Particle Physics Snapshot

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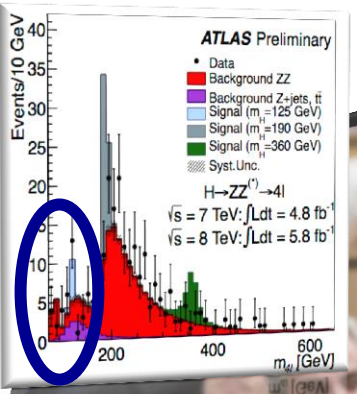
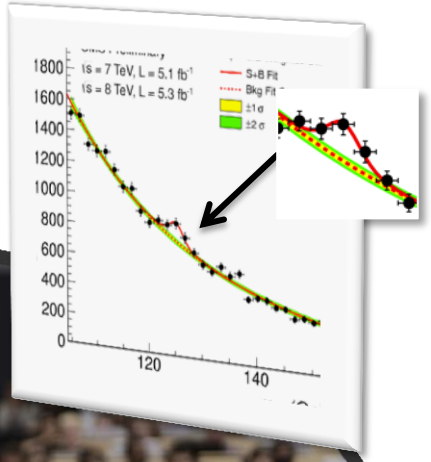
About 10,000 inhabitants of our planet came together to build…

The Large Hadron Collider at CERN, Geneva, Switzerland

And in July 2012…

Two of these 10,000 people presented results…





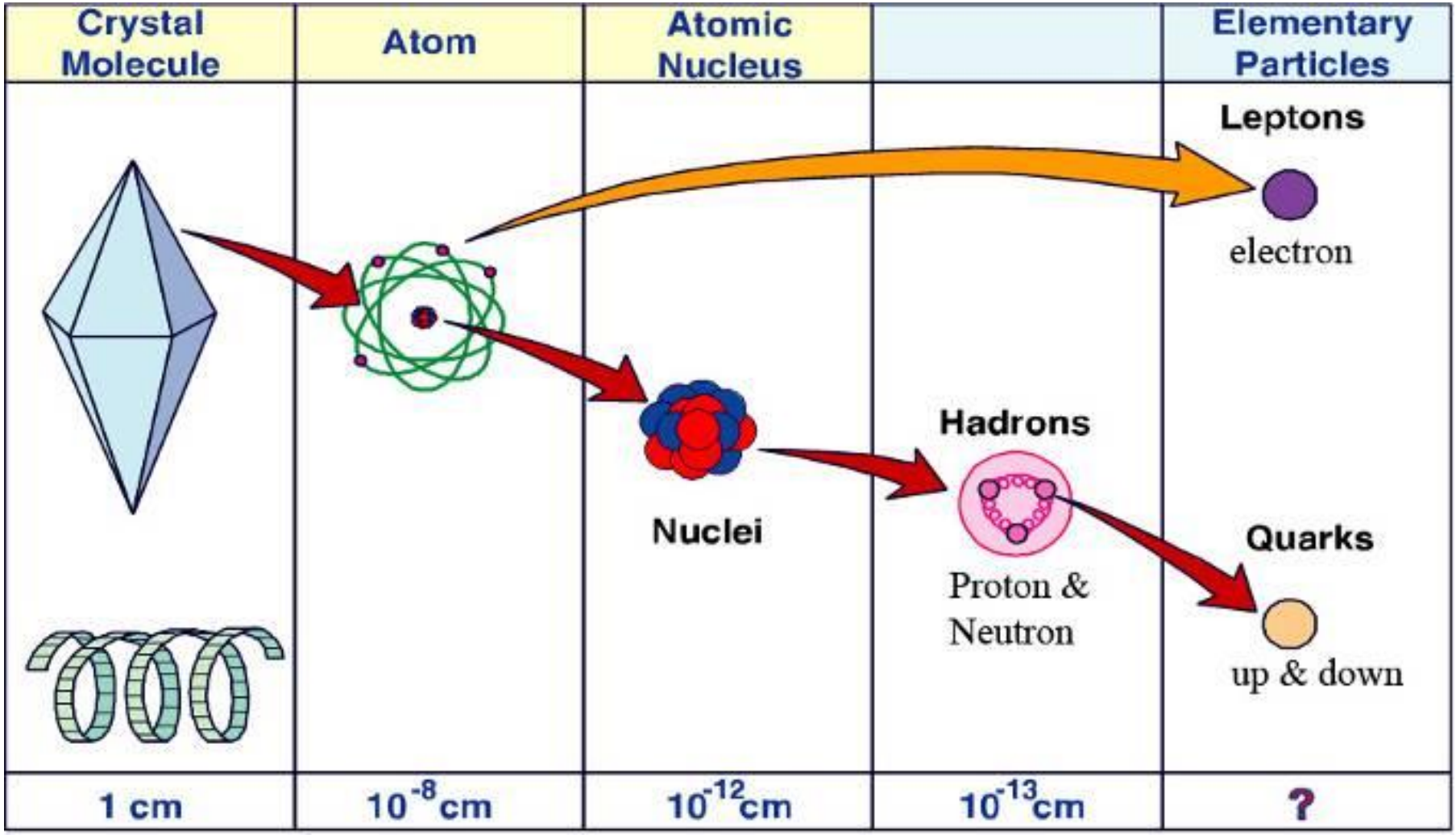
Fabiola Gianotti
ATLAS Spokesperson 2010-2012

Joe Incandela
CMS Spokesperson 2012-2013

…that made a lot of physicists VERY happy…

So what is all the fuss about?

Our current understanding of the constituents of matter



Universal building blocks

Quarks

Up (u)

Down (d)

Lepton

electron

Chemistry!

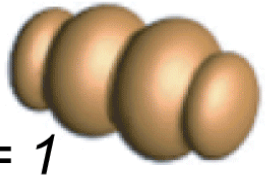
Groups of 3 quarks form Nucleons

- uud = proton
- udd = neutron

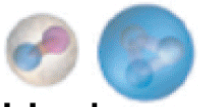
Universal forces

Strong

Gluons



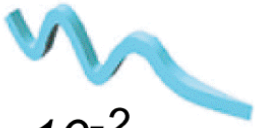
Strength = 1



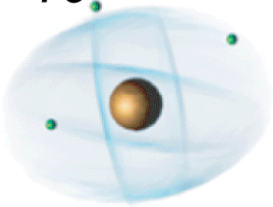
Hadrons Nuclei

Electromagnetic

Photon



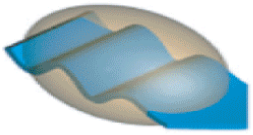
Strength = 10^{-2}



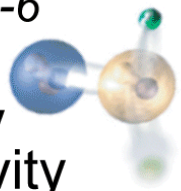
Atoms
Light
Chemistry
Electronics

Weak

W & Z



Strength = 10^{-6}



Neutron decay
Beta radioactivity
Neutrino interactions
Burning of the sun

Gravitational

Graviton

Strength = 10^{-40}

Solar system
Galaxies
Black holes

But that is not the end of the story…

13,700,000,000 years ago there were other things in the Universe – that we can “create” in the laboratory

So we have built a Time Machine!

Fundamental Particles at the time of the Big Bang

Quarks


up


charm


top


down


strange


bottom

Leptons


electron


muon


tau


electron neutrino


muon neutrino

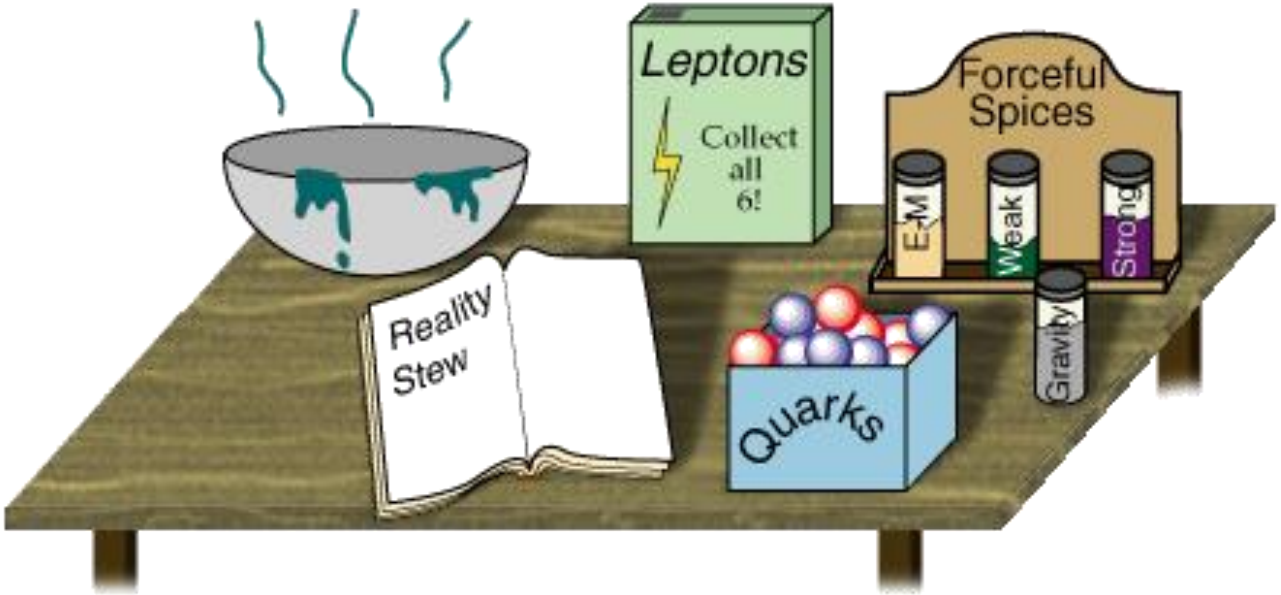

tau neutrino

It looks like we know everything. Right?

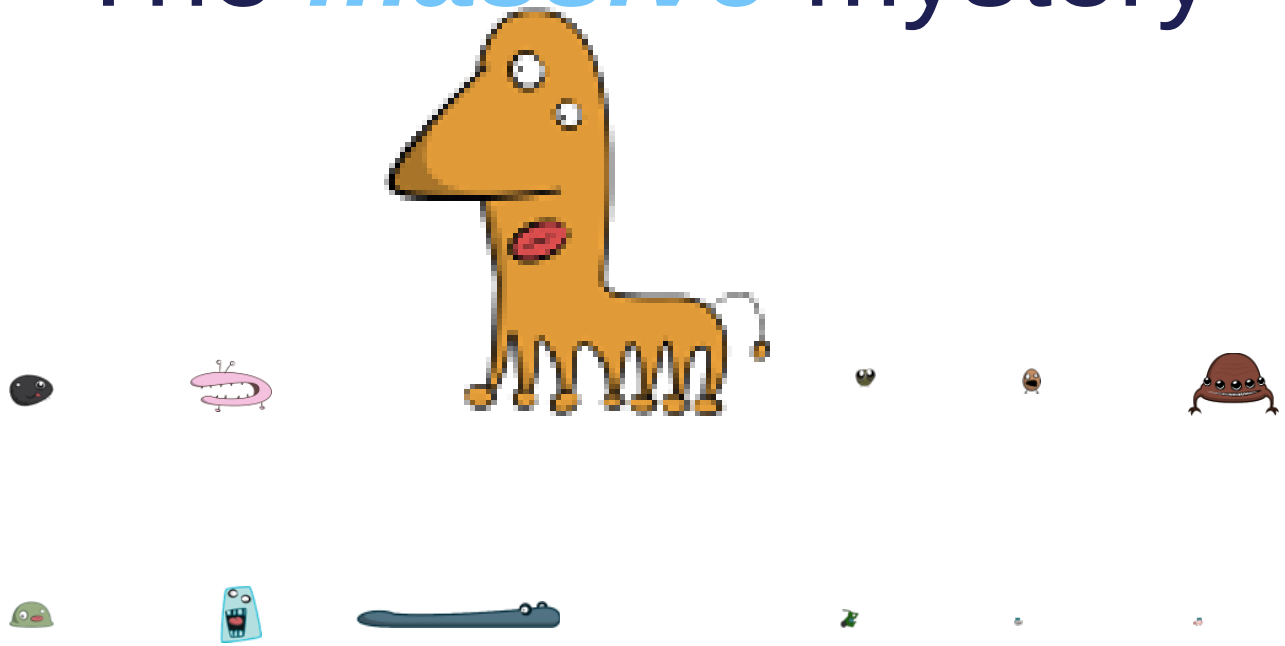
In fact we know very little!

Answers to simple questions

- Since the early 70s, particle physicists have synthesized all their knowledge in a single model: the «Standard Model»
- We know and we understand a lot but we do not know everything …
- Mysteries remain unexplained
- There are things to discover ...



The *massive* mystery



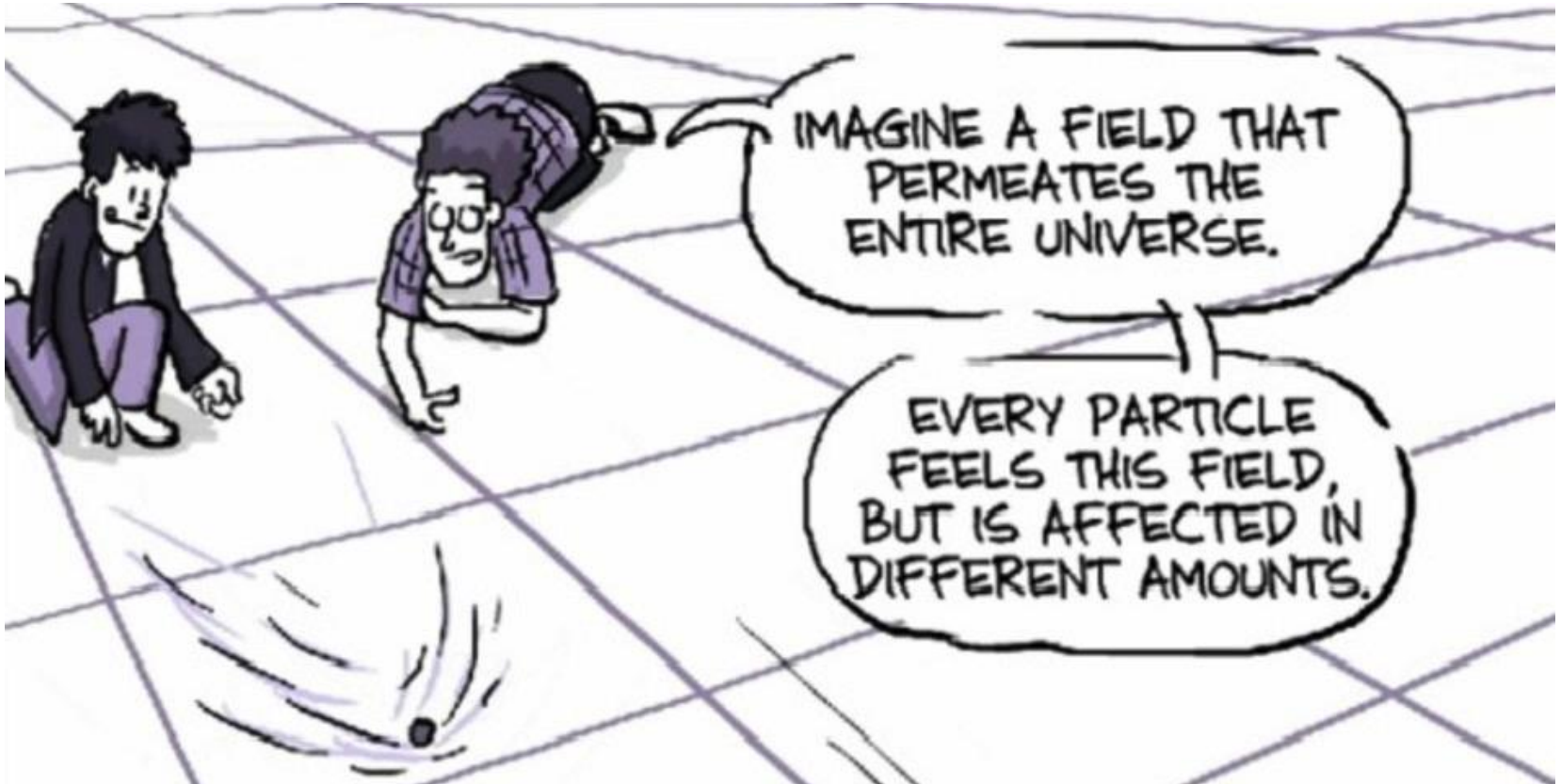
Why do some fundamental particles have mass while others don't?

Nearly 50 years ago six physicists proposed an explanation of how particles get mass…

Kibble Guralnik Hagen *Englert* Brout

Higgs

THEORY: The Brout-Englert-Higgs Field



The more a particle interacts with this *invisible* field, the more mass it gets.

But if this field is invisible, how can we PROVE it exists?

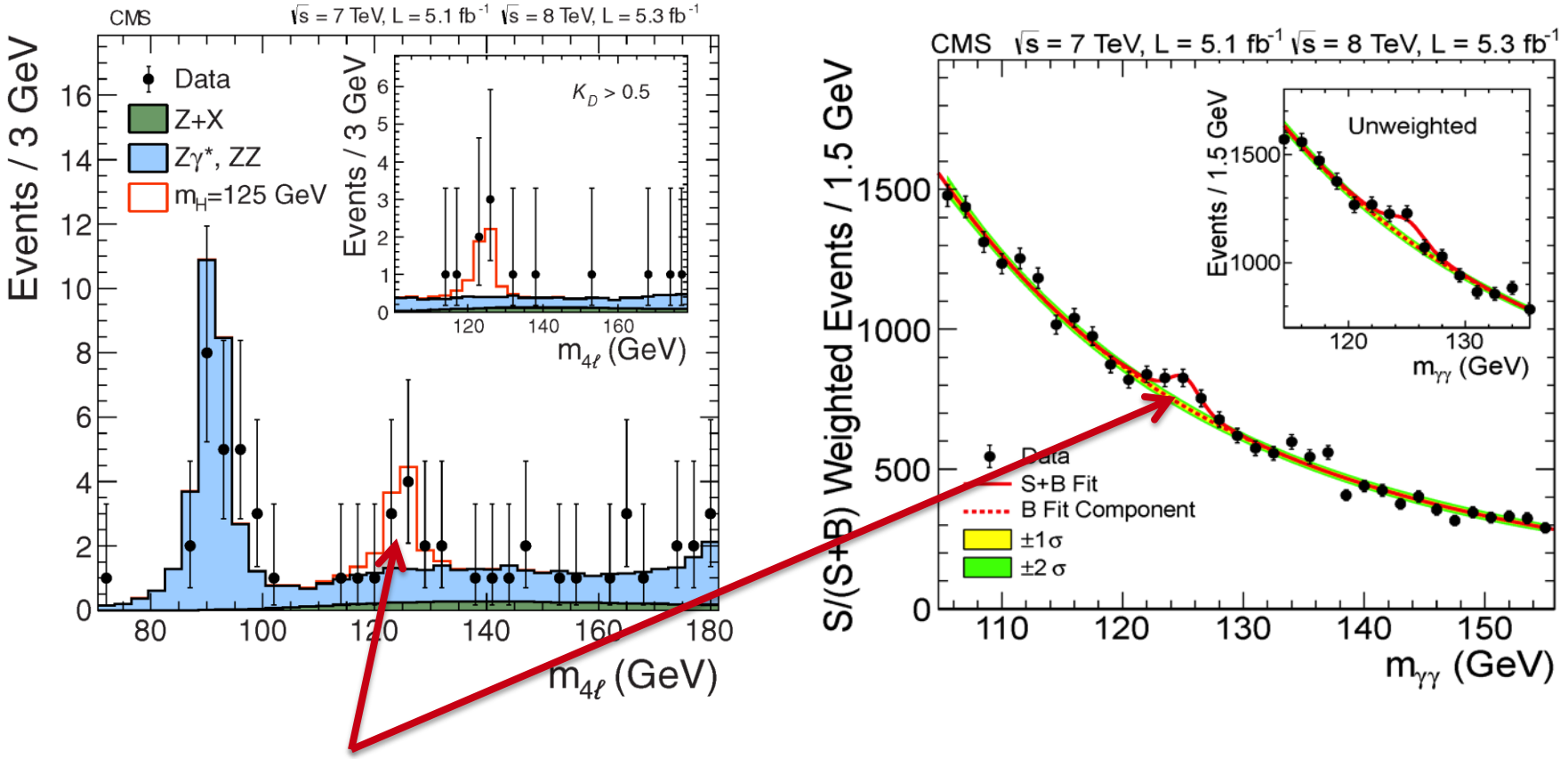
But if this field is invisible, how can we PROVE it exists?

The theory predicts that the field has an associated particle:

The Higgs Boson!

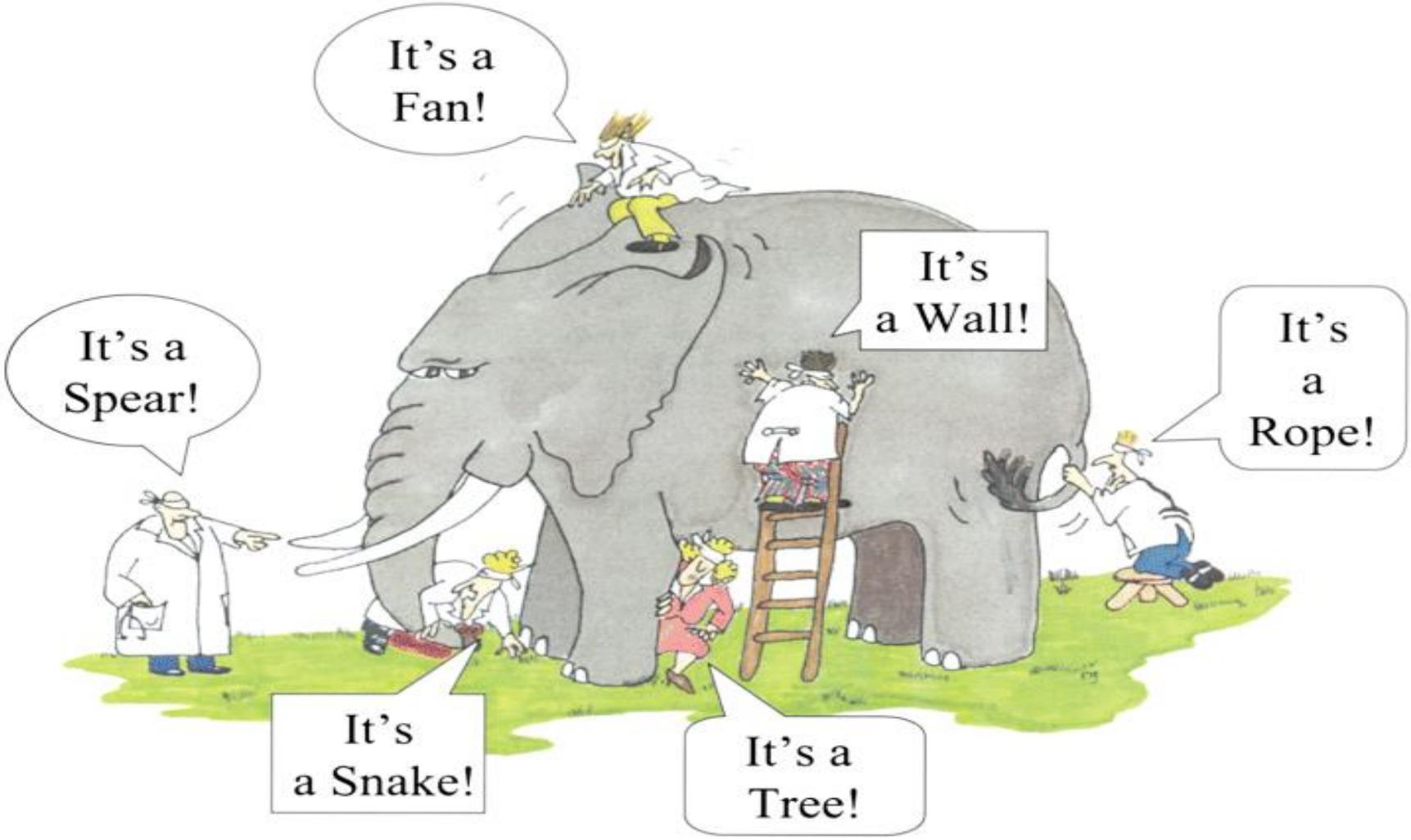
We can try to create the Higgs boson in our experiment!

We Found Some Higgs Bosons!!



These bumps in the data signify a new particle, found in two different ways, at the same mass – about 125 GeV/c2

But we have only just started to understand the Higgs boson…and we need to look from every angle



To create these particles, we have one of the fastest racetracks on earth:

The Large Hadron Collider

Several thousand billion protons travelling at 99.9999991% of the speed of light travel round the **27km ring, 100m underground, over 11000 times a second!**