Status of the dielectron analysis in Run-10, 62 GeV

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Outline:

- The data set
- HBD – signal reconstruction
- HBD – recalibrator
- Status of the pair analysis
- Raw mass spectra
- Outlook

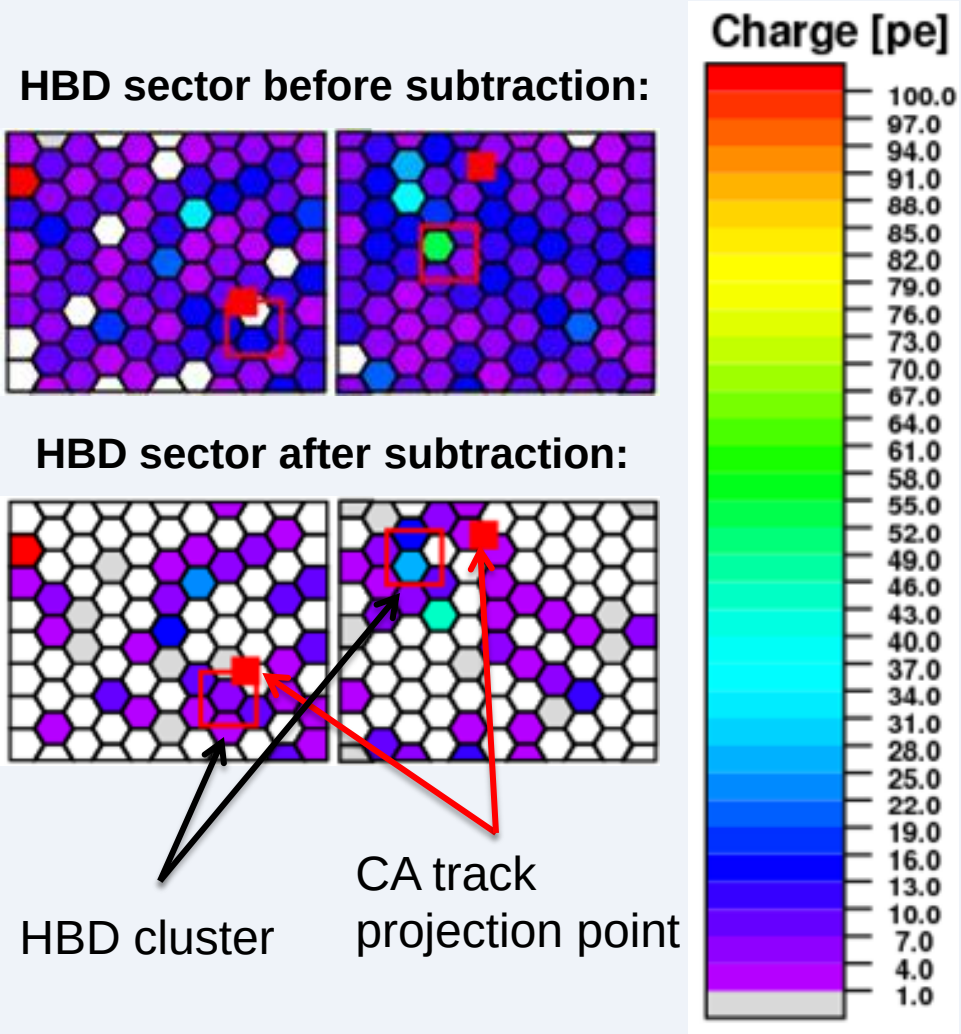
The analyzed data set

- Run-10 – 62 GeV Au+Au data
  - EWG files (293 runs produced)
  - 3 runs discarded due to QA: 311979, 312371, 312825 [*]
- Event cuts:
  - abs(bbcz) < 20 cm
  - the total number of events in the sample, abs(bbcz)<20 cm: 441.8 milion
- Track selection:
  - track quality = 31, 51, 63
- eID cuts:
  - n0 > 2
  - sqrt(emcsdphi*emcsdphi + emcsdz*emcsdz) < 3 [*]
  - dep > -2 [*]
  - chi2/npe0 < 10
  - disp < 5
  - prob > 0.01

[*] Deepali´s H/L PWG presentation from August 12, 2010

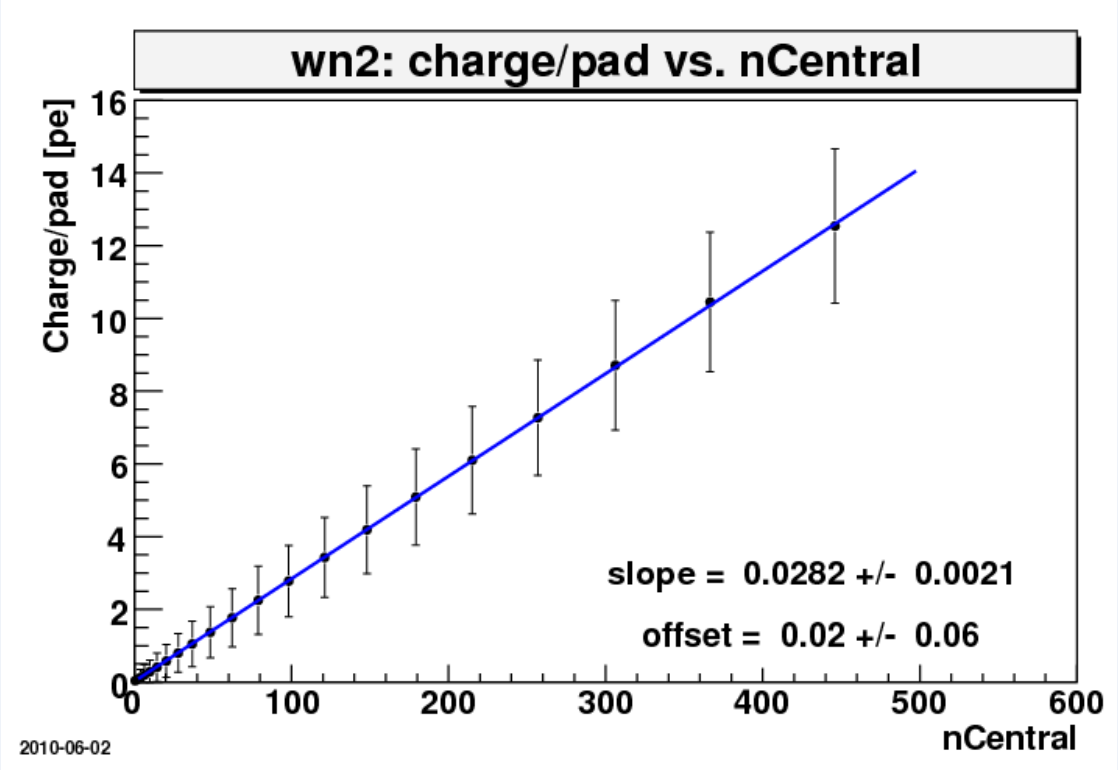
HBD – charge subtraction

- HBD occupancy in the most central events > 95 %
- Charge (mostly from the scintillation) is subtracted to reduce occupancy and allow signal reconstruction
- Subtracted is the average charge per cell, on event-by-event basis for each particular HBD module
- Occupancy reduced to ~30 % in the most central events



HBD – charge subtraction

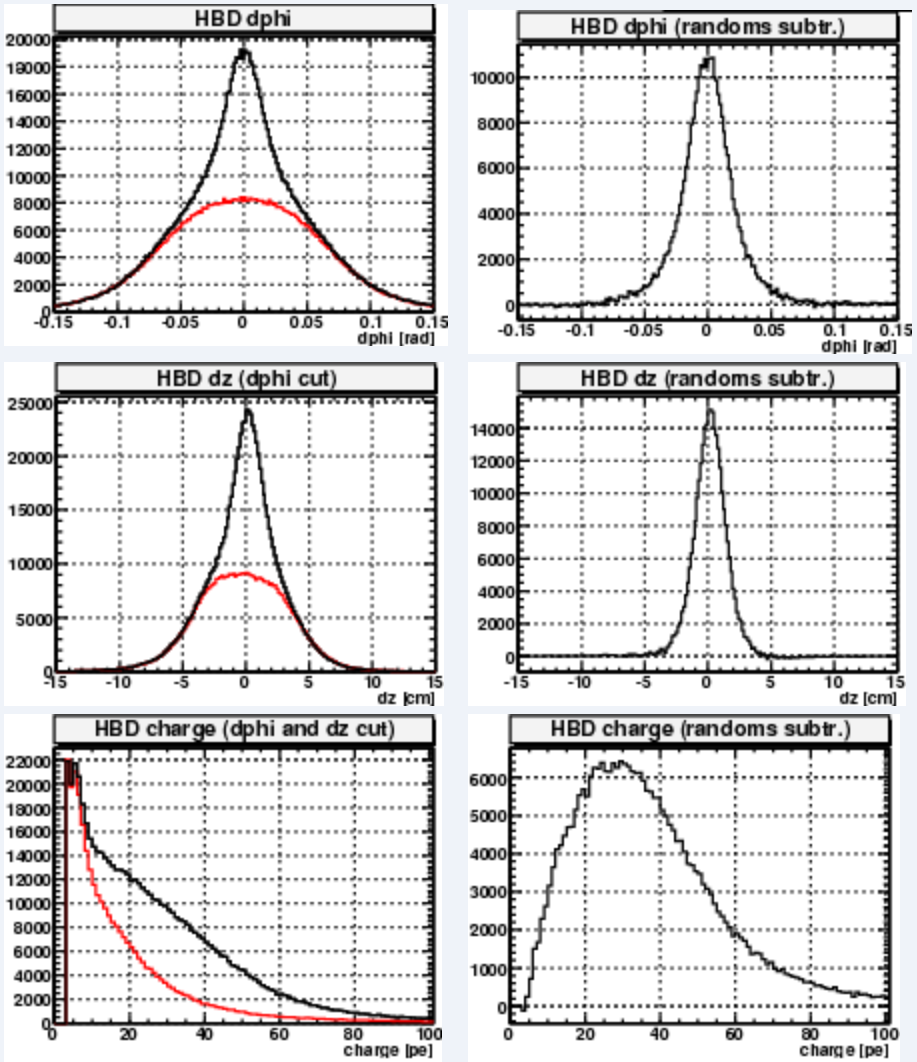
- The subtraction is justified by the fact that the number of the scintillation photons grows linearly with number of tracks in CA
- The example shows this for a single HBD module:



- The bars represent the sigma of the gaussian fit to the average charge distribution (for given centrality)

HBD – matching and charge distributions

- The charge measured in HBD is obtained after matching cuts on hbddphi and hbddz
- The background is estimated by swapping technique (CA tracks are projected to a different module and point to a random HBD cluster)
- The background is normalized to the matching distributions tail-to-tail and subtracted
- S/B inside the matching window ~ 0.87 (for Minimum Bias)

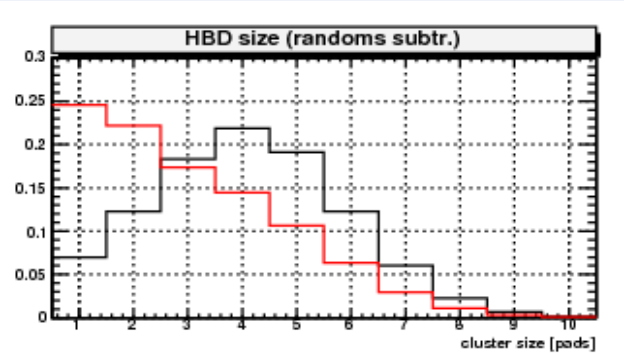


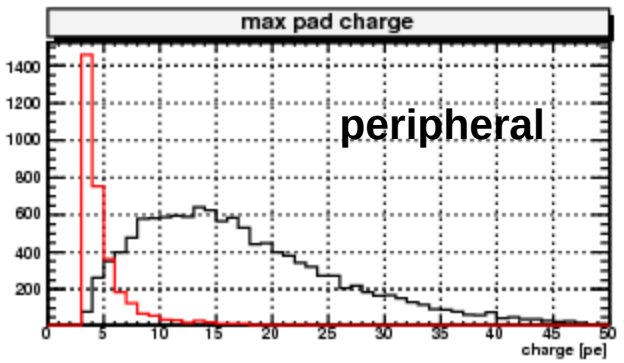
signal+background
background

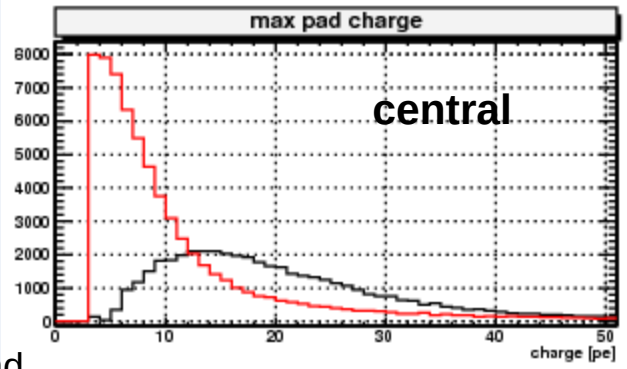
HBD – pattern recognition

- The random matching in HBD is due to the fact that CA electron tracks originating from conversions in and after the HBD backplane have no real matching hit in the HBD

- This background is being removed in two steps:
  1. Rejection of 1 pad clusters
  2. Rejection of clusters with the maximum pad charge below a certain threshold. This threshold is centrality dependent







signal
background

HBD – pattern recognition

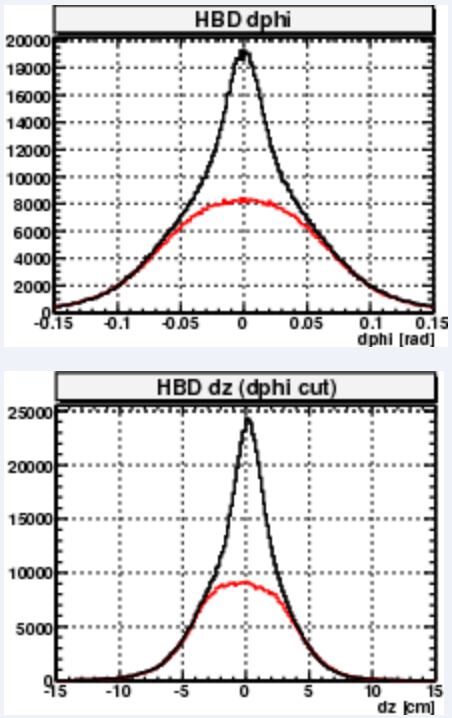
- The pattern recognition significantly improves HBD signal to background

- The efficiency is estimated from MC simulation of single electrons embedded with HBD MB data

- The single electron detection efficiency in HBD is summarized as follows:

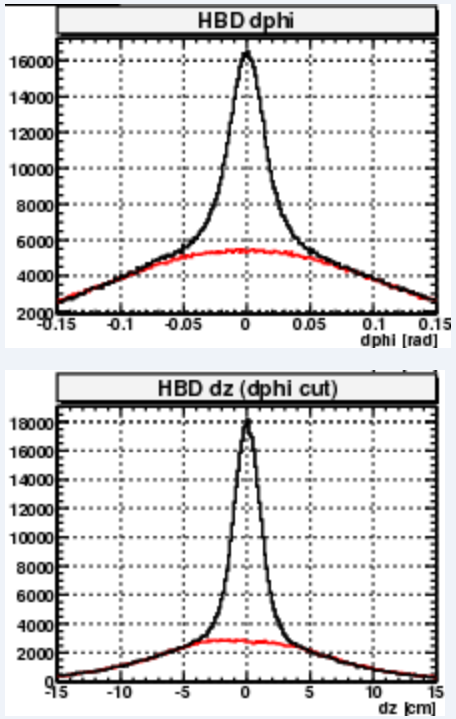
Case	ε
Pure MC, single electrons	**~93 %**
MC embedded with HBD	**~80 %**
MC embedded with HBD + pattern recognition	**~66 %**

Before p.r.



S/B ~ 0.87

After p.r.



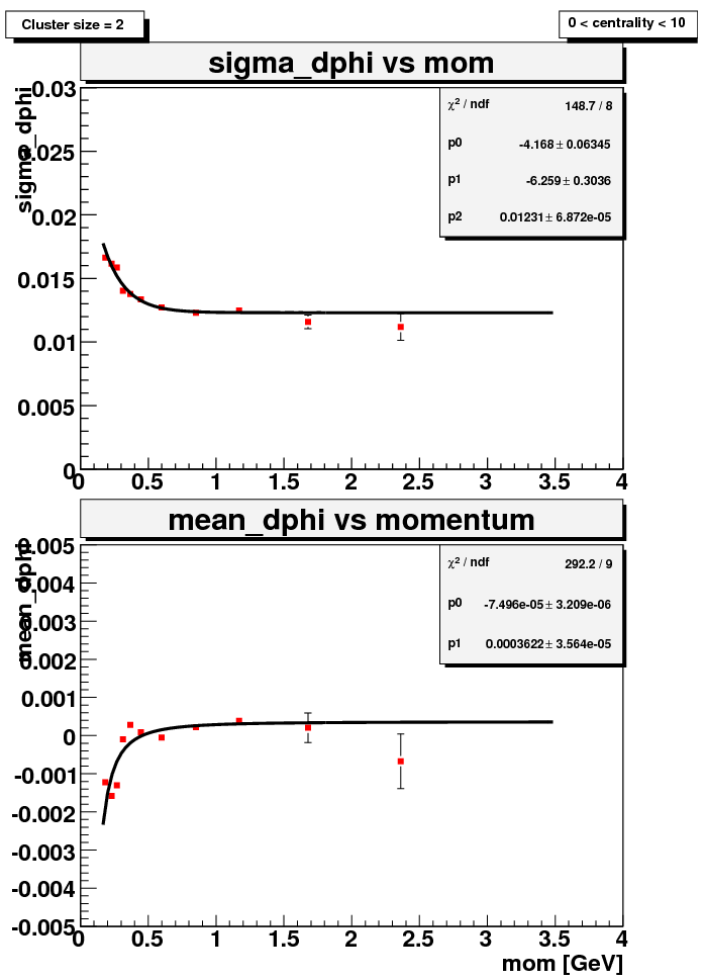
S/B ~ 2.68

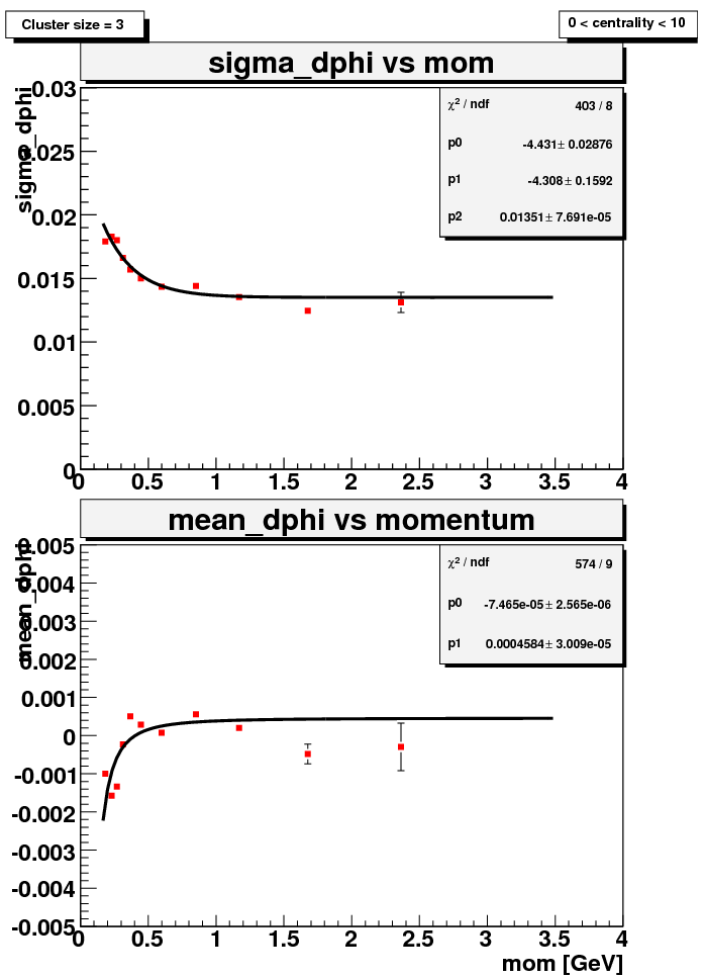
HBD – recalibrator

- The HBD matching distributions are recalibrated for:
  - momentum dependence
  - different „centrality“. „Centrality“ bins temporary defined according to bbc charge. Bins used are: 0-10%, 10-20%, 20-40% and 40-84%
  - HBD cluster size: 2, 3, 4, >=5 pads in a cluster

- The next slides show examples for one centrality bin, the same procedure is applied to all bins.

HBD – recalibrator – hbddphi





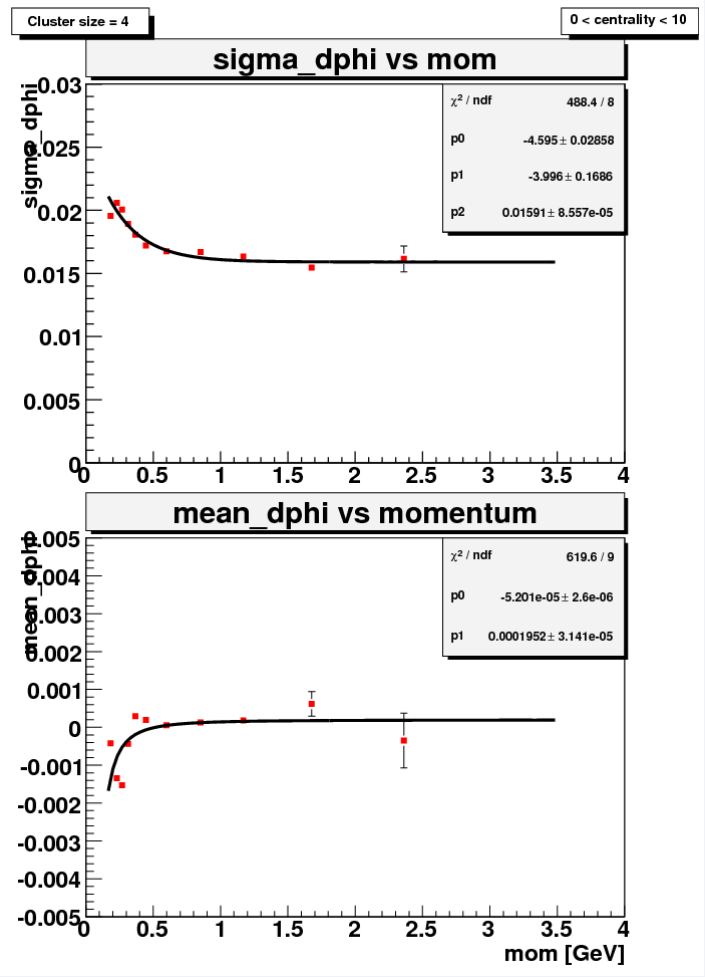
„Centrality“:
0-10 %

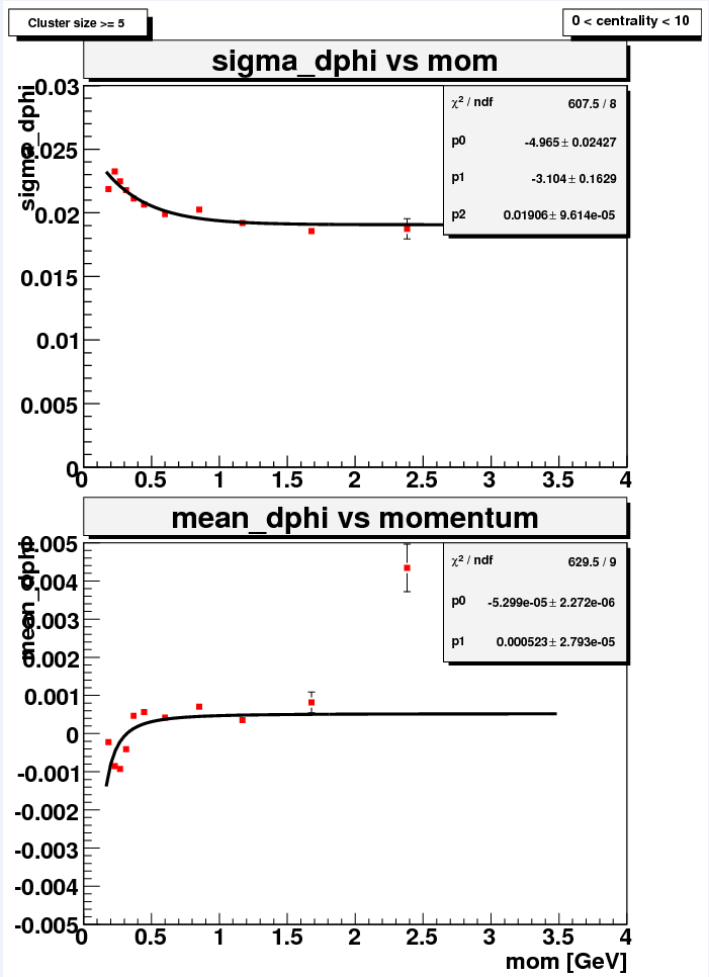
left:
hbd cluster size = 2

right:
hbd cluster size = 3

- sigma(dphi) is fitted with: f(x) = Exp(p0 + p1*x) + p2
- mean (dphi) is fitted with: f(x) = p0/(x*x) + p1

HBD – recalibrator – hbddphi





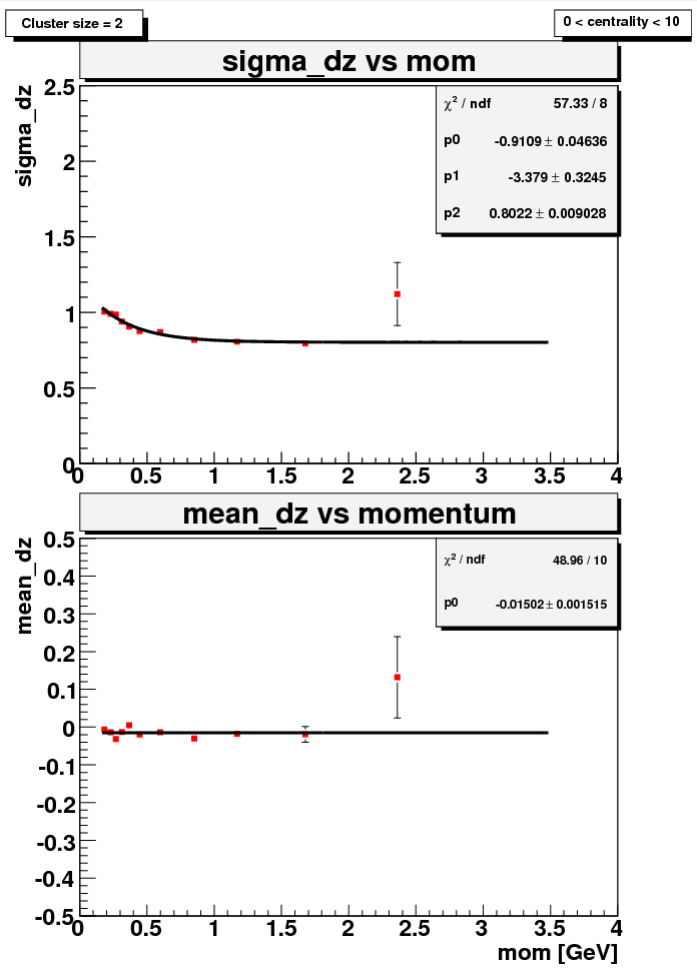
„Centrality“:
0-10 %

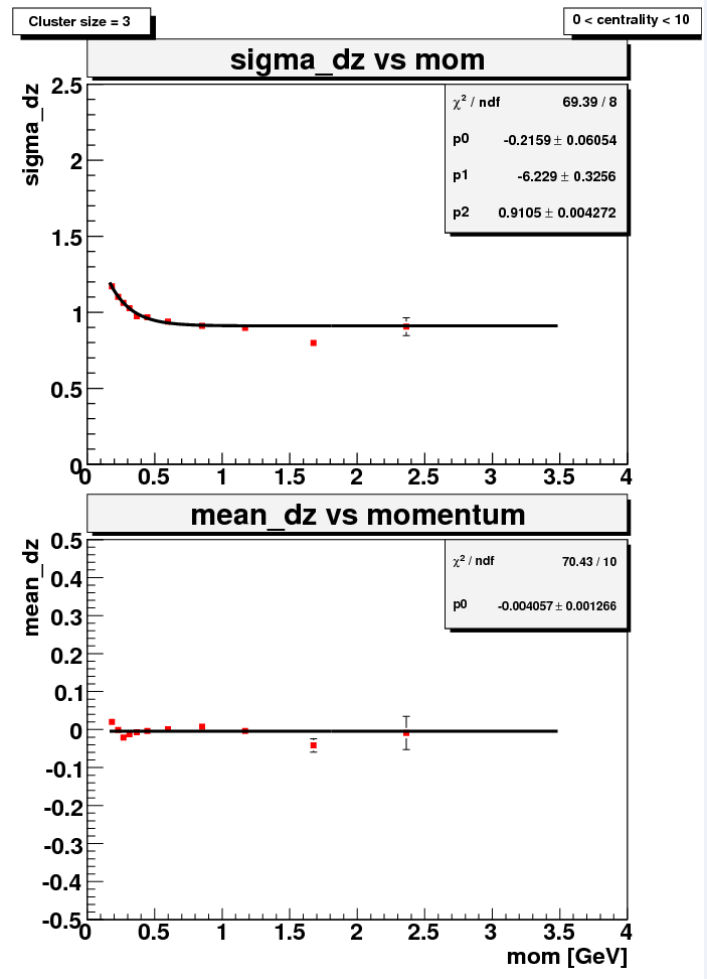
left:
hbd cluster size = 4

right:
hbd cluster size >= 5

- sigma(dphi) is fitted with: f(x) = Exp(p0 + p1*x) + p2
- mean (dphi) is fitted with: f(x) = p0/(x*x) + p1

HBD – recalibrator – hbddz





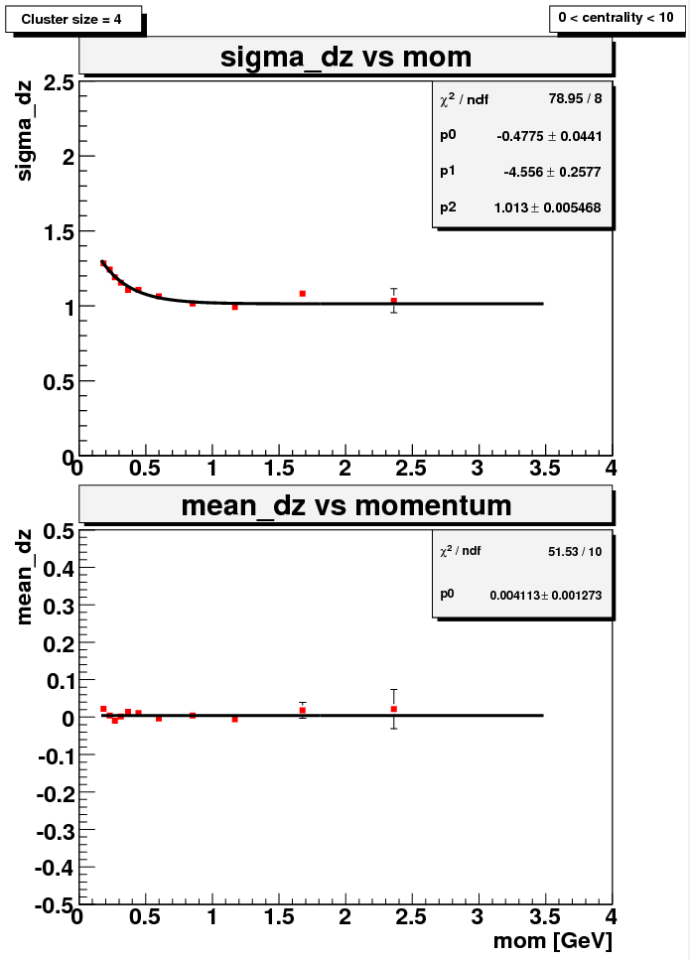
„Centrality“:
0-10 %

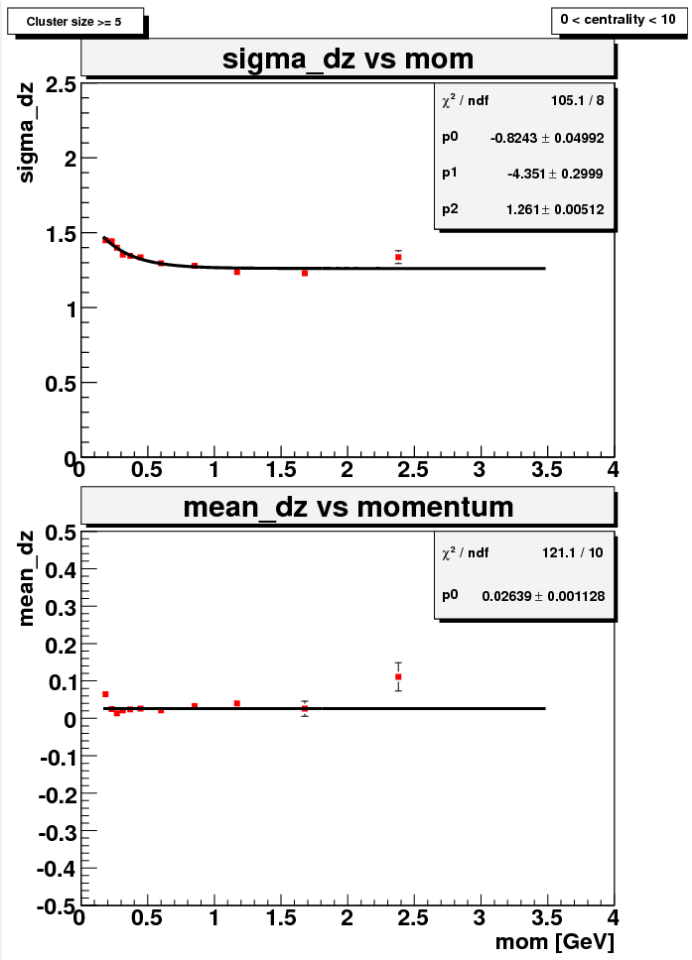
left:
hbd cluster size = 2

right:
hbd cluster size = 3

- sigma(dz) is fitted with: f(x) = Exp(p0 + p1*x) + p2
- mean (dz) is fitted with: f(x) = p0

HBD – recalibrator – hbddz





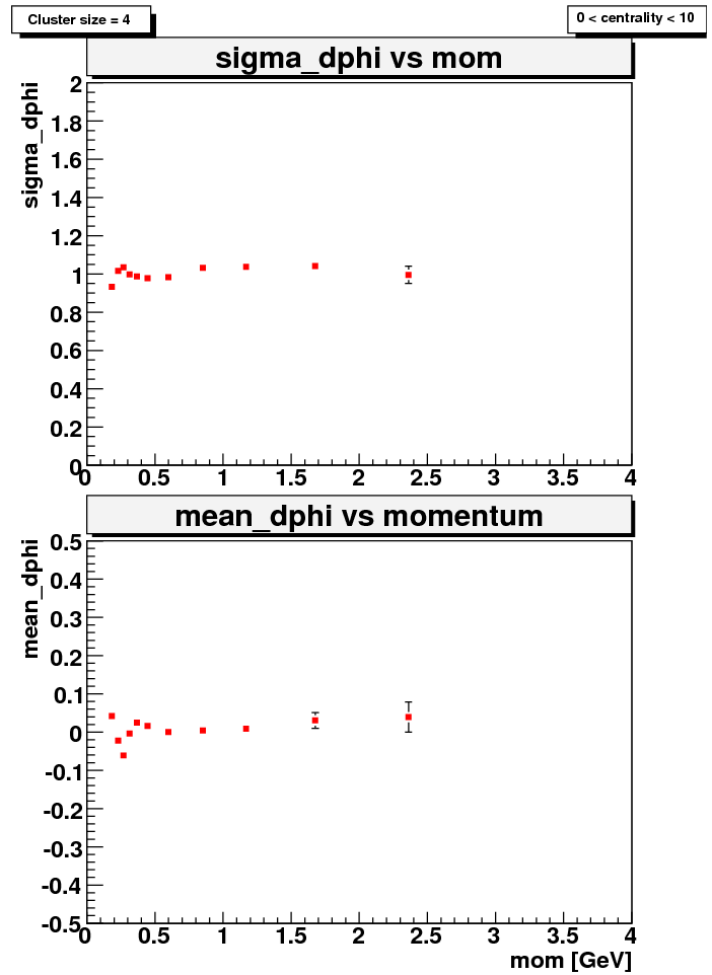
„Centrality“:
0-10 %

left:
hbd cluster size = 4

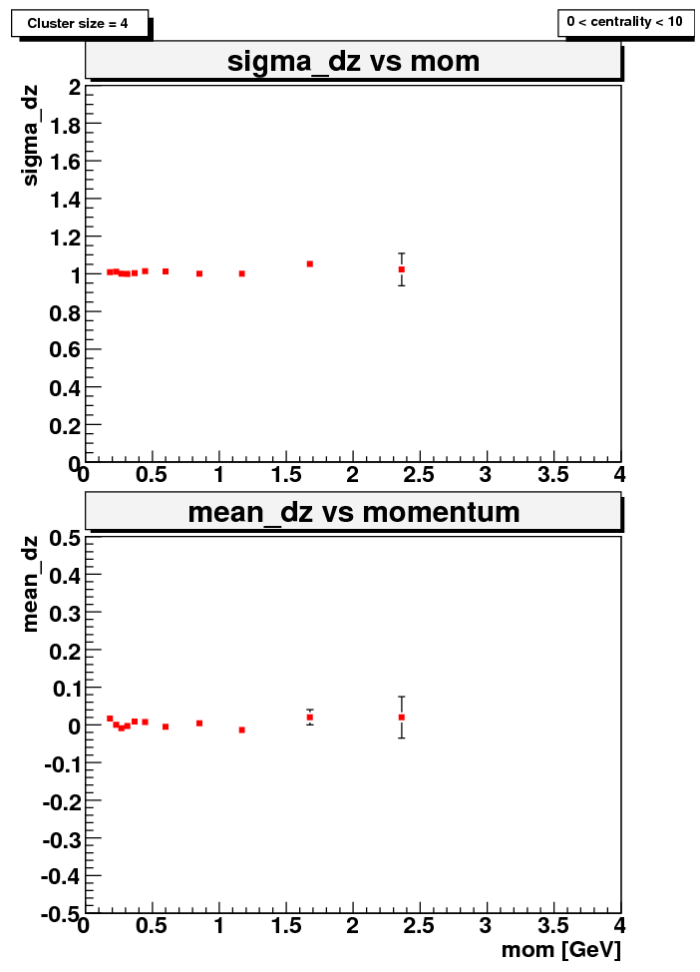
right:
hbd cluster size >= 5

- sigma(dphi) is fitted with: f(x) = Exp(p0 + p1*x) + p2
- mean (dphi) is fitted with: f(x) = p0/(x*x) + p1

HBD – after recalibration



hbdsdphi (sigma units)



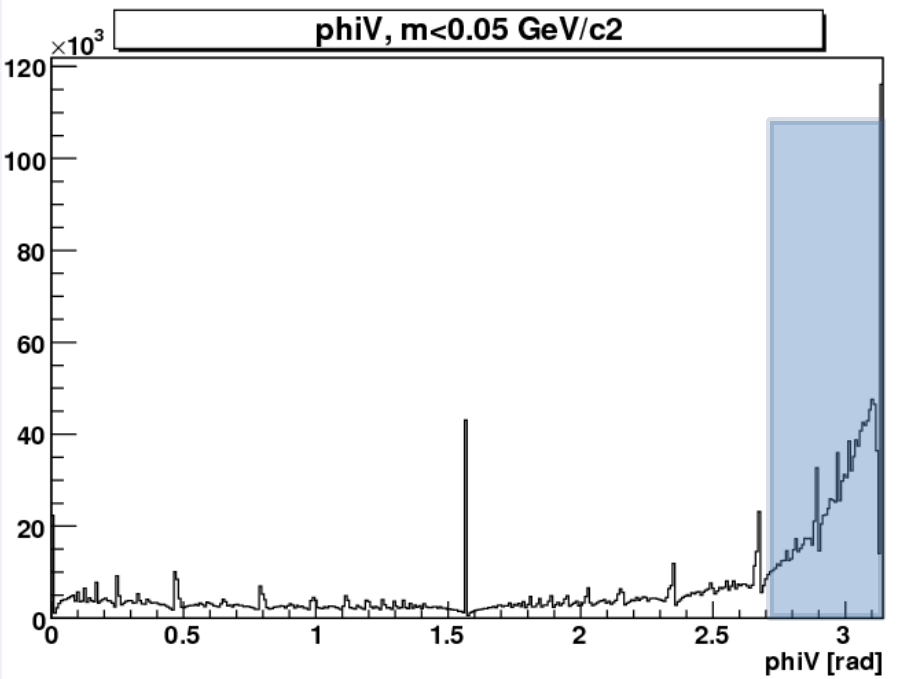
hbdsdz (sigma units)

Strategy for the pair analysis

- CabanaBoy package used for pair analysis
- The background is generated using mixing in Matathias pool:
  - centrality bins = 10
  - bbcz bins = 8 (in +/-20 cm range)
  - reaction plane = not used
  - pool depth = 100
- The ghost tracks have been studied and the following cuts are applied:
  - ghosts in RICH: abs(xphi1-xphi2)<0.08 rad && abs(xz1-xz2)<25 cm
  - ghosts in EMCal: abs(phi1-phi2)<0.05 rad && abs(zed1-zed2)<0.5 cm
  - events with a ghost pair are completly rejected

Pair analysis – phiV cut

- for the „- +“ magnetic field, phiV peaks at π
- shown is the phiV distribution for the mass region m<50 MeV/c^2
- the phiV cut will be optimized in the shaded region using simulation
- the origin of the spikes is unclear
- for the time being the following cut is used - pairs with: m<50 MeV/c^2 && phiV>2.7 rad are rejected

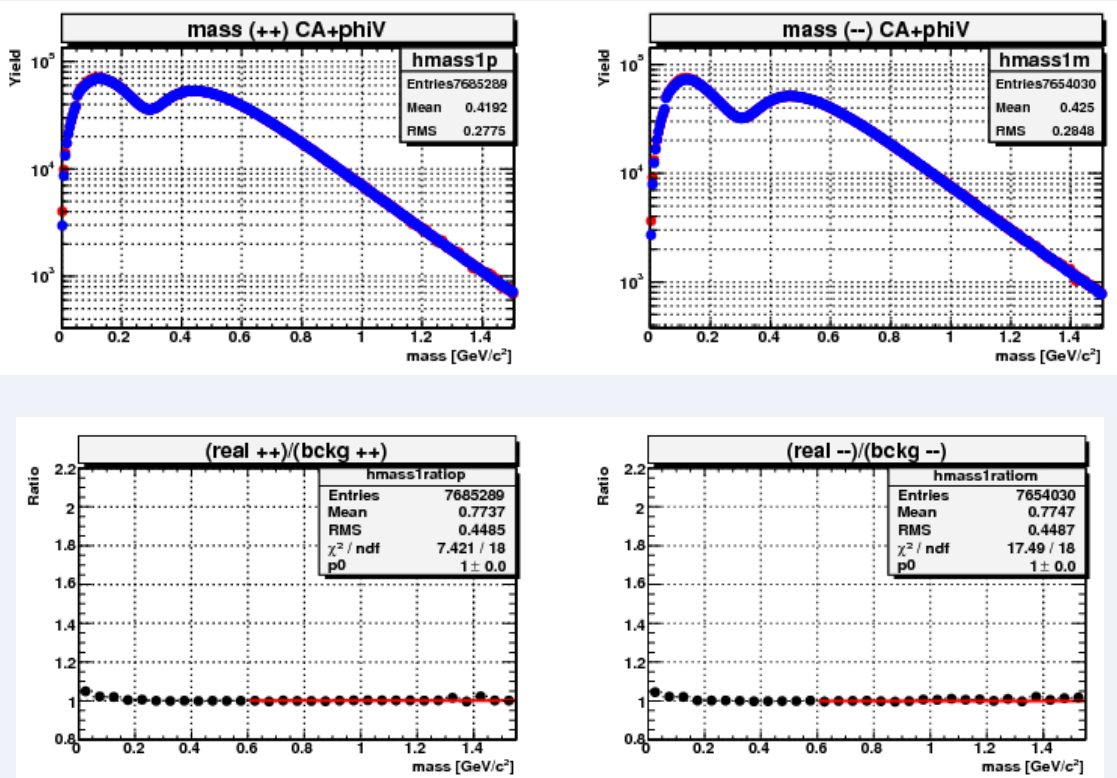


Pair Analysis – background subtraction (CA)

- the background generated by the mixed event technique

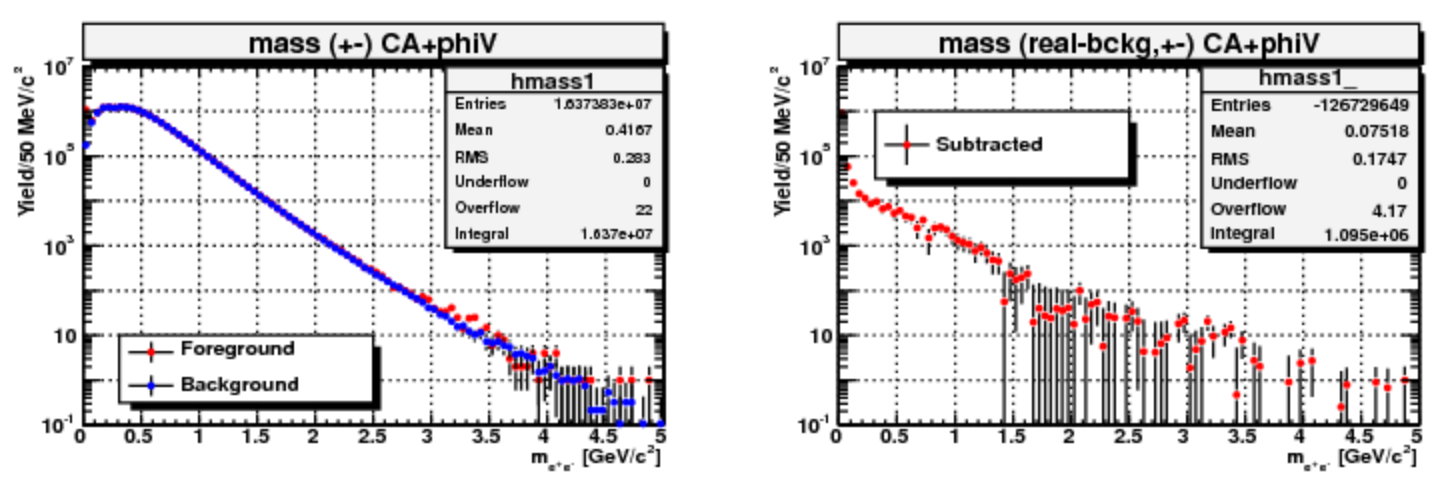
- EID cuts: CA
- Pair cuts:
  - ghost events removed
  - phiV cut

- the unlike sign background is normalized as:
  2 sqrt ($B_{++}B_{--}$)



Raw mass spectrum (CA)

- raw mass spectrum with CA only:



- <u>m < 0.15 GeV/c²:</u>
  Signal = 9.9 10^5
  Backg.= 1.66 10^6
  B/S ~ 1.7

- <u>m > 0.15 GeV/c²:</u>
  Signal = 1.0 10^5
  Backg.= 1.36 10^7
  B/S ~ 130

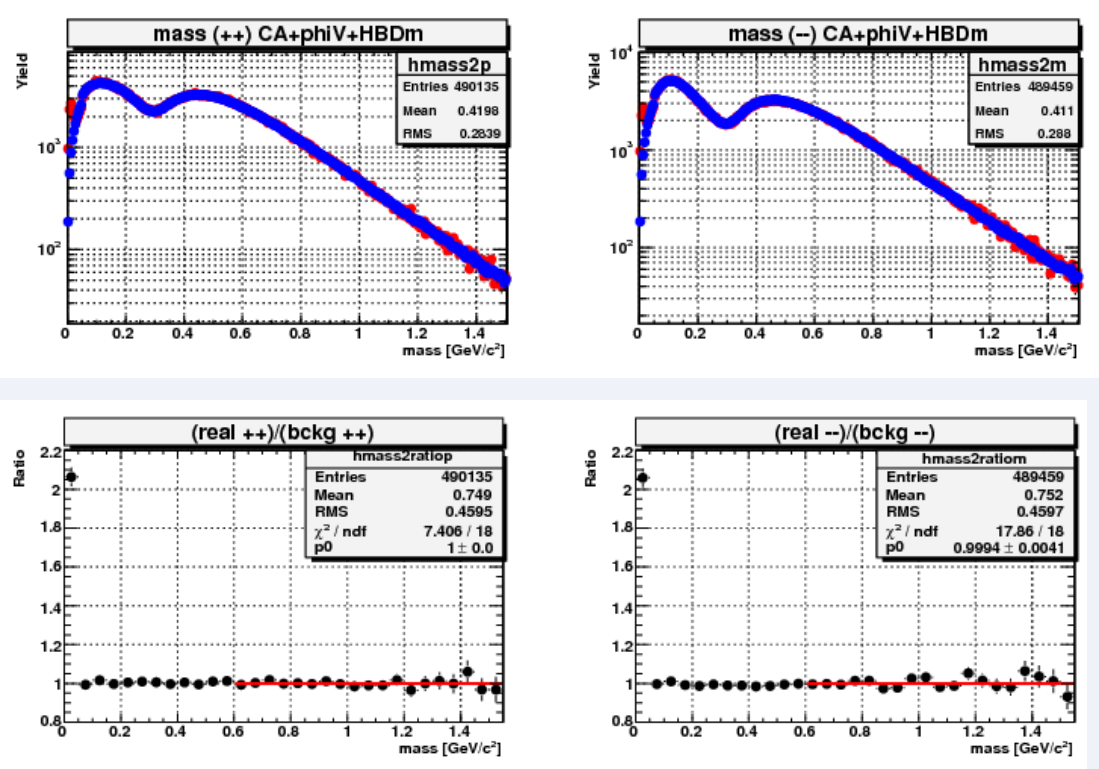
Pair Analysis – background subtraction (CA + HBD)

- the background is generated by the mixed event technique

  - EID cuts: CA + HBD
  - the pair cuts:
    - ghost events removed
    - phiV cut

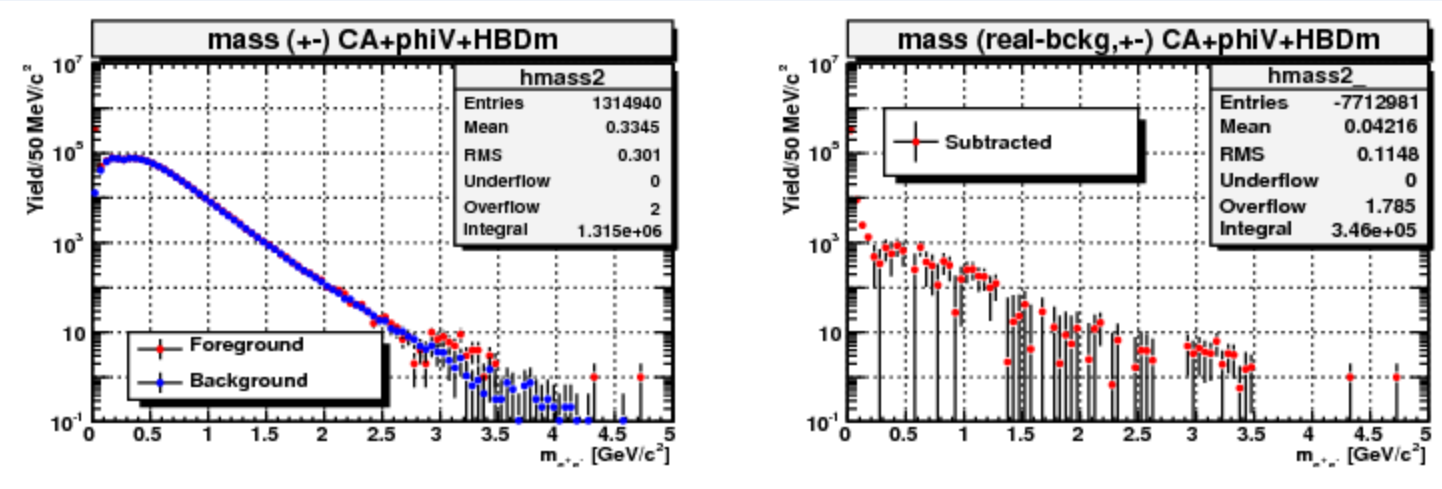
  - the unlike sign background is normalized as:

  2 sqrt ($B_{++}B_{--}$)



Raw mass spectrum (CA + HBD)

- raw mass spectrum with CA and HBD matching:



- <u>m < 0.15 GeV/c²:</u>
  Signal = 3.4 10^5
  Backg.= 1.2 10^5
  B/S ~ 0.35
- <u>m > 0.15 GeV/c²:</u>
  Signal = 9.0 10^3
  Backg.= 8.5 10^5
  B/S ~ 95
- <u>Signal in HBD/CA:</u>
  - m < 0.15 GeV/c²: **0.32**
  - m > 0.15 GeV/c²: **0.09**

  → factor of **~3.5** difference

Raw mass spectrum (CA + HBD)

- When HBD matching is applied, the background is reduced by more than a factor of 10
- At the same time the signal is reduced with almost the same factor so S/B is only slightly improved (especially in the mass region > 0.15 GeV/c2)
- Questions:

1. Why do we lose so much signal when applying HBD matching – are we somehow over-subtracting the background?
2. Why is there a difference in the signal loss in the low and the high mass regions?

Raw mass spectrum (CA + HBD)

- In orded to assess the HBD efficiency we use the embedding
- Single electron reconstruction efficiencies for different particles and centralities:

Embedding

Centrality	DATA	phiee	jpsiee	pi0eeg	etaeeg
0-10%	0.17	0.55	0.57	0.81	0.74
0-30%	0.2	0.64	0.64	0.83	0.78

- the pair efficiency (for embedding) in the low mass region (pi0→eeg) is **~ 0.69**
- the pair efficiency (for embedding) in the high mass region (phi→ee) is **~ 0.40**
- there is a difference in the efficiency due to the different type of hits in HBD:
  - **pi0→eeg** produces mostly double hits in HBD, while **phi→ee** produces single hits.
  - Single hits are more affected by the cuts used, therefore the efficiency is lower

- This could partially explain the mass dependence of the HBD efficiency
- But absolute efficiencies in the data are still unclear

Outlook

- understanding of the HBD pair efficiency
- applying the HBD rejection
- extraction of the pair efficiency corrections