Efficiency and Bias Study

Look at trigger and recon efficiencies as a function of angle and energy. Study angle bias in the reconstruction.

Sample: Generated over a 18x18 cm² patch, angles from 0° to 90°.

- **Charged particles**
  - 20 Mev to 1 GeV
  - Electrons at lower energies, muons at higher energies

- **Gammas**
  - 20 MeV to 2 GeV

- Plus... an excursion into energy measurement...
Distribution of MC particles

McTheta, all, E=1000

mct1000
Nent = 3000
Mean  = 57.81
RMS   = 21.5
Trigger Efficiency, Charged Particles

3-in-a-row trigger
Trigger Efficiency, Continued

- 100 MeV
- 200 MeV
- 500 MeV
- 1 GeV
Recon Efficiency, Charged Particles
Recon Efficiency, Continued
Angle Bias in the Events

Two possible sources of bias:

Reconstruction: Difference between:
- Angle as seen in detector (taken to be defined by first two hits in each plane)
- Angle as reconstructed

This could be due to asymmetries coming from the algorithm, notably: the multiple scattering is symmetric in θ, but the filter uses the slope, or tan(θ).

Trigger: Difference between:
- Angle as generated
- Angle as seen in detector

This could come from asymmetries in the trigger efficiency, coupled to the multiple scattering.
Reconstruction Bias: $(\delta \theta \text{ vs } \theta)$
Reconstruction Bias, Continued
Profiles
Profiles, continued
Trigger Bias : \((\Delta \theta \text{ vs } \theta)\)
Trigger Bias, Continued
"Fits" are not significant, just to guide the eye...
(Effect at low angle probably due to choice of coordinates)
Profiles, Continued
Summary of Slopes (delta $\theta$ per incident $\theta$)

**Reconstruction**

- Slope of $\text{RecTheta-McRecTheta}$ vs $E$
  - Nent = 8
  - Mean = 34.9
  - RMS = 37.15

**Trigger**

- Slope of $\text{RecTheta-McTheta}$ vs $E$
  - Nent = 8
  - Mean = 33.68
  - RMS = 37
Same for Gammas: Efficiencies

Includes single track events

Gamma/charged trigger = 0.57; naïve expectation: $1 - \exp(-7/9 \times 1.32) = 0.64$ ?
Gammas: Angle Bias

Kludge: used “best track” to determine recon angle
Conclusions, So Far

- The reconstruction of triggered tracks is faithful to the apparent angle, except for a very small positive bias, which decreases with energy and increases with incident angle.

- Tracks which scatter to smaller incident angles tend to trigger more efficiently. This introduces a substantial bias in the found angle for tracks incident at high angles and low energies.

- The strategy for correcting this bias depends on knowing the energy of the track. The next slides will explore this.
Energy Measurement

Issues:
1. MinEnergy in Tracker
2. Energy too low in Tracker
3. Energy too high in Tracker
4. Energy too low in CAL

~4300 all_gammas events which trigger and reconstruct at least one track
(1) Due to the minimum energy assigned to a TKR track. Class should probably be modified to store two energies: one for purposes of Kalman, which could have a minimum, and a second, which is the “real” energy. As it stands, the Tkr Energy is too high below a real energy of ~100 MeV.

(2) Gamma gets minimum energy, even though there is plenty of CAL energy around. ???

(3) Due to attaching a 2nd track to the vertex which isn’t the “original” 2nd track. (Remember, the CAL energy is shared between the first two tracks, but combo vertexing may choose a different 2nd track.)
Energy Measurement in the Calorimeter

Cal Energy vs. Mc Energy

I’m going to ignore McEnergy below 100 MeV in what follows...
Cut on Fiducial Volume in CAL

Cut: both x and y inside 720 mm in middle of CAL

\[ R = \frac{\text{CalEnergy}}{\text{McEnergy}} \]

R, Anti-cut on position

R<0.1

Position, cut on R

R>0.6

R, Cut on position
Projections at Middle of CAL for R<0.3

X projection

Y projection

CAL Gaps
Final Cut, including 50-mm Gaps
Energy, after Cuts

CAL problem much better, but still more to do!

Note: cuts keep only ~40% of the original events

Also, I haven't addressed \(E<100\) MeV…
Summary: Efficiency, Bias & Energy

- The tagging and recon efficiencies seem fine, except for their effect on the angle bias.

- There are pretty big angle biases for large-incident-angle events at low energies, but this may be a problem at all energies...after all we're supposed to have this terrific resolution at high energies.
  - One fix is to cut out the entire region (>50°) for those analyses which require the best PSFs.
  - Perhaps we can make an (angle,energy)-dependent correction, but especially at low energies, we don't know the energy for much of the phase space, primarily due to CAL gaps. Since we're stuck with the gaps, we need to do whatever we can to characterize these effects and to correct for them.

- There are some (presumably) technical problems that are causing various TKR energy effects, over and above those coming from the CAL. There are probably some simple fixes for much of this.