Towards a DAQT TDR

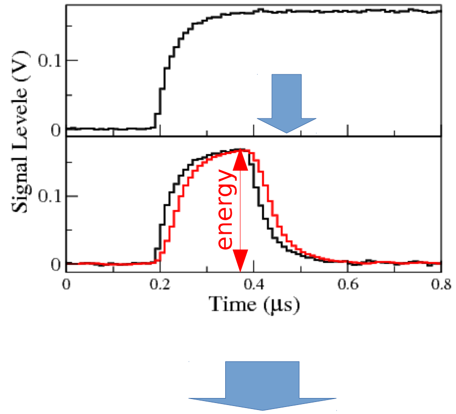
May 2018

Contents of Phase 1 TDR

- **Introduction** : **physics objectives, detector configuration**
  - Cross sections, luminosities, detector performance (tracking, EMC, PID …)
- **Requirements** (**event rates, event size, pile-up situation, storage capacity, event filtering capabilities, partitioning of DAQ, running modes**…)
- **System architecture**
  - Building blocks (**time synchronisation (SODAnet), data concentrators, data transport, FPGA based Compute Nodes, CPU/GPU farm,** …)
  - **Data format, interfaces and data flow**
  - **Event filter: partitioning and performance of algorithms (L1, L2), …**
  - **Run control system, error detection and recovery, Data Quality Monitoring (DQM)**
- **Performance simulations and measurements with prototype systems**
- **Manpower, schedule and cost**

Readout Approach for PANDA

The PANDA readout consist of:



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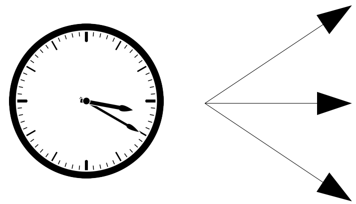
- **Intelligent self-triggered front-end**:
  autonomous hit detection and data pre-processing (e.g. based on
  Sampling **A**nalogue to **D**igital **C**onverter)

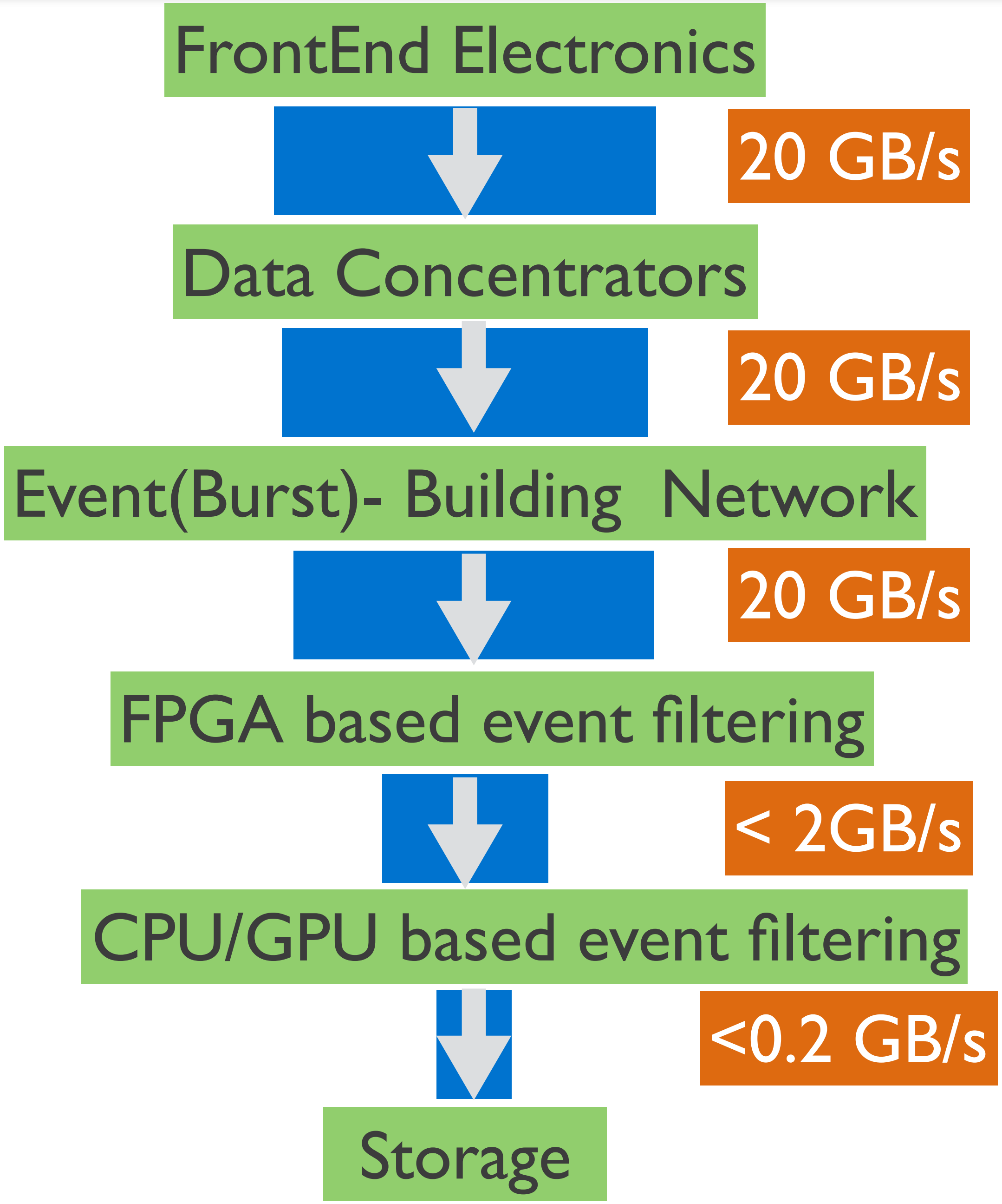


- **a very precise time distribution system (SODANET)**:
  single clock-source for PANDA (event correlation)

- **time-sorting and processing data in real-time**:
  processing in FPGA (**F**ield-**P**rogrammable **G**ate **A**rray)

DAQ Architecture

- Assumptions for Phase I
  - up to 10^6 events/s - 20 GB/s
  - separate runs for physics with “large” vs. “small” cross sections
  - negligible overlap between events (needs to be checked by simulations)
  - Final reduction factor for small cross section physics: 100
  - Reduction by FPGA layer: 10
  - Large cross section physics requires reduced luminosity due to storage limitations



Definition of requirements, interfaces and protocols

- Detector configuration, physics programme of Phase I needs to be defined
    - Cross sections, background situation
    - Event rate, event size and required rejection factors, acceptable efficiency loss
- Protocols, interfaces and network topology specifications:

Work in Progress

Burst-building network:

- Define protocols (data, control)
- Define interfaces for the standard data-processing IP-cores for the burst-building network:
    - Acquire requests from all sub-systems information on required data processing (e.g. pre-clustering, at least time-ordered merging of streams)

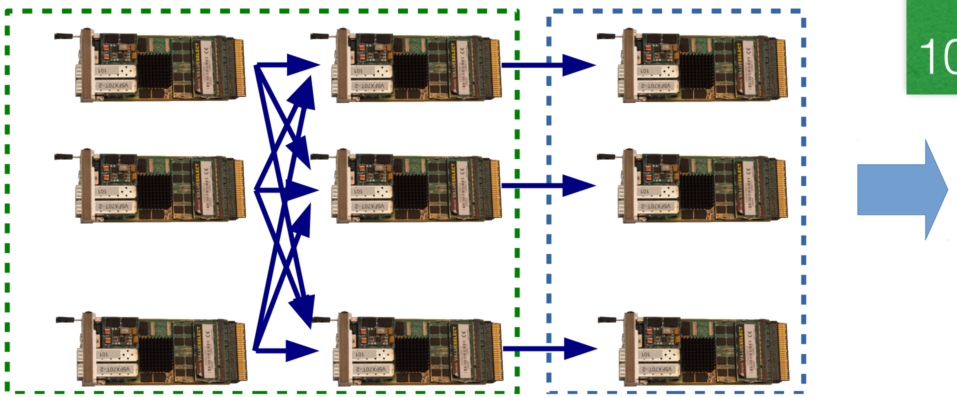
SODANET finished

To be done

Event building:

- Define protocol between the burst-building network and compute nodes (where final particle reconstruction will take place)
- Define network topology (static, dynamic with load-based distribution)
- Define interface to the PC farm

Two options:
10 Gb Ethernet or Aurora links to PCIe card



PC farm,
final event
filtering

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Data format for transport between FEE/Data Concentrators and CN layer

- Proposal: **define universal packet format,** independent of detector subsystem
  - Advantage: we can **use the same set of IP cores** to handle data streams independent of detector and DAQ layer
  - Data is streamed and organised in packets
  - Push architecture, but with support for back pressure
- **Data Origin Definitions:**
  - "detector": Panda Subsystem ID (EMC, STT, MVD etc.)
    - reserve one byte for unique detector definition
  - "module" : section ID of a detector (EMC Forward endcap, STT stereo layer, MVD pixels etc.)
    - reserve one byte for unique module definition
  - "location": unique identifier for the geographical location of a hit within a module (could be STT wire number, MVD pixel ID etc.
    - reserve 4 bytes (need addressing space for MVD)
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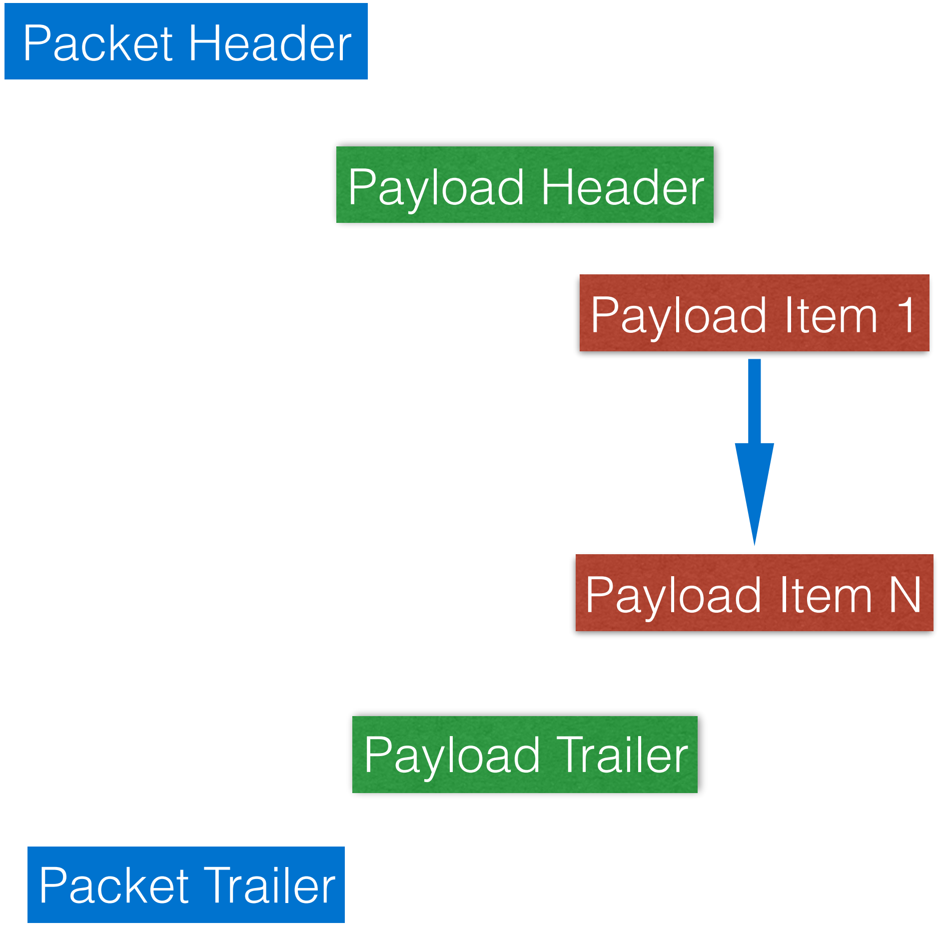
Universal Packet Format (UPF)

- Each packet contains a **packet header** with the following information (distributed in part by SODANET to FEE and/or set by slow control in FEE for local runs):
  - ID for "experiment" number (should be unique over the lifetime of Panda) (2 Bytes ?) (set by run control)
  - Run number (is reset at the start of a new experiment) 2 Bytes (set by run control)
  - Run type (physics, calibration, test/debug, local run, etc.) 1 Byte (set by run control)
  - Event selection identifier or has code pointing to data base(4 bytes ?)
  - Superburst ID: 4 Byte (to be distributed by SODANET) (use also as last packet flag)
  - Payload size (in bytes): 3 Bytes, payload item size in bytes (1 byte) (detector specific)
    - **Payload header** : Number of items in payload
      - **Payload items:**
        - Time stamp
        - Data Origin
        - Data value(s) (detector-specific)
    - **Payload trailer:** repeat payload size, add checksum (CRC)
- **Packet trailer**
  - repeat payload size (for redundancy, debugging and recovery
  - CRC (packet checksum)

Data format for transport between FEE/Data Concentrators and CN layer



Comments

- There is some redundancy in the data format
  - Important for development and integration phase
  - In a later stage, we can think about removing some redundancy for a more compact data format
- There is some freedom for detector - specific aspects in the payload
  - payload item size and number of data values per item can vary
  - data origin definitions RE are flexible (could be "single EMC crystal" or EMC cluster)

Data Format: next steps:

- Agree on the details of the proposed data format
  - needs discussion with FEE developers
- Is the allocated byte size for the individual headers adequate (in particular, for MVD) ?
- How large is the overhead (# bytes for headers /# data bytes)
  - Look into simulated data, right after digitisation

Open questions

- Panda configuration for DAY 1 physics
- Depending on the configuration, what is “first physics"
  - event filtering simulations required