# Daniel J. Ruth

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## Education

**Princeton University**, Princeton, NJ — August 2017 – April 2022
School of Engineering and Applied Science
Ph.D., Mechanical and Aerospace Engineering

**The Pennsylvania State University**, University Park, PA — August 2012 – December 2016
**Schreyer Honors College**
The College of Engineering
B.S., Mechanical Engineering

## Positions

**ETH Zurich**, Zurich, Switzerland — July 2022 – *Present*
*Postdoctoral Researcher, with Dr. Filippo Coletti*

- Employed planar laser-induced fluorescence, particle image velocimetry, and background-oriented schlieren imaging to study the dynamics of turbulence near a free surface and the resulting surface deformations
- Developed experiments with a wind-wave flume to study the characteristics of turbulence beneath wind-driven waves
- Supervised projects of multiple high school, bachelor's, and master's students

**Princeton University**, Princeton, NJ — August 2017 – June 2022
*Ph.D. Candidate (August 2017 – April 2022) and Postdoctoral Researcher (May – June 2022), with Dr. Luc Deike*

- Developed an understanding of the fluid dynamics of air-sea gas exchange by exploring the behavior of bubbles in turbulence
- Performed stereoscopic high-speed imaging and particle image velocimetry to obtain three-dimensional reconstructions of (1) bubbles rising through turbulence and under laboratory breaking waves, (2) the pinch-off of bubbles deformed by turbulence from an underwater needle, and (3) the turbulent bubble break-up cascade
- Numerically simulated the motion of point-bubbles in turbulence and solved the population balance equations for bubbles being broken apart by turbulence

**National Renewable Energy Laboratory**, Golden, CO — January 2017 – June 2017
*Computational Sciences SULI Intern, with Dr. Matthew Muller*

- Employed statistical methods to analyze photovoltaic (PV) performance degradation due to dust and dirt soiling
- Developed and implemented an algorithm to infer the reliability of PV sun-tracking hardware with PV power production data, leading to one first-author journal publication
- Implemented a machine learning approach to impute air pollution data missing from publicly-available datasets

**Sandia National Laboratories**, Livermore, CA — May 2016 – August 2016
*Combustion Research Facility SULI Intern, with Dr. Charles Mueller*

- Carried out signal and image processing on experimental results on ducted fuel injection (DFI), a combustion technique designed to enhance mixing in multiphase fuel-air flows and mitigate soot formation in diesel engines
- Wrote code to facilitate the comparison of results of DFI experiments, producing figures for multiple journal papers

**Volvo Group Trucks Technology**, Hagerstown, MD — January 2015 – August 2015
*Advanced Technology and Research Co-op, with Mr. Samuel McLaughlin P.E., PMP*

- Supported experiments and simulations of advanced combustion strategies and waste heat recovery systems for diesel engines, interfacing with collaborating researchers at the Pennsylvania State University

**Reacting Flow Dynamics Laboratory**, University Park, PA — January 2014 – December 2016
*Undergraduate Research Assistant, with Dr. Jacqueline O'Connor*

- Designed, carried out, and analyzed laboratory experiments on impinging gas jets with high-speed schlieren imaging
- Developed a model to predict diesel spray impingement, leading to a journal paper and first-author conference paper

## Awards & Funding

- **2023 François Frenkiel Award for Fluid Mechanics**, awarded by the American Physical Society Division of Fluid Dynamics to coauthors and me for *Rivière, A., Ruth, D. J., Mostert, W., Deike, L., and Perrard, S. (2022). Capillary driven fragmentation of large gas bubbles in turbulence. Physical Review Fluids, 7(8), 083602.*
- **2020 School of Engineering and Applied Science Award for Excellence**, awarded to School of Engineering and Applied Science advanced graduate students who have "performed at the highest level as scholars and researchers"

- **2020 Princeton University Mechanical and Aerospace Engineering Research Day** First Prize, awarded by a panel of faculty and students to one MAE graduate student for a research presentation during the annual Research Day event
- **2020 Mary and Randall Hack '69 Graduate Award** funding to purchase laboratory equipment to measure dissolved oxygen concentrations in multiphase turbulent flows
- **2015 John P. Karidis Department Head's Award for Research**, awarded by the Department of Mechanical and Nuclear Engineering to the Mechanical Engineering student "who has made the most important contribution in forwarding the research in his or her selected area of study"

## Journal Articles

- **Ruth, D.**, and Coletti, F. (2024). **Structure and energy transfer in homogeneous turbulence below a free surface**. Accepted for publication in the *Journal of Fluid Mechanics*.
- **Ruth, D.**, Aiyer, A., Rivière, A., Perrard, S., and Deike, L. (2022). **Experimental observations and modeling of sub-Hinze bubble production by turbulent bubble break-up**. *Journal of Fluid Mechanics, 951*, A32.
- **Ruth, D. J.**, Néel, B., Erinin, M. A., Mazzatenta, M., Jaquette, R., Veron, F., and Deike, L. (2022). **Three-dimensional measurements of air entrainment and enhanced bubble transport during wave breaking**. *Geophysical Research Letters*, e2022GL099436.
- Rivière, A., **Ruth, D. J.**, Mostert, W., Deike, L., and Perrard, S. (2022). **Capillary driven fragmentation of large gas bubbles in turbulence**. *Physical Review Fluids*, 7(8), 083602.
- Erinin, M. A., Néel, B., **Ruth, D. J.**, Mazzatenta, M., Jaquette, R. D., Veron, F., and Deike, L. (2022). **Speed and Acceleration of Droplets Generated by Breaking Wind-Forced Waves**. *Geophysical Research Letters*, 49(13), e2022GL098426.
- **Ruth, D.**, Vernet, M., Perrard, S., and Deike, L. (2021). **The effect of nonlinear drag on the rise velocity of bubbles in turbulence**. *Journal of Fluid Mechanics, 924*, A2.
- **Ruth, D.**, Mostert, W., Perrard, S., and Deike, L. (2019). **Bubble pinch-off in turbulence**. *Proceedings of the National Academy of Sciences, 116*(51), 25412-25417.
- Gehmlich, R., Mueller, C., **Ruth, D.**, Nilsen, C., Skeen, S. and Manin, J. **Using Ducted Fuel Injection to Attenuate or Prevent Soot Formation in Mixing-Controlled Combustion**. *Applied Energy*, Volume 226, 15 September 2018.
- **Ruth, D.**, Muller, M. and Micheli, L. **A Methodology to Analyze Photovoltaic Tracker Uptime**. *Progress in Photovoltaics*, 1-11, 2018.
- O'Connor, J., Borz, M., **Ruth, D.**, Han, J., Paul, C., Imren, A., & Karlsson, A. (2017). **Optimization of an advanced combustion strategy towards 55% BTE for the Volvo SuperTruck Program**. SAE International Journal of Engines, 10(3), 1217-1227.
- Mueller, C., Nilsen, C., **Ruth, D.**, Gehmlich, K., Pickett, L. and Skeen, S. **Ducted fuel injection: A new approach for lowering soot emissions from direct-injection engines**. Applied Energy, Volume 204, 15 October 2017.

## Conference Papers

- **Ruth, D.**, and Coletti, F. **A free surface's deformations reveal the turbulence underneath**. *Paper presented at:* 26th International Conference of Theoretical and Applied Mechanics, Daegu, Korea. August 25 - 30, 2024.
- **Ruth, D.**, Néel, B., Erinin, M., Mazzatenta, M., Jacuette, R., Veron, F., and Deike, L. **Measurement of entrained air bubble dynamics in a laboratory wind-wave facility**. *Paper presented at:* Cross-linking lab and field measurements and numerical modeling to identify and quantify the mechanisms of air-sea gas transfer, Heidelberg, Germany. September 6, 2022.
- **Ruth, D.**, Mostert, W., Perrard, S. and Deike, L. **Asymmetric bubble pinch-off in turbulence**. *Paper presented at:* 25th International Conference of Theoretical and Applied Mechanics, online. August 24, 2021.
- **Ruth, D.** and O'Connor, J. **Development and Verification of Reduced-Order Model for Diesel Spray Penetration and Spreading during Wall Impingement**. SAE Technical Paper 2017-01-0814, 2017.

## Presentations (as first author)

- **Ruth, D.**, Bullee, P., and Coletti, F. **Measurements of turbulence under wind-driven waves**. *Presented at:* Wind Waves in the Earth System (WISE), Cargèse, France. June 22 - 26, 2024.
- **Ruth, D.**, and Coletti, F. **Deformations to a free surface by sub-surface zero-mean-flow turbulence**. *Presented at:* American Physical Society Division of Fluid Dynamics Annual Meeting, Washington, DC. November 21, 2023.
- **Ruth, D.**, and Coletti, F. **Turbulence under free surfaces at large** $\mathrm{Re}_\mathrm{T}$. *Presented at:* 18th European Turbulence Conference, Valencia, Spain. September 4, 2023.
- **Ruth, D.**, Néel, B., Erinin, M., Mazzatenta, M., Jacuette, R., Veron, F., and Deike, L. **Three-dimensional measurements of air entrainment and enhanced bubble transport during wave breaking**. *Presented at:* American Physical Society Division of Fluid Dynamics Annual Meeting, Indianapolis, Indiana. November 22, 2022.
- **Ruth, D.**, Néel, B., Erinin, M., Mazzatenta, M., Jacuette, R., Veron, F., and Deike, L. **Entrained bubble dynamics under breaking wind-waves**. *Presented at:* The 28th Wind Waves in the Earth System (WISE) Meeting, *online*. June 1, 2022.
- **Ruth, D.**, Néel, B., Erinin, M., Mazzatenta, M., Jacuette, R., Veron, F., and Deike, L. **Formation of sub-Hinze scale bubbles in turbulence and bubble dynamics under breaking waves**. *Presented at:* The 8th International Symposium on Gas Transfer at Water Surfaces, Plymouth, UK. May 18, 2022.
- **Ruth, D.**, and Deike, L. **Experimental observations of sub-Hinze bubble production in turbulence with surfactant**. *Presented at:* American Physical Society Division of Fluid Dynamics Annual Meeting, Phoenix, AZ. November 22, 2021.

- **Ruth, D.**, Mazzatenta, M., Erinin, M., Néel, B., Jacuette, R., Veron, F., and Deike, L. **Bubble dynamics in turbulence: describing the break-up and buoyant rise of air bubbles entrained by breaking waves**. *Presented at:* Environmental Geochemistry and Geosciences Seminar, Princeton University, Princeton, NJ. October 28, 2021.
- **Ruth, D.**,Vernet, M., and Deike, L. **Rise velocity of bubbles in turbulence**. *Presented at:* American Physical Society Division of Fluid Dynamics Annual Meeting, online. November 24, 2020.
- **Ruth, D.**,Vernet, M., and Deike, L. **Rise velocity of bubbles in turbulence**. *Presented at:* Princeton University Mechanical and Aerospace Engineering Research Day, online. September 11, 2020.
- **Ruth, D.**, Perrard, S. and Deike, L. **Bubble pinch-off in turbulence: shape oscillations and escaping self-similarity**. *Presented at:* American Physical Society Division of Fluid Dynamics Annual Meeting, Seattle, WA. November 24, 2019.
- **Ruth, D.**, Perrard, S. and Deike, L. **Bubble breakup in turbulence**. *Presented at:* American Physical Society Division of Fluid Dynamics Annual Meeting, Atlanta, GA. November 20, 2018.

## Service

- **Supervisor** for master's students' Semester Projects involving three-dimensional bubble imaging at ETH Zurich (Spring 2023, Fall 2023, Spring 2024) and a Bachelor's Thesis involving pitot tube measurements of the boundary layer above wind-driven waves (Spring 2024)
- **Mentor** for the three-year long research project of a high school student in the United States (2024 - *Present*)
- **Peer reviewer** for manuscripts submitted to *Microplastics and Nanoplastics* (2022, 2023) and *Fluids* (2022)
- **Ad-hoc reviewer** for an NSF Physical Oceanography grant (2024)

## Teaching

- Assistant in Instruction, ENV 200, **The Environmental Nexus**, Fall 2020. Led office hours and graded assignments for the course's Quantitative Reasoning section, which employed simple numerical models to teach about climate processes.
- Summer Preparatory Assistant in Instruction, ENV 367, **Modeling the Earth System: Assessing Strategies for Mitigating Climate Change**, Summer 2020. Prepared Python code and Jupyter notebooks using the OSCAR Python package for climate modeling.
- Assistant in Instruction, MAE 224, **Integrated Engineering Science Laboratory**, Spring 2020 and Spring 2021. Led sophomore-level laboratories exploring hydrostatics, pipe flow, boundary layers, and airfoils.

## Skills

- **expertise**: fluid dynamics, turbulence, multiphase flows, interfacial instabilities, particle dynamics in turbulence
- **research methods**: particle image velocimetry, laser-induced fluorescence, background-oriented schlieren (synthetic schlieren), stereoscopic triangulation, schlieren imaging, particle tracking, finite-difference numerical simulations
- **software**: Python, Matlab, LabView, SolidWorks

*References are available upon request.*