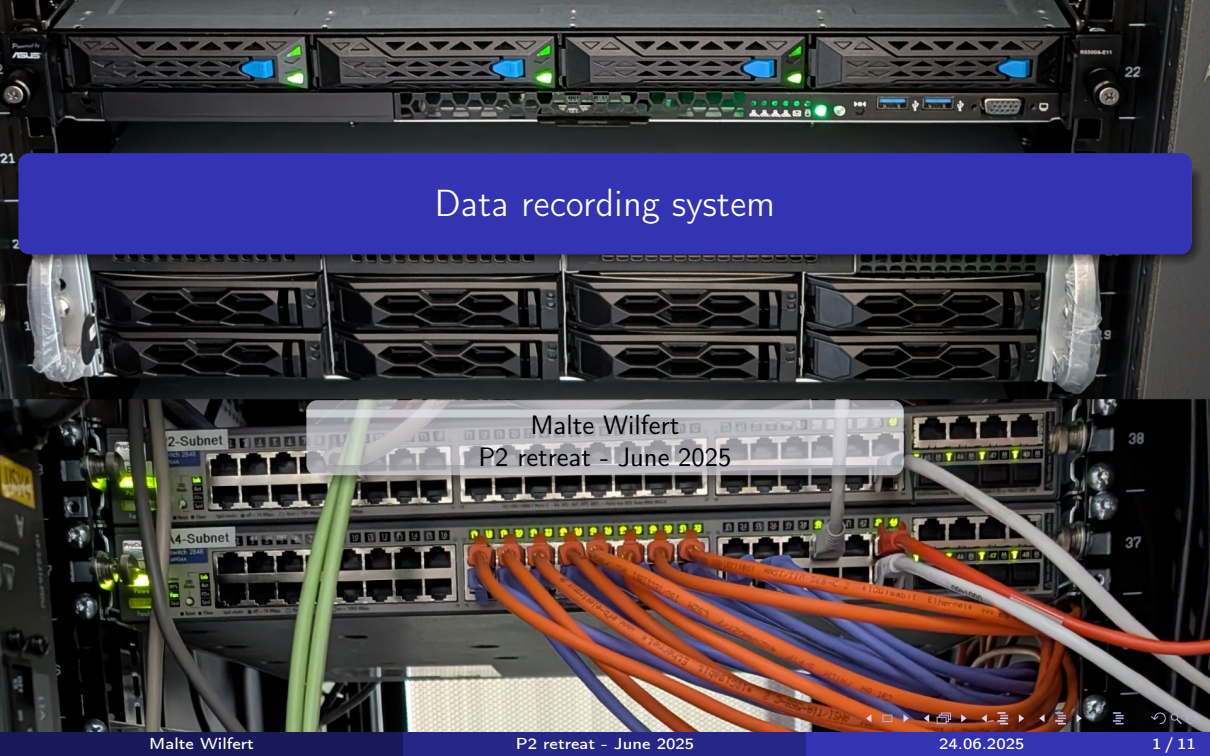


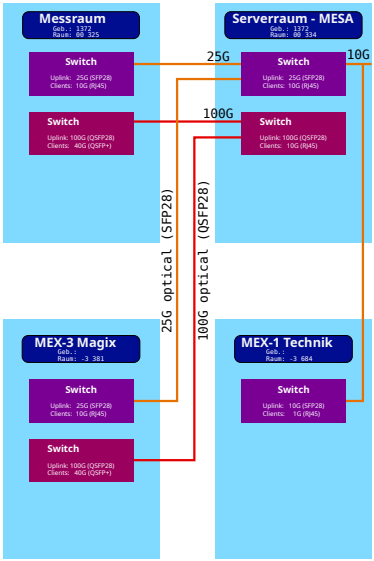
Data recording system

Malte Wilfert

P2 retreat - June 2025

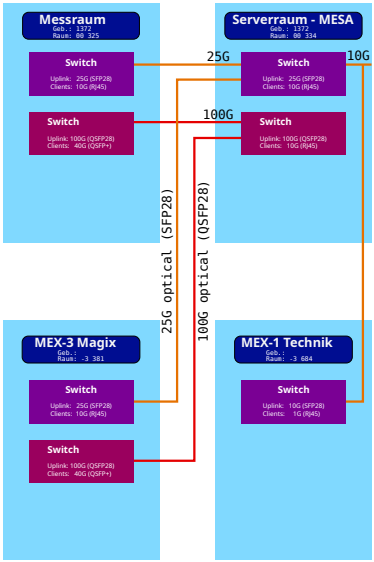
Network

- Idea: Two networks with different speeds
- Data network
  - Fast connection between switches (up to 100G, optical, higher speed possible)
  - 40G connection with SADCs possible
  - 10G connection as alternative for SADC connection
  - 10G connection to server
  - Data connection for BASKET
- Control network
  - 25G connection between switches (optical)
  - Up to 10G connection to server, PCs, equipment, ...



Network - Current status

- Plan for the network structure available
- 2 optical fibre cables in place
  - Connection: Server room ⇔ MAGIX bunker
  - Multimode (OM5) with 12 fibres each
  - → 6 network links per cable possible
  - No connectors yet → splicing needed
- Control network:
  - Should they be POE (power over ethernet) capable?
- Data network:
  - Open question: connection for SADC 40/10G?
- Switches, optical fibre cables, ethernet cables, various tranceivers (100G, 40G, 25G, 10G) could be ordered



Computing - Server

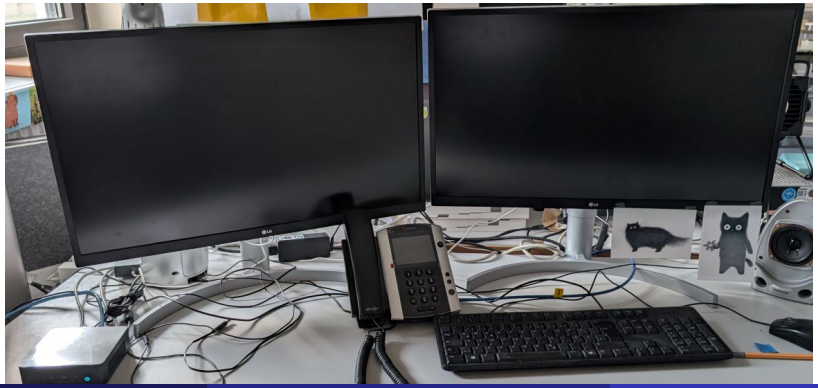
- Ubuntu server 24.04 LTS running on all servers
  - 6 DB / Event builder
    - AMD EPYC 7232P (8 Cores)
    - 64 GByte RAM
    - 2 TByte SSD, 16 TByte zfs-mirror (RAID-1)
    - 2x 10G RJ45 network connection
  - 1 analysis server
    - AMD EPYC 7352 (24 cores)
    - 384 GByte RAM
    - 2 TByte SSD, 64 TByte zRAID2 (RAID-6)
    - 2x 10G RJ45 network connection
  - 1 storage server
    - AMD EPYC 7232P (8 Cores)
    - 192 GByte RAM
    - 2 TByte SSD, 120 TByte zRAID2 (RAID-6)
    - 2x 10G RJ45 network connection
  - 2 Uninterruptible Power Supplies installed
    - Capacity: 6000 W
    - 1G RJ45 network connection

$\Rightarrow$ Total disk space (with out SSD): 280 TByte

$\Rightarrow$ Total number of CPU cores: 80 (160 Threads)

Computing - Control room

- 5 Intel NUC with two displays each available
  - Intel Core i5-1340P (4P + 8E cores)
  - 16 GByte RAM
  - 0.5 TByte SSD
  - 2.5G RJ45 network connection
- Runing Ubuntu 24.04 LTS
- Common user account distributed via LDAP (Lightweight Directory Access Protocol)



Data storage

- For $11.000\,\mathrm{h}$ hydrogen data
  - Estimated $\sim 1\,\mathrm{PByte}$ of disk space needed
  - Including: SADC (Quartz, Lumi, Halo, Beam monitoring, Polarisation), QDC, Asymmetries
- Long term storage for $\sim 2\,\mathrm{PByte}$ needed
- Buy storage from ZDV
  - Contract for 5 years, renewal needed afterwards
  - Storage on disk and tape
- Alternative: Use own storage server
  - Tape storage could be realised together with KPH IT
  - 2/3 server with large raid systems (Master, Backup, (HIMSTER))
    - HIMSTER II has $60 \times 10\mathrm{TByte}$ disks per tray
    - PRIMA is already using a large RAID system
    - Trays/Storage server from HIMSTER II might be available after upgrade

Slow Control

- MESA will use EPICS for distributing/collecting information from the accelerator

$\Rightarrow$ EPICS based slow control needed

  - Hardware with EPICS support (e.g. CAEN HV)

  $\rightarrow$ Easy to be implemented

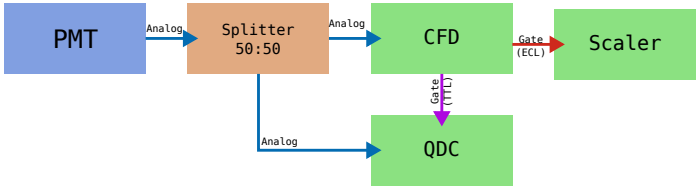
  - Hardware without EPICS support (e.g. solenoid)

  $\rightarrow$ Input Output Controller needs to be developed

- Control system for P2 needs to be developed
  - Web based frontend
  - DOCKER Container for each controler (Ravis Master thesis)
  - PRIMA has developed similar system

Tracking mode - readout

- Self triggering system for each quartz bar
- Using new CAEN VME crate
  - ⇒ Selftriggering successfully tested during test beam August 2024
  - ⇒ First test of new readout of QDC/CFD/Scaler
- Current Status:
  - VME Server
    - Split into diffferent processes (Communication, QDC, Scaler, CFD, SQL, Status)
    - Currently tested with PMT like pulses from function generator (self triggering)
  - Event builder
    - Listen/Record to data from server process
    - Separated for Scaler and QDC
- Possibility to provide trigger signals for each quartz bar via ECL signal



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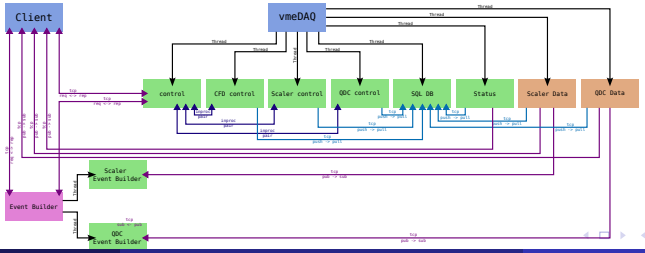
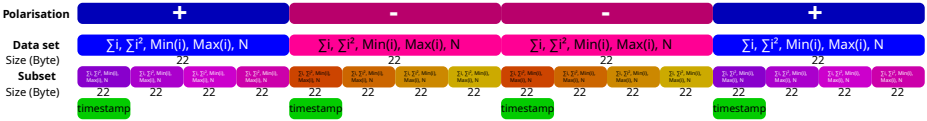


Integration mode - readout



- Data structure:
  - For each helicity window: $t, \mu, \sigma, \sigma^2, N_{Samples}, \min, \max$
  - Same values also for 4 sub windows
  - Decission for storage format (ROOT, HDF5, TXT,...)
- TI-boards
  - 3 Boards available $\Rightarrow$ up to 16 Connections
  - Synchronisation, run start, individual delays for each connection
  - Require at least a T_{stable} signal from source
- All 10 SADC boards and FPGA modules delivered
  - Firmware developement for SADC ongoing
  - Two different versions for TI-board communication and optical data transfer
  - Testing of optical fibre connection ongoing (currently only 1G)
  - Calculation of mean values, signal width... not implemented, yet
- Software developement needed

Helicity generator

- Development of a Helicity generator (Quadruplets,...)
- Discussion with Anselm and Jürgen
  - Anselm developed an FPGA based version of A4 electronics
  - Consists of two parts (Master and source front end)
  - Developed together with electronics workshop
  - Includes De Bruijn Sequence for same amount of $+ \rightarrow -$ and $- \rightarrow +$ transisions
  - We got the schematic from Anseln for these boards
- Develop helicity generator based on this design together with electronics workshop
- Possibility to include TI-firmware on the FPGA for syncronisation with P2-DAQ

Analysis

- Analysis methodes / Programs for asymmetry calculation need to be developed
  - Linear regression algorithms from A4 exists
  - Need to be adapted to P2
  - Testing of algorithms needed
- Analysis methods for calulation of weak mixing angle need to be developed
- Include possibility for blind analysis
  - Provide only calculated asymmetries for each quartz bar instead of measured currents
  - Add additinal artificial offset to asymmetry
  - Cancels out for linear regression

  $\Rightarrow$ Unblinding by subtracting the offset