

Education and Outreach In Particle Physics

Michael Barnett (LBNL)

Not including “communications” (press offices).
But an amazing amount of activity to cover.



To begin:

How does the outside world view us?



At the **World Economic Summit** in Davos 2011

Asked about the next 20 years, Clinton turned to science.

Notice both the very beginning and the ending.



At the **World Economic Summit** in Davos 2011

Asked about the next 20 years, Clinton turned to science.

Notice both the very beginning and the ending.



October 2011

The details were wrong but Clinton came away with:

“a sense of wonder”

This is what I think we should seek via our outreach efforts.

New Approach Proposed for Science Curriculums

By KENNETH CHANG

Published: July 19, 2011

A new framework for improving American science education calls for paring the curriculum to focus on core ideas and teaching students more about how to approach and solve problems rather than just memorizing factual nuggets.

U.S. National Research Council study led by Helen Quinn (quoted here)

“That is the failing of U.S. education today, that kids are expected to learn a lot of things but not expected to be able to use them,” said Helen Quinn, a retired physicist from the [SLAC](#)

[National Accelerator Laboratory](#) in Menlo Park, Calif., who led an 18-member committee that spent more than a year devising the framework.

One of the big goals, the [committee said](#) in a 282-page report, is “to ensure that by the end of 12th grade, all students have some appreciation of the beauty and wonder of science.”

The report, released Tuesday by the [National Research Council](#), also pushes for incorporating engineering into what is taught to students in elementary school through high school.

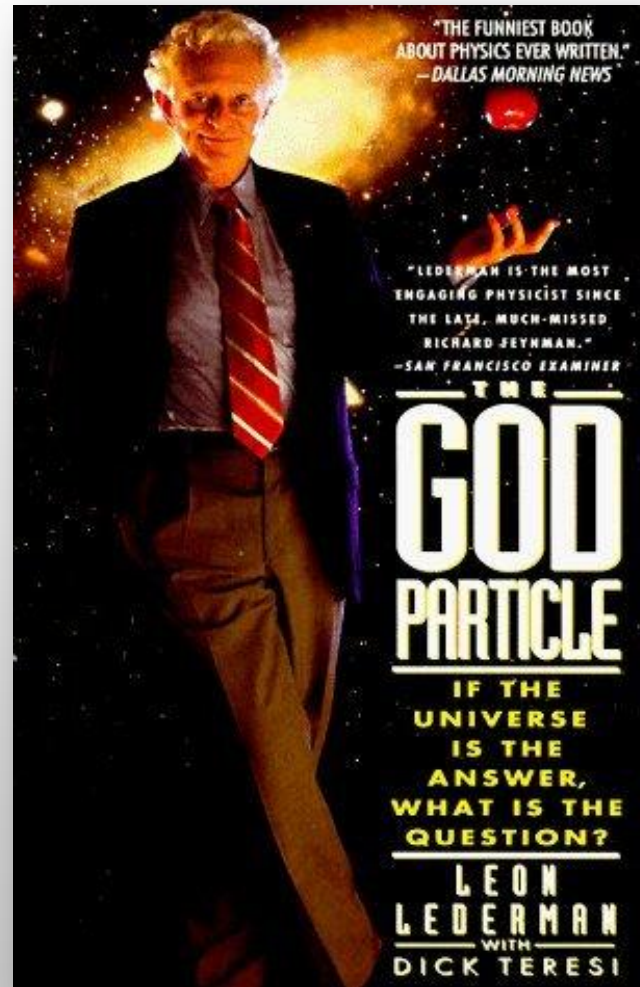
It is the latest in decades of efforts to improve the science knowledge of American students, who have typically ranked in the middle of the pack on international comparison



A new framework for improving American science education calls for paring the curriculum to focus on core ideas and teaching students more about how to approach and solve problems rather than just memorizing factual nuggets.

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ICFA Seminar – Michael Barnett – October 2011

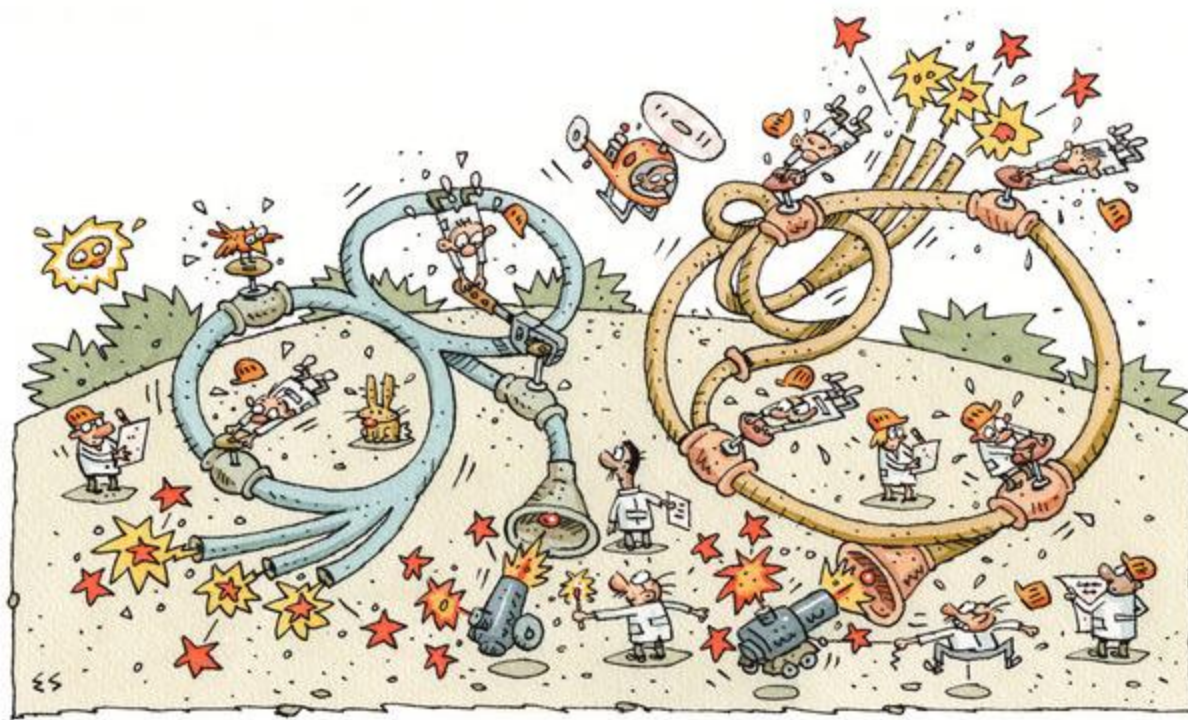


The New York Times

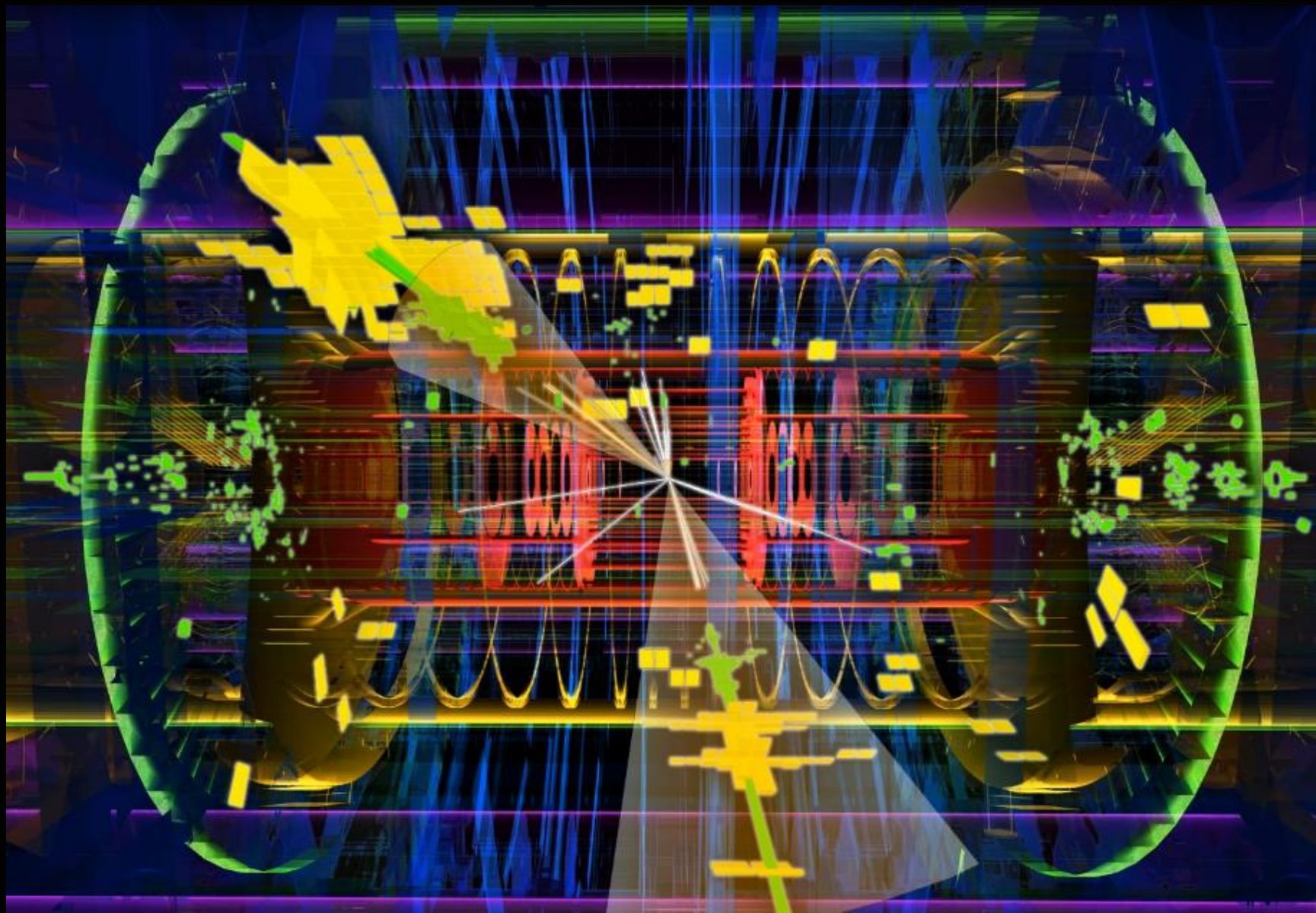
2 August 2011

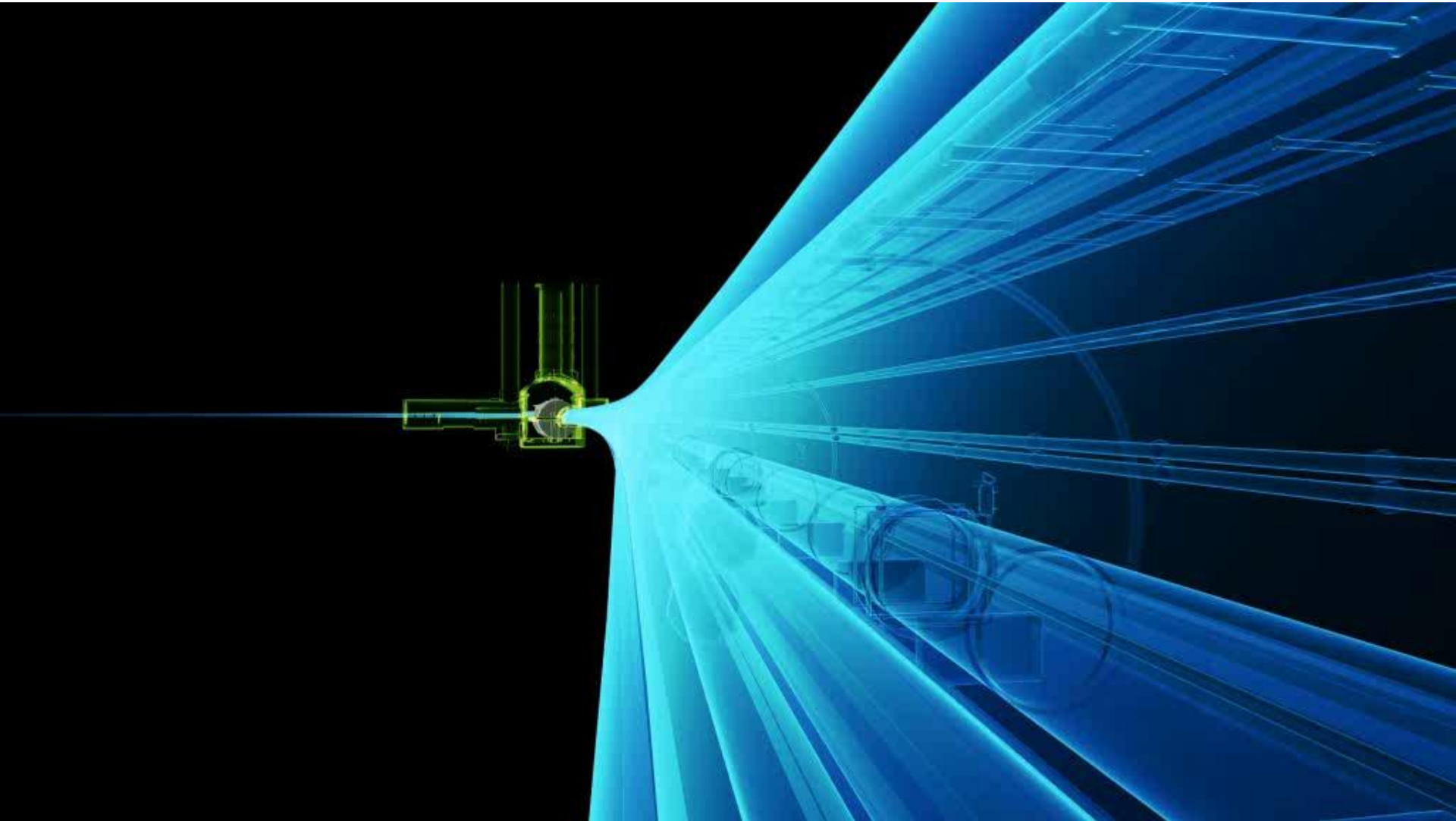
NEWS ANALYSIS

Particle Accelerators Full of Spin and Fury, Signifying Something



Elwood H. Smith

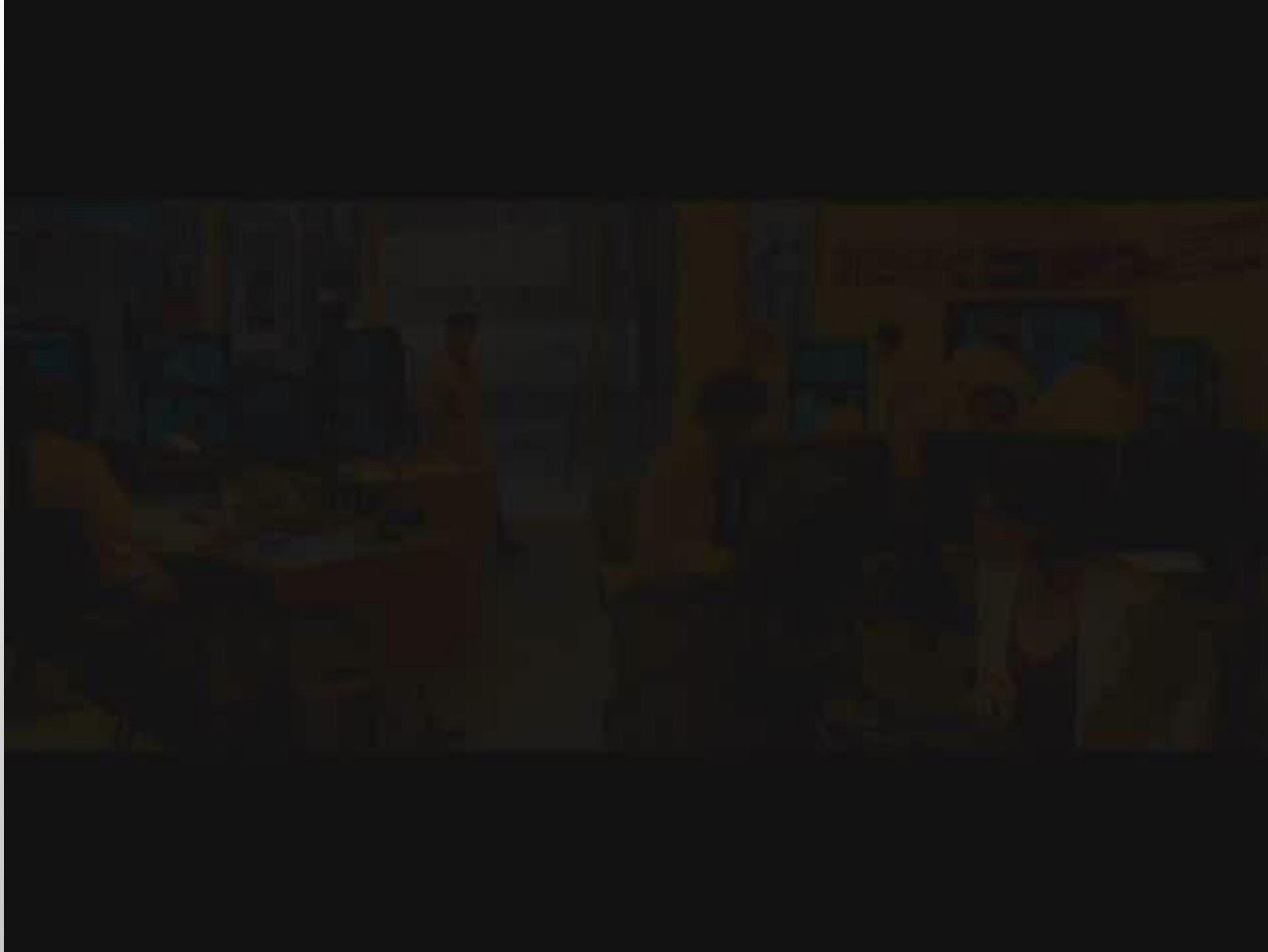




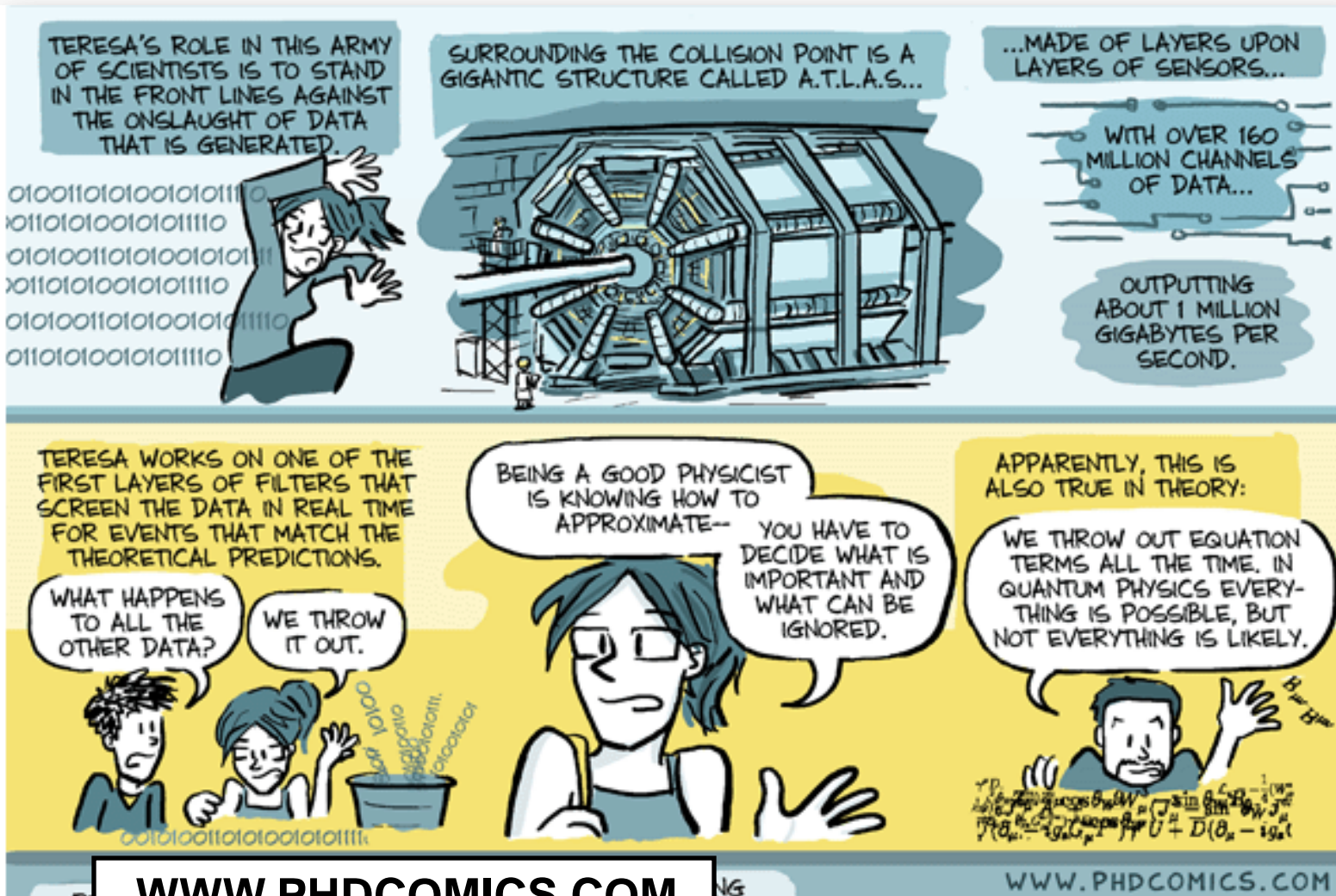
ICFA Summer School - Michael Dine - October 2011





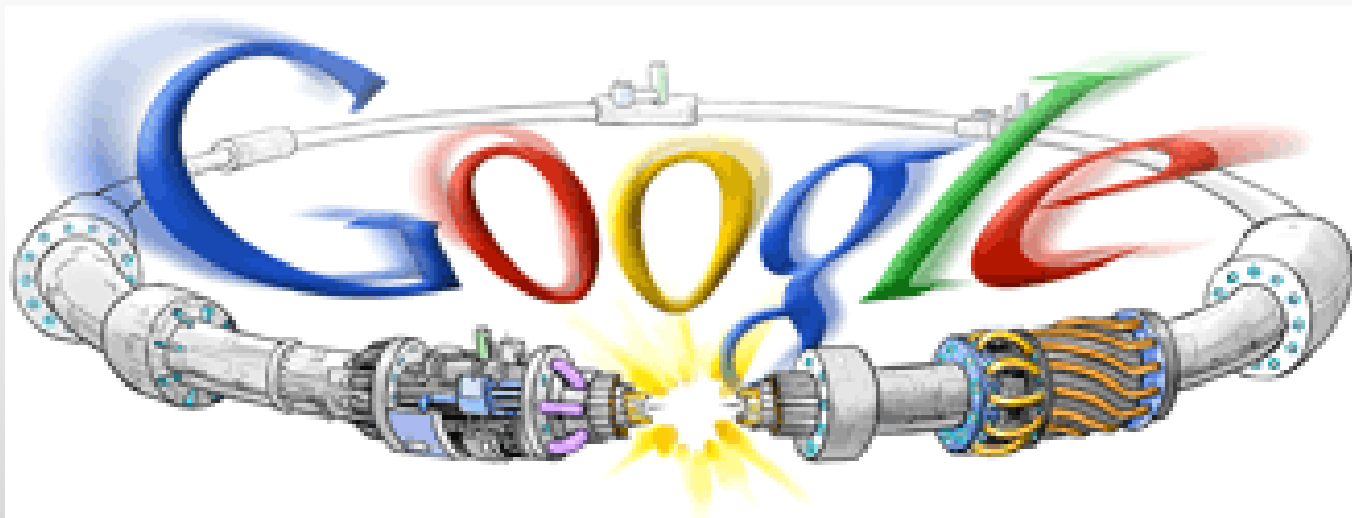


ICFA Seminar – Michael Barnett – October 2011





WWW.PHDCOMICS.COM/TV



The opera *Les Troyens* by Berlioz, as shown in **Valencia**, **St. Peterburg** and **Warsaw**

30 March 2011, Wednesday, 18:00



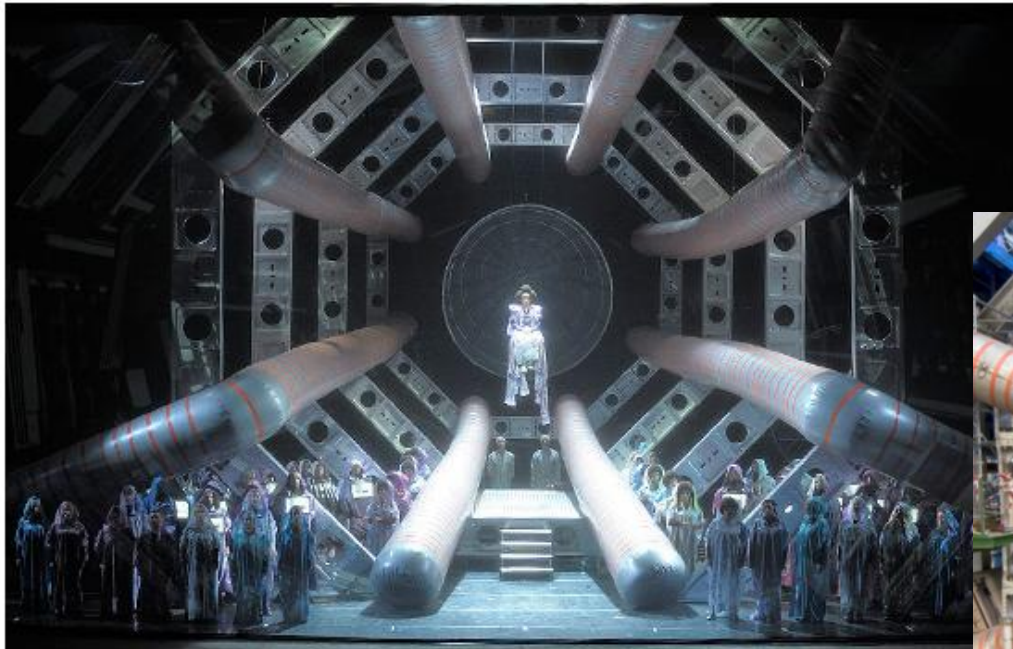
Mariinsky Theatre
1 Theatre Square



Playbill Calendar
July 2011

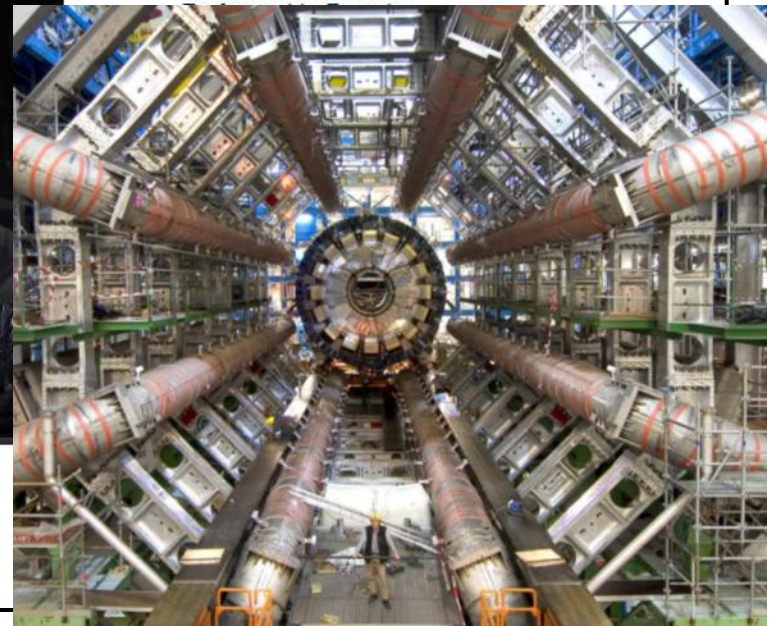


version



Les Troyens

grand opera in five acts
Music by Hector Berlioz
Libretto by the composer after motifs from Virgil's
Aeneid



Cast

Énée: Sergei Semishkur

Credits

Musical Director: Valery Gergiev



ICFA Seminar Michael Barnett October 2011

Forthcoming (November) Muppets movie From the trailer



Impacts can be unexpected

PHOTO GALLERIES

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PRINT

Big Science: The Universe's Ten Most Epic Projects

By Gregory Mone, Brooke Borel, Katherine Bagley and Jennifer Abbasi Posted 7.16.11 at 8:06 pm 11 Comments



Annual budget: **\$1,200,000,000**
Construction cost: **\$7,820,000,000**
Staff: **2,500**
Physical size: **17-mile circumference**
Scientific utility: **8**
WIIFY: **1**
Wow factor: **9**



IMAGE 9 OF 10

2: The Large Hadron Collider

Maximilien Brice/CERN

A proton accelerator to find the elusive god particle

Buried 330 feet beneath the border of Switzerland and France, the Large Hadron Collider is the **world's largest particle collider**. The facility requires 700 gigawatt-hours of energy and some \$1 billion annually to run. More than 10,000 researchers, engineers and students from 60 countries on six continents contribute to the LHC's six standing projects, which are designed to unlock the fundamental physics of the universe.

Scientific Utility

What exactly is **dark matter**? Are there extra dimensions in space? Does the **Higgs boson**, commonly referred to as the "God particle," exist? How did the universe form? The LHC's six particle detectors record and visualize the paths, energies and identities of subatomic particles, which may answer some of these questions. The ATLAS project's detector, for example, is searching for collision events in which there appears to be an imbalance of momentum—an indication of the presence of the supersymmetric particles thought to make up dark matter. The Compact Muon Solenoid project complements ATLAS by searching for supersymmetry and the elusive Higgs boson. LHC-Forward will simulate high-energy cosmic rays, and LHC-Beauty will provide information on why the universe is made up of matter rather than antimatter. TOTEM tracks proton collisions and provides data on the proton's inner structure. And ALICE will track quark-gluon plasmas, similar to experiments conducted at the Relativistic Heavy Ion Collider (also on this list).

What's In It For You

Though the LHC has brought black-hole alarmists out of the woodwork, the project will have little effect on our day-to-day lives, unless your family and friends are the type to discuss the origins of the universe over dinner.

TAGS
Science

IMAGE 9 OF 10

— October 2011

BBC News

Most Popular

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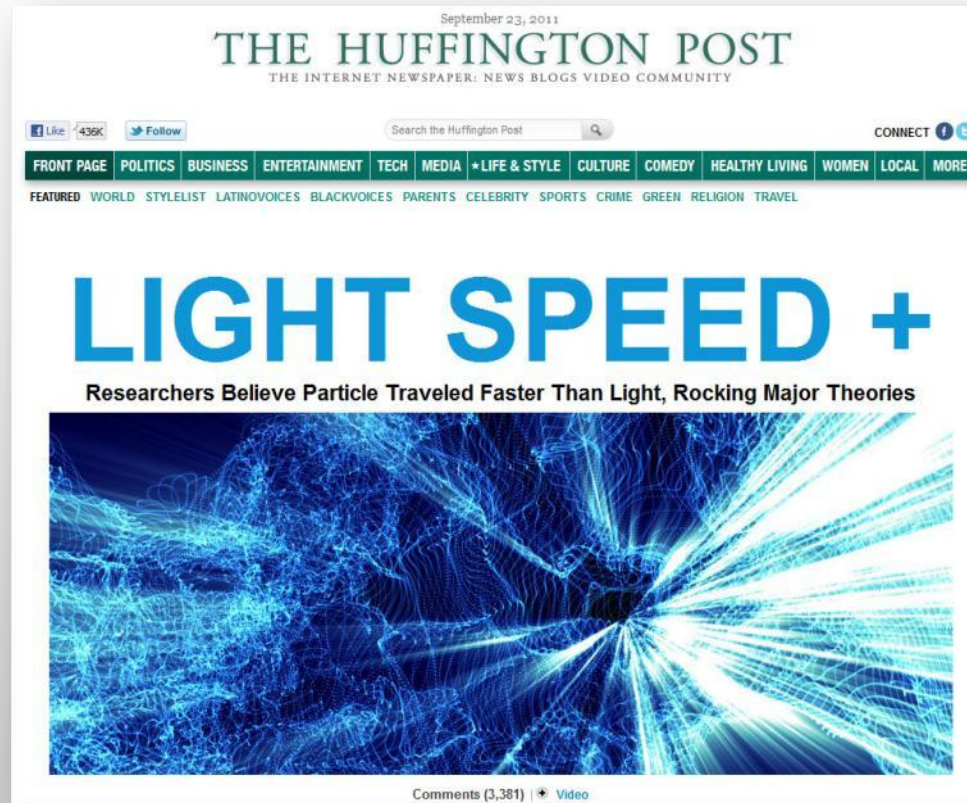
Norway youth camp attack kills 84	1
Ohio ex-Marine murdered 11 women	2
As it happened: Norway attacks	3
Profile: Anders Behring Breivik	4
latest	5
South Sudan rebel leader killed	6
White House debt talks collapse	7
Sunday Mirror phone-hacking claim	8
Higgs hunt results excite scientists	9
Norway's far right not a spent force	10

Elsewhere on the BBC

Norway attacks

Debt talks

Phone hacking



Education/Outreach programs across HEP

**Slides provided by DPF speakers
(which may account for U.S. excess)**

ICFA Seminar – Michael Barnett – October 2011

Hands on Particle Physics

International Masterclasses for High School Students



International Masterclasses

8th International Masterclasses 2012

Each year about 6000 high school students in **24 countries** come to one of about 110 nearby universities or research centres for one day in order to unravel the mysteries of particle physics. Lectures from active scientists give insight in topics and methods of basic research at the fundamentals of matter and forces, enabling the students to perform measurements on real data from particle physics experiments themselves. At the end of each day, like in an international research collaboration, the participants join in a video conference for discussion and combination of their results.

The **International Masterclasses 2012** will be held from **27.2. - 24.3.2012**. Each day up to six out of about 100 institutes participated, see **schedule 2011**. In addition, several institutes will hold a teachers day (click **here** for dates). A parallel program in **US** will include about 20 more institutes, see **schedule 2011**.

Discover the world of Quarks and Leptons with real data



- get out of school for one day and come to a nearby university or research centre
- get insight into topics and methods of basic research at the fundamentals of matter and forces
- perform measurements on real data from particle physics experiments at CERN

Hands on Particle Physics Masterclasses

- provide an opportunity for 15- to 19-year old students to discover particle physics
- take place in more than 110 places in 23 countries with more than 6000 participants worldwide
- are organized every year as a three-weeks period in March
- are organized at TU Dresden in the framework of the European Particle Physics Outreach Group (EPPOG)



This program is organized at **TU-Dresden** in the framework of the European Particle Physics Outreach Group **EPPOG**. The video linkup between the institutes is realized using the **EVO** technology, with valuable technical support from the **Caltech** EVO team and **CERN**. We gratefully acknowledge financial support from the **Helmholtz Alliance "Physics at the Terascale"**, the **BMBF** German Federal Ministry of Education and Research, **EPS HEPP** High-Energy and Particle Physics Division of the European Physical Society, and from **TU Dresden**. Educational material and prizes for the students are contributed from **CERN**. An offline version of this website is available as CD-ROM from the **organizers** and distributed to all participating students.



**Participants are ~ 6000 high school students, aged 15 -19.
Events on DVD that students take home.**

A very successful international outreach programme for high school students. Participants come to a nearby university or research institute to become "researcher for one day". They listen to lectures of active scientists and perform measurements on real data.

International Masterclasses started in 2005 with 3000 participants. In 2011, the programme reached more than 6000 students in 24 countries.

For the first time students did measurements with real data from ATLAS, CMS, and ALICE.

Two categories for 2012

W-path: <https://kjende.web.cern.ch/kjende/en/wpath.htm>

10 000 events in total;

selected from real 2011 data, yielding roughly

W- \rightarrow ev: 1000 events, W- \rightarrow μ ν : 1000 events,

background (QCD + $t\bar{t}$): 8000 events,

plus WW + 0 jets: 250 events,

Z-path: <https://kjende.web.cern.ch/kjende/en/zpath.htm>

10 000 events in total; real data from 2011:

Z: 5000 events,

J/Psi and Upsilon: 500 events each,

background: 3000 events from the W-path sample (QCD + W + WW)

Z' MC events at one mass (1TeV): 1000 events

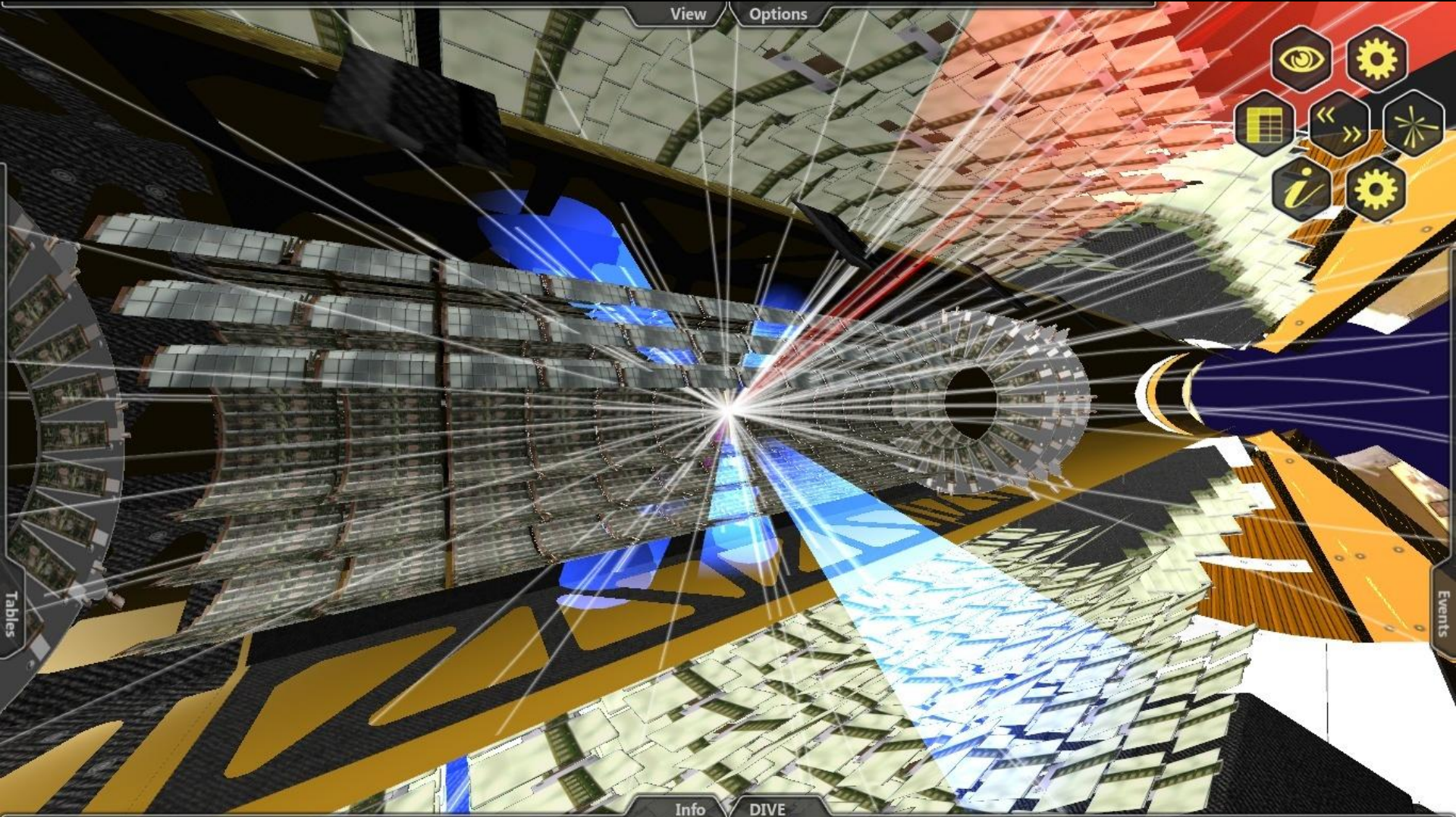
W-path:

W: Determine ratio W^+/W^- to reveal the inner structure of the proton

WW: Measure opening angle between 2 leptons, plot angular distribution

Z-Path:

Determine invariant mass of the two charged leptons in order to measure the Z boson's mass + pick out resonances from that histogram for J/Psi, Upsilon, and Z' (MC simulated)



ALICE: <http://aliceinfo.cern.ch/Public/Welcome.html>

ATLAS: [http:// atlas.ch](http://atlas.ch)

CMS: [http:// cms.cern.ch](http://cms.cern.ch)

LHCb: <http://lhcb-public.web.cern.ch/lhcb-public/>



- Home
- Info
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New York Times: Particle Accelerators Full of Spin and Fury, Signifying Something_

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News: Moonlighting as a Physicist

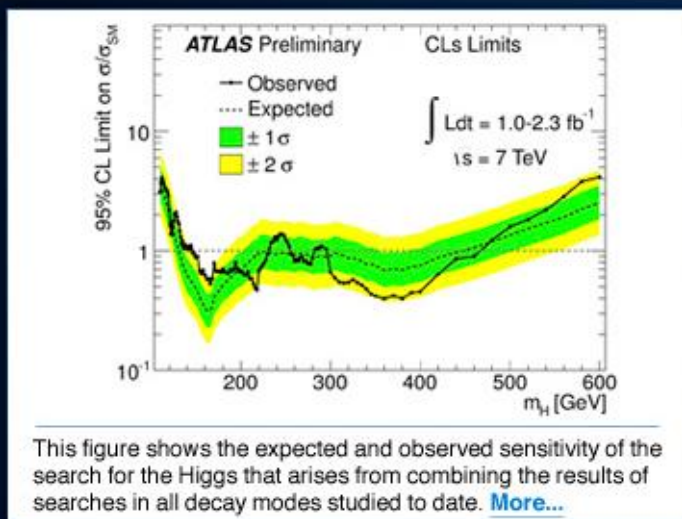
[Photos](#) + [blog](#) of Researchers' Night 2011

TV News Coverage of the Event

Latest News from LP symposium

New ATLAS results at
Lepton Photon symposium 2011

ATLAS advances in the search
for the Higgs and New Physics



ATLAS RUN STATUS

Luminosity 2010-11
Max. = $3.31 \cdot 10^{33}$
Total = 3.824 fb^{-1}

INACTIVE

PROTON RUN HEAVY ION RUN

LIVE EVENTS

LATEST LHC RUNS

STATUS PLANS

IMAGES VIDEOS MURAL

ATLAS Science

Discovery Quest

ATLAS eTours

ATLAS Store

Brochures

DVD

Music CD

Popup Book

Photo Book

3D Viewer

More

About ATLAS

Images

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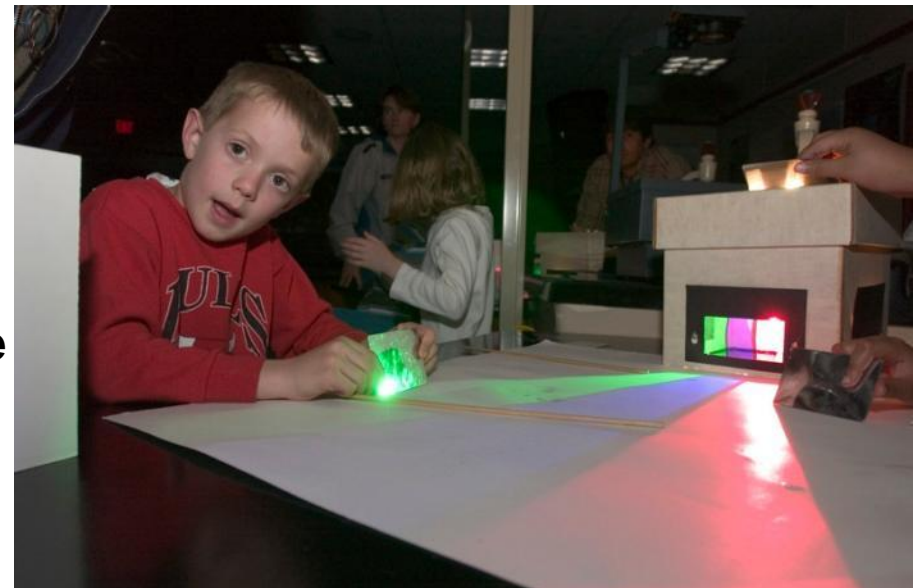
Education at Fermilab

A Legacy of Leon Lederman



Leon began Saturday Morning Physics in 1980 to "use the magnificence of Fermilab to dazzle (and capture) high school kids."

Studying light at the Lederman Science Center.



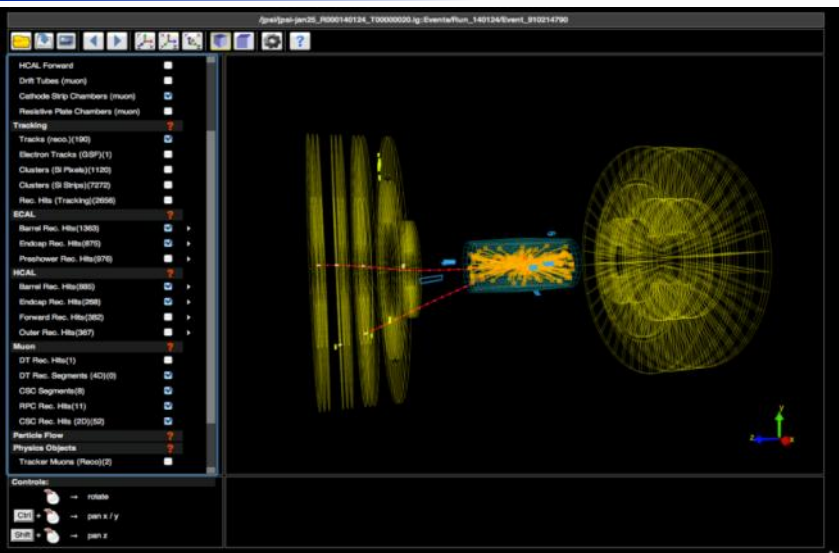


Rob Roser shows physics teachers CDF up close and personal.

Not possible to do justice to the very extensive education program at Fermilab in a few slides



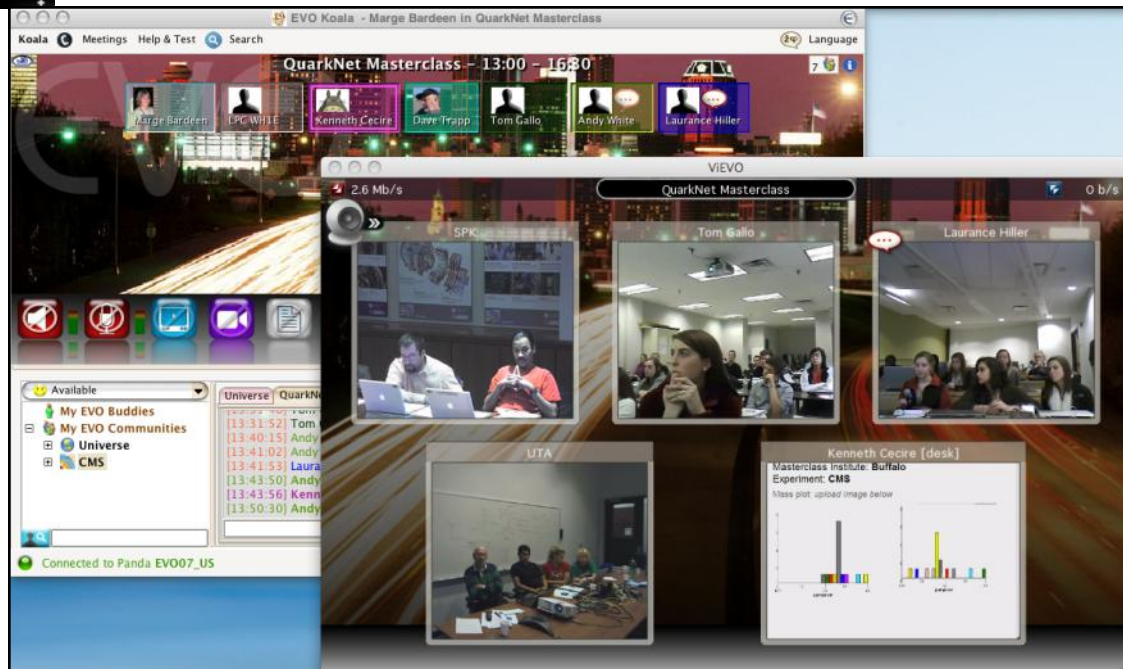
The Dave Schmitz and Michael Cooke show at Millennium Park



- Physicists look at CMS particle collisions in event displays to see what happened or in histograms of multiple events
- On Masterclass Day, students are physicists for a day.

CMS Masterclass (2011)

- 197 students in the U.S. (based on survey)
- 13 Institutes in the U.S.
- plus approx 30 non-US Institutes



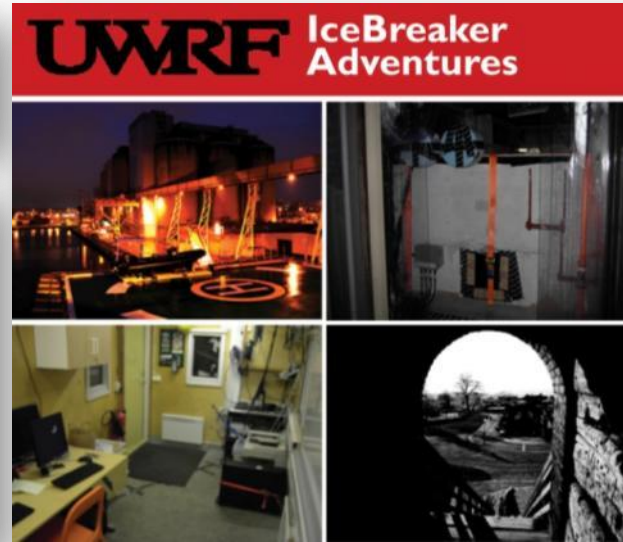


Adler Planetarium, Chicago, Illinois

- Dynamic display of real data
- ~500,000 visitors per year

Hands-on Ice Drilling Activity, Madison, Wisconsin

- Simulates building the IceCube detector
- Appropriate for all ages



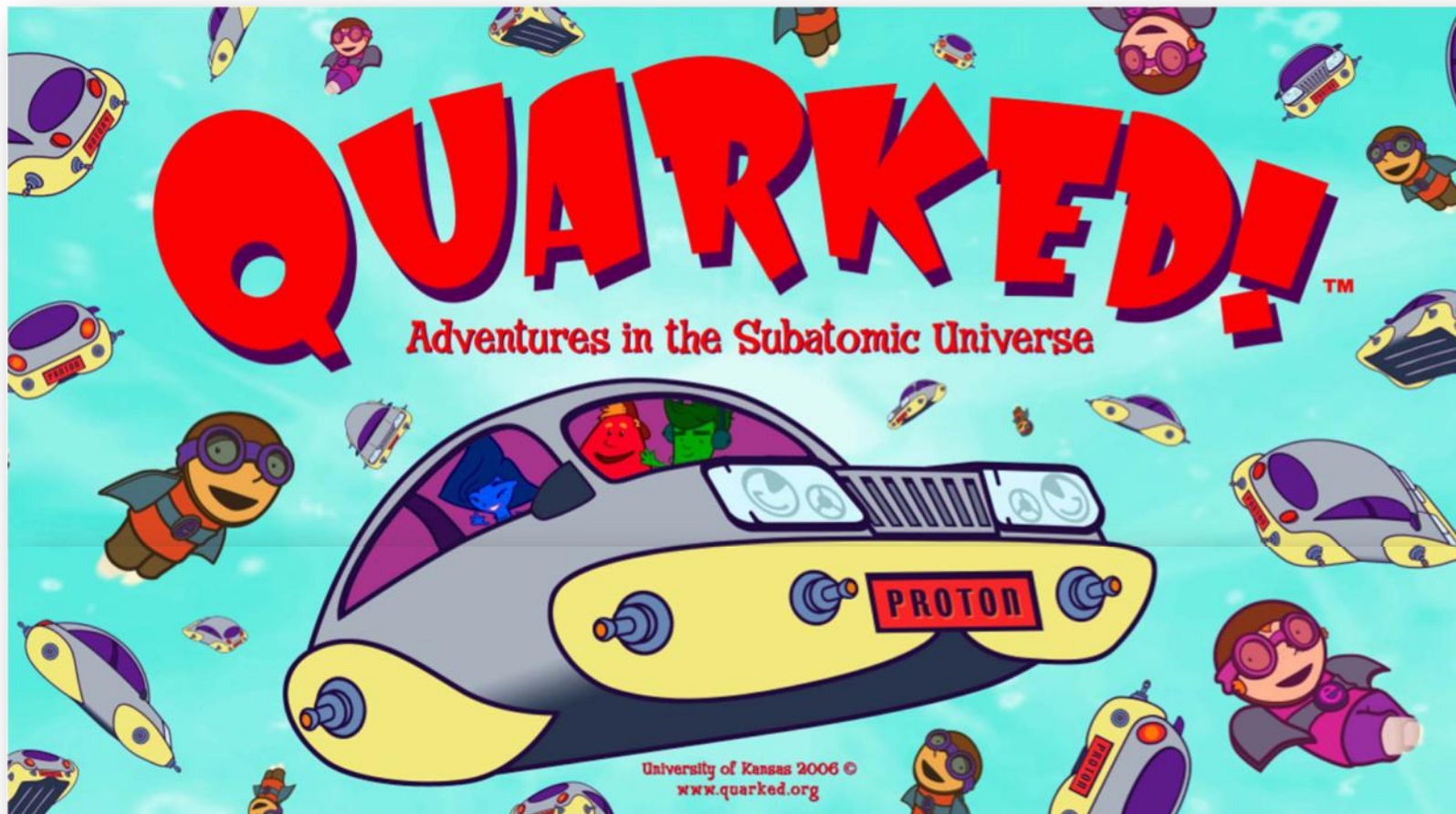
www.blog.icecube.wisc.edu
www.expeditions.udel.edu/antarctica/blog-dec-1-2010.html
www.naardezuidpool.ugent.be/blog.1.html
www2.uwrf.edu/icecube/icebreaker.htm

- Wintering over at the Pole
- Hot water drilling
- Computing, running and maintaining the IceCube detector



Curriculum:

- Introduce particle physics
- Access to real IceCube data
- Generalize concepts to illustrate abstract ideas



Alice Bean University of Kansas

What is the Quarked Project?

- Quarked is a science-based multimedia project for kids (focus on ages 7-12) and others that includes:
 - An interactive web site www.quarked.org
 - Hands on activities elementary school program
 - Other Educational Outreach



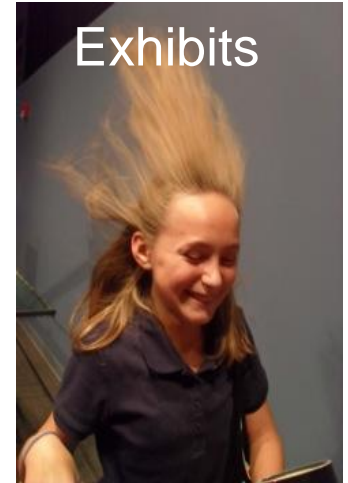
Why this age group?

- At this stage kids are open to everything and don't know that physics is hard.
- **Can you engage elementary and middle school aged children with concepts related to particle physics?**
- Over 5000 children participated from Kansas, Missouri, Colorado in hands on shows
 - Assessment done with students and their teachers
- Website continues to have over 5000 visitors/month

High-tech gravitational
wave research labs



5000 sq. foot Science
Education Center



Tours



K-12



Teacher development

Exhibits



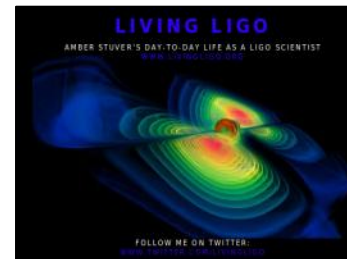
Science Fairs and Festivals



Web



Blogs

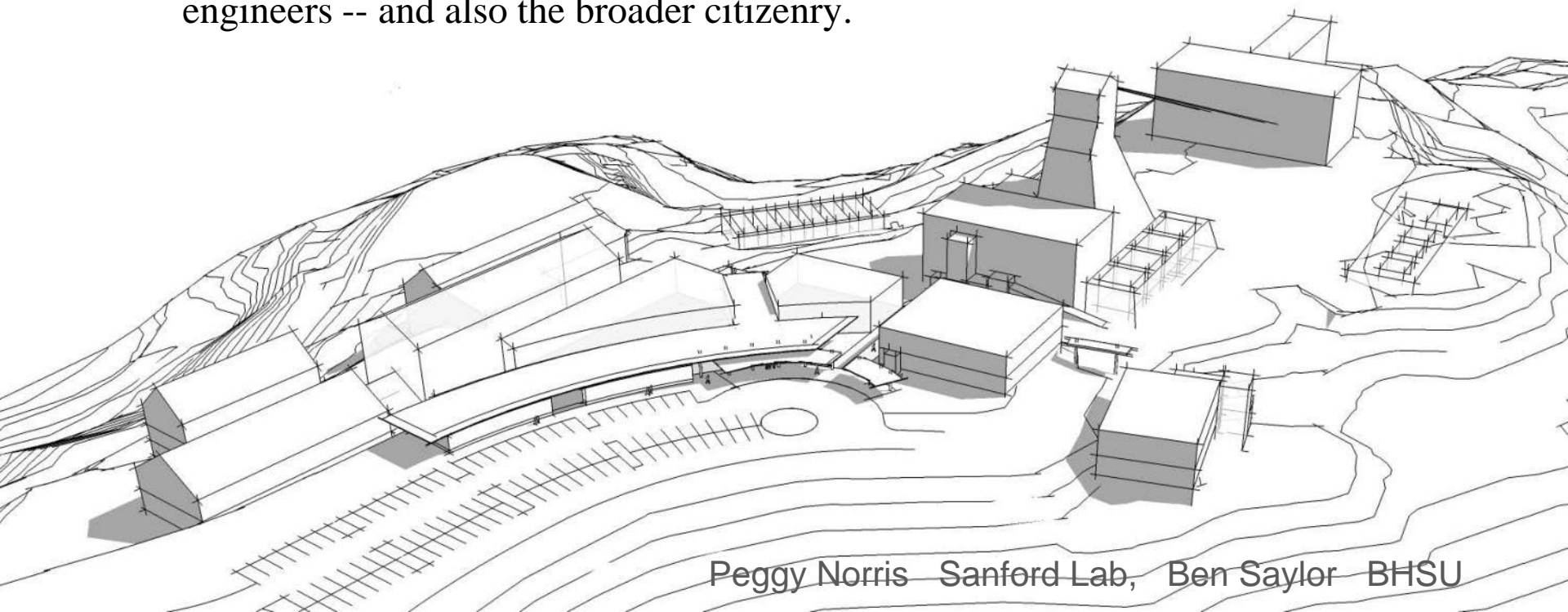


Games



Student training

- Planning is underway for the Sanford Center for Science Education (SCSE)
 - Leveraged by a substantial pledge from philanthropist T. Denny Sanford, the SCSE will be the education and outreach arm of DUSEL or its DOE equivalent
 - The SCSE is envisioned to feature and leverage the science and engineering of the underground lab to excite and help prepare the next generation of scientists and engineers -- and also the broader citizenry.



Early activities build partnerships and capacity, and test content for a variety of audiences

The 2011 Davis-Bahcall Scholars - ten high-achieving students from across the state - pose with teachers from the Black Hills State University Quarknet Center after spending an afternoon at Sanford Lab calibrating several cosmic ray muon detectors with Bob Peterson of Fermilab. Photo by Matt Kapust



**Special efforts are made to serve American Indian audiences,
approximately 10% of the regional population**



Sanford Lab partnered with University of Nebraska Medical Center and Black Hills State University to sponsor a science camp for middle school students from reservations in Nebraska and South Dakota in June 2011. Photo by Matt Kapust.

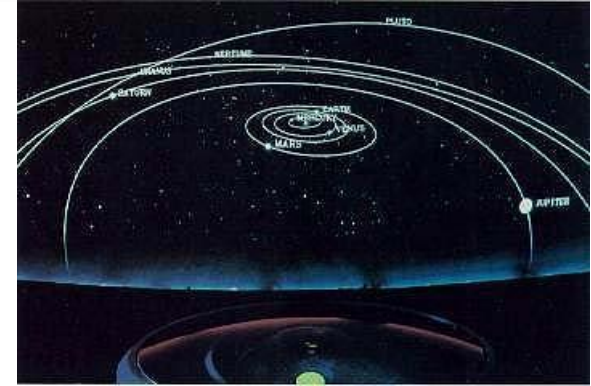
- ✧ Outreach component of NSF CAREER grant
 - Bring ATLAS, LHC, HEP to Planetarium audience
 - In close cooperation with Abrams Planetarium at MSU
- ✧ Already produced a 5-minute planetarium clip
 - Plays at the end of each public show
- ✧ Working on full planetarium show
 - To debut this fall



Reinhard Schwienhorst, Michigan State University

✧ Planetarium display environment

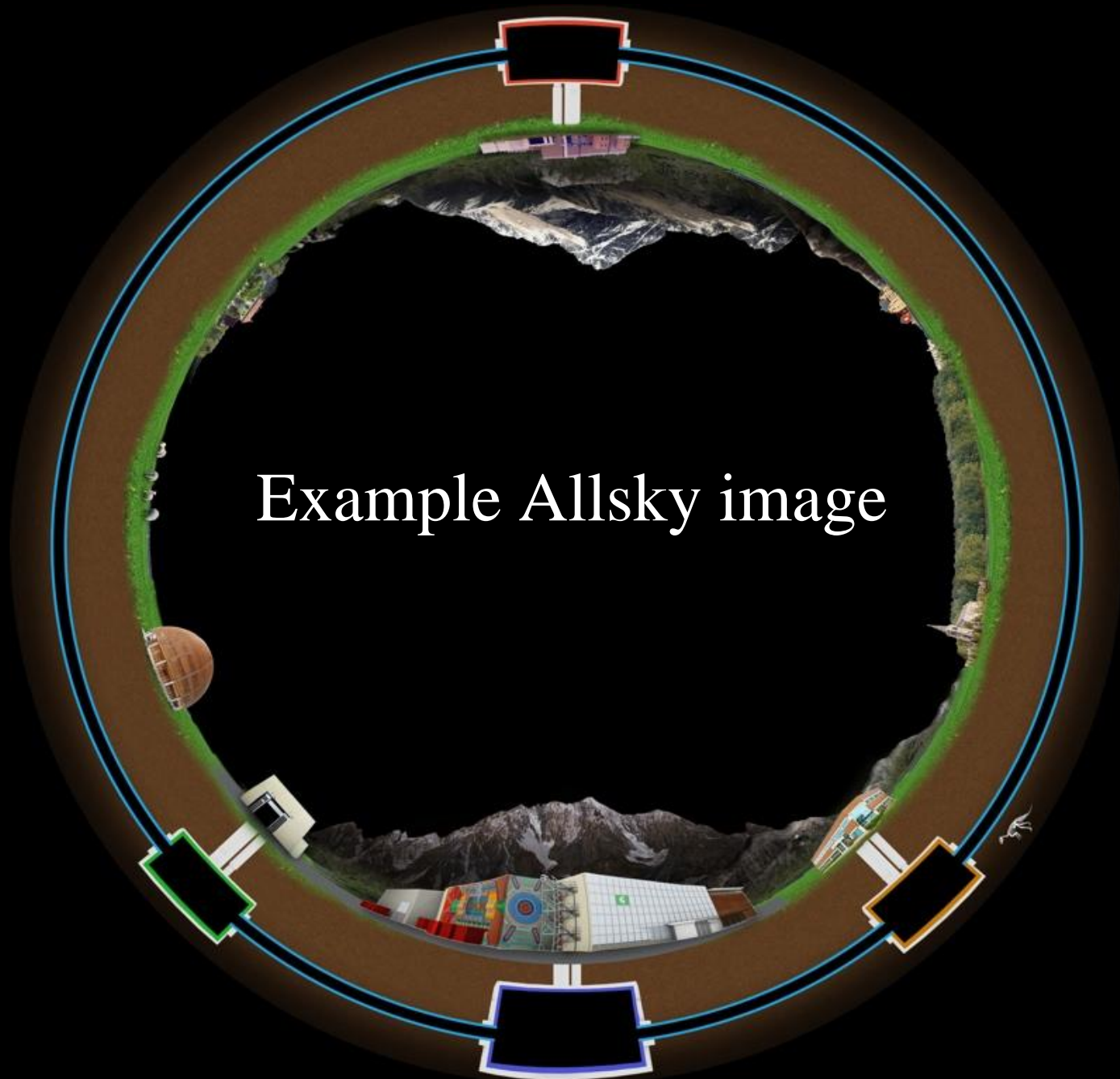
- Together with video projector, slide projectors



✧ Show design by MSU students:

- Undergraduates, professors, graduate student,...
- With support from experts:
 - Professional writing professor
 - Communication graphics and design professor
 - Planetarium show developer





Example Allsky image



Highlights of Education/Outreach at the Pierre Auger Observatory

Malargüe, Mendoza Province, Argentina

- Over 10 years of outreach in Mendoza and beyond
- Positive impact in communities
- Collaboration takes part in local traditions
- Fosters sense of partnership in Auger's scientific mission



Malargüe Day Parade November 2010



Auger **Visitor Center** in its headquarters has hosted over **65,000 visitors** since opening in 2001



Collaboration partnered with Mendoza Province to construct the new **James Cronin School** in Malargüe in 2007



Science presentation



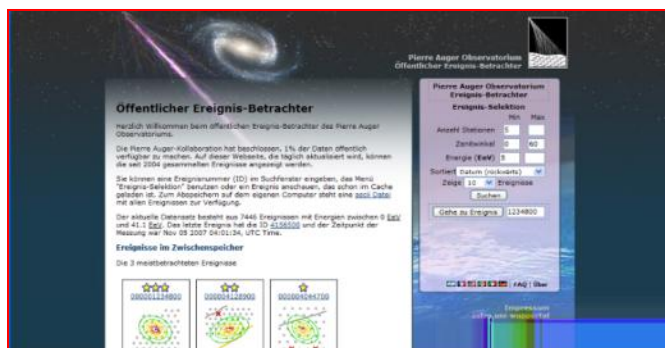
Donation of electric heaters

Rural Schools Program: Observatory staff volunteer to bring cosmic ray science and infrastructure improvements to remote schools that cannot travel to Malargüe

Highlights of Education/Outreach at the Pierre Auger Observatory



The Collaboration sponsored 3-day **Science Fairs** at the Observatory in 2005, 2007, 2010 drawing student and teacher teams from all over the Province. Collaborators serve as judges.



Students use reconstructed air shower data released online for science fairs and independent research projects.

<http://www.auger.org> (5 languages, 4000 hits per year)



Collaborators offer courses in **hands-on science instruction** to local teachers

Plain English Summaries (ATLAS)



47 people like this. Be the first of your friends.

Is Nature Supersymmetric? First Data from the ATLAS Experiment.

24 May 2011

String Theory predicts a new symmetry, called "supersymmetry", that could shed light on some of today's mysteries of fundamental particles and interactions. In supersymmetry, every particle-type should have a "shadow" particle called a super-partner that (in general) has a much higher mass. The ATLAS Experiment has analyzed the first year of its LHC data and searched for evidence of these super-partners of ordinary matter.

In the proton collisions of the LHC, new heavy particles (the super-partners) could be produced. These super-partner particles would subsequently decay in a variety of ways, such as shown in Fig. 1, leaving many different telltale signals that ATLAS has sought to detect. Collision events with a so-called "momentum imbalance" are the key signature for the production of super-partner particles.

According to the law of momentum conservation, the momentum of all particles produced in the collision perpendicular to the proton-proton axis should exactly balance. An imbalance of the momentum would point to "missing" particles — particles that interact extremely weakly with matter. This imbalance occurs because the final decay products include particles that leave the detector without being detected (because they interact extremely weakly with matter). For the case of supersymmetry, these particles are the lightest super-partner particles (the "neutralino" $\tilde{\chi}_1^0$).

Since the neutralino $\tilde{\chi}_1^0$ does not decay at all, it is a permanent component of our universe. This particle might be the so-called dark matter that is 80% of all matter in the Universe. Therefore, these searches could shed light on the nature of dark matter. More about dark matter is [here](#), and see the link to "PhD comics" therein.

The measurement of the momentum balance requires the precise reconstruction of all types of measurable particles and a combination of the many component devices of ATLAS. This makes it one of the most challenging measurements at ATLAS.

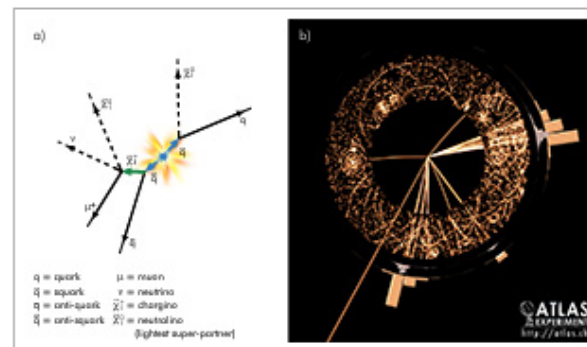
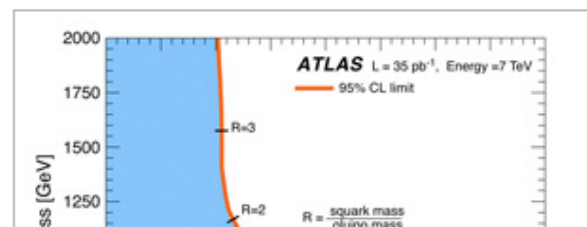


Fig.1 (Click picture for a larger version)

Fig. 1a): In this example, the collision of two protons results in the production of a squark and an antisquark (the super-partner of the quark and its antiparticle). These decay into lighter particles, one of which (a "chargino", written as $\tilde{\chi}_1^\pm$) also decays into still more particles. The chargino and squark are written with a tilde over them, which indicates that they are super-partner particles. The decays happen so quickly that no tracks are left in the ATLAS detector from the squark and chargino. In the end, two of the neutralinos $\tilde{\chi}_1^0$ (lightest super-partner particles) survive, because there are no lighter super-partners into which they can decay.

Fig. 1b): This figure shows an example of the momentum imbalance resulting from collision events such as in Fig. 1a). The two incoming (colliding) protons were perpendicular to this image, and the collision happened at the center. The visible particles are those that came out of the collision at the center. The solid bars on the outside show the areas where most of the energy went. It is clear that most of the momentum (and energy) went to the bottom and right. This imbalance was due to the lightest super-partner particles (and the neutrino) going undetected to the upper left. They leave no tracks and deposit no energy. This momentum imbalance is a signature for new particles.





Jon Butterworth

Webfeed

Profile

Jon Butterworth is a physics professor at University College London. He is a member of the High Energy Physics group on the Atlas experiment at Cern's Large Hadron Collider

Latest

Speak after the beep

30 Sep 2011: Jon Butterworth: Diary entry. An unexpected bonus of the faster-than-light neutrino kerfuffle was a trip to the Palais de Nations and a superbly retro BBC studio.

[Post your comment](#)

Tribute to the Tevatron

29 Sep 2011: Jon Butterworth: On Friday the Tevatron closes after 28 glorious years. There will be many tributes, here's one. To the edge of physics by bicycle

[1 comment](#)

Those faster-than-light neutrinos. Four things to think about

24 Sep 2011: Jon Butterworth: Having read the paper, seen the seminar and watched the excitement over evidence from the Opera experiment that neutrinos violate the speed limit of the universe, here are four things to ponder.

[120 comments](#)

CERN has a Gormley

20 Sep 2011: Jon Butterworth: As I was walking up the stairs, I saw a knot of tangled hair

[27 comments](#)

Do try this at home

17 Sep 2011: The Marvin and Milo book of forty-five physics experiments you can do at home will demonstrate some real, non-trivial physics principles. Plus a video of a balloon hovercraft.

[3 comments](#)



USLHC | USA

[« Older Entries](#)

Expecting the end, but still producing!

Robin Erbacher

Friday, September 30th, 2011

Hello from Fermilab!

Today is a bittersweet day. As you have read in several posts here on the [US LHC blog](#) in [Quantum Diaries](#), most recently from [Kathy Copic](#), [Michael Schmitt](#), and [Ken Bloom](#), the Fermilab Tevatron, which for decades held the title of the “Highest Energy Accelerator in the World” (until the LHC began operations in 2009 of course), is ending its historic 28 year run.

This news has also made it into the popular press, such as the [BBC](#), the [Chicago Tribune](#) (which discusses the future of Fermilab in brief as well) and the [Washington Post](#).



Sitting in the CDF collaboration meeting, discussing new and exciting results, while awaiting the end of the Tevatron in only a few hours...

SEARCH:

BLOGS

PEOPLE

LABORATORIES



European Organization for Nuclear Research

[View Blog \(English\)](#)

[Read Bio \(English\)](#)

[View Blog \(French\)](#)

[Read Bio \(French\)](#)

[When the proton becomes larger](#)

[Nothing travels faster than light but gossip!](#)

[Quand le proton se fait plus grand](#)

[Élémentaire, mon cher neutrino...](#)



TRIUMF

[The limits of science](#)

1000 people for physics presentations.

Over 500 were seated. Another room of over 250, and turned about 200 away.

Particle detectors: they're nearer than you think Marcel Demarteau

Seeking hidden dimensions, Brian Foster

Neutrinos from outer space! Garabed Halladjian

An illumination of dark matter JoAnne Hewett

Why physics, dude? Marc Wenskat

Appreciated by all: long sequence of questions for about an hour.



I have mostly left out Social Media – Blogs, Facebook, Twitter, etc.

Social Media **versus** Face-to-face interactions

Face-to-face interactions dominate what most physicists are doing... and like.

Which has more impact?

Particle physicists from many experiments have been extremely active in reaching out to the world community.

They are continuing to be innovative to seeking new and better forms of communication.

The end