The Prototype Trigger-Less Data Acquisition of the PANDA Experiment

M. N. Wagner

II. Physikalisches Institut, Justus Liebig University

This work was supported in part by BMBF (05P12RGFPF), HGS-HIRe for FAIR and the LOEWE-Zentrum HIC for FAIR
DAQ Chain Test @ MAMI
DAQ Chain

- Detector
  - 48 crystals
  - 16 Tagger channels
- 4 Sampling ADC (Uppsala)
  - Feature extraction mode
- 1 TRBv3
  - 2 Data concentrator
  - 1 SODANET source
- 1 xFP version 3
  - Burst-builder
  - (Filtering)
Setup @ MAMI
DAQ Chain Test @ MAMI

Δt of tagger to proto120

Energy distribution of the central Crystal in a.u.
PTDAQ Test @ Giessen

- DAQ chain
- Detector
- 2 Pulser
- 2 Sampling ADC (Uppsalla)
  - Feature extraction mode
- 1 TRBv3
  - 2 Data concentrator
  - 1 SODANET source
- 1 xFP version 3
  - Burst-builder
  - Filtering
DAQ Chain Test Results

- First time full DAQ chain in a beam test
- Burst building ✓
  - 88,500,500 bursts at Proto120 test
  - More or less only random events → can not be used for comparison
- Zero suppression ✓
- Coincidence measurements ✓
Thanks for your attention
Backup
Our Challenge

Higher interaction rate

Multiple events during the read out time

Many benchmark channels have similar topological signature in signal & background events

No level 1 trigger possible

High data rate

High reduction factor

Full online event reconstruction, disentangling and filtering
The PANDA DAQ
Prototype Trigger-less Data Acquisition (PTDAQ)

Functionality:
- Digitalized data front end electronic synchronized at data concentrator
- Burst building and first filter algorithm
- Event reconstruction and second stage of filter algorithm
Hardware Components

xFP board:
- AMC form factor
- Xilinx Virtex 5FX70T-2
- 2 x 2 GB DDR2
- 4 SFP+ interfaces
  - 6.25 Gbit optical
  - 1 Gb Ethernet

Micro TCA shelf:
- Up to 4 xFP
- Up to 9 data concentrators
Know Cross-Sections of $c\bar{c} \rightarrow pp$?

- Only 6 known cross-sections in $c\bar{c}$
  - $\eta_c$, $J/\psi$, $\chi_{c0}(1P)$, $\chi_{c1}(1P)$, $\chi_{c2}(1P)$, $\psi(2S)$
  - More than 30 resonances
    - including X, Y, Z

- Important Knowledge for ΠνΑΔΑ
  - Input for simulations
Functionality:

- Distribution of clock
- Time stamp
- Distribution of synchronization commands
- Start, stop, calibration
- Signal distributed over optical fiber
- Measurement of a signal propagation time
- Distribution of detector configuration data
- Slow control

SODANET link:

- Bidirectional
  - Source → data concentrator:
    - Synchronization
    - Front end electronic configuration
  - Data concentrator → source:
    - Slow control, used for time calibration
Burst Building Network

Front End Electronic (FEE)

Data Concentrator (DC)

1. Level Event Building

2. Level Event Building

Further filtering
MAMI Test Setup

- **DAQ chain**
  - 1 Sampling ADC
  - Pile-up mode
- **1 xFP version 2**
  - Data concentrator
- **1 xFP version 3**
  - Burst-builder
Additional Hardware Components

TRBv3

Sampling ADC (Uppsalla)
- Version 2012
- 32-ch, 14-bit
- 80 MSPS
- Virtex-6
Used Hardware

Sampling ADC (Uppsalla)
- Version 2011
- 16-ch, 14-bit
- 125 MSPS
- Virtex-5LX50

xFP board:
- AMC form factor
- Xilinx Virtex 5FX70T-2
- 2 x 2 GB DDR2
- 4 SFP+ interfaces
  - 6.25 Gbit optical
  - 1 Gb Ethernet
MAMI Test Location
MAMI Test Results

- Stable Connection between DC and xFP
  - 2-Input burst building successful
  - For ~ \(15 \times 10^6\) Stable events
    - Event size ~ 700 Byte
  - Data rate of ~1 Gbit/s
Jülich Connection Test

- DAQ chain:
  - 1 TRBv3
    - FEE board /TOT
  - 1 xFP version 3
    - Burst-builder / Data concentrator

- STT Prototype
  1 Gb/s UDP
  Greg Korcyl

- FEE

- PTDAQ
  1 Gb/s UDP
  Greg Korcyl

- Storage
Groningen SODAnet Connection Test

Sampling ADC (Uppsalla)

- Version 2012
- 32-ch, 14-bit
- 80 MSPS
- Virtex-6
MAMI Test Setup

- **Beam parameter:**
  - 210 MeV electrons
  - 0.003 - 2 MHz event rate

- **Detector:**
  - 1 mini PWO crystal
  - 2 HAMAMATSU SI-PM
  - 4 PANDA crystals
- VHDL code can be used without many changes
- Increased number of inputs per sub-detector
- Increase the possible data rate
- High performance event reconstruction
- High level event filtering
  - Software trigger on a sever farm or GPUs
The PANDA DAQ

- Freely streaming data: “Trigger-less”
- No hardware triggers
- Event filtering
- Autonomous FEE, sampling ADCs with local feature extraction
- Time-stamping (SODA)
- Data fragments can be correlated for event building
- Caveat: the high-rate capability implies overlapping events !!!
- average time between two events can be smaller than typical detector timescales
- This “pile-up” has to be treated and disentangled
- Real-time event selection in this environment is very challenging and requires a lot of studies