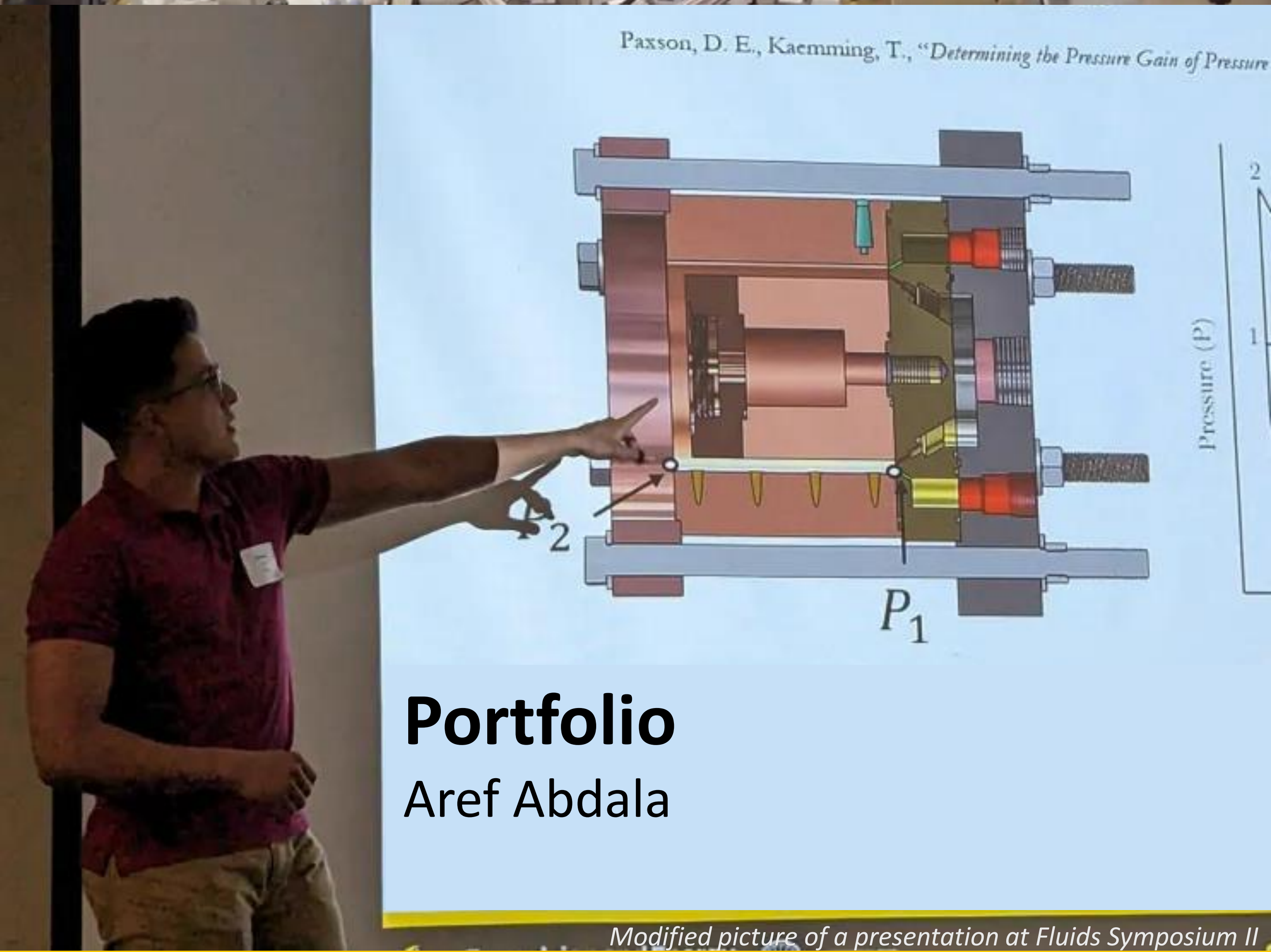
Picture of Small-Scale- RDRE hot-fire



Portfolio

Aref Abdala

Modified picture of a presentation at Fluids Symposium II

Table of Contents

Website: arefabdala.com

Picture of Falcon 9 launch as seen from UCF's football stadium

Machinist

Subtractive Manufacturing

– **Manual Lathe:** Utilized manual lathe for precision boring, facing, threading, and shouldering processes on a variety of components producing up to 20 units per day.

– **Manual Milling:** Operated manual mill to perform milling, drilling, slotting, and tapping operations with precision, ensuring components met specifications.

– **Tool Utilization:** Employed typical shop tools including band saw, dynabrade, dremel, and sanders, contributing to the production of over 100 different components.

– **Quality Assurance**: Maintained a strict tolerance of .010 inches on the majority of stock parts, ensuring precision and consistency in production, resulting in a 98% pass rate on initial quality inspections.

Welding

– **TIG Welding:** Performed TIG welding on various high vacuum components, ensuring welds met stringent high vacuum environment requirements.

Testing

– **Helium Leak Detection:** Conducted thorough testing of manufactured components using helium leak detection devices, ensuring leak rates were below 1 x 10^-9 mbar l/s, consistent with high vacuum standards.

– **Calibration:** Regularly calibrated and maintained helium leak detection equipment to ensure accurate and reliable testing results.

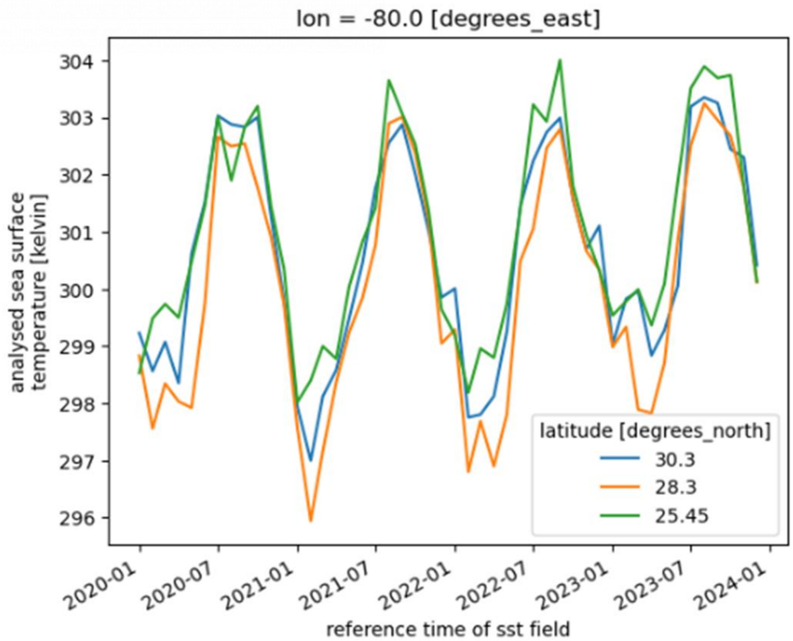
Images of various LDS Vacuum products and leak detection hardware

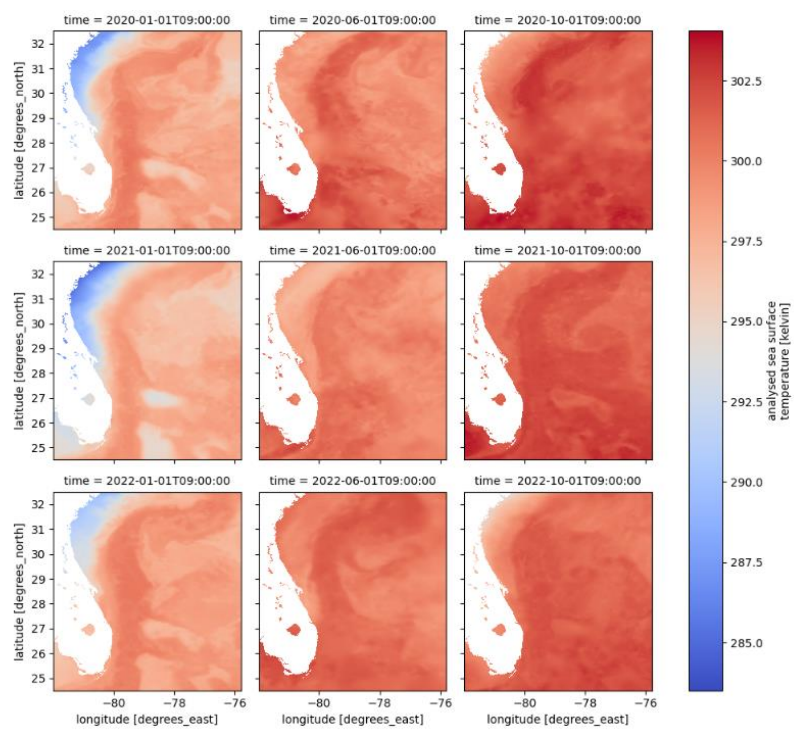
All data & pictures presented are publicly available

Jet Propulsion Laboratory
California Institute of Technology

Data Analytics Intern

- Analyzed sea surface temperature (SST), ocean chlorophyll a, and sea level data from the Surface Water Ocean Topography (SWOT) mission.
- Generated detailed plots with Python to enhance data analysis, processing dozens of granules, each containing 54,000 data points, to uncover significant insights.
- Documented accessibility challenges in extracting data from NASA's PO.DAAC repository using Jupyter Notebooks, improving the understanding of cloud-based data
- Collaborated with cross-functional teams to utilize PO.DAAC tools and services, ensuring seamless data access and analysis through AWS, advancing open science initiatives.





Images present visual and analytical changes of sea surface temperature off the coast of Florida between 2020-2023

All data & pictures presented are publicly available

BOEING

Satellite Test Engineering Intern

Testing

- Conducted the first power-up of the O3B F7 spacecraft and ensured all systems were operational.
- Assisted in the identification of Non-Conformance Reports (NCRs) and safety hazards, enhancing product reliability.
- Performed RF testing, System Checkout Verification Test, and resistance measurements ensuring spacecraft functionality

STE Readiness

- Conducted PSIM calibrations to ensure accurate simulation and testing of satellite systems.
- Performed polarity checks on LBPR #2, verifying proper electrical connections and functionality.
- Completed UTCIF checkout, ensuring test equipment was functioning correctly and ready for operational use.
- Created a comprehensive asset list of the STE equipment in the High Bay, improving inventory management and readiness for testing.

STE Support

- Conducted Cable Kit Testing and certification of STE configurations, ensuring all test setups met required standards.
- Provided technical and troubleshooting support of 5 spacecraft's STE equipment at a time

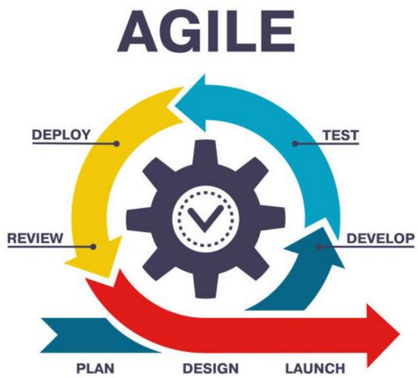
Top Images of two stacked O3B satellites in highbay and in F9 fairings. Bottom image is an example of the simulated telemetry of satellite

All data & pictures presented are publicly available

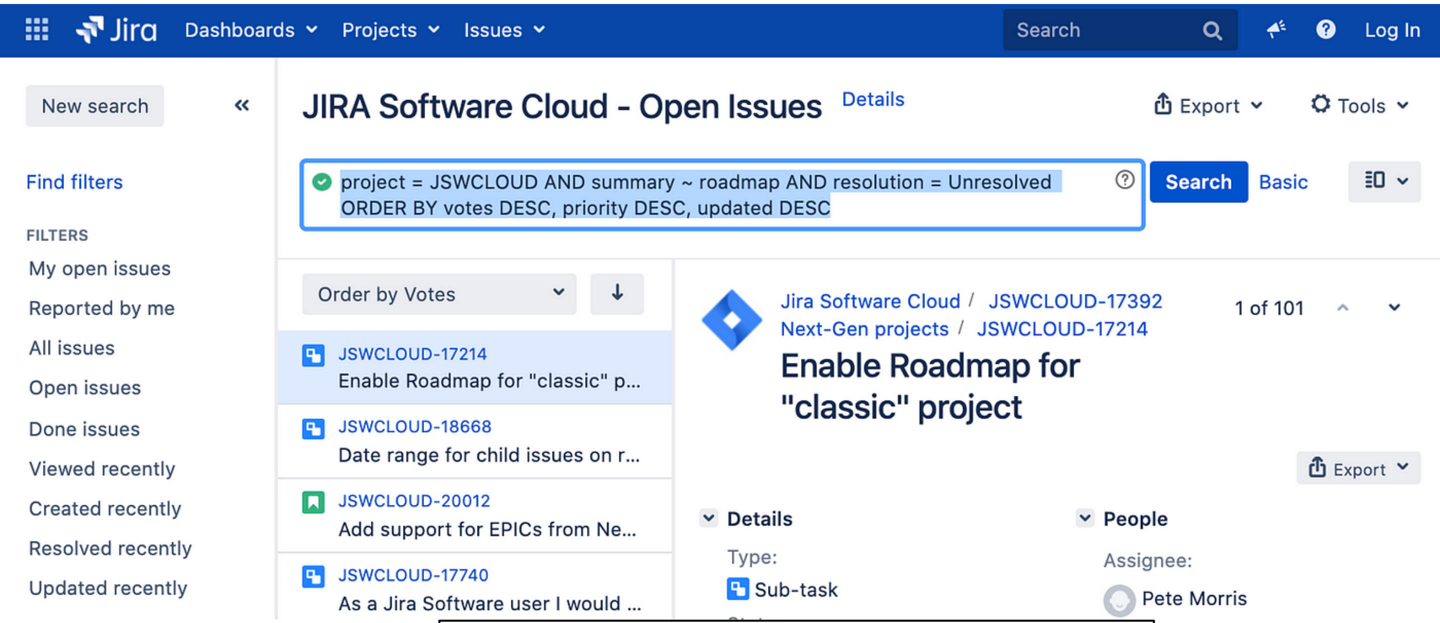
Raytheon Intelligence & Space

Systems Engineering Intern

- Developed a self-auditing directory of over 260 employees on the JPSS CGS program
- Facilitated data quality checks by creating 15+ custom dashboards and filters in Atlassian Jira.
- Established comprehensive documentation guidelines and desk instructions for JPSS CGS, standardizing procedures and improving documentation consistency across the team.
- Provided training and support to team members on using Atlassian Jira dashboards and filters, increasing user adoption and satisfaction by 15%.
- Implemented ongoing enhancements to the directory and information platform based on user feedback



Top Image is of JPSS Mission Badge
Bottom image is of AGILE workflow



Example of filter creation using JQL in Atlassian Jira

All data & pictures presented are publicly available

NATIONAL SECURITY INNOVATION NETWORK

Design Engineer

NAVSEA WARFARE CENTERS CRANE

- Directly contributed to additive manufacturing innovation and problem-solving projects for NSWC Corona Fallbrook Detachment, enhancing the capabilities of military technology.
- Utilized topology optimization techniques to reduce material usage while maintaining structural integrity of additively manufactured projects
- Increased the storage capacity of 81mm Mortars in a Light Armored Vehicle by 150%, significantly enhancing operational capabilities and logistics efficiency.
- Designed and documented modification to the Light Armored Vehicle that would reduce thermal detection

Current design of mortar storage inside a Light Armored Vehicle (top)
Light Armored Vehicle (left)

All data & pictures presented are publicly available

Propulsion and Energy Research Laboratory

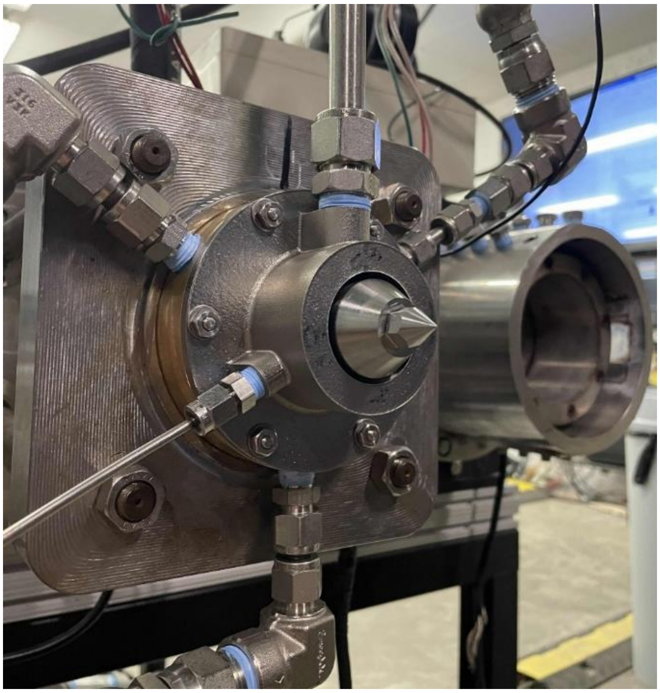
Small-Scale Rotating Detonating Rocket Engine (RDRE) - Project Manager

Project Objectives

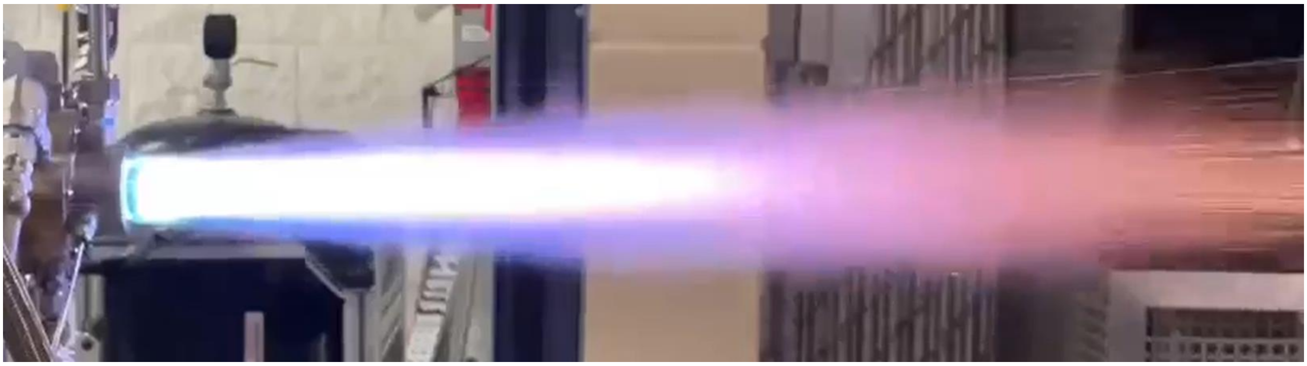
- Design, build, and hot fire a small-scale rotating detonation engine
- Achieve detonation wave propagation in the combustion chamber
- Collect data on detonation frequencies and upstream/downstream pressure of plumbing and combustion chamber

Project Manager Responsibilities:

- Led a team of 8 students to design, analyze, fabricate, and test a small-scale gaseous methane-oxygen rotating detonation engine
- Own the hardware delivery timeline and success through inception, design, assembly, test and re-use.
- Wrote engine testing procedures, calibrated PT/TC DAQ systems, and led testing operations



Small Scale Rotating Detonation assembled on test stand



Small Scale Rotating Detonation at the Testing Facility 4-9-24

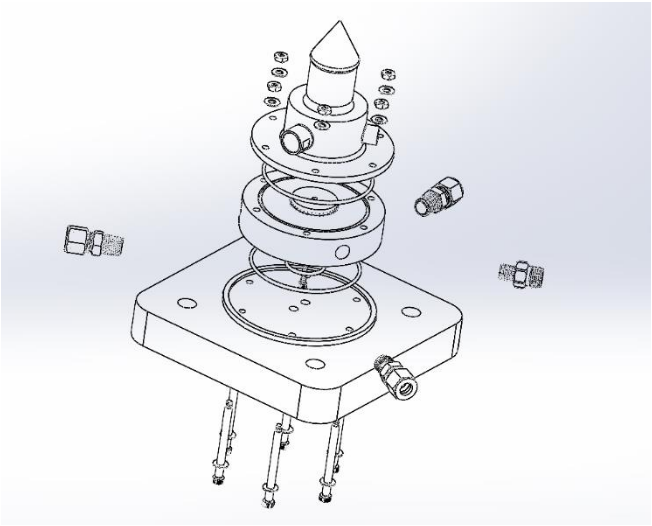
All data & pictures presented are publicly available

Propulsion and Energy Research Laboratory

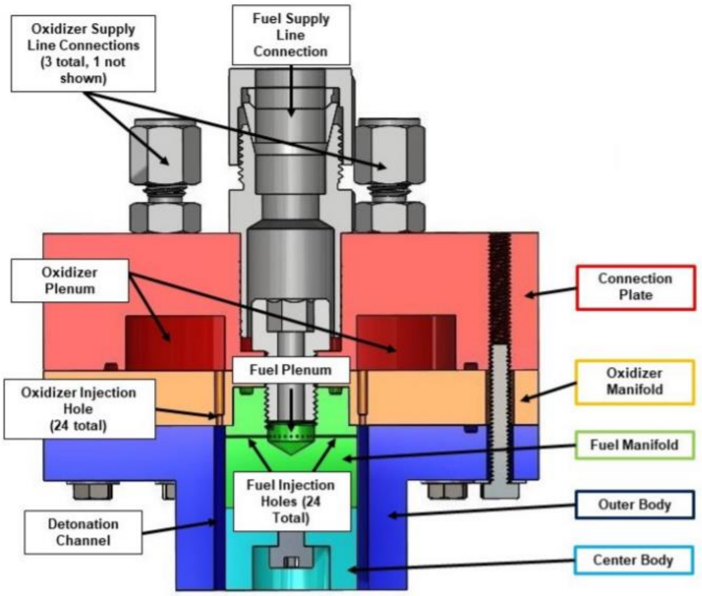
Small-Scale Rotating Detonating Rocket Engine (RDRE) - Project Manager

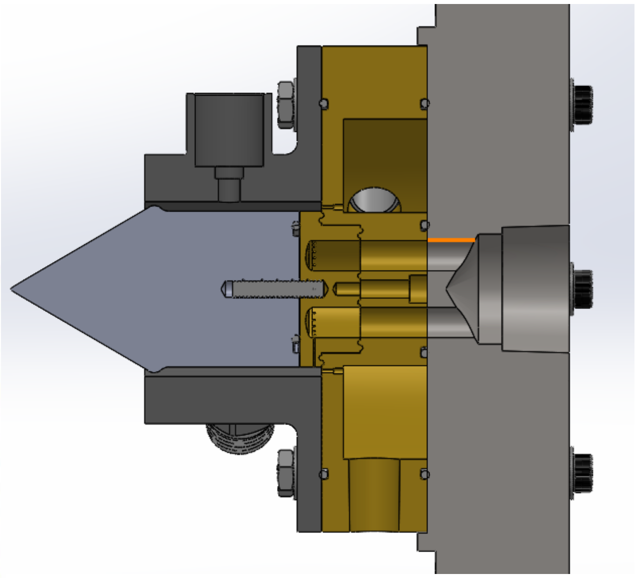
System Level Design – Modeling and Conceptual Development

The general model of our small-scale RDRE was derived from the work produced by **Fiorino et. Al.** and **Jonathan Dechert (bottom left)** at the Air Force Institute of Technology. The right image shows an exploded and the bottom right image depicts the assembled cross-section view of our CAD. There are clear correlations to the hardware structure.



The injector was made up of brass 360 in a Jet-In-Crossflow configuration while the combustion chamber and the aerospike nozzle were additively manufactured in Inconel 718





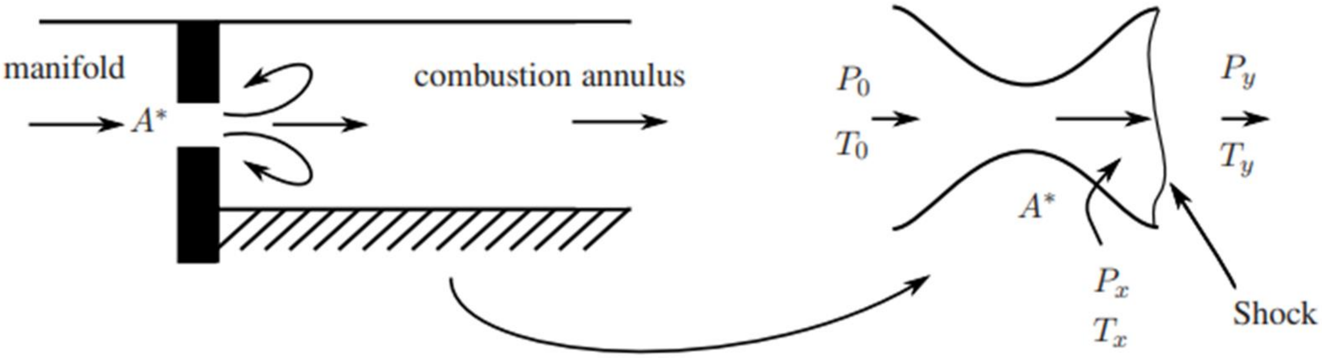
All data & pictures presented are publicly available

Propulsion and Energy Research Laboratory

Small-Scale Rotating Detonating Rocket Engine (RDRE) - Project Manager

System Level Design – Modeling Operational Regimes

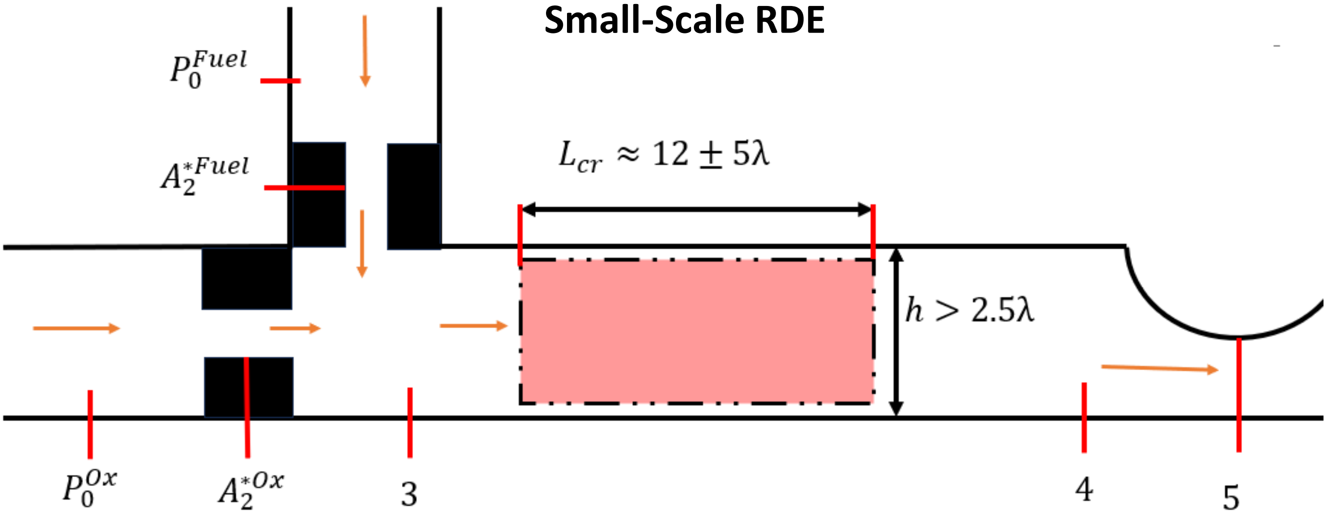
Previous



I developed a modified version of an analytical model that was first introduced by Connolly et. al. and Kiyanda et. al. shown in figure above.

The purpose of the model is to simplify the injection area to simulate an isentropic nozzle with a normal shock located at the end of the nozzle. Where prior literature had assumed pre-mixing propellants with a single injection area, this work implements pressure fluctuations cause by a Jet-In-Crossflow injector (shown below), Isentropic flow and shock relations were used to compute the remainder of the state.

Small-Scale RDE



All data & pictures presented are publicly available

Propulsion and Energy Research Laboratory

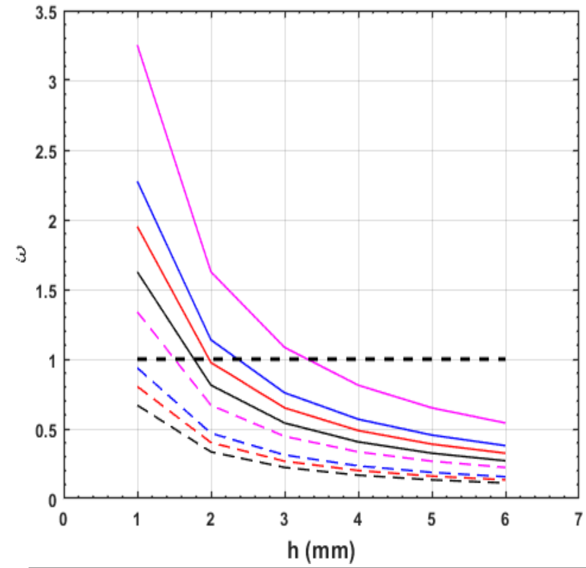
Small-Scale Rotating Detonating Rocket Engine (RDRE) - Project Manager

System Level Design – Modeling Detonation Regimes

Plots on the right-hand side depict the operating regimes for the small-scale RDRE.

The plot on the top-right is made up of multiple unique colored lines. Each color line represents a mass flowrate while the bold and dotted line scheme represent the upper and lower bounds of detonation waves possible at that mass flowrate.

The plot on the bottom-right demonstrates multiple channel widths in which the top line is 5mm and bottom line is 1mm



Where $\dot{m}$= 0.05kg/s, .06kg/s, .07kg/s, .08kg/s

$\dot{m}$=.08kg/s demonstrates the most detonation waves

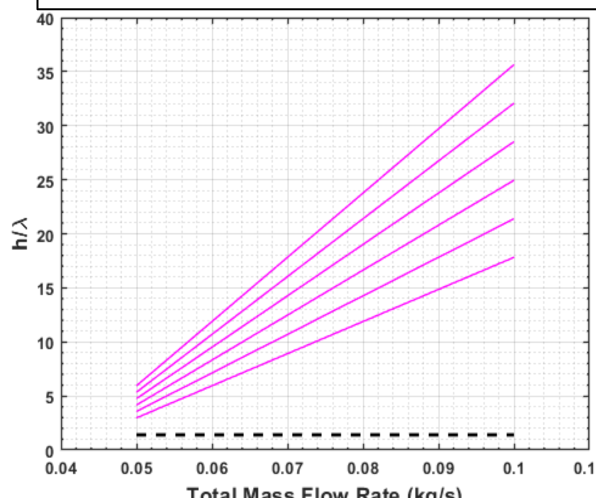
$$A_3^{Eff} = A_2^{*ox} + A_2^{*Fuel} \quad (1)$$

$$\sigma_x = (\gamma_x + 1)\left(\frac{2}{\gamma_x+1}\right)^{\frac{\gamma_x}{\gamma_x-1}} \quad (2)$$

$$P_3^{Eff} = \frac{\sigma_{ox}A_2^{*ox}P_0^{ox} + \sigma_{ox}A_2^{*Fuel}P_0^{Fuel}}{A_3^{Eff}\sigma_{mix}} \quad (3)$$

$$\omega = \frac{\dot{m}R_{sp}T}{C_L\lambda_{ref}P_{ref}U_D h} \geq 1 \quad (4)$$

$$\frac{h}{\lambda} \leq 2.4 \quad (5)$$



Where h=1mm, 2mm, 3mm, 4mm, 5mm

h=5mm has the largest number of cells per Mass Flow rate

Eq. 1-3 *Christopher M. Brophy, Joshua R. Codoni, Joshua A . Teneyck, and Spencer Ewing. "Experimental performance characterization of an RDE using Equivalent Available Pressure"*

Eq. 4-5. *Connolly-Boutin, S., Joseph, V., Ng, H. D., and Kiyanda, C. B., "Small-Size Rotating Detonation Engine: Scaling and Minimum Mass Flow Rate," Shock Waves, Vol. 31, No. 7, 2021, pp. 665–674. https://doi.org/10.1007/s00193-021-00991-2*

All data & pictures presented are publicly available

Propulsion and Energy Research Laboratory

Small-Scale Rotating Detonating Rocket Engine (RDRE) - Project Manager

Testing Plan – Roles and PERL Integration

Prep Shift		Test Shift		Shut Down	
Role	**Name**	**Role**	**Name**	**Role**	**Name**
Test Lead	Aref	Test Lead	Aref	Test Lead	Aref
Procedures	Member 2	Procedures	Member 2	Procedures	Member 2
Plumbing	Member 3	Timing Box	Member 3	Bottles	Member 3
Actuators	Member 4	Engine Plumbing	Member 4	Boxes	Member 4
FOD	Member 5	DAQ/Labview	Member 5	DAQ	Member 5
		Pressure Troubleshooting	Member 6	Cleanup	Everybody
		Plumbing	Member 7	Plumbing	Member 6
		Camera	Member 8		

Test Lead	*schedule campaign, set test points, main POC*	
Prep Shift	*flow lines, electrical cables, camera set up, safety*	
	bottles/tanks, pressures, facility clean	How many tests can we run with the current pressures? Is the labview reading the values correctly? Did you preform leak checks? What are some safety considerations that we need to consider for testing? Is the camera positioned correctly?
Test Shift	*labview and test-fires, timing box*	
	flow lines, safety, inspection of hardware *back-end imaging, video documentation (goPro)*	Are the result formatted correctly in a csv file? What were the decisions behind the timing of the timing box? How are we ensuring the flow reaches the combustion chamber at the same time? What is the delay between fuel and ox actuators? Are there any deformations in test article after pre-det? How are you taking these measurements? Is safety being enforced? Did the camera capture the test? How are we saving that data?
Close Shift	*depressurize, pressures, facility clean,organize cables*	
	camera breakdown, facility clean, move equipment inside	Are lines depressurized? what can we do right now to ensure easier prep next campaign? From the remaining pressures, how many test can be run with that? Where are we putting the micro-rde after testing? Is all borrowed hardware returned as if it was never used? How are we saving that data? Who's going to have access and how is it uploaded? How will it be analyzed?

All data & pictures presented are publicly available

Propulsion and Energy Research Laboratory

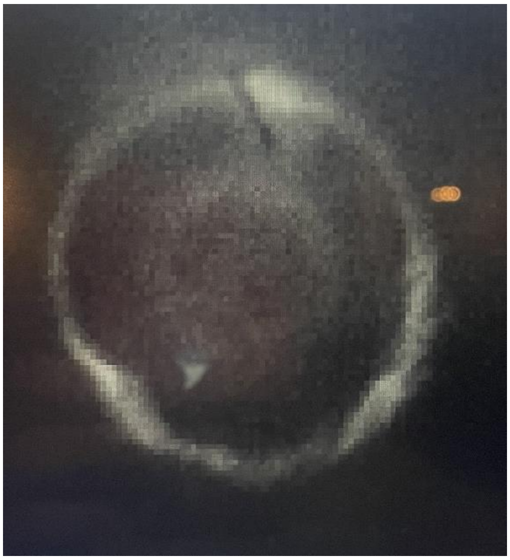
Small-Scale Rotating Detonating Rocket Engine (RDRE) - Project Manager

Conclusion and future considerations

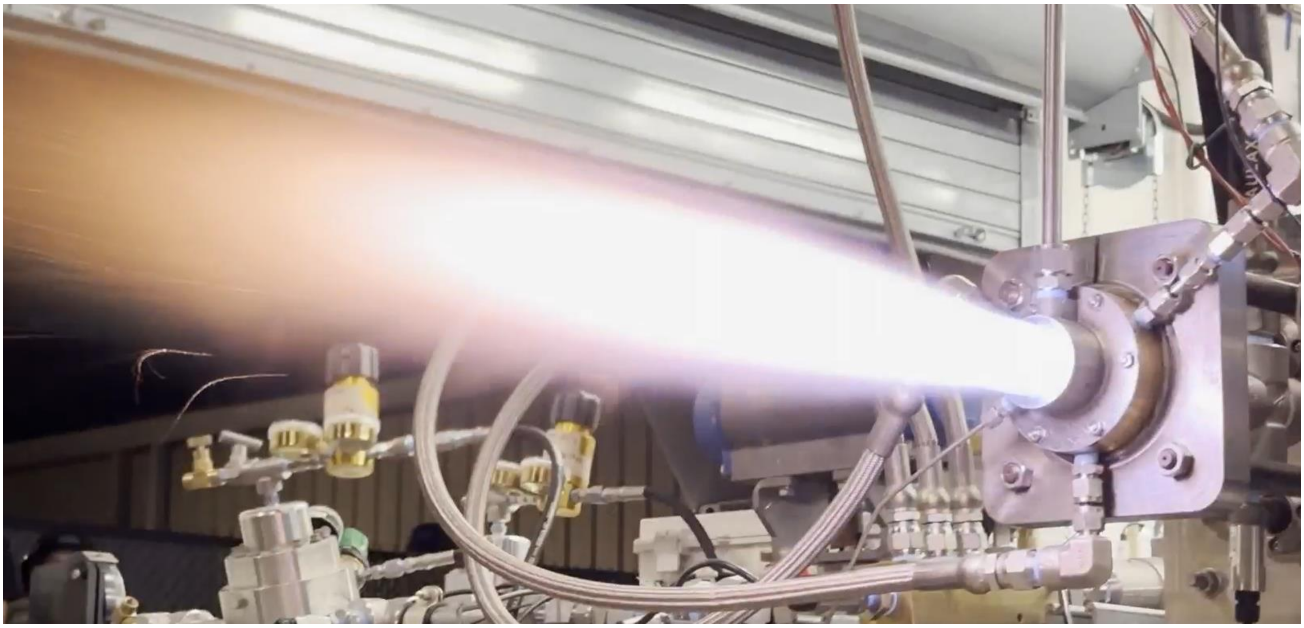
- Developed hardware was tested a demonstrated a 128 Ns Methane/GOx RDRE with three clockwise rotating detonation waves.
- Won "Best in Show" out of 148 Senior Design Projects in the College of Engineering and Computer Science at the University of Central Florida
- Further investigation is needed to compare analytical models with experimental results

Publications

- 2024 AIAA Region II Student Conference– First Author publication (pending publishing)
- 2025 AIAA SciTech Conference – First Author publication (pending approval)
- 2025 AIAA SciTech Conference – Second Author publication (pending approval)



Back End Imaging Showing Three Detonation Waves



Hot Fire Test of Small Scale RDRE

All data & pictures presented are publicly available

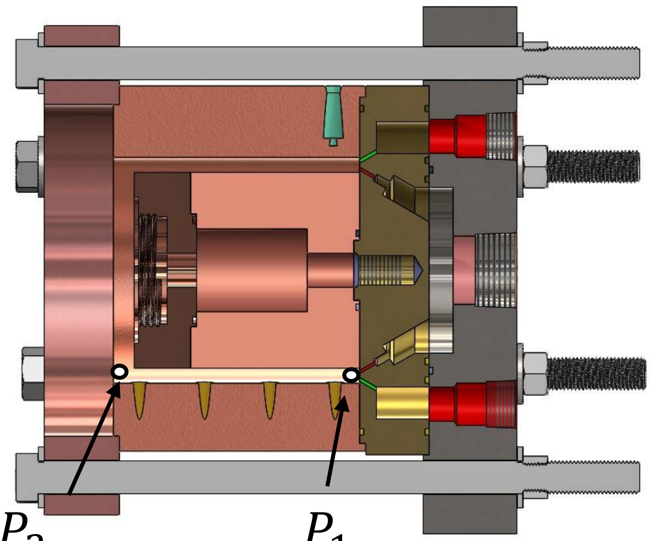
Propulsion and Energy Research Laboratory

3-inch Rotating Detonation Rocket Engine (RDRE) - Lead Researcher

The RDRE has garnered a wide research base given its relevance its potential for increased engine efficiencies through its **pressure-gain combustion** nature. As compared to the Brayton Cycle, RDREs achieve pressure gain combustion through an increase of stagnation pressure by the gas expansion in a constrained heat environment. Theoretical cycle analysis suggests this pressure gain results in 20-30% more work output than isobaric engines.

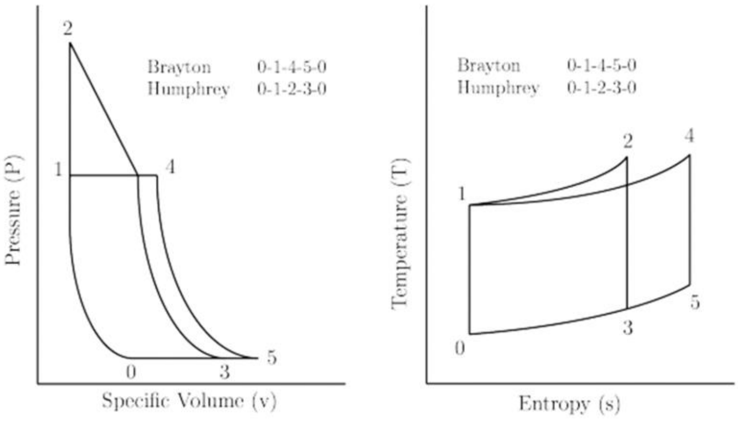
One major constraint for the continued development of these engines is determining the stagnation pressure at the exit of the combustion chamber (P_2 in the bottom left image)

In this work, I compare three different methods of determining the stagnation pressure at the exit of the combustion chamber of an RDRE



$$Pressure\ Gain\ (\%) = \frac{P_2}{P_1} - 1$$

Cross sectional view of the 3-inch RDRE



Pressure-Volume Diagram (Left) & Temperature-Entropy Diagram (Right) highlighting extra work available in Humphry cycle when compared to Brayton Cycle

Nick D. DeBarmore. "CHARACTERIZATION OF ROTATING DETONATION ENGINE EXHAUST THROUGH NOZZLE GUIDE VANES" DEPARTMENT OF THE AIR FORCE AIR UNIVERSITY

All data & pictures presented are publicly available

Propulsion and Energy Research Laboratory

3-inch Rotating Detonation Rocket Engine (RDRE) - Lead Researcher

NPS Method

$$P_2 = P_{e,s} = P_{t4}\left(\frac{\gamma+1}{2}M_e^2\right)^{\frac{\gamma}{\gamma-1}}$$

EAP Method

$$EAP = P_{e,s} = P_{e,t}\left(\frac{\gamma+1}{2}M_e^2\right)^{\frac{\gamma}{\gamma-1}}$$

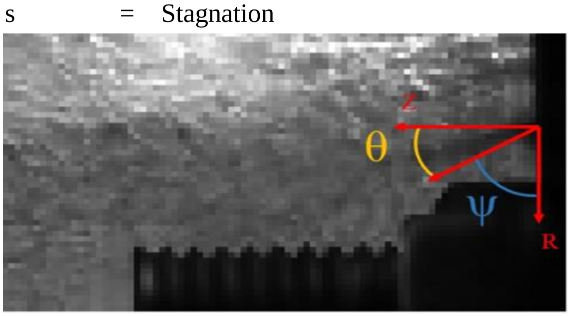
$$P_{e,t} = \frac{\frac{F_g}{A_e}+P_0}{1+\gamma M_e^2}$$

Prandtl-Meyer expansion angle method

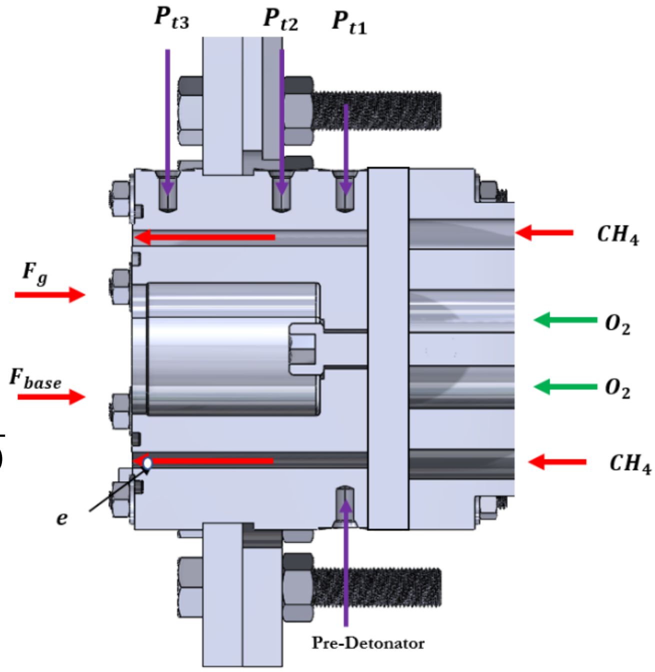
$$\theta = \sqrt{\frac{\gamma+1}{\gamma-1}}\tan^{-1}\sqrt{\frac{\gamma-1}{\gamma+1}(M^2-1)} - \tan^{-1}\sqrt{(M^2-1)}$$

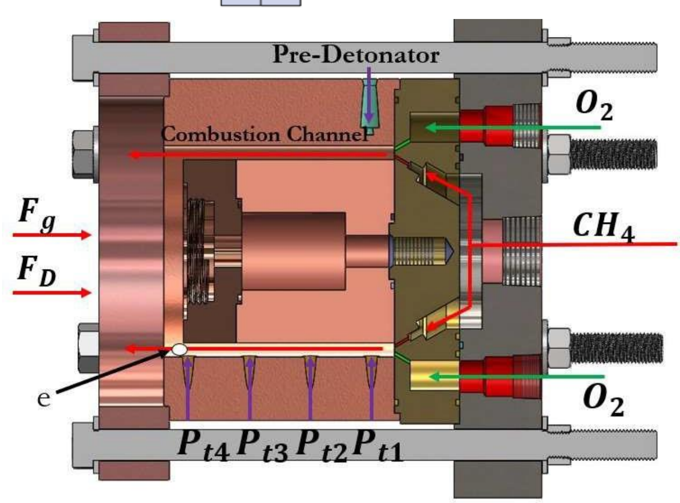
Nomenclature

A	=	Area
P	=	Pressure
γ	=	Specific Heat Ratio
M	=	Mach Value
PG	=	Pressure Gain
EAP	=	Equivalent Available Pressure
Θ	=	expansion angle
Subscript		
E	=	Combustor Exit
g	=	Gross
D	=	Drag
0	=	Ambient
t	=	Static
f	=	Plenum
s	=	Stagnation



Divergence angle used for the Prandtl-Meyer expansion angle method





Top image is of a cross section of the AFRL RDRE used in this campaign

Bottom image is of a cross section of the 3-inch RDRE used in this campaign

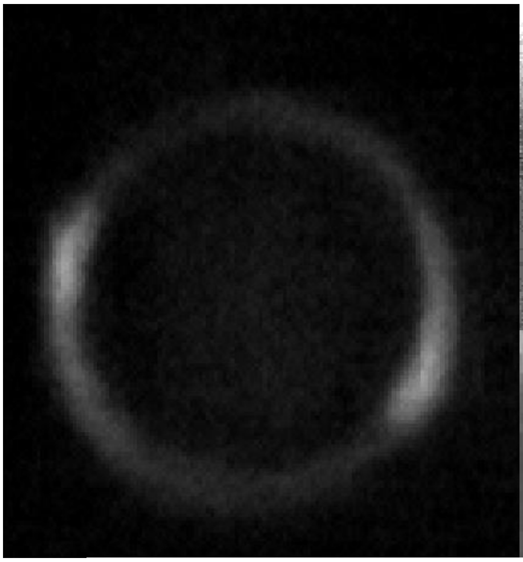
All data & pictures presented are publicly available

Propulsion and Energy Research Laboratory

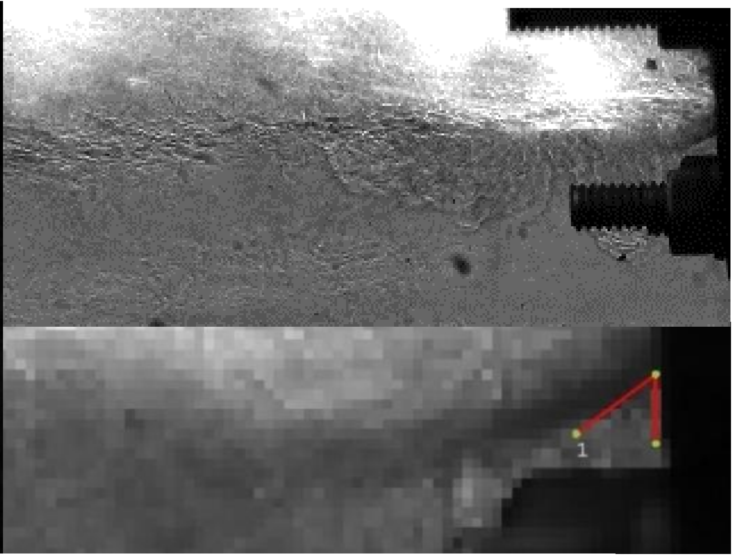
3-inch Rotating Detonation Rocket Engine (RDRE) - Lead Researcher

Testing Plan - Optical Diagnostics

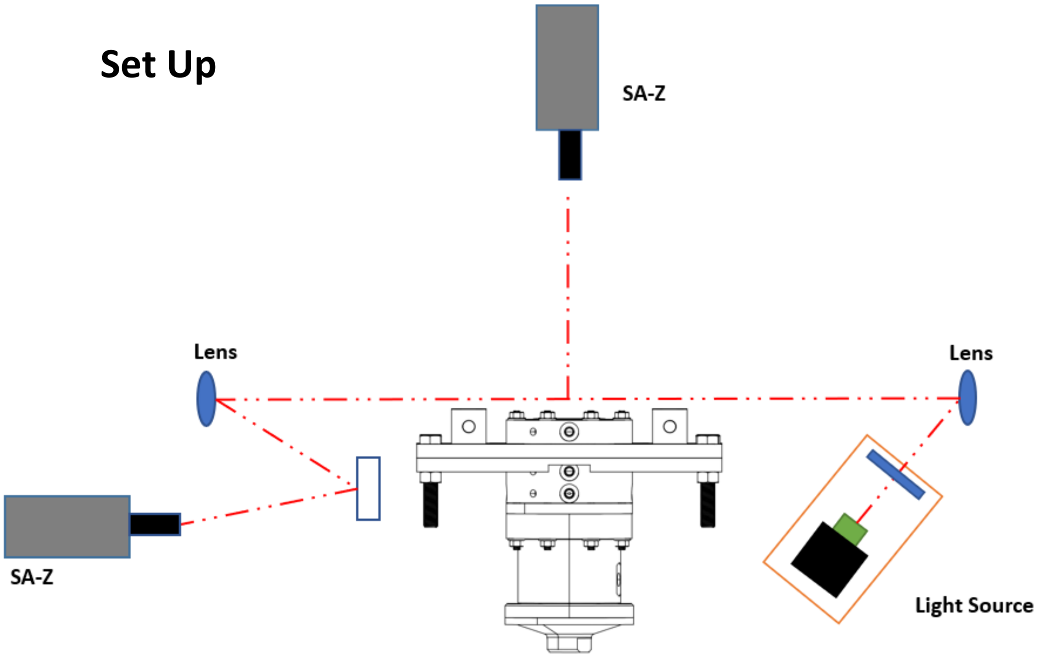
Back-end Imaging



Shadow Graph Imaging



Set Up



All data & pictures presented are publicly available

Propulsion and Energy Research Laboratory

3-inch Rotating Detonation Rocket Engine (RDRE) - Lead Researcher

Results and Conclusion

The data presented was collected at the Propulsion and Energy Research Laboratory (PERL) at the University of Central Florida.

By calculating the Equivalent Available Pressure of the UCF RDE, the pressure gain could be quantified. What was observed in these tests is that there is no standard way to obtain the base drag force from these campaigns. Given the differences in these results, it is important to note the differences in the diagnostics for each method for calculating pressure gain. For a universal method of calculating pressure gain, a common architecture should be shared that allows for the same diagnostics, whether it is with pressure ports or optical access to the plume.

Publications
2023 AIAA Aviation Conference – "Base Drag Considerations to Determine Equivalent Available Pressure in the Rotating Detonation Rocket Engine - First Author publication

Parameter	Value
Divergence Angle	32 °
Specific Heat Ratio	1.2
Jet boundary Static Pressure	14.7 psia
Combustor Exit Stagnation Pressure (Shadow Graph)	159.78 psia
Combustor Exit Stagnation Pressure (NPS)	74.49 psia

Table 1. Comparison of AFRL RDE combustor exit properties.

Parameter	Value
Thrust	64.59 lbf
Specific Heat Ratio	1.2
EAP	63.86 psia
NPS Stagnation Pressure	66.19 psia

Table 2. Comparison of UCF RDE combustor exit properties.

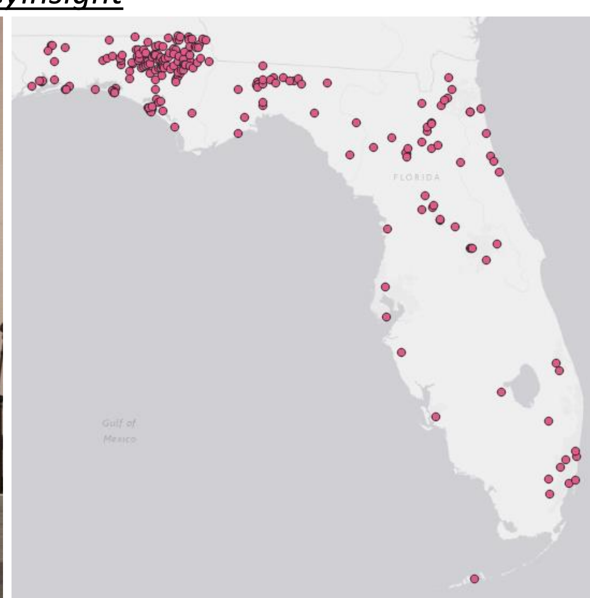
All data & pictures presented are publicly available

Emergency Insights

Co-Founder & CEO

- Identified limitations in existing hazard information platforms, addressing issues of specificity, outdated data, user comprehension, and data accuracy.
- Developed a platform that converts raw data into practical insights, simplifying the process for users to access comprehensive hazard information for their properties.
- Offered an affordable solution for counties seeking annual hazard reports, allowing Hazard Mitigation Officers to customize and download reports directly from the platform.
- Streamlined the process of creating hazard mitigation plans for government entities, enabling effective prioritization of resources and actions.
- Successfully competed at UCF's Joust New Venture Competition, placing 4th out of 64 highly competitive businesses.
- Raised $2,000 for the creation and development of the venture
- Accepted into the 5th session of BuildSpace, a program focused on advancing entrepreneurial ventures.

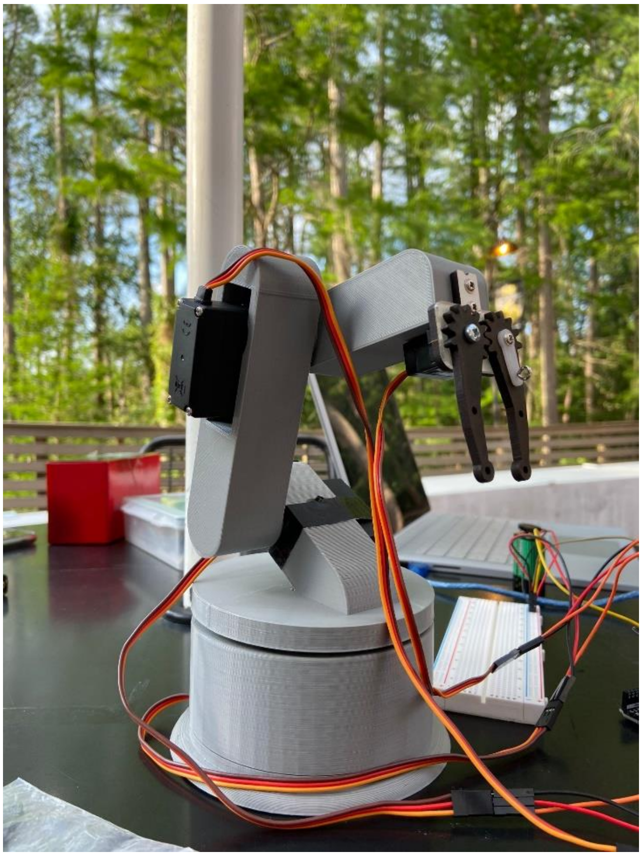
Website: *https://arefabdala.wixsite.com/emergencyinsight*



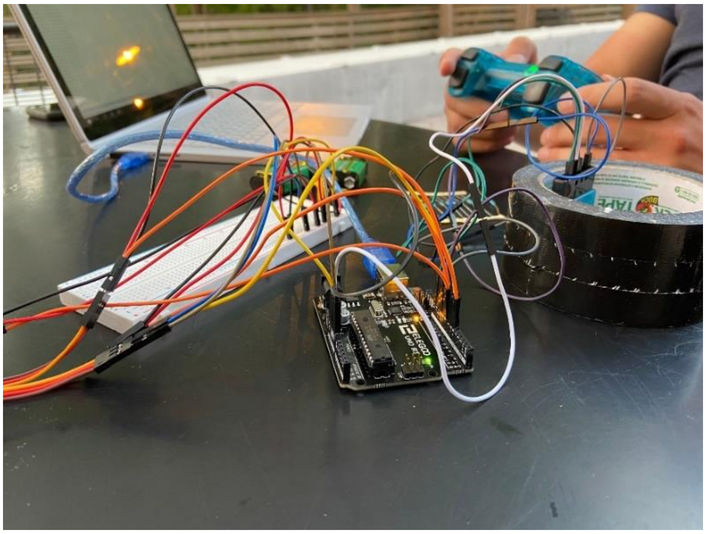
All data & pictures presented are publicly available

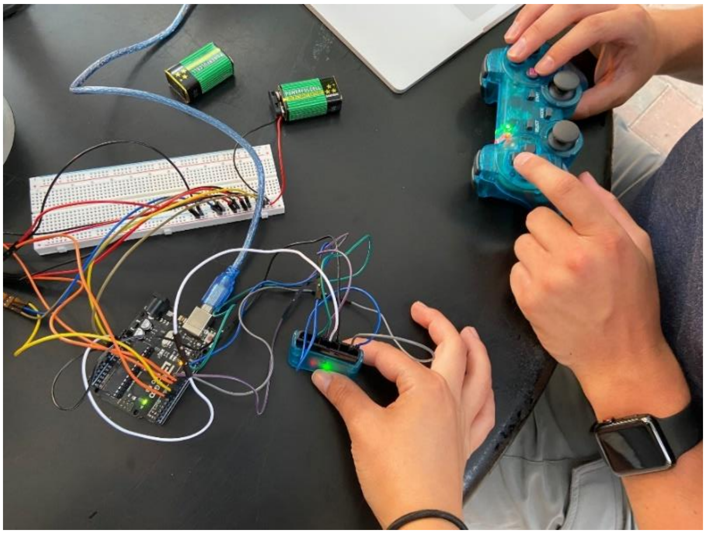
Robotic Arm project - Project Manager

- Oversaw the design, manufacturing and integration of a robotic arm
- Utilized additive manufacturing to print a robotic arm and integrated a PS2 controller into the Arduino code
- Could retrieve up to 5lb with a range of 4 inches around the base in a 360-degree axis



Assembled robotic arm





Testing of the robotic arm

All data & pictures presented are publicly available