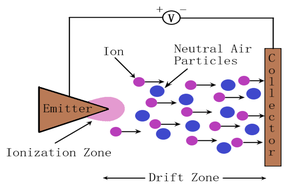
DEVELOPMENT OF LOW ALTITUDE STATION KEEPING ION THRUSTERS FOR HEAVIER THAN AIR SYSTEMS

GUIDE AIR LABS

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

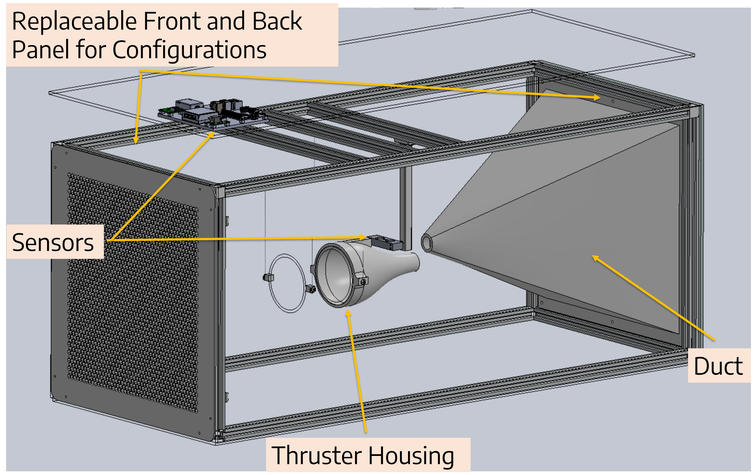


Ions impact and induce velocity on neutral wind particles

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

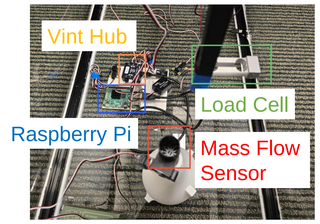
• Modular testbed designed to evaluate EAD thruster performance under various configurations:
  - Open -> For testing entire thruster performance including housing
  - Sealed -> For testing within contained environment
  - Wind tunnel -> For testing of electrode parts only
- Measures key metrics:
  -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



Testbed CAD Model

Sensors and Visualization System

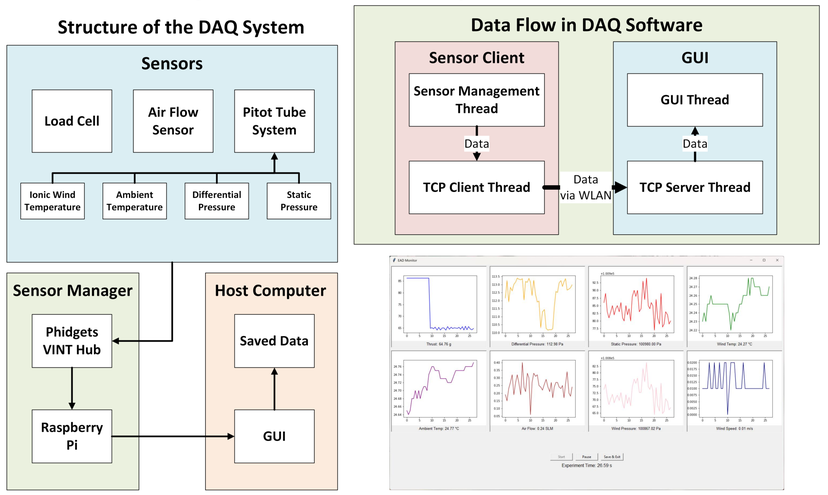
- Two separate sensors are used to detect flow speed:
  - Mass flow sensor for open configuration
  - Pitot tube velocity sensor created using Phidget sensors for wind tunnel configuration on the testbed.
- Dry ice will spread using flow rakes due to requirement for non-polarized smoke



DAQ Hardware Layout

Data Acquisition System (DAQ)

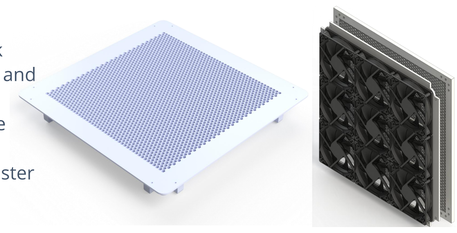
- Designed for measuring the performance of the EAD engine.
- Measuring thrust, total air flow, exhaust wind speed, temperature and pressure.
- Wireless data transmission for safety
- Real-time monitoring and automatic data recording



GUI of the DAQ Software

Wind Tunnel Implementation

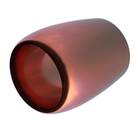
- In the wind tunnel configuration, the testbed front panel, thruster, and back panel will be connected by converging and diverging ducts.
- Eliminate turbulence and condition the flow using Flow Straighteners
- Nine 120mm fans enable the EAD thruster to be tested under forward airflow conditions

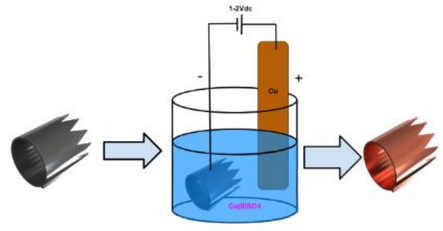


Flow Straightener and Fan Attachments

Ion Electrodes

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

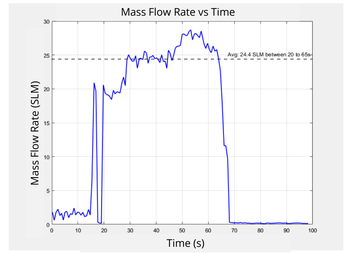


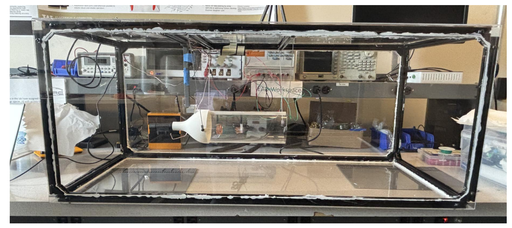


Electroplating Process

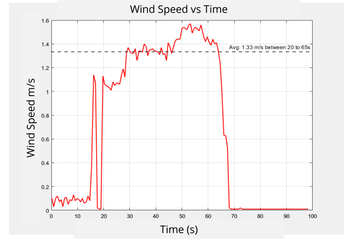
Testing and Results

- 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

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[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).

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