Status of the Tail Catcher/Muon Tracker

Presented by Victor Rykalin

for NICADD   NIU

CALICE     DECEMBER 7-8  2004
Outline

- Current status.

- Plans.
Current status

- Status of the TCMT
  a) TCMT design *(TCMT for the test beam)*
  b) Calibration and monitoring
  c) Scintillator strips
  d) Detectors (SiPM) and electronics
  e) On-Site tests
TCMT design

- Fine” section (8 layers)
  2 cm thick steel
- “Coarse” section (8 layers)
  10 cm thick steel
- 5mm thick, 5cm wide strips
- Tyvek/VM2000 wrapping
- Alternating x-y orientation
- Si-PM photo detection
- Common readout with Hcal
- Along the beam - 142 cm
- Height - 109 cm
- Weight ~10 tons
Good quality steel plates from scrap is available (0.75 and 4 inches thick).

Maximum size for the thicker plates is 1.066m x 1.2m.

Cart being designed with about 10 ton load capacity.

Will have the capability for forward-backward and left-right motion.
Tail Catcher one cassette view

Mech. prototype
Brief summary of the FNAL-NICADD extruded scintillator characteristics.

Thickness: $\sigma \sim 0.6\%$ (Over 300 m)
Width: $\sigma \sim 0.2\%$ (Over 300 m)

LY non-uniformity $\sigma \sim 4\%$ (across 10 cm)
LY non-uniformity $\sigma \sim 2.2\%$ (10*10 cm$^2$)
LY non-uniformity $\sim 3\%$ (Hexagonal cell 9 cm$^2$)

Light Yield 66 % of BC408
~100% of Kuraray SCSN-81

Rad. Hardness < 5 % LY degradation after 1 Mrad (gamma)
FNAL-NICADD extruder line

Output range: 30-200kg/h

- Screw diameter: 44 mm
- Screw speed: 1200 RPM
- Drive power: 200 HP
- Height: ~1100 mm
- Weight: ~3500 kg
- Lifetime: ~40000 hours
QC on scintillator strips

ATTENUATION LENGTH MEASUREMENT SETUP

▲ K2K (L=26.2 cm)
◆ FNAL/NICADD (L=34.7 cm)

<table>
<thead>
<tr>
<th>Number</th>
<th>Batch</th>
<th>L1 (Long)</th>
<th>L2 (Short)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>41.3 cm</td>
<td>38.0 cm</td>
</tr>
<tr>
<td>101</td>
<td>6</td>
<td>59.9 cm</td>
<td>48.8 cm</td>
</tr>
<tr>
<td>121</td>
<td>7</td>
<td>69.0 cm</td>
<td>49.3 cm</td>
</tr>
<tr>
<td>161</td>
<td>9</td>
<td>64.1 cm</td>
<td>51.4 cm</td>
</tr>
<tr>
<td>182</td>
<td>10</td>
<td>31.3 cm</td>
<td>24.1 cm</td>
</tr>
<tr>
<td>Ref</td>
<td>-</td>
<td>43.7 cm</td>
<td>24.1 cm</td>
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</tbody>
</table>

Thickness 4.98±0.03 mm
QC on scintillator strips

A/B(80) ratio = 0.98 ± 0.02

~2%

0.9 mm TYVEK

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Calibration and monitoring

- Individual LED driver for the each strip
- Preliminary driver design has been proposed
- Read-out schema is under discussion

One TCMT cassette includes

- 20 strips
- 20 of current switchers
- 18 inputs
- Pulser Card
- Preamplif. Card
- Com. Card
- Next Slide

Block diagram of current switch at LED

WLS Fiber

Scintillator (painted sides)

LVDS Repeater

Level Shift

V+ O

+V_{\text{trig}}

-V_{\text{trig}}

I_{\text{Sel}}

Gnd

CERC

12/14/2004
Calibration (Proposed by Sten Hansen, FERMILAB)

Pulser Card Block Diagram

- DAC0
- DAC9
- DAC10
- DAC19

I_{Set}^0
+V_{trig}^0
-V_{trig}^0

I_{Set}^9
+V_{trig}^9
-V_{trig}^9

I_{Set}^{10}
+V_{trig}^{10}
-V_{trig}^{10}

I_{Set}^{19}
+V_{trig}^{19}
-V_{trig}^{19}

Data Bus

Timing Adj

Trig

12/14/2004
### LED3-UV-XXX-30 Series

3mm Ultraviolet LED

<table>
<thead>
<tr>
<th>LED Part No.</th>
<th>Chip Material</th>
<th>Peak Wave Length λp (nm)</th>
<th>Emitted Color</th>
<th>Lens Appearance</th>
<th>Absolute Max. Ratings</th>
<th>Electro-Optical Data @ 20mA</th>
<th>Viewing Angle 20° 1/2 (deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Δλ (nm)</td>
<td>Pd (mW)</td>
<td>If (mA)</td>
</tr>
<tr>
<td>LED3-UV-395-30</td>
<td>InGaN</td>
<td>395</td>
<td>BLUE UV</td>
<td>WATER CLEAR</td>
<td>60</td>
<td>100</td>
<td>30</td>
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<tr>
<td>LED3-UV-400-30</td>
<td>InGaN</td>
<td>400</td>
<td>BLUE UV</td>
<td>WATER CLEAR</td>
<td>60</td>
<td>100</td>
<td>30</td>
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<tr>
<td>LED3-UV-405-30</td>
<td>InGaN</td>
<td>405</td>
<td>BLUE UV</td>
<td>WATER CLEAR</td>
<td>60</td>
<td>100</td>
<td>30</td>
</tr>
</tbody>
</table>

Flat Edge
Cathode ID
Ø 1.50 [Ø3.8mm]
Flange Dia.

Ø 0.118 [Ø3.0mm]

0.039 [1.0mm]

0.020 [0.5mm] SQ.

Recommended Mounting
Hole Size = Ø 0.032 ± 0.003
UV LED R&D

1. All LEDs show good reproducibility in the characteristic behavior.

2. ~$1 UV LED is a promising candidate for the calibration of each scintillator strip+SiPM.

3. R&D is under way.

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**LED lifetime test**

<table>
<thead>
<tr>
<th>Time (hours)</th>
<th>PMT output (QDC cts)</th>
<th>Temperature (deg C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000 Thurs</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>0000 Fri</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>0000 Sat</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>0000 Sun</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>0000 Mon</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

**Graphical Data**

- **Equation**: \( y = 0.0019x - 0.0062 \)
  - \( R^2 = 0.9999 \)

<table>
<thead>
<tr>
<th>LED 1</th>
<th>LED 2</th>
<th>LED 3</th>
<th>LED 4</th>
<th>LED 5</th>
<th>LED 6</th>
<th>LED 7</th>
<th>LED 8</th>
<th>LED 9</th>
<th>LED 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.14V</td>
<td>slope 0.0019</td>
<td>0.0019</td>
<td>0.0019</td>
<td>0.0019</td>
<td>0.0019</td>
<td>0.0019</td>
<td>0.0019</td>
<td>0.0019</td>
<td>0.0019</td>
</tr>
<tr>
<td>intercept 0.0062</td>
<td>0.0062</td>
<td>0.0061</td>
<td>0.0062</td>
<td>0.0062</td>
<td>0.0062</td>
<td>0.0062</td>
<td>0.0062</td>
<td>0.0062</td>
<td>0.0063</td>
</tr>
<tr>
<td>( R^2 ) 0.9999</td>
<td>0.9999</td>
<td>0.9999</td>
<td>0.9999</td>
<td>0.9999</td>
<td>0.9999</td>
<td>0.9999</td>
<td>0.9999</td>
<td>0.9999</td>
<td>0.9999</td>
</tr>
</tbody>
</table>

| 5.14V | slope 0.0019 | 0.0019 | 0.0019 | 0.0019 | 0.0019 | 0.0019 | 0.0019 | 0.0019 | 0.0019 | 0.0019 |
| intercept 0.0063 | 0.0063 | 0.0062 | 0.0063 | 0.0063 | 0.0063 | 0.0063 | 0.0063 | 0.0063 | 0.0064 |
| \( R^2 \) 1 | 1 | 1 | 1 | 1 | 1 | 0.9999 | 0.9999 | 1 | 1 |
Detectors and electronics

- Layout of electronics
- New setup for the SiPM commissioning was prepared
- Encapsulation test of the SiPM bonds was performed
- The measurements before and after encapsulation were carried out
Layout of electronics

16*20=320

Tail Catcher Base Board is placed in a standard 19" Crate (Backplane). 2 Crates are needed for the analog channels.

18 layers of detectors

RG174 coaxial cables (SiPM outputs)

6-position Multi-Coax connectors?

216 straight LEMO board connectors on the Base Board.

12 Analog Boards with one ASIC (=18 channels) on one Base Board. Analog Boards are stacked vertically onto the Base Board with a pitch of ~3cm.

Dimensions:
- Analog Board: 9 x 6.4 cm²
- Rec Board: 10 x 7.7 cm²

To DAQ

Power

Tail Catcher Base Board

Analog and Control Signals

84 TE = ~426 mm

12/14/2004
Encapsulation of the wire bonds

* Easy to damage

* Experience of the D0 SiMT

* Availability of the equipment at FNAL Si Det. lab.
Encapsulation setup
New setup and tests results.

1. Allows to have reproducible light flux during the tests
2. Meets mechanical problems (bent legs, different distance between them)
3. Simple and robust
4. We are going to evaluate each sensor (working point)

Data was taken: before at 25.3C, after at 24.9C, thus small difference in absolute value of counts, but the slope is the same and the behavior or noise is the same.
On-Site test and results

- Different lengths of the cable were tested.
- Currently we are comfortable with length of 30 cm with electronics we have.
- The real electronics (FLC_PHY3) tests are necessary with longer cables.
- Some assistance from electronics experts will be requested during current visit to DESY.
Plans

- LED calibration system: to test a single prototype of the current driver.
- LED: to perform a long time stability tests with temperature tracking.
- Electronics: To perform a test with real electronics for one cassette prototype. We expect to test one board at NICADD.
- SiPM sensors: to find a working point for each sensor.
- Mechanics: To make an over all design.
Strips: Done

SiPM: 25 ok!, will need more starting Feb.

Cassette: Mech. Prototype done, 1st ready Feb.05

LED System: design ready this year, prototype ready in Jan. 05

Stack & Cart: Construction starts Feb. 05