From the Ground Up, UND's Race to Space

Advanced Rocketry Club (ARC)

Challenge

- Design, construct, and launch a liquid fueled rocket
- Apogee at 100km
- University led team

ADVANCED ROCKETRY CLUB

- Inclusive university wide organization
- Teach students, faculty, and the community members about rocketry
- Give students practical experience in the rocketry field before they go into a career.
- Increase public awareness of the UND educational abilities
- Be the first university to launch to an altitude of 100 km

UNIVERSITY OF NORTH DAKOTA

Timeline

- Mar - 2019 - Preliminary Design Review (PDR)
- Apr - 2019 - Stripe Launch
- May - 2019 - 1st Subscale Solid Fueled Launch
- Oct - 2019 - 1st Static Test Fire
- Mar - 2020 – Critical Design Review (CDR)
- May - 2020 - 1st Launch

TARGET ALTITUDE

100 KILOMETERS

TOTAL THRUST

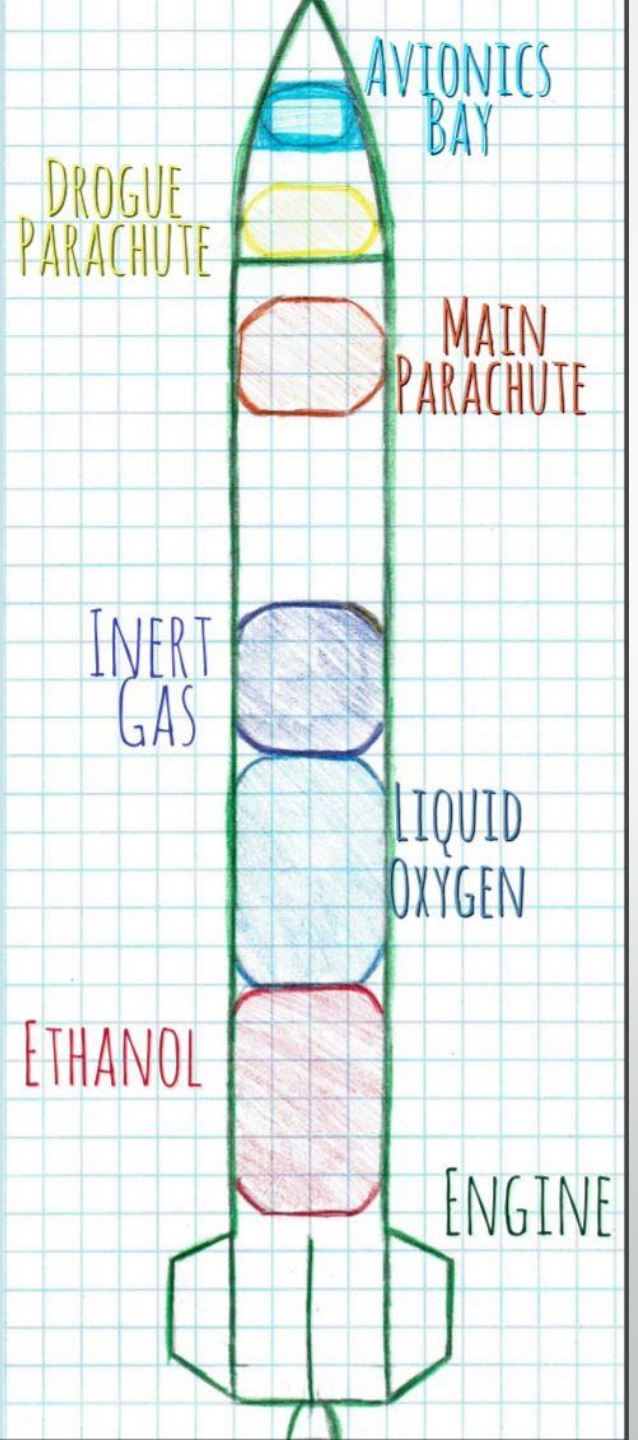
2600 POUNDS

SPECS

30 FEET TALL
2 FOOT DIAMETER

SECTIONS

AVIONICS BAY
PAYLOAD BAY
ENGINE BAY

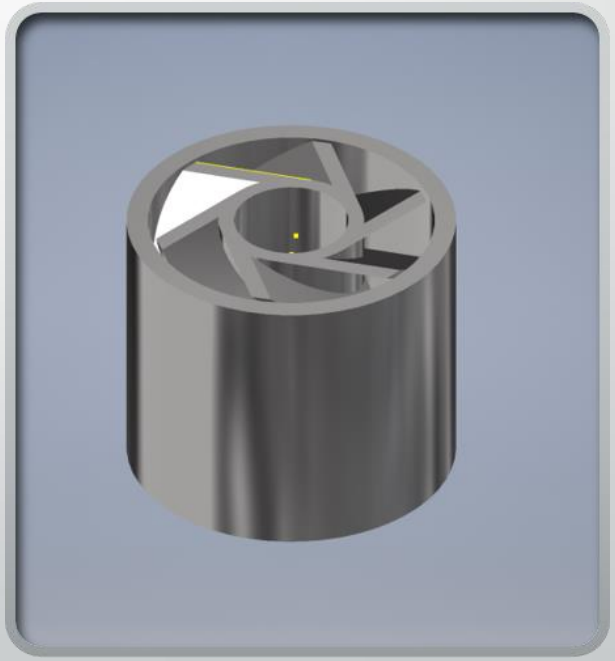


Propulsion- Engine Design

- 30 gallon of fuel and LOX per minute
- Electric motors to drive pumps

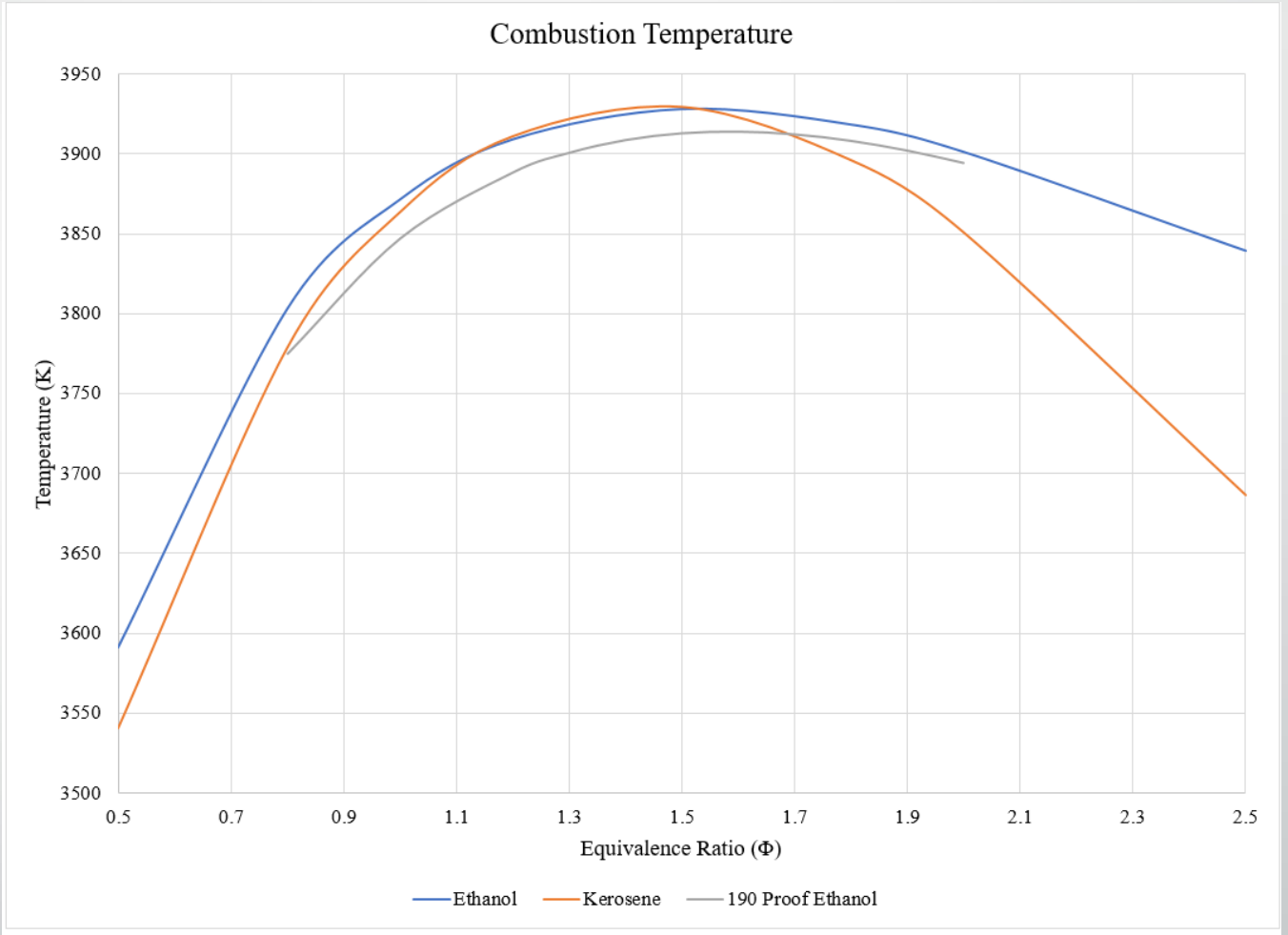
Engine Nozzle

- Milled in fuel and LOX lines for cooling
- Swirler for proper fuel mixture
- 2600 lbs. of thrust



Propulsion- Propellant Selection

- LOX chosen as oxidizer
  - Cheap
  - Non-toxic
  - Commonly employed
- 190 Proof Ethanol chosen as fuel
  - Cheap/Accessible
  - Renewable ("Green")
  - Negligible sooting
  - High combustion temperature
  - Low MW product gas
  - Good cooling properties



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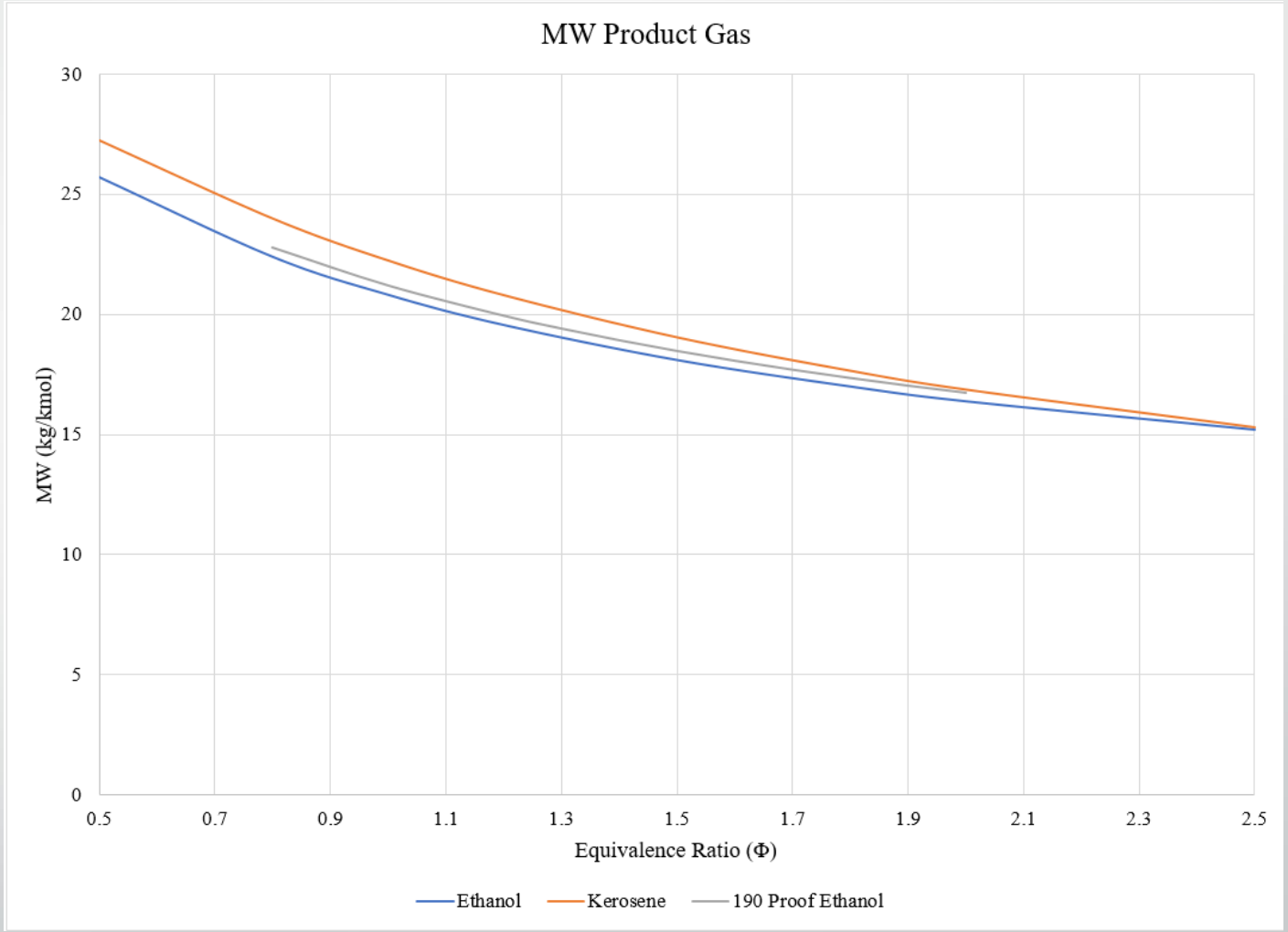
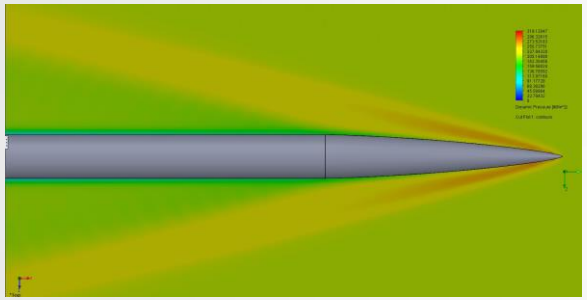


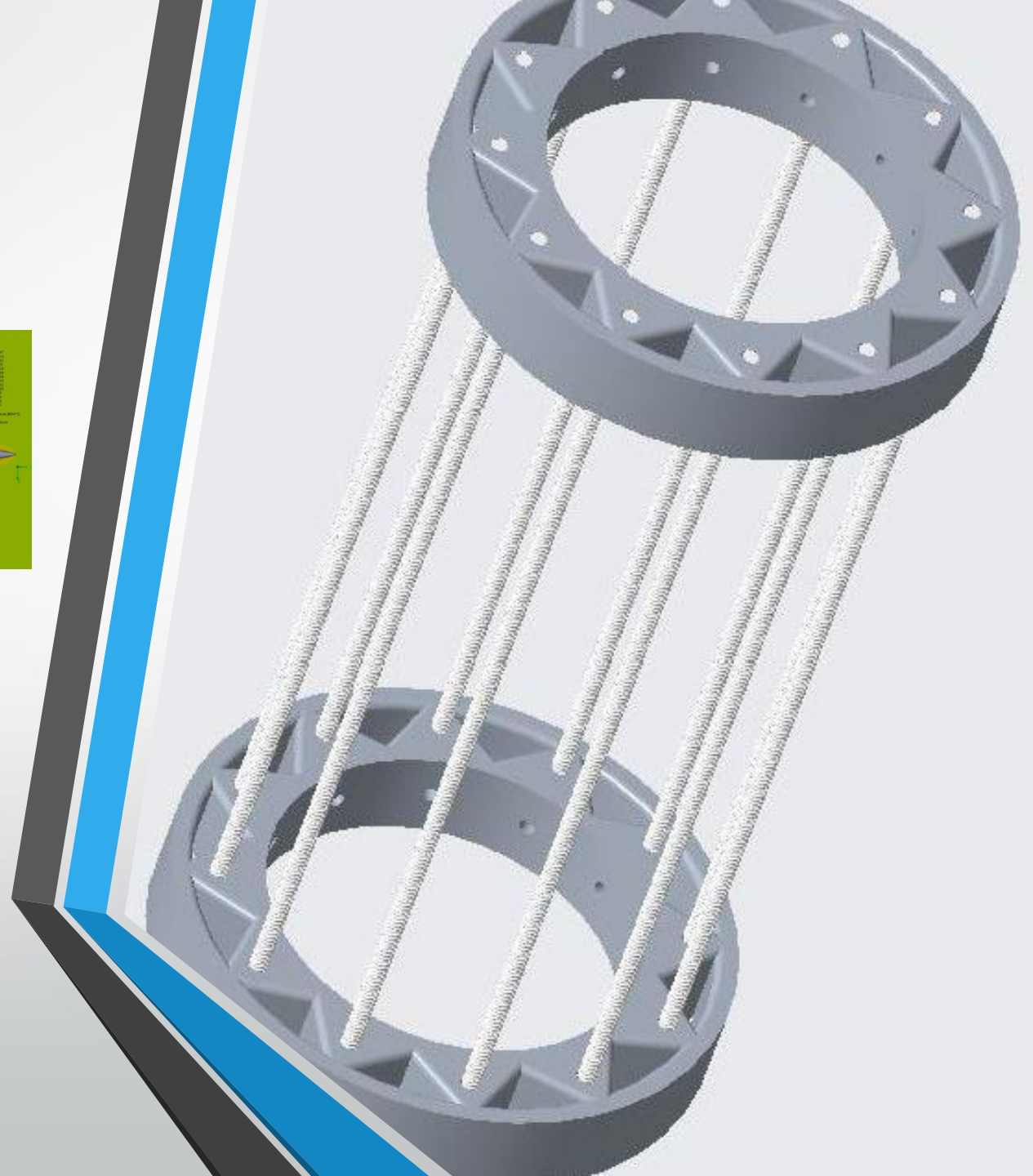
Testing and Analysis

- Vertical test stand
- Made to house full sized rocket
- Using shipping containers
- Bunker for team
- Horizontal loading, vertical firing
- Hydraulic lifts

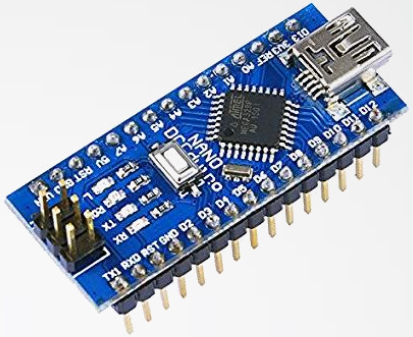
Flight Dynamics and Structure



- Nose Cone
  - Tungsten Tip
    - Supersonic/Subsonic Flow
  - Computational Fluid Dynamics
    - Predict laminar/turbulent transition
- Connecting Rods
  - Threaded Aluminum
- Structural Plates
  - Magnesium Alloy AZ 31B H24
    - Melting Point – 1190 °F
    - Density – 0.0639 lbs/in^2

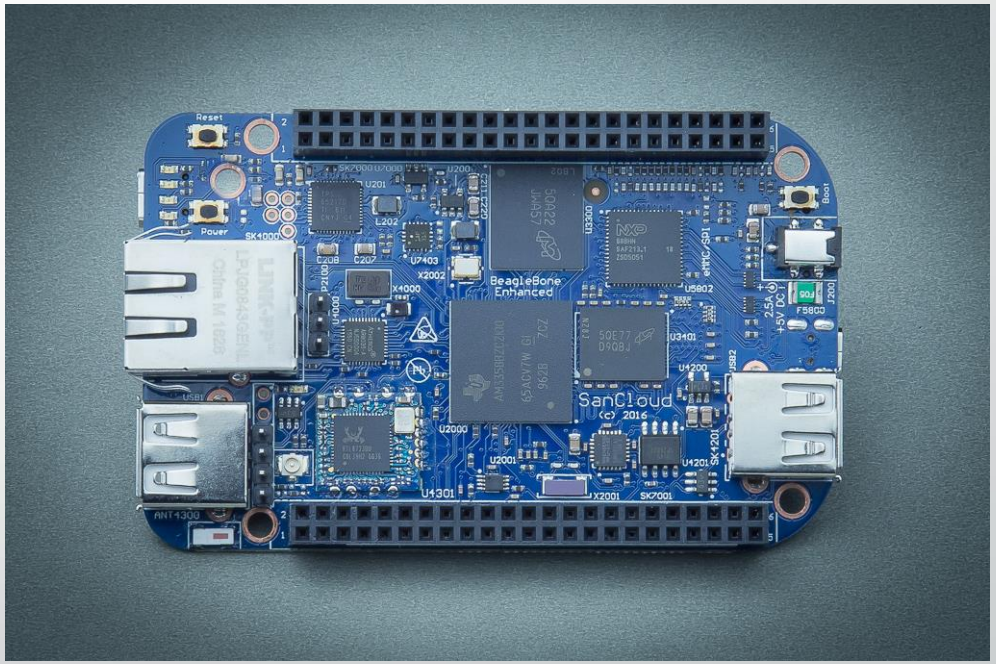


Avionics – Hardware



Flight Hardware

- BeagleBone Enhanced single-board computer
  - "Brain" Telemetry, data logging, abort
- Arduino Nano
  - Engine Controller
  - Recovery



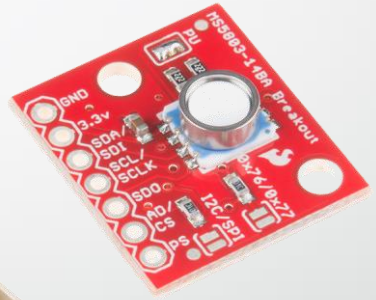
Ground Support

- Directional antenna tracking "turret"
  - 4 directional antennas
  - 1 azimuth servo, 1 elevation servo
  - 1 telemetry & communications antenna
  - Cameras

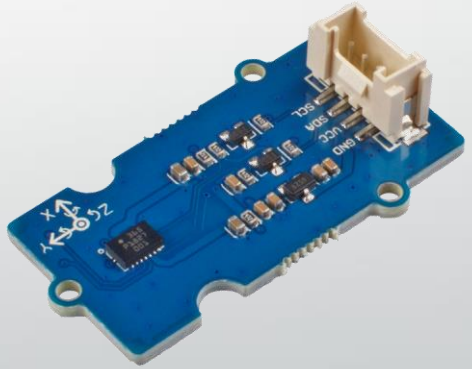
Avionics – Sensors

- Position:
  - GPS < 18km
  - INS (integrated)
- Altitude:
  - GPS < 18km
  - INS
  - Barometer
- Velocity:
  - INS
  - Doppler Effect

GPS:
ublox NEO-M8Q-01A



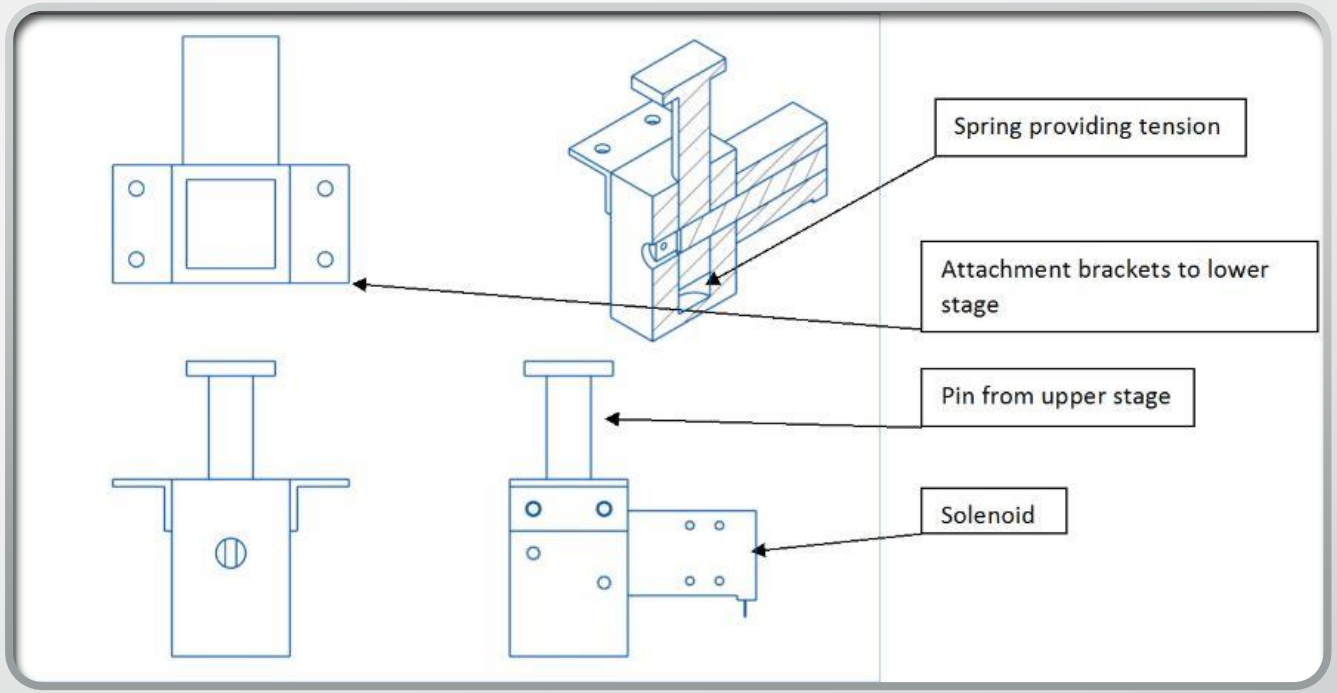
Barometer:
TE MS5803-14BA



INS:
Bosch BMI088

Recovery

- Solenoid Separation
- CO_2 Release Drogue Deployment
  - 12000ft
  - 2 parachutes x 10ft diameter
- Solenoid Main Deployment
  - 2000ft
  - 3 parachutes x 27ft diameter



Questions?