Overview CB-ELSA DAQ system

26.06.2024

Ch. Schmidt

Helmholtz-Instituts für
Strahlen- und Kernphysik

UNIVERSITÄT BONN

Outline

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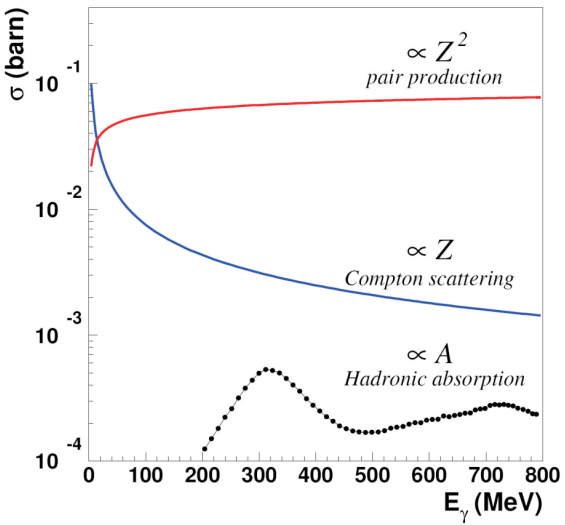
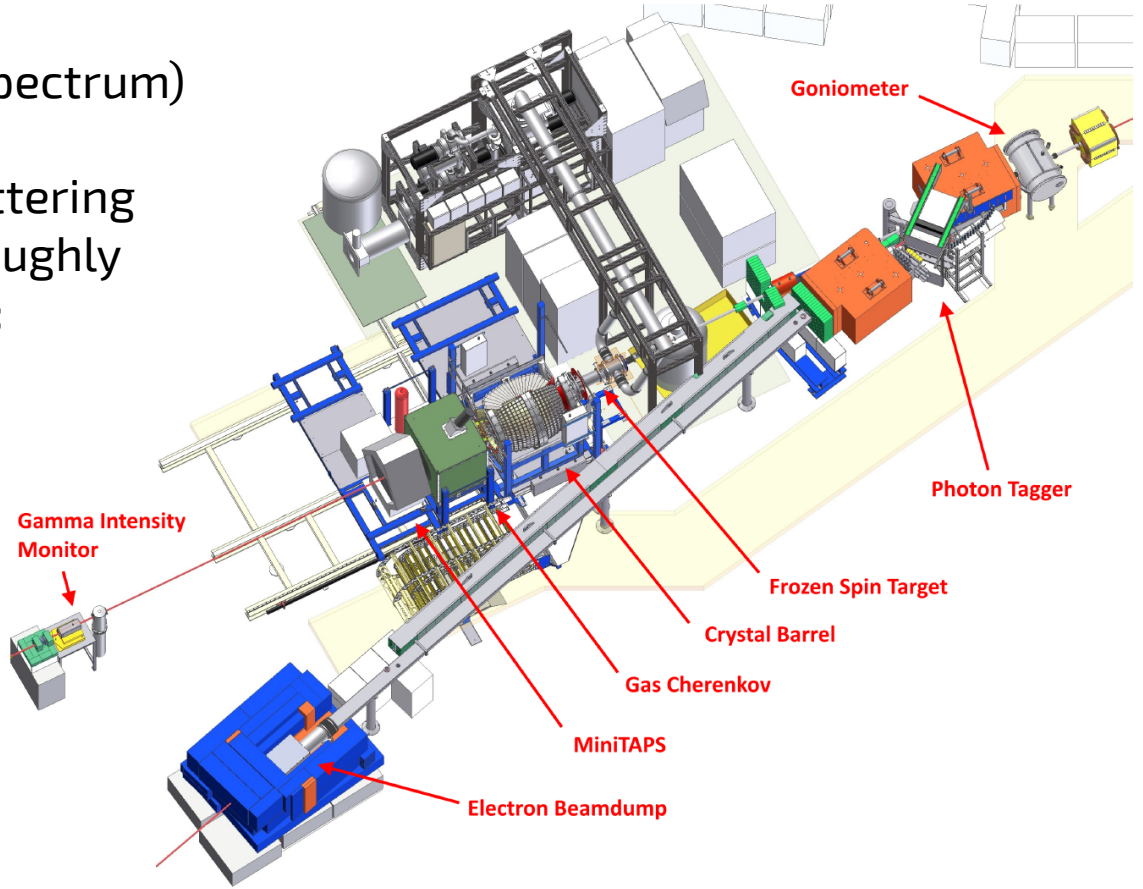
- CB-ELSA/TAPS experiment
- DAQ-system
- Sync-system
- Ideas for the future

Introduction - CB-ELSA/TAPS experiment

„Features“ of a photon beam:

- No fixed energy (Bremstrahl-spectrum)
- Photon cross section for pair production + compton scattering in a liquid hydrogen target is roughly 1000 times higher than $\gamma p \rightarrow pX$:

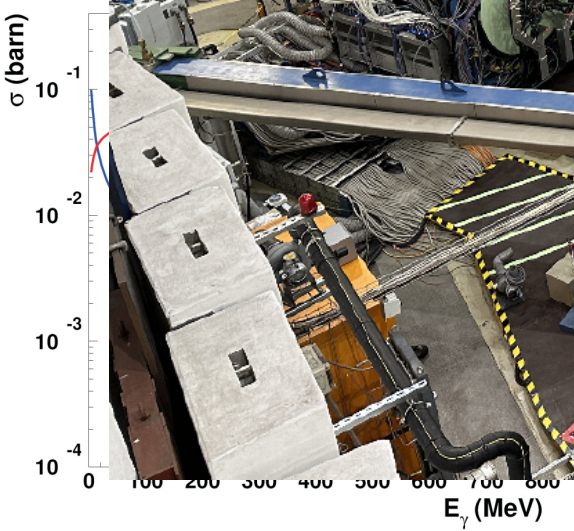




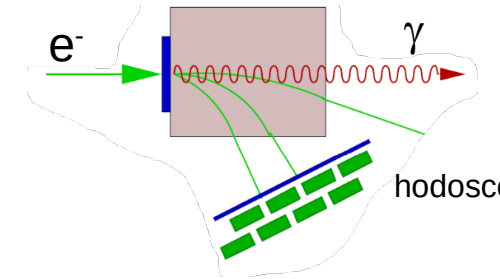
Introduction - CB-ELSA/TAPS experiment

„Features“ of a photon beam:

- No fix
- Photo
  pair p
  in a li
  1000



Current CB-ELSA/TAPS experiment



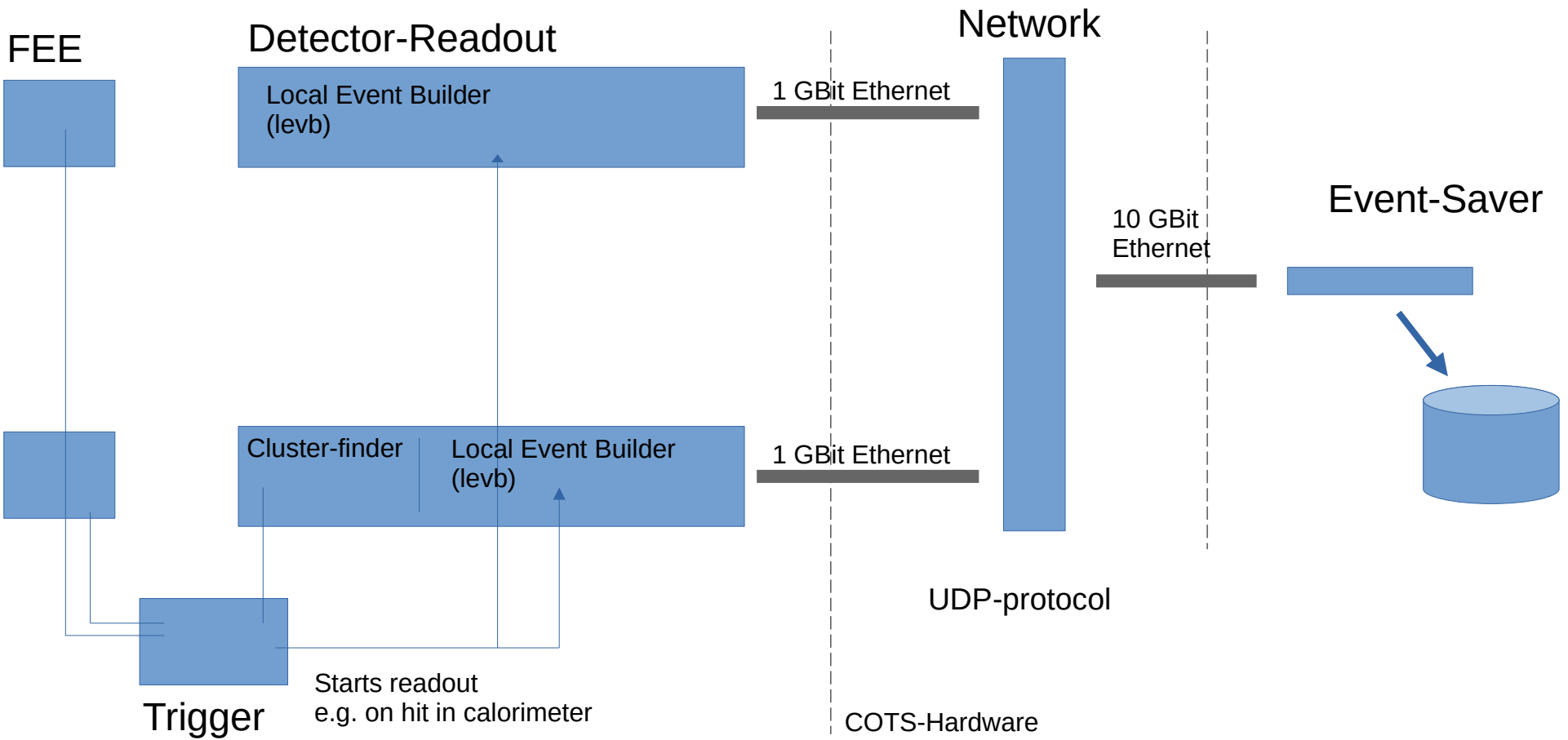
Rate in hodoscope
up to 50MHz

Trigger is used to reduce data rates
mainly by looking for hits in the calorimeter

interesting hadronic events
~10-20kHz

interaction rate
up to 2MHz

DAQ – push architecture



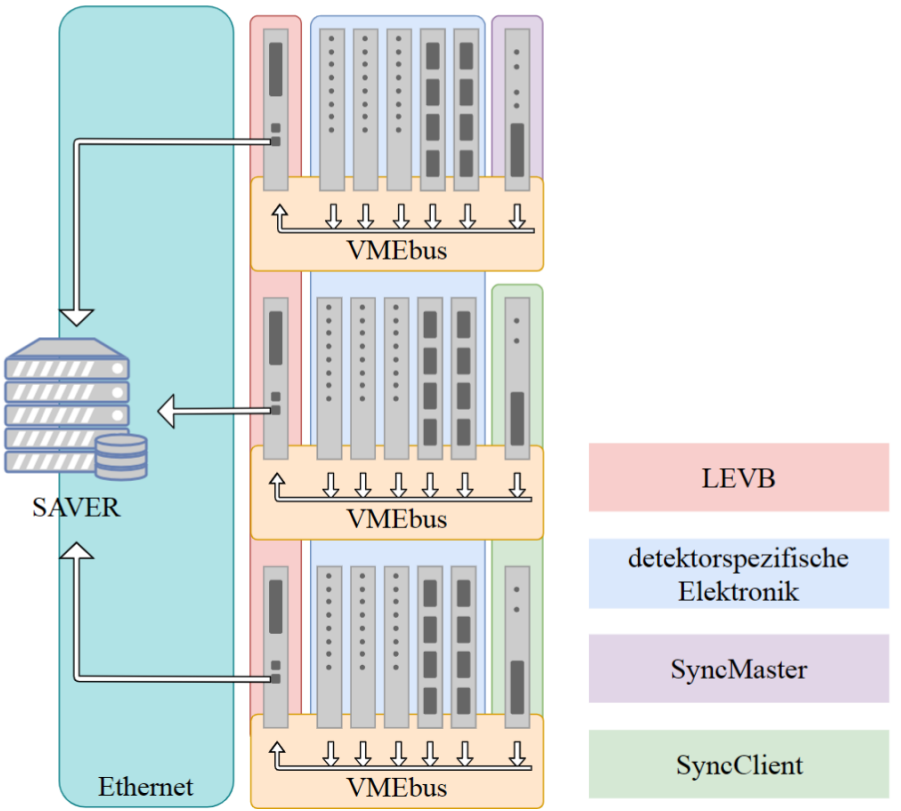
Detector readout

Hybrid system

- VMEbus based modules
  - CPU
    readout, sync-handling, transport
  - FPGA based
    readout, cluster finding, transport
  - Custom boards (TAPS)

- Crystal Barrel readout
  - based on PANDA FWEC SADC
  - levb on FPGA

Deadtime from readout 50-100µs
10kHz Trigger rate → 50-70% livetime



Example VME based FPGA board

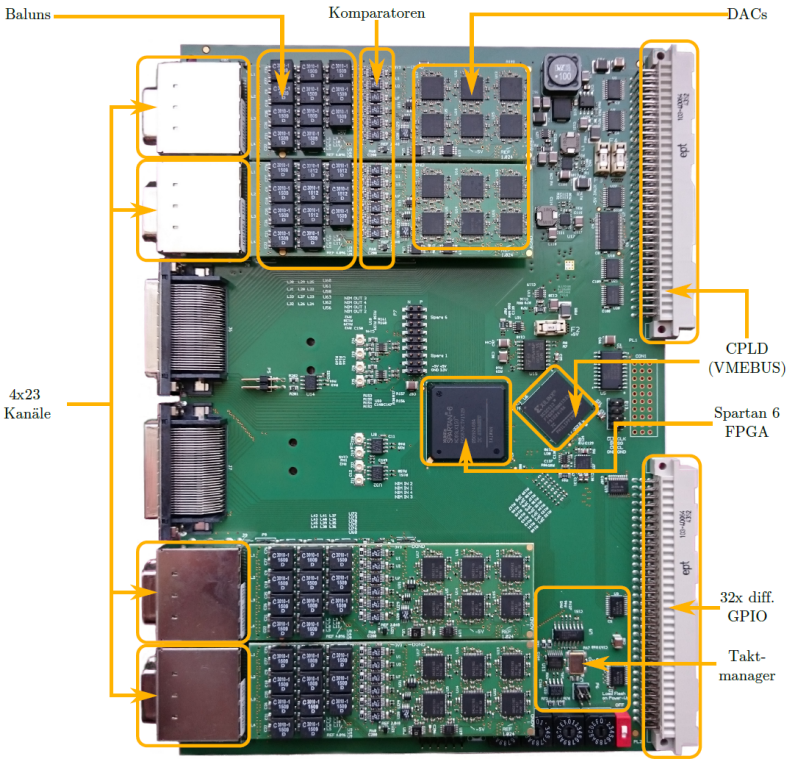
Cluster finder hardware (trigger / readout)

based on Xilinx Spartan 6 board (ELB)

- TDC implementations
  - tapped delay line TDC
    (7bit per 5ns clock cycle → ~40ps)
  - sampling TDC based on deserializer
    (2bit per 5ns cycle → ~1ns)
- Distributed cluster finding logic
  (special backplane to interconnect boards)
- Discriminators on mezzanine card

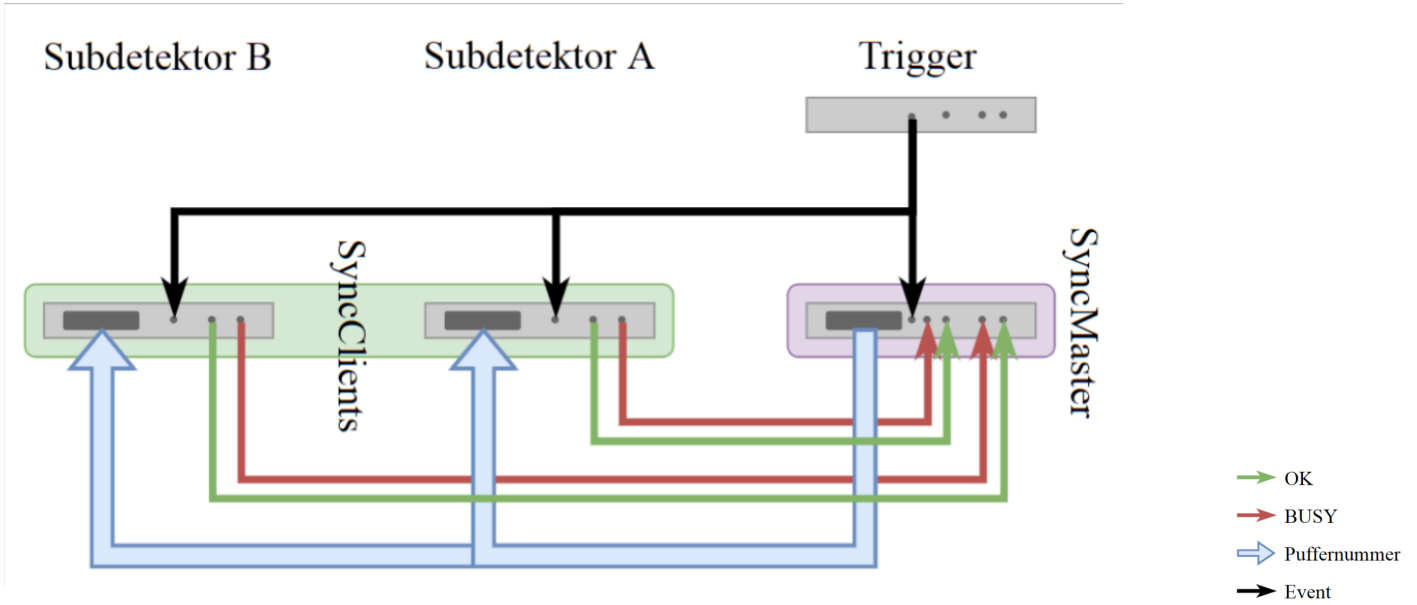
replaced VMEbus data transport
via ext. Gbit card

Orange Tree Technologies



Sync - system

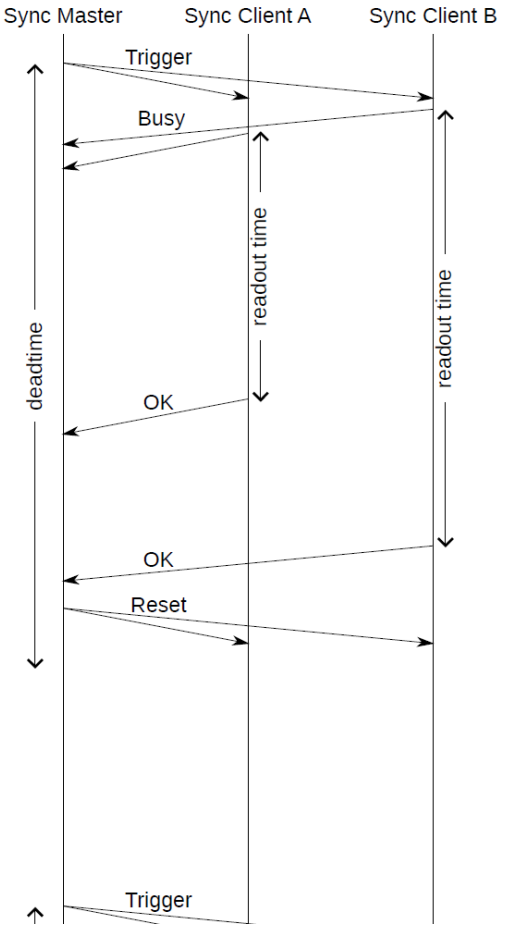
Detectors are read out individiually and in parallel. Sync system used to ensure no subdetector misses a trigger.



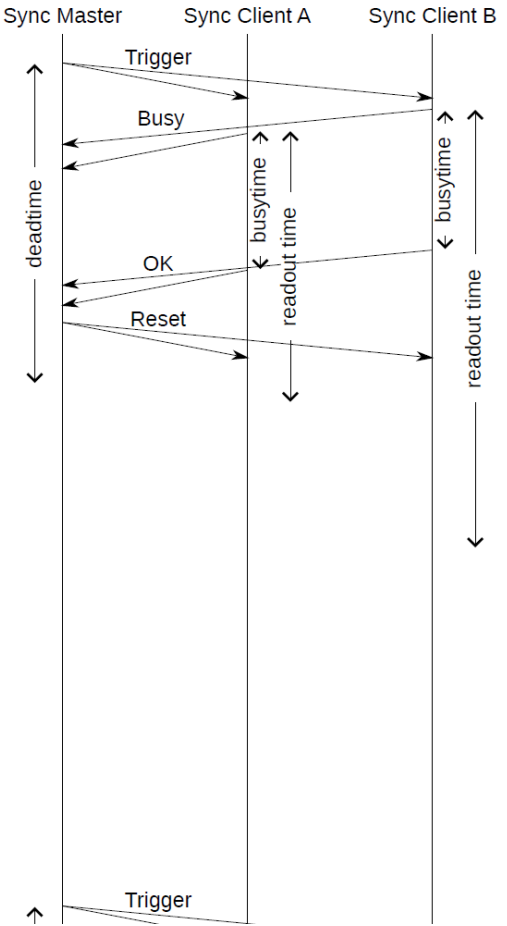
checks for

- successful readout (Busy, OK)
- data integrity (common buffer number)

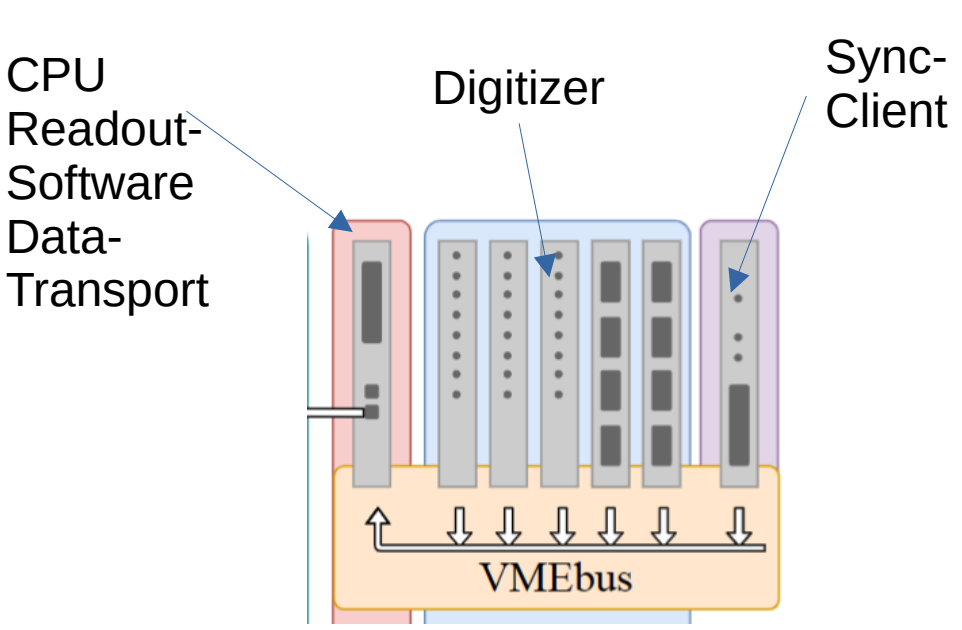
Sync – system / asynchronous readout

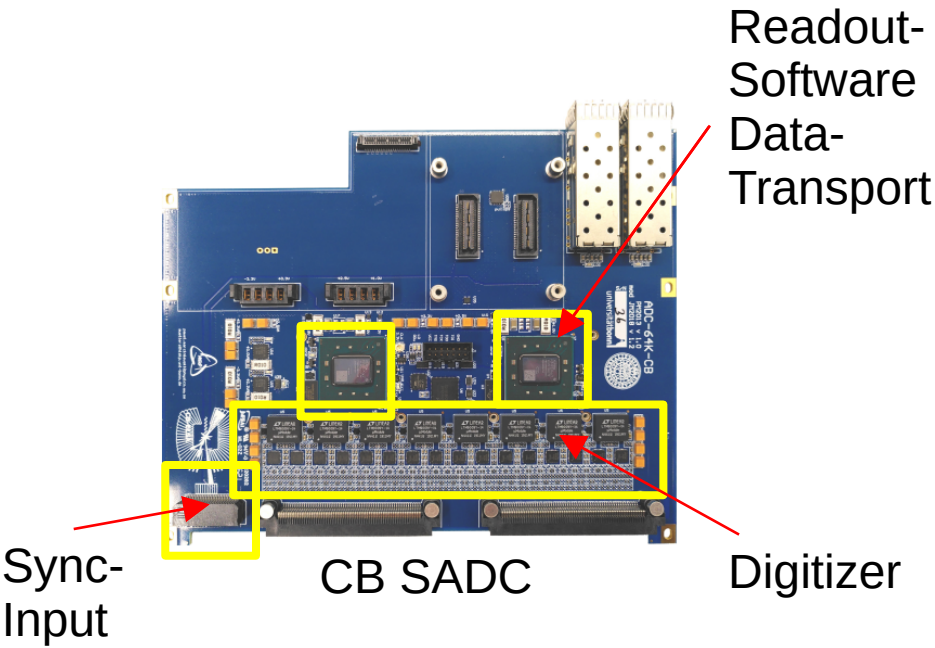


- large buffer available on readout boards
- no need to wait until all data transfered to CPU
- only wait until ready to accept new trigger
- data transfer while waiting for the next trigger
- Not limited to VME readout:
  high-latency transfer (e.g. ethernet) also possible



Concept of LEVB can be integrated on FPGA





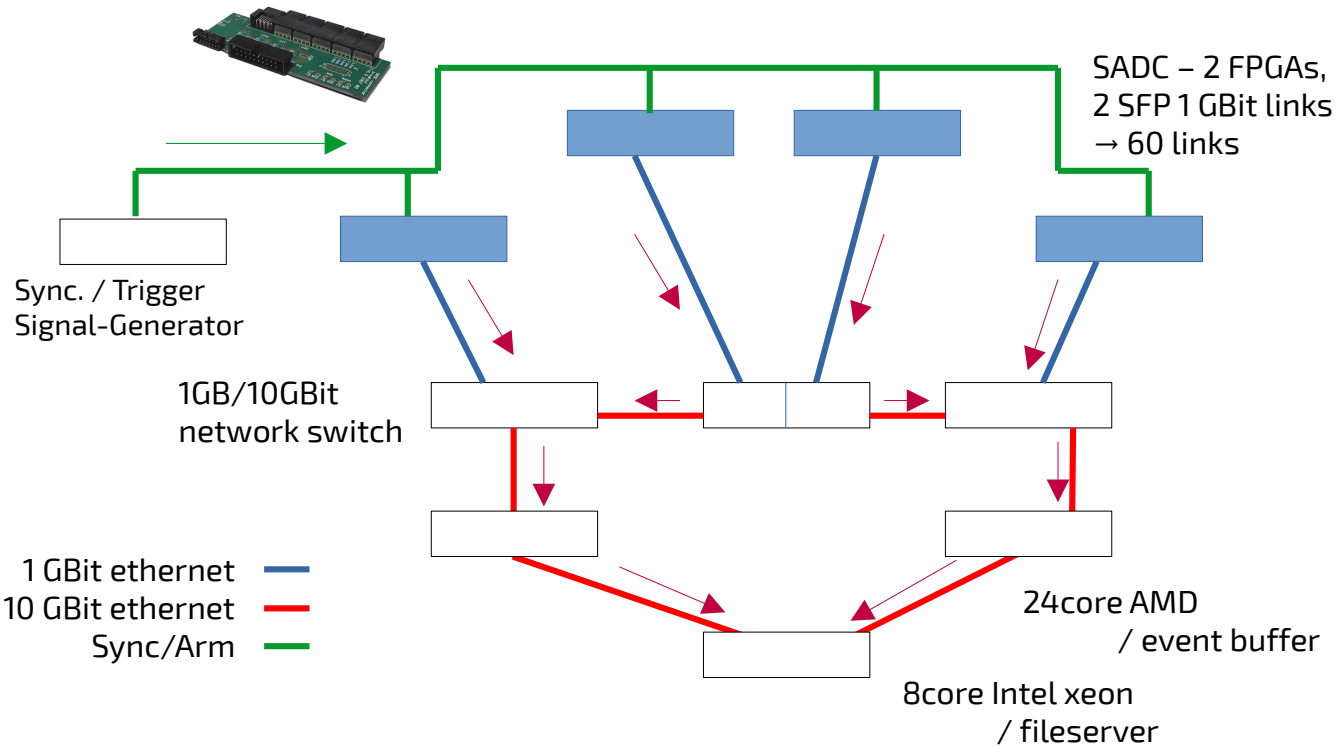
Crystal Barrel SADC readout platform flexibel for triggered or free running readout

→ Choice by adaption of firmware

CB firmware capable of self triggering, but readout is done over 32chs

No central trigger
→ self triggered

- Readout of 32chs and transport introduces significant deadtime. (waveform transmitted)
- To avoid incomplete events sADCs are blocked (disarmed) for some time

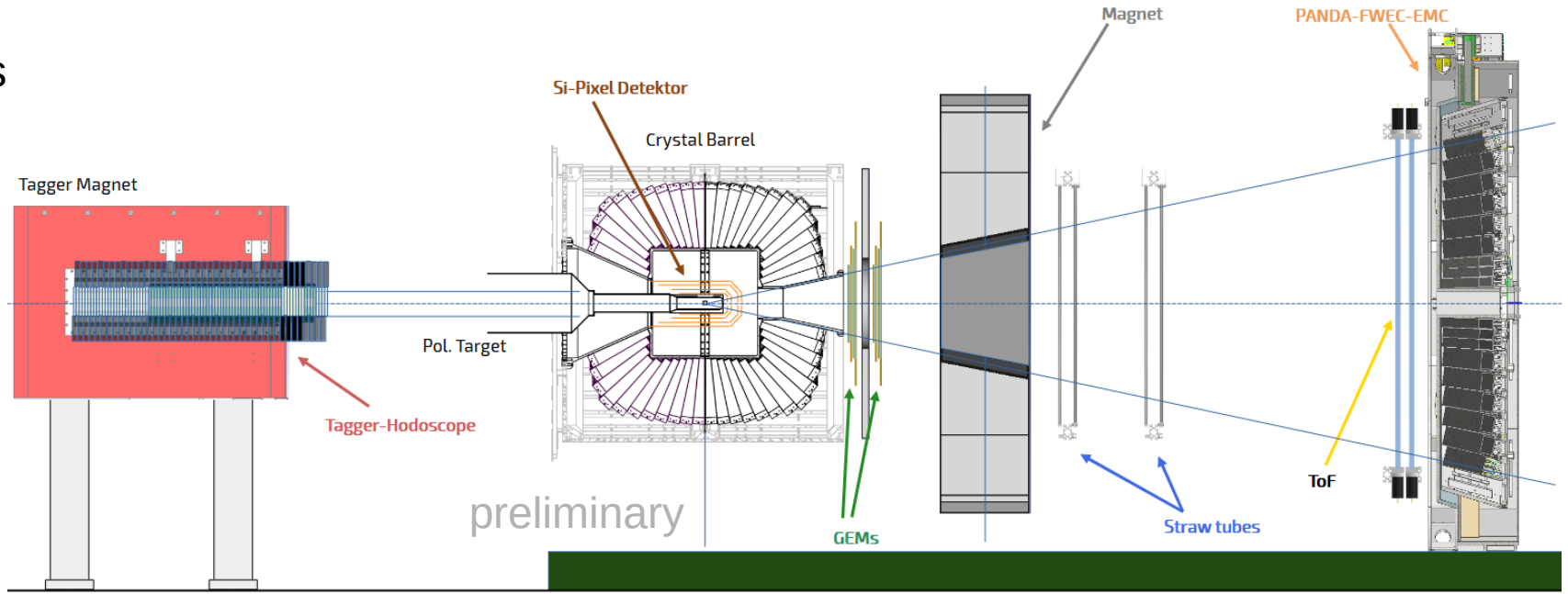


Firmware will be updated to single channel readout.

Future upgrade CB-ELSA

For the upgrade many new detectors will enter

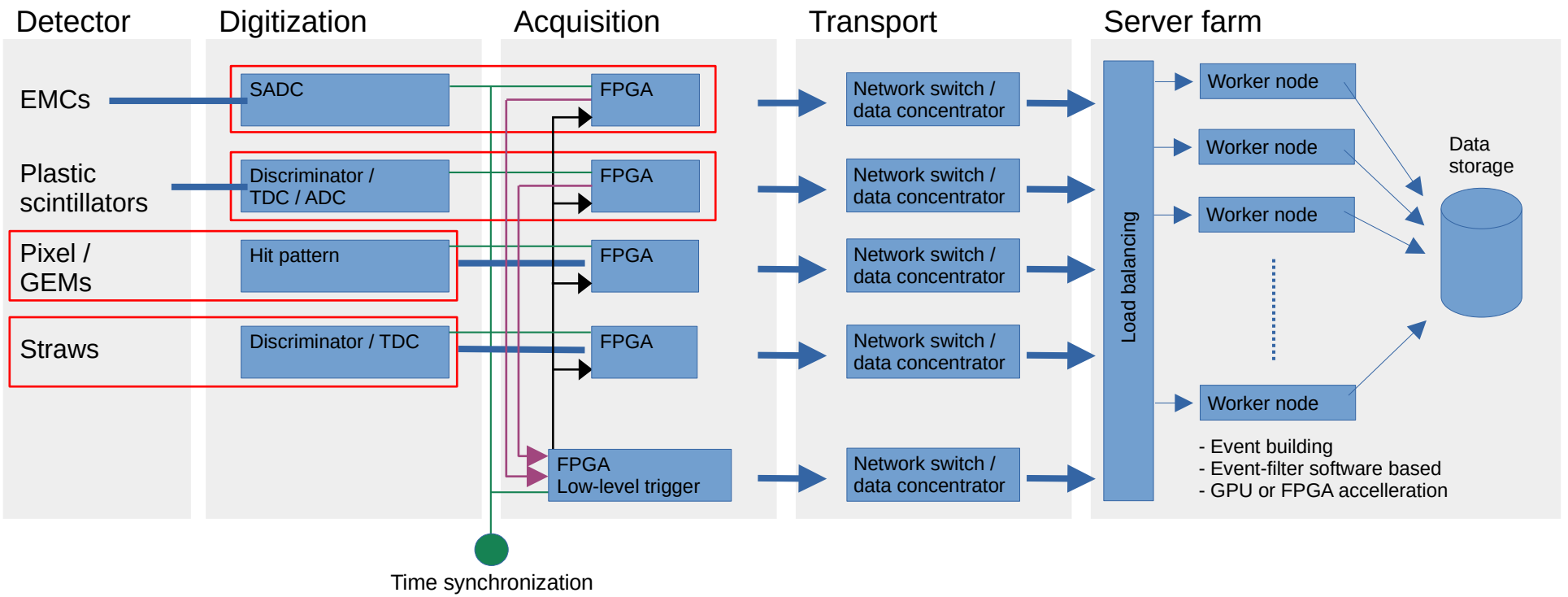
- Pixels
- GEMs
- Straws



New detectors will be FPGA based readout systems

→ CB-ELSA DAQ needs further improvements to integrate new systems

Future DAQ


Detector
Digitization
Acquisition
Transport
Server farm
EMCs
Plastic scintillators
Pixel / GEMs
Straws
SADC
Discriminator / TDC / ADC
Hit pattern
Discriminator / TDC
FPGA
FPGA
FPGA
FPGA
FPGA Low-level trigger
Network switch / data concentrator
Network switch / data concentrator
Network switch / data concentrator
Network switch / data concentrator
Network switch / data concentrator
Load balancing
Worker node
Worker node
Worker node
Worker node
Data storage
- Event building
- Event-filter software based
- GPU or FPGA accelleration
Time synchronization

Summary

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- Current DAQ-system is running fine and is sufficient for current needs

Future upgrade

- Detailed design/planning:

- integration of new systems with more free running architecture
- forward endcap needs some „cluster finder“ for trigger
- introducing a common time reference for event matching

- Transition from a triggered to a more free running system:
- new detectors might need it for trigger/filter
- reuse „hardware trigger“ for a time window to look for wanted events
  → e.g. reduce data rates from tagging system