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University of Illinois/Chicago State University 2023-2025

Examples of Student Work and Results of Analyses

The following pages present an excerpt from the program of the AAPT Winter Meeting January 2023 at New Orleans, Louisiana where two posters and talks were presented by students at high schools where a teacher has participated in QuarkNet at the time of these presentations.

This is followed by an example of an analysis of muon flux that was conducted during the summer workshop.

As reported in the UIC-CSU Annual Report 2024-2025 (prepared by Mark Adams): During the January 2025 AAPT conference in St. Louis students presented three posters on **The Effect of Coronal Mass Ejections on Cosmic Ray Muon Flux** ref 1 (Figure 1). **Total Solar Eclipse Effects on Cosmic Ray Showers** ref 2, and **Removing the Effect of Barometric Pressure on Muon Flux to Isolate the Coronal Mass Ejection Event** ref 3. During the late spring, results were completed for our **Moon Shadow project** (Figure 2) and a final poster was created. Data was collected in Indiana by a group of ten students from the schools during the 2024 total eclipse and results were finalized June 2025 (Figure 3).

August 2026

SAT-POSE-713 | Poster Presentation Traditional | An Examination of Two Professional Learning Communities of Physics Teachers Developing Culture-Based Approaches to Instruction

Presenting Author: Clausell Mathis, Michigan State University

Co-presenting Author | Andrea L Wooley, Michigan State University

Additional Author | Mathilda Smith, Michigan State University

Additional Author | Maria Horak, Michigan State University

Additional Author | Maya Patel, Michigan State University

Additional Author | Lauren Collins, Michigan State University

Understanding how to make physics instruction more equitable has been an ongoing challenge for teachers. We highlight the work of two professional learning communities (PLCs) of physics instructors who have attempted to incorporate culture-based teaching approaches in their classrooms. The first PLC focuses on the critical examination of physics ideas and recognizing non-Eurocentric contributions to physics as a discipline. The second PLC focuses on developing curricula that identify students' cultural resources and incorporate them into physics curricula. We will describe our methodology and findings from the analysis of PLC meetings around developing and enacting culture-based physics instruction. We also will highlight the different types of lessons, artifacts, and statements from teachers on what challenges and affordances they had in participating in the PLC.

SAT-POSE-715 | Poster Presentation Traditional | Using Factor Analysis to Gauge Validity of a Laboratory Exam

Presenting Author: Ari Kaye, University of Northern Colorado

Additional Author | Jennifer Delgado, University of Kansas

Additional Author | Christopher Fischer, University of Kansas

Additional Author | Keita Todoroki, University of Kansas

We present initial validation of an assessment evaluating student understanding of experimental uncertainty in undergraduate physics laboratory courses. This assessment arranges multiple-choice problems in a nested system linking a set of "minor" questions to a "major" question with a common focus. Factor analysis of student responses to this assessment verifies this linking while revealing the correlational network connecting "minor" questions to one another. Isolating each skill needed to answer problems in experimental uncertainty as separate "minor" questions identifies specific pitfalls in student understanding–providing insight for future instructional changes in laboratory courses.

SPS Poster Session (6–7 p.m.) Saturday

SAT-SPS-101 | Poster Presentation Traditional | Baseline: Looking For the Cosmic Ray Moonshadow

Presenting Author: Aitak Mosen Harzandi, New Trier High School

Co-presenting Author | Garrett Chong, New Trier High School

Co-presenting Author | Benjamin Baronofsky, Ida Crown Jewish Academy

Co-presenting Author | Jedidiah Marcus, Ida Crown Jewish Academy

Additional Author | Nathan A. Unterman, New Trier High School

Using multiple detectors set at different angles of elevation, the schools in the collaboration observed a large portion of the sky, collecting muon data to look for the moon's cosmic ray shadow. Each school used one of four angles of elevation, each producing their own sets of data and graphs for each day. These graphs were combined into monthly, then yearly averages. These four graphs were then analyzed and compared to find a consistent dip in muon count, which would hint at the presence of a cosmic ray shadow. The data are consistent with no signal, so an upper limit was determined to guide future experiments.

SAT-SPS-105 | Poster | Method for Measuring Low-Energy Cosmic Rays Using Time

Presenting Author: Ash Eliaser, Rochelle Zell Jewish High School

Co-presenting Author | Miriam Bush, Rochelle Zell Jewish High School

Co-presenting Author | Dalya Frank, Rochelle Zell Jewish High School

Co-presenting Author | Dory Marshall, Ida Crown Jewish Academy

Additional Author | Nathan A. Unterman, New Trier High School

Additional Author | Allen Sears, Ida Crown Jewish Academy

A collaboration of high school students set up cosmic ray detectors to measure low-energy cosmic rays using time with the goal of locating the moon's cosmic ray shadow. The detectors were arranged at different elevation angles aiming south to capture the moon's passage each day. As Earth rotates, the detectors swept the sky daily. Lower energy primary cosmic rays bend more due to magnetic fields and should be found as a shadow well before the moon crosses the meridian. The shadow was not expected after the moon passed the meridian since there are almost no anti-protons in the primary rays. Experiment methods are discussed in this poster.

SAT-SPS-107 | Poster | How Spatial Disorder Affects Quantum Eigenvalue Statistics

Presenting Author: Noah Koch, Berry College

Additional Author | Todd K Timberlake, Berry College

The objective of this project is to illustrate the role of spatial disorder in determining statistical properties of the energy spectrum for a quantum system. We investigate the distribution of energy level spacings in a simple quantum system consisting of several Dirac delta barriers placed

SUN-DB-03 (3:24 to 3:36 PM) | Contributed Talk | Using AI in a University Physics Course

Presenting Author: Alexander Kusenko, UCLA

My colleagues and I use AI powered hints and AI generated practice problems in Physics classes at UCLA. I will review this innovative pracice, the lessons learned, and the steps we take to make the best use of AI for all students, especially, for underrepresented minorities.

SUN-DB-04 (3:36 to 3:48 PM) | Contributed Talk) | Could AI Radically Change Physics Education

Presenting Author: Ali Tuna, Freelance

AlphaGo beat the best Go player in the world while humans were thinking Go was a game machines could not mess with. AlphaFold analyzed and mapped out the structures of proteins better, faster, and more accurately than human beings could for decades. Google's DeepMind found ways to reduce the amount of energy used in its data centers by 40% after some of the best engineers reduced it significantly. Could AI be used to help us devise new methods in Physics teaching the way it started developing proof for Kazhdan-Lusztig polynomials or the way it brought a new perspective to knot theory? By using AI, can we find unconventional ways to solve multi-step Physics problems using shorter and clearer ways that are prone to fewer errors? Can humanity maybe come up with new interpretations of fundamental Physical laws the way Einstein did with gravity? These are the questions I will try to start a discussion on by using the literature authored by some of the brightest researchers of AI.

Session SUN-DG: Authentic Research Across the Spectrum

Sunday, Jan. 7, 3–4 p.m.

Fulton - 3rd Floor Moderator: Darsa Donelan Sponsor: Committee on Space Science and Astronomy

SUN-DG-01 (3:00 to 3:24 PM) | | Unlocking the Cosmos with Radio JOVE: Bridging the Gap for Tomorrow's Astronomers

Presenting Author: Samantha Blair, Dalton State College

Co-presenting Author | Chuck Higgins, Middle Tennessee State University

Co-presenting Author | Derek Thornton, Dalton State College

Astronomy is evolving, breaking free from the confines of expensive equipment and elusive telescope time. Radio JOVE, a NASA Partner project, empowers aspiring scientists, including high school students, to explore the cosmos through radio astronomy. Chuck Higgins, a Radio JOVE Project mentor, will guide us through this transformative journey. Radio JOVE participants construct and operate their multi-frequency radio telescopes, accessing celestial wonders like Jupiter, the Sun, and the Milky Way. Beyond observation, Radio JOVE equips participants to contribute scientific data while immersing in the universe. Samantha Blair, Associate Professor of Physics and Astronomy at Dalton State College, will share her experience integrating Radio JOVE into education, enhancing students' scientific literacy. Dr. Blair's students will join the panel to vividly recount their hands-on experiences and the excitement of conducting research under her guidance. Radio JOVE aims to expand its telescope network, demonstrating the scientific process and providing real-time data access.

Join us on this thrilling cosmic exploration. Discover how Radio JOVE ignites citizen science, nurtures science literacy, and fosters collaboration. Hear from high school teachers and students who ventured into radio astronomy, conducted research, and published findings. Learn how to introduce such projects to your classroom, unlocking the mysteries of the universe for the next generation.

Session SUN-DA: Cosmic Ray Studies in the Classroom

Sunday, Jan. 7, 3–4 p.m.

Commerce - 3rd Floor Moderator: Shane Wood Sponsor: Committee on Contemporary Physics

SUN-DA-01 (3:00 to 3:12 PM) | Contributed Talk | Use of Time to Measure Momentum/Energy of Cosmic Rays

Presenting Author: Miriam Bush, Rochelle Zell Jewish High School

Co-presenting Author | Dalya Frank, Rochelle Zell Jewish High School

Co-presenting Author | Ash Eliaser, Rochelle Zell Jewish High School

Co-presenting Author | Dory Marshall, Ida Crown Jewish Academy

Additional Author | Nathan A. Unterman, New Trier High School

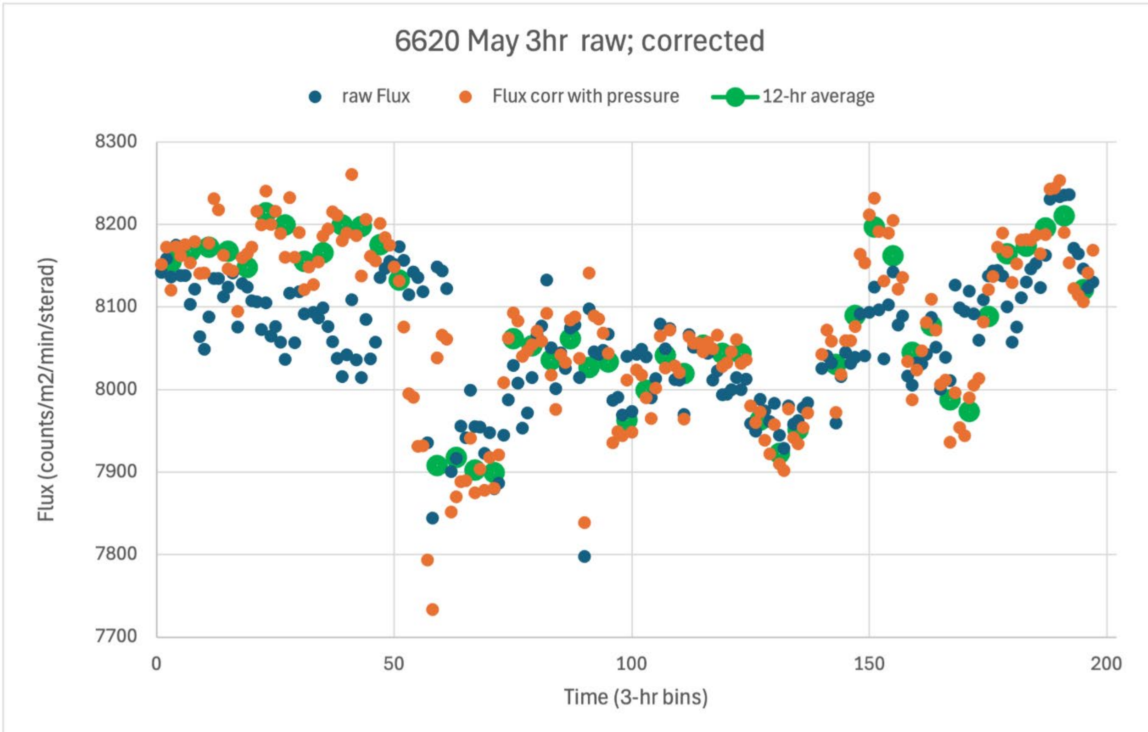
Additional Author | Allen Sears, Ida Crown Jewish Academy

During the total eclipse of 2017, students reported that the anticipated cosmic ray shadow was not in line with the moon (and sun)1. It was suggested that the lunar shadow may be elsewhere in the sky. An experiment was designed to look for the cosmic ray lunar shadow to the west and east of the Moon to account for effects from the Earth's magnetic field. Low energy primary cosmic rays would be bent more than those of higher energy. This allowed the experiment to use time ahead of lunar meridian passage to measure a range of cosmic ray energies—a novel approach. The design of such an experiment will be discussed.

(1) Dallal, Tamar A., et al.; Solar Eclipse and Cosmic Ray Flux, The Physics Teacher, volume 60, pp 100-104. February 2022

SUN-DA-02 (3:12 to 3:24 PM) | Contributed Talk | The Cosmic Watch in the Classroom

Presenting Author: Kenneth Cecire, University of Notre Dame



UIC-CSU QuarkNet Summer Workshop: CME Affect on Muons

From an email from Mark Adams (November 13, 2024)

Plot: muon flux versus time (7-31May in 3-hr bins) for flux (blue), flux corrected for atmospheric pressure (orange), and corrected flux in 12-hr bins (green). DAQ 6620 is a muon lifetime experiment running at Fermilab.

The plot (presented in the workshop agenda page) is a sample of what we were working on and the status of our effort at that time. During the workshop the group looked at 25 different CRMDs active in May during a Coronal Mass Ejection event; selected ten to analyze further. We've held 4 additional 1/2-day workshops since then and results are better understood and much improved.

The figure plots the muon rate versus time in 3-hr bins and covers 7-31May 2024. The CME ejection reached earth on the 10th, disturbed the magnetic field causing the muon rate to drop. The blue points are the muon flux (# events/min/m2/steradian) and orange and green are corrected for atmospheric pressure.

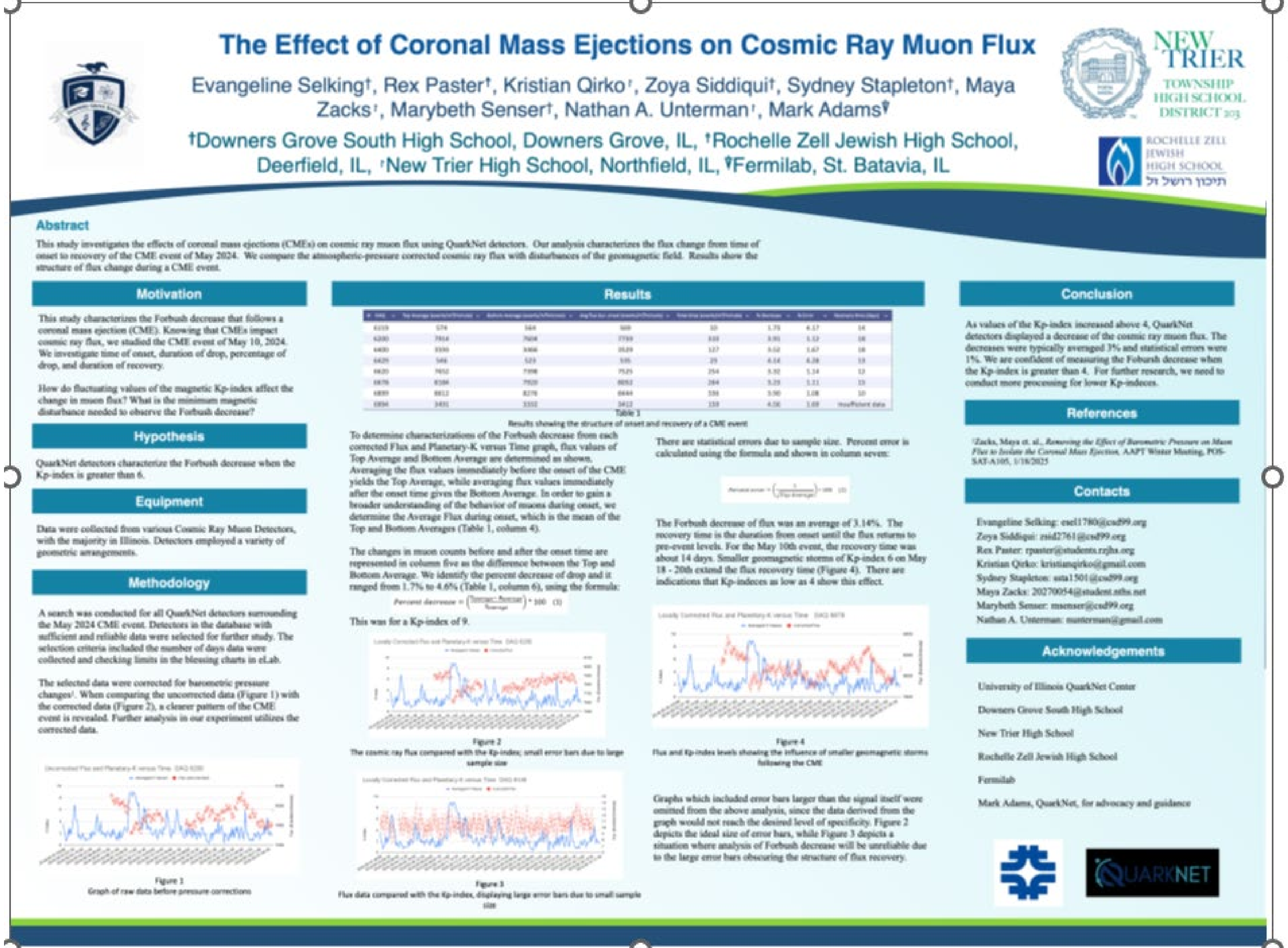


Figure 1. Image of poster presented at AAPT Jan. 2025 CME experiment

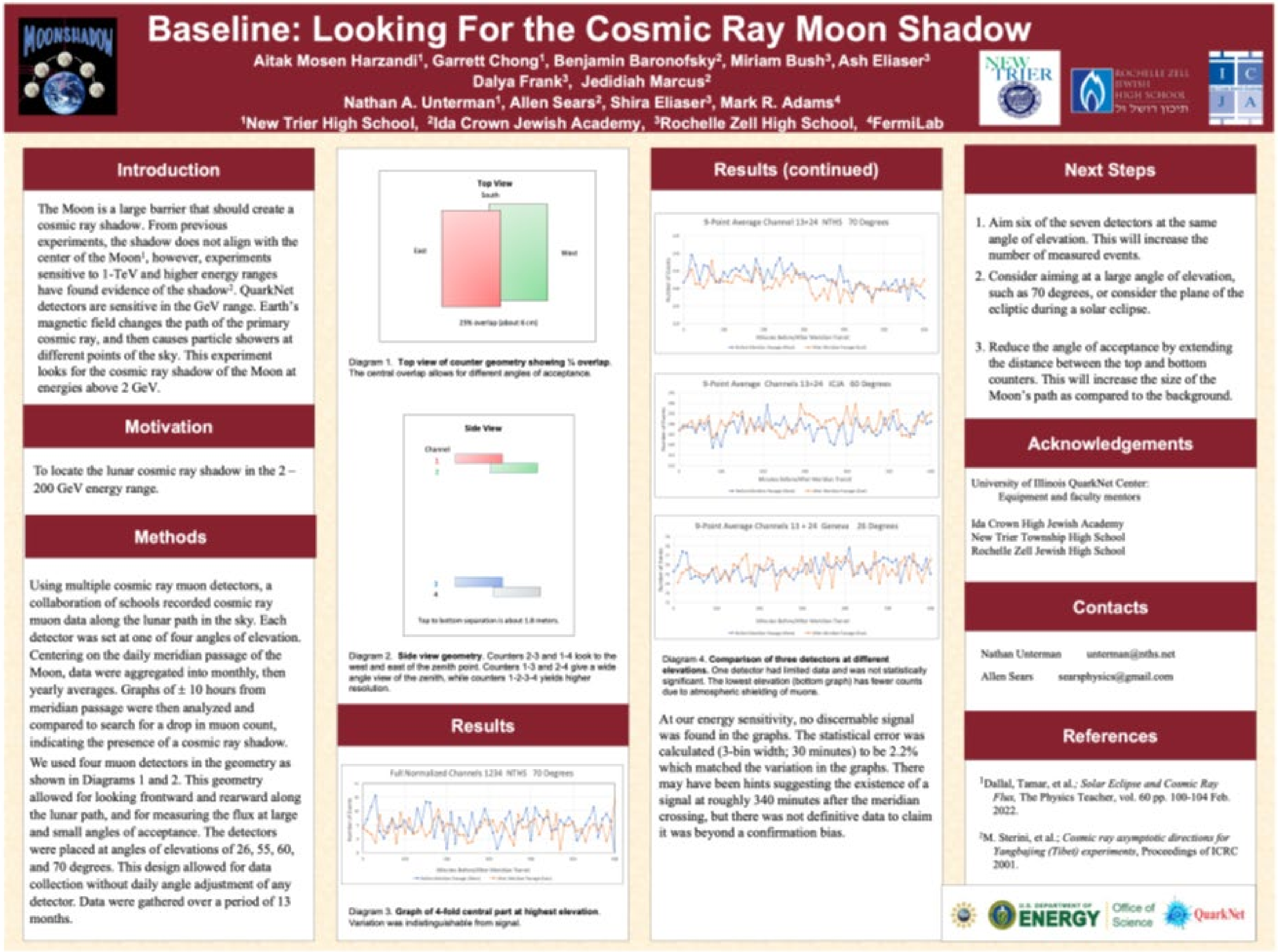


Figure 2. Final poster summarizing the 18-month Moon shadow experiment

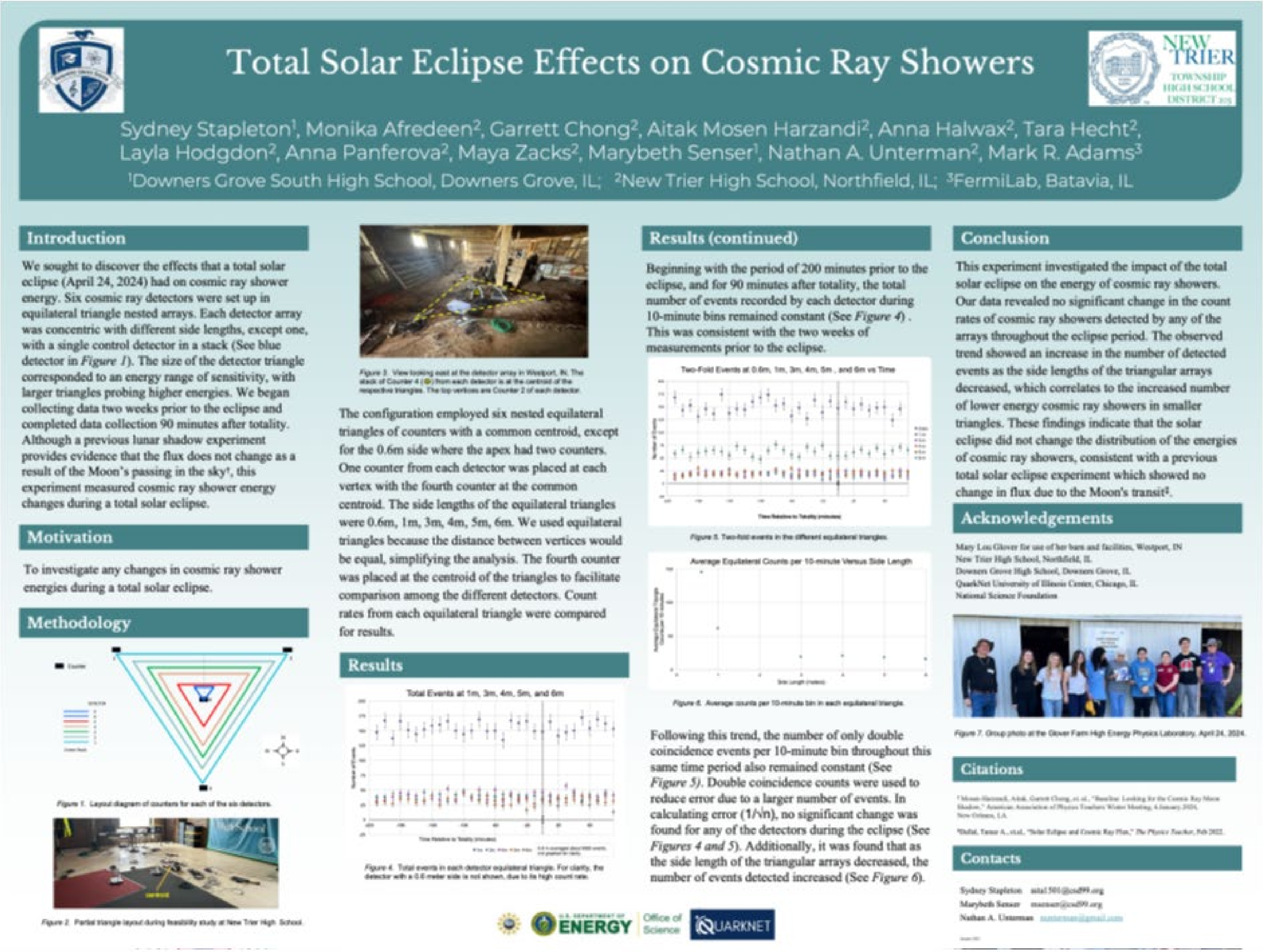


Figure 3. Poster describing final results from the solar eclipse experiment completed June 2025.