

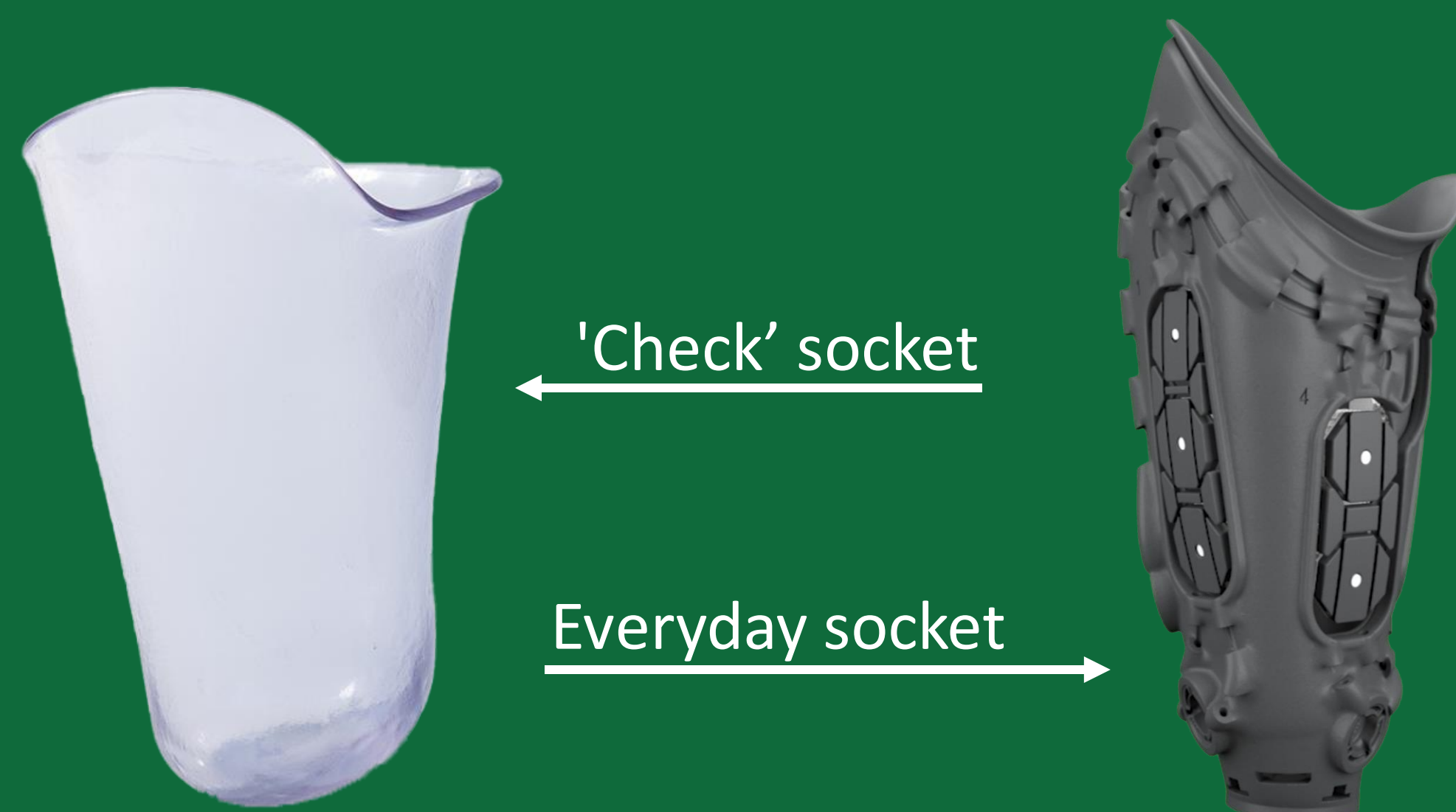


Motivation

- **Reduce** time spent during fitting process
 - Sessions last ~3 hours
- **Improve** patient to practitioner communication
 - The location of discomfort is not always directly related to high pressure areas
- **Provide** an extra tool for prosthetic fitting
- **Optimize** comfort for prosthetic users
- **Output** quantitative and visual data
- **Inform** prosthetics engineering and design

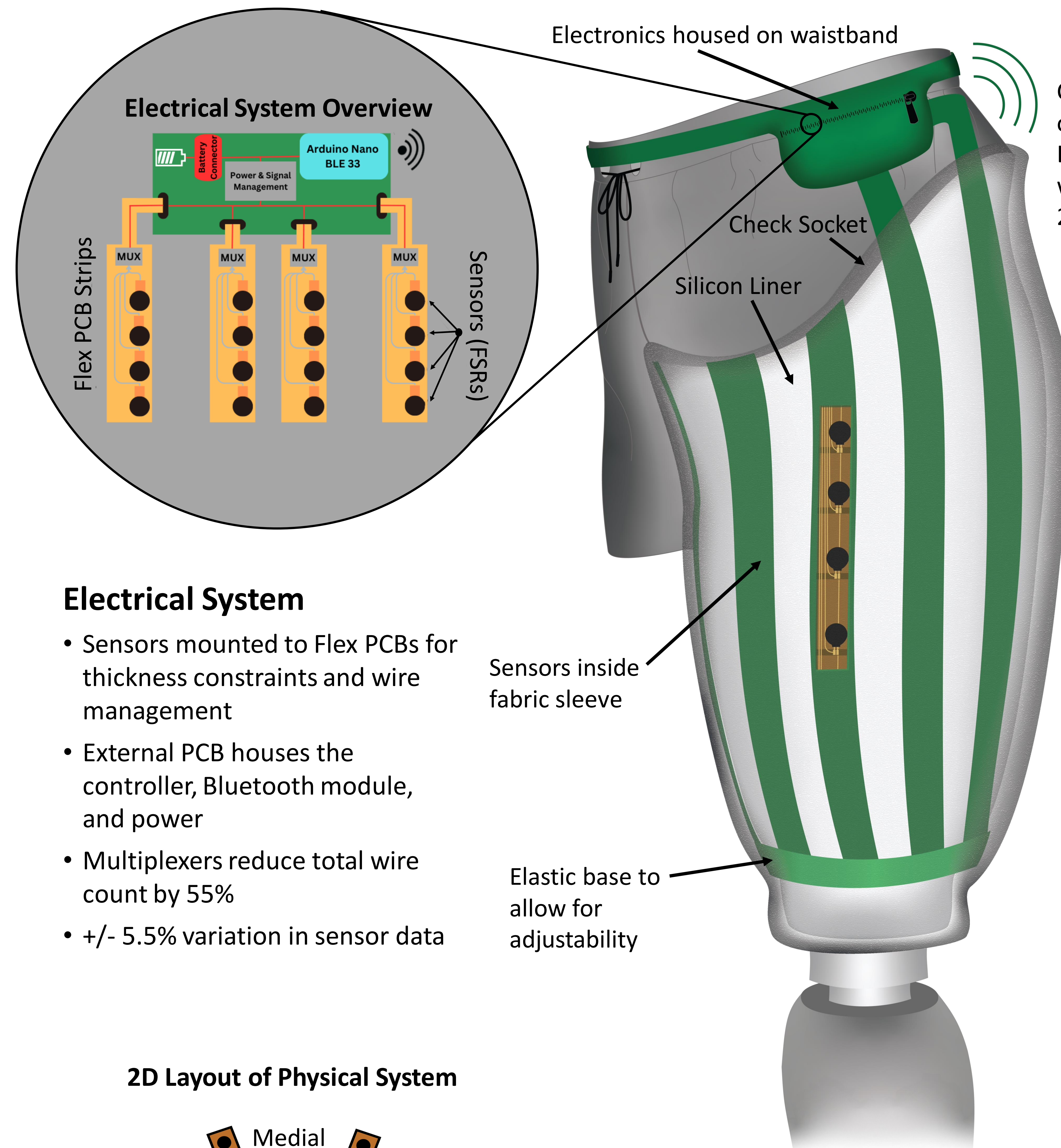
Prosthetic Fitting Process

- Silicone liners used to protect and secure limbs in prosthetics via suction, pin-locking, etc.
- Thermoplastic 'check' socket vacuum formed at 325°F
- High-pressure areas are currently communicated verbally
- A heat gun reshapes socket to offload pressure from more sensitive areas
- Changes in limb geometry due to muscle atrophy require multiple sessions
- 'Check' socket is 3D scanned then used as the basis for the daily use socket



Design Requirements

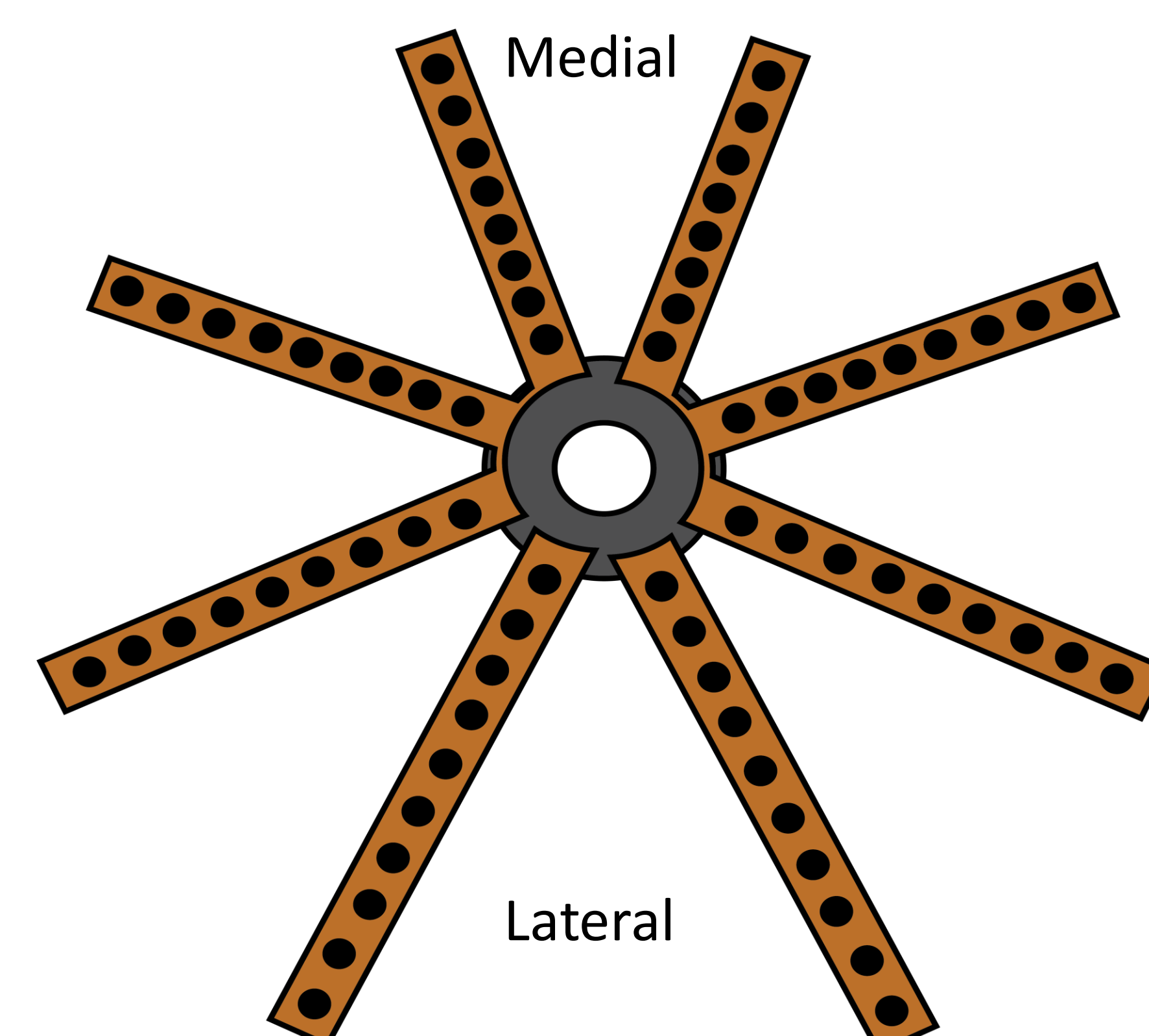
- ✓ Low profile: fabric, PCB, & sensor assembly must be ≤ 0.04 inches thick
- ✓ No extruding electronics on the patient's medial (center) side
- ✓ Adjustable to a range of limb sizes
- ✓ No interference with patient's mobility
- ✓ Quantitative and qualitative data outputs
- ✓ Independent of the prosthetic



Electrical System

- Sensors mounted to Flex PCBs for thickness constraints and wire management
- External PCB houses the controller, Bluetooth module, and power
- Multiplexers reduce total wire count by 55%
- +/- 5.5% variation in sensor data

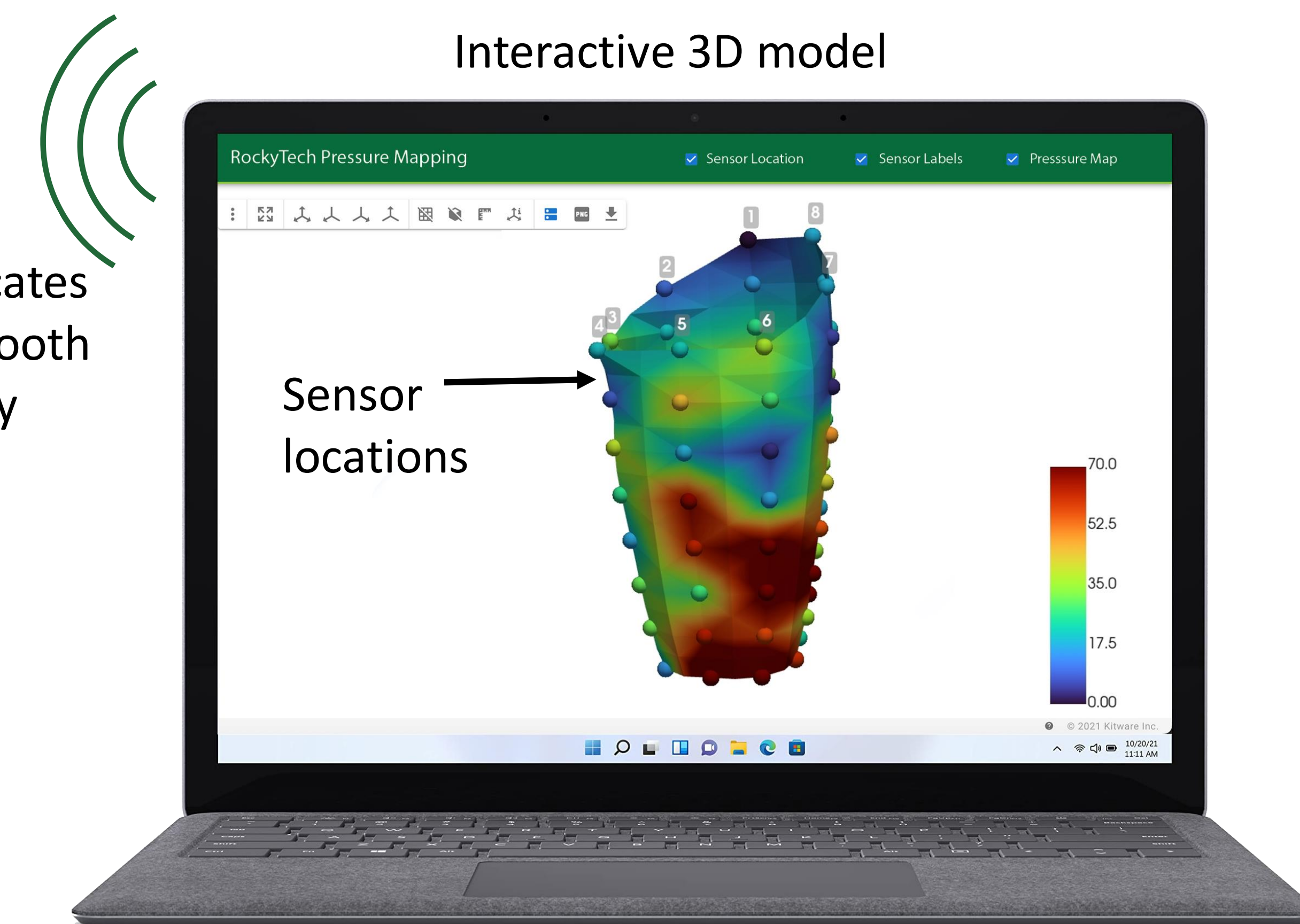
2D Layout of Physical System



Physical System

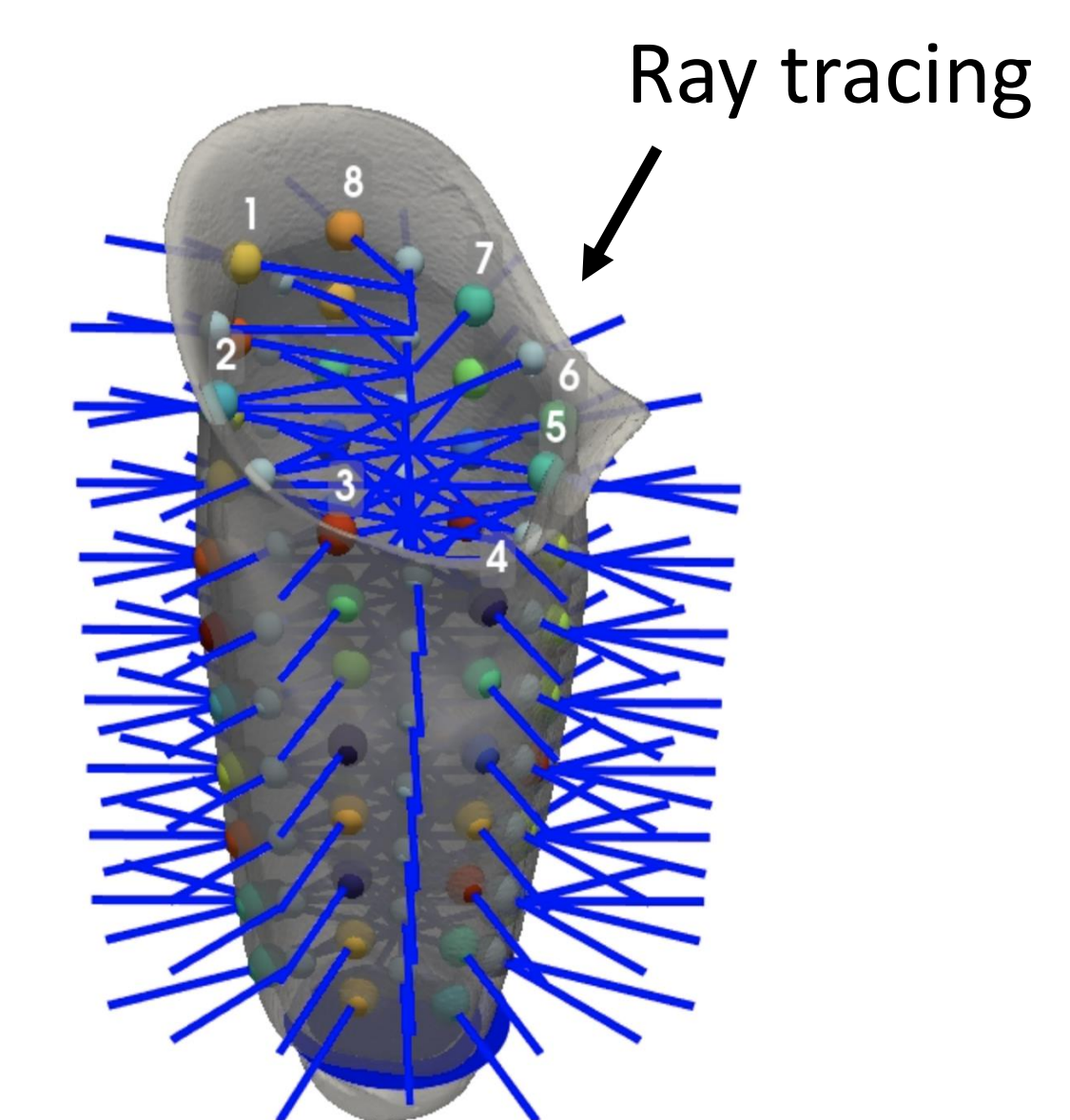
- 'Spider' Design is adaptable to multiple limb sizes
- Asymmetrical design to avoid electronics in sensitive areas
- Product lays between silicone liner and 'Check' socket
- 8 strips with 70 total sensors
- Designed for above-knee amputations

Communicates over Bluetooth Low Energy with a 25'+ range



Software System

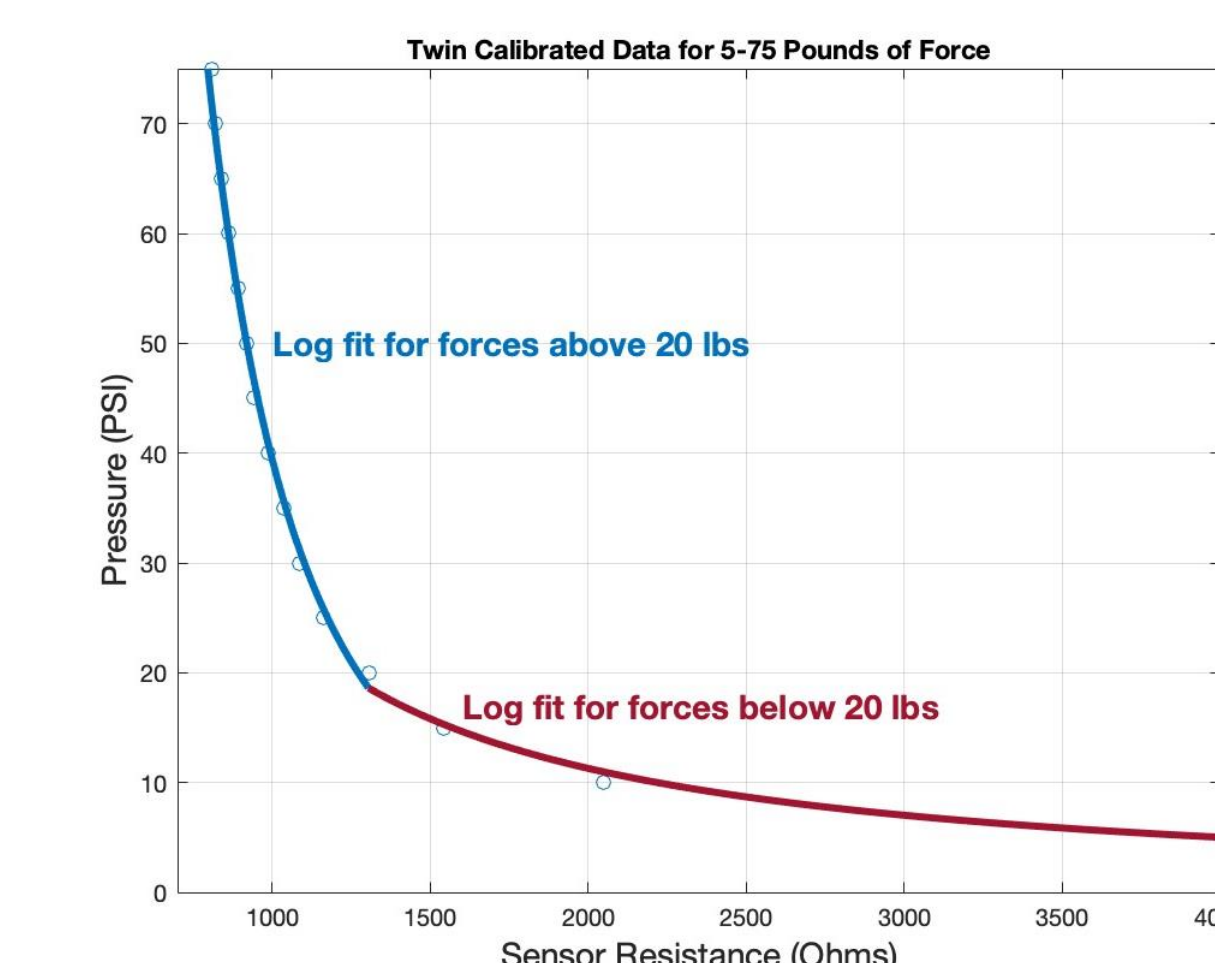
- Near-live visuals of pressure
- Displays a color-coded, interpolated pressure map (qualitative data)
- Provides exact, absolute sensor readings (quantitative data)
- Uses ray tracing to simplify 3D scan of socket



2700x more space efficient than directly using 3D scan

Testing Results

- 820Ω provides the highest sensitivity for the estimated force range
- Flex PCB connectivity maintained for 10,000 cycles of bending at 90°



A two-part log fit calibrates sensors to output accurate force values from 5-75 PSI.

Future Work

- Refine calibration with narrowed pressure range
- Conduct human testing with complete system
- Design for below-knee and children's socket