Jeff Schueler Ph.D. (He/Him)

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Positions Held

Postdoctoral fellow   **April 2023 – Present**
Department of Physics & Astronomy, University of New Mexico, Albuquerque, NM

Physics fellow (high school teaching fellowship)   **June 2013 – Aug. 2015**
New York City Teaching Fellows, New York, NY

Education

University of Hawai'i, Honolulu, HI   **2015 – 2022**
Ph.D in Physics (2022)
- Dissertation Title: *From neutrons to dark matter: Directional recoil detection and utilization of deep learning for gaseous time projection chambers*
- Thesis Advisor: Sven Vahsen

Pace University, New York, NY   **2013 – 2015**
M.S.in Adolescent Education: Physics (2015)

University of Washington, Seattle, WA   **2009 – 2013**
- B.S. with Honors in Physics
- B.S. in Mathematics
- Minors in Chemistry and Applied Mathematics
- Research Advisors: Dr. Thomson (Toby) Burnett, Dr. David Masiello

Research Experience

University of New Mexico, Albuquerque, NM   **April 2023 – Present**
Postdoctoral Research Fellow (PI: Dinesh Loomba): Principal analyst for the MIGDAL experiment – a dark matter adjacent nuclear scattering rare event search experiment utilizing an optical gas time projection chamber (TPC)
- Conceived of, developed, and maintain [migYOLO](#), the core image analysis pipeline for the experiment's search for the Migdal effect.
  - Automated end-to-end deep learning-based object detection pipeline capable of performing our entire Migdal effect search (~2 TB of raw image data per hour) at real-time speeds on a consumer desktop PC
  - First ever application of real-data training for a rare event search experiment
  - Led and published a collaboration-wide paper and gave six invited seminars on this topic
- Developed and maintain a full MIGDAL detector simulation that includes a python-based front-end for configuring and running the DEGRAD Fortran program
- Co-advising two students

University of Hawaiʻi at Mānoa, Honolulu, HI   **Aug. 2022 – Dec. 2022**
Interim Postdoctoral Fellow (PI: Sven Vahsen): Continued PhD work of applying deep learning-based computer vision techniques to improve neutral particle identification and directional sensitivity in gas TPCs:

- Developed custom simulations for our group's TPCs that led to a 10-fold reduction in both memory consumption and computation time compared to previous implementations
- Implemented a data-driven tuning of simulation parameters, leading to topological agreement between the 4D spatial-charge distributions of observed and simulated events
- Wrote and trained custom ResNets on these simulated 4D event images, evaluated them on lab measurements, and ultimately demonstrated, for the first time, statistically significant vector head/tail recognition in sub-20 keV_{ee} nuclear recoil tracks.
- Invited to present this work as an Early Career plenary speaker in the Coordinating Panel for Advanced Detectors (CPAD) 2022 workshop.

University of Hawaiʻi at Mānoa, Honolulu, HI   **Jan. 2017 – Aug. 2022**
Research Assistant (PI: Sven Vahsen): Specialized in directional recoil detection with gas TPCs, which is relevant for directional dark matter and neutrino scattering applications, as well as neutron background characterization at particle accelerators.

- Commissioned two generations of systems of TPCs at the SuperKEKB e^+e^- collider experiment in Tsukuba, Japan. These detectors measure beam-induced neutron backgrounds for the Belle II experiment and are still in use as of 2025.
- Led the design, development, construction, documentation, and implementation of these systems, including remote operation, data collection, data processing, and analyses that are featured in more than five journal publications.
- Utilized machine learning and deep learning to improve background rejection in these TPCs by more than an order of magnitude compared to cuts-based approaches.
- Pinpointed previously unknown neutron production hotspots, leading to a 40% reduction of neutron backgrounds for Belle II.
- Created and maintained GUI displays that provided real-time updates of over 50 quantities of interest from more than a dozen subsystems of the SuperKEKB accelerator and Belle II detector. These displays are still in use as of 2025 and facilitate communication between Belle II detector shifters and SuperKEKB accelerator operators.
- Invited to give beam background seminars at two Belle II Summer School workshops.

University of Washington – Seattle, WA   **June 2012 – June 2013**
Undergraduate Research Assistant (PI: Thompson (Toby) Burnett): Performed statistical analyses supporting research efforts for the Fermi Gamma-ray Space Telescope.

Advising and Mentoring Experience

Wesley Thompson (University of New Mexico; Graduate Student)   **2024 – Present**
    Project title: *Directional reconstruction and characterization of diffusion of protons and alphas in the MIGDAL detector*

Stephanie Paiva-Flynn (University of New Mexico; Undergraduate)   **2024 – Present**
    Honors Thesis: *Deep learning-based keypoint detection for electron recoil vertex identification and trajectory reconstruction*

Hima Bindhu Korandla (University of Hawaii; Graduate Student)   **2021 – 2022**
- Mentored Hima in her first year as a graduate student at the University of Hawaii
- Onboarded Hima in (1) operation of our Hawaii Group's TPCs, and (2) developing and maintaining the SuperKEKB/Belle II live detector monitoring GUI displays

Teaching Experience

University of Hawai'i at Mānoa – Honolulu, HI   **Aug. 2015 – May 2017 and Fall 2019**
Graduate Teaching Assistant: Taught a total of nine introductory physics lab sessions, three introductory physics recitation sessions, and four senior-level quantum mechanics recitation sessions.
- Elected as Head TA responsible for mentoring all physics TAs teaching introductory courses.
- Piloted optional recitation sessions in the upper division quantum mechanics courses
  - Developed all teaching materials many of which were still used as of 2022
  - Recitation sessions were made mandatory after my first semester piloting this course
- Petitioned and piloted recitation sessions that are now core components of the introductory mechanics courses
- Awarded an Outstanding Physics TA prize.
- Twice nominated for the university-wide TA award.

Maspeth High School – New York, NY   **Sept. 2013 – June 2015**
Founding Physics Teacher: Worked to deliver the principles of inquiry, equity, inclusion, and effective assessment through interactive and engaging lessons with data-driven assessment.
- Developed physics curriculum adhering to New York State Physics Core curriculum guidelines.
- Established both the school's AP Physics program and the school's physics lab.
- Wrote over 30 letters of recommendation, many for first generation college applicants.
- Mentored several groups of students who participated in the New York City Science Fair.

Awards

H. Keith and Sue Ernst ARCS Award and Scholarship (2021)
University of Hawaii Department of Physics Outstanding TA prize (2016)
Head Physics TA (2016)

Selected Publications

A complete list of my publications and contributions can be found at my INSPIRE HEP page, which includes over 100 works affiliated with the Belle/Belle II collaborations. Below are publications I substantially contributed to:

1. **J. Schueler**, et. al. (MIGDAL Collaboration), *Transforming a rare event search into a not-so-rare event search in real-time with deep learning-based object detection* Phys. Rev. D 111, 072004 (2025) DOI: 10.1103/PhysRevD.111.072004

2. **J. Schueler**, S.E Vahsen, P.M Lewis, M. Hedges, D. Liventsev, F. Meier, H. Nakayama, A. Natochii, T.N Thorpe, *Application of recoil-imaging time projection chambers to directional neutron background measurements in the SuperKEKB accelerator tunnel*, Nucl. Instrum. Methods Phys. Res., Sect. A 1040 (2022) 167291. DOI:10.1016/j.nima.2022.167291

3. Z. J. Liptak A. Paladino, L. Santelj, **J. Schueler**, S. Stefkova, H. Tanigawa, N. Tsuzuki, et al., *Measurements of beam backgrounds in SuperKEKB Phase 2*, Nucl. Instrum. Methods Phys. Res., Sect. A 1040 (2022) 167168. DOI: 10.1016/j.nima.2022.167168

4. P. M. Lewis, M. T. Hedges, I. Jaegle, **J. Schueler**, T. N. Thorpe, S. E. Vahsen, *Primary track recovery in high-definition gas ti*me projection chambers, Eur.Phys.J.C 82 (2022) 4, 324 DOI: 10.1140/epjc/s10052-022-10283-3

5. M.T. Hedges, S.E. Vahsen, I. Jaegle, P.M. Lewis, H. Nakayama, **J. Schueler,** T.N. Thorpe *First 3D vector tracking of helium recoils for fast neutron measurements at SuperKEKB,* Nucl.Instrum.Meth.A 1026 (2022) 166066 DOI: 10.1016/j.nima.2021.166066

6. A. Natochii et. al. (including **J. Schueler**) *Measured and projected beam backgrounds in the Belle II experiment at the SuperKEKB collider,* Nucl.Instrum.Meth.A 1055 (2023) 168550, DOI: 10.1016/j.nima.2023.168550

7. I. Jaegle, P. M. Lewis, M. Garcia-Sciveres, M. T. Hedges, T. Hemperek, J. Janssen, Q. Ji, D.-L. Pohl, S. Ross, **J. Schueler**, I. Seong, T. N. Thorpe, S. E. Vahsen, *Compact, directional neutron detectors capable of high-resolution nuclear recoil imaging,* Nucl.Instrum.Meth.A 945 (2019) 162296, DOI: 10.1016/j.nima.2019.06.037

Publications in preparation

8. **J. Schueler**, S.E. Vahsen, *First observation of the head/tail effect in sub-10 keV nuclear recoils* [In preparation; 2025]

9. MIGDAL Collaboration et. al. (including **J. Schueler**), *Performance of the Optical Time Projection Chamber of the MIGDAL Experiment* [In preparation; 2025]

10. D. Edgeman et. al. (including **J. Schueler**) *Optical effects in Gas Electron Multipliers* [In preparation; 2025]

11. **J. Schueler**, M. Ghrear, S.E. Vahsen, P. Sadowski, C. Deaconu, *Deep learning for improved keV-scale recoil identification in high resolution gas time projection chambers* [In preparation for journal submission] DOI: https://doi.org/10.48550/arXiv.2206.10822

Invited Talks

Talk titles and links to slides are included in cases where a link to the event is not provided.
- **University of Washington: CENPA Seminar**   March 20th, 2025
- **University of New Mexico: NUPAC Seminar**   Sept. 24th, 2024
- **Berkeley Institute for Data Science Seminar**   Sept. 17th, 2024
  Title: *Object detection enabling data-driven ML training for rare event searches*
- **Stanford/SLAC: FPD Seminar**   Sept. 12th, 2024
- **LUX-ZEPLIN UK/Europe/Australia meeting**   June 20th, 2024
  Title: *A deep learning-based object detection pipeline for real-time Migdal effect searches on CMOS camera data from the MIGDAL experiment*
- **Los Alamos National Lab: Particle Physics Seminar**   Nov. 15th, 2023
  Title: *Deep Learning for Improved Analyses of High Resolution Gaseous TPC Data*
- **CPAD Workshop 2022** (Early Career Plenary)   Nov. 30th, 2022
- **2020 Hawaii US Belle II Summer School**   July 7th, 2020
  Title: Measurement of Neutron Backgrounds with Time Projection Chambers
- **2019 BNL US Belle II Summer School**   July 31st, 2019
  Title: Beam Induced Backgrounds at SuperKEKB

Other Presentations

- **8th International Conference on Micro Pattern Gaseous Detectors**   Oct. 14th, 2024
  (Presented on behalf of the MIGDAL collaboration)
- **APS April Meeting 2024**   Apr. 4th, 2024
- **CPAD Workshop 2023**   Nov. 9th, 2023
- **APS April Meeting 2021**   Apr. 17th, 2021
- **APS April Meeting 2019**   Apr. 15th, 2019

Selected Maintained Software

migYOLO – Companion software for the MIGDAL collaboration's PRD paper *Transforming a rare event search into a not-so-rare event search in real-time with deep learning-based object detection.* The software is self-contained and includes all tools discussed in the paper.
GitHub | Documentation | doi.org/10.5281/zenodo.12628436

MIGDAL_simulator – Fast TPC detector simulation. Includes tools for simulating primary tracks, drifting and diffusing them in a gas mixture, amplification with any number of GEMs, and

digitization. Also includes rudimentary GPU support which I may improve upon with CUDA Python.

GitHub | **Documentation**

objectKeyPointLabelStudio - General framework (with a catchy name!) to automatically generate XML code that enables an object-keypoint detection data labeling interface in LabelStudio. This software includes a custom YOLOv8-pose model I pre-trained to demonstrate ML-assisted labeling with LabelStudio. This software is built to be flexible and can be adapted to object-keypoint detection workflows outside of physics.

GitHub

Outreach, professional development, and other service

- Physics Department Graduate Student Organization (GSO) Representative (2016-2017)
  - Regularly informed graduate students in the Physics department about funding opportunities through the GSO.
  - Coached graduate students on putting together funding applications and advocated for their applications at monthly university-wide GSO meetings .
- University of Hawaii Physics Day volunteer (2015-2016)
- ISEE Professional Development Program participant (2015)
  - Attended 10 days of education-focused professional development focused on inquiry, equity/inclusion, and assessment in university lab instruction.
  - Used backward design principles to develop and teach a 6 hour interactive inquiry lab to an introductory astronomy lab course at the University of Hawaii
- New York City Science Fair judge (2014)
- Taught Saturday Physics Prep courses as volunteer work to public high school students in New York City (2013-2014)