



European Organization for Nuclear Research

50 years of research in physics



Planting the seed...

“... our attention has turned to the question of developing this **new international unit**, a laboratory or institution where it would be possible **to carry out scientific work above and beyond the framework of the various nations taking part** [...] this body could be endowed with greater resources than those available to the national laboratories and could then embark upon tasks whose magnitude and nature preclude them from being done by the latter on their own...”

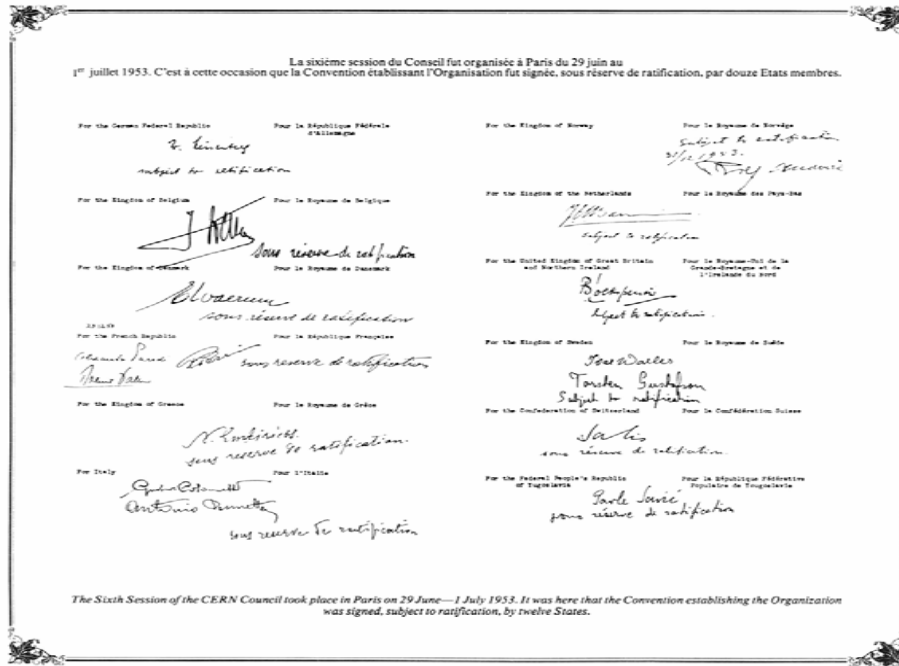
(Louis de Broglie, Lausanne, 1949)



CERN

European Organization for Nuclear Research

- Founded in 1954 by 12 countries
- Today: 20 member states
- ~ 2500 staff
- ~1000 MCHF / Year budget



1954: Convention establishing the Organization - original signatures



2004: The 20 member states



Today CERN has become a World lab

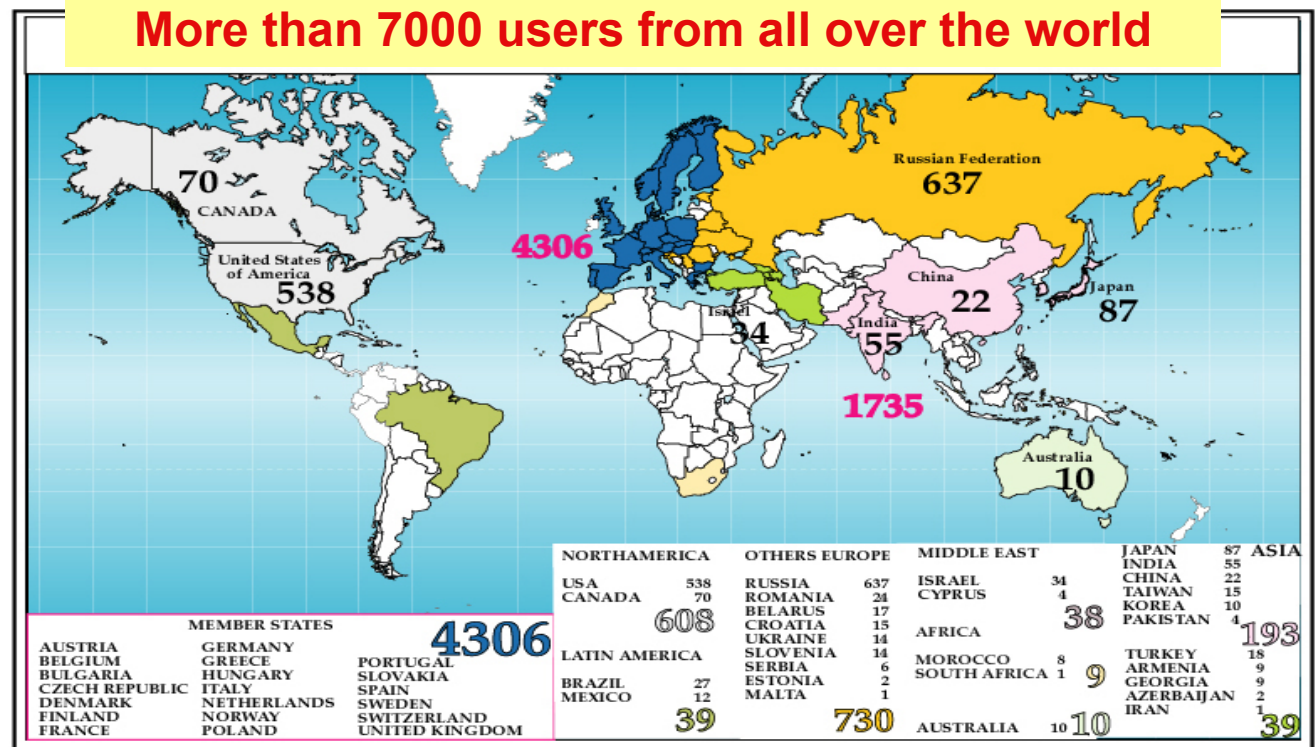
Observer states: Israel, Japan, India, Russian Federation, Turkey, UNESCO & European Commission.

60 non-member countries collaborate with CERN.

CERN is promoting **peaceful collaboration** in the world.

Significant participation from **'South'** & from **'East'**

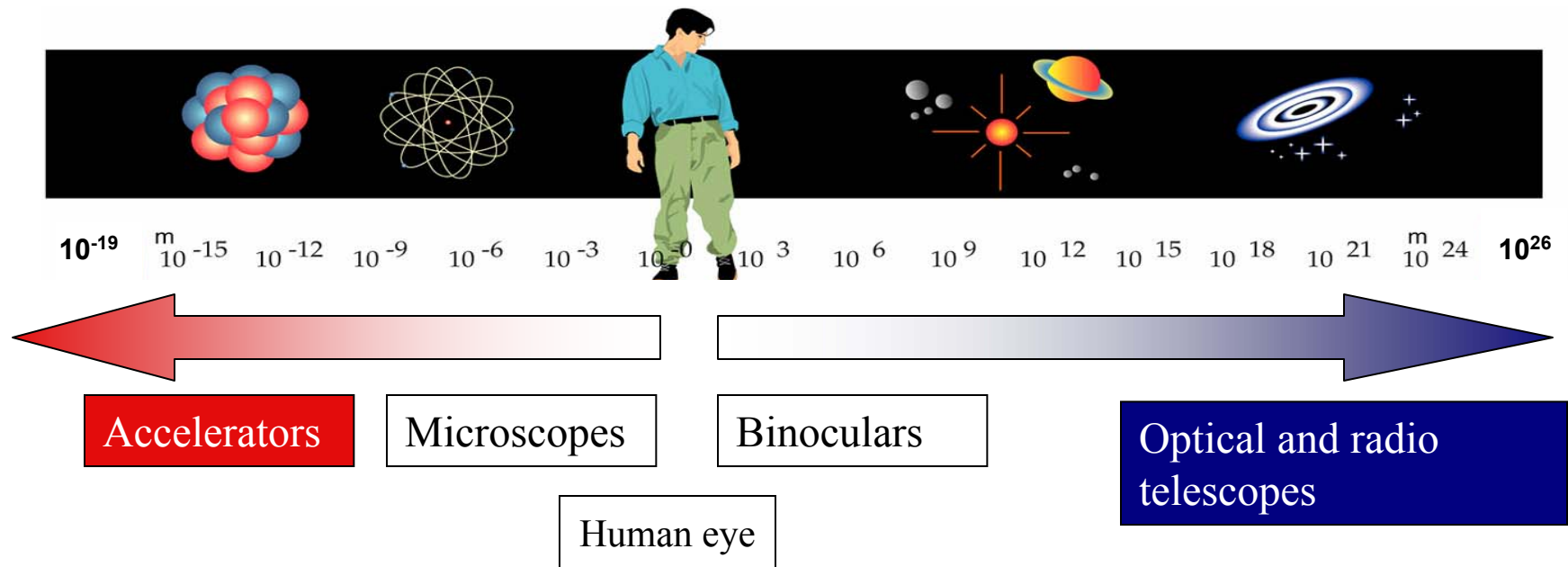
More than 7000 users from all over the world

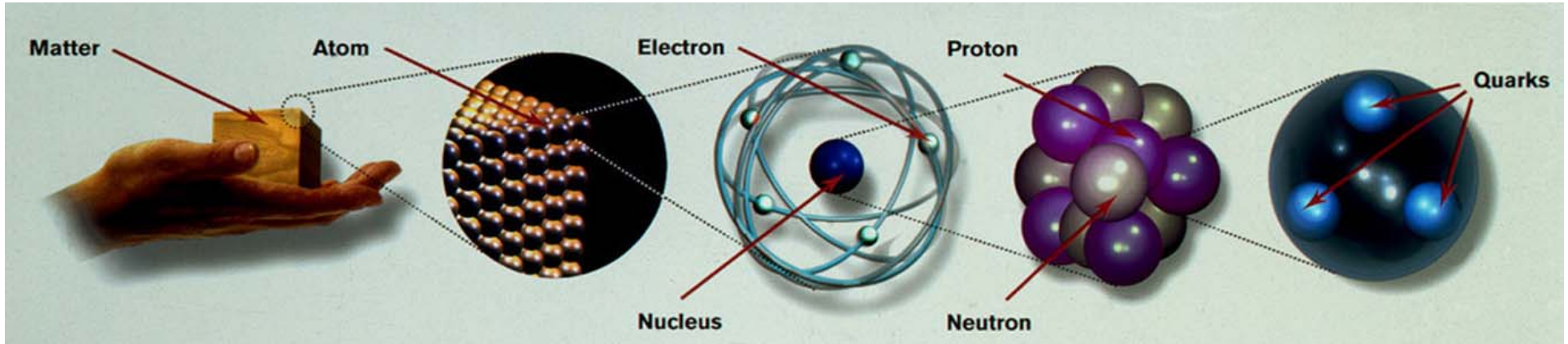




CERN's mission: to study Particle Physics

Particle physicists study matter in its smallest dimensions to understand building blocks and forces

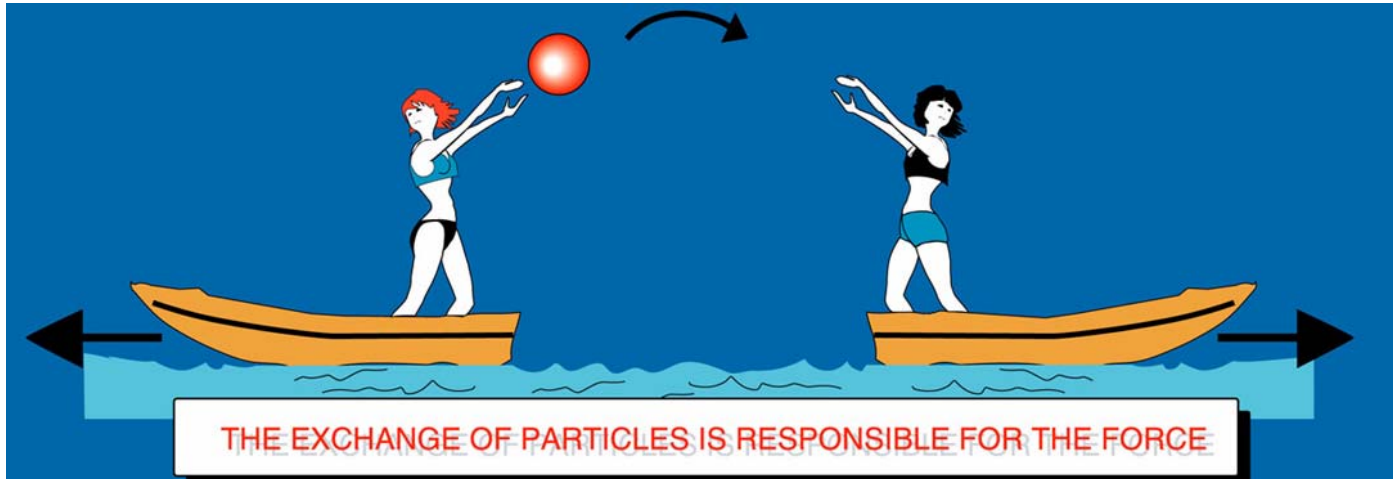




Today's periodic system of the fundamental building blocks

	Quarks		Leptons	
Generation 3	t Top	b Bottom	τ Tau	ν_τ Tau-neutrino
Generation 2	c Charm	s Strange	μ Muon	ν_μ Muon-neutrino
Generation 1	u Up	d Down	e Electron	ν_e Electron-neutrino

Four forces to hold matter together



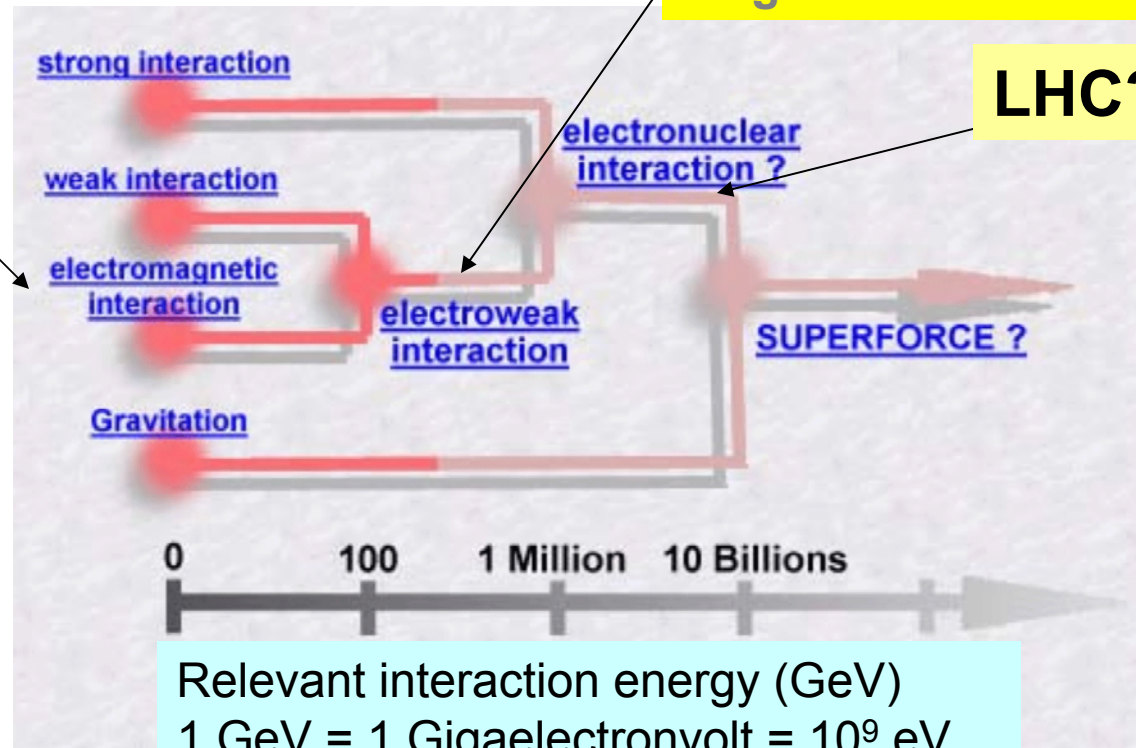
Type	RELATIVE INTENSITY OF FORCES	Particle exchanged (field quantum)	Occurs in:
Strong force	~ 1	Gluons (no mass)	Atomic nucleus
Electro-magnetic force	$\sim 10^{-3}$	Photons (no mass)	Electricity Atomic shell
Weak force	$\sim 10^{-5}$	Bosons Z^0, W^+, W^- (heavy)	Sun - Radioactive β decay
Gravitation	$\sim 10^{-38}$	Gravitons?	Keeping our feet on the ground

Major discoveries at CERN:

- Neutral Currents (1973)
- W&Z bosons (C. Rubbia, S. Van der Meer 1983)
- Confirmation of the existence of 3 neutrino species (1989)

S. Weinberg, A. Salam, S. Glashow :
Unification of electro-magnetic and weak forces

J. C. Maxwell :
Unification of magnetic and electric forces



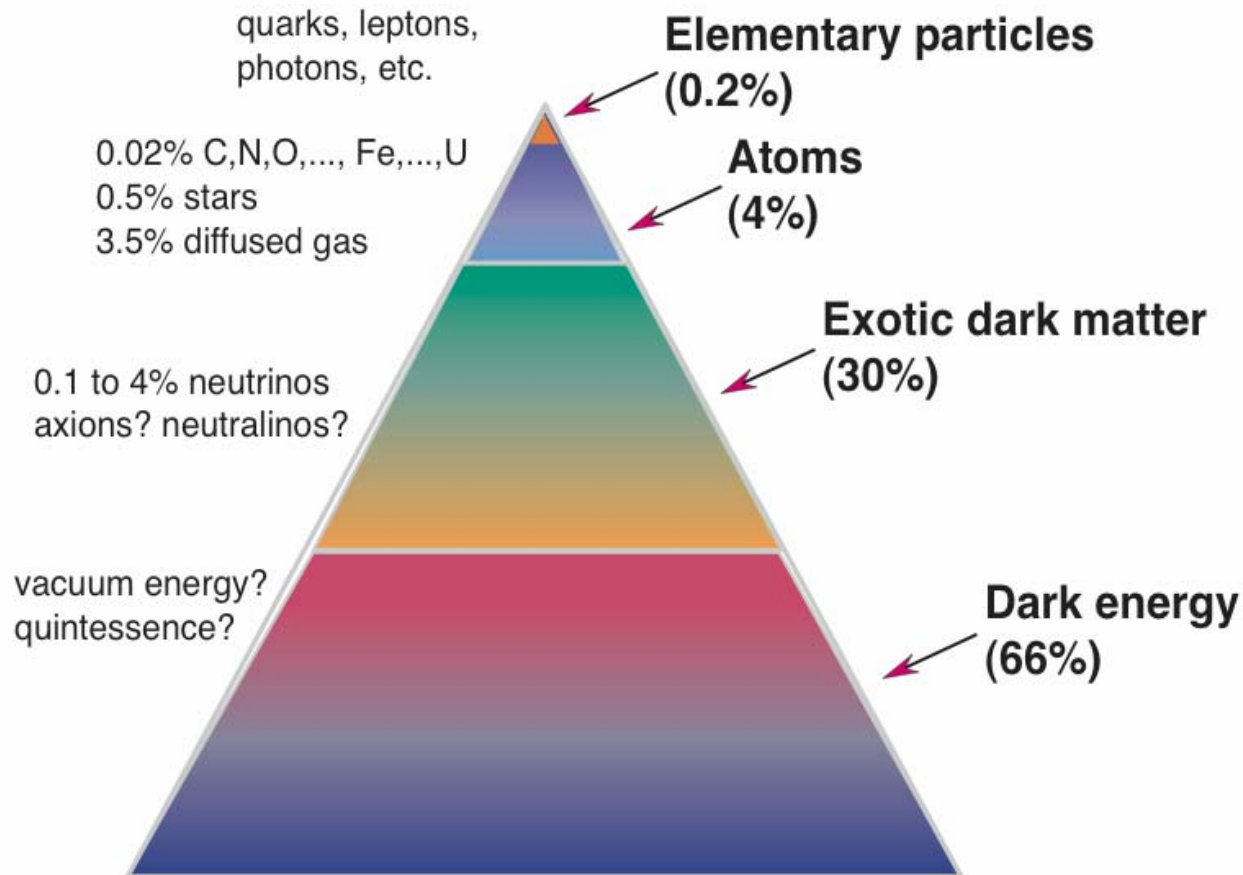
LHC?

Relevant interaction energy (GeV)
1 GeV = 1 Gigaelectronvolt = 10^9 eV

Mystery



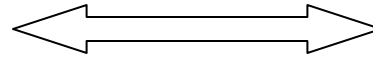
What is the universe made of? 96% of contents not known!





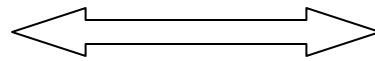
LHC will help solving some of these questions

Elementary particles



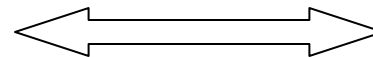
Origin of mass?
Higgs particle?

The 11 microsecond old Universe



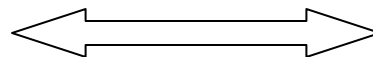
Nuclear collisions

Dark matter in the Universe



Supersymmetry?

Origin of matter



Matter-antimatter
asymmetry?

LHC will explore new territories of physics ...

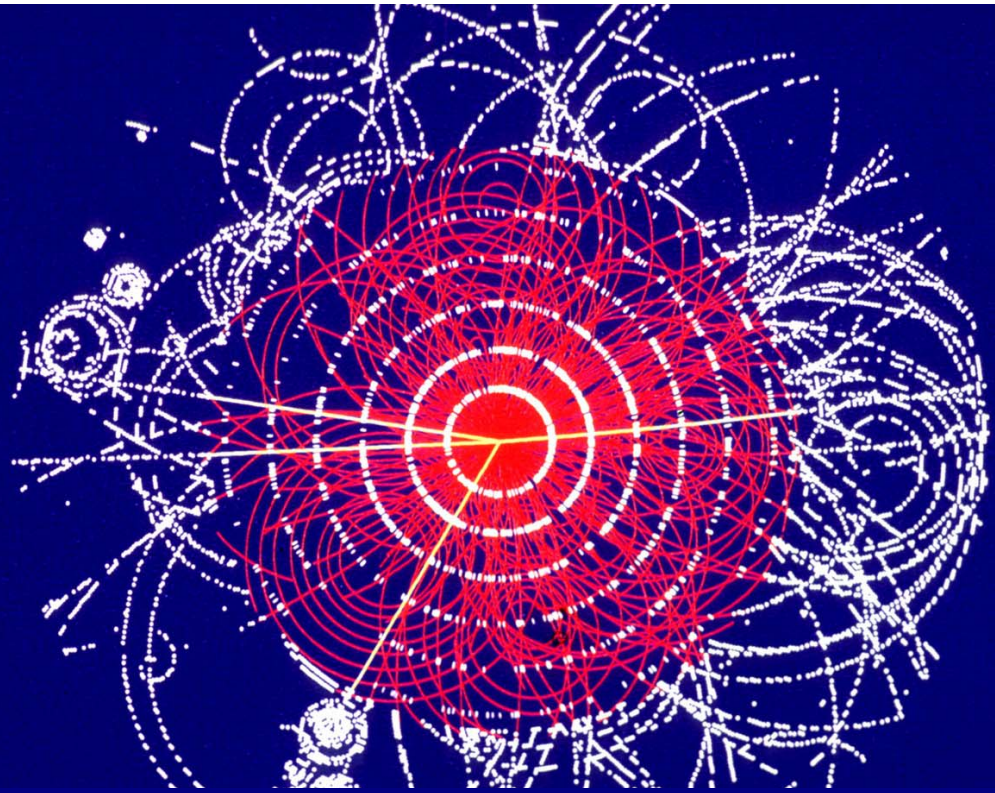


Higgs signature at the LHC

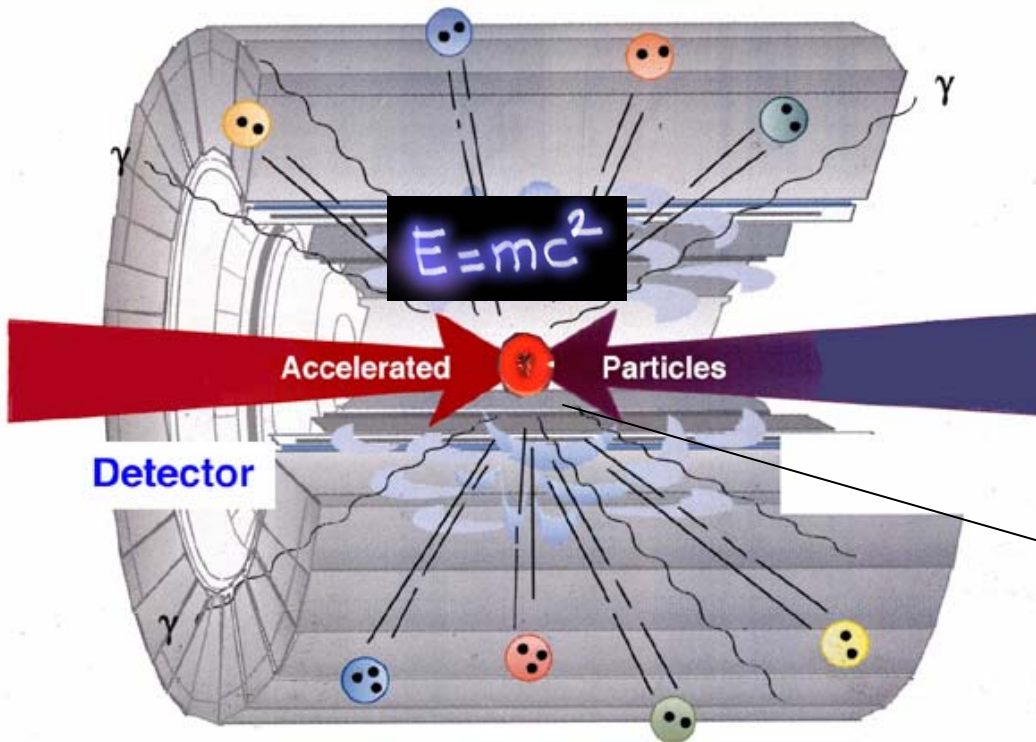
The two 7 TeV* proton beams at the LHC will collide head-on **800 million times per second**

*100 million times the energy of the electrons in your TV cathodic tube

*the energy stored in one beam (362 MJ) is equivalent to the kinetic energy of a Jumbo Jet at take off, when reaching 154 km/h



We expect only 1 Higgs in 1,000,000,000,000 events



1) Concentrate energy on particles (**accelerator**)

2) **Collide** particles (recreate conditions after Big Bang)

3) Identify created particles in **Detector**

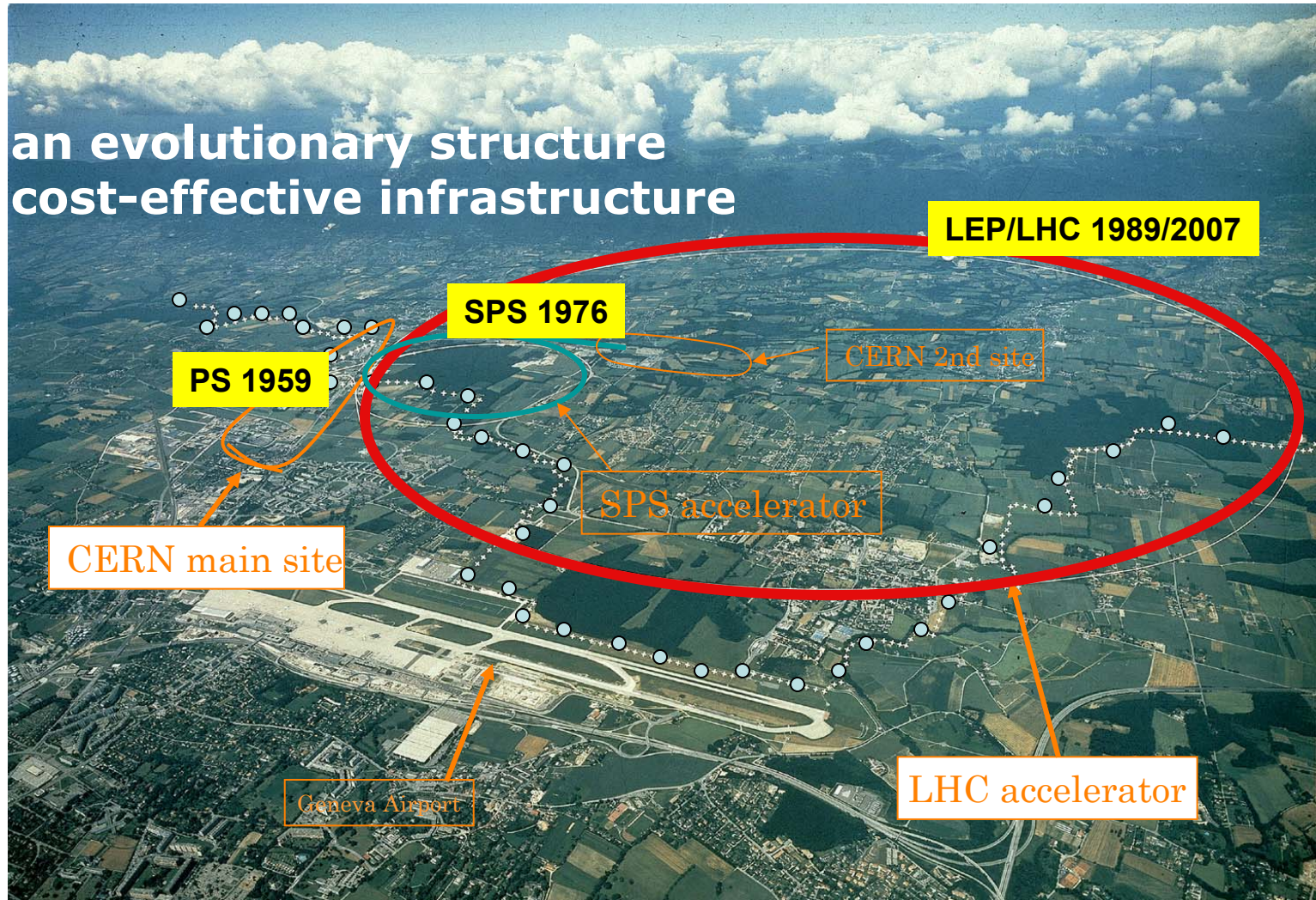
4) **Collect and analyse** data



to provide large infrastructure for particle physics

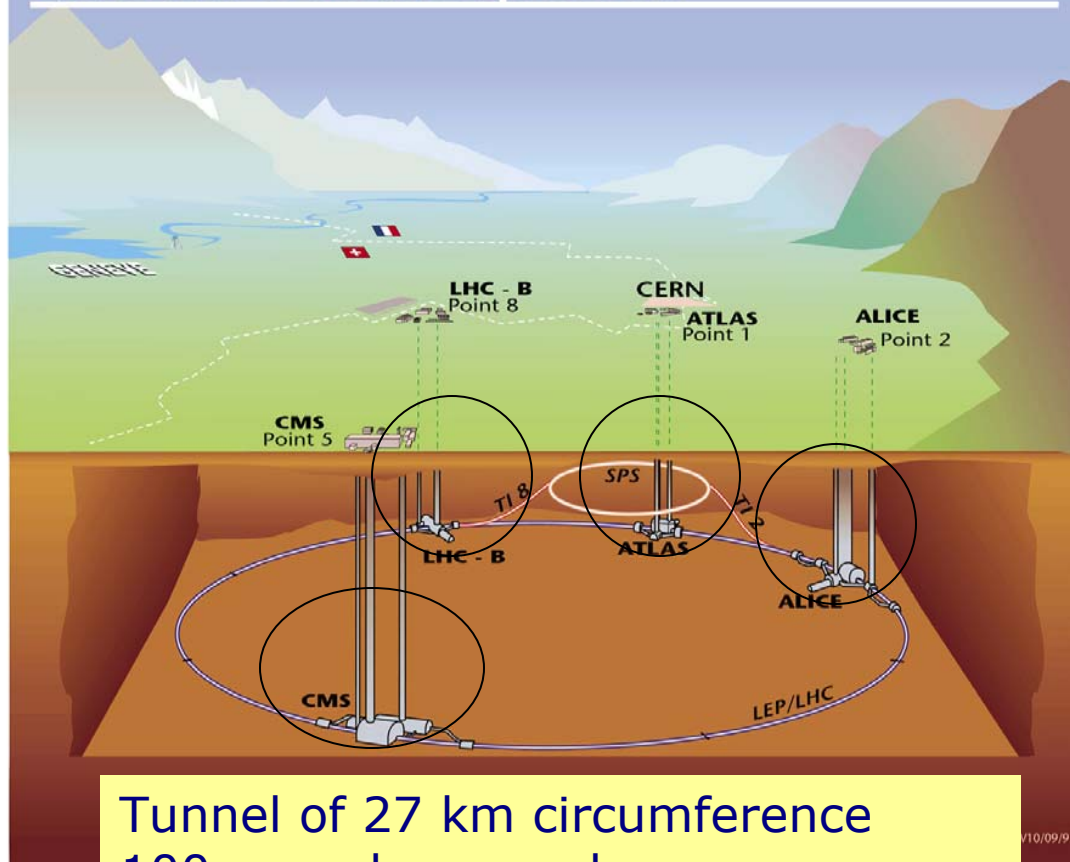
CERN's mission:

an evolutionary structure
cost-effective infrastructure



The Large Hadron Collider (LHC) will be the most powerful instrument ever built to investigate the structure of matter (particle properties) and forces.

Overall view of the LHC experiments.



Tunnel of 27 km circumference
100 m underground

- Four **gigantic underground caverns** to host huge detectors
- The **highest energy** of any accelerator in the world
- The **highest collision rate** of particles
- It will operate at a temperature (-271°C) **colder than outer space** (-270.4°C)

The LHC: what it will look like

The LHC will start operation in 2007.
Great challenge in many different fields



accelerator

detectors

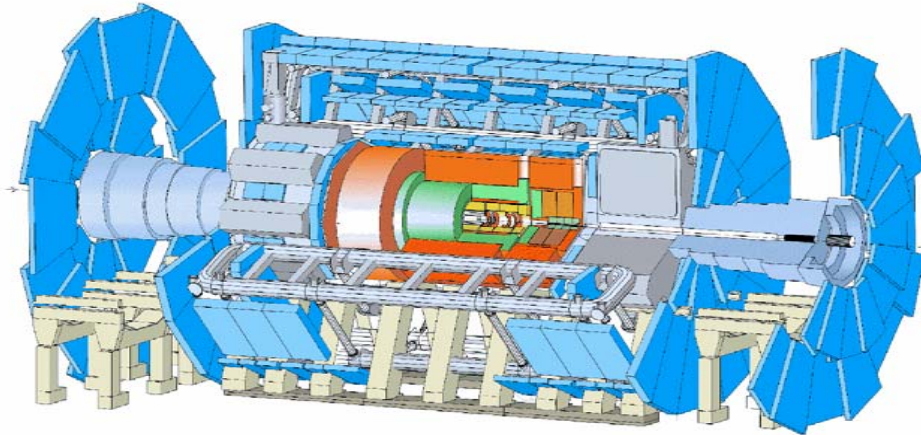
computing

financing

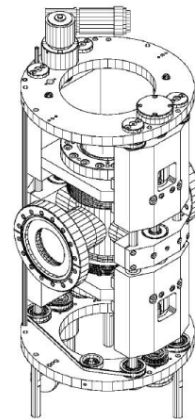
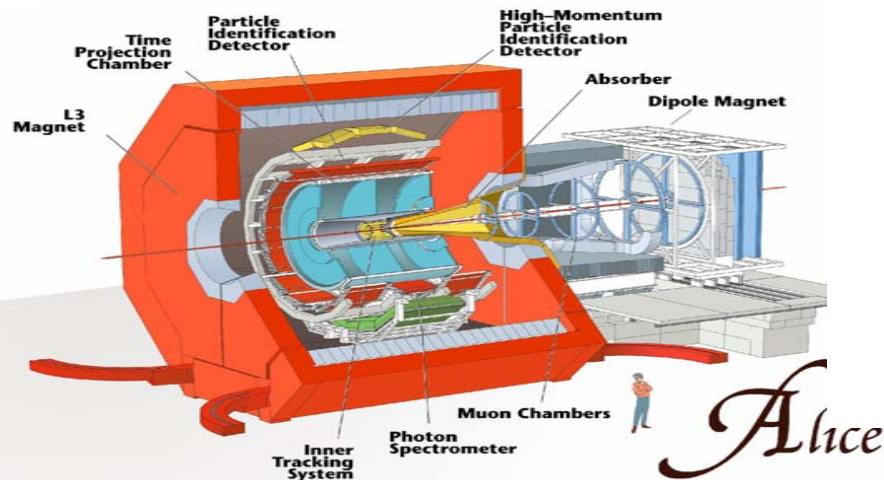
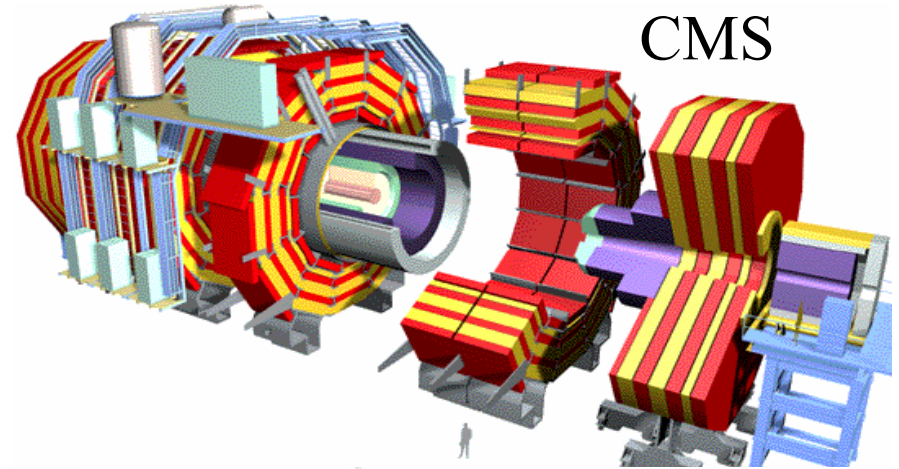
organization

Experiments at the LHC: four gigantic detectors

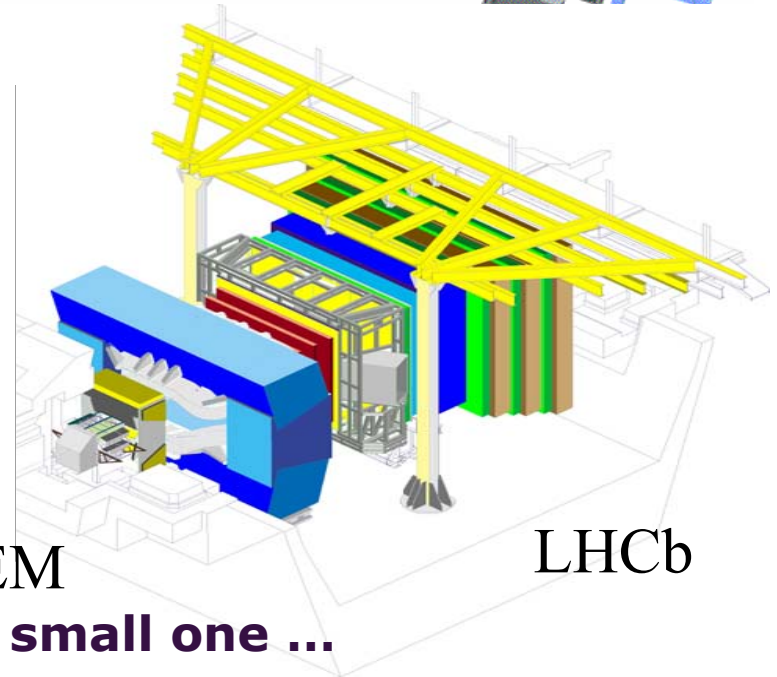
ATLAS



CMS



TOTEM and a small one ...

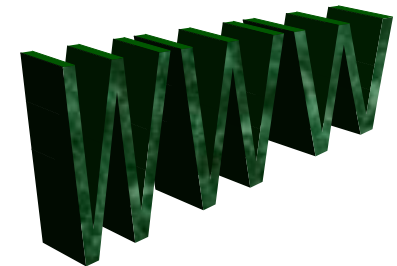


LHCb





CERN, Internet and the WWW



WWW >>> Sharing information



The GRID: a possible solution to CERN computing needs

The objective is to provide LHC experiments with the computing power they need for data analysis while at the same time building the next generation computing infrastructure. The LHC computing GRID is a project funded by the European Union.



GRID >>> Sharing computing resources



Fundamental research drives innovation

Directly from research:
proton spin => NMR

Indirectly from tools:
diagnostics (PET scan),
cancer treatment,
transmutation of
nuclear waste,
computing techniques
and communications
(Monte Carlo, Web, etc.)

