SHINE Reconstruction Software Overview

CERN Collaboration Meeting, 2/11/20
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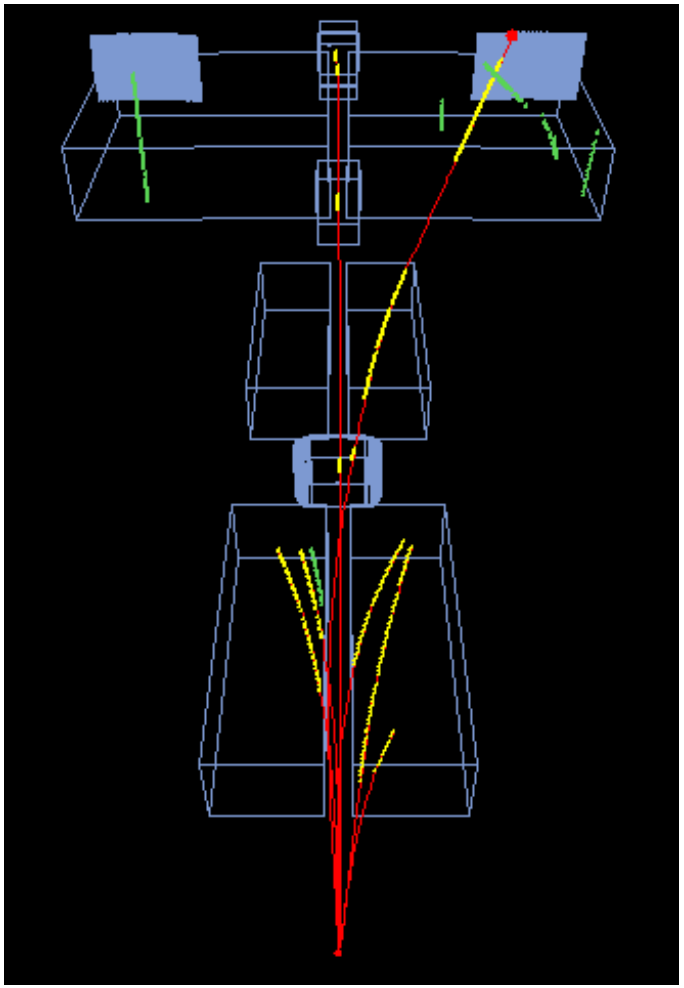
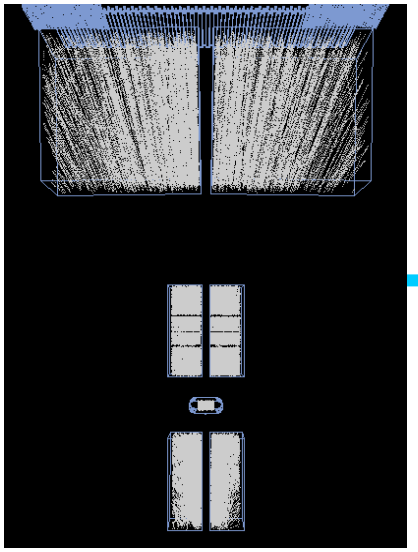
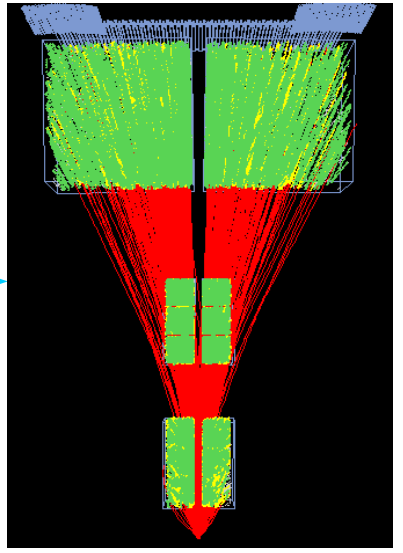
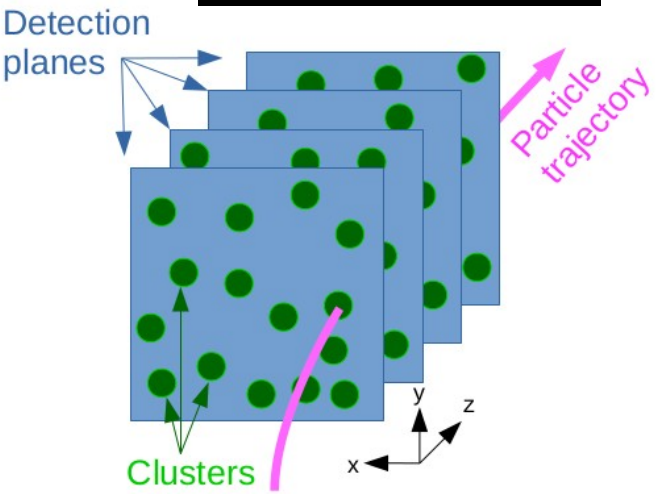
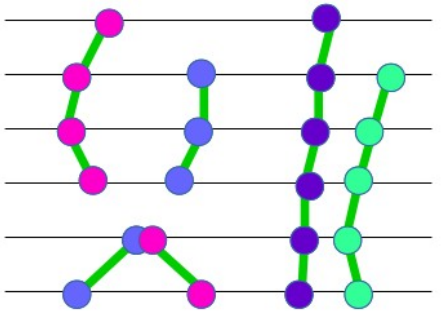










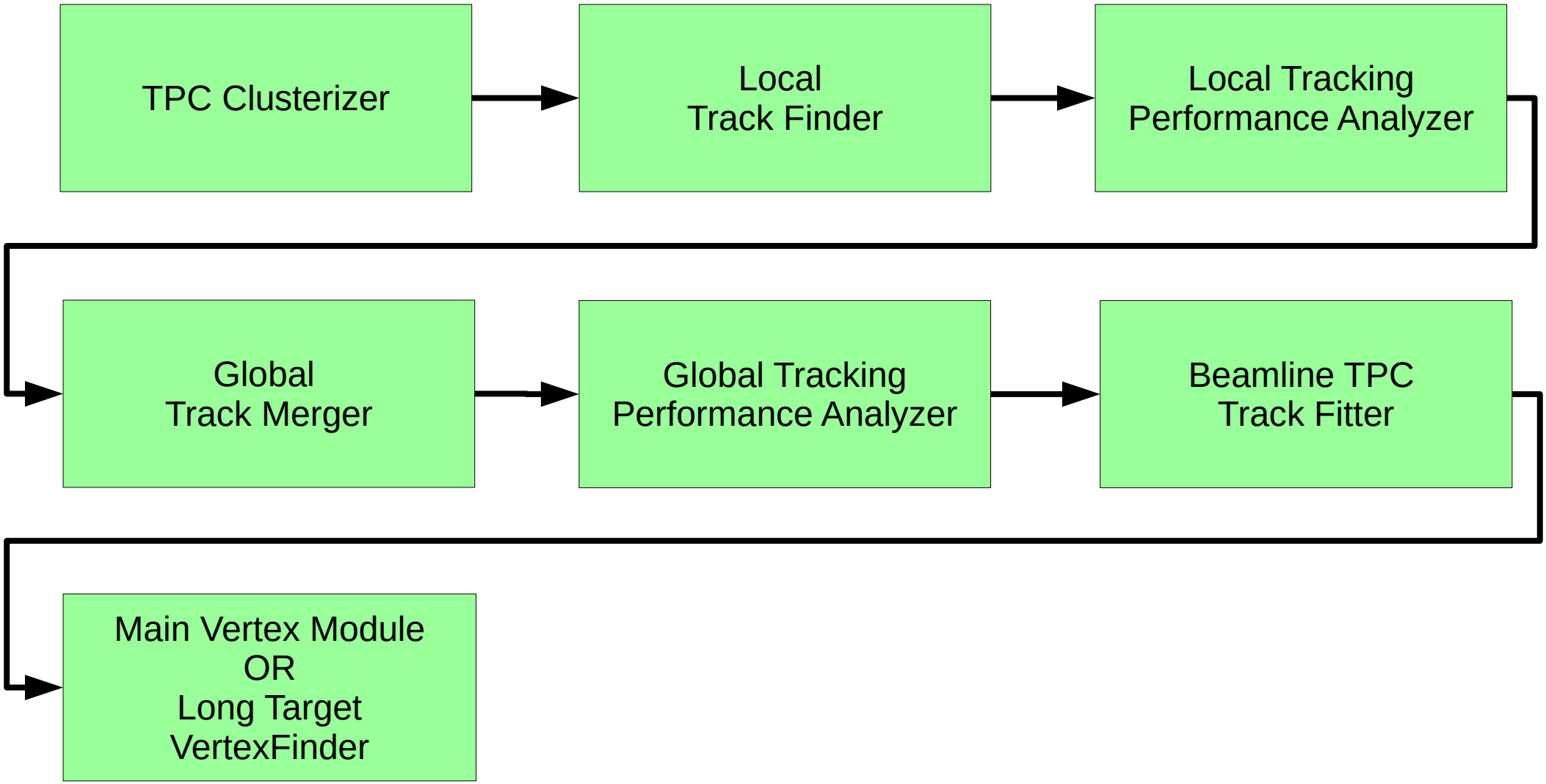
Overview

- Introduction
  - TPC Reconstruction Chain
  - Additional Reconstruction Modules
  - Calibration / Analysis modules

Introduction

- This talk will cover major reconstruction software modules
- Will use terminology from SHINE software framework
- Will assume familiarity with TPC operational principles
- If you’re not familiar with these terms or want a definition, please ask!

SHINE TPC Reconstruction Chain

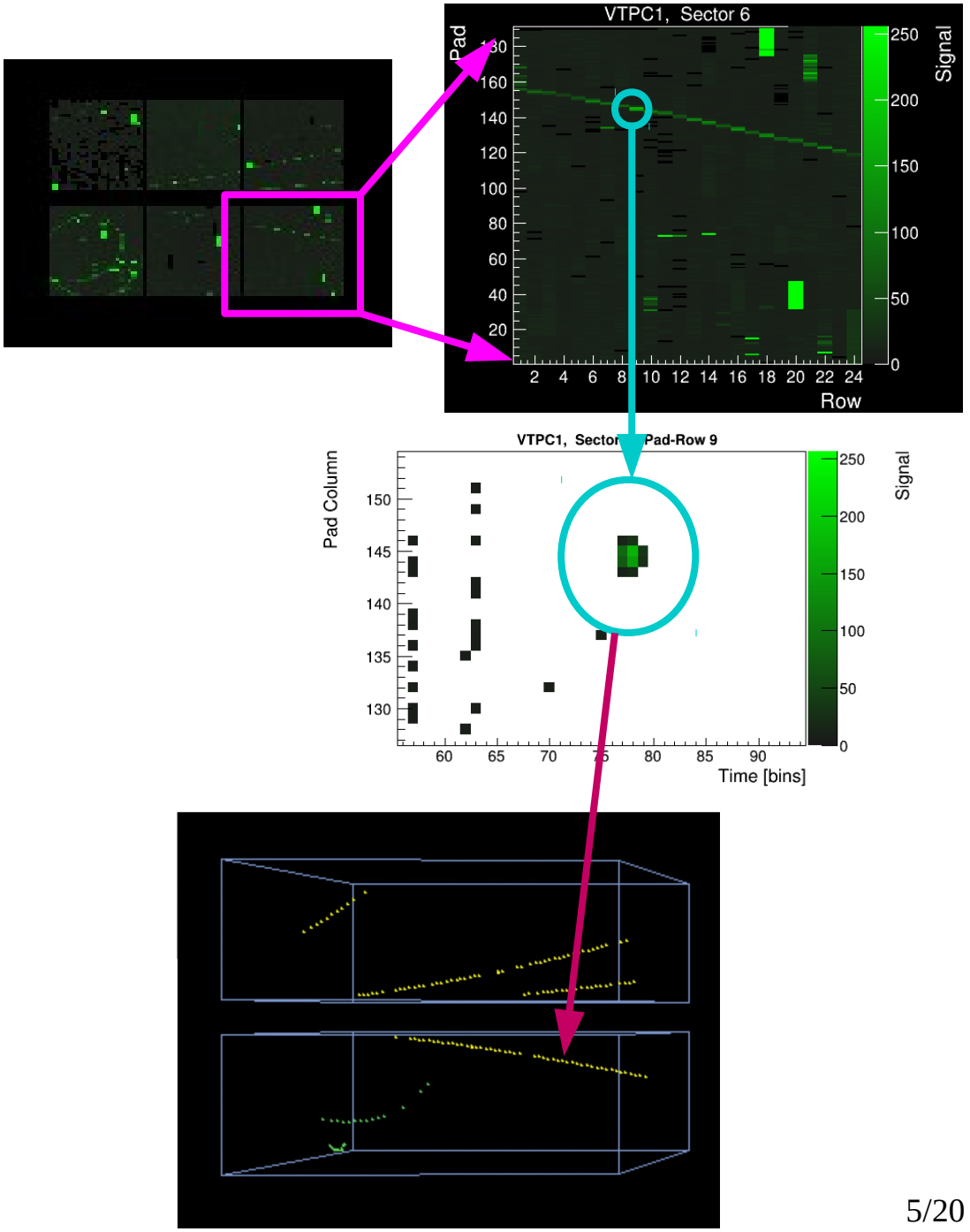


TPC Clusterization

- TPC raw data organized & stored in 2D pixel structure
  - Pixel local x-coordinate:
    Pad center X
  - Pixel local y-coordinate:

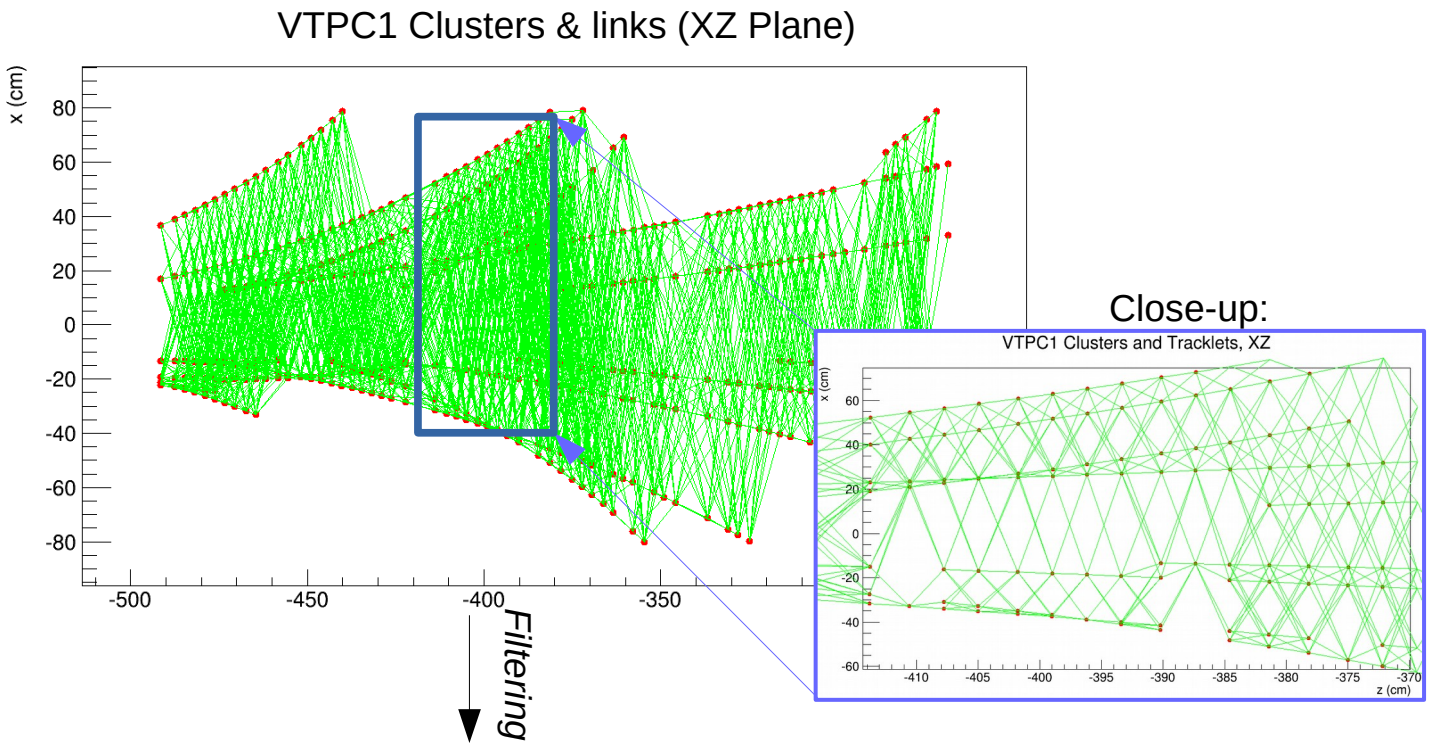
$$y_{cluster} = y_{wireplane} - v_{drift} \cdot (timebin + t_0)$$

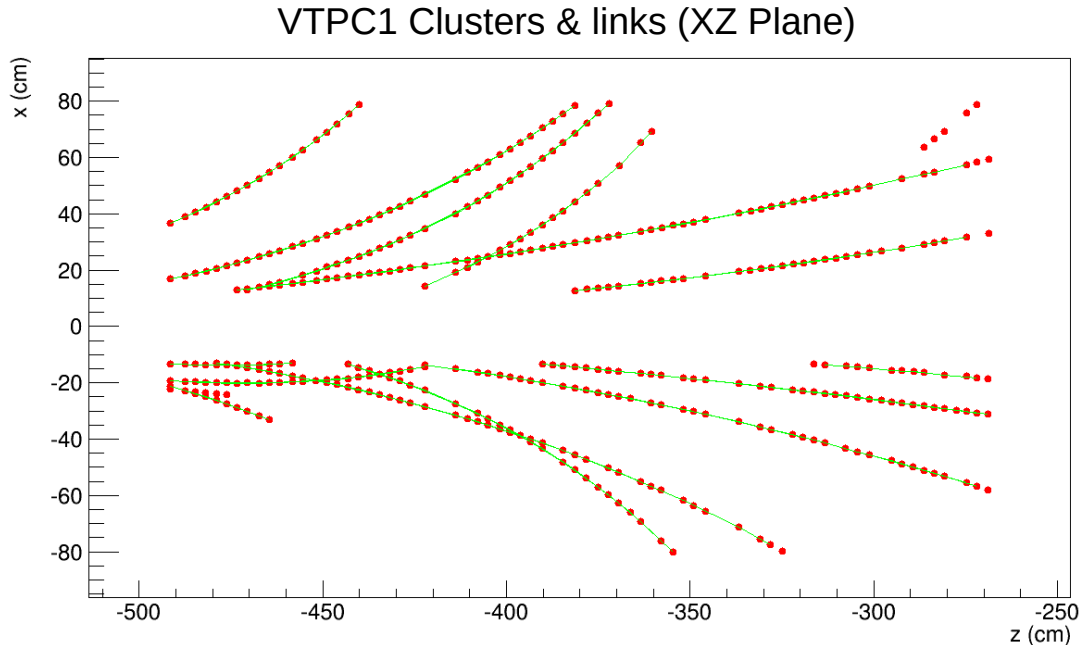
    Pixel local z-coordinate:
    Padrow center Z
- Threshold clusterizer searches for distinct signal “islands” in each padrow plane
  - User-defined threshold for starting clusterization
  - Different threshold for continuing clusterization
- Weighted mean of each “island” calculated in (x,y)
- 3D point recorded & stored: **Cluster**
  - Other properties calculated: ΣADC, σ_x, σ_y...



TPC Local Tracking

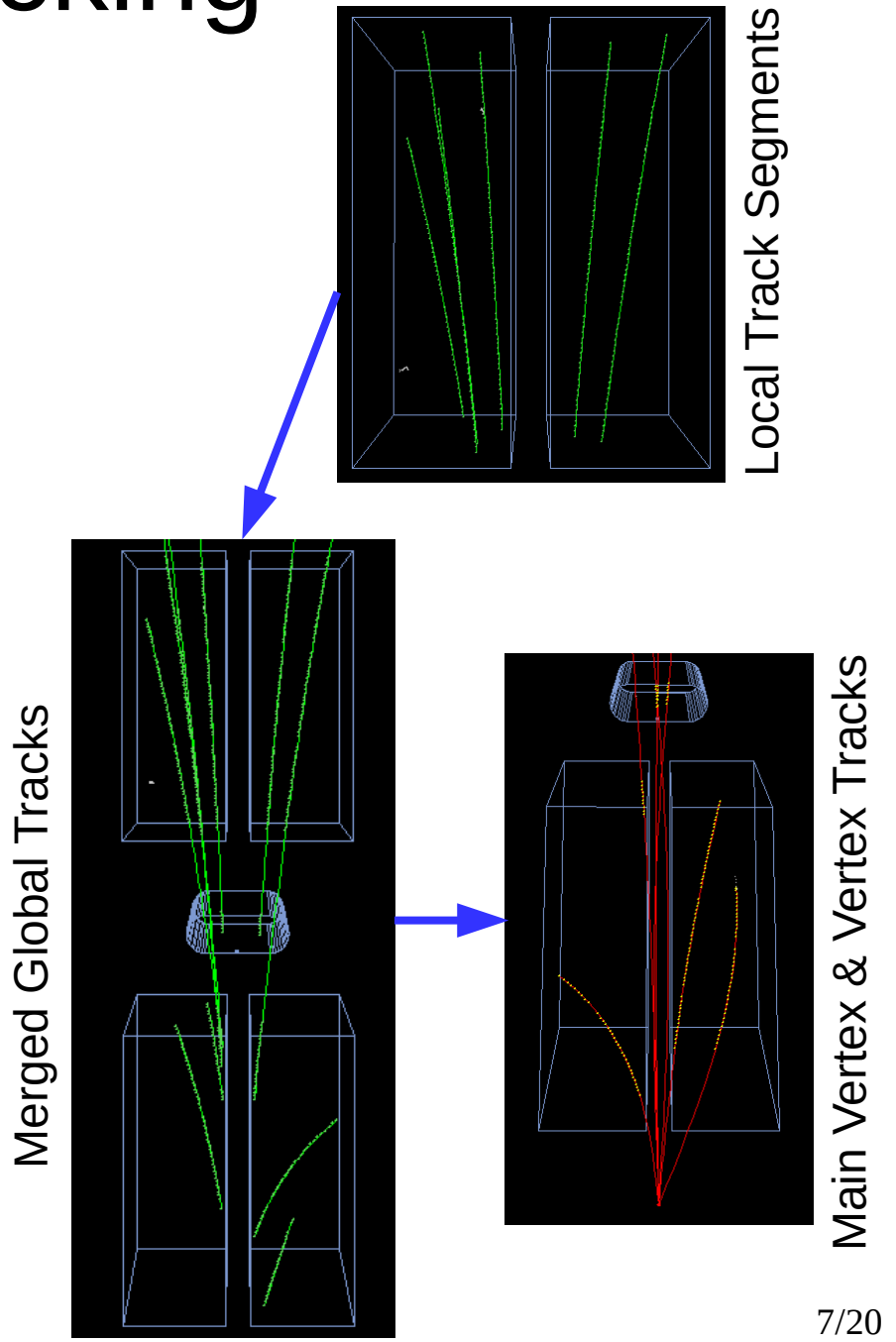
- Tackles pattern recognition problem
- Cellular-Automaton-based Reconstruction Alogrithm
- Algorithm works in Several steps:
  - 1) Link construction
  - 2) Link filtering
  - 3) Track candidate organization
  - 4) Local track fitting
  - 5) Local track merging





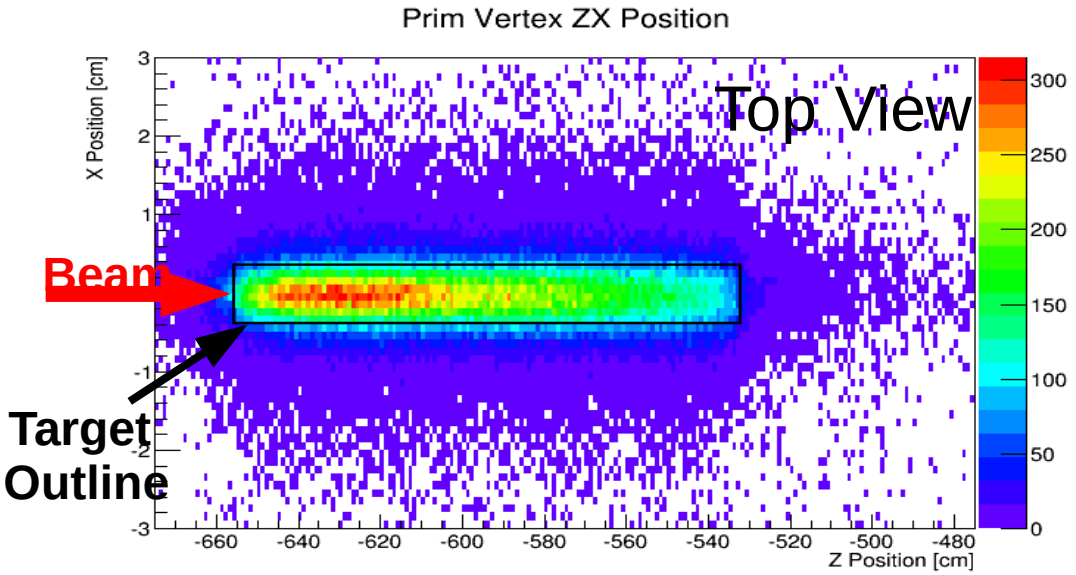
TPC Global Tracking & Vertex Tracking

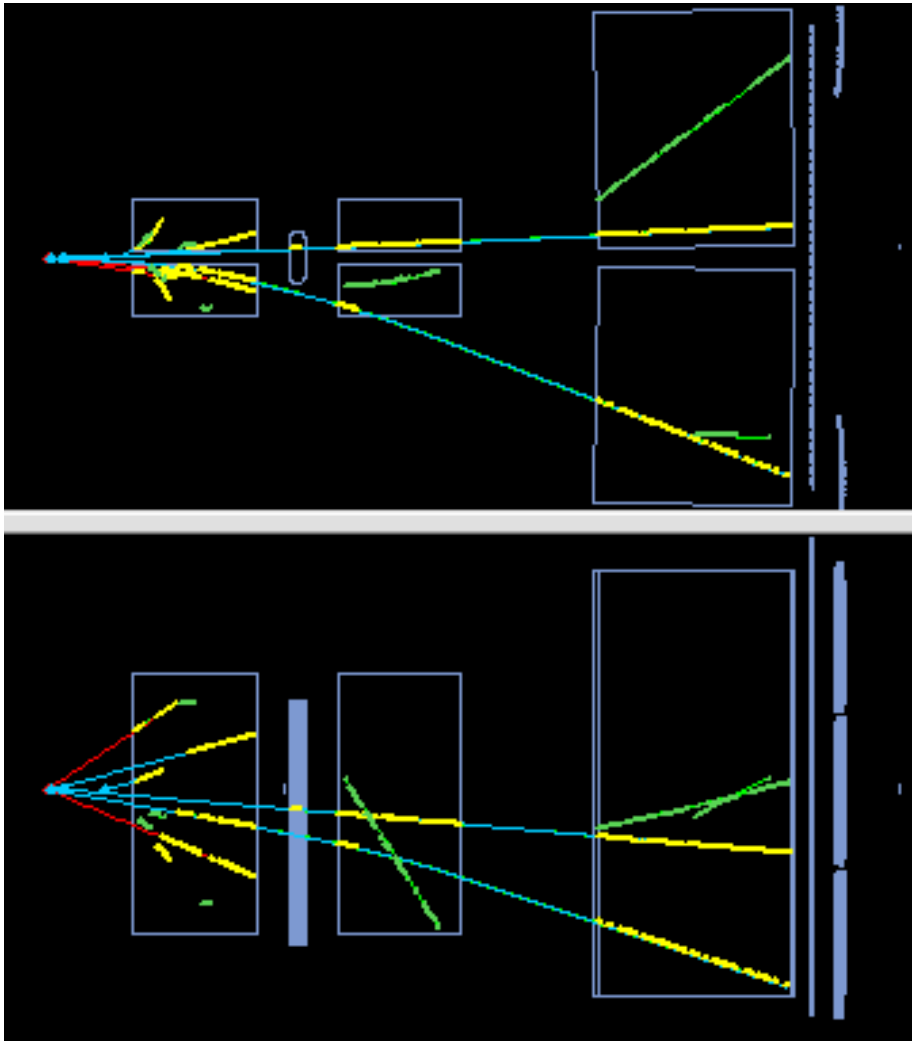
- Local tracks extrapolated to other TPC planes
- Other local tracks organized in list by “compatibility”
  - Defined using tuneable weights for each track parameter
- Best candidates accepted, merged, re-fit
- Main vertex finder & fitter extrapolates global tracks to seed vertex position
- Compatible tracks entered into fit
  - Fit options: 2D, 3D, BPD-constrained
- Tracks re-fit with main vertex position



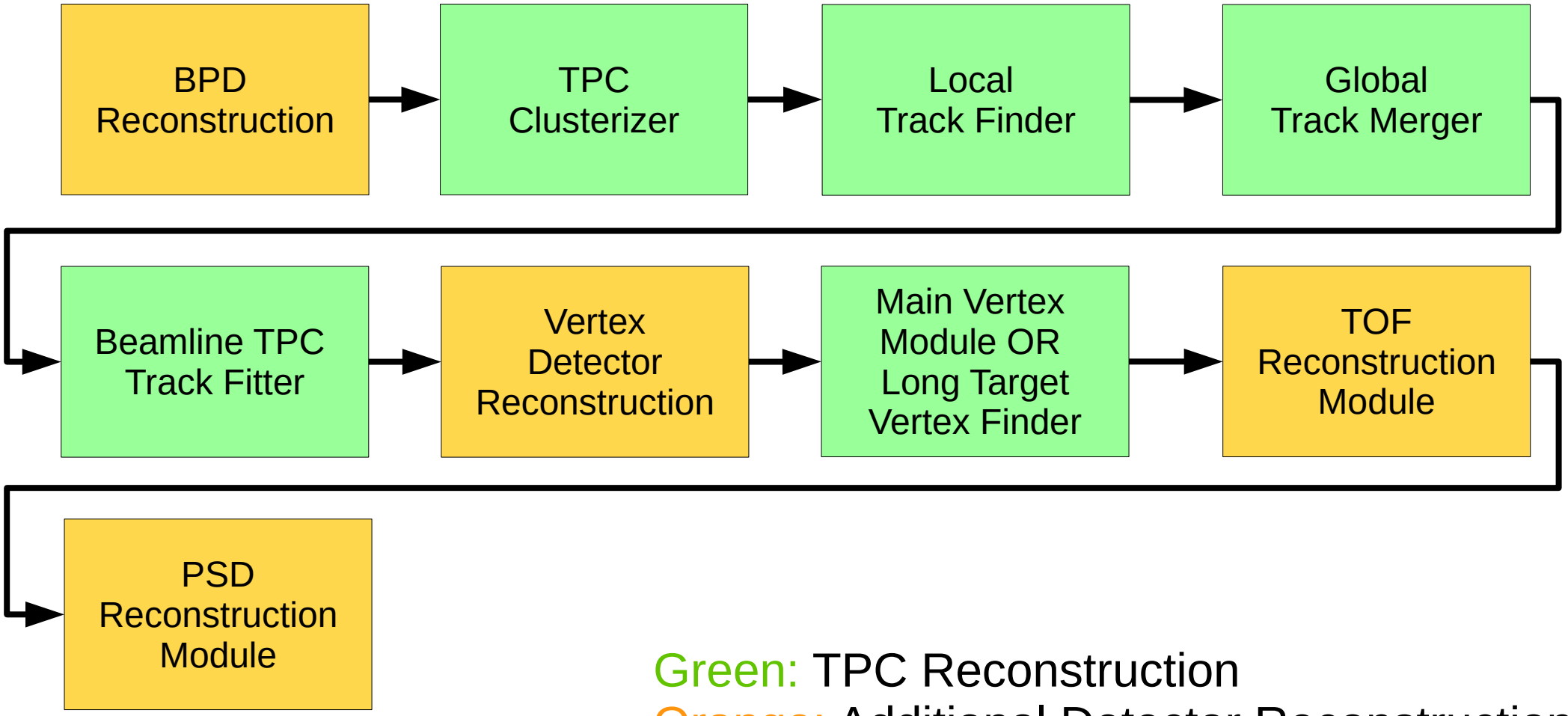
Long Target Vertex Finder

- Optional module can be run instead of MainVertexModule
- Extrapolates tracks to BPD fit line
- Creates origin point at point of closest approach
- Useful for online data taking monitoring, etc





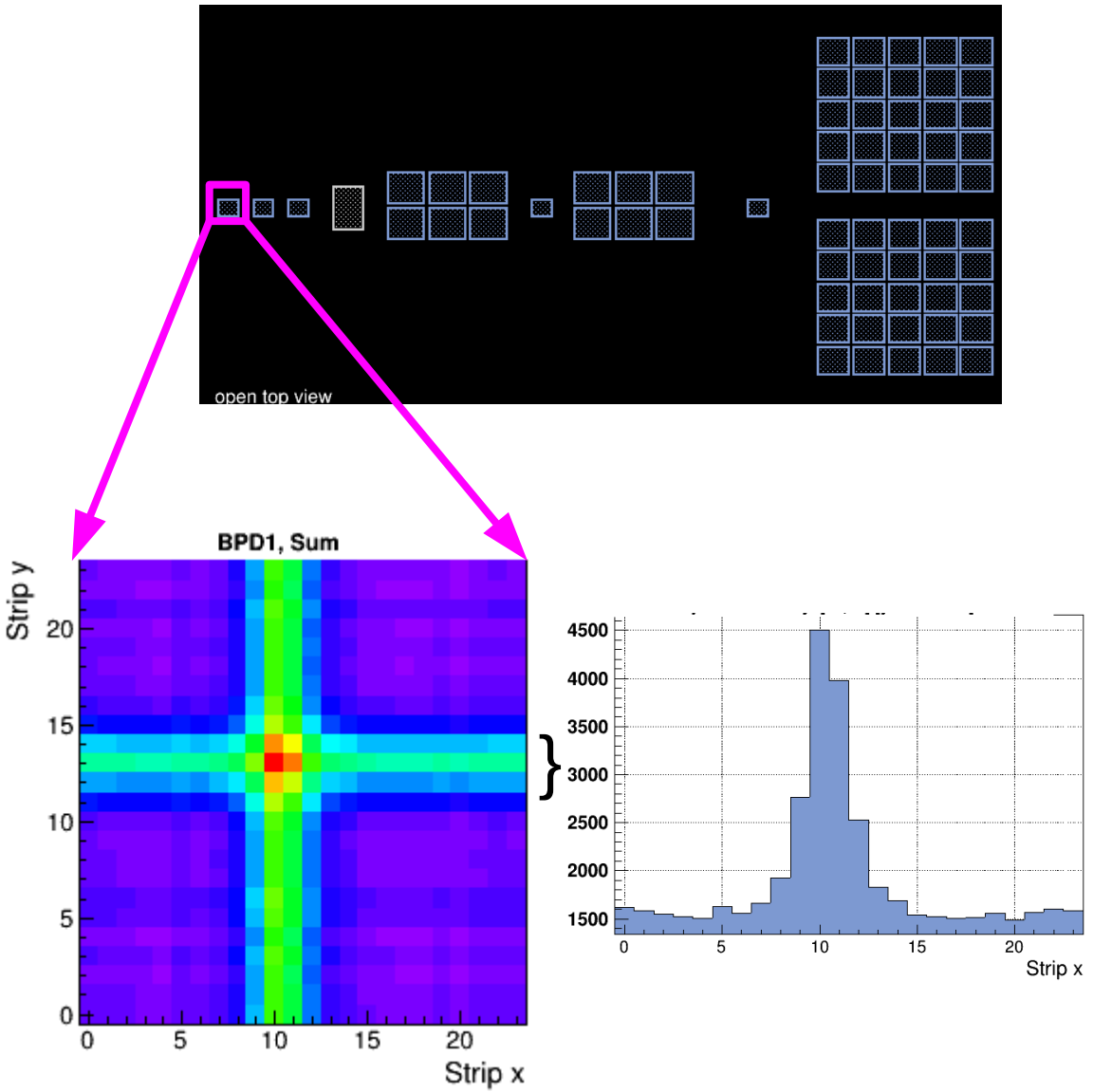
SHINE Reconstruction Chain



Green: TPC Reconstruction
Orange: Additional Detector Reconstruction

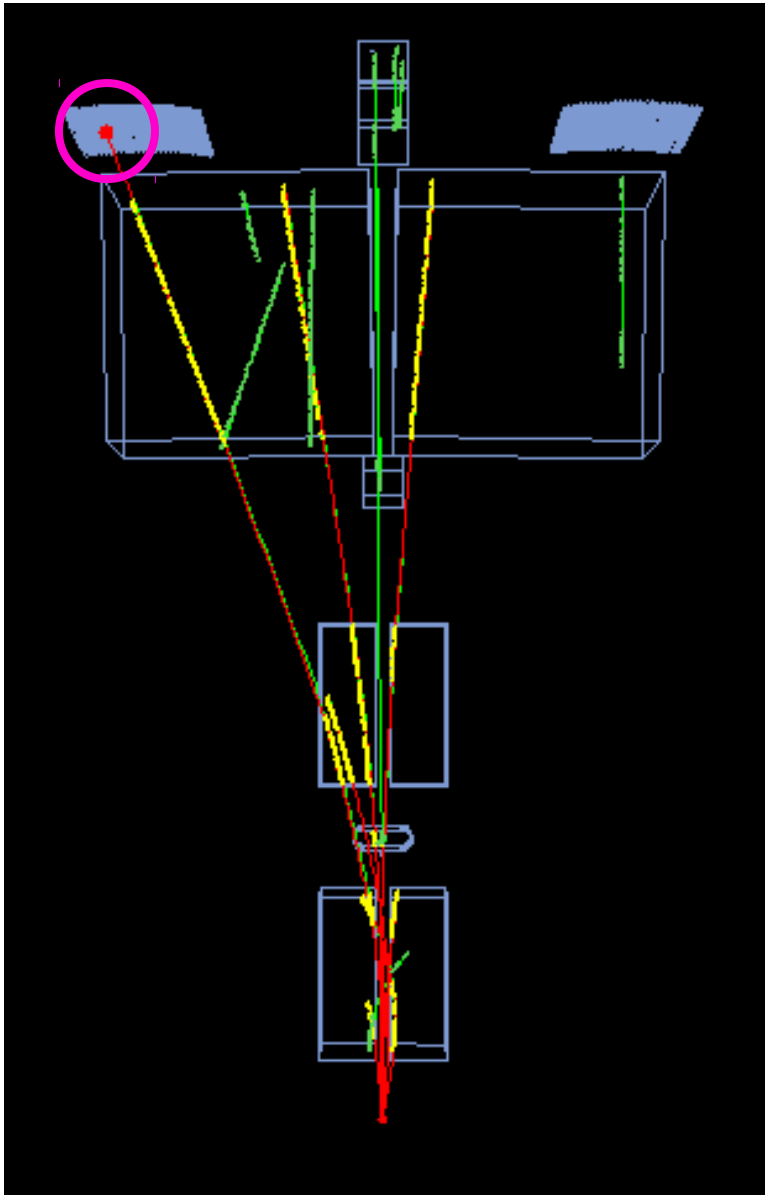
Beam Position Detector Reconstruction

- Signals in BPD strips fit in both X and Y
- Reconstructed BPD clusters fit to straight line
- Decisions made regarding:
  - Quality of BPD measurements: eBadBPD1-3, eOutlier, etc
  - BPDs to enter track trajectory fit



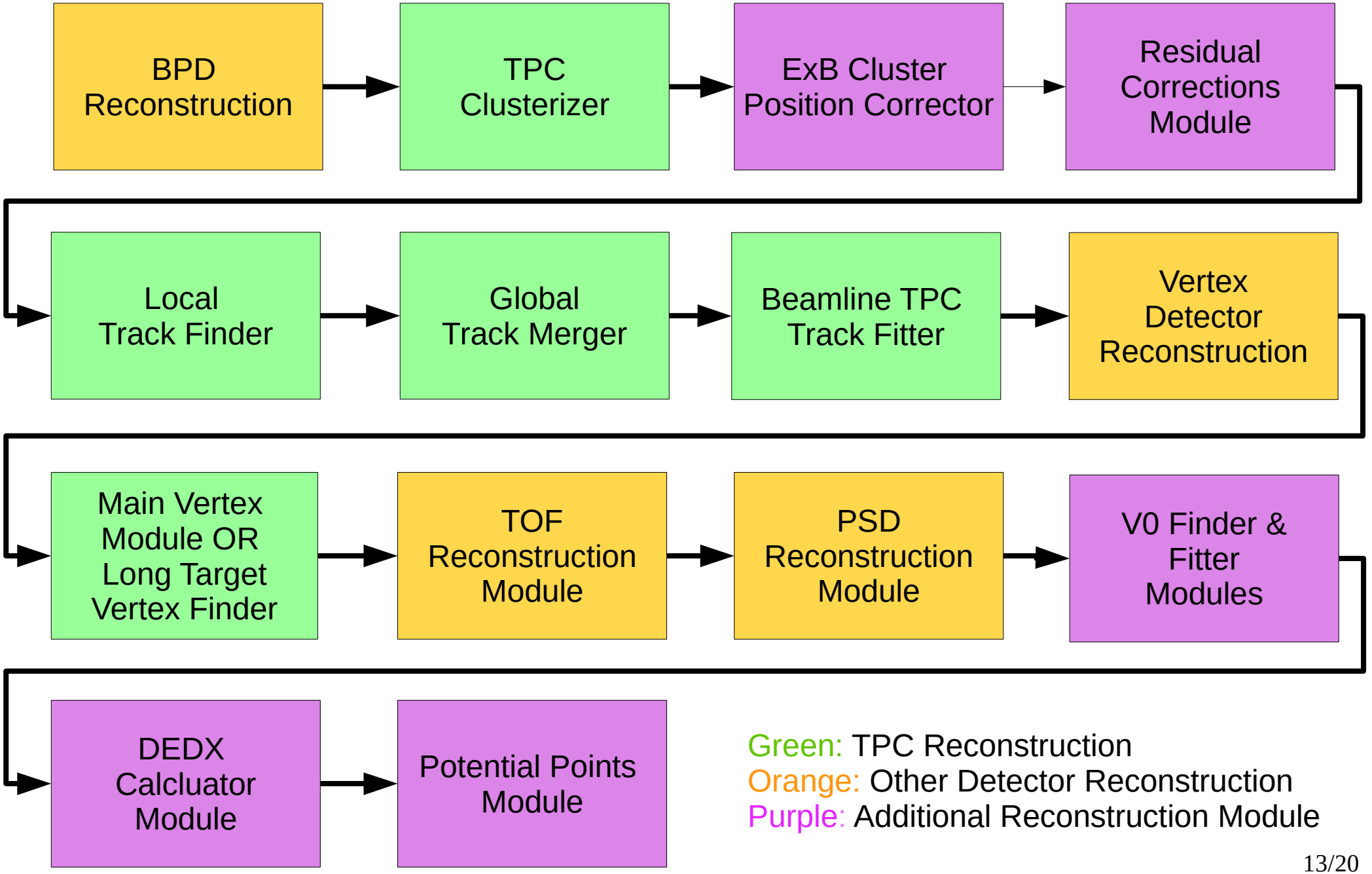
Time Of Flight Reconstruction

- Matches Time-of-Flight hits with vertex tracks
- Searches for hits in ToF L/R
  - Performs quick fit to MTPC clusters on Vertex Tracks
  - Extrapolates to ToF plane and searches for hit
  - If pixel has valid TDC & QDC, add to track
- Extendable to F-TOF walls



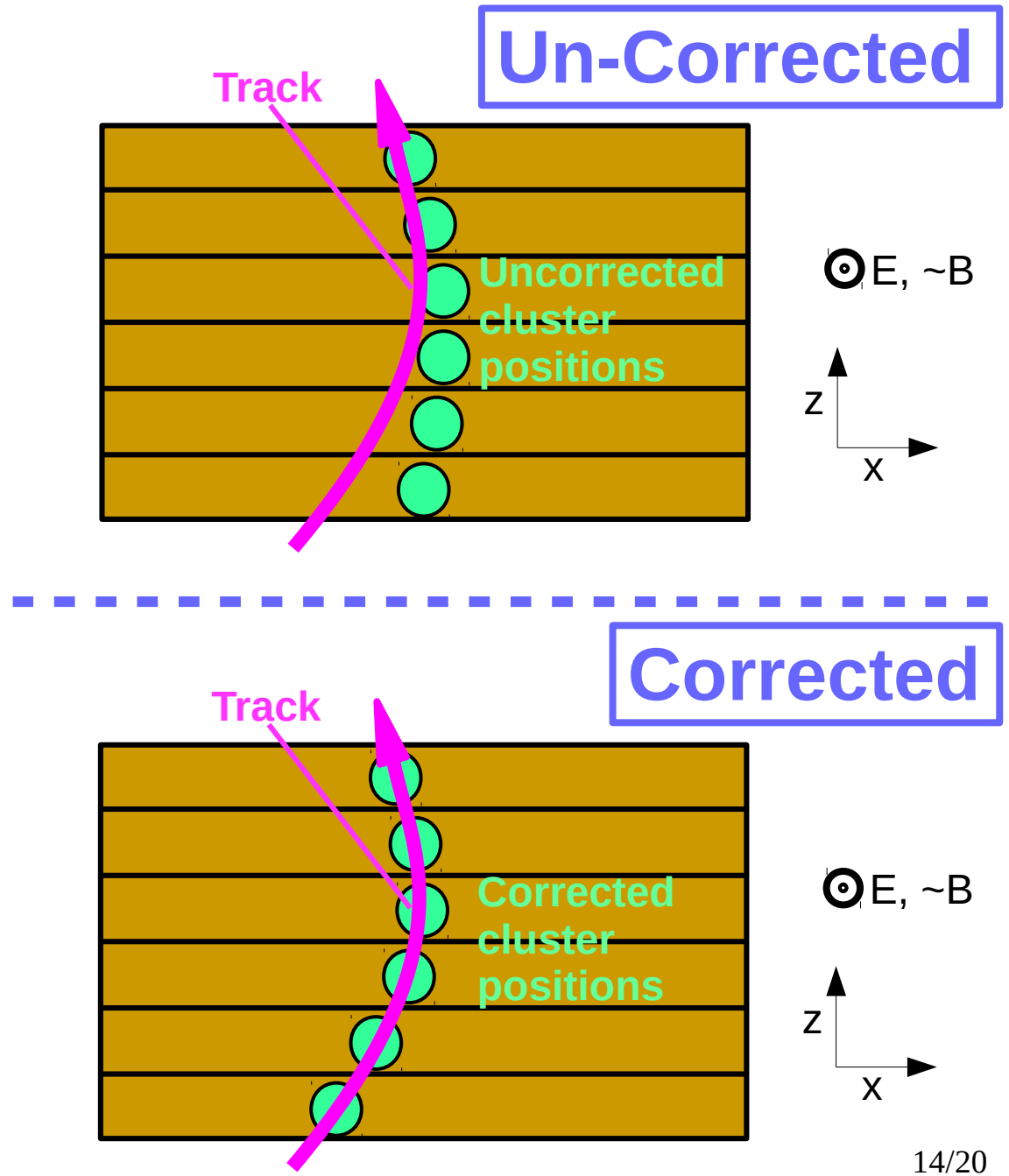
Additional Modules

SHINE Reconstruction Chain + Calibration Modules



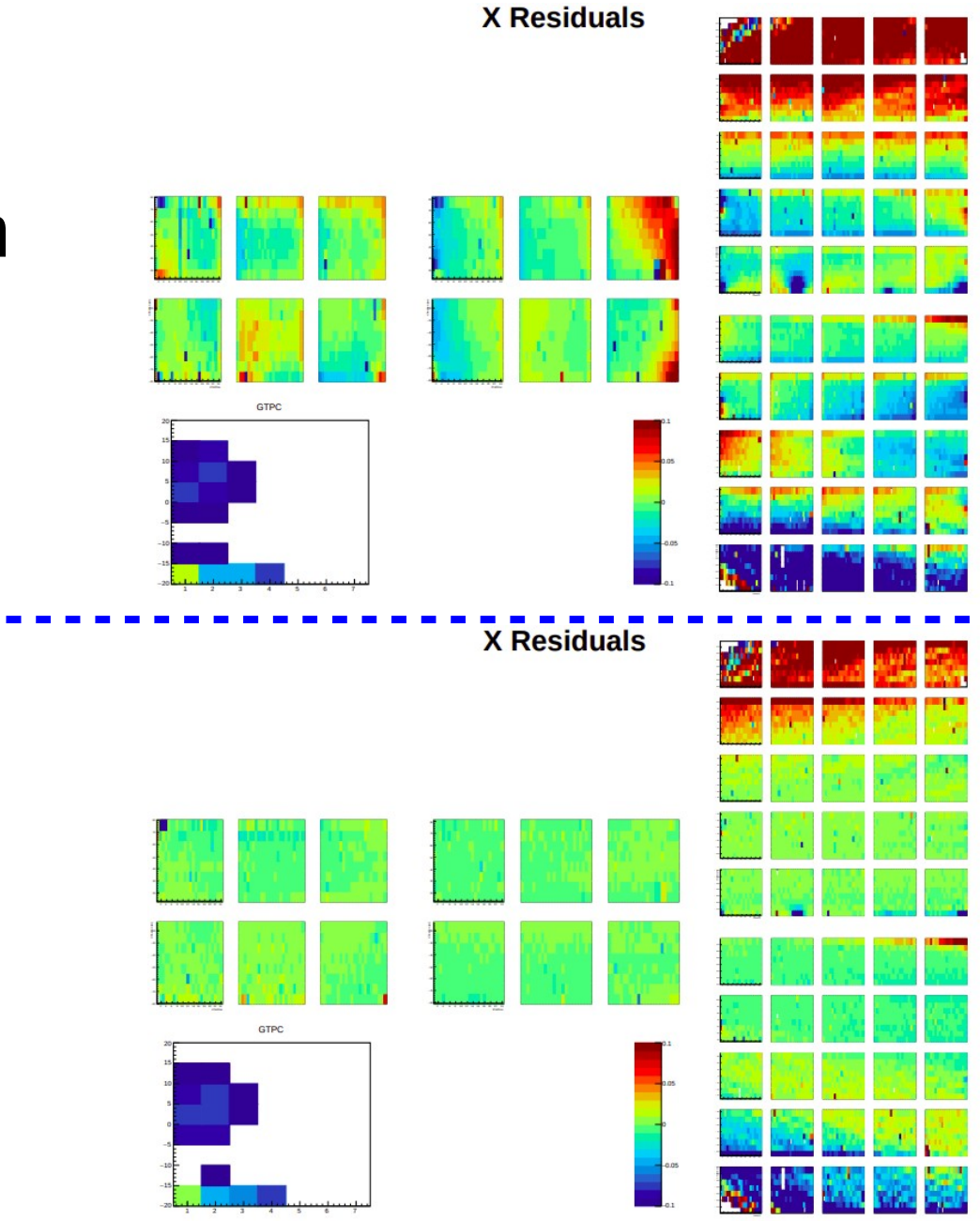
ExB Position Corrector

- Corrects reconstructed cluster positions due to ExB effects
- Occurs in regions where B not parallel to E
- Corrected position calculated using drift time & 5th-order RK ODE integrator
- Must be done before tracking:
  - Improved extrapolation to other TPCs
  - More accurate momentum estimation



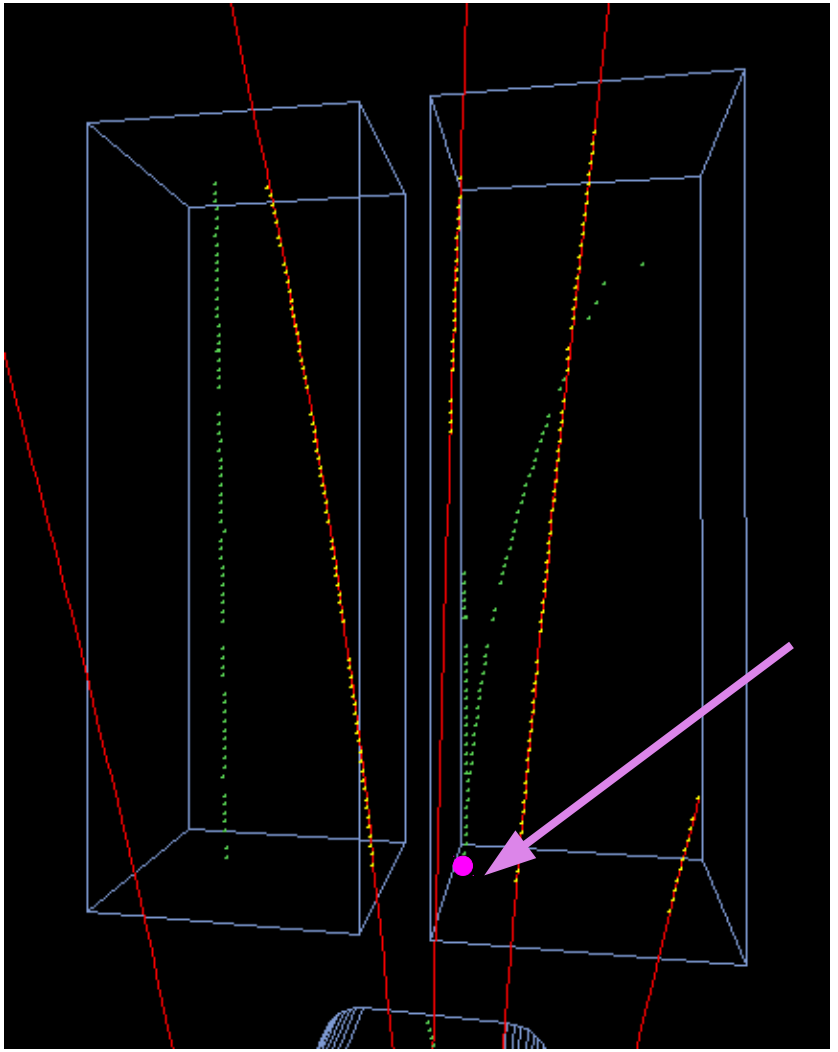
Residual Corrections Module

- Applies position-dependent correction to cluster positions
- Correction based on average deviation from track fits in region
- Applied before tracking module is run



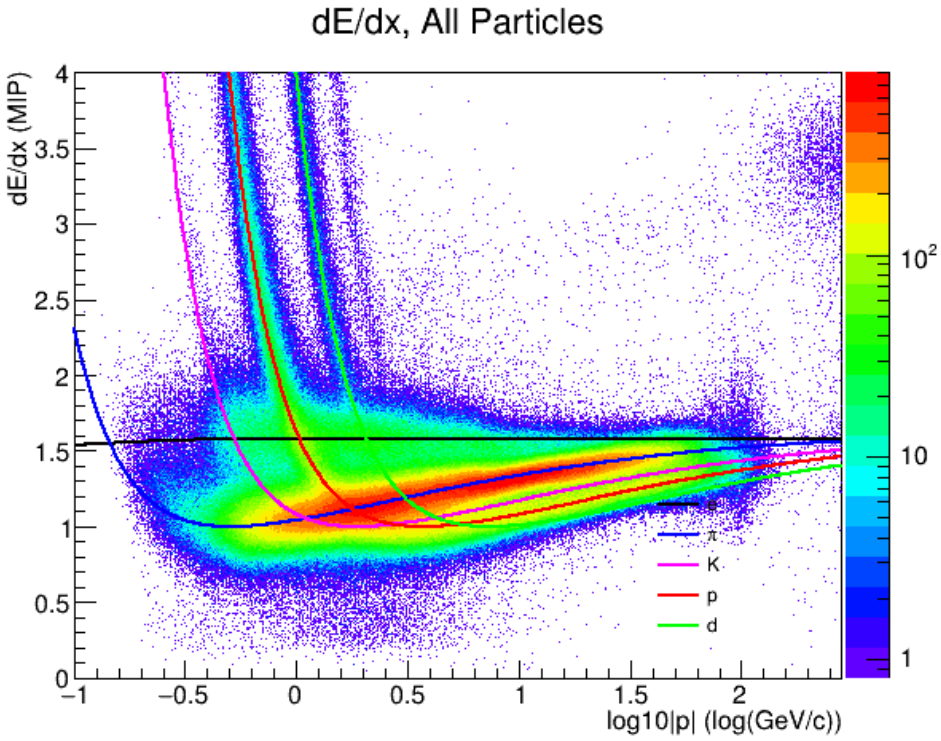
V0 Finder & Fitter

- Searches for secondary decays in TPCs
- For reconstructed positive tracks:
  - Loops through negative tracks
  - Calculates the DCA
  - If small enough, re-fits with common vertex
  - If acceptable, keeps vertex & fitted tracks



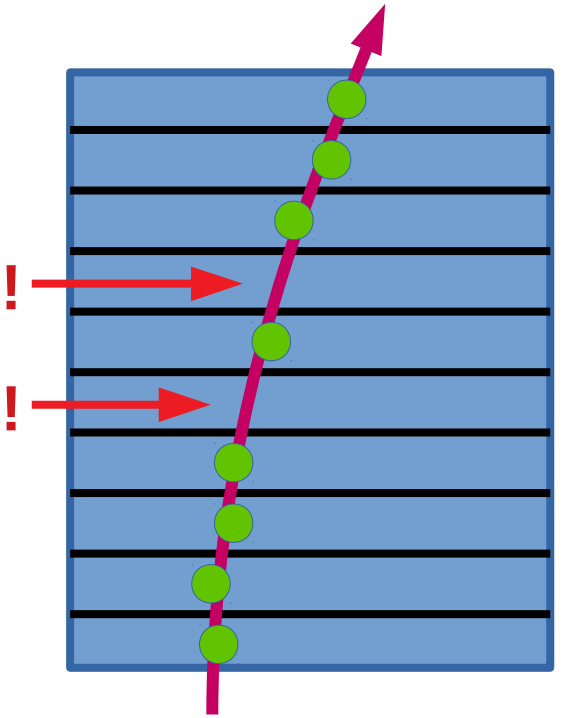
DEDX Calculator Module

- Applies calibration constants to correct reconstructed cluster charge
  - Some corrections dependent on track properties (angles, etc)
- Calculates cluster dE/dx (based on TPC pad length & trajectory)
- Corrections applied:
  - Atmospheric pressure
  - Threshold loss (based on track angles)
  - Time correction
  - Y-dependence correction
  - Sector constants correction
  - Chip gain correction
  - Angle correction



Potential Points Module

- Calculates number of clusters each vertex track could possibly have
- Ratio used in analysis
- Very low ratio indicates problem with track reconstruction:
  - Detector inefficiency
  - Track is a decay product
  - Other issues



Number of Clusters: 8
Number of Potential Points: 10

Thanks!