



QuarkNet: Supporting Physics Teacher Communities for 25+ Years

<https://www.quarknet.org>

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PhysTEC @ AAPT – SM24 – July 8, 2024

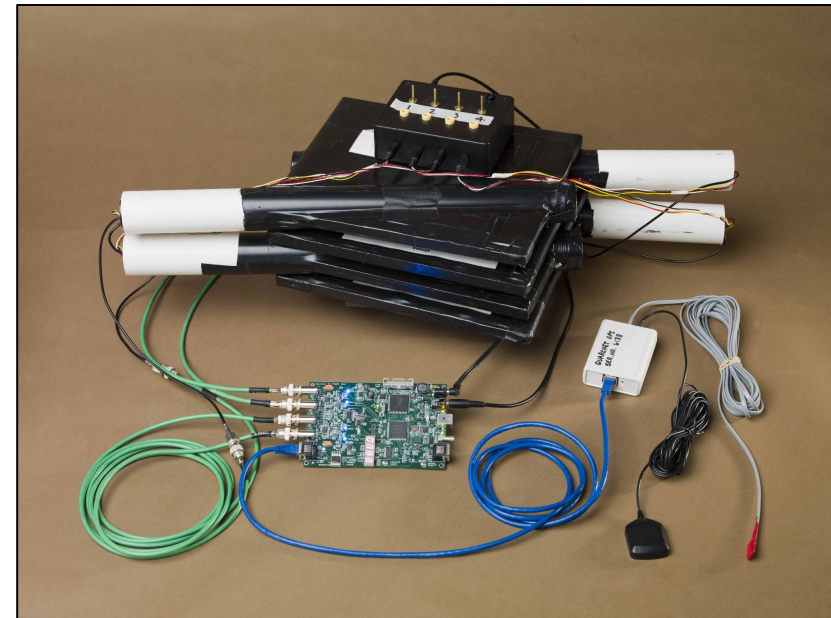




Supporting Physics Teacher Communities

What is QuarkNet?

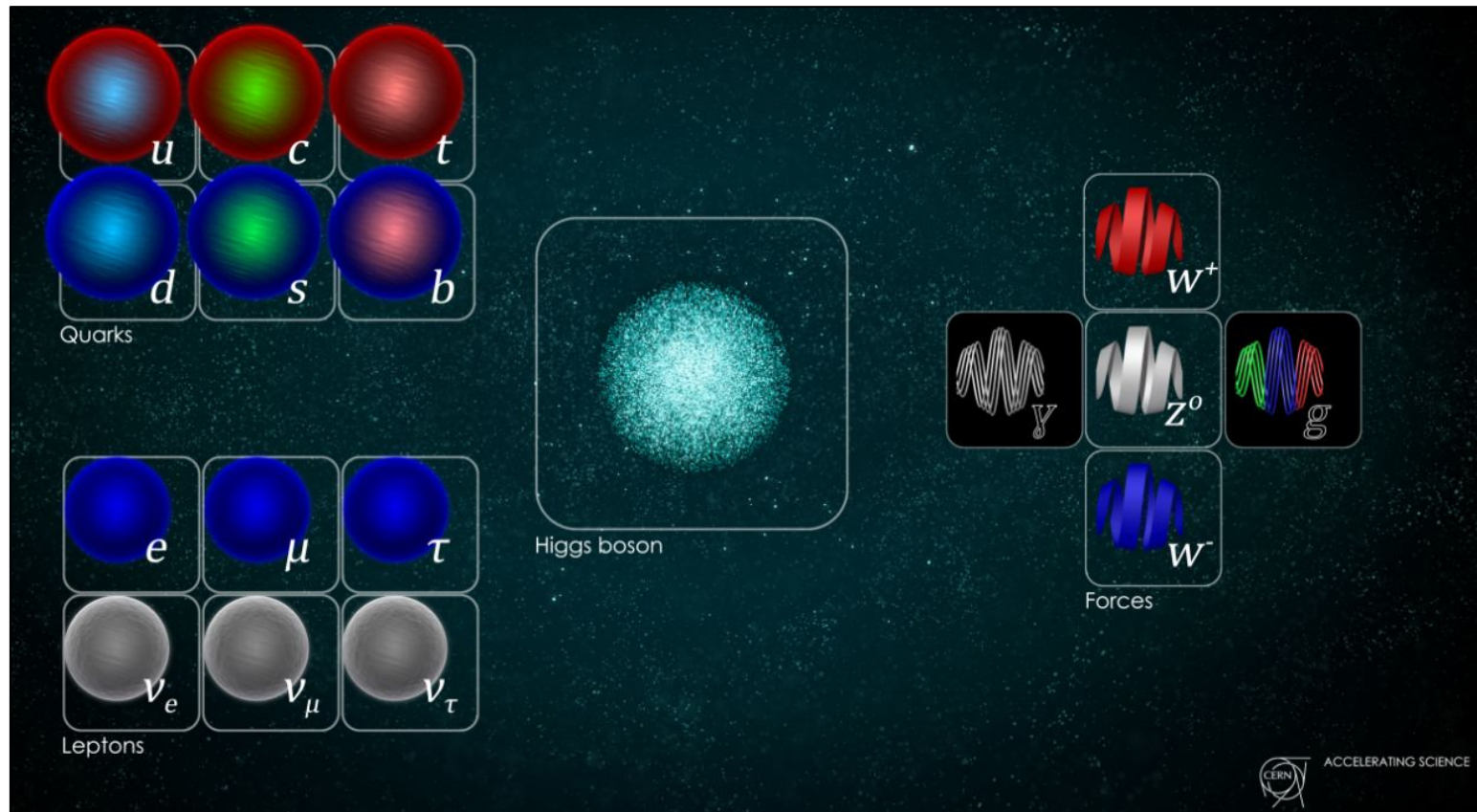
An NSF-supported sustained teacher professional development program that partners with physicist and teachers to build community and to bring 21-century physics into high school classrooms.



Setting the Stage: BIG, small...



The Standard Model



Learning Science/Physics - Parallels

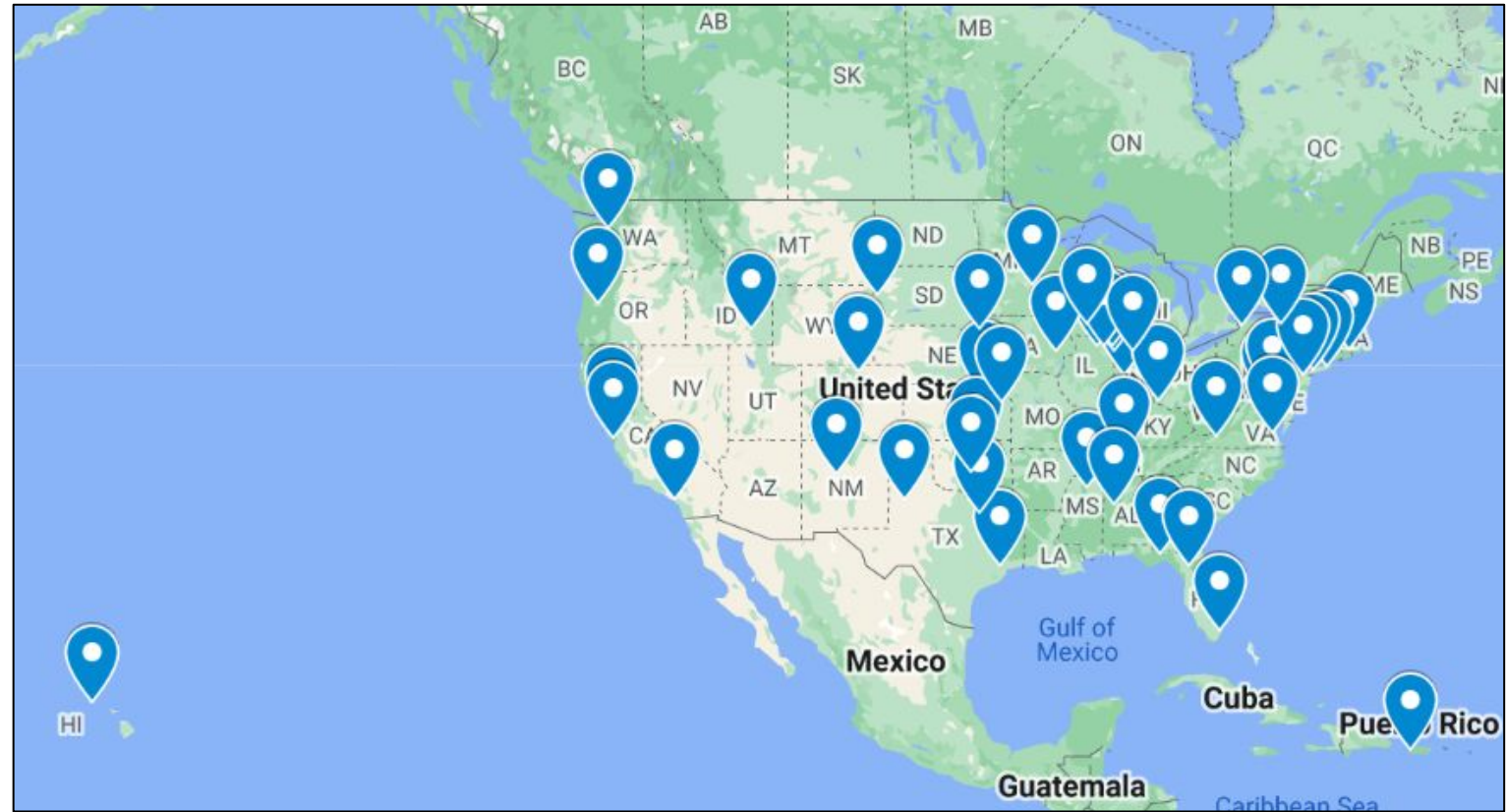


About QuarkNet

~5 PIs and Staff

**~50 QuarkNet
Centers**

~500 Teachers





Supporting Physics Teacher Communities

QuarkNet Centers

QN Staff work with mentors and lead teachers to provide workshop for teachers, masterclasses, and other activities at centers.





Supporting Physics Teacher Communities

National & International Opportunities

Fellows Camp

Data Camp

Coding Camps 1 & 2

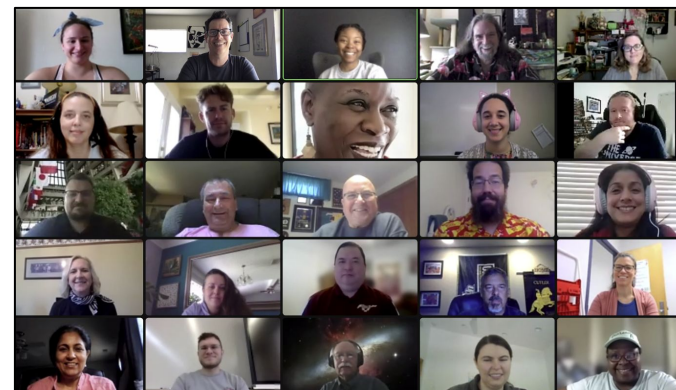
Summer Session for Teachers

QuarkNet Educational Discussions

HST @ CERN

ITW @ CERN


...

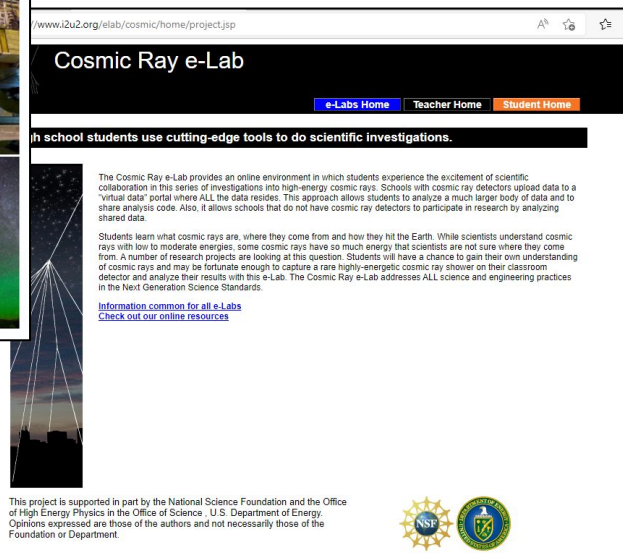


- Data Activities Portfolio
- Cosmic Ray e-Lab
- CMS e-Lab
- International Masterclasses
- Friday Flyer Newsletter
- Partnerships:
 - STEP UP
 - IRIS-HEP
- ...

Resources



www.i2u2.org/elab/cosmic/home/project.jsp

Cosmic Ray e-Lab

[← Labs Home](#)
[Teacher Home](#)
[Student Home](#)


In school students use cutting-edge tools to do scientific investigations.

The Cosmic Ray e-Lab provides an online environment in which students experience the excitement of scientific collaboration in this series of investigations into high-energy cosmic rays. Schools with cosmic ray detectors upload data to a "virtual data" portal where ALL the data resides. This approach allows students to analyze a much larger body of data and to share analysis code. Also, it allows schools that do not have cosmic ray detectors to participate in research by analyzing shared data.

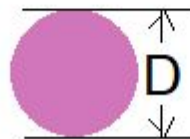
Students learn what cosmic rays are, where they come from and how they hit the Earth. While scientists understand cosmic rays with low to moderate energies, some cosmic rays have so much energy that scientists are not sure where they come from. A number of research projects are looking at this question. Students will have a chance to gain their own understanding of cosmic rays and may be fortunate enough to capture a rare highly-energetic cosmic ray shower on their classroom detector and analyze their results with this e-Lab. The Cosmic Ray e-Lab addresses ALL science and engineering practices in the Next Generation Science Standards.

[Information common for all e-Labs](#)
[Check out our online resources](#)

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.

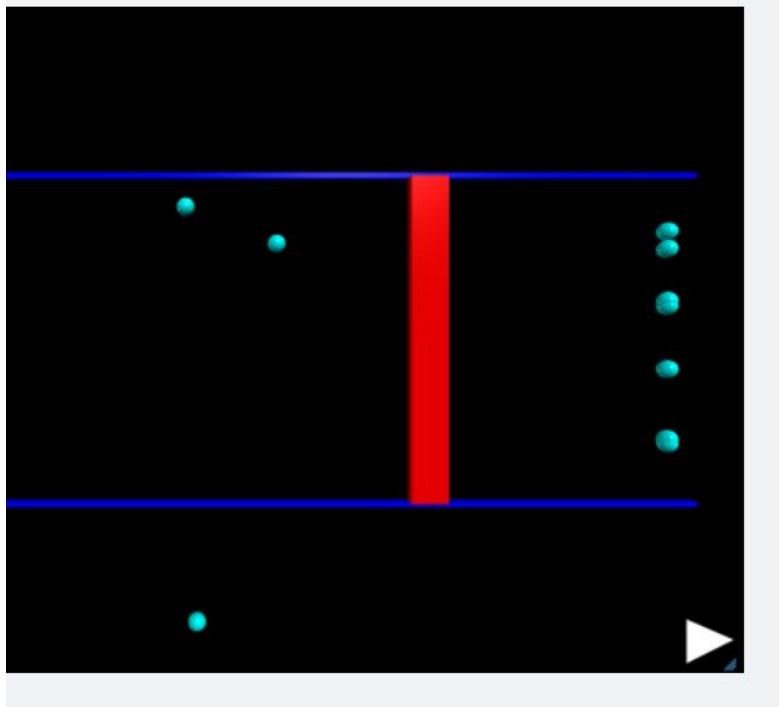


ACTIVITY: Rolling with Rutherford



ACTIVITY: Rolling with Rutherford

Follow the instructions at:



Follow the instructions
at:

[www.tinyurl.com/
rwraapt24](http://www.tinyurl.com/rwraapt24)

ACTIVITY: Rolling with Rutherford

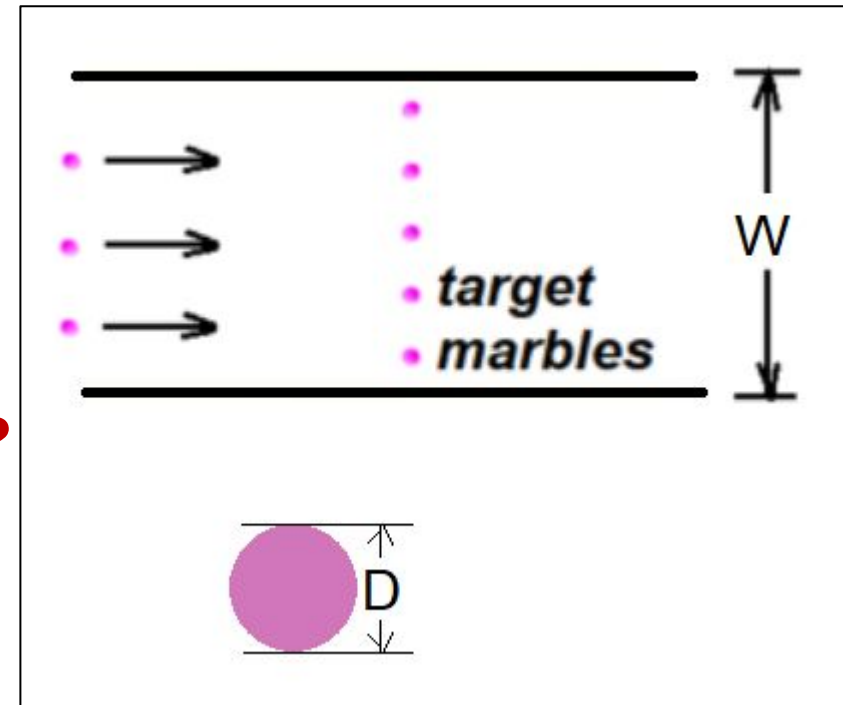
Build a mathematical model relating probability to other parameters

P = Probability of a hit (from histogram)

N = Number of target marbles = 5

W = Width of “beampipe” = 30 cm

D = Diameter of each target marble = ??



ACTIVITY: Rolling with Rutherford

Solve for D , diameter of each target marble.

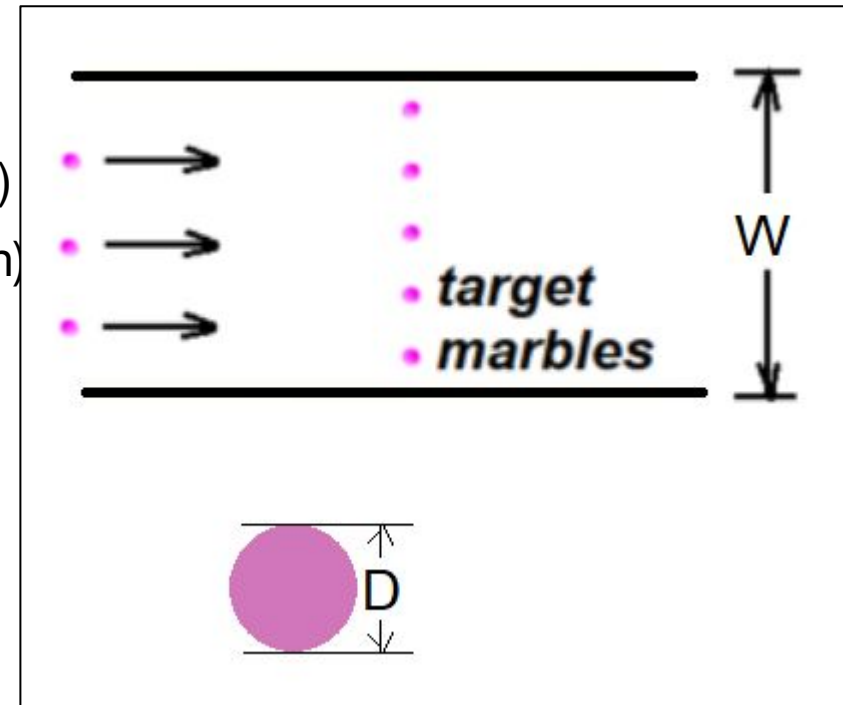
P = Probability of a hit (from histogram)

N = Number of target marbles = 5 (given, from simulation)

W = Width of “beampipe” = 30 cm (given, from simulation)

D = Diameter of each target marble = ??

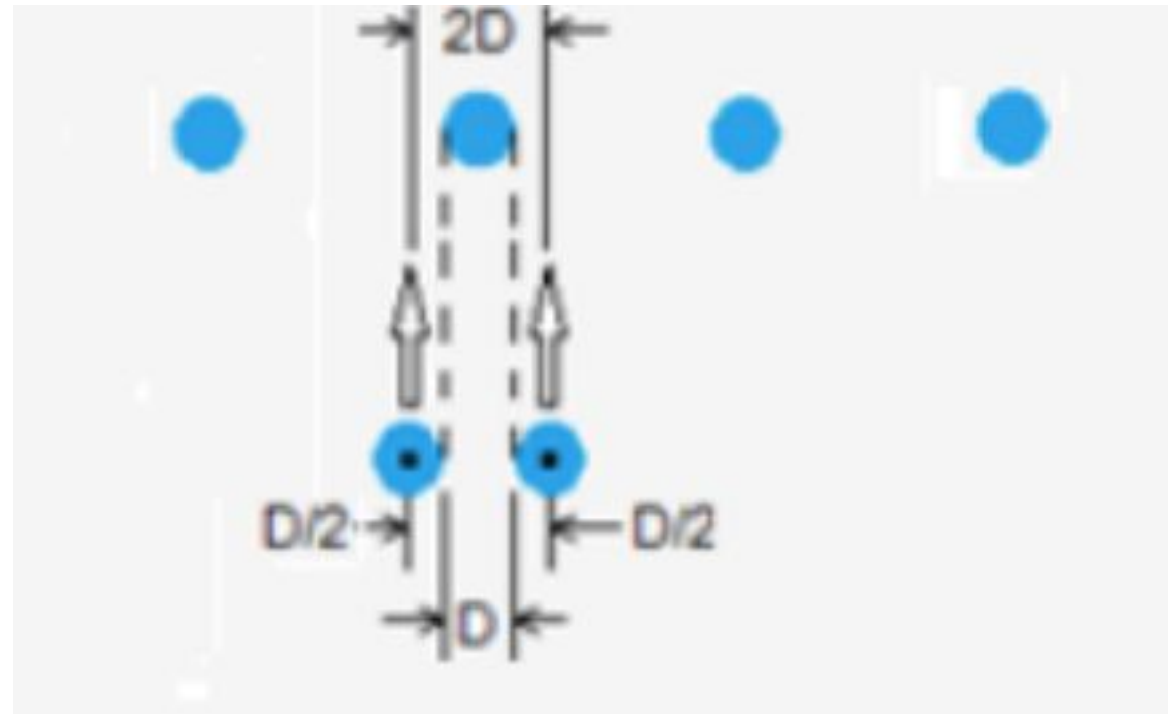
$$D = \frac{P \times W}{N}$$



ACTIVITY: Rolling with Rutherford

Improve the model...

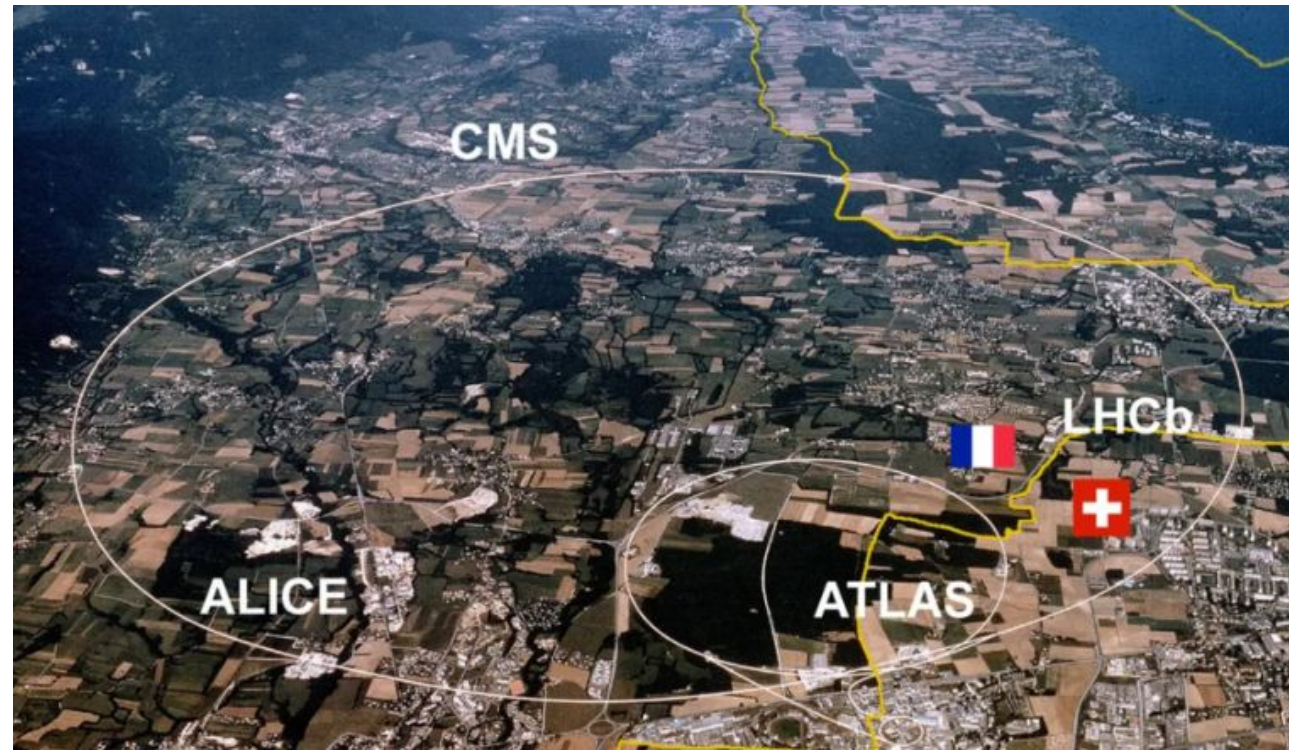
$$D = \frac{P \times W}{2N}$$



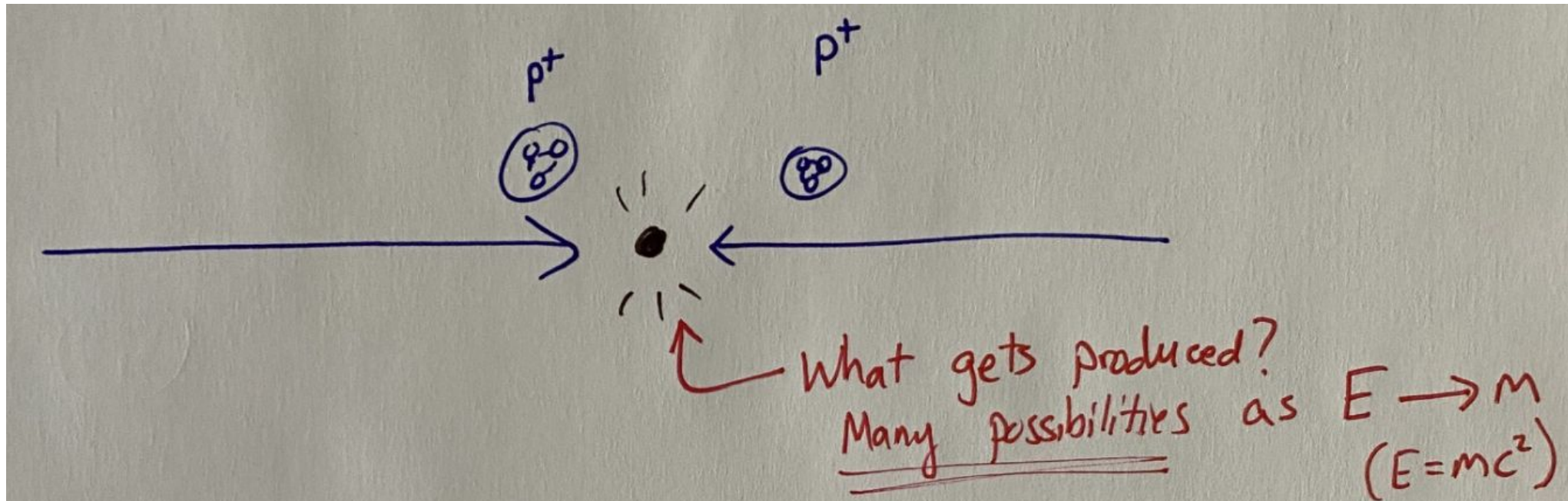
Indirect Evidence



ACTIVITY: Mass of the Z
Using data from CMS detector at the LHC.



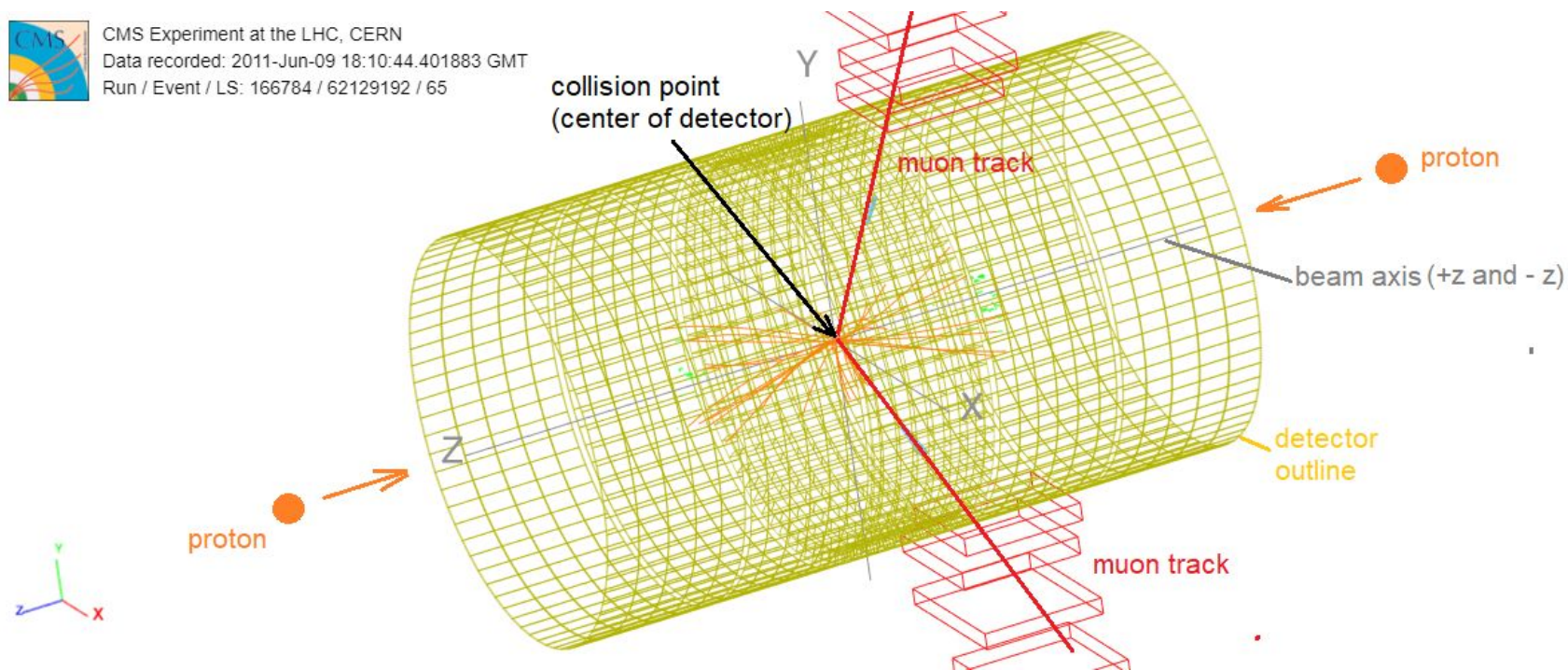
ACTIVITY: Mass of the Z *Using data from CMS detector at the LHC.*



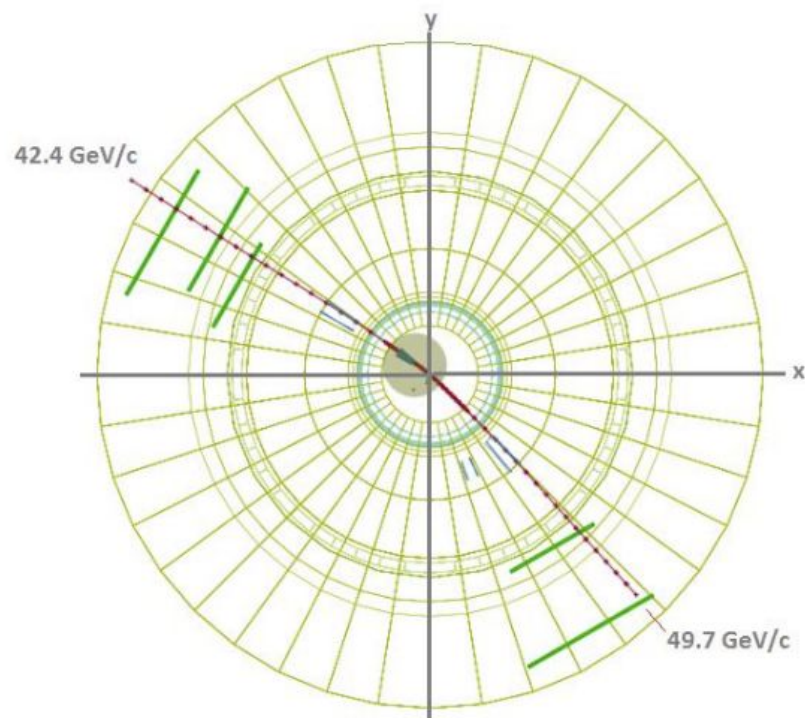
ACTIVITY: Mass of the Z *Using data from CMS detector at the LHC.*



CMS Experiment at the LHC, CERN
Data recorded: 2011-Jun-09 18:10:44.401883 GMT
Run / Event / LS: 166784 / 62129192 / 65



ACTIVITY: Mass of the Z Using data from CMS detector at the LHC.



$$E^2 = p^2 c^2 + m^2 c^4$$

} Solve for m

$$m = \sqrt{\frac{E^2 - p^2 c^2}{c^4}}$$

ACTIVITY: Mass of the Z
Using data from CMS detector at the LHC.

If time permits:

<https://tinyurl.com/zmassaapt24>

Building Community





Supporting Physics Teacher Communities

Contact Information

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www.QuarkNet.org