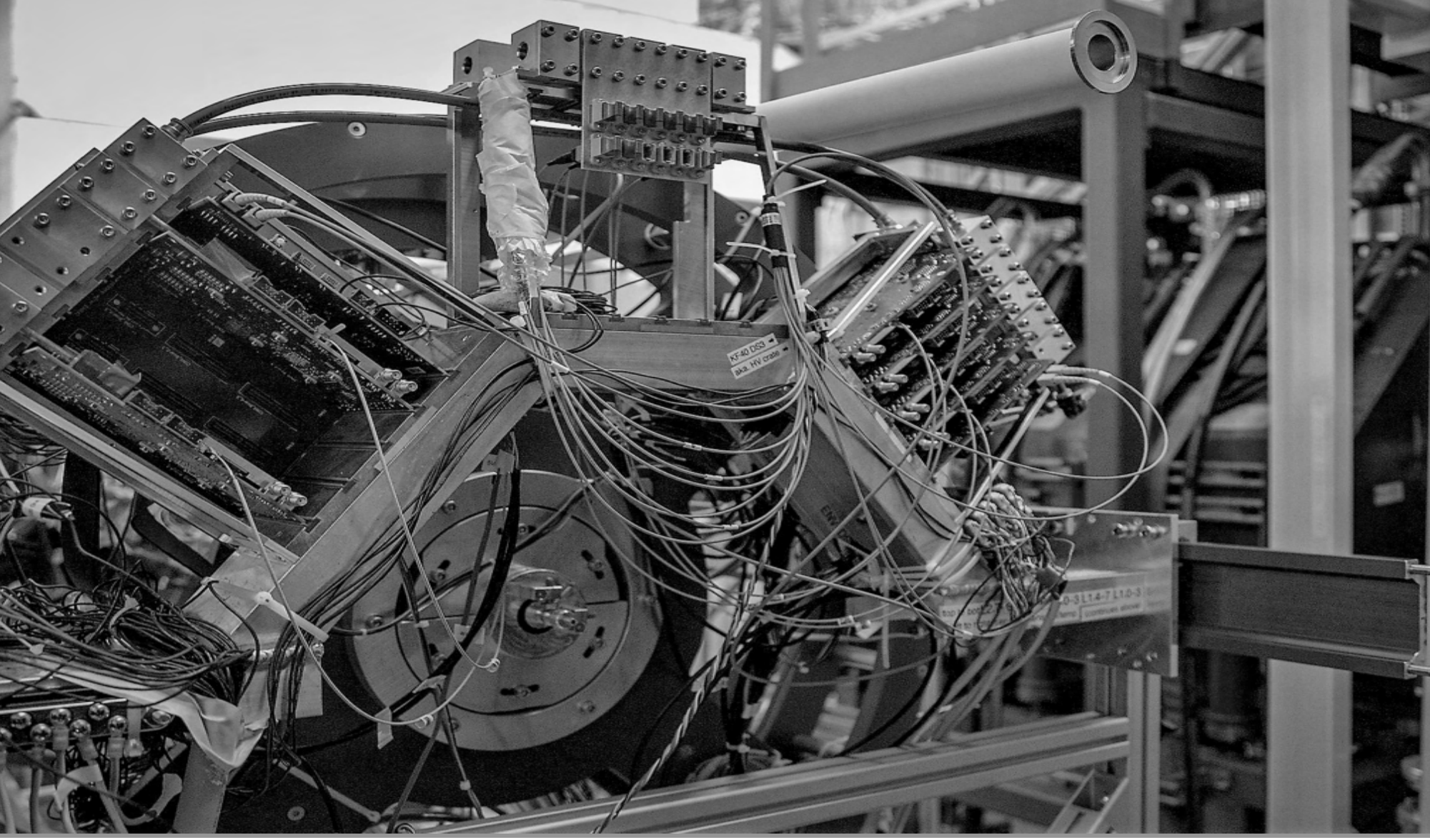


JG|U

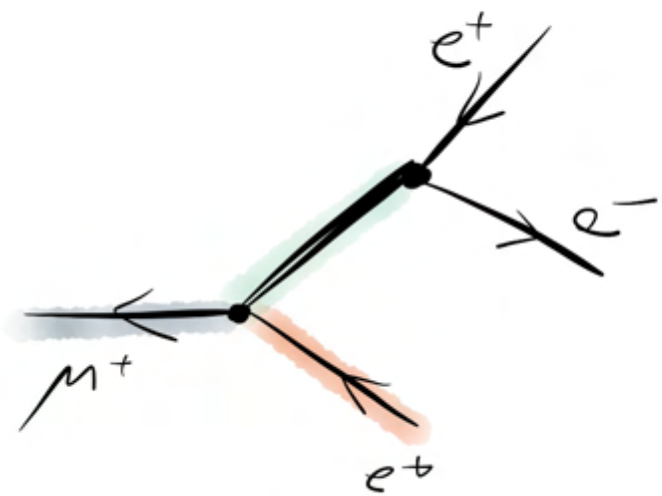
JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Tests of the Mu3e DAQ in the Cosmic Run 2022

Martin Müller, DPG Spring Meeting 2023

Mu3e

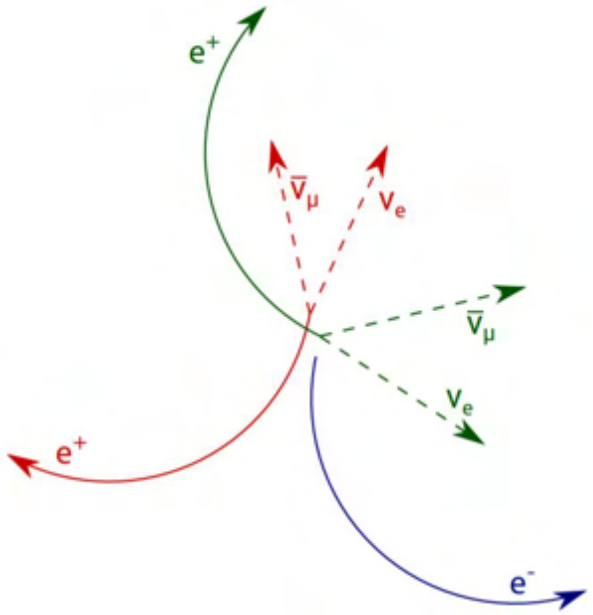
$\mu^+ \to e^+ e^- e^+$



Mu3e

- search for the lepton flavour violating decay $\mu^+ \to e^+ e^- e^+$
- predicted branching ratio of 10^{-54} (not observable)
- observation of $\mu^+ \to e^+ e^- e^+$ would be a clear sign for new Physics

Introduction
Background processes



Background processes:

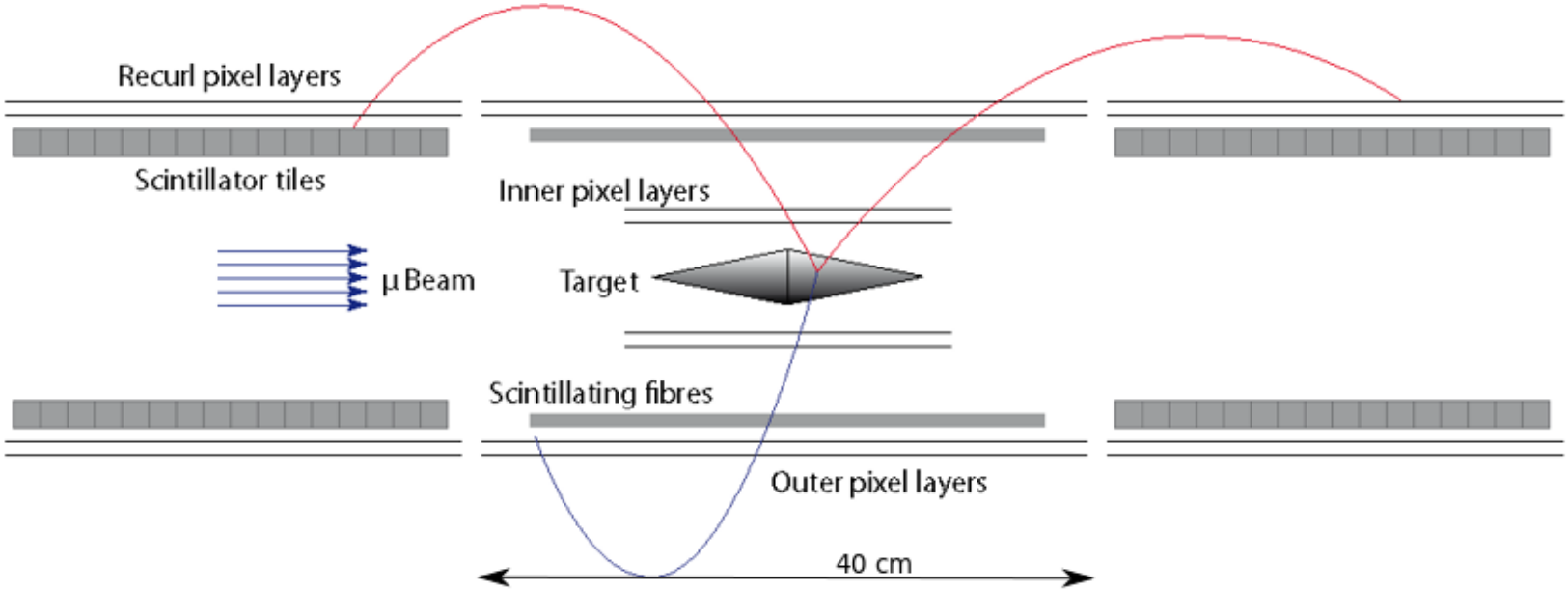
- $\rightarrow$
- combinatorial

For **signal** events: $\sum \vec{p} = 0$, $\sum E = m_\mu$, $\Delta t = 0$, same vertex

Low electron momenta $\rightarrow$ multiple scattering $\rightarrow$ material budget

Introduction

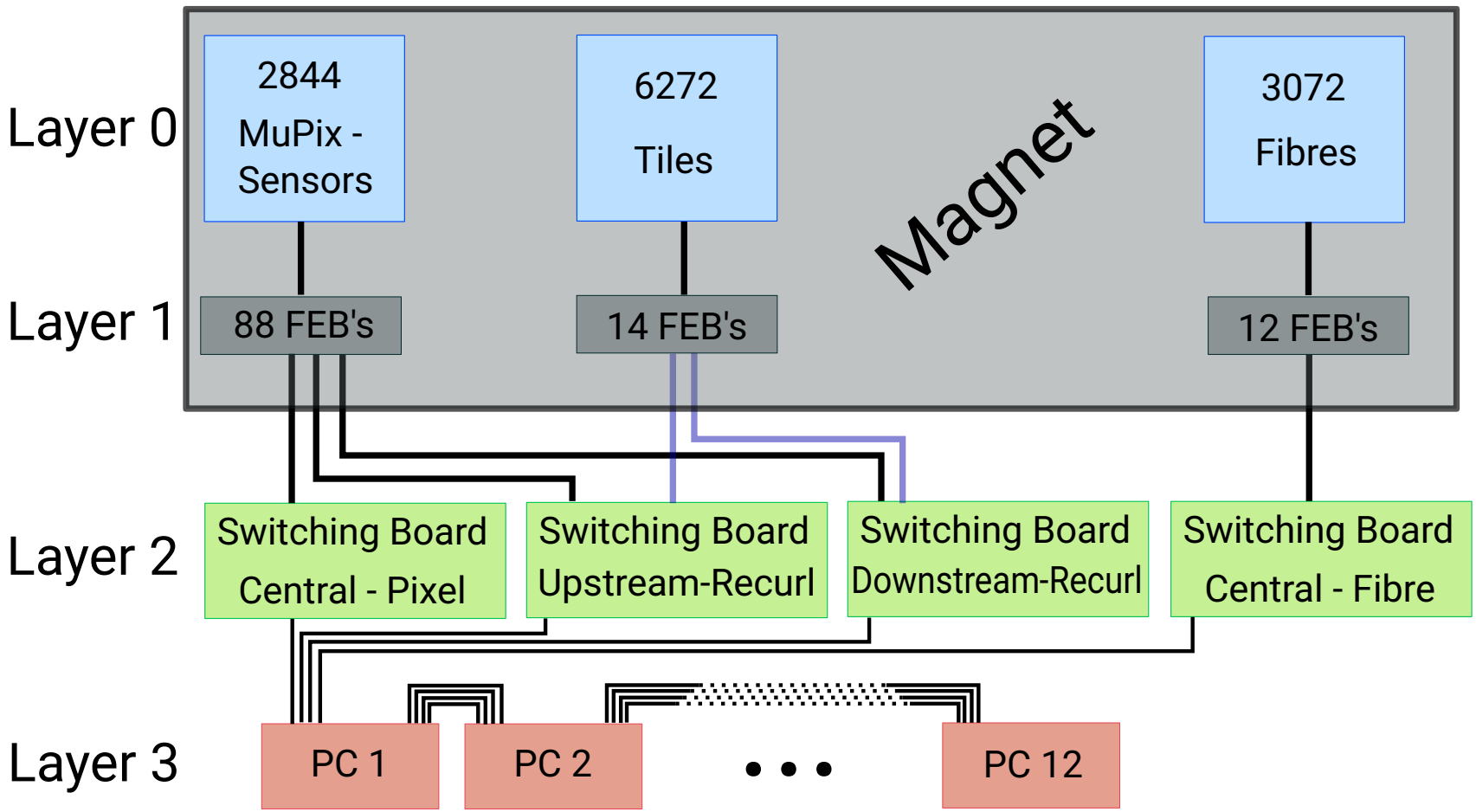
The Mu3e Detector



- 6 layers of pixel sensors ($t_\sigma = 10$ ns)
- scintillating fibres (t_σ =500 ps) & tiles (t_σ =70 ps) to increase timing precision
- 10^8 Muons/s decaying at rest in the target
- expected data rate of up to 80 GBit/s

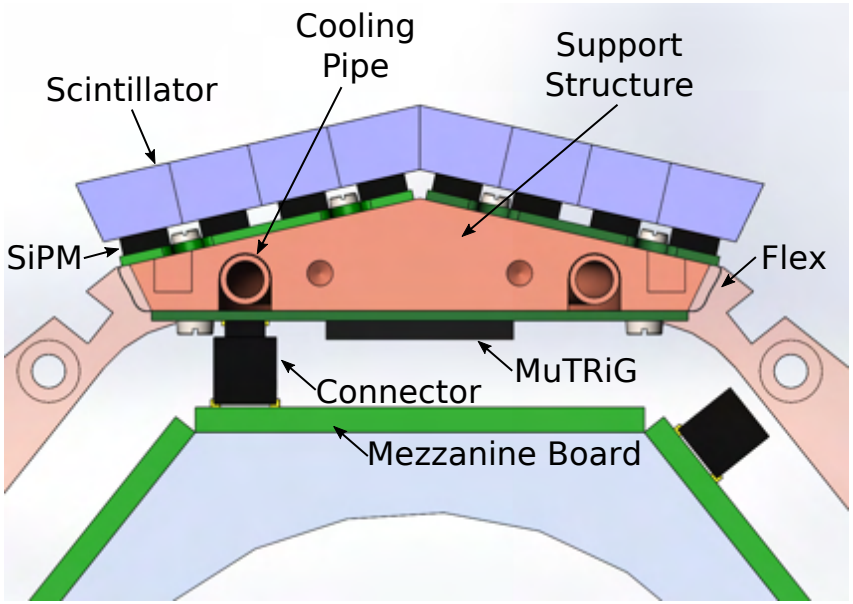
DAQ System

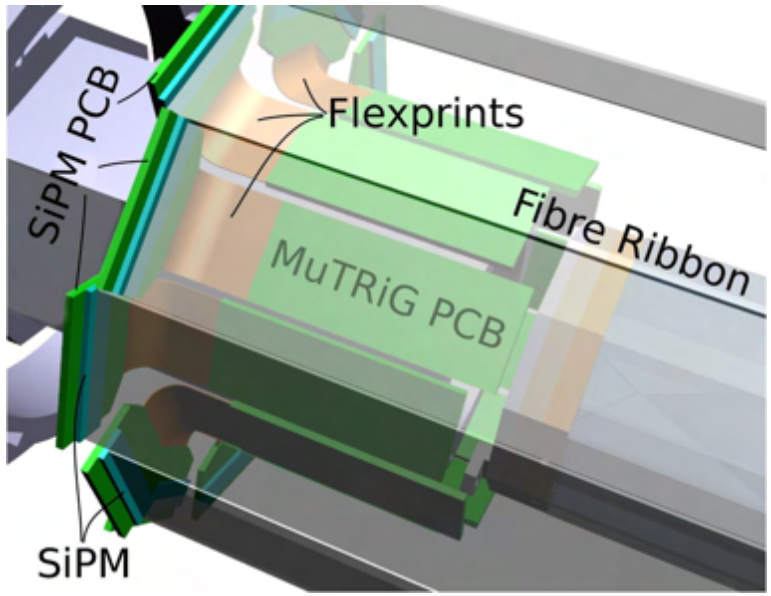
Overview

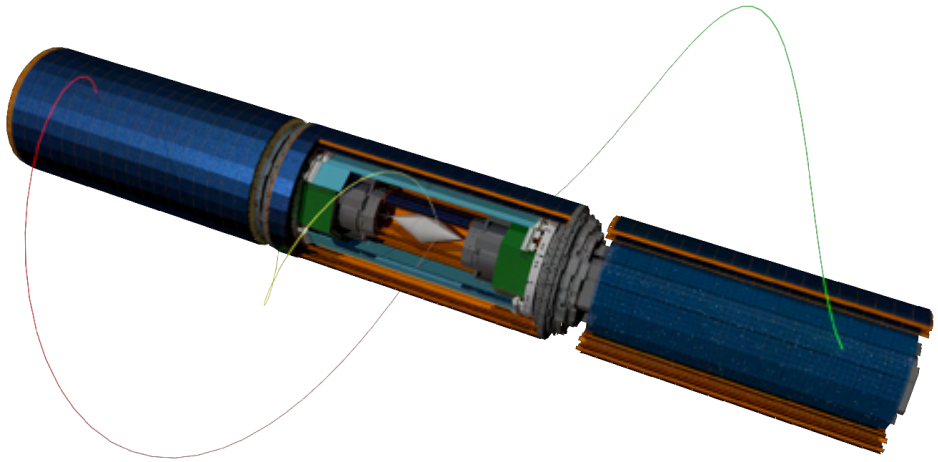


Layer 0

Subdetectors, Subdetector Readout ASICs



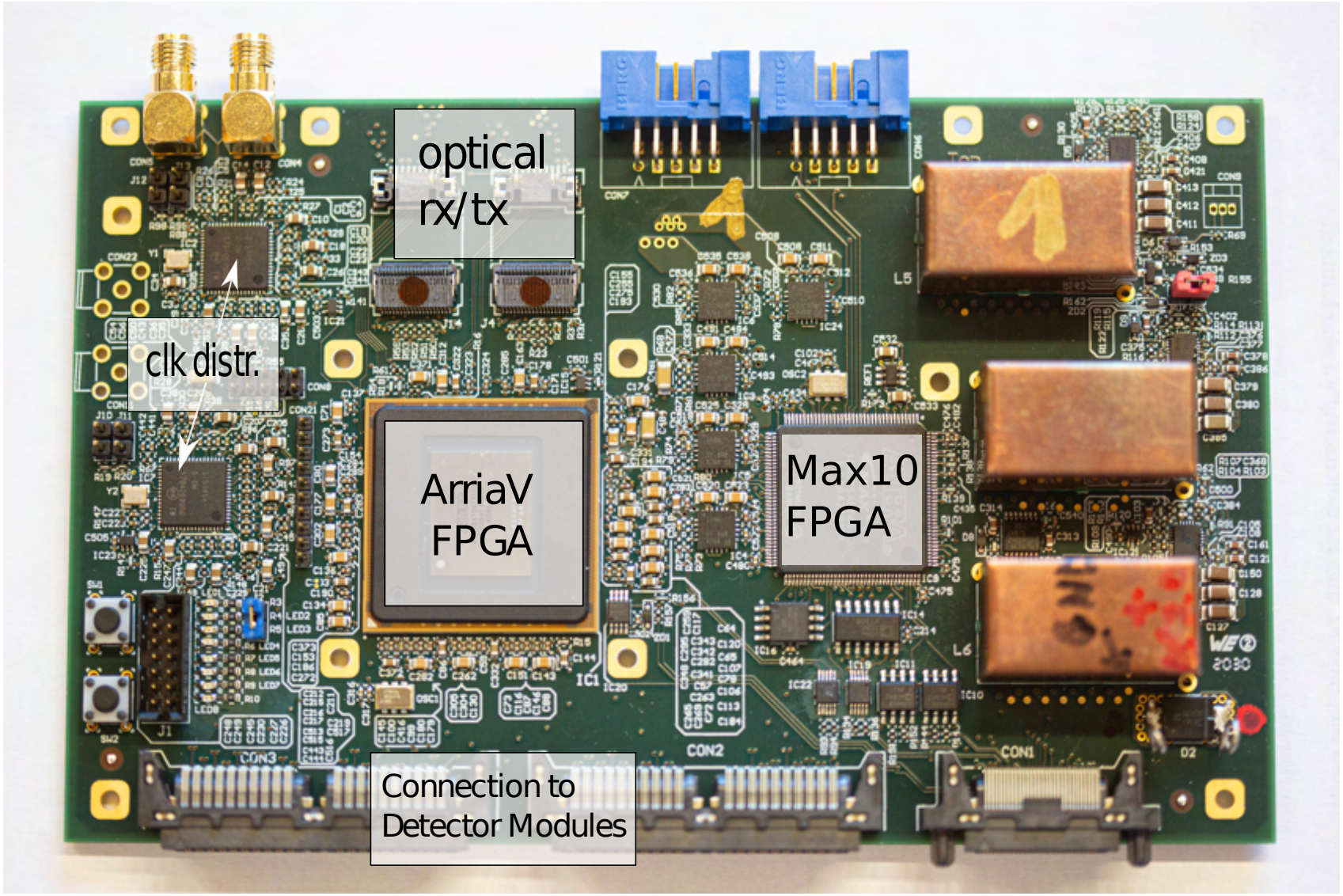


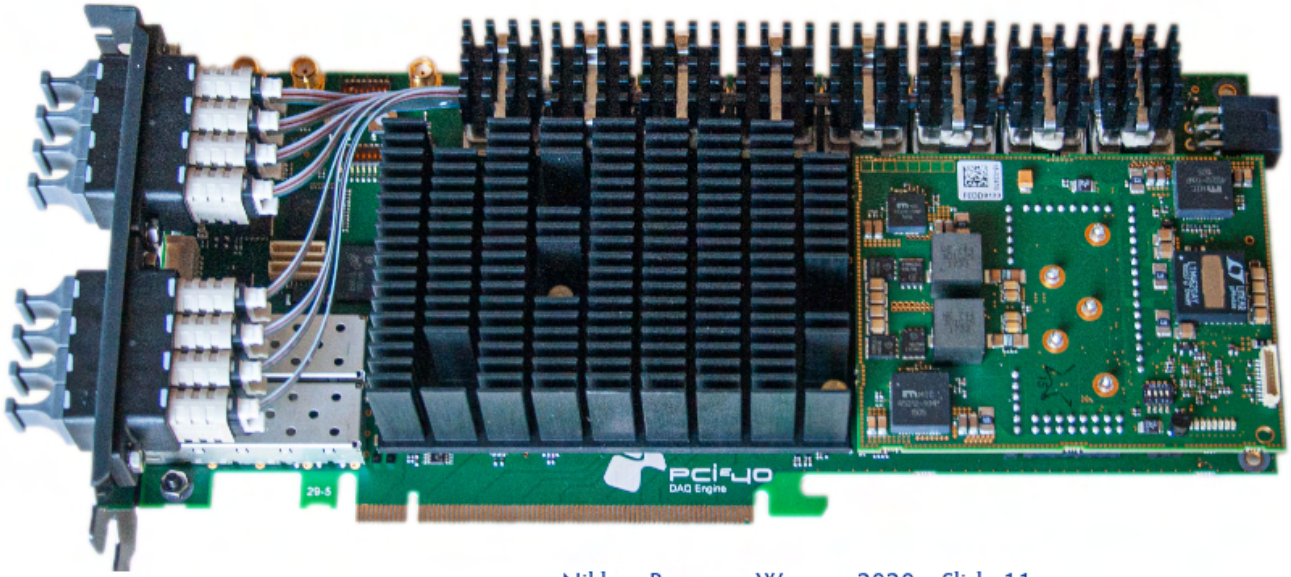


- Scintillating fibres and tiles coupled to SiPMs and read out by the Mutrig ASIC
- 6 layers of Mupix Pixel sensors (HV-MAPS)
- 1.25 Gbit/s LVDS per ASIC

Layer 1

FE Board





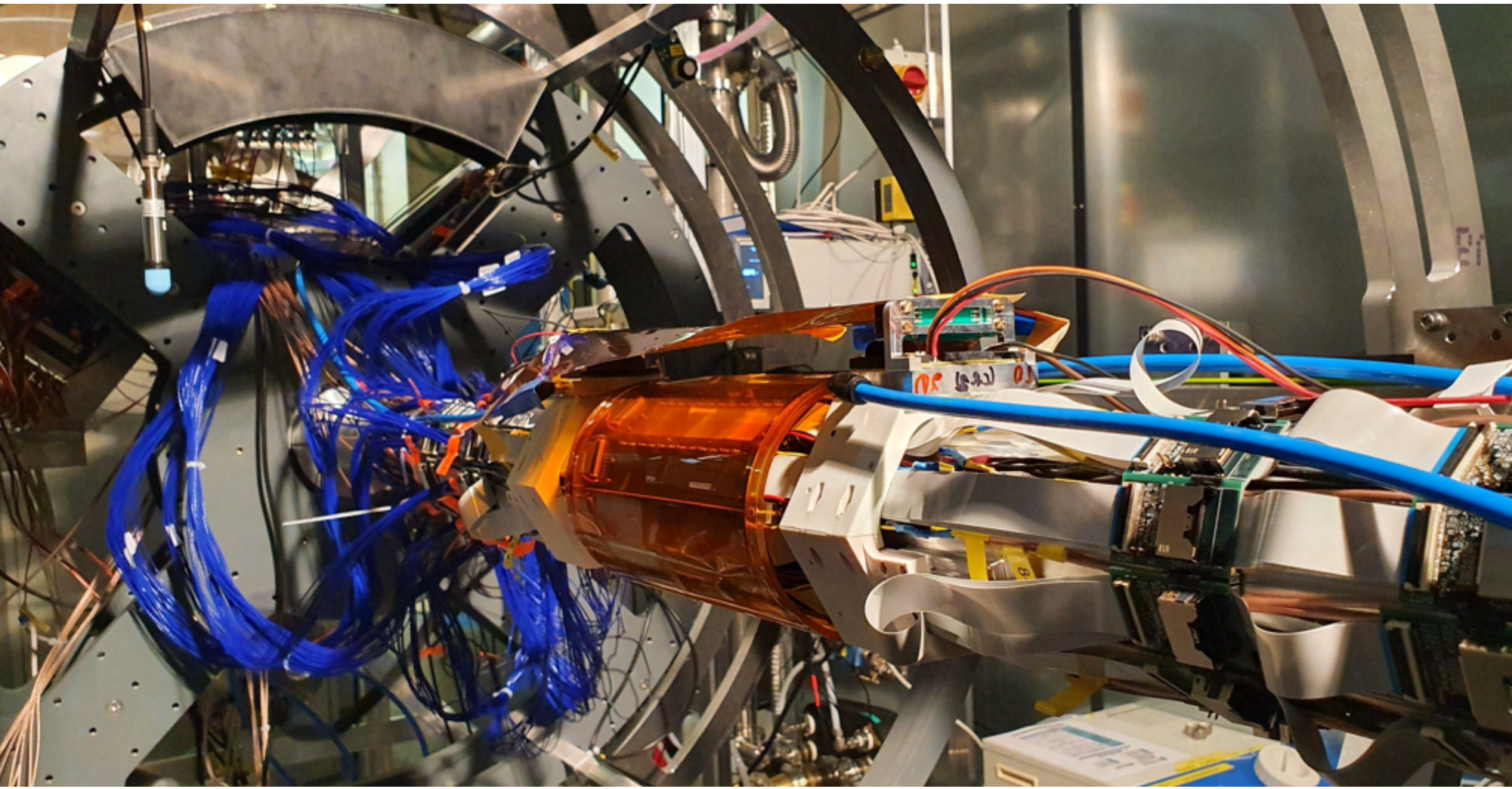
- PCie40 Board for the LHCb / Alice collaboration
- 48 optical in- and outputs
- Control and configuration link to the DAQ software (MIDAS)

Layer 3
GPU filter Farm

- Farm of servers using only commercial hardware
- terasic DE5a Arria10 Fpga Boards (as optical receivers)
- GPU's to run the track reconstruction (T 122.3)

Cosmic Run 2022

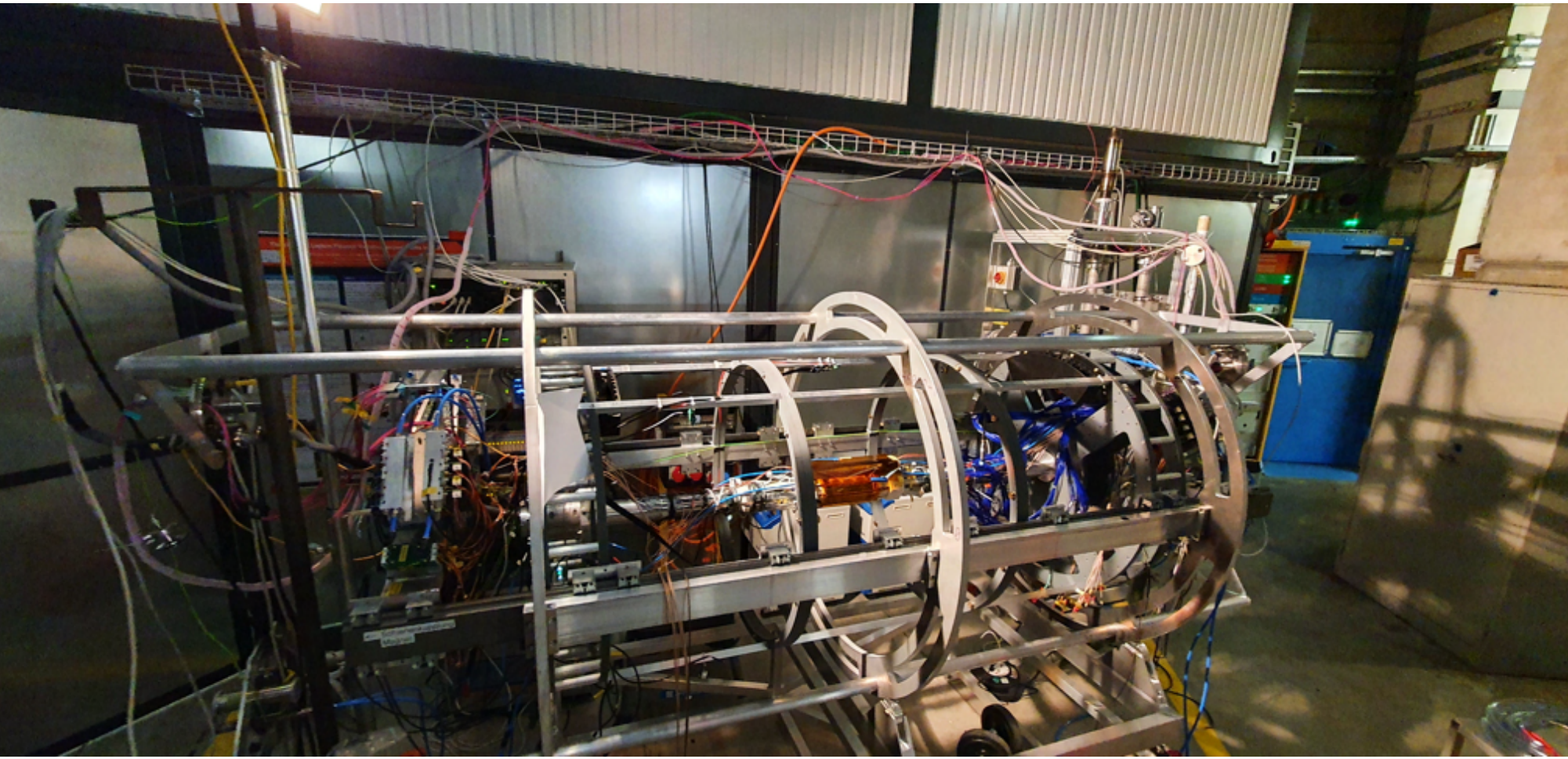
Detector Prototype



- Prototype: 2 Inner Pixel layers, 1 Scifi Module
- development of tuning procedures, QC tests, cooling tests, ...

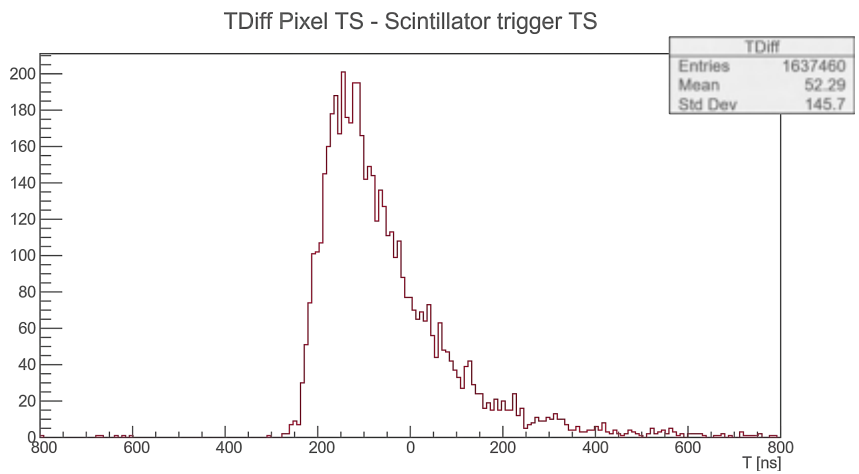
Cosmic Run 2022

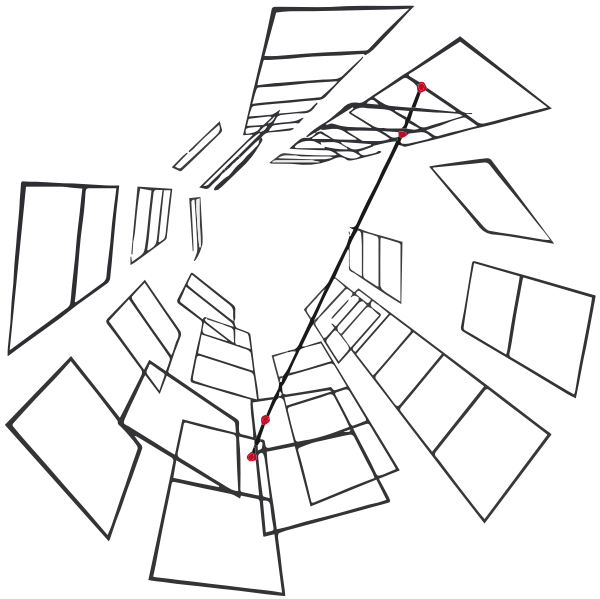
Frame and Infrastructure

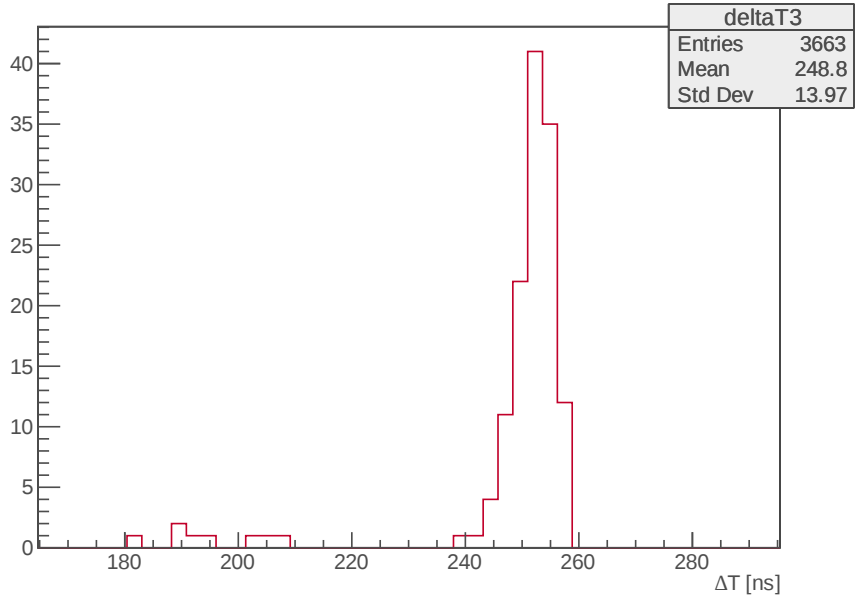


- Exercised building and operating various systems,infrastructure
- established staging area which will also be used for final construction

Cosmic Run 2022
DAQ Sanity checks

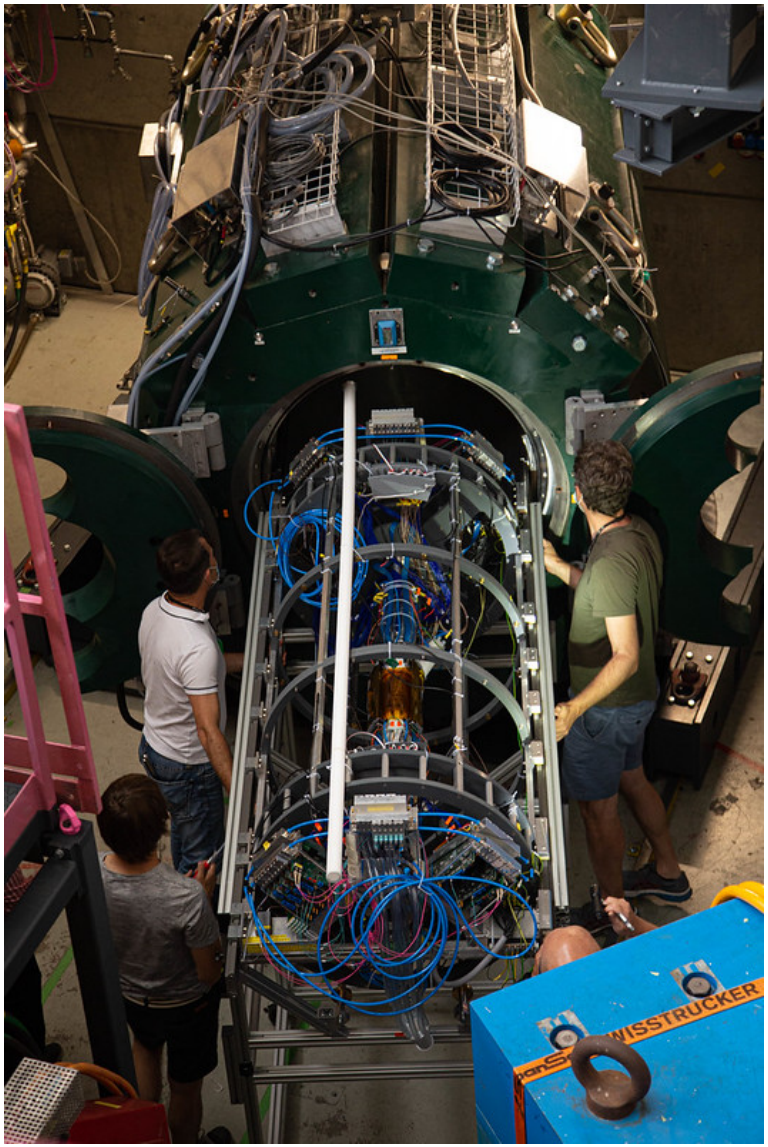






- tested synchronization of detector subsystems
- first track reconstruction in the Mu3e barrel with real data

Conclusion and Outlook



- For the DAQ this was a commissioning run
- All other systems tested building and operating prototypes
- The cosmic run was a final dress rehearsal, building of the final detector is next
- Will use the cosmic run area for continuous tests as the detector modules are assembled