ToT Analysis and Beam Attenuation with TB_RECON And Tagger pitfalls

Derek Tournear
Stanford Linear Accelerator Center
Stanford University

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Outline

- Brief view of Tagger data
- Analysis of the beam attenuation using Vertex reconstruction
- Analysis of ToT
  - What is ToT and what can it tell us
  - Comparing the ToT in data and simulation
  - Using ToT to veto electrons
  - Using ToT to find conversion points
  - comparing ToT cuts to Recon
- Some Event Scans
- Conclusions
Operation of Tagger

From the beam energy and the energy and the angle the deflected beam goes through the energy of the emitted gamma is calculated.
Expected results
Some Anomalies

![Histograms showing some anomalies in photon momentum distributions for different energy levels and angles.](image-url)
Beam Attenuation Study

- Motivated by Hartmut after noticing that the number of entries as a function of the Z position of the vertex did not make sense.

- Only two $\gamma$ were studied (333 and 285)

- Hope information about tb_recon can explain the results.

Derek Tournear and Eduardo do Couto e Silva

SLAC 24 August 2000
20 GeV $\gamma$ run 285 Conversion per layer

![Conversion Plane Diagram](image-url)
Calculating $\chi_0$

<table>
<thead>
<tr>
<th>Material</th>
<th>Thickness (cm)</th>
<th>Density (g/cm$^3$)</th>
<th>$X_0$ (g/cm$^2$)</th>
<th>Radiation Length (cm)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicon Detector (2)</td>
<td>0.040</td>
<td>2.330</td>
<td>0.040</td>
<td>9.36</td>
<td>0.85%</td>
</tr>
<tr>
<td>Printed circuit (2)</td>
<td>0.015</td>
<td>1.420</td>
<td>0.015</td>
<td>xxx</td>
<td>0.25%</td>
</tr>
<tr>
<td>Carbon face sheet (2)</td>
<td>0.075</td>
<td>2.265</td>
<td>0.010</td>
<td>18.80</td>
<td>0.80%</td>
</tr>
<tr>
<td>Aluminum core</td>
<td>0.018</td>
<td>2.700</td>
<td>1.500</td>
<td>8.90</td>
<td>0.20%</td>
</tr>
<tr>
<td>Lead converter (thin)</td>
<td>0.020</td>
<td>11.350</td>
<td>0.200</td>
<td>0.56</td>
<td>3.57%</td>
</tr>
<tr>
<td>Lead converter (thick)</td>
<td>0.160</td>
<td>11.350</td>
<td>1.600</td>
<td>0.56</td>
<td>28.57%</td>
</tr>
<tr>
<td>Glue (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(imagine this is negligible)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper on circuit</td>
<td>0.005</td>
<td>8.960</td>
<td>12.860</td>
<td>1.43</td>
<td>0.08%</td>
</tr>
<tr>
<td>Kapton on circuit</td>
<td>0.008</td>
<td>1.420</td>
<td>0.015</td>
<td>28.60</td>
<td>0.04%</td>
</tr>
</tbody>
</table>

- Copper and Kapton $\chi_0$ values are from Robert’s note
- Al core was calculated using measured density 0.017 g/cm$^3$
Conversions per layer

Measure of Beam Attenuation + Recon Efficiency

With this X axis the coefficient in the exponent should be the radiation length of the trays. Expected values are: 5.7% and 30.7%
To the best we can calculate the radiation lengths should be 5.7% & 30.7%

- Measured values are 8.4% and 20.7%

- Differences must be attributed to efficiency of reconstruction changing through the tracker layers
Scanning events based on ToT cuts

➢ Motivated by the desire to use the ToT information to increase the efficiency and accuracy of the reconstructed tracks.

➢ All analysis was done after using tb_ana provided by Jose with some additional ntuples

➢ Ideally we would like to isolate vertexes by looking at where the ToT goes from 0 to 2 Mips. From one plane to the next

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Time Over Threshold (ToT)

Stored in the Root file in units of counts (200 ns)

Every time there is a hit the ToT starts counting

More charge deposited
Results in longer ToT
Calibrating ToT

- Runs 283 and 360 used (20 and 2 GeV e+)
- Values of ToT from one electron range 6.0 – 8.0 μsec with no sign of energy dependence
  This corresponds to one Mip from charge injection measurements

Layer 17 has an unusually large spread in ToT?
What can we see with the ToT?

We have an ntuple that contains the ToT for each layer and the layer directly before it. (bToT)

- ToT before conversion should be zero
- ToT for an electron should not be zero anywhere
- ToT directly below conversion should be near two Mips

ToT is zero
ToT is two Mips since e\(^-\) and e\(^+\) are deposited on same strip
ToT goes to one mip as the charges are distributed over two strips
Comparing Data and Simulation

What is going on here?

Monte Carlo vs Data ToT Data

Legend
- Simulation
- Data

Nent = 32401
Mean = 2.416

20 GeV e⁻ run

SLAC, Stanford University

Software mtg, SLAC Sept 2000
Using ToT to veto electrons

Electron Rejection Efficiency with ToT cuts

- Requiring the bToT to be equal to zero and ToT to be greater than zero in any layer rejects 99.5% of all electron events!
- As the minimum ToT value increases, the rejection increases.

Run 360 2GeV e⁻
ToT Analysis Photon Run

- No hits ToT should be zero
- 2 hits deposit most of their charge on one strip => ToT ~ 2 Mips
- 2 hits deposit their charge between more than one strip => ToT ~ 1 Mips

Almost all of these events are incorrectly reconstructed.
Efficiency of accepting γ’s

Here I have used the normalization that 100% of the γ’s are found by tb_recon. So applying the cut bToT=0 cuts 13% of the tb_recon events

This is for Layer 25 3rd plane from the top
Comparing ToT to TB_Recon

Events that are in agreement between recon and ToT

- 48 events did have the vertex in the correct place.
- However, recon missed tracks in several of them.

Events that ToT found and recon did not

- 12 events
- 6 events had two photons in one event
- 3 events I couldn't tell whether they were correct photon conversions
- 2 events had low energy electron
- 1 event

The ToT cut used to find a gamma was:

- \( b_{ToT} == 0 \) and \( ToT > 1.4 \) Mips

Events that Recon found ToT did not

- 27 events
- 9 events mess or couldn't see anything sensible
- 9 events correct photon conversion
- 6 events incorrect vertex position
- 1 event electron
- 2 events two photons

This is from the first 10,000 events in run 285 looking at all events that either the ToT or TB_Recon thought converted before plane 3 (1626 reconstructed gammas total in all layers)
Conclusions of Comparison

- Recon correctly reconstructed 57 of 75 it thought it had reconstructed ⇒ correct 74% of the time
- ToT correctly found the vertex 50 of 60 it thought it had found ⇒ correct 83% of the time
- Out of 59 γ’s that ToT \textbf{OR} Recon found they both agreed on 48 ⇒ agree 81% of the time
- Most of the times ToT was wrong was due to two γ’s
- Most of the times Recon was wrong was due to hard to identify events. (I couldn’t easily identify by eye)
Overall conclusions

- Need to be careful when using tagger energy, there are some pitfalls.
- Is there a change in Recon efficiency as the conversion point moves through the detector? Beam attenuation seems to suggest this.
- ToT is very effective in rejecting charged particles > 99.5%.
- ToT is 85% accurate in finding vertex position. Should be implemented as a tool to help in reconstruction.
- We need MC to fully quantify these effects.
Run 285 ID 871

Event that tb_recon and ToT both got correct. The vast majority of the events.
Run 285 ID 5653

Picked up by Recon and not ToT. 2 photons.
Run 285 ID 3980

An event picked up ToT & not by Recon. ToT cut correct/ but there are two gammas!

Majority of events picked up by ToT & not by Recon
Z position is in cm from the center of the bottommost plane.

The bottommost plane is plane 15 composed of layers 0 and 1