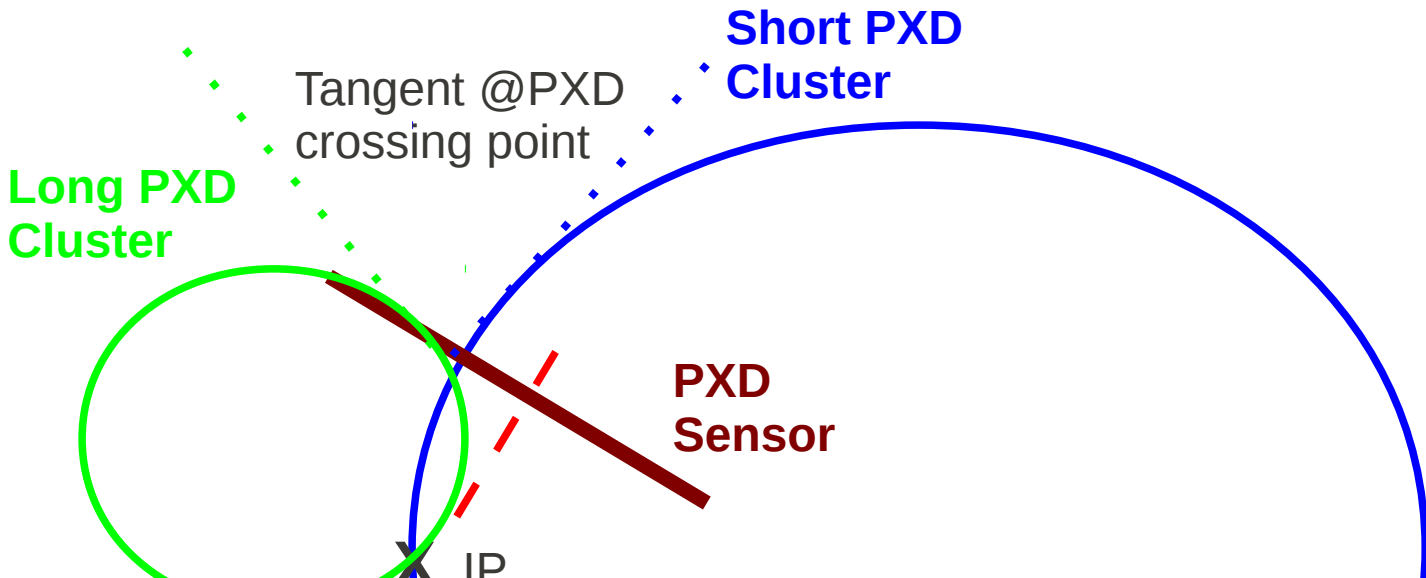
Tracking and Vertexing

Outline

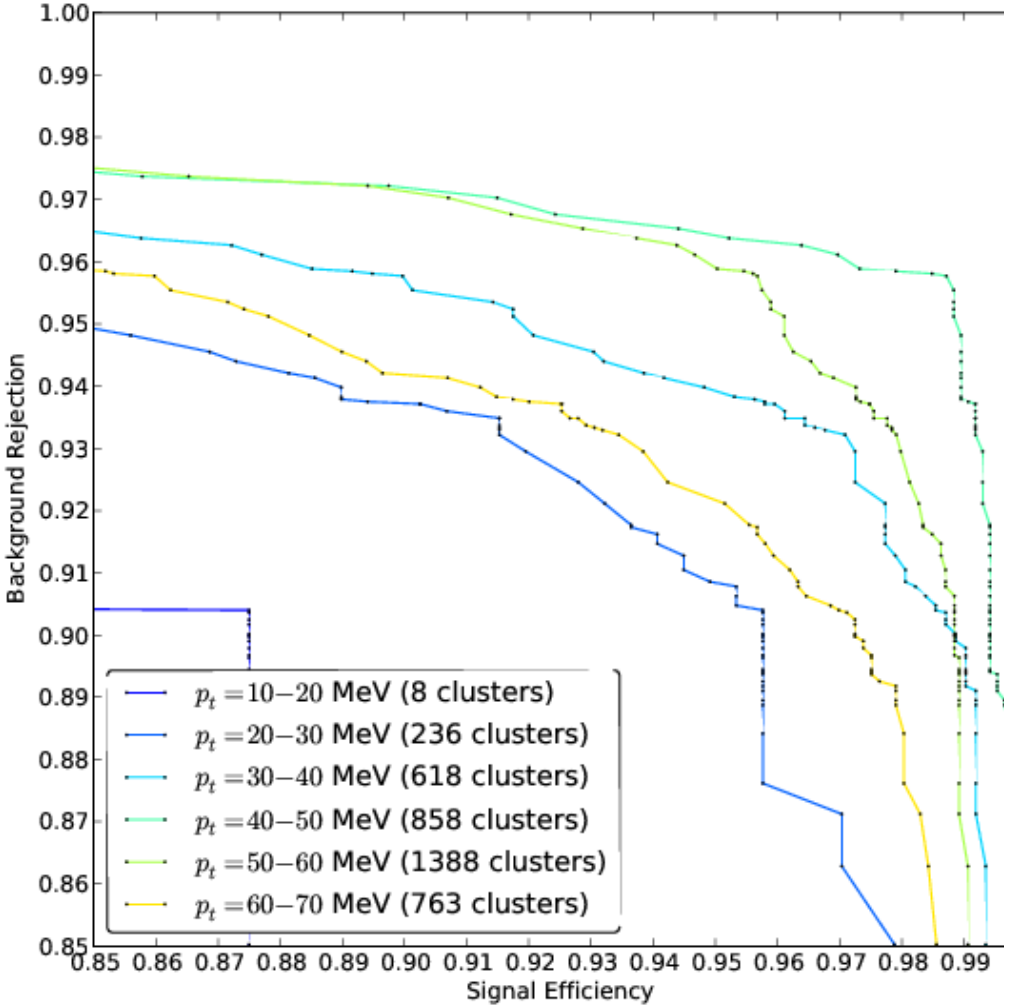
- Pattern Reco Issues
  - PXD
  - SVD
- Fitting Issues
- dE/dx for particle ID
- Other VXD Related Notes

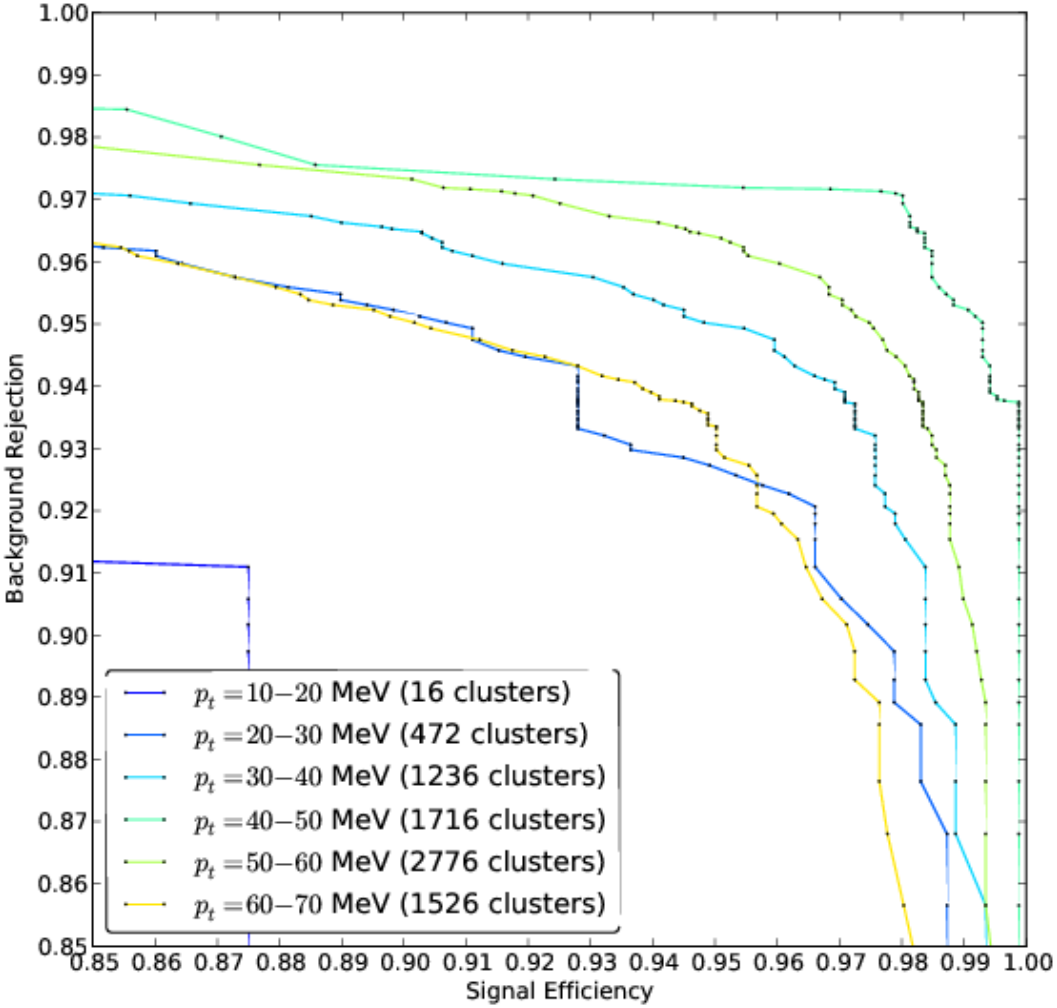
Pattern Reco Issues - PXD

- Clusteranalysis has been taken up again (
  Touschek separation was shown in Yugarawa;
  signal are pions from B decays, that don't reach VXD layer 6)
  - this time with KoralW, BHWide as bkg
    - BHWide doesn't make a lot of hits in the PXD
    - KoralW hits can be separated quite well;
      - Charge variables most important, but
      - often the incident angle into the PXD is quite low in r-phi-direction → clusters extend in r-phi



Good news first.

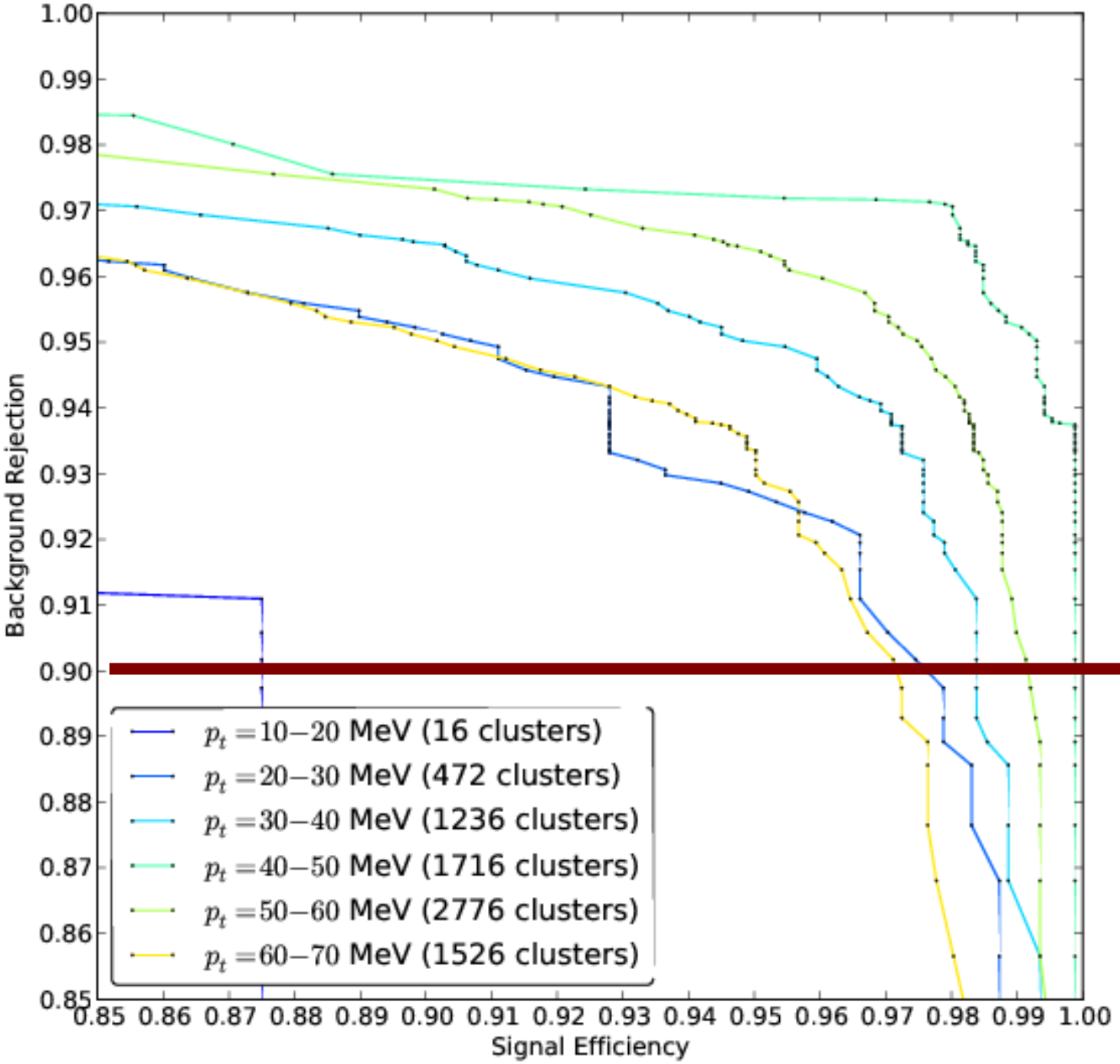




Only Touschek as background. (Yugarawa)

Touschek, BHWide, KoralW

KoralW bkg seems to be even easier separateble.



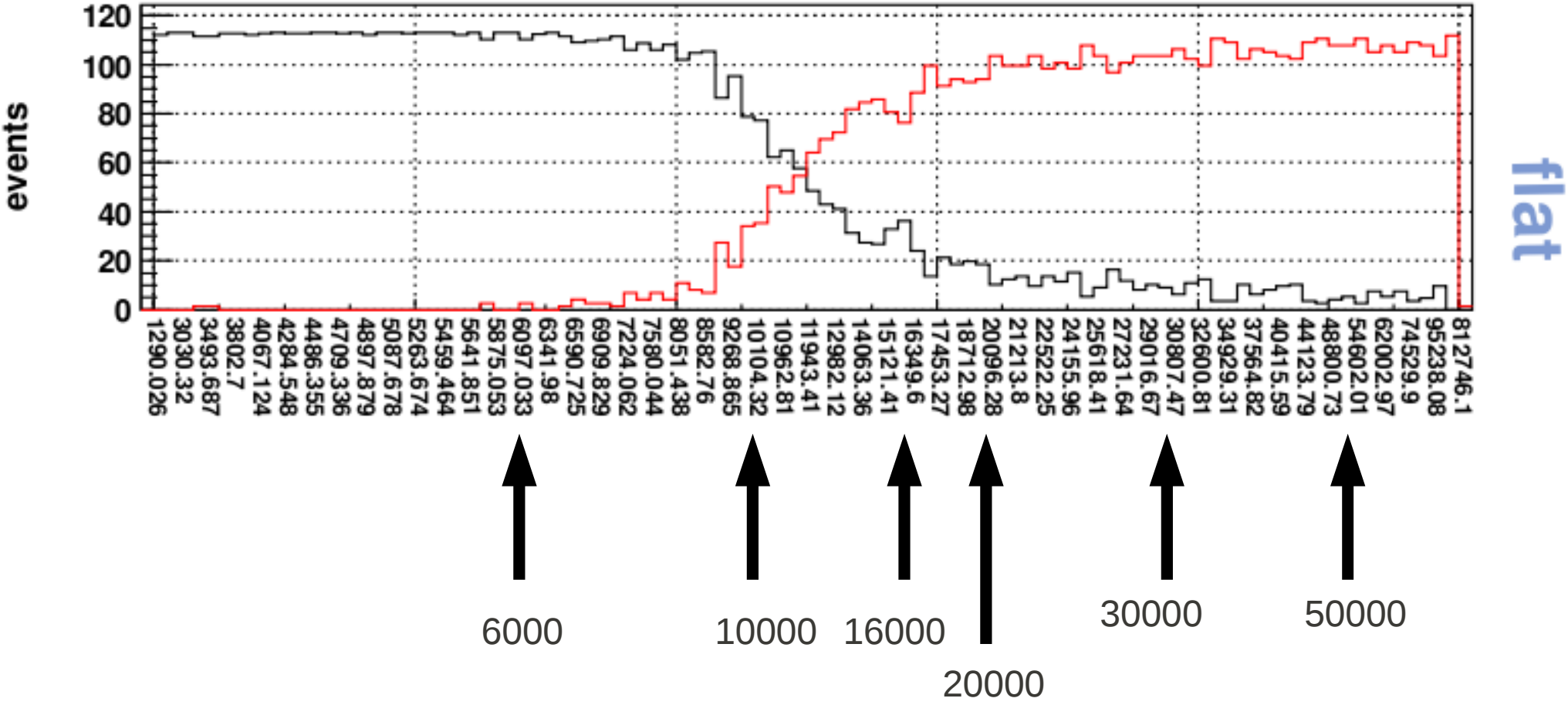
Maximal needed background reduction (Factor 10).

8 Mpx
*** 3% (Occ)**
*** 4 Byte**
~ 960 kB

Write out ~100 kB

Bad news second.

Maximum charge variable in the NN



Analysis doesn't take into account ADC conversion.
Noise isn't an issue (~ few hundred electrons), but currently cut off is planned at 10000 electrons.

- We should carefully study, what is the best cut off value, taking into account
  - Necessity for very good vertexing for fast pions, muons, electrons, that require good charge resolution at low energy depositions.
  - Necessity for very good vertexing for KAONs, Protons, as well at momenta well below MIP (does anybody now the average Kaon momentum in Belle? I guess the median is not more than M(Kaon))
  - If the other things are sufficiently satisfied; cluster analysis for ultra low momentum pions.

At this moment we need more information; e.g. what resolution in the PXD has what effect on the impact parameter? Could different cluster algorithms improve things (see below)?

I hope by summer we can answer these questions.

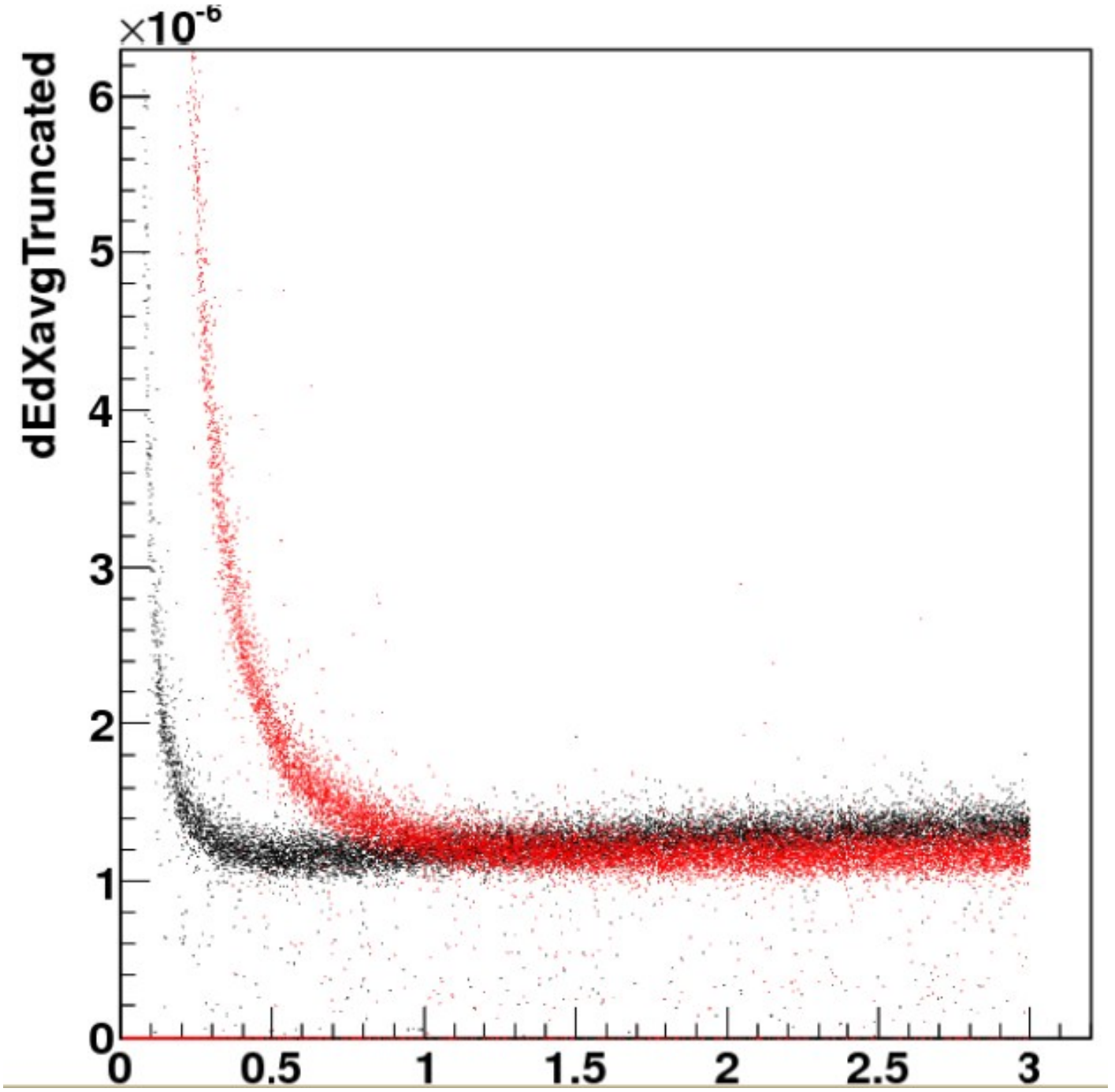
D^0 DECAY MODES:

Example: Full Reconstruction

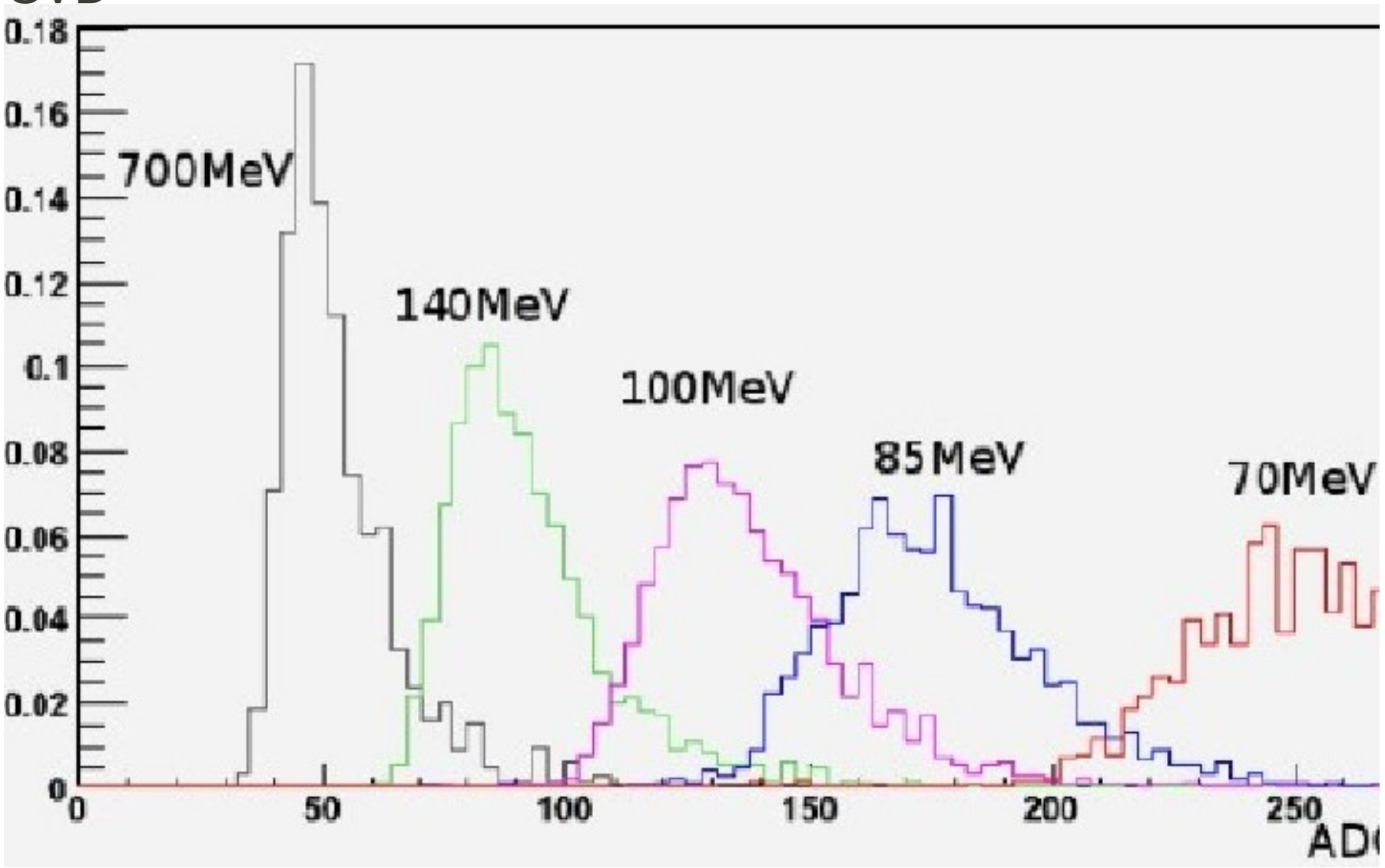
NAME	FS	$\mathcal{B}_i$	ε_i	CONTRIB
$K^-\ \pi^+$	1	3.89 %	83.7 %	18.9 %
$K^-\ \pi^+\ \pi^+\ \pi^-$	1	8.09 %	66.3 %	31.1 % ←
$K^-\ \pi^+\ \pi^0$	1	13.90 %	44.6 %	36.0 % ←
$\pi^+\ \pi^-$	1	0.14 %	79.3 %	0.6 %
$\pi^+\ \pi^-\ \pi^0$	1	1.44 %	42.2 %	3.5 %
$K^0\ \pi^0$	1	1.22 %	12.7 %	0.9 %
$K^0\ \pi^+\ \pi^-$	1	2.94 %	18.8 %	3.2 %
$K^0\ \pi^+\ \pi^-\ \pi^0$	1	5.40 %	10.0 %	3.1 %
$K^+\ K^-$	1	0.39 %	88.4 %	2.0 %
$K^+\ K^-\ K^0$	1	0.47 %	21.0 %	0.6 %

Other possible useful decays:
K 3π π^0 (BR ~ 4.2%), K π $2\pi^0$ (BR ~ 17%);
Vertexing reduces combinatorics, one low momentum pion likely.

RED:
Kaon dE/dx in gas.

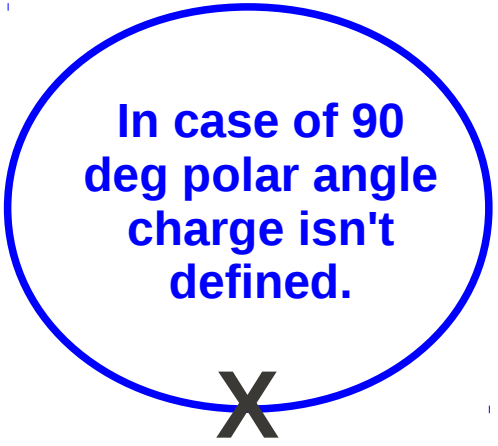


Energy deposition by momentum in the SVD



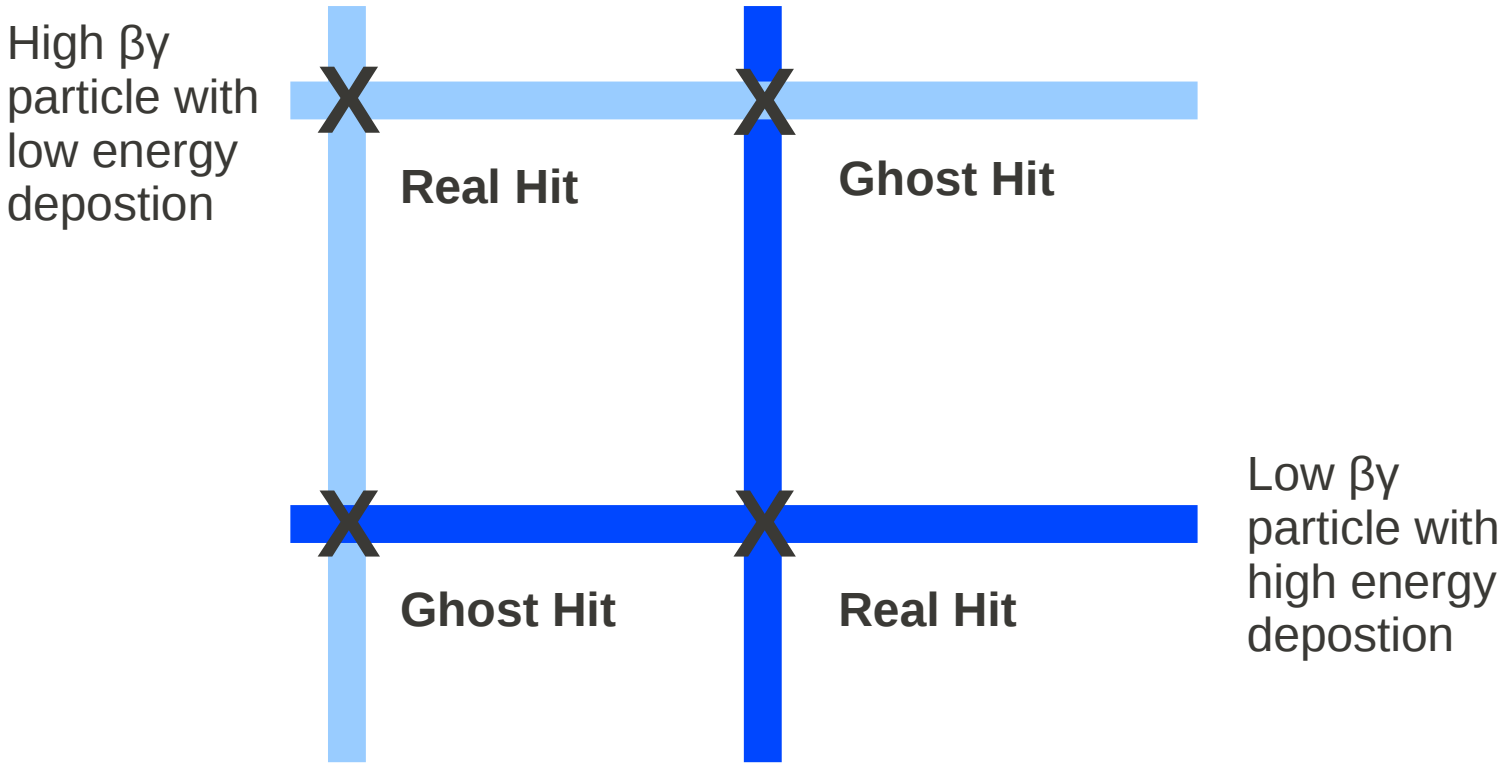
Pattern Reco Issues - SVD

- c = 30 cm/ns
- Most optimistic case for SVD time resolution: 2 ns
  → particles travel <= 60 cm during 1 σ time resolution
- Curling tracks may fly almost 3 meter and even a bit slower than speed of light.
  - Time resolution may be used to identify hits from curling tracks.
    → save charge determination even @ ~90 deg



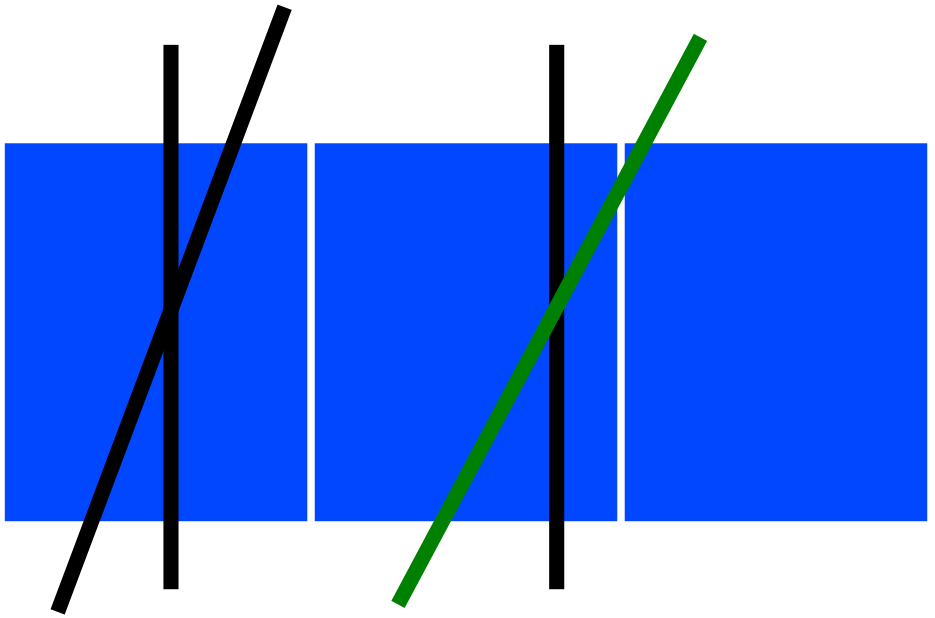
→ This is a nice and useful feature! It would be nice to have this as well in the beginning @ low luminosities. (Christoph mentioned, it might be turned on only later)

- Energy deposition was as well used in Belle to make combinations of strips in the SVD.
  → not yet used by Jakob
  → still potential to improve reduction of fake tracks/taking of optimal combination of possible tracks



Fitting Issues

- Reclustering during fitting can be useful.

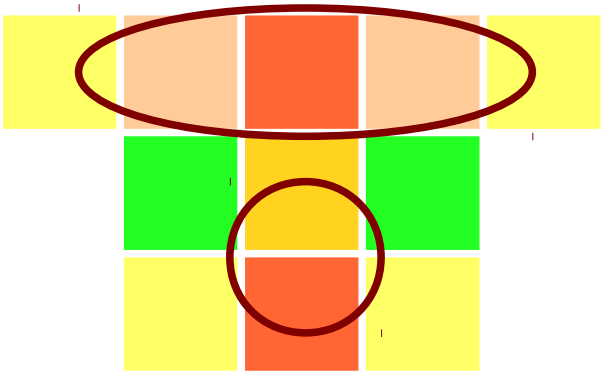


These two tracks produce more or less same signal. (Potentially different charge sharing between cells)

These two tracks may produce more different detector responses, because neighbouring cell is hit as well

==> if only one cell shows a strong signal, the 90 deg track can be closer to the edge than a track, that hits @ small incident angle.
→ This has strong influence on the uncertainty of the hit position.

- There are possible effects, that may make Center-of-Gravity (CoG) algorithm suboptimal for best position as well:
  - Non-linear/R-dependent charge sharing behaviour depending on the exact position.
  - Clusters made of subclusters (probably is rare, but will happen)

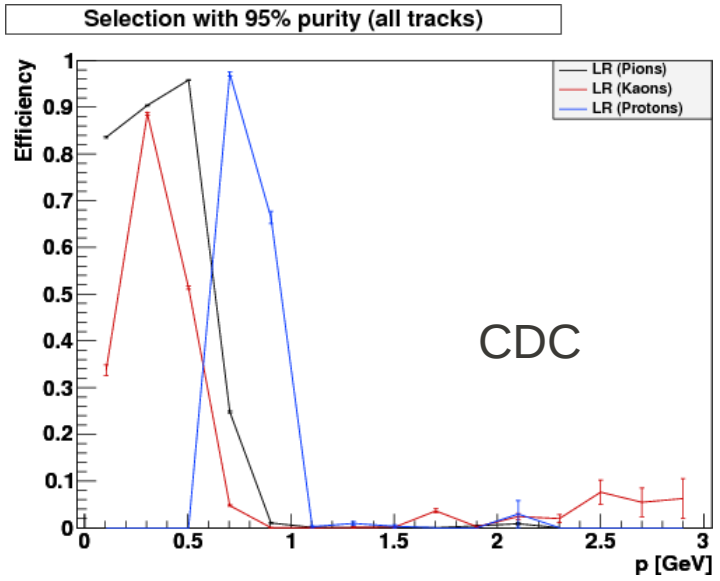


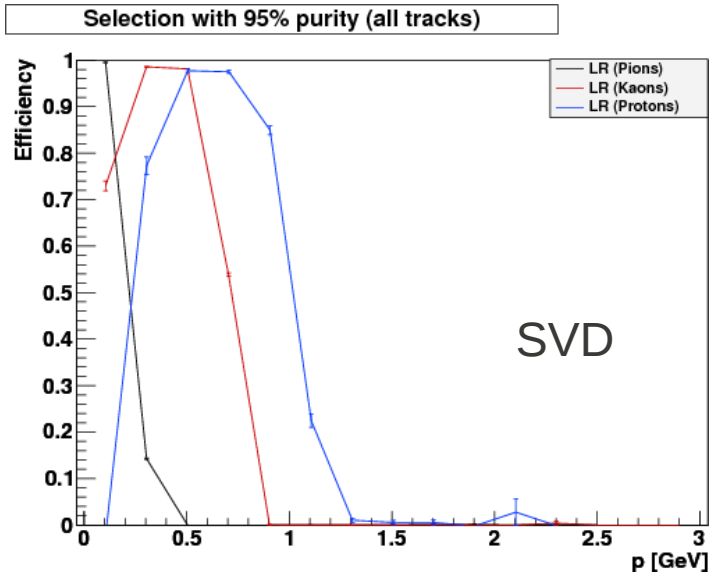
→ The tracking group will try different clustering algorithms making use of the track information (incident angle, but possibly as well momentum), besides the existing CoG and head/tail algorithm.

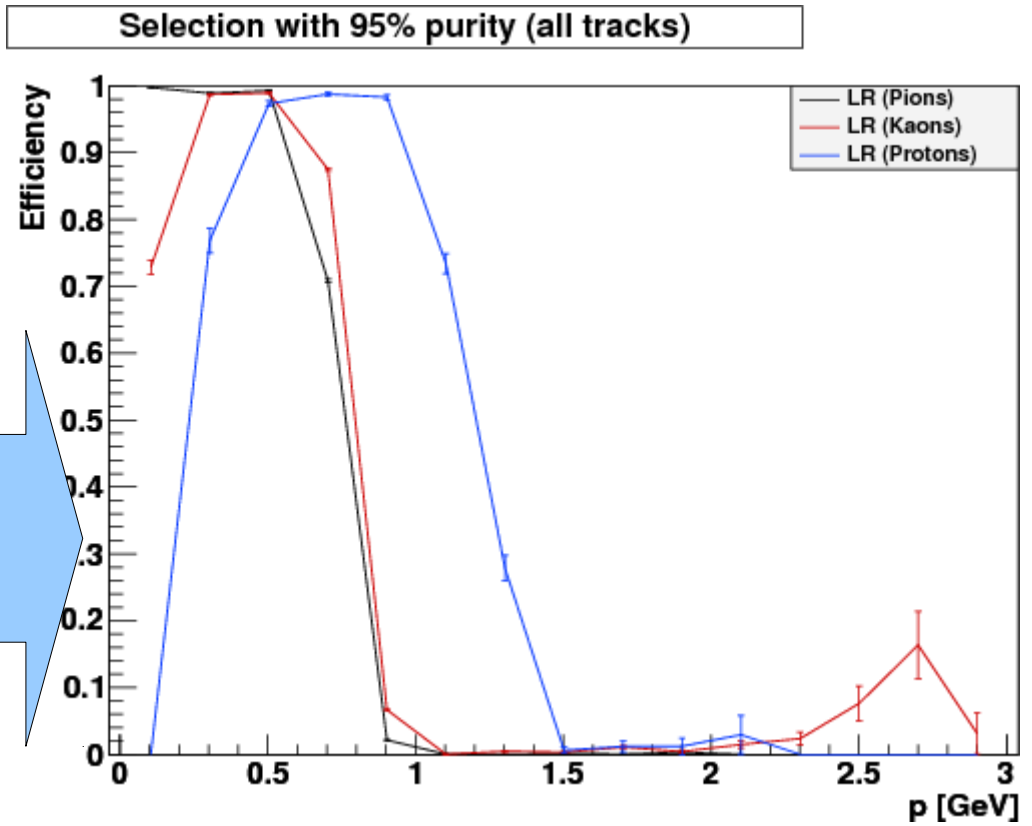
→ The VXD Software should allow the use of different cluster algorithms for pattern reco & first quick fit and final refit, e.g. with a kind of plug-in mechanism or switch or something like that.

This can be fine tuned on data, but should be developed using realistic digitizer. (There are still differences in the PXD and SVD dE/dx response, that I don't understand.)

dE/dx for particle ID







Combining dE/dx information from SVD and CDC substantially increases efficiency and attainable purity, esp. at low momentum.

Other VXD Related Notes

- What is the status of material inclusion into the simulation?

  As well things like the isolation between the SVD and the CDC should be in the simulation.

- Word about Clustering:
  - RAVE adaption by David T., Patrick F. (HEPHY) is committed to SVN; mostly needed is tutorial how to use the code.

Summary

- Clusteranalysis is as well able to handle ee → eeee BKG; However, performance suffers from early cut off.
- Excellent SVD time resolution opens up new possibilities; Energy deposition in SVD can be used to reduce ghost hits;
- “Clusterfit“ is very likely useful; development is going on;
- dE/dx profits from inclusion of SVD, especially it fairly low momentum;
- Dead material implementation would be useful; Vertexing in principle exists, but usage is difficult and undocumented.

Next Tracking Meeting

8th and 9th March in Munich!

http://indico.mppmu.mpg.de/indico/conferenceDisplay.py?confId=1659