CALICE Analysis Note CAN-024 (Addendum A)
October 31, 2010

Addendum A to CALICE Analysis Note 024

The CALICE Collaboration [1]

This note contains preliminary CALICE results, and is for the use of members of the CALICE Collaboration and others to whom permission has been given.

1 Introduction

This addendum updates the CAN-24 and is not comprehensive in itself. The updates are concerned with mapping of CALICE hits (see section 3.3 of CAN-24) and with the assignment of unused isolated hits and small clusters (see section 4 of CAN24). In this addendum (i) mapping of CALICE hits has been done more accurately, and (ii) the assignment of unused isolated hits and small clusters has been done in a more elaborate way. The purpose of these changes is to study the PandoraPFA performance more carefully.

For easy comparison, the results of updated calculations are presented in the same form as in CAN-24. As in the note, to confront test beam data with MC, GEANT4 (version 9.2) simulation for two physics lists was performed using beam profiles corresponding to the data runs. For simulation and digitization the standard CALICE software packages were used: Mokka v07-00 (detector model TBCern07 p0709, range cut 50 micron and time cut 150 ns), calice sim (as of December 2009).

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2 Mapping of shower hits

In CAN-24 hits of both charged and neutral showers from the CALICE calorimeter prototypes were mapped to the cells of the LDC detector. However, the number and thicknesses of layers and absorbers of the LDC detector differ from those of CALICE prototypes, that slightly changes the shower shapes and energy profiles. For this addendum, we have changed the number and thicknesses of layers and absorbers of the detector, so that these values coincide with CALICE's ones. There is still mismatch in the transverse cell sizes in peripheral regions of shower. However, the mismatch is not as important as the the difference of layer thicknesses because (i) showers anyway are quite fragmented in those regions, and (ii) the mismatch does not change the size of showers. Thus, the shapes of mixed charged and neutral showers are now actually the same as those reconstructed in the CALICE calorimeter prototypes, so the PandoraPFA performance is not affected by shower distortions.

3 Isolated hits and clusters

For simplicity, in CAN-24 we considered all isolated hits and small clusters belonging to the neutral hadron shower if PandoraPFA did not include them into the charged hadron shower. This time, the assignment of unused isolated hits and small (< 5 hits) clusters is done proportionally to the estimated energies of the charged and neutral hadrons. To calculate this proportion, the energy of the charged hadron is taken equal to the TPC track energy (corrected by π/e ratio) whereas the neutral hadron energy is taken equal to the difference between the summed energy of both hadrons measured in the calorimeter, and the TPC track energy (corrected by π/e ratio). Such an assignment gives actually zero mean difference between recovered and measured energies for a 10 GeV neutral hadron at large distances from a 10 GeV charged one, Fig. 2. We checked that if we define small clusters as those consisting of either < 4 or < 6 hits, the value of the mean difference at 30 cm between showers will be about $+0.01$ or -0.01 GeV respectively for beam data.

4 Results and Conclusions

In this addendum we present the results of updated calculations for difference between the recovered energy of the neutral hadron and its measured energy, the RMS deviation of the two energies, and the probability of recovering the neutral hadron energy within 2 and 3 standard deviations from its real value. We show updated versions only for most important figures of CAN-24: 4,6,7, and 8 although figures 5, 9, and 10 are also (slightly) affected by our changes and might be presented in future.

The more correct mapping used in this addendum has improved the PandoraPFA performance in the following two ways:

1. in the ECAL the showers have become more smooth due to the use of hits from all 30 layers of the CALICE ECAL,
2. in the HCAL the shower cone has taken its natural size.

We have verified that using only this improved mapping, without changes in the assignment of isolated hits and small clusters, would reduce the RMS_{90} deviation of recovered energy of the neutral hadron from its measured energy by 5-10% for large distances between the neutral and charged hadrons.

Apart from decreasing the mean difference between recovered and measured energies at large shower separation, the modifications in the assignment of isolated hits and small clusters have resulted in a more symmetric distribution of the difference, see right plots in Fig. 1. Due to these two facts, the RMS_{90} deviation of the recovered energy from the measured energy has been significantly reduced for distances of 20–30 cm between 10 GeV neutral and charged hadrons (Fig. 3), *i.e.* for the situation which dominates the confusion error for 100 GeV jets in a 4 T magnetic field (see section 6 of CAN-024).

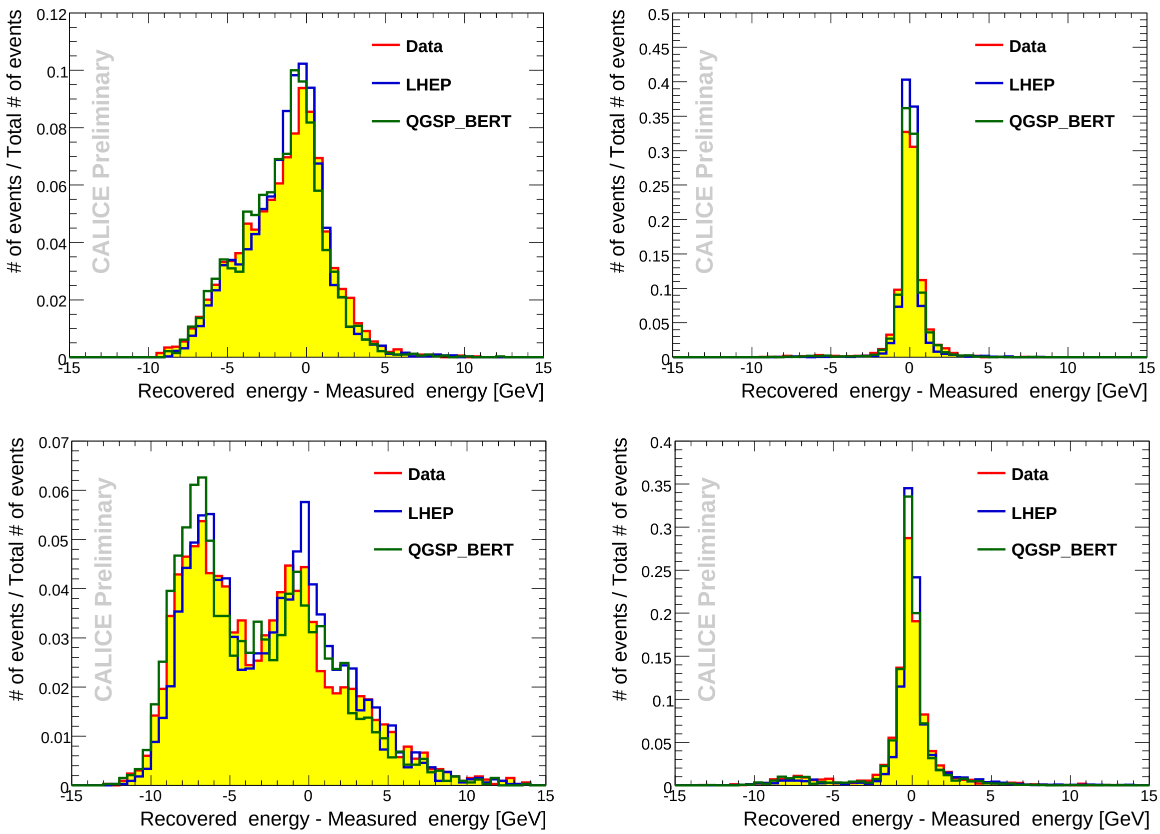

Figure 1: *Difference between the recovered energy and the measured energy for the 10 GeV neutral hadron at 5 cm (left) and at 30 cm (right) from the 10 GeV (top) and 30 GeV (bottom) charged hadrons. Data (red, yellow shaded) is compared to MC predictions for LHEP (blue) and QGSP_BERT (green) physics lists (supersedes Fig. 4 of CAN-024).*

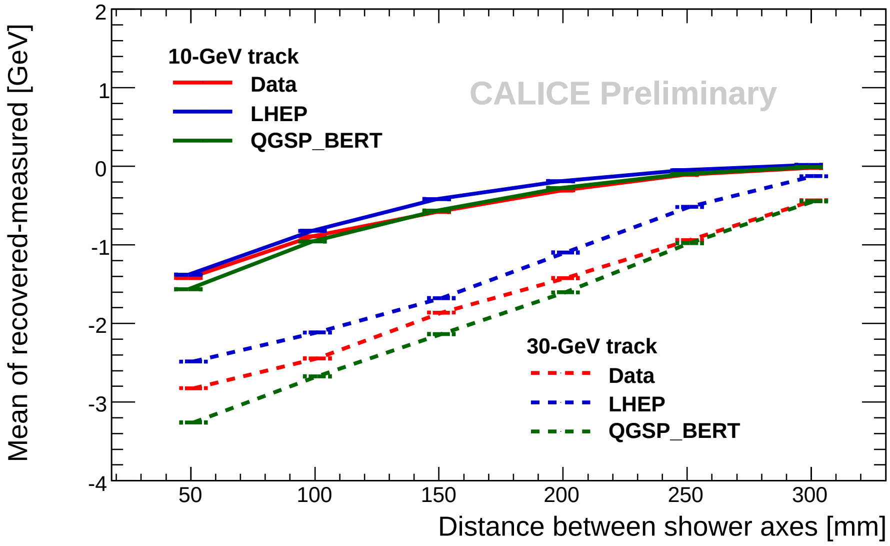

Figure 2: *Mean difference between the recovered energy and the measured energy for the 10 GeV neutral hadron vs. the distance from the 10 GeV (continuous line) charged hadron and the 30 GeV (dashed line) charged hadron (supersedes Fig. 6 of CAN-024).*

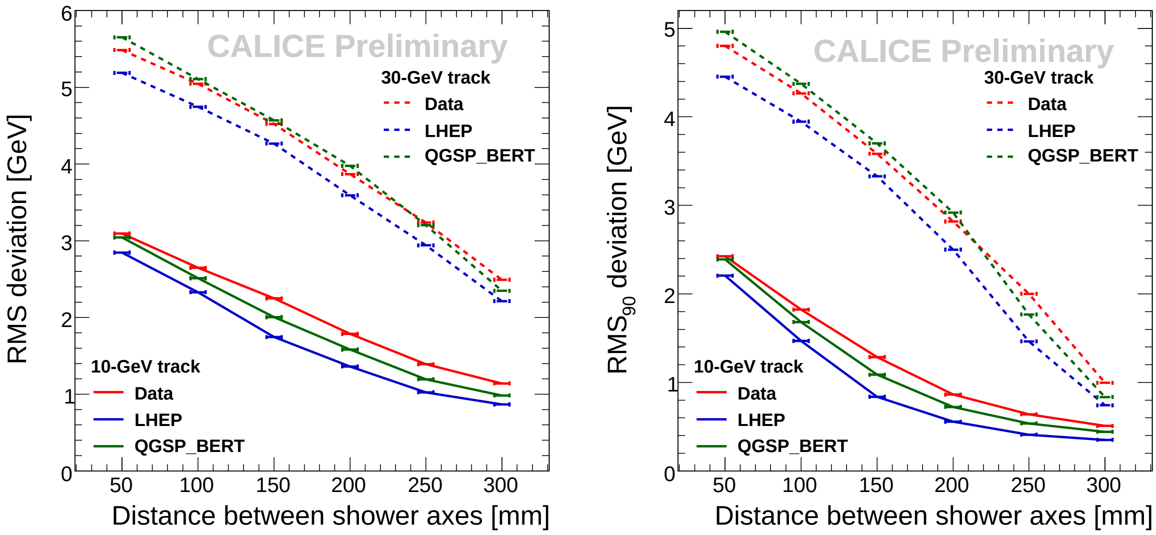

Figure 3: *RMS (left) and RMS_{90} (right) deviations of the recovered energy of the neutral 10 GeV hadron from its measured energy vs. the distance from the charged 10 GeV (continuous line) and the 30 GeV (dashed line) hadron for beam data (red) and for Monte Carlo simulated data, for both LHEP (blue) and QGSP_BERT (green) physics lists (supersedes Fig. 7 of CAN-024).*

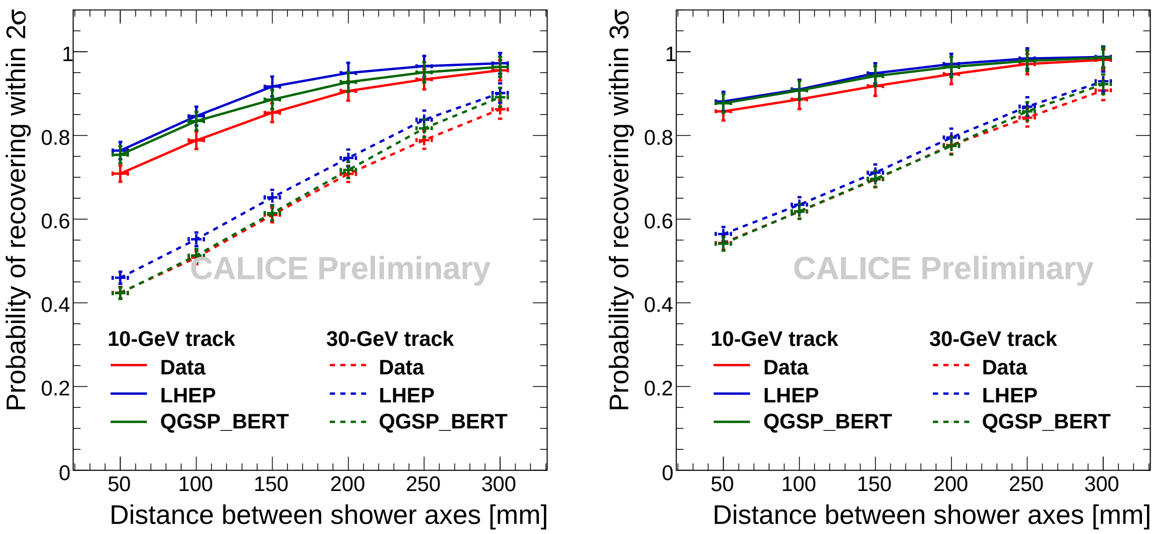

Figure 4: *Probability of the neutral 10 GeV hadron energy recovering within 2 (left) and 3 (right) standard deviations from its real energy vs. the distance from the charged 10 GeV (continuous line) and the 30 GeV (dashed line) hadron for beam data (red) and for Monte Carlo simulated data, for both LHEP (blue) and QGSP_BERT (green) physics lists (supersedes Fig. 8 of CAN-024).*