Overview of the 2024-2025 LaACES Program

Louisiana Space Grant Consortium (LaSPACE)

Department of Physics and Astronomy
Louisiana State University
Baton Rouge, LA

Introductions – LaACES Management

Colleen Fava
LaSPACE Director

Doug Granger
LaSPACE Assistant Director

Aaron Ryan
LaSPACE Flight
Instructor

Dana Browne
LaSPACE Associate

Sabrina Huezo
LSU P&A Electronics
Engineer

Introductions – LaACES Teams

Delgado Community College (DCC):

Faculty Advisor: Joanna Rivers

Loyola University (Loyola):

Faculty Advisor: Anat Burger

McNeese State University (MSU):

Faculty Advisor: Bei Xie

Northwestern State University of Louisiana (NSULA):

Faculty Advisor: Anna Dugas

Southeastern Louisiana University (SELU):

Faculty Advisors: Gerard Blanchard, Ahmad Fayed

Grambling State University (GSU):

Faculty Advisor: Abdul Khaliq

Workshop Goals

- Inform teams of course materials, hardware, and resources available to them
- Make sure the expectations and schedule for all deliverables from teams are clear
- Cover changes applicable to the 2024-2025 LaACES year
- Cover the planned 2025 Launch Week
  - Update on CSBF base access

What is LaACES?

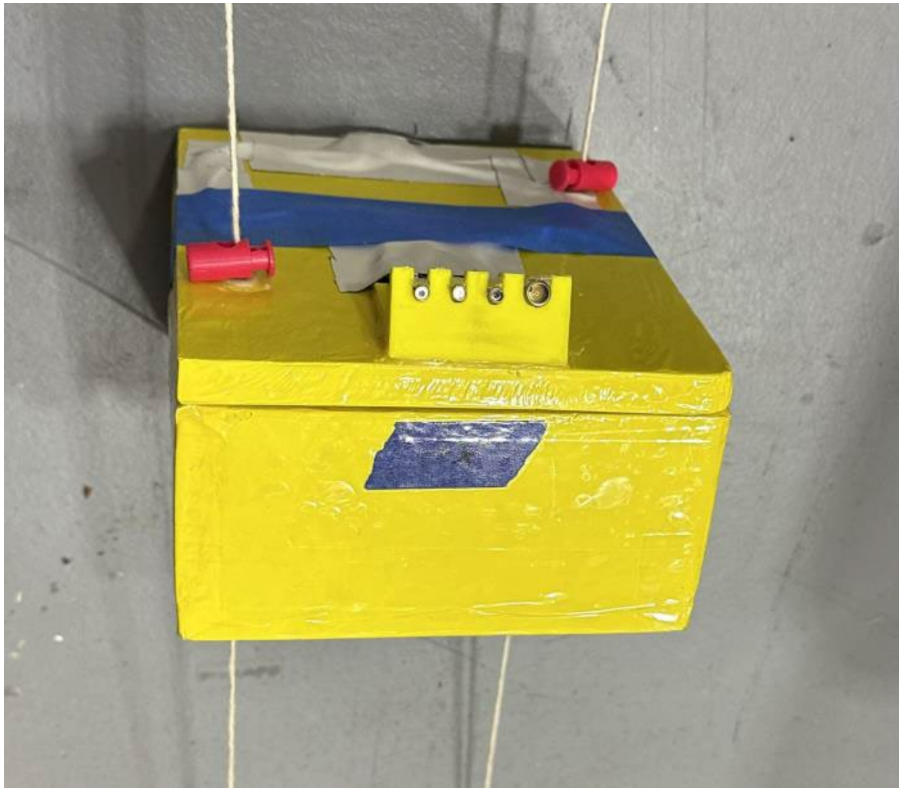
- Louisiana Aerospace Catalyst Experiences for Students
  - Student experiential learning program started in 2002
- Students develop science experiments and fly them to 100,000 feet
- Students gain practical skills in:
  - Electronics
  - Microcontroller programming
  - Project management
  - Writing and communication
- Entry-level spaceflight experience for students at Louisiana Colleges and Universities
- We will launch our 72^{nd} (and possibly 73^{rd}) LaACES Balloon Flight Strings in 2025

Advisor Responsibilities

- Ensure students complete all Fall Lectures and activities
- Review and provide feedback to all student-submitted documents before submitting to LaSPACE
  - Fall Report and Spring Design reviews
- Ensure all deliverables are submitted in a timely manner
  - Some flexibility in due dates to accommodate exams, courseload, etc.
- Ensure all attendees from home institutions at LaACES events comply with guidelines: especially the launch
  - Anyone participating in launch and chase needs to follow all directions and safety rules

Payload Requirements and Bases

- Payload shall weigh less than 500g
  - Ensure flight string complies with 12 lb FAA Part 101 rules
- Payload shall have 2 vertical penetrations separated by 17 cm, >1 cm from the outer payload load wall
  - Comply with the mechanical interface to flight string
  - Recommend embedding inside inner wall
- Payload shall have adequate power and data storage for 4 hours of operation
  - Allow for ~1.5 hours of setup time and ~2.5 hours of flight
- Payload shall operate in exposure to 10 mbar, -50C, +50C conditions
  - Extreme of conditions exposed during the flight



Payload with mechanical interface

Anticipated Participation (estimated)

Institution	Teams	Students
DCC	2	15
Loyola	2	10
MSU	1	6
NSULA	1	6
SELU	2	6
GSU	2	6
LSU	2	10
TOTALS	12	54

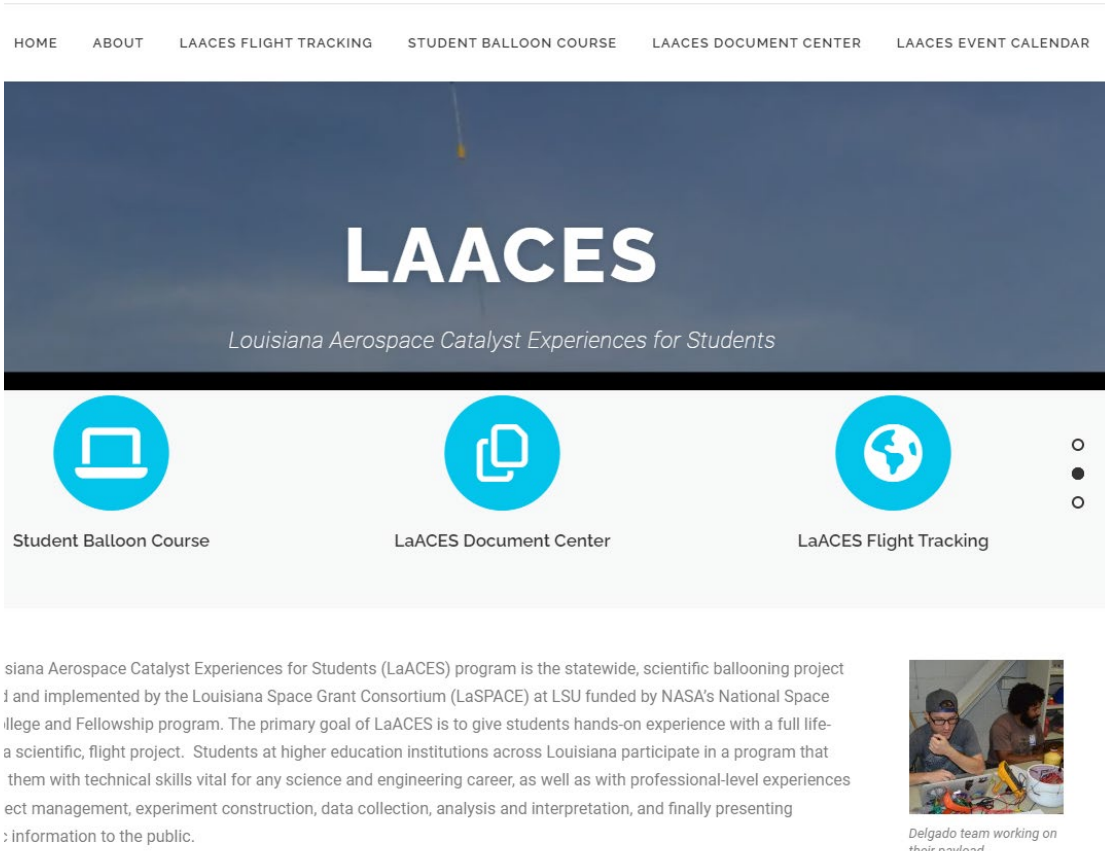
Resources – What we will provide

- SBC: All lectures, activities, plus video recordings are available online at the LaACES website: https://laspace.lsu.edu/laaces/student-balloon-course/
  - Slides and PDFs of Lectures and Activities
  - Recordings of the Lectures and Intros to the Activities
- Monthly Advisors meetings/office hours on Zoom again this year
  - 30-minute meeting with A. Ryan and LaACES Advisors to touch base and answer questions
- Hardware Kits – necessary electronics to complete all required activities

Navigating the LaACES Website
https://laspace.lsu.edu/laaces/

Three Sections of Interest

- Student Ballooning Course
- Document Center
- Flight Tracking



LaACES Website
Student Ballooning Course

HOME ABOUT LAACES FLIGHT TRACKING STUDENT BALLOON COURSE LAACES DOCUMENT CENTER LAA

- Student Ballooning Course
  - Access to lectures, activities, and video recordings
- Document Center
- Flight Tracking

LaACES Student Ballooning Course

Welcome to the Louisiana Space Grant Consortium's Louisiana Aerospace Catalyst Experiences for Students (LaACES) Program.

Part I – Basic Skills Building and Introduction to Basic Components

Part I of the LaACES SBC will introduce the participant to all the technical skills required to complete the LaACES MegaSAT program. In addition to the technical skill this section will also introduce the participant to analytical analysis, documentation and public presentations.

- + Unit 01 - Introduction to LaACES SBC
- + Unit 02 - Introduction to Electronics
- + Unit 03 - Schematics, Prototyping, and Soldering Introduction
- + Unit 04 - SkeeterSAT Assembly and Operation
- + Unit 05 - SkeeterSAT Calibration and Reporting
- + SkeeterSAT Calibration Document Review
- + Unit 06 - Introduction to Programming
- + Unit 07 - Introduction to the Arduino Mega
- + Unit 08 - Introduction to Digital I/O
- + Unit 09 - Data Acquisition

LaACES Website
LaACES Document Center

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LaACES Document Center

- Student Ballooning Course
- Document Center
  - Recording of this workshop
  - Spring Deliverable templates
- Flight Tracking

LaACES at LSU

+ LaACES Information for LSU Students

Document Templates

- Pre-Preliminary Design Review Document Template
- Preliminary Design Review Document Template
- Pre-Critical Design Review Document Template
- Critical Design Review Document Template
- Flight Readiness Review Document Template
- LaACES Security Clearance Template

LaACES Instructor Workshop Presentations

LaACES Website
Flight Tracking

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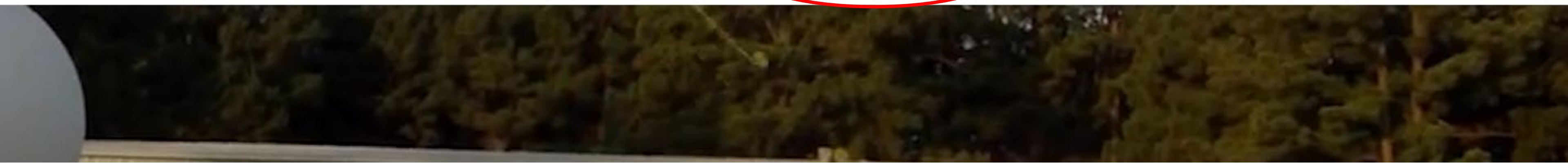


- Student Ballooning Course
- Document Center
- Flight Tracking
  - Easy access to the Amateur Radio (APRS) and Satellite (Iridium) tracking data during flight

LaACES Flight Tracking

Tracking of specific LaACES flights is available on the Flig

ACES-68: May 17, 2022. Ragley, La (30.5149, -93.2362)
Flight Mission: Flight Details, Payload details, etc.

ACES-67: May 17, 2022. Ragley, La (30.5149, -93.2362)
Flight Mission: Flight Details, Payload details, etc.

ACES-66: June 12, 2021. Clandreneau Park, Mamou, LA
Flight Mission: Flight Details, Payload details, etc.

ACES-65: August 03, 2020 . Elton High School, Elton, La
Flight Mission: Flight Details, Payload details, etc.

ACES-64: June 26, 2019. Church Point High School, Church Point, La
Flight Mission: Flight Details, Payload details, etc.

ACES-63: June 11, 2019. Elton High School, Elton, La
Flight Mission: Flight Details, Payload details, etc.

ACES-62: May 22, 2019. Columbia Scientific Balloon Facility in Palestine, Tx
Flight Mission: Flight Details, Payload details, etc.

ACES-61: July 17, 2018. Church Point, La
Flight Mission: Flight Details, Payload details, etc.

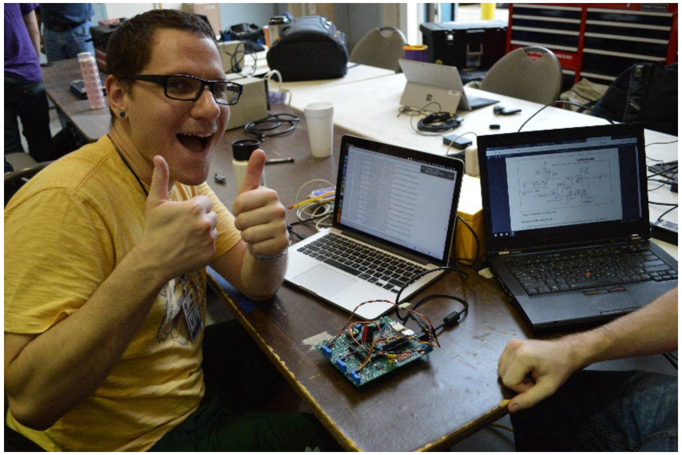
Deliverables Schedule for LaACES 2024-2025

	Recommended Deadline	LaSPACE Deadline
SkeeterSat Report	October 11, 2024	October 18, 2024
Capstone Report	December 2, 2024	December 20, 2024
PDR	February 14, 2025	February 21, 2025
CSBF Security Document		March 1, 2025
CDR	April 11, 2025	April 18, 2025
Thermal / Vacuum Test (at LSU)		April 25, 2025
FRR	May 12, 2025	May 16, 2025
LaACES Launch Trip		May 18, 2025 – May 23, 2025
FRR Defense Presentation (at CSBF)		May 19, 2025

Outline of Workshop

- Anticipated Flight Operations 2025
  - Anticipated 2025 balloon flight operations including NASA base access procedures.
- Student Ballooning Course
  - We will provide an overview of the LaACES course material for the Fall and Spring semesters, discuss major deliverables and due dates, and the expectations for required deliverables.
- LaACES Hardware Kits
  - We will discuss various hardware kits LaSPACE will be providing to teams and their intended use during the LaACES program (Soldering Kits, SkeeterSat, Activities Kit, Arduino, GPS Shield, MegaSAT kit)
- Q & A and Discussion

Previous LaACES Flights



Anticipated LaACES Flight Operations 2025

Aaron Ryan
LaSPACE Flight Program Manager and Lead Instructor
Louisiana Space Grant Consortium (LaSPACE)

Flight Certification Requirements

In order to be flown all teams must complete:

- All Fall deliverables must be completed
- Design Review Documents
  - PDR due Feb. 21, 2025
  - CDR due April 18, 2025
  - FRR due May 16, 2025
- Successful Completion of Thermal Vacuum Test at LSU April 25, 2025 or equivalent testing at home institution
- Successful FRR defense Monday May 19, 2025
- Conform with payload requirements (string width, weight, …)

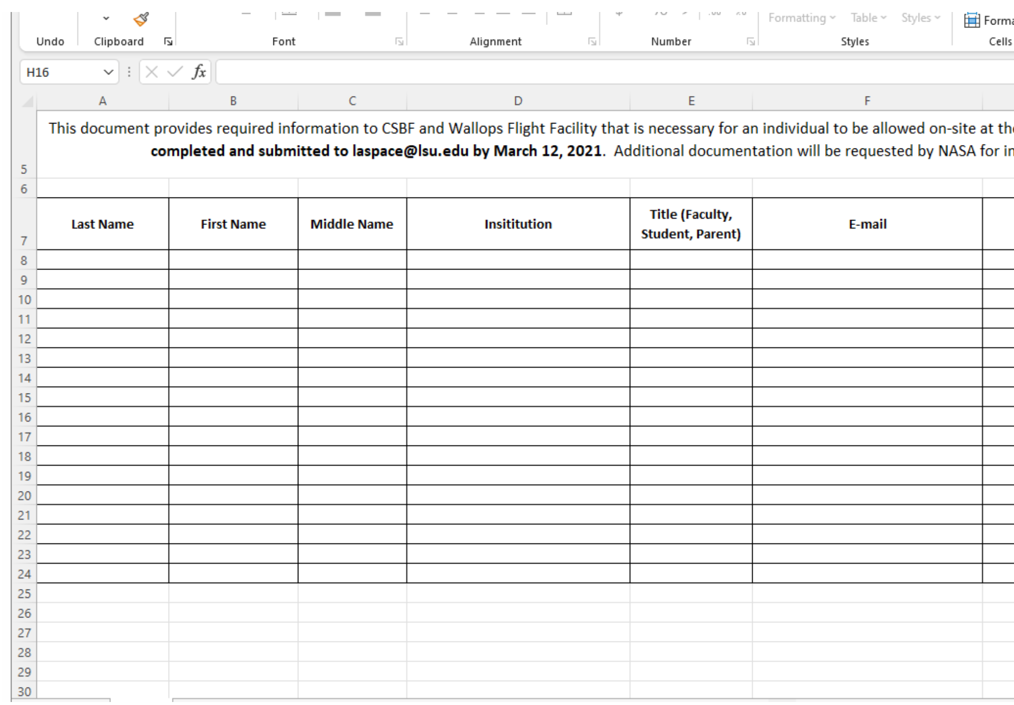
2025 LaACES Flight

- For 2025 we intend to return to launching out of Columbia Scientific Balloon Facility in Palestine, TX
- 2025 LaACES Flight week planned for May 18-23, 2025
- Room block will be set up for the Comfort Suites in Palestine, TX, once we have a headcount of participating individuals
- Palestine ~6-hour drive from Baton, Rouge

CSBF in Palestine, TX

CSBF Security Document

- CSBF Base Access Requires security screening
  - List of anticipated launch attendees will be due March 1, 2025
- List will be used for:
  - CSBF Base Access
  - Setting up the hotel block
    - Assume 2 students in a double room
  - Contact list on chase



This document provides required information to CSBF and Wallops Flight Facility that is necessary for an individual to be allowed on-site at th
completed and submitted to laspace@lsu.edu by March 12, 2021. Additional documentation will be requested by NASA for in

Last Name	First Name	Middle Name	Insititution	Title (Faculty, Student, Parent)	E-mail

Citizenship Categories for Security Screening

US Nationals

- U.S. Citizens
- U.S. Nationals
  - I.E. American Samoa, etc.
- U.S. Permanent Residents

Foreign Nationals

- Foreign Nationals
- Foreign Nationals from designated countries
  - Country of Birth
  - Country of Citizenship

CSBF Access: U.S. Nationals

- Submit information to LaSPACE via CSBF Security Document
- Combined list forwarded to NASA
- View the safety briefing video
  - Will accessible via link distributed in the Spring
- **NEW**: Receive an email from NASA-Visitor.donot-reply@nasa.gov
  - Verify contact info, enter ID information (DL #, etc.)
  - Permanent Residents will need to enter Permanent Resident Number

CSBF Access: Foreign Nationals

- After the security list is submitted to CSBF, you will receive an email to create a profile in IDMAX and upload the requested documentation
  - We have no way of tracking this, so it is important that you ensure students are completing the required documentation promptly
  - **Expired documents** will not be accepted
    - We had a student with an expired visa, but valid I-20 was not accepted
- Require a signed letter on university letterhead listing all foreign nationals and with specific language required
  - Template will be provided

CSBF Access: Foreign Nationals – Designated Countries

- Foreign Nationals holding citizenship **OR** born in the list of designated countries require a one-on-one escort by a NASA employee so will not participate in **ON BASE** activities
- List as of March 2024:
  - https://www.nasa.gov/wp-content/uploads/2024/03/oiir-designated-country-list-3-19-2024.pdf?emrc=575961
  - Requirements are applicable all countries listed in above document (Categories I,II,III,IV)
- Note: This is a different(larger) list than the "adversaries of United States" list for RS 17

Possible Changes

- Please be aware that there has been a rumor of possibly applying the Foreign National requirements to Permanent Residents

- Since that would apply to several advisors, if that becomes the policy we would likely re-evaluate if the CSBF launch is still viable for all teams.
    - We would likely shift to a Louisiana based launch

LaACES Launch Week Schedule

- Sunday - Travel
- Monday
  - AM: FRR Presentations
  - PM: Final Certification and Flight String Integration
- Tuesday
  - Flight and Recovery Operations
- Wednesday
  - Analysis and science presentation prep
- Thursday
  - AM : Science Presentations
  - PM : Return Travel
- Friday
  - Contingency Day – if unable to launch Tuesday, attempt launch Wednesday and shift schedule

CSBF Balloon Hangers.

FRR Defense Presentations

- SHORT summary of FRR (~10 min w/5 min questions)
  - Final time targets will be sent out in March when number of teams are known
- Science Goals (What you are measuring and why)
- Technical Goals (How you are measuring, hardware and software)
- Pre-flight testing results (Calibrations, T-V, etc.)
- Students should be proving
  - The payload has merit to fly
  - The payload will operate correctly throughout the flight

MSU students presenting FRR at McNeese in 2022

Final Payload Preparation

- Teams should arrive with flight-ready payload
- Address any corrective actions from FRR defense
- Final Weigh In: Payload limit <500 g will be strictly enforced
- Tools and troubleshooting assistance will be provided by LaACES management for emergency fixes
- When Payloads placed on string must be in completely flight-ready condition:
  - All hardware (Batteries, SD cards, etc.) installed
  - Flight Software Loaded
  - No further changes after integration
- Payloads must be integrated onto the flight string by 5:00 pm on Monday

A Sample Flight String

ACES-60 total suspended weight is 4.960 kg or 10.9 pounds

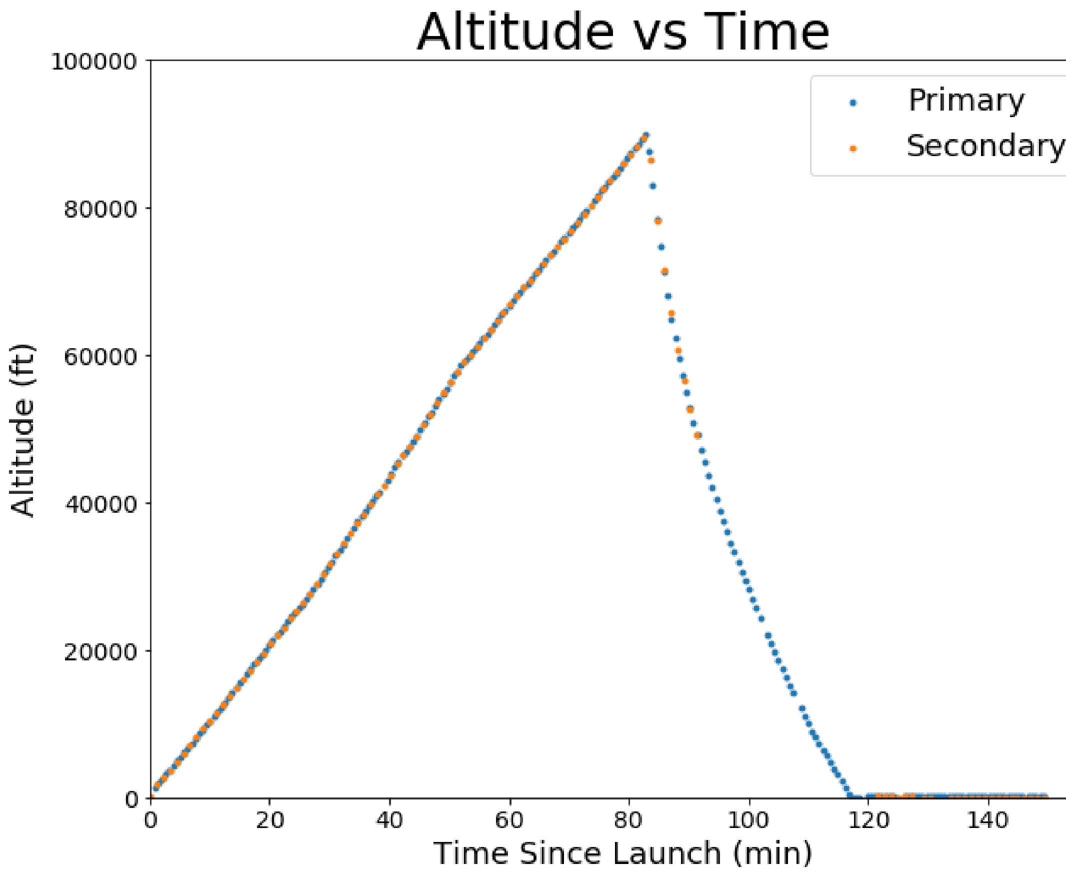
Launch Day

- Teams arrive at CSBF as early as 5:00 am
  - CSBF launches typically earlier than the Louisiana launches of the past years
- Students will be involved in handling balloon string
- Strings are laid out CSBF hanger
- Teams make final payload flight preparations
  - Powering payloads on, checking indicators, etc. not troubleshooting
- Pick up the string and walk to the helium tank
- Balloons inflated and string is walked to launch area
- Countdown… Launch!
- Compliance with LaACES staff instructions and safety rules at all times is paramount

2022 Launch from Ragley, LA

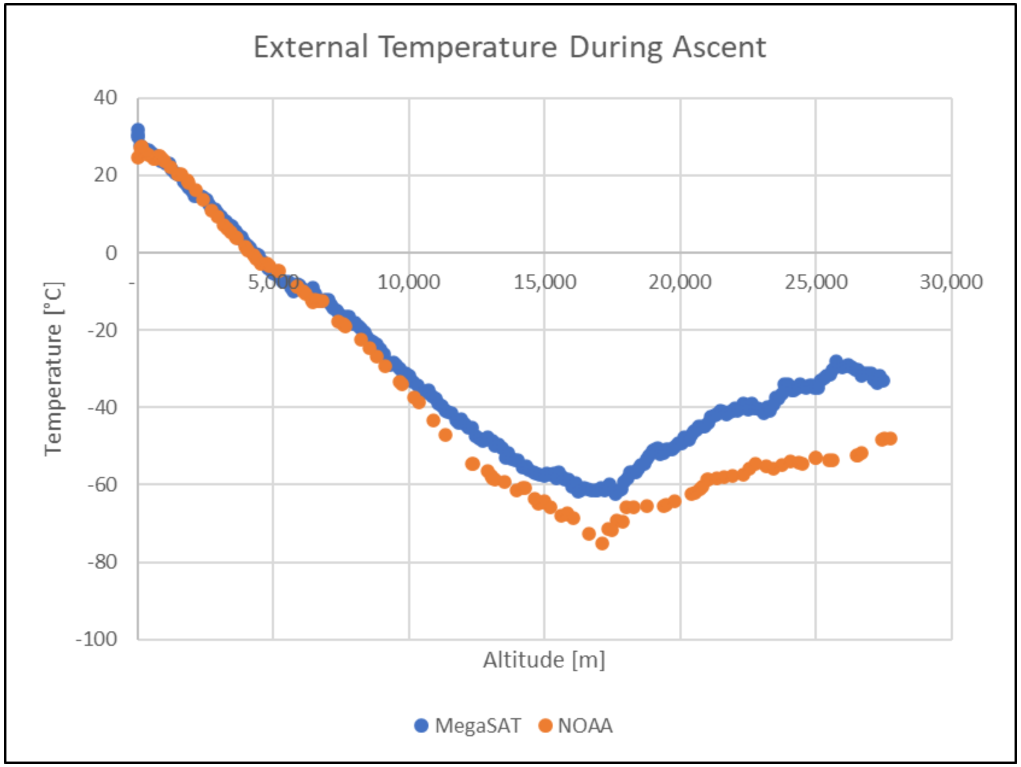
Target Flight Profile – Altitude and Ascent

- 100,000 ft normal target altitude
  - 30 Km
- 1000 ft/min ascent rate
  - 5.08 m/s
- 100 minutes to reach cut
- 40-50 min descent
- May be modified based on predicted trajectory



Flight Profile – Temperature and Pressue

- Cool until ~25Km and then begin to heat back up in upper atmosphere
- Coldest temperatures on exterior of payload -60C
- Minimum pressure ~10 mBar



Tracking The Payload

- Balloon Position Tracked via Amateur Radio frequency beacons (APRS) and Iridium Satellite
- Tracking information will be available on LaACES website
- Fast cell data access may or may not be available during recovery
- We will attempt to spread radio operators out among vehicles
- Cut down command is issued from the primary beacon

Recovery Operations

- Payload lands 45 minutes after the cut-down command is issued at a predetermined altitude
- Ideally, the tracking team is at the landing site upon landing
- Recoveries range from easy to very difficult
- An assortment of recovery tools is brought to assist

Safety during Recovery

- Personal Safety is top priority on flight day
- Chase vehicle driver should not have other duties (no tracking)
- No entering private property without explicit LaACES management direction
- Rural State Highways: High-Speed Traffic, Narrow Shoulders, possible poor visibility
- Water, Sunscreen, Bug Spray, and Proper Attire (Closed Toed Shoes, Long Pants) required for anyone viewing or participating in the launch
- PI is responsible for all attendees from their institution

Post-Flight Science Presentation

- During the launch, teams will be required to present a report on their science results
  - PowerPoint presentation including science background, a brief description of the instrument, calibrations, analyzed data, science results, and error analysis
- Teams will have a full day following the flight to analyze the payload data and prepare their report
- Teams can be provided with a time-stamped altitudes for the flight if needed
- Make sure the team is well-prepared before the launch trip
  - Have the team's presentation done except for the science results
  - Have the ground data handling and analysis software complete, tested and ready to go

The Student Ballooning Course

The LaACES Website

Aaron Ryan

LaSPACE Flight Program Manager and Lead Instructor

Louisiana Space Grant Consortium (LaSPACE)

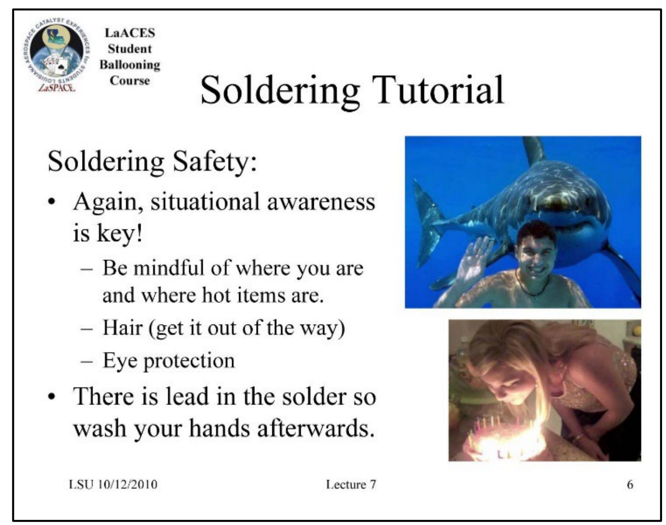
Student Balloon Course (SBC)

Goal:
Take a group of students without any necessary prior experience, teach them the basic electronics, programming, and project management skills to design a payload to fly to the edge of space.

Expectation:
All new students should complete the Fall lectures and activities before attempting to design and construct a payload. Returning students not expected to repeat.

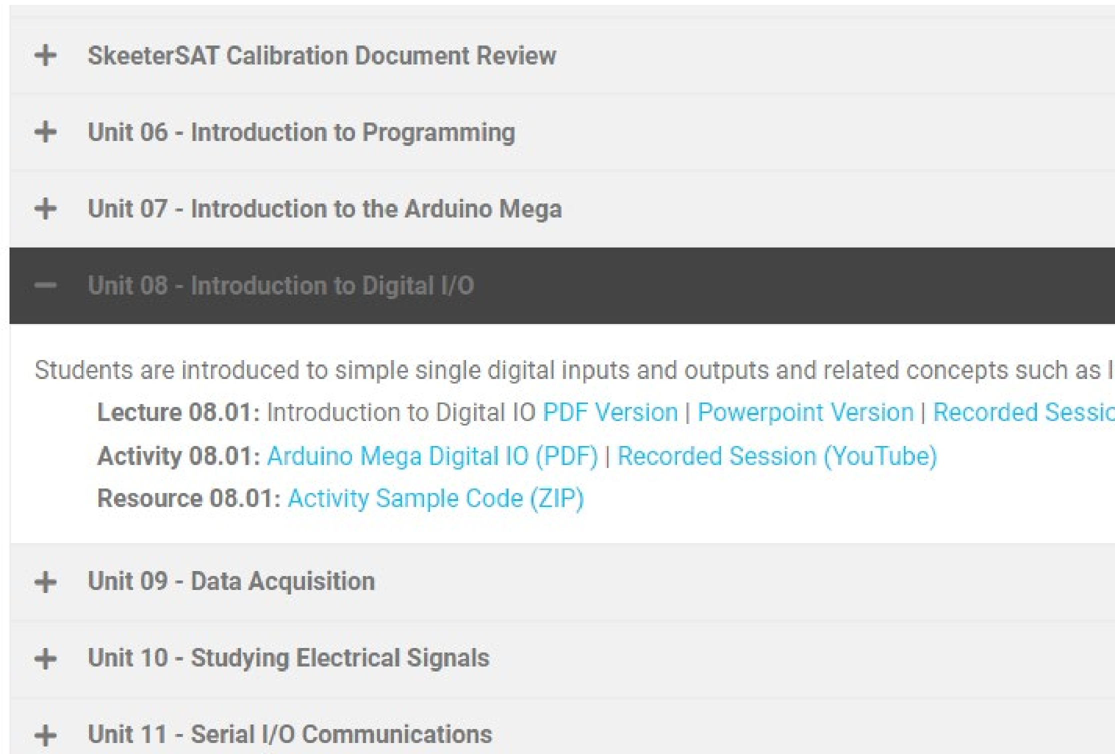
Student Balloon Course (SBC) Content

- Set of materials designed to give an inexperienced student proper skills set to be able to develop a balloon payload
- All lectures, activities, and auxiliary material is available for download from the LaACES website
- ~35 PowerPoint presentations covering the primary topics relevant to the program
- ~30 hands-on activities that complement the lectures



LaACES SBC

- Grouped into related lectures and activities
  - The units are grouped roughly by related topics rather than a fixed time of materials
  - PDF and PowerPoint versions of slides
  - Activities have a short writeup with stepping through a related electronics or programming task
  - Recorded videos for lectures and activities



Course Structure

- Two-semester program culminating in student-designed flight-ready payload
- Intended to be accessible for students regardless of their technical background
- First semester focused on skill-building
- Second semester focused on payload development
- Expected student commitment of ~10-15 hours/week
- At LSU we structure it into 2x 2-hour instructor-led sessions to cover lectures and start lab activities
  - Most activities will require additional independent work time to complete after introduction by instructor

First Semester

- The first semester is focused on skill-building
  - Students should learn skills to take on any of the needed roles in payload development regardless of background
- Introduce students to:
  - Technical Writing and Data analysis
  - Basic Electronics and Soldering
  - Programming and Using the Arduino IDE
  - Interfacing Sensors to a Microcontroller
- Two Major Deliverables in the Fall
  - SkeeterSat Report
  - Capstone Sensor Report

Updates 2024 – Basic Electronics Lectures

- Adding additional information to the electronics lectures to cover in more detail:
  - Breadboard usage and connections
  - Basic Op Amp functions including the "Golden Rules"

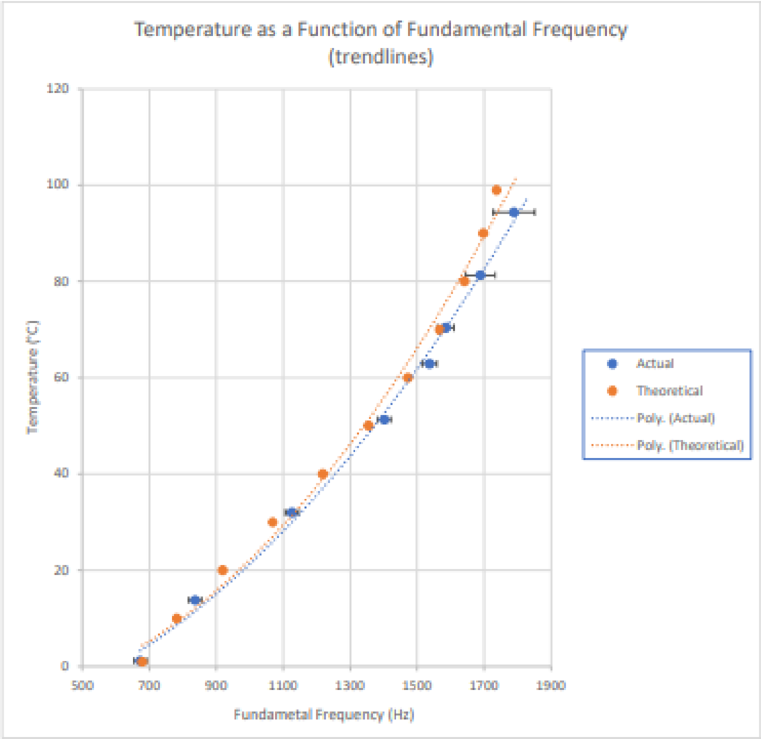
First Milestone: SkeeterSat

- Simple light and temperature sensor
- Beep rate and pitch encode data about ambient light and temperature conditions
- Students will:
  - Construct a simple sensor circuit
  - Perform calibration and analysis of the data collected
  - Document in a technical report

The SkeeterSat board.

SkeeterSat Calibration Report

- First foray into technical report writing
- Sample report available via SBC website
- Each student should independently write a report
- Recommend internal deadline of ~ 1 week before LaACES due date for faculty advisor review and feedback
- Report is due to LaACES Management Mid-October
- LaACES Management will review report

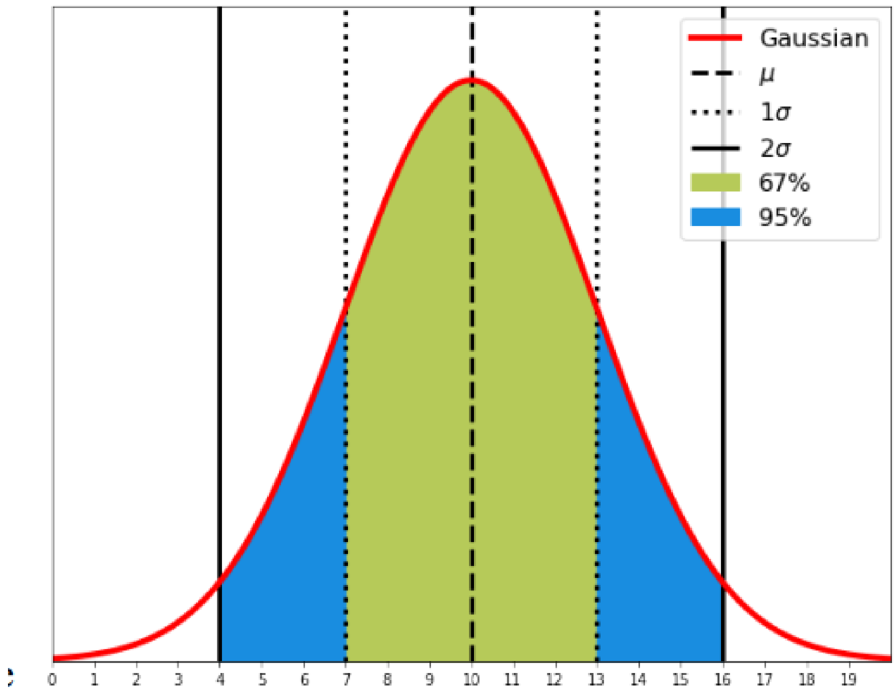


Graph 2 (above): Theoretical vs. Actual Data Points, depicted with the trendlines as 2nd degree polynomials. The actual results gave the function, T = (3*10^-5)f² + (0.0019)f - 12.367, while the theoretical results gave the function T = (4*10^-5)f² – (0.0112)f - 6.276.

Update 2024 SkeeterSat Report

- Covering error analysis during the SkeeterSat report was too much too soon

- The error lectures will remain available resource and reference but do not expect students to cover that in their reports

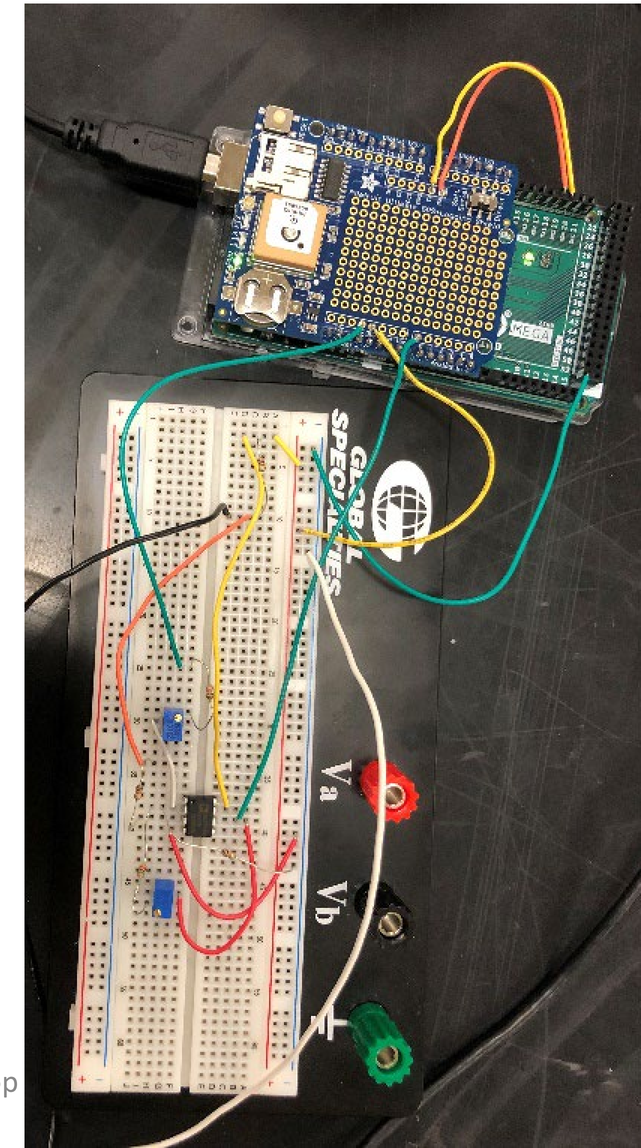


Remainder of Fall Semester

- Introduce Students to Arduino Mega and Arduino IDE
- Students will learn basics of Arduino interfaces
  - I2C, SPI, UART, ADC
- Reading GPS/NMEA strings
- Writing data to onboard storage (SD card)
- Basic Signal Conditioning Amplifying circuits

Fall Capstone Project

- Bring all the knowledge and skills together to build a benchtop "payload"
  - Simple diode temperature sensor with non-inverting op-amp
  - Mega and GPS shield interfaced to a breadboarded sensor circuit
- Calibrate sensors from Voltage->ADC Value-> Physical Units
- Time stamp data using GPS
- Write data packets to the SD Card



Capstone Report

- Build a timestamped datalogger that records real data
- Sample Report available on LaACES Website
- Advisors must review and provide feedback for revisions before submitting
- Due to LaACES Management by mid-December

FileNum	Data#	Time	Fix	Altitude	Date	Temp
5	0	1:01:33	Fix: 1	148.8	12/1/2021	25.71
5	1	1:01:38	Fix: 1	148.8	12/1/2021	25.71
5	2	1:01:44	Fix: 1	148.8	12/1/2021	25.71
5	3	1:01:49	Fix: 1	148.7	12/1/2021	25.71
5	4	1:01:54	Fix: 1	148.7	12/1/2021	25.71
5	5	1:01:59	Fix: 1	148.7	12/1/2021	25.44
5	6	1:02:04	Fix: 1	148.7	12/1/2021	25.44
5	7	1:02:09	Fix: 1	148.6	12/1/2021	25.44
5	8	1:02:14	Fix: 1	148.6	12/1/2021	25.44
5	9	1:02:19	Fix: 1	148.5	12/1/2021	25.44
5	10	1:02:24	Fix: 1	148.5	12/1/2021	25.44
5	11	1:02:29	Fix: 1	148.4	12/1/2021	25.71
5	12	1:02:34	Fix: 1	148.3	12/1/2021	25.44
5	13	1:02:39	Fix: 1	148.2	12/1/2021	25.44
5	14	1:02:44	Fix: 1	148.2	12/1/2021	25.71
5	15	1:02:49	Fix: 1	148.1	12/1/2021	25.16
5	16	1:02:54	Fix: 1	148	12/1/2021	25.16
5	17	1:02:59	Fix: 1	147.9	12/1/2021	25.16
5	18	1:03:05	Fix: 1	147.7	12/1/2021	25.16
5	19	1:03:10	Fix: 1	147.6	12/1/2021	25.16
5	20	1:03:15	Fix: 1	147.5	12/1/2021	25.16

DATA5

Image 8: The image above displays the format of the data written into

-As shown in Image 8, the data above was obtained after the GPS had a

the diode was in at that time was around 20.1 Celsius degrees.

Second Semester

- The second semester is focused on payload development
- Introduce students to:
  - Project management
  - Payload development cycle
  - Surface mount soldering
- Three major design review deliverables
  - PDR, CDR, FRR Documents

Outline of 2nd Semester Tasks

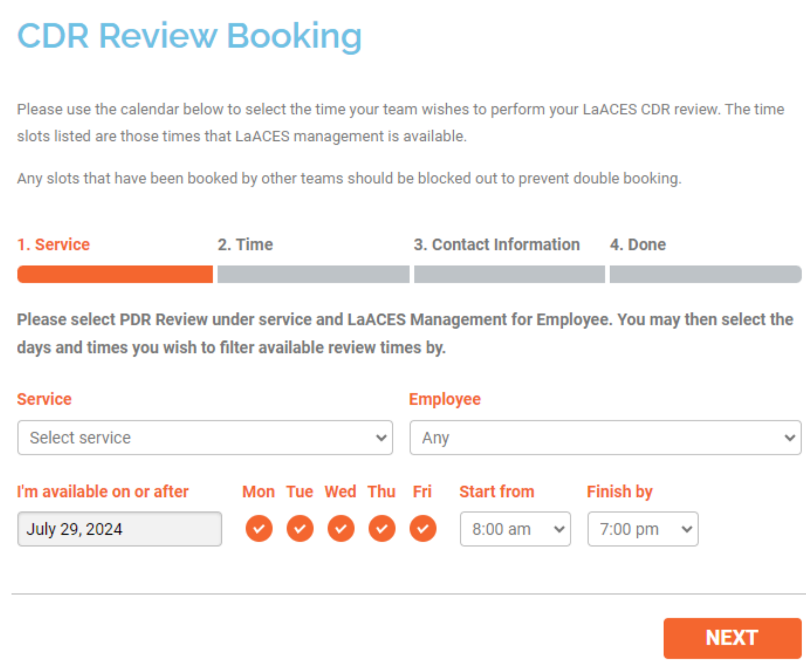
- Students must begin working in teams during payload development
  - Discuss and guide development of the “Team Contract”
  - Want team to define roles clearly and early
- Project Management Unit:
  - Project Structure and Cycle, Requirements, System Design, Tasks and Scheduling, Flowcharts, Risk Management
- Payload Development, Design, and Testing
  - After initial set of project management lectures and teams proceed with payload development
- Thermal Vacuum System Testing at LSU
- Payload design culminates in Flight Readiness Review presentation to be conducted during the flight week

Project Management

- Final set of lectures covered in January to cover the design cycle and project management
- These lectures introduce the basics of project management
  - Writing requirements
  - Generating tasks, timelines, schedules
  - Defining interfaces between systems
  - Design Review cycle of PDR, CDR, FRR

Review Feedback Sessions

- For PDR and CDR would like to continue the online reviews we had from the solar eclipse to give teams feedback earlier
- Will set up scheduler so teams can set up a 30-minute appointment Wednesday-Friday the week after the reviews are due



The Project Reviews

- Modelled on NASA mission review cycle
  - Get students to think about design starting from the science question (requirements)
- Three major reviews
  - Preliminary Design Review (PDR)
  - Critical Design Review (CDR)
  - Flight Readiness Review (FRR)
- We strongly recommend a Pre-PDR and Pre-CDR at your institution to divide the reviews into more manageable sections
- Each review adds on to the previous
- Templates are provided for all review documents

Read carefully all instructions contained within the template!

LaACES at LSU

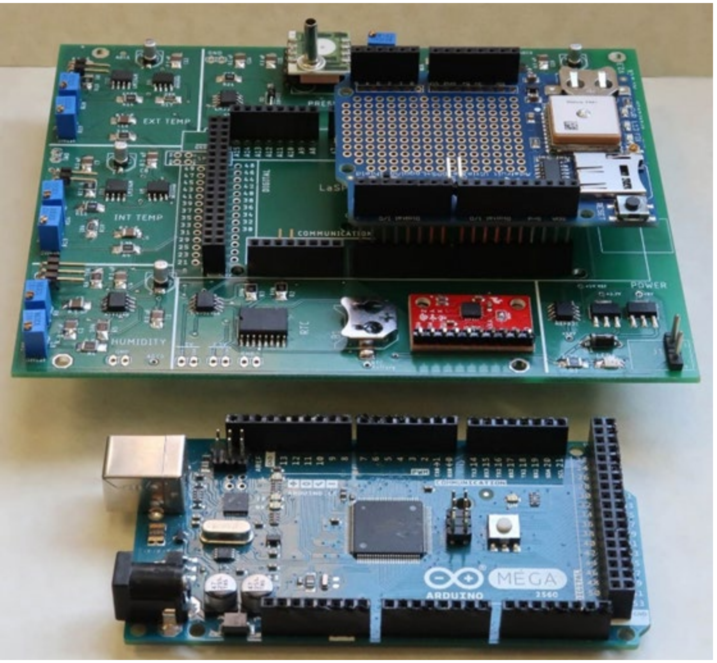
+ LaACES Information for LSU Students

Document Templates

- Pre-Preliminary Design Review Document Template
- Preliminary Design Review Document Template
- Pre-Critical Design Review Document Template
- Critical Design Review Document Template
- Flight Readiness Review Document Template
- LaACES Security Clearance Template

LaACES Instructor Workshop Presentations

LaACES MegaSat Core



LaACES MegaSat payload stack including Arduino Mega and GPS Logger shield

- Core of the payload will be the LaACES MegaSat to be completed by all groups
- Provides baseline sensors, GPS, data storage, and power interface
- Construction of MegaSat shield is done in parallel with other required activities
  - Involves SMT soldering of components
- New teams should use MegaSat as the core of a payload but may expand upon it
  - Existing systems should be included and discussed in design reviews
  - Appropriately allocate the time needed to construct the MegaSat shield

Payload Design, Structure, and Assembly

- Payload design lectures are in Part II, Units 27 through 30 provide reference for the construction and design of a payload
- Unit 27 Electronic Assembly Techniques
  - Surface mount soldering activities
  - Assembly manual for MegaSAT kit
- Provide useful reference materials
  - Building foam payload boxes
  - Determining power budgets
  - Thermal budget calculations

Thermal-Vac Testing at LSU

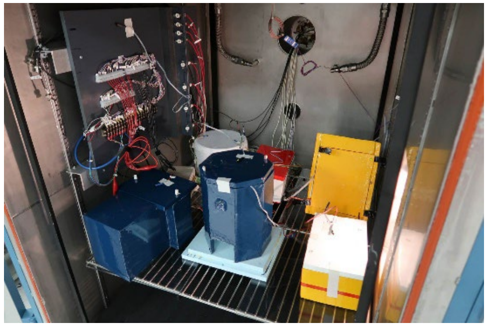
- Teams are strongly encouraged to travel to LSU for testing
- Teams should arrive at LSU with payload flight-ready and be placed in the chamber with minimal assembly
- ~4-hour test hot and cold vacuum cycles
- Post Test – Teams will present either results or failure analysis
- Teams unable to travel to LSU in person should plan to present results of preflight testing virtually via Zoom

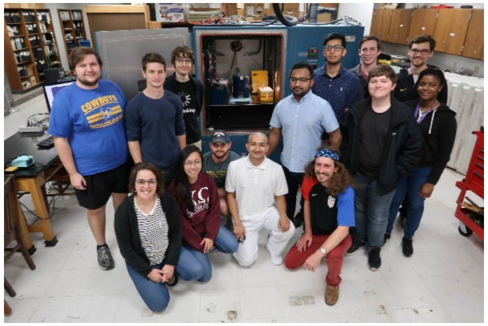
Recommended Payload Testing

- Testing before T/V will make it more likely to have payload operate successfully
- Home freezer or dry ice testing
- Bell Jar or “Pressure Cooker” vacuum testing at home institution
  - NSU recommended vacuum chamber
  - AutoGEN 5 Amazon
  - PBAuto 5 Gallon
- Extended time ground payload testing, i.e. let it run and collect data for several hours
- Physical Drop/Shake testing

Thermal / Vacuum System Test

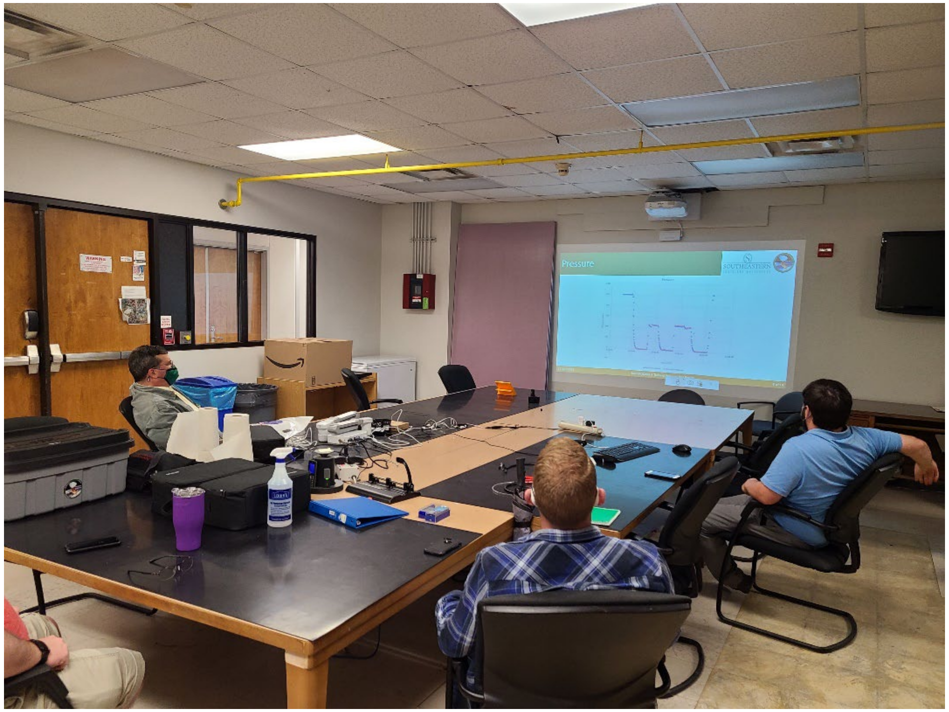
- Use LSU thermal / vacuum (T/V) chamber to simulate the extremes of balloon flight
- Preferred to attend T/V in person but may deliver the payload to LSU via post or physical drop off/pickup
- All payloads are be flight ready and configured for flight.
- Teams should plan to be at LSU by 9:00 am
- Simulated flight profile from -50ºC to +50ºC and altitude to 110,000 ft
- Timestamped independent temperature available





Post Test Presentations

- Teams should be prepared to give 10 min presentation of performance after the test
- ~2 hour for data analysis so teams should have presentation and analysis software ready to drop in the data
- Should identify any corrective actions to be taken in case of failure
- Teams unable to travel to LSU should remotely present their “equivalent testing” results
- Can accommodate remote participation in post-test presentations



LaACES Hardware Kits

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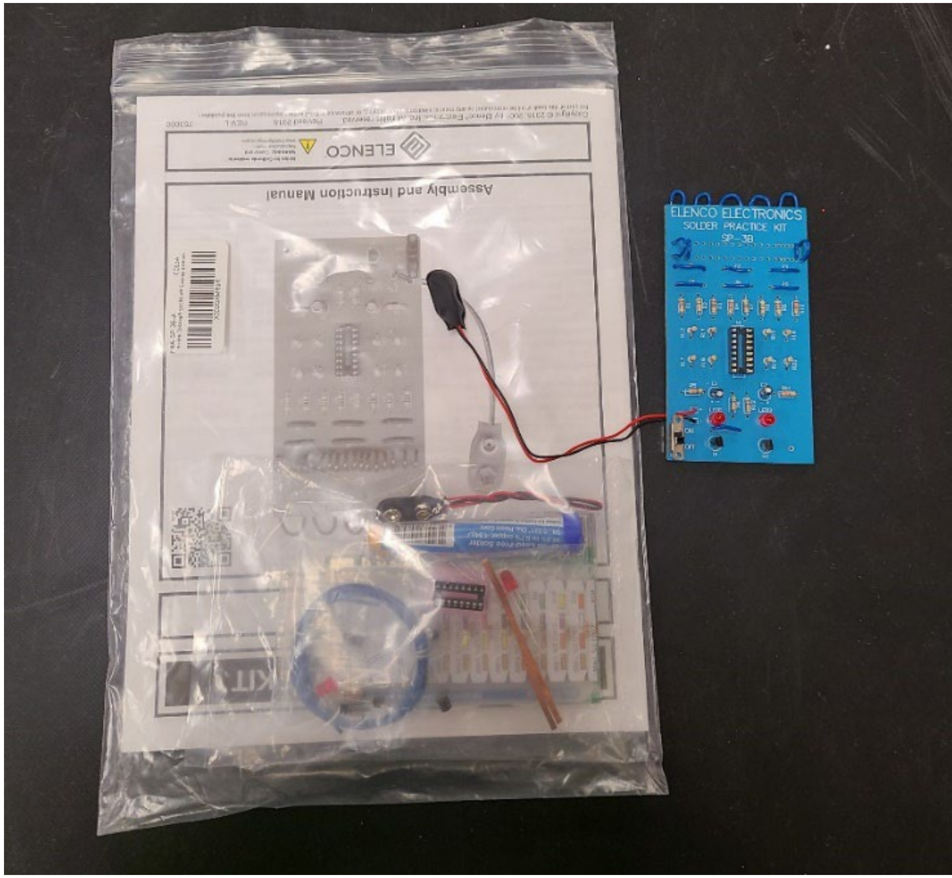
7 Sets of Hardware Kits

Kit	Used By	When Used	Re-usable
Through-hole Solder Practice Kit	Individual Student	Fall Semester	No
SkeeterSat Kit	Individual Student	Fall Semester	No
Arduino Mega	Individual Student	Fall Semester	Yes
Adafruit GPS	Individual Student	Fall Semester	Yes
Activities Kit	Individual Student	Fall	No
Surface Mount Practice Kit	Individual Student	Spring	Yes
MegaSat Kit	Student Team	Spring	No

Through-hole Solder Practice

- Through-hole kit will be covered at the beginning of the Fall semester
- Practice on ICs, passive and active components, and creating bridges and jumpers of various sizes
- Step-by-step instructions
- Is a working circuit when completed
- Comes with lead-free solder
  - Do not recommend using included solder



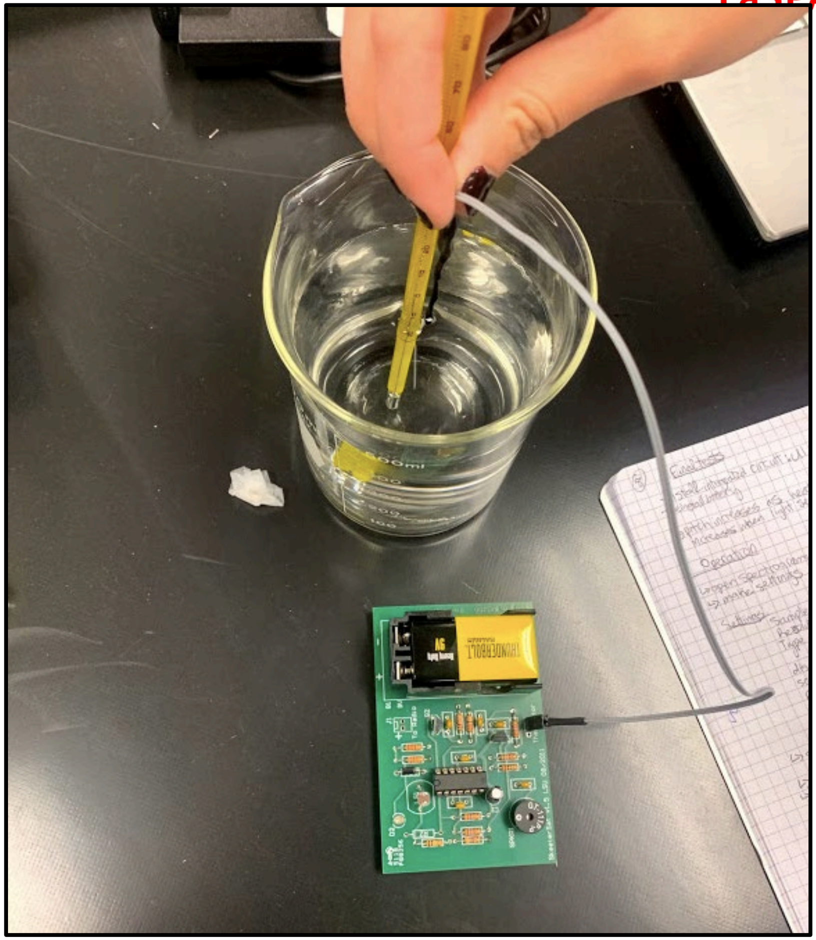
SkeeterSat Kit

- First working circuit that students will build in the course
- Simple 556 Timer based circuit
- Takes 2 inputs (Temperature via Thermistor and Light via Photoresistor)
- Generates an output signal (Tone produced by piezo buzzer) students will calibrate
  - Frequency controlled by RTD resistance
- Note: Teams will need to provide the 9V
  - Multiple students can share a battery

An assembled SkeeterSat

SkeeterSat Outcomes

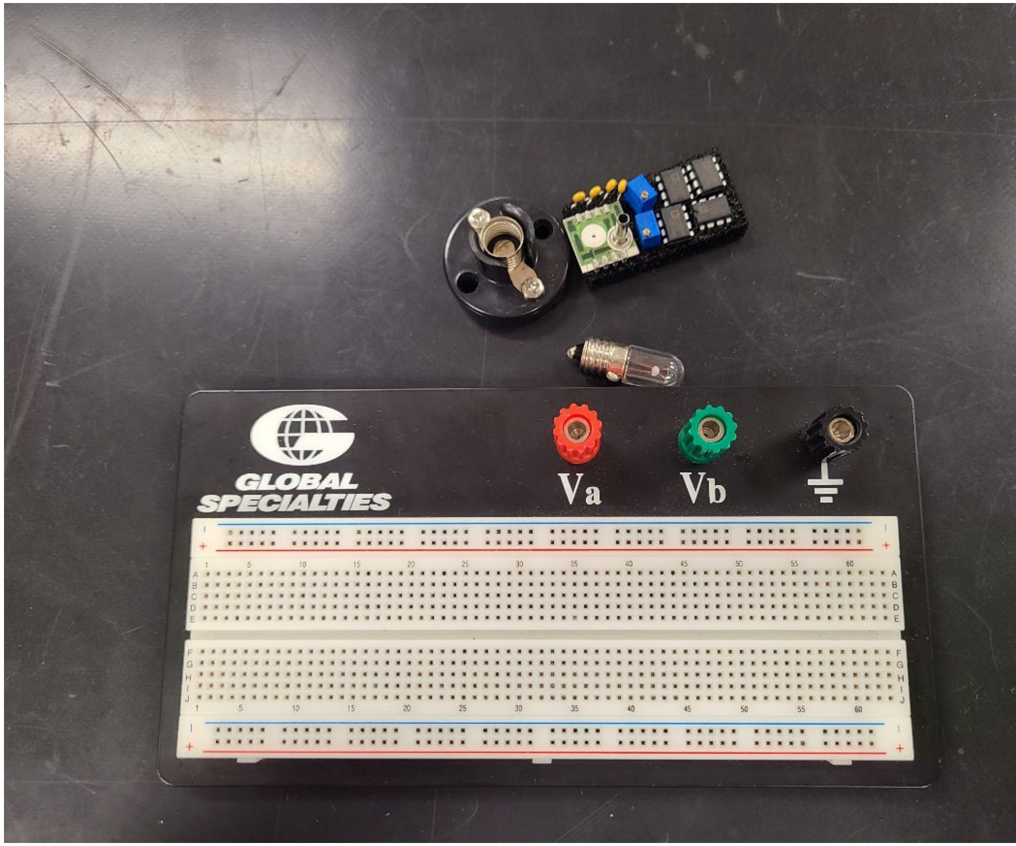
- First full “sensor” students build from start to finish
  - Identify components
  - Read a schematic and datasheets
  - Use an assembly manual
  - Solder a working circuit
  - Troubleshoot a circuit
  - Perform Sensor Calibration
  - Writing a technical reports



Student performing SkeeterSat calibration

Activities Kits

- Assorted resistors, LEDs, switches, etc.
- Provides the parts needed to complete the hands-on activities during the fall semester
- Students will also need access to an Arduino, GPS shield and computer with IDE to complete programming activities
- Teams will need to provide breadboard and jumper wires to complete activities



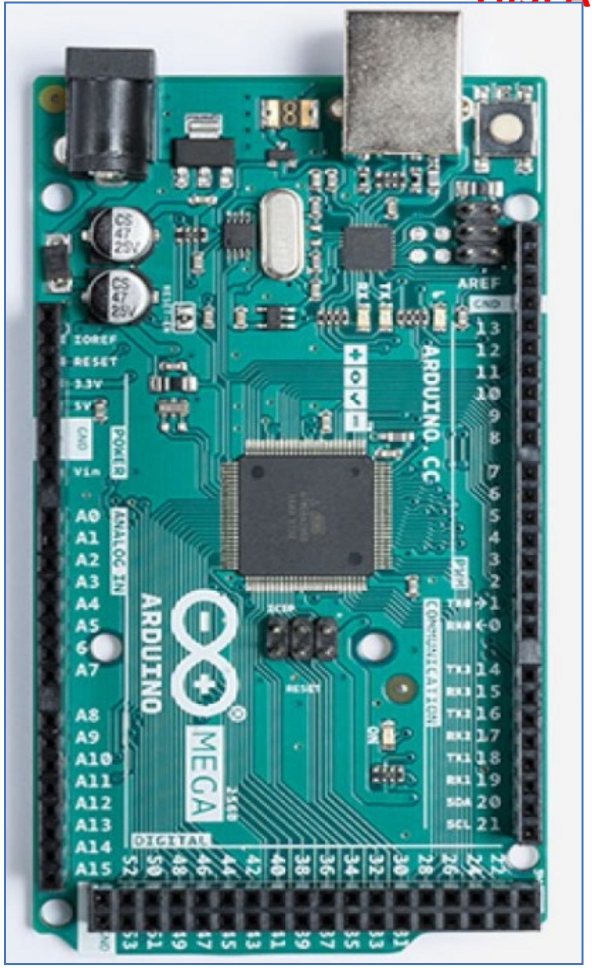
Small selection of materials that will be used during the Fall Activities

Activities Kit Changes 2024

- Replaced old AD820 Op Amp with less expensive TLV271IP
  - Should be drop-in replacement

Arduino Mega2560

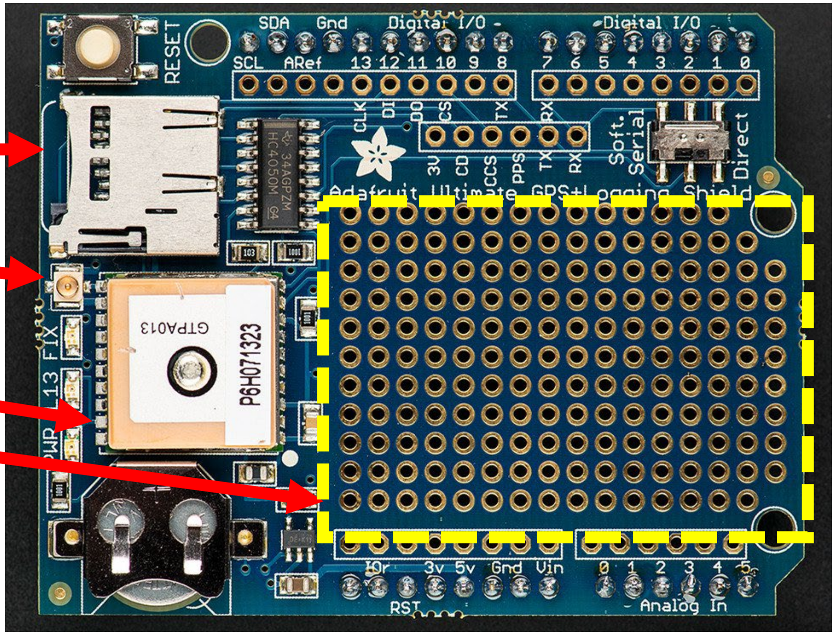
- ATmega2560 Microcontroller
- Operates 5V Logic
- SPI, I2C, 4xUART Digital I/O
- 16 Channel 0-5V 10- bit ADC
- Arduino header pins allow for “stack” of additional boards
- Good selection of shields and active supported libraries



Arduino Mega Development Board

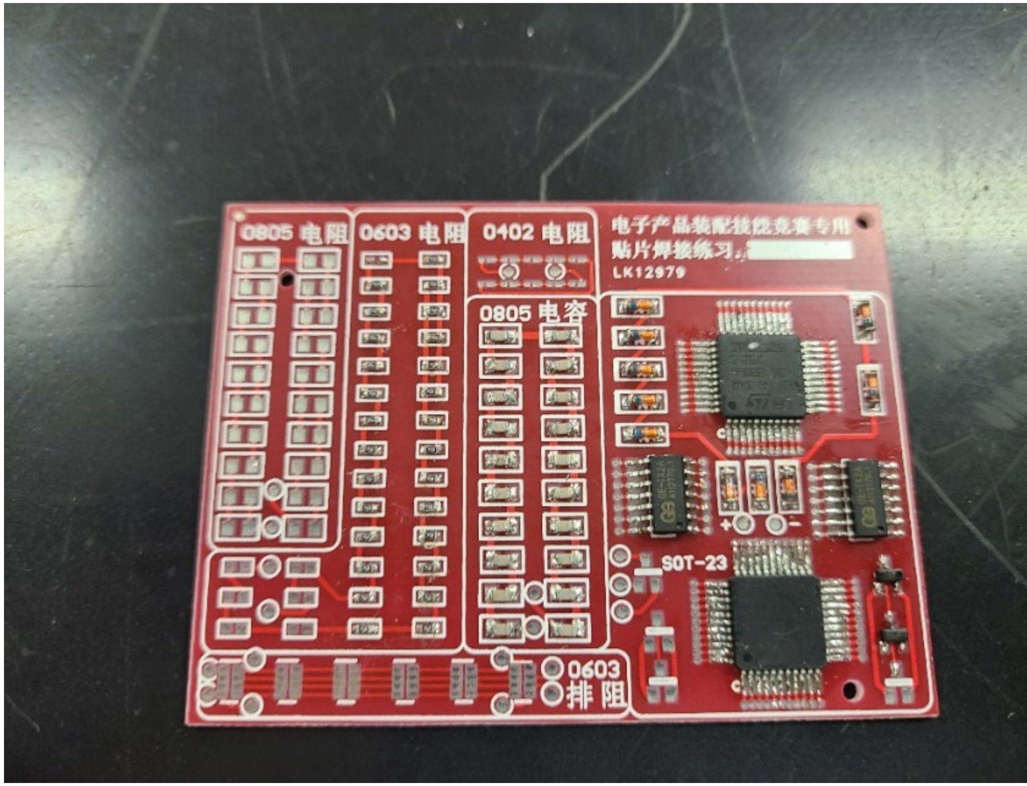
Adafruit Ultimate GPS Logger Shield

- This is the Arduino Ultimate GPS Logger Shield. Provides GPS data and data storage.
  - MicroSD Card socket
  - Connector for external antenna
  - GPS unit
  - Prototyping Area
- All input, output and commanding is via **plain text** UART serial interface.
- Will provide 32 GB SD card in requested quantities.



Surface Mount Solder Practice

- 2 Separate Kits for students to build soldering skills prior to soldering on projects
- Through-hole kit will be covered at beginning of Fall semester
- Surface Mount (SMT) covered in Spring Semester
- All soldering can be completed with standard soldering iron and solder; no paste, oven, or hot air gun needed
- However, a hot air solder station/solder oven could be used for the SMT Kit and MegaSAT

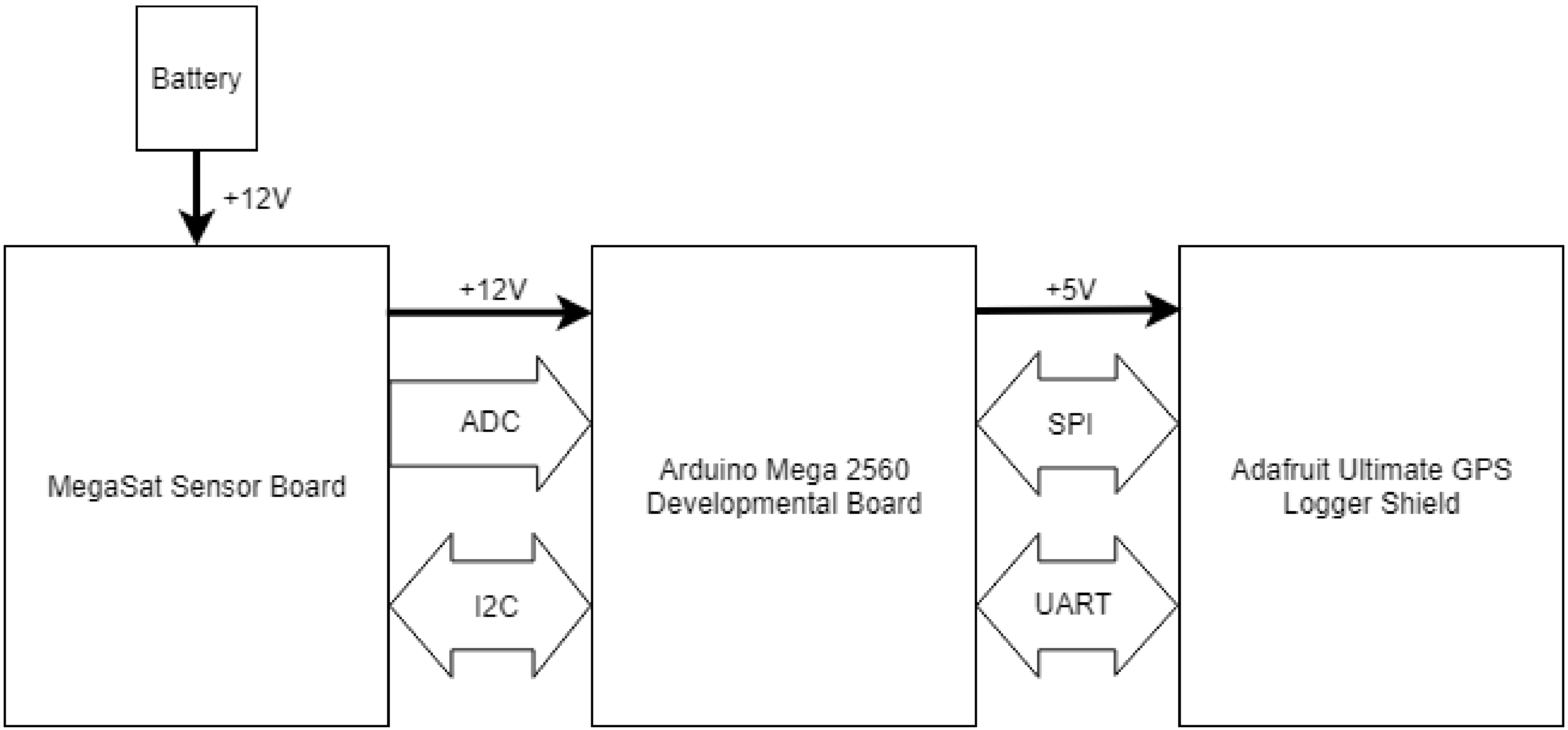


What is the MegaSat?

- Baseline payload for new student teams
- Flight stack of:
  - Arduino Mega
  - Custom Sensor Board (MegaShield)
  - GPS Logger Shield

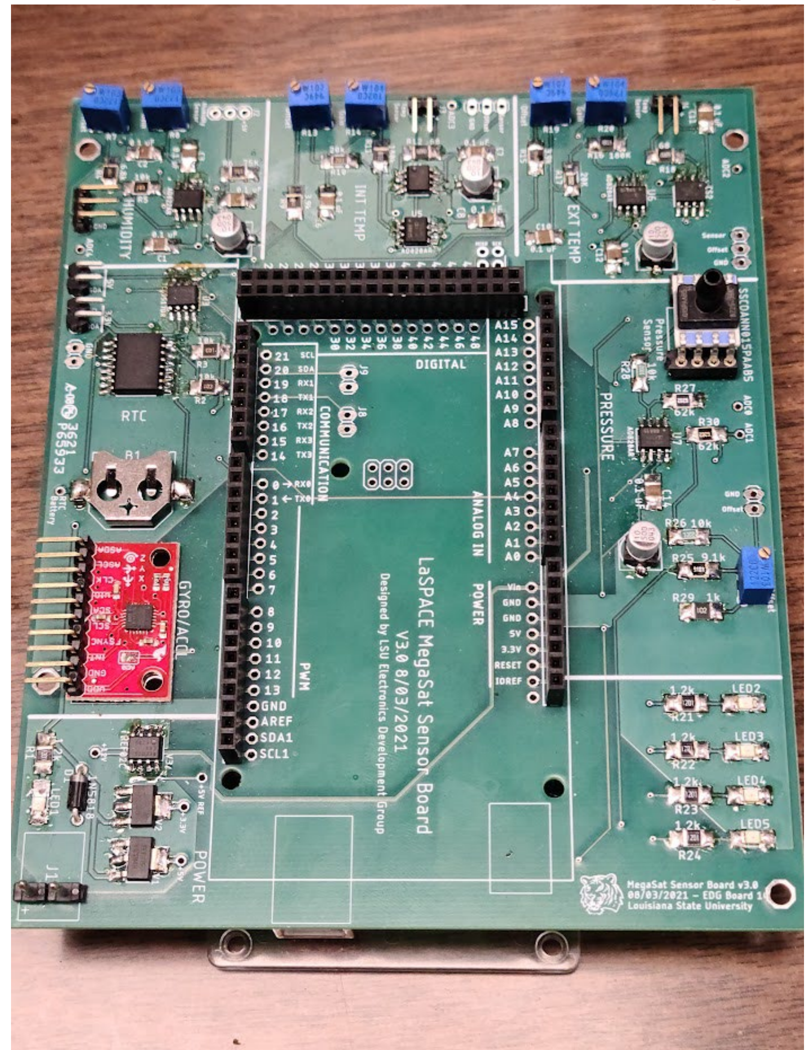
- New teams are recommended to implement the MegaSat and then expand with additional sensors
  - A “simple” atmospheric sensor using the built-in sensors is an acceptable payload

Major Components
MegaSat Payload



MegaSat Shield (MegaShield)

- Baseline Sensor Suite
  - Arduino Mega Interface
  - Real Time Clock
  - Gyroscope / Accelerometer
  - Pressure, Temperature, and humidity sensor
- Provides power connection for the stack (Arduino, GPS, Etc.)
- 4 Diagnostic LEDs for Team Usage
- Recommended supply voltage is 12V but will operate properly at 9V (Does include bias protection)



Expanding the MegaSAT

- 11 unused analog inputs available for team usage
  - 2x Temperatures, Humidity, High and Low Pressure use analog
- 5V and 3.3V I2C bus
  - Addresses 0x68 and 0x69 are used by IMU and RTC
- 2 of 4 5V UART are available
  - GPS Uses Serial1 (TX/RX1)
  - TX/RX0 Can be used but are also connected to the USB so can lead to issues

Changes for 2024-2025

- Replaced difficult to solder capacitor
- Added GPS Jumpers to eliminate the requirement for wired jumpers
- Added connections to hardware SPI pins to allow for faster SD card libraries to be used

Future Changes (Potentially this year)

- Want to make Mini-MegaSAT designed at NSU available to all teams
- Old IMU is no longer manufactured
  - Intend to replace with QWIIC interface to allow multiple I2C devices to be easily added to MegaSAT
- Humidity Sensor is nearly $100
  - Difficult to calibrate and not often used
  - Intend to replace with environmental sensor and modify the amplifying circuit to allow for generic input analog voltage sensor
- Have stock of both sensors so can provide to teams for this year

Closing Remarks and Open Discussion

Follow-up Actions

- Send an updated estimate on student/team count for shipping kits
- Determine availability for monthly instructor meeting
- Aaron Ryan will send a follow-up e-mail requesting this information

Recommendations

- Recommendations or suggestions from previous participants?

Questions

- Questions from any of the advisors?