Data/ Monte Carlo comparisons for the EMC

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EMC Software/Calibration Meeting
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The Task

- To make a systematic study of the performance of the EMC Monte Carlo simulation
- Identify areas where MC can be improved, and where it can be trusted
- Already looked at electrons (see talk at EMC workshop, 5th Dec 2004), now studying photons and muons
- This talk - photons
- Kinematic quantities, event-based quantities (eg Number of crystals with energy deposition), shower shape variables
Since last time…

- Increased the statistics of both data and MC samples
- Tightened a few cuts to improve sample purity and kinematic agreement
- Talked to Neutrals and Simulations groups
Photons from $\mu\mu\gamma$ events

- Photons selected from Run 4 Data (Tau11 stream) and MC (SP-3981) *
- Also looking at muons from these samples (to be shown at later date)
- Using analysis-23 (Release 14)
- Cuts:
  - nTracks = 2
  - One or other of the tracks belongs to Tight $\mu$ list
  - ‘Mass’ of reconstructed photon < 0.1GeV $\left( E_{\text{miss}}^2 - p_{\text{miss}}^2 \right)^{1/2}$
  - Photon Energy > 0.3GeV

*Thanks to Dave Payne for assistance*
Kinematic Quantities (i) Calibrated Energy of Cluster

• End-cap behaviour is less well understood

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Data

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Monte Carlo
Kinematic Quantities (ii)

Digi Energy

BARREL:

ENDCAP:

•Digis taken from “Default” List
Kinematic Quantities (ii)

Theta and Phi

- Agreement of kinematic quantities verified before looking at shower shape variables
Event-Based Quantities (i) No. Crystals

BARREL:

ENDCAP:

• MC peaks at higher value of nCrystals than data
Shower Shapes (i)

**BARREL:**

- LAT, barrel
  - Entries: 26165
  - Mean: 0.2060
  - RMS: 0.02252
  - Underflow: 0
  - Overflow: 0.007198
  - Integral: 1

**ENDCAP:**

- LAT, endcap
  - Entries: 6113
  - Mean: 0.2333
  - RMS: 0.02196
  - Underflow: 0
  - Overflow: 0.0362
  - Integral: 1

**RATIO:**

- LAT ratio mc/data, barrel
  - Entries: 26089
  - Mean: 0.2676
  - RMS: 0.01817
  - Underflow: 0
  - Overflow: 0.7719
  - Integral: 25.71

- LAT ratio mc/data, endcap
  - Entries: 6112
  - Mean: 0.294
  - RMS: 0.165
  - Underflow: 0
  - Overflow: 0.4602
  - Integral: 28.06

-MC shifted systematically to the left of the data
Shower Shapes (ii)

Second Moment

BARREL:

ENDCAP:

• MC shifted systematically to the left of the data
Shower Shapes (iii)

BARREL:

ENDCAP:

- MC shifted to left.
Shower Shapes (iv)

• MC displays slight shift, but agreement is reasonable within errors
Shower Shapes (v)  

Zernike20

MC is slightly shifted right wrt data. Same shift was present for electrons.
Shower Shapes (vi)

**BARREL:**

- Good agreement

**ENDCAP:**

Zernike42
Summary

- We see the same trends in the disagreements for $\gamma$’s as we did for $e$’s (see talk at EMC Workshop, 5th Dec 2004).

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Barrel</th>
<th>Endcap</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n$Crystals</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>LAT</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Second Moment</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>$s1s9$</td>
<td>Slightly shifted</td>
<td>Slightly shifted</td>
</tr>
<tr>
<td>$s9s25$</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Zernike20</td>
<td>Slightly shifted</td>
<td>Slightly shifted</td>
</tr>
<tr>
<td>Zernike42</td>
<td>Good</td>
<td>Good</td>
</tr>
</tbody>
</table>
Simulation Issues

- Discrepancy in nCrystals may indicate a problem in Babar’s simulation of the EMC material or geometry
- Effect of pre-showering in DIRC on EMC showers could also be looked at
- Fixing the discrepancy in nCrystals should improve the agreement of the shower shape variables
Ideas

- Separate out photons which hit centre of crystal from those that hit edge
- Increase the Digi threshold energy for inclusion in cluster – see if agreement improves for higher cut-off
Future

- To be written up as Babar note (work in progress)
- Tom Latham will continue the study and extend to $\pi$, $K$…etc