



FAMU-FSU  
College of  
Engineering

# T506: Wearable Gas Detector

Design Review 6

# Team Introduction



Physical Design

Software & Coding

Integration



1010  
1010



1010  
1010



**Shawn Butler**  
*Manufacturing  
Engineer*

**Benjamin Labiner**  
*Mechatronics  
Engineer*

**Alex McIvor**  
*Power Management  
Engineer*

**Jane Nordhagen**  
*Systems  
Engineer*

**Michaela Porcelli**  
*Mechanical  
Engineer*



# Sponsor



## **Engineering Mentor**

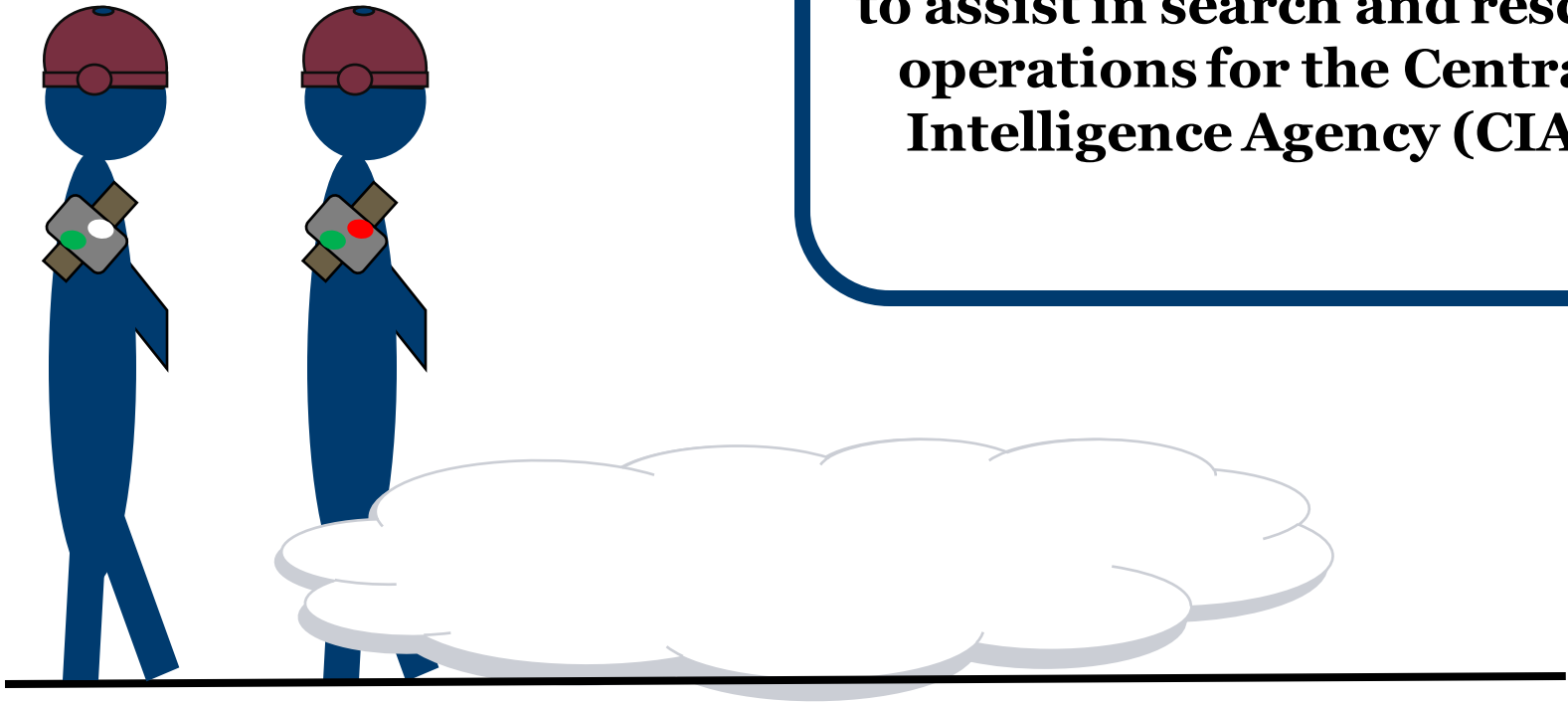
Franklin Roberts, Ben W, Tawanna, and Ray Butler

*Central Intelligence Agency (CIA)*



# Project Objective

**The objective of this project is to design a wearable gas sensor to assist in search and rescue operations for the Central Intelligence Agency (CIA)**



# Project Overview

Background, Customer Needs, Key Goals and Assumptions, Targets



# Background



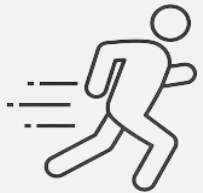
Building collapse sites often contain hazardous gases, posing a danger to search and rescue responders



Current gas detectors are handheld and bulky, making them difficult to monitor and control when wearing response gear



# Customer Needs



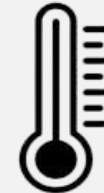
**No  
Interference**



**Alert User**



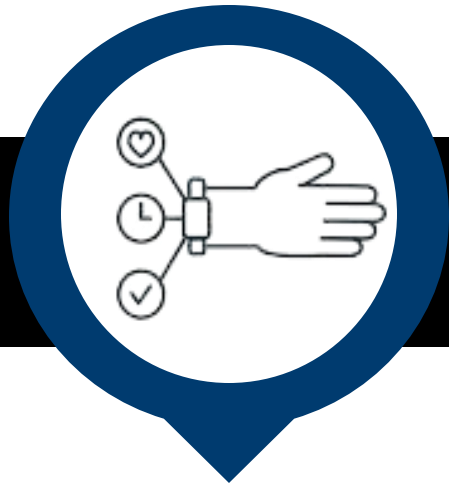
**Continuous  
Battery life**



**Temperature  
Ranges**



# Key Goals



**Wearability**

**Integration**

**Sensibility**

**Notify**





# Assumptions



**Provided LCD Screen**



**Detecting Known Gasses**



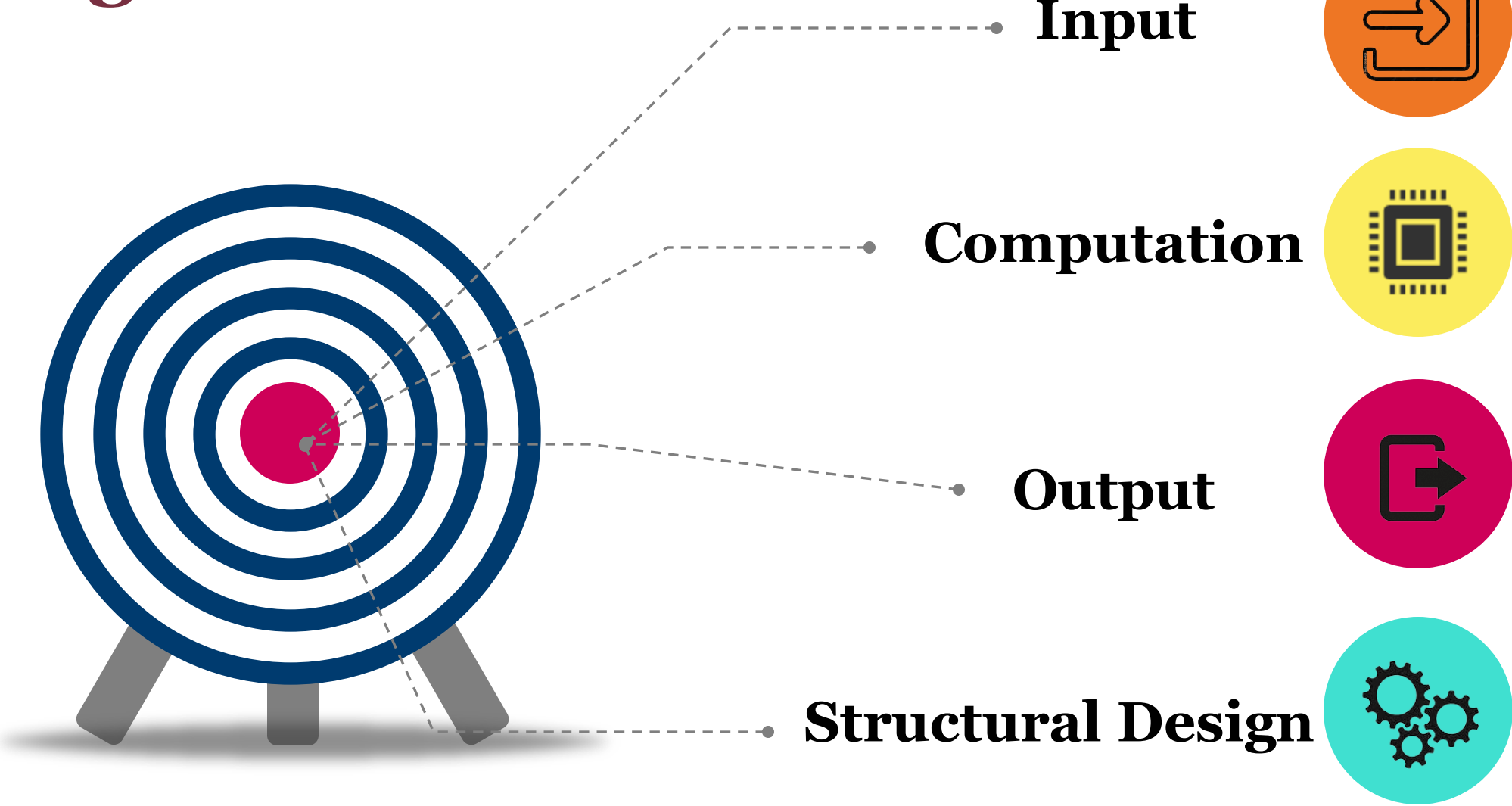
**User will use the device for long period of time**



**User will start mission in a safe standby environment**



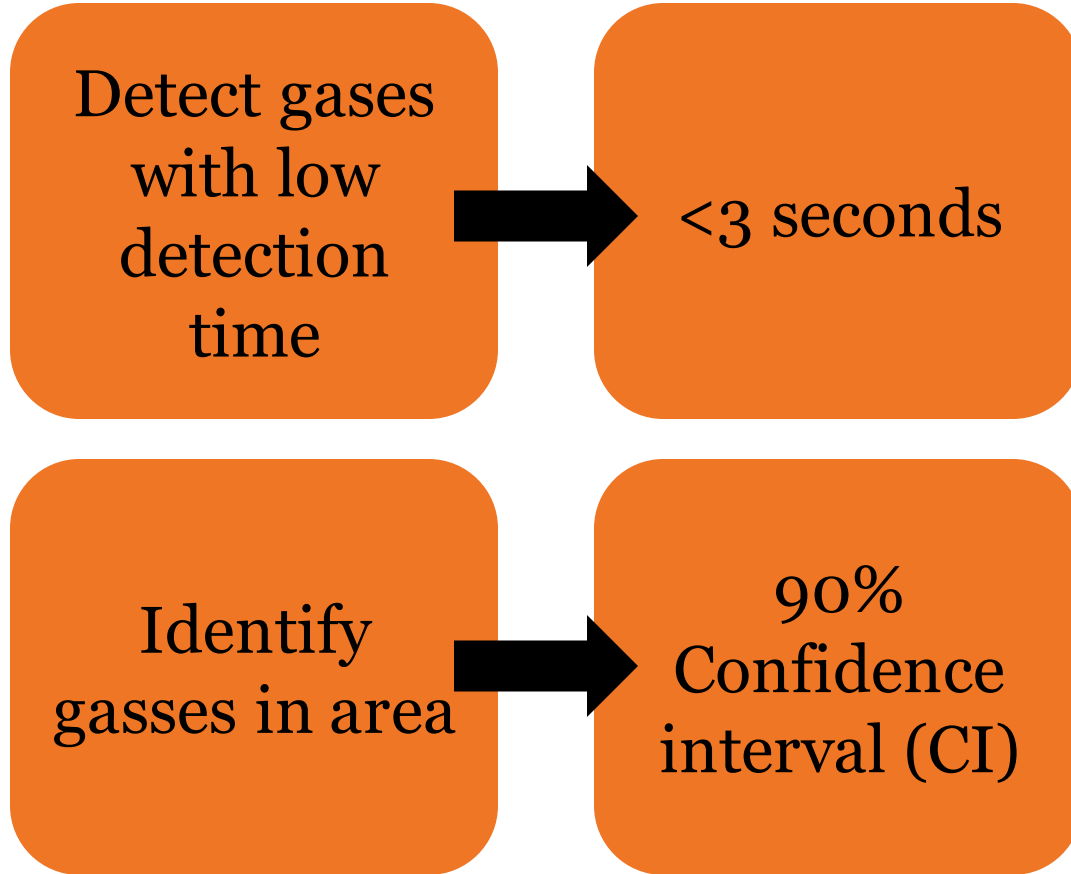
# Targets



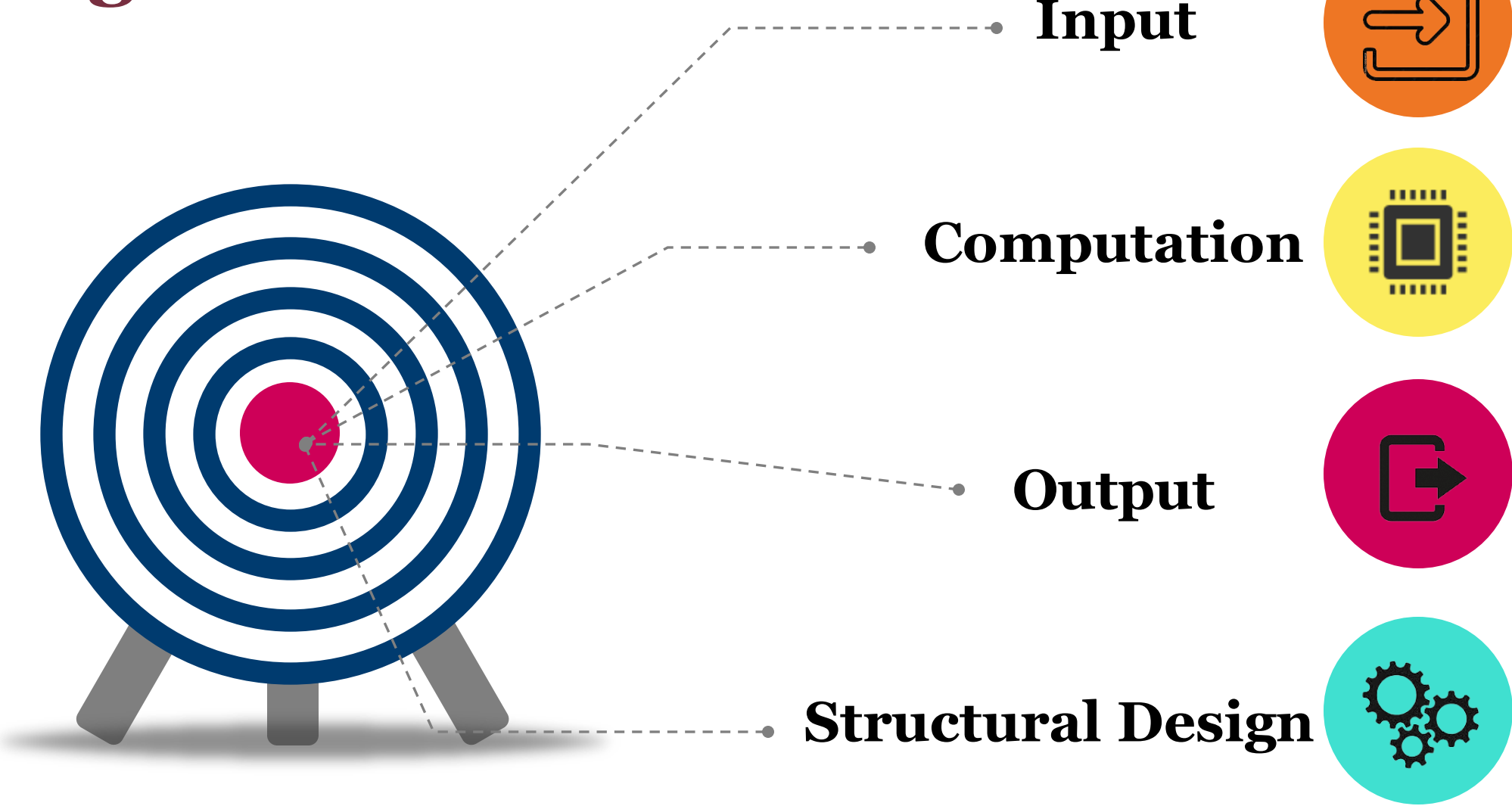
# Targets and Metrics



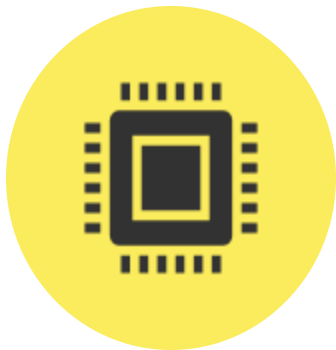
Input



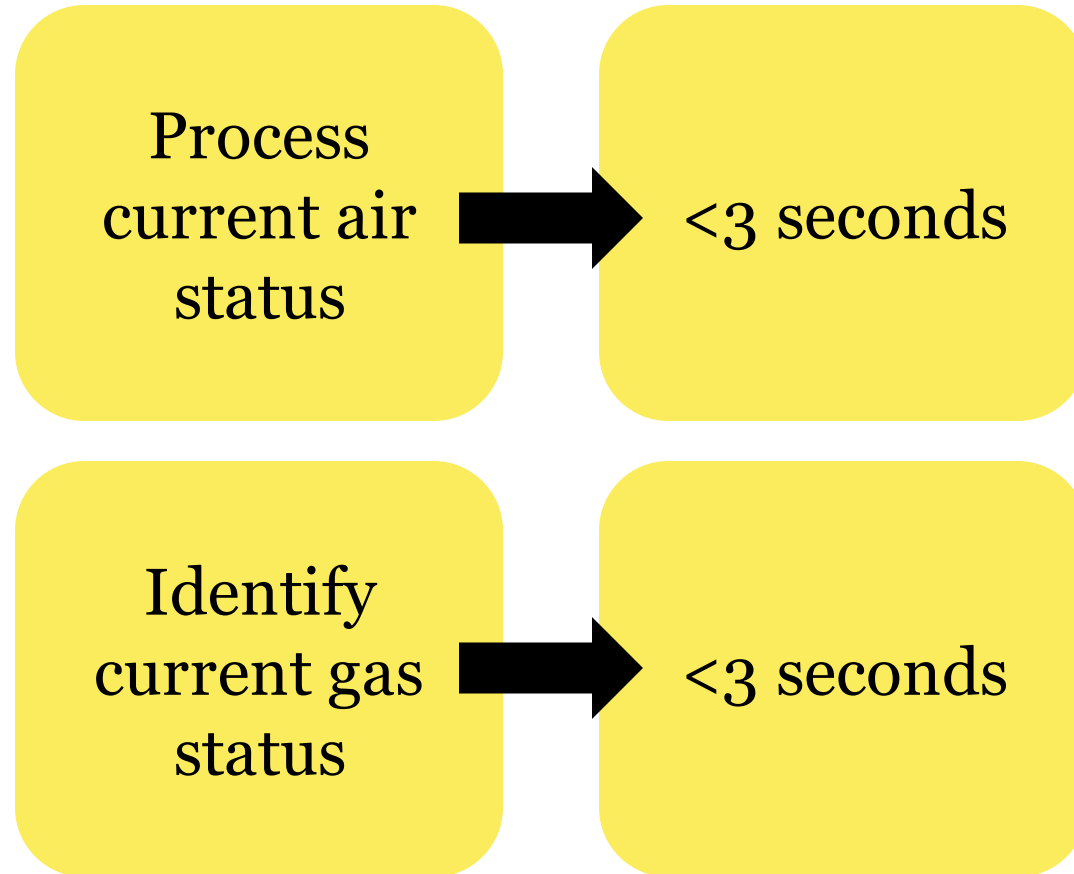
# Targets



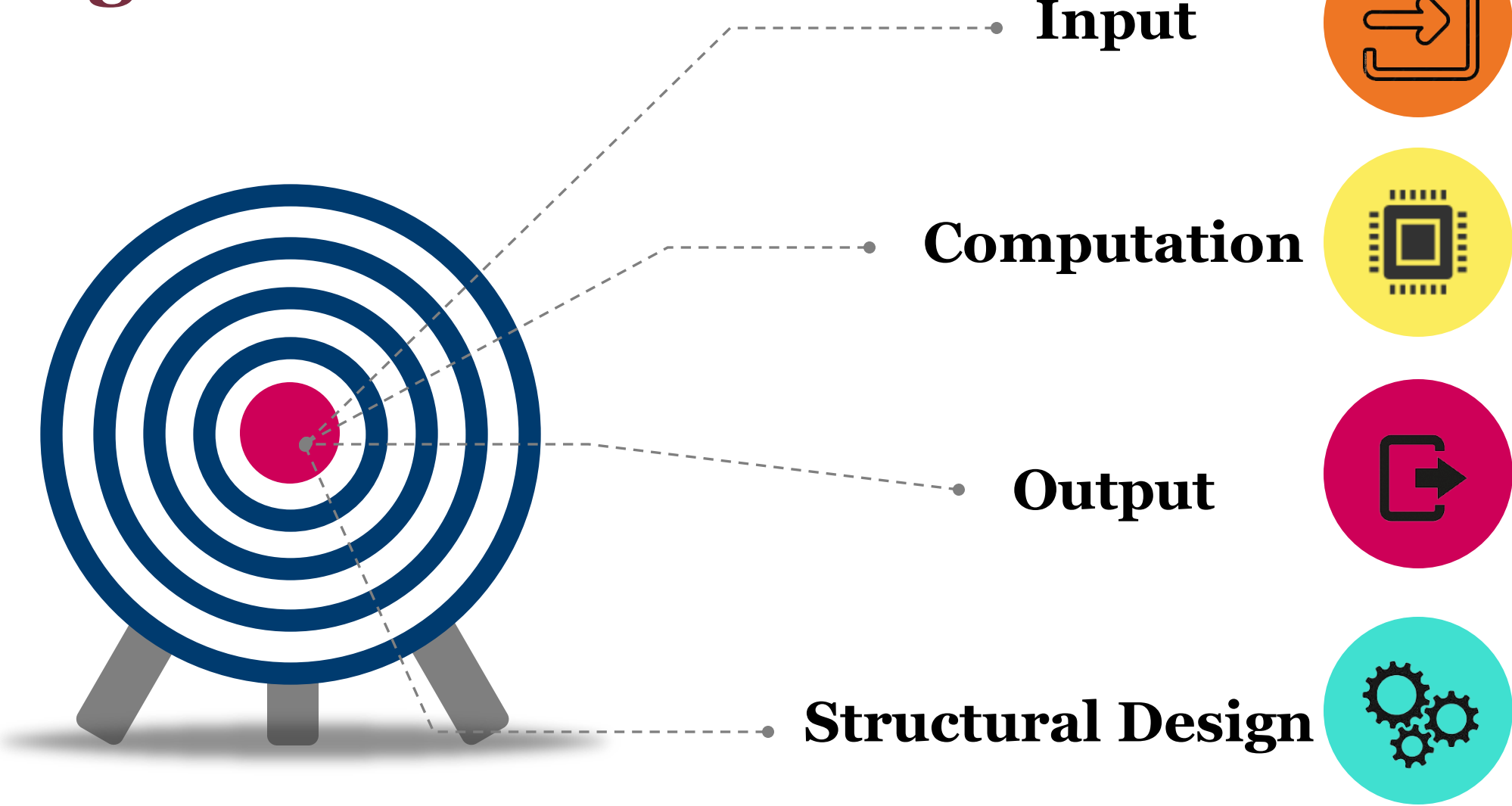
# Targets



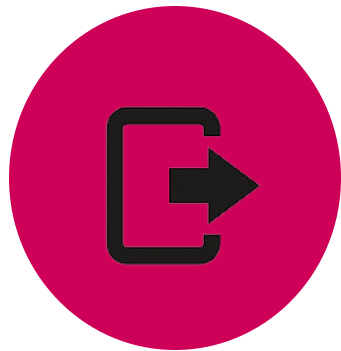
## Computation



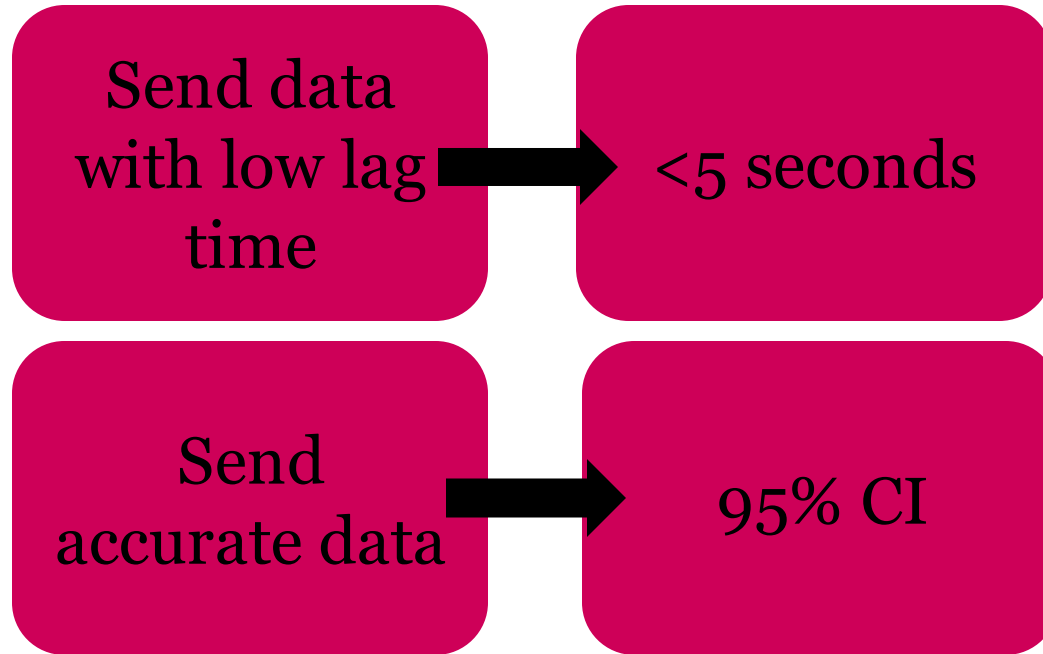
# Targets



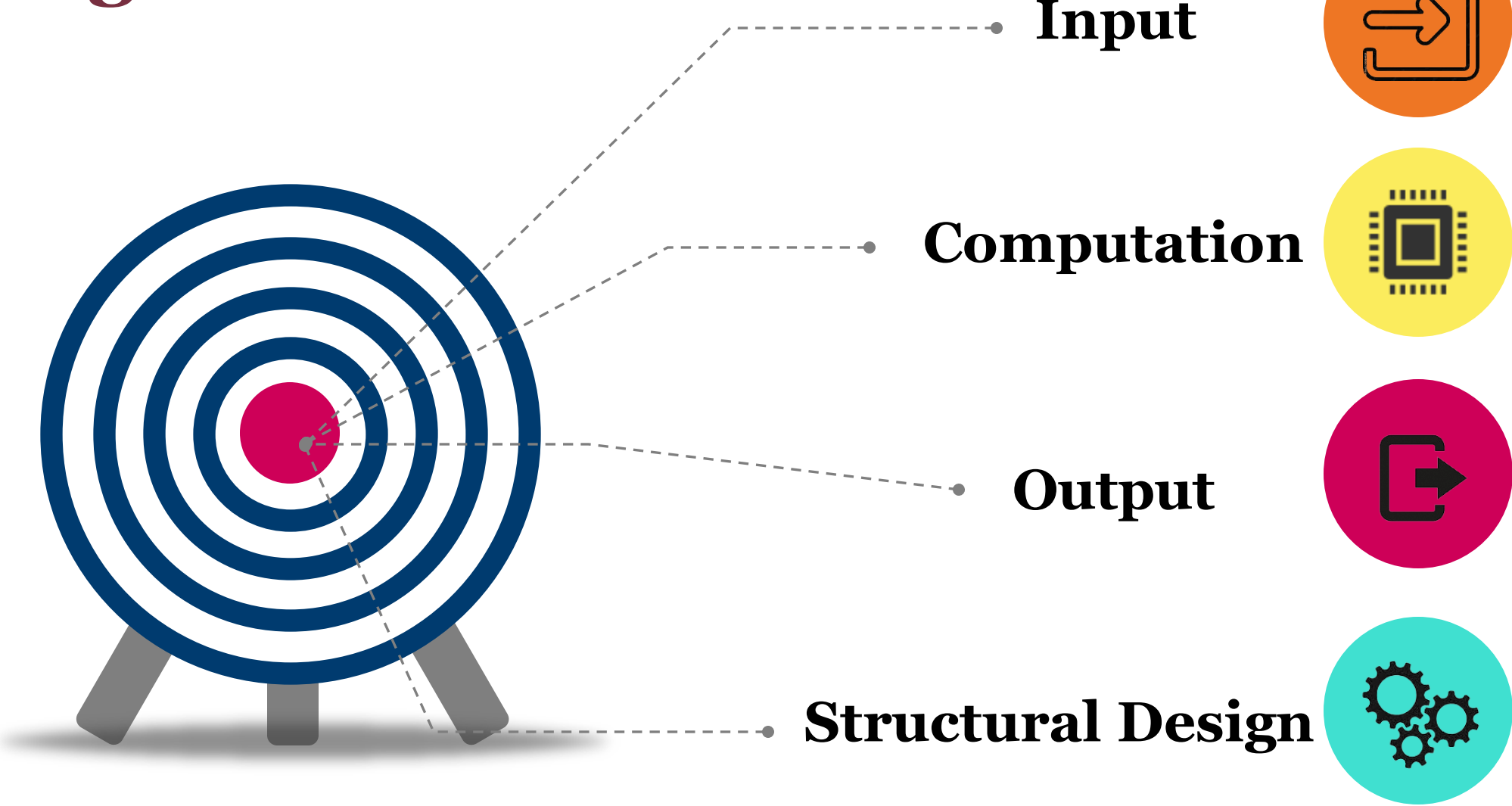
# Targets



Output



# Targets

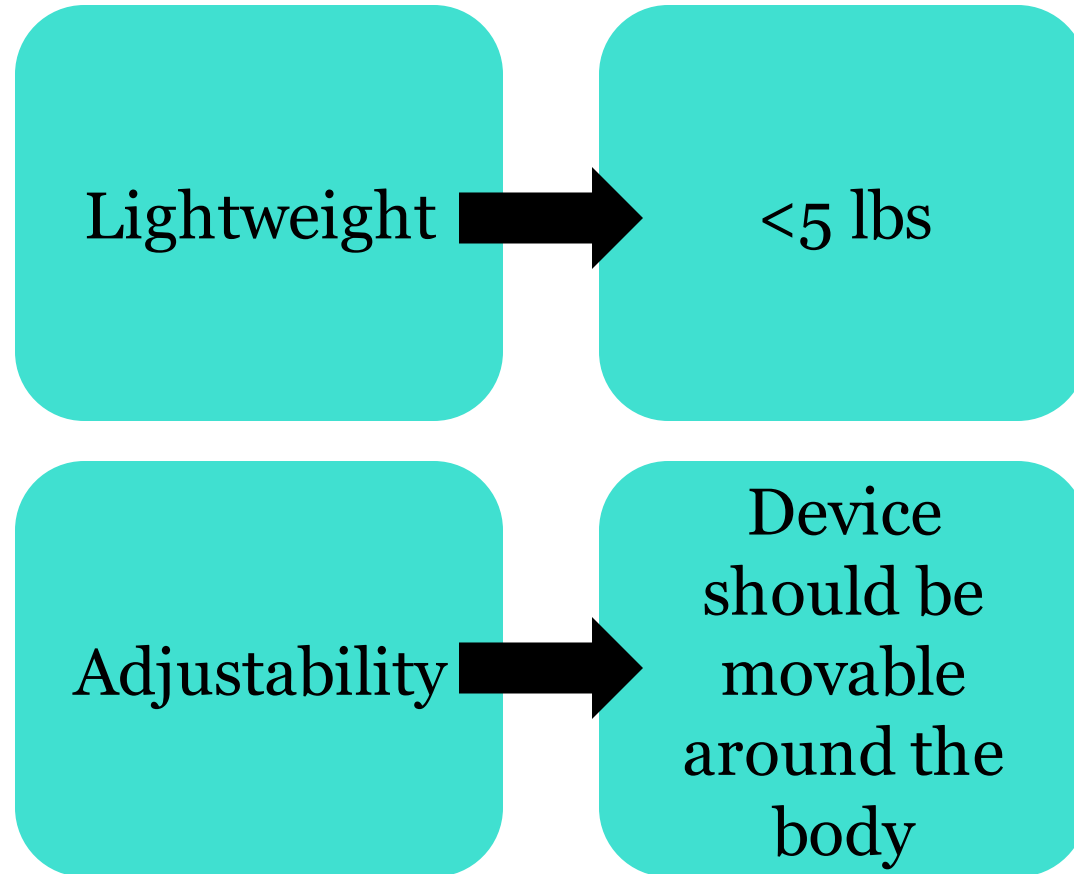




# Targets



## Structural Design

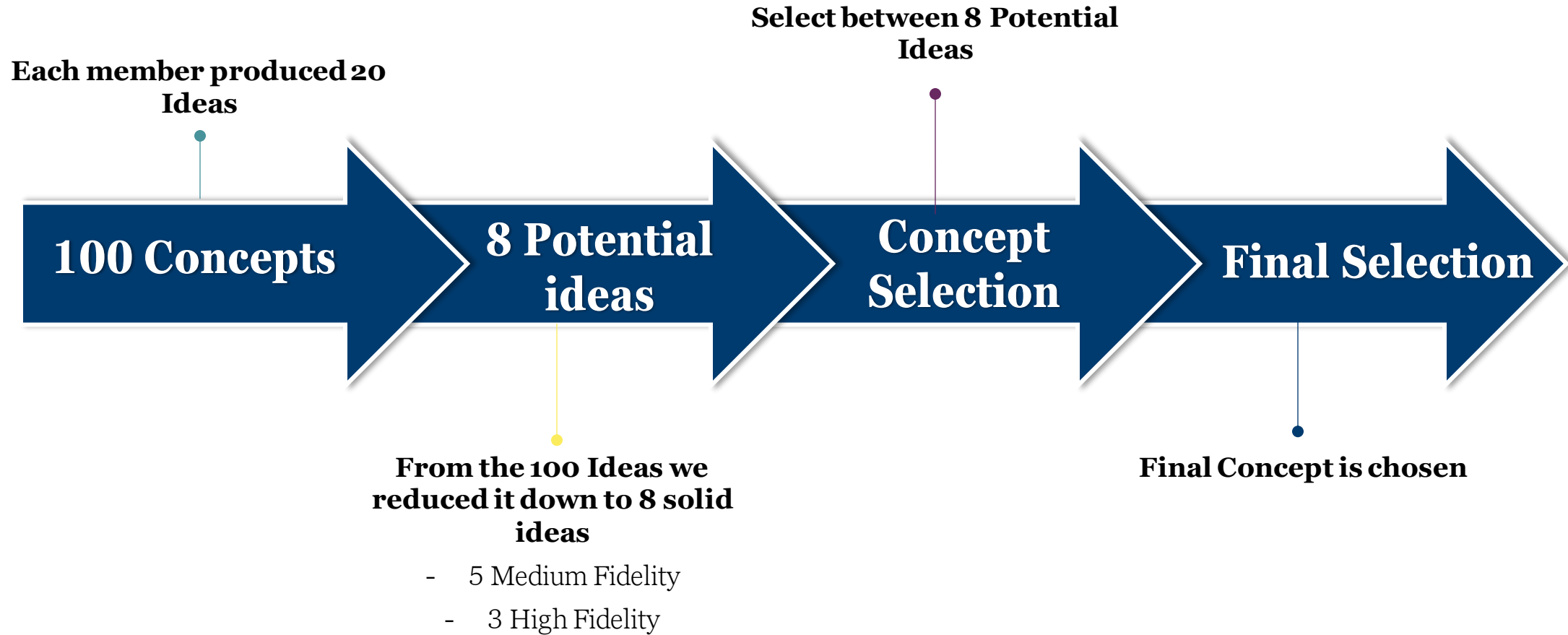


# Concept Overview

Concept Generation, Medium and High-Fidelity concepts, Concept Selection process, Final Design

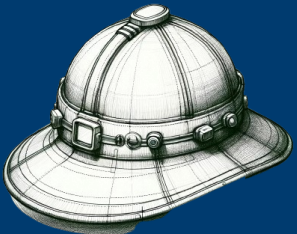


# Concept Generation and Final Selection

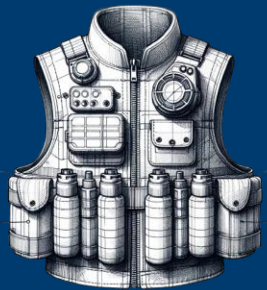


# Medium Fidelity Concepts

Concept #47:  
Hat



Concept #31:  
Vest



Concept #67:  
Boot



Concept #81:  
Belt

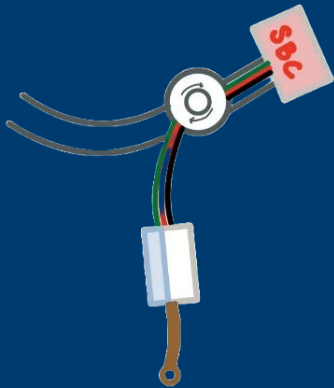


Concept #11:  
Watch



# High Fidelity Concepts

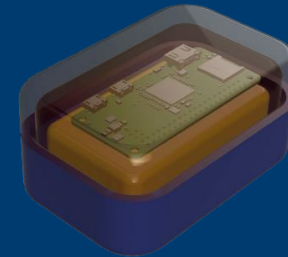
Concept #1:  
Waist Pack



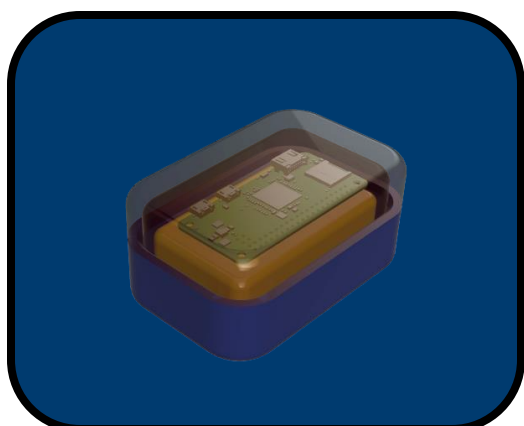
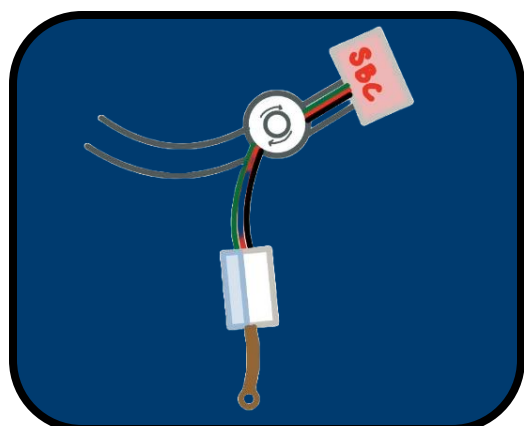
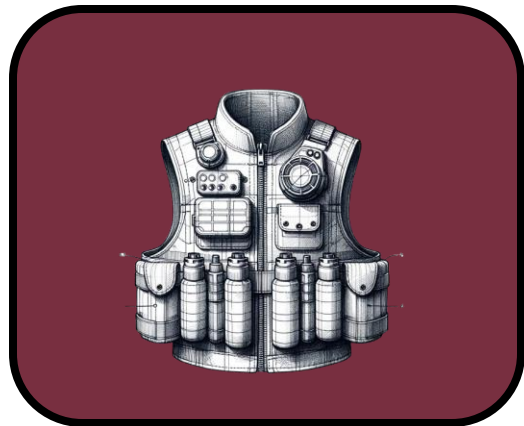
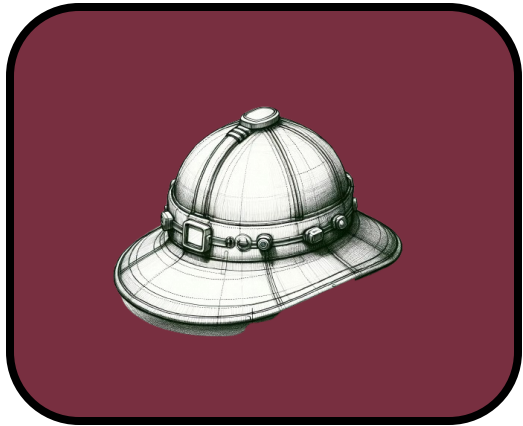
Concept #2:  
Arm Mounted  
Analog sensor



Concept #3:  
Modular Box



# Concept Selection Process



# Selected Final Design: Modular Sensing Box



Increase  
variability &  
user experience



# Selected Final Design: Modular Sensing Box



Increase  
variability &  
user experience

Can be used  
with wide range  
of displays





# Selected Final Design: Modular Sensing Box



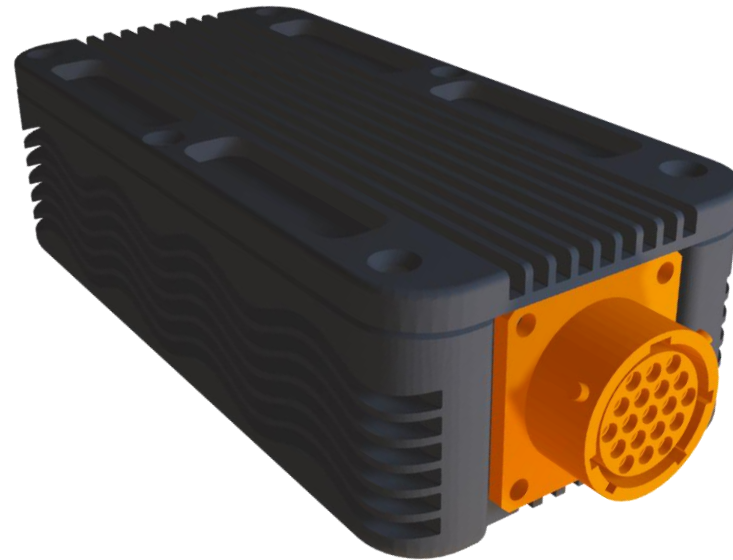
Increase  
variability &  
user experience

Can be used  
with wide range  
of displays

Sensors can be  
moved to  
appropriate  
elevations



# Selected Final Design: Modular Sensing Box



Increase  
variability &  
user experience

Can be used  
with wide range  
of displays

Sensors can be  
moved to  
appropriate  
elevations

Surrounding  
box can used  
to spread heat

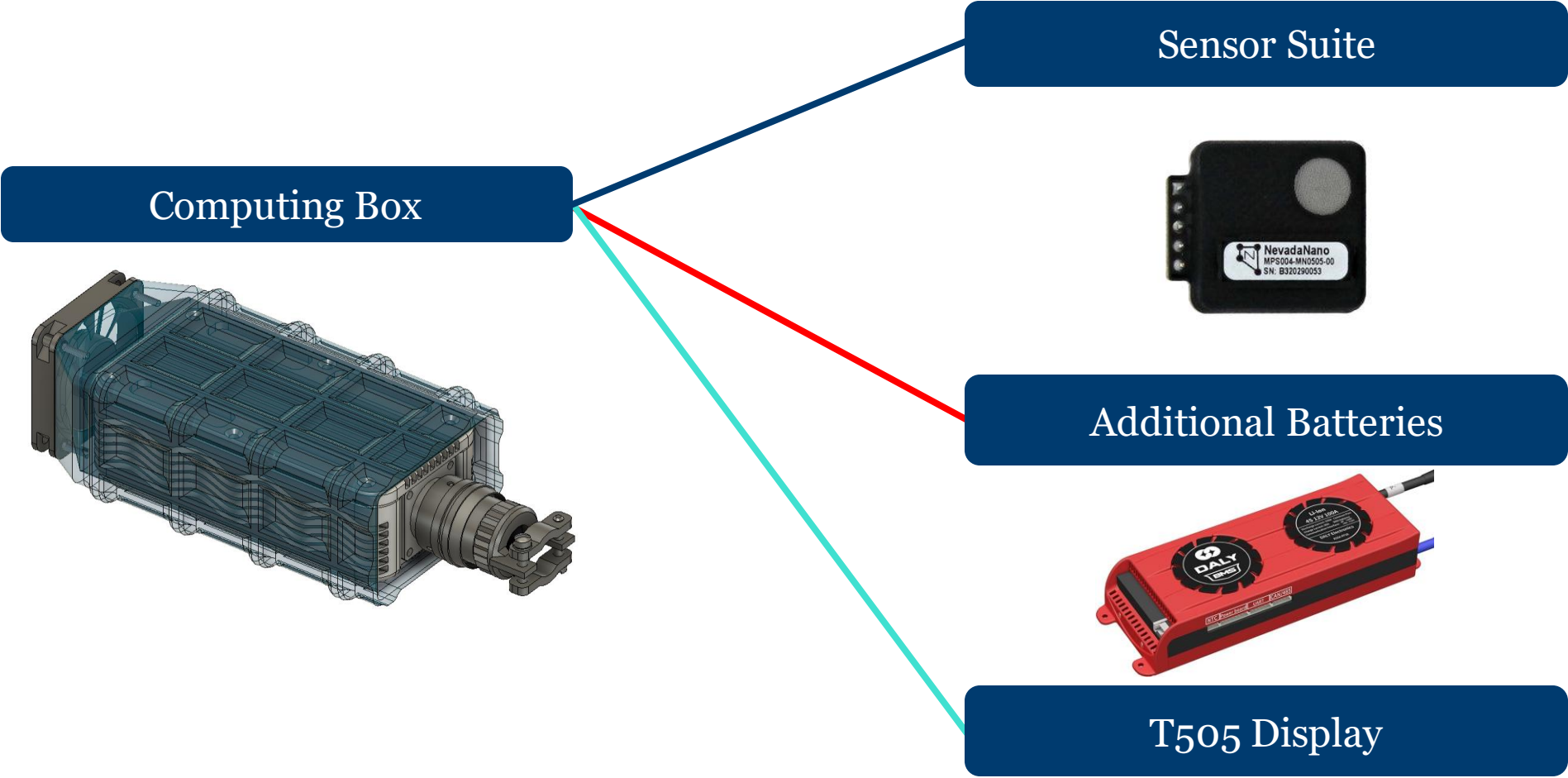


# Final Design Layout and Design Details

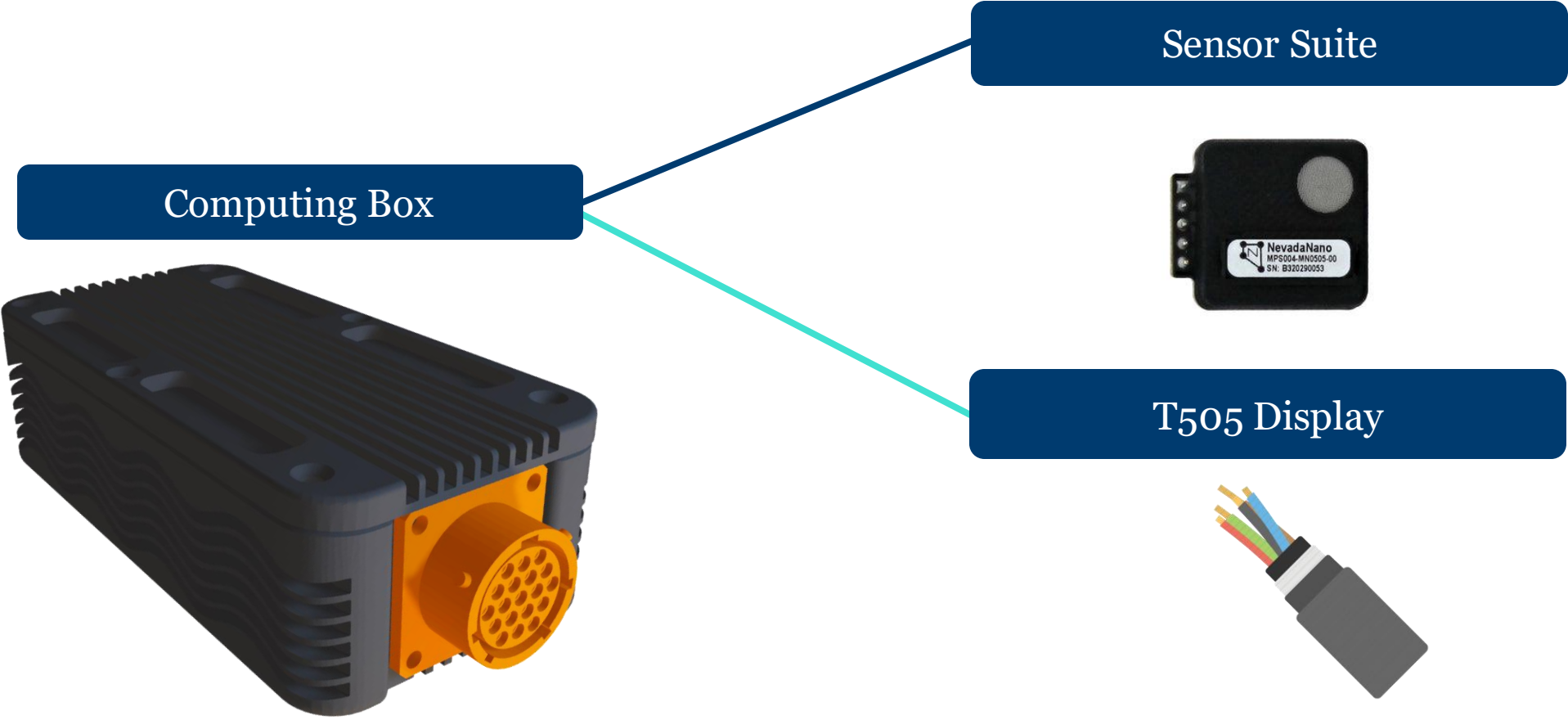
Initial and Current Design layout, Box Design, Detailed Analysis of choice of design



# Initial Design Layout



# Current Design Layout



# Computing Box Design



Protects internal devices from the surrounding environment



Keeps electronics cool during operation



Does not encumber the user when system is active



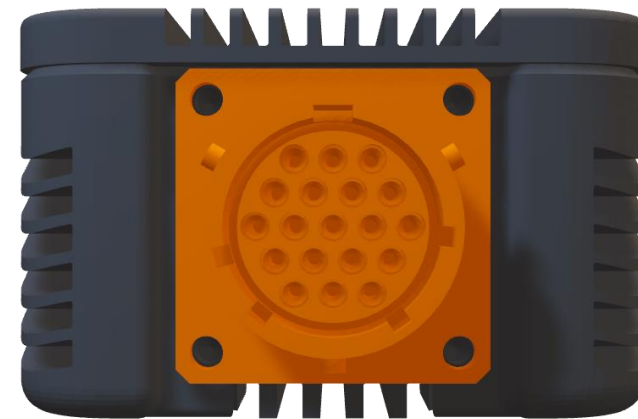
# Main Output Connector



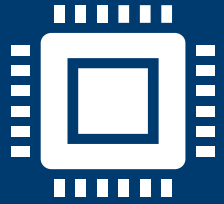
A single output port simplifies design and user experience



The selected connectors are MIL-DTL-26482 rated



# Computing Box Contents



Main Processor: Teensy  
4.1



Power Supply: 9V  
Battery



Power Control: 5V Linear  
Voltage Regulator





# Sensor Suite

## Nevada Nano MPS Combustible Gas Sensor

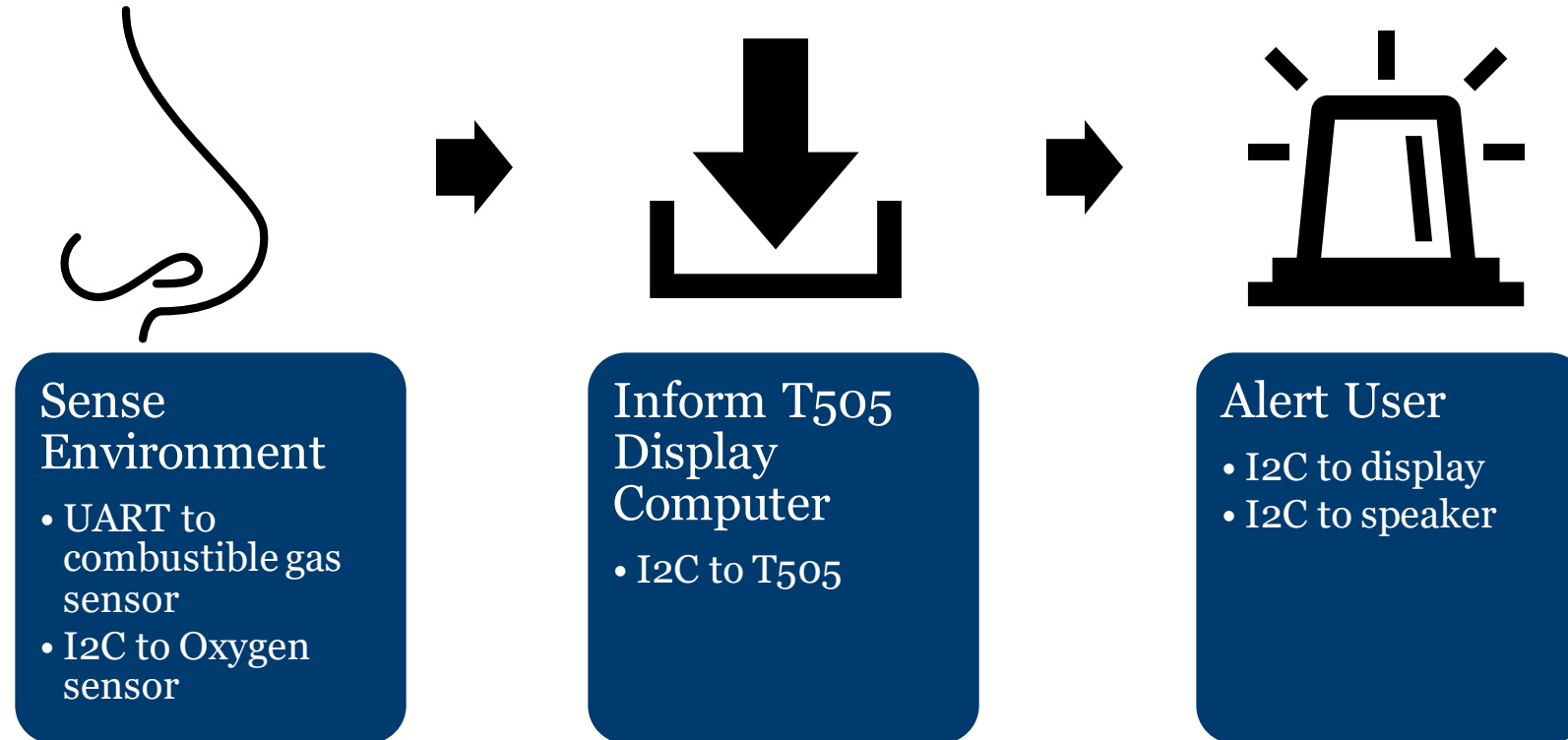
- Detects all combustible gasses in environment

## Gravity Oxygen Sensor

- Compensates for error in CG sensor



# Communication Protocols

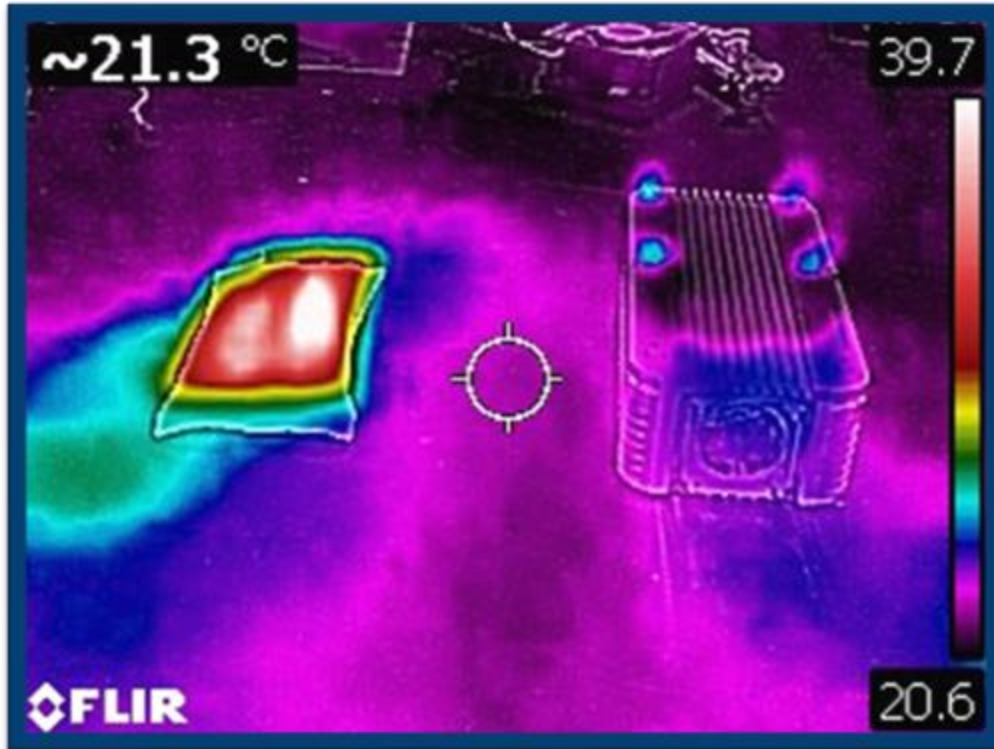


# Testing Overview

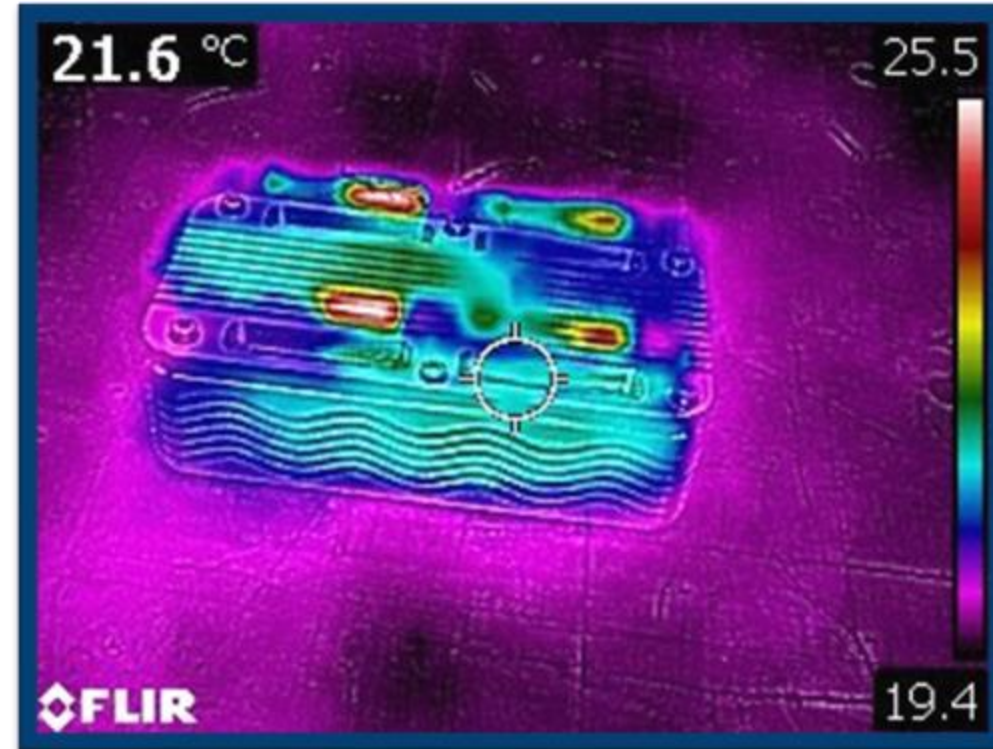
Thermal Testing, Gas testing



# Thermal Analysis Testing



Temperature of heating pad 39.7 C (103.46°F)



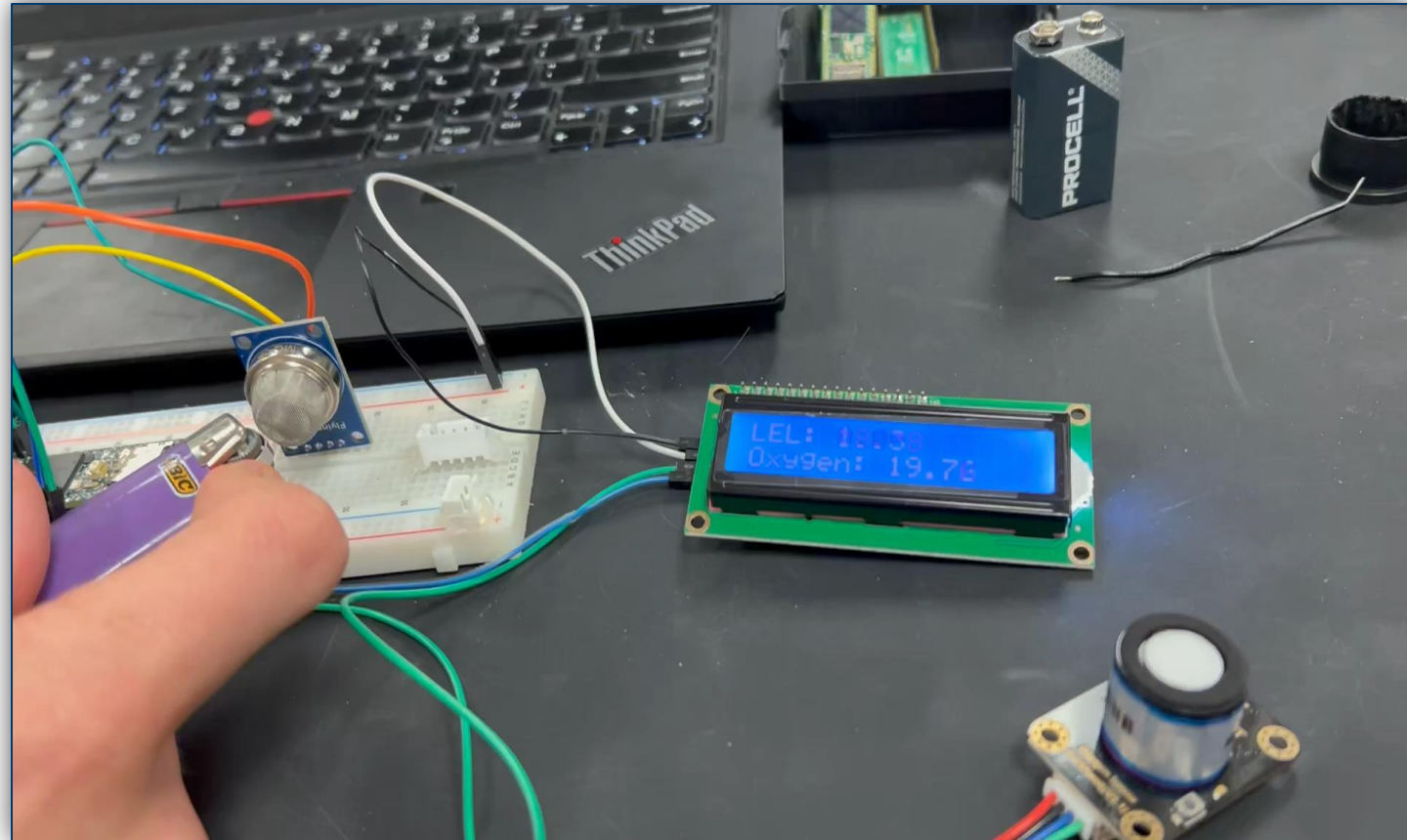
Modular Box temperature ranges from about 20.0 C (68.0°F) – 22.0 C ( 71.6°F) steady state

# Gas Analysis Testing

Tested with different gasses

LCD screen is producing readings

Sensors are picking up LEL (Lower Explosive Limit) also oxygen levels

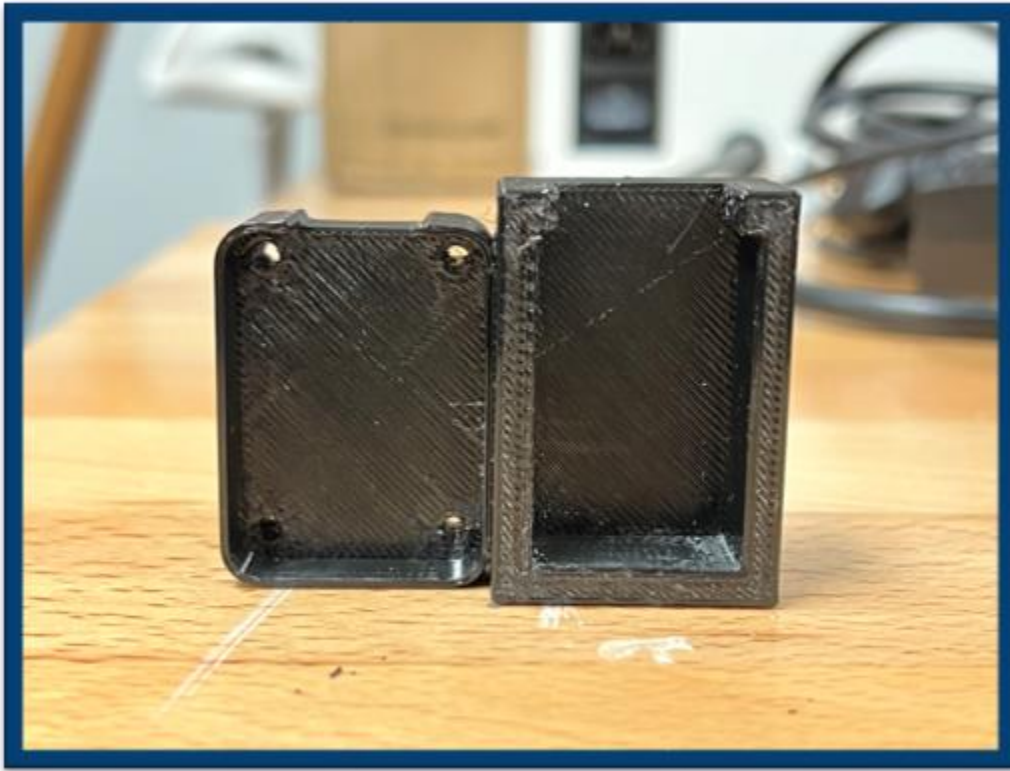


# Mounting System Overview

Sensor Mounting, Box Mounting



# Sensor Mounting System



Left Side is the sensor mount and on the right is The power mount to turn device on.

Image shows the sensor mounting system on the box mounting system.

# Box Mounting System



The modular gas box mount has straps that wrap around the body of the user



The modular gas box would be placed inside the straps on the back of the mount



# Integration Overview

Integration with Team 505



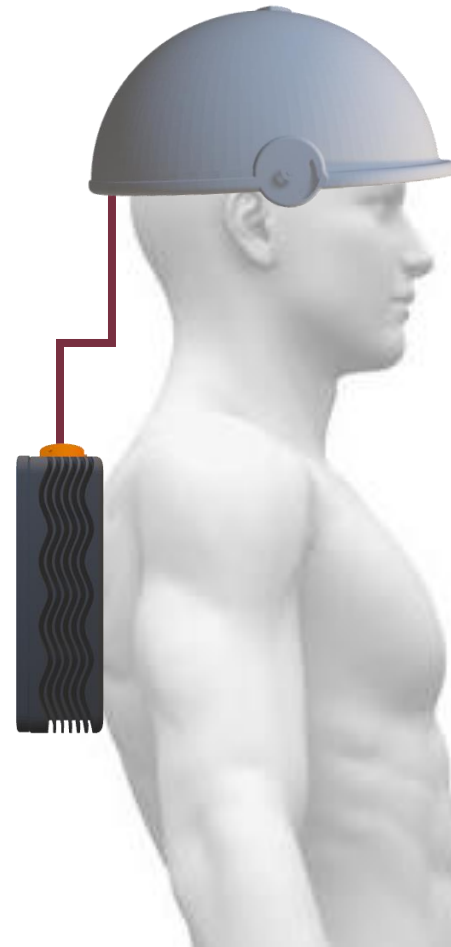
# Integration with T505

## Integration concept: **Wired Connection**

- Device will be wired to Team 506's gas detector
- HUD from Team 505 will intake values and display status
- Both teams utilizing Arduinos
- Our Team can place gas detector anywhere on the body

## Cautions taken:

- Reinforcing connections at both ends
- Reinforcing Wire



# Closing Remarks

Future Work, Budget Breakdown, Lessons Learned, Closing



# Future Work



Manufacture mounting bracket & mounting system



Bluetooth With T505 microcontroller and establish communication



Fully integrate sensors with reliable data



Conduct rugged terrain testing



# Budget Breakdown

	Jan	Feb	Mar	Apr
\$ Exp	\$262	\$279	\$75	N/A
% Exp	13%	27%	30%	N/A

## Received

- Combustible gas sensor
- Oxygen sensor
- 19-Pin M/F connector
- O-Ring
- Arduino Teensy
- Battery
- Voltage regulators
- ON/OFF switch

## Pending Orders

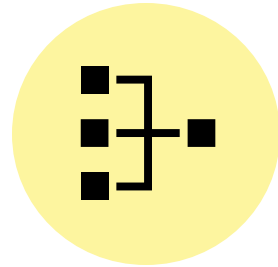
- Back Strap
- Wire Sleeve



# Lessons Learned



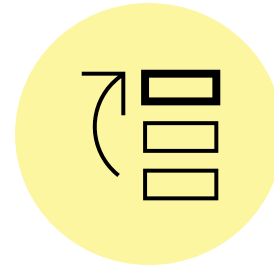
Professional communication



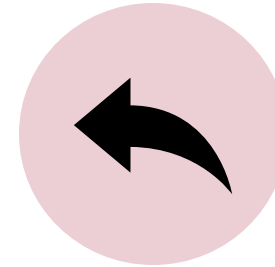
Systems integration



Manufacturing timeline



Establishing prioritization of necessary tasks



Feedback and revision

# Closing

Free up hands with first responders



Wearable Modular Box

Modular box holds our computer, battery, and voltage regulators.

Sensors connect to the box via wires and connect to the user in their chosen location.

Mounting system has been chosen to be on the back to reduce snagging of wires with T505's helmet.



Integration





FAMU-FSU  
College of  
Engineering

# Thank you for listening

Senior Design Team 506

