GLAST LAT SUBSYSTEM TECHNICAL DOCUMENT	Document # LAT-TD-01168-D1	Date Effective Draft 11/26/02
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	Subsystem/Office Anticoincidence Detector Subsystem	
Document Title High-Rate Test for ACD Phototubes		

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT)
High-Rate Test for ACD Phototubes

DRAFT

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes

1. Purpose

This study reports on the performance of ACD phototubes with the flight-design resistor network under high-particle-rate conditions. The performance exceeds the requirement.

2. Definitions and Acronyms

ACD	The LAT Anti-Coincidence Detector Subsystem
ADC	Analog-to-Digital Converter
AEM	ACD Electronics Module
ASIC	Application Specific Integrated Circuits
BEA	Base Electronics Assembly
CAL	The LAT Calorimeter Subsystem
DAQ	Data Acquisition
EGSE	Electrical Ground Support Equipment
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
FM	Flight Module
FMEA	Failure Mode Effect Analysis
FREE	Front End Electronics
GAFE	GLAST ACD Front End – Analog ASIC
GARC	GLAST ACD Readout Controller – Digital ASIC
GEVS	General Environmental Verification Specification
GLAST	Gamma-ray Large Area Space Telescope
HVBS	High Voltage Bias Supply
ICD	Interface Control Document
IDT	Instrument Development Team
I&T	Integration and Test
IRD	Interface Requirements Document
JSC	Johnson Space Center
LAT	Large Area Telescope
MGSE	Mechanical Ground Support Equipment
MLI	Multi-Layer Insulation
MPLS	Multi-purpose Lift Sling
PCB	Printed Circuit Board

PDR	Preliminary Design Review
PMT	Photomultiplier Tube
PVM	Performance Verification Matrix
QA	Quality Assurance
SCL	Spacecraft Command Language
SEL	Single Event Latch-up
SEU	Single Event Upset
SLAC	Stanford Linear Accelorator Center
TACK	Trigger Acknowledge
TDA	Tile Detector Assembly
T&DF	Trigger and Data Flow Subsystem (LAT)
TBD	To Be Determined
TBR	To Be Resolved
TSA	Tile Shell Assembly
TSS	Thermal Synthesizer System
TKR	The LAT Tracker Subsystem
VME	Versa Module Eurocard
WBS	Work Breakdown Structure
WOA	Work Order Authorization

3. Applicable Documents

Documents relevant to the ACD Photomultiplier Quality Plan include the following.

1. LAT-SS-00016, LAT ACD Subsystem Requirements – Level III Specification
2. LAT-SS-00352, LAT ACD Electronics Requirements – Level IV Specification
3. LAT-SS-00437, LAT ACD Mechanical Requirements – Level IV Specification
4. LAT-MD-00039-01, LAT Performance Assurance Implementation Plan (PAIP)
5. LAT-MD-00099-002, LAT EEE Parts Program Control Plan
6. LAT-SS-00107-1, LAT Mechanical Parts Plan
7. LAT-MD-00078-01, LAT System Safety Program Plan (SSPP)
8. ACD-QA-8001, ACD Quality Plan
9. LAT-TD-00760-D1 Selection of ACD Photomultiplier Tube

10. LAT-DS-00739-1 Specifications for ACD Photomultiplier Tubes
11. LAT-TD-00438-D2 LAT ACD Light Collection/Optical Performance Tests
12. LAT-TD-00720-D1 ACD Phototube Helium Sensitivity
13. LAT-DS-00740-1 Temperature Characteristics of ACD Photomultiplier Tubes
14. Response to RFQ 5-09742, Hamamatsu Photomultiplier Tube Proposal

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ACD\Flight\Tests\PMT_flight\PMT_rate.doc

4. How the ACD PMT low-current divider handles high particle rates

ACD PMT voltage divider (resistor network) is designed to minimize the power consumption through the HV line. The maximum estimated single-charged particle rate on the orbit is 1-2 kHz, ACD Level III requirements require the maximum rate of 3 KHz to be handled by ACD. Assuming 1 pC per pulse and rate of 3 KHz, the average anode PMT current is ~3 nA. The divider has to provide at least factor of 100 higher current. Our divider is designed to provide ~ 1 mkA at 800 V.

How the PMT output changes with the particle rate is the subject of these notes. The signals were imitated by LED placed at the PMT face, with the signals from PMT to look similar to that produced by real particles – here cosmic muons. The phototube was one of the qualification Hamamatsu 4443 tubes with a flight-like resistor network.

Rate_rate.ps

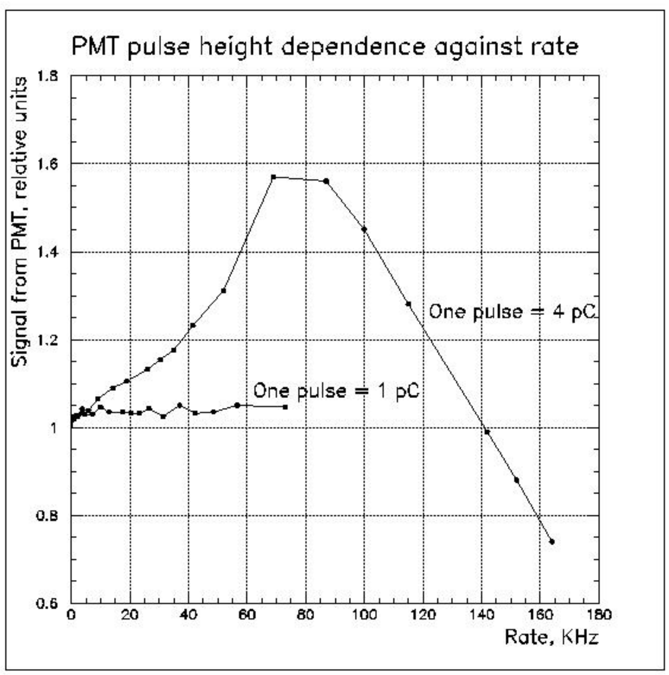

Fig.1. PMT signal change vs. the rate. Measured for two values of signal – 1 pC and 4 pC. The real signals from ACD tile is 0.6-1 pC.

Rate_current_1.ps

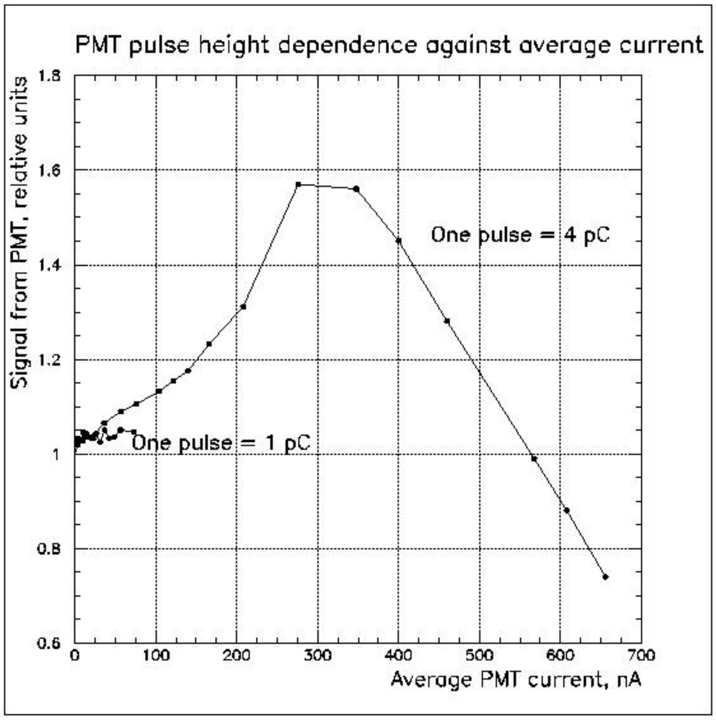

Fig.2. The same data as in Fig.1, but plotted against the average PMT anode current

Rate-current_2.ps

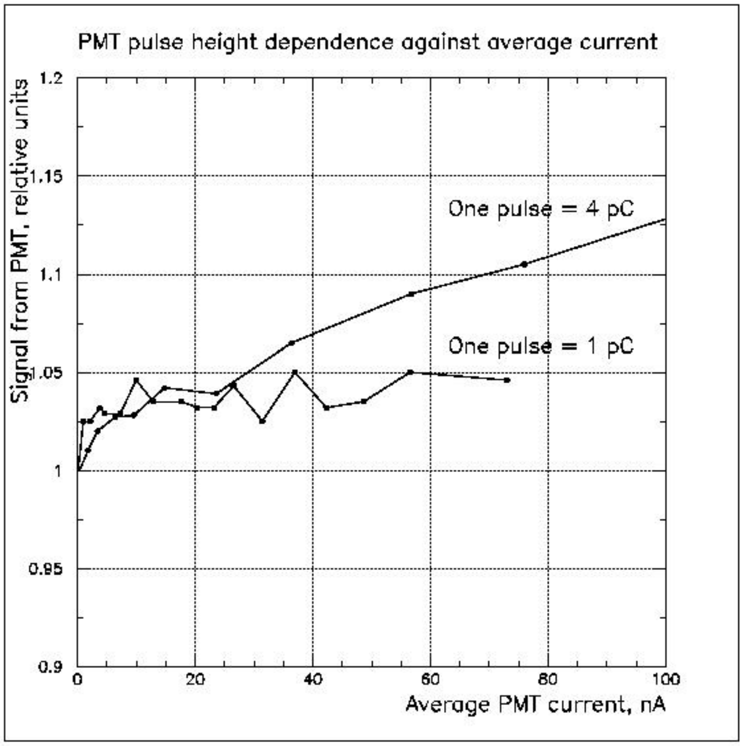

Fig.3. same as Fig.2, but expanded X-axis

Conclusion. Fig.1 shows that up to several tens of KHz there will no visible change of PMT performance for the signals of ~ 1pC. For larger signals we see the effect of signals increase, and after that decrease (saturation). Fig. 2 and 3 (expanded view) show the same results but plotted against the average PMT anode current. It can concluded that our PMT divider performs properly in required rate/anode current range