Dr. Zach Ulibarri

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Education

University of Colorado
Ph.D. in Physics, 2022. Advisor: Tobin Munsat
Thesis Title: *On the Genesis and Measurement of Complex Organics and Isotopic Ratios in Hypervelocity Impact Ice Spectra*
Graduate Student Affiliate, Surface Dust Analyzer (SUDA) Flagship Instrument

Northern Arizona University
B.S. in Physics, *Summa Cum Laude*, 2013
B.S.E. in Electrical Engineering, *Summa Cum Laude*, 2013
GPA: 4.0

Research Experience

Cornell University: May 2024 - Present
51 Pegasi B Postdoctoral Fellow in Planetary Astronomy under Dr. Elaine Petro
and July 2022 – May 2024
Postdoctoral Associate under Dr. Elaine Petro

- Developed an electrospray ionization (ESI) source to gently ionize biomolecules for time-of-flight mass spectrometry
- Designed parts to integrate a goniometer for in-vacuo pitch and yaw control of the ESI ion source assembly in CAD, and machined, assembled, and tested resulting system
- Studied angular properties of ESI plumes for electric propulsion sources
- Designed and machined a precision alignment system for ESI beamline
- Designed and assembled a downstream current-measuring diagnostic device
- Designed a heated ESI source to enable launching of new types of ionic liquids in-vacuo
- Created a python GUI to rapidly and repeatably analyze TOF curves
- Managed graduate and undergraduate students by overseeing their projects, assigning tasks, and reviewing their progress
- Wrote funding proposals and presented scientific results at conferences

University of Colorado at Boulder: Fall 2015 – June 2022

Graduate Research Assistant under Dr. Tobin Munsat

- Performed impact ionization time-of-flight mass spectroscopy experiments of hypervelocity plasma plumes from dust impacts into ice (including projects in support of the NASA Europa Clipper flagship mission)
- Designed and carried out experiment to determine the "speed limit" of spacecraft for hypervelocity ionization studies of organic molecules (6-8 km/s)
- Managed all aspects of day-to-day operation of the IMPACT ultra-high vacuum cryogenic target and designed, developed, and implemented multiple new iterations of it to improve efficiency, modularity, and data collection
- Ran IT for the lab, managed and upgraded laboratory servers, LabVIEW data acquisition pipeline, Windows and Linux computer networks, and software infrastructure (including a complete system rebuild)
- Used the Colorado Nanofabrication Lab to make Ti-Gold mirrors and etched thermistors on sapphire substrates
- Operated the Colorado Dust Accelerator for numerous projects, including the Europa Clipper's Surface Dust Analyzer (SUDA)
- Operated a 20-ton overhead crane for laboratory use (OSHA, ASME, and CMAA certified crane operator)
- Assigned tasks to undergrad students and summer interns and guided them in experimental and hardware design

University of Colorado at Boulder: Fall 2014 - Fall 2016

Graduate Research Assistant under Dr. Tobin Munsat and Dr. Xu Wang

- Set up and characterized the Colorado Solar Wind Experiment, a high current, large aperture ion source to simulate solar wind interaction
- Designed and ran diagnostic experiments with a self-made Langmuir probe and with energy analyzers to measure source performance and ambient plasma characteristics
- Assigned tasks to an undergrad student working to automate system measurements

University of Colorado at Boulder – Fall 2014 - Spring 2015

Graduate Research Assistant under Dr. Tobin Munsat

- Worked on software development of plasma turbulence diagnostic software

University of Colorado at Boulder - Summer 2013

REU student under Dr. Tobin Munsat

- Performed SolidWorks CAD and circuit layout, assembly, and testing for a dust coordinate sensor for the IMPACT dust accelerator

Northern Arizona University - Fall 2012 - Spring 2013

Capstone research project under Dr. Allison Kipple

- Led a team of two other engineers on a project to design a shunt active power filter to reduce harmonic distortion in off-grid power systems

Cornell University – Summer 2012
REU student under Dr. Zhi Zhao

- Constructed and characterized a fiber laser oscillator for the Energy Recovery Linac Project

Northern Arizona University – Spring 2012
Engineering design research project under Dr. Allison Kipple

- Led a team of five other undergrad engineers on a project to design a $30,000 renewable energy system for Moencopi Day School on the Navajo Nation
- Presented design options to both an engineering team and a non-technical audience of elementary school teachers

Invited Colloquia

- Southwest Research Institute (SwRI) Space Science Seminar Speaker Series – April 2025. Minimizing Organic Fragmentation: Impact Ionization Flyby Instruments and a Vacuum Electrospray Ionization Mass Spectrometer.
- Northern Arizona University Department of Astronomy and Planetary Science Colloquium – March 2025. On the Detection of Alien Biomolecules with Time-of-Flight Mass Spectrometry.
- NASA Jet Propulsion Laboratory, Planetary Science Seminar – March 2022 Measurement of the Amino Acid Histidine and its Breakup Products in Hypervelocity Dust-Ice Impact Mass Spectra.
- Cornell University, Mechanical and Aerospace Engineering and Dept. of Astronomy Colloquium – April 2022. Measurement of the Amino Acid Histidine and its Breakup Products in Dust-Ice Hypervelocity Impact Mass Spectra.

Awards and Honors

51 Pegasi B Postdoctoral Fellow (2024)

Cornell Postdoc Achievement Award for Excellence in Community Engagement (2023)

NASA Exploration Science Forum Poster Competition, Second Place (2018)

NASA Exploration Science Forum Poster Competition, Third Place (2017)

Lowell Prize – Given to a single outstanding student from the College of Forestry, Engineering, and Natural Sciences at NAU each year (2014)

Gold Axe – Highly prestigious award given to top seniors at NAU (2013)

Arthur and Catherine Adel Scholar – Given to a single NAU Physics student (2013)

Sigma Pi Sigma Physics Honor Society (2013)

Tau Beta Pi Engineering Honor Society (2013)

NAU Physics Chair's Award (2012)

Bull HN Multicultural Engineering Scholarship (2011)

National Science Foundation Scholarship (undergraduate) (2009)

Peer-Reviewed Publications

- Zach Ulibarri, Elaine Petro. "Direct Two-Dimensional Goniometric Steering of Vacuum Electrospray Ion Beams for Angular Time-of-Flight Studies." *Review of Scientific Instruments, 96*(4). (2025)
- Giuliana Hofheins, Zach Ulibarri, and Elaine Petro. "Electrospray Propulsion Time-of-Flight Secondary Ion Mass Spectrometry Diagnostic." *Review of Scientific Instruments. 96*(6). (2025)
- S. Kempf, S. Tucker, N. Altobelli, C. Briois, M. L. Cable, E. Grün, M. S. Gudipati, B. L. Henderson, H. W. Hsu, K. Hand, M. Horányi, F. Postberg, J. Schmidt, R. Srama, Z. Sternovsky, G. Tobie, M. Y. Zolotov, C. Belting, S. Bortfeldt, J. Bouwman, N. Brennan, K. Bryant, T. Cassidy, D. Crotser, A. Curtin, E. DeVito, D. Ebuen, N. Faber, M. Fisher, J. Fontanese, M. Fowle, W. Frank, S. Gurst, S. Haselschwardt, V. Hoxie, K. Hubbell, D. James, M. Kien, S. Knappmiller, R. Kohnert, A. Lampe, M. Lankton, S. Lev-Tov, C. McGinn, M. Miller, G. Newcomb, S. Oberg, L. O'Brien, K. Pilewskie, S. Polson, V. Scarffe-Barrett, D. Summers, S. Wade, A. Ware, A. Yehle, C. Wuerthner, A. Garcia-Arteaga, B. Oaida, C. Eberl, P. Fitton, W. Goode, Z. Levin, G. Lowry, J. Stanley, A. Tracy, Z. Ulibarri, E. Williams, C. Yoke, B. Southworth, J. Hillier, N. Khawaja, F. Klenner, M. Napoleoni, J. Simolka, J. Sioeng. "SUDA: A SUrface Dust Analyser for Compositional Mapping of the Galilean Moon Europa." *Space Science Reviews* 221(1) (2025)
- T. Becker, M. Zolotov, M. Gudipati, J. Soderblom, M. McGrath, B. Henderson, M. Hedman, M. Choukroun, R. Clark, C. Chivers, N. Wolfenbarger, C. Glein, J. Castillo-Rogez, O. Mousis, K. Scanlan, S. Diniega, F. Seelos, W. Goode, F. Postberg, C. Grima, S. Hsu, L. Roth, S. Trumbo, K. Miller, K. Chan, C. Paranicas, S. Brooks, K. Soderlund, W. McKinnon, C. Hibbits, H. Smith, P. Molyneux, G. Gladstone, M. Cable, Z. Ulibarri, B. Teolis, M. Horanyi, X. Jia, E. Leonard, K. Hand, S. Vance, S. Howell, L. Quick, M. Ishan, A. Rymer, C. Briois, D. Blaney, U. Raut, H. Waite, K. Retherford, K, E. Shock, P. Withers, J. Westlake, and I. Jun. "Exploring the Composition of Europa with the upcoming Europa Clipper mission." *Space Science Reviews* 220(5) (2024)
- Zach Ulibarri, Tobin Munsat, Michael Voss, John Fontanese, Sascha Kempf, Mihály Horányi, and Zoltan Sternovsky. "Detection of the amino acid histidine and its breakup products in hypervelocity impact ice spectra." *Icarus* 391:115319. (2023)
- Zach Ulibarri, Oliver Jia-Richards, and Elaine Petro. "Ultra-Long Baseline Time-of-Flight Mass Spectrometry with the Advanced Mass Spectrometry in Gravity-Free Architectures (AMIGAS) Mission Concept." *2023 IEEE Aerospace Conference* (2023)
- Shawn Cogan, Zach Ulibarri, Elaine Petro, and Amy Hofmann. "Electrospray Mass Spectrometry for In-Orbit Biomolecule Analysis." *2023 IEEE Aerospace Conference* (2023)
- William Goode, Tobin Munsat, David James, and Zach Ulibarri. "Trajectory measurements for individual dust particles on the Colorado dust accelerator."

Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment 908: 269-276 (2018)

- Zach Ulibarri, Jia Han, Mihály Horányi, Tobin Munsat, Xu Wang, Guy Whittall-Scherfee, and Li Hsia Yeo. "A large ion beam device for laboratory solar wind studies." *Review of Scientific Instruments* 88(11): 115112 (2017)
- Andrew Oakleigh Nelson, Richard Dee, Murthy S. Gudipati, Mihály Horányi, David James, Sascha Kempf, Tobin Munsat, Zoltán Sternovsky, and Zach Ulibarri. "New experimental capability to investigate the hypervelocity micrometeoroid bombardment of cryogenic surfaces." *Review of Scientific Instruments* 87(2): 024502 (2016)

Non-Peer Reviewed Publications

- Zach Ulibarri, Giuliana Hofheins, Savera Sahai and Elaine Petro. "True Two-Dimensional Molecular Studies of Electrospray Plumes." *39th International Electric Propulsion Conference(423)*. (2025)
- Stefan Bell, Nikolaos Chalmpes, Zach Ulibarri, Giuliana Hofheins, Emmanuel Giannelis and Elaine Petro. "Nanoparticle Ion Beam Interactions from a Liquid Nanoparticle Ion Source (LNIS)." *39th International Electric Propulsion Conference(46)*. (2025)
- Bryce Kingsley, Nikos Chalmpes, Stefan Bell, Zach Ulibarri, Sadaf Sobhani and Elaine Petro. "Fabrication and Characterization of Two-Photon Printed Glass Electrospray Emitters with Architected Microporous Structure." *39th International Electric Propulsion Conference*. (2025)
- Giuliana Hofheins, Zach Ulibarri, and Elaine Petro. "Electrospray Secondary Ion Mass Spectrometry Diagnostic–Design and Preliminary Results." *38th International Electric Propulsion Conference* (2024)
- Morgan Cable, Sarah E Waller, Rob Hodyss, Amy E Hofmann, Michael J Malaska, Robert E Continetti, Andres Jaramillo-Botero, Bernd Abel, Frank Postberg, Morgan EC Miller, Sally Burke, Anton Belousov, Fabian Klenner, Nick Tallarida, James Lambert, Steve Fuerstenau, Zach Ulibarri. "Plume grain sampling at hypervelocity: Implications for astrobiology investigations." *Bulletin of the AAS* (2021)

In-Prep Publications

- Zach Ulibarri, Giuliana Hofheins, Elaine Petro. "Direct Measurement of High Mass Droplet Mechanics in Two-Dimensional Time-of-Flight Mass Spectral Studies of Vacuum Electrospray Plumes" In preparation for *Physics of Fluids*.
- Zach Ulibarri, Lihsia Yeo, Hannah McLain, Alex Doner, John Fontanese, Sascha Kempf, Mihály Horányi, Tobin Munsat, Elaine Petro, and Zoltan Sternovsky. "Hypervelocity Impact Ionization of Amino-Acid-Laden Dust: First Measurements and Implications for Instrument Capabilities and Prebiotic

Chemistry." In preparation for *Proceedings of the National Academies of Sciences*.

- Zach Ulibarri, Saima Jamal, Lucien Volk, Ashin Alex, Lucas Arzoumanian, Ramchander Rao Bhaskara, Arthur Chadwick, Sneha Gayen, Kyungmin Kim, Mark Lohatepanont, Preeti Nair, Kenia Nova, Carlos Oliveira, Adam Parks, Rachel Pride, Suraj Singh, Abdul Sessay, Joshua Umansky-Castro, Eric Yablonski, Martin Zhou, Elaine Petro, Mason Peck, Dmitry Savransky, Fabien Royer, and Andrew van Paridon. "The CRISPI (Compositional Regolith and Icy Surface analysis via Particle Impact) Mass Spectrometer Mission Concept for an Astrobiological Flyby of Ariel" In preparation for *Acta Astronautica*.
- Zach Ulibarri, Samantha Adamski, Amy Hofmann, Elaine Petro. "Direct Analysis in Real Time Mass Spectrometry (DART-MS) study of amino acids in the vacuum stable solvents glycerol, EMI-BF4, EMI-Im, DEMA-TfO, and DEMA-MsO." In preparation for *Journal of the American Society for Mass Spectrometry*.
- Zach Ulibarri, Elaine Petro. "A Brief History of Electrospray Propulsion." In preparation for *Journal of Propulsion and Power*.
- Ethan Ayari, M. Horányi, N. Turner, T. Corbett, J. Fontanese, J. Hillier, R. Mikula, T. Munsat, J. Schmitt, Z. Sternovsky, M. Trieloff, Z. Ulibarri, and A. Westphal. "Elemental and Isotopic Analysis of Olivine with Impact Ionization Dust Instruments." Submitted to *Planetary and Space Science*.

Scientific Presentations

- International Electric Propulsion Conference, London, UK – September 2025.
  "True Two-Dimensional Molecular Studies of Electrospray Plumes."
- COSPAR Scientific Assembly, Busan, South Korea – July 2024.
  "Vacuum concentration of organic biomolecules with ionic liquids for in-situ astrobiology instruments."
- Astrobiology Science Conference, Providence, RI – May 2024.
  "Initial Studies with a Vacuum Electrospray Ionization Mass Spectrometer."
- IEEE Aerospace Conference, Big Sky, MT – March 2023.
  "Ultra-Long Baseline Time-of-Flight Mass Spectrometry with the Advanced Mass Spectrometry in Gravity-Free Architectures (AMIGAS) Mission Concept."
  and
  "Electrospray Mass Spectrometry for In-Orbit Biomolecule Analysis"
- American Geophysical Union Fall Meeting, New Orleans, LA – December 2021.
  "Detection of complex organic molecules and D-H ratios in laboratory mass-spectra of hypervelocity dust impacts into ice" (*E-Lightning* Presentation).
- Asia and Oceania Geosciences Society Annual Meeting, Singapore – July 2019.
  "On the genesis and detectability of organic chemistry in hypervelocity impact ice spectra."

- American Geophysical Union Fall Meeting, Washington DC – December 2018.
  "On the genesis and detectability of organic chemistry in hypervelocity impact ice spectra."
- Europa Deep Dive 2: Composition, Houston, TX – October 2018.
  "On the genesis and detectability of organic chemistry in hypervelocity impact ice spectra."
- COSPAR Scientific Assembly, Pasadena, CA – July 2018.
  "On the detectability of organics in hypervelocity impact ice spectra."
- LunGradCon, Ames Research Center, Mountain View, CA – June 2018.
  "On the generation and detectability of organic chemistry in hypervelocity impact ice spectra."
- Carbon in the Solar System SSERVI Workshop, Boulder, CO – April 2018.
  "On the generation and detectability of organic chemistry in hypervelocity impact ice spectra."
- LunGradCon, Ames Research Center, Mountain View, CA - July 2017.
  "Laboratory study of hypervelocity impact-driven chemical reactions and surface evolution of icy targets."
- LunGradCon, Ames Research Center, Mountain View, CA - July 2016.
  "The Colorado Solar Wind Experiment."
- Northern Arizona University UGRADS, Flagstaff, AZ - April 2013.
  "Reduction of harmonic distortion in off-grid power systems."

Conference Poster Presentations

- 6x American Geophysical Union Fall Meeting, New Orleans, LA 2025, 2017, Washington DC 2024, Chicago 2022, Digital 2020, San Francisco, CA 2019.
- Lunar and Planetary Science Conference, Digital 2021.
- 5x NASA Exploration Science Forum, Digital 2020, Ames Research Center, Mountain View, CA 2016-2019.
- European Geophysical Union General Assembly, Vienna, Austria 2018.
- Dust, Atmospheres, and Plasma (DAP), Boulder, CO 2017.
- IEEE PES General Meeting, Vancouver, BC 2013.
- Northern Arizona UGRADS, Flagstaff, AZ 2012.

Conference Organizing

LunGradCon
Head organizer, 2017-2021

A NASA-SSERVI funded graduate student conference covering lunar and small body science held annually as a precursor to the Exploration Science Forum.

http://impact.colorado.edu/lungradcon/

Mentoring Experience

- Managed and mentored MEng student Savera Sahai on mass production of a new model of ESI source for two-dimensional statistical studies of ESI plume angular current characteristics (2024-2025)
- Managed and mentored undergrad Engineering Learning Initiative (ELI) student Dean Reiter on a motorized control setup for two-dimensional time-of-flight studies of ESI plumes (2024)
- Managed and mentored undergrad REU student Samantha Adamski in Direct Analysis in Real Time (DART) mass spectrometer studies of amino acids in vacuum stable solvents (2024)
- Managed undergrad student (ELI) Tadg Manna in design and construction of chassis-mounted Arduino motorized stepper motor control system (2024)
- Managed undergrad ELI student Audrey Sackey in creation of Arduino and Raspberry Pi wireless high voltage DAQs (2024)
- Managed undergrad Justice Starks's SOLIDWORKS design of a portable ESI stand for ultra-high mass resolution experiments (2024)
- Partially managed undergrad Ari Rabinovitz in PCB fabrication and population (2024)
- Managed and mentored REU Student Michael Chavez in vacuum high-voltage current sweep studies of ionic liquid ESI sources (2023)
- Managed undergrad ELI student Jack Meyer in programming of stepper motor GUI control system (2023)
- Managed undergrad Dean Reiter in designing a controlled vacuum pump-down system for the group's main vacuum chamber (2023)
- Managed high-level ESI ion source redesign by undergrad Claudia Pietrus (2022)
- Managed undergrad ELI student Justice Starks in the fabrication and testing of a heated ESI source (2022)
- Partially managed undergrad Diya Mehta working on a porous needle ESI system (2022)
- Managed undergrad Aastha Bagree in ESI source software studies (2022)

Outreach

Public Works Founder and Lead Organizer (Oct 2022 – July 2023)
A public colloquium series held at a local bar to allow academics and other experts to communicate their work to the public. I have also given three talks

https://publicworks.info

Specialized Skills

- *Technical:* Design of Experiments, Ultra-High Vacuums, Mass Spectrometry, Hypervelocity Plasma Plumes, Vacuum Cryogenic Hardware Design, CAD, Machining, High-Pressure Gases
- *Software:* SolidWorks, OnShape, LabVIEW, Eagle PCB Design, PCB Artist, GIT, Adobe Illustrator/Photoshop/Premiere/Lightroom.
- *Networking and IT:* Ran networking and IT for the Colorado Dust Accelerator. Reconfigured LabVIEW data acquisition pipeline consisting of NI-PXI DAQs, Windows control machines, and Linux servers. Managed laboratory-wide network attached storage (NAS) Samba shares.
- *Programming:* Python, LabVIEW, HTML, VHDL
- *Project Management:* Lead organizer of LunGradCon 2017-2021 (team of 5), Founder/lead organizer of Public Works 2022-2023 (team of 4), Managed undergrad and grad student projects at both Cornell and Boulder
- *Science Communication:* 31 conference presentations (15 oral, 16 posters) across USA, Europe, and Asia. *2x NASA Exploration Science Forum poster awards*.
- *Other:* Rode a bicycle solo across North America. Solo travelled to India's border with Tibet and to Cambodia's Angkor Wat. Hobbyist woodworker. Semi-professional photographer.

In the Media

- Popular Science
  Interviewed as a relevant expert on mass spectrometers for astrobiology searches in the article "Astronomers want to wield a tiny laser to look for life on neighboring worlds."
  https://www.popsci.com/science/orbitrap-laser-alien-life/?amp

- Xploration Outer Space
  Interviewed and gave a lab tour for Xploration Outer Space episode 707: "The Search for Life." Appeared on Fox syndicates on Oct. 29th, 2022.
  https://rotfeldproductions.wistia.com/medias/3fegt0vzd9

- How on Earth KGNU Guest Speaker
  May 2021

  Gave an interview to the KGNU radio science show about my research and the grad school experience.

  https://howonearthradio.org/archives/tag/zach-ulibarri