Programmable electronics for particle detectors and Positron Emission Tomography

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Outline

1. Data Acquisition Systems
2. Programmable electronics
3. Field Programmable Gate Array devices
4. Applications
5. Summary
Data Acquisition Systems

- Electronics and software that allows to measure and collect data from detectors

Real experiment:
- Different detector types
- Thousands of data channels
- Thousands of measurements per second
- On fly data analysis
Programmable Electronics

Detectors:
- Continuously generate analog signals
- Thousands of channels

Front-End Electronics
- Analog signal shaping
- Discrimination

Readout electronics
- Measurement and digitalization of analog signals
- Preliminary analysis
- Data units construction

Concentrators
- Assembly of data units
- Gateway to the network
- Transmission of control data

Trigger modules
- Generates a “snapshot” signal
- Controls the operation of the system

Event builders
- Combines data units into entire events
- Stores data on permanent storage device
FPGA devices

- Field Programmable Gate Array
- Reconfigurable logic
- Parallel processing
- Communication ports
- Real time signal processing
- CPU solutions

Tasks:
- Implementation of network protocols
- Front End Electronics readout
Applications – HADES (GSI)
High Acceptance Di-Electron Spectrometer at GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt (DE)

- 7 detector subsystems
- 80000 data channels
- Up to 55kHz event rate
- 520 electronic boards (excl FEE)
- 550 FPGAs
- 1050 optical transceivers
- 5km optical fibers
- Gigabit Ethernet network
- Up to 700MBps written to storage
- Running experiment

Cracow Municipal Computer Network:
- 90km optical fibers
- ATM and GbE based infrastructure
- 1250MBps link to Warsaw
Applications – PET (UJ)

- Time-of-Flight Positron Emission Tomography
- Fast reacting scintillating materials
- Precise time measurement
  - Electronics with high resolution
    Time-to-Digital Converters
- Promising results comparable to existing solutions
- Wide range of aspects to improve
Applications - Others

- Acquisition system is being used in many other experiments:
  - Straw Tubes Tracker for PANDA
    - Jagiellonian University, Cracow (PL)
  - DIRC for PANDA
    - GSI, Darmstadt (DE)
    - Justus Liebig University, Giessen (DE)
  - Resistive Plate Chamber based PET
    - University of Coimbra, Coimbra (PT)
Summary

- DAQ system as a versatile solution for detectors readout
- High-performance and expandable
- Applicable for different scenarios thanks to configurable electronics
- Used in a variety of experiments
- Forseen to be used in many forthcoming projects

- Future Plans
  - Development and tests of new electronic modules for the system
  - Implementation of new communication solutions
  - Adaptation and tests of the system in new experiments
  - Maintenance of already running experiments