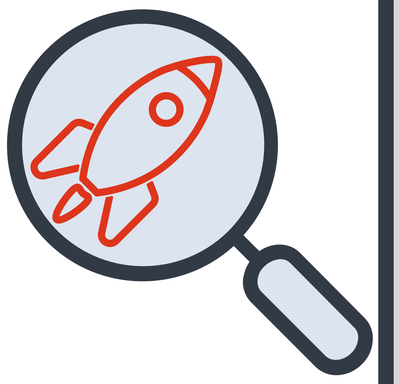
CRITTERS

(Calvin Rocket Investigation and Testing Tools for Engineering Researchers and Students)

Calvin UNIVERSITY

System Overview

Performing tests on model rockets is difficult and expensive due to varying atmospheric conditions and marginal costs per launch. Therefore, an instrumentation setup capable of simulating model rocket flight in a controlled environment is necessary for model rocket research and design. This is the primary goal of **CRITTERS** and was accomplished using two systems. The first system is the **RATS** which simulates and measures the drag force experienced by a model rocket in flight. The second system is the **FERIT** which quantifies the thrust of the model rocket engine. Both systems are operated by the **TOADS**, a custom user interface and control software.



The Team

Duncan Waanders
Bangor, ME
Mechanical

Jack Vandermolen
Elmhurst, IL
Mechanical

Daniel Luce
Waukegan, IL
Electrical

Adam Tjoelker
Sydney, Australia
Mechanical

Acknowledgements

Professor Richard DeJong
- Creator of Calvin Wind Tunnel
- Provided research equipment

Professor Renard Tubergen
- Model rocket project suggestion
- Wind tunnel implementation advice

Chuck Holwerda
- Electronics Shop Technician
- Instrumentation selection

Chris Sorenson
- Machine and Wood Shop Supervisor
- Manufacturing and materials advice

Professor Chris Hartemink
- Senior Design Project advisor

Jeff DeHeer
- Industrial Consultant
- Load cell and FERIT design advice

Professor Randall Brouwer
- Instrumentation advice

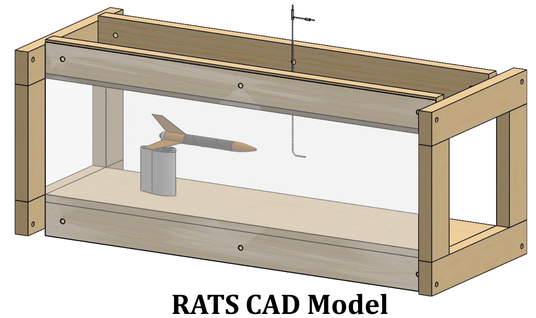
Professor Fred Haan
- Blockage ratio advice
- Stain gauge implementation advice

Professor Matthew Heun
- Calvin lab implementation advice

Rocket Analysis Test Section

RATS

Designed to interface with the Calvin Wind Tunnel, the RATS simulates model rocket flight. By holding a model rocket in the air stream, a 100g load cell measures drag force on the rocket with high precision. To quantify the air speed and properties, the system uses a pitot tube attached to a pressure transducer and a thermistor.

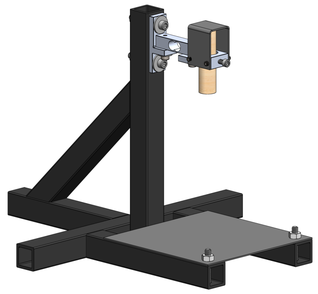


RATS CAD Model

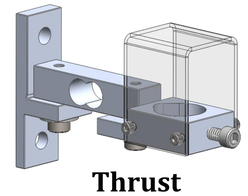
Fixed Engine Rocket Instrumentation Tester

FERIT

The FERIT's purpose is to measure the performance of a model rocket engine and is compatible with ½A, A, B, and C type engines. It measures the thrust force over time by using a 5kg load cell. With a focus on safety, the system is designed for operation from 15ft away, outdoor use for ventilation, and includes a blast deflector to minimize fire hazards.



FERIT CAD Model

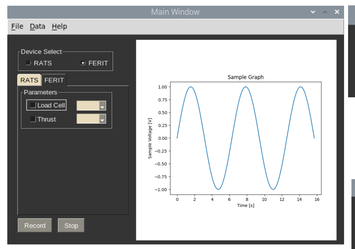


Thrust Measurement Subassembly CAD Model

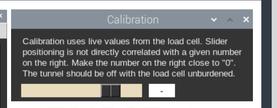
Taring, Operation, and Data Software

TOADS

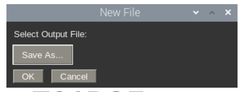
The TOADS is a custom application for data collection and storage. Along with live data graphing, it allows users to easily indicate the current subsystem, select preferred units, calibrate the system's sensors, and export data to a CSV file. The software was written in Python and uses the open-source libraries of Matplotlib and PySimpleGUI.



TOADS Main Window



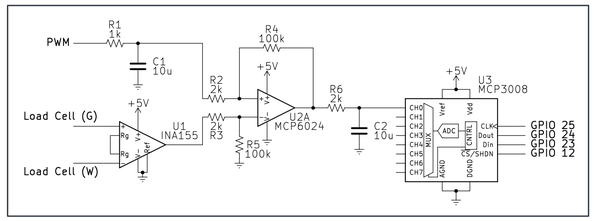
TOADS Taring Control Window



TOADS Export Window

Instrumentation Electronics

For the load cells of the RATS and FERIT to be able to communicate with the Raspberry Pi running the TOADS, an amplification and analog to digital conversion circuit was required. It makes use of three stages: an instrumentation amplifier to increase the voltage difference from the strain gauges, a differential amplifier with a PWM acting to calibration offset voltage, and a low pass filter to reduce electronic noise. The signal then gets passed into an MCP3008 analog-to-digital converter, allowing the Raspberry Pi to read the voltage as a 10-bit.



Load Cell Amplification Circuit Schematic