Preshower Status

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• **Separate preshowers from non-preshowers**
  1. Cuts based on DIRC information (simple)
     • # of Cherenkov photons associated with EMC bump, nHits
     • Success or failure of DIRC ring fit, fitFailed
  2. Use EMC and DIRC quantities as inputs to a multivariate classifier (more complicated)
     • Shower shape variables, nCrystals, nHits and fitFailed

• **Determine energy loss of preshowering photons**
  1. Correction using theta: \( E_{\text{loss}} \sim \text{path length} \)
     \[ \rightarrow \text{theta dependence } (1/\sin \theta) \]
  2. Correction based upon nCrystals and theta
Preshower/Non-Preshower Separation

- From truth matching (using SP 1237)
  - Photons 81%
  - Neutrals 13%
  - Charged particles 6%
  - 72% EMC (post-DIRC)
  - 8% DIRC
  - 1% pre-DIRC

Need separation to yield Purity > 0.5 in order for correction to be useful
Preshower/Non-Preshower Separation

BBbarGeneric (SP 1237)

Average Efficiency: 44%
Average Purity: 53%

Average Efficiency: 26%
Average Purity: 77%
Preshower Separation: Multivariate Approach

Bbbar Generic (SP 1237)

9 variables used as input into TMVA
- absZer42
- absZer20
- lateral moment
- s1s9
- s9s25
- nCrystals
- nHits
- fitFailed
- secondMomentTP

Tried many classifiers, MLP (neural network) seems to give the best separation
Preshower Separation: Multivariate Approach

$B^0 \rightarrow \pi^0 \pi^0$ MC (SP 1043)
Preshower/Non-Preshower Separation

BBbarGeneric (SP 1237)

Average Efficiency: 44%
Average Purity: 53%

Average Efficiency: 50%
Average Purity: 60%
Preshower/Non-Preshower Separation

$B^0 \rightarrow \pi^0 \pi^0 \text{ MC (SP 1043)}$

Average Efficiency: 57%  
Average Purity: 58%

Using Bbbar weights, Avg. Efficiency = 60% and Avg. Purity = 66%
Energy Correction: Theta Correction

\[ s = \frac{w}{\sin \theta} \]

Energy loss is proportional to path length:

\[ E_{\text{loss}} = \frac{dE}{dx} s = \frac{dE}{dx} \frac{w}{\sin \theta} \]
Energy Correction: Theta Correction

- Use MC to determine $E_{\text{loss}} = E_{\text{raw}} - E_{\text{true}}$

- Fit theta profiles with Novosibirsk function

- Difference between MPVs is taken as energy correction, $E_{\text{corr}}$

48 theta bins

Theta Index 11

Non-Preshower: MVP = -0.008 GeV

Preshower: MVP = -0.052 GeV

$E_{\text{corr}} = 0.044$ GeV

typical theta bin
Energy Correction: Theta Correction

Fit using

\[ E_{\text{corr}} = \frac{a}{\sin \theta} \]

For minimum ionizing particle \( a \approx 6.5 \text{ MeV} \), compared to 22.7 MeV from fit.

Endpoints excluded from fit.
Energy Correction: Theta and nCrystals

- Use MC to determine $E_{loss} = E_{true} - E_{raw}$
- Project 3D histogram containing $E_{loss}$, nCrystals and theta and fit with Novosibirsk function
- Difference between MPVs is taken as energy correction, $E_{corr}$

Require
- $nEntries \geq 500$ for preshowers
- $nEntries \geq 2500$ for non-preshowers
Energy Correction: Theta and nCrystals

Use theta correction where theta/nCrystals correction is zero and for nCrystals < 4 or nCrystals > 20
Correction Comparison

Separation using truth matching

SP 1237
Correction Comparison

Separation using MLP (NN)

SP 1237
Conclusions

• Which separation method is best?
  – Cuts on nHits and fitFailed
    • Simplest and easiest to implement
    • Generally gives lower efficiency and purity
  – Multivariate
    • More complex, not immediately apparent how to implement
    • Better efficiency and purity
    • What events should the NN be trained on?
Conclusions

• Which correction method is best?
  – Theta correction
    • Seems to provide a sharper peak in pion mass spectrum
  – Theta and nCrystals correction
    • Still not perfected