THE RANGING AND NANOSATELLITE GUIDANCE EXPERIMENT (RANGE)

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SSDL
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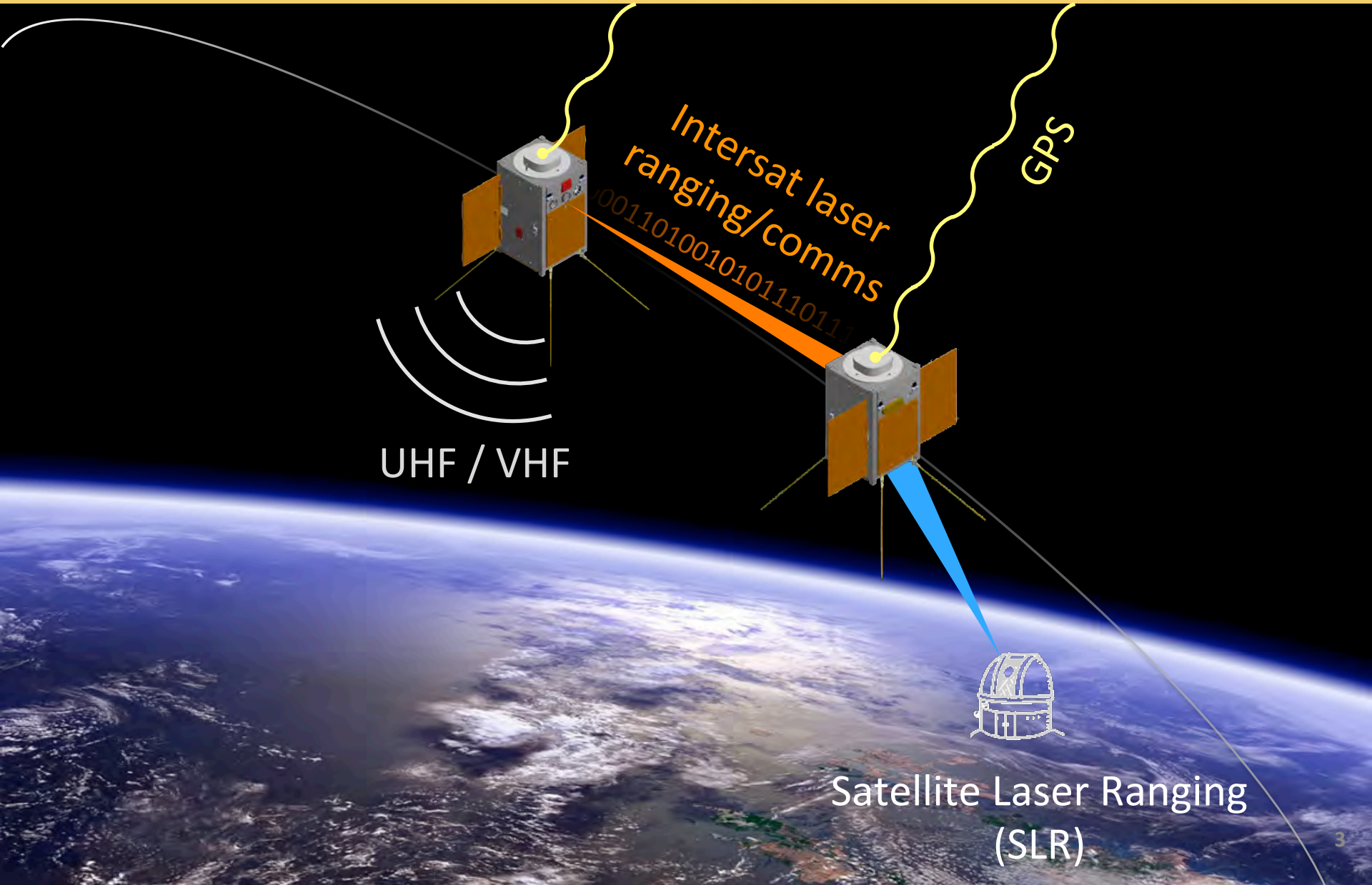
RANGE - MISSION OVERVIEW

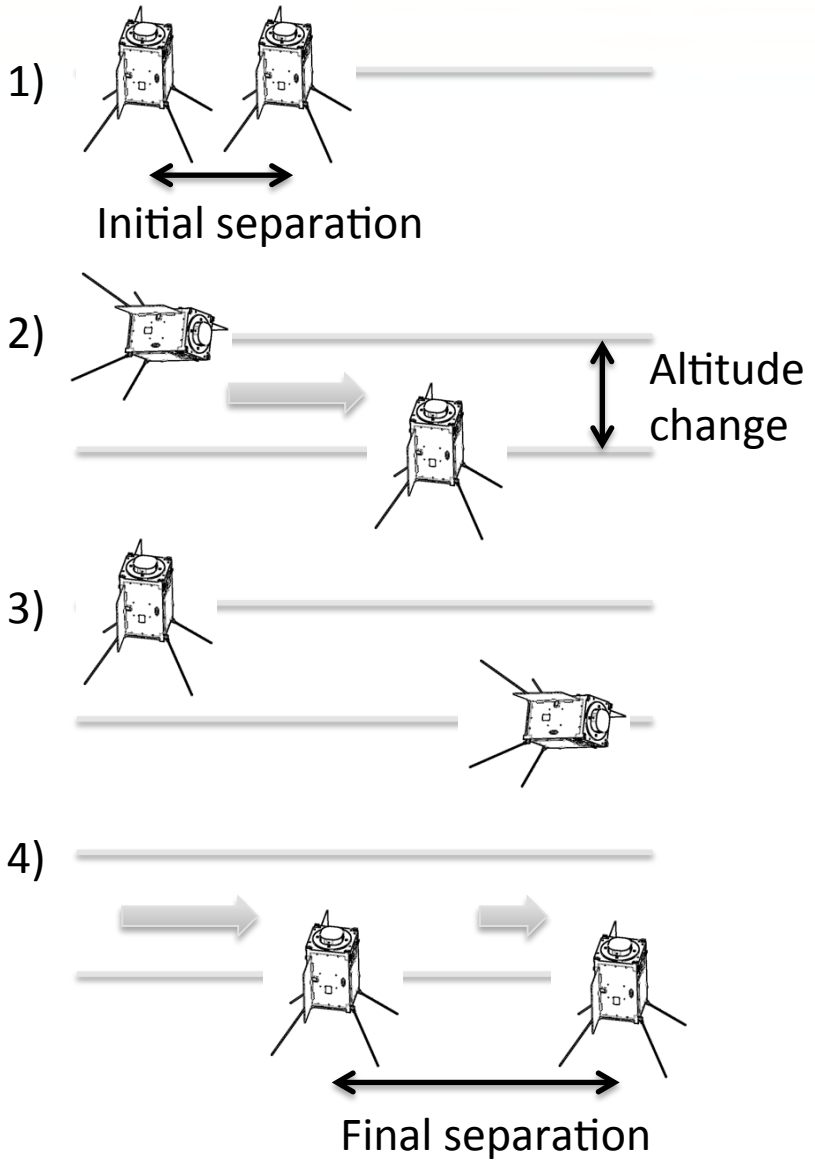
- Two 1.5U satellite formation
- Selected for a launch opportunity through the Terra Bella (formerly Skybox) University Cubesat Partnership
  - Satellite delivery due in 2016
- Mission objectives
  - Improve absolute and relative positioning capabilities of nanosats
  - Explore propulsion-less formation control techniques
  - Transmit low-rate optical (laser) communications
- Innovations
  - Demonstrate m to cm level POD for cubesats
  - Demonstrate mm-level inter-satellite ranging
  - Demonstrate inter-satellite laser comm from a nanosat platform
  - Evaluate performance of miniaturized atomic clock

RANGE - CONOPS



RANGE – DIFFERENTIAL DRAG

- Satellites will have no propulsion system
- Intersatellite distance (in plane) will be controlled through differential drag
  - Change in drag ratio (orientation) between the two satellites causes a relative motion
  - Well described in the literature, but few mission examples (Planet Labs, Aerospace AC6)
- Current mission plan will vary distance from hundreds to thousands of meters



RANGE - PAYLOAD

- Primary payloads
  - Novatel OEM628 Receiver (L1/L2)
  - Chip Scale Atomic Clock (CSAC)
    - < 2.5e-11 ADEV over 10s

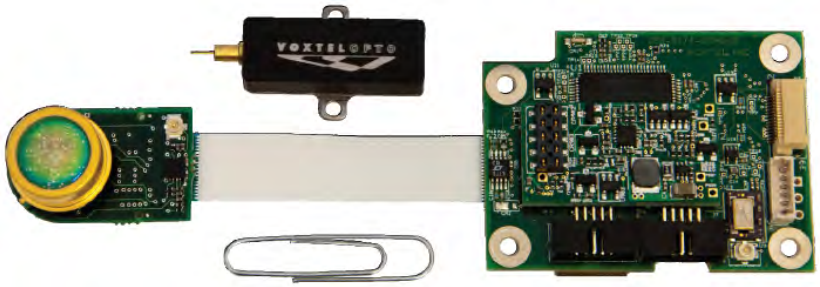
Novatel Receiver

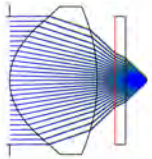
CSAC

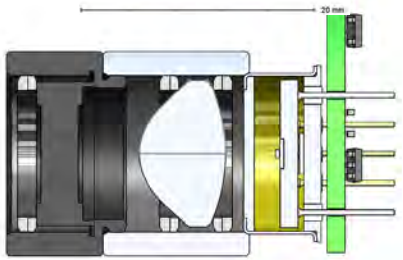
- Orbit validation through ground-based satellite laser ranging (SLR)
  - Service provided by the NLR/ILRS
  - Cm-level accuracy

RANGE - PAYLOAD

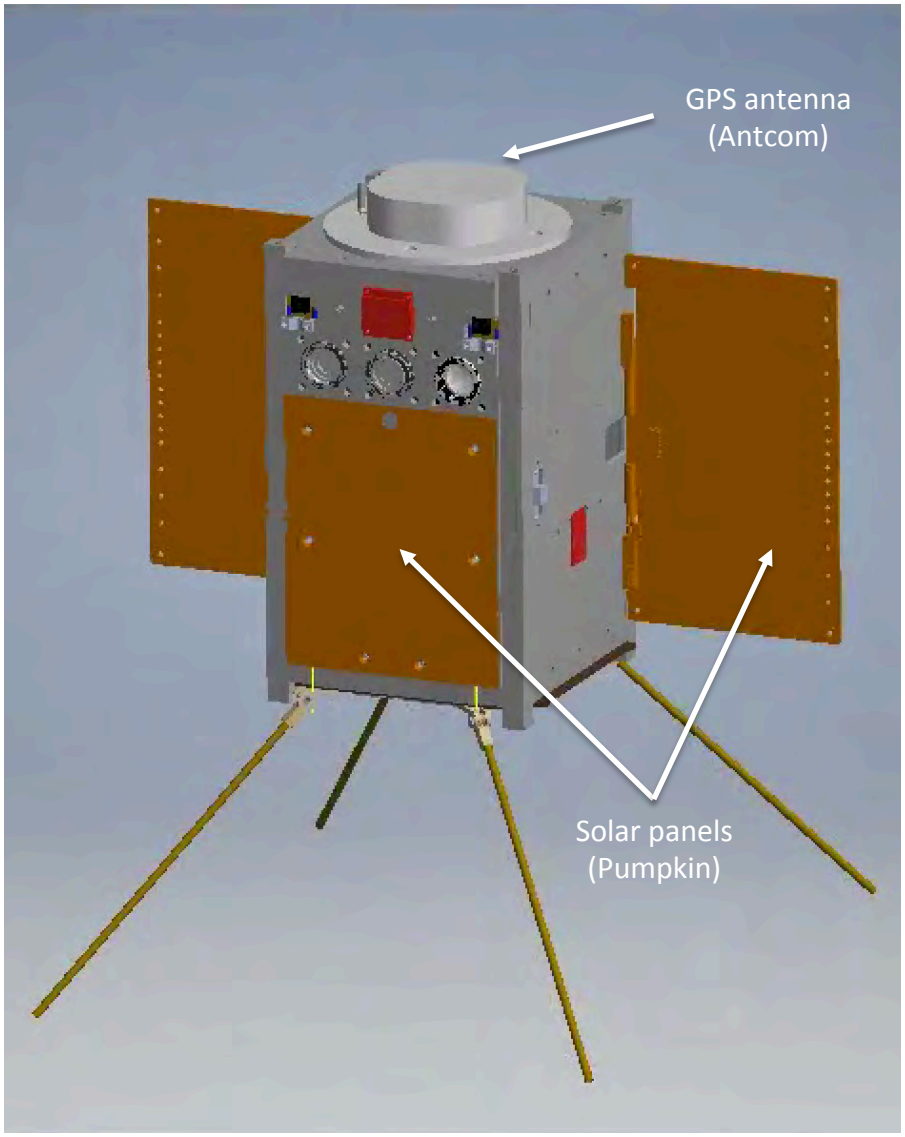
- Laser Rx/Tx System
  - Made by Voxtel
  - 25 kW, 4 ns pulses
  - APD sensitive to nW
  - Custom optics design (GTRI)
  - 2.5^{o} beam divergence to account for coarse s/c pointing
  - Class 1 (eye-safe), 1535nm
- Est. one-way detections to 500 km, dual-way detections < 1km
- Same system will also be tested as a low-rate laser communications

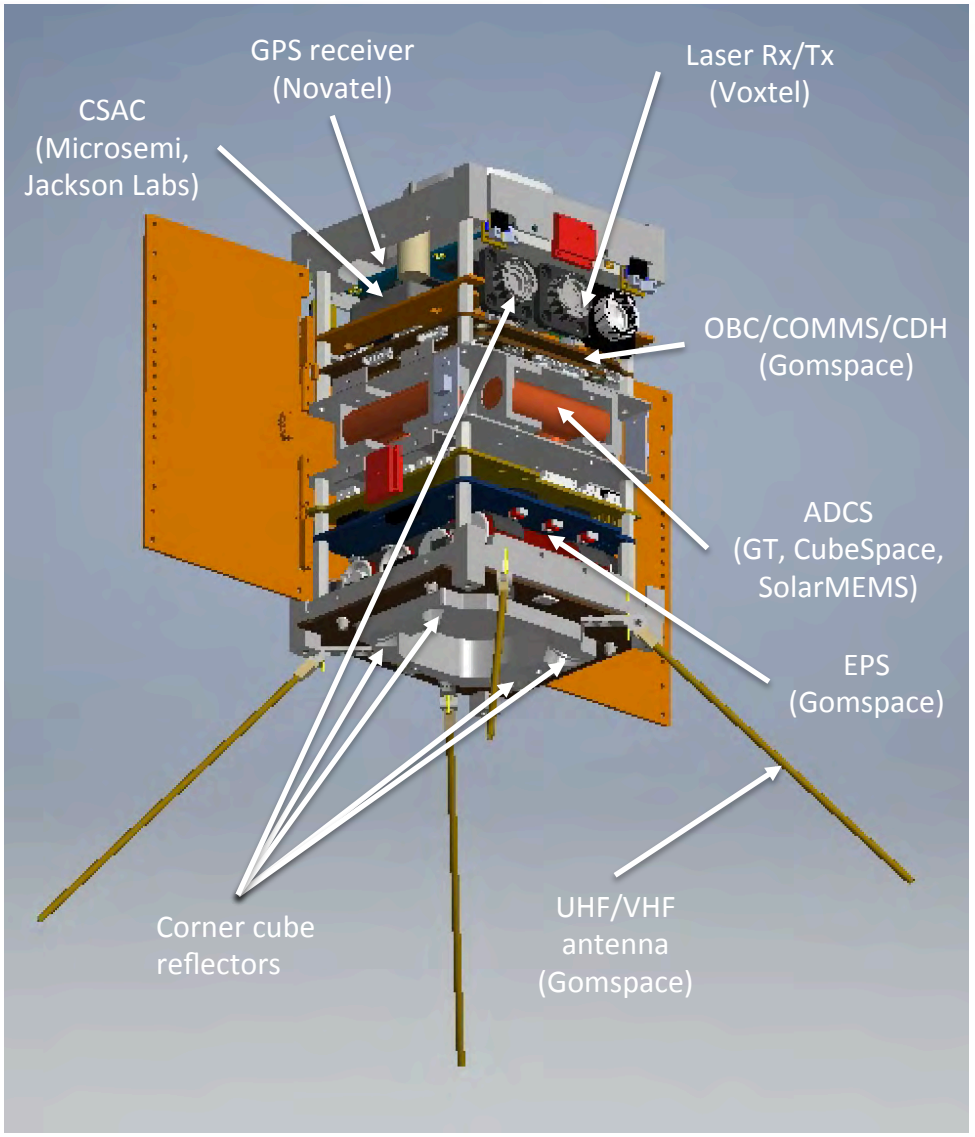






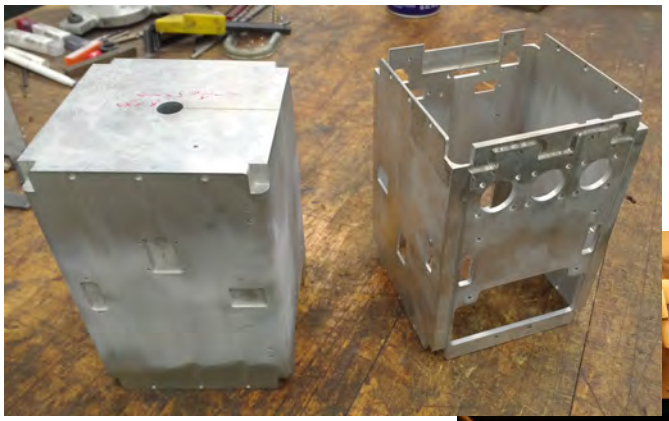
RANGE – S/C DESIGN

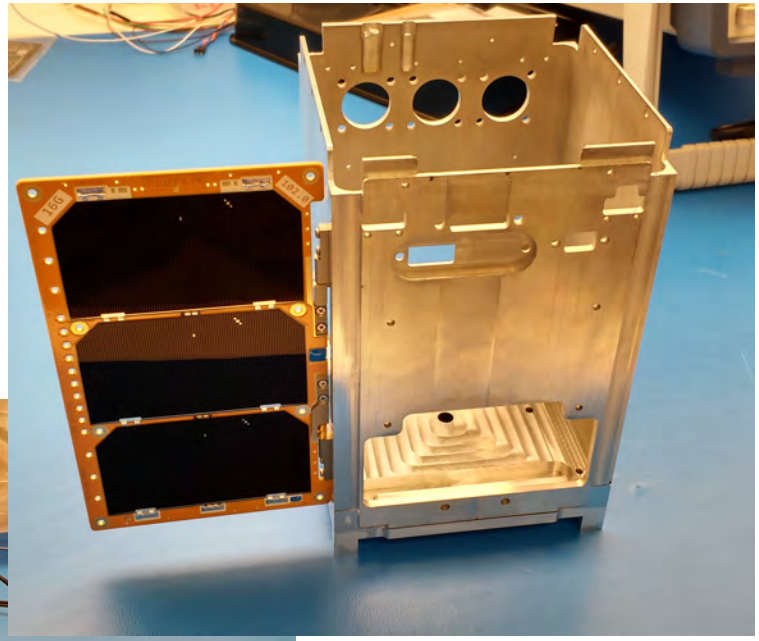


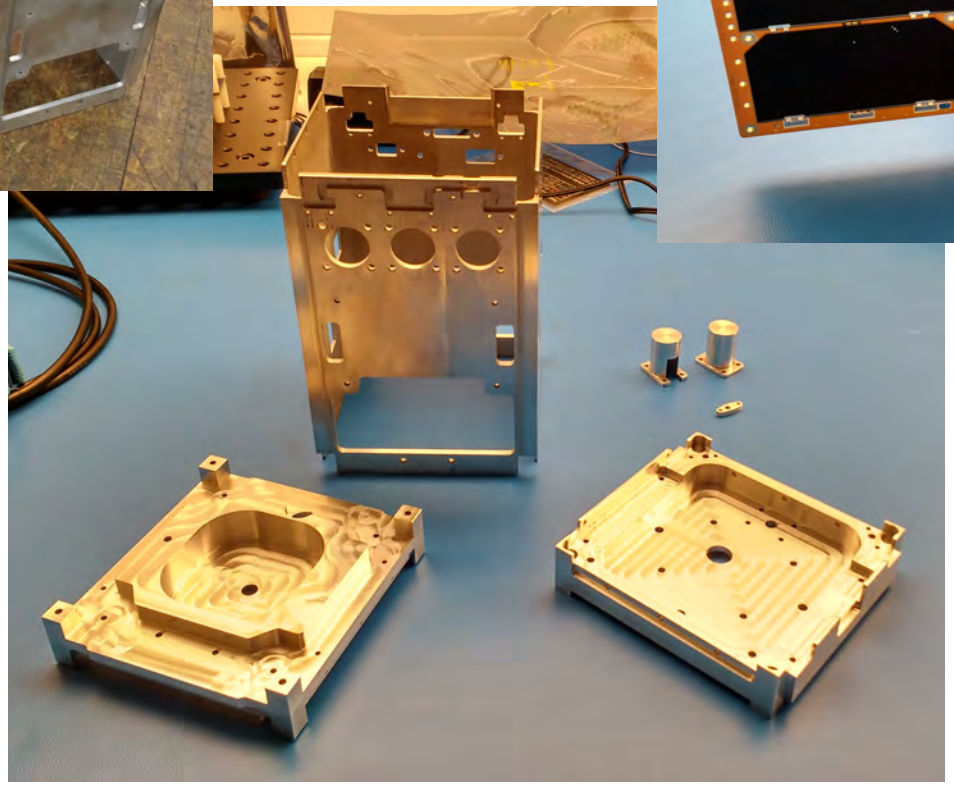


RANGE - HARDWARE

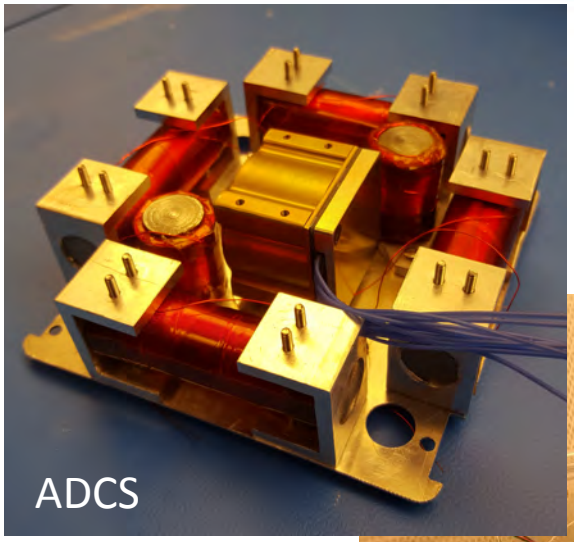
- Custom structure
- Custom solar panels (Pumpkin)



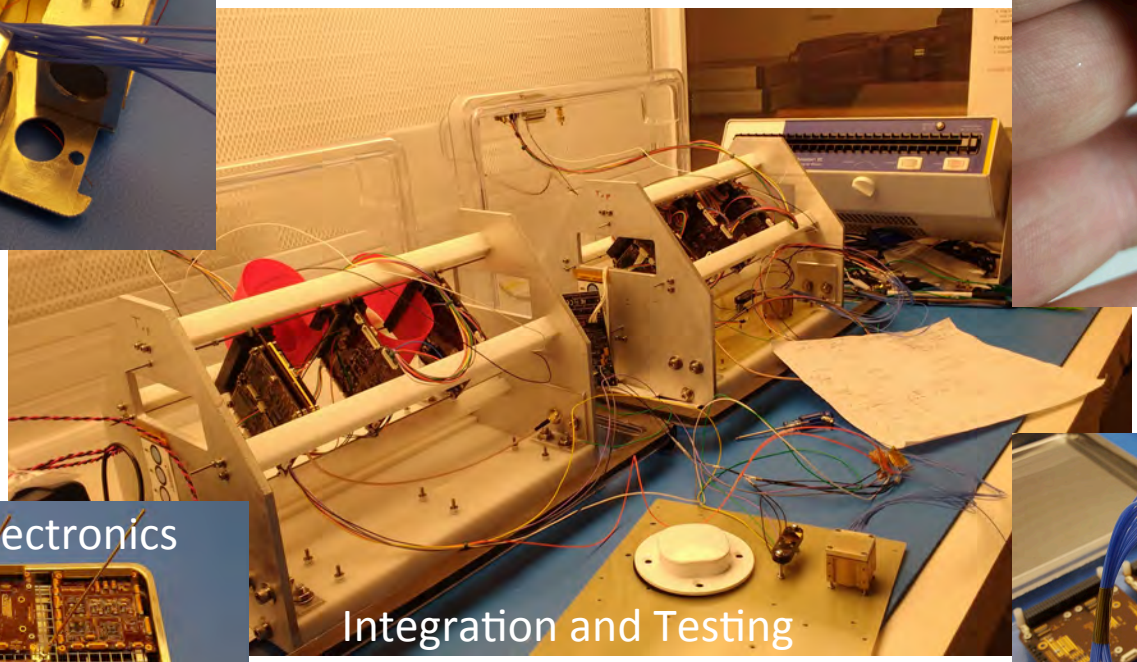


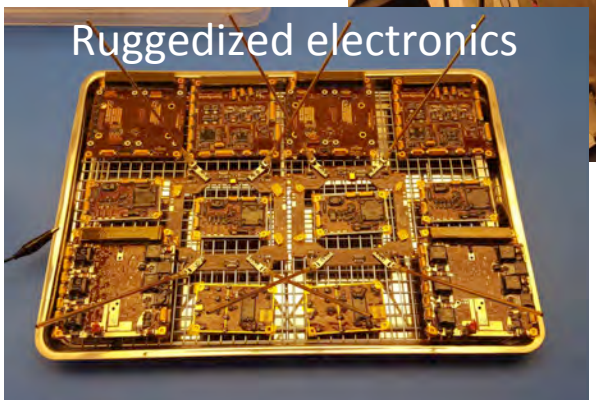


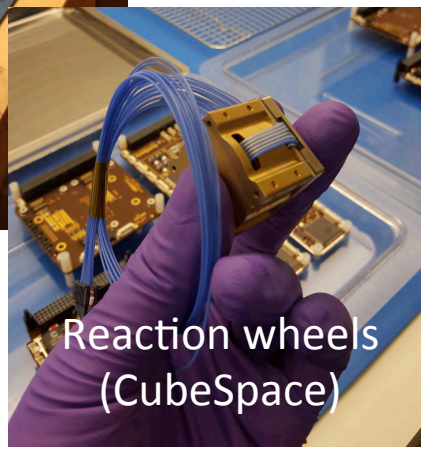
HARDWARE


ADCS


Custom
Torque rods


Integration and Testing


Ruggedized electronics


Reaction wheels
(CubeSpace)

CHALLENGES AND NEXT STEPS

- Complete RANGE integration and testing
  - Flight software maturity
  - Environmental testing (thermal vacuum, vibration, antenna characterization)
- Controlling inter-satellite distance
  - Differential drag techniques still experimental
  - Want to avoid fast/out-of-plane separation of satellites
  - Refining simulations using advanced models (rarefied flow)
- Maintaining sufficient pointing control for laser Rx/Tx
  - 3-axis S/C pointing control expected to be 3-5^{o}
  - With 2.5^{o} laser beam divergence, continuous Rx/Tx not guaranteed
  - With only one reaction wheel, precise rotation only possible for one-axis
  - May require random attitude “search” until alignment achieved

- Acknowledgements
  - Terra Bella
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  - Georgia Tech Research Institute (GTRI)
  - Over 40+ graduate and undergraduate students involved to date

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