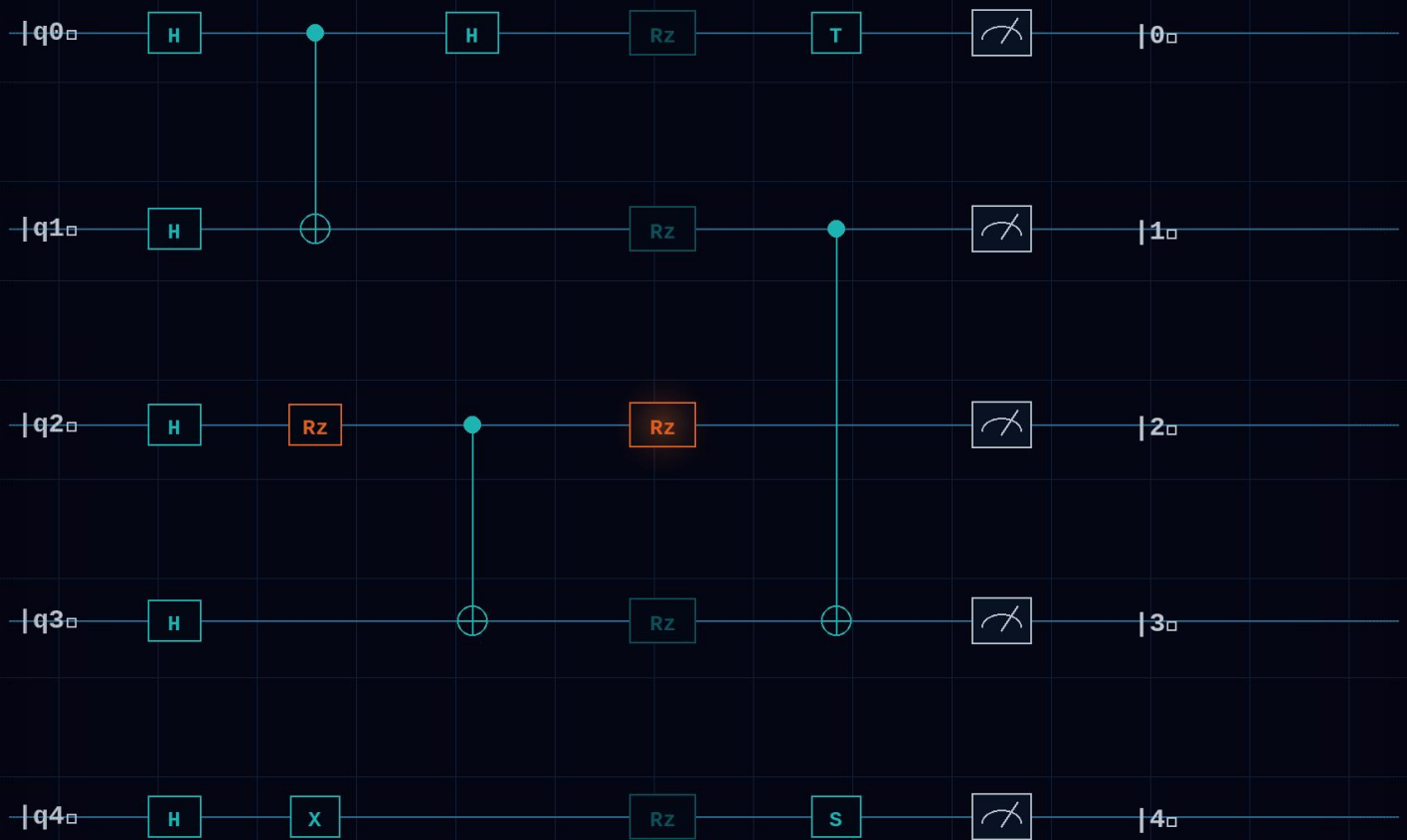
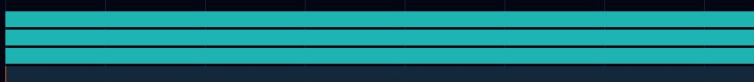




fidelidade:



CleitonForge 1.000
qasm_sim 1.000
statevector 1.000
quantrs2 0.000

QUANTUM CIRCUIT BENCHMARKING IN RUST

How We Found a Silent Bug
That Quantum Volume Misses

Cleiton Augusto Correa Bezerra

Quantum Circuit Benchmarking in Rust

How We Found a Silent Bug That Quantum Volume Misses

A practical guide to cross-backend fidelity testing

Cleiton Augusto Correa Bezerra

First edition — 2026

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Source code: github.com/cleitonaugusto/CleitonForge

Python package: pypi.org/project/cleitonforge

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The source code in this book is released under the Apache License 2.0. See the CleitonForge repository for the full license text.

The findings about quantrs2's Rz gate convention were disclosed to the maintainers prior to publication.

To Elis Regina, my wife, whose patience and love made every late night at the keyboard possible.

To Cesar Augusto, my son — may you always be curious about how things work.

To Maklana, my mother, who taught me that persistence is the only real shortcut.

And to my family, for everything that words cannot measure.

Para Elis Regina, minha esposa, cuja paciência e amor tornaram possível cada noite em frente ao teclado.

Para Cesar Augusto, meu filho — que você sempre tenha curiosidade sobre como as coisas funcionam.

Para Maklana, minha mãe, que me ensinou que persistência é o único atalho real.

E para minha família, por tudo que as palavras não conseguem medir.

About This Book

This book started as a debugging session.

I was building CleitonForge — a neutral quantum circuit benchmarking framework in Rust — and decided to test it against four different Rust quantum simulators. Three agreed on every circuit I threw at them. The fourth produced completely wrong results on QAOA circuits, with fidelity 0.0 against the reference. No error. No exception. Just the wrong answer.

The bug turned out to be a sign convention in the Rz gate — a small but fundamental difference between what OpenQASM 3 specifies and what `quantrs2-core` implements. Cross-backend fidelity comparison was the only testing strategy that could catch it.

That debugging session became this book.

What you will learn:

- Why unit tests and Quantum Volume cannot catch certain classes of simulator bugs
- How the Rz sign convention bug was found, why it matters, and how to fix it
- How CleitonForge is architected as a Rust workspace with a plugin backend system
- How to build an OpenQASM parser in Rust from first principles
- How to measure statevector fidelity, real memory usage, and wall-clock time correctly
- How to integrate CleitonForge into your own project — from the CLI, from Python, and in GitHub Actions CI/CD

Who this is for:

This book is for software engineers and researchers who write or use quantum simulation software and want to be confident their results are correct. You should be comfortable reading Rust code, but you do not need to be a quantum physicist — the physics is explained as needed, at the level required to understand the bugs.

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Chapter 1: The Problem

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Chapter 7: What Comes Next

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Appendix C: Frequently Asked Questions

About the Author

Cleiton Augusto Correa Bezerra is a systems analyst from Brazil with deep expertise in Rust and a focus on open-source software with lasting real-world impact.

He has spent years working at the intersection of systems programming and quantum computing — building production-quality tools that bridge the gap between quantum algorithm research and software engineering practice.

CleitonForge, his open-source quantum circuit benchmarking framework, is the culmination of that work: a neutral, Rust-native tool that found a silent correctness bug in one of the most popular Rust quantum simulators — a bug invisible to unit tests, Quantum Volume benchmarks, and years of real-world use.

Cleiton writes about Rust, quantum computing, and open-source engineering at dev.to/cleiton_augusto_ and maintains CleitonForge at github.com/cleitonaugusto.

“The comparison is the test.”

End of Sample

This is where the free sample stops.

The full book is seven chapters and three appendices: the QAOA circuit where four simulators disagreed, the sign convention that caused it, why Quantum Volume cannot see it, and the differential test that catches it. Plus the parser, the metrics, and how to wire the whole thing into your own CI.

Everything in it runs. The code is at github.com/cleitonaugusto/CleitonForge, and the Python package is `pip install cleitonforge`.

If the sample was worth your time, the rest is at leanpub.com/quantum-rust-benchmarking.

Thank you for reading.

— Cleiton