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Research Focus

I bridge large-scale pre-training and ultra-low-power hardware so that wearable biomedical devices can analyze EEG, ECG, and other biosignals in real time — on the device, not in the cloud. Three directions: foundation models for biosignals, tiny recursion models for time series, and hardware–algorithm co-design for microwatt-power deployment.

Education and Training

ETH Zürich, Switzerland — 2020–2025
Dr. sc. in Electrical Engineering and Information Technology
Integrated Systems Laboratory, supervised by Prof. Dr. Luca Benini
Thesis: "Robust and Practical Machine Learning Solutions for Wearable Biomedical Edge Devices"

ETH Zürich, Switzerland — 2018–2020
M.Sc. in Electrical Engineering and Information Technology
Integrated Systems Laboratory

University of Iceland, Reykjavík — 2015–2018
B.Sc. in Electrical and Computer Engineering

Previous and Current Employment

Postdoctoral Researcher, ETH Zürich, Integrated Systems Laboratory — 2025–present
Leading research on efficient foundation models for biosignal analysis and ultra-low-power edge deployment. Supervising M.Sc. students and coordinating multi-partner research projects including collaborations with clinical partners and industry (GreenWaves Technologies).

Doctoral Researcher, ETH Zürich, Integrated Systems Laboratory — 2020–2025
Developed hardware-aware ML methods spanning wearable seizure detection, EEG foundation models, and embedded deployment on RISC-V edge processors (GAP8/GAP9). Supervised over 30 M.Sc. thesis students; three continued to doctoral studies.

Publication Record

30 peer-reviewed publications; 1,080+ citations, h-index 14 (Google Scholar, July 2026). Venues include NeurIPS, IEEE TBioCAS, Scientific Reports, Epilepsia, EMBC, and BioCAS. Full list: thorirmar.com/publication.

Funding and Awards

Swiss AI Initiative Large Grant — "VitalFM: A Unified Foundation Model for Non-Invasive Physiological-Waveforms, from Alps to Edge" — July 2026 – June 2027
Lead author of the proposal; co-applicant (Scientific Lead: Prof. L. Benini). Awarded 400,000 GPU hours on the CSCS Alps supercomputer (3rd Call for Large Grants; estimated value CHF 260,000) to pre-train a unified foundation model for non-invasive physiological waveforms,

spanning cluster-scale training to edge-deployable checkpoints.

Hasler Foundation Small Project Grant — "Quantized Recursive Inference for Resource-Constrained Edge AI" July 2026 – June 2027
Project lead. CHF 50,000 awarded for research on model compression methods specifically designed for recursive inference architectures, addressing the unique challenge that errors compound across iterative refinement steps. The project introduces adaptive early-exit mechanisms with formal resource guarantees and targets end-to-end deployment on the GAP9 ultra-low-power edge processor.

CSCS Production Project "lp160" — Unified Multi-Modal Biosignal Foundation Models April 2026 – March 2027
Co-applicant (PI of record: Prof. L. Benini). Competitive HPC compute allocation on the HPE Cray EX (*daint@alps*, NVIDIA GH200): 25,000 node-hours per quarter and 20 TB on /store; estimated annual value CHF 269,000. Funds Alps-scale self-supervised pre-training of a topology-agnostic, efficiency-first biosignal foundation model jointly trained on EEG, ECG, and PPG (with optional EMG/EOG), with INT8 edge-deployable checkpoints as a deliverable.

2nd Place, ETH Zürich Probabilistic Computing Hackathon 2026
Thermo-TRM: reframing tiny-recursive-model inference as annealed sampling on an energy-based model, evaluated on a thermodynamic-computing simulator.

Teaching

Main Instructor, "Machine Learning for Brain-Computer Interfaces" 2021–present
ETH Zürich, undergraduate course (D-ITET). Course design, lectures, exercises, and assessment.

Supervision and Mentoring

Supervised **30+ M.Sc. thesis projects** at ETH Zürich (2020–present), spanning wearable seizure detection, EEG/EMG/PPG foundation models, hardware-aware quantization, and on-device deployment to GAP8/GAP9 platforms. Three of the supervised students continued to doctoral studies.

Research Highlights with Selected Works

Efficient wearable seizure detection from concept to clinical-grade deployment

I developed a complete pipeline for wearable epilepsy monitoring, from algorithm design to deployment on ultra-low-power processors. This work addressed a major clinical need: continuous seizure monitoring outside hospitals, where devices must operate for days on a small battery while maintaining high detection accuracy. Starting with temporal convolutional networks and tree-based classifiers, I systematically tackled each bottleneck, including artifact rejection, multi-modal sensor fusion (EEG, PPG, accelerometer), and false-alarm reduction. The resulting systems were validated on clinical data from multiple epilepsy centers and deployed on GAP8/GAP9 processors, achieving real-time inference at sub-milliwatt power. This line of work established me as a leading contributor to the intersection of efficient ML and wearable biomedical systems, with publications spanning the full stack from algorithms to hardware.

[1] **Ingolfsson, T.M.**, et al. "BrainFuseNet: Enhancing wearable seizure detection through EEG-PPG-accelerometer sensor fusion and efficient edge deployment." *IEEE Trans. Biomedical Circuits and Systems*, 18(4):720–733, 2024.
[2] **Ingolfsson, T.M.**, et al. "Minimizing artifact-induced false-alarms for seizure detection in wearable EEG devices with gradient-boosted tree classifiers." *Scientific Reports*, 14(1):2980, 2024.
[3] **Ingolfsson, T.M.**, et al. "EpiDeNet: An energy-efficient approach to seizure detection for

embedded systems." *Proc. IEEE BioCAS*, pp. 1–5, 2023.

[4] **Ingolfsson, T.M.**, et al. "Towards long-term non-invasive monitoring for epilepsy via wearable EEG devices." *Proc. IEEE BioCAS*, pp. 1–4, 2021.

Pioneering EEG foundation models for edge deployment

I initiated and led the development of foundation models for EEG signals that are specifically designed to be efficient enough for edge deployment. The flagship result is LUNA, a topology-agnostic EEG foundation model accepted at NeurIPS 2025, which demonstrated that a single pretrained model can generalize across diverse EEG datasets regardless of electrode configurations. In parallel, I co-led the development of FEMBA (Mamba-based) and Cerebro (efficient attention) architectures, creating a family of complementary approaches. Critically, I drove the quantization and compression of these models for deployment on ultra-low-power hardware, demonstrating that foundation-model-level performance can be achieved within the constraints of wearable devices. This research direction — bridging large-scale pretraining with extreme efficiency — continues in the Hasler-funded project on quantized recursive inference.

[5] Döner, B., **Ingolfsson, T.M.**, Benini, L., and Li, Y. "LUNA: Efficient and topology-agnostic foundation model for EEG signal analysis." *NeurIPS*, 2025.

[6] Tegon, A., **Ingolfsson, T.M.**, et al. "FEMBA: Efficient and scalable EEG analysis with a bidirectional Mamba foundation model." *Proc. IEEE EMBC*, 2025.

[7] Tegon, A., Lehmann, N., Li, Y., Cossettini, A., Benini, L., and **Ingolfsson, T.M.** "FEMBA on the Edge: Physiologically-aware pre-training, quantization, and deployment of a bidirectional Mamba EEG foundation model on an ultra-low power microcontroller." *arXiv preprint*, 2026.

Hardware-software co-design for ultra-low-power wearable AI

I contributed to the design and validation of complete wearable AI systems that integrate custom hardware, efficient algorithms, and real-time processing. This includes GAPses, smart glasses that perform fully on-device EEG and EOG processing on the GAP9 processor, and a wearable speech-imagery BCI system. These projects required co-optimizing across the full system stack: from electrode design and signal acquisition, through algorithm selection and quantization, to deployment on multi-core RISC-V clusters, bringing ML models from PyTorch to real wearable hardware under tight power and memory constraints.

[8] Frey, S., et al. (incl. **Ingolfsson, T.M.**) "GAPses: Versatile smart glasses for comfortable and fully-dry acquisition and parallel ultra-low-power processing of EEG and EOG." *IEEE Trans. Biomedical Circuits and Systems*, 19(3):616–628, 2024.

[9] **Ingolfsson, T.M.**, et al. "A wearable ultra-low-power system for EEG-based speech-imagery interfaces." *IEEE Trans. Biomedical Circuits and Systems*, 2025.

[10] **Ingolfsson, T.M.**, et al. "EEG-TCNet: An accurate temporal convolutional network for embedded motor-imagery brain-machine interfaces." *Proc. IEEE SMC*, pp. 2958–2965, 2020.

Academic Service

Journal Reviewer: *IEEE Trans. Biomedical Circuits and Systems*, *IEEE Trans. Biomedical Engineering*, *Neural Networks*, *Neurocomputing*, *Scientific Reports*, *Biomedical Signal Processing and Control*, *Measurement.*

Conference Reviewer: *MICCAI.*