

# Zack Gotobed

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## Education

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<b>Colorado State University</b> , Ph.D. Candidate in Physics	August 2025- Present
• <b>Research Interests:</b> Precision spectroscopy of $^{173}\text{Yb}^+$ as a method to search for violations of Lorentz Symmetry. Development of precision optical clocks. Numerical simulations of optical clocking schemes as a way to search for novel improvements over existing methods	
• <b>Relevant Coursework:</b> Introduction to Lasers, Quantum Electronics	
<b>University of Massachusetts, Amherst</b> , BS in Physics, BS in Applied Mathematics, GPA: 3.75	Sept. 2021-May 2025
• <b>Relevant Coursework:</b> Quantum Computing, Electronics for Scientists, Optics, Advanced Laboratory, Writing in Physics, Computational Physics, Data analysis for Particle Physics,	

## Awards and Grants

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<b>Edward S. Chang Summer Research Award</b>	May 2023- September 2023
• Awarded \$2,500 to perform research for one semester with Dr. Robert Niffenegger at the University of Massachusetts, Amherst.	

## Research Experience

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<b>Christian Sanner (Physics), Precision Measurement with trapped Ytterbium ions</b> , Fort Collins, CO	August 2025- Present
• Developed a robust simulation framework which performed searches for novel optical clocking methods, seeking improvements by several orders of magnitude. Tools and skills used: Python, Monte-Carlo simulation, C++, and GitHub.	
• Helped design and construct a cryogenic ion trap to improve error budget and increase fractional clock frequency stability by an order of magnitude. Tools and skills used: electrical engineering, optical engineering, and Ansys Zemax.	

<b>Robert Niffenegger (Electrical and Computer Engineering), Trapped Ion Quantum Computing with Strontium</b> , Amherst, MA	June. 2023 - May 2025
• Helped design and assemble a homemade Raman ECDL laser for use in high fidelity single and multi-qubit gates. Tools and skills used: ARTIQ, Python, FreeCAD, optical engineering.	
• Helped develop an open source Python library for creating and 3D printing optical base plates for use in a trapped ion quantum computing system. ( <a href="https://github.com/UMassIonTrappers/PyOpticL">https://github.com/UMassIonTrappers/PyOpticL</a> ). Tools and skills used: FreeCAD, Python, optical circuit design, GitHub.	
• Performed simulations of noisy Rabi flops to compare with real data, allowing us to isolate sources of noise in our homemade laser system. Tools and skills used: Monte-carlo simulations, Python, maximum likelihood estimation, stochastic modeling.	
• Developed a class-based framework for performing trapped ion quantum computing experiments with ARTIQ. This involved restructuring several thousands of lines of code to allow for a more intuitive and user-friendly approach to writing experiments and allowed for	

easier code documentation, as well. Tools and skills used: ARTIQ, Python, data visualization, non-linear curve fitting, data analysis.

## Industry Experience

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**Energy Sciences, Inc.**, Wilmington, MA

June 2021- January  
2023

- Paid intern in the dosimetry department.
- Assisted in assembling, testing, and procuring products for electron beam accelerators. Skills used and developed: Project management, electronics assembly, high-voltage safety, and developing relations with international customers.
- Using the in-house electron beam accelerator I was able to determine the skin-depth of various products that were used for in house testing, thus ensuring our testing protocols were as calibrated as possible. Tools and skills used: Electron beam accelerators, high-voltage machinery, and skin depth calculations.
- Responsible for running customer products through our in-house beam. Customers include: Michelin, Henkel, Pepperidge Farm, and Kellogg's.

## Publications and Pre-prints

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**Qubit operations using a modular optical system engineered with PyOpticL: a code-to-CAD optical layout tool (pre-print):**

Jan. 2025

arXiv:2501.14957

Jacob Myers, Christopher Caron, Nishat Helaly, Zhenyu Wei, **Zack Gotobed**, Kotaro Yabe, Justin Oh, and Robert Niffenegger

## Projects

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**ARTIQ Codebase for performing trapped ion quantum computing experiments.**

- Developed a class based framework to run ARTIQ code for trapped ion quantum computing experiments. Experiments include: Rabi flops, optical clocking, qubit spectroscopy, State preparation and measurement, Doppler cooling, etc.
- Tools used: Python, ARTIQ
- Skills developed: Data visualization, Fisher information, maximum likelihood estimation, Markov chain Monte Carlo, electrical engineering, optical engineering, FPGA control.

**Open source Python library for modular optical circuit design and testing: PyOpticL. Pre-Print found here.**

- Contributed to the development and testing of an open source python library for creation of optical baseplates and circuits. This library uses beam-path simulation and dynamic beam-path routing for quick and easy optical layout by placing optical elements along the beam path.
- Helped test PyOpticL by 3D printing optical baseplates and then assembling baseplates to test stability, precision, and accuracy. Tests included precision optical spectroscopy, Rabi flopping, and saturated absorption spectroscopy.

- Tools used: Python, FreeCAD, OpenSCAD, Elegoo 3D printers
- Skills developed: Optical engineering, optical circuit design, proficiency in FreeCAD and OpenSCAD, 3D printing.

### **Development of a Simulation Suite for testing Novel Optical Clocking Methods**

- Developed an open-source, robust Python and C++ simulation suite (found [HERE](#)) to perform numerical tests of novel optical clocking schemes, preventing bottlenecks in experimental execution.
- Tools used: Python, C++, GitHub, National Instruments cards
- Skills developed: Numerical analysis, version control.

### **Skills**

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**Languages:** Python, ARTIQ, C++, ROOT, pyROOT, UNIX, Git, Mathematica, MatLab, LaTeX, Git.

**Laboratory:** Optical engineering, optical circuits, electronic circuit analysis, FPGAs, laser engineering, CNC milling, soldering, 3D printing, FreeCAD, OpenSCAD.

**Data analysis:** Core Python abilities (matplotlib, numpy, scipy, pandas, tensorflow, etc.), Maximum likelihood estimation, Monte-Carlo methods, Fisher information, stochastic modeling.

### **References available upon request**

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