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**GP-B Telescope Image Divider Assembly (IDA)**  
**General Alignment and Bonding Procedures**  
**P0282 Rev -**

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Bonding Procedures referred to:

- Bonding Procedure for Fused-Quartz Components* (SUGP-B 0218)
- Surface Cleaning For BP, TM, PM, CP, And SM* (excerpt from SUGP-B P0300)

## 1) APPLICABLE DOCUMENTS

These procedures are to be used with each of the following subassembly procedures:

- 1.1) Set up Basic IDA Assembly Fixtures (SUGP-B P0283)
- 1.2) Align Channel B Plate with Laser (SUGP-B P0284)
- 1.3) Position Channel B Roof Splitter on Channel B Plate (SUGP-B P0285)
- 1.4) Position Channel B Reflectors on Channel B Plate (SUGP-B P0286)
- 1.5) Position Image Divider Housing on Channel B Plate (SUGP-B P0287)
- 1.6) Position Beam Splitter to Beam Splitter Holder (SUGP-B P0288)
- 1.7) Align Channel A Plate with Laser (SUGP-B P0289)
- 1.8) Position Beam Splitter Assembly on Channel A Plate (SUGP-B P0290)
- 1.9) Position Channel A Roof Splitter on Channel A Plate (SUGP-B P0291)
- 1.10) Position Channel A Reflectors on Channel A Plate (SUGP-B P0292)
- 1.11) Position Image Divider Housing/Channel B Assembly on Channel A Plate (SUGP-B P0293)
- 1.12) Position Left and Right Relay Lenses on IDA Channel B (SUGP-B P0294)
- 1.13) Position Left and Right Relay Lenses on IDA Channel A (SUGP-B P0295)
- 1.14) Position IDA Pad on IDA (SUGP-B P0303)

## 2) INITIAL FIXTURE QUALIFICATION:

- 2.1) All fixturing used in the bonding work area must be made of materials suitable for use in a class 100 laminar flow workbench (no: cardboard, non-cleanroom paper or wipes, organic fabrics, wood, unsealed painted surfaces, foams, etc.)
- 2.2) Whenever possible, fixturing should be preassembled to determine proper fit and function. Modification of any part, if required, will require that the part be recleaned.
- 2.3) All fixturing used in the bonding work area must be precleaned to removed gross amounts of particles (dirt, metal filings, dust, fibers, loose paint, etc.) and soft contaminants (skin oil, cutting fluids, soap, lubricants, grease, etc.). Any practical method of precleaning may be used that is appropriate for the materials involved. Some methods are: wiping, water rinsing, chemical etching, baking, ultrasonic bathing, etc.
- 2.4) All fixturing used in the bonding area should be visually inspected for remaining large particles or masses of contaminant before final cleaning. Give special attention to threaded holes and the threads and heads of any screws which will be adjusted during flight part assembly.
- 2.5) Final cleaning of all fixturing to be used in the bonding area shall be a careful high purity Methanol (e.g. spectrophotometric grade -- <10ppm total residue after evaporation) rinse or wipe, followed by a close visual inspection using a high intensity fiber optic illuminator (e.g. Cole Parmer Model 41700-10 w/dual light pipe) light and touch-off using cleanroom swabs (e.g. VWR TWTX743B) or wipes (e.g. VWR TWTX604). CO<sub>2</sub> Snowcleaning and DI N<sub>2</sub> air cleaning (using PPE grade gaseous N<sub>2</sub>) may also be used to remove loose lint from wipes or swabs and particle fall-out.

2.6) Use close visual inspection aided by a high intensity fiber optic light source to verify cleanliness. Clean gooseneck often to prevent its becoming a particle source. Reclean fixturing as necessary.

2.7) All fixturing that will contact flight parts must be made of an appropriate material that meets all of the following constraints: a) the material is non-magnetic; b) the contact will not damage the flight part, including (especially) any coatings; c) the contact will not contaminate the flight part (very likely with ground surfaces). If it is considered possible that any of these conditions will not be met, test exposures must be made followed by a cleaning process that will be appropriate for assembled flight parts and subsequent magnetic screening.

### **3) FIXTURE CLEANING DURING WORK:**

- 3.1) Once flight parts have been introduced to the work area, only the following methods of cleaning may be used: a) careful touch-off of particles using cleanroom swabs wetted with high purity Methanol; b) careful wiping of smooth surfaces using cleanroom wipes wetted with high purity Methanol; c) careful blowing with low pressure (<15psi feed) DI N<sub>2</sub> air cleaner using care to blow particles away from flight parts and downstream whenever possible.
- 3.2) Generally, start cleaning closest to the flight part(s) and work outward. To lesson fall-out, start cleaning at the highest and farthest upstream area.
- 3.3) Use close visual inspection aided by a high intensity fiber optic light source to verify cleanliness. Clean gooseneck often to prevent its becoming a particle source. Reclean as necessary.

### **4) WORK AREA:**

- 4.1) All IDA bonding work is to be done in the telescope cleanroom (class 1000 environment) on the class 100 laminar flow clean bench.
- 4.2) Before starting a new series of procedures, the work area must be cleared, thoroughly cleaned by Ethanol wiping, and tested for particle count measurement (<100 particles larger than 0.5µm per minute).
- 4.3) Both the room and workbench aircleaning circulators (HEPA filters and pumps) must be operating whenever exposed flight parts are present (often for weeks at a time) including idle time. Exceptions will only be allowed when vibration or air turbulence interferes with optical alignments. When this occurs, turn off as little filtration equipment as possible, use care to prevent upstreaming of particles, and restore air-flow as soon as possible.
- 4.4) Temperature and humidity should be in a comfortable working range and should be stable (<5°C/<10% changes over prior four hours).

### **5) PERSONNEL:**

- 5.1) All handlers of any flight parts and fixtures during the IDA assembly process shall be certified by Ken Bower or John Lipa.

- 5.2) All handlers of all bonding solutions, equipment, and processes shall be certified by Jason Gwo or John Lipa.
- 5.3) One certified flight part handler and one certified flight part bonder must be present during any IDA flight part bond.

- 5.4) Dr. Dz-Hung (Jason) Gwo shall have overall responsibility for the implementation of all IDA assembly procedures.
- 5.5) Additional personnel in the cleanroom should be minimized, but up to two non-participating viewers may be present.
- 5.6) All personnel in the cleanroom at any time must wear appropriate gowning (bonnet, beard cover if required, coveralls, bootcovers). Personnel handling any tools, equipment, or fixturing must also wear gloves.
- 5.7) All personnel handling bonding fixtures or flight parts or working near the bonding area must wear (in addition to normal gowning) face masks and gloves rinsed in high purity methanol then blown dry.

**6) FLIGHT PART INSPECTION:**

- 6.1) Prior to bonding, all flight parts shall be closely inspected for damage, contamination, and manufacturing errors.
- 6.2) During inspection, all flight parts are to be handled only by certified flight part handlers. All handlers must be gowned as detailed under *Personnel* and gloves should be routinely inspected and cleaned or replaced.
- 6.3) Flight part packaging shall be opened in a manner consistent with proper clean room practices. Typically, outside packages (shipping containers) should be opened outside of the cleanroom environment. Inner packages (storage containers) should be inspected for gross contamination (dirt, heavy dust, packing foam, etc.) before introduction into the clean room environment. Inner packages may be opened in the class 1000 cleanroom away from the work area. Protective packages (sealed) should be cleaned with an Ethanol wipe and inspected for damage prior to opening. Protective packages shall be opened in a clean work area using care not to damage or contaminate the flight part.
- 6.4) To inspect flight parts, shine a bright fiber optic light source approximately perpendicular to each surface and visually inspect the surface for scattering sources from both steep and shallow angles. Remove any contamination with the gentlest means possible. Use special effort to locate and remove contamination from unpolished surfaces. Refer to *Handling of Flight Parts*.
- 6.5) Inspect protective packaging in areas designed to contact the flight parts for excessive wear. Examine flight part in corresponding areas for damage and contamination.
- 6.6) If necessary, reject flight parts or file Discrepancy Reports on the GP-B database if consequential damage or non-removable contamination exists.
- 6.7) Magnetically screen (mag zone 3) all major parts and assemblies before final assembly.
- 6.8) Repeat step 4 immediately prior to any bonding operation.

**7) HANDLING OF FLIGHT PARTS:**



- 7.1) All flight parts are to be kept in closed containers which protect critical surfaces prior to use.
- 7.2) All flight parts are to be kept in the class 100 clean bench area whenever they are exposed to open air and during work.

- 7.3) Enclosed assemblies of flight parts (e.g. IDA, main optics assy.) may be kept in the class 1000 work area provided that they are not exposed to any processes that may cause significant particle contamination. Whenever possible, such parts should be covered, enclosed, sealed, or otherwise protected from contamination and damage.
- 7.4) Flight parts and assemblies shall be stored in such a manner that they are protected from or secured against damage due to accidental or seismic shock. Special care must be used with any assembly including the metering tube due to its mass, size, and shape. This part must always be secured or live monitored. Also, equipment that can fall onto or collide with flight parts must be removed or similarly anchored or monitored.
- 7.5) During bonding processes, all flight parts are to be handled only by certified flight part handlers. All handlers must be gowned as detailed under *Personnel* and gloves should be routinely inspected and cleaned.
- 7.6) Flight parts should be periodically inspected for damage and contamination throughout the work process. Damage should be immediately evaluated and documented. If necessary, Discrepancy Reports shall be filed in the GP-B database and/or new parts shall be used. Contamination should immediately be evaluated and removed, if possible, with the gentlest means possible using the methods described in *Flight Part Cleaning During Work*.
- 7.7) All flight part handlers must be completely familiar with the flight parts they handle. Handlers must know all critical surfaces, edges, and coatings of each part they handle and how to protect them.
- 7.8) Whenever possible (nearly all cases), clean flight parts shall be held only by non-critical surfaces. Bonding surfaces shall only contact protective shim stock and/or cleaning materials until actual bonding. When bonding or coated surfaces must be handled, said surfaces must be closely examined for damage and contamination after handling.

## **8) FLIGHT PART CLEANING DURING WORK**

Refer to *Surface Cleaning For BP, TM, PM, CP, And SM* (attached - A4) from SUGP-B P0300.

**A1) CERTIFIED IDA ASSEMBLY PERSONNEL:**

- A1.1) Flight Part Handler Requirements:
  - A1.1.1) Handlers must be thoroughly familiar with the parts, materials, specifications, coatings, and critical surfaces of all parts to be handled.
  - A1.1.2) Handlers must have experience handling similar non-flight parts under similar bonding conditions.
  - A1.1.3) Handlers must be familiar with clean room protocols.
  - A1.1.4) Handlers must have a general understanding of bonding (SUGP-B P0218)

A1.2) Certified flight part handlers:	approval (K. Bower or J. Lipa)	date
Mr. Kenneth Bower	_____	_____
Dr. Dz-Hung (Jason) Gwo	_____	_____
Mr. Lynn Huff	_____	_____
_____	_____	_____
_____	_____	_____

- A1.3) Flight Part Bonder Requirements:
  - A1.3.1) Bonders must be thoroughly familiar with bonding (SUGP-B P0218)
  - A1.3.2) Bonders must have experience bonding similar non-flight parts under similar bonding conditions.
  - A1.3.3) Bonders must be familiar with clean room protocols.
  - A1.3.4) Bonders must have a general knowledge of the parts to be bonded.

A1.4) Certified flight part bonders:	approval (J. Gwo or J. Lipa)	date
Dr. Dz-Hung (Jason) Gwo	_____	_____
Mr. Kenneth Bower	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

**A2) FLIGHT PART BONDING SIGN-OFF LIST**

SUGP-B P0282  
Rev - (attachment)  
K.Bower

Procedure used: \_\_\_\_\_  
Procedure #: \_\_\_\_\_  
first part(s)/assembly to be bonded: \_\_\_\_\_  
SUGP-B dwg#: \_\_\_\_\_  
Part Serial Number \_\_\_\_\_  
second part(s)/assembly to be bonded: \_\_\_\_\_  
SUGP-B dwg#: \_\_\_\_\_  
Part Serial Number \_\_\_\_\_  
new assembly name: \_\_\_\_\_  
SUGP-B dwg#: \_\_\_\_\_  
Assembly Serial Number \_\_\_\_\_  
  
Flight Part Handler: \_\_\_\_\_  
Flight Part Bonder: \_\_\_\_\_

	Step#:	Date/Time:	By:	Signature:
Fixturing Pre-Qual (SUGP-B P0282):	_____	_____	_____	_____
Work Area Qual (ibid.):	_____	_____	_____	_____
First part(s)/assembly inspected (ibid.):	_____	_____	_____	_____
First part(s)/assembly approved:	_____	_____	_____	_____
Second part(s)/assembly inspected (ibid.):	_____	_____	_____	_____
Second part(s)/assembly approved:	_____	_____	_____	_____
Date/Time of Bond:	_____	_____	_____	_____
Part(s) cleanliness verified (ibid.):	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____

\_\_\_\_\_

\_\_\_\_\_

A2) FLIGHT PART BONDING SIGN-OFF LIST (cont.)

	Step#:	Date/Time:	By:	Signature:
Fixturing set-up	_____	_____	_____	_____
Fixturing cleanliness verified (ibid.):	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
Alignment approved:	_____	_____	_____	_____
Alignment verified:	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
Final bond inspected:	_____	_____	_____	_____
Final bond approved:	_____	_____	_____	_____
Disposition of new assembly:	_____			
Notes:	_____			
	_____			
	_____			
	_____			

**A3) FLIGHT PART BONDING NOTES:**

Parts/Assemblies to be bonded:

- 1)first part/assembly name:
  - 2)second part/assembly name:
- new assembly name:

Description/condition of parts/surfaces prior to bond:

- 1)
- 2)

Cleaning procedures used / cleaning notes:

- 1)
- 2)

Alignment procedures used / notes:

Area of bond:

Bonding solution used (type, volume, drop pattern, etc.):

Date/Time of Bond:

Witness Bond notes:

Initial visual evaluation (bubbles, fringes, time dispersal of solution, particles, etc.):

Alignment checks (note time after bond):

Strength checks (note shear/pull/peel/etc. and time after bond):

Note any special conditions applied during or after bond (cryocycles, bakes, shocks, etc.):

Later visual evaluations of bond:

This bond/assembly transferred to:



A4)

**(EXCERPT FROM SUGP-B P0300 Rev - )  
SURFACE CLEANING FOR BP, TM, PM, CP, AND SM**

From: Jason Gwo  
Date: 9/18/95

**Where:**

Class 100 clean bench in Telescope clean room (Class 1000). Preferably two and NO more than three people are allowed in the clean room.

**General Cleaning Schemes**

In order of increasing time, effort, and effectiveness:

- (A) DI-air cleaning
  - Baseline process after locking the part on centering fixture
- (B) Solvent touch off (plus (A))
  - Baseline process after locking the part on centering fixture
- (C) Snow/air cleaning
  - Baseline process *before* locking the part on centering fixture
- (D) Spin cleaning with DI water (in Telescope clean room)
  - GO's proprietary
  - Stanford has the capability of cleaning parts with only one critical surface.
- (E) GO cleaning (In Telescope clean room or at GO)
  - GO's proprietary
  - Default process conducted by General Optics before shipping
  - Stanford has the facility except the cleaning chucks for parts with two critical surfaces.
  - To be performed by the experienced from GO because of its high danger

A4)

(EXCERPT FROM SUGP-B P0300 Rev - )  
SURFACE CLEANING FOR BP, TM, PM, CP, AND SM (cont.)

**SOLVENT TOUCH OFF**

(1) Use PRA grade Methanol impregnated Technicloth (Polyester) wipe to touch off particulate.

**SNOW/AIR CLEANING PROCEDURE:**

(1) Snow/air clean (i.e. (a) CO<sub>2</sub> snow cleaning and (b) DI-N<sub>2</sub> purging immediately after (a)):

- \* the cleaning compartment in the clean bench,
- \* gloves and sleeves,
- \* all surfaces of the cleaning chuck located in the compartment:
- \* the microscope, and
- \* the cold-light illuminator

(2) Roughly snow/air clean Side B of the part when *firmly* held by two hands on the non-bonding surfaces.

--- Make the snow jet approximately in the same direction as the laminar flow.

(3) Lock the part in position, with Side A exposed, on cleaning chuck.

--- Cushion the part with particulate free shim stock

(4) Snow/air clean all exposed surfaces of the part.

--- Make the snow jet approximately in the same direction as the laminar flow.

(5) Check the bonding surface and its chamfer under strong cold-light illumination with 7X microscope for any visible-light scattering center.

--- (NO picture-taking for surface cleanliness documentation)

(6) Iterate Steps (4) and (5), if necessary.

A4)

(EXCERPT FROM SUGP-B P0300 Rev - )  
SURFACE CLEANING FOR BP, TM, PM, CP, AND SM (cont.)

**PRE-BONDING CLEANING/INSPECTION PROCEDURE:**

When: After alignment is made with the alignment/bonding fixture, and right before bonding

(1) DI-air clean the part for loose particulate; solvent touch off for relatively tenacious particulate

- Keep nothing, including hands, in the upstream of the laminar flow.
- If unsuccessful, perform snow/air cleaning

•Solvent touch off

- (a) Use PRA grade Methanol impregnated Technicloth (Polyester) wipe to touch off particulate.
- (b) Before Methanol vaporizes completely, quickly blow the surface with DI-N<sub>2</sub> jet.

(2) Check the bonding surface and its chamfer under strong cold-light illumination with 7X microscope for any visible-light scattering center.

- (NO picture-taking for surface cleanliness documentation)

(3) Iterate Steps (1) and (2), if necessary, iteratively for both bonding surfaces.

## **A5) COMMONLY USED ACRONYMS**

AC - Autocollimator  
AS - Alignments Scope  
BP - BasePlate  
BS - Beam Splitter  
BSH - Beam Splitter Holder  
ChA - Channel A  
ChB - Channel B  
CP - Corrector Plate (new name: telescope Forward Plate)  
CRP - Centering Reticle Plate  
DI - DeIonized  
DOI - Davidson Optronics, Inc. (2223 Ramona Blvd. West Covina, CA 91790)  
DPA - Detector Package Assembly  
FP - Forward Plate (old name: telescope Corrector Plate)  
GO - General Optics, inc. (554 Flinn Ave. Moorpark, CA 93021)  
IDA - Image Divider Assembly (a.k.a.: KEIDA)  
KEIDA - Knife Edge Image Divider Assembly (a.k.a.: IDA)  
OID - Optical Instruments Design (7371 Hyssop Dr. Etiwanda, CA 91739)  
PM - Primary Mirror  
SM - Secondary Mirror  
SUGP-B - Stanford University Gravity Probe B Relativity Mission  
T - Telescope  
TM - Tertiary Mirror

## **A6) NOTATIONAL METHODS USED**

dwg# - drawing number  
###-####L - OID drawing number  
#####L or #####-###L - SUGP-B drawing number  
P##### - SUGP-B Procedure number  
no suffix - use most recent version; indicate version used on sign-off sheets  
'-' suffix - use rev.- (initial version)  
letter suffix - use rev. indicated by letter