The MOST Microsatellite Mission: One Year in Orbit

Dr. Simon Grocott  Dynacon Inc
Dr. Robert Zee  UTIAS/SFL
Dr. Jaymie Matthews  UBC

11 August 2004
Introduction

• MOST satellite is a tremendously successful scientific mission that has revolutionized the capabilities of microsatellites and their ability to deliver top-quality science.

• Mission Concept
• Satellite Design Overview
• Commissioning Plan
• Commissioning Experiences
• Post commissioning
Mission Concept

- CSA Small Payloads Program
- Photometric study of Asteroseismology
  - measure minute (~1 ppm) variation in intensity of light from nearby stars
  - study oscillations of solar type stars
  - oscillations of metal-poor subdwarfs
    - provide a lower bound on age of the universe
  - light reflected from extrasolar planets
Satellite Design Overview

• Operating Modes
  – Safe hold
    • solar panels on all sides, no attitude control necessary
  – Detumble
    • reduce spacecraft momentum after tip-off
  – Coarse Pointing
    • Provide sufficient accuracy to enter fine pointing mode
  – Fine Pointing
    • Point spacecraft boresight to within 25 arcsecs of target for weeks at a time.
Commissioning Plan

- Health Monitoring
- Spacecraft software upload
- ACS equipment checkout
- Detumble
- Coarse Pointing
- Star Tracker checkout
- Fine Pointing
- Science Commissioning
Launch and Early Operations

- Launch 30 June 2003 14:15:25.395 UTC
- Separation ~3 hrs later
- Groundstation pass ~4.5 hrs later
- First contact successful, battery fully charged, tip-off rates ~3 deg/sec, main solar panels crossing the sun
Spacecraft Software Upload

- Some teething problems experienced during initial V53 software upload
  - ground station tracking poor due to EMI in rack
  - handling of dropped packets critical in SCOS tasks
- Problem downloading files
  - receiver interface on V53 would stop receiving packets
  - problem not reproducible on ground
  - 4 months to debug while performing remainder of commissioning in parallel
  - Work around developed to reset receiver lines
ACS equipment checkout

• Equipment checkout went very smoothly
  – ACS computer and sensors checked out
  – magnetorquer functionality
  – reaction wheel and rate sensor functionality
• Chose to remain in safe hold until reliable whole orbit telemetry was available
• Attitude and power situation acceptable
Detumble

• 24 July 2003, detumbled from 3 deg/sec to <0.1 deg/sec in <6000 sec
Coarse Pointing

- 25 July 2003, Pointing maneuver, attitude determination, slew, stabilization
Star Tracker Checkout

- 29 July 2003, First Light
- Whole orbit data gathered from buffer on ACS node
- Difficulty with stray light
- Star tracker algorithms reworked to deal with stray light

- diffuse stray light a function of location in orbit
- specular stray light a function of attitude
Fine Pointing

- 16 Sept 2003, enter fine pointing, difficulty with SAA
- 7 Oct 2003, reliable stable whole orbit pointing 4.6 arcsec pitch, 4.2 arcsec yaw (1σ)
Science Commissioning

- 9 Oct 2003, ~ 3 months after launch, science data collection begins
- initial science targets selected to test optical and photometric capabilities of instrument
- Means developed to accommodate stray light
- primarily accomplished with science data buffered on ACS computer
- 11 Dec 2003, commissioning completed with new V53 software that allows full science data download
Commissioning Conclusions

- Essentially two significant problems encountered
  - Straylight led to rethink of star tracker algorithms
  - V53 - receiver link hardware limited data downloads, was very difficult to debug, led to long commissioning period

- Commissioning planned to take 2 months
  - reduced science data volume in ~3 months
  - full science data volume in ~5 months

- Ultimately problems overcome
Post-Commissioning

- **Positive scope creep**
  - enhanced capabilities
  - between targets are opportunities to upload new software
  - improved data volume
  - improved star tracker algorithms to get better pointing performance and science data
  - revised star tracker allows for guide star photometry, increased science data

- **0.8 arcsec pitch, 1.4 arcsec yaw (1σ)**
Conclusions

- MOST is an enormously successful microsatellite mission
- All difficulties encountered during commissioning were overcome and the MOST satellite is delivering on all of its promises
- Delivering twice the required volume of science data
- Pointing accuracy ~5 times better than required
- Shocking scientific discovery of no stellar p-mode oscillation in Procyon.
- Scientific discovery reverberating through scientific community resulting is reassessment of capabilities and targeting of COROT mission