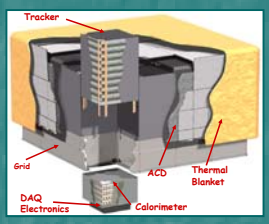
Environmental test activity on the flight modules of the GLAST LAT Tracker

M.Brigida, A.Caliandro, C.Favuzzi, P.Fusco, F.Gargano, N.Giglietto, F.Giordano, F.Loparco, B.Marangelli, M.N.Mazziotta, N.Mirizzi, S.Rainò, P.Spinelli

for the GLAST Collaboration

INFN-Bari & Dipartimento Interateneo di Fisica, Università di Bari

GLAST, the Gamma-Ray Large Area Space Telescope, scheduled for launch in September 2007, is composed by two main instruments: the Large Area Telescope (LAT) and the Gamma Ray Burst Monitor (GBM). The LAT is a gamma-ray telescope consisting of a silicon micro-strip Tracker (TKR) followed by a segmented CsI calorimeter, to reconstruct γ-rays direction and energy. The tracker and the calorimeter are covered by a segmented scintillator anticoincidence system to reject charged particle background.
The Tracker of the Large Area Telescope is based on the conversion of gamma-rays into electron-positron pairs and is arranged in a 4x4 modular array of towers. Each tower corresponds to a stack of 19 carbon fiber trays supporting the silicon detectors and the electronics.



The GLAST LAT Tracker Status in October 2005

All the 16 flight towers have been built, subjected to environmental testing and delivered to SLAC where the Tracker is being assembled. The Tracker assembly status at the 15th October 2005 is shown in the picture on the right: 14 out of 16 towers have been assembled in the flight grid structure.

Status of the TKR assembly at SLAC in October 2005.

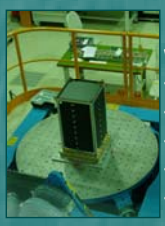
Environmental Test Flow performed on the 16 flight LAT TKR towers

The INFN-Bari group is responsible for the performance of the environmental testing of the LAT Tracker towers. The dynamic and thermal vacuum tests have been performed in the Alenia-Alcatel Assembly Integration and Test facility in Rome. The environmental testing of the flight TKR towers has been completed in October 2005. The test sequence performed is the following:

Tower Assembly → **Functional test** → **Vibration test** → **Functional test** → **Thermal Vacuum test** → **Functional test**

Vibration Tests

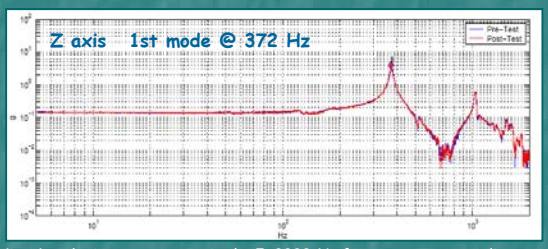
Vibration tests are performed to verify that the flight hardware will survive to the environments imposed during the launch. The dynamic environments are simulated by sinusoidal vibration and random vibration. The response under dynamic excitation is studied both along the thrust axis and lateral directions.



Instrumentation: Shakers LDS V984 and V994

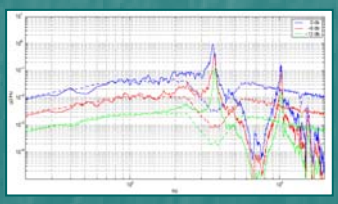
Vibration Test Sequence (Z, X, Y axis):

- Pre Test Low Level Signature Sweep 5 ÷ 2000 Hz
- Sine Test at low frequency 5 ÷ 50 Hz
- Low Level Signature Sweep 5 ÷ 2000 Hz
- Random Vibration 20 ÷ 2000 Hz
- Post Test Low Level Signature Sweep 5 ÷ 2000 Hz



Low Level Signature Sweep in the **5-2000 Hz** frequency range studies the tower normal modes and compares the pre and post test results.

Random Vibration Test
20 ÷ 2000 Hz @ 6.8 g_{rms}



Summary plot of the vibration test results of all flight TKR towers: the pre and post normal modes frequencies and Q values are shown.

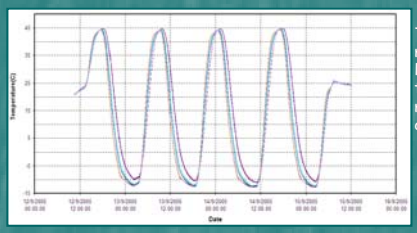
Thermal Vacuum Tests

Thermal vacuum tests on flight hardware are performed to demonstrate that the tower modules will get over the thermal gradients expected during the mission and that the functional capability of the hardware is not degraded by thermal transients.

Each TV test on a TKR tower consists of:

- 4 cycles
- -15°C ÷ +45°C
- 10^{-5} Torr

Functional tests are performed during transitions and at hot/cold plateaus to check the Si detectors performance as a function of temperature.

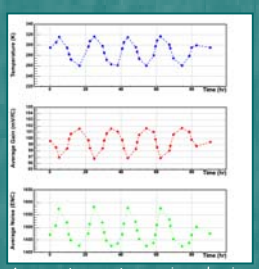


The temperature of the TKR towers is measured by means of thermocouples located on the external sidewalls, on top and on bottom trays as well as by means of the 16 thermistors located on the 8 tower cables.

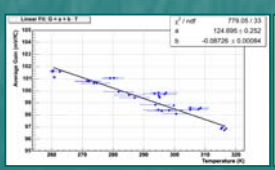
Thermistors' temperature profile as a function of time.

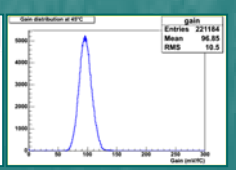
Functional Tests

The main scope of functional tests is to check the detector's performance before, during and after environmental tests. Comprehensive Performance Tests (CPT) include the verification of the front-end electronics and registers, the monitoring of noise and gain of Si strip detectors, the measurement of the number of disconnected channels for each layer, cosmic rays data acquisition. Some results of functional tests performed during TV cycles are shown.

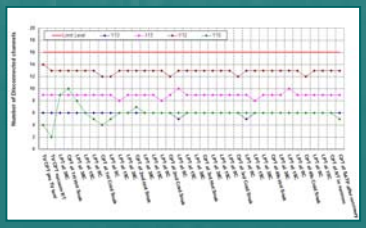


Average temperature, gain and noise measured for each functional test performed during the TV cycles of a TKR tower as a function of time.

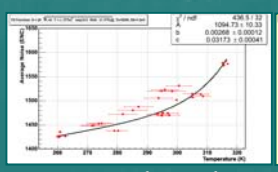


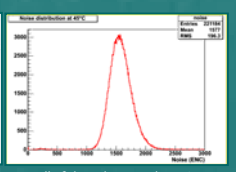


Average gain as a function of temperature (left) and gain distribution measured at 45°C (right)



Summary table of the number of disconnected channels of the layers monitored throughout a TV test. Only the layers having a number of disconnected channels greater than zero are shown.





Average noise as a function of temperature (left) and noise distribution measured at 45°C (right)