Celebrating 30 Years of K-12 Educational Programming at Fermilab
(Engaging Students in Our Science)

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Why Bother? What Leon Says

“What I get out of it is to see the world (one more time) through the unclouded eyes of children.”

Saturday Morning Physics “Why not use the magnificence of Fermilab to dazzle (and capture) high school kids?”

M. Bardeen, DPF, Providence, August 2011
Why Bother? What Teachers Report

“Sprinkled” activities during the year

Tried new teaching practices & curriculum

Taught year-long theme: “Search for Higgs”
Why Bother? What Teachers Report

What makes it to my classroom:
Data
Computer simulations
What high school students would call “sweet”
Bob Grimm

Impact in my classroom:
Prompts student questions about HEP research
Reloads curriculum
Empowers students
Pete Brueckcn

Things my students remember
Talking about Fermilab and CERN
Researching the Higgs Boson
I helped work on building ATLAS.
Deborah Roudebusch
Opportunities: Win-Win-Win Relationships

For physicists:
Sharing an excitement and passion for science
Inspiring the next generation of scientists ... and tomorrow's taxpayers

For teachers:
Reloading the curriculum
Being appreciated as teachers

For students:
Learning about today's science
Experiencing science in action
What Students Say

“QuarkNet has taught me that patience, common sense, and maturity will often serve you better than a book ever will. Through working on intellectually challenging activities, such as testing pods, programming software, and writing webpages, we learned that mistakes are not dead ends, but simply stepping stones.”

Ting Wu, Illinois Mathematics and Science Academy, Aurora, IL
What Teachers Say

“The scientist in me recognizes that while I (and other science teachers) do a great job in showing kids the ‘wow’ of science, we don't do good job in educating kids about real scientific research. (My students) had the chance to do real research. They were frustrated with me in the beginning because they encountered problems that they couldn't easily solve and I didn't have the answers to give them. They expected cookbook answers, but I was as in the dark as they were. At one point I said to them, ‘You have been taught the scientific method, now use it!’ I wish you could have seen the astonished look on their faces. I have watched them transform from high school science students to research scientists.”

Carol Baker, Alan Shepard High School, Palos Heights, IL writing about QuarkNet cosmic ray studies
What Volunteers Say

“I loved studying physics in college. I started looking at the world differently, and it became a much more interesting place. I think science education is very important—you've got to be able to tell what's real and what people are just trying to sell you. Not to mention that the world needs people to provide innovative solutions to real problems. I love spending time with the kids. I like to be silly and have some fun—always trying to spark an interest!”

Anne Heavey, Fermilab Computing Division
Challenges

Finding the right level

Fitting content into the curriculum (standards, common core, testing, time)

Finding ways to engage teachers and students

Preparing “publication quality” materials
HOW is as Important as What!

Needs Assessment – Ask teachers.
Program Development – Partner with teachers.
Program Conduct – Put peers in lead positions.
Program Assessment – Get participant feedback.
What’s Effective?

Engagement and exploration!

In the short term—creating interest
In the longer term—building understanding and relationships

Working directly with students or teachers
Research Experiences
  Academic Year High School Interns
  QuarkNet Summer Research (Student/Teacher Teams)
  TARGET
  TRAC
Field Trips/High School Tours
  Lederman Science Center
  Physics Science Experiences
    Beauty and Charm
    Phriendly Physics
  Prairie Science Experiences
    Insects at Work in Our World
    Prairie – Our Heartland
    Particles and Prairies
  Tours
Teacher Resource Center
  Resource Collections
  Workshops
  Chem West
Classroom Resources
  Classroom Presentations
  Data for Students
    I2U2 e-Labs & Science Investigations
  Online Resources
    What is scientific research?

Classes for Kids
  Prairie Rangers
  Saturday Morning Physics
  Science Adventures
  Scout Programs
Special Events for Kids and Families
  DUSEL Education Collaboration
  QuarkNet Masterclass
  STEM Career Fair
  Wonders of Science
  Family Open House
  Family Outdoor Fair
Awards (Supported by Friends of Fermilab)
  Fermilab Science Award
  Fermilab Science Scholarship
  Program Scholarships
Professional Development for Teachers
  Fermilab/U Chicago QuarkNet Center
  I2U2 Teacher Workshop
  Physics Experiences Teacher Workshops
  Prairie Experiences Teacher Workshops
  Prairie Workshops
  QuarkNet Boot Camp
  QuarkNet Outreach
  Summer Secondary Science Institutes

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M. Bardeen, DPF, Providence, August 2011
Discovery Science

Fermilab: Where Physicists Unravel Mysteries of the Universe
Hover over each hot spot to preview; click to open.

Standard Model  Testable Ideas  Scientific Instruments  Data, Claims & Reasoning  New Physics

A Gateway to Scientific Discovery

It is the dawn of a new era in particle physics. Physicists have incorporated decades of observations and results into the Standard Model, a framework for our current understanding of matter. Even and as they continue to refine it, they are aware that it leaves fundamental questions unanswered. To probe the frontier beyond the Standard Model, particle physicists turn to instruments that break the old barriers of energy, precision and intensity to explore new frontiers in particle physics.

Physicists look for new science by looking for the unexpected. They publish results explaining claims with evidence from Fermilab data so that others can put those results to the test. New understandings lead to new fundamental questions and a new world of discovery.

What is dark matter? What happened to antimatter? What are the neutrinos telling us?

While scientific breakthroughs may seem to occur suddenly, Eureka!, in fact years of research are behind discoveries such as the top quark mass, the construction of the Tevatron or the availability of the World Wide Web.

The resources in this project map provide background information for the next discoveries. Follow along as physicists unravel mysteries of particle physics.
The Standard Model explains much but leaves many unanswered questions.

Activities
- Higgs Reception - Classroom simulation of the Higgs cartoon
- Run II Website - Run II data analysis of W and Z as precursor to the search for Higgs

Additional Resources
- Quantum Universe - The quest to explain the universe (from interactions.org)
- Questions for the Universe - Includes videos of physicists explaining mysteries of particle physics (from Fermilab)
- Frontiers of Particle Physics - Fermilab's physics program (from Fermilab)
- Higgs Cartoon - Cartoon analogy explaining the Higgs mechanism as a cocktail party (D. Miller and CERN)
- Search for Higgs News Stories - CERN Courier and Fermilab Today articles from 1999 to 2011.
- Time Machine - Completing the journey back to the beginning of time (CERN video, 1998)
Providing Resources
Engaging Students in Science

Data for Students

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Engaging Students in Science

Online Investigations with I2U2

LIGO seeks to detect gravitational waves from orbiting black holes, neutron stars and other sources.

Scientists must distinguish gravitational waves from "noise" caused by seismic waves passing through the ground underneath LIGO's detectors.
Engaging Younger Students

Before

After
Family Open House
Presentations

Cryo Show
Charge!
Forces and Motion
Light and Color
Tours and Ask-a-Scientist

Gave tours to visiting college students soon after moving to Fermilab full time
Soon added Q&A sessions with student visitors
Classroom Presentations

Charge! Electricity and Magnetism

- Cathode Ray Tubes, the original kind of TVs, are particle accelerators!
- We need a volunteer!
  - Magnets don't just effect other magnets, they also bend moving charge.
  - Electromagnets in your TV make a single electron beam draw a moving picture.
Community Outreach
Chicago's Lab Fest

Saturday, August 6, 2011
Family Open House

Physics of Spinning Toys
FUNdamentals of Physics
Thanks Leon!
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