

# DAQ Status of COMPASS and AMBER Experiments

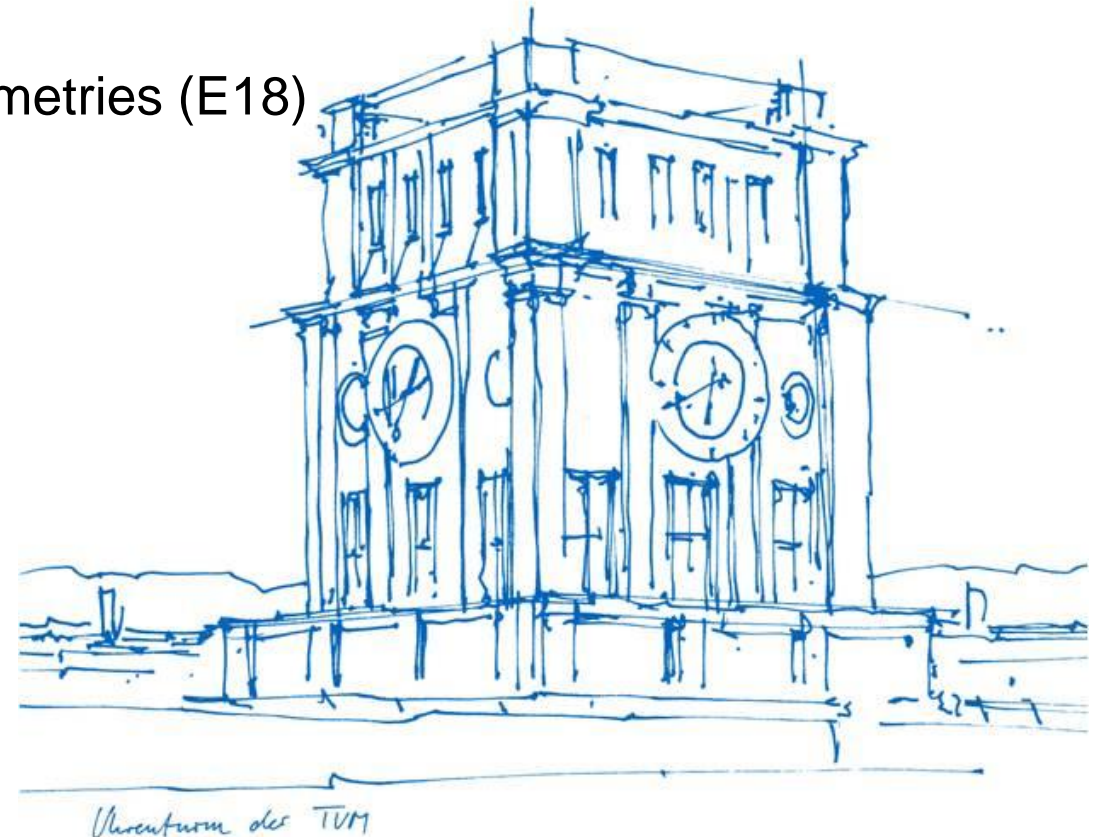
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TUM Department of Physics

Technical University of Munich

Online Meeting, 16-th November 2021



# COMPASS DAQ during 2021 Run

- Stable operation during the run
- Some instabilities :
  - Mismatch between layers
  - Stopping run takes too long
  - Usually caused by detector data problems
- Minor issues related to Dialog due to race conditions. New version deployed in August
- Longest DAQ downtime was due to accidental push of power breaker => DAQ network switch was down
  - Completion of PDUs installation in DAQ barrack before next run

# Data Rate and Collected Data

Run numbers: 289280-292954  
 Number of recorded runs: 2691  
 Number of data files: 508102  
 Total data size: 492.2 TB (1TB =  $2^{40}$  bytes)

## Per periods:

2021T04 (Runs: 291219-291489)  
 Total number of recorded runs: 258  
 Total number of data files: 60553  
 Total data size: 58.7TB (1TB= $2^{40}$  bytes)

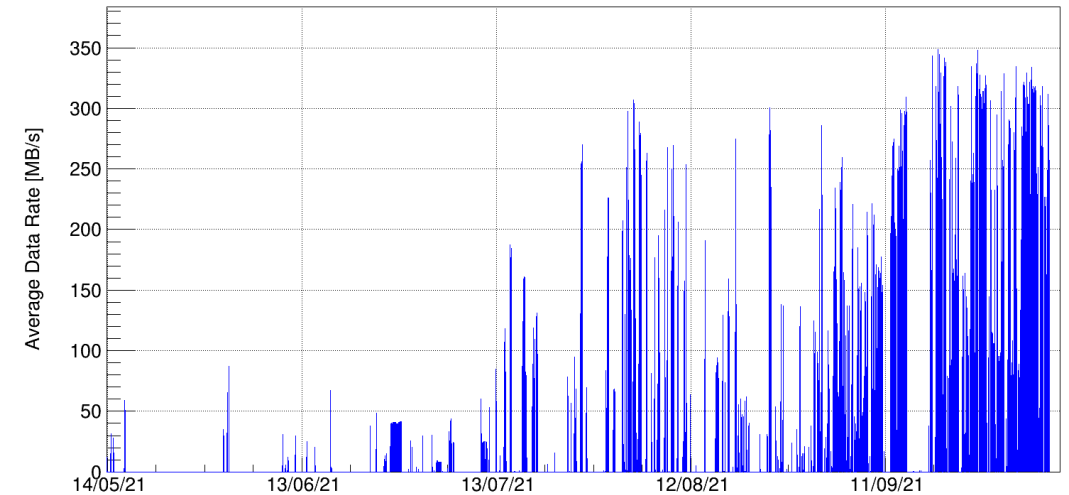
2021W07 (Runs: 292421-292771)  
 Total number of recorded runs: 277  
 Total number of data files: 142785  
 Total data size: 138.9TB (1TB= $2^{40}$  bytes)

2021T05 (Runs: 291490-291820)  
 Total number of recorded runs: 271  
 Total number of data files: 35234  
 Total data size: 34.0TB (1TB= $2^{40}$  bytes)

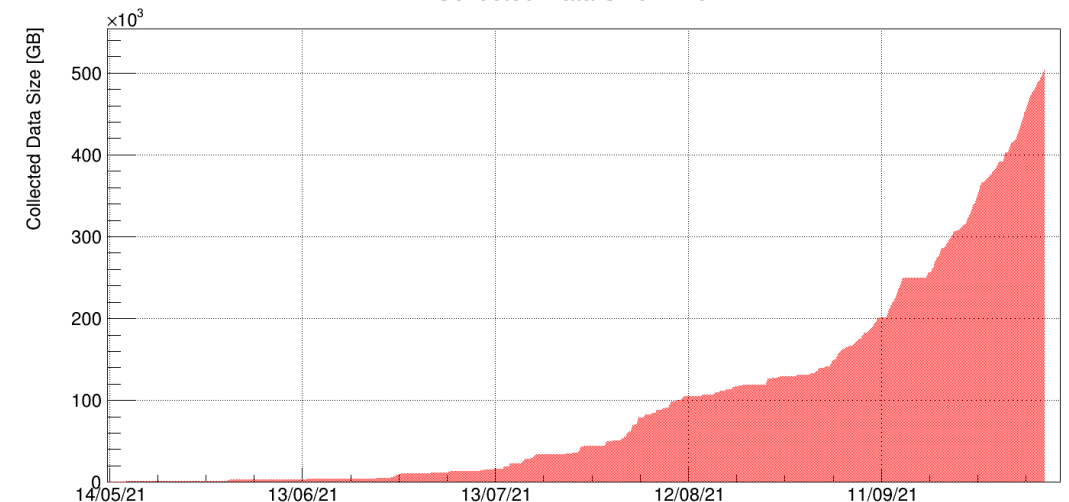
2021W08 (Runs: 292772-292954)  
 Total number of recorded runs: 179  
 Total number of data files: 112717  
 Total data size: 109.7TB (1TB= $2^{40}$  bytes)

2021W06 (Runs: 291821-292420)  
 Total number of recorded runs: 397  
 Total number of data files: 110815  
 Total data size: 107.5TB (1TB= $2^{40}$  bytes)

Data Rate in 2021



Collected Data Size in 2021



# Change DAQ to AMBER, NA64 and back

## AMBER

- New DAQ data structure
- New detectors : SciFis, 5 stations of Silicon detectors and SpeakTime TDC
  - Unused SrcIDs deployed to preserve FE DB

## NA64

- BMS attached to NA64 DAQ
- Changed Slink fibers

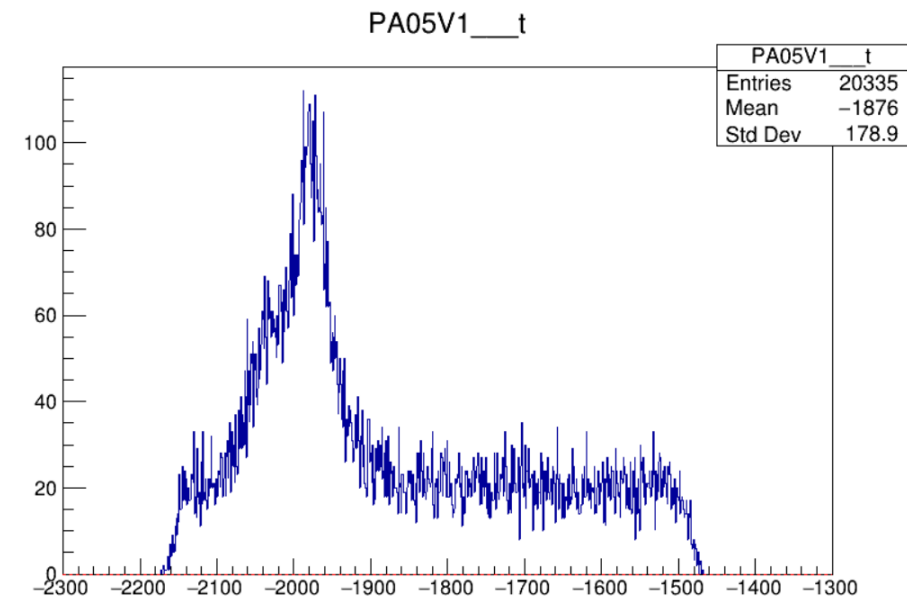
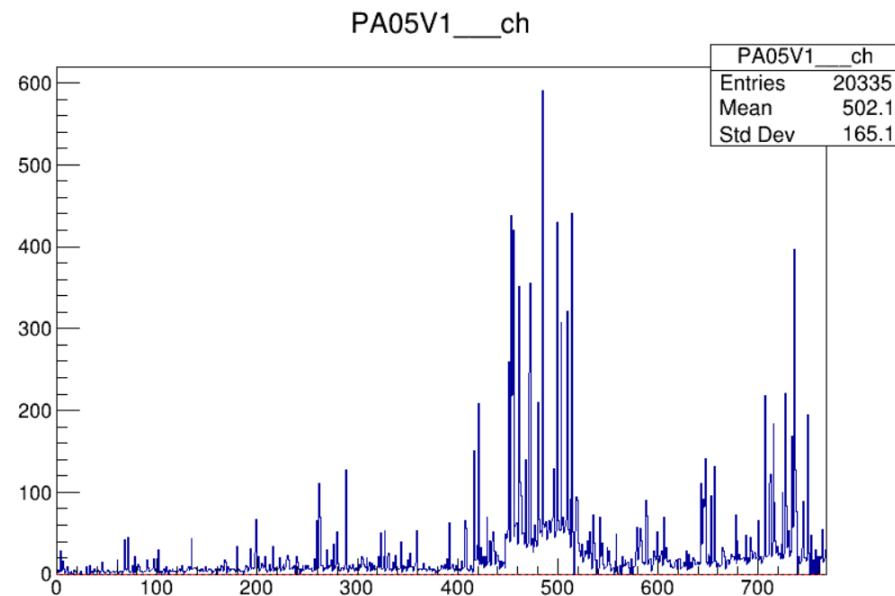
## Switching back to COMPASS

- Decouple from ACTAR(TPC) DAQ - done
- Recover DAQ configuration and reconnect Slink fibers

# MWPC with iFTDC

1 detector or 3 planes equipped with iFTDCs cards and tested with muon beam

- 3x12 = 36 iFTDCs
- One additional iFTDC is master time TDC



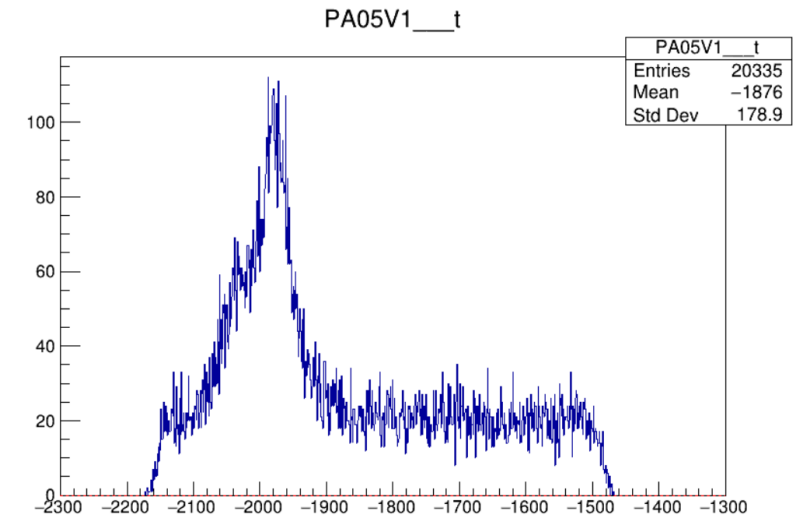
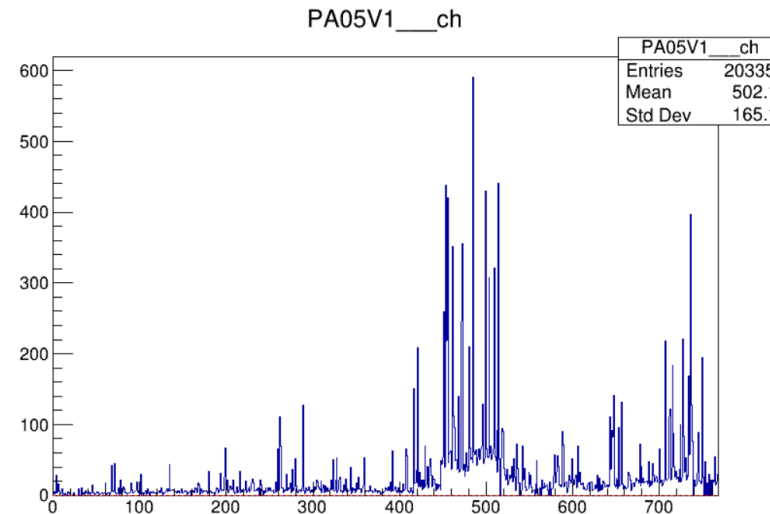
SrcID 459. T0 installen on the same MUX. Threshold=10fC, dead\_time=4us.

# Cross Talk

Noise is high for a moment

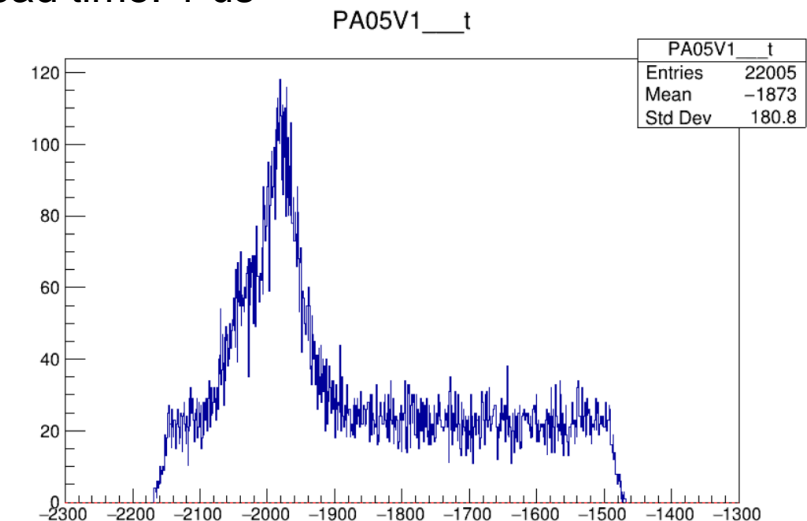
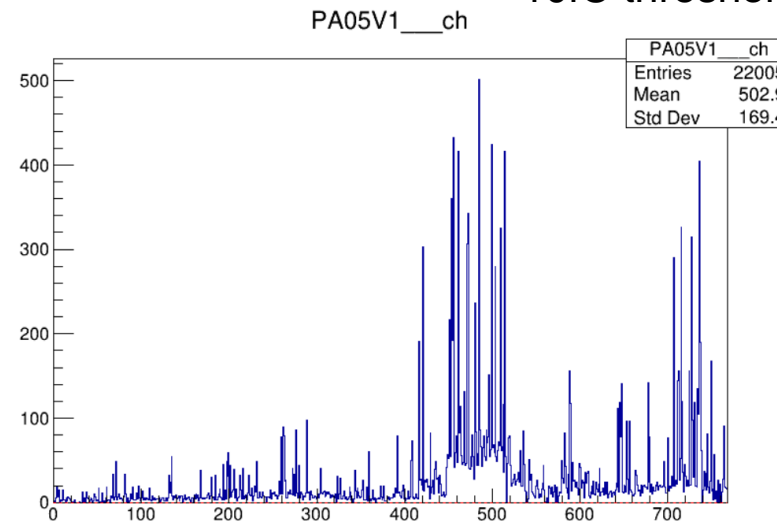
No degradation down to 0.5 us dead time

10fC threshold, Dead time: 4 us



SrcID 459. T0 install on the same MUX. Threshold=10fC, dead\_time=4us.

10fC threshold, Dead time: 1 us



# AMBER DAQ

# DAQ Computing

## DAQ computing for PRM run

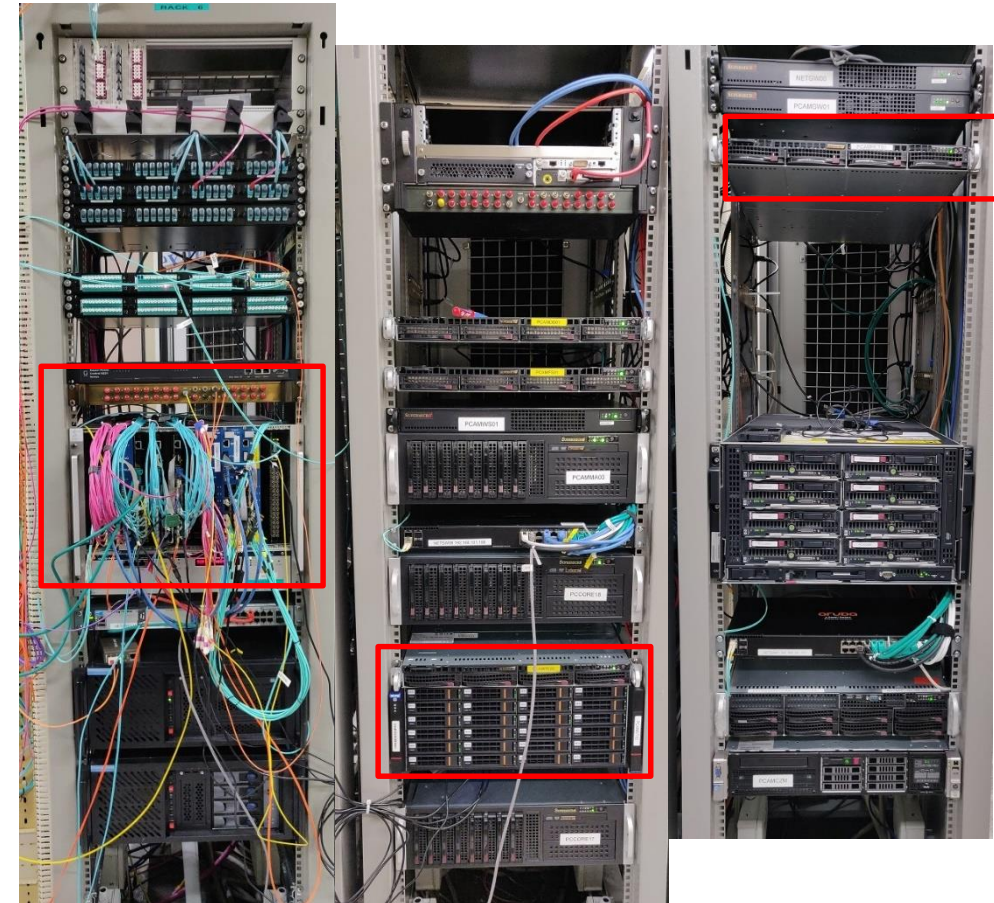
- 4 Read Out Engines + 4 Disk Storage Servers
- 8 HLT nodes

## Mini AMBER DAQ

- 2 x COMPASS type Read out Engines with new PCIe cards
- 1 x AMBER type Read out Engine with New Data storage
- File Server, DB Server
- 1 HLT nodes + 2 HLT nodes shall be delivered (Prague)
- 48 port Ethernet switch will be purchased
- 3 more RC computers for DAQ room will be purchased (Prague)

## Missing computing for PRM run

- 3 Read out engines
- 5 HLT nodes





# DAQ Hardware

## Mini DAQ setup

- Old and new TCS controller
- DAQ Event builder
- 2 iFTDC DHMUX for Hodoscopes and SciFi
- 3 iFTDC DHMUXes for MWPC
- 15 DHMUXes for other detectors
- 2 x UltrascalePlus FPGA cards – for future developments: high performance event builder, trigger logic

## Front-end electronics

- 12 x iFTDCs for Hodoscope + 3 x iFTDC for SciFi
- 15 x DAQ DHMUX cards available
- 2 x UltrascalePlus FPGA cards

Still migration to ATCA standard to be done otherwise we have sufficient FPGA cards for PRM run !!!

# FPGA Firmware Status and Development

## Fully functional

- Event Builder Switch
- New spill buffer

## Firmware in development:

- TCS controller firmware, small changes required
  - Time slice generator
  - Distribution of RUN number
- Modify iFTDC firmware to trigger less version
- DH MUX for iFTDC - advanced , still to be completed

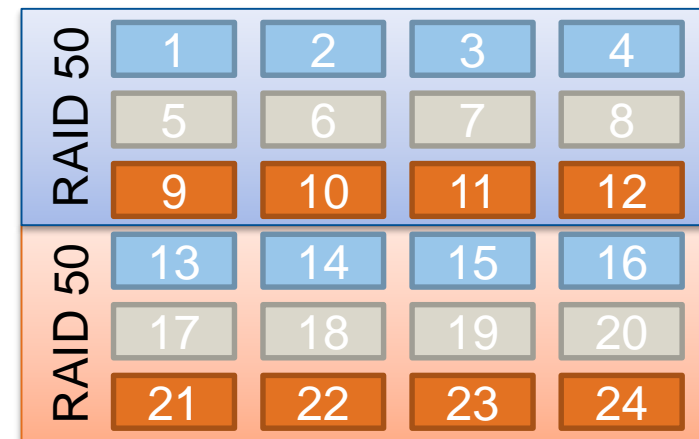
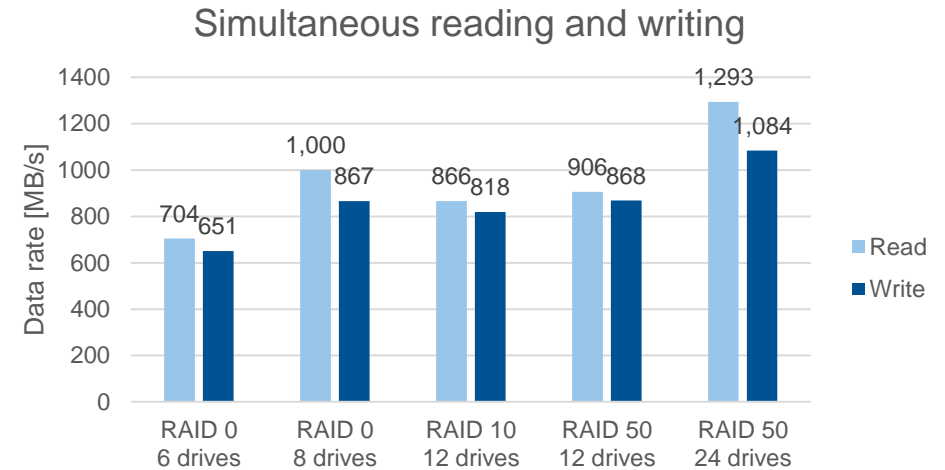
# AMBER DAQ Software

- New DB library implemented, DIALOG library upgraded – the last missing pieces for the rewrite of Master process
- Master process rewrite started using all the libraries developed over the last 3 years
- Communication between Master and slave processes being revamped to a unified JSON format
- DAQ configuration GUI approaching testing phase
- Python wrapper for common client core (DAQ client) finished, testing

# AMBER New Data Storage

## Tests performed

- Various RAID configuration evaluated
- RAID 50 came out as the best trade off
- Provides 75 % utilisation of the total capacity, i.e. **~250TB** (= 0.75 x 24 x 14 TB)
- Resistant to a single disk failure
- Sufficient performance for 1 GB/s sustained
- Software load balancing implemented



Final disk configuration

# AMBER DB

- AMBER DB migrated to the Database-on-demand (DBOD) service provided by CERN
- 3 instances deployed (1 master DB + 2 slaves)
- Fully virtualized containers running on CERN infrastructure (more performant and scalable)
- Running on MySQL Community Edition 8.0 server
- Other benefits: daily backups, advanced monitoring (Grafana), logging service, automatic updates (communicated in advance)

## DB Replication

- Replication between instance is setup and managed by CERN IT
- They take full responsibility for it (full support provided during working days)
- Replication should be more reliable mainly due to the dedicated plugin they use
- Outages of the service are very rare and usually planned in advance
  
- Very positive experience up to now
- Tests with production software to be done
  - Proposal to test DB on demand for production using COMPASS 2021 data

# HLT

- Framework for distributed computing has been tested and works nicely
- Simple coincidence filter implemented as an example
- More details (decoding of data words, timing constants) about individual detectors needed to evaluate the real filtration performance and optimize it

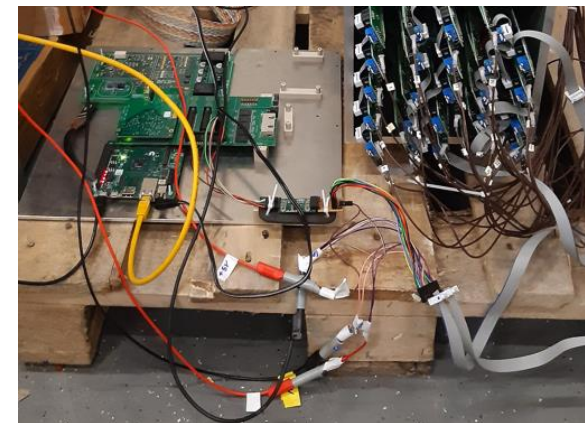
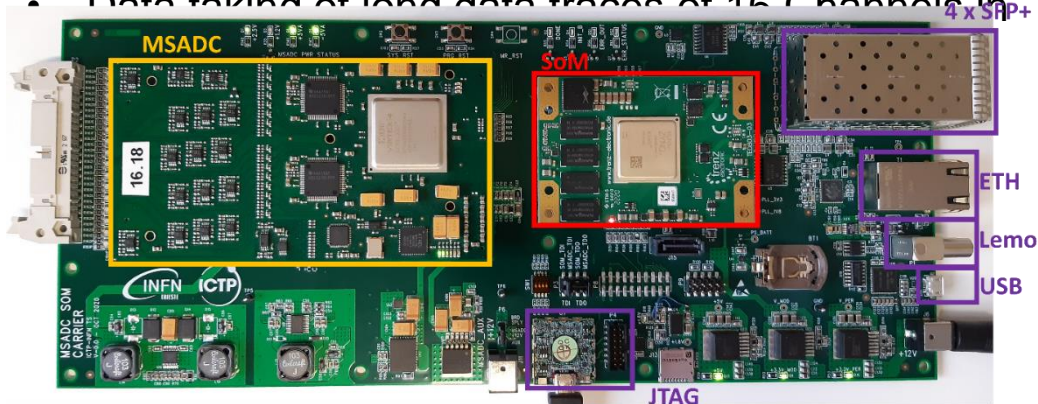
# Goals and Initial Setup

## Main Goals

- Data taking of long data traces of a small ECAL2 detector, for developing a DSP for data features extraction
- Study the noise distribution of the channels
- Study the ECAL2 response (pulse model)
- **Integration and Test of HV Power supply control system**
- Test and validate the MSADC-SoM Carrier card

## Desirable goals

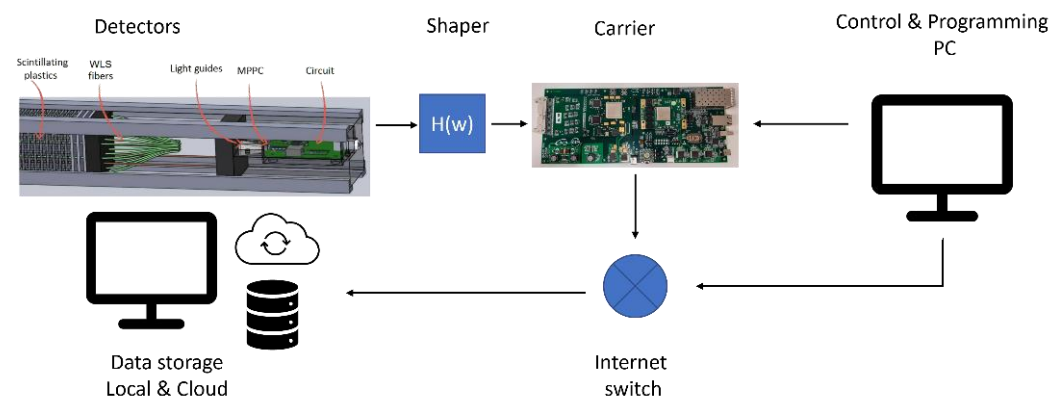
- Data taking of long data traces of 16 Channels in



High Voltage Power supply control

## Initial Setup

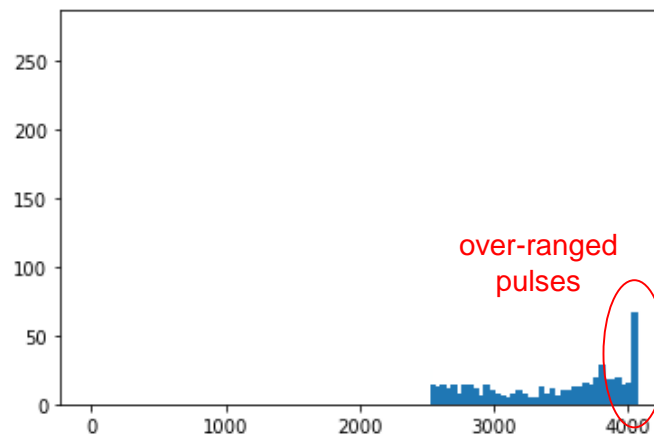
- ECAL2 5x5 matrix
- MSADC-SoM Carrier
- High Voltage Power supply control
- PC for remote data taking, programming and control



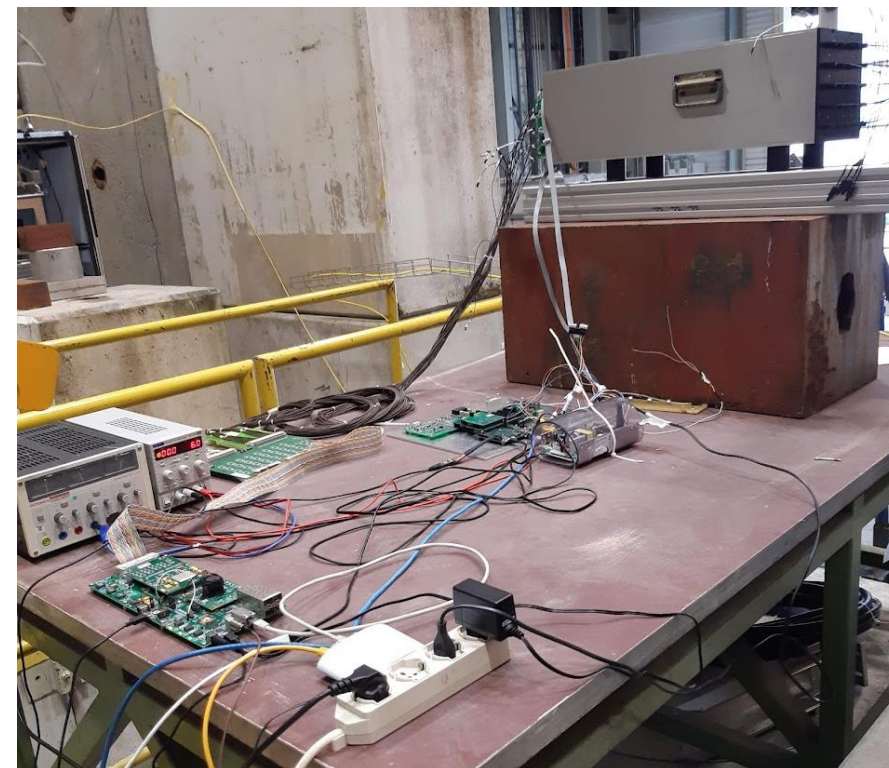
# Data Taking

- Two Channels of continuous data streams, independently and arbitrary selectable
- Up to 4M points of continuous data (~ 54 ms)
- ~ 1.5 TB of good data for analysis
- Development of online quality data analysis scripts (Swan)
- 1 Day of mixed on-spill/no-spill data taking
- 2 Days of only on-spill data taking
- Adjustment of HV
- 1 Day of corrected PMT HV polarization data

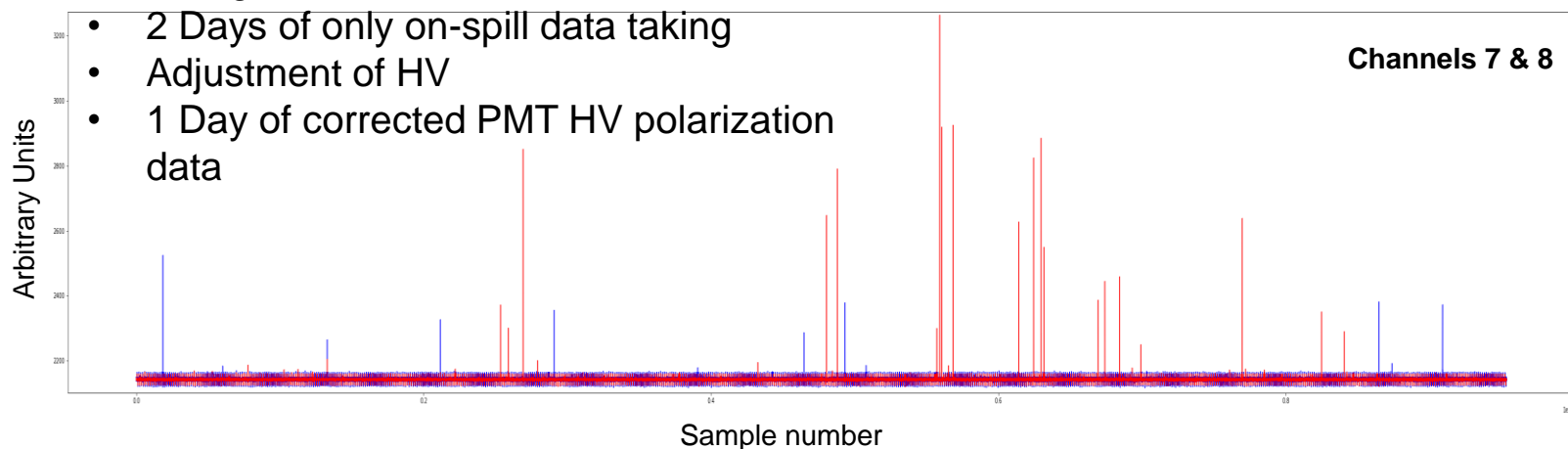
Histogram of Amplitudes CH7  
Online Analysis - No HV correction



Prototype setup at the end of beam line



Channels 7 & 8





# Plans for DAQ Tests

- Test of DAQ could not be performed up to now due to missing firmware
- Current strategy is to prepare DAQ for 2022 beam run and run in parallel with COMPASS and commission the system
  - Detectors in 2022
    - Hodoscope and SciFi already connected and main data source for testsOther detectors may join the DAQ during 2022 run
    - ALPIDE
    - TUM SciFi
    - ECAL2 readout
    - Evaluation of new ECAL2 MSADC readout for TPC
- Problem of components' availability gets worse
- Purchase of missing components shall be done asap (may affect computing, TUM SciFi front-end electronics, and ECAL2 new MSADC read out)

# Conclusions

- COMPASS DAQ is in good shape

## AMBER DAQ

- DAQ Hardware electronics are sufficient for PRM run
- Significant part of computing is missing and to be purchased
- Firmware development advanced but still to be completed
- Main DAQ software is ready for tests
- DAQ tests will be performed during winter shutdown
- DAQ commissioning is expected to complete in parallel with COMPASS run

# Questions

1. Installation of remaining PDUs in DAQ racks to be scheduled. Earlier is better.
2. How long COMPASS DAQ is needed? Is 2022 last year?

# BACKUP Slides

# To Do List

- Finalize the data format (error words, detector specific data words)
- Mapping file format and content (detector specific formats)
- Logbook modifications (slices, calibrations, bookies, etc.)
- Decoding library (convert slice to events, interface to CORAL, COOOL)
- Calibration database (values, requirements, options)
- Calibration extractor (stand-alone software)
- Backup of the /online folder – preferably to TSM (paid CERN service)
- Monitoring of servers (Zabbix server required)
- Run control commands (start-of-the-run command, TCS communciation)
- Start-of-the-run scripts

# DAQ Preparation for 2022

- Decouple software from ACTAR / GEM DAQ - done
- If desirable, after AMBER run control software is finished, it could be backported to COMPASS.  
Motivation: we do not know for how long we are going to be using the COMPASS SW before the changeover to AMBER SW. Switching before the run would maximize the benefit from new SW and allow us to test it. Of course, it is a big change.