Cosmic Muon Veto Detector (CMVD)

CMVD Components

<table>
<thead>
<tr>
<th>CMVD Components</th>
<th>Wall</th>
<th>Top</th>
<th>Back</th>
<th>Left</th>
<th>Right</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layers/Wall</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>13</td>
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</tr>
<tr>
<td>Tiled/Layer</td>
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<td>5</td>
<td>5</td>
<td>5</td>
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<tr>
<td>Di-Counter/Tile</td>
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<td>4</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Scintillator/Di-Counter</td>
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<td>2</td>
<td>2</td>
<td>8</td>
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<tr>
<td>Fibers/Strip</td>
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<td>2</td>
<td>2</td>
<td>2</td>
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<tr>
<td>SiPM/One end of fibre</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
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<tr>
<td>Total SiPMs/Final/Layer</td>
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<td>80</td>
<td>80</td>
<td>496</td>
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<td></td>
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<tr>
<td>Total SiPMs/Final/Layer</td>
<td>704</td>
<td>240</td>
<td>240</td>
<td>1424</td>
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</tr>
</tbody>
</table>

Top 3 layers

Side-3 Layers

Di-counter assembly (basic detector element)

- SiPM : Hamamatsu S13360-2050VE

SiPM Characterisation

![SiPM Characterisation Image]

SiPM: Hamamatsu S13360-2050VE

CMVD Electronics Design Concepts

Design Requirements

- Charge, position & relative arrival time info for each SiPM signal need to be recorded on every mini-ICAL trigger
- Event Marker to collate the CMVD event data with the mini-ICAL data
- Charge recording: 100pC dynamic range with Least Count of 20fC. Single photo-electron (pe) charge of ~100fC
- Relative pulse arrival time recording with LC of 100-200ps/pe. Supported by FE electronics of SiPM
- Baising control for every SiPM or Di-Counter SiPMs and closed loop Gain control
- In-situ Single peak calibration

Conclusion results:

1. Single pe avalanche charge is 0.242 pC
2. Typical Muon yield is 8.11 pC and 13.82 pC for 10 & 20mm Scintillators respectively
3. The pe yield for 10/20mm is 18, 57 pe
4. Position resolution of 9.18 ± 2.37 mm

Possible FE Chips

Trip-1: Made for D0 FE electronics

- 32 channel charge amplifiers
- Charge and time of arrival output per channel
- 48 deep Analog pipeline storage per channel for both paras
- 16 digital outputs crossing set threshold at a time
- Multiplied valid channel readout
- Common Test pulse for calibration

VMM-3: Developed at Brookhaven Lab

- 64 Channel, any polarity
- Each channel has fast digital output signal
- The Peak Charge value and Peak to reference clock TMC value are stored in Analog memory. They are digitized and saved at 38 bit data is formed
- The digital data from valid channels are read out on two lines at 200Mbps
- Threshold of each channel can be set

Background

The possibility of constructing a Cosmic Muon Veto Detector to study rare events, needs to be validated. The advantage of shallow depth is the low background from the primary hadronic and electromagnetic components in cosmic rays. As a proof-of-principle, the CMVD is being built surrounding the mini-ICAL detector at the IChEPE lab at Madurai in southern Indian state of Tamil Nadu.