Mini DAQ for Detector QA

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Idea for test systems

Use subsets of the final DAQ hard-, firm- and software

• Easy re-use of components
• Easy to profit from other developments, minimize duplications
• Quality control
• Portability

• Sometimes slightly steeper learning curve
• Will leave behind parts of the beloved, venerable and sometimes kludgy MuPix telescope history
Basic building blocks

Front-end board
- Electrical to optical transition
- Arria V FPGA
- ~20 boards available
- ~60 boards by Q3 2022
- More whenever we get the remaining FPGAs

Receiving board
- Optical to PCIe transition
- Arria X FPGA
- ~12 boards available, can be bought at Terasic (DDR3 and DDR4 variants)
Other ingredients needed

• A Firefly transceiver (comes with the FEB) Either needs a fan or a cooling plate
• A QSFP+ transceiver for the receiving board
• A MTP cable and an MTP adapter. Types depending on Firely type - please inquire
• Si5433 eval board (others also possible) for clocking, plus 3 SMA cables, plus Windows PC for programming (we try to get rid of that)
• JTAG Programming cable for the FEB

• Linux PC with root access and a PCIe x8 slot for the receiving board
• Intel Quartus software, ideally with a license (FPGA programming is possible without)

• See also https://bitbucket.org/mu3e/online/wiki/Minimal%20slow%20control%20testing%20setup
Running FEBs

- Can run FEB and Firefly standalone on a table (heatsink on the FPGA and a fan)
- Power: 12-20 V from lab supply
- Nicer: Use FEB with cooling plate and a mini-crate - for single FEB safe without water cooling
- Crate controller nice to have, but not needed (FEB can be jumpered on), power same.
Connection to Sensors

- Needs a detector adaptor board (DAB)
  DABs are a subsystem responsibility
  (Pixel: Heidelberg)
- Connects to the back of the backplane
- (can use two connectors soldered together if no backplane available)
- One connector serves up to 6 MuPix (inner layers, three links) or 18 MuPix (outer layers, one link)
- MuPix configuration
  (Currently SPI version, MuPix11 protocol being added)
- Receiving and decoding MuPix data
- Link monitoring, protocol checks
- Time sorting of hits
- Transmission of hits to receiving board
- Board monitoring and programming

On the way:
- Tapping of data at various points in the process
- Receiving and processing MuPix slow control data

- Do the planned Q&A tests need additional FEB firmware?
Receiving board firmware

- Receive data from FEBs
- Optical link monitoring
- Protocol for FEB and ASIC configuration and monitoring
- MIDAS bank building for hit data
- PCIe DMA to PC

- Note that this mixes firmware from the receiving boards and switching boards in the final DAQ

- Do the planned Q&A tests need additional receiving board firmware?
Software

• Driver for PCIe
• C++ libraries for slow control and monitoring interface
• MIDAS code for hit readout, board monitoring
• MIDAS code for ASIC configuration (needs to be adapted for new configuration scheme)
• MIDAS analyzer for hit maps, easily extendable
Meetings

• DAQ developers meetings every Monday at 15:00 (Zoom) 
  Agenda and minutes in online repository wiki 
  - join the DAQ elog for announcements

• Regular discussions of set-ups, firmware and software 
  developments

• We are happy to zoom you through setting up your first 
  MiniDAQ
Summary

• Basic functionality available in hard-, firm- and software

• Many things still a bit rough around the edges - still implementing and testing fixes from the integration run

• Documentation growing, many helpful experts around

• Let us know what you need and give back your tools to main DAQ