Luis Wirth

MSc Student in Computational Science and Engineering at ETH Zurich

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Education

2025 – (2027) **MSc ETH Computational Science and Engineering**
ETH Zurich – Zurich, CH

- **GPA:** 5.69/6.0
- **Field of specialization:** Computational Electromagnetics
- **Focus:** Structure-Preserving Machine Learning
- **Semester Project**: BEM Benchmark of the EPGP for Maxwell Cavity Scattering
- **Key Coursework:**
  - AI in the Sciences and Engineering (PINNs, Graph Neural Operators, Physics Foundation Models)
  - Advanced Numerical Methods for CSE (Boundary Element Method, Hybrid Modeling for PDEs, GPs)
  - Electromagnetics and Differential Forms (Differentiable Manifolds, De Rham Complex, DF Discretization)
  - Mathematical and Computational Methods in Photonics‡ (Boundary Integral, Neumann–Poincaré, Subwavelength)
  - Semiconductor Devices: Quantum Transport at the Nanoscale‡ (Transistor-Level Simulation, NEGF)
  - VLSI 1: HDL Based Design for FPGAs (RTL, SystemVerilog, Xilinx Vivado)
  - VLSI 2: From Netlist to Complete System on Chip (Full-Custom HFT ASIC Project)
  - VLSI 3: Full-Custom Digital Circuit Design (Transistor-Level CMOS, Standard-Cell Design, Cadence Virtuoso)
  - CSCS Summer School (HPC, CUDA, MPI)

‡ *in progress*

2021 – 2025 **BSc ETH Computational Science and Engineering**
ETH Zurich – Zurich, CH

- **GPA:** 5.41/6.0
- **Field of specialization:** Computational Physics
- **Focus:** Finite Element Exterior Calculus
- **Thesis:** Rust Implementation of Finite Element Exterior Calculus on Coordinate-Free Simplicial Complexes
- **Key Coursework:**
  - Numerical Methods for Partial Differential Equations (Finite Element Method, Conservation Laws)
  - Numerical Solution of Stochastic Ordinary Differential Equations (Itô calculus, Euler–Maruyama)
  - Computational Quantum Physics (Multi-Body Problems, Tensor Network States)
  - Statistical Physics and Computer Simulation (Molecular Dynamics, Thermodynamics)
  - High-Performance Computing (Distributed Computing, MPI, OpenMP)
  - Systems Programming and Computer Architecture (C, x86-64 Assembly, Virtual Memory, Caching)
  - Information Theory (Shannon Entropy, Mutual Information, Coding, Typical Sequences)

Professional Experience

2026 Aug – present **Research Assistant**
ETH Zurich (Seminar for Applied Mathematics) – Zurich, CH

- Structure-preserving Gaussian process for source-free Maxwell's equations
- Geometric field theory of electromagnetism on Lorentzian spacetime
- GP kernel built by applying spectral exterior calculus to the Hodge–Dirac equation
- Joint SIAM journal paper (in preparation) with Prof. S. Kurz and F. L. Vittori

2024 Feb – Jun **Teaching Assistant NumPDE**
ETH Zurich (Seminar for Applied Mathematics) – Zurich, CH

- TA for "Numerical Methods for Partial Differential Equations" (Prof. R. Hiptmair)
- Instructed students in weekly tutorials on mathematical theory and C++ implementation

2020 Jun – Dec **R&D Software Engineer**
University of Basel (Dept. of Biomedical Engineering) – Basel, CH

- Joined the MIRACLE project (Minimally Invasive Robot-Assisted Computer-guided Laserosteotome)
- Developed SpectoVR, a virtual reality surgical planning tool
- Implemented real-time multi-volume raymarching with distance-field empty-space skipping for CT/MRI scans
- Added PET-CT scan visualization support

2019 Jul – Aug **Software Engineer Intern**
Adobe – San Francisco, USA

- Joined the Adobe Experience Manager Screens team
- Built a content targeting prototype using TensorFlow for personalized digital signage delivery

Publications & Talks

Guest Lecture: Discretization of Differential Forms for the Numerical Solution of PDEs
ETH Zurich – May 2026

- Given in the course "Electromagnetics and Differential Forms" (Prof. S. Kurz)
- Topics: FEEC, Hodge–Laplace Mixed Formulation, Hodge Decomposition, de Rham Cohomology, Simplicial Cochains, Whitney Forms
- Slides: PDF
- Recording: YouTube

BSc Thesis: Rust Implementation of Finite Element Exterior Calculus on Coordinate-Free Simplicial Complexes
ETH Zurich – May 2025

- *"The best BSc thesis I have seen in years"* — Prof. R. Hiptmair
- Topics: PDEs, FEM, Manifolds, Differential Geometry, Exterior Calculus, Regge Calculus
- Paper: arXiv:2506.02429
- Presentation: YouTube

Seminar Talk: Lean4 and the Curry–Howard Isomorphism
ETH Zurich (ZUCCMAP) – November 2024

- Topics: Functional Programming, Type Theory, Propositions-as-Types and Formal Verification
- Recording: YouTube

Technical Projects & Open-Source

Formoniq | *Rust, FEEC, Differential Geometry, WebGPU*
Coordinate-free finite element exterior calculus engine for PDEs on pseudo-Riemannian manifolds of arbitrary dimension

- Structure-preserving engine for the Hodge–Laplace and Hodge–Dirac operators
- Arbitrary dimension and form degree, with support for non-trivial topology
- Regge calculus for any metric signature: Riemannian and Lorentzian (spacetime)
- Discretization of the de Rham complex (nilpotency, cohomology, and Hodge decomposition)
- ~24k lines of pure Rust across 8 modular crates, each a self-contained math library
- Parallel solver toolchain in Rust (faer direct solves, rayon-parallel assembly)
- Began as the BSc thesis implementation, now a standalone library
- Interactive WebGPU/WebAssembly viewer: formoniq-studio.lwirth.com
- Repository: GitHub

Carveout | *Rust, Rendering, WebGPU, WebAssembly*
High-Performance Digital Pen Note-Taking Application

- Nonlinear undo-tree data structure to preserve full editing history across branches
- Rendering with WebGPU for cross-platform hardware acceleration
- WebAssembly app with custom egui-winit-wgpu integration
- Repository: GitHub

Arcus | *Rust, Embedded Programming, RTIC, Microcontroller*
Smart LED Strip with Interactive Animations

- Embedded Rust based on real-time interrupt-driven concurrency (RTIC)
- Raspberry Pi Pico RP2040 microcontroller
- Programmable IO state machine driver for WS2812 LEDs using PIO assembly
- Controller support for UART, bluetooth and infrared remote
- Repository: GitHub

Skills

Technical:

- Languages: C++, Rust, Python, Lean4, Julia, SystemVerilog
- HPC: MPI, OpenMP, PETSc
- ML Frameworks: PyTorch, JAX
- Graphics / GPU: Vulkan, WebGPU, Compute Shaders
- EDA / Hardware: Cadence Virtuoso, Xilinx Vivado
- Tooling: Linux, Nix, Git, Typst, LaTeX

Spoken Languages: German (native), English (C2), Spanish (B1), French (B1)