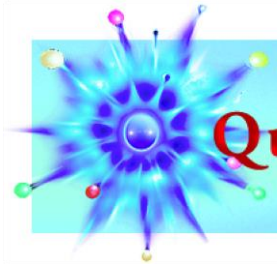


Physics class: we'll get to the good stuff in June

INAAPT April 2019 Meeting

K. Cecire, University of Notre Dame
kcecire@nd.edu

Who is this guy?

Ken, me:

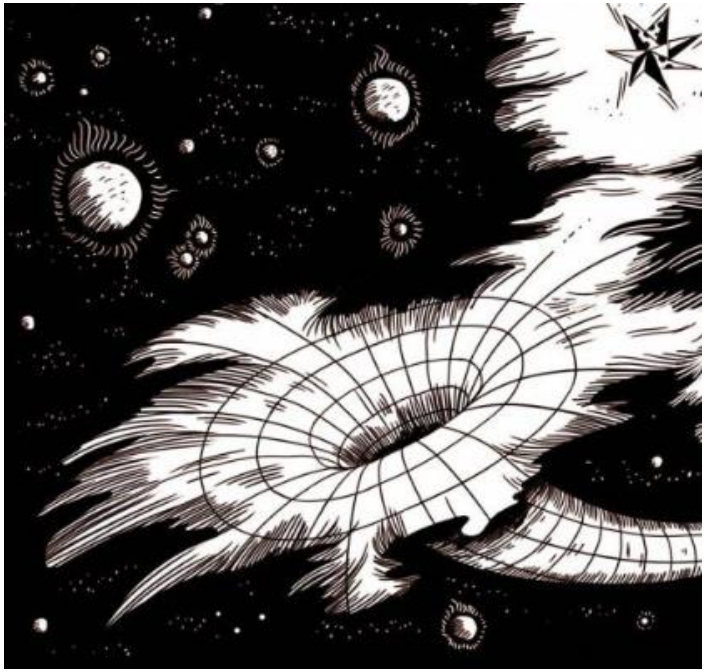
- High School physics teacher for about 20 years - private and public
- QuarkNet staff member for 20 years - Hampton University, then Notre Dame
- Married, 5 children (sort of grown), 4 grandchildren so far
- Co-Coordinate International Masterclasses (more on that)

My avatar on https://quarknet.org.

- Active in AAPT, current chair of COCP

Personal note.

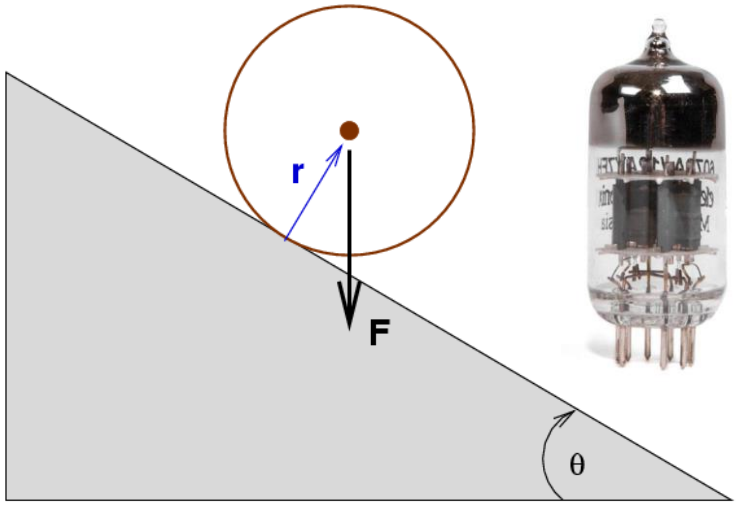
Dad, recently.

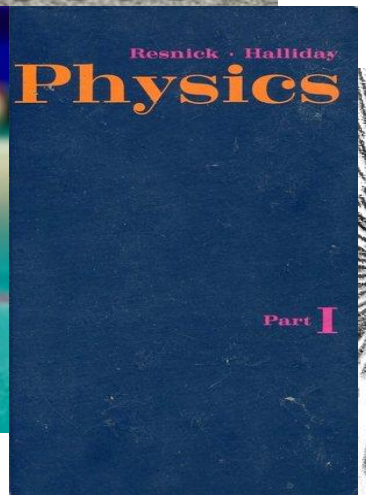


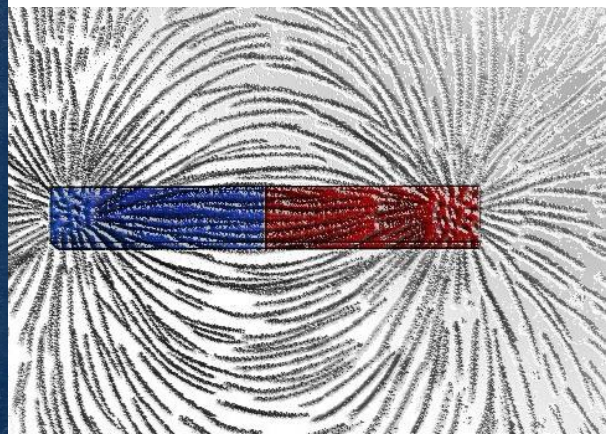
Inside my brain, 1974.

QuarkNet

Awesome physics.

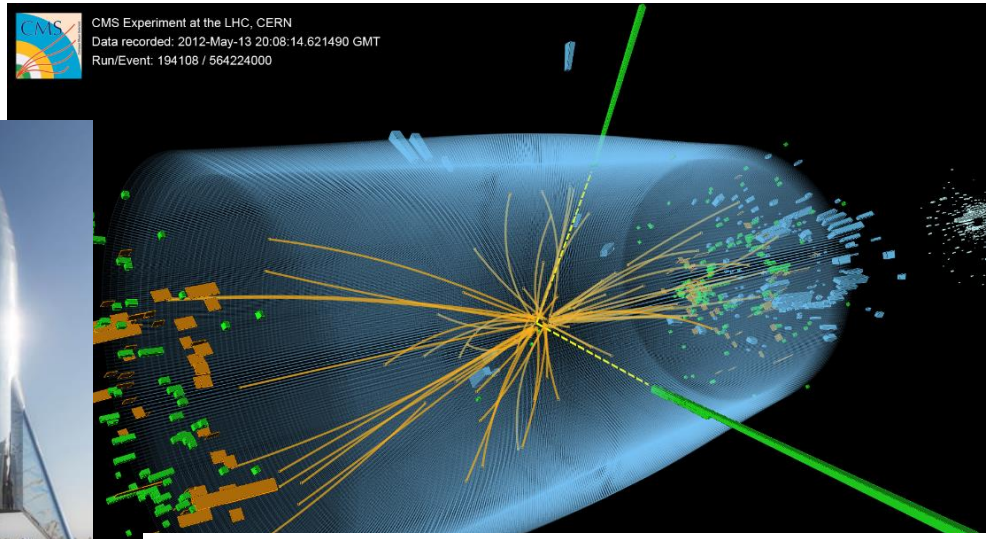


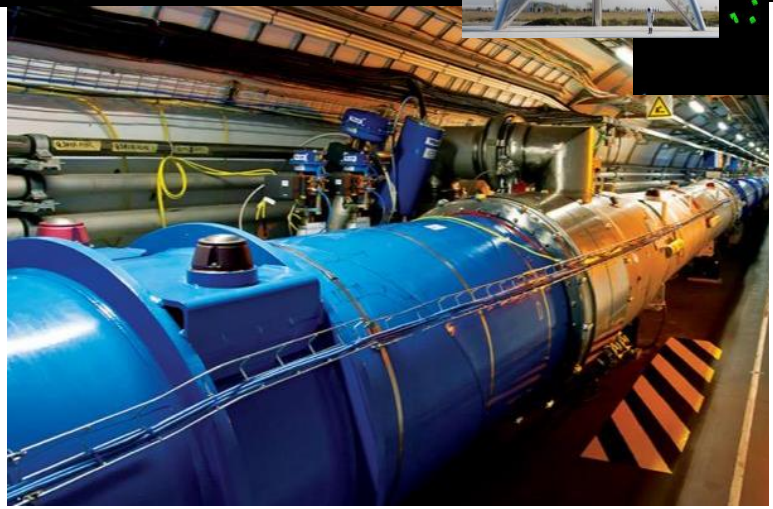


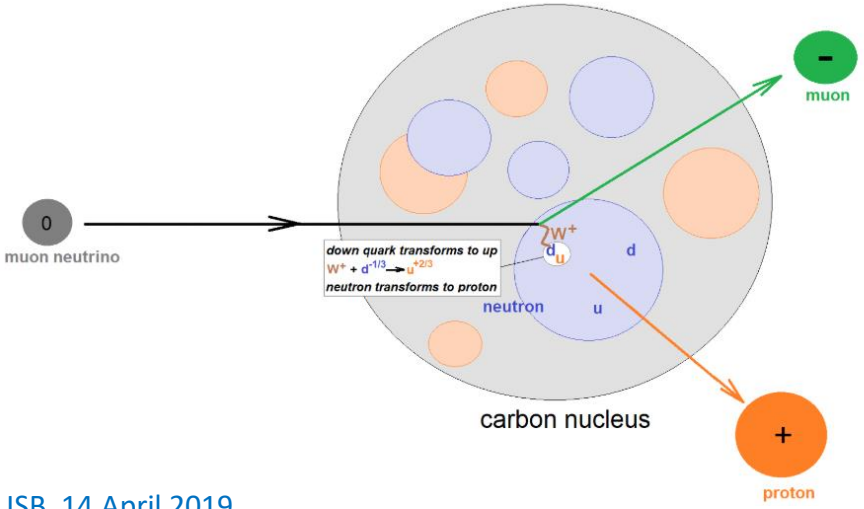


QuarkNet

Awesome physics.







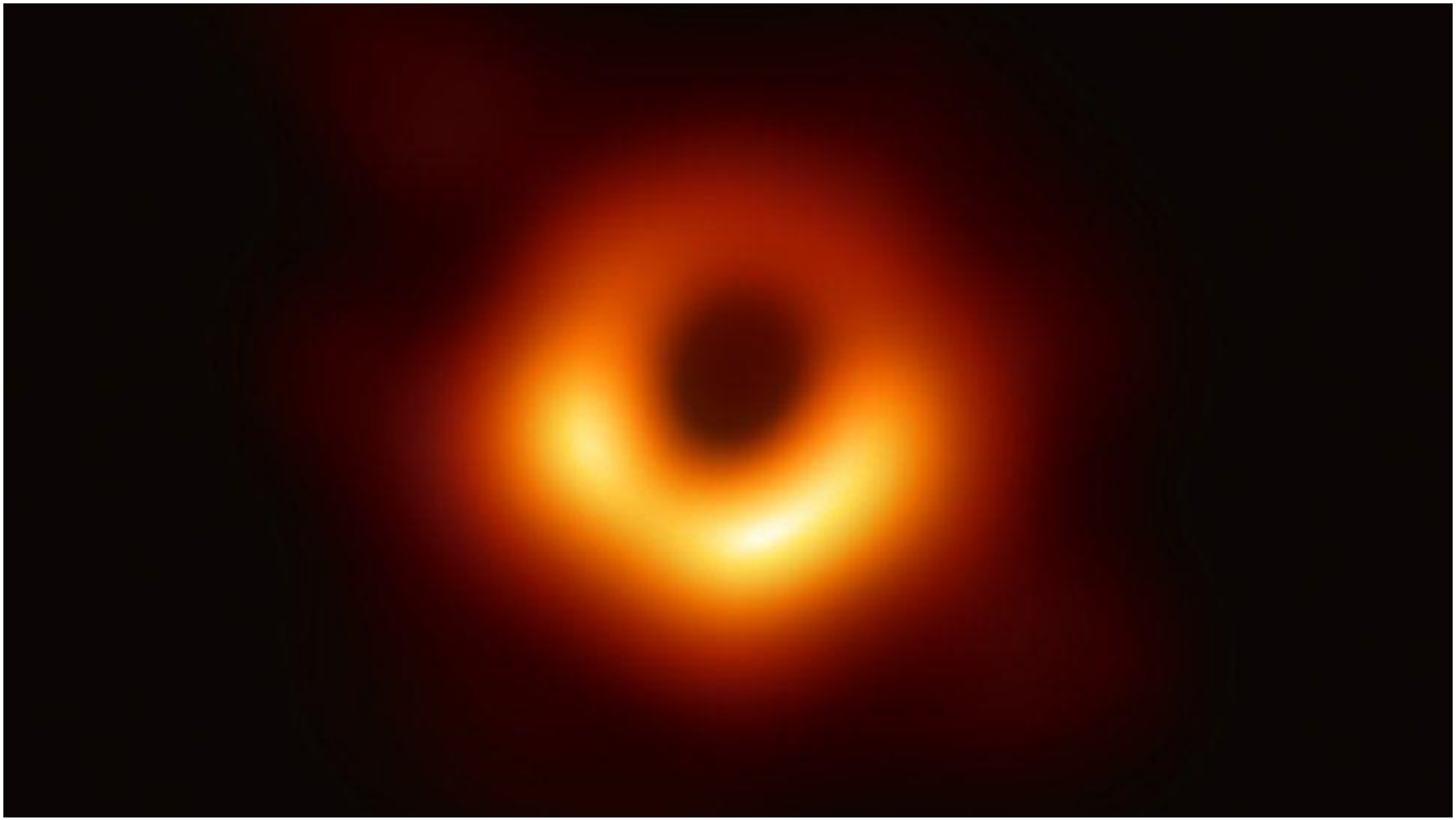
They are the same*.

***Aside from some details, like relativity and quantum mechanics.**

QuarkNet is about:

- Particle Physics
- Physics education reform
- Modeling best practices
- Professional development
- Connecting 21st century forefront physics to students and teachers by means of
  - Actual physics in the curriculum
  - Authentic **data**
  - Encountering exciting physics and physicists
- *Particle physics is our model!*

And we will not be swayed.



But here is what we'd do.

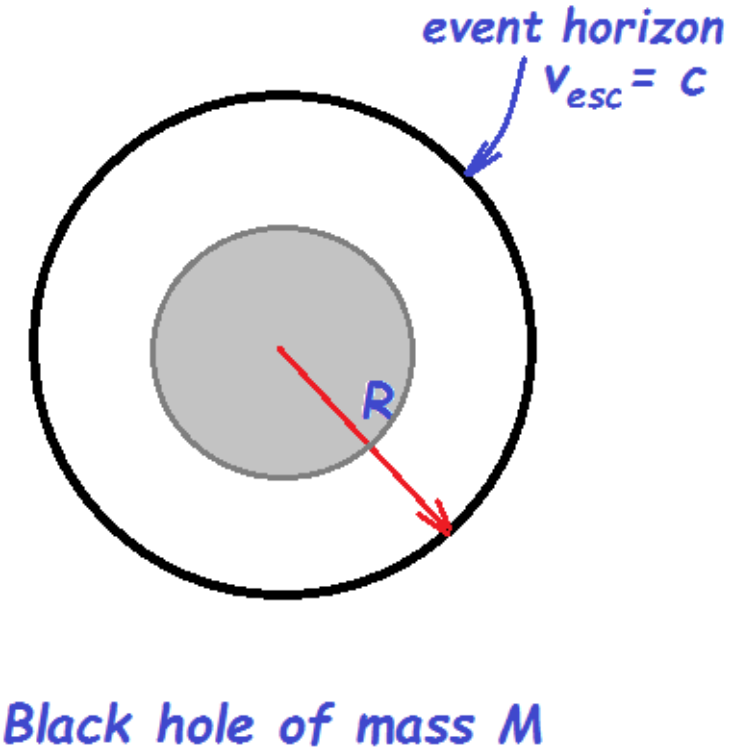
For we teachers…

Event horizon of a black hole:

$$\frac{1}{2}mv^2 = \frac{GMm}{R}$$

$$\frac{1}{2}c^2 = \frac{GM}{R}$$

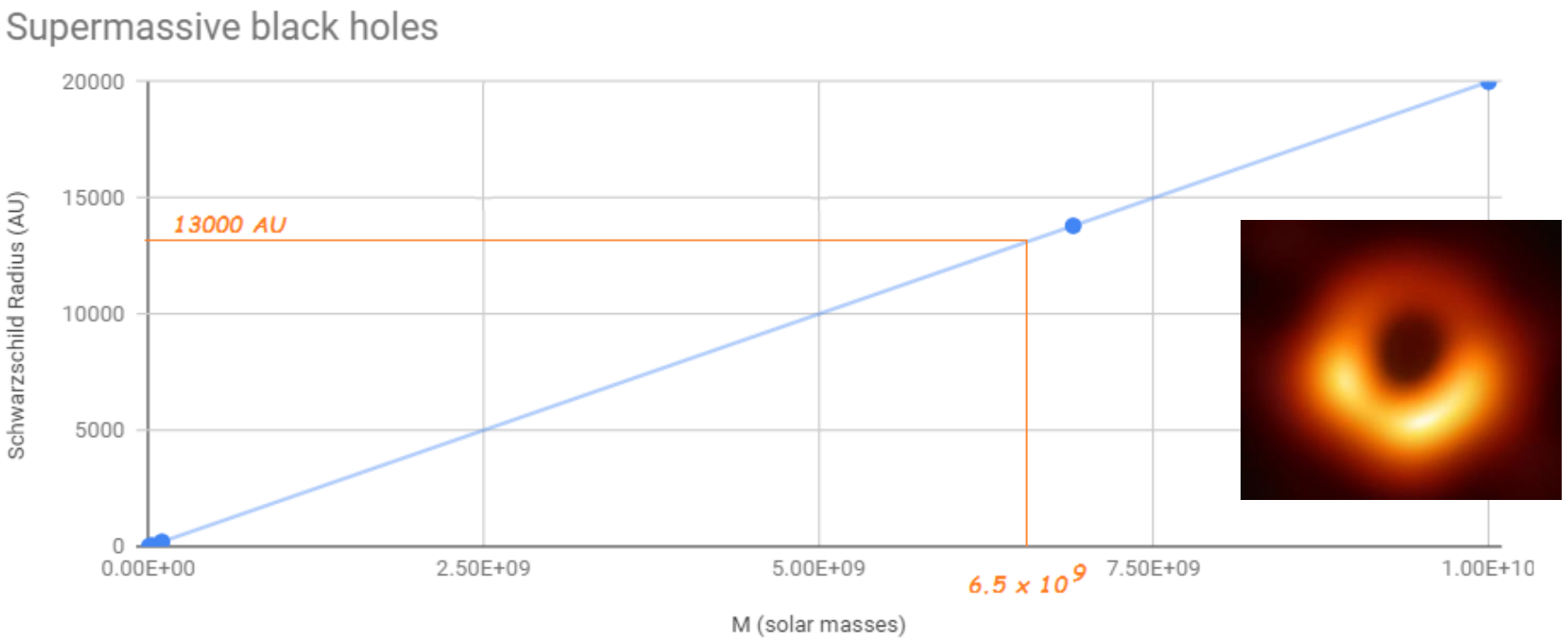
$$R = \frac{2GM}{c^2}$$



Put together data.

Black hole	Solar Masses	Event Horizon (AU)	log M/Ms	log R/(1 AU)
Sag A	4.60E+06	9.2	6.66	0.96
M108	2.40E+07	48	7.38	1.68
M85	1.00E+08	200	8.00	2.30
CID 947	6.90E+09	13800	9.84	4.14
NGC 1281	1.00E+10	20000	10.00	4.30

Students analyze, plot.



black hole diameter = 2 x 13000 AU = 26000 AU = 39 billion km

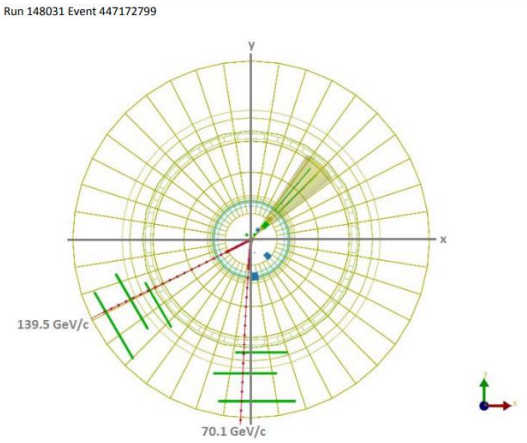
R_{shadow} = 2.5 R_s = 33000 AU = 50 billion km

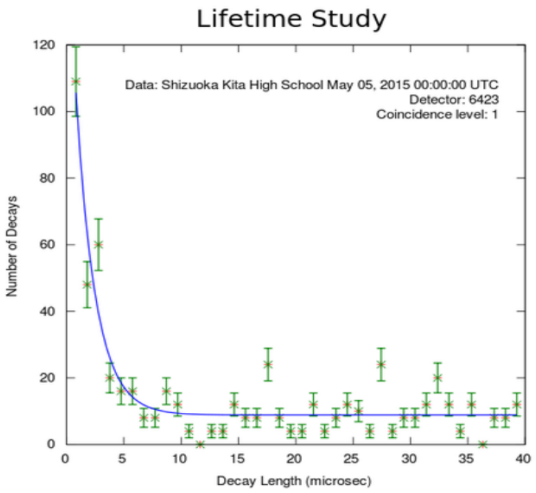
Data Activities Portfolio

But, really, we do particle physics. With activities from our Data Activities Portfolio, teachers and students can:

- Calculate the mass of the top quark or Z boson using vector addition.
- Find the size of a proton using wave diffraction.
- Find muon lifetime from student-taken data,
- Use histograms to model data analysis done by physicists.

Find it at https://quarknet.org.





More Opportunities

It is great to be part of QuarkNet!

Centers:

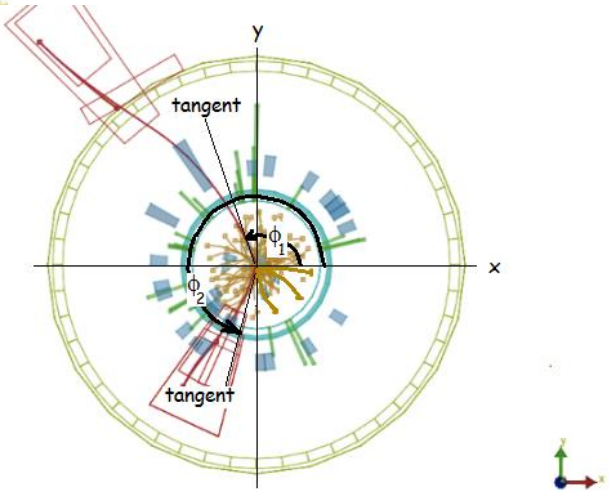
- Notre Dame
- Purdue
- Purdue Northwest
- Cincinnati
- IU Bloomington

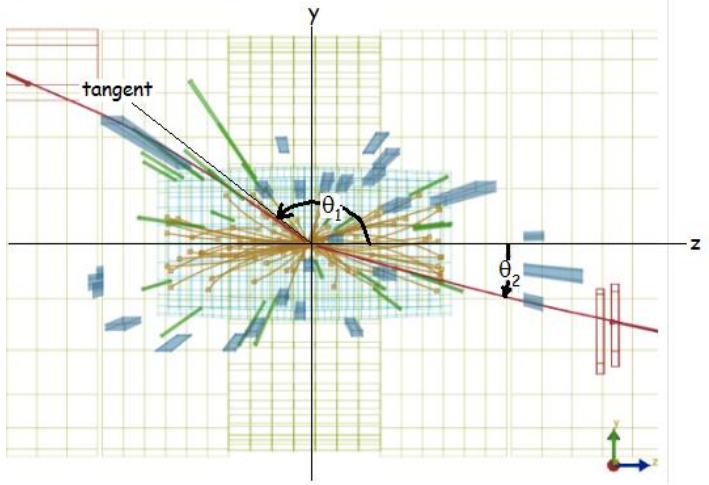
You do not have to be in QN for:

- The Data Activities Portfolio ✔
- World Wide Data Day
- International Masterclasses
- e-Labs.

Find out more at http://tiny.cc/qnin19.

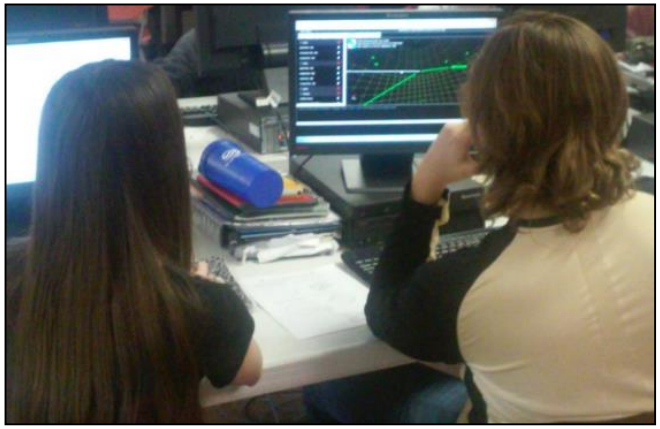
World Wide Data Day





- Simple measurement with real CERN data, ~90 min
- Discuss with physicists, other students in videocons
- One 24-hr “shift” each autumn
- Do from your school, connect worldwide
- Use histograms to model data analysis done by physicists. (Did we say that already?)
- Results: simple but profound!

International Masterclasses



What is a masterclass?

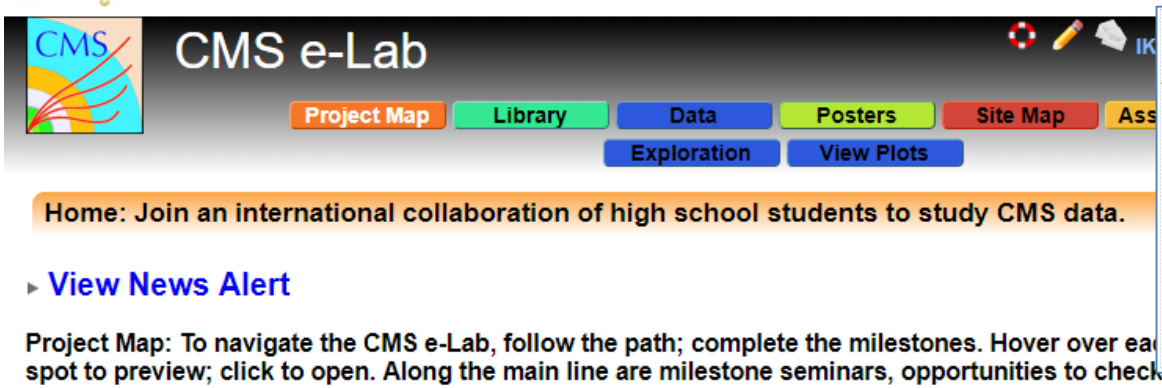
"Particle physicist for a day"

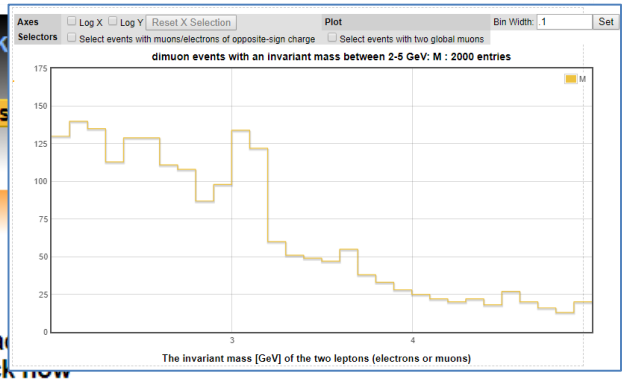
- Intro
- Tour
- Analyze authentic particle data.
- Videoconference

International Masterclasses 2019 and beyond

- > 50 Countries
- > 10^4 Students
- 4 CERN experiments
- 1 new Fermilab neutrino experiment
- More on the way

QuarkNet e-Labs





Two flavors:

- CMS (data from CERN)
- Cosmic ray (data from classroom detectors)

All in the browser!

Use it anywhere!

So what now?

Stay in touch

- kcecire@nd.edu
- 574-631-3343

Visit

- 929 North Eddy Street, South Bend (but we are moving in August)

Try it out:

- http://tiny.cc/qnin19
- I will help. It's my job.
- *Anyone want to develop the black hole measurement?*

Ask questions.