SBS Monte Carlo Sampling

Seamus Riordan
Stony Brook University
seamus.riordan@stonybrook.edu

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Last Review

- From report (no official recommendations):

"simulations need to have a more realistic approach to event generation, including effects of "room backgrounds" and multiple particle events, in the time window of the trigger"

"The experimental simulations to date do not include analysis of minimum bias events."

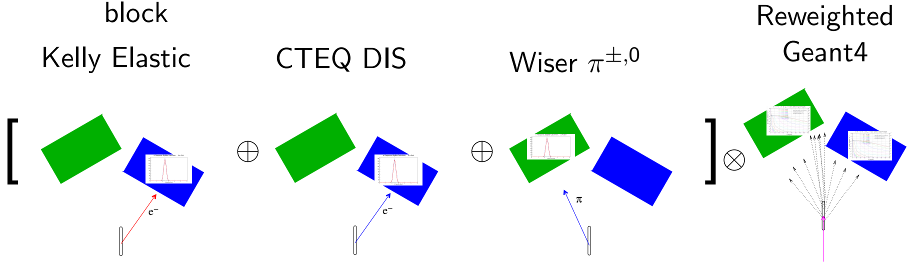
"The panel strongly suggests the generation of a data event flow analysis for each of the 3 experiments that identifies bytes per detector (average and extremes) going onto storage for offline analysis, specifically to look for any bottlenecks."

"The precision of the magnetic field needs to be known for different experimental aspects: ... The effect of the magnetic field on the exit beam line."

Overview

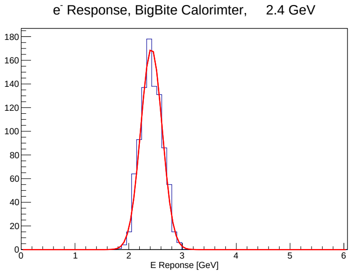
- Present sampling methods
- Possibilities for improving generators
- Plans for the review

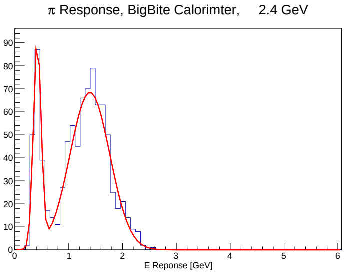
- Presently working with several weighted physics generators
- Full events are created incoherently with primary physics generator (elastic, etc...)
- For G_E^p, each type has Geant4 low-energy background superimposed by resampling distributions calculated for each block



Calorimeter Parameterizations

- Parameterization of Bigbite and HCal calorimeter responses for different particle types developed for speed

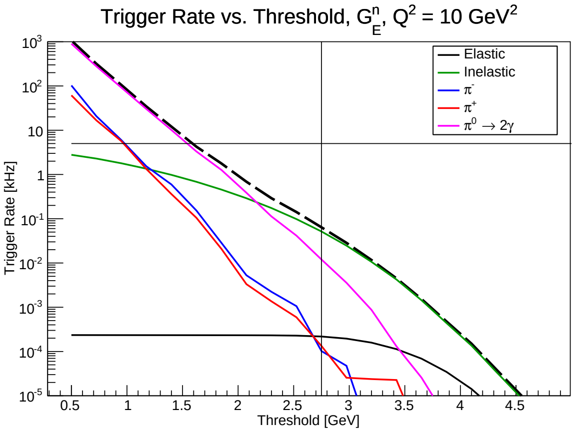




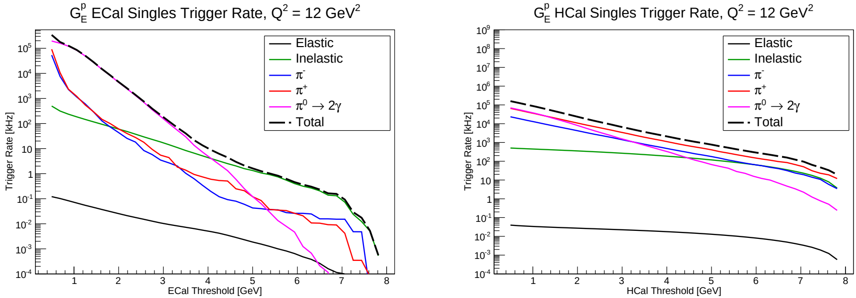
- Simple gaussian and exponential functions with empirical forms for E dependence on means, widths, and relative amplitudes used for sampling

Trigger Rates - G_E^n

- Neutron experiment trigger Rates defined only by calorimeter



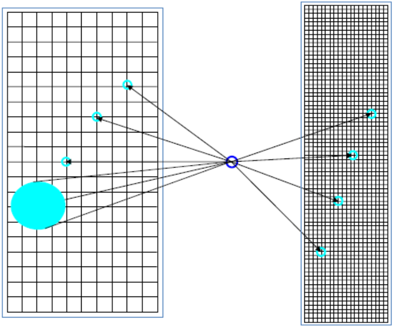
Trigger Rates - G_E^p Singles



- Independent contributions roughly same form as neutron experiments
- In line with our previous expectations of
  - HCal rate of 1.5 MHz at 4 GeV
  - ECal rate of 60 kHz at 0.85 elastic value ($\sim$3.5 GeV)

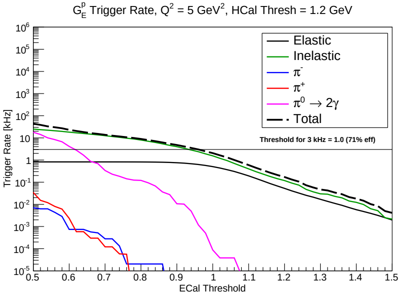
Trigger Rates - G_E^p

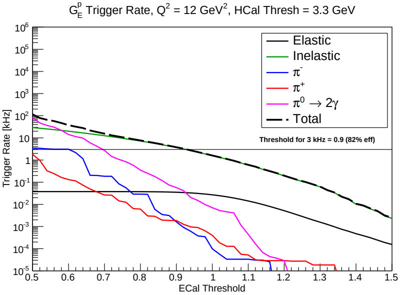
- G_E^p rates require coincidence between ECal and HCal formed triggers
- To reduce accidental coincidences associations between "macroblocks" are formed
- Both calorimeters use parameterized responses for different particles types

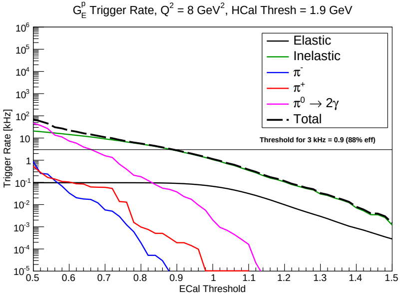


- ECal is made of 8 × 4 sums
- HCal is made of 4 × 4 sums
- ECal threshold varies as function of angle
- HCal fixed (poor resolution)
- 35 ns coincidence window, 16 ns pulse width for pileup

Trigger Rates - G_E^p Coincidence





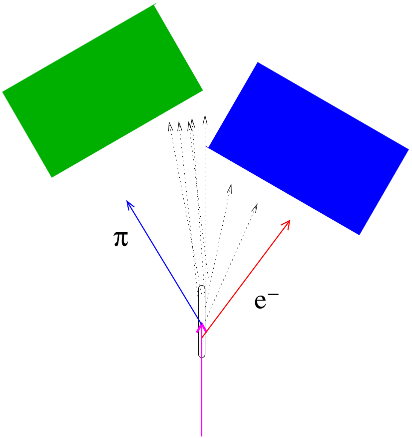


- HCal threshold $\sim$ 0.7 minimum elastic nucleon energy
- ECal threshold $\sim$ 0.9 relative elastic value

Minimum Bias Generators

- "Minimum bias" generators produce full events coherently

- So-called such that event selection is minimally dependent on an assumed configuration/trigger
- Requires *total exclusive cross sections* over broad range of kinematics and *efficient sampling* for all physics processes simultaneously
- Must include all possible backgrounds, radiative effects, etc



Availability

- MB generators that would be required for SBS are typically incomplete - most examples are from high energy community

Most effective for us:

- PYTHIA
  - Physics incomplete - has high energy π from fragmentation model, DIS, radiative effects
  - Electron on nucleus taken out of latest versions (only hadron-hadron)

- PYTHIA + SAID
  - Produced for Hall D, in particular for low energy pion production
  - Only includes photoproduction
- Geant4 (in theory)
  - Incredibly inefficient - Would need to simulate $\sim 10^{16}$ events for each configuration (years of farm time)

Geant 4

Prospects

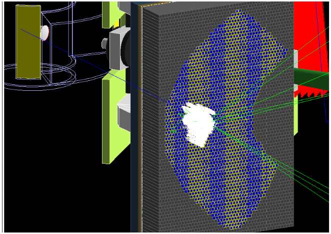
Situation isn't hopeless, but requires significant work

- PYTHIA is likely the best option for existing packages, but is written in FORTRAN
- Existing Hall-D or EIC modifications would be good starting point
- Would require:
  - Elastic sampling from scratch
  - SIDIS generators (work has been done in this direction)
  - Exclusive MAID/SAID electroproduction parameterizations
  - Extended target effects (not sure if included already)
- Validation against existing Wiser pion (reviewed at last meeting) and real data is next challenge
- SoLID would like something like this too

Present Activities

As per last collaboration meeting, we are manpower limited

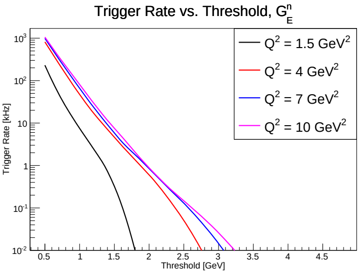
- Work can still proceed look at DAQ requirements
    - UConn has made significant progress improving detector responses
    - Has agreed to produce updated singles rates for Alex starting with G_E^p (later onto nFFs, SIDIS - haven't been worked out yet)
- UConn is continuing to look at beamline and shielding configurations with Bogdan
- UConn is also reviewing individual particle responses and the elastic coincident trigger conditions for G_E^p



BACKUP

Trigger Rates - G_E^n

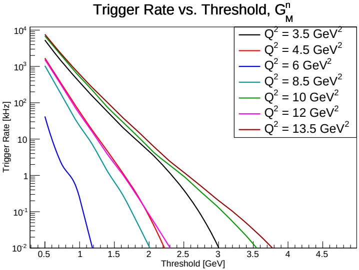
Q^2 (GeV^2)	5 kHz Thresh (GeV)	Thresh at 95% Eff (GeV)
1.5	1.1	1.2
4	1.5	2.1
7	1.5	2.6
10	1.6	2.8



- QE acceptance efficiency >95%

Trigger Rates - G_M^n

Q^2 (GeV^2)	5 kHz Thresh (GeV)	Thresh at 95% Eff (GeV)
3.5	2.0	2.2
4.5	1.4	1.6
6	0.7	1.0
8.5	1.2	1.6
10	2.0	2.9
12	1.3	1.9
13.5	2.1	3.2



- QE acceptance efficiency >95%

Trigger Rates - G_E^p Coincidence

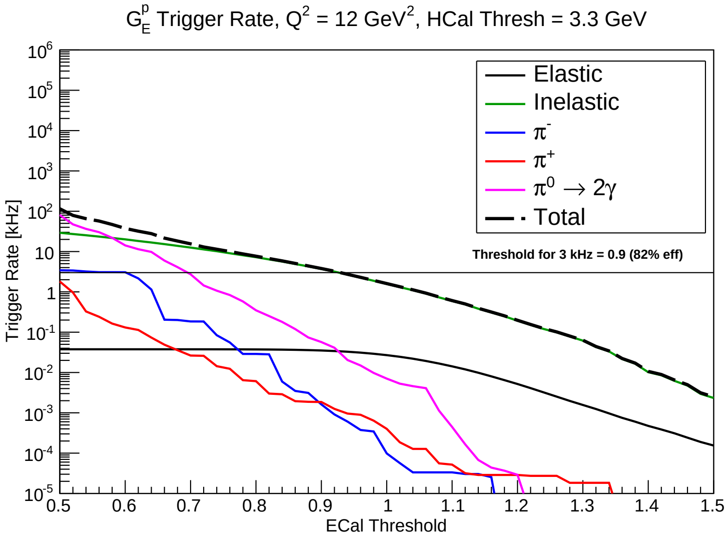
Coincidence logic:

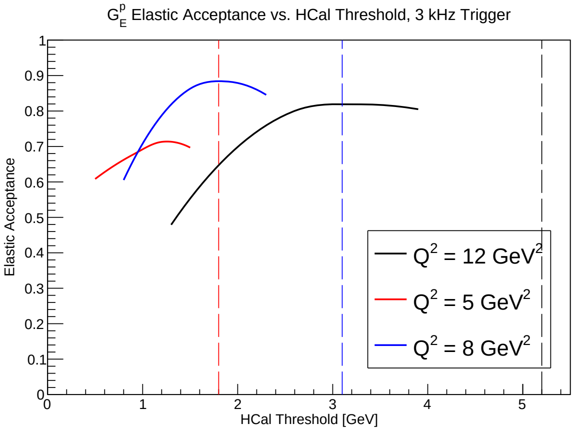
- Macroblock association done empirically through pure elastic data - multiple block associations are allowed
- Macroblock threshold done empirically through data - plot as function of fraction of mean elastic energy

Coincidence procedure:

- Take each background type and generate single event (include real elastic coincidence, etc)
- Overlay "random" background by sampling singles rates for each block (perform position smearing)
- Form macroblock sums for ECal and HCal
- Test each ECal macroblock for paired HCal above threshold

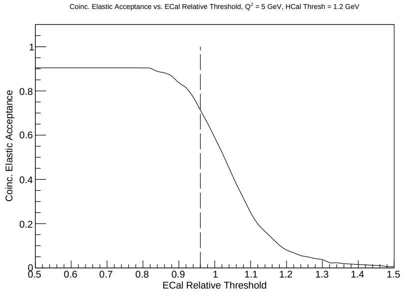
Trigger Rates - G_E^p Coincidence

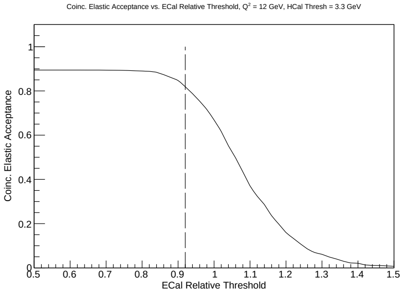


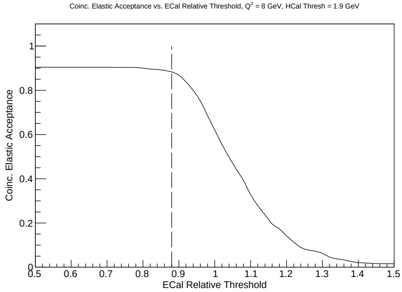


- HCal threshold $\sim$ 0.7 minimum elastic nucleon energy

Trigger Rates - G_E^p Coincidence







Q^2 (GeV^2)	HCal Thr (GeV)	3 kHz Eff (%)
5	1.2	71
8	1.9	88
12	3.3	82