GRAVITY PROBE B

PROCEDURE FOR

PAYLOAD VERIFICATION

P0501 REV. A

May 03, 2001

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	Program Responsibility	Signature	Date
Prepared:	Rob Bernier AS3 Setup and Alignment Leader		
APPROVED:	TED ACWORTH AS3 Science Test Leader		
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APPROVED:	Dorrene Ross, or designee QA Inspector		
APPROVED:	Harv Moskowitz LMSSC		
APPROVED:	Rob Brumley Payload Technical Manager		
APPROVED:	Berry Muhlfelder Program Technical Manager		

NOTES:
Authority to redline this document (make minor changes during execution of this procedure): Rob Bernier, Ted Acworth
Level of QA required during performance of this procedure:
_√_ Stanford QA Representative
___ Government QA Representative

All redlines must be approved by QA

Revision Record

Rev	Date:	ECO #	Summary Description	Date
-	8/25/99		Wrote Original Procedure	8/10/99
A	10 May 01	1264	Incorporated redlines, conformed to new Pdoc format, improved procedure flow	5/8/01

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A Scope

A.1 This Procedure covers Aligning AS3 to the Telescope and setting up the beam so that it is collimated and ready for the Payload Tests.

This Procedure ☐Does☒Does not provide formal verification of GP-B requirements.
This Procedure ☐Does☒Does not include constraints and restrictions for the Payload.

B Safety Requirements

B.1 Harv Moskowitz is required before step R (AS3 Lifting Procedure in Fist Ops Lab) during the installation and removal procedures to monitor safety

B.2 Hardware Safety

B.2.1 Don't Jar the Probe with anything

C Personnel

C.1 QA Notification

C.1.1 The ONR representative and SU QA shall be notified 24 hours prior to the start of this procedure. Upon completion of this procedure, the QE Manager will certify his/her concurrence that the effort was performed and accomplished in accordance with the prescribed instruction by signing and dating in the designated place(s) in this document.

C.2 Red-line Authority

C.2.1 Authority to red-line (make minor changes during execution) this procedure is given solely to the AS3 Test Engineers or his designate and shall be approved by the QA Representatiove. Additionally, approval by the Payload Technical Manager shall be required, if in the judgement of the AS3 Test Engineers or QA Representative, experiment functionality may be affected.

C.2.2 Redlines can be initiated by Rob Bernier or Ted Acworth and must be approved by QA.

C.3 Any nonconformance or test anomaly should be reported by a Discrepancy Report. Refer to the Quality Plan, P0108, for guidance. Do not alter or break test configuration if a test failure occurs; notify quality assurance.

C.4 Required Equipment

C.4.1 Hardware Required

C.4.2 Cabling list between AS3 star module and control rack station. (clockwise from accessory cable)

Accessory A
Accessory B
Video coax 1
Video coax 2

Video coax 3
Video coax 4
Motor 1
Motor 2
Motor 3
Motor 4
Motor 5
Quad Cells
Vacuum hose for AS3 vacuum bell
Vacuum pressure sensor 1
Vacuum pressure sensor 2
Thermistor coax 1
Thermistor coax 2
Thermistor coax 3
Thermistor coax 4
Jitter A
Jitter B
Jitter C
Laser power
N_2 hose for window #4 purge, 20 foot length, 3/8 inch diameter
Vacuum hose for Window #4/AS3 window vacuum volume

C.4.3 Cabling list between AS3 control rack and TRE-GSE control rack

Quantity 9 of 20 foot coax with male BNC connectors on both ends

C.4.4 Equipment requiring formal periodic calibration

Manufacturer	Model	Serial Number	Calibr. Exp. Date
Newport Optical Power Meter	1830-C	1604	11 May 02
Newport Optical Power Meter Detector Head (quantity 2)	818-SL	7761 and 7844	11 May 02
Fluke multimeter “GPB SMD”	85	66500192	16 Nov 01
Torque wrench for tightening flange mount bolts	DA175M and DA130M	STU-0031 and STU-0030	OK to use FIST OPS wrench
Torque wrench (FIST OPS property in bonded storage)		000191	28 Nov 01

C.4.5 Special AS3 test equipment

Description	Part No.	Rev. no.	Serial No.
AS3 star module	25567	A	none
500 bomb cart for AS3 star module	none	none	none
AS3 mounted to bomb cart using three legs setup for on-cart optical transmissibility tests (tabs for holding condenser lens under the AS3 star module	none	none	none
AS3 star module mounting flange		none	none
Torque wrench for tightening flange mount bolts	DA175M	none	STU-0031
Torque wrench for tightening flange mount bolts	DA130M	none	STU-0030
10.75 inch Diameter Mylar sheet for the bottom of the AS3 mounting flange			
N_2 cylinder with valve	none	none	none

AS3 control rack including AS3-PC computer and other instruments	none	none	none
AS3 control station including: 5x video monitors and 2 switch boxes AS3-HR1510 computer, computer monitor, keyboard and mouse AS3-PC computer monitor, keyboard, mouse, and trackball	none	none	none
AS3 vacuum pumping cart:			
Vacuum pump for AS3 vacuum bell	none	none	none
220V power cord	none	none	none
20 feet of QF 50 vacuum hose	none	none	none
Vacuum pump for Window #4/AS3 window vacuum volume (available in FIST OPS)	none	none	none
30 feet of 3/8 inch diameter vacuum hose with QF 10 fittings	none	none	none
Mechanical toolbox	none	none	none
¼ inch socket adapter to 5/32 Allen. Note, due to limitation on space, max 1.100 in long.	none	none	none
Allen wrench, 5/32 (in)	none	none	none
6 inch Caliper	none	none	none
Electrical toolbox	none	none	none
Optics toolbox	none	none	none
AS3 Payload Verification test notebook	none	none	none

C.4.6 Tools

Description	No. Req'd
AS3 Mechanical Toolbox inventoried	1
AS3 Electrical Toolbox inventoried	1
AS3 Optics Toolbox inventoried	1

Toolbox content lists are contained in a separate document titled “AS3 tools list.”

C.4.7 Computers and software:

Computer	Name	Model	Software Vendor	Software Name	Version No
WinTel	AS3-PC	Industrial PC 133 MHz NT	National Instruments and other	Lab View and other	5.0.1
WinTel	AS3-HR1510	Adsys	Various support software		

C.4.8 Expendables

Description	Quantity
Optics cleaning supplies	1 bag
JAZ® disks	4
Blank CD-R disks	20
Video camera and media	1
Still Camera and media	1

C.5 Instrument Pretest Requirements

(Documented in this procedure)

C.6 Configuration Requirements

C.6.1 (Documented in Procedure)

C.7 Optional Non Flight Requirement

C.7.1 Na

C.8 Verification / Success Criteria.

C.8.1 This procedure will be considered a success if at the end of the procedure AS3 is mounted to the probe, all of it's cables are connected, and it is ready for the P0501 the Alignment procedure.

C.9 Constraints and Restrictions:

C.9.1 Be extra careful of the vacuum connections to the Top Hat assembly. They are extra sensitive due to the Probe being sub atmospheric, leaving the possibility of air entering the well a heightened risk.

D References and Applicable Documents

D.1 Drawings, N/A

D.2 Supporting Documentation

D.2.1 Payload Test Verification NoteBook.

D.3 Additional Procedures:

D.3.1 P500 AS3 Installation; P501 Alignment; P555 Telescope Telemetry and optical Power setup procedure; P502 Artificial Star 3 Transmissibility and acquisition range tests of telescope; p503; P504

E AS3 Telescope Alignment Procedure

note: all individual procedure sections assume previous procedure sections have been completed in order.

F Power up the computer, Turn on everything in the Rack Tower

G Set up Matlab

G.1 Run Matlab, change path to AS3-PC C:\Artificial Star 3 Files\Prog Files\Full with the command cd('Prog Files\Full') at the Matlab command prompt. The default directory is C:\Artificial Star 3 Files so this switches it to the correct working directory.

G.2 Run Simulink with the icon, or type 'simulink' at the Matlab command prompt.

G.3 run jitter.mdl. (It's in the working directory)

G.4 Run RTW build (In the simulink menu on the right). It builds the Jitter program, links it to the dSPACE processor, and downloads to the dSPACE boards.

H Set Up LabView

H.1 Run AS3_FRONT_END_F.vi (it's in C:\Artificial Star 3 Files\Prog Files\Full) It's also usually on the desktop. It will prompt for the following procedures.

H.2 Find: C:\Artificial Star 3 Files\Data\Reboot\Before Reboot after kill motors. (Latest File)

File Name:____

H.3 Run After_Reboot_F.vi pulling in the files that are listed as last saved in the C:\Artificial Star 3 Files\Data\Reboot\Before Reboot after kill motors. Then move the motors to Before Reboot Before Kill Motors

I Find the Telescope Reticle Image

I.1 Do a manual visual star field scan looking at the Star Finder in the Rotary Stage CCD camera. Identify where the Reticle is, and the spot A and spot B from the wedge.

J Set up 10 mm beam

J.1 Run Collimate_10mm_F.vi (Procedure Runs Automatically)

J.1.1 Align_10mm_F.vi

J.1.1.1 Extend 1 cm cc z = 1850000 ticks

J.1.1.2 LabView popup box: Set laser source optical power to 0.20 mW as read from

Newport power meter with sensor at fiber source beam splitter (to get good s/n ratio on return spot)

J.1.1.3 LabView popup box: This has been done in the lab: first manually: use 40X obj X and Y adjuster screws to null return spot, and 1 cm beam splitter cube mirror adjuster screws to null return to a good manual adjustment position

J.1.1.4 Null both quad cell spots continuously until both spots are nulled within error limits (runs both nuller programs): Null_Both_F.vi

J.1.1.4.1 Null source spot: Spot_Nuller_F.vi ffc->Source Quad cell.

J.1.1.4.1.1High Range 1500 low range 200

J.1.1.4.2 Null return spot from 1 cm cc: Spot_Nuller_DUP_F.vi ff->return Quad Cell

J.1.1.4.2.1High Range 500 low range 100

J.1.1.4.3 Display data of nulled spot error positions:
Xsource = ____________ Ysource = ____________
Xreturn = ____________ Yreturn = ____________

J.1.1.4.4 Beam is aligned if all error values are less than ___________

J.1.2 Minimize_Spot_Diameter_F.vi to automatically minimize source spot diameter and determine and graph scale factor for source spot

J.1.3 Focus_Automatic_F.vi with 10 mm beam settings

J.1.3.1 Run Focus Iterations (collimate 1cm beam to 1/20 wave or better using 1 cm cc test)

J.1.3.1.1 Focus_F.vi with 10 mm beam settings

J.1.3.1.2 Store data
File name: ____

J.1.3.1.3 Move to new position

J.1.3.1.4 Iterate N times

J.1.3.1.5 Plot N Positions

J.1.3.1.6 Move to Best mean
Snag it: ____

J.1.3.2 Estimate error range on final focus iteration _______________
Display data: 105 mm col z tick position = ___________

J.1.4 Minimize_Spot_Diameter_F.vi to automatically minimize source spot diameter and determine and graph scale factor for source spot

J.1.5 Retract 1 cm cc z = 0 ticks

J.1.6 Store Best Focus Position on 105 collimating lens in /Data/Focus/datestamp-Focus.txt

K **Align 150 mm beam perpendicular to reticle:**

K.1 Set optical power to 1.8 mW for visual test (max)

K.1.1 Find reticle (scan until the image from the reticle is found with the appropriate dynamic reaction to a light finger tap on the dewar.

K.2 Walk beam to center (should have been completed in lab)

K.2.1 Set optical power to 1.8 mW for visual test (max)

K.2.2 adjust acq mirror and fold mirror until centered

K.2.3 re-align beam close to the perpendicular to retical direction manually

K.3 Align_To_Retical_F.vi

K.3.1 Preconditions: 1cm space is aligned, collimated, source spot minimized, return spot from reticle is close to nulled, 150 mm beam is close to collimated

K.3.2 Set laser source optical power to 1.0 mW (to get good s/n ratio on return spot)

K.3.3 Extend 6 " cc to center of 6" beam (6" cc z = 125200 ticks)

K.3.4 Null to 6” cube corner using Null_Both_F.vi (ffc->source, ff->return)

K.3.4.1 High Range 750 Low Range 100

K.3.5 Record nulled spot positions Xs _____________, Ys ____________,
Xr _____________, Yr ____________,

K.3.6 Retract 6 " cc z = 0 ticks

K.3.7 Record nulled spot positions Xs _____________, Ys ____________,
Xr _____________, Yr ____________,

K.3.8 Null_Spot_F.vi to retical using discrete acq->return settings

K.3.8.1 High Range 20 Low range 2

K.3.8.2 Record nulled spot positions Xs _____________, Ys ____________,
Xr _____________, Yr ____________,
Acq Az = ____________ Acq El = ____________

L **Collimate 150 mm beam**

L.1 If using Tel #1 in simulator, retical is replaced by 1/10 wave mirror. Manually find retical using star finder and acquisition scan mirror. Then run Align_To_Retical_F.vi

L.2 record acq az and acq el positions (tel retical position)

L.2.1 Reticle Store Motor Positions:____

L.3 Extend sliding aperture to beam center (sliding aperture z = 267500 ticks)

L.4 Set laser source optical power to 2.0 mW (to get good s/n ratio on return spot)

L.5 Focus_Automatic_F.vi with 150 mm beam sliding aperture settings

L.5.1 Spot_Nuller_Discrete_F.vi Acquisition -> return quad cell

L.5.2 Turn off jitter compensation and stabilize return spot by:

L.5.2.1 closing garage door to stabilize airmass flow

L.5.2.2 averaging spot position

L.5.2.3 put on vacuum cover and pull vacuum

L.5.2.4 Close simulator box door, install plexiglass covers

L.5.2.5 Don't power down the jitter amp (even though this will contribute slightly to error)

L.5.2.6 Collimate 6" beam to 1/50 wave or better using sliding aperture test: Focus_F.vi with 150 mm beam settings

L.5.3 Estimate error range on final focus iteration _______________
Display data: 105 mm col z tick position = ___________

L.5.4 retract sliding aperture z = 0

L.6 OPTIONAL: Focus_Automatic_F.vi with 150 mm beam cube corner settings

L.6.1 If using Tel #1 in simulator, remove 1/10 wave mirror

L.7 Null_Both.vi

M **Starfield / Narrow Acquisition Scan**

M.1 Null to telescope boresite

M.2 Narrow range 2D acq scan 6 arc sec res (just wide enough to see retical and boresight) with sufficient resolution to see return spot and boresight in same scan (1 return spot diam = 2.2 arcsec of 6" beam angle)

M.2.1 Enter Scan Parameter into excel sheet-
Name:_________________________________

M.3 Results expected:

M.3.1 Map transmissibility test locations (detector centers) from narrow scan

M.3.2 Precise boresite to retical alignment

M.3.3 Ghost Field Mapping

M.3.4 Find telescope reticle to telescope boresite distances with Acquisition Mirror:

M.3.4.1 Null to reticle Acquisition : Az: ____________ El: _________________

M.3.4.2 Save Motors: Name: ____

M.3.4.3 Null to Boresite Acquisition: Az: ___________ El: __________________

M.3.4.4 Using Current Calibration for Ac. Az. = _____________________ (µrad/Tic)

M.3.4.5 Using Current Calibration for Ac. El. = ______________________(µrad/Tic)

M.3.4.6 Acq. Calculate Distance between the Boresite and Reticle in (µrad.)

M.3.4.6.1 Acq. Distance Boresite to reticle = _______________ (µrad)

M.3.4.6.2 Acq. Azimuth Boresite to reticle = _____________(µrad)

M.3.4.6.3 Acq. Elevation Boresite to retocle: _____________(µrad)

M.3.5 Find Telescope reticle to telescope boresite distances with Fine Focus Mount:

M.3.5.1 Null to reticle Fine Focus : Az: ____________ El: _________________

M.3.5.2 Save Motors: Name: ____

M.3.5.3 Null to Boresite Fine Focus: Az: ___________ El: __________________

M.3.5.4 Using Current Calibration for FF. Az. = _____________________ (µrad/Tic)

M.3.5.5 Using Current Calibration for FF. El. = ______________________(µrad/Tic)

M.3.5.6 Ff Calculate Distance between the Boresite and Reticle in (µrad.)

M.3.5.7 Ff Distance Boresite to reticle = _______________ (µrad)

M.3.5.7.1 ff Azimuth Boresite to reticle = _____________

M.3.5.7.2 ff Elevation Boresite to reticle: _____________

M.3.5.8 Null to Reticle with Acq. Scan Mirror.

N Calibration of beam scan

N.1 Input the Motor-positions acquisition scan az and el of the reticle and wedge spot A

Wedge_Spot_A from:
Finename:____

Wedge_Spot_B from:
Finename:____

Set Optical Power to 1.00 mW

Move to Wedge spot A Using Acq Scan Mirror
Null to Wedge spot A

Align to Wedge Spot A, use align_to_reticle_F.vi
Manually adjust the optical power so that when the retro reflector
Is out the power doesn't saturate.
Record Ac Az a and El a in
/Data/Calibration/Wedge_Data.txt

Null to Wedge spot B
Align to Wedge Spot B, use align_to_reticle_F.vi
Manually adjust the optical power so that when the retro reflector
is out the power doesn't saturate
Record Ac Az b and El b in
/Data/Calibration/Wedge_Data.txt

Process_Wedge_Data_F.vi
Input Wedge_Data.txt

Calculate the angle theta between the best average spot position
Calculate Ac_Az_Cal and Ac_El_Cal in Arcsec/Tic
Store the latest average calibration and SD in
/Data/Calibration/Calibrations.txt

Move to retical

Spot_Nuller_Discrete_F.vi
Acquisition scan Max 10 Min 2

Realign to boresite
Move to boresite

Null to boresite

N.2 Calibration of beam scan and spot calibration – SpotCalMotion vi.

N.2.1.1 Spot Calibrations data filename ________________________________

N.2.1.2 Acquisition az = _______________ arcsec/tick

N.2.1.3 Acquisition el = _______________ arcsec/tick

N.2.1.4 Fine focus az = _______________ arcsec/tick

N.2.1.5 Fine focus el = _______________ arcsec/tick

N.2.1.6 Source spot az = _______________ Xunits/arcsec

N.2.1.7 Source spot el = _______________ Yunits/arcsec

N.2.1.8 Return spot az = _______________ Xunits/arcsec

N.2.1.9 Return spot el = _______________ Yunits/arcsec

N.2.1.10Spot Calibrations data filename ________________________________

N.3 Null to the Wedge_Spot_A (The reason for this, is that we need a stable reference for AS3, The only one that isn't changing is Spot A and B)

O **AS3 system is set up and ready for telescope science tests**

P **AS3 Functionality Tests:**

P.1 AS3 Alignment verification:

P.1.1 10 mm beam collimation performed:

P.1.1.1 Date: ________________________________

P.1.2 150 mm beam collimation performed:

P.1.2.1 Date: ________________________________

P.1.3 Beam walked to the center:

P.1.3.1 Date:________________________________

P.1.4 Signed: ___________________________________

Q **AS3 is Calibrated, and the latest calibration file has been verified:**

Q.1.1 Calibration of Acquisition Scan last Performed:

Q.1.1.1 Date: ____

Q.1.1.2 Time: ____

Q.1.2 Calibration of FF mount Last Performed:

Q.1.2.1 Date: ____

Q.1.2.2 Time: ____

Q.1.3 Calibration of Spot Diameter last performed:

Q.1.3.1 Date: ____

Q.1.3.2 Time: ____

Q.1.4 Calculation of Relationship between 150 mm beam angle and the X or Y readout of the Quad cell is determined by the return quad cell spot calibration to the ff mount.

Q.1.4.1 Relationship between X position and 6 inch Beam angle:________

Q.1.4.2 Relationship between Y position and 6 inch Beam angle:________

Q.1.5 Calibration Verified By:

Q.1.5.1 Signage: ____

R **Procedure Completion.**

Completed by: ____________________________________
Witnessed by: _____________________________________

DATE: ____________________
Time: ____________________

Quality Manager ____ Date ___________
Payload Test Director ____ Date ___________