

# Science in public: finding a Higgs boson in the media spotlight

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UCL Centre for Languages and International  
Education 28/1/2013

# Outline

- Why the Higgs matters
- The story (as seen by me)
- Some results



SUISSE  
FRANCE

CMS

LHCb

ATLAS

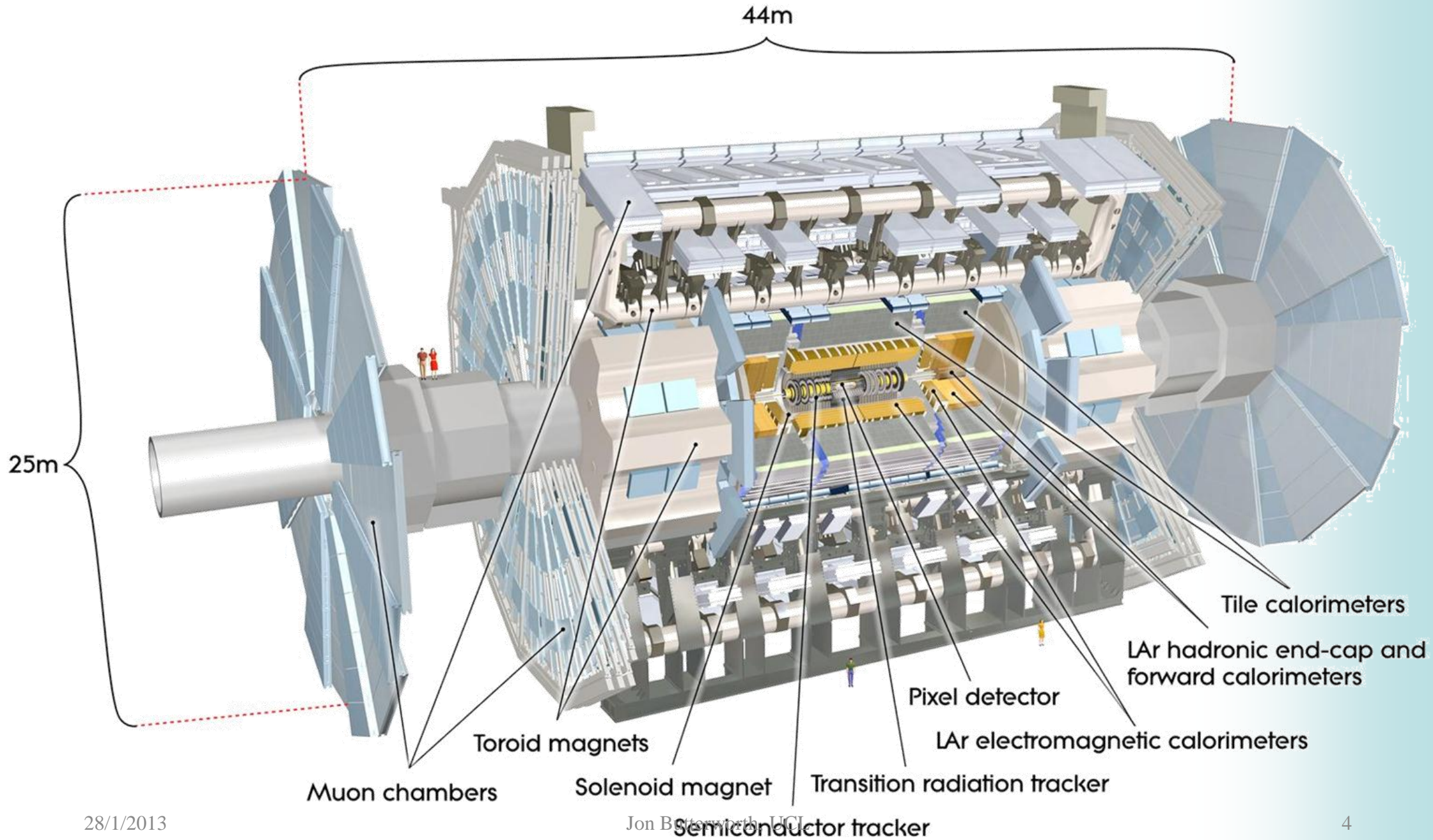
CERN Meyrin

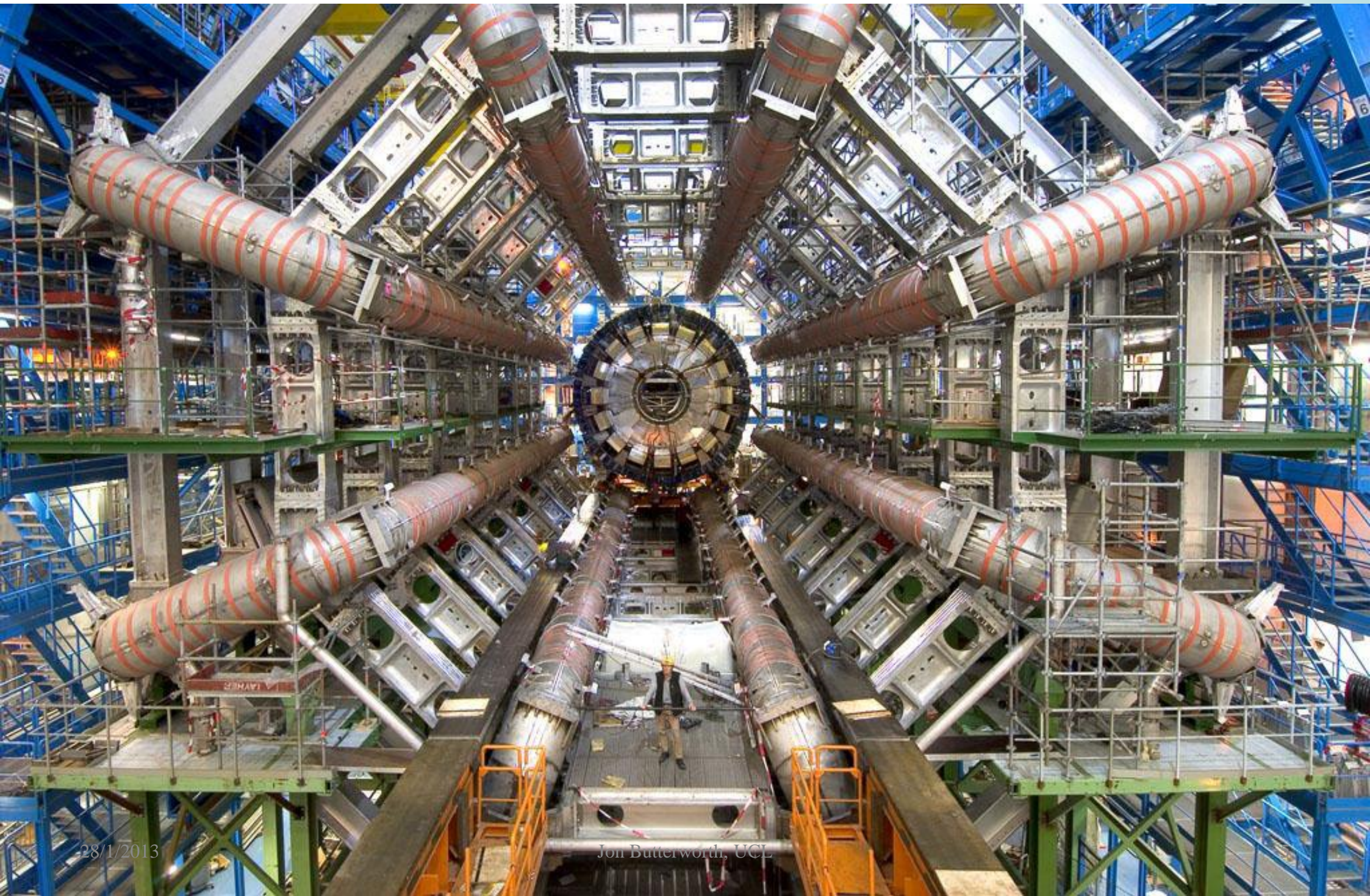
CERN Prévessin

SPS 7 km

ALICE

LHC 27 km

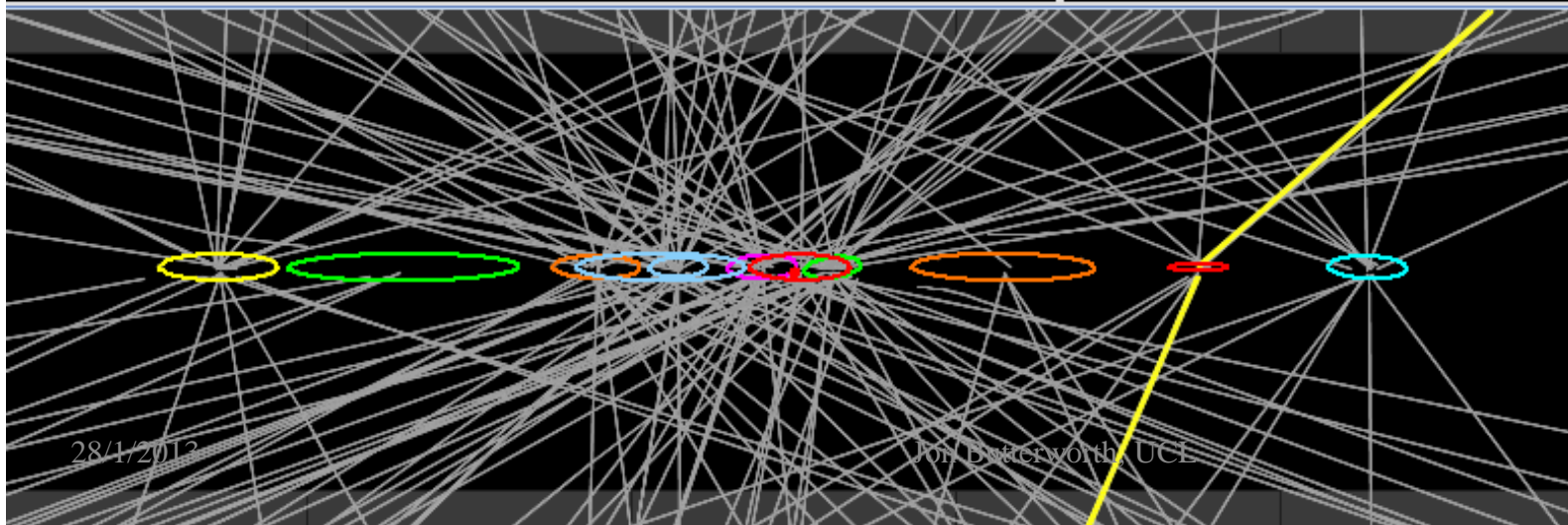
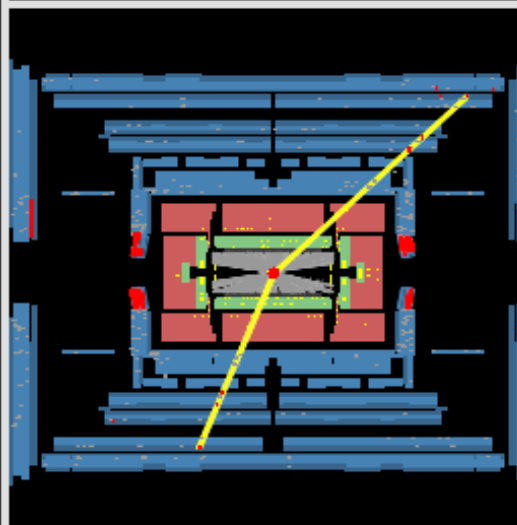
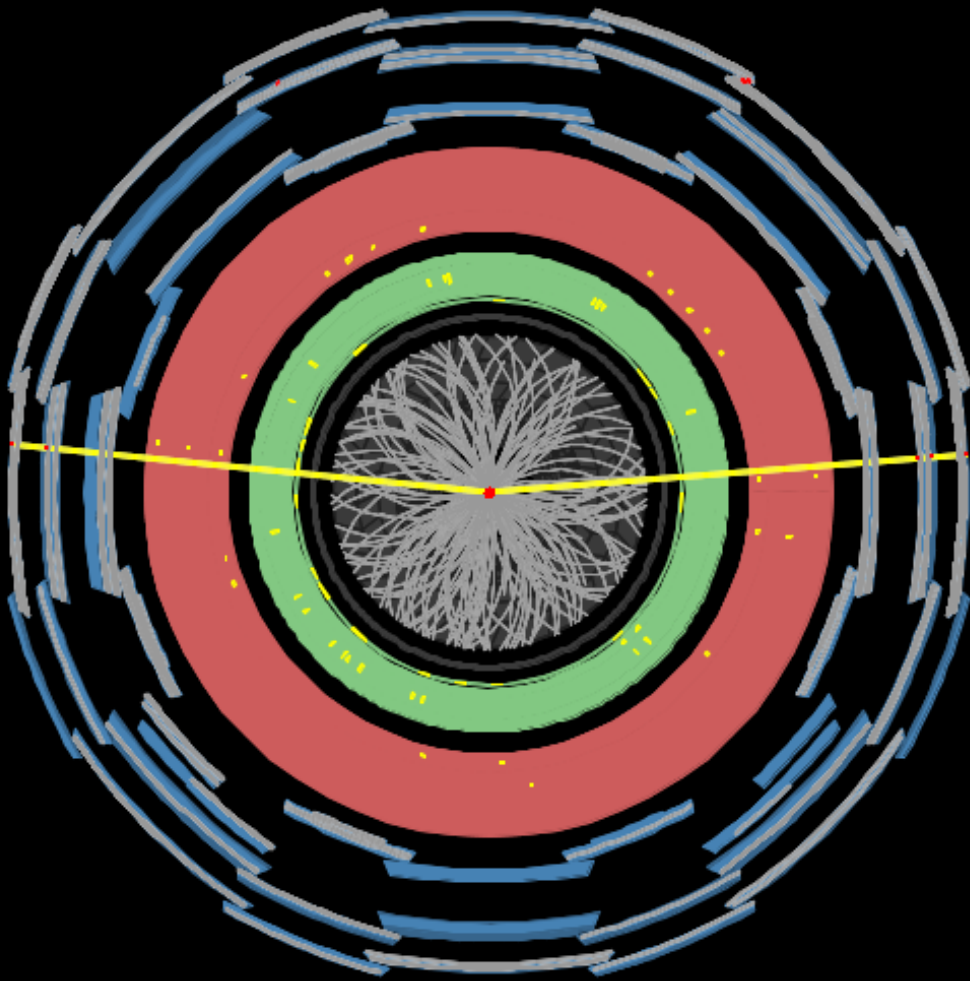




# ATLAS EXPERIMENT

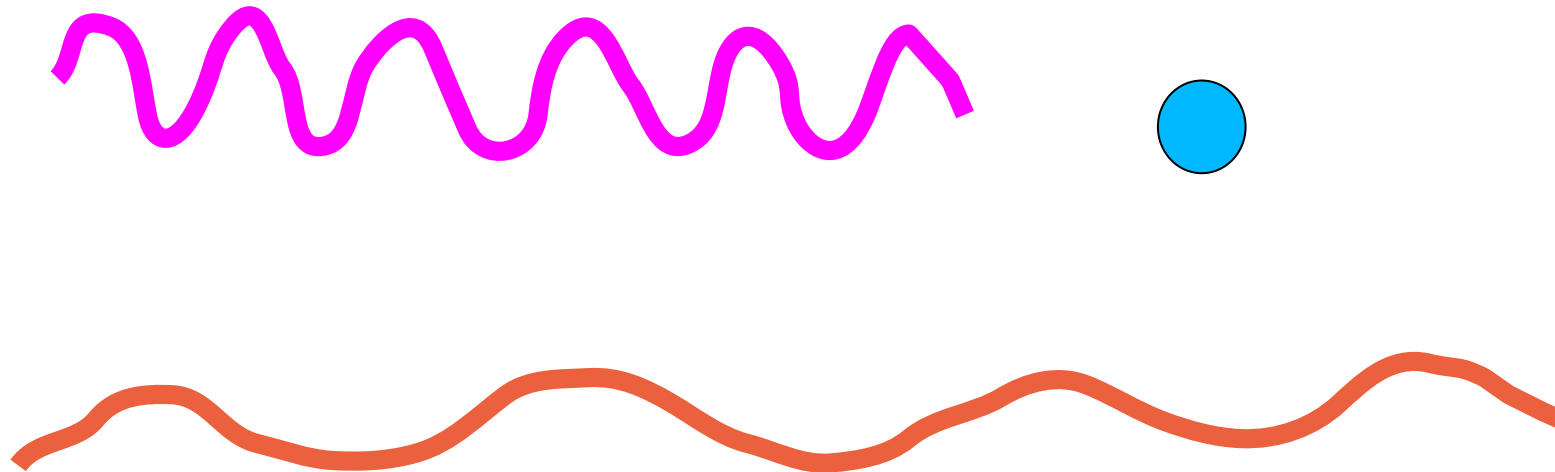
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$$E = mc^2$$

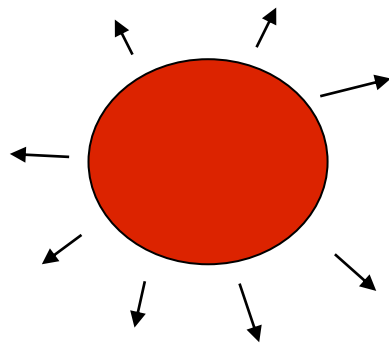
High energy wave means small wavelength



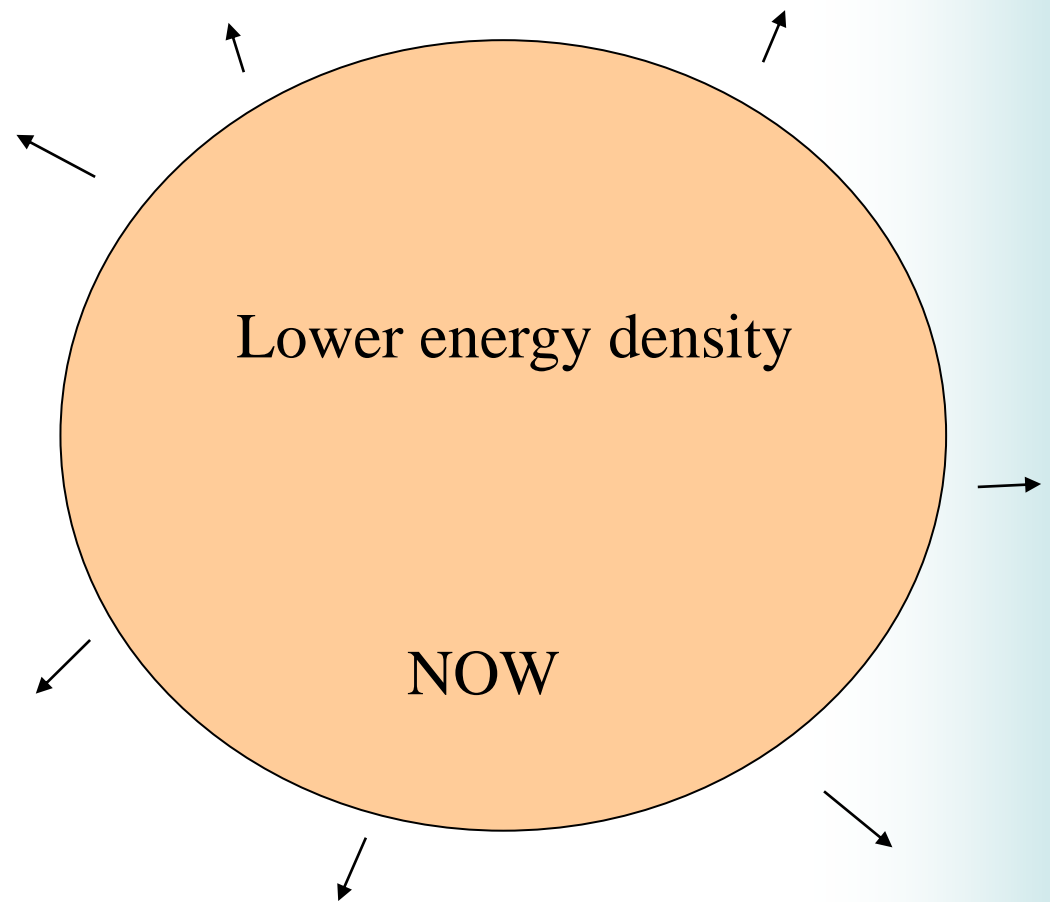
Low energy wave means long wavelength



High energy density



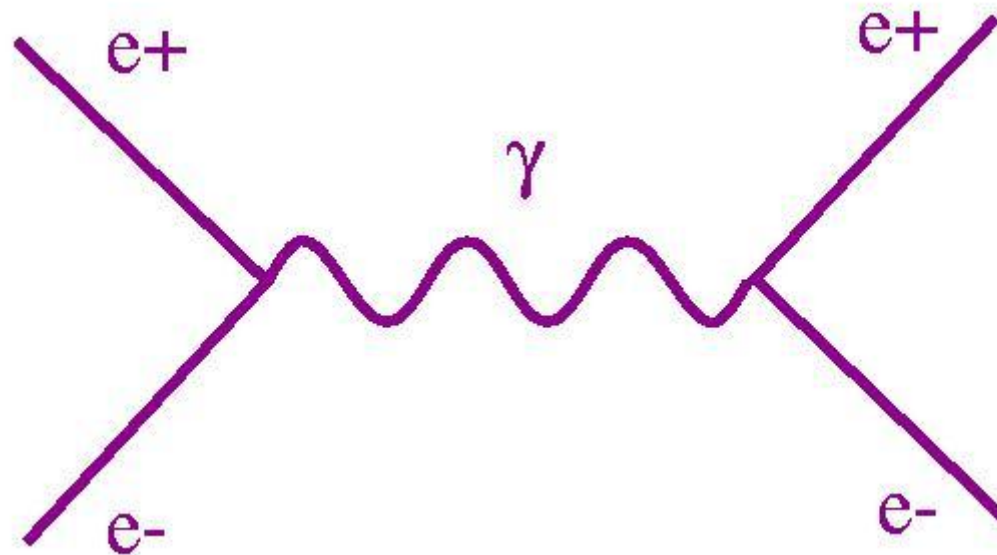
THEN



Lower energy density

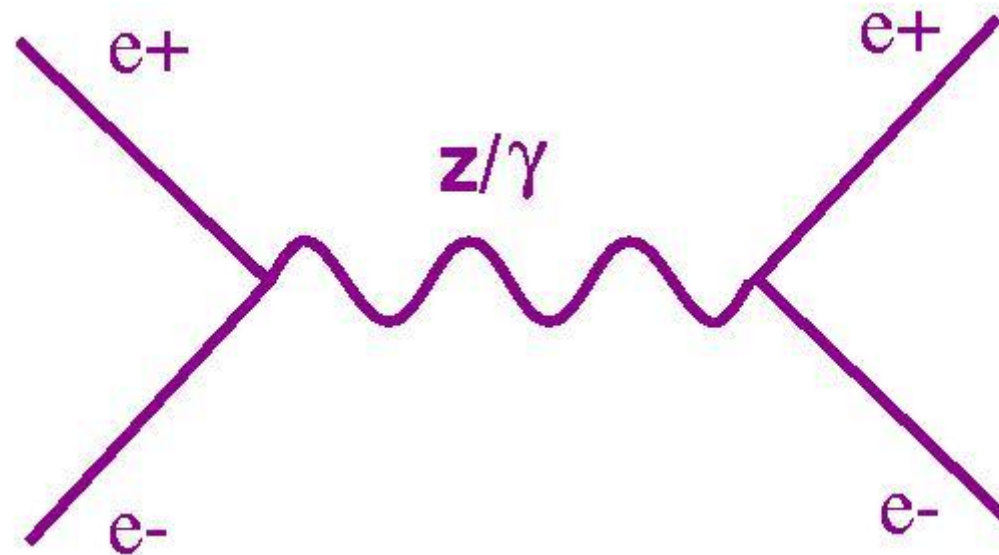
NOW

# Here's one we made earlier...

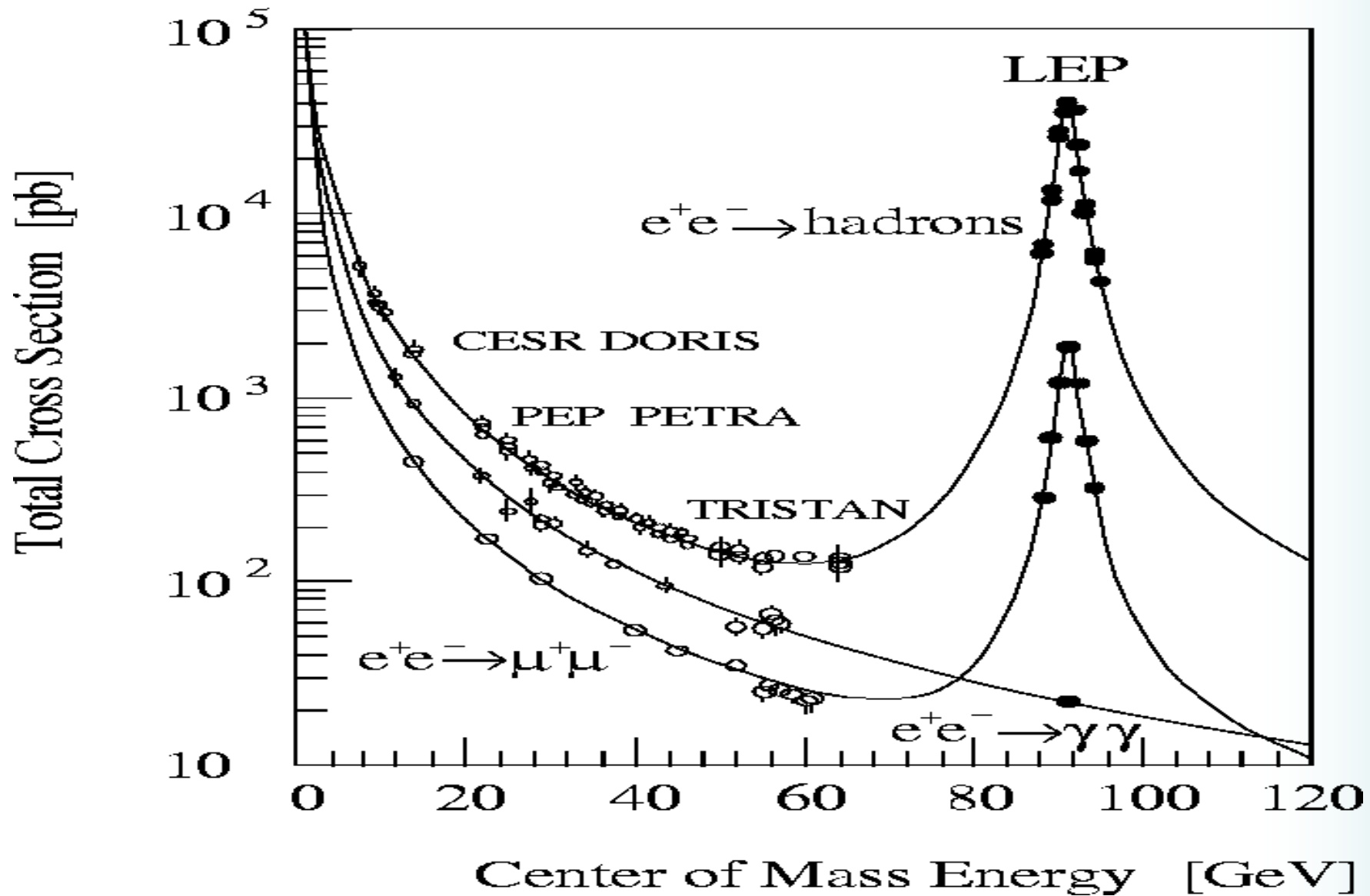


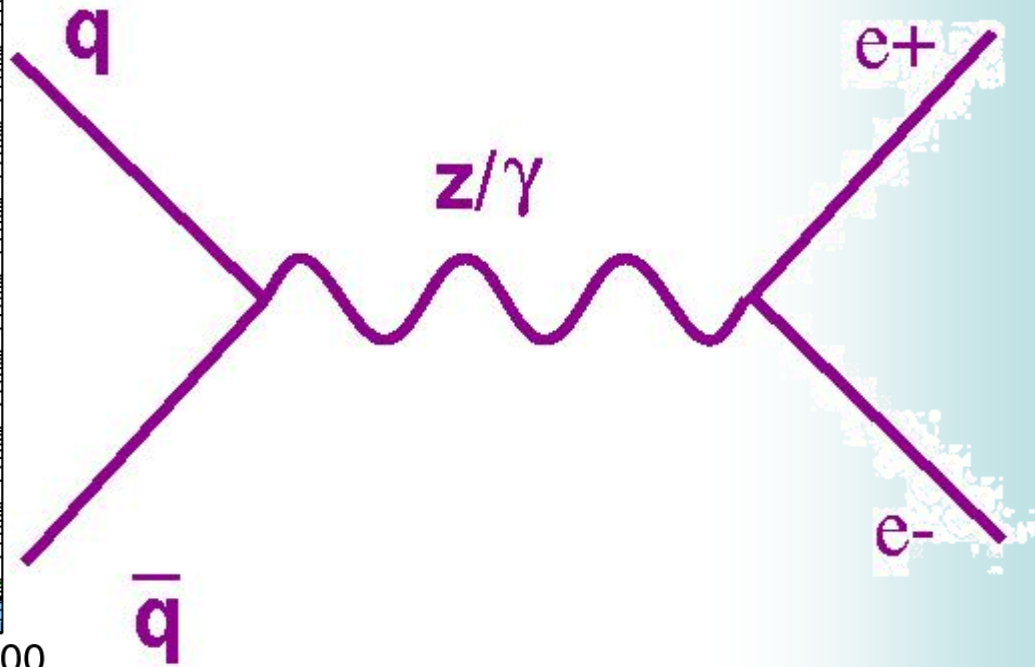
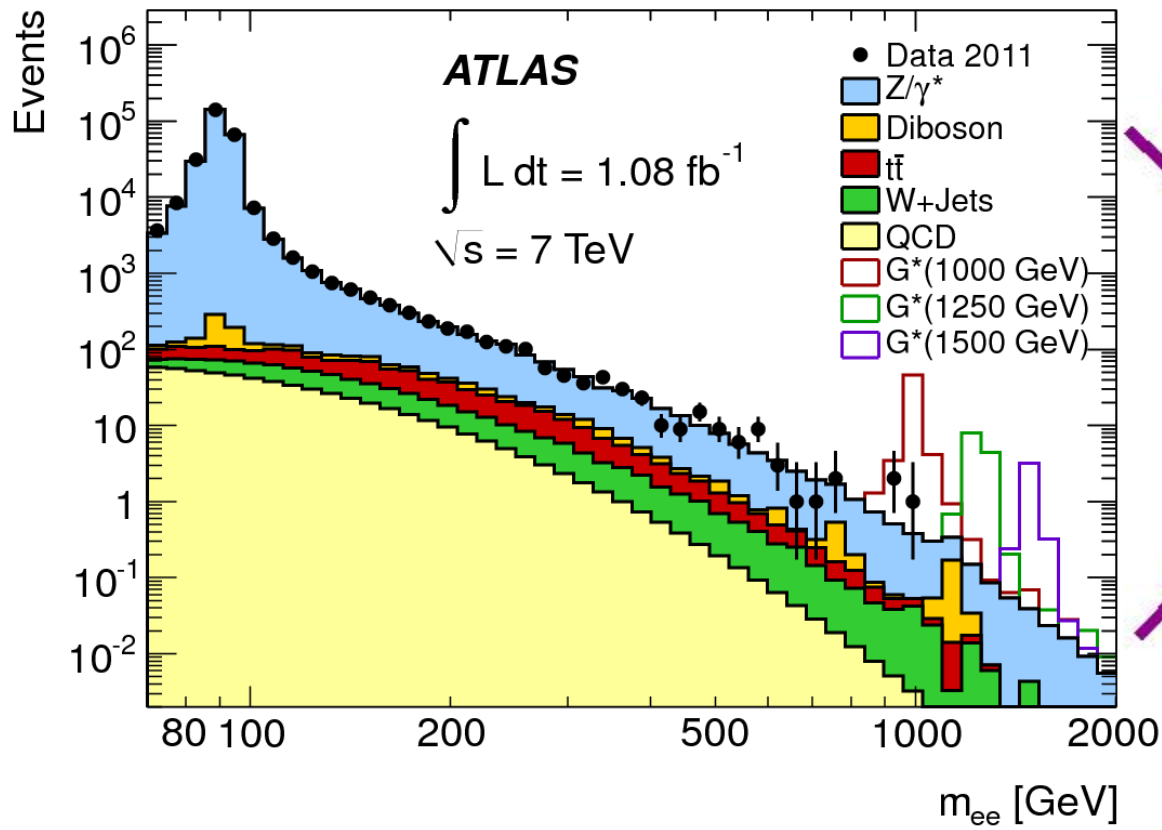
Energy,  $E = mc^2$

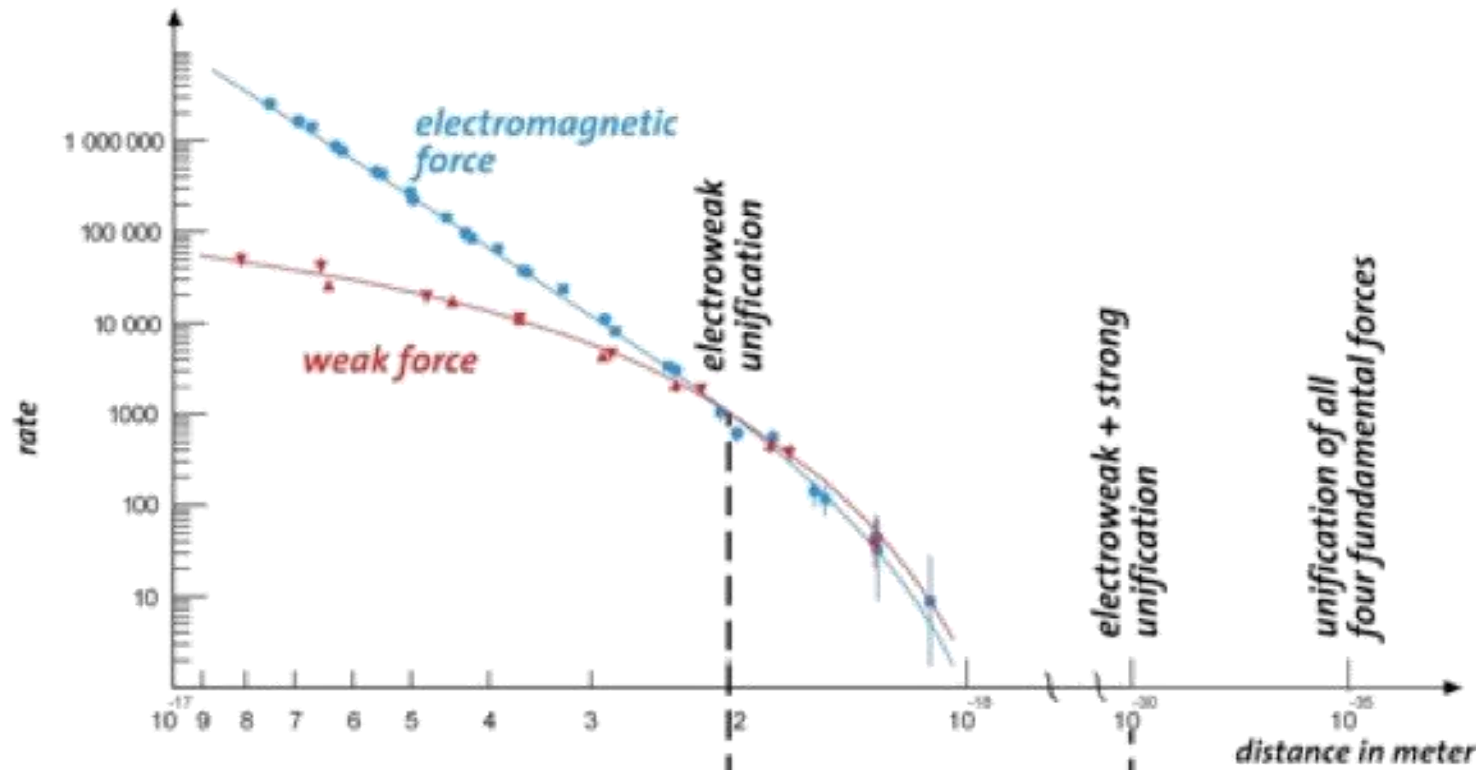
# Here's one we made earlier...



Energy,  $E = mc^2$







**strong force**

**electromagnetic force**

**weak force**

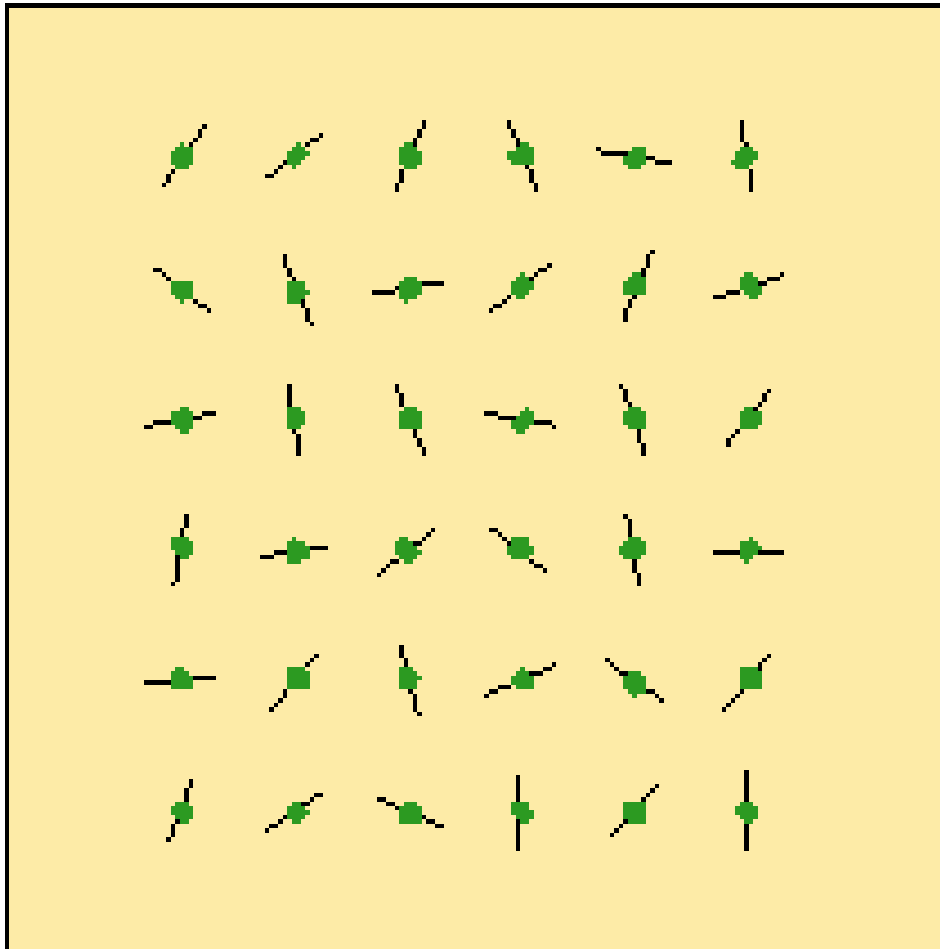
**gravity**

**electroweak force**

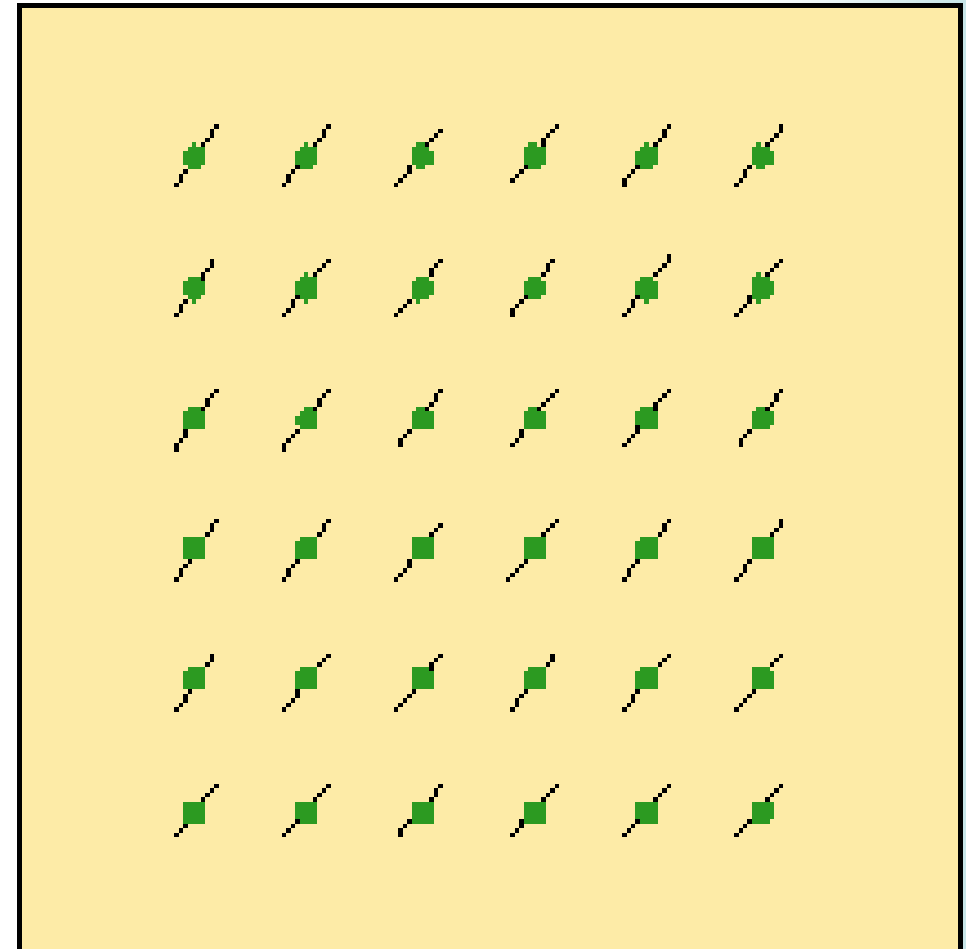
**big bang**



### High Temperature



### Low Temperature



# Science & the media

- A complicated relationship, often characterised by fear, mistrust and misunderstanding on both sides
- But for both sides, it starts with...



# ...Science & the public

- We need public support for what we do
  - *We ought to share the wonders we find*
- The media want viewers/listeners/readers...
  - *Outside of our own specialities, we **are** the public*
- We and the rest of the public need to talk to each other
  - *Much (though not all) of that is via media*

# The early 1990's

- Sudden(?) realisation that we had better engage.
- “Public understanding of science”, “deficit model”... data-collection, evaluation... many cycles (currently “public engagement”)
- But the fundamental shift in attitude was **“this is an important activity for scientists”**

# The LHC startup: 2008

## Episode 01: Codename Eurostar




### Codename Eurostar

The first in a series of films following a team of physicists involved in research at the new Large Hadron Collider (LHC) at CERN in Switzerland.

Gavin, Jon and Adam have a cunning plan to find the Higgs Boson, an elusive particle which physicists have been trying to find for over 40 years. One of the main aims of the the LHC is to discover once and for all whether the Higgs actually exists or not, and 'Eurostar' might just hold the key to finding out...

[Click here to watch Episode 2](#)

 Sign up here to be notified when the next episode is online.

## Web life: Colliding Particles



URL: [www.collidingparticles.com](http://www.collidingparticles.com)

### So what is the site about?

*Colliding Particles* is a series of short films chronicling what it is like to be a physicist at CERN's Large Hadron Collider (LHC). Each instalment of the series focuses on a different aspect of life as a full-time Higgs-hunter, while also (loosely) following the progress of a single team of researchers. The first episode was filmed before the LHC's gala launch on 10 September 2008, and it introduces a few basic ideas about the collider and the Higgs boson. Later episodes explore the media hype on "Big Bang Day", scientific conferences, problems with the collider and why the LHC is worth its multibillion-Euro price tag.

### Who is involved?

The main people in the films are members of "Project Eurostar", a group of researchers working

on a new technique for finding the Higgs using ATLAS, one of the LHC's two main all-purpose detectors. The group's name derives from its origins as an informal collaboration – facilitated by the Eurostar rail link – between London-based experimentalist Jon Butterworth and Paris-based theorist Gavin Salam. Butterworth's PhD student Adam Davison makes fun of the name on camera, but it seems to have stuck. The site itself is supported by the UK Science and Technology Facilities Council's "Science in Society" programme, with films produced by documentary filmmaker Mike Paterson.

### Who is it aimed at?

Although CERN researchers will undoubtedly get a kick out of spotting their colleagues in the background, students interested in science are the site's main audience. Such students will benefit from seeing how science really works – including the disappointing/boring/frustrating bits – and there are some teaching resources available on the site to help them. Unfortunately, the films contain relatively little physics, so anyone who wants more than a cocktail-party-level understanding of the Higgs, the LHC or Project Eurostar itself will need to dig into the site's "further reading" section.

### Why should I visit?

As *Physics World* readers know, the LHC is due to restart later this month, following a long shutdown that began just nine days after its initial switch-on in 2008. Oddly enough, this delay – while terrible for CERN's would-be particle colliders – has been good

for *Colliding Particles*. Recent episodes on the LHC's breakdown and science funding are far more insightful than previous ones filmed in its heady early days. In one scene in the "Collidonomics" episode, for example, Eurostar's Butterworth is at a funding review. As a researcher in the background talks dispiritedly about the rising cost of liquid helium, he manages a wry grin. Life as an academic, he says, "sure as hell doesn't feel like an ivory tower when you have to stand up and defend yourself" from budget cuts. This is something all physicists can appreciate – and that any would-be physics students should see.

### What are some highlights?

In one segment of the "Problems" episode, several researchers struggle to explain what caused the LHC to be shut down last autumn – without using the phrase "blew up", which is apparently off limits. "Engineering breakdown", "technical malfunction" and "catastrophic release of liquid helium – wait, scratch the 'catastrophic' bit" are some of the euphemisms they offer; but amid the silliness, their explanations are sound and easy to follow. At the end of the same episode, Salam, the Eurostar theorist, suggests that the universe is like a piece of music. With the lower-energy collisions at Fermilab's Tevatron, he says, we could hear the double basses, but the LHC will add the cellos – and from there, we will begin to figure out what the rest of the orchestra is playing. In a field full of analogies, most of them over-used, this one feels both fresh and insightful. But here's hoping the next episodes in the series contain some new science, not just new metaphors.

# Life and Physics

Making it up as I go along

[UK \(and/or EU\) Research Grant Prioritisation Pro – Forma »](#)

## The Physics behind the paper behind “Colliding Particles”

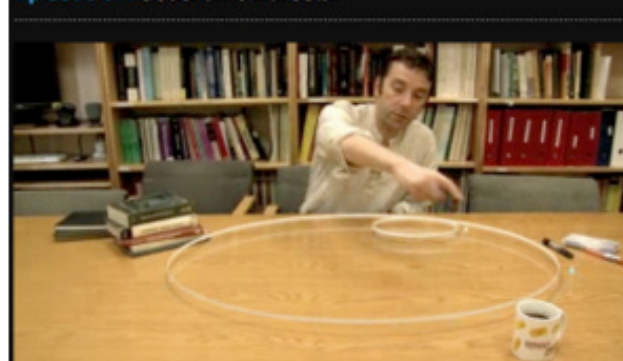
By Jon Butterworth

*This post also at [The Guardian](#).*

This is a bit of a niche post but there was recently a [review in Physics World](#) of [these videos](#) I'm in about research at the Large Hadron Collider (LHC). While generally positive, the review pointed out that although the videos are partially based around a particular [scientific paper about how one might find the Higgs boson](#) (referred to in the films as the “Eurostar paper”), they don't really explain the physics behind it, being focussed more on “how science works” than a specific result. Fair comment. So here is my attempt to explain the physics behind this paper to an intelligent but non-specialist audience.

I'll concentrate on explaining the new ideas in the paper rather than giving a summary of why the Higgs is interesting or what the LHC is. I wrote something about that at the end of [this article for the BBC](#), and might try again at some point. But I'll assume some familiarity with what the LHC is. For now, you need to know that if the Higgs boson exists, and if

Episode 01: Codename Eurostar



# LIFE AND PHYSICS

## JON BUTTERWORTH

HOSTED BY THE GUARDIAN



[Blog home](#)

[Next](#)

## The physics behind the paper behind Colliding Particles

The Colliding Particles films show a lot about how particle physics is done, but don't contain much actual physics. This was my first ever blogpost, which explains some of the physics

This is a bit of a niche post but there was recently a [review in Physics World](#) of these videos I'm in about research at the Large Hadron Collider (LHC). While generally positive, the review pointed out that although the videos are partially based around a particular [scientific paper](#) about how one might find the Higgs boson (referred to in the films as the "Eurostar paper"), they don't really explain the [physics](#) behind it, being focused more on "how science works" than a specific result. Fair comment. So here is my attempt to explain the physics behind this paper to an intelligent but non-specialist audience.

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Posted by  
Jon Butterworth  
Tuesday 29 December  
2009 16.20 GMT  
[guardian.co.uk](#)  
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A SEASONAL STOCKING FILLER?  
SOME COUTURE IN THE SALES?  
A FRENCH FANCY?

### Online science writing Masterclass



In this digestible online video, former Guardian Science Editor Tim Radford reveals his approach to science writing. [Find out more](#)

[and watch now](#)

### Today's best video

GENEVA

MUNICH



**COLLISIONS TOOK PLACE AT A RECORD  
LEVEL OF 7 BILLION ELECTRON VOLTS**







# Two tiny dots flicker – the great atom adventure

it in the control  
est experiment  
enderson writes



Looking at computer  
at the control centre of  
Geneva yesterday. Right-  
visions show on displays in  
detector control room.  
set of the detector

and "capture" so they fire in neat pulses. Then it will be time for business — the collisions that will generate new physics.

By re-creating the environment of the dawn of time, the LHC will detect phenomena that have never before been observed. It should find the Higgs boson, the so-called "God particle" that theory suggests gives matter its mass, but which has never been found. It should also determine whether all particles have a twin, as a theory known as "supersymmetry" suggests, and that explains the mysterious "dark matter" that pervades the Universe, but which cannot be seen.

The LHC may even find new dimensions, beyond the three of space and one of time with which we are familiar. It promises to unlock great secrets of the cosmos.

"Particle physics is a modern name for the centuries-old effort to understand the laws of nature," said Professor Tejinder Virdee, who heads the Compact Muon Solenoid detector team. "Humankind has an unquenchable thirst for knowledge and understanding the surroundings in which we live."

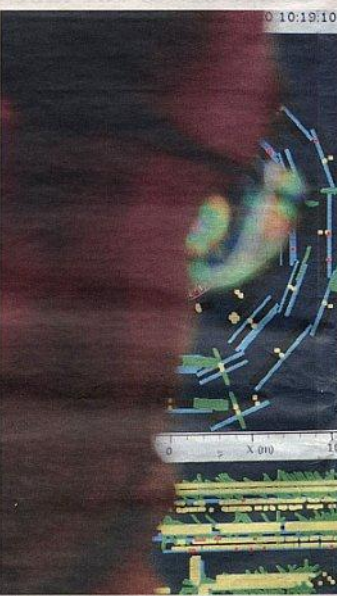
"The excitement is of having completed a machine that's taken 20 years to plan and build. Now we're looking forward to the really interesting part: even more excitement awaits us as we start doing the science. The LHC is going to look deeper into matter and go back further in time than we've been able to go before. It's the most powerful microscope ever built and at the same time the most powerful telescope ever built."

"We have these theories, and now we're getting into new territory to put them to the test. We don't know what we're going to find — that's why we do the experiments."

The first trial collisions, from which researchers will calibrate their detectors, could start as early as next week. The LHC will then start operating at about 70 per cent of maximum energy, before it is stepped up to full power next year. Discoveries about supersymmetry could come quickly, but the hunt for the Higgs boson will take longer, with few results expected before 2013.

For Dr Evans, 61, from Aberdare, yesterday's achievement was "a great relief", the culmination of 14 years of work on the collider, and the harbinger of a happy retirement. "Over the next year and a half I hope to retire the LHC up to its maximum potential, and then say 'I've had my last night'."

Also celebrating was someone at the other end of a scientific career: Kate McAlpine, 23, who has found unlikely online fame with the "Large Hadron Rap". Her rhyme about the LHC has been downloaded almost two million times.



**Thinking big**

**The 1,000 Genomes Project**  
An international project to map the most common human genome variants. This pilot study of the British population genetic data will allow scientists to spot DNA variations between humans that allow susceptibility to disease.

**The Boulby Mine Experiment**  
Raising about 987 more than a kilometre below the Yorkshire attempting to detect ripples in spacetime by measuring the exact patterns of laser retractions between mirrors.

**Phoenix Mars Lander** launched in August last year, arriving on Mars in May, below. The left vehicle is designed to scour the surface of the planet looking for carbon-based chemicals, water and rare materials. The correct combination of these



**Doomsters' quark was worse than their bite**

**Ben Macintyre**  
Commentary

momentous event they didn't understand any more profoundly than the rest of us. The proton and the lead. And the things that it discovers will rock you in the head."

It has inspired a raft of copyright videos, remixes and even "an extreme chill-out experience" for anyone contemplating the beginning, watched nearly two million times. "The LHC accelerates the proton and the lead. And the things that it discovers will rock you in the head."

I was jolly pleased too, though for the more prosaic reason that we had not all been ground up into metaphors: "It is like sending a beam of light smaller than the width of a human hair at the speed of a jumbo jet," said one explicator. "That's what they have done here. And they are jolly pleased."

# BIG BANG

Radio 4

Big Bang Homepage

Programmes

About the Experiment

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CERN in Sci-Fi

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## The LHC: worth the wait?



Professor Jonathan Butterworth

I have never seen so many physicists in the media as there were in September 2008. There we were, often nervous, always excited, trying to explain what the Large Hadron Collider would do (teach us more about the universe) and what it wouldn't do (destroy the universe). One particularly bizarre memory is of retiring to a pub in Westminster, finally exhausted by the LHC event I was helping with, and continuing to

get updates ON MY OWN EXPERIMENT from the BBC news ticker on the TV in the corner. Beams have gone both ways round the LHC... Beams successfully stored... Ah, those were the days! It doesn't get much better than this.

Sadly of course, it didn't. It got a lot worse.

The truth is, while you may have thought we were nervous and excited about being on Breakfast TV, meeting the Minister, blinking in the glare of unaccustomed publicity, we were really nervous and excited about the LHC

## Big Bang Day Programmes

- » The Making of CERN
- » Today
- » Thought for the Day
- » Engineering Solutions
- » Woman's Hour
- » Physics Rocks
- » Afternoon Play - Torchwood
- » 5 Particles
- » Front Row
- » The Great Big Particle Adventure
- » Big Bang Day: The Genuine Particle

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BBC links

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# BIG BANG

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**Programmes**  
**About the Experiment**  
**Live Updates**  
**Gallery**  
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**Audio Archive**  
**Videos**

## Gallery of images from the CERN laboratory



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## Related Links

### BBC links

- » News: Large Hadron Collider Guide
- » Today: Tom Feilden's Blog

Andrew Marr, Professor Brian Cox and Professor Jim Virdee, UCL



<http://www.youtube.com/watch?gl=GB&hl=en-GB&v=shGI-kpnMgY>

# Some dates...

Robin does lots of gigs. You might find some of them at places like [Ents24.com](http://Ents24.com), etc. Here are a few:



(photo © Rob Greig)

**BOOK CLUB** - award winning comedy readings from very bad books.

**THE IMPORTANCE OF BEING INTERESTED** - 2013 tour: Charles Darwin, Richard Feynman, Aristotle and the joy of picking shells up on the beach and realising that being self-conscious in a big universe is a darn good thing.

## DECEMBER

9 LESSONS AND CAROLS FOR GODLESS PEOPLE  
 15/12/2012 The Bloomsbury  
 London  
[event series link](#)

# robinince.com

Welcome to the website of Robin Ince, comedian, writer and that sort of thing. Twitter [@robinince](#). Robin's agents: [noelgay.com](http://noelgay.com)  
 For live event booking enquiries, email [warren@lakinmccarthy.com](mailto:warren@lakinmccarthy.com) or call 020 8530 5179.



## latest news...

**THE INFINITE MONKEY CAGE  
 DOWNLOADS NOW LIVE**



Robin and Brian's BBC Radio 4 comedy/science series is on air again at 4:30PM Mondays, this week featuring Jo Brand talking of brain things. Shows repeat on Tuesdays at 11PM.

Programme [homepage](#) has more info, and more downloads are at [TIMC Podcast Page](#), including iTunes subscription. Twitter is [@themonkeycage](#).

**MORE 9 LESSONS AND CAROLS  
 2011 DVD AVAILABLE**

## Stars of UK Comedy and Science Stand Up Against Unfair Libel Laws in West End Show



Big names in UK comedy, science and politics come together on stage to tell us that England's libel laws have become a dangerous joke.

The Big Libel Gig on Sunday 14 March 2010 at the London's Palace Theatre will raise funds to support the Coalition for Libel Reform. An eclectic line-up, including Dara Ó Briain, Tim Minchin, Marcus Brigstocke, Robin Ince, Ed Byrne, Shappi Khorsandi, Professor Brian Cox, Simon Singh, Professor Richard Wiseman, Dr Peter Wilmshurst and Dr Ben Goldacre, is supporting the campaign for a public interest defence to protect writers, bloggers, academics, human rights activists and performers.

The Big Libel Gig is the brainchild of comedian Robin Ince - whose previous successes include the annual *Nine Lessons and Carols for Godless People* shows and who will be hosting the evening – and Simon Singh, the science author and broadcaster, who will be talking frankly about the impact of libel fears on scientific debate.

Simon Singh, who is currently being sued by the British Chiropractic Association, said: *"Peter Wilmshurst, Ben Goldacre and I will talk about being sued for libel. Peter is being sued for raising concerns about a heart device. He faces bankruptcy by coming up against our draconian libel laws. We are all put at risk if doctors and scientists are scared to speak out because of English libel laws."*

Stars of the show will tell the audience that England's unjust libel laws are preventing free speech and open criticism of big corporations and powerful institutions. They will call for others to support the campaign for a public interest defence and join them in signing the petition for libel reform at [www.libelreform.org](http://www.libelreform.org). The Big Libel Gig will be the culmination of Libel Reform Week, which will raise awareness of English libel laws and urge political

# Back to the LHC: 9 days later



## This Week's Rumor

Posted on [April 21, 2011](#) by [woit](#)

A commenter on the previous posting has helpfully given us the abstract of an internal ATLAS note claiming observation of a resonance at 115 GeV. It's the sort of thing you would expect to see if there were a Higgs at that mass, but the number of events seen is about 30 times more than the standard model would predict. Best guess seems to be that this is either a hoax, or something that will disappear on further analysis. But, since spreading well-sourced rumors is more or less in the mission statement of this blog, I think I'll promote this to its own posting. Here it is:

### *Internal Note*

*Report number ATL-COM-PHYS-2011-415*

*Title Observation of a  $\gamma\gamma$  resonance at a mass in the vicinity of 115 GeV/c<sup>2</sup> at ATLAS and its Higgs interpretation*

*Author(s) Fang, Y (-) ; Flores Castillo, L R (-) ; Wang, H (-) ; Wu, S L (University of Wisconsin-Madison)*

*Imprint 21 Apr 2011. – mult. p.*

*Subject category Detectors and Experimental Techniques*

*Accelerator/Facility, Experiment CERN LHC ; ATLAS*

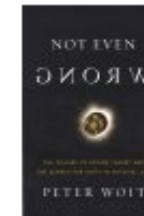
### About

[Peter Woit's Home Page](#)

### FAQ

[Frequently Asked Questions](#) (under construction)

### Not Even Wrong: The Book



### Reviews

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- [Langlands](#) (14)
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- [Not Even Wrong: The Book](#) (26)
- [Strings 2XXX](#) (9)
- [This Week's Hype](#) (68)



# Rumours of the Higgs at ATLAS

Many of us on the ATLAS experiment at CERN have been a little more busy than we anticipated this Easter. I tried to explain why on Channel 4 news

You may have seen reports of rumours of .... dramatic findings at the Large Hadron Collider over the past few days. I haven't commented on them here so far since the rumours are based on a leaked internal document.

Nevertheless when Channel 4 asked me about it I thought I should go on:



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Posted by  
 Jon Butterworth  
 Sunday 24 April 2011  
 21.00 BST  
[guardian.co.uk](http://guardian.co.uk)  
 Jump to comments  
 (89)



Article history

## Science

Cern · Particle physics · Physics · Higgs boson

More from Life and Physics on

## Science

Cern · Particle physics · Physics · Higgs boson

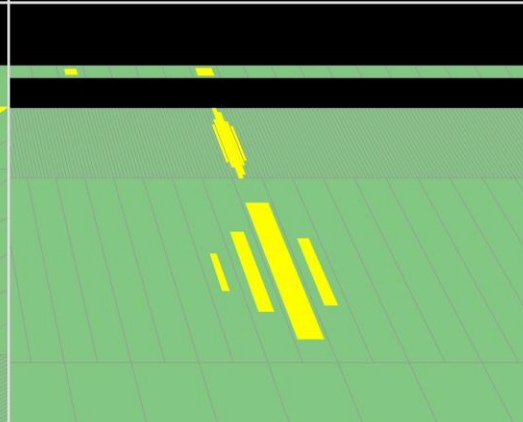
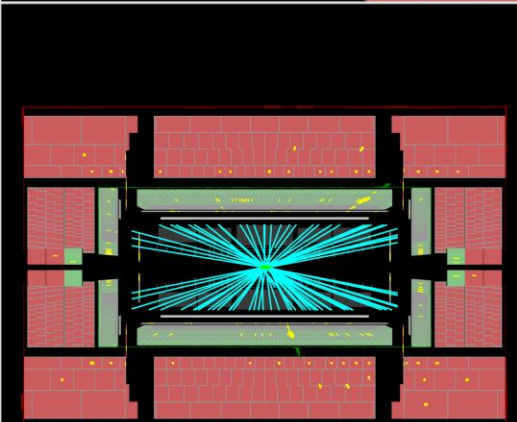
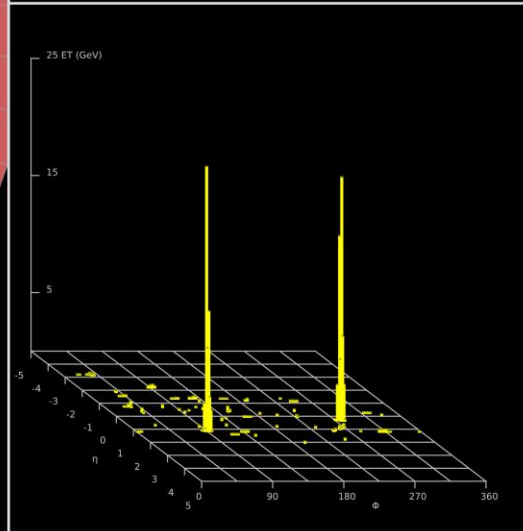
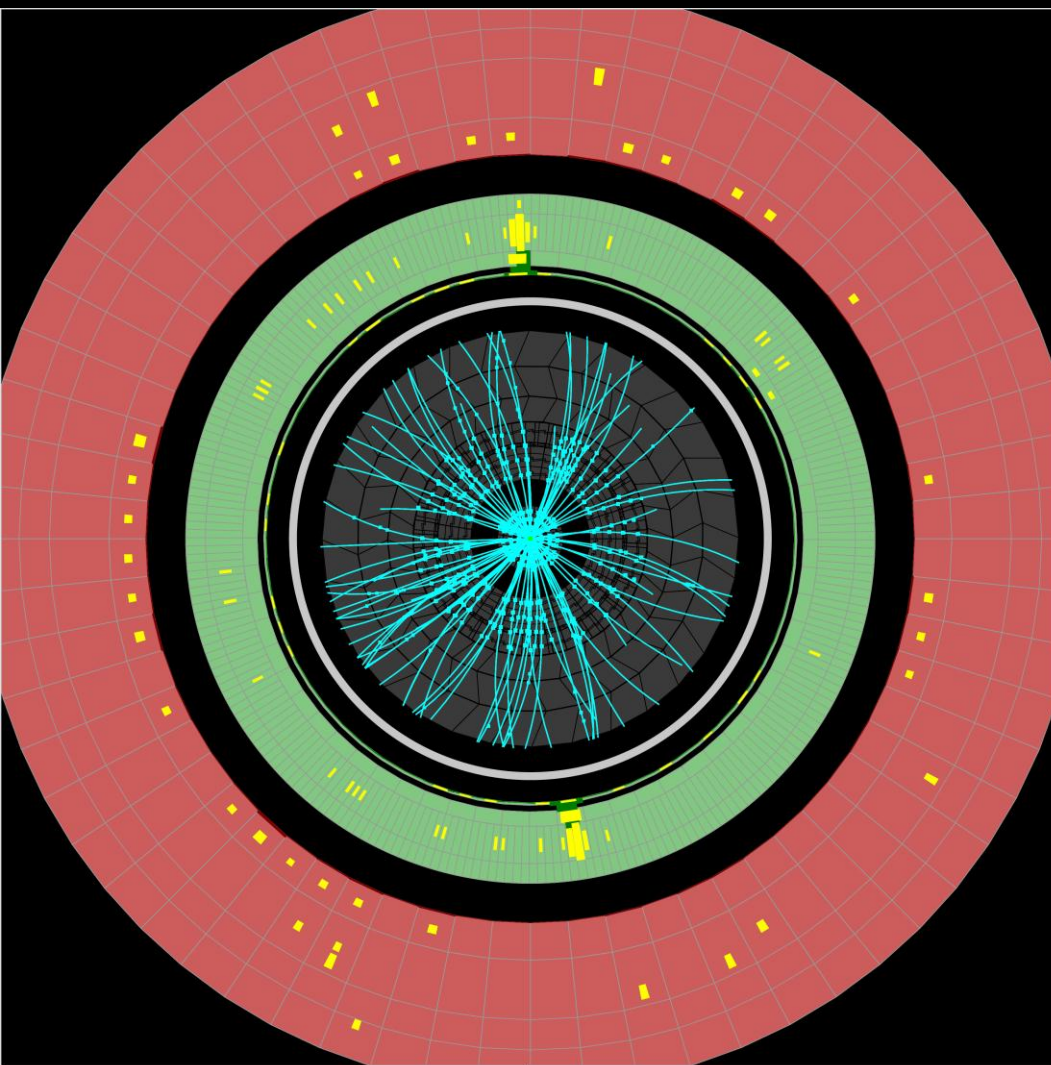
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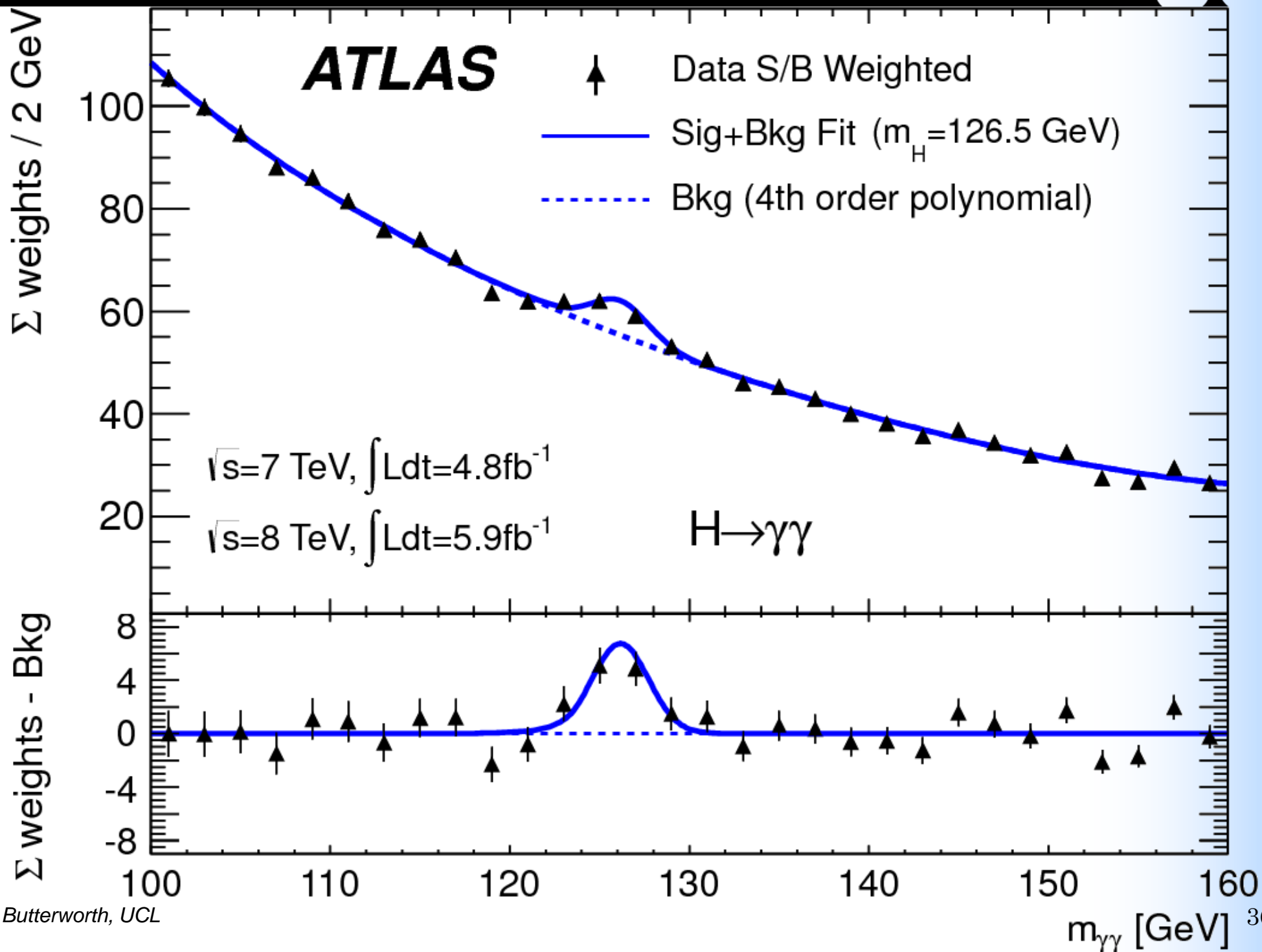


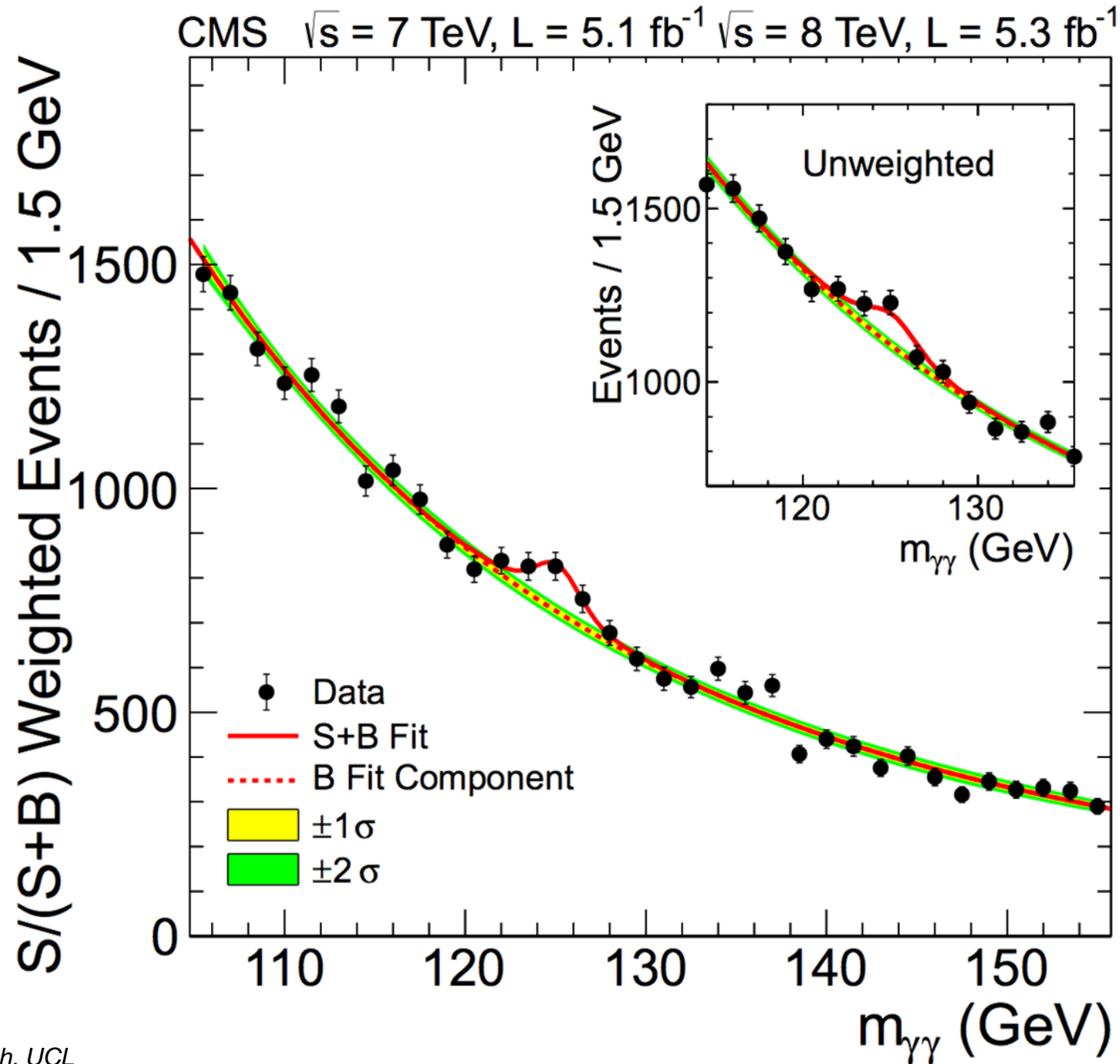
# ATLAS EXPERIMENT

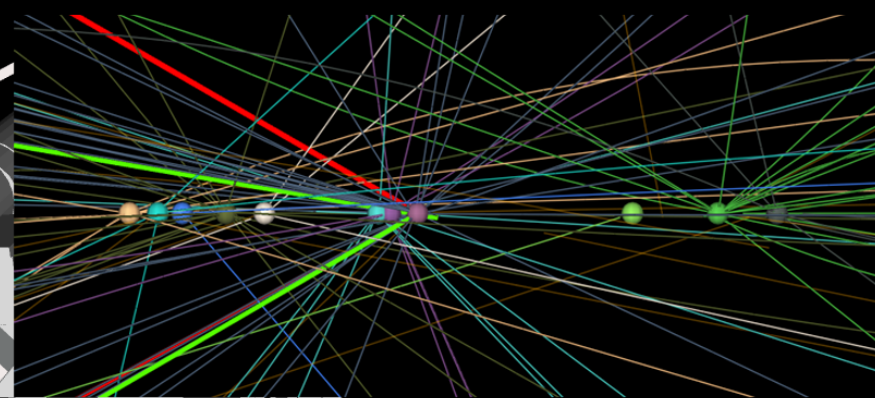
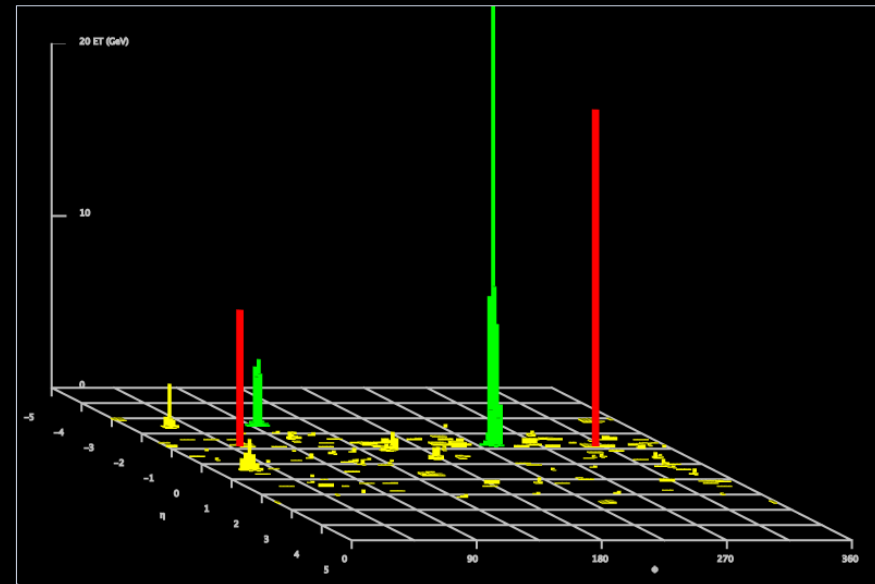
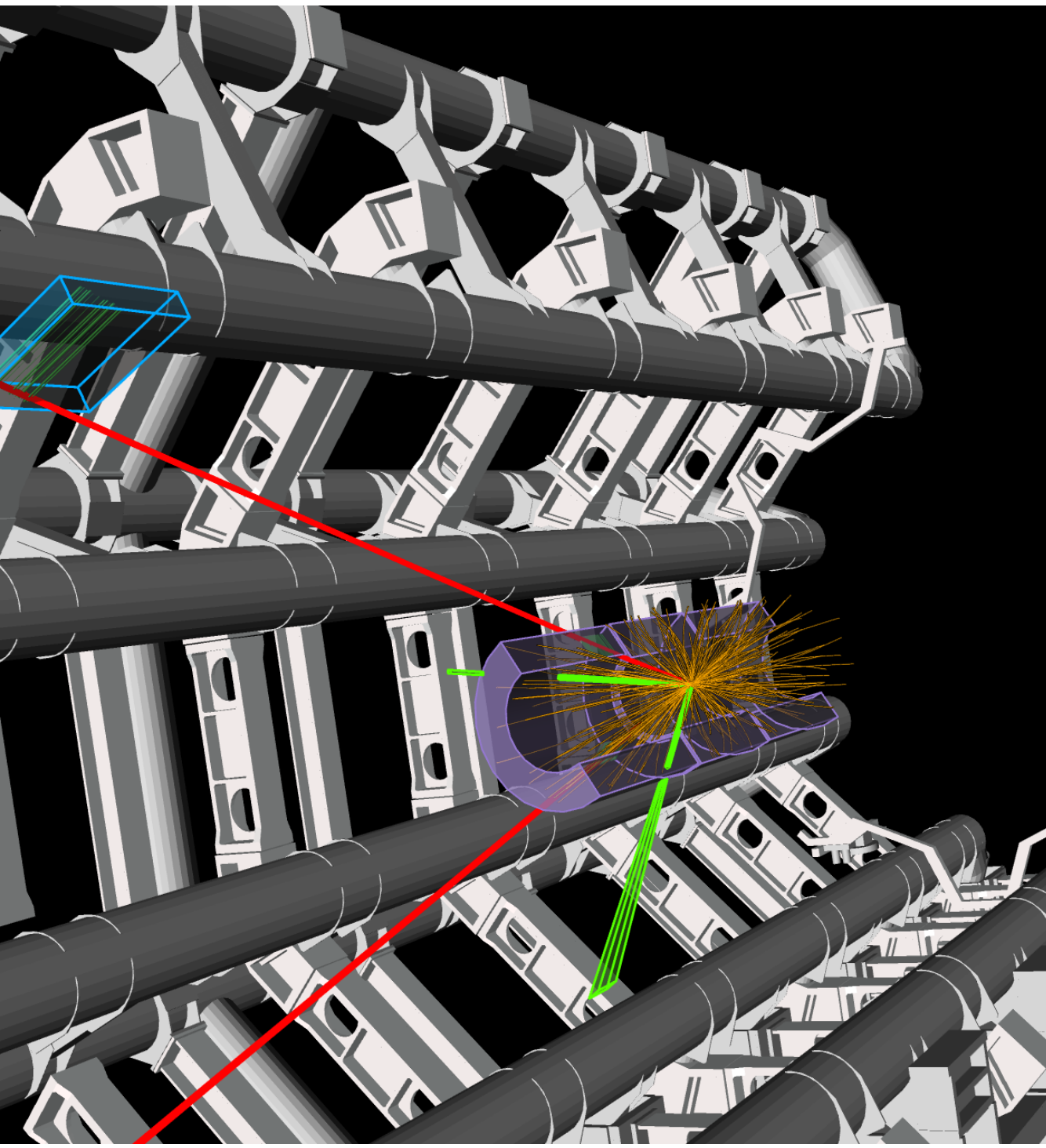
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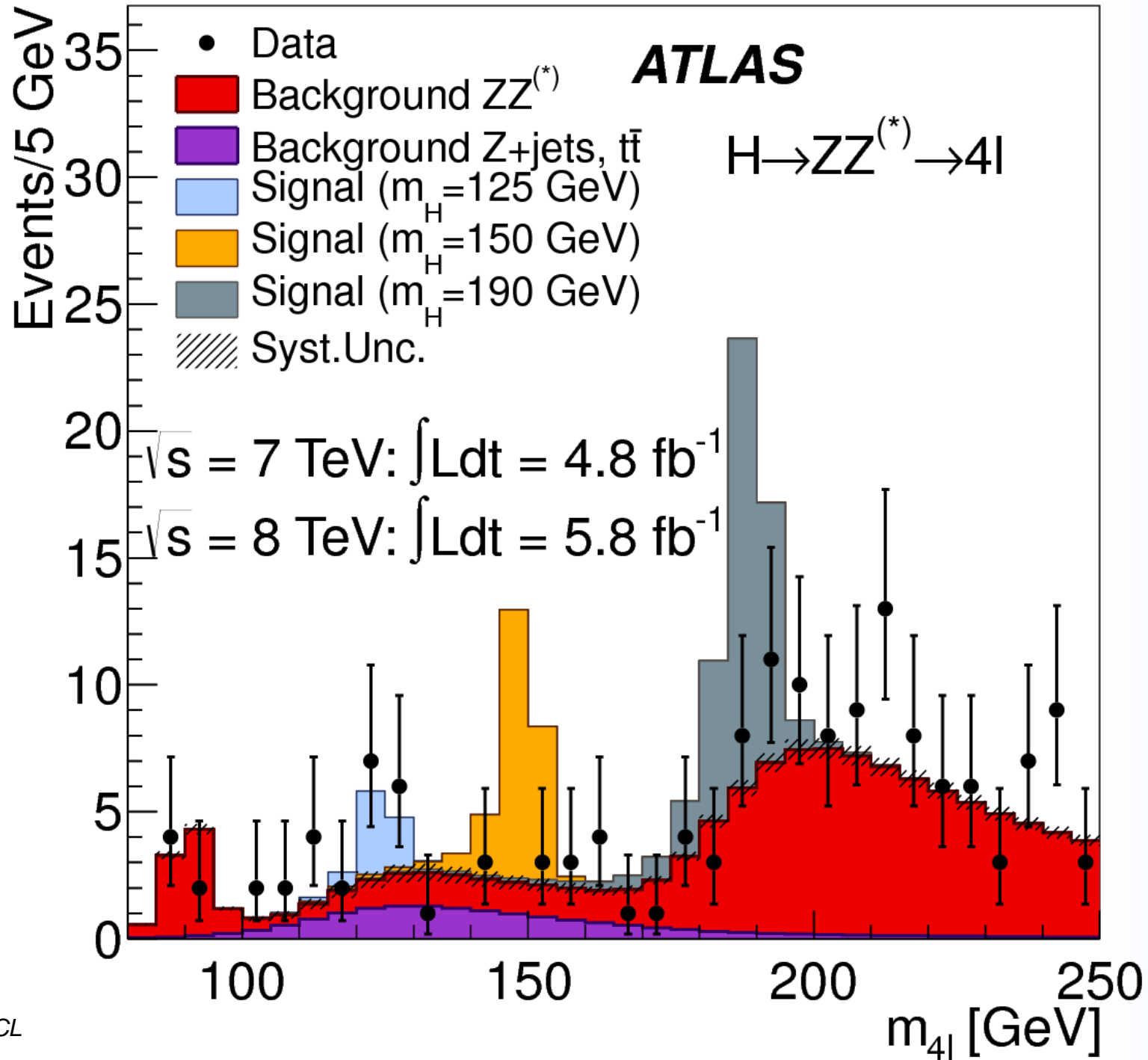
Date: 2012-05-23 22:19:29 CEST

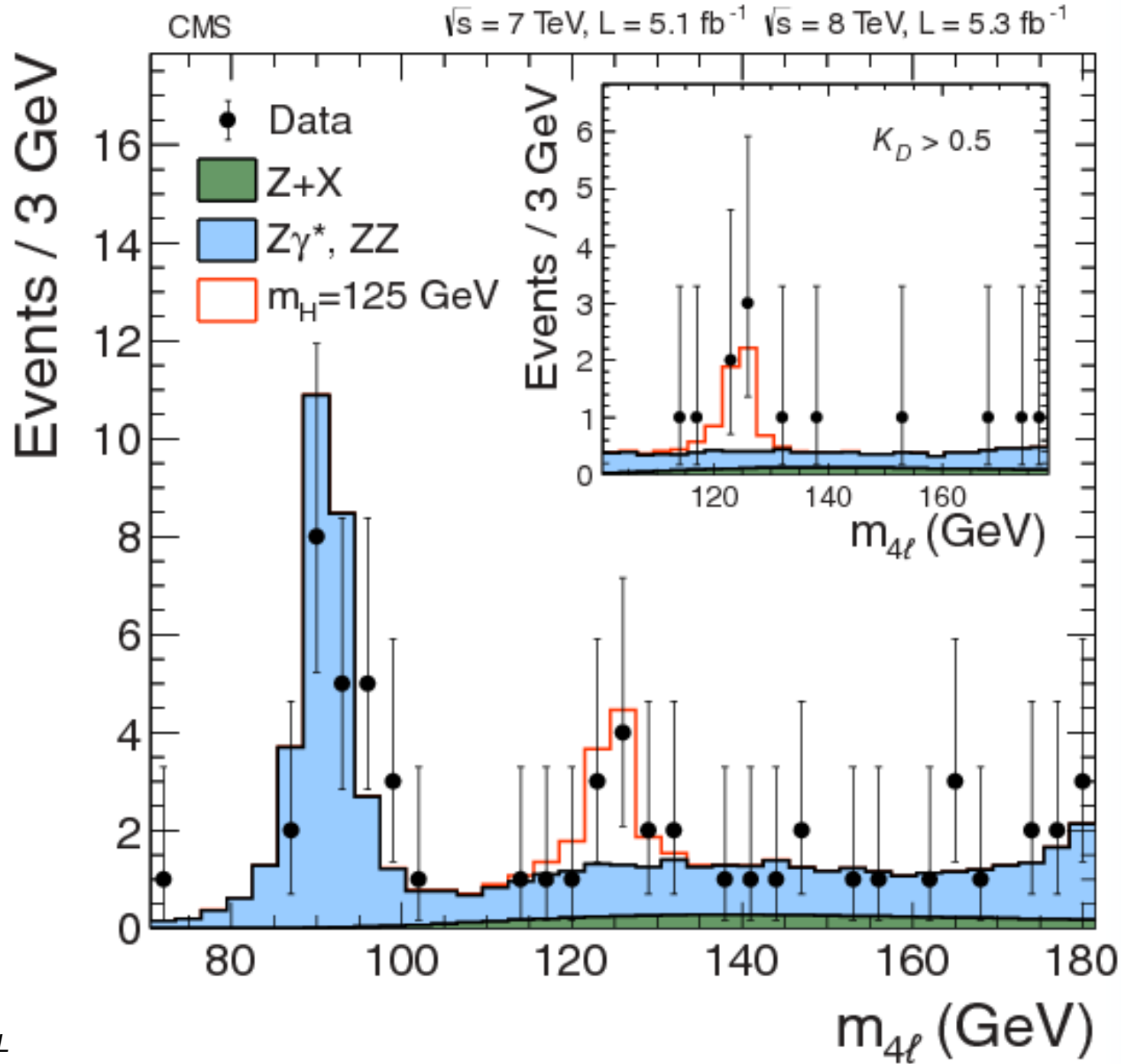




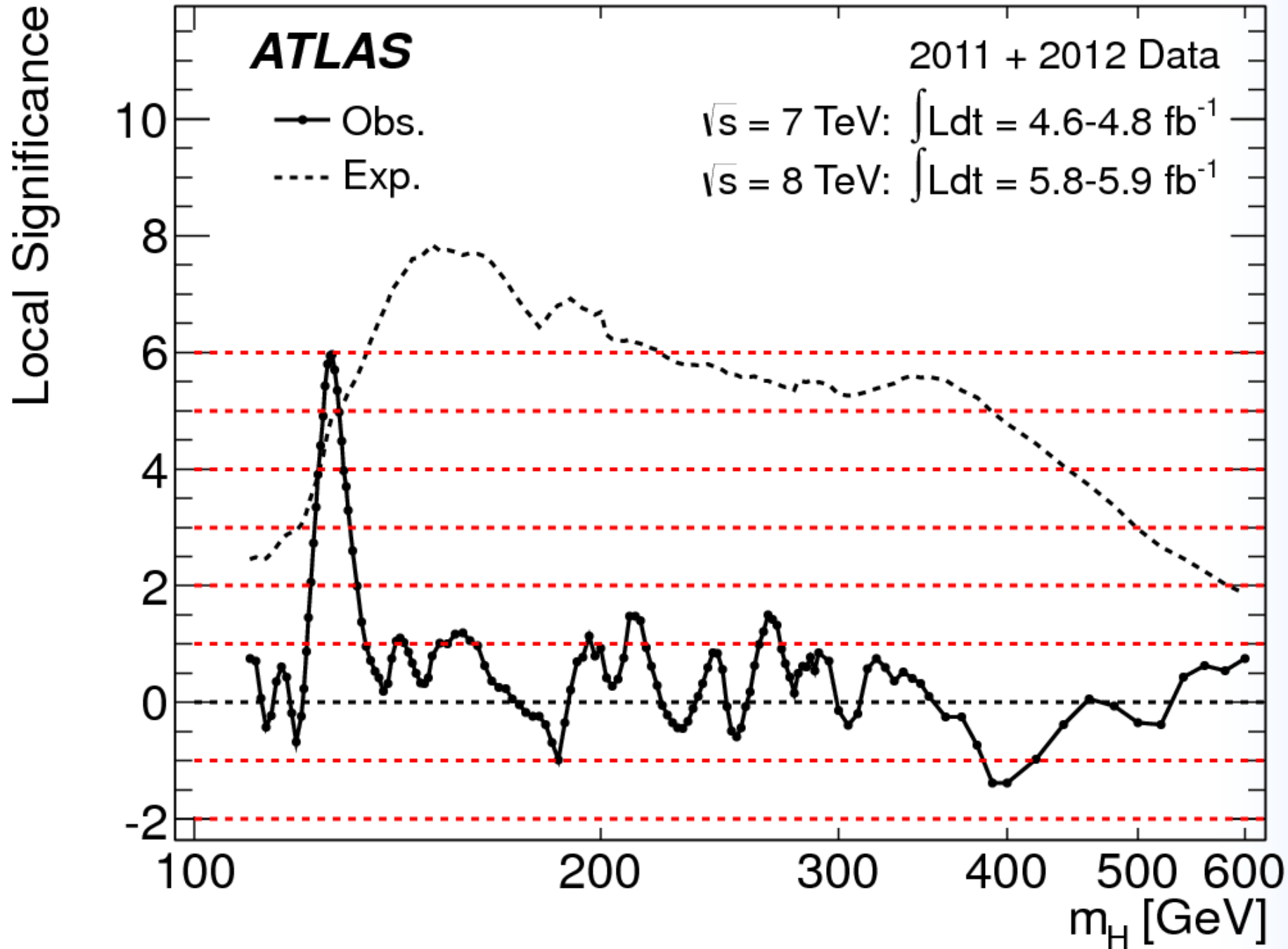


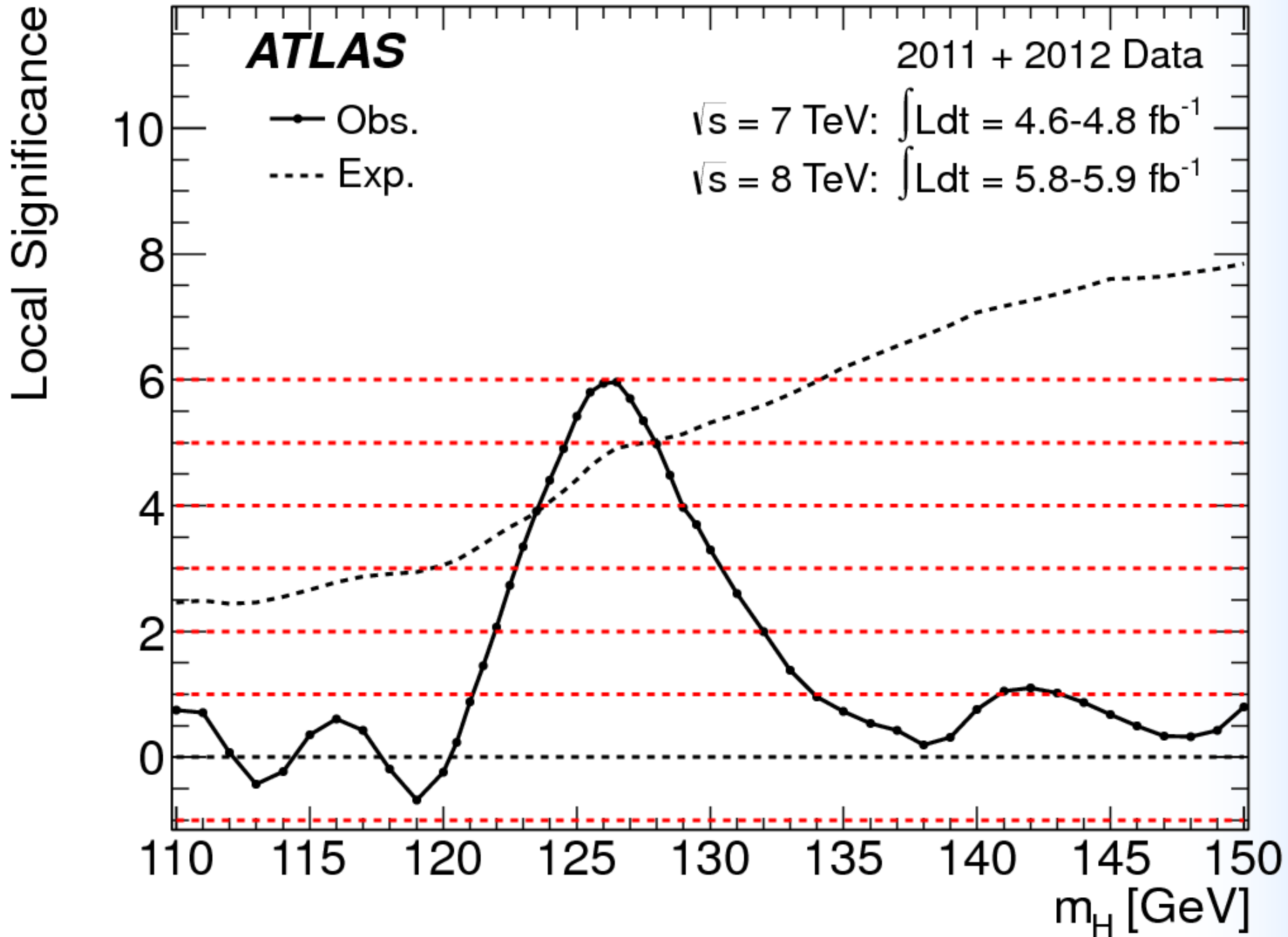




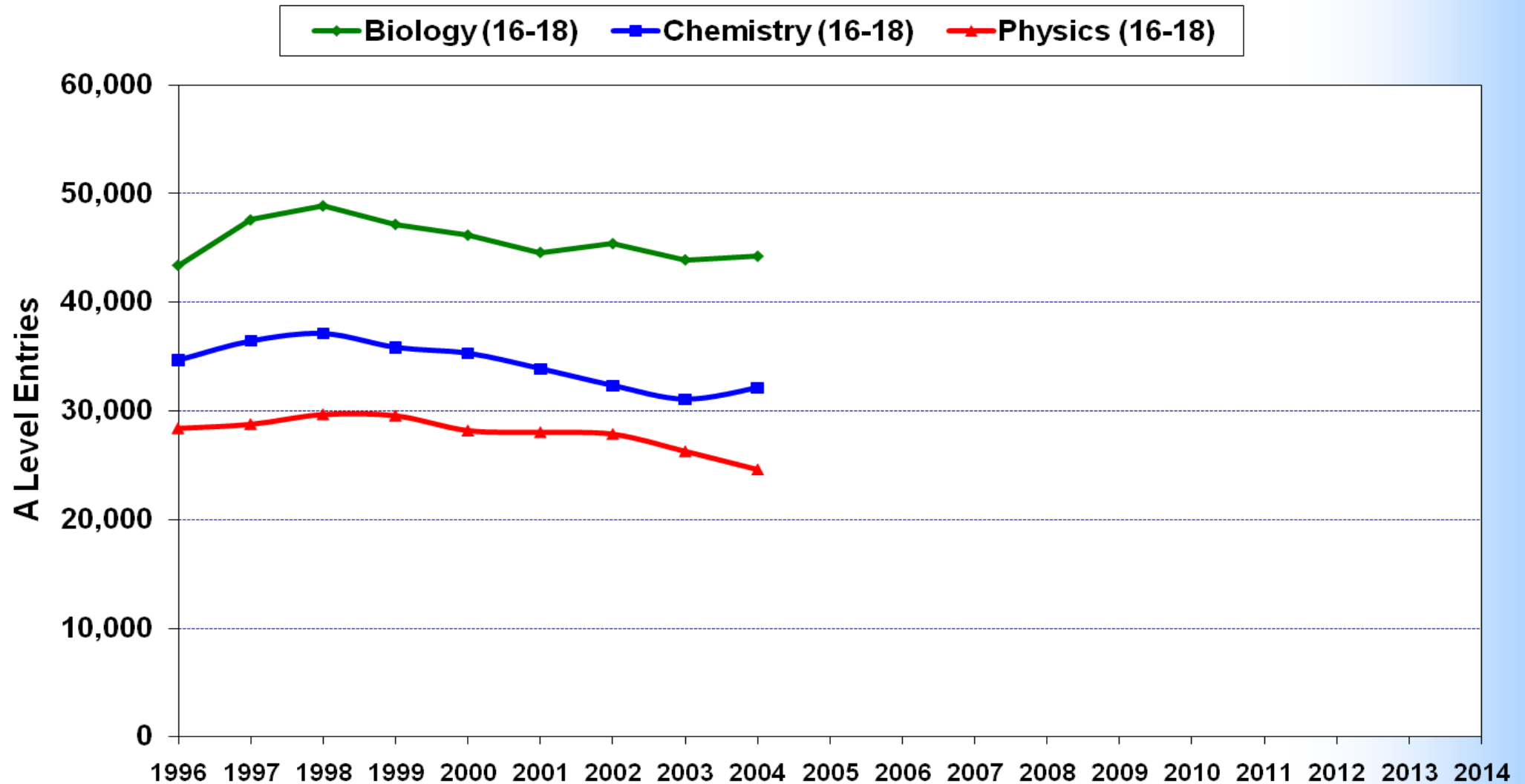




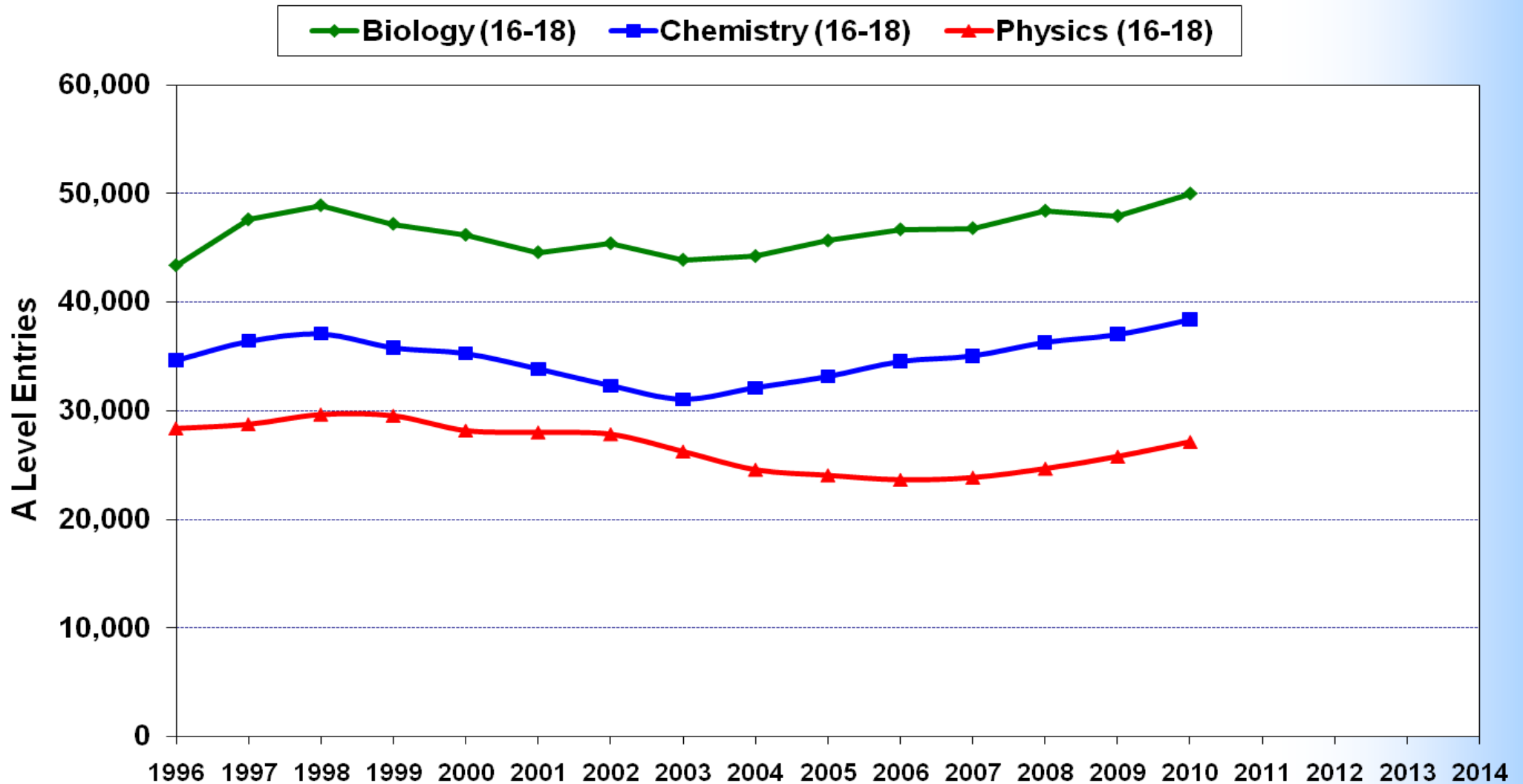




# A Level Science entries



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# University Entry: Physics (including Astronomy/Astrophysics)

- 2005 3069
- 2006 3060
- 2007 3349
- 2008 3452
- 2009 3721
- 2010 3827

*Source: IoP Nov 2011: Accepted places*

# What we may learn from the LHC

- How well the Standard Model works above the electroweak symmetry breaking scale
- Why the W and Z have mass and the photon is massless
- Where mass comes from
- Possible new particles and forces (supersymmetry?)
- Possible new dimensions of space
- Mini black holes/quantum gravity
- Physics in a fundamentally new regime

***The beginning of physics above the  
Electroweak Symmetry Breaking scale...***