

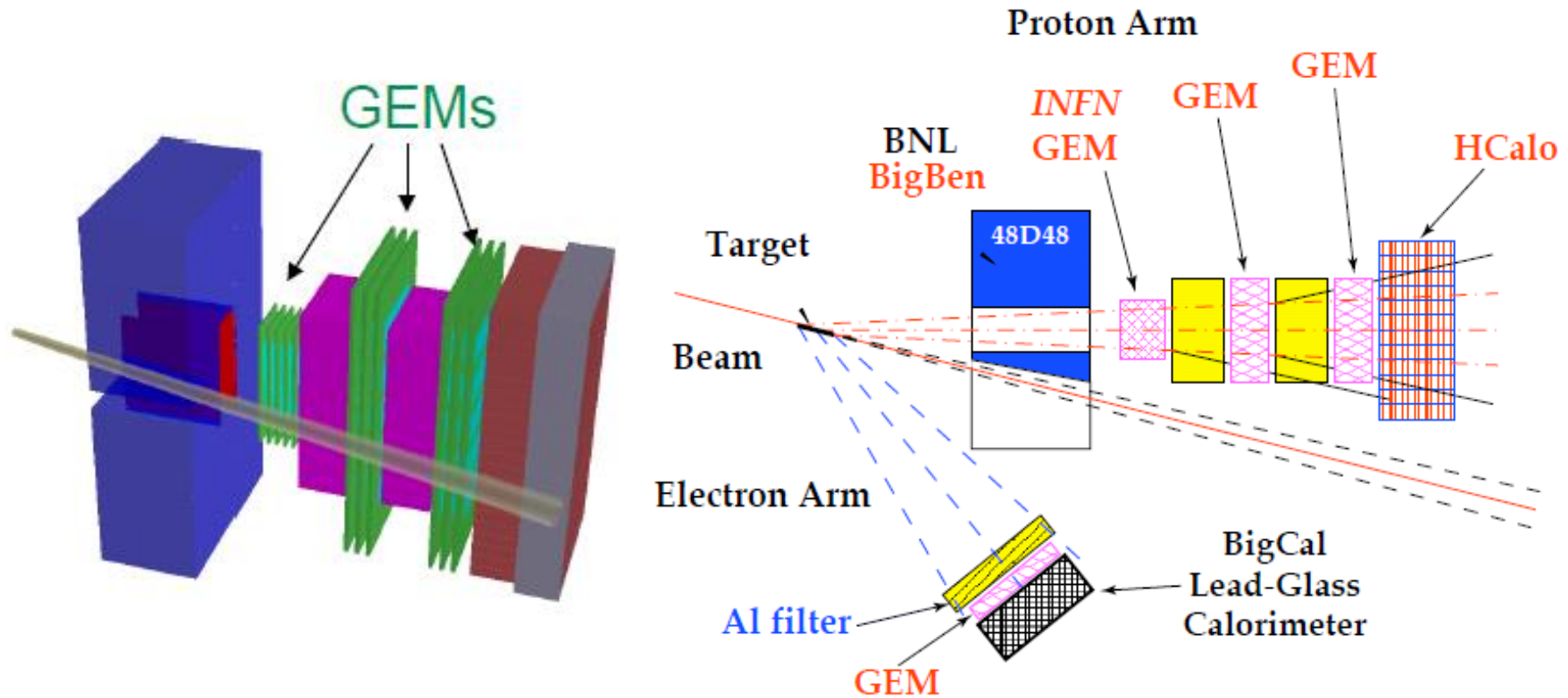
DAQ for GeP5

July 17th 2023

SBS collaboration meeting

Alexandre Camsonne

SuperBigbite Spectrometer Focal Plane Polarimeter setup

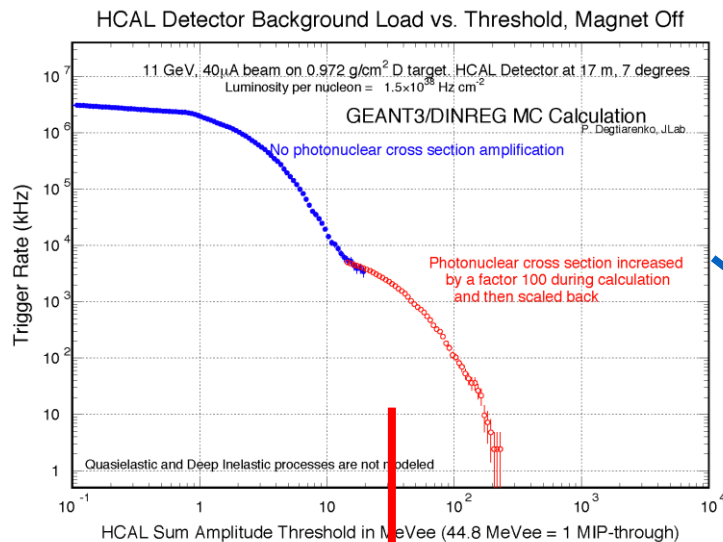


Calorimeter Rates

(CDR section 5.1.7) Most demanding

HCAL

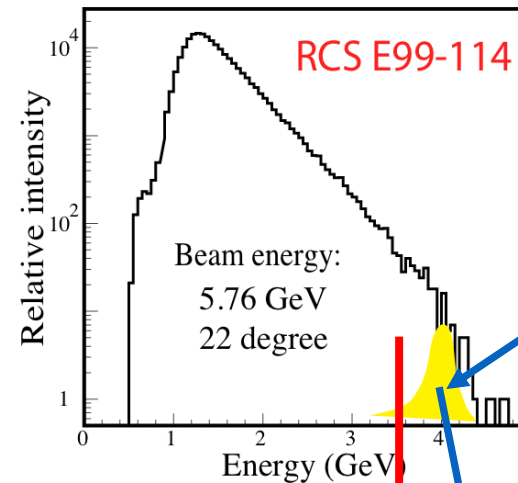
Hadron rate estimate using SLAC & DESY data, Wiser code:
w/4.5 GeV threshold: ≈ 1.5 MHz



background rate vs. cut on deposited energy
(MC studies in progress)

ECAL

From Hall A Real Compton Scattering experiment



NB: Good resolution
 $\approx 16\%/\sqrt{E}$

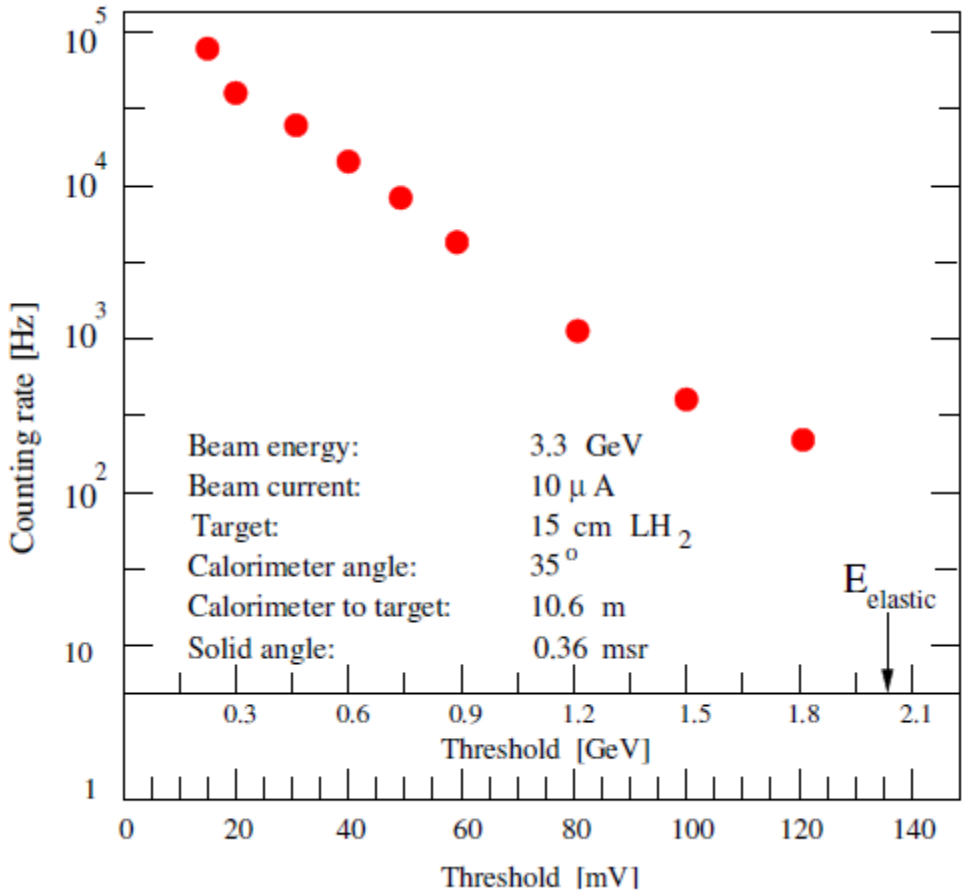
Electron rate estimate w/2.5 GeV threshold (73% of E_{elas}): ≈ 200 kHz

≈ 9 kHz coincidence rate
w/ 30 ns window

DAQ concept

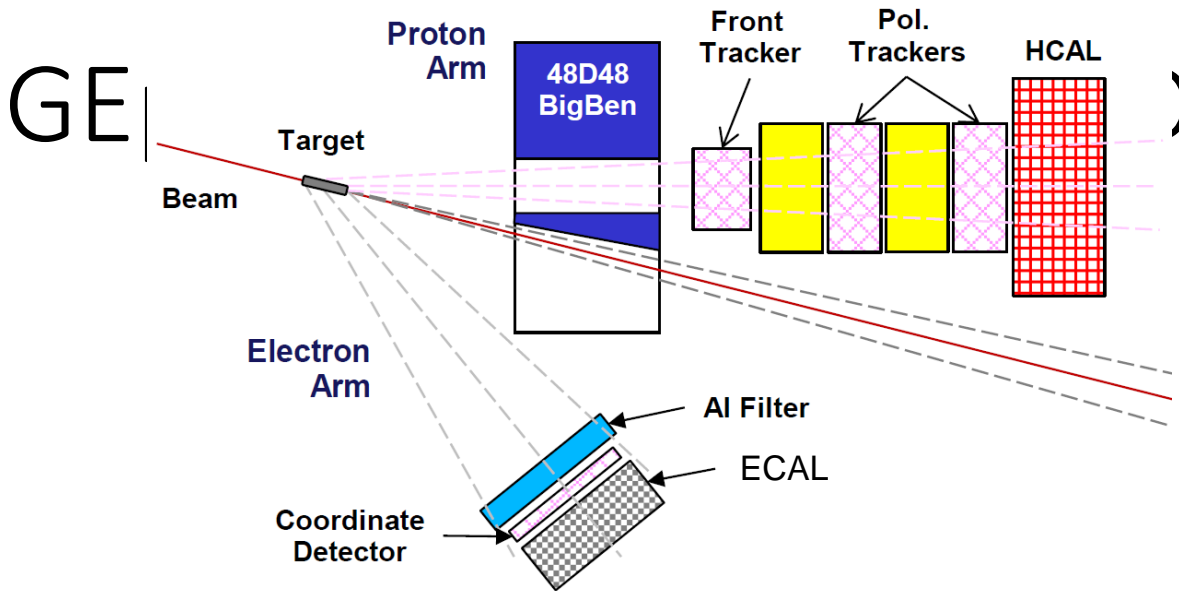
- Hybrid Fastbus and pipelined electronics
 - Level 1
 - ≈ 100 ns latency by analog summing and discrimination
 - Generated by electron arm (≈ 200 kHz rate)
 - Use module flipping scheme to reduce front end deadtime
 - Gate for Fastbus & non-pipelined VME for BigCal
 - Level 2 : coincidence proton in HCAL (1.5 MHz) and electron in ECAL
 - Assume up to ≈ 1.8 μ s latency (L2 800 ns max + Fast Clear 1 μ s)
 - 9 KHz with 30 ns coincidence windows
 - FPGA-based coincidence logic using geometrical constraints reduction by factor 5
- ≈ 2 kHz physics DAQ rate**
- Fast Clear FB & VME after L2 timeout $\Rightarrow \sim 13\%$ Electronics Dead Time

Electromagnetic calorimeter BigCal readout

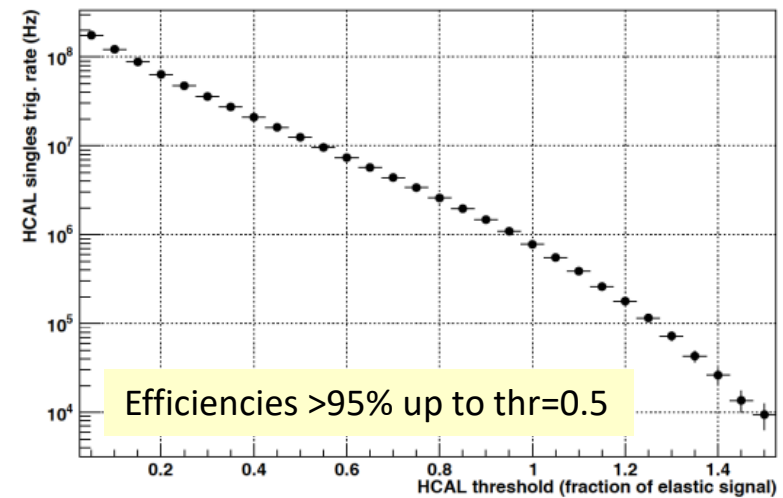


E_{thr}/E_{max} %	50	73	85	90
Rate, kHz	1400	203	60	38

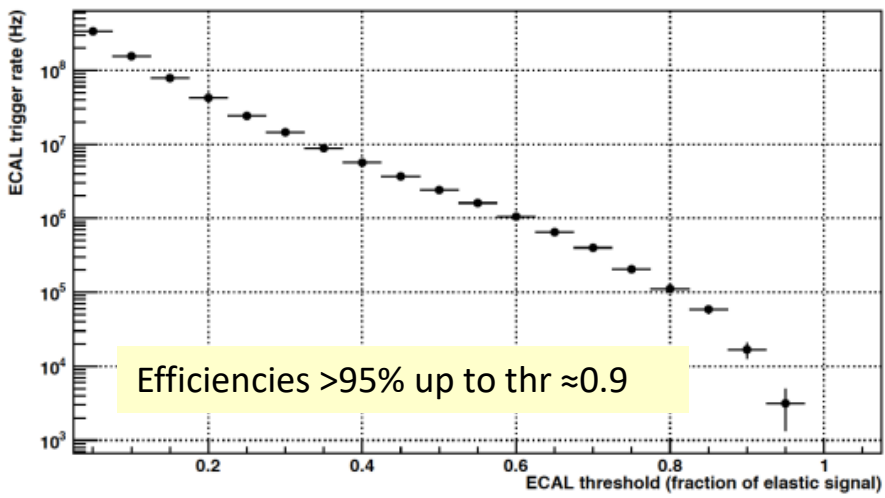
↑
 2.5 sigma cut
 Calorimeter BigCal resolution
 16 %/sqrt E



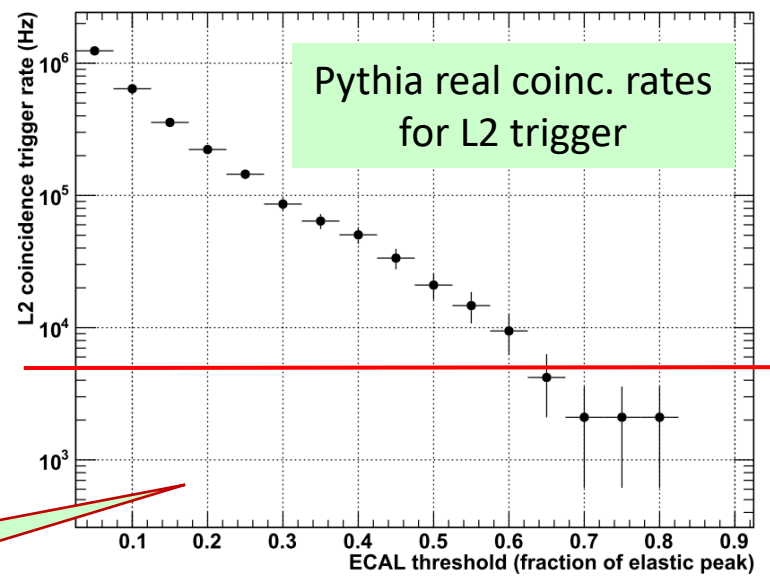
HCAL Singles: SLAC+DESY data in Wisr Code



ECAL Singles: from tuned GEANT4

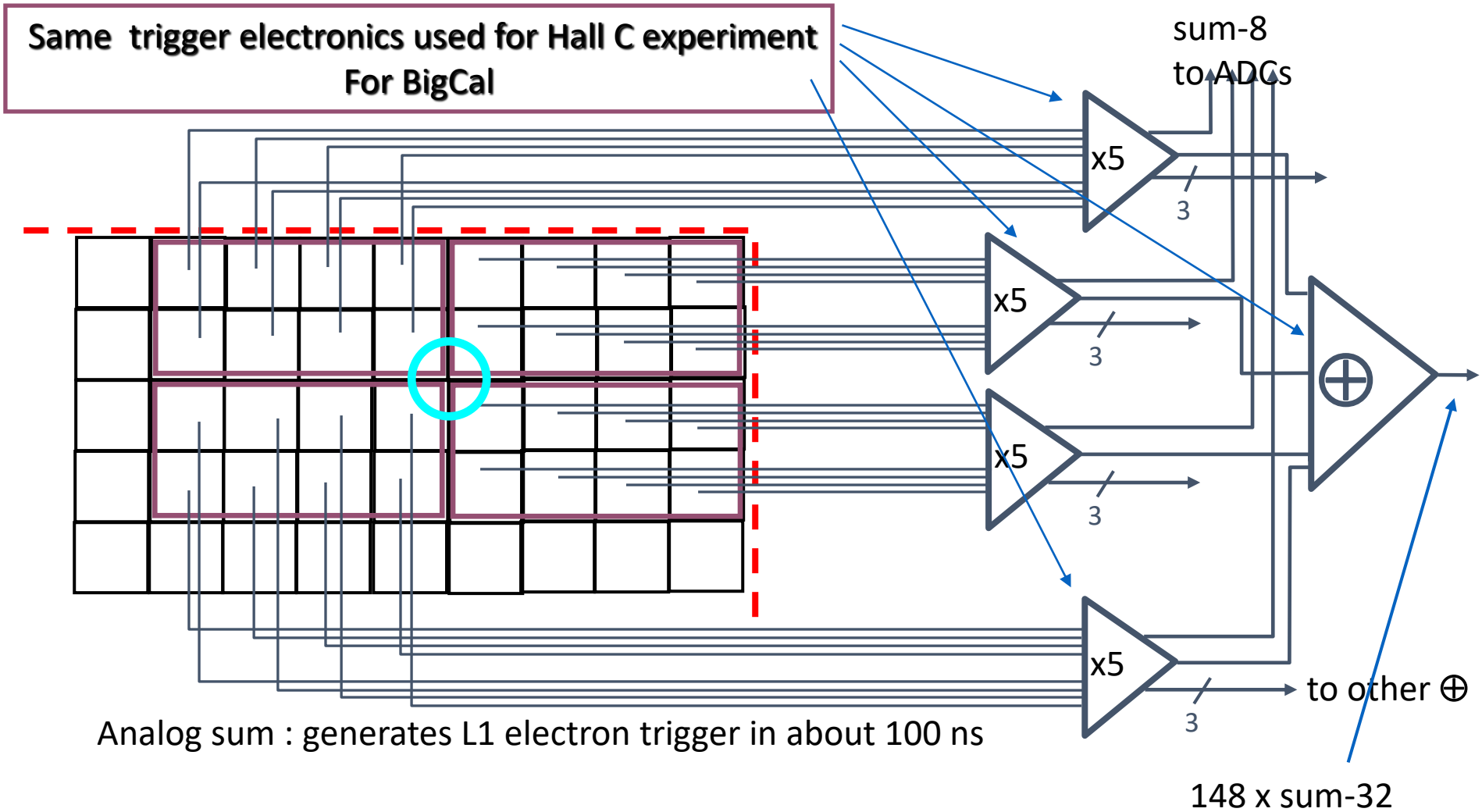


HCAL threshold = 50% of elastic peak



Expected Coincidence Rate (L2) up to 5 kHz (including accidentals)

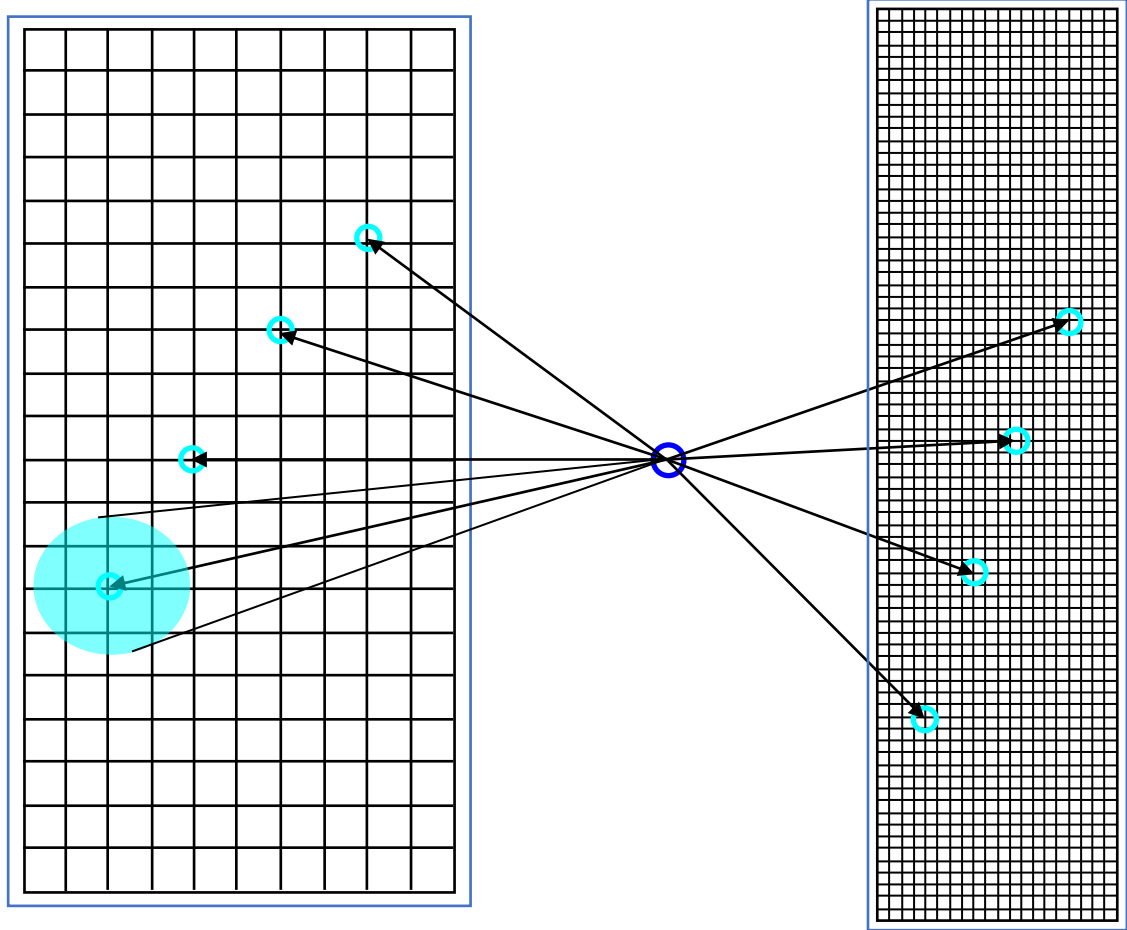
Electron Big Cal trigger



e' -p Kinematic Correlation

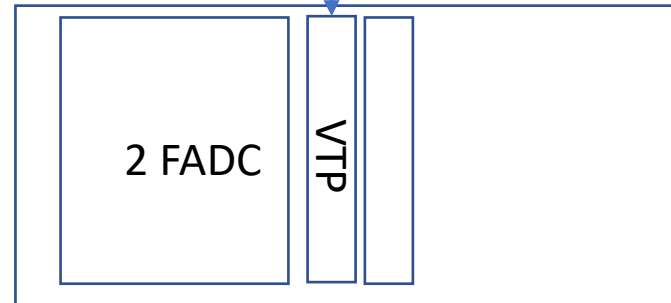
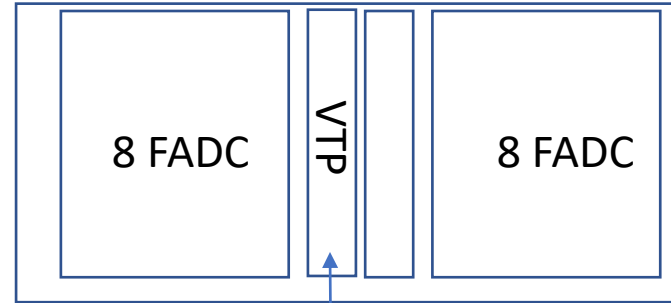
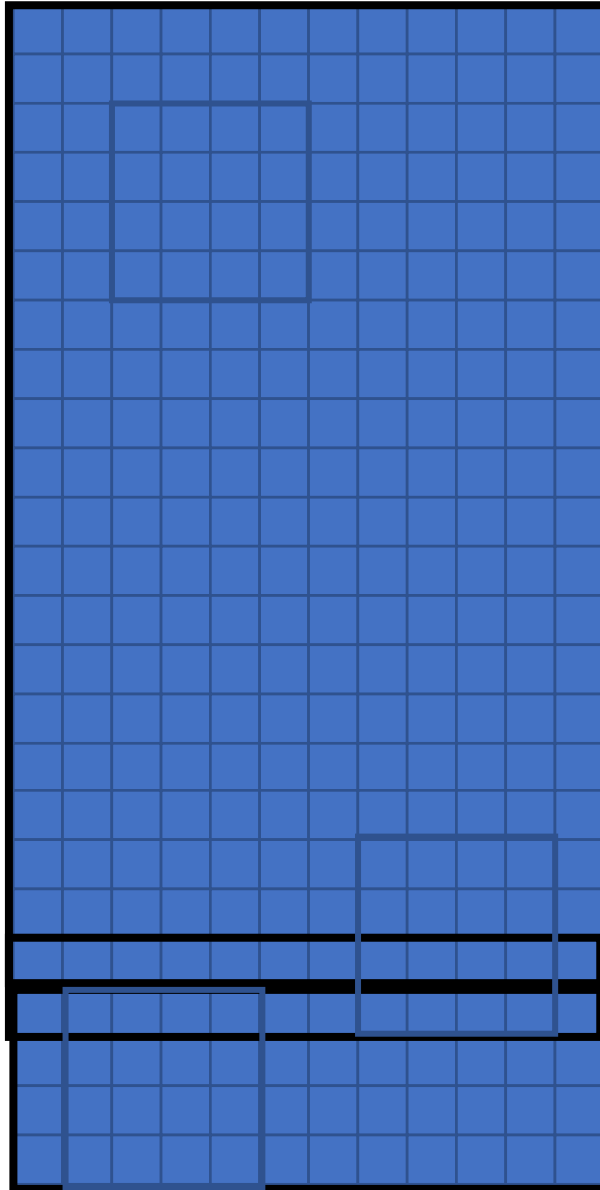
11 x 22 HCAL blocks

20 x 76 ECAL blocks



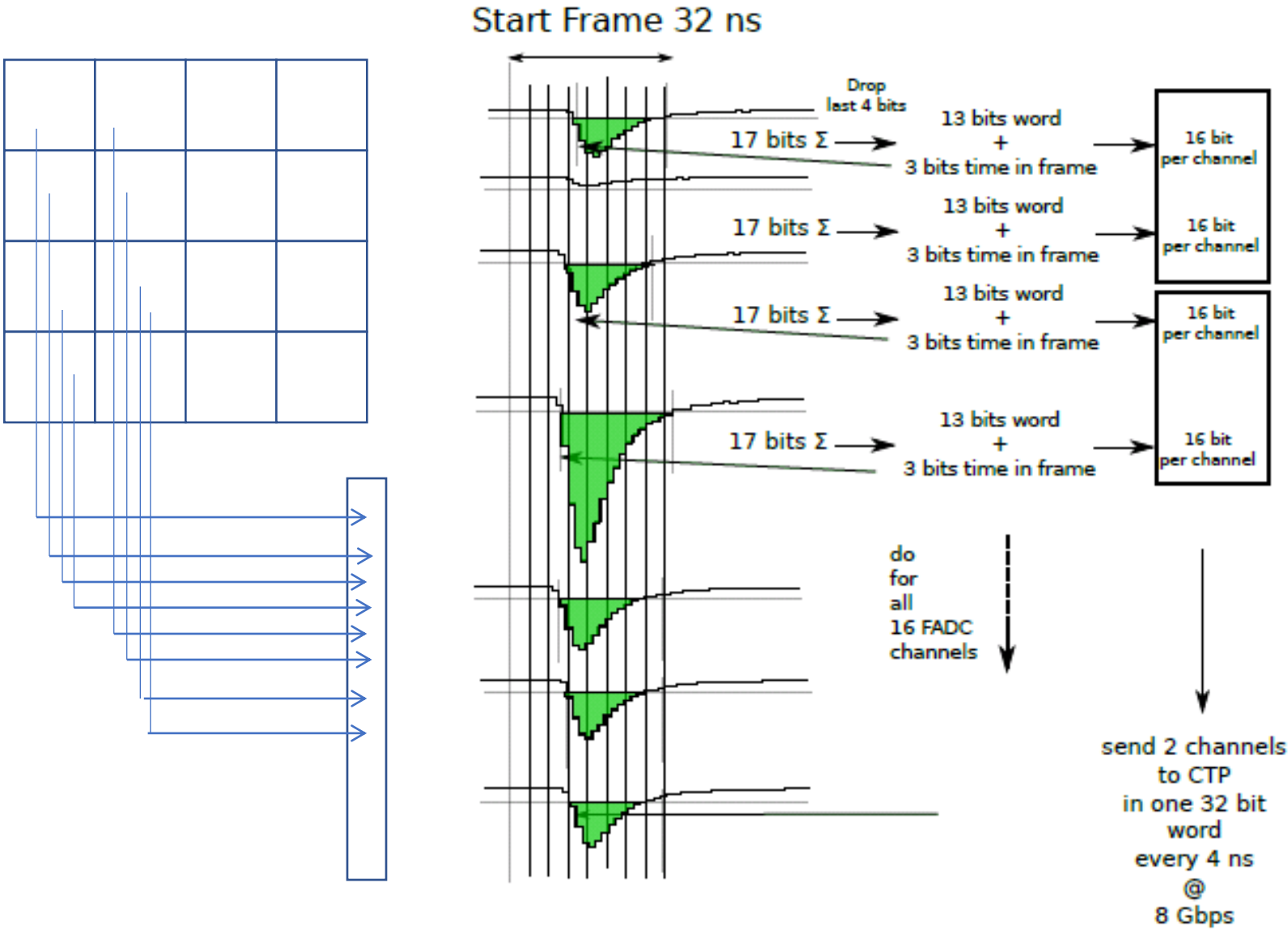
Using geometric correlations from elastic kinematic one can reduce final rate by a factor of 5 and tracker data by at least a factor of 3

SBS HCAL



- 12 x 24 = 288 blocks
- 2 VXS crates
- 18 FADCs
- 2 VTP
- Transfer blocks at crate interface through 10 Gbps optical link

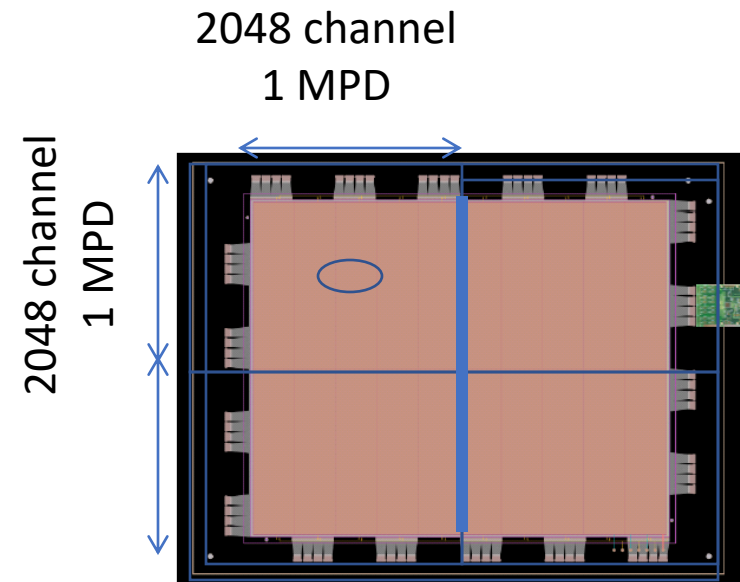
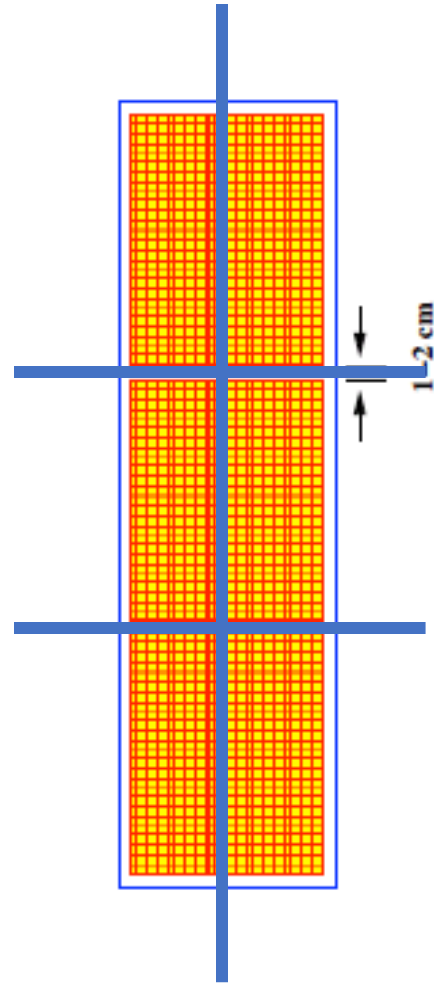
Clustering HPS like



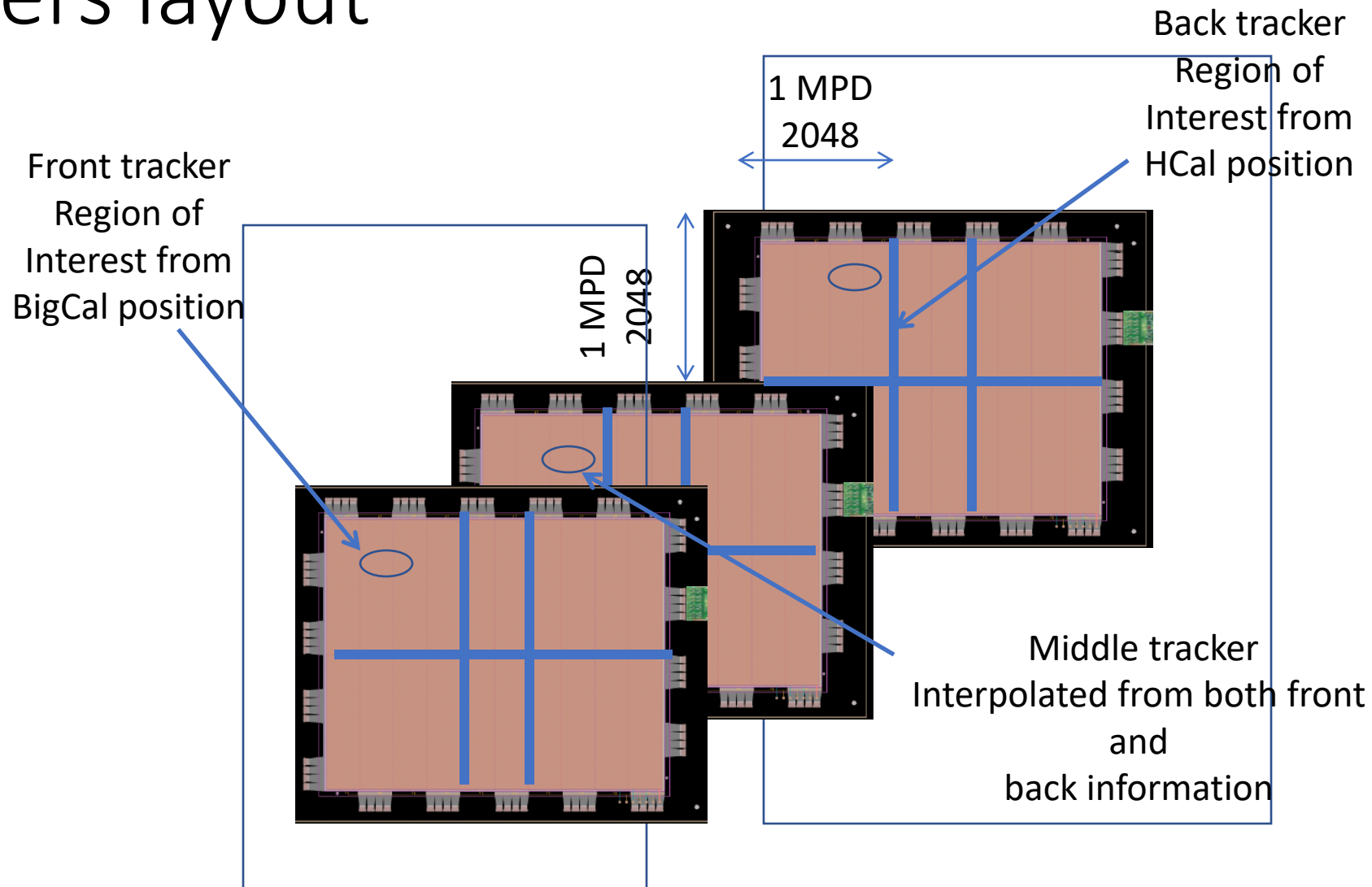
SBS HCAL trigger status

- Single crate 4 x 4 blocks cluster trigger implemented
- Clustering on two crates to be implemented
- Same algorithm for ECAL with 3x3 or 5x5 sums trigger

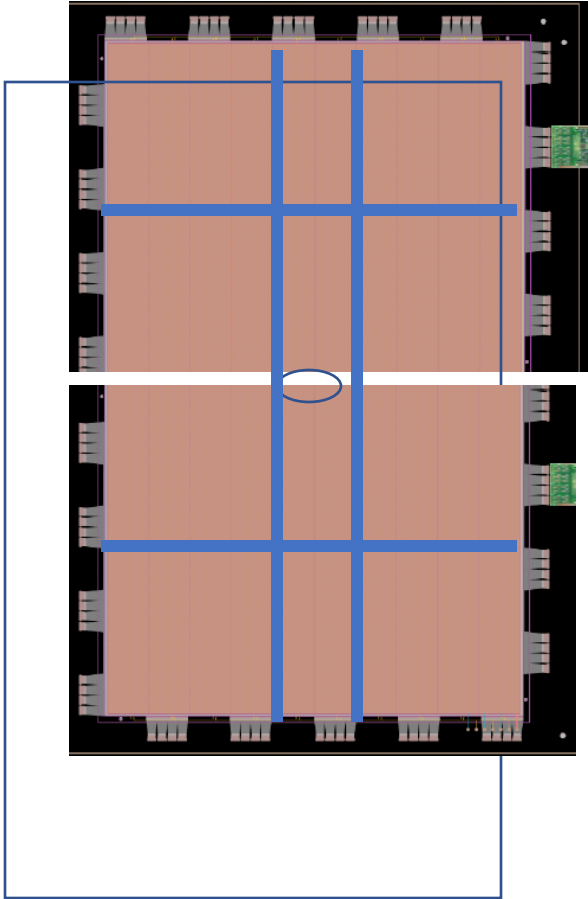
Front Tracker layout



Trackers layout



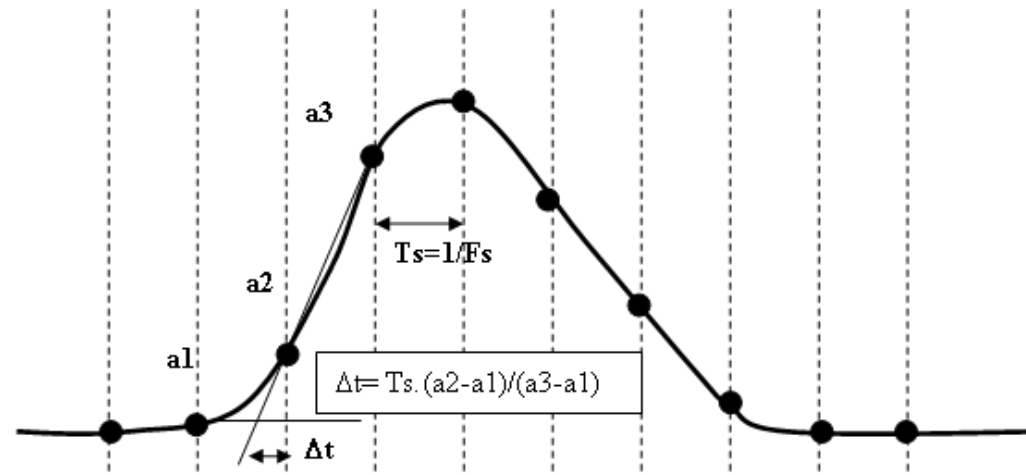
Trackers layout



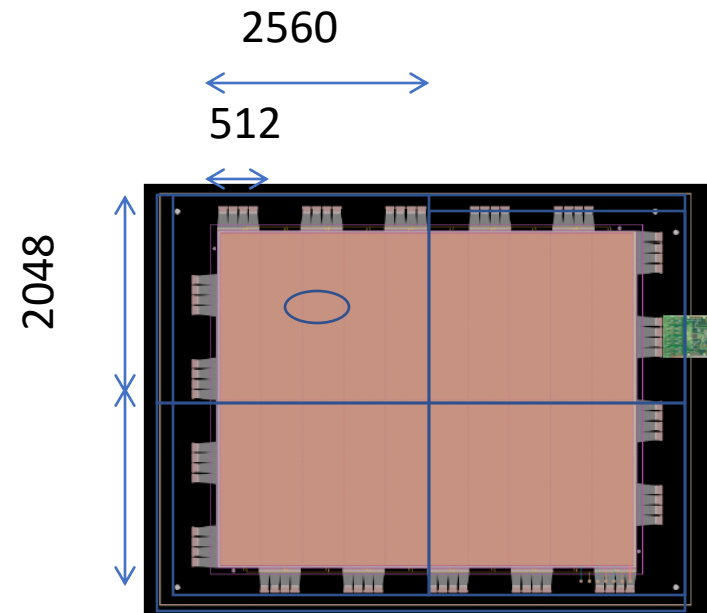
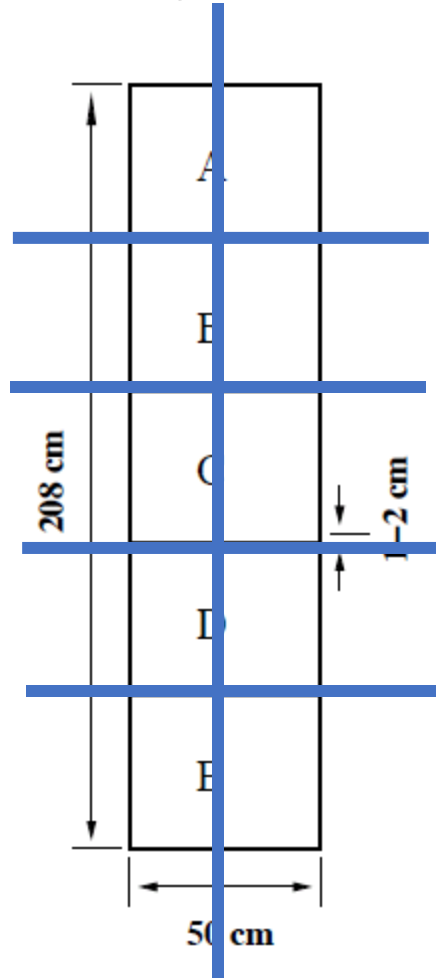
Worst
case
configuration

Suppression schemes

- Several algorithm can be implemented in FPGA for further data reduction
 - Thresholds
 - Timing
 - Fitting χ^2
 - slope



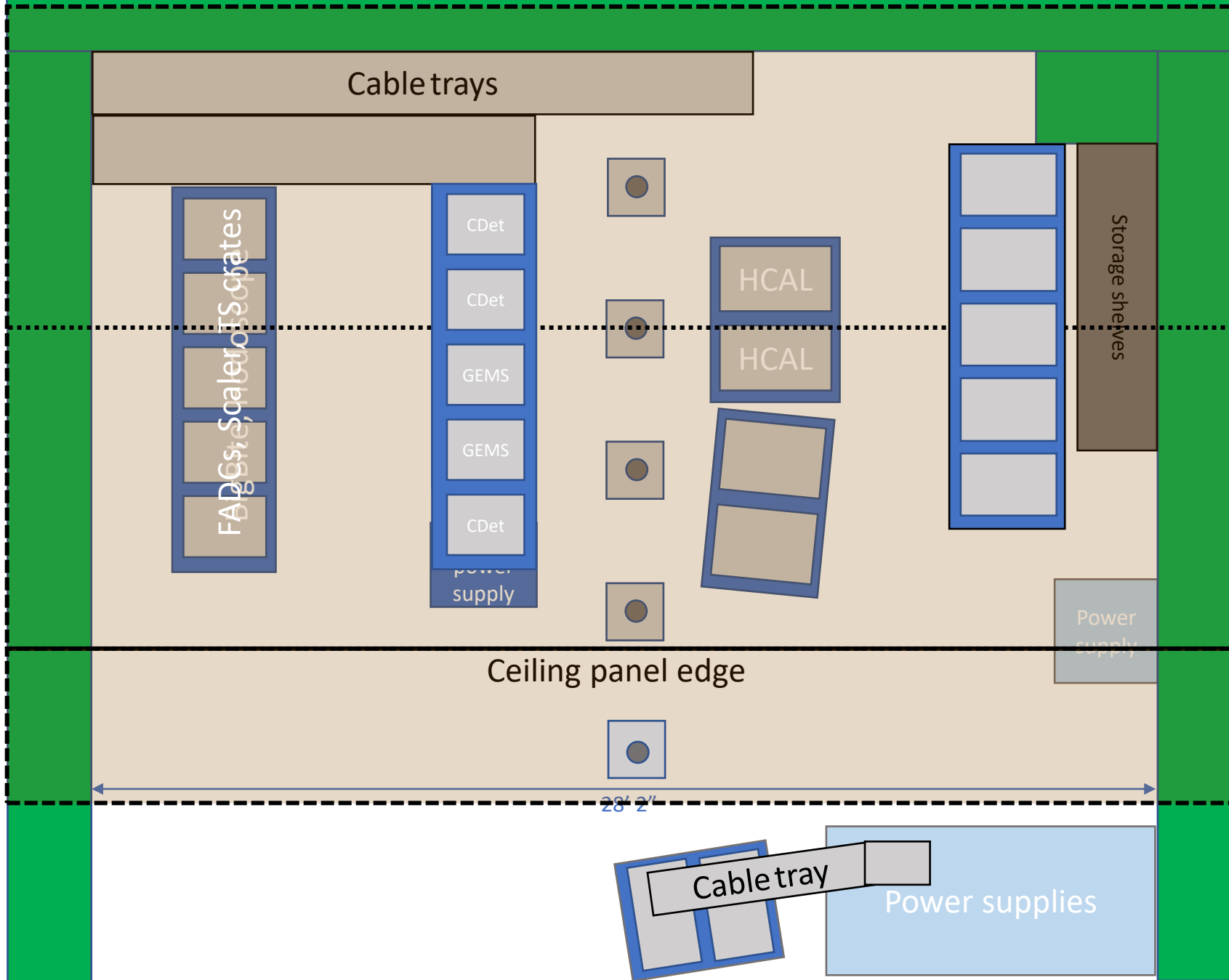
FPP Tracker layout



Ecal readout

- 1656 calorimeter channels
 - Bigbite : 256 channels
 - 1400 channels
 - FADC250 : $1400 / 16 = 88$ modules = 6 VXS crates
 - Order for physics electronics :
 - 104 FADCs
 - 32 VTPs
 - 32 VXS crates
- Should cover Gep5 Ecal even with NPS running

DAQ Bunker in Hall



Current layout

Reconfiguration steps

1. Move storage shelves and install 5 racks for HV in their place. Install HV crates and modules in racks (Summer 2023)
2. Move HCal racks slightly to give more room.
3. De-install BigBite and Hodoscope electronics, HV and cabling (April 2024)
4. Consolidate GEM electronics in two racks (April 2024)
5. Move central racks and power supply outward to allow 3 racks for CDET
6. Install Patch Panels, VME crates for FADCs and Trigger supervisor and install scaler crate.
7. Run cables and connect everything up.
8. Add ceiling panels?

1656 Channels VME FADCs

Cable tray



Cable tray

CDet

2352 channels of scintillating fiber

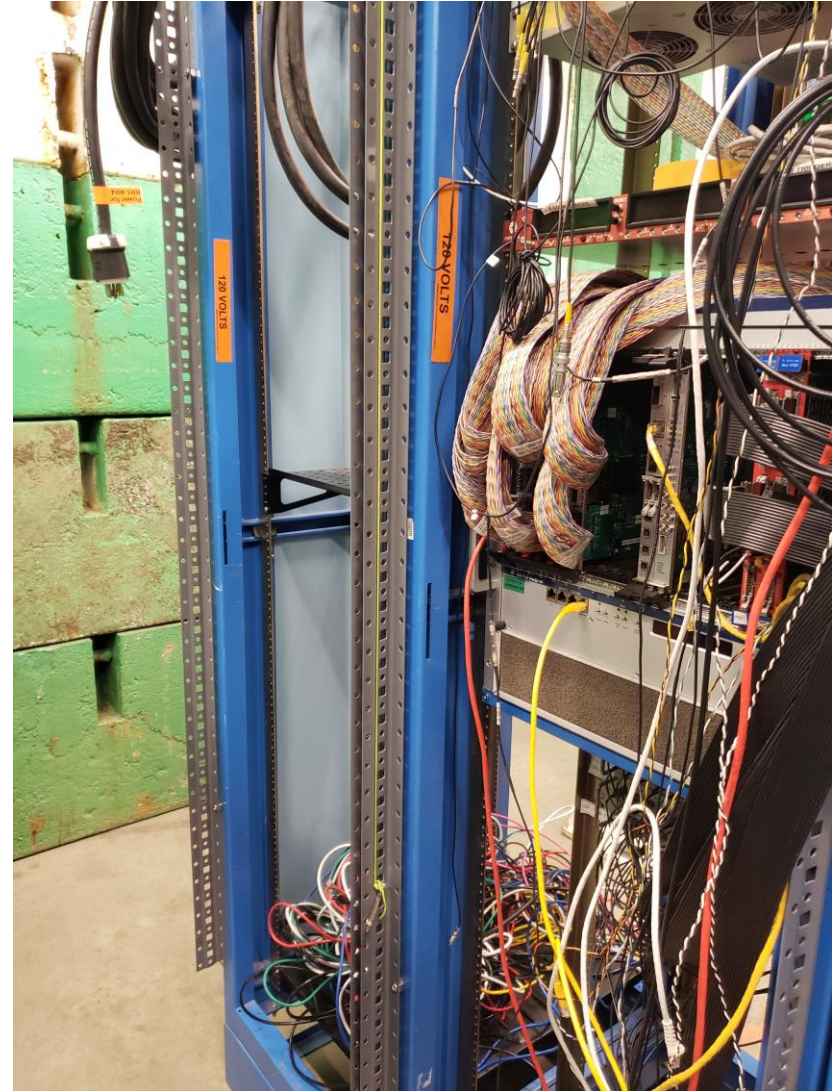
Readout with VETROC in one VXS crate

192 channels per VETROC, 128 in front and 64 in back

Use 13 VETROCs modules

VETROC already used for GRINCH during GMn and GeN

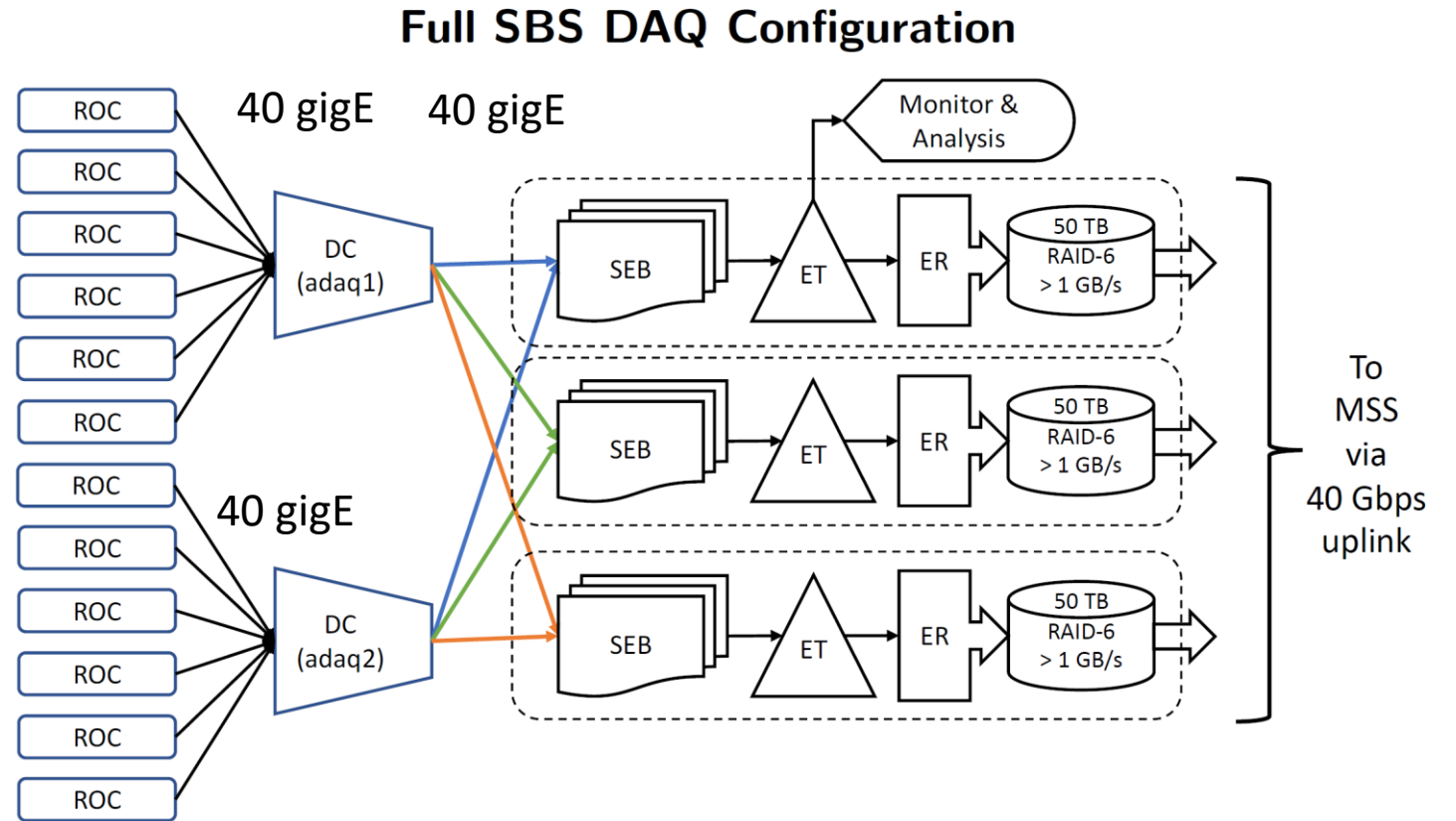
Plan to use high resolution timing firmware : 20 ps per bin will be tested by end of summer 2023



Column1	Column2	Column3	Column4	Column5	Column6	Column7	Column8	Column9	Column10	Column11	Column12	Column13
	Rate per cm2	Rate per plane	hits in 325 ns	occupancy	strip hits	XY	6 samples	bytes	Rate MB/s		Rate	Rate MB/s
1	540	3240	1053	54%	3685.5	7371	44226	176908	884.54		884542031.3	884.54
2	610	3660	1189.5	61%	4163.25	8326.5	49959	199836	999.18		999180000	999.18
3	670	4020	1306.5	67%	4572.75	9145.5	54873	219492	1097.46		1097460000	1,097.46
4	720	4320	1404	72%	4914	9828	58968	235872	1179.36		1179360000	1,179.36
5	740	4440	1443	74%	5050.5	10101	60606	242424	1212.12		1212120000	1,212.12
					0			Total	5372.66			
Column1	Column2	Column3	Column4	Column5	Column6	Column7	Column8	Column9	Column10	Column11	Column12	Column13
	Rate per cm2	Rate per plane	hits in 325 ns	occupancy	strip hits	XY	6 samples	bytes	Rate MB/s		Rate	Rate MB/s
1	280	2520	819	42%	2866.5	5733	34398	137596	687.98		687982031.3	687.98
2	270	2430	789.75	41%	2764.125	5528.25	33169.5	132678	663.39		663390000	663.39
3	260	2340	760.5	39%	2661.75	5323.5	31941	127764	638.82		638820000	638.82
4	260	2340	760.5	39%	2661.75	5323.5	31941	127764	638.82		638820000	638.82
5	230	2070	672.75	35%	2354.625	4709.25	28255.5	113022	565.11		565110000	565.11
								Total	3194.12			
Column1	Column2	Column3	Column4	Column5	Column6	Column7	Column8	Column9	Column10	Column11	Column12	Column13
	Rate per cm2	Rate per plane	hits in 325 ns	occupancy	strip hits	XY	6 samples	bytes	Rate MB/s		Rate	Rate MB/s
1	140	1260	409.5	21%	1433.25	2866.5	17199	68800	344.00		344002031.3	344.00
2	135	1215	394.875	20%	1382.0625	2764.125	16584.75	66339	331.70		331695000	331.70
3	135	1215	394.875	20%	1382.0625	2764.125	16584.75	66339	331.70		331695000	331.70
4	130	1170	380.25	20%	1330.875	2661.75	15970.5	63882	319.41		319410000	319.41
5	135	1215	394.875	20%	1382.0625	2764.125	16584.75	66339	331.70		331695000	331.70
								Total	1658.50			
						22700						
						Total		10225.28	MB/s			
	5 KHz trigger	6 samples				Geometrical Factor		3408.427031	MB/s		1.7 GB/s	

CODA3

- TS/TI Fiber based
- Support for VTP
- Support for multiple stream



Production data during GMn

- Typical rate around 3 kHz
- 90% livetime with one event builder
- 600 MB/s from BigBite GEM
- 240 MB/s HCAL, shower FADCs
- 800 MB/s to disk

- Up to 2.4 GB/s using 3 event builder

The screenshot displays the CMS production control interface. At the top, there are menu items: Control, Sessions, Configurations, Options, Expert, User, Help. Below the menu is a toolbar with icons for various actions. The main interface is divided into several sections:

- Run Parameters:** Shows Expid (SBSDAQ), Session (sbsts), and Configuration (GMN1). The Output File is set to /adaqeb1/data1/e1209019_12904.evio.0.64. User RTV values are unset.
- Run Status:** Shows Run Number 12904, Run State active, and Event Limit 0. Watch Component is ER1 and Data Limit is 0. Total Events is 4,867,512 and Time Limit (min.) is 0.
- Table of Component Rates:** A table with columns: Name, State, EvtRate, DataRate, IntEvtRate, IntDataR... The table lists various components and their current rates.
- Event Rate Graph:** A line graph showing the Event Rate (Hz) over time. The rate starts at 0, rises to about 1000 Hz, then jumps to about 2500 Hz, and continues to rise towards 3000 Hz.
- Log Window:** A table showing the log messages. The columns are Name, Message, Time, and Severity. The messages show the start of the run and the activation of various components.

Name	State	EvtRate	DataRate	IntEvtRate	IntDataR...
ER1	active	2776.0	741884.3	1193.3	314882.4
SEB1	active	2799.5	748094.8	1193.1	314920.9
DC1	active	2816.0	751898.6	1193.8	315115.4
vtpROC20	active	2751.5	601751.6	1194.1	257748.1
bbhodoROC5	active	2818.5	11537.9	1194.2	641.5
sbsvme29ROC1	active	2744.0	1009.7	1194.8	448.2
lhrcROC10	active	2748.0	1671.3	1194.5	734.9
hcalROC16	active	2794.5	62065.5	1194.4	1024.1
hcalROC17	active	2756.5	13767.4	1194.6	1750.8
grinchROC7	active	2770.5	6078.5	1194.7	2594.9
bbgemROC19	active	2788.0	88.8	1194.9	38.5
bbshowerROC6	active	2790.5	38111.7	1194.8	3903.5
sbstS21	active	2744.0	99.8	1195.6	43.3

Name	Message	Time	Severity
sms_GMN1	waiting for... vtpROC20,	02:05:55 12/15	WARN
sms_GMN1	waiting for... bbhodoROC5,	02:05:44 12/15	WARN
sms_GMN1	Prestart succeeded.	02:05:50 12/15	INFO
sms_GMN1	Go is started.	02:05:56 12/15	INFO
ER1	Emu ER1 go: waiting for PRESTART event in module ErModule (client msg)	02:05:56 12/15	INFO
SEB1	Emu SEB1 go: waiting for PRESTART event in module EbModule (client msg)	02:05:58 12/15	INFO
DC1	Emu DC1 go: waiting for PRESTART event in module EbModule (client msg)	02:05:59 12/15	INFO
sms_GMN1	Starting process = EnableEPICS	02:06:06 12/15	INFO
sms_GMN1	Script (/adaqfs/home/sbs-onl/logentry_scripts/enableLIAEPICS)	02:06:06 12/15	INFO
sms_GMN1	Done process = EnableEPICS	02:06:06 12/15	INFO
sms_GMN1	Starting process = SBS_Start_of_Run	02:06:06 12/15	INFO
sms_GMN1	Script (/adaqfs/home/sbs-onl/logentry_scripts/halla/start_run_SBS)	02:06:06 12/15	INFO
sms_GMN1	Done process = SBS_Start_of_Run	02:06:07 12/15	INFO
sms_GMN1	Starting process = InsertRunList	02:06:07 12/15	INFO
sms_GMN1	Script (/adaqfs/home/sbs-onl/logentry_scripts/insertRun)	02:06:07 12/15	INFO
sms_GMN1	Done process = InsertRunList	02:06:07 12/15	INFO
sms_GMN1	Go succeeded.	02:06:07 12/15	INFO

Silo performance

- Achieved 800 MB/s

Mover	LTO	Activity	User	Volume	Volume Set	Seek %	Util %	MB/s	State
scdm1801-1	8			802336	halld-prod	32	34	4	
scdm1801	8								
scdm1802-1	8								
scdm1802	8	Write		802326	rawdup		10	22	
scdm1803-1	8	Write		802327	rawdup		15	46	
scdm1803	8								
scdm1804-1	8								
scdm1804	8			802311	lattice-p				
scdm1901-1	8								
scdm1901	8								
scdm1902-1	8	Write		802324	halla-raw		99	404	
scdm1902	8								
scdm1903-1	8								
scdm1903	8								
scdm1904-1	8			802335	halld-prod				
scdm1904	8	Write		802307	lattice-p		98	351	
scdm2001	8			802328	rawdup				
scdm2003	8			802302	hallb-raw				
scdm2004	8	Write		802330	halla-raw		99	415	
scdm2005	8	Verify		802331	halla-raw		99	428	
scdm2001-1	7								
scdm2003-1	7								
scdm2004-1	7	GeP5 ERR							24
scdm2005-1	7								

Tape cost

		Days	Weeks	Data rate	Seconds	Total data TB	Double	LTO7 in k\$	LTO8 in k\$
E12-12-09-019	GMN	25	3.57	100	2160000	216	432	5	3
E12-17-004	GEn RP	9	1.29	300	777600	233.28	466.56	6	3
E12-09-016	GEN	50	7.14	500	4320000	2160	4320	54	27
E12-07-109	GEP/GMP	45	6.43	3400	3888000	13219.2	26438.4	330	165
E12-09-018	SIDIS	64	9.14	1000	5529600	5529.6	11059.2	138	69
E12-15-006	TDIS	27	3.86	6000	2332800	13996.8	27993.6	350	175

To do list Gep5

- HCAL digital trigger
- VETROC in HCAL crate
- Trigger with geometrical matching HCAL-ECAL
- ECAL FADC readout
- Cdet VME readout
- Simulation
 - Trigger rate
 - Occupancies
- AIML filter ?