Helping Develop America's Technological Workforce

QuarkNet

The QuarkNet Collaboration

Office of Science
U.S. DEPARTMENT OF ENERGY

Helping Develop America's Technological Workforce

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Our Research Community

Physicists, teachers & their students collaborate on research projects and investigations.

QuarkNet . . .

- Supports learning by inquiry.
- Provides teachers and students with real research opportunities in particle physics.
- Encourages national and international collaboration among students, teachers and scientists.

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Vision & Goals

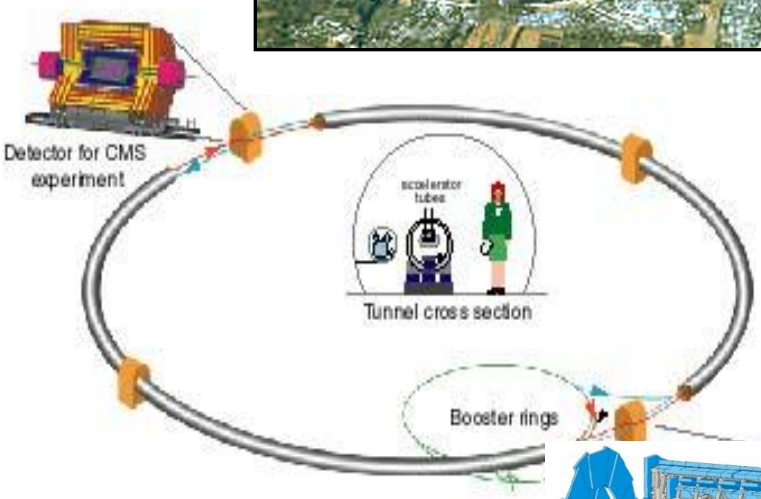
Engagement with Scientific Investigations:

- **Enables teachers to teach basic physics concepts in an exciting & rewarding context.**
- **Builds a teacher's confidence to bring current science into the classroom.**
- **Links high school classrooms with frontier experiments.**
- **Attracts students to careers in science & technology.**
- **Helps develop science literacy.**

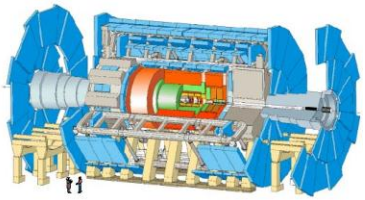
At CERN

Our understanding of the universe is changing as the LHC and its experiments—ALICE, ATLAS, CMS and LHCb—collect and analyze data.

Join particle physicists to work on physics projects exploring the nature of matter, energy, space and time.



ATLAS & CMS



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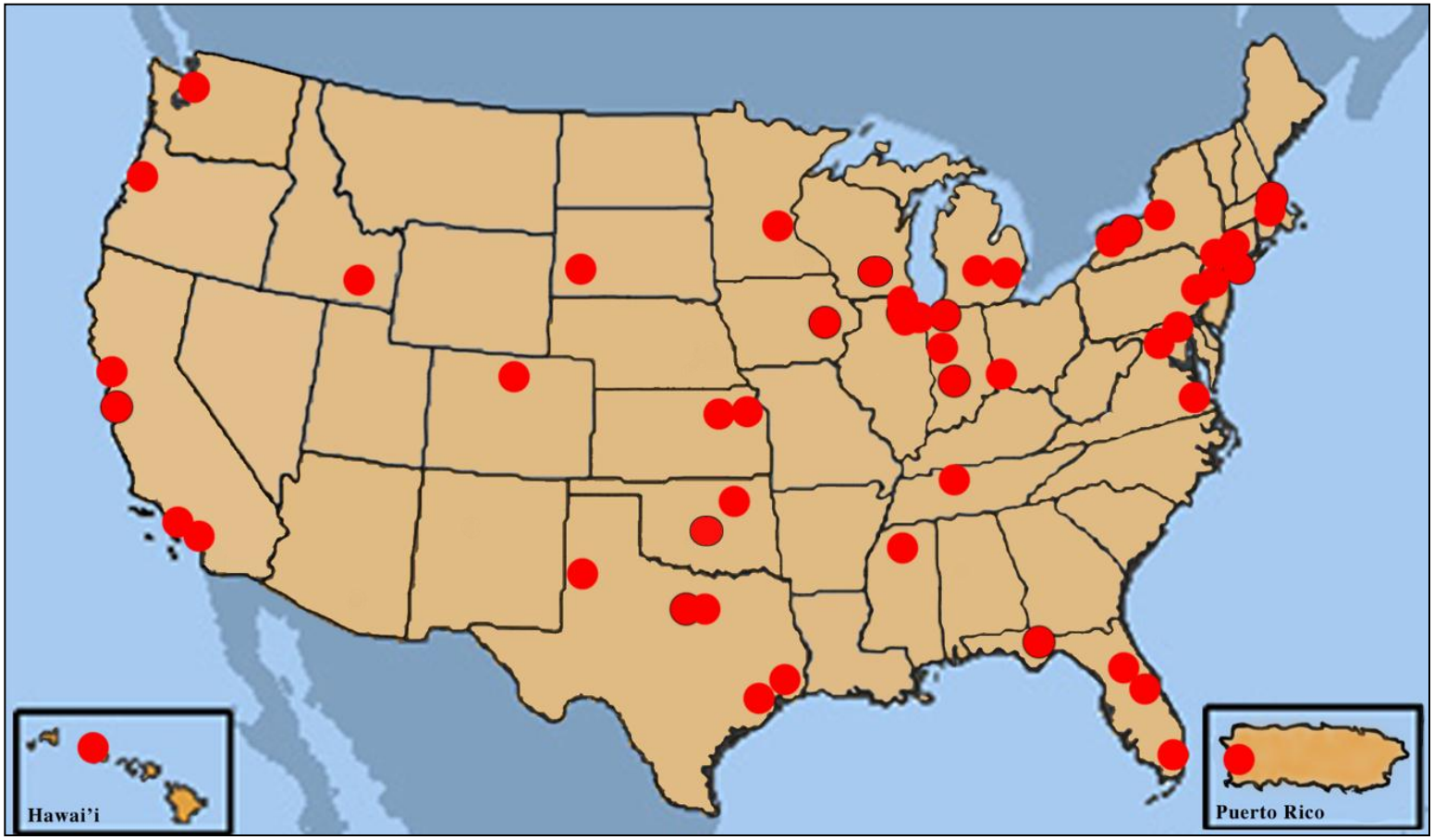
Active Centers



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The Program

At most centers a one-week workshop (with stipend)

Optional Activities

- **Particle Physics Boot Camp**
- **Cosmic Ray Data Exploration**
- **U.S. Particle Physics Masterclass**
- **High School Student Summer Research Teams**

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Boot Camp - Professional Development for Teachers

- Models student investigation
- New lead teachers
- "Returning teachers"
- Teacher milestones
- Research posters
- Pedagogy reflections

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Boot Camp - Professional Development for Teachers

Research teams:

- Explore data to learn about particle physics.
- Use energy and momentum conservation.
- Reconstruct Z decays from event data.
- Present findings in culminating poster session; talks and tours provide background info.

SRCH EPCF

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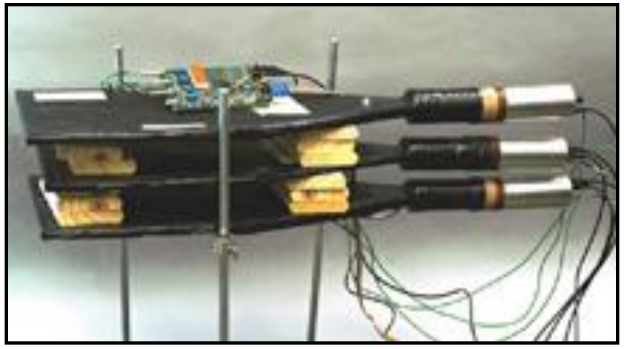
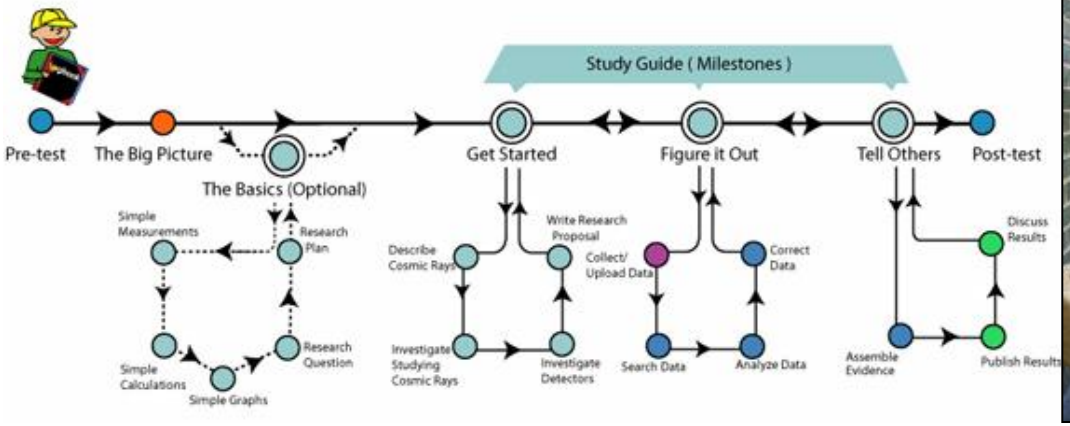
Cosmic Ray Studies

Student investigations:

- Classroom detectors
- Online e-Lab for data analysis & collaboration
- Based on teachers' ideas





e-Lab Study Guide

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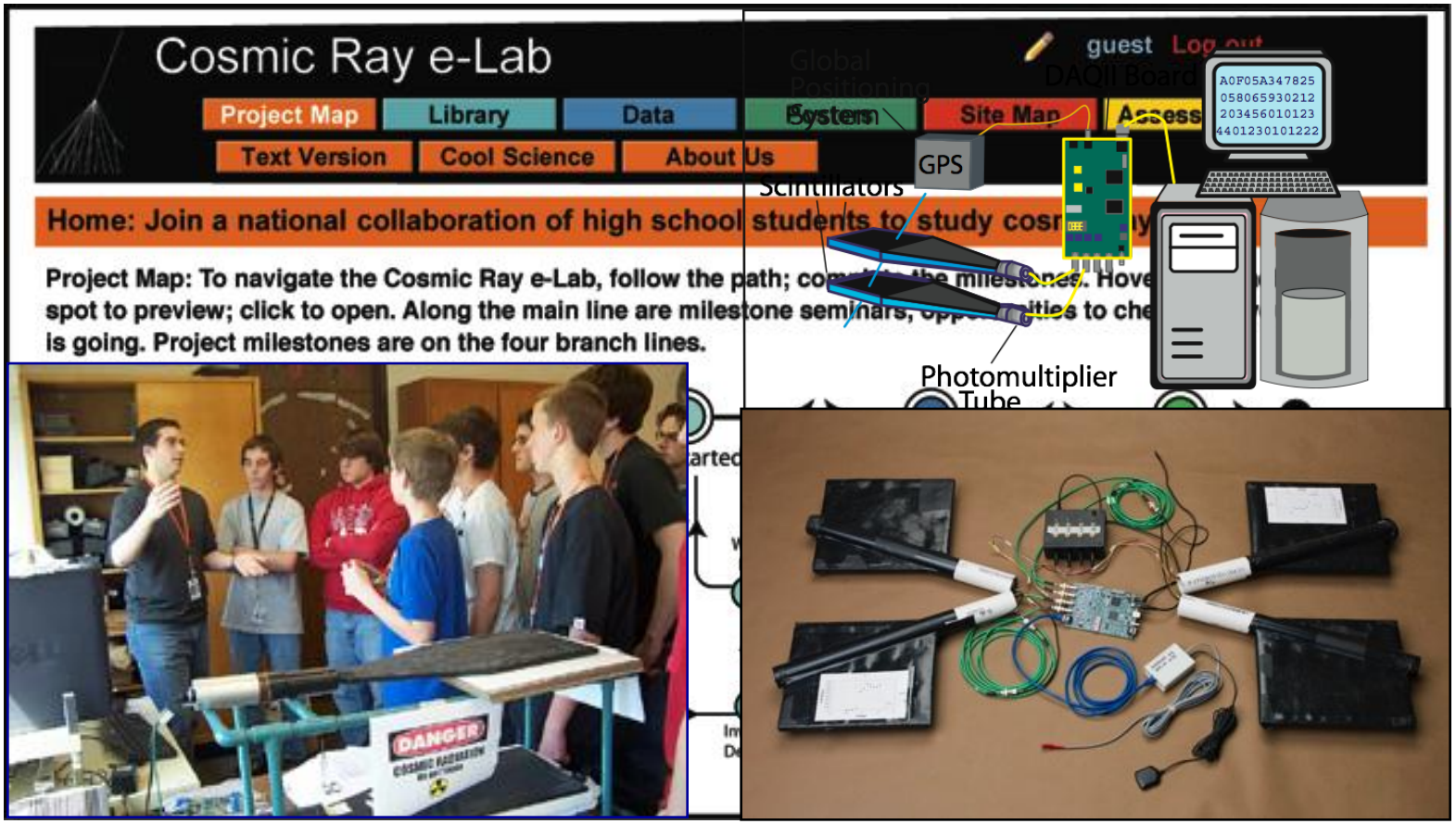
Cosmic Ray Studies



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U.S. Masterclass

Mentors and teachers:

- **Host students for the day.**
- **Teach students to read (LHC) data—ALICE, ATLAS, CMS.**
- **Coach students as they analyze data.**
- **Assist students in interpreting the results.**

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U.S. Masterclass

Student teams:

- **Discover the world of quarks and leptons with real data.**
- **Join a videoconference with students around the world.**

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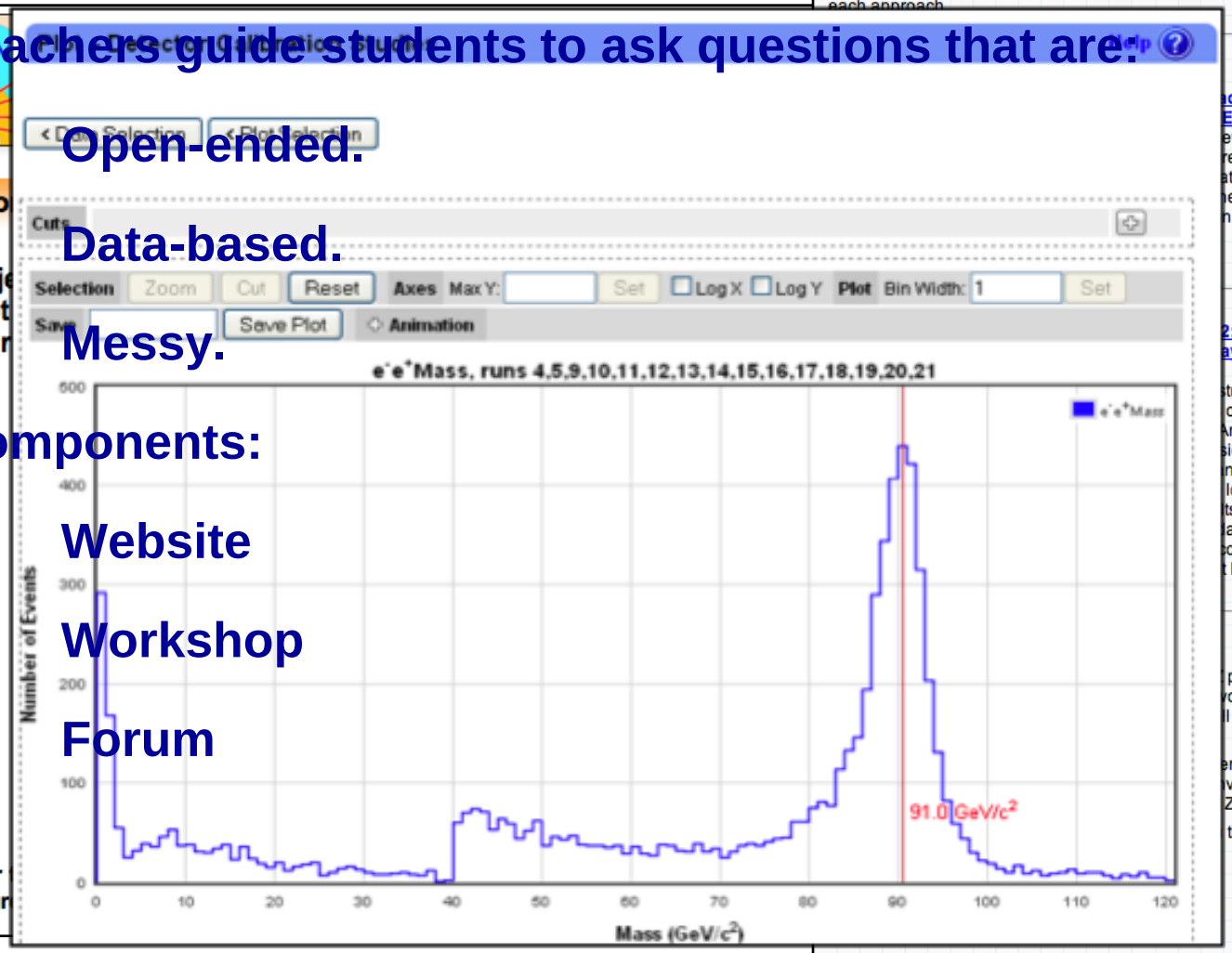
CMS e-Lab:

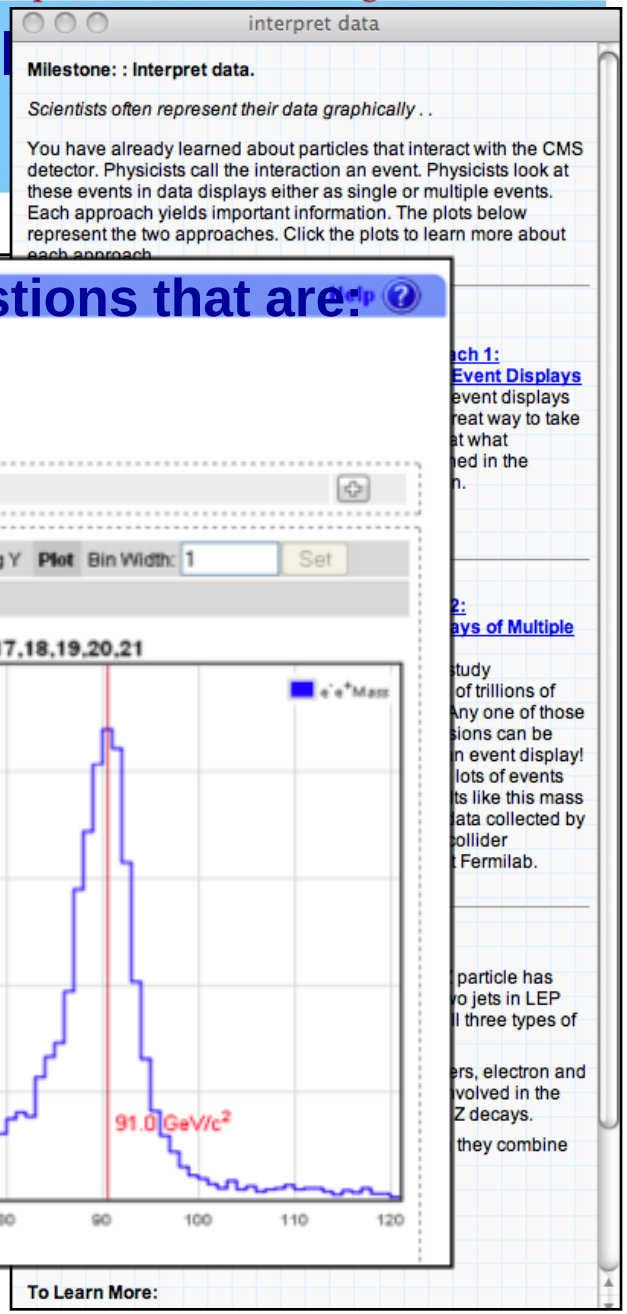
Teachers guide students to ask questions that are:

- Open-ended.
- Data-based.
- Messy.

Components:

- Website
- Workshop
- Forum





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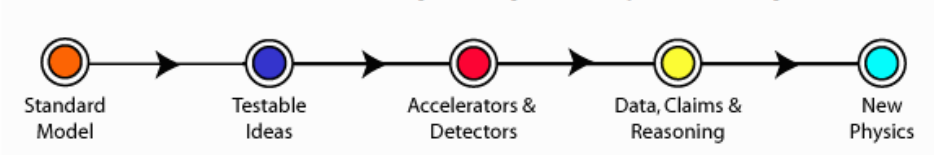
LHC Resources

The LHC: At the Energy Frontier

Hover over each hot spot to preview; click to open.



CERN's Large Hadron Collider will open new vistas on the deepest secrets of the universe, stretching the imagination with newly discovered forms of matter, forces of nature and dimensions of space.

The Standard Model is the current framework for our understanding of matter. LHC and its experiments are designed to address fundamental questions not explained by the Standard Model.

Basic research is a journey, not an event. Following along as physicists close in on new physics requires knowledge of LHC physics, accelerator and detector design, and how data inform claims and reasoning.

What is dark matter? What happened to antimatter? Are there extra dimensions of spacetime? These resources provide background information for the next discoveries. Unit Overview - Student Resources

http://quarknet.fnal.gov/projects/lhc/

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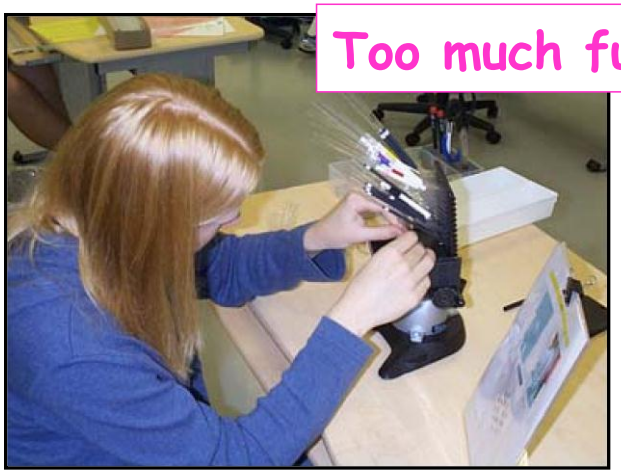
Student Summer Research

Invaluable Experience

Too much fun



Team: 1 teacher + 4 students

Continually challenged me

Astounded by the beauty & simplicity of the particles that define our existence

A taste of a succulent future

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Student Summer Research

"Quantitative Spectral Analysis"
"The Goldilocks Effect: The Drake Equation"
"Sample Preparation for Beam Tests"

2010

Other Opportunities

Five teachers go to CERN in Geneva, Switzerland for a three-week workshop.

and . . .

Some teachers are part of the Fellows Program.

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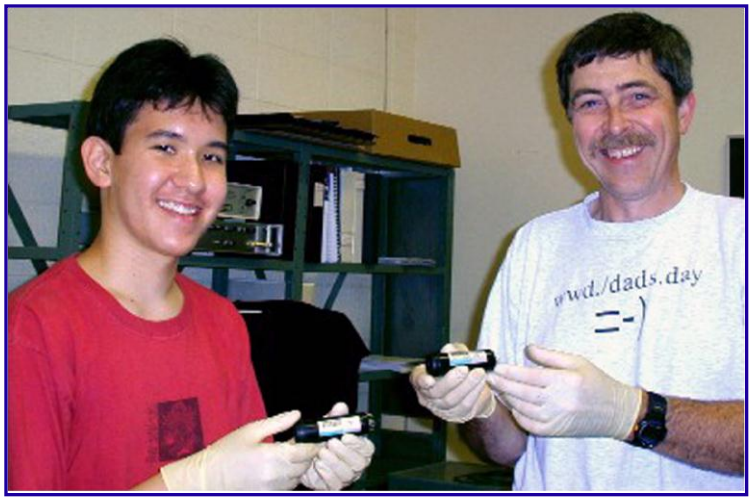
Impact

Long-term relationships for teachers' professionalism

Students' opportunities and abilities to engage in scientific investigations



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Teacher Outcomes

QuarkNet teachers will be able to:

- **Discuss and explain particle physics concepts.**
- **Use particle physics examples in an interactive way when teaching subjects such as momentum and energy.**
- **Facilitate student investigations in a manner that follows scientific practices.**
- **Act in leadership roles to the larger education community.**

Student Outcomes

Students will be able to:

- **Discuss and explain particle physics concepts.**
- **Discuss and explain how scientific knowledge is developed.**
- **Engage in scientific practices and discourse.**

<u>Unexpected Outcomes</u>

- ***Knowledge of what physicists actually do***
- ***Respect for teachers through their work with physicists***

By the Numbers

537 Teachers & Their Students

97 Mentors
53 Centers

9-11 Experiments

5.6 Staff Members
4 PIs

DOE-NSF

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For more information

Kris Whelan

University of Washington

kkwhelan@uw.edu

QuarkNet Website

http://quarknet.fnal.gov