KEK 99 Beam Test
Forward Modules
FR_K81
FR_R_006

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with help from many others

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Basic information

- Place: KEK, Tsukuba
- $\pi$2 beamline in 12 GeV PS at KEK, 4 GeV/c $\pi$
- Modules:
  - M0: KEK-ABCD#1, 12 chips, 285 $\mu$m, trim 2fC=200mV
  - M1: FR-ABCD_K81, 12 chips, 285 $\mu$m, trim 2fC=200mV
  - M2: KEK-ABCD#2, 12 chips, 325 $\mu$m, no trim
  - M3: FR-irrad det-ABCD2T, 2 chips, 285 $\mu$m, trim 2fC=200mV
  - M4: KEK-CAFÉ/ABC, 12 chips, 285 $\mu$m
  - M5: CG3, ABCD1.2, anchor
- Run Conditions:
  - Edge detection = OFF, Mode = Any Hits
  - 20 x 20 mm triggered region with 3 planes of scintillator
  - Temperature -10 °C
Module description
FR-K81

- FW kapton-2 hybrid
- 12 ABCD2T’s, 1st batch
- 4 detectors, 285 microns
  - Top W31: CiS338616,
  - Top W32: CiS339108
  - Bottom W31: CiS338610,
  - Bottom W32: CiS339112
- Melbourne support card SC99
- trimmed to 200 mV at 2 fC
- stable
- noise
  - 1400 electrons @ 2 fC in the lab
  - 1470 electrons @ 2 fC in beam test site
- gain 55 mv/fC @ 2 fC
- ~5% bad channels
Module description
FR-R_006

- FW kapton-2 hybrid
- 2 ABCD2T’s, 1st batch
- 1 W31 CiS3041a03 detector irradiated to $3 \times 10^{14}$ 24 GeV p/cm² in 1998 (from Munich)
- mounted on special irradiation ceramic frame with special fan-in
- 1st chip bonded to 6 cm strips, 40 channels of S1 bonded to 2 6-cm-strips in parallel
- Melbourne support card SC99
- trimmed to 200 mV at 2 fC
- stable
- noise 1440 electrons @ 2 fC in the lab (6 cm)
Analysis Method (1)

Common for all runs:
• telescope alignment (3 telescopes used)
• modules alignment - residuals $\Delta$

Module alignment:

$$\Delta = aT_{1x} + b(T_{2x} - T_{1x}) + cT_{1y} + dT_{1x}T_{1y} + eM + f$$

$$|\Delta| \leq 150 \, \mu \text{m}$$

Coefficient description:
• $a$ telescope cell size
• $b$ track direction
• $c$ module rotation along z-axis
• $d$ detector fan (forward only)
• $e$ detector pitch
• $f$ module offset
• $T$ telescope channel
• $M$ module channel
Analysis Method (2)

Selection procedure for events:

- track finding (min. 2 telescopes),
- single track events accepted only
- track projection onto module plane
- there is a good hit in anchor
- there are no bad channels in the analyzed region (±150 μm)

GOOD EVENTS analyzed further

- hit in the analyzed region = efficient hit
- more hits in the analyzed region = multihit
- hit out of the analyzed region = noise hit
- noise hit out of the triggered window = noise hit out-window (to avoid misinterpreting the beam halo)
Analysis Tools

Raw data processing:
• TBOffline (ROOT/C++ package from ST software by Gareth)

Alignment coefficients:
• paw, Excel Solver

Further track and event evaluation:
• user routines under TBOffline run under ROOT environment

Histogram booking and displaying, graphs:
• set of ROOT macros

The tools are not very fancy (we started from scratch in January), but there is an effort towards making them modular and usable by others - some products are already used for recent H8 TB, which uses the same data format
Conclusions

Working regions for modules

<table>
<thead>
<tr>
<th>Module</th>
<th>Bias (V)</th>
<th>Qth (fC)</th>
<th>Noise Occupancy per channel per event</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>K81 S 0</td>
<td>100 – 180</td>
<td>1.0 - 1.2</td>
<td>&lt;1.0E-4</td>
<td>99.5%</td>
</tr>
<tr>
<td>K81 S 1</td>
<td>80 – 200</td>
<td>1.0 - 1.2</td>
<td>&lt;1.3E-4</td>
<td>99.0%</td>
</tr>
<tr>
<td>Irradiated</td>
<td>400 – 500</td>
<td>1.0 - 1.4</td>
<td>&lt;1.2E-4</td>
<td>87.0%</td>
</tr>
</tbody>
</table>

FR_K81:
• stable, working region with acceptable efficiency and noise exists, although narrow
• median collected charge 3.2 fC

FR_R_006:
• special module - 1st irradiated detector on ABCD2T chips
• efficiency ~90% reached for threshold <1.4 fC
• noise starts to rise for Qth<1 fC
• median collected charge 2.5 fC (significant loss ~30%)
• further studies on irradiated modules necessary
Residuals Module 1, Stream 0

Chi2 / ndf = 203.1 / 54
Constant = 208.4 ± 4.342
Mean = 0.4598 ± 0.4251
Sigma = 23.31 ± 0.2413

Residuals Full Range Module 1, Stream 0
Residuals Module 1, Stream 1

Chi² / ndf = 175.2 / 64
Constant = 224 ± 4.576
Mean = -2.083 ± 0.42
Sigma = 23.74 ± 0.2604

Residuals Full Range Module 1, Stream 1
Chi2 / ndf = 66.23 / 71
Constant = 54.58 +- 1.797
Mean = 2.72 +- 1.165
Sigma = 44.41 +- 0.9469
Residuals Module 3, Stream 0

Chi2 / ndf = 773.2 / 77
Constant = 55.76 ± 2.483
Mean = 80.3 ± 1.632
Sigma = 45.4 ± 1.235

Residuals Full Range Module 3, Stream 0
Module 1, stream 0, Median Charge [fC] vs. Bias [V]

Module 1, stream 1, Median Charge [fC] vs. Bias [V]