



Outreach tools with real HEP data: challenges and opportunities

Fifth Workshop on Data Preservation and Long Term Analysis in HEP
Fermilab, Batavia, IL

M. Bellis

Department of Physics
Stanford University

May 16th, 2011



- **Tuesday, May 17th, 16:00-18:00**
- **Parallel Sessions on DPHEP common projects**
 - *Outreach*
 - Tom Jordan, Quarknet and I2U2

1 MOTIVATION

2 CURRENT MODELS

3 DATA FORMATS

4 PARTICLE PHYSICS WIND CHIME PROJECT

Orientation question

Orientation question

- Are we a **young field** or a **mature field**?

Why bother with outreach?

Why bother with outreach?

- Tell people what we do.
- *Our responsibility.*
- *Justify funding.*

Why bother with outreach?

- Tell people what we do.
- *Our responsibility.*
- *Justify funding.*

Why bother with education?

- Contribute to an educated workforce/society.

Why bother with outreach?

- Tell people what we do.
- *Our responsibility.*
- *Justify funding.*

Why bother with education?

- Contribute to an educated workforce/society.

Why bother with training?

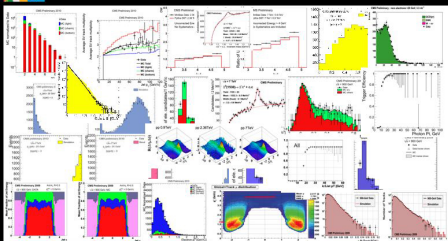
- Train new students/collaborators better.
- Encourage more (**better?**) communication between theorists and experimentalists.

Tell people what we do.

- Particle physics complexity is increasing.
- New-physics or not, we have to explain these results to the general public.
- Citizen-scientist involvement is different than astronomy.



...and plenty of new results coming daily

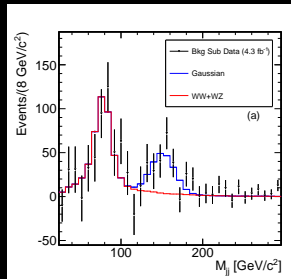
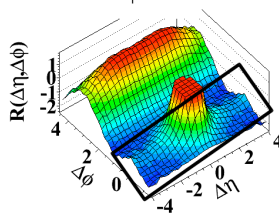


G. Tonelli, CERN/Plas

P-LHC Hamburg

June, 7 2010 1

(d) $N > 110, 1.0 \text{ GeV}/c < p_T < 3.0 \text{ GeV}/c$



A need for future analysts.

- New York Times (May 13th, 2011)
- McKinsey Global Institute
- “Big data: The next frontier for innovation, competition, and productivity”.



<http://techcrunch.com/2010/03/16/big-data-freedom/>

- http://www.mckinsey.com/mgi/publications/big_data/index.asp
- <http://www.nytimes.com/2011/05/13/technology/13data.html>

Contribute to an educated workforce/society

From the McKinsey Global Institute study...

Contribute to an educated workforce/society

From the McKinsey Global Institute study...

- **Analyzing large data sets**, also called big data, **will become a key basis of competition**, underpinning new waves of productivity growth, innovation, and consumer surplus...

Contribute to an educated workforce/society

From the McKinsey Global Institute study...

- **Analyzing large data sets**, also called big data, **will become a key basis of competition**, underpinning new waves of productivity growth, innovation, and consumer surplus...
- The United States alone faces **a shortage of 140,000 to 190,000 people with analytical expertise** and **1.5 million managers and analysts** with the skills to understand and make decisions based on the analysis of big data.

Contribute to an educated workforce/society

From the McKinsey Global Institute study...

- **Analyzing large data sets**, also called big data, **will become a key basis of competition**, underpinning new waves of productivity growth, innovation, and consumer surplus...
- The United States alone faces **a shortage of 140,000 to 190,000 people with analytical expertise** and **1.5 million managers and analysts** with the skills to understand and make decisions based on the analysis of big data.
- (From NYT article) The report points to the need for a sweeping change in business to adapt **a new way of managing and making decisions that relies more on data analysis**.

Contribute to an educated workforce/society

From the McKinsey Global Institute study...

- **Analyzing large data sets**, also called big data, **will become a key basis of competition**, underpinning new waves of productivity growth, innovation, and consumer surplus...
- The United States alone faces **a shortage of 140,000 to 190,000 people with analytical expertise** and **1.5 million managers and analysts** with the skills to understand and make decisions based on the analysis of big data.
- (From NYT article) The report points to the need for a sweeping change in business to adapt **a new way of managing and making decisions that relies more on data analysis.**
- **“Every manager will really have to understand something about statistics and experimental design going forward,”** said Michael Chui, a senior fellow at the McKinsey Global Institute.

Contribute to an educated workforce/society

From the McKinsey Global Institute study...

- **Analyzing large data sets**, also called big data, **will become a key basis of competition**, underpinning new waves of productivity growth, innovation, and consumer surplus...
- The United States alone faces **a shortage of 140,000 to 190,000 people with analytical expertise** and **1.5 million managers and analysts** with the skills to understand and make decisions based on the analysis of big data.
- (From NYT article) The report points to the need for a sweeping change in business to adapt **a new way of managing and making decisions that relies more on data analysis**.
- **“Every manager will really have to understand something about statistics and experimental design going forward,”** said Michael Chui, a senior fellow at the McKinsey Global Institute.

How many particle physicists at grad student/postdoc level, go on to a complete career in particle physics?

Train new students/collaborators better

- We can always do better at training ourselves.

Train new students/collaborators better

- We can always do better at training ourselves.
- Experiments evolve.

Train new students/collaborators better

- We can always do better at training ourselves.
- Experiments evolve.
 - **Jefferson Lab** (Form factors, N^* \Rightarrow PWA (old SLAC-type analysis))
 - **BaBar** (CP -violation $\Rightarrow c\bar{c}$ spectroscopy)
 - **Tevatron** (E frontier, top physics $\Rightarrow b$ spectroscopy, \mathcal{L} /precision frontier)
 - **LHC** (E frontier \Rightarrow ???)

Train new students/collaborators better

- We can always do better at training ourselves.
- Experiments evolve.
 - **Jefferson Lab** (Form factors, N^* \Rightarrow PWA (old SLAC-type analysis))
 - **BaBar** (CP -violation $\Rightarrow c\bar{c}$ spectroscopy)
 - **Tevatron** (E frontier, top physics $\Rightarrow b$ spectroscopy, \mathcal{L} /precision frontier)
 - **LHC** (E frontier \Rightarrow ???)
- SuperB at Fermilab? ILC at SLAC?
- Will LHC lose key developers over lifetime?
- Why do analyses take so long? (Computing expertise? Physics expertise?)

Train new students/collaborators better

- We can always do better at training ourselves.
- Experiments evolve.
 - **Jefferson Lab** (Form factors, N^* \Rightarrow PWA (old SLAC-type analysis))
 - **BaBar** (CP -violation $\Rightarrow c\bar{c}$ spectroscopy)
 - **Tevatron** (E frontier, top physics $\Rightarrow b$ spectroscopy, \mathcal{L} /precision frontier)
 - **LHC** (E frontier \Rightarrow ???)
- SuperB at Fermilab? ILC at SLAC?
- Will LHC lose key developers over lifetime?
- Why do analyses take so long? (Computing expertise? Physics expertise?)
- Can we teach the **integrated knowledge** better?
- DPHEP seems like the right place to learn **a lot** of physics.

Better communication between theorists and experimentalists

- Learn **theory** in classes.
- Learn **experimental analysis** in ???.
- *Experimental analysis school for theorists?*

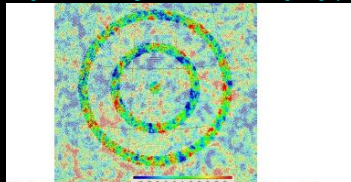
Better communication between theorists and experimentalists

- Learn **theory** in classes.
- Learn **experimental analysis** in ???.
- *Experimental analysis school for theorists?*
- Otherwise, folks may take it into their own hands...

Gurzadyan and Penrose

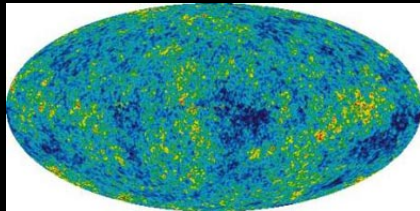
“Concentric circles in WMAP data may provide evidence of violent pre-Big-Bang activity”

<http://arxiv.org/abs/1011.3706><http://physicsworld.com/cws/article/news/44388>



The sky region of Fig. 2 with indication of the low variance circles.
This particular example also illustrates a low-variance central point.

<http://www.nature.com/news/2010/101210/full/news.2010.665.html>



Current models - not an exhaustive list

General outreach

- CPEP
- Contemporary Physics Education Project.
- Demos and information.
- Classroom materials.

<http://www.cpepweb.org/>



Current models - not an exhaustive list

General outreach

- CPEP
- Contemporary Physics Education Project.
- Demos and information.
- Classroom materials.
- Particle adventure.

<http://www.cpepweb.org/>
<http://particleadventure.org/>



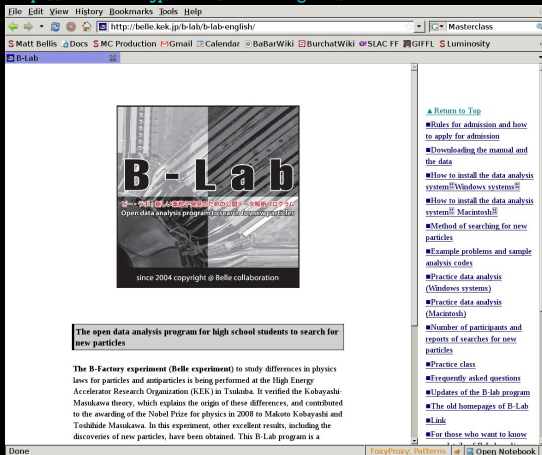
Done

Current models - not an exhaustive list

K-12 models

- **B-Lab (Belle)**
- High school students.
- Summer.
- Basically organized by one emeritus professor.
- *Thanks to Takeo Higuchi for information.*

<http://belle.kek.jp/b-lab/b-lab-english/>



The open data analysis program for high school students to search for new particles

The B-Factory experiment (Belle experiment) to study differences in physics laws for particles and antiparticles is being performed at the High Energy Accelerator Research Organization (KEK) in Tsukuba. It verified the Kobayashi-Masukawa theory, which explains the origin of these differences, and contributed to the awarding of the Nobel Prize for physics in 2008 to Makoto Kobayashi and Toshihide Masukawa. In this experiment, other excellent results, including the discoveries of new particles, have been obtained. This B-Lab program is a

- Return to Top
- Rules for admission and how to apply for admission
- Downloading the manual and the data
- How to install the data analysis system^{Windows systems}
- How to install the data analysis system^{Macintosh}
- Method of searching for new particles
- Example problems and sample analysis codes
- Practice data analysis (Windows systems)
- Practice data analysis (Macintosh)
- Number of participants and reports of searches for new particles
- Practice class
- Frequently asked questions
- Updates of the B-lab program
- The old homepages of B-Lab
- Link
- For those who want to know

Current models - not an exhaustive list

K-12 models

- **Quarknet (NSF/DOE, Fermilab)**
- Some local exercises.
- Links to other sites.
- Inhomogeneous, some old exercises.

<http://quarknet.fnal.gov/>

10 **QuarkNet:** The science connection you've been waiting for!

[Meet last year's teachers!](#)

The Opportunity: "Your program rejuvenates my soul. It connects me with a cadre of intelligent and excited educators. It reinvigorates my teaching and provides me avenues to extend and enliven the projects that I can offer my students. Without the Quarknet program I am sure that I would have left teaching years ago."

The Players: High school students, teachers and physicists working together on physics research projects exploring the hidden nature of matter, energy, space and time.

The Questions: What are the origins of mass? Can the basic forces of nature be unified? How did the universe begin? How will it evolve?

LHC & Fermilab Links	For Teachers	For Students
CERN Homepage - LHC	QuarkNet Classroom Activities	Cosmic Ray Studies Run It Website
ATLAS Experiment - 1st Collisions	Cosmic Rays-Lab Online Resources	View student Webcasts
CMS Experiment - 1st Collisions	QuarkNet Blog Centers	Analyze the data
Fermilab Homepage	Presentations at the 2009 AAET/AAAS Chicago meetings.	Measuring Single Photons
CDF Experiment	Contact us!	Discovering New Particles
DZERO Experiment	Join us !	Applying Chm's Law
	Project Overview	The Particle Adventure
	Kudos for QuarkNet	The Top Quark Online References
		At Work

Current models - not an exhaustive list

K-12 models

- **I2U2 (NSF/DOE, Fermilab)**

<http://www18.i2u2.org/>

File Edit View History Bookmarks Tools Help

http://www18.i2u2.org/

Matt Bellis Docs MC Production Gmail Calendar BaBarWiki BurchatWiki SLAC GIFFL Luminosity

I2U2

I2U2 Home e-Labs L-Labs

I2U2 Home About Us DR K-12

Interacts in Understanding The Universe, I2U2 an "educational virtual organization," strengthens the education and outreach activities of scientific experiments at U.S. universities and laboratories. I2U2 creates and maintains an infrastructure and common fabric to develop hands-on laboratory course content and provide an interactive learning experience that brings tangible aspects of each experiment into an accessible, virtual laboratory setting for education at different levels and in various venues. The I2U2 collaboration of scientists, computer scientists and educators directly addresses the urgent national priority to grow and sustain the scientific workforce, and to promote the public's appreciation of and support for the complex collaborations of our national scientific programs.

I2U2 labs take two similar but distinct shapes. "e-Labs," delivered as Web-based portals accessible in the classroom and at home, are implemented with the ever-expanding capabilities of Web-based media. "L-Labs," delivered as interactive interfaces locally located within science museums and similar public venues, leverage the latest advances in display/technology and human-computer interaction, and bring the experiences and appreciation of scientific investigation and inquiry to the wide audience of informal education. These laboratories break new ground by using the Grid for education in the same way that science is using the Grid. I2U2 reaches communities underrepresented in science and continuously assesses the impact of this approach on science education. I2U2 collaborators use existing partnerships with underrepresented populations to prototype and evaluate the labs.

This project is supported in part by the National Science Foundation and the Office of High Energy Physics in the Office of Science, U.S. Department of Energy. Opinions expressed are those of the authors and not necessarily those of the Foundation or Department.

Done FoxyProxy: Patterns Open Notebook

Current models - not an exhaustive list

K-12 models

- **I2U2 (NSF/DOE, Fermilab)**
- Cosmics elab

<http://www18.i2u2.org/>

Cosmic Ray e-Lab

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

Cosmic Rays

Log in

Username:

Password:

To explore our website,
[click on a link!](#)

Need a student login?
Ask your teacher.

Need a teacher login?
Contact slab@i2u2.org

Current models - not an exhaustive list

K-12 models

- I2U2 (NSF/DOE, Fermilab)
- Cosmics elab
- CMS elab

<http://www18.i2u2.org/>

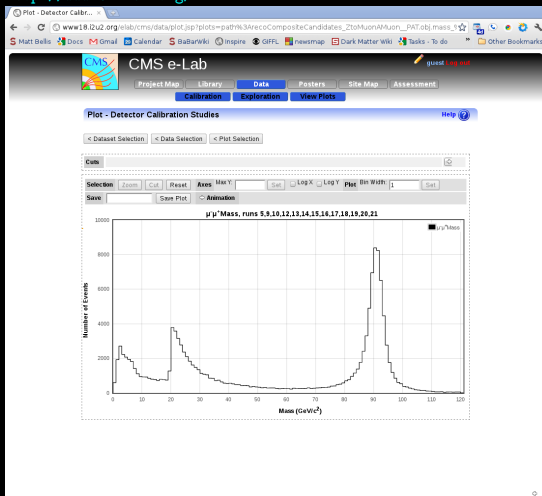
The screenshot shows a web browser window with the address bar displaying www18.i2u2.org/elab/cms/home/. The page title is "CMS e-Lab". The main content area features a welcome message: "Welcome: Join a national collaboration of high school students to study CMS data." Below this is a "Bookmark This Page!" section with a sub-header "Watch a CMS animation of the high-energy collisions at 7 TeV on 30th March 2010. You will be able to look at 3-D events like the one in this collision." This is followed by a video player showing a particle collision event. To the right of the video is a "Log in" section with fields for "Username:" and "Password:", a "Login" button, and links for "Need a student login?", "Need a teacher login?", and "Contact e-lab@fnal.gov".

Current models - not an exhaustive list

K-12 models

- **I2U2 (NSF/DOE, Fermilab)**
- Cosmics elab
- CMS elab

<http://www18.i2u2.org/>



Current models - not an exhaustive list

K-12 models

- **I2U2 (NSF/DOE, Fermilab)**
- Cosmics elab
- CMS elab

<http://www18.i2u2.org/>

The screenshot displays the CMS e-Lab interface. At the top, there are navigation tabs for Project Map, Library, Data, Posters, Site Map, and Assessment. Below these are sub-tabs for Calibration, Exploration, and View Plots. The main content area is titled "View Plots: Search for and view plots." and includes a search bar with "Quick Searches: guest, Jordan, Fermilab, Batada, L, All" and a "Search Data" button. A note states "States include provinces and foreign countries. Use the [allocation](#)." Below this is a grid of 16 plot thumbnails, each with a title, group name, and creation date. The plots include various particle physics data visualizations such as histograms, line graphs, and detector diagrams. Some thumbnails are marked as "Thumbnail not found".

Thumbnail	Title	Group	Created
	2	Group: View207	2011-02-13 13:29:41.818
	positive/negative	Group: Mouse428	2011-02-22 09:45:08.812
	Thumbnail not found		
	Real - 2	Group: Cal891	2011-02-14 13:41:36.272
	Muon Exploration	Group: Brazil	2011-02-15 13:44:26.503
	Detector	Group: India	2011-02-22 23:00:17.019
	Mass_e_mu_log	Group: we1	2010-08-02 14:12:37.21
	graph 3b	Group: Pp148	2011-02-14 21:58:33.815
	mumu1415	Group: we4	2010-08-02 13:17:52.42
	BA	Group: we4	2010-08-02 13:19:01.411
	calibrat	Group: S3NSPC	2010-07-27 12:05:02.788
	graph 1	Group: Pp148	2011-02-14 21:51:06.635
	Poster histogram	Group: G0014	2011-02-11 12:07:25.611
	5	Group: View207	2011-02-13 13:27:50.295
	etaZeromomms	Group: we1	2010-08-02 13:47:34.591
	Thumbnail not found		
	Muon Plot	Group: Purple291	2011-02-23 08:19:25.932

Current models - not an exhaustive list

K-12 models

- International Masterclasses for High School Students
- Hands on Particle Physics

<http://www.physicsmasterclasses.org/>

EPPOG - Hands on P...

www.physicsmasterclasses.org

Home
Participate!
Schedule
My Country
Physics
Local Organisations
Press Review
Archive
Impact
Contact Us

Facebook
International Particle Physics Outreach Group

Einstein in the 21st Century

Hands on Particle Physics

International Masterclasses for High School Students

Hands on Particle Physics Masterclasses

7th International Masterclasses 2011

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 foundations 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 consolidation of their results.

The **International Masterclasses 2011** have been held from 4.3. - 26.3.2011. Each day up to six out of about 100 institutes participated, see [schedule](#). 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](#).

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 foundations of matter and forces
- perform measurements on real data from particle physics experiments at CERN
- participate in an international video conference for discussion of results

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.

Current models - not an exhaustive list

K-12 models

- **International Masterclasses for High School Students**
- **Hands on Particle Physics**
- 6000 students, 24 countries, 110 universities/research centers.

<http://www.physicsmasterclasses.org/>

Hands on Particle Physics
International Masterclasses for High School Students

Hands on Particle Physics Masterclasses
Physics

- What are the fundamental building blocks of matter?
- How can I identify them?
- Which forces hold them together?
- How do these forces work?
- How far have the secrets of forces and matter been understood so far?

Find the answers to these and other questions by browsing, reading, and working through some of the educative materials on particle physics which is collected here. Most of the material contains interactive elements, some even real particle physics events for making your own measurements, and understanding particle physics "hands-on". The material was collected for the EPPOG Particle Physics Masterclasses, where some of the measurements from the practical exercises for high school students spending a day at one of the [Research Institutes](#). More info on the teaching systems, which are suited for a wide range of readers, is accessible via the menu in the left column.

	DE	FR	ES	IT	UK	US	CA	RU	IN	BR	AR	CH	AT	PL	TR	GR	PT	SE	NO	DK	FI	JP
ALICE					x	x	x	x	x	x	x											
ATLAS		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
CMS					x	x	x	x	x	x	x											
Hands On-Cem		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
A Day in the Life of a Top					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Identifying Particles					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Particle Physics Parity					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Other Particle Physics																						

Current models - not an exhaustive list

Masterclass, somewhat inhomogeneous, some old exercises.

Einstein in the 21st Century

The search for the Higgs boson is the most important physics project in the world today. The search for the Higgs boson is the most important physics project in the world today. The search for the Higgs boson is the most important physics project in the world today.

$E^2 = p^2 + m^2$

When p is the high energy of the particle and m is the mass of the particle.

The mass of the Higgs boson is approximately 125 GeV .

When p is the high energy of the particle and m is the mass of the particle.

The mass of the Higgs boson is approximately 125 GeV .

CMS Masterclass Event Display

1. Absolute Energy Converter

2. Lost photon LUT for detector

Generated using ROOT!

Object not found!

The requested file was not found in the store. Please check the file name and the path.

Error 304

Not Found

CMS Masterclass

The CMS detector is a superconducting solenoid structure with an inner tracking detector (ITD) and an outer tracking detector (OTD).

The CMS detector is a superconducting solenoid structure with an inner tracking detector (ITD) and an outer tracking detector (OTD).

BaBar Particle Physics Teaching Package

To see more through the partner (JLab), visit [http://www.jlab.org/babar/teaching/](#)

The material covered in this package is suitable for use in the following [undergraduate courses](#)

The package also contains a number of exercises for students to do as part of their learning. The exercises are designed to be done as part of a course or as a self-study package.

Object not found!

The requested file was not found in the store. Please check the file name and the path.

Error 304

Not Found

Is there something that the DPHEP effort brings to the table?

- HEP analysis have benefitted from common analysis tools
 - ROOT, PAW, GEANTx

- HEP analysis have benefitted from common analysis tools
 - ROOT, PAW, GEANTx
- Analysis and outreach data formats suffer from Tower of Babel.
 - .root, .bos, .txt, Objectivity, XROOTD
 - To store **classes** or not to store **classes**?

- HEP analysis have benefitted from common analysis tools
 - ROOT, PAW, GEANTx
- Analysis and outreach data formats suffer from Tower of Babel.
 - .root, .bos, .txt, Objectivity, XROOTD
 - To store **classes** or not to store **classes**?
- Not always integrated with the the greater computing community.
 - XML, JSON

- HEP analysis have benefitted from common analysis tools
 - ROOT, PAW, GEANTx
- Analysis and outreach data formats suffer from Tower of Babel.
 - .root, .bos, .txt, Objectivity, XROOTD
 - To store **classes** or not to store **classes**?
- Not always integrated with the the greater computing community.
 - XML, JSON
- Archival/Outreach needs are different.
 - **Ease and stability** over **speed of access**.

Revisit FITS

FITS (Flexible Image Transport System). Standardized in **1981**.

- <http://heasarc.nasa.gov/docs/heasarc/fits.html>
- Images *and* catalogs.
- Human-readable header.
- *Many* libraries! http://fits.gsfc.nasa.gov/fits_libraries.html
 - **FORTRAN** (1957)
 - **C** (1973)
 - **IDL** (1977)
 - **Matlab** (~1980)
 - **C++** (1983)
 - **Perl** (1987)
 - **TCL** (1988)
 - **Igor Pro** (1988)
 - **Mathematica** (1988)
 - **Adobe Photoshop** (1990)
 - **Python** (1991)
 - **R** (1993)
 - **Java** (1995)
 - **gimp** (1996)
 - **C#** (2001)
 - **C+0x, Go** (????)

Revisit FITS

FITS (Flexible Image Transport System). Standardized in **1981**.

- <http://heasarc.nasa.gov/docs/heasarc/fits.html>
- Images *and* catalogs.
- Human-readable header.
- *Many* libraries! http://fits.gsfc.nasa.gov/fits_libraries.html
 - **FORTRAN** (1957)
 - **C** (1973)
 - **IDL** (1977)
 - **Matlab** (~1980)
 - **C++** (1983)
 - **Perl** (1987)
 - **TCL** (1988)
 - **Igor Pro** (1988)
 - **Mathematica** (1988)
 - **Adobe Photoshop** (1990)
 - **Python** (1991)
 - **R** (1993)
 - **Java** (1995)
 - **gimp** (1996)
 - **C#** (2001)
 - **C+0x, Go** (????)
- Understand that our data is more complicated...

Previous attempts

This is not the first time we've discussed this...

- **HEPEVT**
 - Event record in a Monte Carlo-independent format.
 - LEP initiative.
 - http://cepa.fnal.gov/psm/simulation/mcgen/lund/pythia_manual/pythia6.3/pythia6301/node39.html
- **STDHEP**
 - Common output format for Monte Carlo events.
 - <http://cepa.fnal.gov/psm/stdhep/>
- **HEPML**
 - Unified XML format of information required for Monte-Carlo (MC) simulation in HEP.
 - <https://twiki.cern.ch/twiki/bin/view/Main/HepML>
- **HEPREP**
 - Generic Interface Definition for HEP Event Display Representables (XML)
 - Wired.
 - <http://www.slac.stanford.edu/~perl/heprep/index.html>

Previous attempts

This is not the first time we've discussed this...

- **HEPEVT**
 - Event record in a Monte Carlo-independent format.
 - LEP initiative.
 - http://cepa.fnal.gov/psm/simulation/mcgen/lund/pythia_manual/pythia6.3/pythia6301/node39.html
- **STDHEP**
 - Common output format for Monte Carlo events.
 - <http://cepa.fnal.gov/psm/stdhep/>
- **HEPML**
 - Unified XML format of information required for Monte-Carlo (MC) simulation in HEP.
 - <https://twiki.cern.ch/twiki/bin/view/Main/HepML>
- **HEPREP**
 - Generic Interface Definition for HEP Event Display Representables (XML)
 - Wired.
 - <http://www.slac.stanford.edu/~perl/heprep/index.html>
- Does the DPHEP effort provide an opportunity to contribute? Or confuse?

HepEdu

- Discussions within DPHEP: format for outreach.
- BaBar, Belle, H1.

- Discussions within DPHEP: format for outreach.
- BaBar, Belle, H1.
- First order attempt: text. Number of particles/tracks in the event

index PID E px py pz for particle 0

index PID E px py pz for particle 1

index PID E px py pz for particle 2

index PID E px py pz for particle 3

```
6
0   -13  1.313  0.407  1.241  0.075
1   -11  2.010 -1.813  0.039 -0.865
2  -211  0.474 -0.134  0.304 -0.308
3   211  0.480 -0.353 -0.112 -0.273
4  -211  1.003 -0.905 -0.369  0.176
5    22  0.212 -0.108  0.147  0.108
3
0   211  1.316 -0.414 -1.239  0.075
1  -211  2.014 -1.802  0.204 -0.865
2   211  0.474 -0.307  0.127 -0.308
```

HepEdu

- Discussions within DPHEP: format for outreach.
- BaBar, Belle, H1.
- Add parent/daughter information.

```
6
0    11  2.305 -0.369 -2.171 -0.678  -1  0
1   -211  0.578 -0.388 -0.059  0.400  -1  0
2    211  0.519 -0.084 -0.476 -0.129  -1  0
3    310  0.686  0.280 -0.164 -0.068  -1  2  4  5
4   -211  0.384  0.337  0.017  0.122   3  0
5    211  0.302 -0.057 -0.181 -0.190   3  0
```

Next steps...

- Formalize data description.
 - Abstract event information.
 - Abstract particle/candidate/track/jet information (4-vector).
 - Attach abstract information:
 - Vertex, detector hits, cut criteria.

Next steps...

- Formalize data description.
 - Abstract event information.
 - Abstract particle/candidate/track/jet information (4-vector).
 - Attach abstract information:
 - Vertex, detector hits, cut criteria.
- Develop proof-of-principle tools.
 - Python library (HepEduEvent?)
 - Examples (BaBar? H1?)
 - Converters. (XML? JSON?)
 - Documentation.

Next steps...

- Formalize data description.
 - Abstract event information.
 - Abstract particle/candidate/track/jet information (4-vector).
 - Attach abstract information:
 - Vertex, detector hits, cut criteria.
- Develop proof-of-principle tools.
 - Python library (HepEduEvent?)
 - Examples (BaBar? H1?)
 - Converters. (XML? JSON?)
 - Documentation.
- BaBar data? H1 data? LASS data?

Next steps...

- Formalize data description.
 - Abstract event information.
 - Abstract particle/candidate/track/jet information (4-vector).
 - Attach abstract information:
 - Vertex, detector hits, cut criteria.
- Develop proof-of-principle tools.
 - Python library (HepEduEvent?)
 - Examples (BaBar? H1?)
 - Converters. (XML? JSON?)
 - Documentation.
- BaBar data? H1 data? LASS data?
- Is there funding for this?
- Could this supplement the Quarknet/Masterclass/I2U2 efforts?
- Where else would this help?

UC Irvine Machine Learning Repository

- Request from our collaborators to upload data.
- <http://archive.ics.uci.edu/ml/index.html>
- Center for Machine Learning and Intelligent Systems at the University of California, Irvine.
- <http://cml.ics.uci.edu/>
 - MiniBooNE particle identification Data Set already exists.
- Request is still being considered...

Would (Should?) ROOT be involved?

- Need a light-weight, standalone TFile library.
 - TString (TCharacter?)
 - TDouble, TFloat, TInteger (TTree?).
 - **That's it!**
- Libraries in C/C++ and Python almost already exist.
- In my opinion, this library should be separate from ROOT.
- Does DPHEP lend weight to this request?

What data can we use?

- Issues with “ownership” of data.
- Non-trivial and may vary from institution to institution.
- Discussion of “outakes” within BaBar.
- Should we prepare for the eventual (inevitable) FOI request?
- Ongoing...

Particle Physics Wind Chime

Science Hack Day SF

Organized by **Ariel Waldman**, David Harris et al.

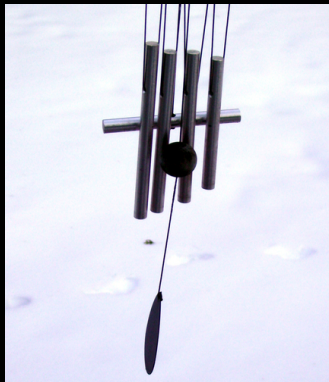
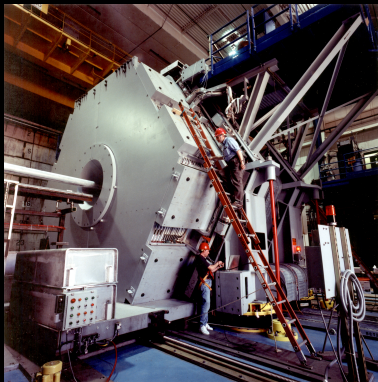
Offshoot of SHD London, 2010. <http://sf.sciencehackday.com/>



From *tantek* on Flickr photostream.

The goal

Particle Physics Wind Chime



The goal

- In 24 hours hack a prototype.
- Map **particle** properties onto **sonic** properties.
- *Let users define their own mappings!*

particle type	pitch	
momentum		
momentum angle		
velocity		
detector x		
detector y	timbre	
detector z		
travel length		volume
detector type		

The goal

- In 24 hours hack a prototype.
- Map **particle** properties onto **sonic** properties.
- *Let users define their own mappings!*

particle type		
momentum		
momentum angle		volume
velocity		
detector x	pitch	
detector y		
detector z		
travel length		timbre
detector type		

The goal

- In 24 hours hack a prototype.
- Map **particle** properties onto **sonic** properties.
- *Let users define their own mappings!*

particle type		
momentum		volume
momentum angle	pitch	
velocity		
detector x		
detector y		
detector z		timbre
travel length		
detector type		

The goal

- In 24 hours hack a prototype.
- Map **particle** properties onto **sonic** properties.
- *Let users define their own mappings!*

particle type		
momentum		
momentum angle		
velocity		volume
detector x		
detector y		
detector z		
travel length		
detector type	pitch	timbre

The goal

- In 24 hours hack a prototype.
- Map **particle** properties onto **sonic** properties.
- *Let users define their own mappings!*

particle type		
momentum	pitch	timbre
momentum angle		
velocity		
detector x		
detector y		
detector z		
travel length		
detector type		volume

The goal

- In 24 hours hack a prototype.
- Map **particle** properties onto **sonic** properties.
- *Let users define their own mappings!*

particle type		
momentum		
momentum angle		
velocity		timbre
detector x		volume
detector y	pitch	
detector z		
travel length		
detector type		

The goal

- In 24 hours hack a prototype.
- Map **particle** properties onto **sonic** properties.
- *Let users define their own mappings!*

particle type		
momentum		
momentum angle		timbre
velocity	pitch	
detector x		
detector y		volume
detector z		
travel length		
detector type		

The goal

- In 24 hours hack a prototype.
- Map **particle** properties onto **sonic** properties.
- *Let users define their own mappings!*

particle type		timbre	
momentum			
momentum angle			
velocity			
detector x			
detector y			
detector z	pitch		volume
travel length			
detector type			

The goal

- In 24 hours hack a prototype.
- Map **particle** properties onto **sonic** properties.
- *Let users define their own mappings!*

particle type	volume
momentum	
momentum angle	
velocity	
detector x	timbre
detector y	
detector z	
travel length	pitch
detector type	

Processing

Processing language

- <http://www.processing.org/>
- Casey Reas and Benjamin Fry, both formerly of the Aesthetics and Computation Group at the MIT Media Lab
- Builds on Java (PApplet)

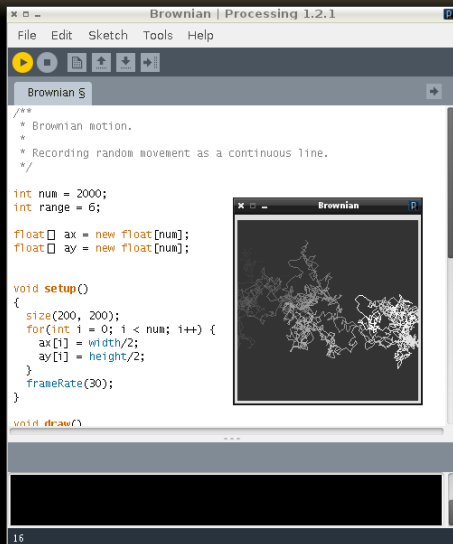


The screenshot shows the Processing.org website. At the top, there is a navigation bar with links for 'Cover', 'Exhibition', 'Reference', 'Learning', 'Download', 'Shop', and 'About'. Below this is a search bar. The main content area features a large image of a colorful, abstract network graph. To the right of the image is a list of links: 'Download Processing', 'Explore the Exhibition', 'Play with Examples', and 'Browse Tutorials'. Below the image is a section titled 'Announcing Processing.js 1.0!' with text describing the release and its features. To the right of this text is a list of links for downloading and exploring the software, including 'Free to download and open source', 'Interactive programs using 2D, 3D or PDF output', 'OpenGL integration for accelerated 3D', 'For GNU/Linux, Mac OS X, and Windows', 'Projects run online or as double-clickable applications', 'Over 100 libraries extend the software into sound, video, computer vision, and more...', and 'Well documented, with many books available'. At the bottom of the page, there is a list of links for 'Processing Wiki', 'Processing Discussion Forum', 'OpenProcessing', 'CreativeApplications.net', 'Q&A by Answers', 'Videos', 'Articles', ' Flickr', and ' YouTube'. A footer at the bottom of the page encourages users to contribute to the development by visiting 'Processing on Google Code' for real instructions for downloading the code, building from the source, reporting and tracking bugs, and creating libraries and tools.

Processing

Processing language

- <http://www.processing.org/>
- Casey Reas and Benjamin Fry, both formerly of the Aesthetics and Computation Group at the MIT Media Lab
- Builds on Java (PApplet)
- Integrated Development Environment (sketchbook)



```
xBrownian | Processing 1.2.1
File Edit Sketch Tools Help
Brownian S
/**
 * Brownian motion.
 *
 * Recording random movement as a continuous line.
 */
int num = 2000;
int range = 6;

float ax = new float[num];
float ay = new float[num];

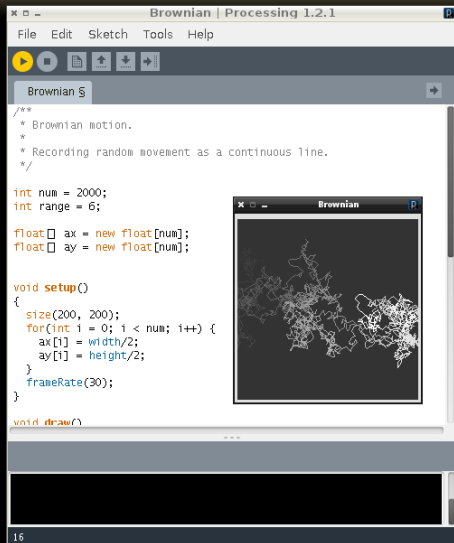
void setup()
{
  size(200, 200);
  for(int i = 0; i < num; i++) {
    ax[i] = width/2;
    ay[i] = height/2;
  }
  frameRate(30);
}

void draw()
...
16
```

Processing

Processing language

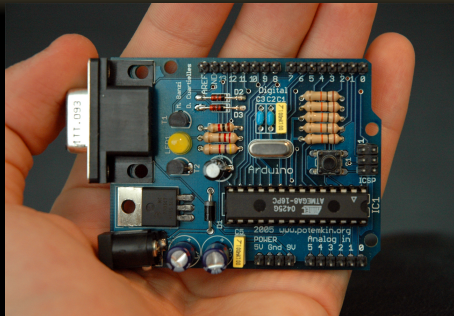
- <http://www.processing.org/>
- Casey Reas and Benjamin Fry, both formerly of the Aesthetics and Computation Group at the MIT Media Lab
- Builds on Java (PApplet)
- Integrated Development Environment (sketchbook)
- `processing.js` (Javascript implementation, Webby)
- 3rd-party libraries (MIDI, GUI, cameras, etc.)
SoundCipher, controlP5



Processing

Processing language

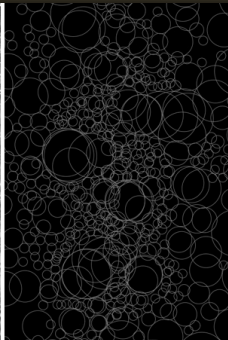
- <http://www.processing.org/>
- Casey Reas and Benjamin Fry, both formerly of the Aesthetics and Computation Group at the MIT Media Lab
- Builds on Java (PApplet)
- Integrated Development Environment (sketchbook)
- `processing.js` (Javascript implementation, Webby)
- 3rd-party libraries (MIDI, GUI, cameras, etc.)
SoundCipher, controlP5
- Arduino/Wiring



Processing

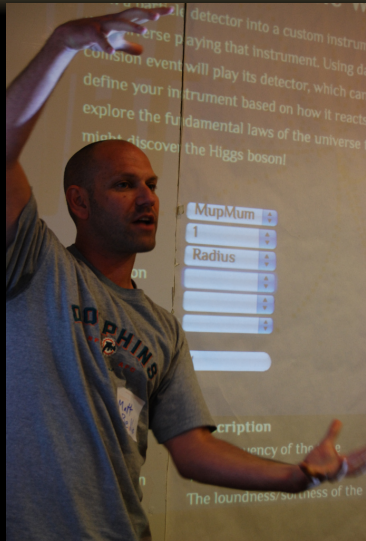
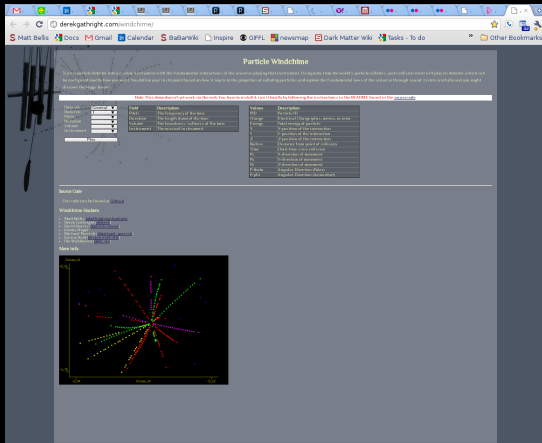
Processing language

- <http://www.processing.org/>
- Casey Reas and Benjamin Fry, both formerly of the Aesthetics and Computation Group at the MIT Media Lab
- Builds on Java (PApplet)
- Integrated Development Environment (sketchbook)
- `processing.js` (Javascript implementation, Webby)
- 3rd-party libraries (MIDI, GUI, cameras, etc.)
SoundCipher, controlP5
- Arduino/Wiring
- **Can export apps for Windows, Mac and Linux!**



Science Hack Day SF

- Had a prototype working on a laptop, but not live website.
- **Standard data format would've made things easier.**
- *We won Best Use of Data award and the People's Choice award!*



From *swissnex San Francisco* on Flickr photostream.

https://www.stanford.edu/group/burchat/cgi-bin/bellis_mediawiki/index.php/Sonification

The screenshot shows a web browser displaying the 'Sonification' page on the Stanford University website. The page header includes the Stanford University logo and the name 'MATT BELLIS'. Below the header, there is a search bar and navigation tabs for 'Articles', 'Discussions', 'New users', and 'History'. The main content area is titled 'Sonification' and includes a 'CONTENTS' table of contents with links to '1 Science Hack Day SF', '1.1 Detailed notes', '2 Other webhosted efforts', and '3 I LHC said'. The main text of the page is titled 'Science Hack Day SF' and describes the event. It mentions that in the middle of May, 2008, the author participated in Science Hack Day SF, an event where scientists, coders, web designers, and artists gathered for a weekend to work on projects. The author's project was 'Sonification', which involved converting data from the LHC into sound. The text describes the process of creating a visualization of the data and then converting it into sound. It also mentions that the author's project won the Best Use of Data award and the People's Choice award. The page includes a 'RELATED MEDIA' section with links to 'Particle worldlines website', 'Meeting Physics professor Grant podcast on science careers run by Steve Seidel, a professor at Southern Methodist University', 'Episode with Steve and I talking about the Particle Physics World Chain', and 'BBC coverage'. There is also a 'PARTNERED TO THE 2030 MEET FOR THE SCIENCE HACK DAY STORY' link. The page features several images, including a circular logo on the left, a visualization of particle tracks in the center, and a screenshot of a presentation slide on the right. The bottom of the page has a navigation bar with various icons and a footer with the text 'M. Bellis May '11 Outreach 33 / 49'.

http://www.stanford.edu/group/burchat/cgi-bin/bellis_mediawiki/index.php/Particle_Physics_Windchime

The screenshot shows a web browser window displaying the 'Particle Physics Windchime' project page. The browser's address bar shows the URL: www.stanford.edu/group/burchat/cgi-bin/bellis_mediawiki/index.php/Particle_Physics_Windchime. The page header features the Stanford University logo and the name 'MATT BELLIS'. Below the header, there is a search bar and navigation tabs for 'Articles', 'Discussions', 'Recent changes', and 'History'. The main content area is titled 'Particle Physics Windchime' and includes a brief description: 'The Particle Physics Windchime (PPW) project grew out of a first-order version developed at the Science Hack Day SF in 2010. The PPW is being developed and maintained by Matt Bellis and David Hahn'. Two side-by-side images show the 'Windchime' visualization: the left one is a 2D version with particles represented as lines radiating from a central point, and the right one is a 3D version with particles as colored spheres. Below the images is a 'CONTENTS' table of contents with links to 'Download', 'Running', 'Using the Particle Physics Windchime', 'Change.pl', 'Creating wind', 'Recent bugs', and 'Thanks'. A 'Download' section follows, stating 'The PPW is written using the processing programming language' and providing links for Linux, Mac OS X, and Windows versions in both 2D and 3D. The browser's taskbar at the bottom shows various open applications like Firefox, Chrome, and a terminal.

Not the only ones doing this

- **LHCsound**

- *Lily Asquith*, currently at Argonne National Lab.
- <http://lhcsound.hep.ucl.ac.uk/>
- **Composers Desktop Project** (MacOSX, Windows)
- Produce .wav/.mp3 files.

- **QCD Audio**

- Katharina Vogt, currently at Institut fur elektronische Musik und Akustik, Austria.
- <http://iaem.at/Members/vogt>
- <http://qcd-audio.at/>
- **SuperCollider** (MacOSX, Windows, Linux)
- Produce .wav/.mp3 files.

- Probably many more out there!
- Confluence of desire and good tools.

Let's see/hear an example!

Sound from particle physics data!

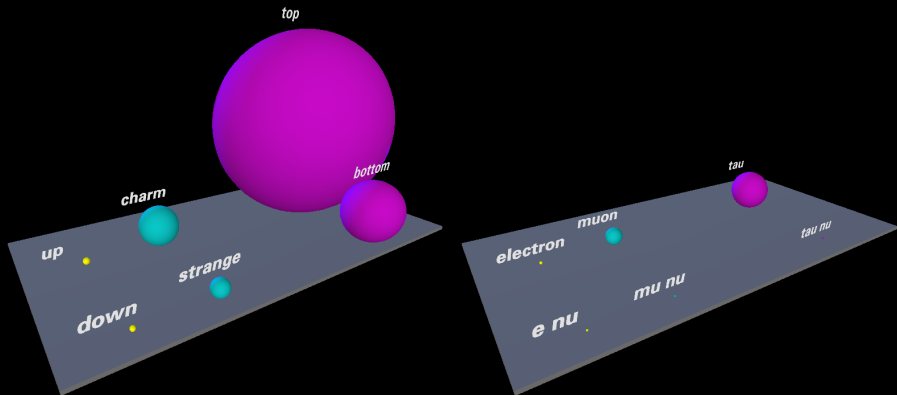
Much excitement stemmed from *context* of the sounds.

Try it yourself!

http://www.stanford.edu/group/burchat/cgi-bin/bellis_mediawiki/index.php/Particle_Physics_Windchime

The Standard Model - Quarks and leptons

This is the invisible world we are trying to make manifest.



Wind Chime as teaching tool

Public-ish talks

- Demo at Southern Methodist University seminar
- Stanford Center for Computer Research in Music and Acoustics (CCRMA)
 - Research in signal processing.
 - **Asked about getting some of our data!**

Wind Chime as teaching tool

Public-ish talks

- Demo at Southern Methodist University seminar
- Stanford Center for Computer Research in Music and Acoustics (CCRMA)
 - Research in signal processing.
 - **Asked about getting some of our data!**

Can teach with this!

- Which fermion/antifermion pair produce the most particles?
 - Why?
- What type of particle is produced most often?
 - Why?
- **Can you find a way to “hear” conservation of energy?”**

Can use this for exploratory learning.

We have something running!
Is it interesting?

We have something running!

Is it interesting?

Stealth motives

We have something running!

Is it interesting?

Stealth motives

Killer app for all ages to learn programming.

We have something running!

Is it interesting?

Stealth motives

Killer app for all ages to learn programming.

Art \iff Science

Summary

- Ideas and enthusiasm for outreach, education and training.

Summary

- Ideas and enthusiasm for outreach, education and training.
- Shortage of people power and resources.

Summary

- Ideas and enthusiasm for outreach, education and training.
- Shortage of people power and resources.
- Continued development of Wind Chime project with BaBar data.
- Do other experiments want to “hear” their data?

Summary

- Ideas and enthusiasm for outreach, education and training.
- Shortage of people power and resources.
- Continued development of Wind Chime project with BaBar data.
- Do other experiments want to “hear” their data?
- Develop HepEdu format, tools. (probably dependent on funding)

Summary

- Ideas and enthusiasm for outreach, education and training.
- Shortage of people power and resources.
- Continued development of Wind Chime project with BaBar data.
- Do other experiments want to “hear” their data?
- Develop HepEdu format, tools. (probably dependent on funding)
- DPHEP organization provides a formal framework.

Thanks for your time!

Backup slides

Linux with persistence



Contribute to an educated workforce/society

From the McKinsey Global Institute study...

Contribute to an educated workforce/society

From the McKinsey Global Institute study...

- **Analyzing large data sets**, also called big data, **will become a key basis of competition**, underpinning new waves of productivity growth, innovation, and consumer surplus...

Contribute to an educated workforce/society

From the McKinsey Global Institute study...

- **Analyzing large data sets**, also called big data, **will become a key basis of competition**, underpinning new waves of productivity growth, innovation, and consumer surplus...
- However, companies and policy makers must tackle significant hurdles to fully capture big data's potential.

Contribute to an educated workforce/society

From the McKinsey Global Institute study...

- **Analyzing large data sets**, also called big data, **will become a key basis of competition**, underpinning new waves of productivity growth, innovation, and consumer surplus...
- However, companies and policy makers must tackle significant hurdles to fully capture big data's potential.
- The United States alone faces **a shortage of 140,000 to 190,000 people with analytical expertise** and **1.5 million managers and analysts** with the skills to understand and make decisions based on the analysis of big data.

Contribute to an educated workforce/society

From the McKinsey Global Institute study...

- **Analyzing large data sets**, also called big data, **will become a key basis of competition**, underpinning new waves of productivity growth, innovation, and consumer surplus...
- However, companies and policy makers must tackle significant hurdles to fully capture big data's potential.
- The United States alone faces **a shortage of 140,000 to 190,000 people with analytical expertise** and **1.5 million managers and analysts** with the skills to understand and make decisions based on the analysis of big data.
- And there are difficult issues around privacy and security, as well as hurdles associated with technological limitations such as the **difficulties of pooling data from legacy IT systems with incompatible formats**.

Contribute to an educated workforce/society

From the McKinsey Global Institute study...

- **Analyzing large data sets**, also called big data, **will become a key basis of competition**, underpinning new waves of productivity growth, innovation, and consumer surplus...
- However, companies and policy makers must tackle significant hurdles to fully capture big data's potential.
- The United States alone faces **a shortage of 140,000 to 190,000 people with analytical expertise** and **1.5 million managers and analysts** with the skills to understand and make decisions based on the analysis of big data.
- And there are difficult issues around privacy and security, as well as hurdles associated with technological limitations such as the **difficulties of pooling data from legacy IT systems with incompatible formats**.
- (From NYT article) The report points to the need for a sweeping change in business to adapt **a new way of managing and making decisions that relies more on data analysis**.

Contribute to an educated workforce/society

From the McKinsey Global Institute study...

- **Analyzing large data sets**, also called big data, **will become a key basis of competition**, underpinning new waves of productivity growth, innovation, and consumer surplus...
- However, companies and policy makers must tackle significant hurdles to fully capture big data's potential.
- The United States alone faces **a shortage of 140,000 to 190,000 people with analytical expertise** and **1.5 million managers and analysts** with the skills to understand and make decisions based on the analysis of big data.
- And there are difficult issues around privacy and security, as well as hurdles associated with technological limitations such as the **difficulties of pooling data from legacy IT systems with incompatible formats**.
- (From NYT article) The report points to the need for a sweeping change in business to adapt **a new way of managing and making decisions that relies more on data analysis**.
- Managers, according to the McKinsey researchers, must grasp the principles of data analytics and be able to ask the right questions.

Contribute to an educated workforce/society

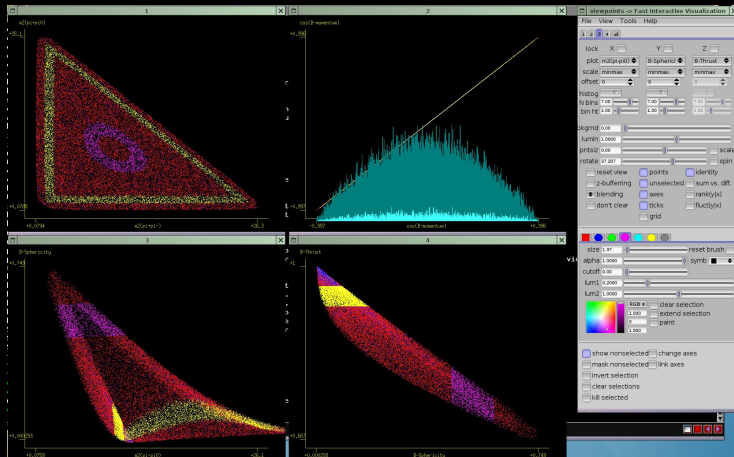
From the McKinsey Global Institute study...

- **Analyzing large data sets**, also called big data, **will become a key basis of competition**, underpinning new waves of productivity growth, innovation, and consumer surplus...
- However, companies and policy makers must tackle significant hurdles to fully capture big data's potential.
- The United States alone faces **a shortage of 140,000 to 190,000 people with analytical expertise** and **1.5 million managers and analysts** with the skills to understand and make decisions based on the analysis of big data.
- And there are difficult issues around privacy and security, as well as hurdles associated with technological limitations such as the **difficulties of pooling data from legacy IT systems with incompatible formats**.
- (From NYT article) The report points to the need for a sweeping change in business to adapt **a new way of managing and making decisions that relies more on data analysis**.
- Managers, according to the McKinsey researchers, must grasp the principles of data analytics and be able to ask the right questions.
- **“Every manager will really have to understand something about statistics and experimental design going forward,”** said Michael Chui, a senior fellow at the McKinsey Global Institute.

Current effort

<http://astrophysics.arc.nasa.gov/~pgazis/viewpoints.htm>

http://www.slac.stanford.edu/~bellis/viewpoints_demo.html



Elementary Particles

Quarks	u	c	t	γ
	d	s	b	g
Leptons	ν_e	ν_μ	ν_τ	Z
	e	μ	τ	W

Three Generations of Matter

Elementary Particles

Quarks	u	c	t	γ
	d	s	b	g
Leptons	ν_e	ν_μ	ν_τ	Z
	e	μ	τ	W

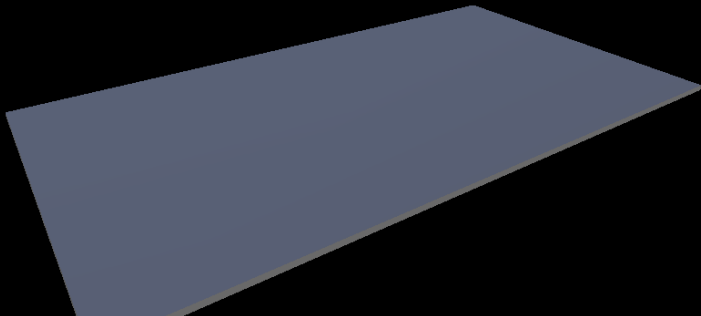
Three Generations of Matter

Elementary Particles

Quarks	u	c	t	γ
	d	s	b	g
Leptons	ν_e	ν_μ	ν_τ	Z
	e	μ	τ	W

Three Generations of Matter

The Standard Model - Leptons



The Standard Model - Leptons



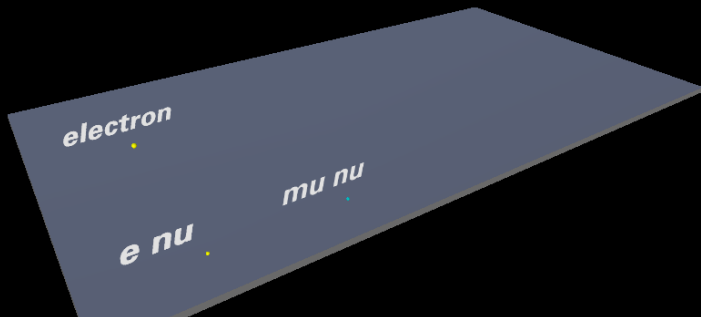
e nu .

The Standard Model - Leptons

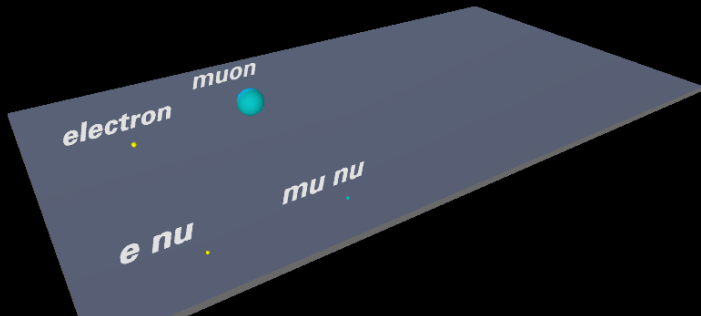
electron

$e \nu$

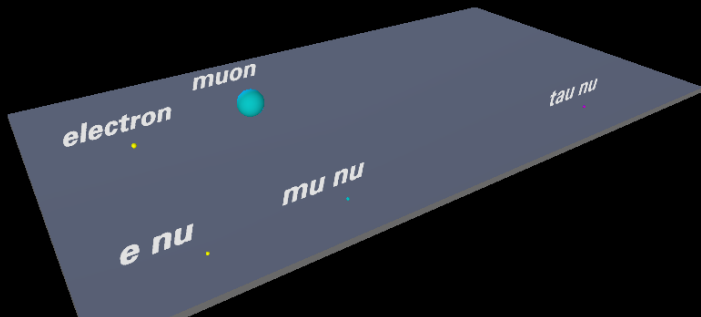
The Standard Model - Leptons



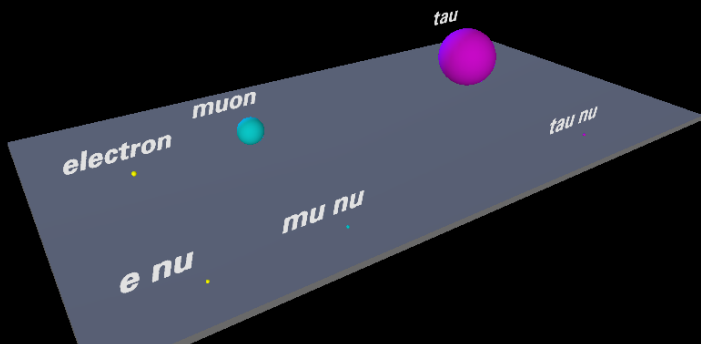
The Standard Model - Leptons



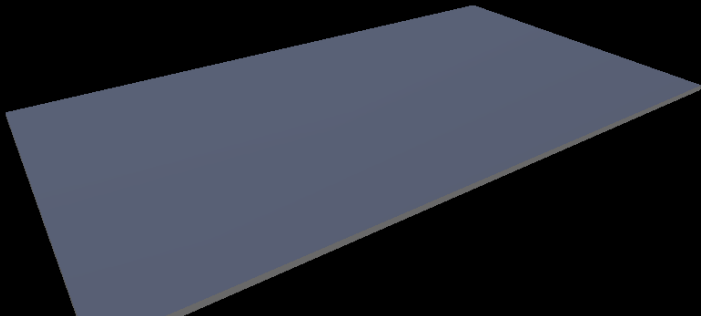
The Standard Model - Leptons



The Standard Model - Leptons



The Standard Model - Quarks

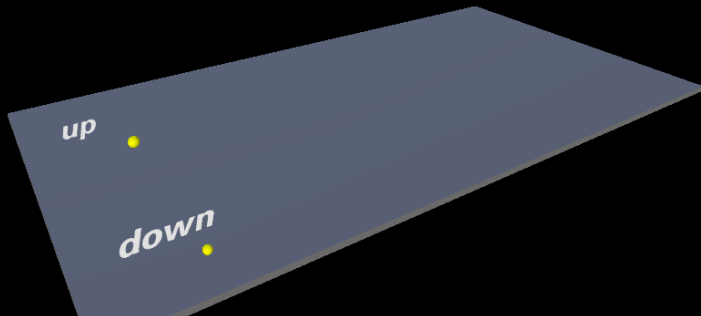


The Standard Model - Quarks

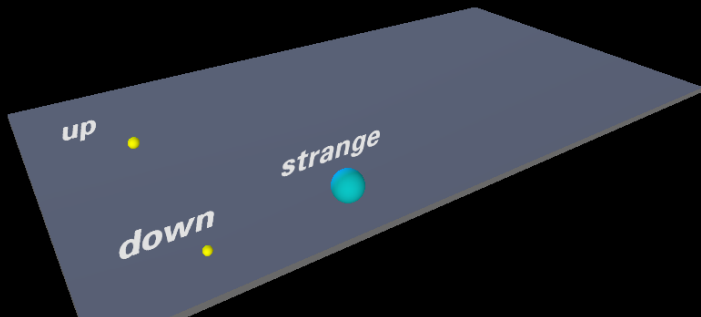
down



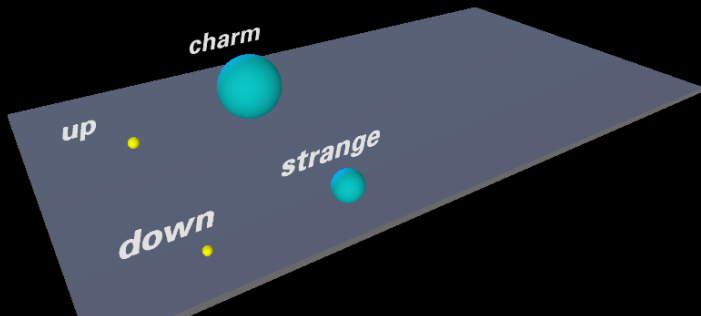
The Standard Model - Quarks



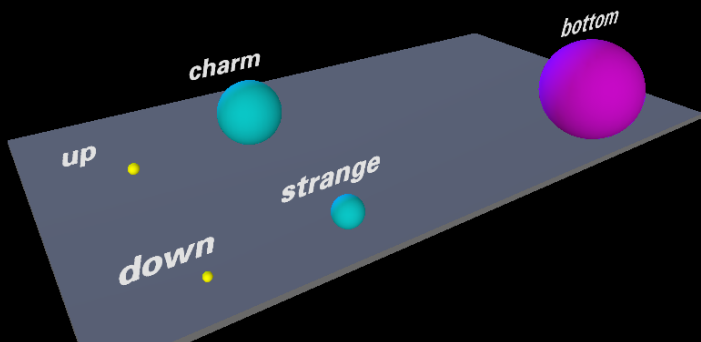
The Standard Model - Quarks



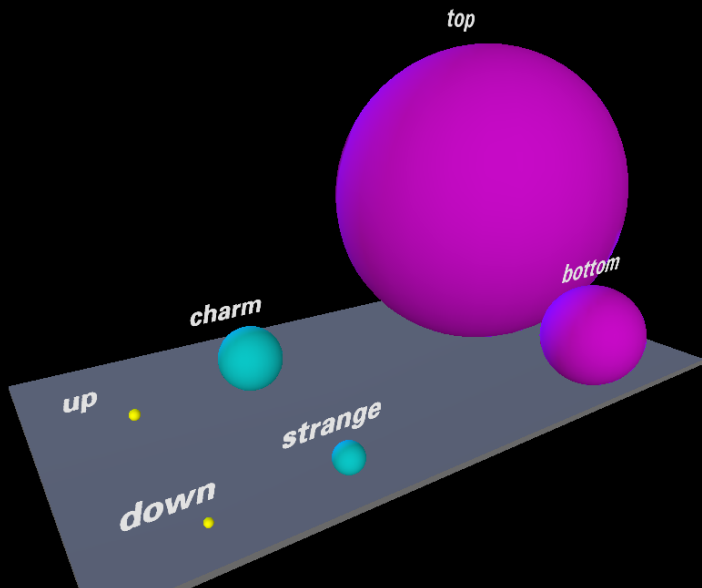
The Standard Model - Quarks



The Standard Model - Quarks

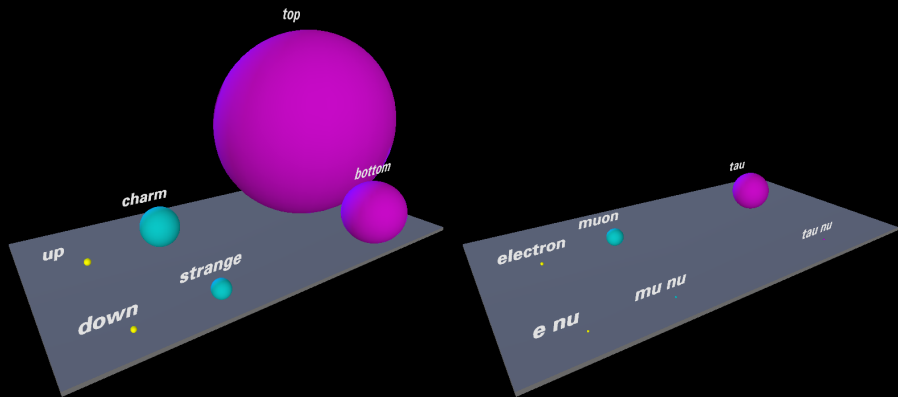


The Standard Model - Quarks



The Standard Model - Quarks and leptons

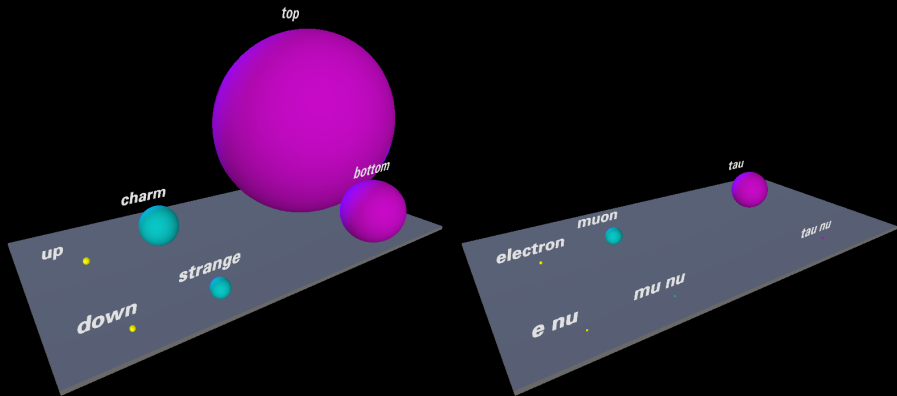
Lots of phenomena! *Mixing, virtual particles, conserved quantities, violation of conserved quantities, group theory*



The Standard Model - Quarks and leptons

Lots of phenomena! *Mixing, virtual particles, conserved quantities, violation of conserved quantities, group theory*

Quarks don't live free. Most of these live for less than a second.



The Standard Model - Quarks and leptons

Lots of phenomena! *Mixing, virtual particles, conserved quantities, violation of conserved quantities, group theory*

Quarks don't live free. Most of these live for less than a second.

Our world. **How do we learn about all of this?**

