DAQ for MuPix8 on Kintex7

PANDA CM 21/2 06/15/2021

Florian Feldbauer

Ruhr-Universität Bochum - Experimentalphysik I AG

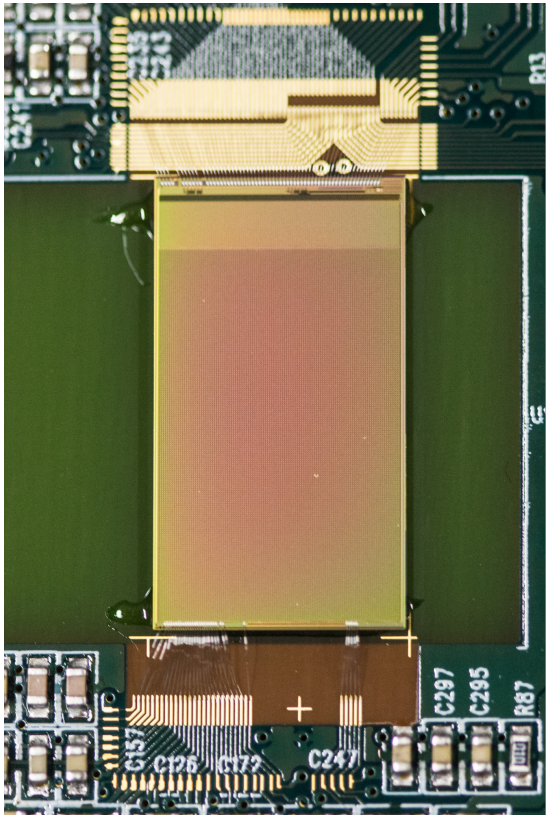
Requirements for FEE

- MuPix read out via 4 LVDS links
- Self triggered with 0 suppression
- External reference clock defines data rate

⇒ Asynchronous communication

⇒ Data Recovery on FPGA necessary

MuPix8 prototype



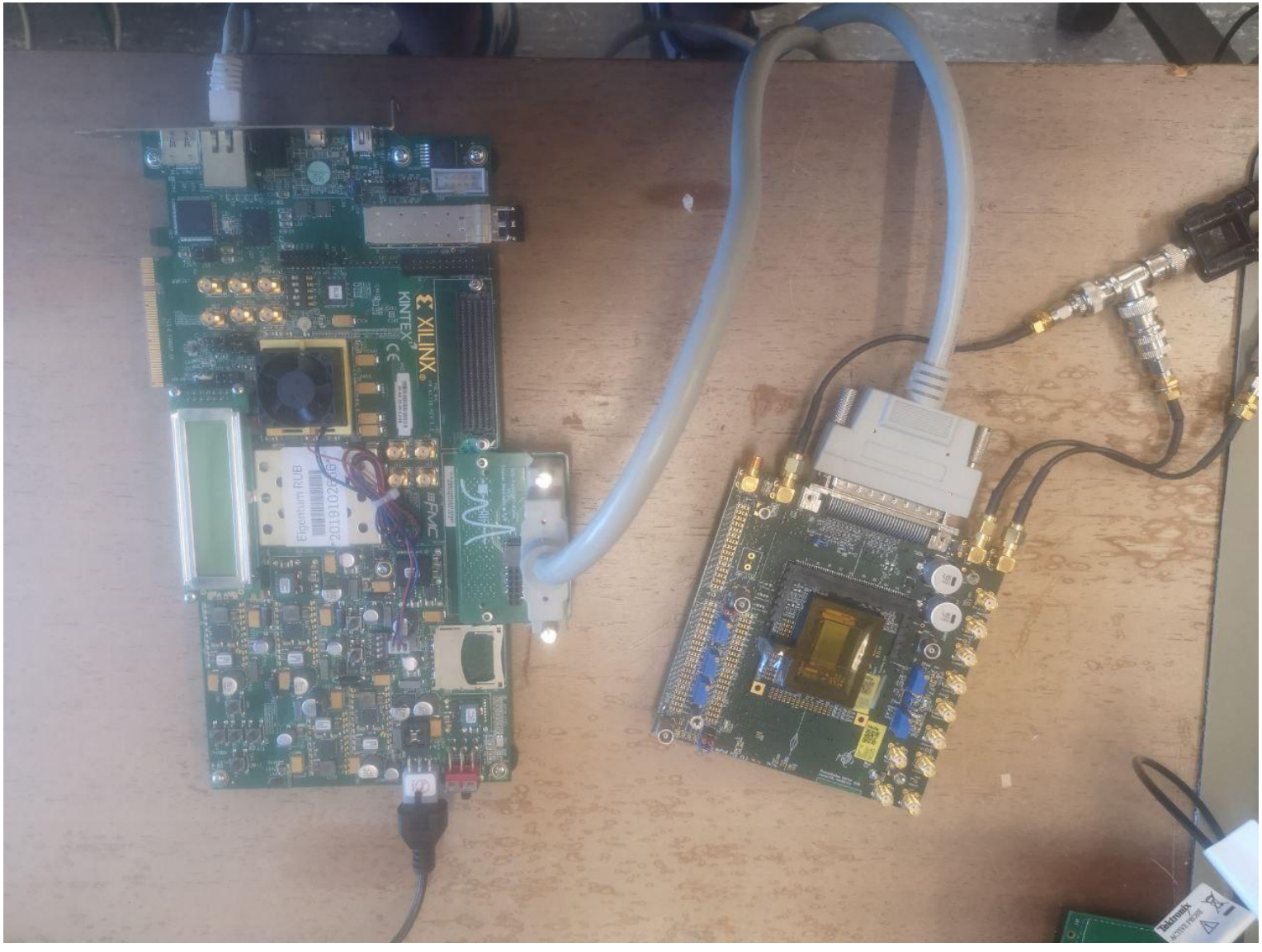
Datagrams from MuPix8

- Data is 8b10b encoded
- Regular K.28.5 comma symbols (unique bit pattern)
- 24bit binary, 8bit gray counter for debuging
- Hits consist of Timestamp, ToT, pixel address
- Max 1 hit per column per datagram

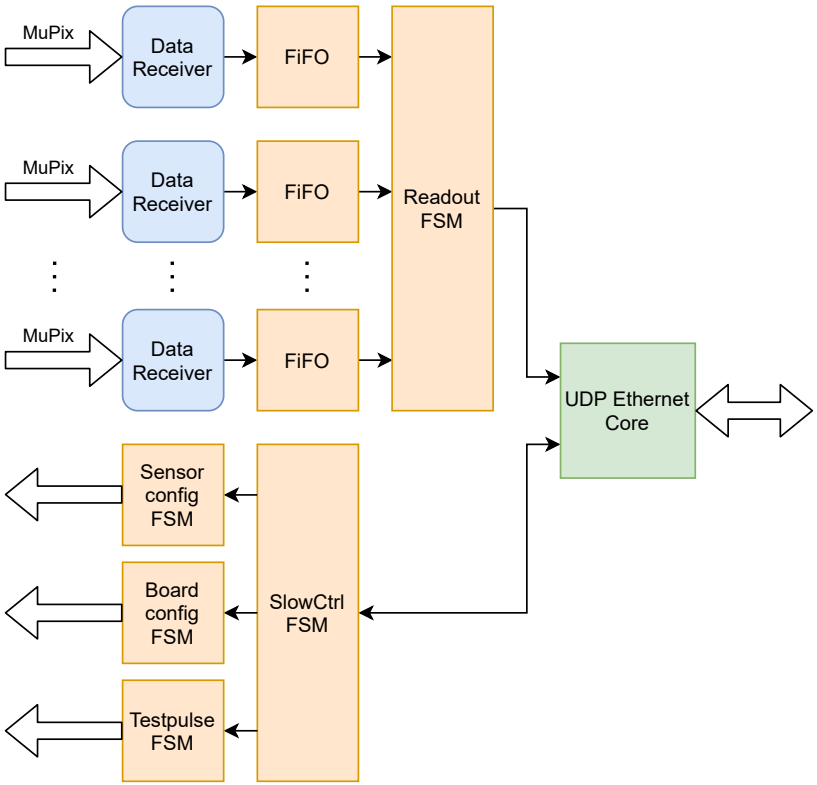
Datagram for timerend = 0

K.28.5 K.28.5 K.28.5 K.28.5
K.28.5 K.28.5 K.28.5 K.28.5
K.28.5 K.28.5 K.28.5 K.28.5
K.28.0 Link ID K.28.5 Link ID
if no hits:
K.28.5 K.28.5 K.28.5 K.28.5
else:
BinCounter[23:0] GrayCounter[7:0]
TS1[9:0] TS2[5:0] Col[7:0] Row[7:0]
TS1[9:0] TS2[5:0] Col[7:0] Row[7:0]
...

Current Setup

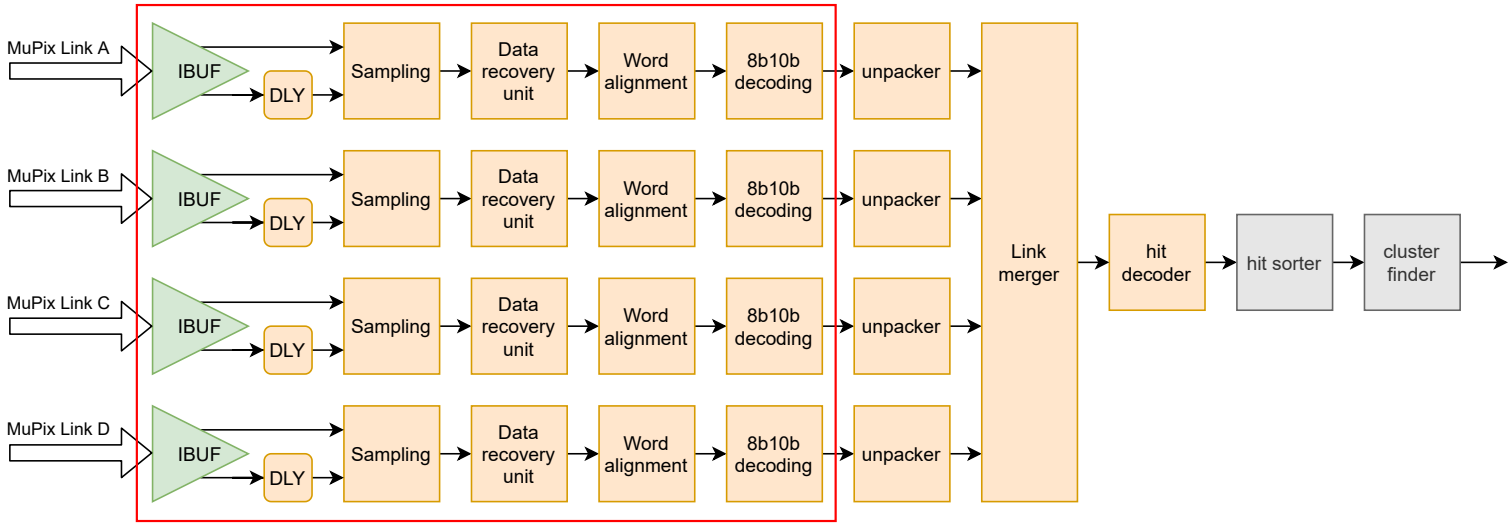


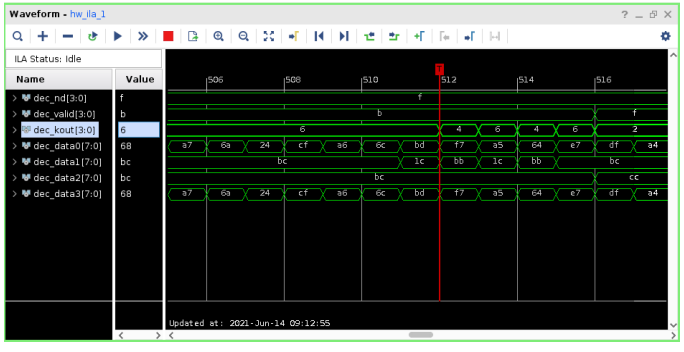
Overview of the Kintex7 Firmware



- Up to 8 MuPix8 sensors
- State machines configuring each MuPix and external DACs
- State machine generating charge injection pulses for MuPix
- Data send to PC via UDP

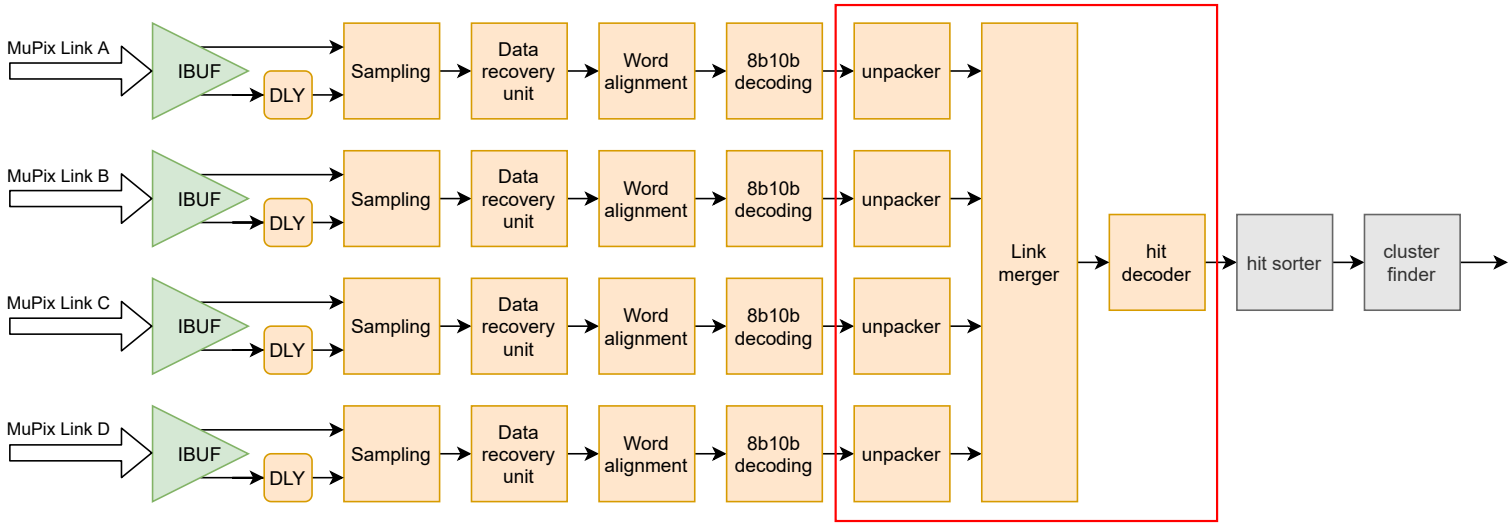
MuPix Data Receiver

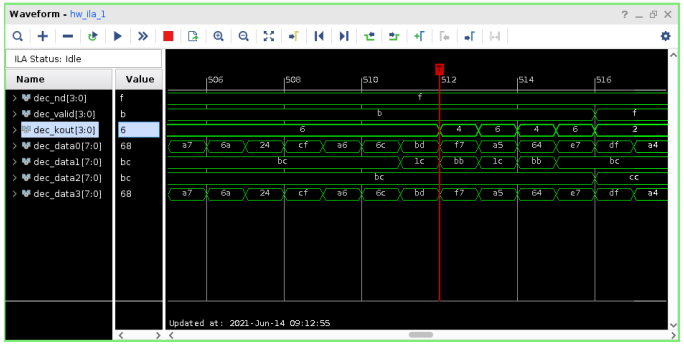




- LVDS receiver with 8b10b decoding

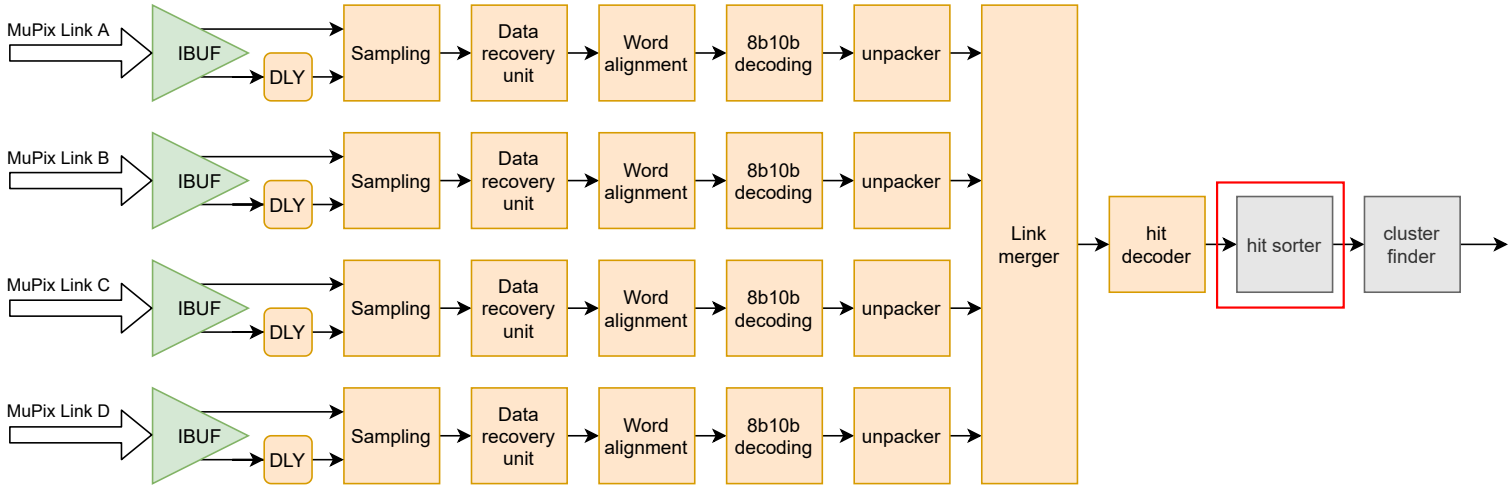
MuPix Data Receiver

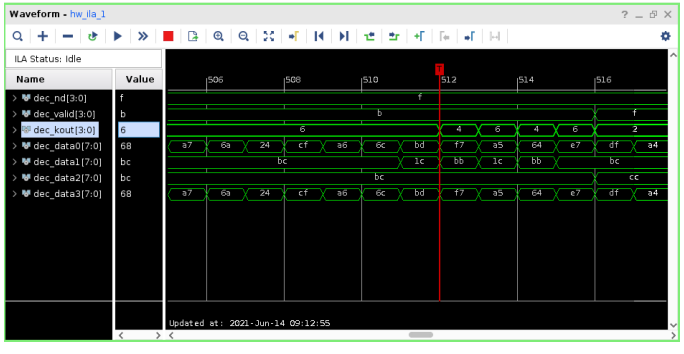




- LVDS receiver with 8b10b decoding
- Extract and decode hits

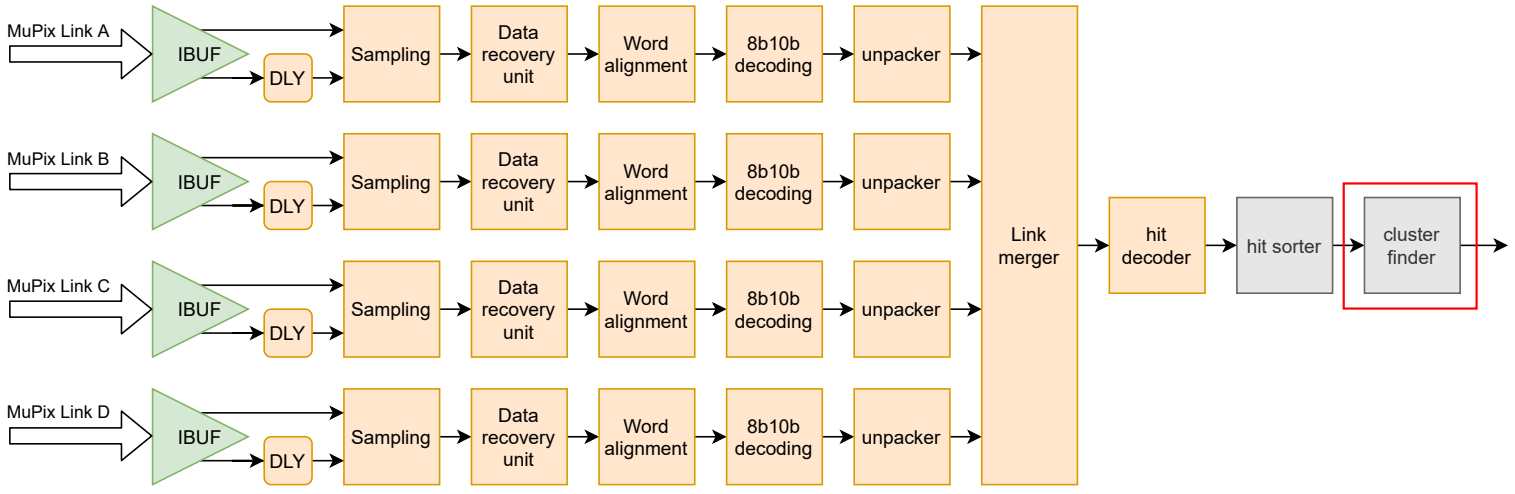
MuPix Data Receiver

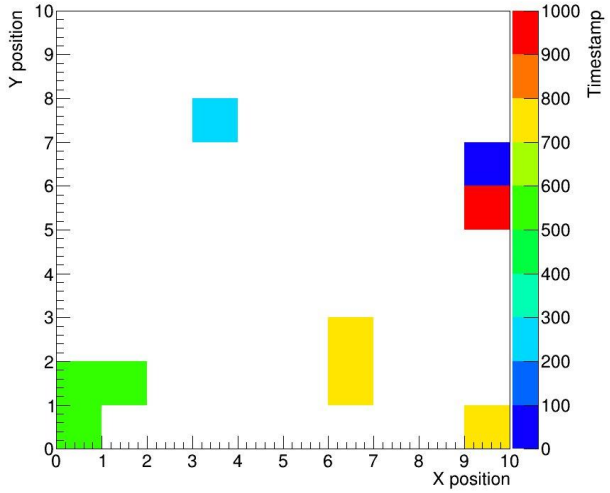




- LVDS receiver with 8b10b decoding
- Extract and decode hits
- *Sort hits from single MuPix by time*

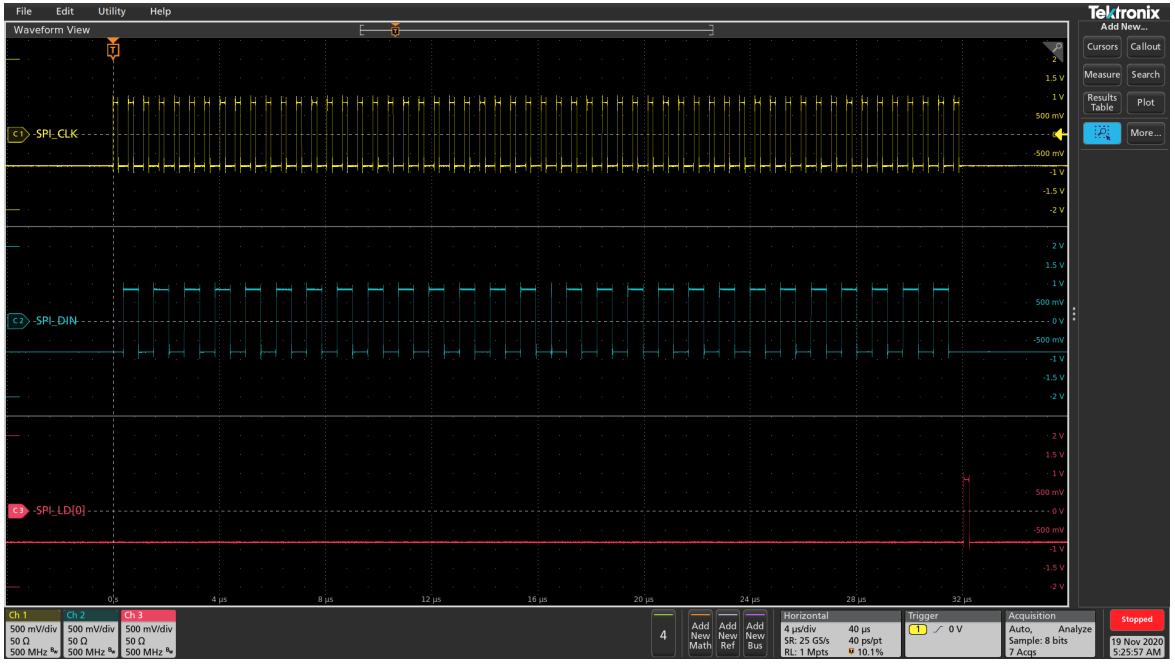
MuPix Data Receiver

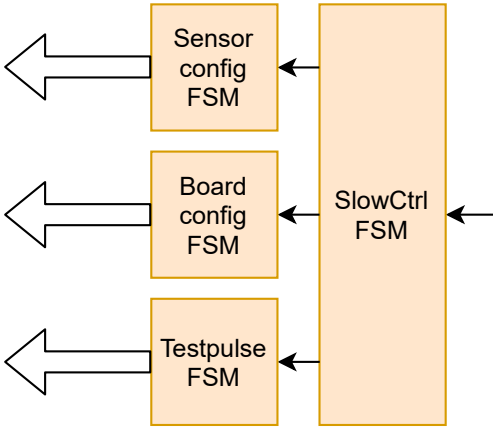




- LVDS receiver with 8b10b decoding
- Extract and decode hits
- *Sort hits from single MuPix by time*
- *Identify clusters*

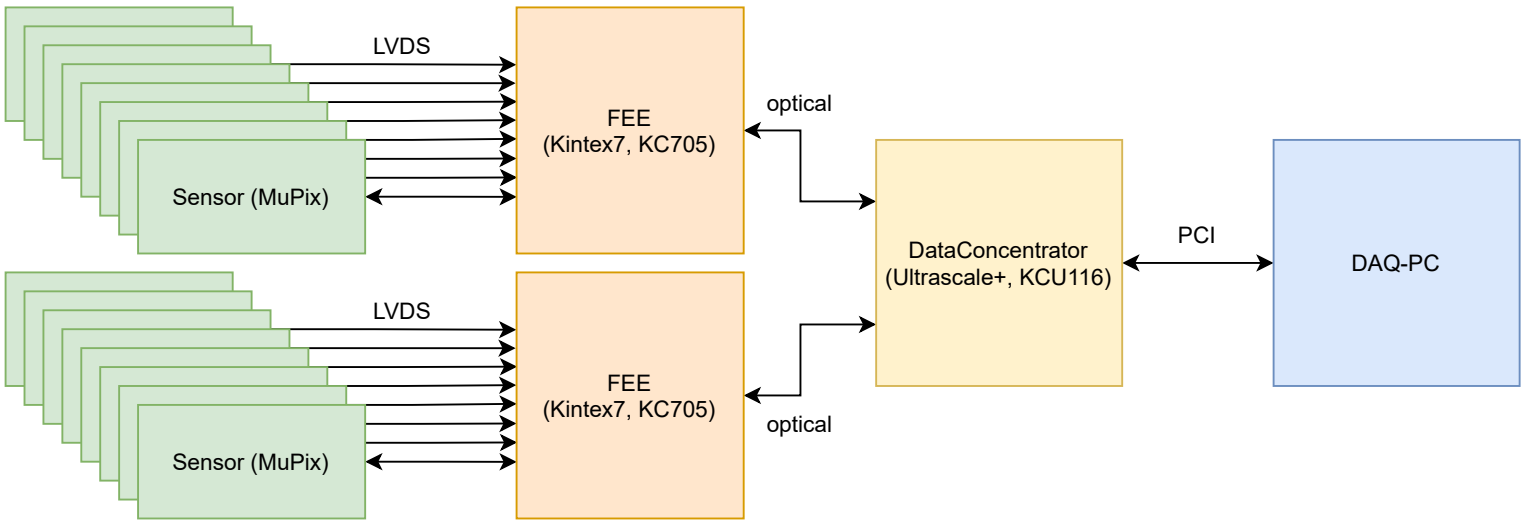
Configuration of MuPix





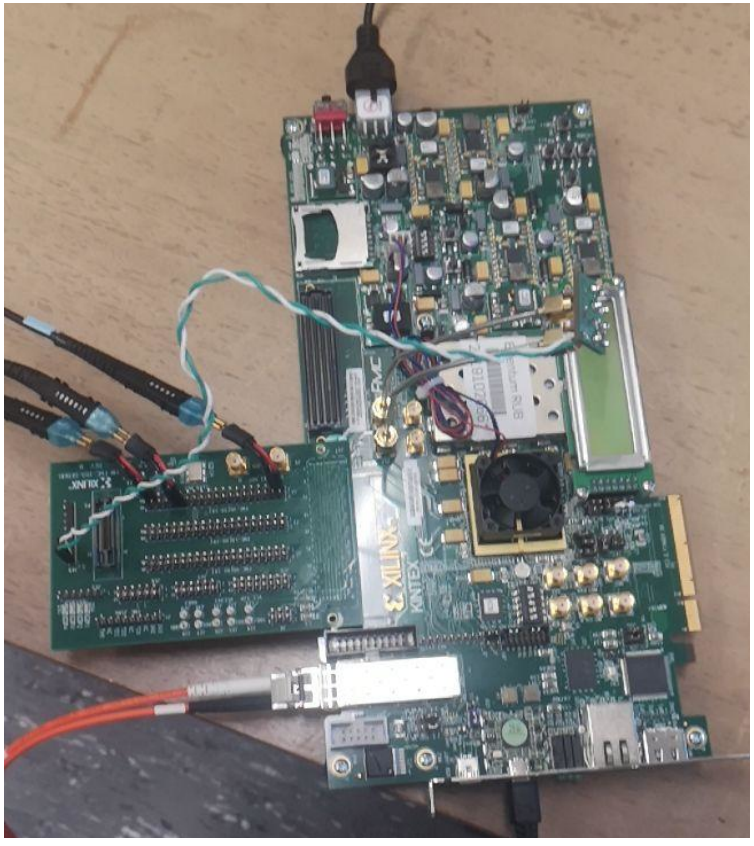
Configuration of MuPix: Setting Thresholds, mask pixels, clock dividers, . . .
Configuration of external DACs: Injection Voltage, external thresholds (on Sensorboard)

DAQ for the LMD Prototpye



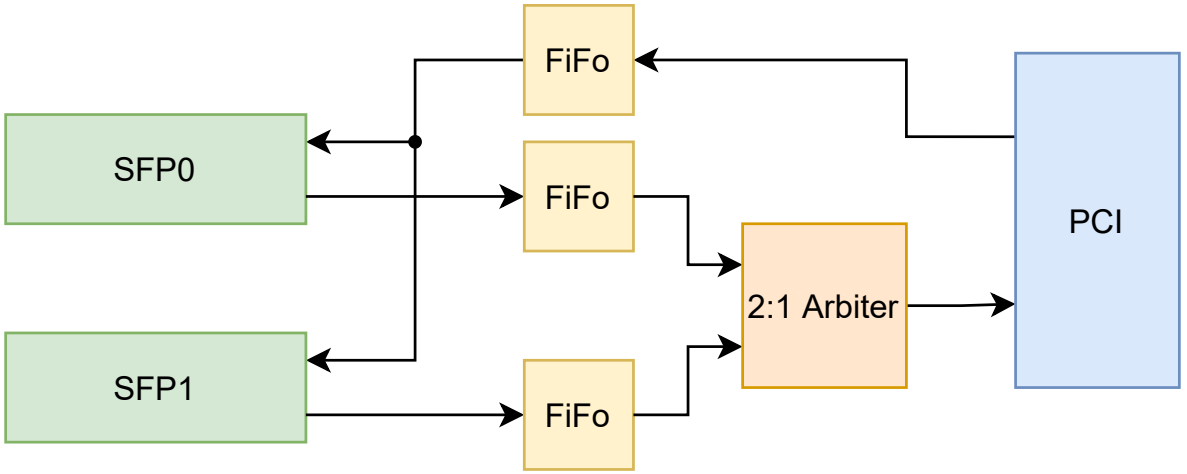
FPGA boards for LMD Prototype

MuPix readout: Kintex7



Data Concentrator: Kintex UltraScale+

Data Concentrator



Data concentrator based on Kintex Ultrascale+ Eval Board

- Communication with multiple Kintex7 via optical links (Xilinx Aurora64b66b)
- Connection to PC via PCIe x1 Gen3
- *Sort hits from all MuPix by time and position*
- *Search for tracks*

Summary and Outlook

- UDP communication works partly
- Configuration of MuPix8 works
- Receiving 8b10b asynchornous data works

- Test data recovery with higher rates (currently 400 $\mathrm{Mbit\,s^{-1}}$)
- Design configuration state machine for MuPix10
- Replace UDP with Aurora64b66b IP Core