

Ian Ballinger

Embedded Hardware & Firmware Engineer ·
Bioelectronic Systems · Technical Leadership

Cambridge, Massachusetts
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Hands-on systems engineer and technical lead with 7+ years developing connected medical devices from first architecture through manufacturing transfer and in-vivo validation. Deep experience in embedded C/C++, RTOS firmware, mixed-signal electronics, low-power wireless systems, PCB integration, electromechanical control, and laboratory debugging. Known for turning ambiguous concepts into working platforms, then enabling and coordinating multidisciplinary teams as programs scale.

CORE EXPERTISE

Embedded

C/C++, Zephyr RTOS, Nordic nRF, STM32, ARM Cortex-M, drivers, finite-state machines

Hardware

Mixed-signal circuits, component selection, rigid/flex PCBs, power systems, RF matching

Interfaces

BLE, Wi-Fi, I²C, SPI, UART, USB, body-area networks, mobile/device protocols

Productization

Architecture, DFM, test methods, design transfer, reliability, V&V, preclinical deployment

EXPERIENCE

Research Specialist · Massachusetts Institute of Technology, Mechanical Engineering

2026–Present

Traverso Lab · Ingestible and implantable electronic systems

- **Lead full-cycle engineering across concurrent medical-device programs**, translating research objectives into requirements, system architectures, integrated prototypes, validation methods, and preclinical-ready devices.
- **Serve as the lab's engineering systems integrator and primary technical resource**, coordinating electronics, embedded firmware, wireless communication, software, mechanics, fabrication, data infrastructure, and experimental teams.
- **Scale projects from individual technical incubation to coordinated team execution**: establish the first working architecture, define subsystem interfaces, mentor contributors, review designs, and integrate outputs into validated systems.
- Own engineering infrastructure and externalities that determine execution quality, including specialized equipment, vendors, source control, design histories, standardized workflows, onboarding, and safe laboratory operation.

Graduate Researcher, S.M. Mechanical Engineering · Massachusetts Institute of Technology

2024–2026

Thesis: secure wireless control and remotely triggered actuation of an ingestible bioelectronic capsule

- **Designed and integrated two generations of a wirelessly controlled ingestible platform** combining capsule-scale electronics, Zephyr firmware, BLE, mobile control, command authentication, power delivery, and electrochemical payload release.
- **Demonstrated wireless in-vivo release of a viable bacterial payload** and validated gastric-device operation with an intact payload barrier after at least six days in a porcine model.
- Sustained always-available BLE telemetry for approximately **2.2–2.9 months**; characterized tissue-loaded RF performance and measured staged in-body receiver sensitivity of approximately **–102 dBm**.
- Diagnosed battery-impedance, RF-detuning, moisture-ingress, and packaging failures; converted experimental evidence into power, antenna, sealing, telemetry, and manufacturability improvements.

Research Engineer II · Brigham and Women's Hospital / Harvard Medical School

2020–2024

Traverso Lab · Multidisciplinary biomedical research and translational engineering

- **Developed low-power 2.4 GHz electronics and firmware for ingestible and implantable devices**, enabling secure through-tissue communication and remote control over multi-day to multi-month studies.
- **Built end-to-end infrastructure for 100-day large-animal experiments** using custom BLE hardware, cloud databases, remote monitoring and control, C#/.NET services, and Jupyter analysis tools; deployed the system to collaborators across the United States.
- Led electronics integration, flexible-PCB fabrication, embedded development, and system validation; hired, trained, and managed engineering staff supporting multidisciplinary programs.
- Directed approximately **\$800K in electronics-fabrication capital purchases** and established advanced in-house assembly processes, reducing supply-chain and external-manufacturing risk.
- Supported CDMO design transfer and engineering documentation for an expedited FDA IDE program; authored sponsor reports and delivered technical reviews and live system demonstrations.

SELECTED ENGINEERING IMPACT

Reusable embedded-device platform

Established a shared platform spanning React Native, TypeScript, C++, Zephyr RTOS, Nordic nRF systems, BLE, containerized builds, automated flashing, and hardware test applications. Created the initial architecture, then integrated work from multiple contributor branches across firmware, sensing, and device-control workflows.

Power- and RF-constrained product design

Characterized silver-oxide discharge and late-life pulse limitations, sized a capsule-manufacturable bypass network, and developed tissue-aware antenna matching and link-budget methods for reliable command delivery under severe volume and energy constraints.

Authenticated embedded control

Implemented and tested a shared C++ SPECK-128 challenge-response protocol across nRF/Zephyr firmware and a React Native controller, gating entry to the device's actuation-capable state behind an authenticated exchange.

Prototype-to-production execution

Developed rigid and flexible electronics, fabrication and assembly procedures, fixtures, validation protocols, manufacturing packages, and corrective actions for failures spanning hardware, firmware, packaging, communication, and experimental use.

PROGRAM & TEAM LEADERSHIP

- **Coauthored a \$13.9M, 24-month DARPA proposal** for a closed-loop ingestible electroceutical, translating a high-risk biological concept into hardware architecture, quantitative milestones, risk mitigations, large-animal validation, and regulatory and transition plans.
- Developed and coordinated engineering contributions across bioelectronics, materials, sensing, controls, computational modeling, animal research, clinical translation, external manufacturing, and regulatory strategy.
- Build teams through technical leverage: create working reference implementations and reusable infrastructure, decompose follow-on work, mentor owners, and retain accountability for integrated system behavior.

EARLIER EXPERIENCE

Power Systems Research Intern · Packetized Energy

2018

Built interactive React/D3/Node.js analytics for distributed power networks, enabling exploration of grid behavior under coordinated energy storage and flexible loads.

Device Design & Process Development Intern · Biogen

2017

Developed instrumented autoinjector concepts for high-viscosity biologics and designed fixtures and Instron methods for repeatable evaluation of implantable spinal-access ports.

EDUCATION

Massachusetts Institute of Technology

S.M., Mechanical Engineering, 2026

University of Vermont

B.S., Electrical Engineering, 2020

SELECTED PUBLICATIONS

Implantable system for chronotherapy. *Science Advances*, 2021. Designed and fabricated a multi-device implant/wearable platform for monitoring and closed-loop drug delivery.

Automated all-in-one system for carbohydrate tracking, glucose monitoring, and insulin delivery. *Journal of Controlled Release*, 2022. Designed and fabricated integrated sensing and delivery hardware.

Additional publications in ingestible sensing, gastrointestinal biomarkers, physiological monitoring, and connected therapeutic systems.

TECHNICAL TOOLS

Firmware & build

Zephyr, nRF Connect SDK, STM32CubeIDE, CMake, Docker, Git, CI workflows

Electronics & test

Schematic capture, rigid/flex PCB layout, circuit and power simulation, oscilloscopes, VNAs, power and logic analyzers, soldering and rework

Software & data

Python, Julia, TypeScript, React Native, C#/.NET, AWS, MySQL, Jupyter