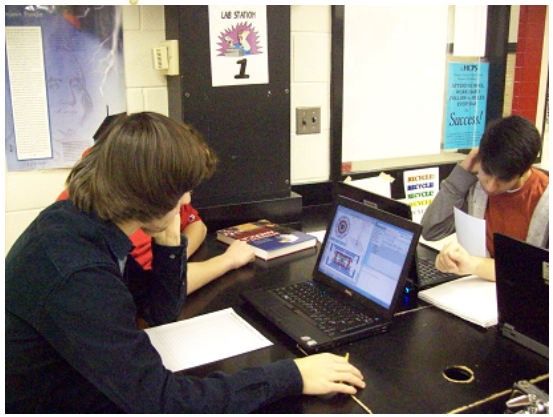
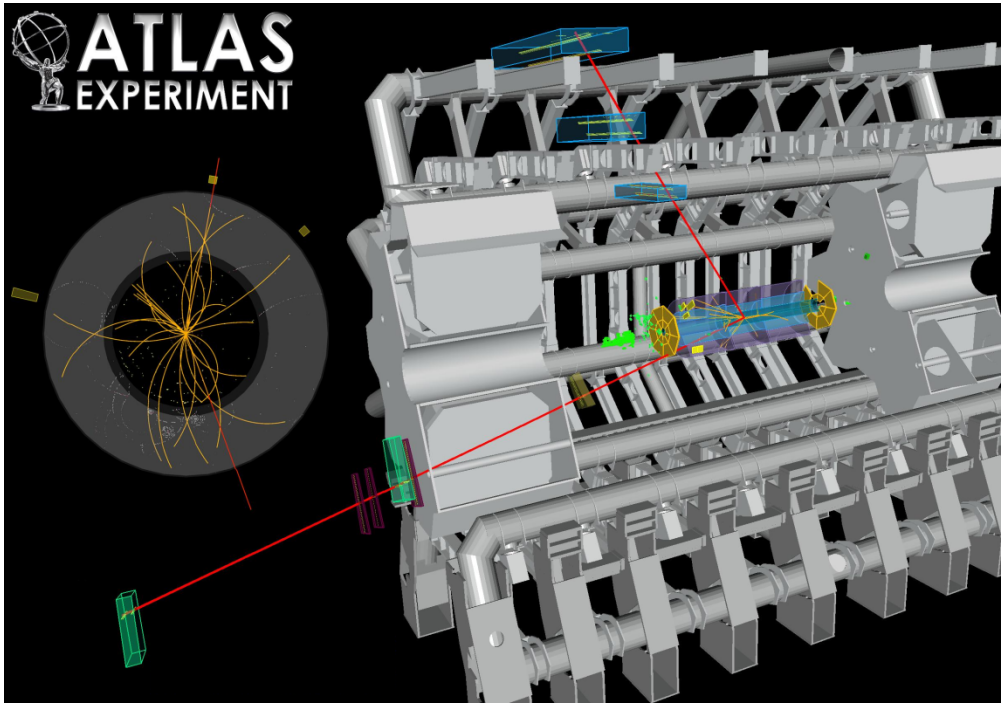
Helping Develop America's Technological Workforce

QuarkNet



ATLAS Data Express

INTERNATIONAL MASTERCLASSES
hands on particle physics



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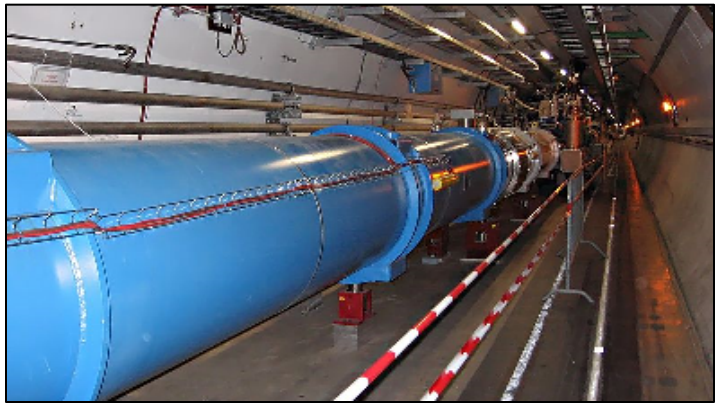
The LHC and New Physics

It's a time of exciting new discoveries in particle physics!

At CERN, the LHC and its experiments are underway.



The ATLAS detector has been taking data. The first job was to confirm how the detector data corresponds to our understanding we call the ***Standard Model****. Now the task is to look for new phenomena…and we are off to a great start*

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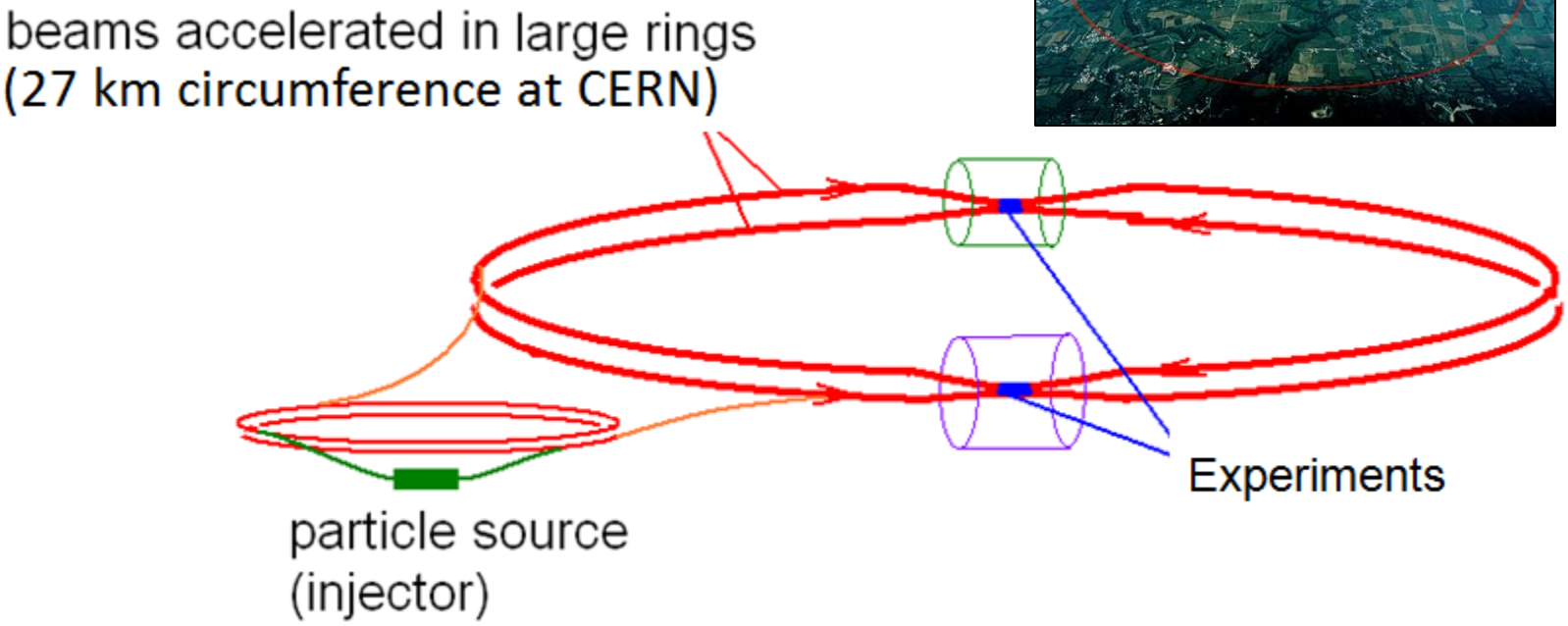
The LHC and New Physics

The LHC is buried ~100 m below the surface near the Swiss-French border.



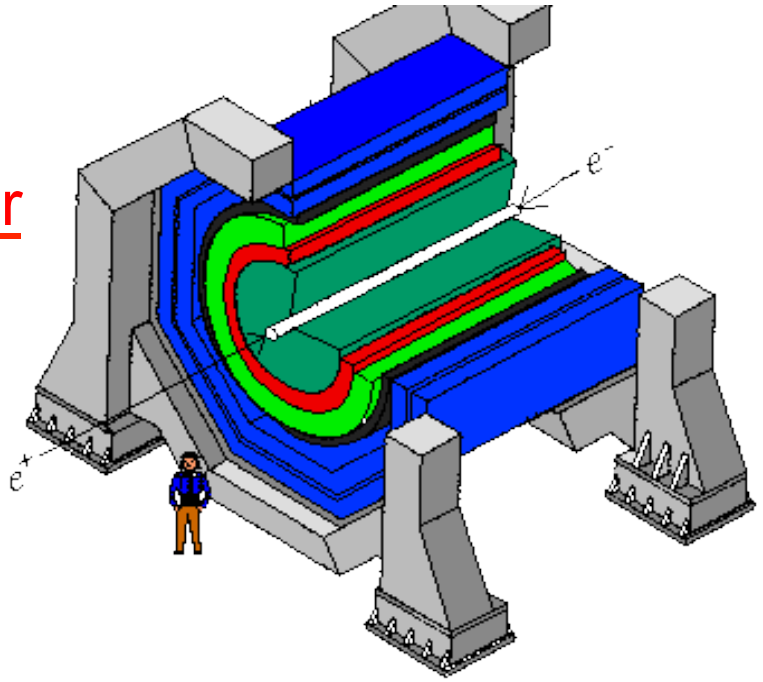
Detectors

Generic Design

Cylinders wrapped around the beam pipe

From inner to outer . . .

- Tracking
- Electromagnetic calorimeter
- Hadronic calorimeter
- Magnet*
- Muon chamber



**Location of magnet depends on specific detector design.*

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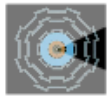
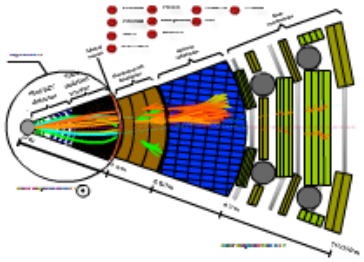
ATLAS Detector

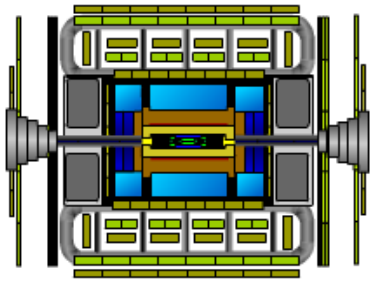
ATLAS

animation





End view



Side view

Created by Jeřábek, Jende 2010

Play with ATLAS online!

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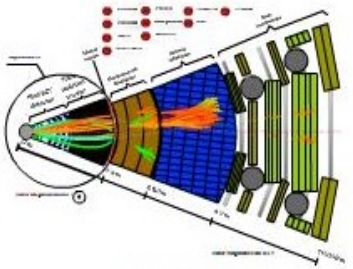
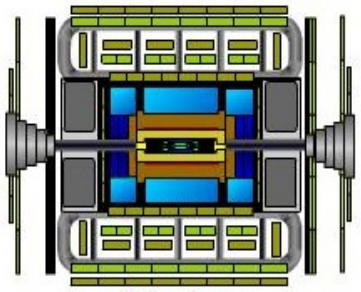
ATLAS Detector

ATLAS

animation



End view



Side view

Created by Jeřábek, Jende 2010

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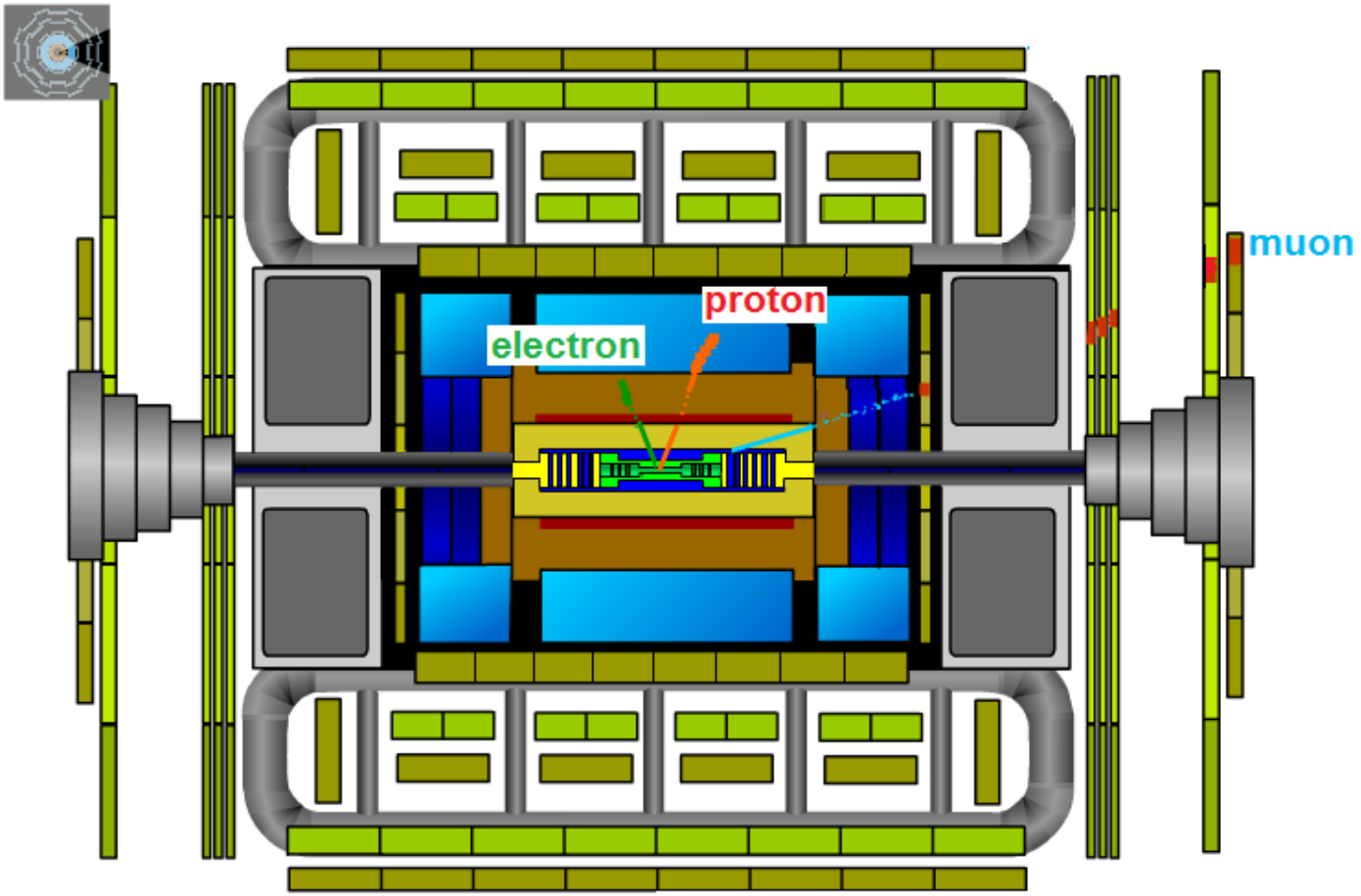
ATLAS Detector

ATLAS

animation



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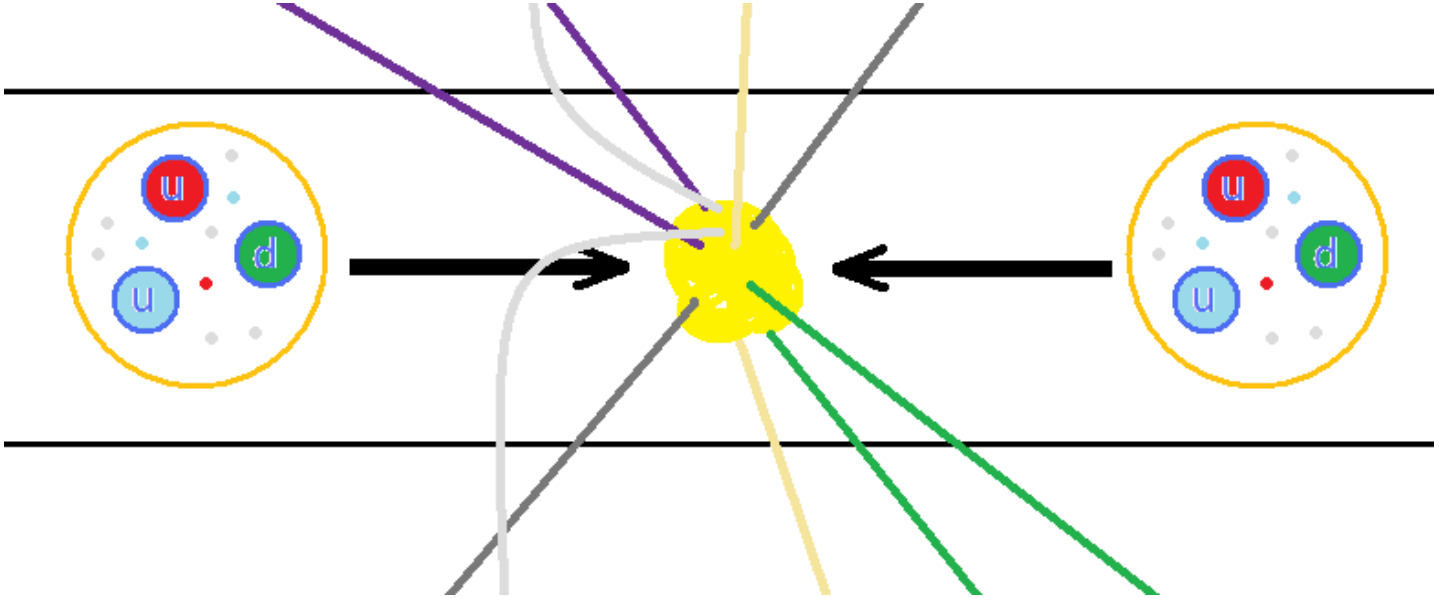
Proton Interactions

If each beam proton has energy 4 TeV....

- The total collision energy is 2 x 4 TeV = 8 TeV.
- But each particle inside a proton shares only a portion.
- So a newly created particle's mass ***must be*** smaller than the total energy.



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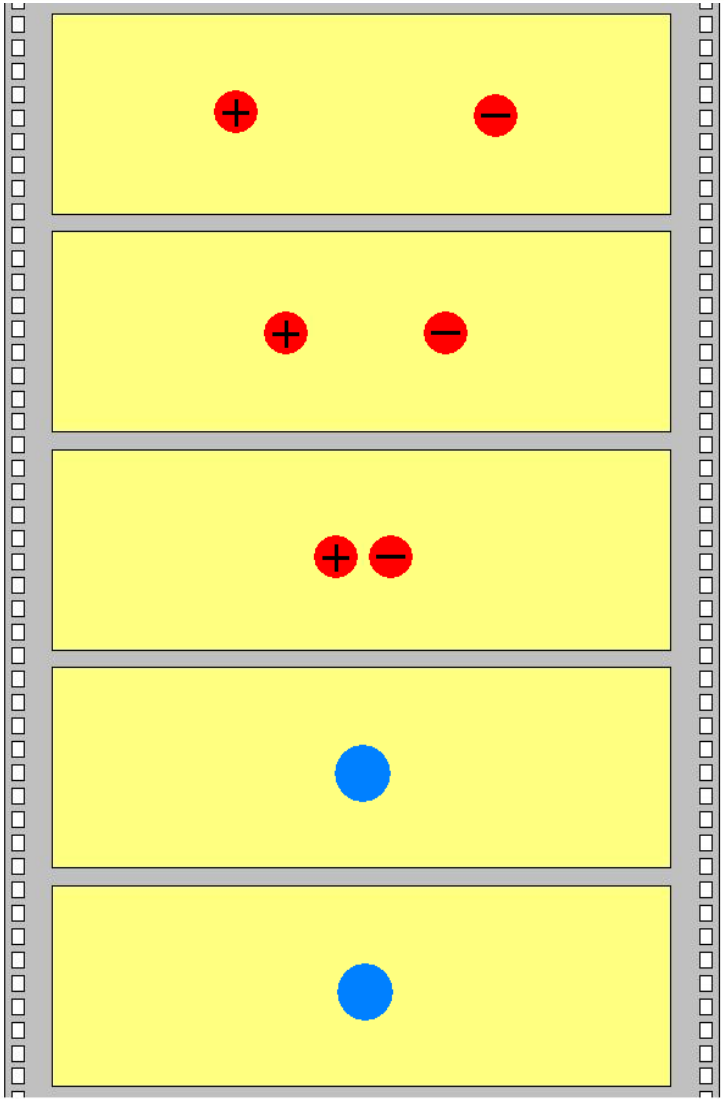
Particle Decays

The collisions create new particles that promptly decay. Decaying particles *always* produce lighter particles.

Conservation laws allow us to see patterns in the decays.

Can you name some of these conservation laws?



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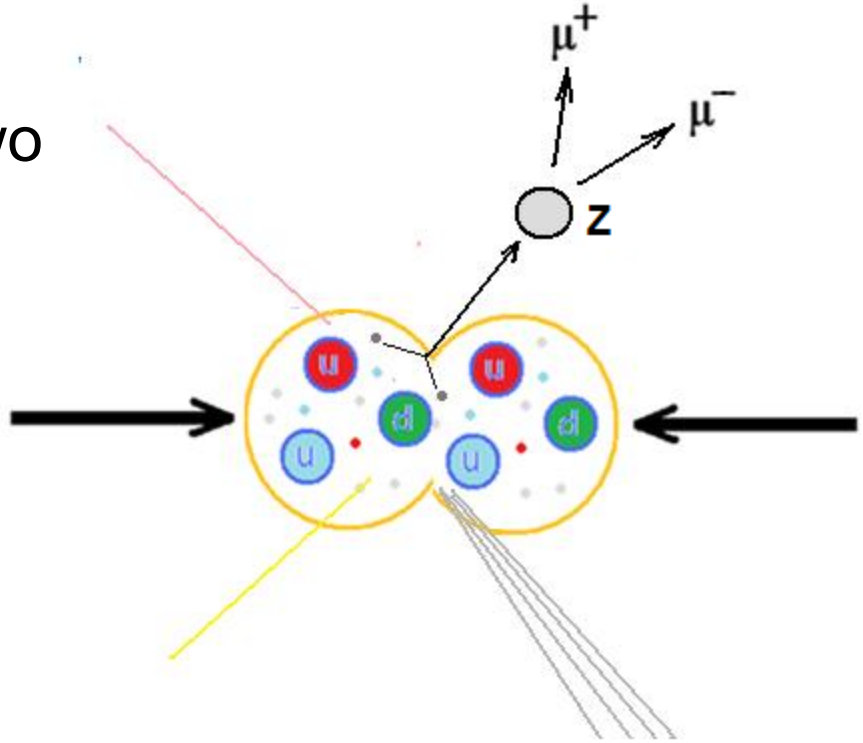
Particle Decays

We are looking for the Z boson, a particle with no charge that decays into two muons or two electrons.*

What do we know about the charges of the muons or electrons? What is the charge of the Z?



*The Z has other decays . . . but these are not what we are looking for.

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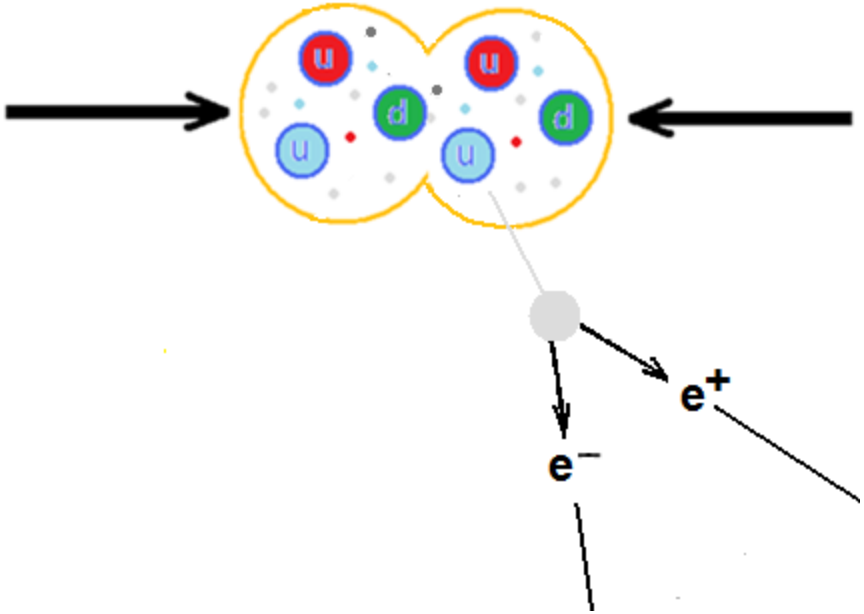
Particle Decays

If we cut out all tracks below, say, 5 GeV momentum, the picture is clearer.

Today, we will filter many events to find Z→e e and Z→μ μ signals and use momentum information from these to find the mass of the Z boson.



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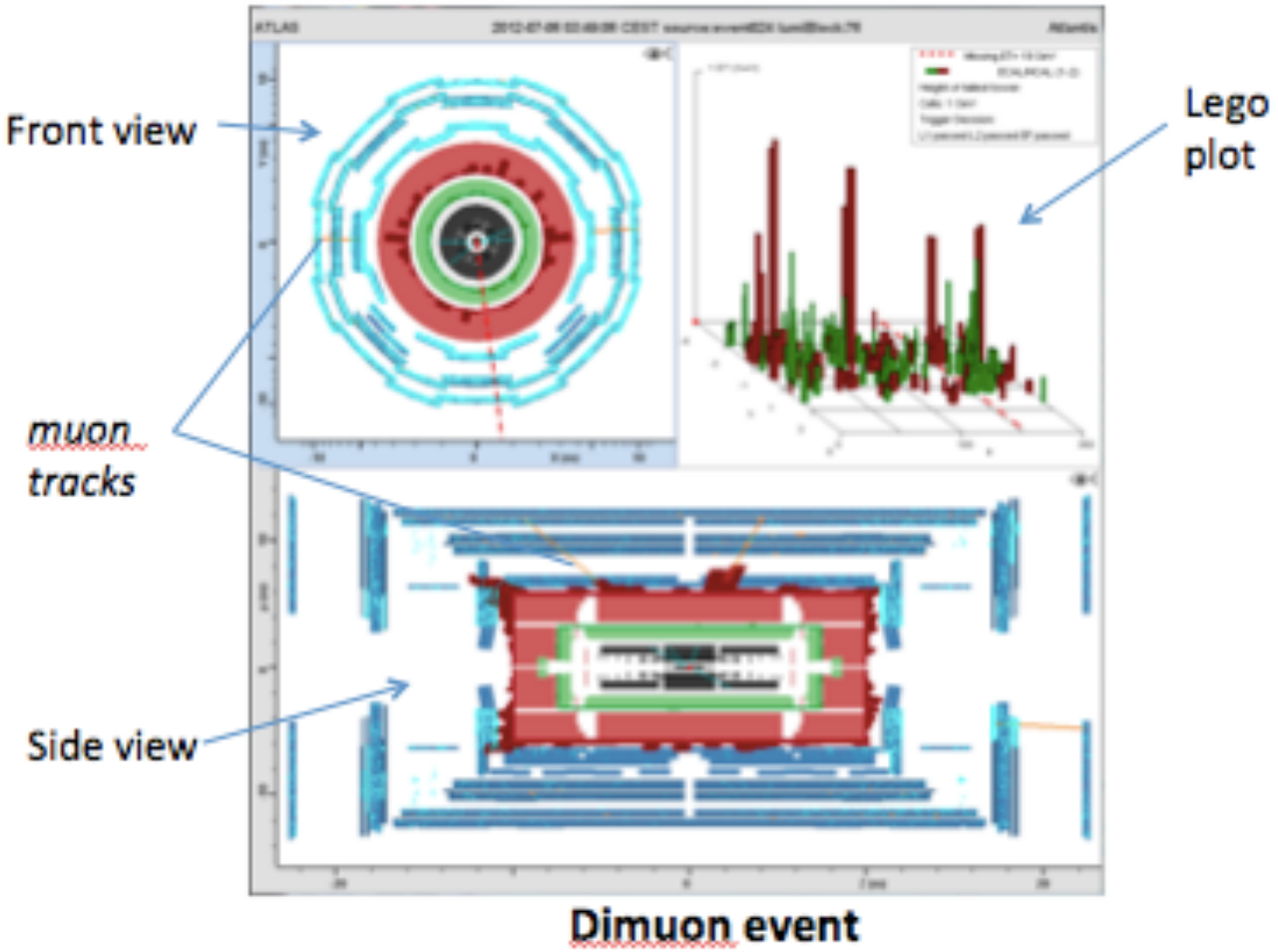
ATLANTIS Event Display



Dimuon event

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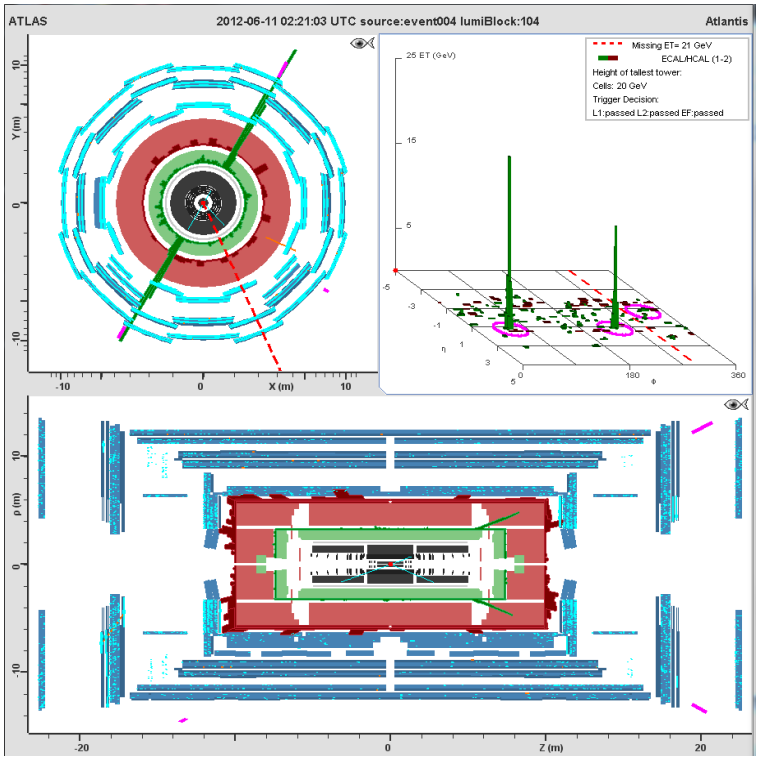
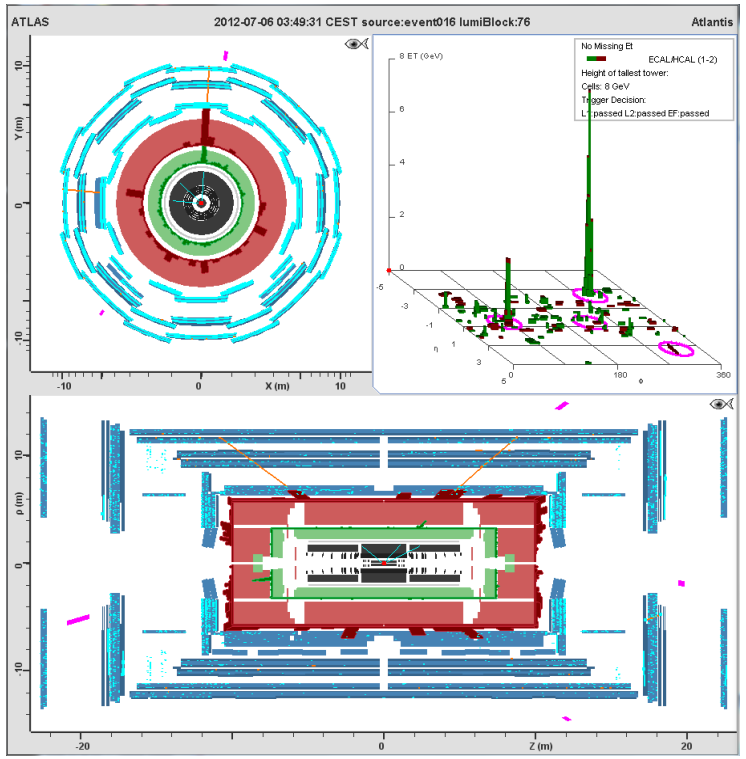
HYPATIA Event Display





How are these events similar? Different? Why?

Let's Analyze Events!

Make teams of two; each analyzes 20 events.

Find good dimuon candidates.

Record the mass of each one. We will count these to make a *mass plot*.

What else can we do with this data?