

Experimental High Energy Physics with the CMS Detector at the LHC

2015 Fall EuroScholars MidStay Program

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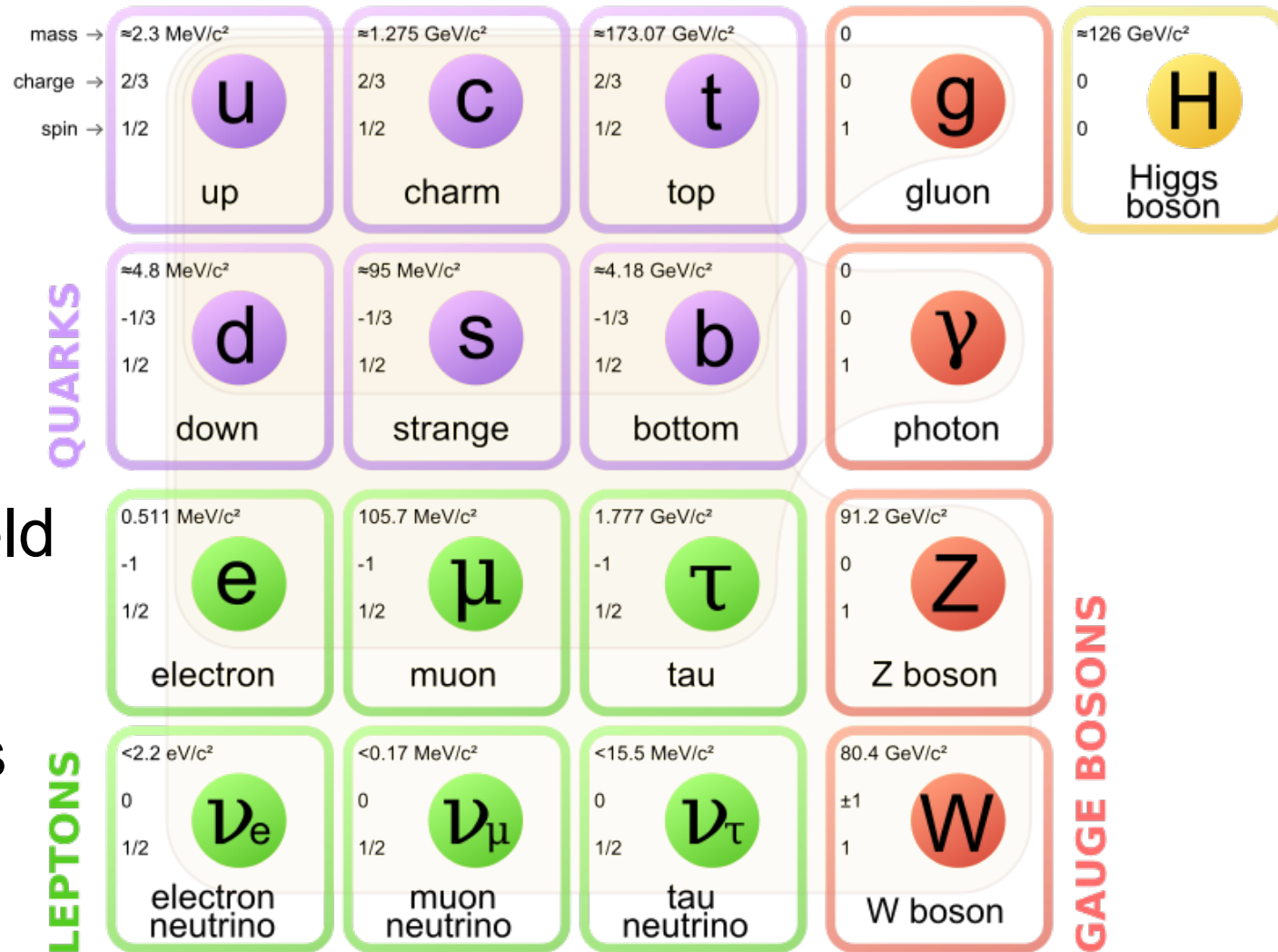
CERN / Universität Zürich

About me



The Standard Model

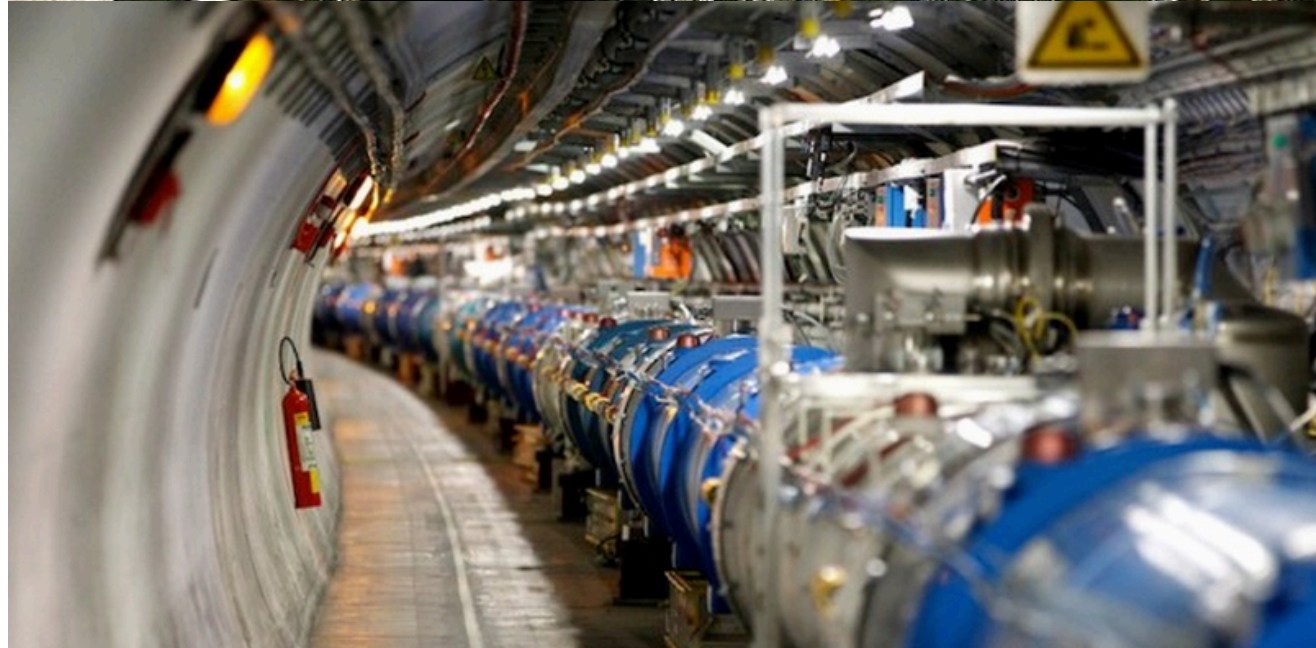
- 1970's:
S. Glashow;
S. Weinberg;
A. Salam.
- Quantum Field Theory
- 12 Fermions
& 4 Bosons
& 1 Higgs



The Large Hadron Collider

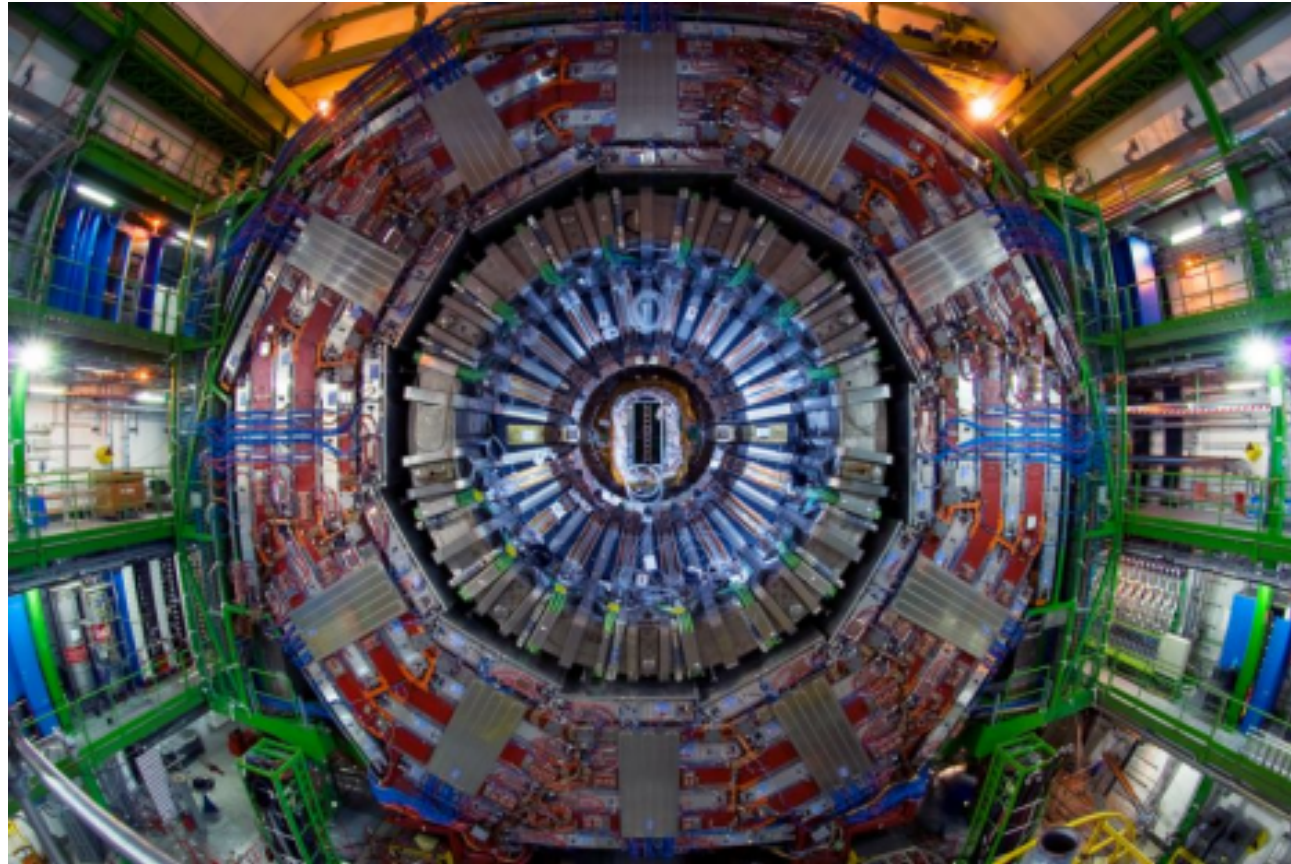
- Operated by CERN
- Swiss-French border
- p-p collisions
- Center-of-Mass Energy at design:

$$\sqrt{s} = 14 \text{ TeV}$$



The CMS Detector

- Pixel detector
- Silicon tracker
- Electromagnetic calorimeter
- Hadronic calorimeter
- Superconducting solenoid
- Muon detector



The CMS Experiment

- **Goals:**

- Search for **Higgs boson**
- Search for extra dimensions
- Search for dark matter

- **Pipeline:**

LHC → CMS → Track Reconstruction → Trigger System → Data Analysis

- **Triumph:** Higgs found on July 4th, 2012!

2013 Nobel Prize in Physics



The Nobel Prize in Physics 2013
François Englert, Peter Higgs

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The Nobel Prize in Physics 2013



Photo: A. Mahmoud
François Englert
Prize share: 1/2



Photo: A. Mahmoud
Peter W. Higgs
Prize share: 1/2

The Nobel Prize in Physics 2013 was awarded jointly to François Englert and Peter W. Higgs *"for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider"*

Now that we've found a Higgs.

What's next???

Run 2:

- Properties of Higgs?
- THE Higgs or families of Higgs?
- New TeV particles?
- Dark matter? Extra dimensions?
- Cosmological constant?

Trigger System

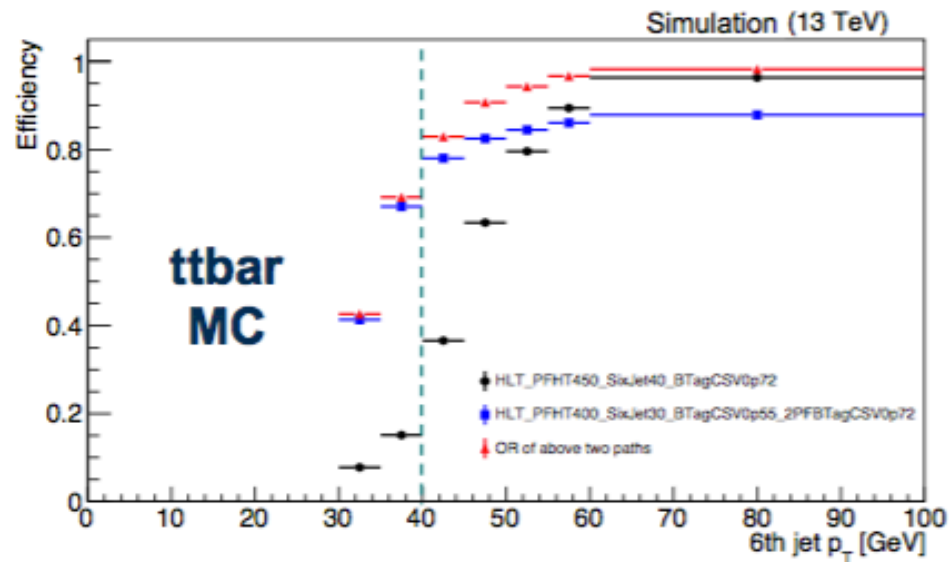
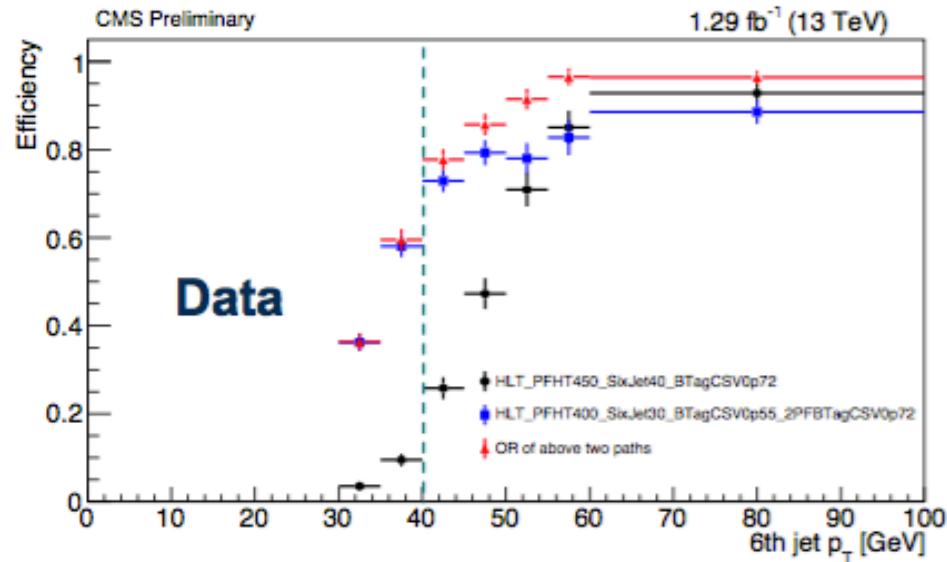
- **Level 1 (L1)**
 - 40MHz event rate to 50kHz
 - Completed within $\sim 3.2\mu\text{s}$
 - Customized, programmable electronics
- **High Level Trigger (HLT)**
 - 50kHz event rate to 1kHz
 - Algorithms written in C++ (ROOT)
 - Trigger paths address different physics object selections

Trigger Efficiencies

**6j, 2b, HT450
offline
selection**

Trigger efficiency measured wrt
 p_T of 6th jet in events with:
 ≥ 6 jets ($p_T > 30$ GeV, $|\eta| < 2.4$),
 ≥ 2 b-tags (CSV 0.89),
 $H_T > 450$ GeV

**Direct
efficiency**



Courtesy: D. Salerno

Thank you!