Purdue QuarkNet Workshop 2012

Schedule

- Monday:
  - Introduction to QuarkNet
  - Particle Physics and Cosmic Rays
  - Online Resources
  - Using the Cosmic Ray Detector
  - Hands on work
- Tuesday:
  - Contemporary Cosmic Ray Physics
  - Modules for Cosmic Ray Detector Experiments
  - More hands on work
- Wednesday:
  - MasterClass activity
  - Video conference with Minnesota QuarkNet center
- Thursday:
  - Tour of Fermilab
  - Cosmic Ray Detector experiments
- Friday:
  - Higgs Boson Discovery Talk
  - Pedagogy discussion

What is QuarkNet?

http://quarknet.fnal.gov/index.html

- Principal Investigators:
  - Marjorie Bardeen (Fermilab)
  - Anna Goussiou (Washington)
  - Dan Karmgard, Mitch Wayne (Notre Dame)
- Staff Teachers:
  - Tom Jordan (Florida)
  - Ken Cecire (Notre Dame)
  - Bob Peterson (Fermilab)
- And many more…

QuarkNet: The science connection you've been waiting for!

The Opportunity: "Your program rejuvenates my soul. It connects me with a cadre of intelligent and excited educators. It reinvigorates my teaching and provides me avenues to extend and enliven the projects that I can offer my students. Without the Quarknet program I am sure that I would have left teaching years ago."

The Players: High school students, teachers and physicsts working together on physics research projects exploring the hidden nature of matter, energy, space and time.

The Questions: What are the origins of mass? Can the basic forces of nature be unified? How did the universe begin? How will it evolve?

LHC & Fermilab Links

CERN Homepage
ATLAS Experiment
CMS Experiment
LHCb Experiment

Fermilab Homepage
CDF Experiment
DZERO Experiment

For Teachers

QuarkNet Classroom Activities
Cosmic Ray e-Lab
CMS Ray e-Lab
LHC Workshop Resources
CMS Masterclass Library
Online Resources
Centers

Contact us!

Join us !

For Students

Cosmic Ray Studies
CMS Studies
Run II Website
- View student Webcasts
- Analyze the data

Measuring Single Photons
Discovering New Particles
Applying Ohm's Law
The Particle Adventure
The Top Quark
Online References

Project Overview

Kudos for QuarkNet

At Work

This project is supported in part by the National Science Foundation and the Office of High Energy Physics, Office of Science , U.S. Department of Energy. Opinions expressed are those of the authors and not necssarily those of the Foundation or Department.

What is QuarkNet?
(my own thoughts)

- One area of leading edge research into the fundamental laws of nature is ***Particle Physics…***
- And in particular, ***High Energy Physics (HEP)***
- As researchers, we get to…
  - Ask big questions like
    - "What is the origin of mass?"
    - "Were is all the anti-matter in the universe?"
  - Develop new technologies for conducting leading edge experiments
  - Carry out some of the most complex experiments ever constructed
  - Collaborate with hundreds or thousands of other researchers from around the world
- This creates some unique opportunities…

What is QuarkNet?

- High school outreach:
  - Valued and supported by the National Science Foundation (NSF)
  - Community benefits from publically funded research
  - Attract students to pursue careers in science and technology

    ”QuarkNet: Helping Develop America's Technical Workforce”
  - Leading edge research is *not* abstract – it is happening now in your community
  - You and your students can be a part of it!
  - You are not on your own:
    - *18* HEP experiments
    - *475* high schools in *24* states
    - *60 ,000* students per year
  - We can help you!

QuarkNet

QuarkNet is a national program sponsored by the National Science Foundation and the U.S. Department of Energy, designed to involve high school physics and chemistry teachers in cutting-edge high energy particle physics research. Teachers work together to develop curriculum which can be incorporated into their teaching; thus, exposing students to the physics and technology of particle physics.

Particle Physics Experiments

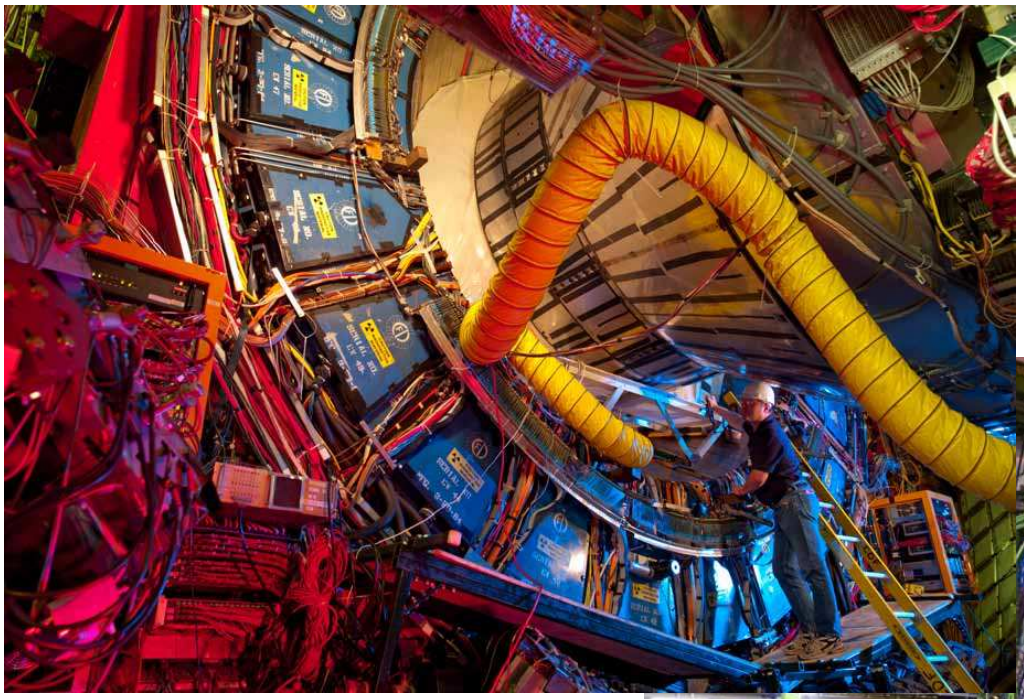
- Accelerator based experiments:

Fermilab (Batavia, Illinois)

CERN (near Geneva, Switzerland)

- Not very easy to put these in your classroom…

Particle Physics Detectors



CDF detector at Fermilab which you can visit on Thursday

CMS detector at CERN

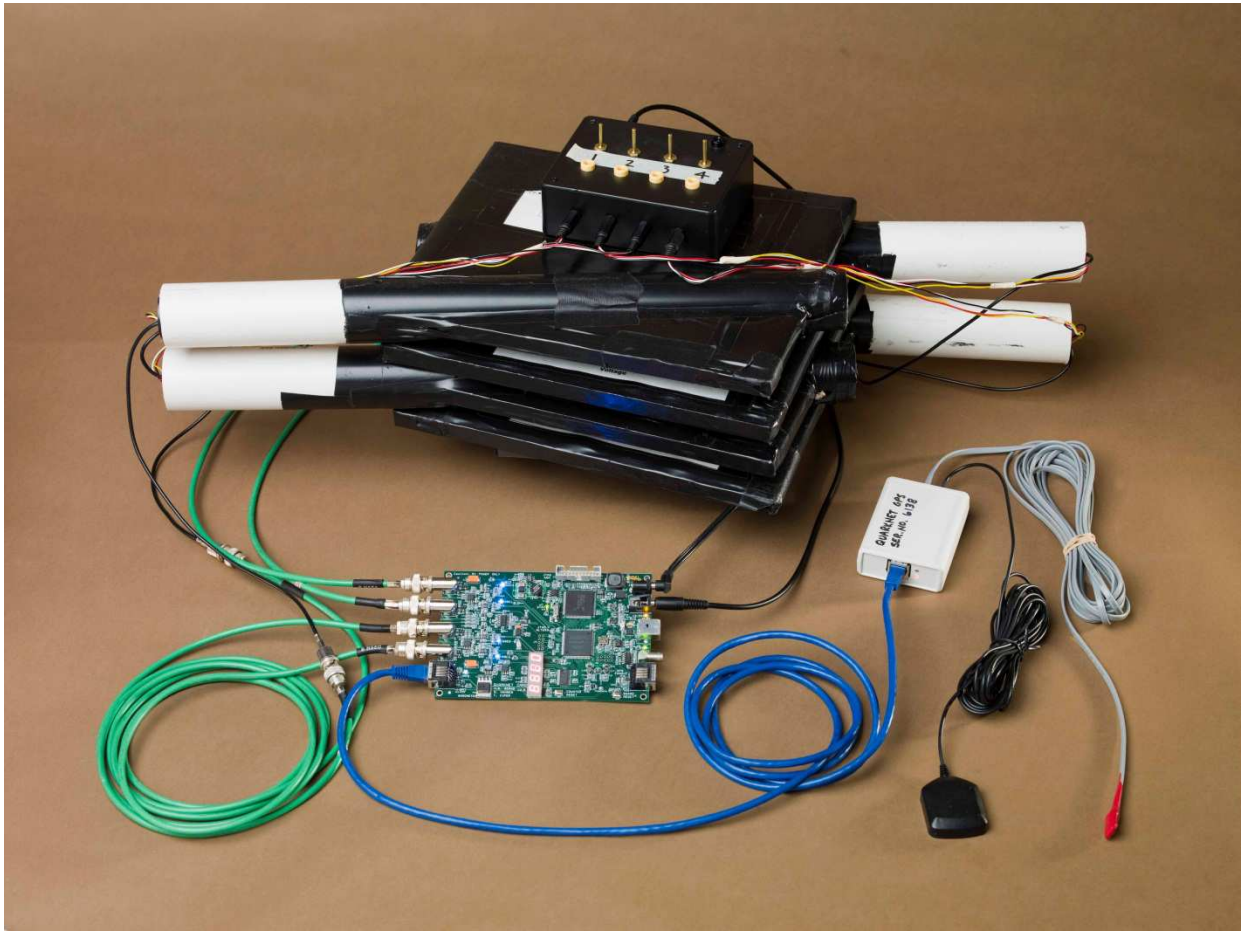
Also not easy to put in your classroom…

Particle Physics In the Classroom

- Cosmic rays:
  - Fundamental subatomic particles (mostly muons)
  - Produced when high energy protons from distant galaxies hit atoms in the upper atmosphere.

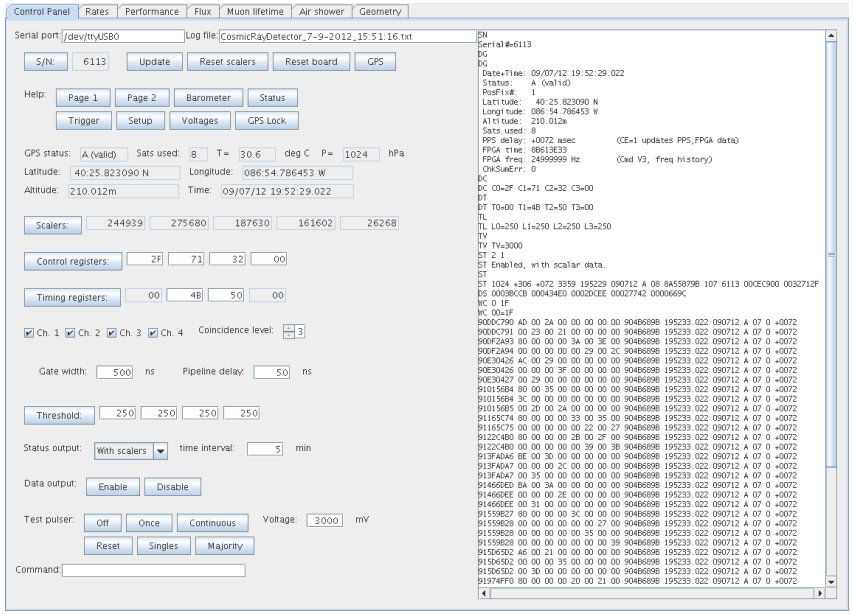
    "Where do they come from? I can't say.
    But I bet that have come a long, long way."
    – Dr. Seuss
  - The study ***fundamental particle physics*** began with the discovery of cosmic rays and is ongoing.
  - With the right equipment (which we can provide) you can study cosmic rays in your classroom.
  - You can do the same experiments that yielded Nobel prizes

QuarkNet Cosmic Ray Detector



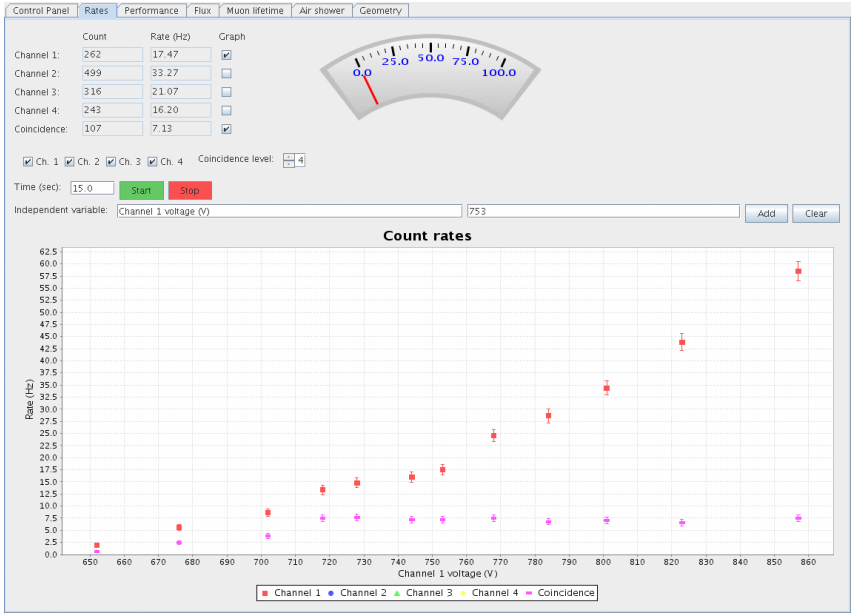
Same technologies used in modern particle physics experiments.

Cosmic Ray Detector Interface



Interacting with the cosmic ray detector hardware used to be a challenge…

… but not any more!

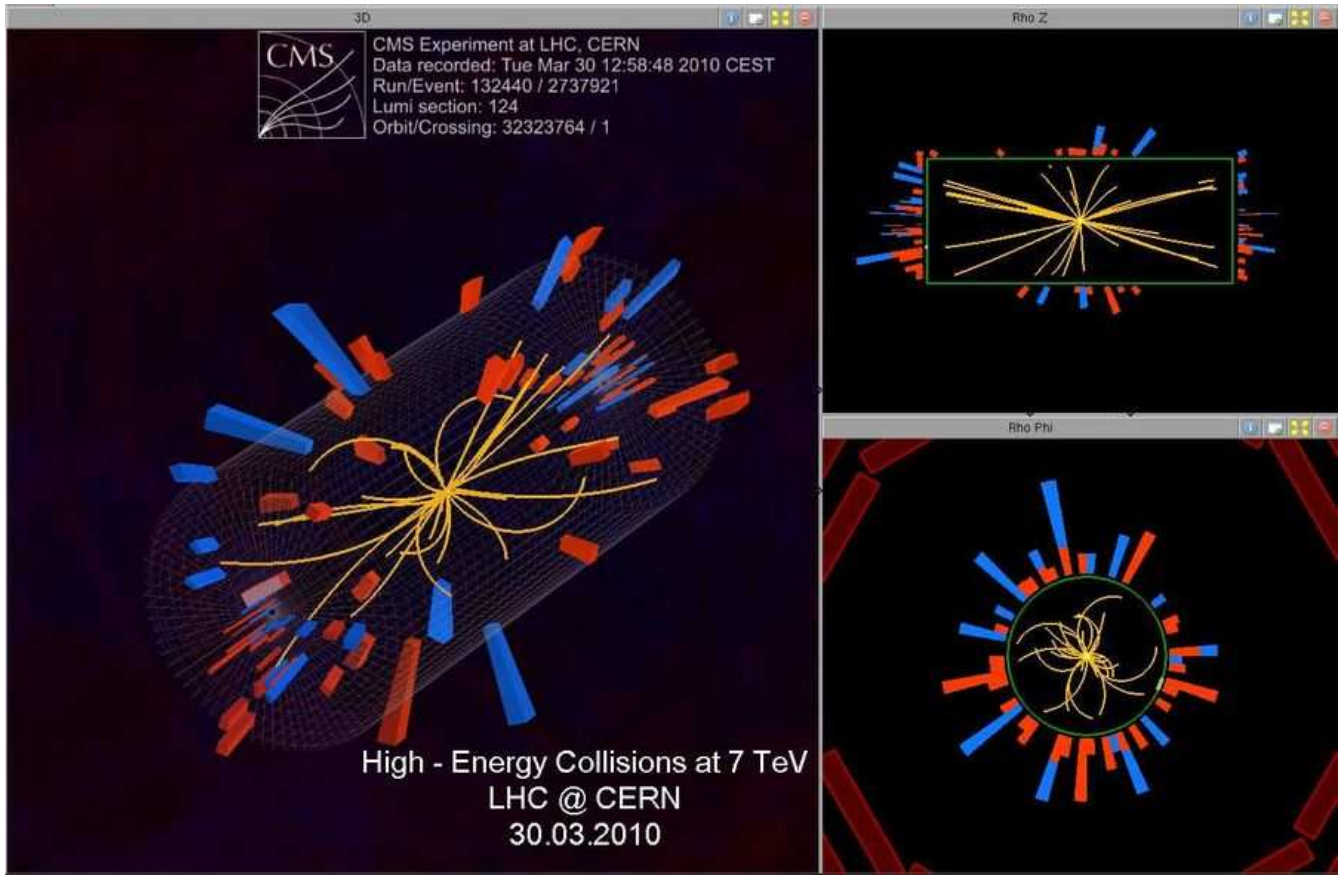


We hope to base many of the activities with the cosmic ray detector on this software interface.

MasterClass Workshops

- We can also analyze data collected with the CMS detector at CERN:
  - Students visit Purdue on a Saturday
  - Analyze data from high energy proton collisions collected with the CMS detector
  - Learn to identify muons, electrons, jets, junk, …
  - Measure stuff and interpret their measurements
  - Video conference with other centers around the world to compare results.

MasterClass Workshops



Impact on Students

- Do students really need to know about cosmic rays and particle physics?
  - Most probably don't…
- Studying cosmic rays is a model for almost any area of leading edge research:
  - We can't directly see cosmic rays, the Higgs boson, cell walls, gravitational lenses, DNA replication, black holes, tectonic plates, etc., etc., …
  - We learn about these by means of various types of technology
  - We develop a mental picture (or model) of these processes
  - We compare our model with the results of experiments
- If you can learn to do this, then you are a scientist.