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Gravity Probe B Relativity Mission

GRAVITY PROBE PROGRAM

PROCESS SPECIFICATION

MEASURING THE ROTOR DIAMETER
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MEASURING THE ROTOR DIAMETER

This procedure describes:
(a) measurement of a diameter at acceptance.
(b) monitoring of the diameter during the polishing process and the final measurement.

A. Diameter measurement at acceptance and during the lapping process

1. Prepare the work area and the Mitutoyo micrometer.

2. Line the v-top block with a viton pad.

3. Place the sphere on the pad.

4. Approach the sphere carefully with the micrometer screw.

5. Gently bring the screw tip to the surface of the sphere to establish contact.

6. Read the number and record the measurement with four decimal point precision.

7. Repeat the measurement in several positions by rotating the sphere.

8. Continue lapping until you reach the diameter measurement of 1.4964 [+.0001|-0.] inch.

B. Diameter monitoring throughout the polishing process and the final measurement
This is a relative measurement performed by using two standard spheres 87R7 and 93H57as a reference. The nominal sizes of the standard spheres are:

a) 1.495901 inch for 93H57
b) 1.4964 inch for 87R7

Note: The 87R7 sphere is used at the beginning whereas 93H57 is used at the end of polishing process. Before the measurement, time has to be allowed for the polished sphere and the standard sphere to reach the same ambient temperature. 20°C is considered the standard room temperature. Otherwise, a correction for thermal expansion difference between the fused silica standard and the measured silicon sphere has to be performed. (See Step 10)

1. Prepare the work area for secure handling of the spheres. In order to avoid accidental switching of the standards with the polished sphere, at no time should there be more than one sphere out of its storage box.

2. Prepare the instrument—the Linear Variable Differential Transducer (LVDT). Since LVDT is temperature sensitive, take precautions and do not touch the sensor.

3. Move the sensor tip with a wooden fork to increase the clearance.

4. Carefully load the sphere into the cradle.

5. Slowly release the sensor tip so that it makes contact with the surface of the sphere.

Note: Please keep in mind that it is easy to damage the surface of the sphere with the hard sensor tip or by allowing the sphere to hit the cradle rail.

6. Record the measurement and the temperature in the lab book.

7. Return the sphere to its labeled box.

8. Bring out the standard sphere and record the difference.

9. Return the standard sphere to its labeled box. At the end of the polishing process, the diameter reading should be recorded in the traveller in the following format:

   [nominal size + difference] ± error.

   For error, one can take the smallest division of the LVDT which is 5 microinches.

10. The data on thermal expansion coefficient of silicon is taken from :
Thermophysical properties of some key solids edited by G.K.White and M.L. Minges
Table 3.2 lists the temperature coefficient of expansion for Silicon at 293.15 K, alpha *, as 2.56 E-6/K

The data for thermal expansion of "quartz glass" is taken from Heraeus brochure: Quartz Glass for Optics Data and Properties.

There is no specific data for Homosil. The value taken is for the range 0-100 degrees Centigrade (Celsius), and is given as the average for the range as 5.1 E-7

The difference (25.6 - 5.1) E-7 = 20.4 E-7 or 2.04 E-6
So the correction applied is 2 ppm / degree Centigrade. As the diameter of the sphere is 1.5 " this means
that the correction is 3 micro inch per degree C.

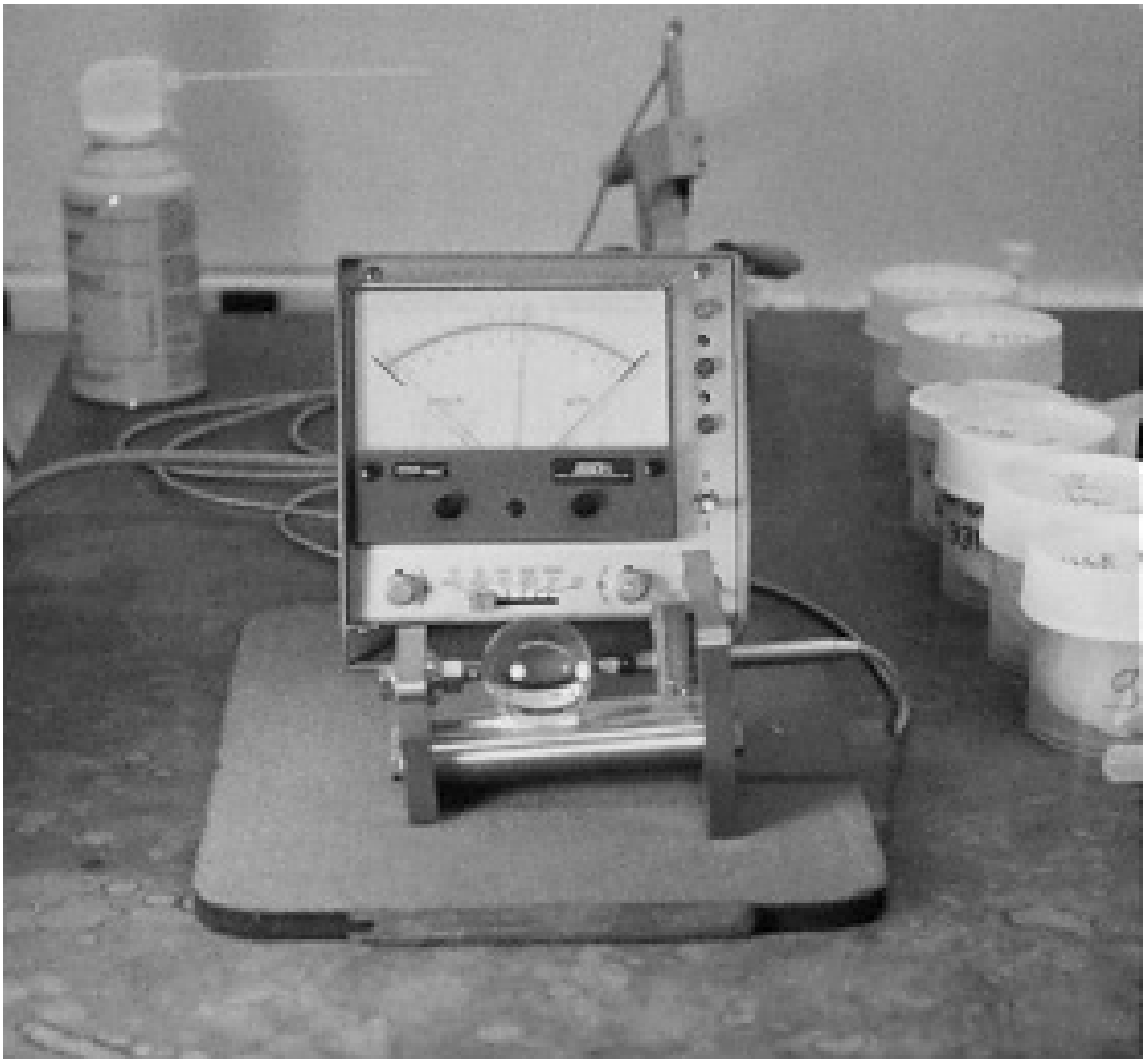

Figure 1 Diameter Measuring Apparatus