DAQ/SC Conceptual Design Review for FD2

G. Lehmann Miotto / CERN

Agenda

15:00 → 15:30 **DAQ Overview and requirements**
Speaker: Giovanna Lehmann Miotto (CERN)
VD DAQ CDR Intro.p... | VD DAQ CDR Intro.p...

15:30 → 15:50 **Slow Control overview and requirements**
Speaker: Xavier Pons (CERN)

15:50 → 16:10 **DAQ software framework**
Speaker: Kurt Biery (Fermi National Accelerator Lab. (US))
VD_CDR_DAQSoftw...

16:10 → 16:25 **Data handling in the readout system**
Speaker: Roland Sipos (CERN)

16:25 → 16:55 **Trigger and data filter**
Speaker: Joshua Klein

16:55 → 17:15 **Development process**
Speaker: Alessandro Thea (Rutherford Appleton Laboratory (GB))

17:15 → 17:35 **Short-term DAQ/SC development plan to support detector prototypes**
Speaker: Giovanna Lehmann Miotto (CERN)
CDR DAQSC short t... | CDR DAQSC short t...

17:35 → 17:55 **R&D towards final DAQ & SC**
Speaker: Alessandro Thea (Rutherford Appleton Laboratory (GB))

17:55 → 18:00 **Summary**
Speaker: Giovanna Lehmann Miotto (CERN)
CDR summary.pdf | CDR summary.pptx

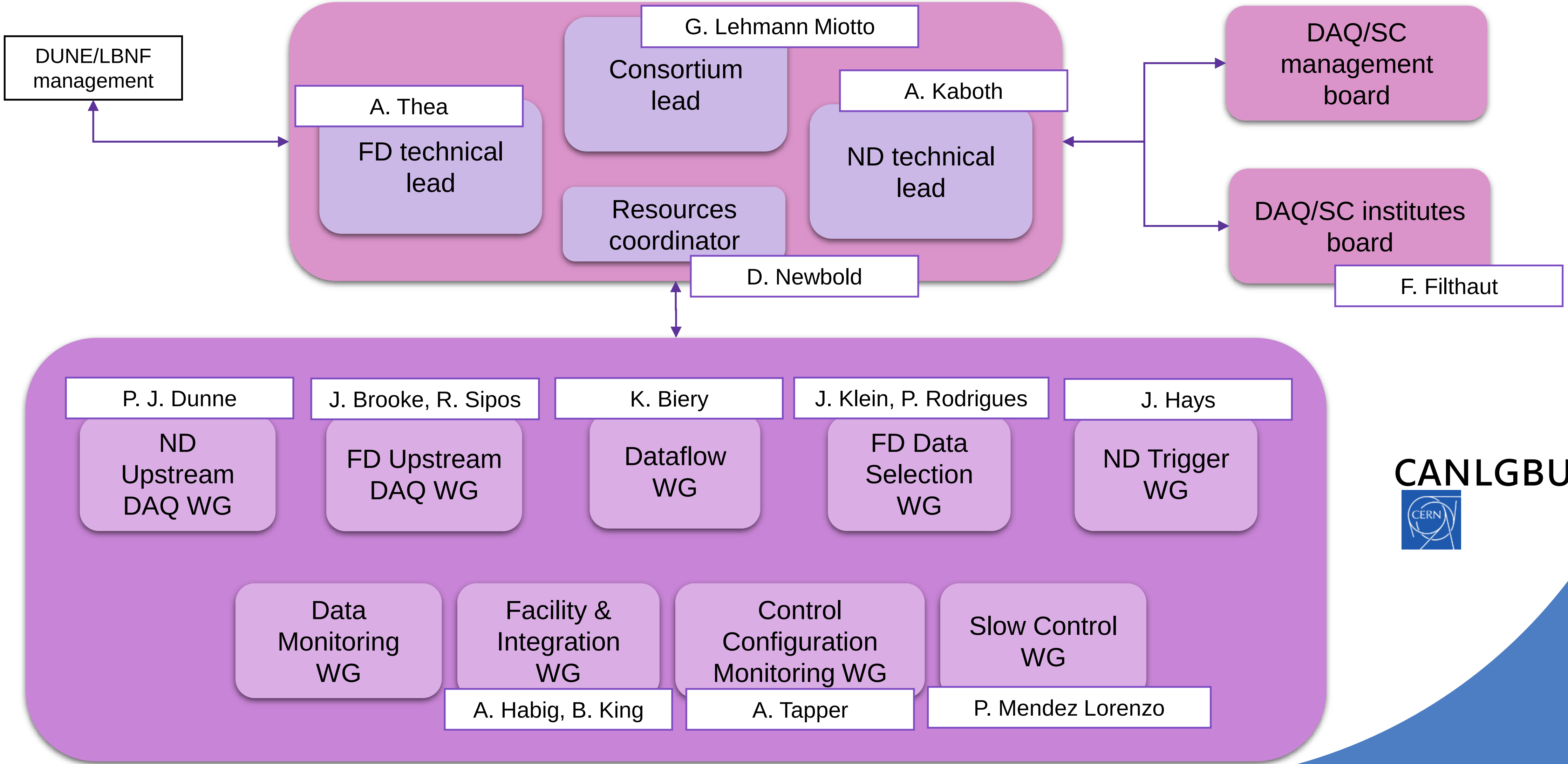
Preface

The DAQ/SC consortium is developing solutions for all DUNE detectors, far and near

Interfaces to all detector components are defined uniformly, in order to make this possible

Wherever specific needs require custom interfaces or behaviors, this results in additional effort

DAQ/SC Consortium organization



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DAQ overview and requirements

G. Lehmann Miotto / CERN

Outline

VD DAQ requirements

- Detectors
- Physics
- Offline

DAQ interfaces

DAQ overview

- Subsystems
- Components

DAQ Requirements

- Distribute clock and unique timestamping to all detectors
  - **Common clock (62.5 or 125 MHz)**
  - **1 us synchronization across FDs**
  - **~10 ns synchronization within one FD**
- Configure, control and monitor the data taking process
  - **Provide sw tools for detector experts to implement their specific functions within the DAQ framework**
  - **The DAQ shall introduce negligible downtime, compared to the experiment requirements**
- Receive timestamped data over optical links from all detectors
  - **Charge readout: data sampled at ~2 MHz**
  - **Photon detectors: 5 us waveforms of tiles that pass an internal trigger threshold**

DAQ Requirements

See talk by J. Klein

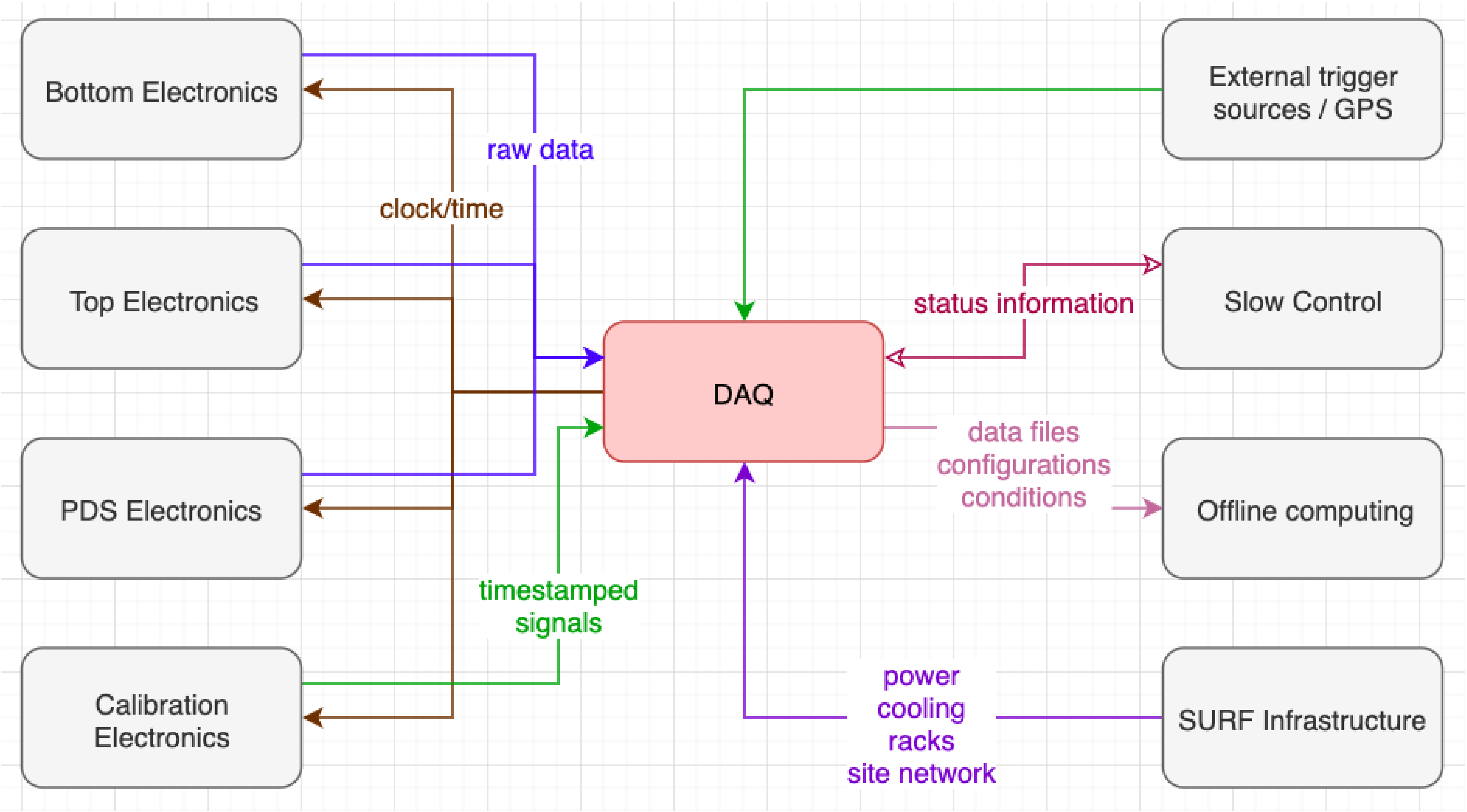
- Buffer, select, aggregate and store detector data
  - **Select data with > 100 MeV of visible ionization energy with very high efficiency (>90%)**
  - **Select data with < 100 MeV and > 10 MeV of neutrino visible energy with a good efficiency**
  - **Generate a SNB trigger candidate if there are more than 60 neutrino interactions wih E_ν>10 MeV within 10 seconds with an efficiency > 95%**
  - **Store all data for 30s corresponding to a SNB trigger (goal to reach 100 s)**
- Transfer the recorded data to FNAL over a dedicated WAN connection
  - **Cap of 30 PB/year for all far detectors raw data set by offline long-term storage capacity; more data may be transferred to FNAL, but not for permanent storage**
  - **In addition, condition, configuration and monitoring data will be transferred to FNAL**

DAQ VD Specifications

- Readout 1040 WIB links (10G), 400 uTCA links (40G), few hundred PDS links (?)
  - **While internal data organisation differs, all packets coming from the electronics shall have a 64b timestamp and a field fully specifying the origin**
    - WIB frame has a header with the required info and 1 ADC value for 256 channels,
    - PDS data expected to have a header with the required info and 375 (750?) consecutive ADC values for 1 channel,
    - Data from uTCA boards will have the required info and N consecutive ADC values for 64 channels
  - **It is a responsibility of the electronics experts to provide data decoders for their data**
- Reduce data volume from ~2 TB/s to ~0.5 10^{-3} TB/s -> reduction factor **4000**
  - **Achieved through selection in time and geographic regions of activity based on the data themselves and through lossless data compression at the end of the chain**

See talk by R. Sipos

DAQ Physical Interfaces

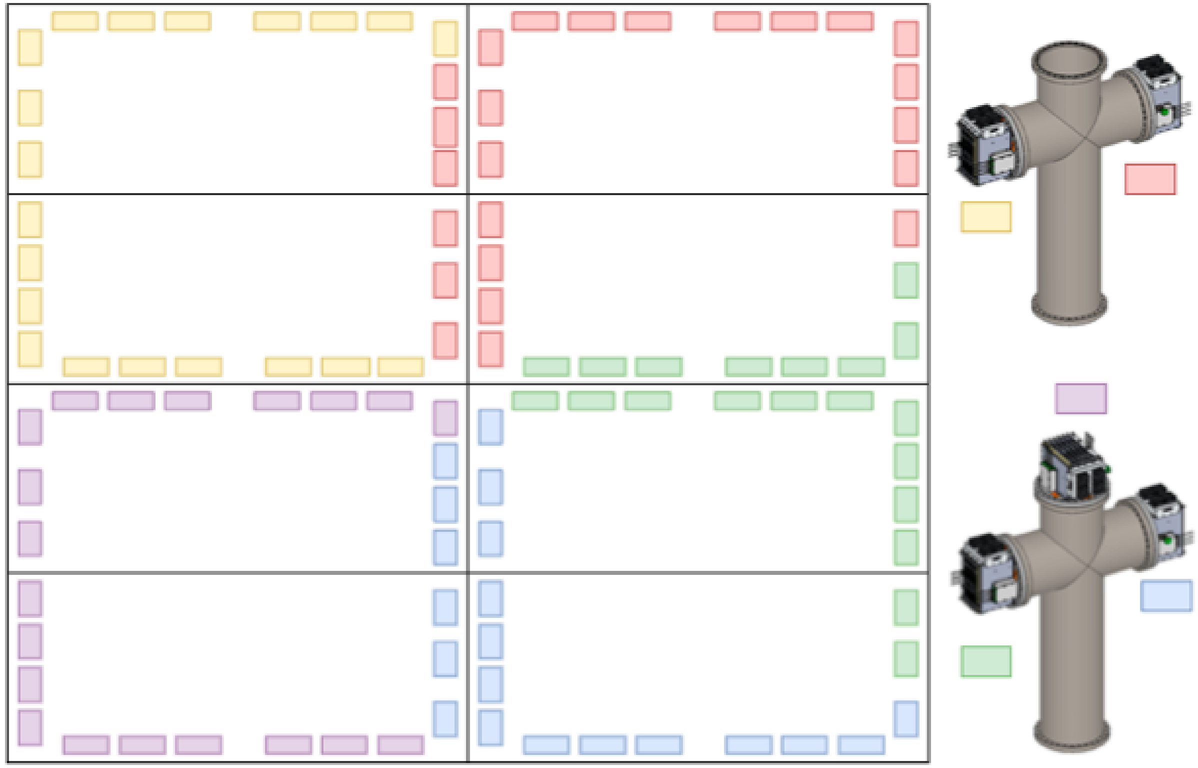


DAQ Interfaces

- Protocols ↔ detector electronics
- Trigger strategy ↔ Physics groups
- Data formats, conditions ↔ offline computing
- Data taking procedures ↔ detector electronics, calibration devices

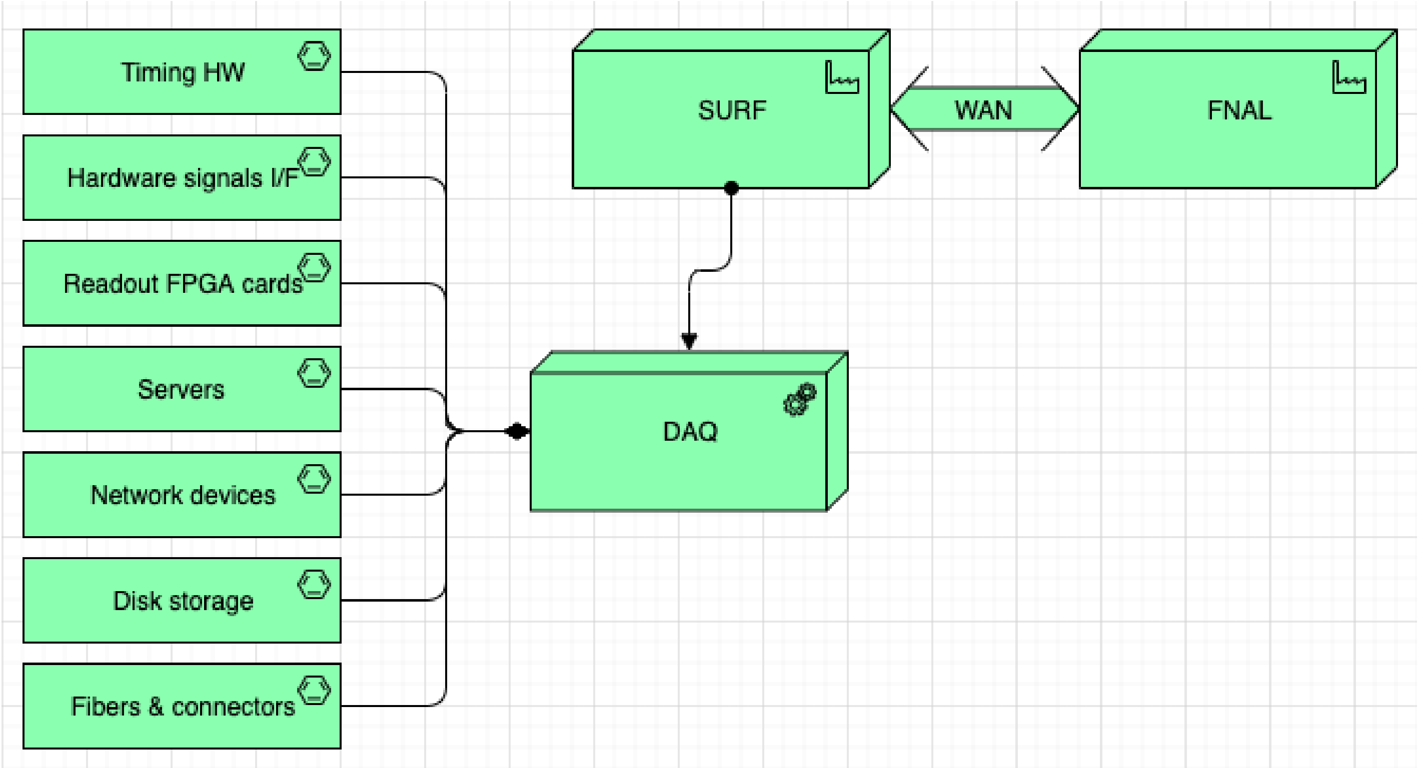
DAQ – Detectors communication

- Besides the interfaces mentioned earlier, there are also finer grained aspects that need to be discussed and agreed upon
- Example: mapping of detector channels can complicate our lives



DAQ Hardware

- Largely based on commercial components
- Distributed on underground cryo-mezzanine and surface MCR
- DAQ VD M&S of ~4.2 M$
- VD procurement 2023 - 2027

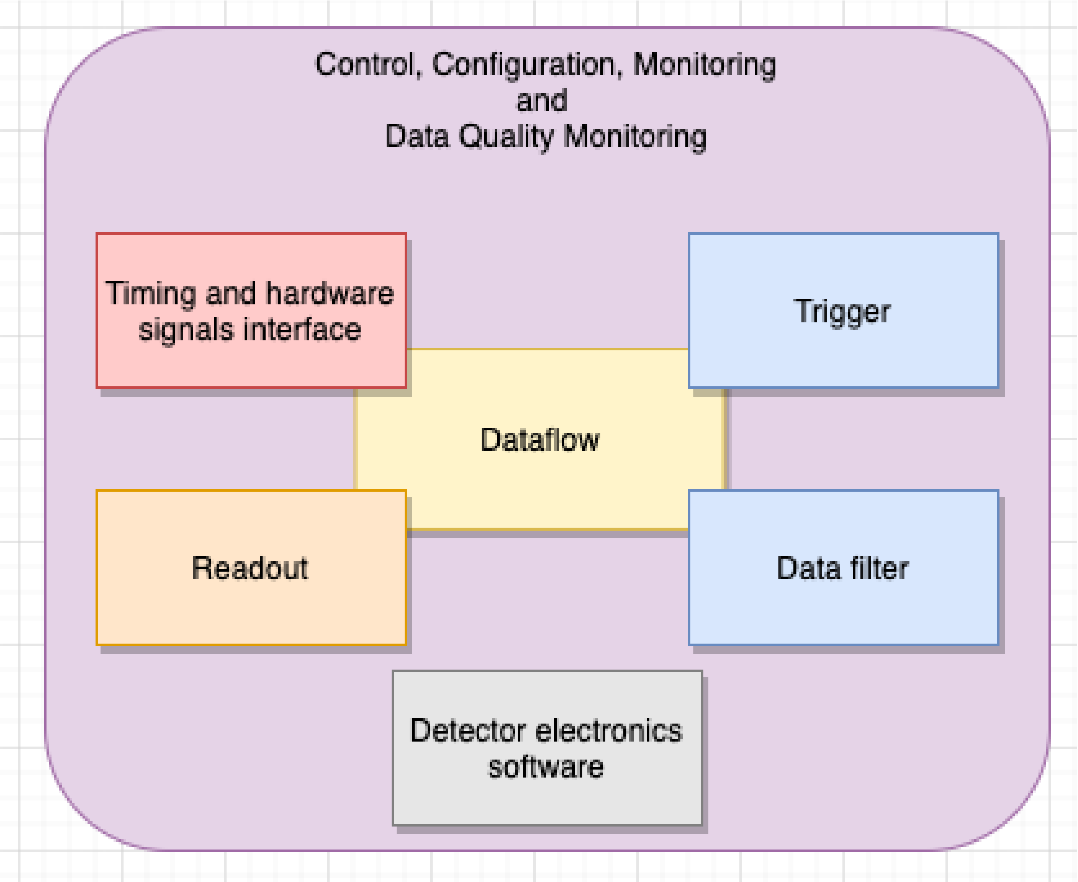


System scale:

- ~200 servers, redundant network with aggregate bandwidth of ~600 Gb/s
- 125 kW in each DAQ barrack on top of the cryogenic mezzanines; Short term UPS
- 50 kW in a common counting room;

DAQ Subsystems

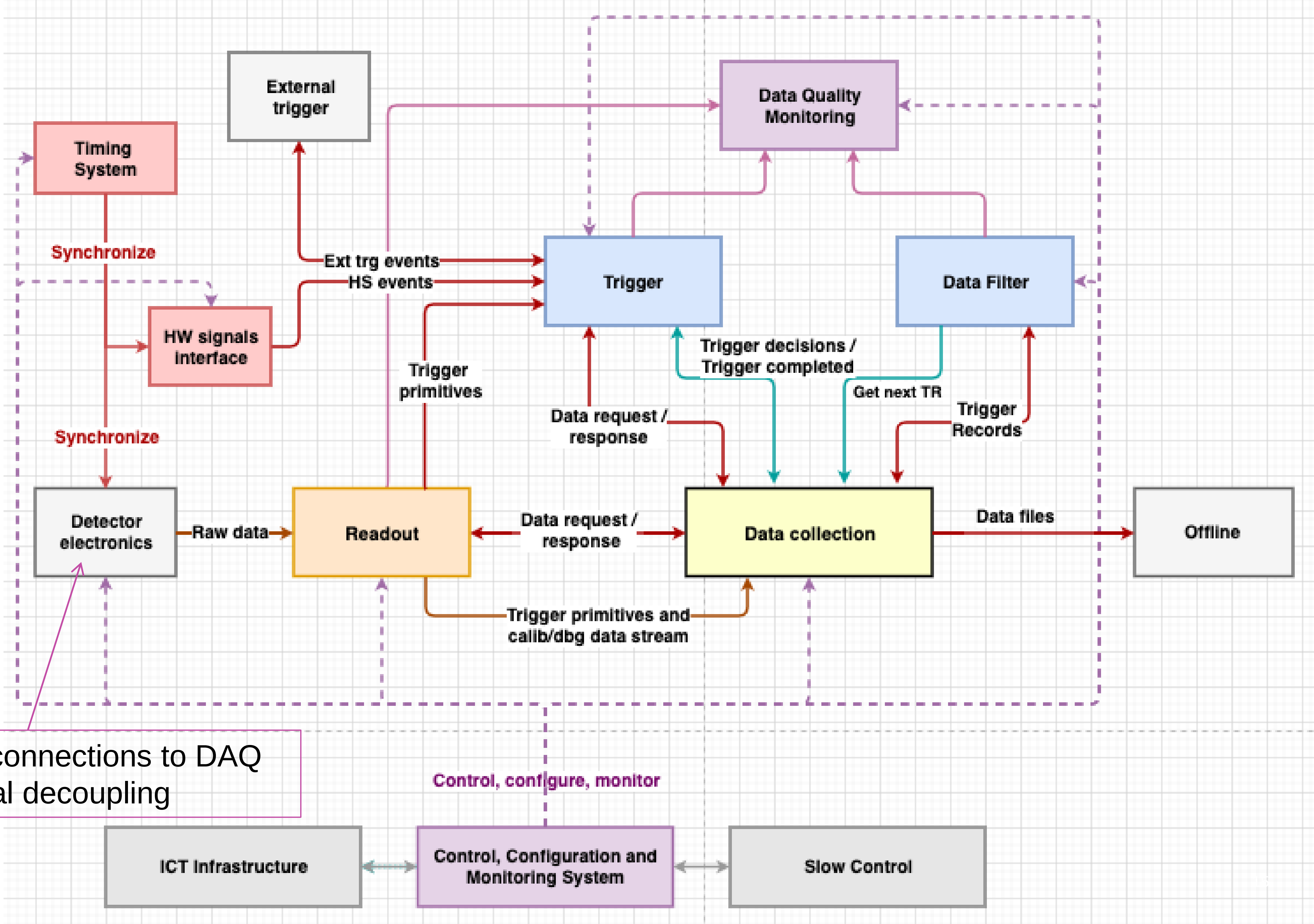
- While timing, readout, trigger and data filter implement specific application-level functions of the DAQ system, the CCM, DQM and Dataflow are a mixture of application-level software and services/libraries used by all other components. As an example, the Dataflow implements the event building application logic, but also provides the DAQ network communication libraries.



See talk by K. Biery

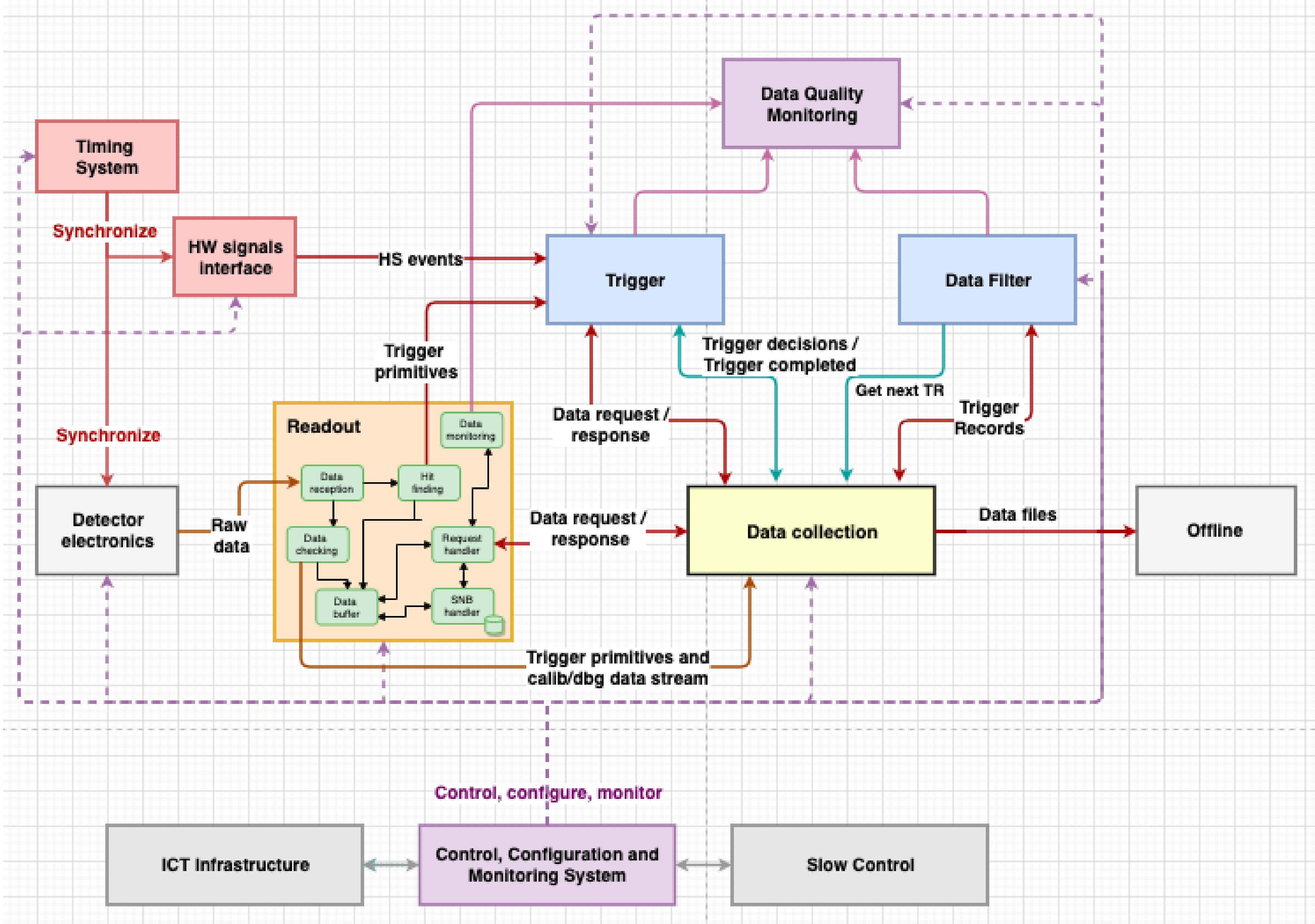
See talk by A. Thea

DAQ overview



Only fiber connections to DAQ for electrical decoupling

DAQ overview



VD DAQ/SC CDR Review

- In this review we will focus on some of the DAQ and SC aspects that are relevant to address the CDR charge:

1. Are the requirements documented? Are they reasonable?

2. Is the scope understood? Is there a team in place? Which institutions are interested?

3. Is there a reasonable plan for R&D and prototyping?

4. Is the design concept reasonable and feasible? Have appropriate mechanical and electrical calculations been performed?

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