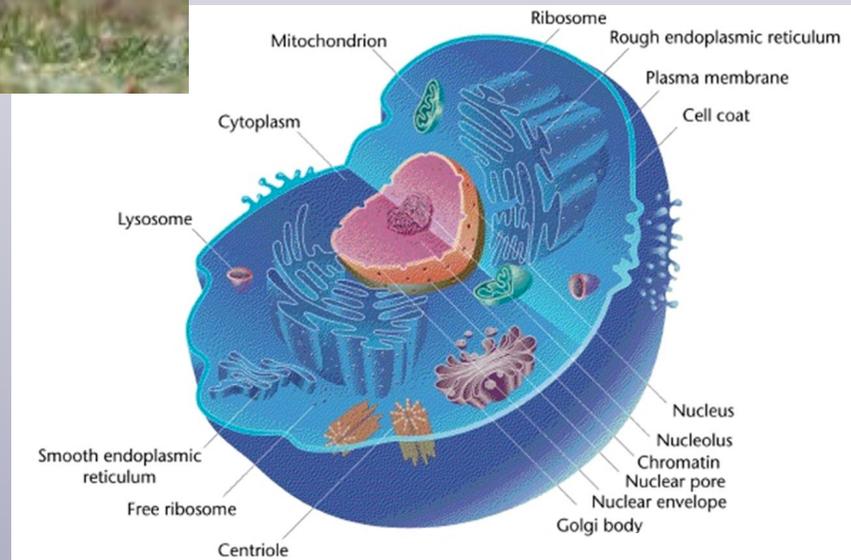


How small are atoms?

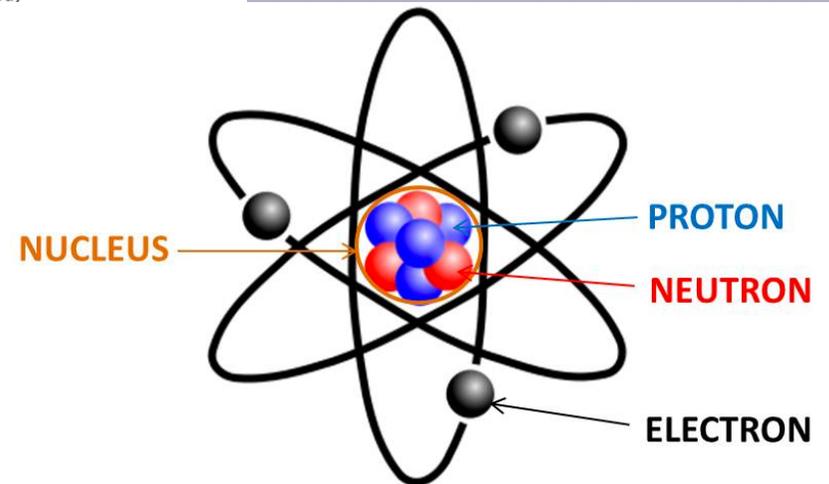


A squirrel has a length of **10 centimeters**

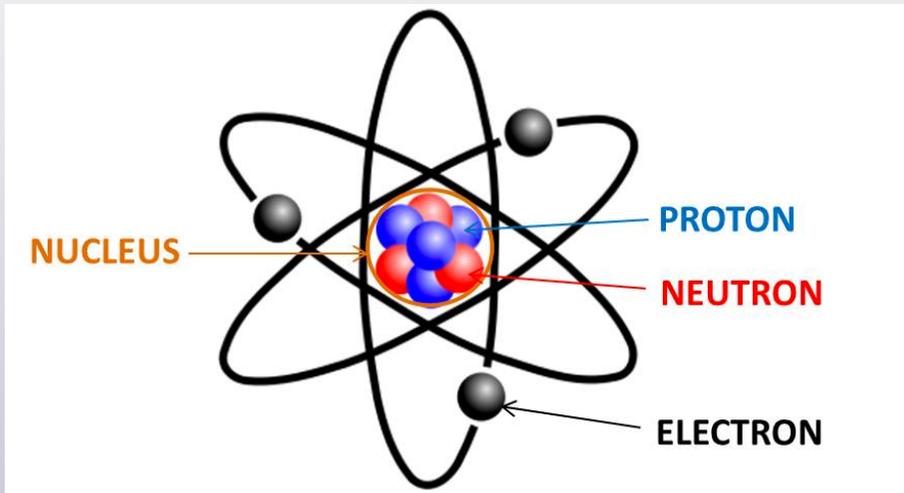
All animals are composed by **cells**, of size **10 micrometers: 10000 times smaller**



The size of an atom is **0.1 nanometers, 1000 million times smaller!** Atoms are really very very small!



From atoms to protons to quarks

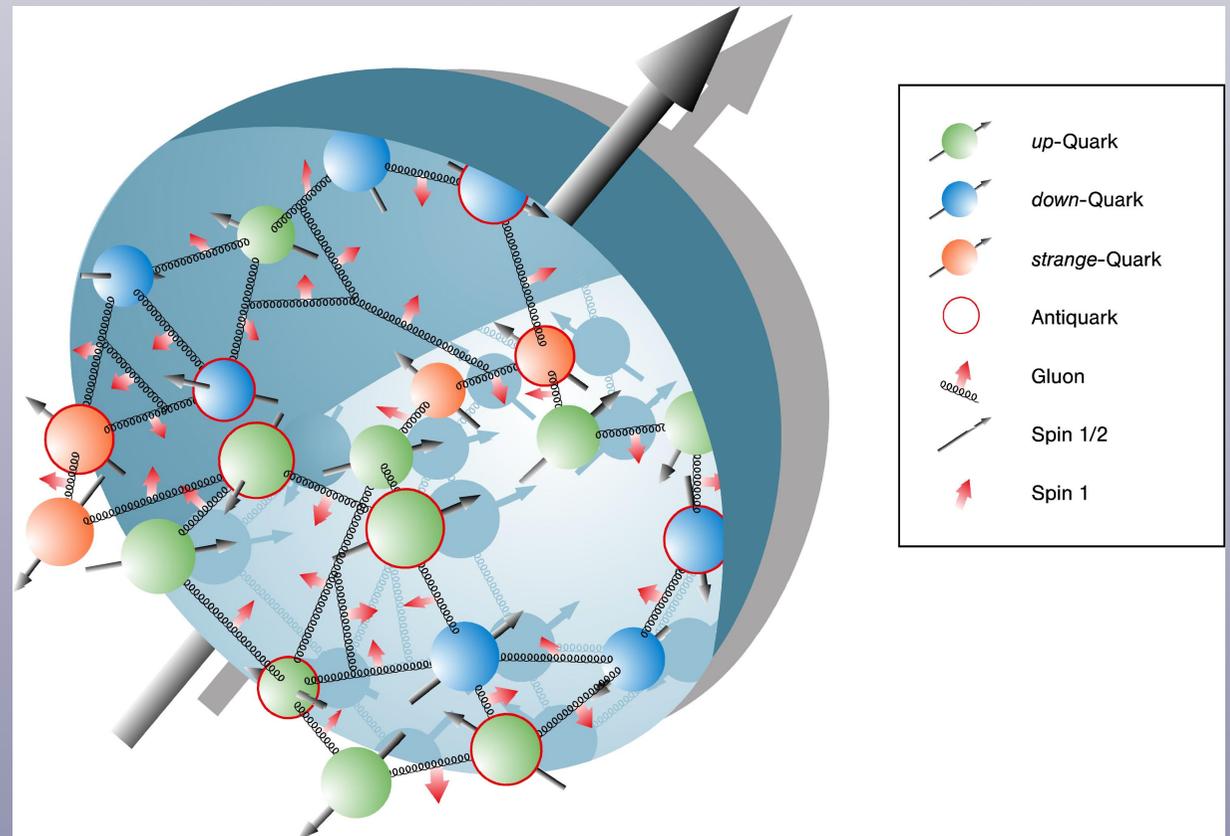


Atoms themselves have even smaller constituents: **protons, neutrons and electrons**

Protons are 10.000 times smaller than atoms!

Even the tiny protons have **smaller constituents**: we call them **quarks and gluons**

Are there **more, even smaller, particles** that we can find? We need to **build gigantic experiments** to answer this!

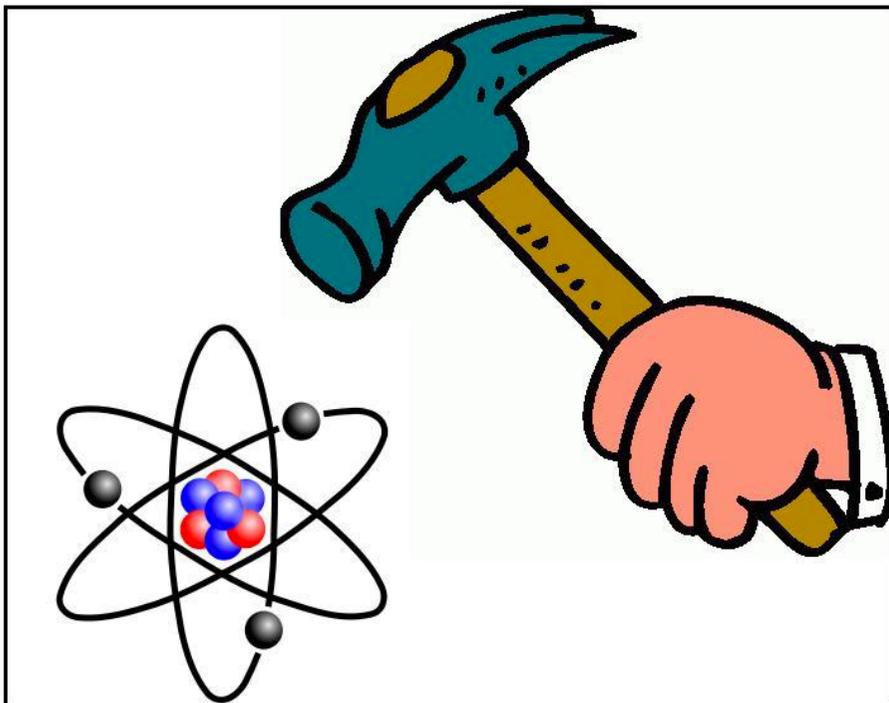


High energy colliders

The idea behind **high-energy colliders** is very simple!

🔧 We want to see **what is inside protons**: we need to **break them**. How we do this?

Bad idea!

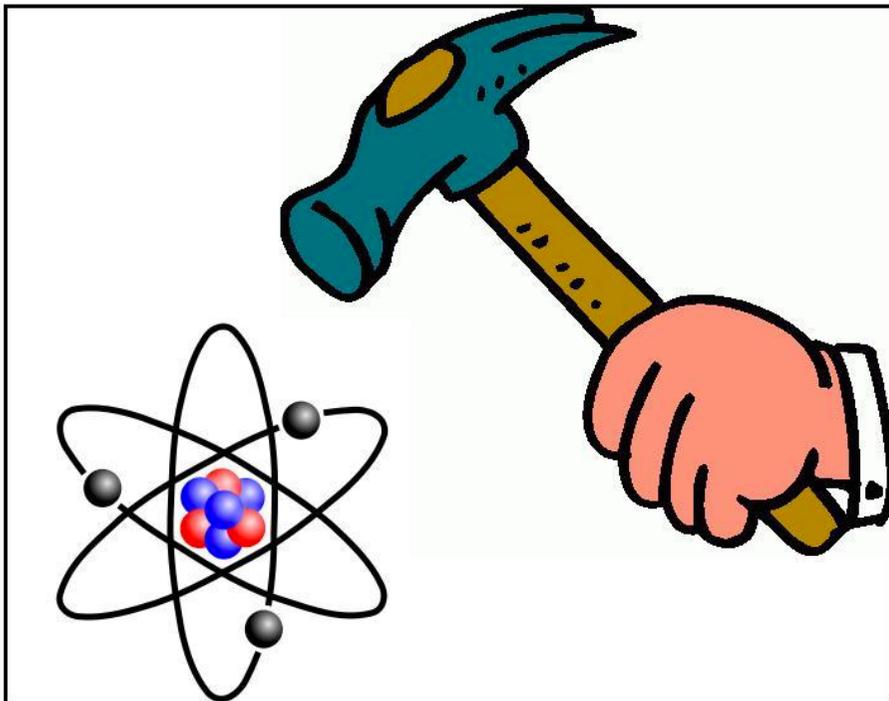


High energy colliders

The idea behind **high-energy colliders** is very simple!

- 🔊 We want to see **what is inside protons**: we need to **break them**. How we do this?
- 🔊 We make protons **go very fast**, and then collide them: by looking at the **results of the collision**, we can understand the stuff protons are made of, if there are new particles or forces
- 🔊 Since protons are very small, we need **extremely high energies to see inside them**: modern colliders are **gigantic machines!**

Bad idea!

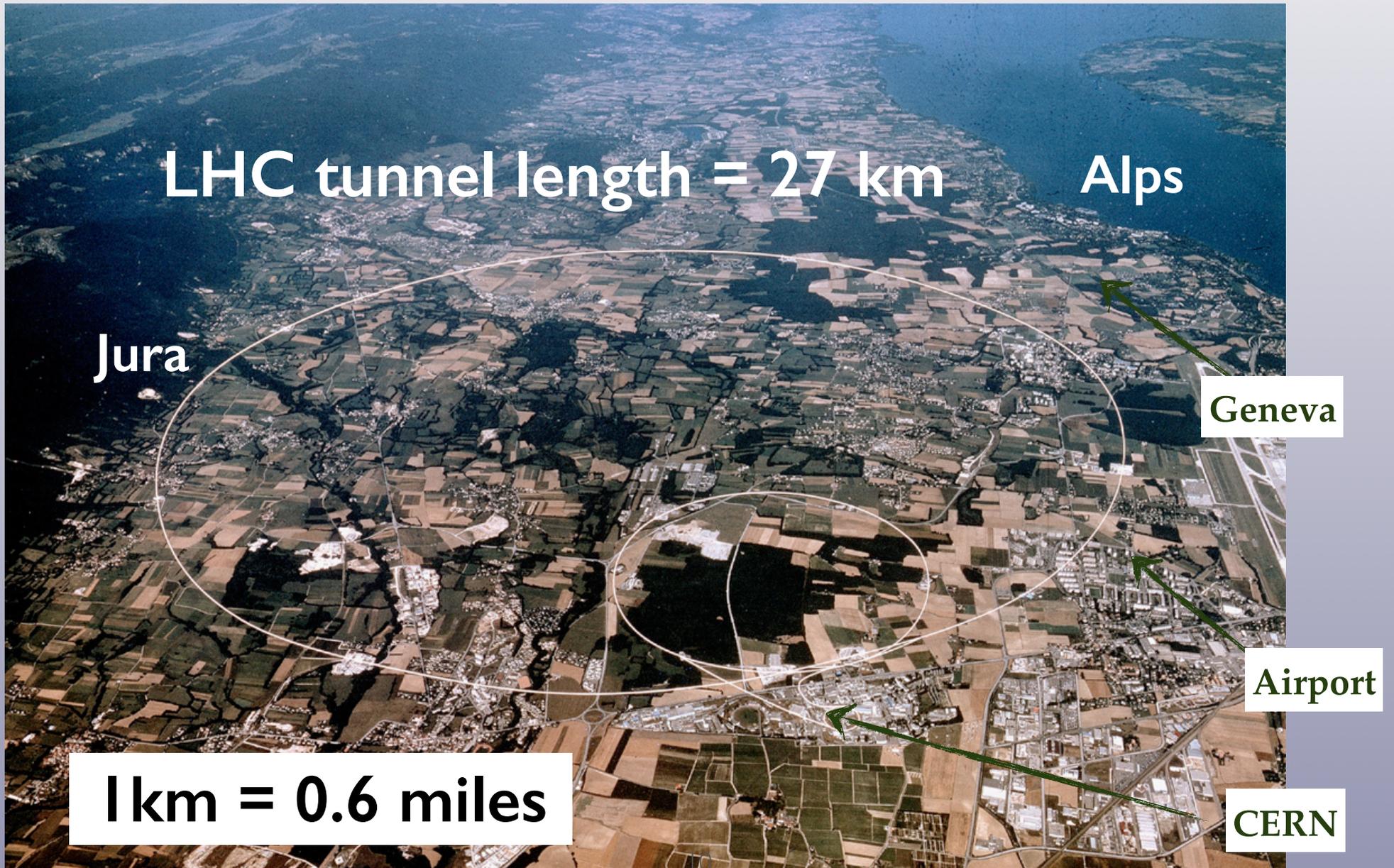


Good idea!



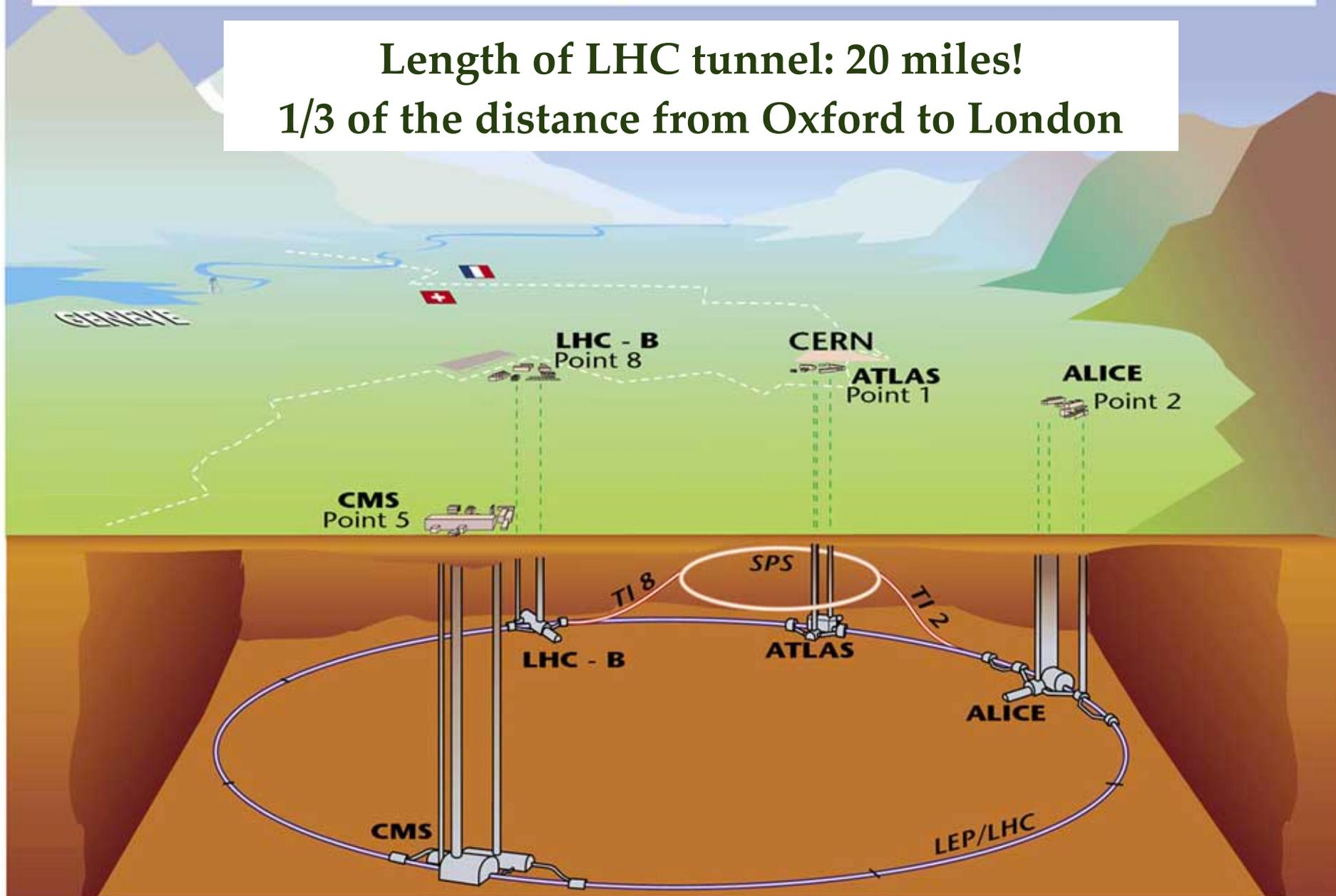
The Large Hadron Collider

- ✓ The LHC is the most powerful particle accelerator ever build by mankind
- ✓ Hosted by CERN in Geneva, the LHC is composed by a massive 27 km long tunnel with four gigantic detectors



Overall view of the LHC experiments.

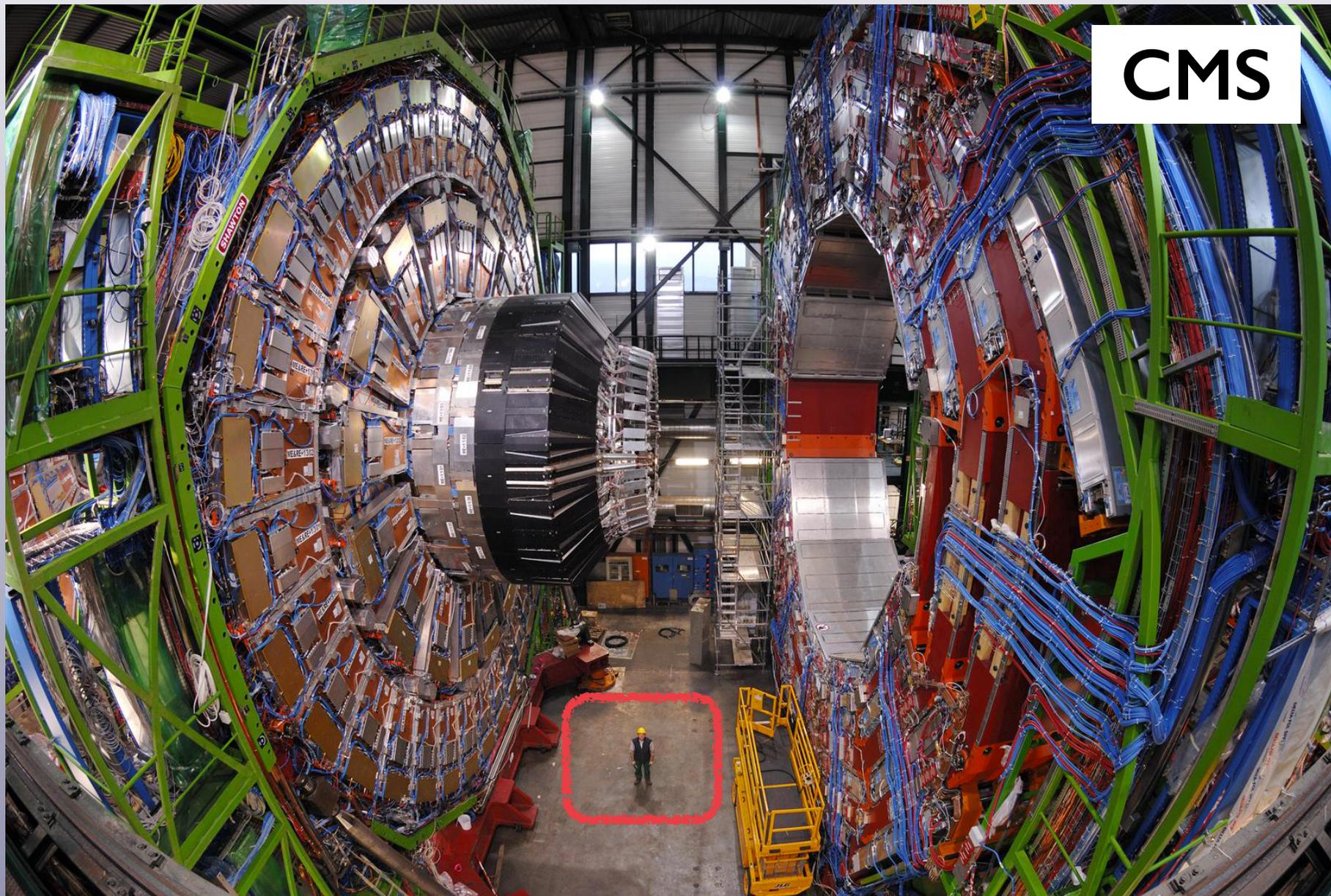
Length of LHC tunnel: 20 miles!
1/3 of the distance from Oxford to London

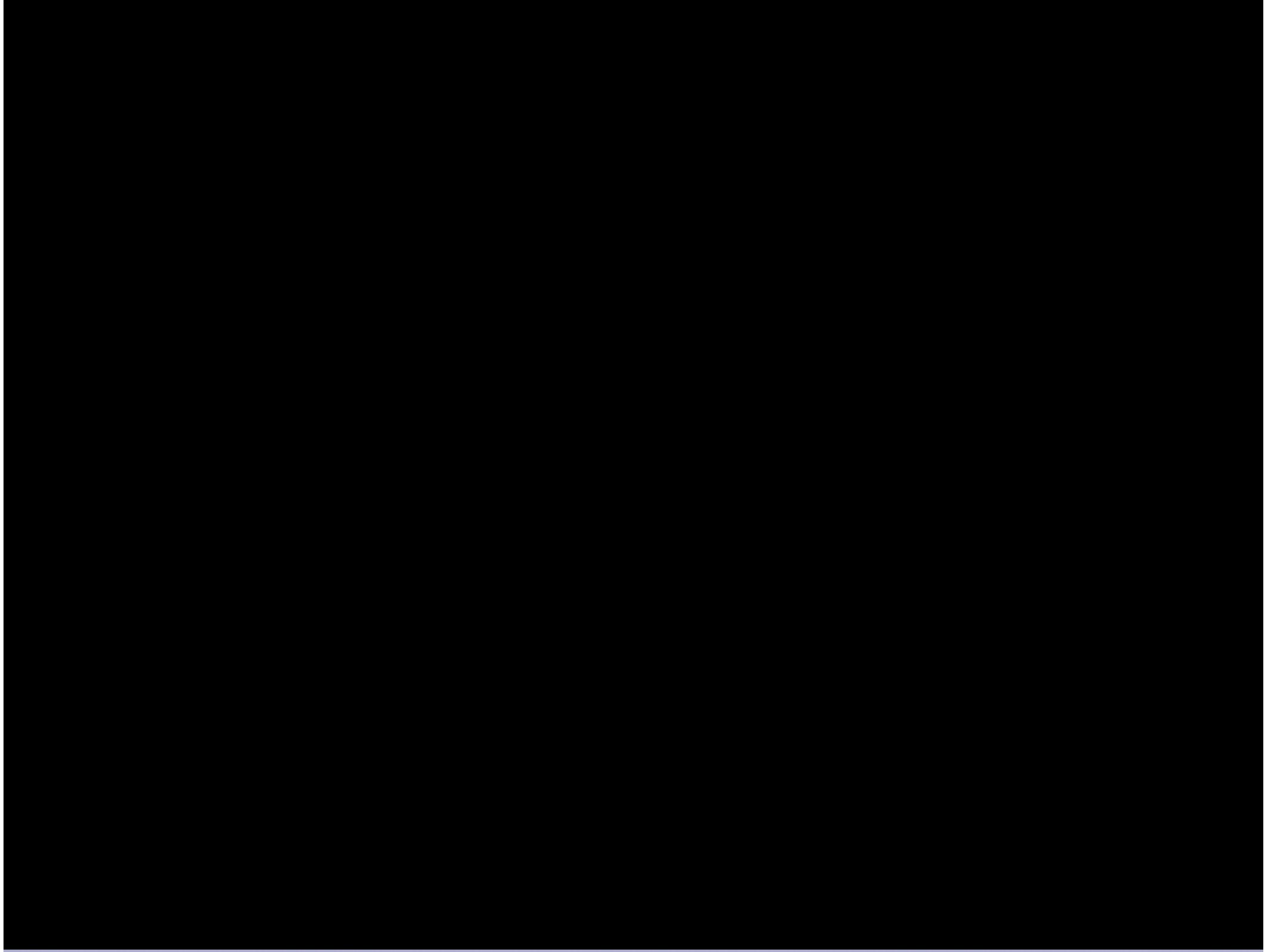


Experiments are hosted in underground tunnel
to avoid noise and contamination

The LHC Detectors

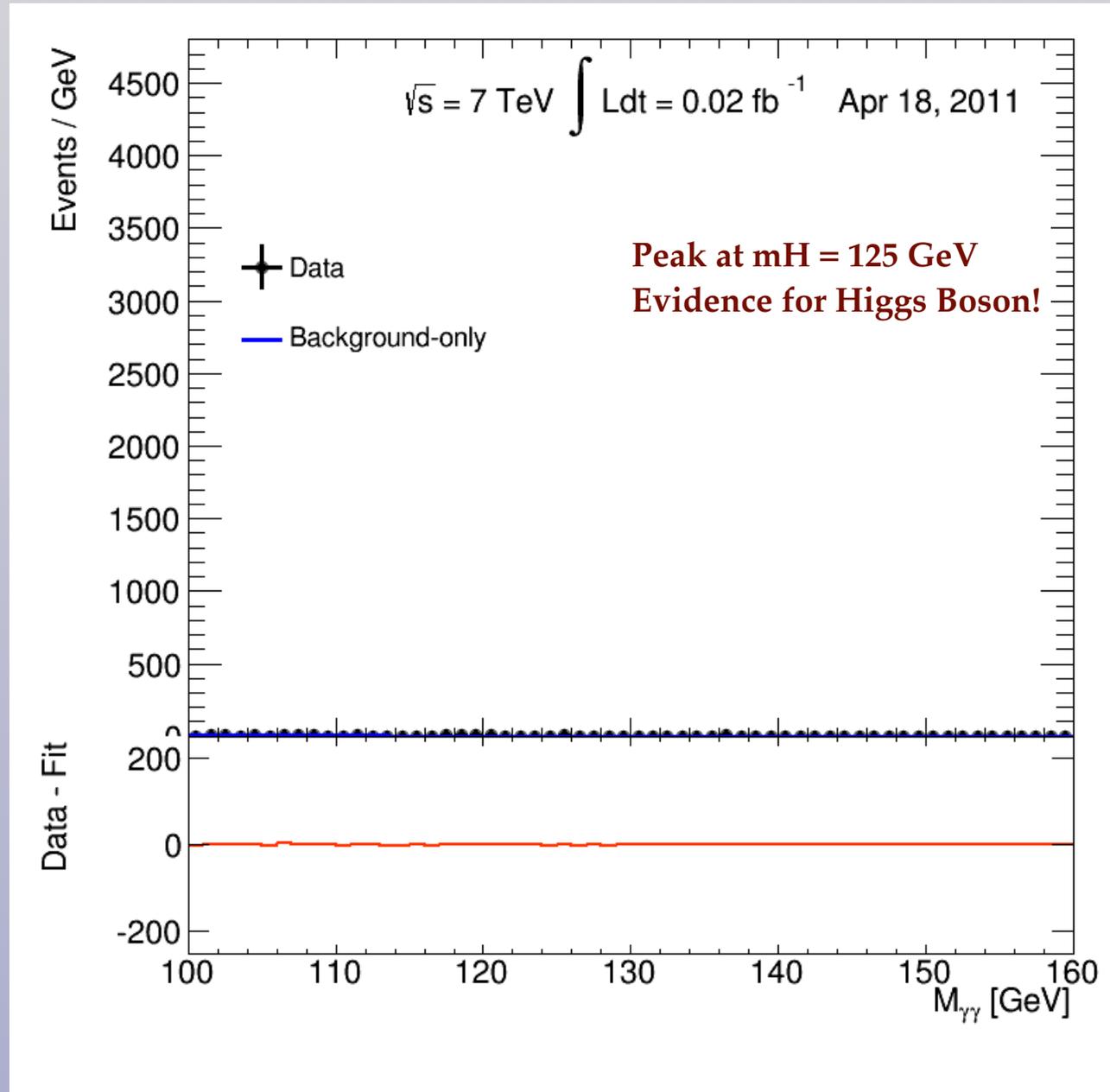
Where proton beams cross and collisions take place, huge detectors measure the products of the collision in an attempt to understand the laws of Nature at the smallest distances





Discovering New Particles

- At the LHC, we search for new **Fundamental Particles**, like the recently discovered **Higgs Boson**, by **looking for deviations** with respect known processes



Discovering New Particles

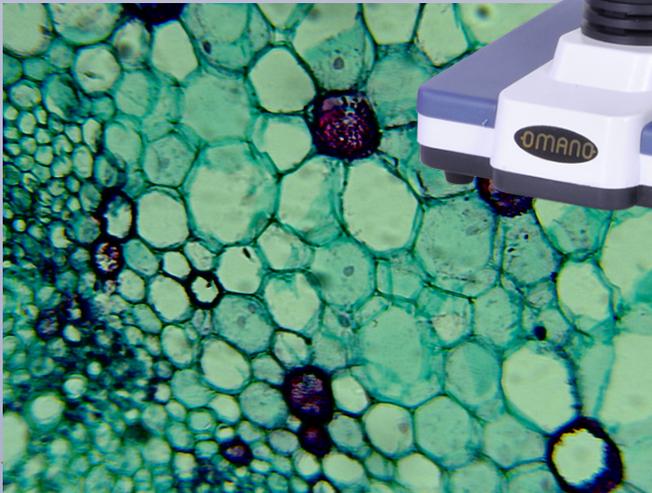
- ✓ At the LHC, we search for new **Fundamental Particles**, like the recently discovered **Higgs Boson**, by **looking for deviations** with respect known processes



Remarkable facts about the LHC

- ✓ The LHC is the most powerful microscope ever constructed, able to see the smallest things ever seen by mankind!

Just as I can use
a microscope to
see cells

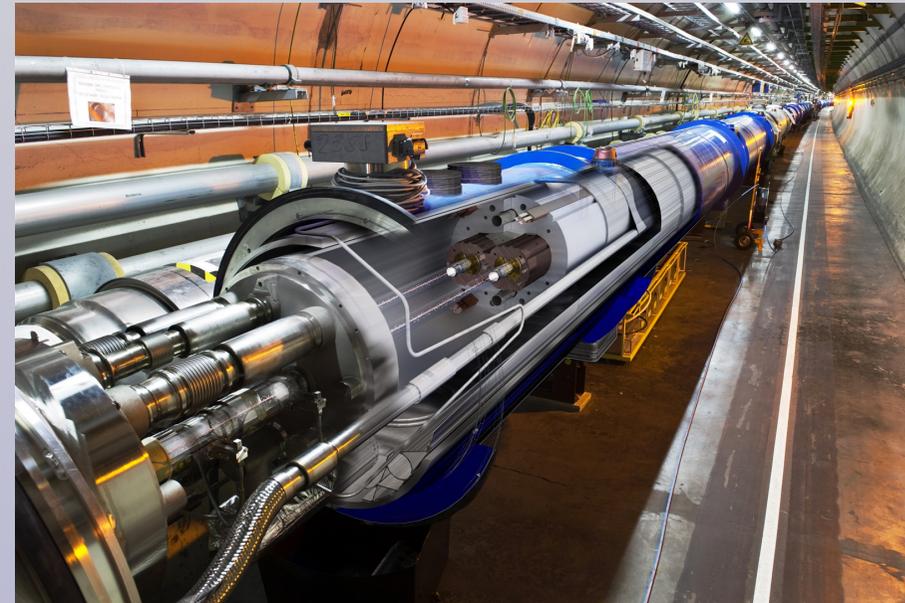
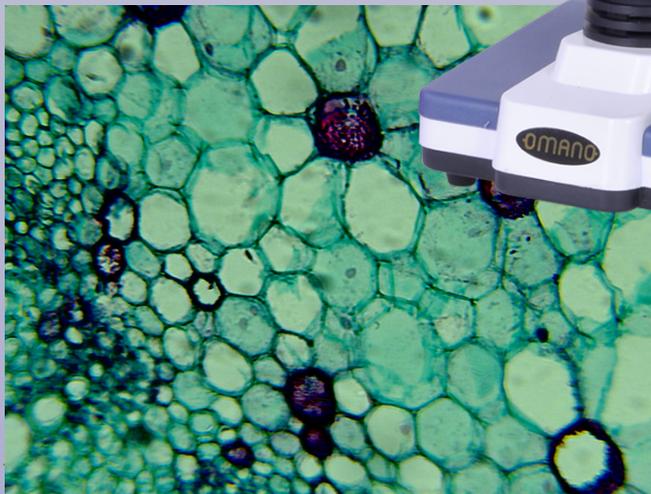


Remarkable facts about the LHC

- ✓ The LHC is the most powerful microscope ever constructed, able to see the smallest things ever seen by mankind!

... I can use the LHC to see new fundamental particles

Just as I can use a microscope to see cells



ONE OF THE THINGS PEOPLE PREDICT WILL COME OUT IS

THE HIGGS BOSON



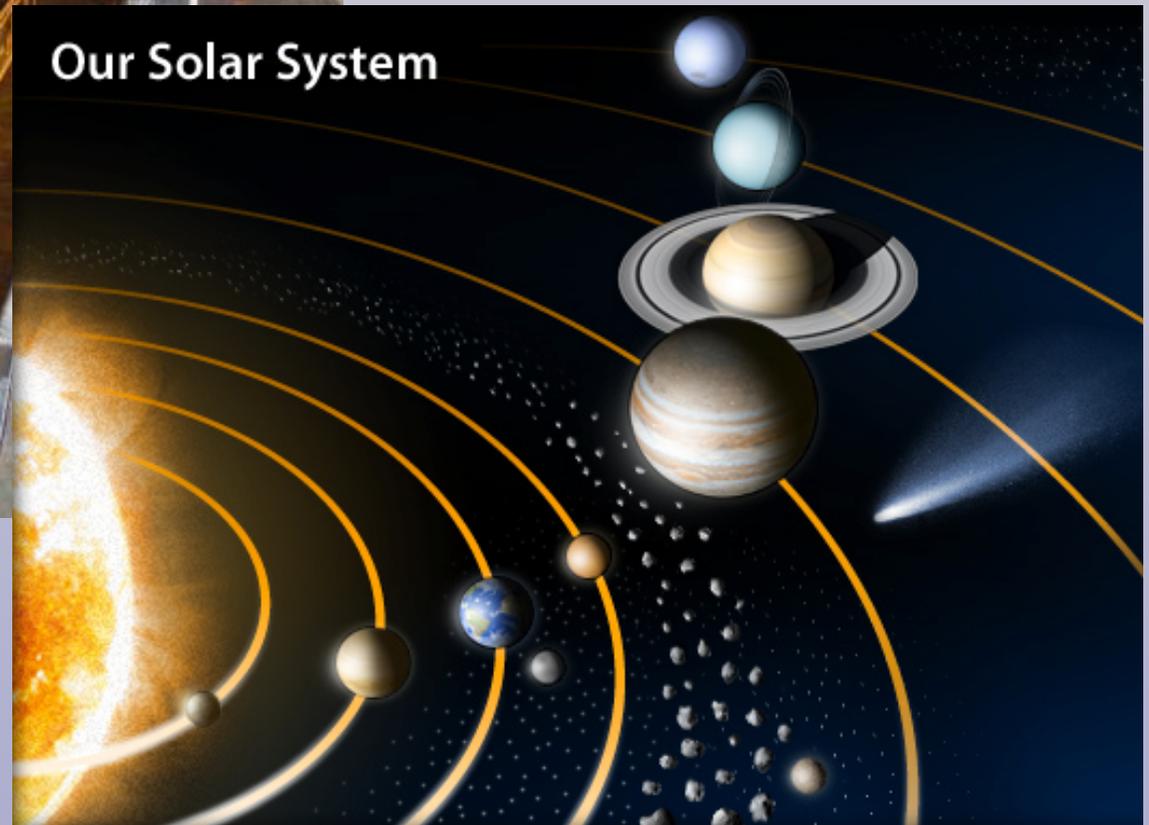
THE HIGGS IS THE PARTICLE RESPONSIBLE FOR GIVING MASS TO OTHER PARTICLES.



you're fat.

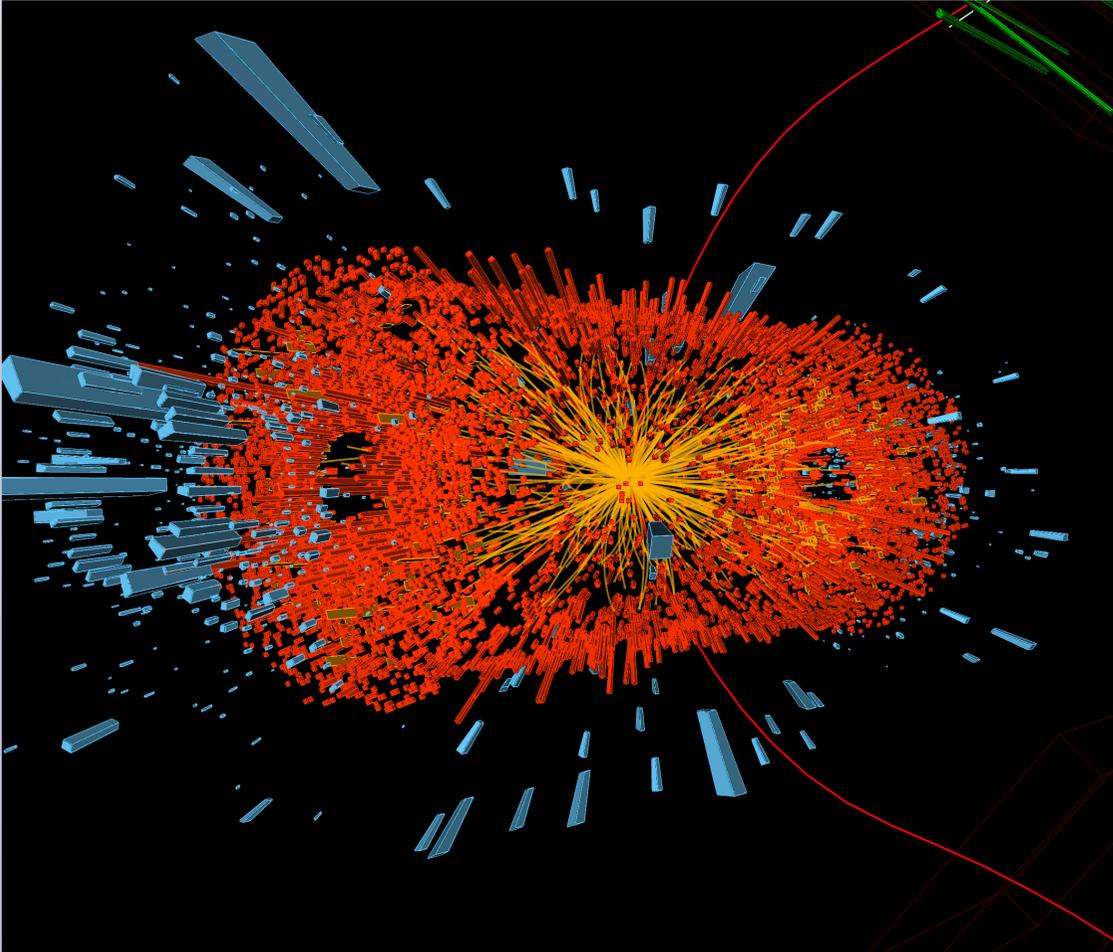
Remarkable facts about the LHC

- ☑ One of coldest places in the Universe: the LHC magnets are kept at only 1.9 degrees above absolute zero, colder than interstellar space!
- ☑ The emptiest place in the Solar System: vacuum in the beam pipe similar to interplanetary space

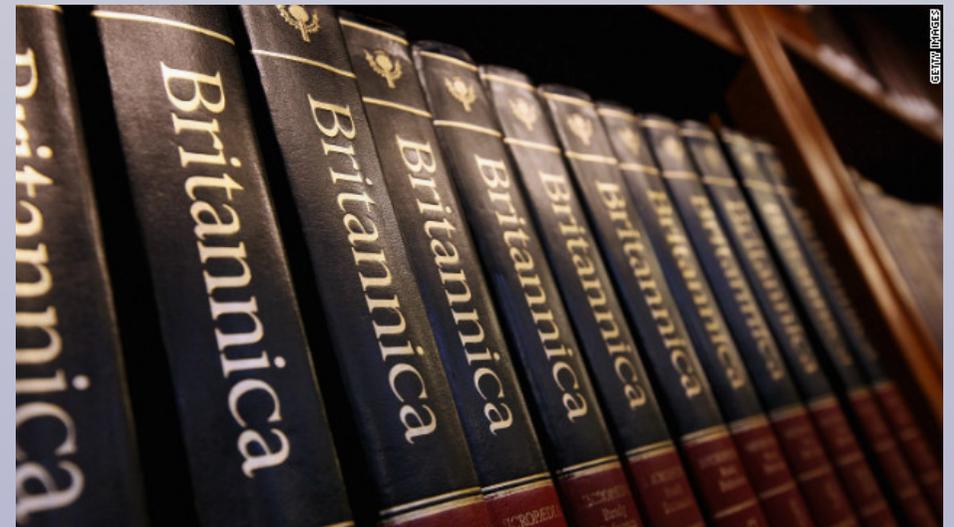


Remarkable facts about the LHC

- ✓ One of **hottest places in the Galaxy**: collisions generate a temperature **billions of times larger than the Sun**, reproducing conditions of **early Universe**

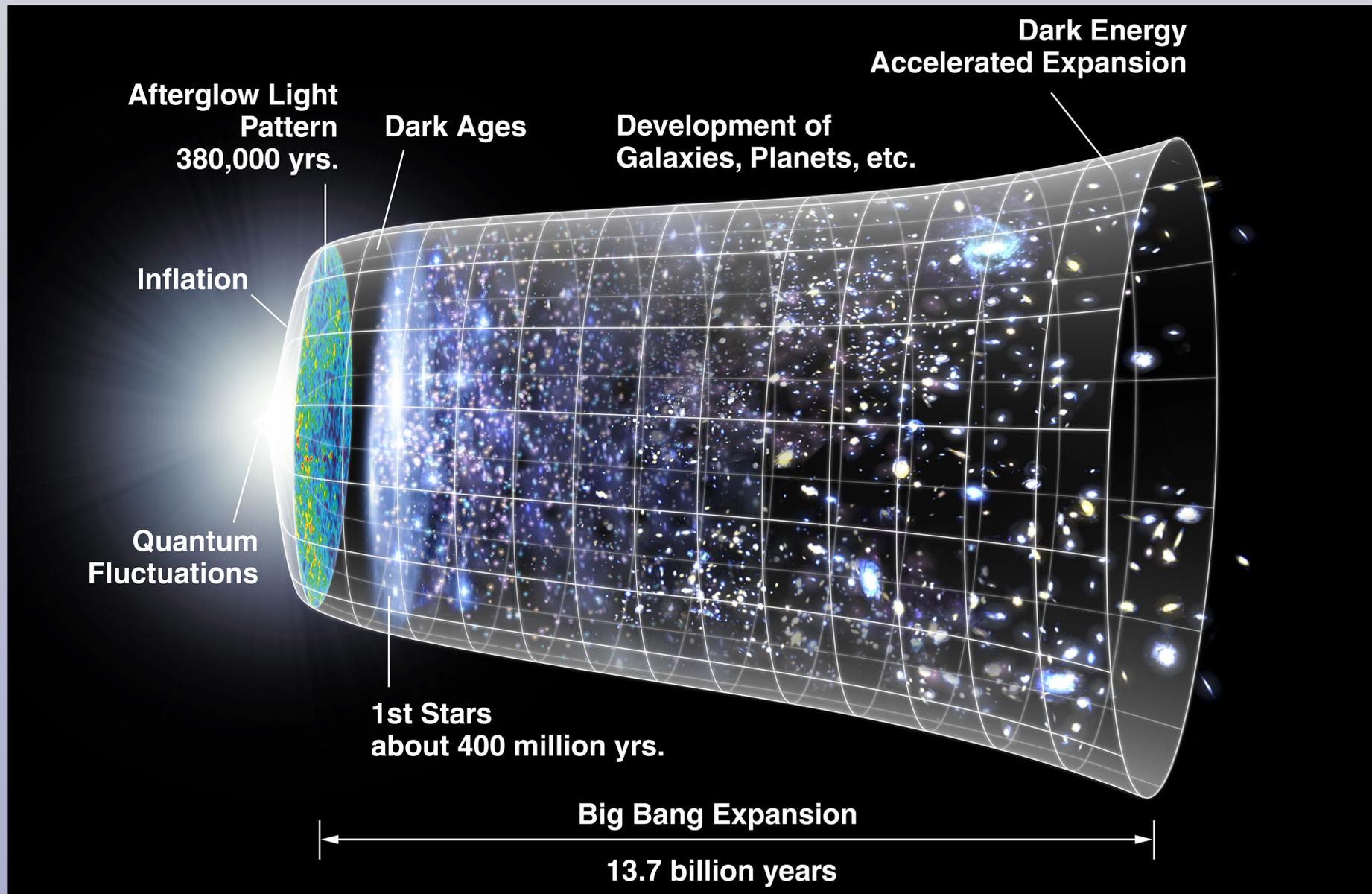


- ✓ The **data volume** recorded is like reading **10,000 times the full Encyclopedia Britannica** each second!



Remarkable facts about the LHC

- ☑ The LHC is so powerful that can reproduce the conditions of the **Early Universe**, just after the **Big Bang**, about **14 Billion years ago!**



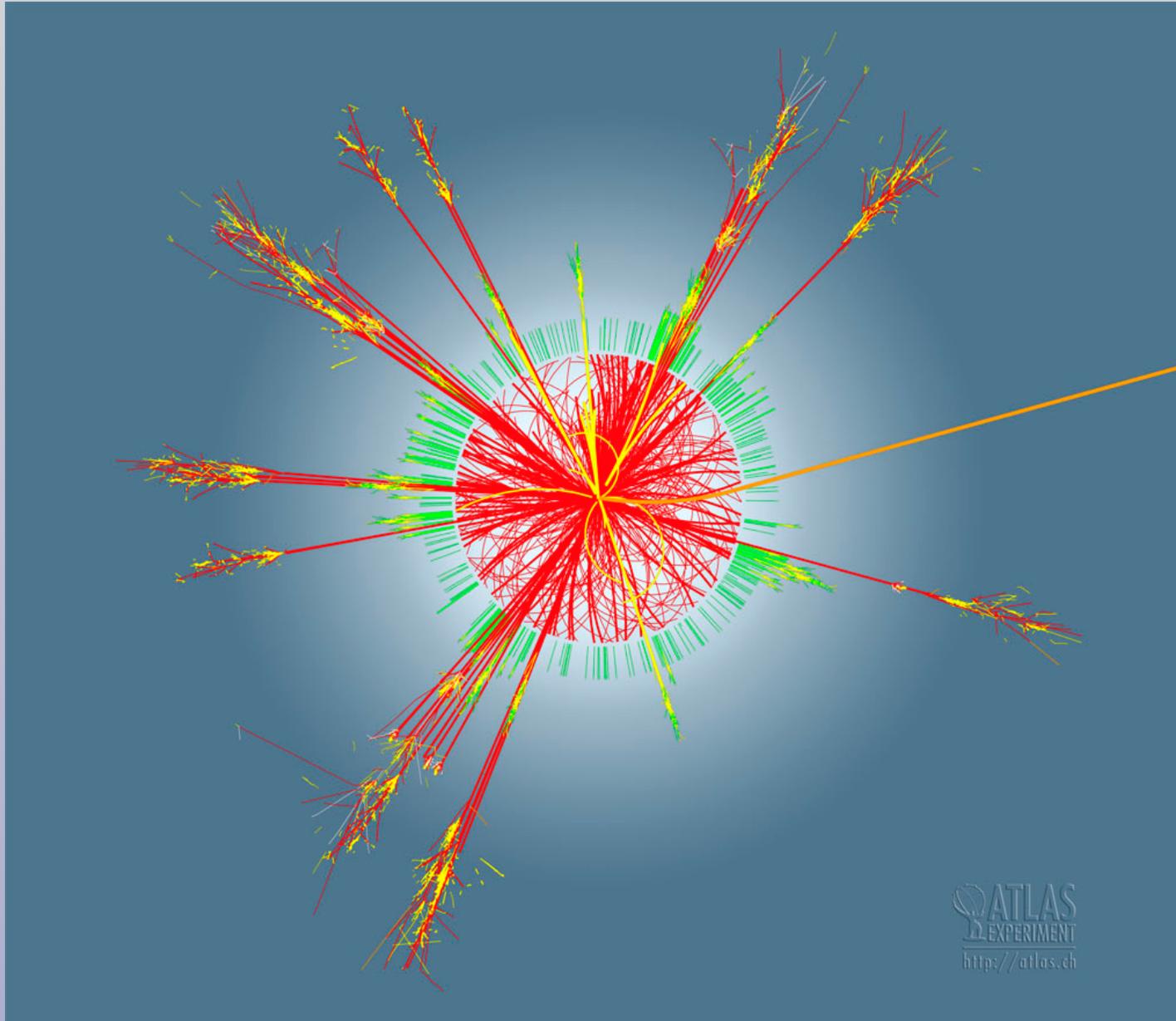
Black Holes at the LHC?

- ☑ **Black holes** are one of the most fascinating objects in the Universe: **nothing can escape from their attraction**, not even light!



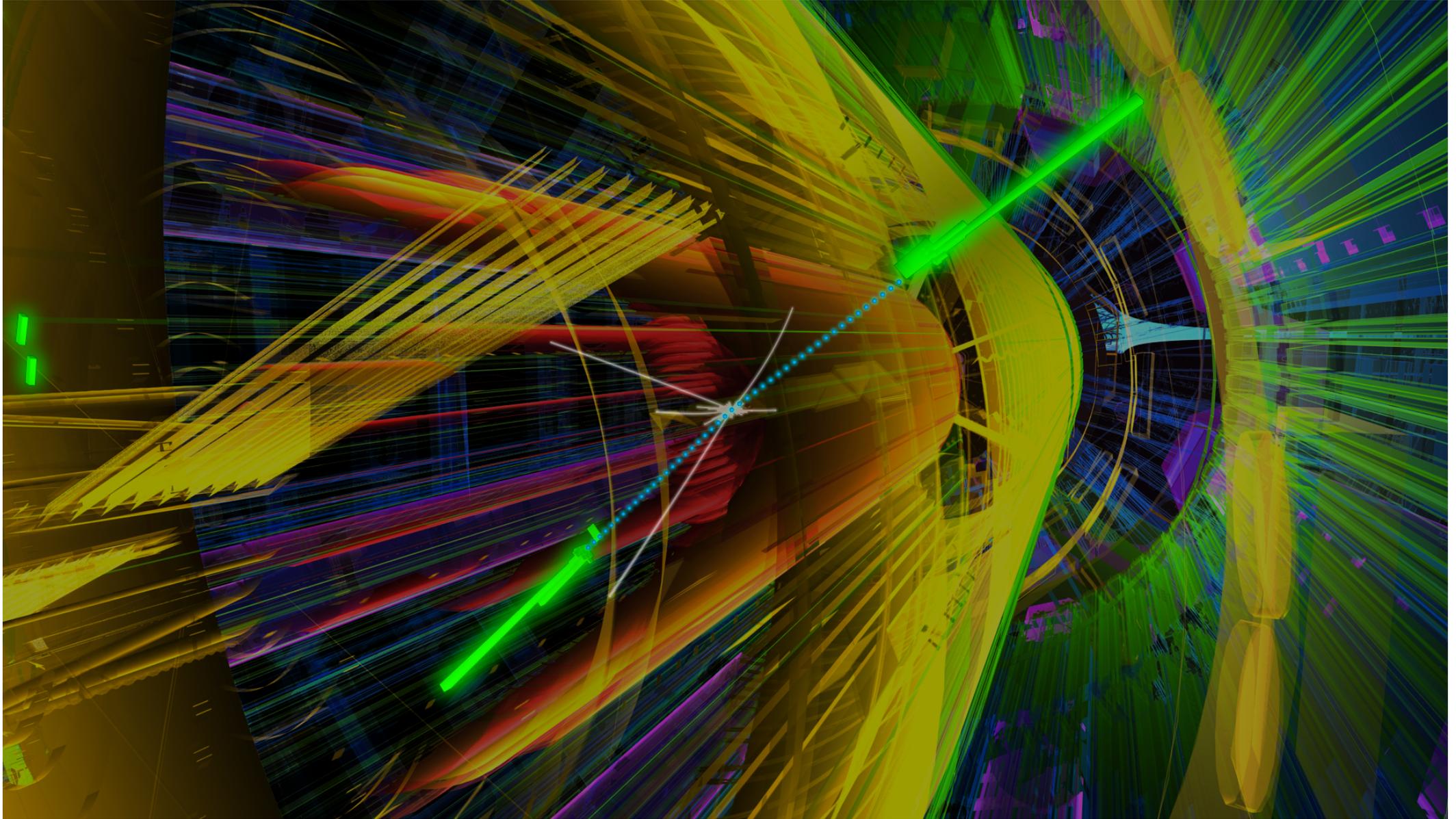
Black Holes at the LHC?

- ☑ At the LHC, we might even create artificially mini **Black Holes**, for example if there are new space-time dimensions





Fascinating times ahead at the high-energy frontier!



Stay tuned for news from the LHC!