GRAVITY PROBE B

PROCEDURE FOR

PAYLOAD VERIFICATION

(PTP) UV GYRO CHARGE CONTROL CHECK-OUT PROCEDURE

20 March 2001

Prepared by: *B. Clarke*

Approvals:

Program Responsibility	Signature	Date
B. Clarke Charge Control REE		
M. Taber Payload Test Director		
R. Whelan Systems Engineering		
D. Ross Quality Assurance		
R. Brumley Payload Test Manager		

NOTES:

Level of QA required during performance of this procedure:

__X__Stanford QA Representative

_____Government QA Representative

All redlines must be approved by QA

Revision Record:

Rev	Rev Date	ECO #	Summary Description
A	20 March 2001	1252	Incorporate redlines from P0565 'as built' dated 10/29/2000. Include provisions for using an Oriel Deuterium UV source. Include provisions for using bias voltage modulation hardware.

Acronyms and Abbreviations:

Acronym / Abbreviation	**Meaning**

Table of Contents

A SCOPE

This document provides the procedure for measuring electric current due to UV photoemission from each of the gyroscope rotor/UV counter-electrode pairs in the SIA at low temperature. With the rotor in contact with the ground plane, the rotor and UV counter-electrode are illuminated with a known flux of UV light. The counter-electrode is biased relative to the ground plane to +3, 0 and –3 volts and in each case, the resulting current between the counter electrode and the rotor is measured.

B REQUIREMENTS VERIFICATION

B.1 Requirements Cross Reference

Science Mission Gyroscope Commissioning has required that normalized currents shall be > +10 fA/uW under a +3V bias condition and < -30 fA/uW under a -3V bias condition. See GP-B P0435AB.

T003 3.7.1.5.2.2.4.1, Photo Emissivity from UV Electrode requires that photoemission from the UV electrode shall be greater than or equal to 1.0e-7 electron/photon (20.5 fA/uW).

T003 3.7.1.5.2.2.1.2.6, UV 254 nanometer Photoemissivity of Rotor requires that the photo emission coefficient shall be greater than or equal to 1.0e-7 electrons/photon (20.5 fA/uW) for 254 nm photons.

The conversion from fA/uW to electrons/photon for light at 254 nm is 1 fA/uW= 4.87e-9 electron/photon.

B.2 Expected Data for Verification per Requirement

The magnitudes of the normalized currents are expected to meet or exceed the measured magnitudes reported in GP-B P0435AB.

C CONFIGURATION REQUIREMENTS

C.1 During the measurement, the probe pressure shall be less than 5 millitorr.
C.2 The gyroscope rotor must be in contact with the ground plane and uncaged.
C.3 There must be no high voltage suspension cables connected to the probe.
C.4 There must be no bias cables connected to the probe.
C.5 During the measurement, access to the immediate area around the probe shall be restricted to the Test Lead and his designates.

D HARDWARE REQUIRED

D.1 Flight hardware required

Description	No. Req'd
None required.	

D.2 Commercial test equipment

Manufacturer	Model	Serial Number	Calibr. Exp. Date
Keithly Autoranging Picoammeter	485		
Keithly Programmable Electrometer	617		
(2) HP 0-25 V Dual Channel DC Power Supply	E3620A E3620A		
Oriel Deuterium UV Lamp w/shutter assembly			N/A
Resonance Ltd. Cs-Te photodiode	Cs-Te M-D-L	A-302	Oct 10, 2000

D.3 Mechanical/Electrical Special test equipment

Description	Part No.	Rev. no.	Serial No.	Certification Date
SMA/LEMO (male) fiber jumper ~ 20 feet in length	N/A	N/A	N/A	N/A
(2) SMA/LEMO (male) fiber jumpers	SK-486-101	-	Op# PRC0682	29 April 1998
(1) LEMO/LEMO (female/female) fiber jumper	SK-486-102	-	Op# PRC0682	29 April 1998
Reynolds to MHV Connector Saver	N/A	N/A	N/A	N/A
Probe C bias connection (6-pin) connector saver	N/A	N/A	N/A	N/A
MHV-BNC-BNC Tee	N/A	N/A	N/A	N/A
Bias voltage 'black box'	N/A	N/A	N/A	N/A

D.4 Tools

Description	No. Req'd
UV resistant safety glasses	2
BNC to banana adapter	4
IEEE interface cables (6' minimum)	3
BNC to alligator clip	3
Alligator clip leads (12 to 16 ")	4
Coaxial cable w/BNC connectors, 10' or longer	4
Coaxial cable w/MHV connectors, 6' minimum	1

Description	No. Req'd
BNC barrel connectors and TEEs	4

D.5 Expendables

Description	Quantity
Ethyl Alcohol	N/A, on hand.
Filtered Compressed Air	N/A, on hand.
Lint free wipes and swabs	N/A, on hand.

E SOFTWARE REQUIRED

E.1 Flight Software

Flight Software Name	Version No.
N/A	

E.2 CSTOL Scripts

CSTOL Script Name	Version No.
N/A	

E.3 SPC Scripts

SPC Script Name	Version No.
N/A	

E.4 Test Support Software

Test Software Name	Version No.
STRAWBERRY TREE DATA ACQUISITION SOFTWARE PC W/IEEE INTERFACE	N/A

F PROCEDURES REQUIRED

Procedure Name	Procedure No.
Pre-Integration UV Fiber Optics checkout	P0429AB
Hook-up and Check-out of All Gyro Cables with Probe Connectors	P0431AB
UV Current Measurements in Probe C (RT)	P0435AB
PROBE C CABLE CONNECTOR INTERFACE	LMMS drawing 1C34103, Rev D

G EQUIPMENT PRETEST REQUIREMENTS

Equipment	Serial No.	Test Required	Proc. No.	Test Performed	
				Date	By
N/A					

H PERSONNEL REQUIREMENTS

Test Leader

The Test Leader shall be Bruce Clarke. He has overall responsibility for the implementation of this procedure.

Other Personnel

All personnel participating in this procedure shall work under the direction of the Test Leader who shall determine whether the person is qualified. Different people will likely be designated at different times. For this procedure, participating integration engineers are expected to be (at various times) Chris Gray, David Hipkins and Robert Brumley.

The QA program office shall be notified prior to the start of this procedure. Dorrene Ross or a Quality Assurance Representative designated by Dorrene Ross shall review any discrepancy noted during this procedure, and approve its disposition.

ONR shall be notified at least one hour prior to the start of this procedure.

I SAFETY REQUIREMENTS

General

Extreme care must be taken to avoid accidentally bumping the Probe or damaging the connectors. Connector savers or equivalent adapters shall be used to protect the connector pins from damage during the measurements. A properly grounded ESD wrist strap must be worn while mating to or de-mating from Probe connectors.

All mate/demates involving flight connectors shall be logged.

UV Lamp

The STU lamp is a strong source of light predominately at the 254 nm wavelength. The optical intensity at the end of the output fibers can be as high as 25 to 50 uW/mm^2. Intensities of this magnitude and wavelength can cause damage to the eyes. Care should be taken to keep the fiber end as far as possible from the eyes. Avoid looking directly into the fiber end while the lamp is on. As an added precaution, any personnel who must work in close proximity to the fiber ends while the lamp is turned on may wear a pair of UV resistant glasses.

J GENERAL INSTRUCTIONS

J.1 Authority to redline this procedure is given solely to the Test Lead with mandatory concurrence form the QA representative. Approval by the Hardware Manager shall be required if experiment functionality may be affected. QA Program Engineering concurrence is required before final review/buyoff (on last page) of the completion of the activity described in this procedure.

J.2 Any nonconformance or test anomaly will be recorded in a D-log or as a Discrepancy Report per Quality Plan P0108. Do not alter or break test configuration if a test failure occurs; notify quality assurance.

Upon completion of this procedure, the QA Program Engineer, D. Ross or her designate, will certify their concurrence that the effort was performed and accomplished in accordance with the prescribed instructions by signing and dating in the designated place(s) in this document.

J.3 Only the following persons have the authority to exit/terminate this test or perform a retest:

Test Lead	Bruce Clarke or his designated representative
QA	Dorrene Ross or other designated representative of Stanford Quality Assurance.

K REFERENCES AND APPLICABLE DOCUMENTS

None.

NOTIFY ONR OF INTENT TO BEGIN THE TEST Date:

Time:

L OPERATIONS

L.1 SET-UP AND LAMP CALIBRATION

SECTION STARTED _____ AT _____
DATE TIME

SIGNED: _____ PRINT NAME: _____
TEST LEAD

SIGNED:_____ PRINT NAME: _____
QA REPRESENTATIVE

L.1.1 Insure the optical surfaces of all fiber optic jumpers are clean by wiping them with ethyl alcohol on a lint free wipe and drying with compressed filtered air. Do not replace any plastic caps after cleaning the fiber ends.

L.1.2 All fiber optic connectors mating to the probe as well as the probe connectors themselves must be inspected for particulate contamination prior to mating. Log all mate/de-mates from the probe connectors in the appropriate log sheet (provided with probe).

L.1.3 Position the electrometer and the Oriel D2 UV lamp near the top hat.

L.1.4 Refer to Figures 1 and 2 when setting up the equipment as outlined in steps L.1.5 through L.1.9.

L.1.5 Connect the input of the picoammeter to the Cs-Te photodiode using a BNC cable. The readout connector on the diode is marked “R” or “Readout”.

L.1.6 Plug in the HP power supply and power it on. Adjust the left channel to 25 V then power the unit down.

L.1.7 From the HP DC power supply, connect BNC cables such that –25 VDC will be applied between the center pin and the shield on the “G” or “Bias” connector on the Cs-Te photodiode.

L.1.8 Connect the D2 lamp to the Cs-Te photodiode using an SMA/SMA fiber. Turn on the Oriel D2 UV lamp and open the shutter.

L.1.9 Plug in the AC power cord for the picoammeter. Power on the picoammeter and the DC power supply which provides –25 VDC bias to the diode. Set the picoammeter to autoscale. Note the time that the lamp was turned on and the initial current reading.

Time Lamp on @ : _____

Initial lamp reading: _____ (-nA)

L.1.10 Allow the lamp to warm for 10 minutes or until the Test Lead has determined the lamp output is stable enough to perform a measurement. The equilibrium output of the lamp though the SMA/SMA jumper is expected to be 10 - 20 uW. The equilibrium output though the SMA/LEMO - LEMO/LEMO - LEMO/SMA optical path is expected to be about 10 - 30% of the SMA output or 1 - 6 uW. Record the diode current reading in Table II under 'Baseline Current – lamp'. Calculate and record the associated optical power and record that value in Table II under 'Baseline Power –lamp'. The optical power is calculated by dividing the diode current by the diode sensitivity in nA/uW.

L.1.11 Remove the SMA/SMA fiber jumper from the lamp and the diode and store. Using the ~20 foot SMA/LEMO (male) fiber jumper, the LEMO (female)/LEMO (female) fiber jumper (P/N SK-486-102) and the LEMO (male)/SMA fiber jumper (P/N SK-486-101) make the optical connections per Figure 2.

L.1.12 Record the diode current reading and the associated optical power in Table II under 'Baseline Current' and 'Baseline Power' in the 'thru LEMOs' column.

L.1.13 Disconnect the LEMO/LEMO jumper (P/N SK-486-102) and the LEMO/SMA jumper (SK-486-101) and store. These are not needed for any further measurements.

L.1.14 Complete the "CALIBRATION SUMMARY" in Table II by dividing the "baseline power" through the LEMOs by the "baseline current " for the lamp.

SECTION COMPLETED _____ AT _____
DATE TIME

SIGNED: _____ PRINT NAME: _____
TEST LEAD

SIGNED:_____ PRINT NAME: _____
QA REPRESENTATIVE

L.2 **Current Measurement by Bias Modulation**

SECTION STARTED _____ AT _____
DATE TIME

SIGNED: _____ PRINT NAME: _____
TEST LEAD

SIGNED:_____ PRINT NAME: _____
QA REPRESENTATIVE

L.2.1 Place the Oriel D2 lamp such that the connection can be made to Gyro #1, fiber A per Table I using the ~20 foot SMA/LEMO (male) fiber jumper. Figure 4 shows the optical set-up for making current measurements.

L.2.2 Hook up the electronics cabling per figure 3. Make the bias connection and the ground plane connection for Gyro #1, fiber A per Table I. At the discretion of the Test Lead, the bias voltage 'black box' may be used to apply the +/-3 V or 0 V bias voltage between the UV counter-electrode and the ground plane. The black box facilitates modulation of the bias voltage with a minimum of switching noise but may add more baseline noise and/or drift in the current readings due to the added cabling in the bias circuit.

L.2.3 Make the optical connection between the STU lamp output LEMO and the top hat optical LEMO for Gyro #1, fiber A per Table I.

L.2.4 Power on all the meters and start the data acquisition routine.

L.2.5 Power on the DC supply that provides the bias voltage and adjust the voltage such that the fixture is biased +3V with respect to the rotor. Enter the data log file name at the appropriate place in the data acquisition routine and begin logging. Record this file name in Table III. Open the shutter on the Oriel D2 lamp if it is not already open.

L.2.6 After enough time has passed for the averaged current values to become stable, record the averaged current value under "UV ON" in Table III.

L.2.7 Adjust the bias voltage to 0V. Repeat L.2.6.

L.2.8 Adjust the bias voltage to -3V. Repeat L.2.6.

L.2.9 Close the shutter on the Oriel D2 lamp. Adjust the bias voltage to 3V.

L.2.10 After enough time has passed for the averaged current value to become stable, record the averaged current value under "UV OFF" in Table III.

L.2.11 Adjust the bias voltage to 0V. Repeat L.2.10.

L.2.12 Adjust the bias voltage to -3V. Repeat L.2.10.

L.2.13 Steps L.2.5 through L.2.12 may be repeated as many times as deemed necessary by the Test Lead in order to achieve a good measurement. Use Table IV as a scratch sheet to keep track of the progress of the test. Only one set of ON/OFF readings need be entered in Table III for each

bias setting.

L.2.14 Stop logging data. Adjust the bias voltage to 3V and power down the DC supply that supplies the bias voltage.

L.2.15 Move the bias connection and the fiber optic connection to Gyro #1, fiber B per Table I. Repeat L.2.5 through L.2.14.

L.2.16 Move the bias connection, the fiber optic connection and the ground plane connection to Gyro #2, fiber A per Table I. Repeat L.2.5 through L.2.14.

L.2.17 Move the bias connection and the fiber optic connection to Gyro #2, fiber B per Table I. Repeat L.2.5 through L.2.14.

L.2.18 Move the bias connection, the fiber optic connection and the ground plane connection to Gyro #3, fiber A per Table I. Repeat L.2.5 through L.2.14.

L.2.19 Move the bias connection and the fiber optic connection to Gyro #3, fiber B per Table I. Repeat L.2.5 through L.2.14.

L.2.20 Move the bias connection, the fiber optic connection and the ground plane connection to Gyro #4, fiber A per Table I. Repeat L.2.5 through L.2.14.

L.2.21 Move the bias connection and the fiber optic connection to Gyro #4, fiber B per Table I. Repeat L.2.5 through L.2.14.

L.2.22 Remove the fiber optic and bias connection at the top hat.

L.2.23 Remove the ~20 foot SMA/LEMO fiber jumper from the Oriel D2 lamp and store. Connect the SMA/SMA jumper from the lamp to the Cs-Te photodiode. Bias the diode with –25 VDC and connect the readout to the picoammeter as in L.1.8 – L.1.10. Record the current reading:

lamp through SMA/SMA jumper _____ (-nA)

L.2.24 The 'lamp monitor' entries in Table III are all the same and will be the average of the readings in step L.2.23 and step L.1.10 (which was recorded in Table II under 'Baseline Current – lamp').

L.2.25 Complete Table III.

The "UV @ rotor" is calculated as follows:
C = "uW @ top hat / nA @ monitor " for the "LAMP LEMO OPTICAL OUTPUT" from Table II
M = "lamp monitor" from Table III
L = "optical losses w/o LEMOs" from Table I

*UV Power @ rotor = C * M * 10 $^{(-L / 10)}$*

The "Normalized current" is calculated as follows:

Normalized current = (net current) / (UV power @ rotor)

L.2.26 Since a Deuterium UV lamp was used, the normalized currents obtained above in step L.2.25 must be multiplied by the appropriate conversion factor in order to give the equivalent Hg source normalized current. See Table III for this conversion.

SECTION COMPLETED _____ AT _____
DATE TIME

SIGNED: _____ PRINT NAME: _____
TEST LEAD

SIGNED:_____ PRINT NAME: _____
QA REPRESENTATIVE

L.3 **Archive Data**

L.3.1 At test completion, the following shall be archived on the Payload Server:
An electronic 'As-Built' version of this document.
Any raw data files collected during the implementation of this procedure.

Server path: _____

The original 'As-Built' hard copy of this document shall be kept as part of: _____ _____

Test completed.

Completed by: _____
Witnessed by: _____
Date: _____
Time: _____

M **PROCEDURE COMPLETION**

The results obtained in the performance of this procedure are acceptable:

Engineer(s)

SIGNED: _____PRINT:_____ DATE:_____

SIGNED: _____PRINT:_____ DATE:_____

SIGNED: _____PRINT:_____ DATE:_____

Test Lead

SIGNED: _____PRINT:_____ DATE:_____

The information obtained under this assembly and test procedure is as represented and the documentation is complete and correct:

Payload Test Director

SIGNED: _____PRINT:_____ DATE:_____

QA Representative

SIGNED: _____PRINT:_____ DATE:_____

Program QA Engineer

SIGNED: _____PRINT:_____ DATE:_____

TABLE I - PROBE C UV OPTICAL AND BIAS CONNECTIONS

[Bias and Ground Plane pin assignments and optical losses are per P0429AB and P0431AB]

GYRO	UV fixture	Top Hat LEMO	BIAS Connector - Pin #	Ground Plane @ Top Hat	Optical losses w/ LEMOs (dB)	Optical losses w/o LEMOs (dB)
1	A	PM IIII	BGPM - 4	CG18	4.75	1.70
	B	UV12 II	BG34 -1		5.73	2.69
2	A	UV12 IIII	BG34 - 3	CG28	6.35	3.30
	B	UV12 III	BG34 - 4		6.43	3.38
3	A	UV34 I	BG12 -1	CG38	6.09	3.04
	B	UV34 II	BG12 -2		6.73	3.68
4	A	UV34 III	BG12 -3	CG48	5.88	2.83
	B	UV34 IIII	BG12 -4		5.58	2.53

TABLE II - LAMP MONITOR CALIBRATION

Diode Location	Cs-Te Diode S/N	Diode Sensitivity (nA/uW)	Baseline Current (-nA)		Baseline power (uW)	
Lamp	A-302	7.39	thru LEMOs	lamp	thru LEMOs	lamp
Baseline	A-302	7.39			0.00	0.00

CALIBRATION SUMMARY	uW @ top hat per nA @ monitor	#DIV/0!

The UV power at the rotor is calculated using these calibrations, the lamp monitor output and "losses w/o LEMOs" from Table I.

TABLE III - CURRENT MEASUREMENTS BY BIAS MODULATION

GYRO #	UV fixture	filename	Bias (V)	CURRENT (fA) UV ON	UV OFF	net	lamp monitor (-nA)	UV @ rotor (uW)	Normalized Current (fA/uW)
1	A		3						
			0						
			-3						
	B		3						
			0						
			-3						
2	A		3						
			0						
			-3						
	B		3						
			0						
			-3						
3	A		3						
			0						
			-3						
	B		3						
			0						
			-3						
4	A		3						
			0						
			-3						
	B		3						
			0						
			-3						

Normalized current should be > +10 fA/uW under +3V bias and < -30 fA/uW under -3V bias.
Current under the 0V bias condition is recorded but not specified.
Oriel D2 lamp used as a UV source
The above 'normalized currents' have been corrected to give the Hg lamp equivalent per data file FQH52A5.XLS

BIAS	Hg value/D2 value
3	0.32
0	0.54
-3	0.58

TABLE IV – BIAS MODULATION RUNNING RECORD

TIME	BIAS (V)	LAMP (nA)	CURRENT (fA)	COMMENT

TABLE IV – BIAS MODULATION RUNNING RECORD (cont.)

TIME	BIAS (V)	LAMP (nA)	CURRENT (fA)	COMMENT

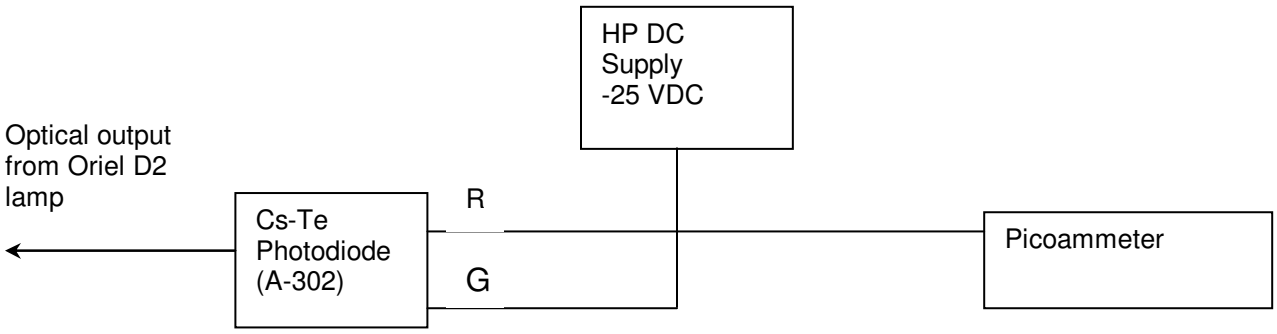

FIGURE 1 – Electronics Set-up – Lamp Calibration

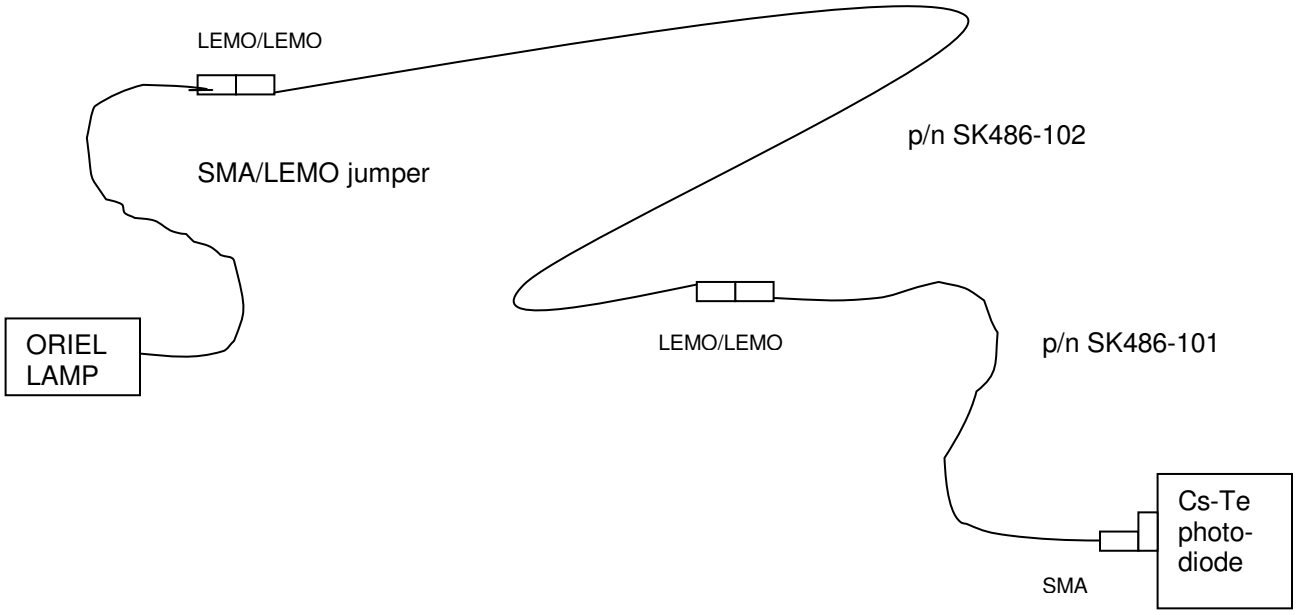

FIGURE 2 – Optical Path Set-up – Lamp Calibration

The optical path outlined above is used to determine the 'Baseline' current at the photodiode. The 'Lamp' current readings are determined by connecting the Oriel lamp directly to the Cs-Te photodiode using an SMA/SMA fiber jumper.

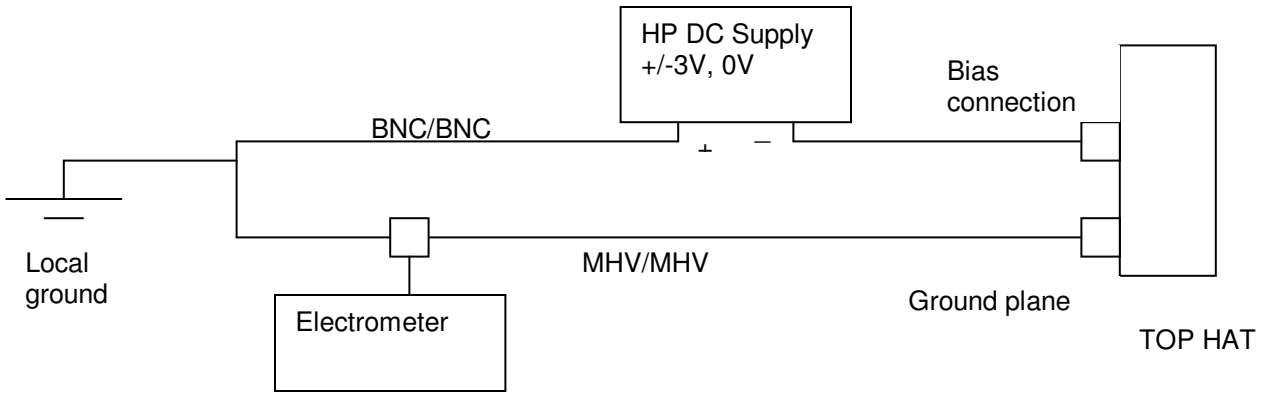

FIGURE 3 – Electronics Set-Up - Current Measurement

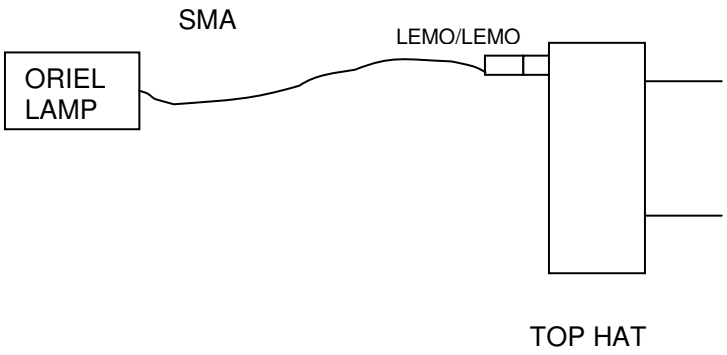

FIGURE 4 – Optical Set-Up – Current Measurement