GPB Document Control #P0392

Stanford University

Gravity Probe B Relativity Mission
W. W. Hansen Experimental Physics Laboratory
Stanford, California 94305-4085

Detector Package Assembly (DPA) Acceptance Test Procedure

Approval:

John H. Goebel — Date
Telescope Readout Electronics Responsible Engineer

Paul D. Ehrensberger — Date
Telescope Readout Electronics Integrated Product Team Leader

Ben Taller — Date
Quality Engineer

Bob Schultz — Date
Lead System Engineer

Mac Keiser — Date
Chief Scientist

John P. Turneaure — Date
Hardware Manager

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Appendicies

1. Introduction

This document pertains to the flight acceptance test procedures for the GPB guide star telescope's optical radiation detectors. The test procedures specified are in accordance with the SIA Specification Matrix (PLSE-12 [F277277] º 3.7.1).

1.1 Definitions

Reference Materials

Item	PLSE 13 º	Control Document	Release Date	RE
Telescope Drawing Tree		**23200-118**	**8/8/97**	**Huff**
DPA Mechanical Drawing	**3.2.3.3.14**	**25712-101** **25712-102** **25712-103** **25712-104** **25712-201** **25712-202** **25712-203** **25712-204**	**11/26/97** " " " " " " "	**Sullivan** " " " " " " "
DPA Manufacturing Plan				**Goebel**
DPA Manufacturing Readiness Review				**Ehrensberger**
Telescope Readout Electronics (TRE) Mechanical Design	**3.2.4.1.1**			**Farley**
Telescope Readout Electronics (TRE) Electrical Design				**Farley**
Telescope Readout Electronics Manufacturing Plan				**Farley**
SIA Mechanical Drawing Tree		**23200-106**	**11/18/96**	**Turneaure**
SIA Readiness Review				

1.1.1 Thermal Isolator

The Thermal Isolator (TI) is a component of the Detector Mount Assembly used in the Gravity Probe B General Relativity Experiment. The TI is photolithographically produced and bonded into a DMA. It serves the function of thermal isolation in a vacuum between the detector platform, which must operate above 30 K in temperature, and the cryogenic heatsink, which is at 2.1 K. It also serves as a flexible printed circuit to carry signals between the detector platform and the warm electronics outside the cryogenic vessel. The size of the DMA is similar to that of a gambling die.

Reference Materials

Item	Control Document	Release Date	RE
Thermal Isolator	25408-201	7/03/97	Sullivan

1.1.2 Circuit Assembly Pedestal

The Circuit Assembly Pedestal (CAP) contains the Cold Telescope Readout Electronics (CTRE) that convert the optical signal presented by the telescope to electronic signal that can be used for tracking purposes by the Science Readout Electronics (SRE).

Reference Materials

Item	Control Document	Release Date	RE
Circuit Assembly Pedestal	25701-102	2/21/98	Sullivan

1.1.3 Detector Mount Assembly

The Detector Mount Assembly (DMA) is a subassembly of the Detector Package Assembly (DPA). The DMA consists of a Detector Platform, TI, Titanium base, and Connector Plug Assembly. The DMA provides the mechanical, electrical, and thermal configuration to interface the Optical Detectors and Preamplifier Electronics with the rest of the telescope.

Reference Materials

Item	Control Document	Release Date	RE
Detector Mount Assembly	25681	10/30/97	Sullivan

1.1.4 Flexible Cable Assembly

The Flexible Cable Assembly (FCA) transports the electrical signals from a single DMA forth and back to the Science Probe wiring and thereby to the Warm Telescope Readout Electronics (WTRE) that is external to the Science Probe and Science Dewar. A full set of cables consists of four unique layouts, one for each DMA in a full complement of four DMAs configured in two DPAs.

Reference Materials

Item	**Control Document**	**Release Date**	**RE**
Flexible Cable Assembly	25674-101	9/16/97	Sullivan
"	25674-102	"	"
"	25674-103	"	"
"	25674-104	"	"
"	25674-201	"	"
"	25674-202	"	"
"	25674-203	"	"
"	25674-204	"	"

1.1.5 **Detector Package Assembly**

The Detector Package Assembly consists of two DMAs, two FCA's and a titanium housing that presents the telescope optical beams to the photodetectors with the aid of a lens and beamsplitter.

Reference Materials

Item	**Control Document**	**Release Date**	**RE**
Detector Package Assembly	25712-101	11/26/97	Sullivan
	25712-102	"	

1.2 **Purpose**

This acceptance test plan is intended to pass on the functionality of the DPA test article(s) for flight operation after launch on a Delta II launch vehicle. The DPA test article(s) to be used in the test plan are to be engineering prototypes and flight qualifiable units. These DPA's will be considered acceptable for integration with the Science Probe and Flight Telescope if they pass all procedures specified in this document.

2. Test Summary and Objectives

2.1 DPA Acceptance Test Summary and Objectives

The objectives of the tests are to:

1. Measure and certify the optical responsivity of the DPA.

2. Measure and certify the electronic noise level of the DPA.

3. Measure and certify the sense node leakage current of the DPA.

4. Measure and certify the heater control and power dissipation performance of the DPA.

5. Measure and certify the temperature coefficient of bias of the preamplifer circuit.

Tests are to be performed to meet the verification and specification requirements that flow down from T-003, that is specifically SIA Specification Matrix (PLSE-12 [F277277] º 3.7.1) and their subsequent embodiment in the TRE Spec [PLSE-13 Pt 3]. The conversion of the Science requirements into Engineering parameters is derived in 3.2.15.1, an attached document to PLSE 13, pt3, and are specified in Section 3.2.3.1, Telescope Readout Electronics (Appendix A). The relevant line items thereof are:

SIA Specification (PLSE-12 [F277277] §3.7.1) Verification Matrix

Section	Title	Text
3.7.1.6.1.2.2	Signal Interfaces	The ST shall output to the Telescope Readout Electronics eight optical signals as listed below. Positive Pitch Axis Alternate Positive Pitch Axis Negative Pitch Axis Alternate Negative Pitch Axis Positive Yaw Axis Alternate Positive Yaw Axis Negative Yaw Axis Alternate Negative Yaw Axis The detailed electrical interface to the probe with identification of the electrical function is given in Section 3.7.6.2.2.

DPA Requirements (extracted from TRE Spec [PLSE-13 Pt 3])

Paragraph	Title	Text & Comments	Method	Verification Plan
3.2.5.3	Platform Temperature Variation at Roll Frequency, as defined in T003, 7.6.2	≤ 2 mK	A,T	Payload level verification
3.2.6.1	Total Telescope Detector Power (All Detectors)	<6 mW (1.5 mW/platform)	T	P392: Power Dissipation Test
3.2.18	TRE Detector Performance Requirement			
3.2.18.1	External Quantum Efficiency at 400 to 900 nm wavelength	>70%	S,A,T	P0392: Optical Responsivity test one fight unit will be tested over several wavelength and use similarity for other flight units. S-Doc TBS
3.2.18.2	External Quantum Efficiency at 550nm wavelength	>70 %	T	P0392: Optical Responsivity test
3.2.18.3	I_Dark	<0.01 fA@80 K	T	P0392: Electrical Leakage Current Test. Measure w/o light and at V_detB=4.0V @T_op 80
3.2.18.4	Diameter of Photoactive Area	0.8 mm	I	P332

3.2.18.6	Operating Temperature (Si JFETs)	80 K ± 10	T	P0392 : Temperature Stability T Measure without light and at V_detB=4.0V @80 K with all components
3.2.18.7	Random Noise	<50 e rms/(0.1 sec read)	T	P0392: Noise test
3.2.18.8	Temperature Coefficient of Bias	< 440 e/(read)/K	A,T	P0392: Temperature Stability Te

2.2 Characterization Test Summary and Objectives

The characterization test that are to be conducted are aimed at understanding the contribution of several testable parameters to the pointing bias variation.

The TRE ETU is able to drive a limited set of parameters, that are summarized in the table below. These are described in the manual describing using the TRE Support Systems prepared by Bob Farley, dated Dec 1997.

ETU Controllable Parameters That Affect Flight Telescope Pointing Bias Variation

Controllable Parameter	TRE ETU Commamd Parameter	ETU Input Test Signal	TRE ETU Input Command Address Range		ETU Output Signal
Name	Name	(V/sec)	Voltage Limits	Hex Limits	(V/sec)
+ Direction Clamp Voltage	CLAMP	Dynamic	Gain Depend	00_FF	
- Direction Clamp Voltage	CLAMP	Dynamic	Gain Depend	00_FF	
▒ Direction Clamp Voltage	CLAMP	Dynamic	Gain Depend	00_FF	
+Reference or Reset Level	SBIAS (OFFSETS)	Dynamic	▒20 mV	00_FF	
-Reference or Reset Level	SBIAS (OFFSETS)	Dynamic	▒20 mV	00_FF	
▒Reference or Reset Level	SBIAS (OFFSETS)	Dynamic	▒20 mV	00_FF	
Diode Bias	PBIAS	Dynamic	-7_0 V	00_FF	

Voltage	(BIAS)				
Heater Voltage	HEAT	Dynamic	0_10V	00_FF	
Control	CONTROL	Static	N/A	N/A	N/A

3. **Test Articles**

The test articles are to be engineering units and flight hardware. These articles are to be supplied by Stanford University, Gravity Probe B, Telescope Readout Electronics, Cryogenic Optical Telescope Sensor Group. The test articles will be housed in a red cryogenic dewar with a big white S on it. The articles will be mounted in a clean can with external electrical connectors and an optical port. The test articles will be subjected to appropriate tests, electrical and optical, that characterize the test articles.

4. **Test Equipment**

The optical testing will be at Stanford University in the detector acceptance test facility located in Cedar Hall, room 13. The following test equipment can be found there.

4.1 Calibrated Light Source NBS traceable, 100 W Lamp

4.2 Quadrupole Mass Spectrometer, SRS Model RGA100

4.3 TurboMolecular Vacuum Pump, Varian Model 300HT

4.4 Vacuum Readout Varian Digital Model Sentorr BA2C

5. **Test Fixtures**

A test fixture will be built to accommodate the test article, cabling and optical fixtures. The test fixture will be mounted on the Optical table to ensure accurate positioning and reproduceablity for measurement of each DPA

5.1 Vibration Isolator Table, Newark Model RS1000

5.2 Calibrated Optical Filters, OCLI Catalog #Invisiglass

5.3 Calibrated Optical Filters, OCLI Catalog #340nm BP

5.4 Calibrated Optical Filters, OCLI Catalog #460nm BP

5.5 Calibrated Optical Filters, OCLI Catalog #550nm BP

5.6 Calibrated Optical Filters, OCLI Catalog #670nm BP

5.7 Calibrated Optical Filters, OCLI Catalog #850nm BP

5.8 Calibrated Optical Filters, OCLI Catalog #Quartz

5.9 Clean Test Dewar, IR Labs Model HDL-8, IR Lab S/N 3017

5.10 Clean Test Can, IR Labs Model NAHF14ZA

5.11 Neutral density filter, "Swiss Glass" 2"X3" microscope slide, Baxter Healthcare Corp. Cat # M6142.

5.12 Various optical component supports, baffles, and mirrors

5.13 Alignment telescope

6. Test Instrumentation

Hardware available to conduct the test are listed here. Items listed for tests are incorporated in the traveler with calibration information and GPB reference number.

6.1 Hardware

6.1.1 Photodiode, NBS traceable, Silicon. Serial #D213

6.1.2 Data logging system, Macintosh 9500 with LabView 4.1 software.

6.1.3 Readout Electronics Unit, Engineering Protoytpe, Lockheed Model EU-003

6.1.4 Enginnering Test Unit of the Warm Flight-like Telescope Readout Electronics with control computer.

6.1.5 Spectrum Analyzer, H-P Model 35567

6.1.6 Lamp Power Supply, H-P Model HP659B

6.1.7 Digitizing Oscilloscope, Tektronix Model 744A

6.1.8 Digitizing Oscilloscope, Tektronix Model 420A

6.1.9 Precision Digital Voltmeter H-P Model 3458A

6.1.10 Multiplexed Digital Voltmeter H-P Model 3457A

6.1.11 Voltage Calibration Source, Datel DVC-8500

6.1.12 Electrometer, Kiethley 6517

6.1.13 Capacitance Meter, Kiethley 595

6.1.14 Semiconductor Parameter Analyzer H-P Model 4156A

6.1.15 Multimeter Fluke Model 8842A, 2ea

6.1.16 Programmable Power Supply, H-P Model 6626A

6.1.17 HeNe alignment Laser, Hughes Model 3599H

6.1.18 Pyroelectric Power Meter, Laser Precision Model Rk-1500

6.1.19 Digitizing Oscilloscope, Tektronix Model 540A

6.2. Software

Software used to conduct the tests is described below.

6.2.1 Software Definition

LabView 4.1 virtual instrument (VI) data collection software will be written to control the test instruments and acquire the data. The Mac OS 7.5.3 and a PowerPC CPU Mac 9500/132 with National Instruments GPIB/PCI control card will be used.

A VI will be written for each test procedure and documentation generated to control the data collection procedure.

1. <u>OpticalResponse.</u>
   This will control the testing procedure for the optical responsivity of the DPA.

2. <u>Noise</u>
   This will control the testing procedure for the electronic noise level of the DPA.

3. <u>LeakCurrent</u>
   This will control the testing procedure for the sense node leakage current of the DPA.

4. <u>TemperatureTest</u>

This will control the testing procedure for the heater control and power dissipation performance of the DPA.

5. <u>PowerDissipation</u>
This will measure the power dissicpation of the DMA and the corresponding operating temperature.

5. <u>ThermalStability</u>
This will measure the preamplifier's temperature stability.

7. <u>LakeShore</u>
This will monitor the germanium thermometer during the test

8. <u>RGA</u>
This will monitor the vacuum system during the test.

6.2.2 Software Specification

1. <u>OpticalResponse</u>

The vi used will be: "*detector.vi single-ended*" which is based on single-ended output of the Engineering Readout and Control Electronics. This software will log the outputs of all four detector channel, XP, XN, YP, and YN. It will also log the two housekeeping channels with ground subtraction and be synchronized by the ATC Strobe.

2. <u>Noise</u>

The vi used will be: "*detector.vi differential*" which is based on the differential output of the Engineering Readout and Control Electronics. This software will log the outputs of two of the four detector channel, XP and YP using the SIGHI and SIGLO readouts. It will also log the two housekeeping channels and be synchronized by the ATC Strobe.

3. LeakCurrent

The vi used will be: "*detector.vi differential*" which is based on the differential output of the Engineering Readout and Control Electronics. This software will log the outputs of two of the four detector channel, XP and YP using the SIGHI and SIGLO readouts. It will also log the two housekeeping channels and be synchronized by the ATC Strobe.

4. TemperatureTest

The vi used will be: "*detector.vi single-ended*" which is based on single-ended output of the Engineering Readout and Control Electronics. This software will log the outputs of all four detector channel, XP, XN, YP, and YN. It will also log the two housekeeping channels with ground subtraction and be synchronized by the ATC Strobe. The two housekeeping channels contain the essential information to measure the thermal parameters.

5. PowerDissipation

The vi used will be: "*detector.vi single-ended*" which is based on single-ended output of the

Engineering Readout and Control Electronics. This software will log the outputs of all four detector channel, XP, XN, YP, and YN. It will also log the two housekeeping channels with ground subtraction and be synchronized by the ATC Strobe. The two housekeeping channels contain the essential information to measure the thermal parameters.

6. <u>ThermalStability</u>

The vi used will be: "*detector.vi differential*" which is based on single-ended output of the Engineering Readout and Control Electronics. This software will log the outputs of all four detector channel, XP, XN, YP, and YN. It will also log the two housekeeping channels with ground subtraction and be synchronized by the ATC Strobe. The two housekeeping channels contain the essential information to measure the thermal parameters.

7. <u>LakeShore</u>

The vi used will be: "*LakeShore.vi*" which measures the output of the Germanium thermometer. "*LakeShore.vi*" is a subvi of "*detector.vi single-ended*" and "*detector.vi single-ended*". The software will monitor the thermometer temperature as reported by the controller. No heater is connected to the heater control circuit.

8. <u>RGA</u>

The vi used will be: "*RGA Communication.vi, RGA command.vi, and Sentorr.vi*" which measures the output of the SRS RGA and Sentorr Vacuum sensor electronic readout module. The software will monitor the two thermocouples and the ionization gauge of the Sentorr unit and the most common gas species from the RGA, e. g., H_20, O_2, N_2, CO_2, etc.

6.2.3 **Software Configuration Control**

Copies of the custom software will be filed with the document configuration control librarian of the GPB Project at Stanford University. Currently that person is Mae Sato. All changes made shall be documented and updated copies of the test software deposited with the librarian.

Software Inventory and Status

Item #	Version	Name	Date Modified	Status
1	7.5.3	Mac OS	4/21/95	Stable/Commercial
2	4.1	LabView for Mac	12/31/97	Stable/Commercial
3	7.1.3	GPIB Driver NI-488	2/17/97	Stable/Commercial
4	6.22	DOS	5/31/94	Stable/Commercial
5	3.4	SQUID	12/20/97	Stable/Custom
6	1.0	OpticalResponse = "detector.vi single-ended"	1/13/98	Subject to modification
7	1.0	Noise = "detector.vi differential"	1/14/98	Subject to modification
8	1.0	LeakCurrent = "detector.vi differential"	1/14/98	Subject to modification
9	1.0	TemperatureTest = "detector.vi single-ended"	1/13/98	Subject to modification
10	1.0	Power Dissipation = "detector.vi single-ended"	1/13/98	Subject to modification
11	1.0	Thermal Stability = "detector.vi single-ended"	1/13/98	Subject to modification
12	1.0	LakeShore = "LakeShore.vi"	1/13/98	Subject to modification
Item #	**Version**	**Name**	**Date Modified**	**Status**
13	1.0	RGA = "RGA Communication.vi" and "RGA Command.vi" and "Sentorr.vi"	1/13/98	Subject to modification
11	3.0.4	KaleidaGraph	6/17/94	Stable/Commercial

12	3.1	Mathcad	1/11/93	Stable/Commercial
13	3.5.4	WordPerfect	5/29.96	Stable/Commercial

6.3 Listed Equipment

Listed here are the Database Reference Numbers of equipment to be maintained in calibration for the purposes of testing in this program. The ETU is not listed because it is Ground Support Equipment which consists of separate components of unlisted equipment. Some of its components need calibration that is handled through internal calibration procedures, e. g., the A/D converter. The ETU oscilloscope is used for monitoring purposes only. The Mac/LabView data acquisition system is not listed as no calibration is possible or relevant. It logs data acquired by the Tek oscilloscopes and the LakeShore temperature controller.

Database Reference Numbers

Item	S/N	DRN	Property Stanford/HEPL LockMar/HP NASA ARC	Calibration Certificate	Last Cal. Date
NIST 100 W tungsten filament calibration lamp GE 30/T24/13	EPIR-1086			NBS Special Publ. 250-1	1984
NIST Silicon Photodiode Hamamatsu Model S2281	S/N D213	61	911652 2/ 02195-2	NIST844/ 257722-97	9/31/97
Tek 744A Oscilloscope	B041929	60	911557 6/ 02119	NASA ARC 365670 M112884	2/09/98
Tek 420A Oscilloscope	B051297	64	911747 1/ HL02263-1	NASA ARC 365669 M112883	2/09/98
Tek 540A Oscilloscope	B011828	65	LM/HP LP 014280 00/ 801229	H1-21 GBTEA	2/25/98
Silicon Diode Thermometers	BC557T Philips Hamburg Slice #20	62	Stanford University PO U3XD E487740	Inst. Of Cryogenics	7/96

Germanium Resistor Thermometers	23531-101		N/A	N/A	N/A
HP 3458A Multimeter	2823A16067	57	902266 9/ 020447	NASA ARC 365672 M112885	2/10/98
LakeShore DRC93CA Controller	17483	63	NASA ARC 007217	NASA ARC 365671	2/11/98
Alignment Telescope Kueffel and Esser	71 5180	71	MPT 027152 00 7-7507-02	Lockheed Y506	9/07/95

7. Required Tests

7.0.1. Illuminate the DPA photodiodes with a known quantity of optical radiation ~100 time greater than that of a bright star observable in flight at a wavelength of 670 nm. Measure the responsivity of the detectors to the radiation. If possible illuminate the photodiodes with a quantity of radiation similar to that anticipated by the actual guide star, nominally IM Peg. Measure the responsivity of one of the flight articles at wavelengths of 460, 550, 670, and 850 nm.. Measure the responsivity using the unapertured filament and with a small pinhole aperture

7.0.2. Measure the detector referred input noise across the frequency spectrum of 0 to 2500 KHz of the DPA detectors with and without optical radiation in the amount appropriate to 7.0.1.

7.0.3. Measure the leakage current of the detector input node without optical radiation at the anticipated flight operational temperature, nominally 80 K.

7.0.4. Measure the temperature stability of the DPA's DMA. Measure this in open loop and closed loop control using the DMA thermometer and housekeeping electronics.

7.0.5. Measure the power dissipation of the DPA's DMA. Measure this in closed loop control using the DMA thermometer and housekeeping electronics. Measure the power dissipation of the DMA.

7.0.6. Measure Temperature Coefficient of Bias's dark current as in 7.0.3. This is accomplished by measuring the dark current at two temperatures differing by 10 K near the desired operating temperature..

7.0.7. Measure the Lateral Shift of the DMA alignment fiducial with respect to the DPA entrance aperture when cooled to LN_2 and LHe temperature.

7.1 **Test Setup**

Electrostatic discharge and overstress precautions will be adhered to as outlined in document P0357. Wrist-straps will be worn when making electrical connection to the dewar with the flight electronics. Wrist-straps will be worn then assembling the DPA and the clean can.

The DPA test article is to be mounted in the clean can of the clean dewar which is attached to the vibration isolation table via a mounting fixture with test equipment. The flight-like warm electronics will be connected. The Lakeshore Controller is to be connected to the dewar through one of the spare electrical connectors. The Engineering Test Unit rack will be connected. The Mac/LabView data system will be connected to necessary test equipment via the GPIB bus and the appropriate test equipment connected to the engineering rack. All grounds will be connected and checked. Equipment will then be turned on and allowed to stabilize. The optical source will be turned on and calibration checked with the calibrated optical radiation detector.

The LakeShore controller is to monitor the Ge thermometer continually. The RGA and Varian Sentorr Units are to monitor the vacuum throughout the test. By the way, there is a room temperature thermometer mounted on the room wall.

7.1.1 **Test Environment**

The DPA test article will be mounted in a clean can in a clean room of cleanliness class 100. It shall remain in the clean can for the duration of the test and be delivered for integration while confined to the clean can. The clean can consists of machined aluminum structure with a glass window and hermetically sealed electrical connections to the external environment. A porous plug will be incorporated to evacuate the clean can and filter any particulate material.

The clean can will be mounted in a clean test dewar. The cleanliness level of the test dewar will be class 10,000. A turbomolecular pump will be used to evacuate the dewar in order to minimize contamination by pump oils.

The test dewar will be used in a normal laboratory environment of no specified cleanliness class. The dewar will be mounted on an standard optical table on which the test beam of light is generated and injected into the dewar window; and thereby into the clean can window; and thereby into the DPA. Normal room temperature and humidity will be suitable for this experiment.

7.1.2 **Test Setup Checklist & History**

Step #	Title	Date & Operator	QA Rep
1	Vacuum System Running Dewar Vacuum Monitors Thermocouple #1 Thermocouple #2 Ionization Gauge RGA		
2	Dewar on test stand		
3	Connect Vacuum system		
4	Open vacuum valve to Pump		
5	Open vacuum valve to Dewar		
6	Wrist strap on		
7	ETU off		
8	Connect ETU Cables A & B		
9	Connect LakeShore Cable		
10	Power up ETU		

11	Power up Lakeshore		
12	Connect Mac/Labview/Tek scopes to ETU patch panel		
13	Check detector operation warm		
14	Start to Record ramp & housekeeping data with Mac/Labview/Tek		
15	Wait at least 2 hours		
16	Optically measure the position of the Detector fiducial with respect to the DPA Aperture before cooling.		
17	Agree on readiness to cool		
18	Make a Recording of ramp & housekeeping data with ETU		
19	Liquid N_2 fill		
20	Adjust balancing during cool		
21	Continue to Record ramp & housekeeping data with Mac/Labview/Tek		
22	Wait at least 3 hours		
23	Optically measure the position of the Detector fiducial with respect to the DPA Aperture before cooling.		
24	Agree on readiness to cool		
25	Make a Recording of ramp & housekeeping data with ETU		
26	Liquid He fill		
27	Adjust balancing during cool		
28	Continue to Record ramp & housekeeping data with Mac/Labview/Tek		
29	Wait at least 3 hours		
30	Optically measure the position of the Detector fiducial with respect to the DPA Aperture.		
31	Make a Recording of ramp &		

	housekeeping data with ETU		
32	Start tests of responsivity		
33	Start large aperture filament test of responsivity		
34	Conclude large aperture filament test of responsivity		
35	Start small aperture filament test of responsivity		
36	Conclude large aperture filament test of responsivity		
37	Conclude test of responsivity		
38	Start test of leakage current		
39	Conclude test of leakage current		
40	Start test of noise		
41	Conclude test of noise		
42	Start test of temperature stability		
43	Conclude test of temperature stability		
44	Start test of power dissipation		
45	Conclude test of power dissipation		
46	Start test of temperature coefficient of bias		
47	Conclude test of temperature coefficient of bias		
48	Optically measure the position of the Detector fiducial with respect to the DPA Aperture before warming.		
49	Agree on conclusion of tests		
50	Make a Recording of ramp & housekeeping data with ETU		
51	Begin to warm up dewar		
52	Vacuum System Running Dewar Vacuum Monitors Thermocouple #1 Thermocouple #2 Ionization Gauge		

	RGA		
53	Record Thermometers Ge Thermometer Si Diode #1 Si Diode #2		
54	Close vacuum valve to Pump		
55	Close vacuum valve to Dewar		
56	Wait for temperature to attain 310 K on the detector Platform		
57	Optically measure the position of the Detector fiducial with respect to the DPA Aperture before cooling.		
58	Disconnect Vacuum system		
59	Bleedup Dewar vacuum pressure		
60	Dismount Dewar		

7.2 Optical Responsivity Test Criteria

Optical responsivity tests are intended to determine if the detectors of the DPA assembly have an external optical quantum efficiency of at least 70 %. The following guideline is to be used:

Table 7A
Optical Responsivity Test Criteria

Wavelength	550 nm
Input Optical Flux	70,000 photons/sec
Star	IM Peg
Preamp Reset Rate	10 Hz
Minimum Output Current	49,000 electrons/sec

7.3 Input Referred Noise Test Criteria

The DPA test article is to have the output noise level of the readout electronics measured and scaled to reflect the system gain. The input referred readout noise in the absence of light is not to exceed the values in table 7B in the frequency ranges specified when exercised by the TRE warm electronics.

The noise spectral specifications have been translated into units of e^-/read for inclusion in PLSE-13, Pt 3.

Table 7B
Input referred noise measurement Criteria

Maximum Noise	50 e- rms/(read)

7.4 Input Leakage Current Test Criteria

The DPA test article is to have the output voltage ramp of the readout electronics measured and scaled to reflect the system gain. The input referred leakage current in the absence of light is not to exceed the values in table 7C in the reset period of 100 ms when exercised by the TRE warm electronics.

Table 7C
Input Referred Leakage Current Measurement Criteria

Maximum Leakage Current	10 aA @ T_{op}

7.5 Temperature Stability Test Criteria

The DPA test article is to be allowed to operate in an uncontrolled temperature stability test. Then DPA test article is to have the closed loop thermal control applied. The controlled temperature stability is expected not to exceed the value in table 7D.

Table 7D
Temperature Stability Test Measurement Criteria

Maximum Temperature Drift	$T_{op} \pm 2$ mK

7.6 DMA Power Dissipation Test Criteria

The DPA test article is to be allowed to operate at a stable uncontrolled operating temperature, 80 K ± 20K. Then DPA test article is to have the closed loop thermal control applied. The power dissipation is expected not to exceed the value in table 7E.

Table 7E
DMA Power Dissipation Test Measurement Criteria

Maximum Power Dissipation	<1.5 mW @ T_{op}

7.7 Temperature Coefficient of Pointing Bias of the Preamplifer Test Criteria

The DPA test article is to be allowed to operate at a stable uncontrolled operating temperature, 80 K ▒ 20K. Then DPA test article is to have the closed loop thermal control applied. The power dissipation is expected not to exceed the value in table 7F.

Table 7F
DMA Temperature Coefficient of Pointing Bias Measurement Criteria

Maximum Temperature Coefficient of Pointing Bias	< 440 e^-/(read)K

7.8 Thermal Alignment, Decentering, Measurement Criteria

The DPA test article is to operate stabily at approximately 310, 90 K and <10 K. That is power dissipation is to be minimal during this test at the Liquid Helium temperature. The thermally induced decentering is expected not to exceed the value in table 7G.

Table 7G
Thermal Alignment, Decentering, Measurement Criteria

Maximum Decentering	▒500 ┤ m

8. Measurements

The following is a description of the measurement procedures for each of the parameters listed in Section 7. You must have a copy of the ETU operation manual and an approved operator of that equipment. Be sure to have completed all steps in the table of section 7.1.2 the Test Setup Checklist & History that preceed commencement of testing. The detector thermometer should be operating at 80 K ▒ 10 K except where the procedure requires a different temperature.

8.1 General Description

Measurements of the Optical Responsivity are to be taken for a minimum time period of 5 minutes, sustained illumination. This measurement is to be repeated a minimum of 10 times using a shutter at alternating periods of 5 minutes. The measurement will be made by peaking the beam of light in the

X-Y, q, w coordinates of the detector plane. The image of the lamp filament will be larger than the detector area, the detector being of dimension 0.5 mm.

Measurement of the electrical noise level of the detector readout will be made continuously and sampled periodically over a period of 1 hour. Independent spectra gathered at random times shall total no less than 30 in number.

Measurement of the leakage current will be made by averaging the difference of detector pairs until sufficient time has passed to measure 10 aA with a minimum S/N of 10.

Measurement of Temperature Stability will be made over a minimum period of 1 hour. A sufficient number of samples will be collected to measure, with a S/N better than 10. Drift shall not exceed $\pm$2 mK.

The power dissipation is to be logged during operation of the stability tests, but will extend the range of temperatures measured from 70 to 90 K.

Measurement of the temperature coefficient of bias will be made by averaging the difference of detector pairs until sufficient time, estimated to be one hour, has passed to measure 440 e^-/(read)K with a minimum S/N of 10.

All tests are to be conducted at 70, 80, and 90 K.

8.2 Control Points

Each test procedure will incorporate calibration checks on the optical and electrical equipments. Optical calibration will be accomplished by the measurement of the light source with a calibrated detector. Voltage calibration will be checked with a precision calibrated voltage source. Calibration certificates will be obtained and records kept of the instrumentation used in each test. A qualified representative of the quality control representative should be present during each test procedure.

8.3 Test Procedure

Detailed test procedures are given here for each of the tested parameters. It is assumed that the testing is done sequentially. If not, then the setup instructions of Section 8.3.1, with the exception of the lamp warmup, apply to all tests.

8.3.1 **Optical Responsivity**

Slowly warm up the tungsten filament calibration lamp by increasing the lamp supply current to 40.00 A. The power supply should be set to regulate to constant current. Periodically monitor the lamp supply voltage at the lamp base and record the result in the log book. Wait for a period of at least 3 hours for the lamp to stabilize before collecting valid data.

Balance the currents in the JFET pairs using the procedure “Balancing the TRE Detector Modules” in the ETU module. Record the Oscilloscope voltage scales and the ETU CLAMP and OFFSET settings.

Check the alignment of the optical system with the HeNe alignment laser so that the laser beam illuminates the alignment fiducial. Adjust the optical components so as to illuminate the fiducial. Record any adjustments.

Turn off the laser and examine the color of the tungsten filament by looking down the optical train. Record the color.

Insert the optical filter in front of the baffle tube with a black foam spacer to seal light leaks.

Examine the color of the tungsten filament by looking down the optical train. Record the color.

Tilt the dewar in the q, w directions to illuminate one of the detector pixels, either the X or Y pixel. Peak up the signal. Measure the tilt angle with the inclinometer and the position angle. Record the result.

Go back and check that the ETU Clamp has not drifted. If it has, then you did not wait long enough after the liquid helium fill. Kick yourself and record the result in the log book.

Using an opaque shutter, make and break the optical beam with a period of 10 minutes and a 50/50 duty cycle. This should continue for a period of time not less than 1 hour. Record the value of the mean slope from the Mac data logging system. Note any drifting or spiking or inadvertent interruptions in the data taking sequence. Such events are not necessarily cause to abort the testing. Check with the test director when such circumstances arise.

Tilt the dewar to illuminate one of the other pair of detector pixels, either the Y or X pixel. Peak up the signal. Measure the tilt angle with the inclinometer and position angle. Record the result.

Go back and check that the ETU Clamp has not drifted. If it has, then you did not wait long enough after the liquid helium fill. Kick yourself and record the result in the log book.

Using an opaque shutter, make and break the optical beam with a period of 20 minutes and a 50/50 duty cycle. This should continue for a period of time not less than 2 hours. Record the value of the mean slope from the Mac data logging system. Note any drifting or spiking or inadvertent interruptions in the data taking sequence. Such events are not necessarily cause to abort the testing. Check with the test director when such circumstances arise.

The recorded slope is in V/sec. The conversion factor to quantum efficiency is (3.62 x 10^6 e-/sec)/(1.11 x 10^7 ph/sec) = 0.326 e^-/ph per V/sec of slope. This is shown in the Mathcad document: *Lamp Emission GPB.* A number of assumptions and measurements are taken into account knowing the optical setup and components. So if anything changes, you better record it and measure it. The optical setup is referred to as the setup for good reason.

Repeat the procedure at temperatures of 80 and 90 K. You don’t have to wait 3 hours for the dewar to stabilize. Just enter a new parameter into DTEMP.

Now change the optical setup by placing the pinhole aperture at the lamp filament so that the detector signal is maximized. Repeat the measurement procedure above at a temperature of 80 K. You should expect to receive a lot less signal in proportion to the arial ratio of the filament projected on the detector to the pinhole area, taking into account the magnification of the lens.

8.3.2 **Electrical Leakage Current**

Block the optical beam completely at the baffle tube entrance and check for optical leaks around the dewar using a flashlight. Correct as necessary. Note any corrections and record the results in the log book. The electrical leakage tests are ready to test when no discernable signal can be detected from the flashlight.

Set the Engineering Test Unit control command to 1500 for each of the DMAs under test and center the output of the detector amplifiers so that they are midrange and stable. Record the Oscilloscope voltage scales and the ETU CLAMP and OFFSET settings.

Record the value of the mean slope from the data logging system. This is in V/sec. The conversion factor to leakage current is 3.62×10^6 e-/sec per V/sec of slope.

Repeat the procedure at temperatures of 80 and 90 K. You don't have to wait 3 hours for the dewar to stabilize. Just enter a new parameter into DTEMP.

8.3.3 **Noise**

Block the optical beam completely and check for optical leaks using a flashlight. Correct as necessary. Note any corrections and record the results in the log book. The electrical leakage tests are ready to test when no discernable signal can be detected from the flashlight.

Balance the currents in the JFET pairs using the procedure "Balancing the TRE Detector Modules" in the ETU module.

Set the Engineering Test Unit CONTROL word for the X and Y channels to 1500. Record the Oscilloscope voltage scales and the ETU CLAMP and OFFSET settings.

Set the Temperature reference of the Engineering Test Unit, DTEMP command, so as to bring the temperature servo-amplifier output into range and approximately center it. Choose a temperature of 70 K. Look up the setting for the temperature command word on the ETU. Engage the local temperature control servo with the ETU.

Record the value of the mean slope, and the standard deviation of the slopes and the variance of the slopes. The conversion factor to current is 3.62 x 10^6 e-/sec per V/sec of slope. One read of the TIA corresponds to 100 ms. 10 e-/sec corresponds to 1 e-/read.

Repeat the procedure at temperatures of 80 and 90 K. You don't have to wait 3 hours for the dewar to stabilize. Just enter a new parameter into DTEMP.

8.3.4 **Temperature Stability of the DMA**

When the dewar is thermally stabilized for no less than 3 hours after filling with liquid helium, the test may commence.

The RGA vacuum monitor must be running during the observation period. The dewar vacuum valve must be open so as to exhaust the vacuum space to the RGA and turbomolecular pump

Set the Temperature reference of the Engineering Test Unit, DTEMP command, so as to bring the temperature servo-amplifier output into range and approximately center it. Choose a temperature of 70 K. Look up the setting for the temperature command word on the ETU. Engage the local temperature control servo with the ETU.

Balance the currents in the JFET pairs using the procedure "Balancing the TRE Detector Modules" in the ETU module.

Begin logging data for a period of at least one hour. During the observation period, the temperature servo-amplifier must not require recentering.

The recorded values of the temperature servo-amplifier should be scaled by the gain corrected voltage sensitivity factor (-576.6/227.27) K/V = 2.537 K/V. This is the differential data collection program. For the single ended case the factor is 5.17 K/V.

Repeat the procedure at temperatures of 80 and 90 K. You don't have to wait 3 hours for the dewar to stabilize. Just enter a new parameter into DTEMP.

8.3.5 **Power Dissipation**

When the dewar is thermally stabilized for no less than 3 hours after filling with liquid helium, the test may commence. The power dissipation will be logged by the computer. The bias voltages and heater voltage reported by the housekeeping channel of the TRE forward electronics are used calculate the dissipation.

Turn off the current to the JFETs, which is the same as tuning off the detector power enable on the ETU.

Choose a temperature of 70 K. Look up the setting for the temperature command word on the ETU, and enter specified HEX value from table in the ETU manual. Engage the local temperature control servo with the ETU. All the time you should be recording data with the Mac/LabView system. Wait 20 minutes and choose another temperature of 50 K. Repeat the process until in 10 K increments until 110 K is achieved.

Repeat the procedure at temperatures of 80 and 90 K. You don't have to wait 3 hours for the dewar to stabilize. Just enter a new parameter into DTEMP.

8.3.6 **Temperature Coefficient of Pointing Bias**

When the dewar is thermally stabilized for no less than 3 hours after filling with

liquid helium the test may commence.

Choose a temperature of 70 K. Look up the setting for the temperature command word on the ETU. Engage the local temperature control servo with the ETU. Set the Temperature reference of the Engineering Test Unit, DTEMP command, so as to bring the temperature servo-amplifier output into range and approximately center it.

Block the optical beam completely at the baffle tube entrance and check for optical leaks around the dewar using a flashlight. Correct as necessary. Note any corrections and record the results in the log book. The electrical leakage tests are ready to test when no discernable signal can be detected from the flashlight.

Set the Engineering Test Unit control command to 1500 for each of the DMAs under test and center the output of the detector amplifiers so that they are midrange and stable. Record the Oscilloscope voltage scales and the ETU CLAMP and OFFSET settings.

Record the value of the mean slope from the data logging system. This is in V/sec. The conversion factor to leakage current is 3.62×10^6 e-/sec per V/sec of slope.

Repeat the procedure at temperatures of 80 and 90 K. You don't have to wait 3 hours for the dewar to stabilize. Just enter a new parameter into DTEMP.

Record the values of the mean slope from the data logging system. This is in V/sec. The conversion factor to leakage current is 3.62×10^6 e-/sec per V/sec of slope.

8.3.7 **Thermal Alignment Shift, Decentering**

At room temperature, liquid nitrogen temperature, and liquid helium temperature, use the alignment telescope to determine the position of the alignment fiducial on the detector chip with respect to the entrance aperture of the DPA. This test can be accomplished during the initial cooldown and repeated, reversed in temperature change rate, upon warmup.

Insert the pellicle beamsplitter into the optical beam. Remove the filter from the optical beam.

With the calibration lamp illuminating the DPA entrance aperture as in the responsivity tests, adjust the illumination intensity with apertures or reflectors for appropriate contrast so as to make the detector alignment fiducial observable with the alignment telescope.

Measure the relative position of the fiducial with respect to the DPA. Record the result. Make three independent measurements. Restore the responsivity measurement setup for further measurements. Repeat as often as necessary.

9. **Data Collection**

Data will be collected and a test record kept of measurements and data files. It is essential that time of collection be recorded. A computerized record of the test article performance will be kept by the Engineering Test Unit and the Mac/LabView Data logging system. Each DPA will have a separate and individually titled notebook that will become the official record of the testing. A traveler will record the history of test article handling. Serial numbers and calibration dates of all measurement equipment used to characterize the test article will be recorded. Test articles will have all relevant identification numbers recorded in the Traveler that will uniquely identify the test article.

9.1 **Data Format**

Data will be collected and a test record kept of measurements and data files. The files will be written in ASCII format and the file will be in spreadsheet format that is compatible with Kalidagraph 3.0.

Three files folders will be generated for each measurement session. These folders will be stored in a separate folder labeled with the DPA # in the Mac File system.

9.1.1 **A file for Header**

The Header file will record the housekeeping measurements, the measured level of a single ramp, the measured slope of the ramp, and a single measured squared error of a single ramp fit to a linear ramp or each of the detectors. This is the same ramp that is recorded in the Frame file. Other pertinent measurements like the time of day will be recorded in this file. The time stamp of the Frame file is recorded here. The LakeShore Controller temperature reading from the Ge thermometers goes here

9.1.2 **A file for Mean.**

The Mean file will contain the mean level of the ramp, the mean slope of the ramp, and the mean squared error of the ramp fit to a linear ramp for a series of 100, or other chosen number, readings of the oscilloscope or each of the detectors.

9.1.3 **A file for Frame**

The Frame file will contain the digitized signal of the ramp waveform for each of the detectors for the first ramp in each of the series of 100 ramps that are acquired in the mean file. This is repeated until the stop number 1000, or other chosen number, is attained. The time stamp of the Frame file is entered into the Header file

9.1.4 **A file for RGA output**

The RGA output file has a record of the vacuum system during the data collection proceedures. It is required for diagnostic purposes.

10. **Pass-Fail Criteria**

Failure is based on performance limits derived from the system design through a model of the telescope control system.

1) The optical quantum efficiency shall be greater than 70 %

2) The noise level shall be less than 50 e^- rms/read.

3) The leakage current shall be less than 10 aA in each frequency range.

4) The temperature stability shall be less than ±2 mK over the period of an hour.

5) The power dissipation shall be less than 1.5 mW per DMA, or 3.0 mW per DPA.

6) The temperature coefficient of bias of the detector circuit shall be less than 440 e^-/(read)/K

7) The thermal shift in alignment, the decentering, shall be less than 500 μm

DPAs that do not meet these specifications shall have a discrepancy report prepared, reviewed and approved with the disposition of the DPA recorded.

11. Qualified Personnel

11.1 Test Director

The qualified test director is Paul Ehrensberger, the Integrated Product Team Manager of the Telescope Readout Electronics (TREIPTL).

11.2 Qualified Test Personnel

Equipment	Personnel
Macintosh Data System	Ali Kashani, John Goebel
Data Analysis	Dave Meckfessel
Engineering Test Unit	Bob Fujimoto, Howard Demroff, Bob Farley, Paul Ehrensberger
Optics and Alignment	John Goebel
Cryogenics	Gene Tam, John Goebel, Paul Ehrensberger,
Vacuum Equipment	John Goebel, Nick Scott, Ali Kashani
Oscilloscopes	Howard Demroff, Ali Kashani, John Goebel
Optical Alignment	Mark Sullivan, Jeff Young, John Goebel

11.3 Quality Control Personnel

A quality control witness will be present during testing. The Quality Control Representative, Ben Taller, or his duely appointed representative, Ken Coleman, will be present at of the commencement of testing of flight articles, and during the testing of each flight article until the completion of testing.

11.4 Government Mission Assurance Representative

The government mission assurance representative testing, Ed Ingraham from Office of Naval Research, will be notified at least 48 hours prior to the commencement of testing of flight articles.

12. **Test Report**

A test report describing test preparation, conduct, data and results will be written and submitted for inspection. The software used to analyze and write the report is specified in section 6.2.3. The handling history will be recorded in section 13.1 and accompany the part as the traveler. The test results will be summarized in section 13.2. Any test discrepancies will be noted in section 13.3.

13. Certificates

13.1 Test Certificate Completion and Acceptance

A test certificate annointing compliance with the certified test procedures will be submitted with a signoff sheet for authorized approvals.

Gravity Probe B Relativity Mission

Detector Package Assembly

Test Completion and Acceptance Certificate for DPA #_______

DPA	S/N	Rev

Approval:

____

John H. Goebel Date
Telescope Readout Electronics Responsible Engineer

____

Paul D. Ehrensberger Date
Telescope Readout Electronics Integrated Product Team Leader

____

Ben Taller Date
Quality Engineer

____

Bob Schultz Date
Chief System Engineer

____

John P. Turneaure Date

Hardware Manager

13.2 **Test Compliance with PLSE 13, Pt. 3**

This document certifies that the test article has been tested in accordance with PLSE 13, pt. 3. The relevant paragraphs are listed and compliance with the pass/fail criteria noted.

DPA	S/N	Rev

DPA Requirements (extracted from TRE Spec [PLSE-13 Pt 3])

Paragraph	Title	Pass/Fail
3.2.5.3	Platform Temperature, Variation at Roll Frequency	
3.2.6.1	DPA Power Dissipation	
3.2.18.1	External Quantum Efficiency at 400 to 900 nm wavelength	
3.2.18.2	External Quantum Efficiency at 550 nm wavelength	
3.2.18.3	I_Dark	
3.2.18.4	Dimaeter of Photoactive Area	
3.2.18.7	Operating Temperature (Si JFETs)	
3.2.18.7	Random Noise	
3.2.18.8	Temperature Coefficient of Bias	

13.3 **Traveler**

The history of handling the DPA during the testing will accompany the test article. Handling procedures will be reported in the traveler.

DPA	S/N	Rev

Station	Action	Condition	Handler	Date
DPA receipt				
DPA incorporation into clean can				
Clean Can incorporation into dewar				
Dewar incorporation into Test Setup				
Dewar disassembly				
Clean Can disassembly				
DPA extraction				
DPA delivery				

13.4 Test Results and Summary

Test Article Identification

DPA	S/N	Rev

Start Date						
Completion Date						

DMA #	**DMA#**
Cable #	**Cable #**
CAP #	**CAP #**

Magnetic Screening
Date
Pass/Fail

Measurement Equipment & Calibration

Item	Manufacture & Model	Calibration Date	Database Reference Number
Lamp			
Photodiode			
Oscilloscope			
Oscilloscope			
Optical Filter			
Optical Filter			
Optical Filter			
Optical Filter			
Alignment Telescope			
ETU			
Temperature Readout Unit			

Test Results

Procedure	**Measure**	**Error**	**Criteria**	**Operator & Date**	**Pass & Fail**
Quantum Efficiency			⩾ 70 %		
Leakage Current			< 10 aA		
Noise			< 50 e^- rms/read		
Power Dissipation			< 1.5 mW		
Temp Stability			T_{op} ▒ 2 mK		
Alignment Shift			Z_0 ▒ 500 ╡ m		
Temperature Coefficient of Pointing Bias			< 440 e^-/(read)/K		

13.5 Test Discrepancies

Test Discrepancies

Procedure	Discrepancy	Operator/Date

13.5 **Bias Test Report**

ETU Controllable Parameters That Affect Telescope Pointing Bias Variation

Controllable Parameter	TRE ETU Commamd Parameter	ETU Input Test Signal	TRE ETU Input Command Address Range		ETU Output Signal
Name	Name	(V/sec)	Voltage Limits	Hex Limits	(V/sec)
+ Direction Clamp Voltage	CLAMP			00_FF	
- Direction Clamp Voltage	CLAMP			00_FF	
[illegible] Direction Clamp Voltage	CLAMP			00_FF	
+Reference or Reset Level	SBIAS (OFFSETS)			00_FF	
-Reference or Reset Level	SBIAS (OFFSETS)			00_FF	
[illegible]Reference or Reset Level	SBIAS (OFFSETS)			00_FF	
Diode Bias Voltage	PBIAS (BIAS)			00_FF	
Heater Voltage	HEAT			00_FF	
Control	CONTROL			N/A	N/A

14. **Disposition of materials and discrepancies**

Tested parts will be delivered to the integration product team for incorporation in the Science Probe or storage in an appropriate secure clean facility. Rejected parts will be dealt with as required by Quality Plan P0108. Any discrepancies will be reported in the traveler and data report.

15. **Safety**

Qualified laboratory personnel will conduct these tests. They are required to have undergone laboratory safety training and be up to date. The HeNe laser is class IV, so formal training is not necessary. The optical setup will capture reflected laser beams to avoid injury concerns, either real or imaginary. Experience with handling high pressure gas cylinders and cryogenic fluids is necessary. Safety training for falling objects in case of earthquake is necessary. Safety training in handling of electrical and electronic equipment is necessary.

Appendix A

Detector Package Assembly Verification Matrix

Telescope Readout Electronics Specification PLSE-13 Part #3

Paragraph	Title	Text & *Comments*	Method	Verification Plan	√
3.2.5	Telescope Detector Mount Assembly	See attached Doc. Text File for an overview of this section.			
3.2.5.1	~~First Natural Resonance~~ Vibration Environment	~~$f_0 \geq 100$ Hz~~ Protoqual @ LN_2 77K	S,T	P0358 DMA vibration test procedure S-Doc TBS	
3.2.5.2	Detector Alignment w.r.t Focused Image Position				
3.2.5.2.1	Pitch/Roll~~Tip/Tilt~~ Yaw	~~≤ 5 degrees~~ ≤ 10 arcmin ≤30 arcmin	I,~~T~~	Inspect vendor data	
3.2.5.2.2	Defocus	~~≤ 200 micrometers~~ ≤500 µm	I,~~T~~	Inspect vendor data	
3.2.5.2.3	Decenter	~~≤100 µm~~ ≤500 µm	I,~~T~~	Inspect vendor data	
3.2.5.3	Platform Temperature Variation at Roll Frequency, as defined in T003, 7.6.2	≤ 2 mK	A,T	Payload level verification	
~~3.2.5.4~~	~~Number of Electrical Leads~~	~~20~~	~~I~~	~~P151 Detector Mount Subassembly Inspection~~	
3.2.5.5	Electrical Lead Resistance	≤ 100 Ω	~~A~~,T	P151- Detector Mount Subassembly Build	
3.2.5.6	Base Temperature				
3.2.5.6.1	Base Operational Temperature	2-6 K	T	P0392: Duration of testing	
3.2.5.6.2	Base Test Temperature	2 - 290 K	T	P0392: Duration of testing	
3.2.5.6.3	Base Bakeout Temperature (survive)	340 K	N/A	P0151	
~~3.2.5.7~~	~~EMI~~	~~TBD~~	~~T~~	~~EMI test booth and GTU-2~~	
3.2.6	Detector Thermal Output				
3.2.6.1	Total Telescope	~~4 mW (1 mW /platform)~~	~~A~~,T	P392: Power	

	Detector Power (All Detectors)	6 mW (1.5 mW/platform)		Dissipation Test	
3.2.7	Detector Base Operational Temperature Range				
3.2.7.1	Operational Temperature range at 10 fA, 10 pA, and 1 microAmp Photo Current Levels	6K - 2K	~~T~~N/A	~~Testing in cryo telescope facility and GTU-2~~ ~~S-Doc TBS~~ Header	
3.2.7.2	Operational Temperature Range at 10 pA Current Level	300K - 2.0 K	~~T~~N/A	~~Testing in cryo and room temperature telescope facilities~~ ~~S-Doc TBS~~ Header	

3.2.13	Telescope to Telescope Detector Interface	Large Picture available in Doc. Text File. Assuming: 65-50% Strehl ratio 0.4 - 1.0 micron wavelength >=70% photons shall fall on the detector 53-21% transmission efficiency -/+ 60 arcsec ST field of view Worst case Guide Star (V711 TAURI) 80% photodetector efficiency Expected photo-current = 12 fA per detector when telescope is centered ~~Minimum~~ Scale Factor≥ = 18*10^(-18) Amp/marcsec per detector	~~A~~		
3.2.18	TRE Detector Performance Requirement				
3.2.18.1	External Quantum Efficiency at 400 to 900 nm wavelength	>70~~80~~%	S,A,T	P0392: Optical Responsivity test one fight unit will be tested over several wavelength and use similarity for other flight units. S-Doc TBS	

3.2.18.2	External Quantum Efficiency at 550nm wavelength	>70~~80~~ %	~~A~~,T	P0392: Optical Responsivity test	
3.2.18.3	I_Dark	<0.01 fA@ ~~T_op~~80 K	~~A~~,T	P0392: Electrical Leakage Current Test Measure w/o light and at V_detB=4.0V @~~T_op~~ 80 K	
3.2.18.4	Diameter of Photoactive Area	~~TBD (.5 to .8 mm)~~ 0.8 mm	I,~~A,T~~	P332	
~~3.2.18.5~~	~~Sense Node Capacitance~~	~~<20 pF~~	~~A,T~~	~~P0392~~	
3.2.18.6	Operating Temperature (Si JFETs)	~~40 K < T_op < 120 K~~ 80 K±10 K	~~A~~,T	P0392 : Temperature Stability Test Measure without light and at V_detB=4.0V @80 K with all components	
3.2.18.7	Sense Node Referred Random Noise	<50 e rms/(0.1 sec read)	~~A~~,T	P0392: Noise test	
3.2.18.8	Temperature Stability	<440 e/(read)/K	A,T	P0392: Temperature coefficient of Stability Test	
~~3.2.18.8~~	~~Transistor Gain~~	~~> .3 E-3 mhos~~	~~A,T~~	~~Measure without light and at V_DetB = 4.0 V @ T_op~~	
~~3.2.18.9~~	~~Transistor Gain Matching~~	~~< 5%~~	~~A,T~~	~~Measure without light and at V_DetB = 4.0 V @ T_op~~	
~~3.2.18.10~~	~~Vgs Matching~~	~~<1%~~	~~A,T~~	~~Measure without light and at V_DetB = 4.0 V @ T_op~~	
~~3.2.18.11~~	~~Vgs Temperature Coefficient Matching~~	~~< 1 %~~	~~A,T~~	~~Measure without light and at V_DetB = 4.0 V @ T_op~~	

Appendix B

Detector Package Assembly Requirements Verification Documents Checklist

Detector Package Fabrication & Assembly

Document	Revision Date	Author	Title	Written	In Database	Approval Status	Dwg Ref	Flow Ref	Verif Ref
P0151	11/26/97	P. Ehrensberger	Procedure for Detector Package Assembly Fabrication	√		Approved	√	√	√
P0219	5/19/97	P. Ehrensberger	Telescope Detector Circuit Assembly Fabrication	√	N/A	Approved		√	
P0332	11/18/97	H. Demroff	Incoming Inspection and test procedure for FLT Rev D TRE circuit on Sapphire carrier	√	N/A	Approved		√	√

Detector Package Test

Document	RevisionDate	Author	Title	Written	In Database	Approval Status	Dwg Ref	Flow Ref	Verif Ref
P0392	1/27/98	J Goebel	Detector Package Assembly (DPA) Acceptance Test Procedure	√		In-Review			√
P0358	1/28/98	J. Goebel	Telescope Detector Mount Assembly Vibration testing	√		Draft			√

Additional Documents

Document	Date	Author	Title	Written	In Database	Approval Status	Dwg Ref	Flow Ref	Verif Ref
P0057 A	9/29/94	J Lockhart	GP-B Magnetic Control Plan - Science Mission	√		Approved	√		
P0059 C	6/19/94	M Keiser	GP-B Contamination Control Plan (Probe B)	√		Approved	√		
P0080	9/5/97	J Lockhart	Cryogenic Magnetic Screening Procedure	√			√		
P0357	2/10/98	H Demroff	Procedure for DPA Electrostatic Discharge Precaution	√		Approved		√	
23200-119 C	12/12/97	B Taller	DRAWING TREE, DETECTOR PACKAGE KIT, SM	√	√	Approved			
25712-101	11/26/97	M Sullivan	DETECTOR PACKAGE KIT, CHANNEL A	√	√	Approved			
25712-102	11/26/97	M Sullivan	DETECTOR PACKAGE KIT, CHANNEL B	√	√	Approved			