Width PID and systematics

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Introduction

A few separate threads:

1. Electron selection efficiency vs energy
2. Simple systematic error method for $\mu$ BG
3. Width distribution and noise
Width cut options

- Median Width (Hits) > 1
- $L_{EM} > L_{LT}$
- Wide Node Fraction > 0.2
- Wide Node Fraction > 0.3

► Fraction of nodes with $N_{hits} > 2$
► Cut at 0.2 gets good efficiency and reasonable BG rejection
Fraction wide nodes data/MC

- Data/MC agreement reasonable above 0.2
- Discrepancy below about 0.15
With increased noise

- Increased `elecSim.MPPC.NoiseTimestampProb.p0d` from 0.0055 to 0.05
- Change is in right place, right direction...
Simple systematic

- Compare fraction of stopping $\mu$ selected in data and MC:

<table>
<thead>
<tr>
<th></th>
<th>Cut</th>
<th>MC sel. (%)</th>
<th>Data sel. (%)</th>
<th>Data/MC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median width</td>
<td>1</td>
<td>0.28</td>
<td>0.58</td>
<td>2.10</td>
</tr>
<tr>
<td>$L_{EM} - L_{LT}$</td>
<td>0</td>
<td>2.0</td>
<td>9.8</td>
<td>4.83</td>
</tr>
<tr>
<td>Fraction wide nodes</td>
<td>0.2</td>
<td>2.9</td>
<td>4.1</td>
<td>1.44</td>
</tr>
</tbody>
</table>

- Opinions on this approach?

- TODO:
  - Stat errors on these numbers
  - What exactly to take as syst? $|1 - \text{Data/MC}|$?
Hit width distribution

- Width from hits, stopping muons
- Chasing two discrepancies:
  - Bump at 5mm
  - Excess in data around 1mm
- Hypothesis: noise rate shows up in widths as “big-big-small” hits in node
Take prod4 beam data and MC. Count hits per cycle

Overall noise rate completely wrong.

Number of clean hits slightly wrong

TODO: veto cycles with reco’d track/shw
Charges of hits in pe. Note different x axis scales!

Threshold not sharp in data ⇒ more low-pe hits ⇒ more narrow but non-zero hit widths
Triplet nodes and noise

From stopping muons

- Right: Nominal Noise $\times 9$
- Effect of increased noise goes in right direction
Triplet nodes - throughgoing

From throughgoing muons

- Nodes with 3 or more hits get nonzero widths (without fit)
- Two peaks: difference in data/MC
- Wild speculation: One peak is 3 physics hits, other is 2 physics + 1 noise?
  - Try turning noise off/up
Conclusions

- Fraction of “wide” nodes effective, even at lower $E$
- Have a simple way to get systematic on $\mu$ BG
- Have suggestions that differences in width/hits per node dists are noise
  - No smoking gun
  - Would like to just reprocess a bunch of data with cleaning set to kill anything below npe, no exceptions
Backup slides
Median width and $\Delta \mathcal{L}$
\textit{\textbf{\textit{\textit{\textit{n}plet nodes: stopping}}}} \text{\textmu}