國立中央大學理學院 X 日本広島大学理学部

Poster- NCU X HU -Symposium

Unraveling the Secrets of Our Universe:
Calibration of Energy Resolution using CMS Test-beam

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Introduction

The discovery of Higgs boson at the Large Hadron Collider (LHC) in 2012 has led curious scientists to ask more questions about our Nature: Is there any deep structure behind the universe? Is there any simpler principle that we can follow up beyond the knowledge we know? With the enthusiastic heart in looking into the universe, I did the research on the detector performance in Compact Muon Solenoid(CMS) of LHC and try to help the facilities to reconstruct the events and to improve the energy resolution with calibrations. Finally, we can know more about the universe with the data we collect!

1 2 3 4 5 6

Hi, I'm Proton!
Let me guide you in the beautiful world of high energy Physics(HEP) with 1~6 stations!

Purpose

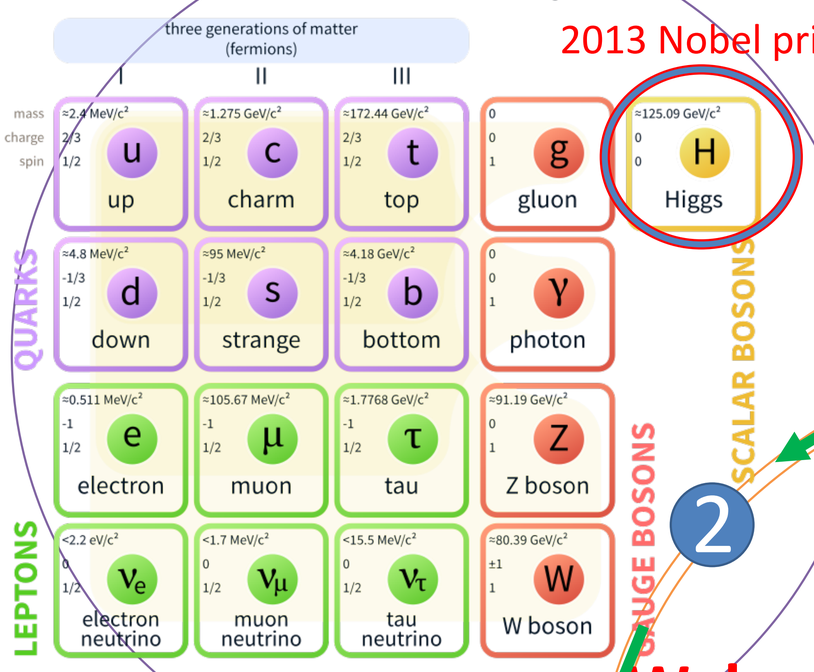
Out of the depths of **space and time**
Even the **bosons** cannot hide
Out of the mess we leave behind
What will they find
You and I
Collide
~LHC<Collide>

Beyond standard model particle exist(s)?
Dark matter exist(s)?
Deep structure in our universe?

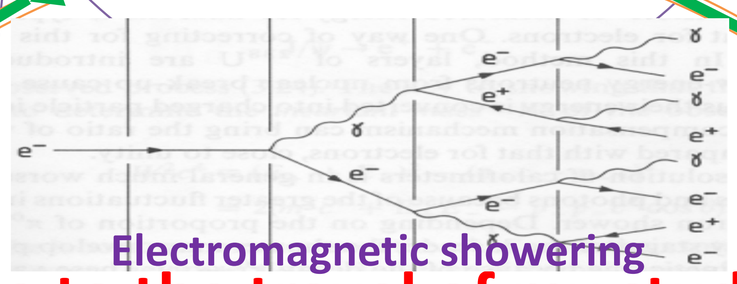
Words definition:

Visible energy: What is seen by the detector
Reconstruction energy: calibrated energy
True energy: Real energy of particle

Standard Model of Elementary Particles



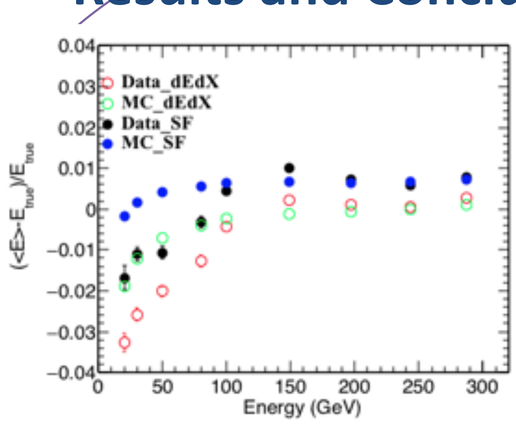
2013 Nobel prize!



Electromagnetic showering

Welcome to the travel of my studies with the proton of the guidance in this collider!
Get started to see what happens!

Results and Conclusion

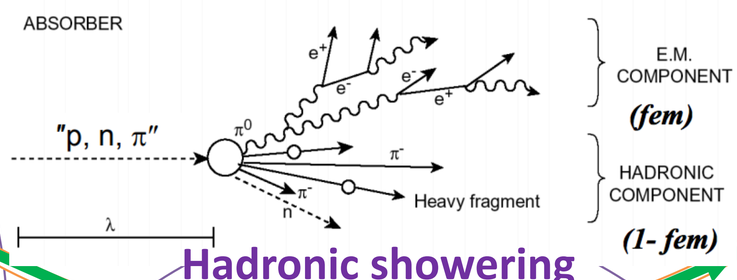


$$\frac{< E > - E_{true}}{E_{true}}$$

- SF calibrations results in higher reconstruction efficiency with the higher energy resolution.
- If we can improve the energy calibration, our physics analysis will have better results.

CMS detector
(One of detectors in LHC)

- Tracking detector: Measure the trajectory of the charged particles (observe : momentum)
- **Calorimeter: Measure the energy of the particles, including electromagnetic part(ECAL) and hadronic part(HCAL) (observe : energy)**
- Muon chamber: Measure Muon momentum



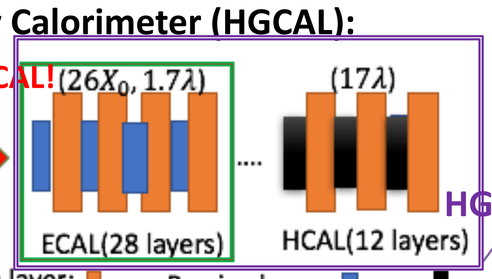
Hadronic showering

What's test beam?

- Since the era of High-Luminosity LHC is coming, the issue in CMS:
  (a) High radiation damage (b)Pileup
- We need to introduce the new detector – **High Granularity Calorimeter (HGCAL):**

Fire e/π to test HGCAL!
Called "test-beam"!

e/π →

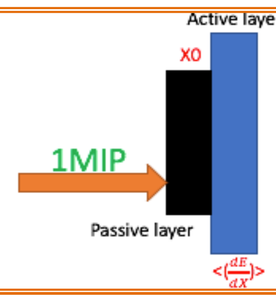


HGCAL prototype

20,30,50,80,100
150,200,250,300(GeV)
Focus on e performance in ECAL!

What are the methods of calibration?

Since a particle won't leave all of the energy in the detector
➔we need to use calibrations to convert the visible energy back to its real energy



(1) dEdX method:

$(\frac{dE}{dX})_i = [<(\frac{dE}{dX})> * (X0)]_i$

Reconstruction energy:

$\sum_{i=layer} E_{visible\ energy\ i} * (\frac{dE}{dX})_i$

(2) SF method:

$$SF = \frac{\sum_{i=1}^{30} E_{active,i}}{\sum_{i=1}^{30} E_{active,i} + \sum_{i=1}^{30} E_{passive,i}}$$

Use active and passive layer energy to estimate
Reconstruction energy:
$SF * E_{visible\ energy}$

Thank you for your participation!
If you are interested, please contact me.