Beam Test of Scintillation Tiles with MPPC Readout

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Test essentials

• Run in April at the Beam Test Facility in Frascati
• 3 detectors exposed: 3x3x0.5 cm scintillator tiles coupled to a Hamamatsu MPPC, readout via a preamp from CPTA (gain ≈15)
• Beam pulse-by-pulse information from a Pb-glass calorimeter and a tracker
The Beam Test Facility

- Extraction line from the DAΦNE LINAC
- Variable energy, we used 477 MeV/c
- Pulse frequency 1 or 50 Hz; we trigger on every RF pulse: a 0-bias measurement
- N.of e-/pulse from 0 up to 20 (actual “policy-dictated” max: $10^3$ /s)
- Beam spot dimensions (narrow core, some halo): $\approx$ 1-2 mm vert., $\approx$ 0.2-1.5 cm horiz.
The setup

- 6-layer RPC tracker
- 3 MPPC detectors
- Pb-glass calorimeter
- Calorimeter “fixed” wrt the beam

Main setup on a x-y moving table
More on the detectors

- **MPPCs:**
  - “1”: 1600 25-µm pixels, *St.Gobain BC-400*, readout using green fiber 1mm thick
  - “2”: 400 50-µm pixels, *generic “green” scintillator*, equivalent to EJ260 from Scionix, readout using green fiber 1mm thick
  - “3”: 400 50-µm pixels, *St.Gobain BC-400*, direct readout (no fiber)

- $V_{bias}$ from HP6614C, readout accuracy 0.03% ± 12mV

- Q measured with 12-bit, 100 fC/ch CAEN V792
Aux equipment

- Lead glass calorimeter 10x10cm$^2$, 20 $X_0$ thick, measured the number of MIPs in every beam pulse
- X-Y tracker, 6 layers of mechanically-quenched(*) RPC’s, measured the beam position with single layer resolution of 2 mm

The BTF calorimeter

- 0,1,2,3-MIP bands with few-% contamination
- Strategy: cut on the Pb-glass calo, and plot our detectors
The RPC tracker

Fitted resolution (cm)

Beam profile on MPPC

A. Calcaterra, LNF-INFN PD2
Q spectra (1 MIP in calor.)

400pxs+EJ260+fiber
69.5 V, G=1.6·10^6

Noise \approx 2-3 \text{ fC} \approx 2\cdot10^4 \text{ e}^{-}

400pxs+BC-400, no fiber, 69.5V, G=2.2\cdot10^6
Q spectra (1 MIP in calor.)

1600pxs+BC-400, fiber, 72V, G=1·10^6

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Q spectra (0 MIP in calor.)

A. Calcaterra, LNF-INFN
MPPC gain

A. Calcaterra, LNF-INFN
Efficiency in a Y-scan
(requesting 1 MIP in calo)

Most favorable impact point in MPPCs 2 and 3

Bkg level at 7% is MPPC dark noise
Efficiency from nearest MPPC (requesting 1 MIP in calo)

Cutting on MPPC 2, $\varepsilon$ in MPPC 3 is (84±1)%

Cutting on MPPC 3, $\varepsilon$ in MPPC 2 is (91±1)%

A. Calcaterra, LNF-INFN
MPPC 1600 pixels

- Step 1: find gain & peak posn's
- Step 2: rebin around peaks
MPPC 1600 pixels

- **N Pixel 1p - Noise Sub**
  - Entries: 950
  - Mean: 26.82
  - RMS: 10.80

- **N Pixel 07 2p - Noise Sub**
  - Entries: 545
  - Mean: 30.03
  - RMS: 25.01

- **N Pixel 07 3p - Noise Sub**
  - Entries: 445
  - Mean: 53.81
  - RMS: 29.51

- **ADC07 Linearity**
  - MPV = 14.24*MIPs - 1.21

A. C
Conclusions

• This is our first shot at the MPPC characteristics in a tile-scintillator detector
• Efficiencies for MIPs are in the ballpark ~80-90% with the geometry we used
• Gains of $\sim 10^6$ with noise rate $\sim 300$ kHz have been obtained
• Preliminary analyses show that the device is linear within the tested range
Outlook

• We need to complete the present analysis, and draw all potential from our data
• A new beam-test is coming up in the fall
• We plan to repeat all measurements, with many improvements
  – T monitoring
  – wider dynamic range (more particles/pulse)
  – different scintillators/photon detectors
Backup Slides
RPC tracker (figs. of merit)
Scanning $V_{\text{bias}}$