Updates in PWG4
Electromagnetic signals

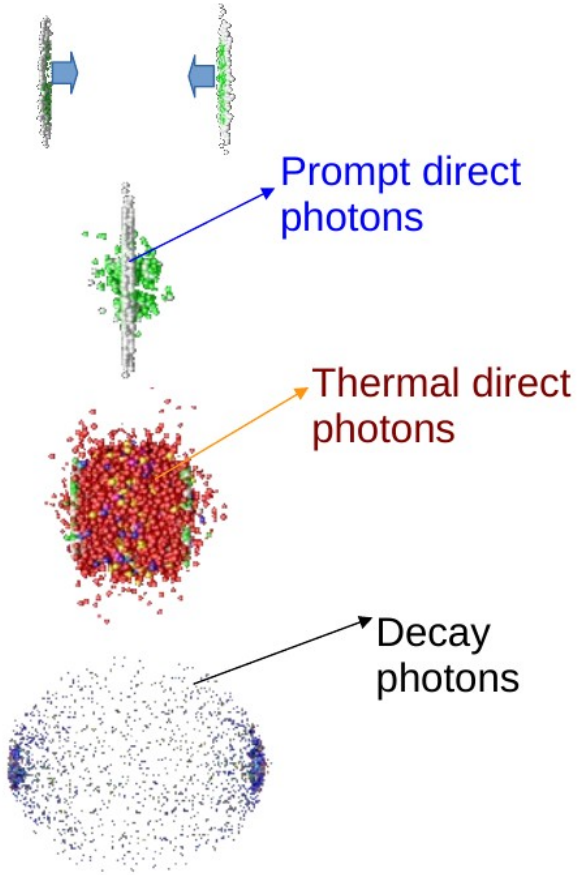
D.Peresunko and C. Yang for the PWG4

PWG4: goals and organization

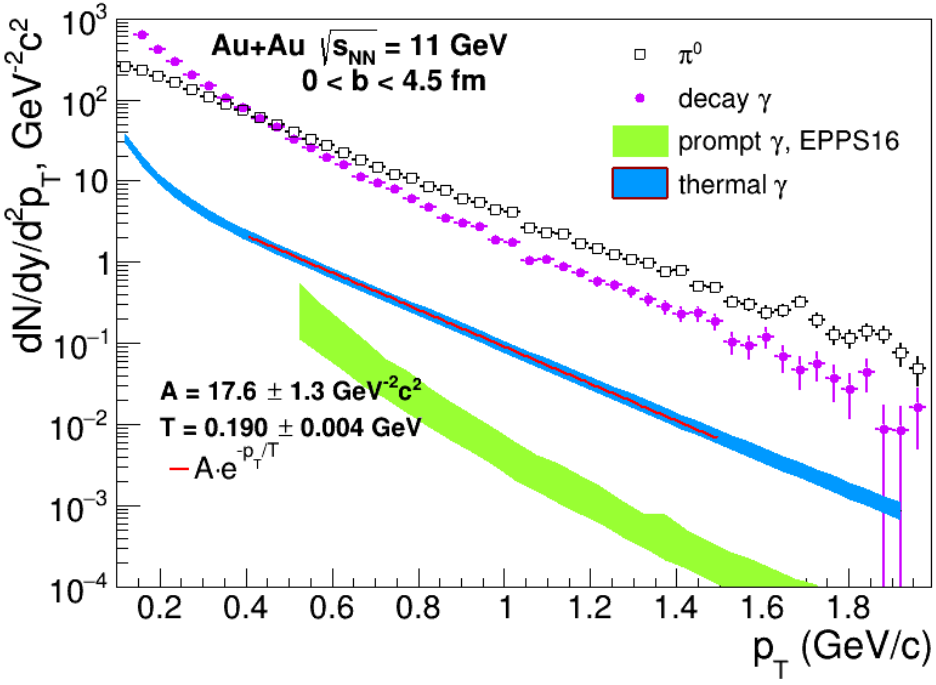
- Conveners: Chi Yang, Dmitri Peresunko
- Physics objectives
  - Neutral meson rapidity, spectra, flow
  - Direct photon rapidity, spectra, flow, interferometry
  - Dileptons: mass distributions, spectra
  - Antineutrons
- Talk overview
  - Recent theoretical predictions
  - Software development
  - Dilepton analysis
  - Neutral meson analysis

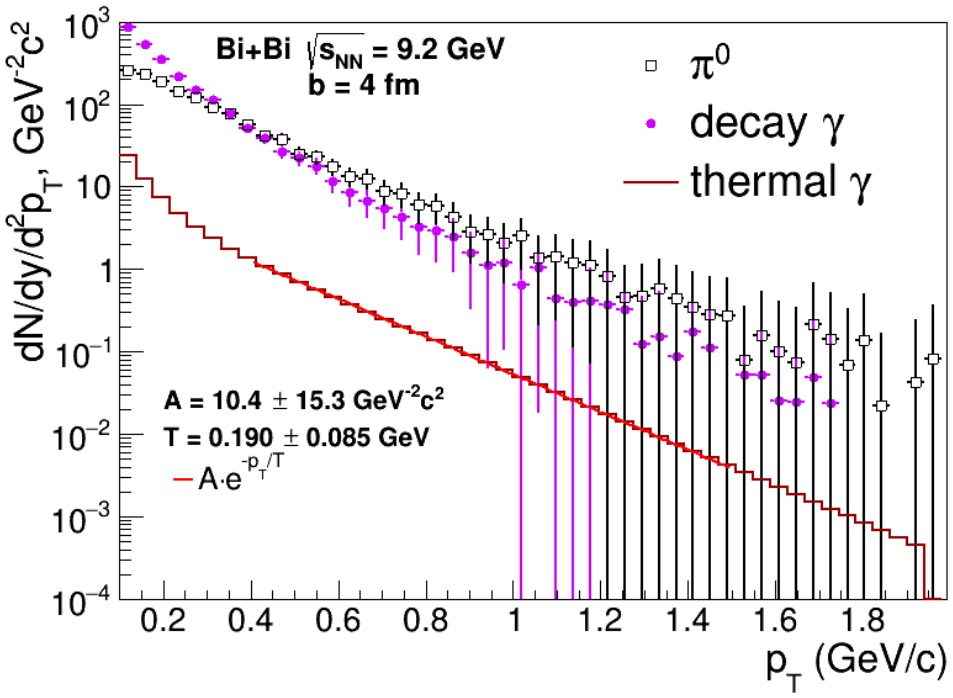
Recent theoretical predictions
(Dmitry Blau)

- UrQMD in hydro mode (bag EOS)
- prompt + thermal direct photons
- «Direct Photon Production in Heavy-Ion Collisions at NICA Energies»,D. Blau, D. Peresunko, Phys.Part.Nucl. 52 (2021) 4, 681-685



Comparision Au+Au vs Bi-Bi (Dmitry Blau)





Absolute yield in Bi-Bi is smaller, but slope and relative yield is similar to Au+Au collisions

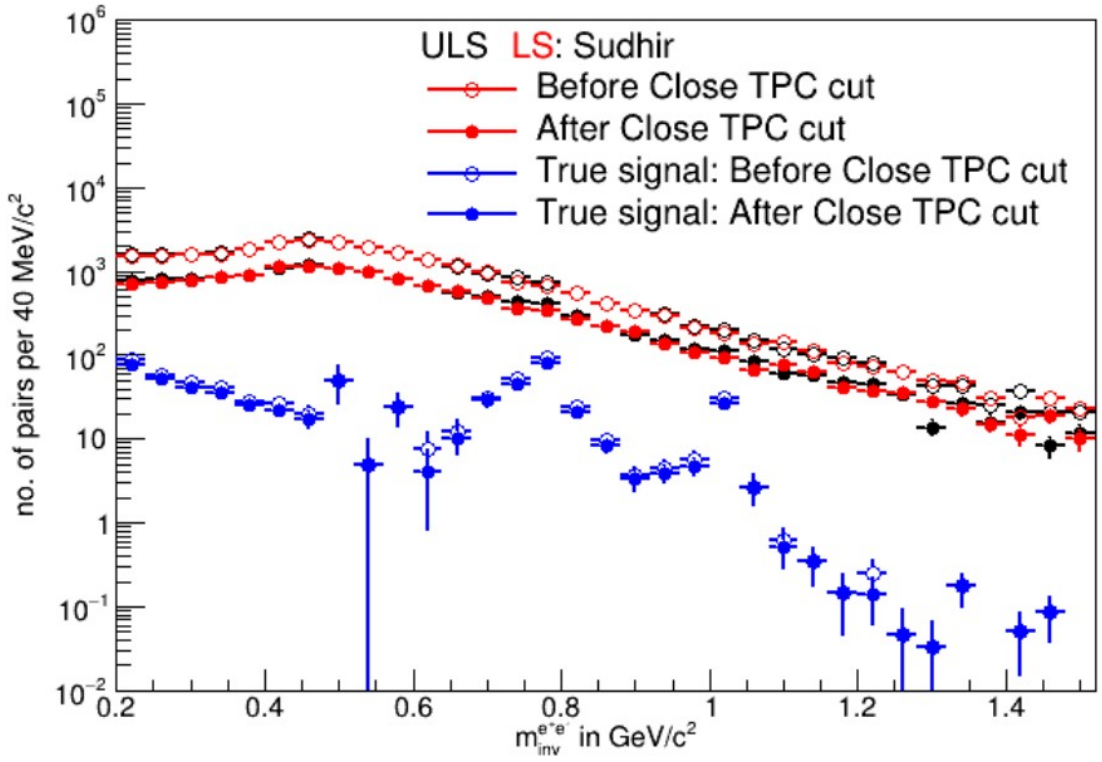
$$R_\gamma = \frac{N_\gamma^{incl}}{N_\gamma^{decay}} \sim 1.06$$ => possible to access

Software development

- V0 finder
  - selects V0 either using cuts or via machine learning
  - Move V0 finder to standalone class
    - mpdroot/physics/evPID/MpdV0Maker.h
  - Fills branch with V0s per event
    - mpdroot/physics/evPID/MpdV0.h
  - So far V0 finder optimized for conversion V0s
    - Do we need combine functionality in existing finder used to produce Λ, K_s^0?
- Neutra meson/photon analysis class mpdroot/physics/photons/MpdConvPi0.h
  - consumes prepared V0s, clusters and produce histograms for analysis
  - was used in Train 1 and Train 2 scans

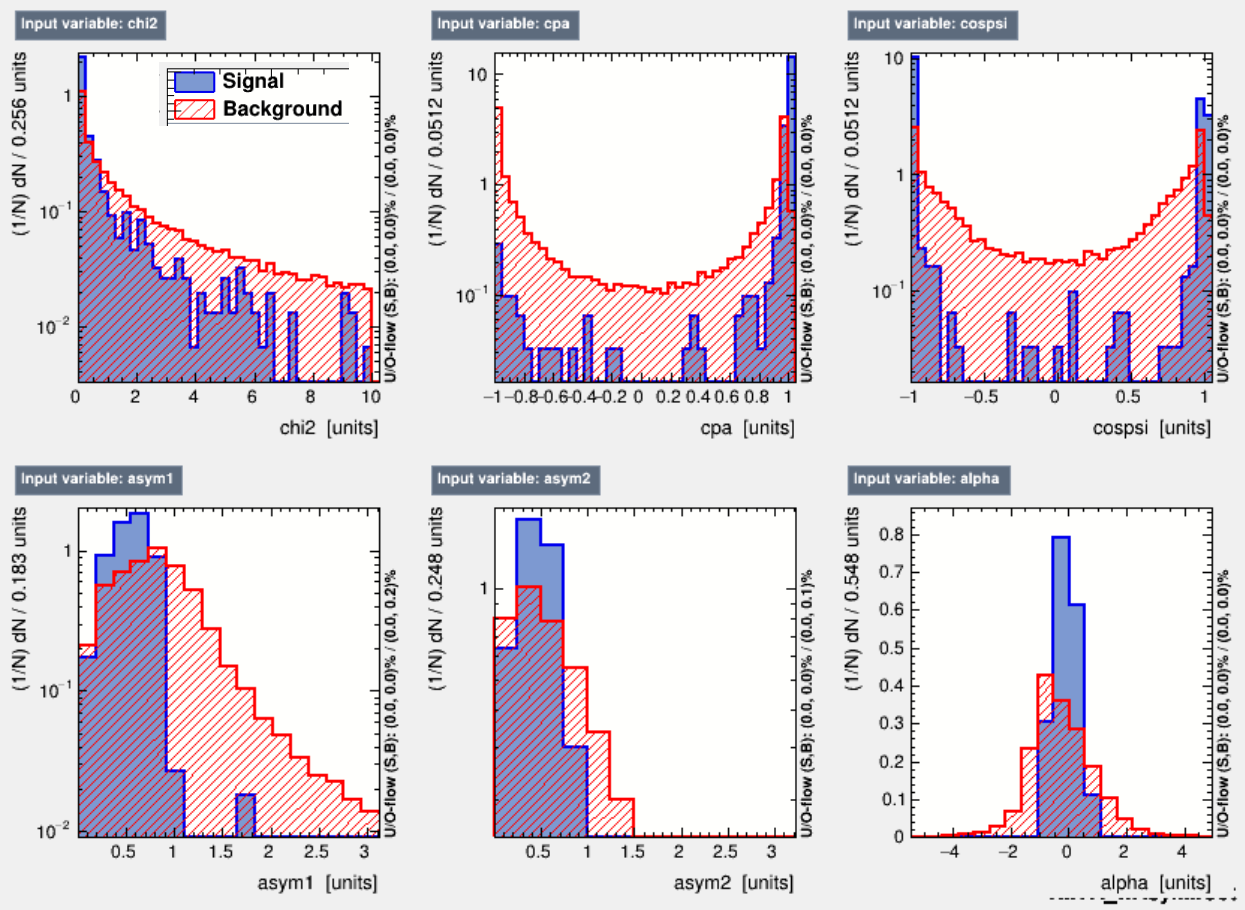
Dilepton analysis (Sudhir)

- Reduce combinatorial background by rejecting pairs from π^0/η Dalitz decays
- More details in Sudhir's talk

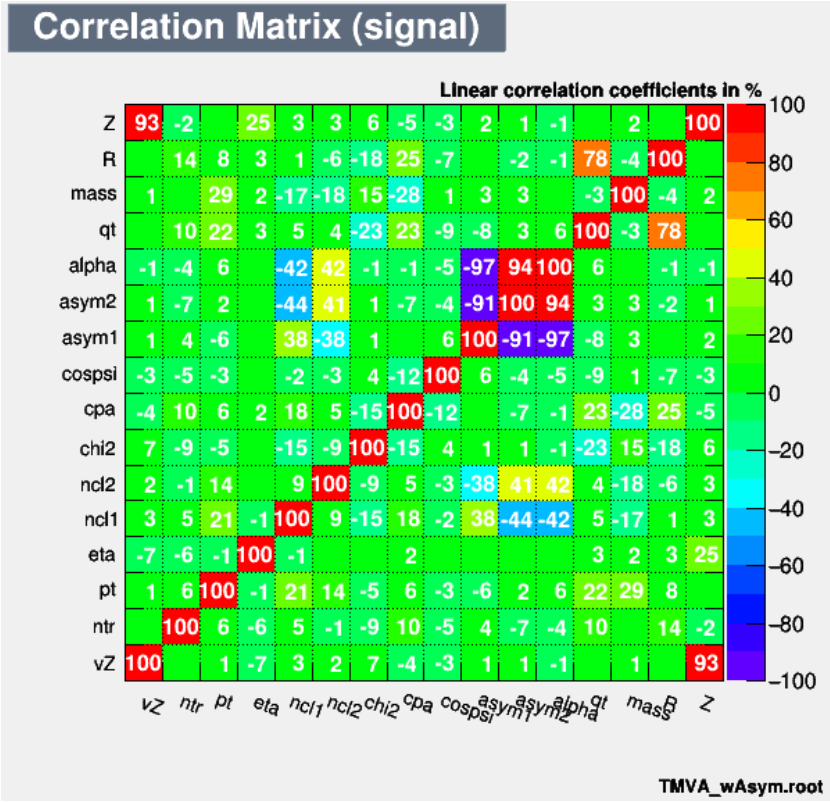


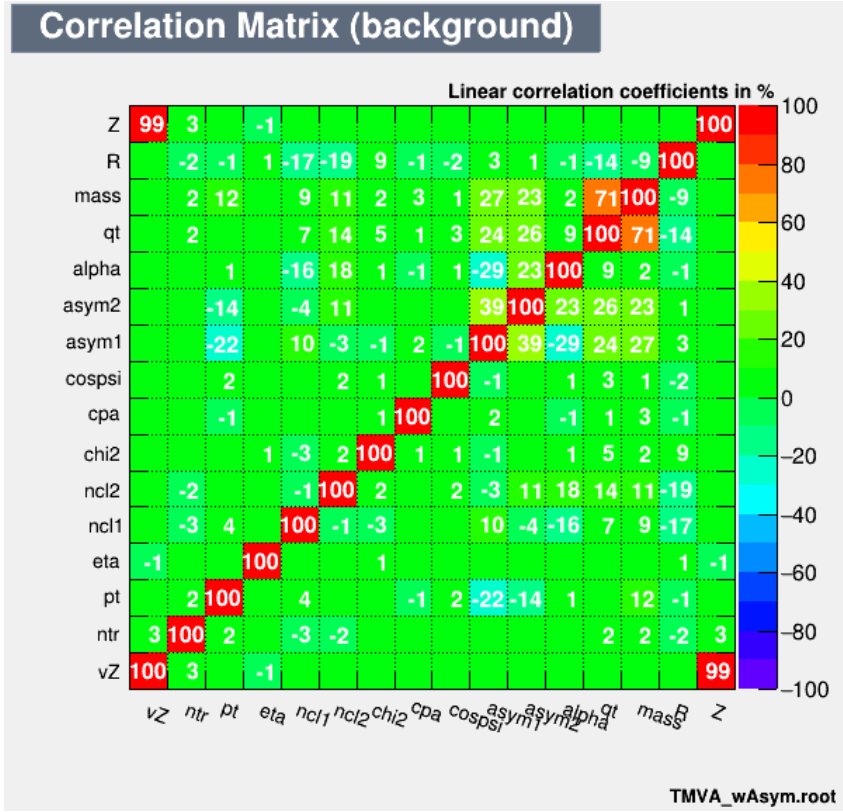
V0 finder: input variables

- vZ: event vertex z coordinate
- ntr: number of tracks
- pt: V0 pt
- eta: V0 eta
- ncl1, ncl2: number of TPC clusters
- chi2: chi2 of the Kalman fit
- cpa: cosine of angle between momentum and dirction from secndary vertex to primary vertex
- cospsi: cosive of agle of pair orientation w.r.t. magnetic field
- asym1, asym2: track momentum asymmetry
- alpha, qt: Armenteros-Podalansky variables
- mass: m_{ee} pair mass
- R, Z: conversion radius and z coordinate



Variables correlation

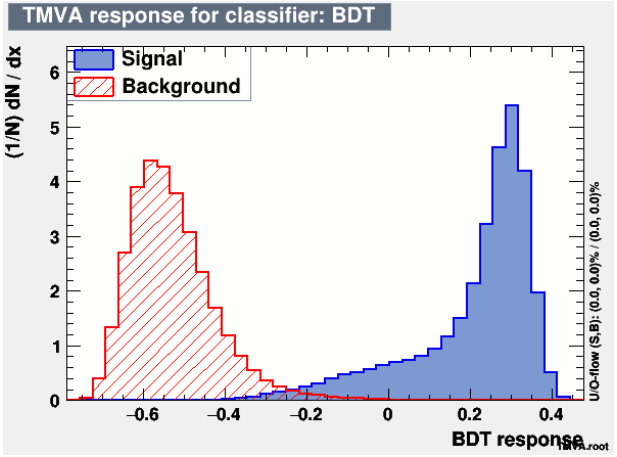


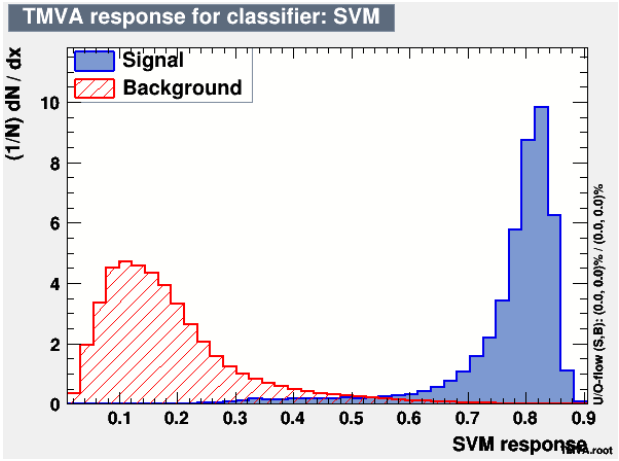


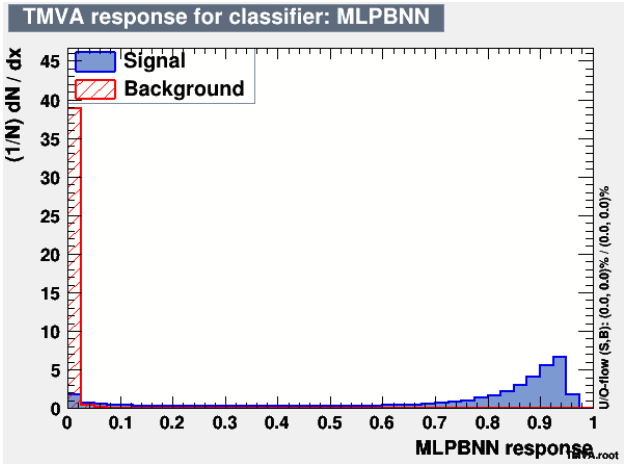
Most of variables are independent. Some correlated, e.g. event vZ and conversion Z, asymetry and alpha. Some correlations not obvious: ncl vs asym, qt and R. To be optimized

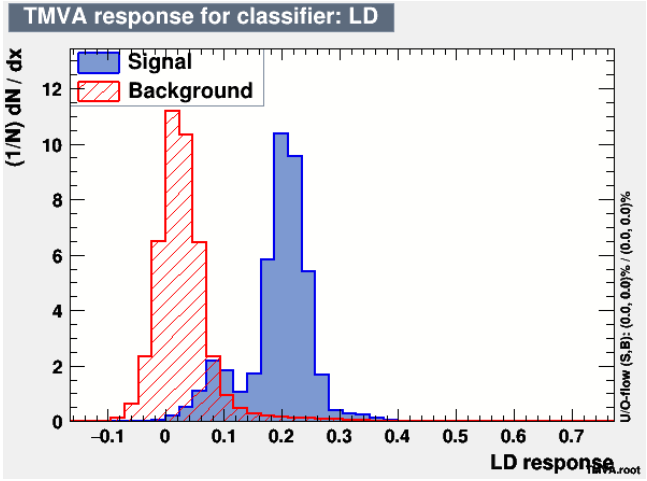
Classifiers outputs

Some classification algorithms provide clear separation of signal and background (random pairs)



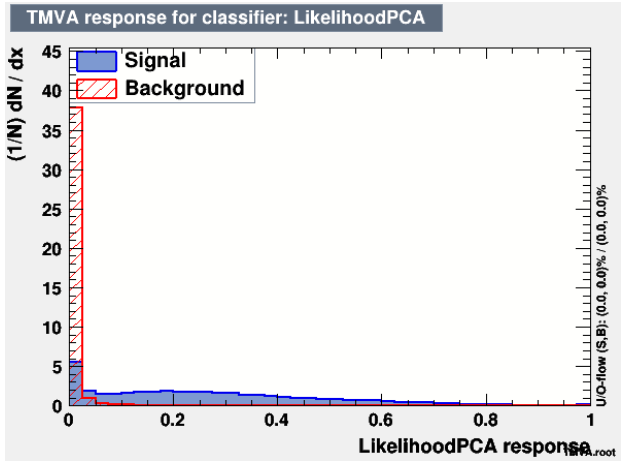


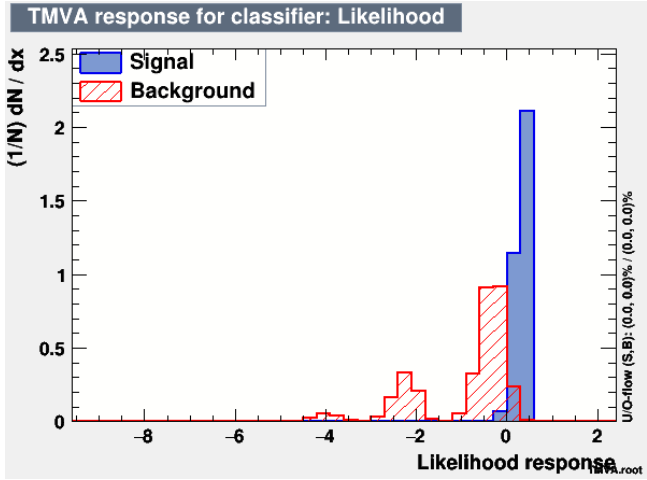


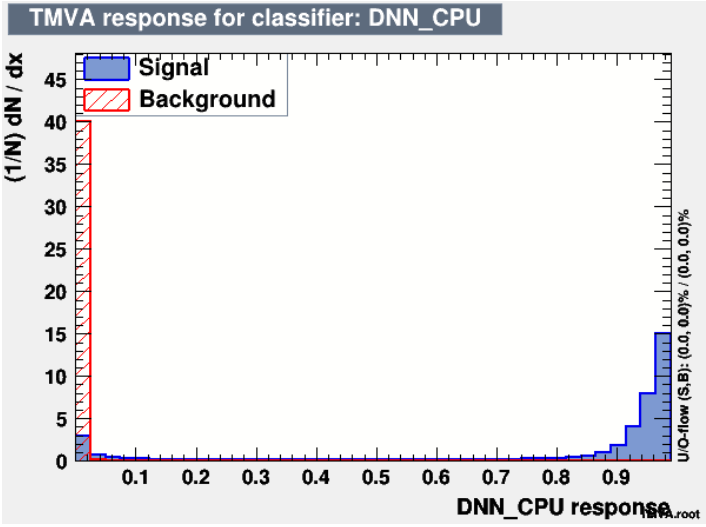


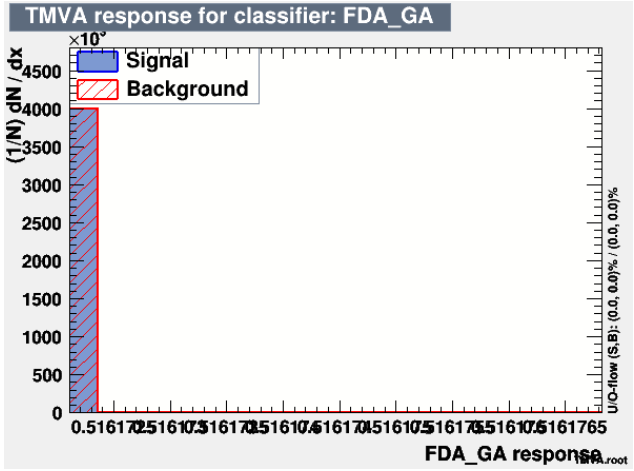
Classifiers outputs (2)

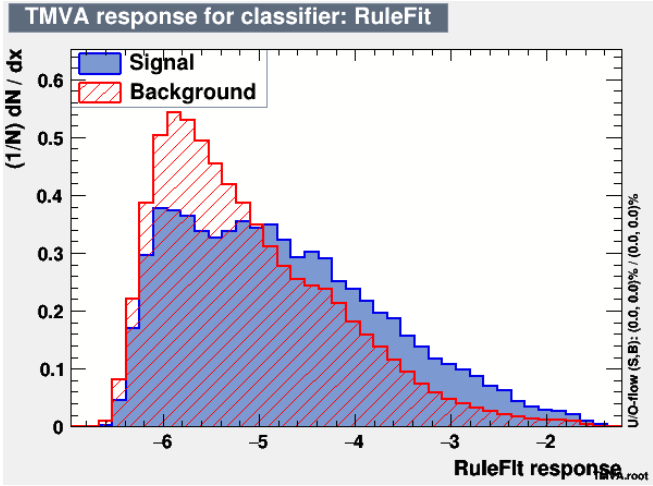
Some clussifiers do not separate signal/background (e.g. RuleFit)



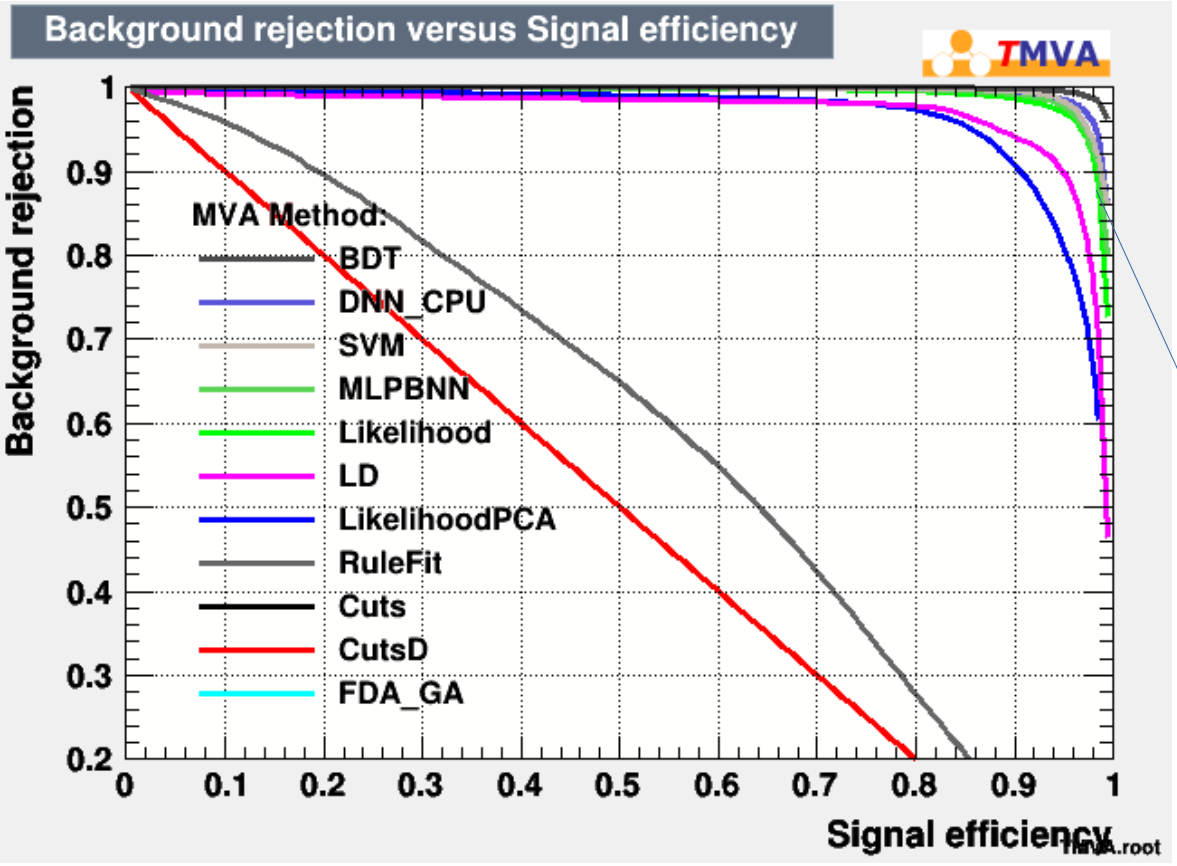


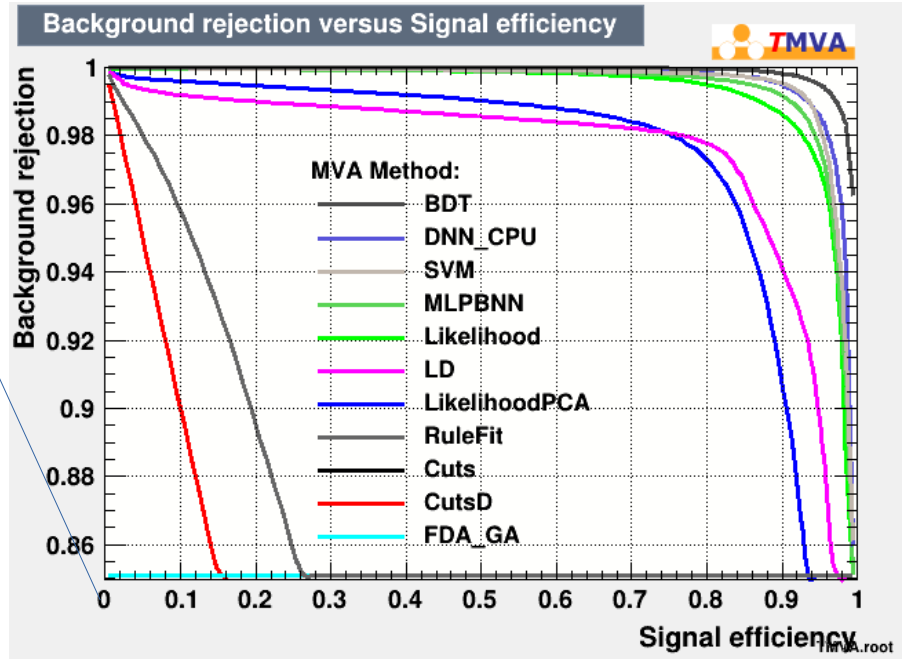






Operation response curves

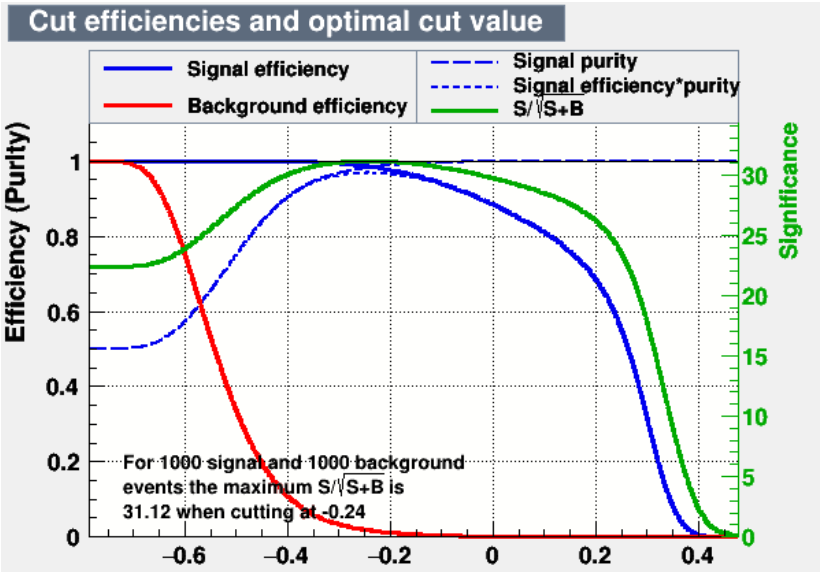


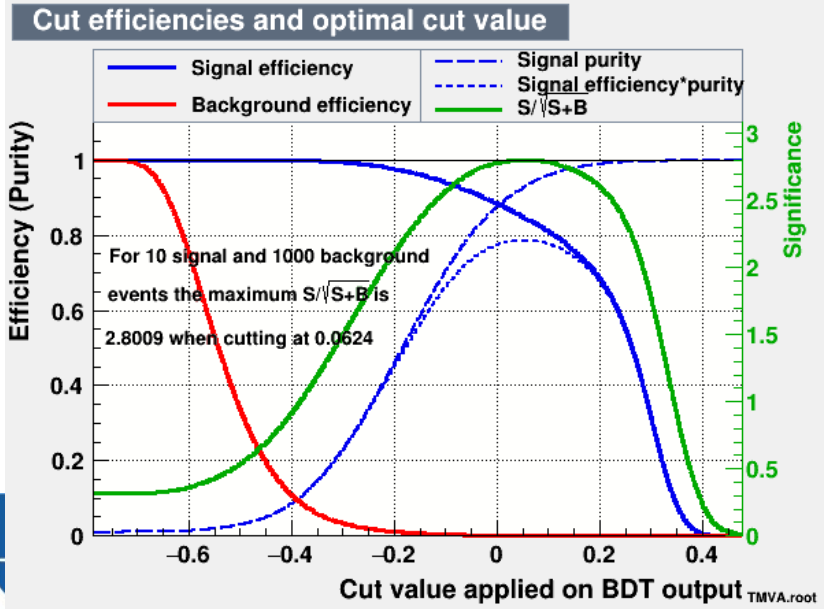


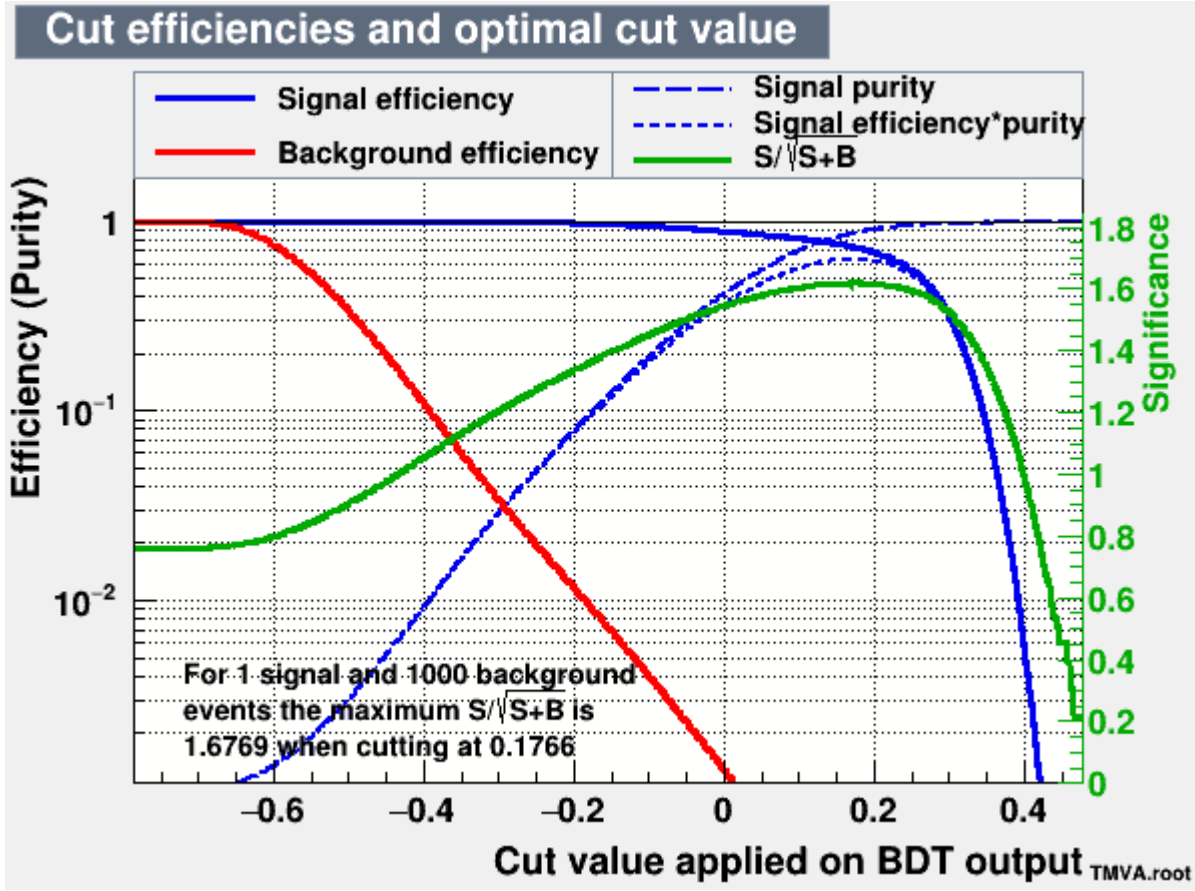
Best performance:
BDT, SVM, DNN_CPU

Bad performance: CutsD, RuleFit, LikelihiidPCA, LD

BDT optimal cut

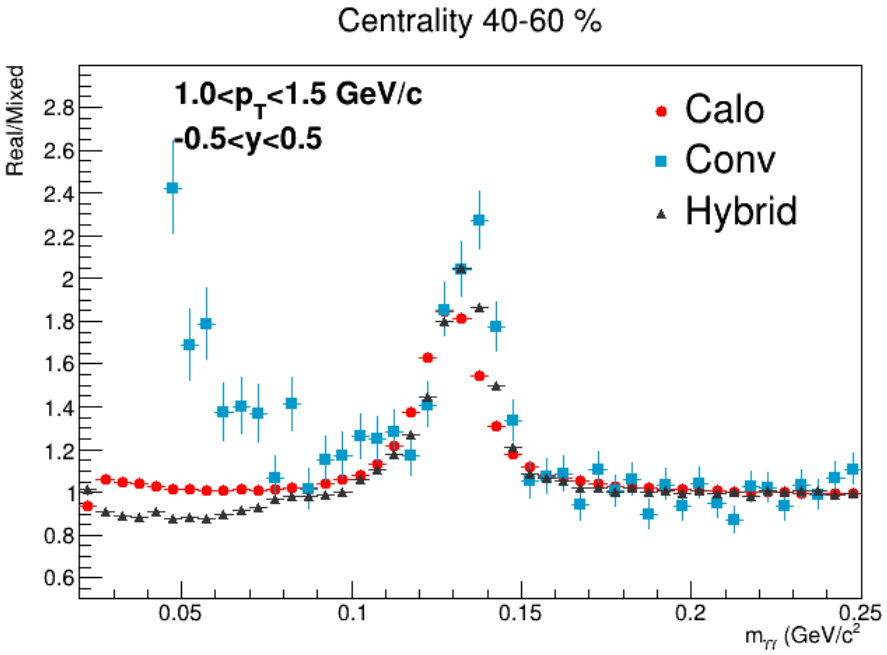


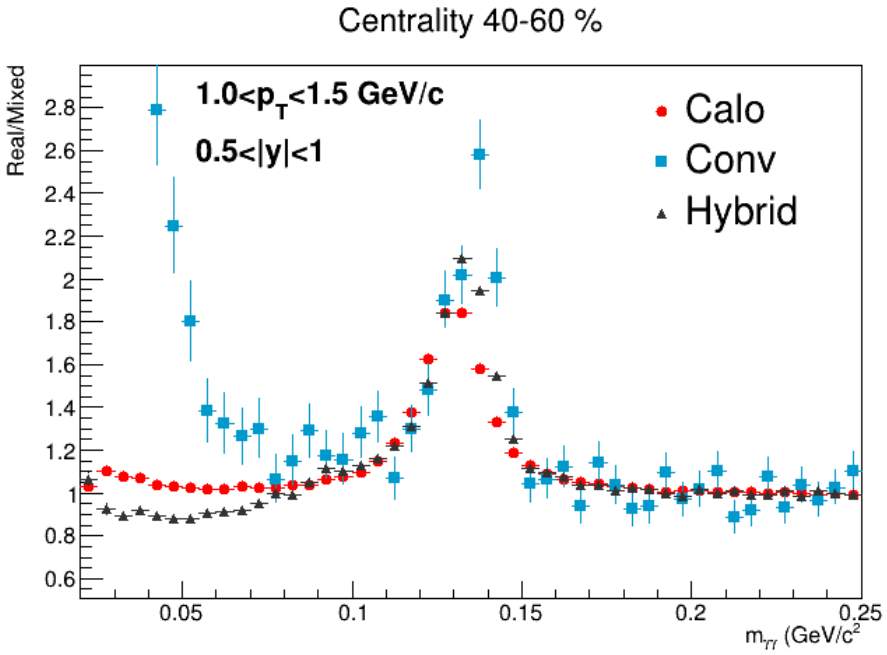




Use cut maximizing significance in the case 1/1000 S/Bg V0s

π^0 spectra and rapidity distributions (E.Nekrasova)

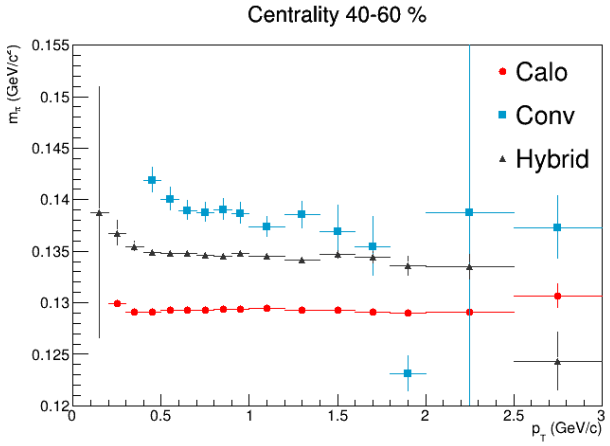


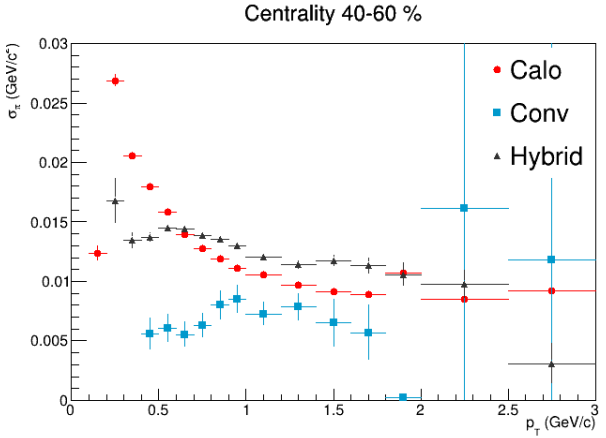


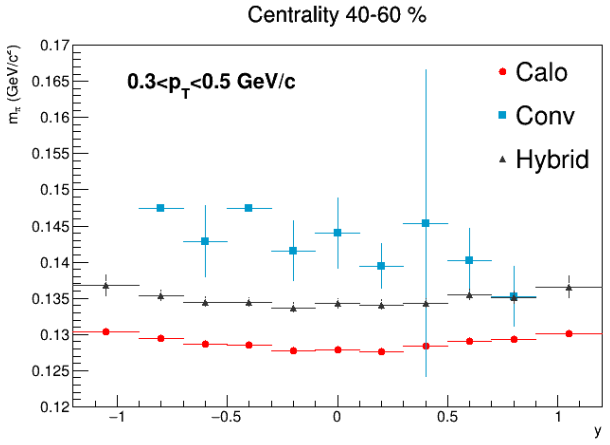
Conversion shows the largest Signal/Bg ratio, calorimeter — smallest
Minor dependence of Signal/Background on rapidity

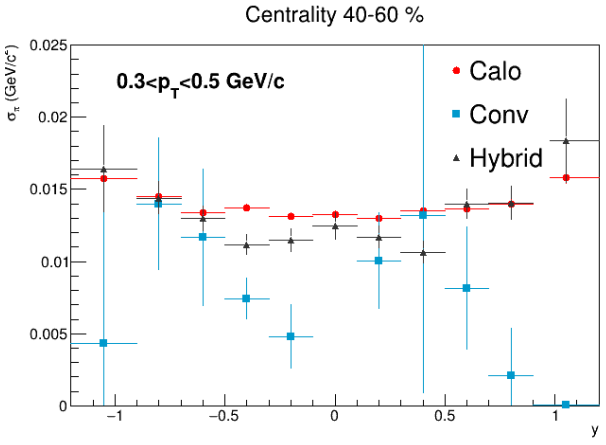
Peak position and width dependense

- Calorimeter
  - No pT dependence =>correct non-linearity
  - Minor y-dependence of resolution => small detoriaration of resolution at large z
- Conversion
  - Peak position shifted to higher m
  - No rapidity dependence
- Hybrid
  - Width not between calo and Conv => look at peak shape





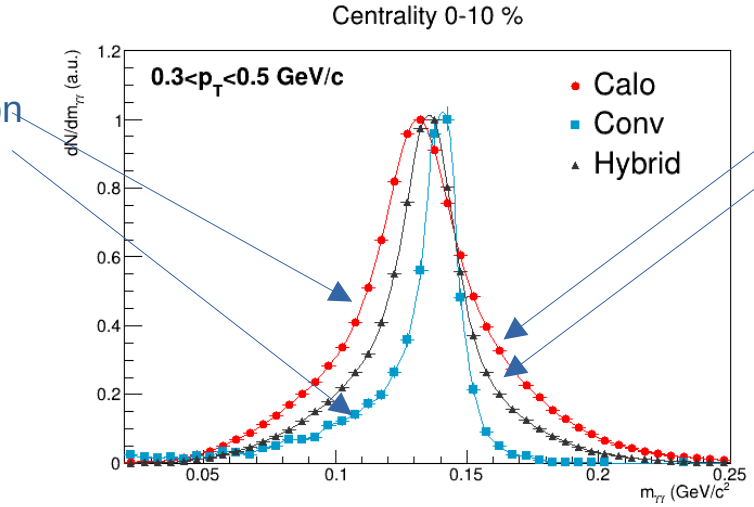


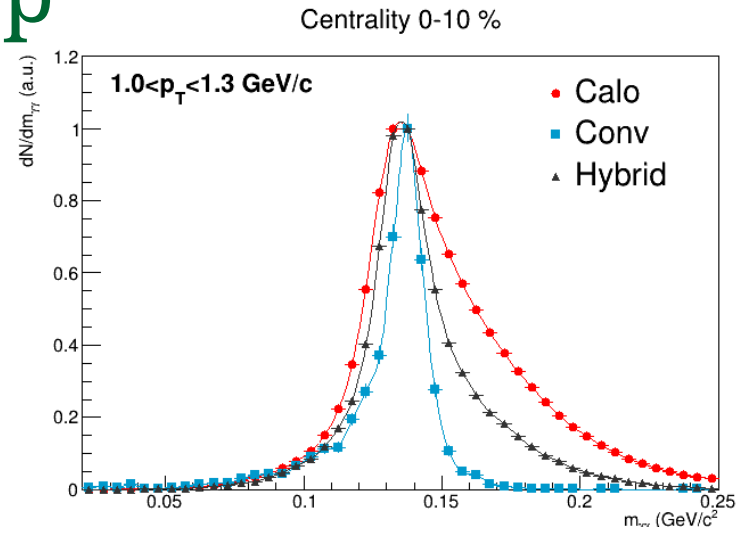


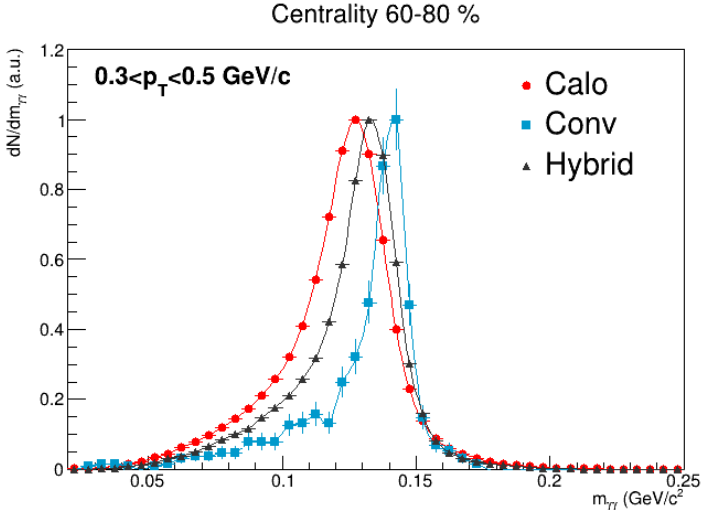
Conversion and cluster overlap

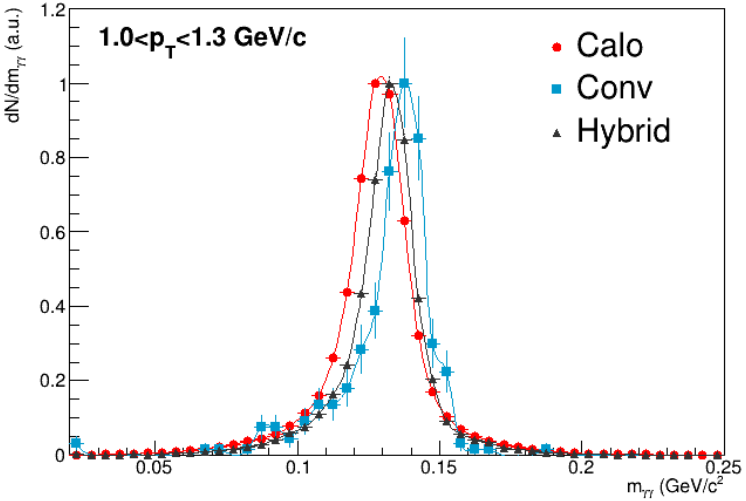
Photon conversion $e^{\pm}$ E loss

Cluster overlap



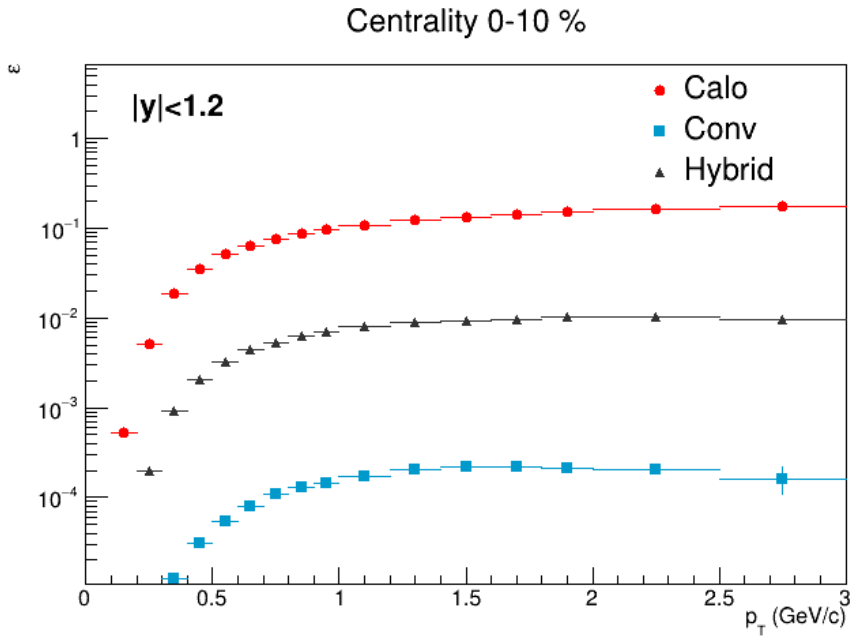


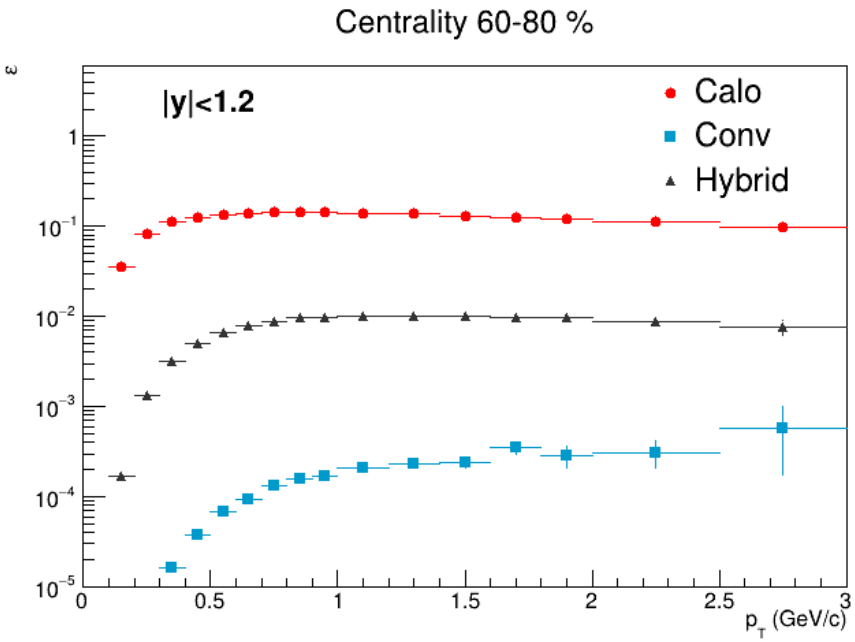




esunko, PWG4 status

Effieincy





- Occupancy
- mass/width

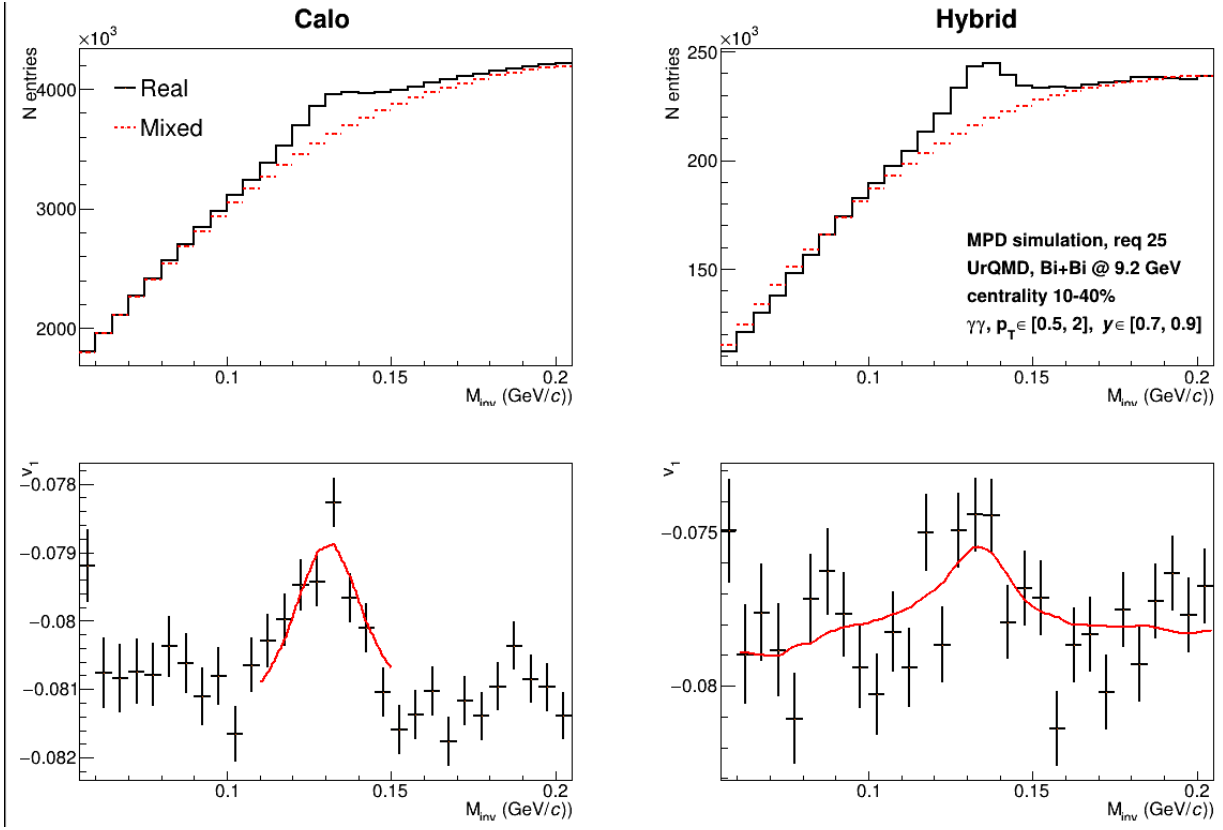
π^0 analysis summary

- Software produces reasonable results
  - Expected mass and width dependence on p_T and y
- Strong photon conversion electron E-loss contributions
  - Reduce with PID cuts (reduced efficiency)
  - Will be a problem in photon interferometry analysis
- Strong cluster overlap contribution
  - Use core energy
  - Reduce with dispersion PID
  - Optimize clusterization algorithm

π^0 flow (O. Golosov)

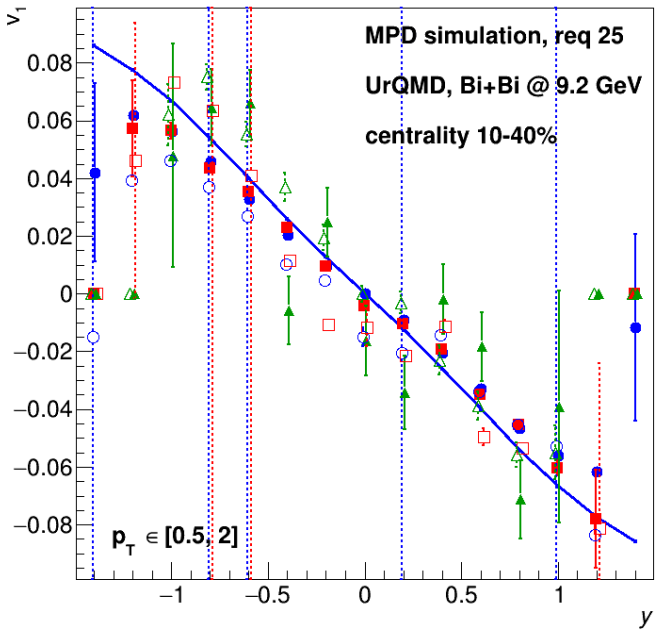
- Code implemented in the analysis class
  mpdroot/physics/photons/MpdConvPi0.h
- Output of train 2 is analyzed
- $v_n(m)$ is fit with function

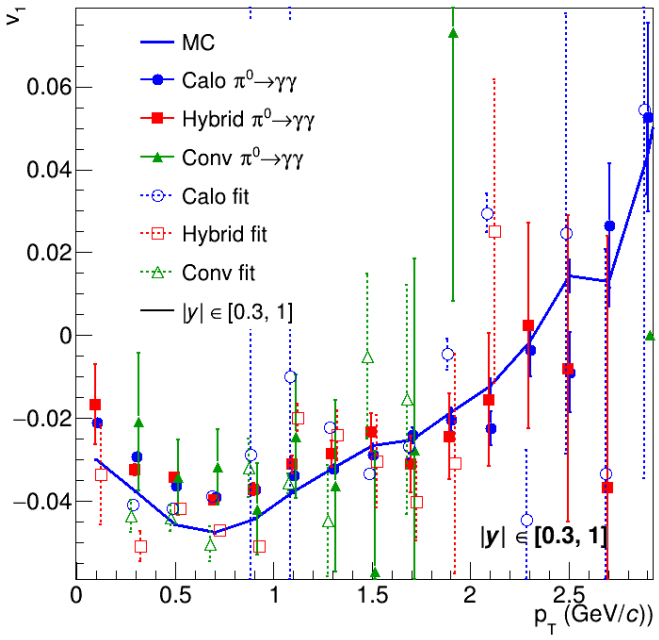
$$v(m_{\gamma\gamma}) = \frac{N_S(m_{\gamma\gamma})v_s + N_{BG}(m_{\gamma\gamma})v_{BG}}{N_S(m_{\gamma\gamma}) + N_{BG}(m_{\gamma\gamma})}$$



π^0 flow (O. Golosov)

- Pion flow can be extracted for all 3 reconstruction techniques
- Flow estimeted w.r.t. true reaction plane
- MC (solid line) do not contain long-lived resonance decays and deviates from the measured flow (to be checked)
- Filled symbols: true pairs





Conclusions

- Analysis software is being developped
- Basic analyses started
  - revealed some points in ECAL reconstruction requiring optimisation
- Much more analyses in pipeline
  - $\pi/\eta \to \gamma(e^+e^-)$
  - $K_s^0 \to \pi^0\pi^0$
  - $\pi \to \pi^0\gamma$, $\pi^0\pi^+\pi^-$
  - $\eta' \to \eta\pi^+\pi^-$
  - $\Sigma^0 \to \Lambda\gamma$, $\Sigma^0 \to \Lambda(e^+e^-)$, $\Sigma^+ \to p\pi^0$, $\overline{\Sigma}^{\pm} \to \bar{n}\pi^{\pm}$
  - Dielectron continuum, LVMs
  - Single e_{HF}
  - Fluctuations $<\pi^0,\pi^{\pm}>$
  - ….