Kinematic Modifications for Lower Beam Energy for GEP

Andrew Puckett

SBS Weekly Meeting

August 22, 2019

UCONN Jefferson Lab

Reminder: From Thia's Summer 2019 Notes

1. All SBS experiments should consider implications of lower (10.6 GeV) maximum beam energy – including for lower pass calibrations. Please send any associated configuration changes by the end of August 2019.
   a. Also don't assume high precision on spectrometer angle positioning (can know installed position well, but movement to a particular position will be difficult).
   b. What is cutoff where we need to change layouts?

GEP PAC47 Kinematics Table

TABLE I. Kinematics, projected accuracy and beam time allocations. The projected statistical uncertainties in the form factor ratio include the assumption of 70% overall event reconstruction efficiency due to the combined efficiencies of the individual detectors, including DAQ dead-time.

E_{beam}, GeV	Q^2 range, GeV^2	$\langle Q^2 \rangle$ GeV^2	θ_{ECAL} degrees	$\langle E'_e \rangle$, GeV	θ_{SBS} degrees	$\langle P_p \rangle$ GeV	$\langle \sin\chi \rangle$ degrees	Event rate Hz	Days	$\Delta(\mu G_E/G_M)$
6.6	4.5-7.0	5.5	29.0	3.66	25.7	3.77	0.72	291	2	0.029
8.8	6.5-10.0	7.8	26.7	4.64	22.1	5.01	0.84	72	11	0.038
11.0	10.0-14.5	11.7	29.0	4.79	16.9	7.08	0.99	13	32	0.081

- Strategy: Because changing SBS angle is “hard” and changing electron arm angle is “easy”, we adjust for lower beam energy as follows:
  - Compute new central Q^2 for elastically scattered nucleon from SBS central angle and adjusted beam energy
  - Compute electron scattering angle for new central Q^2
  - Move electron arm to new central electron scattering angle

New "Central" Kinematics, average Q^2, rates and FOM—PRELIMINARY

$E_{beam}\ (GeV)$	$\theta_p\ (deg)$	$p_p\ (GeV)$	$\theta_e\ (deg)$	$E'_e\ (GeV)$	$Q^2\ (GeV^2)$	$\langle Q^2 \rangle\ (GeV^2)$	Rate (Hz)	$\Delta\left(\mu\frac{G_E}{G_M}\right)$
10.6	16.9	7.26	30.0	4.22	12.0	11.4	14	0.075
8.48	22.1	5.15	27.6	4.19	8.1	7.7	76	0.036
6.36	25.7	3.84	30.0	3.51	5.7	5.4	314	0.027

Below: PAC47 update numbers for comparison

TABLE I. Kinematics, projected accuracy and beam time allocations. The projected statistical uncertainties in the form factor ratio include the assumption of 70% overall event reconstruction efficiency due to the combined efficiencies of the individual detectors, including DAQ dead-time.

E_{beam}, GeV	Q^2 range, GeV^2	$\langle Q^2 \rangle$ GeV^2	θ_{ECAL} degrees	$\langle E'_e \rangle$, GeV	θ_{SBS} degrees	$\langle P_p \rangle$ GeV	$\langle \sin\chi \rangle$ degrees	Event rate Hz	Days	$\Delta\,(\mu G_E/G_M)$
6.6	4.5-7.0	5.5	29.0	3.66	25.7	3.77	0.72	291	2	0.029
8.8	6.5-10.0	7.8	26.7	4.64	22.1	5.01	0.84	72	11	0.038
11.0	10.0-14.5	11.7	29.0	4.79	16.9	7.08	0.99	13	32	0.081

UCONN Jefferson Lab

Conclusions

- If we choose not to change SBS central angle, the central ECAL angle to match the SBS central kinematics increases by about 1 degree for all three kinematics in going from 11 GeV → 10.6 GeV (and also scaling down lower-pass beam energies by the same factor)
- Changing only the central angle of ECAL and the beam energy, and not anything else (target-calorimeter distance, target length, beam-time allocations, etc.), we find (unsurprisingly):
  - Slight decrease in acceptance-averaged Q^2
  - Slight increase in elastic event rate
  - Slight reduction of the statistical uncertainties
- To-do:
  - Look at what would happen if we didn't change the layout at all (just as a cross-check).
  - Look at max. beam energies lower than 10.6 GeV?
  - Repeat this exercise for GEN, SIDIS
- Thanks to Eric for quickly updating GMN kinematics and rate estimates!