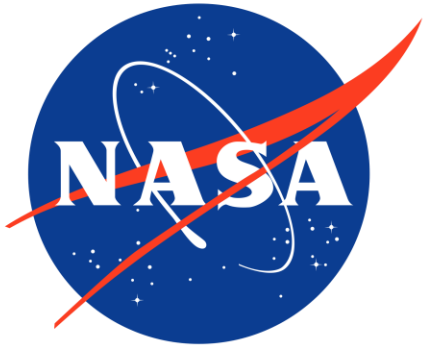
The University of Texas at Austin
Aerospace Engineering
and Engineering Mechanics
Cockrell School of Engineering

TEXAS SPACECRAFT LABORATORY

Information Session

What is TSL?

- Undergraduate-driven laboratory led by Dr. Brandon Jones
- Laboratory focusing on the design, manufacturing, and operation of small satellites
- Focusing on primarily government-funded projects for spacecraft, payload, and algorithm design and implementation



Projects

Past Missions

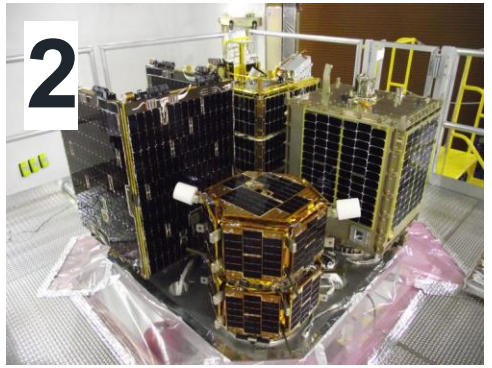
- Bevo-1
- FASTRAC
- RACE
- Bevo-2
- ARMADILLO
- Seeker Vision

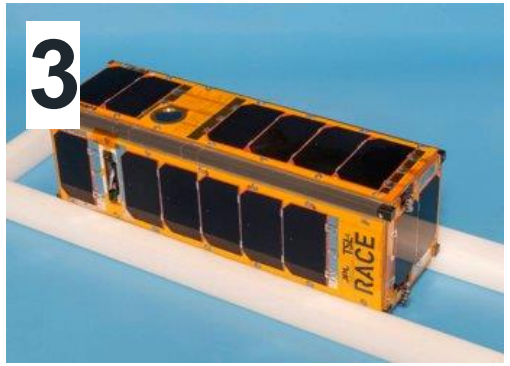
Ongoing Missions

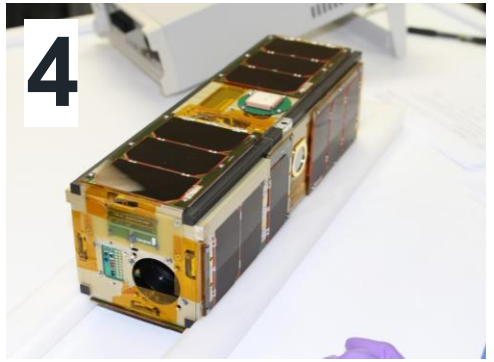
- SCOPE-1
- REACT
- Weather Balloon

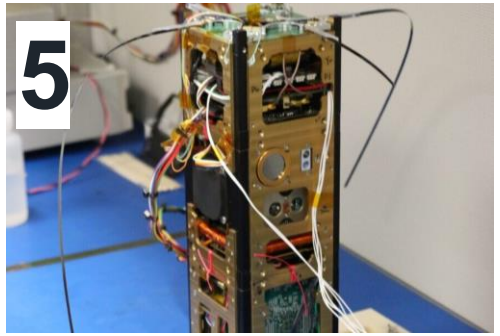
Past Missions

1. **Bevo 1 (2009)**
   - Autonomous docking & rendezvous experiment
   - Texas A&M, NASA JSC
2. **FASTRAC (2010)**
   - Formation Autonomy Spacecraft with Thrust, Relnav, Attitude and Crosslink (FASTRAC)
   - AFRL (UNP-3)
3. **RACE (2014)**
   - Radiometer Atmospheric CubeSat Experiment (RACE)
   - NASA JPL
4. **Bevo 2 (2016)**
   - Autonomous docking & rendezvous experiment
   - Texas A&M, NASA JSC
5. **ARMADILLO (2019)**
   - Atmospheric Related Measurements of Sub-Millimeter Debris in Low Earth Orbit
   - AFRL (UNP-7)
6. **VISION (Algorithm onboard JSC's SEEKER in 2019)**
   - Visual Identification System for Intelligent Orbital Navigation

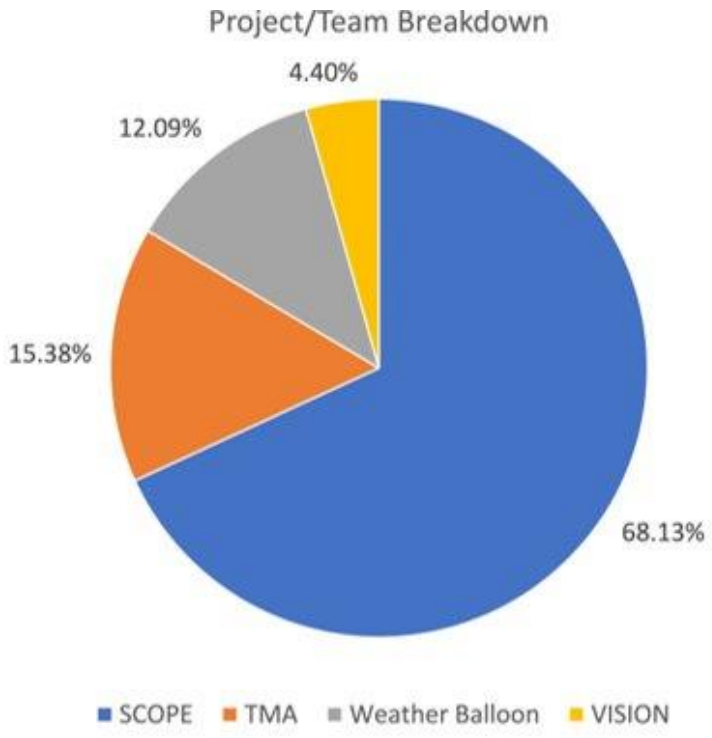


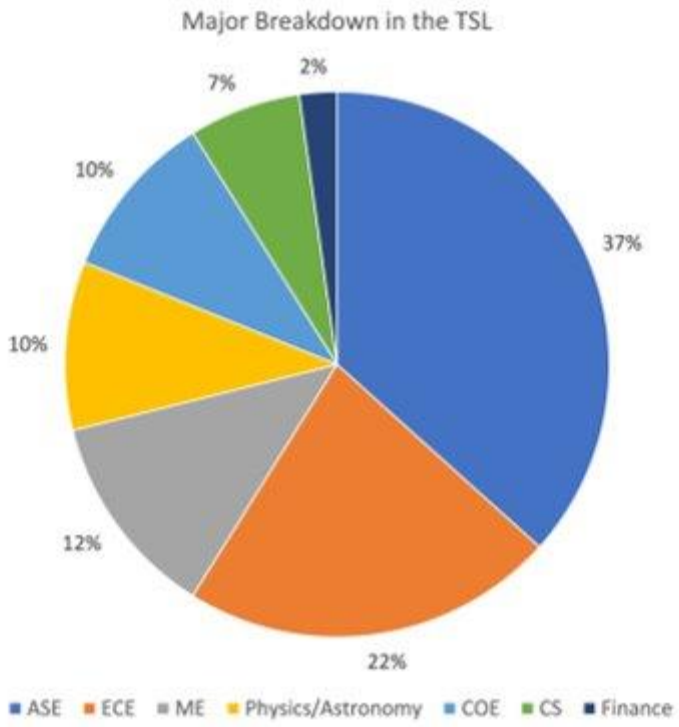


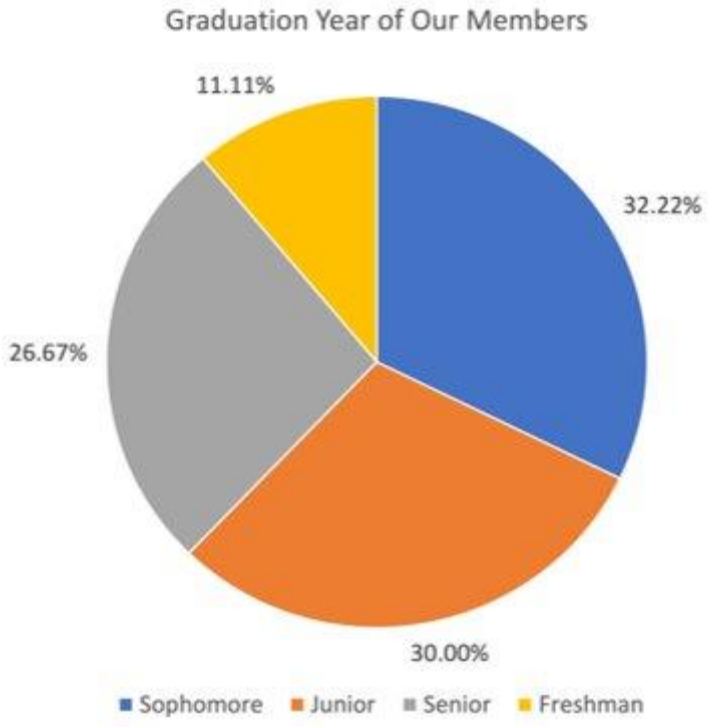




Typical TSL demographics breakdown







Ongoing Missions

SCOPE-1

Spacecraft for Optical-based Position Estimation-1

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Mission Overview

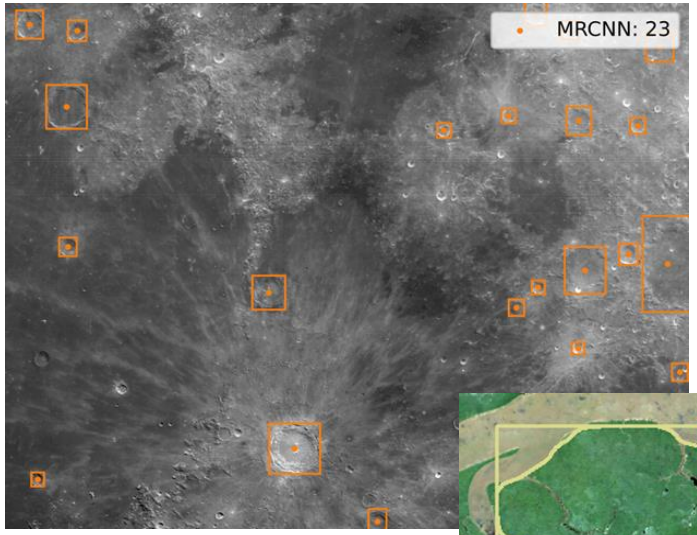
Collaboration b/w TSL, UT Grad students, Dr. Jones & Dr. Zanetti

Sponsored by NASA Small Spacecraft Technology Program

Mature PNT (Position, Navigation, Timing) algorithms originally developed for lunar applications

Develop new detector for Earth Islands & archipelagos

Low Earth orbit demo for future lunar application



Mission Concept

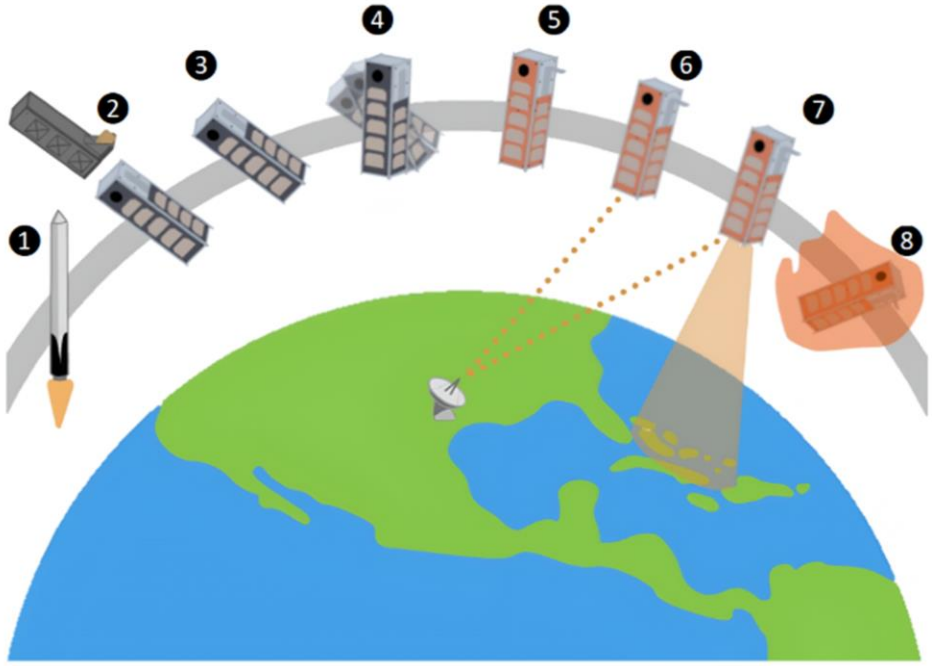
Capture image of ground target (islands/archipelagos)

Utilizing ML (computer vision) approach, estimate spacecraft position and timing on orbit

Simultaneously collect position & timing information from GNSS

Post downlink, compare measurements and estimates to verify algorithms

Mission success: 100 m error/axis, 100 ms error



Mission History

Started in Fall 2020

Completion through PDR at the end of Spring 2022

1 year hiatus until we received approval for funding in Fall 2023

Completed CDR, currently building flat sat and preparing for SIR

Mission Requirements Review (MRR)
Mission Proposal supported with technology gap assessment, 3+ mission options explored, timeline, overview, risk planning & mitigation, and preliminary design requirements

Internal Design Reviews (IDR)
Subsystem infrastructure establishment, subsystem requirements, added details to timeline, hardware Design To specifications, and build start of robust documentation

Preliminary Design Review (PDR)
Establish specifications, drawings, ICD's, qualification plans, optimize schedule and cost decisions, and resolve any system requirement conflicts

Critical Design Review (CDR)
Subsystem design details meeting all subsystem requirements, hardware Build to specifications, operations plan and robust documentation within design deliverables

Test Readiness Review (TRR)
Complete set of procedures, software test configuration, quality control plans, post-test data handling plans, and acceptance criteria

Flight Readiness Review (FRR)
Trained personnel, operational readiness criteria, verification requirements compliance, verification procedures and data, launch facility checkout, and go/no go criteria

SCOPE-1 Subteams

Command and Data Handling (CDH)

What we do

- Develop software in Fprime to control other components on the satellite bus, route and store data products (telemetry, results, event logs etc.)
  - Utilizing BeagleBoneBlack as Flight computer

Communications (COM)

What we do:

- Procure and test communications hardware including satellite radios and antennas
- Develop Link budgets and communications data requirements
  - Involves FCC RF and NOAA Imaging Licensing
- Create software to manage messages sent to and from the satellite
- Operate the Lab ground station located on the ASE garage rooftop

Electrical and Power Systems (EPS)

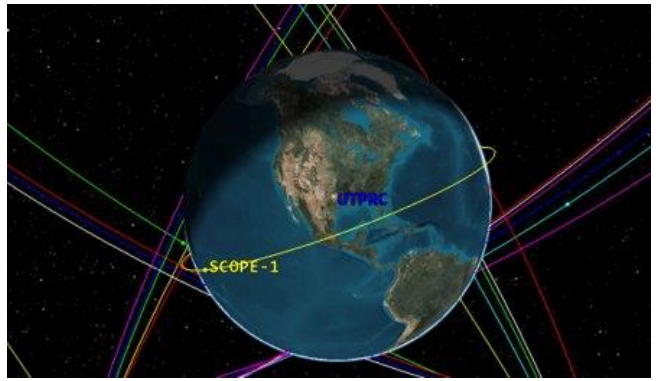
What We Do:

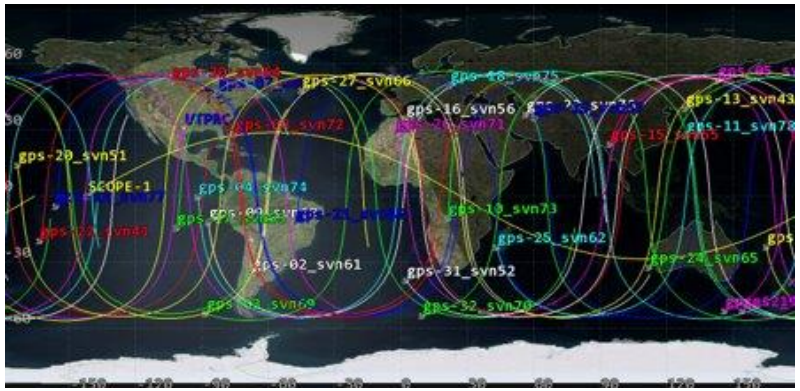
- Select and test electrical power hardware, including batteries, solar panels, and ground test equipment
- Develop system Power Budget and run energy analysis simulations to predict power consumption in orbit
- Support other subsystems with PCB development, especially with power electronics and converters

Flight Dynamics Systems (FDS)

What We Do:

- Identify, simulate, and interface with attitude determination and control hardware (reaction wheels, magnetorquers).
- Work with GPS/GNSS receiver calibration and work on mission design/modeling.
- Generate detumble analysis, pointing budgets, island coverage simulations, etc.

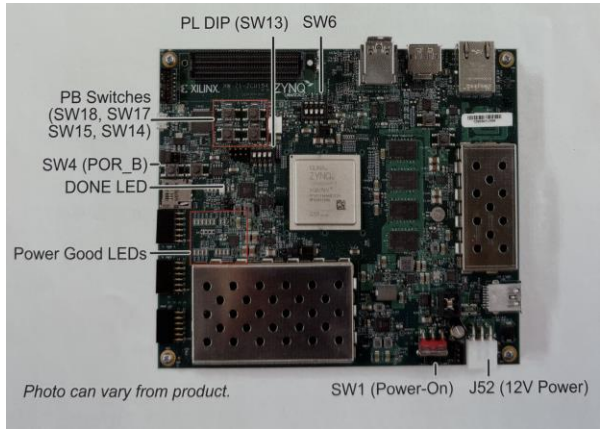




Payload (PAY)

What We Do:

- Create and document the payload system and integrate the payload system into the overall satellite structure.
- Develop and train ML/computer vision island detector model
- Develop methods of testing hardware and software components to optimize the payload system.

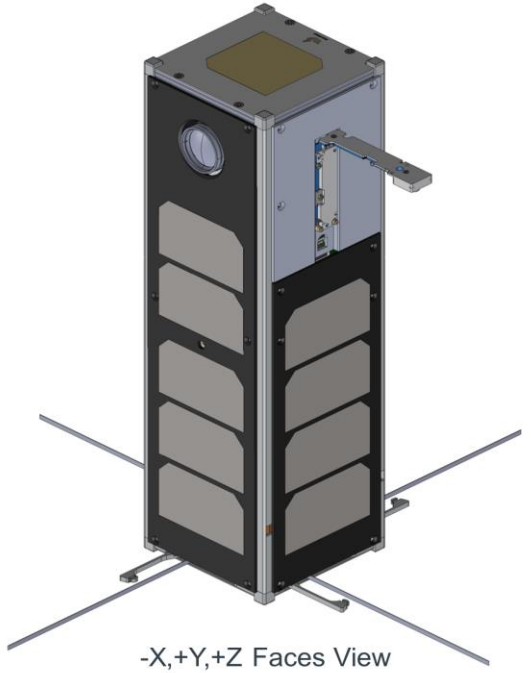


Nvidia Jetson Developer Kit

Structures (STR)

What We Do:

- Obtain, utilize, and integrate CAD assets into high-fidelity assembly
- Design custom component mounting structures
- Finite-element analysis of satellite model, including steady-state and vibrational forces
- Prepare satellite assembly procedure documents and assemble physical satellite

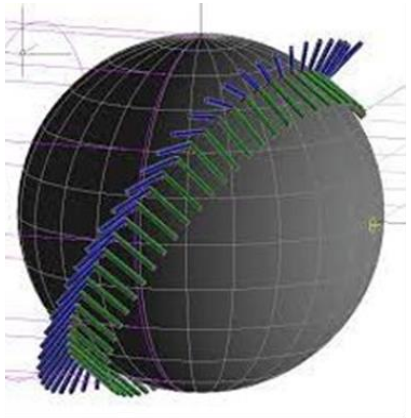


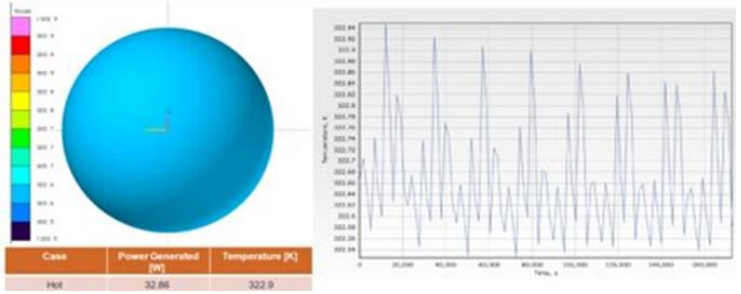
-X,+Y,+Z Faces View

Thermal Protection Systems (TPS)

What We Do:

- Analyze and model the thermal profile to ensure all components are in the working in their ideal temperatures
- Develop temperature/thermal budgets

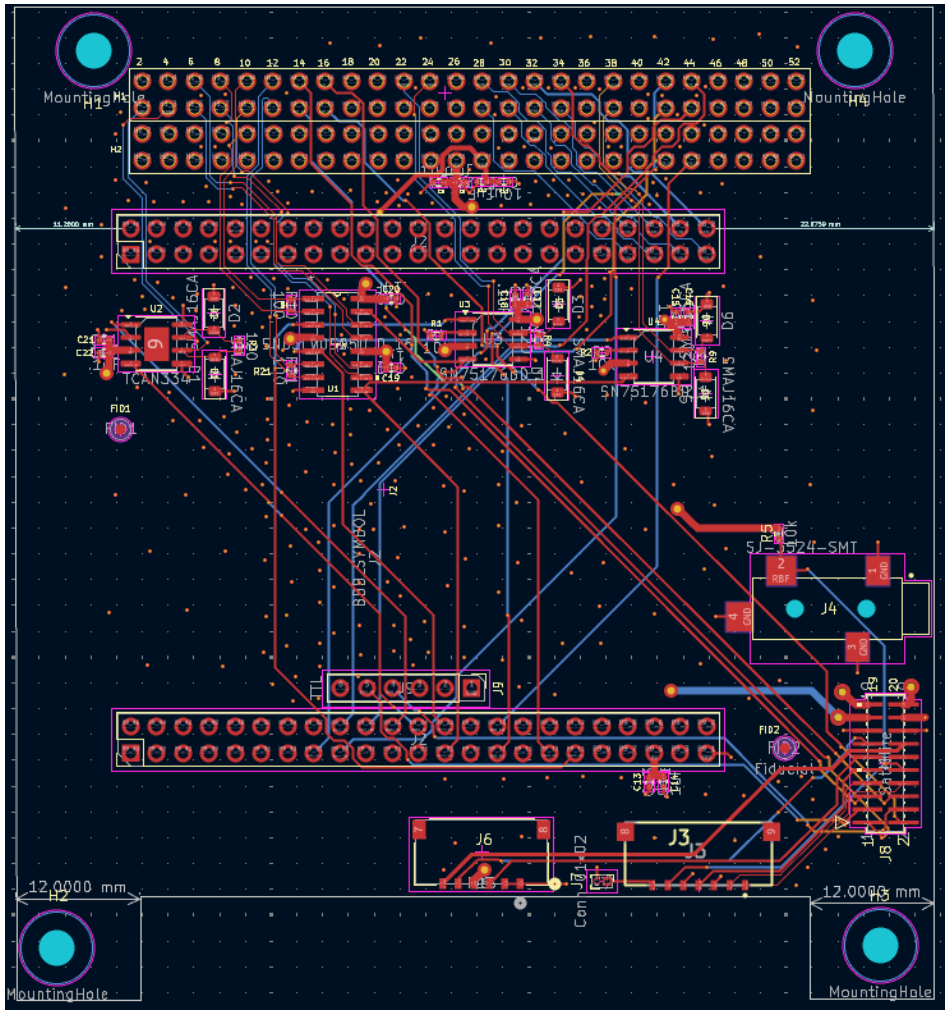




PCB/SYS Team

What We Do:

- Design interface boards using KiCad
- Assemble, test and integrate the boards with the rest of the flight hardware & software



REACT

Reaction-wheel Emissions and Analysis Control Team

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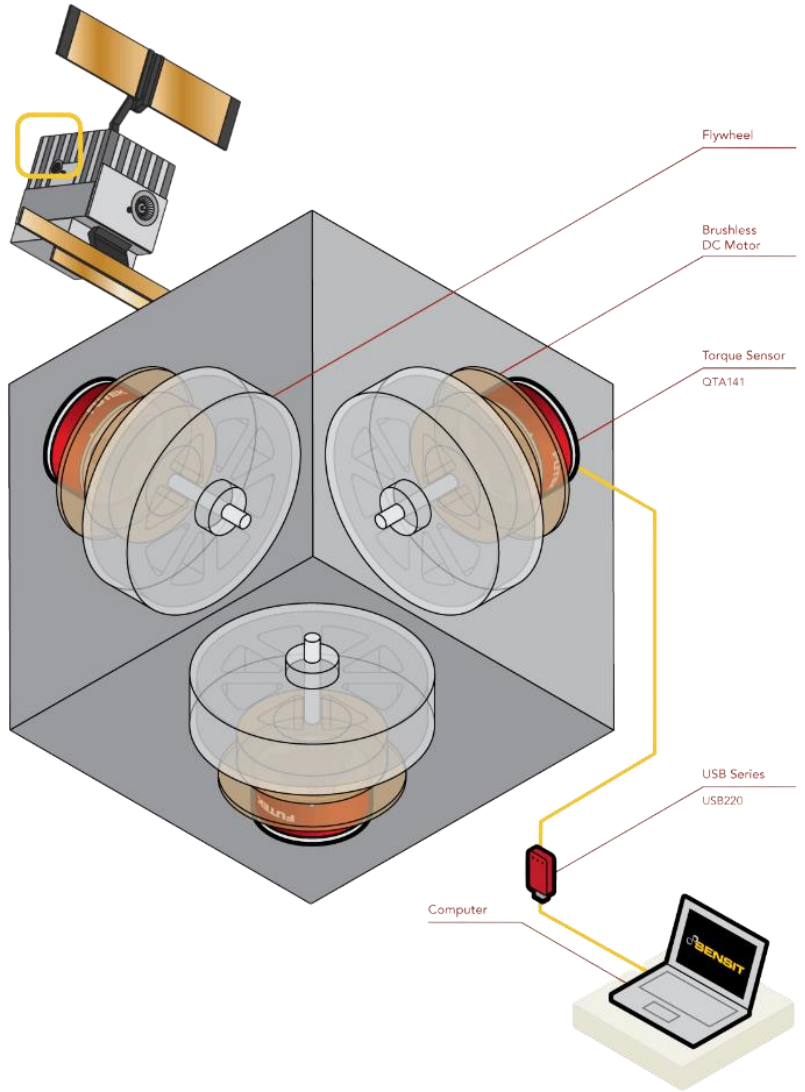
REACT OVERVIEW

Focus:
Investigating magnetic field emissions from satellite reaction wheels

Why it matters:
Emissions can interfere with sensitive instruments and degrade satellite performance

Goal:
Develop and test mitigation strategies that improve satellite reliability

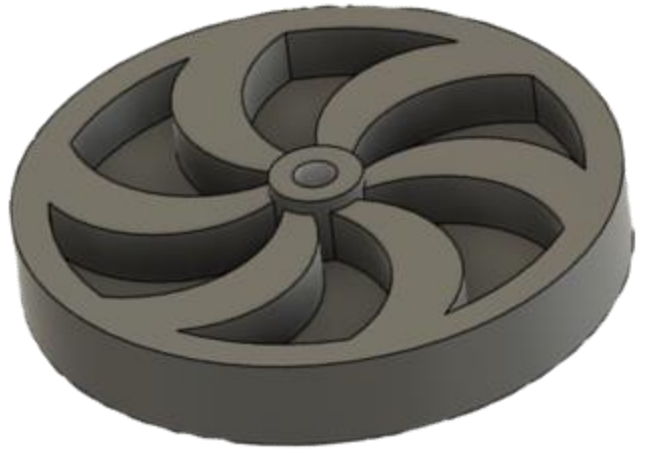


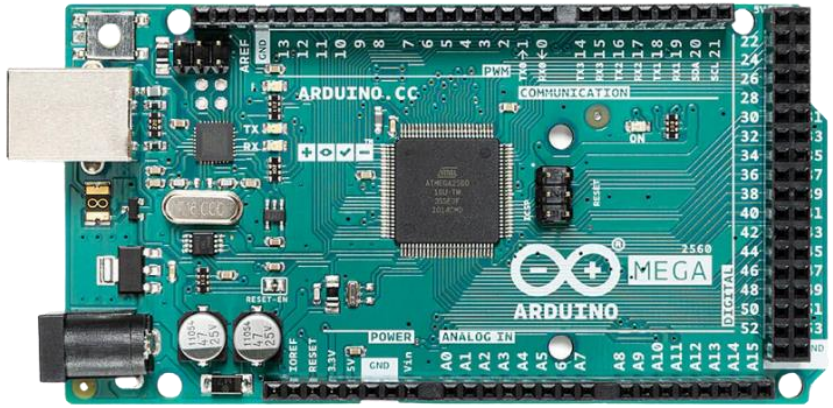
Mission Timeline

Phase 1:
Build and test our own reaction-wheel, proving the problem exists

Phase 2:
Research and prototype mitigation techniques

Phase 3:
Analyze data and publish results to push the field forward.





Team Structure

Hardware

- CAD design
- Machining
- Test stand builds
- Reaction wheel fabrication

Electronics

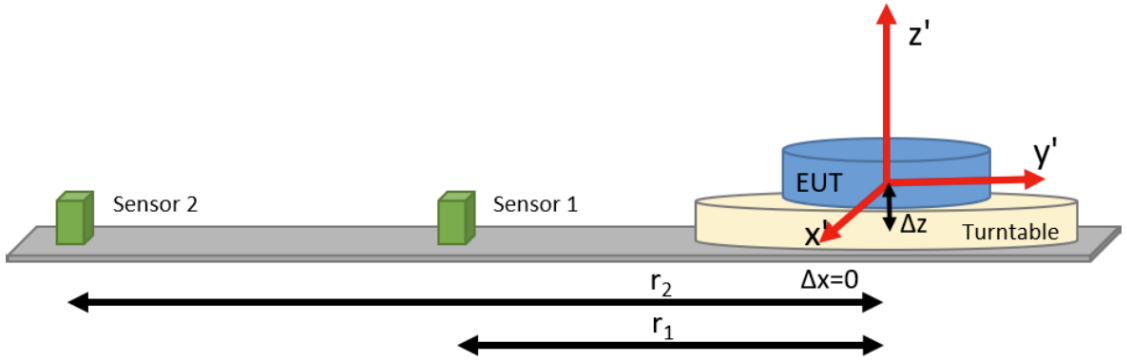
- Sensors
- Wiring
- PCBs
- Signal Processing
- EMI testing.

Software

- Data collection
- Automation
- Modeling
- Control algorithms.

Physics

- Magnetic field modeling
- Data interpretation
- Paper writing
- Experimental Analysis

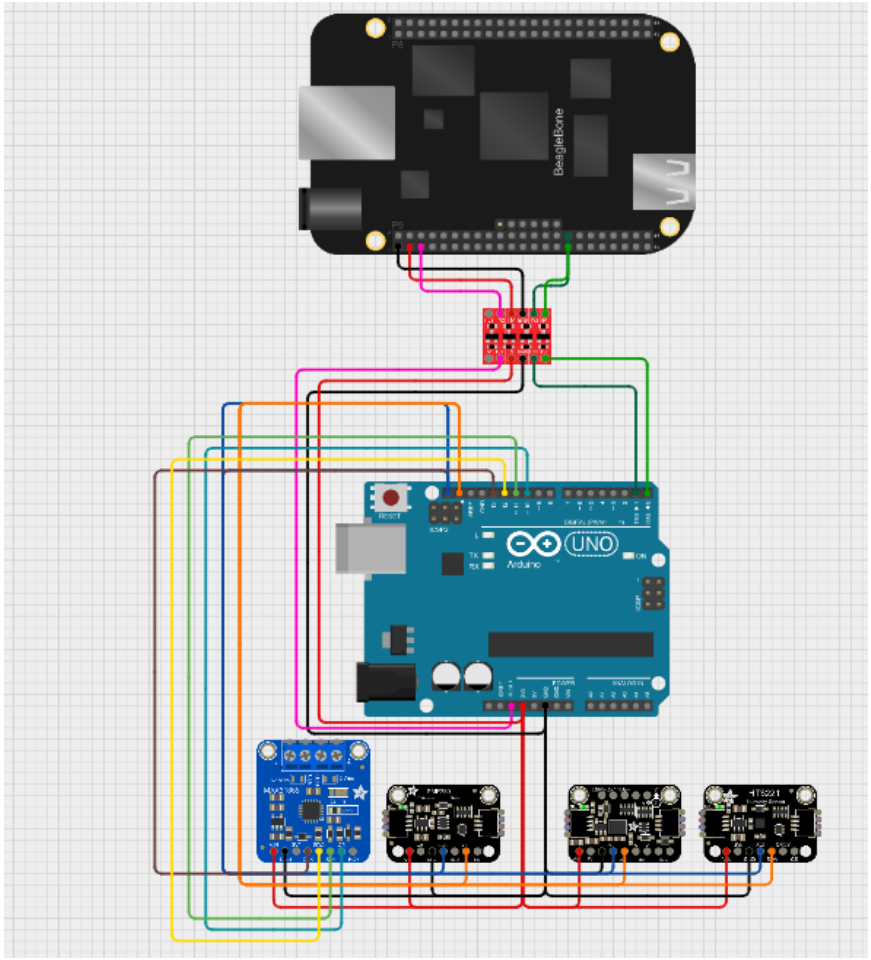


Weather Balloon

What We Do

Objectives:

- Designing a high altitude balloon testbed to be used as a risk testing platform by other TSL missions
- Create a testbed apparatus that is compatible with other mission's equipment to allow for testing at near space altitudes
- Payload will act as its own CubeSAT that is trackable and recoverable
- Provide an onboarding experience reflective of satellite design process




```
Serial.begin(9600);
while (!Serial) delay(10);  // Wait for the Serial Monitor

// Initialize the sensor
if (!lsm.begin()) {
  Serial.println("Failed to find LSM9DS1 chip");
  while (1) delay(10);
}

// Set ranges for accelerometer, gyroscope, and magnetometer
lsm.setupAccel(lsm.LSM9DS1_ACCELRANGE_2G);
lsm.setupGyro(lsm.LSM9DS1_GYROSCALE_245DPS);
lsm.setupMag(lsm.LSM9DS1_MAGGAIN_4GAUSS);

Serial.println("LSM9DS1 Found!");
```

Project Phases

Low Altitude Balloon Test

- Purpose: Test basic payload design and integration and establish launch procedures
- Progress: Assembly

High Altitude Balloon Test

- Purpose: Test more advanced payload at higher altitudes and establish launch, tracking, and recovery procedures
- Progress: Assembly

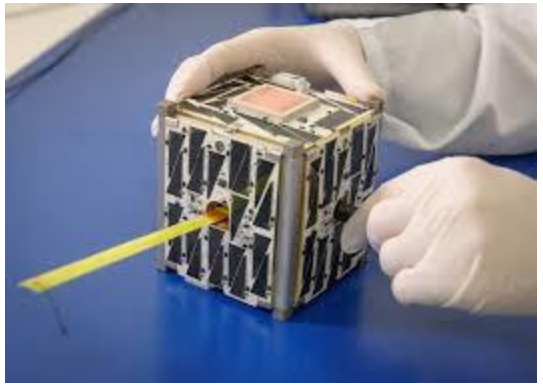
High Altitude Balloon Testbed

- Purpose: Create a high altitude testing platform for TSL missions and TMA projects
- Progress: Concept of Operations

Other Projects/Teams

Freshman Exploratory Team

- On-ramp for freshmen to work on SCOPE-1 and REACT
- One-semester project where you learn the NASA systems engineering process on a well-defined project
  - •Start from PI/Lab provided Neads, Goals, and Objectives to produce a working implementation
  - •Work with existing TSL leaders and learn about our ongoing projects
  - •Learn about small satellite development, ESD/Clean room protocol, and more
- •Upon completion of the project, “graduate” to an existing TSL project



Spring 2026 Exploratory Project

- **Purpose:** Provide a structured onboarding resource so new TSL members can quickly learn lab organization and systems engineering practices

- **Goal:** Create an extensible and easily managed resource that trains new members of the TSL on lab processes, subsystem documentation, and project fundamentals

- **Scope:** Focus on systems engineering, design, and implementing training modules; content guidance provided by leadership

- **Deadline:** Before start of Spring 2026 semester

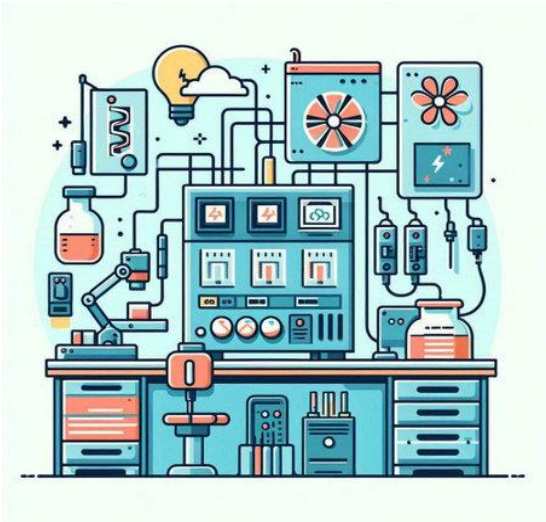
Lab Operations

Logistics

- Social media management, internal comms, event organization

Facilities

- Oversee day-to-day operations, manage documentation, streamline equipment usage
- Thermal chamber, vacuum chamber, satdex, and purchasing POCs



Application Info

TSL Recruitment Information

- **Application opens Tuesday, January 20th.**
- **If you apply BEFORE Monday, January 25th, we will aim to email you a decision no later than Monday, Febuary 8th.**
- **If you apply AFTER Monday, January 25th, decisions will be made on an as-needed/rolling basis (you may not get a response).**
- Must have a GPA of at least 3.0.
- All applicants must be a U.S. citizen or U.S. permanent resident.
  - If you'll be attending UT for at least one more year (through Spring 2027), then you may be eligible as well.
  - Come talk to us afterwards!

TSL Recruitment Advice

- All applicants must complete the Authorization and Release of Private Information form; applications will not be considered without it.
- Fill in **all** questions on the application.
  - Even if you are applying during the "rolling"/non-response-guaranteed phase.
  - We do not consider incomplete applications.
- Be prepared to talk in depth about any technical experience or projects on your resume.
- Your essays should aim to highlight all your technical experiences.
  - In the application backend, it is much easier for us to access and read your essays than your resumes.
- Upload any documents, projects, research, etc. you want to show off.
- If you apply earlier, your application will be looked at and decided on sooner.

Join Us!

TSL Email List:
https://bit.ly/3AYN08U

Follow the Instagram for application updates!

@ut.tsl

Attendance and Application Forms

Application Form

https://utexas.qualtrics.com/jfe/form/SV_6POZ06uAOb8OAoC

Attendance Form

https://utexas.qualtrics.com/jfe/form/SV_1XG8pFFEPAIx9ki

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Questions?

Stick around or email tsl.director@utexas.edu!

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