

**QuarkNet**

# **Particle Physics Masterclasses: Bringing 21<sup>st</sup> Century Physics to High School Students**

*April 16, 2023  
APS April Meeting  
Minneapolis, MN*

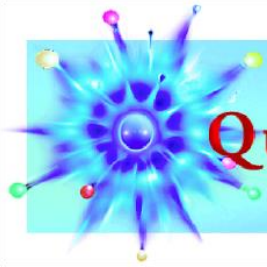
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[www.QuarkNet.org](http://www.QuarkNet.org)



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science

 **Fermilab**

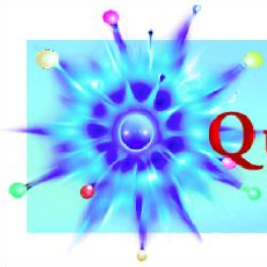


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# What is QuarkNet?

NSF-supported collaboration of physicists  
and high school teachers





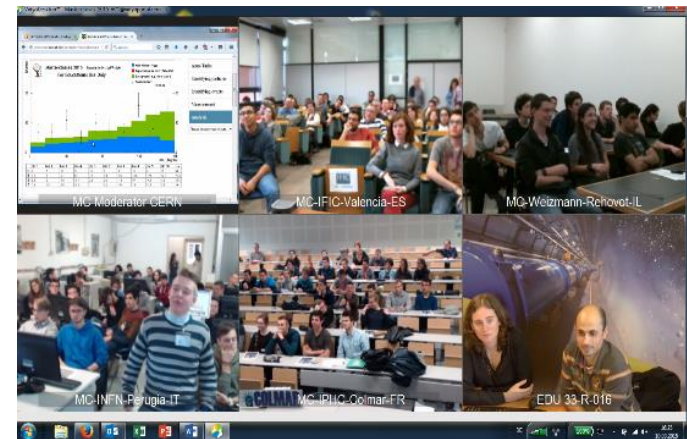
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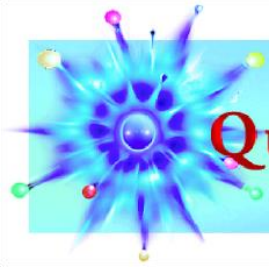
# What is a Masterclass?

High school students (13k+/year) come to a research lab to be “*scientists for a day*”

- Introduction to particle physics
- Hands-on: data from
  - LHC (ATLAS, CMS, ALICE, LHCb)
  - Neutrino experiments (MINERvA, NOvA)
  - Belle II
  - Particle Therapy (treatment plan)
- International video conference (3-5 groups + CERN / Fermilab / KEK / GSI)

**Like a masterclass in the arts...  
but in particle physics!**








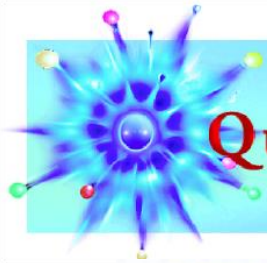
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# What is a Masterclass?

## Sample agenda...

- 09:00 Welcome, **Sign-In** & Ice Breaker (Shane will complete **attendance summary** )
- 09:30 Introductory Talk (Greg)
- 10:30 Tour 1 Nano Lab/Clean Room
- 11:30 **Analysis Talk** (Greg & Shane)
- 12:30 Lunch with a physicist (lunch provided)
- 13:30 Data Analysis - MINERvA **Student Start Page**: <http://tiny.cc/mmc-go>
- 14:30 Tour 2 - Mu2e Lab
- 15:00 Discussion of results, Q&A
- 15:45 Break; set up for videoconference
- 16:00 Video conference (**connect with Zoom**)
- 16:35 End of day survey (**student survey** , **teacher/mentor survey** )
- ~16:45 End of day





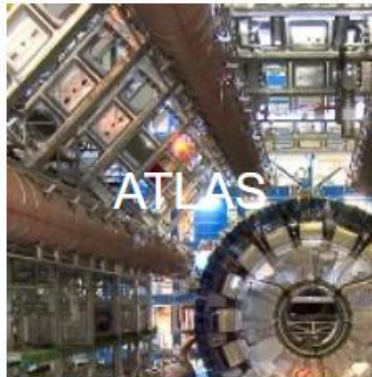
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<https://physicsmasterclasses.org>



**International Masterclasses**

19<sup>th</sup> International Masterclasses 2023



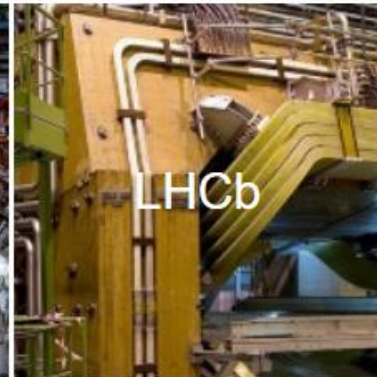
ATLAS



ALICE



CMS



LHCb



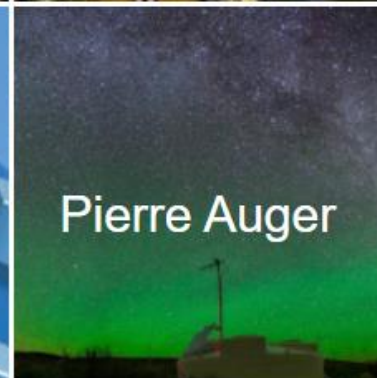
BELLE II



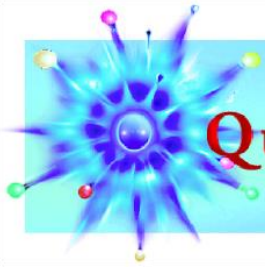
MINERvA



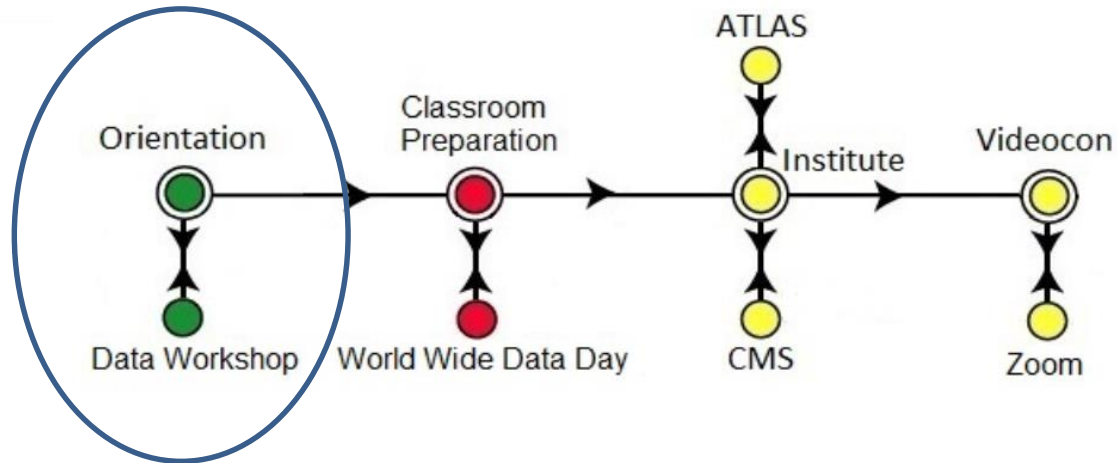
Particle  
Therapy



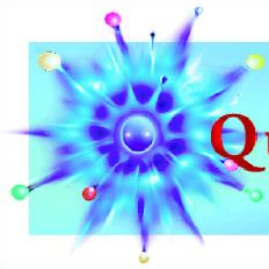
Pierre Auger



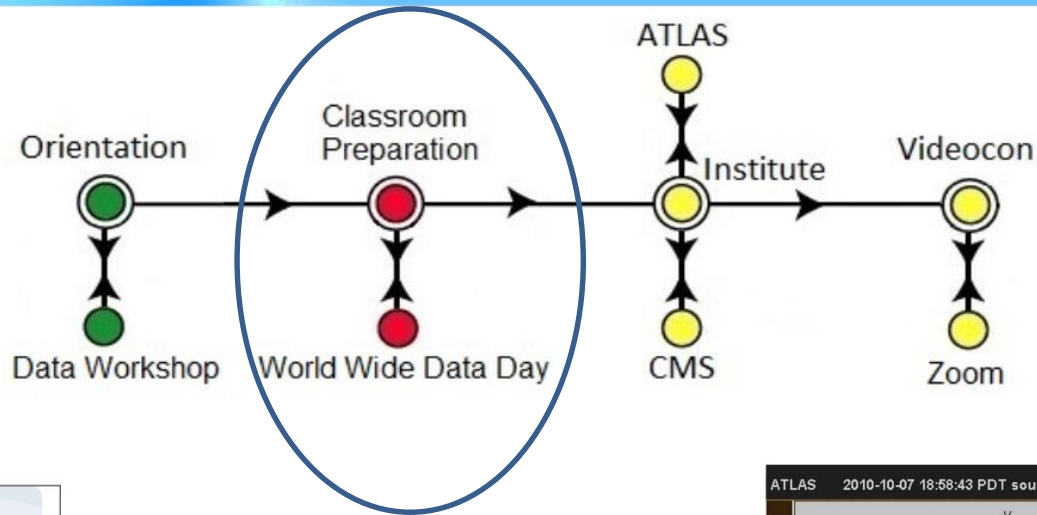
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**UP QUARK**  
DISCOVERED: 1963

**DOWN QUARK**  
DISCOVERED: 1969

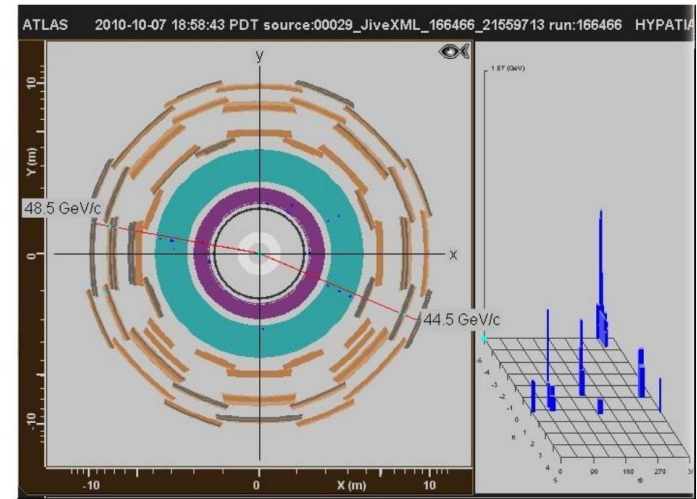
**ELECTRON**  
DISCOVERED: 1897

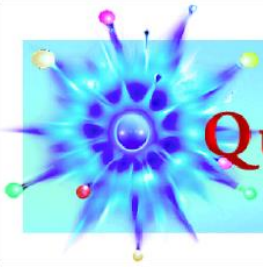
**MATTER PARTICLE**

Mass:  
Electric Charge:  
Strong Charges:  
Weak Charge:

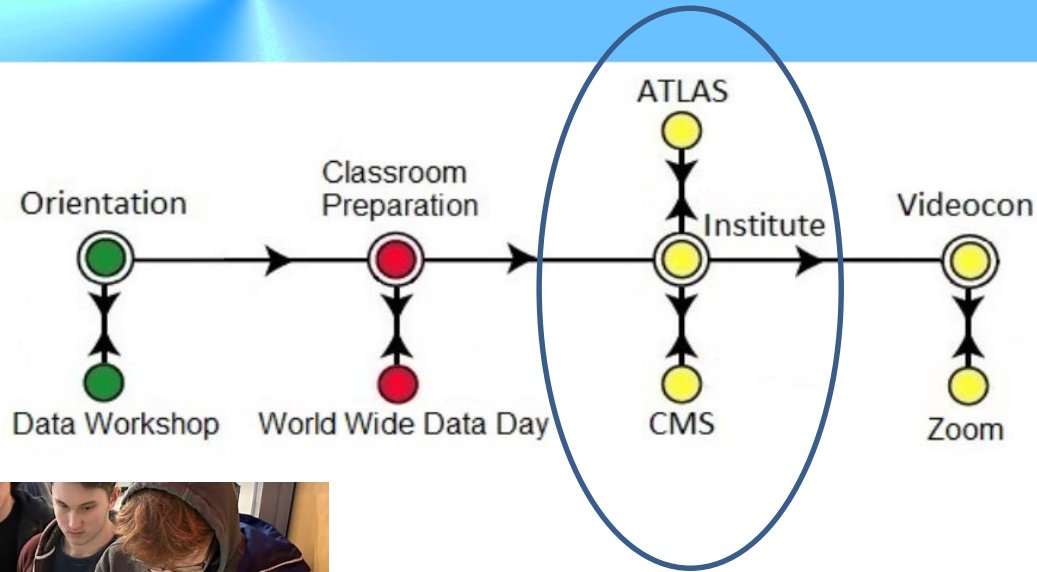
Lifetime:

Mass: 0.511 MeV/c<sup>2</sup>  
Electric Charge: -1  
Strong Charges: -  
Weak Charge: -1/2  
Lifetime: unlimited

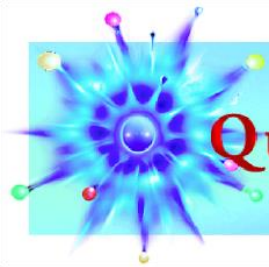




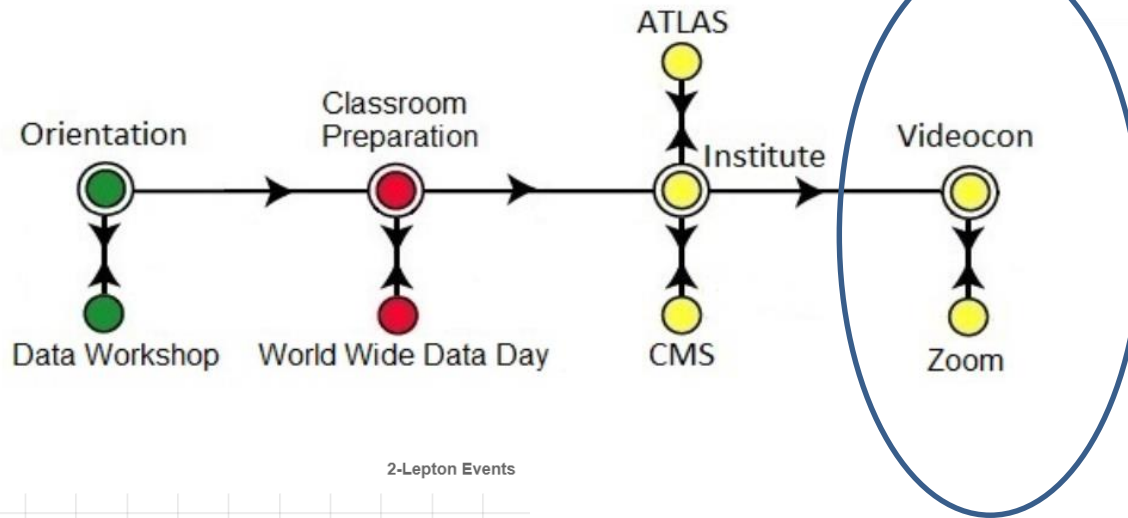
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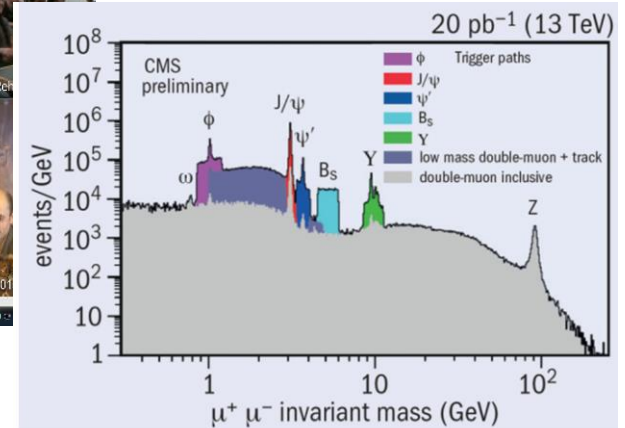
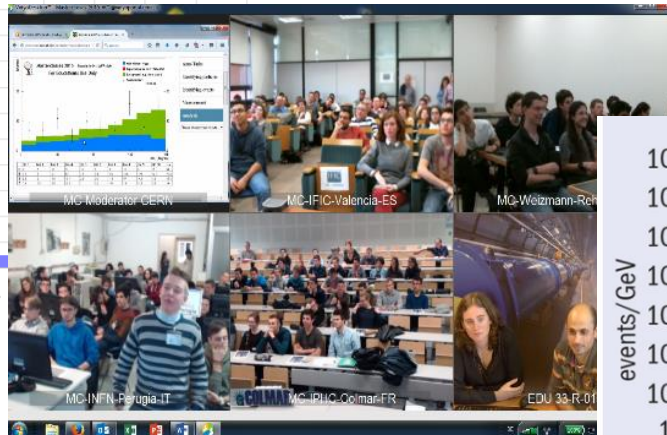
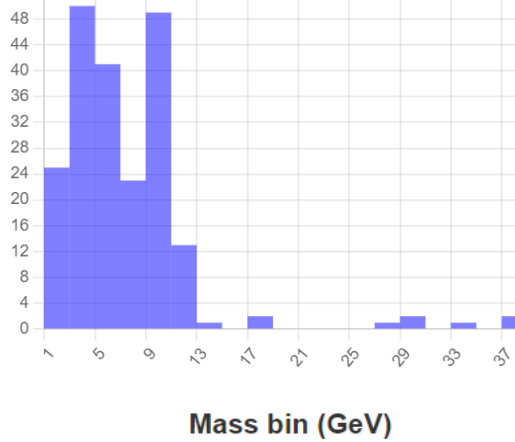


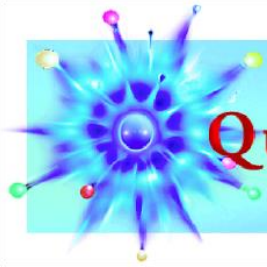


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Events /  
2GeV





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Join us!

- Organize/host a masterclass
- Become a masterclass tutor
- Become a masterclass videoconference moderator
- Help create new masterclass measurements
- Other ways...

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