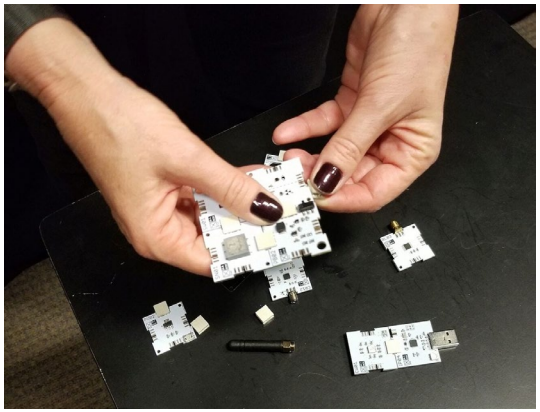
PRINCETON UNIVERSITY

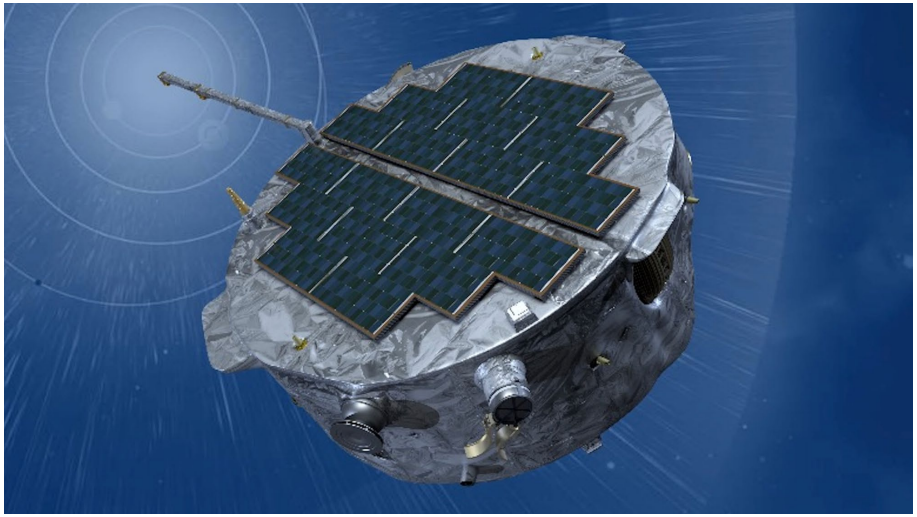
Princeton's Experience in MaxIQ's STEM Launch Program to the ISS

Mike Galvin
mgalvin@princeton.edu



My Background

- Lockheed Martin Space Systems
- Lead Mechanical Engineer for Princeton Space Physics Group
- Instructional Staff for MAE342: Space Systems Design
- Principal Investigator for TigerSats student nanosatellite group



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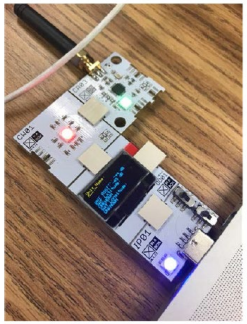
Anuja Magdum

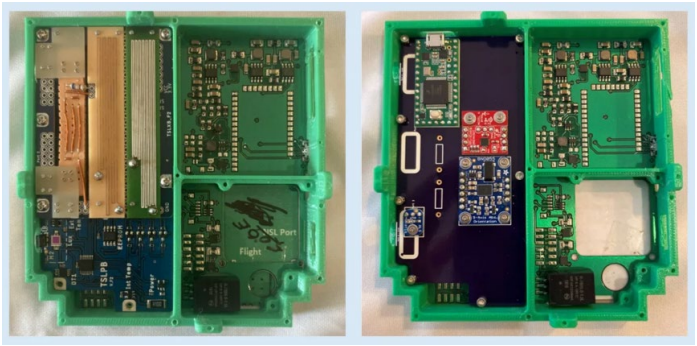
- Student Lead
- TigerSats
- Rocketry Club Treasurer
- Internships

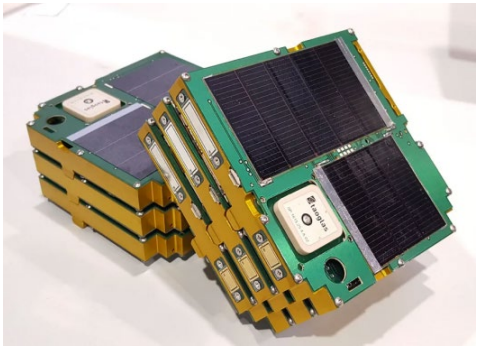
ThinSat (CDW 2018)

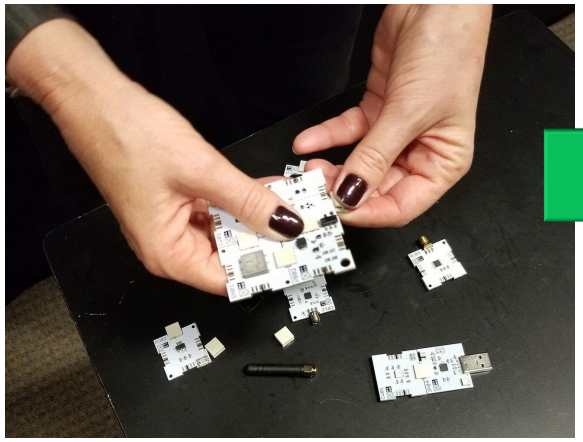


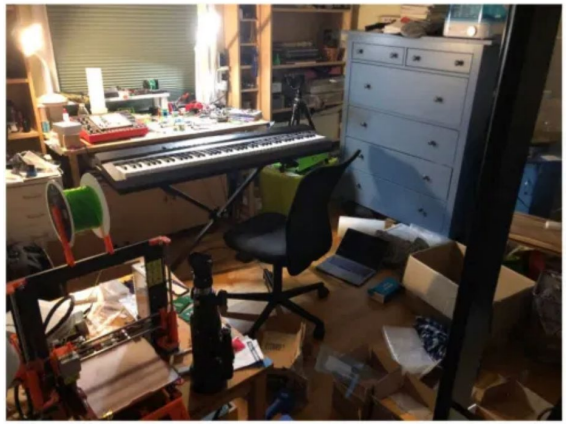
Ground Station

Weather Sat









NG-15 (2021)

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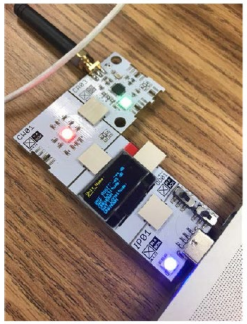
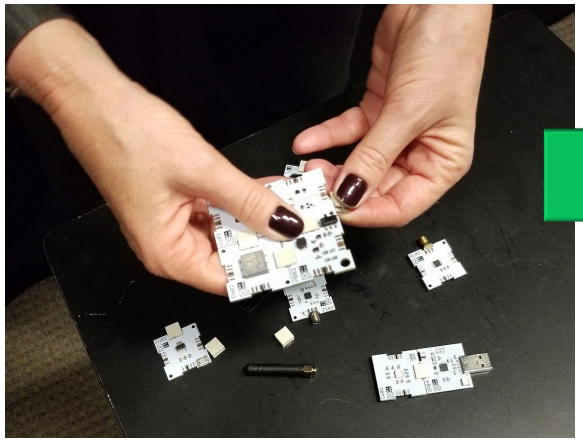
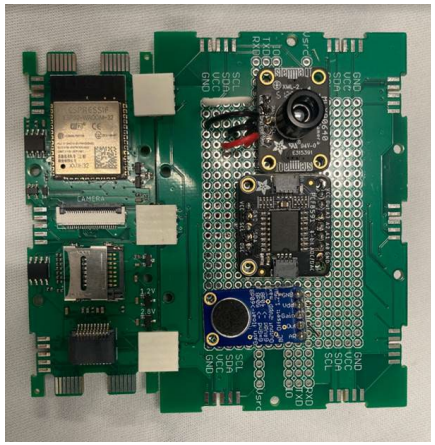
MaxIQ (2024-25)

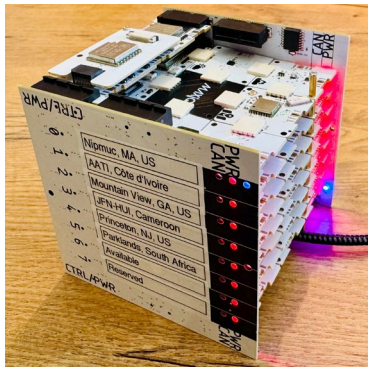


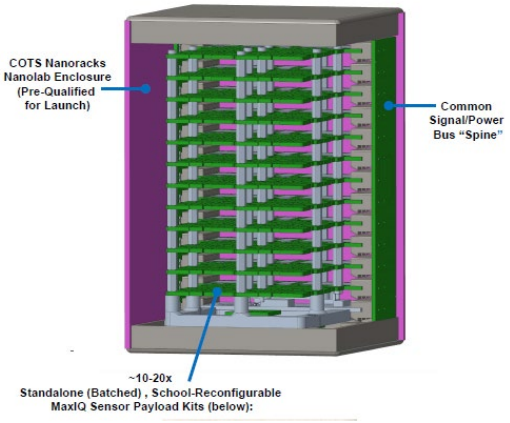
Ground Station

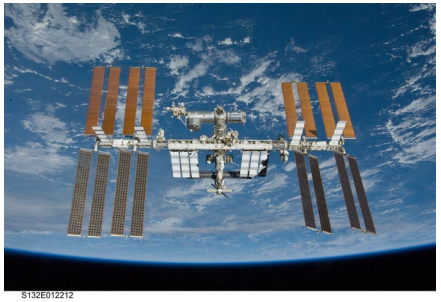
Weather Sat











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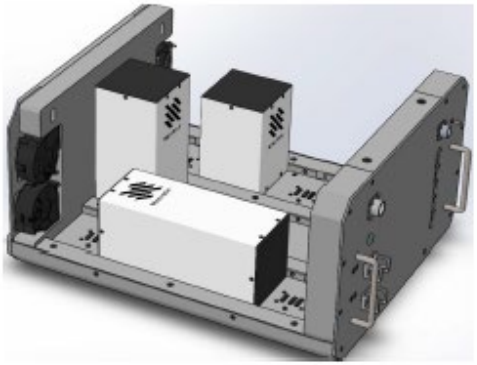
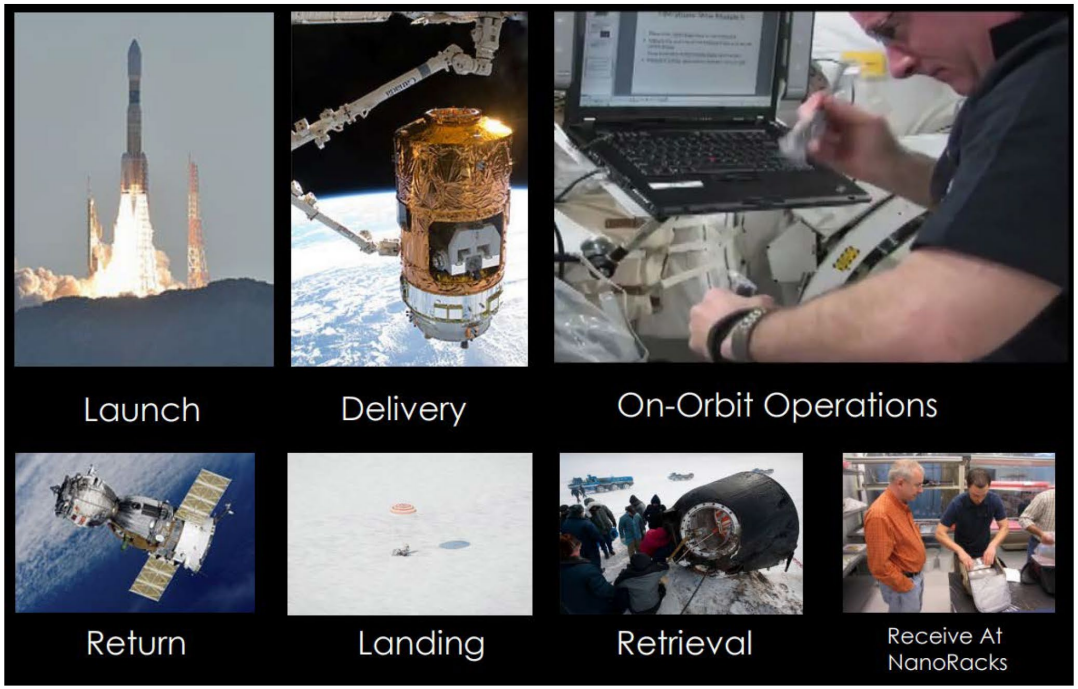
NanoLabs (Voyager Space)



Nanoracks "Nanode"
Experiment Locker



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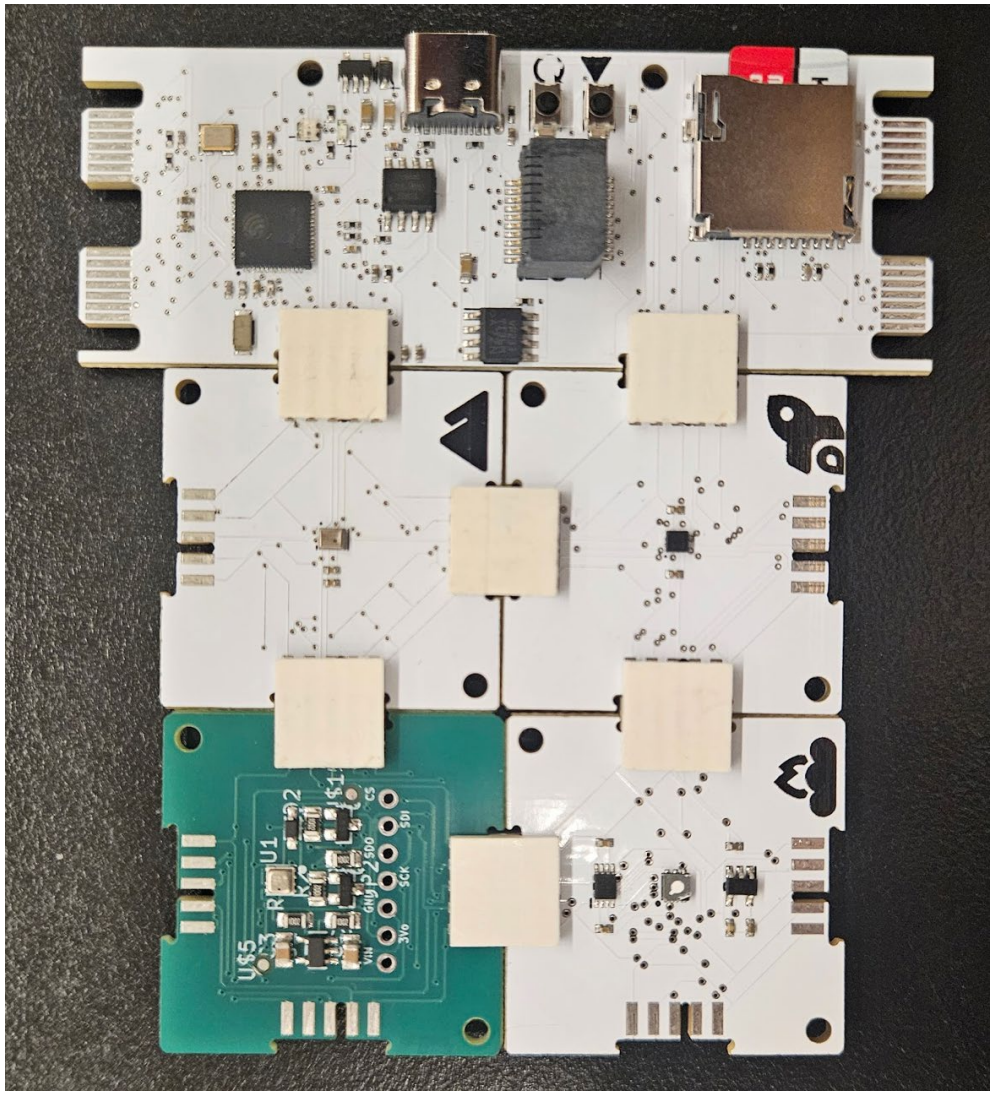
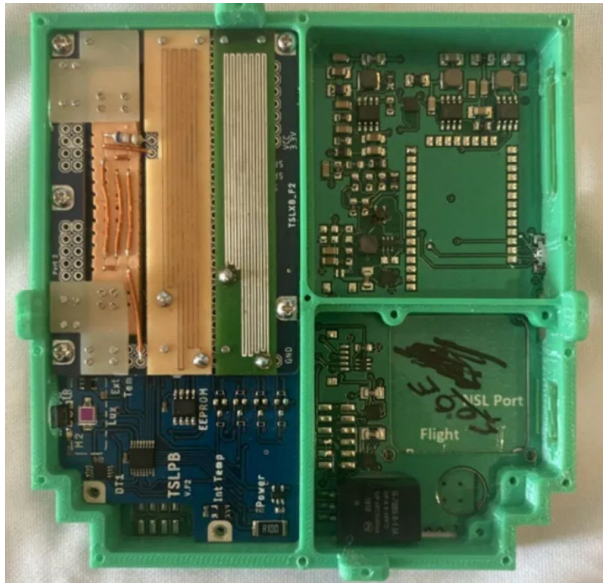
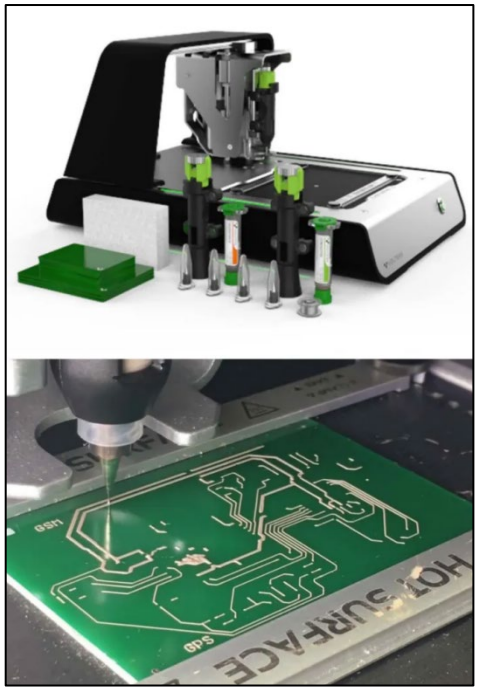
Princeton xChip Experiment (Freshmen)

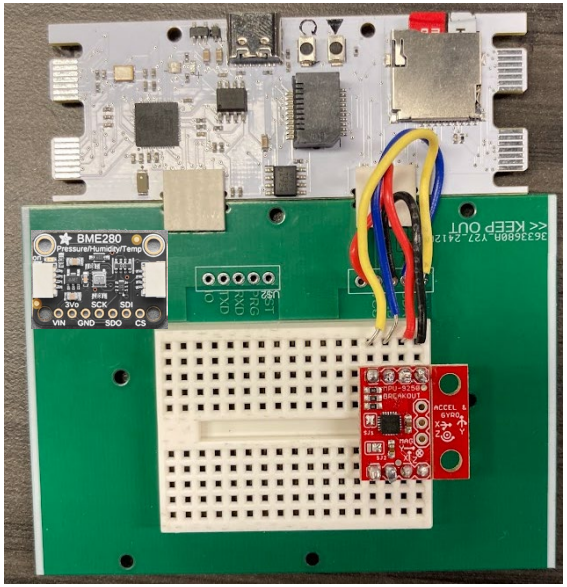


Princeton Circuit Fab Survivability Experiment (Freshmen)

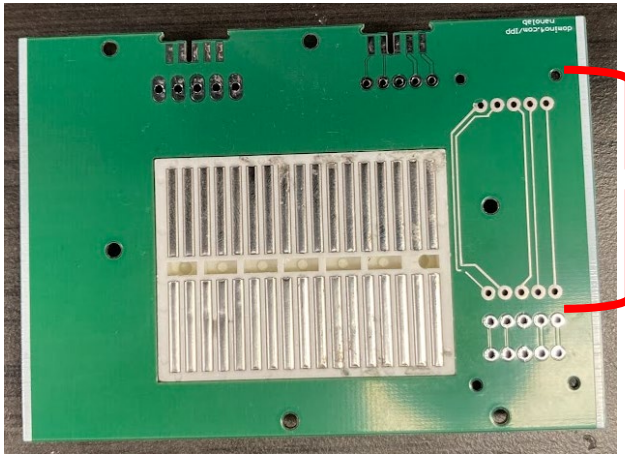
“ProtoSat” (ThinSat ‘21)







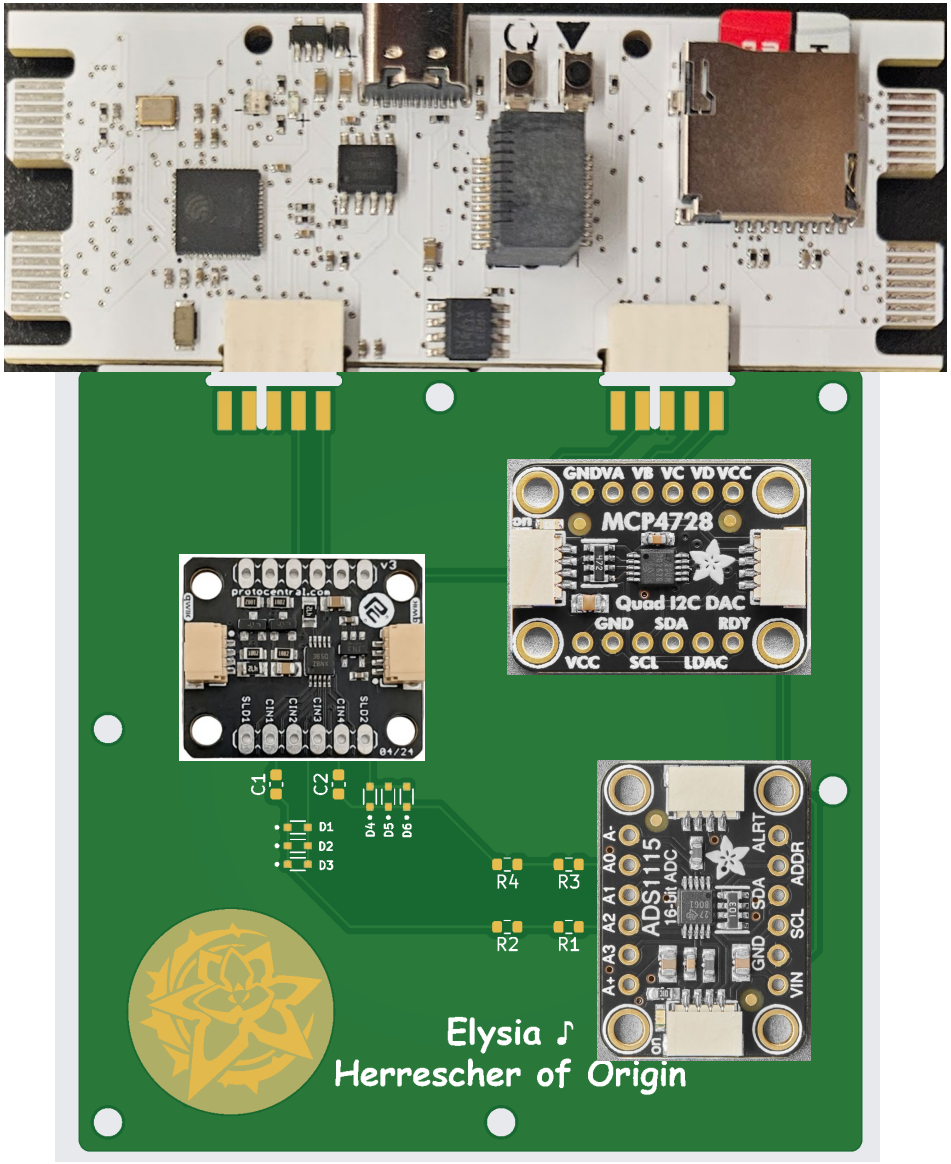
Top



Voltera circuit

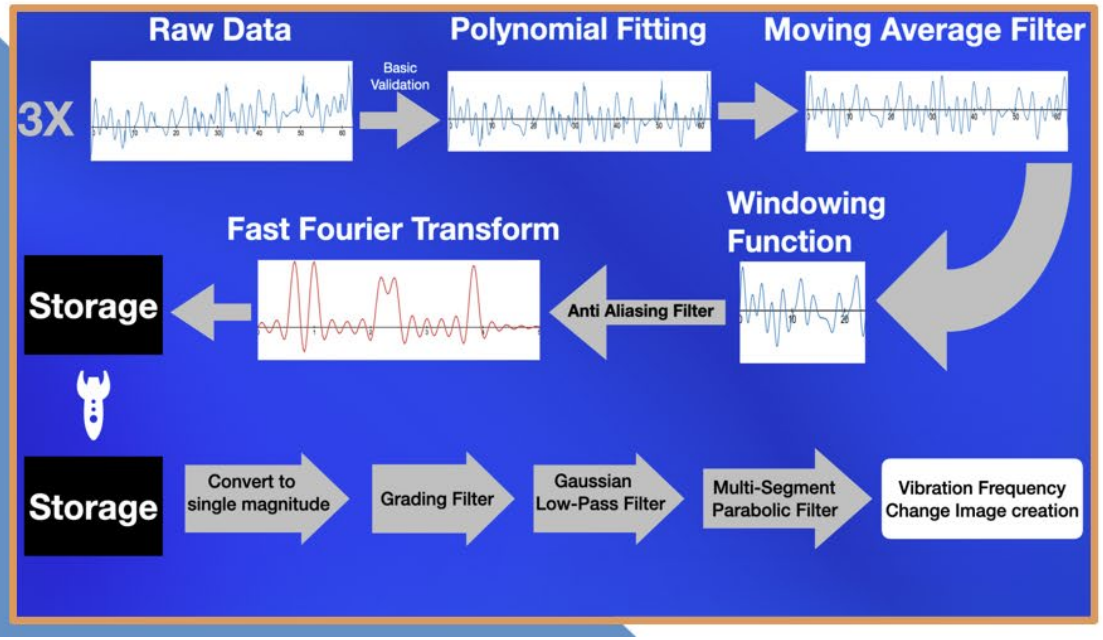
Bottom

Princeton Orbital Speedometer (ECE Grad Student)



Parklands (South Africa) Vibration Experiment

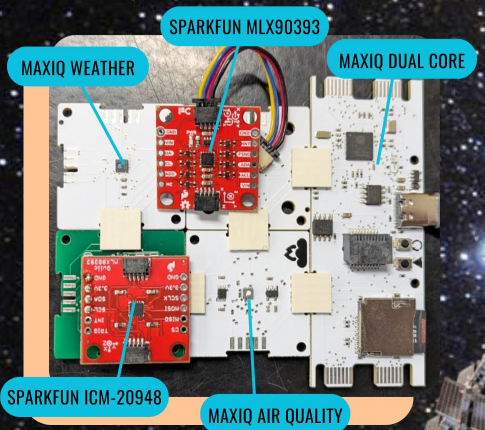
We plan to conduct a vibrational analysis, a technique commonly used in electric pump systems involving measuring vibrations and their changes over time to predict faults before they occur, on the ISS where it has not been attempted before.

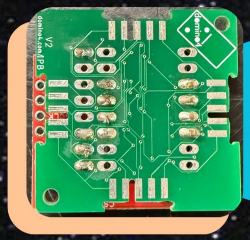


Nipmuc High School (MA) xChip Experiment

MAXIQ RIDESHARE MISSION TO THE INTERNATIONAL SPACE STATION

PAYLOAD LAYOUT





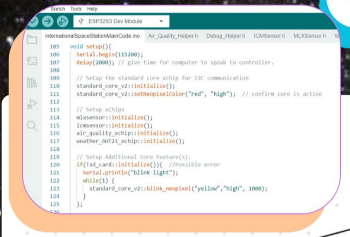
SOLDERING FOR THE SPARKFUN ICM-20948 SENSOR - ATTACHED TO A MAXIQ PROTOTYPING CHIP

SENSORS

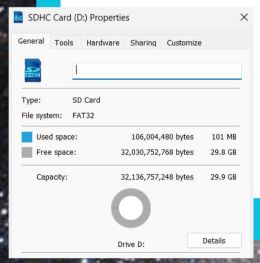
1. **Magnetometer:** SparkFun Triple Axis Magnetometer Breakout - MLX90393
2. **Gyroscope:** SparkFun 9DoF IMU Breakout - ICM-20948
3. **Air Quality:** MaxIQ Air Quality sensor (CO2, Ethanol, Hydrogen, VTOCs)
4. **Weather:** MaxIQ Weather xChip (Temperature and humidity)

PROGRAMMING & TESTING

The main program is composed of two tasks, or functions, that run on separtate cores of the MaxIQ Dual Core. The code ensures that the two tasks are not run at the same time to prevent data corruption and other various issues. Input is taken from each of the sensors on one core through the dataCollectionTask(), and then stored in a buffer mutex. Once a round of data collection finishes, the program switches to the other core and saves the data to the SD card in a specified order. This is completed through the saveDataToSDCardTask(). Data is recorded and stored to the SD card approximately every 1 second.



All code was developed in Arduino IDE using the Arduino language, which is based off of C++. Each sensor program is written as a library that can be included in the main program. The libraries all include a namespace for the corresponding sensor, which defines variables and functions to help the program run. Variables are created inside structs for every data column, and each sensor has at least two functions to initialize the sensor and record data.



TEST #1: SD CARD STORAGE TEST

(12:45 pm 3/11/2025 → 12:55 pm 3/17/2025) → 6 days of continuous running and data storage

Used space: 106,004,480 bytes (106 MB)
Total space: 32,136,757,248 bytes (32 GB)
Space per day (used space/6 days): 17,667,413.333 (17.6 MB)

If the payload continuously ran, storage would run out in 1,818 days or just under 5 years (total space/space per day)

The SD Card stored two folders titled "0" and "1", meaning that the payload stopped and restarted at some point. It is helpful to know that this piece of the code works (The data will not be overwritten if power is turned on and off).

NIPMUC REGIONAL

Requirements!!

RELEASED - WEBSITE USE 2022.09.28 18:27:17 -05'00'

Interface Definition Document (IDD)

Nanoracks Mainframe (Nanode)

Nanoracks

Doc No: NR-NANODE-S0001
Revision: A

NASA TECHNICAL STANDARD

NASA-STD-6016

National Aeronautics and Space Administration
Washington, DC 20546-0001

Approved: 07-11-2008
Expiration Date: 07-10-2013
Superseding NASA-STD-(I)-6016

STANDARD MATERIALS AND PROCESSES REQUIREMENTS FOR SPACECRAFT

MEASUREMENT SYSTEM IDENTIFICATION: METRIC/SI (ENGLISH)

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INTERIM NASA TECHNICAL STANDARD

NASA-STD-(I)-6001B

National Aeronautics and Space Administration
Washington, DC 20546-0001

Approved: 04-21-2008
Expiration Date: 04-21-2010
Superseding NASA-STD-6001

FLAMMABILITY, OFFGASSING, AND COMPATIBILITY REQUIREMENTS AND TEST PROCEDURES

MEASUREMENT SYSTEM IDENTIFICATION: METRIC (INCH-POUND)

This document represents the technical consensus of the developing group but does not yet have final NASA approval.

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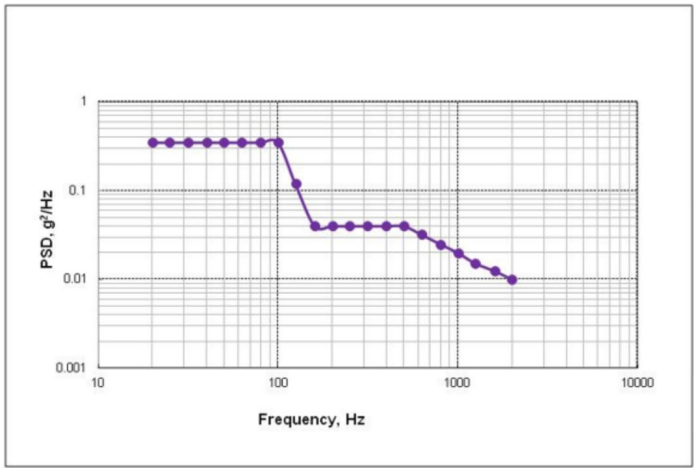
Table 4.2.4.2-1: Random Vibration Environment
Ref. SSP 57000, Rev S, Table D.3.1.2-1

FREQUENCY (Hz)	PROTOFLIGHT TEST LEVEL (g^2/Hz)
20	0.35
100	0.35
100 - 160	-15.4 dB/octave slope
160 - 500	0.04
500-2000	-3 dB/octave slope
2000	0.01
Overall	8.8 g_{rms}
Duration	1 min/axis



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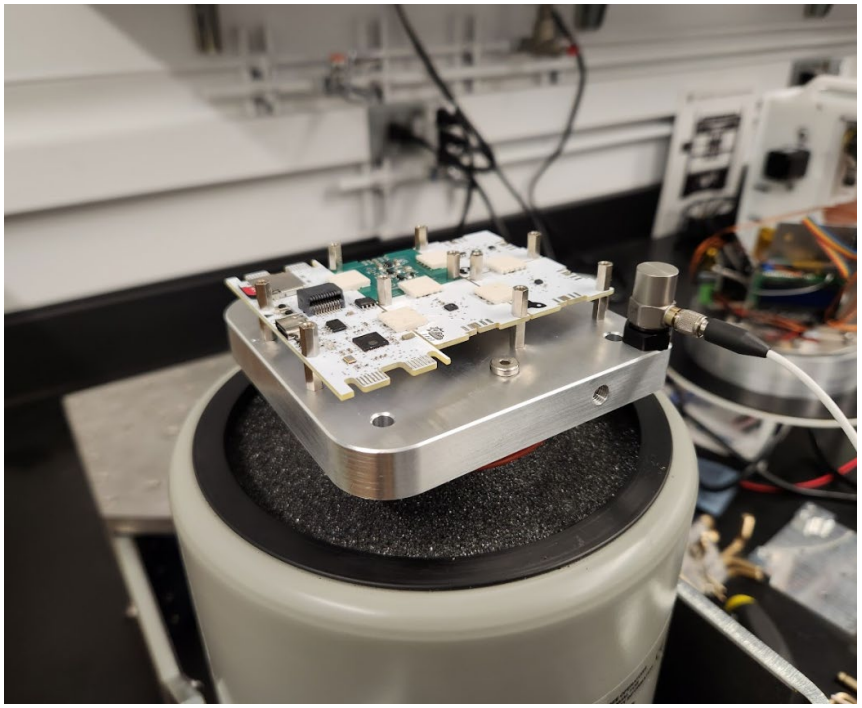
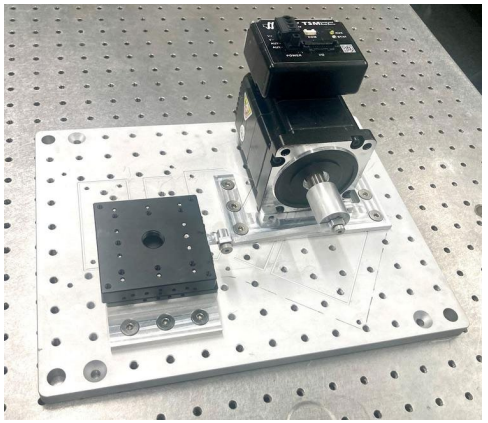
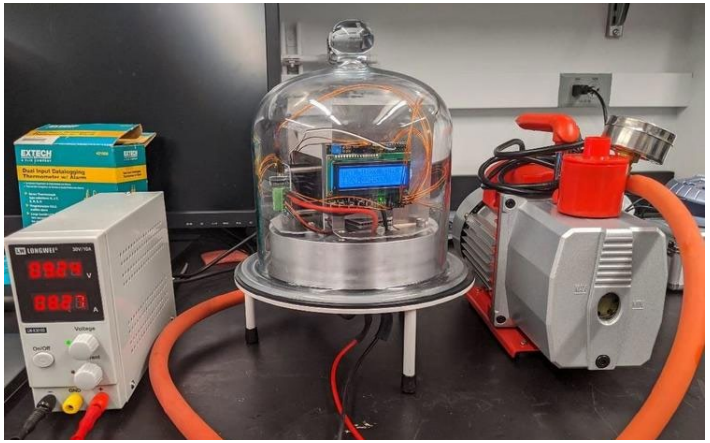
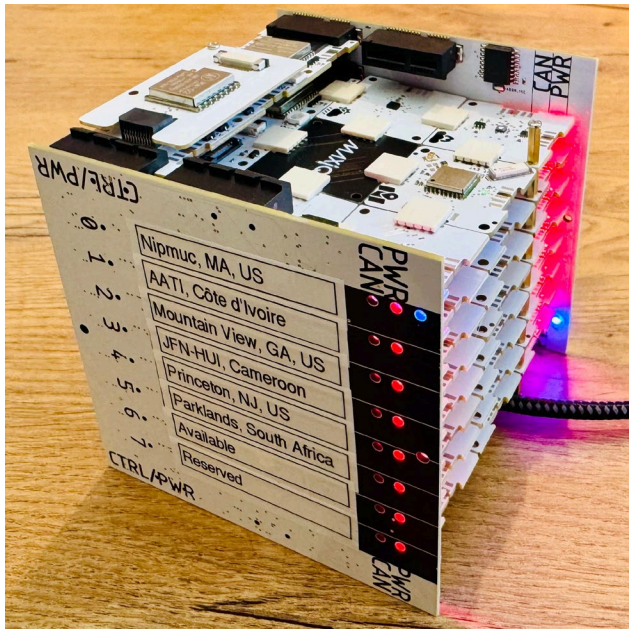
Environmental Qual Testing







Summer Balloon Launch



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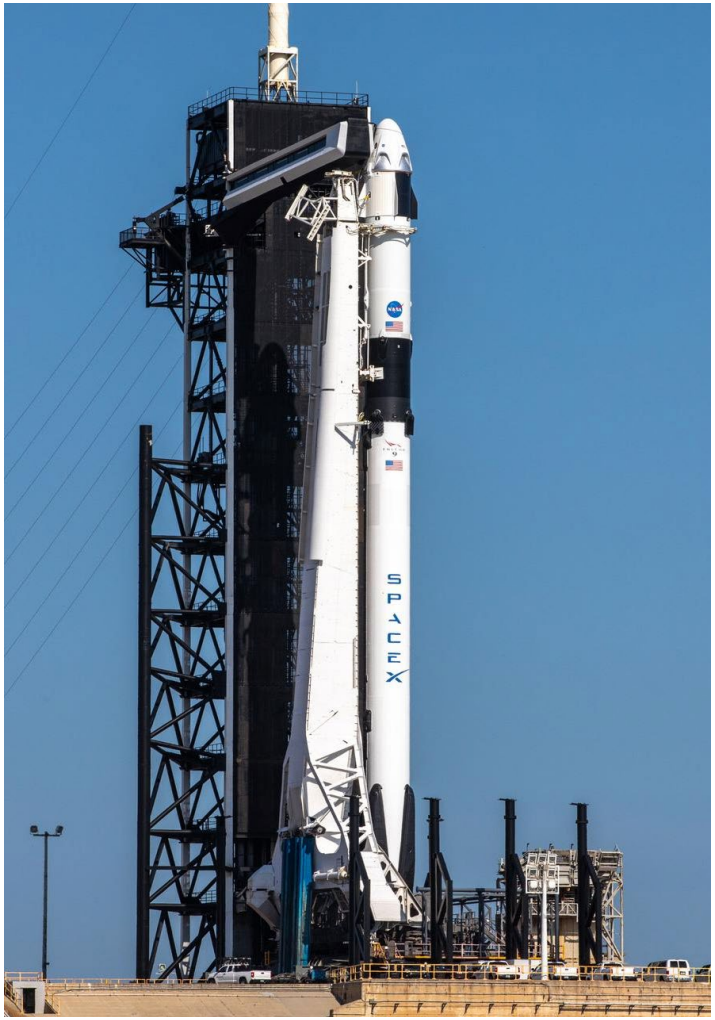
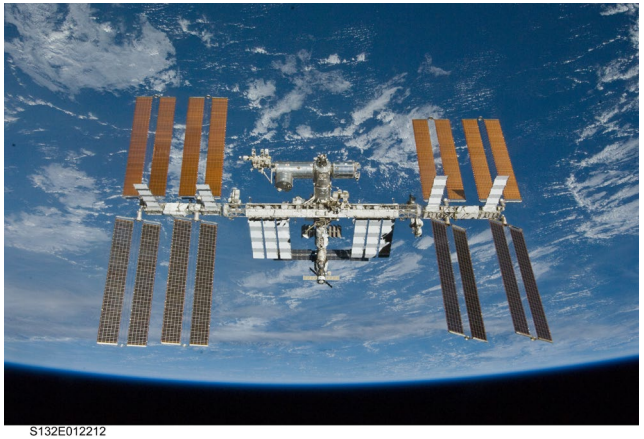
October(?) ISS Launch

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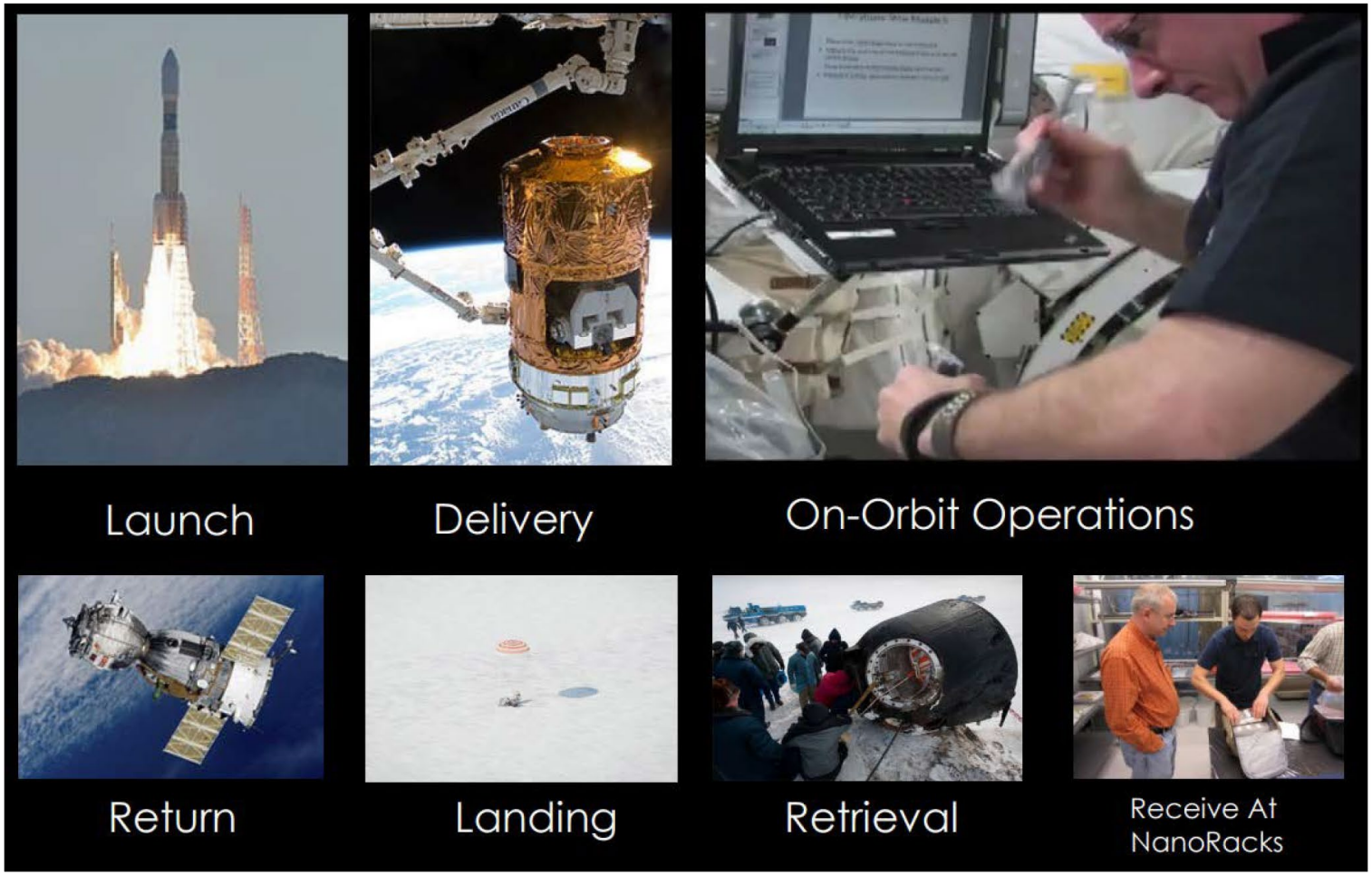
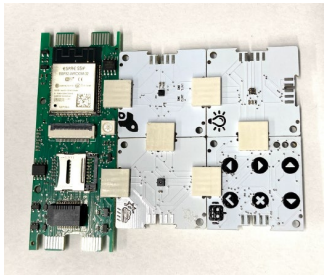
Mission & Return



MaxIQ (Next Cycle)



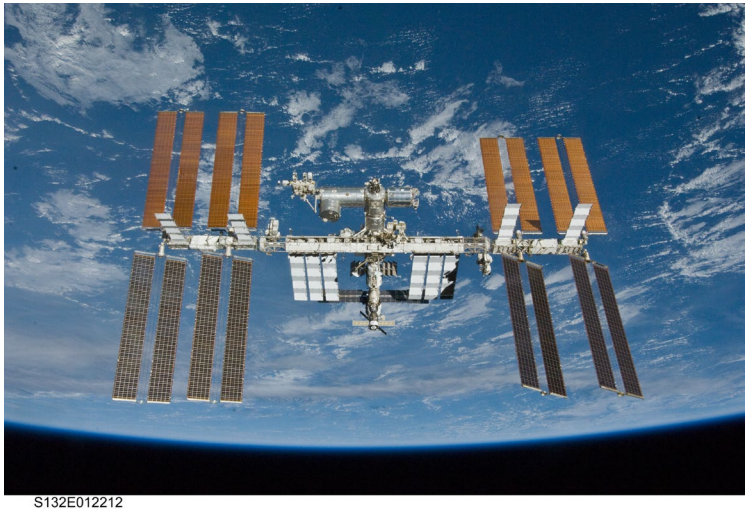
Early-Bird Pricing: $15K total

First 40% payment ($6K) =

- No-solder sensor/coding kits for your whole classroom
- Furnished curriculum, tutorials & live MaxIQ-hosted Zoom workshops
- Includes HAB launch!

Second 60% payment ($9K, due later) =

- Continue on to the batched launch to the ISS
- Astronauts bring experiments back to Earth after 6-week mission!



S132E012212

(7th-12th grade or adaptable to universities)

Questions?

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mgalvin@princeton.edu
tigersats.princeton.edu

https://themaxiq.com/products/international-space-station