SBS DAQ overview

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February 26th 2019

SBS Collaboration meeting

Outline

- Neutron Form Factors experiments
- GeP
- SIDIS
- TDIS
- Data rates
- Upgrade plan
- Conclusion

Experimental setup GMn

- BigBite
  - Shower
  - Preshower
  - Scintillator
  - GRINCH

  (check Eric's talk)

  - GEM
- Neutron detector
  - CDET
  - HCAL
- LHRS

Detector	Channels	NINO	Readout	ADC	TDC
Shower	7x27 = 189 27 sums		Fastbus	X	
Preshower	2x27 =54 2 sums		Fastbus	X	
Scintillator	200 x 2	X	VME	X	X
GRINCH	550	X	VME		X
GEM	5 planes		VME		

Detector	Channels	NINO	Readout	ADC	TDC
HCAL	288		VME	X	X
CDET	2352	X	Fastbus		X

SBS GMn DAQ Overview

- Calorimeter
  - ECAL : Fastbus
  - HCAL :FADC , F1 or VETROC TDC
- SBS GEM
  - APV25 INFN MPD
- BigBite
  - Scintillator
  - Shower preshower
  - Fastbus
- Coordinate detector
  - Fastbus

SBS Gen RP DAQ Overview

Additionnal detectors

- 2 Hodoscope arrays 24+24 scint bars from (Old) BB Hadron stack 2 PMTs/bar 96 HV, signal channels)
- 10 'Rear' GEM planes 6 in-line with SBS detector stack 2 in front of 'left' hodoscope array (proton pol.) 2 in front of 'right' hodoscope array (proton pol.)

Electronics

- 6+2 F250 FADC Draw from 'NPS/LAD' FY19 plans (*)
- 1 C1190 TDC In hand (1+spare: Glasgow + Hall C spares)
- 6+2 CAMAC Discrim. 4 in hand; 4 to locate
- 1 VXS crate In hand (1+spare: Glasgow + Hall C spares**)

GRINCH readout

- 6 VETROC ordered for Compton
- 6x128 = 768 channels
- Backplane board ordered for 192 channels
- 4 boards for Compton
- Existing initial prototypes : 2 x 192
- Using spare Compton crate 1 VXS crate spare desired (15 K$)

Glasgow Hodoscope readout

- VME based
  - V1190 TDC
  - V792 QDC
  - VME64X crate

- Existing drivers already
- CODA setup beginning of 2019

Inventory GMn/GEn

- TS : VXS crate, TS, TD, 1 Intel CPU
- HCal
  - 288 channels : 18 FADCs, 2 VXS crates (JLAB + UVA), 2 VTP, 2SD, 2 CPU, 2 TI, 5 F1 TDC
- BigBite
  - 243 shower channels : 4 Fastbus ADC, 1 SFI (from ECAL), 1 TI (from ECAL)
  - 90 hodoscopes bar = 180 channels : NINO + 3 V1190 (Glasgow) + 2 V792 (Glasgow) + 1 VME64X crate
  - 550 GRINCH : 3 or 5 VETROC + VXS crate + 1 GTP + 1 CPU + 1 TI
  - 4 INFN GEMs 1 UVA GEM : 1 VXS crate (UVA)+ 2 VME 64 X crate (JLAB + UVA) + 20 MPDs + 4 SSP (Hall A+C) + 1 SD (SBS) + 3 CPUs + 3 TI
- Cdet
  - 2520 channels
    - NINO + 9 Fastbus crates +9 SFI +9 INTEL CPU + 27 TDC 1877S (3 per crate)
- LHRS
  - 768 VDC channel on 3 Fastbus crates, 3 SFI, 3 new TI (ECAL) , 3 intel CPU (from ECAL)
  - 2 S0, 32 S2m on F1 ,10 Cerenkov ,68 channels Pion Rejector on Fastbus

GMn tasks

- BigBite (see Eric’s talk)
- GEM readout
- HCal
- CDet

GMn tasks

- BigBite (see Eric's talk)
- GEM readout
  - SSP readout with Danning suppression working for 4 MPD
  - New firmware with new event structure and L2 clear installed end of 2018
  - SSP readout for 32 MPDs Summer 2019

GMn tasks

- Cdet
  - only one crate right now
  - all hardware needed
  - start spring or summer 2019 full Fastbus system
- HCal
  - HCAL readout working for one crate though reduce set of channels (APEX using 10 FADCs)
  - need to test 2 crates readout (need VXS crate)

GMn

- Switch to CODA3 ?
  - need to use all new intel CPUs
  - VTP readout options : 10 gigE capability

GEp

- Coincidence trigger and
- ECAL readout :
  - analog trigger
  - Fastbus fast readout
- HCal trigger :
  - 1 crate trigger working
  - 2 crate trigger and ECAL coincidence and GEM
- GEM readout : need test full scale system

GEM occupancy and data rates GMn

- occupancies from Q2 = 13.5 GeV2, with luminosity 2.8 10^38 A^{-1} cm^{-2} s^{-1} (44uA on 10cm LD2 target) and rates from low Q2 point : 1.3 KHz

	Rate per (KHz/cm2)	Rate per plane (MHz)	hits in 325 ns	Occupancy (%)	strip hits	x2 XY (strips)	x6 samples	Evt size (bytes)	Rate MB/s
1	86	516	167.7	26%	586.95	1173.9	7043.4	28178	118.35
2	94	564	183.3	28%	641.55	1283.1	7698.6	30794	129.34
3	93	558	181.35	28%	634.725	1269.45	7616.7	30467	127.96
4	92	552	179.4	28%	627.9	1255.8	7534.8	30139	126.58
5	54	324	105.3	16%	368.55	737.1	4422.6	17690	74.30
								Total	**577**

Worse case scenario using High Q2 occupancies with low Q2 rates

Deconvolution on SSP : **expect factor of 3 reduction about 190 MB/s**

Gep GEM data rates

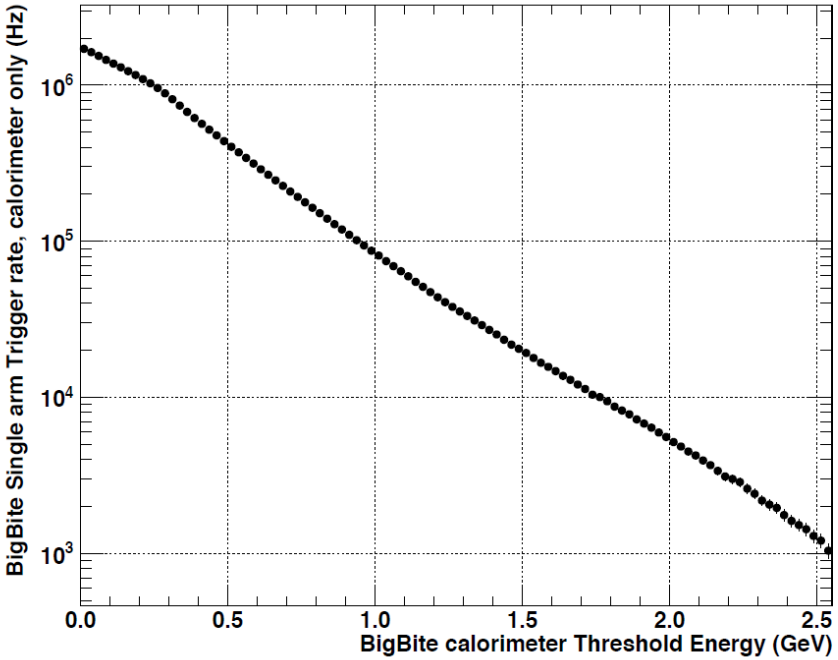
	Rate per cm2	Rate per plane	hits in 325 ns	occupancy	strip hits	XY	6 samples	bytes	Rate MB/s
1	540	3240	1053	100%	3240	6480	38880	155524	777.62
2	610	3660	1189.5	100%	3660	7320	43920	175680	878.40
3	670	4020	1306.5	100%	4020	8040	48240	192960	964.80
4	720	4320	1404	100%	4320	8640	51840	207360	1036.80
5	740	4440	1443	100%	4440	8880	53280	213120	1065.60
								Total	4723.22
Column1	Column2	Column3	Column4	Column5	Column6	Column7	Column8	Column9	Column10
	Rate per cm2	Rate per plane	hits in 325 ns	occupancy	strip hits	XY	6 samples	bytes	Rate MB/s
1	280	1680	546	84%	1911	3822	22932	91732	458.66
2	270	1620	526.5	81%	1842.75	3685.5	22113	88452	442.26
3	260	1560	507	78%	1774.5	3549	21294	85176	425.88
4	260	1560	507	78%	1774.5	3549	21294	85176	425.88
5	230	1380	448.5	69%	1569.75	3139.5	18837	75348	376.74
								Total	2129.42
Column1	Column2	Column3	Column4	Column5	Column6	Column7	Column8	Column9	Column10
	Rate per cm2	Rate per plane	hits in 325 ns	occupancy	strip hits	XY	6 samples	bytes	Rate MB/s
1	140	840	273	42%	955.5	1911	11466	45868	229.34
2	135	810	263.25	41%	921.375	1842.75	11056.5	44226	221.13
3	135	810	263.25	41%	921.375	1842.75	11056.5	44226	221.13
4	130	780	253.5	39%	887.25	1774.5	10647	42588	212.94
5	135	810	263.25	41%	921.375	1842.75	11056.5	44226	221.13
			Total		7958.32	MB/s		Total	1105.67
			Geometrical Factor		2652.772031	MB/s			
			SSP reduction		884.2573438	MB/s			
			Drop to 3 samples		442.25	Mb/s			

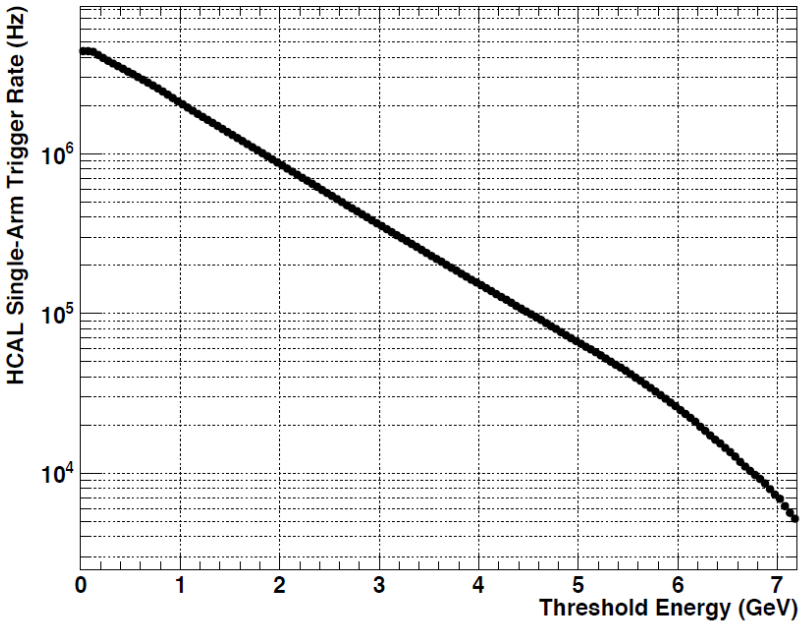
Data rate GEp

- Ecal : 40 MB/s
- Hcal : 63 MB/s
- Cdet : 11 MB/s

- Total 1 GB/s

Latest SIDIS single-arm trigger rates from PYTHIA





- Left: BigBite singles rate (calorimeter only) vs threshold. At 0.8 GeV threshold, singles rate ~= 150 kHz (ASSUMING target windows can be collimated; i.e., this is from the target gas only)
- Right: HCAL singles rate vs. threshold. At 1.5 GeV, singles rate ~= 1.3 MHz (again due to target gas only).
- Assuming a 30-ns coincidence window, N1 N2 dt ~= 6 kHz accidental coincidence rate, ***without GRINCH in trigger***!
- Real physics event rate is of order 100 Hz.
- Assuming something like ~5X reduction by adding GRINCH, we would be down to a very manageable DAQ rate.
- I think it is safe to assume that the main DAQ rate can be kept under 5 kHz, and will probably be something like 1-2 kHz if we can put the GRINCH in the trigger to suppress photon-induced trig. Rate
- Note: these rates are based on final trigger logic: OR of all possible 4x4 sums in HCAL, OR of two-row sums in BigBite Shower and preshower, with one row of overlap.

UCONN Jefferson Lab

Occupancies / data rates

- GEMs (both BigBite and SBS): 40-50 kHz/cm2
- RICH: 100 kHz-1 MHz per PMT
- GRINCH: 100 kHz-1 MHz per PMT

Assume 5 KHz trigger rate

Data rates SIDIS

Column1	Column2	Column3	hit	Column4	strip	XY	6 samples	bytes	Column5	Rate	Column6	Rate MB/s
1	50	300000000	97.5		390	780	4680	18720		93600000		93.6
2	50	300000000	97.5		390	780	4680	18720		93600000		93.6
3	50	300000000	97.5		390	780	4680	18720		93600000		93.6
4	50	300000000	97.5		390	780	4680	18720		93600000		93.6
5	50	400000000	130		520	1040	6240	24960		124800000		124.8
												499.2

Column1	Column2	Column3	hit	Column4	strip	XY	6 samples	bytes	Column5	Rate	Column6	Rate MB/s
1	50	400000000	130		520	1040	6240	24960		124800000		124.8
2	50	400000000	130		520	1040	6240	24960		124800000		124.8
3	50	400000000	130		520	1040	6240	24960		124800000		124.8
4	50	400000000	130		520	1040	6240	24960		124800000		124.8
5	50	400000000	130		520	1040	6240	24960		124800000		124.8
												624
										Total		1123.2 MB/s
										SSP reduction		374.4 MB/s

About 400 MB/s at 5 KHz trigger rate

TDIS data rates

- From Paul's talk
  - up to 0.6 GB/s per chamber = 6 GB/s total with 160 ns integration time
  - 80 ns integration time and smaller pads can help
  - would help to reduce data with tracking
    - can that be done in FPGA of SSP / VTP
    - L3 farm ? (coming back in fashion with streaming readout so maybe work out at deal with IT and management)

Network upgrade

- Replace hall A router with an Arista switch, reuse existing hall A router as the switch for the racks. This provides dense 10Gig aggregation, with 40Gig expandability. Estimate $30K, 3 month lead time.

- Single Mode Fiber Installation in the hall (required for any speeds>1Gbit/sec), rough estimate $30K, 6 month lead time.
  Counting House to left arm, 24 strand
  Counting House to right arm, 24 strand
  Counting House to Labyrinth, 24 strand
  Counting House to Hall Floor Rack Area, 24 strand

- 40Gig uplinks to CEBAF center ($20K upgrade to item 2).

- Bottomline : 10 Gig capability 30 K$ + temporary fiber 10 gigE for GMn

- Full upgrade : for Gep, SIDIS, TDIS additionnal 50 K$

Infrastucture status (500 MB/s) 2020

Item	Status
LHRS DAQ	1 intel CPU 4 Vxworks CPU
Computer disks	2 raid arrays 2000 MB/s
Network	Gigabit ethernet in Hall (100 MB/s) 10 GigE router 10 Gig adapter on adaq1 and adaq2 (1000 MB/s) 1 fibers 10 Gig Ethernet to Silo (1000 MB/s)
Silo	8 drives LTO5 8 drives LTO6 4 LTO7 (300 MB/s) 4 LTO8 (360 MB/s) -> 5 GB/s

Current infrastructure should satisfy GMn and Gen close from limit for only high rate point

Infrastucture should (1GB/s) 2021/2022

Item	Status	Cost
LHRS	1 intel CPU 4 intel CPU	15 K$
Computer disks	2 raid arrays 2GB/s 8 SSD (8x 2GB/s)	20 K$
Network	1 Gigabit ethernet in Hall 40 GigE router 40 Gig adapter on adaq1 and adaq2 (1000 MB/s) 2 fibers 10 Gig Ethernet to Silo (2000 MB/s)	30 K$ 5 K$
Silo	8 drives LTO5 8 drives LTO6 4 LTO7 (300 MB/s) 4 LTO8 (360 MB/s) 4 LTO8 (360 MB/s) -> 6.2 GB/s	40 K$ (IT)

Moderate upgrade 70 K$: can easily handle GMn and GEn, can test CODA3, should be ok for Gep unless bad background surprise

Easy upgrade to 40 gigE, can take full advantage of VTP readout

Infrastucture like
(5 GB/s capability)

Item	Status	Cost
LHRS	1 intel CPU 4 intel CPU	 15 K$
Computer disks	2 raid arrays 2GB/s 8 SSD (8x 2GB/s) 1 PB disk array	 20 K$ 300 K$
Network	10 Gigabit ethernet in Hall 40 GigE router 40 Gig adapter on adaq1 and adaq2 (5000 MB/s) 2 fibers 40 Gig Ethernet to Silo (8000 MB/s)	30 K$ 30 K$ 5 K$ 20 K$
Silo	8 drives LTO5 8 drives LTO6 4 LTO7 (300 MB/s) 4 LTO8 (360 MB/s) 14 LTO8 -> 11.2 GB/s	 40 K$ (IT) 140 K$ (IT)

Safe for Gep, TDIS and future program, can use fast VTP readout
120 K$ upgrade + 300 K$ disk + 140 K$ silo
(could delay silo and large disk for better cost and upgrade every year)

Conclusion

- GMn
  - BigBite
  - HCal DAQ OK
  - Finalize Cdet DAQ
  - Switch to CODA3
  - Ready by fall 2019
- GeP (busy year 2019 2020)
  - finalize coincidence trigger
  - test full scale DAQ
  - ECAL
- SIDIS
  - similar setup as GMn and Gen + RICH
  - GEM rate about 400 MB/s
- TDIS : need major upgrade and / or efficient way to reduce data from 6 GB/s to about 1 GB/s