MSFC-003-ABSTRACT

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Abstract Submitted
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Gravity Probe B Timing System and Roll Phase Determination[1] JIE LI, Stanford University, JEFFERY KOLODZIEJCZAK, NASA/MSFC — An oven-controlled crystal oscillator at 16.368 MHz provides clock signals to all GP-B components and synchronizes the data collection, transmission and processing. The sampled science data signals are stamped with the vehicle time, a counter of the 10Hz data strobe divided down from the clock. The GPS receiver supplies an external reference for time transfer between the vehicle time and coordinated universal time. Ground and space flight tests show the time transfer error is within 1 μs. The time latency between the effective sample time of science signals and the stamped vehicle time is verified to 1 ms in the ground tests. The GP-B satellite is controlled to roll with a period of 77.5 sec about an axis along the direction to the guide star to average out the disturbance torques fixed to the body of the satellite and reduce the gyroscope readout noise. The roll phase is determined on the ground to high accuracy with the telemetry data from two star trackers and used in the data analysis to separate the drifts of gyroscope spin axes in the orbital plane and perpendicular to the orbital plane. The flight data shows that the roll phase is controlled to within 40 arcsec with a measurement uncertainty of 7 arcsec.

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☐ Prefer Oral Session
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MSFC-003-PRESENTATION

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Gravity Probe B Timing System and Roll Phase Determination

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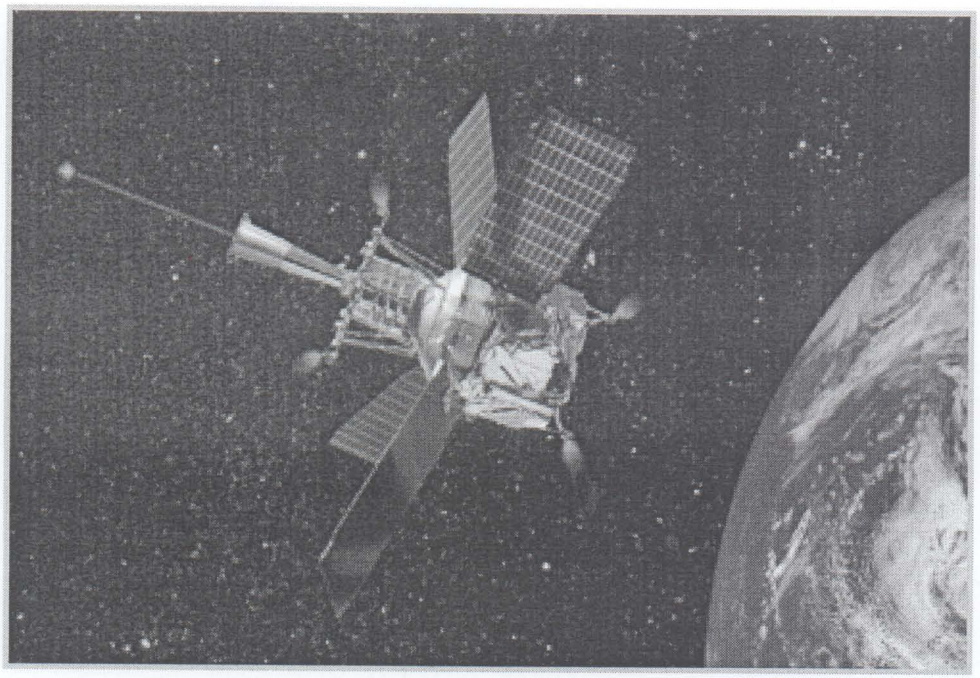
Introduction: Roll Phase



- The GP-B satellite is controlled to roll with a period of 77.5 sec about an axis along the direction to the guide star
  - Disturbance torques fixed to the body of the satellite are averaged out
  - Gyroscope readout noise is reduced

- The roll phase is required in the data analysis to separate the drifts of gyroscope spin axes in the orbital plane and perpendicular to the orbital plane

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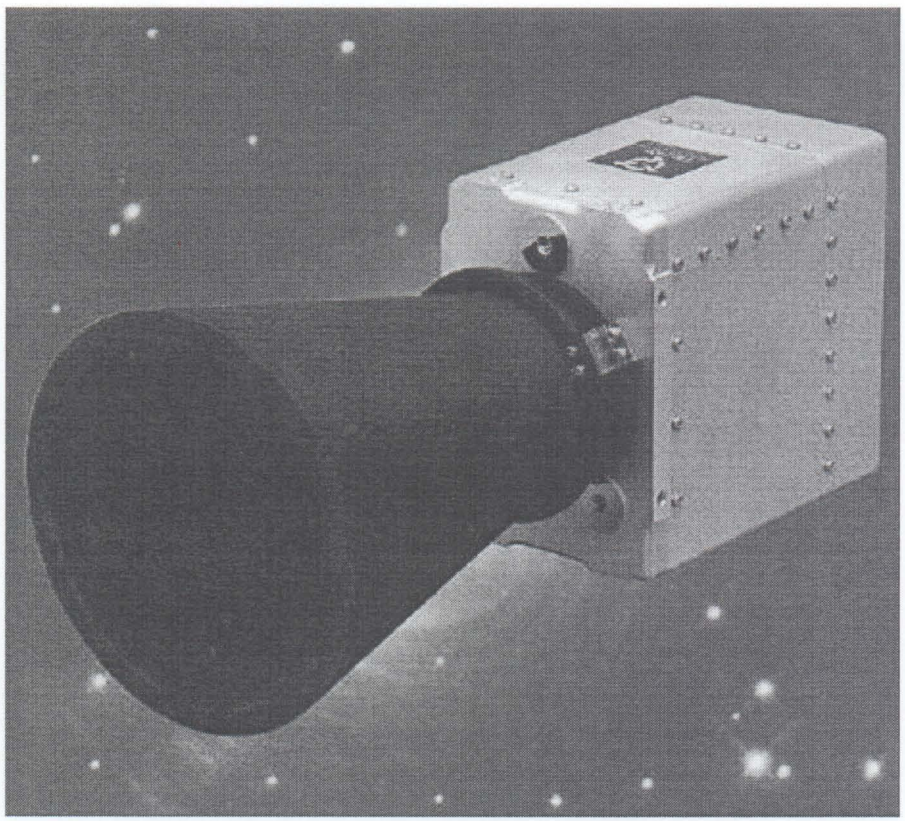
Roll Phase Instrumentation (1)



- The roll phase is determined on the ground to high accuracy with the telemetry data from star trackers
- Two star trackers onboard the GP-B satellite
  - Field-of-view: 8°x8°
  - Boresight axes are 50° and 60° away from the satellite roll axis, out of phase by 180°
  - Each star tracker provides measurements of 6~10 stars in a roll period

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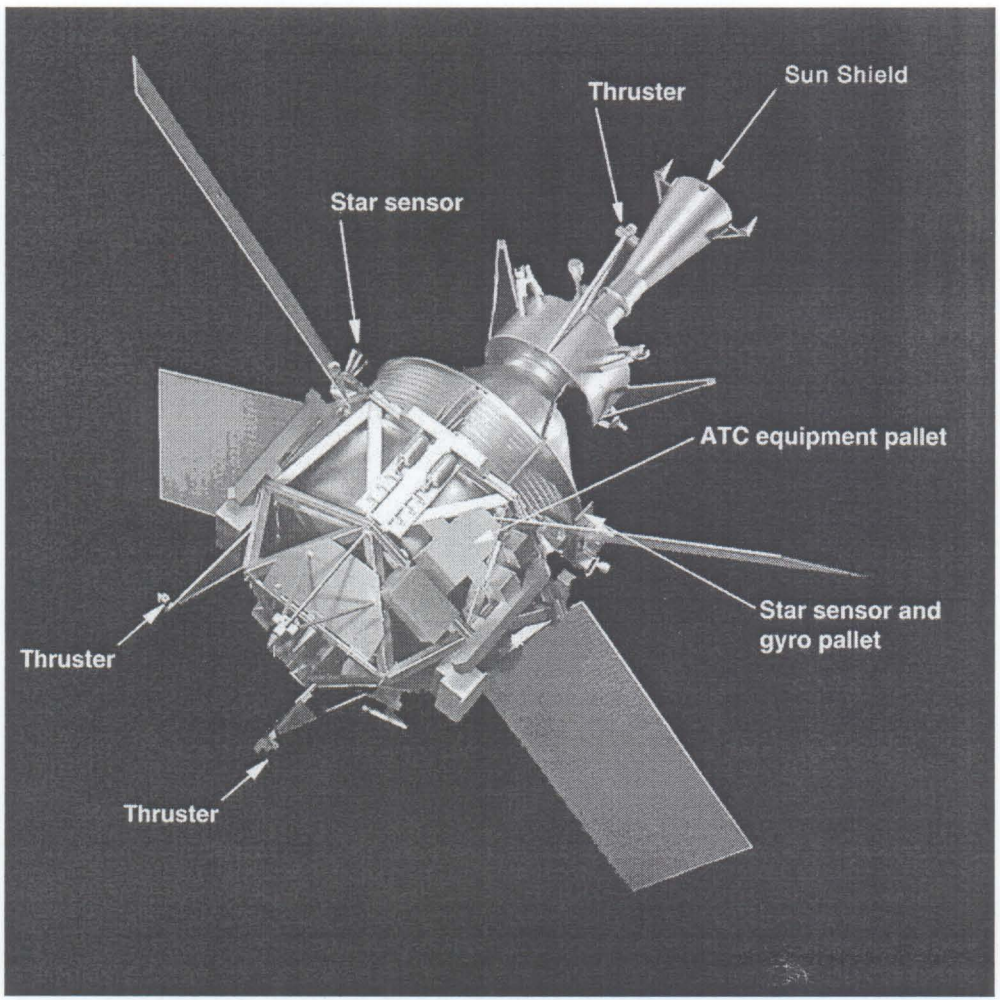
Roll Phase Instrumentation (2)



- Two Attitude Reference Platforms (ARPs) are mounted on the graphite ring around the dewar of the satellite
- One control gyroscope package and one star tracker are mounted on each ARP
- Close-loop control of the roll phase is implemented with 16 proportional cold gas thrusters by the Attitude and Translation Control (ATC) system

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Roll Phase Determination (1): Star Tracker Telemetry Data

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Roll Phase Determination (2): Star Identification

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Roll Phase Determination (3): Star Tracker Data Processing

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Roll Phase Determination (4): Roll Phase Error

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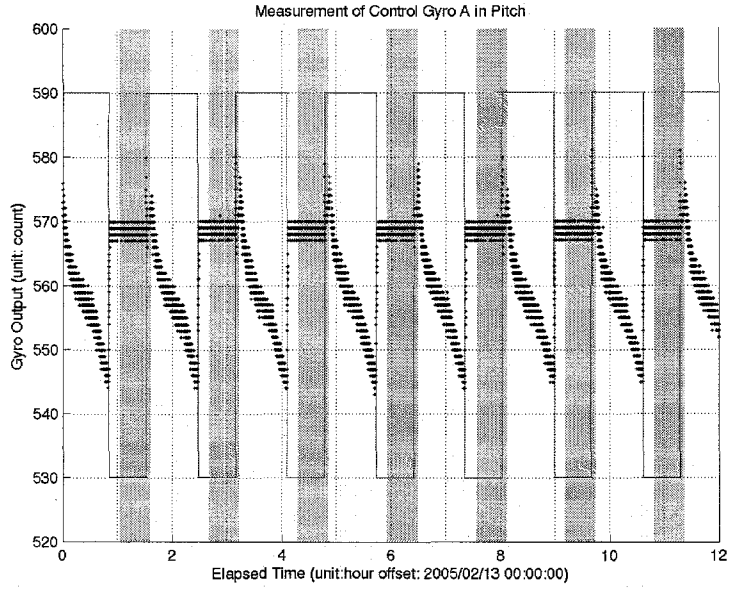
Thermal Distortion of the ARP



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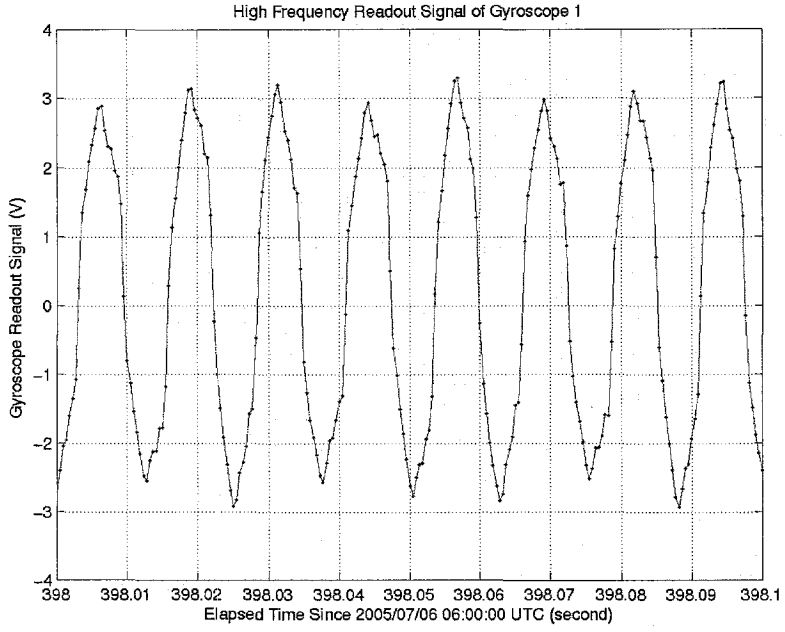
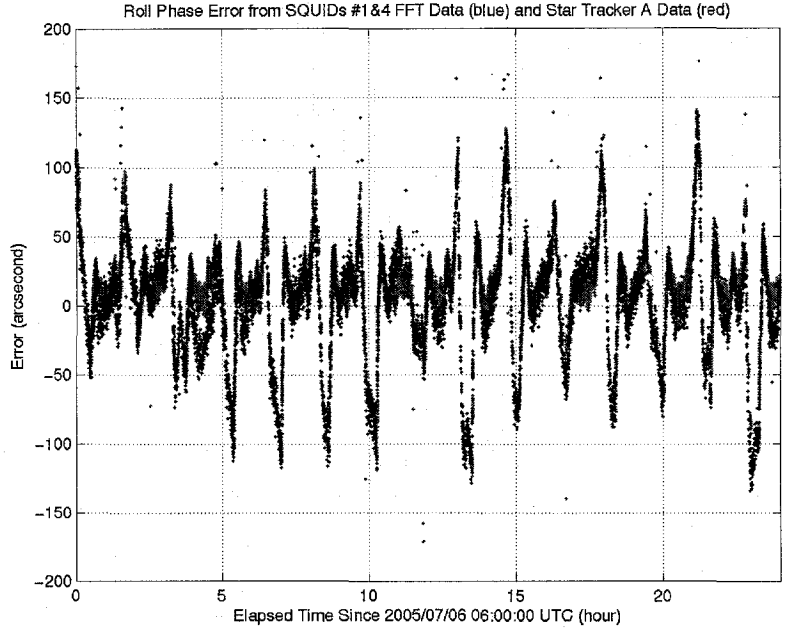
Roll Phase Determined from Science Gyroscope Data

- Roll phase error (deviation of roll phase from uniform roll) determined from high frequency readout signals of the science gyroscopes is independent of the thermal distortion of the ARP
- Observation: Roll phase error determined from science gyroscope data and star tracker data shows good consistency





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Conclusions

- The space flight test shows
  - The peak-to-peak value of the roll phase error is less than 80 arcsec
  - The RMS error of the roll phase determined on the ground is 7 arcsec