Brief GEp Trigger Analysis Summary and Notes

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1 Intro

After obtaining (likely) finalized beam energy settings, kinematic parameters, and detector placements for all four kinematic variants of GEp, updated trigger simulations were ran and coincidence rate estimates were produced. The updated experiment settings are given in figure 1. It should also be noted that these simulations accounted for the 9cm upstream shift of the target.

SBS GEP Kinematics Table (including parameters relevant for simulation)

Name	GEP-1	GEP-2	GEP-2a	GEP-3
			(aka GEP-0)	
Beam Energy (GeV)	6.476	8.588	4.359	10.688
SBS angle (deg)	25.7	22.1	28.5	16.9
Central/nominal Q^2 (GeV^2)	5.732	8.127	3.860	12.039
ECAL angle (deg)	29.46	27.27	35.0	29.75
ECAL distance (m)	8.0	6.5	5.0	4.7
SBS distance (m)	1.6	1.6	1.6	1.6
HCAL distance (m)	10.0	10.0	10.0	10.0
Central proton momentum (GeV)	3.881	5.185	2.845	7.294
Central electron energy (GeV)	3.422	4.257	2.302	4.273
SBS magnetic field (% of maximum)	53	71	39	100
Central precession angle (deg, rough)	43.7	57.7	32.8	80.5
epsilon	0.733	0.720	0.691	0.616
P_T	-0.068	-0.044	-0.114	-0.029
P_L	0.674	0.692	0.707	0.787

Figure 1: Updated Kinematics Table

2 Rate Estimates

Shown in table 1 are the updated real and accidental coincidence rate estimates from high statistics simulations of minimum bias Pythia6 events tracked through G4SBS. All four kinematic variants used nominal threshold settings of 0.8 and 0.5 for ECal and HCal respectively.

Kinematic	Accidental	Real
GEp 0 (2a)	3400	300
GEp 1	10160 +/- 28	1680 +/- 60
GEp 2	1094.7 +/- 2.8	380.0 +/- 19.9
GEp 3	1581.7 +/- 6.9	694.3 +/- 41.5

Table 1: Updated Coincidence Rate Estimates for all four kinematic variants of GEp

It is worth noting that the low energy range of GEp 0 is getting dangerously close to being so low that Pythia6 becomes unreliable. This is clear by looking at the fast drop off of the exponential

trend of the ECal singles rate vs threshold. The exponential trend seen at the threshold region of 0-0.4 can be extrapolated to the nominal threshold of 0.8. This shows a drop off of the singles rate given by Pythia6 of roughly an order of magnitude, thus the estimated accidental rate was multiplied by a factor of 10. The accidental coincidence rate estimated from Pythia events scaled up by an order of magnitude is what is shown in the table abbove. The real coincidence rate estimate is much more complicated in accounting for the physics missed by Pythia simulations. Some more work is being put into estimating how much real coincidence rate may be contributed from inelastic events, however this work is ongoing as of the writing of this document. The estimated real coincidence rate for GEp 0 should be considered incomplete and is likely off by atleast an order of magnitude.

3 Notes on Updated Analysis Process

3.1 Elastic Analysis

The analysis script for looking at elastic simulations 'g4sbs/root_macros /gep_trigger_analysis_elastic _L2.C' has had several updates. Previously it was required that the script get_trigger_thresholds be used with an extremely large number of elastic events in order to fit the elastic peak for each block of ECal and HCal. This is no longer required as the elastic analysis takes the detector position information along with the scattering kinematics in order to calculate the expected elastic peak at each detector block via the angular dependence of the energy deposition. The accuracy of these elastic peak calculations can be checked by looking at the hEsum_smear_norm_ECAL_max_shouldhit and hEsum_smear_norm_HCAL_max_FPP1cut histograms (in the output of the elastic analysis script) for ECal and HCal respectively to check that the gaussian peaks are roughly at one. If either of these are not peaking around one, then the variables normfac_ECAL or normfac_HCAL should be adjusted appropriately.

The new elastic analysis also outputs two new files named e/hcal_cluster_mapping.txt, these files provide all of the relevant information about each cluster grouping including but not limited to cluster indexing, corresponding bin indexing, blocks/cells included in the cluster, position information, and the expected energy deposition given by the expected elastic peak calculation.

It is also worth noting, that this script has significant speed improvements compared to previous versions.

3.2 Minium Bias/Pythia6 Analysis

The analysis script for minimum bias events gep_updating_trigger_analysis_L2_generic_oct16.C has seen major speed improvements allowing for a complete analysis of roughly 300-500 million events to safely run within 24 hours. Luckily, this is range of statistics needed to produced relatively low-uncertainty real coincidence rate estimates, so there is no parallelization needed.

There are three arguments of note for this analysis script. The association file is the lookup table between HCal and ECal bins used for coincidence matching. This file is produced from the root macro ECAL_HCAL_Correlations.C which takes as input, the output root file from the elastic analysis. The e/hcal cluster file arguments are required to be in the format of the cluster text files output by the elastic analysis discussed above. Using the output cluster files from the elastic analysis alleviates the need for any other independent files describing information such as the elastic peak positions for each cluster, cluster indexing, cluster to bin lookup information, etc.