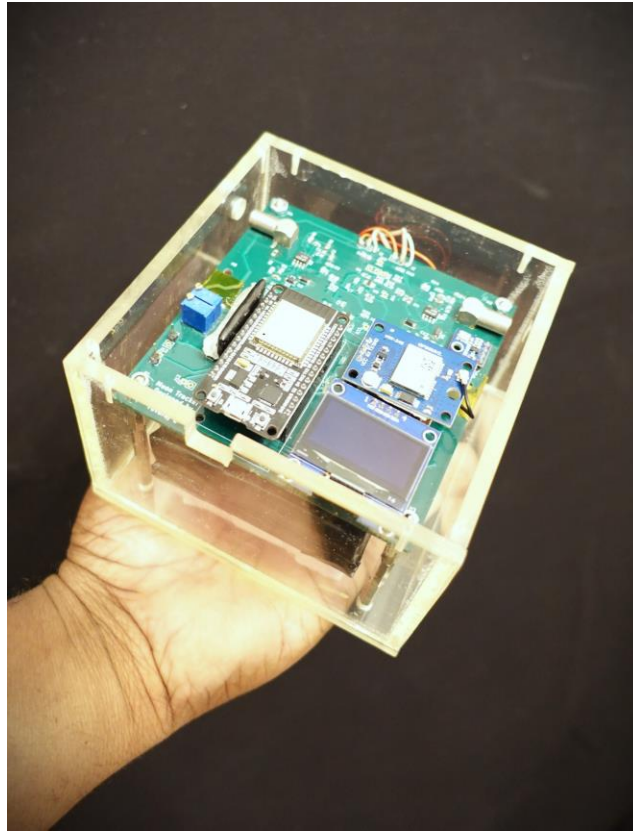


Cosmic Muon Explorer



Yuvaraj Elangovan (On behalf of the Group)

University of Pittsburgh

yue8@pitt.edu

05/13/2024

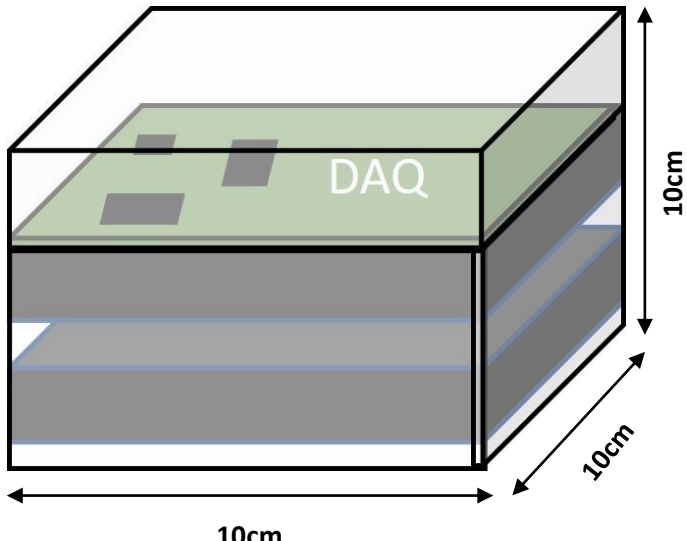
Objective

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

Overview

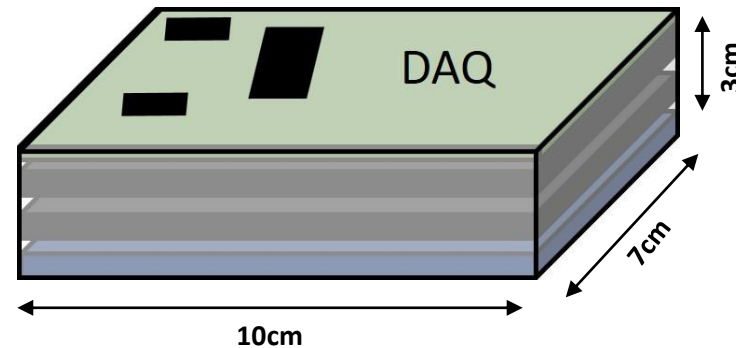
Phase 1 (Mumbai, India)

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

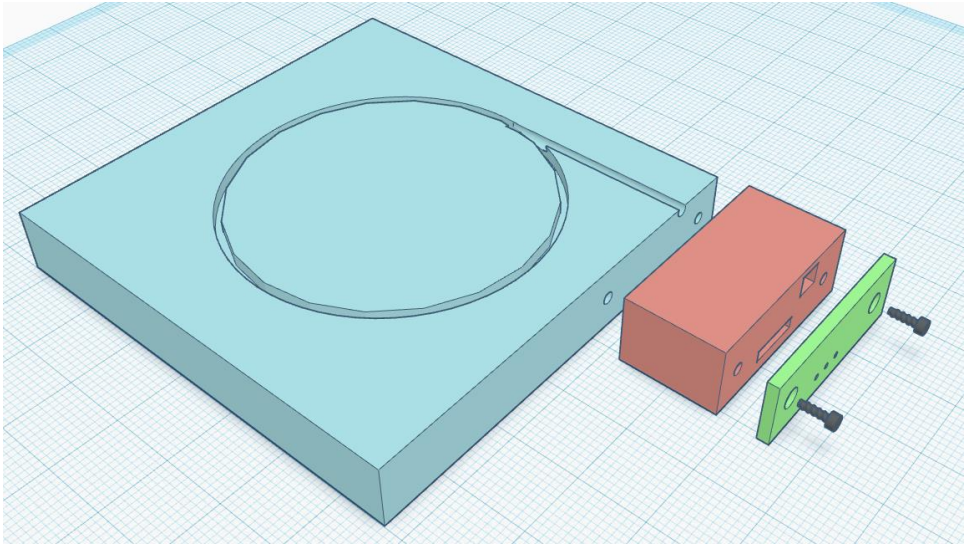


Phase2 (Pittsburgh, US)

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



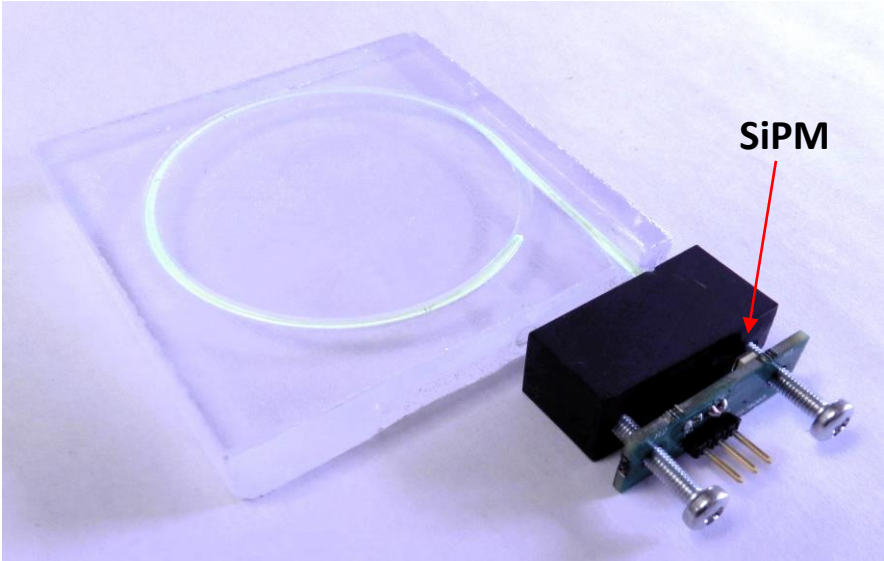
Detector Overview



Detector 3D Model



Fiber & Scintillator



Detector Interface with SiPM



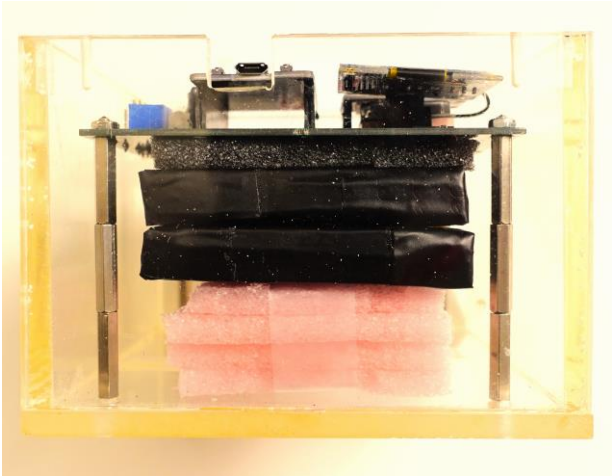
Reflector Packing



Black Sheet Packing



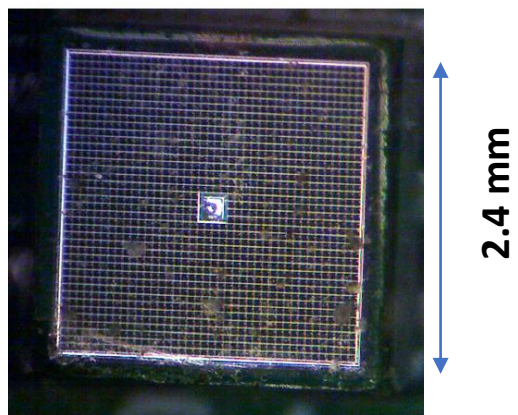
Black Tape Packing



2 Scintillator Stack

SiPM and WLS Fiber

Silicon Photomultiplier



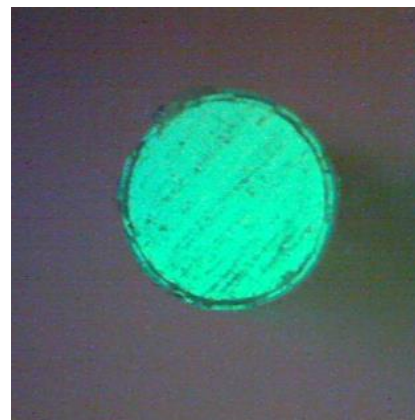
2.4 mm

2.4 mm

Hamamatsu
S13360-2050VE

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

Kuraray Wavelength Shifting (WLS) Fiber



Before Polish



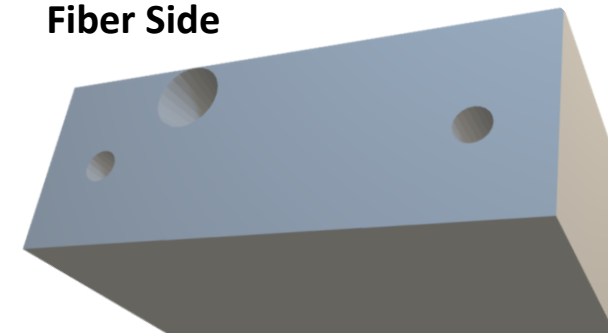
Lapping Sheets



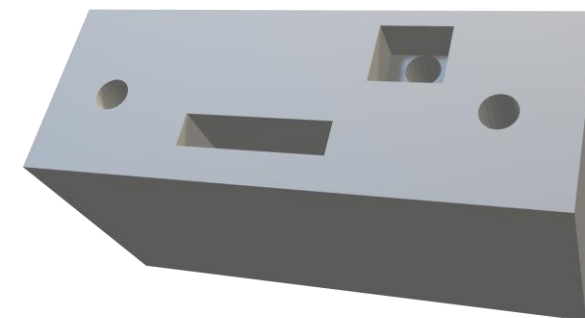
After Polish

SiPM-Fiber Adapter

Fiber Side



SiPM Side



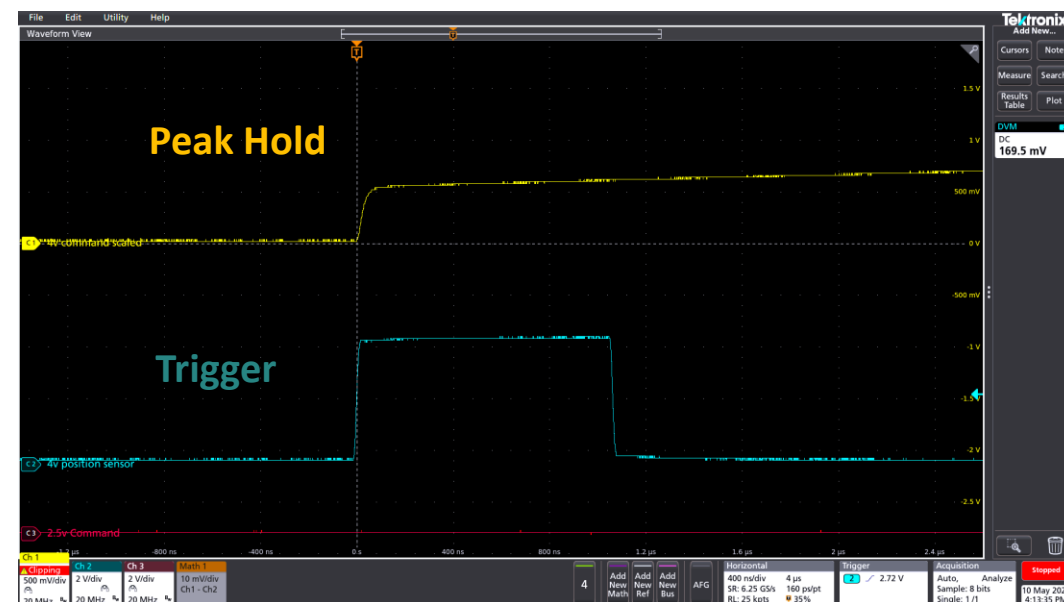
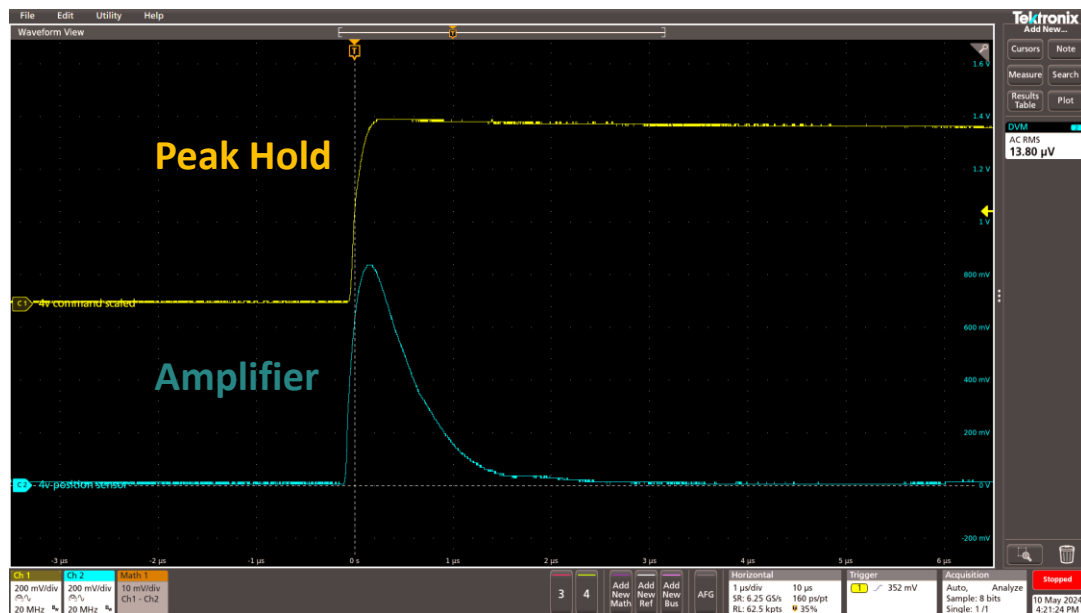
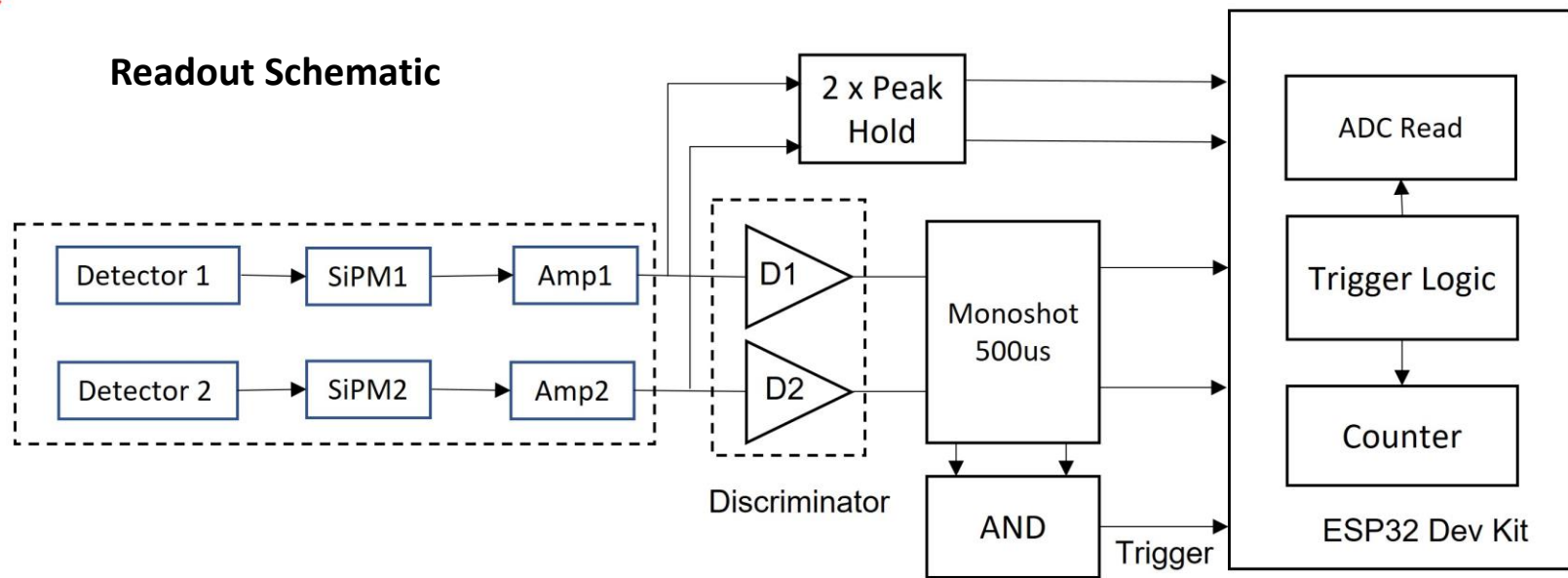
| Description | Emission | | | Absorption Peak[nm] | Att.Leng. ²⁾ [m] | Characteristics |
|-------------|----------|---------|----------|---------------------|-----------------------------|--|
| | Color | Spectra | Peak[nm] | | | |
| Y-11(200) | green | | 476 | 430 | >3.5 | Blue to Green Shifter (K-27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

Readout Electronics

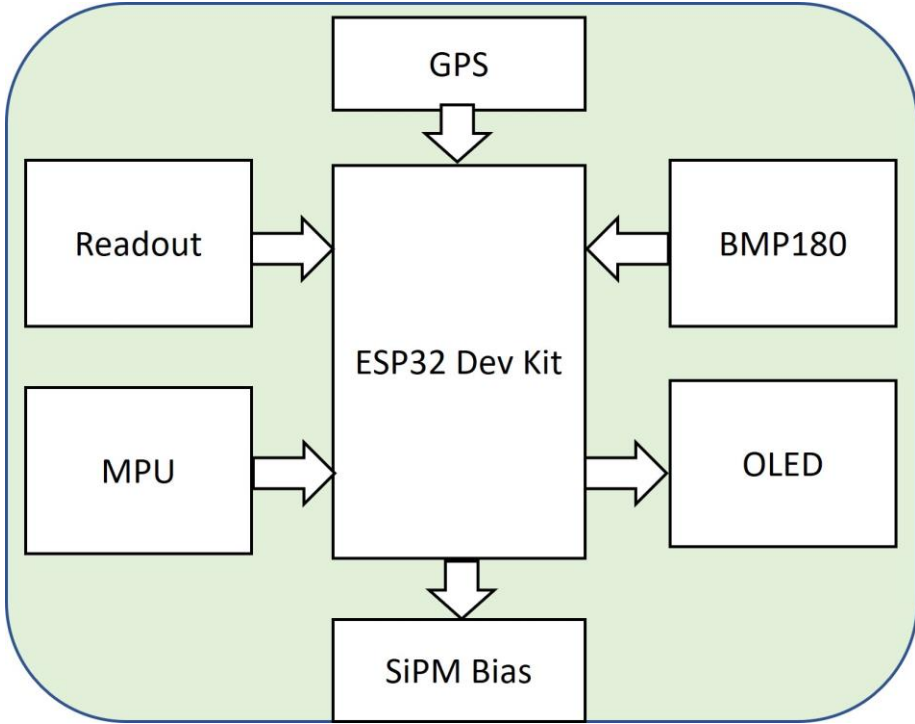


DAQ Mother Board

Readout Schematic

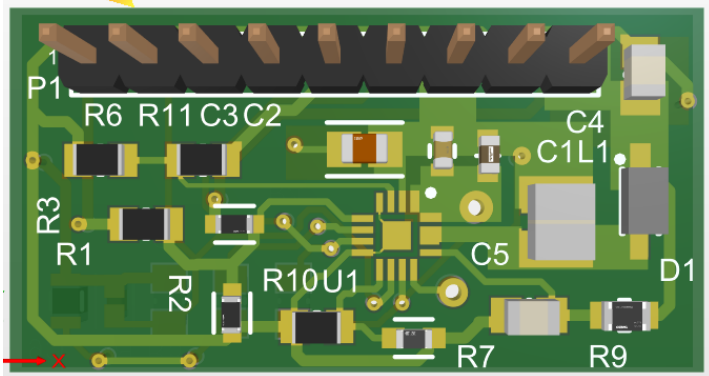


Frontend

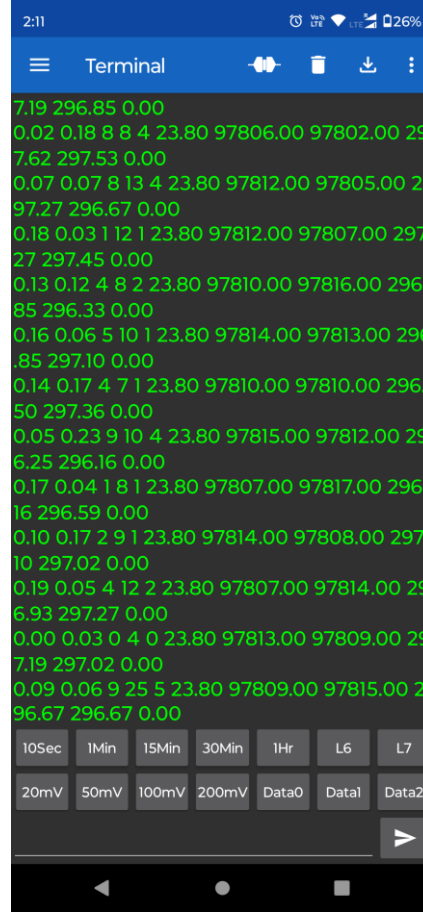


DAQ Peripherals

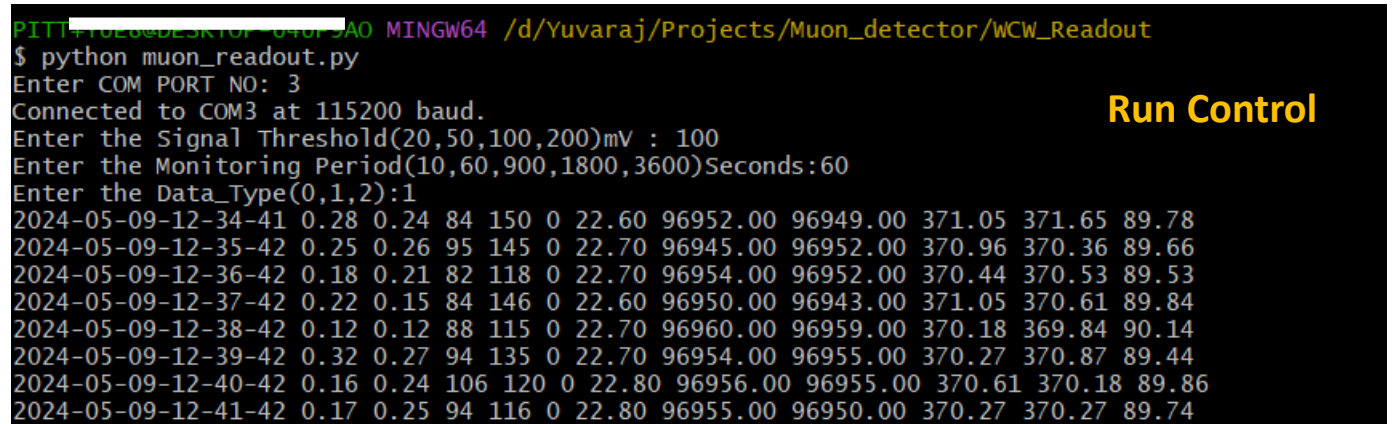
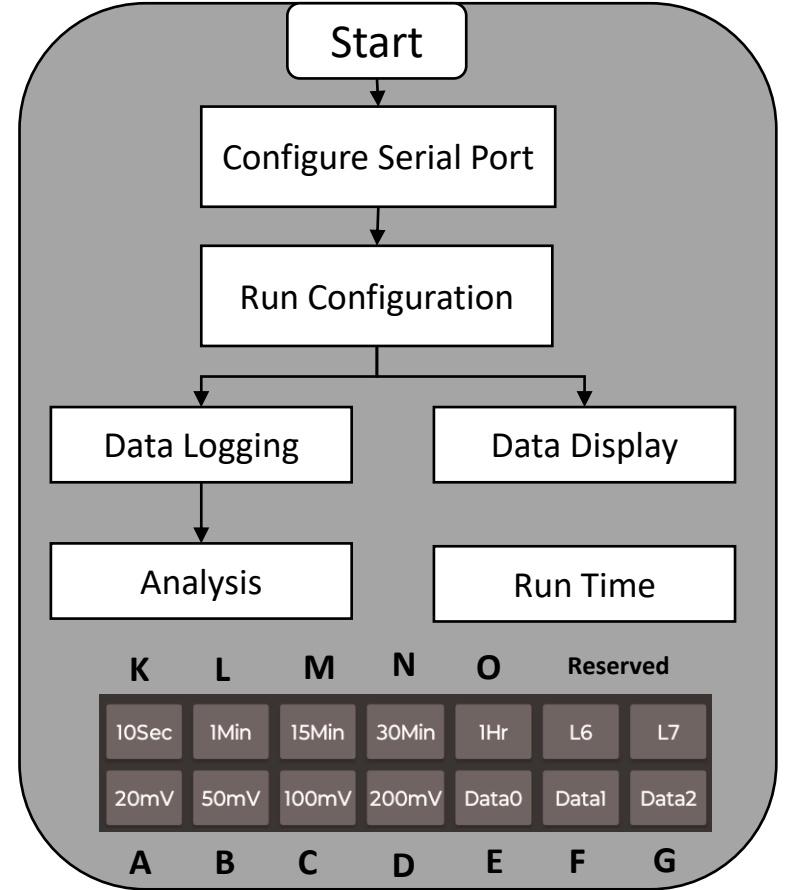
SiPM Bias Supply (54V)



Serial Bluetooth Terminal App

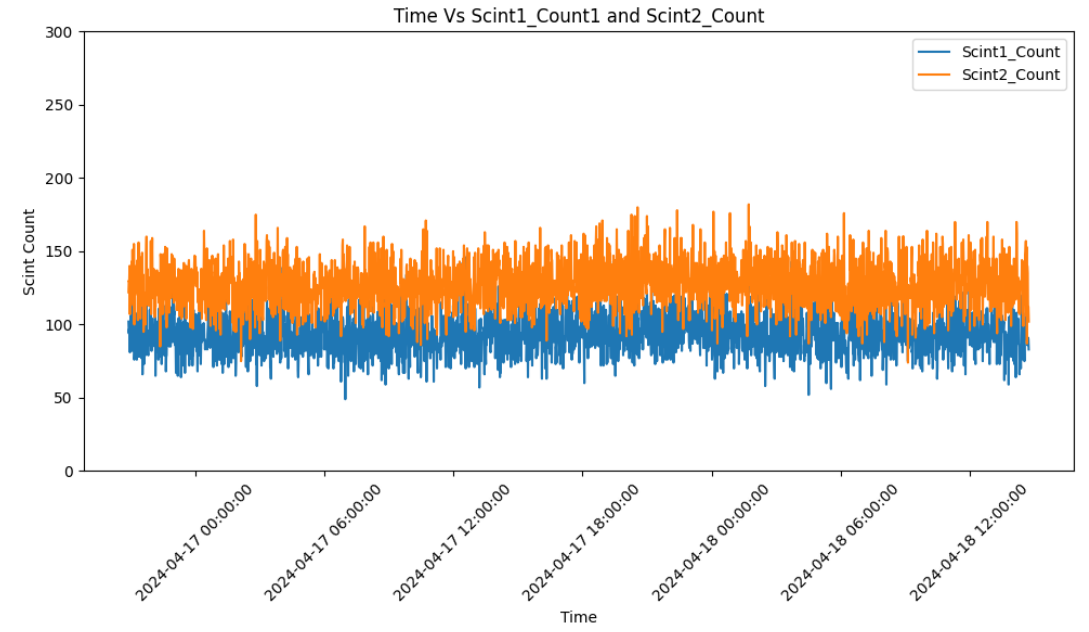
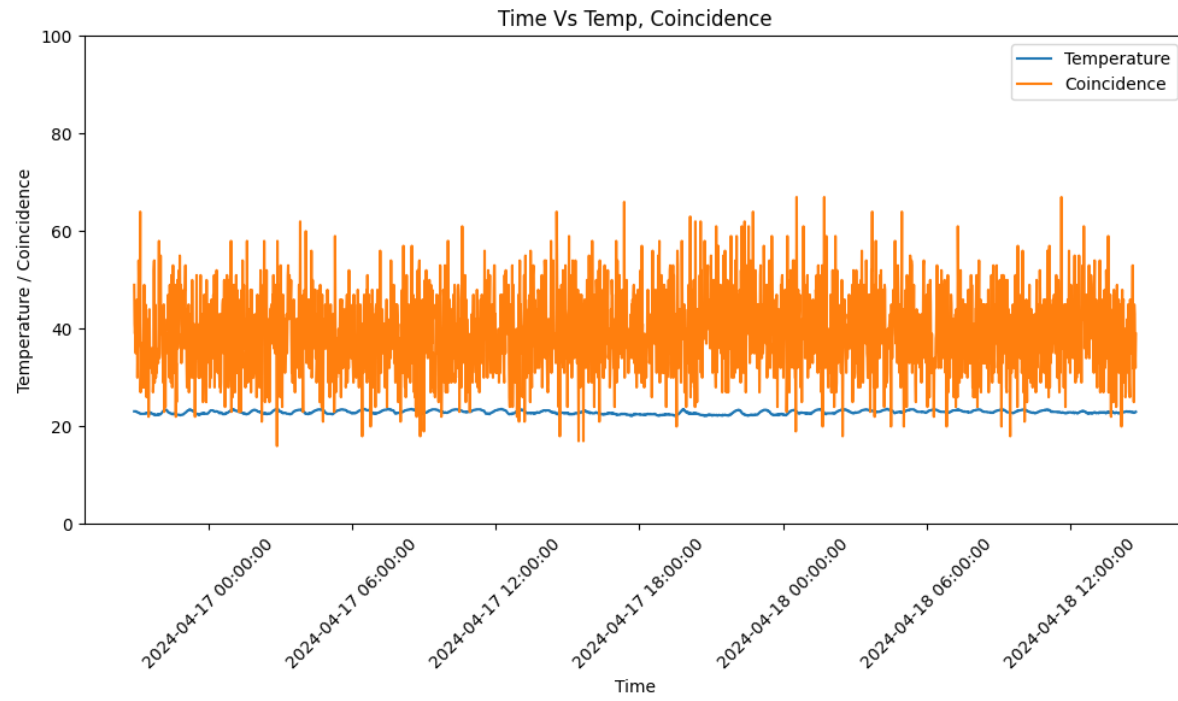


Backend

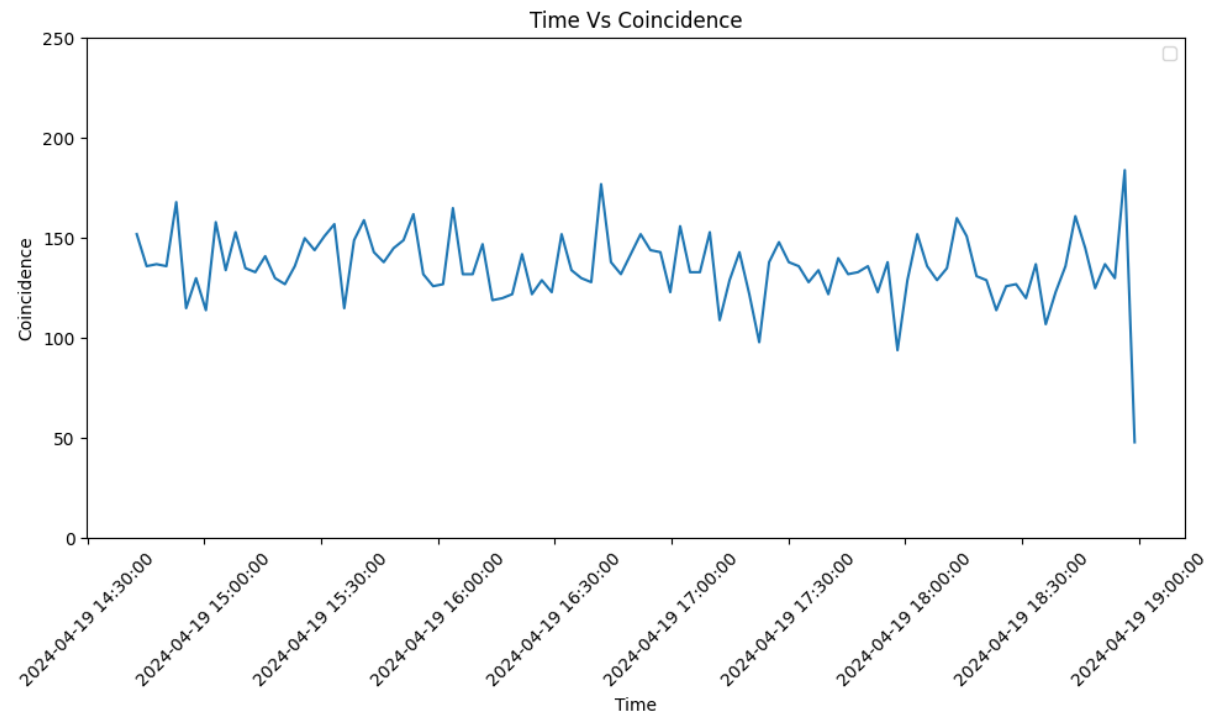
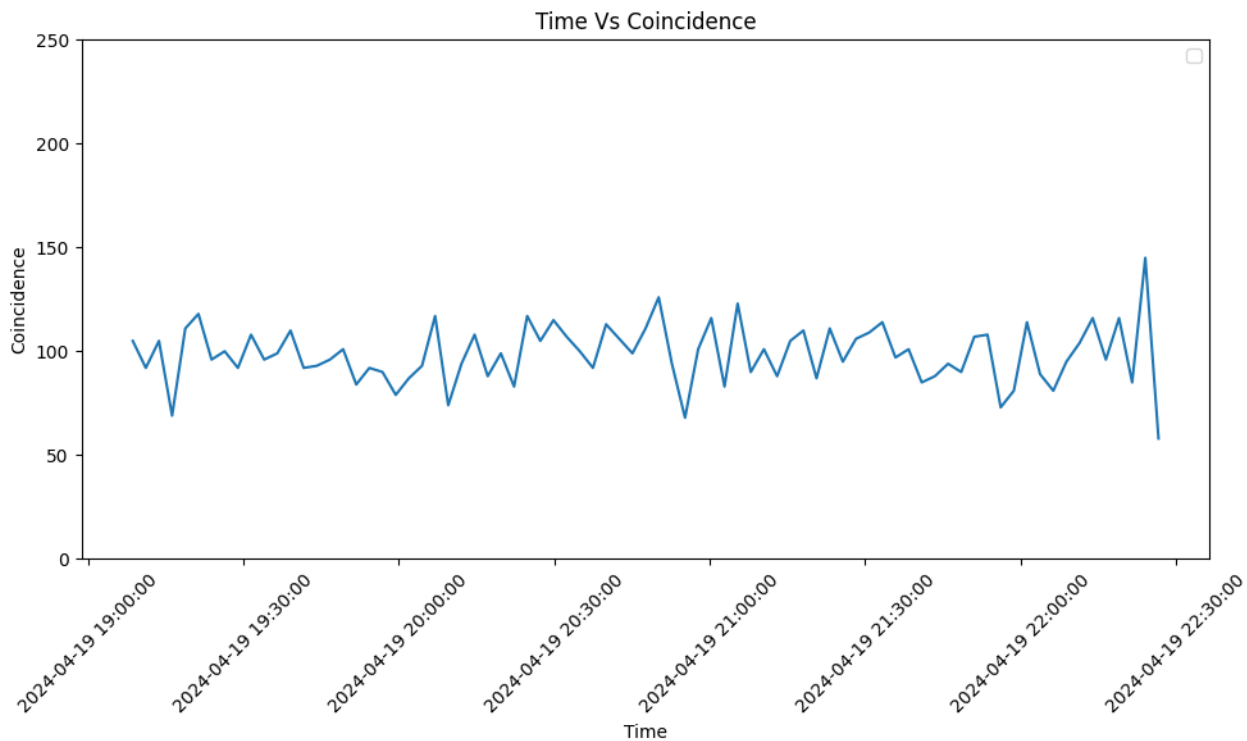


Run Control

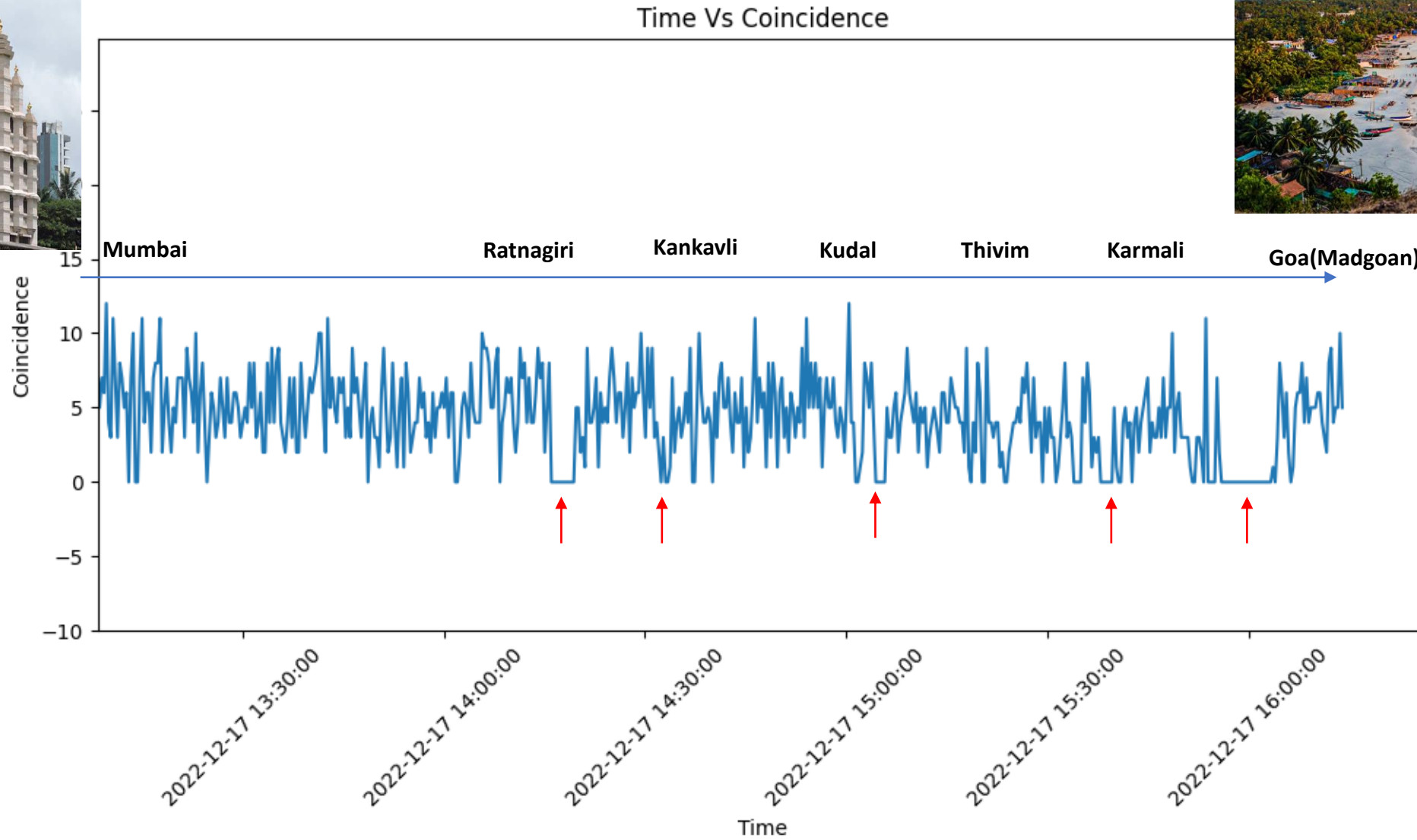
Results Part 1



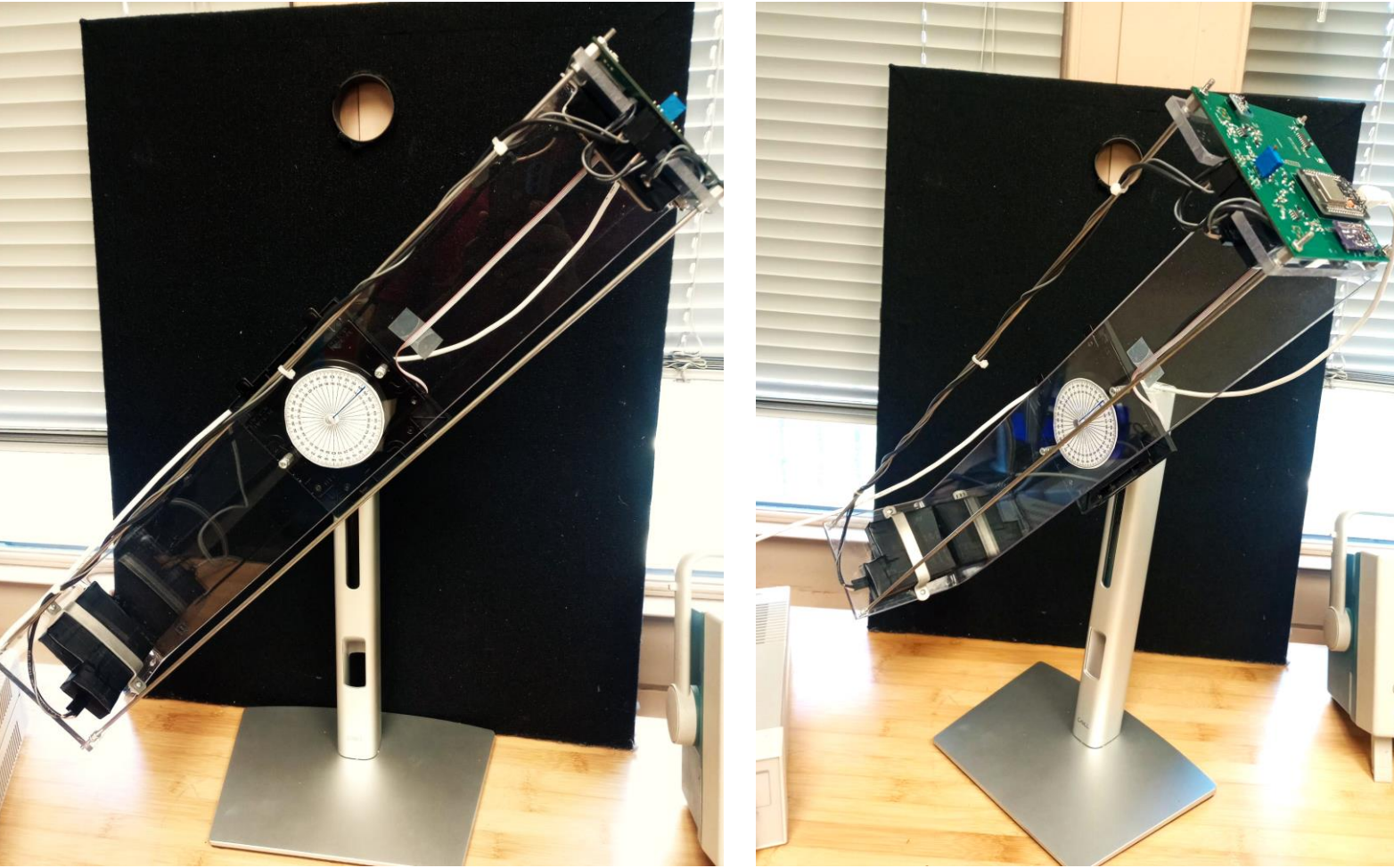
Results Part 2 : Source Testing



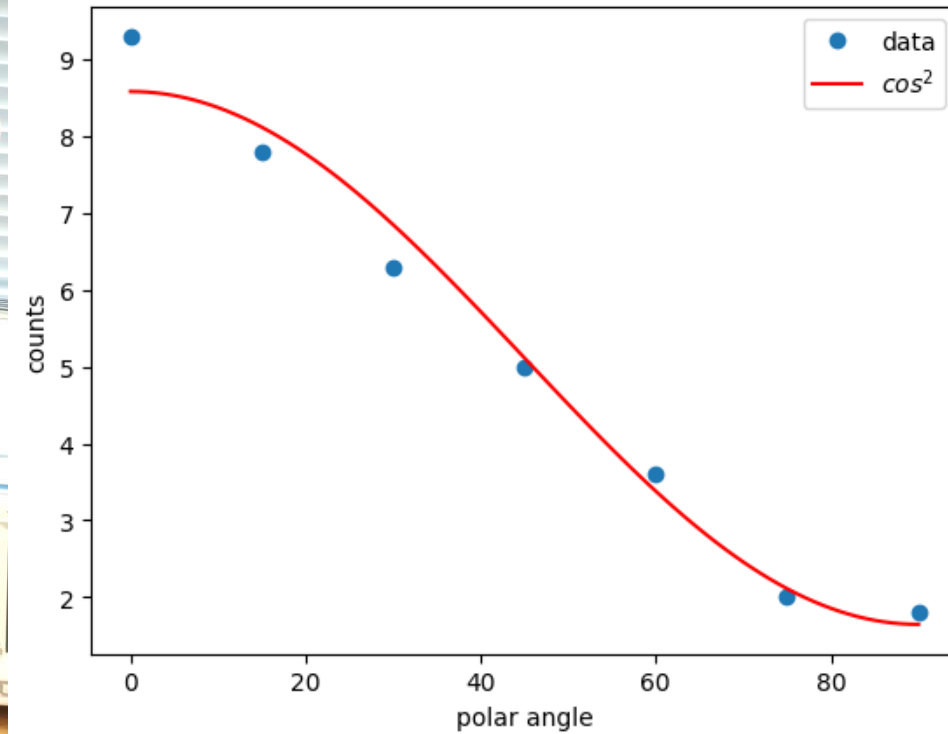
Results Part 3: Muon Flux under Tunnel



Results Part 4 : Angular Distribution



Detector Assembly to keep Detectors 50cm Apart



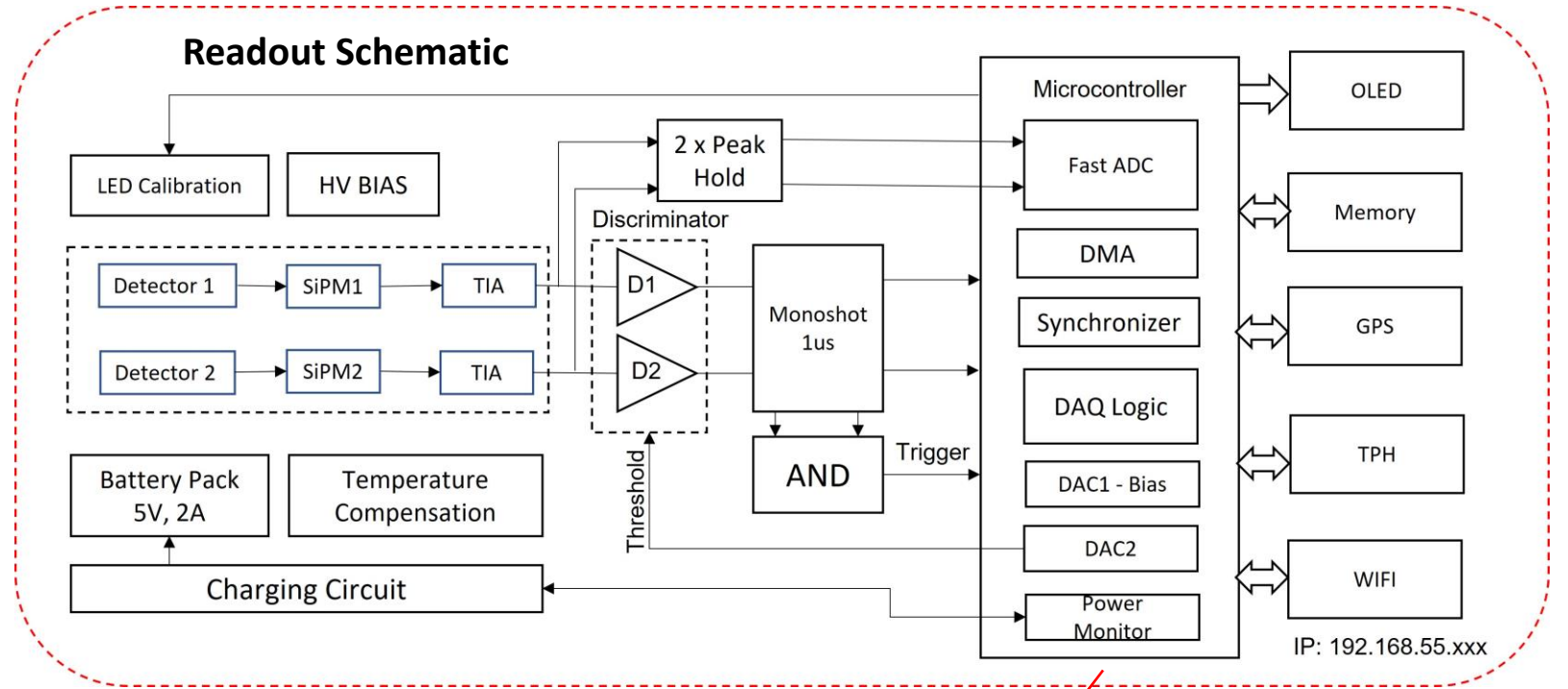
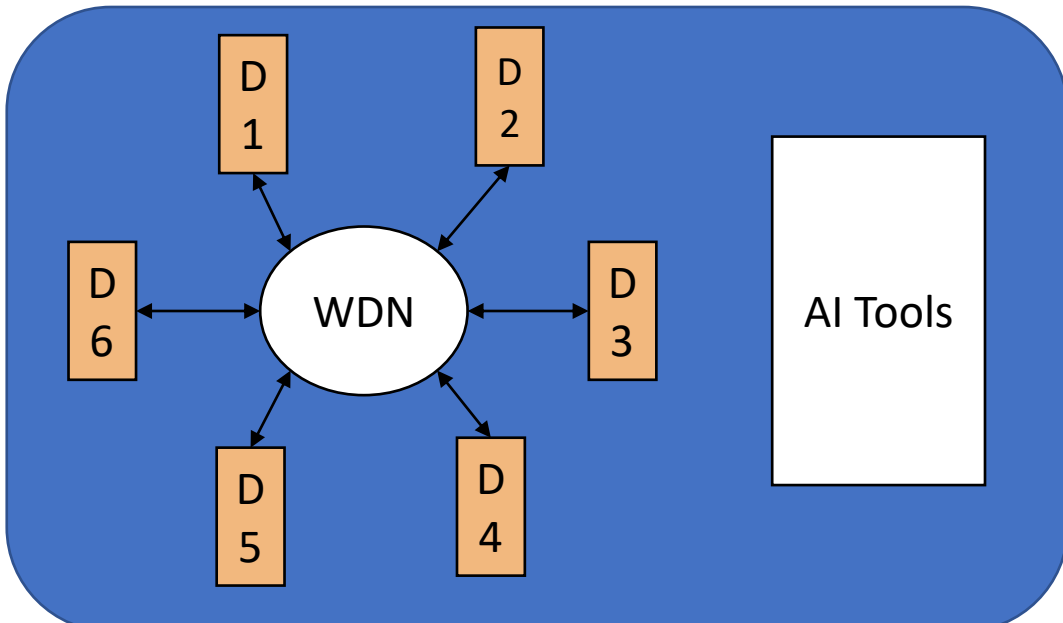
Prof. Danko, Istvan Zsolt, Instruction Lab

Phase 2:

Stack up View of Detector Assembly



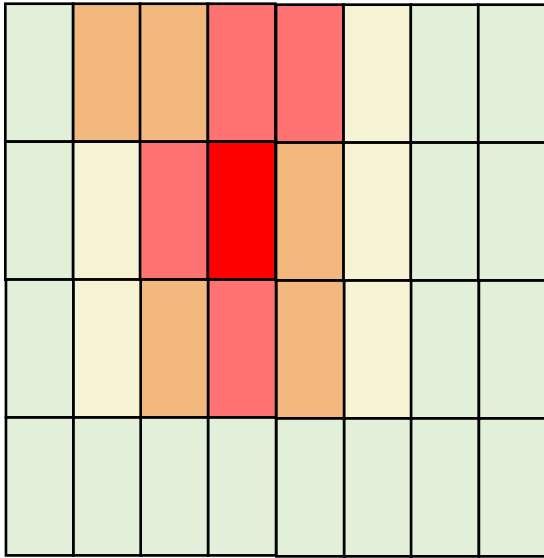
Wireless Detector Network



EFM32WG380F256-QFP100

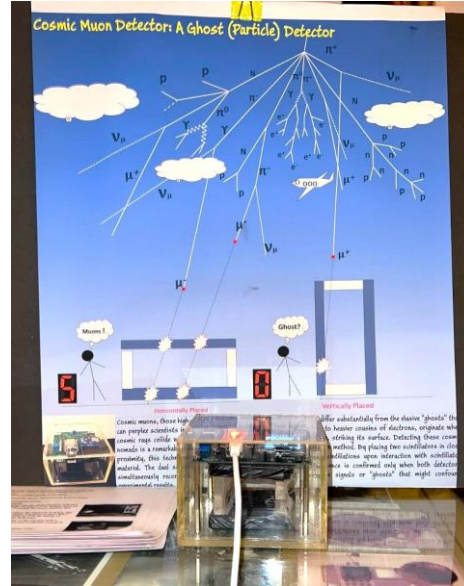
Phase 2 : Applications

Background Measurement



WDN

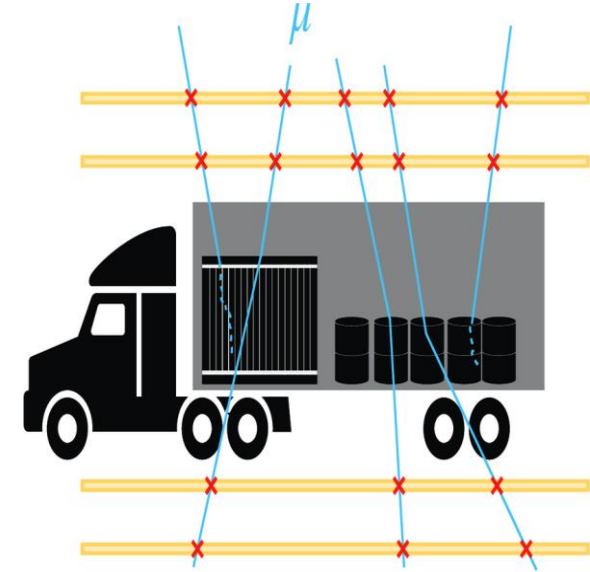
Educational Outreach



Balloon Flight

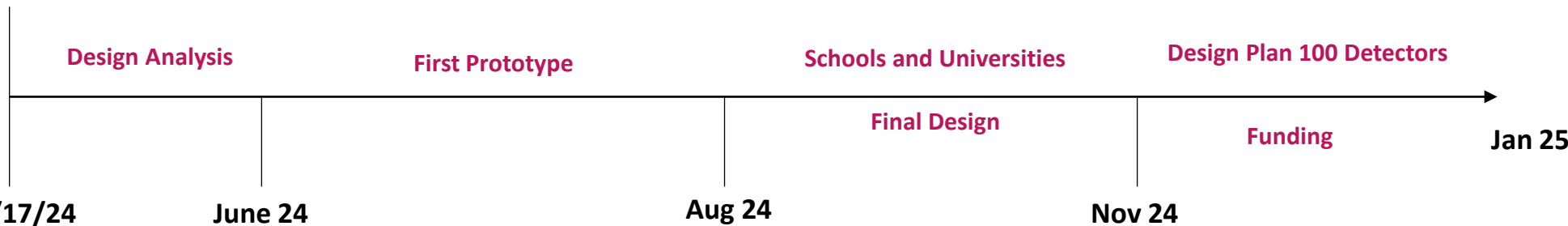


Cargo Scanning



DOI:[10.3390/instruments7010013](https://doi.org/10.3390/instruments7010013)

Time Line



Inspiration and Credits

Conclusion

Phase 1 : Completed

Learnings:

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

Phase 2 : Started

- Design Specification
- Scintillator Selection
- Budgeting

MIT Cosmic Watch Program



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

Open Gamma Detector



<https://github.com/OpenGammaProject>

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 Upadhyya, 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