# **Cosmic Muon Explorer**







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## Objective

This Projects aim is to design and develop handheld, cost-effective, and low-power Muon Detectors for Experiments and Science Outreach

## **Overview**

#### Phase 1 (Mumbai, India)

- 2 Fold Plastic Scintillator Coincidence
- Simple Readout
- Coarse Resolution
- No Temp Compensation



#### Phase2 (Pittsburgh, US)

- 2 Fold
- Sophisticated Readout(TIA etc..)
- Fine resolution (pe level)
- Temp Compensated
- Battery Operated



# **Detector Overview**



**Detector 3D Model** 



Fiber & Scintillator



**Detector Interface with SiPM** 



**Reflector Packing** 



**Black Sheet Packing** 



**Black Tape Packing** 



2 Scintillator Stack

# SiPM and WLS Fiber

Silicon Photomultiplier



2.4 mm

#### Hamamatsu S13360-2050VE

Photo Sensitive Area	2x2mm
Pixel Pitch	50um
Number of Pixels	1584

#### Kuraray Wavelength Shifting (WLS) Fiber





**Before Polish** 



**After Polish** 

#### SiPM-Fiber Adapter



#### SiPM Side



Description		Emission		Absorption	Att.Leng.2)	Characteristics
Description	Color	Spectra	Peak[nm]	Peak[nm]	[m]	Characteristics
Y-11(200)	green		476	430	>3.5	Blue to Green Shifter (K-27 formulation) Long Attenuation Length and High Light Yield



Lapping Sheets

# **Readout Electronics**





**DAQ Mother Board** 





# Frontend



**DAQ** Peripherals

#### SiPM Bias Supply (54V)



#### Serial Bluetooth Terminal App

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10Sec	1Min	15Min	30Min	1Hr	L6	L7					
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# Backend



#### -JAO MINGW64 /d/Yuvaraj/Projects/Muon\_detector/WCW\_Readout python muon\_readout.py Enter COM PORT NO: 3 **Run Control** Connected to COM3 at 115200 baud. Enter the Signal Threshold(20,50,100,200)mV : 100 Enter the Monitoring Period(10,60,900,1800,3600)Seconds:60 Enter the Data\_Type(0,1,2):1 2024-05-09-12-34-41 0.28 0.24 84 150 0 22.60 96952.00 96949.00 371.05 371.65 89.78 2024-05-09-12-35-42 0.25 0.26 95 145 0 22.70 96945.00 96952.00 370.96 370.36 89.66 2024-05-09-12-36-42 0.18 0.21 82 118 0 22.70 96954.00 96952.00 370.44 370.53 89.53 2024-05-09-12-37-42 0.22 0.15 84 146 0 22.60 96950.00 96943.00 371.05 370.61 89.84 2024-05-09-12-38-42 0.12 0.12 88 115 0 22.70 96960.00 96959.00 370.18 369.84 90.14 2024-05-09-12-39-42 0.32 0.27 94 135 0 22.70 96954.00 96955.00 370.27 370.87 89.44 2024-05-09-12-40-42 0.16 0.24 106 120 0 22.80 96956.00 96955.00 370.61 370.18 89.86 2024-05-09-12-41-42 0.17 0.25 94 116 0 22.80 96955.00 96950.00 370.27 370.27 89.74

# **Results Part 1**



# **Results Part 2 : Source Testing**



# **Results Part 3: Muon Flux under Tunnel**



# **Results Part 4 : Angular Distribution**



Prof. Danko, Istvan Zsolt, Instruction Lab

**Detector Assembly to keep Detectors 50cm Apart** 

# Phase 2:

Stack up View of Detector Assembly



**Readout Schematic** 

Microcontroller

OLED

Memory

GPS

TPH

WIFI

# Phase 2 : Applications

**Background Measurement** 



#### **Educational Outreach**



**Balloon Flight** 



**Cargo Scanning** 



DOI:10.3390/instruments7010013

# **Time Line**



# Conclusion

#### Phase 1 : Completed

Learnings:

- Temperature Compensation
- Calibration
- Trigger on Photo Electron level Threshold

#### Phase 2 : Started

- Design Specification
- Scintillator Selection
- Budgeting

## **Inspiration and Credits**

#### **MIT Cosmic Watch Program**

#### **Open Gamma Detector**



http://www.cosmicwatch.lns.mit.edu/



# **Special Thanks**

Dhanalakshmi Krishnamurthy (On-field Measurements)

## Team :

Phase 1 :

### Tata Institute of Fundamental Research, Colaba, Mumbai, India.

Yuvaraj Elangovan, Dr. Satyanarayana Bheesette, Shashwat Kakkad, Raj Shah, Suresh Upadhya, Ravindra Raghunath Shinde, Mandar Saraf. Acknowledgment: Santhosh Chavan, Darshana Gonji, Vishal Asgolkar.

#### Phase 2:

#### University of Pittsburgh, Pittsburgh, PA, US.

Possible Team (Yuvaraj Elangovan, **Mo Kyle, Brent Clelland**, Surukuchi Pranava Teja, Tae Min Hong ....) Looking for **Time and Funding...** 

# **Thank You**