National Aeronautics and Space Administration

The Gravity Probe B Satellite

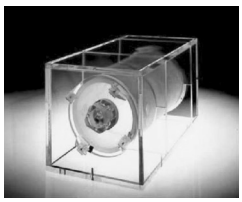
Gravity ProBe

The Gravity Probe B satellite is an amazing piece of equipment, finally completed in 2003 after four decades of development and construction. From its largest to smallest parts, it is filled with cutting-edge technology and materials, many of which were invented specifically for the Gravity Probe B mission.

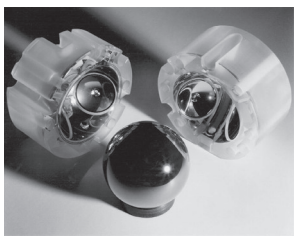
The main body of the GP-B structure is the nine-foot tall dewar, a 650-gallon thermos that insulates the science instrument from solar radiation. It can maintain a stable supercooled environment for eighteen months by using a "porous plug" to remove evaporating helium gas from the helium liquid in its superfluid state. Some important equipment is attached outside the dewar, including the telescope's sunshield, the solar array panels, and the helium gas thrusters. But the technological heart of Gravity Probe B resides in the Science Instrument Assembly (SIA) inside the dewar.

The SIA

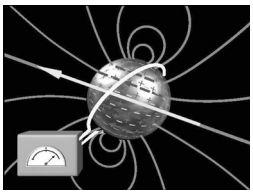
A 14-inch fused quartz telescope, with a 5.5-inch aperture, is able to pinpoint the center of a distant star (IM Pegasus) to within 0.1 milliarcseconds.



Bonded to the rear of the telescope is a fused quartz block containing the centerpieces of the GP-B mission, four fused quartz gyroscopes. These 1.5-inch gyroscopes spin at 4,000 rpm inside housings arely larger than the gyroscopes. They are the most spherical objects in the world, polished to within 0.01 microns of perfect sphericity.



Within the fused quartz block are superconducting loops and SQUID's (Superconducting QUantum Interference Devices) to monitor magnetic fields around the gyroscopes. The quartz block also contains electronics to keep the gyroscopes levitated and centered within the housings, and a gas transport system that spun up the gyroscopes at the start of the mission and maintains a near-perfect vacuum throughout the mission.



A lead "bag" surrounds the SIA to accomplish two goals: 1) to protect it from any interfering magnetic fields, and 2) to create a magnetic field vacuum inside the SIA to $<10^{-7}$ gauss. The entire quartz block and telescope are constructed of several ultra-pure quartz sections, attached through "molecular adhesion" to limit gravitational sag. The SIA is also surrounded by supercooled liquid helium which keeps the probe at 1.8 Kelvin (-271.4°C). This allows the superconducting materials to function and further stabilize all the quartz materials.

Before Gravity Probe B was completely integrated, each component went through years of testing and construction. Some parts even had to be de-constructed and rebuilt. The entire probe was assembled in a Class-10 clean room, as any particles larger than a single micron would disrupt the precise structure.

Using this sophisticated instrument and satellite, Gravity Probe B is orbiting the Earth for 14 months, examining the shape and motion of local spacetime in an attempt to make the most precise test of Einstein's general theory of relativity ever attempted.

For more information, comments or questions, contact GP-B at www@relgyro.stanford.edu or visit http://einstein.stanford.edu/

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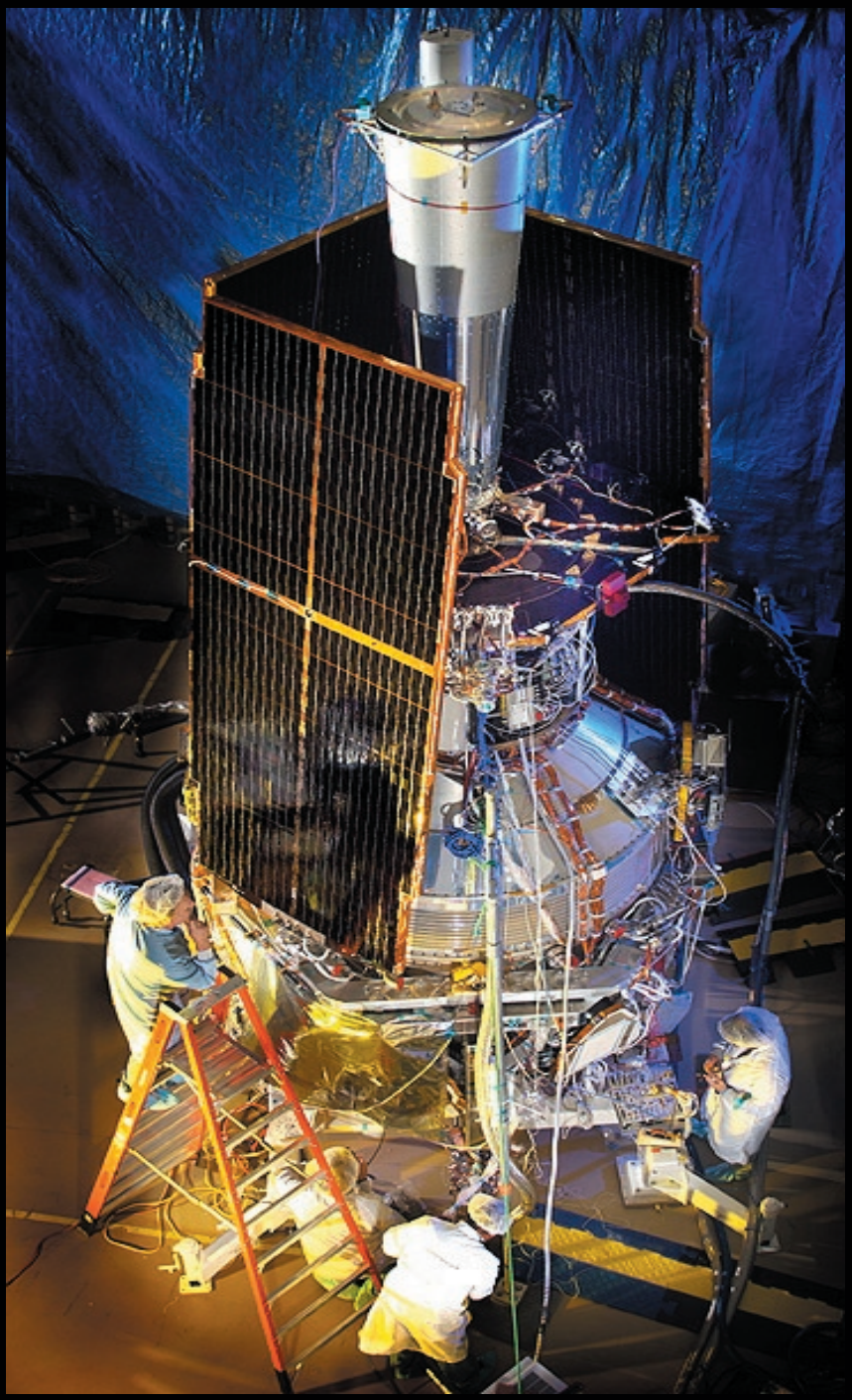
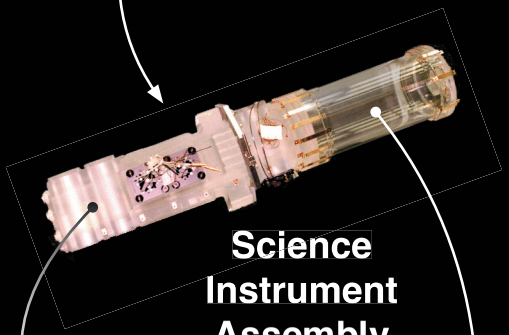
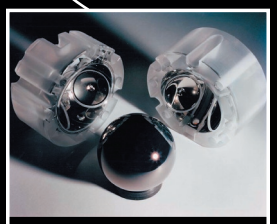
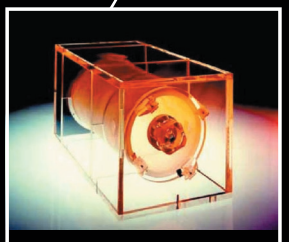




Science Instrument Assembly



The World's Roundest Gyroscope



5.5-inch Aperture Telescope