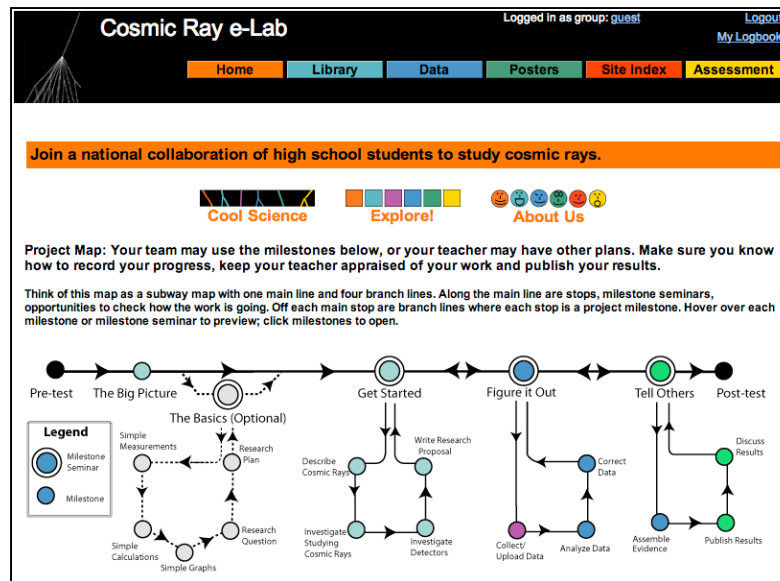


The Thinking Behind an e-Lab

A Marriage Between High School Physics & Grid Computing

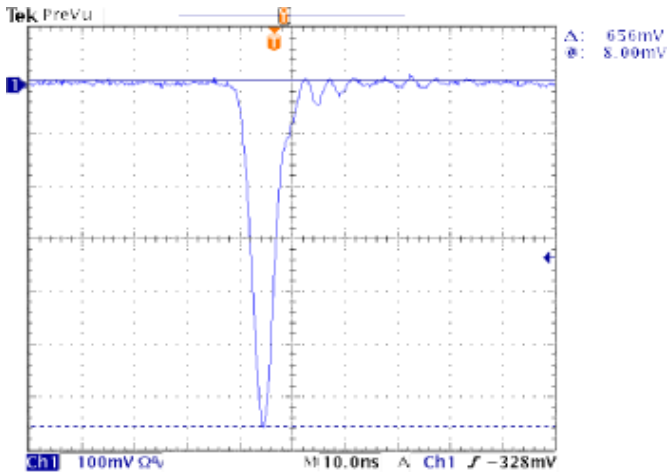


Marge Bardeen
Fermilab

Have cosmic ray data.
 Would like to share.
 Let's do shower studies.

```

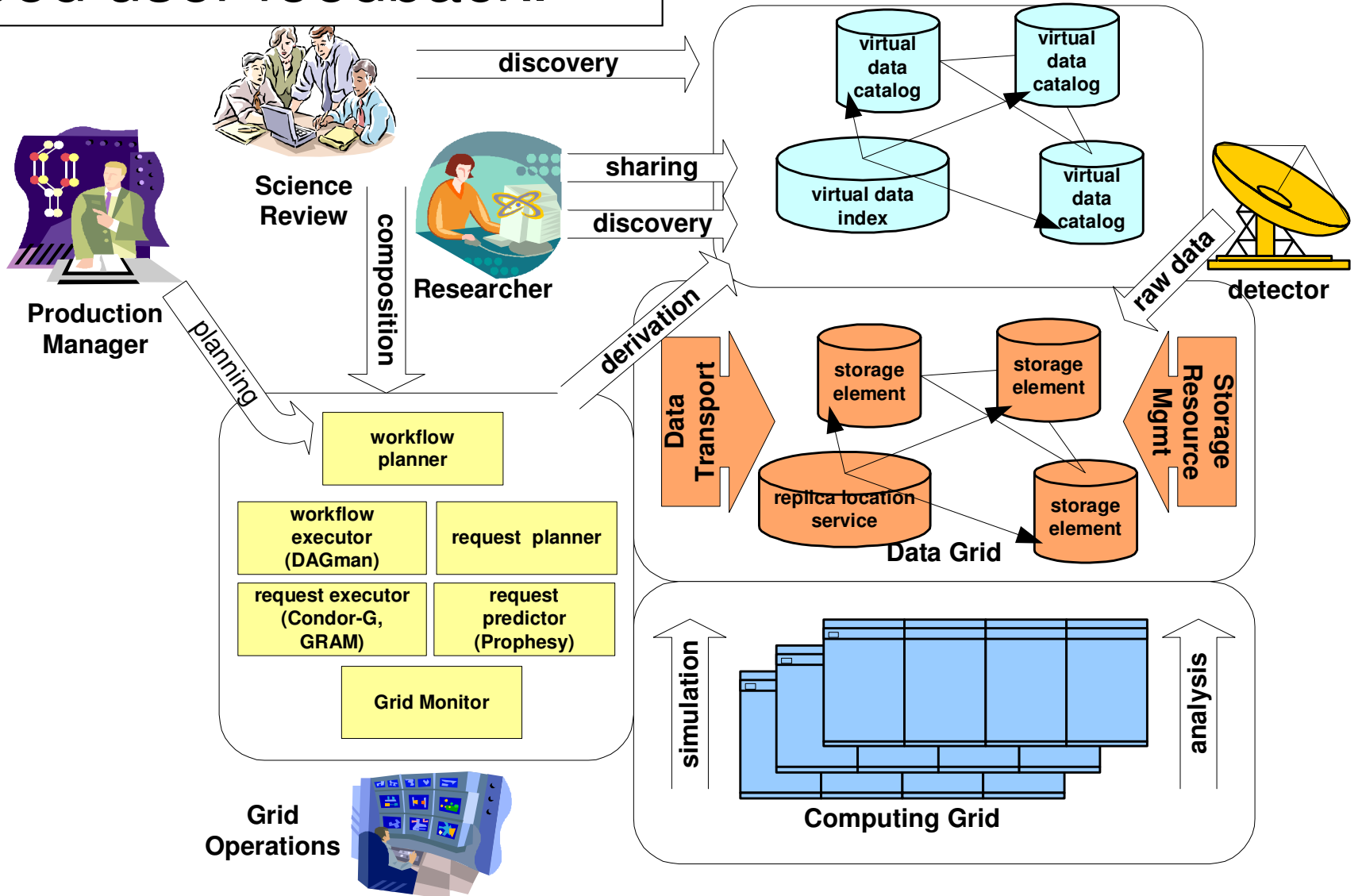
02F17C70 AE 3E 23 30 00 01 00 01 01BAB196 053657.359 260105 A 10 0
00 01 00 01 3B 01 1814BD14 053706.358 260105 A 10 0
00 01 00 01 01 2A 1814BD14 053706.358 260105 A 10 0
00 01 00 01 00 01 1814BD14 053706.358 260105 A 10 0
00 01 00 01 2E 3A 2203DEA2 053710.358 260105 A 10 0
00 01 3C 01 00 01 5B22DF98 053733.357 260105 A 10 0
00 01 01 33 00 01 5B22DF98 053733.357 260105 A 10 0 +0366
1 2E 32 00 01 629638C4 053736.356 260105 A 09 0 +0389
1 39 01 36 01 8A52BEFF 053752.356 260105 A 10 0 +0367
1 01 27 01 2F 8A52BEFF 053752.356 260105 A 10 0 +0367
4 00 01 33 3F 8A52BEFF 053752.356 260105 A 10 0 +0367
1 00 01 00 01 8A52BEFF 053752.356 260105 A 10 0 +0367
3AC041A3 80 01 28 57 00 01 27 2C 3AA752A6 053902.352 260105 A 10 0 +1371
3AF5EFAC BC 01 00 01 00 01 31 3E 3AA752A6 053903.352 260105 A 10 0 +0371
3AF5FE7D 01 24 00 01 00 01 00 01 3AA752A6 053903.352 260105 A 10 0 +0371
  
```



```

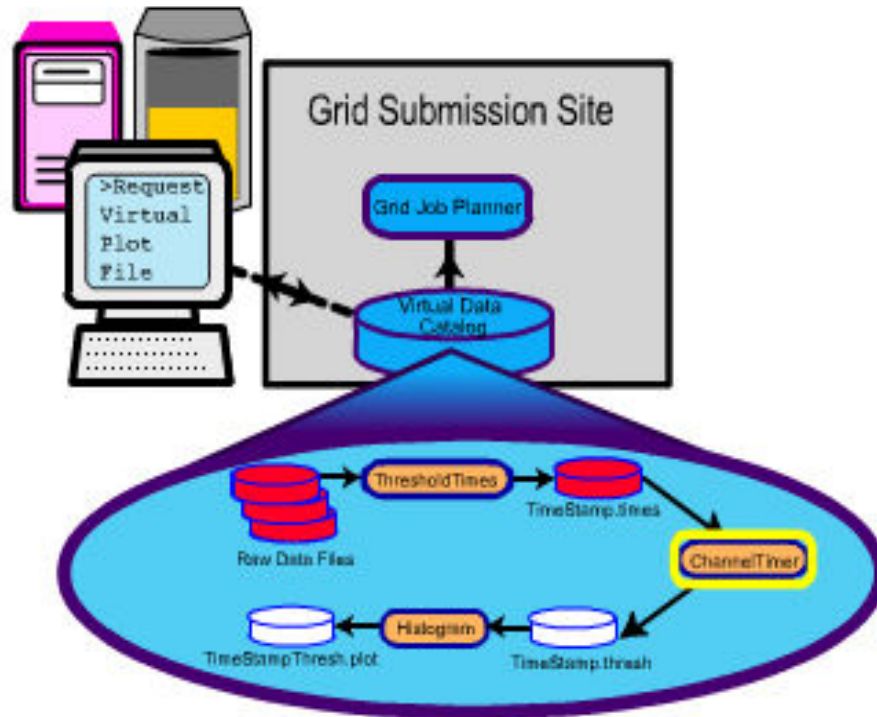
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E5232B7E 80 01 00 01 00 01 3C 01 E4A3B580 055213.307 260105 A 08 0 +0451
E5232B7F 26 3B 24 3E 28 01 01 38 E4A3B580 055213.307 260105 A 08 0 +0451
  
```

Have Virtual Data Grid. Need user feedback.



Create a “Virtual Data Workstation” for High School Teachers & Students

- It’s just
- Ke
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- Co
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ata).

tools to install.

What Should the Workstation Look Like? Ask the Teachers!

- Tie-ins to “big” science questions & research data
- Inquiry-based online student investigations
- Hands-on element—cloud chamber, cosmic ray detector “One-stop shopping”
- Browser-only access
- Support materials
- Standards-based (inquiry/research, process)
- . . . plus a host of suggestions for student pages

High School Workstation Requires Educational Scaffolding—a new beast!

- How to section for teachers
 - Background—science & pedagogy
 - Resources—tests, rubrics . . .
 - Assistance—helpdesk, news box, place to share
- Guided-inquiry implies *student guide*
- Less complicated data interface
- Easy way to share results
- Ways to communicate with peers & scientists
- . . .
- Registration


Our solution—an electronic laboratory that supports student-led, teacher-guided investigations.

```
629E49DA AE 3C 00 01 2E 32 00 01 629638C4 053736.356 260105 A 09 0 +0389
8C0E16A5 80 01 00 01 39 01 36 01 8A52BEFF 053752.356 260105 A 10 0 +0367
8C0E16A6 00 01 00 01 01 27 01 2F 8A52BEFF 053752.356 260105 A 10 0 +0367
8C95913A AD 01 27 34 00 01 33 3F 8A52BEFF 053752.356 260105 A 10 0 +0367
8C95913B 01 23 00 01 00 01 00 01 8A52BEFF 053752.356 260105 A 10 0 +0367
```

cosmic rays

All research starts with things you know. The path winds through areas of knowledge that you don't know, but will need to master. The starting point is the simple and well understood.

Let's describe cosmic rays in simple terms.

[Log it!](#) 

References

- [Cosmic Extremes](#) - Excellent cosmic ray overview available to print (pdf file)
- [SLAC: high energy cosmic rays](#) - read about cosmic rays
- [NASA: cosmic ray pages](#) - larger perspective
- [COSMICOPIA: cosmic rays in the news:](#) - current trends
- [COSMUS: cosmic ray simulation:](#) - centered on Chicago (need QuickTime plugin)

[Close Window](#)

Cosmic Ray e-Lab

Logged in as group: [quest](#) [Logout](#) [My Logbook](#)

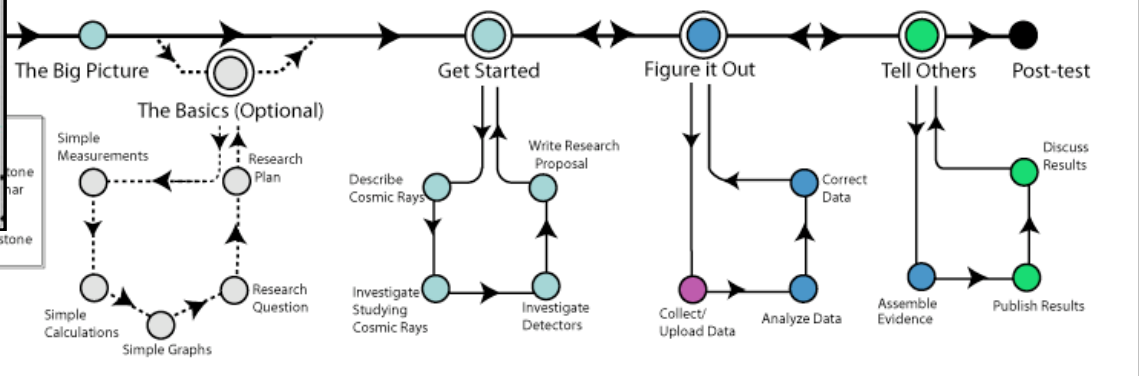
[Home](#) [Library](#) [Data](#) [Posters](#) [Site Index](#) [Assessment](#)

International collaboration of high school students to study cosmic rays.

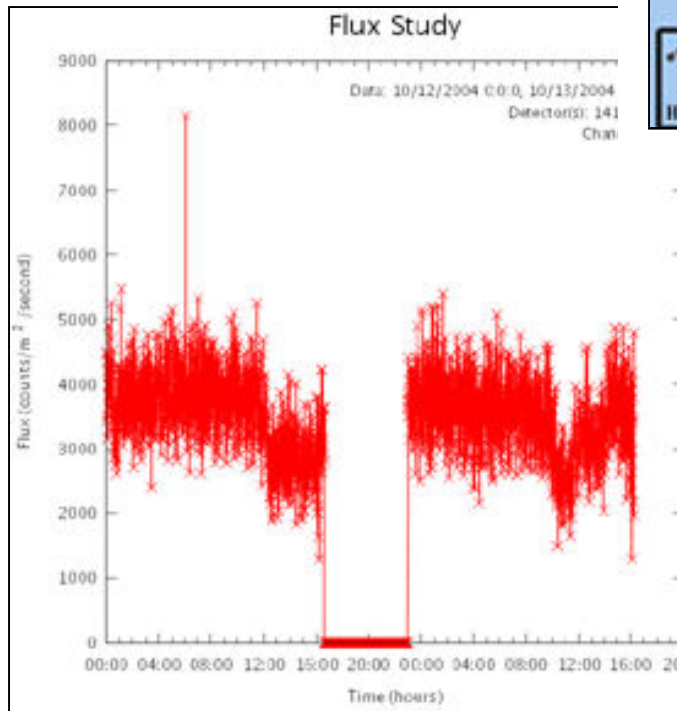
[Cool Science](#) [Explore!](#) [About Us](#)

Map: Your team may use the milestones below, or your teacher may have other plans. Make sure you know your progress, keep your teacher apprised of your work and publish your results.

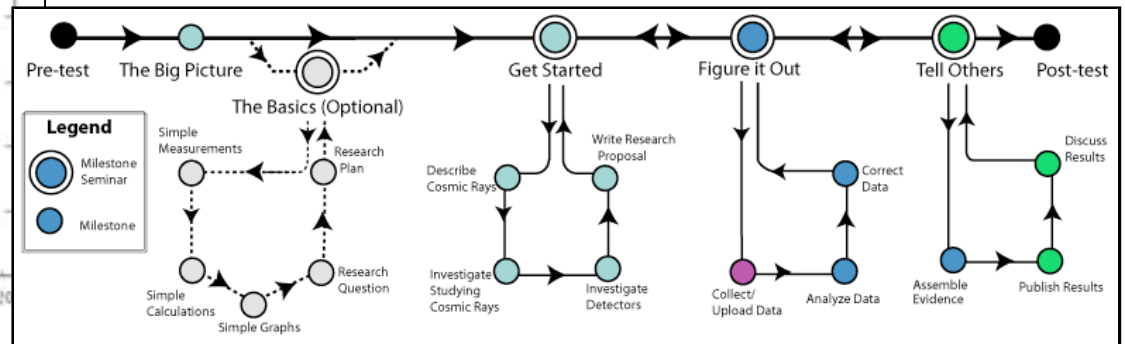
Map as a subway map with one main line and four branch lines. Along the main line are stops, milestone seminars, to check how the work is going. Off each main stop are branch lines where each stop is a project milestone. Hover over each milestone seminar to preview; click milestones to open.



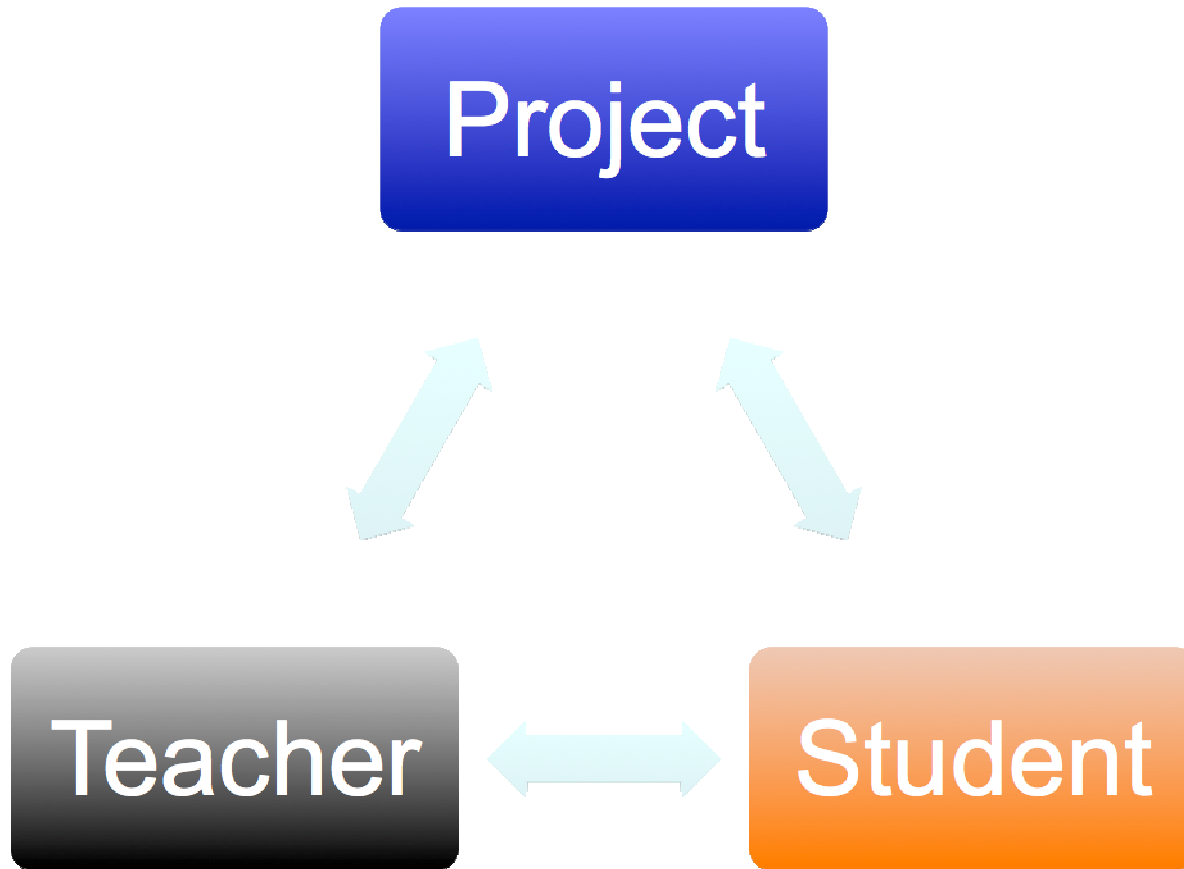
```
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```



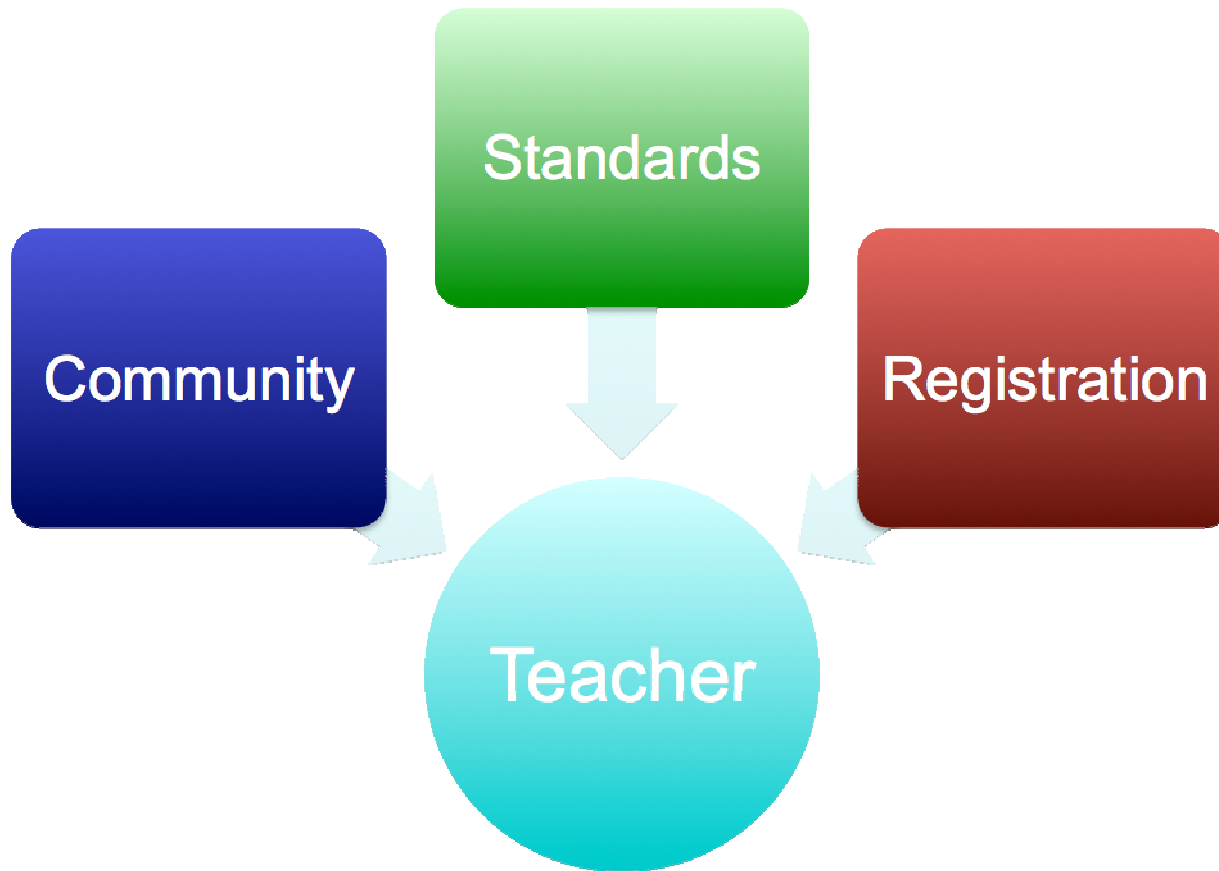
The Original: Cosmic Ray e-Lab




The View from 40,000 Ft.



Teacher Pages



Teacher Pages



Cosmic Ray e-Lab

Logged in as group: [TestTeacher](#) [Logout](#)
[Helpdesk](#) [My Logbook](#)

[Teacher Home](#) [Community](#) [Standards](#) [Site Index](#) [Registration](#)
[Student Home](#)

Teacher Home - Bookmark It!

Abstract:

Working in a research group, students experience the environment of scientific collaborations in this series of investigations into high-energy cosmic rays. From start to finish this is a student-led, **teacher-guided** project. Schools with cosmic ray detectors can upload data to the web. A virtual data portal enables students to share these data and associated analysis code with students at other schools whether or not those schools have their own cosmic ray detectors.

To begin their research, students check the performance of the detectors they have chosen for their study. Then they can perform one of three investigations: muon lifetime, muon flux or extended air showers. Students can use the project milestones to conduct their research and can record their work and reflect on their progress in their e-Logbook. Students post the results of their studies as online posters. The real scientific collaboration follows. Students can review the results of other studies online comparing data and analyses. Using online tools, they can correspond with other research groups, post comments and questions, prepare summary reports and, in general, participate in the part of scientific research that is often left out of classroom experiments.

Read about the [website features](#) that guide and support student research.

Introduction to Research:

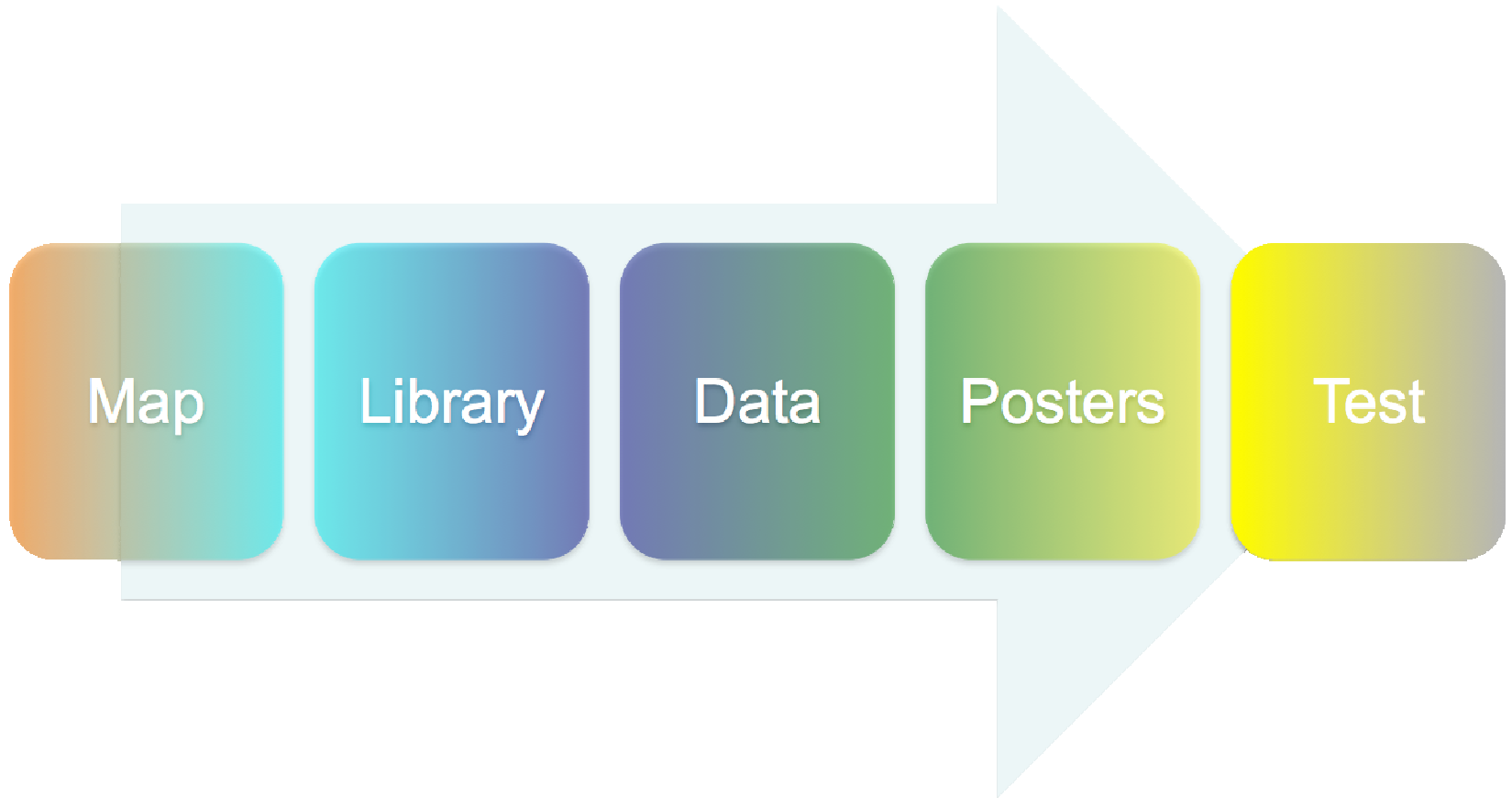
The Cosmic Ray e-Lab provides an opportunity for:

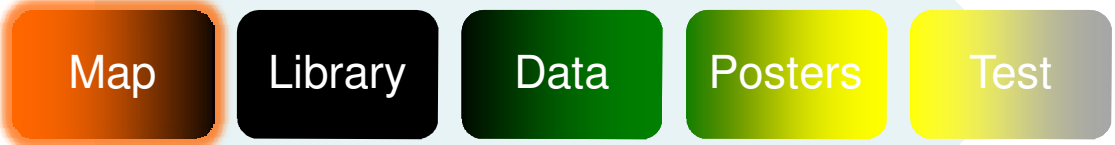
- Students to do authentic research using exploratory virtual data tools to access, process and publish data, report and share their results as online posters, and have online discussions with one another about their work.
- Student researchers to experience the environment of scientific collaborations.
- Student researchers to make real contributions to the study of high-energy cosmic rays.

News Alert

All Cosmic Ray Muon Detector owners
Please start now; include these commands with all data-taking:
ST 2 5
SA 1
This will embed status lines in the raw data needed to "bless" your data.
Send concerns to:
[HELPDESK](#).
Use this Cosmic Ray e-Lab URL:
www.i2u2.org/elab/cosmic
Published Thu Feb 25 10:00:00 CST 2010

Student Pages





Cosmic Ray e-Lab Logged in as group: [guest](#) [Logout](#)
[My Logbook](#)

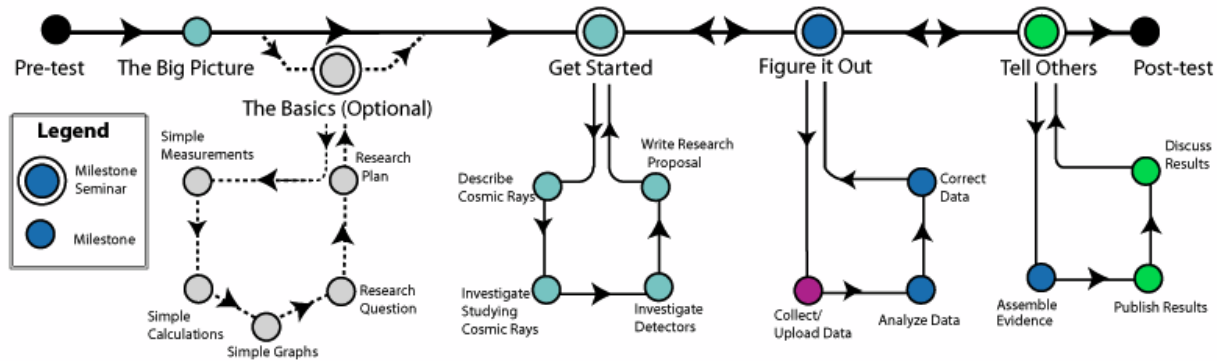
[Home](#) [Library](#) [Data](#) [Posters](#) [Site Map](#) [Assessment](#)

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



Project Map: Your team may use the milestones below, or your teacher may have other plans. Make sure you know how to record your progress, keep your teacher apprised of your work and publish your results.

Think of this map as a subway map with one main line and four branch lines. Along the main line are stops, milestone seminars, opportunities to check how the work is going. Off each main stop are branch lines where each stop is a project milestone. Hover over each milestone or milestone seminar to preview; click milestones to open.





Resources

Cosmic Ray e-Lab Logged in as group: [TestTeacher](#) [Logout](#)
[Home](#) [Library](#) [Upload](#) [Data](#) [Posters](#) [Site Map](#) [Assessment](#)
[Glossary](#) [Resources](#) [Big Picture](#) [FAQs](#) [Site Tips](#)

Resources: Check out the online resources or contact someone.

Tutorials

[Step-by-Step Instructions and Tutorial](#) - Understand how to do and interpret the output of the **Performance Study**.

[Step-by-Step Instructions and Tutorial](#) - Learn how to understand the results of a **Flux Study**.

[Step-by-Step Instructions and Tutorial](#) - Discover how to tell if you have seen a **shower**.

[Step-by-Step Instructions and Tutorial](#) - Discover how to read a **Lifetime Study** graph.

[Updating Geometry Tutorial](#) - Learn how to properly input the layout of your detector.

Advanced details on how to use the CRMD
[Series "3000" CRMD Users Manual](#)
[Series "200" & "5000" CRMD Users Manual](#)

Learn how to assemble the CRMD
[Series "3000" CRMD Assembly Instructions](#)
[Series "5000" CRMD Assembly Instructions](#)
["3000" ICSDTO PowerPoint](#)
["3000" Spreadsheet Form](#)

Cosmic Ray Sites

General Background

[Wikipedia](#), a good place to start

[Pierre Auger Cosmic Ray Observatory](#) - Background and Q&A

[Cosmic Extremes](#) - Excellent cosmic ray overview from Columbia University (pdf file)

[Build a Cosmic Ray Cloud Chamber](#) - Instructions (pdf file)

[Cosmic Rays](#), a larger perspective from NASA

[COSMICOPIA](#)

[Cosmic Rays](#), from SLAC, Stanford University

[MINOS](#) - Physicists detect cosmic rays in their neutrino detectors.

[Cosmic Weather Gauges](#) - Cosmic rays and upper atmospheric temperatures from *Symmetry Magazine*

[Leads Logbook](#) - Tips for keeping a logbook


[Cosmic Ray Simulations \(need QuickTime plugin\)](#)

[COSMUS](#), from University of Chicago

[Simulation](#), from Goethe Universität Frankfurt am Main

Cosmic Ray e-Lab Logged in as group: [TestTeacher](#) [Logout](#)
[Home](#) [Library](#) [Upload](#) [Data](#) [Posters](#) [Site Map](#) [Assessment](#)
[Glossary](#) [Resources](#) [Big Picture](#) [FAQs](#) [Site Tips](#)

Glossary: Look up unfamiliar words.

DAQ	DAQ: QuarkNet Data Acquisition Board - Electronic device that interprets the raw photomultiplier tube (PMT) signals and searches for patterns within them. If the signals match a user-specified pattern, the DAQ sends data to a local computer. The DAQ also interprets data from an attached GPS antenna (for timing the arrival of raw PMT signals), as well as sensors for temperature and barometric pressure. See: Electronic Simulation - shower study data acquisition. Every DAQ has its unique detector id .
GMT	Greenwich Mean Time (GMT) is the mean solar time at the Royal Greenwich Observatory in Greenwich near London, England, which by convention is at 0 degrees geographic longitude. Noon Greenwich Mean Time is the moment when the Sun crosses the Greenwich meridian (and reaches its highest point in the sky in Greenwich). On January 1, 1972, GMT was replaced as the international time reference by Coordinated Universal Time (UTC), maintained by an ensemble of atomic clocks around the world.
GPS	Global Positioning System - A set of 24 satellites primarily providing navigation information. Also, the system distributes coordinated time signals derived from atomic clocks managed by the United States Naval Observatory . Tutorial: GPS
UTC	Coordinated Universal Time - Time kept by atomic clocks located at time labs around the globe and delivered by the GPS satellites. UTC is five hours ahead of Eastern Standard Time. UTC replaced GMT as the time reference. Times given in UTC are almost always given in terms of a 24-hour clock. Thus, 14:42 (often written simply 14:22) is 2:42 p.m., and 21:17 (21:17) is 9:17 p.m. United States Naval Observatory .
abstract	Abstract: An abstract is a shortened  version of the paper and should contain all information necessary for the reader to determine: <ol style="list-style-type: none"> 1. what the objectives of the study were; 2. how the study was done; 3. what results were obtained; 4. and the significance of the results.

Glossary

Cosmic Ray e-Lab Logged in as group: [TestTeacher](#) [Logout](#)
[Home](#) [Library](#) [Upload](#) [Data](#) [Posters](#) [Site Map](#) [Assessment](#)
[Glossary](#) [Resources](#) [Big Picture](#) [FAQs](#) [Site Tips](#)

Frequently Asked Questions: Find answers to common questions.

The QuarkNet Cosmic Ray e-Lab address I entered returned "not found on this server". What have I done wrong?

Sometimes the server hosting the Cosmic Ray e-Lab will change as computers are switched out or upgraded. If you have made a browser bookmark tied to the server address, then the link will break and report a 404 error: "Not Found - The requested URL ... was not found on this server". The permanent URL door will redirect to the correct server. Bookmark this:

- www.I2u2.org/ie/lab/cosmic

How do I run a study?

- Click on the "Data" tab in the navigation bar.
- Click on the Performance, Lifetime, Flux or Shower to do a study of the respective type.
- Search for data to use in your study.
- Once you have selected all of the data you want to analyze, click the "Run Study" button on the right.
- Change any parameters (presets are automatically placed for fields which require it) and click Analyze.
- Wait patiently. This may take some time, depending on the number and size of your data files.
- View your plot, and save it if desired.

Why can't I upload large files?

Most web browsers (like Internet Explorer and Firefox) can only handle files smaller than 2GB. Safari can handle files smaller than 4GB. If you have any files larger than your web browser can handle, you'll have to split those files.

If you need to split your files, contact your school's system administrator so he or she can install a file splitting program on your school computer.

How can I find out how big my files are?

- On Windows: Right-click the file in Explorer and select **Properties**
- On a Macintosh: Select the file in the Finder and press **⌘ I**

FAQs

Cosmic Ray e-Lab Logged in as group: [TestTeacher](#) [Logout](#)
[Home](#) [Library](#) [Upload](#) [Data](#) [Posters](#) [Site Map](#) [Assessment](#)
[Glossary](#) [Resources](#) [Big Picture](#) [FAQs](#) [Site Tips](#)

Site Tips: Use these tips to help you use the e-Lab.

How to use the website.

Log In/Log out:
 Check the upper right hand corner to see the current status.

Getting Around:
 Use the navigation bar.


[Home](#) [Library](#) [Data](#) [Posters](#) [Site Index](#) [Assessment](#)



If you have upload privileges, your navigation bar will look like this:

[Home](#) [Library](#) [Upload](#) [Data](#) [Posters](#) [Site Index](#) [Assessment](#)

[Navigation Overview](#)

Special icons and links:
 Click on these.

 and links in the text for explanations of terms in the glossary and variables in the analyses.

 and  to show and hide analysis controls.

Popup Windows:
 Be sure that you are not blocking popup windows in your browser.

Resources:
 Explore tutorials, online resources, animations and contacts.

Site Tips

Map

Library

Data

Posters

Test

Cosmic Ray e-Lab Logged in as group: [TestTeacher](#) [Logout](#)
[Helpdesk](#) [My Logbook](#)

[Home](#) [Library](#) [Upload](#) [Data](#) [Posters](#) [Site Map](#) [Assessment](#)
[View Data](#) [Performance](#) [Flux](#) [Shower](#) [Lifetime](#) [View Plots](#) [Analyses](#)

Calculate the flux for your data file. Remember, flux = particles / time / area

This analysis looks at the arrival rate of cosmic ray muons over time. The calculations average the instantaneous arrivals and create a scatter plot of rate vs. time.

Gain confidence by running a practice analysis.

[Understand the graph](#)

You're analyzing...	Chan1 events	Chan2 events	Chan3 events	Chan4 events	Raw Data	Remove from analysis
Fermilab Test Array May 7, 2007 0:0:1 UTC	45551	45078	45326	45053	View Statistics Geometry	<input type="checkbox"/>
Fermilab Test Array May 8, 2007 0:0:0 UTC	46844	46346	46615	46369	View Statistics Geometry	<input type="checkbox"/>
Total (2 files 367182 events)	92395	91424	91941	91422	Compare files	<input type="button" value="Remove"/>

Analyze the same files in [lifetime](#) or [shower](#)

Click **Analyze** to use the default parameters. Control the analysis by expanding the options below.

▼ **Analysis Controls**

? Channel Number:

Map

Library

Data

Posters

Test

Poster

Liberty High School May 2006

Liberty High School May 2006

Determining the Period in a Flux Study

05/27/2008

Gautham Ragunathan, Zach Sandberg, Ben Hu, Kevin Chung

Abstract

We analyzed the data collected by the Liberty High School and determined the period of the flux based on peaks and troughs of the data.

Methods and Materials

1. Look at the graph 2. Check to see whether the graph displays periodicity 2. Determine the period by tracking one cycle

Results

The period is approximately 24 hours +/- 3 hours

Figures

Flux Study

Figure 1. Liberty High School Flux Data

Discussion and Conclusions

The period was determined to be 24 +/- 3hrs. The uncertainty is due to the lack of more detailed axes. A smaller interval for time and a greater range for data would have decreased the uncertainties

Bibliography

Not entered

Map

Library

Data

Posters

Test

Answer the following questions and click Record Answers to take the New Cosmic Survey.

Don't guess!! "Do not know" is a perfectly good answer. You will learn the answers to questions like these in your investigation.

1. Students in Ms. Marchant's third hour class did an experiment with 151 United States pennies. They were asked to write down the "observables" on the pennies and organize the results. Each group decided to inspect each penny and record their own set of observables. Three groups asked their teacher for an electronic balance in order to measure the mass of each penny.

Groups brainstormed which observable to record and argued about whether or not some could be measured accurately. Their final list included:

the penny's shininess

the year that the penny was made

the mass of the penny

the worn-ness of the penny

the mint the stamped the penny

Which of these can be accurately and reliably determined? You may choose more than one.

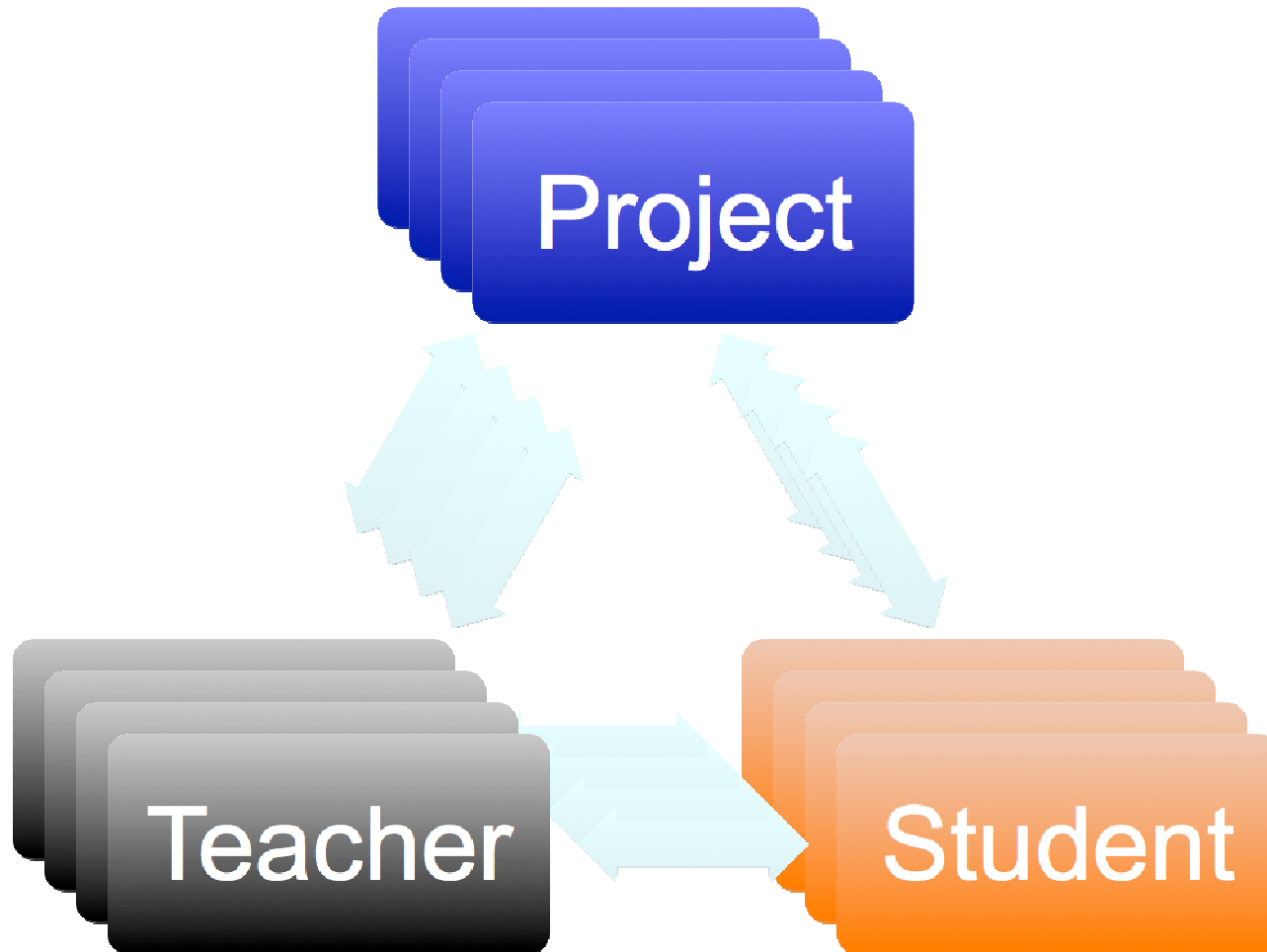
- a. All
- b. Shininess, year and mass
- c. Year, mass and worn-ness
- d. Year, mass and the mint location
- e. Mass, worn-ness and mint location
2. Which of these characteristics requires measurement by a scientific instrument?
- a. Shiny-ness
- b. Year
- c. Mass

Cosmic Is a Success!

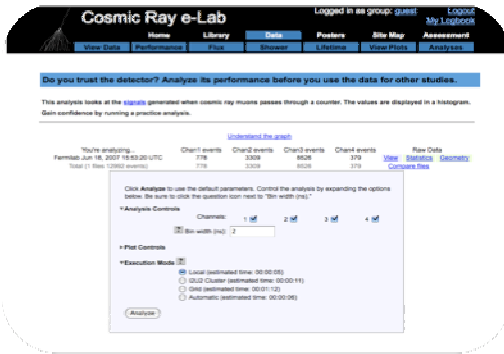
April 2010 Report

- 761 teacher accounts
- 1,509 student research group accounts
- 517 DAQs in the field
- 16,240 data files from 306 QuarkNet schools in 46 states
- 454 posters, 21 in March alone
- Server stats for March: 5,962 visits from 1,566 unique sites

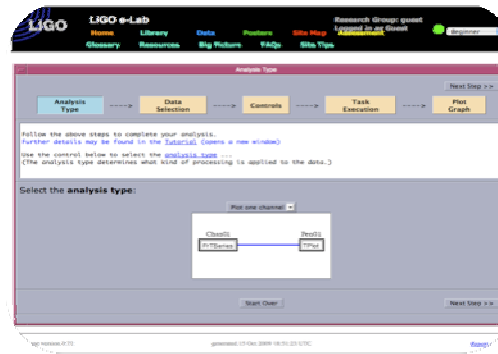
What Next?



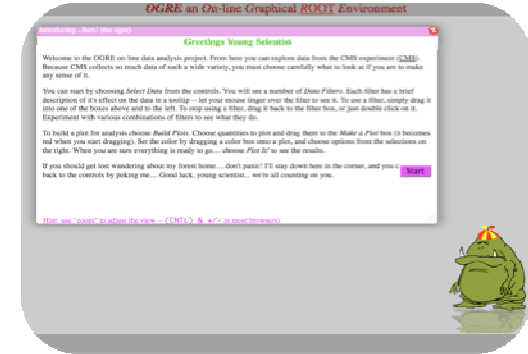
A Research Question: Can other experiments make use of the virtual data workstation?



Cosmic



LIGO



CMS



Using The Virtual Data Grid For Discovery in Science Education

A partnership of GriPhyN, iVDGL, and QuarkNet

Presented by Mike Wilde
Argonne National Laboratory

Grid Physics Network – GriPhyN
International Virtual Data Grid Laboratory – iVDGL



Lepton Photon 2003 – Fermilab – 14 August 2003

Everybody Wins

- Education — A new style of collaborative learning:
 - Investigating highly motivating science content
 - Modeling scientific research
 - Analyzing data
 - Publishing and defending results
 - Reviewing results of others
 - Synthesizing findings
 - Using Grid tools and techniques
 - Computing resources
 - Data on the Grid
 - Systematized data analysis (metadata)
 - Collaboration tools

Everybody Wins

- Science & Grid Computing
 - Test Bed
 - Research collaborators
 - Potential students
 - Future research scientists and computer scientists
 - Goodwill ambassadors
 - Public support
 - . . .