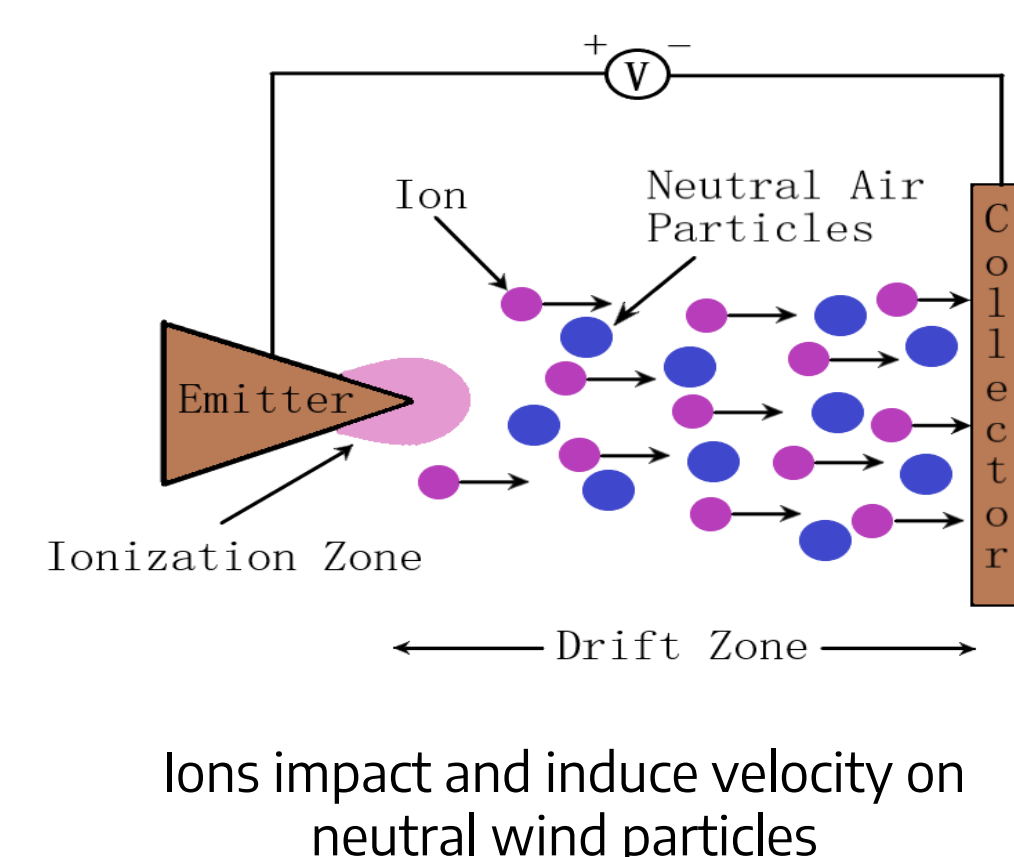


## Motivation

- Conventional small-scale propulsion systems (e.g. propellers and fuel-based thrusters) face challenges with noise, emissions, and or bulk.
- Electroaerodynamic (EAD) thrusters generate thrust using ionized air, offering silent, compact, and emission-free propulsion.
- Existing Designs typically exceed \$5,000

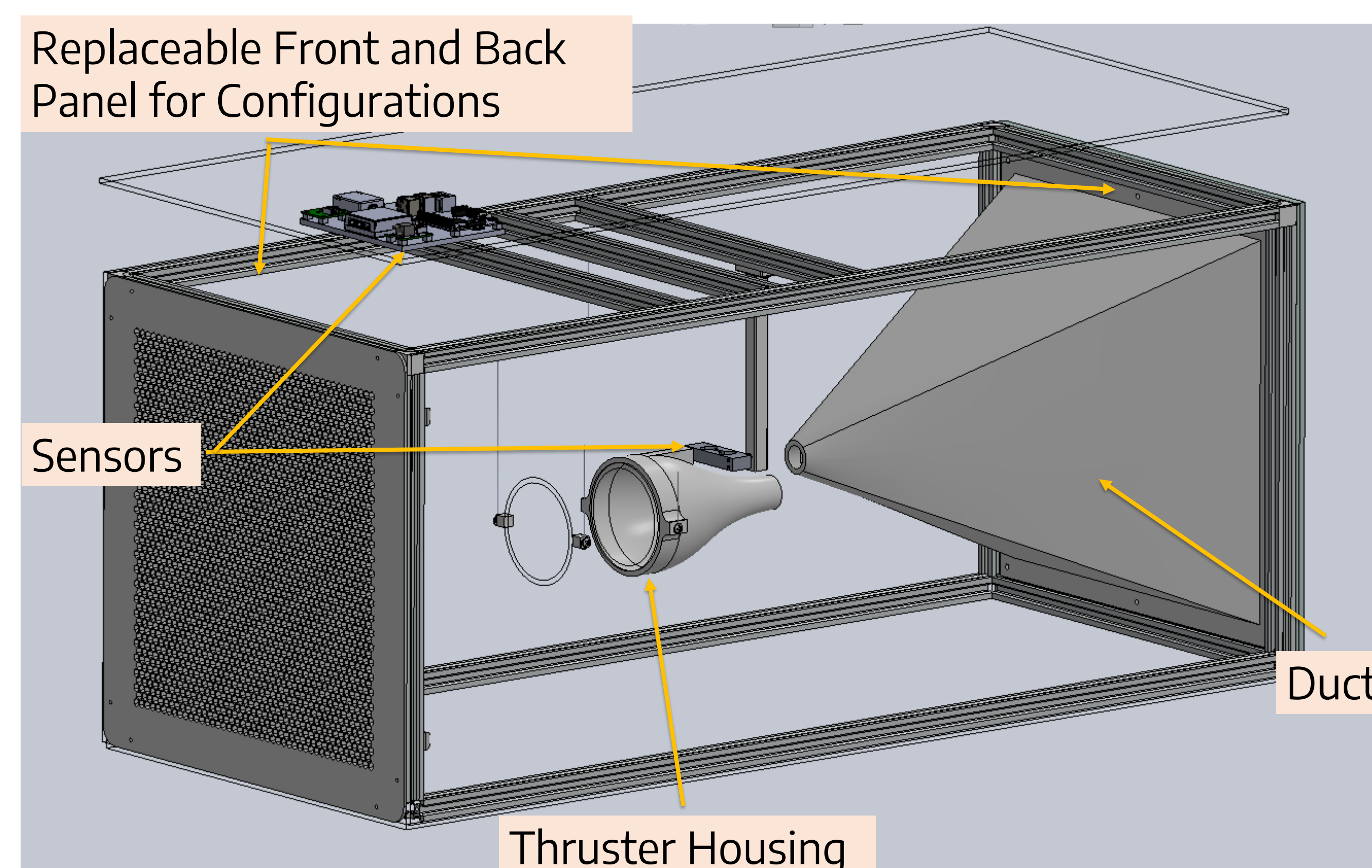


Our project aims to design and build an affordable testbed to measure and optimize the EAD thruster performance under various operating conditions.

## EAD Testbed System

- Modular testbed designed to evaluate EAD thruster performance under various configurations:
  - Open -> For testing entire thruster performance including housing
  - Sealed -> For testing within contained environment
  - Wind tunnel -> For testing of electrode parts only
- Measures key metrics:
  - Thrust
  - Exhaust velocity
  - Mass flow rate.

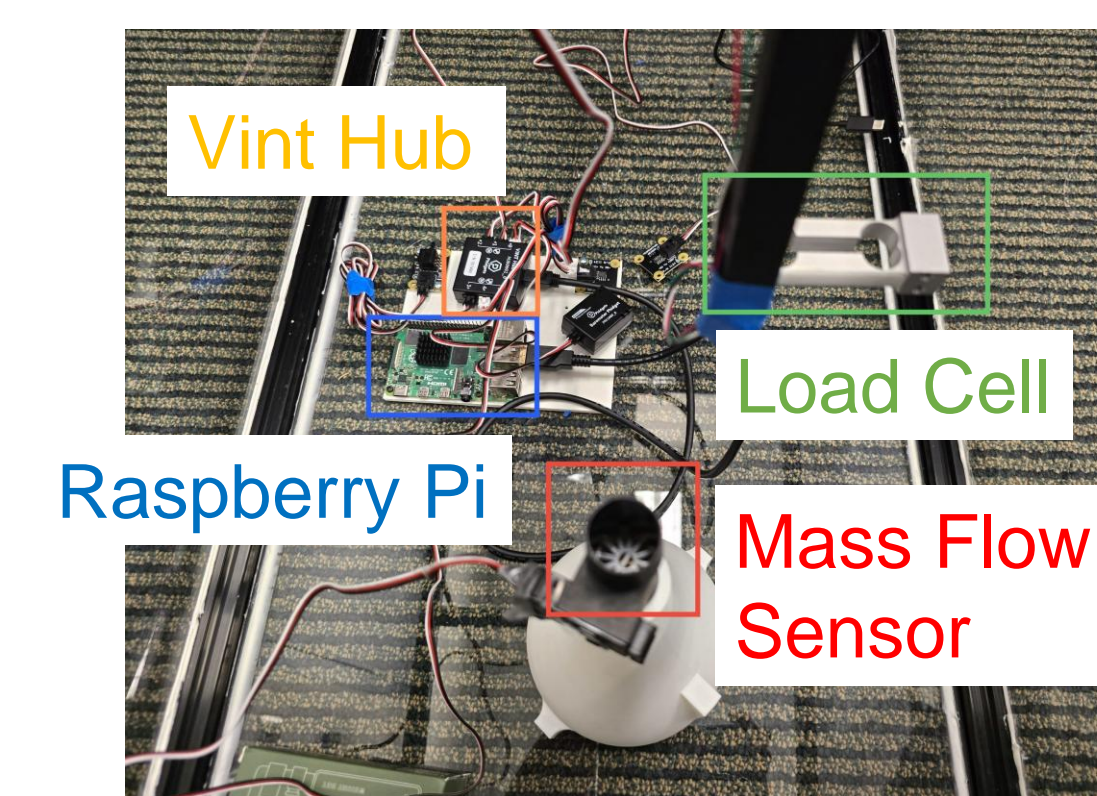
Replaceable Front and Back Panel for Configurations



Testbed CAD Model

## Sensors and Visualization System

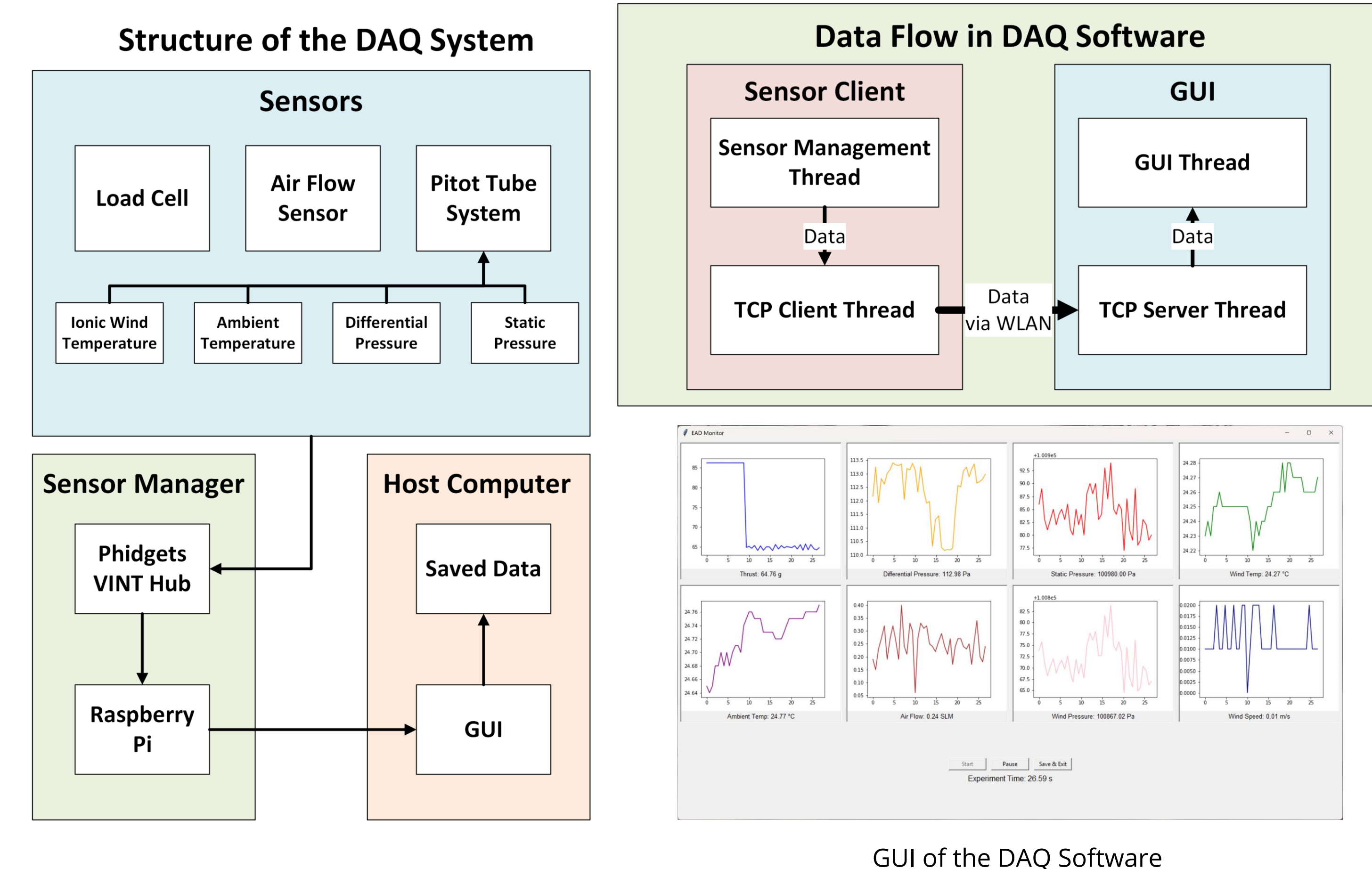
- Two separate sensors are used to detect flow speed:
  - Mass flow sensor for open configuration
  - Pitot tube velocity sensor created using Phidget sensors for wind tunnel configuration on the testbed.
- Dry ice will spread using flow rakes due to requirement for non-polarized smoke



DAQ Hardware Layout

## Data Acquisition System (DAQ)

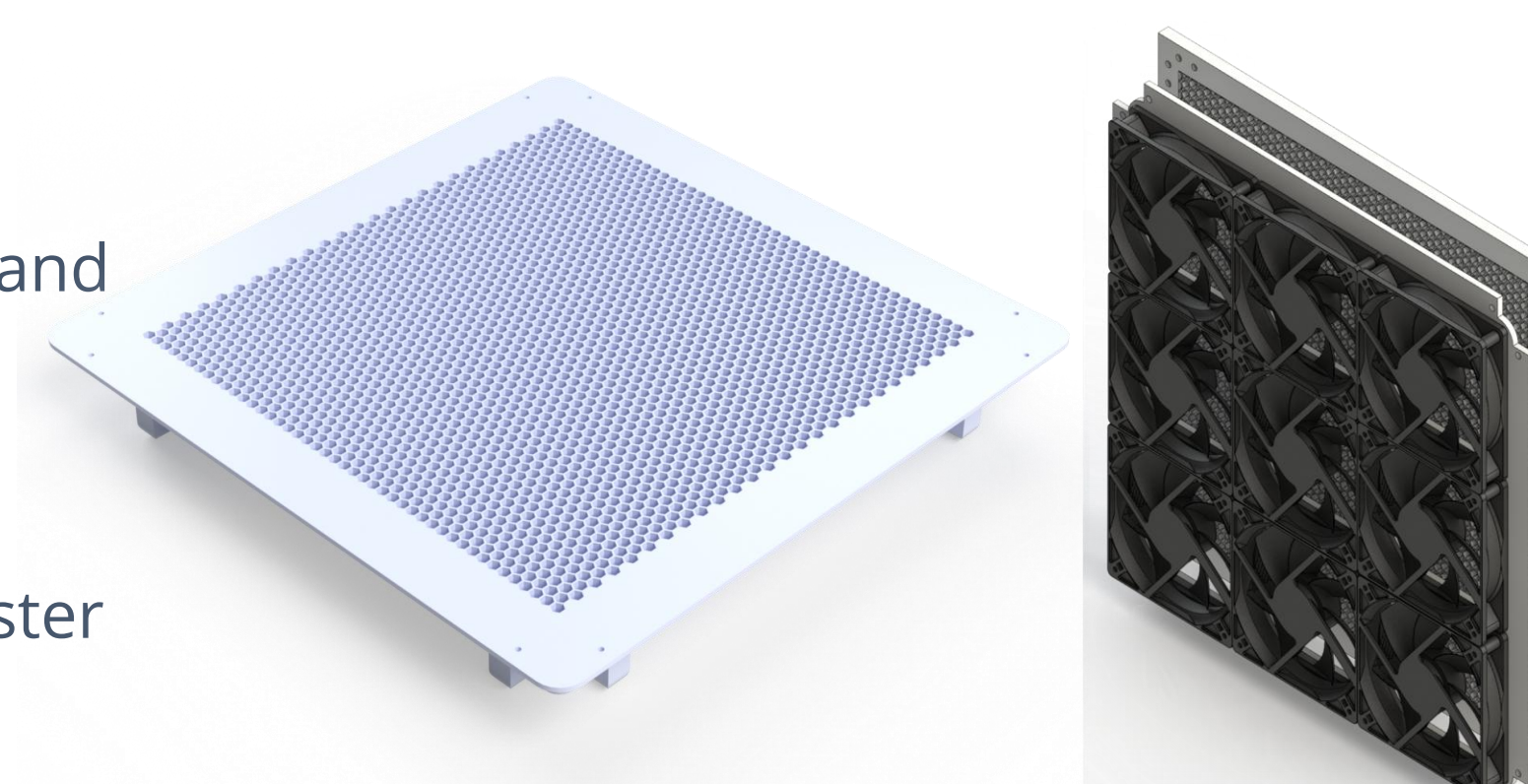
- Designed for measuring the performance of the EAD engine.
- Measuring thrust, total air flow, exhaust wind speed, temperature and pressure.
- Wireless data transmission for safety
- Real-time monitoring and automatic data recording



GUI of the DAQ Software

## Wind Tunnel Implementation

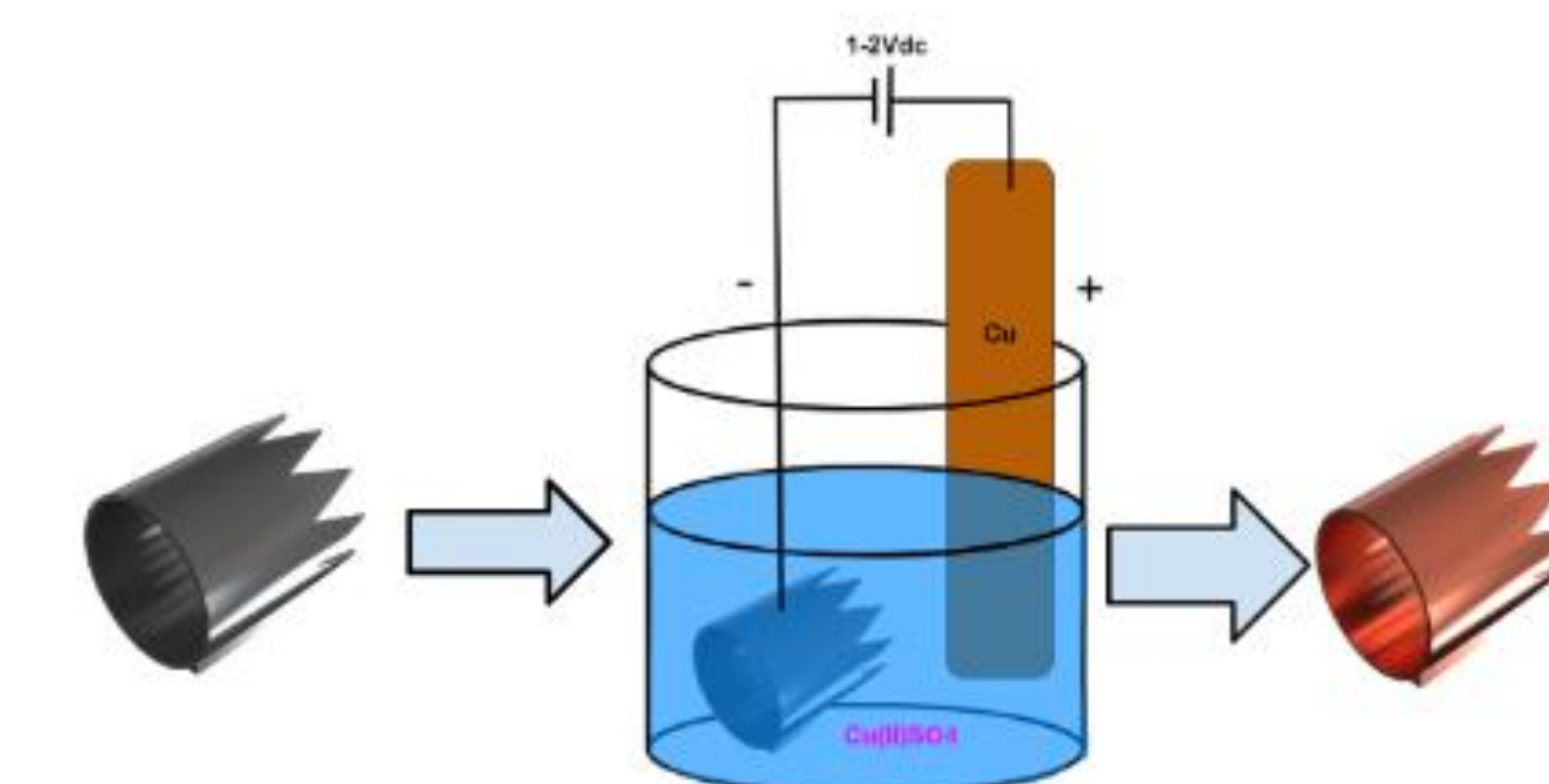
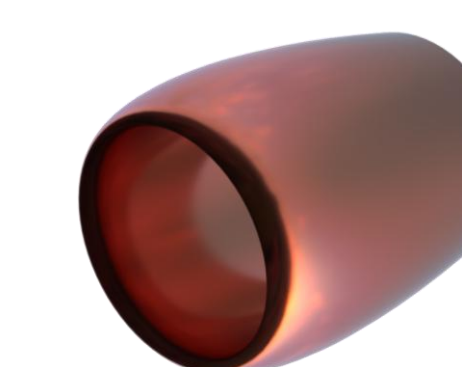
- In the wind tunnel configuration, the testbed front panel, thruster, and back panel will be connected by converging and diverging ducts.
- Eliminate turbulence and condition the flow using Flow Straighteners
- Nine 120mm fans enable the EAD thruster to be tested under forward airflow conditions



Flow Straightener and Fan Attachments

## Ion Electrodes

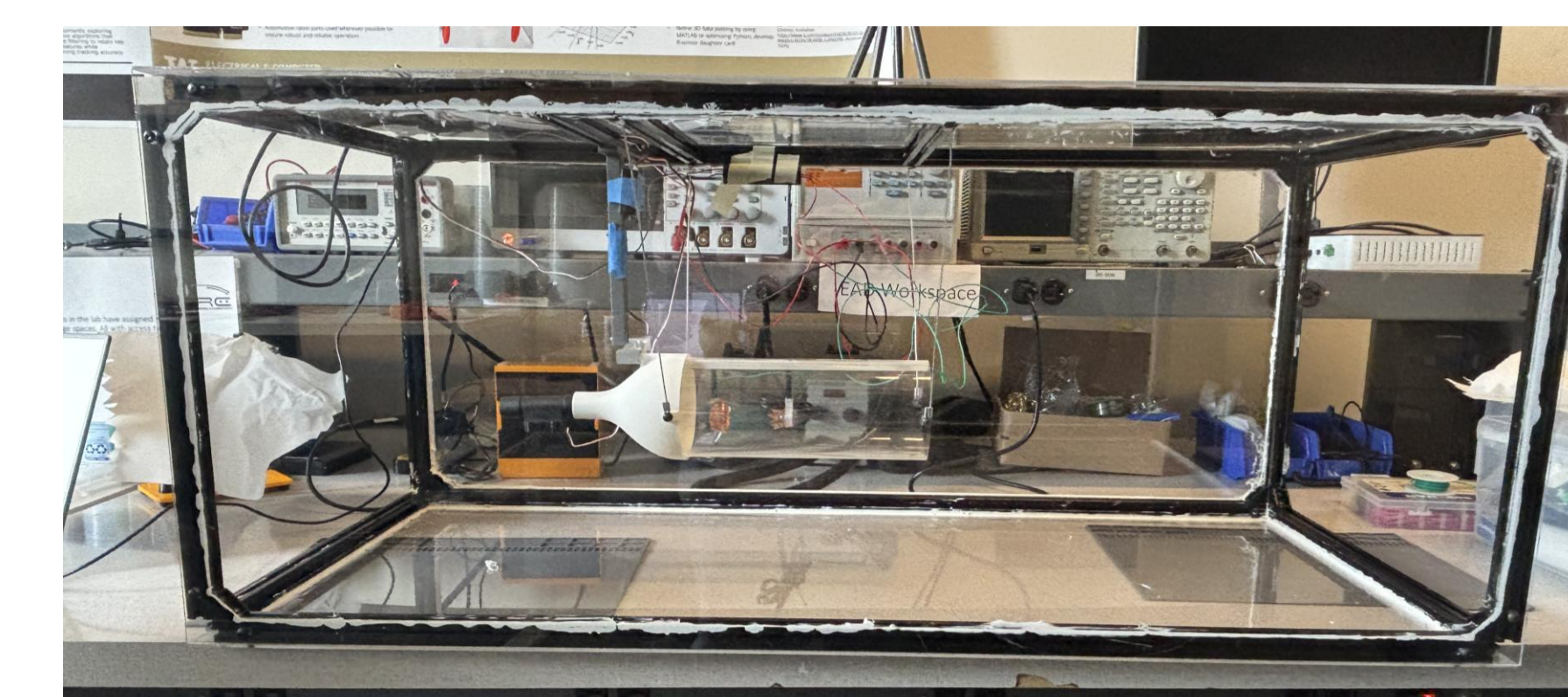
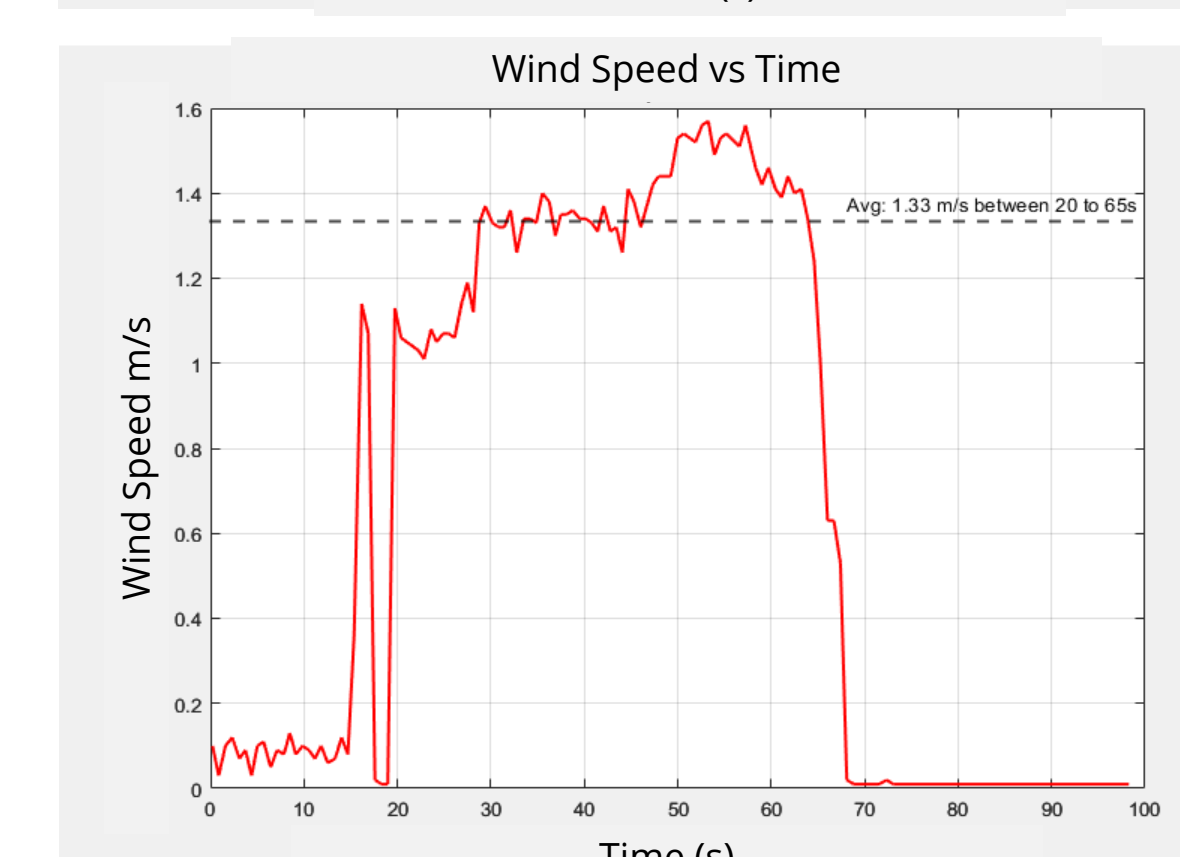
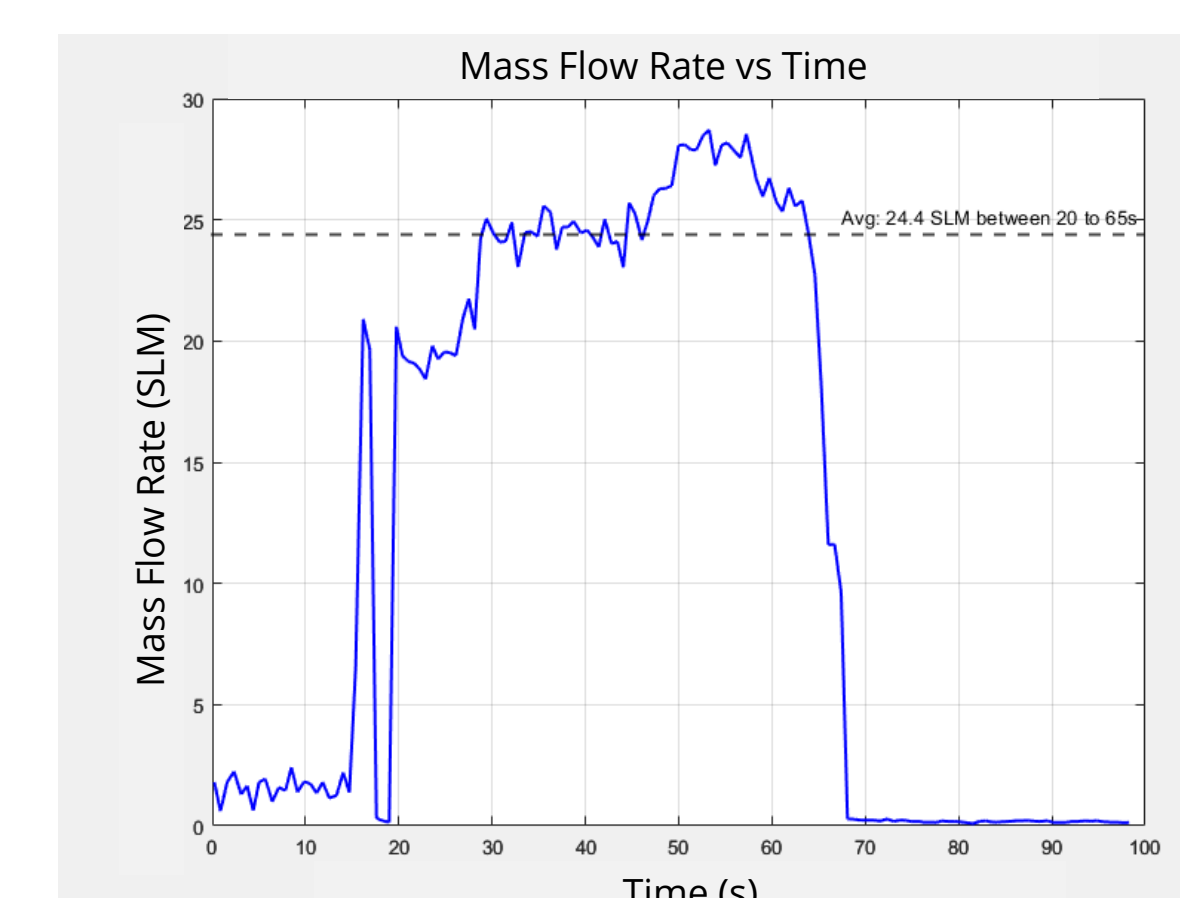
- Manufactured Ion Electrodes with 3D printing
- Prints are carbon painted and electroplated



Electroplating Process

## Testing and Results

- Measurements for copper wrapped electrode was initially tested with open configuration of the test bed
- Ionic wind created and successfully measured the total air flow and wind speed
- Low thrust due to only 1 pair of electrodes used and lack of high voltage power supply system



Testbed Demo

Testbed Demo Results

## Future Work, References, and Acknowledgments

- Increasing thrust performance by improving electrode manufacturing process and optimizing electrode parameters.
- Implementation of flow visualization system
- Creating a 10-100kV Variable Power Supply System

Undergraduate Students: Ernst Anderson, Joydeep Saha

- [1] W. H. Jerrod, *A Modular, 3D-Printed Low-Speed Wind Tunnel as a Versatile Platform for STEM Education and Outreach*.
- [2] A. Patel, "Ion Thruster," Instructables, <https://www.instructables.com/Ion-Thruster/> (accessed May 12, 2025).