

Rylan Noah Malarchick

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EDUCATION

Embry-Riddle Aeronautical University

Daytona Beach, FL

Bachelor of Science in Engineering Physics

May 2027

Track: Spacecraft Instrumentation | Minor: Computational Mathematics

Master of Science in Engineering Physics

May 2028

Track: Thesis

PUBLICATIONS & PRESENTATIONS

Malarchick, R. (2026). “The Verifier Side of Speculative Window Decoding: A Predictability Bracket, a Machine-Checked Blast-Radius Bound, and a Decoder-Agnostic Recover Loop.” [arXiv:2607.13062](https://arxiv.org/abs/2607.13062)

Malarchick, R. (2026). “Measuring Control-Plane Openness in Near-Term Quantum Computing: A Rubric, Its Validation, and an Application to Thirteen Vendor Stacks.” [arXiv:2605.15233](https://arxiv.org/abs/2605.15233)

Malarchick, R. (2026). “Cache Hierarchy and Vectorization Analysis of Lindblad Master Equation Simulation for Near-Term Quantum Control.” [arXiv:2603.18052](https://arxiv.org/abs/2603.18052)

Malarchick, R. (2026). “End-to-End Fidelity Analysis of Quantum Circuit Optimization: From Gate-Level Transformations to Pulse-Level Control.” [arXiv:2601.20871](https://arxiv.org/abs/2601.20871)

Malarchick, R., Steed, A. (2026). “Parallelizing the Variational Quantum Eigensolver: From JIT Compilation to Multi-GPU Scaling.” [arXiv:2601.09951](https://arxiv.org/abs/2601.09951)

Malarchick, R. (2025). “When Does Numerical Pulse Optimization Actually Help? Error Budgets, Robustness Tradeoffs, and Calibration Guidance for Transmon Single-Qubit Gates.” [arXiv:2511.12799](https://arxiv.org/abs/2511.12799)

Malarchick, R. et al. (2026). “Predictive Target Pursuit for Autonomous UAVs using RF-DETR.” *Proc. SPIE 14030, Defense + Commercial Sensing 2026*, 140300O. [doi:10.1117/12.3094732](https://doi.org/10.1117/12.3094732)

RESEARCH EXPERIENCE

Los Alamos National Laboratory

Jun 2026 – Present

Quantum Computing Summer School (QCSS) Fellow

Los Alamos, NM

- Developing robust-optimization methods for variational quantum circuit compilation under hardware uncertainty
- Mentors: Harsha Nagarajan, Abhijith Jayakumar

NASA Goddard Space Flight Center

May 2025 – Aug 2025

OSTEM Intern – Atmospheric Remote Sensing

Greenbelt, MD

- Cloud base height retrieval from 1,426 NASA ER-2 observations across five research flights
- Gradient boosting on ERA5 atmospheric features reaches within-flight $R^2 = 0.744$ (MAE 117 m), beating CNN and ViT image models
- Surface temperature the dominant predictor (72% importance), consistent with lifting-condensation-level thermodynamics
- Catastrophic cross-regime domain shift (leave-one-flight-out $R^2 = -15.4$); few-shot with 50 target samples recovers $R^2 = 0.57$ – 0.85 where MMD, instance weighting, and TrAdaBoost fail
- Production-ready within-flight (0.28 ms CPU inference, 1.3 MB model); two first-author manuscripts pending NASA / NTRS review (Dr. Dong Wu)

Engineering Physics Propulsion Laboratory (ERAU)

Sept 2024 – Apr 2026

AIRHOUND – PI & Perception Lead, team of 7

Daytona Beach, FL

- RF-DETR detector (TensorRT, ~30 ms on Jetson Orin) fused with an Intel RealSense D455 for 3D target localization
- ROS2 autonomy stack: camera, detection, depth-fusion, and tracking nodes feeding PX4 offboard control
- Hardware-in-the-loop tested on the assembled drone; secured an ERAU SPARK equipment grant
- Presented at SPIE Defense + Commercial Sensing 2026 (paper 14030-26); methods paper in ERAU Beyond

PROJECT EXPERIENCE

Qconform – Pulse-Level Conformance Checker | *Zig*

2026 – Present

- Vendor-neutral, design-time checker for pulse-level quantum control
- Decides whether a pulse program is realizable on a device from its declared capabilities
- Zero-dependency Zig; no LLVM/MLIR

QubitPulseOpt – Quantum Optimal Control | *QuTiP, Python, GRAPE*

Oct 2025 – Present

- Coherent single-qubit gate error to machine precision ($<10^{-9}$) in 20 ns via GRAPE
- Full T_1/T_2 error budget benchmarked against DRAG
- Calibrated to IQM Garnet-representative parameters; published as arXiv:2511.12799

Lindblad-Bench – Cache Hierarchy Analysis | *C11, AVX2, Roofline*

Mar 2026

- 2–4× speedup over baseline via structure-of-arrays layout and vectorization
- Roofline analysis pinpoints the memory-bound regime (L1 / L2 / L3 at $d = 3 / 9 / 27$)
- Bare-metal C, Padé [13/13] exponential; validated on Intel and AMD

QCO-Integration – End-to-End Quantum Compilation | *Python, C++17*

Dec 2025 – Jan 2026

- 87.8% / 100% two-qubit-gate reduction on QFT / QAOA circuits
- Pulse duration the strongest negative fidelity predictor ($r = -0.73$) over a 4,452-run campaign on 371 circuits, hardware-validated on IQM Garnet
- C++17 optimizer (OpenQASM 3.0, DAG IR, SABRE routing) linked to a per-gate Lindblad fidelity model, cross-validated vs `qiskit-dynamics`

High-Performance VQE | *PennyLane, JAX, OpenMPI*

Oct 2025 – Jan 2026

- 117× speedup on H_2 ground-state VQE via JIT, multi-GPU, and MPI
- Scaled on ERAU Vega HPC (4× H100, 192 EPYC cores); published as arXiv:2601.09951

NVIDIA Blackwell Kernel Hackathon | *CUDA, CuTe/CUTLASS, B200*

Feb 2026

- 6× speedup over the reference kernel (NVIDIA × GPU MODE)
- NVFP4 grouped GEMM on B200 (SM100): FP4 tensor-core MMA, TMA async copies, warp-specialized pipeline

OPEN-SOURCE CONTRIBUTIONS

- **PennyLane Catalyst #2965**: MLIR canonicalization pattern for the quantum dialect; merged Jul 2026
- **Qiskit-Braket Provider #342**: Abelian grouping of commuting observables in `BraketEstimator`; merged Jun 2026

TECHNICAL SKILLS

Languages: Python, C/C++17, Rust, Zig, Julia, CUDA, MATLAB, Bash, x86-64 Assembly

Compilers: LLVM passes, OpenQASM 3.0, DAG IR, pass managers, SABRE routing, Qiskit transpiler

Quantum: QuTiP, PennyLane, Qiskit, JAX, GRAPE, Lindblad, transmon Hamiltonians

HPC / GPU: CUDA, CuTe/CUTLASS, OpenMPI, H100/B200, JIT, HPC clusters (PBS)

ML: PyTorch, TensorFlow, scikit-learn, XGBoost, TensorRT

Systems: gRPC/Protobuf, Docker, Linux, CI/CD, CMake, ROS2

Agentic Workflows: multi-agent orchestration, git-worktree parallelization, CI/eval-gated agents, MCP tooling, spec-driven codegen

AWARDS & HONORS

- **Goldwater Scholarship National Finalist** (2025)
- **NCAA Division II Cross Country & Track** (Aug 2023 – Present)
- **USTFCCCA Academic All-American** (2024, 2025)
- **3rd Place, ERAU Cyber Rodeo CTF** (Feb 2026, 40 teams, inter-collegiate)
- **ERAU Dean's List**