

# Track Properties by Tracklet Seed



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# Overview

- **Graphs and Results**

- Analyzed MC Samples with hybrid **algorithm restricted to using particular tracklet seeds**
  - 9000: 2 - 100 GeV single-muon & single-electron events with 2 - 8 GeV counterparts
  - Restricted algorithm to tracking seeds L1L2, L3L4, etc.
    - Also ran an unrestricted algorithm
  - Measured some properties
- **Found performance dip for particular seeding combination**
  - Was due to a bug in the tracking algorithm
  - This doesn't influence the unrestricted algorithm, though

- **How I Did This**

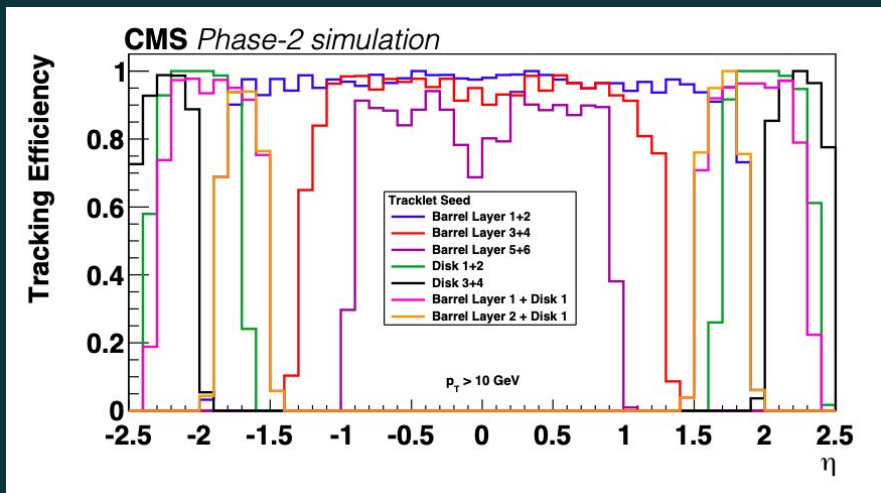
- **My plotting script is up on GitLab**
  - Takes in outputs of `L1TrackNtuplePlot.C()` and overlays chosen graphs/histograms on one another (these could be “eff\_eta”, “resVsEta\_ptRel\_H\_68”, etc.)

# Graphs and Results

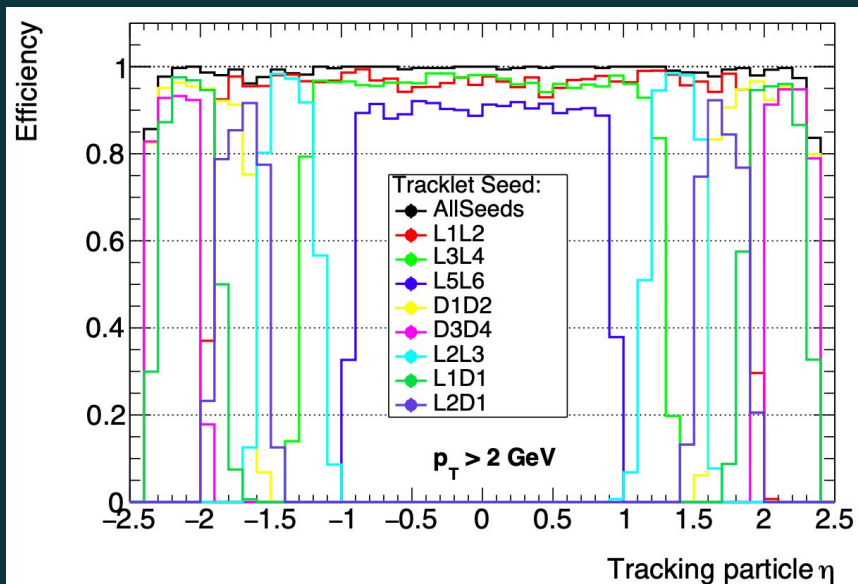
*$\eta$  efficiency for  $\mu$ : 2016 vs. 2020*

**NB:** The previous dip in the efficiency of L5-L6 based tracks for low pseudorapidity is no longer present.

THEN (2016)



NOW



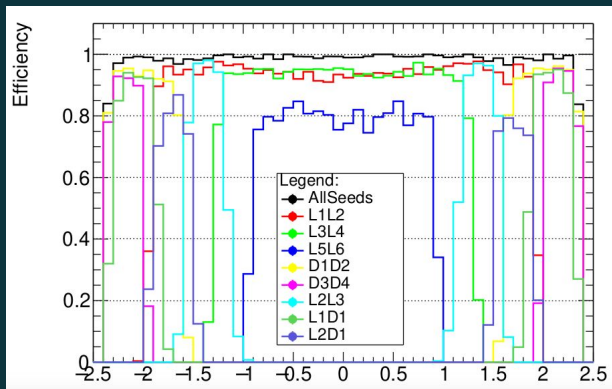
From <https://arxiv.org/pdf/1910.09970.pdf>

# Graphs and Results

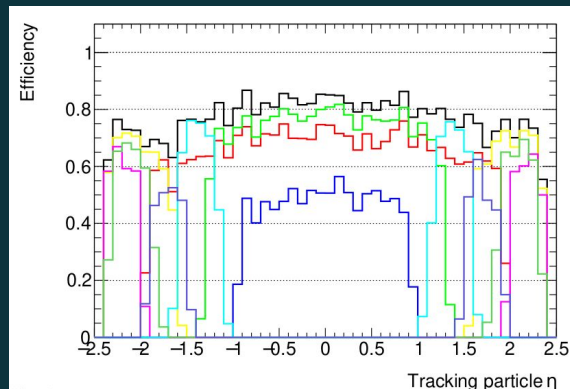
$\eta$  efficiency for  $\mu$  and  $e$

2 - 8 GeV

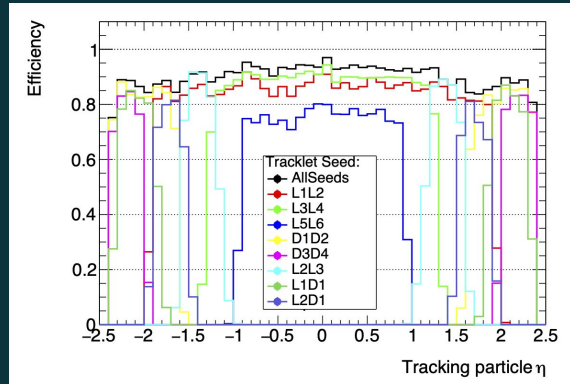
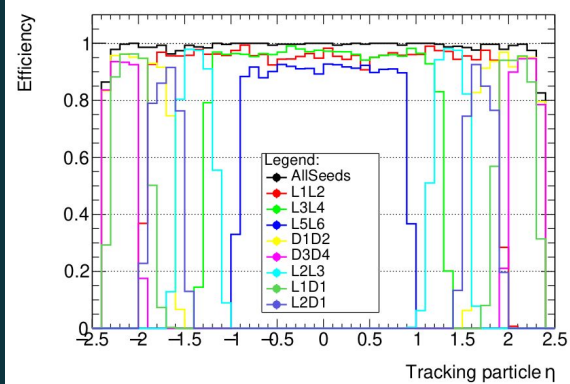
$\mu$



$e$



10 - 100 GeV

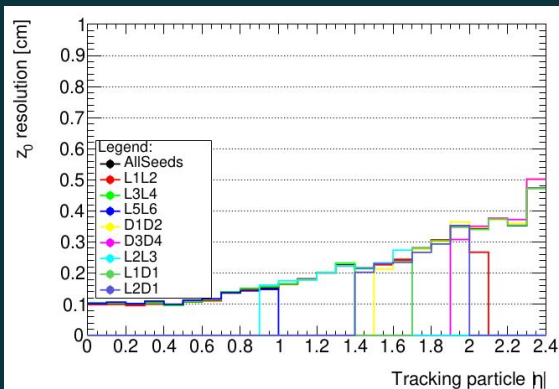


# Graphs and Results

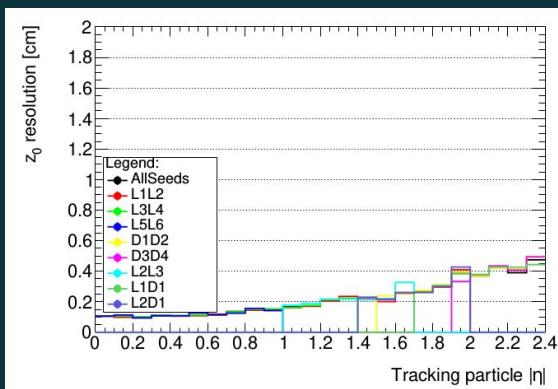
*res vs.  $|\eta|$ :  $z_0$  for  $\mu$  and  $e$*   
 68% of ( gen - reco ) distribution width for each eta

2 - 8 GeV

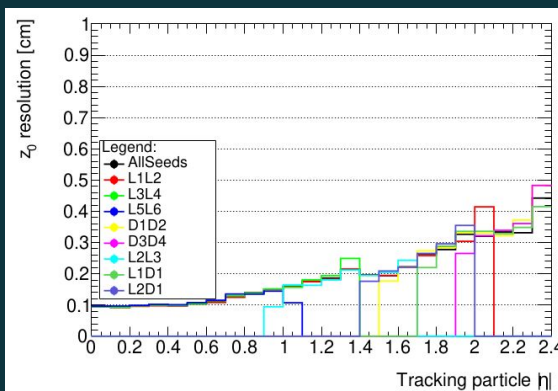
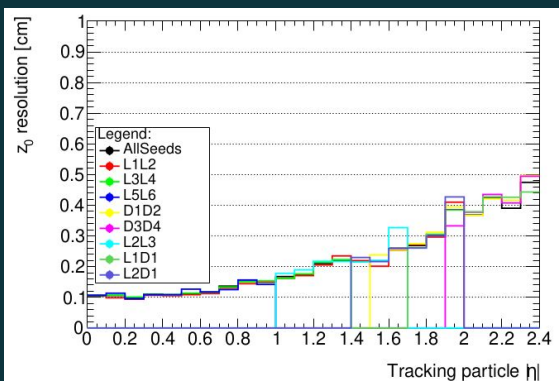
$\mu$



$e$



10 - 100 GeV

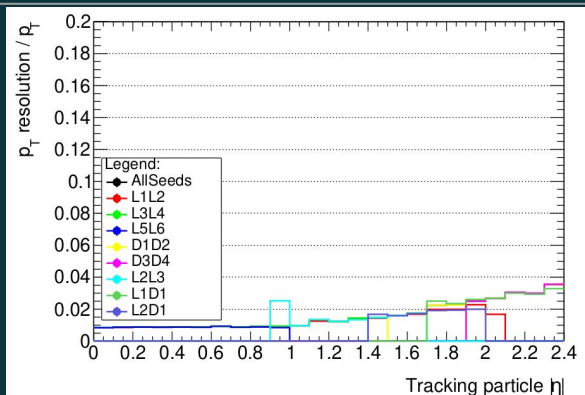


# Graphs and Results

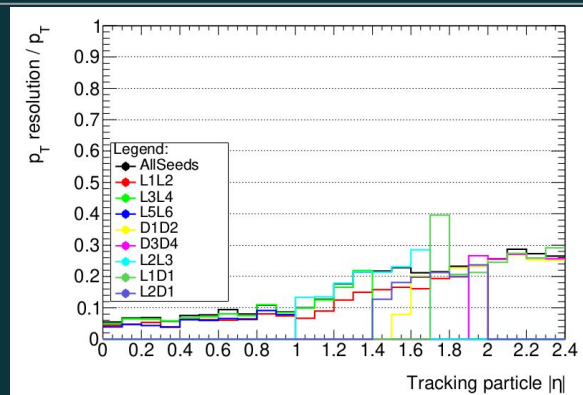
*res vs.  $|\eta|$ :  $p_{T, Rel}$  for  $\mu$  and  $e$*   
 68% of ( gen - reco ) distribution width for each eta

2 - 8 GeV

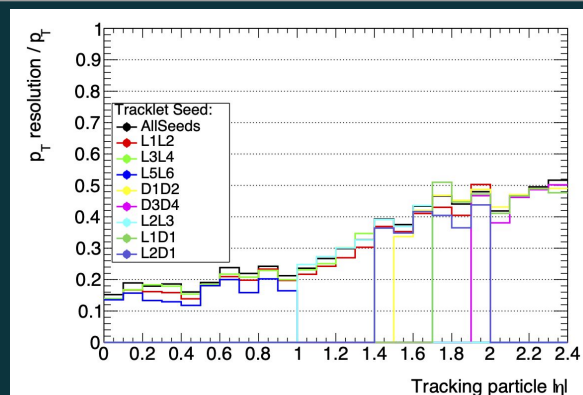
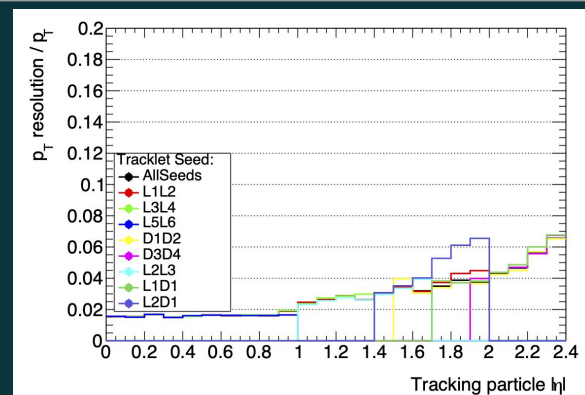
$\mu$



$e$



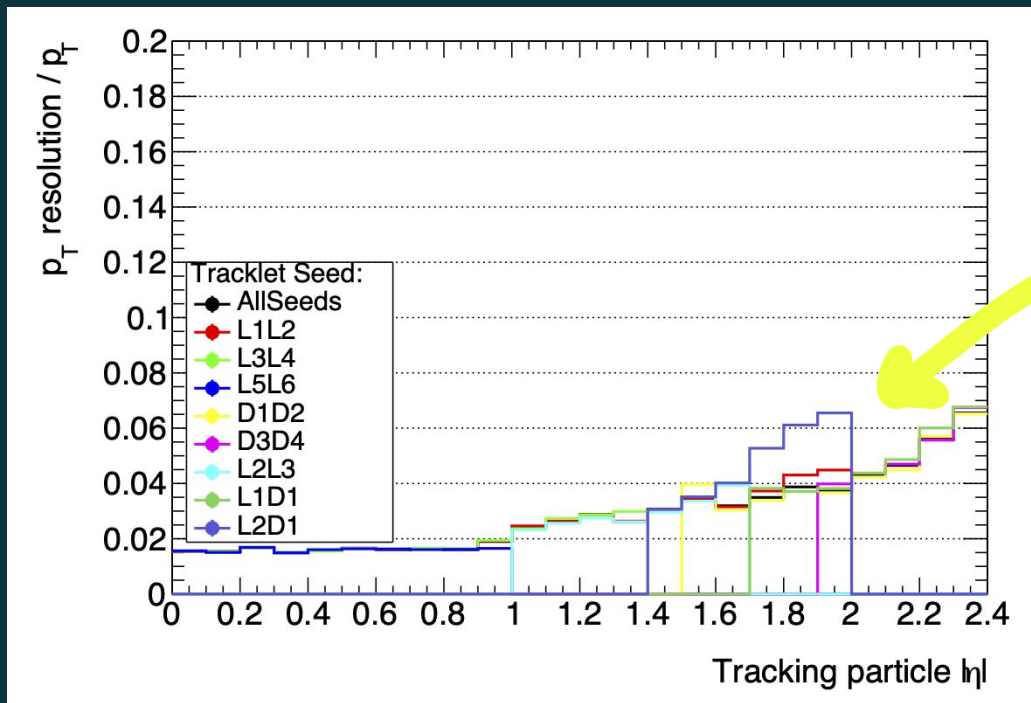
10 - 100 GeV



# Graphs and Results

Low  $p_T$  res. in L2D1 seeds

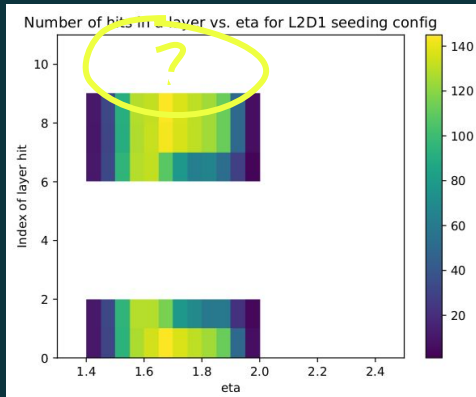
*Hey wait, what's up with that thing?*



$p_{T\text{ Rel}}$  res vs.  $|\eta|$  (Single Muon, 10 - 100 GeV)

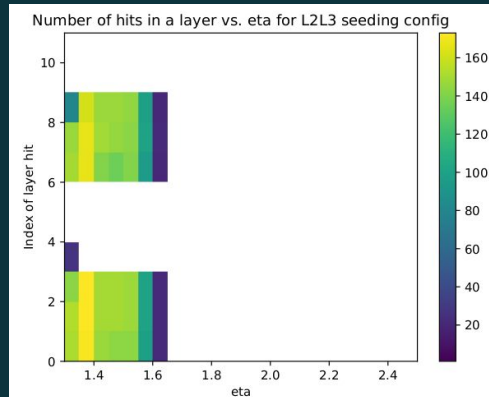
# Graphs and Results

Low  $p_T$  res. in L2D1 seeds

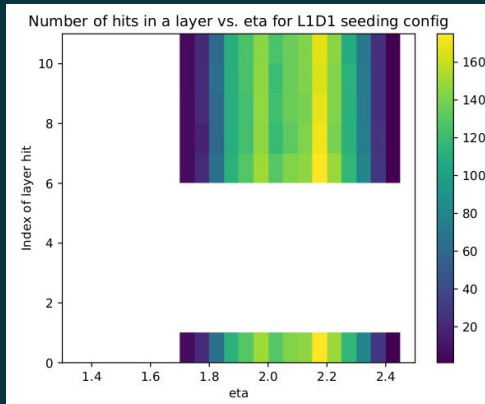


**L2D1**

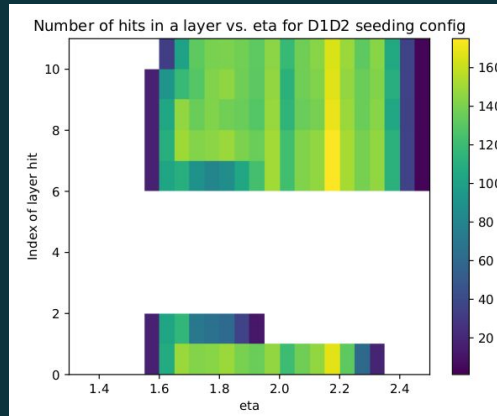
*L2D1 seeds not propagating to D4*



**L2L3**



**L1D1**



**D1D2**

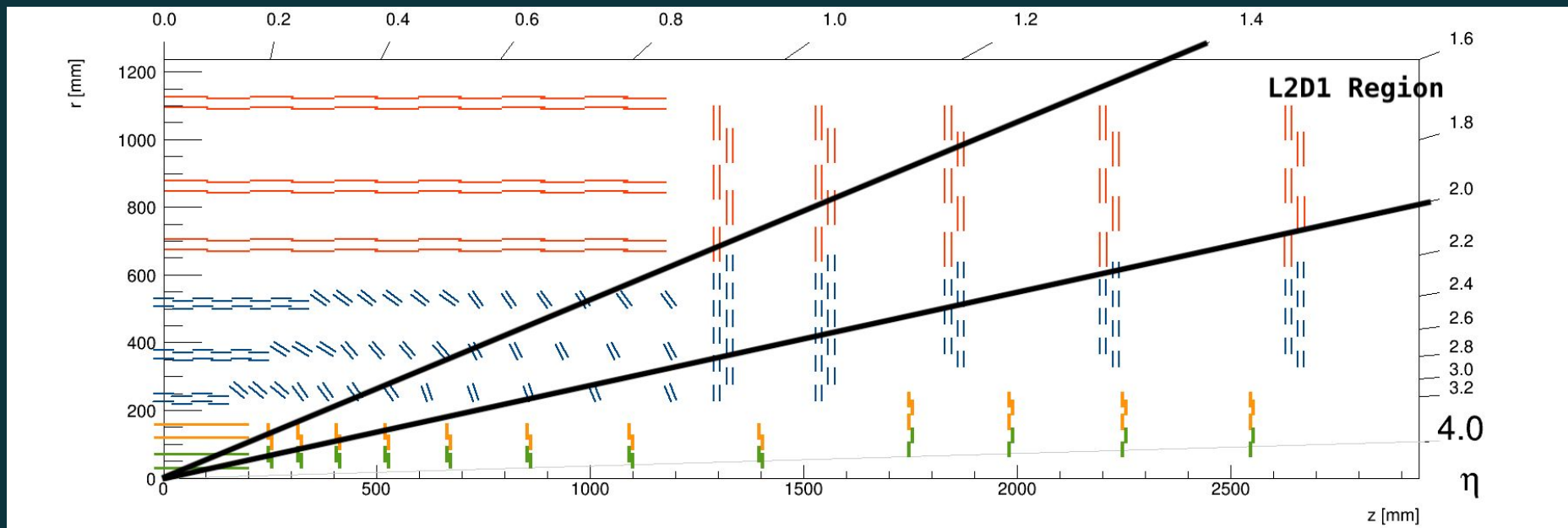
(Single Muon,  
2-100 GeV<sup>8</sup>)



# Graphs and Results

Low  $p_T$  res. in L2D1 seeds

*This doesn't make sense with the tracker geometry.*



*Future tracker geometry "T14" that these samples ran on.*

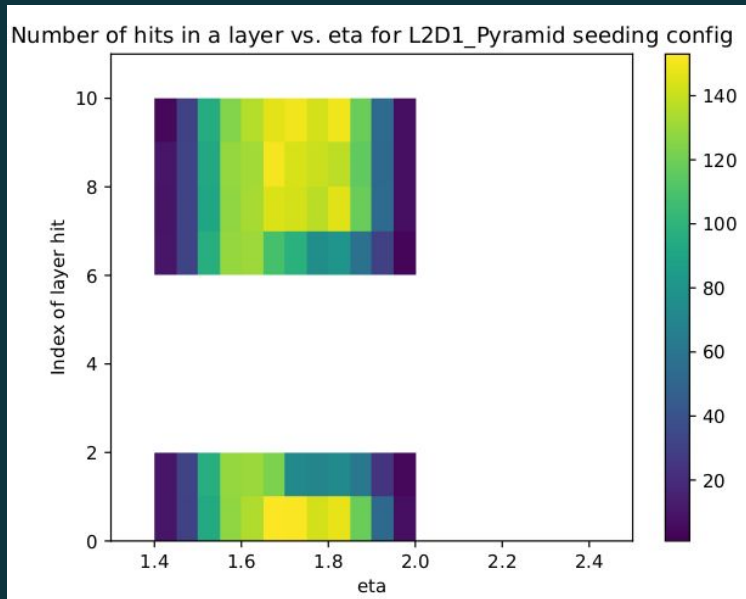
**NB:** The L2D1 region clearly encompasses discs 4 and 5.

# Graphs and Results

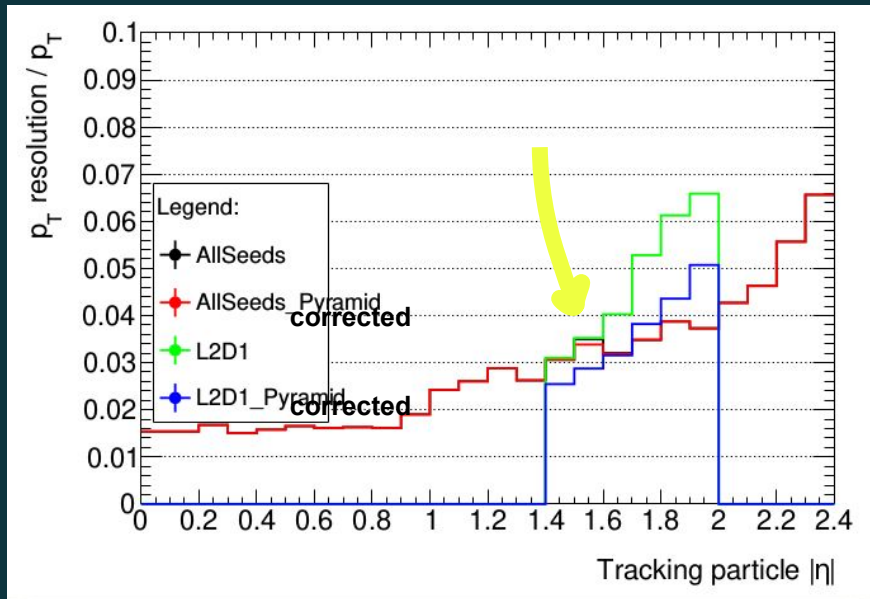
Low  $p_T$  res. in L2D1 seeds

*So what went wrong?*

There was a place in the code intended to prevent L2L3 tracks from seeding to D4 that was also preventing L2D1 tracks from seeding there. This was corrected.



The problem is fixed!



L2D1  $p_T$  resolution becomes ~30% better.

# How I Did This

## *Specialized plotting function*

- **Workflow**

- Change flags to restrict seeding layers, produce stubs and analyze
- Shove seeding-layer-restricted Ntuples through L1TrackNtuplePlot.
- Then...

- **overlayPlot.C()**

- Makes plots from different seeding layers with a plot type...
  - “eff\_eta”, “resVsEta\_ptRel\_68”
- ...a common prefix...
  - “output\_TTbar\_PU200\_”
  - “output\_SingleMu\_PU0\_”
- ...and a set of identifying suffixes.
  - “L1L2”, “L2D2”, “AllSeeds”

```
// -----  
// OVERLAY PLOT: A function that takes in plot output files with a common prefix ("output_TTbar_PU200_", etc.)  
// and an output graph to overlay and overlays the output graphs on top of one another, using the part of the  
// files that isn't common as the legend.  
//  
// This function was originally created to compare properties of tracks that come from different seeding  
// configurations. To produce these files, go to interface/Constants.h and set "d0L1L2" (etc) flags to restrict  
// allowed seeding layers for the tracklet algorithm. Then, use L1TrackNtuplePlot.C to produce plot output files  
// from the results of these restrictions.  
//  
// Parameters:  
// - plot_name: name of the plot to be compared across plot output files. ("eff_eta H", "tp_pt", etc.)  
// - common_prefix: the name that the output files share. Can also begin with a directory.  
// - suffixes: a list of the suffixes of the plot output files you are overlaying. This list  
//   will be used as the legend.  
// - group_name: an optional parameter that allows easy separation of output files. For example, I  
//   created this parameter to deal with comparing track properties for different tracklet seeding  
//   configurations for electrons and muons separately.  
//  
// "Sort of parameters" but actually just variables set in the code:  
// - "displayText": This can be commented out if no text needs to be displayed.  
// - All of the plotting stuff. (Legend position, draw options, etc.)  
// - output location: this function outputs a single graph to the location specified in "save output as pdf".  
//  
// Run this file with:  
// root <options> 'overlayPlot(  
//   <name of plot in output to overlay>,  
//   <common prefix of output files>,  
//   <array of suffixes of output files>,  
//   <optional group name>  
// )'  
void overlayPlot(TString plot_name, TString common_prefix, std::vector<TString> suffixes, TString group_name="") {  
    SetPlotStyle();  
    // load trees  
    const int NUM_SUFFIXES = suffixes.size();  
    TH1F* h_output[NUM_SUFFIXES];  
    for (int suffix = 0; suffix < NUM_SUFFIXES; suffix++) {  
        TFile* file = new TFile(common_prefix + suffixes[suffix] + ".root");  
        h_output[suffix] = (TH1F*)file->Get(plot_name);  
    }  
    // set colors; draw the histograms  
    TCanvas c;  
    for (int suffix = 0; suffix < NUM_SUFFIXES; suffix++) {
```



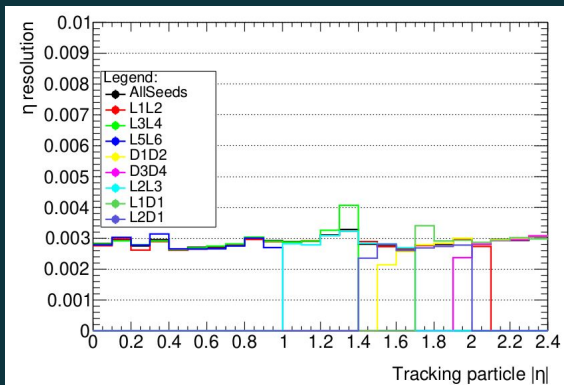
# Graphs and Results

*res vs.  $|\eta|$ :  $\eta$  for  $\mu$  and  $e$*

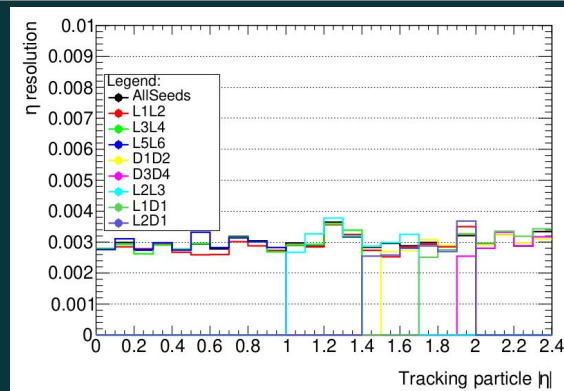
68% of ( gen - reco ) distribution width for each eta

2 - 8 GeV

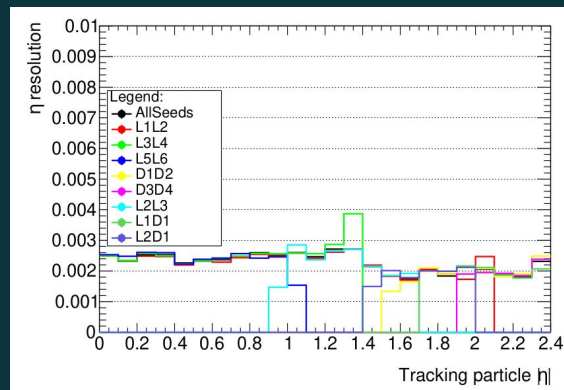
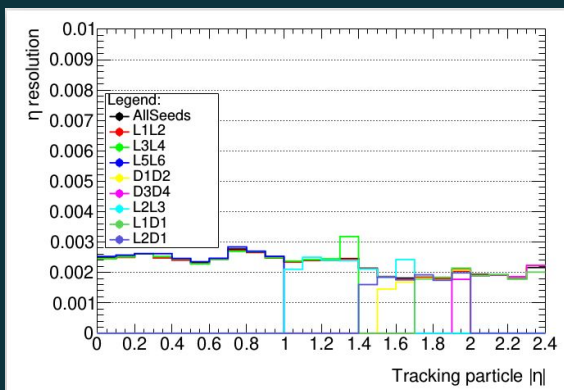
$\mu$



$e$



10 - 100 GeV

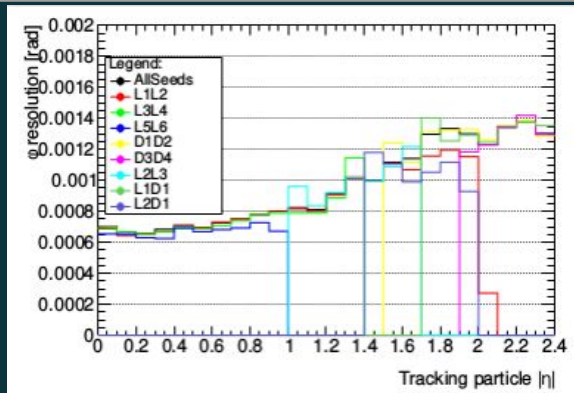


# Graphs and Results

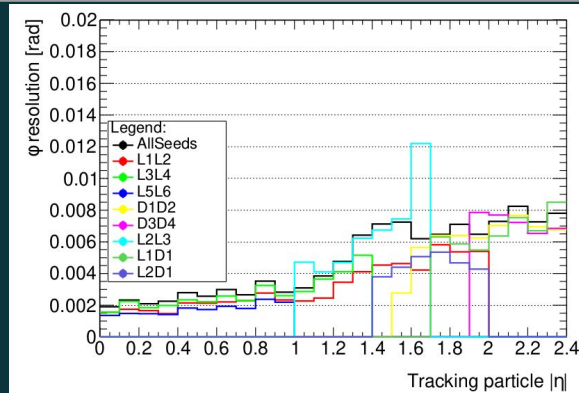
*res vs.  $|\eta|$ :  $\phi$  for  $\mu$  and  $e$*   
 68% of ( gen - reco ) distribution width for each eta

2 - 8 GeV

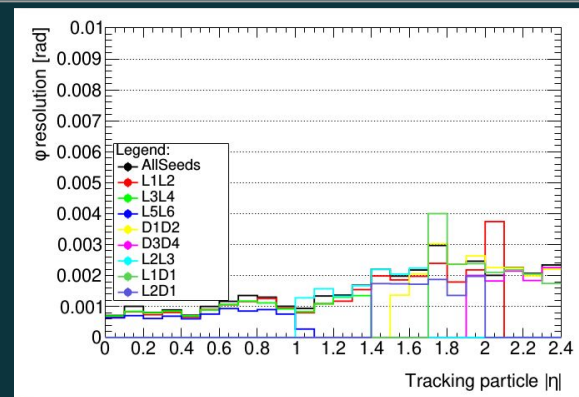
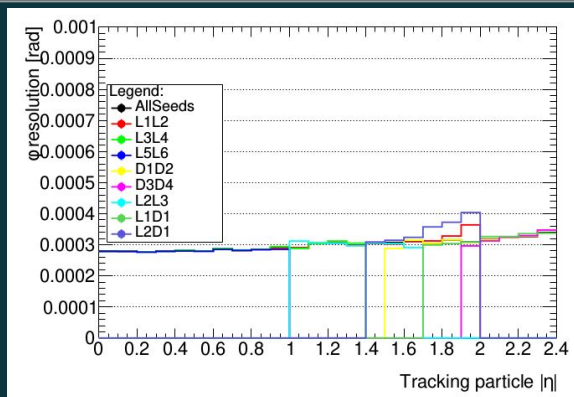
$\mu$



$e$



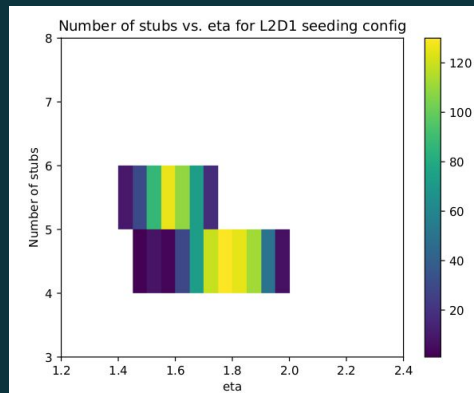
10 - 100 GeV



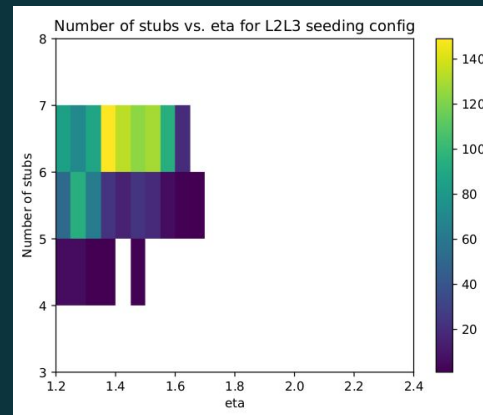
# Graphs and Results

Low  $p_T$  res. in L2D1 seeds

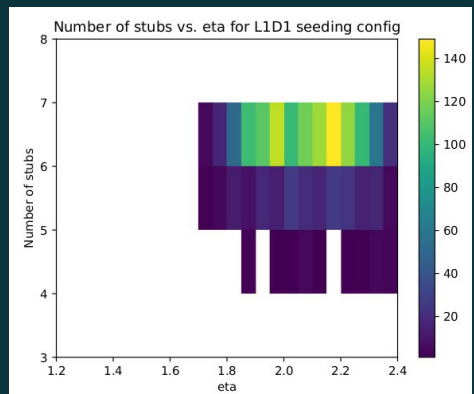
*Fewer hits here vs. other seed configs*



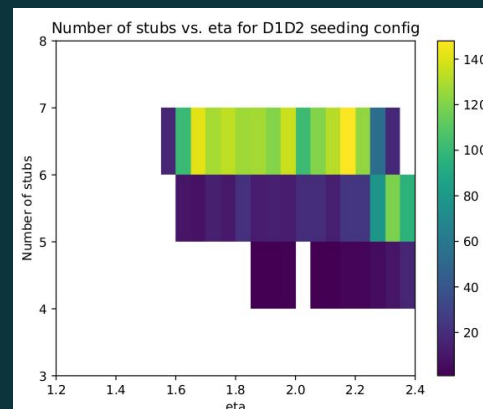
**L2D1**  
**5 stubs** (max)



**L2L3**  
**6 stubs**



**L1D1**  
**6 stubs**



**D1D2**  
**6 stubs**

(Single Muon,  
2-100 GeV)