Beam Tests of the DAQ for the Mu3e Experiment

Marius Köppel[1] for the Mu3e Collaboration[2]

[1] PRISMA+ Cluster of Excellence and Institute of Nuclear Physics, JGU Mainz

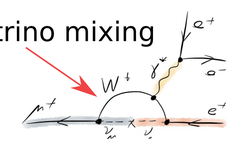
[2] Paul Scherrer Institute (PSI), Uni Bristol, Uni Geneva, Uni Heidelberg, KIT Karlsruhe, Uni Liverpool, UCL London, JGU Mainz, Uni Oxford, ETH Zürich, Uni Zürich

Summary

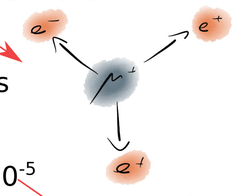
The Mu3e experiment searches for the lepton flavour violating decay of a muon into two positrons and one electron electrons. The experiment aims for an ultimate sensitivity of one in 10^{16} decays. The highly granular detector based on thin high-voltage monolithic active pixel sensors (HV-MAPS) and scintillating timing detectors will produce about 100GB/s of data. This poster presents the ongoing integration of the sub detectors into the Field Programmable Gate Array (FPGA) based readout system which is used to sort and transport the data to the filter farm. Integration test-beam campaigns are conducted to test and integrate the different detector systems.

The Mu3e experiment

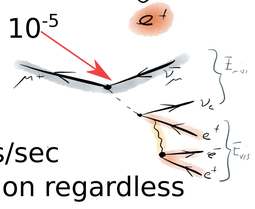
- Search for $\mu^+ \rightarrow e^+e^+e^-$
- Standard Model (SM) via neutrino mixing BR < 10^{-54}
- Observation of $\mu^+ \rightarrow e^+e^+e^-$ → Physics beyond SM



- Signal has one electron, two positrions from one vertex
- Random combinations as background from Michel decays with Bhabha scattering and photon conversion

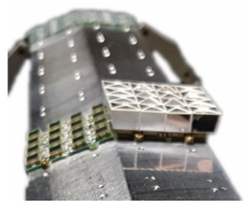


- SM background with BR < 3.4 10^{-5} → suppress background with good vertex, timing and momentum resolution

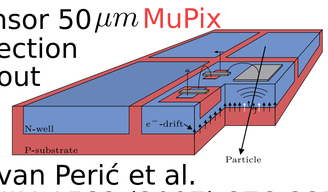


- High rats of 10^8 to 10^9 muons/sec
- Excellent momentum resolution regardless low momentum of electrons

→ Low material budget and multiple scattering



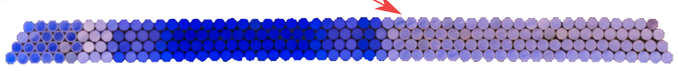
- Thin Si pixel sensor 50 μm MuPix
- Fast charge collection
- Integrated readout electronics



Ivan Perić et al.
NIM A582 (2007) 876-885

Scintillating tile detector with Timing of < 70 ps

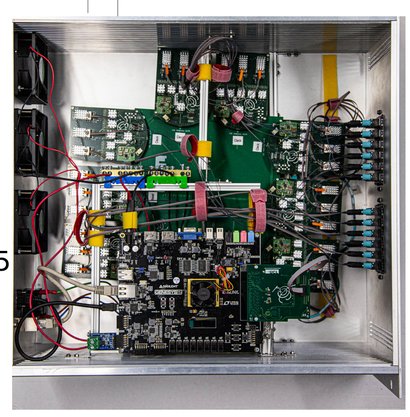
Scintillating fibres detector with Timing of < 500 ps



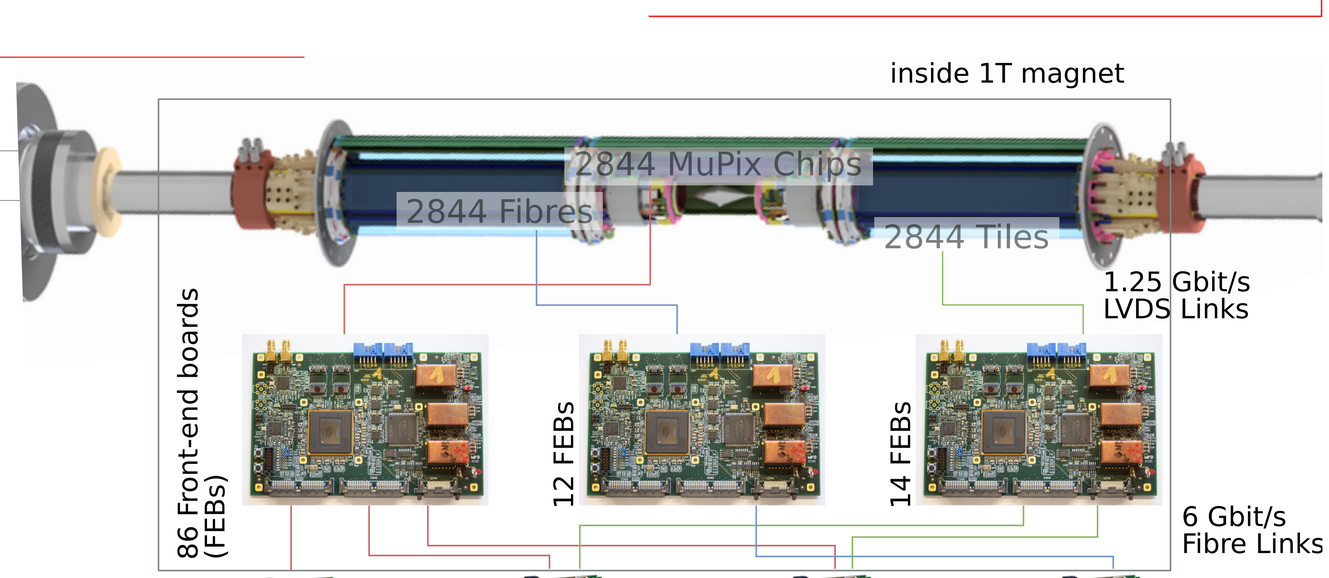
The Mu3e DAQ

144 copies of 125 MHz global clock

& run transition commands



Clock & Reset System

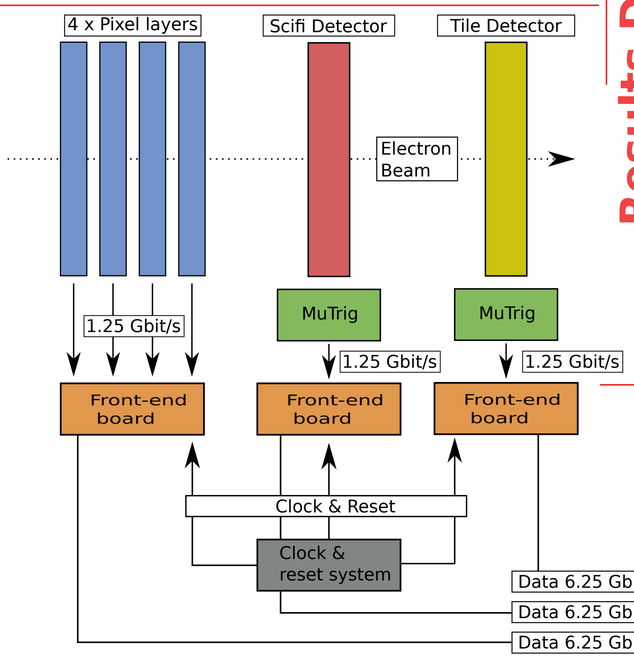


https://www.terasic.com

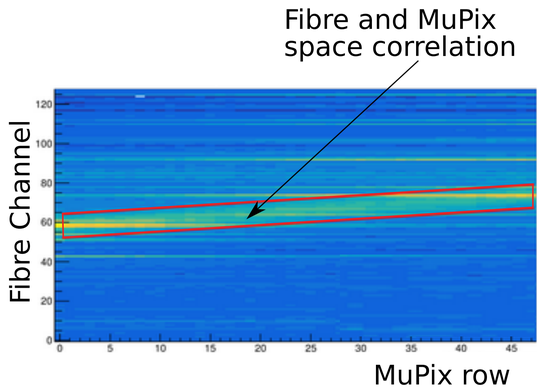
Filter Farm FPGA Boards with GPU selection

MIDAS Data Collection
https://midas.triumf.ca

DESY Setup

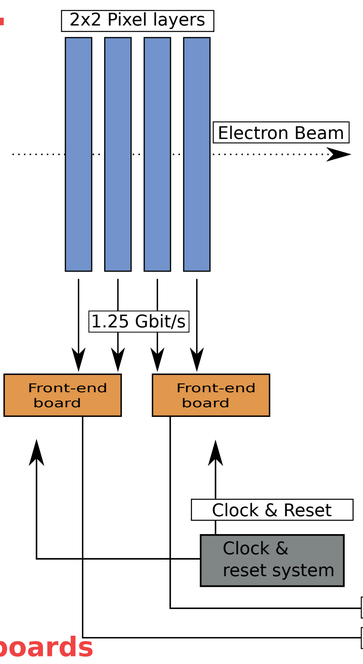


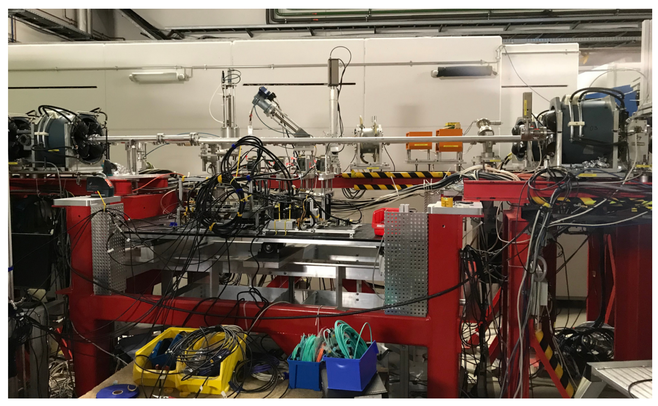
Results DESY



- Space correlations between different detectors
- Detector readout works for multiple Front-end boards

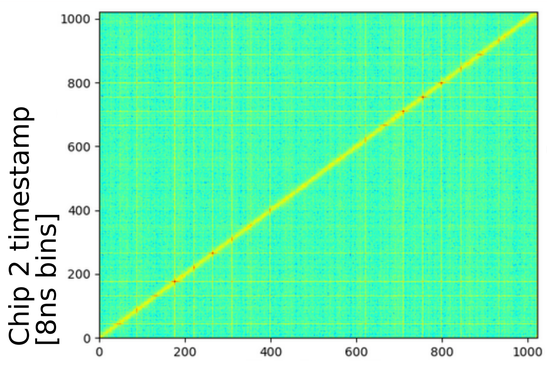
MAMI Setup



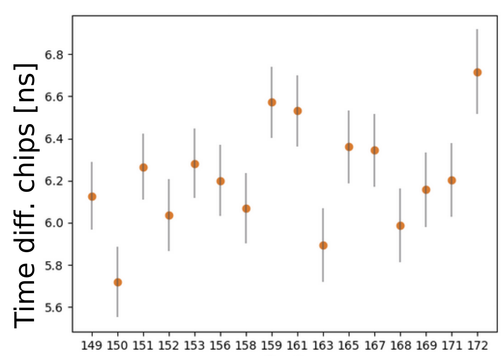


Current Status:
Working DAQ system
for multiple Front-end boards
and different detector typs

Results MAMI

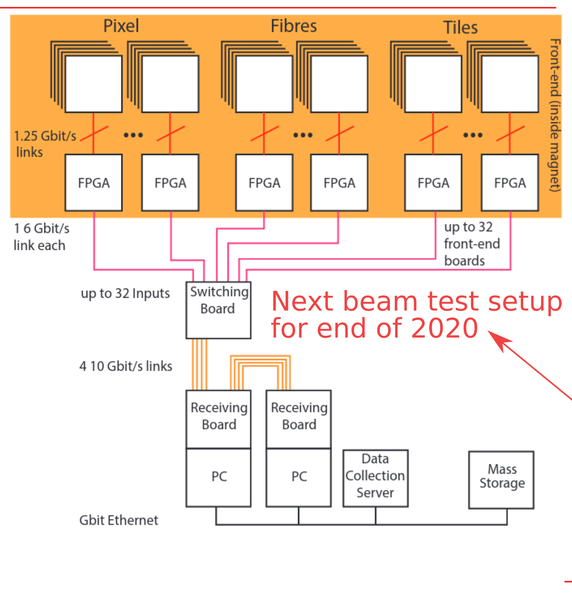


Fit difference of chip time →

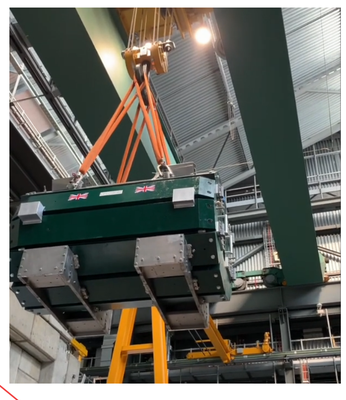


- Stable synchronization of two MuPix chips over multiple runs
- Slow control and configuration possible over MIDAS

Outlook



Next beam test setup for end of 2020



Further tests:
Scaling up the DAQ system
Testing system inside 1T Magnet

www.psi.ch/mu3e

MPA MAINZ PHYSICS ACADEMY

JG|U