ePIC Electronics, Readout, & DAQ working group

Part 2 (RDO -> Data Center)

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Current Efforts

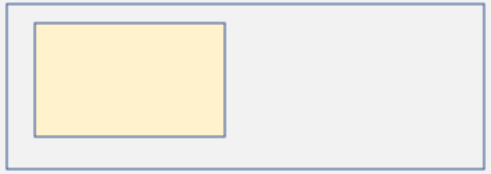
- RDO
- Slow Controls
- Data Volumes
- DAQ Computing
- Connection to S&C Streaming WG

EPIC Electronics / DAQ

Standard Component Names and Functions

Global Timing Unit (GTU)

-Interface between collider, Run Control, & DAM
-Config & Control
-Clock & Timing



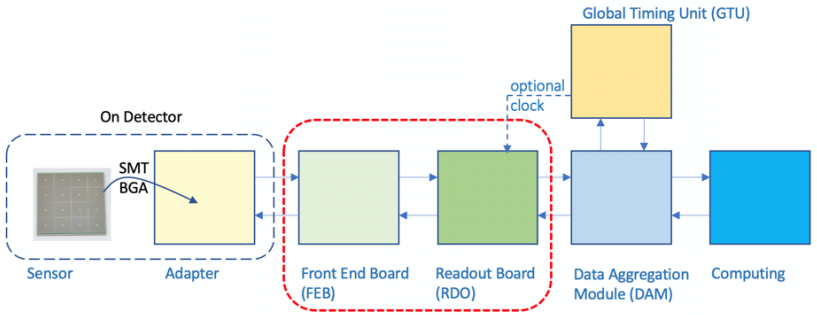
Name	Sensor	Adapter	Front End Board (FEB)	Readout Board (RDO)	Data Aggregation Module (DAM)	Computing
Sharing	Detector Specific	Detector Specific	Detector Specific	Few Variants	Common	Common
Function	-Multi-Channel Sensor	-HV/Bias distribution -HV divider -Interconnect routing	-Amplification -Shaping -Digitization -Zero Suppression	-Communication -Aggregation -Formatting -Data Readout -Config & Control -Clock &Timing	-Computing Interface -Aggregation -Software Trigger -Clock & Timing -Config & Control	-Data buffering and sinking -Run Control -Calibration Support -QA / Scalers -Collider Feedback -Event ID/Building? -Software Trigger -Monitoring
Attributes	-MAPS -AC-LGAD -MCP-PMT -SiPM -LAPPD	-Sensor Specific -Passive	-ASIC/ADC -Discrete -Serial Link	-FPGA -Fiber Link	-Large FPGA -PCIe -Potentially Ethernet	

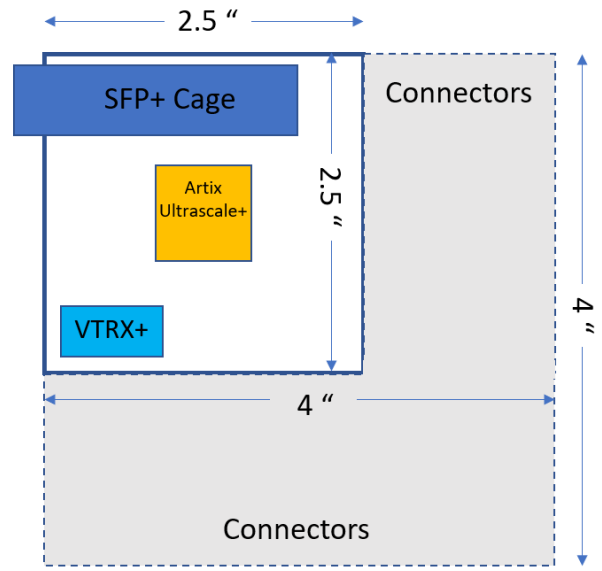
RDO Discussions

- Physical Characteristics
  - Locations
  - Size
  - Power / Cooling
  - Radiation Requirements
  - Link distances/rates
- Optical Protocol Requirements
  - Timing (5ps / 50-100ps)
  - I2C for ASICs/FEBs
  - Real-Time Command / Control Protocol
  - Data Transfer Protocol (10Gb/s / 25 Gb/s)
- Optical Protocol Choices
  - ePIC – simple custom protocol
  - GPT in FPGA
  - Dedicated Clock/Reconstructed Clock (2 or 3 fibers/RDO?)

RDO Specifications/Guidance

- Nominally 2.5 in^2 for common RDO components including FPGA and optical link options (for example if it is integrated on the same PCB as the FEB). For standalone RDO, allow for up to 4 in^2 to provide space for copper-based connectors to FEBs.
- Power requirements: 3-5 Watts. Allow for at least two LV levels nominally 5V (for optics) and a lower voltage for FPGA power and ASIC signal management.
  - Consider using radiation tolerant switching voltage regulators (e.g. from CERN).
- Multiple optical link interfaces allow for flexible implementation of the RDO as either a standalone readout solution or use with the DAM boards. They can also be used for accepting an alternative low-jitter clock input.
  - Samtec Firefly connectors are also a potential option as they have a footprint similar to VTRX and also provide MTP options.

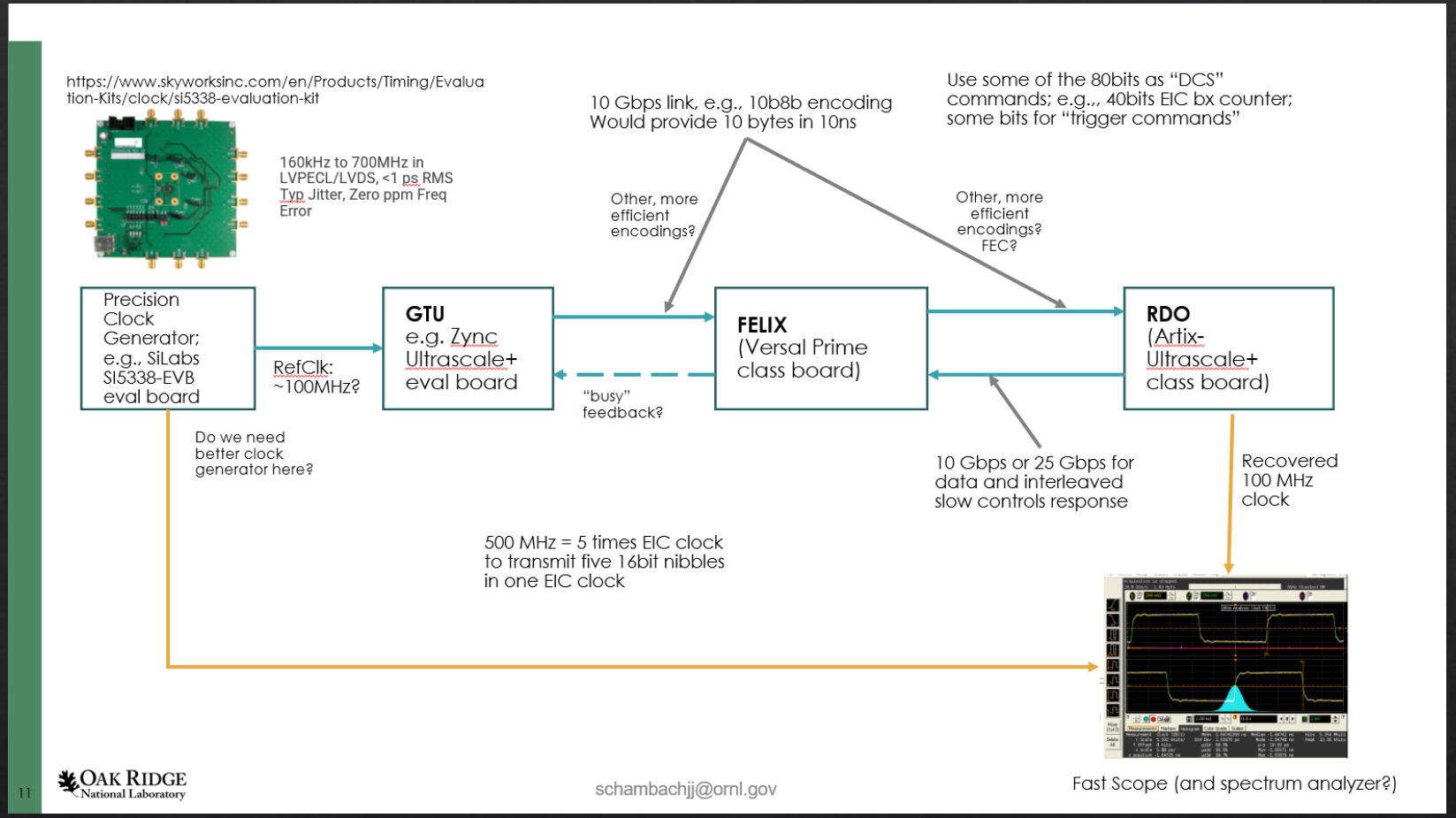




RDO Discussions

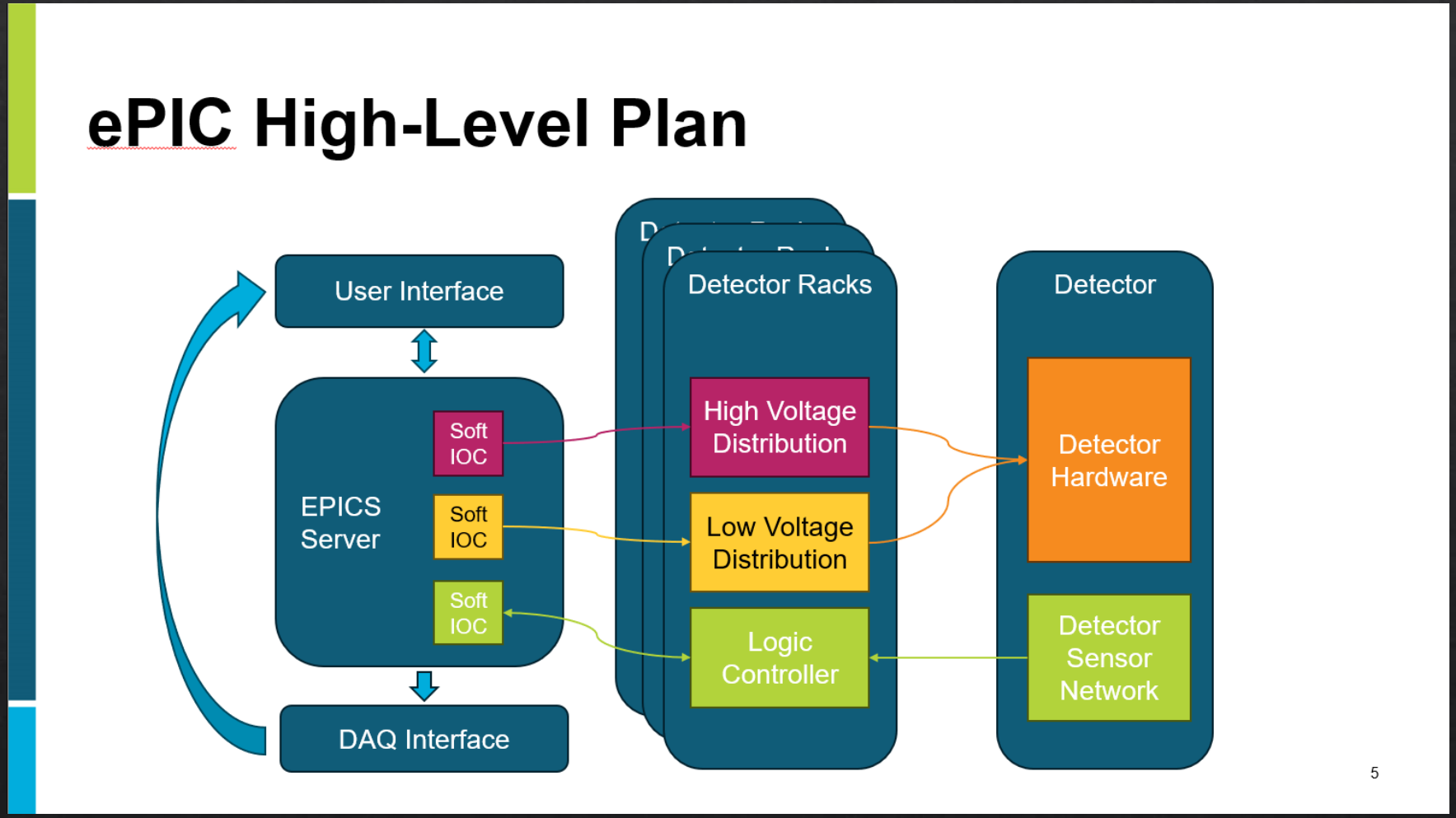
- RDO / Timing subgroup to mock up GTU/DAM/RDO to answer these questions
  - Slow startup due to time constraints of group members
  - Devkits being distributed
  - Arrangements for FELIX 182 slow but progressing

- Hope to start getting answers this fall
  - Protocol document
  - Timing measurements



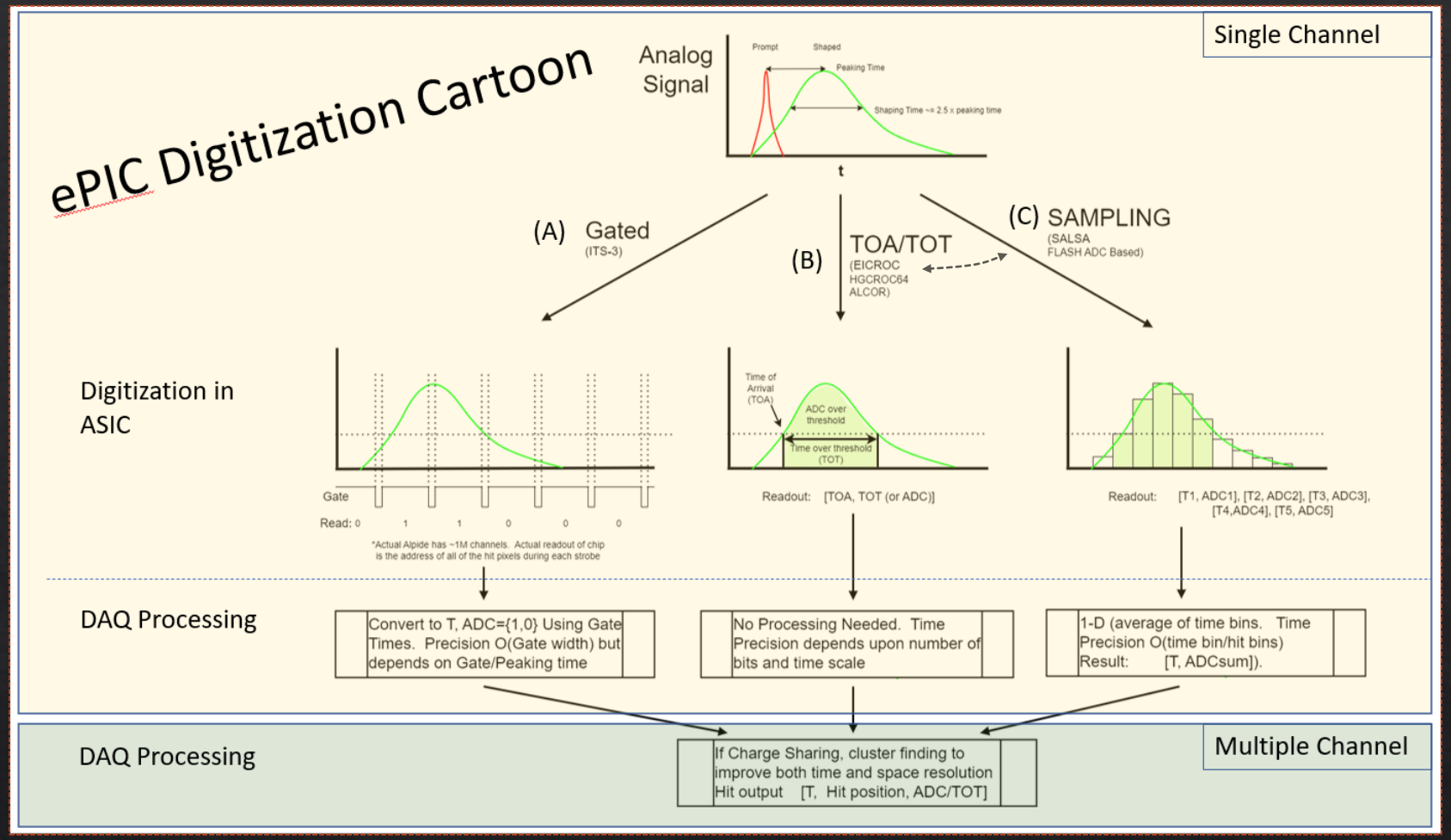
Slow Controls Integration

- Listed under 6.10.9 (DAQ) in the project
  - The slow controls efforts for each detector listed under the detector
  - Integration will
    - Coordinate with collider
    - Coordinate with detector systems (common hardware/software)
    - Provide common computing/network infrastructure
- Project hire (Lee Flader)
  - Working with Norbert Novitzky on HCALs as model project
- Standardize to:
  - EPICs for control
  - Allen Bradley for PLC's



Data Volumes

- Distilled volumes from
  - Background Group Simulations provide hits/sec above detector thresholds
    - Synchrotron Radiation
    - Hadron Beam
    - Electron Beam
    - DIS (18x275 scaled to 500khz)
  - Noise estimates from
    - “digitization spreadsheet”
    - E&DAQ WG presentations
    - No charge share/time share
  - Bits / hit = Charge Sharing * Hit Duration * Bits Per Hit
  - Cluster finding (where possible) reduces hit size to BitsPerHit
  - Cluster finding (when possible) reduces noise x 10^-5
  - Software “triggering” for Far Backward/dRICH
- Charge sharing / Time Sharing / noise estimates should be considered VERY preliminary



Preliminary Throughput Summary: (no surprises so far!)

100% Occupancy	27.5-1760 Pb/sec

Aggregate	3.4 Tb/sec
Noise	3 Tb /sec
Signal from particle hits	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

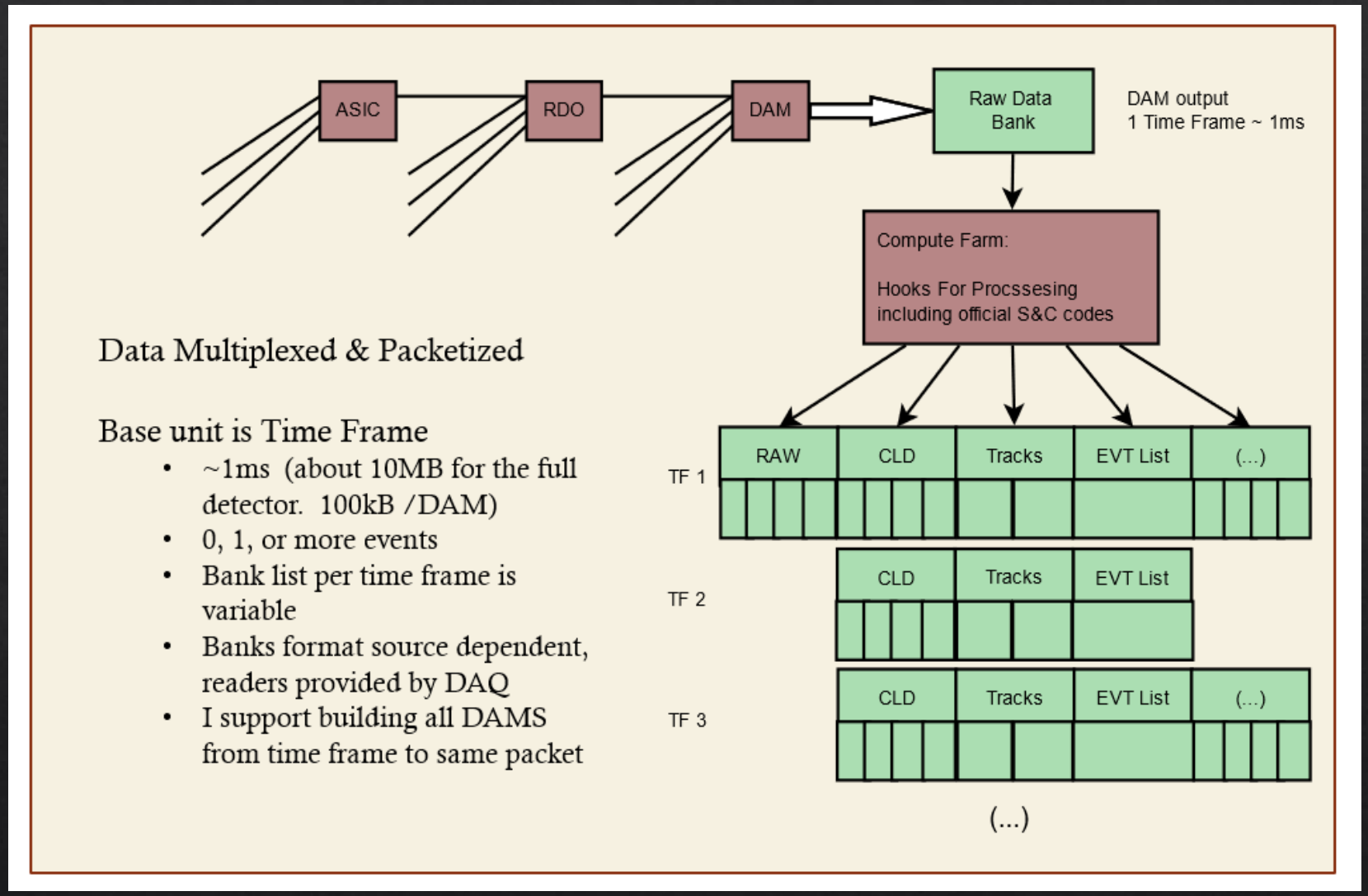
See Electronics & DAQ WG indico for 7/20/23 for spreadsheet
Need to get the granularity to specific channels / FEB / RDO
These need to be formalized and incorporated into S&C metrics

DAQ Computing

- Time Frames (~1ms)
  - Up to ~500 events
  - ~10MB output data
  - ~100kB avg / DAM

- Routing data
- Formatting data
- Processing data
  - DAM FPGA & CPUs
  - Cluster finding
  - Software triggering
  - Sanity Checkers
  - QA Monitoring
  - Metadata
  - Slow controls integration

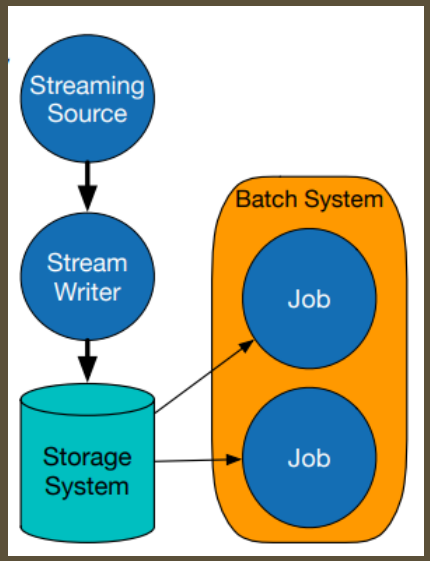
- Scalers / continuously running DAQ components

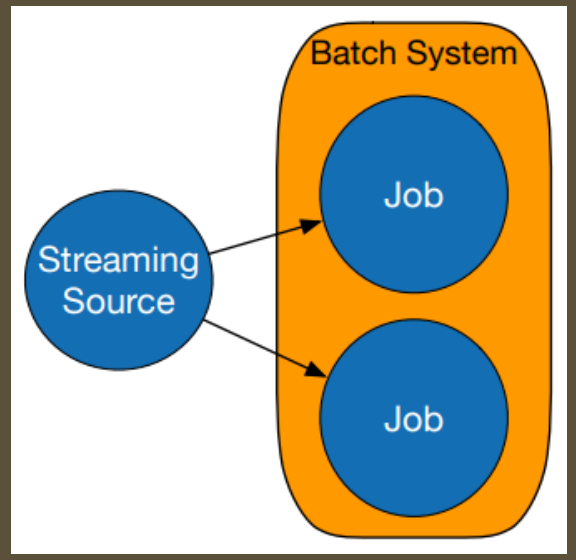


S&C Streaming DAQ WG

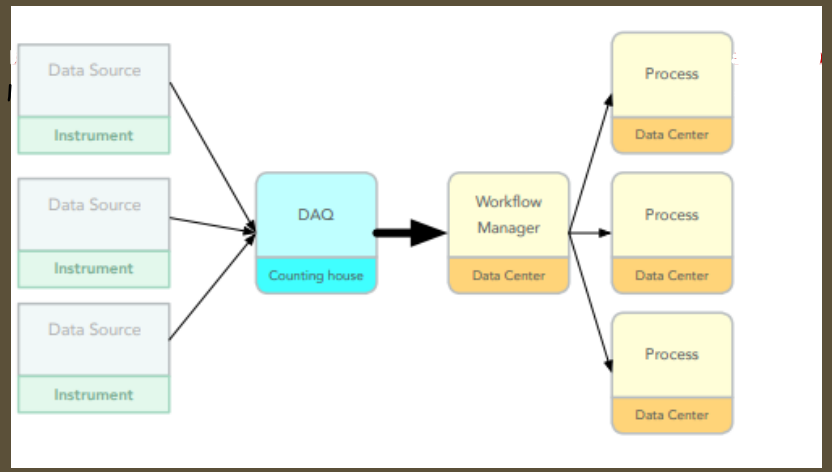
- Two streaming concepts
  - (Electronic) No Level-0 trigger
  - (Institutional) Rapid turn around of reconstructed data (streaming as opposed to batch processing)
- The focus of the group is the institutional requirements and organization
  - International Collaboration
  - Tasks to be done and associated institutional requirements
  - Support for streaming model
    - Automated data handling
    - Automated calibration tools
    - Automated monitoring tools
- We expect this may lead also to links between the DAQ and the streaming reconstruction for rapid turn around of critical information such as calibrations

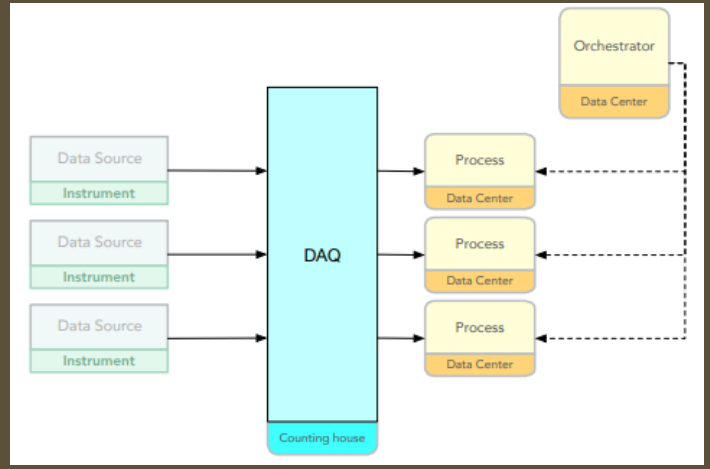
Batch options: (reconstruction is human driven)





Streaming options: (reconstruction is data driven)





Graham Heyes

Questions?