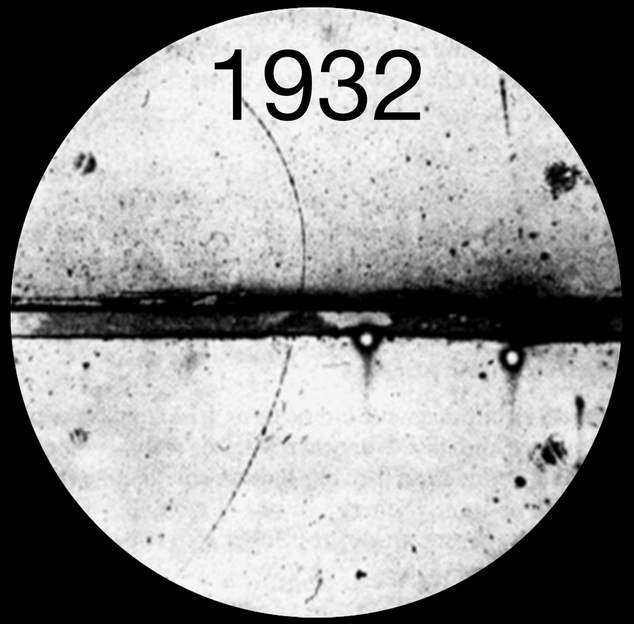
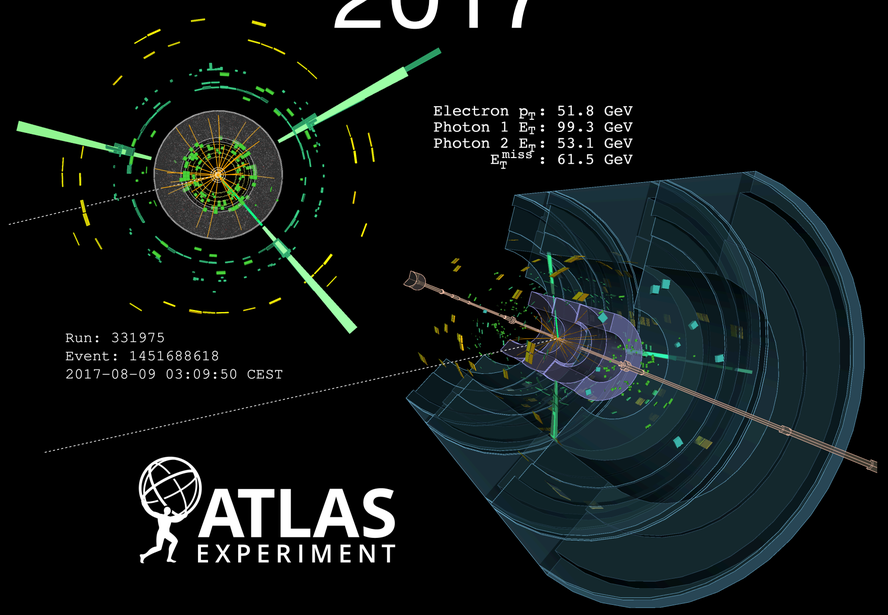
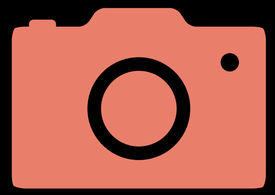
# PHYS 7363 - Experimental Particle Detection and Detectors I




2017

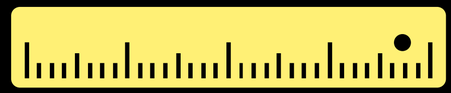



Particle detectors are the workhorses of experimental physics. In this course, we'll dive deep into their physics, exploring the incredible evolution of our experimental techniques over the past nine decades. You'll gain a solid understanding of *particle detection* and *identification*, examine the intricate designs of modern detectors, and learn how machine learning is being harnessed to push the boundaries of detector design. If you're intrigued by how we “see” subatomic particles, this course is for you!



Detect

Identify



Measure

To discuss prerequisites (and any questions on the content of the course), please contact me: saptaparnab@smu.edu

# Schedule

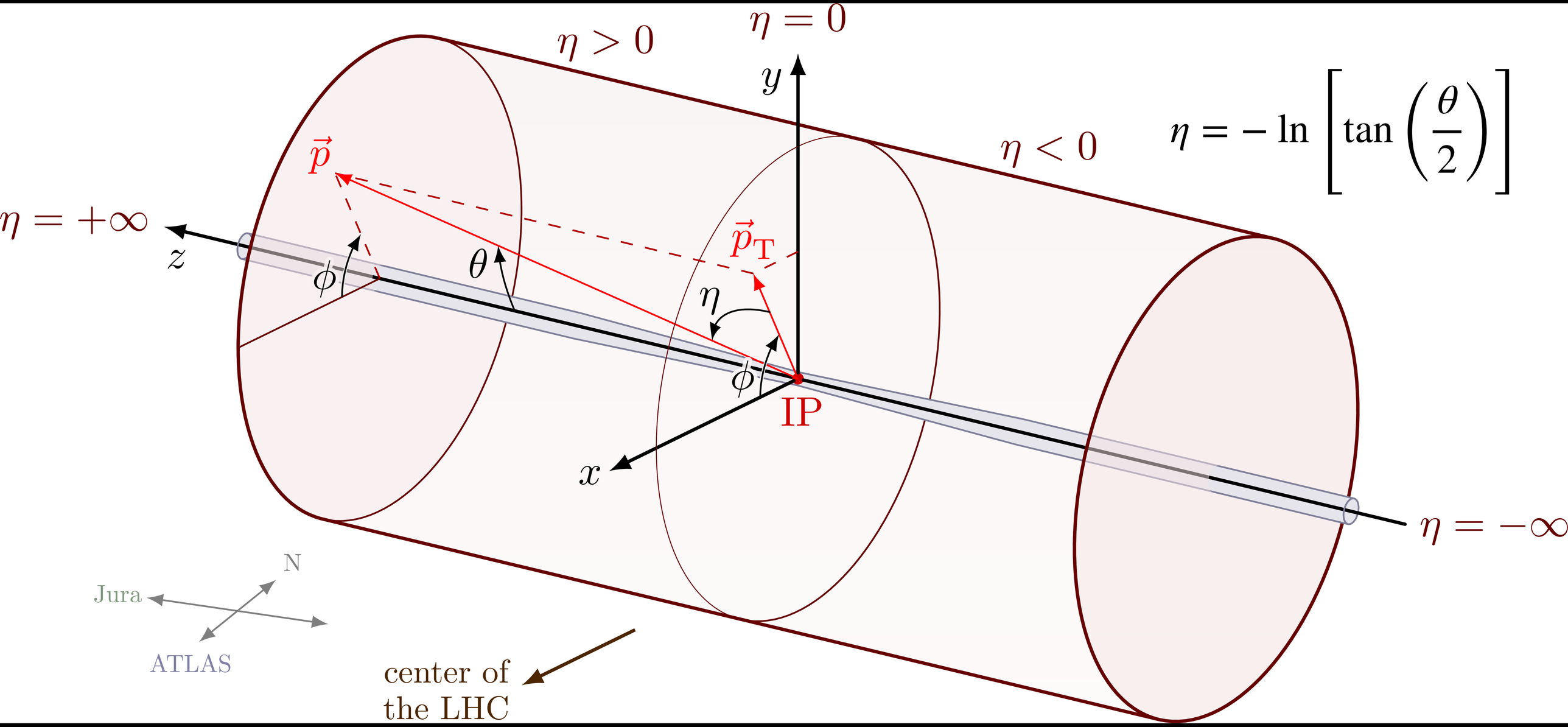
| Month | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| August | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| | 25 ✅ | 26 | 27 | 28 | 29 ✅ | 30 | 31 |
| September | 1 | 2 | 3 ✅ | 4 | 5 ✅ | 6 | 7 |
| | 8 ✅ 1.5 hours | 9 | 10 | 11 | 12 | 13 | 14 |
| | 15 ✅ 1.5 hours | 16 | 17 ✅ 1.5 hours | 18 | 19 ✅ 1.5 hours | 20 | 21 |
| | 22 ✅ 1.5 hours | 23 | 24 ✅ 1.5 hours | 25 | 26 ✅ 1.5 hours | 27 | 28 |
| October | 29 ✅ 1.5 hours | 30 | 1 ✅ 1.5 hours | 2 | 3 ✅ 1.5 hours | 4 | 5 |

# Schedule

| Month | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| October | 6 ✅ 1.5 hours | 7 | 8 ✅ 1.5 hours | 9 | 10 | 11 | 12 |
| | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| | 27 | 28 | 29 | 30 | 31 | 1 | 2 |
| November | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| December | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | 8 | 9 | 10 | 11 | 12 | 13 | 14 |

# Schedule

- Midterm on October 27th
- We decided on continue with this 80 min long lectures thrice a week
  - We will continue with this schedule unless I think that we don’t need to meet for that long a time frame
  - This week, I am away at a conference, so we will meet on Monday as planned in person, Wednesday would be a zoom lecture and no lecture on Friday


$\eta = 0$
$\eta > 0$
$\eta < 0$
$\eta = -\ln\left[\tan\left(\frac{\theta}{2}\right)\right]$
$y$
$\vec{p}$
$\eta = +\infty$
$z$
$\phi$
$\theta$
$\vec{p}_{\mathrm{T}}$
$\eta$
$\phi$
IP
$x$
$\eta = -\infty$
N
Jura
ATLAS
center of
the LHC

# Relevant parts of the book

- Chapters: 1-3
- Chapter: 8 (Semiconductor detectors)
- Chapter: 9 (Track model)
- Chapter: 15 (Calorimeters)
- What we will cover (at a minimum):
  - Chapter 12-13 (Cherenkov and Scintillation detectors),14 (particle identification), 18 (triggers)
  - Accelerator basics

Shower fluctuations

# Hadronic Showers Fluctuations

- interesting measurements of the longitudinal energy deposition in em and hadronic showers were made with the "Hanging file calorimeter"

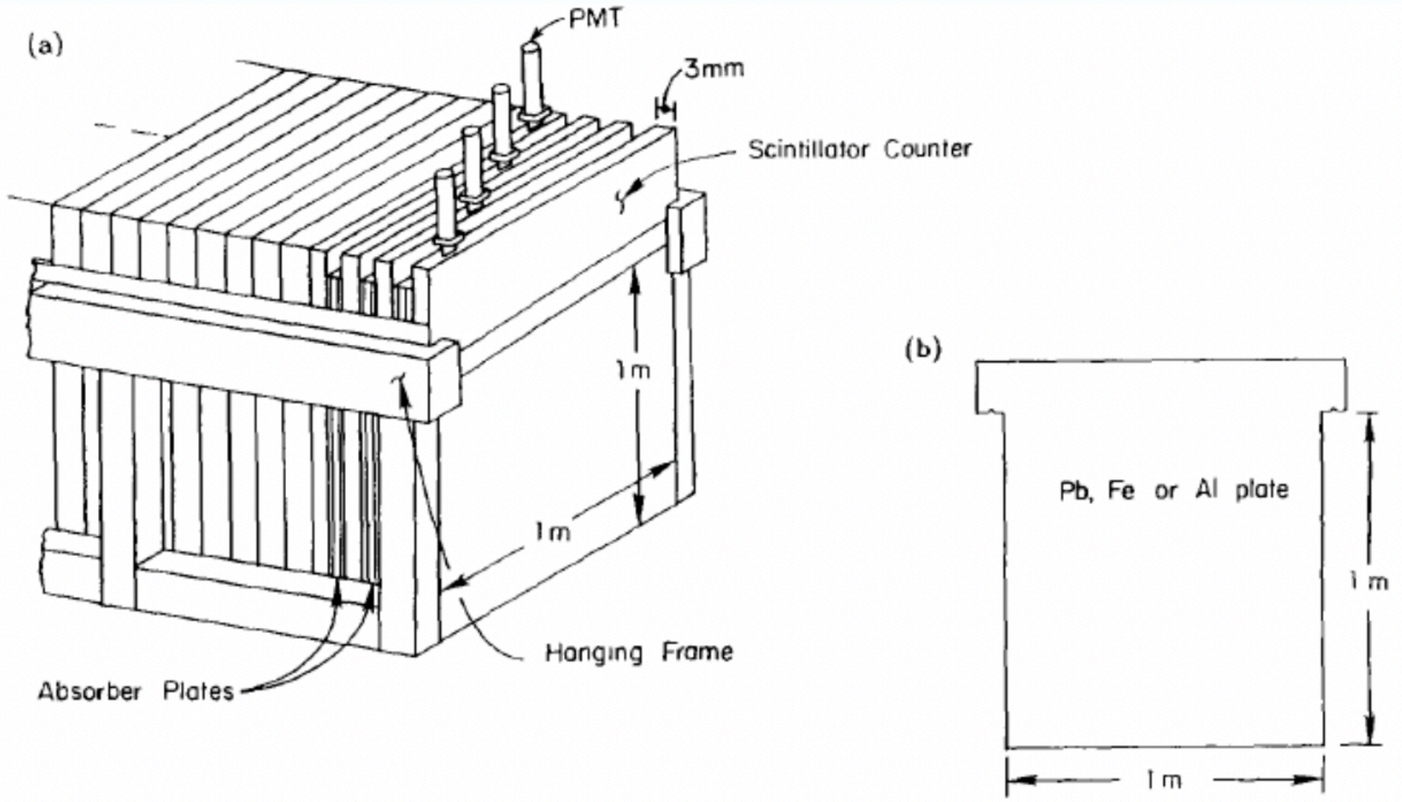
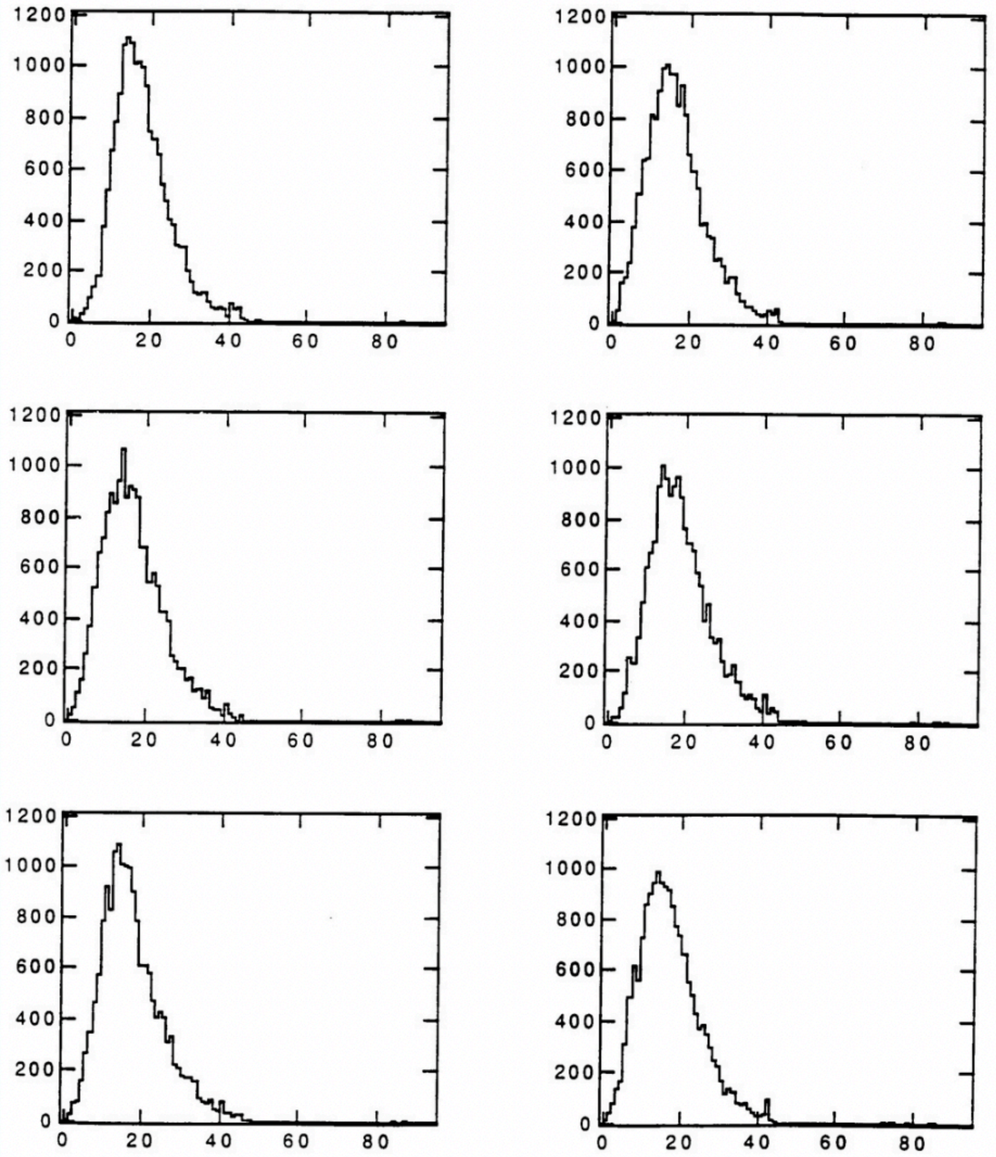



Fig. 1. (a) Schematic overview of the hanging file calorimeter (HFC). There was no transverse segmentation. The maximum depth of the calorimeter can be configured up to 2.2 m with a maximum number of 105 read-out planes. Each scintillator counter was read out separately. (b) Schematic drawing of the absorber plate.

Shower fluctuations

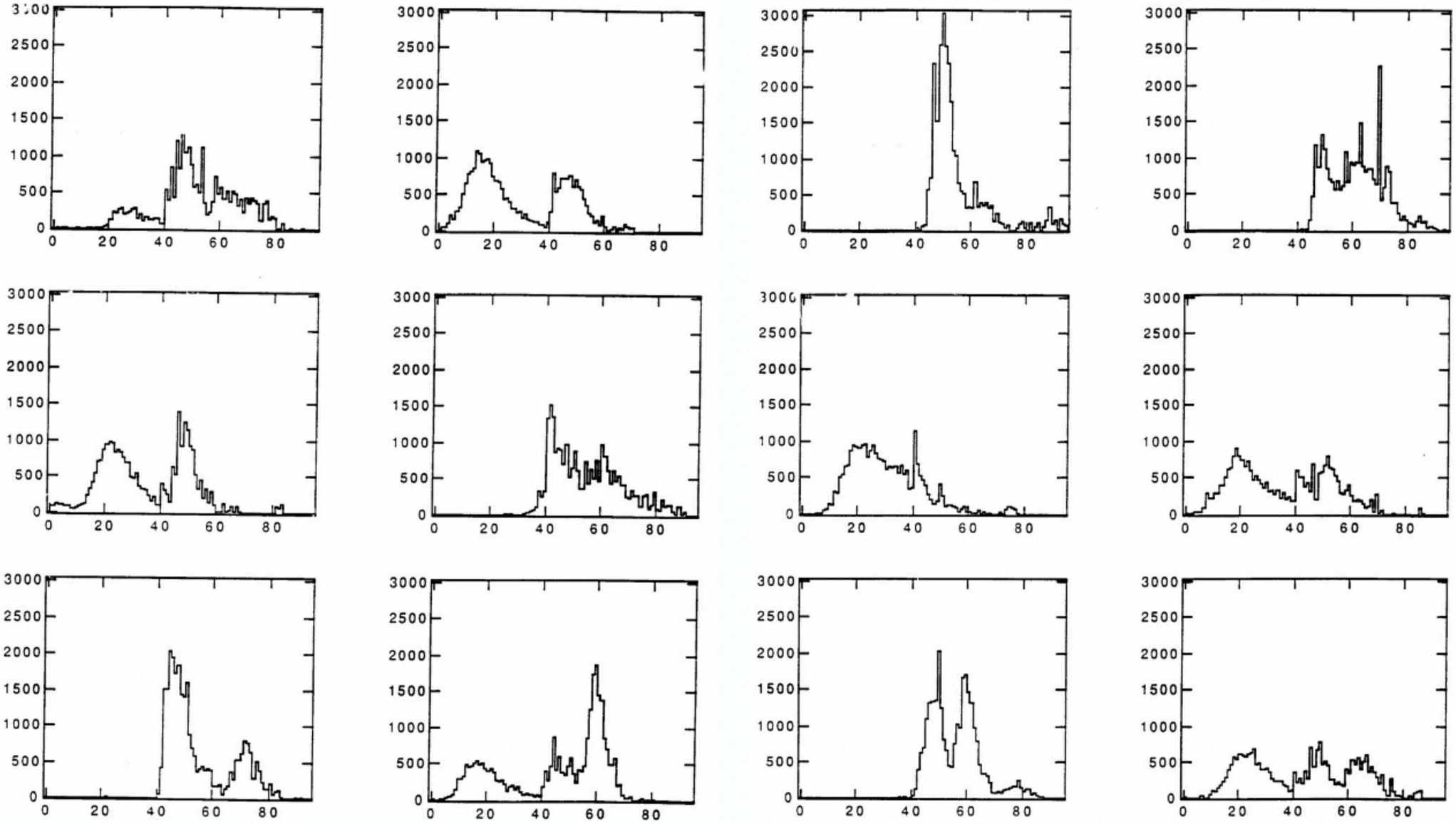
# EM Shower Fluctuations

- 170 GeV electrons hit the Hanging file calorimeter
- Longitudinal shower profile is reconstructed by reading out each layer for each event
- EM shower depositions do not fluctuate significantly



Shower fluctuations

# HAD Shower Fluctuations
# 270 GeV Pions



# Installing Geant4

- Follow instructions here: https://indico.jlab.org/event/963/contributions/16842/attachments/13259/21368/usersdocs_examples_jlab_august2025.pdf
- Useful tutorial at JLAB this year: https://indico.jlab.org/event/963/timetable/#all.detailed

# CLD Detector

- CLD Paper: https://arxiv.org/pdf/1911.12230
- Read the paper and we will discuss it in class next Monday