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

ROOM-TEMPERATURE SPINUP PROCEDURE FOR GYROSCOPES IN PROBE C

GP-B SCIENCE MISSION PROCEDURE P0505

June 25, 1999

PREPARED	_____	_____
	R. Brumley, Gyroscope RE	Date
APPROVED	_____	_____
	B. Clarke, Gyroscope Verification	Date
APPROVED	_____	_____
	D. Ross, Quality Assurance and Safety	Date
APPROVED	_____	_____

S. Buchman, Hardware Manager	Date

1. SCOPE

This procedure covers the spinup of gyroscopes at room temperature in Probe C. It is only intended for very low-frequency spins.

2. REFERENCES

2.1 Plans and Procedures

P0481	Levitation of Gyroscopes in Probe C
P0410	Room-temperature pump down of Probe C
P0178	Room-temperature Checkout of SM Gyroscopes in Probe C

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.

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 extensive training in the testing of GP-B gyroscopes and are qualified to perform this procedure.

- David Hipkins
- Bruce Clarke
- Chris Gray
- Robert Brumley
- Charles Warren
- 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.

WARNING!

The vacuum flanges on Probe C are extremely delicate. Great care must be taken to not scratch the mating surfaces. All fittings shall be inspected for scratches prior to being mated to the probe.

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 one hour before beginning this procedure.
- ONR QA must be notified at least one hour 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.

4. REQUIRED EQUIPMENT

4.1 Flight Hardware

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

4.2 Ground Support Equipment

The following GSE equipment is necessary to perform this procedure:

Item	Quantity
Probe C Pumping Cart GSE	1
Probe C to Pumping Cart Pumpout Manifold GSE (connected to the pumping cart)	1
6" ISO O-ring	1

Pumping Cart Spinup Manifold to 2 Gammah Fitting Adapter	1
Gammah Gaskets	4
Cleanroom Test for Mating Pumping Cart to Probe	1

4.3 Software

No software is required.

4.4 Tools and Miscellaneous

Various Wrenches.

5. PRE-SPINUP CHECKLIST

Start Date: _____

Start Time: _____

Gyroscope #: _____

5.1	Verify the gyroscope is levitated and in the center of the housing	_____
5.2	Verify that the gyroscope is not charged >70 volts	_____
5.3	Verify that there in no oscillation in the position greater than 40 microinches.	_____
5.4	Verify that the gyroscope has been levitated for at least one hour	_____

6. OPERATIONS

6.1 Pre-Spin Spinup Manifold Evacuation (Stage 1)

6.1.1 Verify that the valves are in the following states:

- ρ Gate Valve Protect Switch ⇐ Override
- ρ 6" Electropneumatic Gate Valve ⇐ Open
- ρ IV-1 ⇐ Open
- ρ VLV (Flow Controller) ⇐ Closed
- ρ S1, S2, S3, S4 on Probe C ⇐ Closed
- ρ REG-1 ⇐ Open
- ρ SSV ⇐ Closed
- ρ SIV ⇐ Open
- ρ SBPV ⇐ Open (if closed, correct with 6.1.3 below)
- ρ MV-1 ⇐ Open
- ρ V V-1 ⇐ Closed
- ρ V V-2 ⇐ Closed
- ρ Foreline Valve IV-3 ⇐ Open
- ρ Foreline Bypass Valve PV-2 ⇐ Open

6.1.2 Close the 6” VAT valve on the pumping cart _____

6.1.3 ***Slowly*** open SBPV if it is already closed _____

6.1.4 Verify again that VLV is closed, and open SSV. The configuration should now be as in Figure 1 _____

6.1.5 Open the 6" VAT valve on the pumping cart. _____

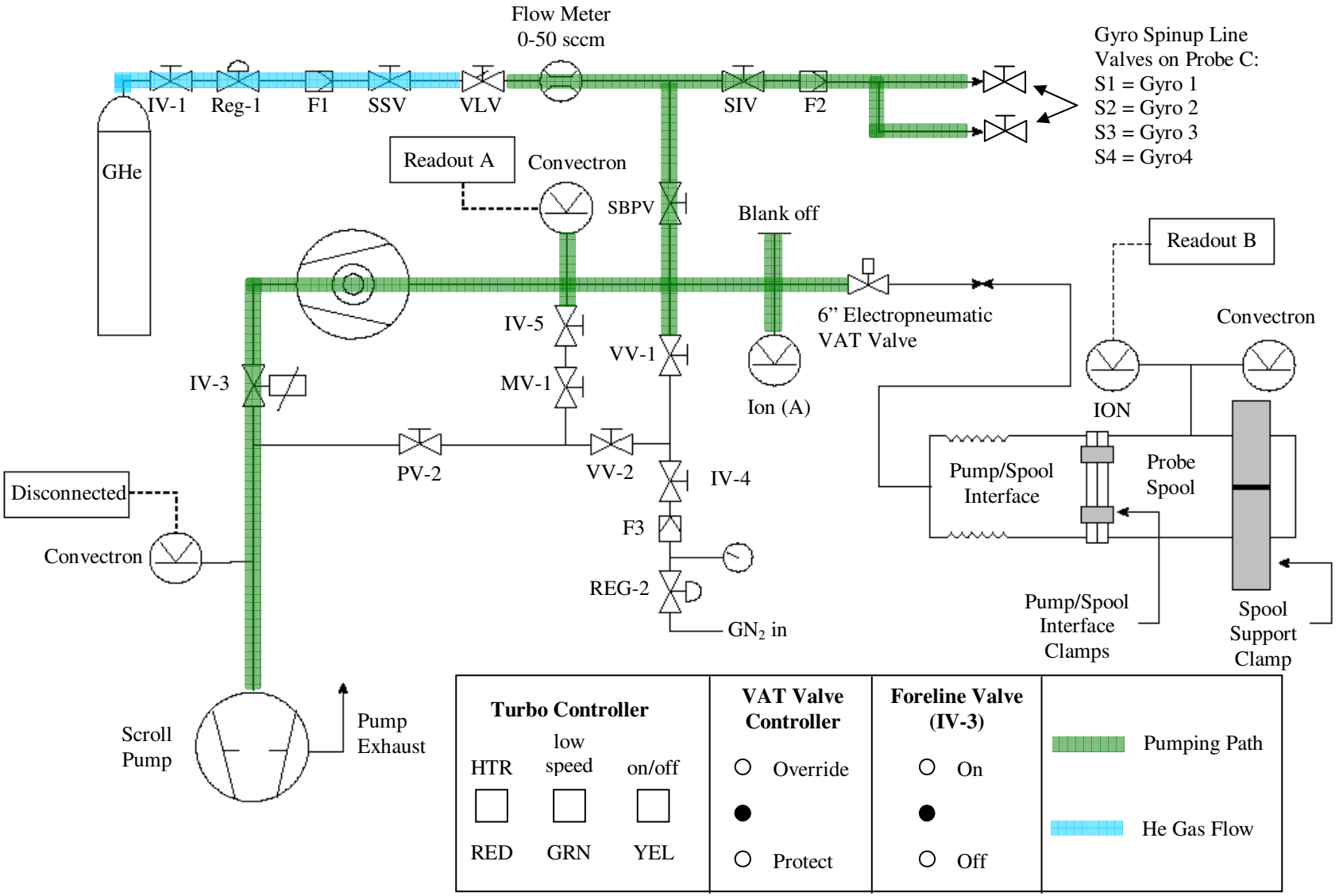

Figure 1: Configuration to Open SBPV if it is closed

6.1.6 Verify that the pressure in the IG-A is still low (less than 1×10^{-5} torr) _____

6.1.7 ***Gently*** open the spinup valve on the probe for the gyroscope being spun. The designations for these valves are:

S1 = Gyroscope #1
S2 = Gyroscope #2
S3 = Gyroscope #3
S4 = Gyroscope #4 _____

6.1.8 The system is now primed for spinup. Take a minute to inspect all gauges, verify once again that the gyroscope is still not charged, etc. The system should now be as in Figure 2. _____

Notes:

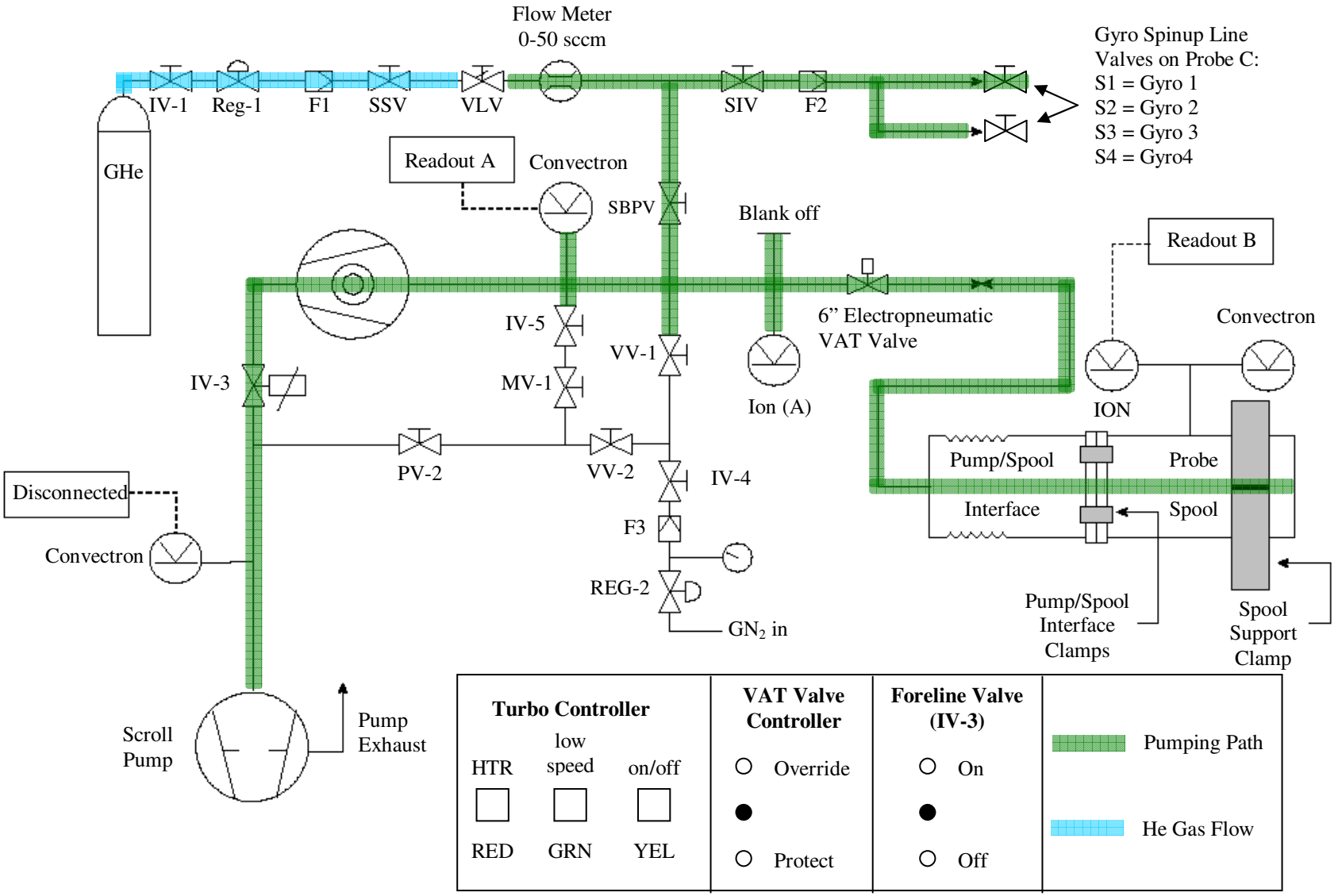

Figure 2: Primed for Spinup

6.2 Initiate Bypass Flow

6.2.1 Close SIV to isolate the gyroscope from the spinup manifold

6.2.2 Initiate a bypass flow by slightly opening VLV. Initially, use only a few sccm until getting a good calibration for how much the pressure rises in the probe, etc. during a spin. Note that the values for flow rate and other spinup parameters must be recorded in Table 1.

6.2.3 The system should now be in the configuration of Figure 3.

Notes:

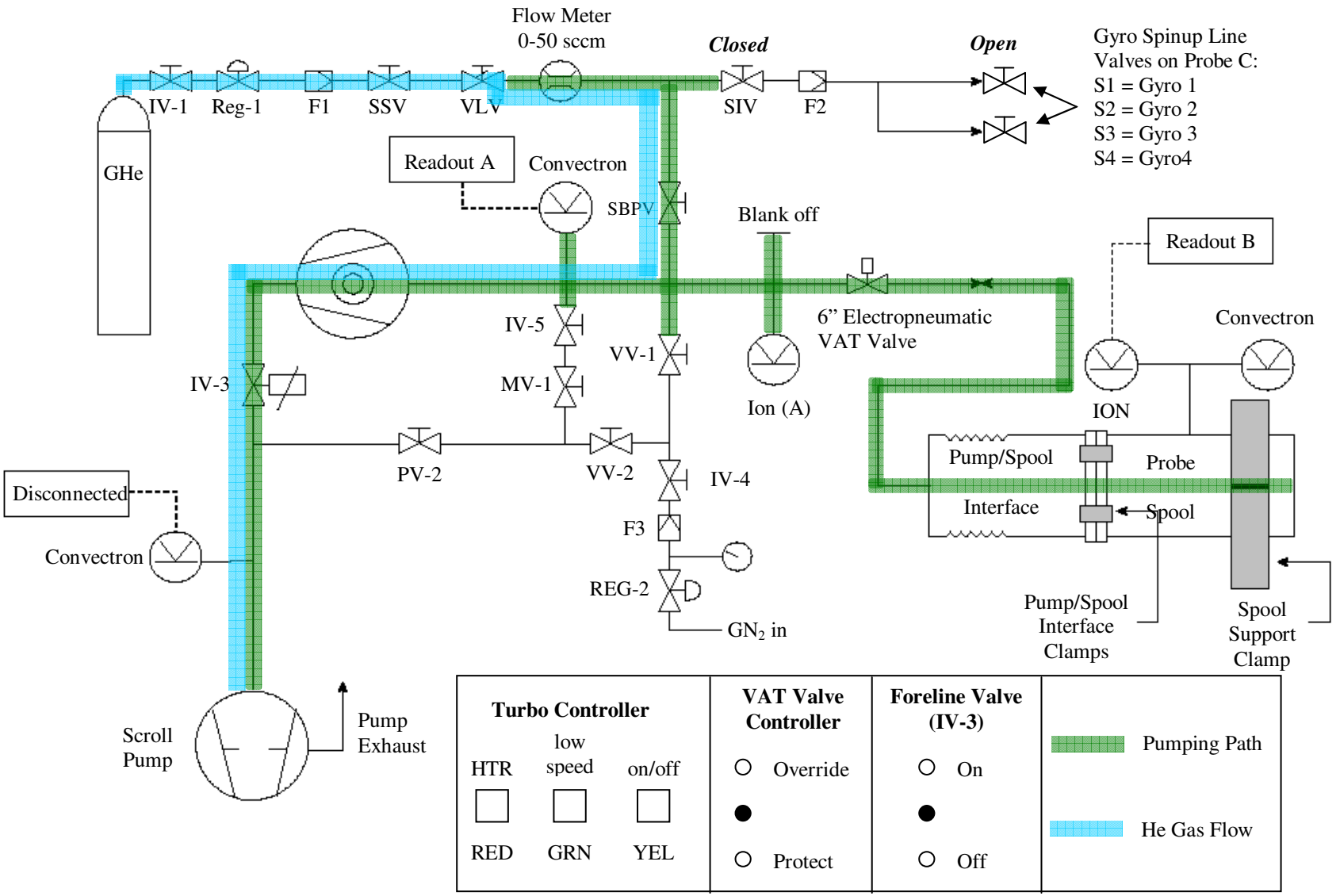

Figure 3: Initiate Bypass Flow

6.3 Gyroscope Spinup

6.3.1 When ready to spin the gyroscope, open SIV. _____

6.3.2 Close SBPV. Wait for however long it is intended to flow gas to the gyroscope. Initially, this should only be for a few seconds. The configuration should now be as in Figure 4. _____

6.3.3 Open SBPV, then close SIV to reinitiate a bypass flow. Record the appropriate parameters in Table 1 _____

6.3.4 Steps 6.3.1 - 6.3.3 should repeated as necessary to spin the gyroscope. Initially, use only a few sccm for a few seconds to get a feel for the spinup. This may be gradually increased as necessary. If uncertain whether the gyroscope is spinning or not after several attempts, stop the process to assess the situation. _____

Table 1

Time	Flow Rate (sccm)	Length of Flow	Gyro Spin Speed	Comments

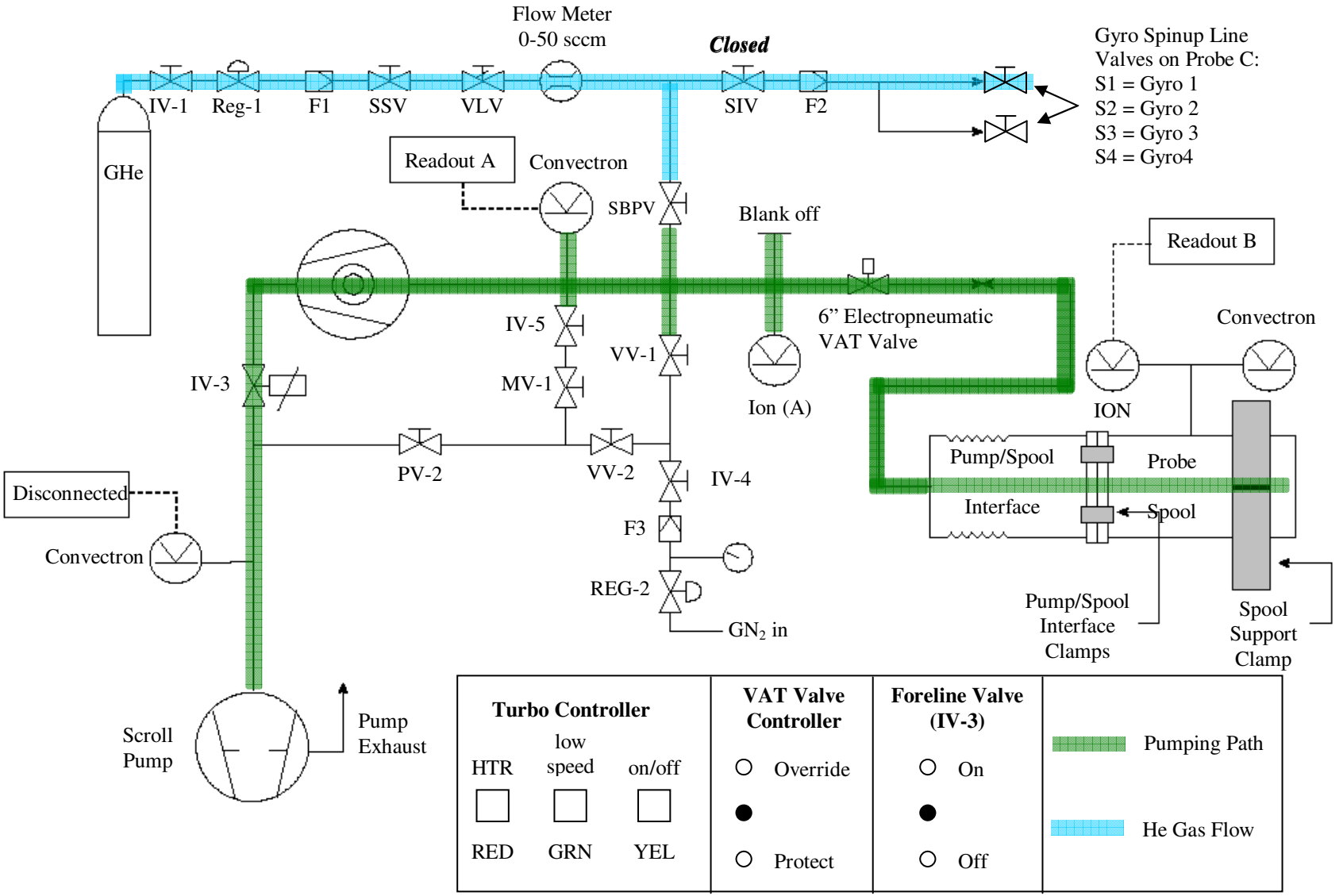

Figure 4: Spin Gyroscope

Table 1 (con't)

Time	Flow Rate (sccm)	Length of Flow	Gyro Spin Speed	Comments

6.4 Post-Spinup Procedure

6.4.1 Close the valve on the probe for the spinup inlet. _____

6.4.2 Close SSV to stop the flow of gas. _____

6.4.3 Wait until the space between SSV and VLV has pumped out, then close VLV. Do not close VLV too tightly -- it is a delicate valve. _____

6.4.4 Set the Gate Valve Protect Switch to Protect. Verify that the system is in the following state (per Figure 5) _____

- ρ Gate Valve Protect Switch ⇐ Protect
- ρ 6" Electropneumatic Gate Valve ⇐ Open
- ρ IV-1 ⇐ Open
- ρ VLV (Flow Controller) ⇐ Closed
- ρ S1, S2, S3, S4 on Probe C ⇐ Closed
- ρ REG-1 ⇐ Open
- ρ SSV ⇐ Closed
- ρ SIV ⇐ Open
- ρ SBPV ⇐ Open
- ρ MV-1 ⇐ Open
- ρ V V-1 ⇐ Closed
- ρ V V-2 ⇐ Closed
- ρ Foreline Valve IV-3 ⇐ Open
- ρ Foreline Bypass Valve PV-2 ⇐ Open

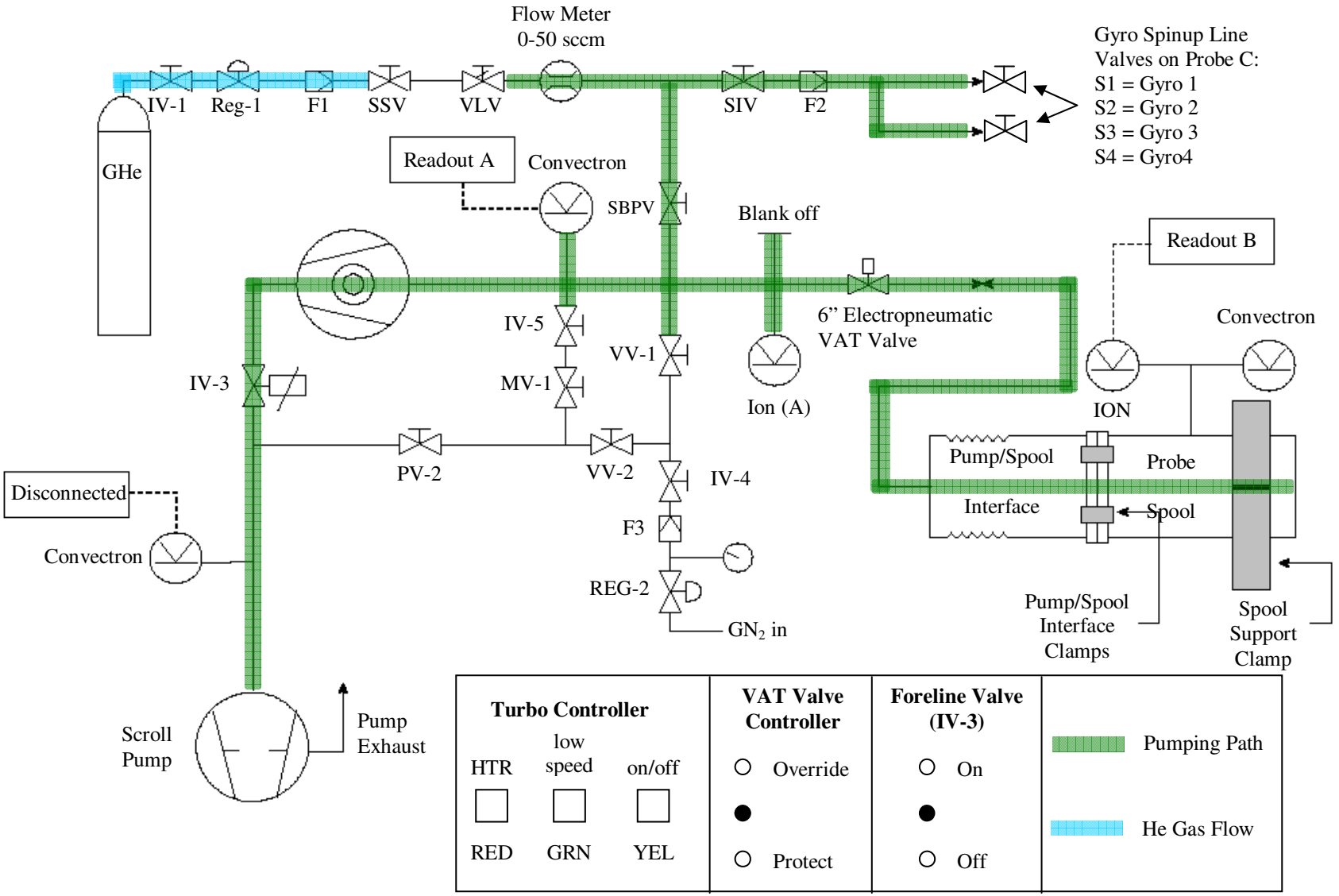

Figure 5: Vacuum System Configuration at end of Procedure

7. 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)