

# TableSat 1C

for the

## NASA Magnetospheric MultiScale Mission

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### About TableSat 1C

The Advanced Controls Lab (ACL) at the University of New Hampshire has constructed a series of table top experimental test beds (TableSats) for MMS spacecraft dynamics, control, and flexible structure analysis. TableSat I, the first generation of TableSats, is a limited 3-DOF rotation (full spin and limited nutation) test bed. To study the effects of spin rate and nutation control on the experimental spacecraft bus and flexible booms, a PID and LQR controller have been implemented on TableSat 1C using sensor feedback from an on-board Inertial Measurement Unit (IMU).

### MMS Mission

NASA's Magnetospheric MultiScale (MMS) mission is a Solar Terrestrial Probes Program that is expected to launch in 2014. The objective of this mission is to study the interaction between the Sun's solar winds and the Earth's magnetosphere. Each of the four spacecraft have six instrumentation booms: four flexible 60 m Spin-plane Double Probe (SDP) booms with thicknesses of just under 2 mm, and two rigid 12.5 m Axial Double Probe (ADP) booms. The SDP booms are of primary focus because of their extreme length and flexibility, and hence their influence on the overall dynamics of the MMS spacecraft.

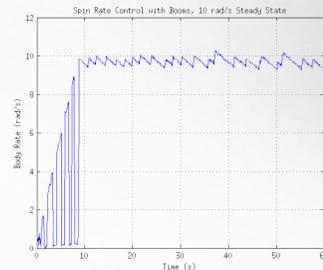
### Electronics

- 16 MHz Microprocessor
  - Control algorithm
  - Processes sensor data
  - Actuates thrusters
- Xbee Wireless Transceiver
  - Receives commands
  - Sends test data
- Inertial Measurement Unit (IMU)
  - Orientation and rate data

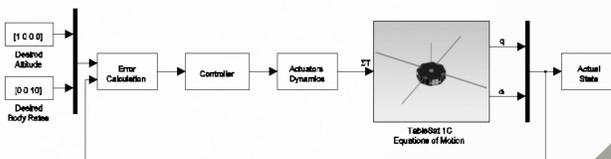


### Control

- Pulse-Width Modulation (PWM)
  - Solenoid valve is on/off
  - Pulse thrusters to vary thrust
- PID and LQR control algorithms
  - Receives IMU measurements
  - Performs algorithm
  - Determines pulse width
  - Spin rate and nutation control



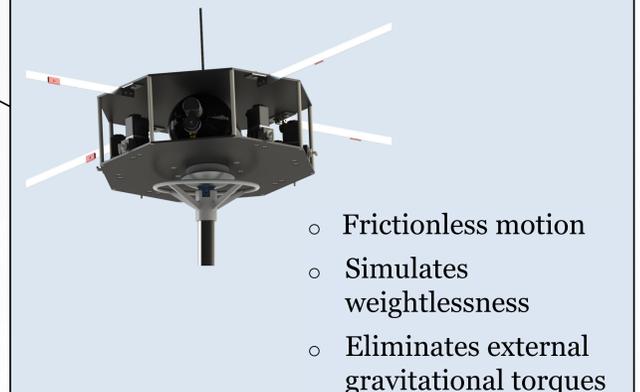
### System Block Diagram



### Booms

- Axial Double Probe (ADP)
  - Rigid similar to MMS ADP booms
- Spin-plane Double Probe (SDP) booms
  - MMS booms are 60 m (200 ft) in length
  - Flexible to simulate MMS booms
  - Three accelerometers per SDP boom
  - Sensors provide dynamics data

### Air Bearing



- Frictionless motion
- Simulates weightlessness
- Eliminates external gravitational torques

### Propulsion

- 3,000 PSI nitrogen tank
- Two regulators for stability
  - First: 3,000 PSI to 400 PSI
  - Second: 400 PSI to 15 PSI
- Nitrogen distributed to 6 solenoid valves
- Solenoid valves control flow to nozzles
- Nozzles control orientation of test platform
  - 4 nozzles control nutation
  - 2 nozzles control rotation

