Streaming DAQ – Computing Interface

Few slides to kick start the discussion, please interrupt to discuss at any moment

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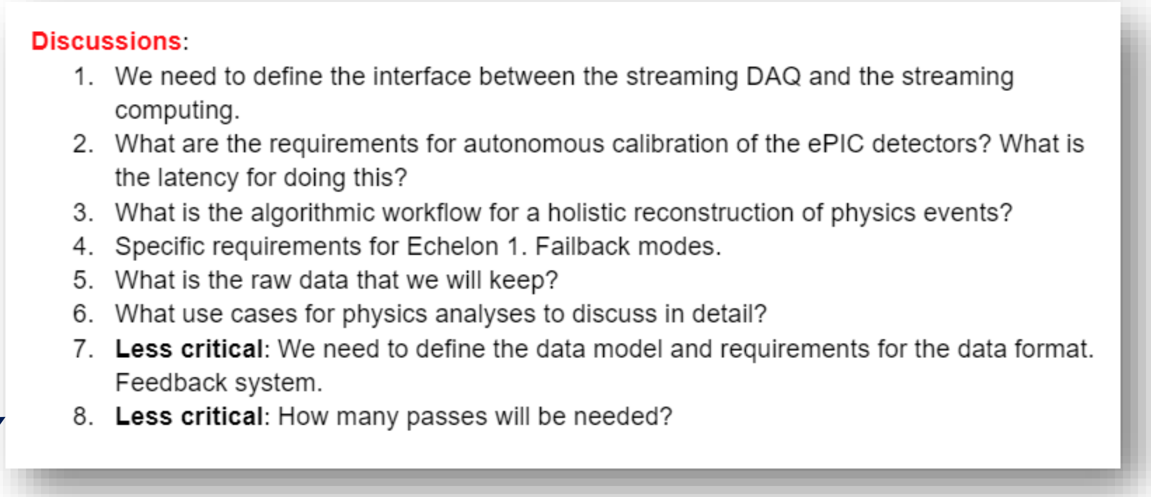
Introduction

- SRO WG meetings was kickstarted in July 2023, started with overview discussions (July 11 & 18)
- Last two Aug meetings
  - Data rate
  - Open-minded discussion on streaming computing model
  - Concluded a list of follow up discussions

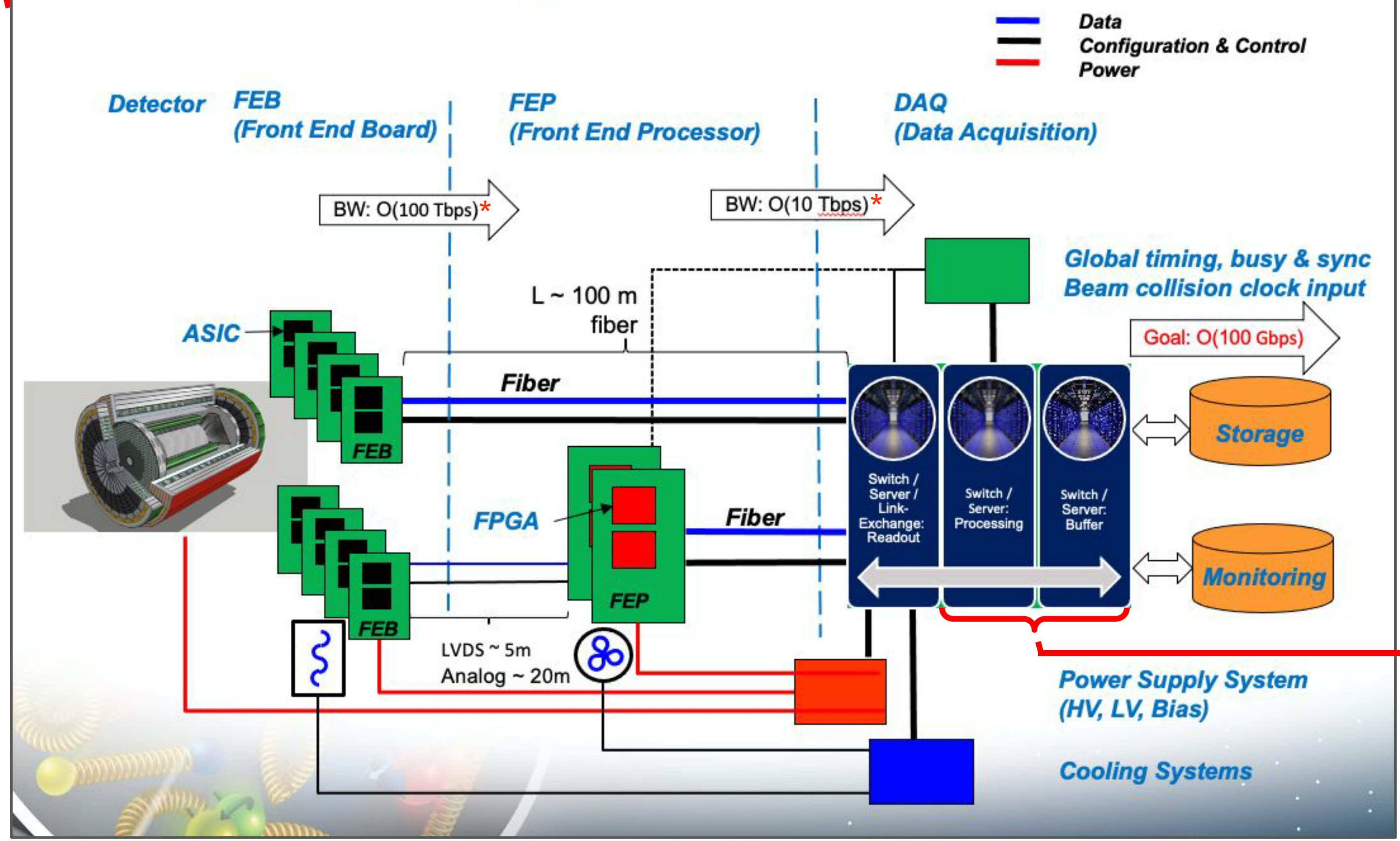


Discussions:

1. We need to define the interface between the streaming DAQ and the streaming computing.
2. What are the requirements for autonomous calibration of the ePIC detectors? What is the latency for doing this?
3. What is the algorithmic workflow for a holistic reconstruction of physics events?
4. Specific requirements for Echelon 1. Failback modes.
5. What is the raw data that we will keep?
6. What use cases for physics analyses to discuss in detail?
7. **Less critical**: We need to define the data model and requirements for the data format. Feedback system.
8. **Less critical**: How many passes will be needed?

- This meeting: focus on item 1: DAQ-Computing interface
- Near term events:
  - Welcome to join in-person ePIC Software & Computing Meeting @ UIC Sept 20-22
  - Preparation towards ePIC computing review in Oct 2023

EIC Streaming Readout Architecture



Data

Configuration & Control

Power

Detector

FEB (Front End Board)

FEP (Front End Processor)

DAQ (Data Acquisition)

BW: O(100 Tbps)*

BW: O(10 Tbps)*

Global timing, busy & sync

Beam collision clock input

Goal: O(100 Gbps)

L ~ 100 m fiber

ASIC

Fiber

FEB

FPGA

Fiber

FEP

LVDS ~ 5m

Analog ~ 20m

Switch / Server / Link-Exchange: Readout

Switch / Server: Processing

Switch / Server: Buffer

Storage

Monitoring

Power Supply System (HV, LV, Bias)

Cooling Systems

factor of 100 in data reduction

*ATHENA estimates assumed much more suppression at early stages, but still 100Gbps output. (See J. Landgraf talk at SRO X)

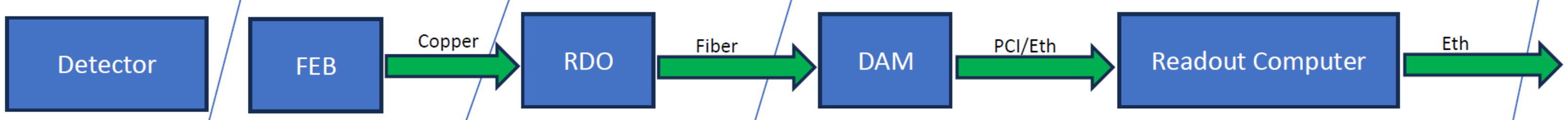
EIC Streaming Readout (From Fernando Barbosa's talk at AI4EIC Sep. 9, 2021)

Summary of Channel Counts

By Jeff Landgraf, presented on Aug 22 WG meeting [link]

Detector Group	Channels					RDO	Fiber	DAM	Data Volume (RDO) (Gb/s)	Data Volume (To Tape) (Gb/s)
	MAPS	AC-LGAD	SiPM/PMT	MPGD	HRPPD					
Tracking	36B			202k		872	1744	24	27	26
Calorimeters	88M		123k			258	556	10	502	27
Far Forward	300M	2.3M	170k			178	492	5	15	8
Far Backward	146M		2k			50	100	6	150	1
PID		7.8M	320k		140k	241	523	39	2628	36
TOTAL	36.5B	10.1M	615k	202k	140k	1599	3415	84	3,322	98

Summary of Data Flow



100% Occupancy	27.5-1760 Pb/sec

Aggregate	3.4 Tb/sec
Noise	3 Tb /sec
Signal from Physics + Background	400 Gb / sec

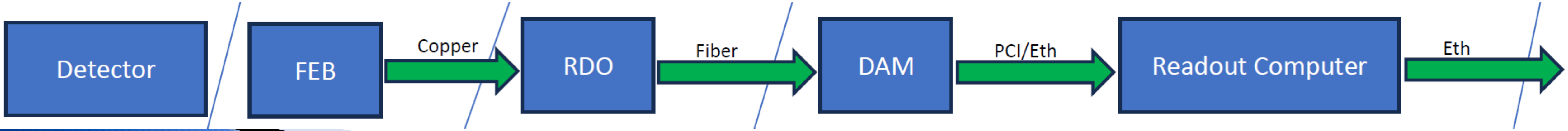
Aggregate	3.4 Tb/sec
Per fiber (Avg)	1.85 Gb/sec

Aggregate	99 Gb/sec
Collision Signal	38 Gb/sec
Synchrotron Rad	.01 Gb/sec
Electron Beam	4 Gb/sec
Hadron Beam	22 Gb/sec
Noise	35 Gb/sec

Streaming DAQ – Computing Interface: consideration 1

For kickstart the discussion, please interrupt to discuss at any moment

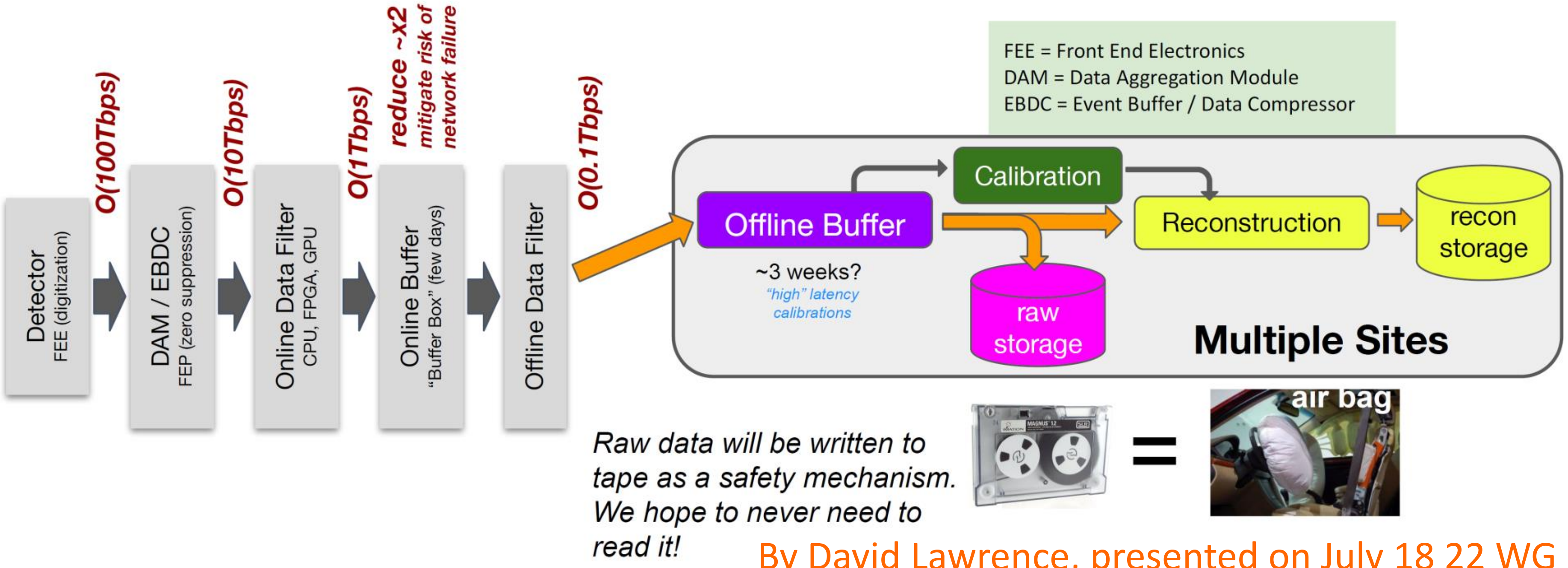
- Streaming DAQ naturally leads to no clear separation of streaming DAQ and computing
- Streaming DAQ relies on data reduction computationally (i.e. no real-time triggering) → Any data reduction in streaming DAQ is a computing job
- Which could be done at ASIC, FPGA, online-computers
- Example could be zero-suppression (simple or sophisticated), feature extraction (e.g. amplitude in calo and tracklet in FB tracker)
- If on xPU, DAQ, we could use offline software components



Streaming DAQ – Computing Interface: consideration 2

For kickstart the discussion, please interrupt to discuss at any moment

- Sooner or later, a “raw” data is defined and saved for permanent storage
  - We will define which stage of data is “raw”
- This “raw” data could be viewed as a DAQ – computing boundary



FEE = Front End Electronics
DAM = Data Aggregation Module
EBDC = Event Buffer / Data Compressor

Raw data will be written to tape as a safety mechanism. We hope to never need to read it!

By David Lawrence, presented on July 18 22 WG meeting [link]

Streaming DAQ – Computing Interface: consideration 2

For kickstart the discussion, please interrupt to discuss at any moment

- Paid by project
- Has a hard archival limit (O(100Gbps)) from both throughput and tape cost
- Main goal on "online-computing" is data reduction to fit output pipeline (+QA)
- As minimal reduction as affordable to
  - (1) reduce unrecoverable systematic uncertainty
  - (2) reduce complexity, cost, failure modes.
  - Any processing beyond minimal need a physics motivation to justify project cost/schedule reviews (and possible descope reviews)
- High availability: any down time cost $O(0.1)M/day → usually on host lab

Before "raw" data archival: DAQ

- Driven by collaboration, operation fund
- We would like to complete within a small latency (<O(1)week)
  - Usually driven by calibration and debugs
- Main goal on "offline-computing" is to bring out physics objects for analysis (+QA)
- Can afford to redo reconstruction if new algorithm or with new physics insights (at cost of time, effort and computing)
- Can wait for short interruptions and can be distributed

After "raw" data archival (or use of it from buffer): Computing

Please continue the discussions

- Feel free to share your views

Live note on indico [link]