Mu3e experiment - filter farm and camera alignment system

By

Haris Murugan

Supervisor: Prof. Dr. Niklaus Berger

"Mid Term Review 2022"

European Commission

Intense

JG|U

Johannes Gutenberg-Universität Mainz

June, 2022

Self Intro

- My name is Haris Avudaiyappan Murugan and I'm from Madurai, India.

- BS-MS dual degree (August 2016 - June 2021)

- Indian Institute of Science Education and Research (IISER), Berhampur, India.

- Master's Thesis Title: "Searches for Pentaquark States with the STAR Experiment At RHIC"

- Abstract: "We present the results on the search for pentaquark candidate that neutrally decay through ΛK_s^0 decay channel, with the STAR experiment at RHIC in minimum bias Au+Au collisions at $\sqrt{s_{NN}}$ = 39 GeV. The methods used in optimization of topological cuts and in reconstruction of the pentaquark state are discussed in this thesis work. We search the ΛK_s^0 invariant mass distribution to identify the signals that correspond to possible pentaquark candidate."

- Started as Marie Curie Early Stage Researcher (ESR) and PhD in physics at Universität Mainz in October 2021.

PhD Requirements

- I have completed the teaching assistantship of Advanced Practical course on Balmer series for the summer semester, 2022.

# Workshops and Conferences

- Attended the International Workshop on Cosmic-Ray Muography 2021, Gent, Belgium online.

- Attended the DPG Conference, Heidelberg online, 2022.

- Mu3e Collaboration Meeting at PSI, 2022.

- Attended muEDM Workshop Pisa online, 2022.

- Will attend the Italian Summer Student Program at University of Pisa.

Mu3e Experiment
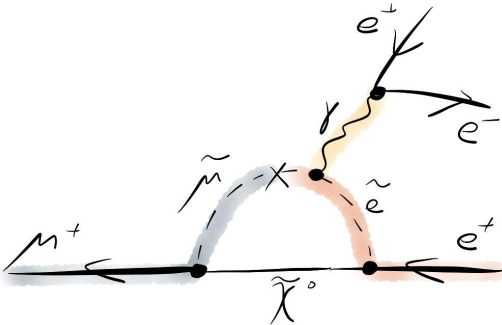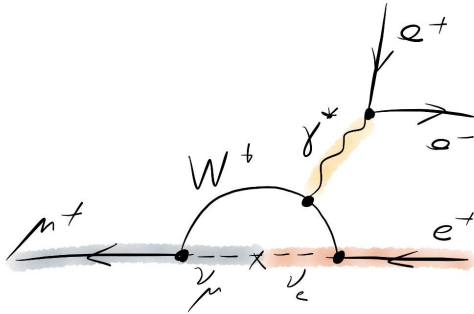
- The Mu3e experiment searches to observe or exclude the decay of a positive muon to two positrons and an electron.

- Such an observation would be a violation of the lepton flavour conservation and indicate for Physics Beyond the Standard Model of particle physics.

- In standard model, the lepton flavour violating decay is possible via neutrino mixing but suppressed to a branching ratio $Br < 10^{-54}$.

- SINDRUM achieved $Br < 10^{-12}$ (1988) PSI.

- The Mu3e experiment will observe more than $> 10^{16}$ muon decays in order to probe existence of new physics beyond the standard model in the $Br > 10^{-16}$.
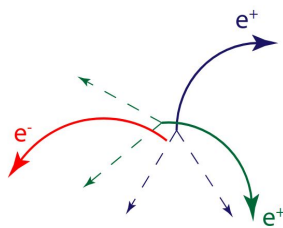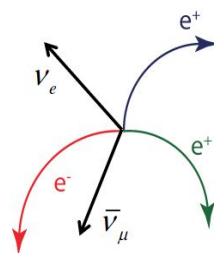
Mu3e Detector
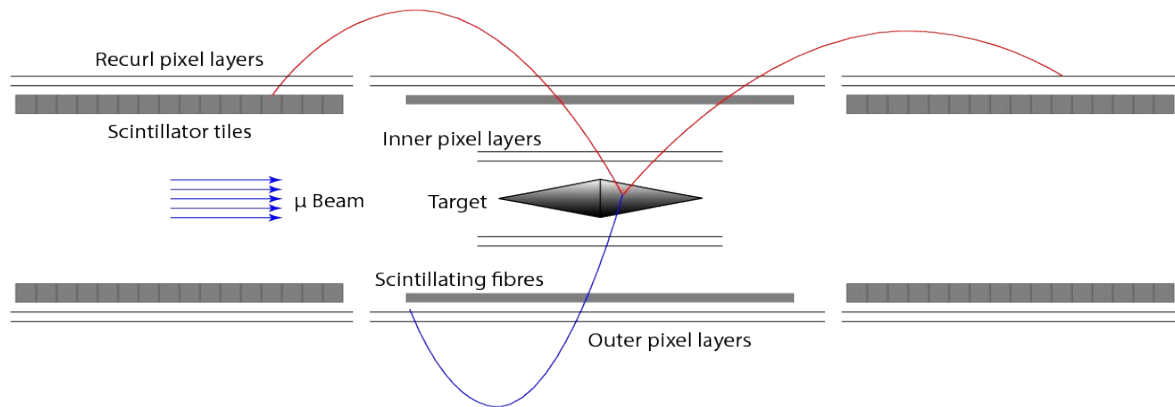
Schematic diagram of Mu3e detector.
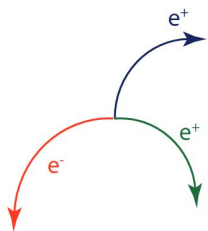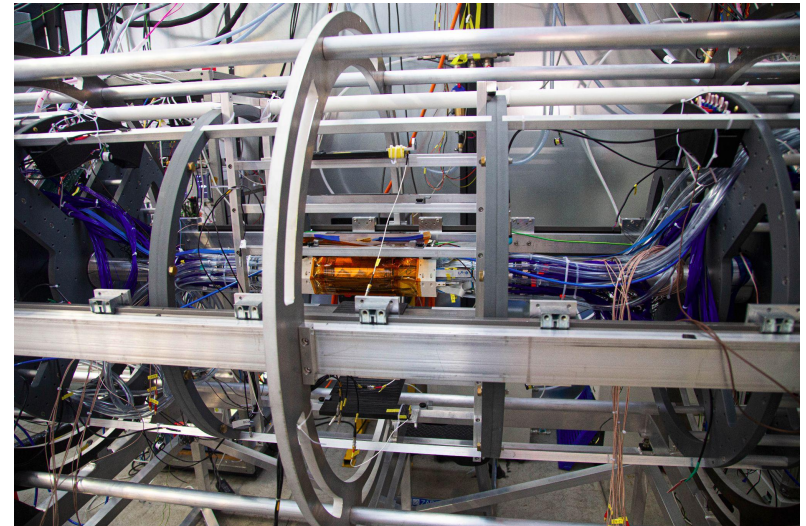

Signal

Combinatorial Background

Internal photon conversion
(Br = 3.4×10^{-5})

| Detector	Rate (Gbit/s)
Pixel sensors	43
Fibers	26.3
Tiles	11.6
Total	80.9

Cosmic Run - PSI

- The Mu3e detector components were assembled to test run various subsystems in a helium atmosphere to detect the cosmic muons. (March - May, 2022)
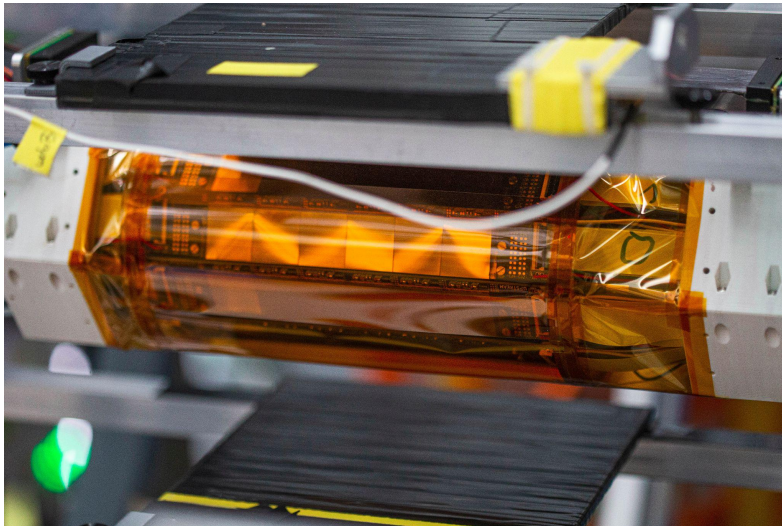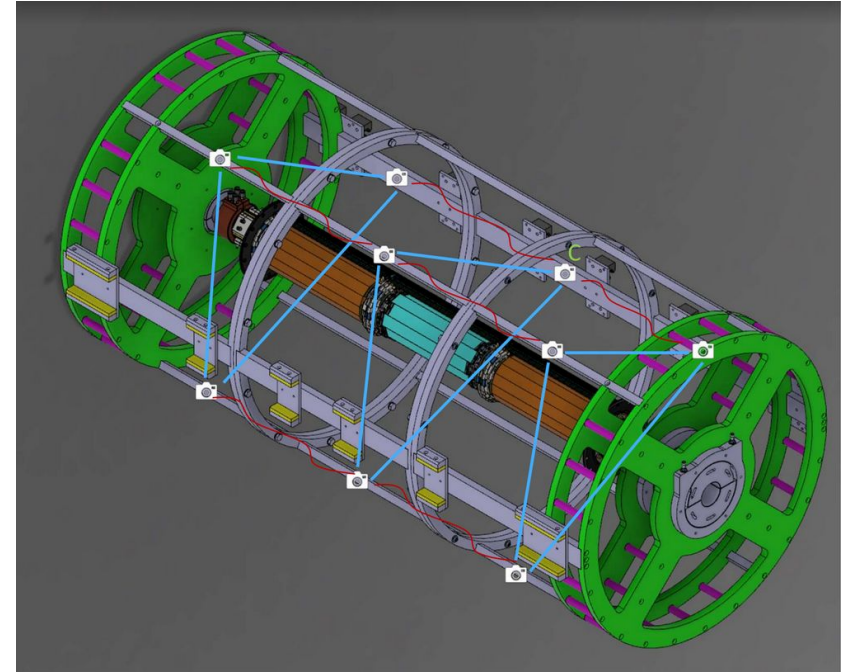
Filter Farm

- Objective of the Filter Farm is to select signal candidate events by reconstruction of tracks and vertices. The data rate is decreased by over a factor of 100, reducing it to below 100 MB/s, which can be written to disk.

- For the Mu3e Cosmic Run 2022, Installed two Farm PC in the counting house.

- Successful at implementing a parallel program using the GPUs to count events and hits of cosmics.

- Integrated the GPU firmware with the MIDAS Data Acquisition.
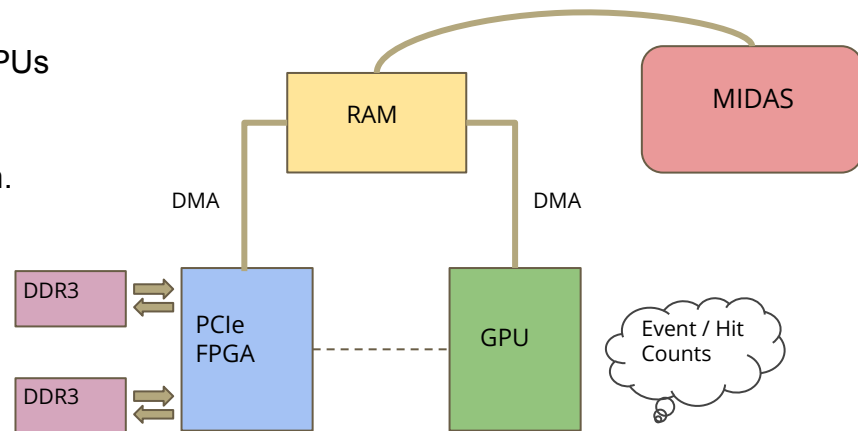
Camera Alignment System

- The main goal is to drive the camera measurement precision to be comparable to the individual tracking detector pixels, which is at 80 μm.

- The detector system is viewed as 3 individual detector components.

- Camera system with 3 cameras at the middle of each component.

- LEDs are mounted on the camera to triangulate the position measurements of individual cameras.

Camera Images
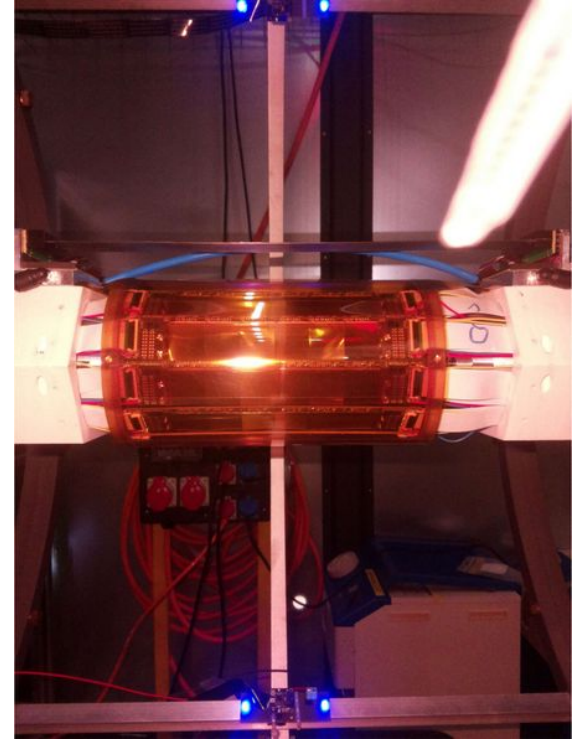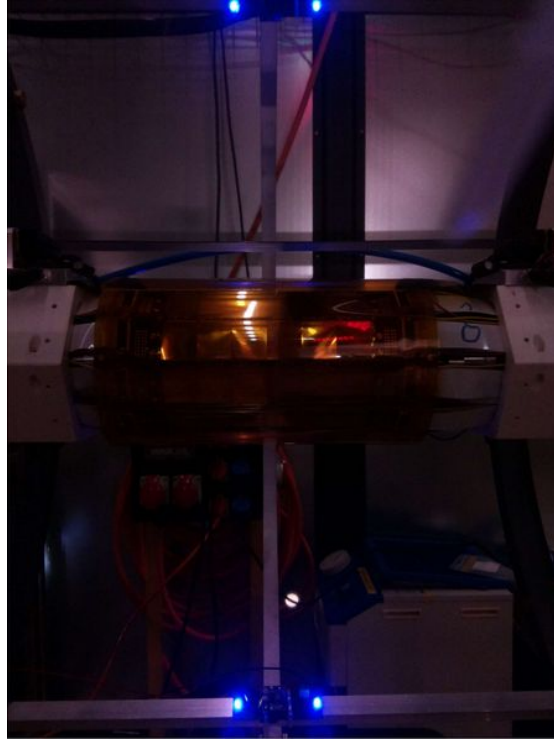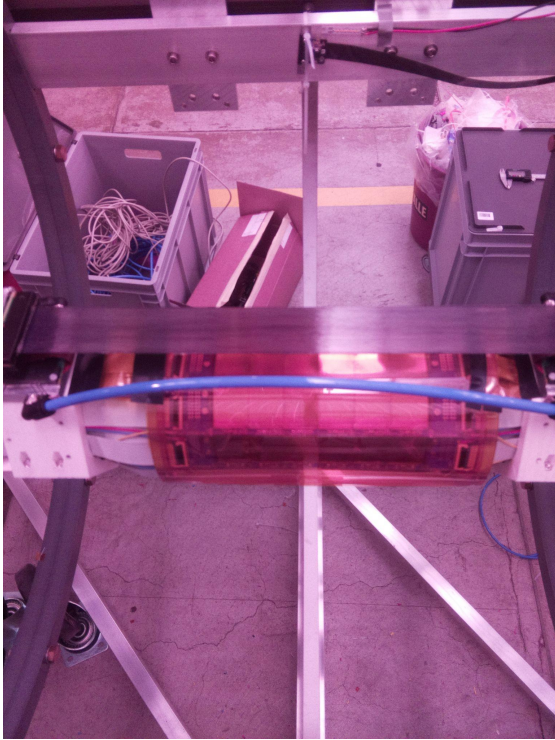
Things to do:

- Develop firmware for the GPU selection in the filter farm.

- Integrate multiple Farm PCs for the commissioning of the Mu3e Filter Farm.

- Online Reconstruction of Tracks in the GPU filter farm.

- Pattern recognition to detect the misalignment in the position of the chips.

- Need to answer the question of if it would be precise enough to identify misalignments at the pixel level.

Thank You