PHYS 1444 – Section 004
Lecture #1

Wednesday, Jan. 18, 2012

Dr. Jaehoon Yu

- Who am I?
- How is this class organized?
- What is Physics?
- What do we want from this class?
- Brief history of physics

Today's homework is homework #1, due 10pm, coming Monday!!

Announcements

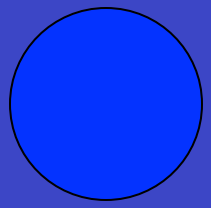
- Plea to you: Please turn off your cell-phones, pagers and computers in the class
- Reading assignment #1: Read and follow through all sections in appendix A by Monday, Jan. 23
  - A-1 through A-7
- There will be a quiz on this and Ch. 21 on Wednesday, Jan. 25.

Who am I?

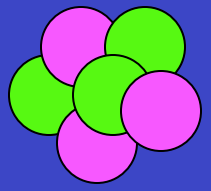
- Name: Dr. Jaehoon Yu (You can call me **Dr. Yu**)
- Office: Rm 342, Chemistry and Physics Building
- Extension: x22814, E-mail: *jaehoonyu@uta.edu*
- My profession: High Energy Particle Physics (HEP)
  - Collide particles (protons on anti-protons or electrons on anti-electrons, positrons) at the energies equivalent to 10,000 Trillion degrees
  - To understand
    - Fundamental constituents of matter
    - Forces between the constituents (gravitational, electro-magnetic, weak and strong forces)
    - Origin of Mass
    - Creation of Universe (**Big Bang** Theory)
  - A pure scientific research activity
    - Direct use of the fundamental laws we find may take longer than we want but
    - Indirect product of research contribute to every day lives; eg. WWW
  - Why do we do with this?
    - Make our everyday lives better

Accelerators are Powerful Microscopes.

They make high energy particle beams that allow us to see small things.



seen by
low energy beam
(poorer resolution)



seen by
high energy beam
(better resolution)

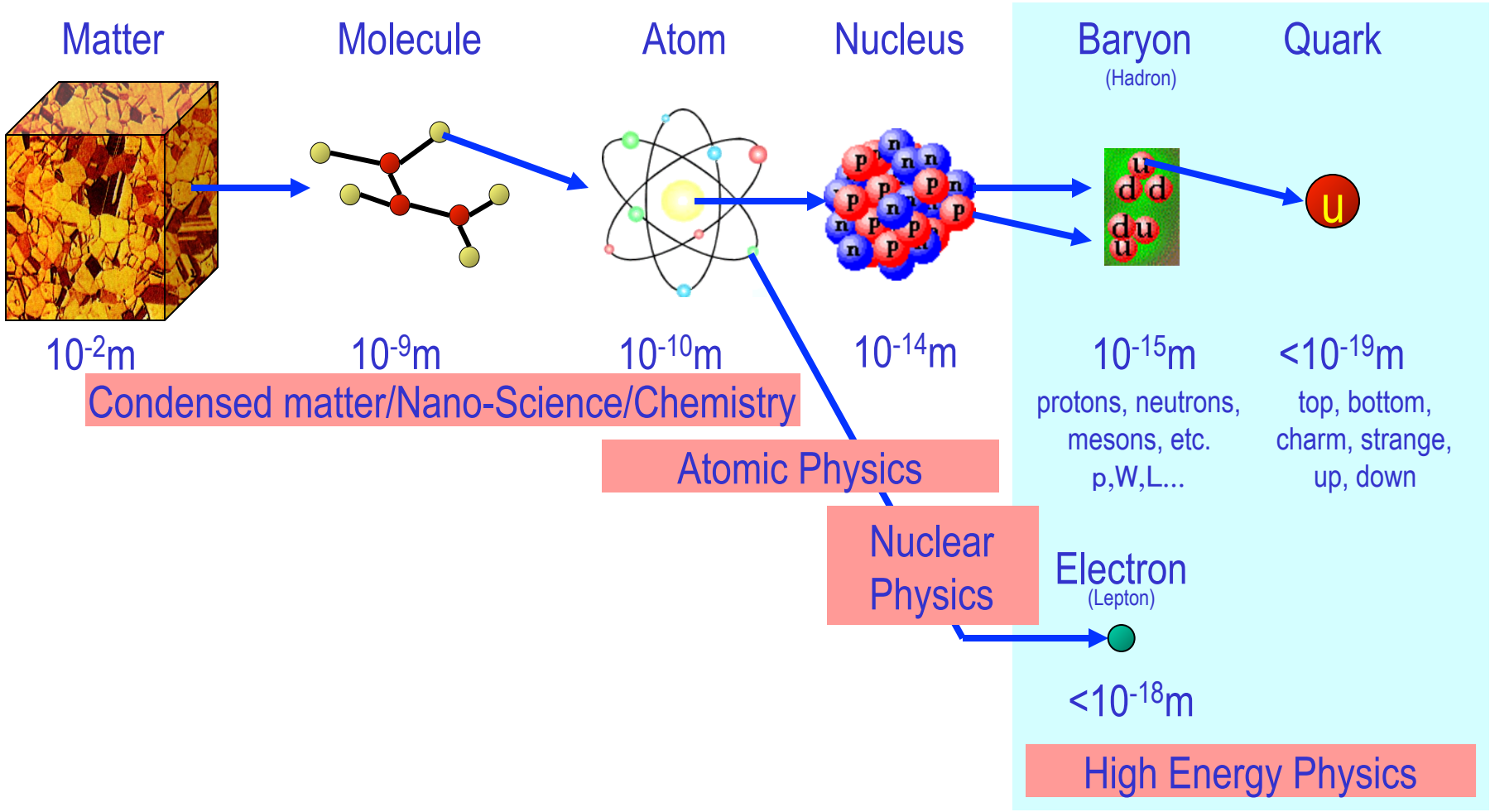
Accelerators are also Time Machines.

They make particles last seen
in the earliest moments of the universe.

Particle and anti-particle annihilate.

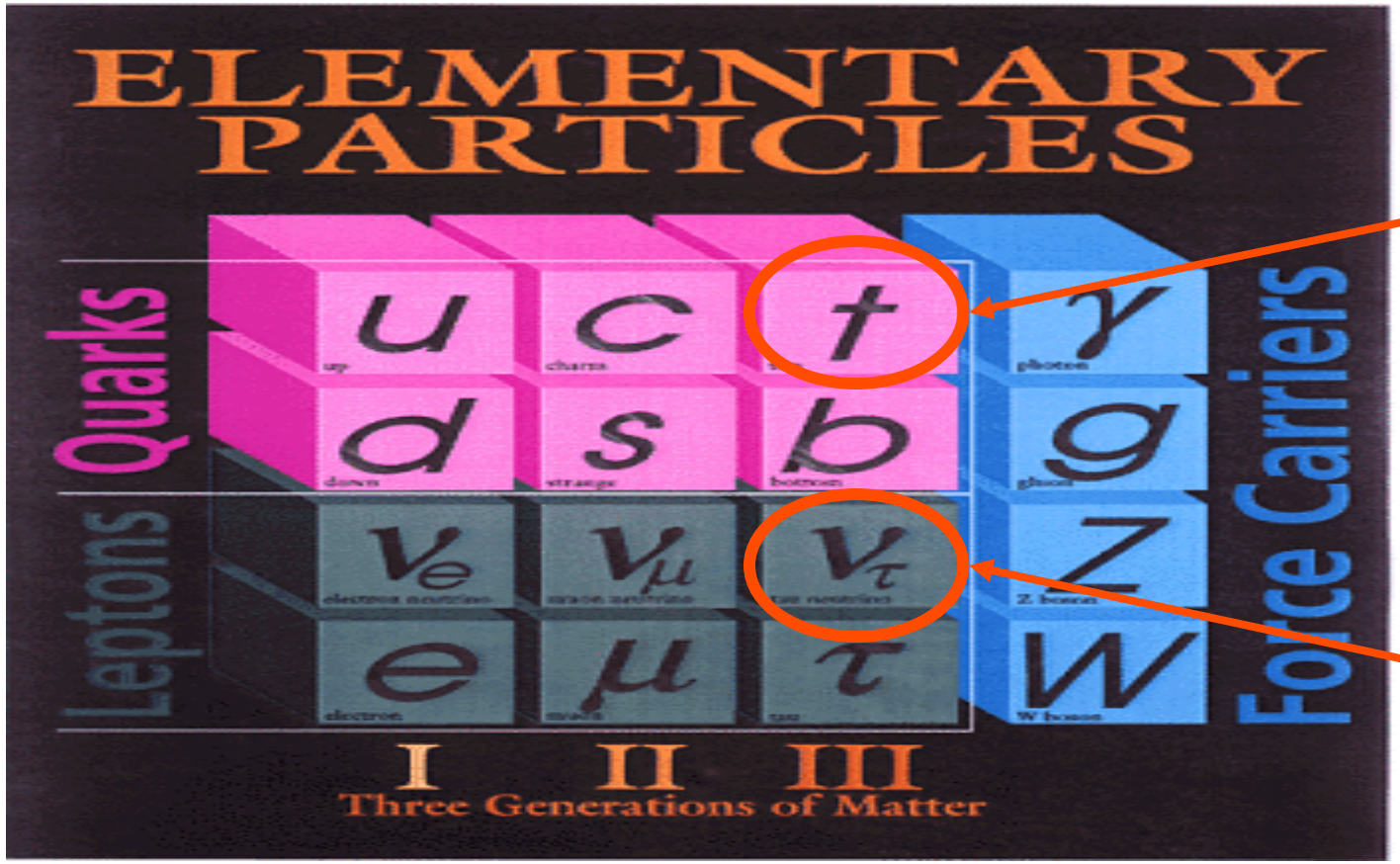
$$E = mc^2$$

Structure of Matter



The Standard Model

- Assumes the following fundamental structure:

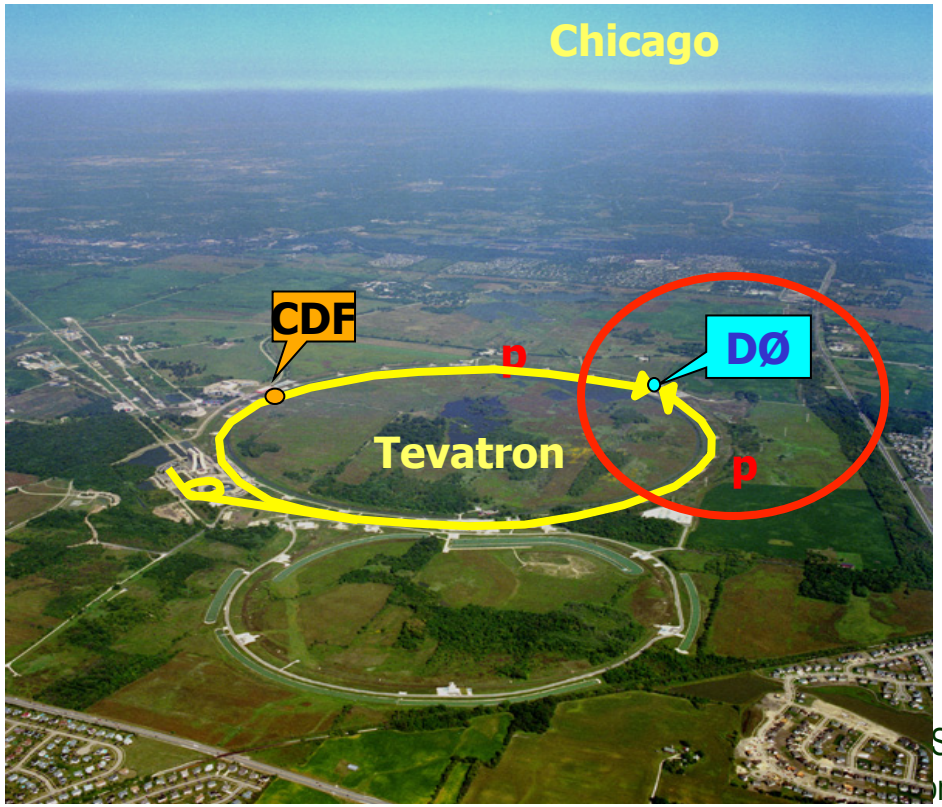


Discovered in 1995

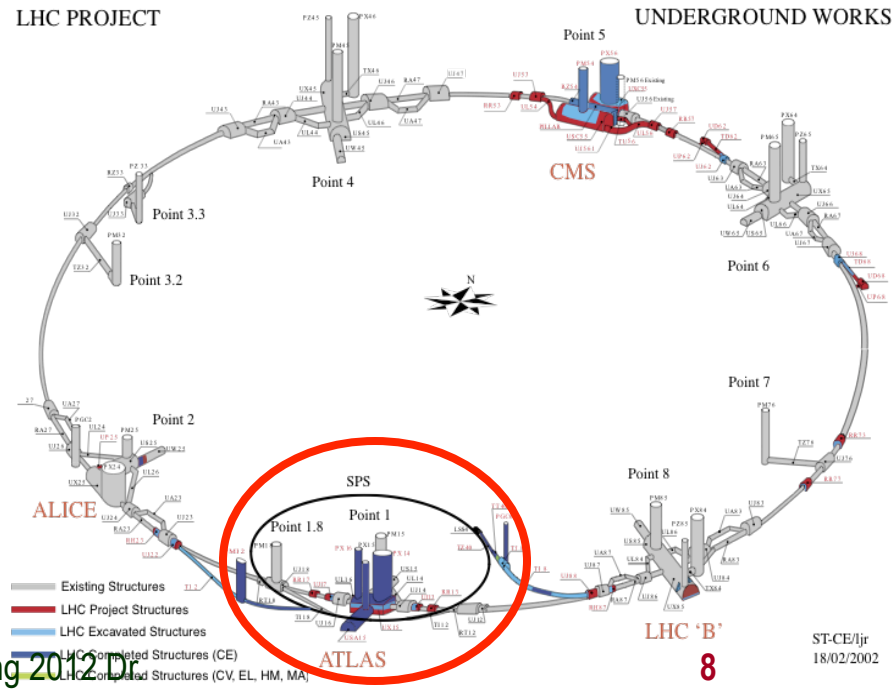
Directly observed in 2000

Fermilab Tevatron and LHC at CERN

- World's Highest Energy proton-anti-proton collider
  - 4km circumference
  - E_{cm}=1.96 TeV (=6.3x10^{-7}J/p➔ 13M Joules on the area smaller than 10^{-4}m^2)
  - Equivalent to the kinetic energy of a 20t truck at the speed 81mi/hr➔ 130km/hr
    - ~100,000 times the energy density at the ground 0 of the Hiroshima atom bomb
  - **Was shut down at 2pm CDT, Sept. 30, 2011**
    - **Other parts of the complex is still running!!**



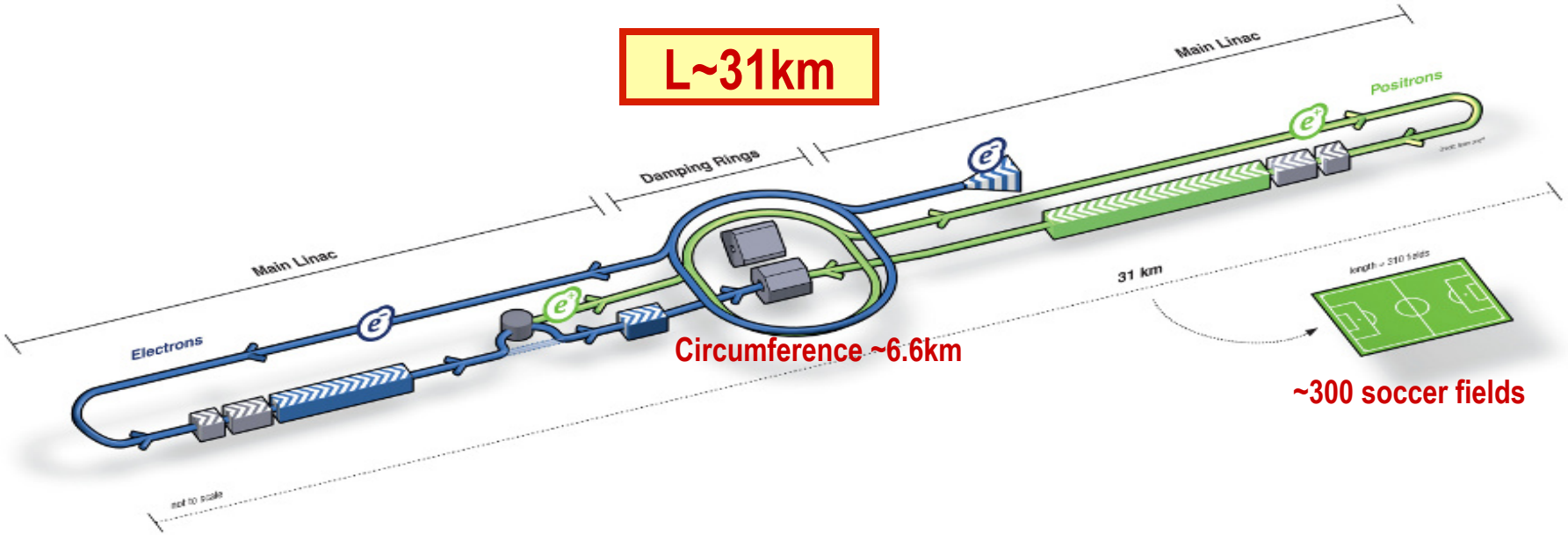
- World's Highest Energy p-p collider
  - 27km circumference, 100m underground
  - Design E_{cm}=14 TeV (=44x10^{-7}J/p➔ 362M Joules on the area smaller than 10^{-4}m^2)
  - ➢ Equivalent to the kinetic energy of a B727 (80tons) at the speed 193mi/hr ➔ 312km/hr
    - ➢ ~3M times the energy density at the ground 0 of the Hiroshima atom bomb
- First 7TeV collisions on 3/30/10 ➔ The highest energy humans ever achieved!!
  - **First collisions in 2012 in mid March, 2012**



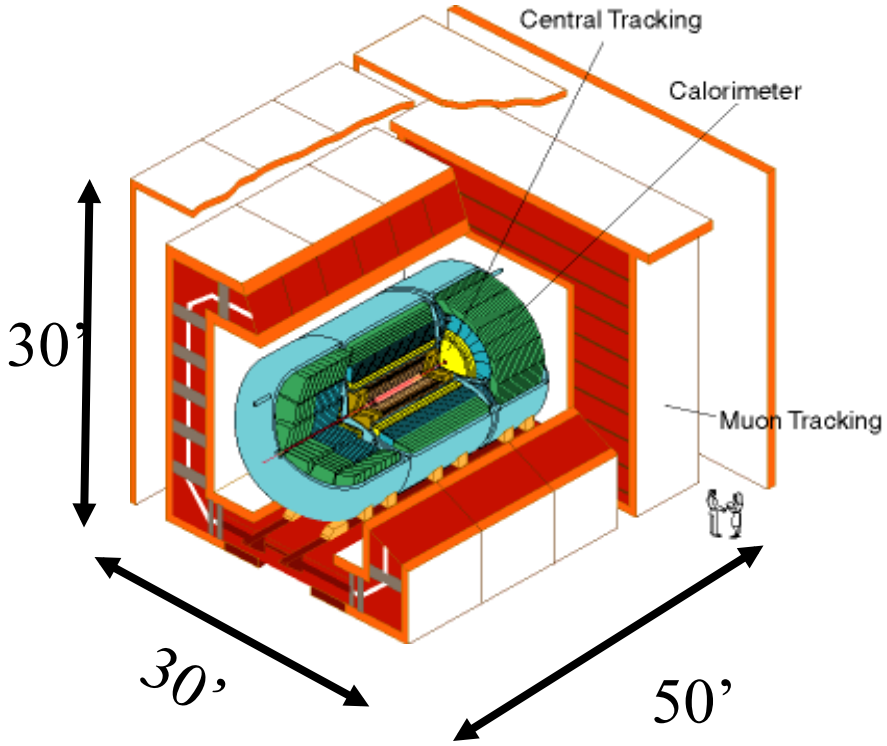
LHC @ CERN Aerial View

A Future Linear Collider

- An electron-positron collider on a straight line for precision measurements
- CMS Energy: 0.5 – 1 TeV
- 10~15 years from now (Japanese PM announced that they would bid for a LC in Japan)
- Takes 10 years to build the accelerator and the detector

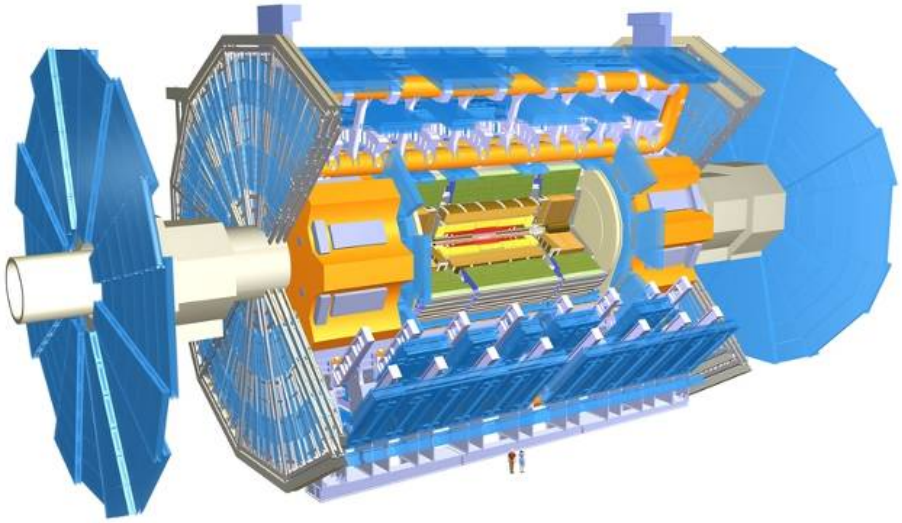


DØ Detector



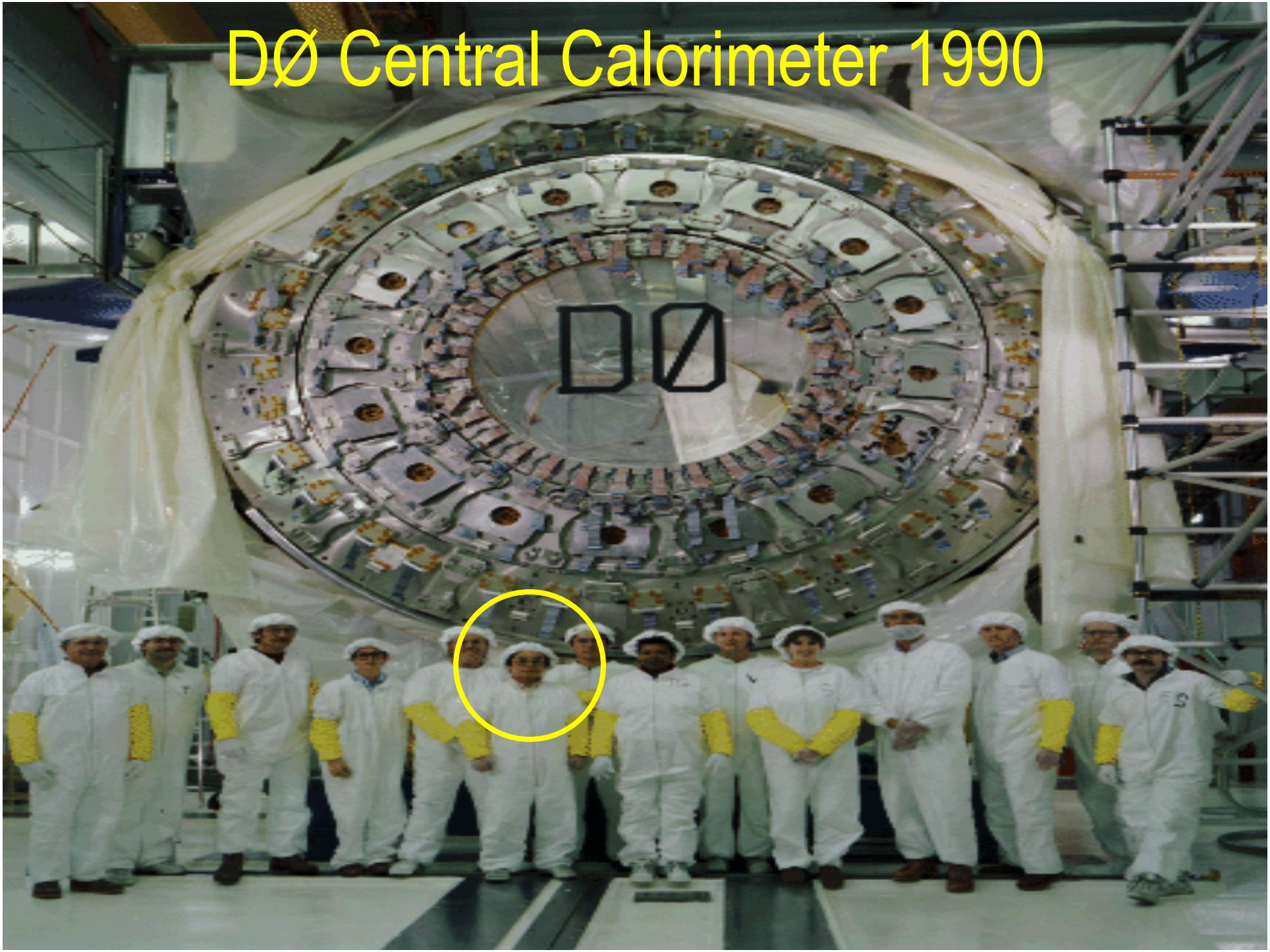
- **Weighs 5000 tons and 5 story tall**
- Can inspect **3,000,000** collisions/second
- Record **100 collisions/second**
- Records approximately **10,000,000** bytes/ second
- Records **0.5x10^{15}** (500,000,000,000,000) bytes per year (0.5 PetaBytes).

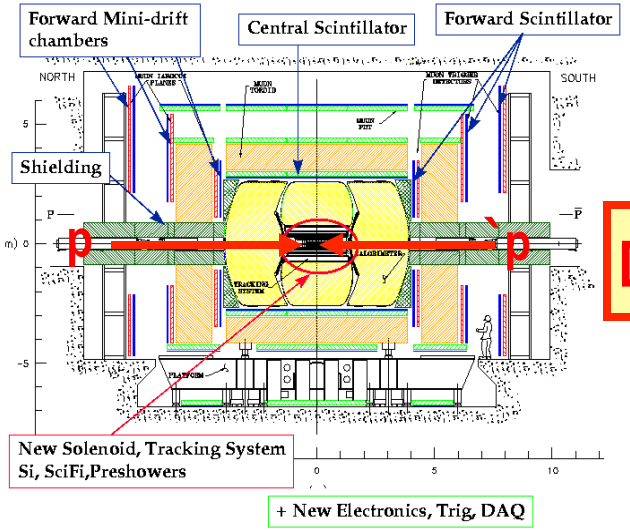
ATLAS Detector



- **Weighs 7000 tons and 10 story tall**
- Can inspect **1,000,000,000** collisions/second
- Records **200 – 400 collisions/second**
- Records approximately **350,000,000** bytes/ second
- Record **2x10^{15}** (2,000,000,000,000,000) bytes each year (2 PetaByte). ➔ **200*Printed material of the US Lib. of Congress**

DØ Central Calorimeter 1990

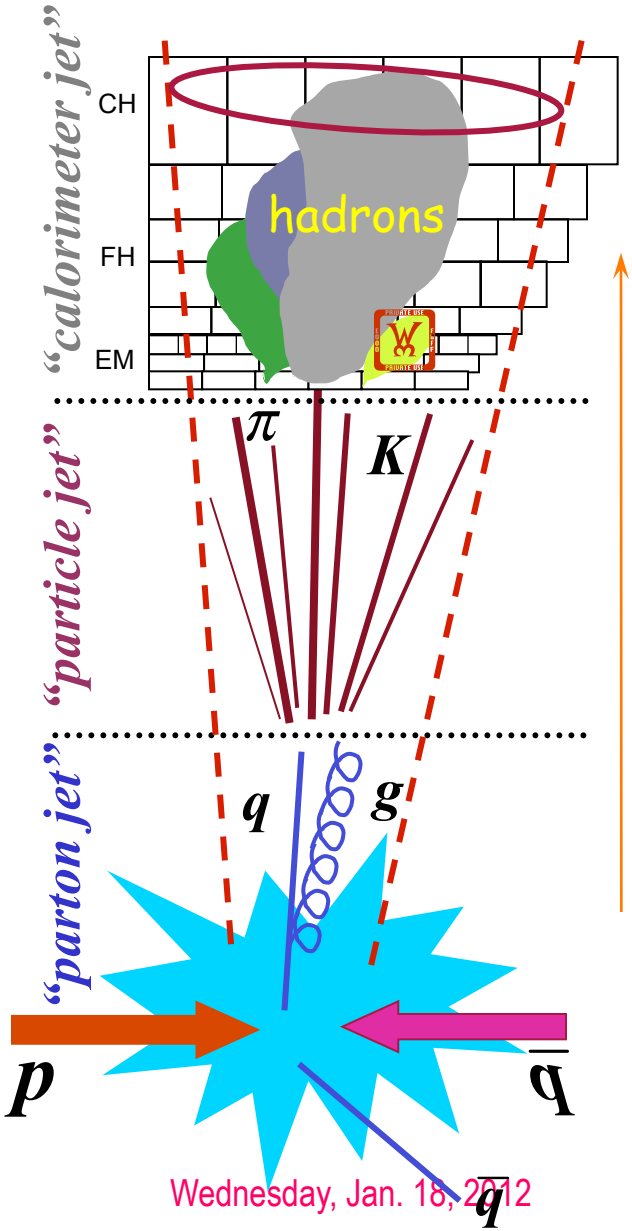


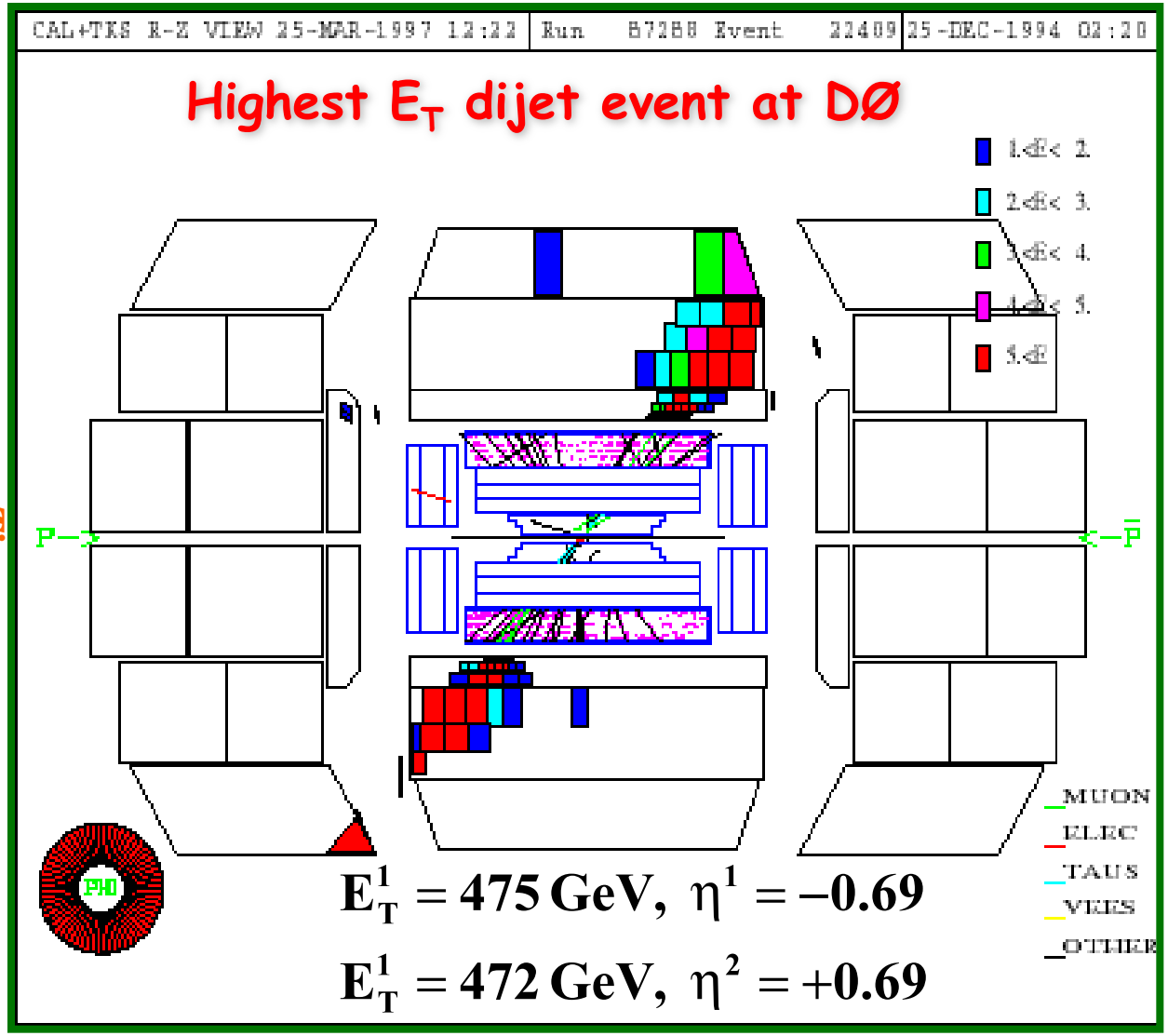


Digital data

Data Reconstruction

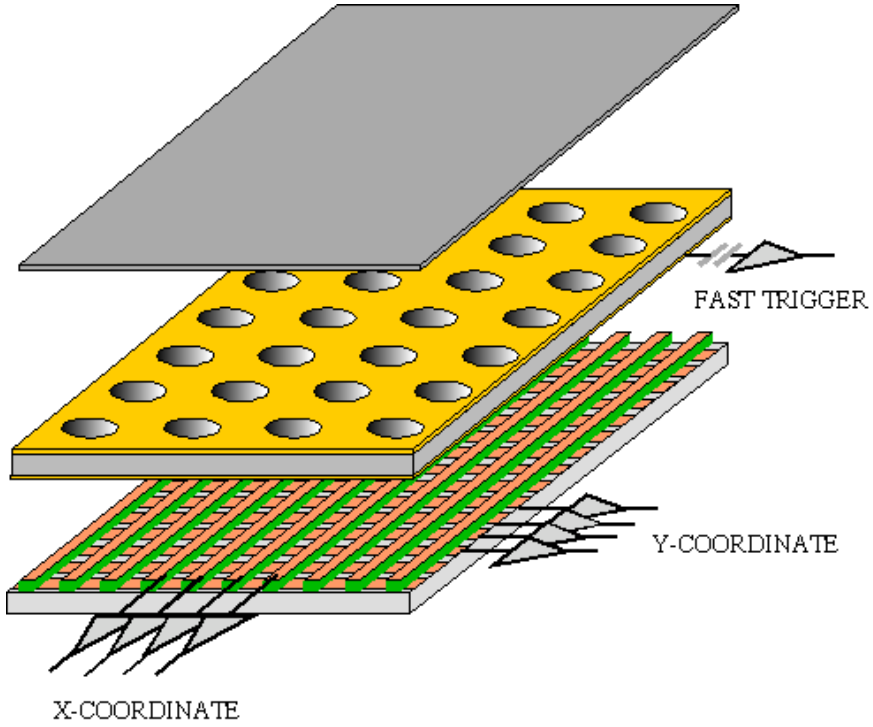
How does an Event Look in a Collider Detector?





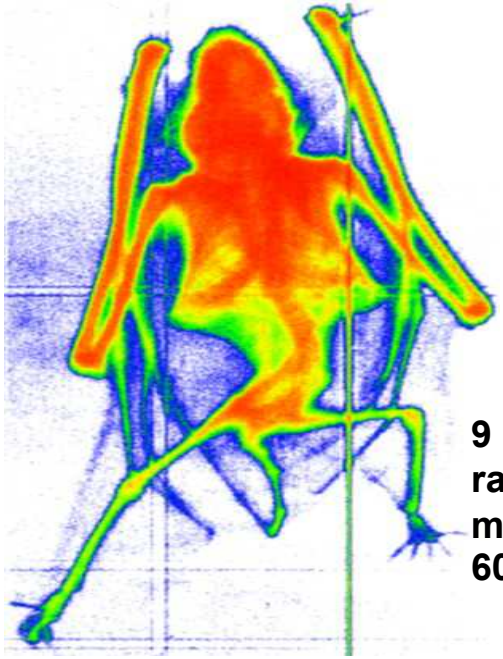
GEM Application Potential

Using the lower GEM signal, the readout can be self-triggered with energy discrimination:



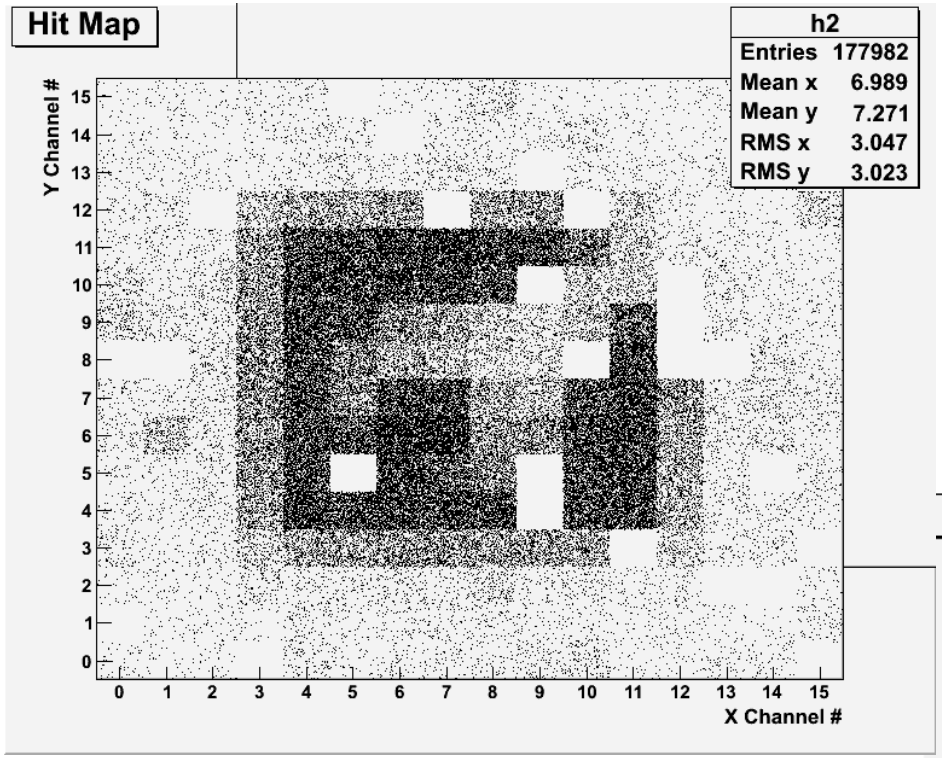
A. Bressan et al,
Nucl. Instr. and Meth. A 425(1999)254
F. Sauli, Nucl. Instr. and Meth.A 461(2001)47

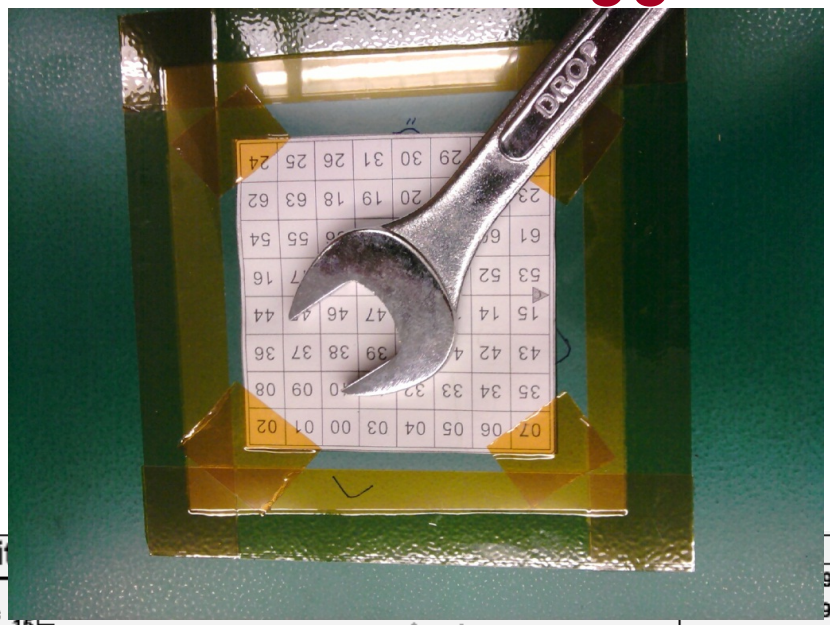
FAST X-RAY IMAGING

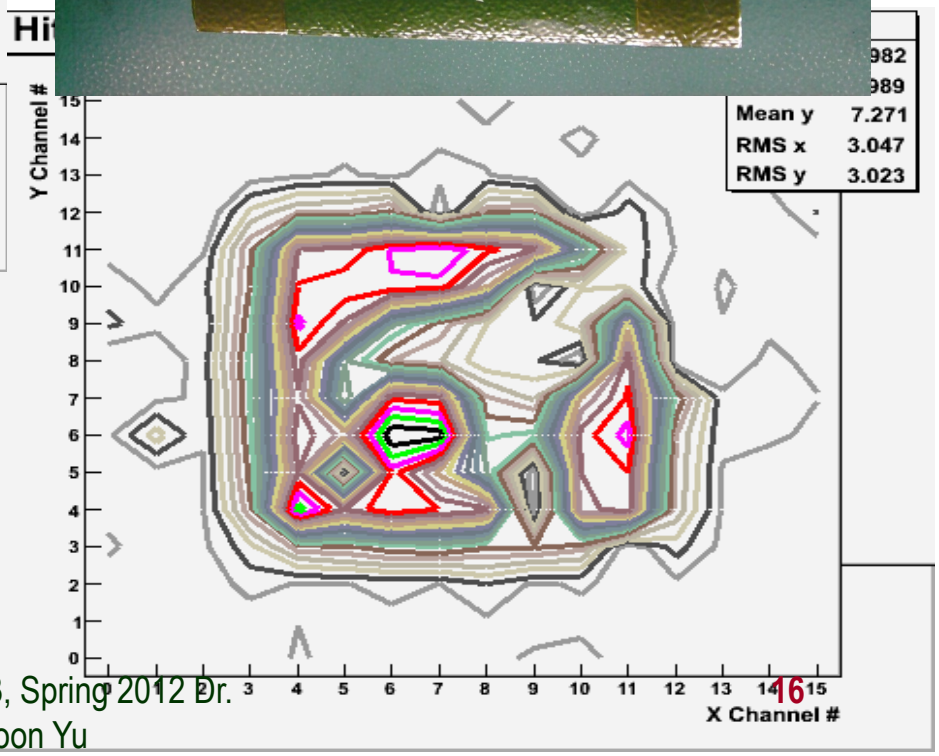


9 keV absorption radiography of a small mammal (image size ~ 60 x 30 mm^2)

Radioactive Source Run with Internal Trigger





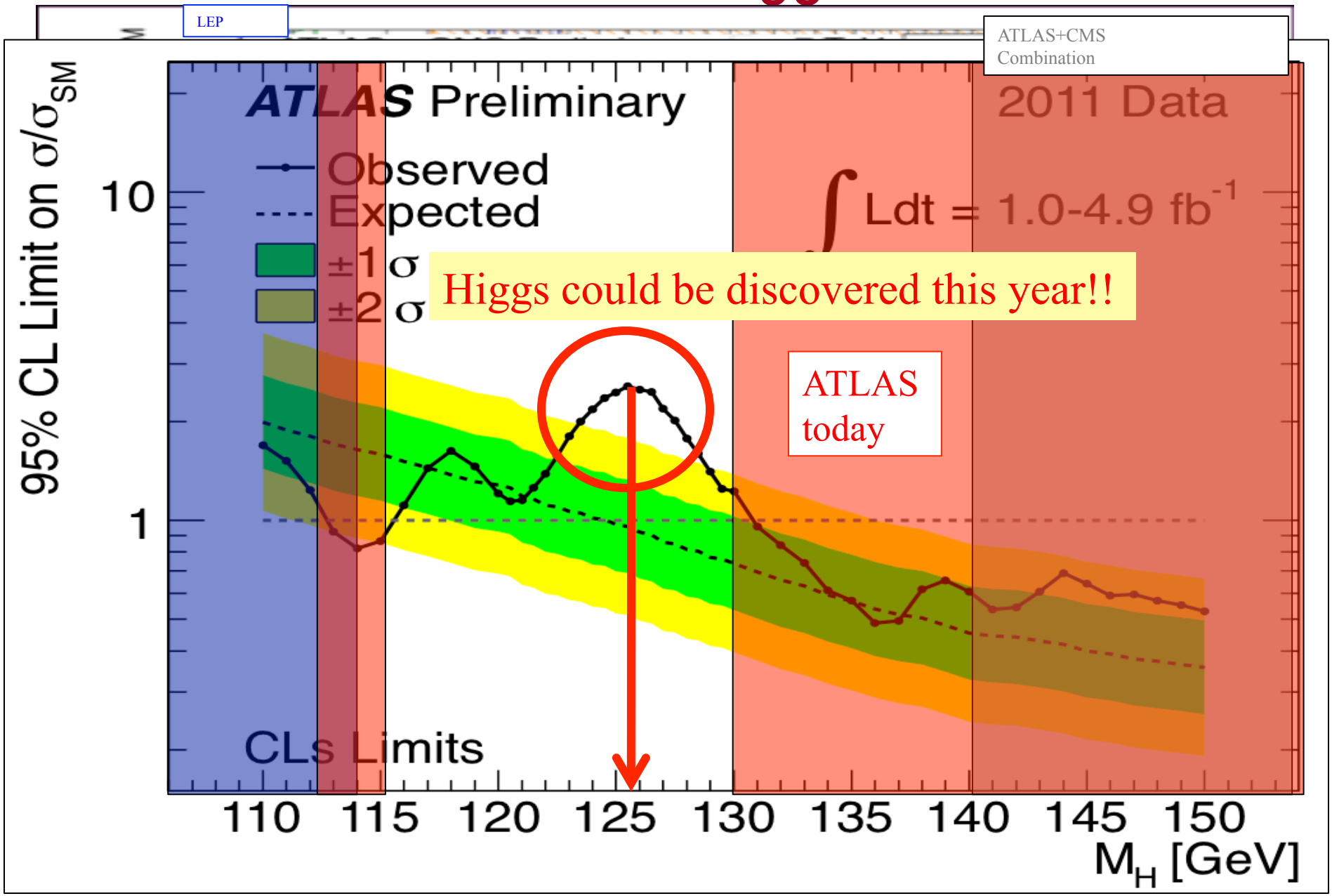


Noisy channels masked out!

Can you see what the object is?


And in not too distant future, we could do ...

Where are we with Higgs searches?



Information & Communication Source

- My web page: http://www-hep.uta.edu/~yu/
  - Contact information & Class Schedule
  - Syllabus
  - Homework
  - Holidays and Exam days
  - Evaluation Policy
  - Class Style & Communication
  - Other information
- Primary communication tool is e-mail: Make sure to subscribe to the class e-mail distribution list **PHYS1444-004-SP12** by clicking on the link https://listserv.uta.edu/cgi-bin/wa.exe?A0=PHYS1444-004-SP12
  - 5 point extra credit if subscribed by Friday, Jan. 20.
  - 3 point extra credit if done by Tuesday, Jan. 24
  - A test message will be sent out Wednesday, Jan. 25
- Office Hours: 4:00 – 5:00pm, Mondays and Wednesdays or by appointments

Evaluation Policy

- Homework: 25%
- Exams
  - Midterm and Final Comprehensive Exams (3/26 and 5:30pm, 5/7): 19% each
  - One better of the two term Exams: 12%
    - Total of two non-comprehensive term exams (2/22 and 4/25)
    - One better of the two exams will be used for the final grade
    - Missing an exam is not permissible unless pre-approved
      - No makeup test
      - You will get an F if you miss any of the exams without a prior approval
- Lab score: 15%
- Pop-quizzes: 10%

100%

- Extra credits: 10% of the total
  - Random attendances
  - Physics department colloquium participation
  - Strong participation in the class discussions
  - Special projects
  - Planetarium shows and Other many opportunities
- Grading will be done on a sliding scale

Homework

- Solving homework problems is the only way to comprehend class material
- An electronic homework system has been setup for you
  - Details are in the material distributed today and on the web
  - https://quest.cns.utexas.edu/student/courses/list
  - Choose the course **1444-Spring12**, unique number **44004**
  - Download homework #1, solve the problems and submit them online
  - Multiple unsuccessful tries will deduct points
  - Roster will close Monday, Jan. 23
  - You need a UT e-ID: Go and apply at the URL https://idmanager.its.utexas.edu/eid_self_help/?createEID&qwicap-page-id=EA027EFF7E2DA39E if you don't have one.
- Each homework carries the same weight
- **ALL** homework grades will be used for the final grade
- Home work will constitute **25% of the total** ➔ A good way of keeping your grades high
- Strongly encouraged to collaborate ➔ Does not mean you can copy

Attendances and Class Style

- Attendances:
  - Will be taken randomly
  - Will be used for extra credits
- Class style:
  - Lectures will be on electronic media
    - The lecture notes will be posted on the web **AFTER** each class
  - Will be mixed with traditional methods
  - Active participation through questions and discussions are **STRONGLY** encouraged ➔ Extra credit….
  - Communication between you and me is extremely important
    - If you have problems, please do not hesitate talking to me

Lab and Physics Clinic

- Physics Labs:
  - Starts Monday, Jan. 23
  - Important to understand physical principles through experiments
  - 15% of the grade
  - Lab syllabus is available in your assigned lab rooms.
    - Go by the lab room between 8am - 6pm M – F and pick up the syllabus
- Physics Clinic:
  - Free service
  - They provide general help on physics, including help solving homework problems
    - Do not expect solutions of the problem from them!
    - Do not expect them to tell you whether your answers are correct!
    - It is your responsibility to make sure that you have done everything correctly!
  - 11am – 6pm, Mon – Fri in SH 007
  - This service begins Monday, Jan. 23

Extra credit

- 10% addition to the total
  - Could boost a B to A, C to B or D to C
- What constitute for extra credit?
  - Random attendances
  - Physics department colloquium participation
    - Some could even be double or triple credit
  - Strong participation in the class discussions
  - Special projects
  - Watch the valid planetarium shows
  - Many other opportunities

Valid Planetarium Shows

- Regular running shows
  - We are Astronomers
  - Astronaut
- Shows that need special arrangements
  - Black Holes
  - Ice Worlds
  - Magnificent Sun
  - Stars of the Pharaohs
  - Time Space
  - Two Small Pieces of Glass
  - SOFIA
  - Violent Universe
  - Nanocam: Trip into Biodiversity
- How to submit for extra credit?
  - Obtain the ticket stub that is signed and dated by the planetarium star lecturer of the day
  - Collect the ticket stubs
  - Tape all of them on a sheet of paper with your name and ID written on it
  - Submit the sheet at the end of the semester when asked

What can you expect from this class?

- All A's?
  - This would be really nice, wouldn't it?
  - But if it is too easy it is not fulfilling or meaningful….
- This class is not going to be a stroll in the park!!
- You will earn your grade in this class.
  - You will need to put in sufficient time and sincere efforts
  - Exams and quizzes will be tough!!
    - Sometimes problems might not look exactly like what you learned in the class
    - Just putting the right answer in free response problems does not work!
- But you have a great control of your grade in your hands
  - Homework is 25% of the total grade!!
    - Means you will have many homework problems
      - Sometimes much more than any other classes
      - Sometimes homework problems will be something that you have yet to learn in class
      - Exam's problems will be easier that homework problems but same principles!!
  - Lab 15%
  - Extra credit 10%
- I will work with you so that your efforts are properly rewarded

What do we want to learn in this class?

- Physics is everywhere around you.
- Skills to understand the fundamental principles that surrounds you in everyday lives…
- Skills to identify what laws of physics applies to what phenomena and use them appropriately
- Understand the impact of physical laws and apply them
- Learn skills to think, research and analyze observations.
- Learn skills to express observations and measurements in mathematical language
- Learn skills to express your research in systematic manner in writing
- But most importantly the confidence in your physics ability and to take on any challenges laid in front of you!!

Most importantly, let us have a lot of FUN!!

In this course, you will learn…

- Fundamentals of Electricity and Magnetism
- Electric and Magnetic Forces and Fields
- Electric charge and magnetic poles
- Electric and magnetic potential, energy and power
- Propagation of electric and magnetic fields
- Relationship between electro-magnetic forces and light
- Behaviors of light and optics
- Special relativity and quantum theories