BEN MESSERLY

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ACADEMIC APPOINTMENTS

University of Minnesota — Minneapolis, MN
Particle Physics Postdoctoral Associate — *2020 - Present*

Carleton College — Northfield, MN
Visiting Assistant Professor of Physics — *2023*

St. Olaf College — Northfield, MN
Adjunct Assistant Professor of Physics — *2022*

EDUCATION

University of Pittsburgh — Pittsburgh, PA
M.S. & Ph.D in Physics — *2019*
Single Charged Pion Production by Muon Neutrinos in the MINERvA Detector Using the NuMI Beam
K. P. Dietrich School of A & S Fellow

Bowdoin College — Brunswick, ME
B.A. in Physics — *2011*
Minor in Philosophy

RESEARCH INTERESTS

Experimental high energy nuclear and particle physics

High performance and scientific computing

Data science, machine learning, data visualization, statistics

Open science

RESEARCH

Mu2e Experiment — Univ. of Minnesota, Fermilab
Collaboration member — *2020 - Present*

- **Calibration and Analysis Groups**
  - Neural network based track alignment and energy calibrations.
  - Analysis infrastructure tools development.
- **Detector Construction**

  Lead postdoc in the Heller UMN lab for construction of the Mu2e straw tube electron tracking detector during key phases and completion between 2020-2022. Responsibilities and tasks included:
  - Develop detector construction lab procedures, troubleshoot equipment, solve QA/QC problems, and write documentation.
  - Hire, supervise, schedule, and train ∼100 undergraduate employees.
  - Mentor graduate, undergraduate, and REU student researchers.

  - Convene weekly group staff meetings, and present weekly production status to collaboration.
  - Work with university services, scientists, and technicians to acquire parts and services and to solve lab problems.
  - Use python to analyze and visualize production data for rapid QA/QC decisions.
  - Develop, manage, and deploy custom lab data collection software and SQL database in a production environment serving dozens of concurrent users. Train, manage, and mentor 2-3 student software development employees to build features and manage app stability. Code link.
  - Lab equipment: including high voltage supplies, circuits, soldering, arduinos, high-pressured gas cylinders, DAQs, epoxies, laser machining, temperature controls, power tools, precision-measurement tools.
- **Collaboration Activities**
  - Attend collaboration meetings at Fermilab, deliver tracker working group plenary reports.
  - Deliver Mu2e presentations and posters at several conferences and university colloquia.
  - Young Mu2e group member for early career collaborators.

MINERvA Experiment Fermilab
Collaboration member *2013 - Present*

- **Pion Production Analysis Group** - Measurement of neutrino-induced charged pion production. Publication in experimental review. Code link.
- **MINERvA Analysis Toolkit** - As a part of MINERvA's data preservation and open science effort, designed and built a toolkit for standardization, centralization, and calculation of systematic errors, used for all collaboration publications, and adopted by other experiments. Code link.
- **Neutrino Beam Flux Simulation Group** - Regular contributor; extensive studies of G4NuMI beam simulation, focusing uncertainties, hadron production uncertainties, and beam particle composition. Code link.
- **Calibrations Group** - Expert; emphasis on raw data, pedestals, and PMT gains.
- **Test Beam Group** - Led data validation group; aided in detector installation.

Author on 47 collaboration publications, including several more in preparation, and several as primary author or with direct involvement in analysis, writing, and internal review.

Neutrino Scattering Theory-Experiment Collaboration (NuSTEC) Remote
Analyzer, Publications Working Group *2016-Present*

· Performed cross-experiment neutrino scattering data analysis for 2016 and 2019 Tensions workshops and publications.
· Co-author and editor of three NuSTEC publications summarizing priority topics in neutrino scattering with a goal of identifying community funding priorities.

NuMI-X Group Fermilab
Collaboration member *2014 - 2020*

· Inter-experimental effort to advance knowledge of the NuMI Beam.
· MINERvA liaison and regular contributor to simulation and modeling improvements.

NA61/SHINE Experiment CERN
Collaboration member, US-NA61 Group *2013 - 2018*

· Data-taking run operations and data validation.
· Included in author list on 25 collaboration publications.

Solid State Acoustics Lab Bowdoin College
Undergraduate Research Fellow *2010 - 2011*

· Mapped acoustic wave propagation on the surfaces of various anisotropic crystalline solids.

SELECT PUBLICATIONS

A. Bercellie, K.A. Kroma-Wiley *et al.* [MINERvA Collaboration], *Simultaneous measurement of muon neutrino ν_μ charged-current single π^+ production in CH, C, H2O, Fe, and Pb targets in MINERvA*, Phys.Rev.Lett. 131 (2023) 1, 011801, e-Print: arXiv:2209.07852.

M. B. Avanzini, *et al.*, *Comparisons and challenges of modern neutrino-scattering experiments (TENSIONS report)*, Phys.Rev.D 105 (2022) 9, 092004, e-Print: arXiv:2112.09194.

B. Messerly, *et al.* [MINERvA Collaboration], *An Error Analysis Toolkit for Binned Counting Experiments*, EPJ Web Conf. 251 (2021) 03046. e-Print: arXiv:2103.08677.

R. Fine, B. Messerly, and K. S. McFarland, *Data Preservation at MINERvA* (2020), e-Print: arXiv:2009.04548.

M. Betancourt, *et al.*, *Comparisons and challenges of modern neutrino scattering experiments (TENSIONS report)*, Physics Reports, 0370-1573 (2018). e-Print: arXiv:1805.07378.

C. L. McGivern, *et al.* [MINERvA Collaboration], *Cross sections for ν_μ and $\bar{\nu}_\mu$ induced pion production on hydrocarbon in the few-GeV region using MINERvA*, Phys. Rev. D **94**, no. 5, 052005 (2016). e-Print: arXiv:1606.07127.

In Preparation

B. Messerly, E. Granados, *et al.* [MINERvA Collaboration], *High statistics measurement of ν_μ induced pion production in MINERvA.* *Oct 2024*

Neutrino Scattering Theory-Experiment (NuSTEC) Collaboration, *Current Experimental and Theoretical Challenges of Neutrino-Nucleus Scattering.* *Early 2025*

B. Messerly, A. Lister, A. Rothman, *Livingston-style numerical and historical survey of neutrino detection.* *2025*

TALKS AND PRESENTATIONS

Invited Talks

- *Dethroning the Standard Model: Neutrinos and Muons at Fermilab* — Univ. of Minnesota Duluth
  Postdoc Science Seminar Series — *Oct 2024*
- *Understanding Neutrino Cross Sections* — Otranto, IT
  Neutrino Oscillation Workshop — *Sep 2024*
- *Dethroning the Standard Model: Neutrinos and Muons at Fermilab* — St. Olaf College
  Physics Colloquium — *May 2023*
- *An Error Analysis Toolkit for Binned Counting Experiments* — Remote
  International Conference on Computing in High-Energy Physics (vCHEP) — *May 2021*
- *Studying Neutrinos in the MINERvA Detector* — Bowdoin College
  Physics Colloquium — *Nov 2016*
- *Studying Neutrinos in the MINERvA Detector* — Franklin & Marshall College
  Physics Colloquium — *Nov 2016*
- *MINERvA in 10 Minutes* — Fermilab
  New Perspectives Conference — *Jun 2016*
- *Charged Pion Production in MINERvA* — Fermilab
  New Perspectives Conference — *Jun 2016*
- *Shaking Surfaces: Investigating Crystalline Solids with Ultrasound* — Bowdoin College
  President's Science Symposium — *Oct 2010*

Conference Presentations and Posters

- ν_μ *Charged Current Pion Production on Different Nuclei with MINERvA* — Univ. Hamburg, DE
  European Physical Society Conference on High-Energy Physics — *Aug 2023*
- *The Mu2e Straw Tube Tracking Detector* — Univ. Hamburg, DE
  European Physical Society Conference on High-Energy Physics — *Aug 2023*
- *Charged Kaon Production By Neutrinos at MINERvA* — Chicago, IL
  International Conference on High Energy Physics 2016 — *Aug 2016*

Lecture Series

- *Particle Physics Lecture Series* — Univ. of Minnesota
  Bi-weekly seminars for summer research students — 2021
  Introduction to Mu2e, *The Standard Model*, *Physics of the Mu2e Lab*, *Particle Physics Detectors*, *The Mu2e Tracker*, *Data Science in Experimental Particle Physics*

TEACHING

PHYS 4511 – Intro to Nuclear and Particle Physics — Univ. of Minnesota
Course design, co-teaching, for senior undergraduate and early Ph.D students — *Fall 2024*

Instructor PHYS 145 – Mechanics and Waves — Carleton College
Newtonian mechanics for non-majors — *Spring 2023*

Instructor PHYS 386 – Advanced Lab St. Olaf College
For senior physics majors *Fall 2022*

· Explored advanced topics in physics with emphasis on lab technique, analytical skills, independent work, and scientific writing.
· Students conducted two short experiments in the first half of the course and one self-designed experiment in the second half.
· Topics: laser technology and spectroscopy; atomic emission spectroscopy and energy splitting; positron spectroscopy; noise and entropy; Faraday rotation; liquid drop formation with a high-speed camera; scanning electron microscope.

Instructor MINERvA 101 Fermilab
Led annual week-long schools for new collaborator onboarding *2015-2019*

· Seminars and full day activities to introduce MINERvA experiment concepts.
· Topics: detector calibrations, neutrino beam flux, systematic uncertainties.
· Organized social events and tours.

Teaching Assistant Univ. of Pittsburgh
Lab and recitation instructor, grader *2013 - 2014*

· PHYS 1371 - Introduction to Quantum Mechanics
· PHYS 0212 - Intro to Laboratory Physics
· PHYS 0175 - Basic Physics for Science and Engineering II
· PHYS 0110 - Intro to Physics 1

Teaching Assistant Bowdoin College
Held office hours, grader *2009 - 2011*

· PHYS 104 - Introductory Physics II
· PHYS 223 - Electric Fields and Circuits
· PHYS 224 - Quantum Physics and Relativity

STUDENT ADVISING, MENTORSHIP, AND RESEARCH

Mu2e Physics Lab Univ. of Minnesota
Manager and Mentor (Hired Student Researchers) *2020 - Present*

· Klara Northrup (Fermilab), Emma Martin (Fermilab), Hanna Hass (Fermilab), Zach Carpenter (Arizona State Univ. Physics), Aseila Awad (UMN).

Neutrino Research Carleton College
Principle Investigator *2023 - Present*

· *Numerical and Historical Review of Neutrino Detection Methods with Livingston-style Mass and Position Resolution Visualization.*
· Research collaboration with Adam Rothman (Carleton College) and Dr. Adam Lister (Univ. of Wisconsin Madison).
· Publication in preparation.

Ph.D Students

· Everardo Granados Vazquez (Univ. de Guanajuato Ph.D 2024, now at Florida State Univ.). *Multidimensional Differential Cross Section Measurement of Neutrino Pion Production at MINERvA.*

· Faraz Samavat (Univ. of Minnesota Ph.D expected 2025). *Machine Learning Based Calibration of the Mu2e Detector.*

Summer REU Students — Univ. of Minnesota
Primary Advisor (under supervision of PI) — *2023-2024*

· Haley Harms (Univ. of Northern Iowa), Synnove Hunnes (Gustavus Adolphus College). *Booster Neutrino Beam Monitoring with the Short Baseline Neutrino Detector Cosmic Ray Tagger.*

· Will Leija (Texas State Univ.). *Tension & Leak Material Assessment of Mu2e Drift Straws.*

Applied Computer Science for the Mu2e Experiment — Univ. of Minnesota
Manager and Mentor (Hired Student Researchers) — *2020-2023*

· Trained and managed undergraduate research assistants in various computer science projects used by the Mu2e experiment.

· Python, app and full stack software development, version control, data management, data science.

· Isaiah Wardlaw (Boston Univ. Physics), Adrian Leal (Microsoft), Adam Arnett (Medtronic), Himanshu Joshi (Perficient), Matthew Breach (UMN), Oscar Wiestling (UMN).

OUTREACH

Climate and Diversity Committee Member — Univ. of Minnesota
Department of Physics and Astronomy — *Oct 2021 - Present*

· Advocacy group building welcoming and supportive environment with special emphasis on inclusion, diversity, and community building. Organizes activities, hosts workshops, distributes resources, and facilitates conflict mediation.

· Postdoc representative. Organize postdoc coffee hours and social events.

Minnesota State Science Fair Judge — St. Paul, MN
Minnesota Academy of Science — *Mar 2023*

High School Colloquia on Particle Physics — Univ. of Minnesota
Mu2e lab tours and hour-long lectures introducing particle physics — *2021 - 2022*

· Quarknet High School Teachers Group - *Aug 2021, Jun 2022, Aug 2024*

· Blake High School Student Group - *May 2022*

· College in the Schools: Physics by Inquiry High School Teachers Group - *Nov 2021*

Neutrino Hall Underground Tour Guide — Fermilab
Aug 2016 - 2019

Affirmative Action and Diversity Committee Member — Univ. of Pittsburgh
Department of Physics and Astronomy — *Nov 2015 - 2018*

News Article — Fermilab Today
"The Flux of the Matter" — *Dec 2015*

Investing Now High School Outreach Volunteer — Univ. of Pittsburgh
Physics demos and discussions with K-12 groups in the Pittsburgh area — *Apr 2013*

SCHOLARSHIPS AND AWARDS

Postdoc Association Award — Univ. of Minnesota
For outstanding contributions to teaching and mentoring — *Aug 2022*

Computational and Data Science School for HEP (CoDaS-HEP) — Princeton Univ.
Jul 2022

International Neutrino Summer School Director Award — Fermilab
Historical survey of neutrino detector mass and position resolution — *Aug 2017*

U.S. DOE Office of Science Graduate Student Research Award — Fermilab
Full support to pursue Ph.D. studies at Fermilab — *2016 - 2017*

PITT PACC Fellowship — Univ. of Pittsburgh
For Dissertation Research in Neutrino Physics — *2015*

K. P. Dietrich School of A & S Fellowship — Univ. of Pittsburgh
Full support in recognition of outstanding undergraduate record — *2012 - 2015*

Surdna Fellowhip — Bowdoin College
For Research in Solid State Physics — *2010*

GRADUATE COURSEWORK

Advanced Classical Electricity and Magnetism
Advanced Particle Physics
Computational Methods
Dynamical Systems
Field Theory
Mathematical Methods in Physics
Non-Relativistic Quantum Mechanics
Teaching of Physics
Thermodynamics & Statistical Mechanics

TECHNICAL SKILLS

Python
C++
Jupyter Notebooks
Google Colab
Version control (git, svn)
SQL Databases
Pandas
Web scraping
Data cleaning
Data visualization
Grid computing
Python-based GUIs
Monte Carlo simulation
Bash/Unix
Linux
CERN Root
Geant4
NI LabVIEW
Mathematica