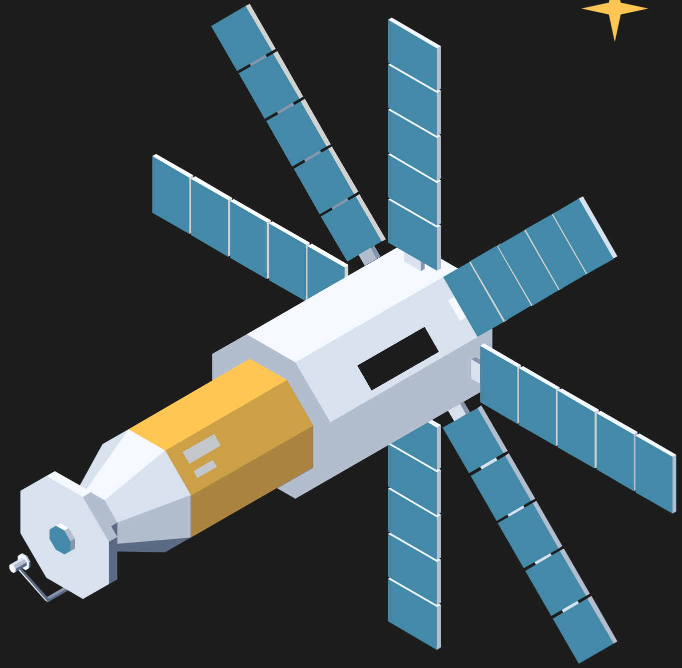
Portfolio

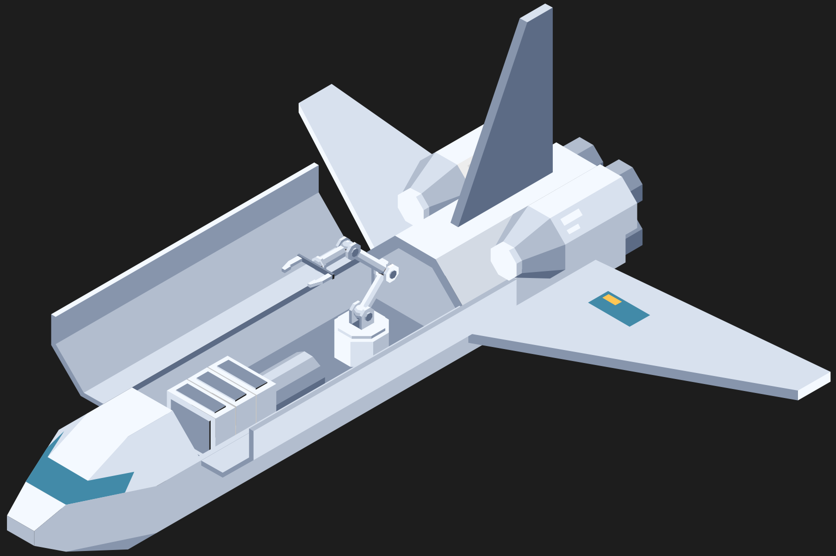
Sid Vaidy



About Me

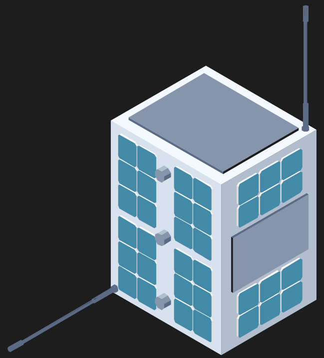
- College: Arizona State University
- Graduated B.S. Mechanical Engineering (05/24)
- Pursuing Masters Degree in Robotics and Autonomous Systems focus in Aerospace Engineering (05/26)
- Published Co-Author: Vaidyanathan, S., et al. (2024). **Integration and Delivery of the Deployable Optical Receiver Aperture (DORA) Cubesat**. In *5.01 Small, Low-Cost Missions in Development and Operations for Space and Earth Exploration* (Paper No. 2660).

Professional Experience



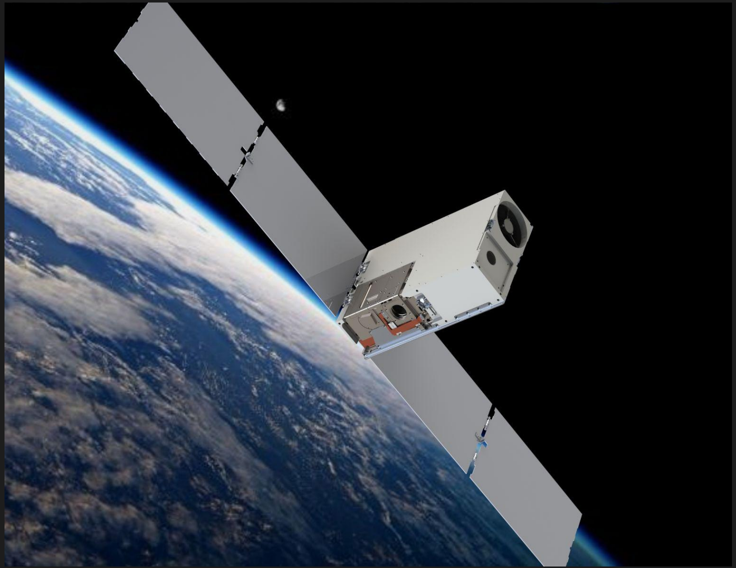
SPARCS

Assembly, Integration, and Test of the
Star-Planet Activity Research CubeSat



SPARCS Mission

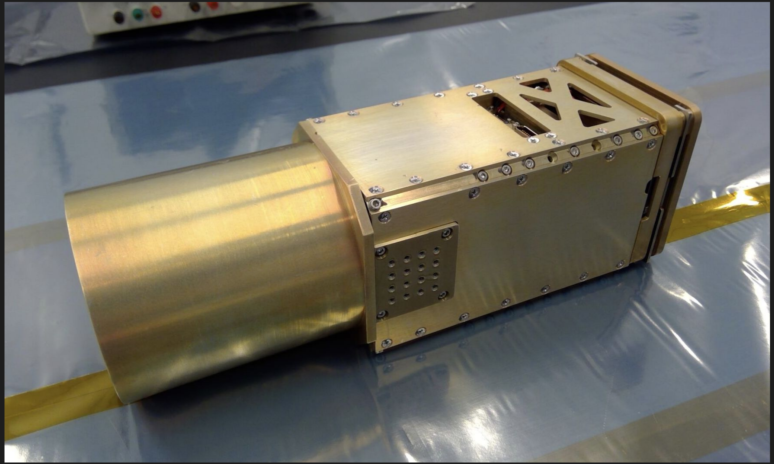
- 6 unit NASA-funded CubeSat
- Objective: Study low-mass stars to correlate solar activity with the atmospheric composition of exoplanets
  - Quiescent low mass measurements
  - Flare measurements
  - Demonstration of UV-delta doped detectors
- Sun Synchronous Orbit
- Mission time ~1 year
- Set to launch late 2025



Render of SPARCS CubeSat

Assembly (Payload & Bus)

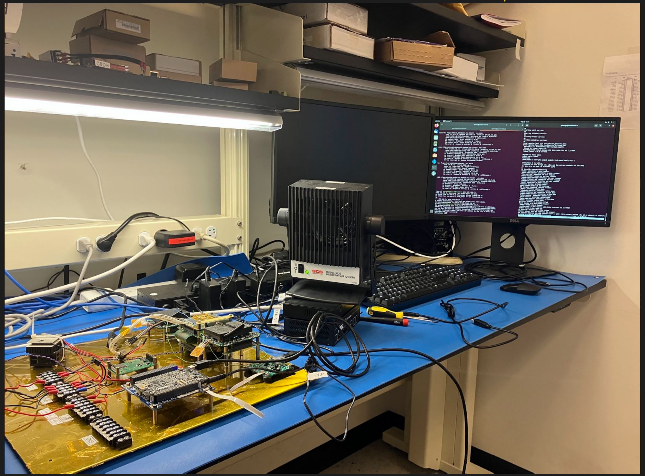
- UV detector payload
  - Designed by JPL
  - Structure assembled and tested at ASU
- SPARCS 6u Bus
  - Designed by BCT
  - Staking and conformal coating of Bus PCBs
  - Arathane 5750 <1% TML
  - Nylon spacers and thread lockers



SPARCS payload assembly

Integration & Test

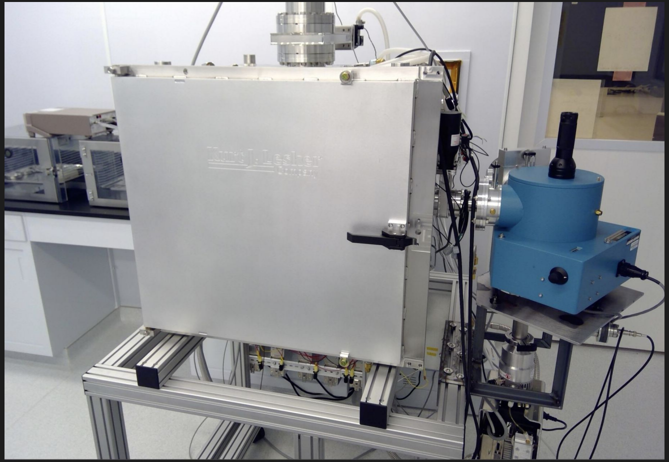
- Before bakeout and integration
- Payload to Bus integration
  - Payload power, IO, Heater, Solar array, release mechanism, structure
- Safe-to-mate
  - D-sub connectors
  - Breakout box (continuity, isolation, impedance)
- DITL (Day In the Life) testing



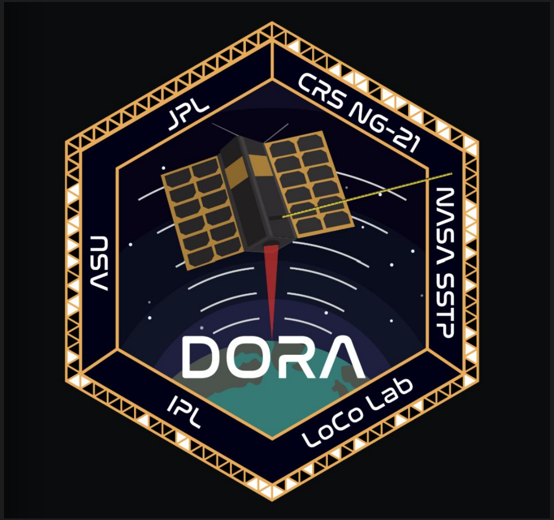
SPARCS FlatSat

Environmental: TVAC

- Bakeout and TVAC cycling
  - Individual bakeout for bus and payload before integration
- RGA and TQCM
  - Monitoring contamination via mass spectrometer and quartz crystal
- Thermocouples placed on Spacecraft, AIT Structure, and chamber shroud
- Training students to monitor TVAC and swap LN2 dewars, and general lab safety

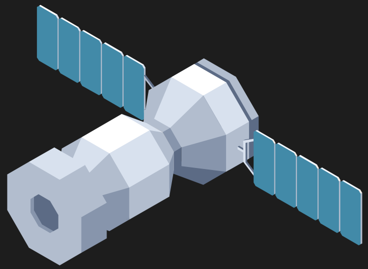


SPARCS TVAC chamber cycling



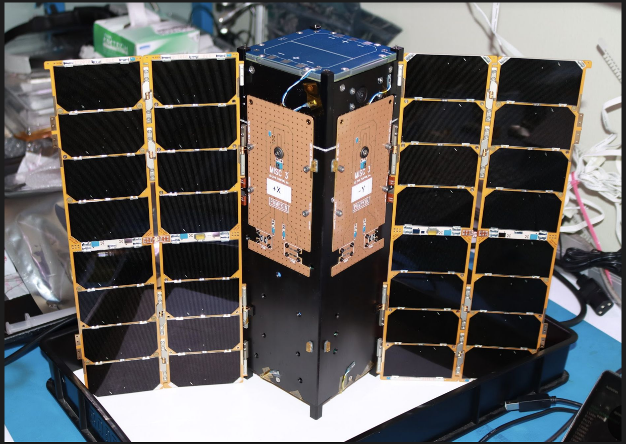
DORA

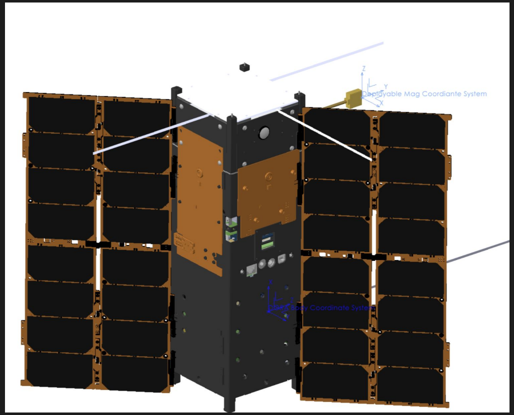
Design and Integration of the
DORA CubeSat



Structural Integration

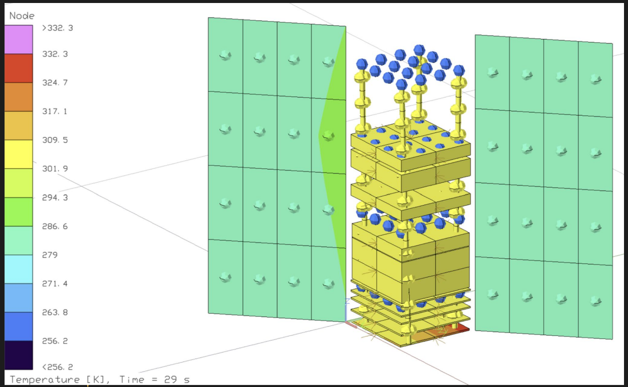
- Lead mechanical engineer in charge of working with Pumpkin Space Systems to design and integrate a structure for the DORA CubeSat.
- In charge of CAD design and component assembly for the mission
- Managed Assembly, Integration and Testing (AIT) for the Satellite to meet project requirements

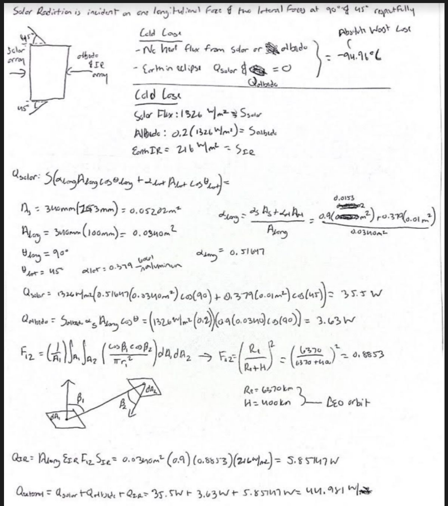




Thermal Analysis

- Designed and used fundamental heat transfer principles to create a thermal model of the DORA CubeSats in orbit using Thermal Desktop.
- Used basic hand calculations to verify thermal parameters in orbit and tuned the Thermal Desktop model according to verified calculations





Solar Radiation is incident on one longitudinal face & two lateral faces at 90° & 45° respectfully

solar array
albedo & IR array

Cold Case
- No heat flux from solar or albedo
- Earth in eclipse Q_{solar} & $Q_{albedo} = 0$

$= -94.96°C$ — Absolute Worst Case

Cold Case
Solar Flux: 1326 W/m² → S_{solar}
Albedo: $0.2(1326\ W/m^2) = S_{albedo}$
Earth IR $= 216\ W/m^2 = S_{IR}$

$Q_{solar}: S(\alpha_{long} A_{long} \cos\theta_{long} + \alpha_{lat} A_{lat} \cos\theta_{lat}) =$

$A_s = 340mm(153mm) = 0.05202m^2$
$A_{long} = 340mm(100mm) = 0.0340m^2$
$\theta_{long} = 90°$
$\theta_{lat} = 45°$ $\quad \alpha_{lat} = 0.379$ — 6061 aluminum

$\alpha_{long} = \frac{\alpha_s A_s + \alpha_{al} A_{al}}{A_{long}} = \frac{0.9(0.0153\ m^2) + 0.379(0.01\ m^2)}{0.0340\ m^2}$
$\alpha_{long} = 0.51647$

$Q_{solar} = 1326\ W/m^2(0.51647(0.0340m^2)\cos(90) + 0.379(0.01m^2)\cos(45)) = 35.5\ W$

$Q_{albedo} = S_{albedo}\alpha_s A_{long}\cos\theta = (1326\ W/m^2(0.2))(0.9(0.0340)\cos(90)) = 3.63\ W$

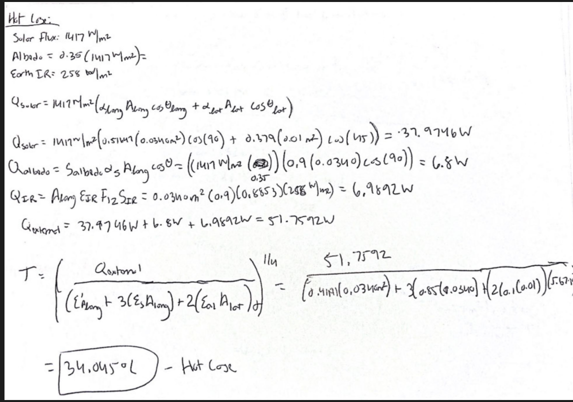
$F_{12} = \left(\frac{1}{A_1}\right)\int_{A_1}\int_{A_2}\left(\frac{\cos\beta_1 \cos\beta_2}{\pi r_1^2}\right) dA_1 dA_2 \rightarrow F_{12} = \left(\frac{R_e}{R_e+H}\right)^2 = \left(\frac{6370}{6370+400}\right)^2 = 0.8853$

dA_1, dA_2, β_1, β_2

$R_e = 6370km$
$H = 400km$ — LEO orbit

$Q_{IR} = A_{long}\varepsilon_{IR}F_{12}S_{IR} = 0.0340m^2(0.9)(0.8853)(216\ W/m^2) = 5.85147\ W$

$Q_{external} = Q_{solar} + Q_{albedo} + Q_{IR} = 35.5W + 3.63W + 5.85147W = 44.981\ W$



Hot Case:
Solar Flux: 1417 W/m²
Albedo $= 0.35(1417\ W/m^2) =$
Earth IR: 258 W/m²

$Q_{solar} = 1417\ W/m^2(\alpha_{long} A_{long}\cos\theta_{long} + \alpha_{lat} A_{lat}\cos\theta_{lat})$

$Q_{solar} = 1417\ W/m^2(0.51647(0.0340m^2)\cos(90) + 0.379(0.01\ m^2)\cos(45)) = 37.9746\ W$

$Q_{albedo} = S_{albedo}\alpha_s A_{long}\cos\theta = ((1417\ W/m^2(0.35))(0.9(0.0340)\cos(90)) = 6.8\ W$

$Q_{IR} = A_{long}\varepsilon_{IR}F_{12}S_{IR} = 0.0340m^2(0.9)(0.8853)(258\ W/m^2) = 6.9892\ W$

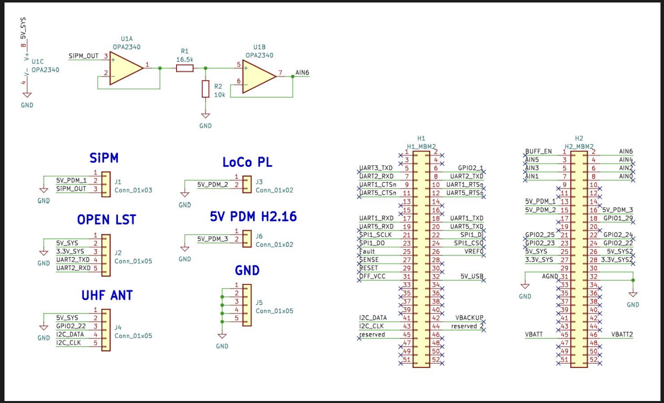
$Q_{external} = 37.9746W + 6.8W + 6.9892W = 51.7592W$

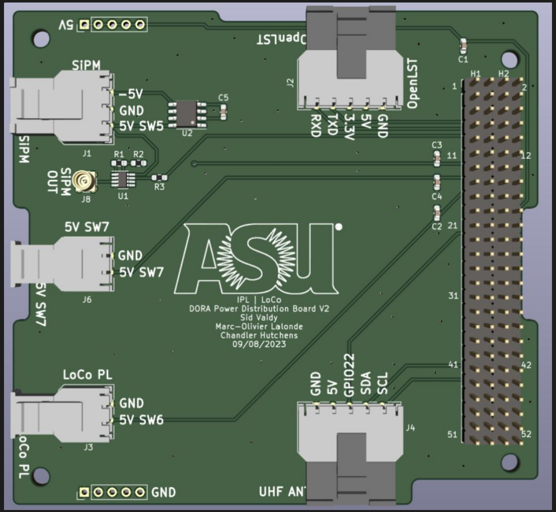
$T = \left(\frac{Q_{external}}{(\varepsilon' A_{long} + 3(\varepsilon_s A_{long}) + 2(\varepsilon_{al} A_{lat}))\sigma}\right)^{1/4} = \frac{51.7592}{(0.4181(0.0340m^2) + 3(0.85(0.0340)) + 2(0.1(0.01)))(5.67 \cdot 10}$

$= \boxed{34.045°C}$ — Hot Case

PCB Design

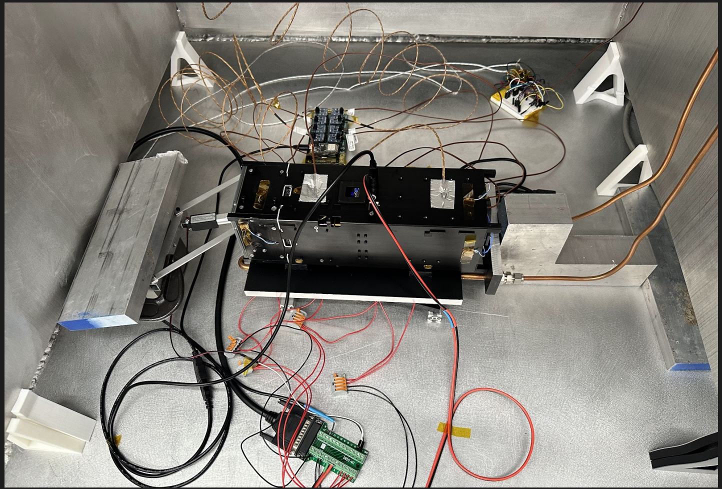
- Aided in designing and developing a Power Distribution board for the DORA CubeSat using KiCAD. The Power Distribution Board traces power from PC-104 connections in the satellite to external connectors for the payload to interface to.





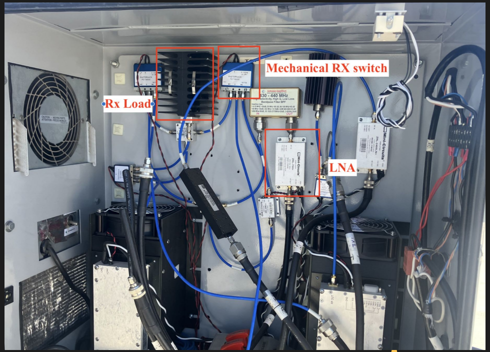
Validation and Testing of DORA CubeSat

- Conducted Vibration and Thermal Cycle testing to meet ISS and launch deployer requirements as well as validation for day in the life testing for the satellite.

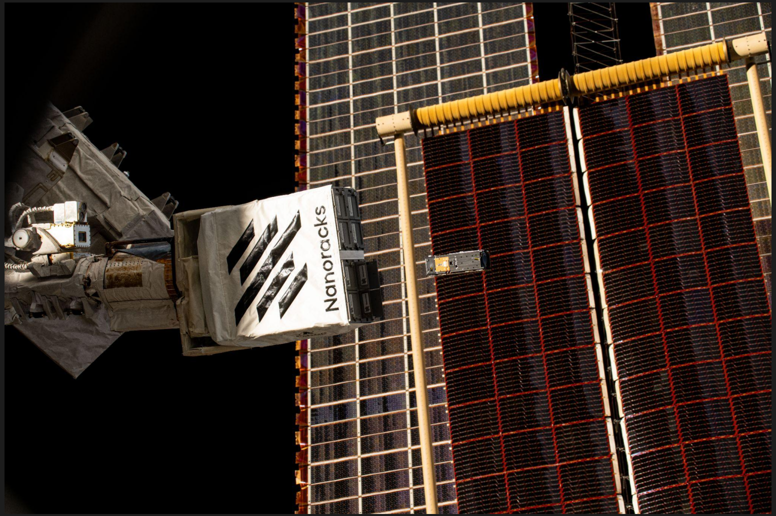




Ground Station and Operations Setup

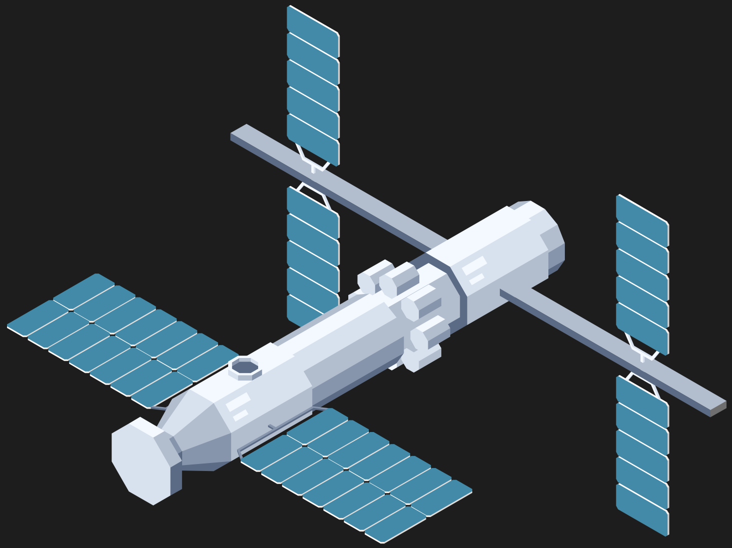
- In charge of setting up SatNOGS Station to transmit and receive packets from deployed CubeSats at Arizona State University
- Developed a 2 pole yagi-antenna system to transmit and receive data
  - 1 Antenna is used to transmit and another to receive
  - Used an rf switching system to coordinate transmissions and receptions
  - Used open source software (hamlib, rigctl) to directionally point groundstation to track satellites



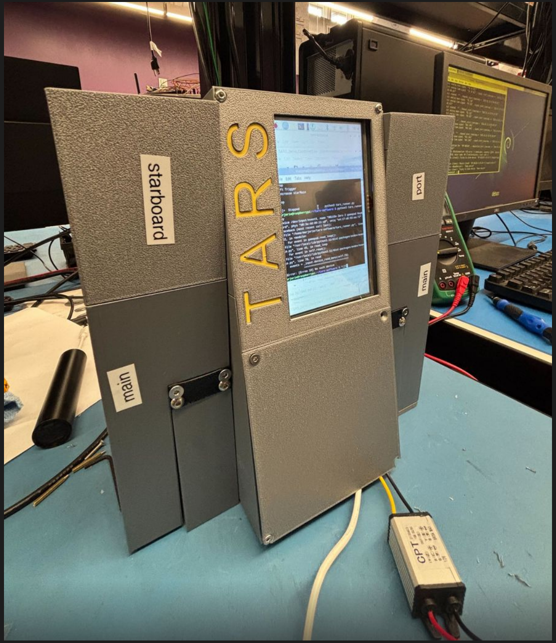
DORA in SPACE!

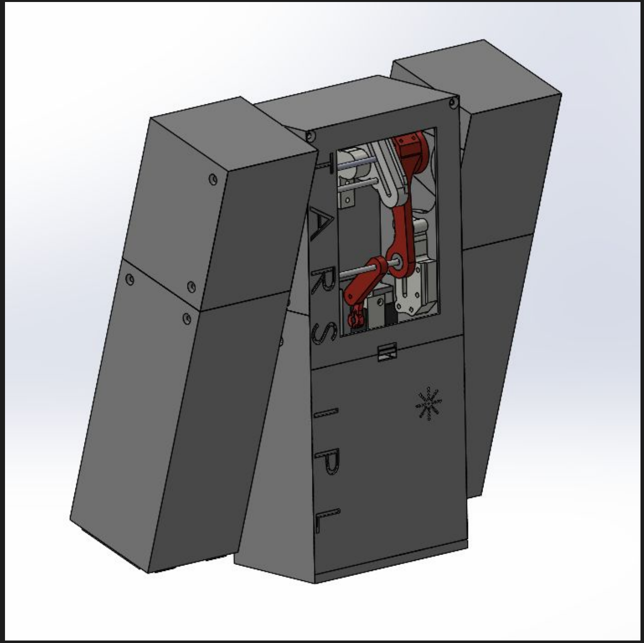


Personal/Academic Projects



OpenAI TARS: An Open Source GPT Integrated TARS (From Interstellar)



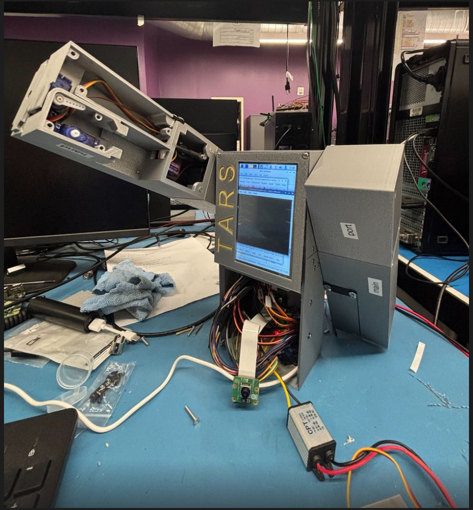


GP-TARS Electromechanical Assembly and Design

- Revised and redesigned open-source project that replicated TARS from *Interstellar* with an integrated OpenAI model
- Open AI model provides visual object detection and can input and output voice commands.

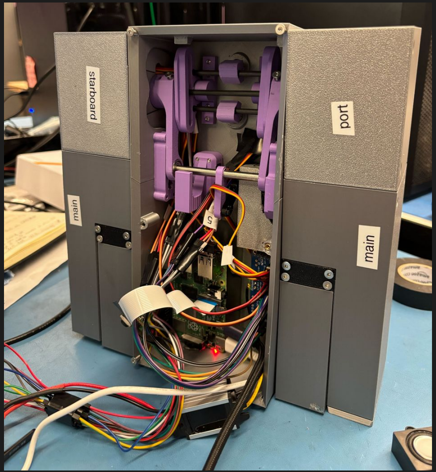
Click here to watch TARS in action!

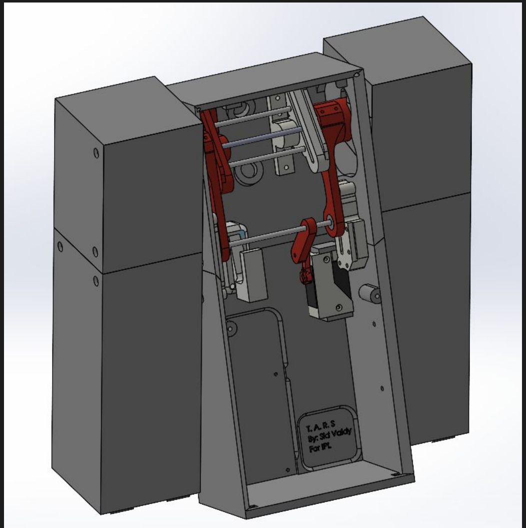
https://drive.google.com/file/d/1R9l30r6tyqpW_A_NTZhtzY-8GJd9N-Zi/view?usp=sharing



Electromechanical Assembly and Design

- Designed CAM mechanism to convert rotary motion from a servo to a linear motion that allows TARS to move up and down.
- Developed Scaled prototypes on SolidWorks with motion analysis to simulate robot functionalities
- TARS has a unique style of movement similar to “monkey” where his movement is momentum based.

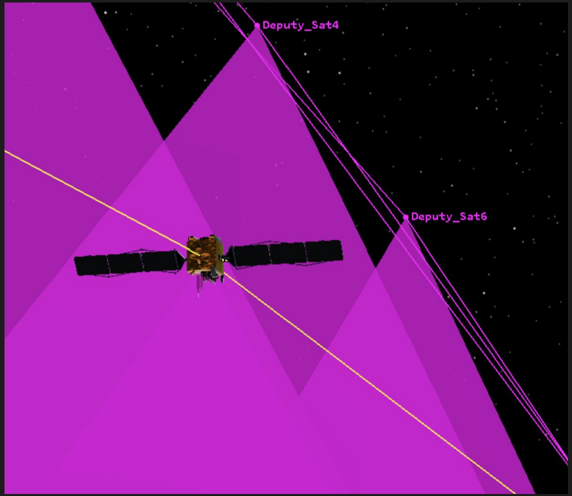


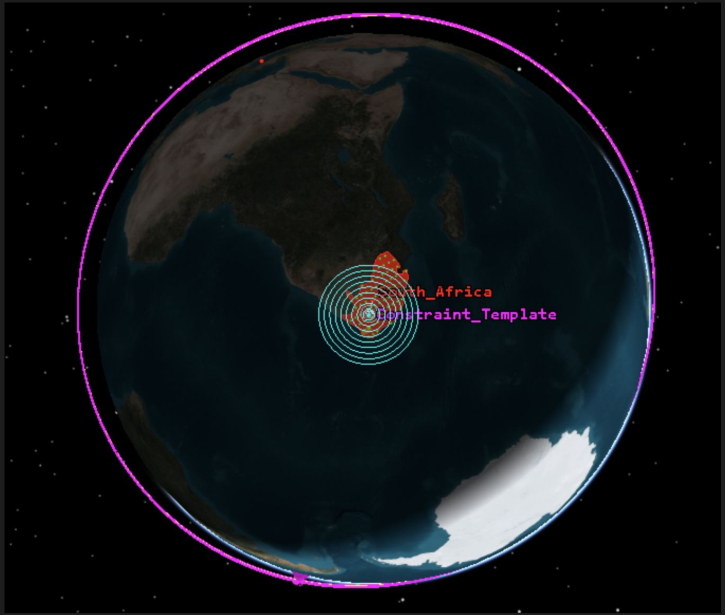


Electromechanical Assembly and Design

- Developed electrical interface for easy integration and with a low cost budget
- TARS electrical interface consists of:
  - Raspberry Pi (OBC that does all the computing and processing)
  - 16-Channel PWM Driver (Servo Driver)
  - 12V Lipo Battery (Power Supply to Power Servos because they're power hungry!)
  - Portable battery unit (To power Rpi)
  - LCD Screen (Displays TARS UI eg. text to speech converter, images)

Distributed Control of Lower Earth Orbit (LEO) Satellite Constellations





Project Contribution

Advanced Satellite Swarm Design: Proposed and developed a 7-satellite swarm (1 chief, 6 deputies) in low Earth orbit (LEO) to augment the HERA antenna array's interferometric baselines for high-resolution imaging of the Epoch of Reionization (EoR).

Dynamic Control System Implementation: Designed a MATLAB-STK integrated framework utilizing Clohessy-Wiltshire equations and stability controllers to achieve precise satellite formations optimized for spatial coverage and signal quality.

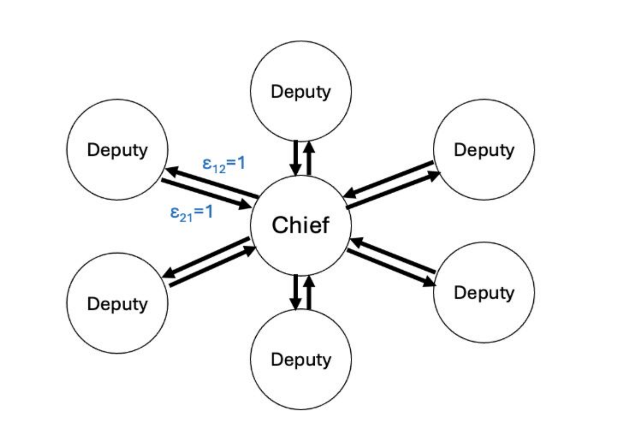


Fig.8 - Balanced and Strongly Connected Network Graph for Dynamics

$$f_c = 2\sqrt{\frac{\mu}{r_{chief}^3}} \quad (12)$$

$$\ddot{x}_i - 2f_c\dot{y}_i - f_c^2 x_i = -\frac{\mu(x_i + x_{chief})}{[(x_i+x_{chief})^2+(y_i+y_{chief})^2+(z_i+z_{chief})^2]^{\frac{3}{2}}} - \dots \quad (13)$$

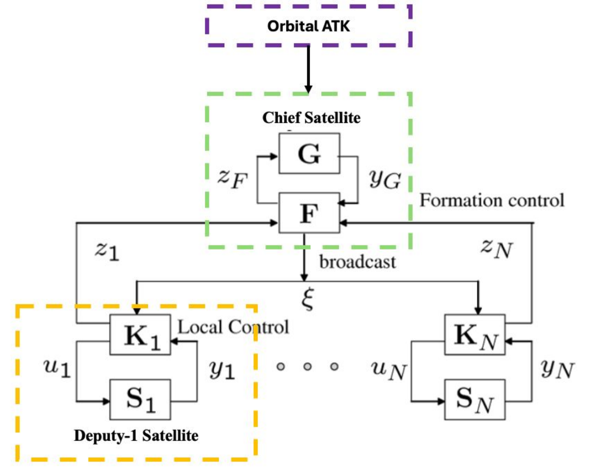
$$(D_{x,i} - D_{x,chief}) + \frac{\mu_{x.chief}}{r_{chief}^3} - u_x$$

$$\ddot{y}_i + 2f_c\dot{x}_i = -\frac{\mu(y_i + y_{chief})}{[(x_i+x_{chief})^2+(y_i+y_{chief})^2+(z_i+z_{chief})^2]^{\frac{3}{2}}} - \dots \quad (14)$$

$$(D_{y,i} - D_{y,chief}) + \frac{\mu_{y.chief}}{r_{chief}^3} - u_y$$

$$\ddot{z}_i = -\frac{\mu(z_i + z_{chief})}{[(x_i+x_{chief})^2+(y_i+y_{chief})^2+(z_i+z_{chief})^2]^{\frac{3}{2}}} - \dots \quad (15)$$

$$(D_{z,i} - D_{z,chief}) + \frac{\mu_{z.chief}}{r_{chief}^3} - u_z$$



Project Contribution

Impactful Results: Demonstrated enhanced spatial resolution, stable hexagonal formation, and maximized observation time over South Africa, contributing to advancements in low-frequency cosmology.

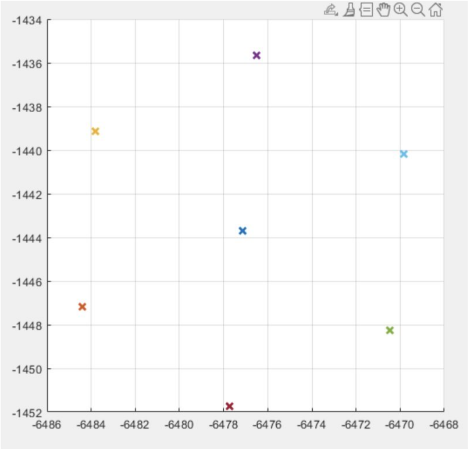


Figure 15: Final Positions of the Satellites

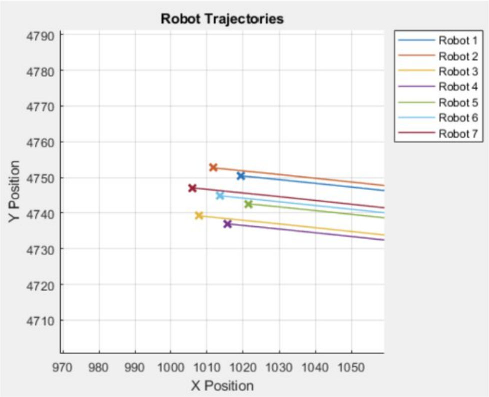


Figure 20: 2 Zoomed Body Plot of Satellite Trajectories in the X and Y Planes Showing Hexagonal Formation

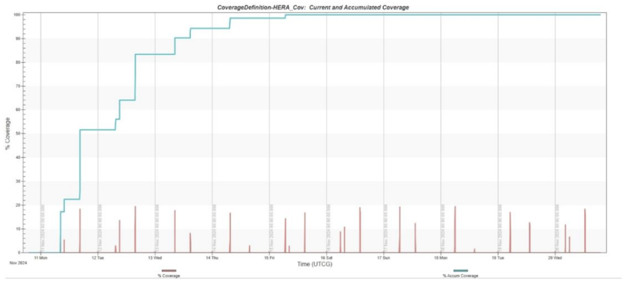
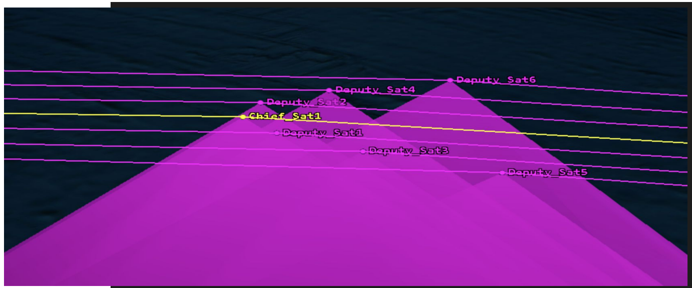
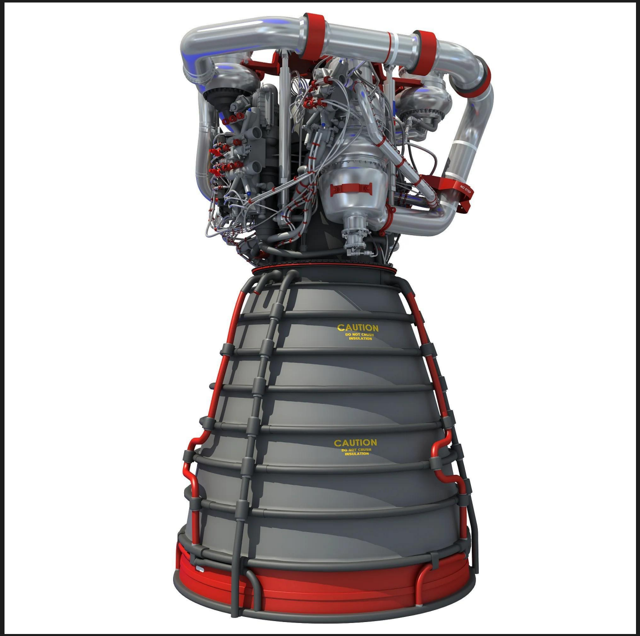
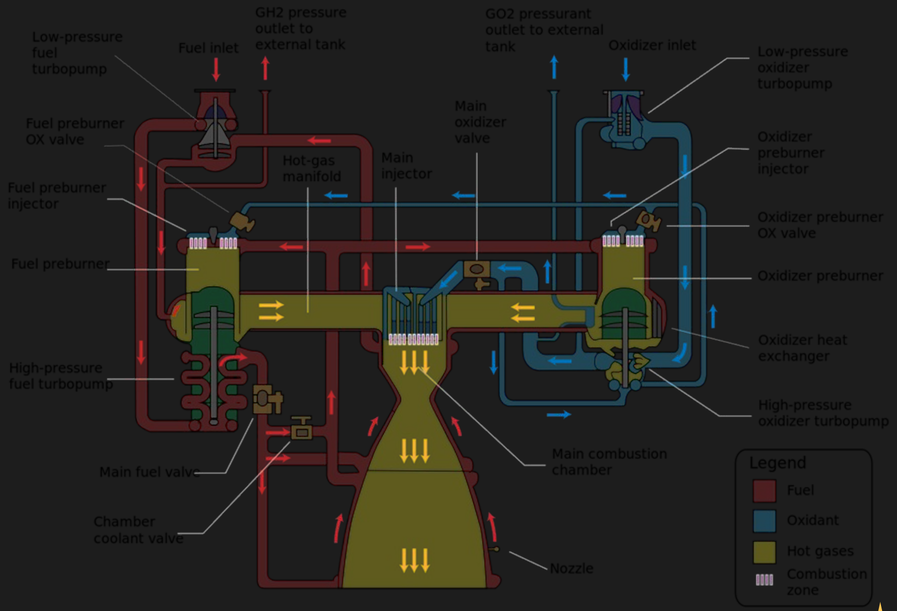


Figure 26: Coverage of HERA over 10 Day Period



RS-25 Engine Analysis





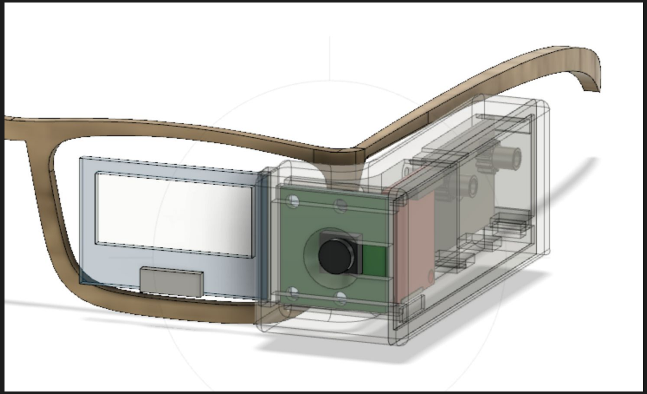
RS-25 Engine Analysis

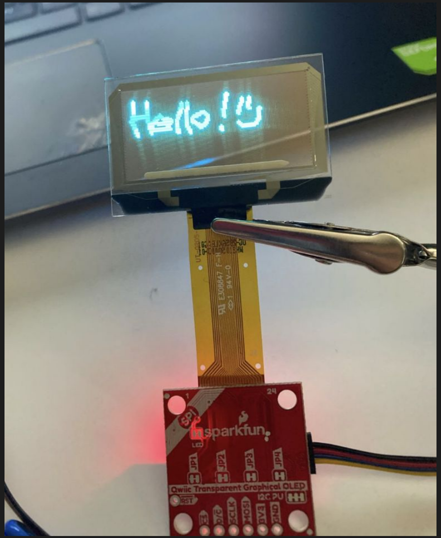
- Examine the feed system of the RS-25 engine, used in the Space Shuttle and NASA's Space Launch System (SLS) to estimate thrust, nozzle efficiency, and specific impulse values.
- Using calculations for values across each component in the RS-25 Feed System, thrust data was calculated as shown in the table below. Values were calculated at Sea Level as well as in a vacuum condition. There was some erroneous values as greater vacuum efficiency was expected. Accordingly, based on the change of values between calculations taken at frozen flow and shifting equilibrium in the expansion nozzle, a future thrust calculation should be taken with values somewhere in between frozen and shifting equilibrium flows.

Table 36: Thrust Data

Property	Value		
	Sea Level	Vacuum	Units
Resulting jet thrust (SL)	2816	2816	kN
Resulting pressure thrust (SL)	-314	109	kN
Resulting nominal thrust (SL)	2502	2925	kN
Nozzle divergence thrust loss	0.80	0.80	%
Resulting divergence-corrected thrust (SL)	2480	2902	kN
Actual thrust coefficient C_T (SL)	1.98	2.32	---
Ideal thrust coefficient (C_T)_ideal (SL)	1.83	2.84	---
Resulting nozzle C_T efficiency (SL)	1.083	0.815564055	---
Specific Impulse I_sp (SL)	543	635	s

Memory Glass





Relevant Work Experience

MemoryGlass – Systems Integration Engineer:

- Designed eyewear attachment that displays names utilizing facial recognition to help patients with Alzheimer's.
- Designed components for the eyewear attachment such as the electrical components, glasses, OLED display, and a case and clamp system using Solidworks, which was later used for fabrication.
- Used Circuit Diagramming software to map transparent oled to Arduino Uno board.
- Used graphics libraries in Arduino IDE to input and control drawing outputs in a graphical user interface.

Contact Information

Email: svaidy12@asu.edu

Phone: 480-494-6050

Linkedin: https://www.linkedin.com/in/siddharth-vaidyanathan/

GrabCAD: https://grabcad.com/sid.vaidyanathan-1

Github: https://github.com/sidthekid3