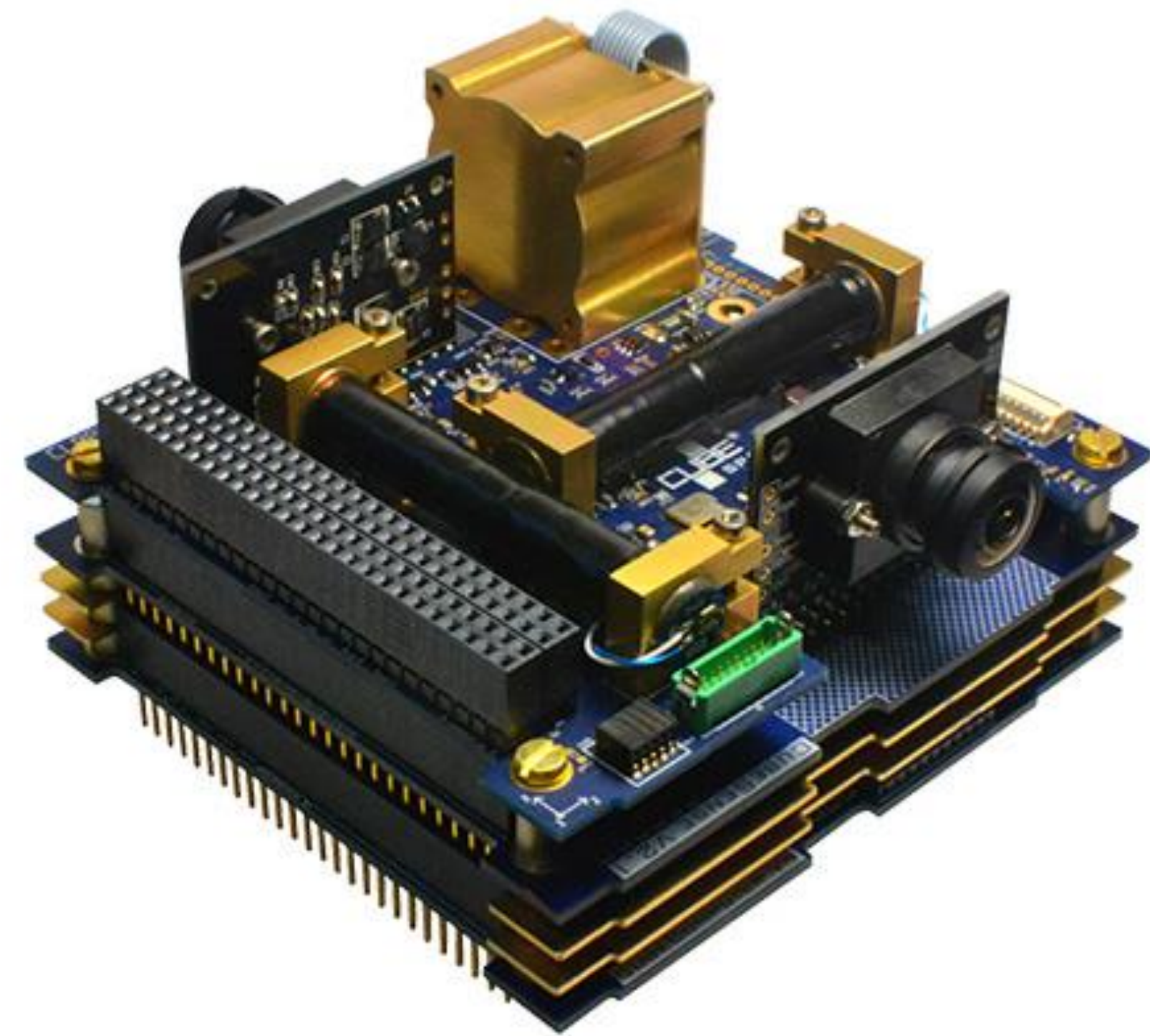


# Satellite Attitude Determination, Communication, and Control with AI

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## Background

Orbiting the Earth alongside large objects like the Hubble Telescope, small satellites, known as CubeSats, are flown for educational or experimental purposes and are about the size of a shoebox. Two integral components of these small satellites are the ADCS, the system that controls the satellite's position, and the communication module, the system that sends and receives information. Integrated, commercial versions of these systems are generally cost-prohibitive for a CubeSat application. The goal is to instead use individual components to make a cheaper control system and to create a board that will apply existing technology to the CubeSat scale. The solutions we create will lead to better control of the satellite and increased ability to send information to ground.



A commercial ADCS unit, ranging from \$25K-100K

## Attitude Determination and Control System

### Objective

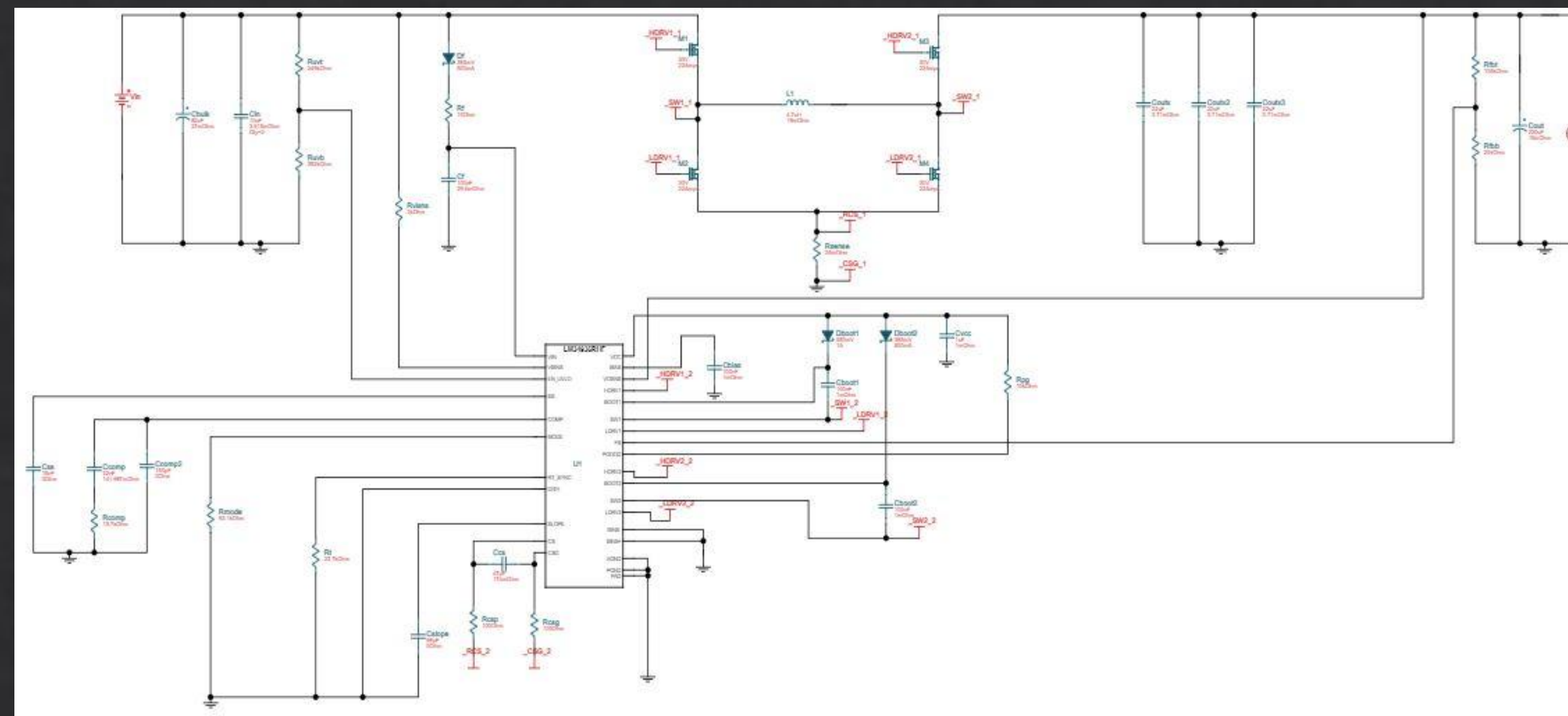
To evaluate and combine COTS components to create a more cost-effective ADCS unit prototype

### Concept Development

Researching components and analyzing functionality to narrow down the choice to test

### Validation and Future Work

Purchase components and integrate into a test bed to evaluate functionality



Schematic for the Buck Boost Converter

## Iridium 9523 Carrier Module

### Objective

Develop a CubeSat Carrier Module for the Iridium 9523 transceiver and the firmware to facilitate encrypted communication between TES satellite and a ground server we develop.

### Previous Years

- Team SCUBEE (2018-2019)
  - Developed Dev Board for the 9523.
- Team FIRE (2019-2020)
  - Developed firmware for Short Burst Data /RUDICS mode on the 9523 module using a raspberry pi/python

### Concept Development

Researched a more powerful microcontroller to replace SCUBEE's. Researched parts to redesign power converters for the new module.

Determined sufficient software and encryption libraries and verified they work on the SAMD51.

### Validation Plan & Future Plan

- Redesign and build breakout boards for the following power converters:
  1. Linear Buck Converter
  2. Buck Boost Converter
  3. Flyback Converter
- To create the new Carrier Module with new Microcontroller using Altium.
- Port firmware from SCUBEE's Dev Board to the new TARDIGRADE one.
- Implement RUDICS functionality with Encryption along side switching back to SBD

## AI In The Sky

### Objective

Develop a useful machine learning algorithm to run onboard using graphics processing unit, and to overcome issues with heat dissipation and radiation.

### Requirements

Software that can switch between active programs, test the effects of radiation, interact in a low bandwidth way, & demonstrate active machine learning. Develop a heat transfer system and radiation shielding with 25% attenuation.

### Concept Development

Researched materials capable of gamma ray & neutron shielding, and evaluated them based on attenuation, cost, volume efficiency, & machinability.

### Final Design

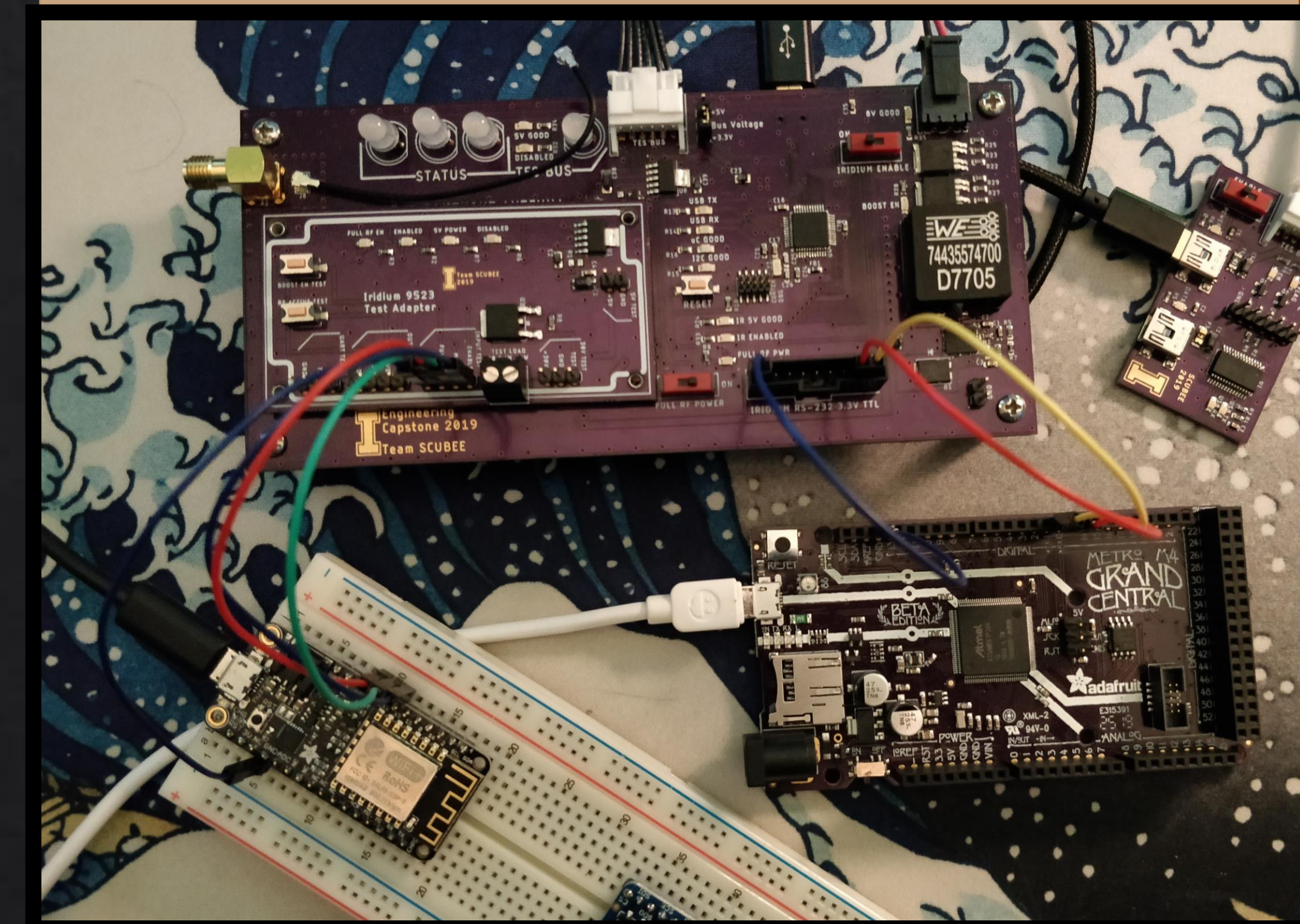
A 3D printed boron-carbide filament case, with either tungsten-copper or tungsten oxide resin and software to run on the GPU

### Validation Plan

Calculate the necessary thickness for the boron filament and tungsten element & model total attenuation.

### Future

Develop programming for the GPU and select a heat dissipation system.



Top Left: SCUBEE's Dev Board (SAMD21) with 9523 sim  
Top Right: TES power Adapter  
Bottom Left: Other Microcontroller testing Enable Pins  
Bottom Right: Grand Central Express (SAMD51)