Space Technology 5 (ST-5)
Enabling Future Micro-Sat Constellation Science Missions

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Mission Overview

• Three 25-kg spacecraft including new technologies

• Research-quality science demonstration using the constellation

• Integrated constellation operations

• 3-month flight validation mission
Mission Design Overview

• 25-kg research spacecraft
  - ~53cm x 48cm
  - Magnetically clean (<10 nT at sensor)
  - Low voltage power system (8.4V max)
  - Spin stabilized (~20 rpm)

• 3 spacecraft launched on single Pegasus XL

• Launch Readiness Date: Feb. 28, 2006

• Sun-synchronous elliptical polar orbit (300km x 4500km)
25 Kg Research Spacecraft!

- Variable Emittance Surface (radiator and electronics)
- X-Band Antenna
- Miniature Spinning Sun Sensor
- Nutation Damper
- X-Band Transponder
- Magnetometer Deployment Boom
- Magnetometer (sensor and electronics)
- Low Voltage Power Subsystem (Li-Ion battery, triple junction solar cells)
- CULPRiT 0.5 V Logic chip (on C&DH card)
- Cold Gas Micro-Thruster
- Miniature Magnetometer (sensor and electronics)
Science Validation Plan

• Demonstrate ST-5 as a suitable platform for research-quality scientific measurements
  - Formation fly in pre-determined configurations over the Earth’s northern and southern auroral zones
  - Return research-grade magnetometer measurements
  - Autonomously respond when field-aligned current sheets are encountered (rise in rate-of-change of magnetic field)
  - Measure auroral current sheet motion and thickness, electric current density and temporal stability using the ST 5 constellation data
    • First mission to take simultaneous measurements across the auroral sheets
• Comparison with Defense Meteorological Satellite Program (DMSP) data and ionospheric models
Constellation Configurations

Constellation configurations allow simultaneous measurements of magnetic field across auroral current sheets.

At deployment
S/C are meters apart
Argument of perigee: ~160°

Science Val 1 Configuration
~21 days after launch
S/C spacing: ~25km, ~75 km
Argument of perigee: ~135°

Science Val 2 Configuration
~63 days after launch
S/C spacing: ~50km, ~100 km
Argument of perigee: ~84°
Constellation Operations

- Demonstrate concepts for autonomous constellation management and autonomous operations
- Plug-and-play automation components
  - Goddard Mission Services Evolution Center (GMSEC) “smart sockets” architecture allows communication between ground system applications
  - Real-time command and control system used for I&T and on-orbit operations
  - Simulink model of on-board solid state recorder and power management
    - Automatically updated by downlink telemetry
  - Automated Mission Planning and Scheduling System updated by Simulink model
  - Automated monitoring of telemetry and events with paging of flight ops team
  - Data Trending and Analysis System
- Ground-based maneuver planning to maintain constellation configuration
- One week “lights-out” automation demonstration
ST-5 Spacecraft

Spacecraft #1
Integration & Test

C&DH double-sided board

Micro-thruster

Li-Ion Battery

Triple junction solar array

Evolved antenna (genetic algorithm)

Variable Emittance Coating
Thermal Surface

Miniature Magnetometer
Technology Transfer and Outreach (1)

- ST-5 addresses technology challenges for future nano and micro-satellite missions
  - Validate science-grade measurements, constellation concepts, spacecraft, component technologies
  - ST-5 Constellation validation contributes to Sun-Earth Connection geospace science
  - Reduce risk for future missions
- ST-5 Technology Outreach website provides information on ST-5 technologies
  - http://st5techor.gsfc.nasa.gov
- JPL’s public outreach and education website
- Technology Validation Report will be prepared
Technology Transfer and Outreach (2)

- Technology Forum will present flight validation results and lessons learned
  - 3-6 months after mission completion

- Some ST-5 component technologies are already planned for future missions
  - THEMIS: Miniature spinning sun sensor
  - DAWN: Propulsion tank
  - GEC: Magnetometer boom
  - MagCon: S/C bus
  - SDO: Li-Ion battery