Contribution ID: **15** Type: **Poster**

The TileCal Online Energy Estimation for Next LHC Operation Period

Tuesday 2 September 2014 08:00 (1 hour)

The ATLAS Tile Calorimeter (TileCal) is the detector used in the reconstruction of hadrons, jets, muons and missing transverse energy from the proton-proton collisions at the Large Hadron Collider (LHC). It covers the central part of the ATLAS detector ($|\eta|<1.6$). The energy deposited by the particles is read out by approximately 5,000 cells, with double readout channels. The signal provided by the readout electronics for each channel is digitized at 40 MHz and its amplitude is estimated by an optimal filtering algorithm, which expects a single signal with a well-defined shape. However, the LHC luminosity is expected to increase leading to signal pile- up that deforms the signal of interest. Due to limited resources, the current DSP-based hardware setup does not allow the implementation of sophisticated energy estimation methods that deal with the pile-up. Therefore, the technique to be employed for online energy estimation in TileCal for next LHC operation period must be based on fast filters such as the Matched Filter (MF) and Optimal Filter (OF).

Both the MF and OF methods envisage the use of the background second order statistics in its design, more precisely the covariance matrix. However, the identity matrix has been used to describe this quantity. Although this approximation can be valid for low luminosity LHC, it leads to biased estimators under pile-up conditions. Since most of the TileCal cell present low occupancy, the pile-up, which is often modeled by a non-Gaussian distribution, can be seen as outlier events. Consequently, the classical covariance matrix estimation does not describe correctly the second order statistics of the background for the majority of the events, as this approach is very sensitive to outliers. As a result, the MF (or OF) coefficients are miscalculated leading to a larger variance and biased energy estimator. This work evaluates the usage of a robust covariance estimator, namely the Minimum Covariance Determinant (MCD) algorithm, to be applied in the MF design. The goal of the MCD estimator is to find a number of observations whose classical covariance matrix has the lowest determinant. Hence, this procedure avoids taking into account low likelihood events to describe the background. It is worth mentioning that the background covariance matrix as well as the MF coefficients for each TileCal channel are computed offline and stored for both online and offline use.

In order to evaluate the impact of the MCD estimator on the performance of the MF, simulated data sets were used. Different average numbers of interactions per bunch crossing and bunch spacings were tested. The results show that the estimation of the background covariance matrix through MCD improves significantly the final energy resolution with respect to the identity matrix which is currently used. Particularly, for high occupancy cells, the final energy resolution is improved by more than 20%. Moreover, the use of the classical covariance matrix degrades the energy resolution for the majority of TileCal cells.

Primary author: ATLAS TILE CALORIMETER COLLABORATION, Bernardo Sotto-Maior Peralva on behalf of (CERN)

Presenter: SOTTO-MAIOR PERALVA, Bernardo (Juiz de Fora Federal University (BR))

Session Classification: Poster session

Track Classification: Data Analysis - Algorithms and Tools