Planning for SBS Analysis

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Hall A Collaboration Meeting
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"Big Picture" SBS Analysis Preparation Plans

- Follow the traditional Hall A approach:
  - Use the C++ Analyzer framework, with updates for 12 GeV environment
  - Develop software modules for new detectors, building on existing code
  - New modules best written by respective detector experts/user groups. Likewise for related calibration software
- Since SBS analysis will be more challenging than that of traditional 6 GeV experiments (and is more formally reviewed), develop detailed plans/task list/milestones well in advance

SBS Analysis Challenges

- Large data rate/volume
  - $\approx$ 100 MB/s $\rightarrow$ $\mathcal{O}(100)$ TB/yr
  - $\approx \times 100$ more than typical 6 GeV experiment!
- Limited experience with new pipelined electronics
  - need tools to detect possible firmware bugs etc. $\rightarrow$ DAQ experts
  - decoding software must be written & tested
- New detector systems (GEMs, polarimeter, HCAL, ECAL, CD, etc.)
  - substantial software development needed
  - new code requires debugging & testing $\rightarrow$ realistic simulations
  - performance optimization needed, may be time-consuming
- High occupancy in some GEM trackers
  - non-trivial tracking, needs extra attention
  - algorithm needs to be fine-tuned $\rightarrow$ time-consuming

SBS Data Taking Parameters

Rather preliminary . . .

Experiment	"SBS-I"		"SBS-II"	
	G_E^n	G_M^n	$G_E^p(5)$	Transv
PAC number 12-	09-016	09-019	07-109	09-018
Config	BBG+ND	BBG+ND	SBS+BC	SBS+BB
PAC days	58	48	60	64
Schedule(?)	– 2016/2017 –		– 2017/2018 –	
Evt size (kB)	30	20	120	5
Trig rate (kHz)	2	2	1	5
Data rate (MB/s)	60	40	120	25

Legend: BB: BigBite, BBG: BB(GEM), BC: BigCal, ND: neutron det, SBS: SuperBigBite

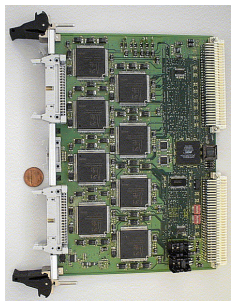
Offline Computing Requirements

Rough estimates for SBS currently on the planning spreadsheet:

	2016 SBS-I	2017 SBS-II
Time per event/core (ms)	40	60
Passes through data	3	3
Output size/input size	1	1
Years to analyze	3	3
Replay duty factor	75%	75%
Output held on work disk	20%	10%
⇓		
Hall A Totals (including prior years' carryover)		
CPU time per year (s)	1.4E9	2.0E9
Dedicated farm cores	60	84
Cooked data to tape (PB)	0.51	1.64
Raw+cooked to tape (PB)	0.89	2.77
Work disk storage (TB)	102	215
Storage bandwidth (MB/s)	67	211

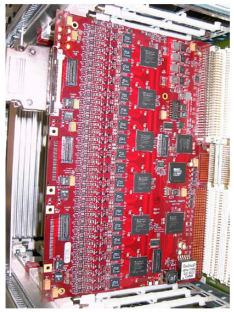
The Computer Center is prepared to provide these resources, but experiments must communicate their requirements early (and update them)

Pipelined Electronics



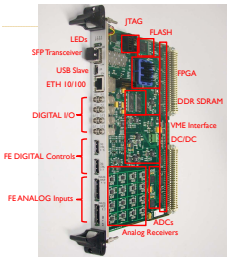
64-channel flash TDC ("F1 TDC")

16-channel flash ADC, 12-bit, 250 MHz



72-channel flash ADC, 125 MHz

Crate Trigger Processor (maybe custom version for HCAL)



Multi-Purpose Digitizer (for GEM readout)

- Decoding software to be written. May be complex since some modules offer advanced operating modes
- Special modes of some modules might require architectural upgrades of analysis software (*e.g.*, non-linear processing) $\rightarrow$ close collaboration between DAQ and offline experts needed
- "Event reassembly"
  - Module data arrives in "blocks" (data from up to 200 consecutive triggers)
  - Must correlate blocks from different modules to reconstruct event-by-event data
  - A lot of work to implement. DAQ group has taken responsibility
  - But: final debugging probably up to the users

SBS Reconstruction Software Tasks (Preliminary)

- C++ Analyzer upgrades
  - Automatic event-level parallelization (ETA mid-2013)
  - Pipelined electronics decoders
    - ★ SBS plans to make extensive use of pipelined electronics
    - ★ Decoder software needed for both standard and SBS custom modules
- GEM track reconstruction
  - Prototype reconstruction code exists. Works with Monte Carlo data, using a couple of shortcuts
  - Needs further testing, esp. with real data, & algorithm optimization
  - Optics/vertex reconstruction
  - GEp(5) kinematic correlation analysis to determine tracking search window
- Coordinate detector analysis
- GEp(5) recoil polarimetry
- Calorimeter cluster reconstruction
  - Several calorimeter setups proposed for the different SBS experiments
  - At least some cluster analysis software will need to be written. Different algorithms needed for different calorimeters.

Management & Responsibilities

Project / Subsystem	Responsible / Contact	
	Staff	User
General-Purpose Software		
C++ Analyzer development	O. Hansen	
Standard front-end decoders	A. Camsonne	
Event reassembly	JLab DAQ group	
SBS Program		
Overall coordination	B. Wojtsekhowski	
MPD decoder & integration		
GEM track reconstruction		INFN Rome, Carnegie Mellon
BigBite track reconstruction (GEMs)		
GEM data analysis (calibration)		INFN Catania, UVa
GEp(5) recoil polarimetry		
Hadron calorimeter analysis		Carnegie Mellon
Coordinate detector analysis		William & Mary

Conclusions

- SBS data analysis presents a number of challenges, which are not hard to meet, but do require a substantial amount of work
- Early planning, and starting software development well in advance, is important
- Should assign responsibilities in detail and develop milestones. Follow up with regular SBS analysis meetings or similar.