Report on the use of the EUDET telescope in the CALICE DHCAL test beam of July 2008 at CERN

Imad Laktineh[1]
For the GRPC European DHCAL group

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Abstract

In this short report the CALICE group reports on its use of the EUDET telescope at CERN in July 2008. Very preliminary results are presented. This is a summary of a presentation given at the EUDET Annual Meeting in Amsterdam.

[1] Université de Lyon 1, Villeurbanne;CNRS/IN2P3, Institut de Physique Nucléaire de Lyon

1 Introduction

One of the aims of the test beam organized by the DHCAL group of the calice collaboration at CERN in July 2008 is the study of the glass resistive plate chamber (GRPC). The latter is a good candidate as a sensitive medium for the high granularity digital hadronic calorimeter proposed for the future International Linear Colliders. The longitudinal granularity of such DHCAL is determined by the size of the electronics board cells used to readout the signal left by the passage of charged particles in the GRPC's gap filled by a special gas mixture. The cell size in the proposed DHCAL is 1 cm2. Two cells are separated by a distance of 500 microns.

In the avalanche mode regime, the GRPC efficiency depends on the high voltage applied on the two glass plates. For very thin GRPCs as the ones proposed for the DHCAL, the efficiency can be as high as 96% for certain high voltage values. Part of the inefficiency of the GRPCs can be related to the spacers used to separate the two glass plates.

Others inefficiency sources can be the deformation of the electric field on the detector edges and the non-sensitive inter-pad area.

2 Study of the GRPC inefficiency using the EUDET telescope

To investigate the two possible sources of GRPCs inefficiency mentioned above, the position of the charged particles crossing the detector on the edges or between two cells has to be known with good precision. This suggests the use of the EUDET telescope which can provide a precision of few microns when the two arms are used and much better than 100 microns when only one arm is used. The latter scenario was used in our case since multiple scattering that takes place in our setup made of 4 GRPCS prevents the use of the two arms.

To align the EUDET telescope with our setup placed between the two telescope arms, a system provided by the CERN photogrammetry service was used. This provides an excellent alignment (<100 microns) which combined with the one provided by the telescope is sufficient for the purpose of this study.

The acquisition systems of the DHCAL and the EUDET telescope were synchronized through the TLU device. A triggering system formed of two tiny scintillators placed in front and behind the two telescope arms is used to detect the passage of a charged particle in the telescope and sends a signal to the TLU which then trigs the two acquisition systems allowing to record the same event in the two systems.

In order to study both the edge and the inter-pad effects, a scanning procedure was followed. Starting from a position in which the DHCAL is slightly outside the telescope scope, the DHCAL was then moved into the scope of the telescope by steps of 3500 microns in the horizontal direction using a movable stage. For each position between 2000 and 3000 events are accumulated. The events recorded by the telescope DAQ were then analysed. Tracks reconstructed from the hits left in the three sensors of the front arm are then extrapolated to the first GRPC and the impact position of the associated particle is determined. The absence of signal in the predicted position determines the inefficiency of that part of the detector.

To reduce the possible fake tracks provided by the EUDET telescope, the presence of signal associated to the predicated track in two out of the three remaining GRPC's was required.

3 Results

To check the good alignment between the DHCAL setup and the EUDET telescope, the barycentre of the clusters built from the hit pads of the first GRPC is compared to the predicted position of the particle impact on the detector. Figure 1 shows the correlation between the two. Usually the number of hit pads due to the particle passage is either one or two. The clusters barycentre coincides often with the pad centres or the inter-pad position.

Figure 1 shows clearly the correlation between the expected particle impact and the associated cluster barycentre for each set of events related to a given position of the GRPC with respect to the EUDET telescope.

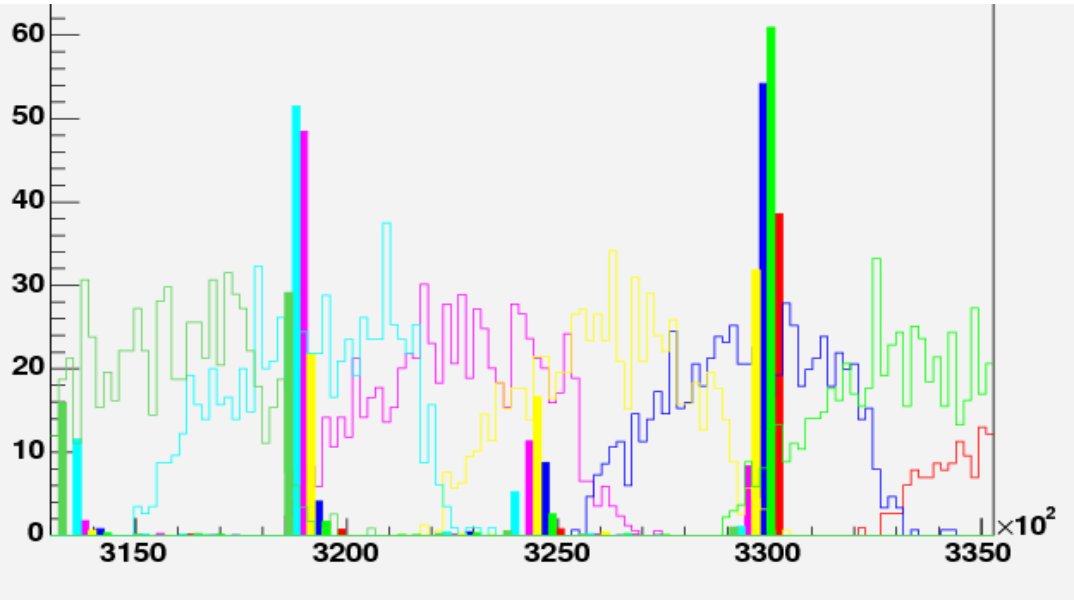

Figure 1

The tracks predicted by the EUDET telescope are then compared to those for which a cluster in the GRPC is associated. This is a direct measurement of the local GRPC efficiency.

Two interesting results are found. The first concerns the GRPC efficiency when the particle hits the GRPC in the inter-pad zones. Figure2 shows that the inter-pad zone efficiency does not differ from the other adjacent zones. This result confirms the idea that the shower extension at the anode level is larger than the inter-pad distance (500 microns in our case) which means that when the particle goes through the inter-pad zone, the shower created is well seen by the adjacent pads. Dedicated study is needed to show if the signal in this case is as large as the one detected when the particle crosses a pad zone.

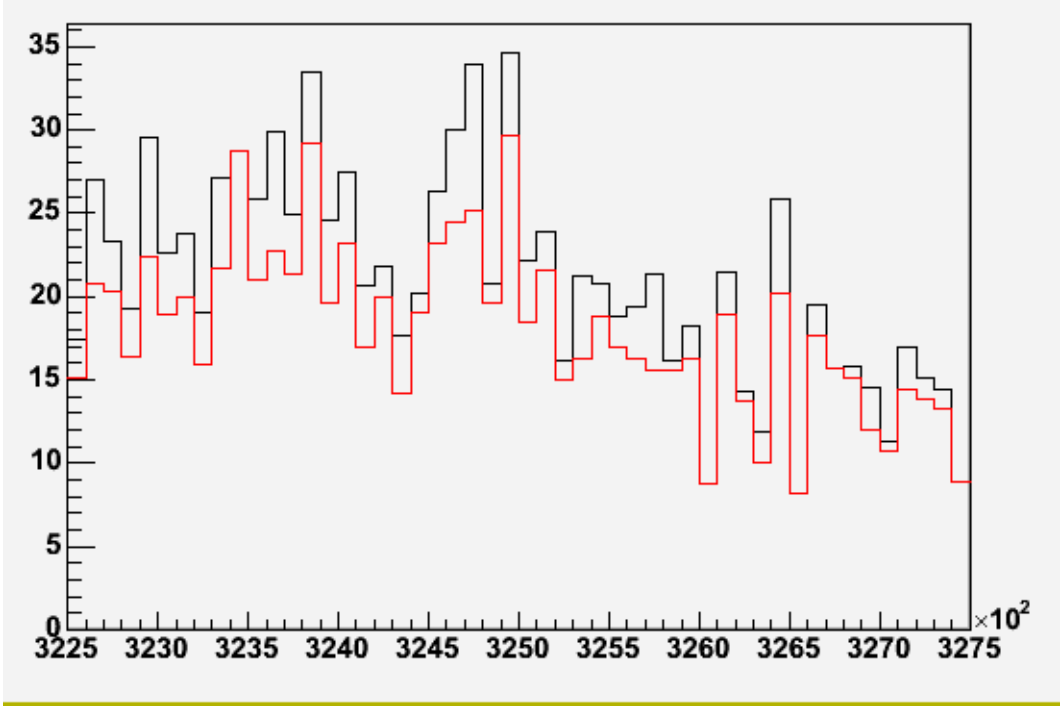

Figure 2

The second result concerns the edge effect. Figure3 shows that the efficiency of the edge zone is well below the one observed inside the detector (Figure2). Indeed up to 3 mm from the edge, the efficiency is 30-40% lower than the one observed inside the detector. This efficiency reduction may be explained by the electrical field deformation in the detector edge. However, more simulation study is needed to quantify such effect before to incriminate the electrical field deformation as the only reason.

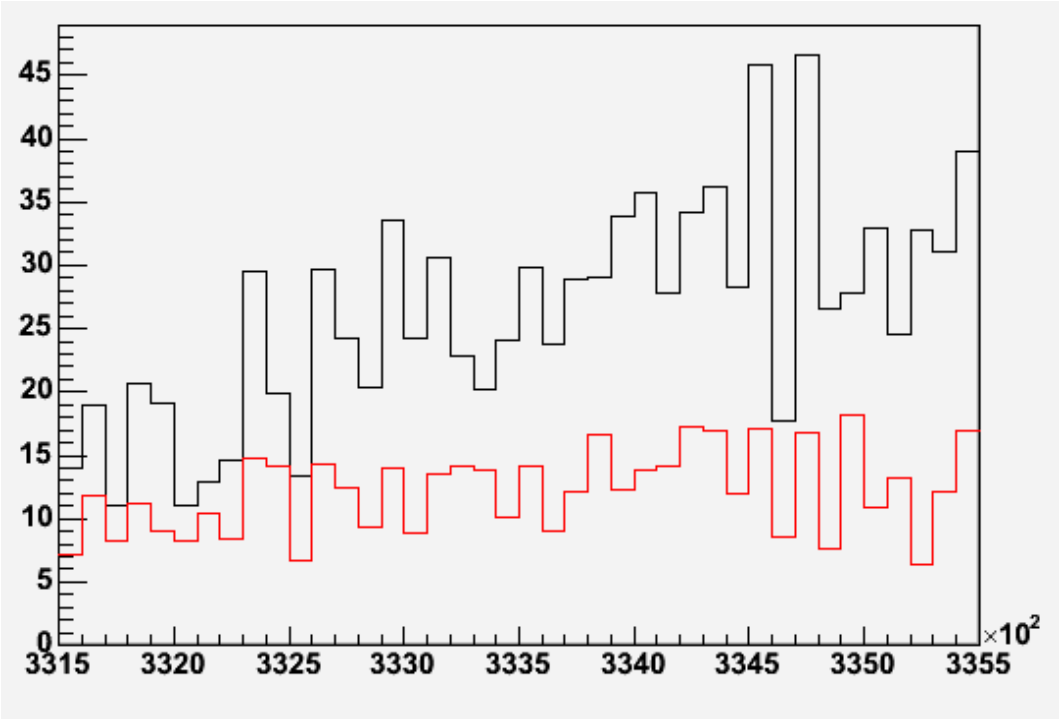

Figure 3

4 Preliminary conclusion

The use of the EUDET telescope in association with the DHCAL setup was a powerful tool to scrutinize the behaviour of the GRPC detector. The precision the EUDET telescope provides has helped to detect an edge effect that one has to solve in order to guarantee a very good efficiency all over the detector. It confirms that the choice of inter-pad distance of 500 microns is a good choice to prevent a possible inefficiency.

Acknowledgement

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