

QuarkNet

Forging New, Non-Traditional Partnerships among Physicists, Teachers and Students

quarknet.i2u2.org

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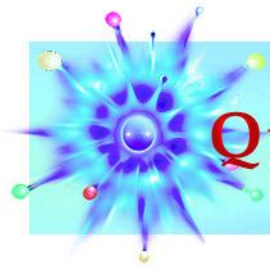


U.S. DEPARTMENT OF
ENERGY

Office of
Science



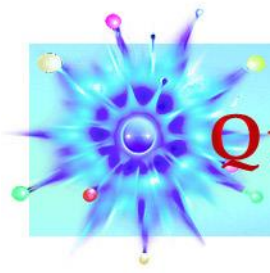
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Overview

Context
The Collaboration
Benefits
Others too



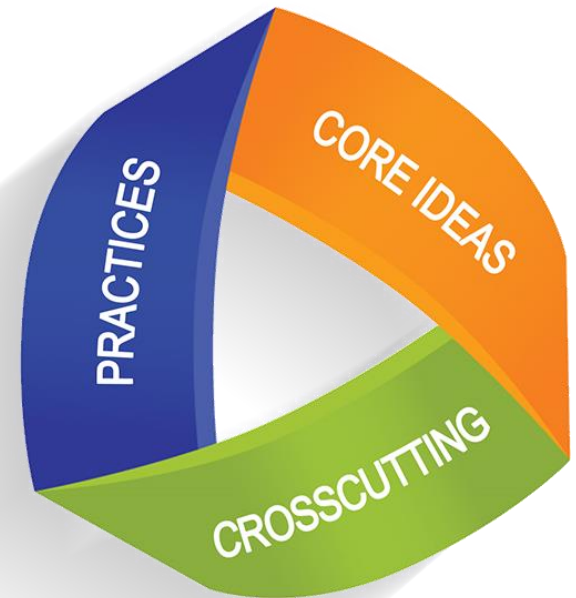
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National Education Efforts

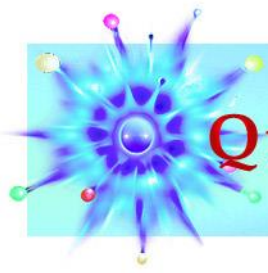
Next Generation Science Standards Science and Engineering Practices

“... to make science education more closely resemble the way scientists work and think.

... students will gradually deepen their understanding of scientific ideas by engaging in practices that scientists and engineers generally use.



Next Generation Science Standards: <http://www.nextgenscience.org>

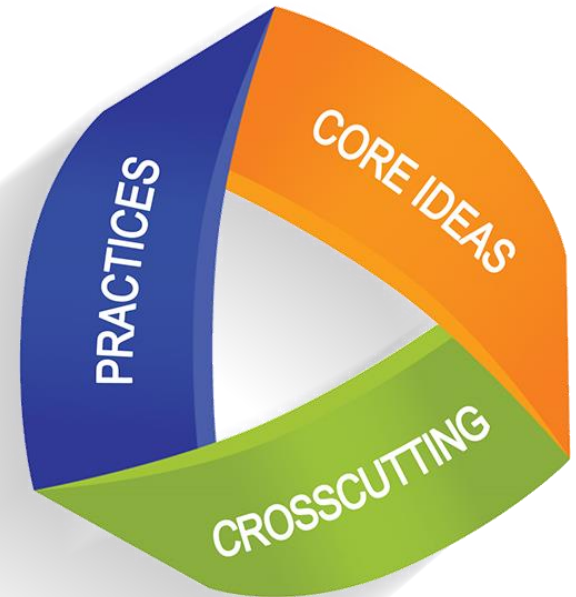


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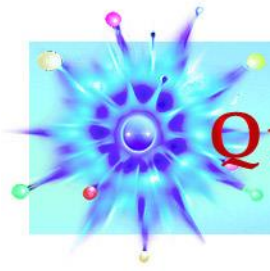
National Education Efforts

Next Generation Science Standards Science and Engineering Practices

“The practices better explain and extend what is meant by ‘inquiry’ in science and the range of cognitive, social, and physical practices that it requires.”



Next Generation Science Standards: <http://www.nextgenscience.org>



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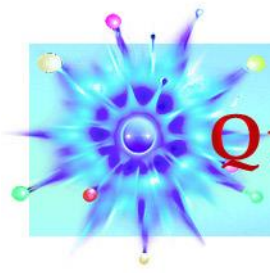
Nature of HEP Research

**. . . lends itself to non-traditional
education (outreach) programs.**

**Large collaborations & facilities
Long development & run times**

**Central management with
distributed work nationally & internationally**

(more than 160 U.S. universities, institutes & labs)



QuarkNet The QuarkNet Collaboration

QuarkNet – starting its 19th year

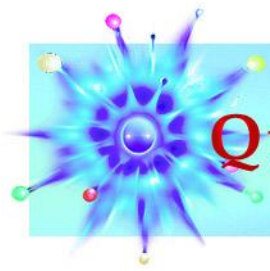
**A long-term professional development program
for physics teachers supported by the
particle physics research community**

50+ centers at universities & labs across the U.S.

82 physicists as volunteer mentors

563 active teachers & their students

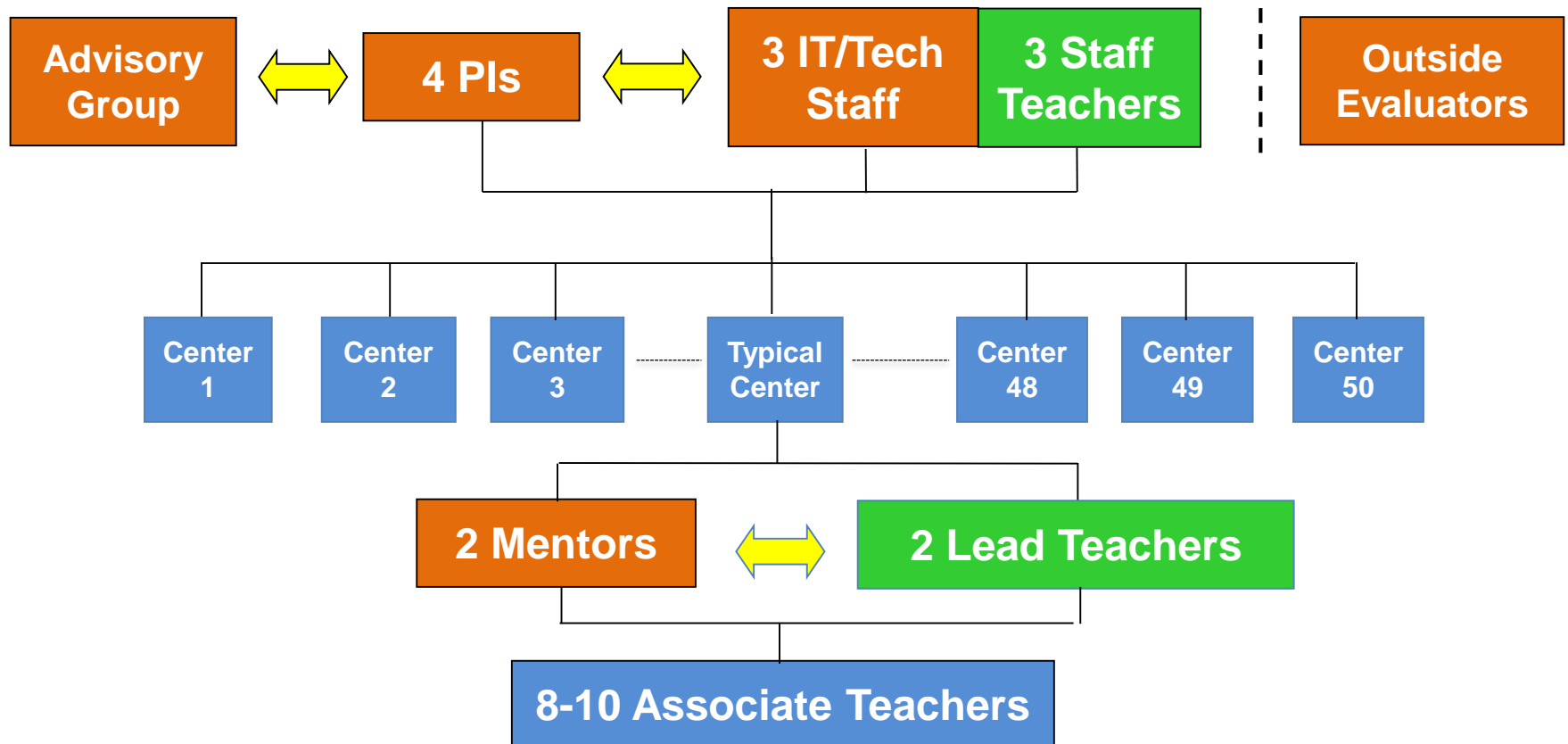
+ international outreach

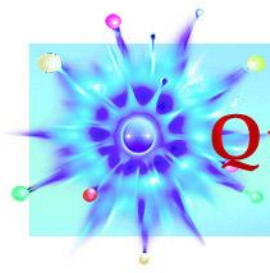


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The QuarkNet Collaboration

Management Chart





QuarkNet The QuarkNet Collaboration

What makes it non-traditional? It's . . .

- **About building lasting relationships.**
- **18 years old.**
- **A partnership between physicists & teachers top to bottom.**
- **An open door for teachers into our research community.**
- **About teachers & student teams making meaningful contributions to HEP experiments.**
- **Bringing 21st century physics into classrooms.**



QuarkNet Program

Engagement with Scientific Investigations

- Research internships
- Research-based workshops
- Masterclasses
- Cosmic ray detectors
- Access to online datasets
- Data-based instructional materials
- Ongoing support





Local Centers

Where Teachers “Meet QuarkNet”

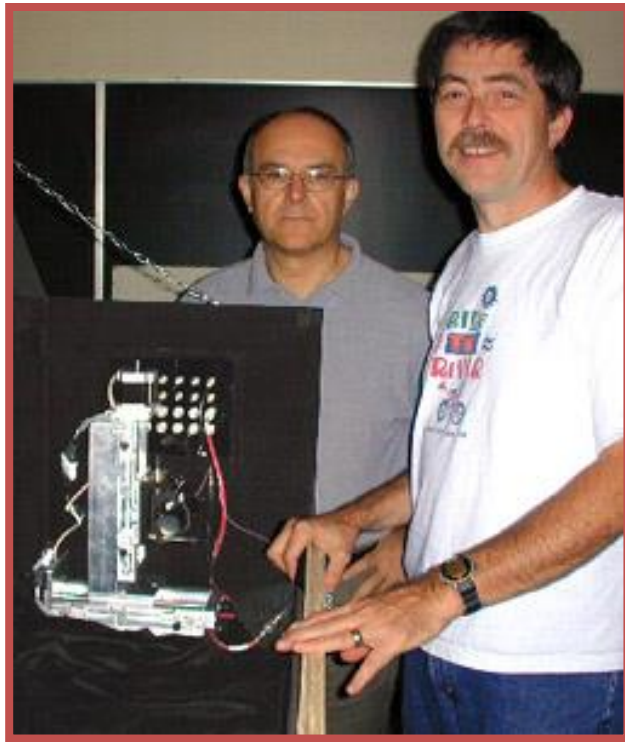
- Contact point within a distributed program
- Participants form their center
- Meet local interests and needs
- Supported by staff teachers
- Variety of formats and activities



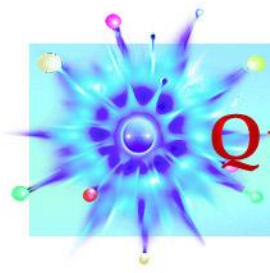


Research Experience

Year 1: Teacher Research Experiences



- Construct & test detector components.
- Analyze data & conduct simulation studies.
-



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Associate Teacher Institute

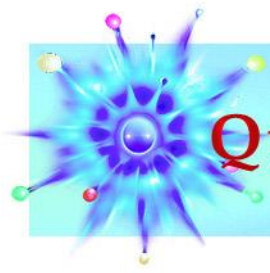
Year 2: Typical Activities

All include a study of particle physics:

- **Lectures**
- **Data analysis**
- **Experiments**
- **Tours**

All include classroom transfer:

- **Activities**
- **Lesson plans**
- **Investigations**
- **Demos**

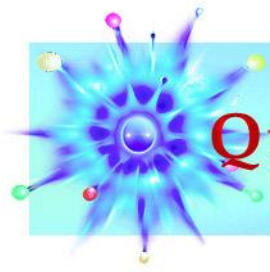


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Follow-on Program

Year 3+: Three Basic Formats + Student Research Teams

- **Physics Alliance**
- **One-week workshop (summer/several days during the academic year)**
- **An expanded program with a QuarkNet one-week program as the core**



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For Students

Learning Fundamental Physics by:

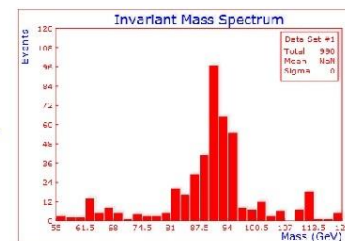
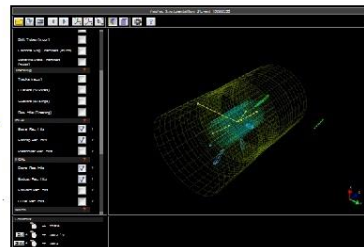
- **Covering topics in 21th century physics.**
- **Analyzing real data delivered online.**
- **Collaborating with students worldwide.**
- **Participating in inquiry-oriented investigations.**
- **Experimenting using classroom cosmic ray detectors.**
- **Visiting research groups & experiments.**



For Students

Participating in International Masterclasses

- Students + Physicists + Teachers → Masterclass Institute
- N institutes on one day ($N < 5$)
 - Learn about particles physics.
 - Analyze data and combine. → Upload results.
- Videoconference with CERN or Fermilab
- March is “Masterclass season.”



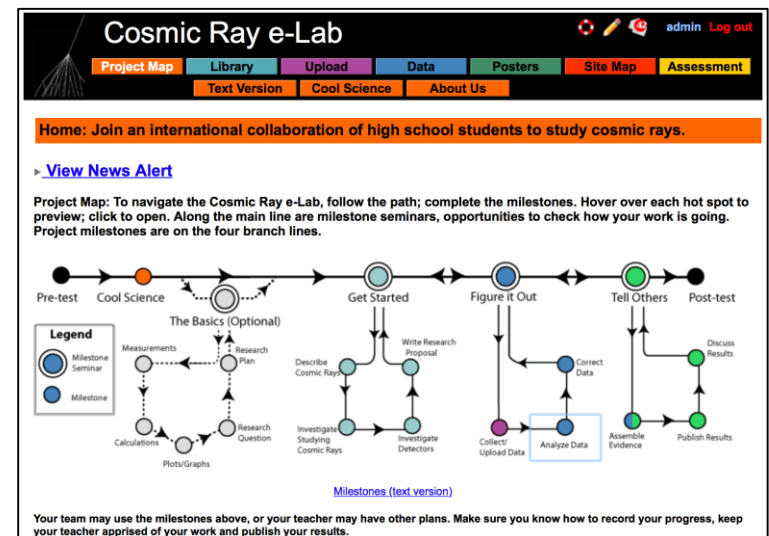
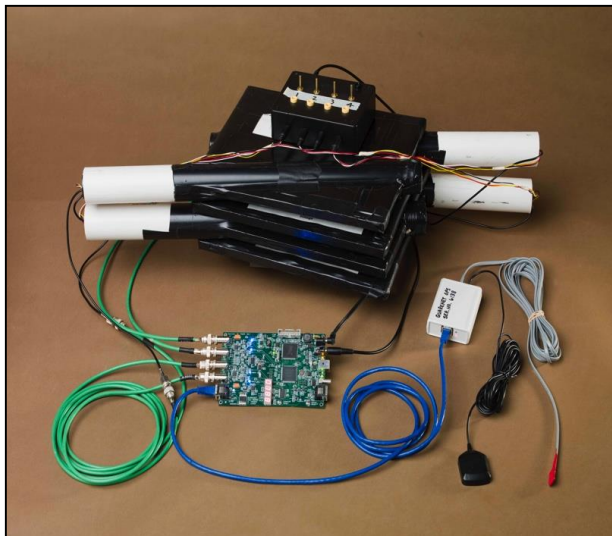


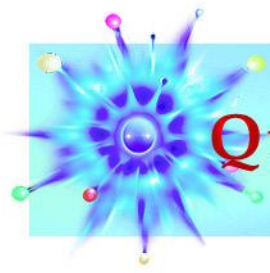
For Students

Studying Cosmic Rays

Hands-on experience with tools
just like particle physics experiments

Detectors - Analysis Tools - Collaboration





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What Students Get

Opportunities to:

- **Learn science by doing science, not just reading about science.**
- **Go right to the experts; talk directly with physicists.**
- **Collaborate with students worldwide.**
- **Experience the environment of a scientific collaboration.**
- **Conduct their own scientific investigations.**



What Physicists Get

Opportunities to:

- Share their passion for particle physics.
- “Recruit” the next generation of scientists . . . and new students for their department.
- Get help in their ongoing research from an interested and eager team.
- Use sophisticated cosmic ray experiments to inspire undergraduate and graduate students.



What Physicists Get

Opportunities to:

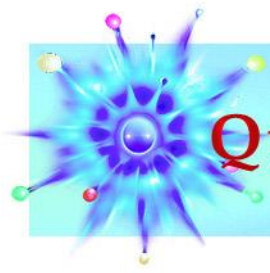
- Learn from the challenges and opportunities of teaching high school physics.
- Reach out to their communities.
- Participate in a credible, impactful outreach program that is highly regarded by our funding agencies.



What Teachers Get

Opportunities to Work:

- With physicists who are passionate about the work they do.
- With real data . . . with all of the joys and frustrations that accompany that.
- On "real-world" problems that don't necessarily have clear "back of the book" answers.
- On building things! (e.g., detector components or classroom cosmic ray detectors)



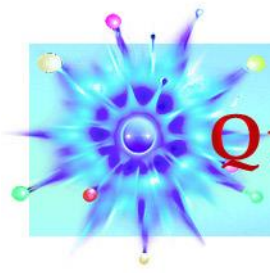
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What Teachers Get

Opportunities to:

- Study topics in 21st century physics.
- Learn science by doing science, not just reading about science.
- Have a sense of wonder about the universe.

- Challenge even the brightest students.
- Motivate students to potentially pursue physics or some STEM field.



QuarkNet The QuarkNet Collaboration

**QuarkNet – a strong outreach program that
benefits teachers, students & physicists**

**“The QuarkNet program offers a unique way to
extend the excitement of particle physics to teachers
and students everywhere in the United States. It is a
jewel of the NSF portfolio.”**

Could you adapt our model?



We Are Not Alone

Teilchenwelt, Germany (2010)

<http://www.teilchenwelt.de>

HISPARC, The Netherlands (2001)

<http://www.hisparc.nl>

- - - -

Institute for Research in Schools, UK (2016)

<http://www.researchinschools.org>

