Gamma-ray Large Area Space Telescope

Mini-Tower test results

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**INFN Pisa**
for the TKR subsystem

GLAST International Collaboration Meeting
Accademia Nazionale dei Lincei
Roma 15-18 September 2003
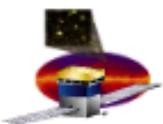
Motivations

• **First complete working prototype of flight-like hardware**

• **6 Si-layers – 5 trays – minimal configuration for L1T**

• **Test specific TKR hardware components and assembly strategies:**
  ▪ **flight Si-Ladders assembly and test**
  ▪ **mechanical Trays assembly**
  ▪ **MCMs (GTFE/GTRC tests), assembly onto trays, bonding**
  ▪ **flex cables**
  ▪ **tower sidewalls and assembly tools**

• **Test ELX/DAQ components**

• **Develop EGSE TKR test suite to test, qualify, operate a tower before delivery to I&T**

• **Develop documentation templates for efficient hands-off to I&T**

• **Support I&T during integration with CAL**

• **Data taking with CR and 17MeV VdG gamma**
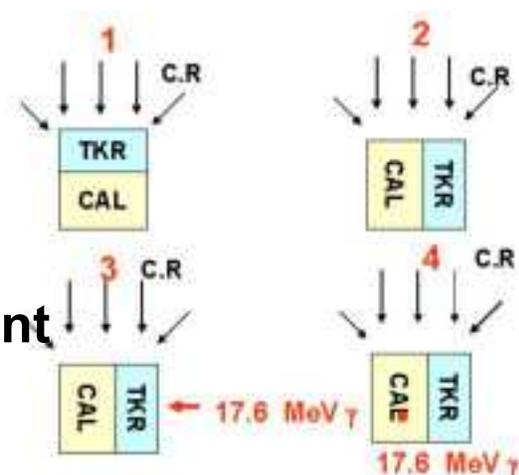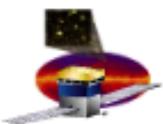
History
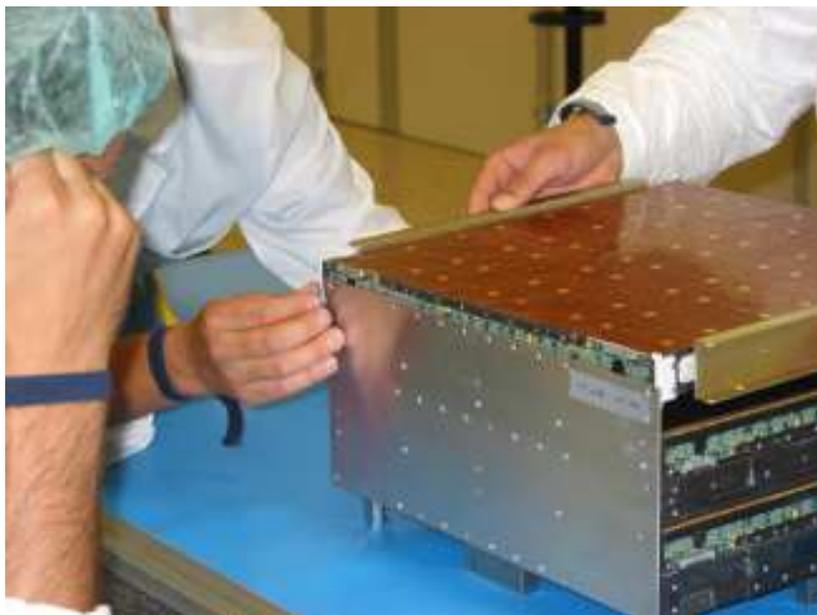
First version of minitower built last february/march

Main problems to be addressed

• **MCM:**

▪ **instabilities in the GTFE chip required fine-tuning of the low voltage**

▪ **bad pitch adapter (too small pads, not flat surface)**

▪ **bad bias HV insulation**

• **Flex cables and connectors to MCM**

Trays were shipped back to INFN and refurbished with new electronics:

• **MCM:**

▪ **new GTFE chip (G3)**

▪ **improved pitch adapter**

▪ **HV insulation improved with insertion of a Kapton layer**

• **New flex cables and connectors**
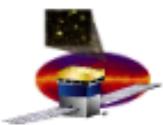
Preliminary tests on MCMs

Functional tests from UCSC repeated in Pisa on all bare MCMs

- ✓ GTFE /GTRC register testing
- ✓ Load all possible layer configurations and read few events
- ✓ Inject charge in all channels and look for noisy or dead channels (1 dead ch found)
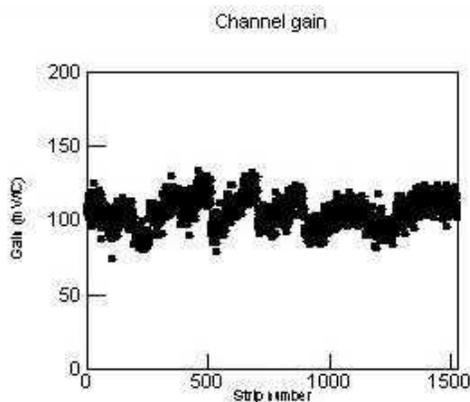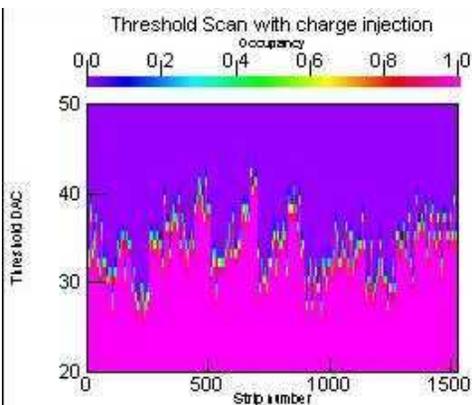
occupancy scan vs threshold

Gain is threshold giving 50% occupancy divided injected charge
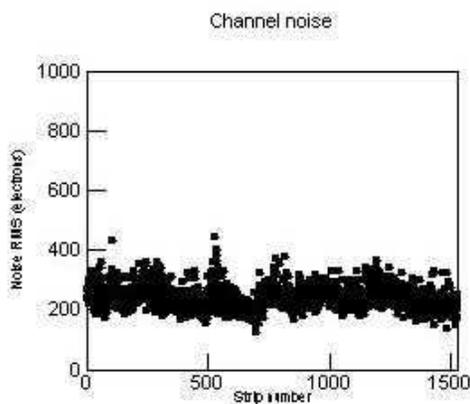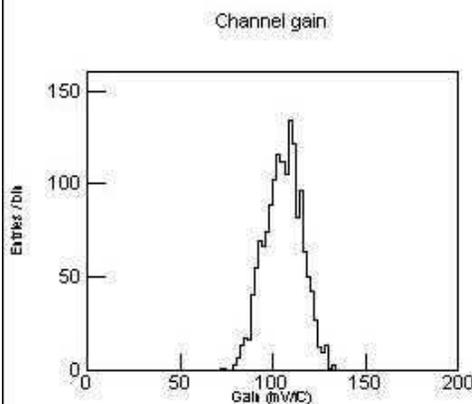
Noise is width of curve
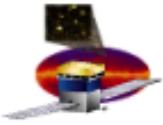
Gain and noise measurement with strips connected

gain does not change
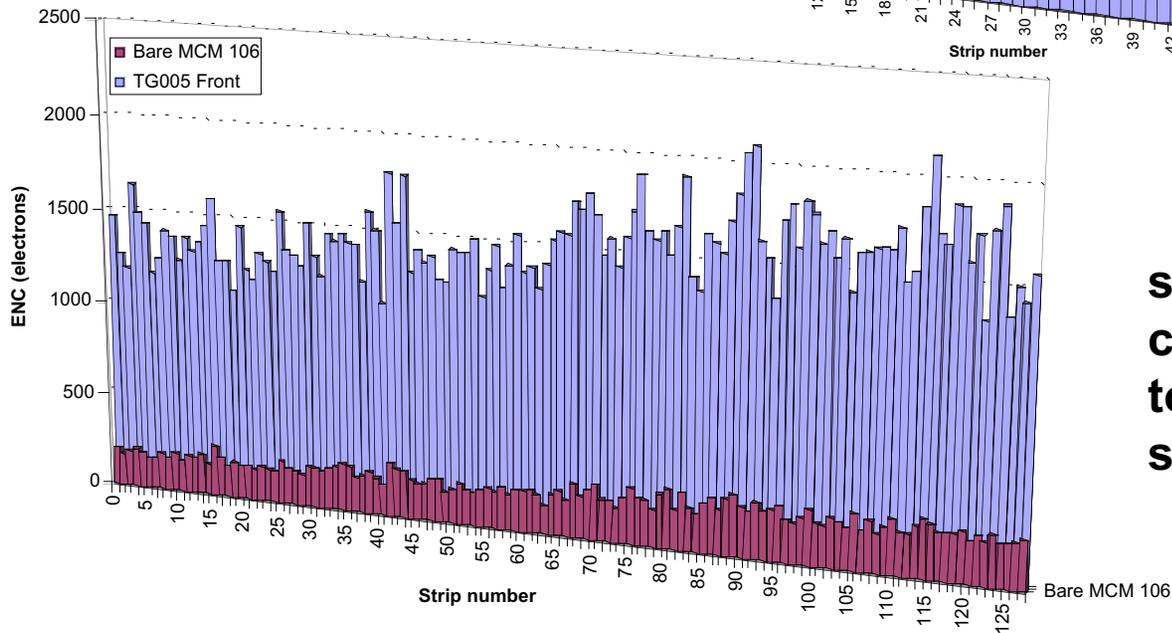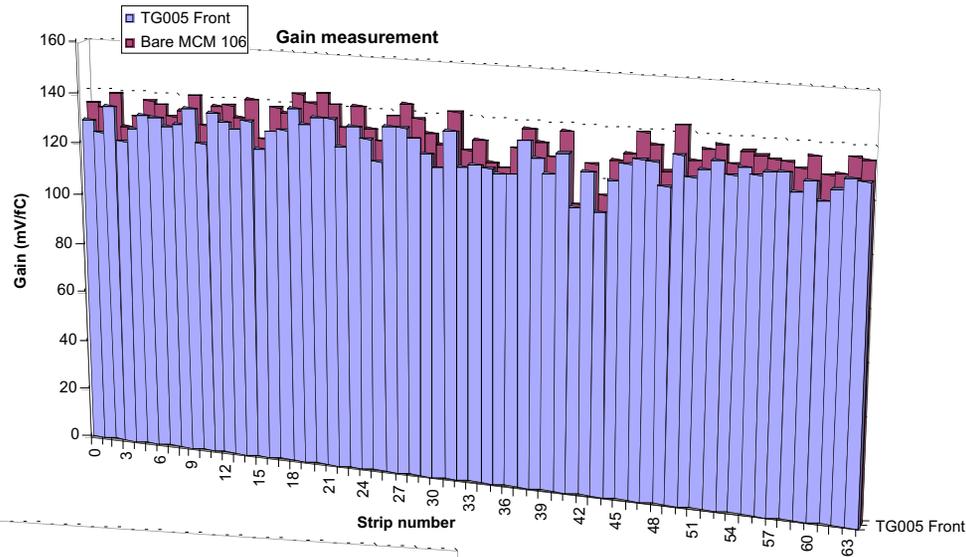
strip noise dominated by capacitive load – reliable tool for disconnected strip search
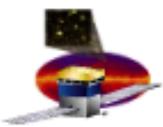
Still missing channels for pitch adapter problems

**left side**   **right side**

tracks shift
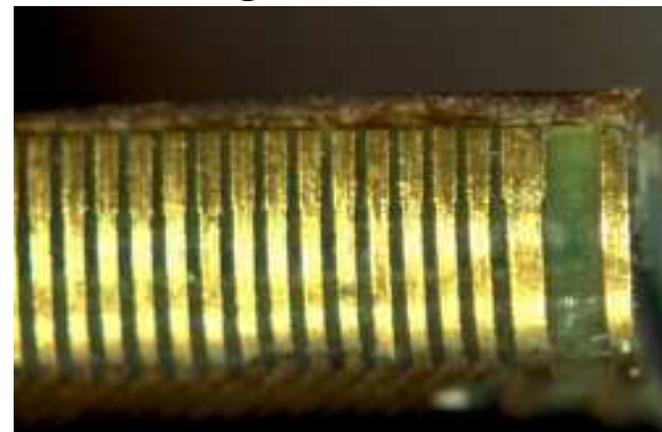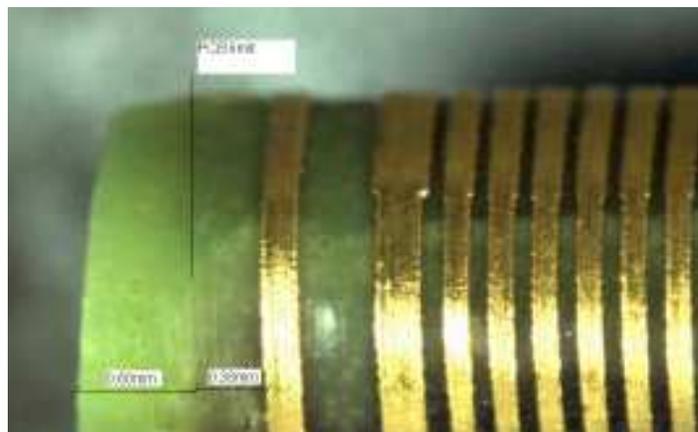
Bad gluing and planarity
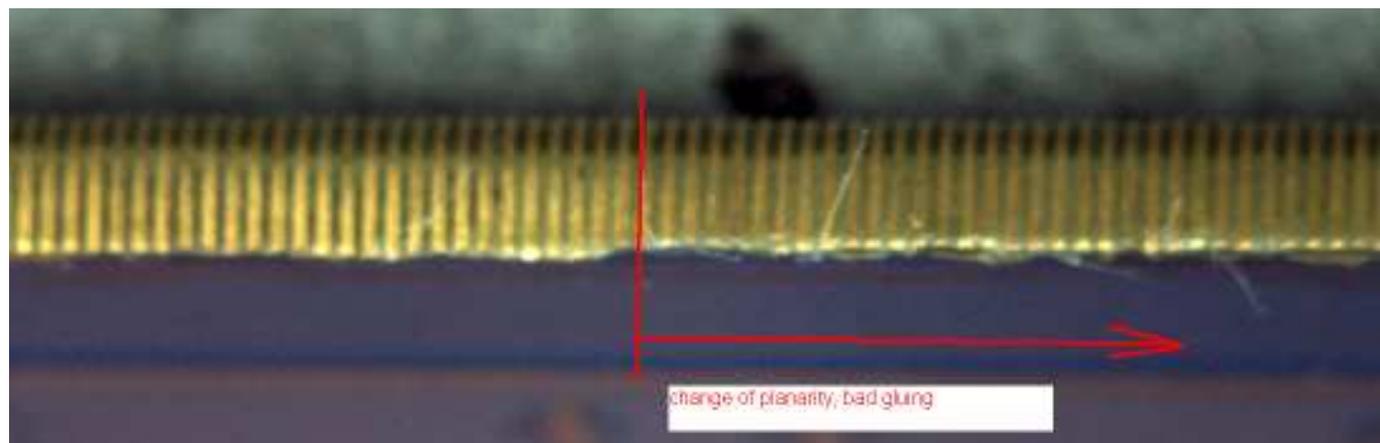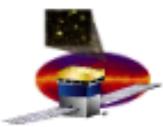
Still missing channels for pitch adapter problems

The HV, GND and some channels lines are wrapped around the PCB edge, preventing bonding
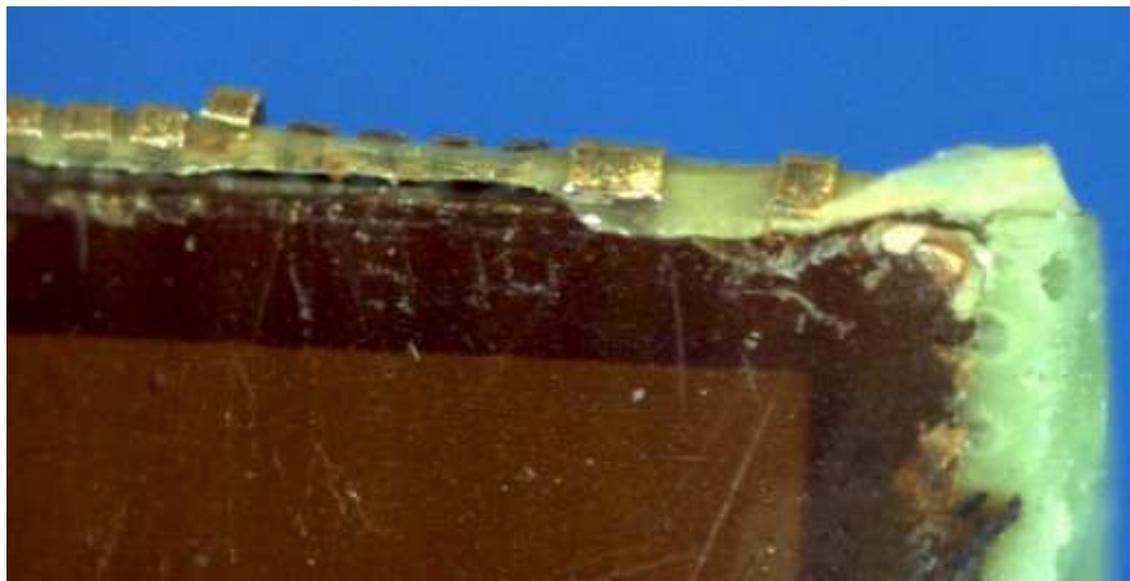
Wrong pitch

• **191 missing wire-bonds to strips**
• **had to give up redundancy of bias HV connections on border ladders**

TS01 MCM102 pitch error
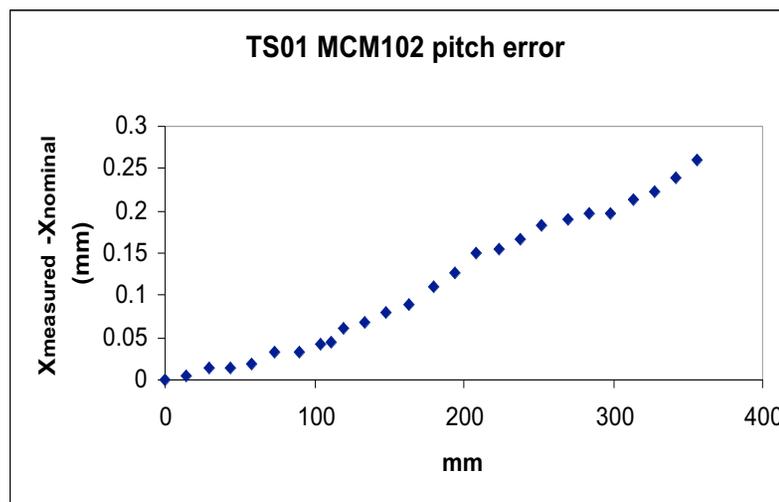
Minitower construction

Stacking the trays - sidewalls are reference and support

Complete the stack

Cabling each side after opening its sidewall
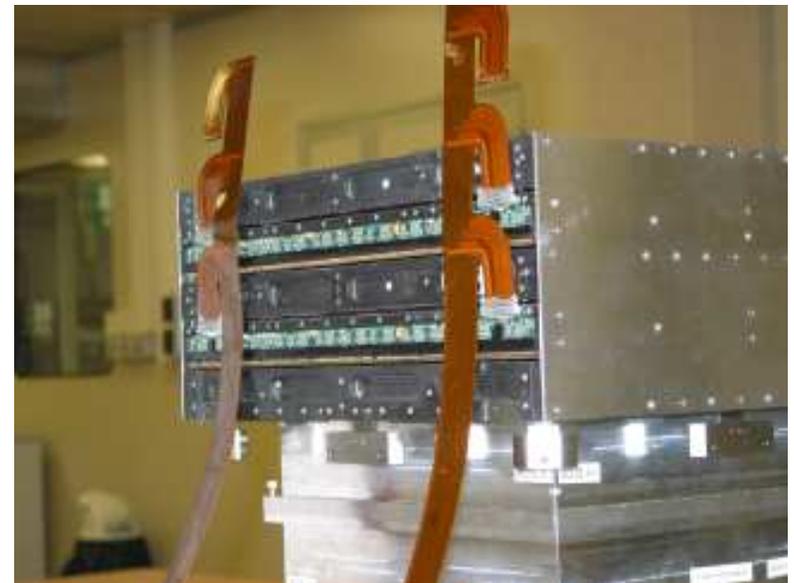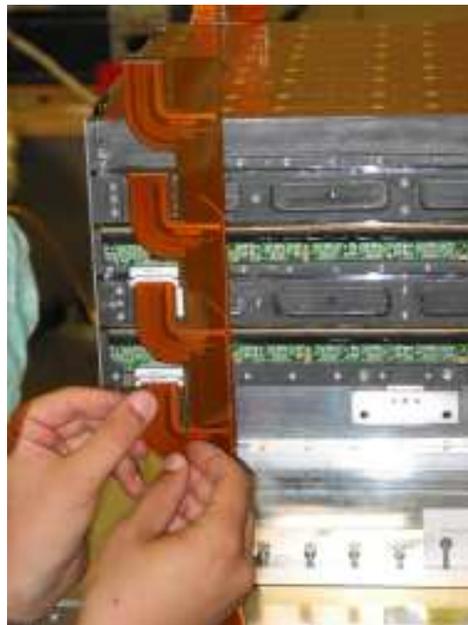
Complete open structure
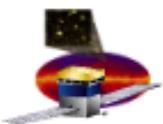
Just 2 hours later real cosmic events start flowing
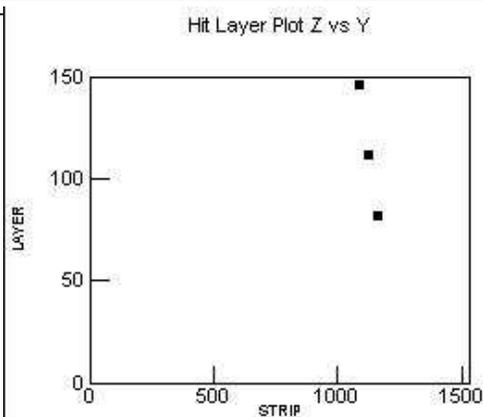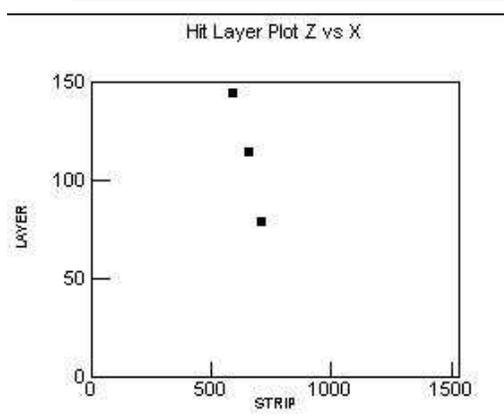
tracks
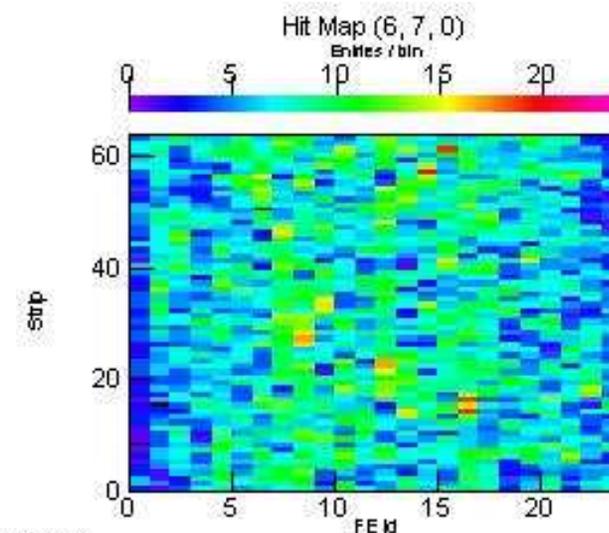
hitmaps
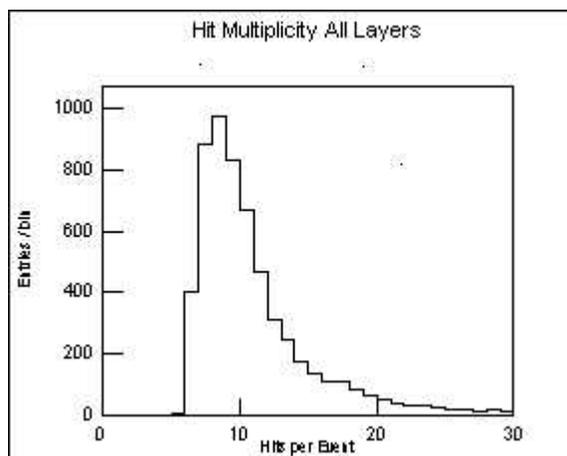
Hit multiplicity
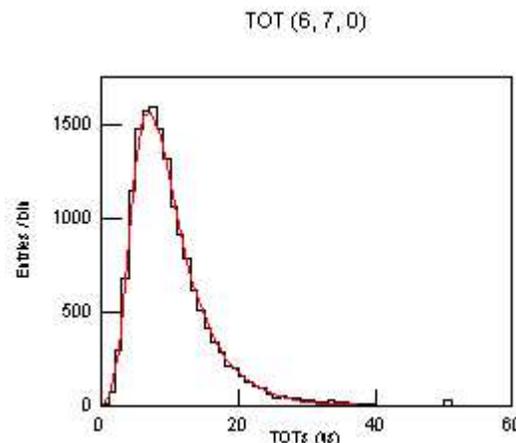
Time Over Threshold
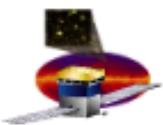
Noisy strip search   Strip Occupancy

low statistics
Occupancy < 10^{-4}
(LAT-SS-17-5 TKR Level III specs)
13 strips masked

22M evts
threshold DAC = 30

Noise occupancy for layer Y1

Noise occupancy for layer Y1 — Total entries = 1492

Noise occupancy for layer Y2

Noise occupancy for layer Y2 — Total entries = 1530
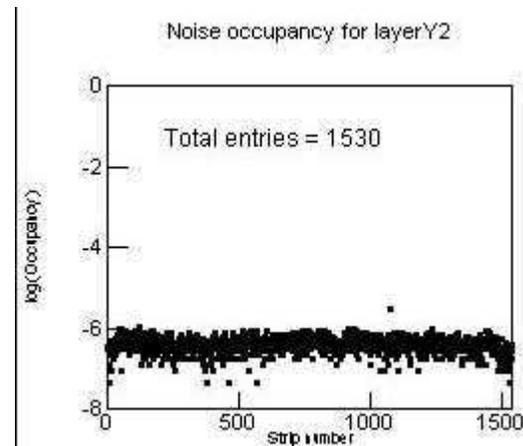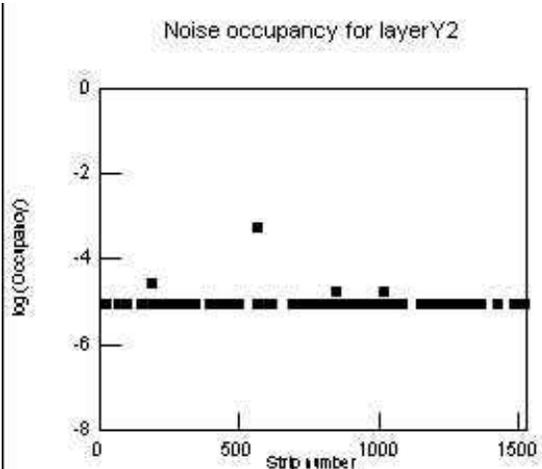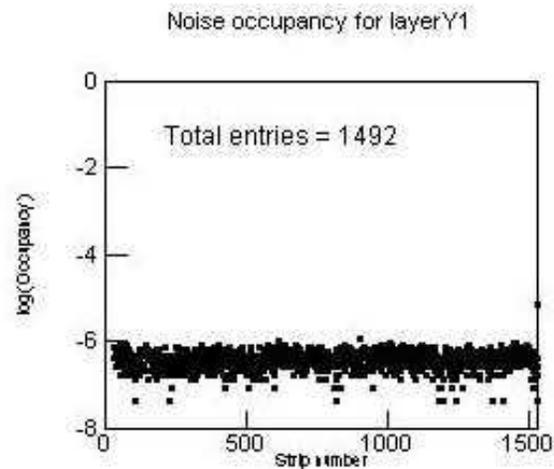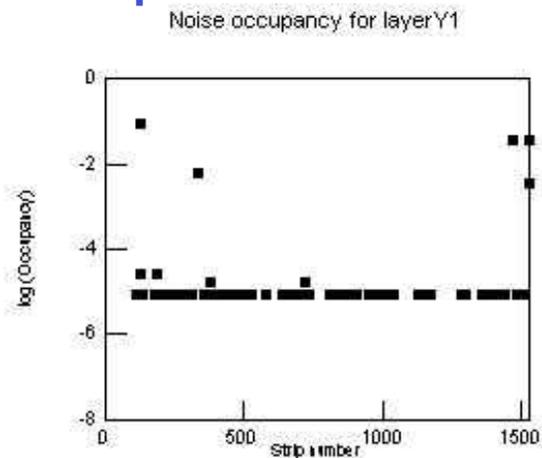
Layer noise occupancy

Residual occupancy dominated by CR

CR occupancy ☐= CR accidental rate

<ToT><cluster-size><CR trigger rate>

☐= 10☐s * 2 * 30Hz ☐ 6 10^{-4}

☐ 1/4 MIP

Residuals distribution for layerX1

Residuals distribution for layerX2
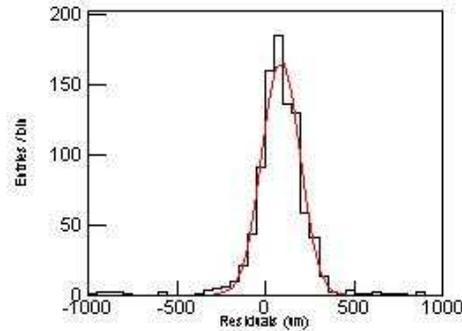
Residuals distribution for layerX3
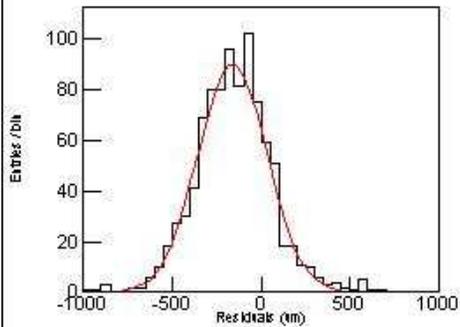
Residuals distribution for layerY1
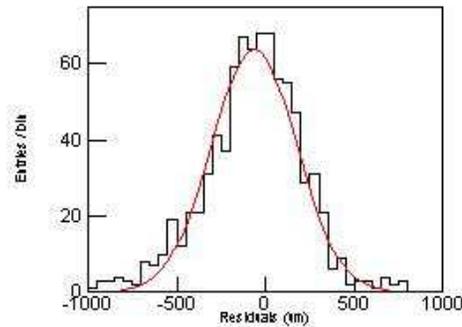
Residuals distribution for layerY2

Residuals distribution for layerY3

Spatial resolution

layer	Exp STDEV (um)	Meas STDEV (um)	Meas AVG (um)
X1	250	225	-185
X2	115	105	85
X3	210	195	-160
Y1	210	240	-64
Y2	115	135	35
Y3	250	275	-75

Alignment

Ratio	Expected value	Measured value
mean(X2)/mean(X1)	0.46	0.46
mean(X2)/mean(X3)	0.54	0.53
mean(Y2)/mean(Y1)	0.54	0.55
mean(Y2)/mean(Y3)	0.46	0.48

Detection efficiency

Detection efficiency for layerX1

Detection efficiency for layerX2

Detection efficiency for layerX3

60%   **1MIP**

Detection efficiency for layerY1

Detection efficiency for layerY2

Detection efficiency for layerY3

Full efficiency plateau up to ⬚ _ MIP

Occupancy @ beginning of efficiency plateau is already as low as 10 $^{-7}$ (mainly cosmics)

Noise occupancy for layerY2

Total entries = 1530
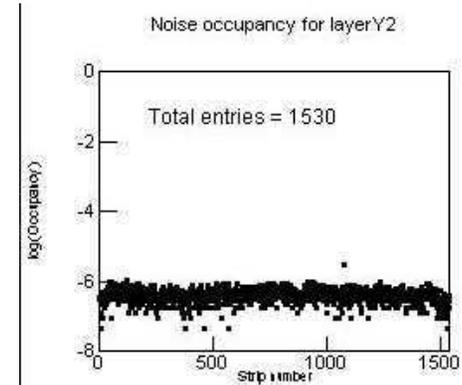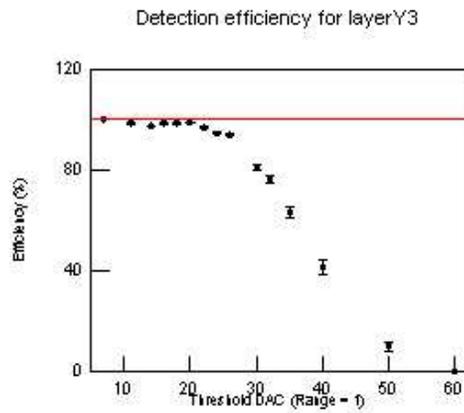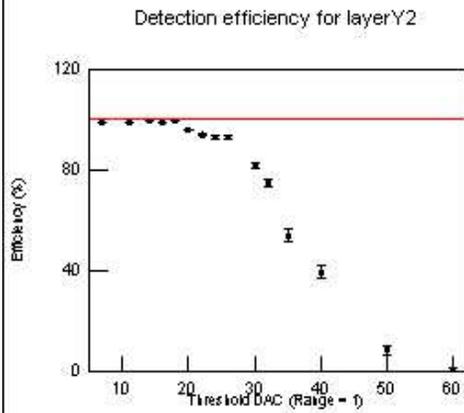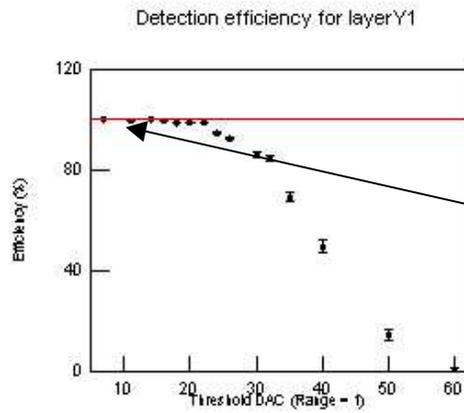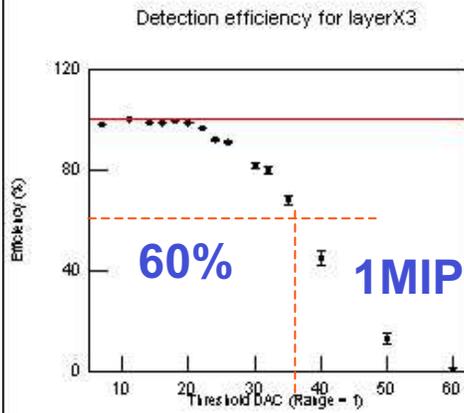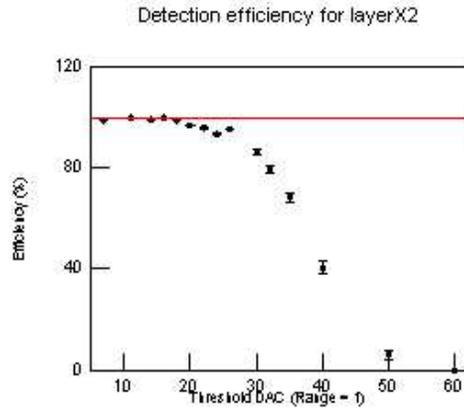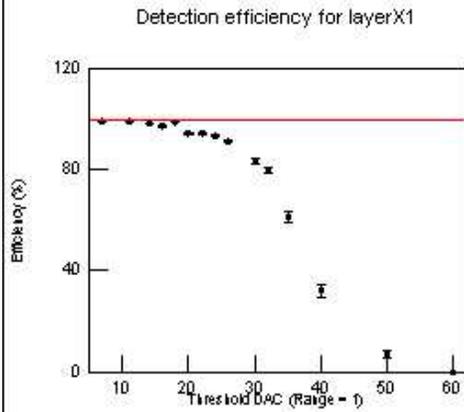
Occupancy @ DAC Threshold = 10

Light leak from the top

X3 top layer

Y1 internal layer

Charge injection

efficiency

Pulse height

Liveness plot for X3

Liveness plot for Y1

Detection efficiency for layerX3

Detection efficiency for layerY1

TOT (0, 1, 1)

TOT (4, 5, 1)

Sidewall could not be tightened for a thermistor out of place on a cable
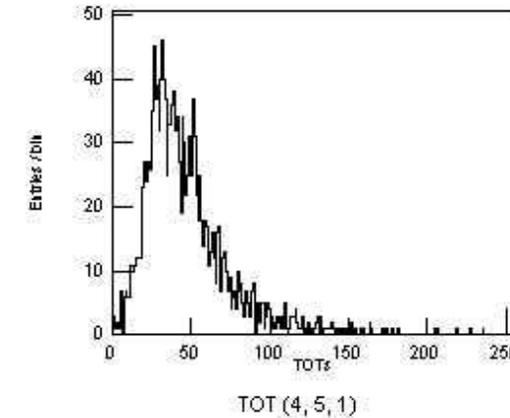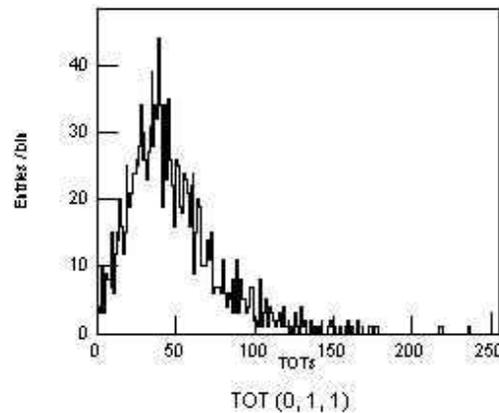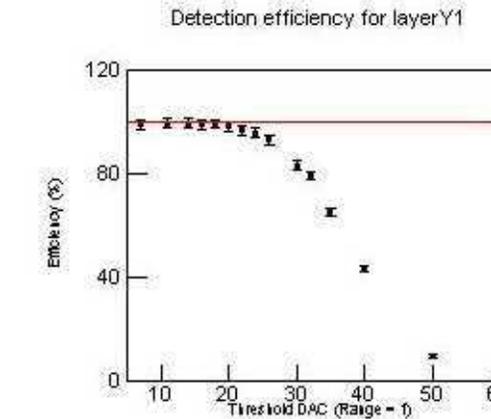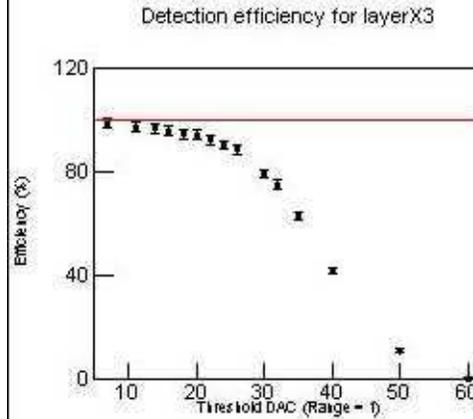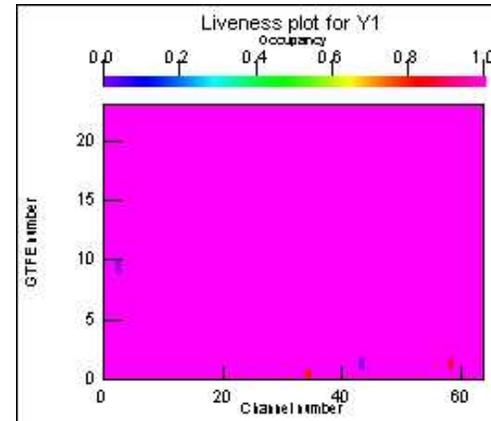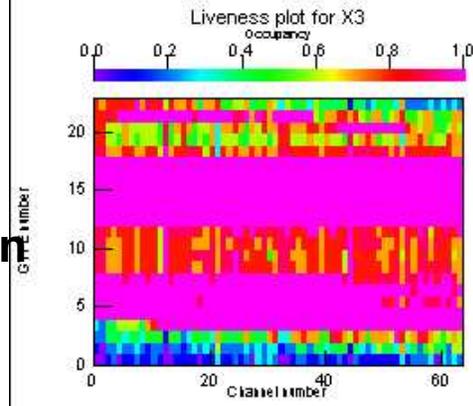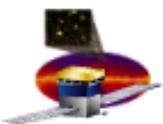
Light leak and leakage current
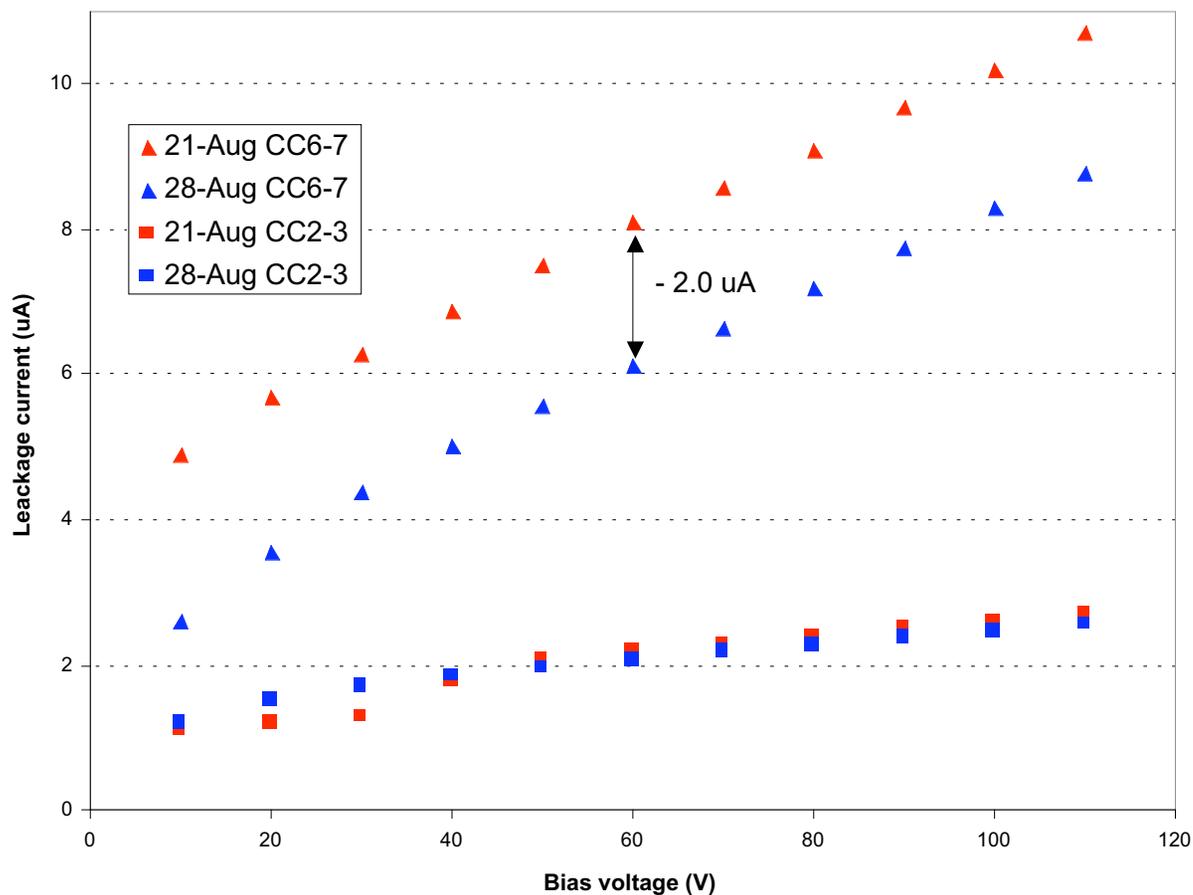
CC with top layer see non-negligible current decrease
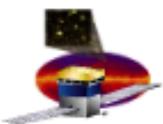
Bad HV connection on border ladder

Border HV line not bonded for pitch adapter and bias circuit inconsistency Inner line interrupted on MCM side Repaired with drop of coductive gloue

Cosmics - hitmaps

Threshold = 30 DAC, range 0, 13 strips masked. ~ 15000 events collected.

Y1 and Y2: "shadow„ of Y3.

X2: "ladder 4„ issue.

X3: 7 wire bonds removed.

Y3: 157 wire bonds missing (due to problems with pitch adapter).
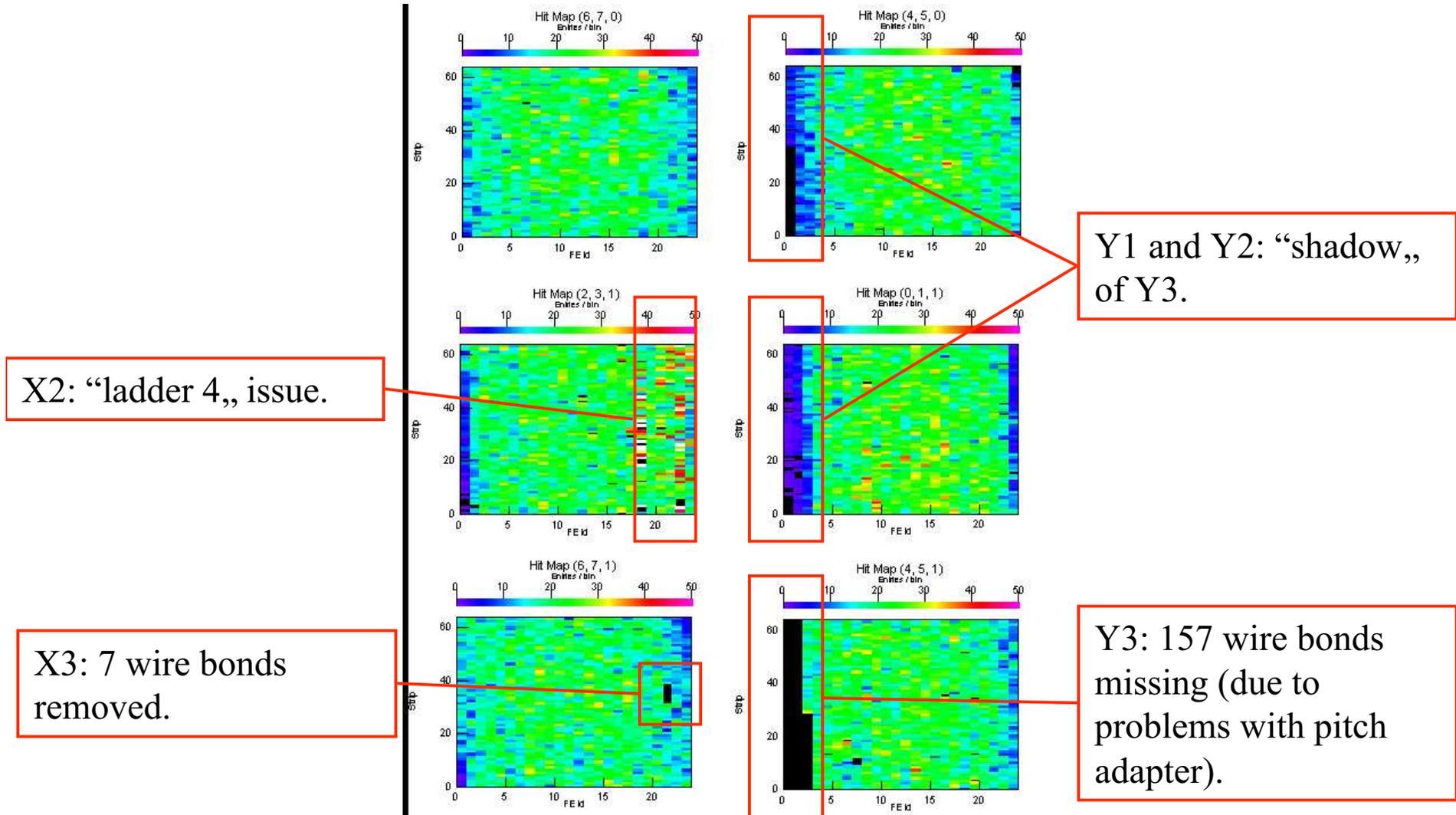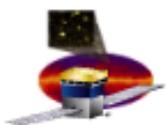
Real CR events from the integrated system
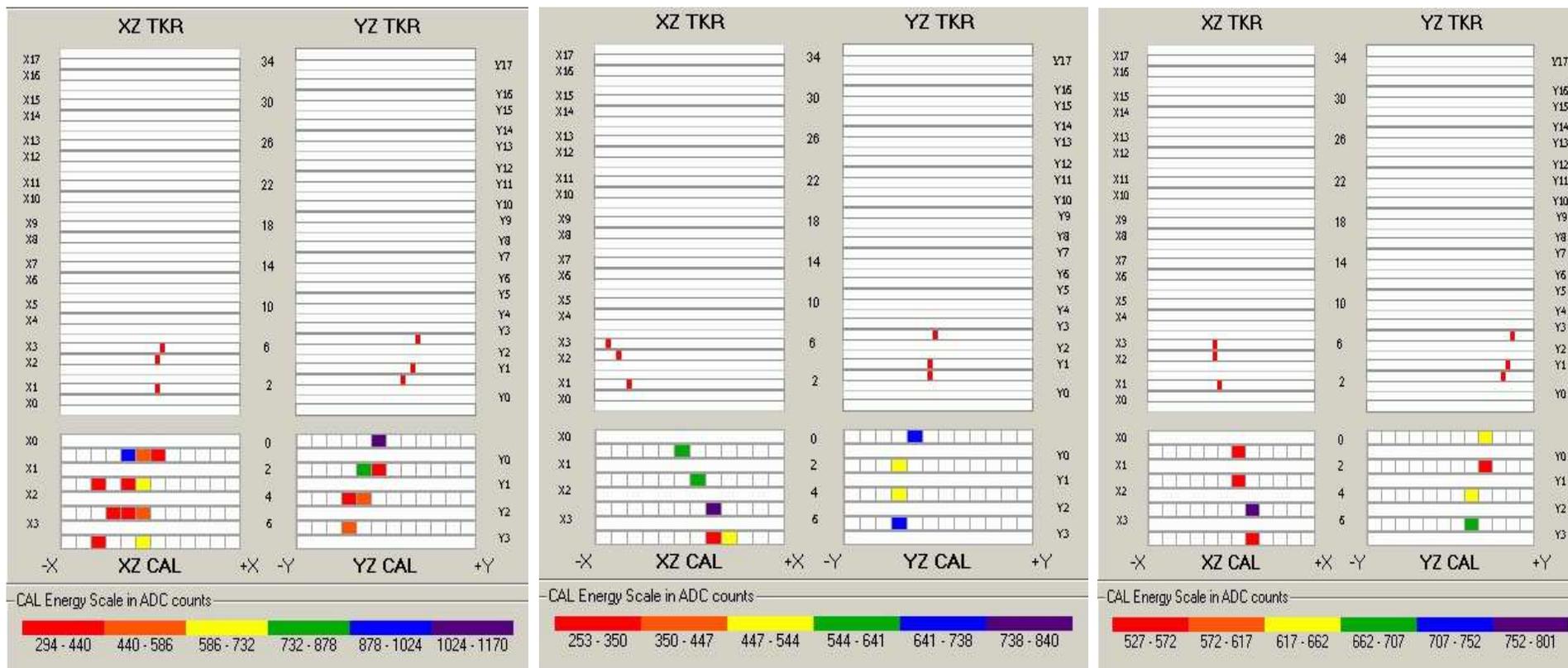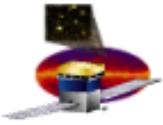
Conclusions

- **TKR Minitower refurbished in one week**
- **TKR Minitower completely characterized before delivery**
- **Met specs in terms of efficiency, occupancy**
- **TKR Minitower delivered to I&T according to schedule**
- **Integration with CAL at SLAC**
- **Still problems in mechanics of pitch-adapter (2% channels could not be bonded)**
- **Residual problems in pitch adapter alignment and MCMs bias lines + inconsistencies with older bias circuit induced bias problems in 2 border ladders**
- **Still read-out problems (time-out errors) in few events ($\sim$1/1000)**

find more at http://glastserver.pi.infn.it/glast

Noise occupancy for layerX1
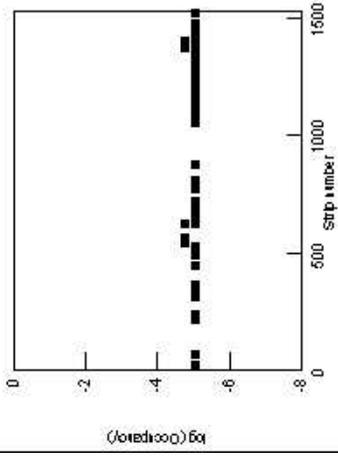
Noise occupancy for layerX2
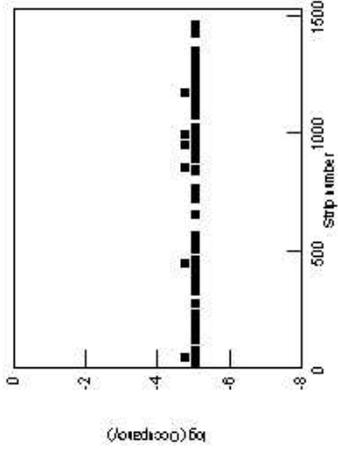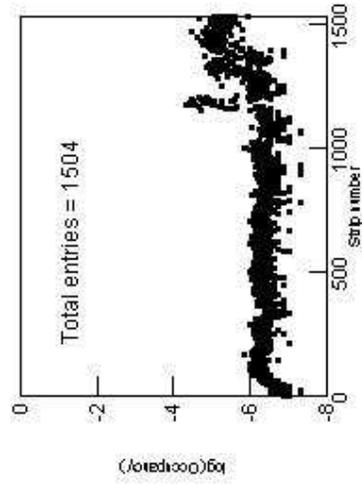
Noise occupancy for layerX3

Noise occupancy for layerY1

Noise occupancy for layerY2

Noise occupancy for layerY3

Noise occupancy for layerX1

Total entries = 1532

Noise occupancy for layerX2

Total entries = 1504

Noise occupancy for layerX3

Total entries = 1504

Noise occupancy for layerY1

Total entries = 1492

Noise occupancy for layerY2

Total entries = 1530

Noise occupancy for layerY3

Total entries = 1362