I. ELASTIC CALIBRATIONS

As the asymmetry measurement uses only a single-arm, it is highly desirable to obtain an absolute energy calibration of the BETA spectrometer via the $e+p$ elastic scattering reaction. Protons detected in the HMS in coincidence with BETA will be used to define electrons of known energy in the calorimeter. The constraints in selecting the appropriate kinematics for these calibrations are: the deflection of the incident electron beam in the target magnetic field, the limitation in the proton and electron angles caused by the magnetic field coil obstruction, and the desirability of a calibration with electrons of 0.8-2.2 GeV energy similar to those used in the asymmetry measurement. Of the various beam energies available with a 5 pass=5.7 GeV linac tune, only the 2 pass=2.32 GeV setting is compatible with these constraints. Therefore, a special beam energy is required for these calibrations. As the target material will not be polarized, it will be possible to increase the beam current to 1 μA to increase the calibration counting rate and reduce the total beamtime required.

These energy calibrations will be obtained with the target field aligned parallel and anti-parallel to the electron beam. Thus, even though the beam energy is relatively low, it will be undeflected. In this target orientation, scattering angles from $\pm 50^o$ are unobstructed, and a number of HMS angle settings can be used to define 1-2 GeV coincident electrons across the full horizontal range of the calorimeter. The planned kinematics are listed in Table I. HMS angle scans with parallel and anti-parallel fields will allow calorimeter blocks 35 cm below and above beam height to be calibrated. A third scan with the field off will calibrate those in the middle, as well as to allow the dependence of the calibration upon magnetic field orientation to be studied. These are shown in Fig. 1. Two additional scans with parallel and anti-parallel fields at half strength (2.55 T) will fill in the gaps in-between, raising the fraction of the calorimeter to be calibrated in this manner to approximately 90%.

The anticipated elastic coincidence rates per 4×4 cm^2 crystal are listed in Table I. As expected, the coincidence rate drops quickly as Q^2 is increased. Taking 400 elastic counts per 4×4 cm^2 crystal as the desired minimum for the calibration, we estimate that the entire study will take 3.3 days of beam (at 60% data-taking efficiency). Additional time will be required for the target and linac setup.

We have also investigated the use of the 4.6 and 5.7 GeV electron beams to parasitically monitor the energy calibration during the assymetry measurements. At these energies, the $e + p$ elastic cross section drops even more steeply with angle, so the low rates preclude the use of more than a single HMS angle per beam energy. Some kinematics which are under consideration for the parasitic calibration monitor are listed in Table II. We anticipate only

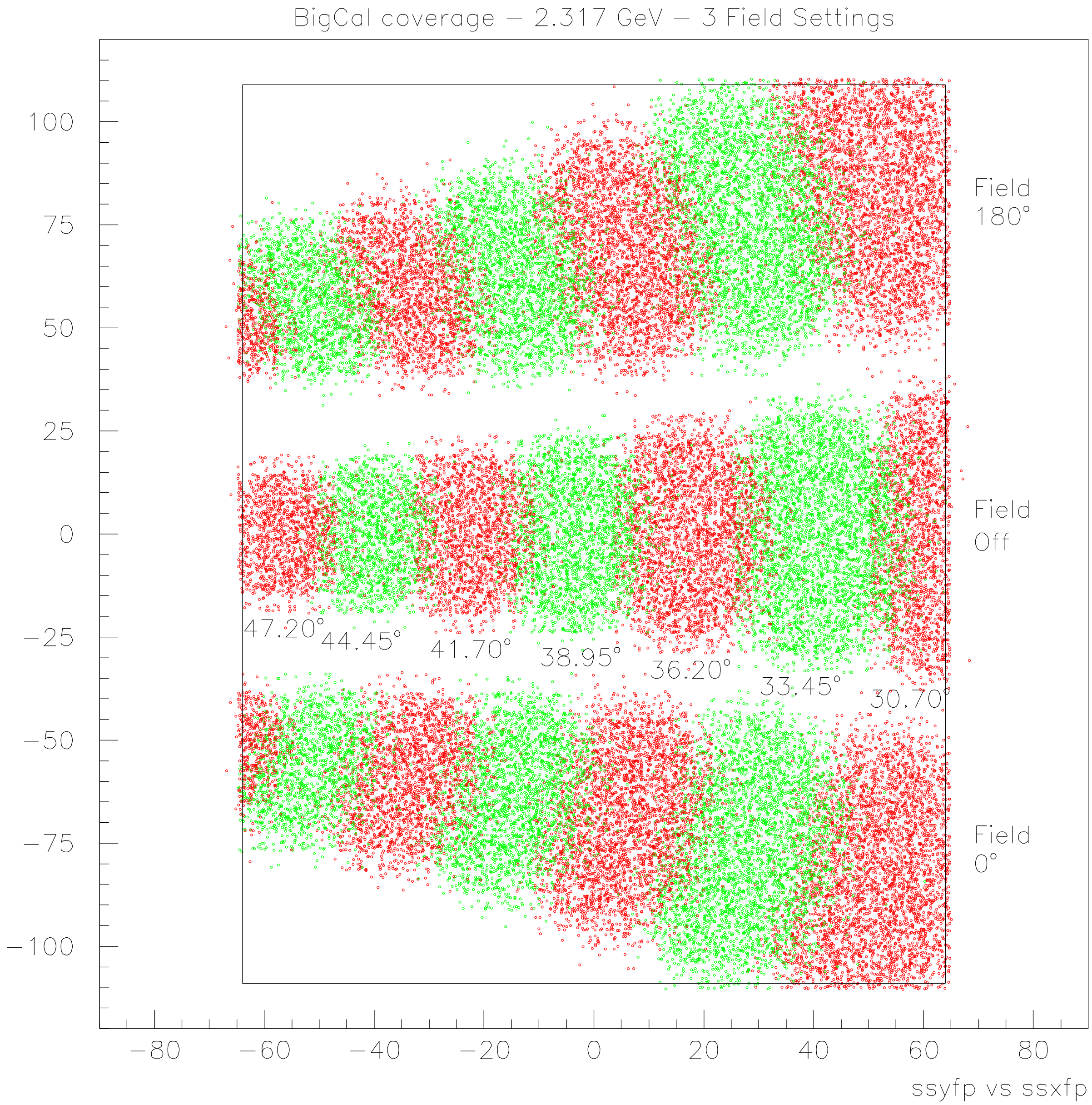

FIG. 1: Simulated locations of electron hits across the calorimeter for the various HMS (proton) angle settings and target field orientations listed in Table I. The half-field settings are not shown. BETA is set at an angle of 40^o and 320 cm from the target throughout.

a few dozen coincidences per crystal per 100 hours of asymmetry running. Perhaps the

2.32 GeV $e+p$ elastics										
$E_{e'}$	$\theta_{e'}$	Q^2	θ_p	p_p	Counts/cell/hr			Beam time (hrs)		
(GeV)	(deg)	(GeV^2)	(deg)	(GeV)	0^o Field	180^o Field	Field Off	0^o Field	180^o Field	Field Off
1.92	30	1.07	47.20	1.19	1810	1820	6800	0.3	0.3	0.1
1.66	33	1.22	44.45	1.29	1860	1820	1980	0.3	0.3	0.3
1.58	36	1.38	41.70	1.39	1010	1010	1090	0.4	0.4	0.4
1.49	39	1.55	38.95	1.50	560	550	600	0.8	0.8	0.7
1.39	43	1.73	36.20	1.61	310	300	330	1.3	1.4	1.3
1.29	47	1.92	33.45	1.72	160	170	180	2.5	2.4	2.3
1.19	50	2.11	30.70	1.84	94	95	104	4.3	4.3	3.9
Half-Field Rates										
1.92	30	1.07	47.20	1.19	3140	3160		0.2	0.2	
1.66	33	1.22	44.45	1.29	1950	1910		0.2	0.2	
1.58	36	1.38	41.70	1.39	1080	1070		0.4	0.4	
1.49	39	1.55	38.95	1.50	590	580		0.7	0.7	
1.39	43	1.73	36.20	1.61	325	320		1.3	1.3	
1.29	47	1.92	33.45	1.72	175	180		2.3	2.3	
1.19	50	2.11	30.70	1.84	103	102		3.9	3.9	
Total Time (100% efficiency)								19	19	9

TABLE I: Elastic scattering kinematics and projected BETA+HMS coincidence rates as determined from a SIMC simulation including the effect of the 5.1 T target magnetic field, the beam slow raster, etc. The proton is detected in the HMS and the scattered electron is in BETA, which is positioned at 40^o and 320 cm from the target throughout. The rates are per hour per 4×4 cm^2 cell assuming a beam current of 1 μA and the 3 cm target.

Parasitic energy monitor settings									
E_{beam}	$E_{e'}$	$\theta_{e'}$	Q^2	θ_p	p_p	counts/cell/100 hr		Total counts/100 hr	
(GeV)	(GeV)	(deg)	(GeV^2)	(deg)	(GeV)	80^o Field	180^o Field	80^o Field	180^o Field
4.57	1.98	43	4.86	23.40	3.40	36	37	5830	5340
5.70	2.53	37	5.95	22.60	4.00	18	20	2530	2380

TABLE II: Elastic scattering kinematics which could be used as a parasitic calibration monitor during the physics data-taking. The rates are per 100 hours per 4×4 cm^2 cell assuming a beam current of 85 nA and the 3 cm target.

most important use of these events will be to provide two higher energy calibration points to verify the linearity of the calorimeter energy calibration. By summing over several dozen adjacent crystals (a small fraction of the 1744 available), the necessary statistical precision for this check could be obtained. In addition to providing an absolute energy calibration, these coincidence data could be used to measure the target packing fraction by comparing to the known $e + p$ elastic cross sections. In this case, one might sum over adjacent crystals to improve the statistical precision of the packing fraction measurement.