HBD clusterization software

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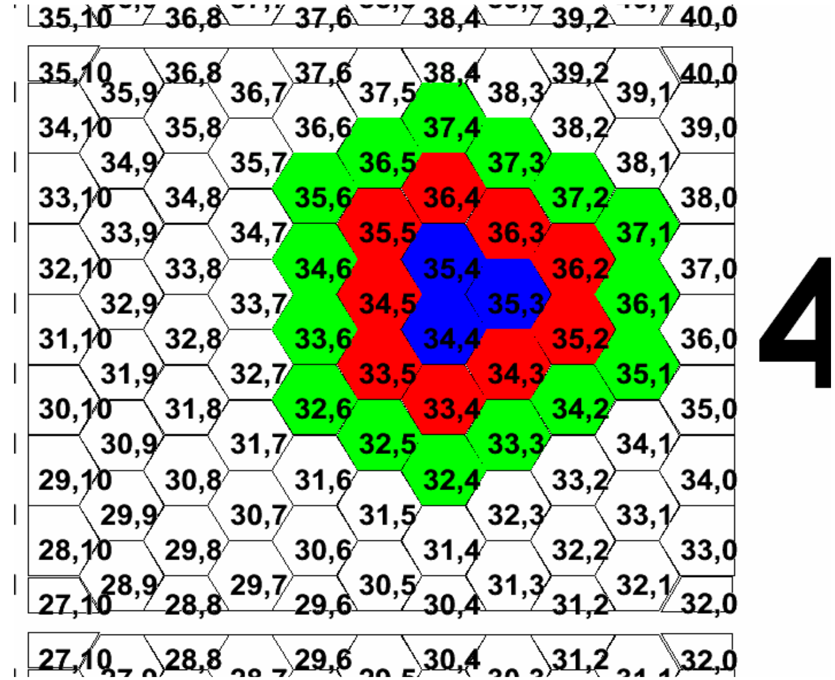
HBD Analysis Workshop

2010.11.13

The original version

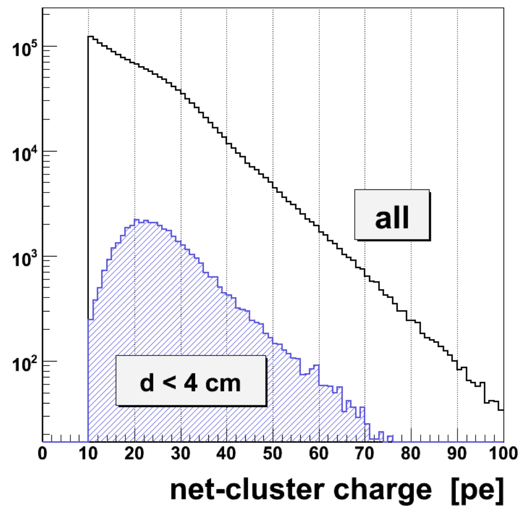
- First step of the algorithm is the selection of preclusters.
  - Candidates for preclusters are all possible triplets in the HBD
  - Background is estimated for triplets as the median per pad charge of first and second neighbors.
  - Only triplets with a sufficient net charge are kept to the next step
- Merge all good triplets which overlap in at least one pad
- Prune clusters
  - Remove peripheral pads if their net signal is too small

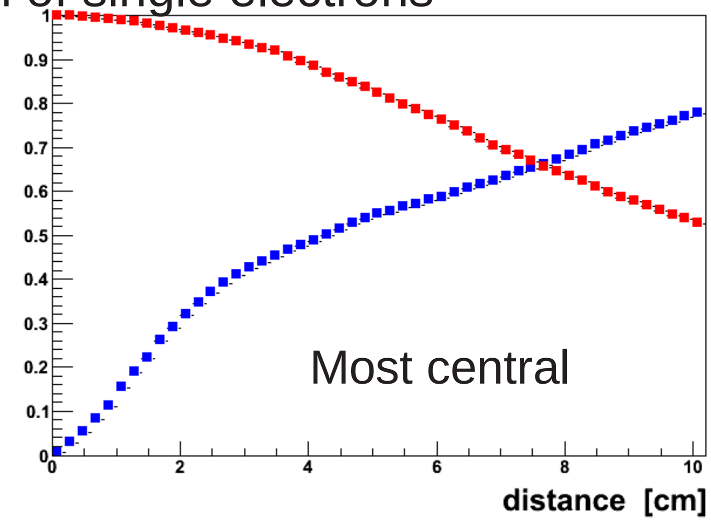


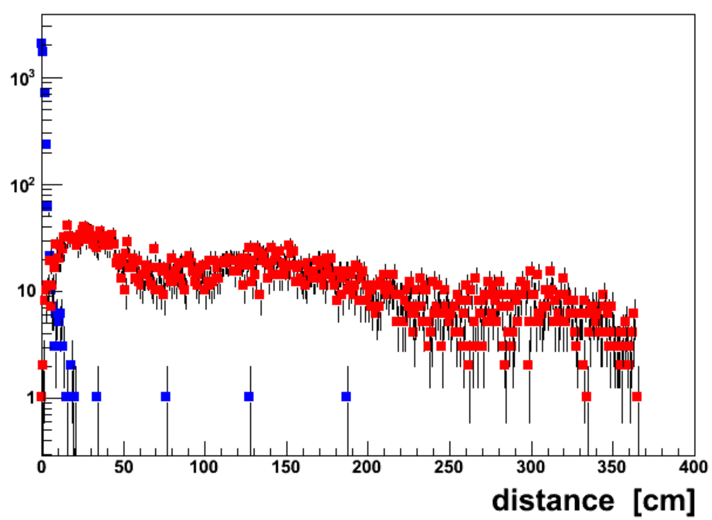
A number of tuneable Parameters:
- triplet net charge cutoffs
- pad charge threshold
- maximum pad charge

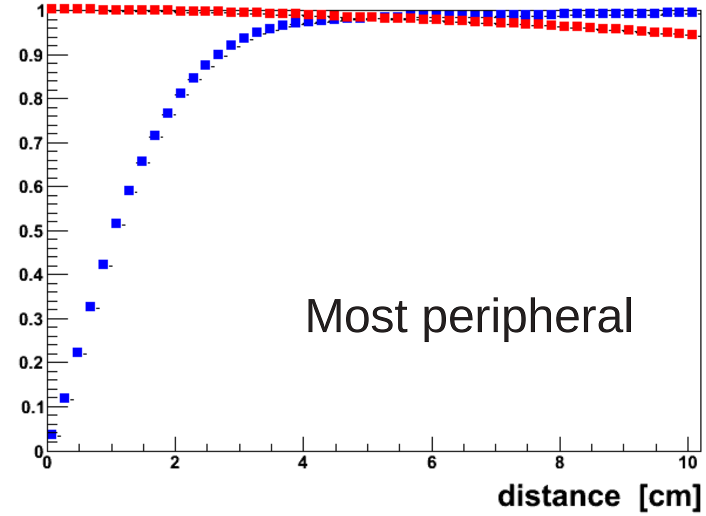
Efficiency and rejection of original version

- After some tuning and testing parameter sets
  - The efficiency and rejection in central events was still insufficient
  - Plots below are from embedded simulation of single electrons

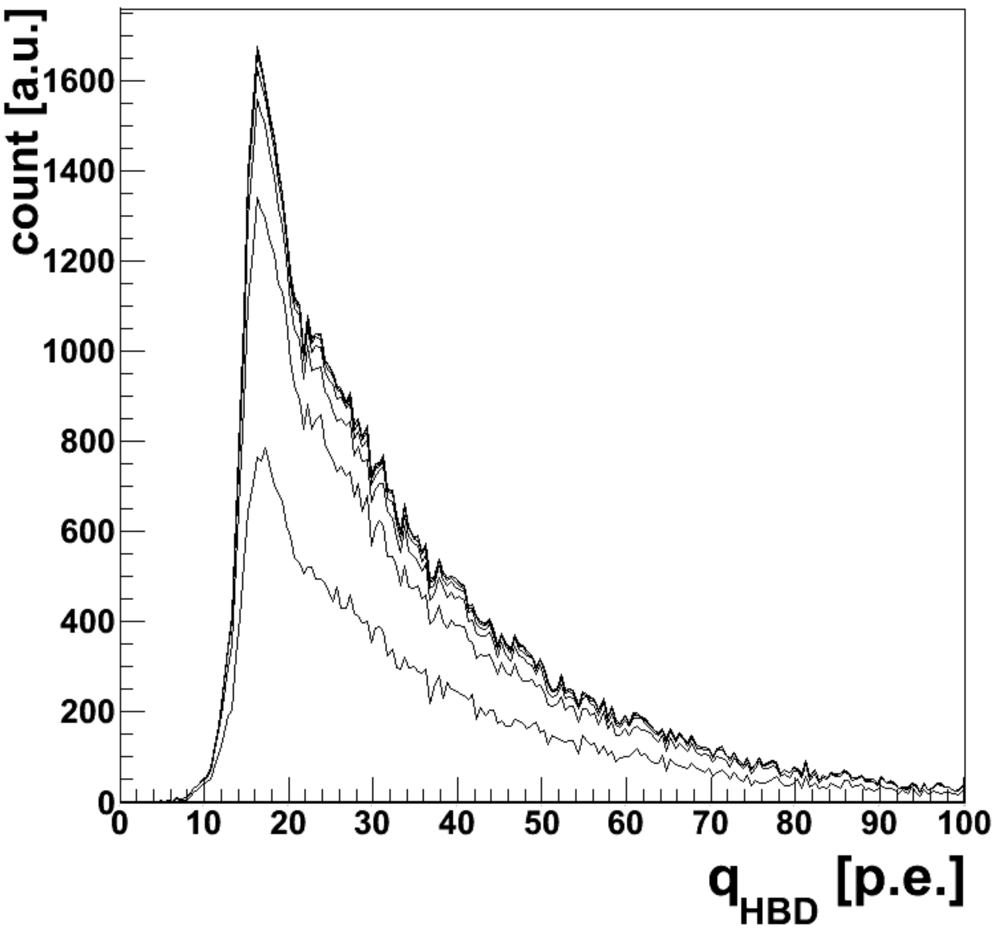








Not so successful in real data

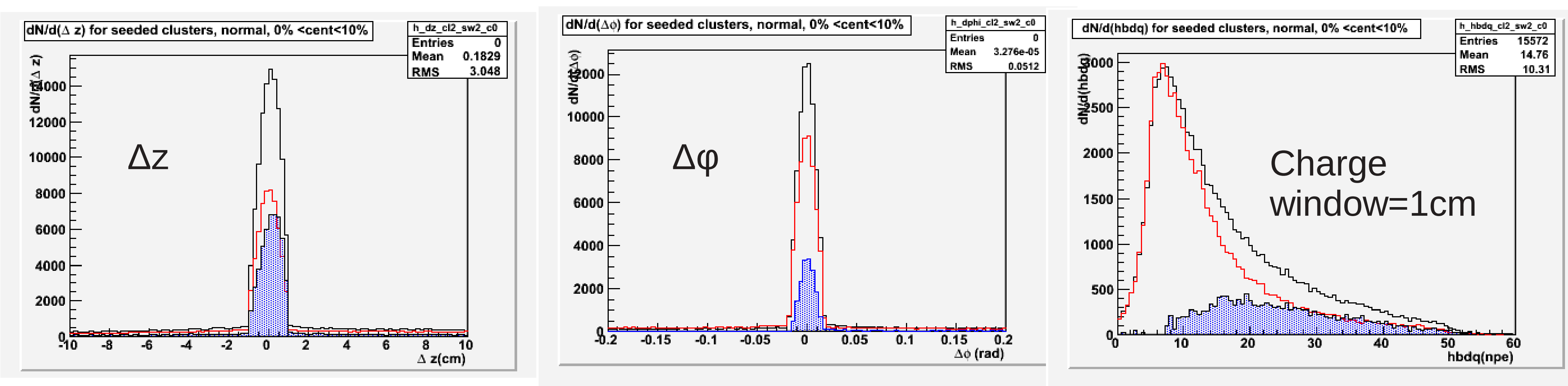


HBD charge of clusters associated to identified electron tracks in different centrality classes.
Not much of a hint of signal

Using track projections

- Change in approach: Instead of trying to find all possible “hot spots” and then associating tracks to the closest one, we start from projection and merge all triplets with a CG that lies within a given distance off the projection
- The idea of matching distance has little sense, because the cluster by construction lies at the projected position of the track in the HBD

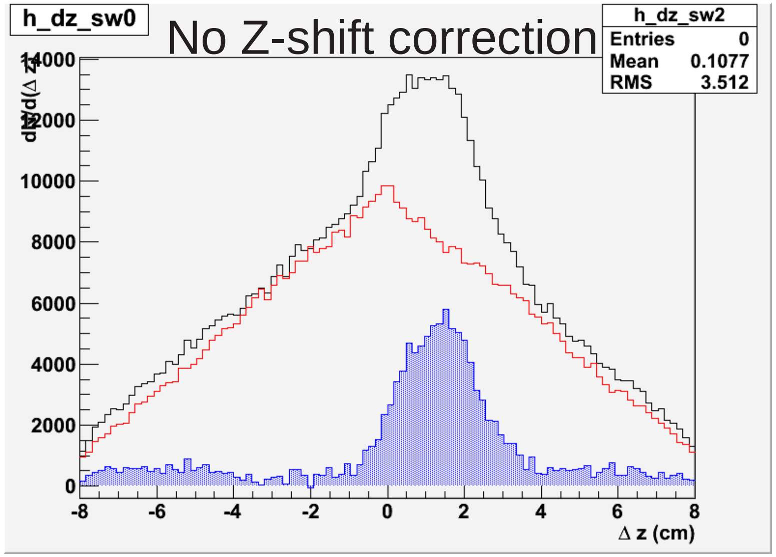
10% most central

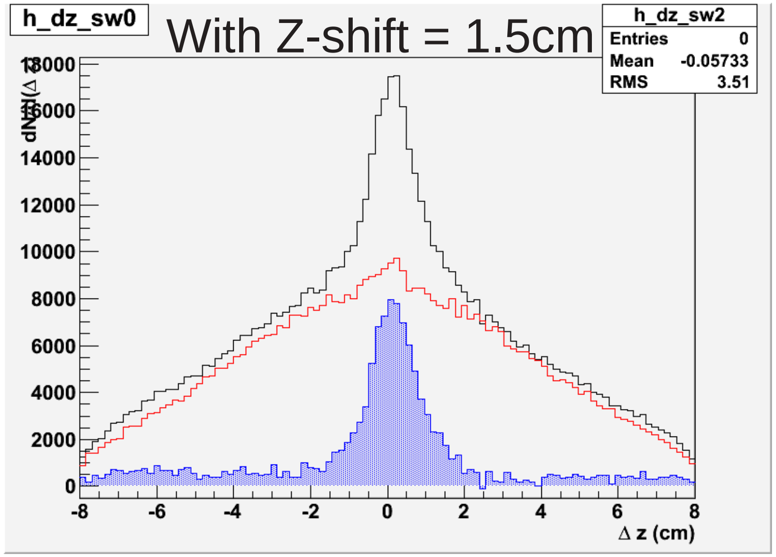


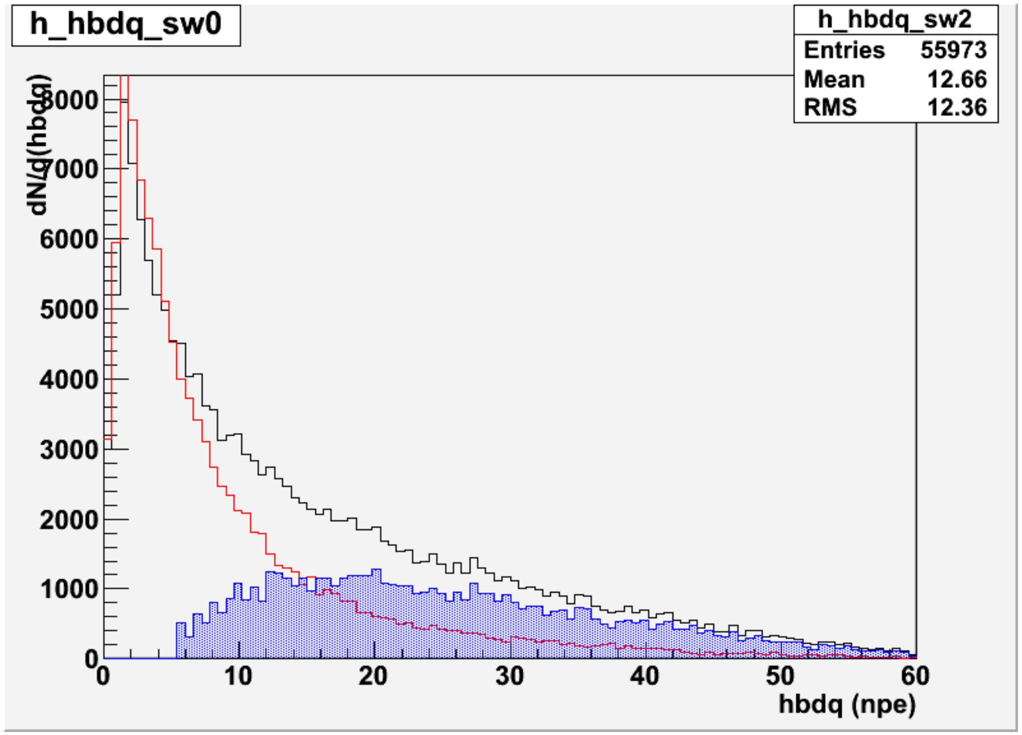
- At this point, association didn't require that only the cluster merged around a given track projection gets associated to that track, resulting in a uniform tail in matching distribuiton
- Z distribution for non swapped search is skewed whereas the matching for swapped tracks seems centered
- The z mismatch resulted in a very bad “signal to background” in the charge distribution

Alignment

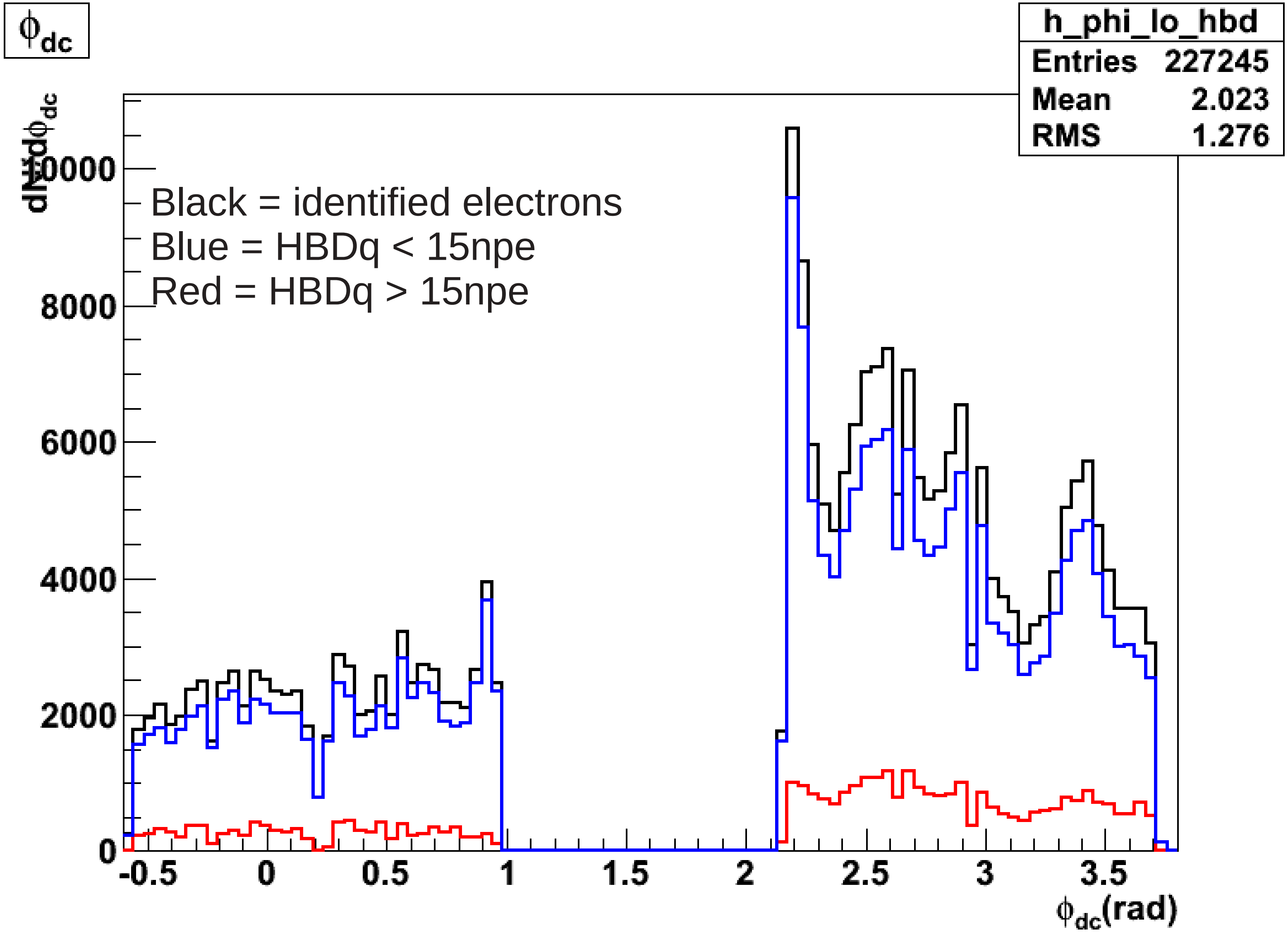
- Match tracks to nearest triplet with a very high charge (>15)
- Shift until the signal peak is well centered
- Once the correction has been determined, go back to merging triplets within a window that have a net charge of > 1
- Signal to background in charge distribution looks more reasonable after the correction



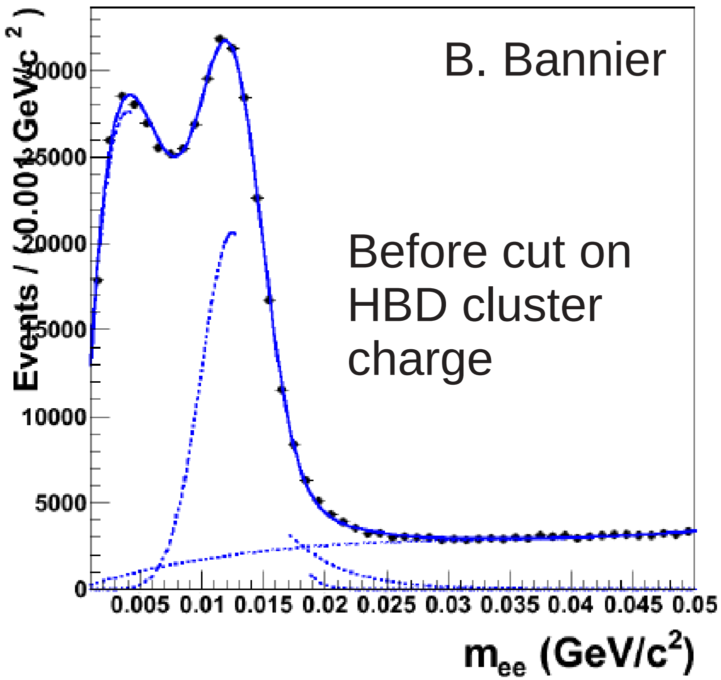


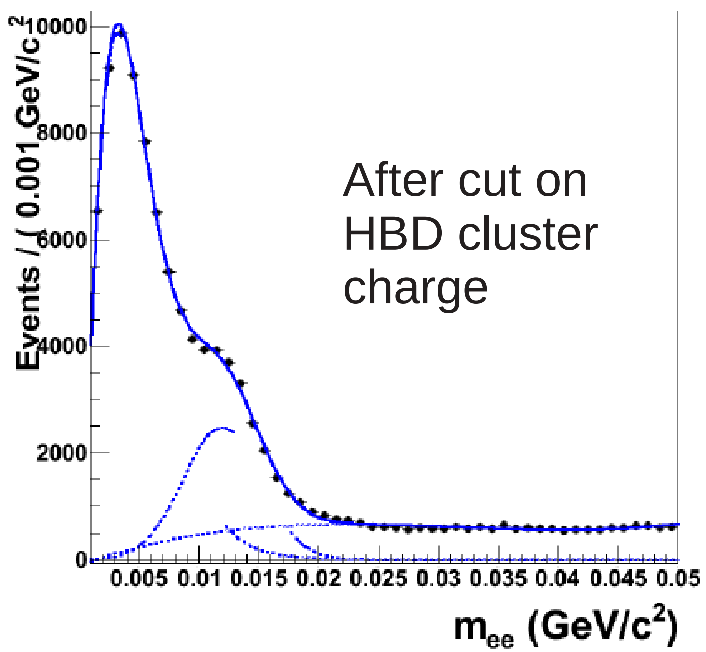


Rejection of strut conversions



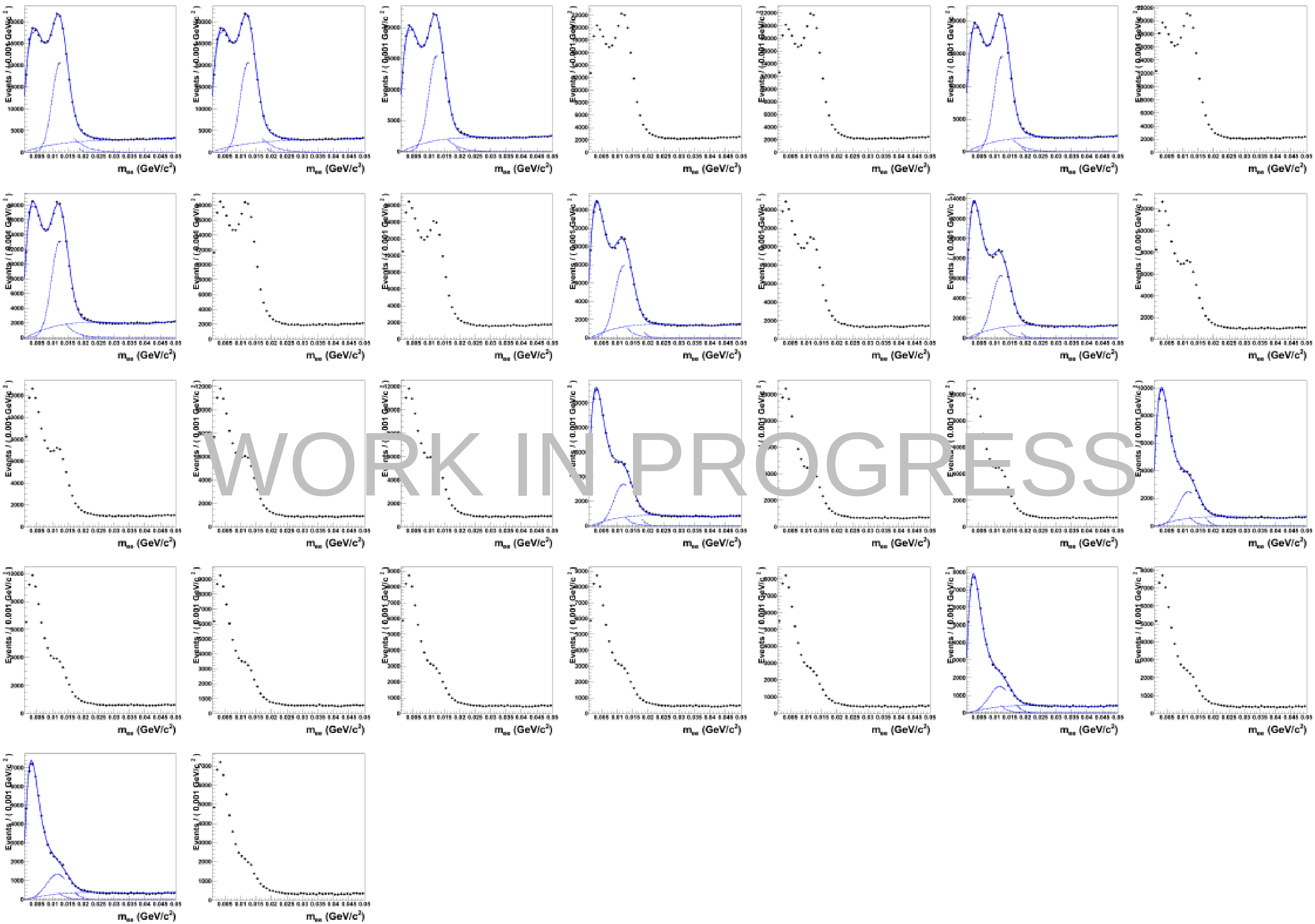
Rejection of backplane conversions



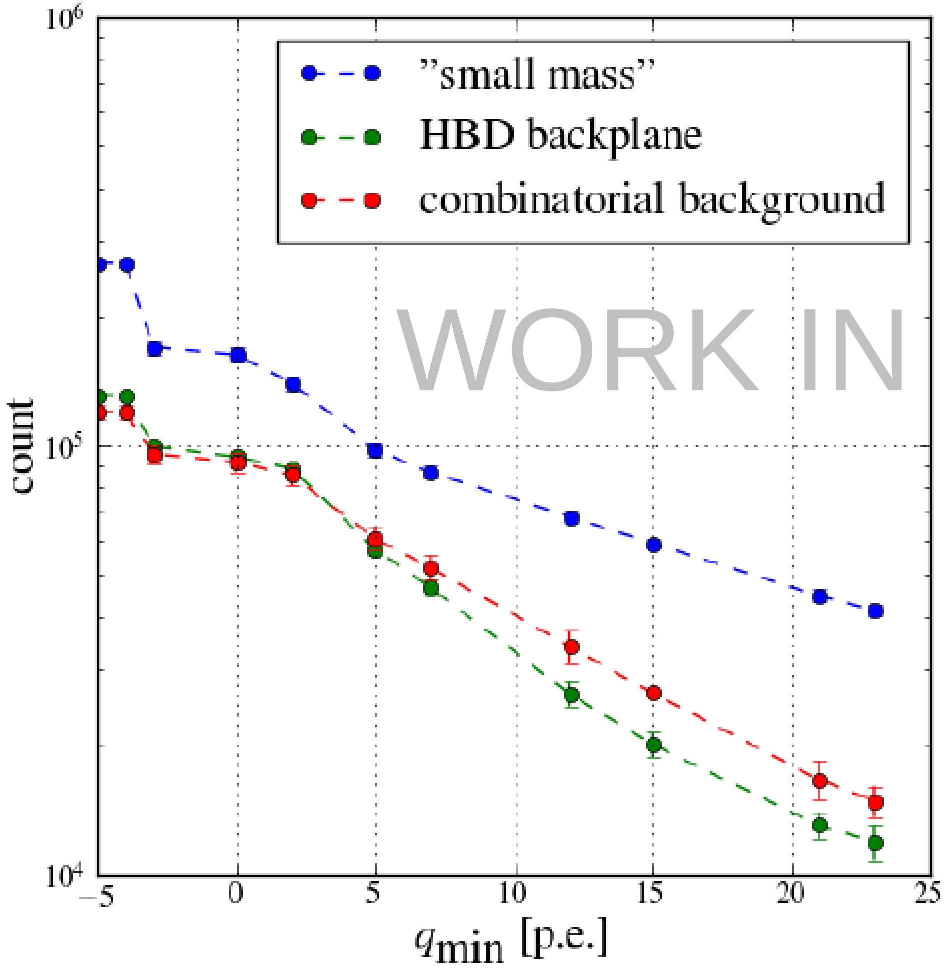


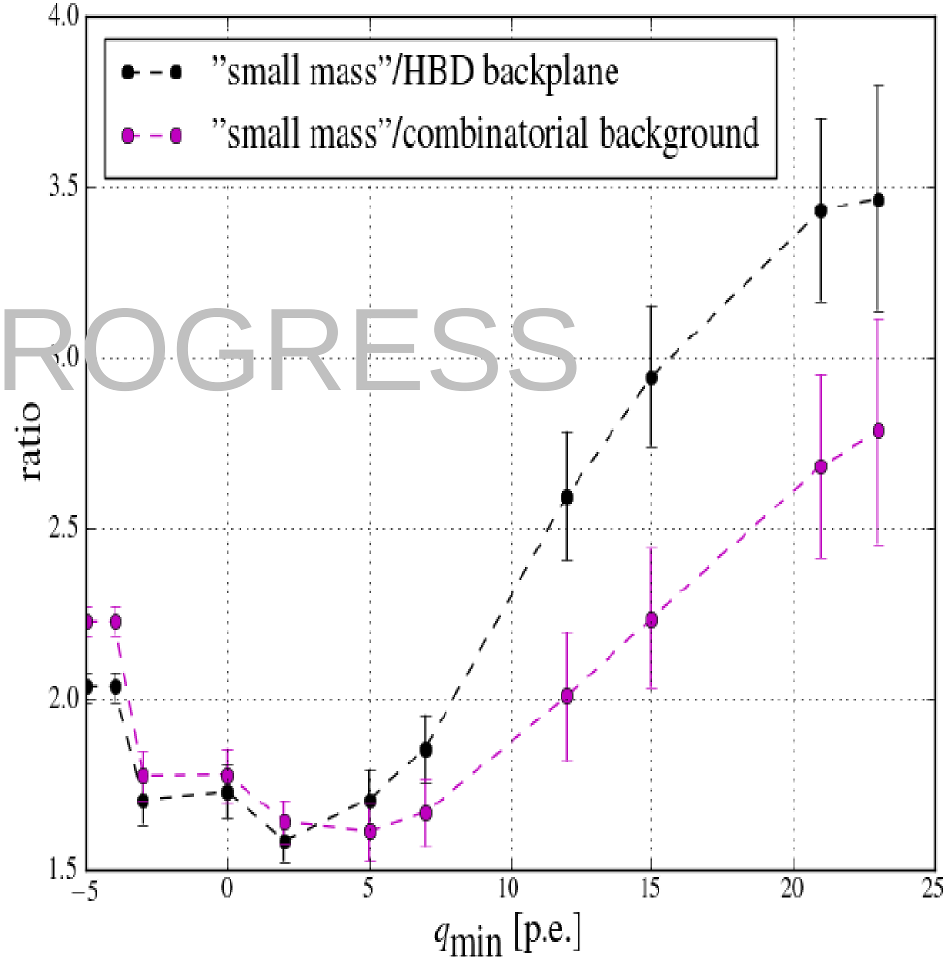
- Invariant mass of dielectrons below 50 MeV
  - Clear components
    - Pi0 Dalitz + Beam pipe conv (~3MeV)
    - Backplane conversion (~12MeV)
  - A cut on the HBD Charge at 15pe removes the backplane conversions more effectively than signal electrons
  - Caution: Efficiency for signal electrons is low
- This shows that one variable approach will be not very effective
- We are working on other variables
  - Merging within a larger window
  - Shape and matching
- Final answer will probably involve more than one variable to cut on

Attempt to extract efficiency and rejection



Attempt to extract efficiency and rejection

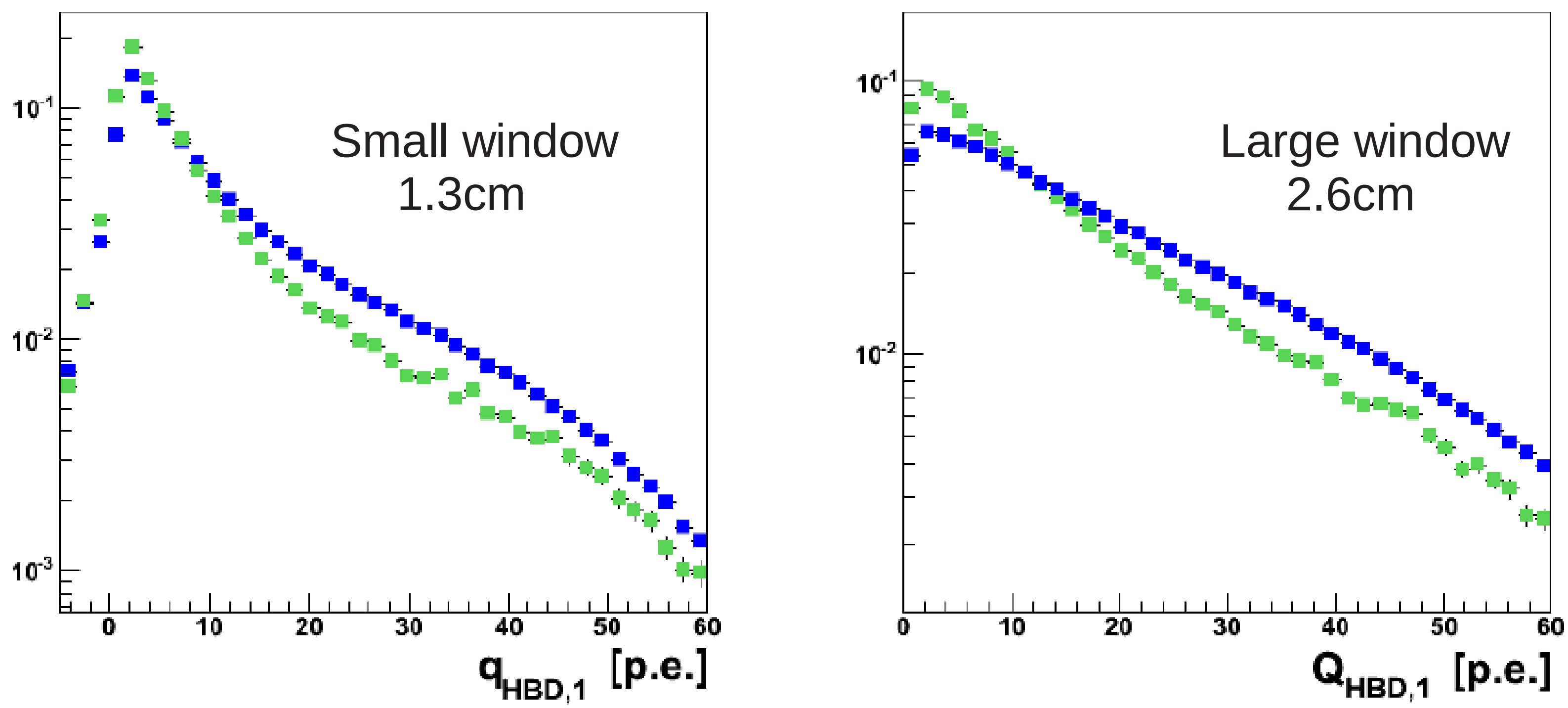




WORK IN PROGRESS

Merging in a wider window

- Drawback of this merging approach is that for double hits, requiring a very narrow search window will lead to loss of charge.
- So we add another charge variable for every track where valid triplets within a wider merging window can be added to the final cluster



$m_{ee} < 5\,\mathrm{MeV/c^2}$, $11\,\mathrm{MeV/c^2} < m_{ee} < 13\,\mathrm{MeV/c^2}$

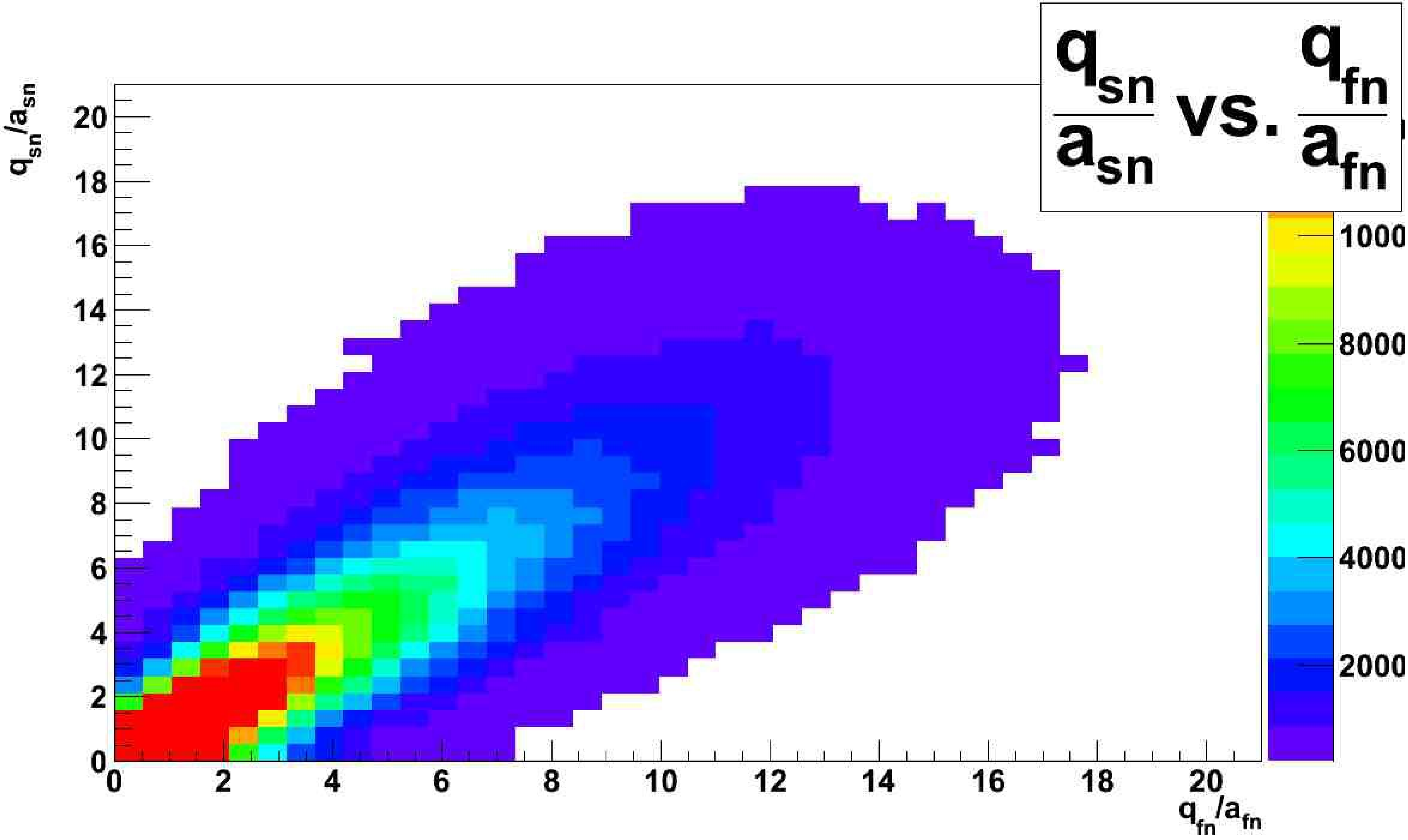
Summary

- A slight change in merging approach (projection based)
  - Seems to be giving good backplane rejection
  - Efficiency still needs to be worked on
  - More quantitative involving both data driven and MC underway

Backup

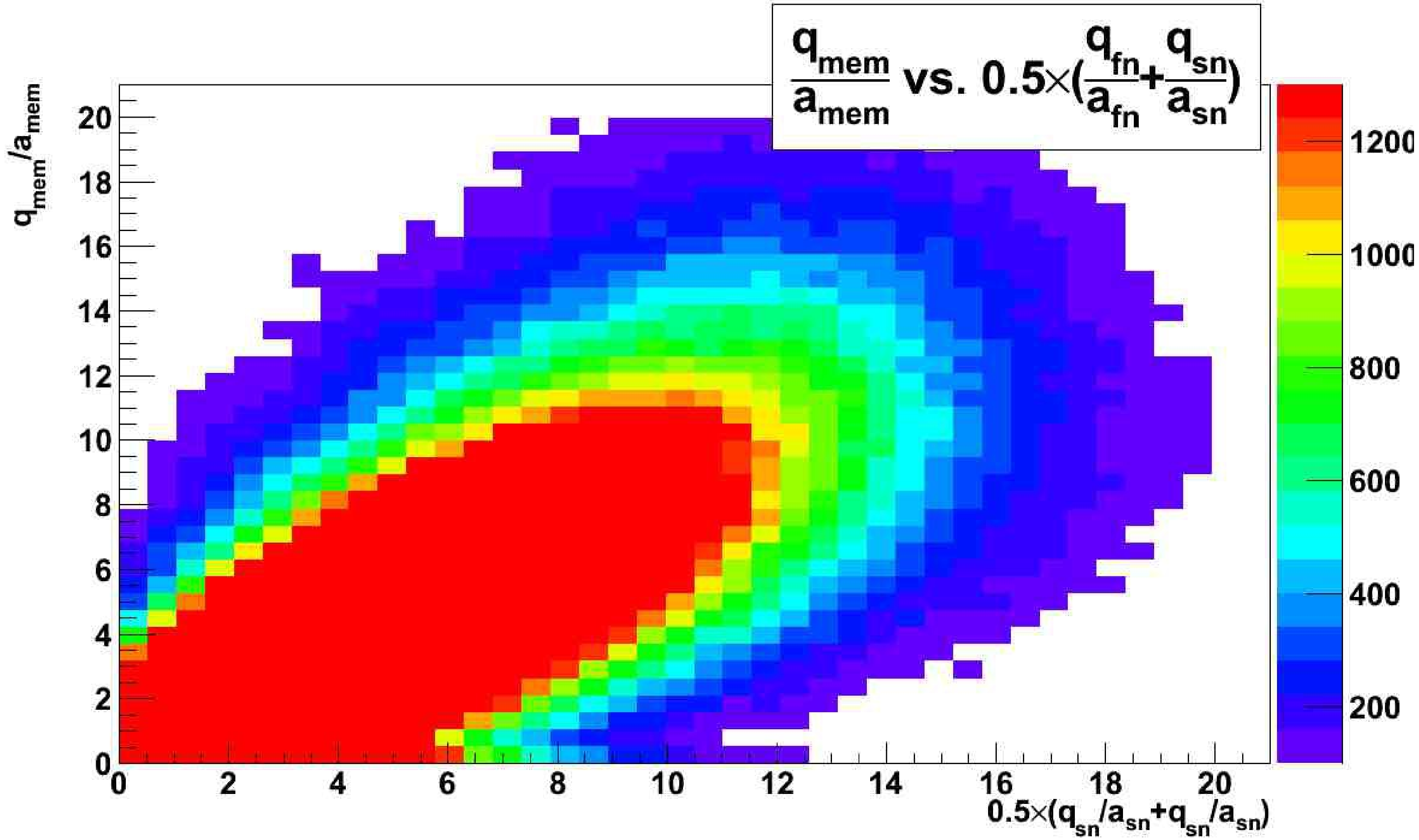
Justification of background estimation

- Basic assumption of the method
  - Scintillation background varies continuously over HBD surface
  - Background in any compact group of pads can be estimated from the average rate of npe in its neighboring pads



Justification of background estimation

- Basic assumption of the method
  - $$bkg = a_{mem} * \left(\frac{w_{fn} * q_{fn}}{a_{fn}} + \frac{(1 - w_{fn}) * q_{fn}}{a_{sn}}\right)$$

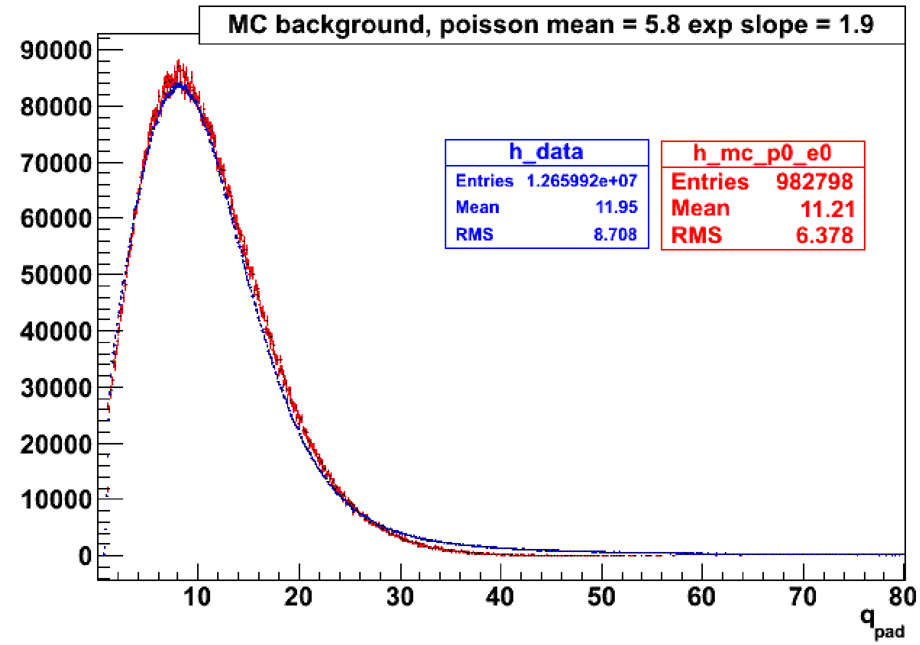


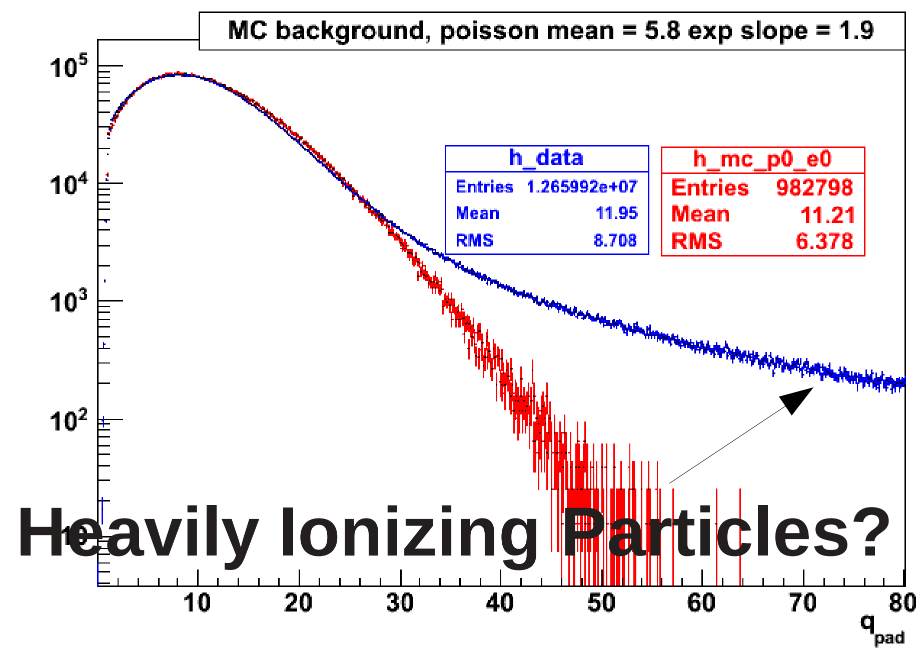
Mimic the real data backgrond

- Attempt to generate RD like background

$$q = \sum_{0}^{P(M)} \exp(\tau)$$

  - M (Poisson RV mean) and tau (Exp. RV decay const.) are hand tuned to match the RD pad charge distribution
    - Ten centrality bins of 10%
    - The long tail in RD is hard to reproduce (probably coming from jets? If so maybe can be added with some effort.)
    - This kind of detail matters for clusterizing
  - Using temporarily as a rough approximation to scintillation background





HIPs: an issue with a solution

- The pad by pad charge distribution has a very long tail
  - Caused by physics processes that deposit a huge amount of energy
  - Much more than typical per pad charge expected from either scintillation or Cerenkov
  - Rate is proportional to intensity
  - X-ray, neutrons heavy particles?
- These pads if left alone are a big problem for any clusterization algorithm, because they can seed fake clusters.
- Fortunately, event by event, they cover only a very small fraction of the active HBD area