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	Prepared by(s) Craig Coltharp	Supersedes None
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Document Title Helium Exposure to ACD PMTs		

**Helium Exposure to
ACD Photomultiplier Tubes**

Prepared by:

Craig Coltharp
ACD I&T Manager
Code 568

Review by:

Mike Amato
System Engineer

Al Lacks
QA

Bob Hartman
ACD Scientist

Approve by

Tom Johnson
Instrument Manager

Dave Thompson
Subsystem Manager

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1 INTRODUCTION

1.1 Background

The Anti-Coincidence Detector (ACD) is a subsystem of the Large Area Telescope (LAT). The LAT will be integrated into the Gamma-ray Large Area Space Telescope (GLAST). The ACD is designed, build, integrated and tested by the Goddard Space Flight Center (GSFC). The ACD includes 194 Photomultiplier tubes (PMTs). These PMTs are very sensitive to Helium (He) and their performance will degrade over time due to exposure to He. Normal atmospheric air contains approximately 5 parts per million (ppm) of He. In the GSFC environment in buildings 2 and 10 He

is used extensively in labs and test chambers and at times has been recorded above 350 ppm with daily accumulation amounts of greater than 2000ppm-hours, see the Helium Mitigation Report, ACD-RPT-000314. The ACD PMTs spent a great deal of time in the building 2 and 10 environments. To reduce helium exposure, the ACD and its Electronic Chassis were controlled by the ACD Helium Monitor and Control Plan (ACD-PLAN-000156).

1.2 Purpose

The purpose of this document is to report on the amount of He exposure of the ACDs PMTs. This report contains the data, the assumptions and the calculation techniques utilized in developing the He exposure levels.

1.3 Scope

The scope of this report is the duration that the PMTs were exposed to Helium, i.e. from the time they were manufactured until they were delivered to the LAT instrument at the Stanford Linear Accelerator Center (SLAC) in California.

1.4 Definitions

ACD	The LAT Anti-Coincidence Detector Subsystem
EC	Electronic Chassis
GLAST	Gamma-ray Large Area Space Telescope
GN2	Gaseous Nitrogen
GSFC	Goddard Space Flight Center
He	Helium
I&T	Integration and Test
LAT	Large Area Telescope
PMT	Photomultiplier Tube
ppm	parts per million
SCFH	Standard Cubic Feet Per Hour
SLAC	Stanford Linear Accelerator Center
TSA	Tile Shell Assembly

1.5 Applicable Documents

Documents relevant to the Helium Exposure to ACD PMTs Report include the following:

- ACD-RPT-000314, Helium Mitigation Report
- ACD-PLAN-000152, ACD Helium Monitor and Control Plan

2 ACD Chronology of events and assumptions pertaining to the PMTs

2.1 Manufacture:

The PMTs were manufactured by Hamamatsu starting in the fall of 2002. The production ranged for two months. We are assuming for purposes of helium exposure that the average date of PMT manufacture was October 1, 2002. The PMTs were then tested and delivered to GSFC over the following 9 months, being delivered in batches of 30. We are assuming the PMTs were stored in air at the manufacturer thus exposing them to a 5PPM He environment.

In summary from Oct. 1, 2002 to Jun. 30, 2002 the PMTs were exposed to a total of 6552 hours of Ambient air environment of 5.0ppm unpurged environment resulting in an exposure of 32760ppm-hrs.

2.2 PMT buildup at GSFC:

The PMTs, once arriving at building 2 at GSFC were tested, assembled with resistor networks, and tested some more. When not being directly worked on they were stored in dry boxes and purged with gaseous nitrogen (GN2). The average time out of the dry boxes and exposed to the environment in building 2 was approximately two weeks. This two week period was an 8 hour day, 5 day per week period. The purge gas utilized in building 2 measured a 0.5ppm He content. The Helium levels in building 2 varied significantly but on average we are assuming a 40 ppm in air and a 3 ppm environment in the purged dry boxes. The helium levels were monitored on the second floor where the PMT dry boxes were located. The monitor was an Inficon model 12206 Protec detector.

In summary during this period, July 1, 2003 through Jan 31, 2005, the PMTs were exposed to a total of 80 hours of Building 2 environment of 40ppm unpurged, 13864 hours of 3ppm purged environment for a total He exposure of 44792ppm-hrs.

2.3 Integration and test at Electronic Chassis level:

From February 1, 2005 through April 30, 2005 the PMTs were then integrated into the 12 Electronic Chassis (EC) and tested in building 2. While in building 2 in the EC assembly they were purged except when directly being integrated. The average period of time in this configuration was 2 months. For about 1 week of that time during assembly (2 days/ 8 hours per day) and light pulsar testing (4 days/ 8 hours per day) they were not purged. They were also exposed to air for their vibration test in building 7 for 3 days (12 hours) at a level not to exceed 50ppm. They also underwent Thermal Vacuum testing in building 2 but the He environment was negligible during the test which had a duration of 1 week (5 days, 24 hours/day). However at the beginning and end of the test the ECs were exposed for 8 hours during test set up and checkout.

The delivery dates to building 10 for ACD integration were:

4R	3/1 – 3/15
1L & 3L	4/7
4L	4/20

2L 5/3
 2R 5/10
 1R & 3R 5/13
 4R 5/18

In summary during this period from February through May 2005, the ECs were exposed as the following table shows:

Chassis	PMT Buildup	Building 2/7 I&T	Building 10 I&T	Building 7 Purged (5ppm)	Bldg 10 purged (3ppm)	Bldg 10 unpurged (15ppm)	Period Sum at delivery to I& T bldg 10:
4R	F: 552hr M: 406.5 A: 720hr M: 296.5hr 1975hrs @ 3ppm = 5925ppm-hr	F: 48hr M: 0 A: 0 M: 48 96hr @ 40ppm = 3840ppm-hr	F: 36hr M: 0 A: 0 M: 36 72hr @ 50ppm = 3600ppm-hr	F: 36hr M: 0 A: 0 M: 36 72hr @ 5ppm = 360ppm-hr	F: 0 M: 337.5hr A: 0 M: 0 337.5hr @ 3ppm = 1012.5ppm-hr	F: 0 M: 0 A: 0 M: 0 0hr	14737.5ppm-hr to 0830 on 5/18
1L & 3L	F: 672hr M: 624hr A: 152.5 1448.5hr @ 3ppm = 4345.5ppm-hr	F: 0 M: 48hr A: 0 48hr @ 40ppm = 1920ppm-hr	F: 0 M: 36hr A: 0 36hr @ 50ppm = 1800ppm-hr	F: 0 M: 36hr A: 0 36hr @ 5ppm = 180ppm-hr	n/a	n/a	8245.5ppm-hr to 0830 on 4/7
4L	F: 672hr M: 774hr A: 344.5 1790.5hr @ 3ppm = 5371.5ppm-hr	F: 0 M: 0 A: 48hr 48hr @ 40ppm = 1920ppm-hr	F: 0 M: 0 A: 36hr 36hr @ 50ppm = 1800ppm-hr	F: 0 M: 0 A: 36hr 36hr @ 5ppm = 180ppm-hr	n/a	n/a	9271.5ppm-hr to 0830 on 4/20
2L	F: 672hr M: 774hr A: 600hr M: 56.5hr 2102.5hr @	F: 0 M: 0 A: 48hr M: 0 48hr @	F: 0 M: 0 A: 36hr M: 0 36hr @	F: 0 M: 0 A: 36hr M: 0 36hr @	n/a	n/a	10207.5ppm-hr to 0830 on 5/3

	3ppm = 6307.5ppm-hr	40ppm = 1920ppm-hr	50ppm = 1800ppm- hr	5ppm = 180ppm-hr			
2R	F: 672hr M: 774hr A: 600hr M: 224.5hr 2270.5hr @ 3ppm = 6811.5ppm-hr	F: 0 M:0 A: 48hr M: 48hr @ 40ppm = 1920ppm-hr	F: 0 M: 0 A: A: 36hr M: 36hr @ 50ppm = 1800ppm- hr	F: 0 M: 0 A: 36hr M: 36hr @ 5ppm = 180ppm-hr	n/a	n/a	10711.5ppm -hr to 0830 on 5/10
1R & 3R	F: 672hr M: 774hr A: 720hr M: 176.5hr 2342.5hr @ 3ppm = 7027.5ppm-hr	F: 0 M: 0 A: 0 M: 48hr 48hr @ 40ppm = 1920ppm-hr	F: 0 M: 0 A: 0 M: A: 36hr 36hr @ 50ppm = 1800ppm- hr	F: 0 M: 0 A: 0 M: : 36hr 36hr @ 5ppm = 180ppm-hr	n/a	n/a	10927.5ppm -hr to 0830 on 5/13

Note: F = February, M = March or May, A = April

2.4 Integration and test at ACD level:

After the Electronic Chassis were built up and environmentally tested, they were delivered to the big top tent in building 10. There they were mechanically integrated onto the ACD structure, connected to the clear fiber cables and extensively tested. The ECs were exposed to the building 10 environment only when work was being directly performed on the ACD, otherwise they along with the ACD were in a lumiloy tent and purged with gaseous nitrogen (GN2). This GN2 was measured at <0.5ppm with the Helium denoted in the Helium Mitigation Report (ACD-RPT-000314). The helium levels were monitored and recorded outside the purge tent at all times. Whenever the helium levels reached 50ppm, the high bay door to building between 7 and 10 was closed, and we followed the requirements of the Helium Monitor and Control Plan. As a guide we attempted to minimize the He exposure to less than the Plan and utilized an email from Bob Hartman saying we want to keep total exposure < 60,000PPM-Hours during the I&T period. Initially this would be, for the I&T period from 1 Feb to 31 May, an average of 500-PPM-Hours/day

We are assuming the Helium exposure to the EC/ACD while bagged was 5ppm, as we did not have the monitor inside the purge tent. Exposure levels when unbagged were actual levels recorded by the Helium monitoring system. The reference to the data is provided in appendix 1.

Delivery to SLAC:

The ACD was delivered to the Stanford Linear Accelerator Center Saturday morning August 13, 2005. The ACD had been bagged and purged at 15SCFH with manufactured air for the trip. The He content of the manufactured air as measured by the Inficon detector was < 2ppm,

however as the bottler were depleted by the time of arrival at SLAC, it was assumed for calculation purposes that the He content of the air was 5ppm. The ACD underwent testing by the GSFC ACD I&T group for several days to assure there was no degradation to the ACD due to shipping. This testing was concluded on August 16, 2005. While at SLAC the Inficon He detector was turned on and monitored. The readings were in the range of normal atmosphere, ie. 5 ppm. The ACD was not bagged nor purged during the testing at SLAC however it was maintained in the SLAC/ ACD clean tent.

3 Calculations and Results

The total Helium exposure is provided below for each Electronic Chassis associated with each phase of its development, integration and test.

Chassis	Manufacture	PMT buildup in building 2	Building 2/7 EC I&T	Bldg 10 ACD I&T	Total cumulated He exposure Manufacture to SLAC delivery 2400 on 8/16/2005
4R	32760ppm-hrs	44792ppm-hrs	14737.5ppm-hr to 0830 on 5/18	16063	108353 ppm-hr
1L & 3L	32760ppm-hrs	44792ppm-hrs	8245.5ppm-hr to 0830 on 4/7	25707.5	111505 ppm-hr
4L	32760ppm-hrs	44792ppm-hrs	9271.5ppm-hr to 0830 on 4/20	22305.3	109129 ppm-hr
2L	32760ppm-hrs	44792ppm-hrs	10207.5ppm-hr to 0830 on 5/3	19321.8	107081 ppm-hr
2R	32760ppm-hrs	44792ppm-hrs	10711.5ppm-hr to 0830 on 5/10	17670	105934 ppm-hr
1R & 3R	32760ppm-hrs	44792ppm-hrs	10927.5ppm-hr to 0830 on 5/13	16891.9	105371 ppm-hr

4 Conclusions

The PMTs have been in existence (on average) for 2.877 years, ie from Oct.1, 2002 to Aug 16, 2005. At ambient conditions this would have amounted to 126,000 ppm-hr cumulated exposure. The actual exposure to the ACD PMTs was less (at worst case 111,505 ppm-hr), even considering the He rich environment in buildings 2, 7 and 10 at the GSFC.

Appendix 1:

Recorded He data from the Inficon detector is found in the ACD Library in the following documents:

Document Name	Filename:
ACD-DATA-000400	helium1mar05.txt
ACD-DATA-000401	helium2mar05.txt
ACD-DATA-000402	helium3mar05.txt
ACD-DATA-000403	helium4mar05.txt
ACD-DATA-000404	helium08mar05.txt
ACD-DATA-000405	helium10mar05cont.txt
ACD-DATA-000406	helium28mar05.txt
ACD-DATA-000407	helium05apr05.txt
ACD-DATA-000408	helium11apr05.txt
ACD-DATA-000409	helium19apr05.txt
ACD-DATA-000410	helium21apr05.txt
ACD-DATA-000411	helium26apr05.txt
ACD-DATA-000412	helium3may05.txt
ACD-DATA-000413	helium16may05.txt
ACD-DATA-000414	helium23may05.txt
ACD-DATA-000415	helium25may05.txt
ACD-DATA-000416	helium31may05.txt
ACD-DATA-000417	helium6june05.txt
ACD-DATA-000418	helium14june05.txt
ACD-DATA-000419	helium20june05.txt
ACD-DATA-000420	helium27jun05.txt
ACD-DATA-000421	helium05july05.txt
ACD-DATA-000422	helium7july05.txt
ACD-DATA-000423	helium11july05A.txt

ACD-DATA-000424	helium18july05a.txt
ACD-DATA-000425	helium20july05.txt