# JOSHUA ECKELS

PhD Student in Aerospace Engineering

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## EXPERIENCE

**Computational Autonomy Lab**, Ann Arbor, MI
PhD student, 2021-present

- Modeling and integration lead team in NASA's JANUS institute for high-power electric propulsion testing.
- Applied reduced-order modeling and uncertainty quantification with Bayesian/machine learning methods.
- Developed fluid/hybrid particle-in-cell modeling of electrospray ion thrusters and Hall thrusters.

**NASA Jet Propulsion Laboratory**, Pasadena, CA
Electric propulsion intern, 2025

- Developed Hall thruster fluid simulation tools.
- Developed and tested reduced-order modeling algorithms for transient detection and data-driven acceleration.

**NASA Glenn Research Center**, Cleveland, OH
Electric propulsion intern, 2024

- Development of hybrid particle-in-cell models of Hall thruster plume and spacecraft interactions.
- Analysis of transient start-up arcing during vacuum chamber electric propulsion testing.

**Tesla,** Palo Alto, CA
High-voltage firmware intern, 2021

- Developed Python regression test scripts to validate high-voltage battery firmware.
- Improved and upgraded battery pack testing infrastructure, hardware, software, and automation.

**Los Alamos National Laboratory,** Los Alamos, NM
R&D engineering intern, 2020

- Improved performance of ultrasonic wavefield imaging software for non-destructive evaluation.
- Developed and automated a new deep learning-based processing method for ultrasonic defect detection.

## EDUCATION

**University of Michigan,** Ann Arbor, MI
PhD in Aerospace Engineering, (expected) 2026

**Rose-Hulman Inst. of Technology,** Terre Haute, IN
BS in Mechanical Engineering, 2021

## SKILLS

| | (years) |
|---|---|
| **Python** | 5+ |
| numpy, scipy, pytorch, etc. | |
| **Open-source** | 5+ |
| linux, vcs, ci/cd, etc. | |
| **Scientific computing** | 3 |
| hpc, mpi, slurm, etc. | |
| **Other languages** | 1-2 |
| fortran, c, c++, js, java | |
| **Finite-element** | 1-2 |
| cfd, ansys, plasmas, etc. | |
| **Fabrication** | 1 |
| cnc, laser cutting, etc. | |

## AWARDS

**NSTGRO fellowship,** 2023
NASA space technology award

**R&D100 award,** 2022
Los Alamos patented technology

**Heminway prize,** 2019
Academic award for top of class

## RESEARCH

**Electric propulsion,** predictive models for design, test, and optimization of Hall thrusters

**Plasma physics,** accelerating kinetic particle-in-cell methods for low-temperature plasmas

**Reduced-order modeling,** data-driven methods for accelerating complex models

**Uncertainty quantification,** Bayesian methods for model validation, sensitivity analysis, and experimental design

## PEER-REVIEWED PUBLICATIONS

**J. Eckels**, T. Marks, M. Allen, B. Jorns, and A. Gorodetsky, "Hall thruster model improvement by multidisciplinary uncertainty quantification," *Journal of Electric Propulsion*, vol. 3, no. 19, 2024, doi: 10.1007/s44205-024-00079-w.

**J. Eckels** et al., "Predicting local material thickness from steady-state ultrasonic wavefield measurements using a convolutional neural network," *Ultrasonics*, vol. 123, 2022, doi: 10.1016/j.ultras.2021.106661.

## CONFERENCE PRESENTATIONS

**J. Eckels** et al, "Adaptive surrogate modeling of coupled Hall thruster plasma and plume simulations," presented at the SIAM conference on Computational Science and Engineering, Fort Worth, TX, 2025.

**J. Eckels** et al, "Dynamic mode decomposition for particle-in-cell simulations of a Hall thruster and plume," presented at the 38th International Electric Propulsion Conference, Toulouse, France, 2024.

D. Aksoy, S. Vutukury, T. Marks, **J. Eckels**, and A. Gorodetsky, "Compressed analysis of electric propulsion simulations using low rank tensor networks," presented at the 38th International Electric Propulsion Conference, Toulouse, France, 2024.

**J. Eckels** et al, "Surrogate-enabled inference of high-dimensional systems through dimension reduction: applications to fluid plasma simulations," presented at the SIAM conference on Uncertainty Quantification, Trieste, Italy, 2024.

M. Allen, T. Marks, **J. Eckels**, A. Gorodetsky, and B. Jorns, "Optimal experimental design for inferring anomalous electron transport in a Hall thruster," presented at the AIAA SciTech 2024 Forum, Orlando, FL, 2024, doi: 10.2514/6.2024-2164.

C. Lipscomb, I. Boyd, K. Hansson, **J. Eckels**, and A. Gorodetsky, "Simulation of vacuum chamber pressure distribution with surrogate modeling and uncertainty quantification," presented at the AIAA SciTech 2024 Forum, Orlando, FL, 2024, doi: 10.2514/6.2024-2369.

**J. Eckels**, C. Whittaker, B. Jorns, and A. Gorodetsky, "Optimal experimental design to learn reduced-fidelity models for porous electrosprays," presented at the AIAA SciTech 2023 Forum, National Harbor, MD, 2023, doi: 10.2514/6.2023-0066.

**J. Eckels** et al, "Simulation-based surrogate methodology of electric field for electrospray emitter geometry design and uncertainty quantification," presented at the 37th International Electric Propulsion Conference, Boston, MA, 2022.

C. Whittaker, **J. Eckels**, A. Gorodetsky, and B. Jorns, "A moment-based model of multi-site emission for porous electrosprays," presented at the 37th International Electric Propulsion Conference, Boston, MA, 2022.

M. Allen, **J. Eckels**, M. Byrne, A. Gorodetsky, and B. Jorns, "Application of optimal experimental design to characterize pressure related facility effects in a Hall thruster," presented at the 37th International Electric Propulsion Conference, Boston, MA, 2022.

**J. Eckels**, I. Fernandez, K. Ho, N. Dervilis, E. Jacobson, and A. Wachtor, "Application of a u-net convolutional neural network to ultrasonic wavefield measurements for defect characterization," presented at the Int. Modal Analysis Conference, 2021, doi: 10.1007/978-3-030-76335-0_18.

## OPEN-SOURCE CONTRIBUTIONS

eckelsjd/amisc – Adaptive Multi-Index Stochastic Collocation
Ground-up implementation of an efficient, multidisciplinary surrogate method using sparse grids.

eckelsjd/uqtils – Uncertainty quantification utilities
Ground-up implementation of useful tools for uncertainty quantification and Bayesian methods.

eckelsjd/copier-numpy – Template repository for Python scientific computing
Customizable template for Python scientific computing numpy-based projects.

JANUS-Institute/HallThrusterPEM – Hall thruster predictive modeling
Ground-up implementation of a predictive engineering model for a Hall thruster.

UM-PEPL/Hallthruster.jl – 1d fluid simulation of a Hall thruster
Small code contributions and extensive stress testing and automation of built-in modules.