Physics & CERN & Stuff

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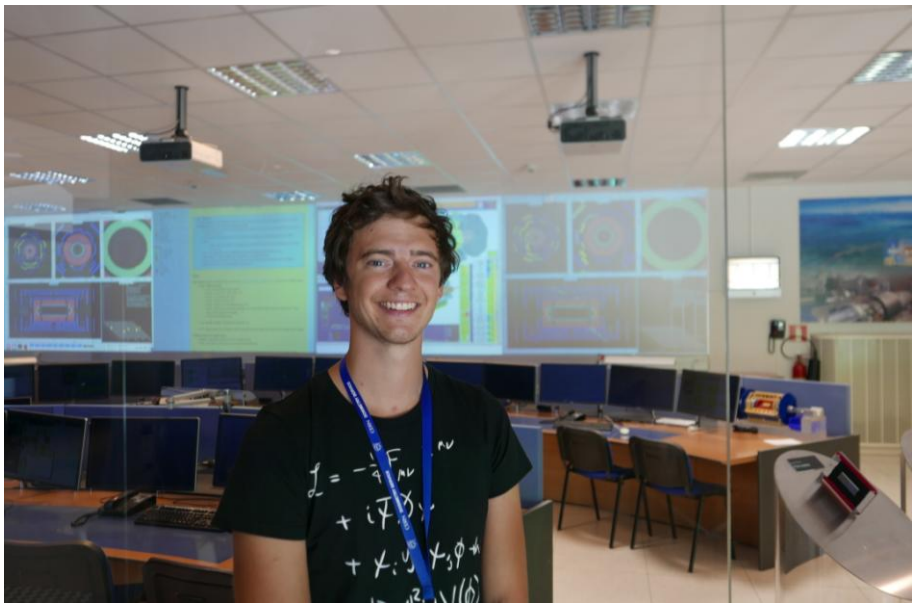
ATLAS EXPERIMENT

How I ended up here

G.C.S.Es:
no idea what to do at A-level

A-levels:
Physics/Maths/Chemistry
(no idea what to do at university)

Decide on physics
(with year abroad)



University: No idea still = make it an MSci!

4th year:
No idea still = gap year!

Gap year:
Still no idea... PhD?

PhD: Science Communication sounds interesting

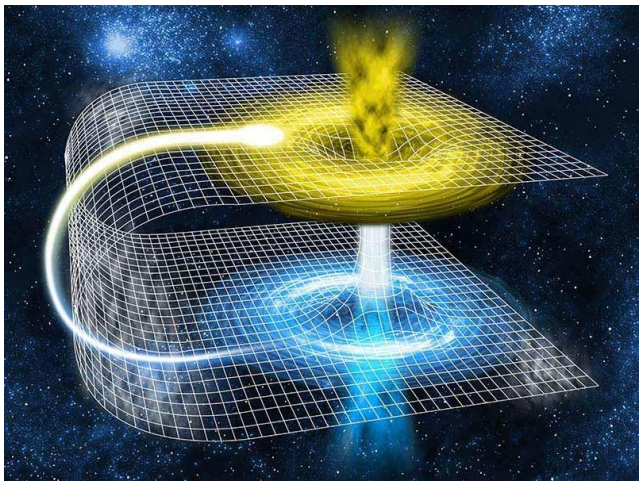
Now – still no idea
(gap year 2..?)

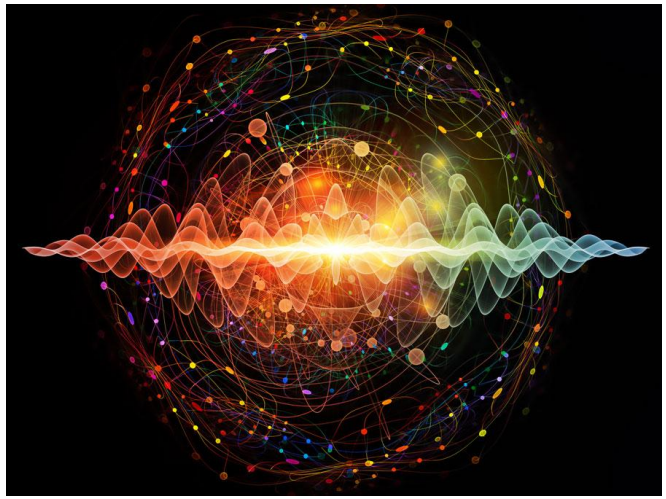
Why study physics?

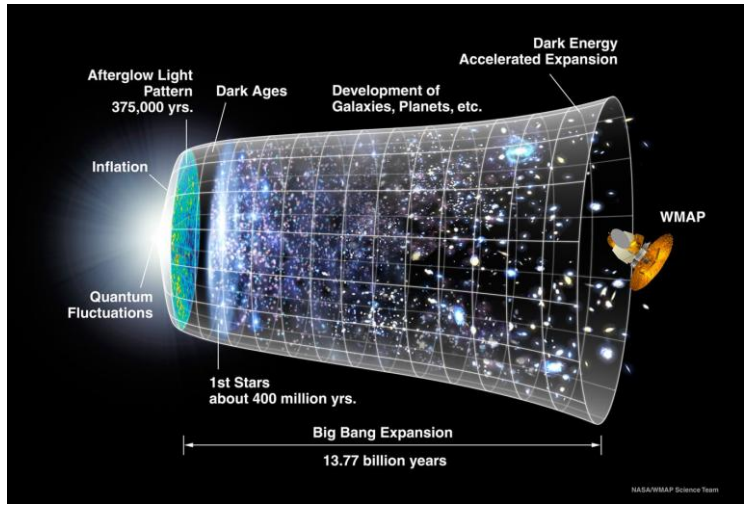
The only universe I'm (probably) ever going to live in – may as well find out how it works

Makes logical sense – either right or wrong* (don't have to pretend that a protagonist's choice of breakfast is an allegory etc...)

*Doesn't make logical sense – you realise that the universe is far more complicated than a human brain is capable of truely understanding







I'm not a great decision maker about my future – may as well pick the option which keeps open the most doors*

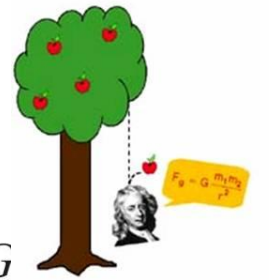
People assume you are clever (regardless of exam scores and stupidity in all other aspects)

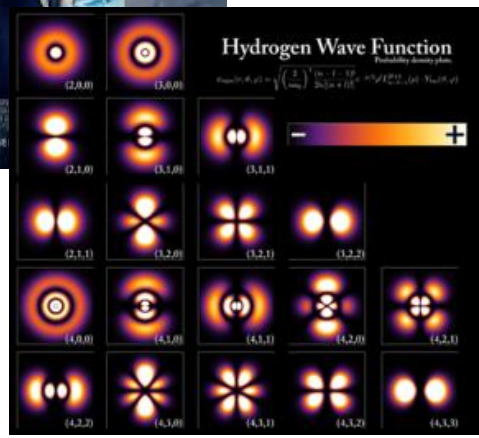
Genuinely interesting – see photos

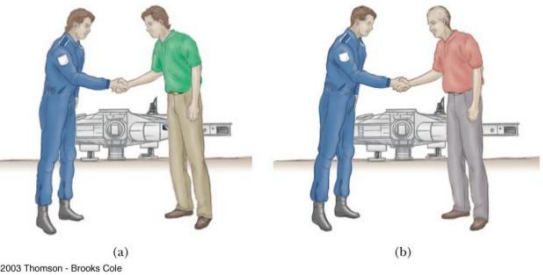
* warning: may mean future decision making is difficult

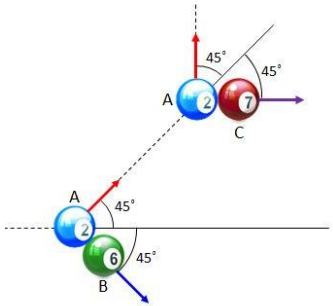
Undergraduate physics

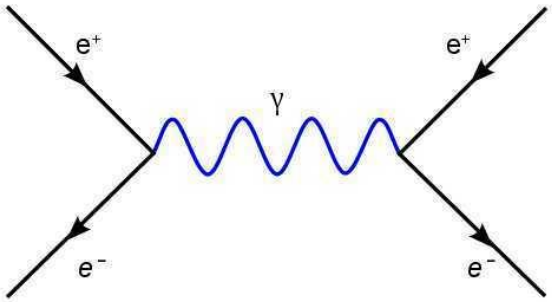
- Lots of work (& more challenging) but much more interesting









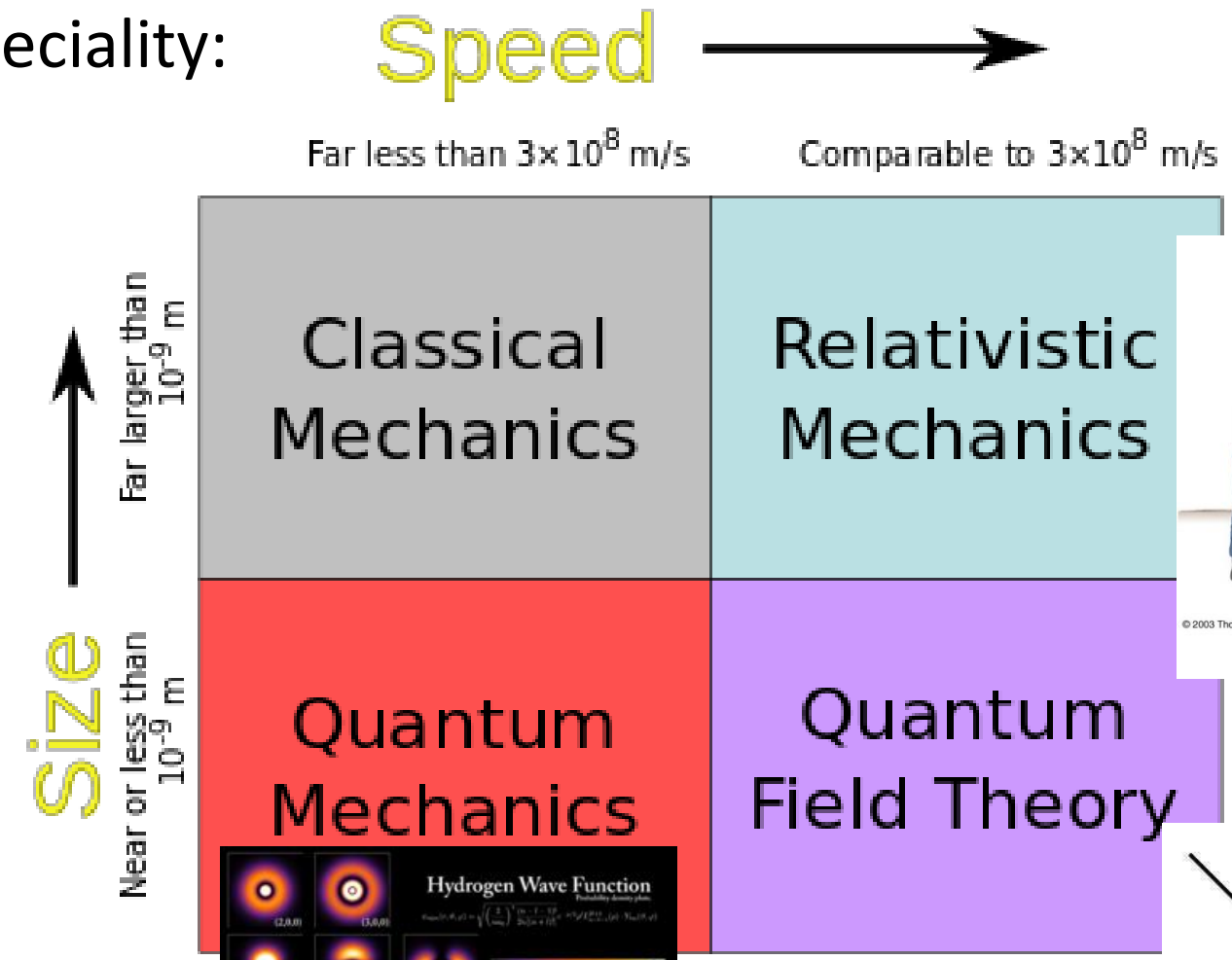


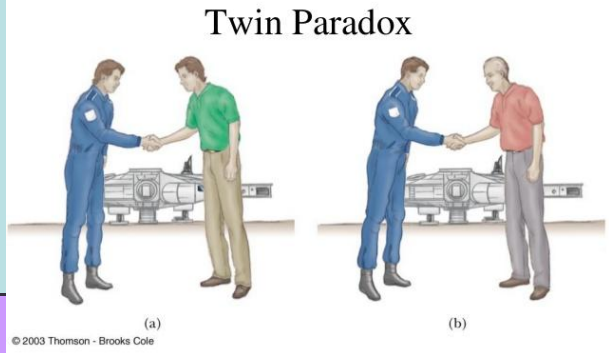
Annihilation of a electron and a positron creating a photon which decays into an new electron positron pair

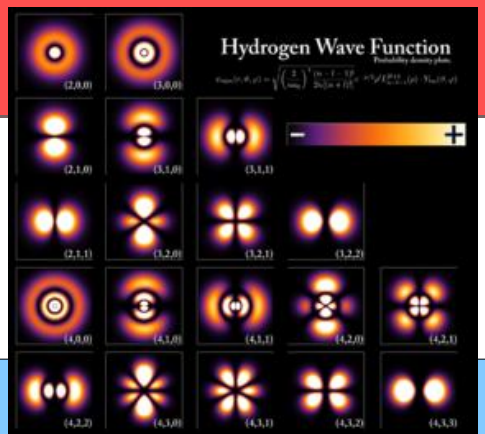
Undergraduate physics

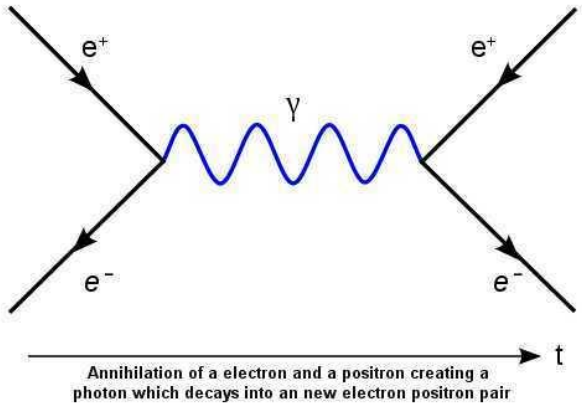
- My speciality:

(the bottom of the cube on the previous slide)



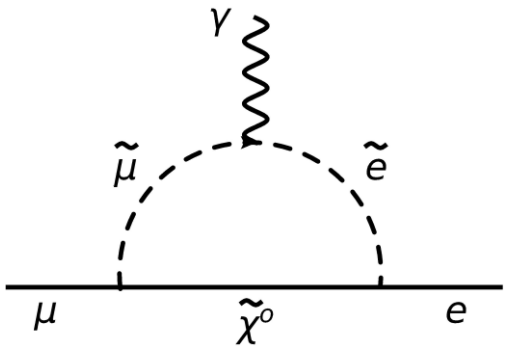


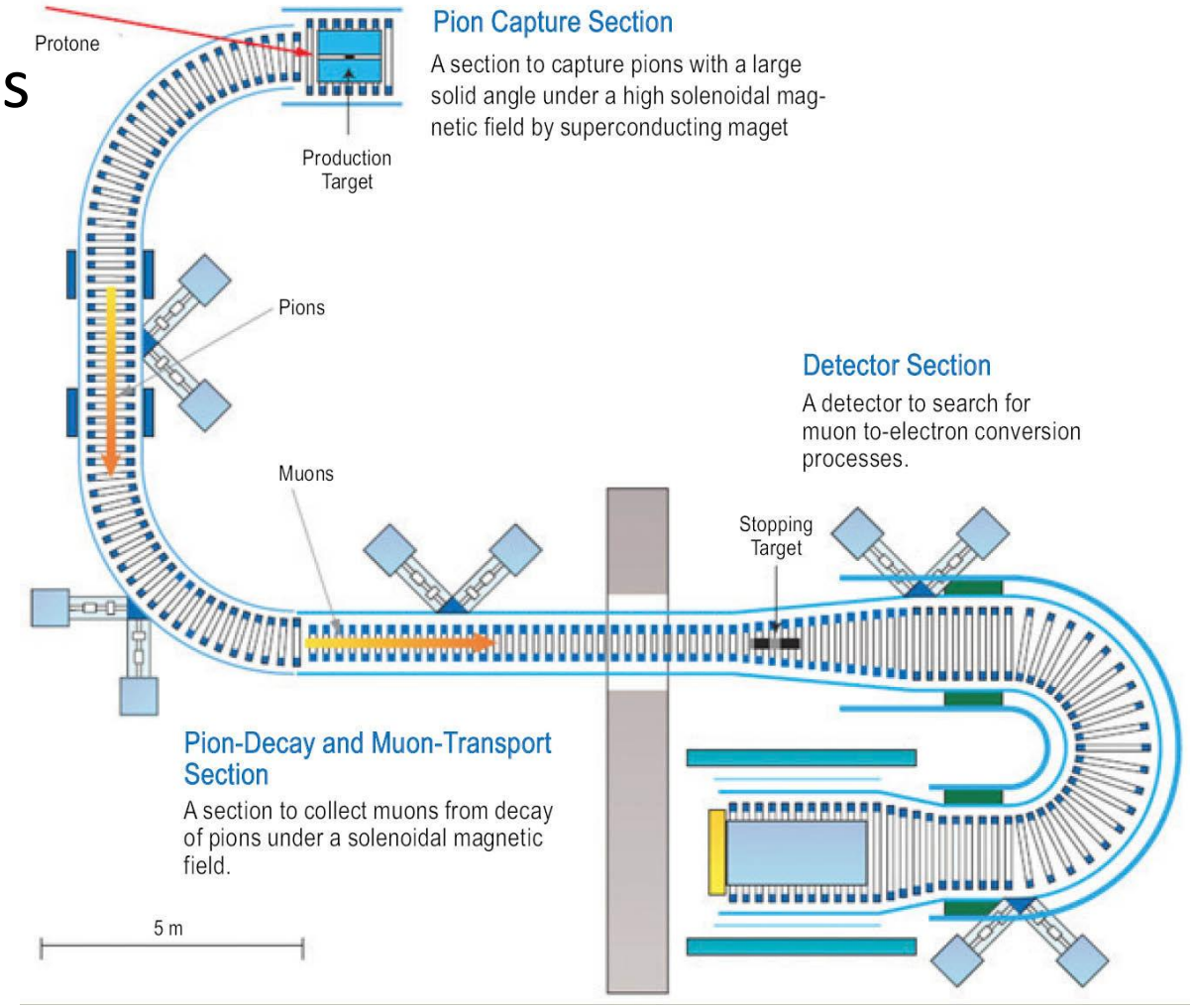




Undergraduate physics

- My speciality 2: Experimentalist (theory is hard!)
- Msci project: COMET
- Looking for 'neutrinoless muon to electron conversion'
- Would violate a widely held principle
- Switch on 2019(..?)





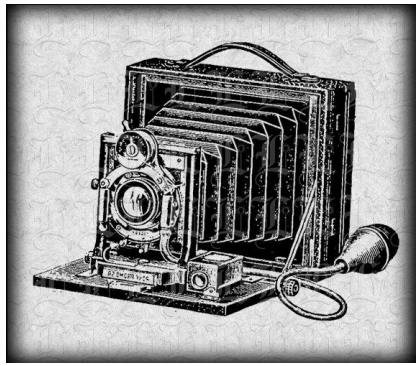
PhD work

What is ATLAS?

- The ATLAS detector is like a camera that takes ‘photos’ when bunches of protons collide.
- In the collision, new particles may be produced.
- The ‘photos’ capture the position of the new particles as they move through the detector and their energy.

What do we do with ATLAS?

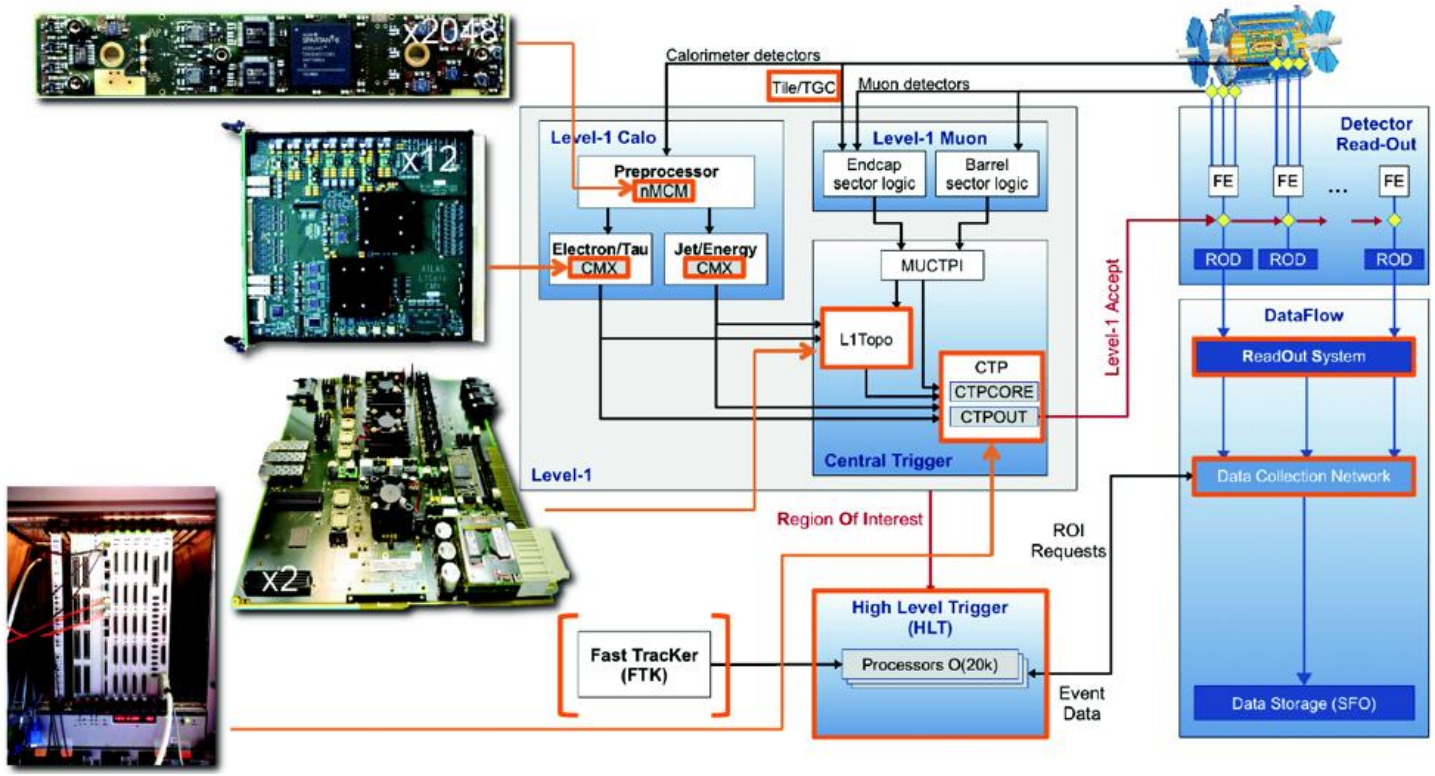
- Using the ‘images’ we rebuild a 3D history of the collision.
  - We learn what particles emerge from the collision.
  - We can guess which particles are produced even if they disappear before we can capture the ‘photo’.
  - Looking at thousands of collision ‘images’ we can discover new particles and learn their properties!
- If the detector was a camera it would be 100 Megapixels and take 40 million photos every second.
- The ATLAS ‘camera’ is huge – as heavy as the Eiffel tower!



Trigger system

Bunches of protons cross 40 million times a second.
Each bunch contains 10^{11} protons.
Number of proton-proton collisions in the detector: 1 billion per second.
When any of the protons collide, the process is called an "event".
A given bunch crossing sometimes has particles from more than one proton-proton collision.

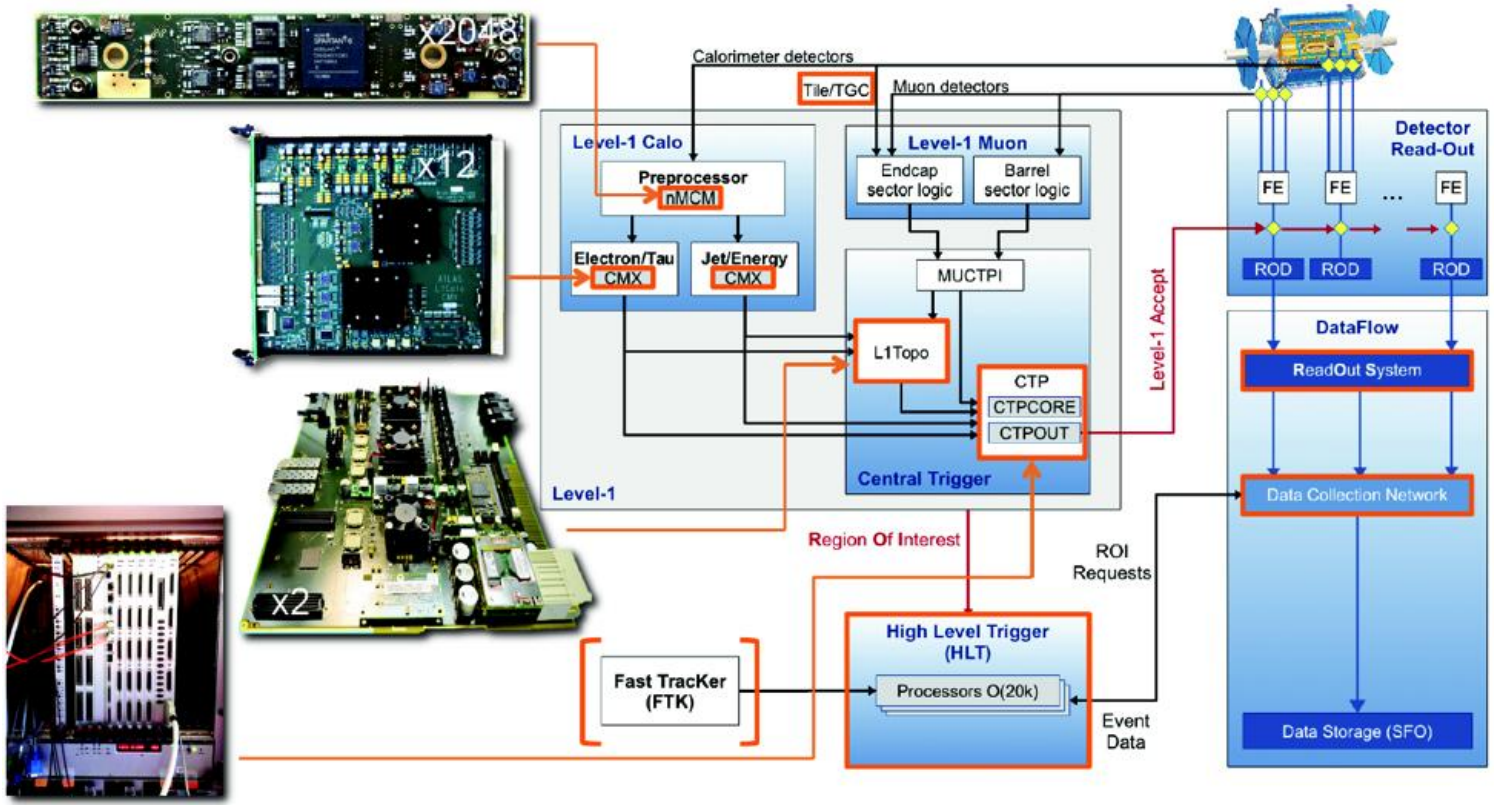
If all data would be recorded, this would fill 100 000 CDs per second. This would create a stack of CDs 150 m (450 ft) high every second, which could reach to the moon and back twice each year.
This data rate is also equivalent to making 50 billion telephone calls at the same time.



Trigger system

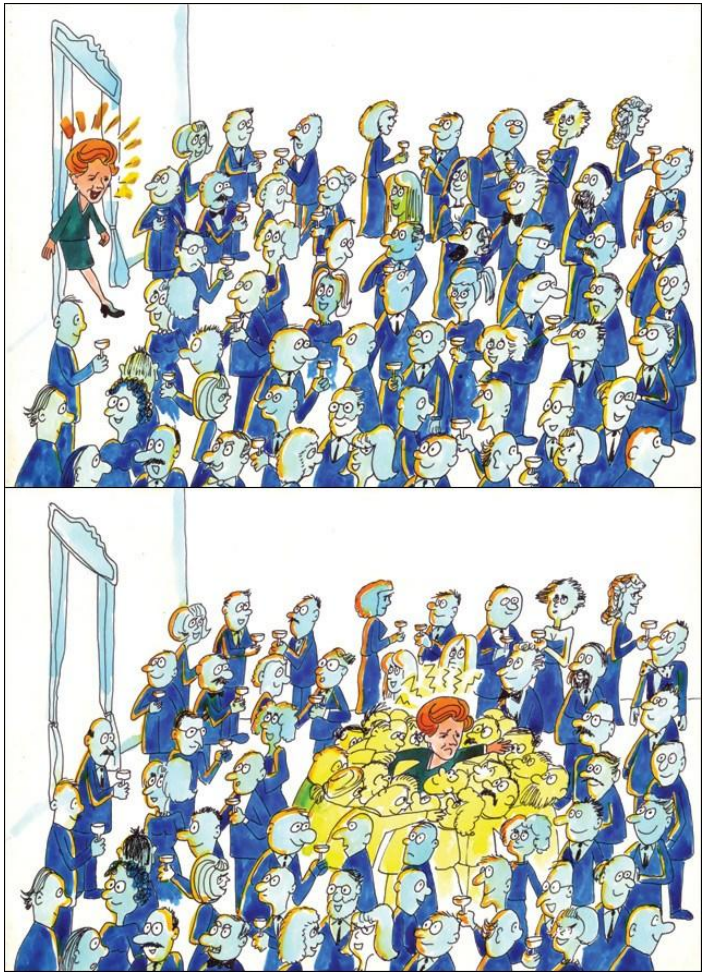
The 3200 terabytes of data that will be seen by ATLAS each year are the equivalent of the content in:

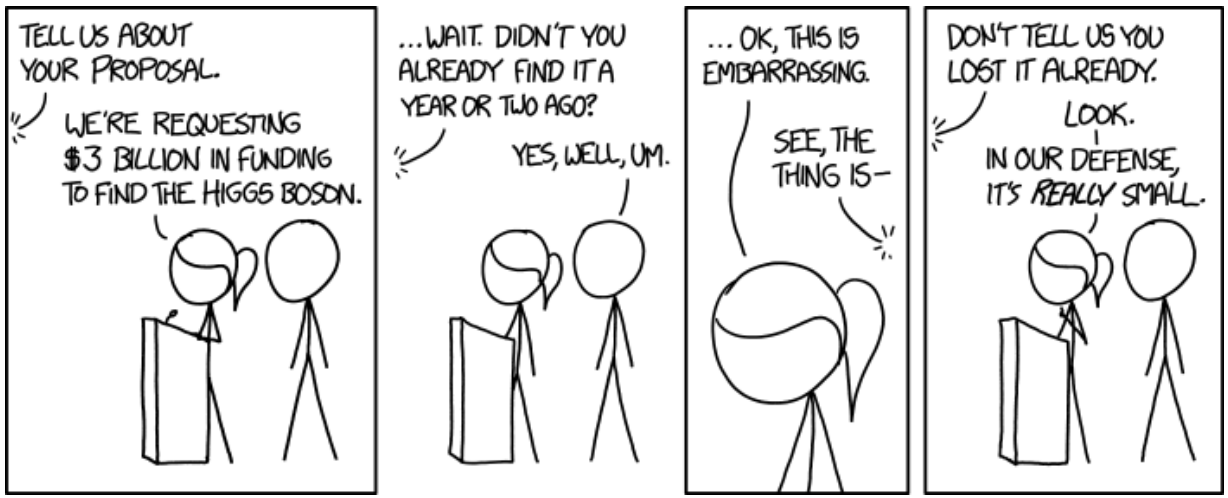
- 160 million trees made into books.
- 7 km (4 miles) of CD-ROMs stacked on top of each other.
- 600 years of listening to songs.
- 160 US Library of Congress (3 billion books).



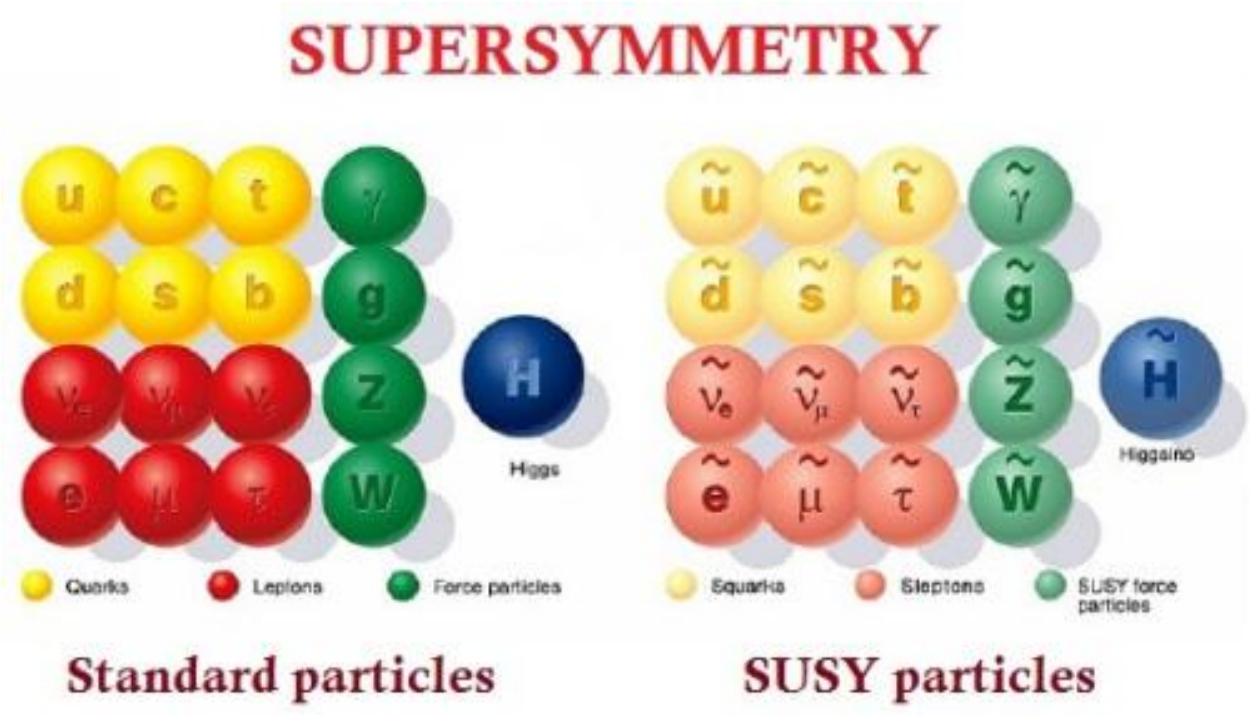
Higgs boson

- Higgs boson – resonance of the Higgs field
- Interaction with Higgs field = mass



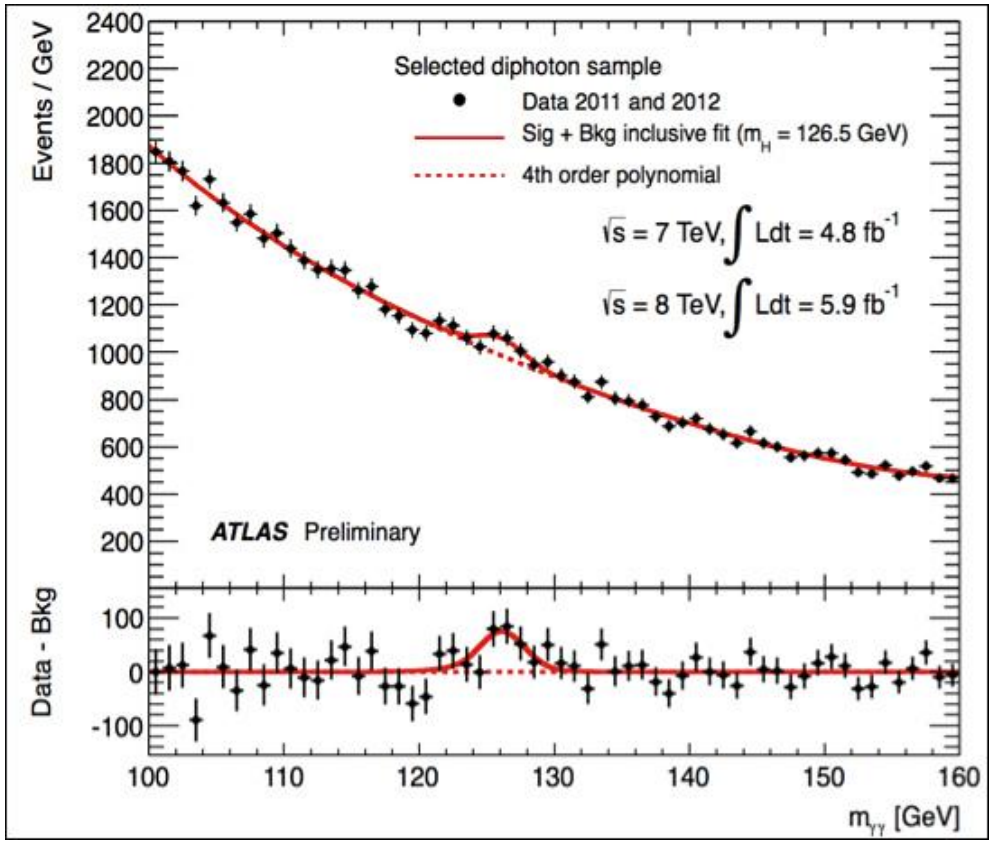


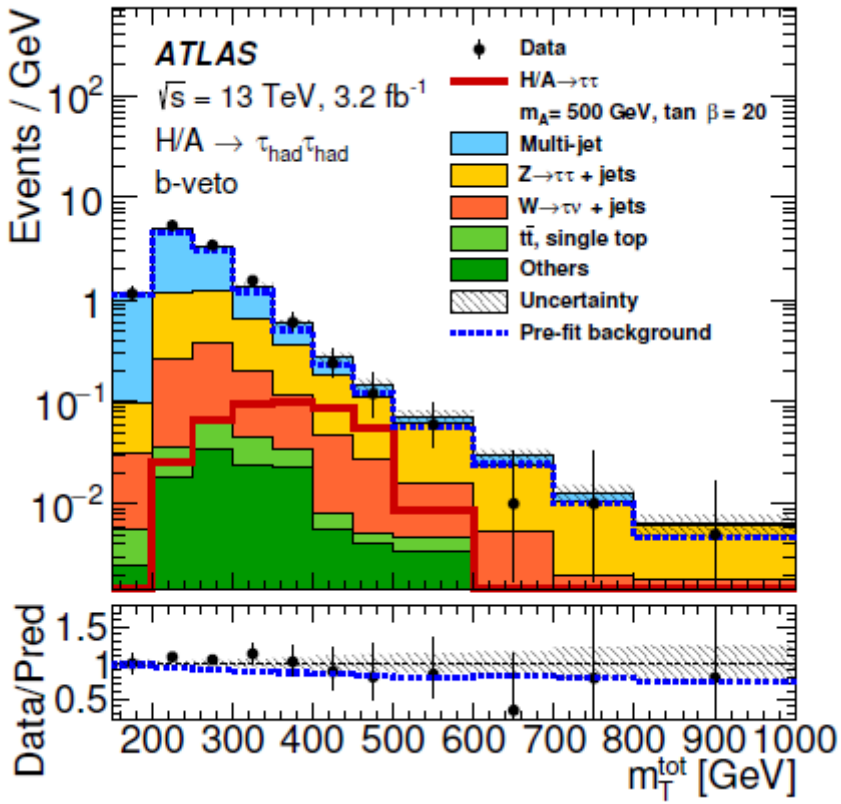
Only one Higgs?



- Many models require the existence of new particles
- Many require more than one Higgs boson
- Some may be charged, some may be massive

Only one Higgs?





- Analyse collision data – split searches by end product
- Reconstruct the original event from the product information
- Compare the data to your ‘normal physics’ (SM) prediction (e.g. simulation)
- Look for excess of data

Science communication

- Government spends a lot of money on science
- Results in a lot of investment = more money back!
- Results in a lot of inventions that people like (WWW, proton therapy, touchscreens – CERN influenced)
- Results in a lot of discoveries that people might not understand… (what is the Higgs? Dark Matter?)
- The public funds us – we need to make sure they understand

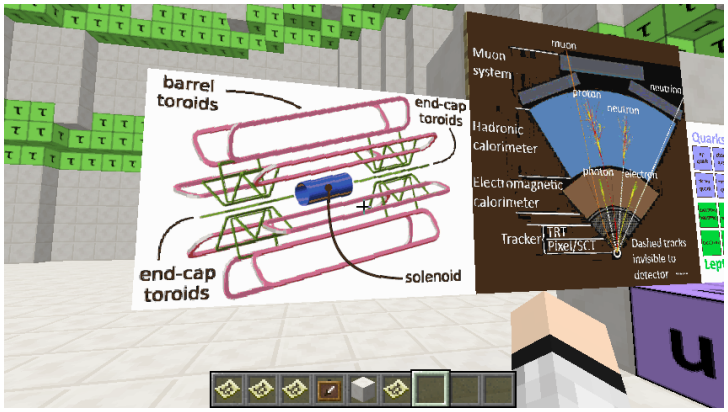
We do:

- Tours, masterclasses, visits, games, VR, AR, publicity, briefings, many more

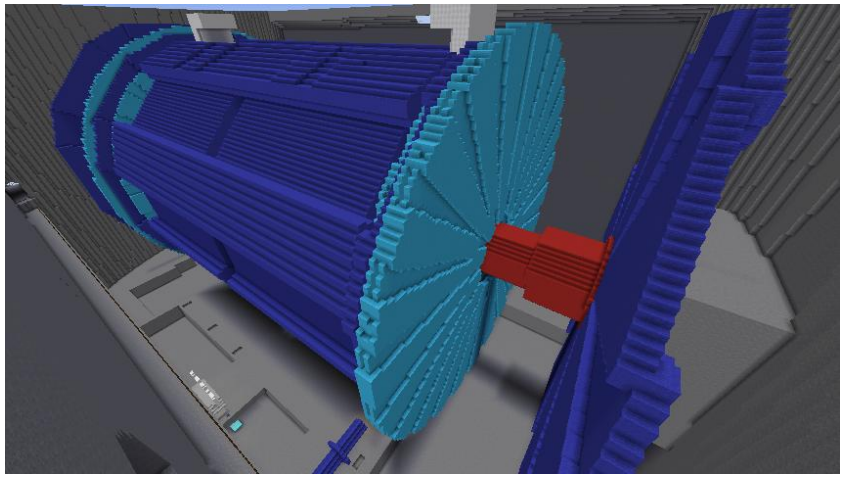
ATLAScraft game

Visit control room

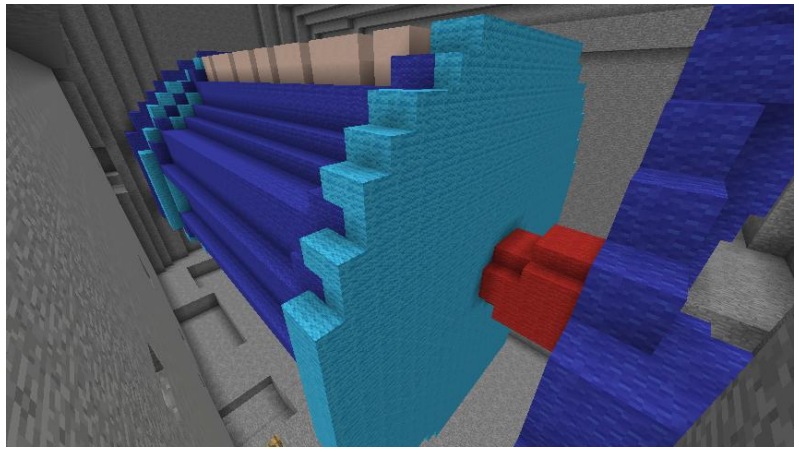
General info on ATLAS/LHC in warehouse



‘Shrink’ to 5x detector



Visit 1:1 scale detector

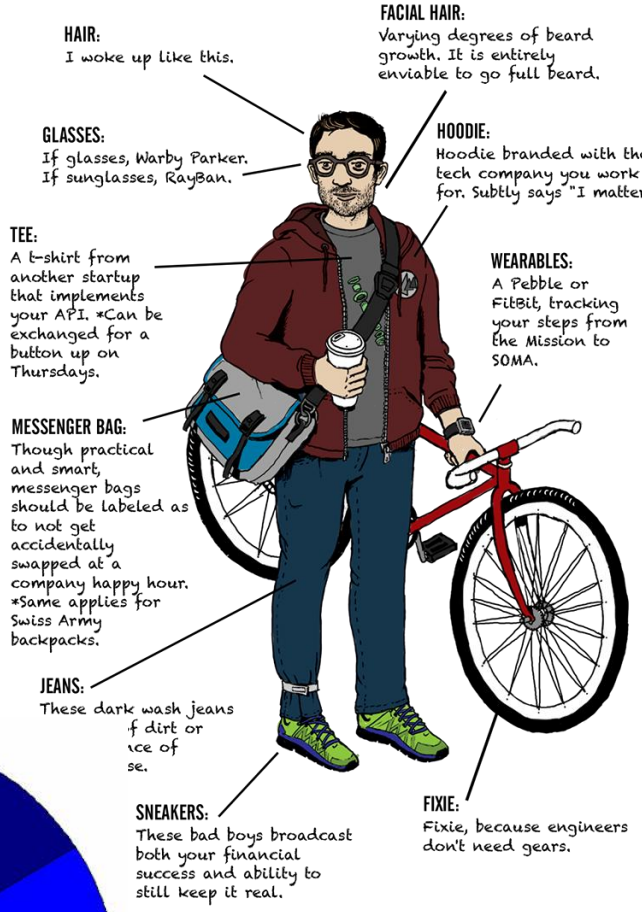


Physics careers

Finance/business

Consulting

Tech



Leader of Germany (not common career path)