



Physics Masterclasses

Students and Teachers Making Connections Collaborating with the International Particle Physics Outreach Group

QuarkNet is a key contributor to and participant in International Masterclasses, affording learning opportunities for teachers and students, and professional growth for teachers.





Physics Masterclasses

What is a Masterclass?

Like a cello masterclass, but

- Physicists are the “masters.”
- Instead of playing music, students analyze data.
- Final “concert” is discussion of results and videocon with other groups.

Participants become “particle physicists for a day.”





Physics Masterclasses

The Masterclass Day

Teachers bring students to university or lab for a day.

- **Standard Model presentation**
- **Intro to measurement**
 - **ATLAS, CMS, or MINERvA**
 - **NOvA in development**
 - **Belle II organized by Ole Miss**
- **Data analysis**
- **Discussion of results.**
- **Videoconference with up to 5 other masterclasses**
 - **Moderators from CERN, Fermilab, KEK**





Physics Masterclasses

Masterclasses the QuarkNet Way

Unique approach:

- Staff orient mentors and teachers beforehand.
- Teachers lead students in prep activities beforehand.
- Teachers assist mentors in helping students.





Physics Masterclasses

Why Masterclasses for QuarkNet?

For Students:

- Hands-on, authentic particle data
- Work with students from:
 - Other schools
 - Other QuarkNet centers
 - Other countries

For Teachers:

- All of the above and professional development



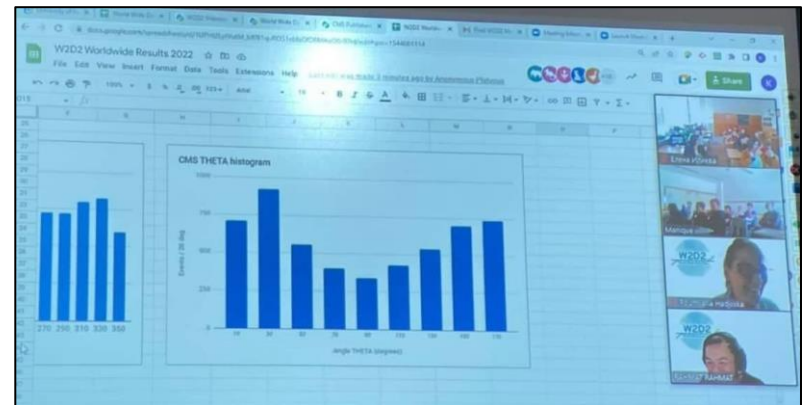


Physics Masterclasses

Made by QuarkNet

QuarkNet developed:

- CMS & Neutrino masterclasses
- World Wide Data Day: in-school teacher-run masterclass
- International Muon Week: masterclass-inspired interactions





Physics Masterclasses

IMC 2023 by the Numbers

QuarkNet Masterclasses:

- ~80 teachers, ~650 students in 26 FNAL videocons

Global Masterclasses:

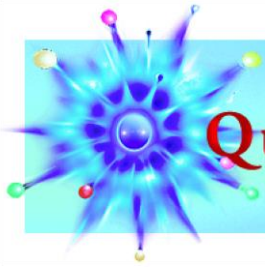
- ~10,000 students in 337 masterclasses

World Wide Data Day:

- 11 U.S. classrooms, 42 classrooms worldwide

International Muon Week:

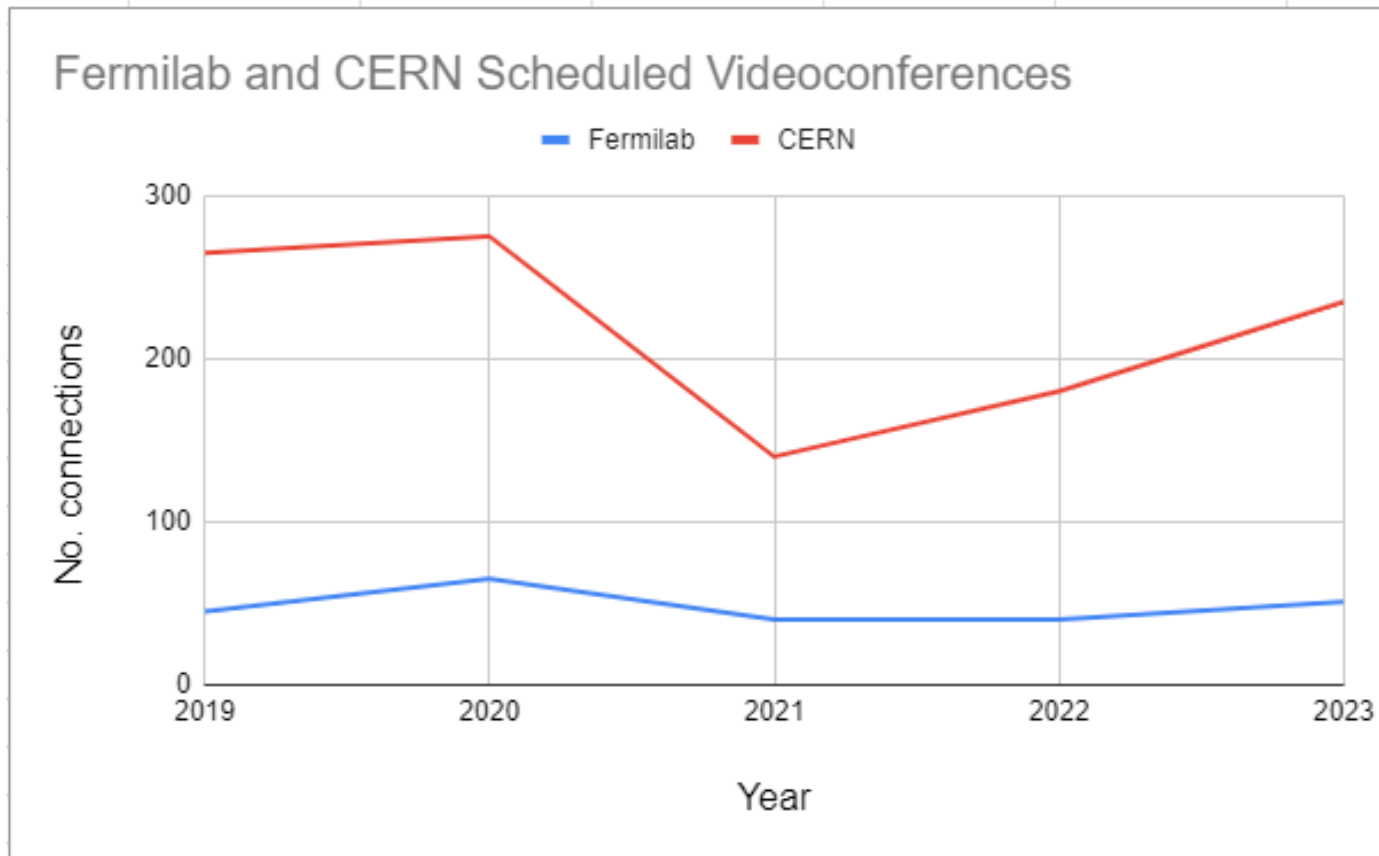
- 14 U.S. nodes, 26 nodes worldwide



QuarkNet

Physics Masterclasses

Scheduled Videocons Since 2018





Physics Masterclasses

Future Plans: Continue Growth and . . .

LHC

- Data Camp \leftrightarrow Masterclass \leftrightarrow Workshops
 - e.g. W-mass in New Questions workshop 2023
- More, new data
- Improvements

New Neutrino

- NOvA 2023
- ProtoDUNE ~2025

More

- Belle II expansion
- Masterclasses to New Countries . . . and new counties

