ECAL performance with new geometry, transverse energy and eID status

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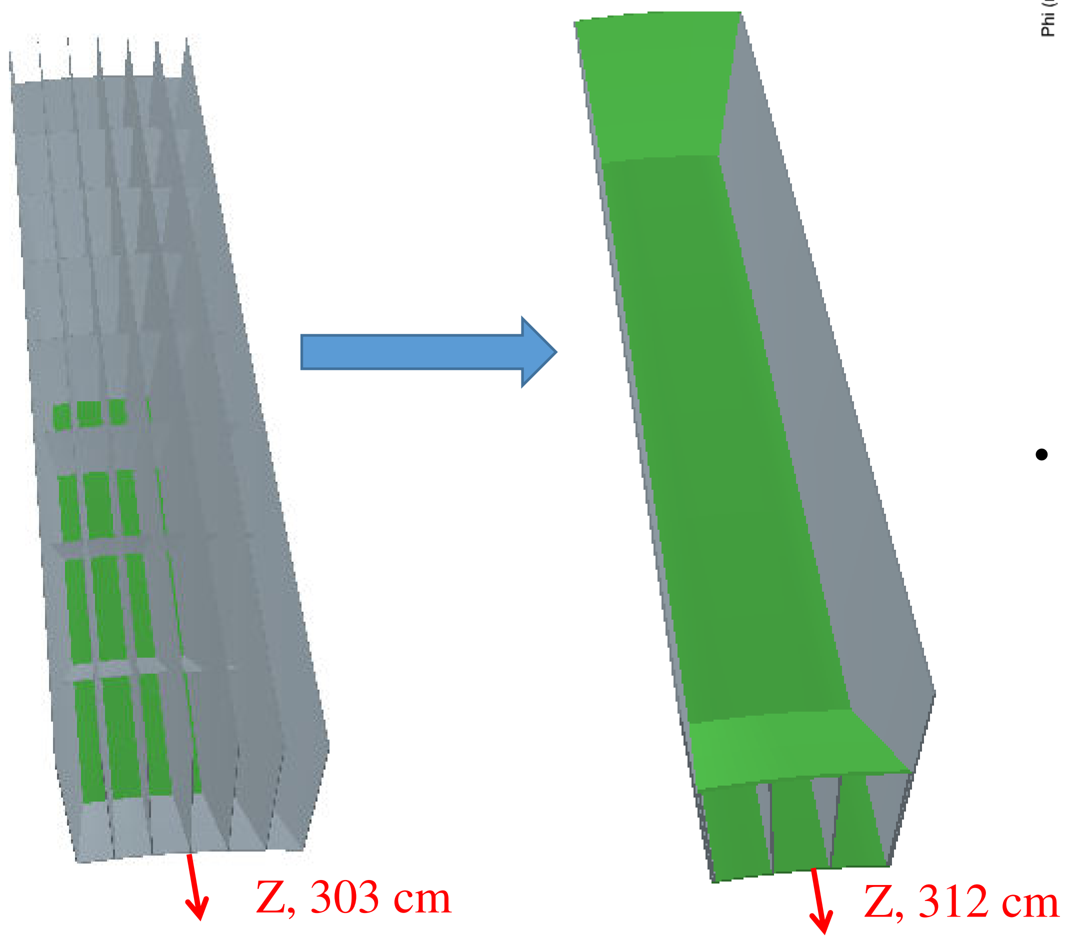
Outlook

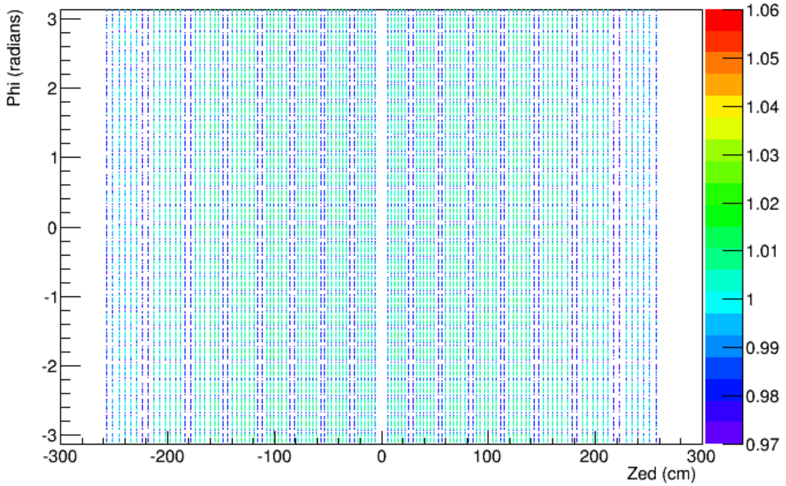
- ECAL performance with new ECAL geometry (v.4, see talk by Maxim)
- E_T distributions and centrality categorization
- eID studies with updated dE/dx calculations (-dev mpdroot)

ECAL performance with v.4 geometry

Geometry changes: v.4 vs. v.3

- The main changes are in geometry of baskets (half-sectors) :
  - ✓ no internal walls in new (v.4) geometry



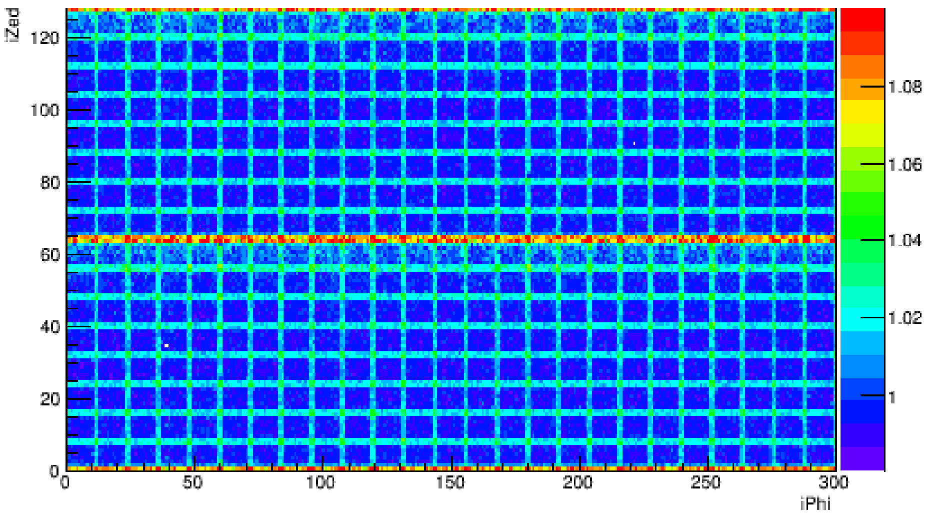


- Internal walls in the basket resulted in worse energy resolution:
  - ✓ observed nonhomogenity of the ECAL absolute energy scale
  - ✓ the closer the cluster to the walls the larger the scale drop (energy leaks)
  - ✓ variation of the absolute scale results in worse energy resolution after averaging over the whole detector acceptance

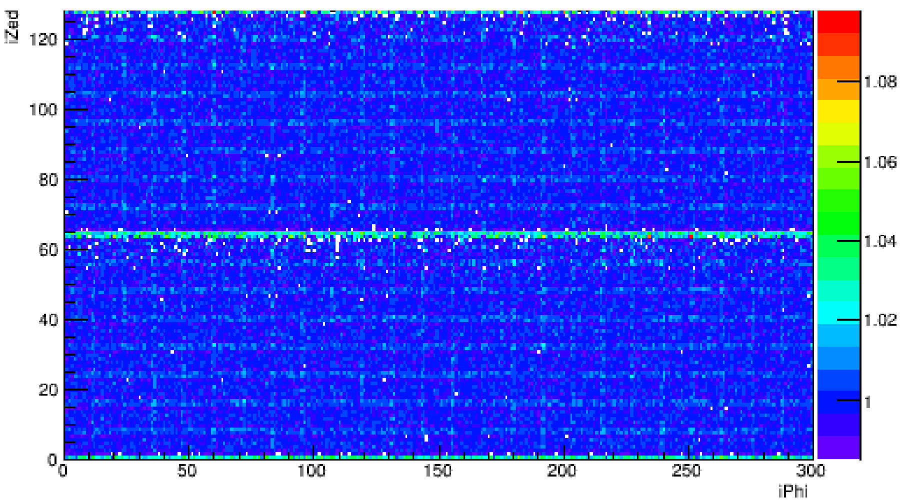
Tower-by-tower calibration (v.3)

- Intended to reduce effect of absolute scale variation in the ECAL acceptance
- Corrections are evaluated as a ratio of generated to reconstructed cluster energies for central cluster towers
- Process converges in two iterations
- Stored in mpdroot/input/**MpdEmcCalib.root** and are used by default in the reconstruction

Iteration 0



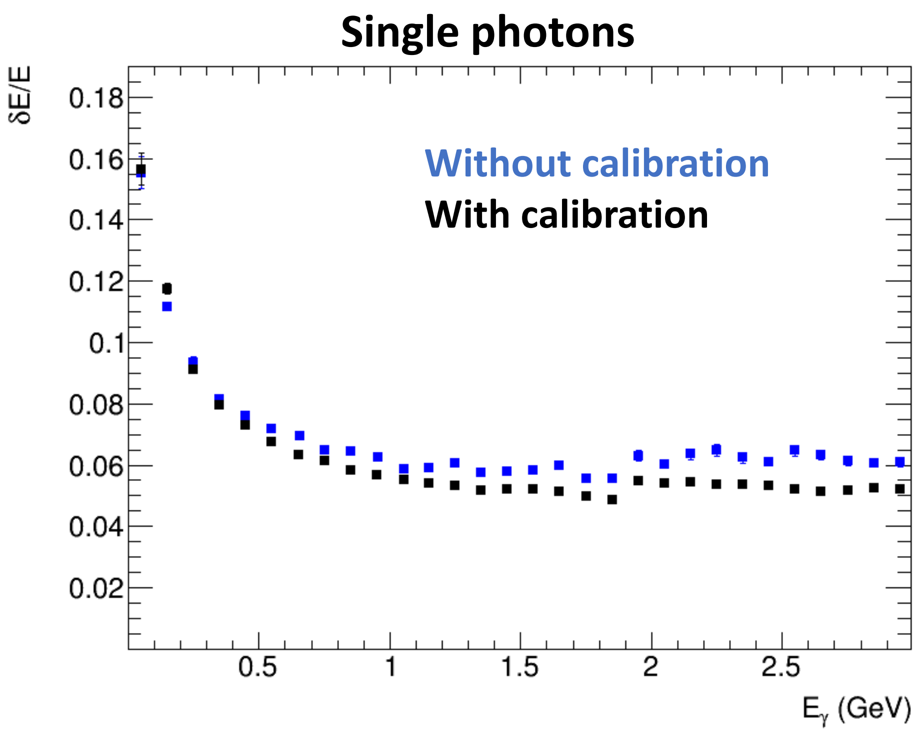
Iteration 2

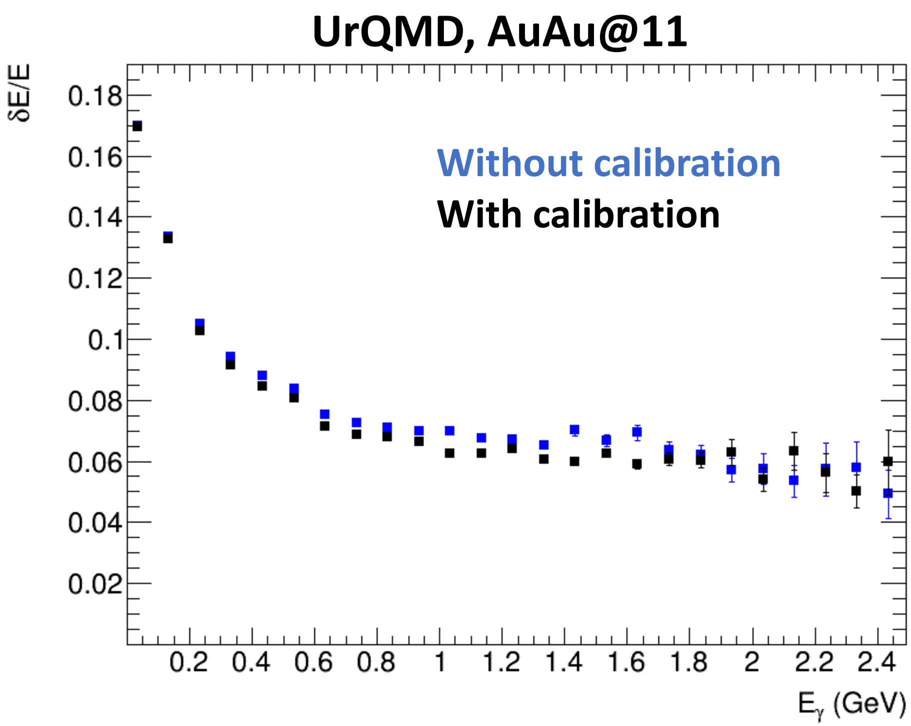


- After tower-by-tower calibration the absolute scale variation is significantly reduced

Effect of tower-by-tower calibration (v.3)

- Compared energy resolutions with/without the fine calibration
- Single photons and UrQMD, minbias AuAu@11; realistic vertex distributions



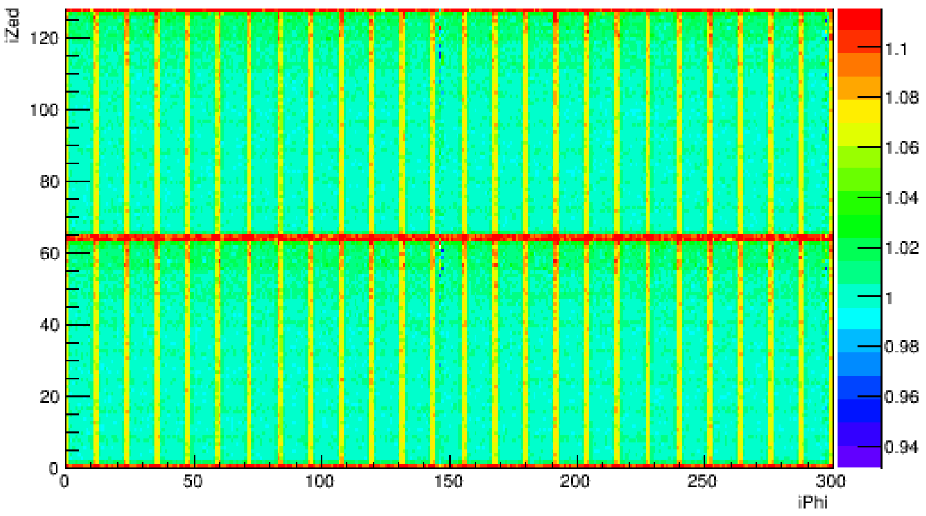


- Calibration improves energy resolution
- Equivalent effect is quadratic subtraction of 2%: $\delta_{NEW} = \sqrt{\delta_{OLD}^2 - 0.02^2}$

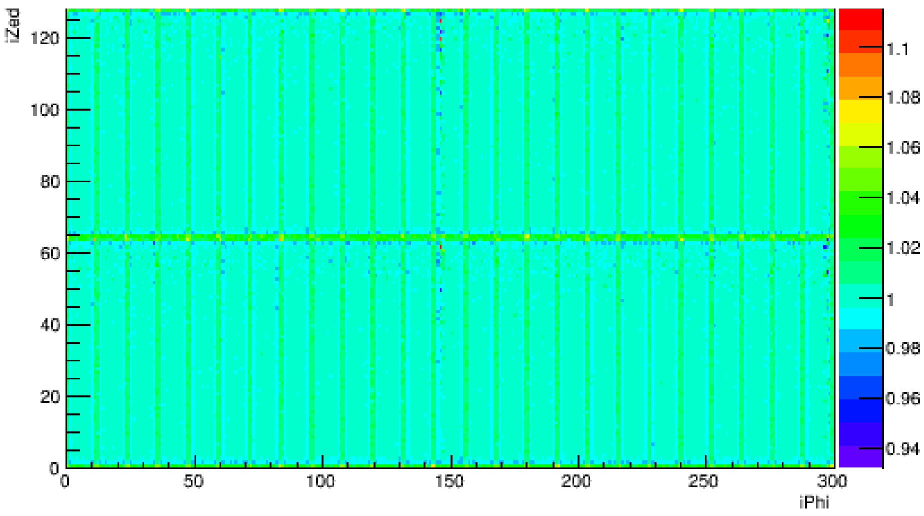
Tower-by-tower calibration (v.4)

- Recalculated tower-by-tower calibrations for the new ECAL geometry (v.4)
- Corrections are evaluated as a ratio of generated to reconstructed cluster energies for central cluster towers (40M single photons)
- Process converges in two iterations
- Updated **MpdEmcCalib.root** is to be committed in MpdRoot

Iteration 0



Iteration 2

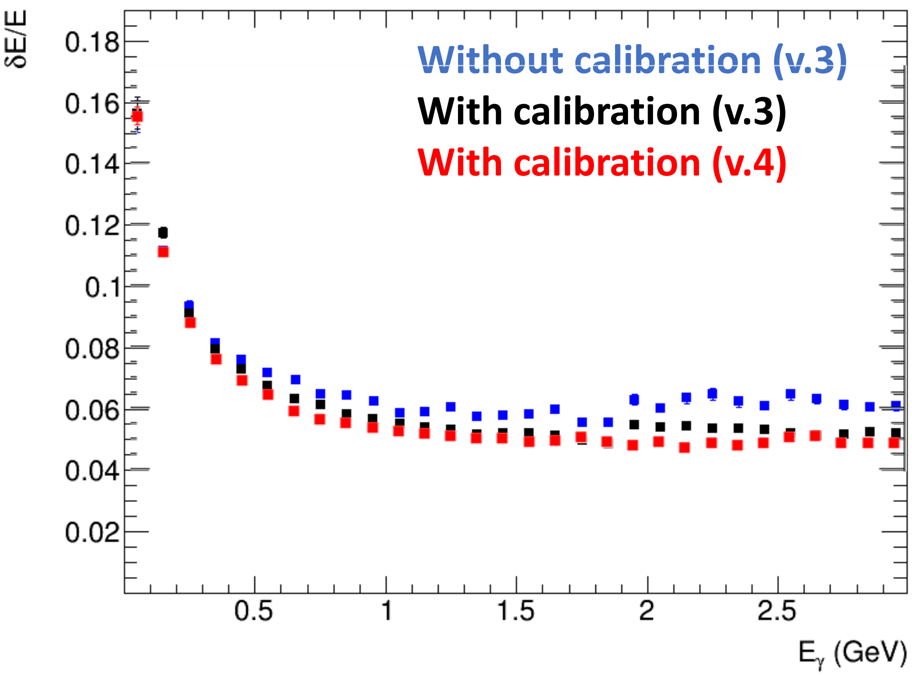


- After tower-by-tower calibration the absolute scale variation is significantly reduced

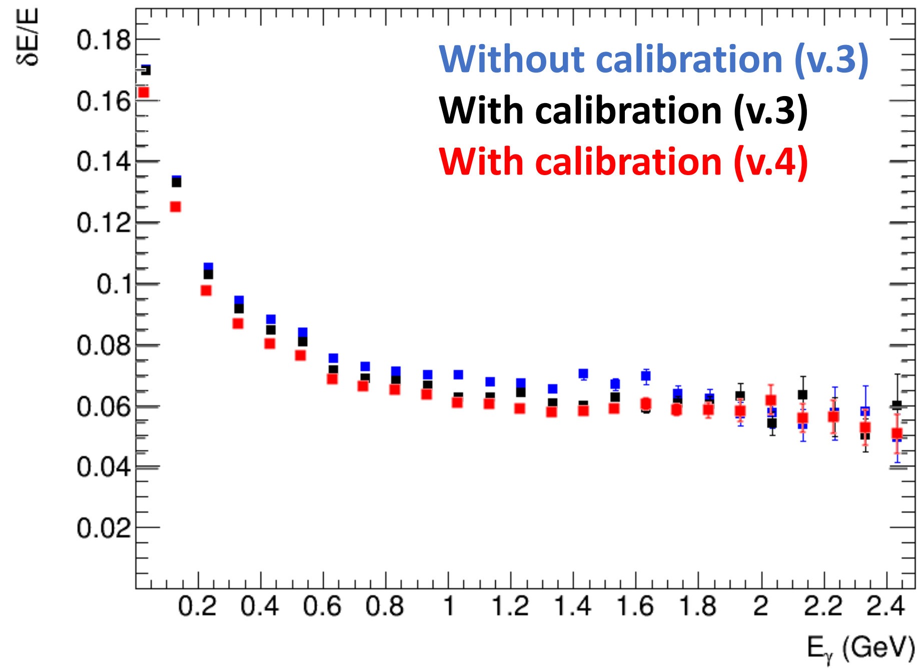
Energy resolution (photons)

- Compared energy resolutions with/without the fine calibration
- Single photons and UrQMD, minbias AuAu@11; realistic vertex distributions

Single photons



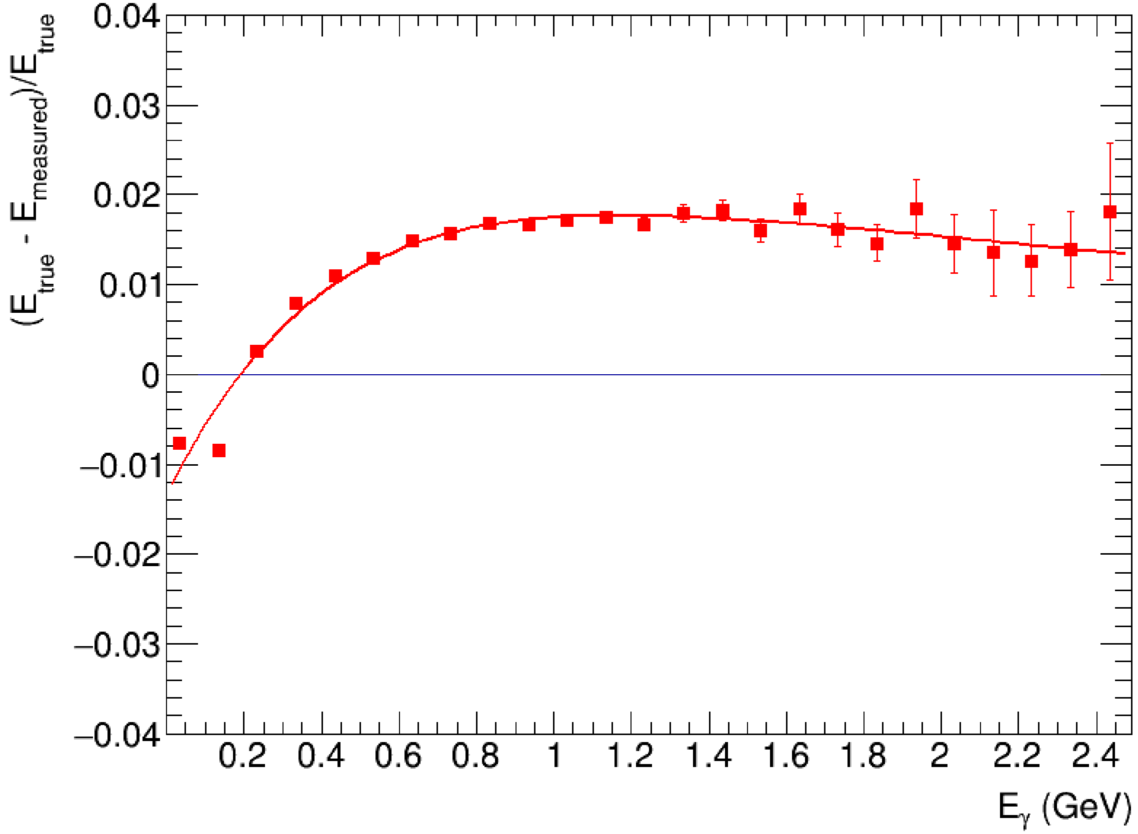
UrQMD, AuAu@11



- Tower-by-tower calibration with v.4 geometry has a weaker effect for energy resolution (smaller corrections → smaller effect)
- Energy resolution with v.4 geometry is better, but not very much
- This is not intrinsic energy resolution of the ECAL, the resolution also accounts for clusterization algorithm which may not account for part of the deposited energy

Non-linearity

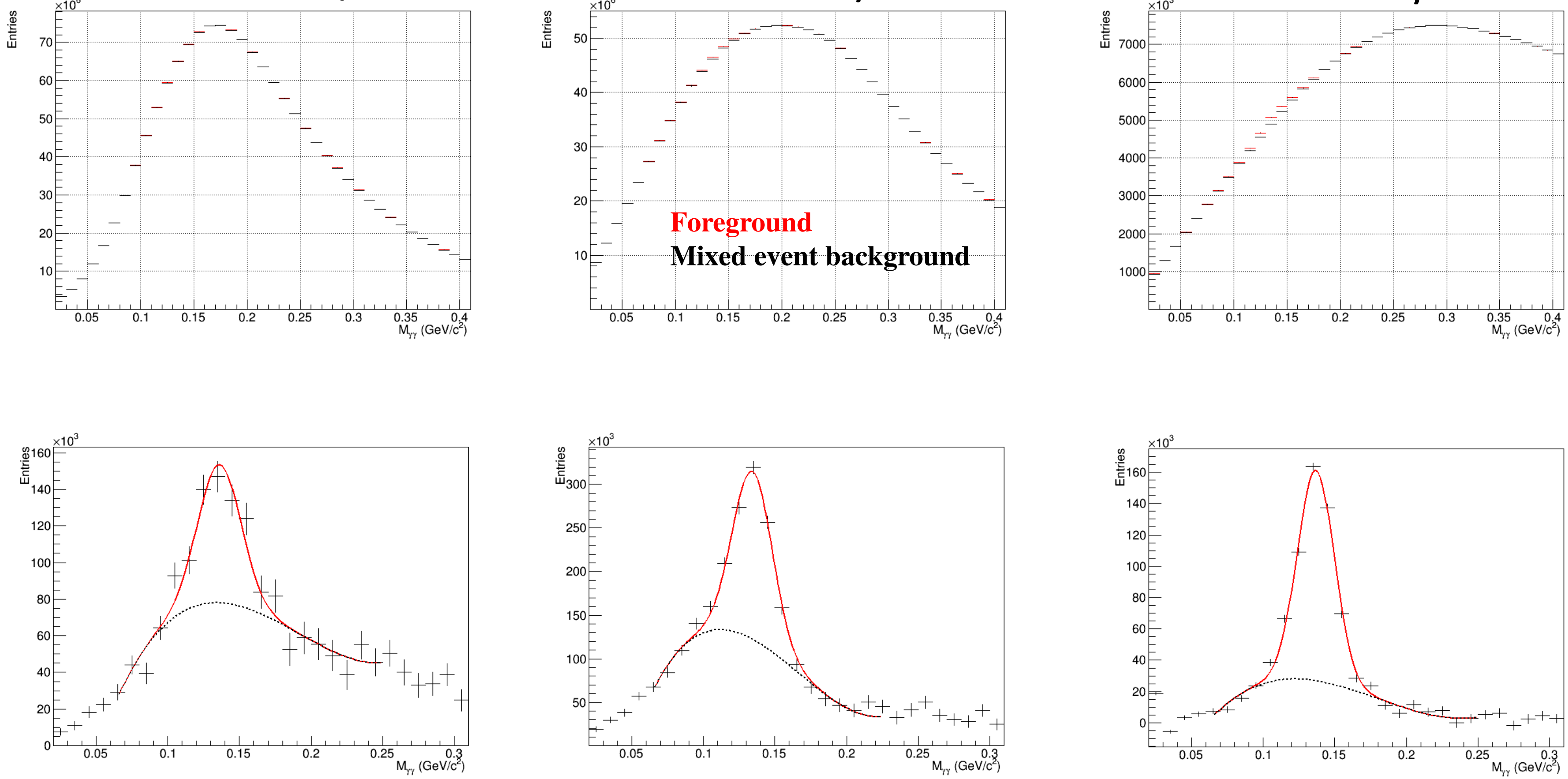
- Reconstructed photon energy does not exactly match the generated one
- Observe non-linearity of ~ 3%
- Can be parameterized and corrected as a function of reconstructed energy to ~ 0.5%



π^0 peak examples

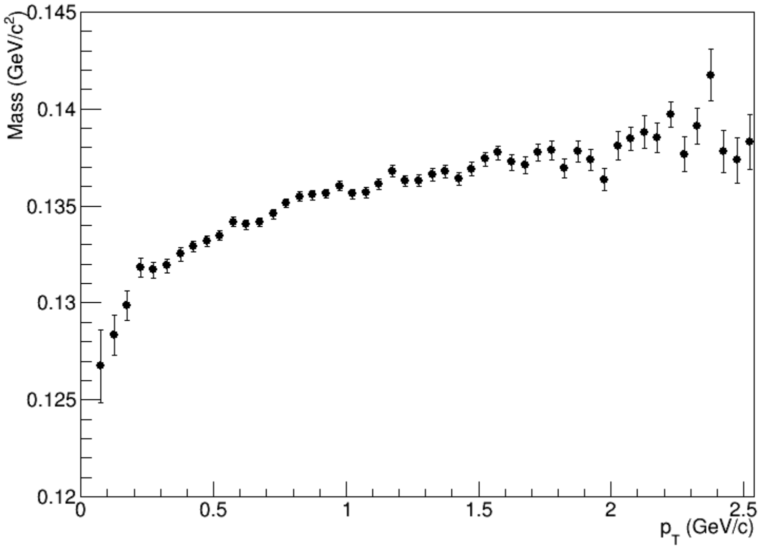
- UrQMD. Minbias BiBi@9.2, realistic vertex distribution

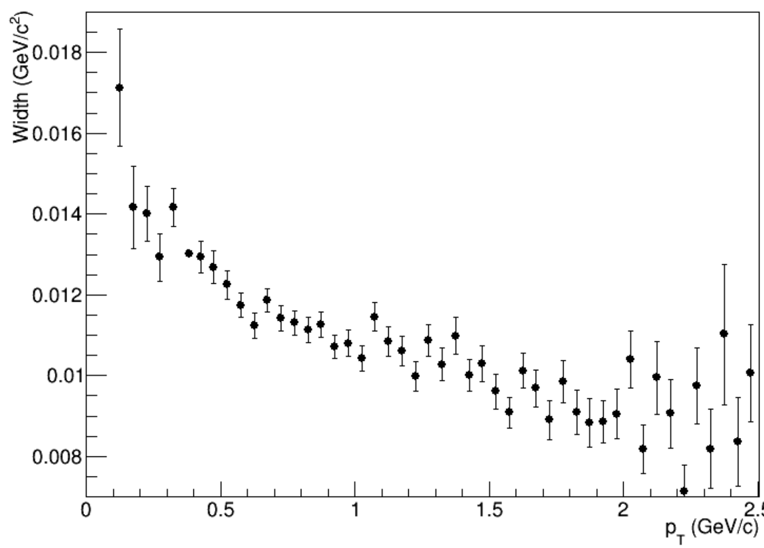
0.05-0.15 GeV/c **0.2-0.3 GeV/c** **0.5-0.6 GeV/c**



π^0 mass and width (Gaussian)

- UrQMD. Minbias BiBi@9.2, realistic vertex distribution, |z-vertex| < 50 cm





- Mass dependence is due to energy leakage
- Width is driven by single photon energy resolution

Conclusions

- New (v.4) geometry gives slightly better energy resolution
- Nonlinearity ~ 3% → can be corrected to ~ 0.5%
- New tower-by-tower calibration file has been produced → to be committed in MpdRoot
- π^0 reconstruction and parameters have not changed

E_T distribution

Selection cuts

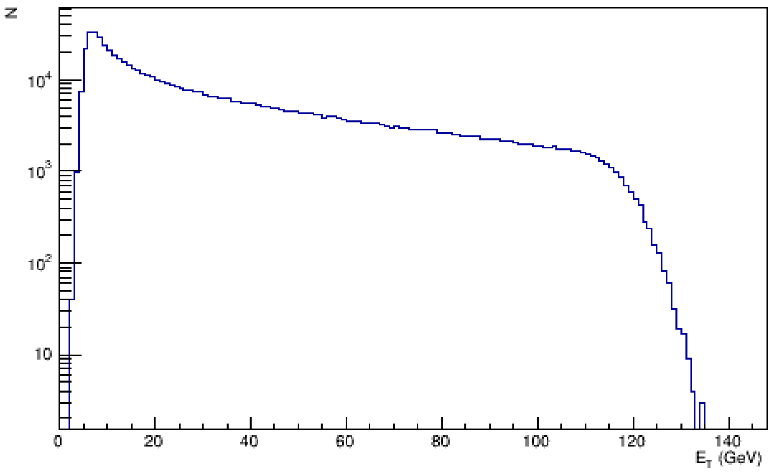
- Event selections:
  - ✓ BiBi@9.2, UrQMD v.3.4
  - ✓ z-vertex smeared with $\sigma = 22$ cm, $|z\text{-vertex}| < 50$ cm
  - ✓ no centrality/multiplicity selections

- Track selections:
  - ✓ n-hits > 10
  - ✓ $|\eta| < 1$
  - ✓ $|DCA_{x,y,z}| < 3\sigma$

- ECAL cluster selections:
  - ✓ $E_{\gamma} > 50$ MeV
  - ✓ n-towers > 1

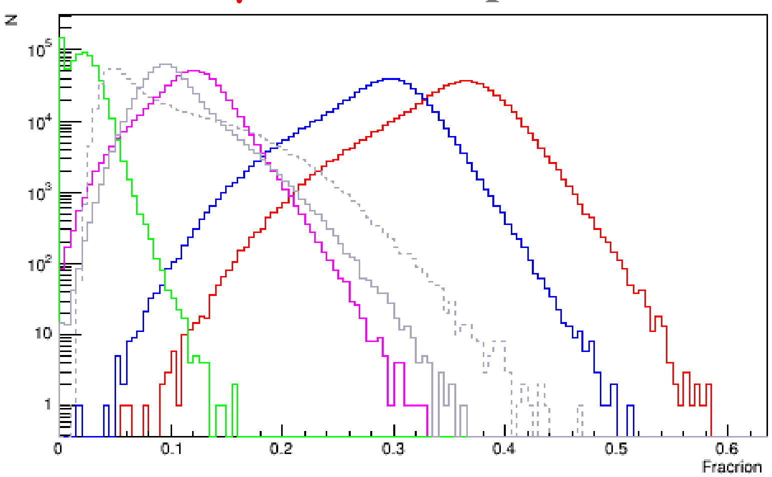
E_T distributions

- $\langle E_T \rangle \sim 35.5$ GeV



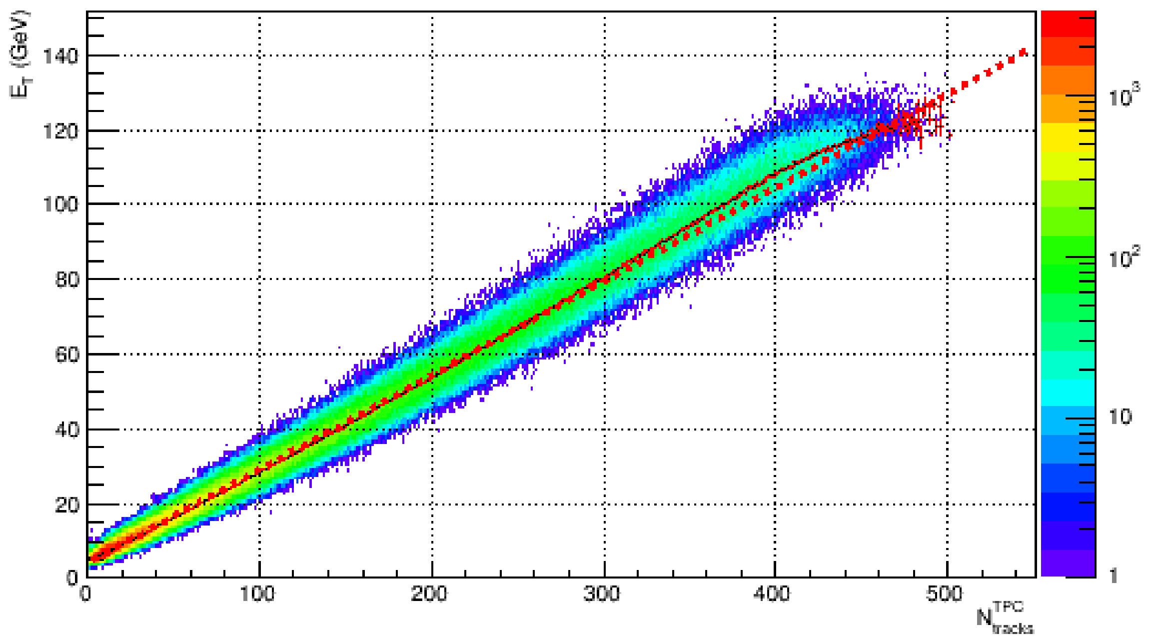
- Contributors:

γ, $\pi^{\pm}$, $e^{\pm}$, $K^{\pm}$, $p^{\pm}$, n



- Main contributors:
  - ✓ pions (**photons**, $\pi^{\pm}$, $e^{\pm}$)

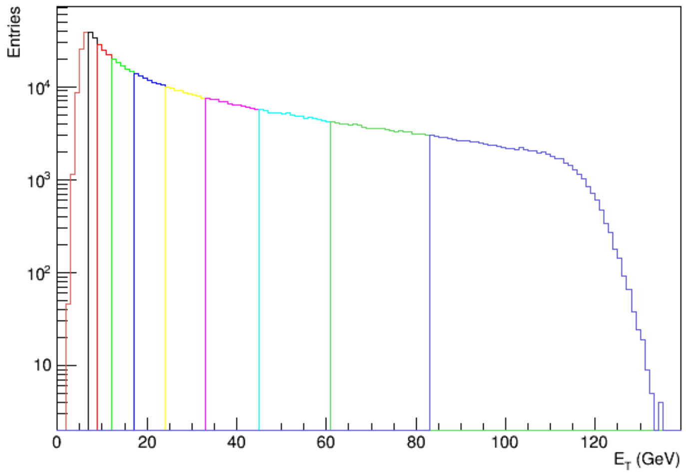
E_T vs. N_{tracks}

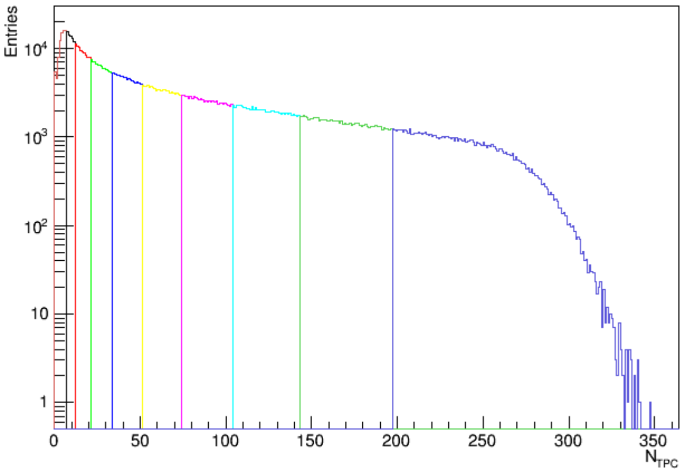


- Rather narrow but not linear correlation

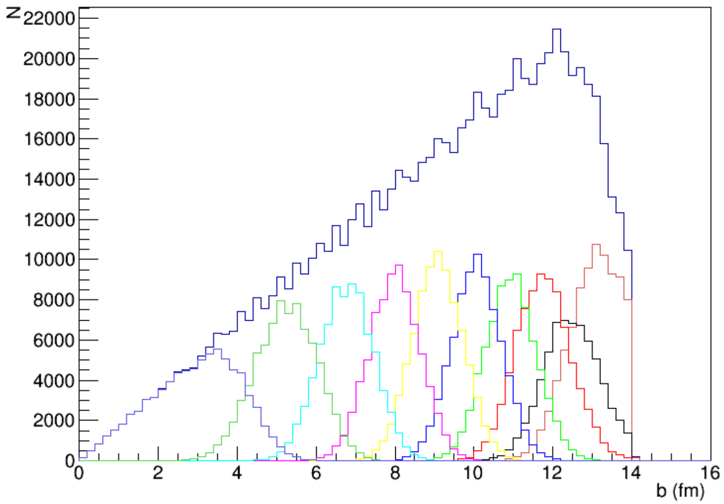
Multiplicity bins: E_T vs. N_{TPC}

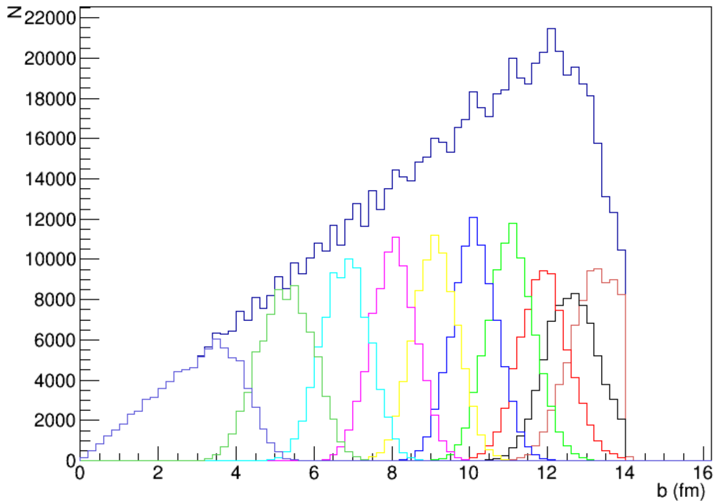
- Definition of multiplicity bins



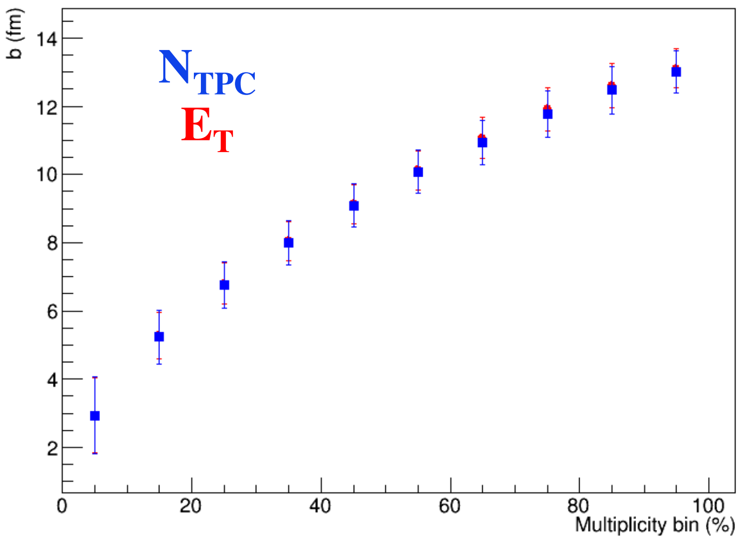


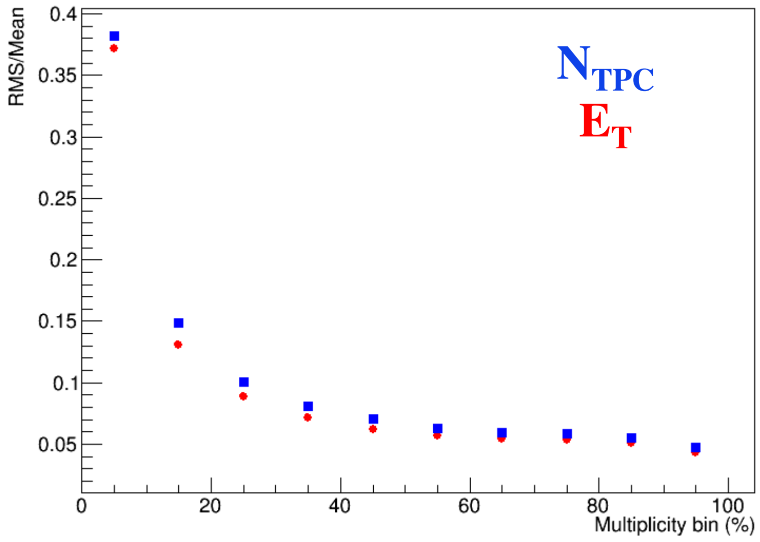
- Corresponding impact parameter (b) distributions





Multiplicity bins: <b> and RMS





- Very similar events are selected with NTPC and ET multiplicity selections
- Resolution of measurements with E_T is marginally better

Conclusions

- Mean $\langle E_T \rangle$ ~ 35 GeV in BiBi@9.2
- E_T is dominated by pions → close correlation between E_T and N_{TPC}
- E_T can be used as a measure of centrality, resolution is similar the case of TPC multiplicity
- E_T and N_{TPC} multiplicity classes select mostly the same events

eID studies

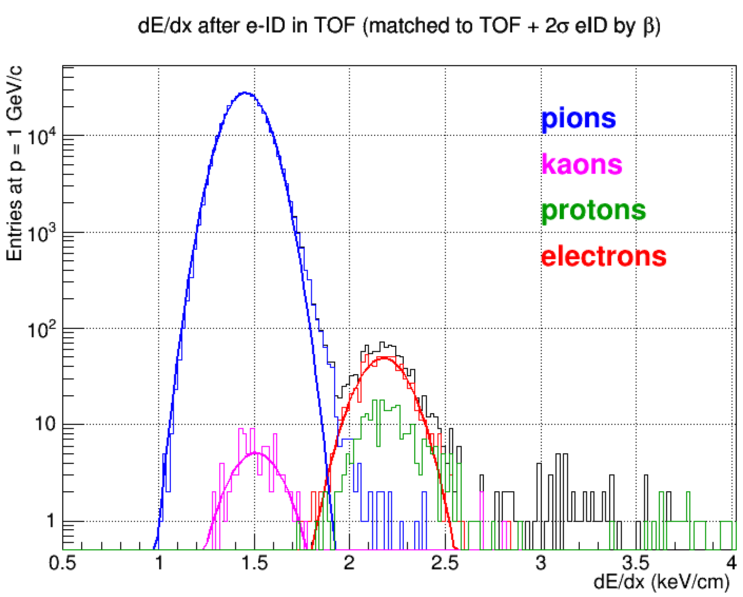
Problems with dE/dx calulations

- BiBi@9.2, UrQMD v.3.4
- dE/dx distributions for tracks identified as electrons in TOF

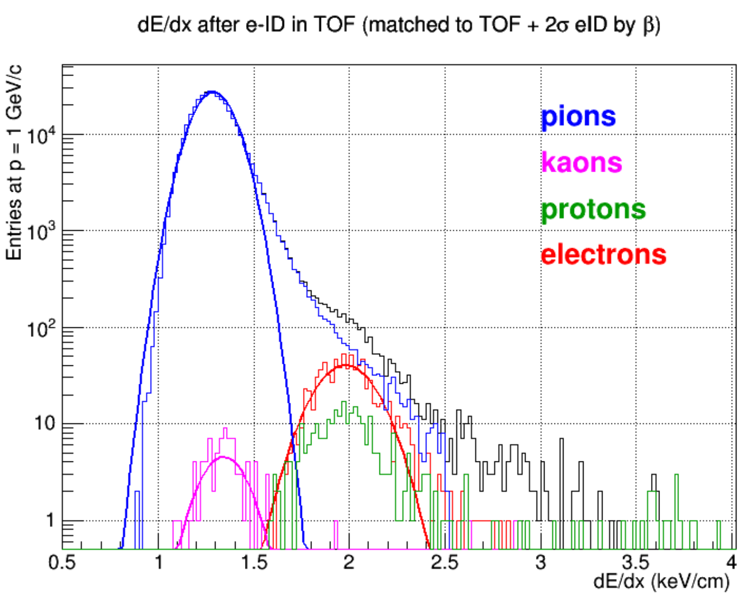
- Selected tracks:
  - ✓ hits > 39
  - ✓ $|\eta| < 1$
  - ✓ |DCA_x,y,z| < 2.5 σ
  - ✓ p_T = 1 GeV/c

- eID selections:
  - ✓ 2σ matching to TOF
  - ✓ 2σ TOF-eID

Request 11



Request 13

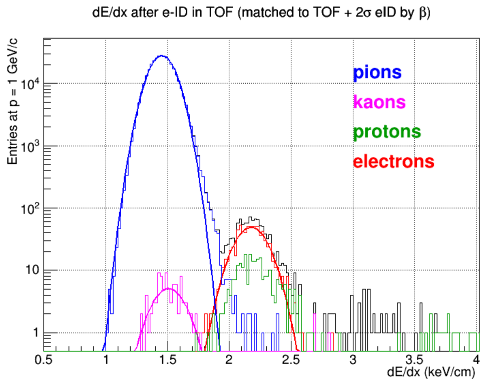


- Kaon and proton contributions are comparable after TOF e-PID
- Observed long non-Gaussian tails of dE/dx distributions for hadrons in Request 13, electrons can not be distinguished from the pion tail

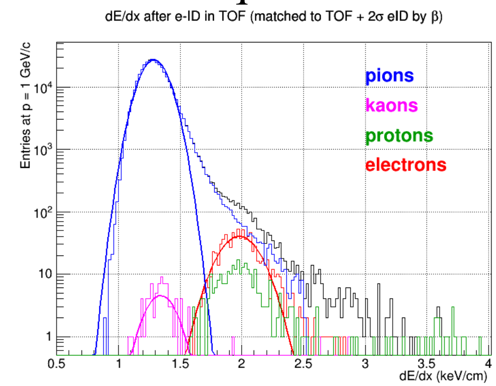
New version of dE/dx

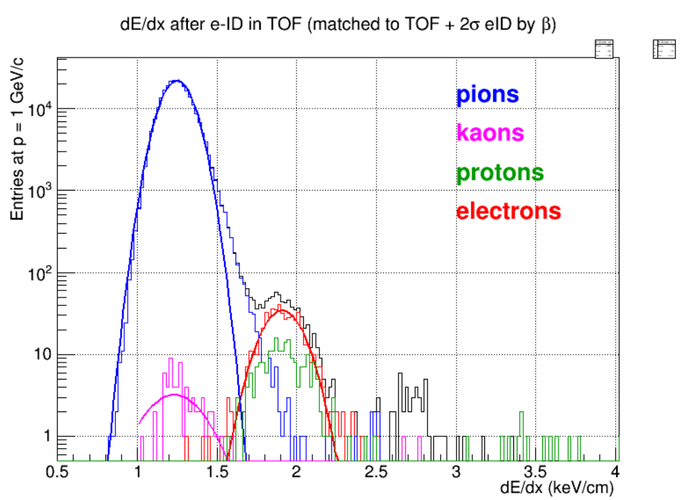
- Origin of tails was traced to the edges of read-out chambers in the TPC
- Version of TPC digitizer, which is intended to take care of the tails has been released a few months ago (-dev mpdroot)

Request 11



Request 13

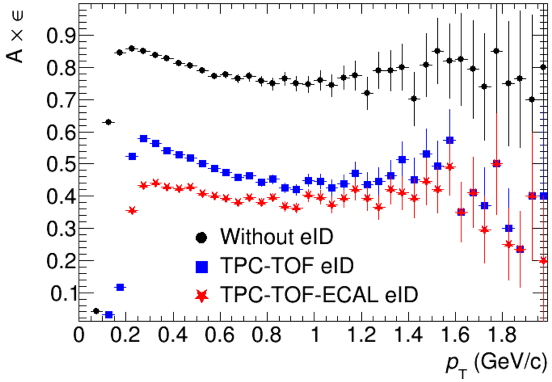


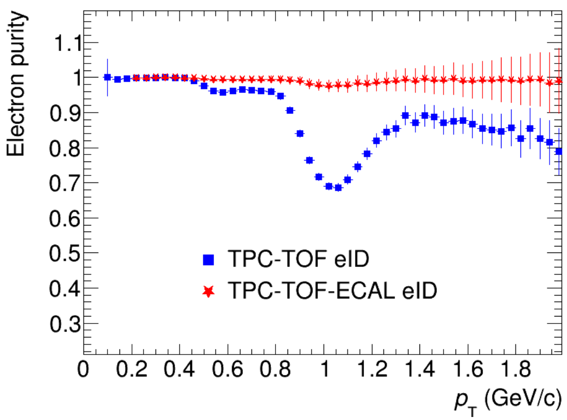


New digitizer gives intermediate results, closer to Request 11 → electrons can be distinguished from pions but not as good as with Request 11

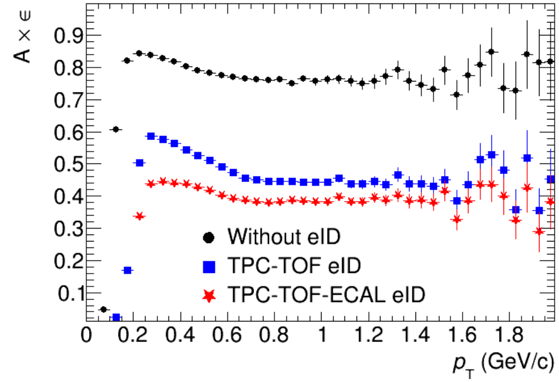
Efficiency and purity

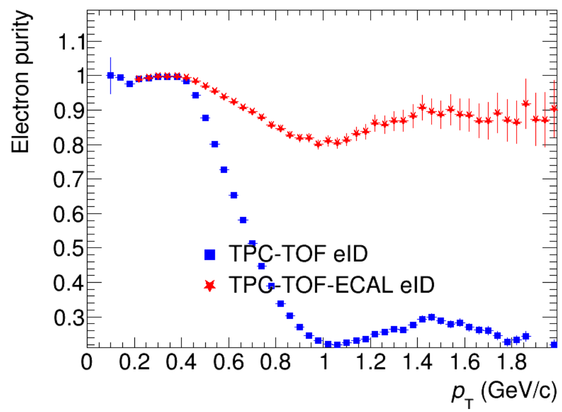
Request 11



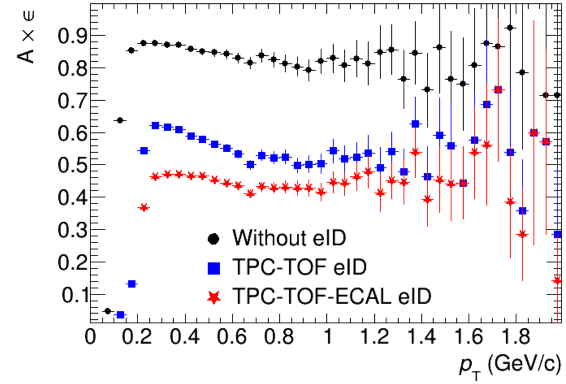


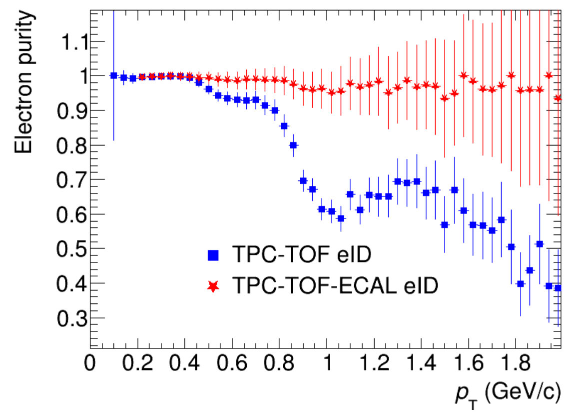
Request 13





New digitizer





- Efficiencies are identical
- As expected, TPC-TOF purity is closer to Request 11, EMC-TPC-TOF purity is the same

Improving purity …

- dE/dx for tracks identified as electrons in TOF

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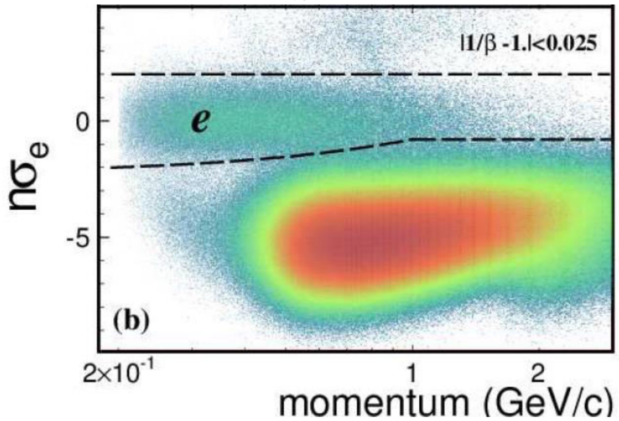
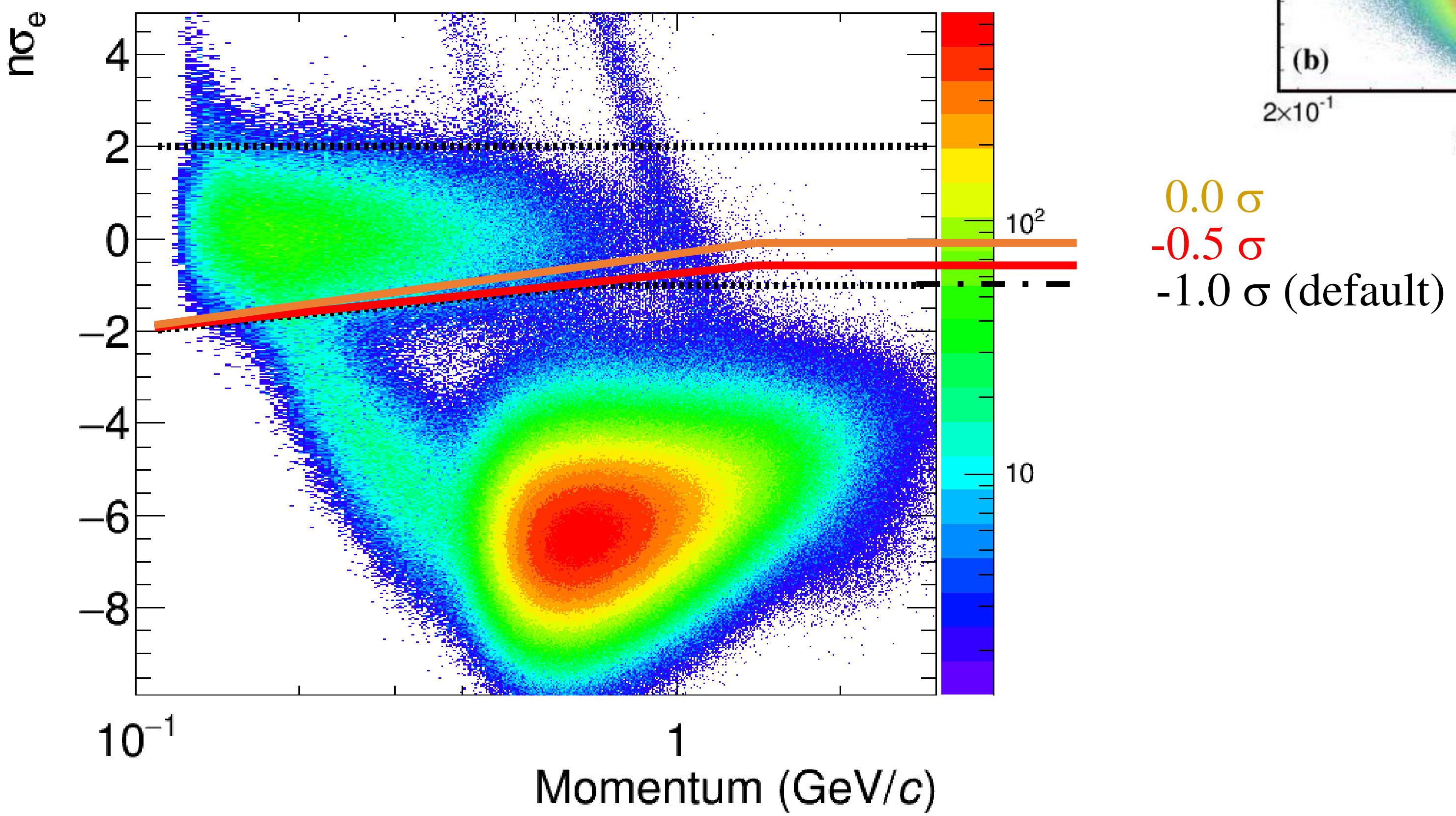
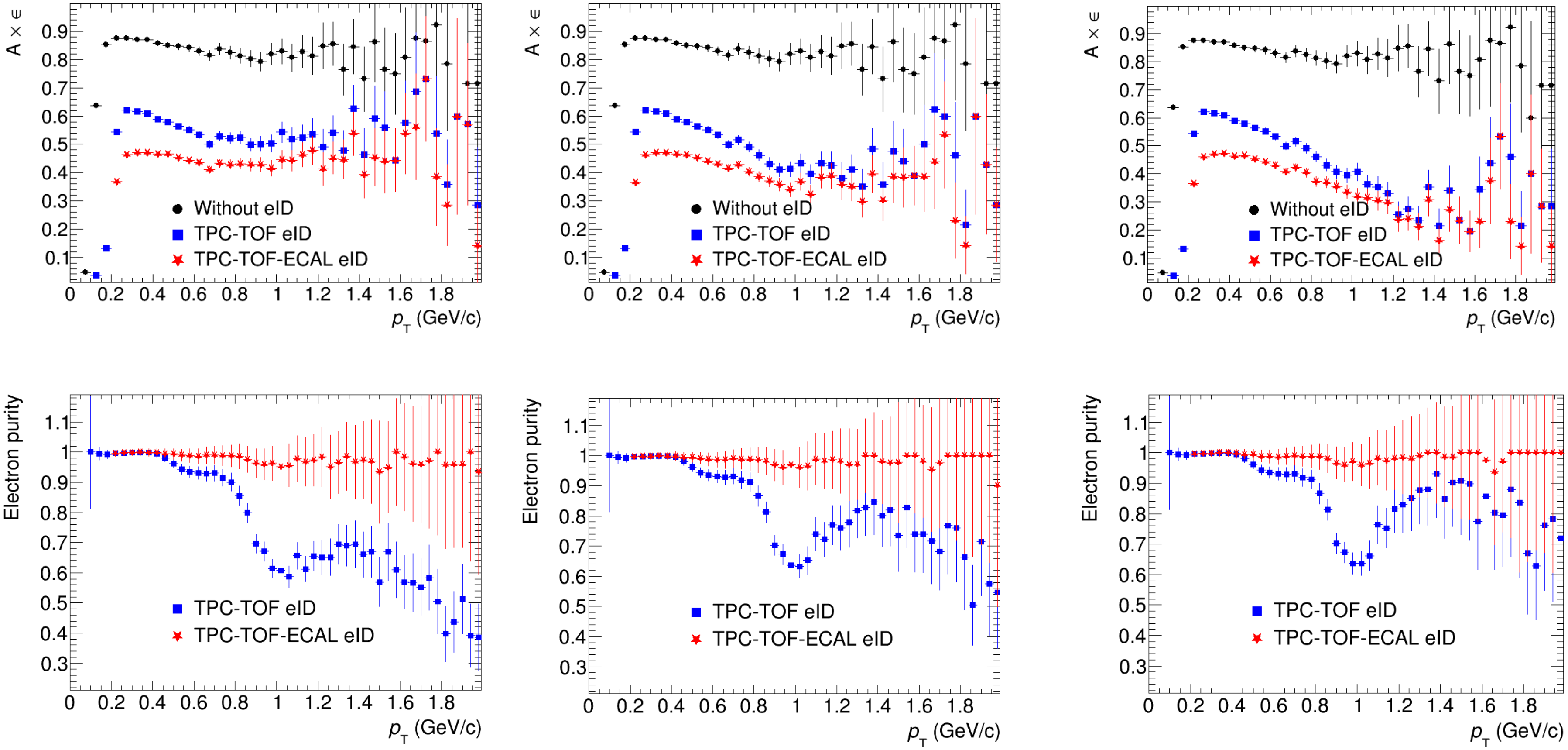




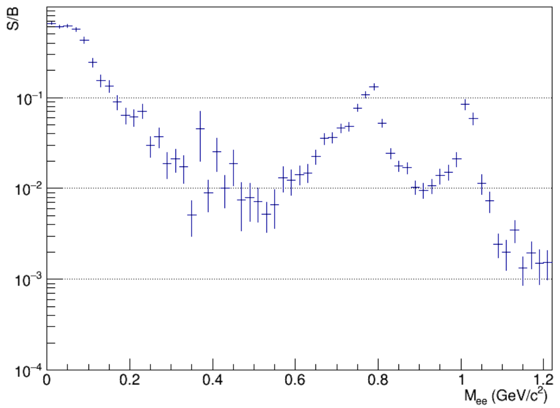
Improving purity …

-1.0 σ **-0.5 σ** **0 σ**

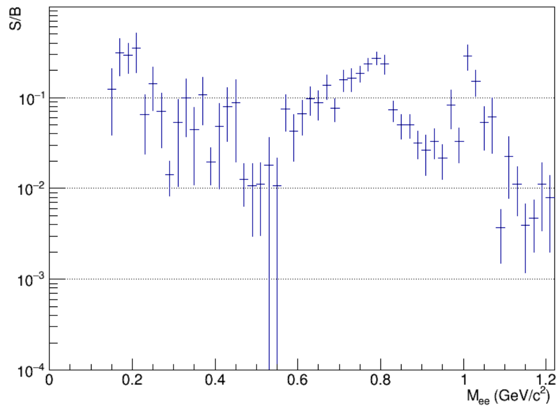


- TPC-TOF purity can be improved at the expense of lower efficiency
- EMC-TPC-TOF purity remains ~ 1
- Exact selections are to be decided based on the purity and significance of physical signals

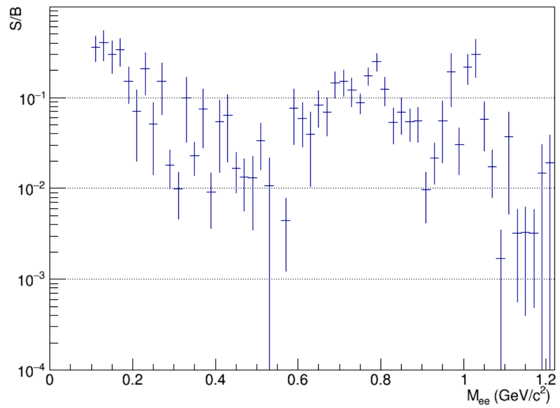
Dielectrons



M_{cut} = 150 MeV/c^2



M_{cut} = 150 MeV/c^2 $|\eta| < 0.5$



S/B in 0.2-1.5: 0.025
=====================
Omega (s/sqrt(b)): 1.62
Phi (s/sqrt(b)): 0.84
LMR (s/sqrt(b)): 0.39
=====================

S/B in 0.2-1.5: 0.082
=====================
Omega (s/sqrt(b)): 1.38
Phi (s/sqrt(b)): 0.82
LMR (s/sqrt(b)): 0.36
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S/B in 0.2-1.5: 0.091
====================
Omega (s/sqrt(b)): 0.72
Phi (s/sqrt(b)): 0.78
LMR (s/sqrt(b)): 0.22
====================

- S/B decreased but not dramatically
- S/B ~ 0.1 is still reachable

Conclusions

- The major problem with dE/dx tails has been solved with the latest update by A. Zinchenko
- eID performance with TPC&TOF became worse but not dramatically
- Suggestion is to stay with this option of dE/dx and wait for real data for further fine tuning
- Going to request a mass production for dielectrons