Update of the Analysis of the Test Beam Experiment of the CALICE ScECAL Physics Prototype
—Erratum to CAN-016b—

The CALICE collaboration

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.

Abstract

One of the progresses presented in CALICE Analysis Note 016-b is the implementation of the temperature correction to the ADC-photo-electron conversion factors. The previous results used those calibration factors from an old dataset. This made updates of the correction with consistent conversion factors derived from the same data as the temperature correction itself necessary. The intrinsic energy resolution of the ScECAL prototype is improved from \(12.9 \pm 0.1 \text{(stat.)} \pm 0.4 \text{(syst.)}\)% and \(1.2 \pm 0.1 \text{(stat.)} \pm 0.4 \text{(syst.)}\)% to \(12.8 \pm 0.1 \text{(stat.)} \pm 0.4 \text{(syst.)}\)% and \(1.0 \pm 0.1 \text{(stat.)} +0.5 \pm 1.0 \text{(syst.)}\)% for the stochastic term and constant term, respectively. The maximum deviation from a linear fit is also modified from 2.0% to 1.6%.

1 Introduction

The CALICE ScECAL is a granular electromagnetic calorimeter using fine segmented scintillator strips with a lateral size of \(45 \times 5 \text{mm}^2\). Each scintillator is read out with a pixelated photon detector (PPD). The response of PPD has a saturation phenomenon as a function of the number of fired pixels due to the finite number of pixels of the sensor. Therefore, we need to convert the response into the number of fired pixels for each channel in order to apply the saturation correction. For this the ADC-photo-electron conversion factor \((c_{\text{p.e.}})\) is used, which is determined as the ADC counts corresponding to distance between photo-electron peaks measured with LED light. However, \(c_{\text{p.e.}}\) varies depending on the temperature of the PPD according to a linear function:

\[ c_{\text{p.e.}}(T) = c_{\text{p.e.}}(T_0) + \frac{\text{d}c_{\text{p.e.}}}{\text{d}T}(T - T_0), \]

where \(T\) is the temperature at which the measurement was taken, and \(T_0\) is some reference temperature. Therefore, we need to determine \(c_{\text{p.e.}}(T_0)\) and \(\text{d}c_{\text{p.e.}}/\text{d}T(T - T_0)\), for each channel.

2 Database of the ADC-photo-electron conversion factor in the CALICE DB

In the CALICE database ScECAL has two sets of ADC-photo-electron conversion factors \((c_{\text{p.e.}})\) so far. One, the name is ScECALGain is a trial version which was created with a standalone

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analysis, and the other one, ScECALGainfit, was created by using a code in the CALICE software, ScECALGainTempDependProcessor. The latter has the data elements of \( \frac{dp^e}{dT} \), \( p^e (T_0 = 20^\circ C) \), and the error of those and the number of temperature points measured successfully for each channel. Since the mean of \( \frac{dp^e}{dT} \) of all the channels of the prototype from ScECALGain was applied for the temperature correction on \( p^e (T_0) \), \( p^e (T_0) \) should have been taken from the same database for consistency in CALICE Analysis Note 016-b (CAN-016b) [1]. Therefore, we reanalyzed whole of events with ScECALGainfit instead of ScECALGain in this update note.

3 Updated result with ScECALGainfit

Figure 1 left top shows the mean deposited energy as a function of the incident beam momentum with ScECALGain, with the deviation from the fitted line shown in the bottom panel. These plots are taken from CAN-016b. Figure 1 right also shows the same plots but with ScECALGainfit. In particular the deviation from the fit shows the improvement of the linearity with the new calibration.

Figure 1: Response linearity with \( p^e \) of ScECALGain (left) and of ScECALGainfit (right).

Figure 2: Energy resolution with \( p^e \) of ScECALGain (left) and of ScECALGainfit (right).
Figure 2 left shows the energy resolution as a function of the inverse of the square root of the beam momentum with data ScECALGain, while right shows the same plot with ScECALGainfit. From those plots, it is apparent that the energy resolution is also improved with ScECALGainfit.

With the corrected calibration from the database, ScECALGainfit, the maximum deviation from a linear fit is 1.6% at 20 GeV, while it is 2.0% with ScECALGain. The intrinsic energy resolution of the prototype is $12.8 \pm 0.1\text{(stat.)} \pm 0.4\text{(syst.)}\%$ and $1.0 \pm 0.1\text{(stat.)} \pm 0.5\text{(syst.)}\%$ for the stochastic term and constant term, respectively, while they are $12.9 \pm 0.1\text{(stat.)} \pm 0.4\text{(syst.)}\%$ and $1.2 \pm 0.1\text{(stat.)} \pm 0.9\text{(syst.)}\%$ with ScECALGain, in the previous analysis.

4 Summary

In CAN-016b the database of $c^{p,e}$ was not correctly used. In this update of the analysis the database is correctly assigned. As a consequence, the energy resolution, and in particular the linearity were improved.

References