Online data processing with the CBM-MVD prototype*

Q. Li, S. Amar-Youcef, M. Deveaux, C. Müntz, and J. Stroth for the CBM-MVD Collaboration

Institut für Kernphysik, Goethe-Universität, Frankfurt, Germany

The CBM Micro Vertex Detector (MVD) will have to handle high data rates and occupancies, which calls for efficient data processing. We study the option to complement the on-chip zero suppression of the CMOS sensors by an online cluster finding and classification. The aim is to exploit the computing resources of the FPGAs controlling the sensors without increasing the network bandwidth needed for the consecutive data transport.

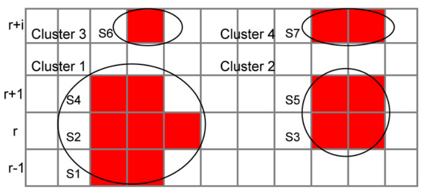

Figure 1: Clusters encoded in states

Our study relies on the MIMOSA-26AHR (M26) CMOS sensors [1] known from the MVD prototype. These sensors host digital circuits for data sparsification, which group up to four consecutive fired pixels in a line into a so-called state. This shape information is encoded together with the column number of the first pixel into a 16-bit word. Separate data words are needed to indicate the line number of the group. Fig. 1 shows an example of four hit clusters comprising seven states (S1-S7) and four states for line information (not shown). In the example, one requires 11 words of 16 bit to encode four clusters. In general, the precise number of states depends on the detector occupancy and the cluster shape.

Our strategy for data pre-processing is to perform an FPGA-based cluster finding and to fit each of the resulting clusters into a single 32-bit word. As 22-bits are needed for position information, 10-bits remain for encoding the cluster shape. This space is insufficient to encode the pixels bit-wise. Therefore, it was considered to attribute a unique shape code to a given cluster shape. Provided, the total number of different cluster shapes found in the MVD data remains below 1024, this concept allows for a lossless encoding of the experimental data.

To test this approach, the cluster finder was implemented in C++ and tested with data from CBMRoot simulations and experimental data obtained from the beam test of the MVD prototype in Nov. 2012 at the CERN-SPS. The six stations of the prototype allowed for a precise tracking of the traversing high energy pions and hence, for selecting high-purity tracks and clusters. Data on the shape of the clusters was recorded for various sensor temperatures, inclination angles, and discriminator thresholds. Fig. 2 presents preliminary results on the dependence of the mean number of fired pixels per cluster as a function of inclination angle for three different applied discriminator thresholds. In general, the number of pixels in a cluster is smaller than known from earlier studies (see for example [2]). This is due to the more efficient charge collection mechanism found in the partially depleted active volume [3] of the novel sensor. Fig. 3 shows the cluster shape distributions and the eight most frequent cluster shapes. Only substantially less than 0.01% of all measured clusters (the ones with ShapeCode=0) could not be encoded with the shape code algorithm proposed.

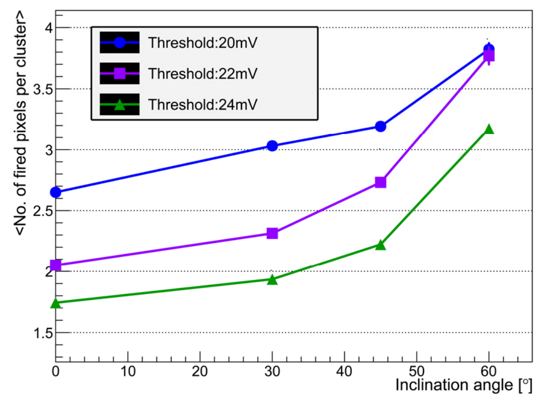

Figure 2: Mean cluster size

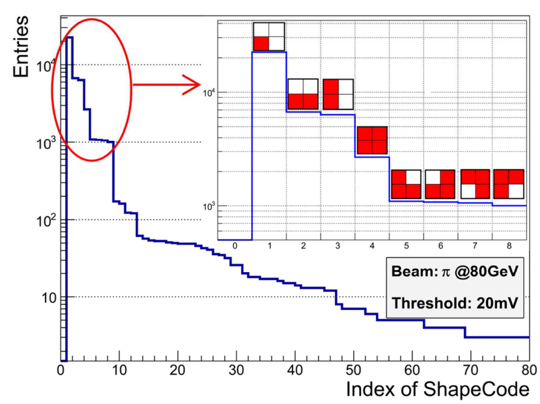

Figure 3: Cluster shape distribution

Both preliminary results are in favour of the strategy proposed. Still, the analysis of the experimental data remains to be completed and simulations are needed to confirm the conclusion for the higher occupancies of the real MVD. Hereafter, the algorithm will be encoded on FPGA.

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References

[1] C. Hu-Guo et al., NIM-A 623, P. 480-482 (2010)
[2] C. Dritsa et al., POS(BORMIO2010)015
[3] A. Dorokhov et al., NIM-A 624, P. 432-436 (2010)