Initial Results from ST7-Disturbance Reduction System on LISA Pathfinder

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on behalf of the LISA Pathfinder Team

1. Jet Propulsion Laboratory, California Institute of Technology
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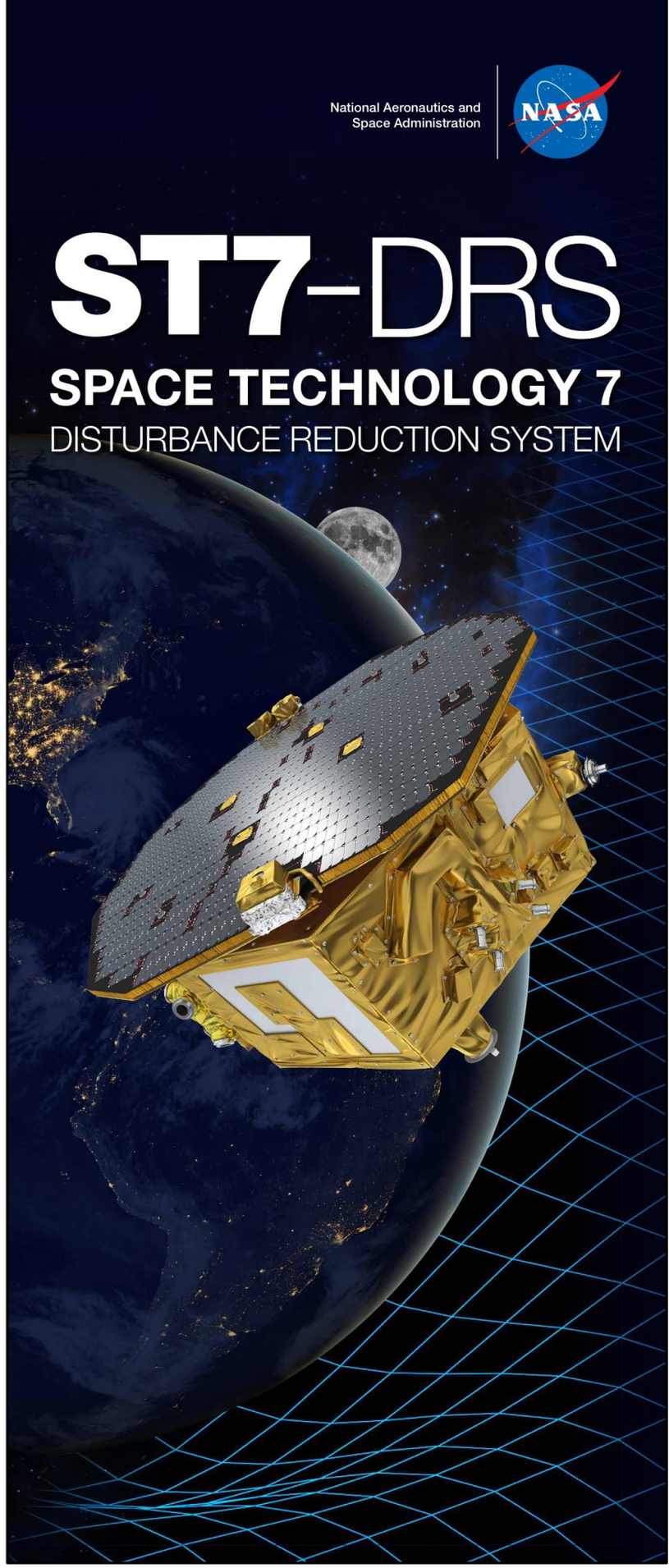

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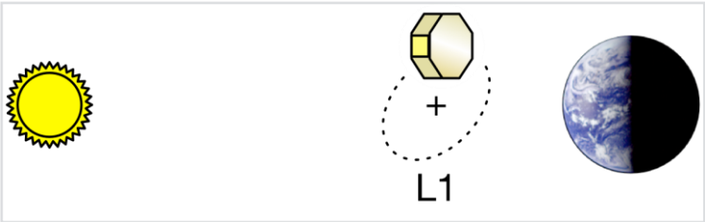
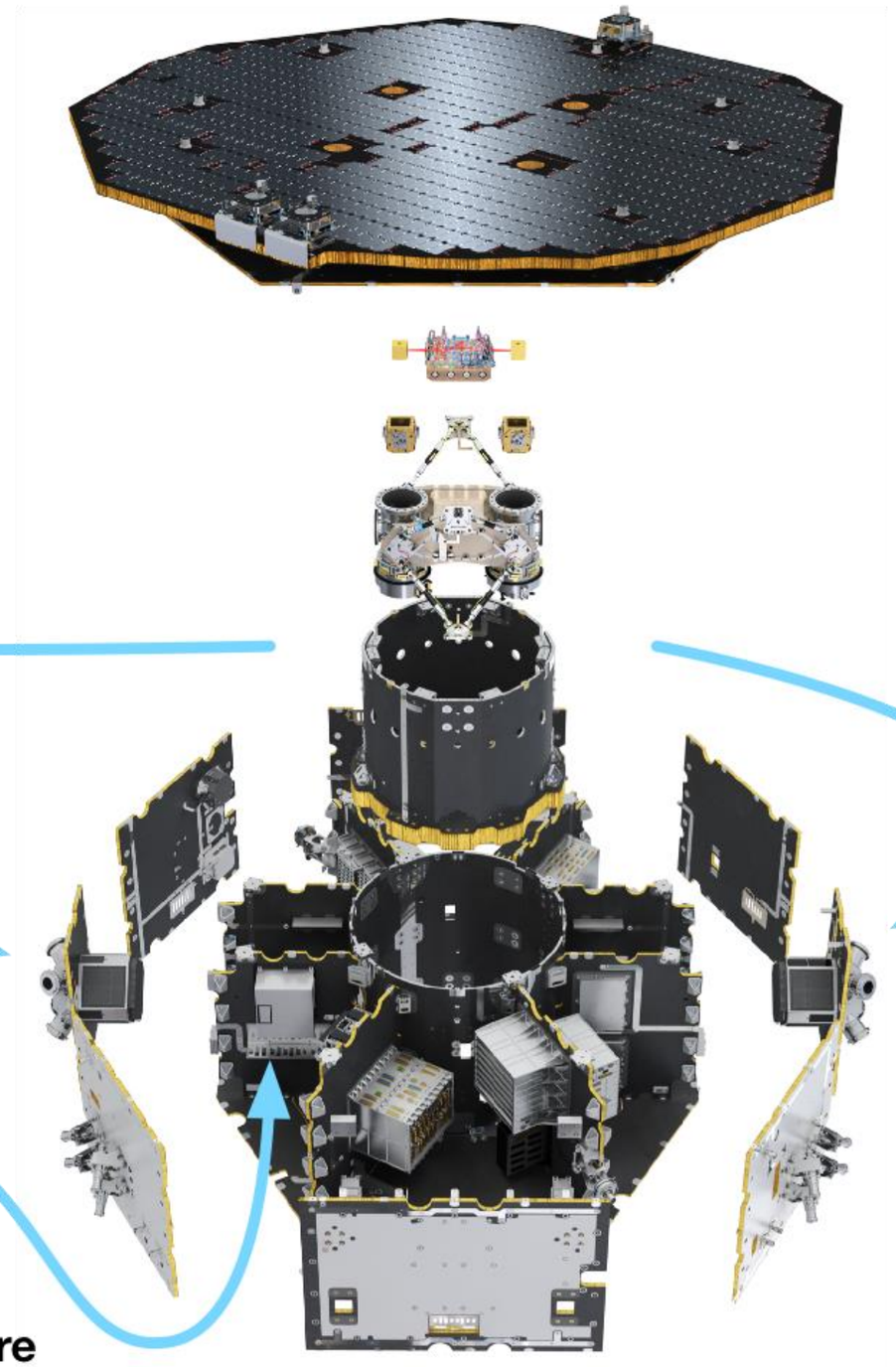
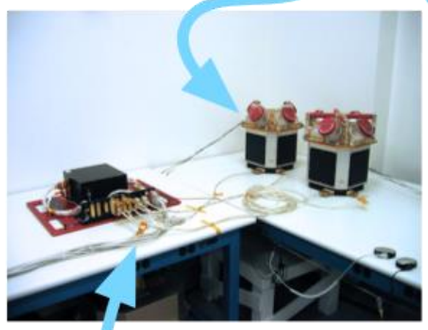
LISA Pathfinder Mission & DRS

- DRS is a NASA contribution to the ESA LISA Pathfinder mission at L1





Colloid Micro-Newton Thrusters
2 cluster of 4 thrusters, each
Busek Corp.



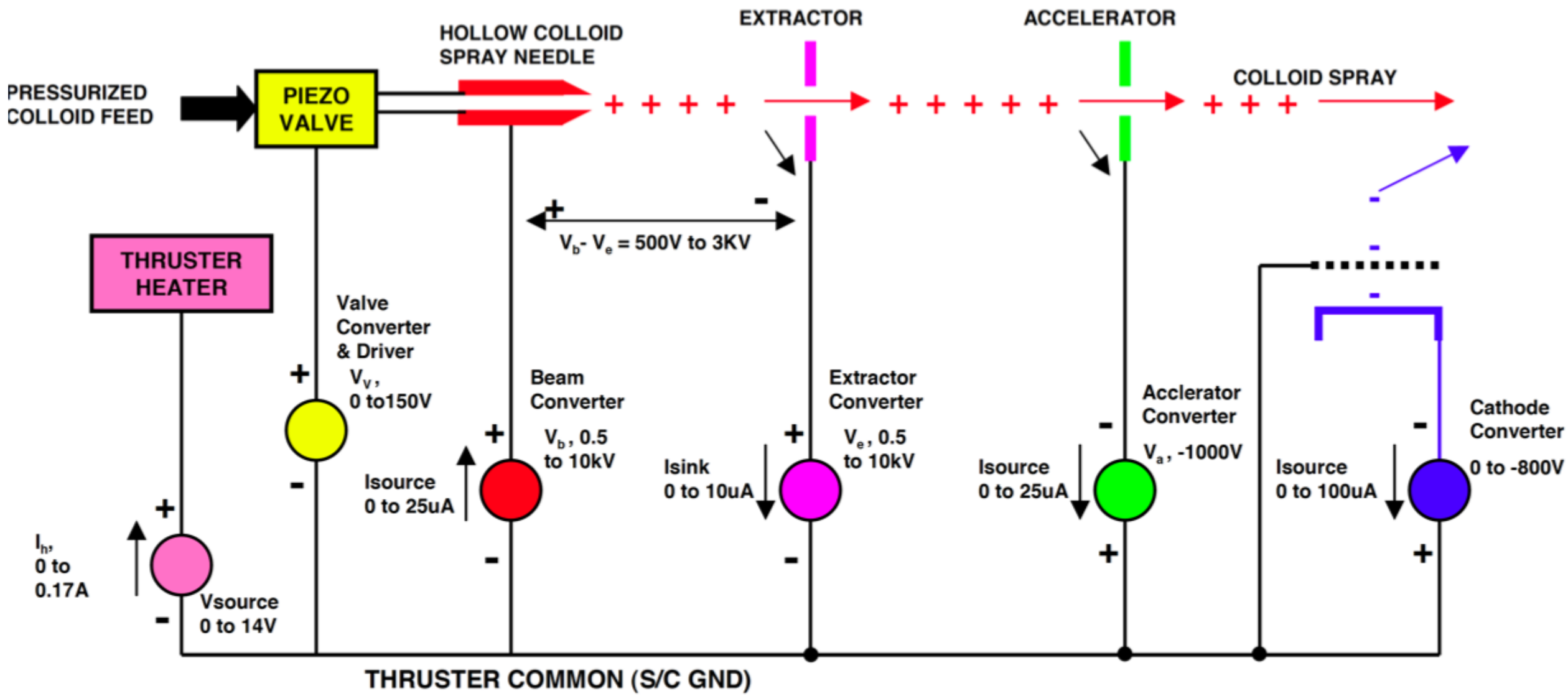
Integrated Avionics Unit
Rad750, power switching & comm
Broad Reach

Dynamic Control System Software
18 Degree of Freedom control
Goddard Space Flight Center

exploded view © ESA

Colloid Electrostatic Thrusters

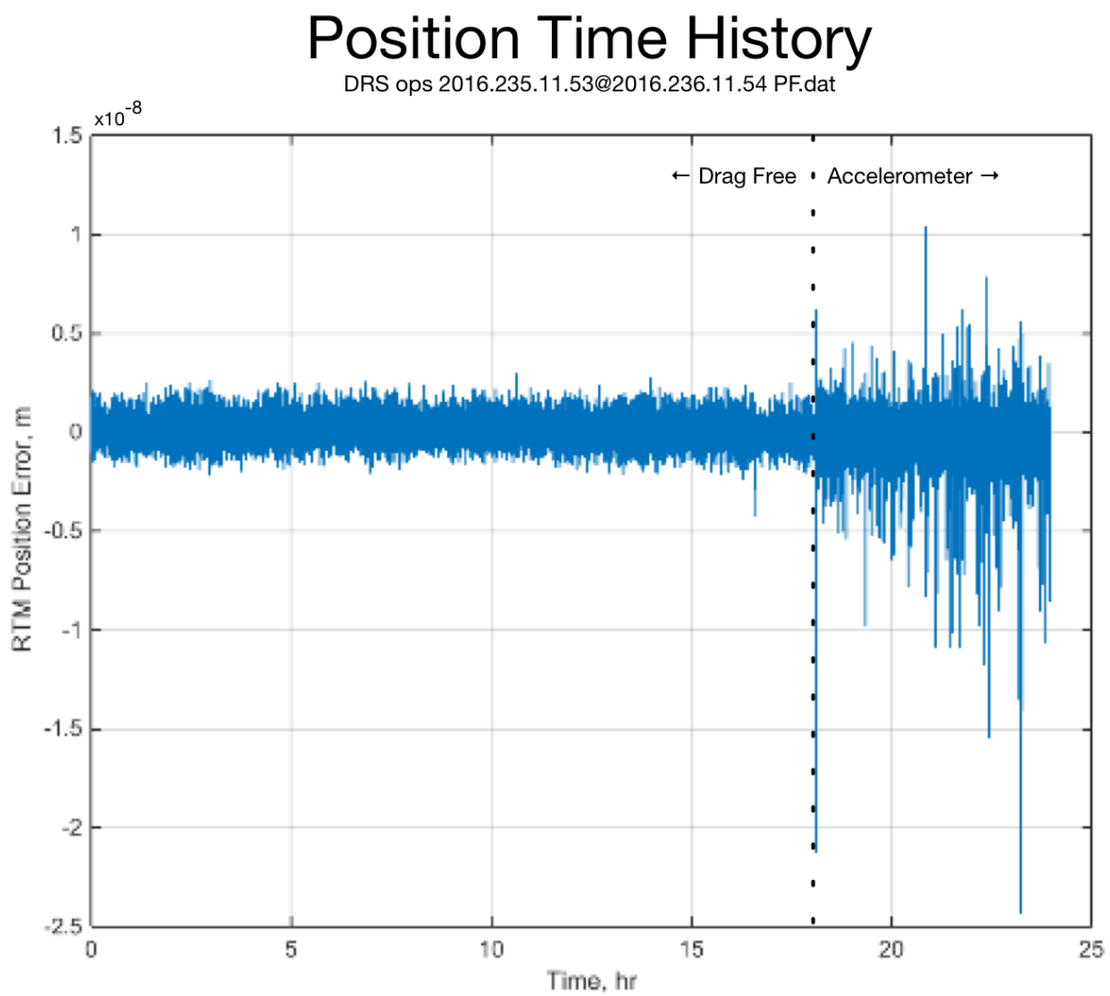
- Thrust: 5 µN - 30 µN (nominal)
- ΔThrust: 0.1 µN
- Power Consumption: 24 W/cluster

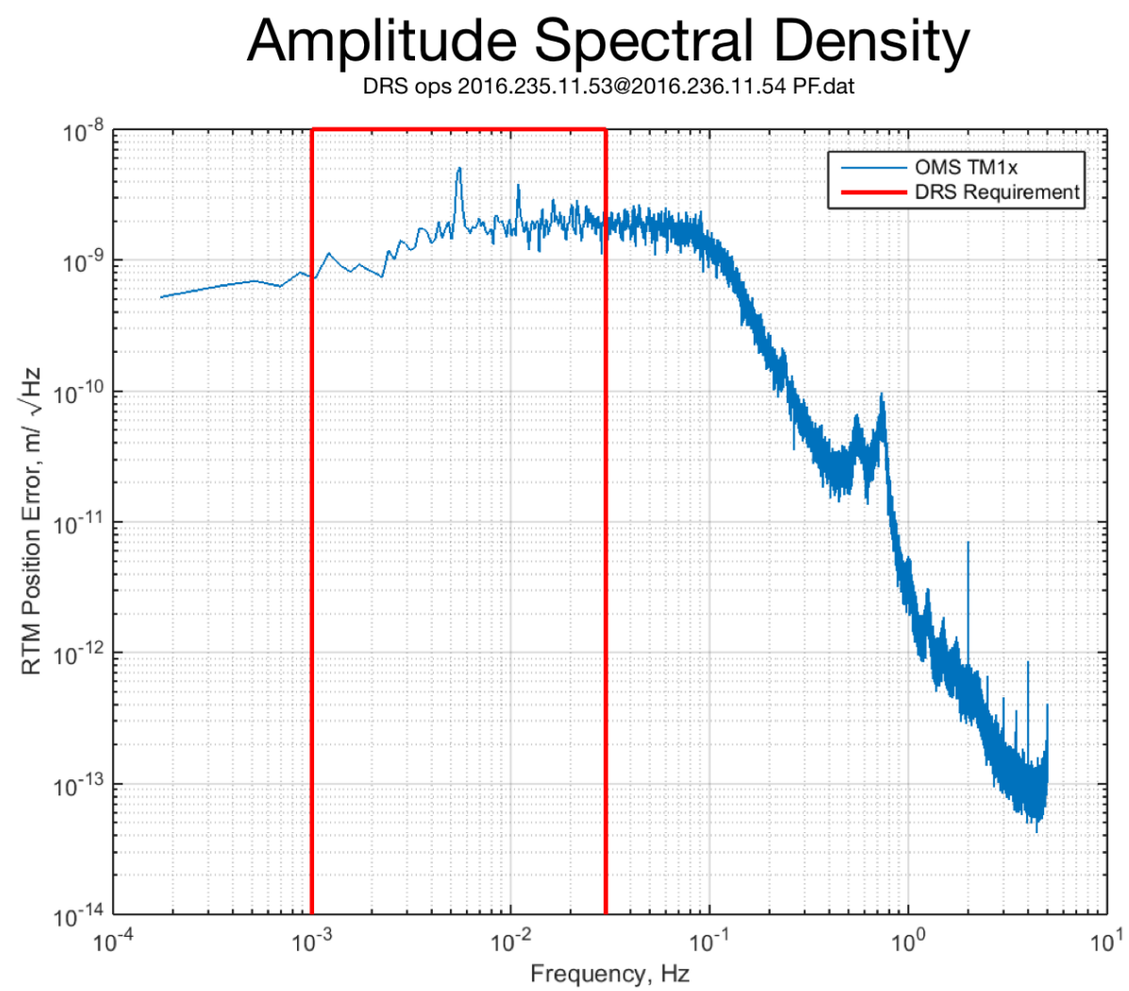


CONTROLLED VARIABLES: V_b, (V_b- V_e), V_v, I_h, I_c

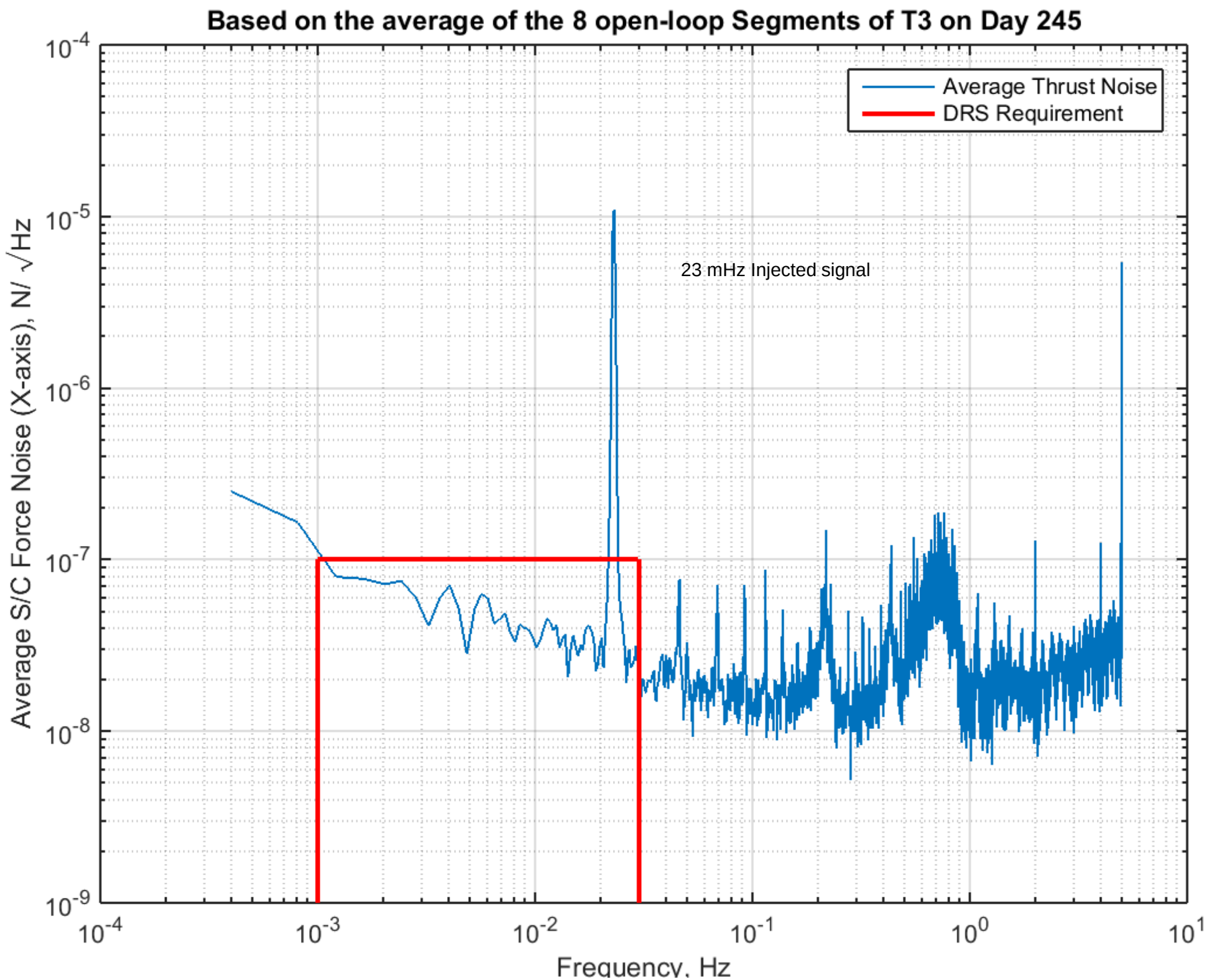
Position Control

Reference Test Mass X-Coordinate relative to S/C





Propulsion Noise



Major Conclusions

- ST7 was a successful demonstration of drag-free control at a performance level necessary for a LISA-type GW observatory
- The space disturbance environment is understood at the 0.1 μN/√Hz level
- The Colloid Micro-Newton Thrusters performed at a noise level predicted by pre-launch testing
- The European LTP Inertial Sensor functioned in the DRS system as expected
- 18 degree of freedom drag-free control operated reliably
- The self-gravity model of DRS is correct at the few pm/s^2 level

Current Status

- On October 27, Thruster 4 was rendered inoperable due to an unrecoverable short
- A hybrid drag-free mode was developed using a constant thrust produced by four spacecraft cold gas thrusters and the remaining colloid thrusters → Slightly degraded performance
- ST7 is approved for extended operations:
  - Characterize and understand cause of Th-4 short
  - Improvements in thruster control loop
  - Higher resolution thrust
  - Improved thruster characterization enabled by SW update
- Expected mid-March to mid-April 2017