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GLD PFA Review

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In this proceeding, I aim to review the status of the study of PFA in GLD simulation group, including the cheated and realistic methods.

1. INTRODUCTION

The work can be separated into two categories: cheated related and realistic related. This document follows this categorization.

Selections of electromagnetic (EM) and hadronic (HD) shower models are based on the models which could duplicate energy resolution results as close as our prototype data [1]. Calibration factors used for both cheated and realistic PFA are not energy dependent. Details of the selected shower models and the updated calibration factors can be found in other proceedings [2] [3].

We use the **GEANT4**-based [4] simulation tool named **Jupiter** to simulate the full detector of GLD. The purpose of cheated PFA study is to understand the leading components and the ultimate of jet energy resolution. For the realistic PFA study, we want to optimize the PFA algorithm itself.

2. CHEATED RELATED

The name cheated is due to the usage of Monte Carlo (MC) truth information. For example, if a particle makes energy showers (hits) in scintillator tiles, we can know the exactly hit positions of the shower cluster which is equivalent to infinite segmentation.

We have studied the possible candidates which may affect the jet energy resolution. The used physics event is Z $\rightarrow q\bar{q}$ ($q = u, d, s$) at 91.187 GeV.

- Kink. A kink is a particle decayed in TPC. We'll have a mother track and its charged and neutral daughters. We compare the two cases: 1) keep the mother track and kill the daughter tracks; 2) keep the daughter tracks and kill the mother track. The case 1) will provide better jet energy resolution, so we use this treament for kink.

- Calorimeter resolution. By fitting the deposited energy in the ECAL and HCAL, we obtain the contribution from the calorimeter.

- Tracker resolution. There is almost no contribution from tracker.

In summary, the jet energy resolution with the cheated method is about 25.3%. Those components affect jet energy resolution is given in Table I, but still 22% contributions are unknown.

3. REALISTIC RELATED

Instead of using MC truth information, we redo the clustering. The steps are as follows:

Table I: Summary of the contributed components to jet energy resolution. The **Sigma** is obtained by fitting the energy distribution with a Gaussian function. Total means all of the devices are turned on. HD is the comparsion between turn on and off the HCAL. Similar for EM and Track.

	Sigma	**Contribution**
Total	2.48 GeV	100%
HD	1.70 GeV	48%
EM	1.36 GeV	30%
Track	0.00 GeV	0%
Unknown	1.16 GeV	22%

- Small clustering. First, we find the most energetic scintillator tile among the "fired tiles" in the calorimeter as a starting tile. The "fired tiles" means the tiles with deposited energy higher than 50 MeV. If the neighbor tiles are also "fired", the starting tile and this neighbor will connect together as a small cluster. The clustering is repeated until no more candidates can be connected.

- Photon finding. Based on the small clustering, we choose the most energetic tile in the ECAL and connect its "fired" neighbors. Assuming a small tube (radius $\leq$ 5 cm) along with the thrust axis of the most energetic small cluster, it would cover the most EM showers. The longitudinal shower profile from the clusters within the tube are fitted by a Gamma-distribution function [5]. We remove the clusters which have too large fitting chisqure. In addition, we also remove the small clusters which has a track in front of it ($\leq$ 7 cm).

- Track Matching. After removing the photons by photon finding method, we connect the remaining "fired tiles" with the track. With the track information, the remaining tiles will be treated as contribution from charged hadrons. For those without the track information tiles, they will be treated as contribution from neutral hadrons.

Applying the realistic PFA in the physics event, $Z \rightarrow q\bar{q}$ ($q = u, d, s$) at 91.187 GeV, we get the jet energy resolution to be 40%. The energy-weighted efficiency and purity obtained by the photon finding method is 60% and 99%, respectively. The energy-weighted efficiency and purity obtained by the track matching method is 86% and 82%, respectively.

The goal for jet energy resolution in the realistic PFA study is 30%. One may need to do some more improvement to reach it. For example, the efficiency of the photon finding method should be improved. Some other points are also reported in another proceeding [6].

References

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