XTheta Residual vs ThetaIndex

- XTheta – distance from center of crystal in theta direction normalized to crystal face width

Non projectivity angle vs ThetaIndex
• Current code applies a constant +/-2.5 mrad correction for this bias

• Variation of non-projectivity at barrel-endcap interface not currently taken into account

• It would be better to understand the origin of the bias and correct at a deeper level
Theta reconstruction with shower depth and nonprojectivity taken into account

- Weighting scheme
  \[ V = \sum \left( \frac{w(E_i) \cdot V_i}{\sum w(E_i)} \right) \]
  where \( V_i \) is \( X_i, Y_i \) or \( Z_i \) for the \( i \)-th digi of the cluster

- Position of shower centroid in the \( i \)-th digi \( (X_i, Y_i, Z_i) \) is:
  \[ X_i = [R_i + d \cdot \sin(\theta_{n_i})] \cdot \cos(\Phi_{digi_i}) \]
  \[ Y_i = [R_i + d \cdot \sin(\theta_{n_i})] \cdot \sin(\Phi_{digi_i}) \]
  \[ Z_i = R_i \cdot \cotg(\theta_{digi_i}) + d \cdot \cos(\theta_{n_i}) \]

- Shower depth calculated according
  \[ d = (\log(\text{ClusEnergy}/0.0145) + p) \cdot X_0 \]

- Best results obtained for \( p = 5 \)
Shower Depth vs Energy

Theta Residual vs ThetaIndex using shower depth method

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Average absolute value of theta residual vs Eclus and Vtxz
No vertex correction

- Resolution depends strongly on z-coordinate of primary vertex
Average absolute value of theta residual vs Eclus and Vtxz after vertex correction

- Uniform resolution across Vtxz range
Comparison of theta residual for the two methods in a situation relevant for $K^*$ gamma

- Cuts applied
  2.5 $<$ Eclus $<$ 3.5 GeV
  0.2 $<$ $\cos(\text{ThetaClus})$ $<$ 0.6
  $\text{Abs(Vtxz)} > 1$ cm

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