







# Experimental High Energy Physics with the CMS Detector at the LHC

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## About me



The General Faculty of the University of Virginia have conferred the degree of

> Bachelor of Arts With High Distinction

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who has completed the courses prescribed for this degree, In Collings Whovet the General Faculty have caused this Diploma to be issued, verified by the signatures of the Direction of the Direction of the Direction of the School, and under the corporate seal of the Directity, attested by the Registrar, at Charlottesville, Virginia, this the seventeenth day of May, 2015 and in the two hundred thirty-ninth year of the Commonwealth.

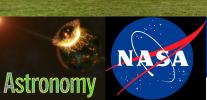




Seresa A. Jullion

In B. Baum















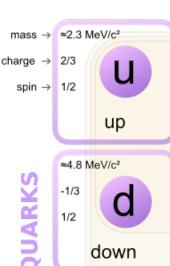






#### The Standard Model

- 1970's:
- S. Glashow;
- S. Weinberg;
- A. Salam.
- Quantum Field Theory
- 12 Fermions



0.511 MeV/c2

1/2

е







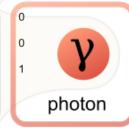






1.777 GeV/c2

1/2













electron



muon

105.7 MeV/c2

1/2



tau

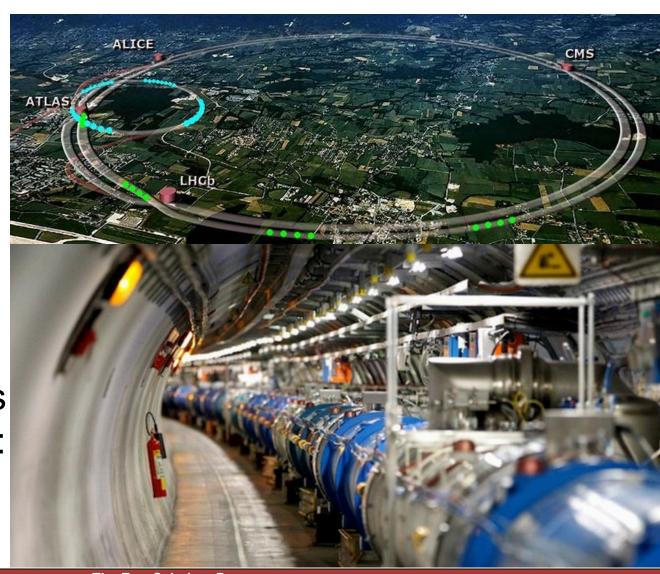




# The Large Hadron Collider

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

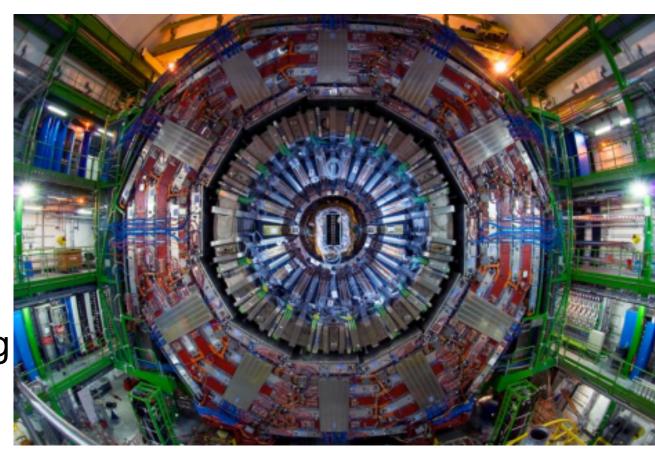
$$\sqrt{s} = 14 \, \mathrm{TeV}$$





### 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:

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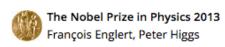
LHC→CMS→Track Reconstruction→Trigger System → Data Analysis

Triumph: Higgs found on July 4<sup>th</sup>, 2012!



# 2013 Nobel Prize in Physics





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#### The Nobel Prize in Physics 2013



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"

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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



- 40MHz event rate to 50kHz
- Completed within ~3.2µs
- Customized, programmable electronics

#### High Level Trigger (HLT)

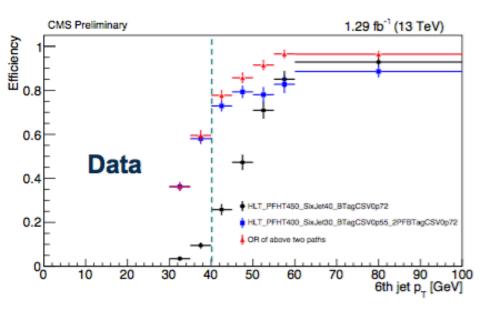
- 50kHz event rate to 1kHz
- Algorithms written in C++ (ROOT)
- Trigger paths address different physics object selections



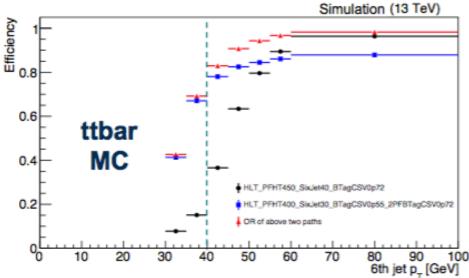
## Trigger Efficiencies

6j, 2b, HT450 offline selection Trigger efficiency measured wrt p<sub>T</sub> of 6<sup>th</sup> jet in events with: ≥6 jets (p<sub>T</sub>>30 GeV, |η|<2.4), ≥2 b-tags (CSV 0.89), H<sub>T</sub>>450 GeV





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Courtesy: D. Salerno



## Thank you!