

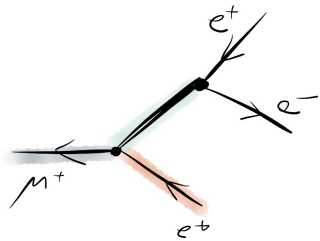
JG|U

JOHANNES GUTENBERG
UNIVERSITÄT MAINZ

The First Layer of the Mu3e Data Acquisition System
Martin Müller, DPG Spring Meeting 2022



Mu3e



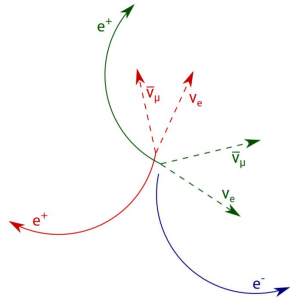
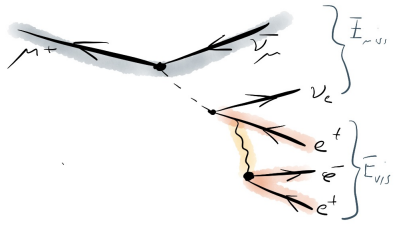
Mu3e

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



Introduction

Background processes



Background processes:

- $\mu^+ \rightarrow e^+ \nu_e \bar{\nu}_\mu e^+ e^-$
- combinatorial

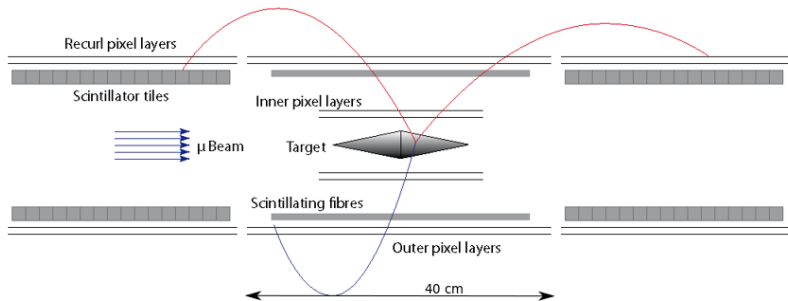
For **signal** events: $\sum \vec{p} = 0, \sum E = m_\mu, \Delta t = 0, \text{ same vertex}$

Low electron momenta \rightarrow multiple scattering \rightarrow material budget



Introduction

The Mu3e Detector

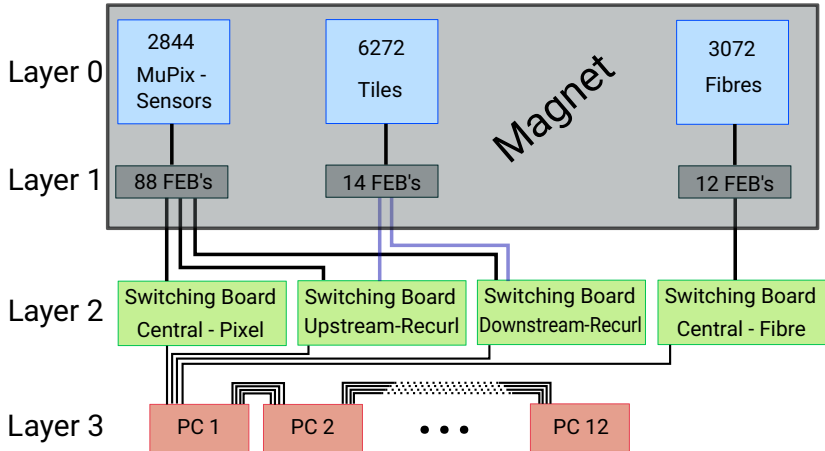


- 6 layers of pixel sensors ($t_{\sigma} = 10$ ns)
- scintillating fibres ($t_{\sigma} = 500$ ps) & tiles ($t_{\sigma} = 70$ ps) to increase timing precision
- expected data rate of up to 80 GBit/s



DAQ System

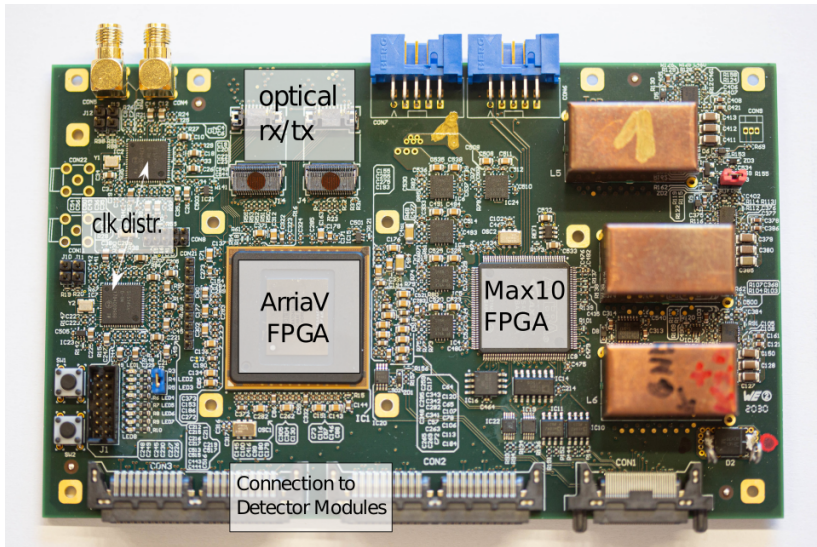
Overview





FE Board

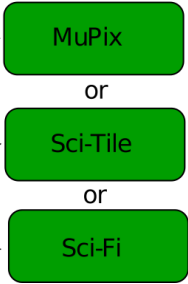
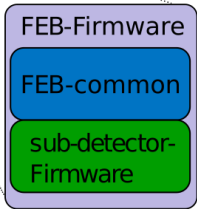
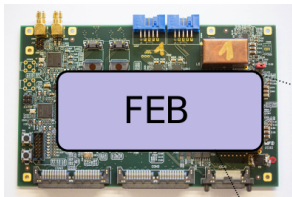
FE Board





FE Board

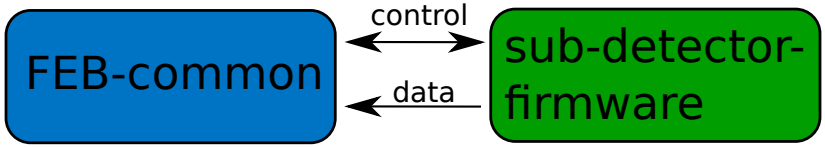
Firmware concept





FE Board

Firmware concept



- Only 2 connections between common and sub-detector firmware
- simplifies exchange of sub-detector firmware







FE Board

FEB Common Firmware

FEB COMMON

Optical
rx / tx

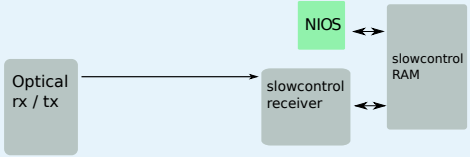
-  125 MHz Global
-  156.25 MHz
-  125 MHz recovered
-  50 MHz free



FE Board

FEB Common Firmware

FEB COMMON



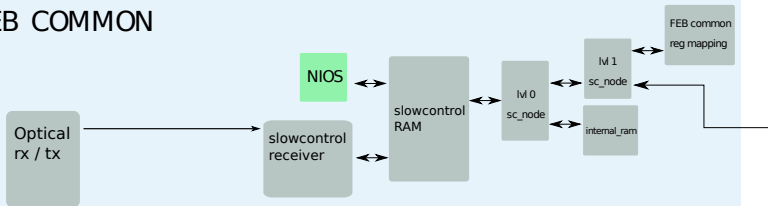
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- 125 MHz recovered
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FE Board

FEB Common Firmware

FEB COMMON



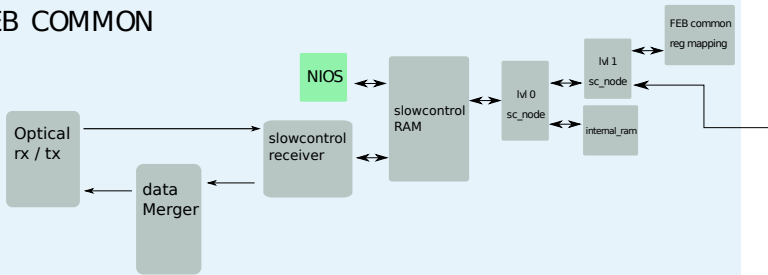
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FE Board

FEB Common Firmware

FEB COMMON



125 MHz Global

156.25 MHz

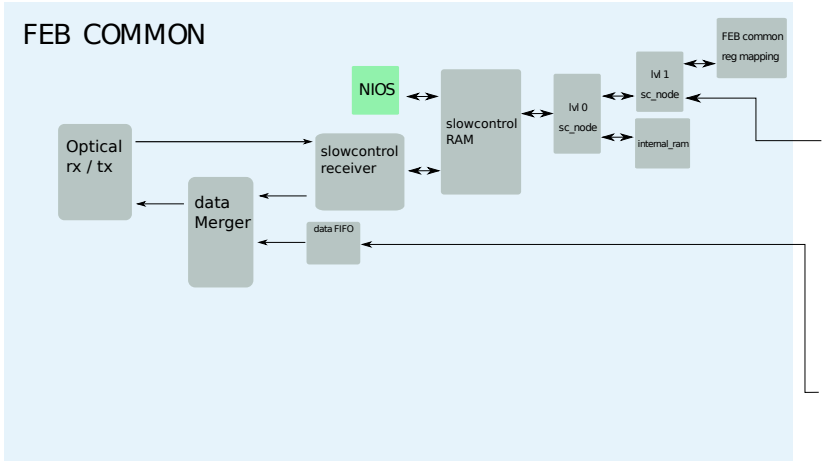
125 MHz recovered

50 MHz free



FE Board

FEB Common Firmware



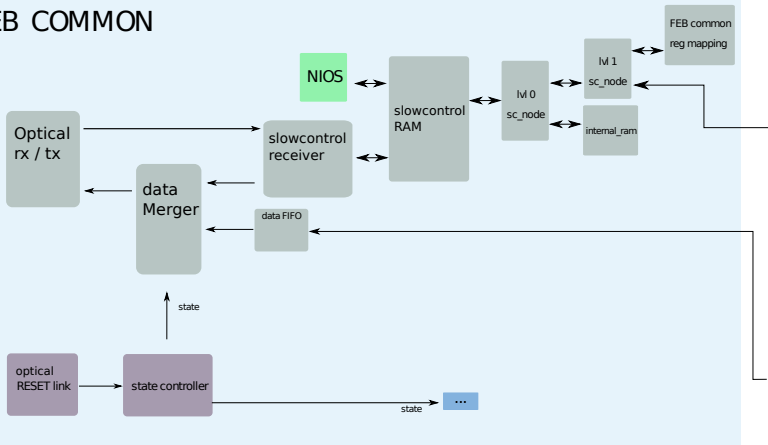
- 125 MHz Global
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FE Board

FEB Common Firmware

FEB COMMON



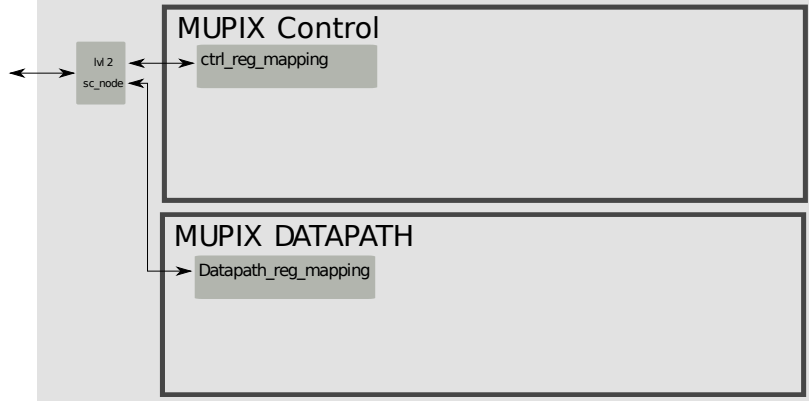
- 125 MHz Global
- 156.25 MHz
- 125 MHz recovered
- 50 MHz free



FE Board

FEB Mupix Firmware

MUPIX BLOCK



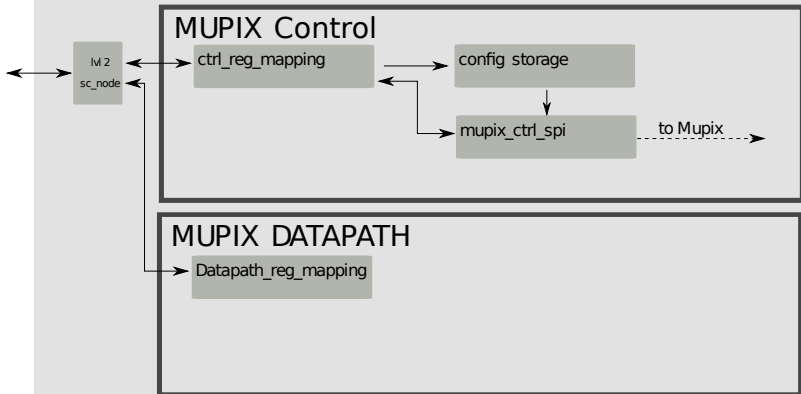
■ 125 MHz Global ■ 156.25 MHz ■ 125 MHz recovered ■ 50 MHz free



FE Board

FEB Mupix Firmware

MUPIX BLOCK



125 MHz Global

156.25 MHz

125 MHz recovered

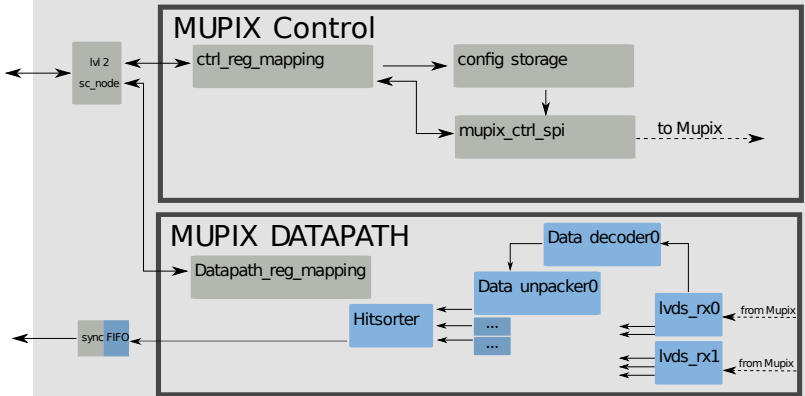
50 MHz free



FE Board

FEB Mupix Firmware

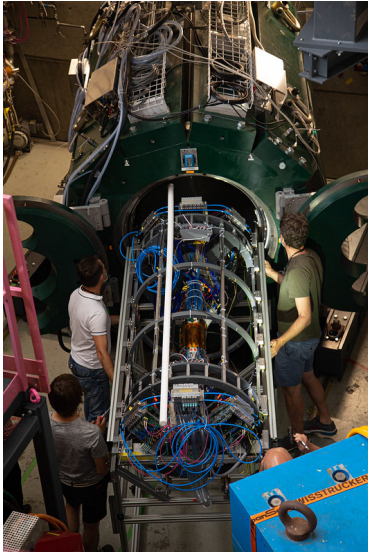
MUPIX BLOCK



125 MHz Global (Blue square) 156.25 MHz (Grey square) 125 MHz recovered (Purple square) 50 MHz free (Green square)



Conclusion and Outlook



- The developed firmware was successfully operated in the 2021 integration run
- More commissioning runs planned for this year
- Extensive testing & adding of features is ongoing