The Gravity Probe B Science Instrument Assembly

Saps Buchman, Barry Muhlfelder, and John Turneaure

The SIA Assembly
1. Bond telescope to Quartz Block
2. Mount Gyroscopes
3. Connect to support structure "bird cage"
4. Mount SQUIDS
5. Complete connections
   - Gyroscope suspension, thermometers, heaters
   - SQUID rf thermometers and heaters
   - Telescope electronics and thermometry

What is Required for GP-B Performance?
¾ Materials:
   - Matching CLE to 1 ppb/K
¾ Science Instrument Assembly - SIA
¾ Fused silica, Nb coating
¾ Mount Gyroscopes
¾ "Zero" rotor asphericity
¾ "Zero" rotor inhomogeneity
¾ "Zero" electric charge
¾ "Zero" residual acceleration
¾ "Zero" gas pressure
¾ "Zero" magnetic field
¾ Lowest noise gyroscope read-out
¾ Most sensitive star-tracking telescope
¾ Largest flight dewar
¾ Best proper motion of star
¾ Lowest noise gyroscope read-out
¾ Most sensitive star-tracking telescope
¾ Largest flight dewar
¾ Best proper motion of star

The Telescope
- 150" focal length, 5.6" aperture
- Superconducting pickup on gyroscope housing
- London moment read-out with dc SQUIDs
- Image splitting with roof prisms
- Image divider
- Star Acquisition
- 0.1 marcsec measurement
- 34.5 marcsec/Hz pointing
- Optical aberration due to orbital motion
- Pressure at gyroscopes

Low Temperature Bake-out
- Spin-down periods on orbit (years)
- Spin-down pressure (torr)
- Pressure at gyroscopes is about 10^-14 torr
- Spin-down in Science Mission was not intensity gas pressure

The SQUIDS
- London moment read-out with dc SQUIDs
- Best Gyro
- Gyro spin-down periods on orbit (years)
- Gyro #1 - 79.4, 0.57
- Gyro #2 - 177.8, 0.52
- Gyro #3 - 182.1, 1.30
- Gyro #4 - 64.8, 0.29
- Gyro #4 x 4

Operations
I. GP-B Launch: Apr. 20, 2004
   - Initial orbit checkout - 4 months
   - Plan was 40-60 days
II. Science Mission Start: Aug. 27, 2004
   - Science Mission - 11.5 months
III. Science Mission End: Aug. 15, 2005
   - Post Mission Calibrations - 1.5 months
IV. Helium Depleted: Sep. 29, 2005
V. First Data Release: April, 2007

The Gyroscopes
- Materials:
  - Fused silica, Nb coating
  - Diameter 3.8 cm
  - Sphericity: < 1 ppm
  - 1 x 10^-3 " of damage
  - Homogeneity: < 2 ppm
  - Mass unbalance: < 1 ppm

Space improves gyro accuracy by > 1,000,000!

W. W. Hansen Experimental Physics Laboratory • Stanford University, Stanford, CA 94305-4085 • http://einstein.stanford.edu

This research supported by NASA on contract NAS8-39225