Electronics & DAQ WG Meeting (10/5/23)

- News
  - Meetings & Review Schedules
  - Electronics & DAQ task reminders notifications
- Discussion and status of ongoing topics and requests for information
  - VTRX+ --- (Fernando)
  - Finalizing ASIC specifications (Qmin/Qmax) --- (Fernando)
  - RDO locations & Counts Status --- (Jeff)
  - Digitization needs --- (Jeff)

News: Schedule & Meetings

- Project Reviews
  - 8/22-8/25 EIC Detector Comprehensive Design Review
  - 8/23-8/24 DAC Review of detector R&D
  - 10/10-10/12 Directors Review
  - 10/19-10/20 ePIC Software and Computing Model Review
  - November EIC CD-3A Independent Cost Review
  - 11/14-11/16 EIC CD-3A OPA Independent Project Review
  - 12/4-? – Computing Model presentation to EIC Resource and Review Board
- Meetings
  - 9/20-9/22 – In person software and computing (UIC)
  - 11/28-12/2 – SRO XI (Hawaii)
    - https://indico.bnl.gov/event/20010/
    - Jo Schambach, overview of ePIC DAQ
  - 1/8/24 – ePIC Collaboration Meeting
  - 1/8/24 – Scheduled RHIC cooldown for ‘24 run (Myself, Jin)

News: reminders & plans & activities

- FF/FB detector details to be updated (Yulia and Fernando working on readout chain and will go into table soon).
- The project L2/L3 CAMS to meet with Omega regarding FELIX
  - Expectation / organization of how needed FELIX modifications might be organized
    - We don't plan resources to design FELIX from scratch
    - We do expect a long ePIC lifetime and worry that FELIX development could diverge from ePIC needs
  - What kinds of modifications might be needed.
    - 48 fiber version
    - Timing interface
    - I/O details
- Timing subgroup – many related tasks (hardware clarification, protocol definition, timing measurements) – we need to make the work, goals & deliverables more clear
- Software SRO workgroup is meeting regularly, preparing document for the software review in a few weeks. There will be a summary of DAQ in this document, though Electronics & DAQ are not the main focus, and they intend eventually to publish it --- See SRO WG
- Need to go through another round of detector presentations to try to make our understandings of the readout chains more concrete
  - There need to be concrete plans for each detector
  - Electronics & DAQ need to have concrete understanding of these plans

RDO Count and Location Status

(green means we can tell mechanical engineering enough to let them make detailed drawings and evaluation cooling and space requirements)

Detector System	Detector	RDO Chain Status (relative to current need)	Next Steps
Si Tracking			
	3 vertex layers	* VTRX+ needs clarification, * aggregation needs clarification, * RDO vs Data Management Board functionality needs clarification	In hands of project / Electronics & DAQ: clarify VTRX+ In hands of detector groups: clarify readout scheme
	2 sagitta layers		
	5 backward disks		
	5 forward disks		
MPGD Tracking			
	Electron Endcap	uRWELL SALSA FEB / off detector RDO	Further define RDO & FEB, Map space for RDO's outside detector
	Hadron Endcap	uRWELL SALSA FEB / off detector RDO	Further define RDO & FEB, Map space for RDO's outside detector
	Inner Barrel	mm SALSA based FEB / off detector RDO	Further define RDO & FEB, Map space for RDO's outside detector
	Outer Barrel	uRWELL SALSA FEB / off detector RDO	Further define RDO & FEB, Map space for RDO's outside detector
Forward Calorimeters			
	LFHCAL	HGCROC based FEB / off detector RDO	Further define RDO & FEB, Map space for RDO's outside detector
	HCAL Insert*	HGCROC based FEB / off detector RDO	Further define RDO & FEB, Map space for RDO's outside detector
	pECAL W/SciFi	FLASH based FEB/ off detector RDO	Further define RDO & FEB, Map space for RDO's outside detector
Barrel Calorimeters			
	HCAL	HGCROC based FEB / off detector RDO	Further define RDO & FEB, Map space for RDO's outside detector
	ECAL SciFi/Pb	HGCROC based FEB / off detector RDO	Further define RDO & FEB, Map space for RDO's outside detector
	ECAL Imaging Si ASTROPIX	Astropix / unclear aggregation	Define FPGA end of stave / RDO aggregation & functionality
Backward Calorimeters			
	nHCAL	HGCROC based FEB / off detector RDO	Further define RDO & FEB, Map space for RDO's outside detector
	ECAL (PWO)	FLASH based FEB / Off detector RDO	Further define RDO & FEB, Map space for RDO's outside detector

Notes: I'm comfortable with the FEB/RDO counts in all detectors. Where there is uncertainty the uncertainty has been discussed and is manageable
MPGD assumes that uRWELL detectors follow the same scheme as mm based detectors which is reasonable, but needs verification!

RDO Count and Location Status

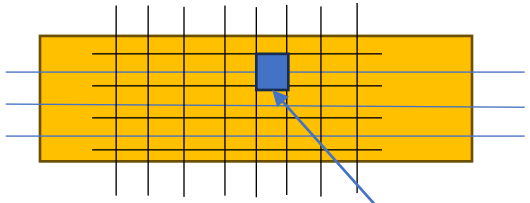
Detector System	Detector	RDO Counts and Location	
Far Forward			
	B0: 3 MAPS layers	Jeff hasn't been following closely enough	Yulia and Fernando Discussing and will update soon
	B0: 1 or 2 AC-LGAD layers	Jeff hasn't been following closely enough	
	2 Roman Pots (RP)	EICROC baseline, defined counts	
	2 Off Momentum (OMD)	EICROC baseline, defined counts	
	ZDC: Crystal Calorimeter	What is status of streaming FEB?	
	ZDC: 32 Silicon pad layer	What is status of streaming FEB?	
	ZDC: 4 Silicon pixel layers	What is status of streaming FEB?	
	ZDC: 2 boxes scintillator	What is status of streaming FEB?	
Far Backward			
	Low Q Tagger 1		Yulia and Fernando discussing and will update soon
	Low Q Tagger 2		
	Low Q Tagger 1+2 Cal		
	2 Lumi PS Calorimeter		
	Lumi PS tracker		
PID-TOF			
	Barrel bTOF	EICROC based FEB, RDO in envelope	Mechanical design. FEB, RDO protocol and connection design
	Hadron Endcap fTOF	EICROC based FEB, RDO close to envelope	Clarify whether envelope works & mechanical design. FEB, RDO protocol and connection design
PID-Cherenkov			
	dRICH	ALCOR based, in module FEB/RDO	VTRX+ clarification, FEB, RDO protocol and connection design
	pfRICH	FEB volume defined, RDO?	Verify location & count of RDO. Currently 17 RDO, but if dRICH/TOF scheme -> 68 FEB modules
	hpDIRC	Assume 24 RDO, but tech uncertain	Define technology verify location of RDO

Digitization Needs

Background group has been struggling to get appropriate thresholds:

HGCROC Channel

Sum over SiPM

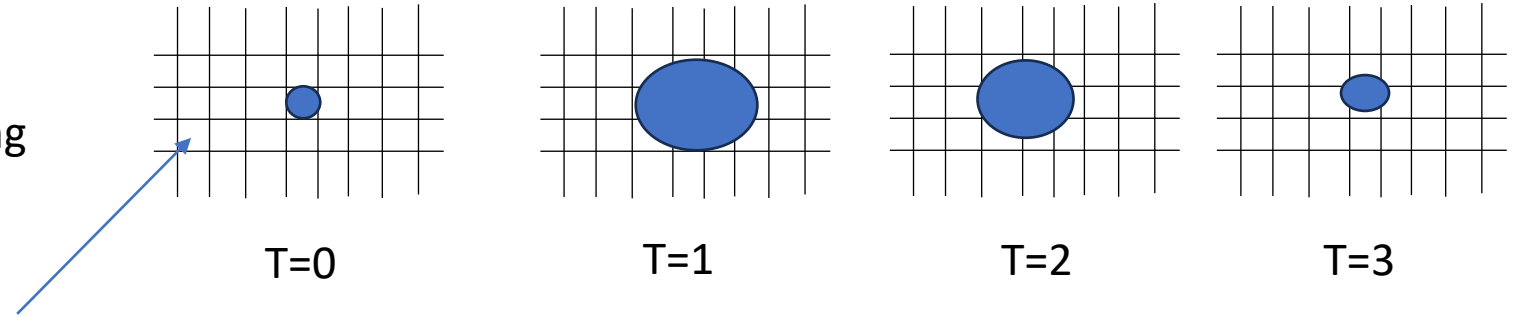


Sum Contributions Light in fiber

Simulations give energy deposited in Cell ID

Array of Channels

Real Signal after shaping



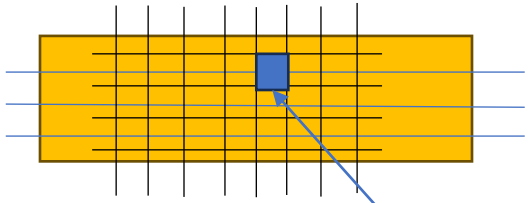
T=0 T=1 T=2 T=3

- Energy Deposit Threshold
- SiPM Sensitivity Threshold
- ASIC zero-suppression threshold
- Clustered hit threshold

Digitization Needs

HGCROC Channel

Sum over SiPM



Sum Contributions Light in fiber

Simulations give energy deposited in Cell ID

Hits
- Energy deposited in Cell ID

RawHits
- CalorimeterHitDigi.cc
- PhotoMultiplierHitDigi.cc
- SiliconTrackerDigi.cc

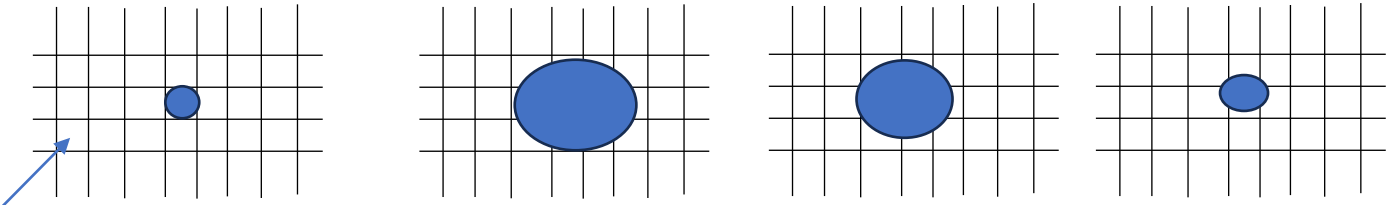
These are meant to be output of DAQ, but no charge sharing/time extents

Are these still in cell ids?

RecHits
- Meant to be somewhat degraded versions of the original, but there is processing to get from one to the other. I think these are back to cell ids

Array of Channels

Real Signal after shaping



T=0 T=1 T=2 T=3

Digitization Needs

What we need:

- Make sure we are applying proper thresholds. This means each detector experts.

- We need to understand the output of the ASICs relative to detector hits:
  - Charge sharing and time sharing
  - Includes ASIC effects, so we need help. E.g. What is the output of a HGCROC calorimeter shaped calorimeter hit?

- I'm assuming that the digitization scheme won't be completely upgraded at this time, and we stay with 1:1:1 ratio for HIT -> RawHit -> RecHit. To get to data volumws we need to multiply by charge sharing

To do items for DAQ:

1. Look at the software Digitization. The digitization is localized:
   CalorimeterHitDigi.cc, PhotoMultiplierHitDigi.cc, SiliconTrackerDigi.cc
2. Give me better numbers for the charge sharing

Detector System	Detector	Charge Sharing	Time Sharing
Si Tracking			
	3 vertex layers	1.2	
	2 sagitta layers	1.2	
	5 backward disks	1.2	
	5 forward disks	1.2	
MPGD Tracking			
	Electron Endcap	5	2
	Hadron Endcap	5	2
	Inner Barrel	5	2
	Outer Barrel	5	2
Forward Calorimeters			
	LFHCAL		5
	HCAL Insert*		5
	pECAL W/SciFi		5
Barrel Calorimeters			
	HCAL		5
	ECAL SciFi/Pb		5
	ECAL Imaging Si ASTROPIX		
Backward Calorimeters			
	nHCAL		5
	ECAL (PWO)	5	

Detector System	Detector	Charge Share	Time Share
Far Forward			
	B0: 3 MAPS layers		
	B0: 1 or 2 AC-LGAD layers		
	2 Roman Pots (RP)	9	2
	2 Off Momentum (OMD)	9	2
	ZDC: Crystal Calorimeter		
	ZDC: 32 Silicon pad layer		
	ZDC: 4 Silicon pixel layers		
	ZDC: 2 boxes scintillator		
Far Backward			
	Low Q Tagger 1		
	Low Q Tagger 2		
	Low Q Tagger 1+2 Cal		
	2 Lumi PS Calorimeter		
	Lumi PS tracker		
PID-TOF			
	Barrel bTOF	3	2
	Hadron Endcap fTOF	9	2
PID-Cherenkov			
	dRICH		3
	pfRICH		2
	hpDIRC		2