Results from the Fermilab Source Test

Hardware/software contributions from Boston, Chicago, Fermilab, Maryland, & Princeton

Hardware set up by Terri S., Jim R., Sergey L., Anatoly R., Eric H., J. Mans

Data taking by Jim R., Sergey L., Anatoly R.
Jan 24: calibration mode, HPD HV off (bias on)
Gaussian pedestals observed in each cap of Ch. B
with a sigmas of 1.15 channels (2400 electrons)
Ch. A is under investigation

Jan 31: HPD at 7 KV
Gaussian pedestals with widths of 1.34
(2800 electrons)
1 mC radioactive source observed with scintillator
at signal of 0.086 (180 electrons)

Feb. 5:
Source signal is reproduced
Run 10261, pedestal Ch. B  all Caps

0.4 M events

18.089 ± 0.002
σ = 1.603 ± 0.002
(3300 electrons)

<table>
<thead>
<tr>
<th>NO.</th>
<th>NAME</th>
<th>VALUE</th>
<th>ERROR</th>
<th>SIZE</th>
<th>DERIVATIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Constant</td>
<td>0.11041E+06</td>
<td>200.12</td>
<td>279.31</td>
<td>−0.41532E−07</td>
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<tr>
<td>2</td>
<td>Mean</td>
<td>18.589</td>
<td>0.24187E−02</td>
<td>0.47027E−01</td>
<td>−16.952</td>
</tr>
<tr>
<td>3</td>
<td>Sigma</td>
<td>1.6027</td>
<td>0.16153E−02</td>
<td>0.40546E−02</td>
<td>−13.280</td>
</tr>
</tbody>
</table>

CHISQUARE = 0.5797E+02  NPFIT =  18
Run 10261, pedestal Ch. B  Cap ID = 0

0.1 M events

18.550 ± 0.004

σ = 1.324 ± 0.003

(2750 electrons)
Run 10261, pedestal Ch. B  Cap ID = 1

0.1 M events

17.812 ± 0.004
σ = 1.323 ± 0.003
(2750 electrons)

<table>
<thead>
<tr>
<th>EXT PARAMETER</th>
<th>STEP</th>
<th>FIRST</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO.  NAME  VALUE</td>
<td>ERROR</td>
<td>SIZE</td>
</tr>
<tr>
<td>1  Constant 33456.</td>
<td>124.61</td>
<td>84.639</td>
</tr>
<tr>
<td>2  Mean 18.312</td>
<td>0.39740E−02</td>
<td>0.46326E−01</td>
</tr>
<tr>
<td>3  Sigma 1.3234</td>
<td>0.28851E−02</td>
<td>0.33480E−02</td>
</tr>
<tr>
<td>CHISQUARE = 0.9096E+01</td>
<td>NPFIT = 16</td>
<td></td>
</tr>
</tbody>
</table>
Run 10261, pedestal Ch. B Cap ID = 2

0.1 M events

$19.220 \pm 0.004$

$\sigma = 1.319 \pm 0.003$

(2740 electrons)

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<tr>
<td>NO. NAME</td>
<td>VALUE</td>
<td>ERROR</td>
</tr>
<tr>
<td>1 Constant</td>
<td>33573.124.74 84.934</td>
<td>−0.60208E−05</td>
</tr>
<tr>
<td>2 Mean</td>
<td>19.720 0.39635E−02 0.49887E−01</td>
<td>−0.59073</td>
</tr>
<tr>
<td>3 Sigma</td>
<td>1.3190 0.28620E−02 0.33369E−02</td>
<td>−2.9135</td>
</tr>
</tbody>
</table>

CHISQUARE = 0.8460E+01 NPFIT = 15
Run 10261, pedestal Ch. B  Cap ID = 3

0.1 M events

16.782 ± 004

σ = 1.337 ± 0.003
(2780 electrons)
Data of 31–Jan–02, Ch. B (all Caps)

HPD: 7000 kV, 90 V bias, QIE: calibration mode

Mean (channels)

source on (1 mC)

source off

time (minutes)
Run 10269, Ch. B, all Caps

Mean
(channels)

10 × 0.5 M events per time bin
(1000 HTR blocks)

source on

467 measurements

time (140 ms bins)

source off
Run 10269, Ch. B, all Caps

0.5 M events per bin
(1000 HTR blocks)

0.0863 ± 0.0003
(180 electrons)

time (14 ms bins)
Run 10287, Ch. B, all Caps

0.5 M events per bin

0.0870 ± 0.0003 (181 electrons)

time (14 ms bins)
Mean (channels)

Number of measurements (0.5 M events) per 0.002 ch.

Run 10287, Ch. B, all Caps
Run 10275, Cap ID = 3

Dist. of widths (meas. per 0.002 ch.)

source on

source off
Run 10287, Ch. B, all Caps

1 M events

From mean:
0.0870 ± 0.0017

From fit (g+p):
0.0876 ± 0.0015
(182 ± 3 elec.)

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<tbody>
<tr>
<td>NO.</td>
<td>NAME</td>
<td>VALUE</td>
</tr>
<tr>
<td>1</td>
<td>P1</td>
<td>0.24146E+06</td>
</tr>
<tr>
<td>2</td>
<td>P2</td>
<td>0.87629E−01</td>
</tr>
</tbody>
</table>

CHISQUARE = 0.1585E+03  NPFIT = 24
and now a surprise...
Run 10287, Ch. B, Cap ID = 0

Mean (channels)

source on

0.087 ch.

source off

time (140 ms bins)
Run 10287, Ch. B, Cap ID = 1

Mean (channels)

source on

0.087 ch.

source off

Mean (channels)

time (140 ms bins)
Run 10287, Ch. B, Cap ID = 2

Mean (channels)

source on

0.087 ch.

source off

time (140 ms bins)
Run 10287, Ch. B, Cap ID = 3

Mean (channels)

source on

0.087 ch.

source off

time (140 ms bins)
Ch. B, Cap ID = 0

Run 10329
(0.008 ch./ bin)

Run 10330

177 s later

time (14 ms bins)
Ch. B, Cap ID = all

Run 10331

35.0 MHz

Run 10332

30.0 MHz
Ch. B, Cap ID = 0

Run 10331

35.0 MHz

Run 10332

30.0 MHz
At 30 MHz we expect a signal from the source at a strength

\[ 0.087 \times \frac{35}{30} = 0.102 \]

we see the a signal of

\[ 0.1025 \pm 0.0003 \]
Run 10296, Ch. B, Cap ID = all
Run 10301, Ch. B, Cap ID = all
Run 10301

Cap 0

Cap 1

Cap 2

Cap 3
Run 10301

Cap 0

Cap 1

Cap 2

Cap 3
Response of each cap to the led pulse:
(expect 1.25)

\[
\begin{align*}
cap 0 &= 1.27 \\
cap 1 &= 1.25 \\
cap 2 &= 1.27 \\
cap 3 &= 1.22
\end{align*}
\]
Source Signal (electrons)

Jan. 31: Source put in
Feb. 5: Clock adjusted
Nine measurements: Jan. 31 & Feb. 5

mean: 179 ± 1 electrons

sigma: 2.6 ± 1.0
CERN CMS Week March 2001: Source test as spin-off of demonstrator was born

- **Source**: 10 cm/sec
  - data point every 2 mm
  - \( \Delta t = 20 \text{ ms} \), use 100 ms; \( 4 \times 10^5 \) b/s

- DATA point: \( 2 \times 10^7 \) readings

- **Flow**: how fast

- \( 10^7 \times 25 \times 10^9 = \frac{1}{4} \text{ sec} \)

- \( \Lambda \text{Cu} = 3.7 \times 10^9 \text{ decays/sec} \)
  - \( \sim 4 \times 10^9 \)

- \( \mu \text{Cu} = 4 \times 10^6 \text{ decays/sec} \)

- **Histogram Mode**
  - 128 M bytes/sec, 8-Link Channel
  - \( \sim 40 \text{ M readings/sec} \)

- **Streaming mode**
  - format, 1 byte, toss exponent

- \( 10 \times 32 = 320 = 8/\text{sec} \)
Conclusions:

Calibration of HCAL by radioactive source to $\leq 2\%$ can be made to work, (the "source test" is completed)

Scintillator + fibers, HPD, QIE, TTCvx, TTCvi, Glink, HTR, LVDS link, DCC, Slink, VME CPU have been successfully integrated!

and ...
only 9143 more channels to build!