Track 2 Highlights

Online Computing

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Track 2 - Online Computing

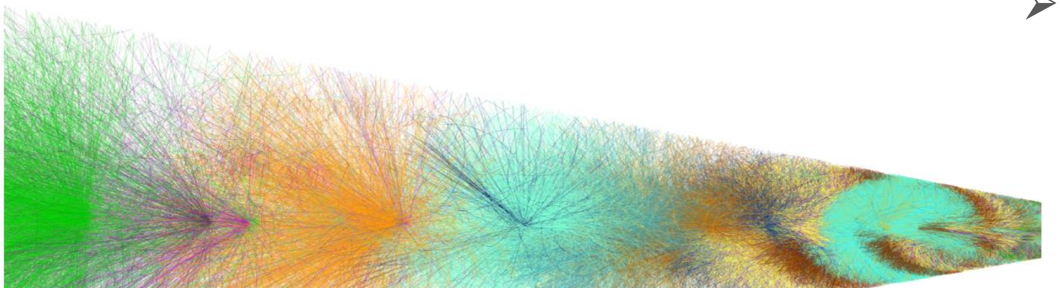
- 42 Talks (2 plenary) and 14 posters

Track conveners :

Claire Antel	(ATLAS)
Ruben Shahoyan	(ALICE)
Satoru Yamada	(Belle II)
Felice Pantaleo	(CMS)

Topics :

- Triggerless/Smart L1 trigger
- Accelerated online computing
- Common readout device
- Network & event-building
- Monitoring, Data-quality check and management tools

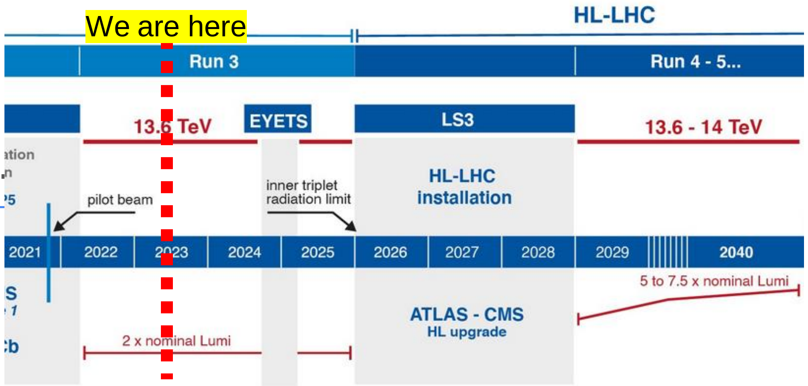


Overlapping events in TPC with realistic bunch structure @ 50 kHz Pb-Pb
Timeframe of 2 ms shown (will be 2.8 ms in production)
Tracks of different collisions shown in different colour

David Rohr, Giulio Eulisse

Demands for higher throughputs in upcoming years

- LHC experiments (ALICE, ATLAS, CMS, LHCb) :
  - Run3 started in 2022 : “One year of data taking”
  - Towards HL-LHC(～2029) : Developments for the phase-II upgrades are ongoing.
- Nuclear experiments
  - STAR, sPHENIX, various medium-energy programs ongoing and future EIC
- Neutrino experiment
  - proto-DUNE, DUNE far-detector(～2030)
- e+e- collider : Belle II(2019～)
  - On the way to the designed luminosity(～2034).

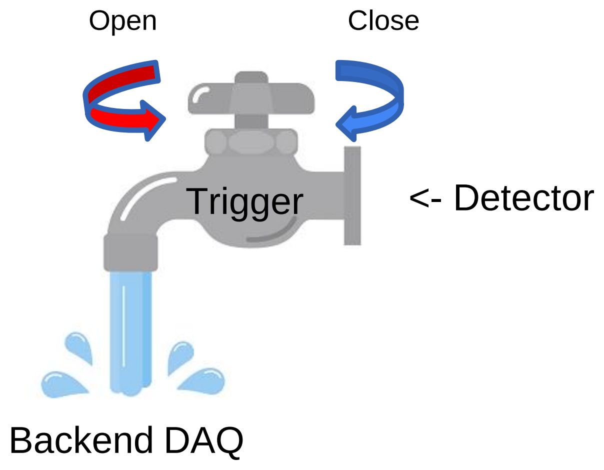


https://hilumilhc.web.cern.ch/content/hl-lhc-project

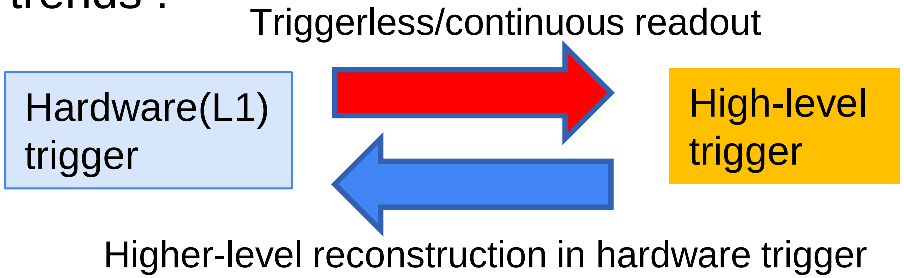
Trigger scheme

Two very important but basically conflicting demands for Trigger

- ➢Decrease throughput to backend DAQ
- ➢Keep trigger-efficiency high



Two trends :

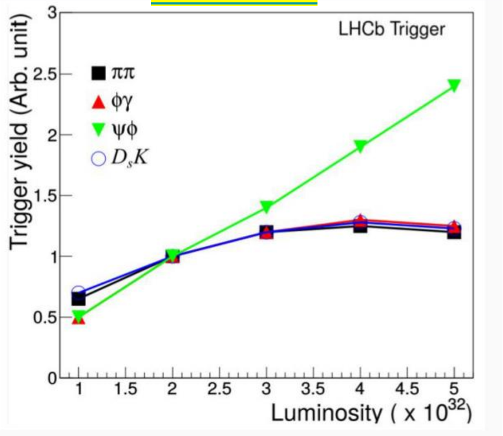


“One year of data taking”:
Triggerless/streaming readout

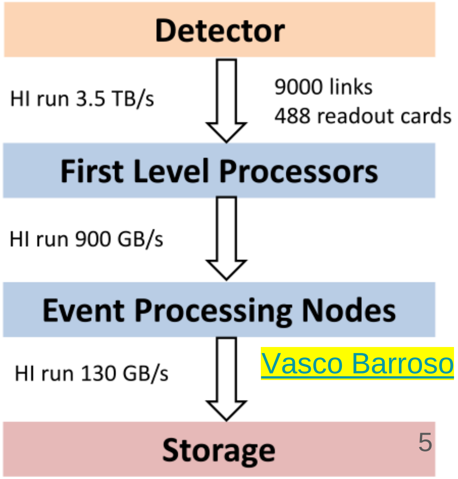
- Triggerless DAQ in LHCb
  - The system has been successfully used for the first part of Run3 !
  - Development : Implementing trigger for Long-lived particle detection (short track and displaced vertex)

- New ALICE DAQ system (O2/FLP) for Run3
  - Reconstruct TPC data in continuous readout in combination with triggered detectors.
  - Excellent initial performance, quite promising for Run 3

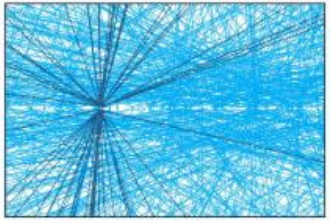
Full collision-rate readout: why?
Flavio Pisani

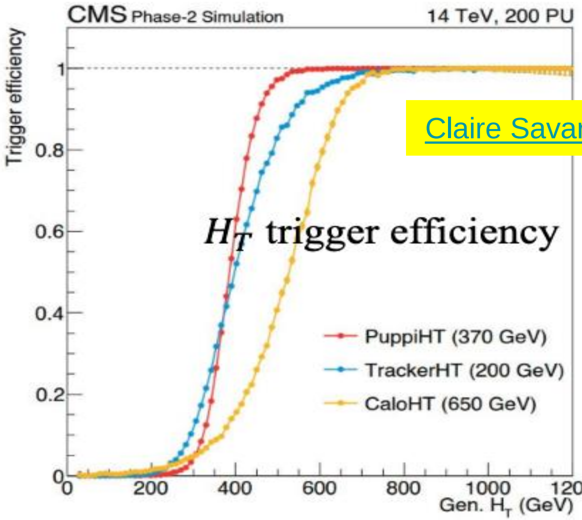


ALICE data-flow



Scaling up for HL-LHC
: Smarter Level1 trigger



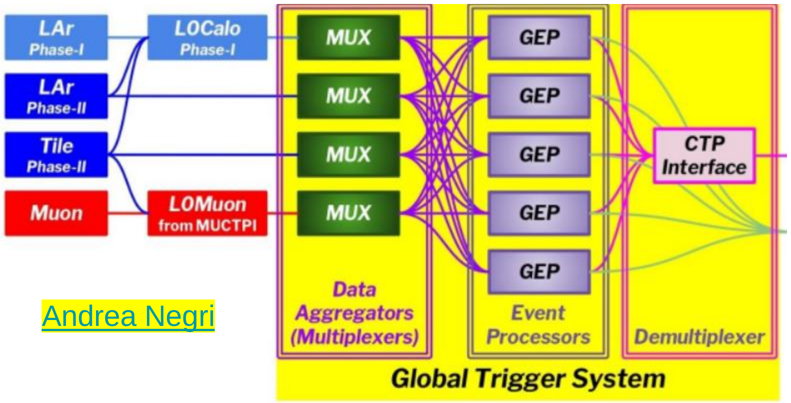


Claire Savard

- HL-LHC : Need to maintain current physics reach with 200PU (from 60)

- CMS phase II upgrade of Level 1 trigger
  - The Particle Flow used for offline will be brought to L1 trigger.
  - Include tracking trigger in L1 trigger system
  - Displaced vertex trigger for exotic events
- ATLAS L0 trigger for HL-LHC
  - HLT-like object-level and event-level reconstruction and analysis at 40 MHz
  - Collect all trigger data from a single event onto one FPGA

L0 global trigger in ATLAS for HL-LHC

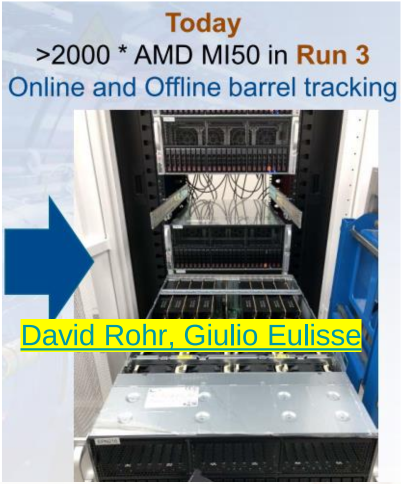


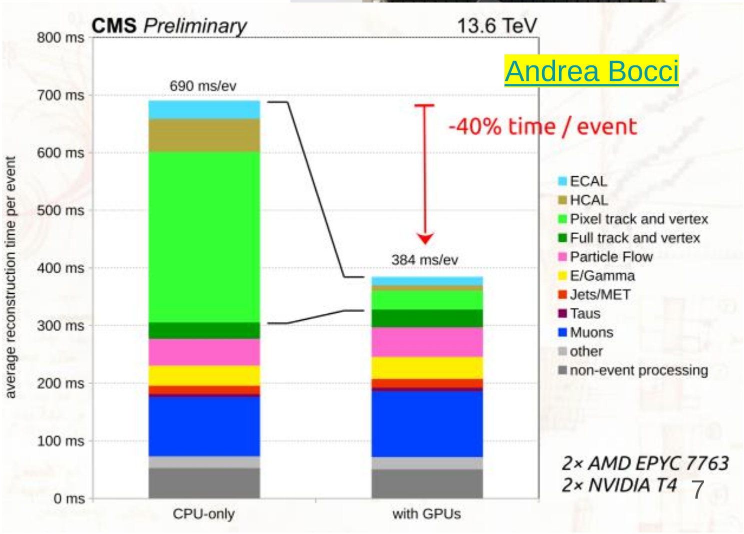
Andrea Negri

Accelerated online Computing : GPU

- ALICE Run 3: GPU for online (&offline) reco acceleration.
    - Without GPUs, more than 2000 64-core servers would be needed for online processing!
- CMS Run 3: 40% of reconstruction accelerated by GPUs
    - Achieve full performance portability with Alpaka

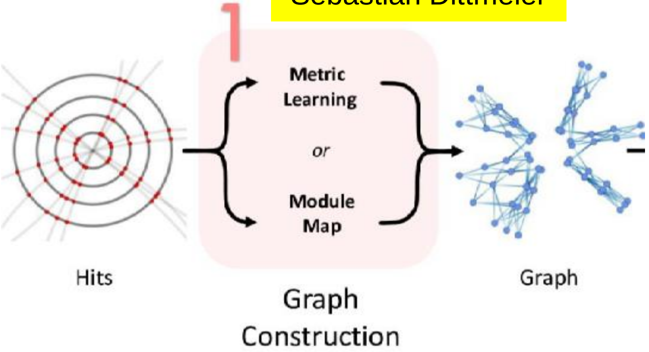
GPU in ALICE DAQ





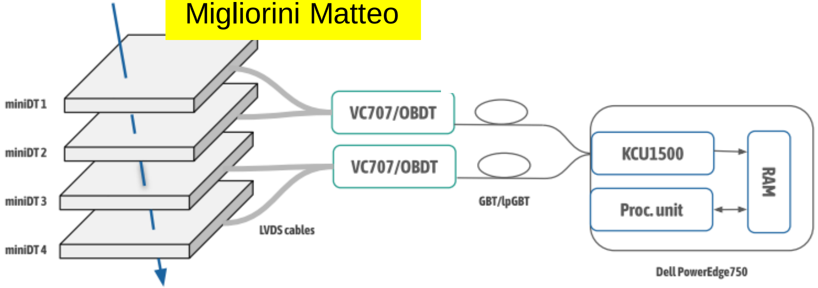
Accelerated online Computing : FPGA

Sebastian Dittmeier



- GNN in ATLAS event-filter for HL-LHC
  - FPGA resource constraints : Quantization + Pruning was used in the study
- Triggerless DAQ with Anomaly detection of machine learning
  - It sounds interesting if we can keep the main DAQ running and adding a simple triggerless DAQ system for exotic-event search, for example.

Migliorini Matteo

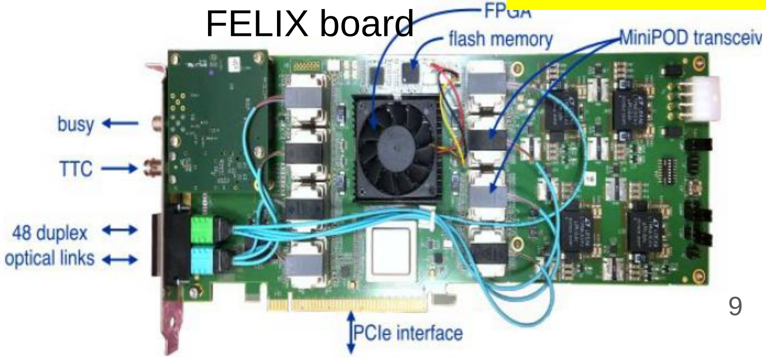


Common Readout device

- Readout device : Interface between front-end electronics and the off-the-shelf world(= servers + switches).
  - New readout hardware was deployed in LHC Run3 to cope with higher throughput and granularity.
- Structures is somewhat similar (large FPGA with many transceivers, high-speed interface with a server = PCIExpress) and they are used in many other experiments.
  - FELIX : ATLAS, ProtoDUNE, sPHENIX and CBM
  - PCIe40/CRU : LHCb, ALICE and Belle II

Joaquin Hoya

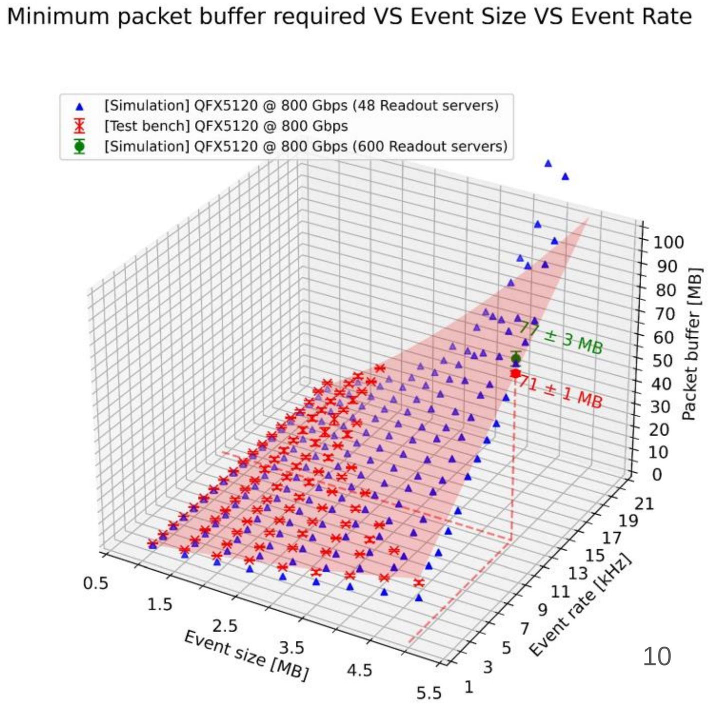
FELIX board



Network and event-building

- A good strategy is to take advantage of the growing bandwidth capabilities of network devices.
- However, simply bringing off-the-shelf products may not work for extreme use cases.
  - The minimum buffer size in a network switch was simulated to avoid TCP incast in HL-LHC ATLAS.
  - The data handling unit used in the event-building process of HL-LHC CMS will be based on a orbit rather than an event, in order to reduce overhead.

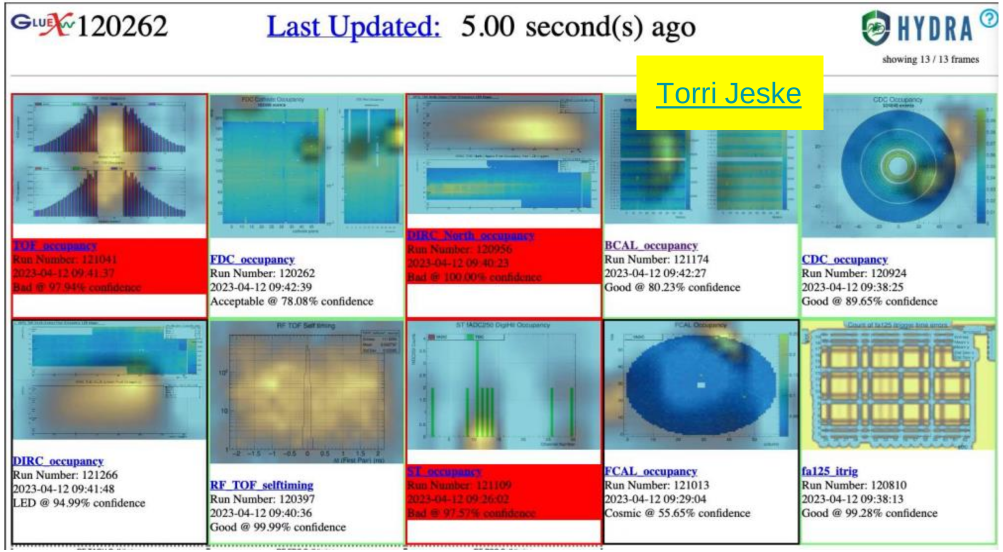
Eukeni Pozo Astigarraga



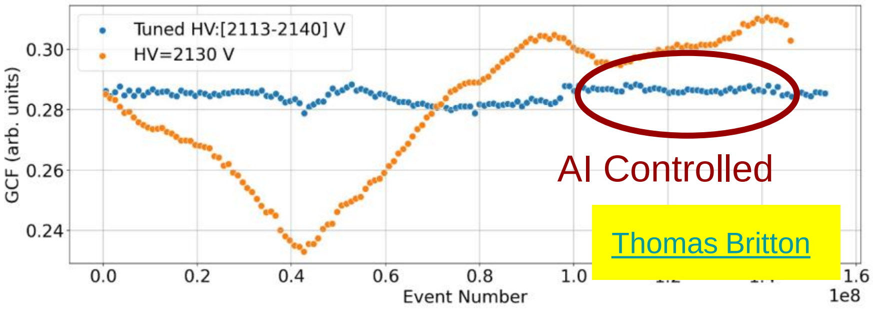
Monitoring & Control Becoming Smart

Machine learning to not only detect anomalies in DQ monitoring but also to adjust experiment conditions…

AI can be used to check hundreds of DQM graphs in the GlueX experiment at Jlab.

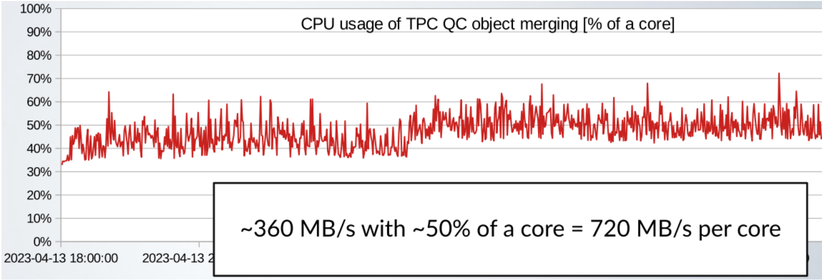


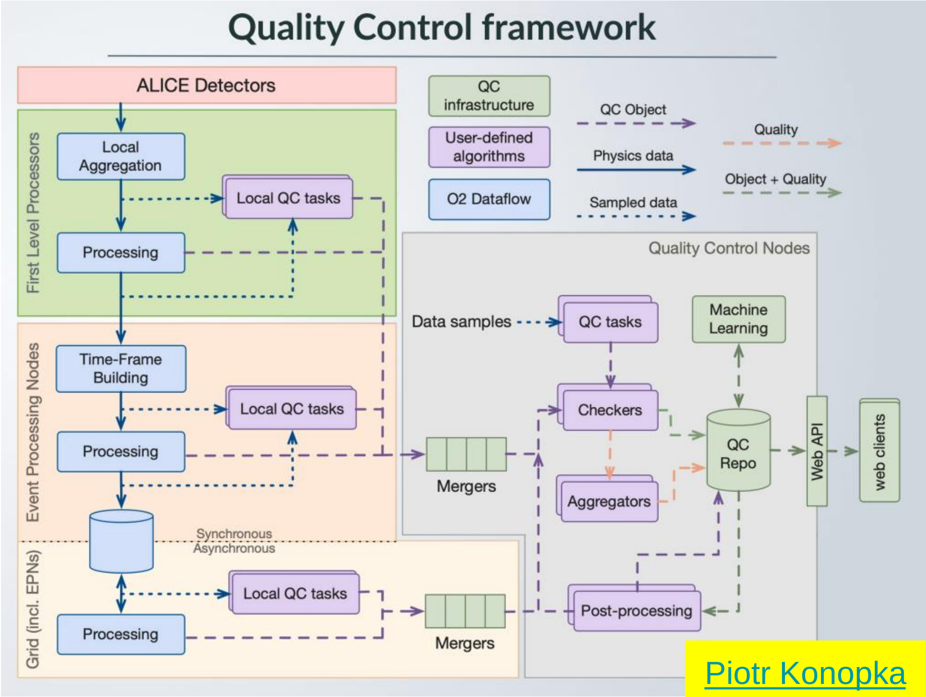
Adjusting HV by AI to get stabilize the gain



“Unified online/offline quality assurance and monitoring”

- ALICE “Quality Control” system in Run3
  - Collecting data from FPN, EPN and Grid
  - Based on the O2 message passing framework allowing large data throughputs

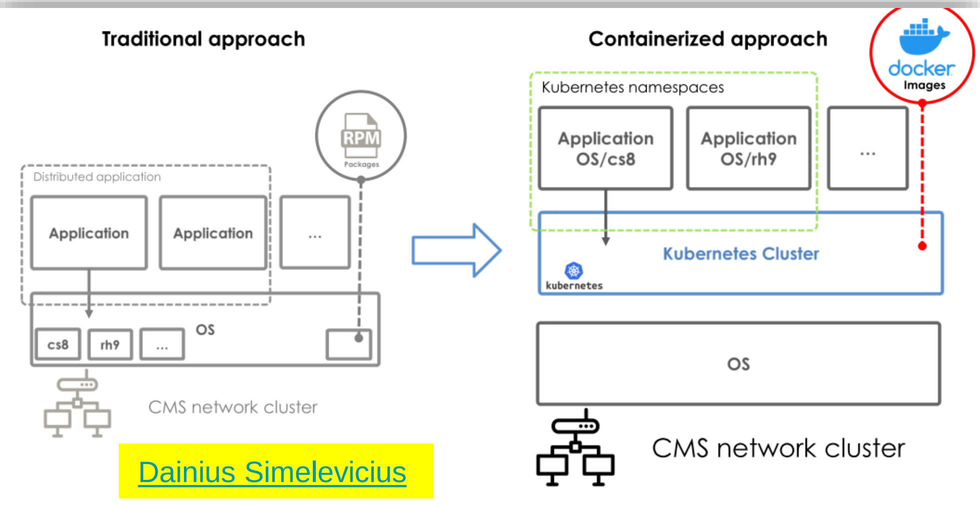




Piotr Konopka

Management tools : “Containerized DAQ” on Kubernetes

- Each DAQ application is containerized and handled by Kubernetes(container orchestration tool)
  - Remove the dependency on OS/Library
  - Easier deployment of DAQ application over hundreds of nodes.
- Study is ongoing in DUNE and CMS.
  - To what extent can Kubernetes control the DAQ system?



Dainius Simelevicius

Pierre Lasorak

- DAQ syster
- Naturally fitting in K8s
  - Services (flask,…)
  - Web UI
  - Databases
- Potentially challenging
  - DAQ readout processes
    - Hardware interaction
    - Pinning to Host, CPU, RAM
    - Networking
  - Data flow, data filtering

Thank you for all your contributions and discussions!