SPACE HAUC: A Undergraduate CubeSat Mission to Demonstrate High Bandwidth Communication using an X-band Phased Array

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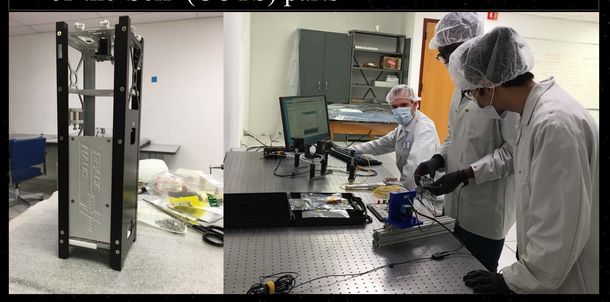
SPACE HAUC

***S**cience **P**rogram **A**round **C**ommunication **E**ngineering with **H**igh **A**chieving **U**ndergraduate **C**adres*

- CubeSat mission at UMass Lowell funded by NASA Undergraduate Student Instrumentation Program (USIP) and Massachusetts Space Grant Consortium (MASGC)
- Goals:
  - Provide an opportunity for undergraduate students to design, build and fly a space mission
  - Technology demonstration of student developed high bandwidth (50-100 Mbps) communication system in X-Band with beam steering capability using a phased array antenna

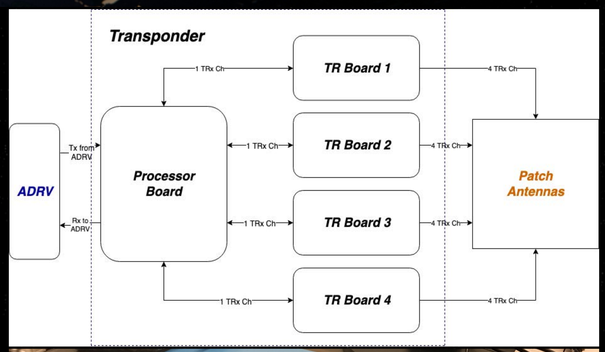
Spacecraft:

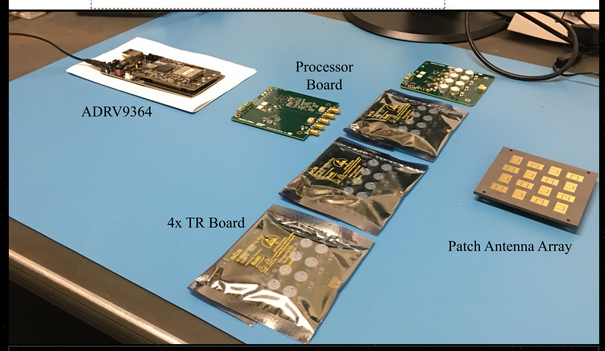
- 3U CubeSat– 34 x 10 x 10 cm^3; 4 kg
- Will be deployed by NanoRacks from the International Space Station (ISS)
- ISS Orbit– 400 km altitude; 51.6º inclination
- Mission Lifetime: 1-2 years
- Student designed and built using Commercial of-the-Self (COTS) parts



X-Band Communication System

- Student-designed system to achieve 50-100 Mbps from space to Earth
  - 10x compared to current standard of 5 Mbps
- Modulation: QPSK
- Beam steering capability from 4x4 phased array antenna
- Consist of
  - COTS Software Defined Radio: ADRV9364
  - Students designed Transponder with COTS parts
    - Processor Board: Up and down conversion
    - TR Board: Phase shifting and amplification
  - Student-designed wideband patch antenna array
- Operations:
  - A X-Band signal is sent up to the spacecraft from Earth Station at UMass Lowell
  - Spacecraft antenna does a spiral search using the algorithm developed by students until reference signal strength is detected
  - Spacecraft detects the location of Earth Station from uplink signal by measuring the phase difference using 2 pairs of patch antenna
  - Spacecraft transmits downlink signal to MIT Haystack–Westford Radio Telescope based on the detected UMass Lowell uplink signal

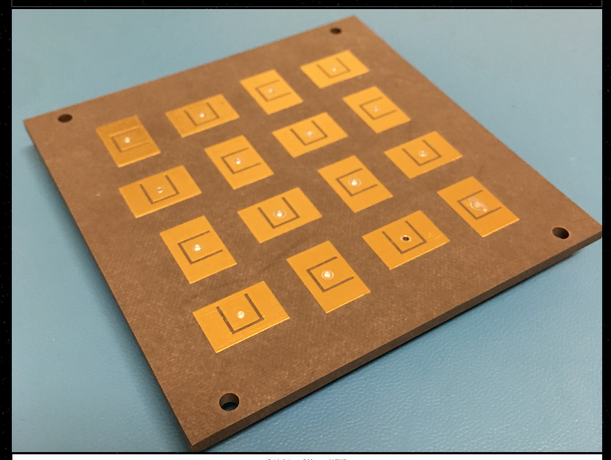


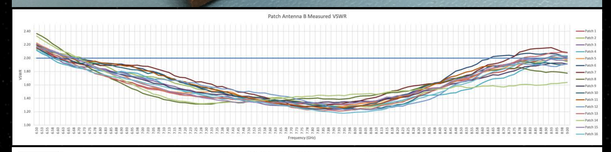


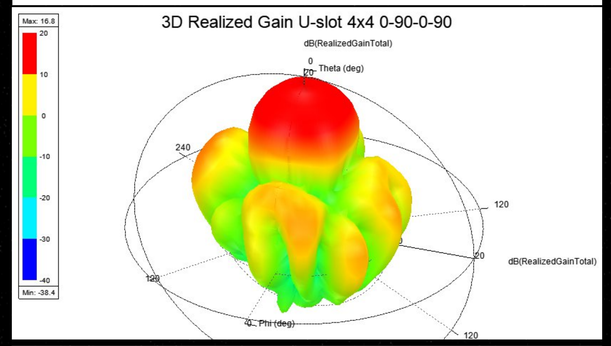
- **System Specifications:**
  - Transmitter RF Power: 1.6 W
  - Receiver sensitivity: -115 dBm
  - Beam width: 25º
  - Beam steering: ±45º with ≤5º error
  - Input supply: CubeSat standard 5V and 3.3V
  - Electrical Power: Tx: 9 W and Rx: 9 W

Wideband Patch Antenna Array

- Student-designed antenna array to resonate (≤VSWR 2:1) from 7 GHz to 8.5 GHz
  - 20% resonance band at fc=7.75 GHz
  - U-slot patch-antenna design for wideband
  - 4 x 4 Elements
  - Polarization: Right Hand Circular
  - Antenna Gain: 16.8 dB
  - Beam width: 25º (FWHM)
  - Steering capability: ±45º







Earth Station

Uplink	Downlink
• UMass Lowell Earth Station	• MIT Haystack Earth Station
• Helical on 1.8 m Parabolic Reflector	• Helical on 18 m Parabolic Reflector
• Gain: 30 dBi	• Gain: 59 dBi
• Frequency: 7.2 GHz	• Frequency: 8.35 GHz
• Bandwidth: 2 MHz	• Bandwidth: 56 MHz

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