DWG NO. 564420 SH 1 REV

| APPLICATION | | | REVISIONS | | | |
|---|---|---|---|---|---|---|
| PART NO. | NEXT ASSY | USED ON | REV | DESCRIPTION | DATE | APPROVED |
| | | IN0112A | – | INITIAL RELEASE | | W. ANDERSON |
| | | | | | | |
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| | | | | | | |

AS RUN Red line

△1 P. 12, 14, 16, 22 OB 4/25/03

Note: All steps calling for UDT photometer are N/A because the photometer was out of the facility during these tests. The spheres were calibrated using an ASD spectrophotometer on Mar 20, 2003 DLH 4/23/03

CO 283382 OP 820

| REVISION | – | – | – | – | – | – | – | – | – | – | – | – | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHEET | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | | | |
| REVISION | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| SHEET | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |

REVISION STATUS OF SHEETS

| DRAWING TYPE (PER MIL-T 31000) | |
|---|---|
| CONCEPT. DES. | |
| DEVELOP. DES. | |
| PRODUCT | |
| COMMERCIAL | |

**UNLESS OTHERWISE SPECIFIED**

BREAK SHARP EDGES –

INTERPRET DRAWING PER MIL-STD-100 AND PRODUCT STANDARD 25030

SURFACE TEXTURE EXCEPT AS NOTED 125 √

DIMENSIONS ARE IN INCHES TOLERANCES

| .XX | .XXX | X° |
|---|---|---|
| ±.03 | ±.010 | ±1° |

LAYOUT NO.

| APPROVED | DATE | APPROVED | DATE |
|---|---|---|---|
| THERMAL N/A | | PREP BY Donald Hampton | 03/01/27 |
| STRL ANAL N/A | | RESP ENGR Donald Hampton | 03/01/27 |
| MASS PROP N/A | | I&T L. Hunter | 03/01/28 |
| MATL & PRCS N/A | | Optics James Baer | |
| SAFETY N/A | | FIT/FUNC CHK N/A | |
| QA John King | 03/01/28 | FIT/FUNC ANAL N/A | |
| LOGISTICS N/A | | SYSTEMS Marty Huisjen | 03/01/27 |
| | | RELIABILITY N/A | |

CONTRACT NO.

Ball Aerospace & Technologies Corp.
P.O. Box 1062
Boulder, CO 80306

# Medium Resolution Instrument (MRI) Performance Test Procedure

| SIZE | CAGE CODE | DWG NO. | REV |
|---|---|---|---|
| A | 13993 | 564420 | – |
| SCALE NONE | | WT N/A | SHEET 1 OF 28 |

A6356_BR2281[42A]



BR 2281 7/15/02

GODDARD SPACE FLIGHT CENTER

# GSFC STI PUBLIC DISCLOSURE EXPORT CONTROL CHECKLIST

**Title: Deep Impact - Integration and Test Instrument - Document No: 564420**

**Instructions** – This checklist is used for the disclosures of STI, and ITAR or EAR controlled information.

For STI (scientific and technical information) disclosures subject to NPG 2200.2 (Guidelines for Documentation, Approval, and Dissemination of STI), this checklist should be forwarded with the NASA Form 1676 (NASA Scientific and Technical Document Availability Authorization (DAA)). For all other ITAR (International Traffic in Arms Regulations, 22 CFR 120-130) and EAR (Export Administration Regulations, 15 CFR 730-774) disclosures, this checklist should be forwarded with a copy of the information to the GSFC Export Control Office for review/approval. Completion of this checklist should minimize delays in approving most requests.

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If your information is already in the public domain in its entirety through a non-NASA medium and/or through a NASA release previously approved by any NASA Export Control Office, the information is exempt. If the information falls into this category, you may attest that you are using this exemption by signing below.

| Print Name and Code | Signature | Date |
|---|---|---|

**EXEMPTION II – Scientific data**

If your information pertains exclusively to the release of scientific data (e.g., data pertaining to studies of clouds, soil, vegetation, oceans, planets, stars, galaxies and the universe) without the disclosure of information pertaining to articles controlled by the ITAR or EAR, such as flight instruments, high-speed computers, or launch vehicles, the information is exempt. If the information falls into this category, you may attest that you are using this exemption by signing below.

| Print Name and Code | Signature | Date |
|---|---|---|

GODDARD SPACE FLIGHT CENTER

# GSFC STI PUBLIC DISCLOSURE EXPORT CONTROL CHECKLIST *CONTINUED*

**EXEMPTION III – General purpose information**

If your information falls into the ITAR or EAR areas of concern as referenced above, but is offered at a general purpose or high level (e.g., poster briefs and overviews) where no detailed technical information (e.g., design, development, production, or manufacturing) pertaining to ITAR or EAR controlled items is offered, the information is exempt. If the information falls into this category you may attest that you are using this exemption by signing below.

| Print Name and Code | Signature | Date |
|---|---|---|
| **Edwin J Grayzeck 690.1** | Edwin J Grayzeck | **Sept 28, 2005** |

**EXEMPTION IV – Software safety and assurance methodologies**

If your information pertains exclusively to the release of software safety and assurance methodologies or studies, without disclosing information pertaining to articles controlled by the ITAR or EAR, the information is exempt. If the information falls into this category, you may attest that you are using this exemption by signing below.

| Print Name and Code | Signature | Date |
|---|---|---|
| | | |

**REQUEST FOR ITAR 125.4(b)(13) EXEMPTION – Technical data**

If your information is not satisfied by the exemptions stated above, the information might be releasable using exemption 125.4(b)(13) of the ITAR. This exemption allows the release of ITAR controlled information into the public domain and does not require that the information be published in order to qualify. Use of this exemption is afforded only to agencies of the Federal Government. The GSFC Export Control Office will approve this exemption only after receiving assurance that such a release is a responsible action. The following guideline has been established regarding the use of this authority: The information may not offer specific insight into the design, development, production, or manufacture of an identified ITAR controlled item (reference paragraph 2 above) in sufficient detail (by itself or in conjunction with other information in the public domain) to allow potential adversaries to replicate the item, or exploit or defeat controlled U.S. technologies. All signatures of approval on NASA Form 1676 (and in the signature blocks below) expressly indicate concurrence with the responsible use of this exemption when it is requested. If you determine that you have met these criteria, you may attest your determination by signing below, and the GSFC Export Control Office will offer favorable consideration toward approving your request under this special exemption.

| Print Name and Code | Signature | Date |
|---|---|---|
| | | |

If a NASA Form 1676 does not accompany this request, use of this exemption requires approval from a Branch-level or higher management official.

| Print Name and Code | Signature | Date |
|---|---|---|
| | | |

The GSFC Export Control Office ☑ approves ☐ does not approve this exemption/request. 9-28-05

| Center Export Administrator (CEA) | Signature | Date |
|---|---|---|
| **Thomas A. Weisz, Code ~~232~~ 234** | Thomas A. Weisz | 9/28/05 |

*If your STI, ITAR, or EAR disclosure does not satisfy any of the above exemptions, please contact the GSFC Export Control Office for further clarification on the releasability of your information under the ITAR or EAR.*

CONTENTS

## 1 SCOPE

This procedure describes the steps to be performed to test the throughput performance of the Medium Resolution Instrument (MRI) for Deep Impact. These tests will be performed as part of the overall Thermal Vacuum test described in Test Procedure 564426. Focus and boresight measurements are made at room temperature and are governed by Test Procedure 564422.

## 2 APPLICABLE DOCUMENTS

The following documents form a part of this procedure to the extent specified herein. Unless a specific issue or revision is listed, these documents shall be of the latest issue or revisions in effect at the time of the test. In the event of a conflict between this procedure and the reference documents, the contents of this procedure shall govern.

### 2.1 Deep Impact Program Documents / Drawings

| | |
|---|---|
| 559700 | Instrument Platform Assembly |
| 559698 | Medium Resolution Instrument (MRI) |
| 564304 | Instrument Electronics Assembly, MRI |
| 564307-501 | Pre-Amp Clock Bias Assembly (MRI) |
| 564422 | Instrument Platform Alignment Procedure |
| 564426 | Instrument Platform Thermal Vacuum Procedure |
| 564435 | CSTOL: DI MRI Single Mode Dark Imaging |
| 564436 | CSTOL: DI MRI Single Mode Light Imaging |
| 576704 | CSTOL: DI MRI Three Frame Set Imaging |
| 576705 | CSTOL: DI MRI Five Frame Set Imaging |
| 576700 | CSTOL: DI MRI Power On |
| 576701 | CSTOL: DI MRI Power Off |

## 3 TEST CONDITIONS AND REQUIREMENTS

### 3.1 Precautions

Failure to follow the procedures contained in this document, as well as SPS 1930 and SPS 3096, may result in damage to flight hardware.

#### 3.1.1 ESDS Equipment. (If Applicable)

The test specimen contains electrostatic-discharge sensitive (ESDS) devices that may be exposed at the electrical interfaces. Therefore, it shall be handled per MIL-STD-1686 Class 1, as implemented by SPS 120211. The test specimen, the test operator (using wrist straps), and related electrical test equipment shall be connected to a common ground before any electrical connecting or disconnecting operations, and during the use of any electrical test equipment probes. The following requirements are important:

A. All personnel within 1 meter of the Instrument or Electronics, and all related test equipment shall be connected to a common ground at all time.
B. An ionizing blower shall be in place and operating whenever static generators such as nylon sheeting or paper are within one meter of exposed electrical interfaces.
C. Under no circumstances shall connections be made to the unit under test while power is applied.
D. Test cables and equipment shall have all pins shorted to equal potential (or ground) prior to being connected to ESDS hardware. This requirement shall be met by using shorting devices on applicable connectors prior to mating.

### 3.1.2 Proof Load Certification

All equipment to be used for flight hardware lifts shall have current proof load certification. If certification paperwork does not exist, or is out of date, proof load testing must be performed, using a technique appropriate for the device in question. Immediately prior to use, each such device shall be visually inspected for damage. Any hardware exhibiting cracks, or any cable having parted strands, or any similar defects, shall be disposed of and replaced or documented on an MDR, regardless of its state of certification.

### 3.1.3 General Precautions for Connectors:

A. Connector savers shall be used on all flight hardware electrical connectors as specified in the Deep Impact Connector Guidelines.
B. Flight hardware electrical connectors shall be capped with ESD approved covers when they are not in use, to minimize contamination, and to prevent damage from electrostatic discharge.
C. Before mating any connector, examine the connector to assure that there is no interference or visible contaminants at the pin or socket interface. Notify QA if connectors exhibit any problems.
D. Extreme care shall be exercised should connectors need to be probed at any time, and the following precautions taken:
   - The probing pin shall be a mating pin or socket that is insulated to prevent shorting.
   - The probing pin shall be gold plated, or of a non-marring smooth surface.

## 3.2 Safety Requirements

In accordance with the Reliability, Parts and System Safety Handbook SP0031A-014, the System Safety Engineer or his delegate has final authority over safety provisions contained in this procedure, and in controlling any hazardous conditions which may arise during any operations performed in accordance with this procedure.

### 3.2.1 Responsibility for Safety.

All personnel are responsible for maintaining a safe work environment. The Test Conductor or cognizant operator shall assure that appropriate safe practices are implemented during these operations, and that operations are performed in a proper order.

### 3.2.2 Test Readiness Reviews

Prior to the commencement of any activities detailed in this document, and again at each shift change, the Test Conductor or cognizant operator shall conduct a pre-test briefing. Also, immediately prior to each hazardous sequence of operations, the Test Conductor or cognizant operator shall conduct a pre-task briefing. Both the pre-test and pre-task briefings shall include a discussion of:

A. Test sequence, objectives, and equipment.
B. Nature and location of the specific hazards to be encountered.
C. Hazard controls, including protective equipment, safety boundaries, personnel access, etc.
D. Limitations on concurrent activity.
E. Emergency instructions and response, and, when the situation warrants, the availability of emergency shutdown procedures.

### 3.2.3 Caution and Warning Notations

In this procedure follow these definitions:

- **Caution**: Operational step, etc., which if not adhered to or observed could result in damage to the equipment;
- **Warning**: Operational step, etc., when not adhered to or observed, could result in loss of life, personal injury, or exposure.

### 3.2.4 Mechanically Assisted Lift Hazard

Severe damage to personnel and flight hardware may result if lifting fixtures are excessively loaded. Lifting hardware shall never be used in a configuration that may apply loads greater than the working load that is clearly marked on each piece of lifting hardware. Never use lifting hardware that is not marked with a working load and proof test date. A properly certified crane operator shall control the lift.

## 3.3 Cleanliness And Environment

Except as provided herein, these operations shall be conducted in a Class 10,000 or better clean area as defined in FED-STD-209B, and as implemented by BATC process standard BPS 21.04. Cleanliness of the test units shall be established and maintained per BATC specification SPS 2780.

Standard laboratory conditions of atmospheric temperature (18 to 28°C), pressure (520 to 810 torr), and relative humidity (25 to 70 percent) are acceptable for the operations defined herein.

## 3.4 Controlled Redline Procedures

BATC DEEP IMPACT test procedure change control shall be implemented in compliance with DEEP IMPACT QWI.

A. Any testing of flight hardware shall be required to be done in accordance with a test procedure that has been formally released prior to the start of the applicable test. This means that test procedures must be released through BATC Engineering Document Control prior to use.

B. Once the test procedure is released, it may be changed in compliance with WI Test.4.3.005 Controlled Redline Test Procedure. Such changes may also be made during the test.

C. Such changes must be approved by the following personnel:
Minor Changes: Test Engineer and Quality Engineer.
Major Changes: Test Engineer, Quality Engineer and Responsible Design Engineer and/or Systems Engineer (As determined by QE)

D. The "AS-RUN COPY" of the test procedure containing such changes is controlled by the Test Engineer.

E. Subsequent to completion of the applicable test, but before final buyoff of that test in the applicable Certification Log, the redline changes to the "AS- RUN COPY" test procedure shall be incorporated in a formal revision of the test procedure. (Note: At the discretion of the program the final Spacecraft Integration procedures may not be updated.)

## 3.5 Software Configuration

Prior to beginning any DEEP IMPACT instrument/spacecraft level test, the revision of all flight software and test software shall be recorded. The listing will include the software version numbers, tables and database version numbers. If any software is revised during the testing, record the revision information required identifying the software configuration used during each test operation.

# 4 Quality Assurance Provisions / Test Management Responsibilities

## 4.1 Quality Assurance Provisions

QA provisions operative during activities defined in this procedure are derived from the DEEP IMPACT Product Assurance (PA) Plan and the DEEP IMPACT Quality Work Instructions (QWI) document. These provisions, summarized below, identify the interfaces between QA and test personnel.

A. The PEQA shall be notified, in advance, of performance of any activities described in this procedure. A QA Inspector shall be assigned to monitor those activities as is deemed necessary or appropriate, in accordance with the QWI. When required, QA shall notify the customer and/or government representatives, who may, at their option, monitor or witness the activity. The PEQA shall attend the "Ready-to-Test" meeting with assigned QA personnel, to assure QA support during the test, and to address and resolve outstanding QA items.

B. The PEQA shall assure that the proper "as-run copy" of this procedure document has been prepared, and that the required Cert Log is in proper order. When all pre-test conditions have been met, the PEQA shall complete the "Ready-to-Test" entry in the applicable Cert Log.

C. During testing, the PEQA shall approve, **prior to its implementation**, any major changes to the test procedure involving actual testing deviation, test set-up, measurement methodology, or tolerance changes, along with the cognizant design engineer and the Test Conductor.

D. Test Support provided by the QA Inspector shall be as follows:

- Verify that calibration is current for test and measuring equipment in accordance with QSP 11.1 " Selection, Maintenance, and Control of Inspection, Measuring, and Test Equipment".
- Verify that applicable lifting and handling GSE has been properly proof tested and tagged.
- Assure that the proper change control practices are applied as described in section 3.4, which implements the applicable provisions of QSP 4.4 Design Changes.
- Assist in assuring that the precautionary and safety requirements stated in sections 3.1 and 3.2 are met.
- Assist in the inspection of test setups prior to application of power to a test specimen, and prior to any mechanism-assisted lifts or moves.
- Prepare quality assurance test documents as applicable. In the Action Item List of the Certification Log, document any discrepancies or non-conformances noted during or after testing, and immediately notify the PEQA.

E. At completion of the test, the PEQA/Inspector shall perform the following:

- Review all test data for completeness, and to verify that all measurements are within tolerances.
- Assure that the resulting test data fulfills the test requirements of the end item.
- Verify completion of any related action items and disposition of any related MDR's in the test Cert Log.

F. Upon the occurrence of a test anomaly (any event that deviates from the planned procedures, exceeds normal variations, or generates unexpected data), operation of the test article shall be stopped immediately. All other test conditions and parameters shall be maintained (except as those conditions that may pose an immediate hazard). The Inspector and the Test Conductor shall review the anomaly. Minor, non-destructive, investigative troubleshooting that will not change the failure mode of the article under test, may be conducted by the Test Conductor, with PEQA concurrence. All troubleshooting shall be performed in accordance with QSP 13.1 Control of Nonconforming Product and WI PA.13.1.004 Test Anomaly Work Sheet (TAWS). If the anomaly is found to result from human error or test equipment problems that have not affected the test article, corrective action shall be taken and testing may continue. The PEQA will check the "continue test" box, the approval box, and sign the TAWS along with the Responsible Engineer.

G. If a test anomaly cannot be resolved as described above, the PEQA shall be notified, and an appropriate entry shall be made in the Action Item List (AIL) portion of the Certification

Log. The PEQA shall prepare a Material Discrepancy Report (MDR) and convene the Material Review Board (MRB) for action as specified in WI PA.13.1.002 "Completion of Material_Discrepancy Report". The MRB convened to resolve an anomaly that occurred during testing shall include a representative of the project test group. Testing of the failed item shall then not continue without prior authorization from the MRB.

## 4.2 Test Management Responsibilities

### 4.2.1 Integration And Test Manager

The Integration and Test Manager shall have responsibility for the following:

a. Delegate responsibility to conduct the SIM Alignment and Test Procedure or portions of this procedure to qualified personnel.

b. Release of the Alignment and Test Procedure.

c. Release of all required procedures, drawings, E.O.'s and other documents.

d. Approve exceptions to requirements of this procedure, including facility ambient requirements.

e. Availability and certification of required GSE.

f. Approval on the final completion of the SIM Alignment and Test Procedure

### 4.2.2 Test Conductor

The test conductor (T/C) as delegated by the Integration and Test Manager is assigned shift responsibility for the following:

a. Verify that required flight hardware and GSE are available and certified for integration and alignment as described in this procedure.

b. Verify that GSE and other test equipment is available and calibrated where applicable and that calibration will not expire during performance of this procedure.

c. Verify that required documentation is released, correct and complete. Documentation will include:
   - A copy of the latest revision of the Integration and Alignment Procedure
   - The Certification Log for the Instrument
   - The Assembly drawing for the FPA integration to the Telescope Assembly
   - All necessary prints, E.O.'s and other documents

d. Verify that setup, integration and alignment are in accordance with the requirements of this procedure, including facility ambient conditions. Setup shall be verified by an independent observer and recorded in the Certification Log.

e. Collect, identify and store all raw data generated during the procedure. Data storage will be in the program SER files and referenced in the Certification Log.

f. Responsible for sign off, on completion, all integration and alignment process steps, torque values and / or other measured and recorded values as specified in this procedure in the Certification Log. The person who performed the operation shall perform sign off.

g. Conduct the integration and alignment in a safe manner.

h. Notify the Integration and Test Manager and QA monitor or PEQA if out of tolerance conditions occur. Flag out of tolerance conditions in the Certification Log.

i. Supervise the troubleshooting and rework as required.

j. Maintain a record in the Certification Log of all action items and ensure that all items are closed prior to final sign-off of the Certification Log.

k. Notify the Integration and Test Manager and QA monitor or PEQA of completion of this procedure for data review and sign-off in the certification log.

The test conductor has the authority to change, in writing, the sequence of events of this procedure, during the conduct of this procedure, to facilitate availability of certain test equipment, flight hardware or personnel. The T/C is responsible for certifying that such deviations do not jeopardize the intent or the data integrity of this procedure.

The test conductor has the authority to substitute equivalent test equipment for those items called out in Section 6 of this procedure. The T/C is responsible for certifying that the substituted items are up-to-date in terms of their certification and that these substitutions do not jeopardizing the intent nor the data integrity of this procedure.

## 5 TEST DESCRIPTION

This procedure describes three tests, which will be run at different thermal conditions, as specified in the Instrument Platform Thermal Vacuum Test Procedure, 564426.

1) A set of CCD dark current measurements taken as the CCD cools down to its operating temperature
2) An *optional* test is a set of images of a bright spot followed immediately by images taken without the bright spot to determine the level of latent charge remaining in the CCD. This will be done in coordination with steps in the alignment and focus test procedure 564422

3) Throughput calibration using an integrating sphere. This is used to establish a calibration (using both the previous sphere calibration, and a reference photodiode), establish system flatfield images, determine system linearity, and test system gain using the gain-variance technique.

## 6 TEST ARTICLE CONFIGURATION

The MRI shall be configured as described in the as-run copy of 564426, Instrument Platform Thermal Vacuum Procedure

## 7 REQUIRED TEST EQUIPMENT

- 24” LabSphere integrating sphere system including sphere, calibrated lamp and lamp controllers
- 65” LabSphere integrating sphere system including sphere, calibrated lamp and lamp controllers
- Optical Test Station #2, CW light source, ND2 filter
- Calibrated photodiode and amplifier

## 8 TEST PROCEDURES

Inspect all electrical and mechanical setup ✓

Confirm that last functional test shows that system is operating properly ✓ 2/26/03

Confirm that QA has given OK to test in Cert Log ✓

For each section below, if not explicitly stated, use the following CSTOL procedures to turn instrument electronics power on and off:
Power ON: TP576700
Power OFF: TP576701

When powering electronics on or off, notify the personnel monitoring the chamber thermal conditions so they can compensate for change in power.

### 8.1 Dark Current Measurements During CCD Cooldown

The cooldown of the MRI CCD offers a unique opportunity to measure the CCD dark current vs. temperature for a range of temperatures expected in flight. During the steps to cool the CCD specified in Test Procedure 564426, conduct the following steps as needed to gather images.

1. Cover the window of the TV chamber with either dark cloth or Al foil (or both) to greatly reduce stray light ✓ Both on main wind / black cloth on ZnSe
2. Power on the MRI instrument electronics using CSTOL script TP576700. Alert test operator that instrument electronics are powered on. ✓

3. Start the MRI VIS Single Mode Dark CSTOL script, TP564435 (Single Mode Dark)
4. Repeat the following steps as needed.
   a) Record the current CCD temperature in the image log, as measured by the test temperature monitor
   b) Use Figure 8-1 below to determine the approximate integration delay time needed to produce at least 5 DN of signal at the measured CCD temperature
   c) Collect two to four (2 – 4) MODE 1 images with 0 msec integration delay
   d) Collect two to four (2 – 4) MODE 1 images with the integration delay calculated in the previous step, using CSTOL script TP564435 (shutter closed)
   e) Using DIVe (or other analysis tool) determine the dark current by measuring average signals in the image area and the serial overclocked region (columns 0-7 or 1015-1023)
   f) At the discretion of the test conductor, take images of other modes (2-9) during cooldown using same integration delay time calculations
5. Power down instrument electronics using CSTOL script TP576701, and alert test operator that instrument electronics are powered off.

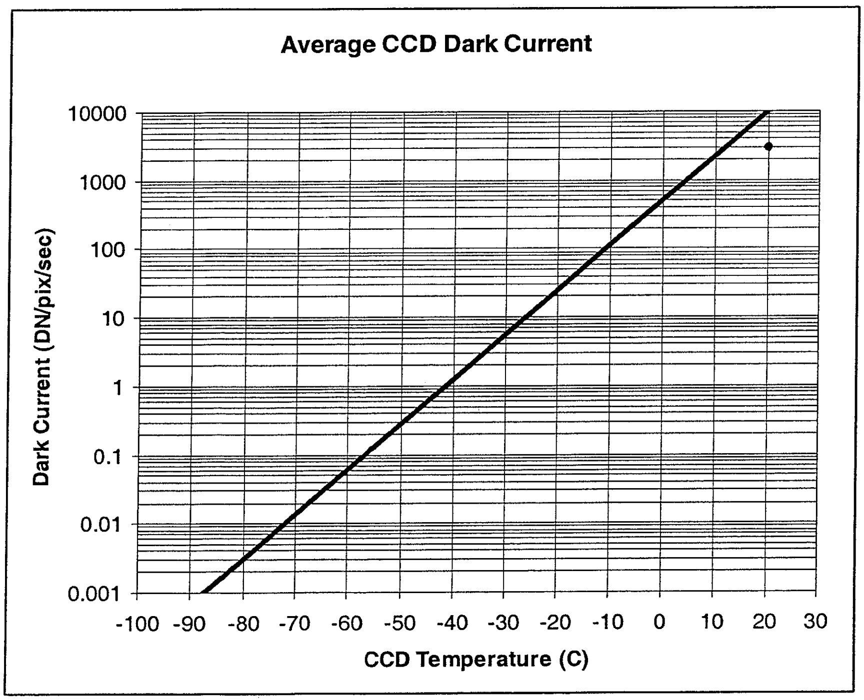


**Figure 8-1 Average Dark Current For Deep Impact CCDs.**

## 8.2 Latent Image and Large Sphere Tests (Optional)

### 8.2.1 Latent Image

1. During alignment testing of MRI using optical test station #2 and at the discretion of test director and systems engineering, perform the following ✓
2. Place the ~~knife edge~~ iris target ~~in the~~ near the target stage of optical test station #2 ✓ — ~2 inches forward of focus
3. Remove the end of the fiber optic feed from the flash lamp and insert in the CW lamp ✓
4. Turn on CW lamp and place diffuser behind ~~knife edge~~ iris target ~~with the fiber optic feed shining through an ND-2 filter and onto the diffuser~~ — place ND2 in front of iris (Δ DLH 3/01/03)
5. Collect MODE 1 image, 100 msec integration delay, using CSTOL script TP564436 and use DIVe to determine the signal level of the lit portion of the knife edge target ✓ CB 4/25/03
6. Adjust the output of the CW lamp and repeat the previous step until the average signal in the lit portion is not saturated ✓
7. Remove the filter ✓
8. Using CSTOL script TP564436, set up to collect a series of 16 MODE 1 images with 100 msec integration delay and follow the steps below. Image count can be found in the Detector Ops telemetry window with mnemonic **IIIDOVISEXCC** ✓
   a. Place a light block in front of the chamber window ✓
   b. Start the image sequence ✓
   c. When the image count reaches 2 remove the light block ✓
   d. When the image count reaches 6 replace the light block and let the sequence finish ✓
9. Examine the images using DIVe and determine that there are at least 3 images with a saturated CW lamp filament image. If not repeat the image sequence and light block steps above — repeat in mode 6 with 64 images Δ DLH 3/1/03 CB 4/25/03
10. With the same light setup as in step 8, collect 4 MODE 1 images with 10 sec integration delays using CSTOL script TP564435, single mode dark to test the shutter blocking.

### 8.2.2 Large Sphere (3/6/03)

While the large (65") integrating sphere is being used for calibration of HRI, and at the discretion of the test director and systems engineering, perform any or all of the following steps

1. Move the instrument platform thermal vacuum translation stage so that the MRI is addressing the 16" fused silica chamber window and therefore the 65" integrating sphere. ✓

2. If the integrating sphere is not lit by a single internal lamp, follow the steps in 564419 to get to that state ✓ Lamp E
3. Confirm that the MRI filter wheel is at position 1. If not move the filter wheel to position one by issuing the OASIS command "`CMD IMF VIS_FW_ABS WITH FILTER_NUM 1`"
4. Collect 8 MODE 1,2,3,5 and 9 images, 0 msec integration delay using CSTOL procedure TP564435, single mode dark. These are bias frames. ✓
5. Collect 8 MODE 1,2,3,5 and 9 images, looking at lit integrating, sphere, with 0 msec integration delay using CSTOL procedure TP564436, single mode light
6. Use DIVe to determine the average signal level in each quadrant. Calculate the integration delay time that will saturate the detector (14,000 DN), using 8.5 msec exposure time for 0 msec integration delay. Use that calculation to determine a set of integration delays that will produce up to 120% of detector saturation. Saturates on filter 1 do not take filter 6 DLH 3/6/03
7. Collect 8 MODE 1 images with the exposures determined in the previous step
8. Move the filter wheel to position 6 (clear) using the OASIS command "`CMD IMF VIS_FW_ABS WITH FILTER_NUM 6`" N/A
9. Repeat steps 4 through 7 at filter positions 6
10. Repeat steps 4 through 7 at filter positions 4 and 5 ✓
11. Repeat steps 4 through 7 at filter positions, 7, 8 and 9, with integration delay times that produce a signal at least ¼ full well ✓
12. Install UDT photometer in front of 65" integrating sphere
13. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with UDT and Window"
14. Cover the "Rambo" chamber window with black cloth or low reflectivity material
15. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with UDT, Window Covered"
16. Remove the UDT calibrated photodiode

NA no UDT DLH 3/6/03

17. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp without UDT, Window Covered" ✓
18. Remove the dark cloth from chamber window ✓

### 8.3 MRI Flatfield Source Imaging

Tests at room temperature indicate that the un-attenuated quartz-halogen source feeding the 24" LabSphere will saturate the CCD for very short exposure times. Thus the calibration and linearity tests require that the variable aperture (attenuator), which is part of the LabSphere, will need to be used to bring the source to a level that will allow for on-scale imaging. The following steps allow a determination of the final source intensity used to calibrate the MRI, compared to the un-attenuated source intensity. Photometer readings will be collected on sheets labeled Instrument Platform Calibration Photometer Worksheet included in the Appendix. Make as many copies as needed. This will be shortened to "Photometer Worksheet" in the procedure steps.

#### 8.3.1 Cold Dark Measurements

When the MRI structure and the MRI electronics have reached their expected operating temperature, as defined in test procedure 564426, conduct the following steps.

1. Record CCD temperature as read from the test temperature monitor -97.34, -97.2
2. If not already on, power on the instrument electronics using CSTOL procedure TP576702 (0) ✓
3. Cover the thermal vacuum chamber window with dark cloth or Al foil (or both) ✓ CB 4/25/03 DLH 3/2/03
4. Start CSTOL procedure TP564435 (Single Mode Dark) ✓
5. Collect sixteen to thirty-two (16 – 32) image in each of 9 MODEs with the minimum integration delay time (0 msec for modes 1, 2, 3, 5 and 9; 4 msec for modes 4, 6, 7 and 8) ✓ 24 each mod 9 + 8
6. Determine minimum exposure time to produce at least 5 DN of signal from dark current, either from Figure 8-1 or from extrapolated data from section 8.1 N/A 5DN > 1 hour run @ 300 sec
7. Collect sixteen to ~~thirty-two (16 – 32)~~ 20 only images in each of 9 MODEs with integration delay equal to the exposure time calculated in the previous step ✓
8. Power down instrument electronics using CSTOL script TP576703, and alert test operator that instrument electronics are powered off. N/A
9. Uncover thermal vacuum chamber window ✓
10. Record CCD temperature as read from the test temperature monitor -96.8, -96.7 Also see image log.

#### 8.3.2 Installing the Integrating Sphere

1. Place the front aperture of the 24" LabSphere integrating sphere in front of the chamber window so that the center matches the MRI boresight outside the chamber within 1 inch. The approximate locations of each component is shown in Figure 8-2

Note used 20" fold flat on optical test station 2

over for diagram →

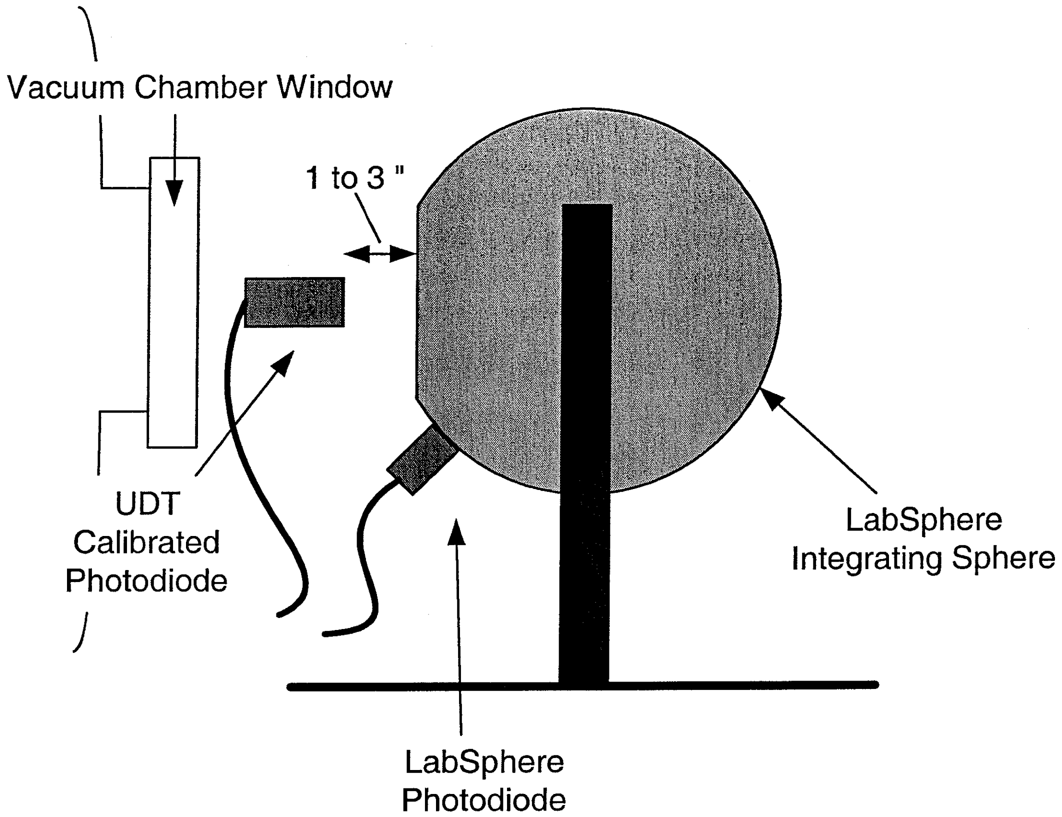


**Figure 8-2 Integrating Sphere Mechanical Setup**

2. Connect COM port of a PC computer with LabSphere USS-2000V software to LabSphere control module (Model SC5500, port 1) using serial cable to null modem cable.
3. Start USS-2000V software on laptop ✓
4. Turn on Labsphere control module, interface module and lamp power supply C ✓
5. Confirm that the Labsphere photodiode is operating ✓
6. Confirm that variable aperture (VA) control is working ✓
7. Set the VA to 255 (full open) for section 8.3.3

### 8.3.3 Ambient signals

1. Record CCD temperature as read from the test temperature monitor -96.5, -96.4 180.92K
2. If not already on, power on the MRI electronics using CSTOL script TP564700 N/A on
3. Cover vacuum chamber window with black cloth or Al foil (or both) N/A already done 8.3.1 DLH 3/6/03

4. Collect eight to sixteen ( 8-16 ) images in all MODEs with the minimum integration delay (0 msec for MODEs 1, 2, 3, 5 and 9, 4 msec for others) using CSTOL script TP564435 for bias frame measurements already done see 8.3.1
5. Remove cover from vacuum chamber window, and confirm that integrating sphere lamp is not on (is on, VA=0 – this also gets the lamp external to sphere)
6. Note the lighting conditions in the FT-1 T/V chamber area. It is highly recommended that overhead lights above the sphere be turned off, and that this test be conducted after sunset so that the skylights do not introduce variable illumination. Use dark cloth or dark baffles as needed to reduce ambient light as needed after 6pm all overhead lights off monitors & incandescent off
7. Collect eight images in MODE 1 with 1 sec integration delay using CSTOL script TP564435 as dark images (Use images from section 8.3.1)
8. Collect eight to sixteen (8 – 16) images in all MODEs with ~~1~~ 10 sec △ DLH 3/2/03 CB 4/25/03 integration delay using CSTOL script TP564436 as an ambient light level reading.
9. Move to each filter and collect eight (8) images in MODE 1 with 10 sec integration delay ✓ using CSTOL script TP564436. If any of these images saturates the CCD, re-collect with shorter exposure until the images are within the dynamic range of the CCD OK
10. Install the calibrated photodiode (UDT) in front of the integrating sphere N/A no UDT DLH 3/6/03
11. Use a Photometer Worksheet to collect ambient photometer measurements with "Lighting Conditions" labeled "Ambient" ✓
12. Record CCD temperature as read from the test temperature monitor -95.1C, -95.0C 182.3K

### 8.3.4 Source Measurements

1. Confirm that the variable aperture is set to 255, full open
2. Turn on the calibrated quartz halogen lamp (controller C) in the LabSphere integrating ✓ sphere to the calibrated current level of 6.250 amps and allow at least 30 minutes to stabilize
3. Record lamp run time from LabSphere controller at power on See attached lamp log. DLH 3/6/03
4. Record the stabilized current 6.250 and voltage N/A ✓
5. Use Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with UDT and Window" ✓
6. Cover the "Rambo" chamber window with black cloth or low reflectivity material ✓

7. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with UDT, Window Covered" N/A no UDT
8. Remove the UDT calibrated photodiode
9. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp without UDT, Window Covered" ✓
10. Remove the dark cloth from chamber window ✓
11. Set the LabSphere variable attenuator to closed by entering 0 in the USS-2000V "VA" field ✓
12. Set the variable attenuator to ~~20~~ 10
13. Re-install the UDT photometer in front of the integrating sphere N/A No UDT
14. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with UDT and Window"
15. Remove the UDT photometer
16. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with Window, no UDT" ✓

### 8.3.5 Clear Filter Measurements

1. Verify that the MRI filter wheel is set at position 1 (Clear Filter). If not move to position 1 by issuing OASIS command "`CMD IMF VIS_FW_ABS WITH FILTER_NUM 1`" and confirm position by reading Mechanism telemetry page ✓
2. Collect MODE 1 images using CSTOL script TP564436 and analyze in real time using DIVe to find an integration delay that produces images with signal level that is between 4000 and 5000 DN above the serial overclocked region signal (full well is ~14000 DN ) ✓
3. Use Table 8-1 below to spread 20 to 25 integration delay times from 0 msec to that needed to produce 120% of the nominal CCD full well (450,000 e-, 15,000 DN) ✓
4. For each integration delay entered in Table 8-1 collect eight to twenty-four (8 – 24) MODE 1 images using CSTOL script TP564436 (single mode light) see logsheets
5. Collect sixteen (16) MODE 2, 3, 5 and 9 images using CSTOL script TP564436 with an integration delay at the midpoint of the delays listed in Table 8-1 ✓ 10 sec
6. Collect sixteen (16) MODE 4, 6, 7, and 8 images using CSTOL script TP564436 with 4 msec integration delay (minimum for these modes). also 10 sec

7. Move the MRI filter wheel to position 6 by issuing OASIS command "`CMD IMF VIS_FW_ABS WITH FILTER_NUM 6`" and confirm positions by reading from mechanism telemetry page ✓
8. For each integration delay entered in Table 8-1 collect eight to twenty-four (8 – 24) MODE 1 images using CSTOL script TP564436 (single mode light) ✓
9. Collect ~~sixteen (16)~~ 8 MODE 2, 3, 5 and 9 images using CSTOL script TP564436 with an integration delay at the midpoint of the delays listed in Table 8-1 ✓
10. Collect ~~sixteen (16)~~ 8 MODE 4, 6, 7, and 8 images using CSTOL script TP564436 with ~~4~~ 1000ms msec integration delay (minimum for these modes)
11. Collect eight (8) MODE 1 images using CSTOL script TP564435 with 0 msec integration delay ✓
12. Collect ~~eight (8)~~ 2 MODE 1 images using CSTOL script TP564435 with the longest integration delay listed in Table 8-1 for a shutter blocking test ✓

Δ DLH 3/2/03 3 places

VA=6 Filter 12 — Filter 6 ✓ VA=15

**Table 8-1 Clear Filter Exposure Times**

| # | T_exp (msec) | % Full Well | # | T_exp (msec) | % Full Well |
|---|---|---|---|---|---|
| 1 | 0 ✓ | | 15 | 0 [16] ✓ | 1900 [8] ✓ |
| 2 | 15 ✓ | | 16 | 1 [16] ✓ | 2000 [8] |
| 3 | 71 ✓ | | 17 | 2 [16] ✓ | 2100 [8] |
| 4 | 229 ✓ | | 18 | 3 [16] ✓ | 2200 [8] |
| 5 | 690 ✓ | | 19 | 5 [16] ✓ | 2300 [8] |
| 6 | 2267 ✓ | | 20 | 10 [16] ✓ | 2400 [8] |
| 7 | 7500 ✓ | | 21 | 30 [16] ✓ | |
| 8 | 15000 ✓ | | 22 | 100 [8] ✓ | |
| 9 | 30000 ✓ | | 23 | 300 [8] ✓ | |
| 10 | 35000 ✓ | | 24 | 600 [8] ✓ | |
| 11 | 22500 ✓ | | 25 | 1000 [8] ✓ | |
| 12 | | | 26 | 1250 [8] ✓ | |
| 13 | 10000 ✓ | | 27 | 1500 [8] ✓ | |
| 14 | | | 28 | 1750 [8] ✓ | |

Some vignetting

22:11:20

### 8.3.6 Bandpass Filter Measurements

1. For the 100 nm bandpass filters (4 & 5) perform the following steps
   a. Move the filter wheel to the next filter positions by issuing the OASIS command "`CMD IMF VIS_FW_ABS WITH FILTER_NUM N`" where `N` is the desired filter position

b. Collect a MODE 1 image with 10 100 msec integration delay using CSTOL script TP564436 and analyze in real time using DIVe to find the average signal level. ✓

c. Use Table 8-2 below to spread up to 12 integration delay times from 0 msec to that needed to produce 120% of the nominal CCD full well (450,000 e-, 15,000 DN) ✓

d. Record CCD temperature as read from the test temperature monitor 186.5K

e. For each integration delay entered in the table collect eight to twenty-four (8 – 24) MODE 1 images using CSTOL script TP564436 (single mode light)

f. Collect sixteen (16) images of MODEs 2 through 9 CSTOL script TP564436 with an integration delay at the midpoint of the delays listed in Table 8-2

g. Repeat steps a. through f. for the next filter

h. Re-install the UDT calibrated photodiode at the aperture of the integrating sphere at the same place as previously installed

N/A no UDT

i. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with UDT and Window"

j. Remove the UDT photometer

k. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with Window, no UDT" ✓ P27 J.

l. Record CCD temperature as read from the test temperature monitor 186.5K

**Table 8-2 100 nm Bandpass Filter Integration Delay Times**

| # | Filter 4 T_delay (msec) | Filter 5 T_delay (msec) |
|---|---|---|
| 1 | 0 ✓ 16 | 0 16 |
| 2 | 3 ✓ 16 | 6 16 |
| 3 | 10 ✓ 8 | 20 8 |
| 4 | 30 ✓ 8 | 60 8 |
| 5 | 100 ✓ 8 | 200 8 |
| 6 | 300 ✓ 8 | 600 8 |
| 7 | 1000 ✓ 6 | 2000 8 |
| 8 | 1500 ✓ 4 | 3000 4 |
| 9 | 2000 ✓ 4 | 4000 4 |
| 10 | 2300 ✓ 4 | 4400 4 |
| 11 | 2700 ✓ 4 | 6600 4 |
| 12 | | |
| 13 | | |
| 14 | | |

VA = 25

Full well → 10

1.2x fw → 11

Ball Aerospace & Technologies Corp.

P.O. Box 1062 Boulder, CO 80306

| SIZE | CAGE CODE | DWG. NO. | REV |
|---|---|---|---|
| A | 13993 | 564420 | – |

Operator: DLH 3/3/03 | SHEET 19

A6356 BR2281[42A] BR 2281 7/15/02

2. Set the variable aperture to 0 ✓
3. Set the variable aperture to 115 ✓
4. For the visible band gas photometry filters (2 & 3) perform the following steps
   a. Move the filter wheel to position the next filter position by issuing the OASIS command "CMD IMF VIS_FW_ABS WITH FILTER_NUM 2" ✓
   b. Record a MODE 1 image using CSTOL script TP564436, with ~~1~~ 100ms sec integration delay. ✓
   c. Use DIVe to determine the average signal level and determine the integration delay time needed to produce 120% of the nominal CCD full well (450,000 e-, 15,000 DN). If the 120% integration delay is significantly longer than 1 minute adjust the variable aperture and repeat the MODE 1 image until the integration delay is ~ 1 minute or less, or the variable aperture is open. Record variable aperture setting used 42. ✓
   d. Use Table Table 8-3 to spread up to 12 integration delay times from 0 msec to that needed to produce 120% of the nominal CCD full well (450,000 e-, 15,000 DN). ✓
   e. Record CCD temperature as read from the test temperature monitor 186.35K
   f. Re-install the UDT calibrated photodiode at the aperture of the integrating sphere at the same place as previously installed N/A no UDT
   g. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with UDT and Window"
   h. Remove the UDT photometer
   i. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with Window, no UDT" ✓
   j. For each integration delay entered in the table collect eight to twenty-four (8 – 24) MODE 1 images using CSTOL script TP564436 (single mode light) ✓
   k. Collect sixteen (16) images of MODEs 2 through 9 CSTOL script TP564436 with an integration delay at the midpoint of the delays listed in Table 8-3 ✓
   l. Move filter wheel to the next filter position by issuing an OASIS command "CMD IMF VIS_FW_ABS WITH FILTER_NUM N" where N is the desired filter number ✓
   m. Collect one MODE 1 images with integration delay of 2 sec ✓

n. Use DIVe to determine the average signal level and determine the integration delay time needed to produce 120% of the nominal CCD full well (450,000 e-, 15,000 DN).

o. Repeat steps j. and k. ✓

p. Re-install the UDT calibrated photodiode at the aperture of the integrating sphere at the same place as previously installed

q. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with UDT and Window"

N/A no UDT

r. Remove the UDT photometer

s. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with Window, no UDT" ✓

t. Record CCD temperature as read from the test temperature monitor 186.5 K ✓

**Table 8-3 Visible Gas Photometry Bandpass Filter Integration Delay Times**

| # | Filter 2 T_delay (msec) | Filter 3 T_delay (msec) |
|---|---|---|
| 1 | 0 ✓ | 0 16 |
| 2 | 5 ✓ | 10 16 |
| 3 | 10 ✓ | 20 8 |
| 4 | 20 ✓ | 60 8 |
| 5 | 30 ✓ | 100 8 |
| 6 | 50 ✓ | 300 8 |
| 7 | 100 ✓ | 600 8 |
| 8 | 150 ✓ | 2000 8 |
| 9 | 300 ✓ | 6000 4 |
| 10 | 1000 ✓ | 20000 |
| 11 | 3000 ✓ | 30000 |
| 12 | 10000 ✓ | 42000 ← full well |
| 13 | 15000 ✓ | 50000 ← 1.2x |
| 14 | 21000 ✓ (full well →) | |

1.2x → 25000 ✓

5. Set the variable aperture to 255 (full open) ✓

6. For the UV gas photometry bandpass filters (7, 8 & 9) Perform the following steps

a. Move the filter wheel to position 9 by issuing the OASIS command "`CMD IMF VIS_FW_ABS WITH FILTER_NUM 9`" ✓

b. Cover the thermal vacuum chamber window and collect a MODE 1 image with 30 sec (10 sec) integration delay using CSTOL script TP564435 as a dark current measurement ✓

c. Uncover the thermal vacuum window and collect a MODE 1 image with 30 sec integration delay using CSTOL script TP564436 ✓

d. Analyze the difference of the two images using DIVe, and calculate exposure time needed to produce full well, 14000 DN. If this time is significantly longer than 600 sec (10 minutes) then a second lamp may be required – perform steps in Section 8.3.7, otherwise continue with these steps → yes use 3 lamps

e. Use Table 8-4 below to spread 10 exposure times from 0 msec to full well ✓

f. Install the full spectrum UDT photodiode in front off the integrating sphere

g. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with Window and UDT" N/A no UDT

h. Install UDT UV photodiode (model 222) in front of integrating sphere

i. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with Window and UDT"

j. Remove the UDT photometer

k. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with Window, no UDT" ✓

l. For each integration delay time listed in Table 8-4 collect 2 to 8 MODE 1 images using CSTOL script TP574436 ✓

m. At an intermediate exposure time in Table 8-4 collect 8 to 12 MODE 2 through 9 images ✓

n. Cover the thermal vacuum chamber window with black cloth or Al foil (or both) and take a single MODE 1 image using CSTOL script TP576435 for the longest exposure time used in Table 8-4 for a dark current measurement ✓

1) DLH 3/3/03 CB 4/25/03

o. Repeat the previous ~~two~~ three steps for filters 7 and 8. Move to filter position using OASIS command "`CMD IMF VIS_FW_ABS WITH FILTER_NUM N`", where `N` is the desired filter number. Begin with short exposures and work out in real time the exposure to achieve full well. ✓

p. Re-install the full spectrum UDT photodiode in front of the integrating sphere

q. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with Window and UDT" N/A no UDT

r. Install UDT UV photodiode (model 222) in front of integrating sphere N/A no UDT

s. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with Window and UDT"

t. Remove the UDT photometer

u. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with Window, no UDT" ✓ p. 27 I

**Table 8-4 UV Gas Photometry Bandpass Filter Integration Delay Times**

3 lamps
VA=255

| # | Filter 7 T_delay (msec) | Filter 8 T_delay (msec) | Filter 9 T_delay (msec) | |
|---|---|---|---|---|
| 1 | 0 16 | 0 ✓16 | 0 0 | 3 msec ✓16, 16 |
| 2 | 1 16 | 1 ✓16 | 4 10 | ✓16 |
| 3 | 2 4 | 2 ✓16 | 2 30 | ✓16 |
| 4 | 5 6 | 5 ✓16 | 3 100 | ✓16 |
| 5 | 10 8 | 10 ✓16 | 5 300 | ✓16 |
| 6 | 30 8 | 30 ✓16 | 10 1000 | ✓ 8 |
| 7 | 100 8 | 100 ✓16 | 30 3000 | ✓ 8 |
| 8 | 250 8 | 300 ✓16 | 100 10000 | ✓ 4 |
| 9 | 500 4 | 1000 ✓8 | 300 30000 | ✓ 4 |
| 10 | 1000 4 | 3000 ✓8 | 1000 100000 | ✓ 4 |
| 11 | 2500 4 | 10000 ✓4 | 300000 | 280000 2 Full well |
| 12 | 5000 4 | 33,000/40,000 ✓4 | ~~600000~~ | 360000 ✓2 120% Full well |

~1900 DN/sec 7400 4, 8600 4 ~420 DN/sec

### 8.3.7 Additional lamps for UV measurements

If lamp C in the 24" integrating sphere does not produce enough UV signal for the 309 nm filter, additional lamps may be used. Complete the following steps to take UV filter images.

1. Complete the steps in 8.4, Source Verification
2. Turn on lamp power supply controller for an internal integrating sphere lamp ✓
3. Verify that the integrating sphere fan is operating ✓
4. Check that the lamp current is properly set ✓
5. Turn on internal lamp and allow 15 minutes to stabilize ✓
6. Cover thermal vacuum chamber window with black cloth or Al foil (or both) ✓
7. Collect a MODE 1 image with 30 sec integration delay using CSTOL script TP564435 as a dark current measurement ✓
8. Uncover thermal vacuum chamber window to view lit integrating sphere ✓

9. Collect a MODE 1 image with 30 sec integration delay using CSTOL script TP564436 ✓
10. Analyze the difference of the two images using DIVe, and calculate exposure time needed to produce ¼ full well, 3000 to 4000 DN. If this time is significantly longer than 600 sec (10 minutes) then another lamp will be required. Repeat the previous steps for a second internal lamp ✓
11. Return to step 3.-e. of section 8.3.6 ✓

## 8.4 Source Verification

With the single calibrated lamp powered on at the integrating sphere, perform the following steps

1. Return variable attenuator to full open, 255, using USS-2000V software
2. Re-install the UDT calibrated photodiode at the aperture of the integrating sphere at the same place as previously installed
3. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with UDT and Window, VA = 255"
4. Remove the UDT photometer
5. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with Window, no UDT, VA = 255"
6. Move the variable attenuator to 0, full closed
7. Move the variable attenuator to 75
8. Re-install the UDT calibrated photodiode at the aperture of the integrating sphere at the same place as previously installed
9. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with UDT and Window, VA=75"
10. Remove the UDT photometer
11. Use a Photometer Worksheet to collect photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Lamp with Window, no UDT, VA = 75"
12. Record CCD temperature as read from the test temperature monitor __________
13. Either return to section 8.3.7, or continue to section 8.5, Lamp Power Off

N/A NO UDT

N/A see calibration data from March 21, 2003
DLH 4/23/03

### 8.5 Lamp Power Off

1. Turn off power to lamp C using either UVS-2000 software control or from the front panel of the Labsphere Lamp power supply
2. Record lamp run time from LabSphere controller at power off ________ see Sphere Lamp log attached
3. Use a Photometer Worksheet to collect Labsphere photometer measurements of the integrating sphere with "Lighting Conditions" labeled "Ambient, no UDT" ✓

### 8.6 Visible Stimulator Test

To test the operation of the LED that will be used as a visible stimulator conduct the following steps

1. Confirm that the primary/secondary mirror decontamination heater circuit, side A, is connected to 35 V power supply ✓
2. Disconnect leads to the heater circuit and set up power supply to provide 28 V, and turn off power supply ✓
3. Reconnect the beamsplitter decon. heater circuit leads to the power supply
4. If not already on, power on the MRI instrument electronics using CSTOL script TP576700 on
5. Collect four MODE 1 images with 100 msec integration delay, using CSTOL script TP564435 (Single Mode Dark)
6. Turn on power supply ✓
7. Collect four MODE 1 images with 100 msec integration delay, using CSTOL script TP564435 ✓
8. Turn off power supply ✓
9. Repeat steps 1 through 8 with the power supply set to 26V and 35V ✓
10. Turn off MRI instrument electronics using CSTOL script TP576701 ✓

Need to ensure correct polarity of line!

## 9 DATA PRODUCTS & WORKSHEETS

The following table lists the calibration products and the associated procedure and section where the data are collected to produce the needed results

| Product | Document | Section | Comments |
|---|---|---|---|
| Plate Scale | 564422 | 8.1 | Survey point source with theodolite |
| IFOV | 564422 | 8.1 | |
| FOV | 564422 & 564446 | 8.1 | 1008 active pixels x IFOV |
| PSF | 564422 | 8.2 | Knife Edge and/or Pinhole Tests |
| MTF | 564422 | 8.2 | " |
| Noise | 564420 | 8.3.5 & 8.3.6 | Gain Variance |
| Readout Smear | 564420 | 8.2.1 | Latent Image Tests |
| Gain | 564420 | 8.3.5 | Gain Variance. Each Quad independently |
| Linearity | 564420 | 8.3.5 | Gain Variance, per filter |
| Flat Field | 564420 | 8.3.5 & 8.3.6 | Per filter |
| Bad Pixel Maps | 564420 | 8.3.5 | Hot and Dead pixels |
| Radiometric | 564420 | 8.3.5 & 8.3.6 | Calibrated lamp and sphere |
| Stellar Radiometry MSSR 5.2.13.2-4 | | | Combine Radiometric and PSF results |

The following sets of images will be produced for each subsection of section 8

| Subsection | Mode | # Images | Comments |
|---|---|---|---|
| 8.1 | 1 (1-9) | 40 to 160 | Based on HRI SIM test Aug. 25, 2002 |
| 8.2.1 | 1 | 32 | Latent Image |
| 8.2.2 | 1-9 | 360 | Large Sphere |
| 8.3.1 | 1-9 | 576 | Dark |
| 8.3.3 | 1-9 | 361 | Ambient |
| 8.3.5 | 1-9 | 1477 | Clear Filter |
| 8.3.6.1 | 1-9 | 833 | 100 nm bandpass filters |
| 8.3.6.4 | 1-9 | 833 | Visible Gas Emission Filters |
| 8.3.6.6 | 1-9 | 530 | UV Gas Emission Filters |
| | Total | 5130 | |

# Instrument Platform Calibration Photometer Worksheet

Procedure & Section 564420 Instrument MRI
Date & Time 10:05 2/27/03 Var. Atten. 20
Lighting Conditions FT-1 light on window no UDT
UDT Photometer
Readings N/A

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading

Labsphere Photometer
Readings X10⁻⁸

| | | | | |
|---|---|---|---|---|
| 1.89 | 1.9 | 1.898 | 1.895 | 1.871 |
| 1.868 | 1.886 | 1.882 | 1.898 | 1.896 |

Average Reading
Comments

-16°C Flatfields
used Theodolet to align

---

Procedure & Section Instrument MRI
Date & Time 11:00 2/27/03 Var. Atten. 20
Lighting Conditions
UDT Photometer
Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading

Labsphere Photometer
Readings X10⁻⁸

| | | | | |
|---|---|---|---|---|
| 1.924 | 1.934 | 1.928 | 1.922 | 1.919 |
| 1.928 | 1.912 | 1.909 | 1.933 | 1.916 |

Average Reading
Comments

After imaging

Ambient X10⁻⁸ 1.232, 1.237, 1.22 1.221 1.225 1.226
1.233, 1.237, 1.231 1.217 1.238 1.224

## Instrument Platform Calibration Photometer Worksheet

Procedure & Section 564420 Instrument MRI
Date & Time 2/27/03 18:10 Var. Atten. 0
Lighting Conditions Ambient evening – lights on
UDT Photometer
Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading

Labsphere Photometer
Readings x10^-8

| | | | | |
|---|---|---|---|---|
| 1.185 | 1.188 | 1.195 | 1.194 | 1.173 |
| 1.19 | 1.169 | 1.188 | 1.193 | 1.181 |

Average Reading
Comments

---

Procedure & Section 564420 Instrument MRI
Date & Time 2/27/03 Var. Atten. 20
Lighting Conditions ~~[illegible]~~ sphere + window
UDT Photometer
Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading

Labsphere Photometer
Readings x10^-8

| | | | | |
|---|---|---|---|---|
| 1.876 | 1.869 | 1.875 | 1.863 | 1.868 |
| 1.87 | 1.854 | 1.863 | 1.871 | 1.866 |

Average Reading
Comments

pre – 30° flats – never use VA 20
see post @ 20:00 – same day

Ball Aerospace & Technologies Corp.
P.O. Box 1062
Boulder, CO 80306

| SIZE | CAGE CODE | DWG. NO. | REV |
|---|---|---|---|
| A | 13993 | 564420 | – |

Operator: DLH 2/27/03 SHEET 27 B

# Instrument Platform Calibration Photometer Worksheet

Procedure & Section 564420 Instrument MRI
Date & Time 2/27/03 18:45 Var. Atten. 0
Lighting Conditions Lights out in high bay
UDT Photometer
Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading

Labsphere Photometer
Readings x10-8

| | | | | |
|---|---|---|---|---|
| 1.187 | 1.181 | 1.171 | 1.169 | 1.16 |
| 1.168 | 1.175 | 1.176 | 1.184 | 1.163 |

Average Reading
Comments

AMBIENT – Lights out in high bay

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Procedure & Section 564420 Instrument MRI
Date & Time 2/27/03 20:00 Var. Atten. VA 15
Lighting Conditions Lamp – high bay lamps off night
UDT Photometer N/A
Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading

Labsphere Photometer
Readings x10-8

| | | | | |
|---|---|---|---|---|
| 1.502 | 1.505 | 1.482 | 1.507 | 1.493 |
| 1.49 | 1.482 | 1.506 | 1.498 | 1.485 |

Average Reading
Comments

post -30° Flats 13.61V internal

# Instrument Platform Calibration Photometer Worksheet

Procedure & Section 564420 8-3-3 Instrument MRI
Date & Time Mar 2 2003 19:30 Var. Atten. 0
Lighting Conditions AMBIENT
UDT Photometer
Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading

Labsphere Photometer
Readings x10^-11

| | | | | |
|---|---|---|---|---|
| 1181 | 1201 | 1199 | 1189 | 1202 |
| 1187 | 1215 | 1191 | 1190 | 1184 |

Average Reading
Comments

---

Procedure & Section 564420 8-3-4 Instrument MRI
Date & Time Mar 2 2003 19:50 Var. Atten. 255
Lighting Conditions Lamp with window (no UDT)
UDT Photometer
Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading

Labsphere Photometer
Readings x10-6

| | | | | |
|---|---|---|---|---|
| 1.0137 | 1.0129 | 1.0128 | 1.0124 | 1.0125 |
| 1.013 | 1.0128 | 1.0129 | 1.0131 | 1.0129 |

Average Reading
Comments 13.44V

Lamp Labsphere photom → window covered x10-6

| | | | | |
|---|---|---|---|---|
| 1.0118 | 1.012 | 1.0118 | 1.0115 | 1.0114 |
| 1.0113 | 1.0113 | 1.011 | 1.011 | 1.0112 |

# Instrument Platform Calibration Photometer Worksheet

Procedure & Section 564420 8-3.4 Instrument MRI
Date & Time Mar 2 2003 20:21 Var. Atten. 6
Lighting Conditions Lamp+Window NO UDT
UDT Photometer Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading

Labsphere Photometer Readings
X10⁻⁸

| | | | | |
|---|---|---|---|---|
| 1.227 | 1.240 | 1.216 | 1.237 | 1.243 |
| 1.221 | 1-233 | 1.213 | 1.229 | 1.231 |

Average Reading
Comments Post fltr 1 X10⁻⁸

1-201 1-201 1-201 1.181 1.198
1-207 1-221 1.196 1-213 1-200

---

Procedure & Section 564420 8-3.4 Instrument MR
Date & Time Mar 2 2003 22:25 Var. Atten. 15
Lighting Conditions Lamp + Window NO UDT
UDT Photometer Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading

Labsphere Photometer Readings
X10⁻⁸

| | | | | |
|---|---|---|---|---|
| 1.536 | 1.542 | 1.555 | 1.537 | 1.525 |
| 1.543 | 1.517 | 1.526 | 1.527 | 1.53 |

Average Reading
Comments X10⁻⁸

Filter 6 Between mode 1 & all modes see page 4 of 6 image log

1.542 1.557 1.559 1.54 1.541
1.567 1.57 1.571 1.558 1.560

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Boulder, CO 80306

| SIZE | CAGE CODE | DWG. NO. | REV |
|---|---|---|---|
| A | 13993 | 564420 | – |

Operator: DLH ~~2/27/03~~ 3/2/03    SHEET 27 E

# Instrument Platform Calibration Photometer Worksheet

Procedure & Section: 564420 8.3.5
Instrument: MRI
Date & Time: Mar 2 '03 23:40
Var. Atten.: 15
Lighting Conditions: Lamp no UDT + window
UDT Photometer Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading: ____________

Labsphere Photometer Readings: X10^-8

| | | | | |
|---|---|---|---|---|
| 1.566 | 1.551 | 1.544 | 1.556 | 1.559 |
| 1.548 | 1.558 | 1.551 | 1.556 | 1.545 |

Average Reading: ____________

Comments: X10^-8

AMBIENT Lamp on VA=0

| | | | | |
|---|---|---|---|---|
| 1.214 | 1.199 | 1.192 | 1.221 | 1.209 |
| 1.216 | 1.224 | 1.213 | 1.194 | 1.208 |

---

Procedure & Section: ____________
Instrument: ____________
Date & Time: ____________
Var. Atten.: ____________
Lighting Conditions: ____________
UDT Photometer Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading: ____________

Labsphere Photometer Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading: ____________

Comments:

# Instrument Platform Calibration Photometer Worksheet

Procedure & Section 564420 Instrument MRI
Date & Time Mar 3 '03 16:30 Var. Atten. 0
Lighting Conditions Ambient window no UDT
UDT Photometer
Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading

Labsphere Photometer
Readings x10⁻⁸

| | | | | |
|---|---|---|---|---|
| 1.156 | 1.160 | 1.153 | 1.17 | 1.148 |
| 1.157 | 1.145 | 1.165 | 1.154 | 1.166 |

Average Reading
Comments

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Procedure & Section 564420 Instrument MRI
Date & Time Var. Atten. 255
Lighting Conditions Lamp C only window no UDT
Labsphere ~~UDT Photometer~~
Readings x10⁻⁶

| | | | | |
|---|---|---|---|---|
| ~~1.172~~ 1.0173 | 1.0172 | 1.0170 | 1.0173 | 1.0171 |
| 1.0169 | 1.0170 | 1.0166 | 1.0165 | 1.0164 |

Average Reading

window covered –
Labsphere Photometer
Readings

| | | | | |
|---|---|---|---|---|
| → 1.0163 | 1.0162 | 1.0159 | 1.0158 | 1.0159 |
| 1.016 | 1.0161 | 1.0160 | 1.0160 | 1.0162 |

Average Reading
Comments

window uncovered → 1.0158 1.0161 1.0162 1.0161 1.0162

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Operator: DLH 3/3/03 SHEET 27 G

# Instrument Platform Calibration Photometer Worksheet

Procedure & Section 564420 Instrument MRI
Date & Time 17:45 Mar 03 '03 Var. Atten. 255
Lighting Conditions 3 lamps external + A + D NO UDT
Labspere ~~UDT Photometer~~
Readings x10-6

| | | | | |
|---|---|---|---|---|
| 2.908 | 2.908 | 2.908 | 2.907 | 2.907 |
| 2.908 | 2.908 | 2.908 | 2.908 | 2.908 |

Average Reading
Post 309 filter ~19:50
Labsphere Photometer
Readings x10-6

| | | | | |
|---|---|---|---|---|
| 2.908 | 2.909 | 2.909 | 2.909 | 2.909 |
| 2.910 | 2.910 | 2.911 | 2.911 | 2.912 |

Average Reading
Comments

---

Procedure & Section 564420 Instrument MRI
Date & Time Mar 3 '03 20:40 Var. Atten. 255
Lighting Conditions 3 lamps wintoco no UDT
Labsphere ~~UDT Photometer~~ POST Filter 8
Readings x10-6

| | | | | |
|---|---|---|---|---|
| 2.913 | 2.914 | 2.913 | 2.914 | 2.914 |
| 2.913 | 2.913 | 2.912 | 2.911 | 2.911 |

Average Reading
21:30 after ~~mode~~ filter 7
Labsphere Photometer
Readings x10-6

| | | | | |
|---|---|---|---|---|
| 2.915 | 2.916 | 2.916 | 2.916 | 2.916 |
| 2.916 | 2.916 | 2.916 | 2.916 | 2.916 |

Average Reading
Comments Lamp C only 21:33 VA=255

Ambient
1.352x10-8
1.326
1.336
1.338

x10-6

| | | | | |
|---|---|---|---|---|
| 1.006 | 1.008 | 1.007 | 1.006 | 1.006 |
| 1.006 | 1.007 | 1.006 | 1.006 | 1.007 |

VA = 128 x10-7

| | | | | |
|---|---|---|---|---|
| 3.546 | 3.549 | 3.55 | 3.552 | 3.551 |
| 3.554 | 3.552 | 3.552 | 3.550 | 3.552 |

# Instrument Platform Calibration Photometer Worksheet

Procedure & Section: 564420
Instrument: MRI
Date & Time: Mar 3 '03 21:50
Var. Atten.: 42
Lighting Conditions: Lamp + Window no UDT
~~UDT Photometer~~
Readings x10^-8

| | | | | |
|---|---|---|---|---|
| 4.539 | 4.536 | 4.52 | 4.513 | 4.549 |
| 4.521 | 4.530 | 4.515 | 4.533 | 4.534 |

Average Reading
Post filter 2
Labsphere Photometer: VA=42 time = 22:55
Readings x10^-8

| | | | | |
|---|---|---|---|---|
| 4.453 | 4.465 | 4.449 | 4.459 | 4.48 |
| 4.441 | 4.46 | 4.462 | 4.444 | 4.456 |

Average Reading
Comments: time 23:45
Post filter 3
VA=42
x10^-8

| | | | | |
|---|---|---|---|---|
| 4.386 | 4.401 | 4.40 | 4.39 | 4.402 |
| 4.38 | 4.377 | 4.392 | 4.379 | 4.409 |

Procedure & Section: 564420
Instrument: MRI
Date & Time: Mar 3 2003 23:50
Var. Atten.: [42]
Lighting Conditions: Lamp + Window no UDT
Labsph ~~UDT~~ Photometer
Readings VA=0 Ambient x10^-8

| | | | | |
|---|---|---|---|---|
| 1.194 | 1.190 | 1.175 | 1.202 | 1.183 |
| 1.191 | 1.203 | 1.197 | 1.173 | 1.178 |

Average Reading
Labsphere Photometer: Post Filter 4 Lamp, no UDT VA=25
Readings

| | | | | |
|---|---|---|---|---|
| 2.269 | 2.285 | 2.264 | 2.262 | 2.283 |
| 2.273 | 2.262 | 2.273 | 2.267 | 2.272 |

Average Reading
Comments: Post Filter 5 Lamp + Window No UDT 01:00
x10^-8

| | | | | |
|---|---|---|---|---|
| 2.28 | 2.278 | 2.28 | 2.248 | 2.285 |
| 2.258 | 2.258 | 2.274 | 2.284 | 2.253 |

VA=0 Ambient x10^-8

| | | | | |
|---|---|---|---|---|
| 1.185 | 1.192 | 1.189 | 1.188 | 1.173 |
| 1.179 | 1.190 | 1.203 | 1.181 | 1.201 |

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| SIZE | CAGE CODE | DWG. NO. | REV |
|---|---|---|---|
| A | 13993 | 564420 | – |

Operator: DLH 3/3/03 SHEET 27J

## Instrument Platform Calibration Photometer Worksheet

Procedure & Section 564419 Instrument MRI
Date & Time Var. Atten. NA
Lighting Conditions Large Sphere
UDT Photometer
Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading

Labsphere Photometer
Readings x10^-5 Amps 2003 Mar 06, 21:35

| | | | | |
|---|---|---|---|---|
| 1.5804 | 1.5805 | 1.5807 | 1.5812 | 1.5807 |
| 1.5816 | 1.5807 | 1.5806 | 1.5815 | 1.5807 |

Average Reading
Comments

---

Procedure & Section Instrument
Date & Time Var. Atten.
Lighting Conditions
UDT Photometer
Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading

Labsphere Photometer
Readings

| | | | | |
|---|---|---|---|---|
| | | | | |
| | | | | |

Average Reading
Comments

## Equipment List

| | | |
|---|---|---|
| Labsphere Integrating sphere System control | SC5800 | P118387 |
| Labsphere Variable Attenuator Controller | VAC-1000 | P118392 |
| Labsphere Halogen Lamp Power Supply | LPS045-H "A" | P118391 |
| " | " "B" | P118388 |
| | "C" | P118389 |
| | "D" | P118390 |
| Labsphere 24" integrating Sphere | | P118394 |

65" Labsphere system – see AS-RUN 564419

| Date | Lamp | Time On | Time Off | Chron On | Chron Off | Current (A) | Voltage (V) |
|---|---|---|---|---|---|---|---|
| 26-Feb-03 | D | 10:45 | 11:02 | N/A | N/A | N/A | N/A |
| 26-Feb-03 | C | 11:28 | 13:03 | 10:05:49 | 11:35:07 | 6.25 | N/A |
| 27-Feb-03 | C | 8:30 | 11:25 | 11:35:07 | 14:25:01 | 6.25 | 13.64 |
| 27-Feb-03 | C | 17:30 | 20:11 | 14:25:01 | 17:06:50 | 6.25 | 13.61 |
| 2-Mar-03 | C | 17:00 | 23:45 | 17:06:50 | 23:49:59 | 6.25 | 13.44 |
| 3-Mar-03 | C | 16:20 | 16:57 | 23:49:59 | 24:27:00 | 6.25 | 13.44 |
| 3-Mar-03 | A | 16:42 | 17:01 | 4:50:00 | 5:09:00 | N/A | N/A |
| 3-Mar-03 | C | 16:58 | 1:00 | 24:27:00 | 32:23:32 | 6.25 | 13.61 |
| 3-Mar-03 | A | 16:59 | 21:30 | 5:04:00 | 9:30:34 | N/A | 7.81 |
| 3-Mar-03 | D | 17:03 | 21:31 | 6:00:18 | 10:24:36 | N/A | 8.28 |