

Project



Hawai'i Space Grant Consortium

University of Hawai'i Community Colleges

Honolulu CC Kapiolani CC

Kauai CC Windward CC

Mission Overview:

Project Imua (*to move forward* in Hawaiian):

... to encourage University of Hawai'i Community College (UHCC) students to explore and enter STEM-based careers by engaging in team-oriented, problem-solving activities integrating the design, development, construction, testing and documentation of launch-ready CubeSats and scientific payloads.

Objective – provide \$100,000 in scholarships annually to UHCC students to participate in payload design, testing, delivery and launch.

Success criteria – 8 students and 2 faculty members attend successful RockSat-X launch with a fully integrated, in-house built and environmentally tested scientific payload.

Coalition of 4 UHCC Campuses

Institutional Objective:

Two-year project will serve as a test bed to ascertain whether the specialized skills and strengths of each campus can be integrated and galvanized into a successfully functioning structure for developing and launching small satellite payloads, especially in collaboration with the Hawai'i Space Flight Lab.

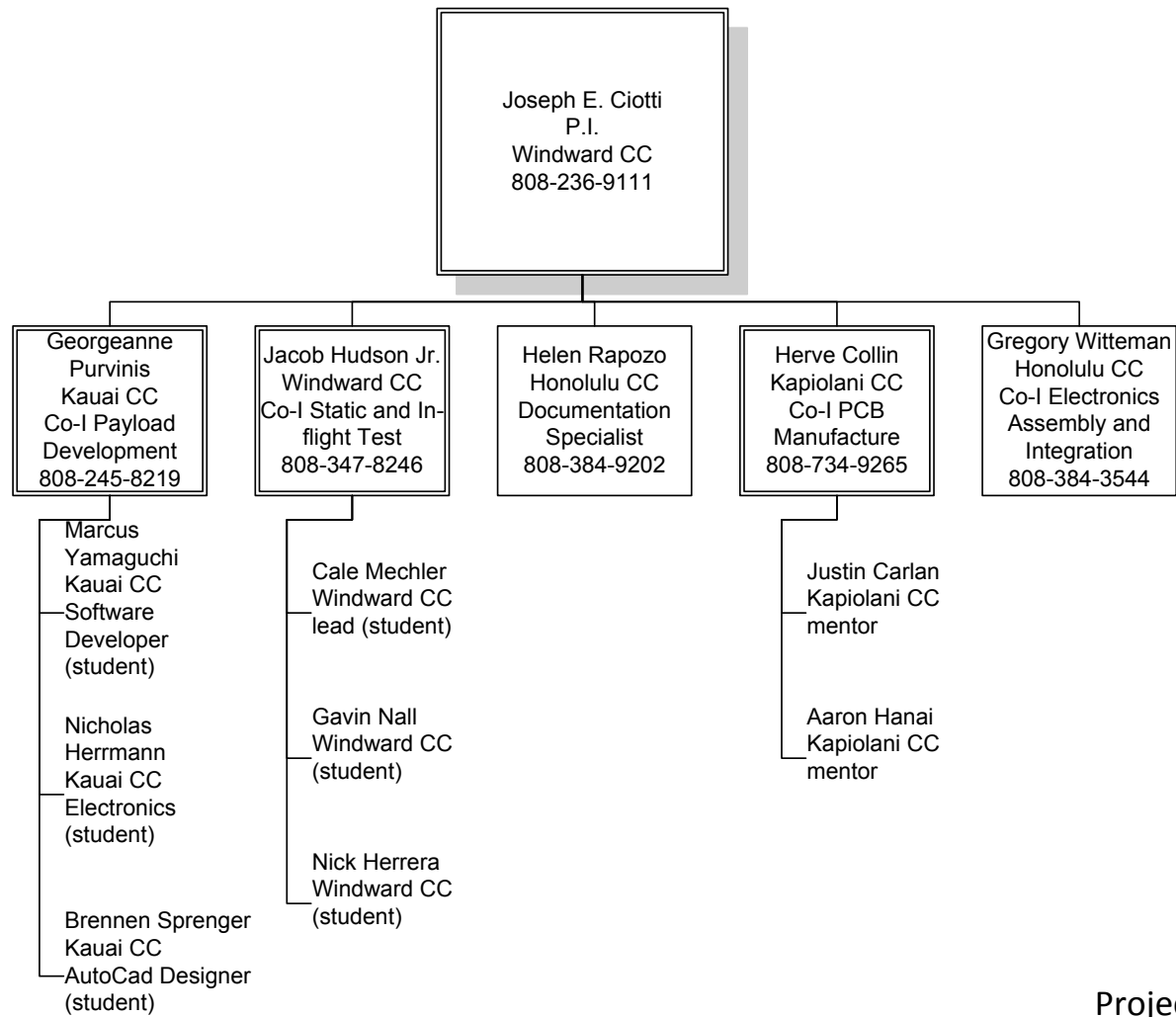


Ahupua'a

Project Imua is modeled after the ancient Hawaiian water management system that relied upon a division of labor to achieve a basic self-sustaining community.

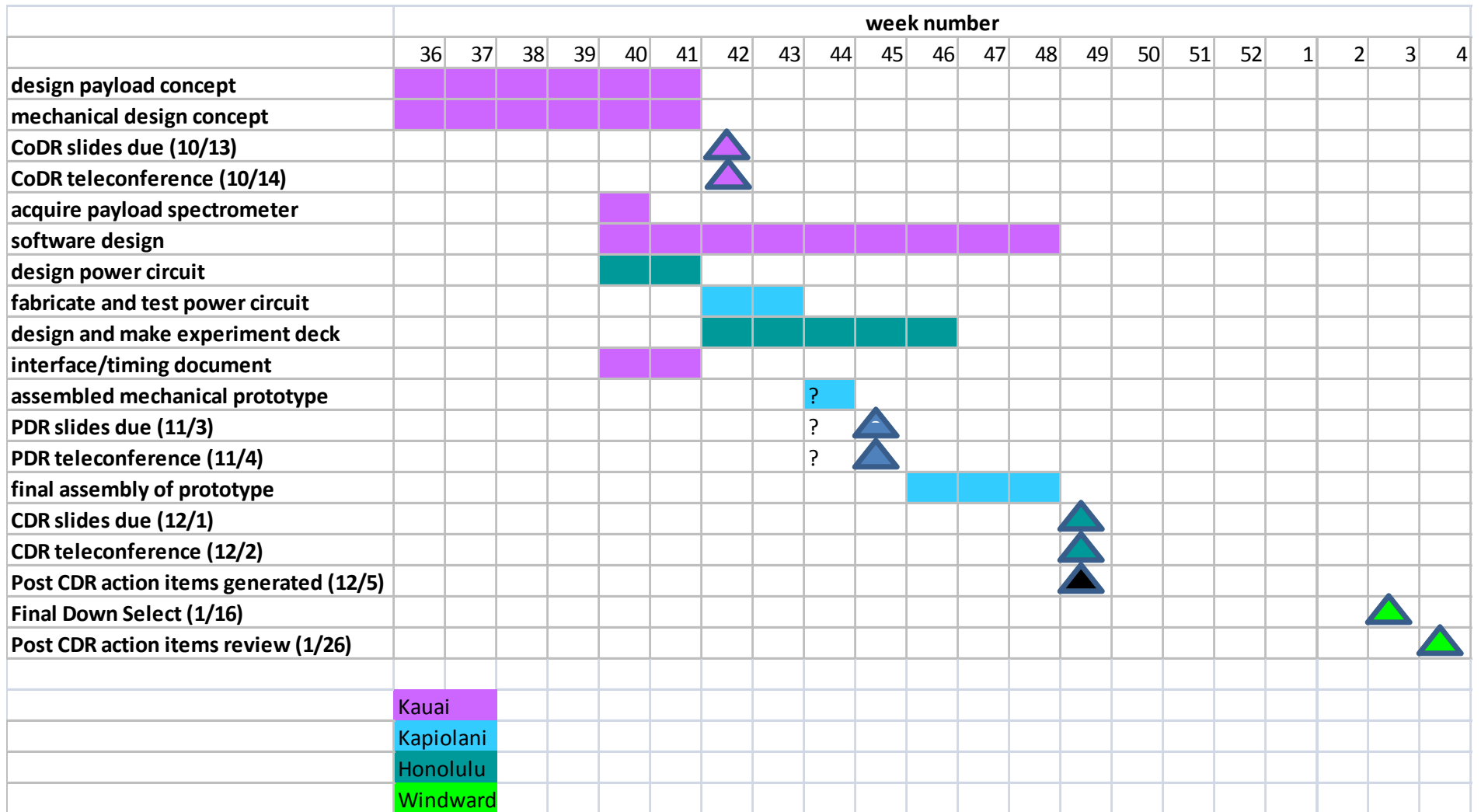
Management:

Team Org Chart



Project Imua PI: Luke Flynn
RockSat-X PI: Joe Ciotti

Management: Schedule



Payload Instruments

Year 1: UV spectrometer (200-600 nm) to measure solar radiance above the atmosphere

Year 2: space-based scintillator neutron detector for the detection of high-energy neutrons ($>20\text{MeV}$)

Launch Delivery System:

RockSat-X sounding rocket
Wallops Flight Facility



Mission Overview: Theory and Concepts

Limitation: direct UV not possible on ground

UV experiences
high absorption at
sea level

Need to be above
stratosphere

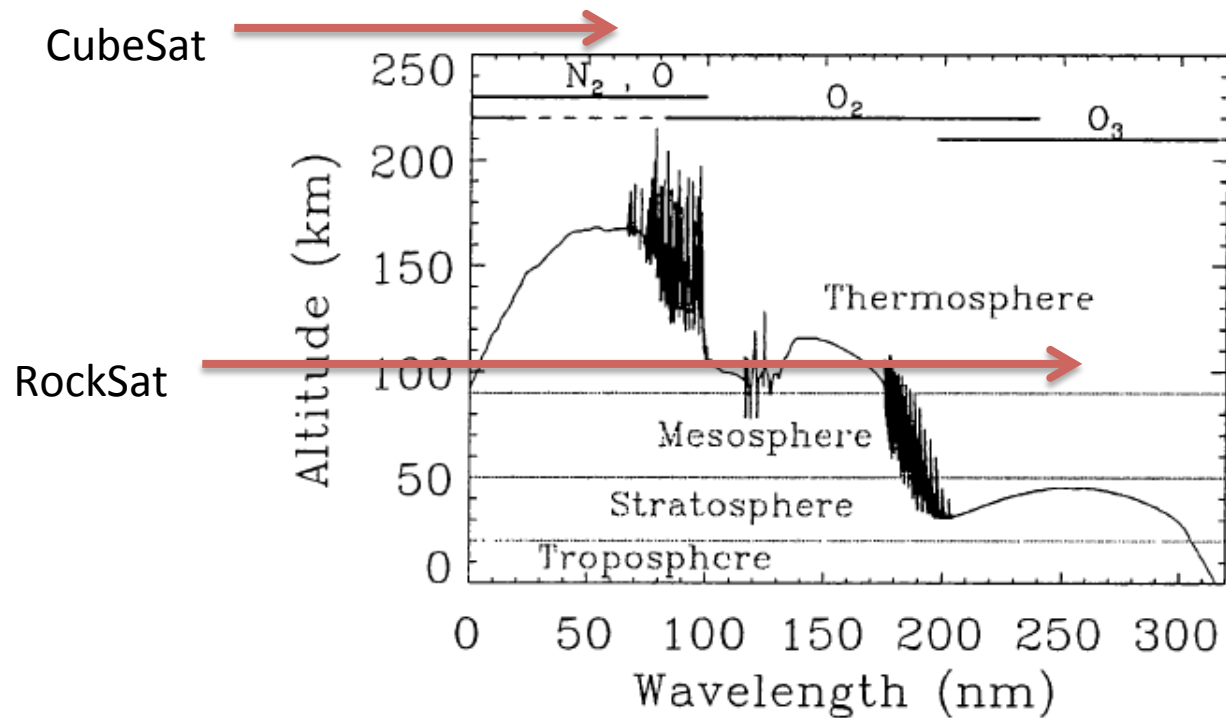
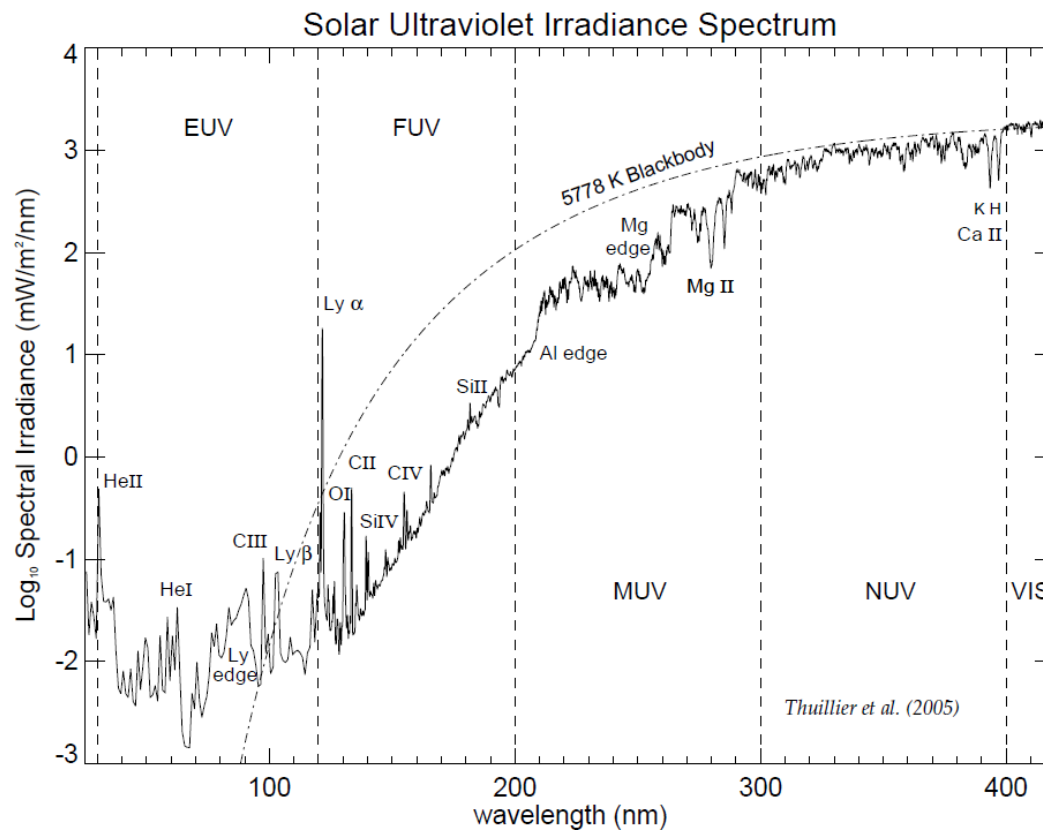


Fig. 1. Altitude of unit optical depth as a function of wavelength for the terrestrial atmosphere with atmospheric regions labelled. (Adapted from [1].)

UV affects climate

Solar UV/EUV Irradiance Spectrum



This mission will study the relationship between magnetic activity, climate, and solar activity. Our efforts will be over more than one sub-orbital or Low Earth Orbit mission

Kauai CC: Payload Design

- Blue Wave Miniature spectrometer

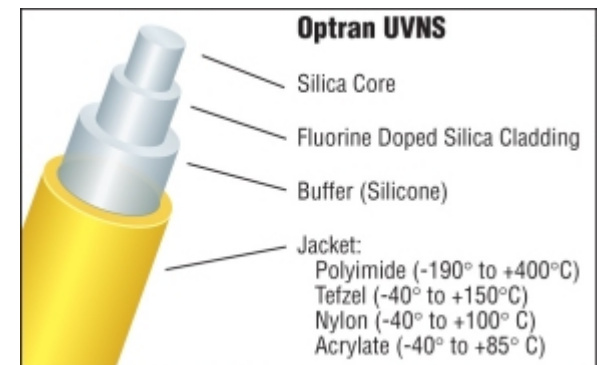
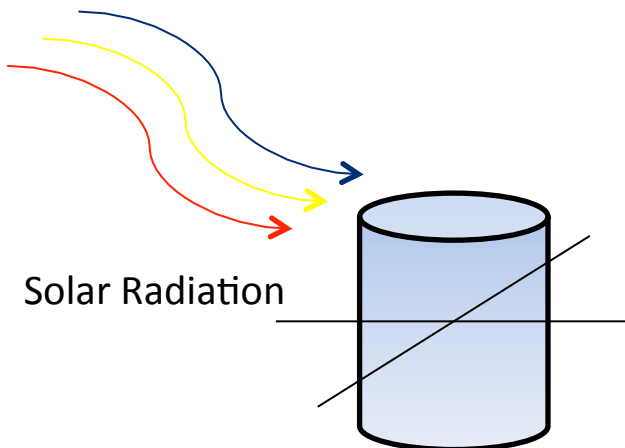
Wavelength Range(nm)	Grating (g/mm)	Slit nm-res	Integration Time
200-600	2400	0.4	1ms-65s

StellarNet BlueWave miniature spectrometer



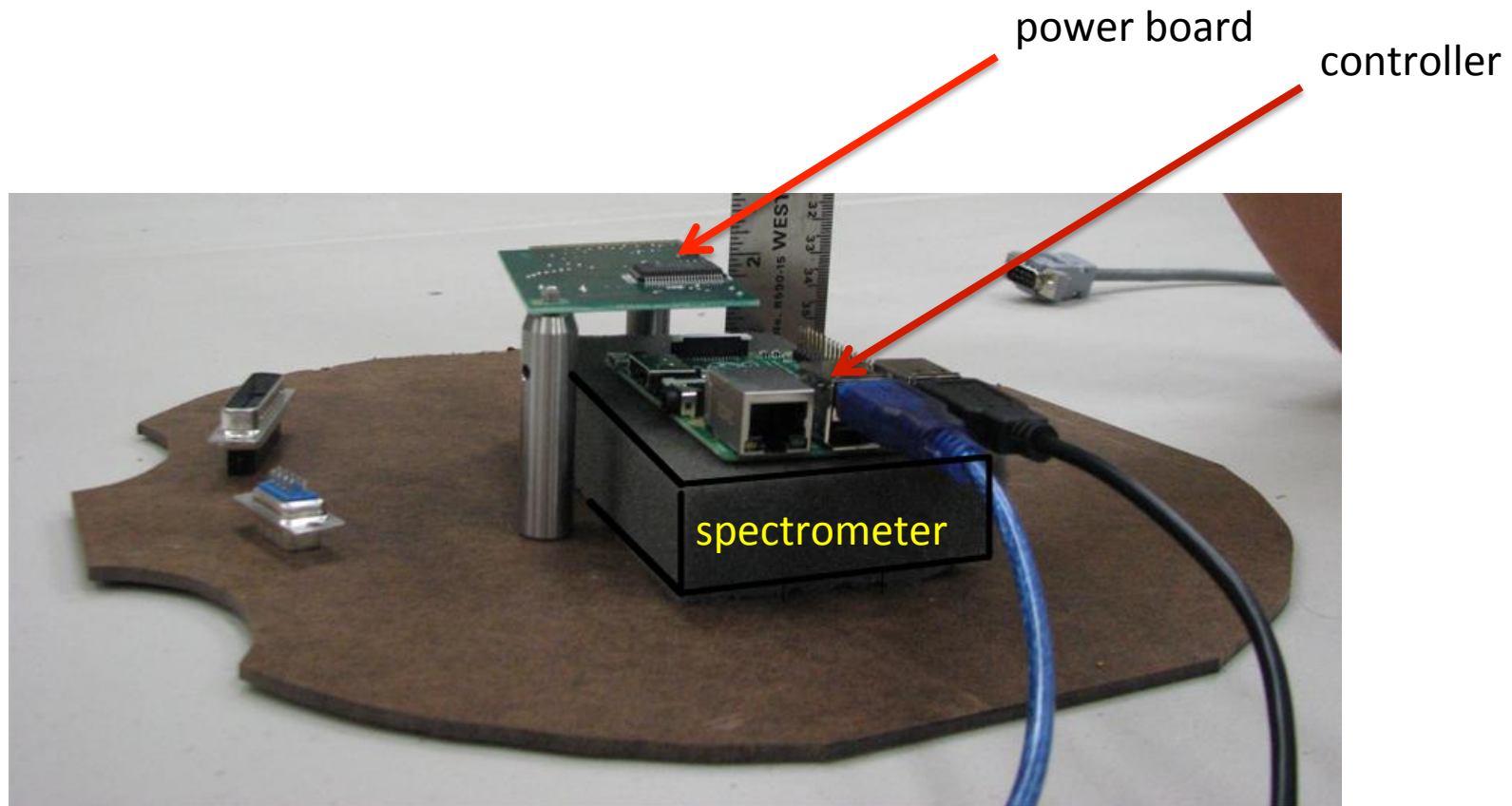
- Ceram Optics OPTRAN® UVNS (UV NON-SOLARIZING)
- MULTIMODE FIBER

- $NA = 30 \pm 0.02$

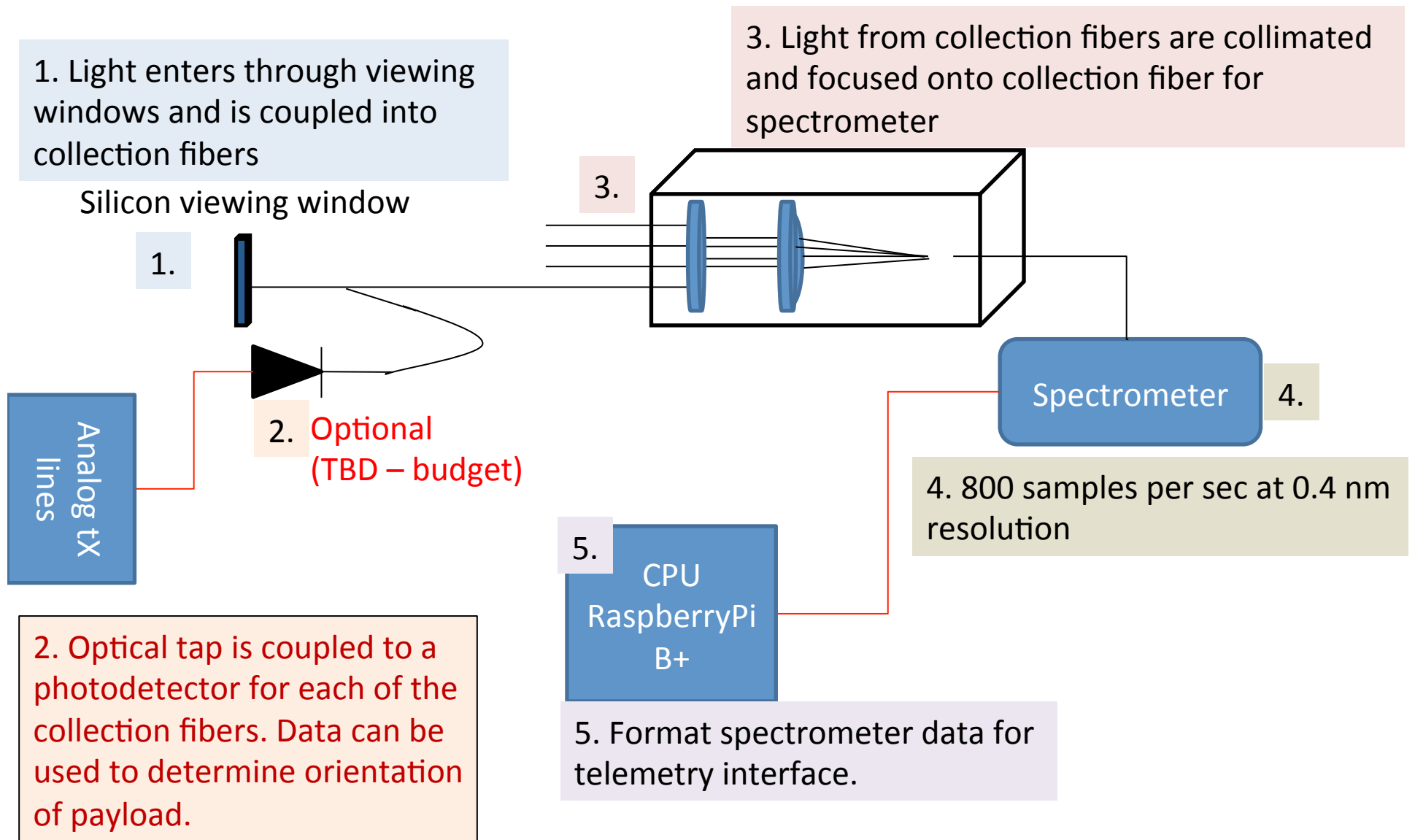


- Spectrometer and optical components contained in aluminum cylinder with ceramic heat shielding
- 2-4 optical fibers x-y orientation for light collection

Payload Layout



Design Overview: Science Design



Engineering Design Overview:

Major Subsystems

- **Power** - Step down voltage from 28V to 5V
 - ✓ MuRata UEI15-050-Q12PM-C (9V-36Vin to 5 V, 3A)
- **Main CPU/Data Controller** -Get spectrometer data and format to fit telemetry protocols
 - ✓ Raspberry Pi B+
 - On board UART
 - GPIO
 - 4 USB
 - 5 Volts
- **Spectrometer**
 - ✓ StellarNet Blue Wave Miniature Spectrometer
 - USB plug N play
 - 200 – 600 nm, 0.4 nm resolution
 - 1 x 3 x 5 inches. Ruggedized

Honolulu CC: Power Design

Mouser Part #: 580-UEI15-050Q12PM-C
Manufacturer Part #: UEI15-050-Q12PM-C
Manufacturer: [Murata Power Solutions](#)
Description: Isolated DC/DC Converters 15W 24
(9-36) Vin 5Vout 3A Pos Polarity SMT



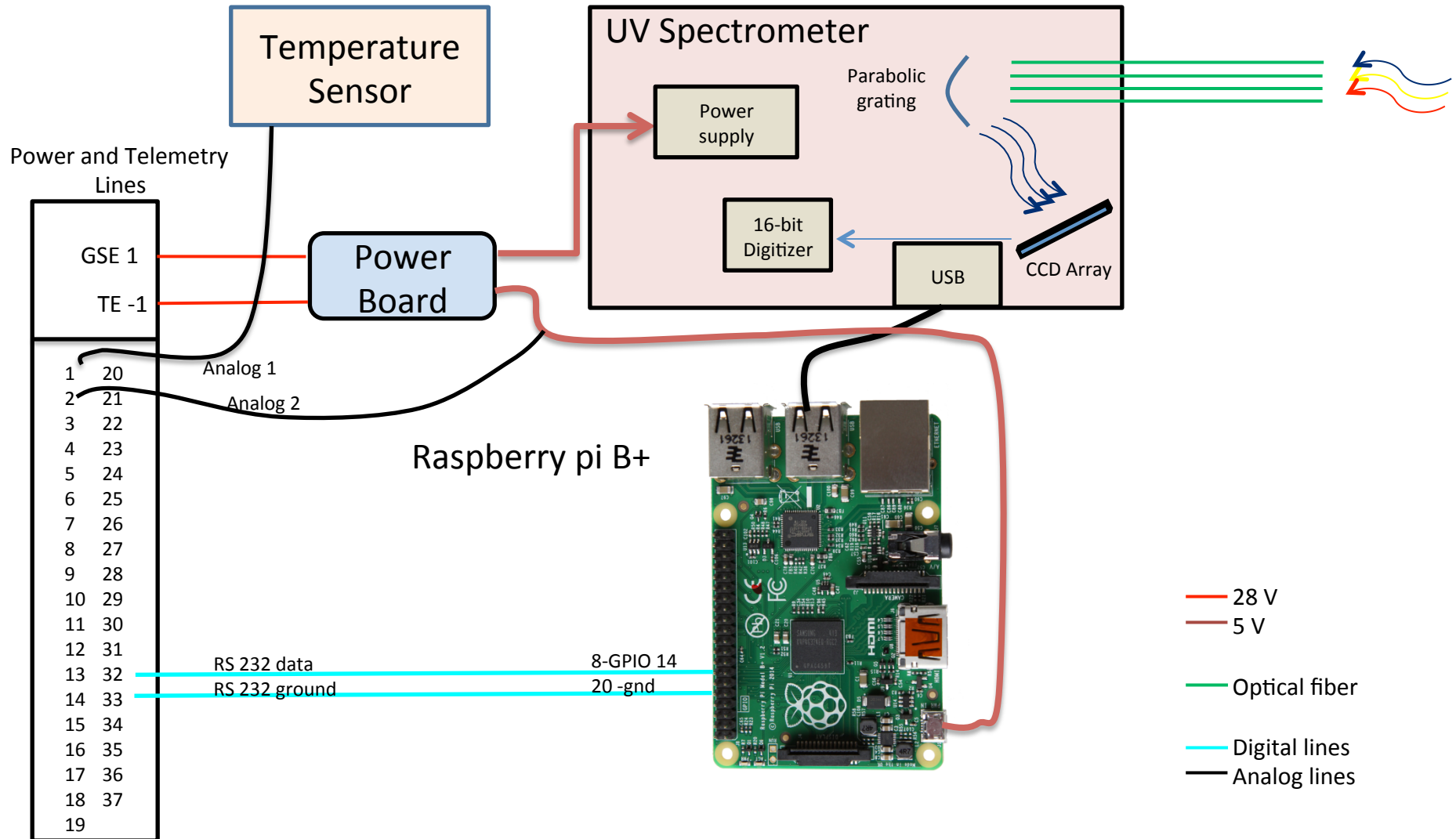
Power limits

- 28 V DC
- 1 amp-hour capacity/ payload
- Combined timed lines < 3.75 A
- Combined GSE lines < 1.85 A

1.1 in x 0.96 in x 0.32 in
0.352000 oz

	Power Consumption	Input Voltage	Input Current
Raspberry pi B+	0.5-1 W	5 V	700 mA (min)
Blue Wave Spectrometer	.5 W	5V	< 100 mA

Design Overview: Functional Block Diagram



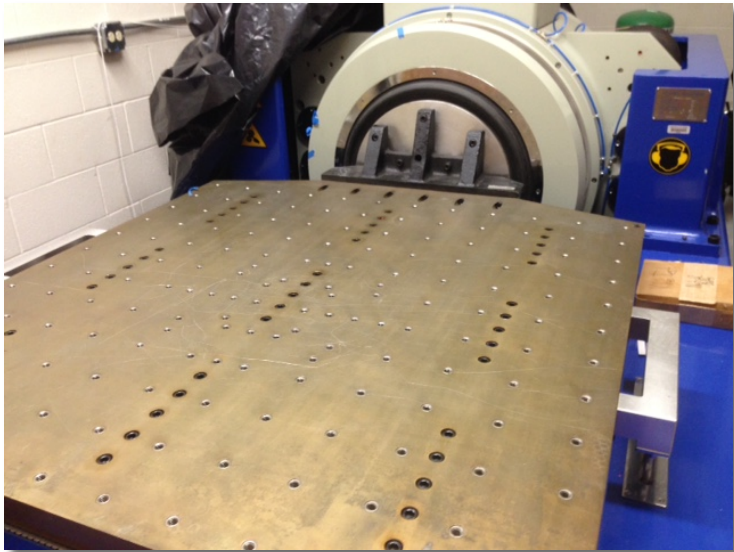
Kapiolani CC: PCB design and construction

- Eagle software for PCB design
- out-source for printing of PCB

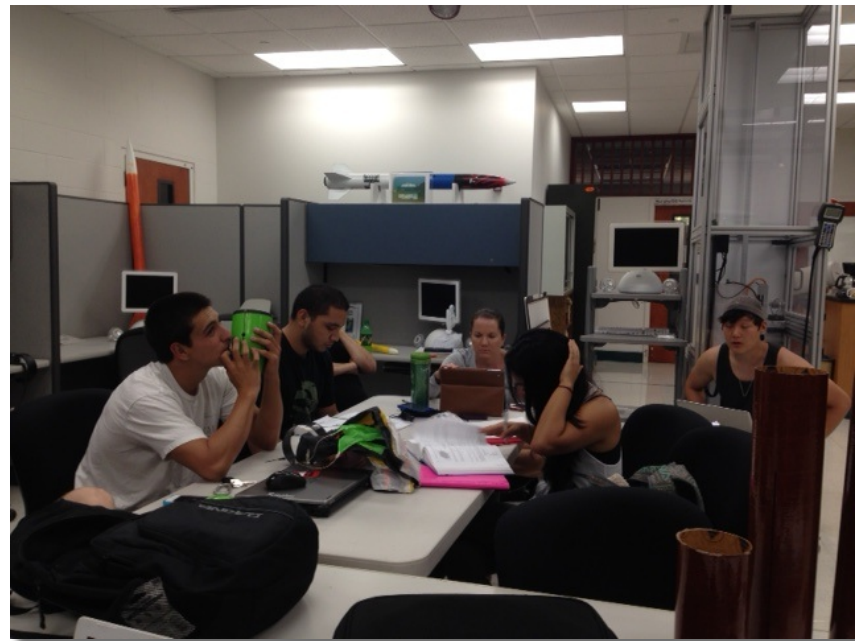


Windward CC: Static Testing

constructing a shake table for vibration testing similar to device at UH Manoa:
capable to 50g

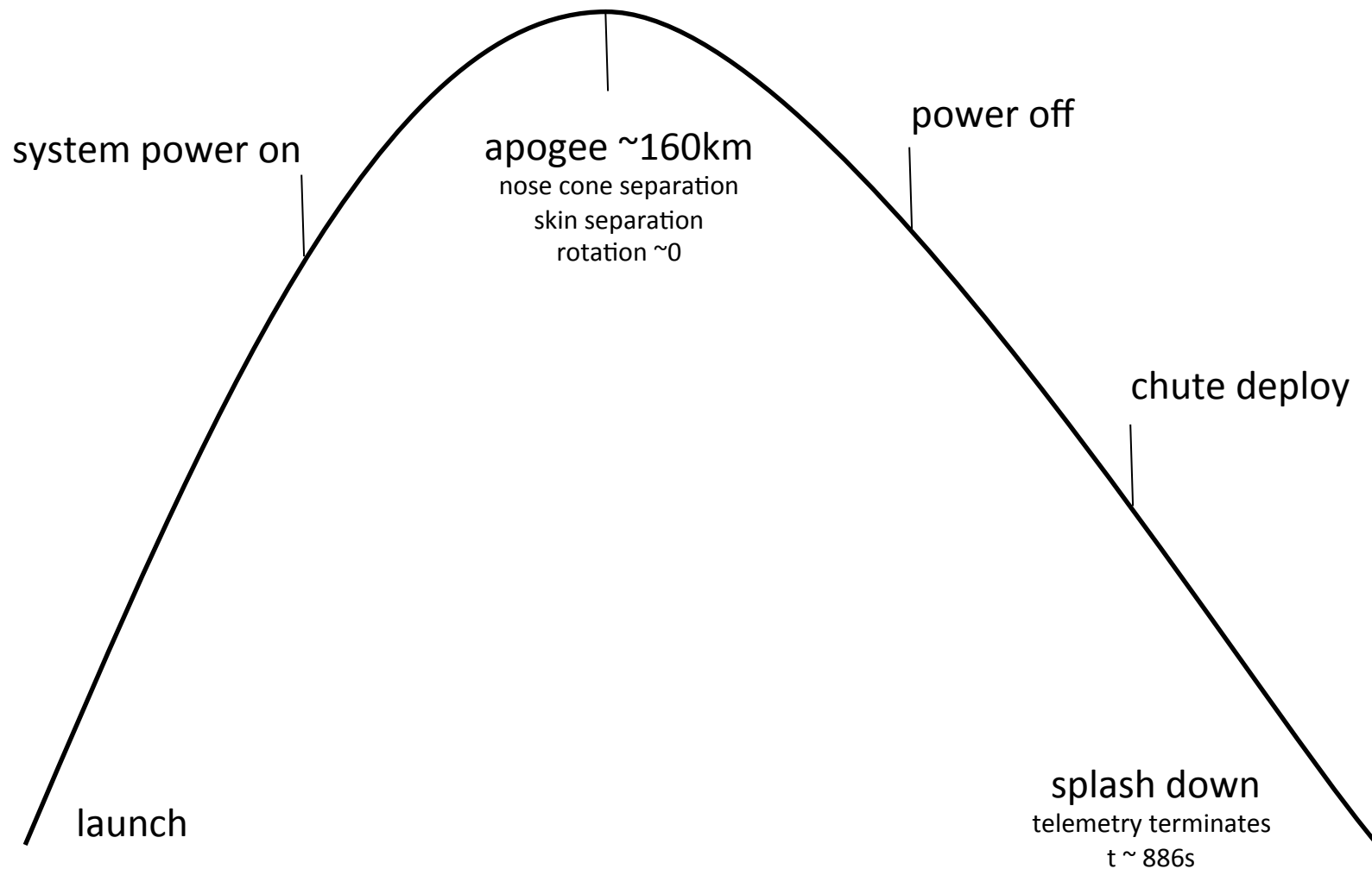


shake table at UH Manoa



WCC high-powered rocketry lab
with zero-g drop tower

Design Overview: Science Design ConOps



Educational Outreach

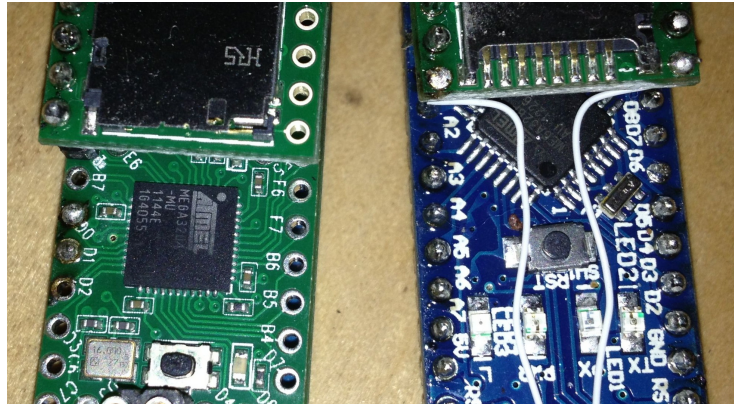


rocketry presentation
for UH Alumni group

model rocket launch
at campus family event



Workshop on IC board development



HCC Loggers 2 — 8-Bit Microcontroller with SD storage



assembling HCC logger2



Arduino group tutorial

IMU Development Timeline

- Initial IMU selection and testing
 - Arduino Nano (8-Bit MCU, 10-bit A/D 16MHZ yields aprox 8MIPS, 5V),
 - discrete 3-axis gyro, accelerometer, magnetometer chips, micro-SD storage
- HCCLogger Version 2 (initial H-Sat Payload controller)
 - Teensy (Atmel 32U4 Microcontroller) Can be run at 3.3V, reduced part/chip count on Microcontroller board with low-power options down to <1 microamp standby.)
- HCCLogger Version 3 (Used in H-Sat Payload)
 - TI ARM-Cortex 32-bit 96MHz risc MPU. On-Chip RTC, similar low power characteristics to ver. 2, 3.3V. IMU Changed to single –package (Ivinsense corp MPU-9150) then upgraded to pin-compatible MPU9250 with better magnetometer and gyroscope stability.

HSGC/HSFL Overview

- Operationally Responsive Space -4 Mission will launch from Kauai in January 2015.
 - HiakaSat (UH System 55 kg microsatellite) is the main payload
 - Honolulu CC has a camera payload that will image the separation events.
 - Kauai CC has S-band and UHF/VHF ground stations that will provide command and control for missions.
 - Two NASA ELaNa payloads will launch as well.
 - Six NASA Ames CubeSats
- Status
 - Rocket motors complete
 - Launch pad complete
 - HiakaSat Pre-Ship Review is on 10/15
 - Range integration begins in December 2014

Launcher and 1st Stage Motor Test



July 2014



August 2014

HSFL 2.0

- UH Vice Chancellor for Research asks for expansion plan following successful launch
- Basic plan is a Mission-Oriented Science and Engineering Department focused on Small Satellite and UAV Missions.
- HSGC/HSFL submits a plan to include Space Technology Development in SOEST, CoE, and the CC's
 - 14 positions would be created.
 - 5 within SOEST would increase mission development capabilities and instrument development for Small Sats and UAV's. Much builds on ESPCoR success
 - Trevor Sorensen - COSMOS Mission Architecture
 - Robert Wright – THI and SUCHI instrument development
 - 4 positions within CoE in Mechanical Engineering
 - ME experienced a 100% increase in enrollment in last 3 years
 - HSFL provides projects for all ME Senior Design classes: new ADCS solutions.
 - 2 faculty positions for UAV's and 3-D printing: Like PrintSat (Montana State)
 - 5 positions would accelerate pre-engineering and physical science at the Community Colleges.
 - Space Grant CC award has huge impact to move us forward.
 - New Department focuses on 3rd and 4th year courses and graduate education. CC's would provide support at the 1st and 2nd year level.
- Plan forwarded to UH Vice President for Research in September 2014
- Space Grant and EPSCoR have made this possible!