

Fiber Platform for Flexible Sensing Arrays

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Functional Fiber Electronics (FFE)

Heterogeneous 3D

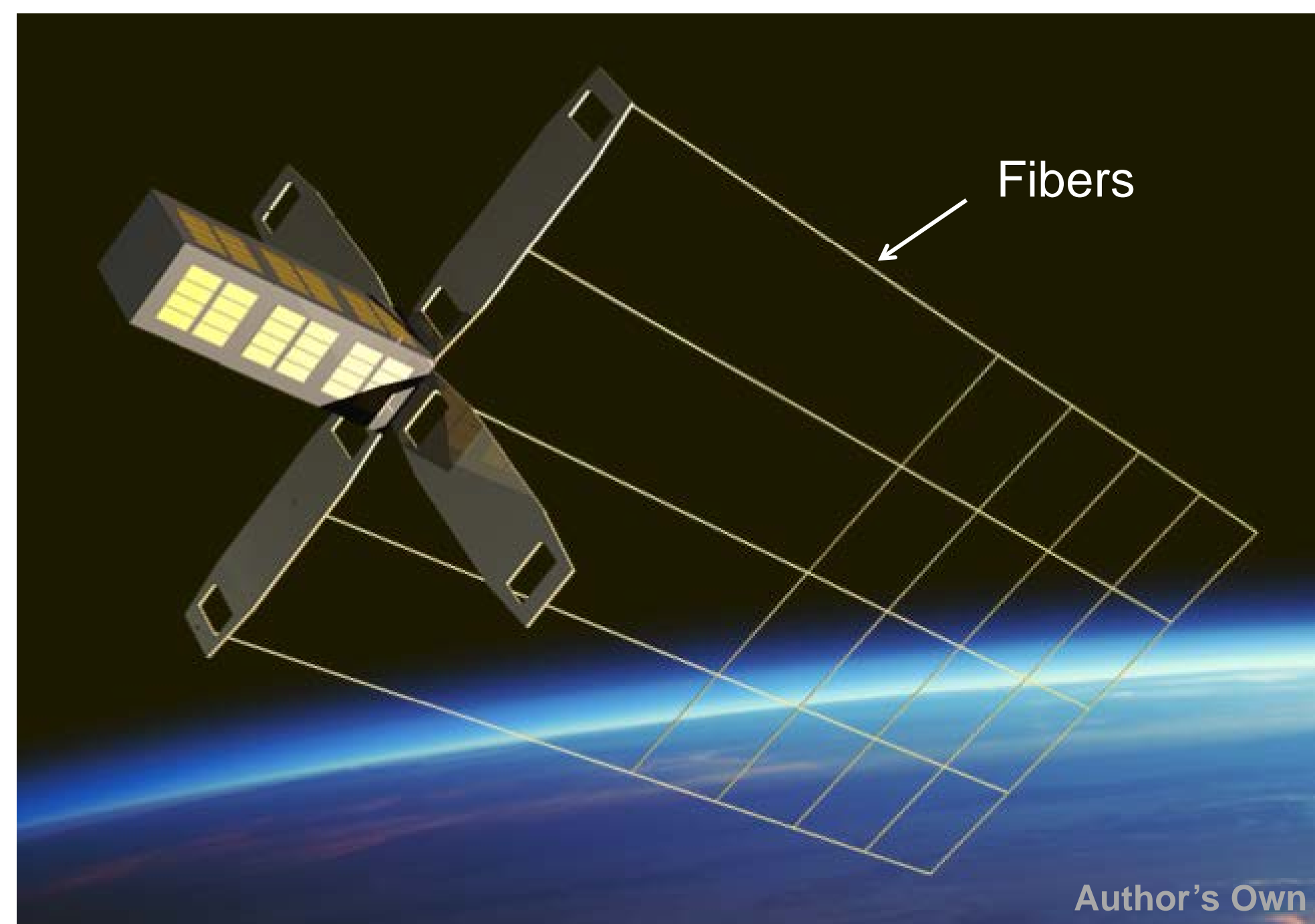
Background

There are many DoD applications that would benefit from a long-length, lightweight, flexible array of sensors, including:

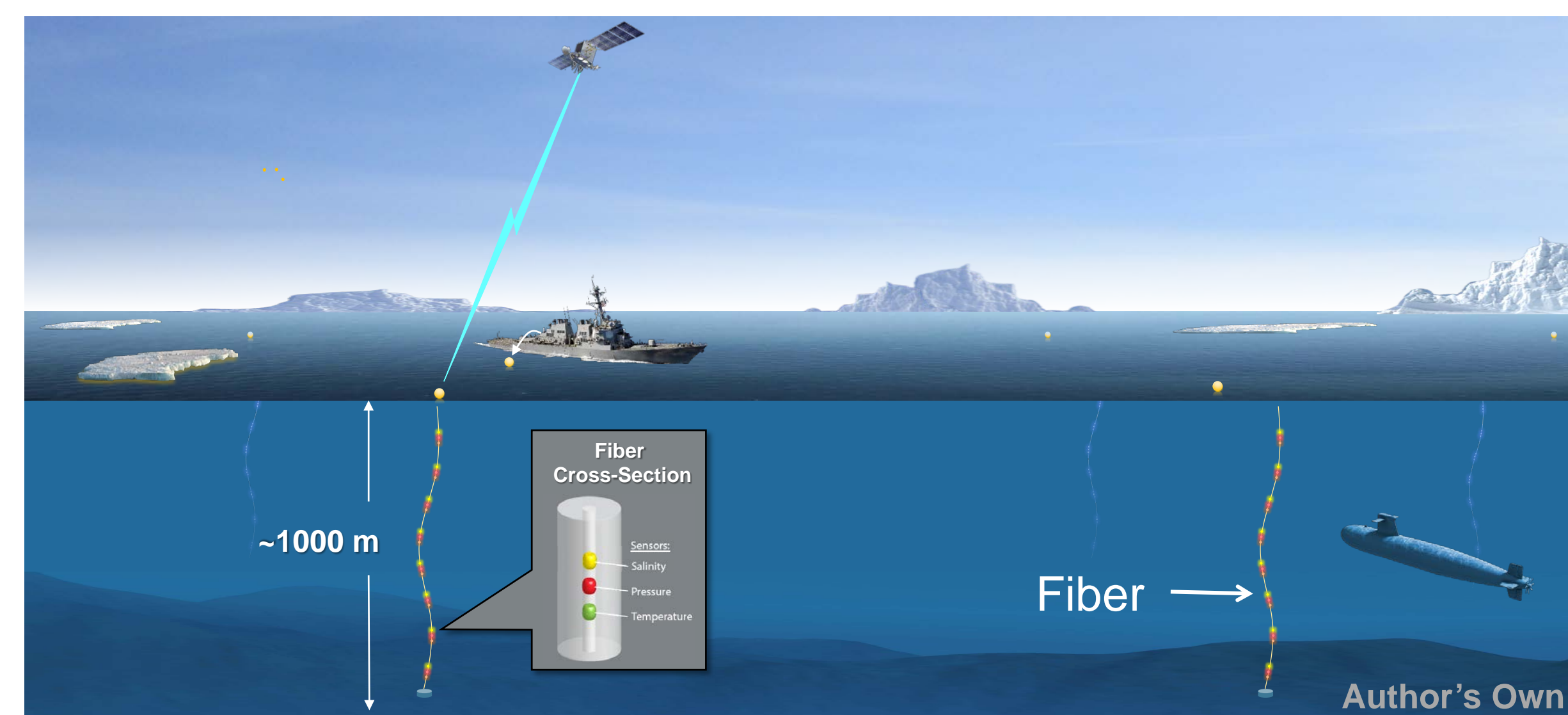
1. Space-based antenna arrays
2. Ocean-based measurements of sound velocity
3. Ground-based deployable radars

To address this need, MIT Lincoln Laboratory is currently developing techniques to embed sensors into polymer fibers, offering a platform solution into which the DoD partners can design. Lightweight design (< 5 g/m) will offer 100x less cost than state-of-the-art deployable, large-area space antennas

Proposed concept for deployable, phased array antennas from a small satellite that is enabled by a light-weight, fiber sensing array



Persistent undersea measurement of temperature, pressure, and salinity for estimating sound velocity

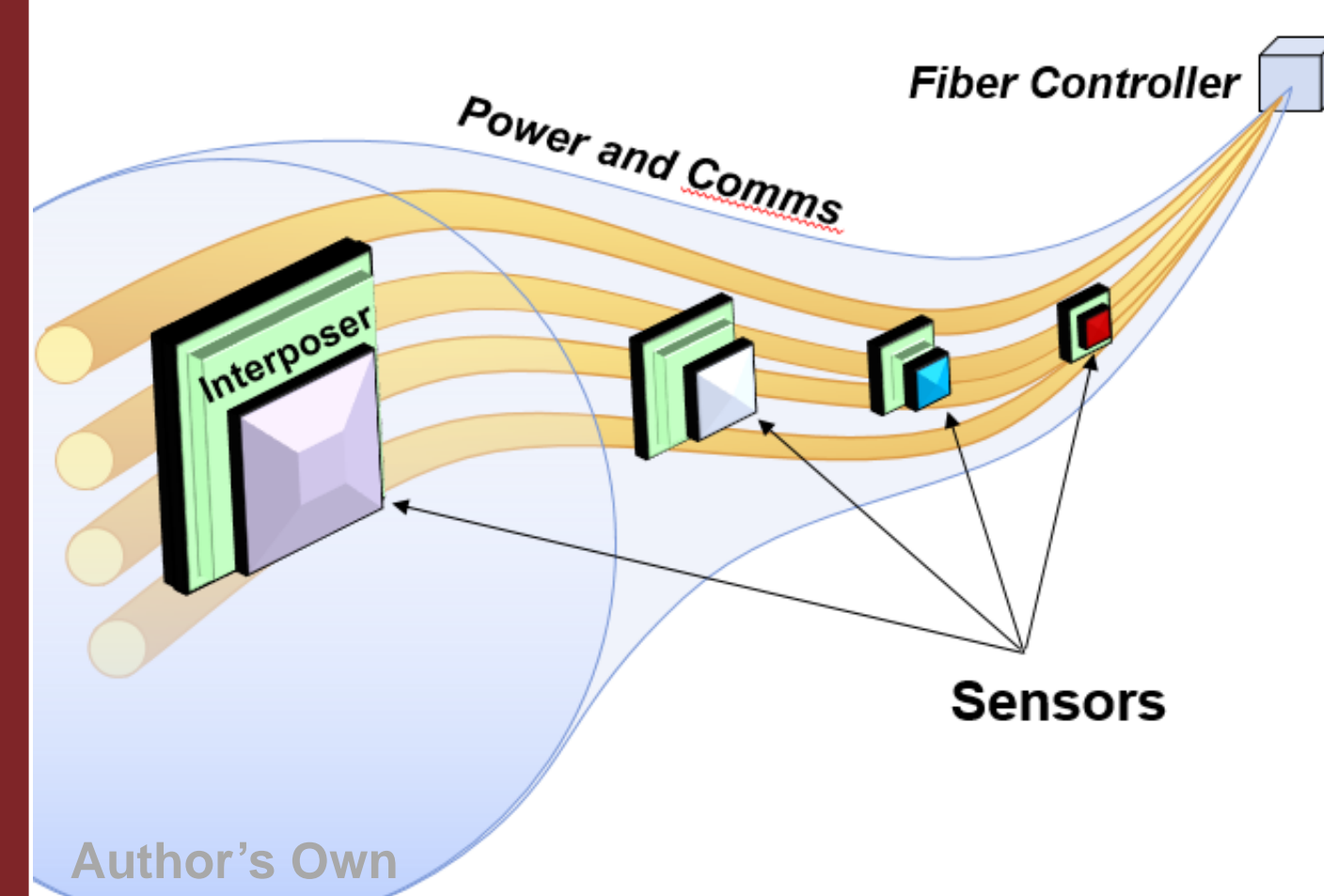


Approach

In order to deliver both data and power over long lengths (>100m), we developed a process with the following features:

- Four uninsulated copper wires are drawn into the interior of a polymer fiber with controlled pitch
- Sensor electronics are interfaced to the copper wires through an interposer PCB
- Embedded sensor is encapsulated to allow operation in harsh environments

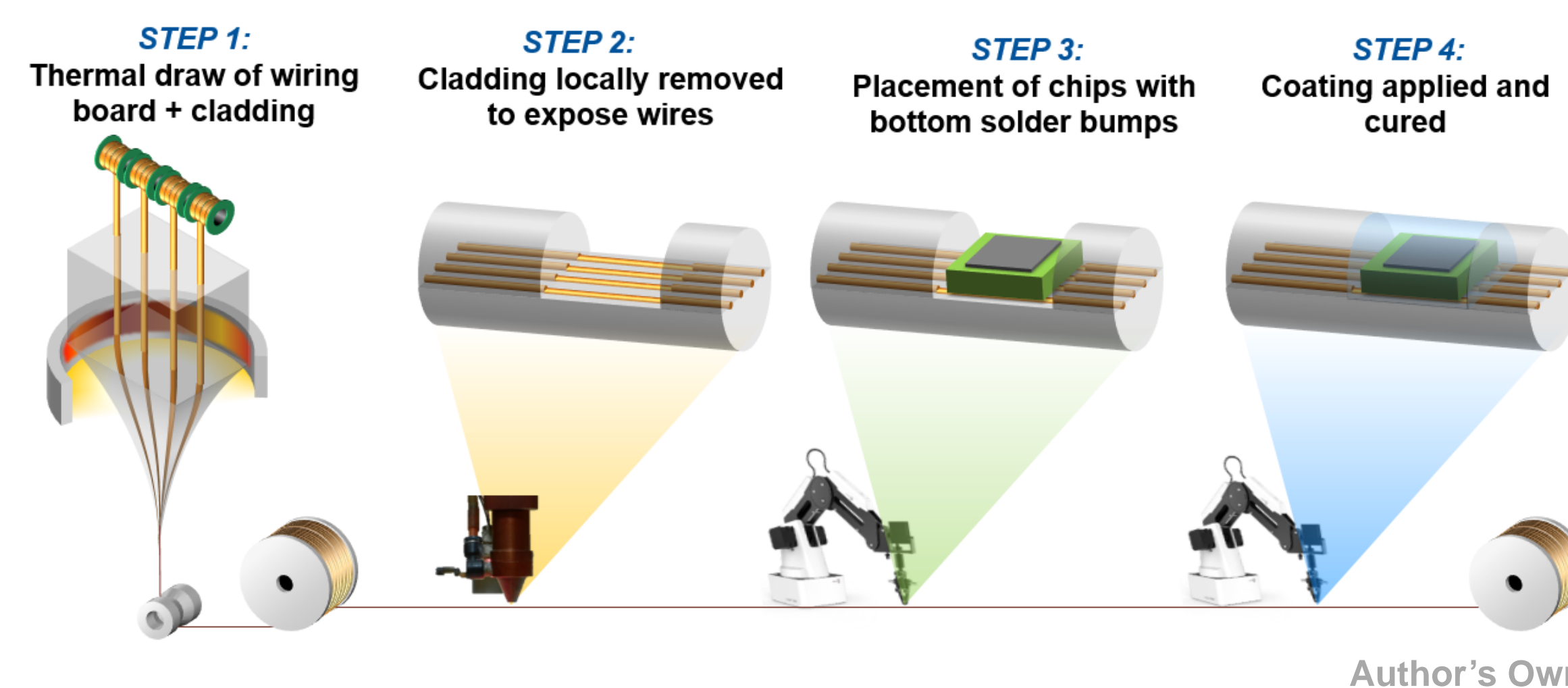
Illustration of a fiber-based sensor array utilizing a four-wire bus



Four copper wires drawn in parallel inside a polycarbonate fiber



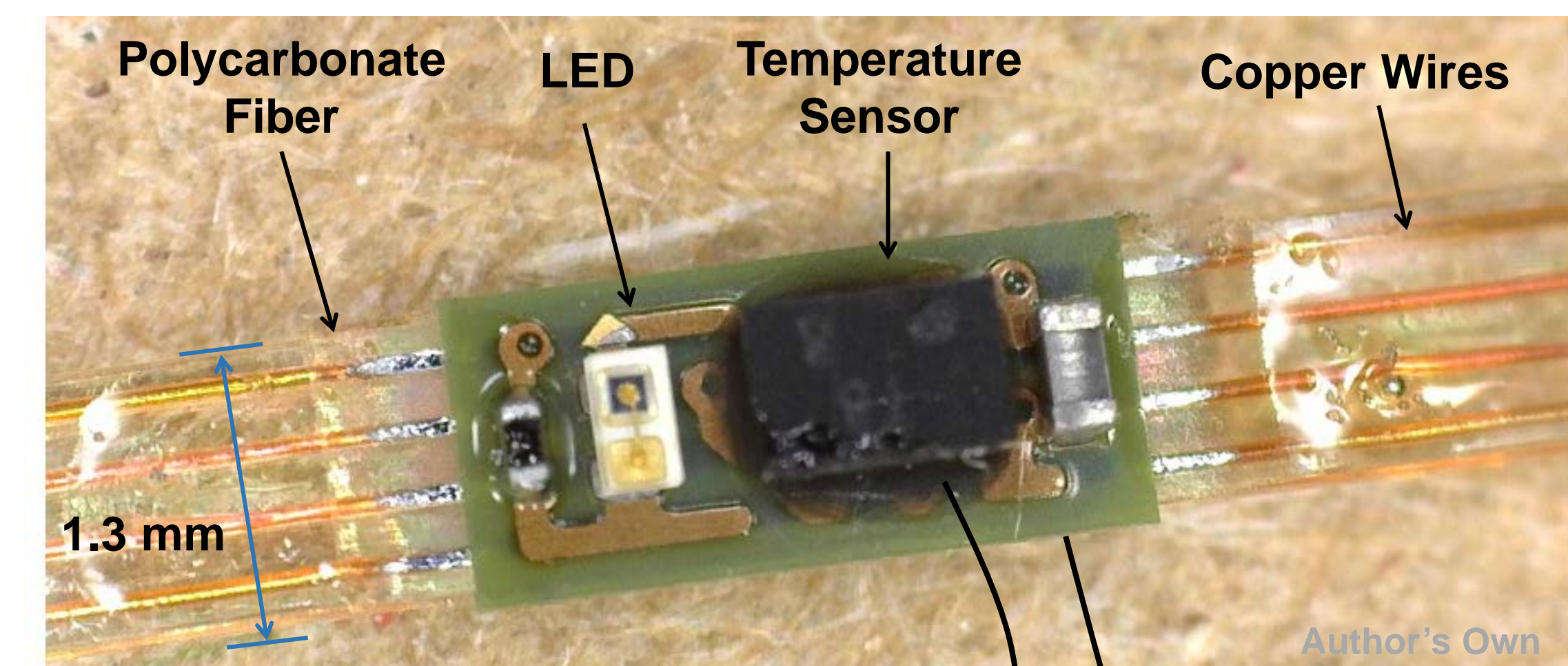
Process developed for integrating sensor nodes into the fiber



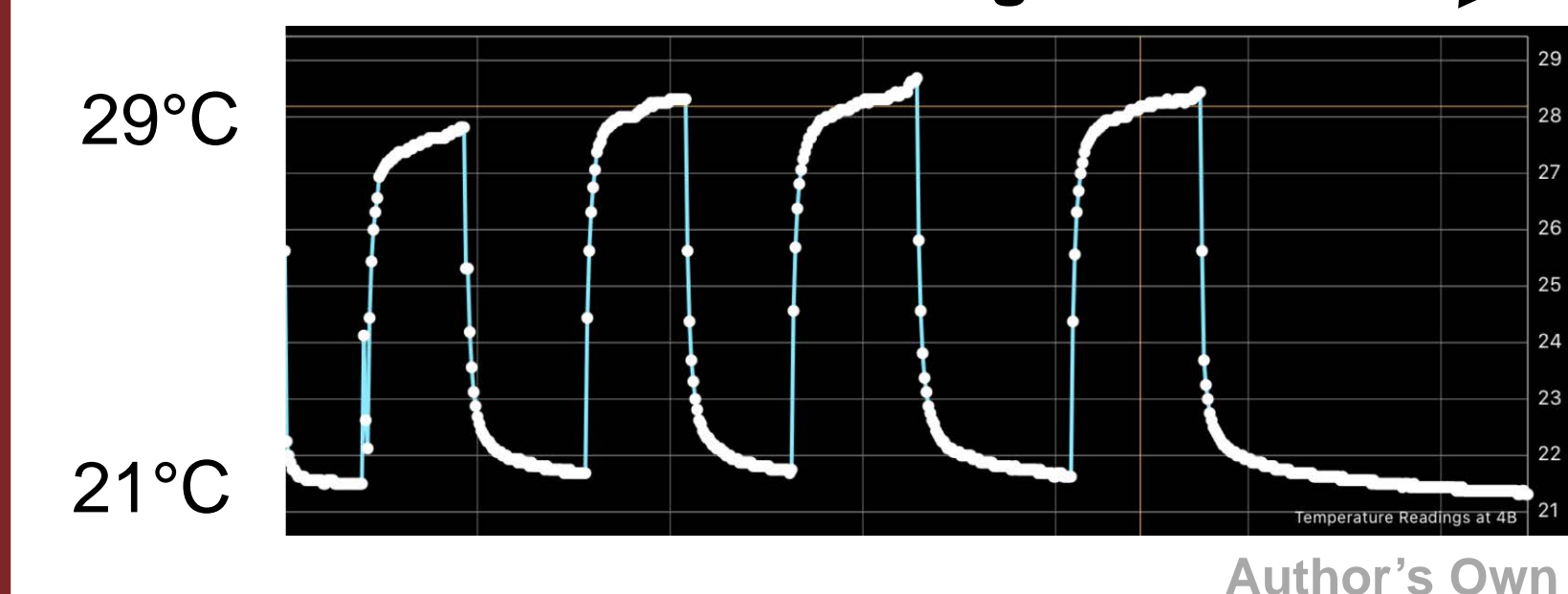
Results and Impact

- Evaluated a large number of solder types and polymer materials to establish a robust method of attachment
- The existing process can accommodate a variety of electrical and optical sensors with maximum size of ~ 3 x 5 mm
- Current length of fiber is 5 m, with plans to extend to 300 m
- Existing data rates are kbps, with plans to scale up to Mbps (electrical bus) and Gbps (optical)
- We are currently open for inquiries for prototype design and demonstration of functional fibers

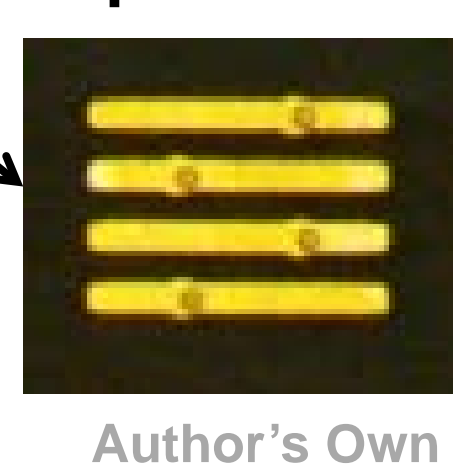
Interposer PCB integrated into polycarbonate fiber with temperature sensor and LED



Temperature measured over time in fiber for LED turning on and off



Bottom View of Interposer PCB



Spool of 5-meter fiber with embedded sensors and illuminated LEDs



Glove with embedded temperature sensors in fingers

