Space Science Program Around Communication Engineering with High Achieving Undergraduate Cadres (SPACE HAUC): UMass Lowell's CubeSat mission

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University of Massachusetts, Lowell

7th Nano satellite Symposium,
Kamchia, 2016

University of Massachusetts Lowell

Outline

- An Introduction to UMass Lowell and the group
- The USIP program
- SPACE HAUC

UMass Lowell Overview

- 17,000 students
  - Enrollments increased by 47% since 2007
  - SAT scores increased 79 points since 2008
  - Retention and Graduation rates improved

- More than 120 undergraduate, 39 masters and 33 doctoral degree programs in 6 colleges
- 1000+ faculty
- $63M+ in research expenditures
- Urban campus with polytechnic focus

New Models for Industry-University-Government Partnerships

Co-location catalyzes innovation, strengthens cluster development, and enhances workforce development

HEROES
UMass Lowell/NSRDEC
HARNESSING EMERGING RESEARCH OPPORTUNITIES TO EMPOWER SOLDIERS

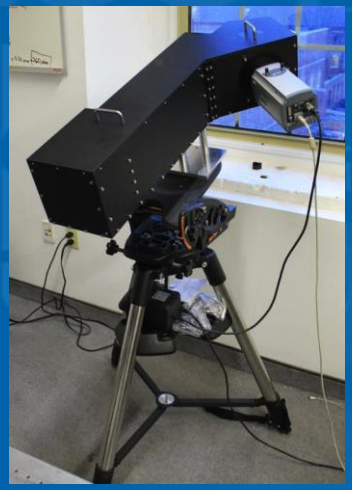
NERVE CENTER
@ UMASS LOWELL

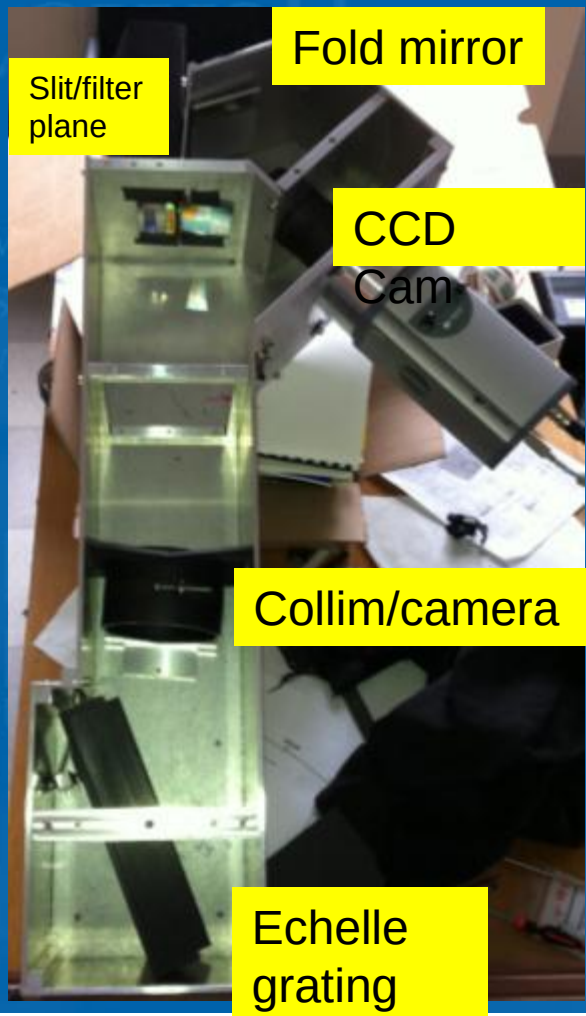
Raytheon

LoCSST: Objectives

- Train next generation of space scientists, technologists, teachers, business leaders and policy makers
- Involve industry partners in curriculum, research and proposals/business development
- Provide a home for space science and technology research activities on UMass Lowell campus

We are toolmakers





A full-waveform lidar for quantitatively assessing forest structure, sequestered carbon

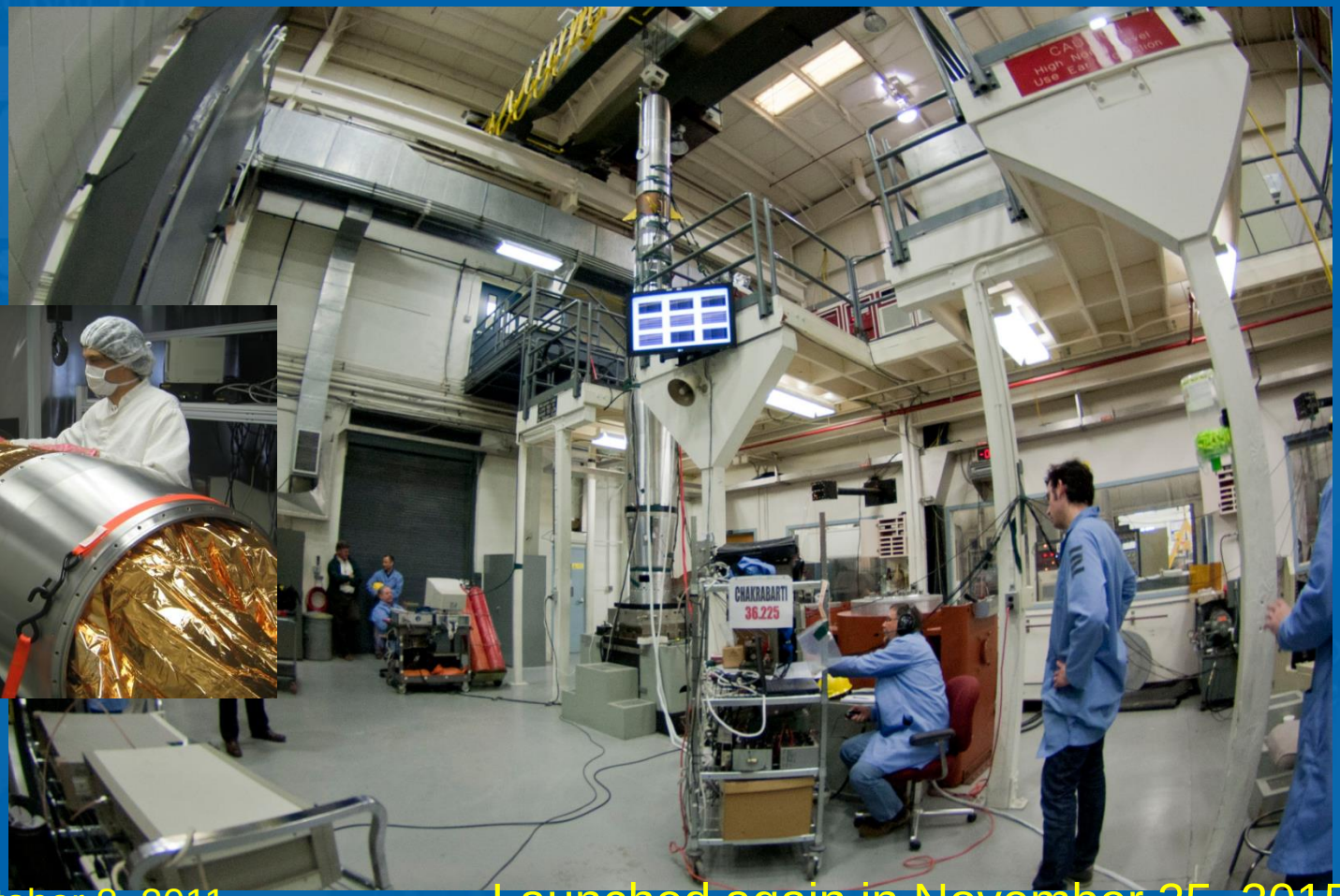
A high-resolution echelle spectrometer for round-the-clock space-weather studies

We observe from balloons

Pictures of Balloon flight from Hyderabad in 2010

Two new flights coming up in 2017 and 2019

PICTURE rocket: Direct Imaging of Exoplanet environment



Launched October 8, 2011
Demonstrated 5 milli-asec pointing

Launched again in November 25, 2015
Demonstrated 3 milli-asec pointing

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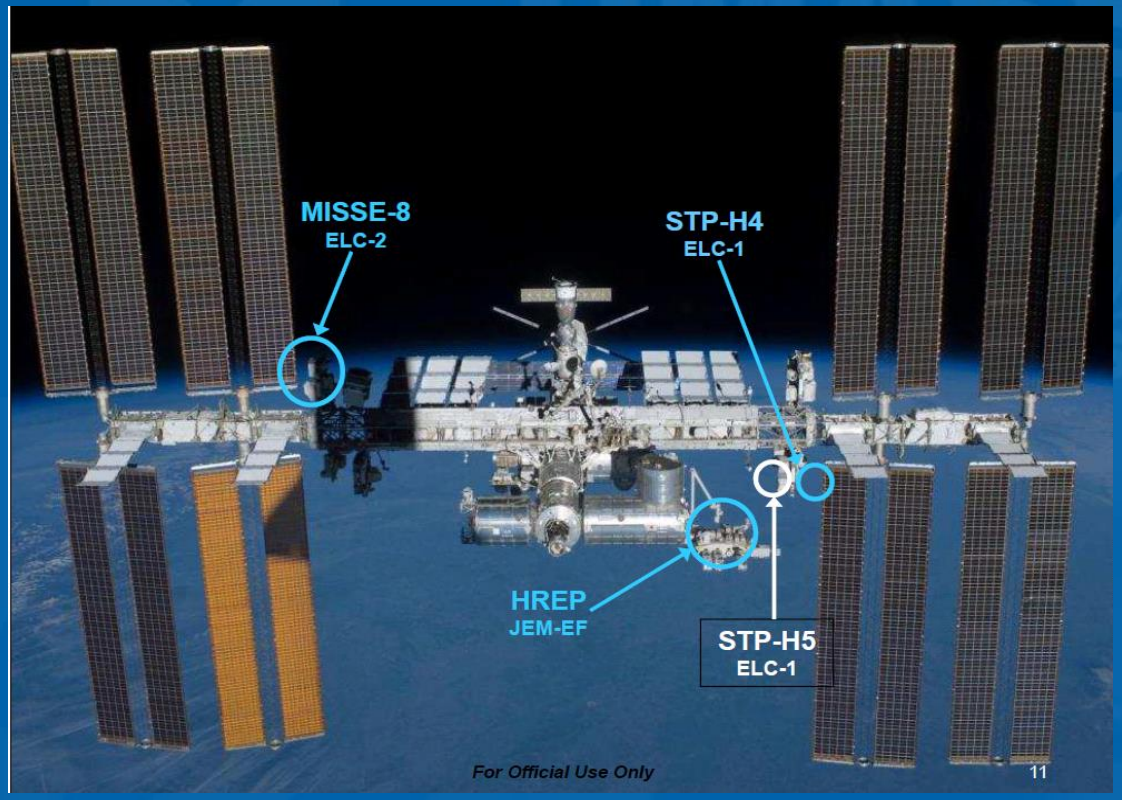
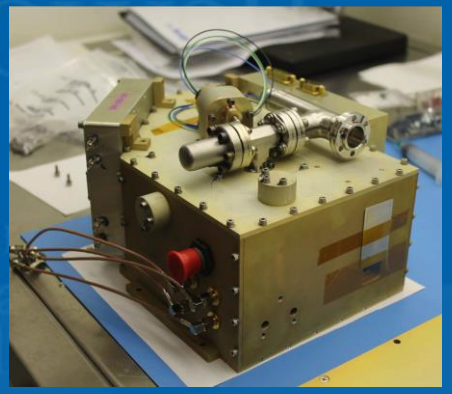
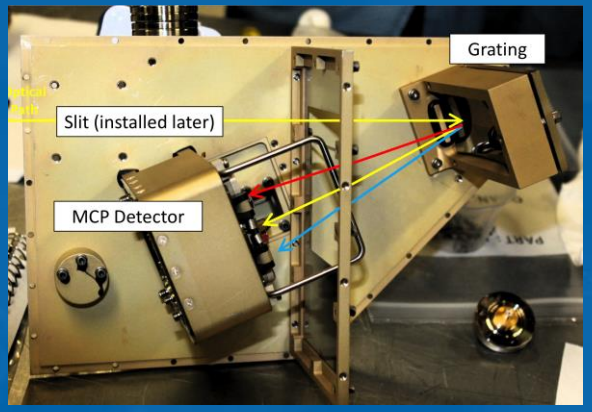
Our LITES instrument flies aboard the ISS in early 2017







LITES: **L**imb-imaging **I**onospheric and **T**hermospheric **E**xtreme ultraviolet **S**pectrograph

And now….

SCIENCE PROGRAM AROUND COMMUNICATION ENGINEERING WITH HIGH ACHIEVING UNDERGRADUATE CADRES (SPACE HAUC)

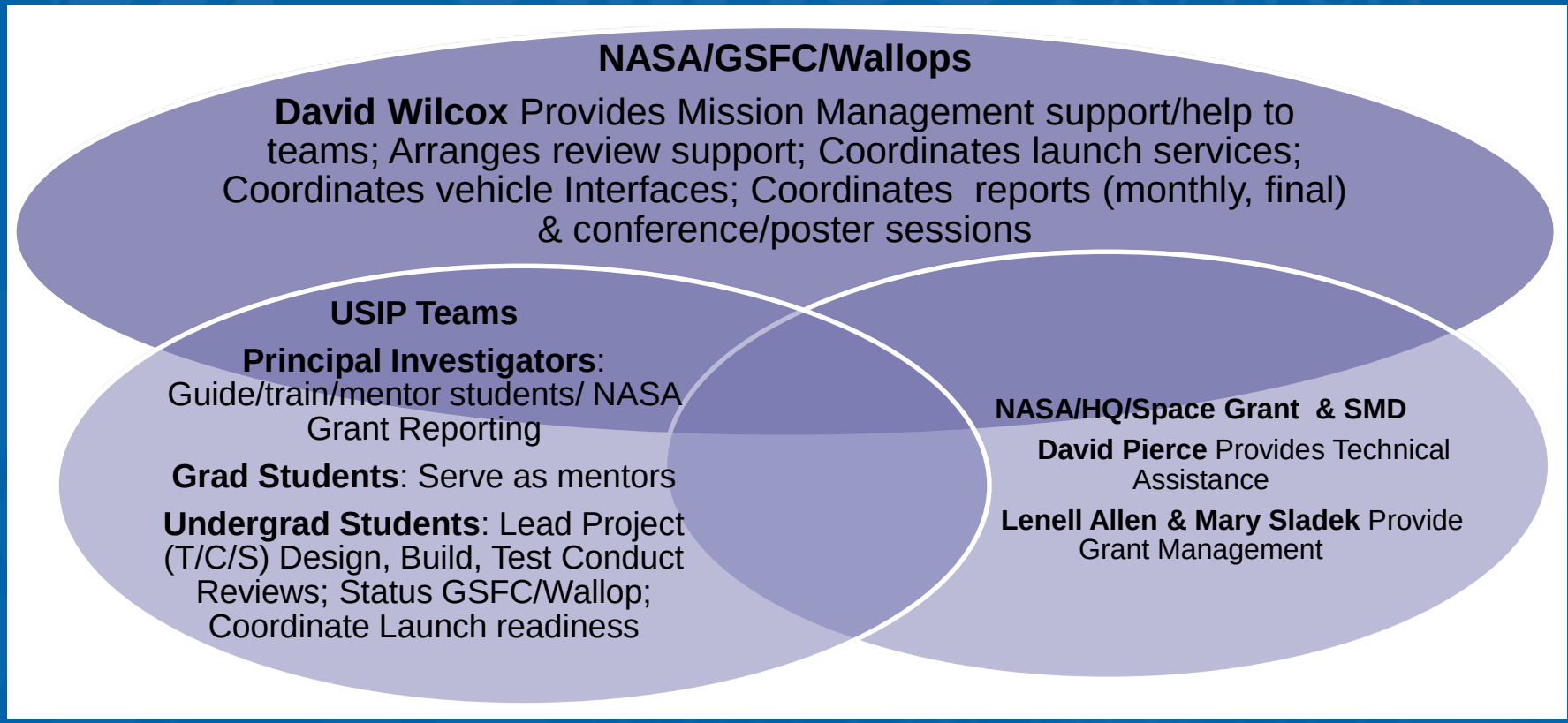
Undergraduate Student Instrumentation Project (USIP)

USIP Project Goals

The two goals of this USIP SFRO are:

- To provide a hands-on flight project experience to enhance the science, technical, leadership, and project skills for the selected undergraduate student team.
- To fly a science and/or technology investigation relevant to NASA strategic goals and objectives on a suborbital-class platform.

Organizational relationship



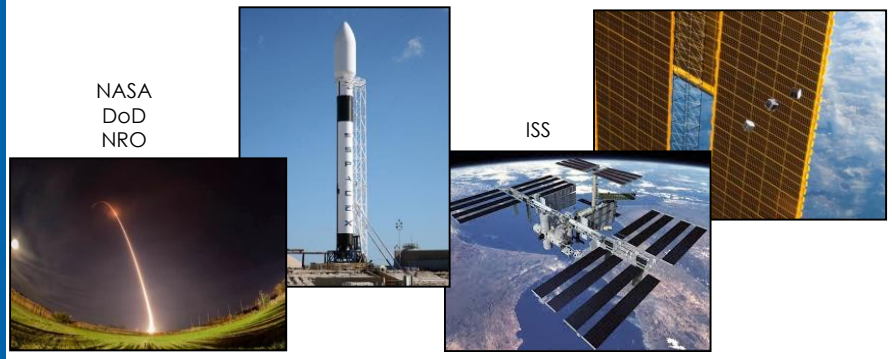
NASA will provide launch services for USIP through CSLI

CSLI and USIP

- The NASA CubeSat Launch Initiative (CSLI) will be the means of providing all 23 USIP Cubesats access to space.
- Step 1: Submit USIP proposal to CSLI (Nov 22, 2016)
- Step 2: Selection to USIP (~ Feb 2017)
- Step 3: Manifesting on a particular launch (~ time of I&T)
- Step 4: Launch and mission operations.
- The 2016 CSLI solicitation can be found at:
- http://www.nasa.gov/sites/default/files/atoms/files/cubesat_launch_initiative_announcement_2016.pdf
- More information about the CubeSat Launch Initiative is available at: http://go.nasa.gov/CubeSat_initiative.

CubeSat Launch Initiative

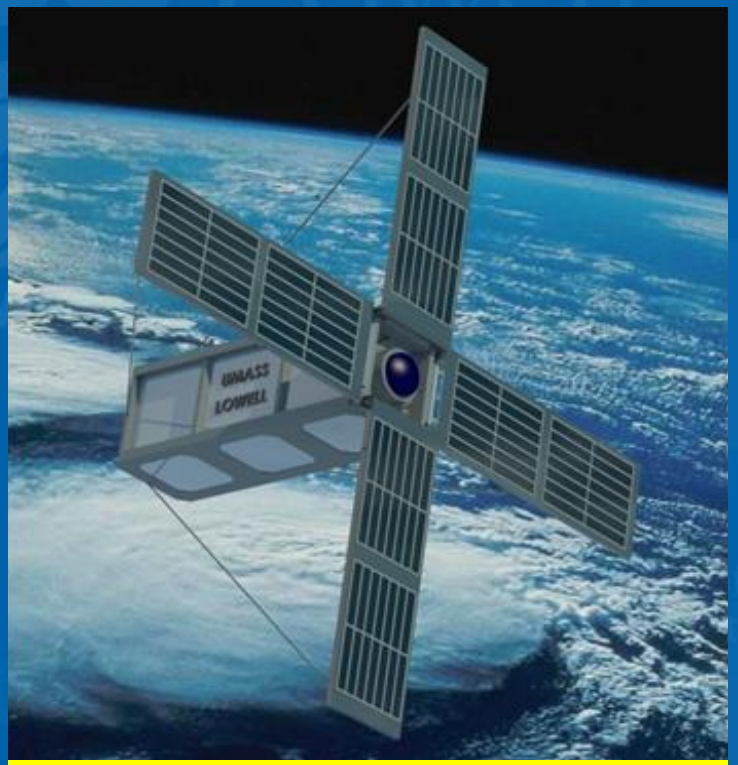
NASA's CubeSat Launch Initiative (CSLI) provides launch opportunities to educational institutions, non-profit organizations and NASA Centers who build small satellite payloads that fly as auxiliary payloads on previously planned launches, commercial missions or as International Space Station deployments.



September 2016 USIP-II Kickoff Meeting 20

SPACE HAUC Objectives

- Demonstrate practicality of high-data rate, high frequency communications on a CubeSat
- Achieve rapid beam steering for dynamic pointing of X-band uplink/downlink
- Use phased array of patch antennas
- Camera will take high-res images of Sun to transmit back to Earth



See:
https://www.uml.edu/Research/LoCSST/Research/spacehauc/about.aspx

The students have formed teams (with minimal “adult supervision”)

- Project management
- Systems engineering
- Beam Steering
- Antennas
- Telemetry
- Deployables
- Power system
- Attitude determination and control
- Thermal
- Structures
- Command & Data Handling
- Ground Station
- Promotion Management

Organization examples
(student slides from first organization meeting)

How to Get Started

- Accept invitation to CubeSat group (university Office 365) and file repository (Workbench)
- **SUBSCRIBE TO THE GROUP FOR ANNOUNCEMENTS**
- Research CubeSats and satellite subsystems (you should already have been doing this)
- Sort yourselves into teams, schedule meetings with each other

Some Places to Start your Research…

- http://www.cubesat.org → Documents → Papers
- http://www.polysat.calpoly.edu → Team → Published Papers
- Library Databases (IEEE, Science Direct, Wiley)
  - Search terms such as “cubesat” and “nanosatellite”
  - Search for journal articles and conference publications
  - Senior projects and master’s theses are good sources
- Space Mission Analysis and Design (SMAD) → Space engineering bible
- Textbooks, for basics and fundamentals
- Workbench → Resources → Papers (stuff that I’ve found that is helpful)
- …and of course, Google

One more
(student slides from first organization meeting)

Tips for Involvement

- Be open to criticism → keep long-term goal in mind
- Be proactive → don't wait around for someone to tell you what to do
- Communicate often.
- Communicate often!
- Communicate often!!!
- In event of:
  - Conflict with a team member,
  - Stress due to work, school, etc,
  - or anything else
- …talk to your team leader or to your program manger → we'll help

Time Commitment and Example Schedule

- 6 – 8 hours/week
- Work as a team; distribute the work
- You get out what you put in
- Don't promise what you can't deliver

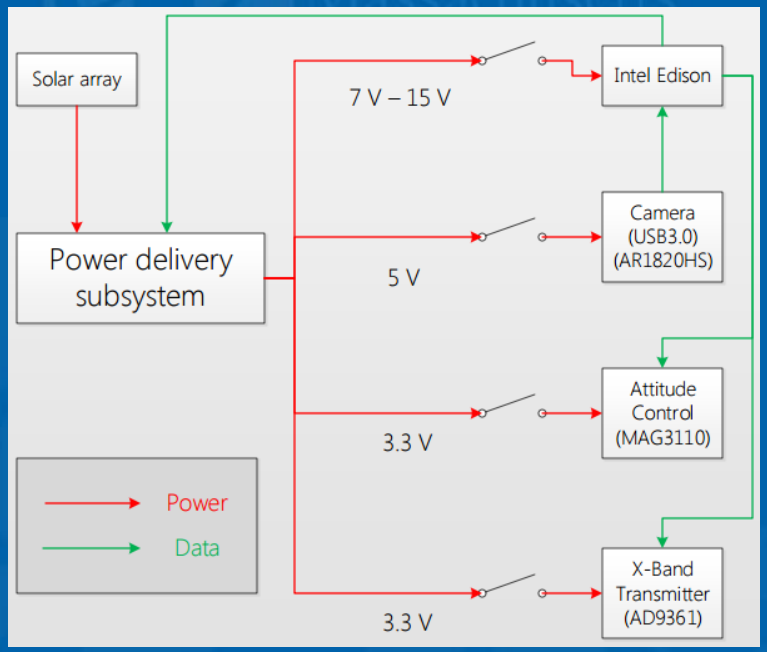
Day	Amount of Time (hours)	Example of Effort
MON	1	Team meeting, brainstorming
TUE	2	Informal get-together with team members to brainstorm
THU	2	Individual work/research
SAT	1	More individual work/research
SUN	2	Document progress for next team meeting, write your share of the specifications document
TOTAL: 8 hours		

LOCSST

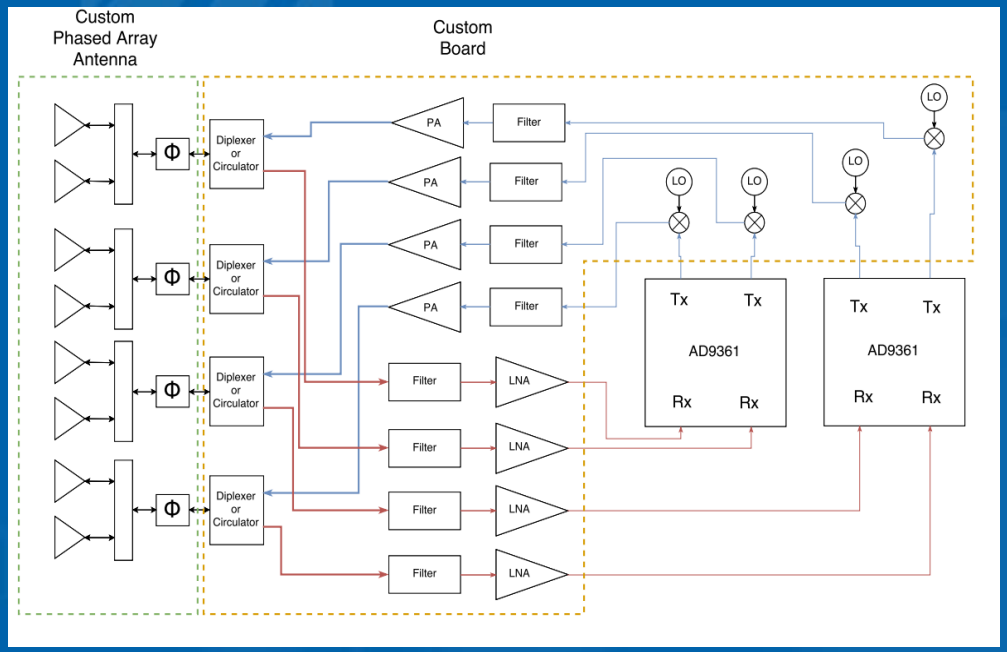
UMASS University of Massachusetts Lowell

System design examples

Power

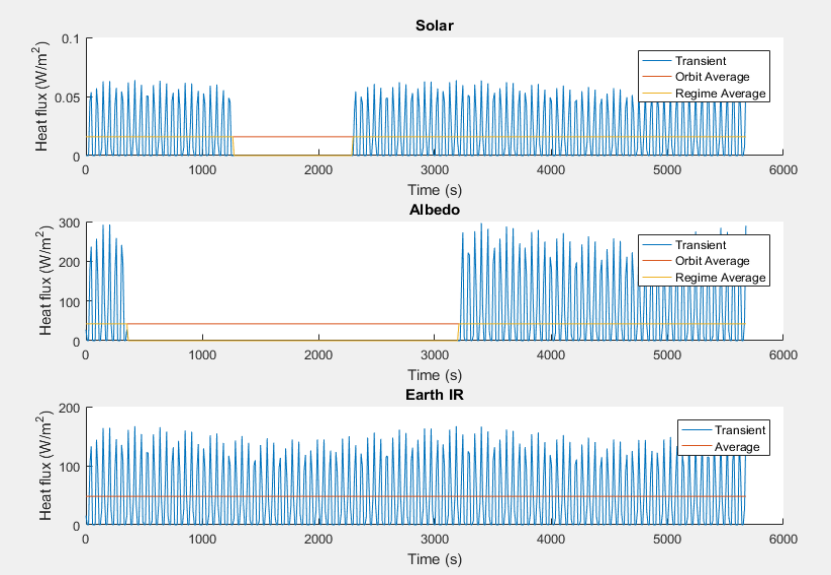


Telemetry

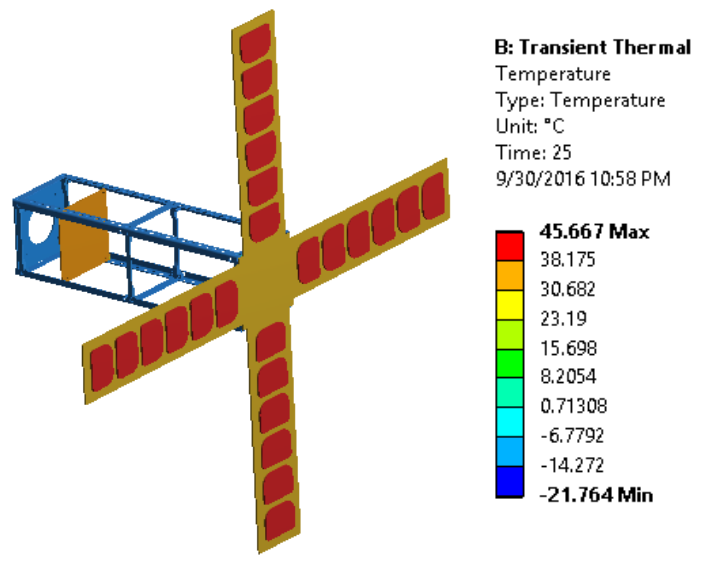


Thermal analysis example

An orbit assumed, and…

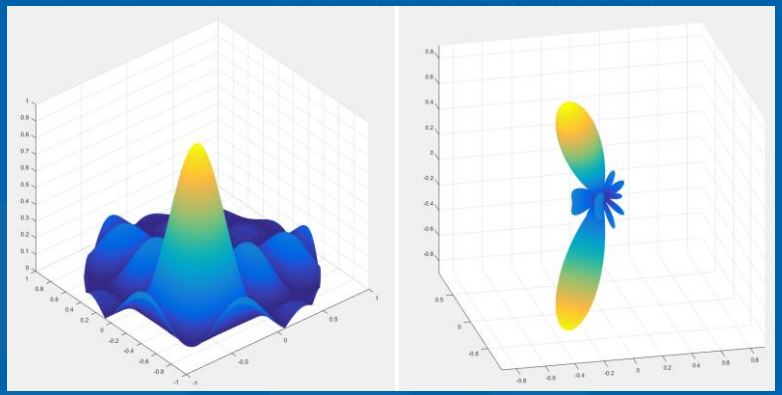


First-cut results

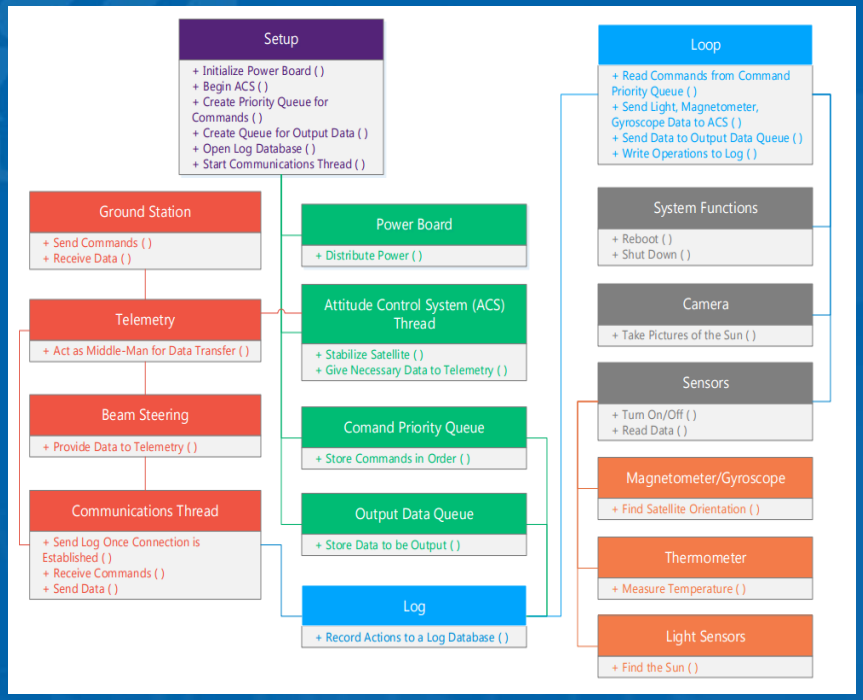


More examples

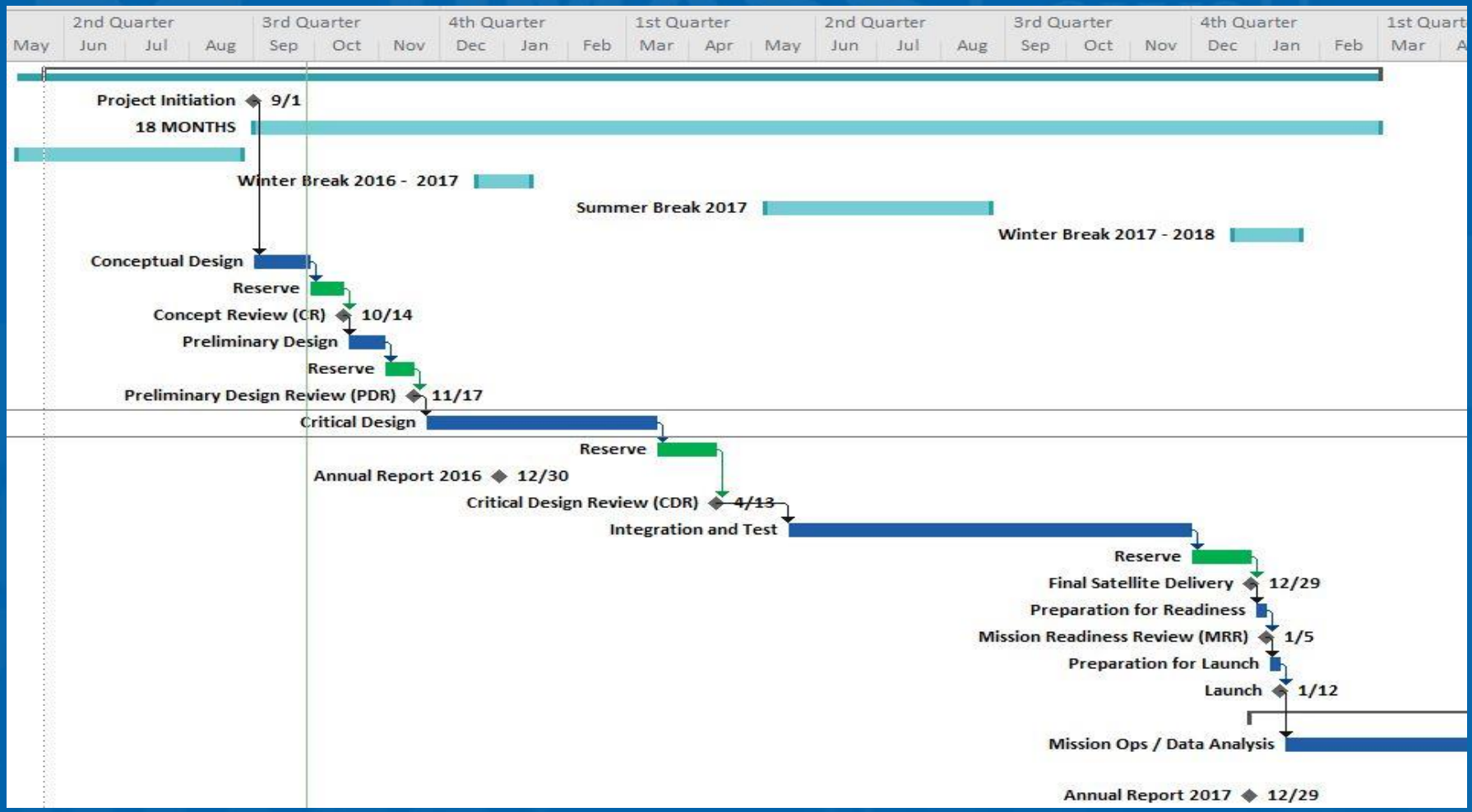
Beam steering simulation



Flight software organized



Our planned schedule



Our other student-involved work

- K-12
  - High school Newton's Laws experiment
  - Curriculum developed used in several schools in Massachusetts
- Undergraduate
  - Involved in all phases of all projects
  - SPECTRE
  - SPACE HAUC (launch 2018)
- Graduate
  - 8 Ph. D.s and 11 M. A.s in 15 years
  - Placed in Academia, Government, Private Industry and Private Start ups

Our upcoming space flights

- Science
  - Exoplanet
    - PICTURE balloon 1 – Launch 2017
    - PICTURE balloon 2 – Launch 2019
  - Ground based studies of airglow and aurora (HiT&MIS)
    - Total solar eclipse – “Launch” 2017
  - Space based Ionospheric Studies (ISS/LITES) – Launch: 2017
  - Support for MISTIC WINDS with BAE – aircraft Launch: 2017
- Education and technology demonstration
  - SPACE HAUC – Launch 2018

A symposium announcement

- To commemorate 60 years of space exploration, we will host a symposium on April 21-22 at UMass Lowell entitled

  Domestication: The future of space exploration in the upcoming decade

- Please join – you will help shape the future

https://www.uml.edu/Research/LoCSSTNews/Symposium.aspx