

# SBS DAQ

SBS collaboration Meeting

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# Outline

- GMn rates
- GEp rates
- Network
- Counting house disks
- Tape silo
- Conclusion

# SBS DAQ Overview

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

# Expected trigger rates GMn

Preferably single electron trigger to avoid biased in neutron detector

| Q <sup>2</sup>   | n+p QE xsec | L(per atom)                                    | QE rate | Beam time | Total |
|------------------|-------------|--|---------|-----------|-------|
| GeV <sup>2</sup> | fb          | 10 <sup>38</sup> /cm <sup>2</sup> /s<br>design | Hz      | Hours     | Hz    |
| 3.5              | 6700        | 0.35   | 235     | 12        | 2100  |
| 4.5              | 1015        | 0.7  | 70      | 12        | 1400  |
| 5.7              | 97.9        | 1.4  | 13.5    | 18        | 140   |
| 8.1              | 47.4        | 1.4  | 6.6     | 18        | 390   |
| 10.2             | 31.6        | 0.7  | 1.5     | 24        | 210   |
| 12               | 5.04        | 1.4  | 0.7     | 36        | 200   |
| 13.5             | 6.25        | 1.4  | 0.87    | 96        | 100   |

Maximum trigger rate 2.1 KHz, assume factor 2 safety margin for 4.2 KHz for low Q<sup>2</sup>  
less than 500 Hz at high Q<sup>2</sup>  
Single electron trigger is a good option  
( possibility to add Cerenkov in the trigger if needed )

High trigger rate capabilities : rates high for 2 low Q<sup>2</sup> points  
rates are modest for other points

# GEM occupancy and data rates GMn

- occupancies from Q2 = 13.5 GeV2, with luminosity  $2.8 \cdot 10^{38} \text{ A}^{-1} \text{ cm}^{-2} \text{ s}^{-1}$  (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 | 89.6               | 537.6                | 174.72         | 27%           | 612        | 1223           | 7338       | 29357            | 123.30        |
| 2 | 101.6              | 609.6                | 198.12         | 31%           | 693        | 1387           | 8321       | 33284            | 139.79        |
| 3 | 101.4              | 608.4                | 197.73         | 30%           | 692        | 1384           | 8305       | 33219            | 139.52        |
| 4 | 98.1               | 588.6                | 191.295        | 29%           | 670        | 1339           | 8034       | 32138            | 134.98        |
| 5 | 89.3               | 535.8                | 174.135        | 27%           | 609        | 1219           | 7314       | 29255            | 122.87        |
|   |                    |                      |                |               |            |                |            | <b>Total</b>     | <b>660.46</b> |

Worse case scenario using High Q2 occupancies with low Q2 rates  
 Deconvolution on SSP : **expect factor of 3 reduction about 220 MB/s**

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|---|--------------------|----------------------|----------------|---------------|------------|----------------|------------|------------------|------------|
| 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      |
|   |                    |                      |                |               |            |                |            | <b>Total</b>     | <b>577</b> |

Worse case scenario using High Q2 occupancies with low Q2 rates  
 Deconvolution on SSP : **expect factor of 3 reduction about 220 MB/s**

# Data rates GEp

| Detector       | Rate   | Channels         | Occupancy | Data size Bytes | Data rate MB/s<br>5 KHz<br>3 samples | Geometrical factor | Data size geo Reduc MB/s |
|----------------|--------|------------------|-----------|-----------------|--------------------------------------|--------------------|--------------------------|
| Front Tracker  | 400.00 | 49000.00         | 1         | 589149          | 2946                                 | 3.00               | 269.88                   |
| Second Tracker | 130.00 | 61440.00         | 1         | 738720          | 3694                                 | 5.00               | 203.04                   |
| Third Tracker  | 64.00  | 61440.00         | 1         | 738720          | 3694                                 | 5.00               | 203.04                   |
| <b>Total</b>   |        | <b>171880.00</b> |           | <b>2066589</b>  | <b>10332</b>                         |                    | <b>2459</b>              |

Need further reduction by using deconvolution and maybe clustering on SSP

# Updated 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              |           | 7958.32MB/s     |         |           | Total   | 1105.67   |
|         |              |                | Geometrical Factor |           | 2652.772031MB/s |         |           |         |           |
|         |              |                | SSP reduction      |           | 884.2573438MB/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
- or 600 MB/s recording 3 samples

# Network

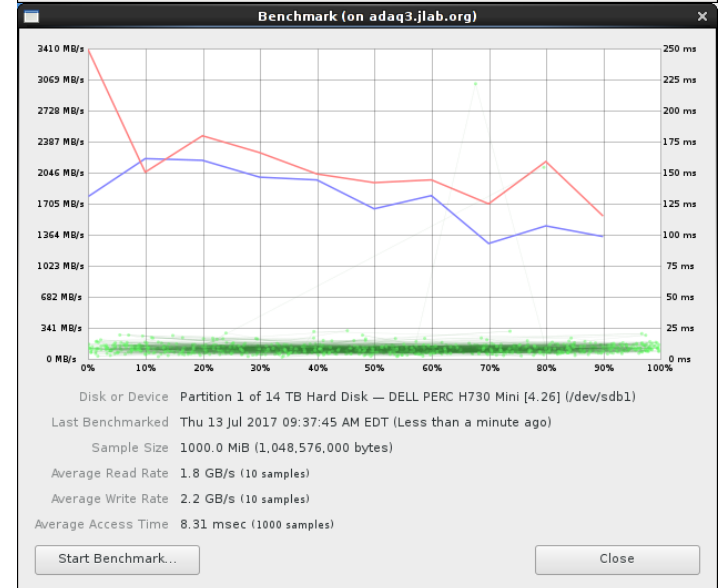
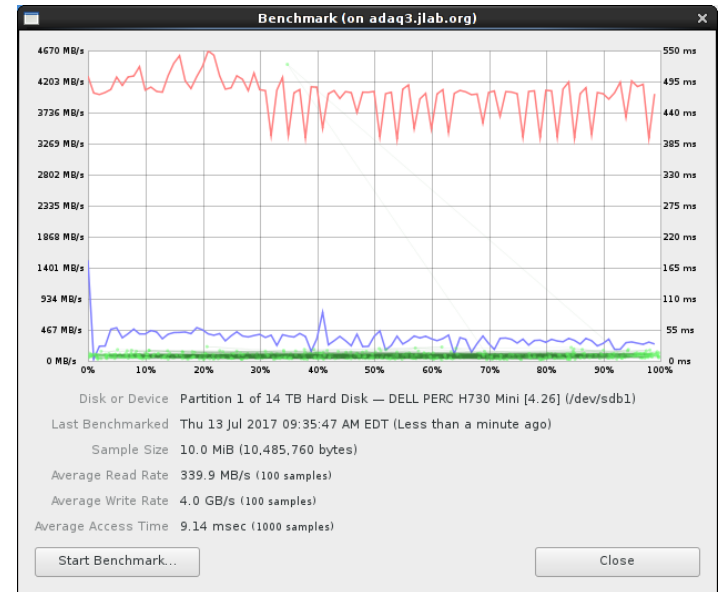
- Thanks to 2014 UIM upgrade
  - 2 x 10 GigE link
  - 1 or two more fibers available
  - Upgradable from 10 to 40 GigE when cost go down ( 100 GigE starts to be available ) Hall A counting house upgrade about 60 K\$ most likely done for SBS to go to 10 gigE everywhere
  - additional 20 K\$ for 40 gigE link capability to Computer Center
  - No issue for link from Counting house to Silo / L3
  - Up to 3 x 40 Gbit /s = 15 GB/s  
(3 x 100 Gbit/s = 37.5 GB/s)

# 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).

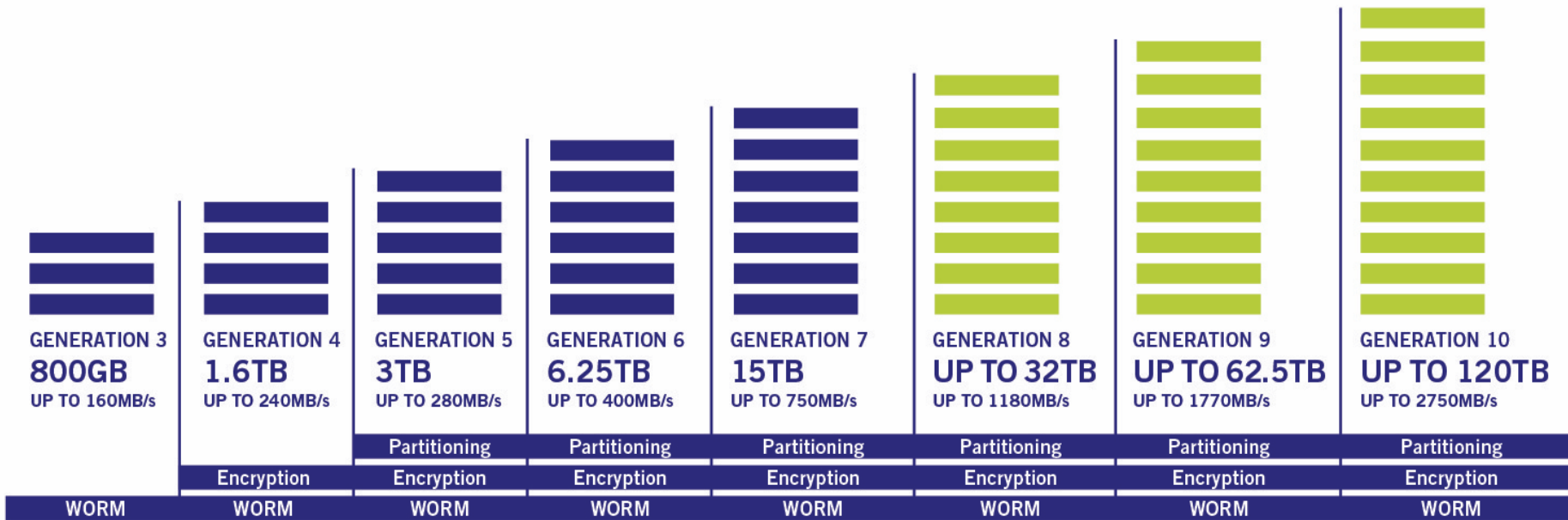
# Hard drives

- SAS/SATA
  - 4TB GB 200 MB/s 500 \$
- SSD SATA
  - 500 GB 169 \$ 500 MB/s
- SSD PCIe
  - 1.6 TB 1.2GB/s 3.5 K\$
  - 375 GB 2.2 GB/s 1.5 K\$
- SBS rates within reach with current drive technology with not too much cost
- Hard drive upgrade : 8 SSD = 12 K\$
- Raid array (3 days of data ) : 1 PB = 130 K\$ of disk or 300 K\$ off the shelf



# LTO timeline

## LTO ULTRIUM ROADMAP ADDRESSING YOUR STORAGE NEEDS



Note: Compressed capacities for generations 1-5 assume 2:1 compression. Compressed capacities for generations 6-10 assume 2.5:1 compression (achieved with larger compression history buffer).  
Source: The LTO Program. The LTO Ultrium roadmap is subject to change without notice and represents goals and objectives only.  
Linear Tape-Open, LTO, the LTO logo, Ultrium, and the Ultrium logo are registered trademarks of Hewlett Packard Enterprise, IBM and Quantum in the US and other countries.

Currently : 14 drives give 2.24 GB/s ( LTO4 to LTO6) up to 16 drives for now. With LTO8 could be up to 0.75 GB/s per drive max 12 GB/s for 16 arms  
Bottomline : 3 GB/s is reasonable by 2020

# Tape price

| Experiment | Days | Rate (MB/s) | seconds | Total TB | Double | LTO5    | LTO6   | LTO7 |
|------------|------|-------------|---------|----------|--------|---------|--------|------|
| GEP        | 45   | 250         | 3888000 | 972      | 1944   | 97200   | 58320  |      |
| GEN        | 50   | 250         | 4320000 | 1080     | 2160   | 108000  | 64800  |      |
| GMN        | 25   | 250         | 2160000 | 540      | 1080   | 54000   | 32400  |      |
| SIDIS      | 64   | 250         | 5529600 | 1382.4   | 2764.8 | 138240  | 82944  |      |
|            |      |             |         |          | Total  | 397 K\$ | 239K\$ |      |

- Raid 5/6 typical 250 MB/s or more
- SSD 500 MB/s, can scale with RAID array
- Tape SILO : 140 MB/s per drive uncompressed, 280 MB/s compressed 2:1  
up to 16 arm per frame ( 10 K\$ per arms )
- Second drive frame available
- Need to test when Hall B and D are running ( Hall D could do 700 MB/s)
- Can do 500 MB/s after upgrade, need SILO upgrade for more or L3 ( could make case for future)
- Plan for SILO test next year

# Tape price

|         | Days | Weeks | Data rate | Seconds  | Total data<br>TB | Double  | LTO5 in k\$ | LTO6 in k\$ | LTO7 in k\$ | LTO8 in k\$ |
|---------|------|-------|-----------|----------|------------------|---------|-------------|-------------|-------------|-------------|
| GMN     | 25   | 3.57  | 100       | 2160000  | 216              | 432     | 22          | 13          | 5           | 3           |
| GEN     | 50   | 7.14  | 500       | 4320000  | 2160             | 4320    | 216         | 130         | 54          | 25          |
| GEP/GMP | 45   | 6.43  | 1000      | 3888000  | 3888             | 7776    | 389         | 233         | 97          | 46          |
| SIDIS   | 64   | 9.14  | 4000 ?    | 5529600  | 22118.4          | 44236.8 | 2212        | 1327        | 553         | 259         |
| TDIS    | 27   | 3.86  | 4000 ?    | 2332800  | 9331.2           | 18662.4 | 933         | 560         | 233         | 109         |
| Total   | 211  | 30.14 |           | 18230400 | 37713.6          | 75427.2 | 3,771.36    | 2,262.82    | 942.84      | 441.96      |

- Upgrade to 16 LTO 8 drive = 160 K\$
- 12 GB/s for 4 Halls

# Conclusion

- Updated GMn data rates , slightly better 577 MB/s about 200 MB/s after SSP
- Updated Gep data rates, still 1 GB/s if no better reduction from SSP
- disk upgrade 160 K\$ ( Hall A )
- propose to do network upgrade 80 K\$ ( Hall A )
- propose silo upgrade : 160 K\$ like 40 K\$ for SBS program ( IT )