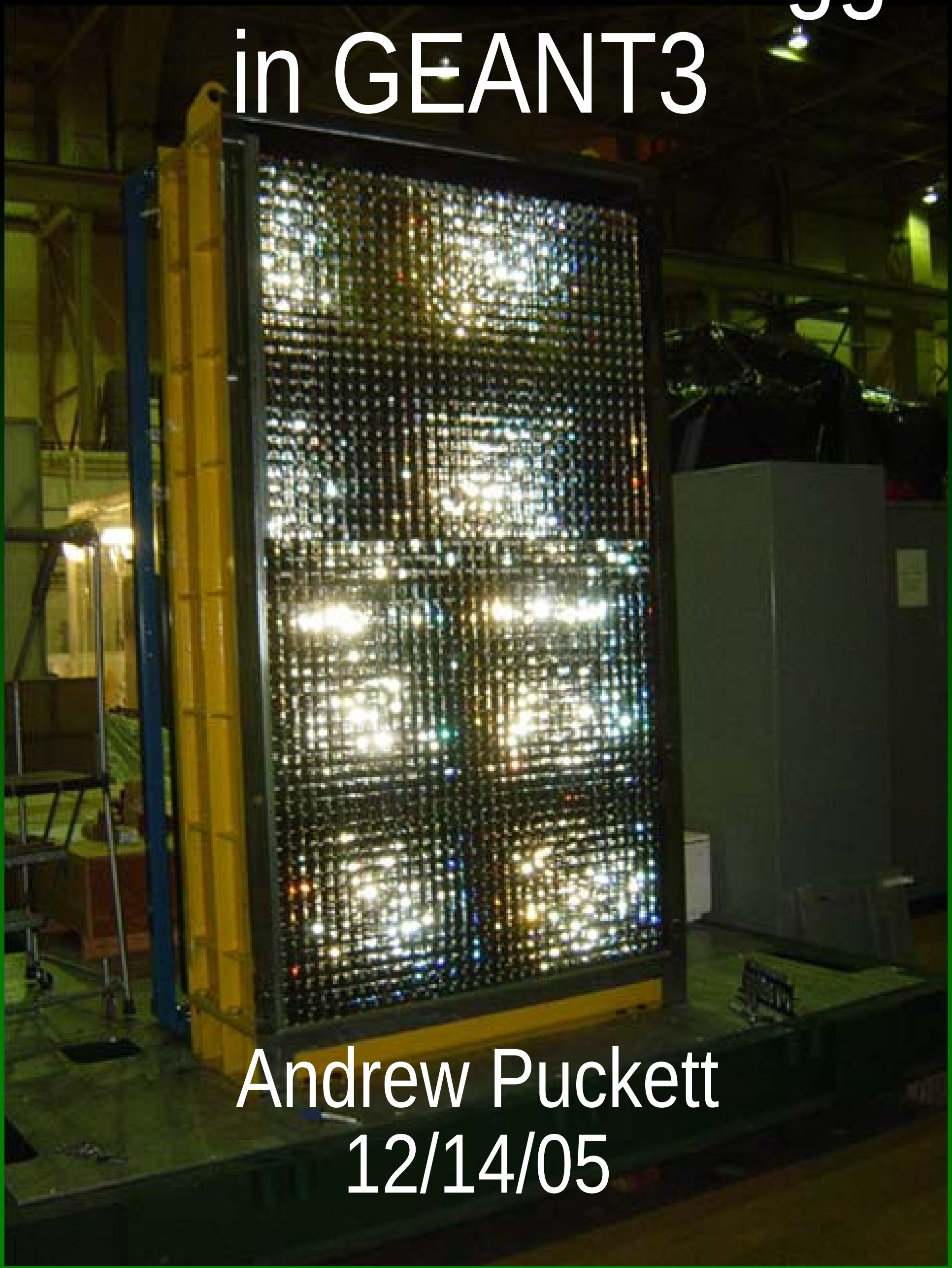
G_E(p)-III BigCal Calorimeter: Background Simulations/Trigger Studies in GEANT3



Andrew Puckett

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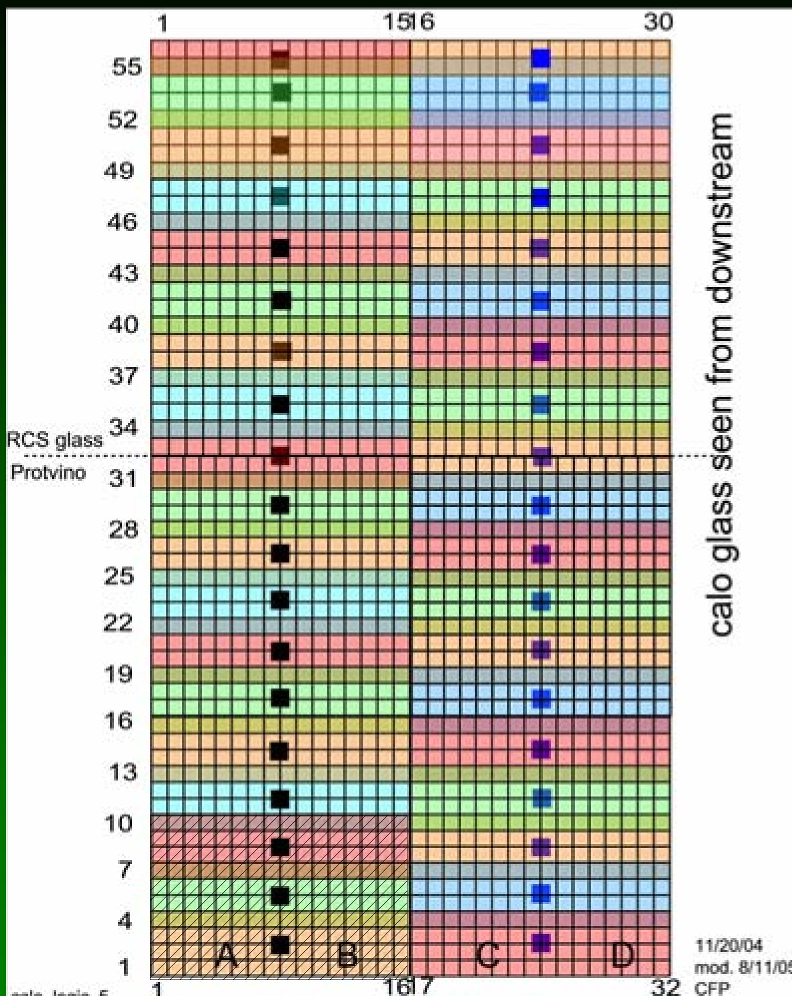
BigCal Calorimeter

- Detect electron from elastic e-p in coincidence with proton in HMS
- PMT’s detect Cerenkov radiation in lead-glass.
- Second-level trigger system—Adders and discriminators apply threshold to combinations of ADC amplitudes

BigCal Trigger Logic



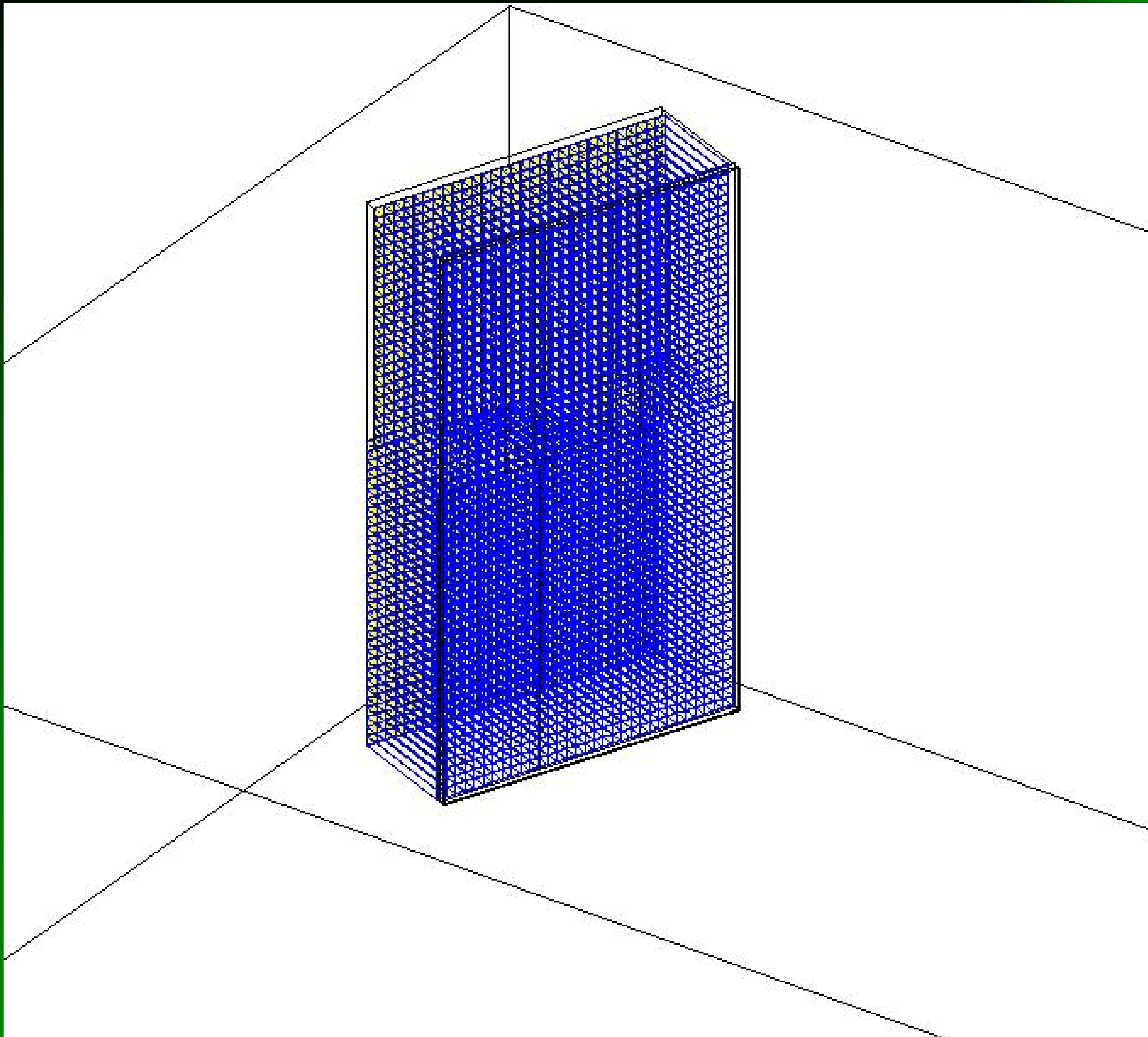
- 1744 channels, 32 × 32 (Protvino) + 30 × 24(RCS)
- Apply discriminator threshold to groups of 64 channels, 16(x) × 4(y)
- Overlapping groups maximize efficiency

Hall C Background

- Based on Pavel Degtiarenko's Hall C setup with 15 cm LH_2 target.
- Calorimeter located at $r = 440$ cm, $\theta = 68°$
- 6.0 GeV beam energy
- Empty (air) box at BigCal location
- Store kinematic properties of all particles entering this box for background spatial, energy, particle profile

Simulating Calorimeter Response: by K. Shestermanov, Protvino

- Full GEANT3 description of Calorimeter
- Implementation of Cerenkov radiation
- Counts number of photoelectrons at photocathode of each PMT



Results I: Background Profile

- Generated 2.66×10^9 events (beam electrons, 6.0 GeV) incident on the LH_2 target, which gave about 7.0×10^5 BigCal events
- Hadronic cross sections amplified by a factor of 100 to increase stats.
- Must divide by this factor to get correct hadronic yields. However, running in this fashion has some yet-to-be-understood effects.
- Rates and background spectra obtained from these results are PRELIMINARY.

Results I (cont.)

- What kinds of particles are produced in e-p scattering at 6.0 GeV?
  - $e^+/e^-/\gamma$ (pure EM, π^0 decay, etc.)
  - $\pi^\pm/\pi^0$ (Strong Δ decays, etc)
  - $\mu^\pm$ (primarily charged pion decay)
  - n/p
- Energy spectra of background particles
- Spatial profile of background particles

Results II: Detector Response

- Transform coordinates from Hall C background simulation to coordinate system of Protvino BigCal description
- Track particles through calorimeter.
- Output is number of photoelectrons at the cathode of each PMT.
- Analyze results in the context of Level-2 trigger logic. Estimate trigger rates.

Results II (cont.)

- Amplitude spectrum by particle type. 1,000 particles, each with 1.2 GeV momentum, distributed uniformly over the face of BigCal.
- In elastic scattering, $Q^2 = 2M\nu$, so $E_e' = 1.2$ GeV
- Trigger efficiency as a function of threshold for 1.2 GeV electrons
- Trigger rates vs. discriminator threshold (assuming 100 μA beam current)
- Divide hadronic yields by 100 for proper normalization

Pion Rate Calculation

- Pions could be a significant source of background
- Calculated pion rates based on fits to data from SLAC (thanks P. Bosted) to compare to simulated rates. Based on David Wiser’s Stanford thesis experiment.
- Momentum dependence of BigCal response to charged pions – use to get trigger rate
- Integrate trigger efficiency times calculated rate over momentum to get total trigger rate

(In-?)Conclusions

- Early results suggest that electromagnetic particles dominate the BigCal trigger rate
- Charged π/μ trigger rates less than 1 % of total.
- n/p trigger rates even smaller
- BigCal trigger rate is high but manageable at this Q^2, given our electronics' rate abilities (100 MHz discriminators): 7 MHz trigger rate at 700 MeV threshold $\times$ 64 blks per logic group / 1744 blks total = 257 kHz per discriminator.

Conclusions (cont.)

- With $\leq$ 1 kHz HMS trigger rate in a 30 ns coincidence window with BigCal, we have 40 Hz of accidental coincidences, compared to $\approx$ 6 Hz true coincidence rate.
- Trigger efficiency for true coincidences is $\approx$ 96-97 % at this threshold
- Need more unboosted stats to get a better trigger rate. Updated results will be posted at http://hallcweb.jlab.org/experiments/GEp-III/bigcal_frames/geant.html

More Studies Planned…

- Effect of 10 cm Al absorber to be placed in front of BigCal?
- Effect of gain variations in BigCal?
- 20 cm instead of 15 cm LH_2 target (increase rate by factor of 4/3?)
- Examine the other two kinematics of the experiment: $Q^2 = 7.5$ GeV^2 and 4.8 GeV^2
- Examine sources of trigger efficiency loss—events near edges/middle of BigCal?