

Zack Gotobed

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Education

Colorado State University, Ph.D. Candidate in Physics August 2025- Present

- **Research Interests:** 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
- **Relevant Coursework:** Introduction to Lasers, Quantum Electronics

University of Massachusetts, Amherst, BS in Physics, BS in Applied Mathematics, GPA: 3.75 Sept. 2021-May 2025

- **Relevant Coursework:** Quantum Computing, Electronics for Scientists, Optics, Advanced Laboratory, Writing in Physics, Computational Physics, Data analysis for Particle Physics,

Awards and Grants

Edward S. Chang Summer Research Award 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

Christian Sanner (Physics), Precision Measurement with trapped Ytterbium ions, 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.

Robert Niffenegger (Electrical and Computer Engineering), Trapped Ion Quantum Computing with Strontium, 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. (<https://github.com/UMassIonTrappers/PyOpticL>). 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

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 Kellogs.

Publications and Pre-prints

Qubit operations using a modular optical system engineered with PyOpticL: a code-to-CAD optical layout tool (pre-print):
arXiv:2501.14957

Jan. 2025

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

Projects

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

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
