

# Calorimeter Elastic Calibrations

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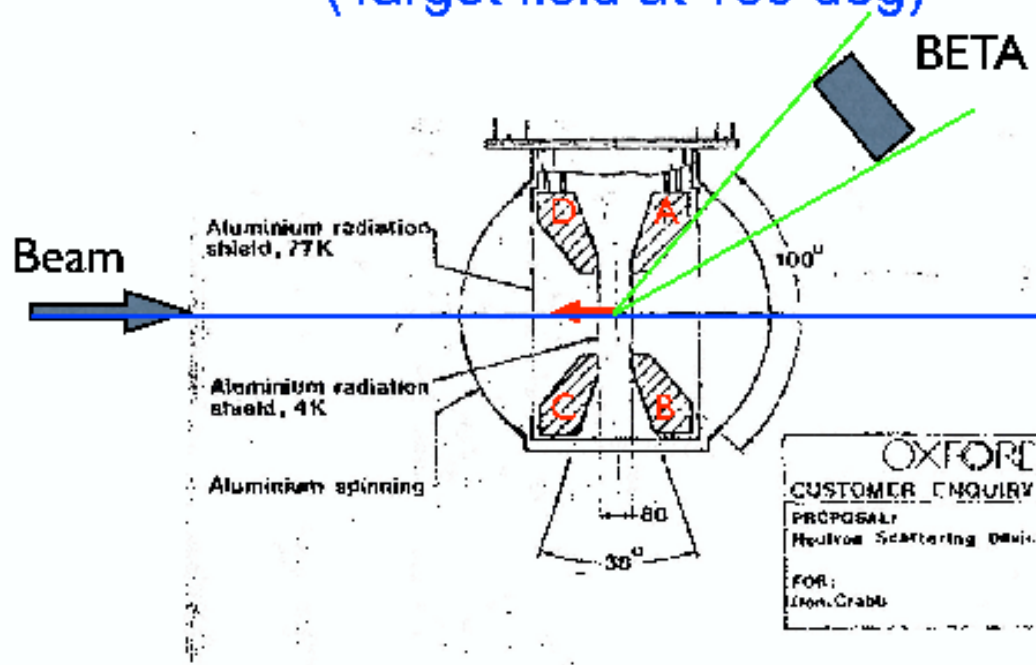


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# Purpose

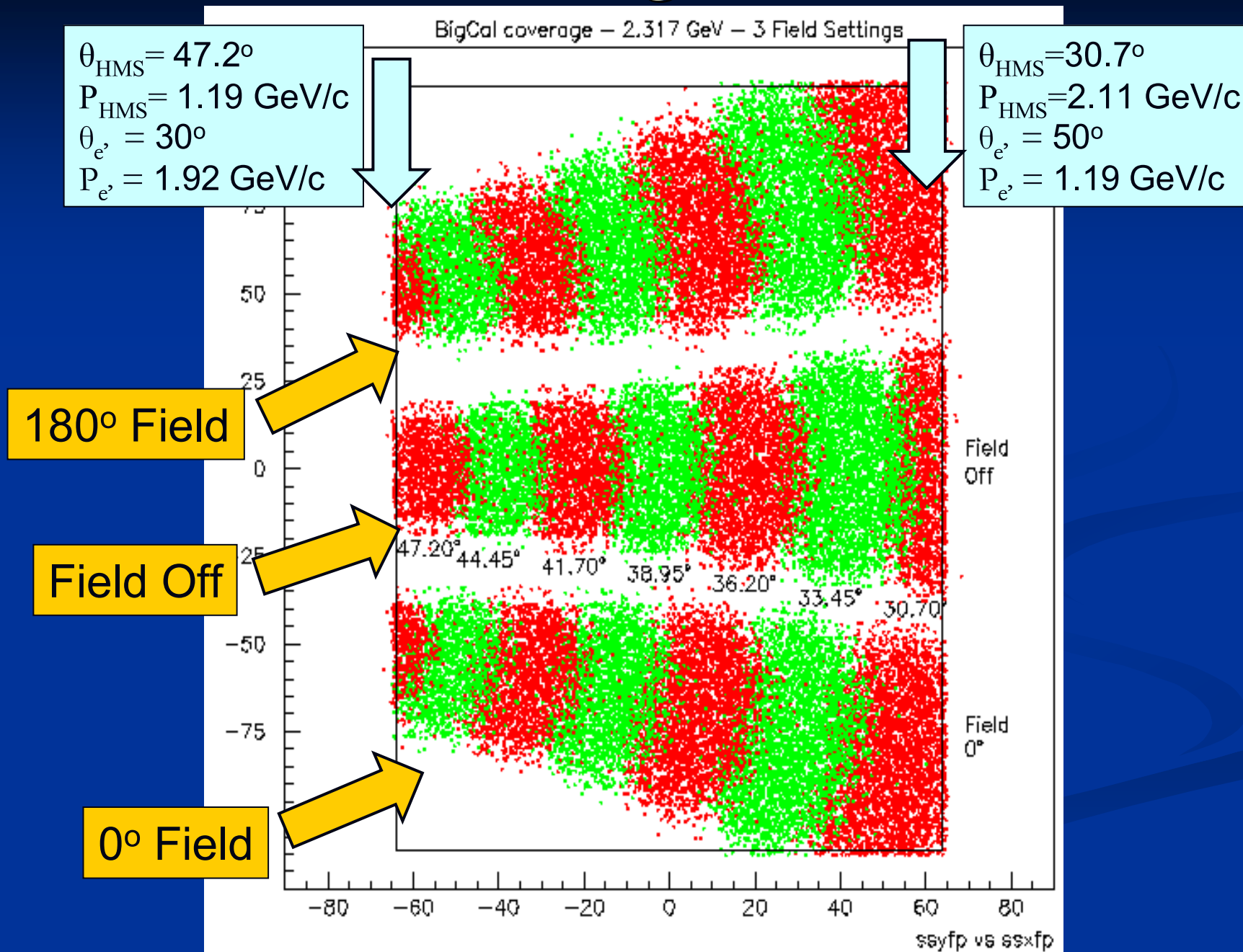
- The purpose of the elastic calibrations is to provide an absolute energy calibration of scattered electrons in the calorimeter.
- Elastically scattered electrons are tagged by the detection of the conjugate protons in the HMS.
- Constraints in selecting the appropriate calibration kinematics:
  - Deflection of the incident electron beam by the target magnetic field.
  - Proton and electron angles must not be obstructed by the target coils.
  - Desirable to calibrate with electrons of 0.8-2.2 GeV energy.
- Only the 2 pass=2.32 GeV beam and 180° target orientation are compatible with these requirements.
- As the target material will not be polarized, beam current up to 1  $\mu\text{A}$  can be used to reduce the total beam-time required.

## SANE Magnet Configuration (Target field at 180 deg)



- Even though 2.32 GeV beam energy is relatively low, the beam will be undeflected by the parallel or anti-parallel magnetic field.
- Calibrations will be performed with the target field at 0°, 180°, and with the field off in order to calibrate blocks below, above, and at beam-height.
- SIMC simulations incorporating:
  - deflection of the proton and the scattered electron in the target field.
  - $e+p$  coincidence in the HMS and calorimeter acceptances.were used to determine the optimal kinematic settings, and expected coincidence rates per unit calorimeter area.

# SIMC electron hits on BigCal – 2.32 GeV elastics



# Rates – 2.32 GeV Elastics

$E_e$ (GeV)	$\theta_e$ (deg)	$P_p$ (GeV)	$\theta_p$ (deg)	Counts/cell/hr			Beam-time (hrs)		
				0°	180°	Off	0°	180°	Off
1.92	30	1.19	47.20	1810	1820	6800	0.3	0.3	0.1
1.66	33	1.29	44.45	1860	1820	1980	0.3	0.3	0.3
1.58	36	1.39	41.70	1010	1010	1090	0.4	0.4	0.4
1.49	39	1.50	38.95	560	550	600	0.8	0.8	0.7
1.39	43	1.61	36.20	310	300	330	1.3	1.4	1.3
1.29	47	1.72	33.45	160	170	180	2.5	2.4	2.3
1.19	50	1.84	30.70	94	95	104	4.3	4.3	3.9
Total Time (100% efficiency)							10	10	9

Desired minimum: 400 elastic counts per 4x4 cm<sup>2</sup> crystal.  
 Two days of beam should calibrate ~75% of the calorimeter.

# Parasitic Energy Calibration Monitor

- The use of HMS coincidences to parasitically monitor the BigCal energy calibration during the 4.6, 5.7 GeV physics runs has also been investigated.
- The elastic cross section drops steeply with angle, so the low rates preclude the use of more than one HMS angle per beam energy.
- Only a few dozen coincidences per crystal per 100 hours of running are expected.
- The most important use of these events may ultimately be to provide two higher energy calibration points to verify the linearity of the energy calibration.
  - Would need to sum over several dozen adjacent crystals to obtain the necessary statistical precision.
- Might also measure the target packing fraction by comparing to the known elastic cross sections.

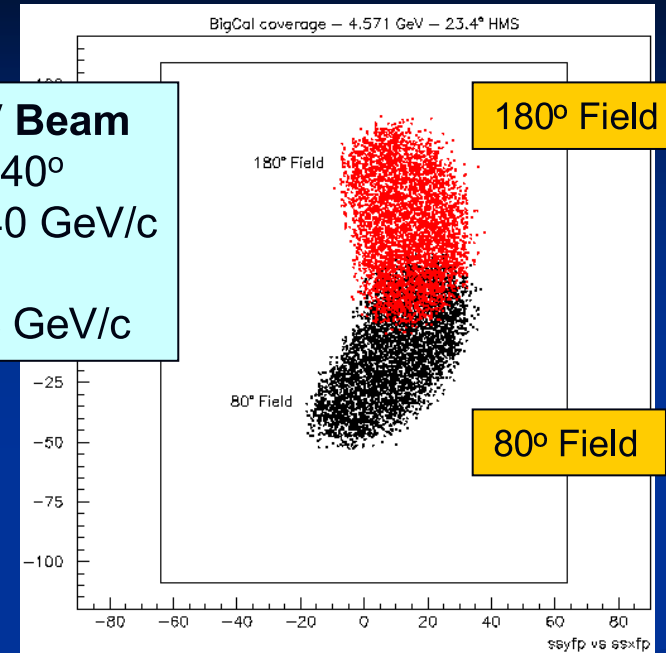
## 4.57 GeV Beam

$$\theta_{\text{HMS}} = 23.40^\circ$$

$$P_{\text{HMS}} = 3.40 \text{ GeV}/c$$

$$\theta_{e^-} = 43^\circ$$

$$P_{e^-} = 1.98 \text{ GeV}/c$$



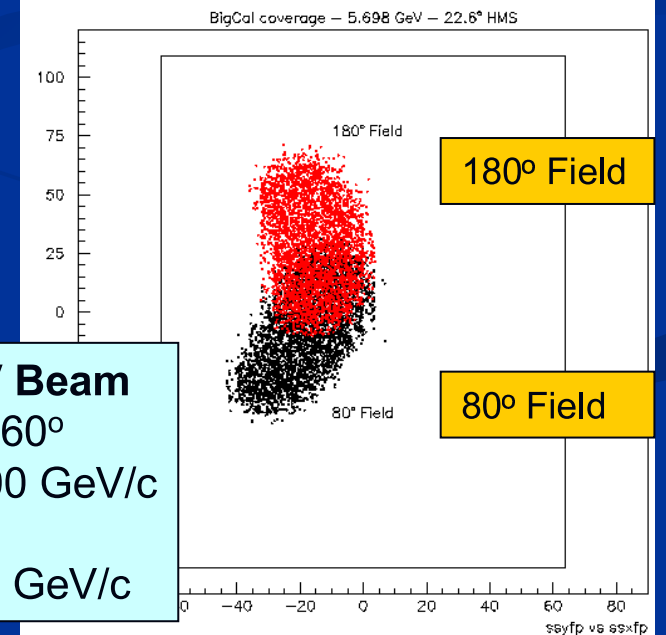
## 5.70 GeV Beam

$$\theta_{\text{HMS}} = 22.60^\circ$$

$$P_{\text{HMS}} = 4.00 \text{ GeV}/c$$

$$\theta_{e^-} = 37^\circ$$

$$P_{e^-} = 2.53 \text{ GeV}/c$$



# Summary

- Simulations project that  $\sim 75\%$  of the BigCal can be elastically calibrated via the use of three magnetic field settings.
- Aiming for 400 coincidences per crystal, the full calibration scan should take about 2 days of 2.32 GeV beam.
- A parasitic energy monitor is also possible, but the coincidence rate is only a few dozen counts per crystal per 100 hours of beam.
- The SIMC simulations do not yet incorporate any acceptance blockage caused by the target coils.
  - Would only effect the largest angle calibration settings.
  - Planning to write the relevant routine in the near future.