UNIVERSITY OF CALIFORNIA
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CMS at the LHC: The TeV Frontier

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The LHC

What is CMS?

Compact

- As small as possible to keep costs down

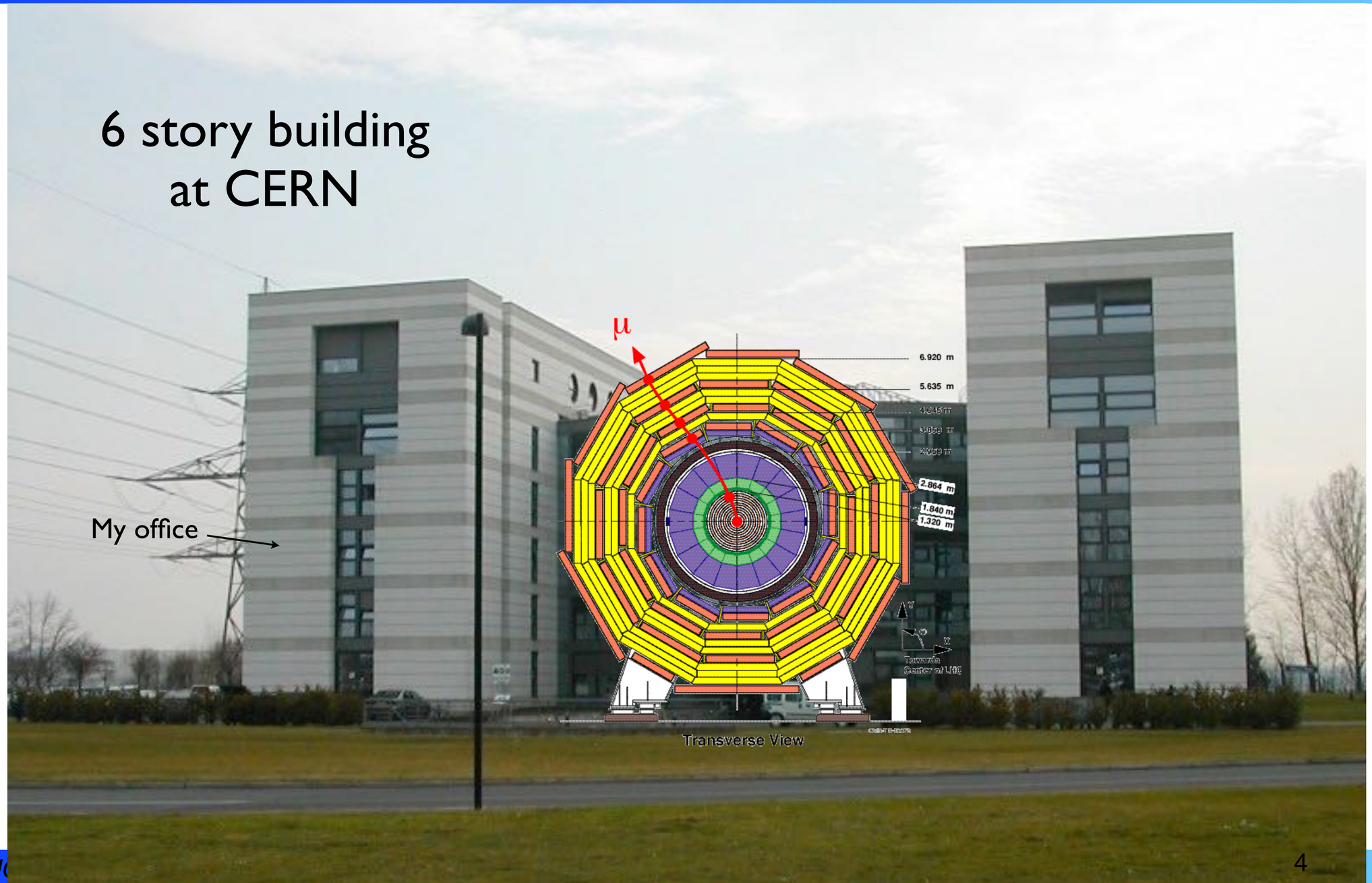
Muon

- Muons are an excellent probe for new physics
  - Used in the discovery of (among many others):
    - J/ψ, ϒ, W, Z, top quark, Higgs

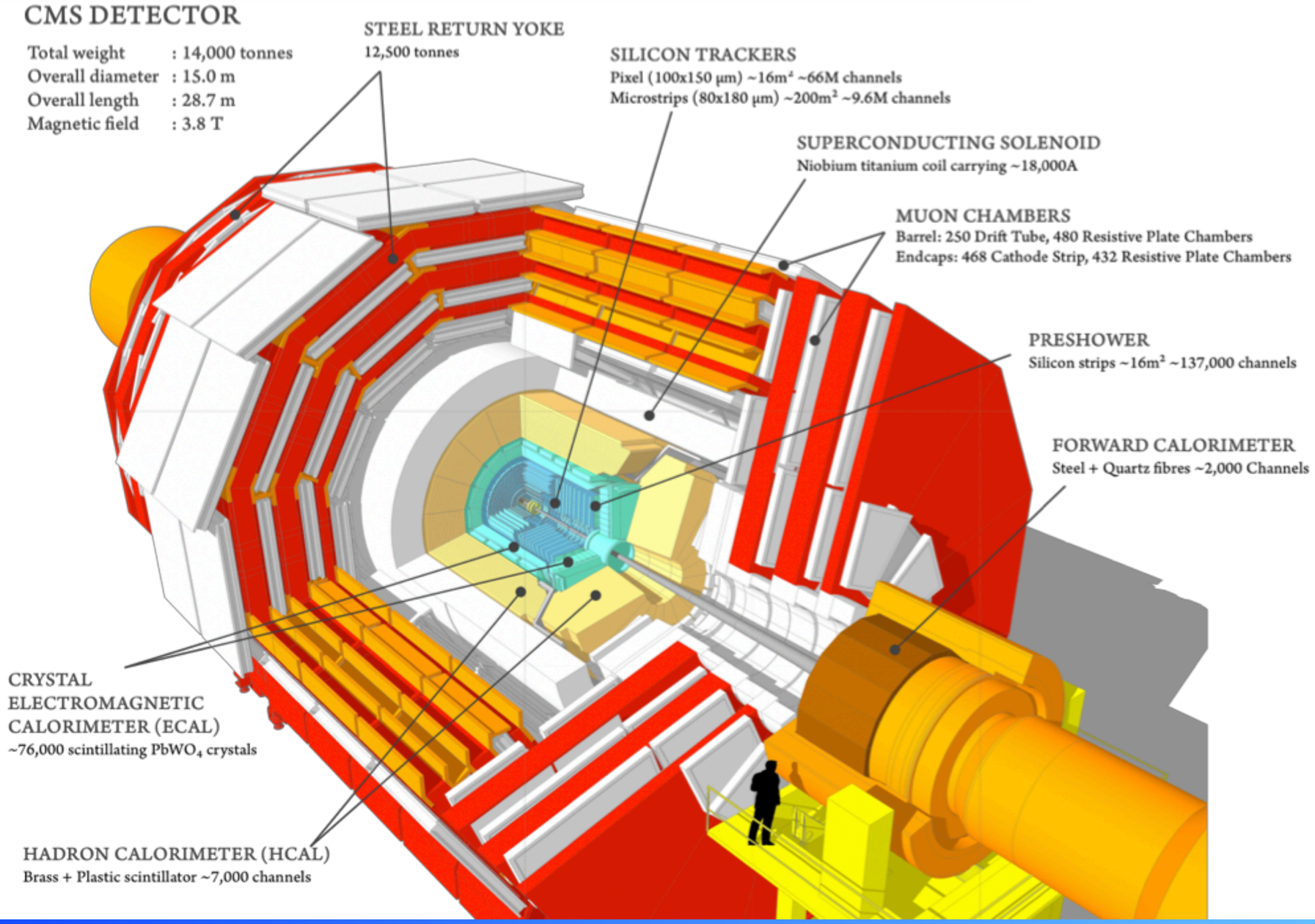
Solenoid

- Need a magnet to analyze the momentum of charged particles
- Most experiments have a central solenoid
- The CMS solenoid is one of the major elements of the overall detector design

Compact, but not small!



“Exploded” view of CMS



Physics Goals of CMS and the LHC

To look for:

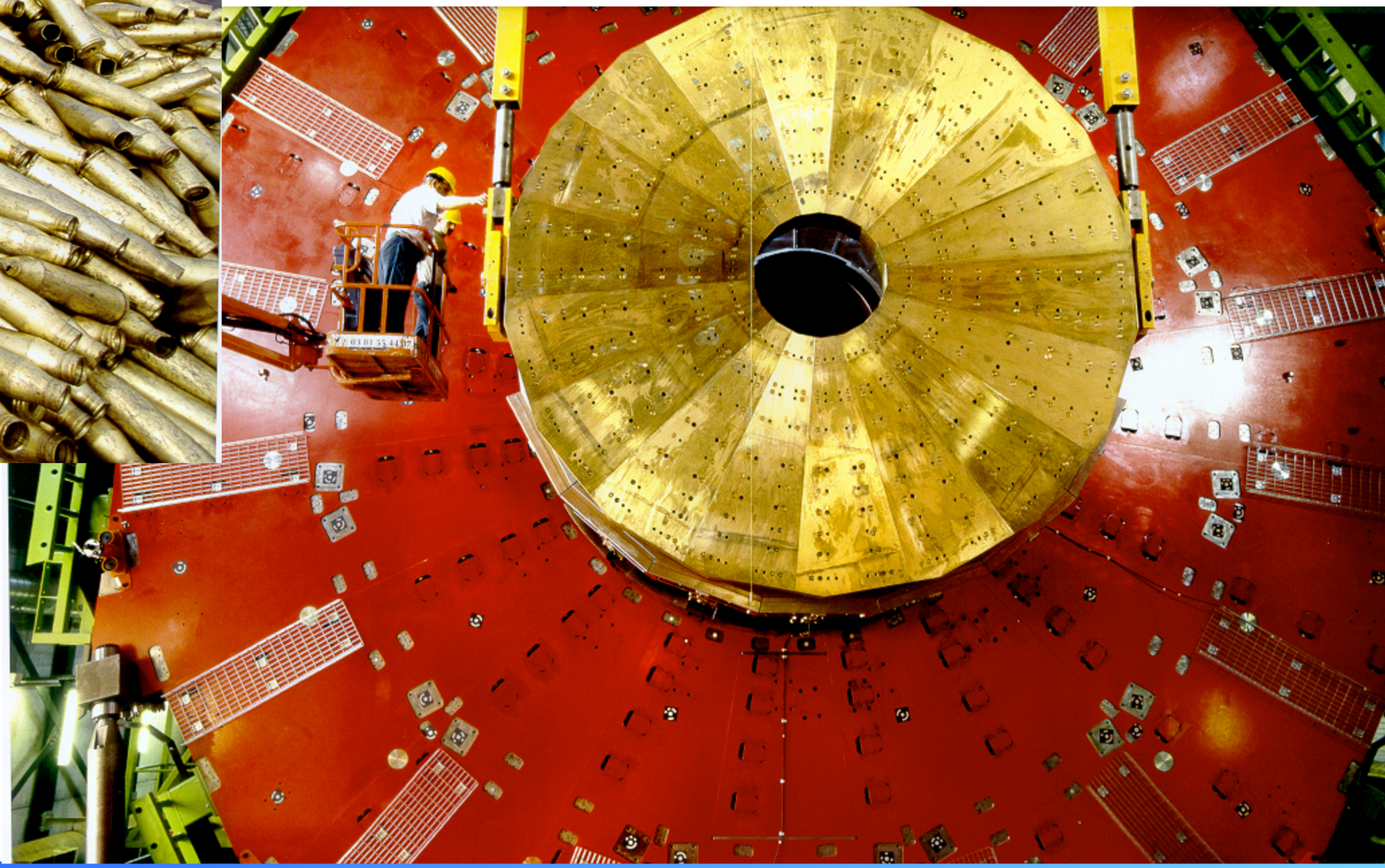
- New particles, such as supersymmetric particles (a lot of theorists like them), gravitons (quantum gravity), mini black holes (more gravity?), or, even more exciting, completely unexpected ones

To understand:

- why the world is the way it is
- why some particles weigh more than others (top is 350,000 times more massive than an electron)
- what is dark matter (quarks & leptons are only 4% of the universe!)
- are there more dimensions of space (we know of 4: *x*, *y*, *z*, *t*)
- the properties of the hot, dense plasma that existed in the early universe

The Solenoid

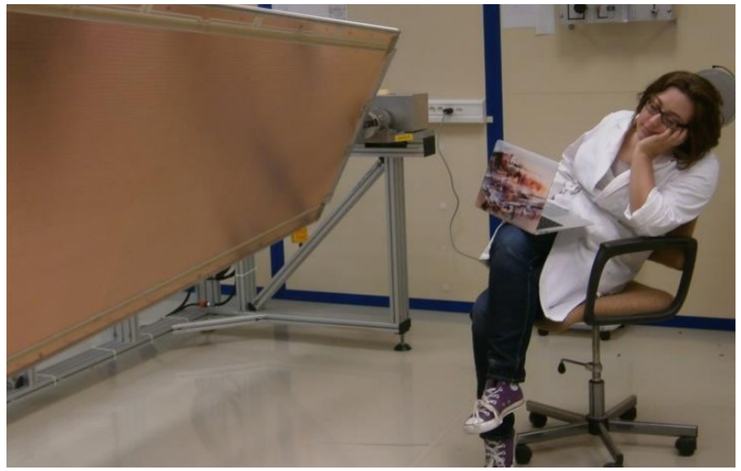
The HCAL

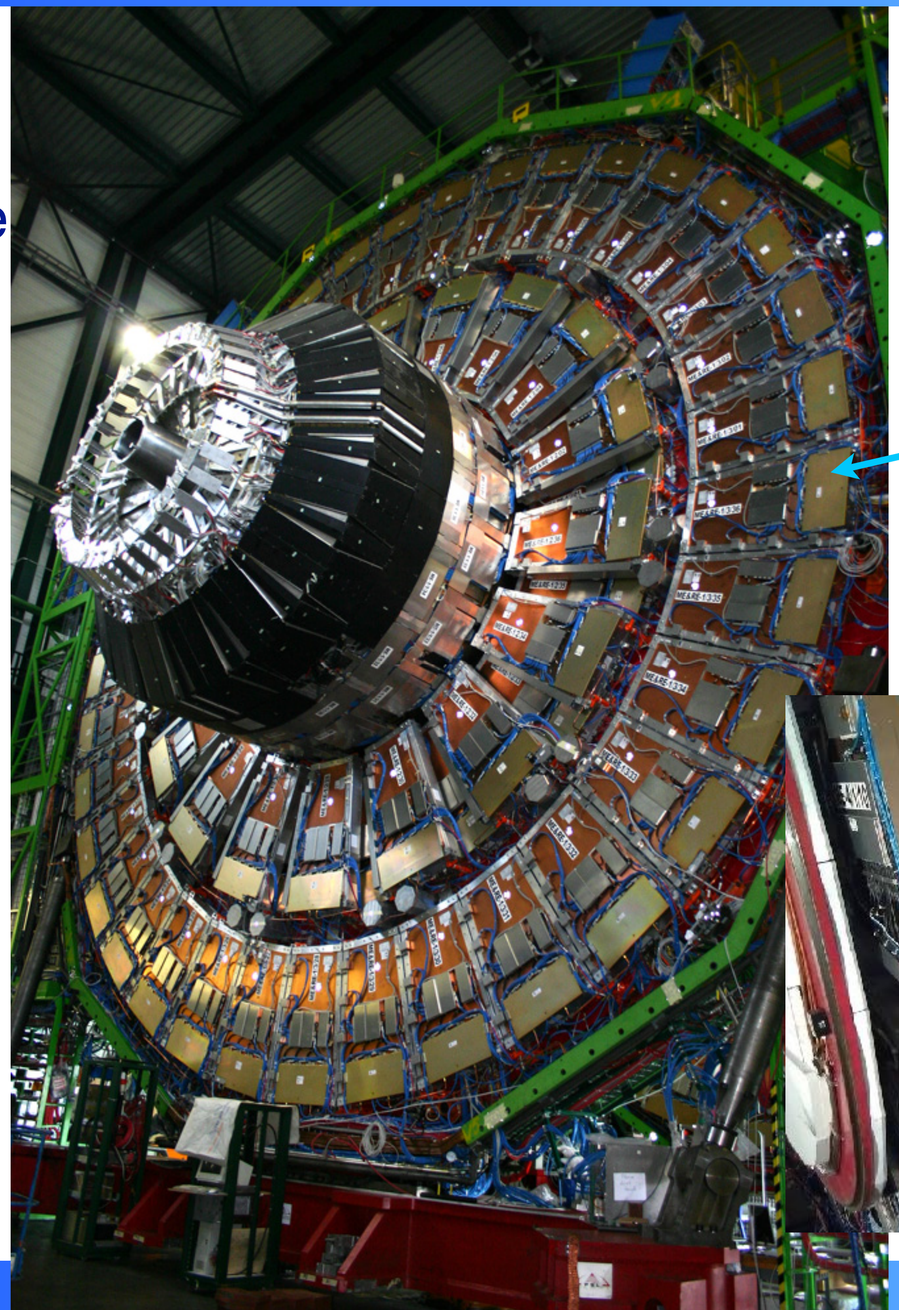


The Muon System

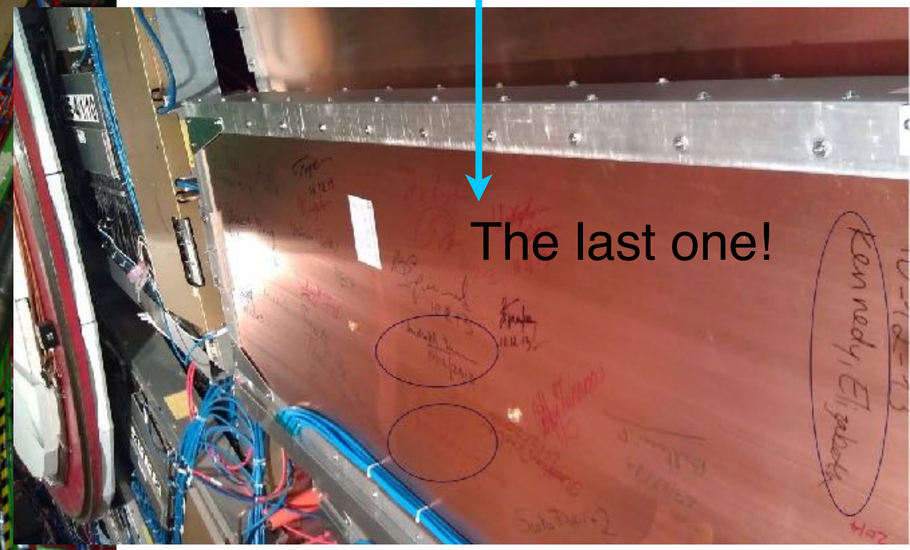
Cathode strip chambers in the endcaps

UCR helped design and build the chambers





Cathode strip chamber

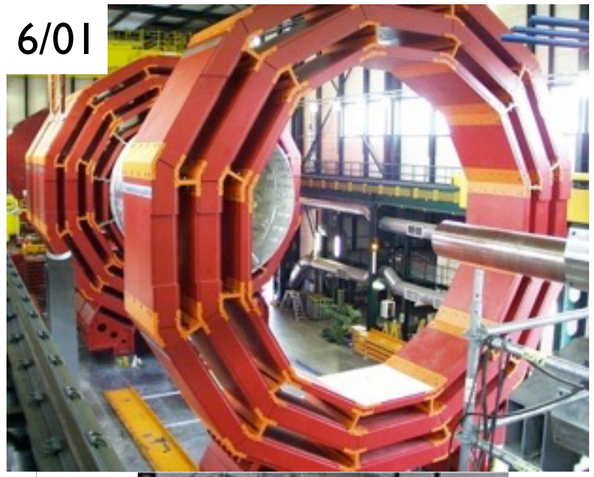


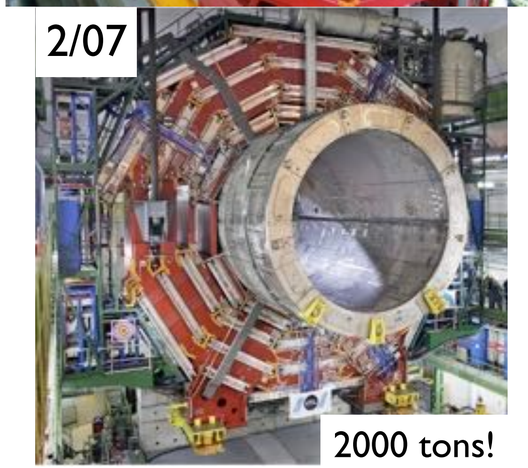
Overview

The design of CMS started in 1992!

Major construction and assembly started in 2000.

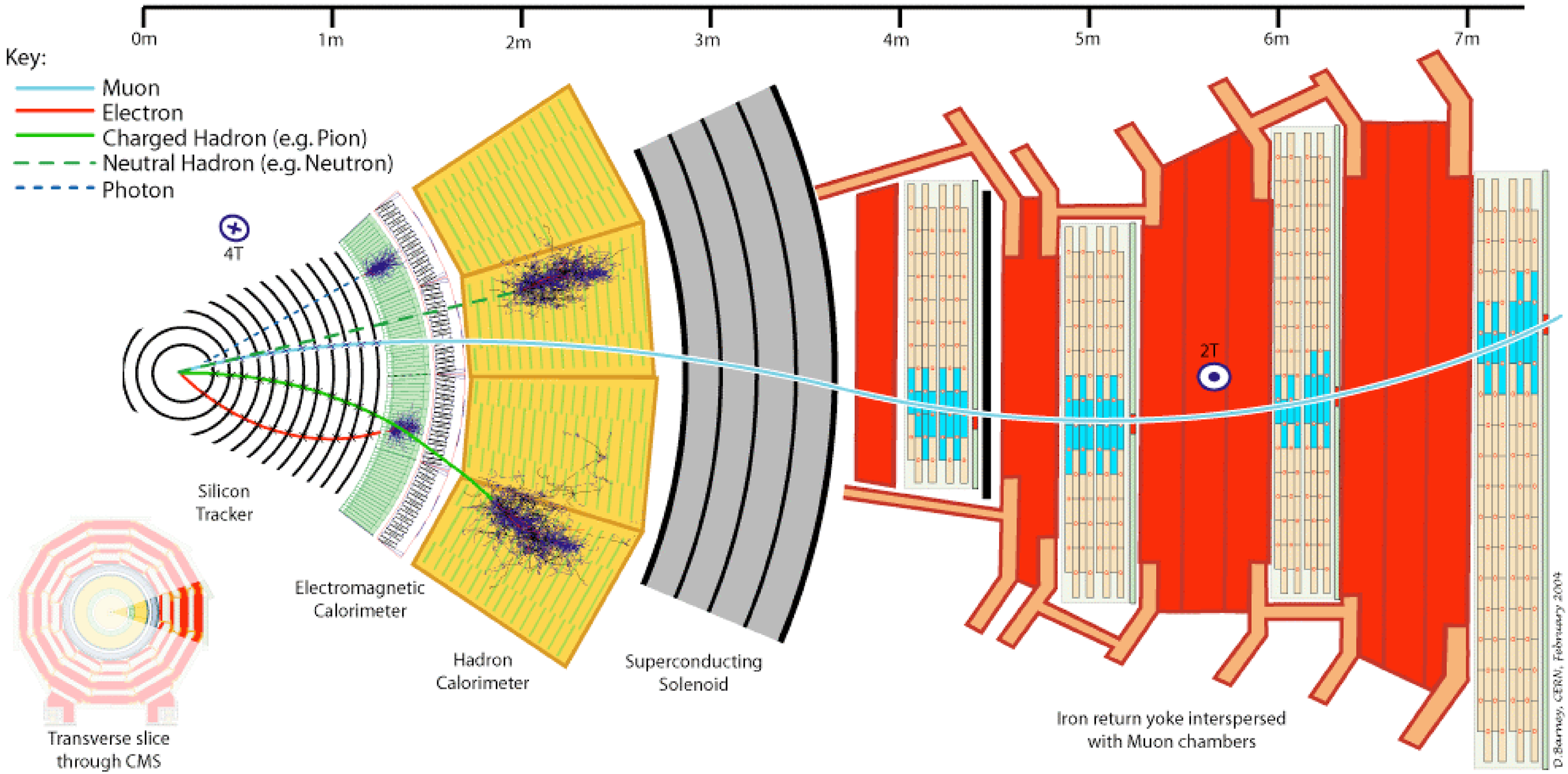
Lowering into the cavern started in 2006, and took 2 years.



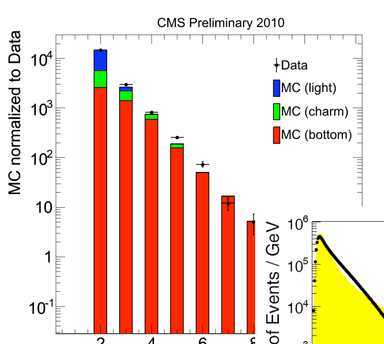


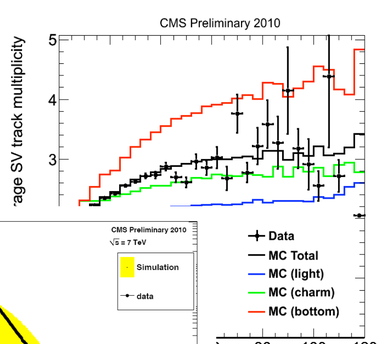
Closed and ready for beam!

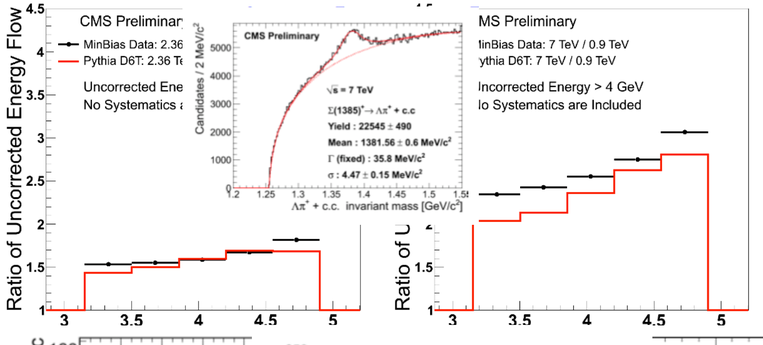
What do particles do in CMS?

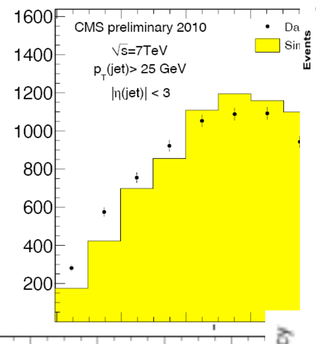


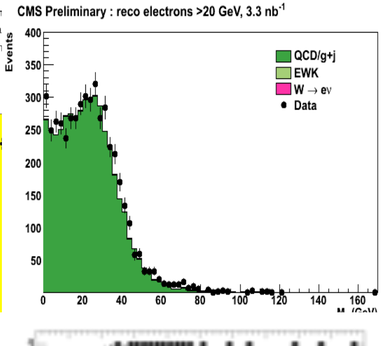
Some results — from over 600 papers

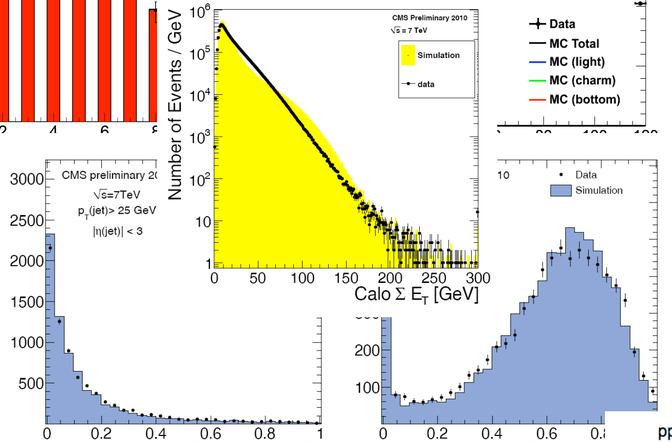


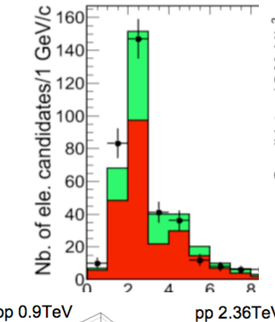


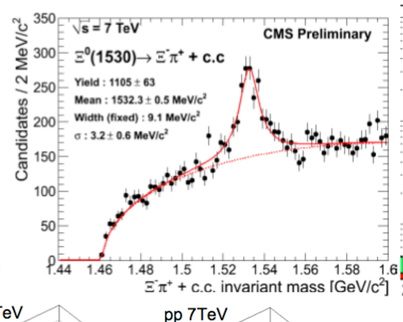


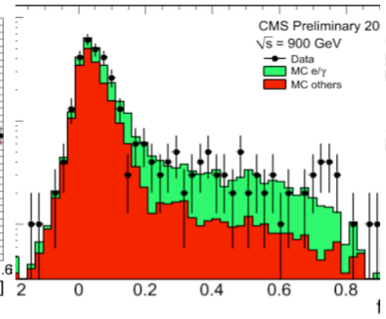


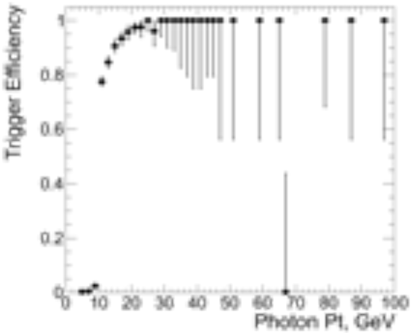


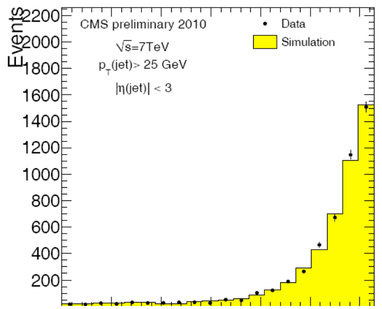


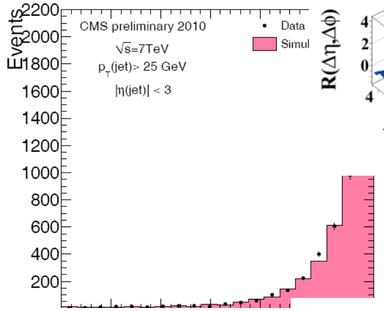


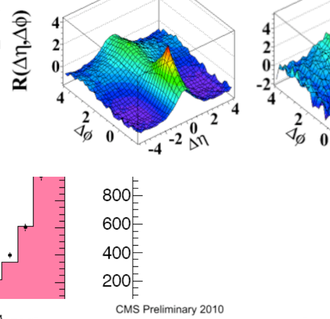


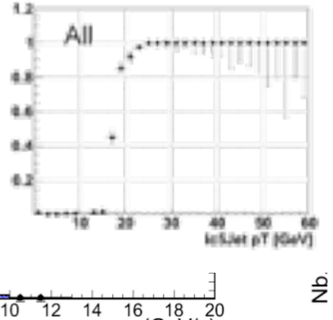


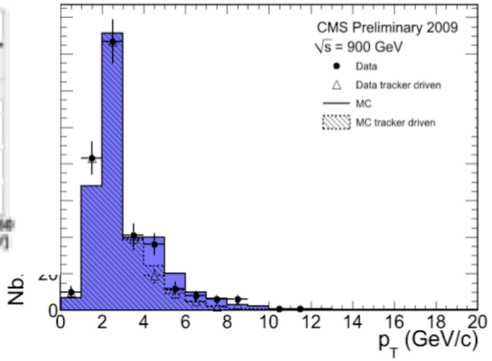


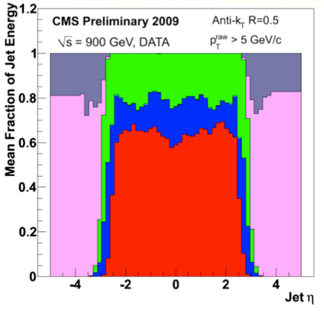


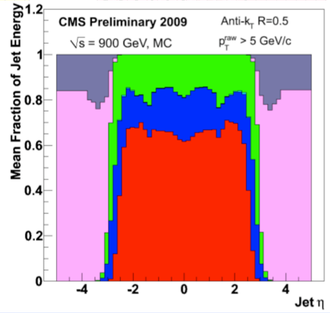


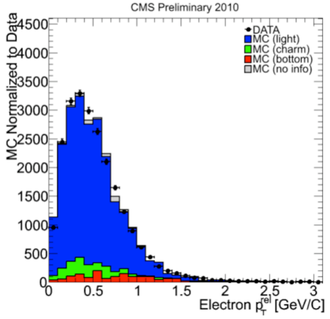


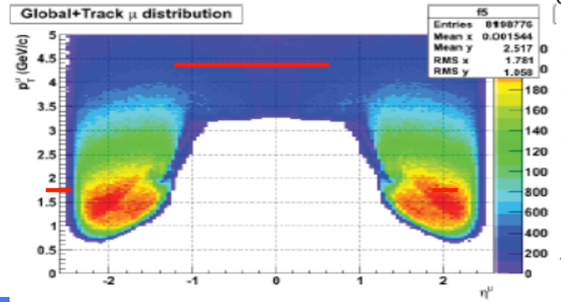


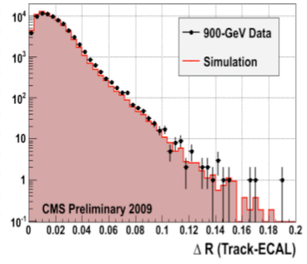


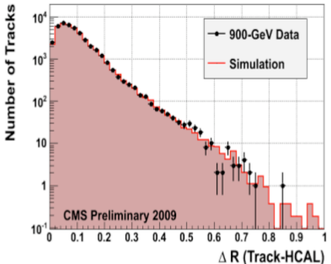




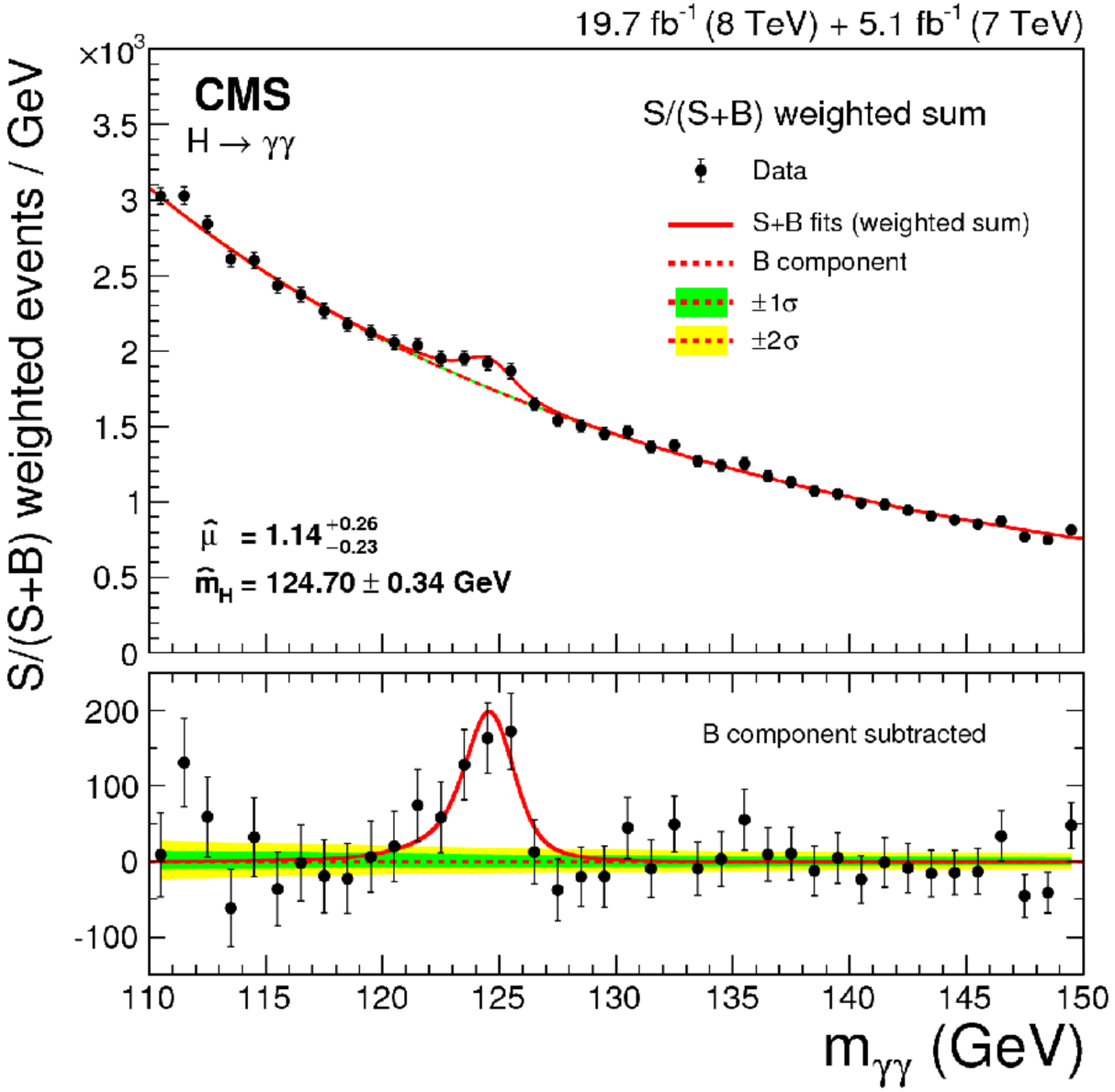


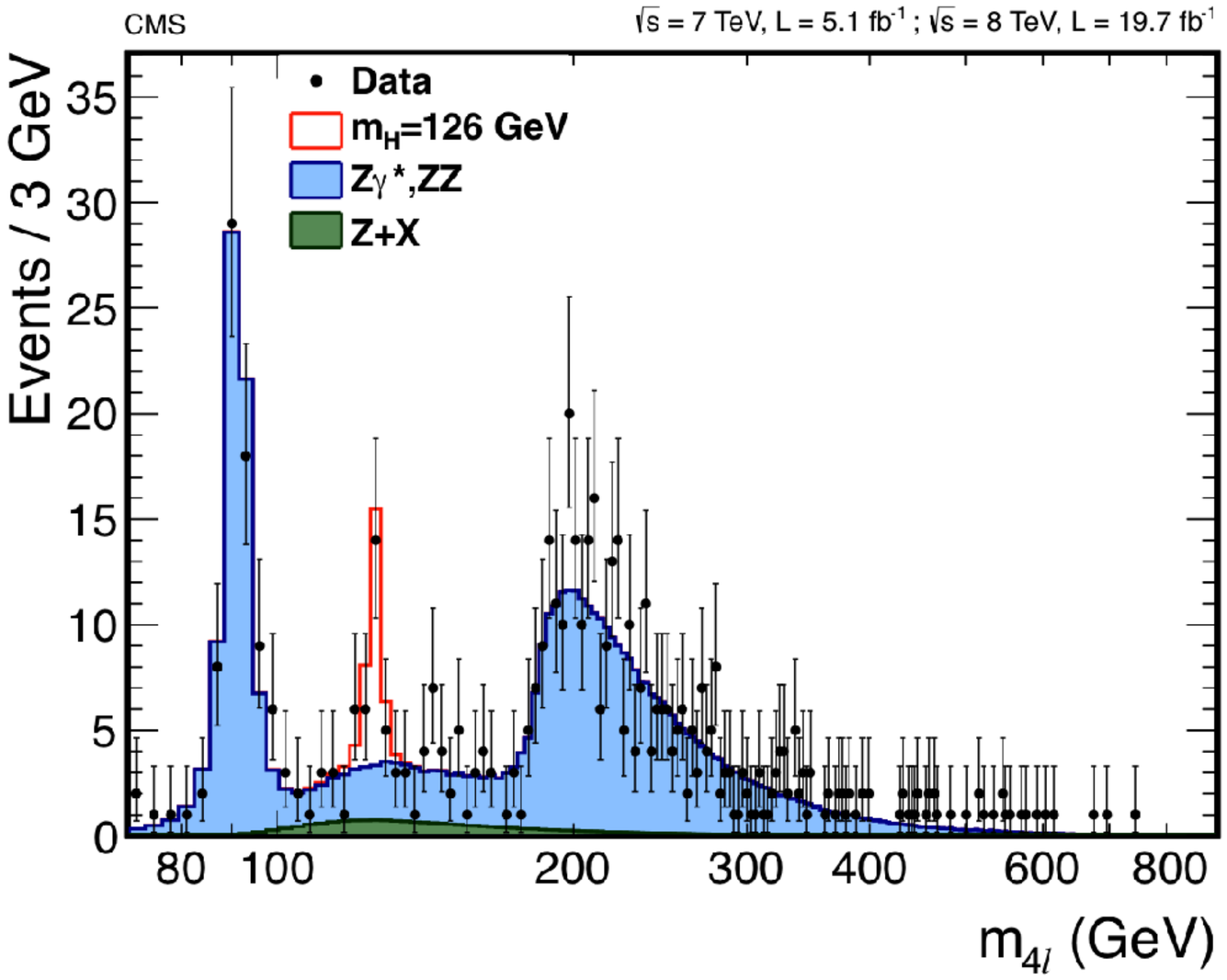




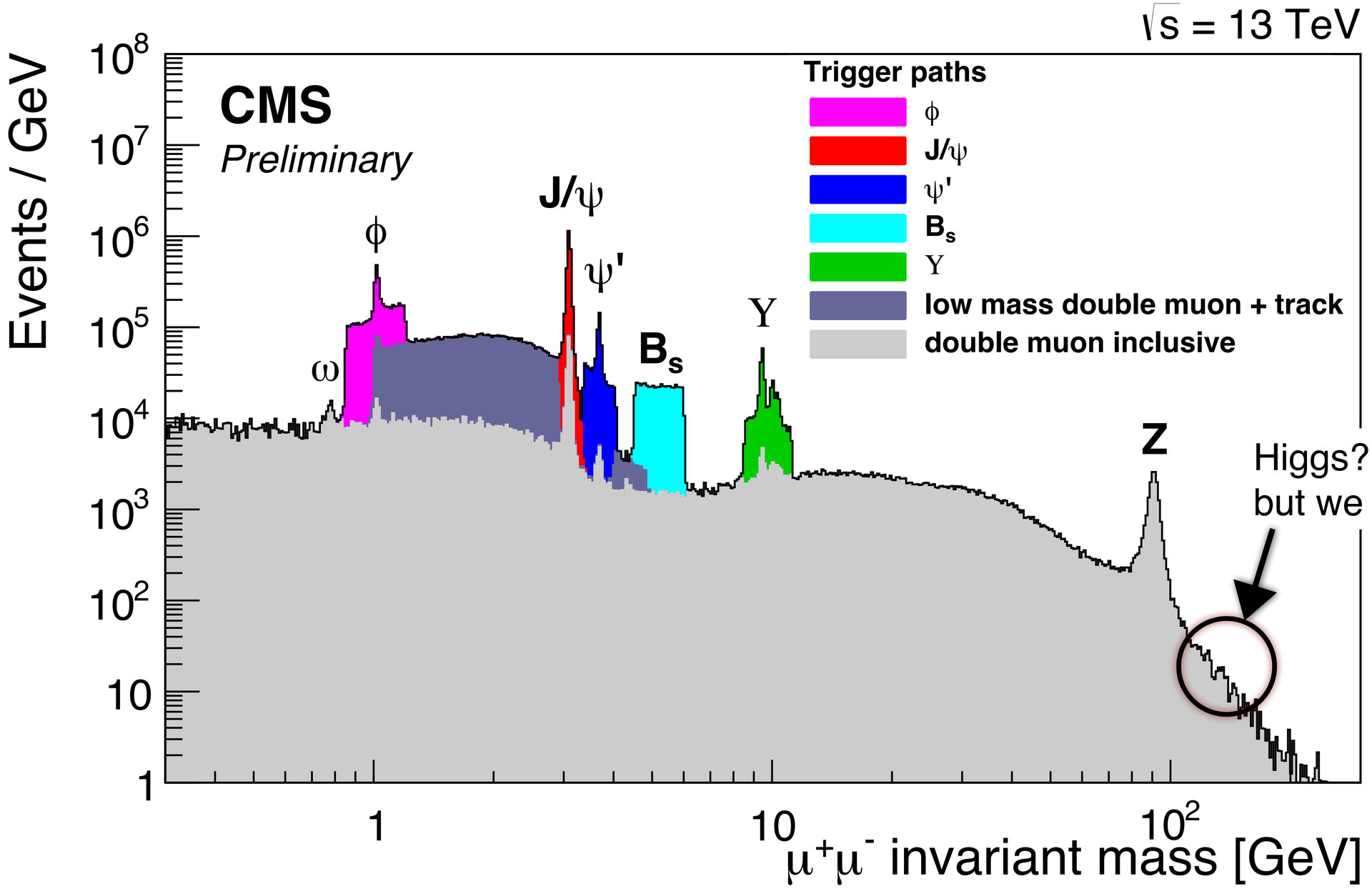


And, of course, the Higgs!

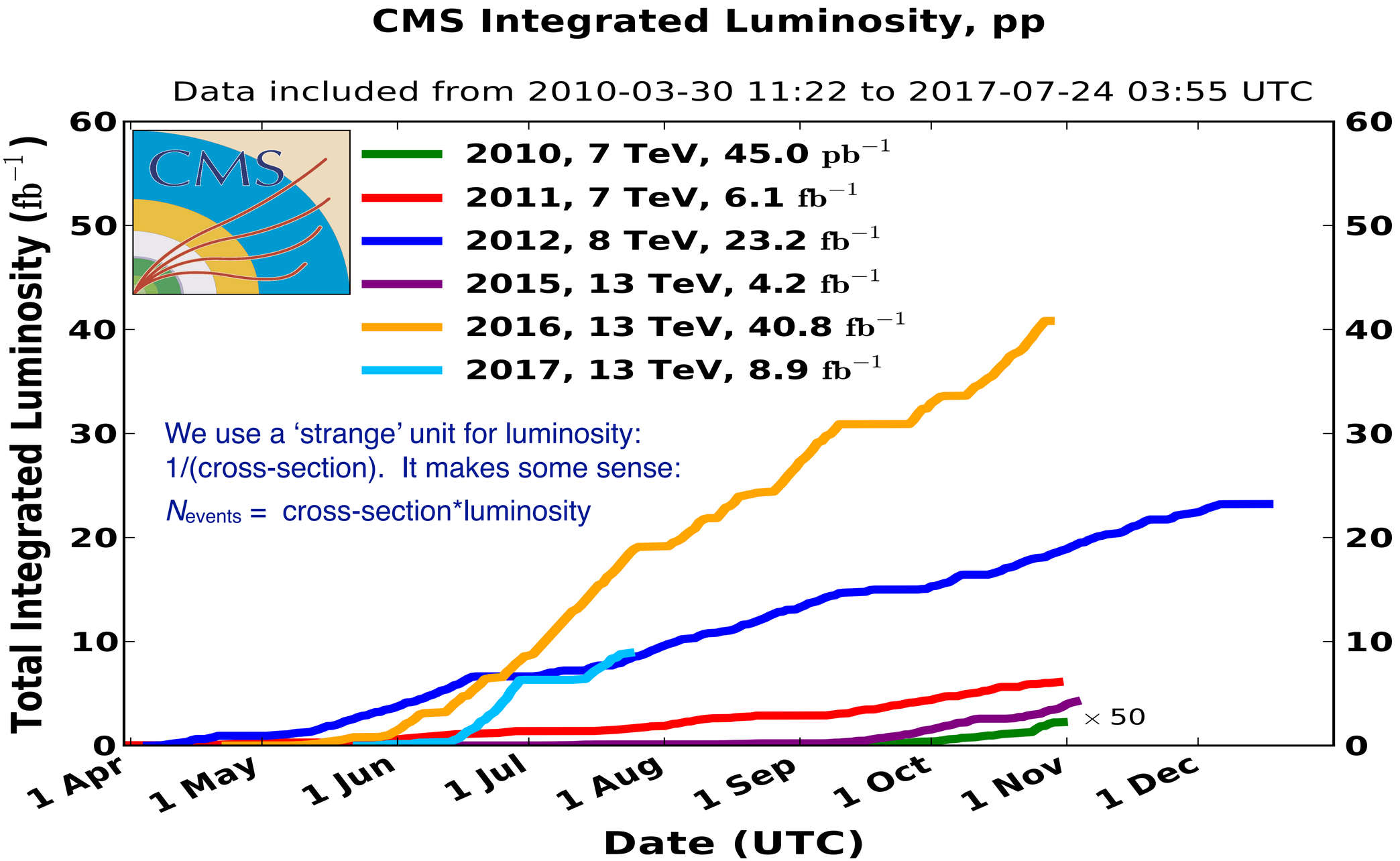




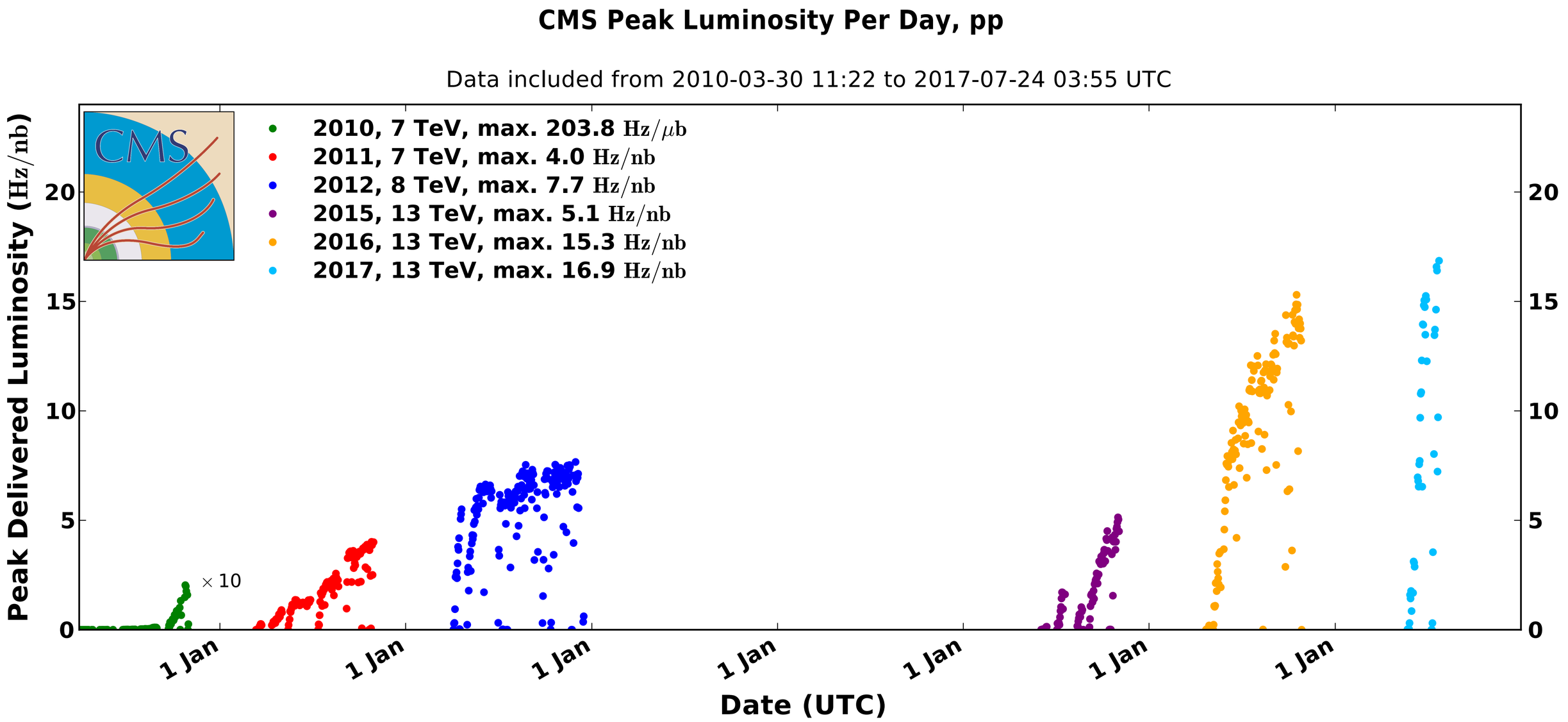
Practically all particles that decay to $\mu^+\mu^-$



LHC performance over the years…



Luminosity keeps getting better!



2017 Data taking

Data taking started again in June.

We will more than double (hopefully!) our high energy data-set this year.

But most of our data is still to come in the next 20 years.

And thus…

Searches for New Physics will continue in earnest!