

The DAQ of the Mu3e Integration Runs

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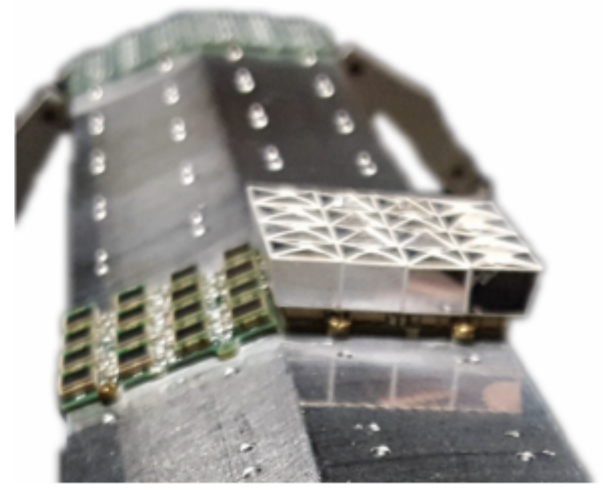
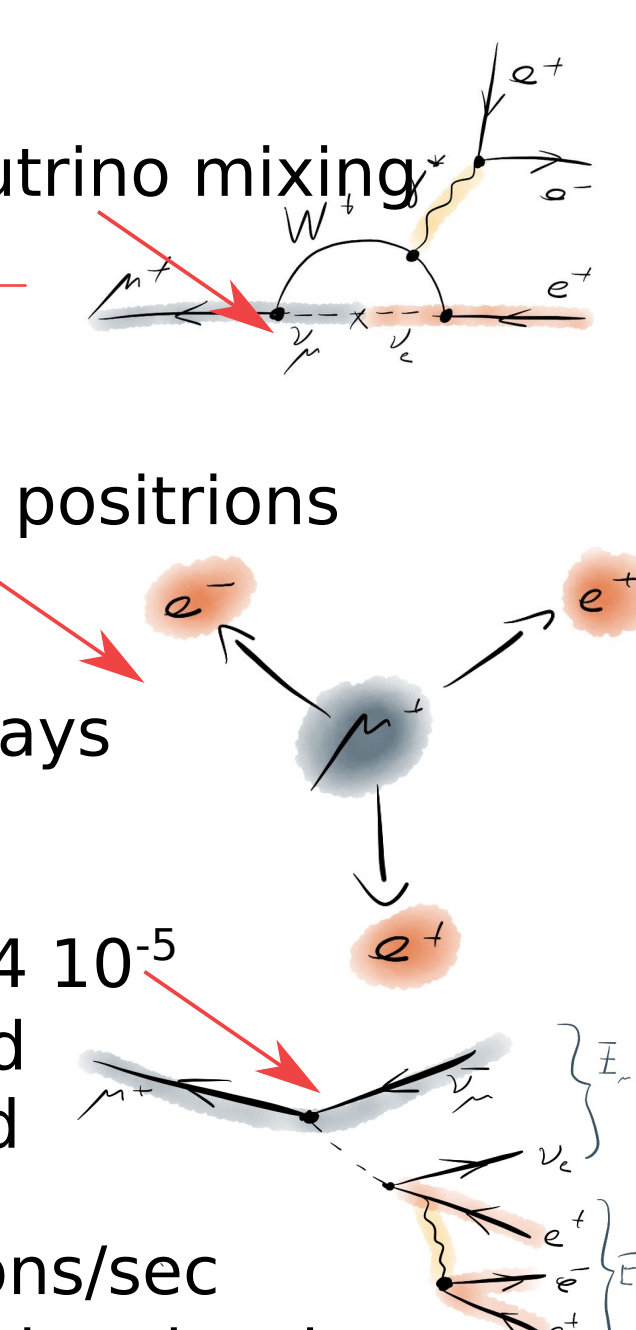
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2) Paul Scherrer Institute (PSI), Uni Bristol, Uni Geneva, Uni Heidelberg, KIT Karlsruhe, Uni Liverpool, UCL London, JGU Mainz, Uni Oxford, ETH Zürich, Uni Zürich

Summary The Mu3e experiment at the Paul Scherrer Institute (PSI) searches for the charged lepton flavour violating decay of a muon into two positrons and one electron. The experiment aims for an ultimate sensitivity of one in 10^{16} decays. The first phase of the experiment, currently under construction, will reach a branching ratio sensitivity of $\sim 10^{-15}$ by observing 10^8 muon decays per second over a year of data taking. The highly granular detector based on thin high-voltage monolithic active pixel sensors (HV-MAPS) and scintillating timing detectors will produce about 100 GB/s of data at these particle rates. The Field Programmable Gate Array based Mu3e Data Acquisition System (DAQ) will read out the different detector parts. The trigger-less online readout system is used to sort, time align and analyze the data while running. A farm of PCs equipped with powerful graphics processing units (GPUs) will perform the data reduction and the identification of interesting events. The poster presents the ongoing integration of the sub detectors into the DAQ, in particular focusing on the time aligning and the data flow inside the FPGAs of the filter farm. It shows the DAQ system used in the Mu3e Integration Run 2021 and the Mu3e Cosmic Run 2022.

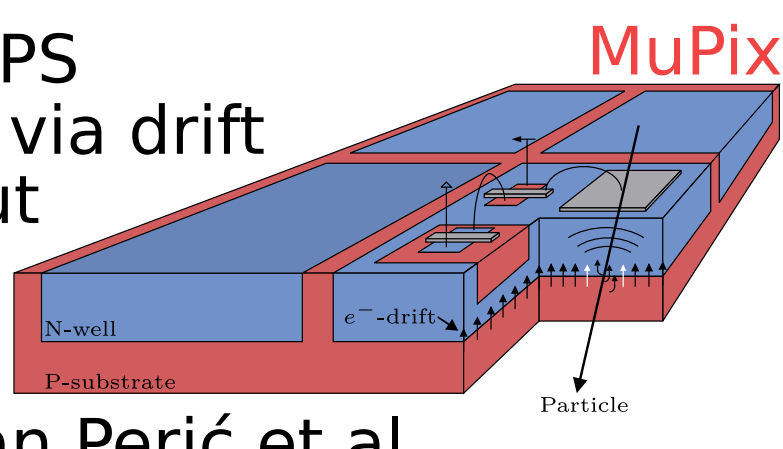
The Mu3e experiment

- 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 positrons from one vertex
- **Random combinations as background** from Michel decays with Bhabha scattering and photon conversion
- **SM background** with BR $< 3.4 \cdot 10^{-5}$
 - suppress background with good vertex, timing and momentum resolution
- High rates of 10^8 to 10^9 muons/sec
- Excellent momentum resolution despite low momentum of electrons
- Low material budget & multiple scattering

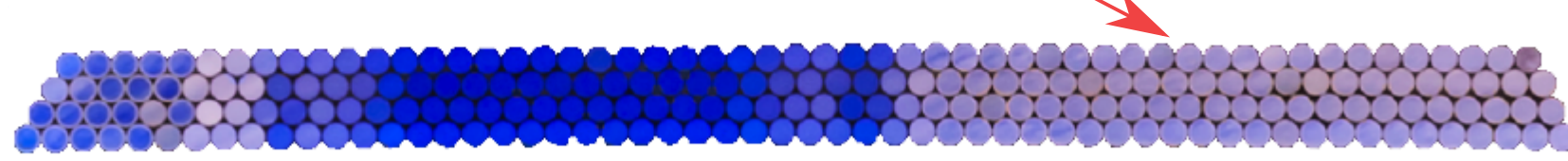


Scintillating tile detector with time resolution of < 70 ps

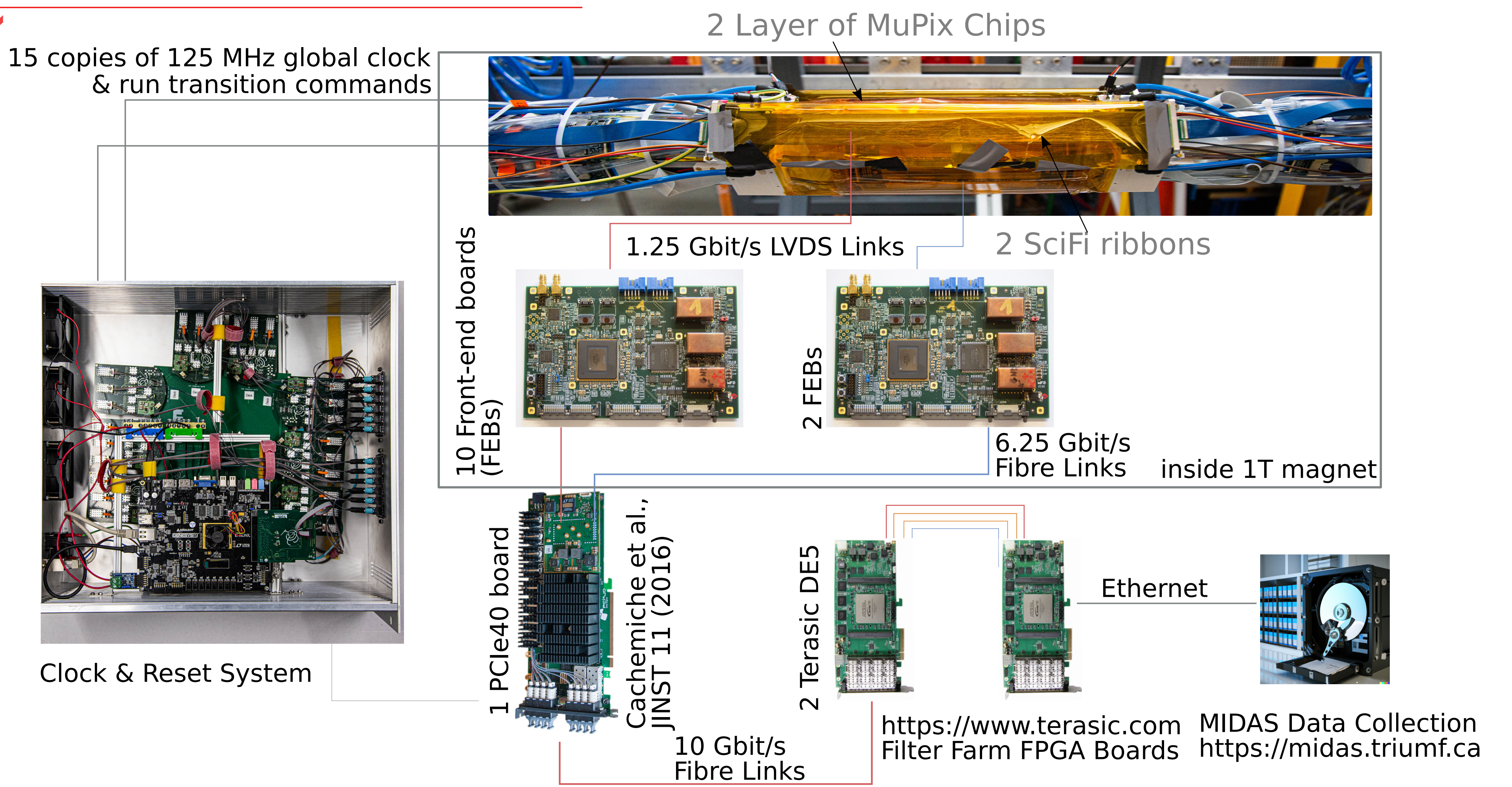
- 50 μ m thin HV-MAPS
 - Charge collection via drift
 - Integrated readout electronics
- Ivan Perić et al. NIM A582 (2007) 876-885



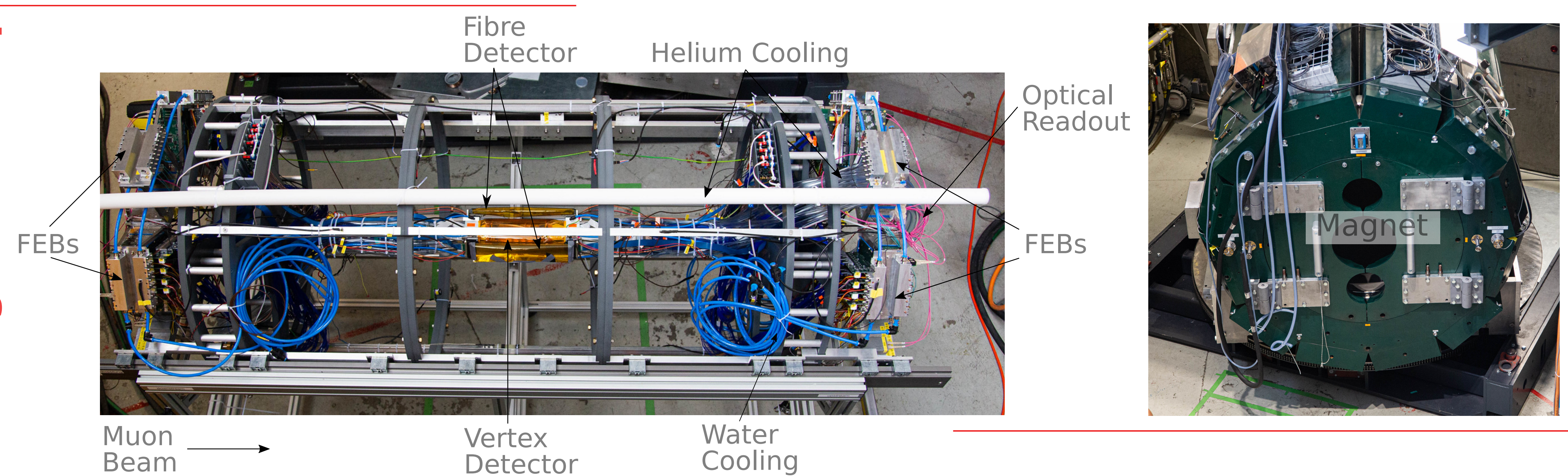
Scintillating fibre detector with time resolution of < 500 ps



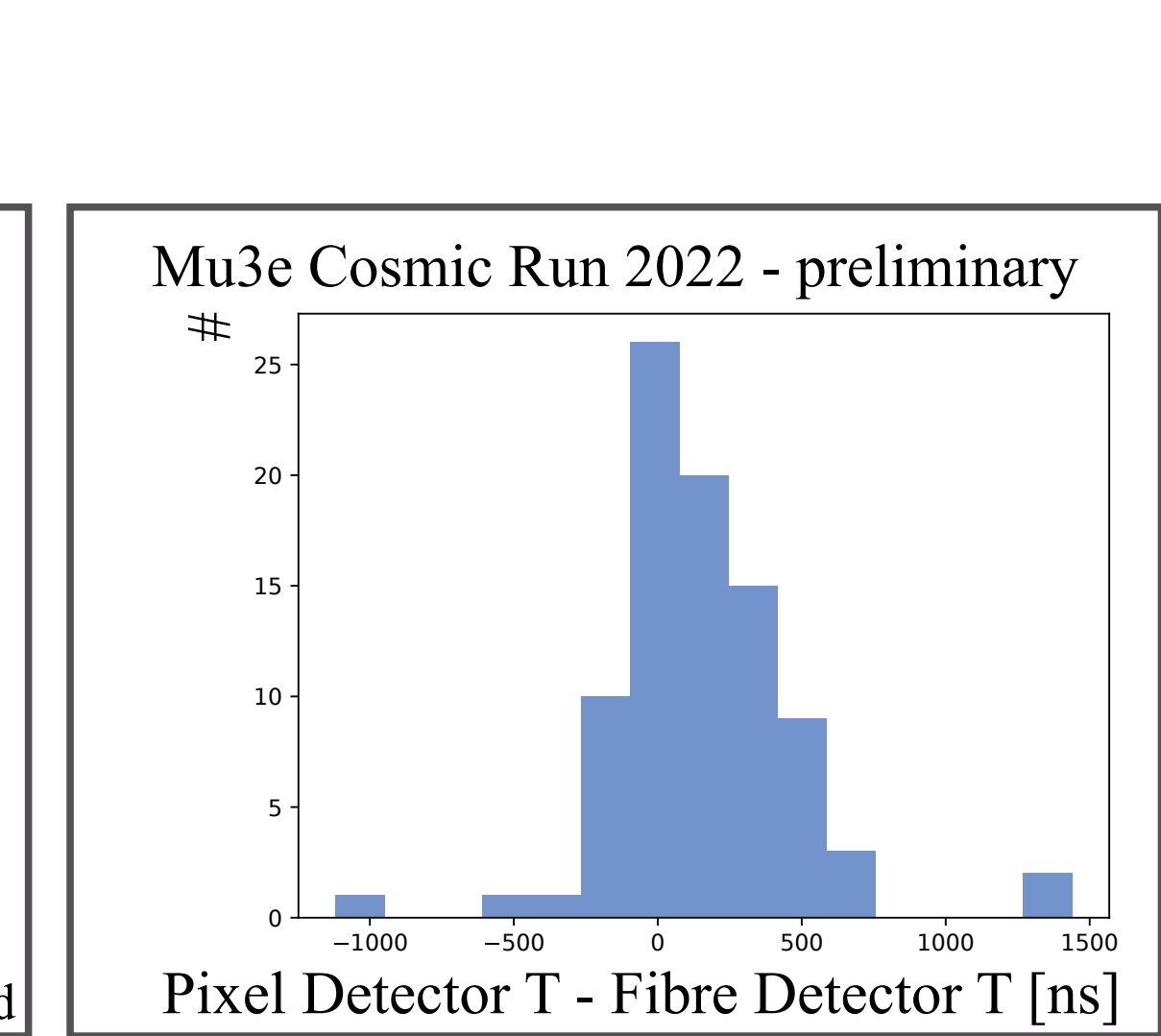
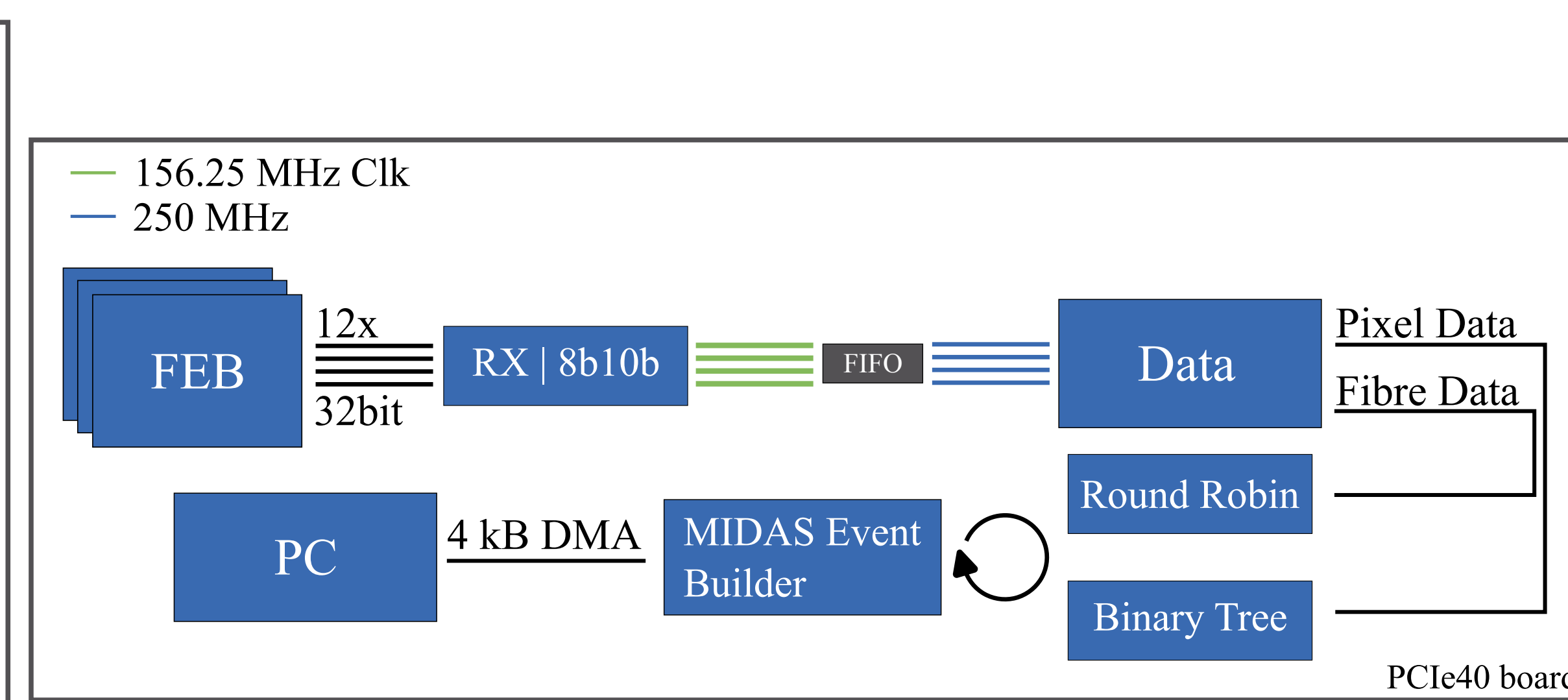
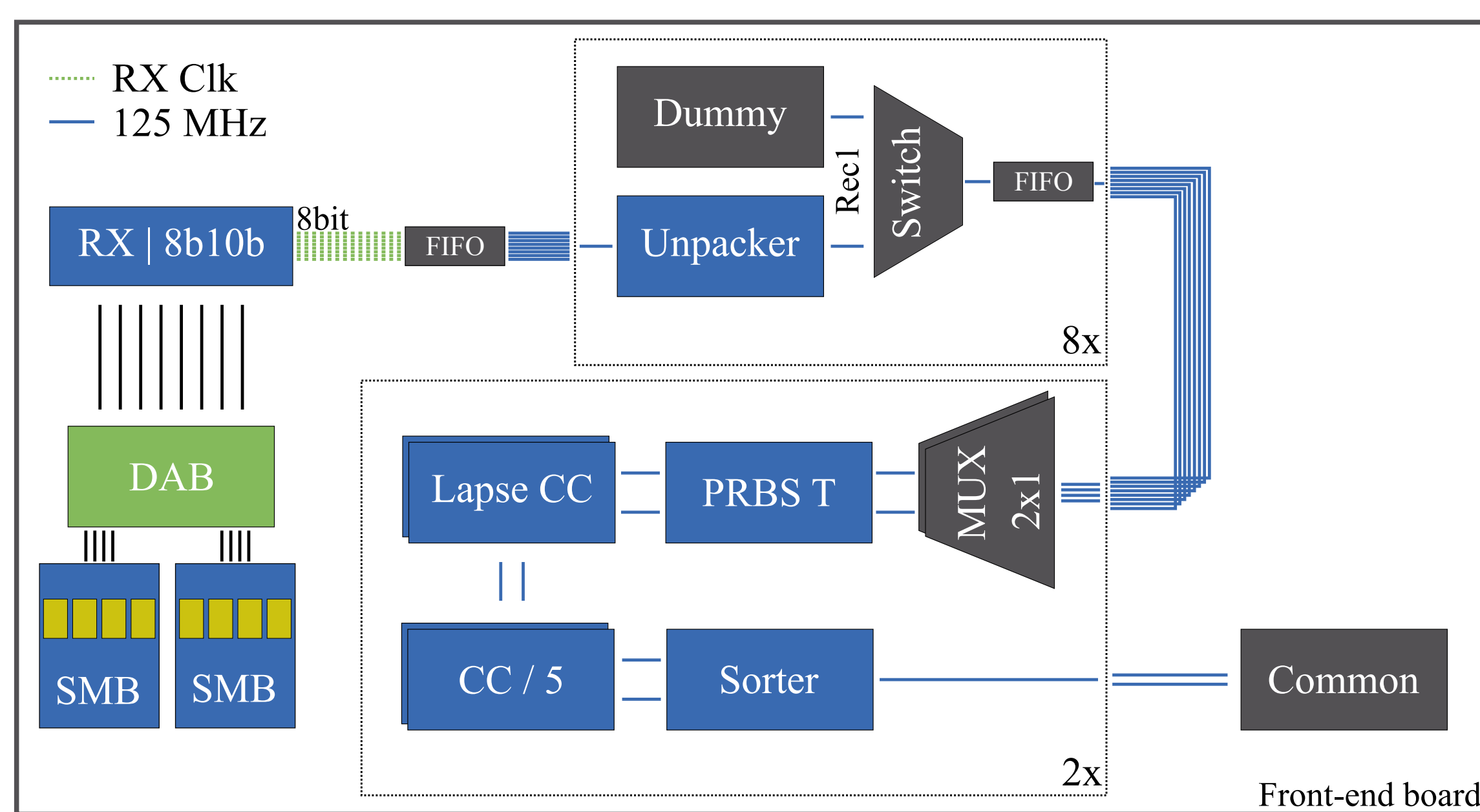
The Mu3e DAQ



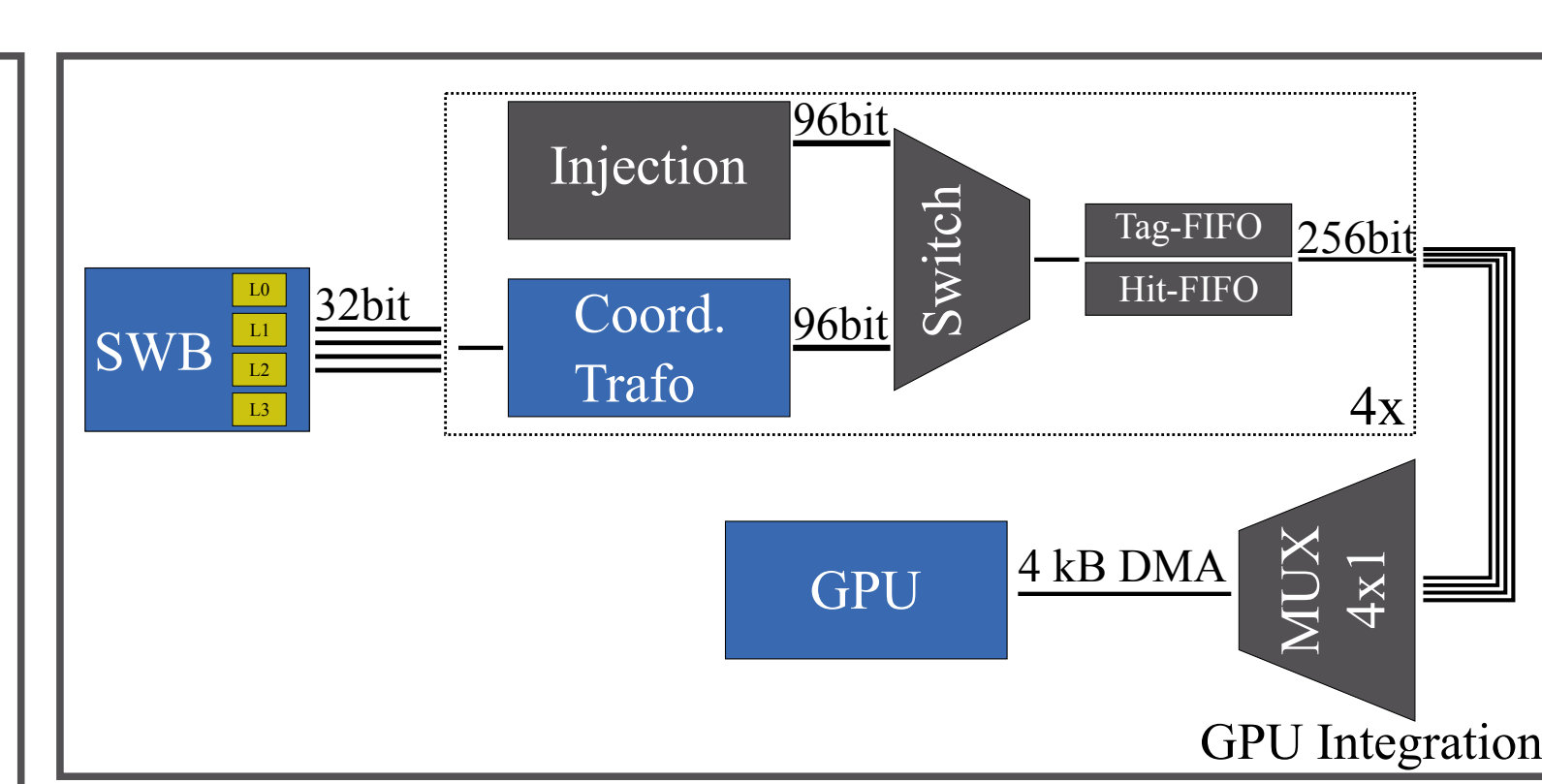
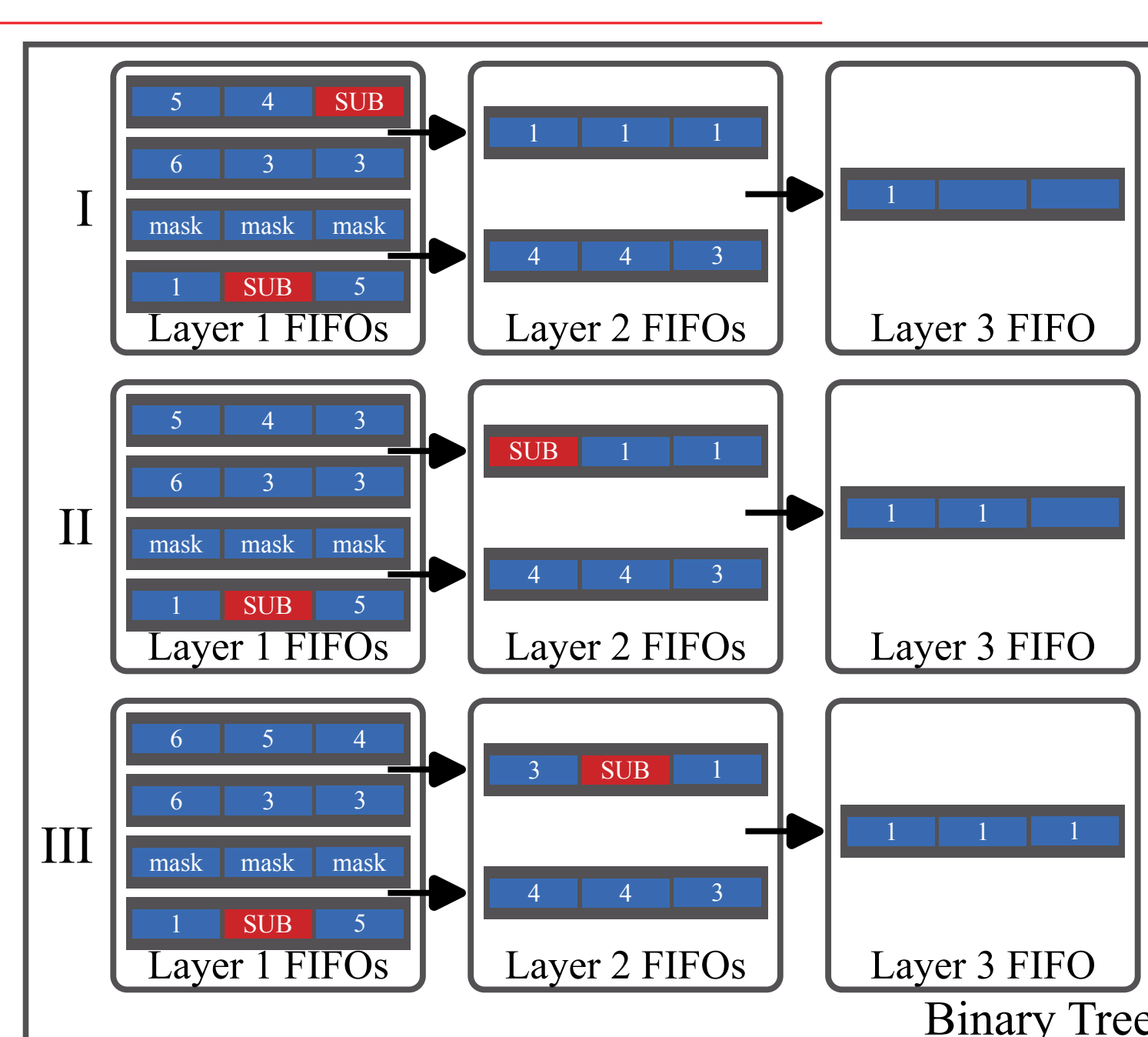
Integration Setup



Data Flow



Outlook / Conclusion



- Detector readout works for multiple Front-end boards
- First time working readout via the PCIe40 board
- Implementation of the GPU Integration
- Commissioning of the PCIe40 board firmware

