GRAVITY PROBE B

OPERATION ORDER FOR

ARTIFICIAL STAR 3 TEST

REMOVING THE VACUUM COVER WHHILE THE STAR IS MOUNTED TO THE PROBE AND ACCESSING INTERNAL OPTICS

REV. -

17 Oct. 97

Prepared by: Edward "Ted" Acworth 723-2863 eba@leland.stanford.edu

Approvals:

Program Responsibility	Signature	Date
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Rob Bernier AS3 Test Manager		
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Authority to red-line this document (make minor changes during execution of this procedure):
Edward Acworth, Rob Bernier

Level of QA required during performance of this procedure:
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__√__QA Rep. Edward Acworth, Rob Bernier (one at a time)

Revision Record:

Rev	Rev Date	ECO #	Name	Summary Description
-	Oct. 97	N/A	Edward Acworth	

Acronyms and Abbreviations:

Acronym / Abbreviation	Meaning
AS3	Artificial Star # 3
SMD	Science Mission Dewar
MUX	multiplexer

Operation Number
Date Initiated
Time Initiated

Scope

During the AS3 Test it may become necessary to gain access to the intenal components of the AS3 star module while it is attached to the probe flange, in order to be able to successfully complete th optic setup procedure (section I.2 os AS3 Test procedure P0347). Removing the vacuum cover enables the AS3 test operators (Edward Acworth and Robert Bernier) to visually confirm optic positions, and to make manual asjustments if necessart. These observations anbd adjustments enable the operators to bring the AS3 light beam into alognment with the telescope axis, and to collimate the beam. The data gathering segments of th e AS3 test require that the optics be set up.

Personnel Requirements

Ted Acworth and Rob Bernier are required to to handle the vacuum cover bolts and to make th eoptic observations and adjustments.

Mike Taber is required to operate the crane and observe the vacuum cover lifting and repositioning.

References and Applicable Documents

Tool list

AS3 Test Procedure (P0347)

Operations

Remove Vacuum Cover

Date and time initiated_____

Close off the vacum pump valve

Open the vacuum chamber venting valve and allow to begin venting (takes 15 minutes)

(Crane hook is already connected to to the AS3 shackle and crane function has been verified as part of the AS3 Test procedure P0347)

Remove the 12 bolts holding the vacuum cover to AS3

(Authorized crane operator) raise the vacuum cover above AS3, transport to staging area of FIST floor, and set down on floor on 3 protective feet (2x4s are fine)

Access Optics

One person (Edward Acworth or Robert Bernier) may be on the SMD scaffold to observe optic components and adhjust optic mounts, while the other is at the control station. This proc3edure segment may last four hours in duration

Replace Vacuum Cover

(Authorized crane operator) raise the vacuum cover into position above AS3 and lower the vacuum cover back onto AS3

Replace the 12 bolts holding the vacuum cover to AS3

Leave crane hook on shackle, tension relaxed, as a safety backup

QA_____

Operation order completed.

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

14 Oct 97
From Ted Acworth and Rob Bernier
Gravity Probe B AS3

For distribution to:

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GRAVITY PROBE B

PROCEDURE FOR

GTU-2 TEST PROGRAM

ARTIFICIAL STAR 3 TEST

REV. -

13 Oct. 97

Prepared by: Edward "Ted" Acworth 723-2863 eba@leland.stanford.edu
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Approvals:

Program Responsibility	Signature	Date
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Level of QA required during performance of this procedure:
___Program QA Eng.
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Operation Number
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Scope

Operation of AS3 may be divided into three regimes of operation. First, AS3 must be mounted to the Probe-B and it's beam "shaped" so that it is sufficiently collimated with flat wavefront, and aligned to the telescope return mirror. Second, AS3 requires the capability to scan it's beam angularly in elevation X and elevation Y over a range of 2 arcmin with a resolution approaching 1 marcsec. At scan resolutions approaching milliarcseconds, mechanical, thermal and acoustic noise drown out the scan. So, lastly, a jitter removal system is required to sense the jitter quantity and cancel it out in real time

When referring to scanning optic mounts within the AS3 star module, elevation and azimuth are terms used. In the special case of the beam exiting AS3, elevation X and elevation Y are used, since, when elevation equals 90 degrees, azimuth becomes a pure rotation about the beam axis and is no longer applicable

The following is an outline of our procedure to check out AS3 and to gather data on the performance of the GPB telescope

Set Up Hardware

Set Up Optics

Instrument Jitter Quantity and Evaluate Jitter Removal System Using AS3 Readout

(Optional) Measure the Angle between the Telescope Return Mirror and the Telescope Axis (as observed when the telescope's readout is centered)

(Optional) Instrument Jitter Quantity and Evaluate Jitter Removal System Using Telescope Readout

(Optional) Evaluate Acquisition Scanning

(Optional) Evaluate Fine/Focus Scanning

Hardware Shutdown and Removal

Configuration Requirements

The FIST lab area must be "quiet." Air conditioning, pumps, etc. may need to turned off as required. Any noise sources which adverseley affect the test will be sought out and shut down with the permission of the GTU-2 Test Director

The flange area of the dewar must be clear out to a radius of at least 4', extending up to the crane on the ceiling, and continuing down at least two feet below the plane of the dewar flange

Roll-in access to a floor area, of 4 ft x 5 ft minimum, for staging is required, accessible by the overhead crane to lift the star module onto the probe flange.

The control station requires floor space area of 10 ft x 6 ft minimum, and must be within 8 m of the probe flange for cabling to reach. A 4 ft x 3 ft space directly next to the dewar is required to set up the vacuum pump. Standard 110 VAC and 3 phase 208 VAC are required topower AS3 and the vacuum pump respectively

The Artificial Star 3 assembly with window #4 adapter plate will be bolted to the probe flange. Umbilicals will trail off the star module down to the control station and pump.

Hardware/Software Required

Commercial test equipment

Manufacturer	Model	Serial Number	Calibr. Exp. Date
Tektronix scope	tas475	b010332	3/19/97
Fluke multimeter	77	67960182	Not applicable

Special test equipment

Description	Part No.	Rev. no.	Serial No.
artificial star 3 star module	25567	A	
artificial star control rack			
artificial star vacuum pumping system			
10 meter cables A and B.			
4x 10 meter BNC video cables.			
3x 10 meter high voltage BNC jitter mirror cables.			
mechanical toolbox			
electrical toolbox			
optics toolbox			
2x video monitors and switch boxes			
2x computer monitors			
Macintosh keyboard and mouse			
AS3 GTU-2 test notebook			

Equipment Pretest Requirements

Equipment	Serial No.	Test Required	Proc. No.	Test Performed Date	By

AS3 star module		internal optics aligned, 1 cm and 6" beams collimated, covered and evacuated, and mounted to transport cart.	P0348	day before test	E. Acworth and R. Bernier
AS3 star module		Vacuum system leak tested		Jun. 97	E. Acworth and R. Bernier
AS3 star module		Vacuum structure and shackle (for crane hook connection) tested to 2x load with chamber at atmospheric and evacuated		8 Oct. 97	E. Acworth and R. Bernier
AS3 star module		Install the AS3 star module to Probe-B flange adapter plate			
AS3 star module		Window #4 space vacuum leak check			

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 "tools list."

Computers and software:

Computer	Model	Software Vendor	Software Name	Version No
Macintosh	8100 av	National Instruments	Lab View	4.0.1
		none - in-house	AS3 virtual instrument	-

The Mac is mounted within the control rack module.

Personnel Requirements

Primarily, Ted Acworth will be managing the test and Rob Bernier will be operating AS3. Ted Acworth and Rob Bernier will swap positions on occasions throughout the test.

Mike Taber is required at the beginning of the test to operate the crane and observe the star module lifting, positioning and mounting operations onto the SMD flange. Mike Taber will also be required at test end during star module removal.

Safety Requirements

Things to consider:
When pushing the control rack make sure that it doesn't topple over
When maneuvering the AS3 star module be careful not to allow the accelerations to exceed 2 G - avoid shock
Al Rodriguez's presence will be necessary during lifting for safety assurance
The lifting operation should be QC'd by the GTU-2 Test Director (Mike Taber) who will direct the lifting of AS3 over the SMD
Personnel should not be present beneath the AS3 star module during lifting operations

General Instructions

Electrical mating and demating of connectors

Place cable connector A only into socket A, etc.

Connection and disconnection shall be performed only when the equipment involved is in a powered-down state.

Connectors shall be inspected for contamination and for bent, damaged, or recessed pins prior to mating.

Whenever star module is uncovered optic protective covers shall be installed

Position MUX switches to unused positions before powering up the power supplies

Power up the power supplies only when LabView is running with it's DAQ boards initialized

References and Applicable Documents

Tool list

AS3 internal optics alignment procedure (P0348)

Operations

Set Up Hardware

Date and time initiated_____

Verify crane is available and functioning properly

Al Rodriguez's presence is required to assure safety during lifting _____

Set up control station components in position on the platform near the SMD. Plug into line AC but do not power up any components

The star module is transported to the FIST lab on a cart. Roll the cart into place in the crane staging area. Fix the AS3 shackle to the AS3 vacuum chamber mounting point. (The shackle and AS3 vacuum structure have previously been loaded to two times normal load in a structural test, both with the vacuum chamber evacuated and at atmospheric pressure)

Connect the crane hook to the AS3 shackle

Remove the bolts mounting the star module to the transport cart

(Authorized crane operator) raise the star module about 1 foot off it's cart. Remove the star module feet. Check the adapter plate to Probe-B flange interface O-ring.

Raise and position the AS3 star module onto the window #4 interface flange. Clock the star module to the probe telescope to align elevation X+ and elevation Y+ orientation

Safety Rep _____

Bolt the AS3 star module to the SMD flange, in a star sequence to ensure uniform seating, using 16 10-32 x 1" hex bolts torqued to 15 N-m (10 ft-lb)

Attach the electrical umbilicals from the control station on the lab floor

Attach the QF50 vacuum hose from the pumping cart to the star module

NOTE:

All following procedures will be performed at the control station remotely from the SMD to avoid accidents involving the SMD and probe. In the event that AS3 needs to be opened while mounted atop the probe, this procedure will be perfomed in the presence of Mike Taber

Turn off the AC->DC Power Supply box. Turn off the Manual Motor Control box. Set manual MUX switches in the Signal Distribution box to A=B=C=D=12, E=10 (unused channels). Power up the UPS power supply. Power up the Mac and all monitors. Start LabView. Run the "AS3_FRONT_END.vi" program. Quit the "AS3_FRONT_END.vi" program. Power-up the AC->DC Power Supply box to turn on the AS3 star module. Run any other desired VI's.

QA _____

Set Up Optics

Date and time initiated_____

Check, and if necessary realign, the AS3 internal optics systems

QA _____

Align the beam normal to the telescope return mirror to within 10 arcsec

Elevation X error value from return mirror normal _____ Elevation Y error value from return mirror normal _____ (see AS3 GTU-2 test notebook for calculations)

Collimate the beam to within 1/8th wave peak-to-valley

Peak-to-valley error in collimation _____

Aperture the AS3 beam to within 5 mm from aperture center

Elevation X error value from aperture center _____ Elevation Y error value from aperture center _____

QA _____

Instrument Jitter Quantity and Evaluate Jitter Removal System Using the AS3 Readout

Date and time initiated_____

The AS3 quad cell return beam readout scale factor has previously been empirically calibrated (marcsec/volt)

Instrument the jitter quantity between the telescope and AS3, without the jitter removal system activated, from the AS3 return signal quad cell

Center the return spot on the return quad cell by aligning the beam normal to the telescope return mirror

Acquire sample data set from return quad cell in LabView. Acquire at least 10 seconds of samples at a sample rate of at least 1000 samples/second (to generate FFT with 0.1 Hz resolution)

Number of samples/channel _____ Scan rate (samples/sec) _____ Actual scan period _____

Datafile name and directory path _____

Additional data set file names and scan parameters will be recorded in the AS3 GTU-2 Test notebook

Activate the AS3 jitter removal system

Instrument the jitter quantity, with the jitter removal system activated, from the AS3 return signal quad cell

Acquire sample data set from return quad cell in LabView. Acquire at least 10 seconds of samples at a sample rate of at least 1000 samples/second (to generate FFT with 0.1 Hz resolution)

Number of samples/channel _____ Scan rate (samples/sec) _____ Actual scan period _____

Datafile name and directory path _____

Additional data set file names and scan parameters will be recorded in the AS3 GTU-2 Test notebook

Deactivate the jitter removal system

QA _____

(Optional) Measure the Angle between the Telescope Return Mirror and the Telescope Axis (as observed when the telescope's readout is centered)

Align the beam normal to the telescope return mirror

Elevation X error _____ Elevation Y error _____

Starting fine/focus scan plate azimuth encoder value _____ Starting fine/focus scan plate elevation encoder value _____

Drive the beam from telescope return mirror normal position until it's at the center of telescope readout, using the fine/focus scan plate

Ending fine/focus scan plate azimuth encoder value _____ Ending fine/focus scan plate elevation encoder value _____

Elevation X angular difference between telescope return mirror normal and telescope readout center _____ Elevation Y angular difference between telescope return mirror normal and telescope readout center_____

(Optional) Instrument Jitter Quantity and Evaluate Jitter Removal System Using the Telescope Readout

Date and time initiated_____

Drive the beam to the center of telescope readout

Instrument the jitter quantity, without the jitter removal system activated, from the telescope readout

Acquire sample data set from return quad cell in LabView. Acquire at least 10 seconds of samples at a sample rate of at least 1000 samples/second (to generate FFT with 0.1 Hz resolution)

Number of samples/channel _____ Scan rate (samples/sec) _____ Actual scan period _____

Datafile name and directory path _____

Additional data set file names and scan parameters will be recorded in the AS3 GTU-2 Test notebook

Activate the jitter removal system

Instrument the jitter quantity, with the jitter removal system activated, from the telescope readout

Acquire sample data set from return quad cell in LabView. Acquire at least 10 seconds of samples at a sample rate of at least 1000 samples/second (to generate FFT with 0.1 Hz resolution)

Number of samples/channel _____ Scan rate (samples/sec) _____ Actual scan period _____

Datafile name and directory path _____

Additional data set file names and scan parameters will be recorded in the AS3 GTU-2 Test notebook

Deactivate the jitter removal system

(Optioanl) Evaluate Acquisition Scanning

Date and time initiated_____

Deactivate the jitter removal system

Align the AS3 beam to the center of telescope readout

Acquisition scan mirror azimuth encoder value at center of telescope readout _____ Acquisition scan mirror elevation encoder value at center of telescope readout _____

Acquisition scan left to right (elevation X)

Drive the AS3 beam to <= -1 arcmin elevation X relative to telescope center readout position using the acquisition scan mirror azimuth

Azimuth encoder position at negative limit _____ Elevation X angle at negative limit _____

Drive the AS3 beam to >= +1 arcmin elevation X as telescope data is being acquired into LabView

Acquire sample data set from telescope quad cell in LabView

Scan motor control voltage_____

Number of samples/channel _____ Scan rate (samples/sec) _____ Actual scan period _____

Datafile name and directory path _____

Additional data set file names and scan parameters will be recorded in the AS3 GTU-2 Test notebook

Azimuth encoder position at positive limit_____ Elevation X angle at positive limit_____

Drive the acquisition scan mirror back to telescope center readout position using the acquisition scan

mirror

Azimuth encoder value_____ Elevation encoder value_____

Acquisition scan bottom to top (elevation Y)

Drive the AS3 beam to <= -1 arcmin elevation Y relative to telescope center readout position

Elevation encoder position at negative limit_____ Elevation Y angle at negative limit_____

Drive the acquisition scan mirror to >= +1 arcmin elevation Y as data is being acquired into LabView

Acquire sample data set from telescope quad cell in LabView

Scan motor control voltage_____

Number of samples/channel _____ Scan rate (samples/sec) _____ Actual scan period _____

Datafile name and directory path _____

Additional data set file names and scan parameters will be recorded in the AS3 GTU-2 Test notebook

Elevation encoder position at positive limit_____ Elevation Y angle at positive limit_____

Drive the acquisition scan mirror back to telescope center readout position

Azimuth encoder value_____ Elevation encoder value_____

(Optional) Evaluate Fine/Focus Scanning

Date and time initiated_____

Align beam to center of telescope readout

Fine/focus scan plate azimuth encoder value_____ Fine/focus scan plate elevation encoder value_____

Activate the jitter removal system

Fine/focus scan left to right (elevation X)

Drive the AS3 beam to <= -10 arcsec elevation X relative to telescope center readout position using the fine/focus scan plate

Azimuth encoder position at negative limit_____ Elevation X angle at negative limit_____

Drive the AS3 beam to >= +10 arcsec elevation as data is being acquired into LabView

Acquire sample data set from telescope quad cell in LabView.

Scan motor control voltage_____

Number of samples/channel _____ Scan rate (samples/sec) _____ Actual scan period _____

Datafile name and directory path _____

Additional data set file names and scan parameters will be recorded in the AS3 GTU-2 Test notebook

Azimuth encoder position at positive limit_____ Elevation X angle at positive limit_____

Drive the fine/focus scan plate back to telescope center readout position

Azimuth encoder value_____ Elevation encoder value_____

Fine/focus scan bottom to top (elevation Y)

Drive the AS3 beam to <= -10 arcsec elevation Y relative to telescope center readout position using the fine/focus scan plate

Elevation encoder position at negative limit_____ Elevation Y angle at negative limit_____

Drive the AS3 beam to >= +10 arcsec azimuth as data is being acquired into LabView

Acquire sample data set from telescope quad cell in LabView.

Scan motor control voltage_____

Number of samples/channel _____ Scan rate (samples/sec) _____ Actual scan period _____

Datafile name and directory path _____

Additional data set file names and scan parameters will be recorded in the AS3 GTU-2 Test notebook

Elevation encoder position at positive limit_____ Elevation Y angle at positive limit_____

Drive the fine/focus plate back to telescope center readout position

Azimuth encoder value_____ Elevation encoder value_____

QA _____

Hardware Shutdown and Removal

Set all manual MUX switches in the Signal Distribution box to unused channels. Turn off the AC->DC power supply box. Turn off the manual motor control box. Quit all Mac applications and clean up files. Duplicate all test data files for backup onto Zip disk. Power down the Mac and all monitors. Power down the UPS power supply.

Unplug all AS3 AC power lines: the control station AC power line and the pumping station AC power lines

Disconnect umbilicals at the star module and stow with the control station

Stow all miscellaneous components into the major transport modules

Al Rodriguez's presence is required to assure safety during lifting _____

Position the crane over the star module and hook to the star module shackle

Take up slack between the crane hook and the star module

Remove the16 10-32 x 1" hex head mounting bolts at the star module to Probe-B flange interface area

Hoist away the star module to position 1 foot above the transport cart in the staging area

Attach the star module feet

Place the star module down onto the transport cart and thread on three feet retaining bolts

QA_____

Test completed.

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