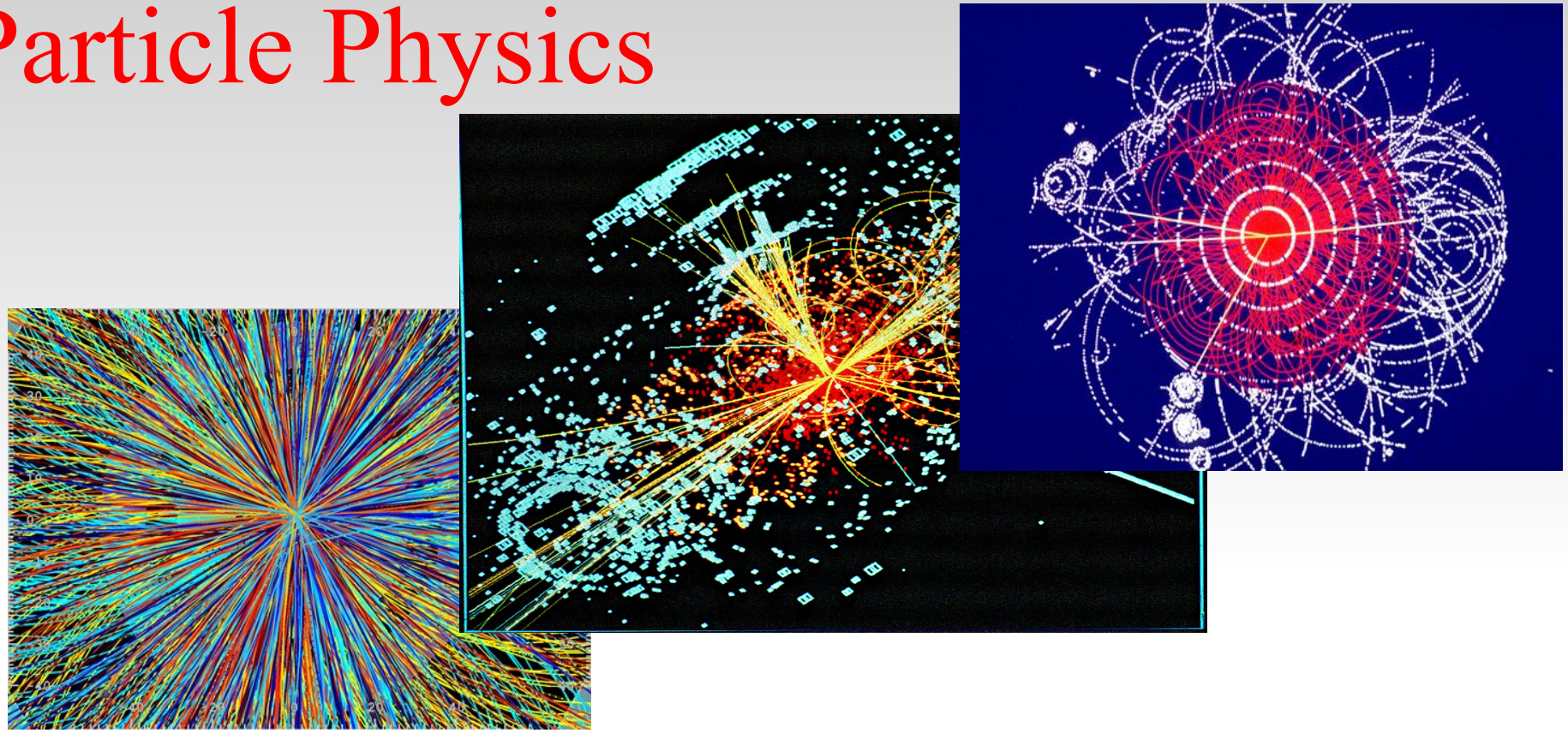
Particle Physics



University of Glasgow

Brian Colquhoun

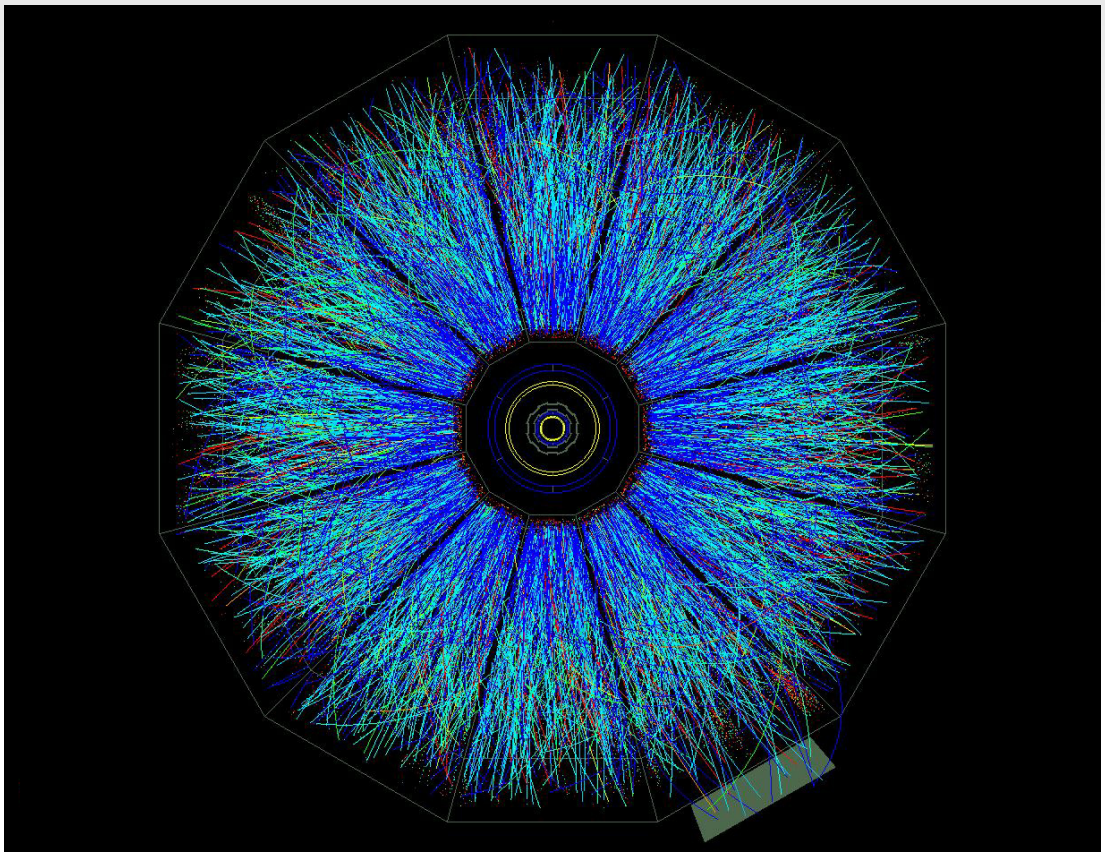
Physicists

“A physicist is a man who does research on natural things like black holes etc, and research on the future when it will be the end of the world” - Dilan

http://dessine-moi-un-physicien.web.cern.ch/dessine-moi-un-physicien/dessins/Bellavista-6PT/

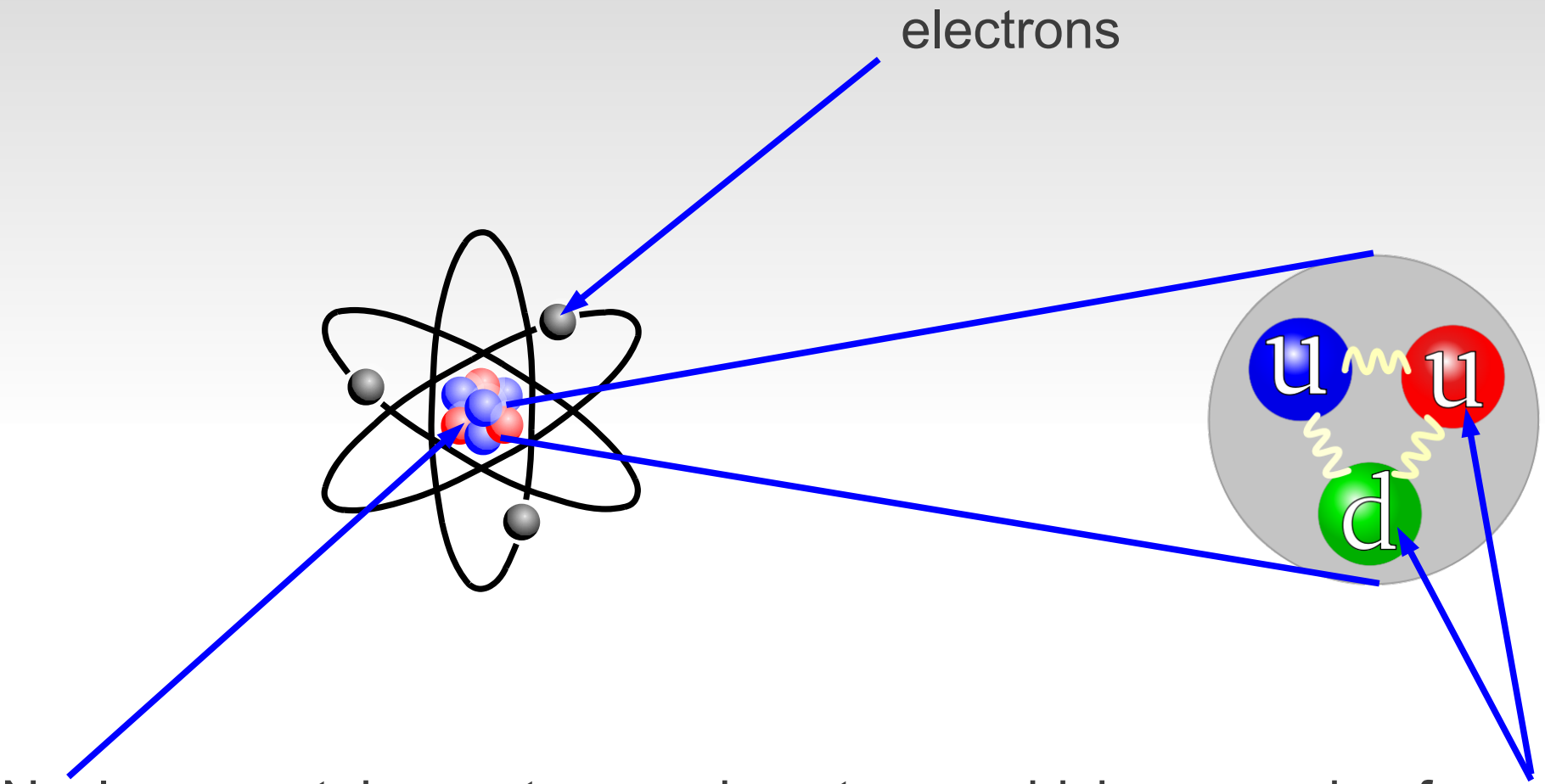
What is particle physics?

Particle physicists want to understand what particles there are in the universe.



But importantly we want to understand the forces that act between the particles, too!

What stuff is made of...

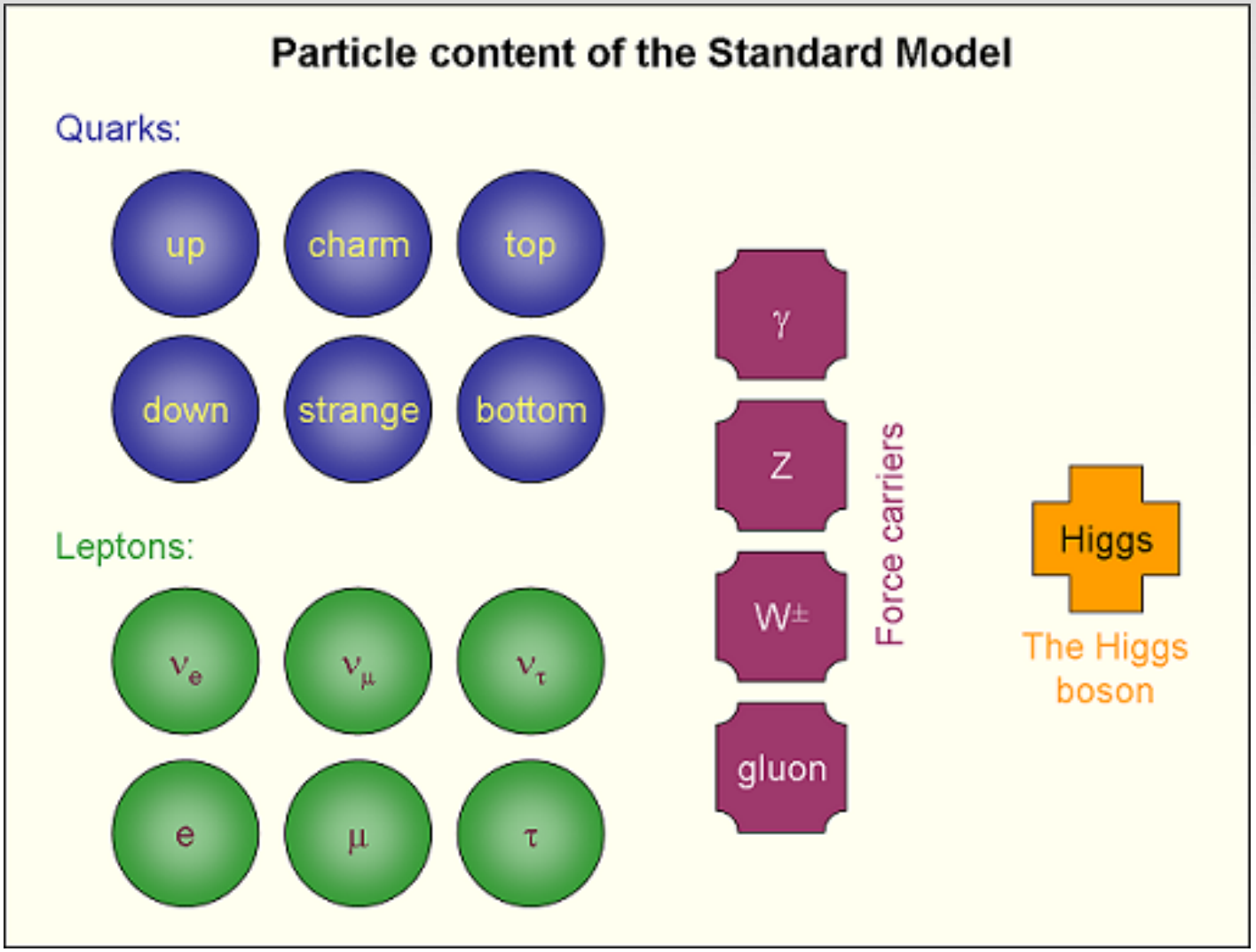


Nucleus: contains protons and neutrons, which are made of quarks.

The Standard Model

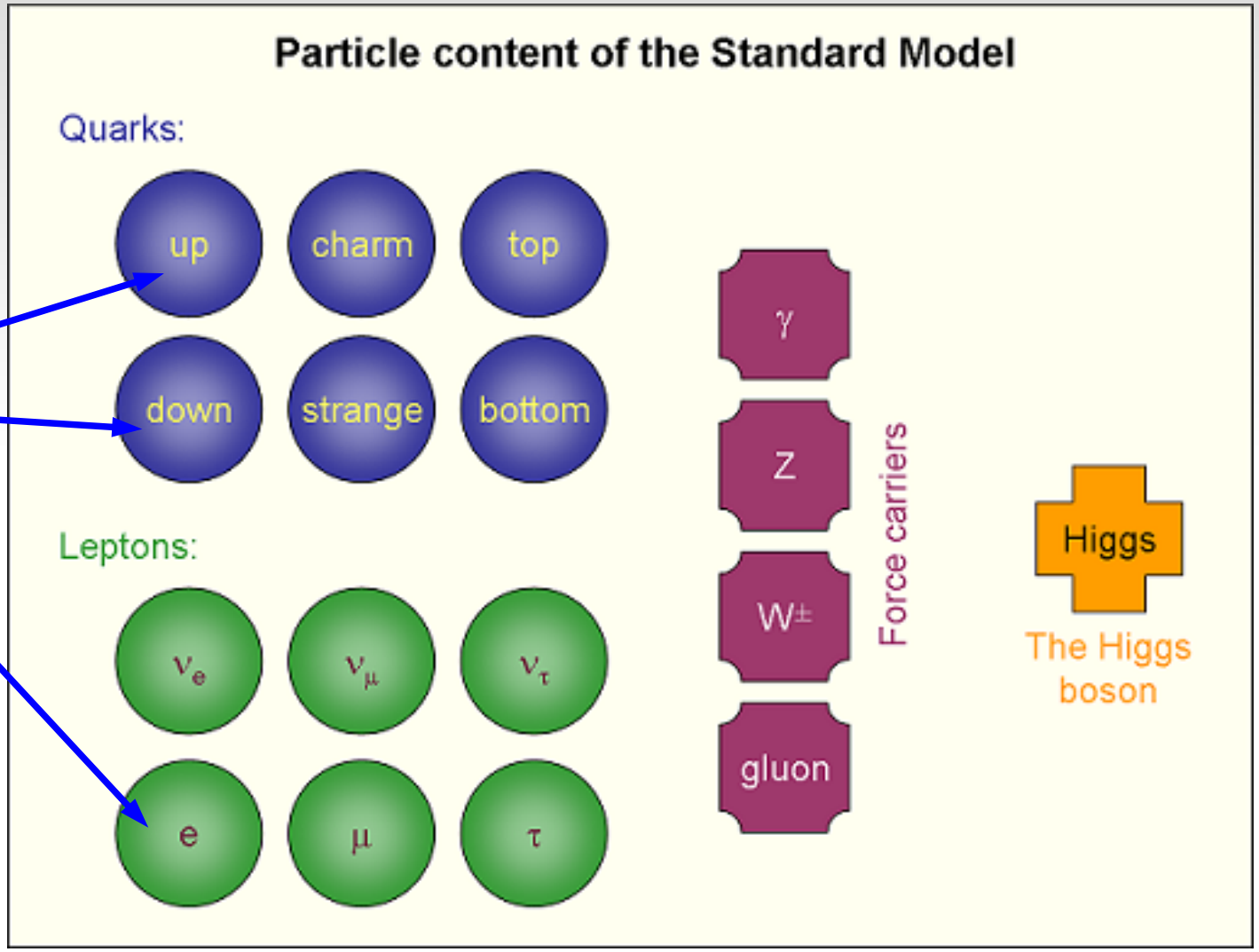
This is the standard model.

Everything we know about particle physics is here; every particle we have discovered has either been one of these or made of of these.

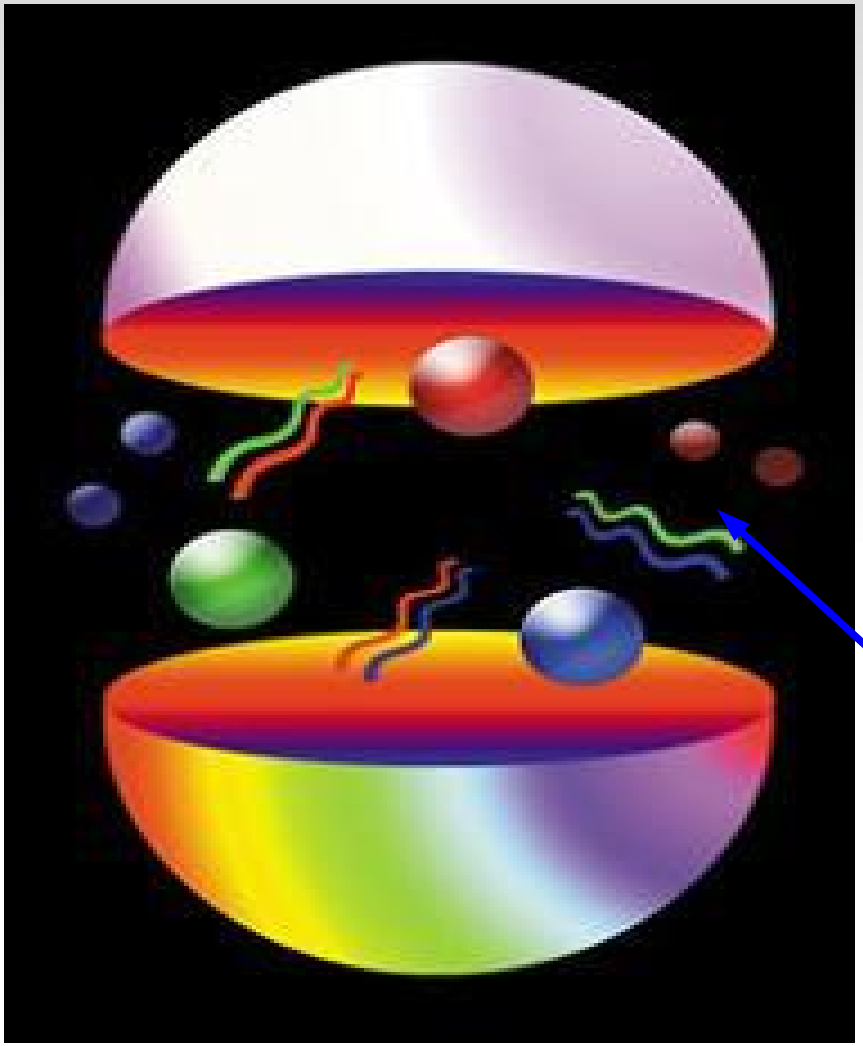


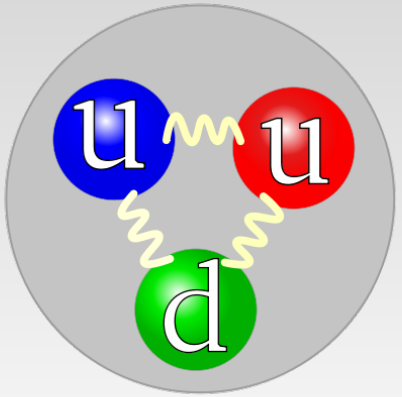
The Standard Model

You are made of these three. In fact, everything you can see is made of these three...



What protons are made of...





Three quarks: up, up and down.

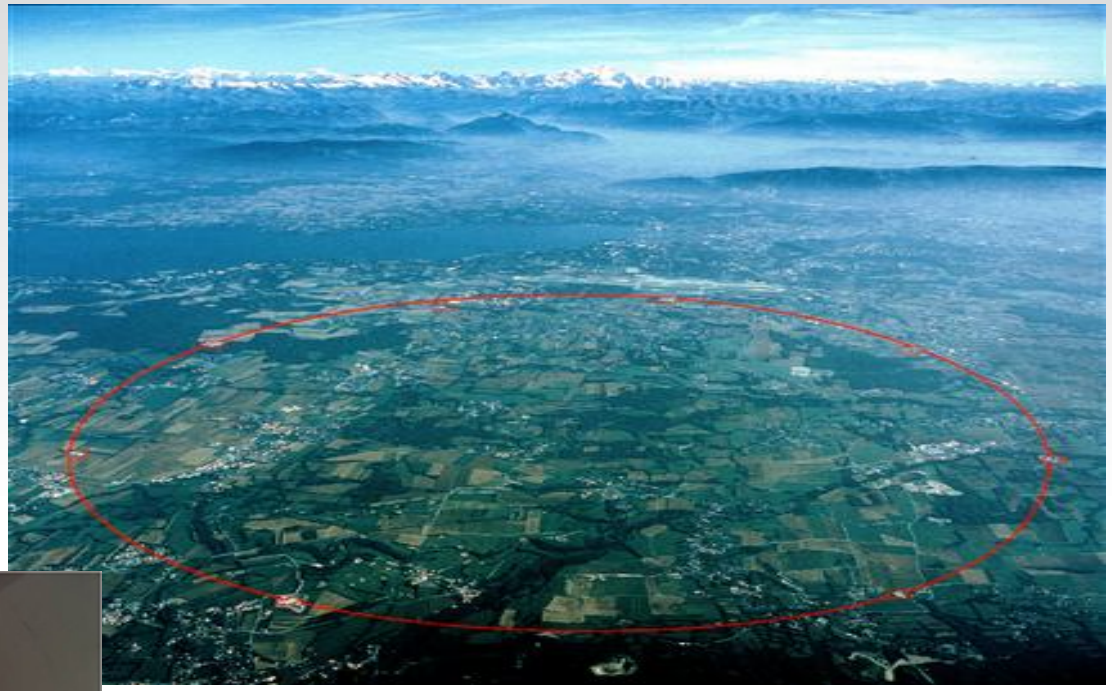
Also, there's a lot of other things happening. That's lucky for us – because of this other stuff we don't fly apart.

Any particles made up of quarks is called a hadron. That's why the machine at CERN is called...

The Large Hadron Collider

Underground tunnel almost 27km in circumference

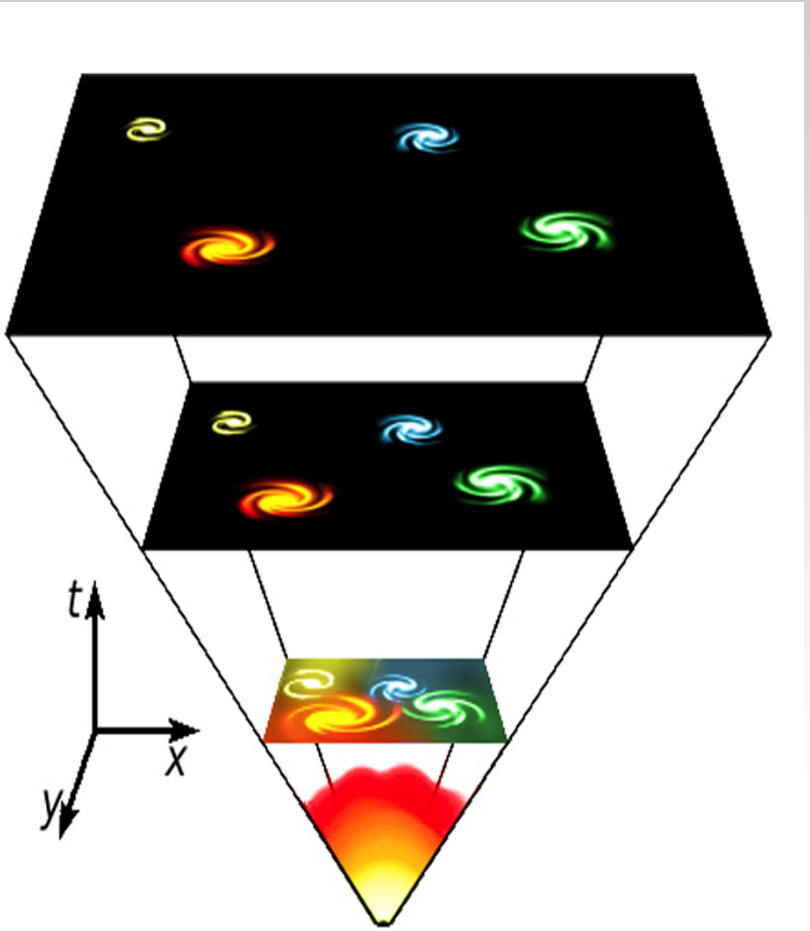
Biggest particle collider ever built and it has the highest energy.



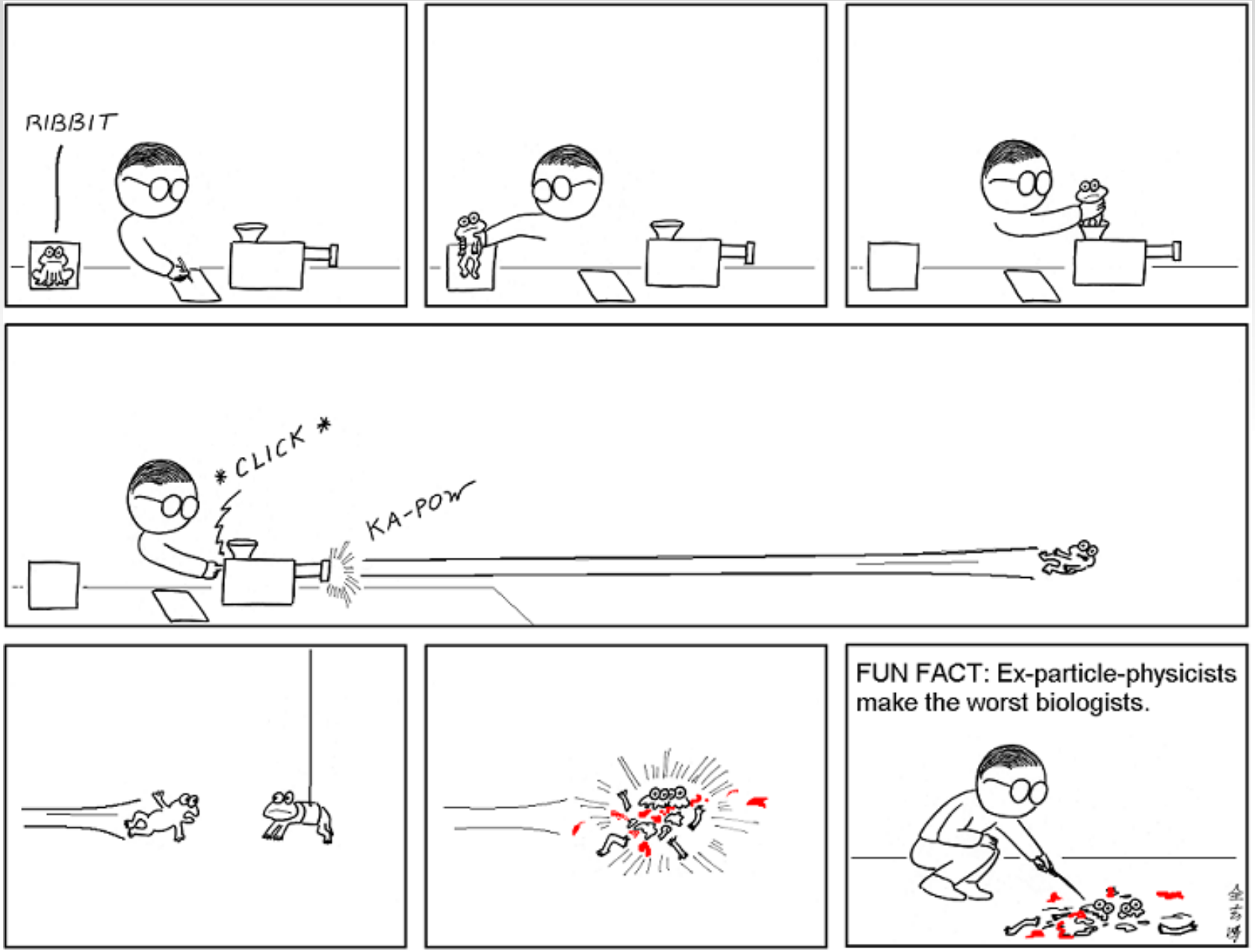
Two beams of protons are steered round the accelerator at almost the speed of light and collide together at four different experiments: ATLAS, CMS, LHCb and ALICE.

Unravelling the mysteries

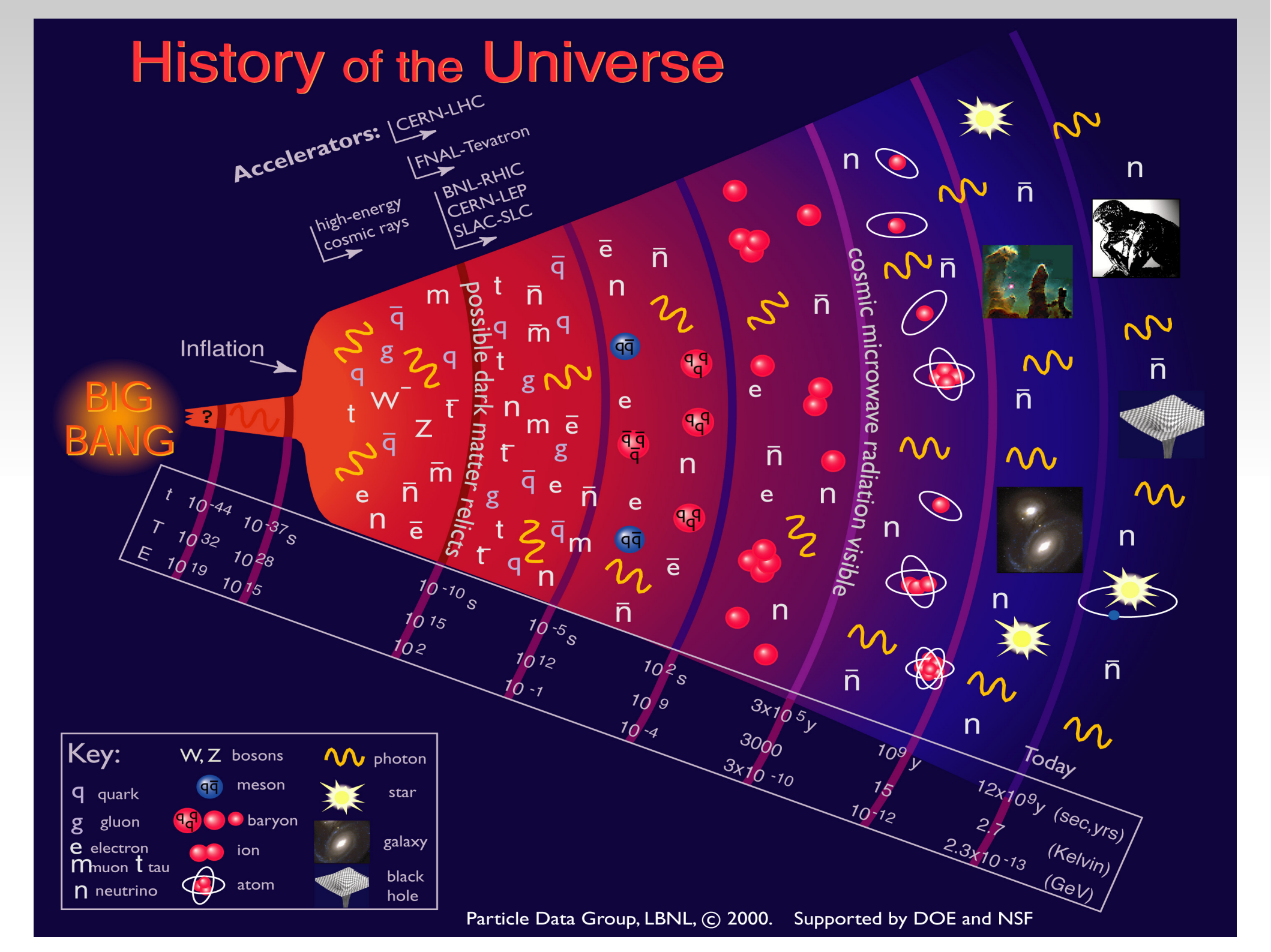
The conditions a fraction of a second after the big bang are created and we look through the debris.



Colliders aren't always the best way

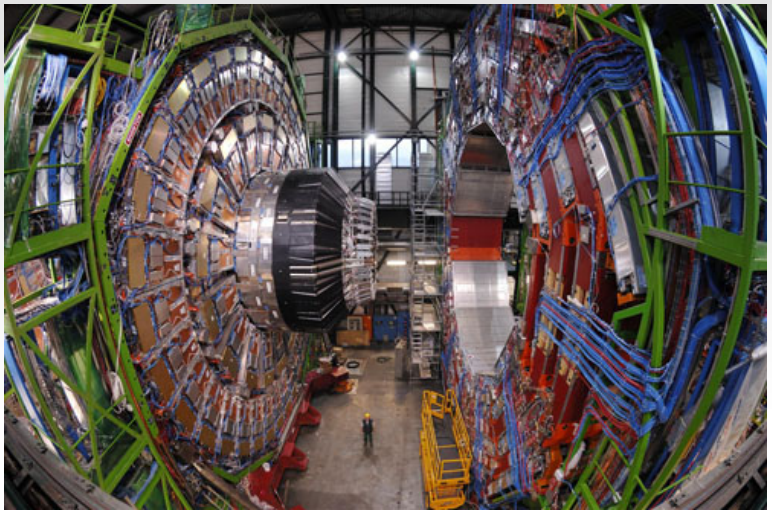


History of the Universe



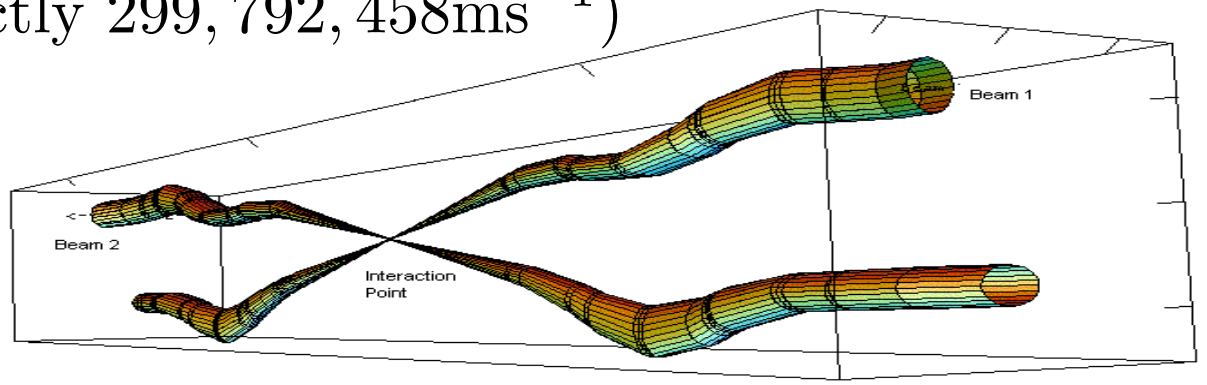
Facts and figures

$26,659$m in circumference.



9300 magnets inside to steer the beam.

Protons travel at 99.9999991% the speed of light.
(The speed of light is exactly $299,792,458\text{ms}^{-1}$)

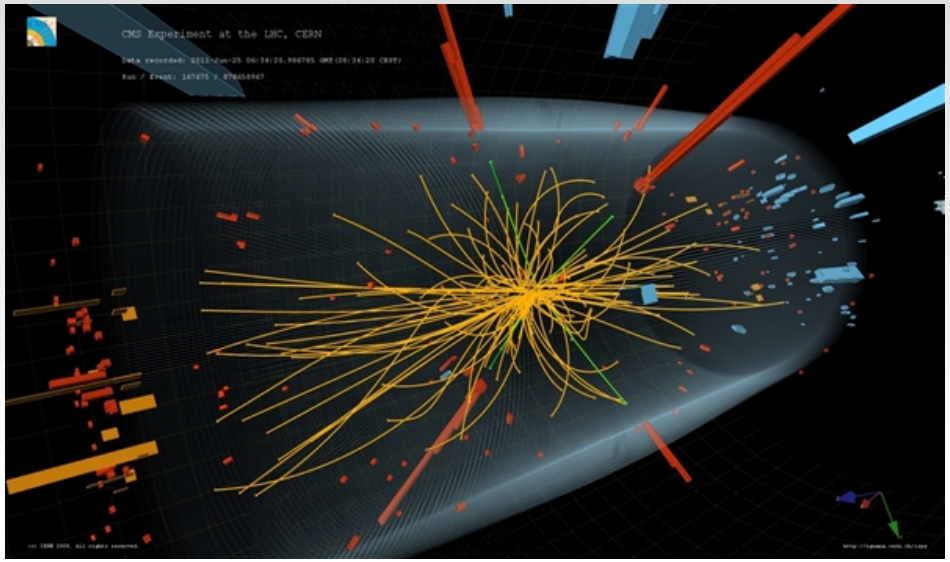


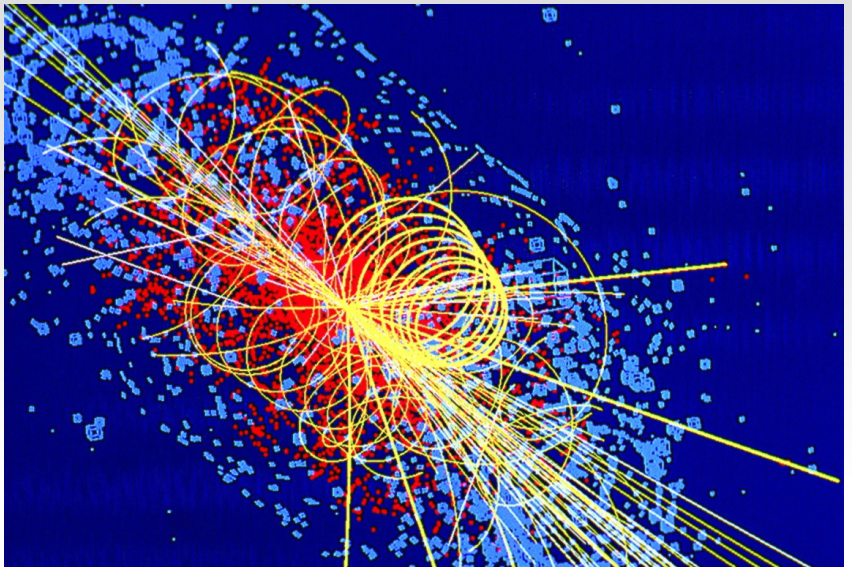
Relative beam sizes around IP1 (Atlas) in collision

The protons get round the accelerator ring $11,245$ times every second.

Facts and figures

Pressure is ten times lower than pressure on the moon



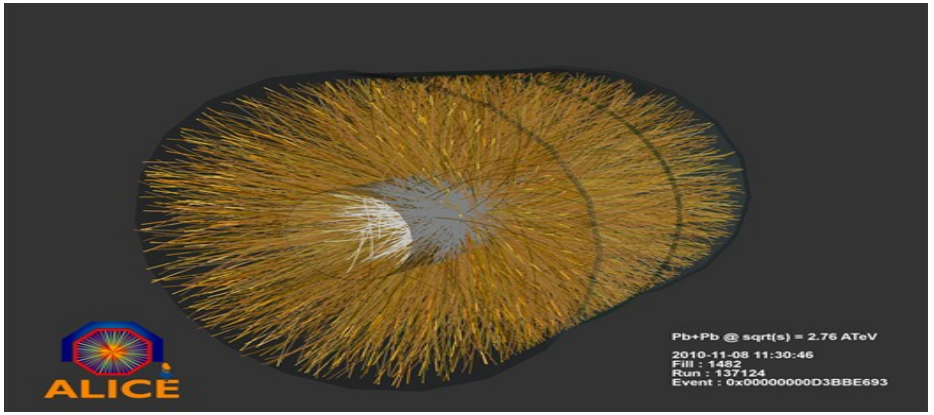


1.9 K (that's $-271.3°$C!); outer space is hotter at about 2.7K

Collisions are $100,000$ times hotter than the sun.

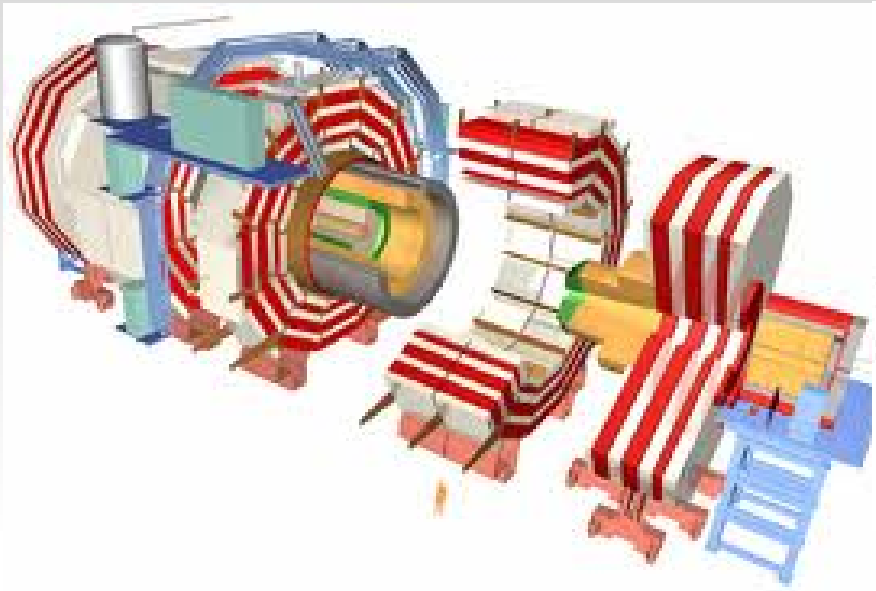
600 million collisions a second.

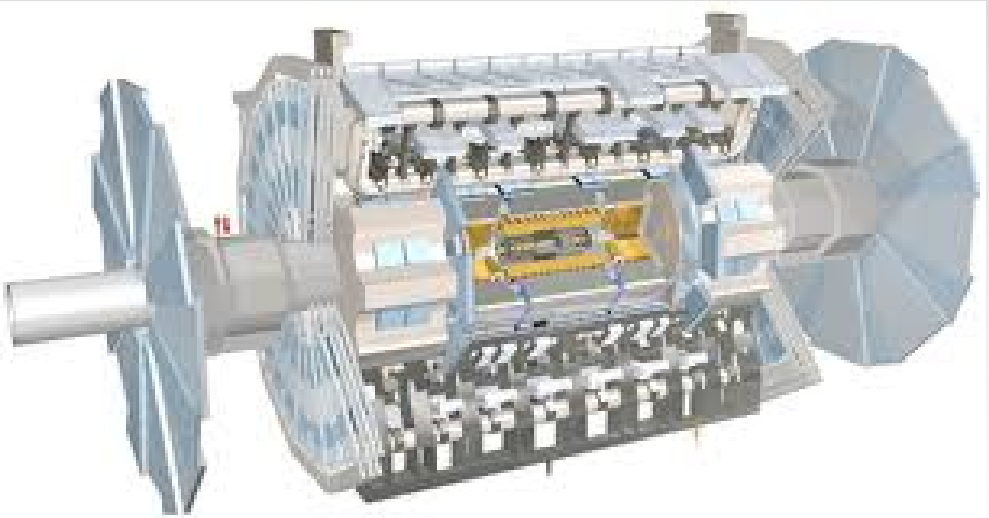
$100,000$ dual layer DVDs worth of data every year.

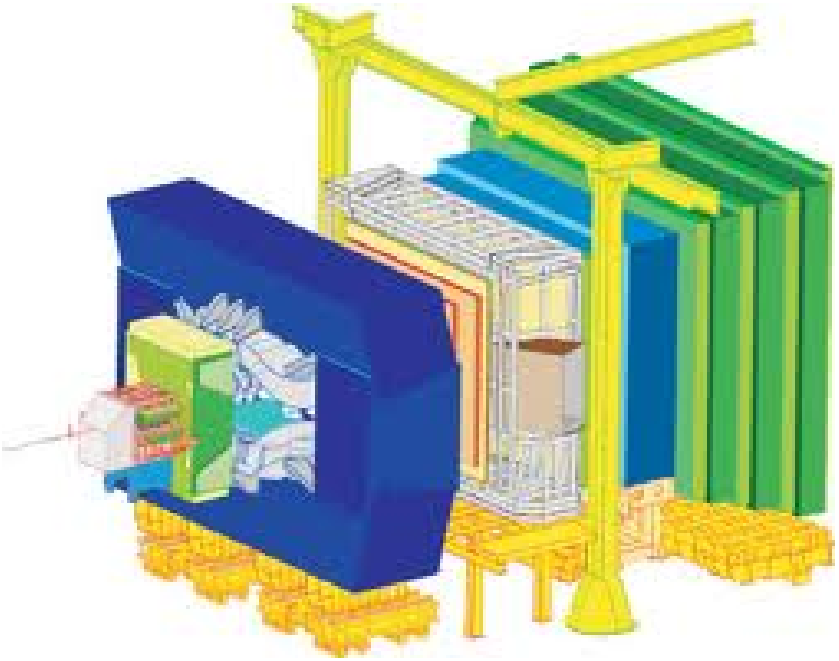


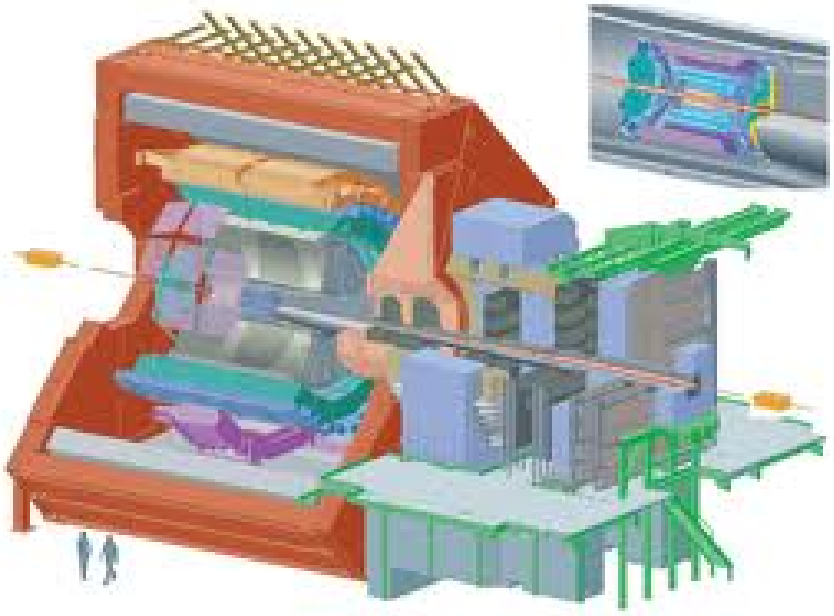
The Grid

The experiments

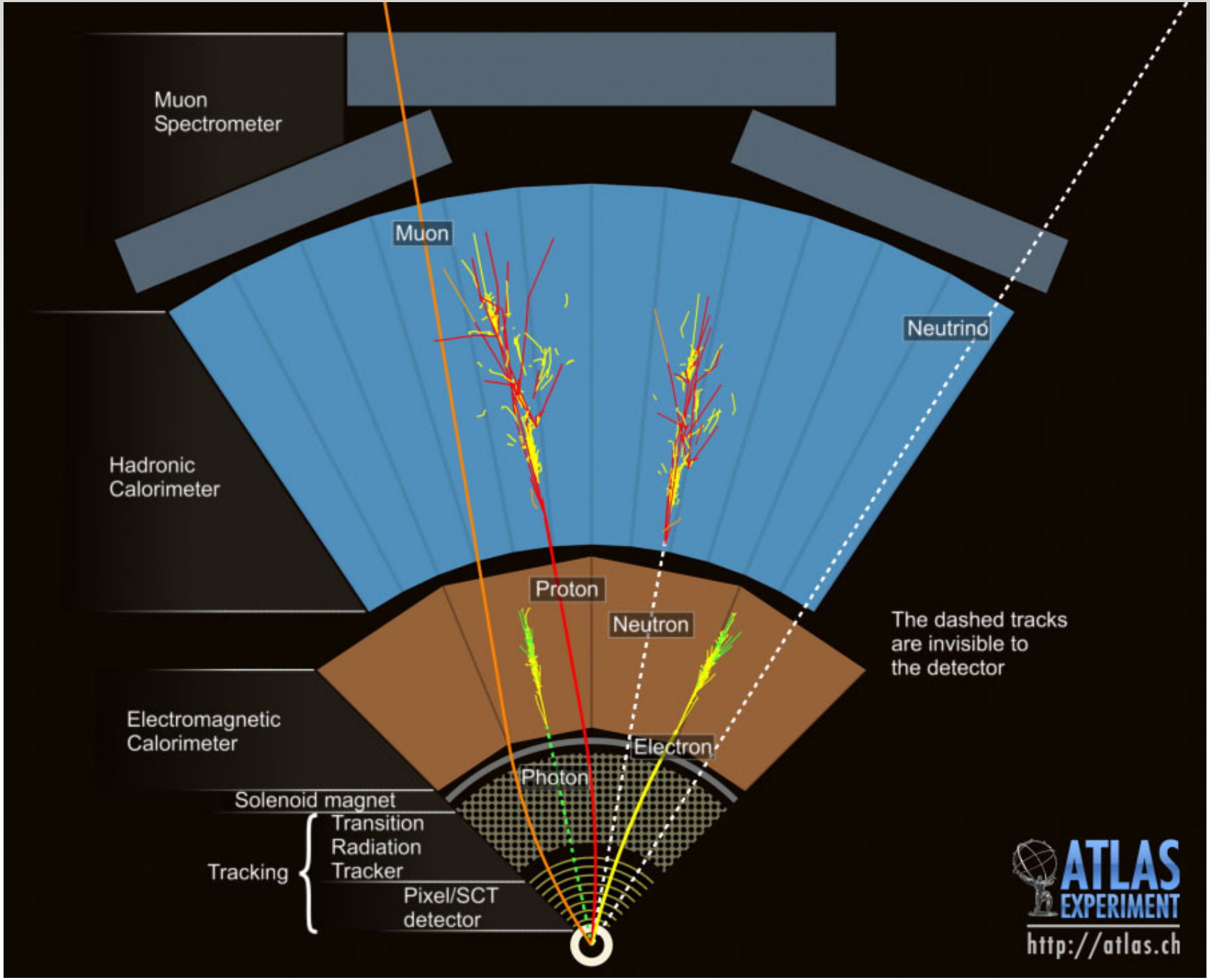




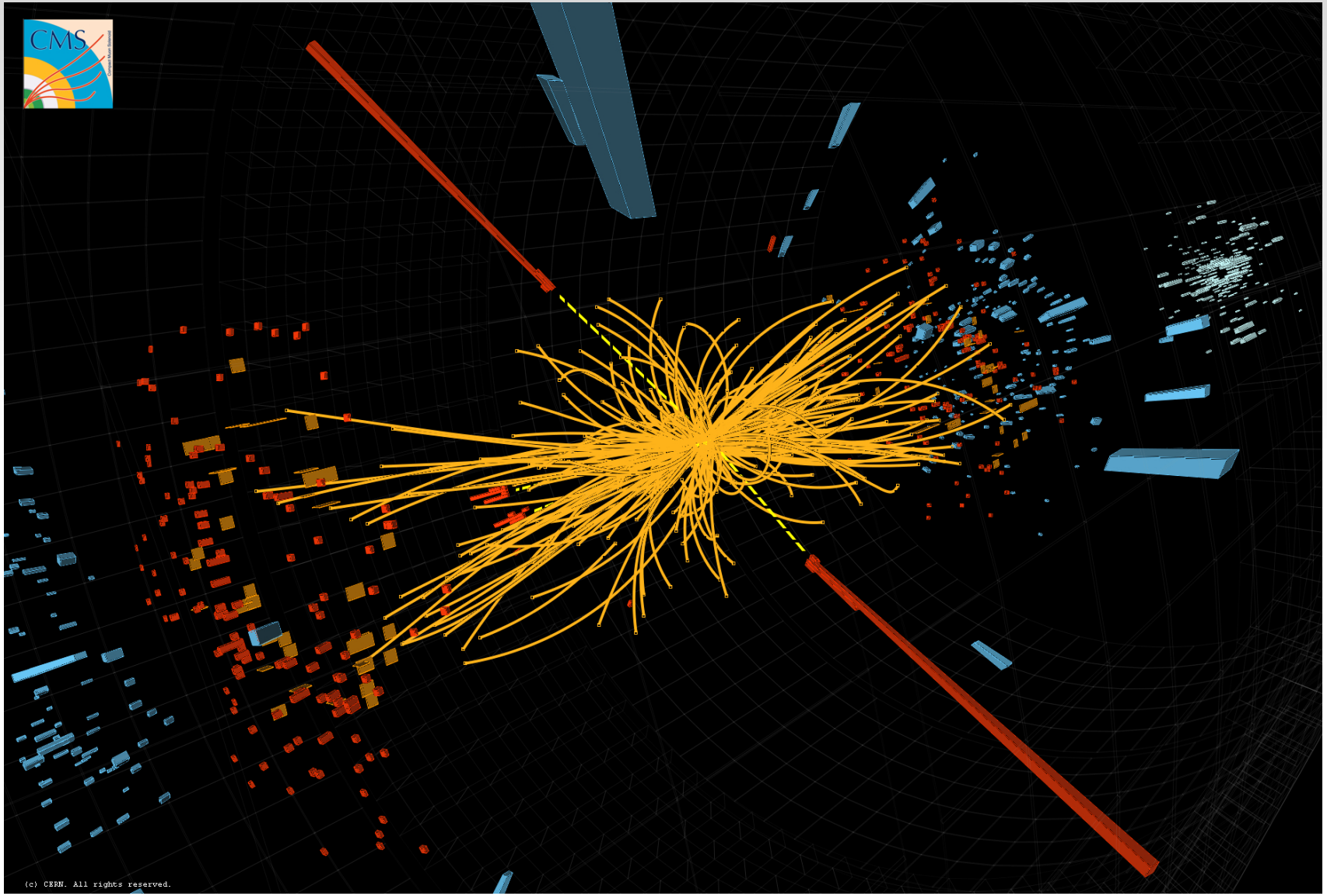




Detectors


Muon
Spectrometer
Muon
Neutrino
Hadronic
Calorimeter
Proton
Neutron
The dashed tracks
are invisible to
the detector
Electromagnetic
Calorimeter
Electron
Photon
Solenoid magnet
Tracking
Transition
Radiation
Tracker
Pixel/SCT
detector
ATLAS
EXPERIMENT
http://atlas.ch

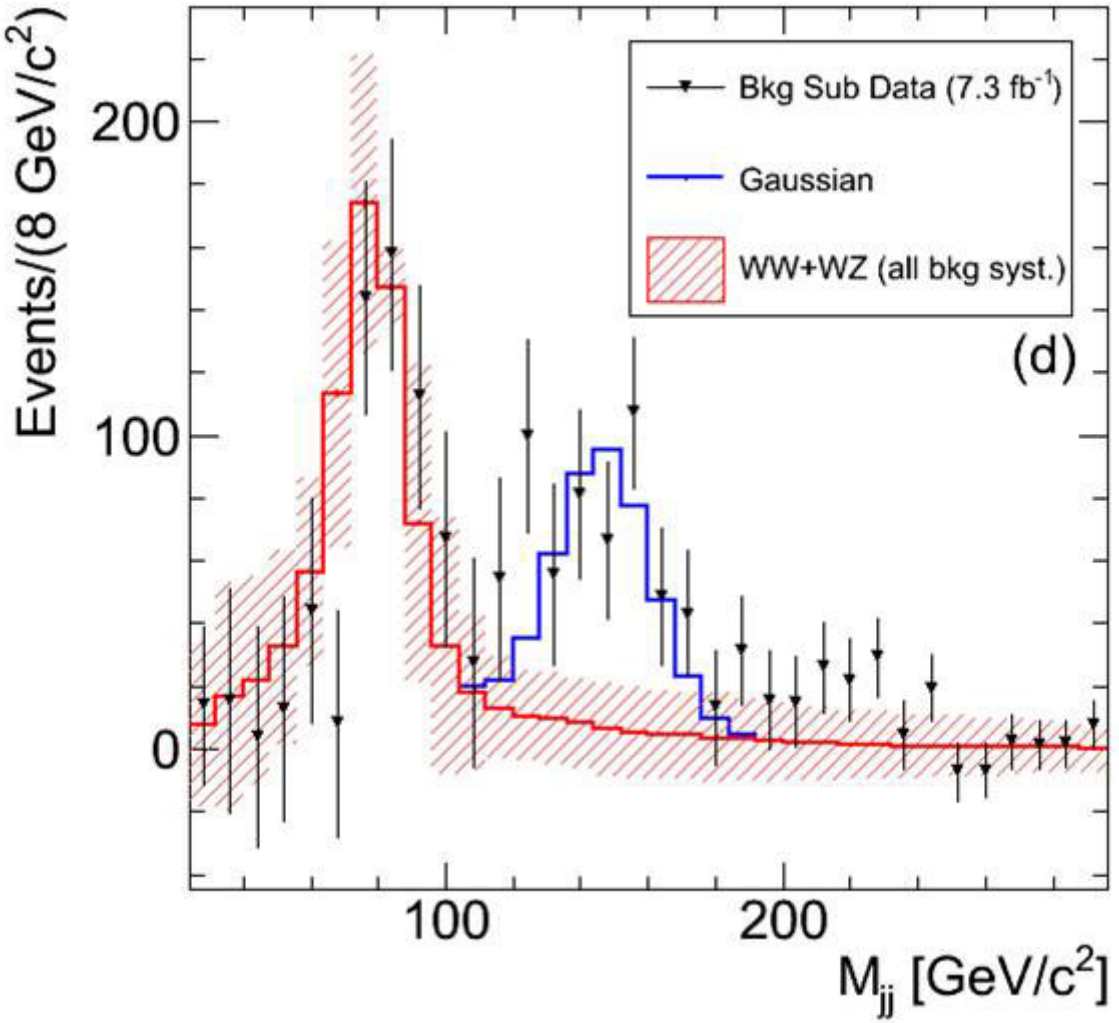
Reconstructing

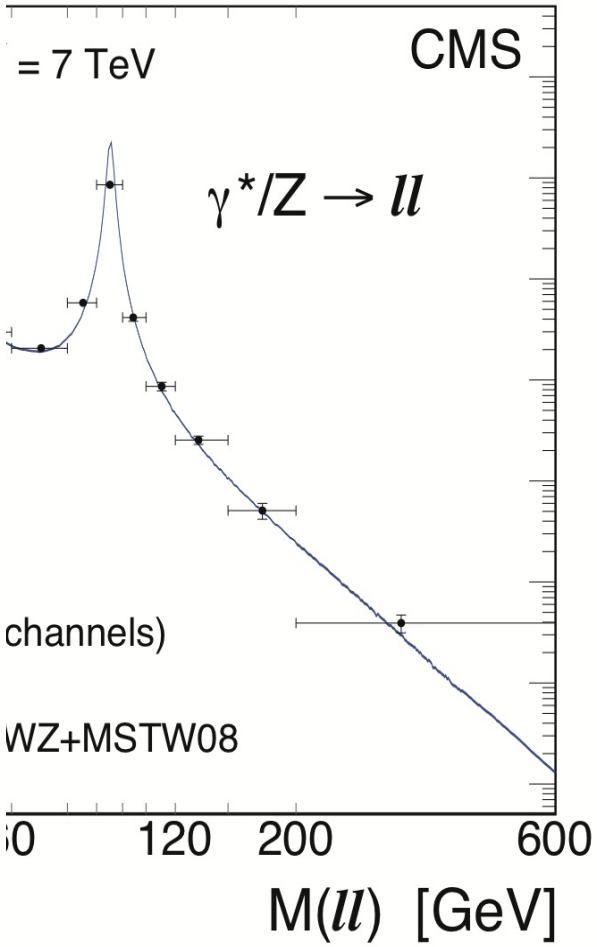


Do we really know what we're looking for?

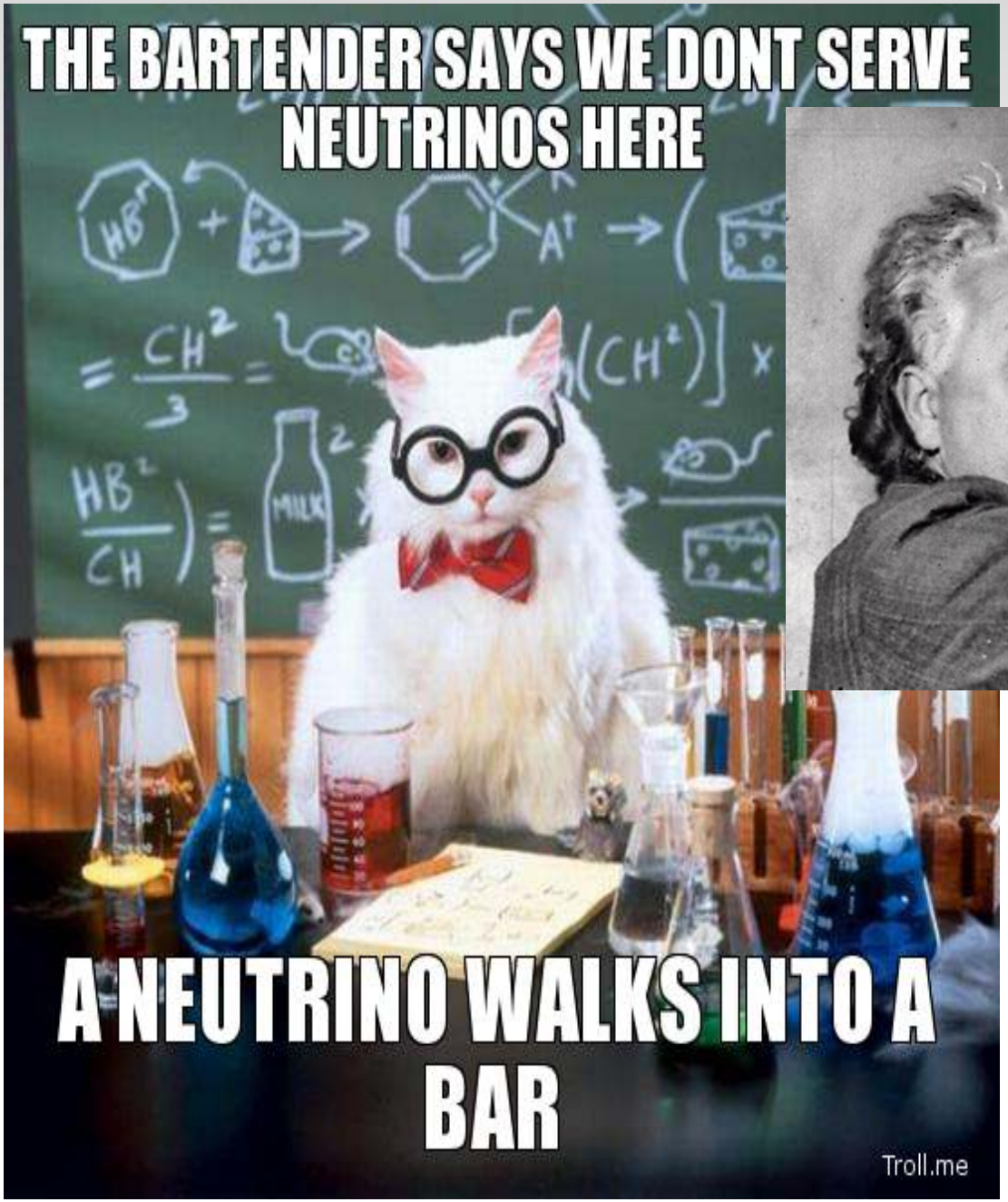
This is why experimental scientists hate theoretical scientists.

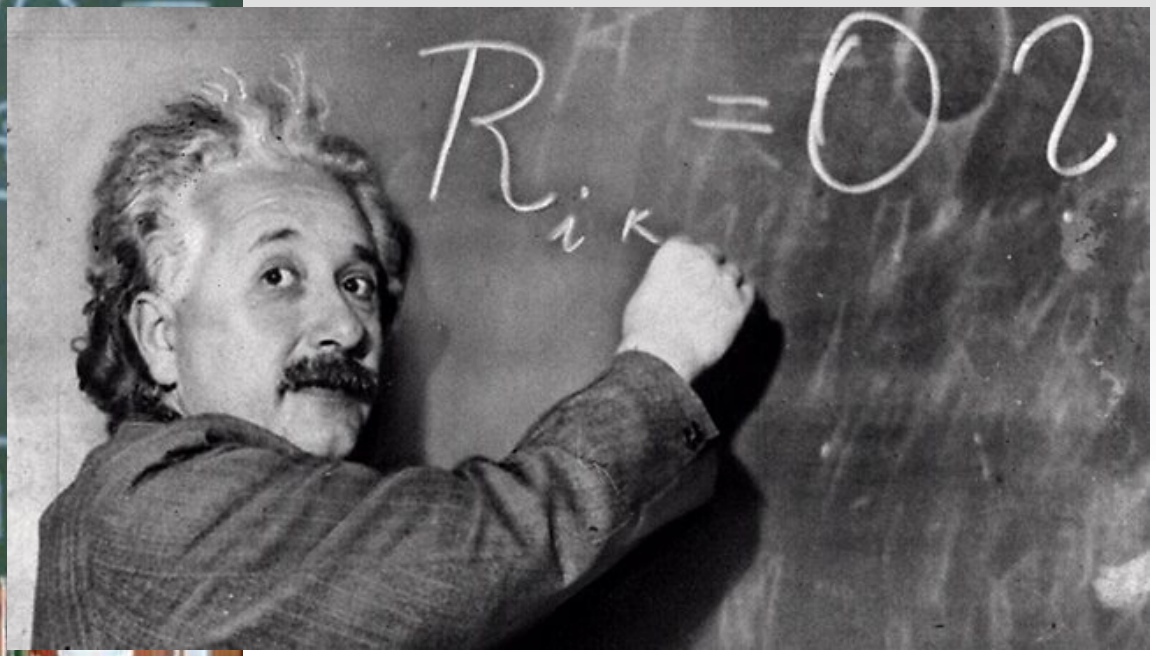
Looking for bumps



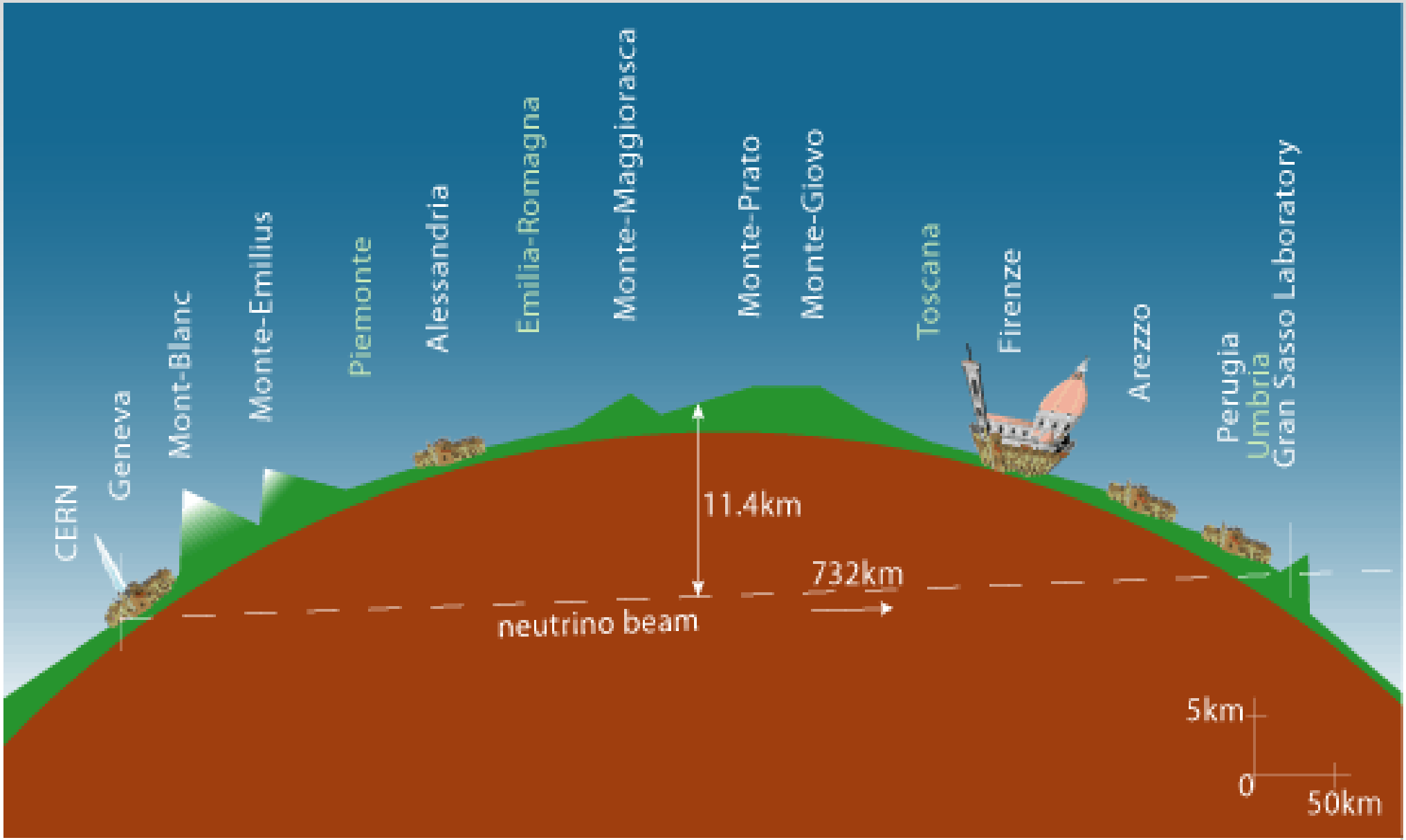


Faster than light neutrinos

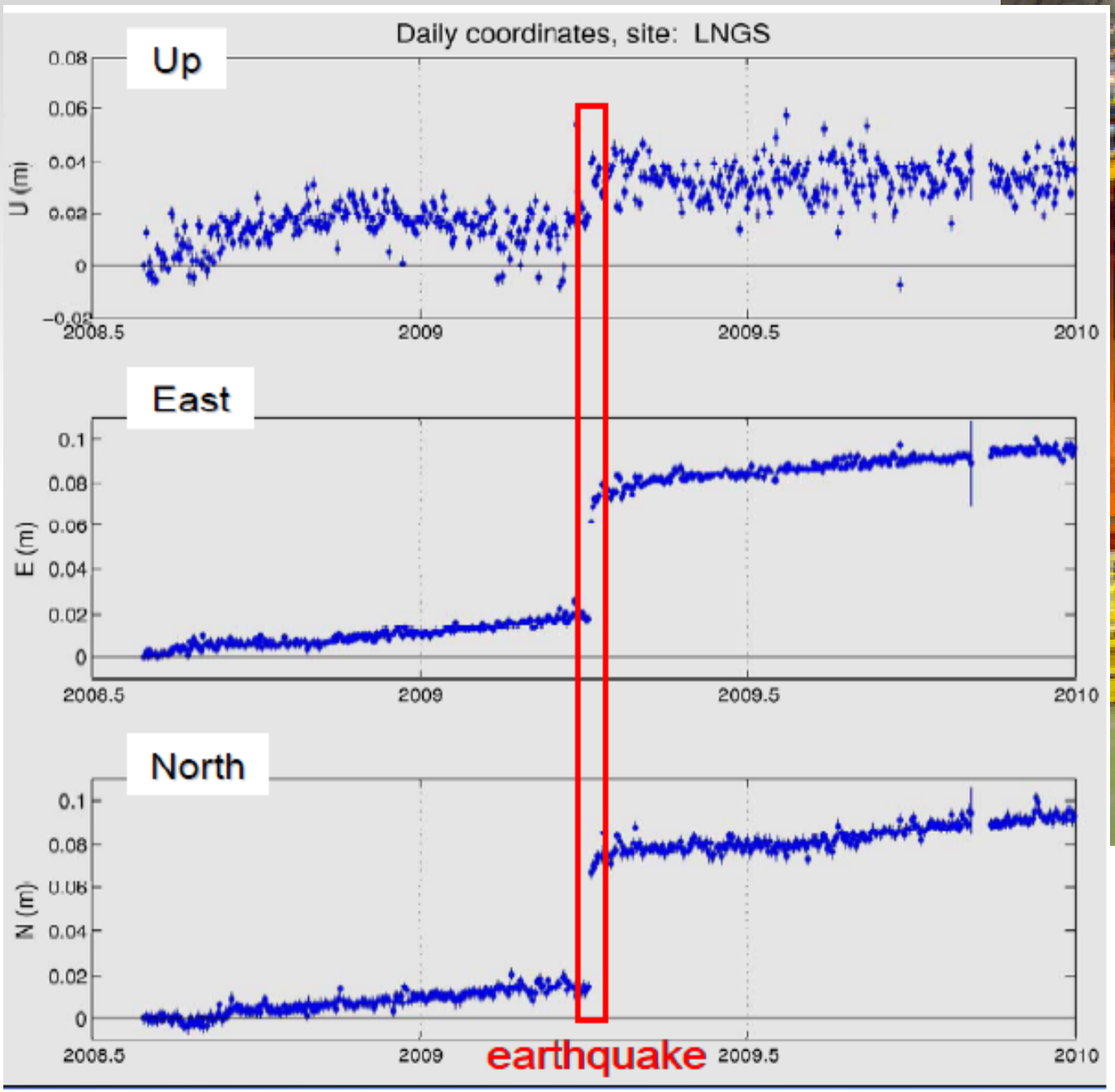


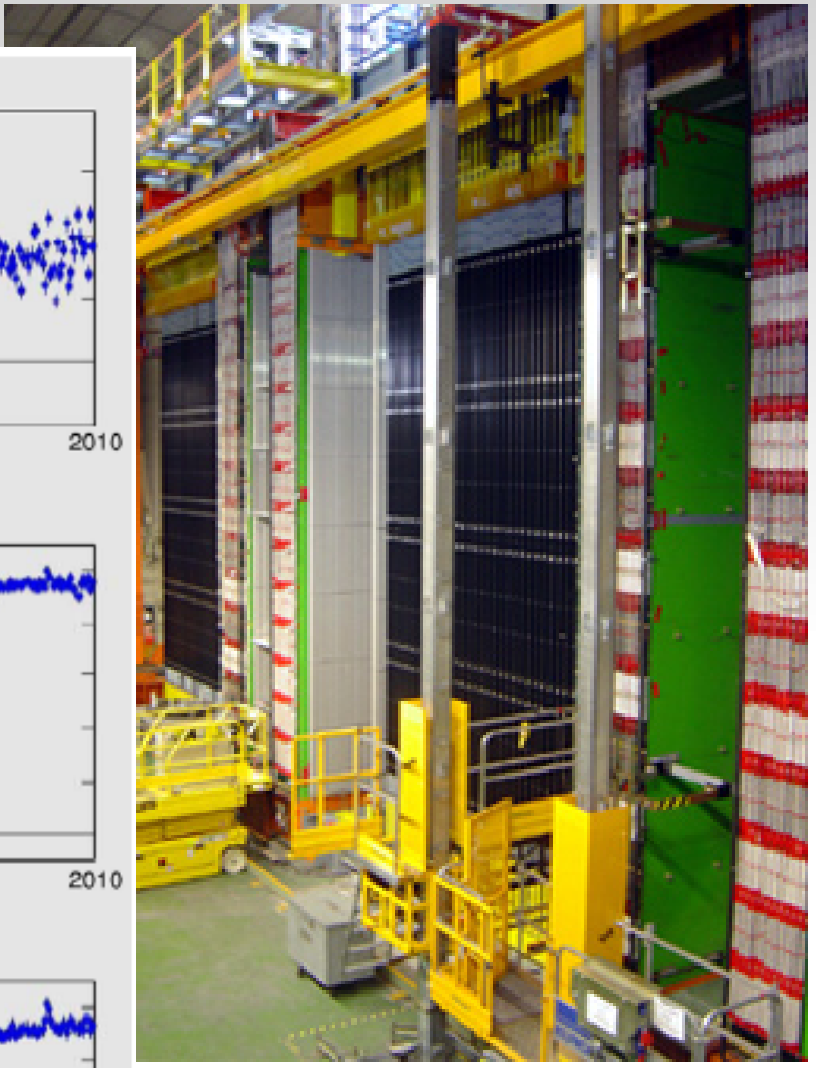


Faster than light neutrinos

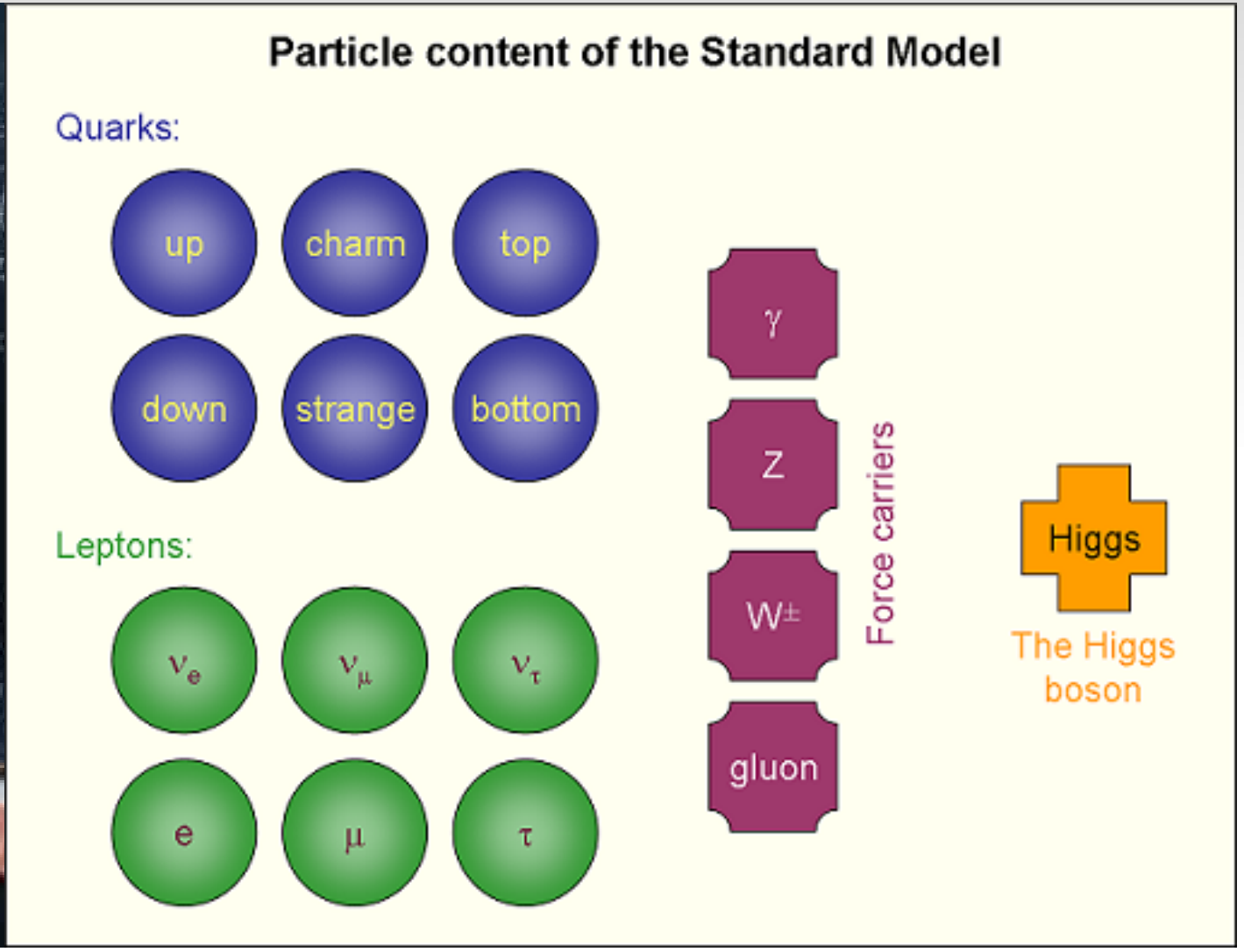


Faster than light neutrinos



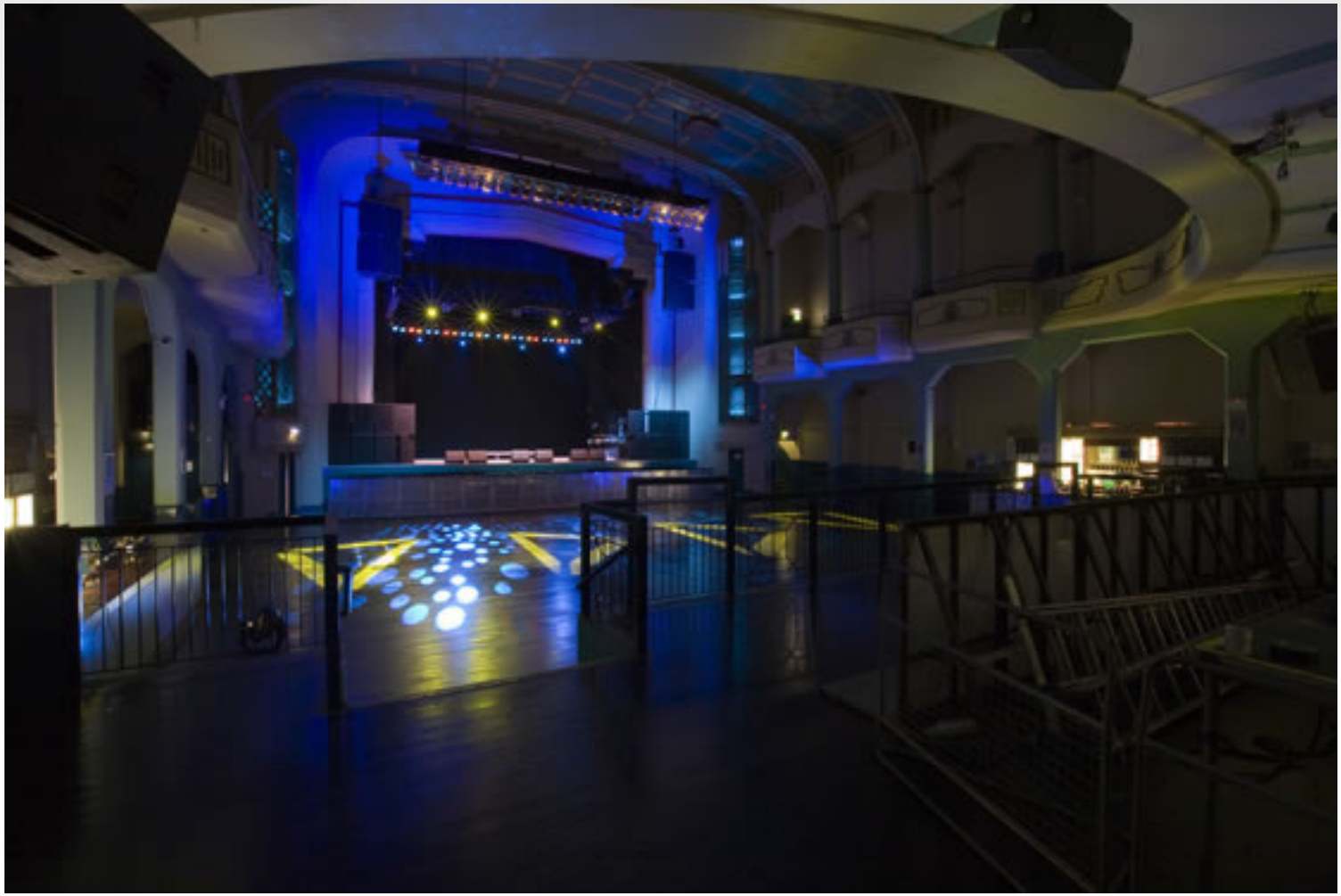


The Higgs Boson



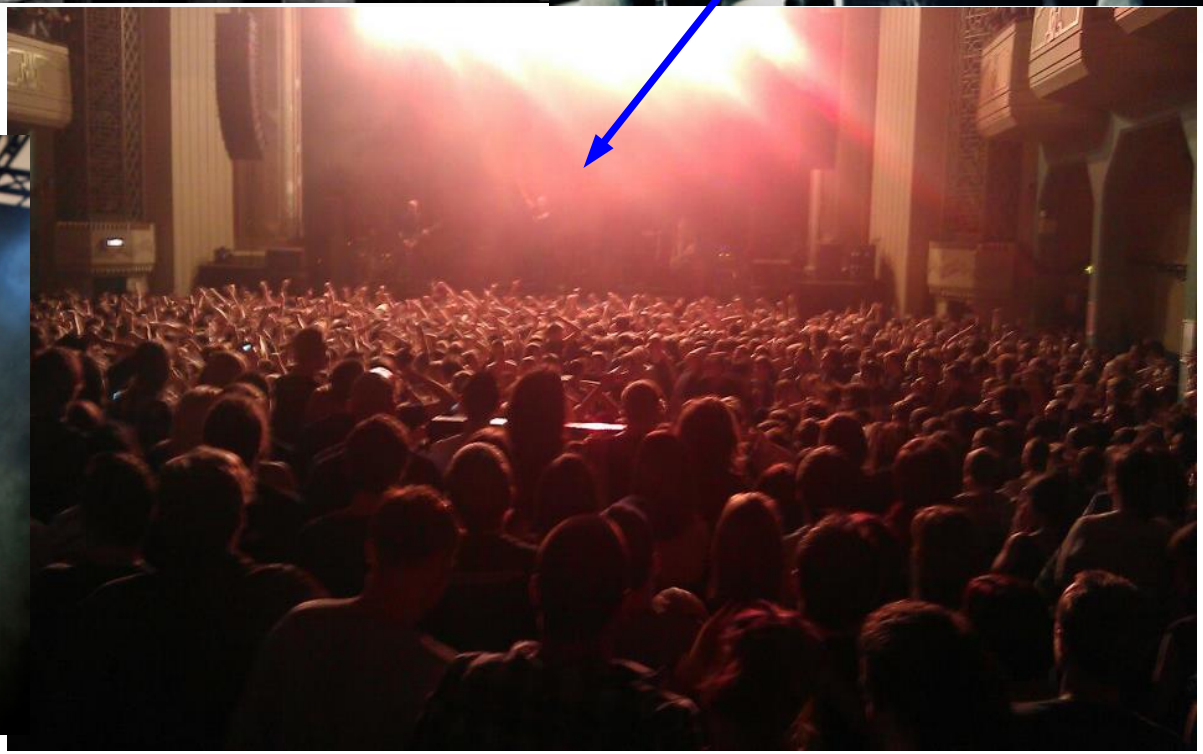
The Higgs Boson

The Higgs Boson is designed to fix a problem: although we predict the other particles in the standard model, they should be massless. The Higgs fixes this by giving the particles mass.

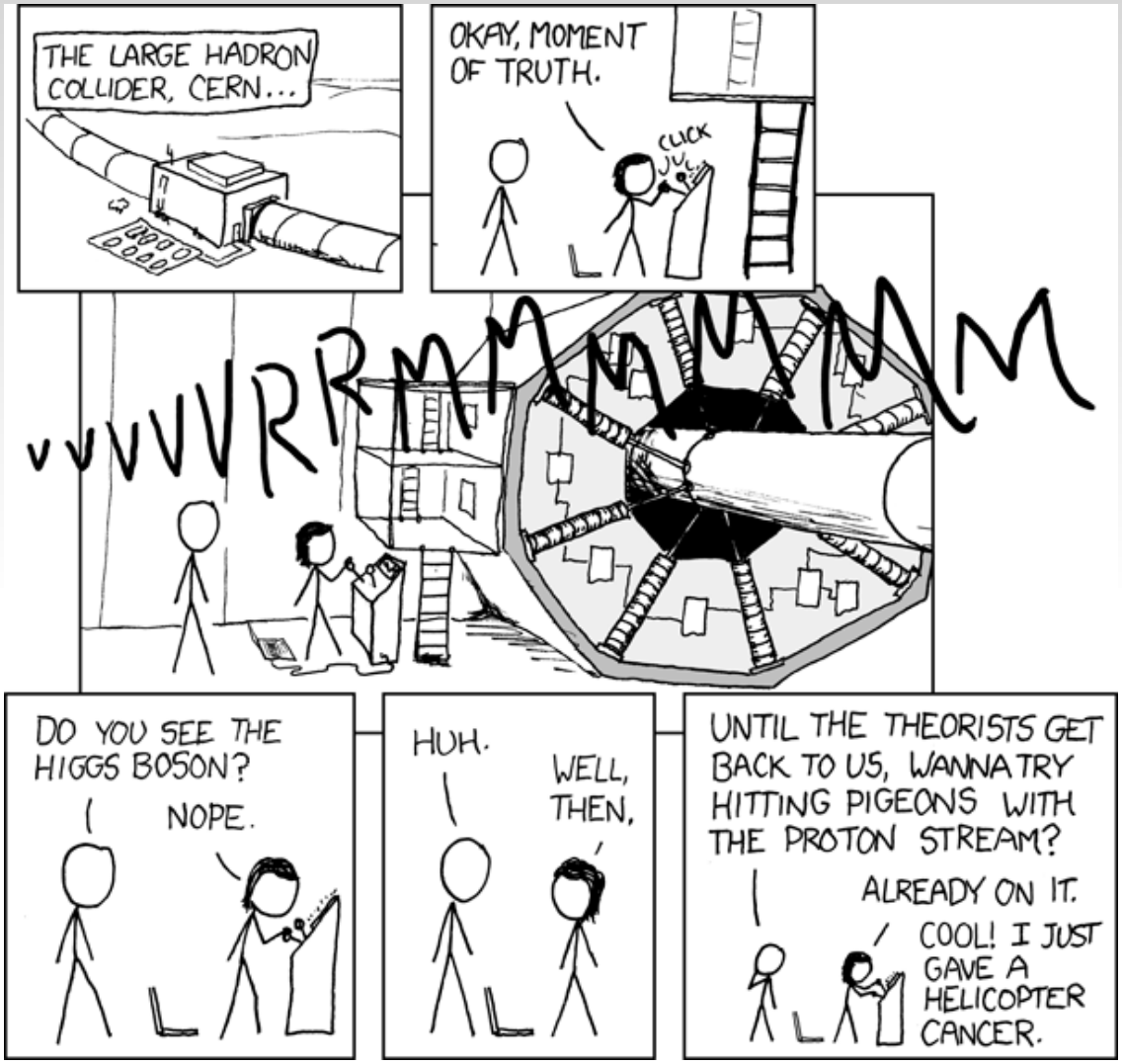


The Higgs Boson

The Higgs Boson



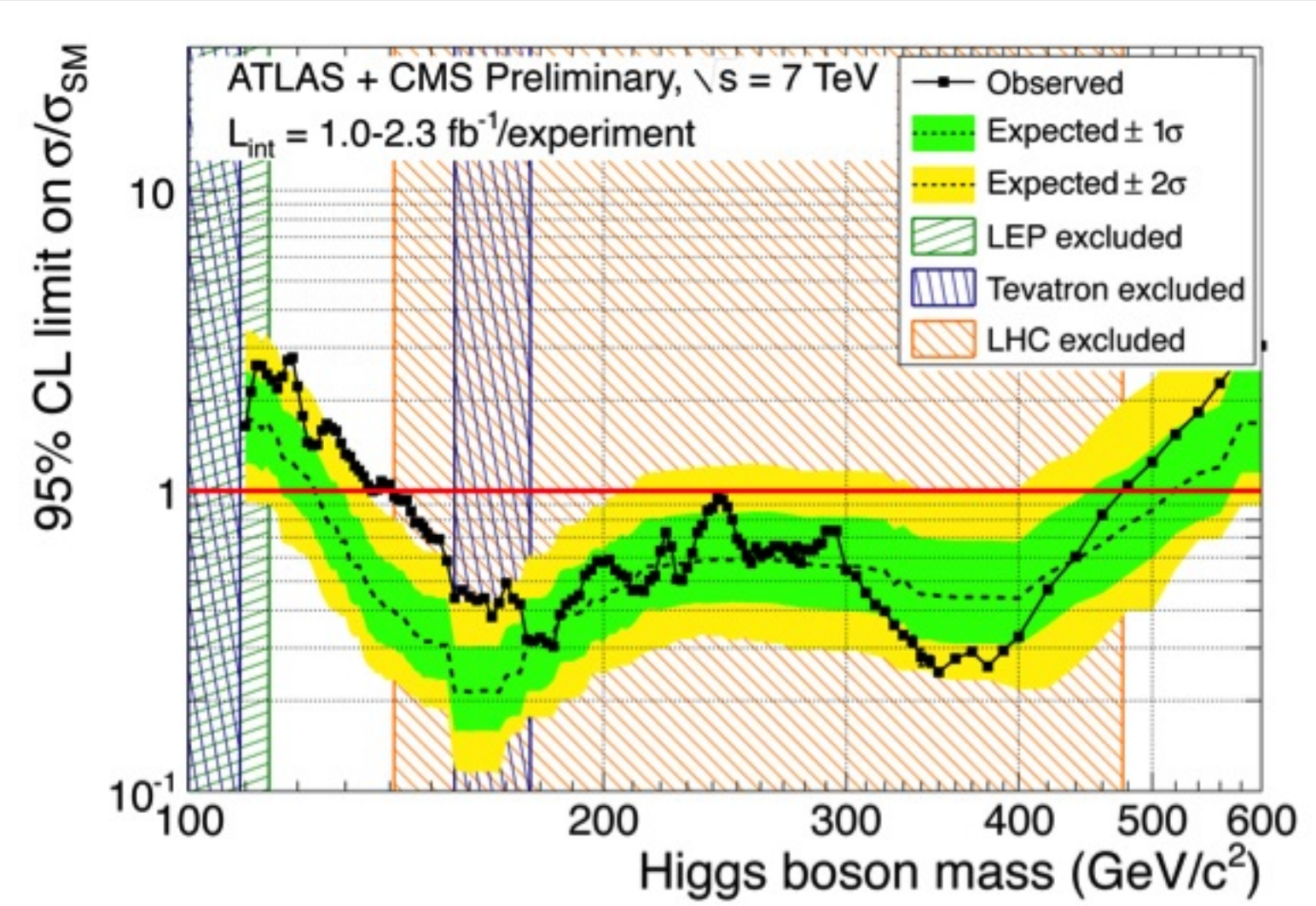
Looking for the Higgs



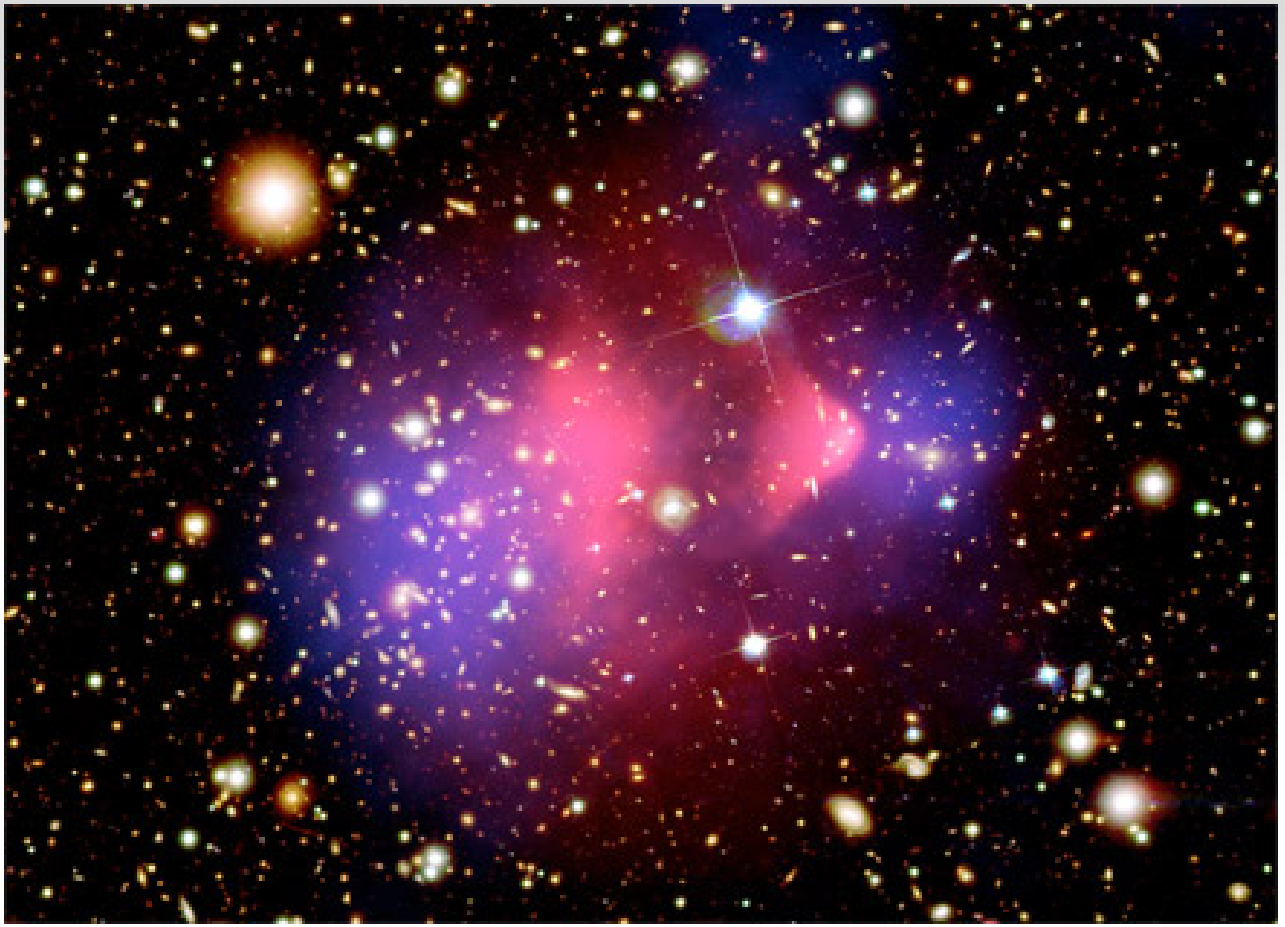
We can't see the Higgs itself – it decays to other things too quickly. What we look for are the particles to which it decays. One thing we can look for is $H \rightarrow \gamma + \gamma$

Looking for the Higgs

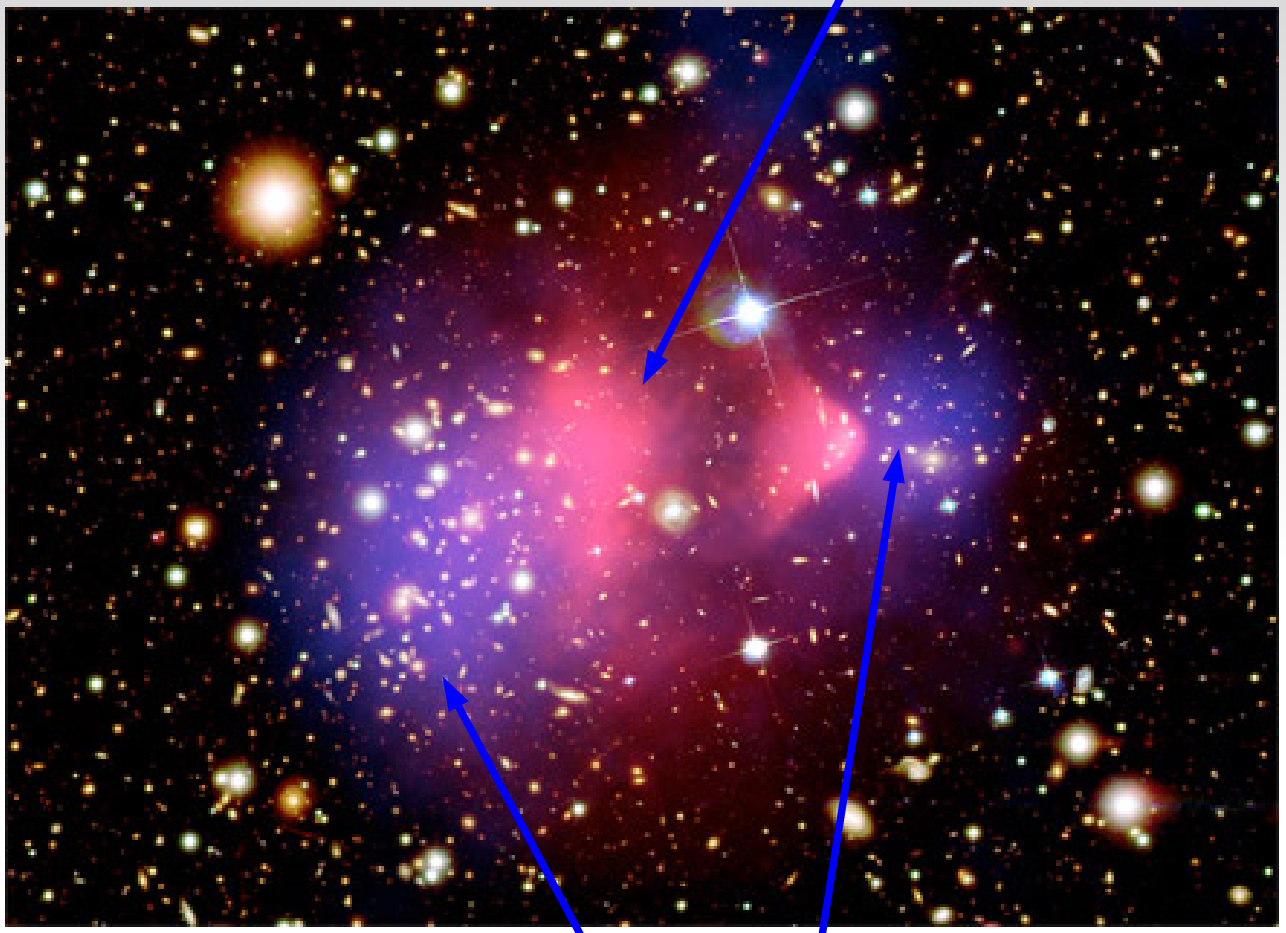
We might be close...



Dark Matter



Dark Matter

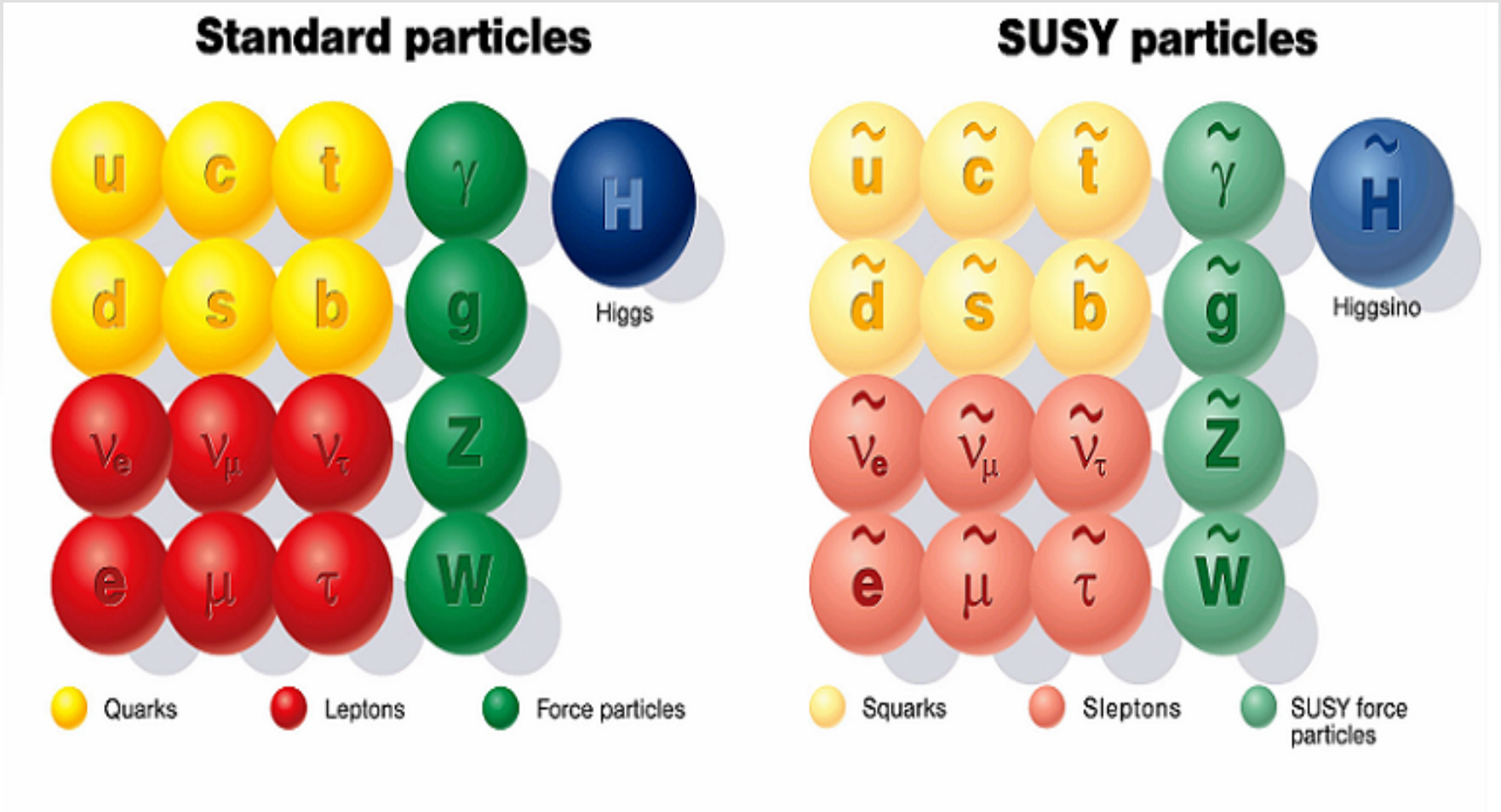


Dark Matter

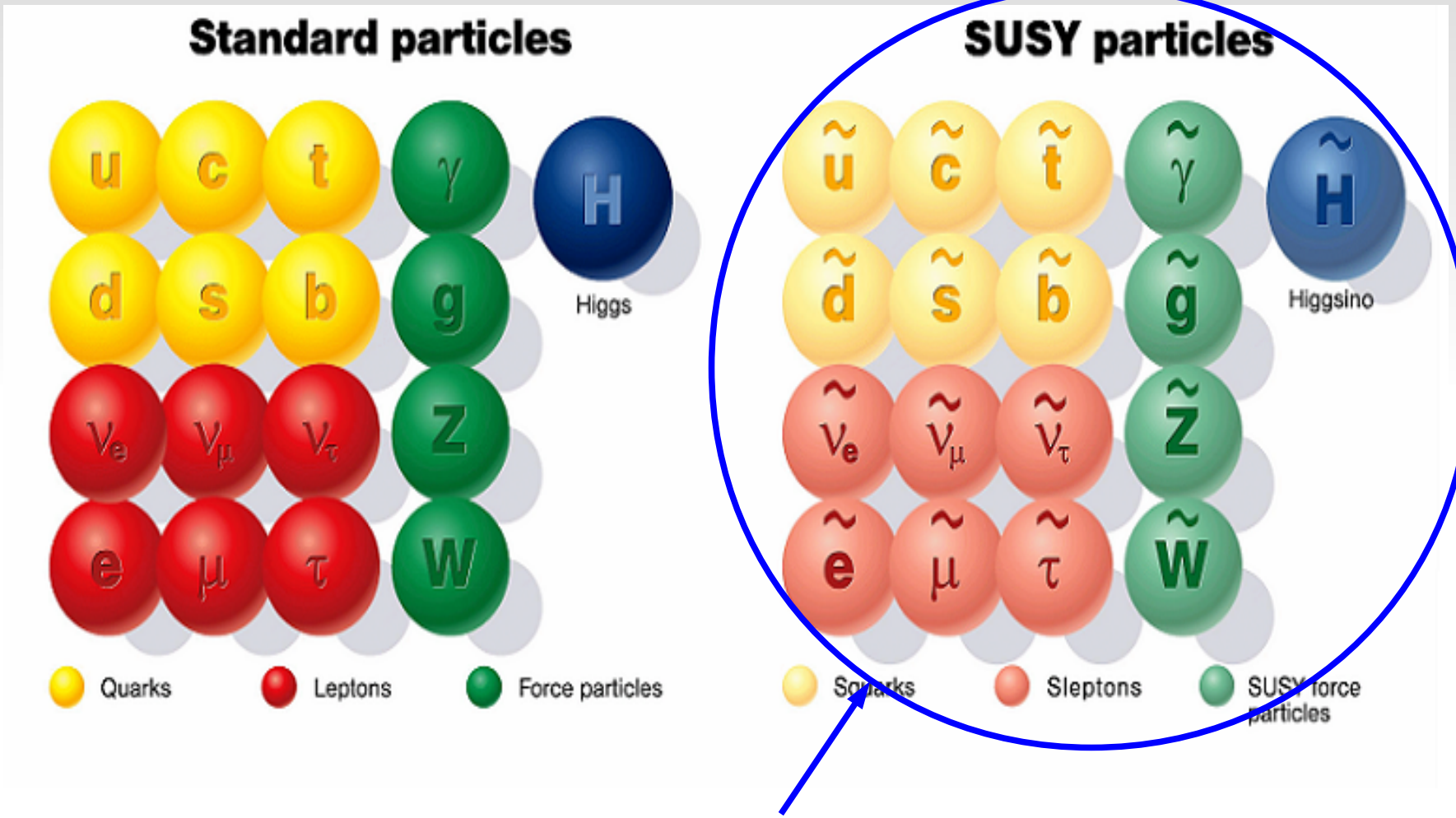
There are experiments looking for dark matter including the LHC. But it could be hard to find because it hardly interacts with matter at all.

Weakly interacting massive particles: WIMPs – we can try to look for these, but it could be hard work.

Supersymmetry

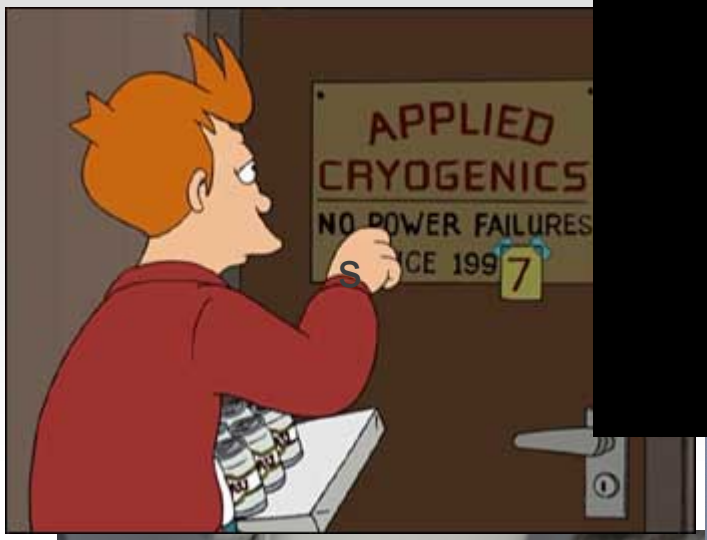


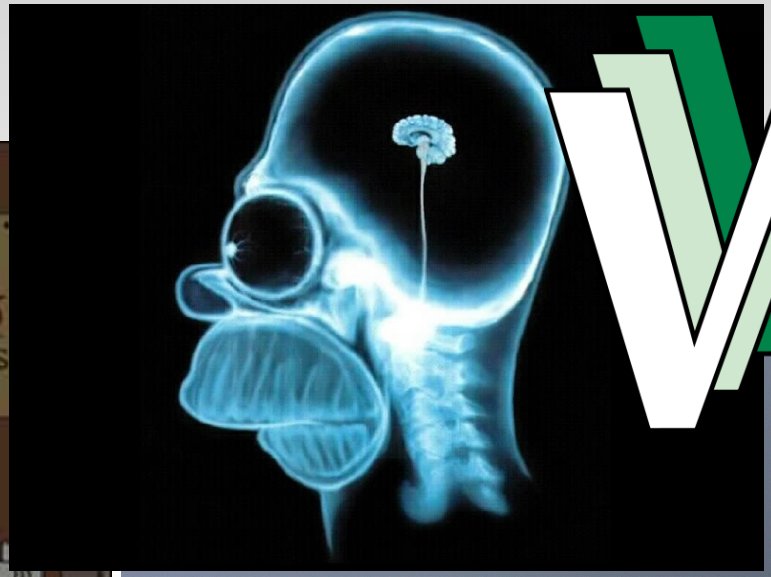
Supersymmetry

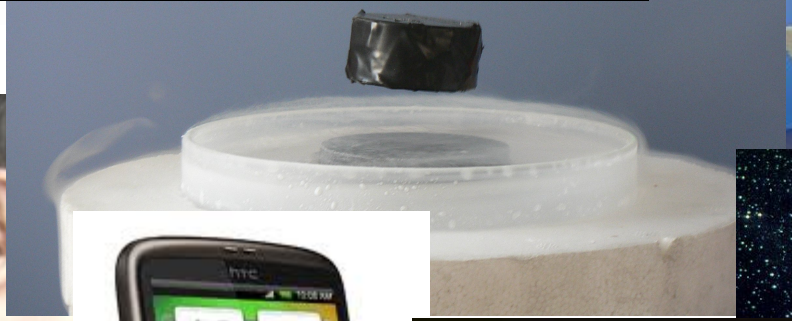


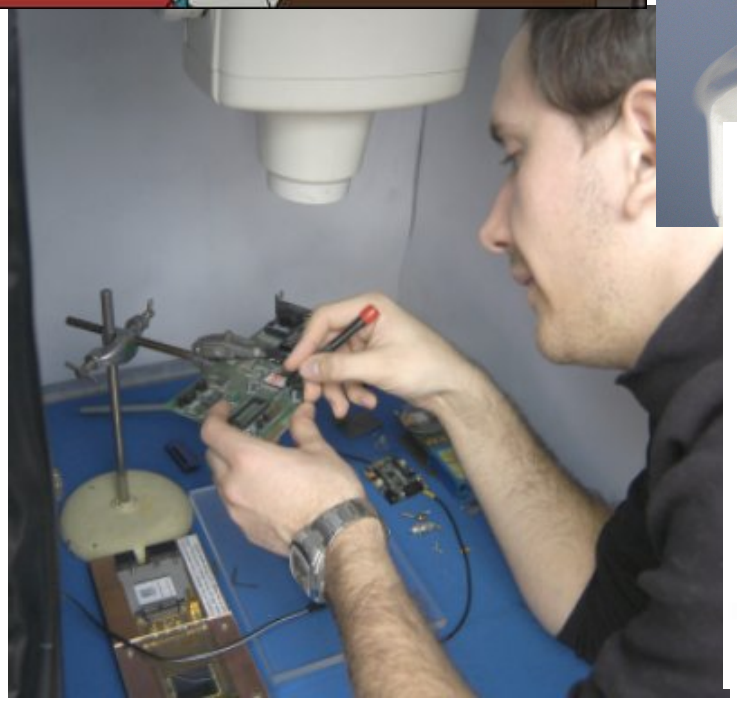
Dark matter in here somewhere?

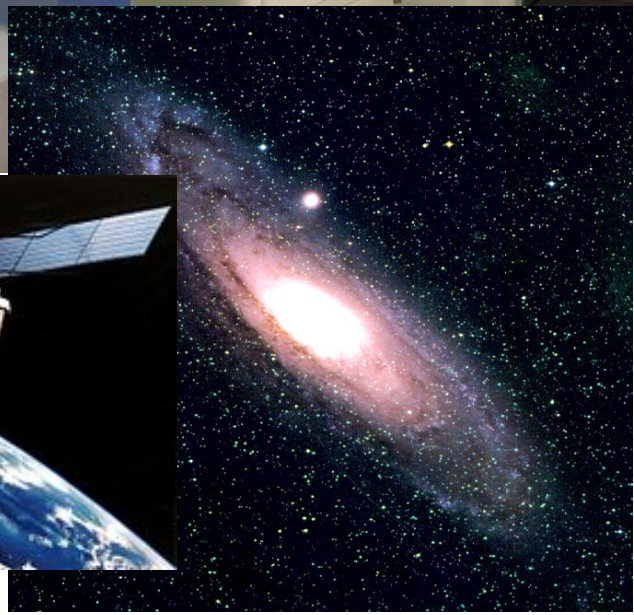
Physics is everywhere...











But the most important thing is this:

Some websites and information

http://www.physics.gla.ac.uk

http://www.physics.gla.ac.uk/ppt

http://cern.ch

I also have an email address if you ever have questions:
b.colquhoun@physics.gla.ac.uk