STANFORD UNIVERSITY
W.W. HANSEN EXPERIMENTAL PHYSICS LABORATORY
GRAVITY PROBE B, RELATIVITY GYROSCOPE EXPERIMENT
STANFORD, CALIFORNIA 94305-4085

ROOM-TEMPERATURE TEST OF CAGING SYSTEM IN PROBE C

GP-B SCIENCE MISSION PROCEDURE P0536 Rev-A

September 11, 2000

PREPARED	_____	_____
	R. Brumley, Gyroscope RE	Date
APPROVED	_____	_____
	J. Mester, Caging System RE	Date
APPROVED	_____	_____
	C. Gray, Gyroscope Verification	Date
APPROVED	_____	_____
	D. Ross, Quality Assurance and Safety	Date
APPROVED	_____	_____
	B. Muhlfelder, Technical Manager	Date

REVISION HISTORY

Rev	Date	Comments
-	07/11/99	
A	09/11/00	Change procedure to incorporate minor redlines from the previous run. Main structure of the procedure has not been changed.

1. SCOPE

This procedure is intended to be used to verify the functionality of the caging system as part of the room-temperature checkout of Probe C prior to the cryogenic acceptance testing. It may be used at other stages of probe acceptance testing if so desired. This procedure is only intended to verify basic functionality of the system (i.e. that the gyroscope cages and uncages). It does not seek to measure any basic parameters of the caging process. Note that the DDC must be installed per procedure P0481 before performing this procedure.

2. REFERENCES

2.1 Plans and Procedures

P0481	Levitation of Gyroscopes in Probe C
P0505	RT Spinup of Gyroscopes in Probe C
P0410	Pumpdown and leak check

3. GENERAL REQUIREMENTS

3.1 Environmental Requirements

3.1.1 Cleanliness

This procedure takes place in the Class 1000 cleanroom in the HEPL building. Minimum protective garments for personnel working in the clean rooms shall be the standard Tyvek clean room apparel. All activities taking place within this room must be in accordance with the guidelines established by the cleanroom manager.

3.1.2 Particulate Contamination

All connectors shall be inspected and verified free of particulate contamination before they are mated to Probe C. It is also desirable to keep the probe in general clean and free of particulate contamination.

Note: The caging lines have an I.D. of 5 milli-inches. It is therefore very easy to clog the lines should any contamination be present. Great care must be taken to ensure that no particles get into the caging lines.

3.1.3 Magnetic Contamination

This procedure takes place after the vacuum can is sealed, making the experiment much less sensitive to magnetic contamination. However, great care shall still be taken to avoid cross contamination between any magnetic (e.g. steel) item and the

probe, particularly on the probe's "cold" end. Therefore no magnetic items may be used in the immediate vicinity of the "cold" end of the probe.

3.2 Test Personnel

3.2.1 Test Director

The test director for this procedure shall be Robert Brumley, or his appointed replacement.

3.2.2 Personnel

The following personnel have received the training necessary to perform this procedure.

- David Hipkins
- Bruce Clarke
- Chris Gray
- Robert Brumley
- Dr. John Mester
- Dr. Sasha Buchman

See section 3.4 for details on the requirements for Quality Assurance notification and witnessing of this procedure.

3.2.3 Minimum Personnel

No activity shall be performed on the science mission probe without at least two people in the room, i.e. at least one person to perform the procedure and one person to observe the procedure.

3.3 Safety

3.3.1 Hardware Safety -- General

It is important to be cognizant at all times of the position of the probe. Be extremely careful not to accidentally bump into the probe. If any connector does not connect smoothly and securely, do not try to force it. Instead, remove the connector and inspect it to find the reason for the difficulty. Great care must be taken at all times during the performance of this procedure.

3.3.2 Electrostatic Discharge

Grounded wrist straps shall be worn at all times when mating or demating to an electrical connector on Probe C.

3.3.3 Personnel Safety

All operations shall take place according to Stanford University safety guidelines. Any person observing a situation which they deem unsafe shall report the fact immediately to the test director. The Quality Assurance representative shall be responsible for monitoring that all activities are performed in a safe manner.

3.4 Quality Assurance

- Stanford QA must be notified at least 24 hours before beginning this procedure.
- ONR QA must be notified at least 24 hours before beginning this procedure.
- D. Ross (or her designate) must be present to monitor the completion of this procedure.

This procedure shall be conducted on a formal basis to its latest approved and released version. The QA Program Engineer shall be notified of the start of this procedure. A Quality Assurance representative designated by D. Ross shall review any discrepancy noted during test. Redlines shall be approved by the QA representative. The QA representative will nominally be Russ Leese. Upon completion of this procedure, the QA Program Engineer, D. Ross or R. Leese, shall certify his or her concurrence that the effort was performed and accomplished in accordance with the prescribed instructions by signing and dating the appropriate approval line at the end of the procedure.

3.5 Red-Line Authority

Authority to red-line (make minor chances during execution) this procedure is given to the qualified personnel listed in section 3.2.2. All redlines must be approved by the QA representative. In addition, approval by the Hardware Manager shall be required if, in the judgement of the test director or the QA representative, experiment functionality may be affected.

3.6 Electrical Connections

When mating to any flight connector, the following items are required:

- A grounded ESD strap must be worn by any person handling a connector on Probe C
- Inspect both connectors being mated to ensure that there are no particles that might interfere with the mate.

- Each mate and demate of flight connectors must be logged in that connector's mate/demate log sheet. Note that these log sheets have already been started for all suspension lines.

4. REQUIRED EQUIPMENT

4.1 Flight Hardware

- Probe C assembly with vacuum can installed, no sunshade.

4.2 Ground Support Equipment

The following equipment is necessary to perform these tests.

Item	Quantity
GSE plumbing assembly for caging	1
Bottle of ultra-pure He	1
Gaskets for VCR fittings (connector savers for flight gammah connections)	3
Digital Multimeter capable of reading resistances >200 MΩ. Model: _____ S/N: _____	1
DDC-Probe C Interface Box	1
DDC Suspension System	1 / gyro testing

4.3 Software

No software is necessary for this procedure.

4.4 Tools and Miscellaneous

Fluke meters and capacitance meters shall be readily available should the need to trouble shoot arise.

5. GUIDELINES FOR OPERATIONS

- This procedure may be completed with the probe either at atmospheric pressure or in high vacuum.
- This procedure should be completed for each gyroscope in the probe.
- Note that the DDC must be installed per P0481 before performing this procedure.
- Gyroscopes 1 and 2 can be tested separately
- Note that the same line feeds both gyroscopes #3 and #4. Therefore both gyroscopes cage at the same time. However, there are two valves that feed this one line. Both of these valves need to be checked.
- This procedure leaves the option for either a full cage (160 psi) or a partial cage "touch test" (~40 psi)

6. INITIAL SETUP

6.1 Enter the following data:

Start Date: _____

Start Time: _____

Gyroscope(s) #: _____

Note: Gyroscopes 3 and 4 are automatically caged at the same time. _____

6.2 Assemble all equipment on the Equipment list in Section 4 _____

6.3 Turn on and prepare the leak detector for test. This should be done in accordance with its user manual. _____

6.4 Purge the caging GSE for at least 5 minutes by opening V1, V2, V3, V5, V6 and the metering valve. V4 (the vent valve) should be closed. _____

6.5 Set the regulator on the He supply to 165 psid.

Note: One should not exceed 185 psi on the caging assembly. Since the probe will be evacuated, 185 psi on the caging assembly = 185 – 14.7 ~ 170 psi on a gauge. Therefore the regulator on the He supply is set to 165 to provide some safety margin. _____

6.6 Close the regulator on the caging GSE enough so that a very light flow of He is still present. _____

6.7 Connect the GSE plumbing to probe C and the leak detector per Figure 1. Note that Figure 1 contains the proper valve designation. Record here: _____

Line Designation = CG_____

6.8 Set the valves to the following states:

(Open means gas can flow through the valve, Closed means gas can not flow through the valve)

V1 ⇐ Open _____

V2 ⇐ Open _____

V3 ⇐ Open _____

V4 ⇐ Closed _____

V5 ⇐ Open _____

V6 ⇐ Open _____

V7 ⇐ Open _____

V8 ⇐ Closed _____

Metering Valve ⇐ Closed _____

GSE regulator ⇐ Closed _____

He bottle regulator ⇐ Open at 165 psi _____

6.9 Prepare to open the valve on the caging line of Probe C.

6.10 ***To be completed if caging lines are currently under vacuum***

Cycle the leak detector to test mode per the instructions in its user manual. Pump on the caging assembly until the base pressure goes below 10^{-3} torr. Open the relevant caging valve on the probe. Go to step 6.12 (skip 6.11)

6.11 ***To be completed if caging lines are currently at atmosphere***

Open the relevant caging valve on the probe.

(Optional) It is now permitted to pump on the caging line and GSE with the leak detector. This step need only be performed if (a) there is a desire to leak check the portion of the caging lines outside the vacuum can, or (b) it is desired to eliminate any N2 in the lines prior to a cryogenic insertion.

Check if line was pumped on: _____

6.12 ***OPTIONAL CHECK FOR CAGING LINE TO WELL LEAKS***

If the lines are being pumped on with the leak detector according to 6.10 or the optional component of 6.11, it is now possible to perform a leak check on the portions of the caging lines that are outside the vacuum can. Record Results in Table 1.

Check if done: _____

TABLE 1 (OPTIONAL): CAGING LINE LEAKAGE RATE CHECK
(Caging Line to Well Leaks)

Caging Line CG_____

Time	Port Pressure	He Rate	Notes

TABLE 1 (OPTIONAL): CAGING LINE LEAKAGE RATE CHECK (Caging Line to Well Leaks)

Time	Port Pressure	He Rate	Notes

6.12 Isolate the leak detector by closing V7. _____

6.13 Vent the leak detector according the instructions in its user manual. _____

6.14 (Optional) Re-connect the leak detector to its test port on the pumping system (LTV). This allows a leak check of the portions of the caging lines which sit inside the vacuum can (by monitoring the rate of He rise in the can when the lines are pressurized for the cage). To do this, configure the system according to the instructions of P0410 Section 7.

Check if done: _____ _____

6.15 The system is now ready to begin pressurization of the caging line. _____

7. GYROSCOPE CAGING VERIFICATION _____

7.1 Verify that the DDC is already connected to the probe. If not, connect per P0481 Section 6. _____

7.2 If not already done, connect the DDC - Probe C connector saver to the ground plane connection for the gyroscope of interest. For reference, these connections are:

Gyroscope #1: CG18

Gyroscope #2: CG28

Gyroscope #3: CG38

Gyroscope #4: CG48

Note that static protection wrist bands must be worn during this procedure. _____

7.3 Connect the Electrometer to the ground plane connection per Figure 2. _____

7.4 Connect the other electrometer lead to probe ground (which should be identical to the potential of the caging fixture potential).

7.5 Record the initial (uncaged) position indicated on the DDC (microinches). Note that the second line is only to be used if caging two gyroscopes simultaneously (i.e. Gyros 3 and 4)

X = _____ Y = _____ Z = _____ Gyro # _____

X = _____ Y = _____ Z = _____ Gyro # _____ _____

7.6 Verify that the valves are in the following state: _____

V1 ⇐ Open _____

V2 ⇐ Open _____

V3 ⇐ Open _____

V4 ⇐ Closed _____

V5 ⇐ Open _____

V6 ⇐ Open _____

V7 ⇐ Closed _____

V8 ⇐ Closed _____

Metering Valve ⇐ Closed _____

GSE regulator ⇐ Open at 160 psi (40 for partial cage) _____

He bottle regulator ⇐ Open at 165 psi (45 for partial cage) _____

Caging Valve on Probe ⇐ Already open _____

_____

7.7 Open the metering valve slowly. _____

7.8 Gradually increase the pressure regulated by the caging GSE's regulator until the gyroscope cages. Record the process in the following table. The gyroscope is caged when the resistance indicated on the ohmmeter goes from >1 GΩ to ~100 MΩ and when the rotor has stopped moving on the DDC position readout. _____

7.9 Close the metering valve and V3 _____

7.10 Record the final (caged) position indicated on the DDC (microinches). Note that the second line is only to be used if caging two gyroscopes simultaneously (i.e. Gyros 3 and 4)

X = _____ Y = _____ Z = _____ Gyro # _____

X = _____ Y = _____ Z = _____ Gyro # _____ _____

7.11 ***Venting Line to Atmosphere***

The gyroscope may be uncaged using this method if it is not being completed as the final operation on the caging line prior to insertion into the LT dewar. Otherwise use step 7.11

Vent the line by opening V4. Close V4 as soon as the high-pressure He has left the line. _____

7.12 ***Leaving Line in Vacuum***

This step leaves the line in vacuum. It should be performed whenever it _____

is necessary to leave the line without any air in it (e.g. prior to low-temperature insertion).

Reconnect the leak detector to V7 and cycle the leak detector to test. As the space between the leak detector and V7 is being pumped down, open V7 to pump out the entire line. _____

7.12 Close the CG valve on the probe for the caging line being tested. _____

7.13 Record the final (uncaged) resistance:

R = _____ _____

7.14 Record the final (uncaged) position below (the second line is to be used if two gyroscopes are being caged at once).

X = _____ Y = _____ Z = _____ Gyro # _____

X = _____ Y = _____ Z = _____ Gyro # _____ _____

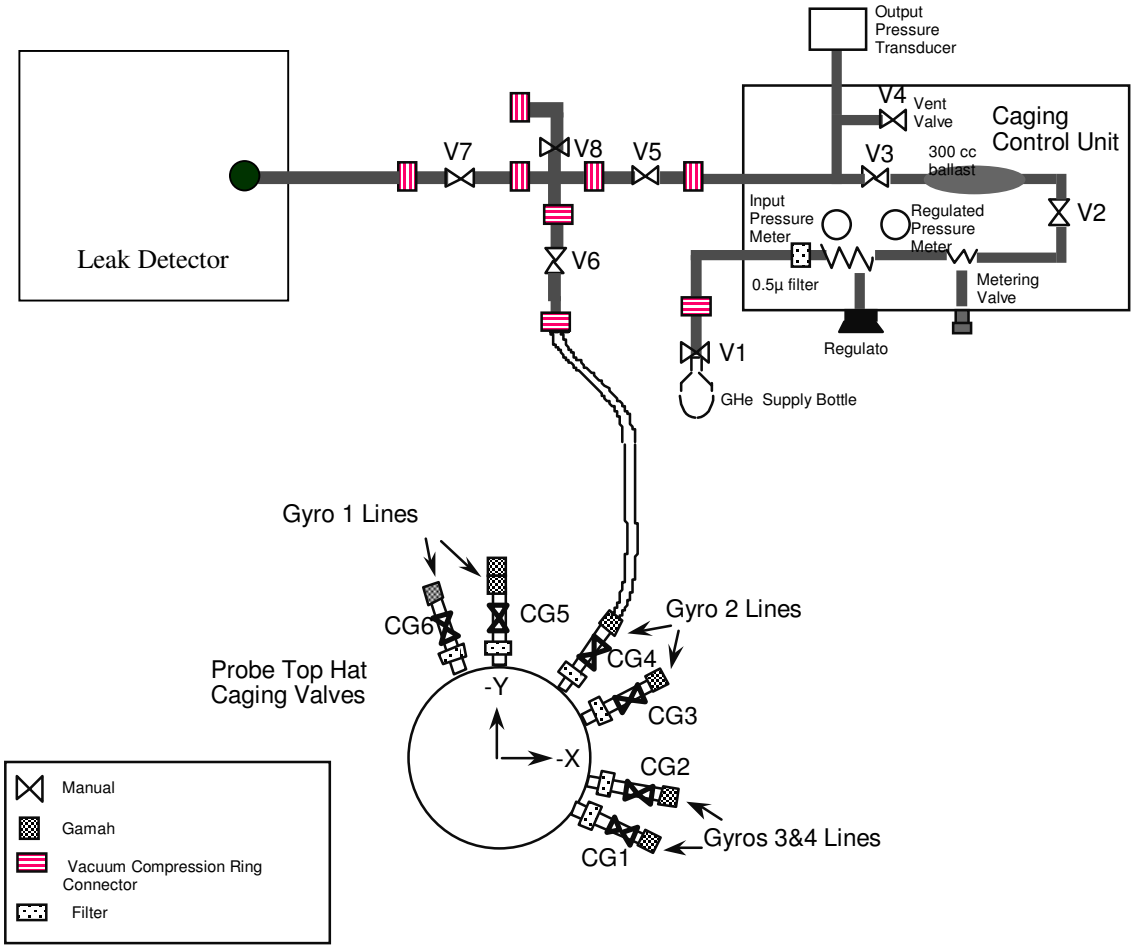
7.13 Remove the caging GSE from the probe. _____

7.14 Replace the cap on the valve of the caging line in the probe _____

RECORD OF CAGING CHECK

Gyroscope # _____ Caging Valve CG_____

Pressure (psid)	Resistance	Gyroscope Position [X Y Z] microinches	Notes (e.g. Caging Leak Rate)



Caging GSE Plumbing Schematic
- not to scale

Figure 1: Caging Test Assembly

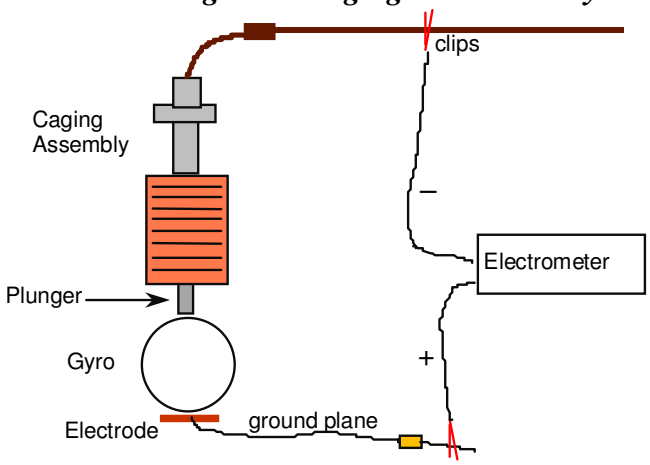


Figure 2: Schematic for Ground Plane Resistance Check

8. PROCEDURE COMPLETION

Record completion of this procedure in the traveler, as appropriate.

Record any abnormalities or deviations from this procedure in the D-Log. If the QA representative decides it is appropriate, open a Discrepancy Report to document the event.

This test has been completed according to the procedure contained herein. All redlines used have been integrated into this document.

Test Director: (print)	(sign)
(optional) **Test Engineer:** (print)	(sign)
(optional) **Test Engineer:** (print)	(sign)
QA Representative: (print)	(sign)