CERN Summer Student Report
Primary Vertex Reconstruction in ATLAS

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Abstract

The project is to implement the new algorithm for primary vertex reconstruction(vertexing) and test its performance with Monte Carlo simulation. Properties of the vertices are being studied to improve the performance.

1 Introduction

Vertex fitting serves two purposes. The first is to estimate the position of the point of interaction and the momentum vectors of the track emerging from this point. The second is to check the association of tracks to a vertex. Figure 1 shows the vertex topologies in ATLAS: primary and pile up vertices, vertices from conversions and long-lived particles, vertices in jets and vertices from decay chains. Therefore an accurate primary vertexing algorithm is of fundamental importance for physics analysis.

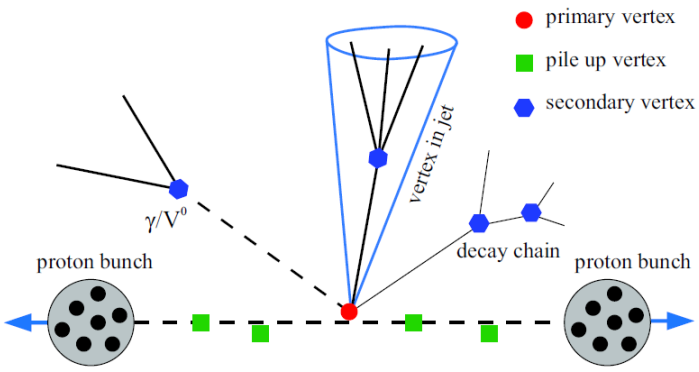


Figure 1: Vertex topologies

2 Medical Imaging Vertexer

ATLAS now adpots the new seeding algorithm, Medical Imaging Vertexer (MIV), inspired by Positron Emission Tomography (PET).

Figure 2 shows the collaboration diagram of the algorithm. The seeding algorithm (MIV) filters the noise and produces the approximated primary vertex positions (seeds). The seed is re-defined in the cluster finding process with track density above certain threshold.The precise vertex position is then found in the vertex fitting part using least square fitting and Kalman filter.

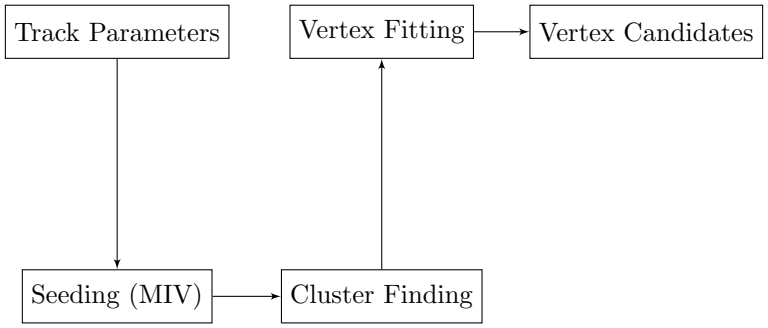
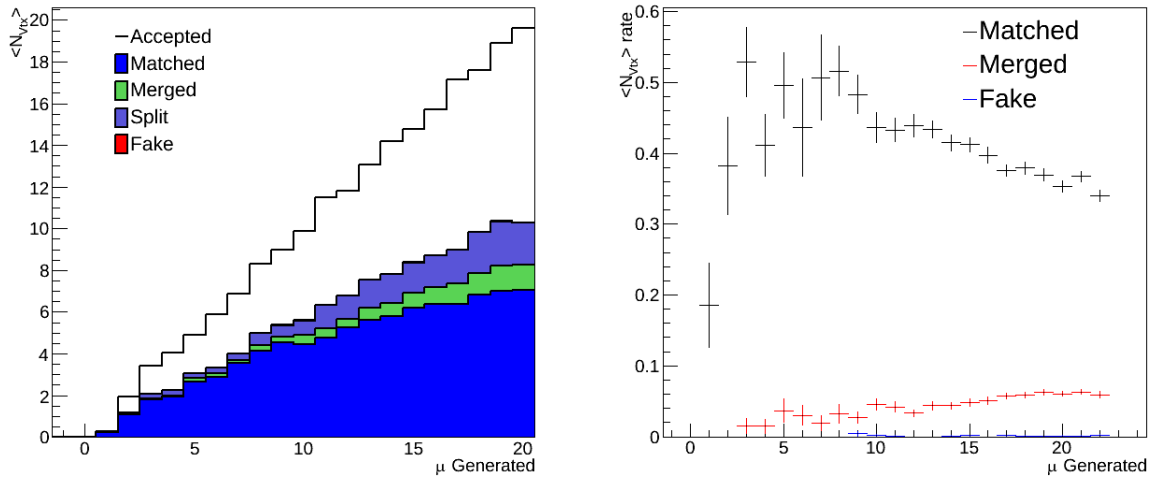


Figure 2: Collaboration diagram showing the idea of vertexing

3 Algorithm Performance



(a) Number of reconstructed vertex

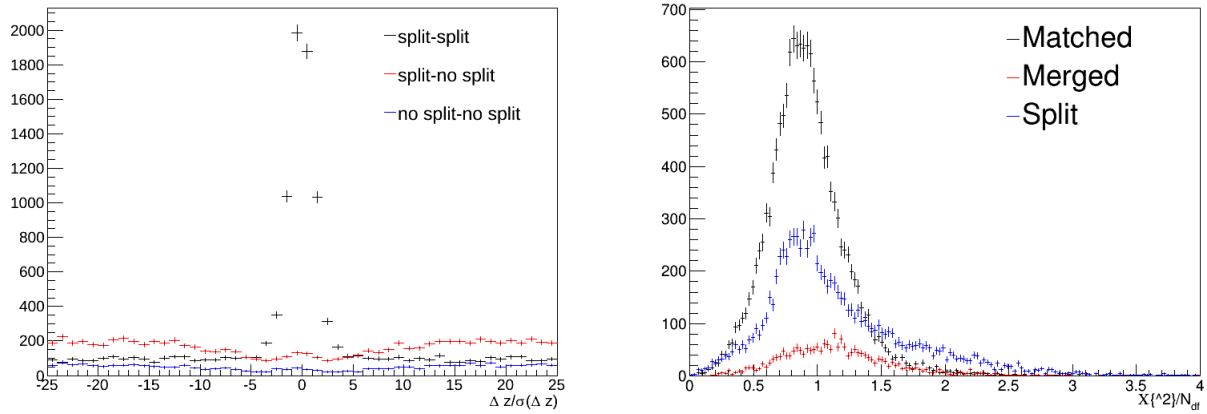
(b) Rate of reconstructed vertex

Figure 3: Vertexing performance

The algorithm performance was studied with $\sqrt{s} = 8$ TeV Monte Carlo sample.Figure 3a is a stacked histogram showing the number of recostructed primary vertex as a function of number of interactions. The number of split and merged vertices increases with the number of interactions. The number of split vertex is

greater than the merged vertex, which shows that the split vertex is a dominated problem in reconstruction. Figure 3b shows the corresponding reconstructed rate. The matched rate is significantly reduced when the number of interaction increases. Therefore, the efficiency of vertexing is expected to be lower for high-pile up event.

4 Re-merge Split Vertex



(a) Primary vertex displacement in z coordinate

(b) χ^2_{red} distribution of the primary vertex

Figure 4: Plot for split vertex identification

Figure 4a shows the primary vertex displacement in z coordinate. The distribution of the split vertex peaks at zero. Hence, a selection cut is applied in the interval close to zero to re-merge most of the split vertices. Figure 4b shows the χ^2_{red} distribution of the primary vertex.

5 Conclusion

The vertex displacement and $\sum p_T^2$ (not shown here) are good criteria for split identification. Studying in Monte Carlo sample with high centre of mass energy and develope tools for merging split vertices are being done in future.

References

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[2] R. FRÜHWIRTH et al. Data Analysis Technique for High-Energy Physics Second Edition (Cambridge University Press, 2000), Chapter 3.4

[3] E. Bouhova-Thacker et al. Vertex Reconstruction in the ATLAS Experiment at the LHC, ATL-INDET-PROC-2008-003