Systems Integration

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SPHERES Systems: Integration Approach

16.684 CDIO CDR Presentation

Objective

Motivation

Systems

Sub-systems
- Structures
- Propulsion
- Metrology
- Power
- Avionics
- Comm
- Software

- Systems

Program Plan

Summary

- Test each subsystem independently
  - Ensure functionality of each subsystem

- Physically integrate subsystems into structure
  - Address spatial allocation conflicts within SPHERE
  - Optimize position of avionics cards and wiring

- Test each subsystem after integration into the SPHERE
  - Ensure functionality of each subsystem after integration
  - Verify subsystem interfaces

- Test overall functionality of integrated SPHERE
System Integration Tests

- Integrate propulsion, avionics and power
  - Ability to control thrusters / verify propulsion board
- Add a communications capability
  - Allow remote thruster control
- Incorporate metrology functionality into SPHERE
  - Ability to calculate position
  - Check interference issues: thruster noise
- Transmit metrology data to ground station
  - Capacity to transmit large data stream for analysis
- Incorporation of metrology data with maneuvering
  - Closes control loop
  - Shows functionality of fully integrated testbed
• Should simulate as closely as possible the effects of microgravity in a 1-g environment

• Must provide 3 degrees of freedom (restricted to 2-D movement)
  – 2 translational DOF (along x- and y-axes)
  – 1 rotational DOF (about z-axis)

• Must allow for minimal physical modification of the article to be tested
• Air bearing levitation vehicle
  – Three CO\textsubscript{2} tanks feed three pucks via a single regulator
  – A SPHERE satellite sits atop the square mounting plate for testing
  – Can also run off of in-house lab air supply
SPHERES Integration Results

- Accomplishments
  - Open loop control of single satellite
  - Limited position and attitude determination of satellite
  - Every system integrated and functional (metrology system needs refinement)
  - Integration highlighted necessary flight hardware design modifications
    - “Frictionless” 2-D air-bearing

- Issues discovered
  - Tolerance buildup
  - Quality of manufactured boards
  - Wire / Tubing buildup
  - Conflicts with subsystems; mainly propulsion and metrology
    - Too much electrical interference with propulsion
    - Too much acoustic interference with thruster firings