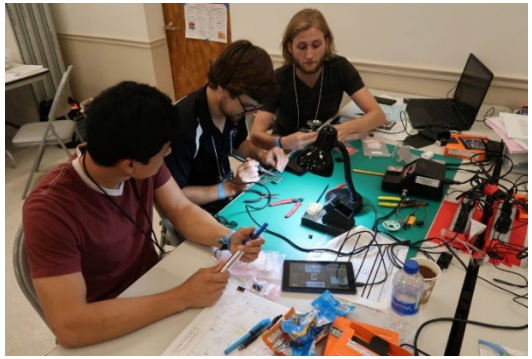
Second Semester of the 2021-2022 LaACES Program

Objectives for 2nd Semester

- Goal:
  - "To inspire students to continue towards STEM related careers"
- Objectives:
- Provide students with an authentic flight project experience not normally available through the classroom
- Develop student skills in electronics, real-time programming, communication, and project management
- Guide students to work in teams and to use acquired knowledge to create a science payload for balloon flight
- Students communicate their progress through required documents and presentations on a milestone schedule
- Conduct annual flight operations where approved student team payloads are flown on a latex sounding balloon to an altitude of ~100,000 feet or the very "edge of space"



Outline of 2nd Semester Tasks

- Guide students toward a realistic payload based upon the MegaSat stack
  - Provide choice of different options
  - Fabrication and use of the MegaSat
- Students must be working in a team during payload development
  - Discuss and guide development of the “Team Contract”
- Project Management Unit:
  - Introduction, Requirements, System Design, Tasks and Scheduling, Flowcharts, Risk Management
- Payload Design Unit:
  - Mechanical Drawings, Fabrication, Materials, Power Systems
- Payload Design, Development, Fabrication, Calibration, System Testing
  - Preliminary Design Review and Critical Design Review milestones and deliverables
- Thermal Vacuum System Testing at LSU
- Flight Readiness Review milestone and deliverable

Balloon Payload Requirements

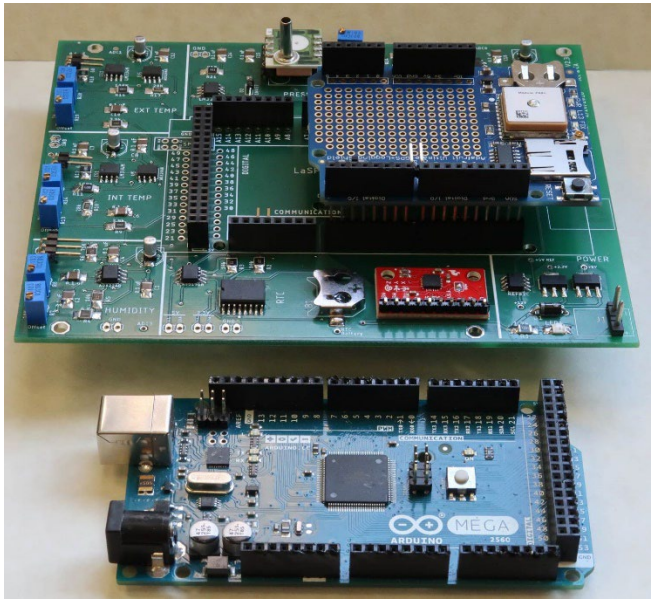
- Limited to about 500 grams weight
- Roughly a polygonal prism with 15 cm to 20 cm long sides
- Mechanical structure constructed from ¾” polystyrene foam
- Vehicle interface is a pair of strings, separated by ~17 cm, that pass through the payload unbroken and secured with spring clips.

Payload mechanical interface

- Needs to conduct science or technology experiment
- Designed, built, tested and shown to be fully “space worthy” by May 2022.
  - Need to successfully complete three major design reviews and T/V system test.
- 48 hours after flight the team will need to have calibrated science results from the flight and present results to an audience of professional scientists and engineers.

LaACES MegaSat Core

- The core of the payload will be the LaACES MegaSat that includes
  - Two temperature sensors, one humidity sensor, one pressure sensor, 3-axis accelerometer, 3-axis gyroscope, and a real-time clock with backup battery
- Payload controller will be the Arduino Mega.
- Will have the Adafruit Ultimate GPS Logger shield for GPS data throughout the flight and recording NMEA data on a SD card.



LaACES MegaSat payload stack

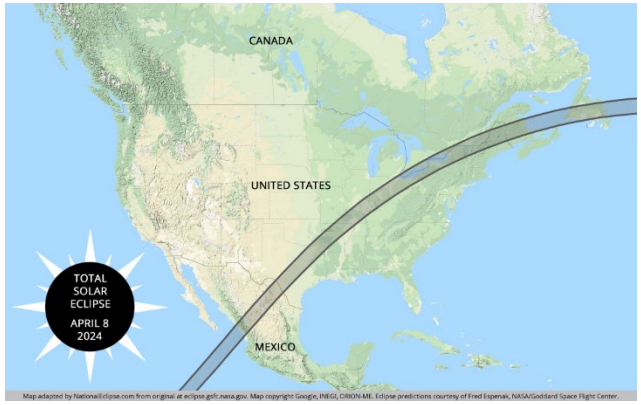
- The prototype area on the Adafruit GPS shield or a separate proto-shield board can be used to interface with other sensors.
- Construction of MegaSat shield is done in parallel with other required activities
- The team will need to include in planning
  - The components that will be part of the payload
  - Time needed to construct the MegaSat shield
  - How to interface additional sensors to the Mega

Suggested possible science topics

- Radiation Intensity as a function of altitude
- Measure intensity of UV bands as function of altitude to deduce properties of ozone layer
- Directly measure concentration of O3, NOx, COx gases as a function of altitude using solid state sensors
- Develop a system to measure air flow (e.g. hot wire anemometer) at high altitudes (i.e. very low pressure).
- Investigate methods to optimize atmospheric temperature measurements
- Investigate thermal flow and conductivity of boundary layer around payload
- Develop an inertial sensing system which will provide sub-minute of arc orientation knowledge
- Additional details for suggested ideas can be found in L18.01

Upcoming Solar Eclipse Ballooning Opportunities

- As we did for the 2017 solar eclipse, we will also hold a competition during LaACES 2022-2023 for "solar eclipse" student payloads
  - Payload science objective determined by the individual science team
  - Selected teams will be awarded a seat on LASPACE Balloon flights during the Solar Eclipses
  - October 14, 2023 annular solar eclipse launch
  - April 8, 2024 Total solar eclipse launch
  - Details for the upcoming solar eclipse competition will be released at a later date
- LaSPACE selected as an Engineering POD lead for select teams for the National Eclipse Ballooning Project - https://eclipse.montana.edu/
  - Applications are scheduled to be released in late 2022.
  - 2 science track for NEBP balloons
    - Atmospheric Science track
    - Engineering Science track



Payload Development Requires Team Cohesion

- The activity for the Project Management unit is to have each team produce their own "Team Contract"
  - Students need to identify and write down their "rules of engagement" for how they will operate as a project team
  - The Team Contract should include items such as meeting schedule, document management, roles, task management, as well as joining and leaving a team
- The institution faculty advisor will lead this effort
- These Team Contracts are not a LaACES deliverable
- However, teams that do not spend sufficient time determining, and writing down, how to operate as a group tend to have a high probability of failure

Payload Development Requires Management

- Project Management lectures and materials are in Part II, Units 21 through 26
  - https://laspace.lsu.edu/laaces/student-balloon-course/
- These lectures and materials include the following:
  - Lecture 21.01: Management, Life Cycle, Documentation
  - Lecture 22.01: Requirements Module - The Basics
  - Lecture 22.02: Requirements Module - Writing Requirements
  - Lecture 22.03: Requirements Module – Change Management
  - Lecture 23.01: System Design
  - Lecture 23.02: Producing a System Design Drawing
  - Lecture 24.01: Defining the Project Tasks, Costs & Schedule
  - Lecture 24.03: The Project Schedule
  - Lecture 24.02: Working with MS Project
  - Lecture 25.01: Basics of Flowcharts
  - Lecture 26.01: Risk and Risk Management

Payload Structure and Design

- Payload design lectures are in Part II, Units 27 through 30
  - https://laspace.lsu.edu/laaces/student-balloon-course/
- Units 27 and 28 are concerned with fabrication, testing, and use of the MegaSat
- Other payload lectures and materials available for reference (These will not be covered in a formal session)
  - Lecture 29.01: LaACES Balloon Vehicle and Flight Profile
  - Lecture 29.02: Mechanical Design Guidelines
  - Lecture 29.03: Payload Construction Consideration & Techniques
  - Lecture 29.04: Constructing an ACES cube payload
  - Lecture 29.05: Constructing an ACES octagon payload
  - Activity 29.01: Constructing a Structure with XPS foam
  - Lecture 30.01: Simple Power Systems
  - Lecture 30.02: Batteries and Battery Packs
  - Activity 30.01: Power Systems and Budgets

The Project Reviews

- There are at least three major reviews during a project
  - Preliminary Design Review (PDR)
  - Critical Design Review (CDR)
  - Flight Readiness Review (FRR)
- You should also include a Pre-PDR and Pre-CDR review at your institution to divide the reviews into more manageable sections
- Each review has a somewhat different objective and emphasis and provides a check on project progress for all stakeholders
- Templates are provided for all review documents. Read all instructions contained within the template carefully!
- Required deliverables to LaACES Management are written documents for the PDR, CDR, and FRR
  - These documents must be fully vetted by the institution faculty advisor(s)
- The required documents will be rated as Pass / Fail. A "Fail" on any document means the team will very likely not fly

The Project Reviews Document Templates

- The templates provide a sequence of payload documentation from the initial organization and justification to the final defense of the payload flight worthiness
- Each template ADDs to the previous template so it is important for a student team to fully complete one document before moving on to the next.
  - Pre-Preliminary Design Review (Pre-PDR) template
  - Preliminary Design Review template (PDR)
  - Pre-Critical Design Review (Pre-CDR) template
  - Critical Design Review (CDR) template
  - Flight Readiness Review (FRR) template
- These templates can be found on the LaACES Document Center at https://laspace.lsu.edu/laaces/laaces-document-center/
- Will talk about these reviews and expectations in the Project Management overview lecture.

Milestone Schedule for LaACES 2021-2022

	Recommended Deadline	LaSPACE Deadline
PDR	February 11, 2022	February 18, 2022
CDR	April 1, 2022	April 8, 2022
Thermal / Vacuum Test (at LSU)		April 22, 2022
FRR	April 29, 2022	May 6, 2022
LaACES Launch Trip		May 15, 2022 – May 20, 2022
FRR Defense Presentation (at CSBF)		May 16, 2022