

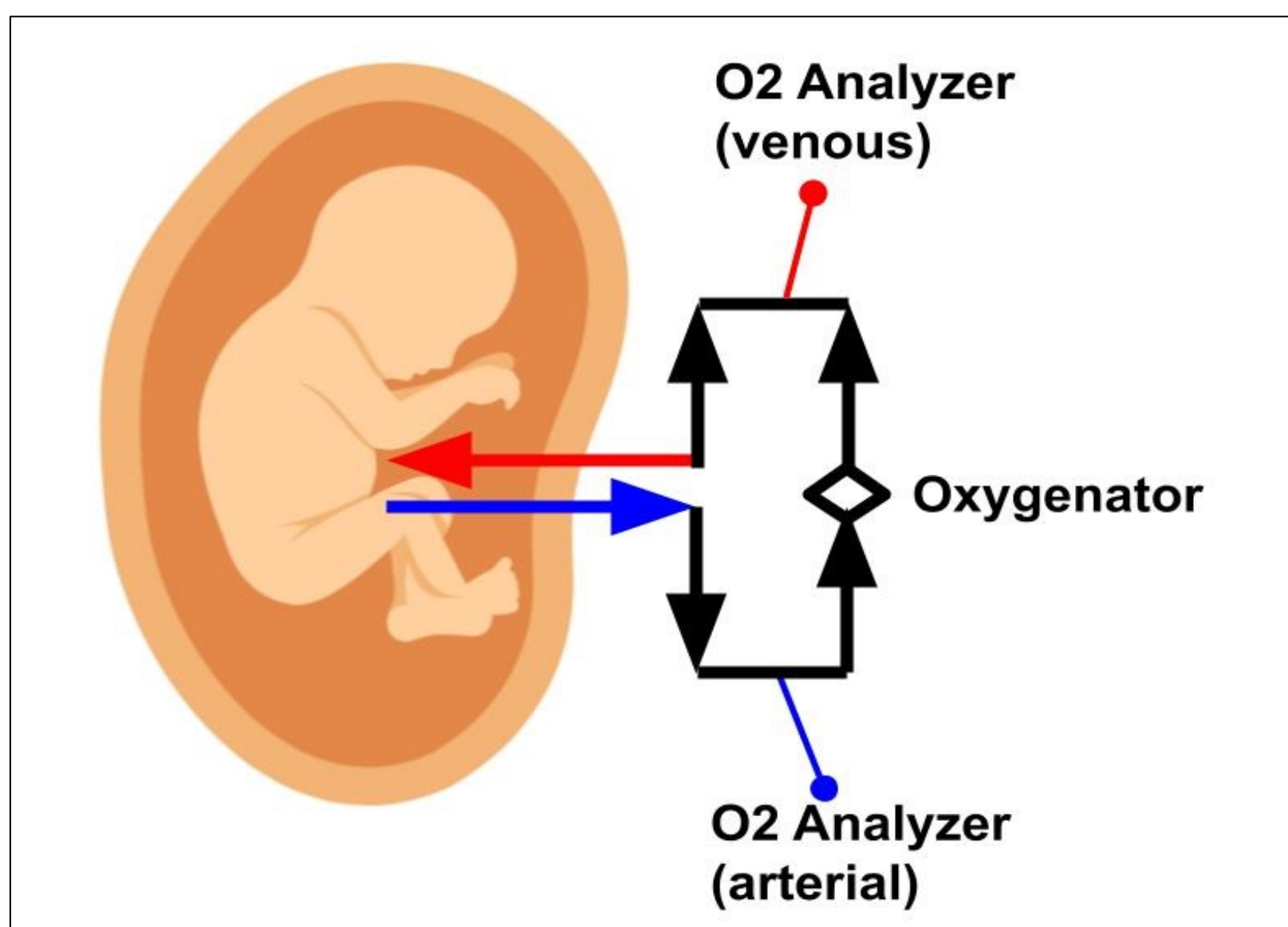
# 11 Non-Invasive Pulse Oximeter for an ECMO Circuit

**Team:** Katie Aleszczyk, Jake Karwoski, Isabel Kuzy, Maddie Tran, Connor Zabielski

**Advisors:** Chris Campbell, Bartosz Jaskulski, Andre Maitre

## Need

**Problem** - The Vitara Extend system (led in development by Dr. Marcus Davey), an artificial womb device, requires accurate blood oxygen (SO<sub>2</sub>) readings through their extracorporeal membrane oxygenation circuit (EMCO) throughout treatment.



**ECMO circuit**  
Blood is removed from patient's body through umbilical artery, oxygenated, and reintroduced through umbilical vein.

**Objective** - Design a cost-effective oximeter for use on an ECMO circuit that provides accurate blood SO<sub>2</sub> characterization in a NICU environment

## Existing Solutions

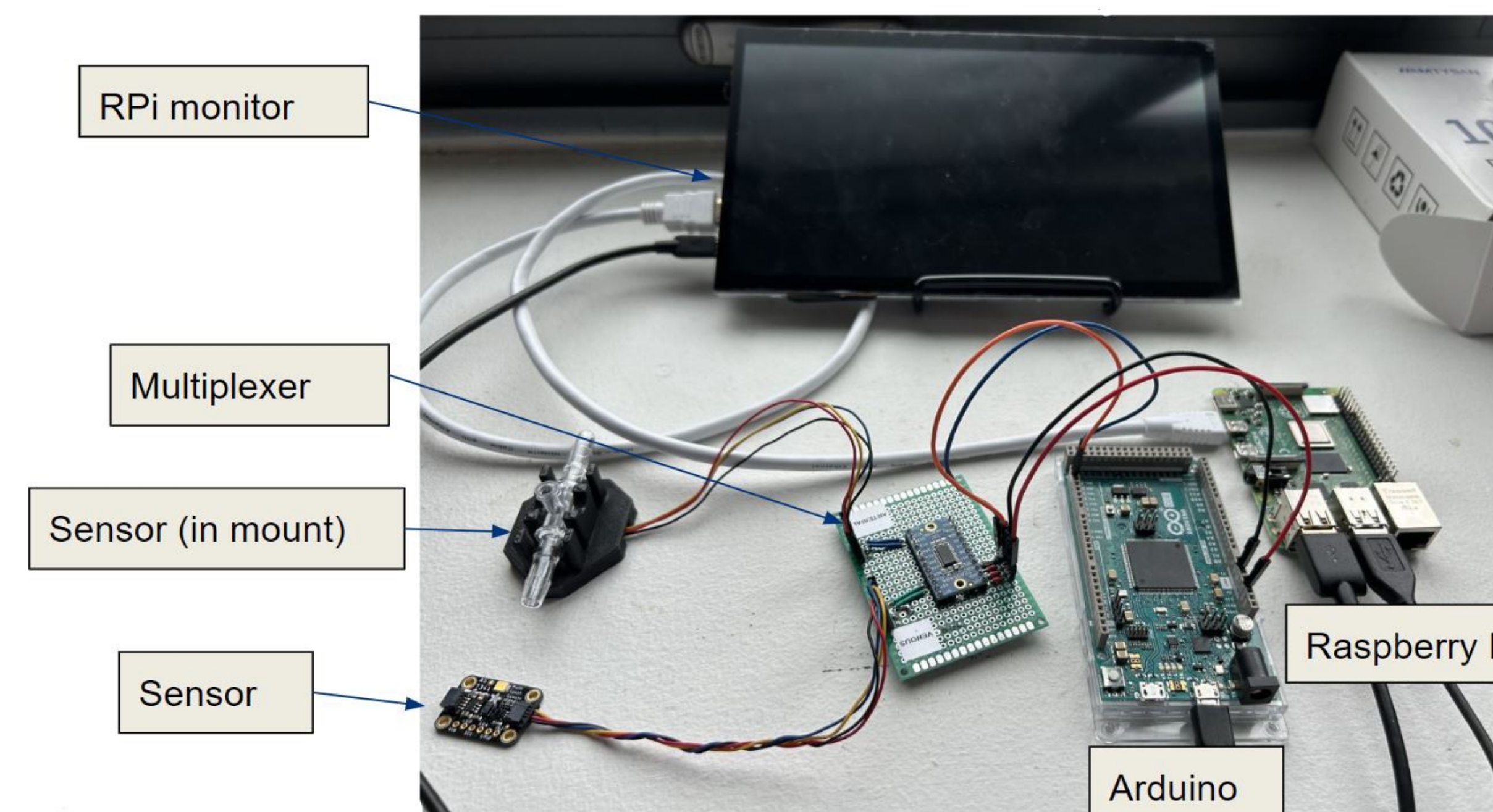
- *Spectrum Medical Quantum Perfusion*: prohibitively expensive (\$50,000/ct.)
- *Senior Design 2021-2022*: No GUI, live calibration, or system integration

## Design Inputs

C#	Name	Constraint
C6	Fixture Dimensions	Compatible with Gantry + Fittings
R#	Name	Requirement
R1	Sampling Rate	>= 1 Hz
R2	Data Storage	>= 48 MB
R3	SO <sub>2</sub> Accuracy	+/- 2% within Spectrum readings
R4	Calibration Mode	+/-2% within Spectrum readings
R5	GUI Display	Displays SO <sub>2</sub> plot vs real time

## Assembly / Intended Use

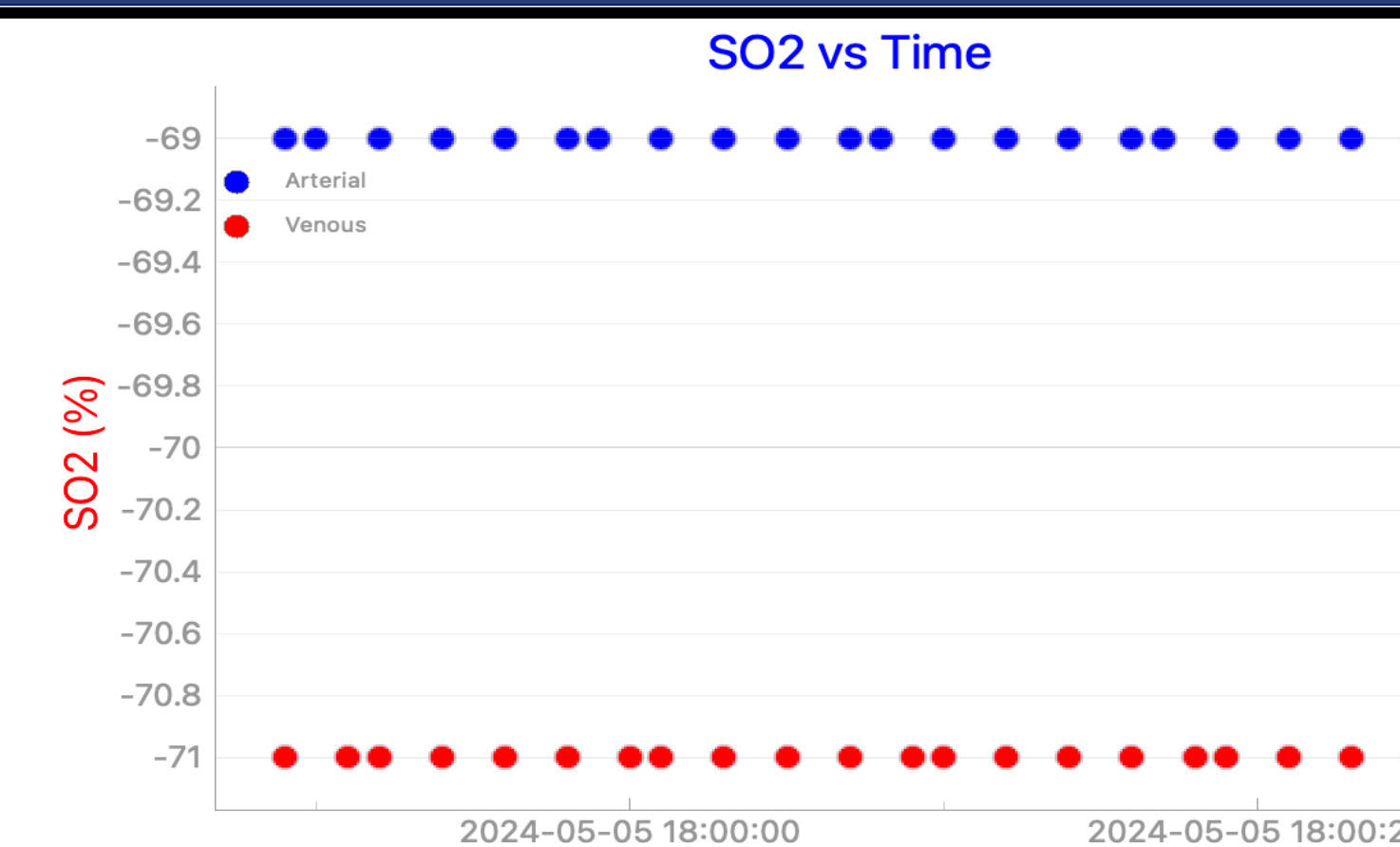
**Build** - The *sensor* reads the *color of blood*, and data is analyzed by the *Arduino Duo*. *Linear regression model* converts the RGB to SO<sub>2</sub>, which are fed to *Raspberry Pi*, where they are then plotted onto a *GUI display*.



## Component Details

### Front-End

**LCD Screen** – Trend line and display modes, calibration screen



### Back-End

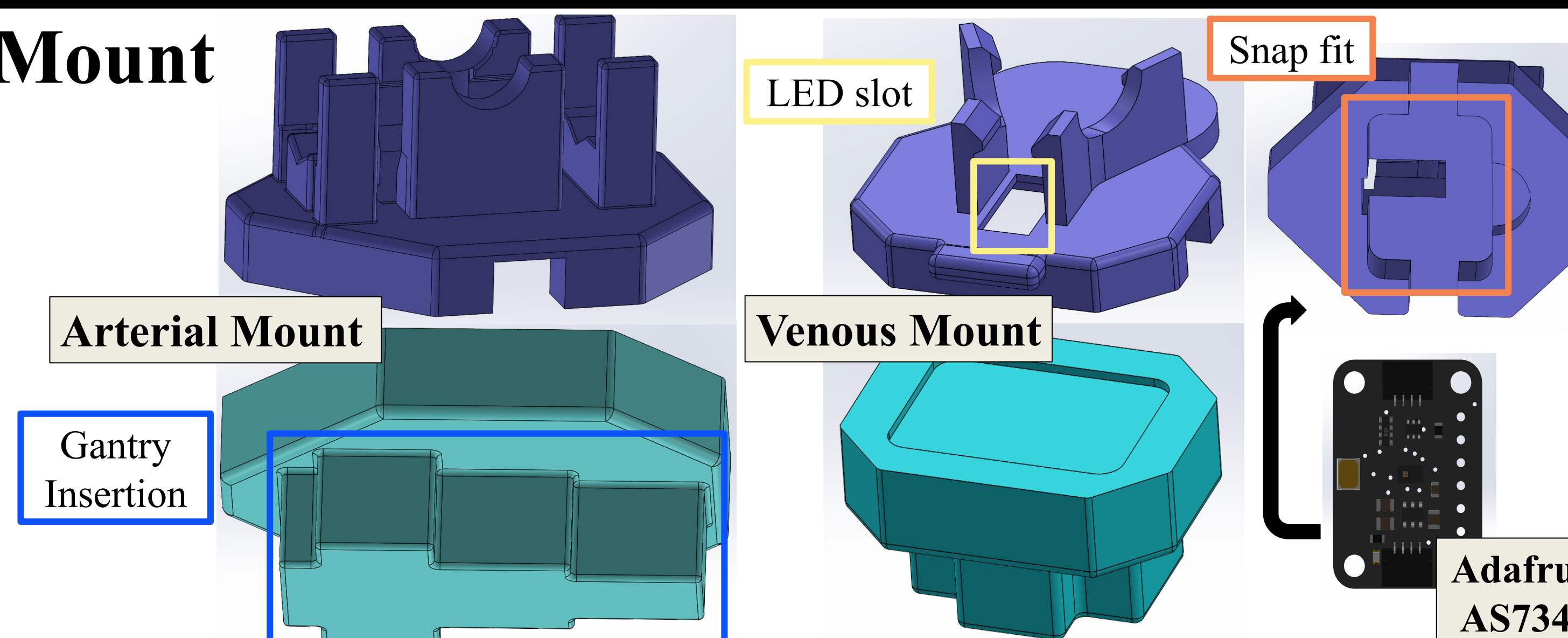
**RGB to SO<sub>2</sub> linear regression model** – Converts raw sensor data to SO<sub>2</sub> %

**Model**  

$$SO_2 \sim Y + R + G + B$$

$$R^2 = 0.866$$

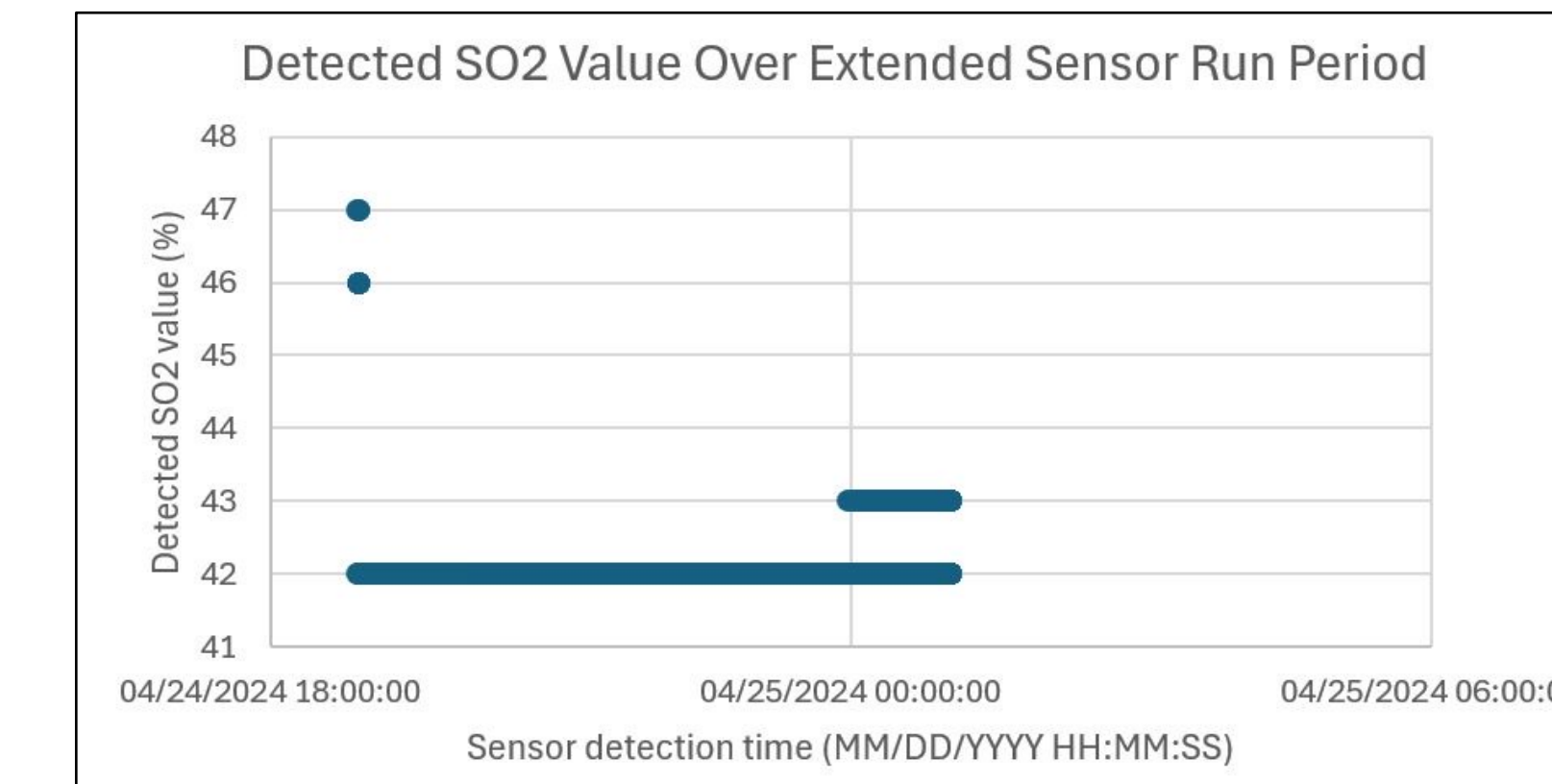
### Mount



## Verification/Validation

**SO<sub>2</sub> Consistency:** Determines presence of drift (R3)

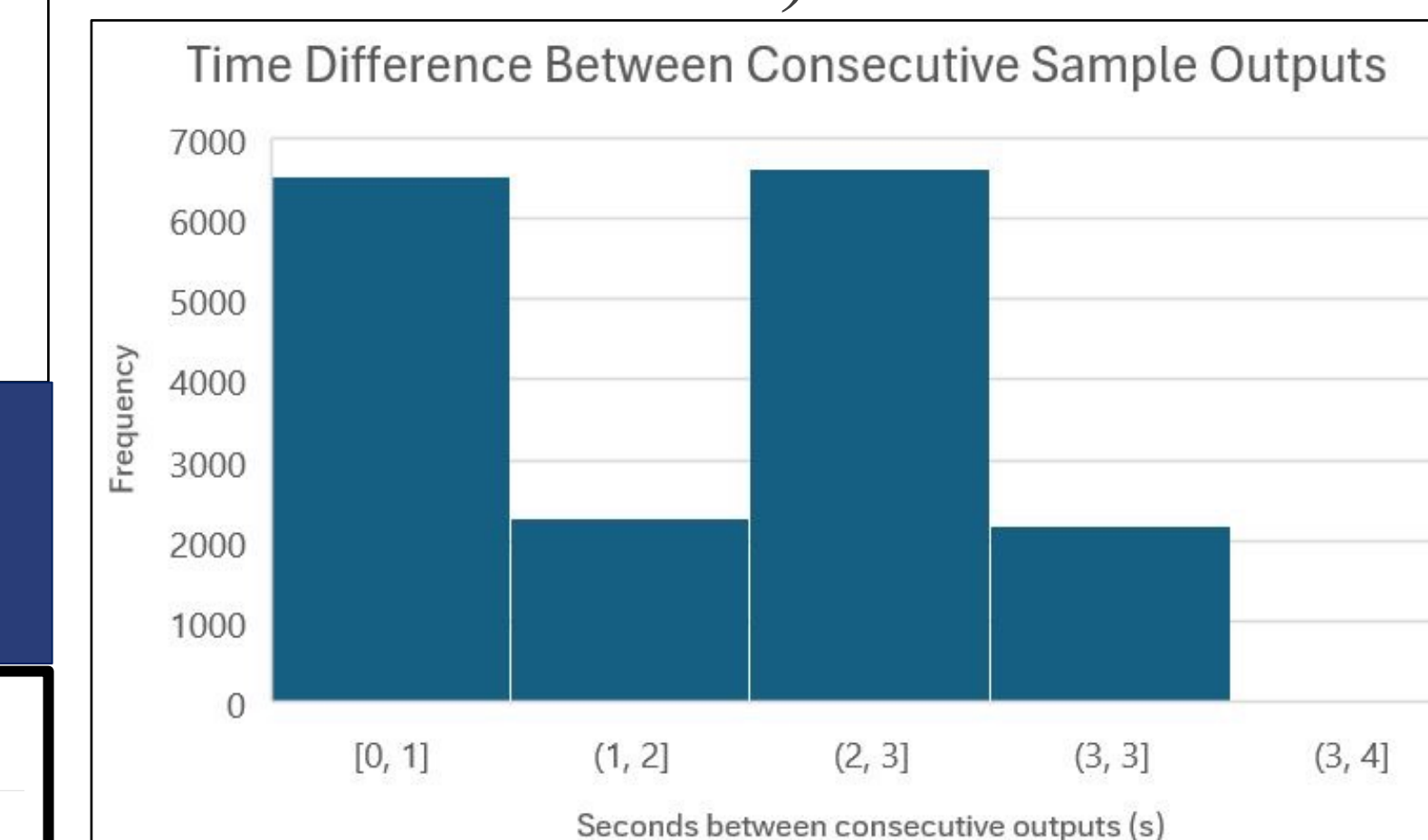
- **Results:** SO<sub>2</sub> values consistently remained at 42-43%



**SO<sub>2</sub> readings remained within 2% of 42% - TEST PASSED**

**Sampling Rate:** Ensure sampling rate is = 1 second

- **Results:** Avg. Sampling rate = 1 second (supported by Wilcoxon test)



**Wilcoxon Signed Rank test: (p << 0.05) – TEST PASSED**

## Conclusion

### Accomplishments

- Component Design and assembly complete
- Majority of verification tests passed

### Innovations

- Sensor mount design allows for integration into Vitara Extend System
- Calibration mode and GUI Display

### Impact

- More cost-effective compared to Spectrum
- Increased autonomy over oximeter device

### Acknowledgements

- Vitara Biomedical Advisors
- Drexel University School of Biomedical Engineering and Health