Drag-free Technology Demonstration on a SmallSat

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KACST JCEP R&D with global reach

Stanford | Hansen Experimental Physics Laboratory

Outline

- Overview of Stanford-KACST Space Program
- SaudiSat Bus
- UV LED Mission
- Modular Gravitational Reference Sensor

Science: Earth and Planetary & Gravitational Physics

Aeronomy – Drag-free mission - 2016

- Study of upper region of the atmosphere of planets and moons where atmospheric tides, dissociation and ionization are critical

Geodesy – mGRACE (2 SC) - 2018

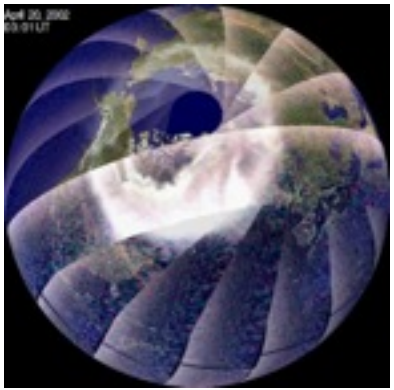
- Study of gravitational fields and their time variation of planets and moons including geodynamical phenomena

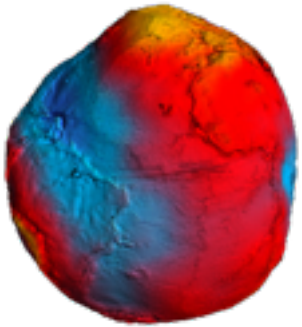
Inverse Square Law – Drag-free "Pioneer"

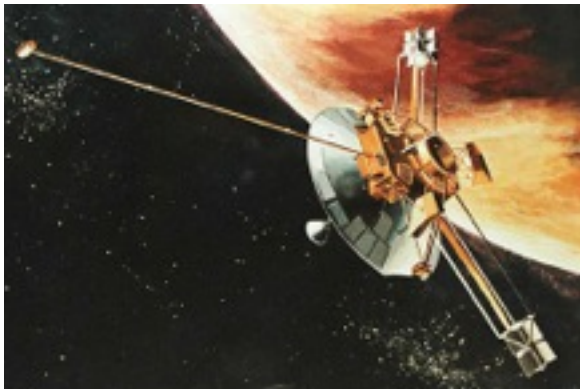
- Measurement of deviation of gravity from the inverse square law in the solar system with: 10^{-12} m/s^2 to 10^{-15} m/s^2 precision

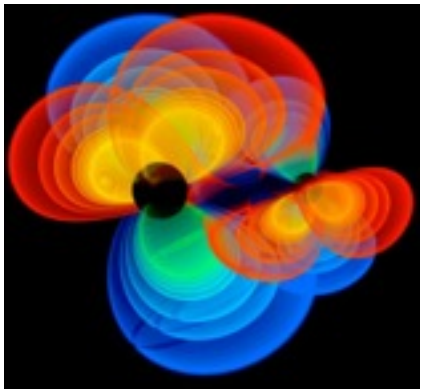
Gravitational Waves – LISA 2020

- Ripples in the curvature of spacetime that propagate at c and transport energy as gravitational radiation

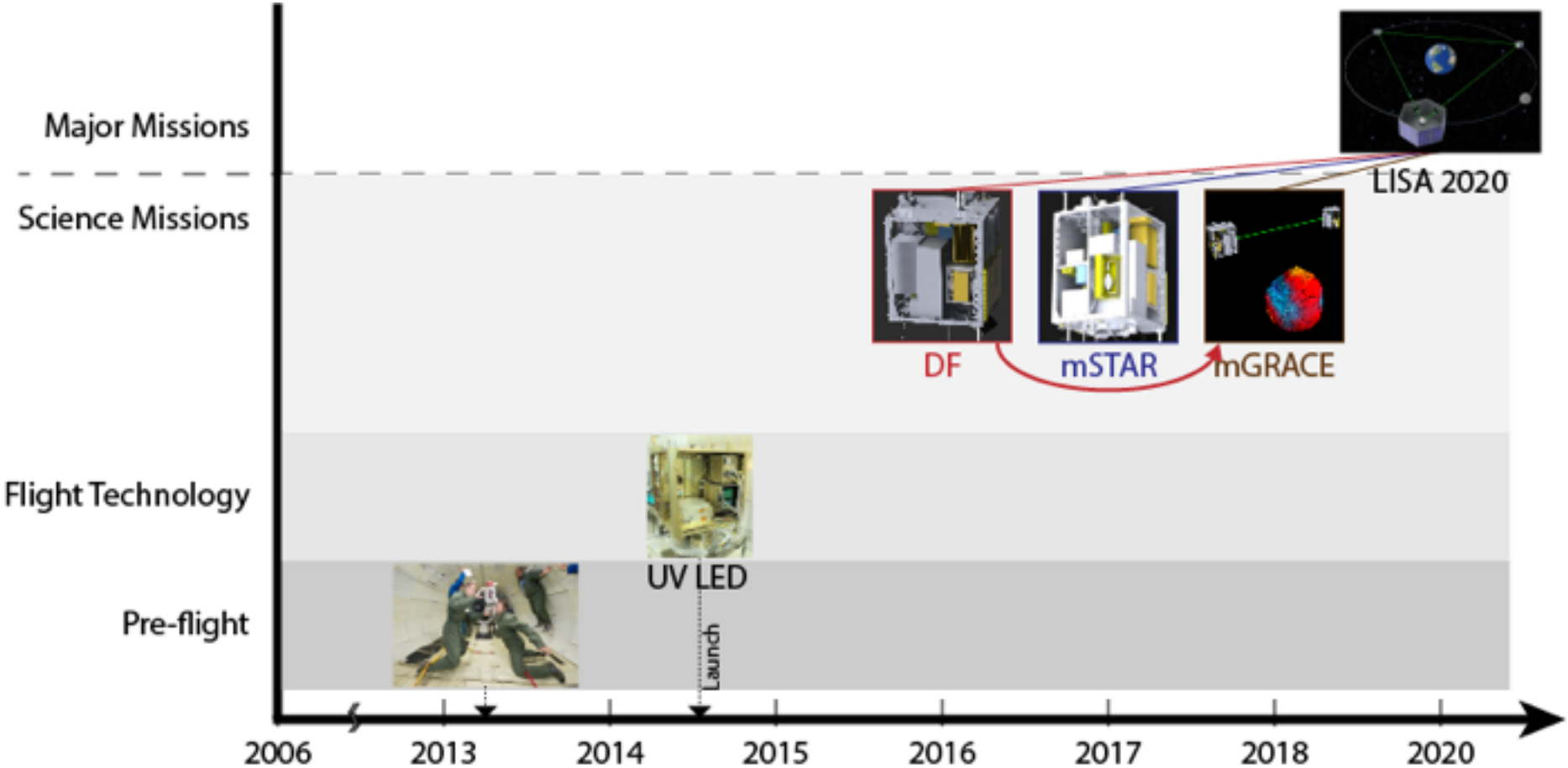








The Stanford-KACST Space Program



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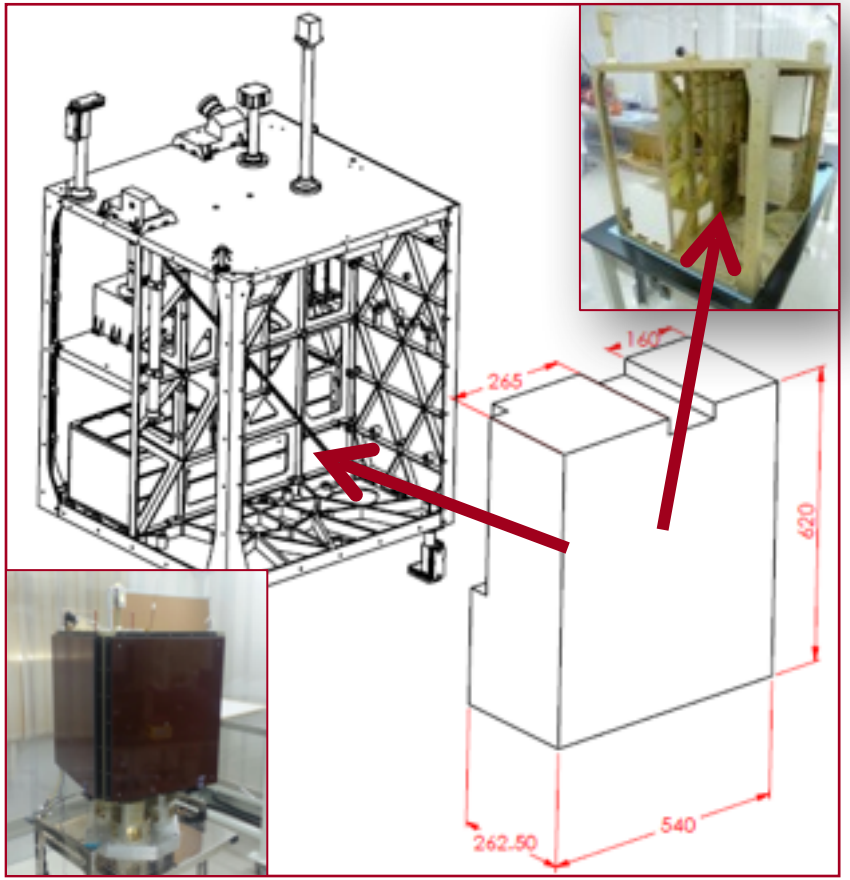
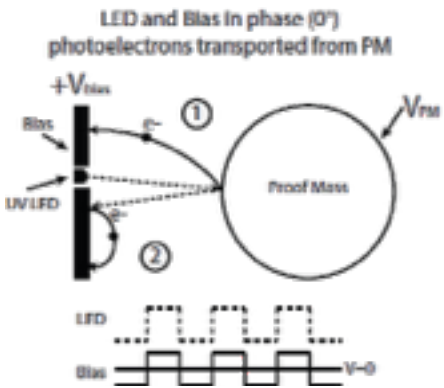
SaudiSat 4 Configurable Bus

- Total Launch mass: 112 kg
  - Bus: 50-80kg (depending on ADACS)
- Power Generation: 61-86 W
  - Payload: 45 W
- Power Storage: 113-452 Wh
- Data Storage: 28 Gbyte at 25 MB/s
- Downlink: 358 Mbit/s

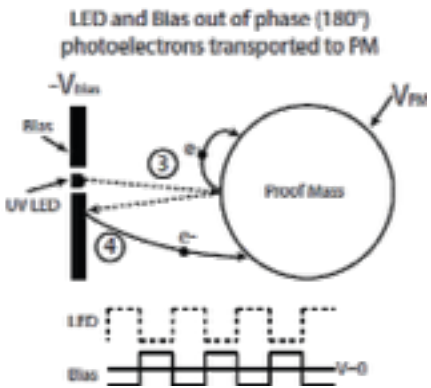


UV LED Charge Management

- To be launched June 2014 on Saudi Sat

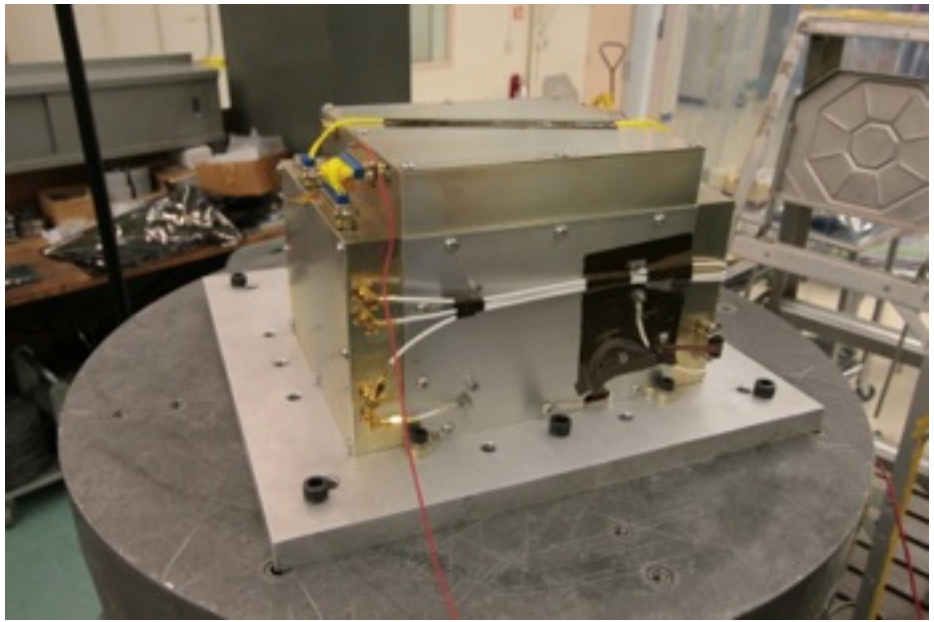


"Positive Charge Transfer"

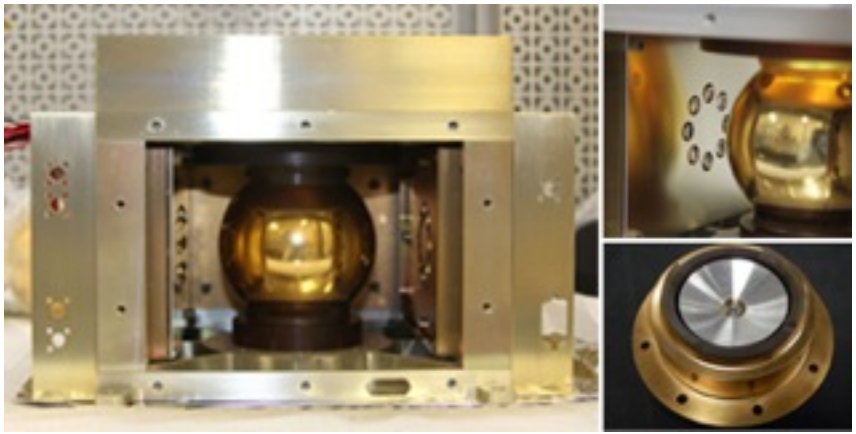


"Negative Charge Transfer"

- Below: engineering model on vibration table

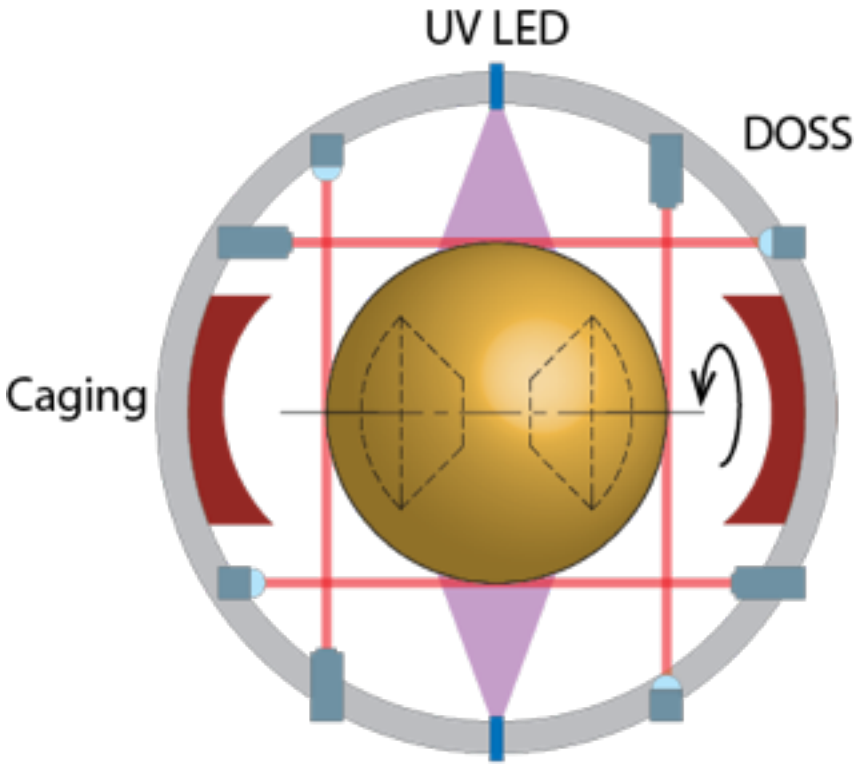


UV LED Charge Management



- 16 total LEDs
- Four bias plates
- Gold coated sphere
- Contact probe
- Gold coated Ultem tubes for shielding

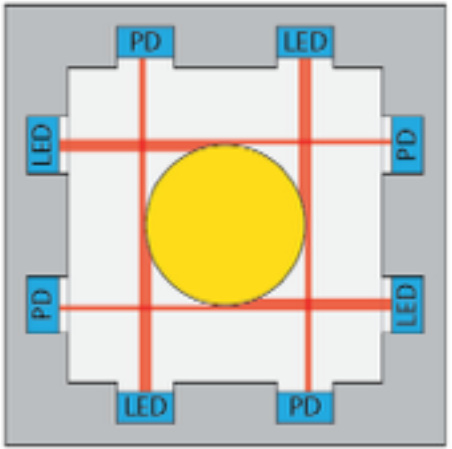
Modular Gravitational Reference Sensor

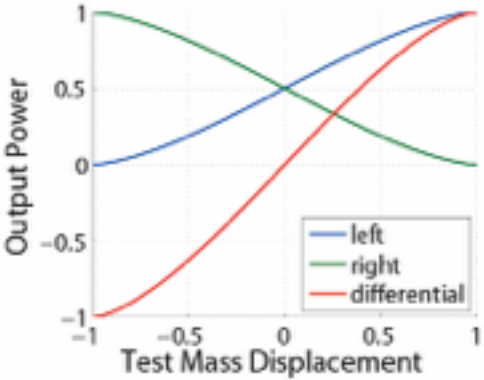


- Differential Optical Shadow Sensor (DOSS) to sense external disturbances
- UV LED for Charge Management to compensate internal disturbance
- Caging Mechanism designed for 200N holding force
- Spinning sphere for spectral shift of disturbances

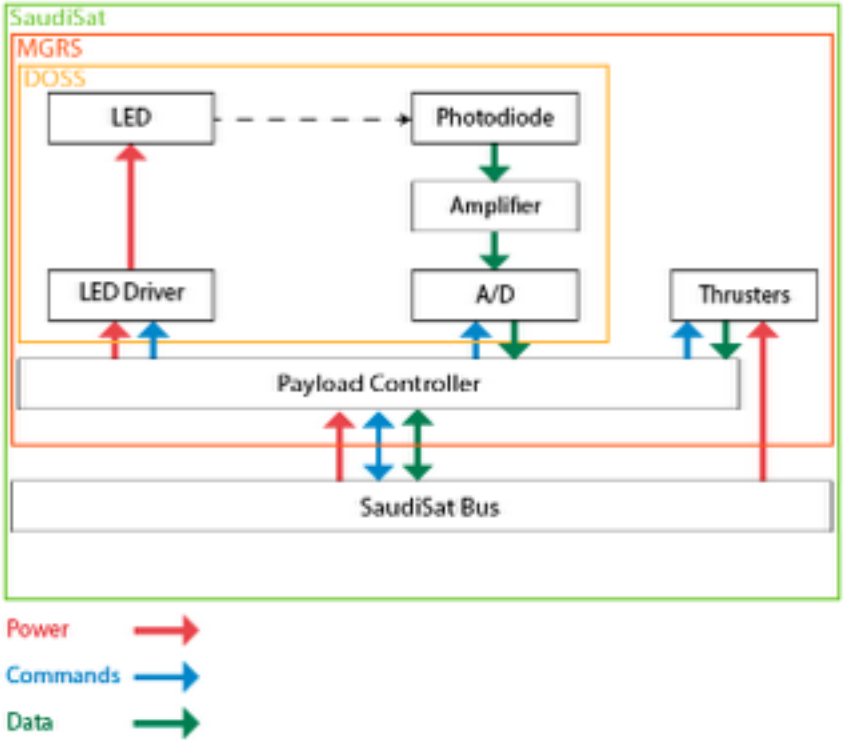
Differential Optical Shadow Sensor (DOSS)

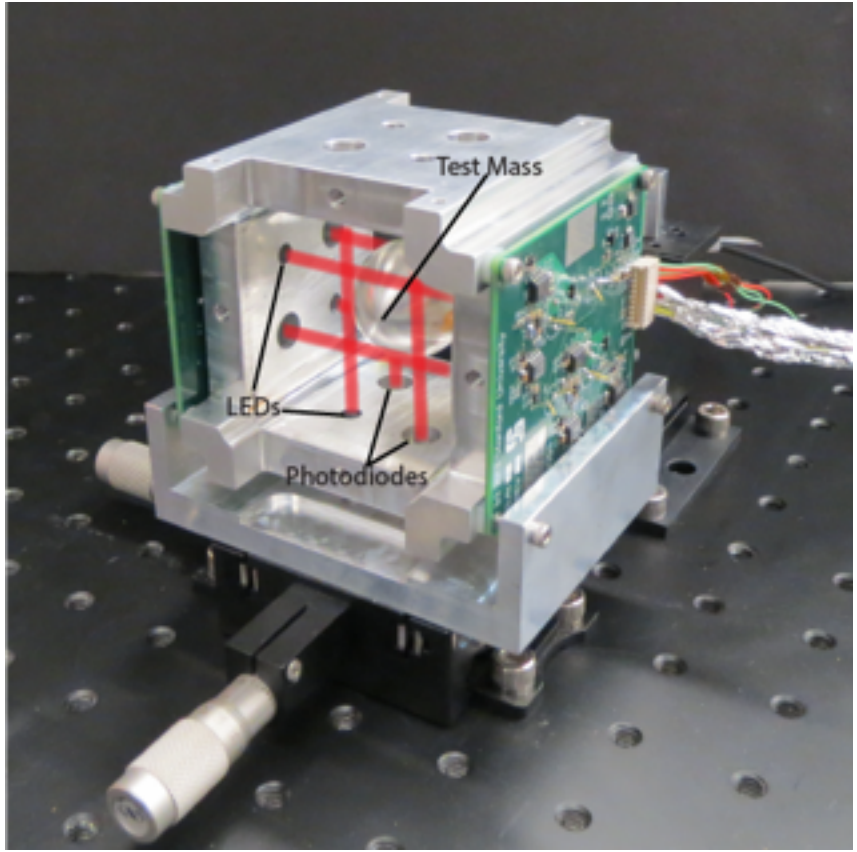
- Precision displacement measurement
- Designed for 10nm resolution at 10mHz-1Hz
- 8 balanced beams for redundant 3D measurement



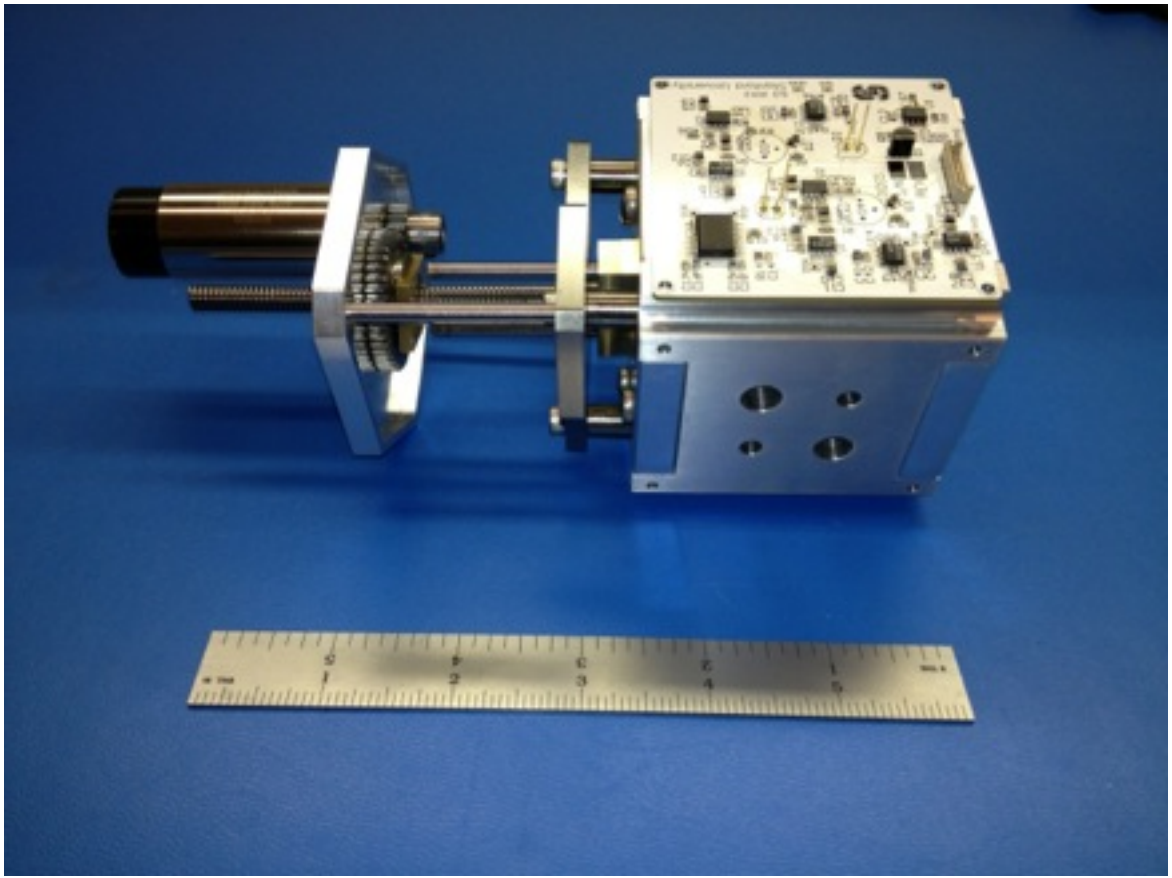


DOSS System Overview

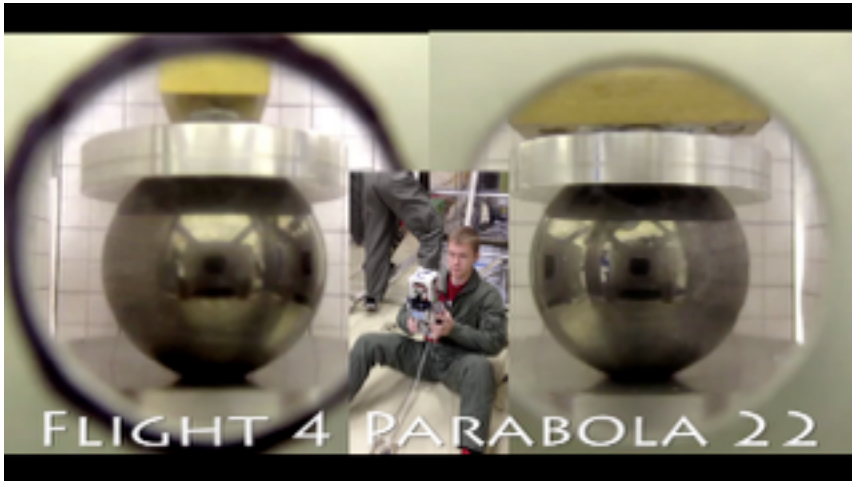


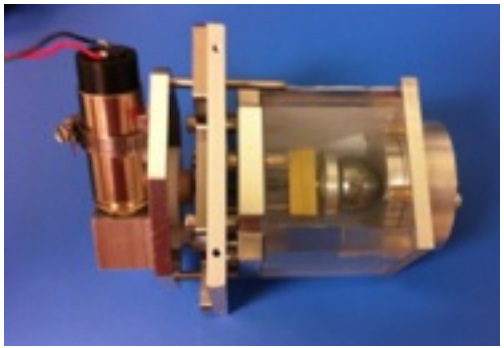


Caging System

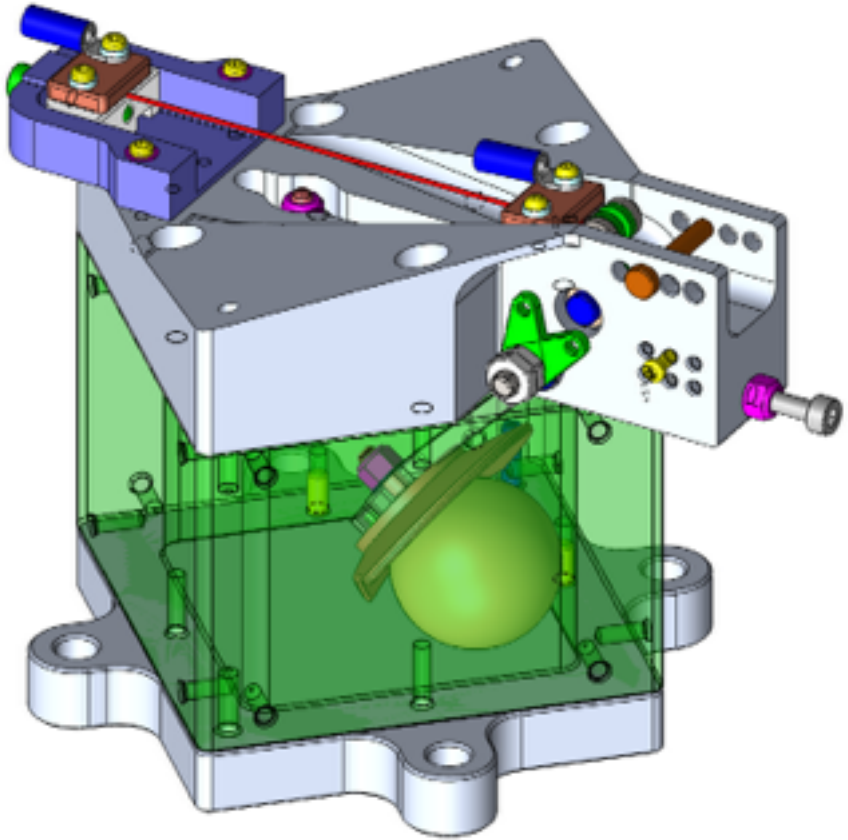


Caging System on ZeroG Flight

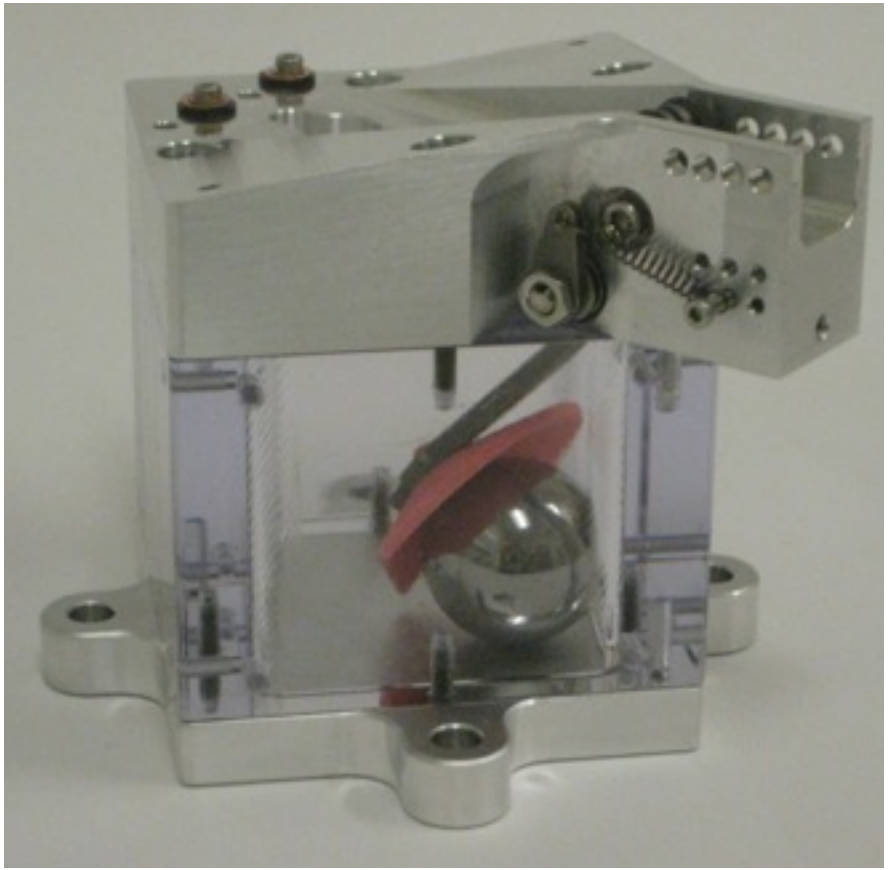




Single Cycle Caging System



shape memory alloy test prototype



Further Research Activities

- Magnetic levitation and spinup for spherical test masses
  - Poster by Abdul Alfauwaz
- Thermal shielding for microkelvin temperature stability
- Proof Mass coatings
- Laser stabilization, optical clocks
- Laser ranging
- Laser ablation thrusters

With contributions from
Abdul Alfauwaz, Abdulaziz Alhussien, Karthik Balakrishnan, Sasha Buchman, Robert L. Byer, Grant Cutler, Dan B. DeBra, Eric Hultgren, John Lipa, Shally Saraf, Alberto Stochino, Zach Sunberg, Si Tan

THANK YOU