Undergraduate Research and Recruitment through MoNA and the CEU

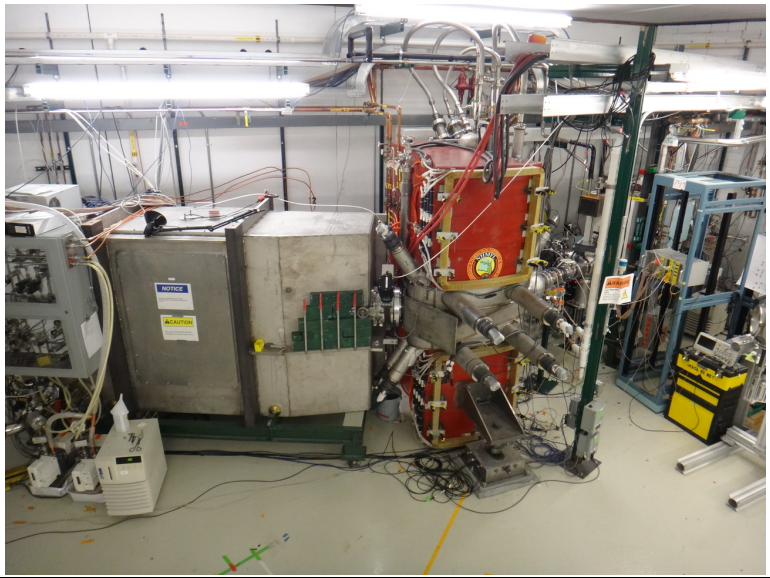
W.F. Rogers
Indiana Wesleyan University

Workshop for Applied Nuclear Data Activities
February 1, 2021

MoNA Collaboration – PUIs and undergraduate involvement

- Augustana College
- Central Michigan University
- Davidson College
- Hope College
- Indiana University South Bend
- Indiana Wesleyan University
- Michigan State University
- Wabash College

Construction of MoNA and LISA - Multi-College Collaboration – 2 NSF MRI grants (2002, 2010)



The 2020 **MoNA** Report

The MoNA Collaboration

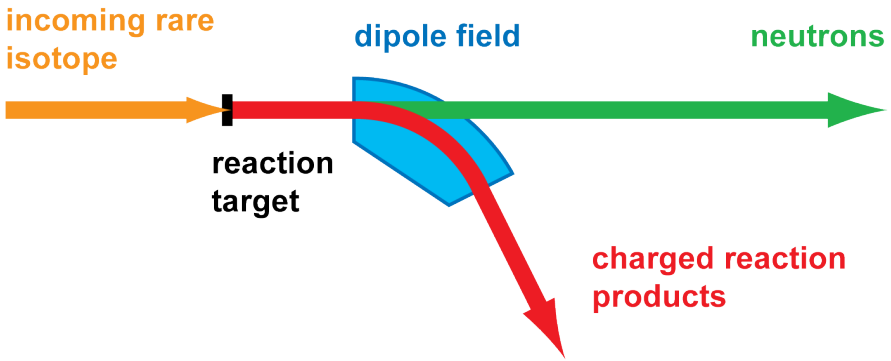
T. Baumann, J. Brown, P. A. DeYoung,
J. Finck, N. Frank, P. Guèye,
J. Hinnefeld, A. Kuchera, B. A. Luther,
W. F. Rogers

Augustana College, Rock Island, IL 61201
Central Michigan University, Mount Pleasant, MI 48859
Concordia College, Moorhead, MN 56562
Davidson College, Davidson, NC 28035
Hope College, Holland, MI 49423
Indiana University South Bend, South Bend, IN 46634
Indiana Wesleyan University, Marion, IN 46953
Michigan State University, East Lansing, MI 48824-1321
Wabash College, Crawfordsville, IN 47933

January 4, 2021

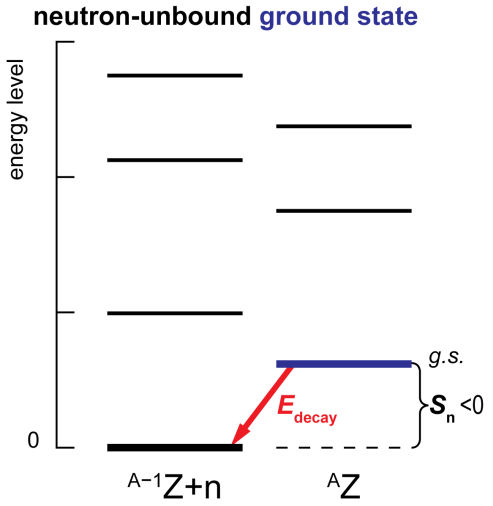
Invariant Mass Spectroscopy

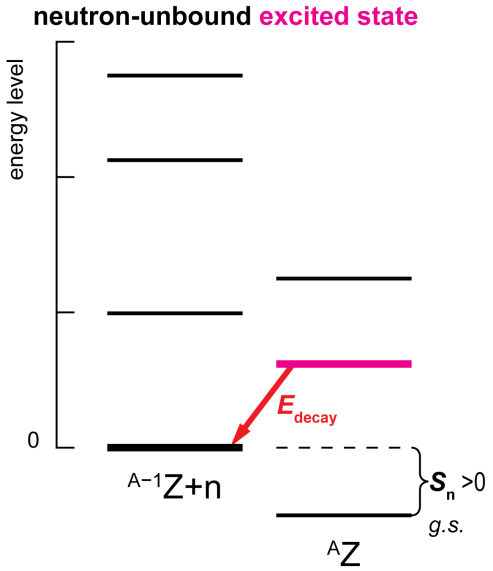
Reconstruction of unbound state by determining momentum vectors of constituents.



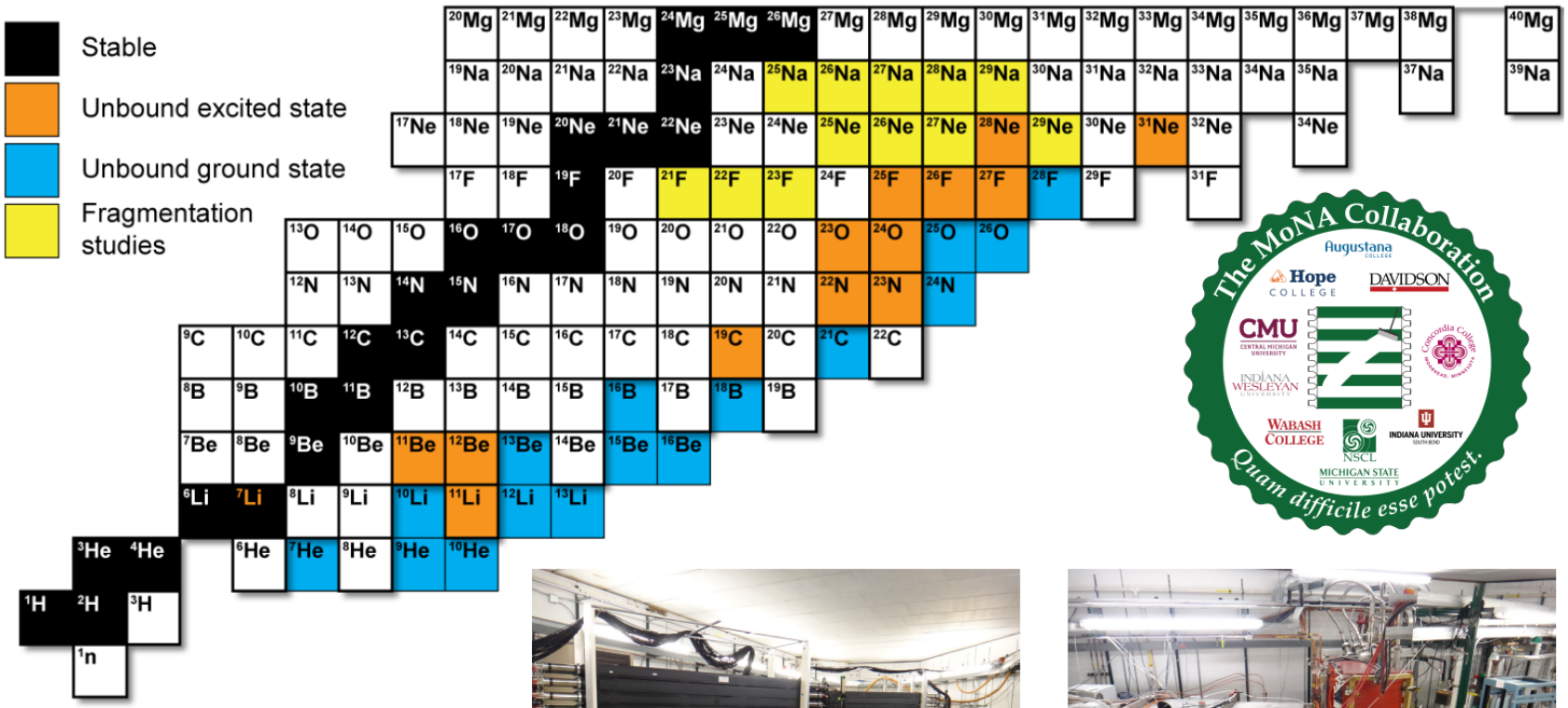
Population of unbound state occurs in secondary reaction target
Typical reactions used to produce unbound state includegraphics

- proton knockout
- (d,p) reactions
- Coulomb excitation



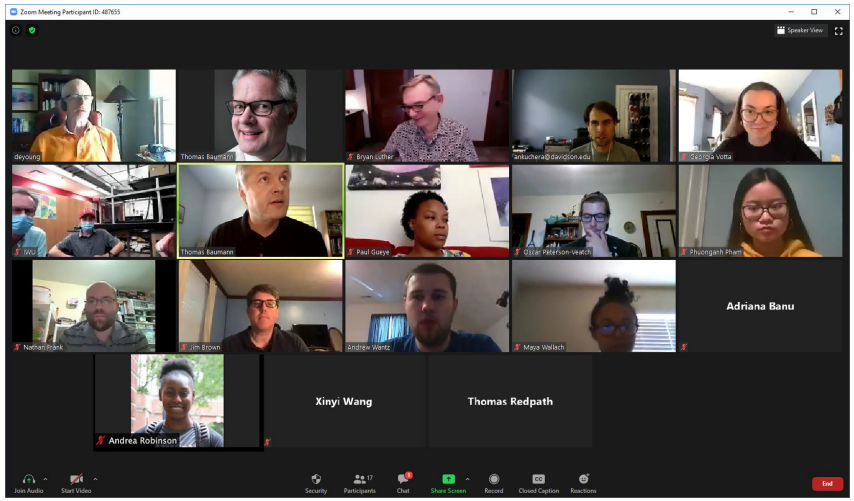


MoNA Collaboration Research



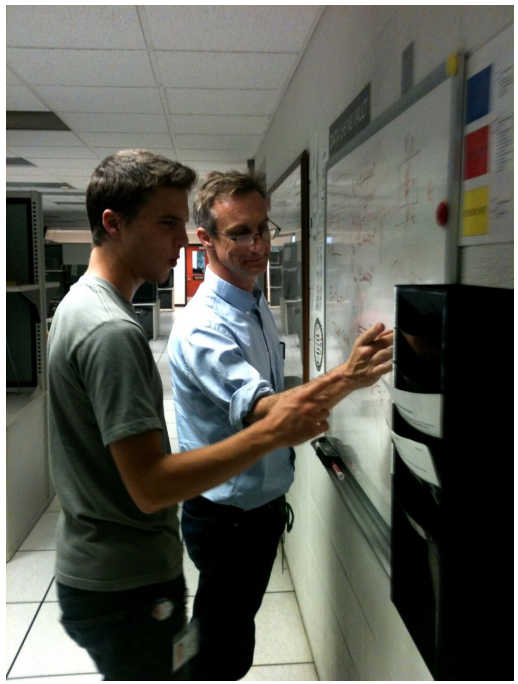
Regular collaboration meetings

- The MoNA collaboration has maintained remote weekly meetings since its inception
- Agenda includes plans for experimental proposals, facility updates, analysis updates, paper writing updates, etc.
- Students are encouraged to share research updates
- Annual MoNA Collaboration meetings in late summer



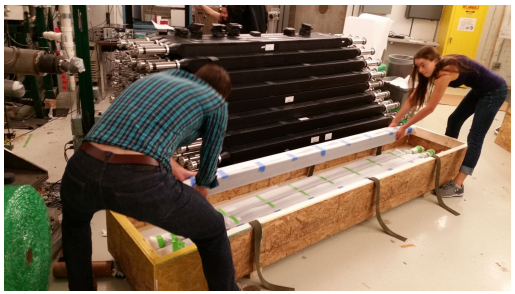
Undergraduate Students and Research ...

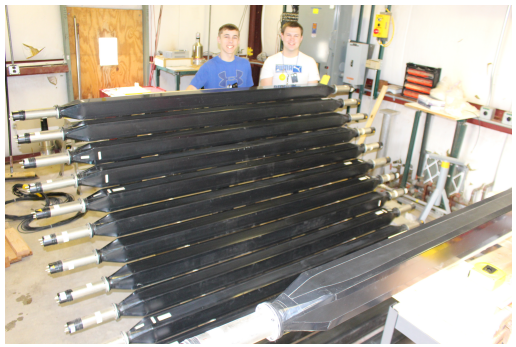
- Undergraduate research experience:
  - is motivational
  - equips students with important skills
  - builds confidence and competence
  - enables students to meaninfully contribute to the group
- Start students in research early
- Creativity in assigning tasks is important



Undergraduate Research Experience

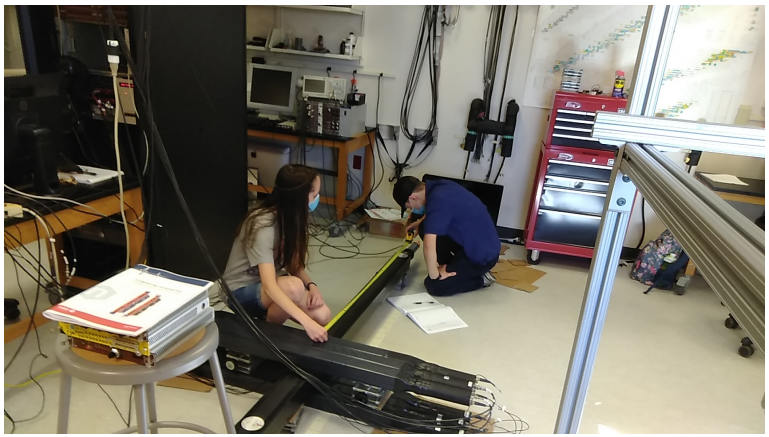
- Mentorship needs to involve:
  - identifying student strengths, getting to know the students
  - modeling how research is pursued from strategy to implementation
  - encouragement and reward
- College years are transformational
- Emergence of personal identity, competence, confidence, transition to adulthood
- Little knowledge of contemporary physics research, opportunities

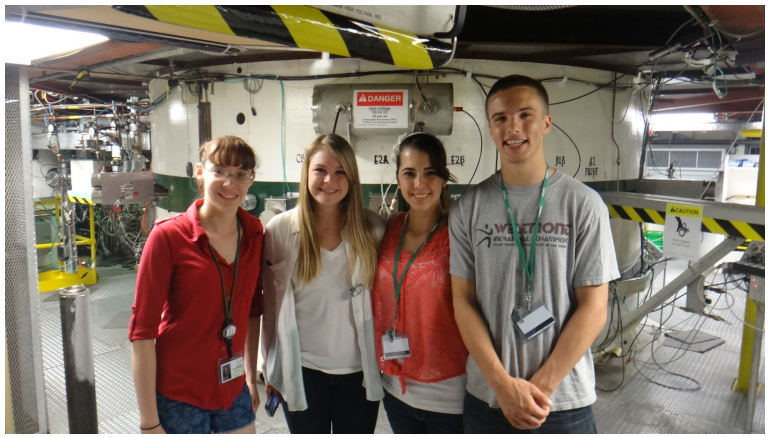




Additional important issues

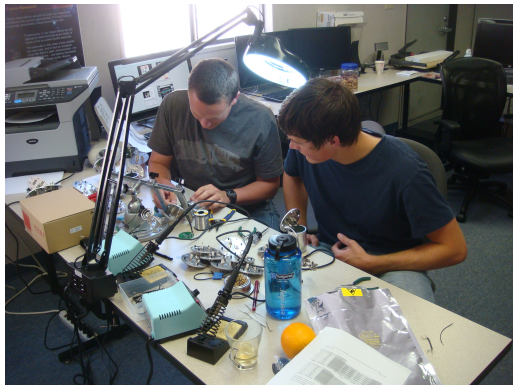
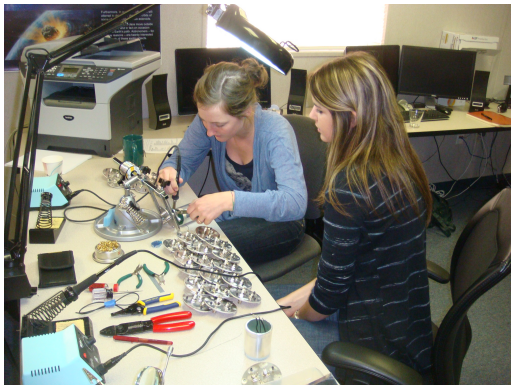
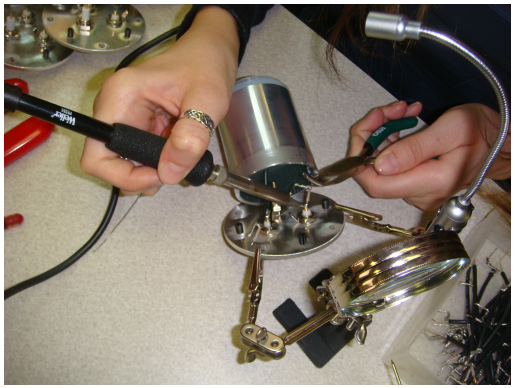
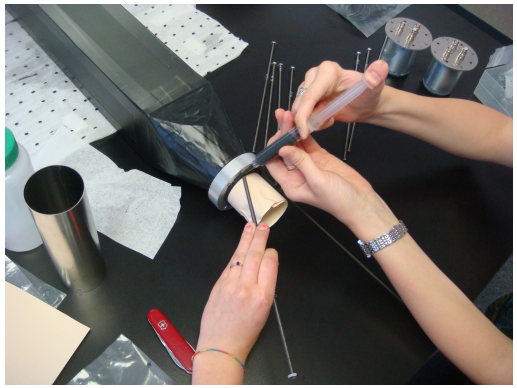
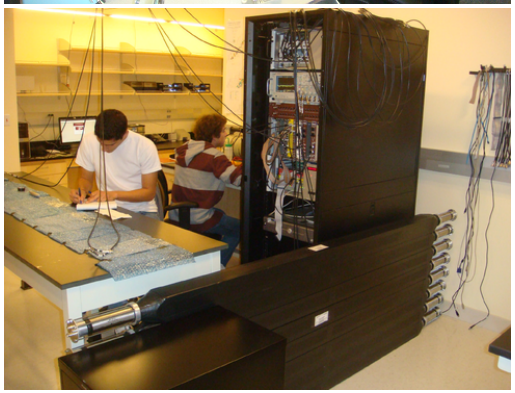
- Wide variation in the quality of their High School physics experience
- Physics prep can be minimal
- Sequencing of courses is important, and to start right away
- Many PUI (and some R1) physics departments don't maintain a nuclear physics course





Student Participation in the Construction of LISA



Student Research Participation

In the MoNA collaboration, students have exposure to and gain experience in many aspects of fundamental research, including:

- Construction of neutron detectors soldering, assembling, testing, calibrating, shipping, installing
- Cabling and testing the array before experiments
- Participate in experiments, troubleshoot, cover shifts, analyze data as it comes in
- Calibration of detectors - time, energy, parameterize, diagnosing, correct for drifts, etc.
- Perform isotope separation using sophisticated analysis gating techniques
- ROOT analysis, writing code and macro routines
- Geant4 simulation and χ^2 minimization
- Writing papers
- Presenting work at national conferences
- Learn a LOT of cutting edge, contemporary nuclear physics
- Included as co-authors in MoNA publications

MoNA students and Graduate School

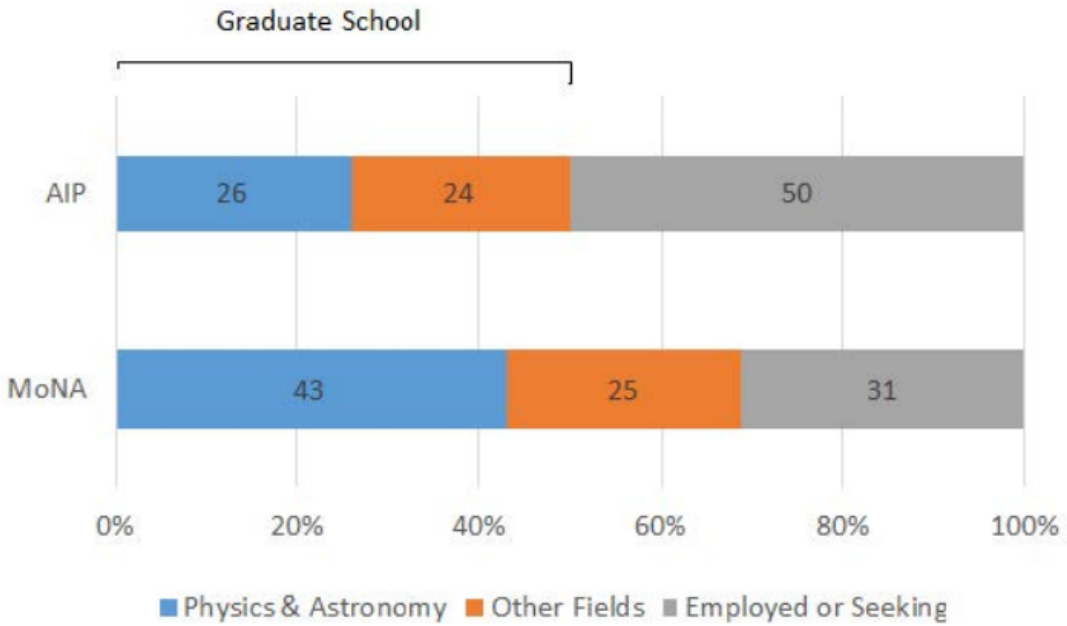


Figure 21: Career choices of BS/BA graduates from bachelor's granting institutions in the U.S. from an AIP survey [29] and from the MoNA collaboration. The AIP data is from 1974 respondents from 2011 and 2012, and the MoNA data is based on 97 students from 2002 ? 2014.

MoNA and CEU – Nuclear Physics Graduate School

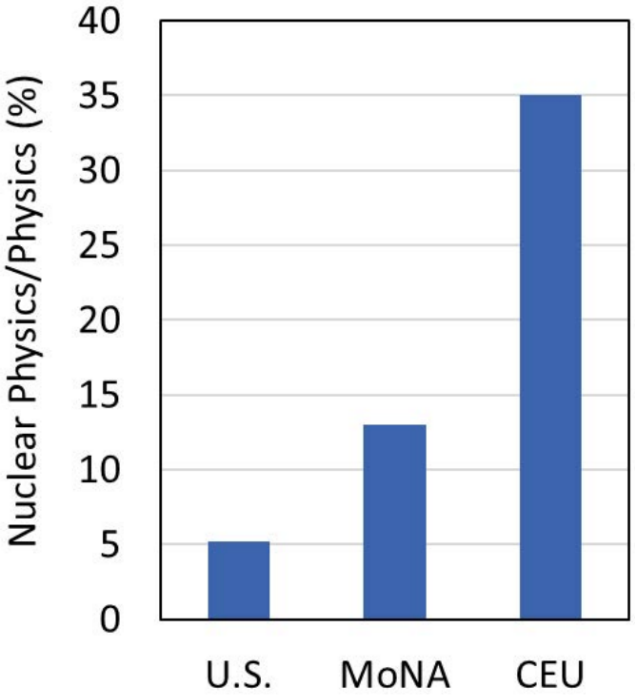


Figure 22: Fraction of graduate students in Nuclear Physics. The U.S. fraction corresponds to the average number of PhDs from 2000–2012 [30].

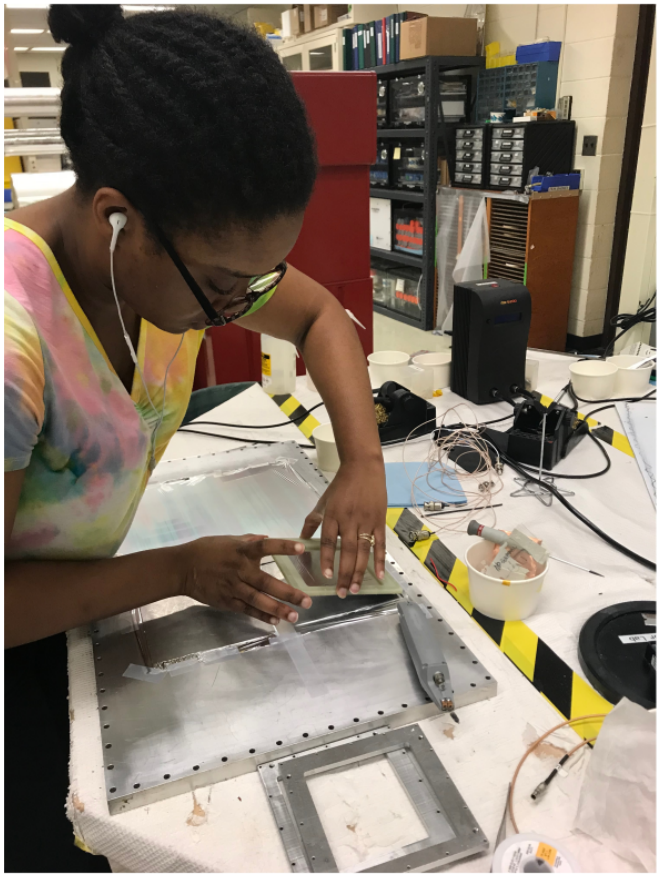
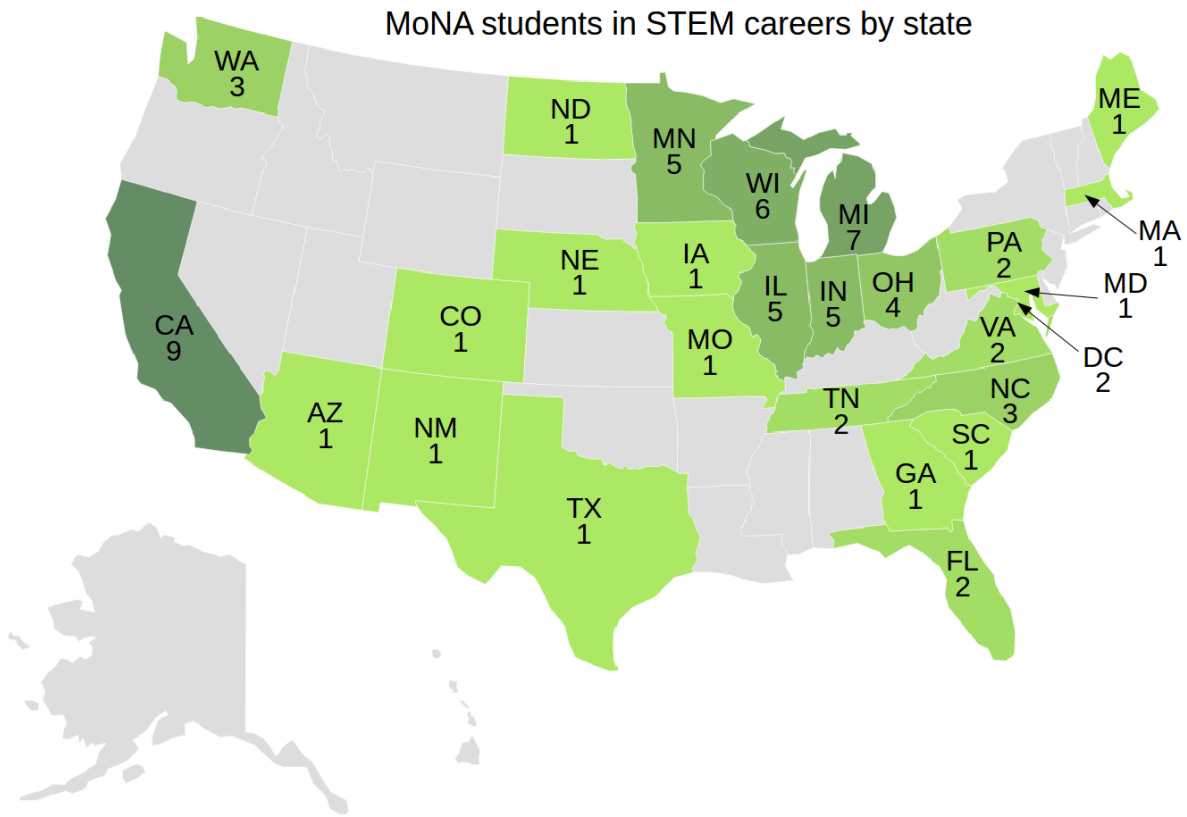


Figure 20: Undergraduate April Christopher working on a prototype GEM detector for next generation MoNA detectors.

To Date ...

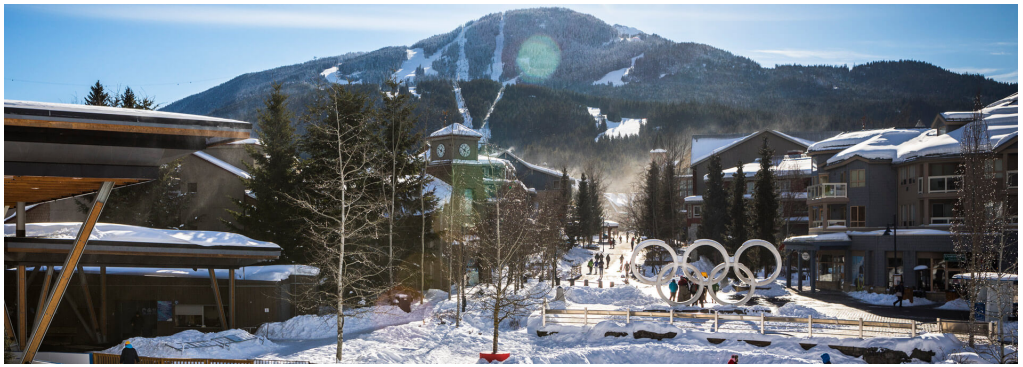
- The MoNA collaboration has published over 50 peer-review journal articles, over half of which have undergraduate co-authors
- 190+ undergraduate and 20 graduate students have participated in MoNA research
- They have presented their work over 80 times at national conferences



Undergraduate Research Experience

- Important for workforce development, recruitment and retention
- Experience of joining the larger professional community
- Emerging of vision for career

Conception of the CEU: Whistler, BC, 1997



- APS DNP97 meeting in Whistler, BC
- Conversation with Steve Padalino, SUNY Geneseo
- Lunch with Brad Keister, NSF nuclear physics program
- Encouragment and support from Stuart Freedman
- Birth of a proposal, awarded \$25k from NSF and DOE

Organizing the first CEU 1998

Estimates and preparation

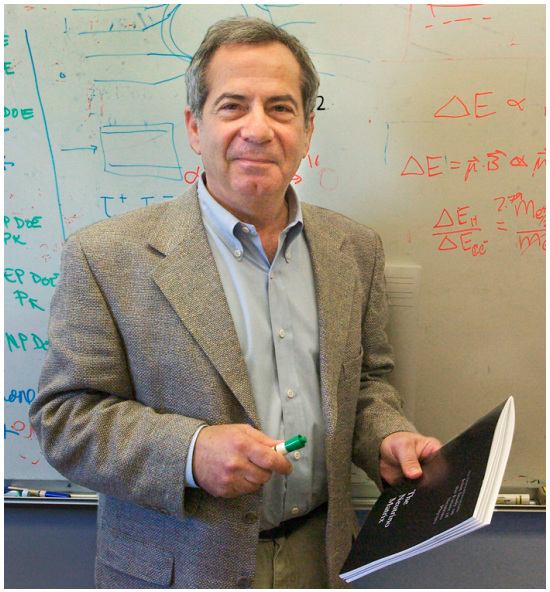
- Proactive approach - contact research advisors, encourage their students to apply
- Assembled a quick webpage for applications, review group for abstracts
- Expected perhaps 25 participants, received 65 applications
- Assembled review committee to rank applications
- Travel awards dispersed, lodging for all
- Thanks to many early supporters and encouragers:
  - Stuart Freedman, Bunny Clark, Michael Thoennessen, Jolie Cizewski, Andy Bacher, Sherry Yennello, Brad Keister, Susan Seestrom, Ani Aprahamian, Peggy McMahan, Tim Hallman, Steve Padalino

First CEU, 1998

Santa Fe, NM

- Susan Seestrom, chair of the local organizing committee

- Placed students in hotel about 1/2 mile from conference center
- Poster session mid-conference, posters stayed up for remainder of conference
- Harry Lipkin gave spontaneous seminar for students
- Students toured Los Alamos grounds and Bradbury Science Museum
- Spontaneous dinner with about half students left



Financial Support and Assistance

The Conference Experience for Undergraduates is supported by

- National Science Foundation
- Department of Energy (through the national laboratories)
  - Jefferson Lab
  - Brookhaven Lab
  - Oak Ridge Lab
  - Lawrence Berkeley Lab
  - Los Alamos Lab
  - Argonne Lab
- Division of Nuclear Physics, American Physical Society

CEU 13 – Newport News, VA

165 Participants

The goal of Conference Experience for Undergraduates (CEU) is to provide a capstone conference experience for undergraduate students who have conducted research in nuclear science by providing them the opportunity to present their research to the larger professional community and to one another. Additionally, it enables the students to converse with faculty and senior scientists from graduate institutions about graduate school opportunities.

CEU13 Schedule

Wednesday 10/23

3:00 pm	DNP Plenary Session – *Grand Ballrooms I & II*
6:00 - 7:30 pm	**DNP Welcome Reception** – *Grand Ballroom, Rotunda Areas*

Thursday 10/24

9:30 - 10:15 am	**CEU group meeting** – *Grand Ballroom II*
10:30 - 11:15 am	**CEU Nuclear Physics Seminar** – *Bright future for Nuclear Physics: FRIB* – **Dr. Michael Thoennessen**, Michigan State University, *Grand Ballroom II*
2:00 - 4:00 pm	**CEU Research Poster Session** – *Grand Ballroom II*
4:05 - 4:15 pm	**CEU Group Picture** – *Location TBA*
5:45 - 7:45 pm	**Thomas Jefferson National Accelerator Laboratory Tour**
8:00 - 9:30 pm	**CEU Ice Cream Social** – *Grand Ballroom II*

Friday 10/25

9:00 - 10:00 am	**Applying to Graduate School**, **Dr. Jolie Cizewski**, Rutgers University – *Grand Ballroom II*
10:30-11:15 am	**CEU Nuclear Physics Seminar** – *A Touch of Magic – Nuclear Structure Around* ^{132}*Sn Investigated with Transfer Reactions* – **Dr. Kate Jones**, University of Tennessee, Knoxville, *Grand Ballroom II*
12:00 - 1:30 pm	**Graduate School Fair** – *Grand Ballroom II*
7:00 pm	**DNP Banquet ($30 for CEU students)** – *Grand Ballroom I & II*

Some Statistics

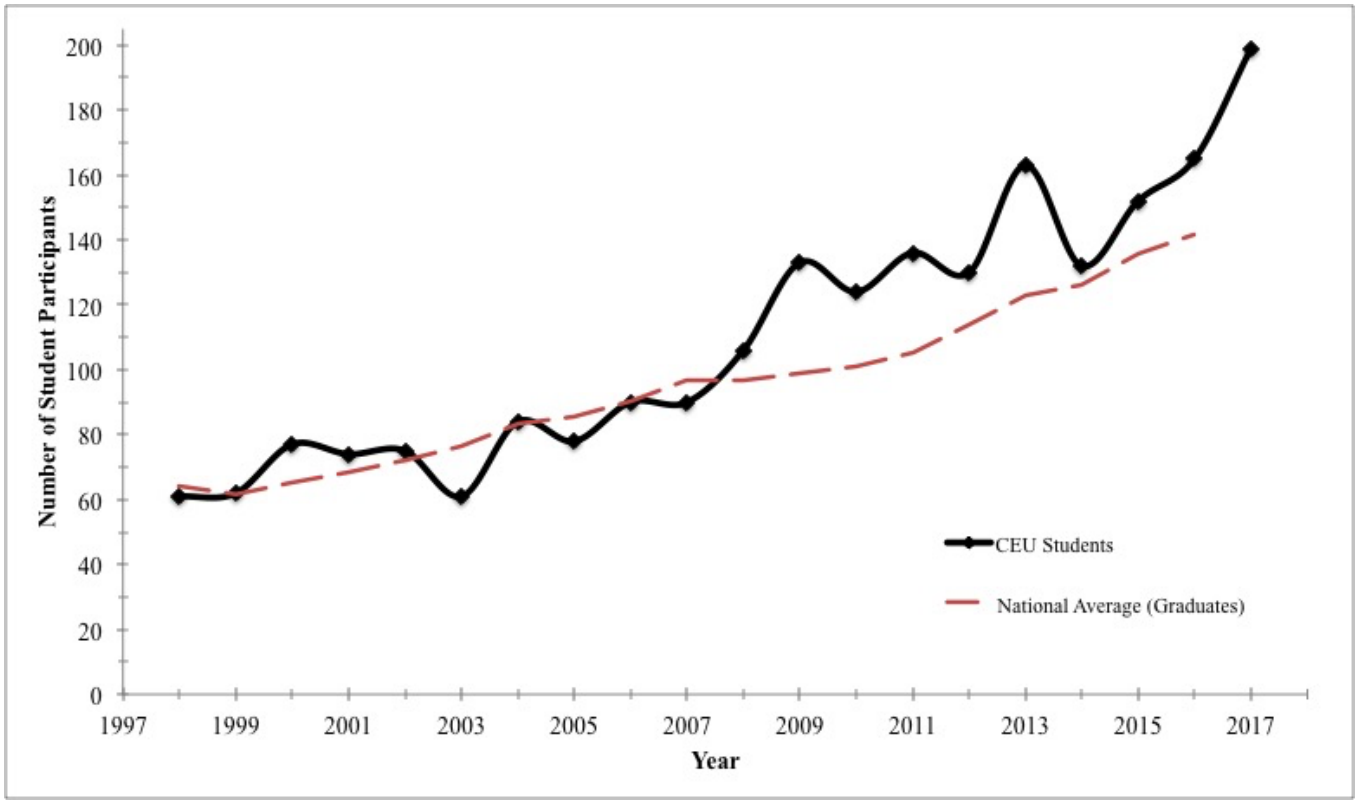
When tracking the participants from 1998 – 2002:

- 74% of CEU students pursued advanced degrees
- 49% of CEU students pursued PhD in physics
- 23% of CEU students pursued PhD in nuclear physics

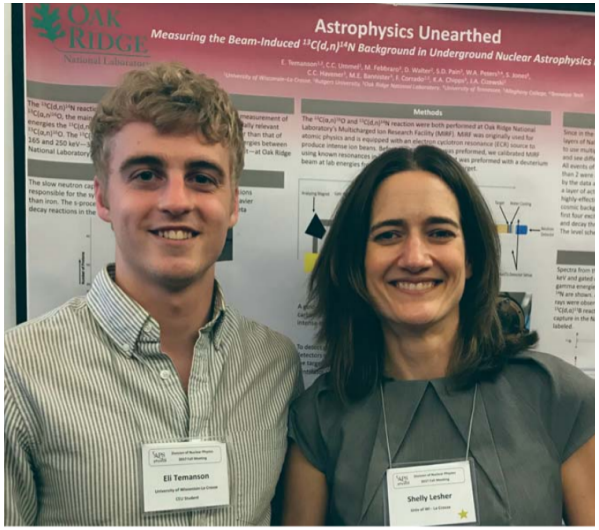
When compared to physics graduates during that same time period,

- 50% pursued advance degrees
- 29% enrolled in PhD programs in Physics

Participation Numbers Through the Years



Under new management



SHELLY LESHER (right), author of this commentary, with undergraduate research student Eli Temanson during the Conference Experience for Undergraduates poster session in Pittsburgh, Pennsylvania.

Dr. Shelly Lesher, University of Wisconsin La Crosse

- Member of the first CEU class
- Later served on review committee
- Shelly began organizing the CEU from 2016 to the present

Miscellaneous ...

- Model for other APS divisions?
- One crazy person is necessary and cost-effective
- 2017 was 20^{th} CEU anniversary
  - Plenary session, Nobel Laureate and 3 alums
  - David Gross, Michael Miller, Christine Aidala, Calem Hoffman
  - 20^{th} anniversary CEU mini-symposium
- Physics Today article
- 2005: Rising Above the Gathering Storm – Norman Augustine commission
  - Gems: US universities and national labs
  - Importance of research and innovation for US future

Thanks to my current MoNA research colleagues

Current collaborators...

Michael Thoennessen[1], Thomas Baumann, Paul Gueye (Michigan State University)
Jim Brown (Wabash College)
Paul DeYoung (Hope College)
Nathan Frank (Augustana College)
Jerry Hinnefeld (Indiana University, South Bend)
Anthony Kuchera (Davidson College)
Bryan Luther (St. John's College)
Shea Mosby (Los Alamos National Laboratory)

[1] Editor in Chief, APS

And thanks to my undergraduate students over the years

Andrea Munroe (current)
Jeremy Hallett (current)
James Boone
Andrew Wantz *
Aria Hamman *
Tim Seagren
Rachel Parkhurst
Nathaniel Taylor
Alyson Barker *
Sierra Garrett
Jackson Kwiatkowski
Mark Skovorodko
Bethany Sutherland
Alegra Aulie
Amanda Grovom

Lewis Eliot
Christopher Morse *
Christopher Sullivan *
Michael Bennett *
Michael Gardner *
Alexandra Reed
Malinda Reese
Jamie Gillette
Evan Mosby
Shea Mosby *
Michael Strongman *
Kyle Watters *
Lance Elliott
Sarah Clark
Chris Ritchey
Nathan Walker

Brett Isselhardt *
Joe Stevick *
Kevin Veenstra
Heather Severson
Kevin Boles
Andrew Johnson
Jonathan Mitchell *
Andrew Davies *
Gene Grimm *
Scott Riley *
Bill Klug *
Molly Uhl
Joslyn Misaki