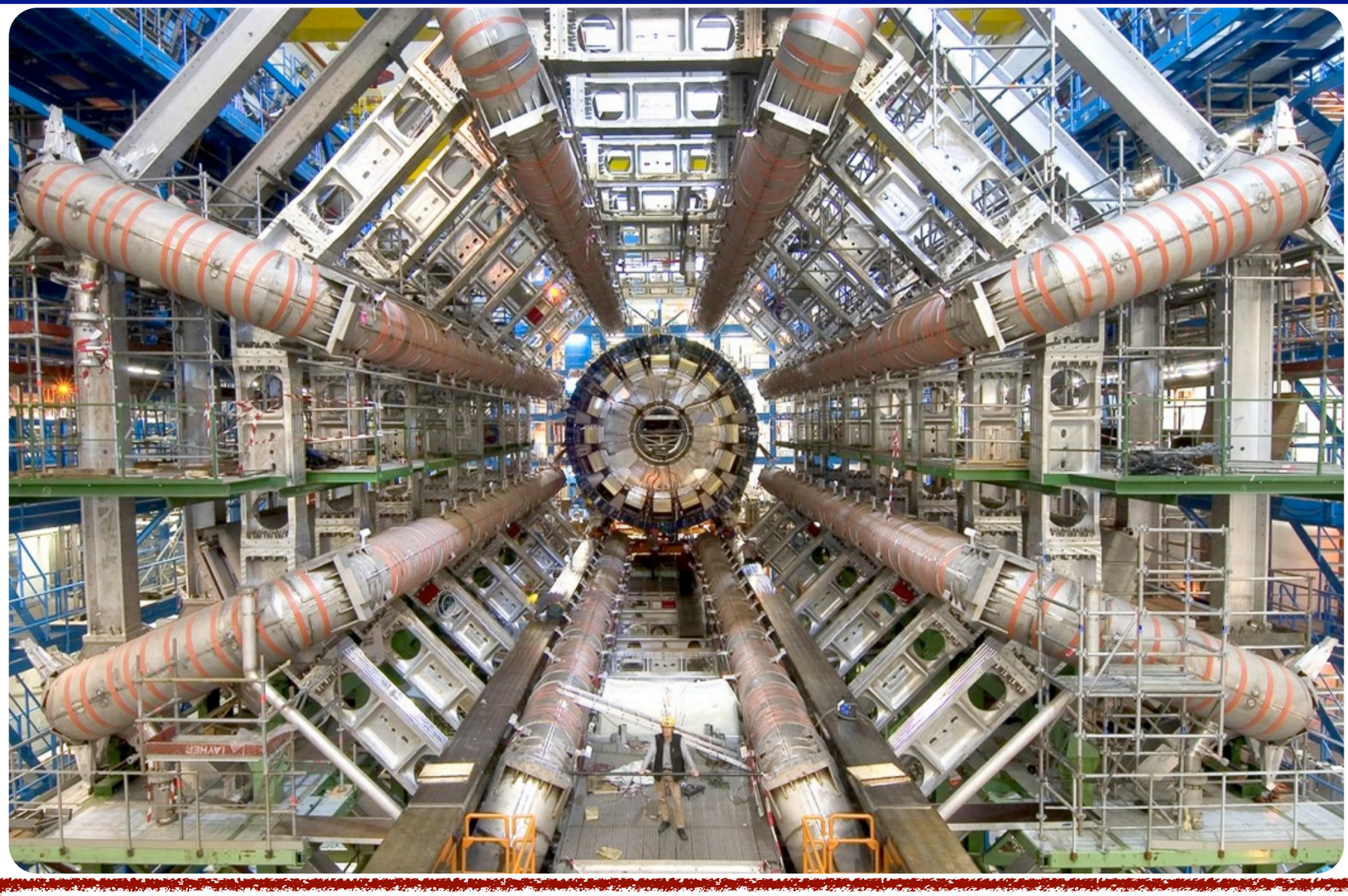
Searching for SUSY

at the Large Hadron Collider



Stephanie Majewski, UO QuarkNet 2013

What is CERN?

a particle physics laboratory outside of Geneva, Switzerland

http://atlas.ch

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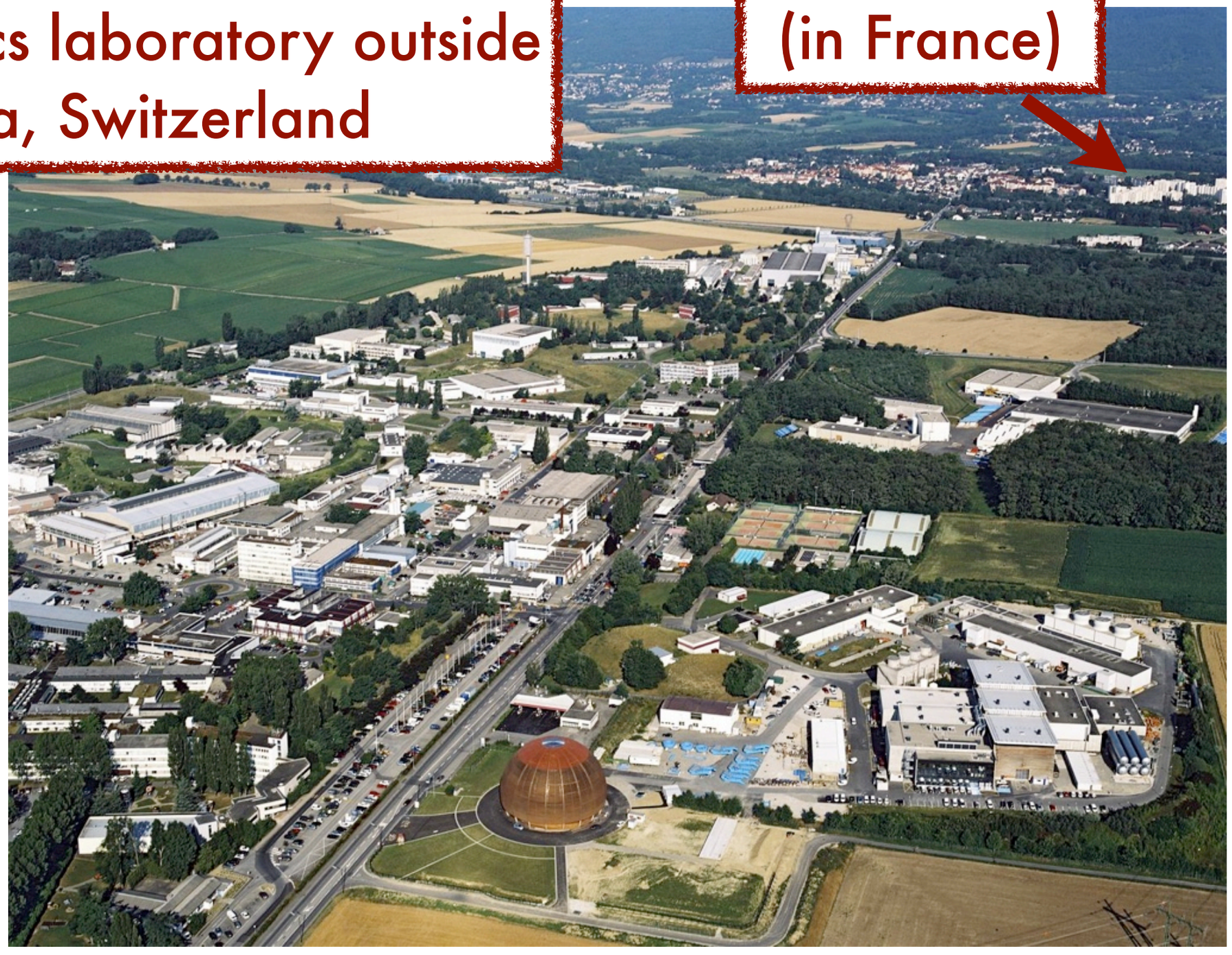
a particle physics laboratory outside of Geneva, Switzerland

I lived here (in France)



http://atlas.ch

What is CERN?

a particle physics laboratory outside of Geneva, Switzerland

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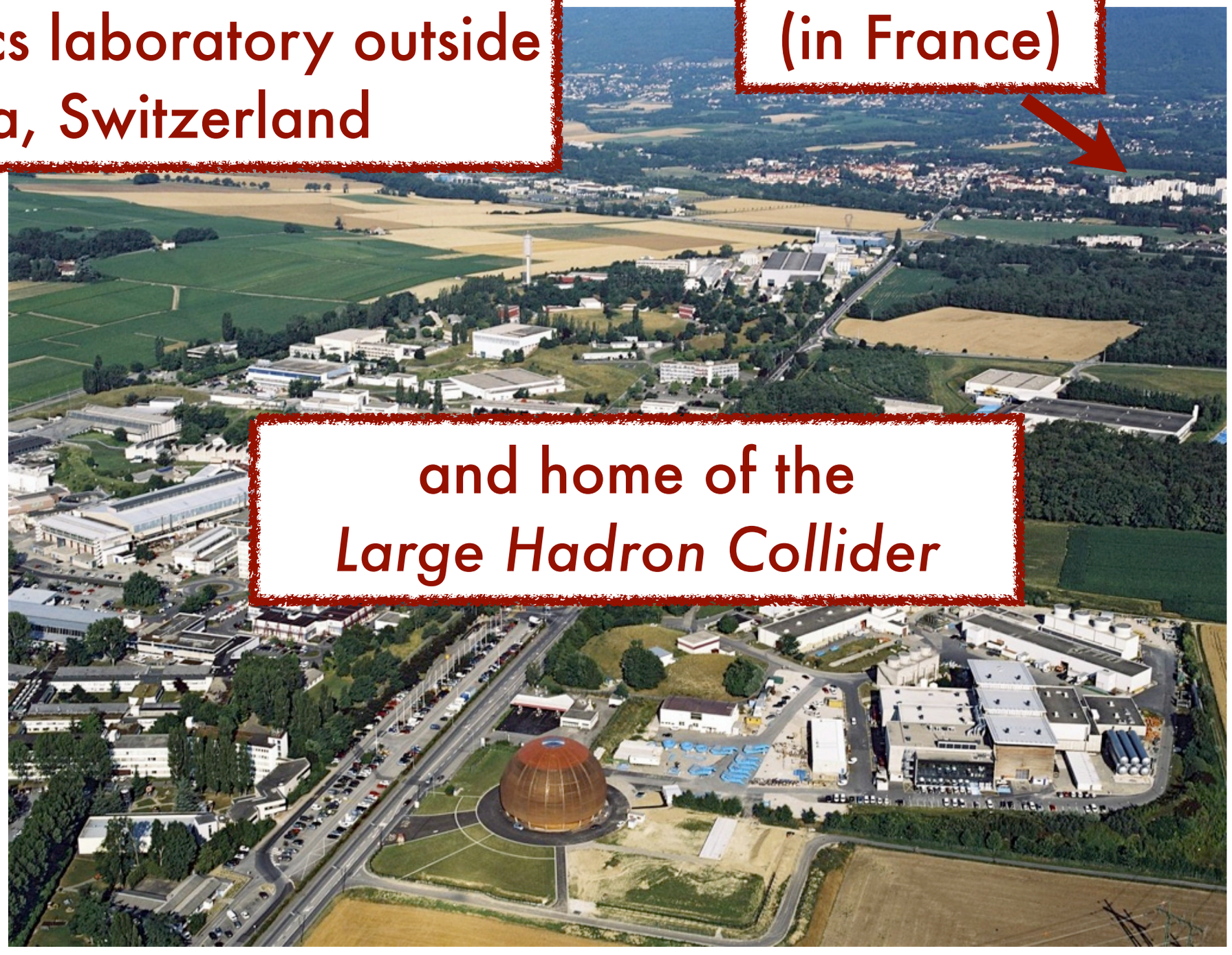

and home of the *Large Hadron Collider*

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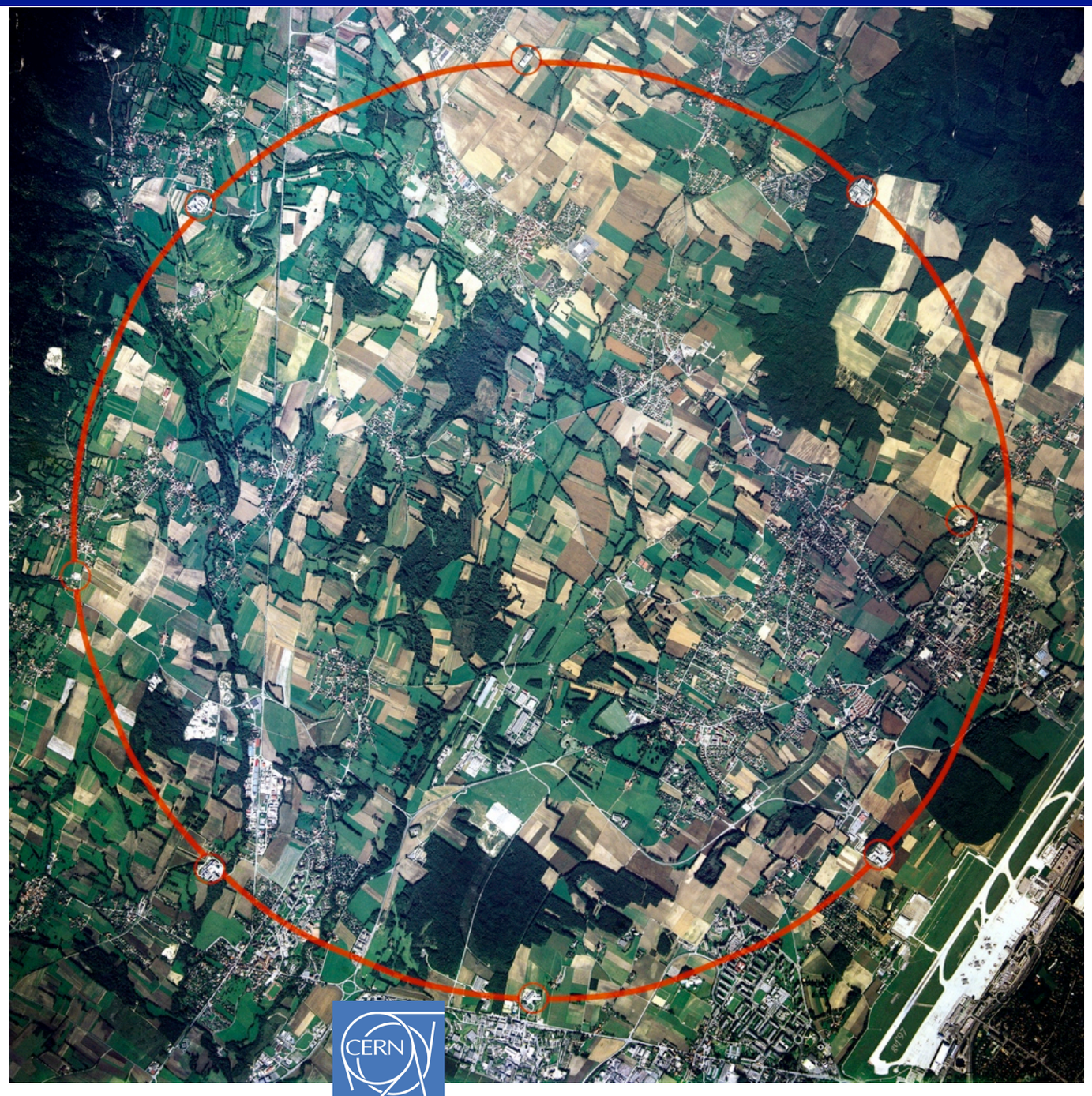
The Large Hadron Collider



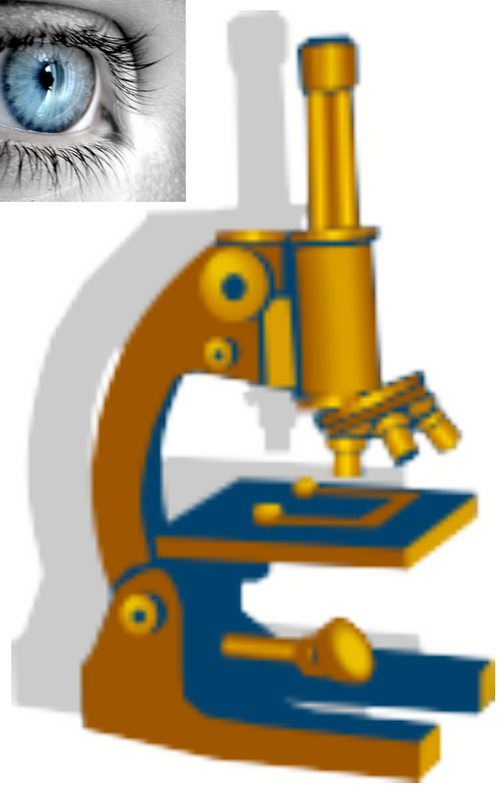
a 17-mile long "microscope"

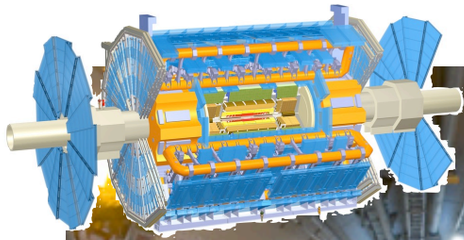
and the *fastest* racetrack on the planet!

http://atlas.ch

Microscopes

A particle physicist's microscope...





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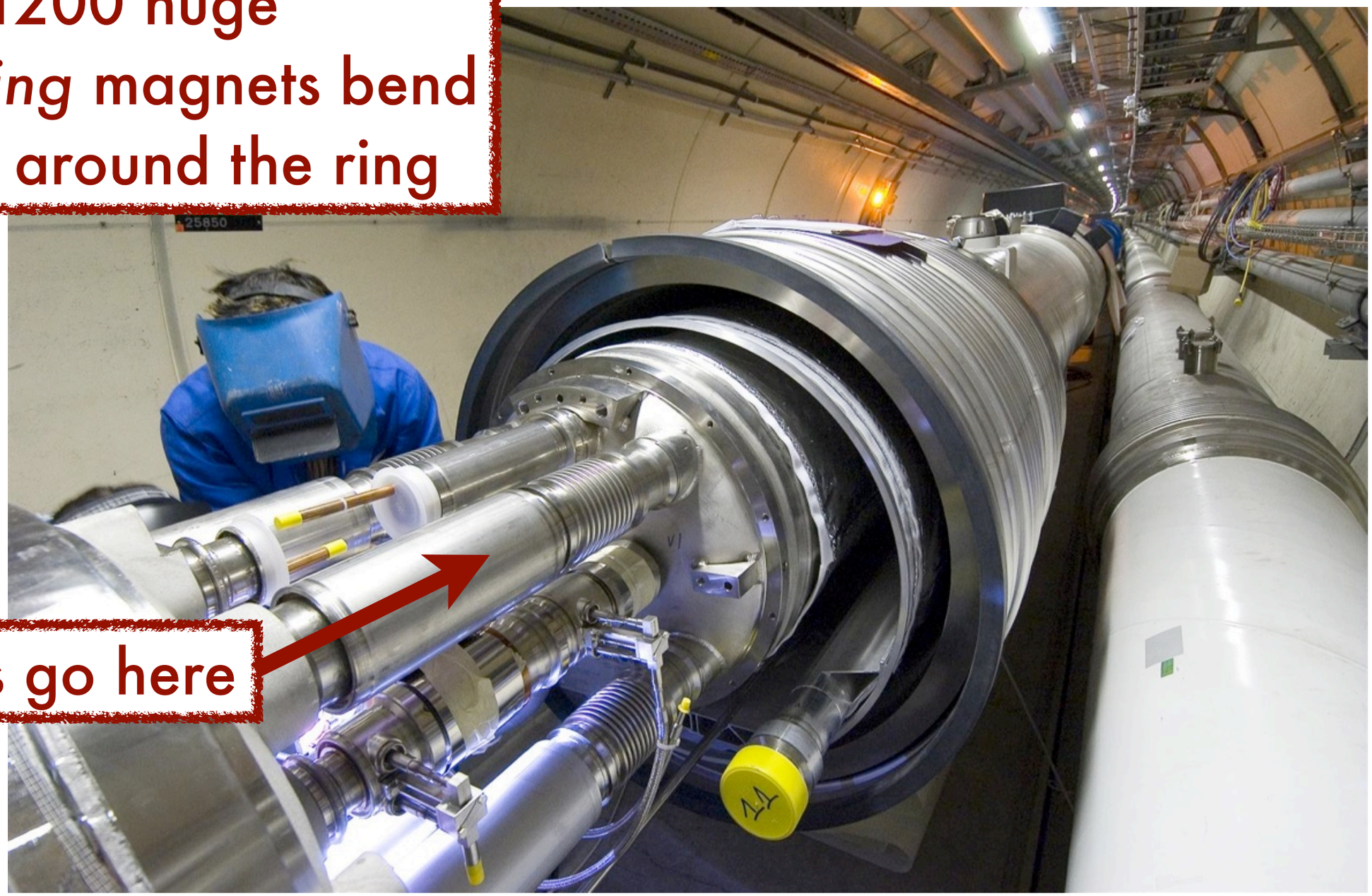
The LHC

Over 1200 huge *superconducting* magnets bend the particles around the ring



particles go here

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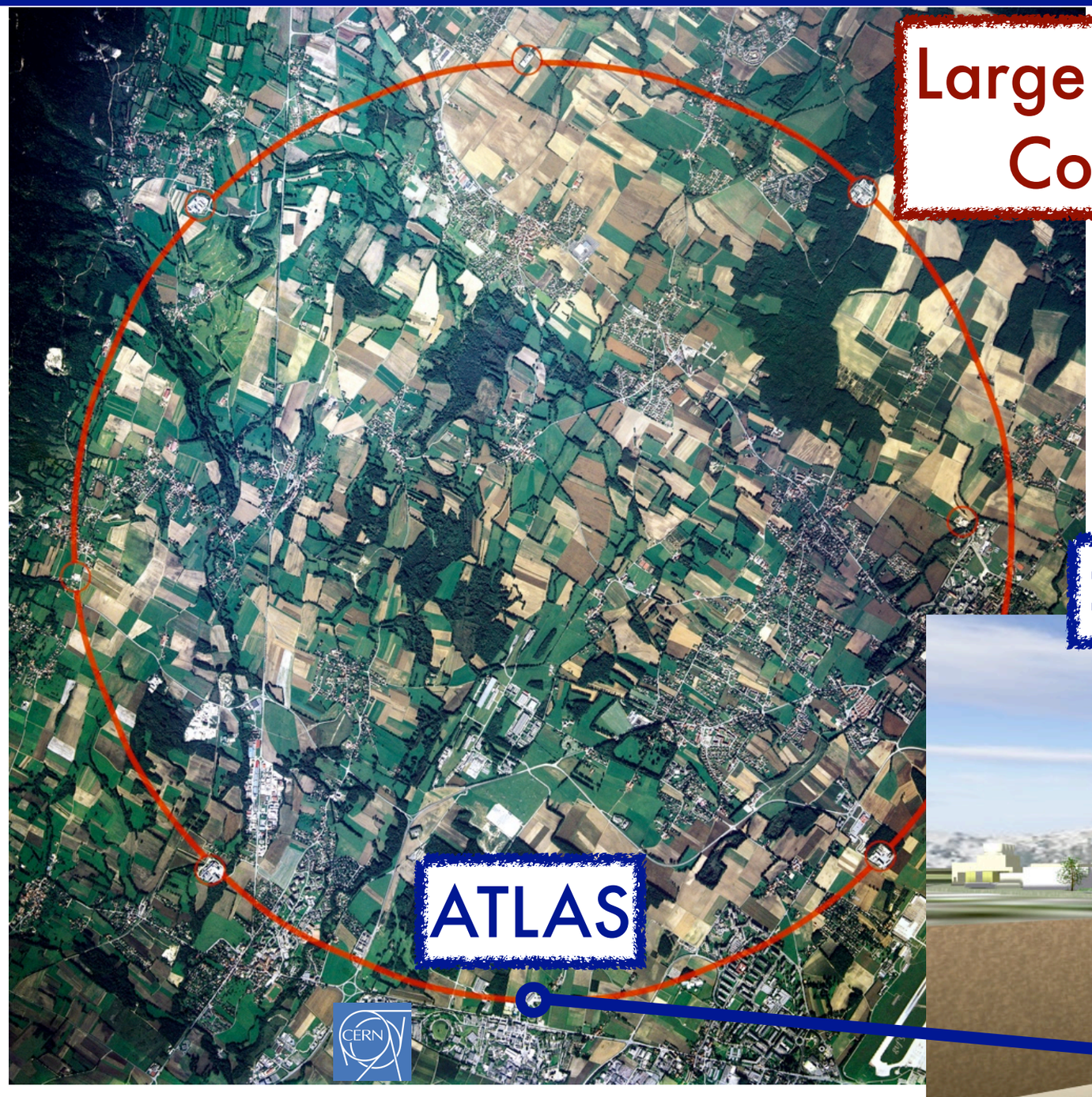
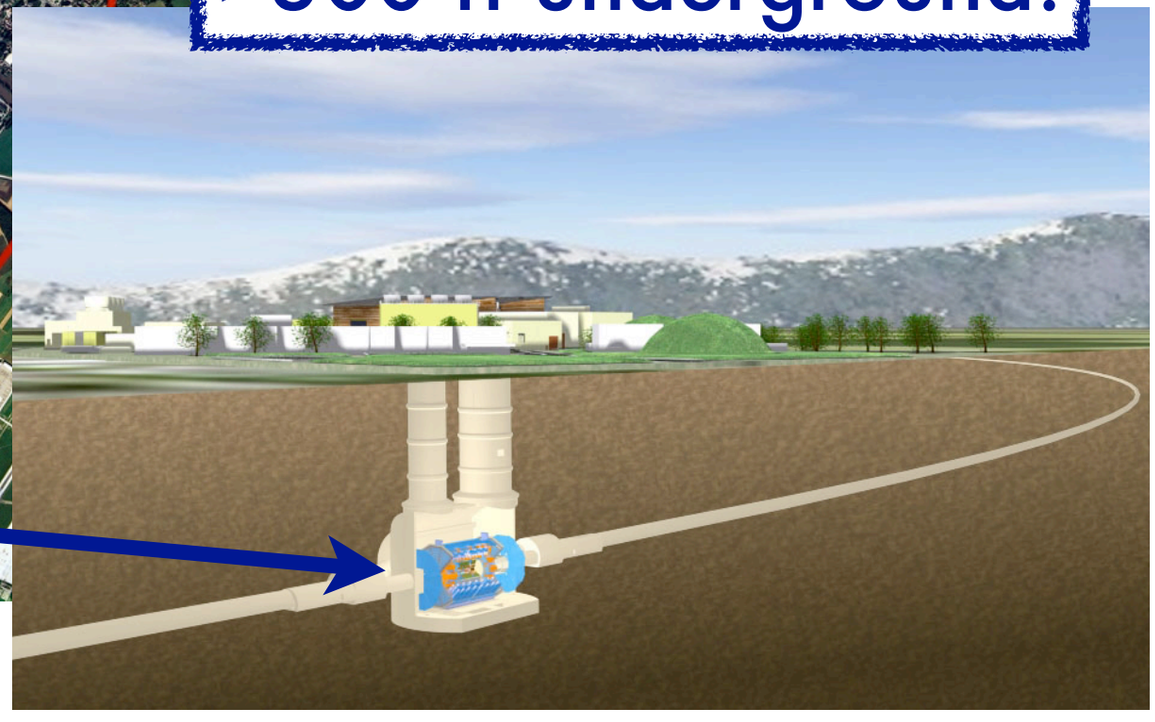
The ATLAS Detector



>300 ft underground!

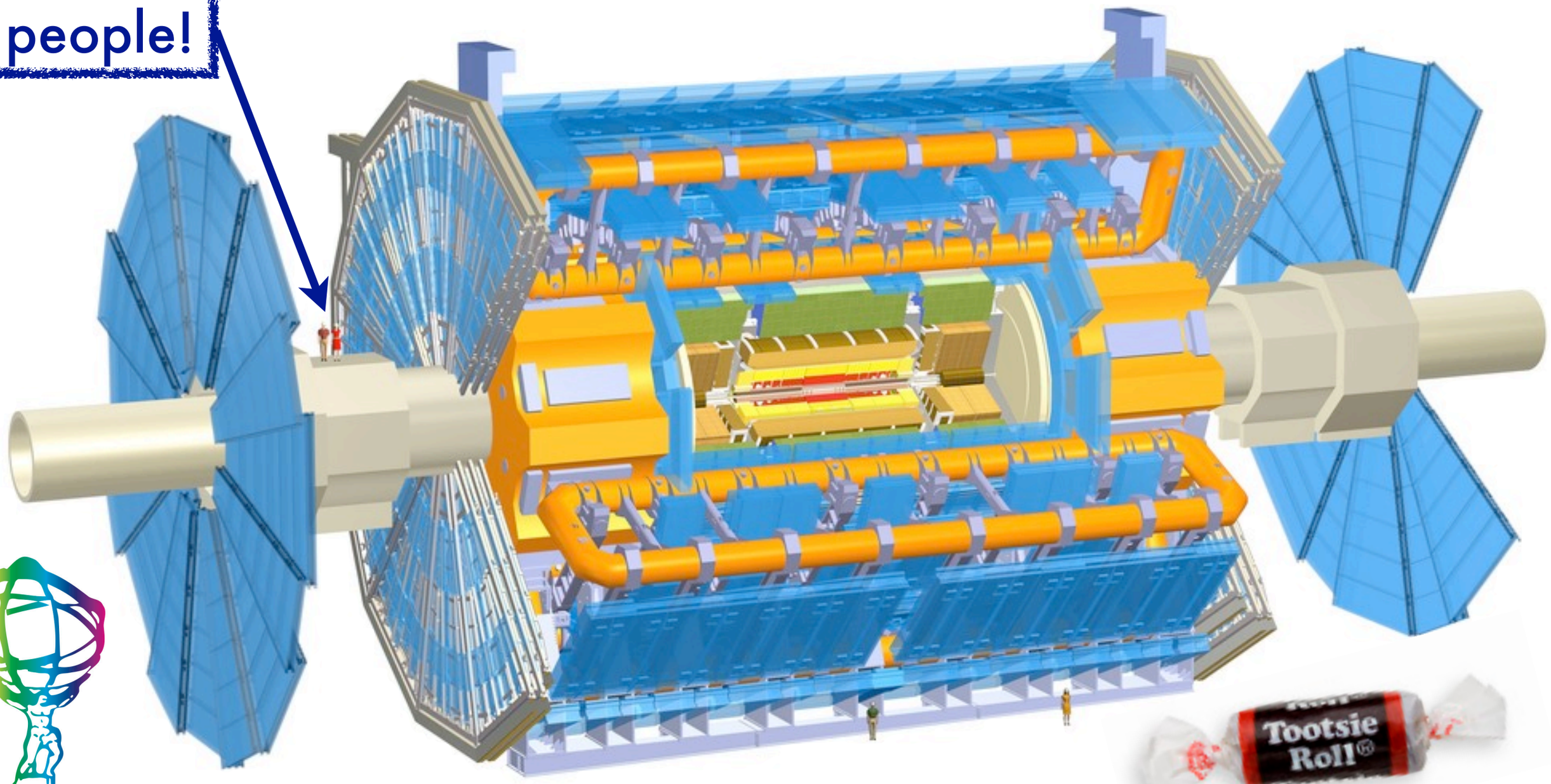


http://atlas.ch

The ATLAS Detector

= the eye of the microscope

people!



http://atlas.ch

(not to scale)

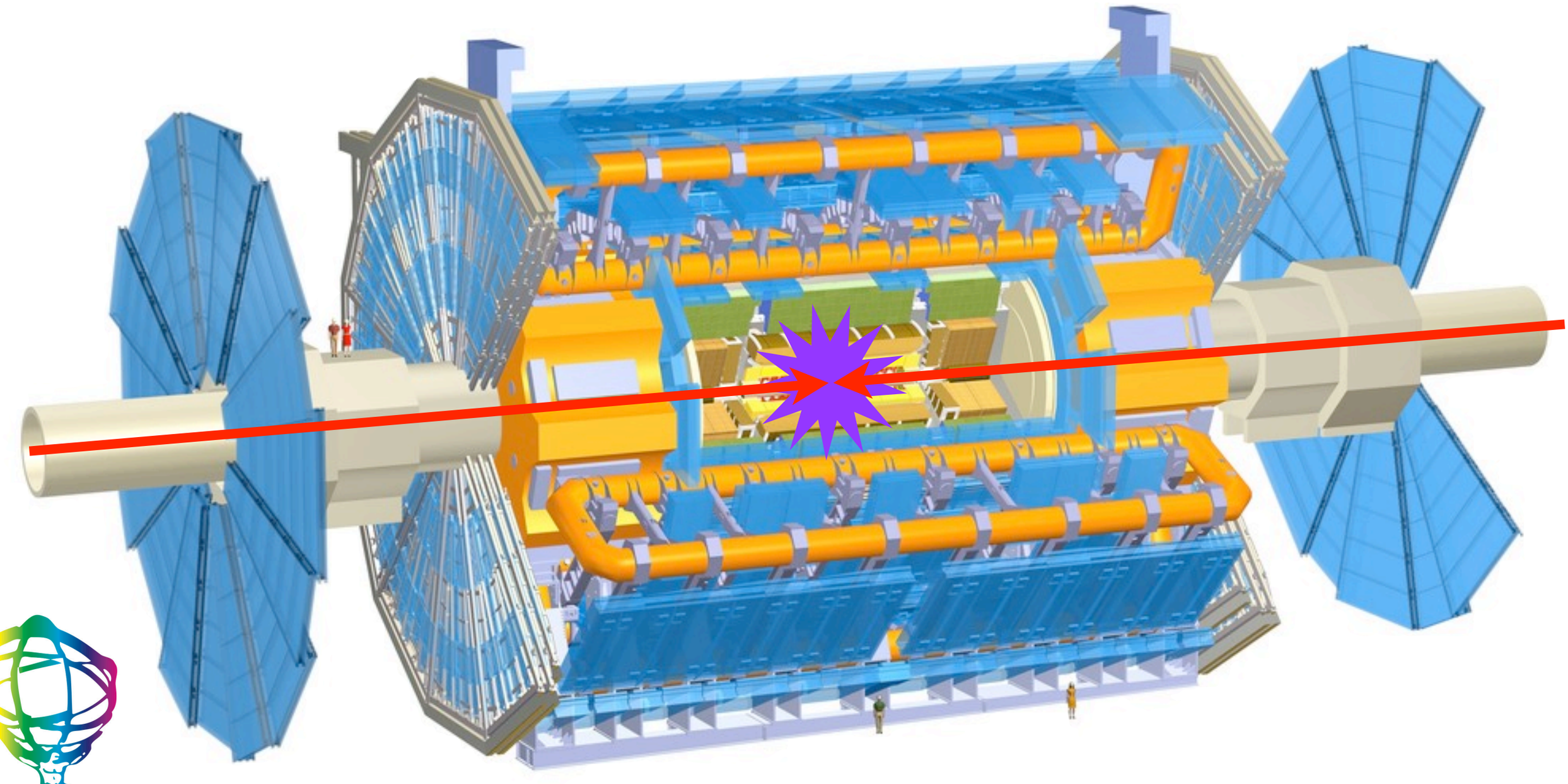
How big is ATLAS?

as heavy as the Eiffel Tower!

as tall as a 5-story building!

http://atlas.ch

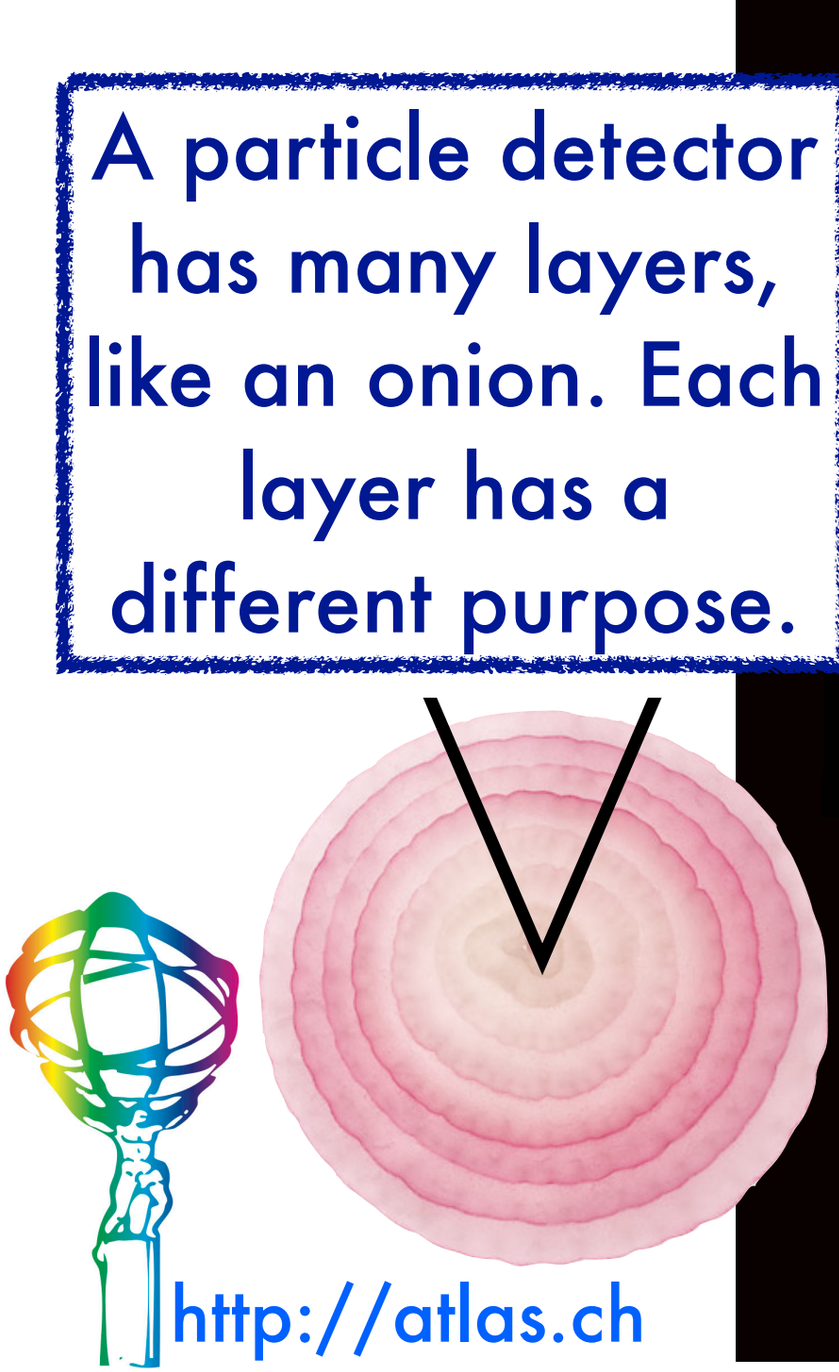
Particles Collide HERE



http://atlas.ch

After the collision…

A particle detector has many layers, like an onion. Each layer has a different purpose.



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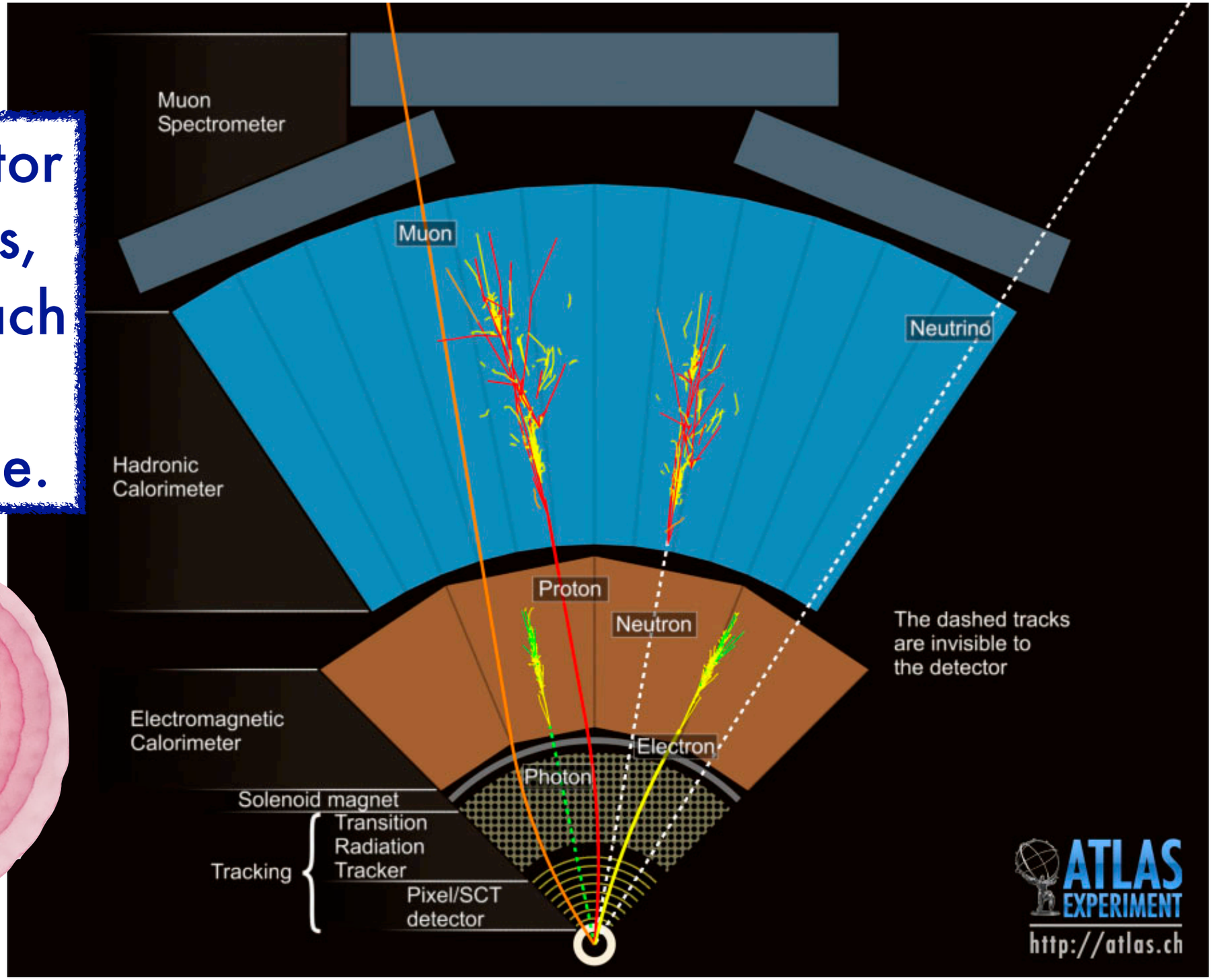
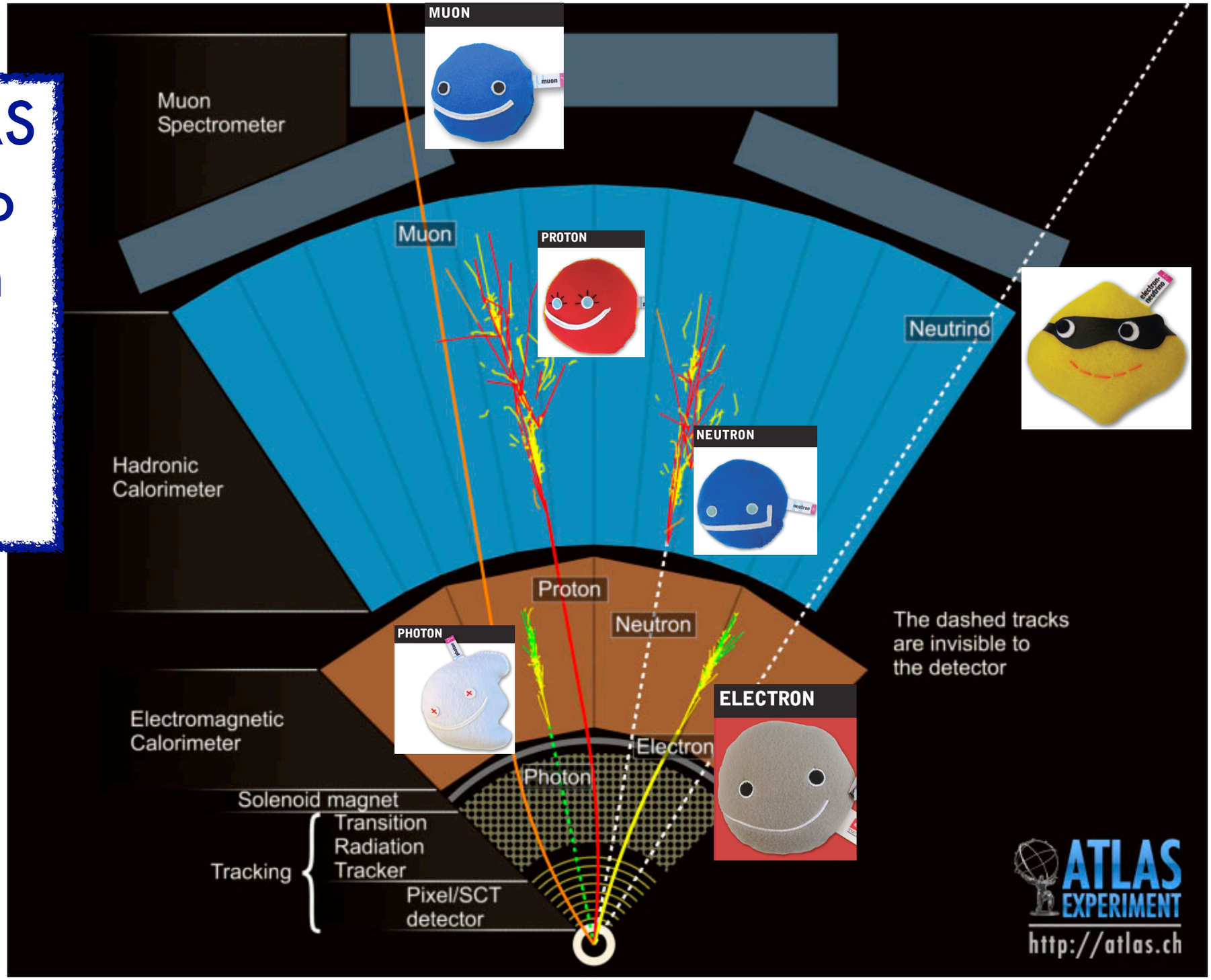


After the collision…

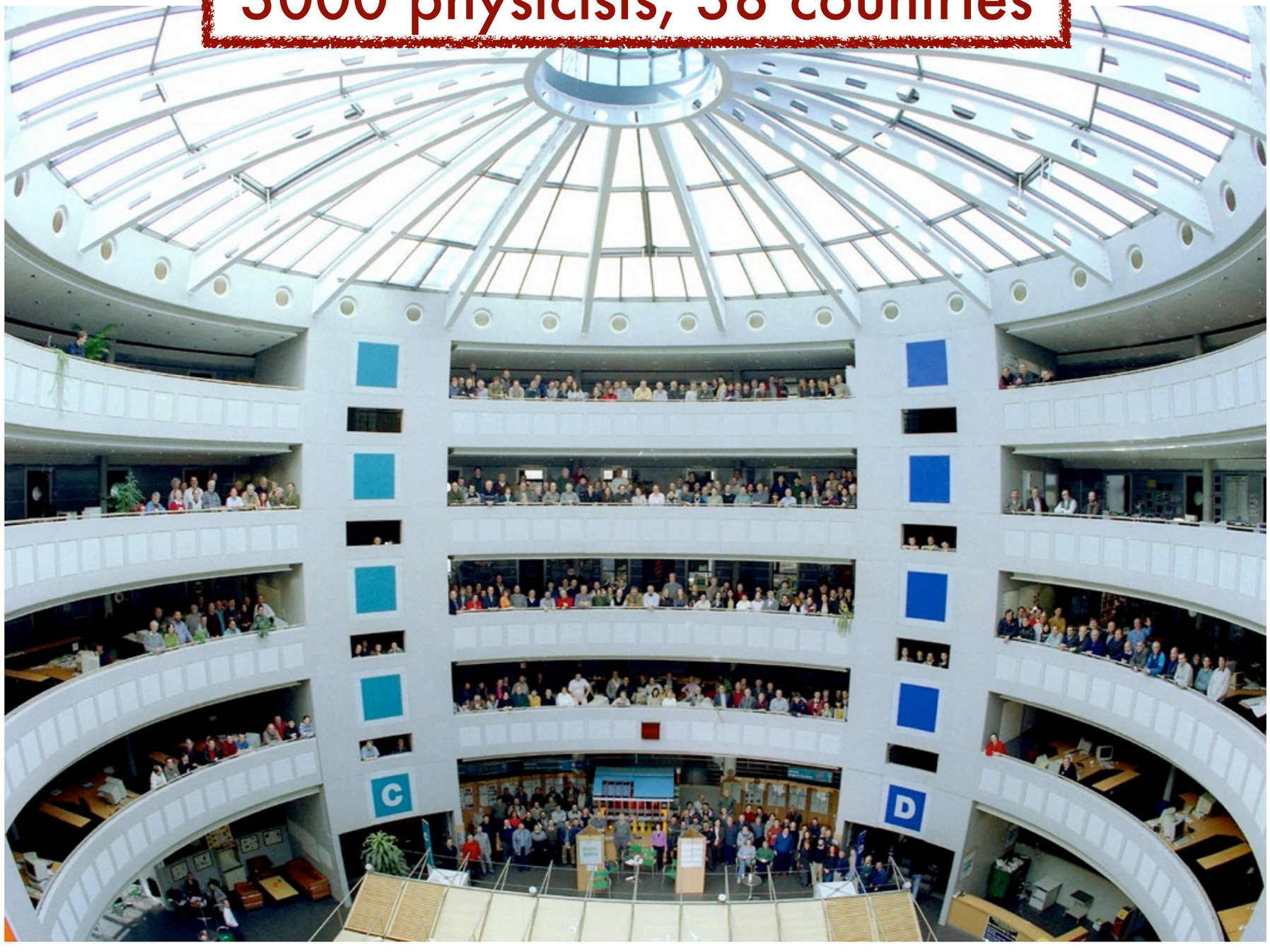
We use the ATLAS detector to try to figure out which particles were produced in the collision.



http://atlas.ch

The ATLAS Collaboration

3000 physicists, 38 countries



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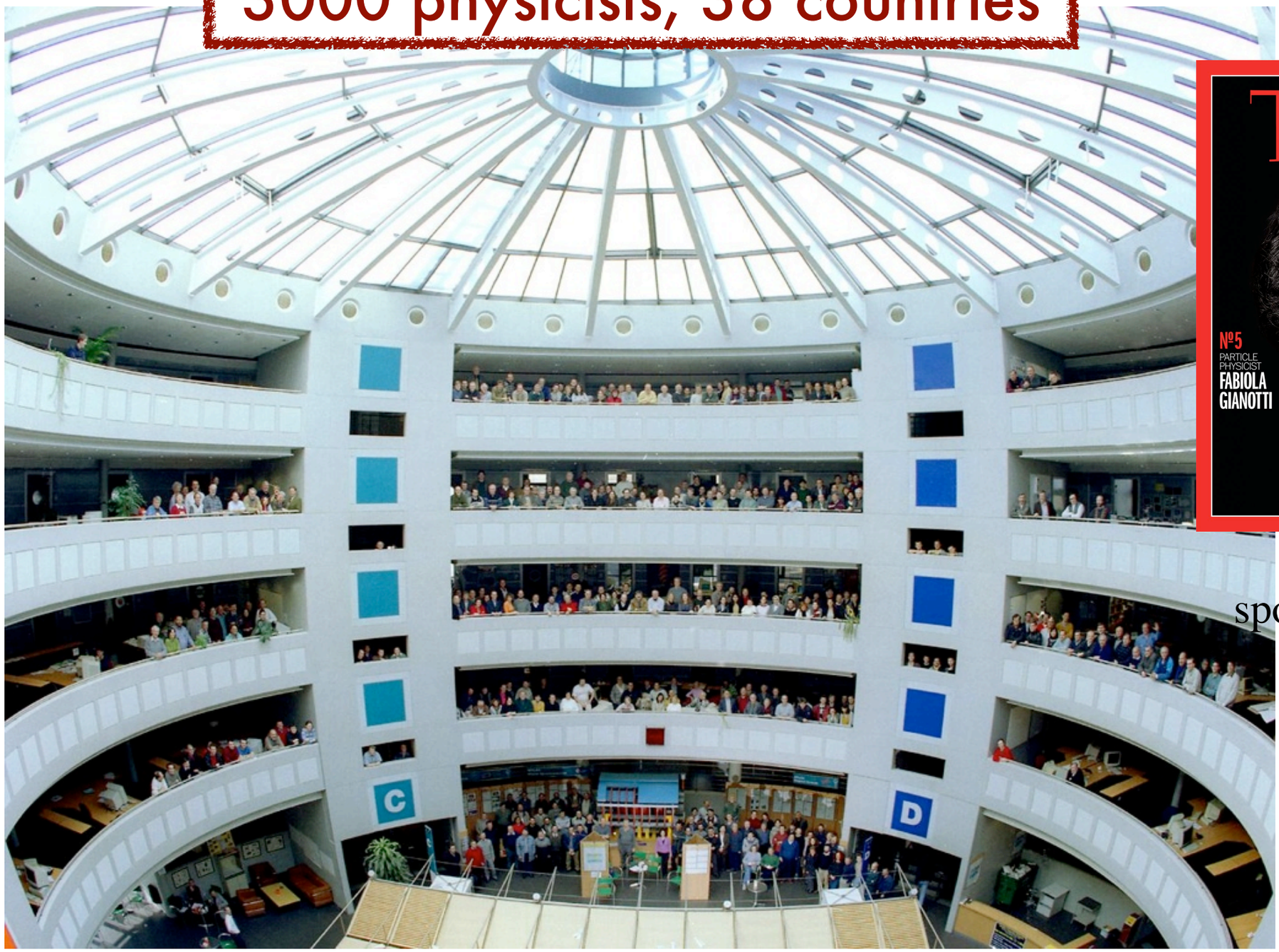

(former spokesperson of ATLAS)

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The BIG Questions

We are trying to answer some major questions:

1. What is the origin of mass?
2. What is dark matter?
3. Are there any new particles or new forces?

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The BIG Questions

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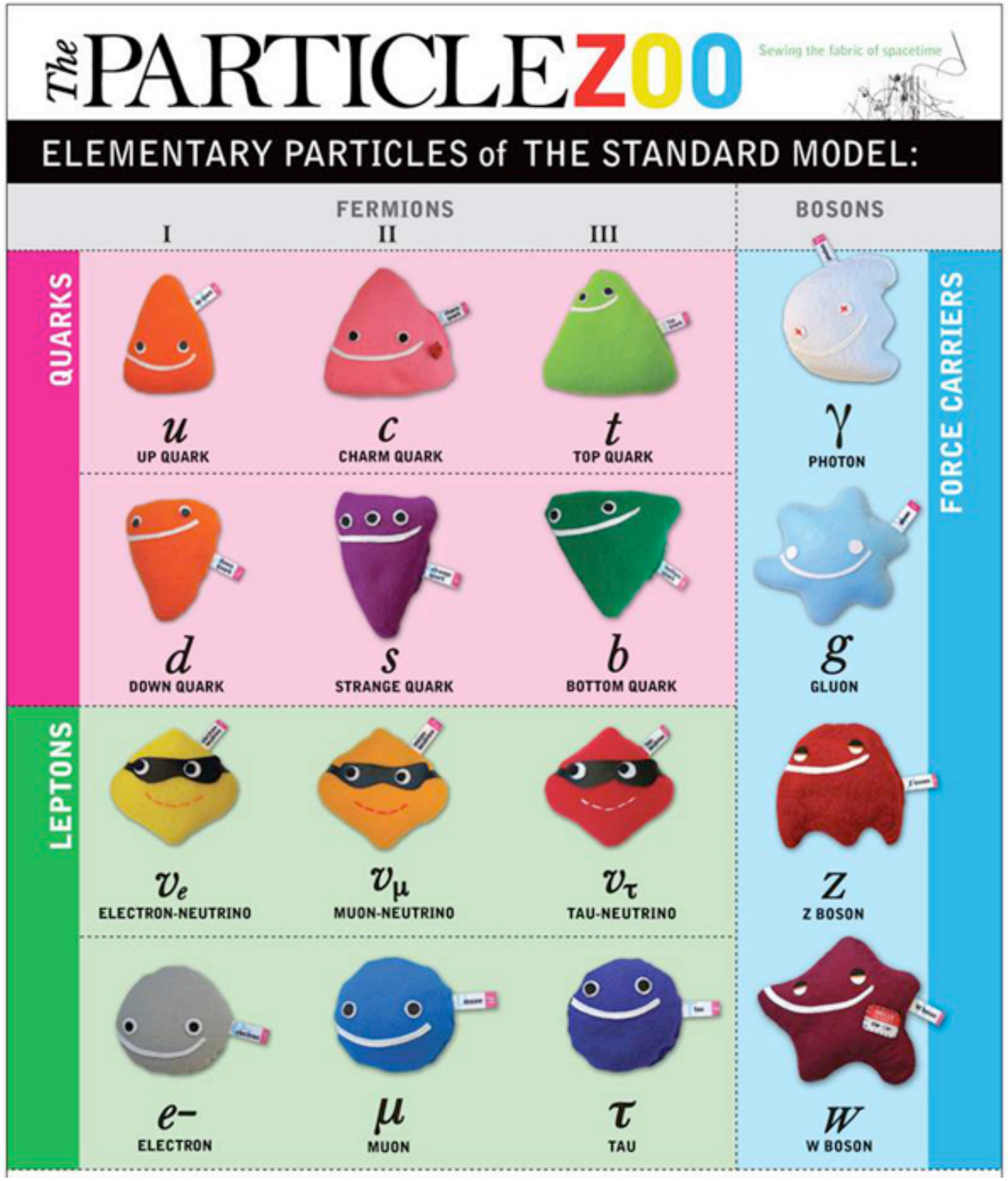
We already have a zoo…



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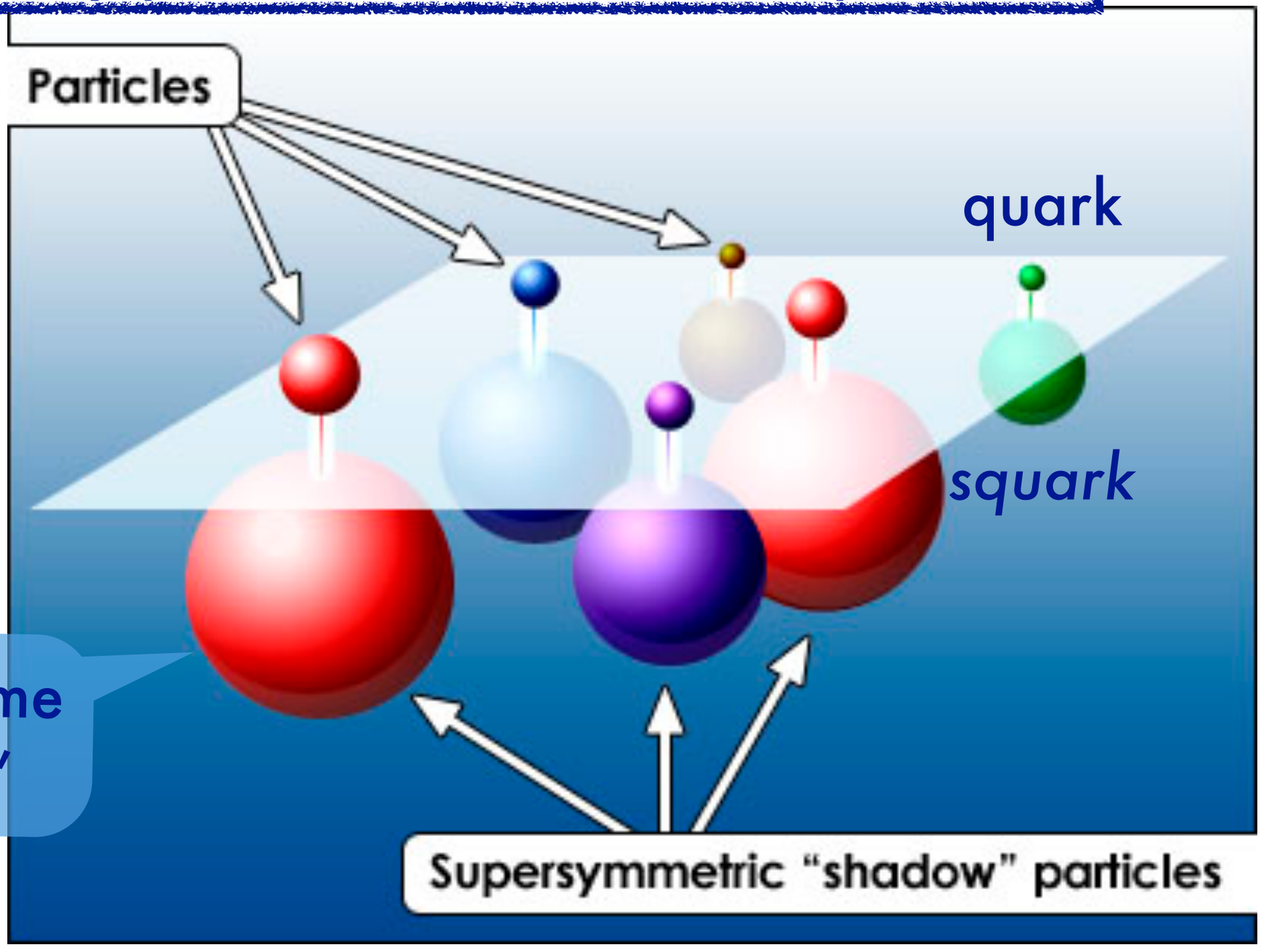
Supersymmetry

What if every particle has a "shadow" particle?



Just call me "SUSY"

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Supersymmetry

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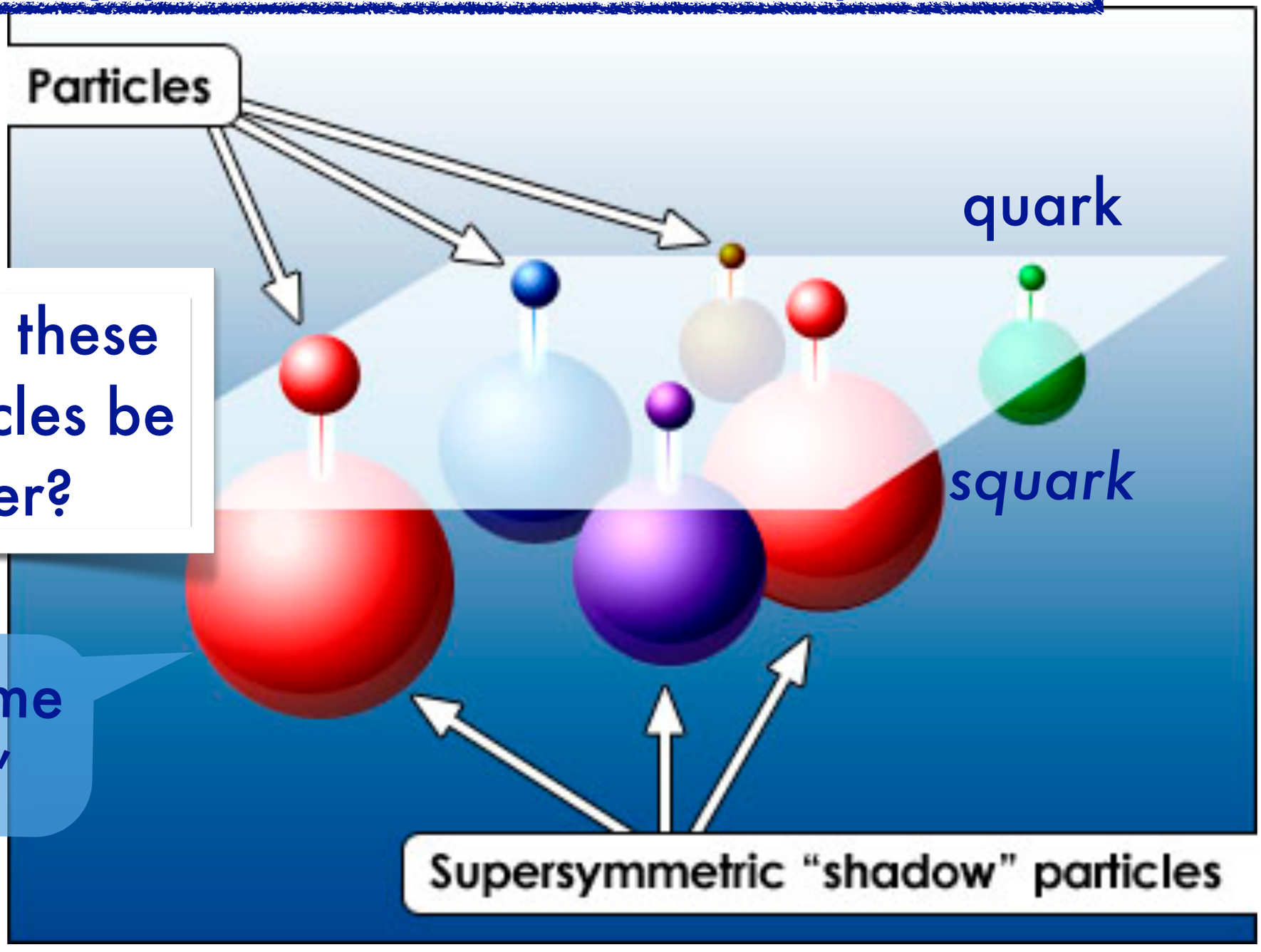

Could one of these "super" particles be dark matter?

Just call me "SUSY"

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Searching for Interesting Events

http://atlas.ch

Looking for SUSY

The LHC has been colliding particles since November 2009...

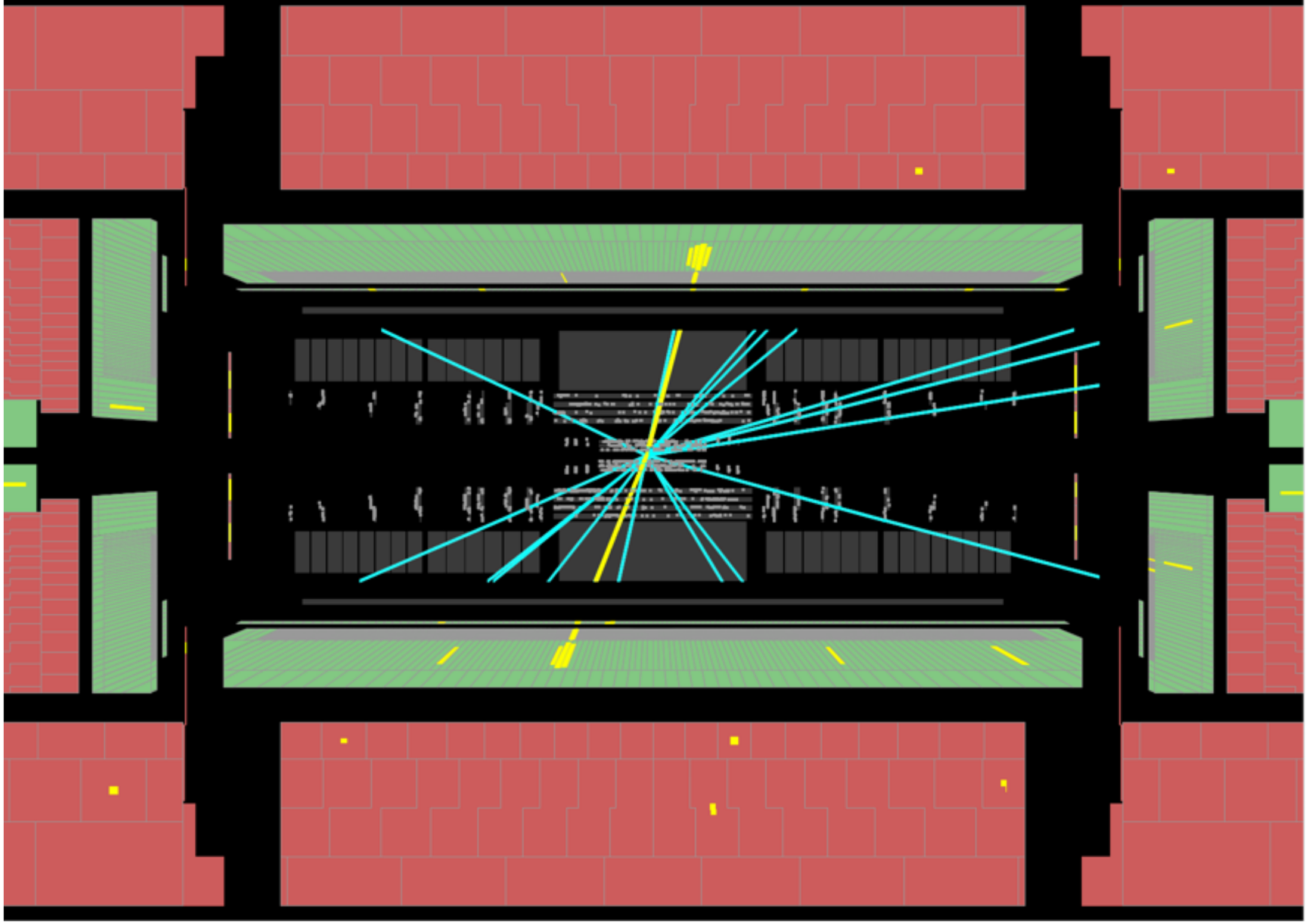
how do we analyze the collisions to search for SUSY?

http://atlas.ch

sprays of particles
called "jets"

ATLAS EXPERIMENT

Run Number: 154817, Event Number: 968871
Date: 2010-05-09 09:41:40 CEST



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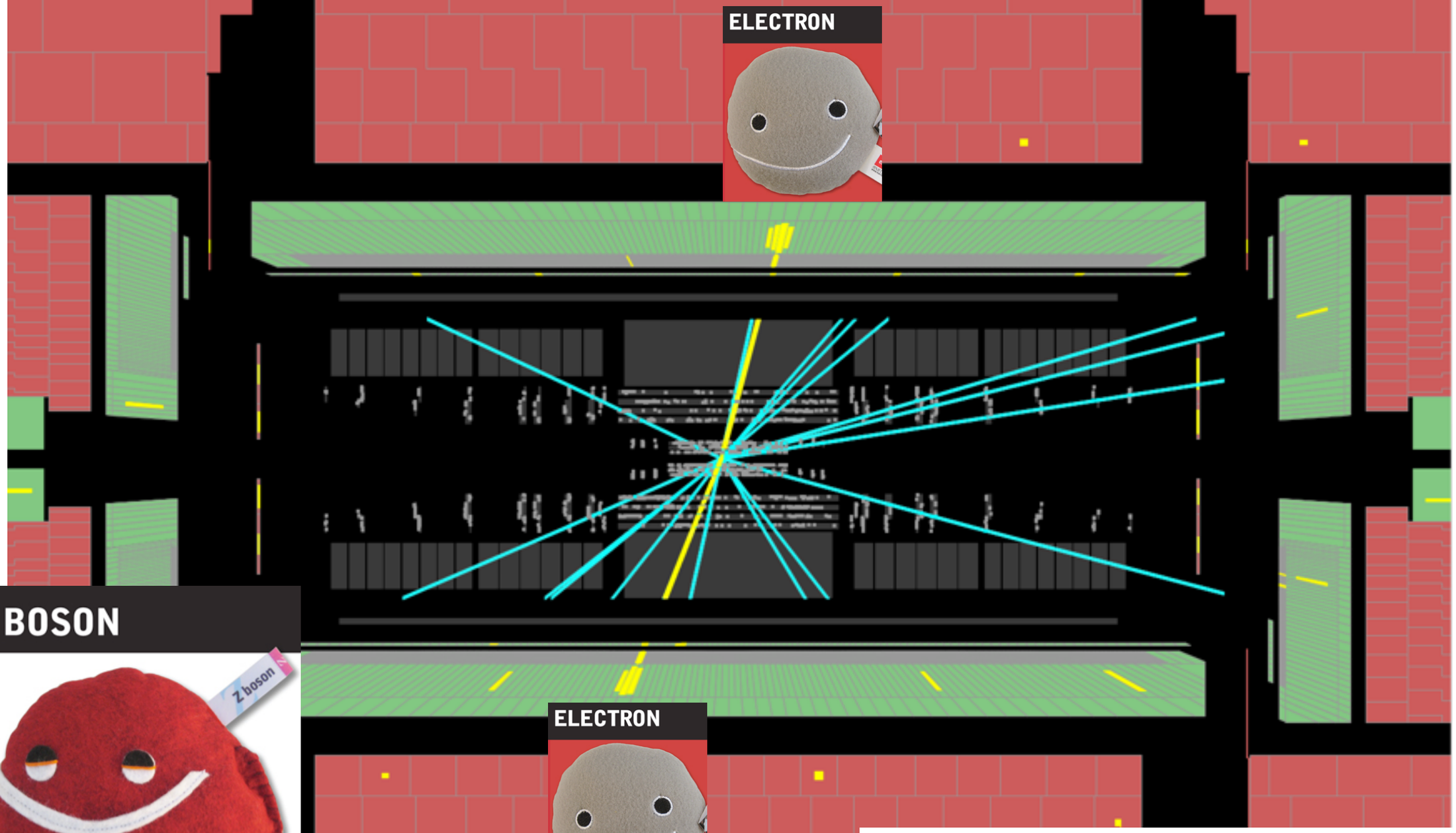
M_{ee} = 89 GeV

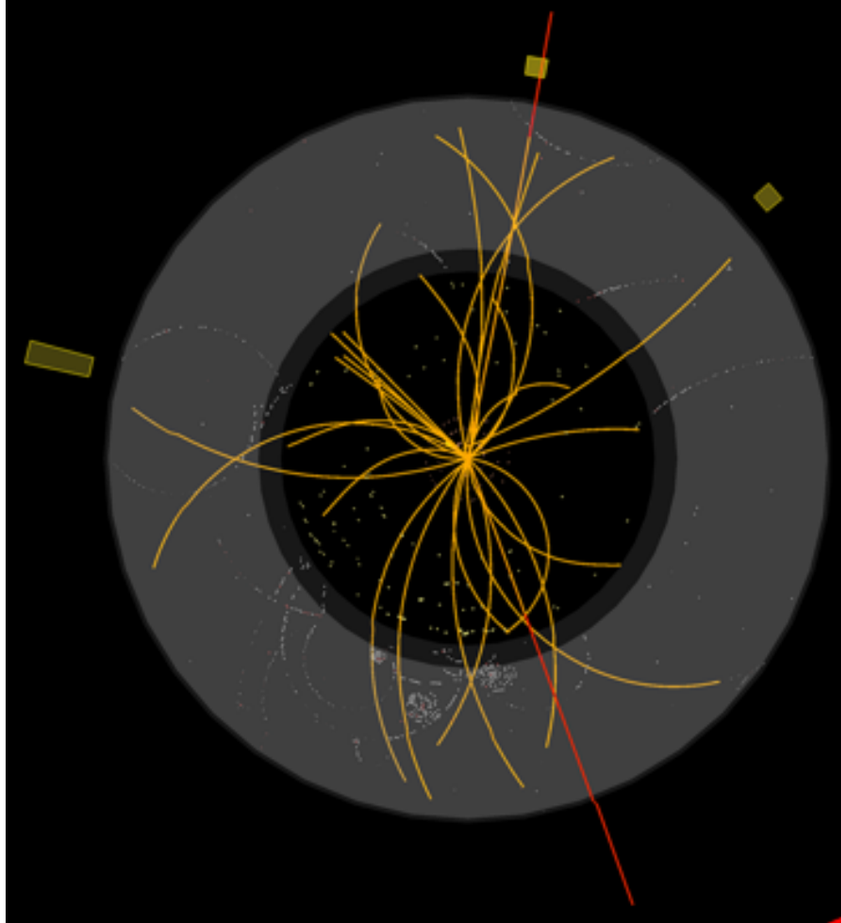
Z→ee candidate in 7 TeV collisions

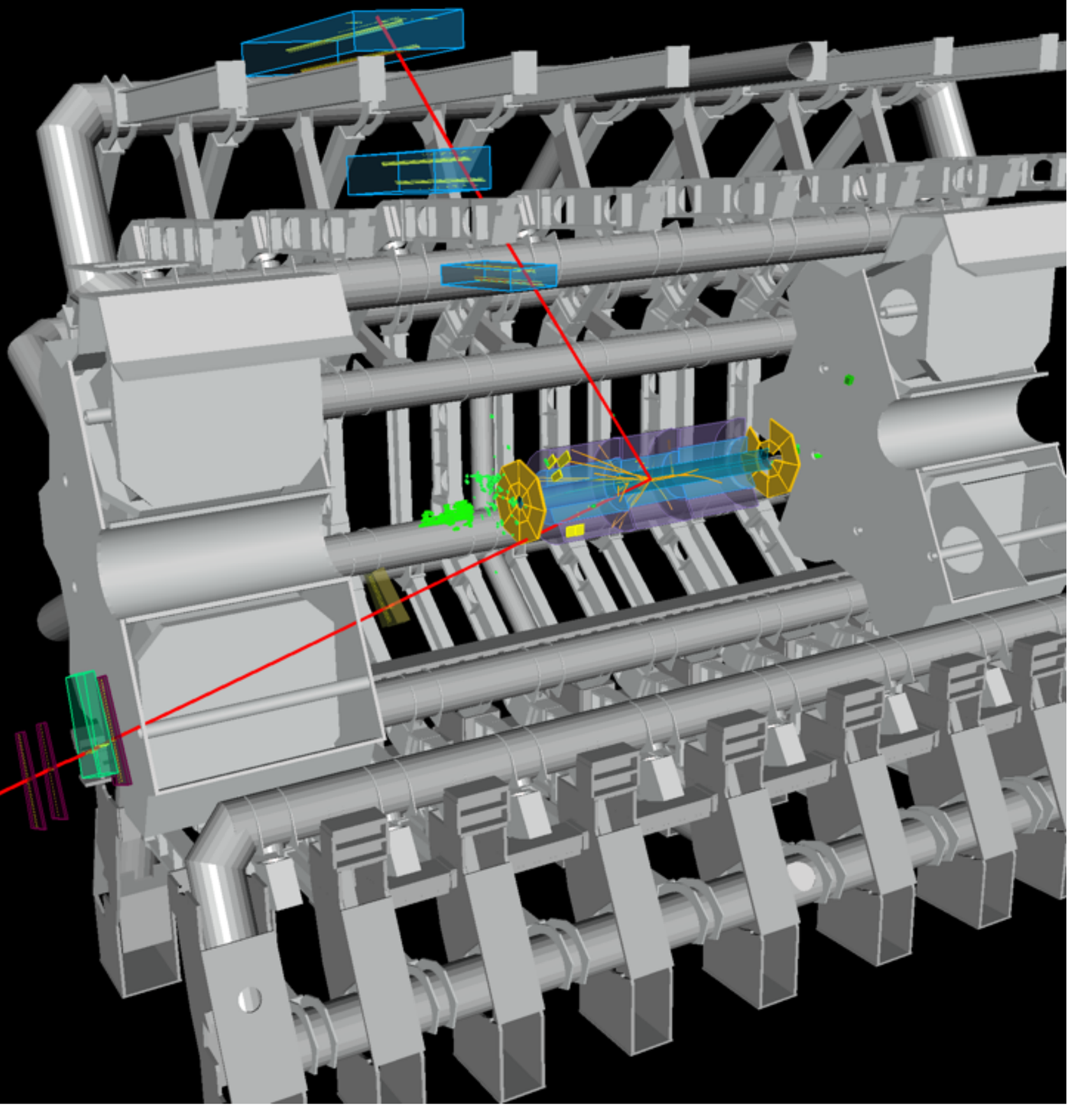


Z BOSON

the Z boson, decaying to 2 electrons

ATLAS
EXPERIMENT
Run: 154822, Event: 14321500
Date: 2010-05-10 02:07:22 CEST





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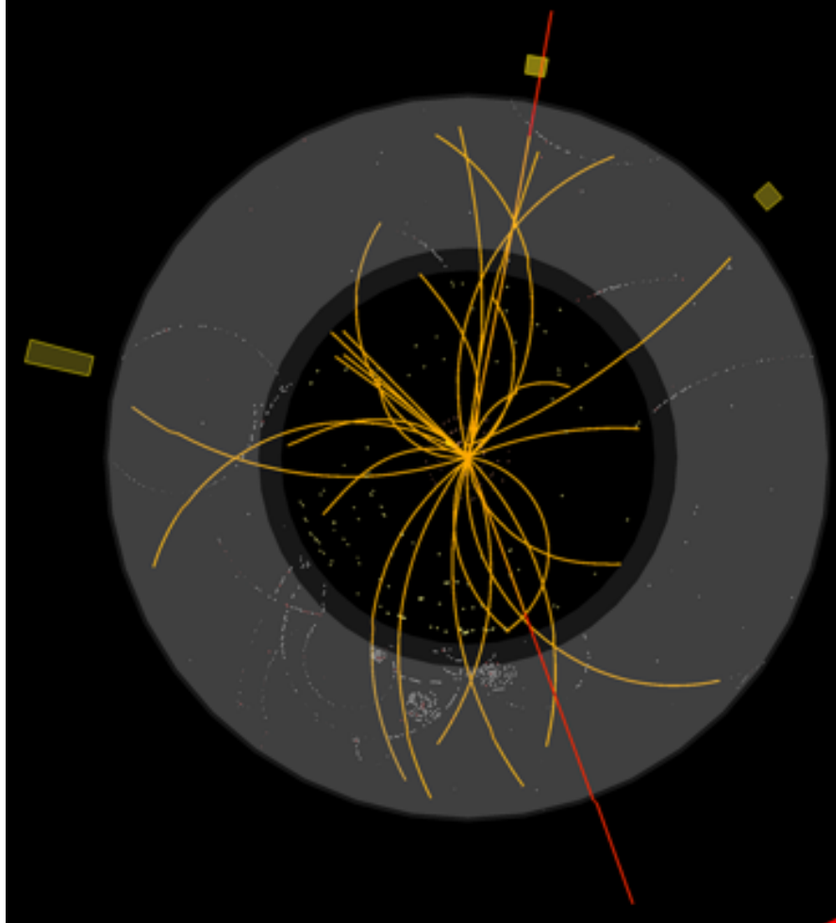

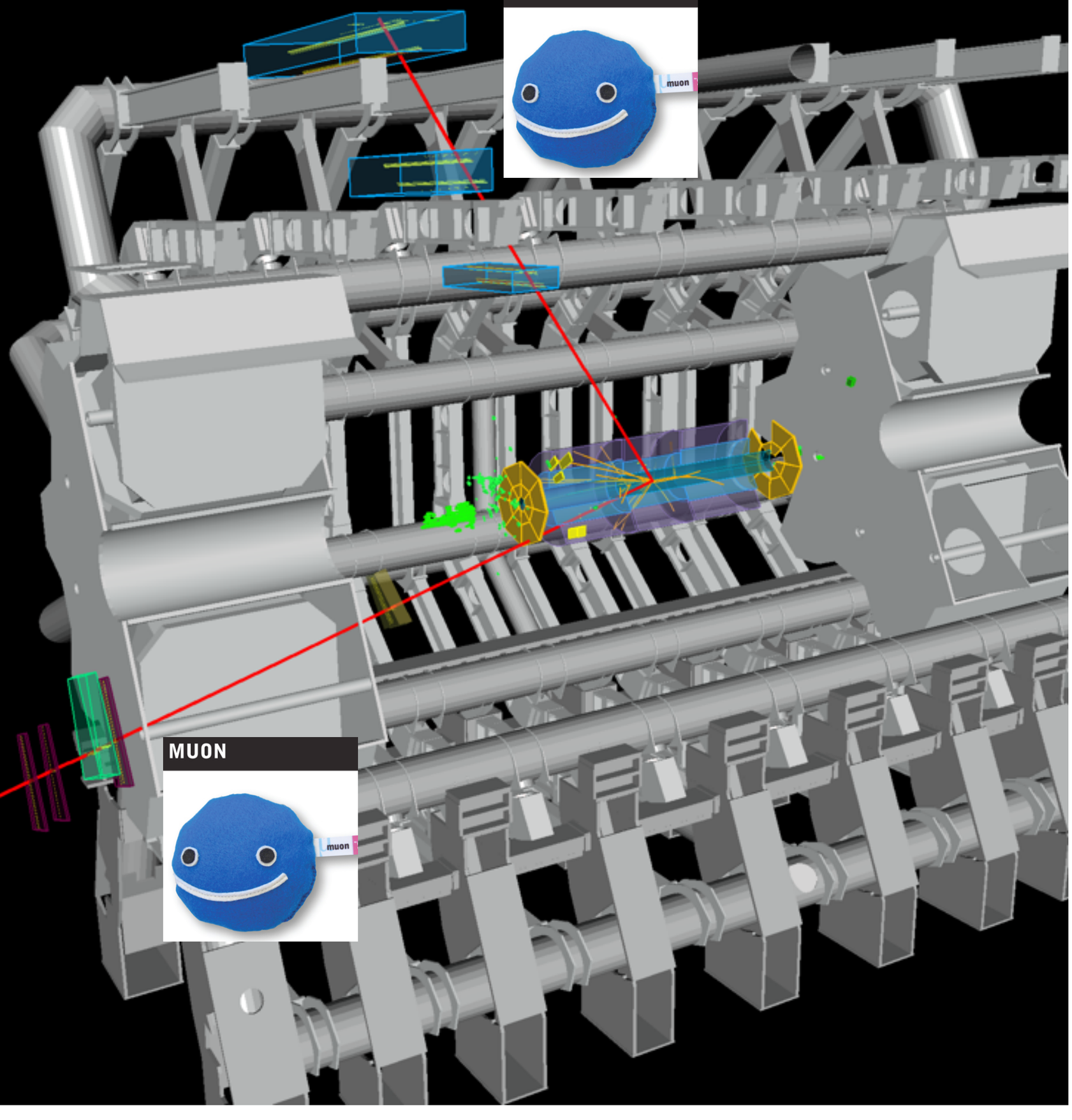

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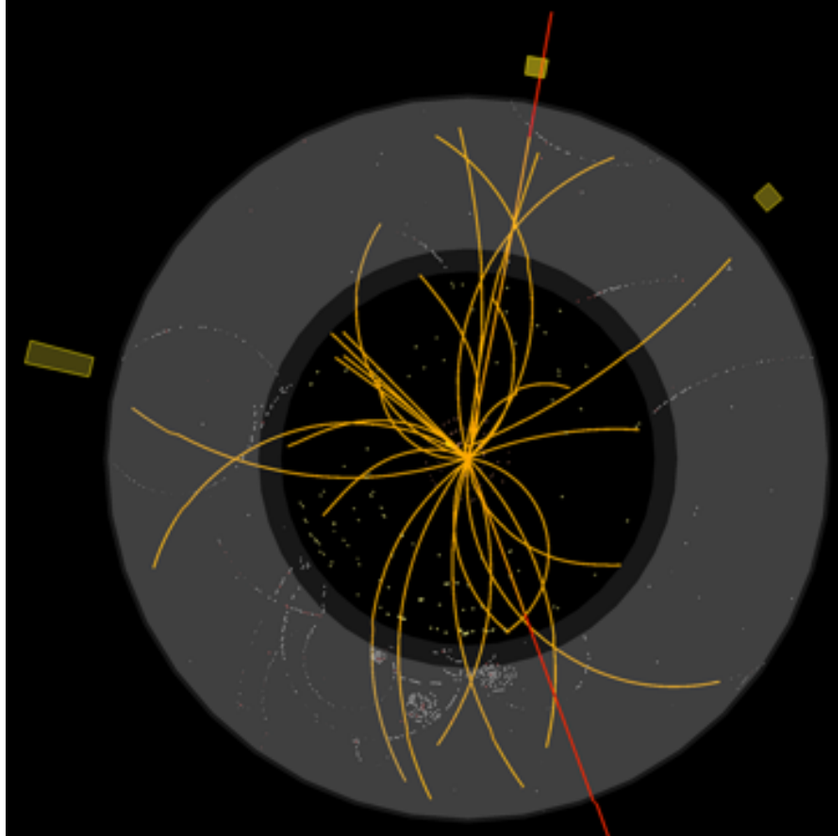
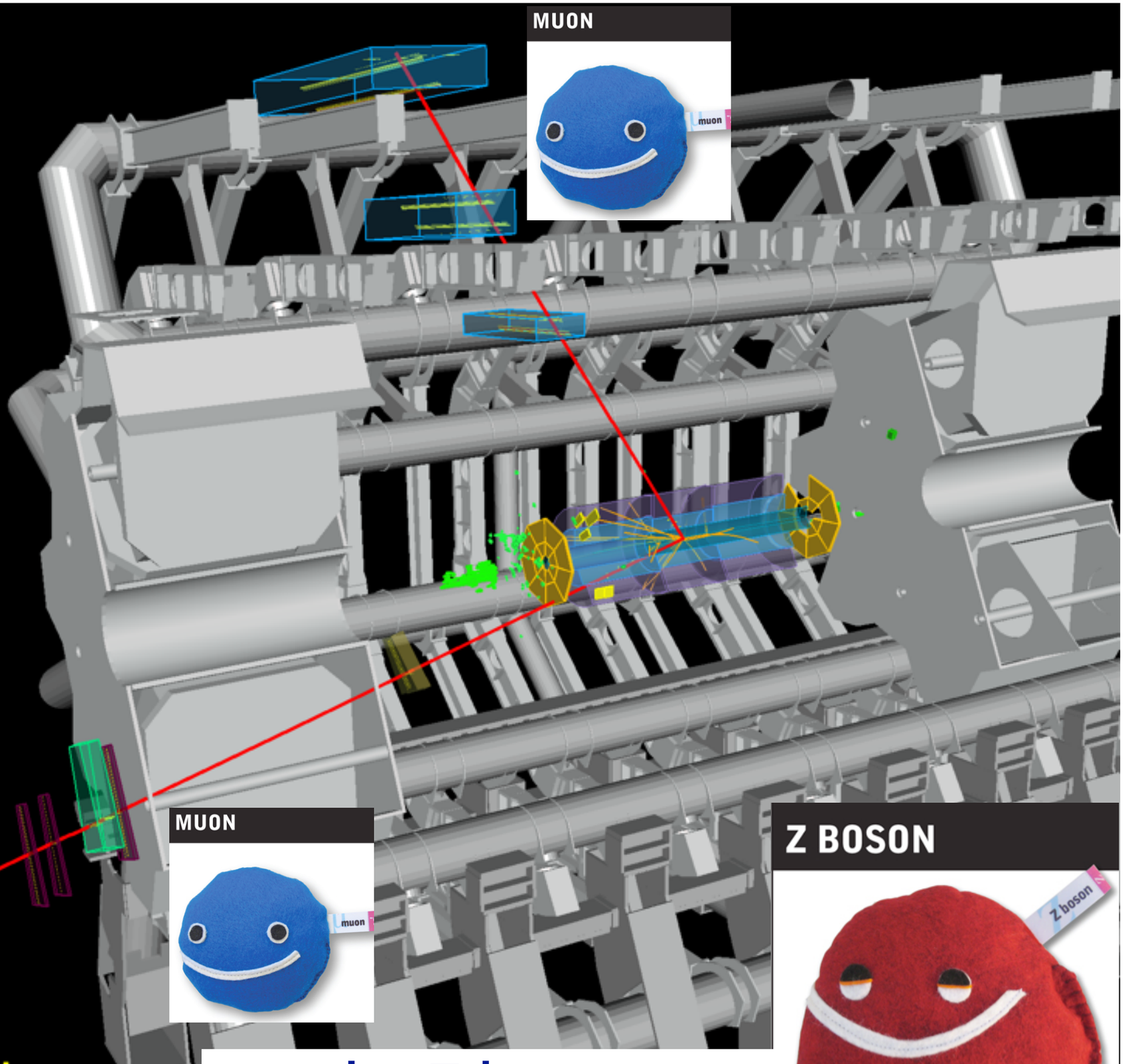
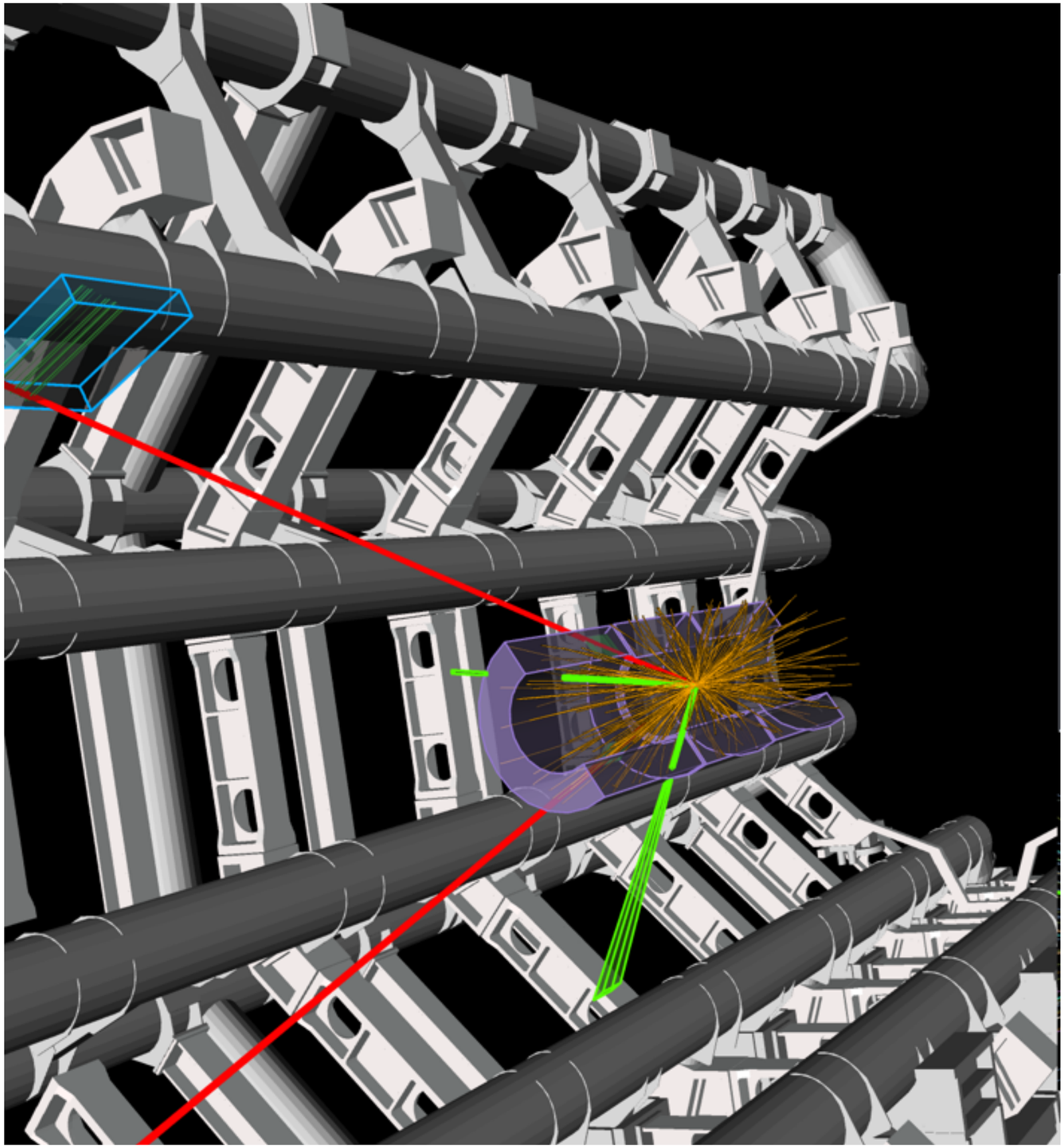


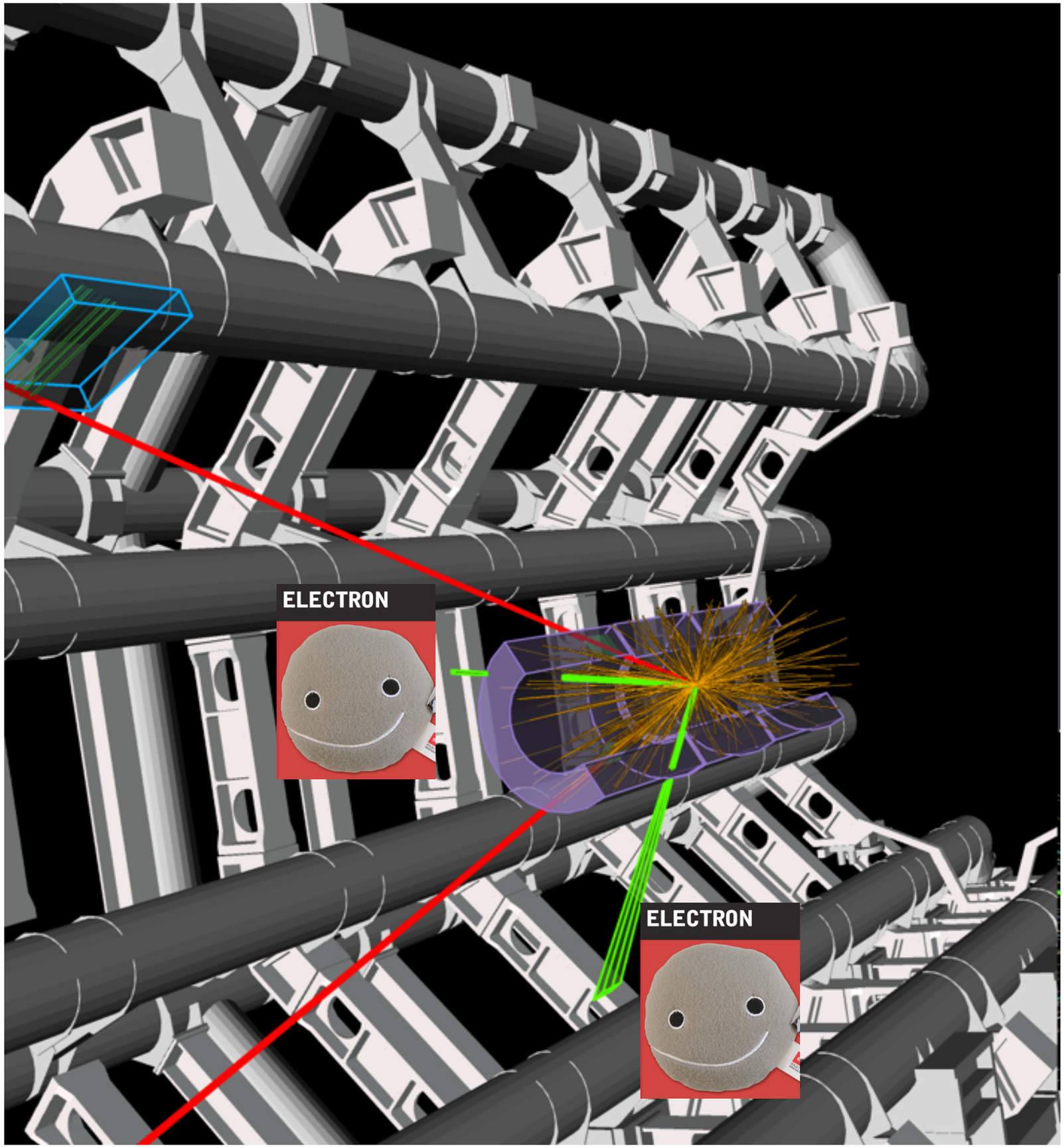
$p_T(\mu^-) = 27$ GeV $\eta(\mu^-) = 0.7$
$p_T(\mu^+) = 45$ GeV $\eta(\mu^+) = 2.2$
$M_{\mu\mu} = 87$ GeV

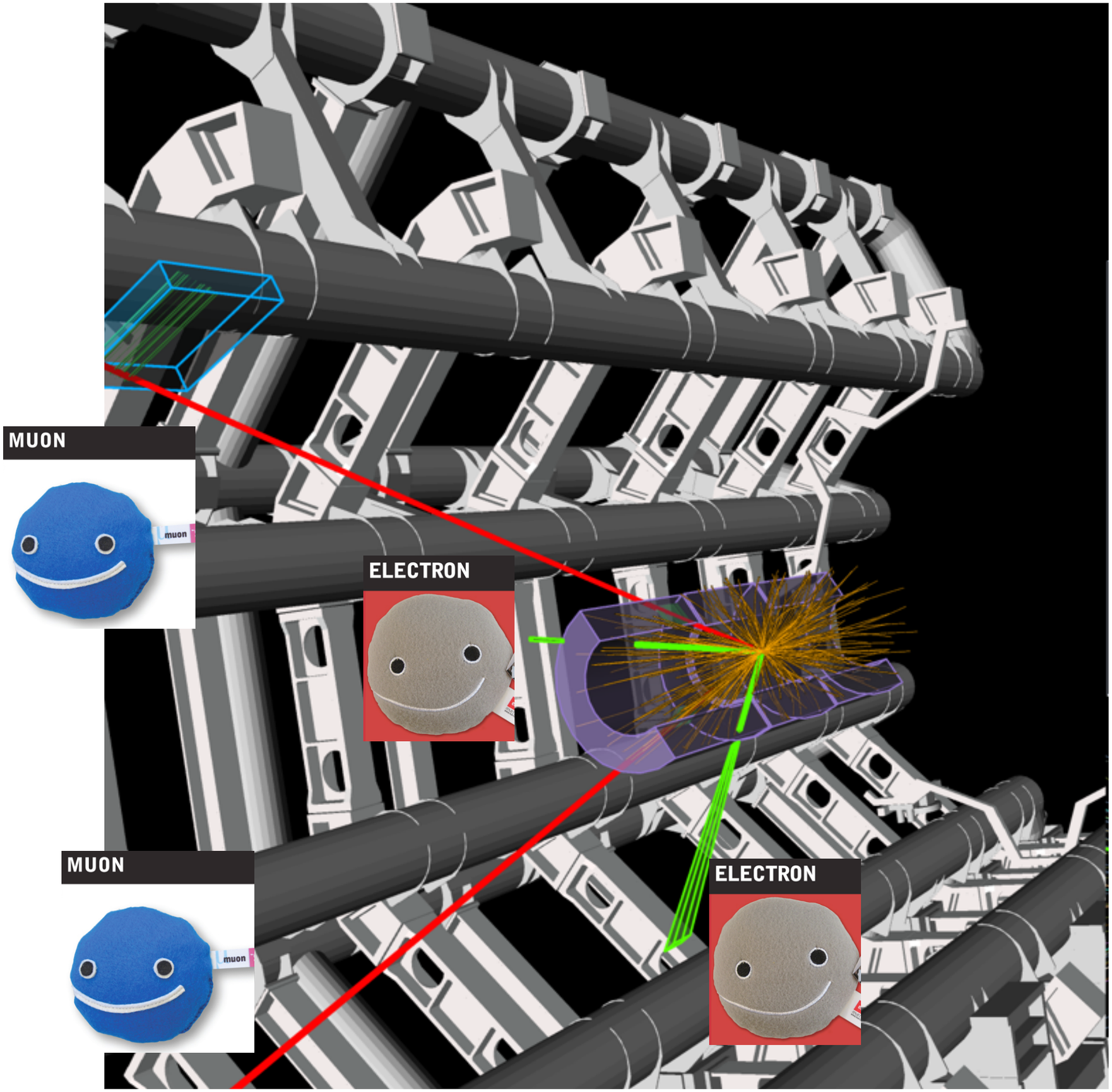
Z→μμ candidate
in 7 TeV collisions



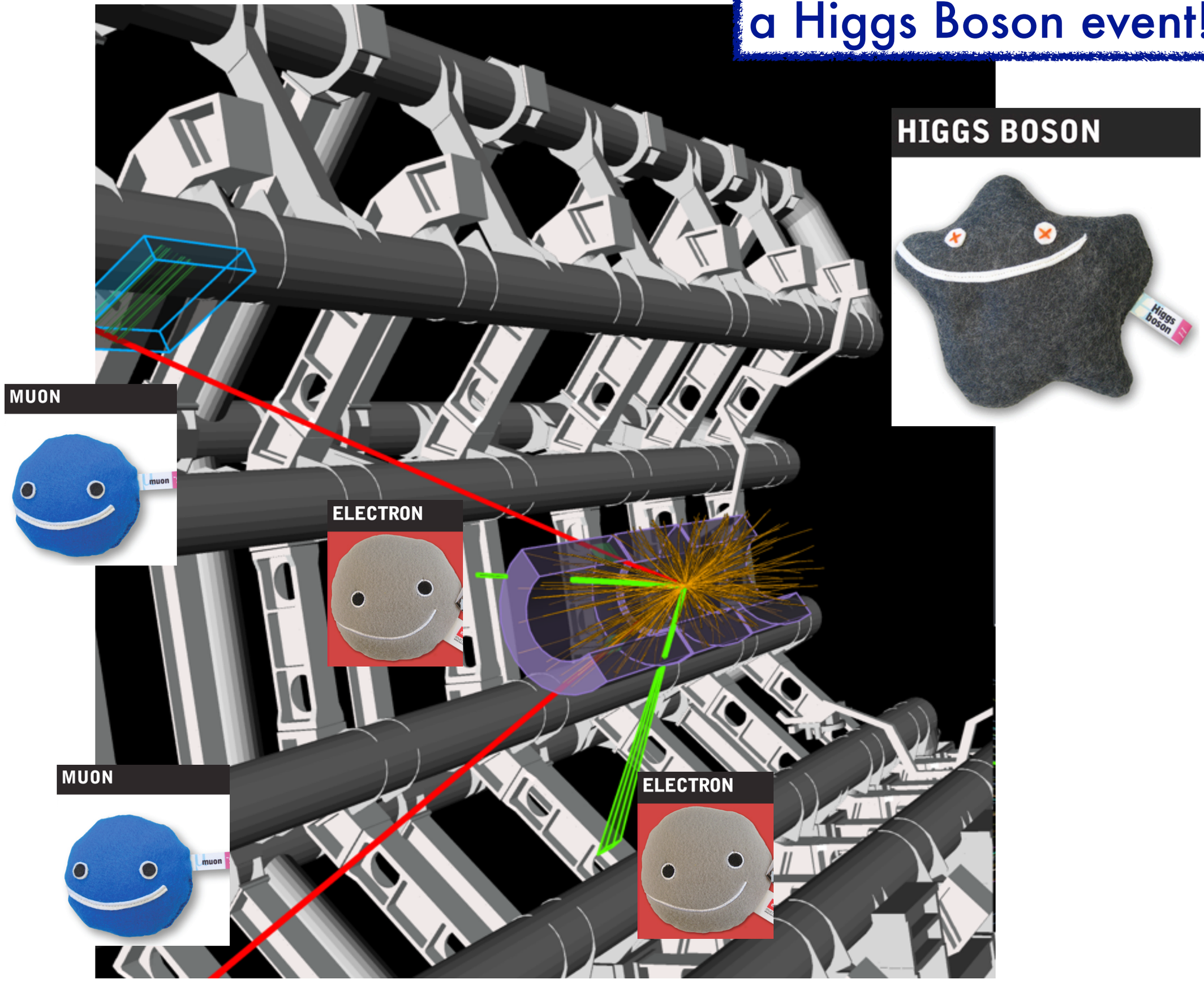
the Z boson,
decaying to 2 muons

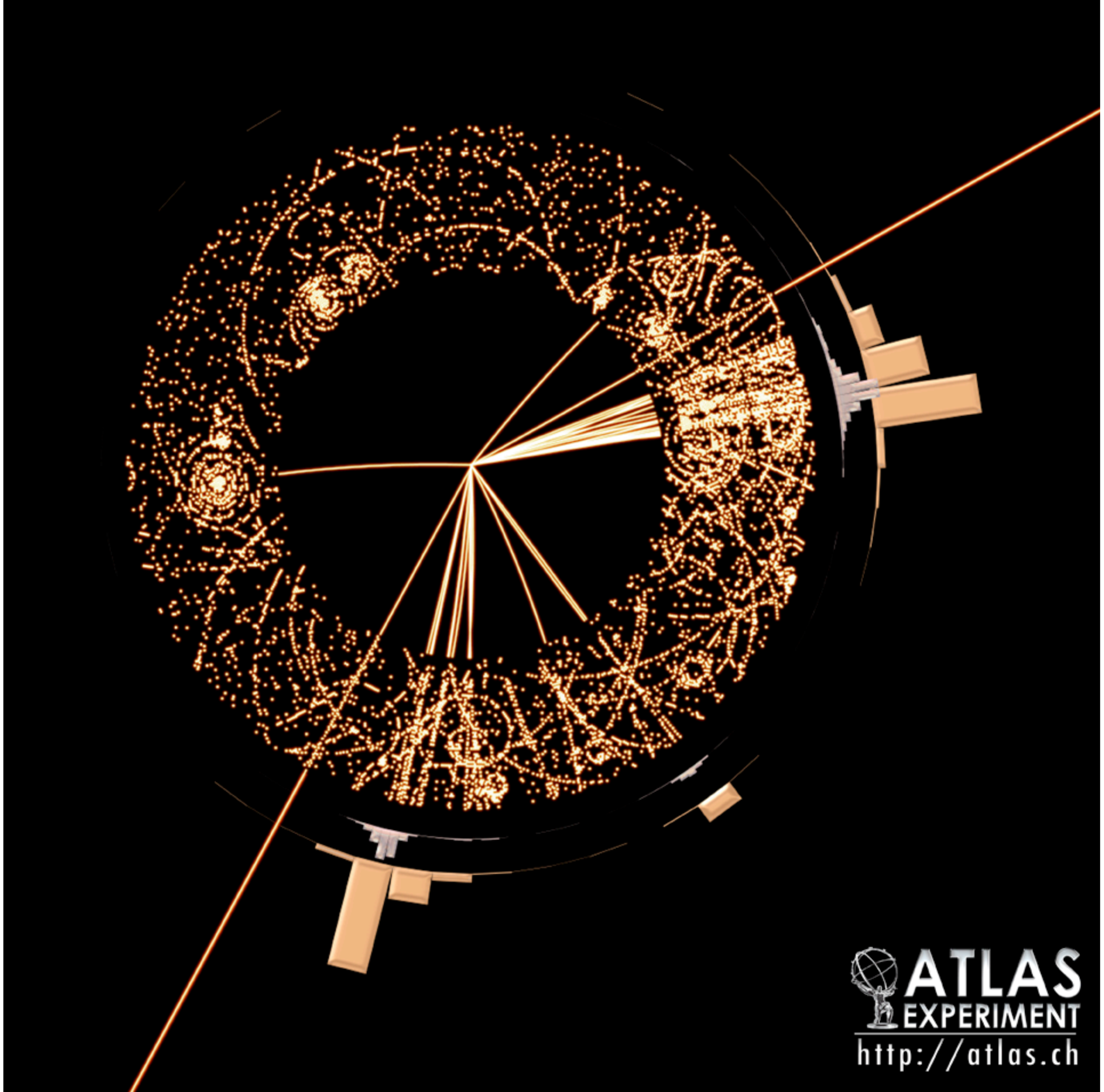



ELECTRON
ELECTRON


MUON
muon
ELECTRON
MUON
muon
ELECTRON

a Higgs Boson event!




ATLAS
EXPERIMENT
http://atlas.ch

?

MUON

MUON

ATLAS EXPERIMENT

http://atlas.ch

DARK MATTER

MUON

MUON

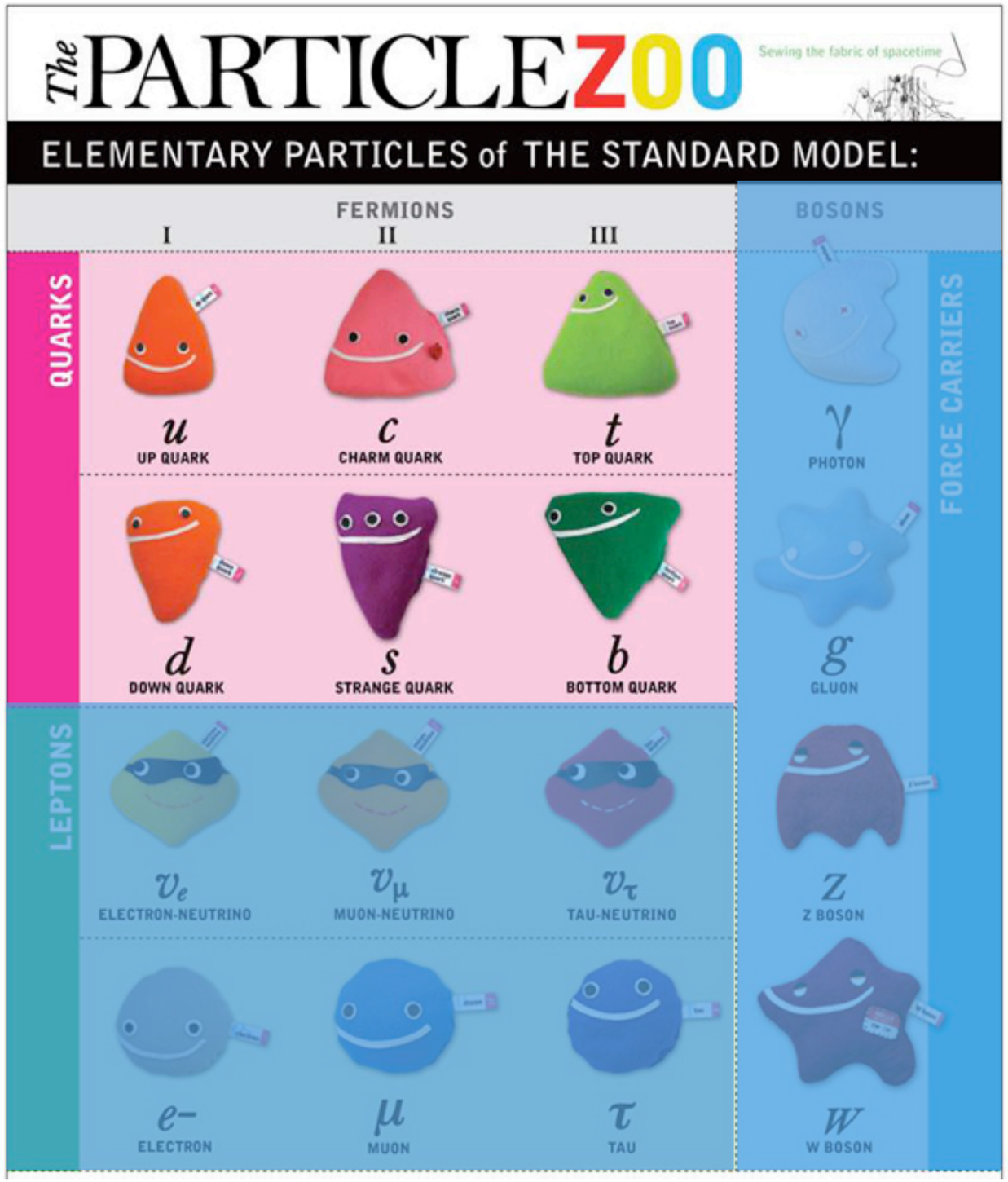
a *simulated* Supersymmetry event… we haven't seen this yet!

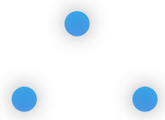
ATLAS EXPERIMENT
http://atlas.ch

The PARTICLE ZOO

Sewing the fabric of spacetime

ELEMENTARY PARTICLES of THE STANDARD MODEL:



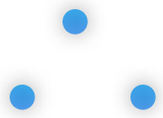


up, down, strange: *very light*

up, down, strange: *very light*

$m_{\text{bottom}} \sim 5$

$m_{\text{charm}} \sim 1.5$



up, down, strange: *very light*

$m_{\text{top}} \sim 175$

$m_{\text{bottom}} \sim 5$

$m_{\text{charm}} \sim 1.5$

up, down, strange: *very light*

Why is the top quark so heavy?

$m_{\text{top}} \sim 175$

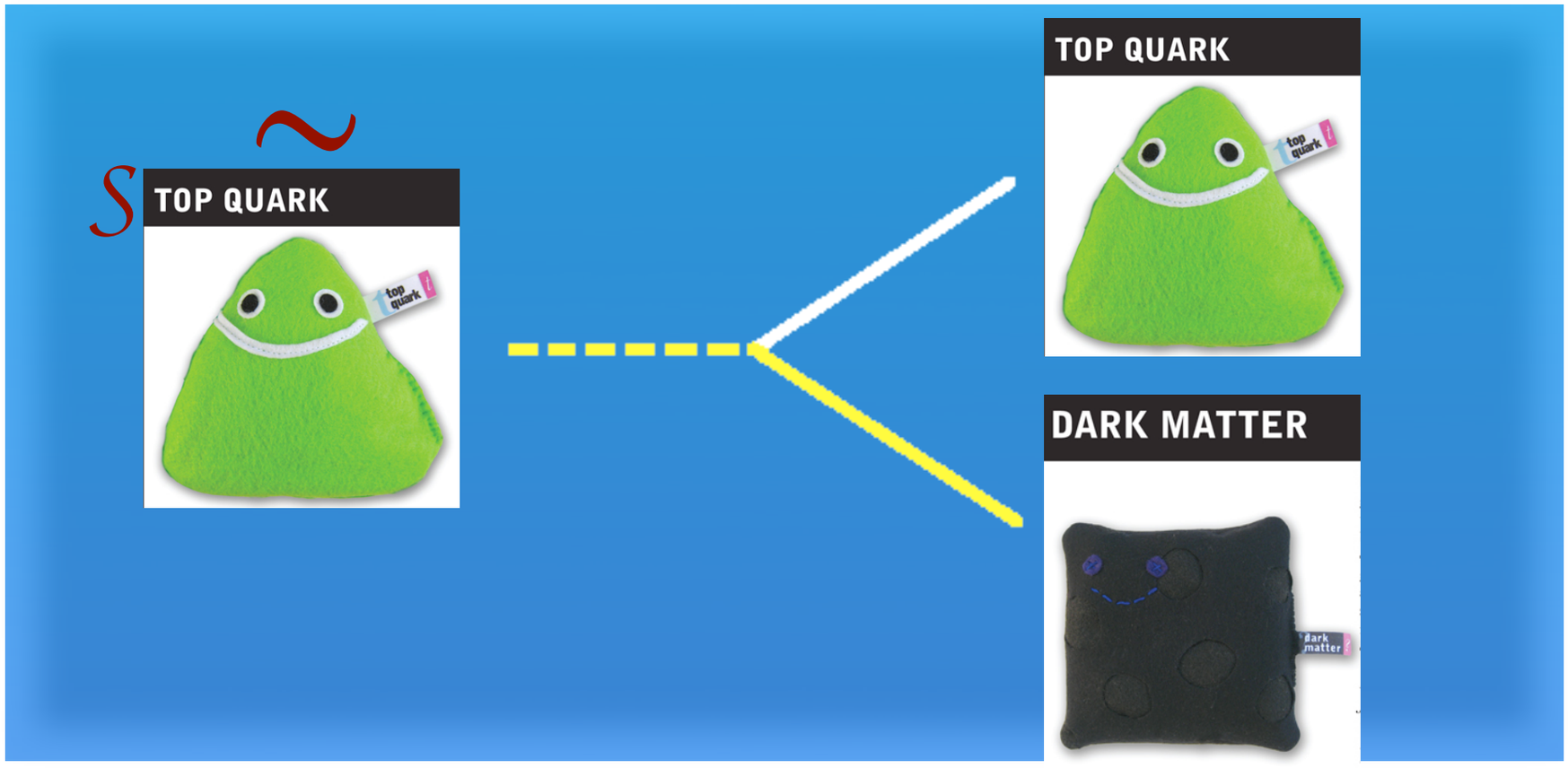
$m_{\text{bottom}} \sim 5$

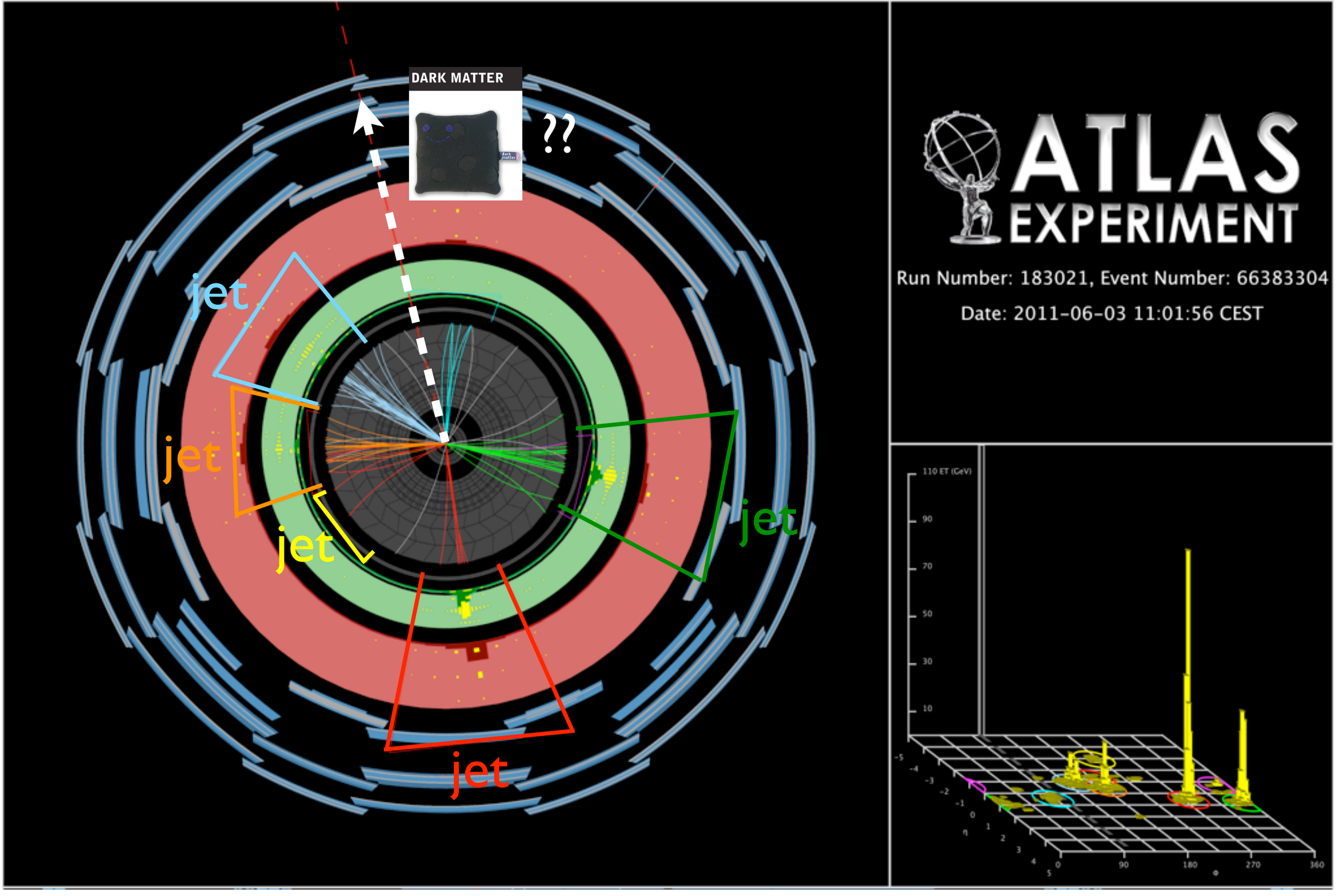
$m_{\text{charm}} \sim 1.5$

up, down, strange: *very light*

Can we look for its SUSY partner?

Can we look for its SUSY partner?


TOP QUARK
top quark
TOP QUARK
top quark
DARK MATTER
dark matter



A “candidate” SUSY event

Where's SUSY?

Une petite pause...

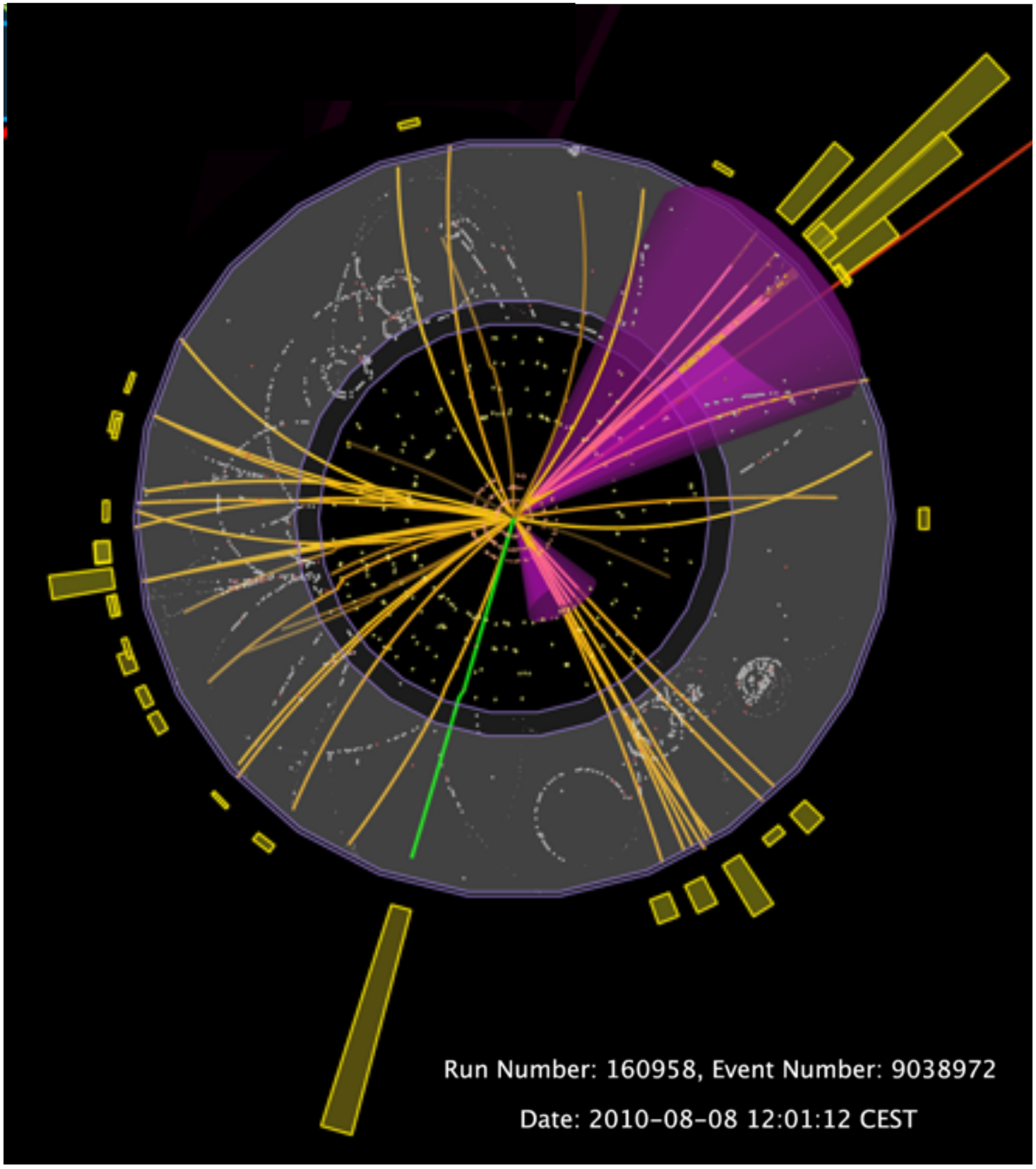
- We haven't found SUSY yet...
- The LHC is currently on break until 2015
- It will restart with higher energy, spruced up detectors, and refreshed collaborations
- ... is SUSY just around the corner?

➡ **stay tuned!**

http://atlas.ch

Additional ATLAS Events

http://atlas.ch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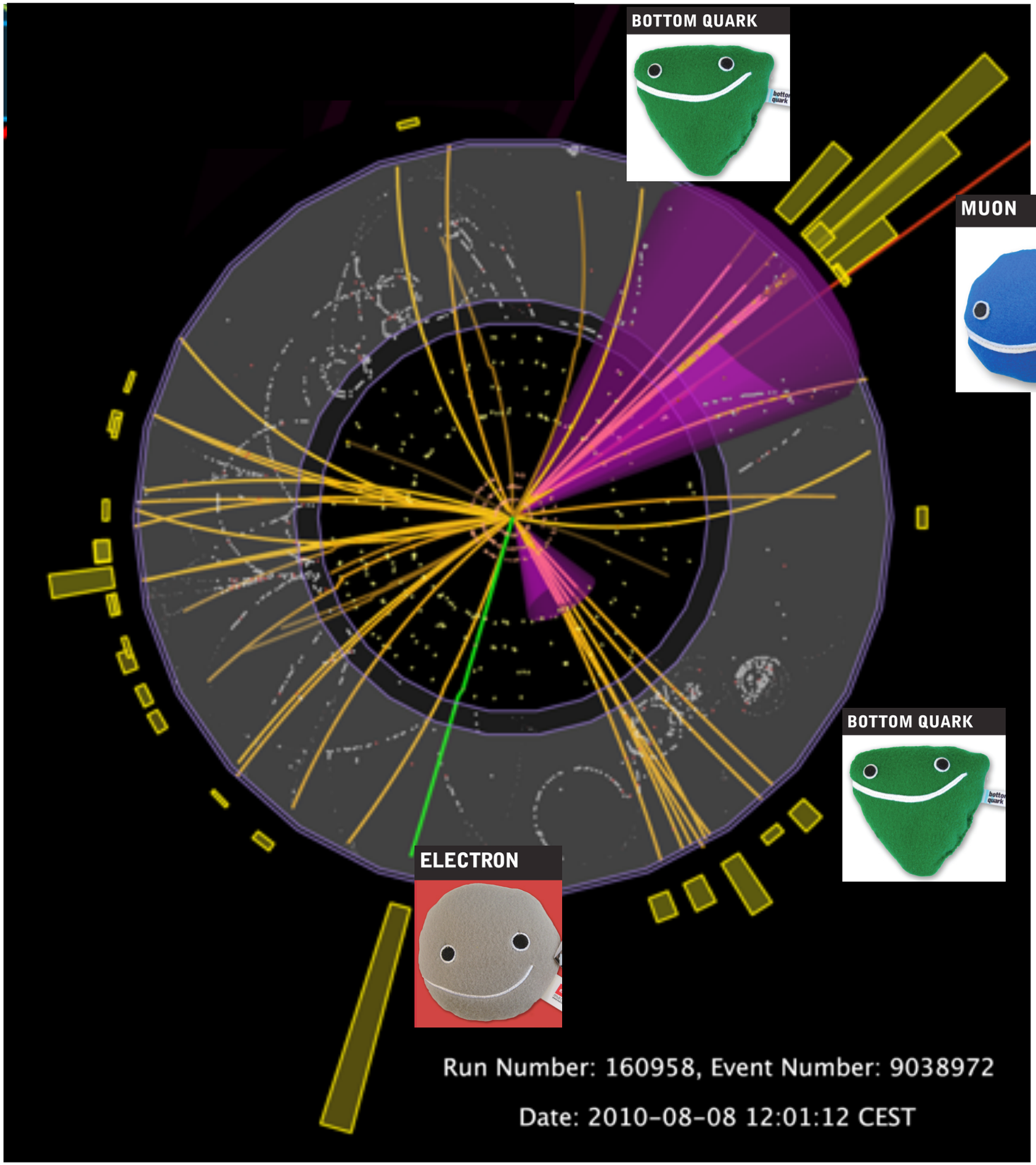
BOTTOM QUARK
MUON
ELECTRON
BOTTOM QUARK
Run Number: 160958, Event Number: 9038972
Date: 2010-08-08 12:01:12 CEST

a top quark decay