The ATLAS Experiment

Mapping the Secrets of the Universe

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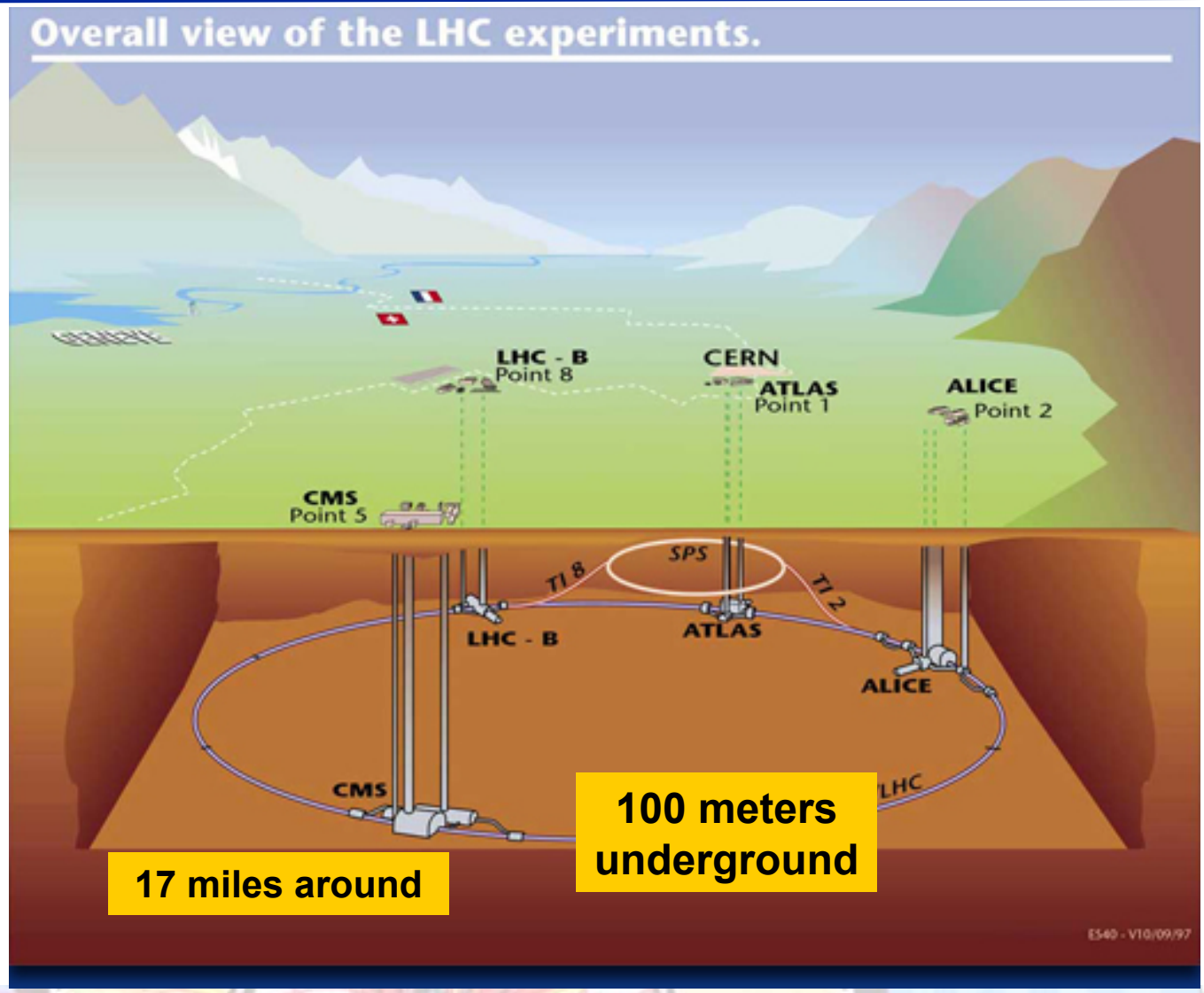
Physics Division
July 2007

With help from:
Joao Pequenao
Paul Schaffner

Large Hadron Collider

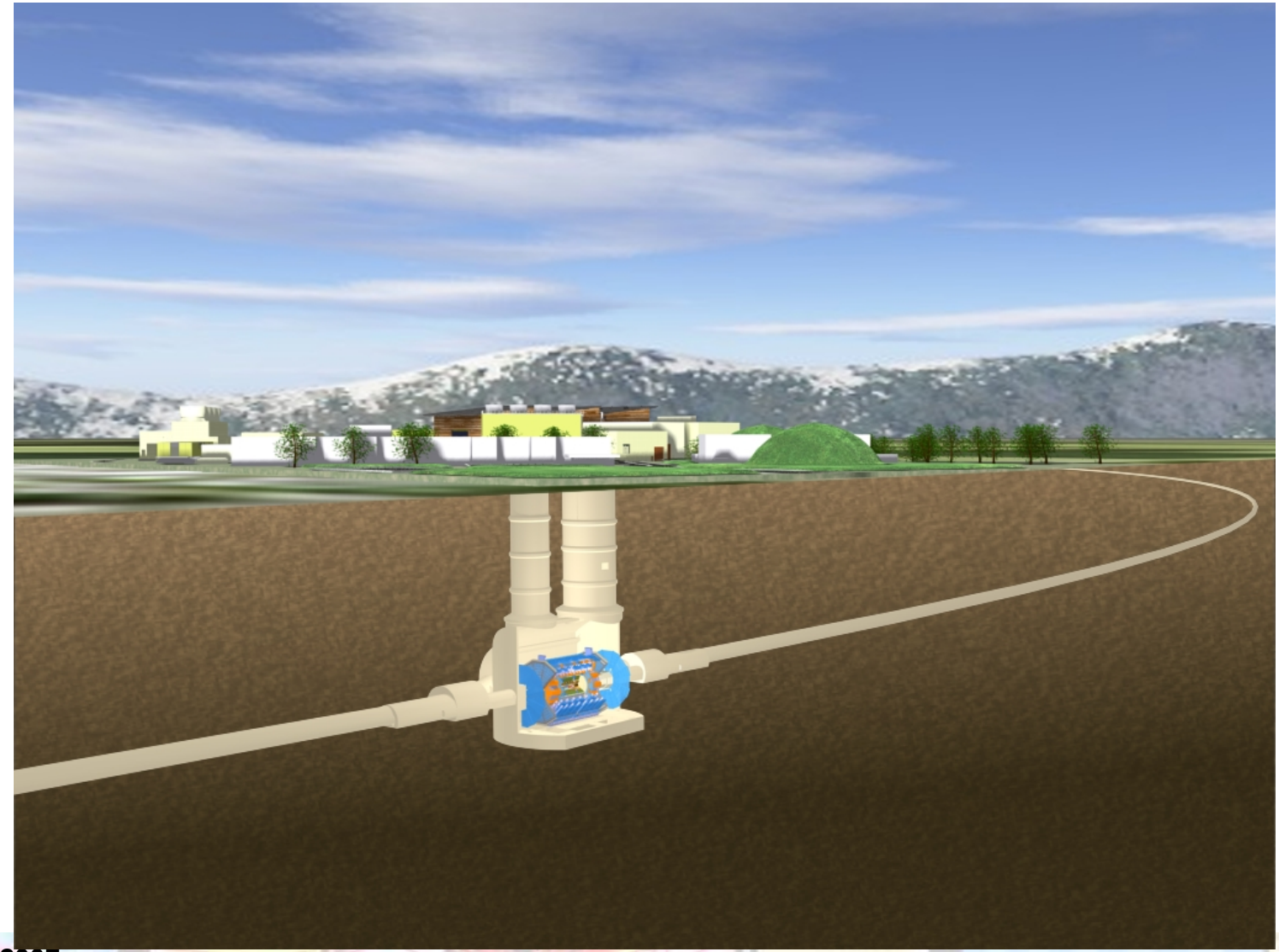
CERN lab in Geneva Switzerland

Protons will circulate in opposite directions and collide inside experimental areas



The ATLAS Experiment

See animation



Large Hadron Collider Numbers

The fastest racetrack on the planet

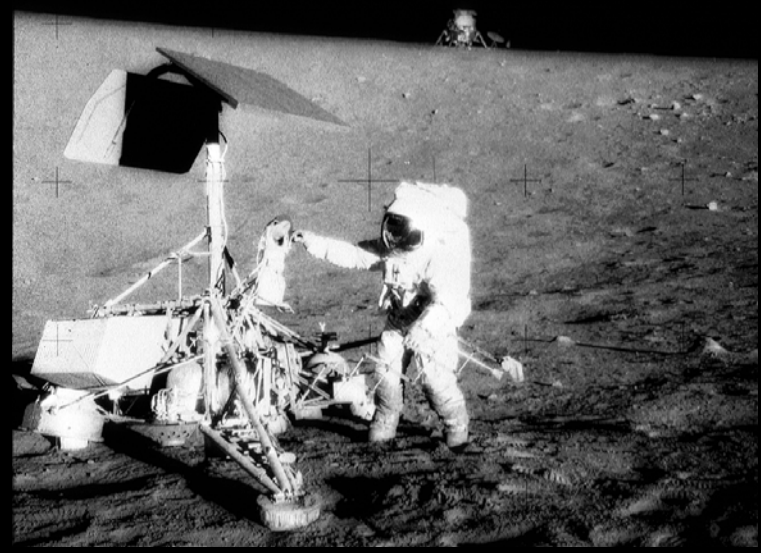
Trillions of protons will race around the 17-mile ring 11,000 times a second, traveling at 99.9999991% the speed of light.

Seven times the energy of any previous accelerator.

The emptiest space in the solar system

Accelerating protons to almost the speed of light requires a vacuum as empty as interplanetary space.

There is 10 times more atmosphere on the moon than there will be in the LHC.

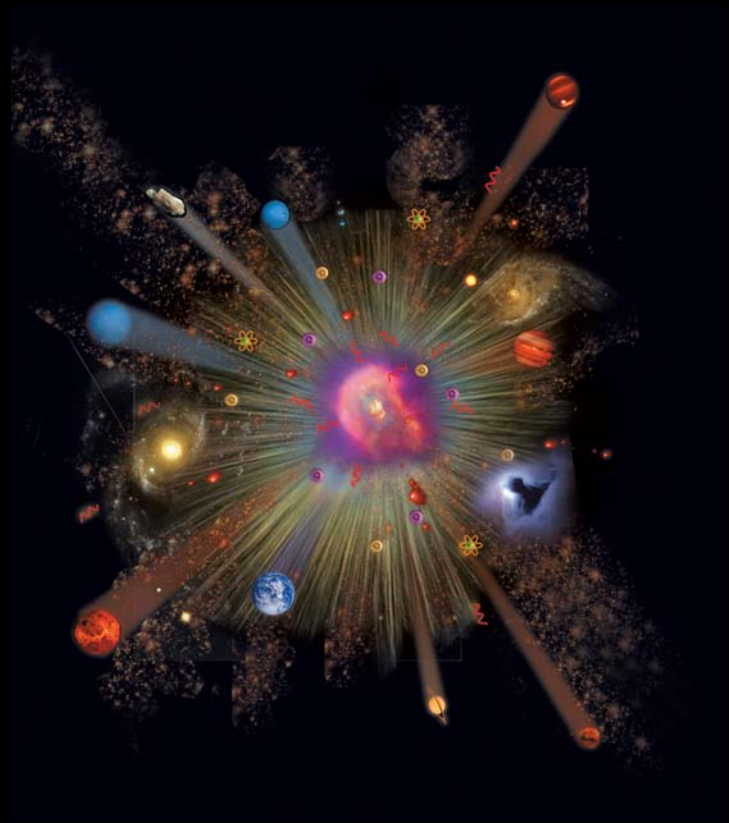


Large Hadron Collider Numbers

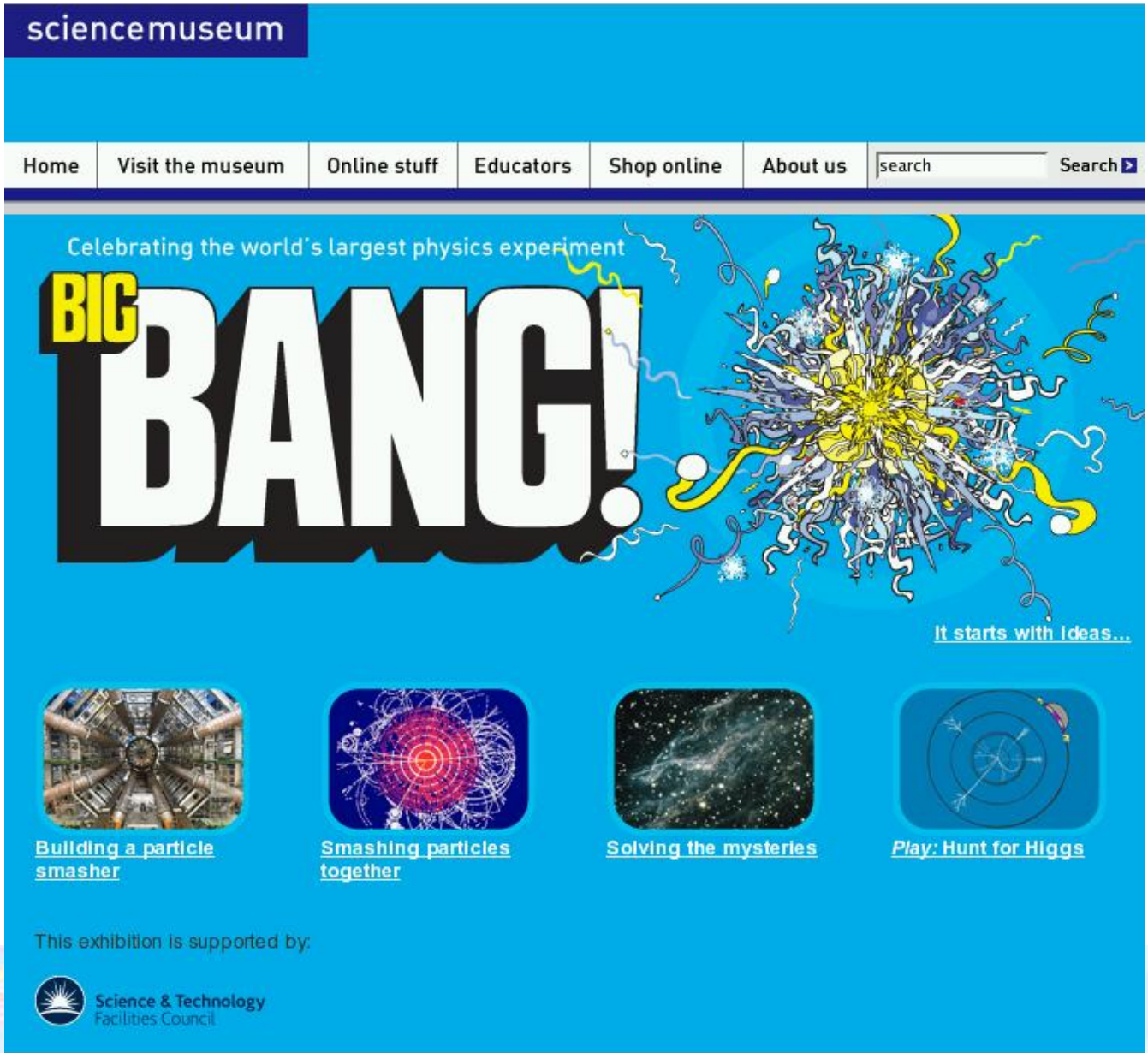
The hottest spot in our galaxy

Colliding protons will generate temperatures 100,000 times hotter than the sun (but in a minuscule space).

Equivalent to a billionth of a second after the **Big Bang**



LHC Exhibition at London Science Museum



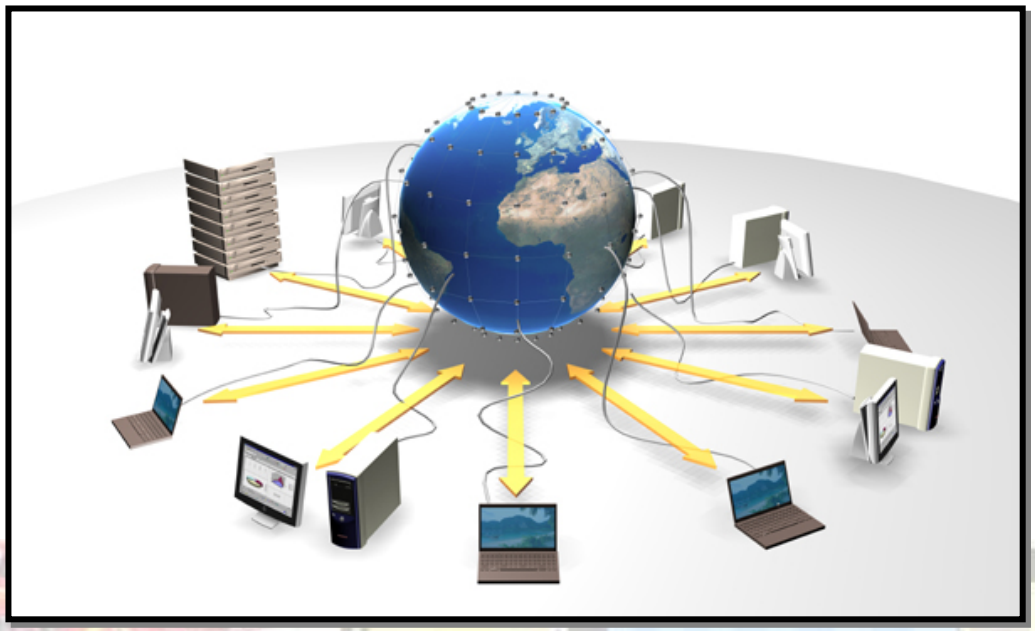
Large Hadron Collider Numbers

The biggest most sophisticated detectors ever built

Recording the debris from 600 million proton collisions per second requires building gargantuan devices that measure particles with 0.0004 inch precision.

The most extensive computer system in the world

Analyzing the data requires tens of thousands of computers around the world using the Grid.



ATLAS Experiment Numbers

Weight of ATLAS detector

A hundred 747 jets (empty)

Size of ATLAS detector

About half the Notre Dame Cathedral

Superconducting wire in magnets

Is 122 km (76 miles) long,

plus 3000 km (1865 miles) of ordinary cables elsewhere.

Data recorded each year

3200 terabytes, equivalent to 7 km (4 miles) of CDROMs stacked on top of each other.

Electronic channels

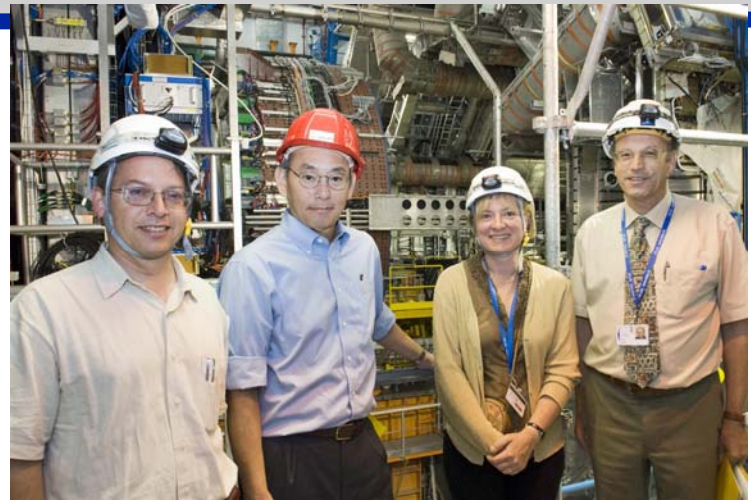
About 100 million

Who builds and operates ATLAS?

1900 scientists from 164 universities and labs in 35 countries

LBNL People on ATLAS

6	Undergrads
7	Grad students
9	Postdocs
3	Engineers
4	Techs
5	Computer scientists
14	Senior physicists
48	TOTAL

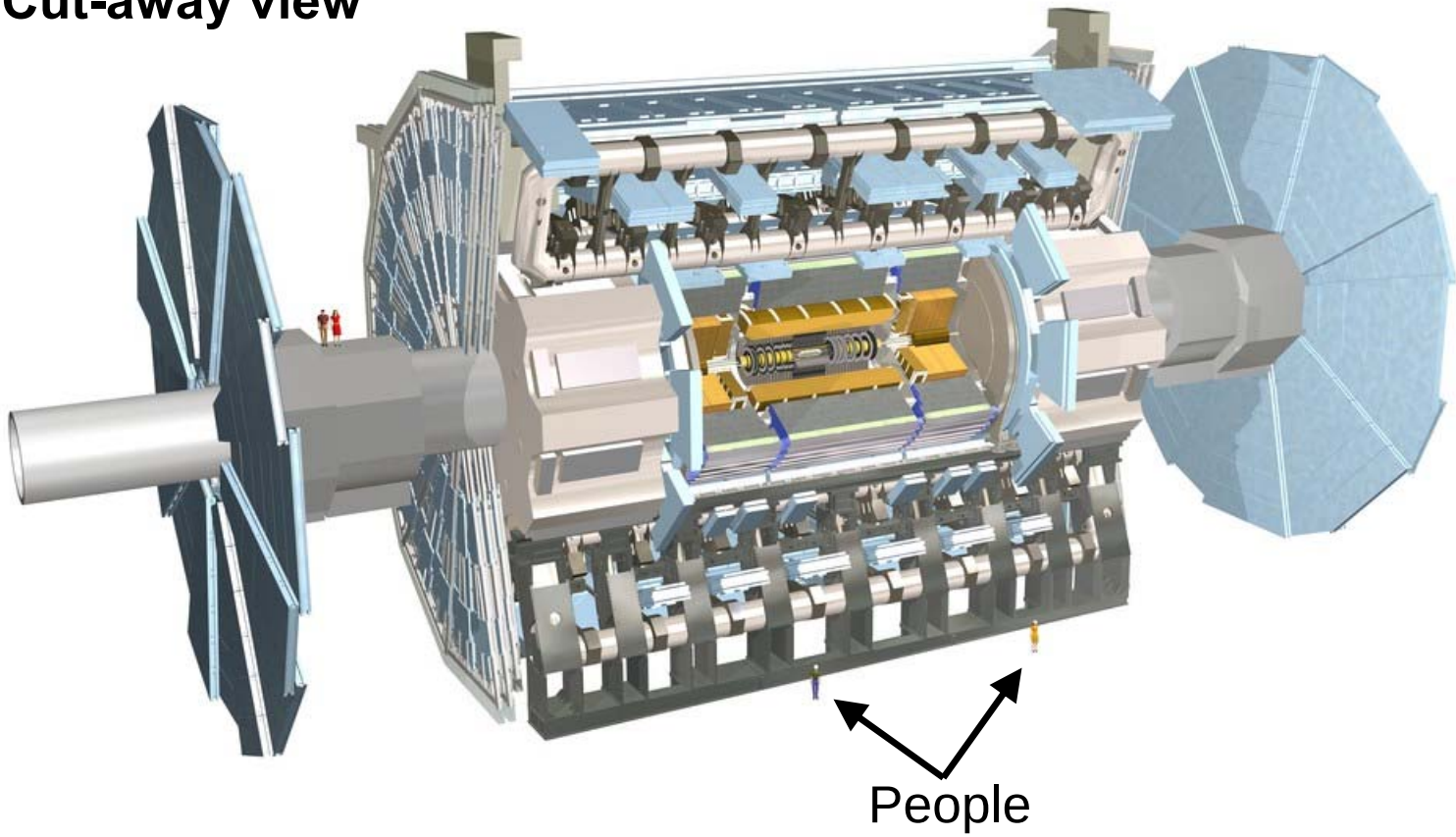


Director Chu visiting ATLAS

Berkeley pixel team at CERN

ATLAS Detector

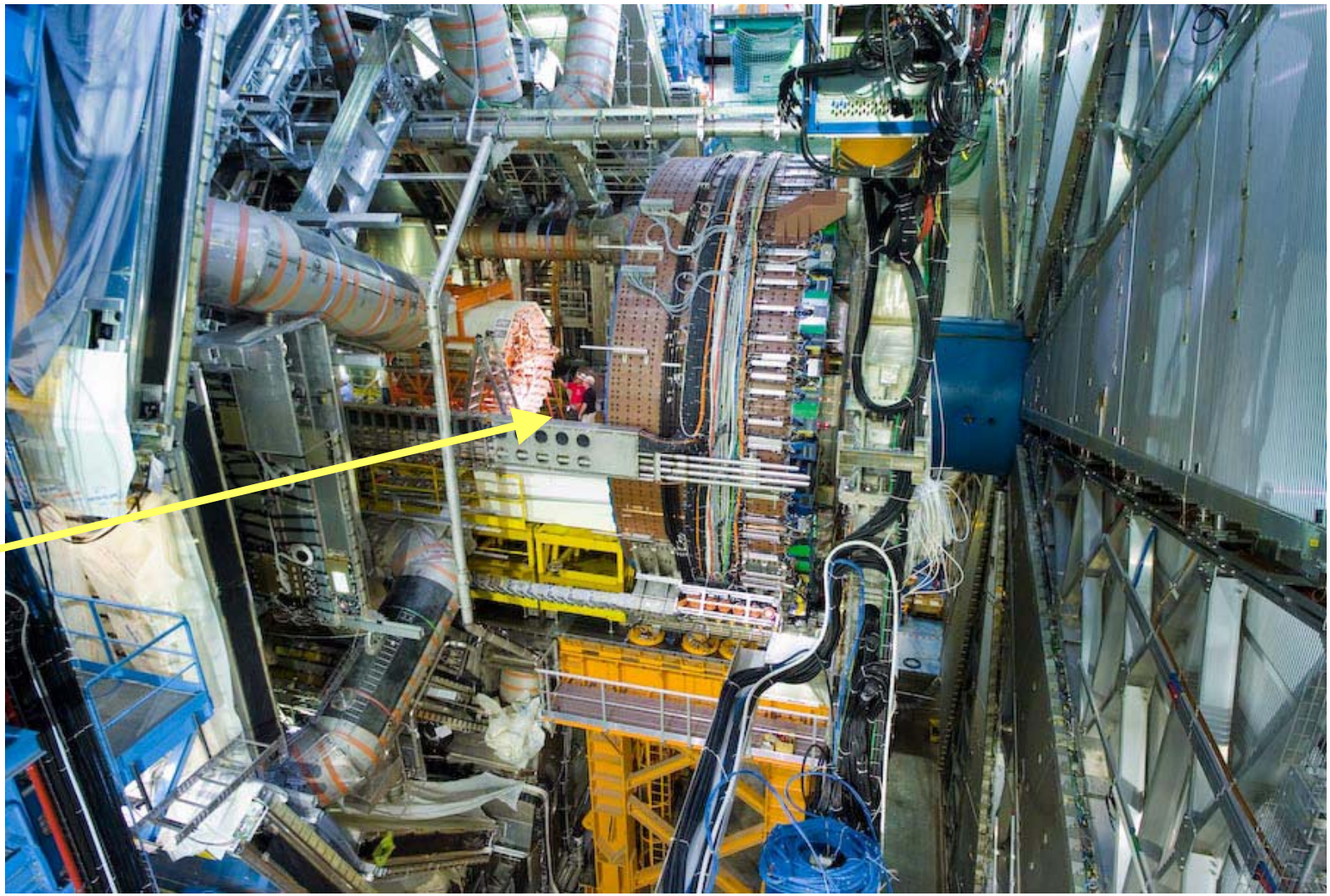
Cut-away view



ATLAS Detector (under construction)

May 2007

People

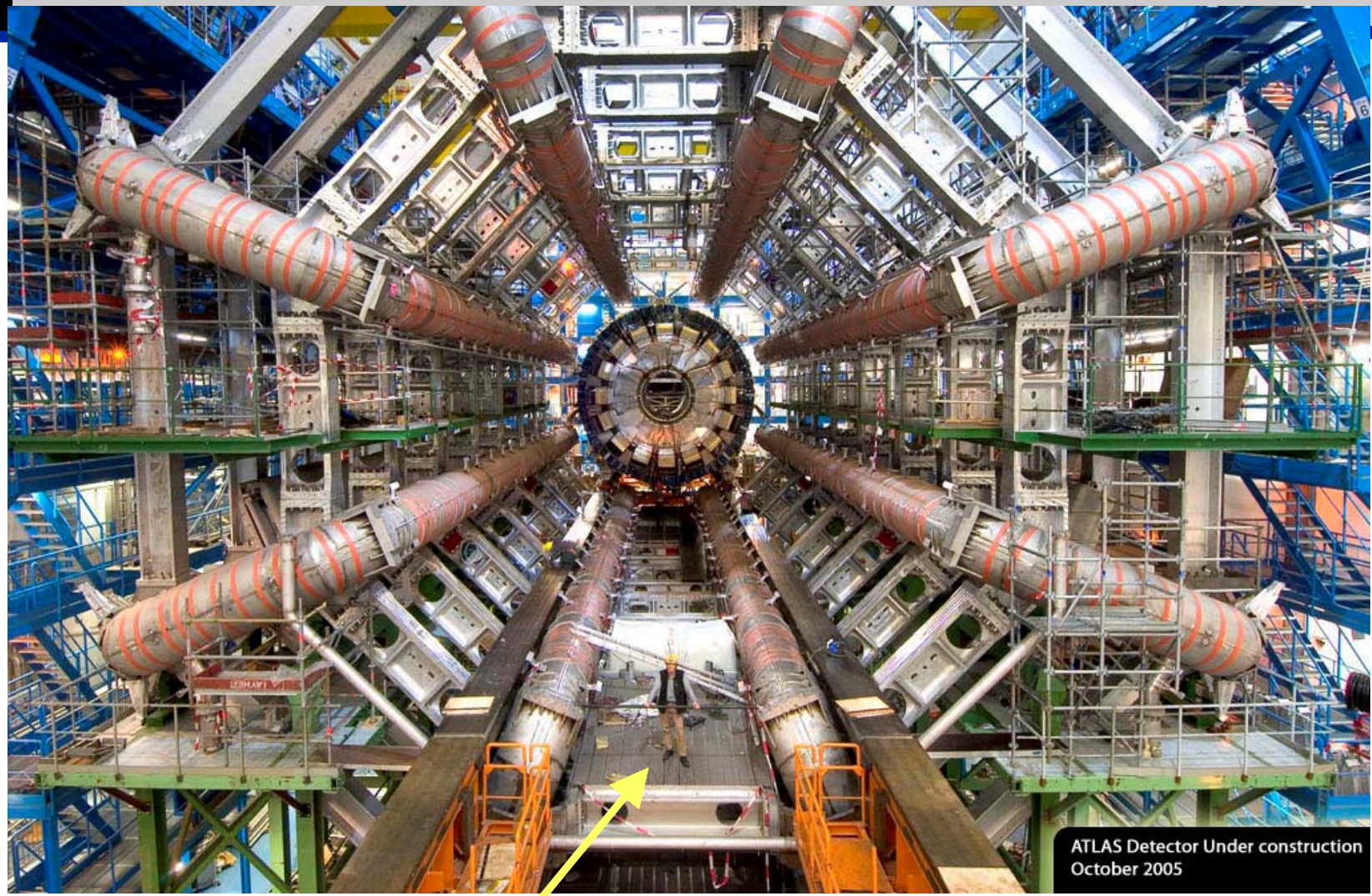


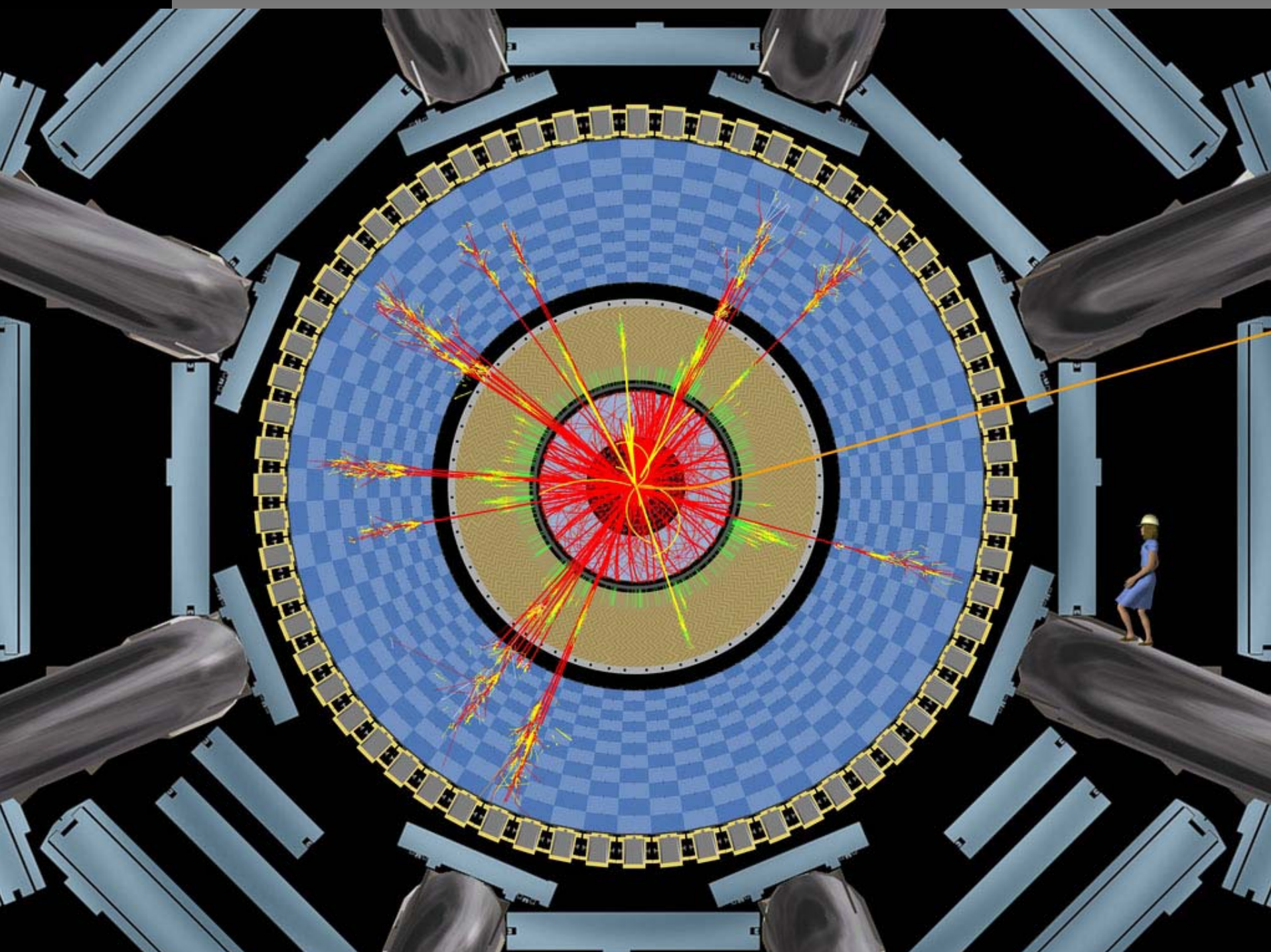
ATLAS Detector (under construction)

Nov. 2006

One beam is coming right at you.

The other is going away from you





Very impressive, but…

Why?

Let's look at the Discovery Channel's take on this.
(this is a shortened version)

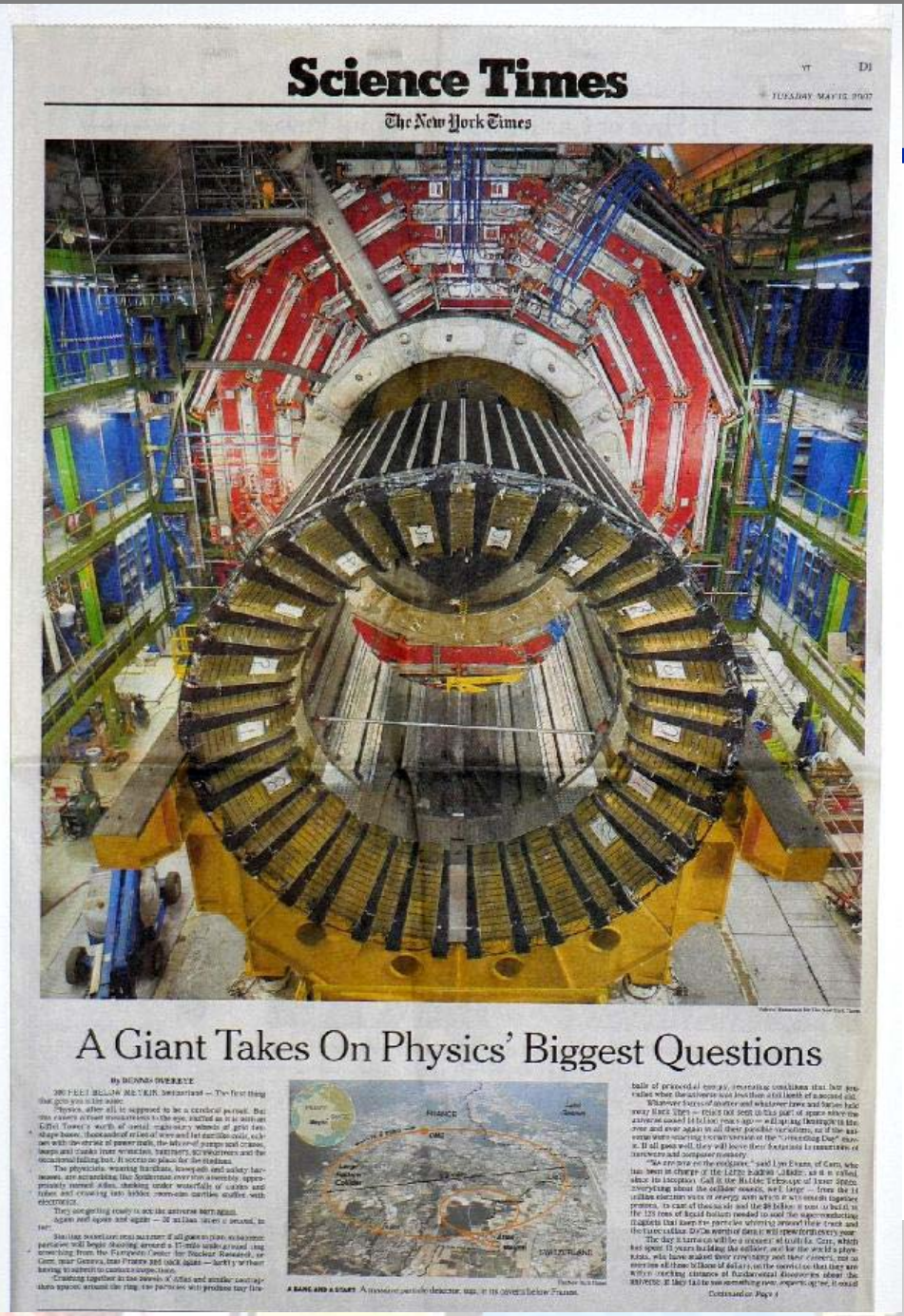
Why?

New York Times talks about recreating the conditions a trillionth of a second after the Big Bang, and says:

"Whatever forms of matter and whatever laws and forces held sway Back Then — relics not seen in this part of space since the universe cooled 14 billion years ago — will spring fleetingly to life, over and over again in all their possible variations, as if the universe were enacting its own version of the "Groundhog Day" movie."

— Dennis Overbye

It describes discoveries such as "a mysterious particle called the Higgs that is thought to endow other particles with mass, new forms of matter that explain the mysterious dark matter swaddling the cosmos and even new dimensions of spacetime."



Science Times

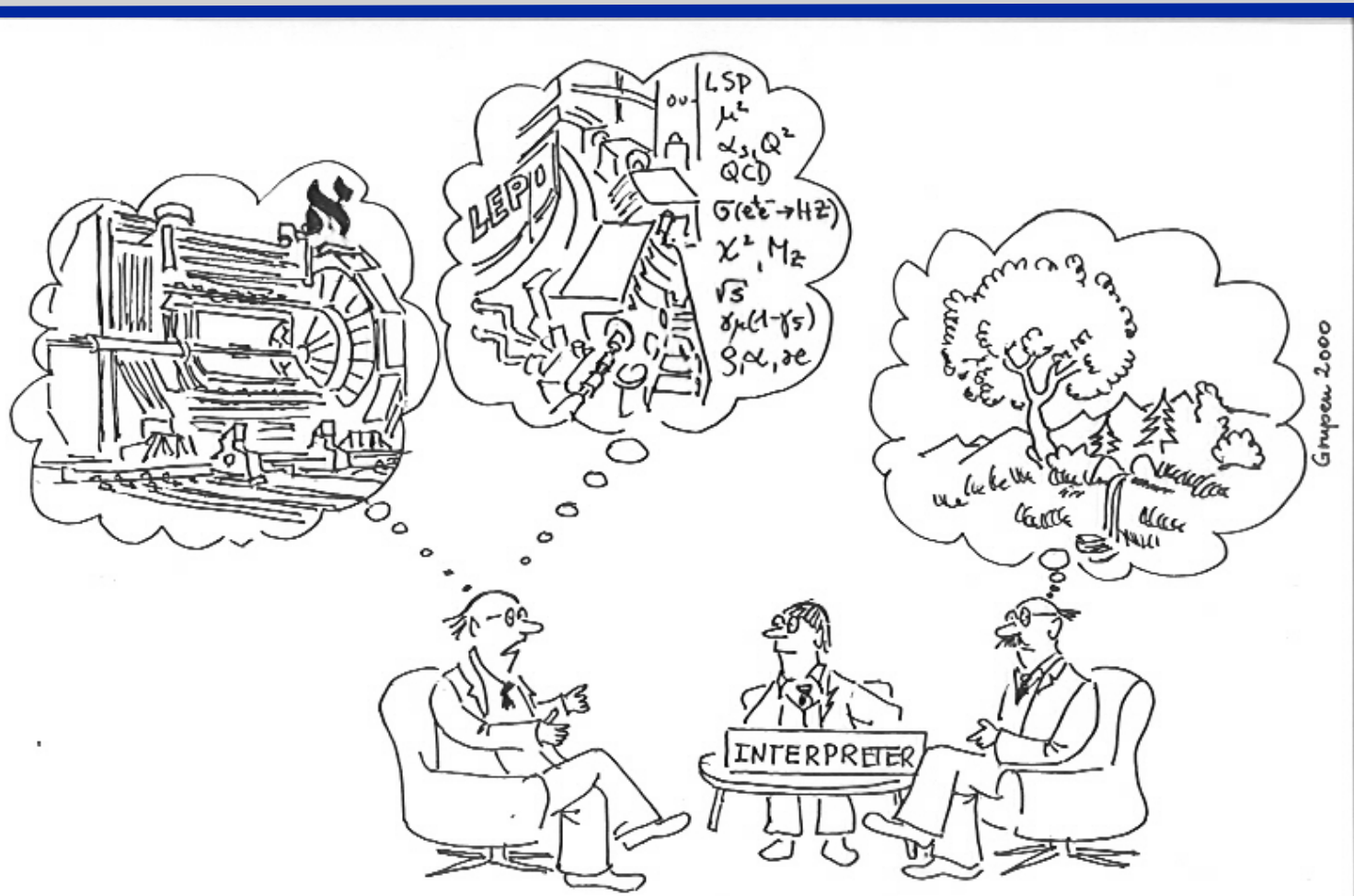
The New York Times

A Giant Takes On Physics' Biggest Questions

Secrets of the Universe

- Identify dark matter
- Search for extra dimensions of space and mini-black holes
- Find “evidence” for string theory
- Find the Higgs Boson
- Understand antimatter
- Learn about the fundamental forces that have shaped the universe since the beginning of time, and will determine its fate.

Explaining Physics



An ATLAS expert explains the Higgs evidence to a layperson.

Higgs Boson

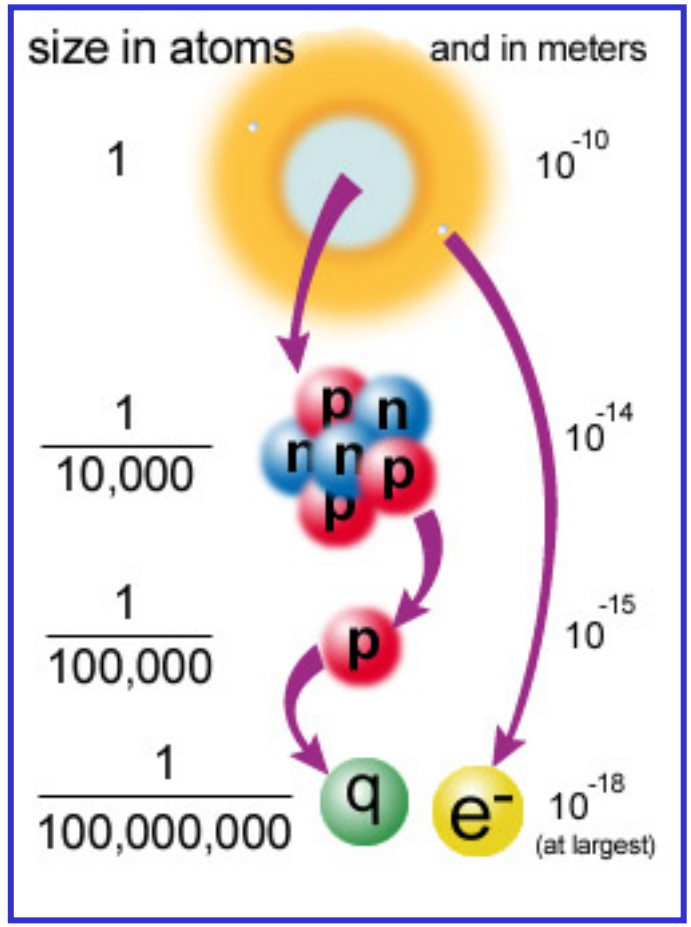
What is the origin of mass?

For composite particles such as atoms, it is often the masses of their constituents.

But what gives masses to fundamental particles such as quarks and electrons and why are they different?

Peter Higgs proposed that all of space is permeated by a field, the Higgs field. Quantum theory says that all fields have particles associated with them, so…

in this case…a Higgs Boson.

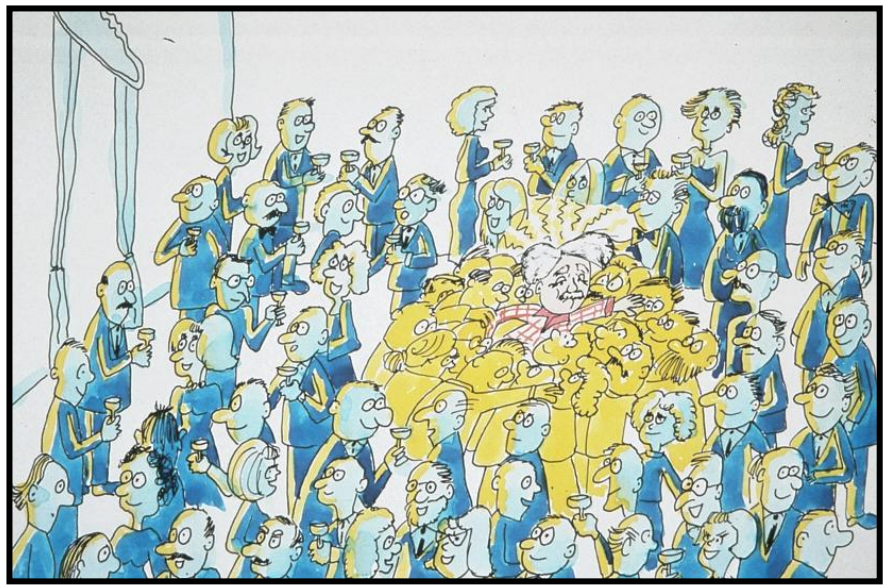


Higgs Boson

To understand the Higgs mechanism, imagine that a room full of physicists chattering quietly is like space filled with the Higgs field ...

Higgs Boson

... a well-known scientist walks in, creating a disturbance as he moves across the room and attracting a cluster of admirers with each step ...



... this increases his resistance to movement, in other words, he acquires mass, just like a particle moving through the Higgs field...

-- Prof. David Miller

How a Higgs boson event might look in ATLAS

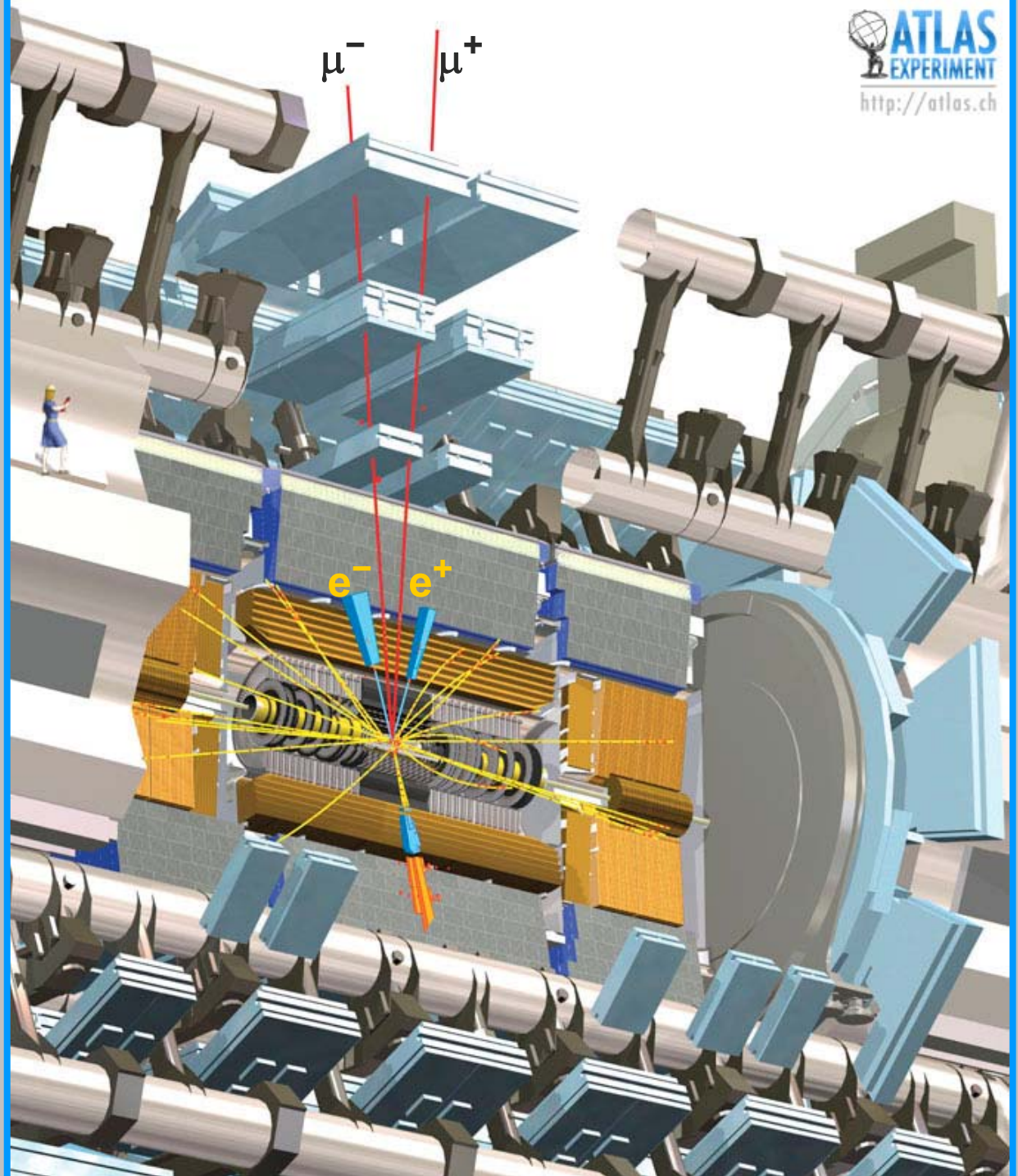
In this event, a "jet" was produced going downward,

and a Higgs was produced going upward but decayed almost instantly.

$H \rightarrow Z + Z$

$Z \rightarrow e^- + e^+$

$Z \rightarrow \mu^- + \mu^+$



String Theory

In trying to resolve a number of theoretical problems and incorporate quantum mechanics, gravity and relativity in a single theory, some theorists have proposed a theory called String Theory.

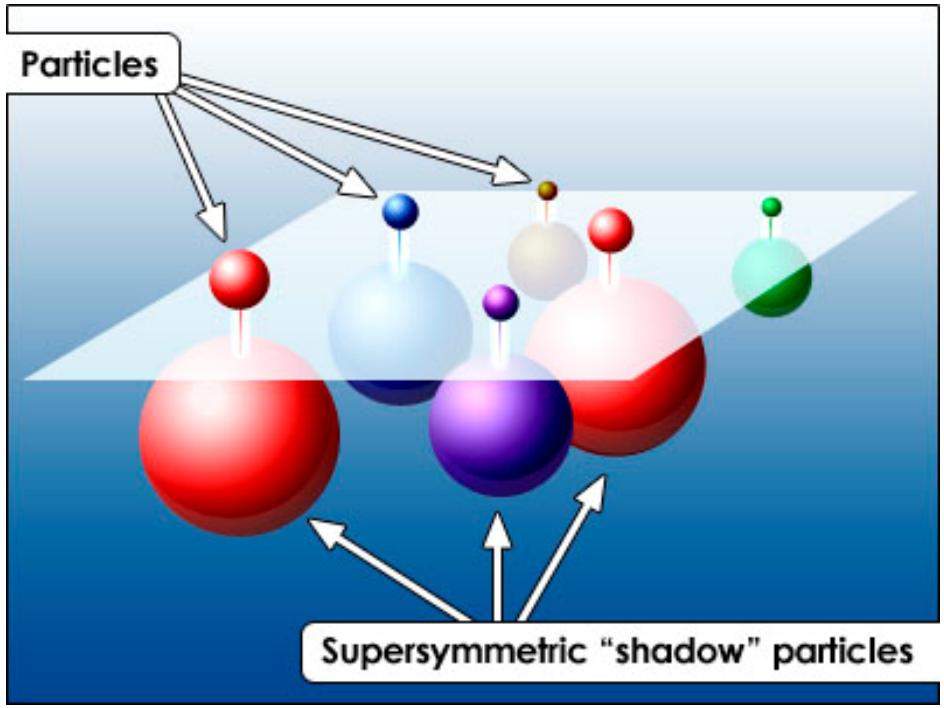
Among its predictions are some extra dimensions of space and a new symmetry called "supersymmetry".

Supersymmetry

For fundamental particles, supersymmetry says:

Every matter particle (fermion) should be associated with a massive "shadow" force carrier particle (boson).

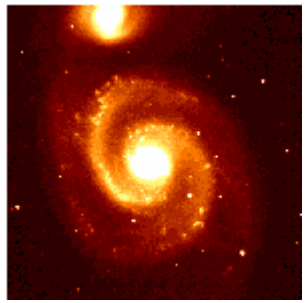
Every force carrier particle should have a massive "shadow" matter particle.



This has possible implications for Dark Matter

Dark Matter

Dark matter …



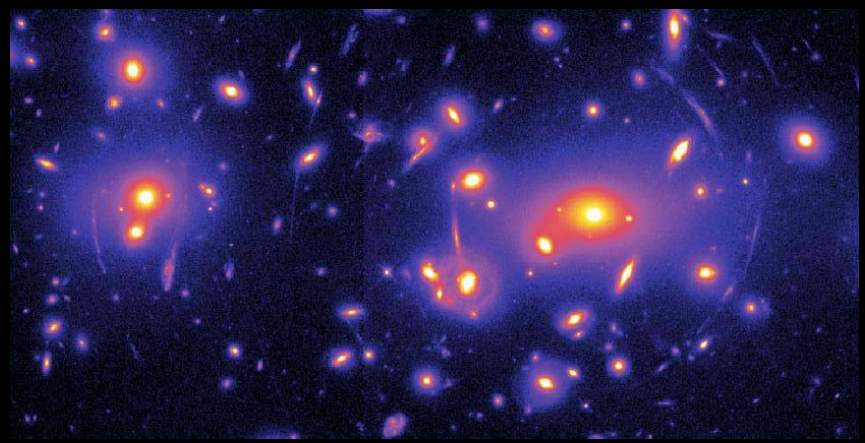
Not dark matter

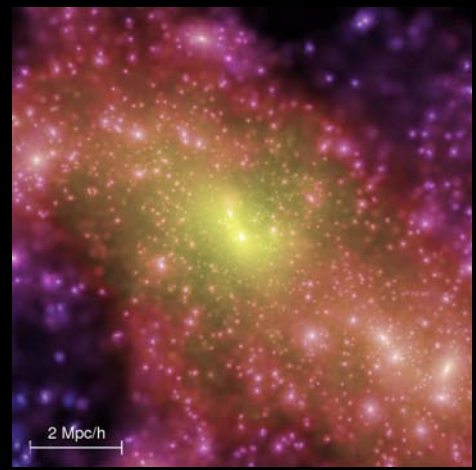
… except that's not really true

Dark Matter

Much evidence for its existence

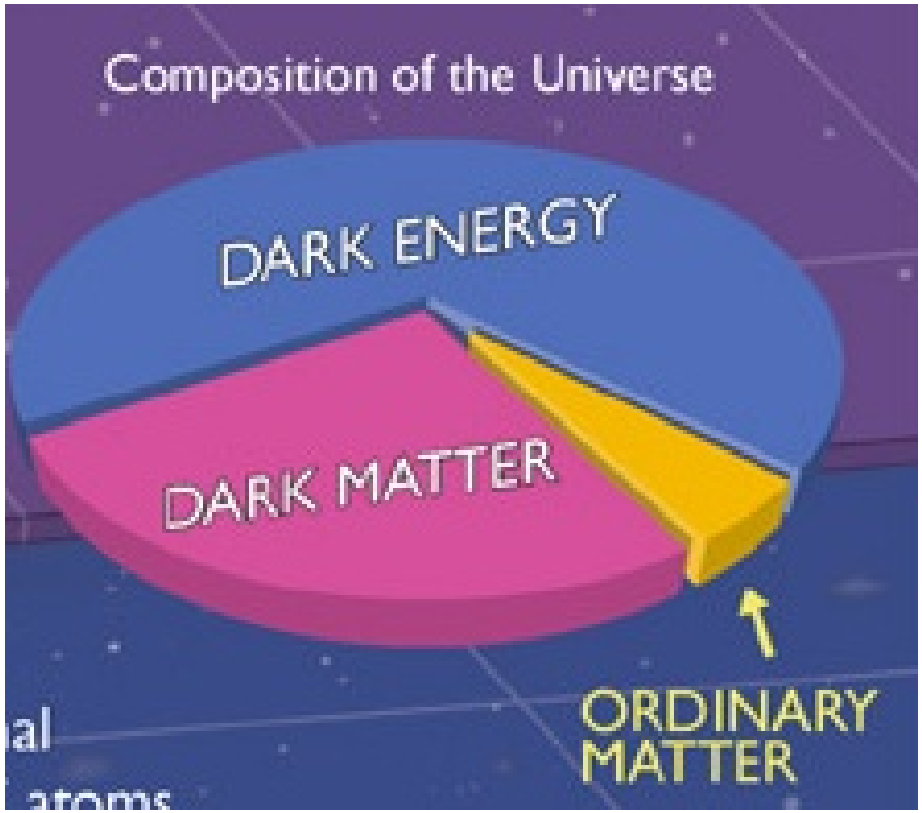
In galaxies and galaxy clusters





Dark Matter

See animation

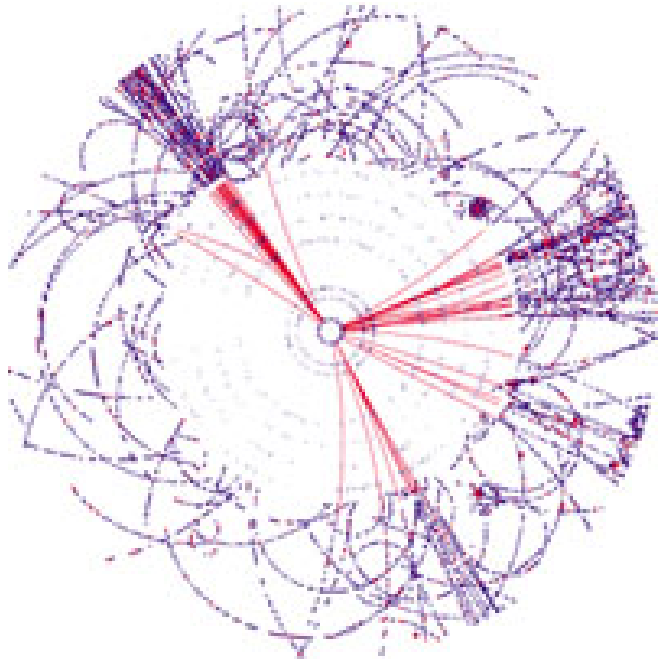


What is Dark Matter?

We don't know

But we have ideas

It might be one of those supersymmetric particles, but of course we have to find it to know for sure.



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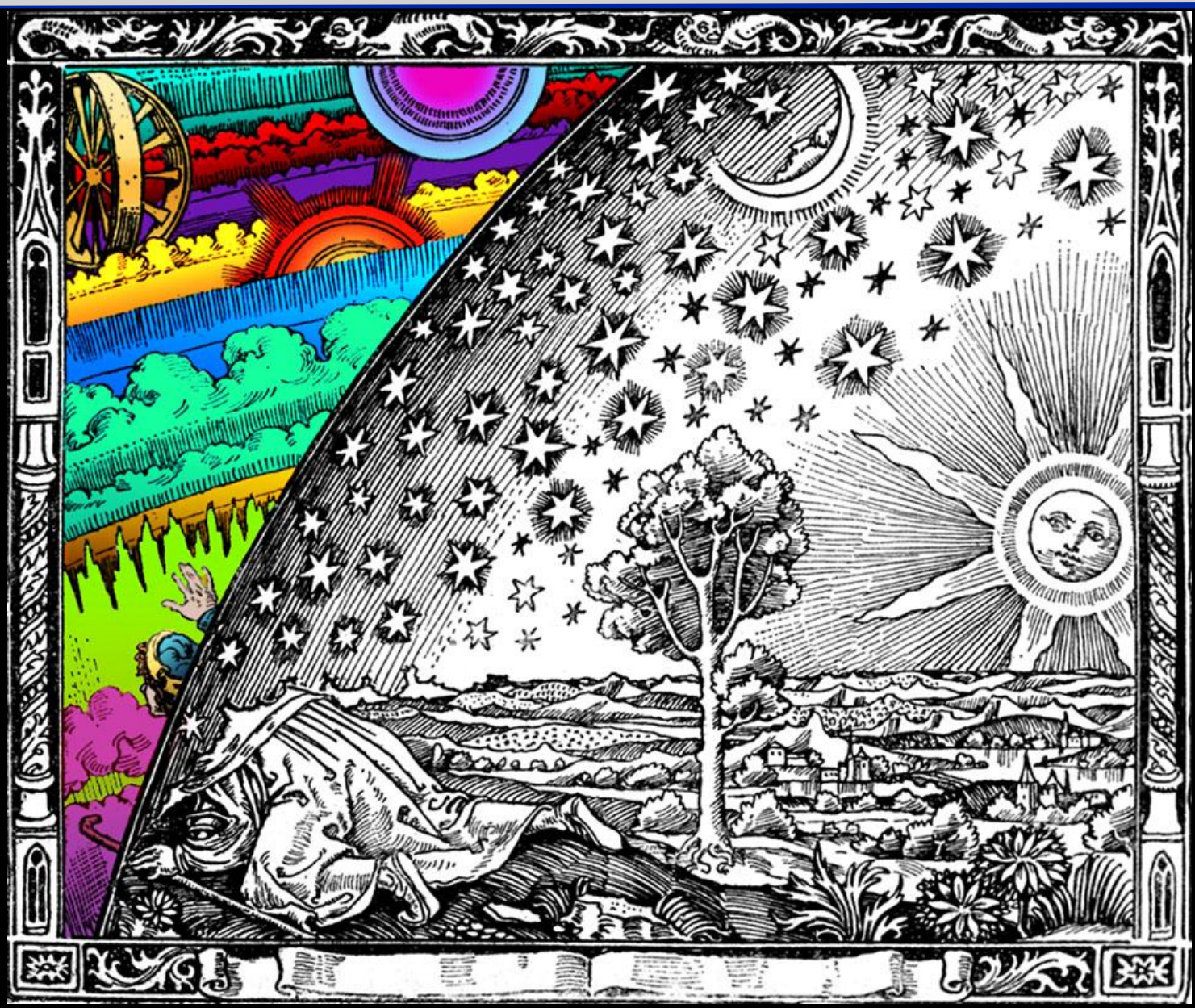
Extra Dimensions of Space



Extra Dimensions of Space

in art

SALVADOR DALI –
TO RESEARCH OF THE 4TH DIMENSION

Picasso

(Dora Maar series)

Extra Dimensions of Space

in literature

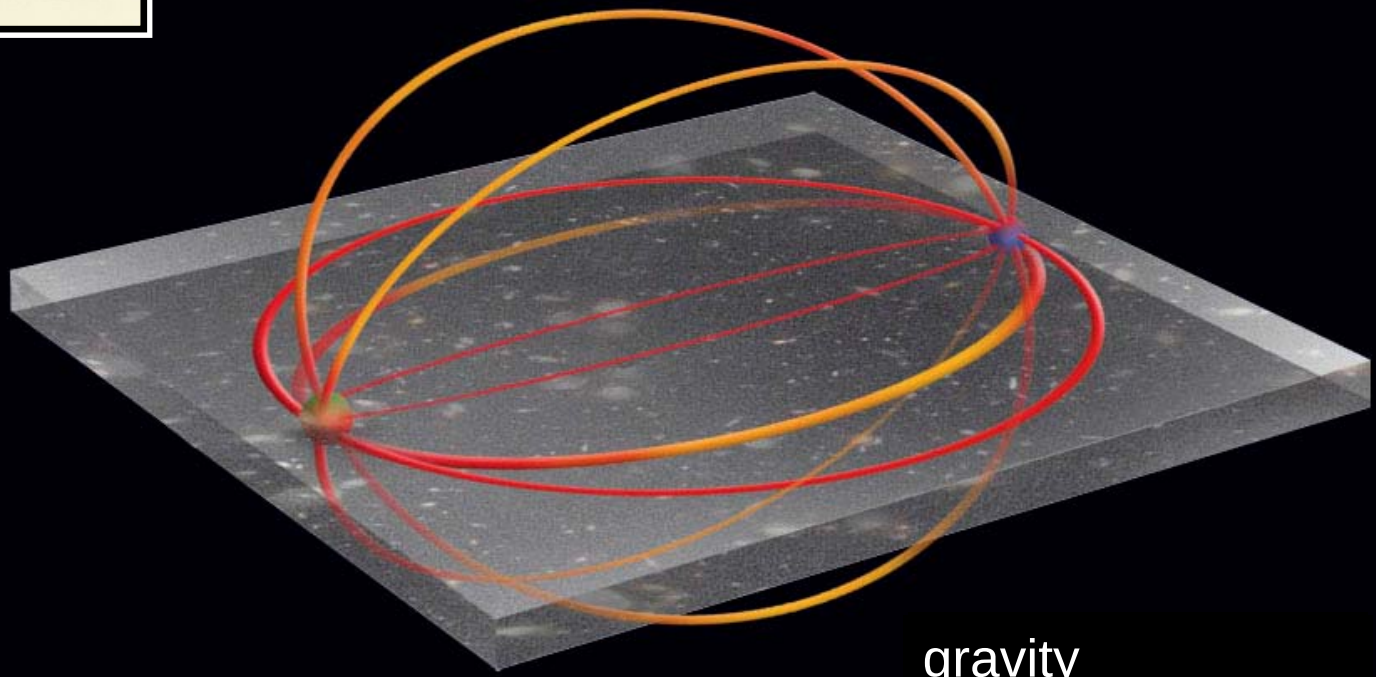
Narnia

Extra Dimensions of Space

in science? More than String Theory?

Gravity is extremely weak (compared to e-m).

Why is it so weak?



gravity

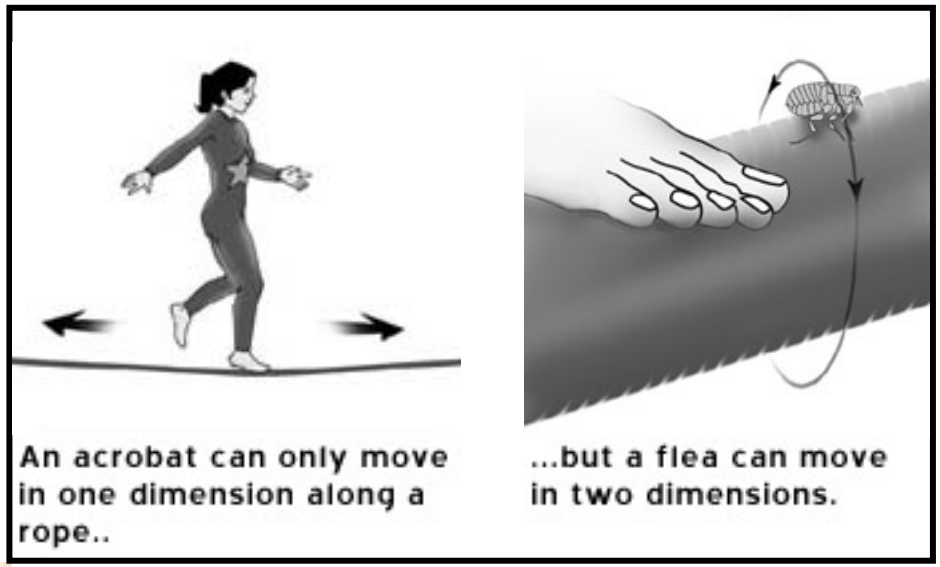
How can there be extra dimensions?

Think about an acrobat and a flea on a tight rope.

The acrobat can move forward and backward along the rope.

But the flea can also move sideways around the rope.

If the flea keeps walking to one side, it goes around the rope and winds up where it started.

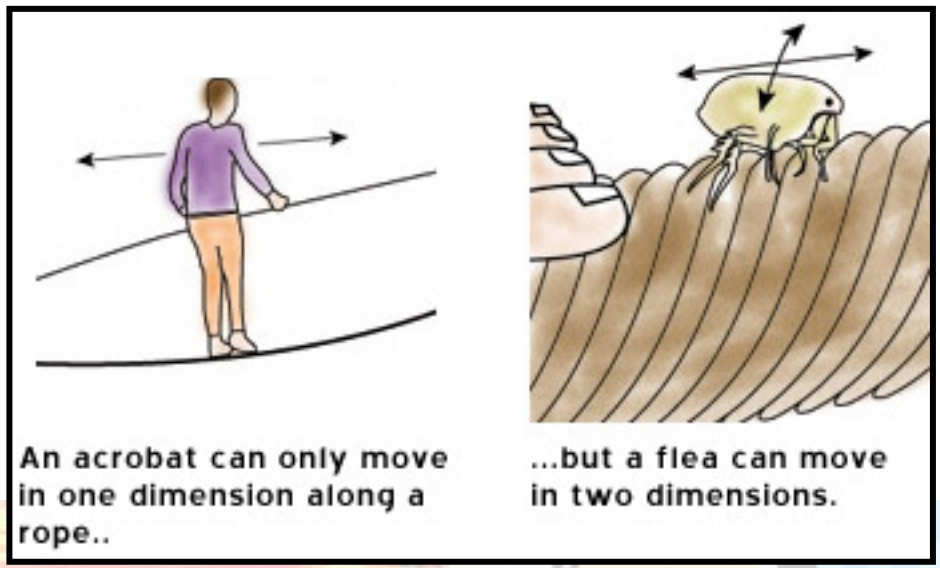


How can there be extra dimensions?

So the acrobat has one dimension, and the flea has two dimensions, but one of these dimensions is a small closed loop.

The acrobat can only detect the one dimension of the rope, just as we can only see the world in three dimensions, even though it might well have more.

This is impossible to visualize, precisely because we can only visualize things in three dimensions!



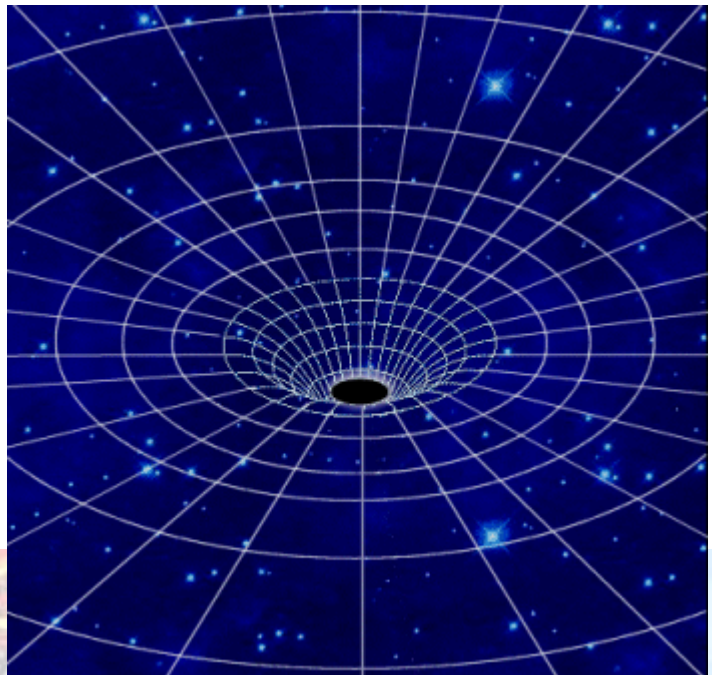
Mini-Black Holes

Mini- Black holes?

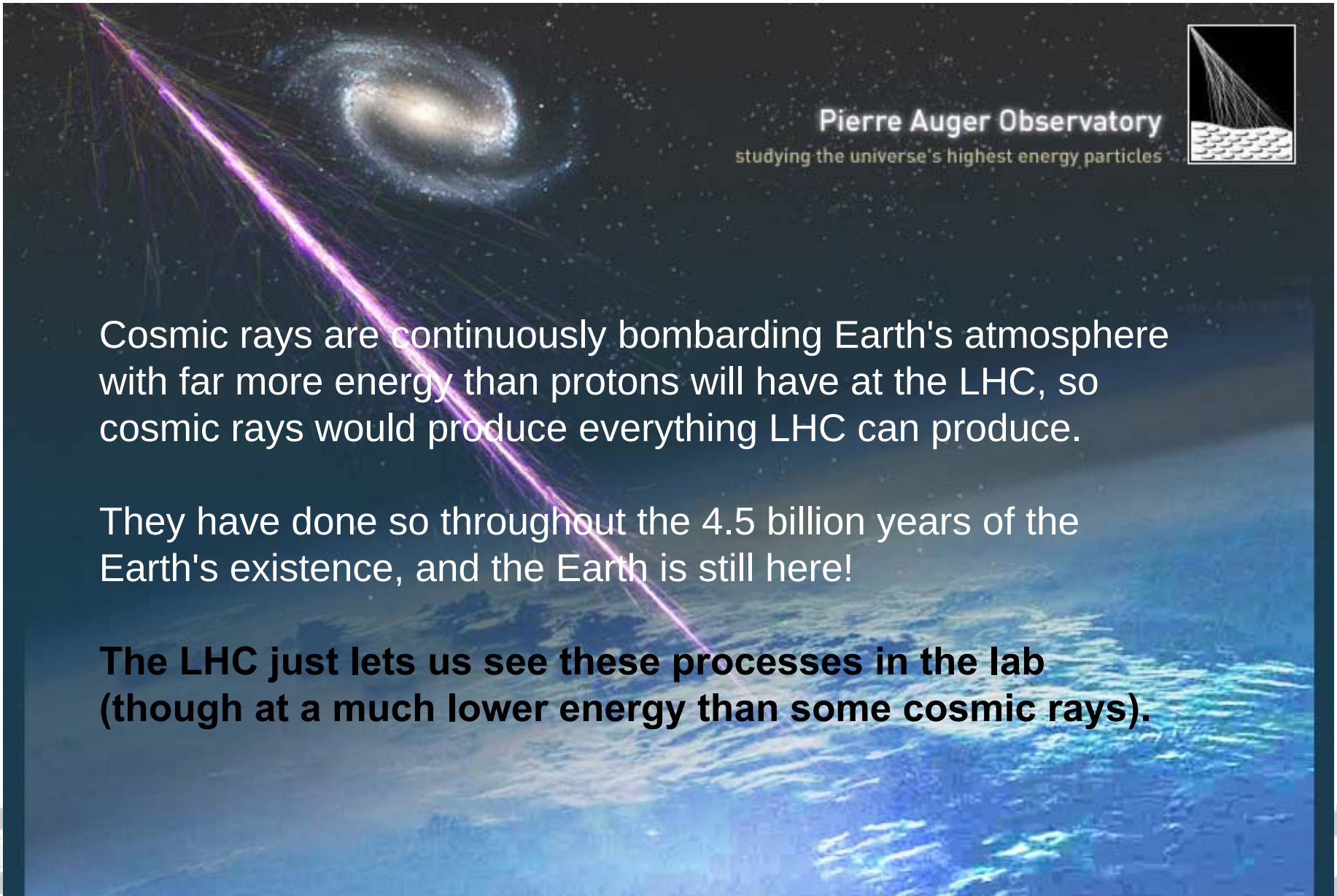
According to some theoretical models, tiny black holes could be produced in collisions at the LHC.

They would then very quickly decay and be detected by experiments (the tinier the black hole, the faster it evaporates)

.



Are Mini-Black Holes Dangerous?



Cosmic rays are continuously bombarding Earth's atmosphere with far more energy than protons will have at the LHC, so cosmic rays would produce everything LHC can produce.

They have done so throughout the 4.5 billion years of the Earth's existence, and the Earth is still here!

The LHC just lets us see these processes in the lab (though at a much lower energy than some cosmic rays).

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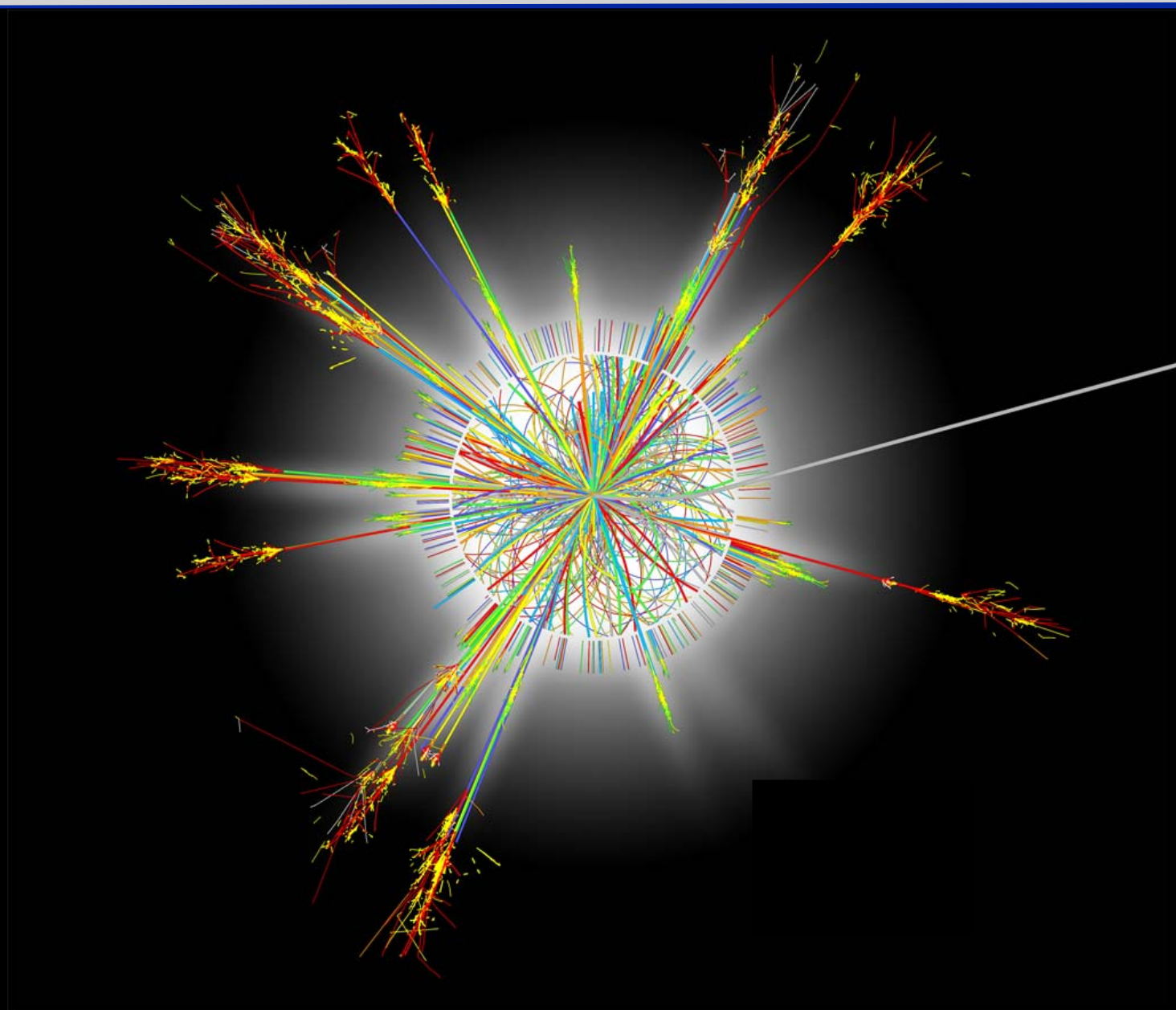
Mini-Black Hole Event



Summary

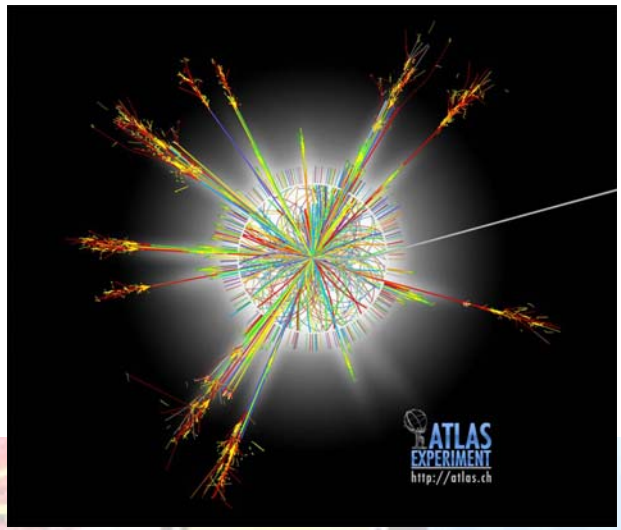
Tentative Schedule

Protons in ring in May 2008

Protons collide in July 2008

Earliest physics results perhaps by end of 2008

Real excitement in ???



Video Clips 1

Inserting the Pixel Detector into the center of ATLAS.

A major Berkeley project

Video Clips 2

We placed a camera on one of the huge toroid magnets as it was lowered into the cavern.

So you can ride down with it.

Video Clips 3

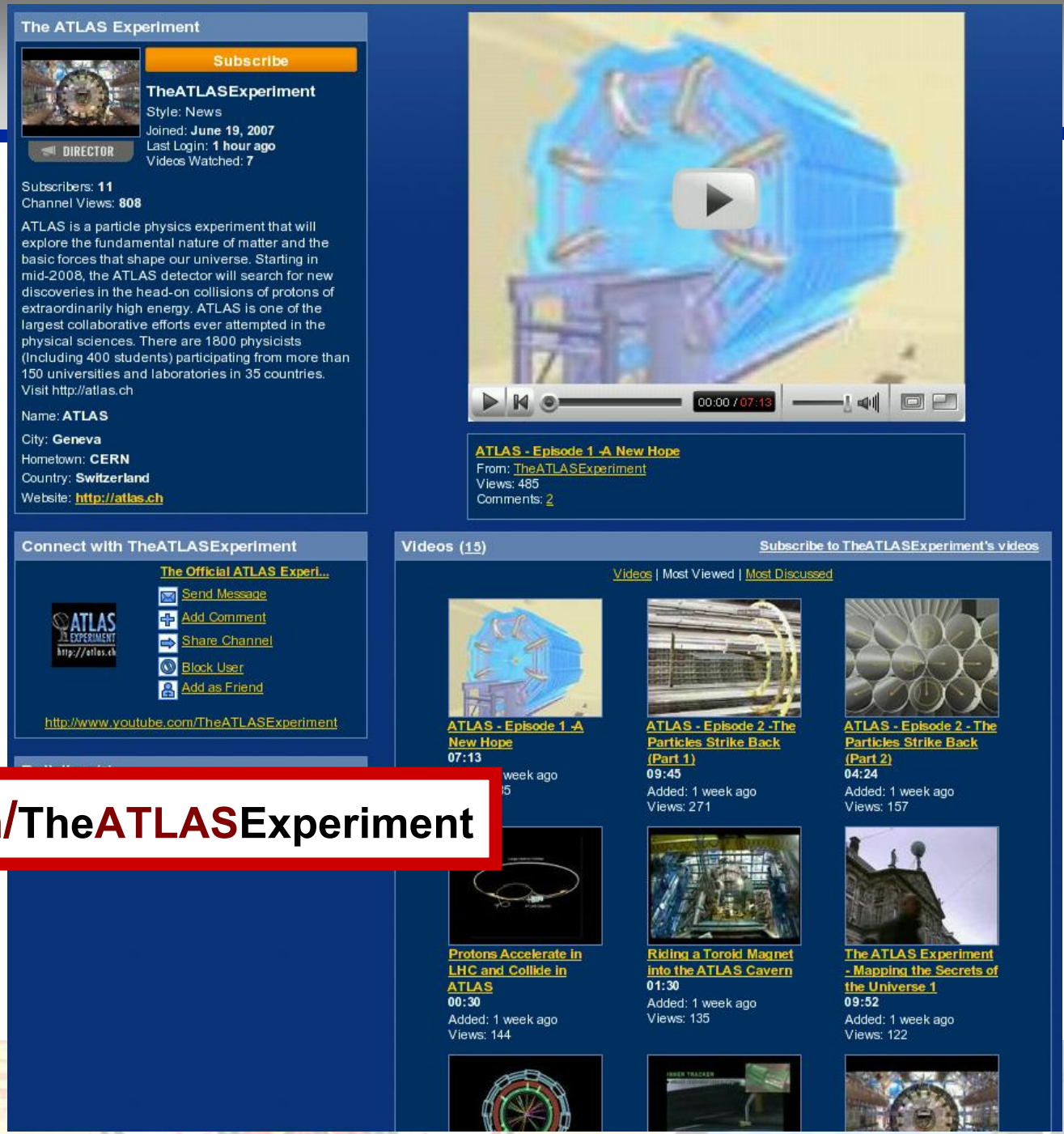
The ATLAS Crawl

Very little space remains in ATLAS, so working in confined space is complicated.

ATLAS EXPERIMENT
http://atlas.ch

All this and more on

YouTube Broadcast Yourself

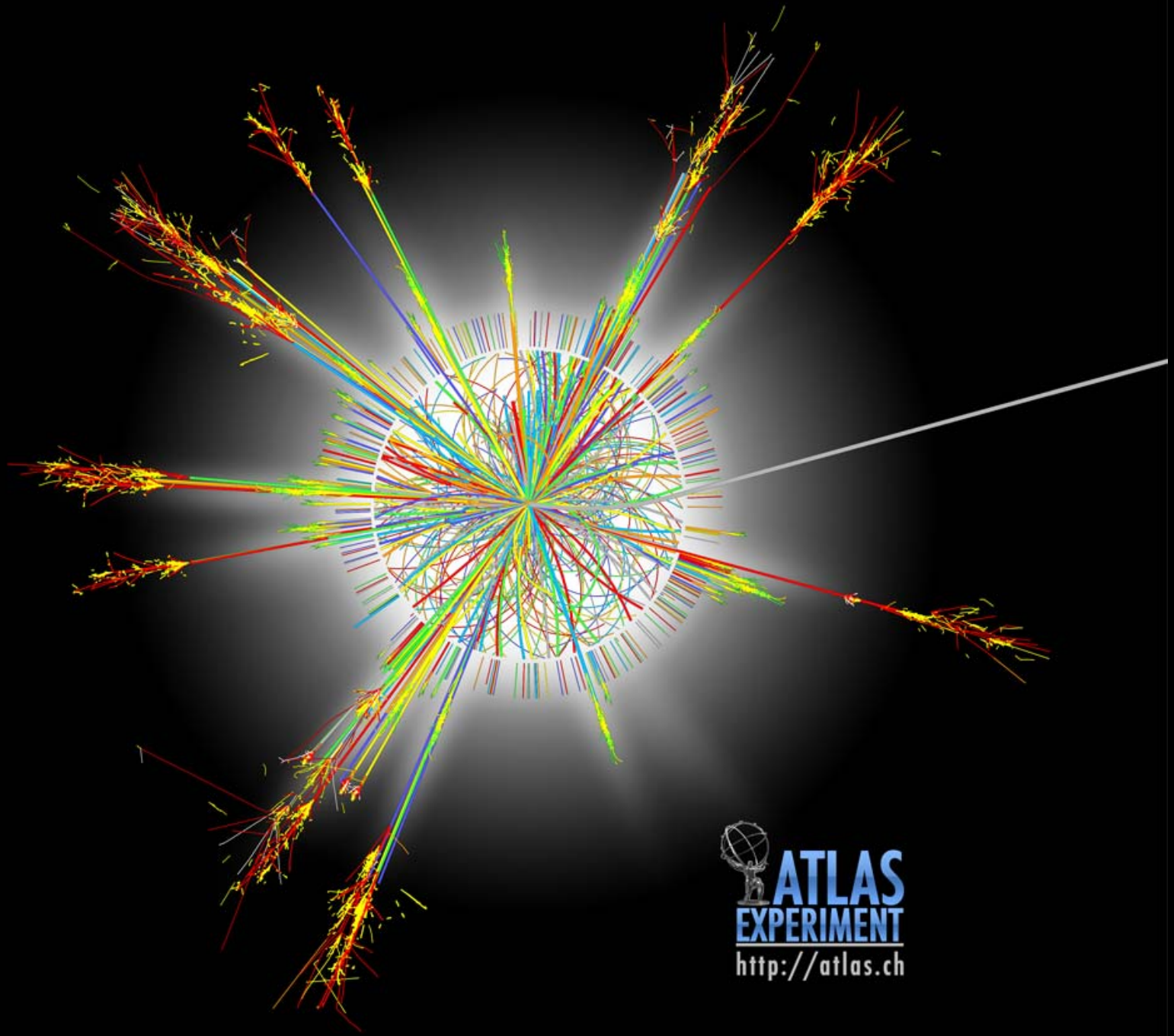


http://youtube.com/TheATLASExperiment

and **http://atlas.ch**

http://atlas.ch

The End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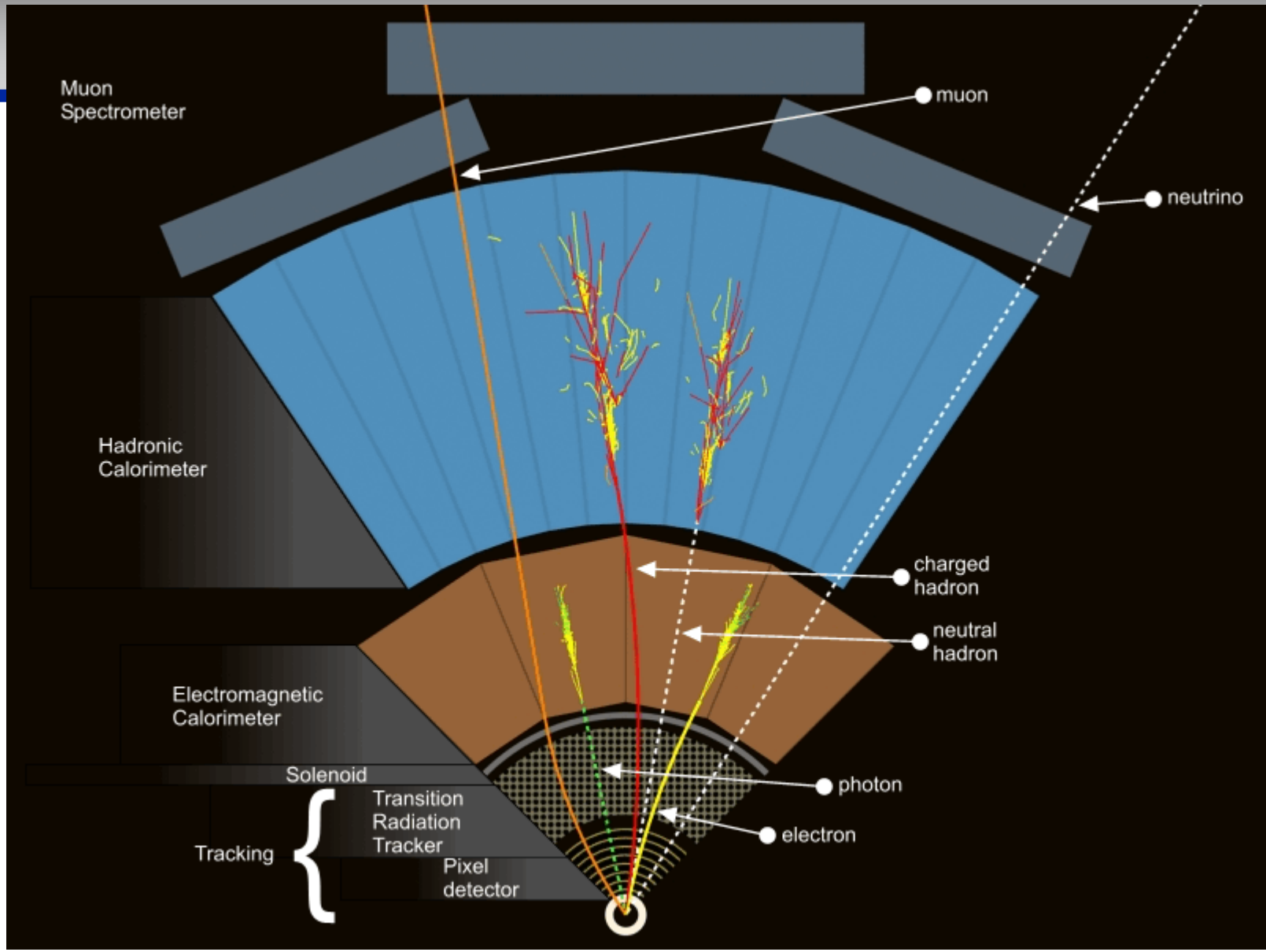
Muon
Spectrometer
muon
neutrino
Hadronic
Calorimeter
charged
hadron
neutral
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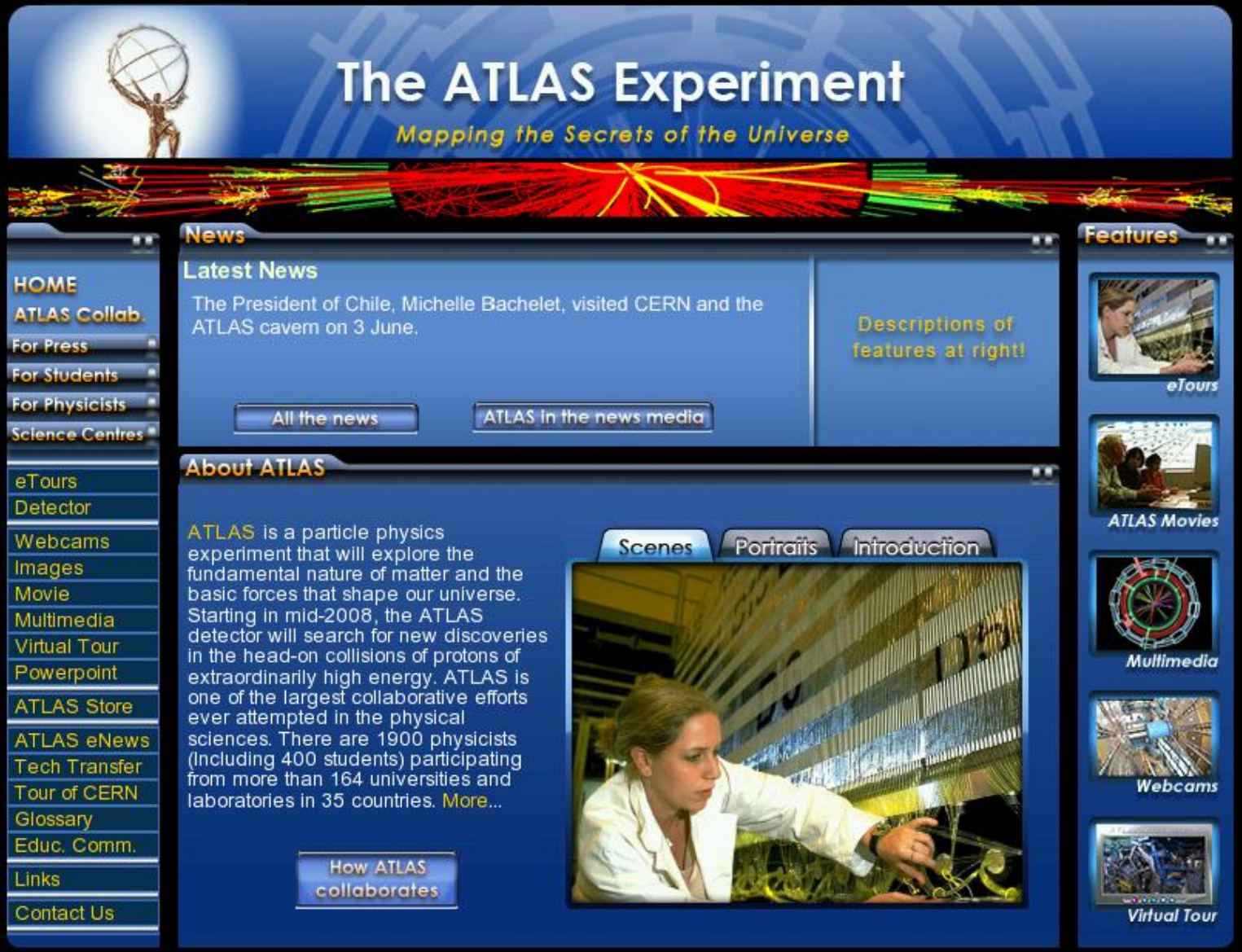
Electromagnetic
Calorimeter
Solenoid
photon
Transition
Radiation
Tracker
Tracking
electron
Pixel
detector

Public webpages: http://ATLAS.ch



Virtual Tour

New homepage for eTours

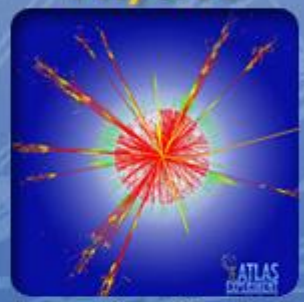
Welcome to the ATLAS eTours!

ATLAS Home

Introduction

An overview of particle physics experiments.

Physics



An overview of the physics goals of the ATLAS Experiment.

Choose one of four eTours

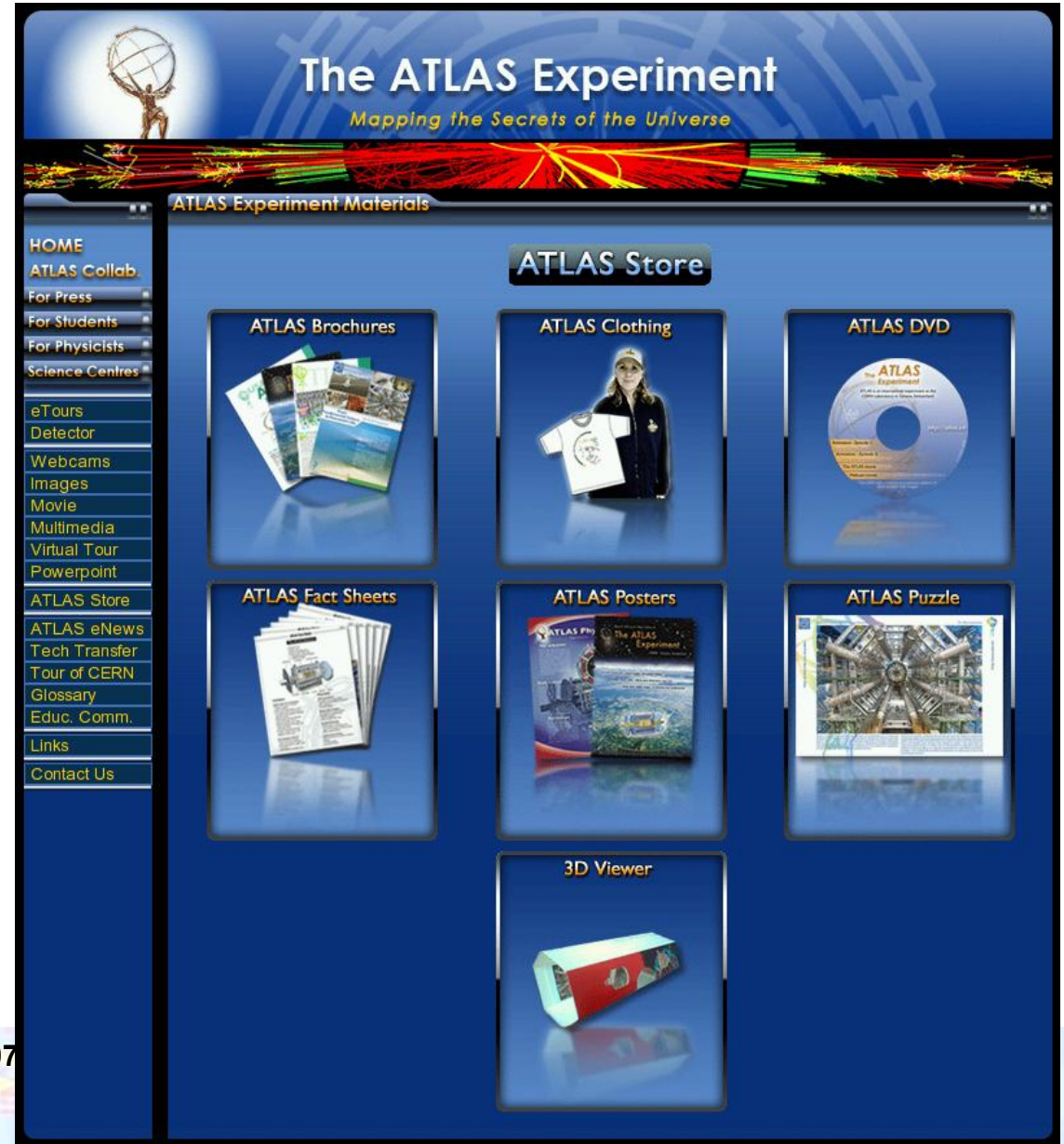
Experiment

How the ATLAS detector works.

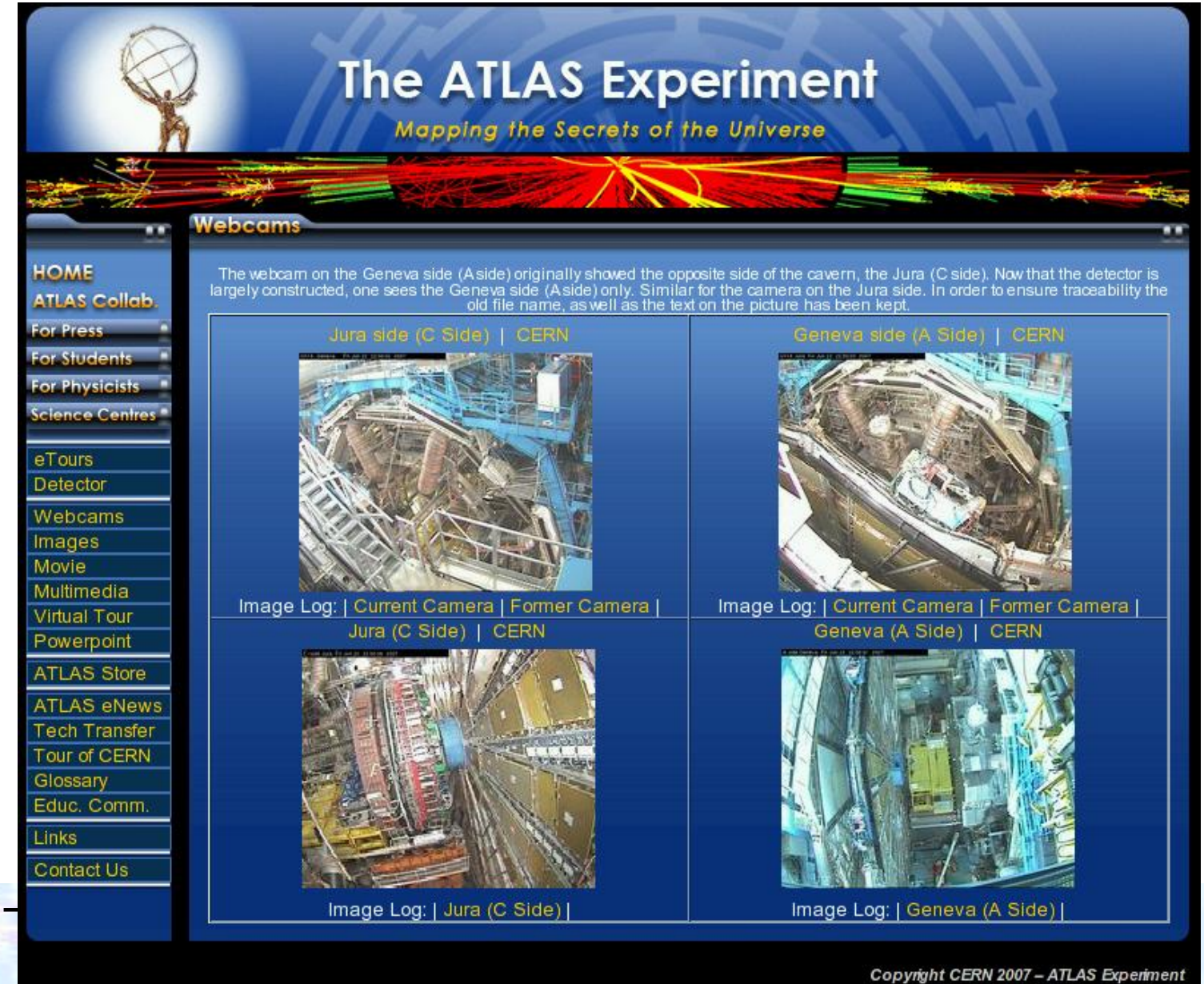
Accelerator

A description of the Large Hadron Collider.

The ATLAS Store



Webcams


The ATLAS Experiment
Mapping the Secrets of the Universe
Webcams
HOME
ATLAS Collab.
For Press
For Students
For Physicists
Science Centres
eTours
Detector
Webcams
Images
Movie
Multimedia
Virtual Tour
Powerpoint
ATLAS Store
ATLAS eNews
Tech Transfer
Tour of CERN
Glossary
Educ. Comm.
Links
Contact Us
The webcam on the Geneva side (A side) originally showed the opposite side of the cavern, the Jura (C side). Now that the detector is largely constructed, one sees the Geneva side (A side) only. Similar for the camera on the Jura side. In order to ensure traceability the old file name, as well as the text on the picture has been kept.
Jura side (C Side) | CERN
Image Log: | Current Camera | Former Camera |
Geneva side (A Side) | CERN
Image Log: | Current Camera | Former Camera |
Jura (C Side) | CERN
Image Log: | Jura (C Side) |
Geneva (A Side) | CERN
Image Log: | Geneva (A Side) |
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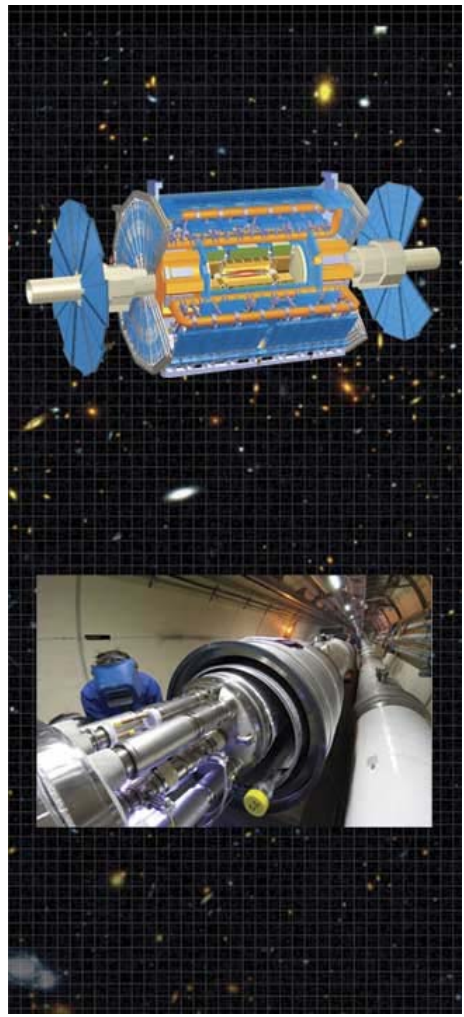
The ATLAS Event Challenge

- An educational project using ATLAS particle collisions

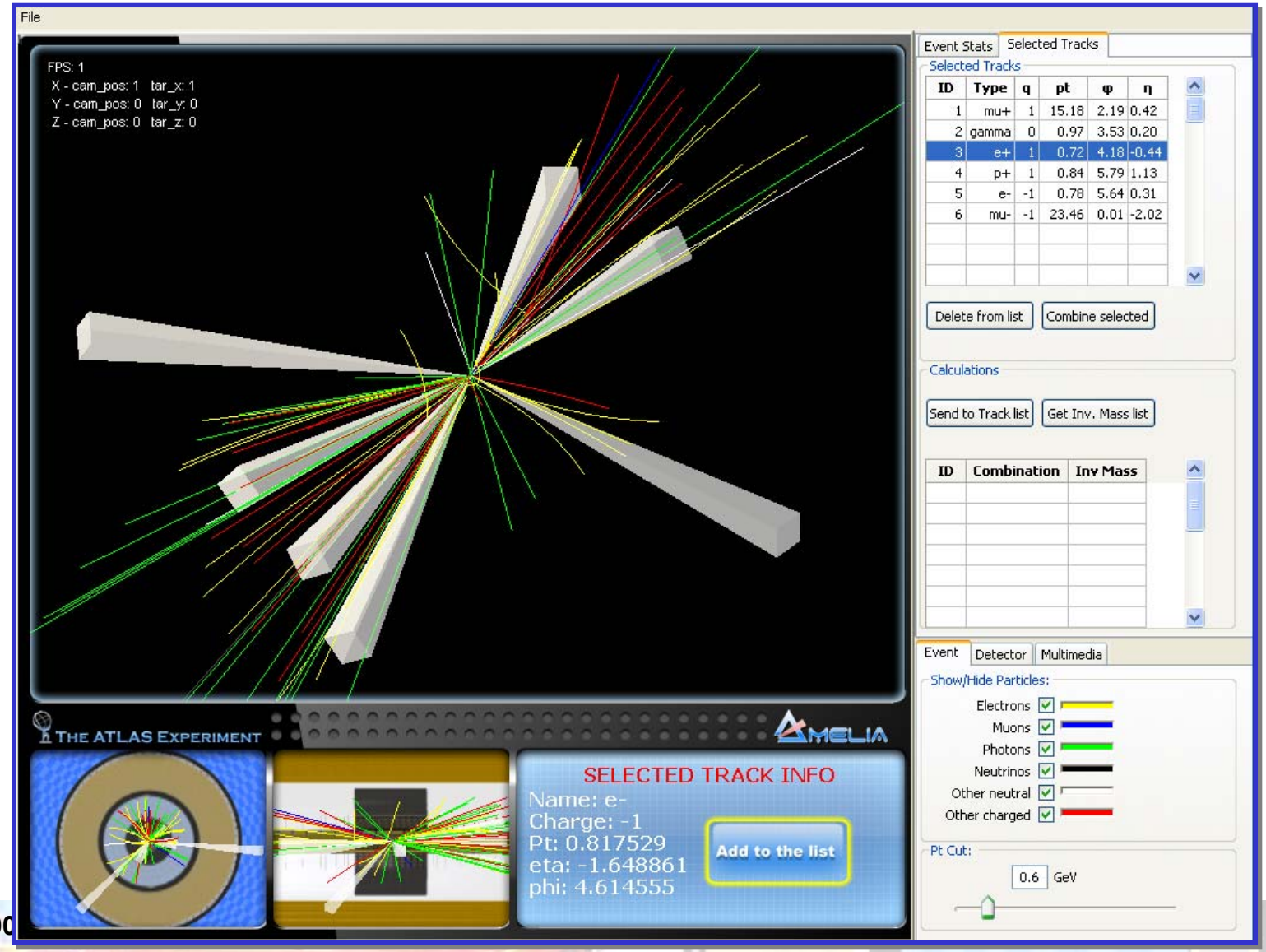
The ATLAS Student Event Challenge will make high school students part of the ATLAS Experiment by sharing actual ATLAS events with them and giving them the tools to analyze these collision events.



Student Event Analysis (AMELIA)

Interactive event analysis for students and public

ATLAS Multimedia Educational Lab for Interactive Analysis



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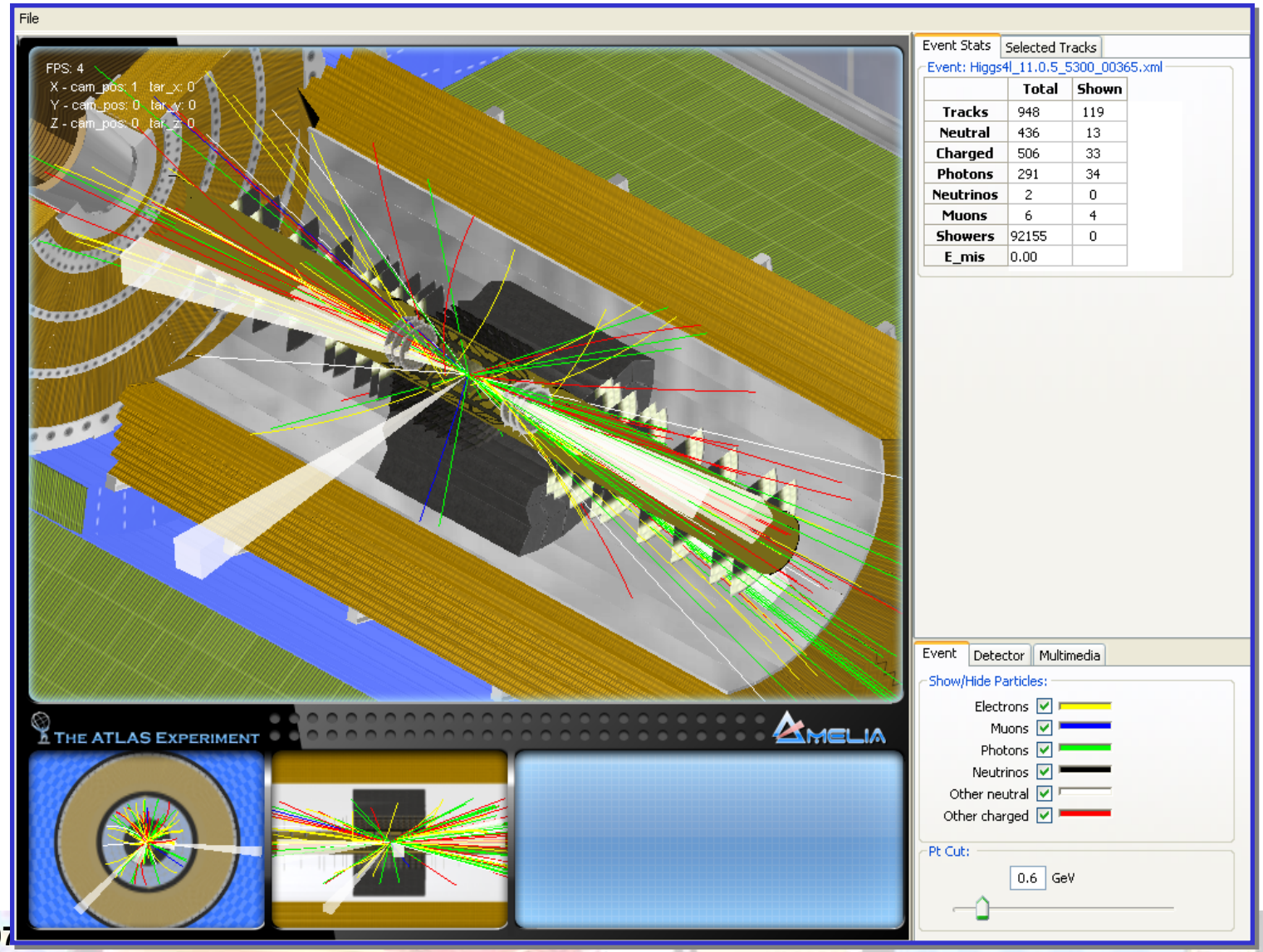

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http://atlas.ch

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07:13
Added: 1 week ago
Views: 485
8 ratings

ATLAS - Episode 2 -The Particles Strike Back (Part 1)
09:45
Added: 1 week ago
Views: 271
10 ratings

ATLAS - Episode 2 - The Particles Strike Back (Part 2)
04:24
Added: 1 week ago
Views: 157
6 ratings

Protons Accelerate in LHC and Collide in ATLAS
00:30
Added: 1 week ago
Views: 144
1 rating

Riding a Toroid Magnet into the ATLAS Cavern
01:30
Added: 1 week ago
Views: 135
2 ratings

The ATLAS Experiment - Mapping the Secrets of the Universe 1
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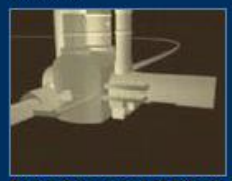

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