Mini-Tower test results

Luca Latronico
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

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
Minitower construction

Stacking the trays - sidewalls are reference and support

Cabling each side after opening its sidewall

Complete the stack

Complete open structure
Just 2 hours later real cosmic events start flowing.

Tracks:

- Hit Layer Plot Z vs X
- Hit Layer Plot Z vs Y

Hit multiplicity:

- Hit Multiplicity All Layers

Hit maps:

- Hit Map (6, 7, 0)
- Time Over Threshold

L. Latronico – TKR subsystem – INFN Pisa
Noisy strip search

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

Strip Occupancy

22M evts
threshold DAC = 30

Noise occupancy for layer Y1

Total entries = 1492

Noise occupancy for layer Y2

Total entries = 1530
Layer noise occupancy

Residual occupancy dominated by CR
CR occupancy $\approx$ CR accidental rate
$\langle ToT\rangle \langle\text{cluster-size}\rangle \langle\text{CR trigger rate}\rangle$
$\approx 10 \mu s \times 2 \times 30 \text{Hz} \approx 6 \times 10^{-4}$

$\approx 1/4 \text{ MIP}$
Spatial resolution

<table>
<thead>
<tr>
<th>layer</th>
<th>Exp STDEV (um)</th>
<th>Meas STDEV (um)</th>
<th>Meas AVG (um)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1</td>
<td>250</td>
<td>225</td>
<td>-185</td>
</tr>
<tr>
<td>X2</td>
<td>115</td>
<td>105</td>
<td>85</td>
</tr>
<tr>
<td>X3</td>
<td>210</td>
<td>195</td>
<td>-160</td>
</tr>
<tr>
<td>Y1</td>
<td>210</td>
<td>240</td>
<td>-64</td>
</tr>
<tr>
<td>Y2</td>
<td>115</td>
<td>135</td>
<td>35</td>
</tr>
<tr>
<td>Y3</td>
<td>250</td>
<td>275</td>
<td>-75</td>
</tr>
</tbody>
</table>

Alignment

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Expected value</th>
<th>Measured value</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean(X2)/mean(X1)</td>
<td>0.46</td>
<td>0.46</td>
</tr>
<tr>
<td>mean(X2)/mean(X3)</td>
<td>0.54</td>
<td>0.53</td>
</tr>
<tr>
<td>mean(Y2)/mean(Y1)</td>
<td>0.54</td>
<td>0.55</td>
</tr>
<tr>
<td>mean(Y2)/mean(Y3)</td>
<td>0.46</td>
<td>0.48</td>
</tr>
</tbody>
</table>
Detection efficiency

Full efficiency plateau up to ~ _ MIP

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

Occupancy @ DAC Threshold = 10
**Light leak from the top**

**X3 top layer**

**Charge injection efficiency**

**Pulse height**

**Y1 internal layer**

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
Border HV line not bonded for pitch adapter and bias circuit inconsistency. Inner line interrupted on MCM side. Repaired with drop of conductive glue.
Cosmics - hitmaps

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


X3: 7 wire bonds removed.

Y1 and Y2: “shadow,” of Y3.

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 (~1/1000)

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