#### SBS Simulation and Software

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for the Software Working Group

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- Present group and manpower
- Progress in the last year
- Short Term Projects
- Long Term Goals

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Glasgow	John Annand	
	Kieran Hamilton	
INFN	Evaristo Cisbani	
Research scientist or postdoc		

Graduate student

### Progress in Last Year

#### Continued excellent progress since last meeting!

- Significant progress in organizing Geant4 simluation
- Continued improvement of rates and generators
- C16 G4 simulation (DOE requirement for last winter)
- Continued work on radiation calculations
- Spin transport code development





#### Trigger Rates at Review - UConn Group

Pythia6 integrated into existing MC



• Geant4 would require prohibitive computation time as minimum bias generator for rare events

- Doesn't include elastics, resonances but offers place to start with minimum bias trigger
- Integrated in with updated crescent geometry and trigger organization
- Present results are single Pythia events working on superimposing backgrounds



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G<sup>p</sup><sub>c</sub> HCal Singles Trigger Rate, Q<sup>2</sup> = 12 GeV<sup>2</sup>

#### GEp Trigger Rates - Coincidence

10 PYTHIA6.4 10 0.8 1.0 ECAL threshold (fraction of elastic peak) G<sup>p</sup><sub>c</sub> Trigger Rate, Q<sup>2</sup> = 12 GeV<sup>2</sup>, HCal Thresh = 3.3 GeV 10 Elastic 105 Inelastic 10 \_\_\_\_\_π  $\pi$ 10  $\pi^0 \rightarrow 2\gamma$ Trigger Rate [kHz] Total 10 reshold for 3 kHz = 0.9 (82% eff) 10 104 10 104 105 0.8 1.4 ECal Threshold

HCAL threshold = 50% elastic peak



- Compare well to results from last review
- Need to improve Pythia statistics
- Analysis of event types and particles
- Will continue introducing accidental complexity

Lots of important work done for simulation https://github.com/JeffersonLab/g4sbs

- uconn\_dev branch merged to master
- Code migrated to Geant4.10
- Compatible with ROOT6
- Significant cleaning up of code and example scripts (thank you Juan Carlos!)
  - Few inconsistancies found with configuration numbers
- Automated build tests through Travis CI
- Documentation migrated to github wiki (thank you Andrew!)
  - https://github.com/JeffersonLab/g4sbs/wiki

- Review and include development branches from various groups
- Continue to iterate geometries, analysis
  - Shielding Electronics hut (Dasuni)
- Spin-transport code
- Digitization, full analysis (more later)
- Maintain/improve codebase
  - Import remoll-style generators
  - Pre-vertex radiative effects and multiple scattering missing
  - Adapt so has output trees compatible with SBS GEM response code

#### Analysis Software

- GEM classes integrated with TreeSearch tracking test of clustering algorithms
- Framework for CDet, GRINCH, ECal, RICH
- Analysis class for HCal FADCs
- Coherent track association and PID between all detector sets
- Improved GEM digitization using Xray box inputs
  - More than just us needs this
- "End to end" simluation with production of pseudodata simulation of data sizes
- Demonstration of event-by-event analysis for full experiment

This is a job for a full time postdoc with a bent for programming+ grad student/collaboration support leading up to run

Seamus Riordan — SBS 2016 SBS Soft 9/15



## GEM Decoding

- GEM test stand used with CODA readout
- Decoding done with stand-alone reading directly EVIO
- SBU (w/ grad student Charlie Shugert) working on
  - Integrating with modular decoder (analyzer 1.6)
  - Getting TreeSearch algorithm and existing GEM classes to work with this decoder

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- SBS-offline repository
- http://github.com/JeffersonLab/SBS-offline
- Requires databases will be talking to GEM experts
- analyzer can read data and first pass decoder library (based much on Evaristo's work) responds to data

Have working whitepaper

http://cinder.physics.sunysb.edu/~seamus/sbs/sim\_whitepaper.pdf

- Need to have offline analysis library with complete subsystems
- Requires work, support, and organization from subsystem leaders
- SBS will start having scrutiny from JLab reviews
  - Software Review Nov 10-11
  - Need to have set of clear milestones ready
- Need work also on complete event analysis, optics models

#### Continuing Work and Shifting Focus - From Ole ca. 2012

#### 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.

Ole Hansen	(Jefferson Lab)	
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Planning for SBS Analysis

Hall A Coll Mtg, Dec 10, 2012 7 / 9

# Continuing Work and Shifting Focus - Assigning Responsibility

General Purpose Software		
analyzer Development	Hansen (JLab)	
Front End Decoders	Camsonne (JLab)	
Event Reassembly	JLab DAQ Group	
SBS Specific		
Overall Coordination	Riordan w/ Software Group	
MPD Decoding	SBU, JLab, UVA, INFN	
GEM Tracking	INFN, JLab	
HCal Analysis	CMU	
ECal Analysis	?	
Coord. Det	?	
BigBite	?	
GEp Event Recon.	?	
GEn, GMn Event Recon.	SBU, CMU	

Based on previous table from Ole

Need to converge on this ASAP!

- Sep 2016 GEM Decoding Implemented
- Oct 2016 Analysis Library Skeleton
- Jan 2017 Start Digitized Simulation Output
- Jul 2017 Each detector system in analyzer
  - Data decoding ready at this point
- Dec 2017 Simulation Interfaced to analysis
- Jan 2018 Start simulated analysis for Neutron Experiments
- Jun 2018 Neutron full offline analysis
- Jan 2019 Start simulated analysis for GEp
- Jun 2019 GEp full offline analysis

Requires several *dedicated* people

- Excellent progress has been made in producing more complete simulations
- Simulation has received much needed attention in getting more organized
- Present goals are focusing on radation shielding and full digitized output
- Work on analysis framework should continue to ramp up