SoLID DAQ update

Alexandre Camsonne

March 7th 2017

SoLID collaboration meeting

Overview

- DAQ directors review response
- PVDIS events and data rates
- SIDIS event size and data rates
- Cerenkov readout
- TOF readout options
- GEM readout
- Hardware progress
- Simulations needs

DAQ director response feedback

- Add reference to DAQ and electronics group
- Develop on data rate feasibility
- Response from Compton and PVDIS experience
- Trying to get experimental results in a few months with Compton setup

PVDIS electron trigger

- Coincidence ECAL and Gas Cerenkov

	Old	Hall D
Singles ECAL	290 KHz	230 KHz
Singles rates Cerenkov	1.9 MHz	803 KHz
Accidental 30 ns	16.5 KHz	4.1 KHz
DIS electron	10 KHz max	7.7 KHz
Total rate	**27 KHz**	**12.1 KHz**

Event size data rates PVDIS

						Total strips	occupancy				
Sector		Rate	X		Y			XY	Bytes	3 samples	
0			81.7		88.3	453	0.375275938	170	680	2040	
1			73.3		75.6	510	0.291960784	148.9	595.6	1786.8	
2			68.3		72.5	583	0.241509434	140.8	563.2	1689.6	
3			56.4		58.2	702	0.163247863	114.6	458.4	1375.2	
4			54.5		56.9	520	0.214230769	111.4	445.6	1336.8	
Total hits / sector		0						574.3	2742.8	8228.4	
									10971.2	32913.6	
Data rate / sector		20000							54856000	164568000	
Data rate (sector Mb/s)									54.856	164.568	
FADC											
	20000						10				
	Event size FADC	Nb channel	Header			Trailer	Sample				
	Calorimeter	14	4			4	12	280			
	Preshower	6	4			4	12	120	400		
	Cerenkov	9	4			4	12	180			
									11600000		
								580	11600000	11.6	
									Total rate	176.168	MB/s

Cerenkov PMT readout

- MAROC3 close to what we need
  - 64 channels
  - Variable gain
  - Discriminated fast logic signal
  - Missing : analog sum of 8, need sum of 64

  8 sum of 8 available just need to sum them, will check with INFN for modified RICH board, requested 10 K$ preRD money
  - Radiation hardness is pretty good, need to be tested, possibility of new version to handle Single Event Upset
  - MAROC default option
  - MAROC testboard available

  - Will check design with electronics group for FADC analog output
- Possible readout schemes
  - FADC only (default)
  - FADC + VETROC
  - VETROC only : needs to be evaluated

  - Preferred : Add TDC readout for each Cerenkov channel 232 VETROC additionnal 700 K$, could improve Cerenkov trigger

  - Need simulation to evaluate options
  - Need to follow with electronics group to start testing (anyone from Cernkov group interested ?)

TOF options

- Expected timing resolution 80 to 50 ps
- Default readout
  - NINO + TDC : 20 ps timing resolution
- R&D MRPC : 20 ps
  - Sampling TDC ASICs : PSEC4/5, SAMPIC, DRS4 give 5 to 1 ps resolution
  - Need new chip DRS5 or PSEC5 to handle SoLID trigger rate (analog pipeline) (might develop for EIC)
- Depends on final detector choice
- sPhenix solution: DRS4 system , existing chip but not optimal

- Need to determine effect of photon background, might need sampling to deal with pile up

GEM readout

- SRS deployed in Hall B Prad
- MPD implemented in CODA
  - BLT testing few KHz
  - Optical fiber readout to be implemented for high rate test (100 MB/s to 1.6 GB/s)
- Preliminary results from Weizhi : one sample no deconvolution not sufficient, new occupancy number
- Data reduction on SSP for SBS
- On chip deconvolution (implemented in MPD) still an option if needed
- preRD to get VMM3 chip
- SAMPA chip from ALICE

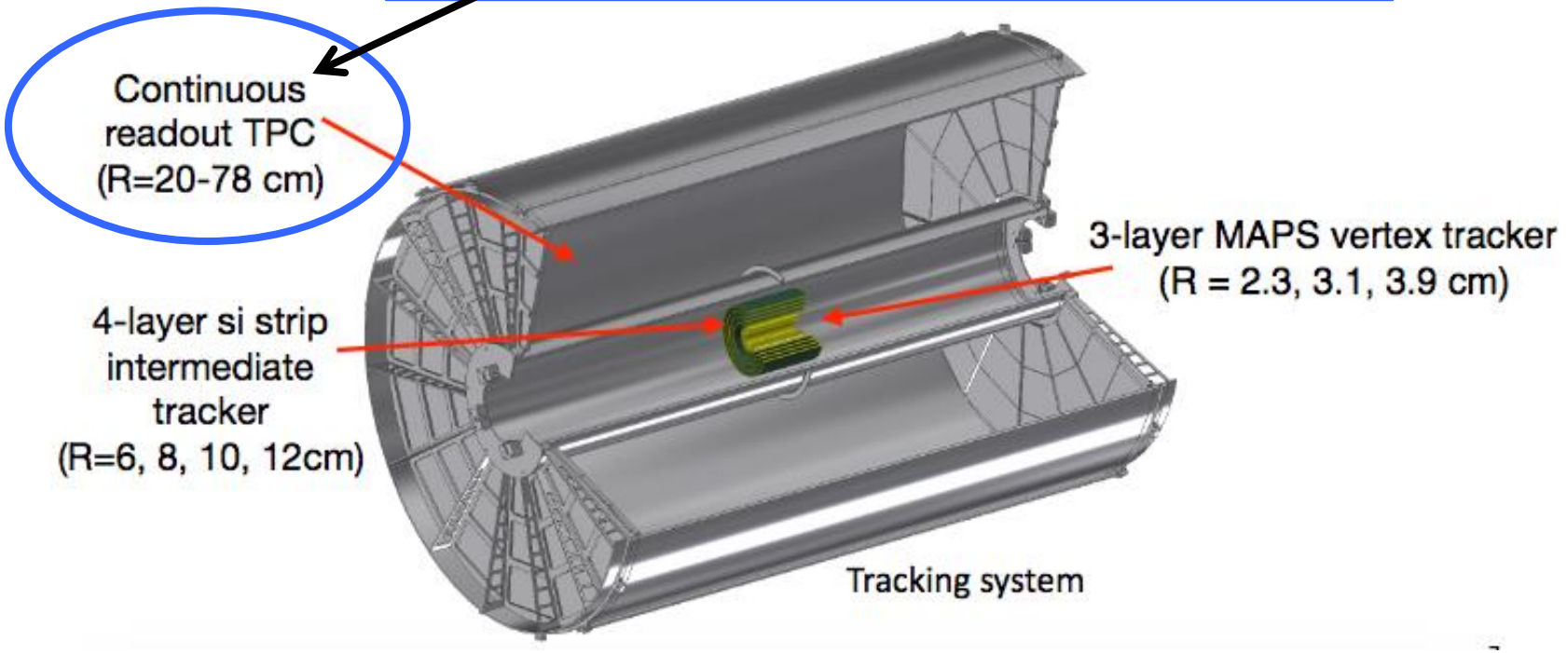
GEM readout

- Prove 100 KHz (or more) rate capability of APV25 hardware
- Other chips start to be available : VMM3 prototype and SAMPA
- https://eic.jlab.org/wiki/index.php/Trigger/Streaming_Readout

sPHENIX TPC readout

There it is – the "C" word.

Continuous Readout == Streaming Readout



Front-End – ALICE SAMPA Chip

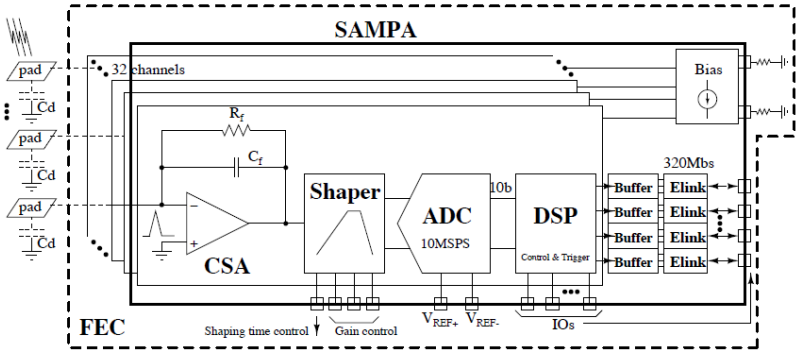


Figure 6.4: Schematic of the SAMPA ASIC for the GEM TPC readout, showing the main building blocks.

ASIC developed for ALICE for the TPC

More functionality than we would need while streaming

10Ms/s @ 10Bit -> 100Mbit/s internally, 32channels

This oversubscribes its external links

Above-threshold waveform delivery – send chunks of the waveform around samples “sticking out” above a threshold + bookkeeping

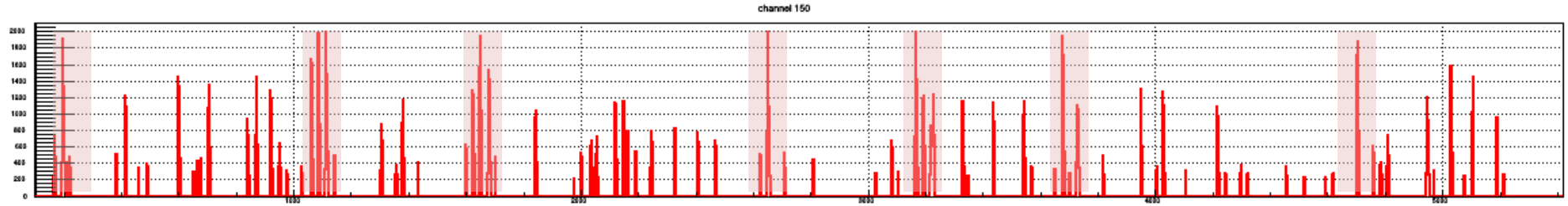
Estimate 5 samples/channel/hit and 3 channels -> 15 samples/”hit”

8 Sampa chips on one Front-end card – 256 channels

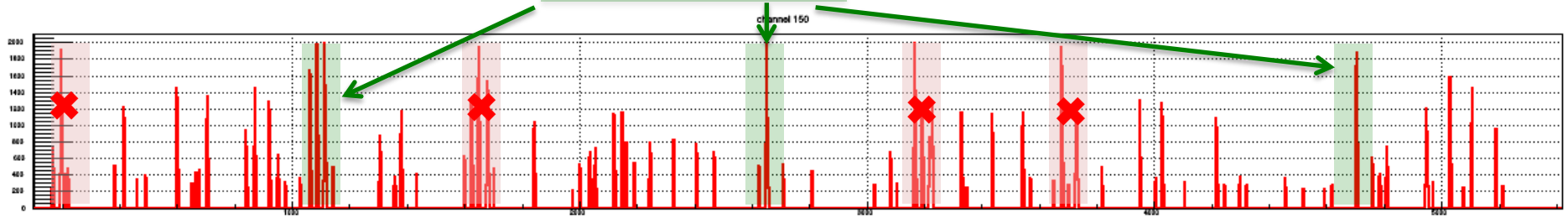
~400 FEE cards

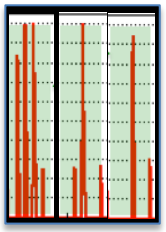
Streaming Readout concept

The streaming data are recorded all the time, and broken up in chunks above threshold



Only chunks correlated with triggered events are then kept





This results in a greatly reduced data stream

The real-time processing demands are very high

SIDIS event size

Occupancies with one sample readout by Weizhi , rates for 100 KHz

GEM	Occupancy	Number of strips	XY strips	Strips per chambers	Event size (bytes)	Data rate 100 KHz	MB/s
1	2.21	453	906	27180	2402.712	240271200	240.2712
2	8.78	510	1020	30600	10746.72	1074672000	1074.672
3	3.63	583	1166	34980	5079.096	507909600	507.9096
4	2.31	702	1404	42120	3891.888	389188800	389.1888
5	1.78	520	1040	31200	2221.44	222144000	222.144
6	1.3	640	1280	38400	1996.8	199680000	199.68
Total	20.01	3408	6816	204480	26338.656	2633865600	2633.8656

GEM dominating (35 bigger than initial proposal) 2.6 GB/s same requirement as PVDIS for L3

Need to look at FADC occupancies

Data rate FADC

Event size FADC	Nb channel	Time			Amplitude	12			
Calorimeter	92	4			4	1	0	828	82800000
L CAL	20	4			4	1	0	180	18000000
Preshower	183	4			4	1	0	1647	164700000
Cerenkov	30	4			4	1	0	270	27000000
Scintillator	15	4			4	1	0	135	13500000
MRPC	45	4			4	1	0	405	40500000
Heavy C	10	4			4	1	0	90	9000000
								3555	355500000
						FADC MB/s			355.5

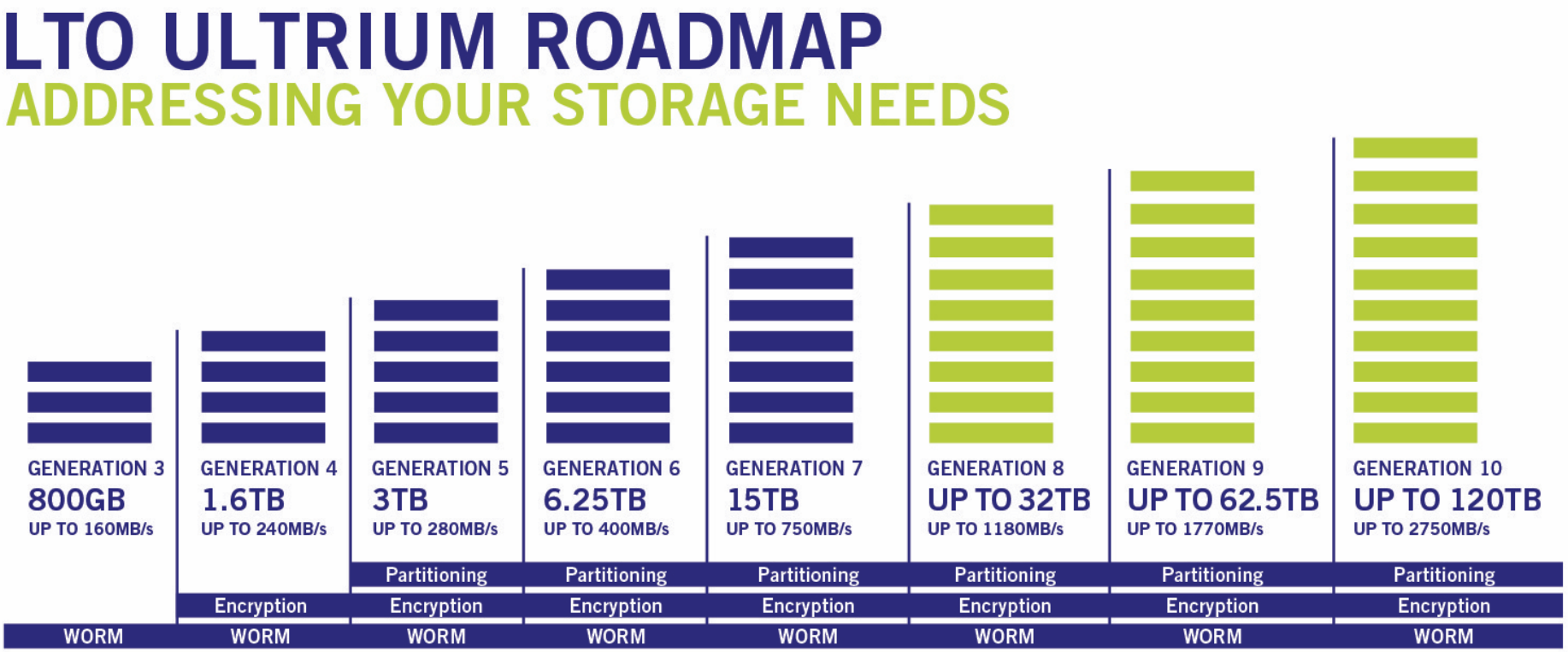
Need updated singles rates for occupancies

So far of order of total 3 GB/s at 100 KHz

L3 farm

- Have digitized data for GEM for SIDIS and PVDIS
- Weizhi has tracking algorithm take 2 to 10 ms to process one event so about 1000 nodes for 100 KHz
- Need :
  - Other include detector data
  - Additionnal reduction algorithm
  - Implement tracking
  - Test on Hall D or DAQ cluster
- Discussion with HPC/IT, seems reasonable to assume CPU available

LTO timeline



Bottomline : 3 GB/s is reasonable by 2020, L3 farm optional

Network

- 2 x 10 GigE link
- 1 or two more fibers available

- Upgradable from 10 to 40 GigE when cost go down

- No issue for link from Counting house to Silo / L3
- Up to 3 x 40 Gbit /s = 15 GB/s

To do list simulation

- GEM occupancies and digitization SIDIS for event size, occupancy and tracking (Ole, Zhiwen, Weizhi) ✓
- Updated trigger rates PVDIS, SIDIS(Zhiwen, Rakitah) ✓
- FADC digitization PVDIS : realistic PID and pile up(?)
- Cerenkov simulation only timing readout no FADC(?)
- Effect 1 sample vs 3 samples GEM (Weizhi) and 20 samples vs time integral SIDIS (?) ✓
- Full FADC trigger simulation : Not started
- MRPC simulation : response to background (ongoing Sangwa) timing simulation / event size
- Data reduction algorithms (?)

Hardware on going test SBS

- Trigger test HCAL : 16 FADC + VTP
  - Trigger test completion
  - 5 MPDs
  - First iteration of CODA library
  - Implementation optical link readout (complete)
    - Testing : reach 60 KHz with one sample, need to be optimized might be limited by computer
  - SRS : successfully used up to 5 KHz
  - HPS : 50 KHz with 6 samples
  - Need for GMp readiness review June 2017
- Compton :
  - Setup moved back in TEDF

To do list

- GEM APV25 test up to 100 KHz (200 KHz) (2 months)
- Deadtime asymmetry measurement using Compton setup in TEDF (2 months)
- Update FADC singles rates for SIDIS PVDIS
- Update document for Director’s review document

Conclusion

- New results from Simulation
  - PVDIS rate lower 12KHz, not an issue
  - SIDIS :
    - 1 sample GEM readout seems to work and with occupancies similar to PVDIS data rate
- Up to 3 GB/s most likely can be handled by SILO, L3 most likely not required and could be available mostly for free
  - To do :
    - TOF background
    - Need to check J/Psi and TCS occupancies, rates and efficiencies
- MAROC default option for Cerenkov readout
- TOF : PSEC5 preferred option, need simulation
- PVDIS deadtime : hardware setup, ongoing study with Compton setup
- Continue work on Director's review response, working with DAQ group