A NEW CLUSTER FINDER FOR THE ALICE MUON ARM FOR RUN3

SEAN MURRAY
mrrsea003@myuct.ac.za

INTRODUCTION

ALICE is moving to a new framework for Run3 merging offline and online software. The muon electronics will be triggerless. The muon reconstruction performance is to be improved. The algorithms need to rewritten or migrated into the new framework, alternatively new algorithms implemented. The cluster finding takes up about 70% of the reconstruction time for the muon arm. The key points to consider

- The current code while slow, runs well and is deemed to be accurate and therefore the benchmark.
- The algorithm for finding the cluster centers needs to be stable under all conditions.

LEGACY ALGORITHM

The legacy algorithm is a heavily modified Maximum Likelihood Expectation Maximisation (MLEM). It combines the bending and non-bending planes of cathodes into a pixelated anode plane. It uses an iterative process to find the seeds for a Mathieson fit[3]. If there are more than 3 seeds for a precluster, the precluster (a grouping of adjacent pads) is then split.
Reconstruction time for each part of the reconstruction process as a % of total time:

	Time in		
Function	2016 pp	2011 PbPb	2015 PbPb
Data Decoding	4	3	1
Data Filtering	2	2	1
PreClustering	10	10	10
Clustering	63	68	72
Tracking MCH	7	6	5
Tracking MID	6	6	6
Track match	8	5	5

MCH = Muon tracking chamber
MID = Muon trigger

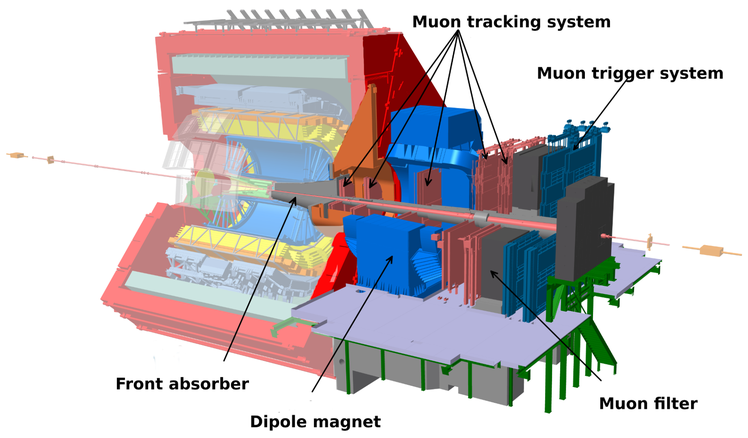
RADIAL BASIS FUNCTIONS

Radial Basis Function (RBF) Neural Network is a type of 3 layer feed-forward neural network. A radial basis function is any real-valued radially symmetric function. We used a Mathieson fit[3] due to the detector being made of cathode pad chambers with narrow cathode anode distance. A weighted mean subtractive clustering was applied to get the centers for the the Radial basis functions for learning on the training set.

REFERENCES

[1] Zinchenko et. al. NIMA 502 (2003) 778-780
[2] Internalnote: ALICE-INT-2003-006 ALICE Internal Note Feb 19 2003
[3] Mathieson, E. NIMA270 (1988) 602-603

MUON DETECTOR AND CLUSTERS



ALICE apparatus with muon arm highlighted

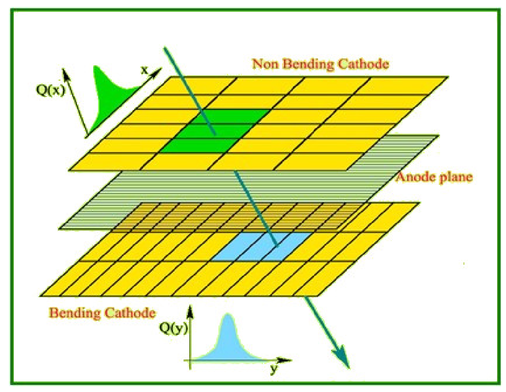
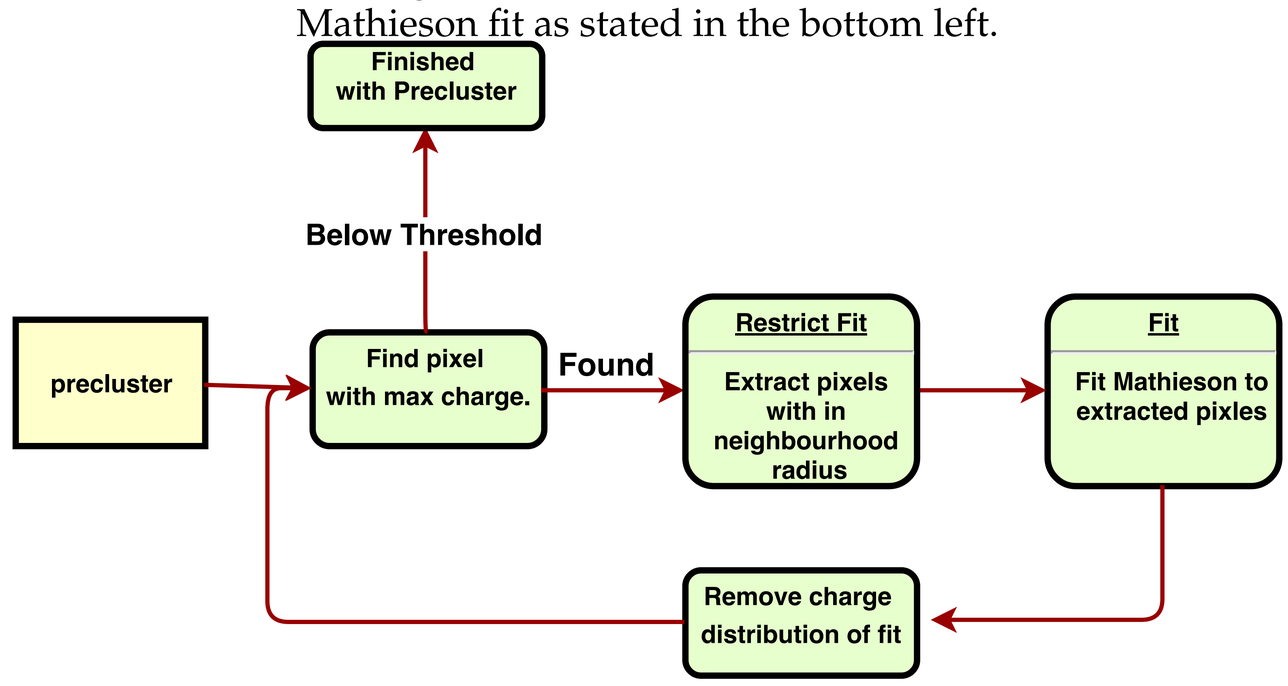


Diagram showing the bending and nonbending planes spanning the anode wire plane

ALGORITHM

We have a functioning algorithm, and a large data set, we therefore have a lot of training data and test data. The bending plane (Y) and non bending plane (X) detectors are still combined into a pixelated anode, by dividing the cathode pads as they are orthogonal. The anode dataset is then sent through the RBF neural network. The basis function of which the Mathieson fit as stated in the bottom left.



The weighted mean subtractive clustering is used in the training set. The neural network is then trained via : Apply the weighted mean subtractive algorithm to samples, compute the hidden units in the RBF network, compute the weights between the outer and hidden layers.
Comparison of legacy (current) with the new cluster finder:

Legacy method, 1000 Υ [2]			
Nominal Background level	0	1	2
Eff ($\pm 3\sigma_x$), [%]	99.5	98.2	96.7
Eff ($\pm 3\sigma_y$), [%]	95.5	92.7	89.5
time/event [sec]	0.2	0.7	1.0
New method, 1000 Υ			
Nominal Background level	0	1	2
Eff ($\pm 3\sigma_x$), [%]	95	92	88
Eff ($\pm 3\sigma_y$), [%]	93	90	86
time/event [sec]	0.1	0.3	0.5

Performance results of the legacy (current) cluster finder and the cluster finder for 3 different, nominal backgrounds. Efficiency is the relative number of hits with residuals with in the windows defined above. σ_x and σ_y are the values used in the track reconstruction namely, 1.44mm and 0.1mm respectively. The CPU timing was performed on an Intel Xeon E5-2660 .
The 1000 Υs decay was chosen as it was the original comparison to compare the soon to be legacy cluster finder with its predecessor, in the original internal note [2]. It is clear that more tuning is required to get the algorithm as accurate as the legacy algorithm. The new algorithm is faster by a factor of 2, though without a similar efficiency it is not usable.
The algorithm is designed with a GPU in mind, and the imminent migration should improve these numbers significantly.

GOING FORWARD

The algorithm is migrating to NVIDIA GPU, and the new ALICE O2 framework. The choice of NVIDIA is due to being readily available but the OpenCL library will be used to be hardware agnostic.

SOURCE CODE

The source code resides on a branch of AliRoot, the current ALICE software framework, on github.
Poster #575