Calorimeter Trigger Study for FACET Detector

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Di-Photon Signal Model

\[ B \rightarrow K + \Phi, \Phi \rightarrow \gamma\gamma \] generated directly from FASER B files

- \( m_\Phi = 3 \text{ GeV}, c\tau_\Phi = 1 \text{ m}, \theta_\Phi < 5 \text{ mrad}, p_\Phi < 1.5 \text{ TeV} \)
Decay Kinematics

$hists$ normalized to unity

$Z_{HODO}$

$Z_{CALO}$
Simple Calorimeter Model

- Based on estimates for Phase-2 front-end calorimeter
- Assume positional resolution of 4mm for photon hits at front of CALO and angular resolution of 7mrad in $\theta$
- Scale track energy/momentum by factor corresponding to 15% resolution
- Reconstruct photon track collections from smeared quantities
- Making assumptions based on asymptotic behavior, since all studies are in higher $p_T/E$ regime

5.1.3.2 Position resolution, and angular resolution

Because of the small cell sizes a position resolution of better than 1 mm can be obtained, in each layer, for high $p_T$ electromagnetic showers, with little effort. This has been confirmed by the measurement of position measurement resolution in the test beam (Section 5.2). The ultimate position resolution performance, which should be significantly better than this, will require sophisticated multivariate corrections for numerous subtle biases.

Shower direction can also be measured. The axis of electromagnetic showers is determined using a principal component analysis methodology as a starting point for the construction of shower shape variables. The angular uncertainty in $\theta$, obtained for a $p_T = 25$ GeV shower, without corrections, tuning, or optimization is 7 mrad. It is expected that this can be significantly improved by the use of more sophisticated techniques.
Comparing Angular Resolution

From reply to comments:

This translates into \( \sigma_\eta = \sigma(\theta) / \sin(\theta) \approx \sigma(\theta)/\theta = 0.025 \), which is pretty good angular resolution. For instance, for a photon found in the HGCAL,

\[
\sigma_\eta = \frac{\sigma \theta}{\theta} \Rightarrow \sigma \theta = 0.025 \arctan(0.34/10) = 8.5 \text{ mrad}, \text{ similar to quoted number}
\]
Geometrical Efficiency

- ~25% of $\Phi$s produced in sample decay inside

- For tracks decaying inside detector volume, we see ~71% hit the front and back of the calorimeter
Di-Photon Reconstruction

• Calo Photons:
  • decay vertex inside tank
  • Both photons hit front & back of calorimeter
  • Smeared with calo resolutions

• Able to reconstruct 83% and 93%, respectively, of truth and RECO photon hits in CALO with assumed resolution limit
Next Steps

• Incorporate background photons
  • tag_g.txt FLUKA file photons or gluons?

• Refine calorimeter model
  • Add layer-by-layer resolution, better understand cluster overlap, etc.