

Data flow in the Mu3e DAQ

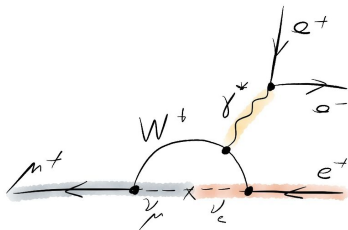
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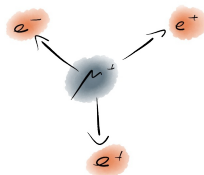
25.03.2019

Mu3e Motivation



SM with ν oscillation Br: $< 10^{-54}$

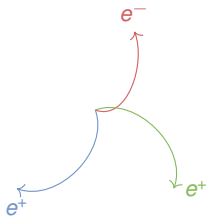
- search for Lepton Flavor Violation $\mu^+ \rightarrow e^+ e^- e^+$
- current limit (Br $< 10^{-12}$) set by SINDRUM (1988)



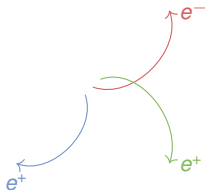
decay in rest

- muon beam of $10^8 \mu/s$ in one year
- sensitivity up to one in 10^{15}
- very high data rate of 80 GBit/s

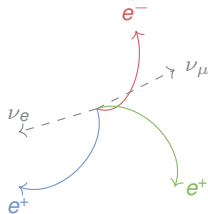
Mu3e Experiment



signal



random combinations

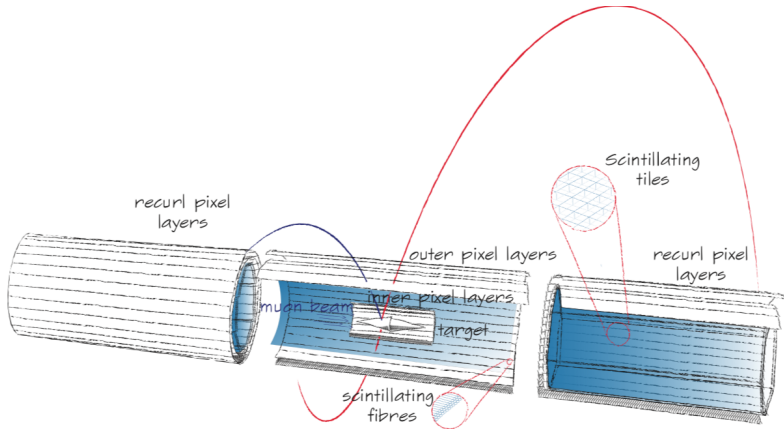


internal conversion

- $\sum \mathbf{p}_e = 0$
- $\sum E_e = m_\mu$
- good vertex and time resolution

→ all selections need to be done online & no trigger

Mu3e Experiment



DAQ Requirements



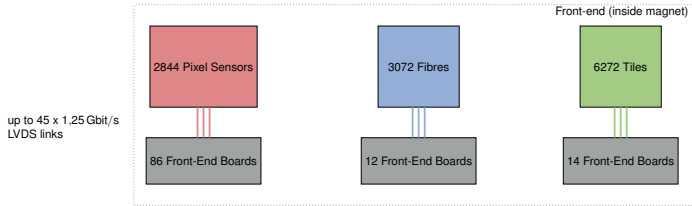
- no trigger
- online time sorting of the events
- muon stopping rate of $10^8 \mu/s$
- around 10000 sensors
- total average rate of 43 Gbit/s per MuPix (80,9 Gbit/s with fibers and tiles)

2844 Pixel Sensors

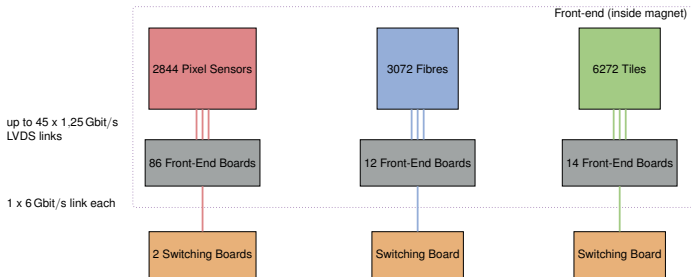
3072 Fibres

6272 Tiles

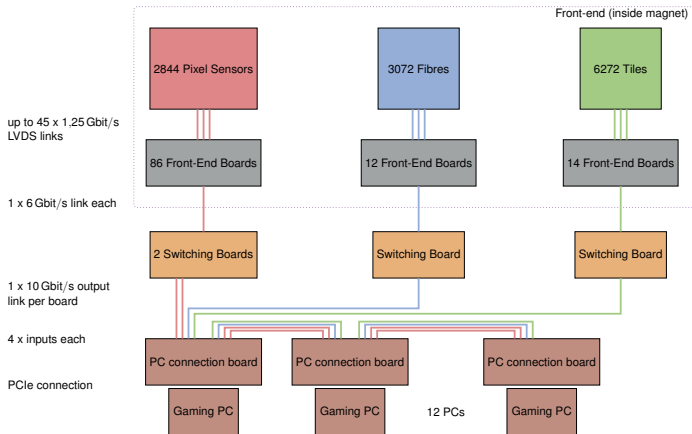
DAQ



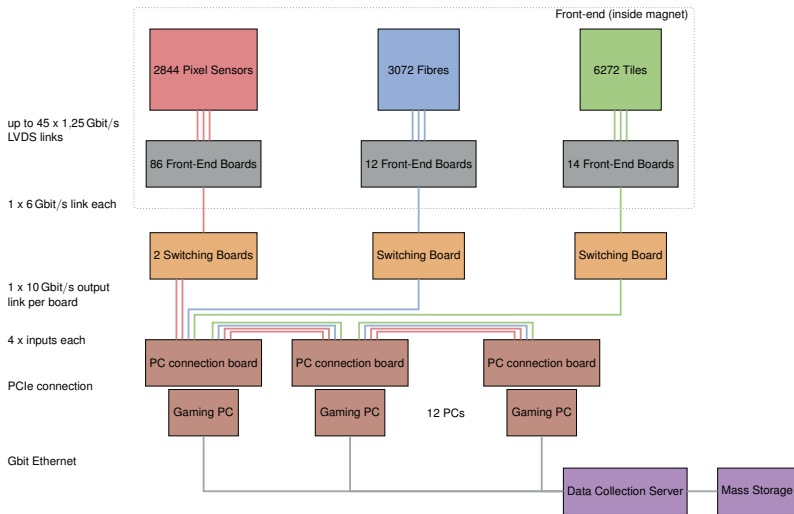
DAQ



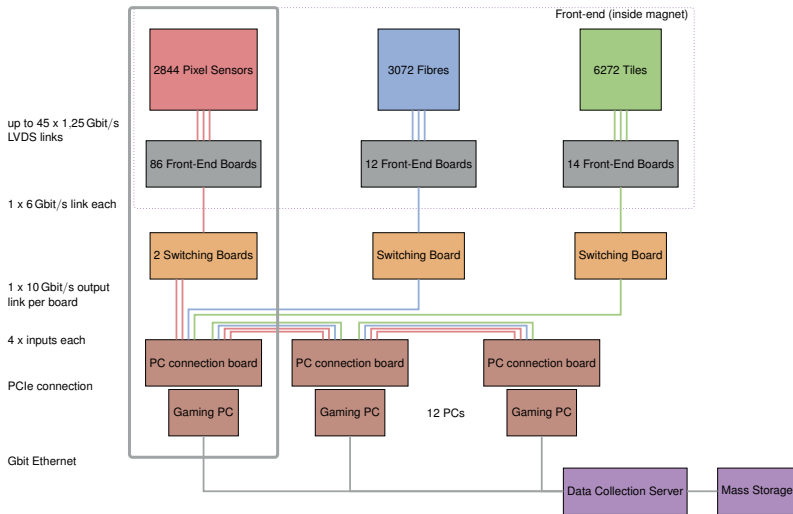
DAQ



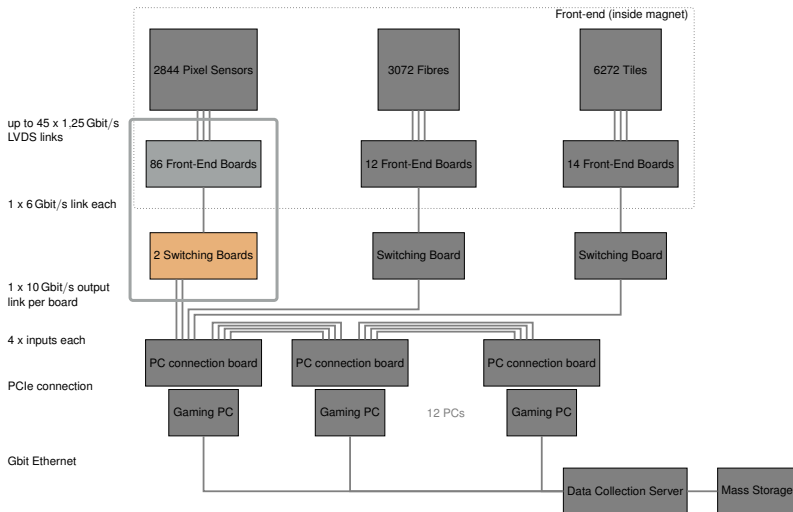
DAQ



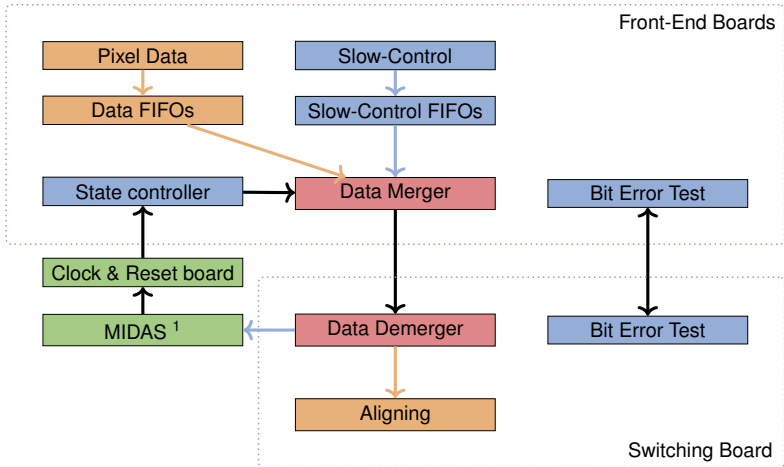
DAQ



Front-End - Switching Board

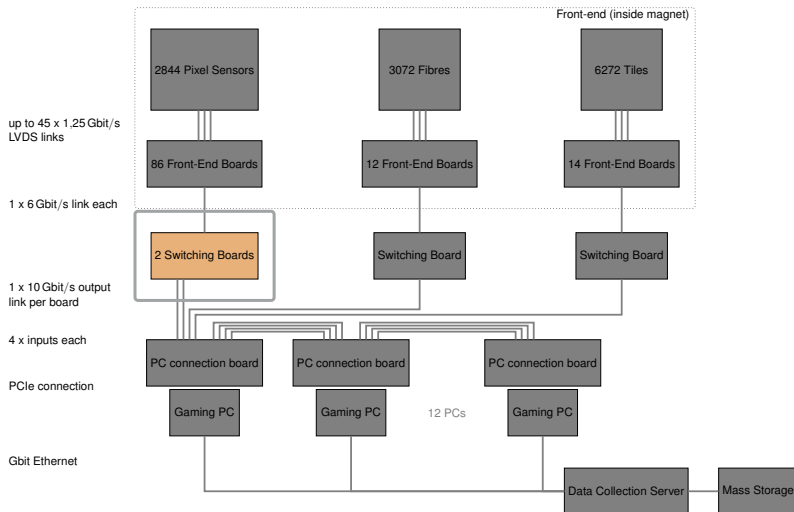


Front-End - Switching Board

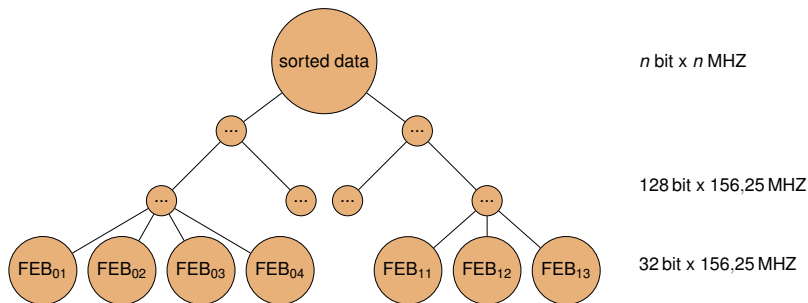


¹MIDAS. . <https://midas.triumf.ca>. Accessed: 2019-03-23

Aligning on the Switching Board

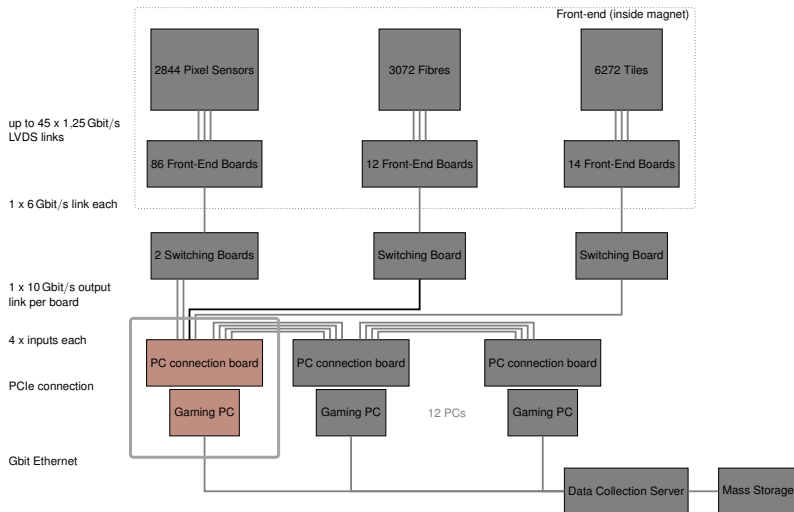


Aligning on the Switching Board



- expected data rate 40 Gbit/s
- aligning data from multiple Front-End Boards

PCIe-FPGA Speed Tests

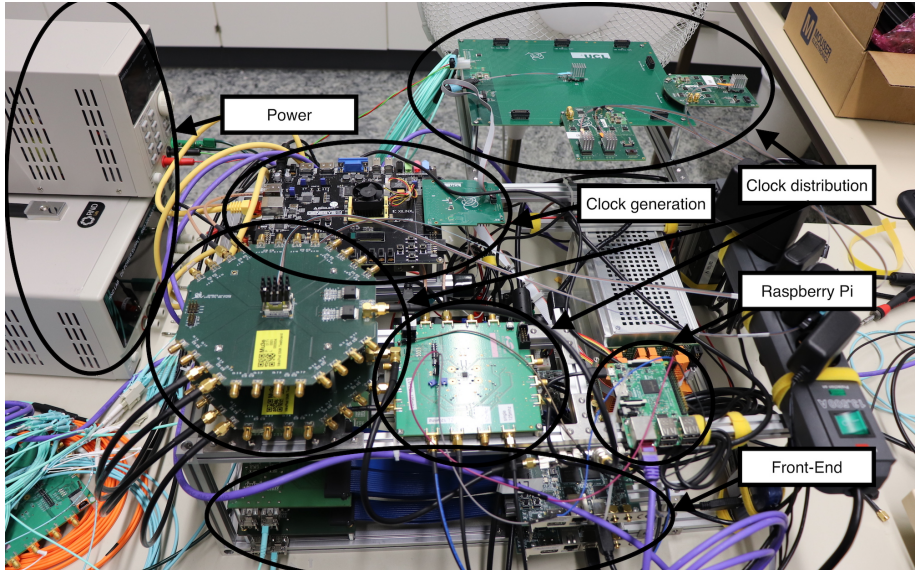


PCIe-FPGA Speed Tests



- 8 lines PCI Express 3.0
- sending data from PC connection board to a Graphics processing unit (GPU)
- data rate of 38,40 GBit/s was tested

Test Setup



Conclusion & Outlook

Conclusion

- connection Front-End → Switching Board
- sufficient data rate from PC connection board to GPU
- aligning algorithm on the Switching Board

Outlook

- tests with the full data rate
- firmware for the PC connection board

Specifications

vertex and time resolution of $100 \mu\text{m}$ and 500ps

PCIe-FPGA Speed Tests

