

THE RANGING AND NANOSATELLITE GUIDANCE EXPERIMENT (RANGE)

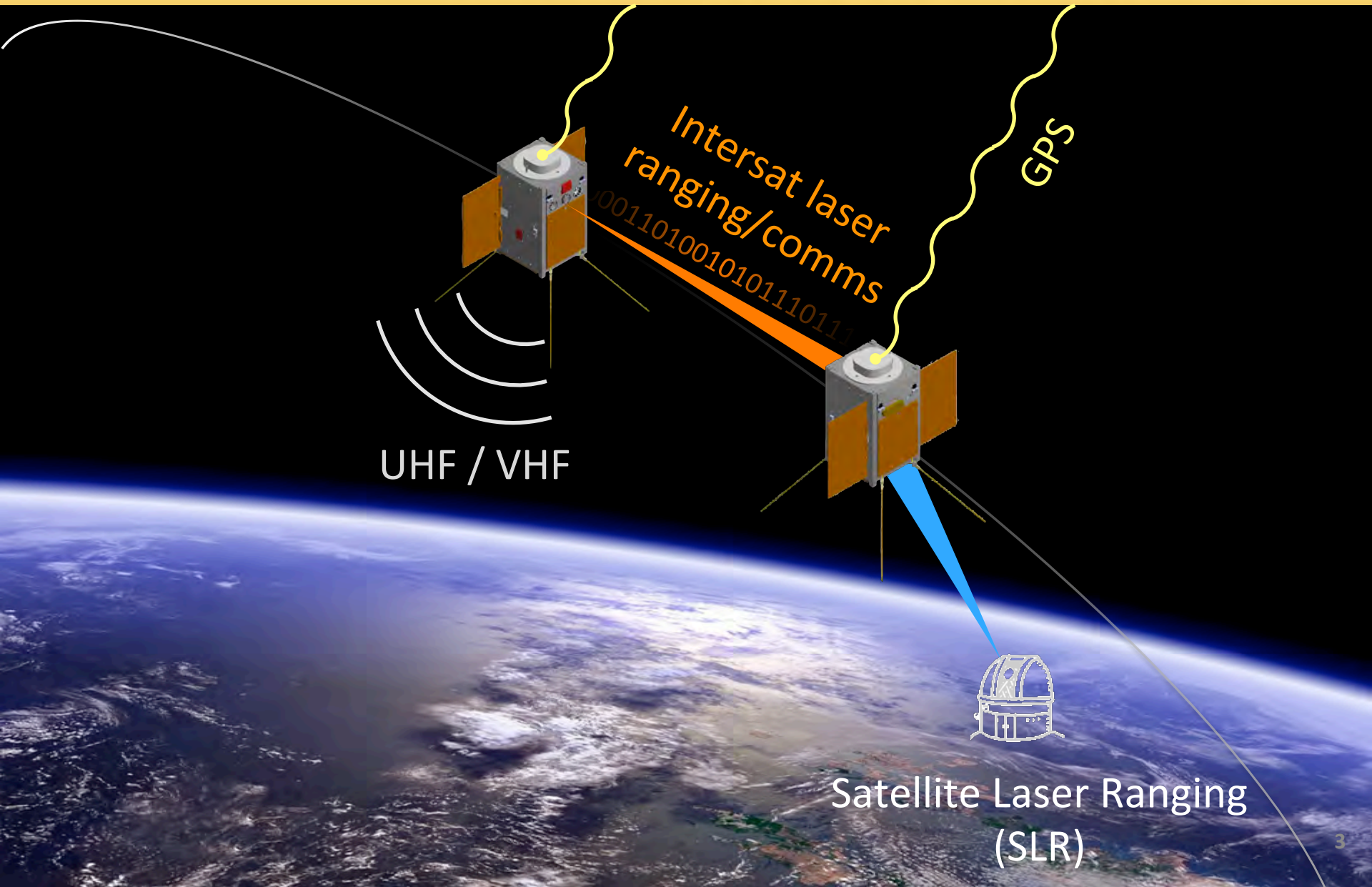


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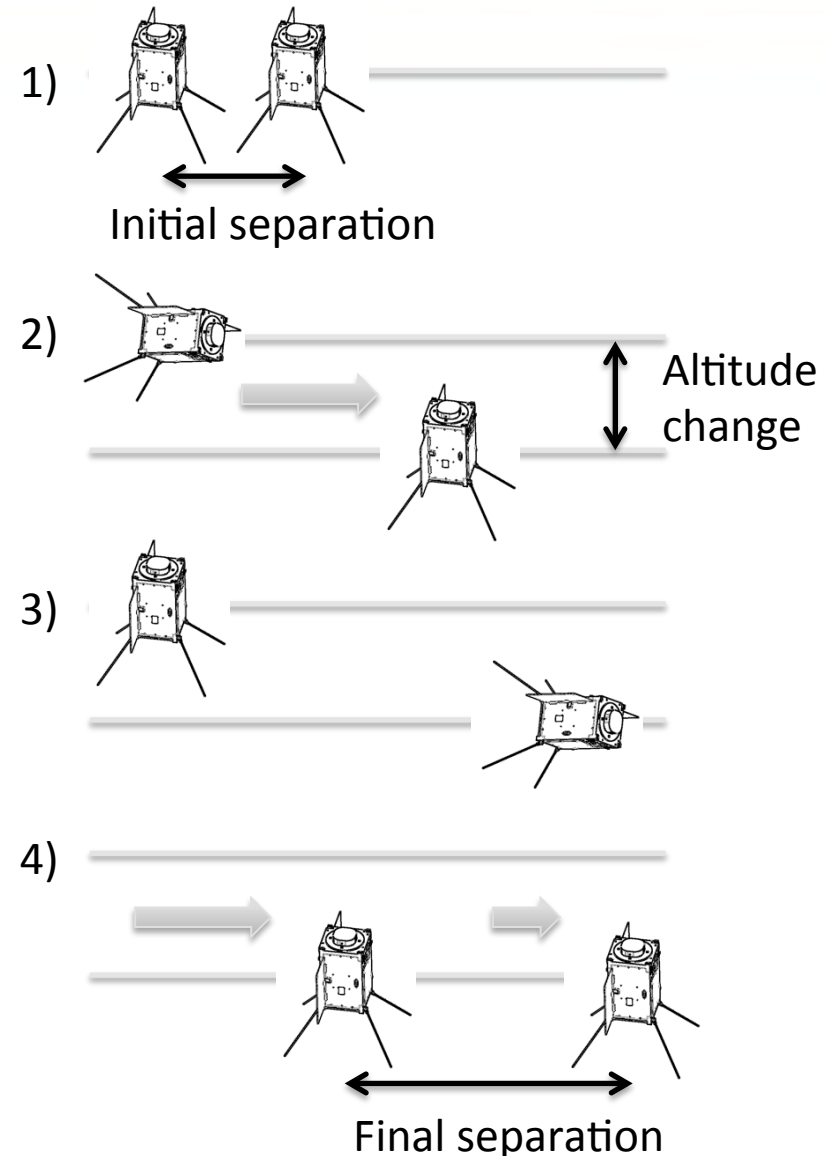
- Two 1.5U satellite formation
- Selected for a launch opportunity through the Terra Bella (formerly Skybox) University Cubesat Partnership
 - Satellite delivery due in 2016
- Mission objectives
 - Improve absolute and relative positioning capabilities of nanosats
 - Explore propulsion-less formation 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

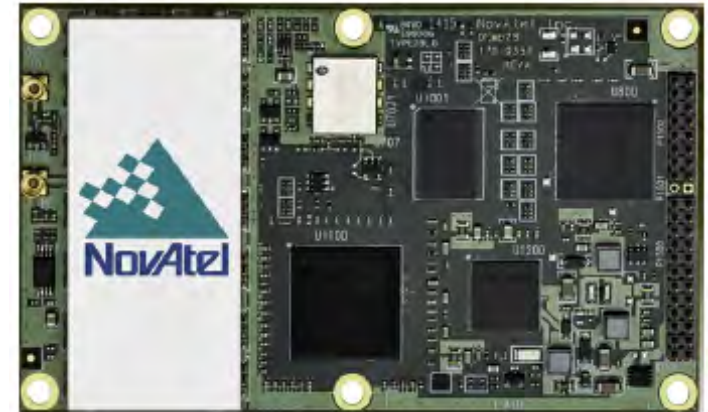
- Primary payloads
 - Novatel OEM628 Receiver (L1/L2)
 - Chip Scale Atomic Clock (CSAC)
 - $< 2.5e-11$ ADEV over 10s



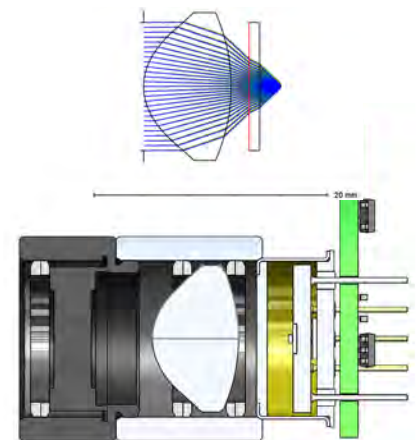
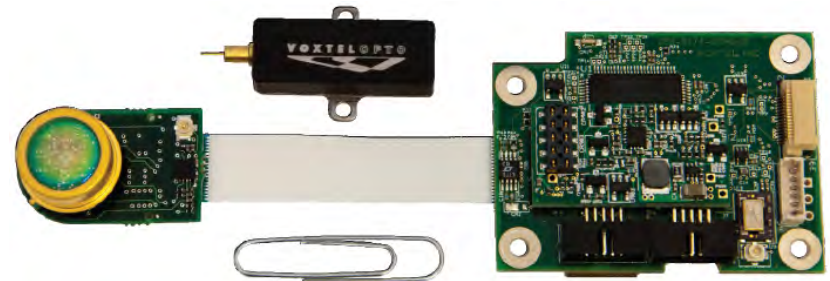
CSAC

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

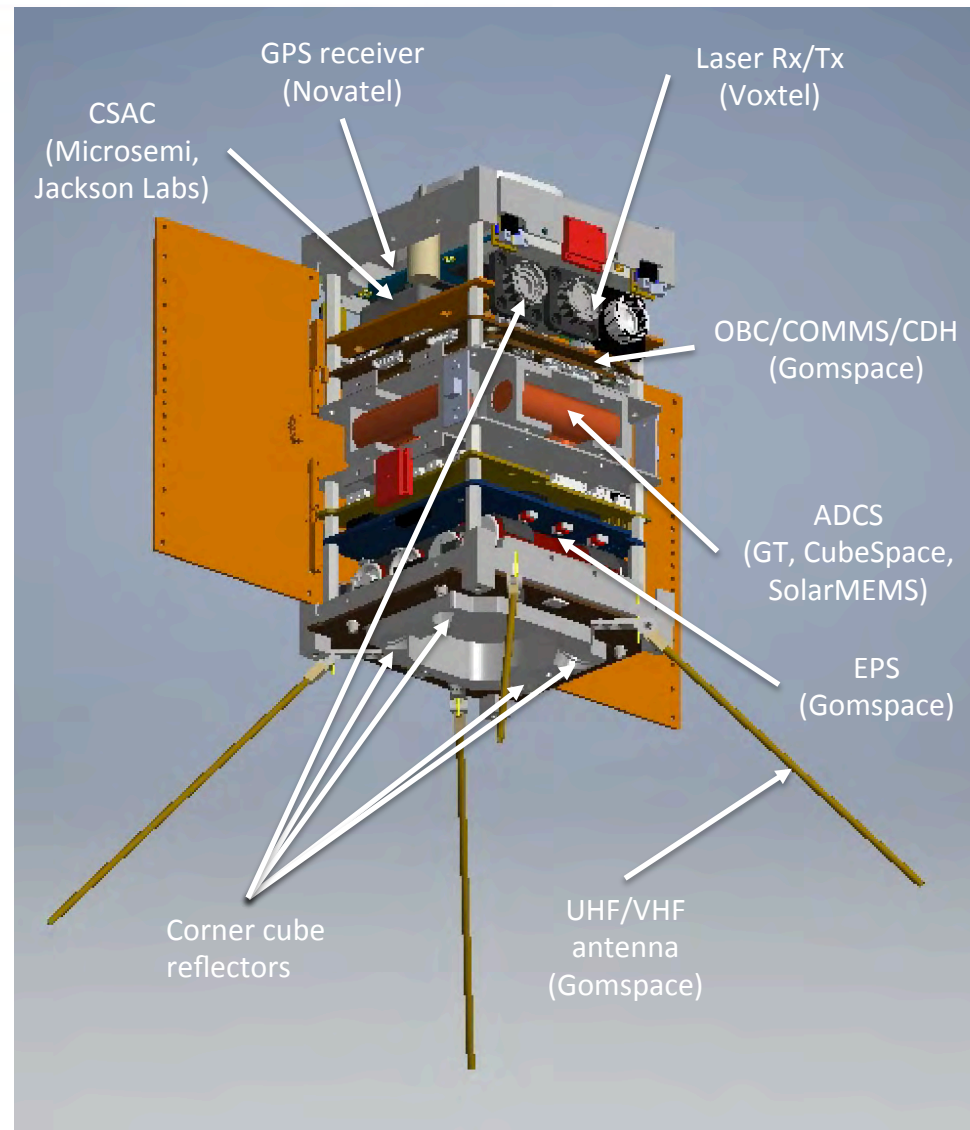
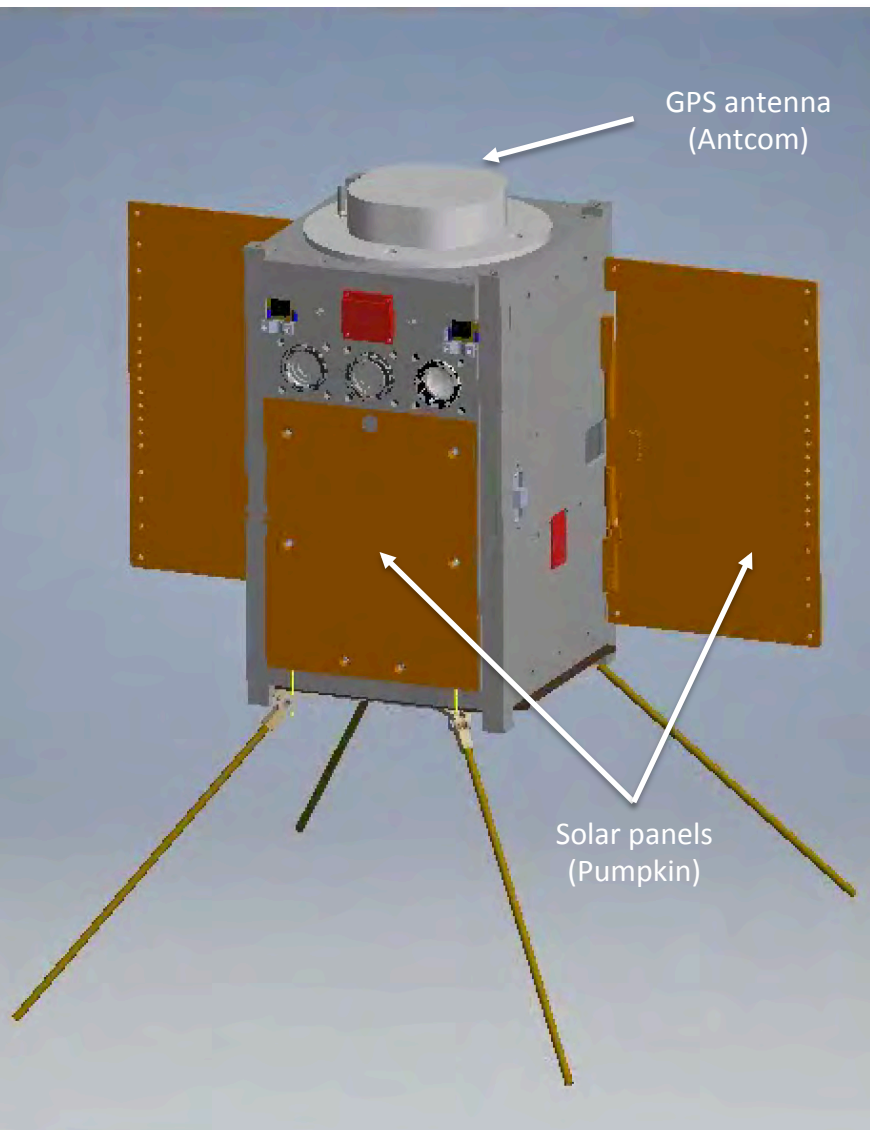
Novatel Receiver



- Laser Rx/Tx System
 - Made by Voxtel
 - 25 kW, 4 ns pulses
 - APD sensitive to nW
 - Custom optics design (GTRI)
 - 2.5° 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

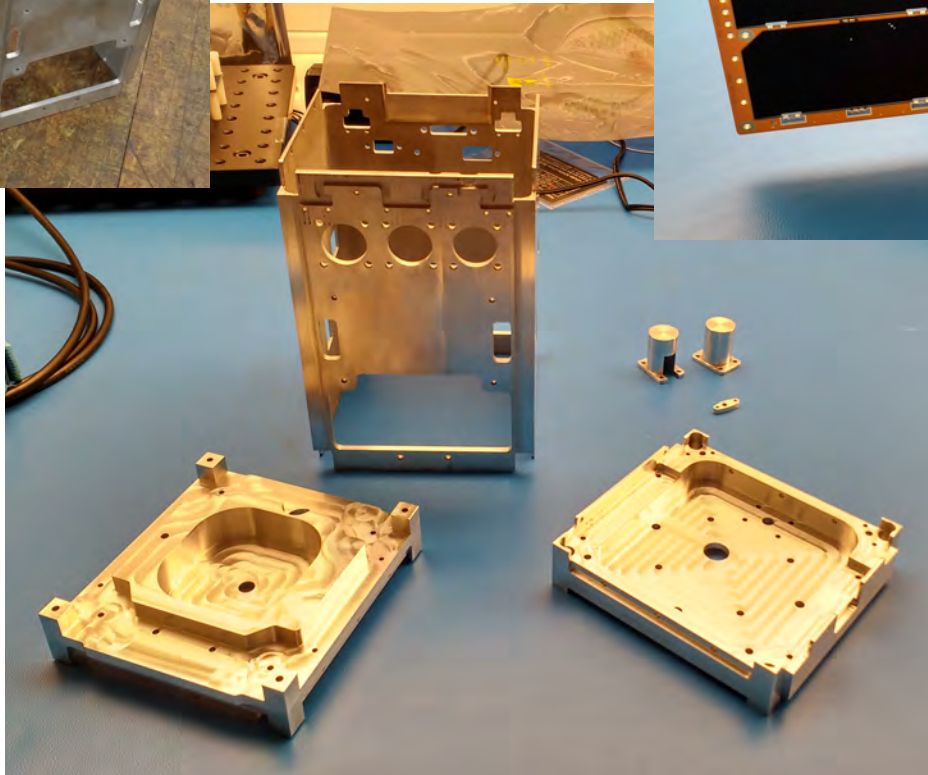
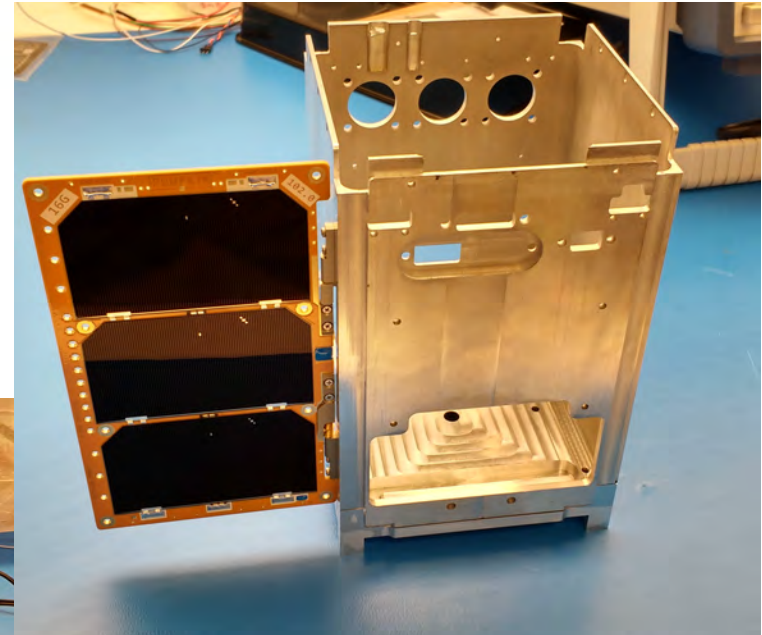
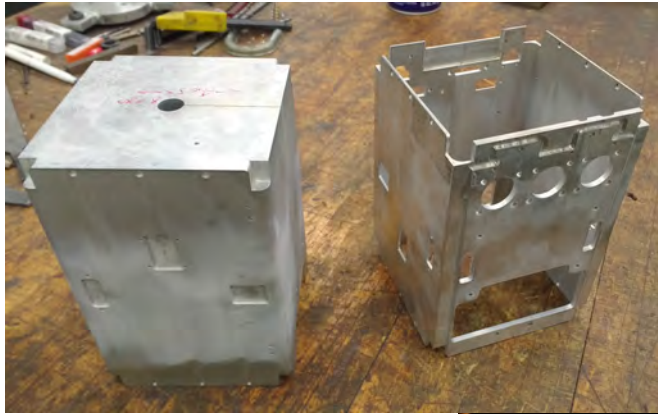


RANGE – S/C DESIGN

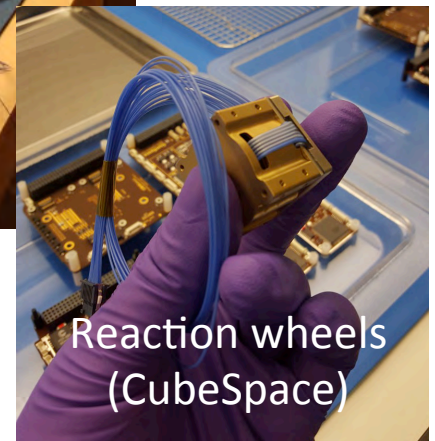
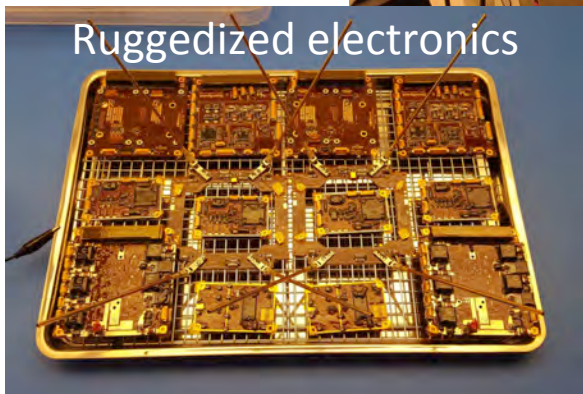
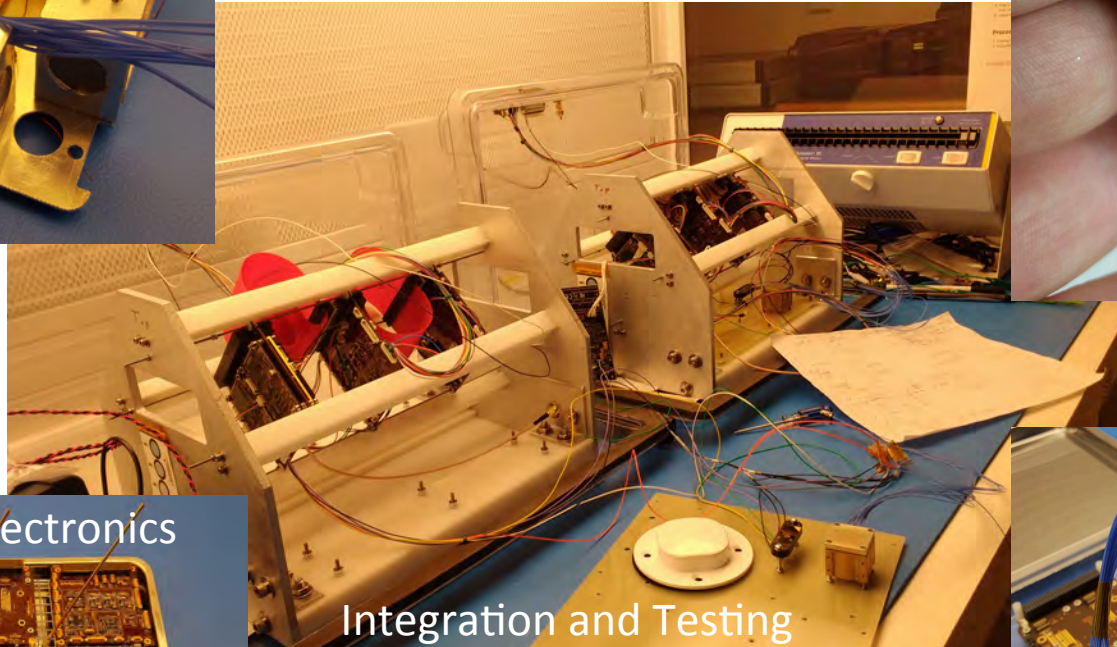
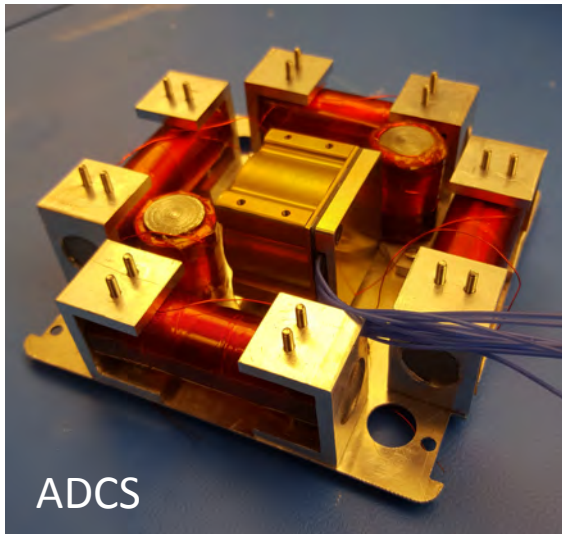


RANGE - HARDWARE

- Custom structure
- Custom solar panels (Pumpkin)



HARDWARE



- 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°
 - With 2.5° 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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