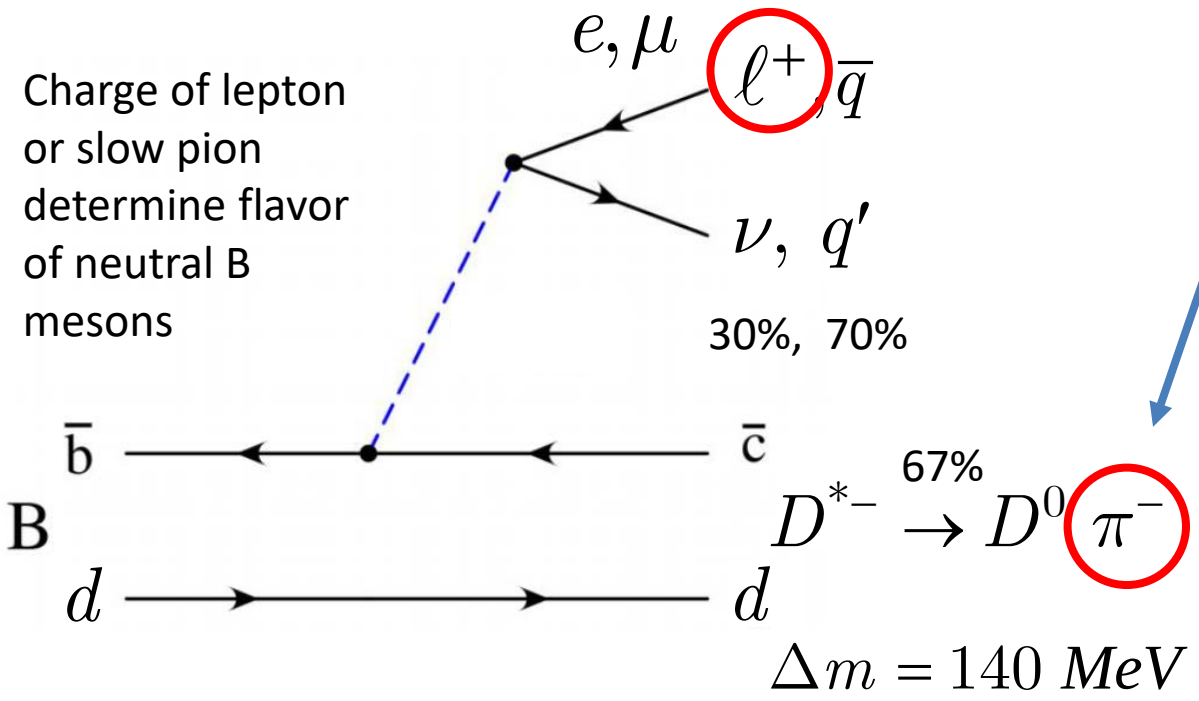
FSP Workshop: Slow Pion Tracking

Slow Pions as Flavor Taggers

Charge of lepton or slow pion determine flavor of neutral B mesons



Motivation:

- Slow pions from D* decays are low momentum (< 250 MeV)
- Only very few make it into the CDC
- Are reconstructed mainly by the SVD

- PXD pixels (clusters) in addition would (hopefully) help in the reconstruction

PXD Stand-alone Rescue Project

Problem: Estimates of PXD data size at full lumi will exceed rest of Belle II detectors by ~ a factor 10 (main bg: QED 2photon events).
-> Some day (?) the ROI selection will be turned on

SVD-only recontruction has problems at low momenta
PXD-Pixels from unreconstructed tracks will get lost

Idea to „rescue“ the valuable PXD hits stand-alone:

- try to identify PXD clusters from slow pions against electron (QED) bg without any external detector (no ROIs from SVD needed)
- form clusters at the DHH-Level and subject them to a pattern recognition algorithm (e.g. neural nets) in the DHH FPGA
- send clusters identified as „pions“ to ONSEN (-> additional „ROIs“)

- Option: „6 layer online tracking“ with selected PXD clusters via DATCON

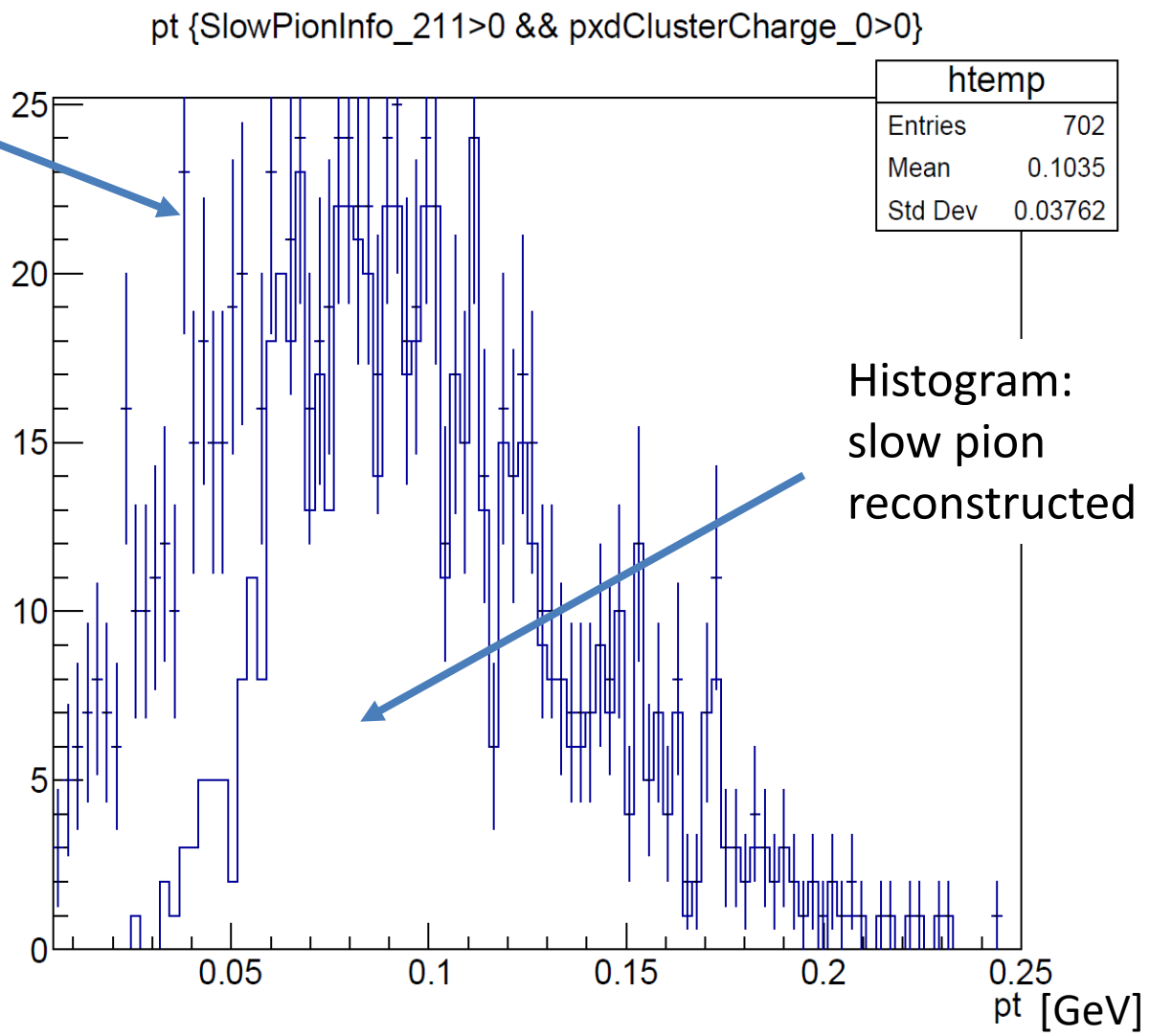
Pt Spectrum of Slow Pions

Histogram with error bars: Slow pion not reconstructed

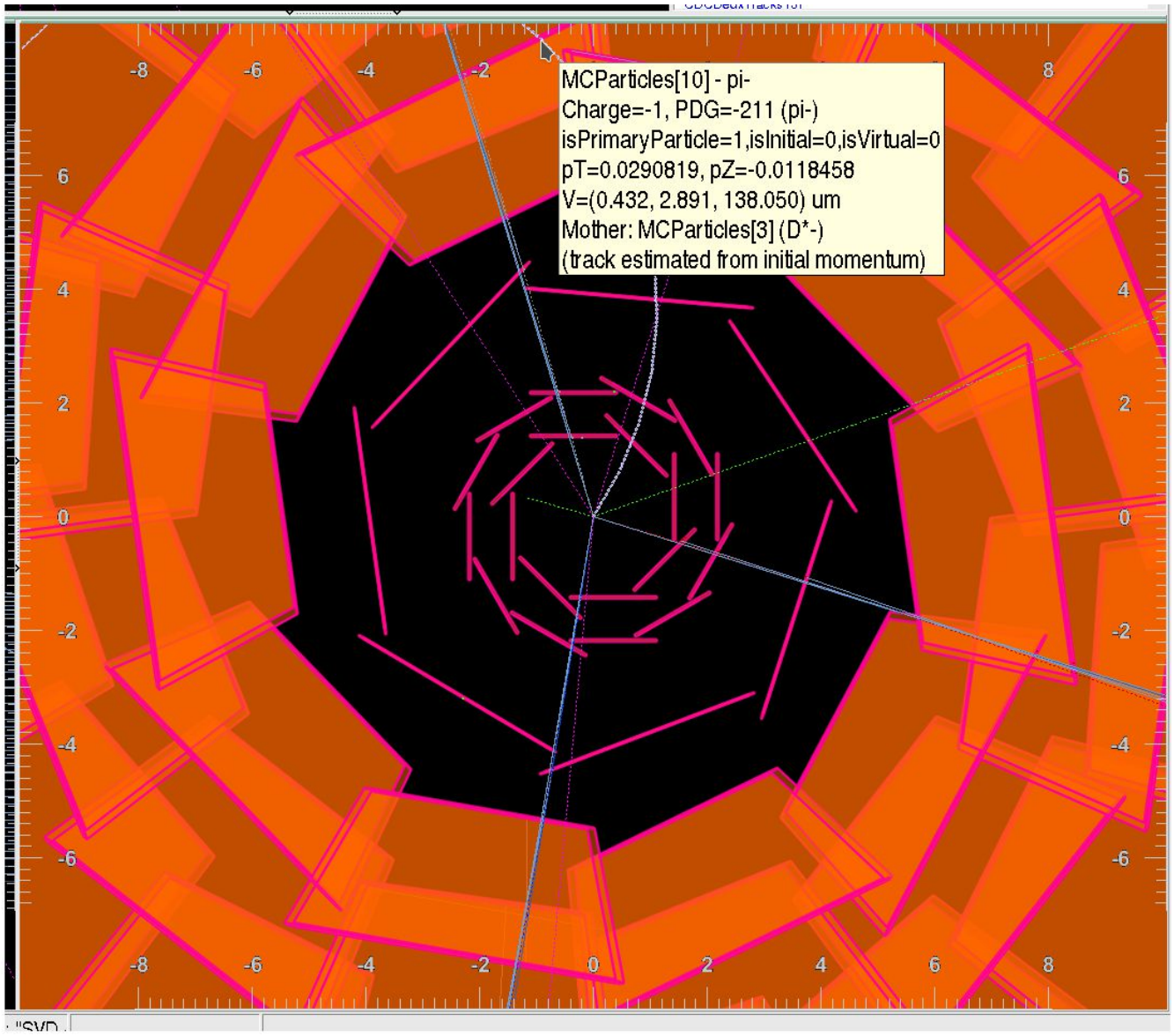
-> 30% to be rescued

BUT:
this is MC, reality could be less optimistic, i.e. fraction of unreconstructed pions > 30%

Can such low pt tracks be reconstructed ?



PXD Clusters in B Meson Events



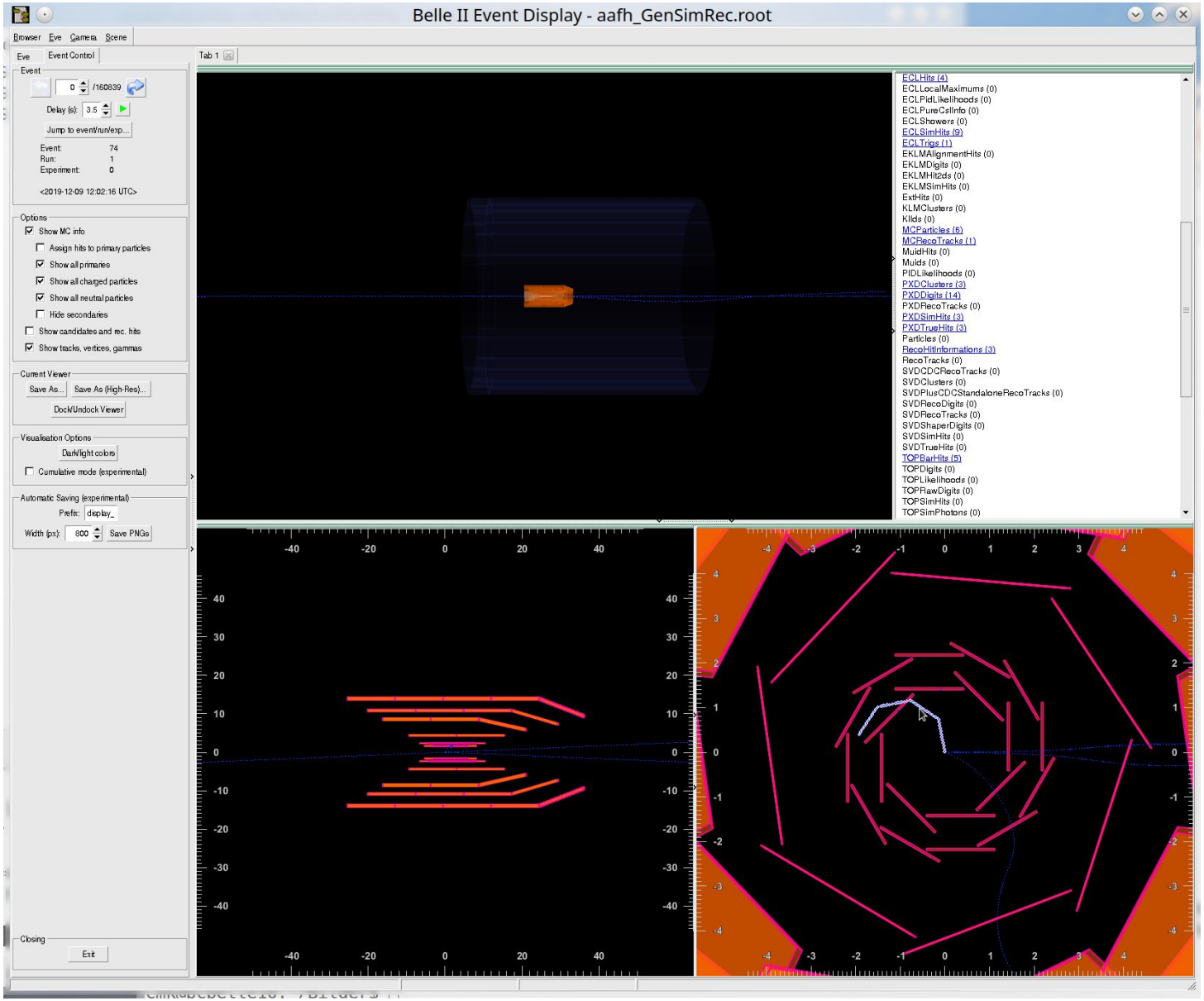
Slow pions may not traverse all 4 SVD layers, so are lost !

Slow Pion could be reconstructed (with a NEW algorithm to be written), if PXD clusters are also considered …..

Beat combintorial BG: PXD hits selected by pattern recognition algorithm

Could SVD clusters also be used for PID (?)

Dominant PXD Clusters from QED Events



MC simulation:

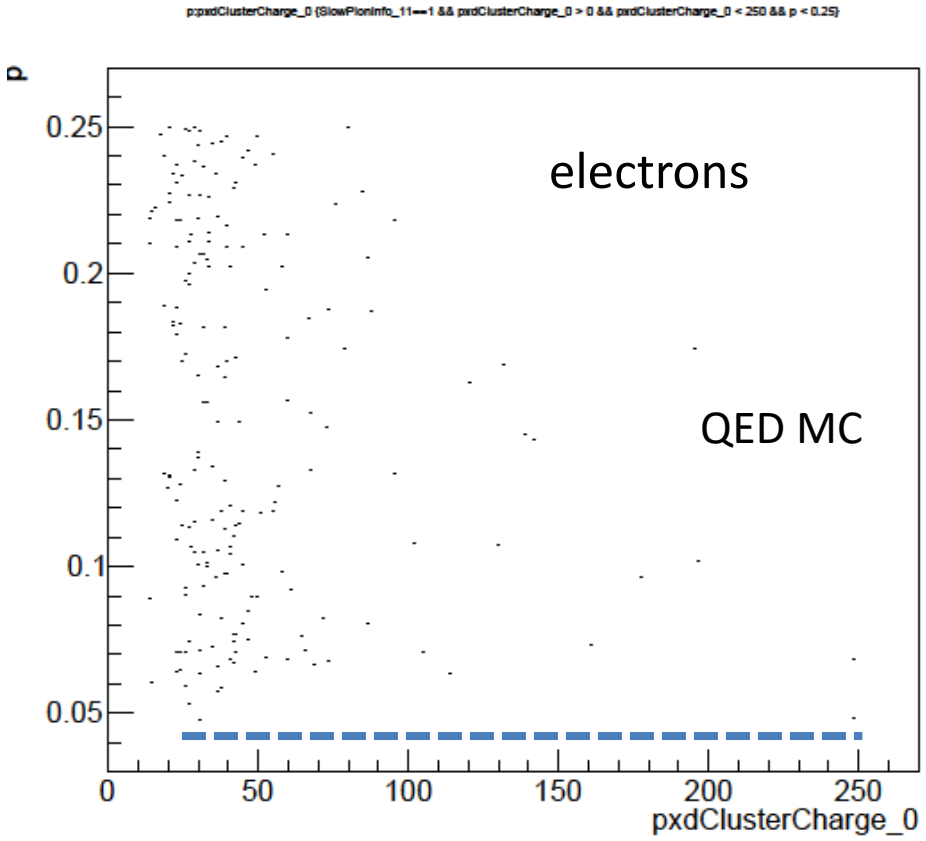
QED events generate the known large background when the luminosity is high

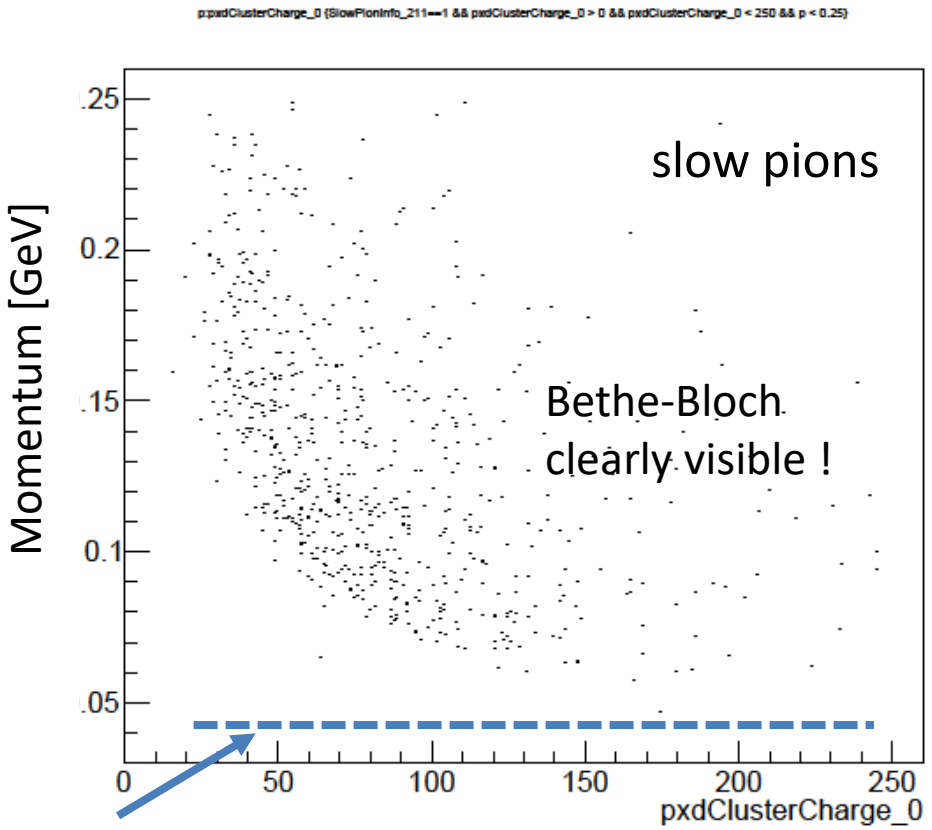
PXD clusters predominantly on layer 1 (due to matrix element)

QED BG could already be studied now with the data we accumulate

PXD Clusters, pions vs QED electrons

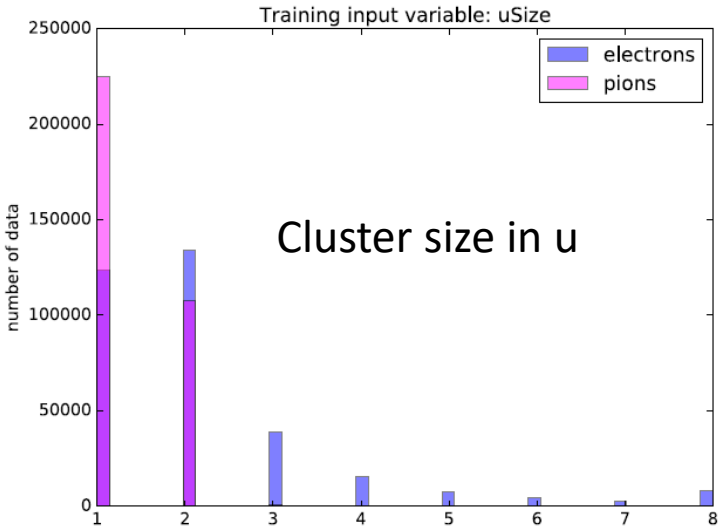
MC productions: Slow Pion from $B^0 \rightarrow D^* e^- \nu$, $D^* \rightarrow D \pi^-$, $D \rightarrow K^+\pi^-$ (+ $B^0 \rightarrow \nu \nu$)
-> Ntuple with MC, reco and associated clusters

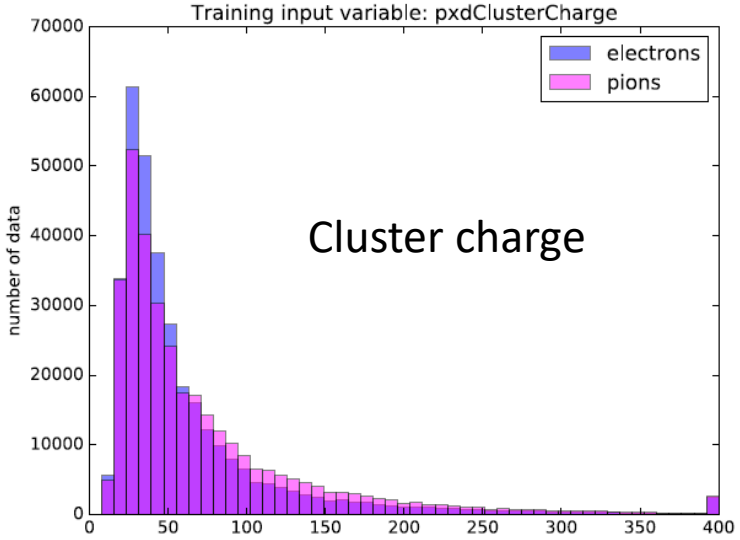


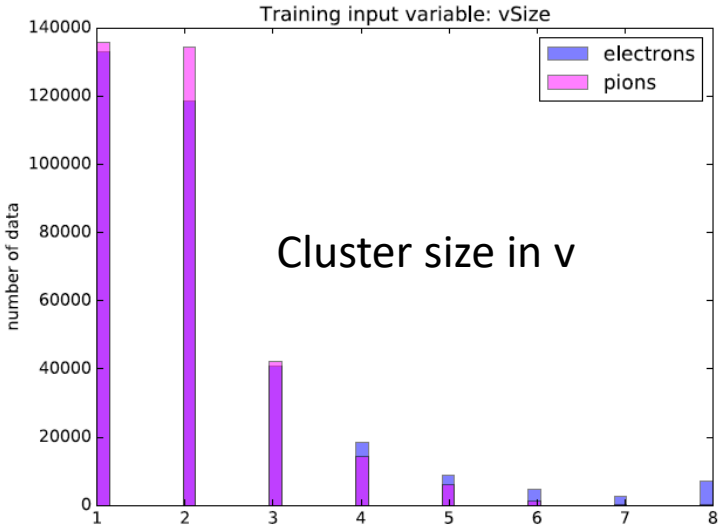


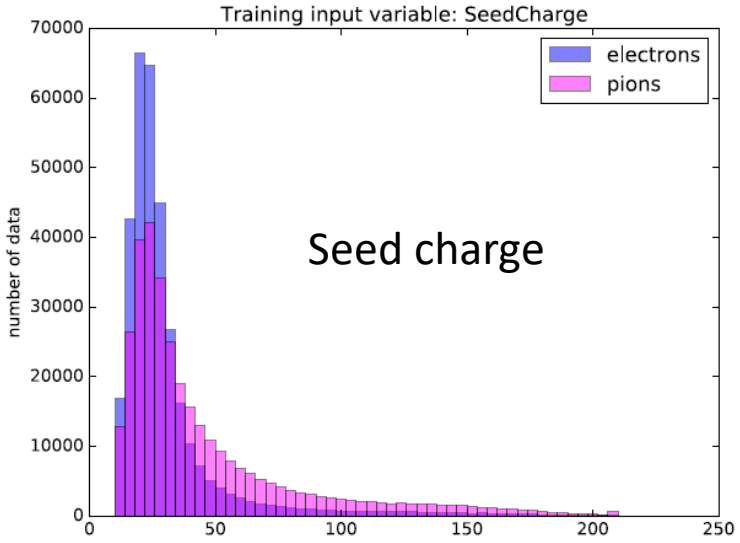
The clusters show (hopefully) different patterns between electrons and (slow) pions

Some Sample Quantities









Resumée

Slow pions (slow particles in general) are physically very relevant
(see coming presentations)

PXD clusters could be used (to some extent) for the identification of slow pions against other (high momentum) particles or the dominating electron background

PXD clusters could then be used to help the VXD-only track reconstruction

Combinatorial background from QED could be beaten by pattern recognition
(remove a sufficiently large fraction of the background)

Plan:

- Search for algorithms to efficiently mark slow pion (particle) clusters **online**
- check performance of algorithms (PID & VXD reconstruction) with real data

- when promising, consider implementation in DHH/Onsen
  (mark selected cluster as additional „ROIs“ to be sent to HLT)