

QuarkNet

QuarkNet

- **A bit of history**
- **Current Program Structure**
- **Program Activities**
 - **National Program**
 - **Local Centers**
- **Summary**

Mitch Wayne

University of Notre Dame



Our Vision

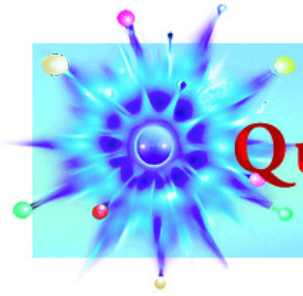
To create a lasting community of researchers that includes high school teachers and students as well as physicists

“Doing science.”

School science reflects the practice of science.

Science is what students DO, not what is done to them

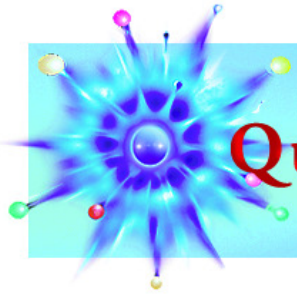




QuarkNet

The QuarkNet Collaboration





QuarkNet

Administrative Structure

NSF Meeting on Broader Impacts – circa '97

Project Creators:
Baker, Bardeen, Barnett, Ruchti



Advisory Board

Project Offices
Fermilab and Notre Dame
PI: Bardeen

Project Evaluation

Project Staff
Teachers

Project
Administrative and
Technical Staff

1

2

3

4

>>>

48

49

~50

Virtual
Center



Personnel

QuarkNet Project Staff

• Principal Investigators:

- M. Bardeen, Fermilab
- M. Barnett, LBNL
- D. Karmgard, Notre Dame
- R. Ruchti, Notre Dame
- M. Wayne, Notre Dame

• Administrative Staff:

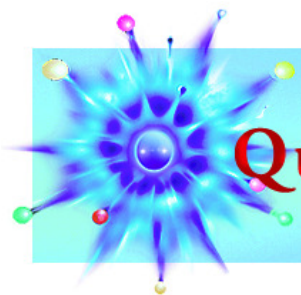
- L. Gill, Fermilab
- G. Millman, Fermilab
- M. Zakas, Notre Dame

• Staff Teachers:

- K. Cecire, Hampton (now Notre Dame)
- T. Jordan, Florida
- B. Marchant, Notre Dame (emerita)
- R. Peterson, Fermilab
- K. Whelan, LBNL

• Technical Support:

- D. Hoppert + Docents, Fermilab
- J. Marchant, Notre Dame
- M. Vigneault, Notre Dame



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Program Growth

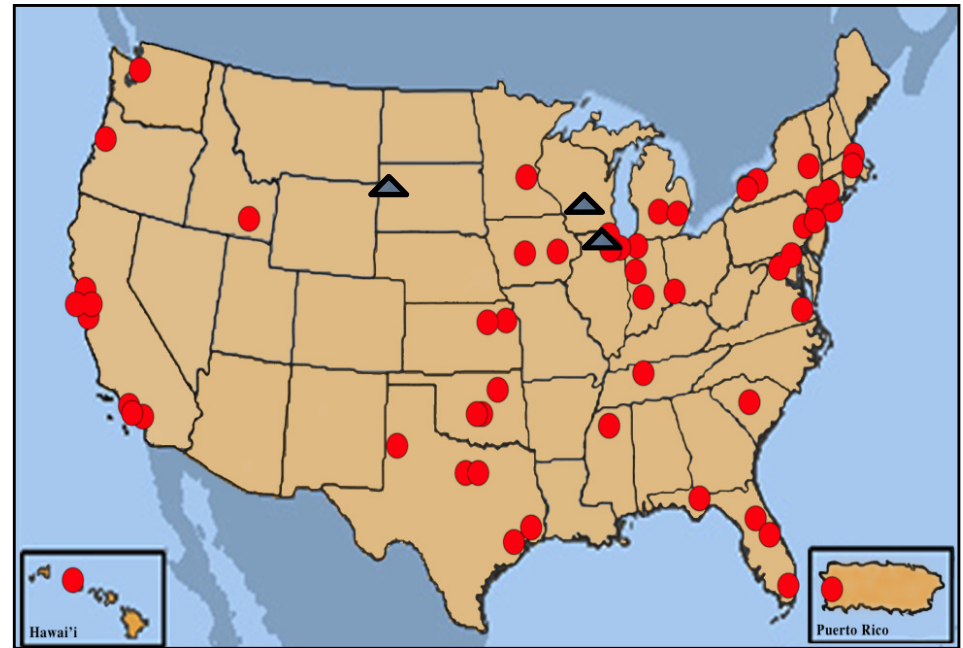
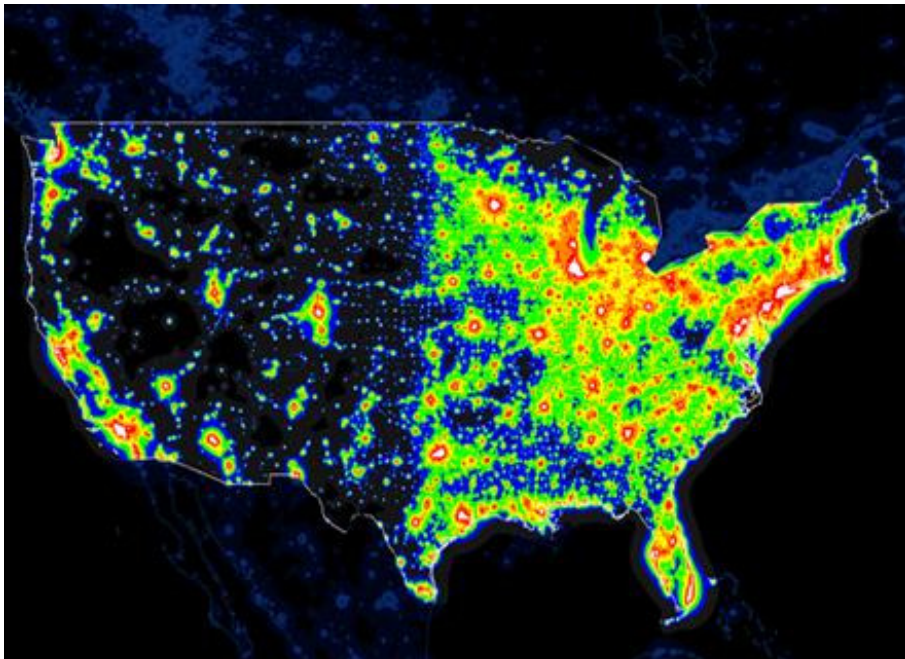
Active Center Participation by Year

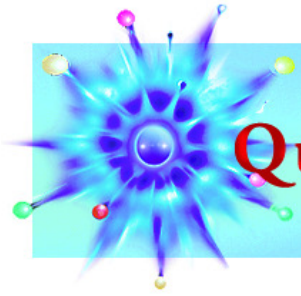
Project Year	# Center I	# Center II	# Center III	# Center III + students	Total # centers
1999	11				11
2000	13	11			24
2001	8	13	11		32
2002	7	8	24		39
2003	9	7	32		48
2004	4	9	33	6	52
2005		4	36	12	52
2006	1	2	28	13	51
2007	1	1	23	16	52
2008	1	1	27	16	45 (+1)
2009	2	1	23	23	49 (+1)



Geographical Distribution of Centers

QuarkNet Center Locations





QuarkNet

Program Planning and Evolution

**FY 98 – FY02:
Program Establishment**
Initial Center Formation

Inquiry –
based
instruction

**FY02 – FY07:
Program Growth**
Maximum Size of 50 Centers

Student
Researchers
Introduced

e-labs and
i-labs/I2U2
Concept

**FY07 – present:
Enrichment**

Teacher –
Learning
Fellows

I2U2
Launched

LHC
Fellows

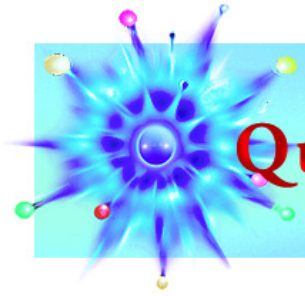
e-Labs

Master
Classes

Virtual
Center

LHC
Awareness

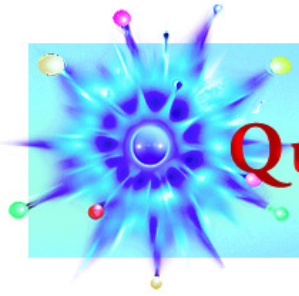
Participation in and access to LHC (and other experiments) and data



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Project Activities

- **National level**
 - **Fellows**
 - **Boot Camp**
 - **Virtual Center**
 - **e-Labs**
 - **Masterclass**
- **Local level**
 - **QuarkNet weeks**
 - **Teacher professional development**
 - **Student Research Experience**



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Teacher Fellows

The fellows are a force multiplier for staff efforts.

- 5 existing groups
 - LHC
 - vLHC
 - Teaching and Learning
 - e-Labs
 - Leadership



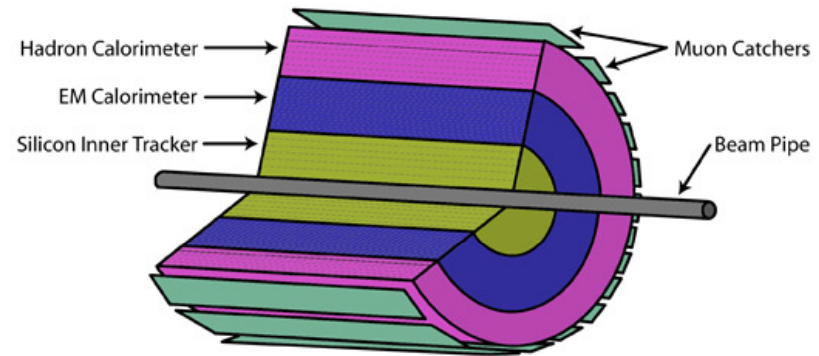


Annual Boot Camp

Provide more teachers the opportunity to:

- Connect entry-level physics to particle physics.
- Experience guided learning from the “other side of the desk.”

SRCH Detector System





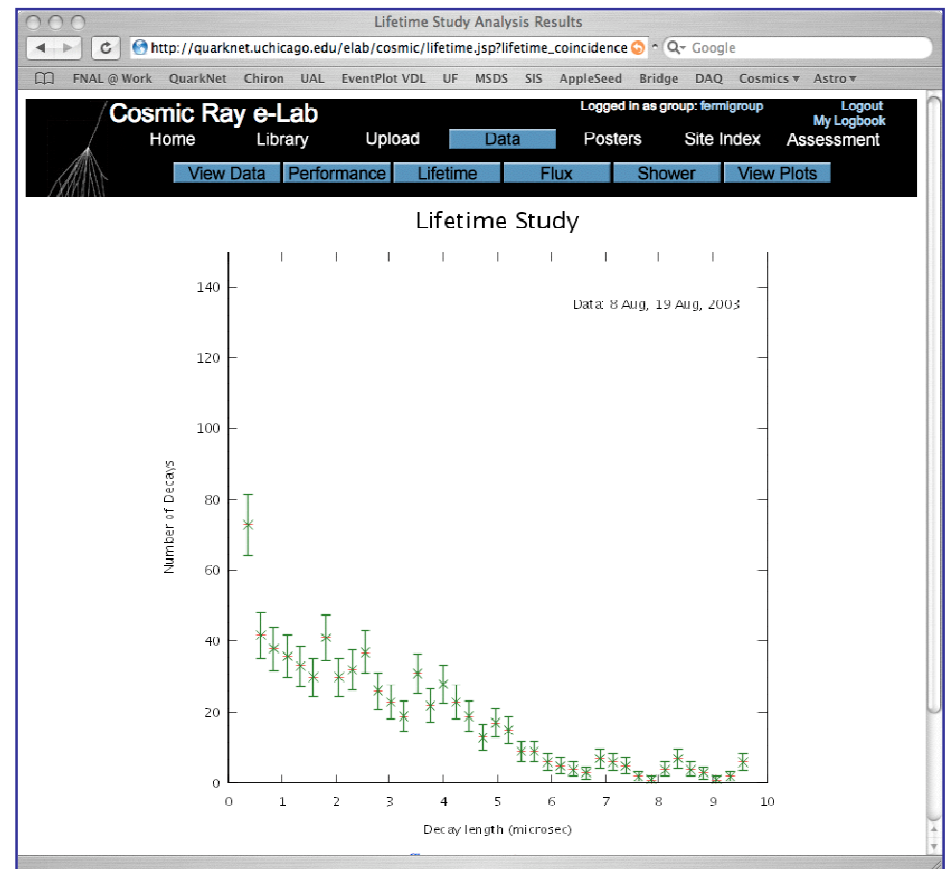
Virtual Center

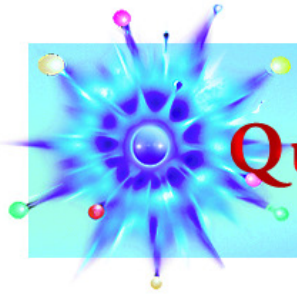
- **Supports teachers that have been “orphaned” due to:**
 - Their own relocation.
 - Their center disbanding.
- **Teachers were already QuarkNet participants.**
 - Set up Web 2.0 site for interaction and sharing
 - Hold monthly EVO meetings.
 - Explored the e-Lab with e-Lab fellows.
 - Contact with international colleagues
- **Holding a face-to-face meeting at ND this week**



e-Labs

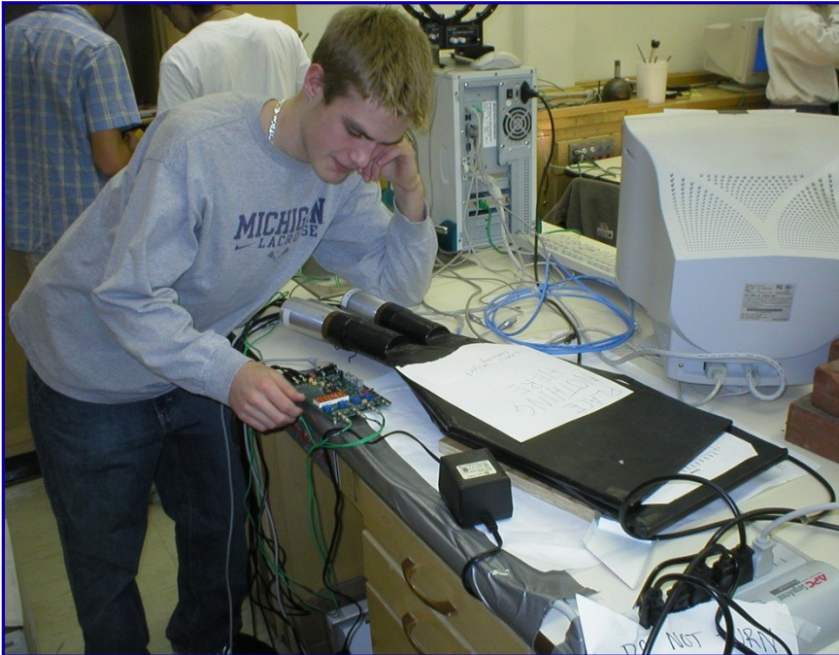
- Supports access to:
 - Raw or MC data
 - Analysis routines
 - Data product storage
 - “Publication” of results



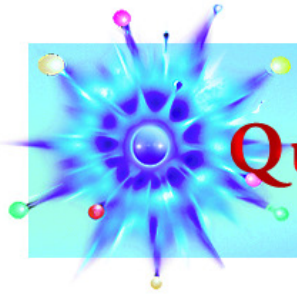


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Cosmic Ray Muon Detectors



- 350 in the field
- Requests for 48 more in 2009
- Significant interest outside QuarkNet
- Students & teachers collaborate on simple experiments:
 - Shielding
 - Rates
 - Showers



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The Cosmic Ray e-Lab

A screenshot of a web browser displaying the QuarkNet Cosmic Ray e-Lab homepage. The browser's address bar shows the URL 'http://quarknet.uchicago.edu/elab/cosmic/home.jsp'. The page features a navigation menu with buttons for 'Home', 'Library', 'Data', 'Posters', 'Site Index', and 'Assessment'. A prominent orange banner reads 'Join a national collaboration of high school students to study cosmic rays.' The main content area is titled 'Why cosmic rays?' and includes sections for 'Who are we?' and 'Who can join?'. A 'Logout' button is visible in the top right corner of the page content.

Quarknet Grid Home

http://quarknet.uchicago.edu/elab/cosmic/home.jsp

FNAL @ Work QuarkNet Chiron UAL EventPlot VDL UF MSDS SIS AppleSeed Bridge DAQ Cosmics Astro

Cosmic Ray e-Lab Logged in as group: [] Logout My Logbook

Home Library Data Posters Site Index Assessment

Join a national collaboration of high school students to study cosmic rays.

Why cosmic rays?

Spending all your time in a shower?

When you're sleeping or sitting in class, cosmic rays shower the earth and everything on it.

What are cosmic rays?

Where do they come from?

Where do they hit?

Some cosmic rays have so much energy that scientists are not sure where they come from. A number of research projects are looking at this question.

Who are we?

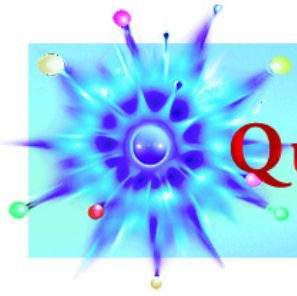
We're a collaboration of high school students and teachers collecting and analyzing cosmic ray data to answer some of these questions. We're working with computer scientists to provide cutting edge tools that use grid techniques to help you share data, graphs, and posters and collaborate with other students nationwide.

Who can join?

You! Think about steps you'd take to investigate cosmic rays. How would you get started? What do you need to know? Can you collect and use data?

Logout
If you are not logged in, click here to login.
Logout

- ~ 600 teacher accounts
- > 1,000 student accounts
- ~20,000 raw data files
- Thousands of analyses run this year
- Hundreds of posters created by students



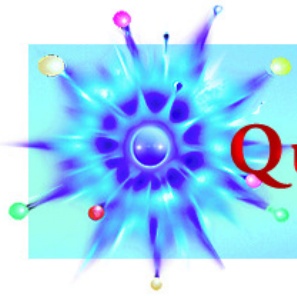
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U.S. Masterclass

EPPOG runs this for European high school students. Students analyze LEP data to study Z-decays and LHC Monte Carlo data

- **QuarkNet teachers modified this to be more involved in what the students do and learn.**
 - **21 centers participated in 2009**
 - **~350 students in total**
 - **QuarkNet mentors tutored students.**



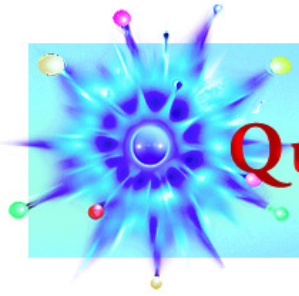


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Local Center Activities

QuarkNet Centers ...

- **Construct equipment to take into the classroom**
 - Cloud chambers
 - Cosmic ray detectors
 - Radio telescopes
 - Balloon borne measurements ...
- **Design experiments using the equipment**
- **Host talks on latest developments in the experiments (ATLAS, CMS, etc.) and in physics**
- **Promote sharing of curriculum among teachers**
- **Arrange for tours of Fermilab, university labs, etc.**
- **Guest lecturers for classrooms**



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High School Summer Students

Students Doing Summer Research



- 23 Centers in 2009
- Students are plugged directly into experiments in HEP, including:
 - D0 Fiber Tracker
 - CMS HCAL
 - MINERvA
 - ILC R&D ...



QuarkNet

Helping Develop America's Technological Workforce

ND Center Activities

THE MAGICAL WORLD OF PHOTONIC METAMATERIALS

OPN Optics & Photonics News

November 2008
Vol. 19 No. 11 | \$8.25
www.osa-opn.org

Coaxial Holographic Data Recording
Analysis of a Sunset
Optical Interference Coatings

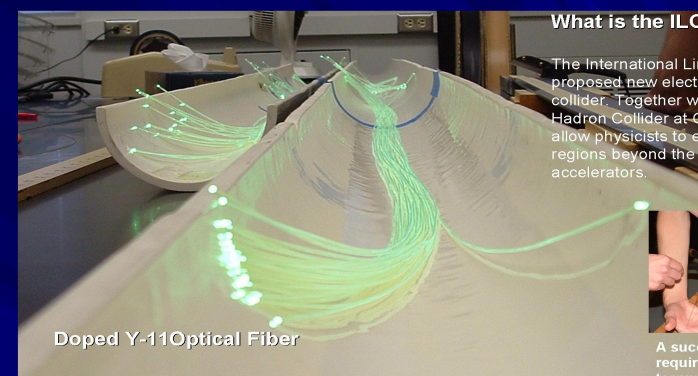
Turning High Schoolers into High-Energy Physicists

OSA



International Linear Collider Muon Detector Prototype

A New Effort in High Energy Physics for the Future

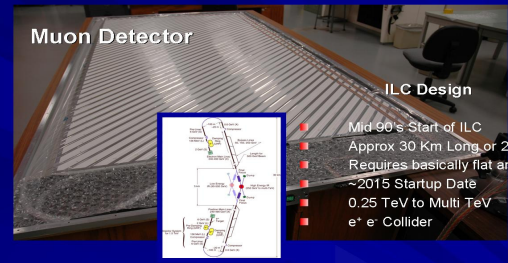
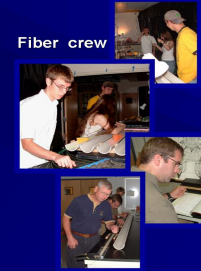


What is the ILC?

The International Linear Collider is a proposed new electron-positron collider. Together with the Large Hadron Collider at CERN, it would allow physicists to explore energy regions beyond the reach of today's accelerators.

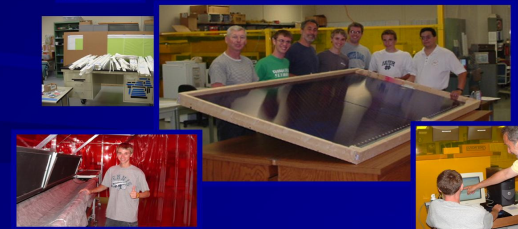


A successful project requires a lot of teamwork



ILC Design

- Mid 90's Start of ILC
- Approx 30 Km Long or 20 mi.
- Requires basically flat area
- ~2015 Startup Date
- 0.25 TeV to Multi TeV
- e⁻e⁺ Collider



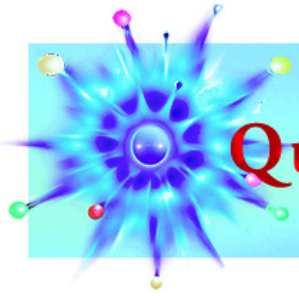
Muon Detector Construction

- Notre Dame collaboration with FermiLab & other Universities
- Prototype using Scintillator and Fibers
- 1/4 sized or is it 1/2?

Muon Detector Construction Team: Dr. Mitch Wayne, Mike McKenna, LeRoy Castle, Rich Eberly, Pat Kosciuk, Matt Weis, Stanley Strycker, Tom Burger, Sarah Schlobahn, ND Machine Shop: Don Gard, Terry Arter, Michael Wright

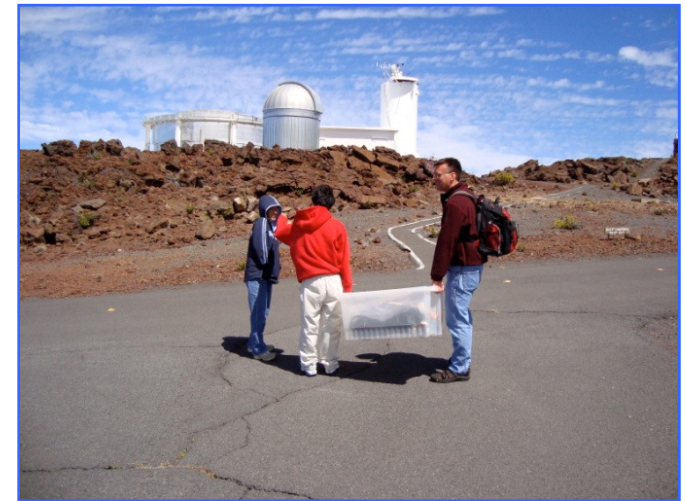
Collaboration with: Fermi National Accelerator Laboratory, Wayne State University, University of California, Davis, Colorado State University

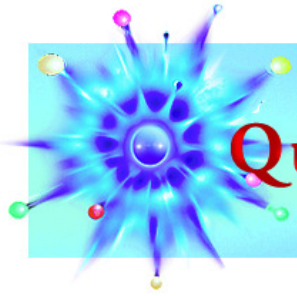




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Local Program - Stories





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Summary

- **A model of inquiry-based learning**
- **A large community**
 - **~ 50 Centers in 25 states + Puerto Rico (+ virtual center)**
 - **Serving 570 high schools**
- **A large impact on teachers**
 - **A community of teachers**
 - **University/lab faculty as mentors**
- **A large impact on students (about 400,000 since 1998)**
- **Analysis of real data from forefront experiments**
- **Use of Grid tools and networking**
- **Persistence – a twelve-year history and going strong**
 - **A staff of four high school teachers to make it work**
- **Looking forward to start of LHC, ATLAS and CMS**