Optimization of photon conversion cuts

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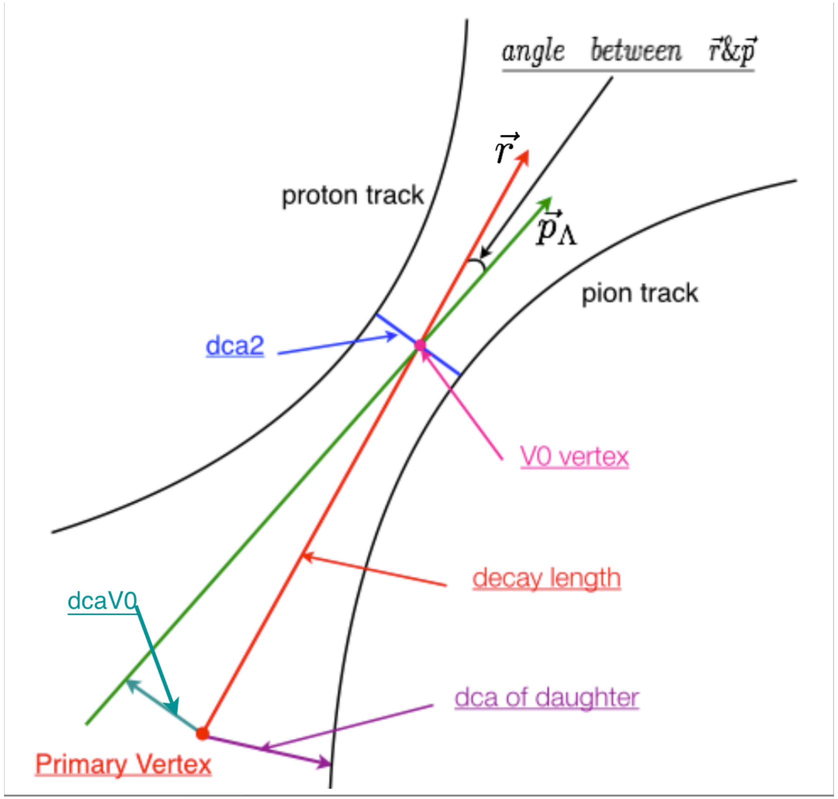
Definition of variables for V0 selection

- Opposite charges
- Conversion radius (decay length)
- χ^2 of Kalman fit of track pair
- m_{e+e-}
- α = angle between $\bar{r}$ & $\bar{p}$
- Daughter tracks DCA
- Asymmetry
- Ψ-cut (pair orientation wrt B)
- Armenteros-Podalanski



Plot from STAR collaboration

Data analyzed

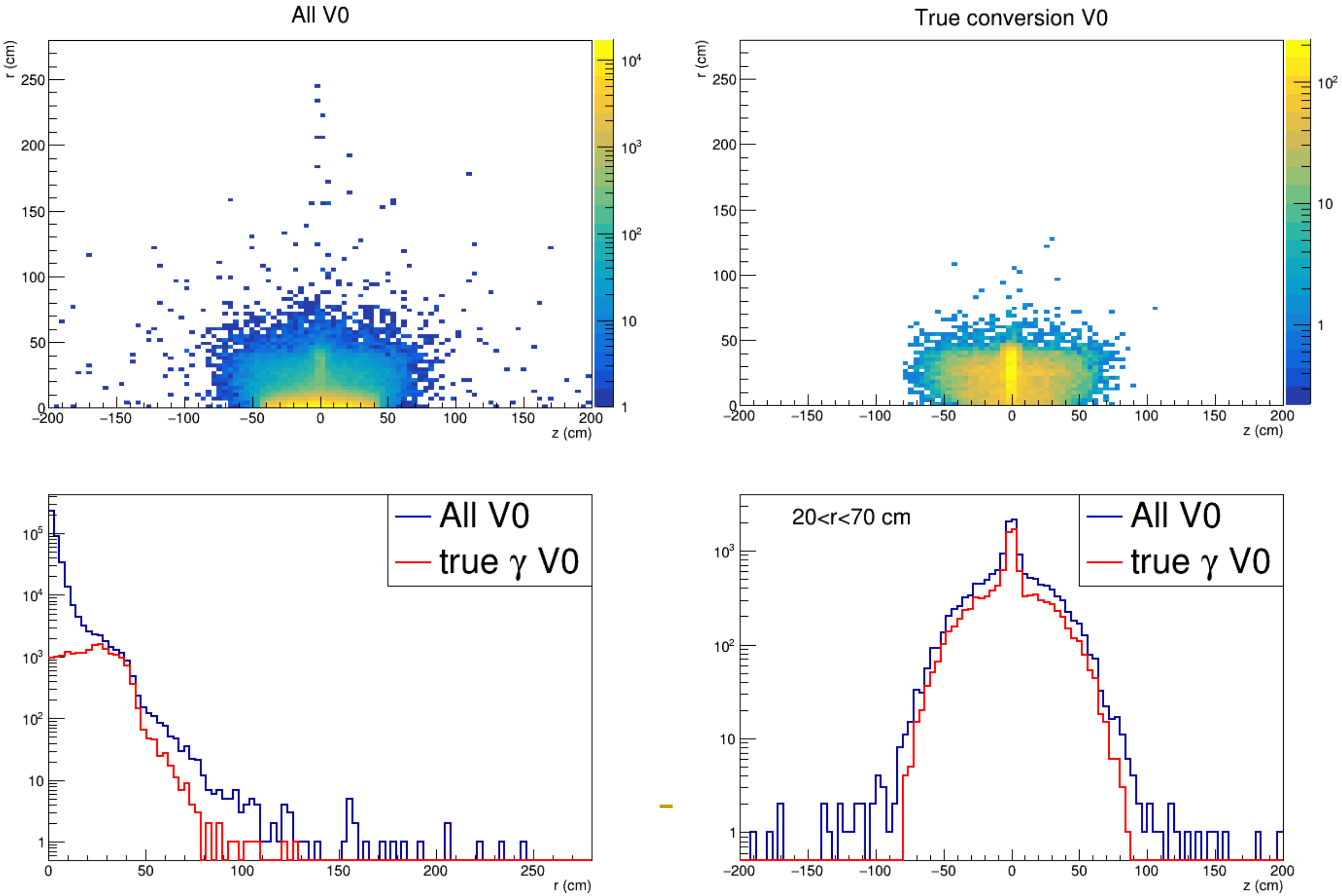
- Production BiBi-09.2GeV-mb*
- 160 kEvents
- Event selection:
  - $|z|<40$ cm
- Track cuts:
  - Nhits>10
  - $|eta|<1$
  - Probability electron >0.75
  - dE/dx: < 3 sigma from electron band

Material budget or conversion map

- Cut on minimal conversion radius effective

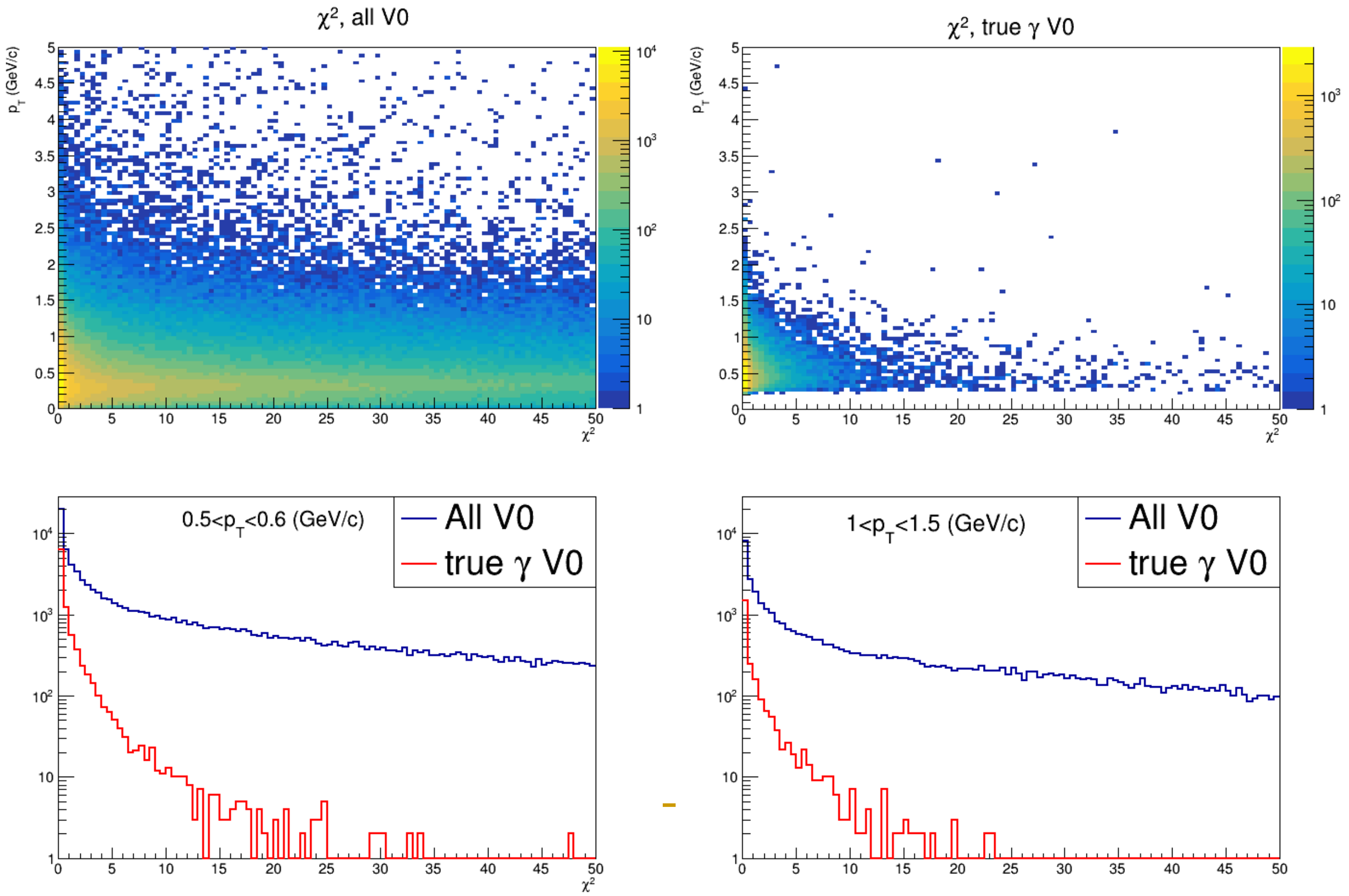
  20<r<100 cm (remove combinatorics and Dalitz decays)
- Cut on

  |z| < 100 cm possibly useful



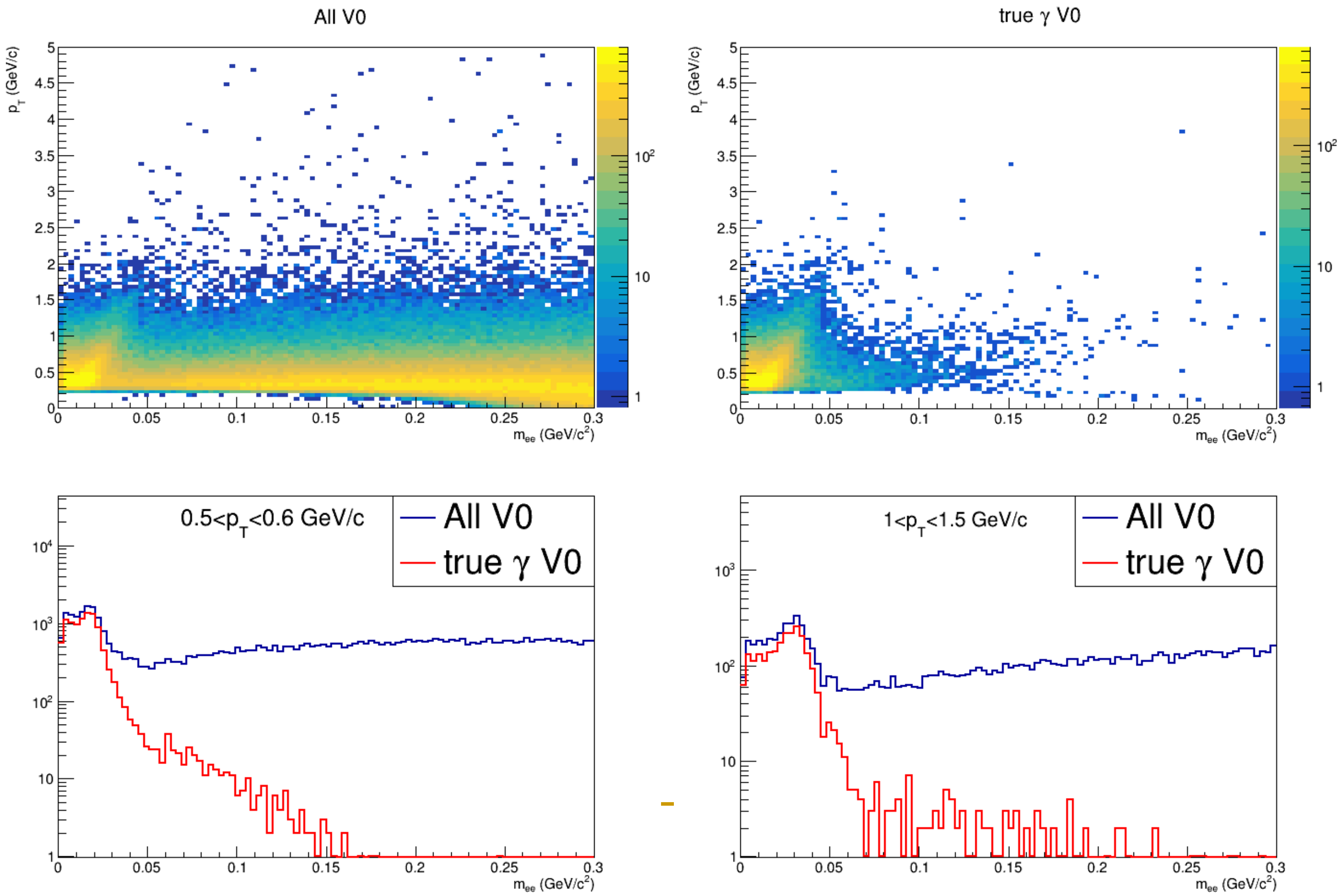
Kalman fit χ^2

- Distribution for true pairs is narrower. Try χ^2<Cut



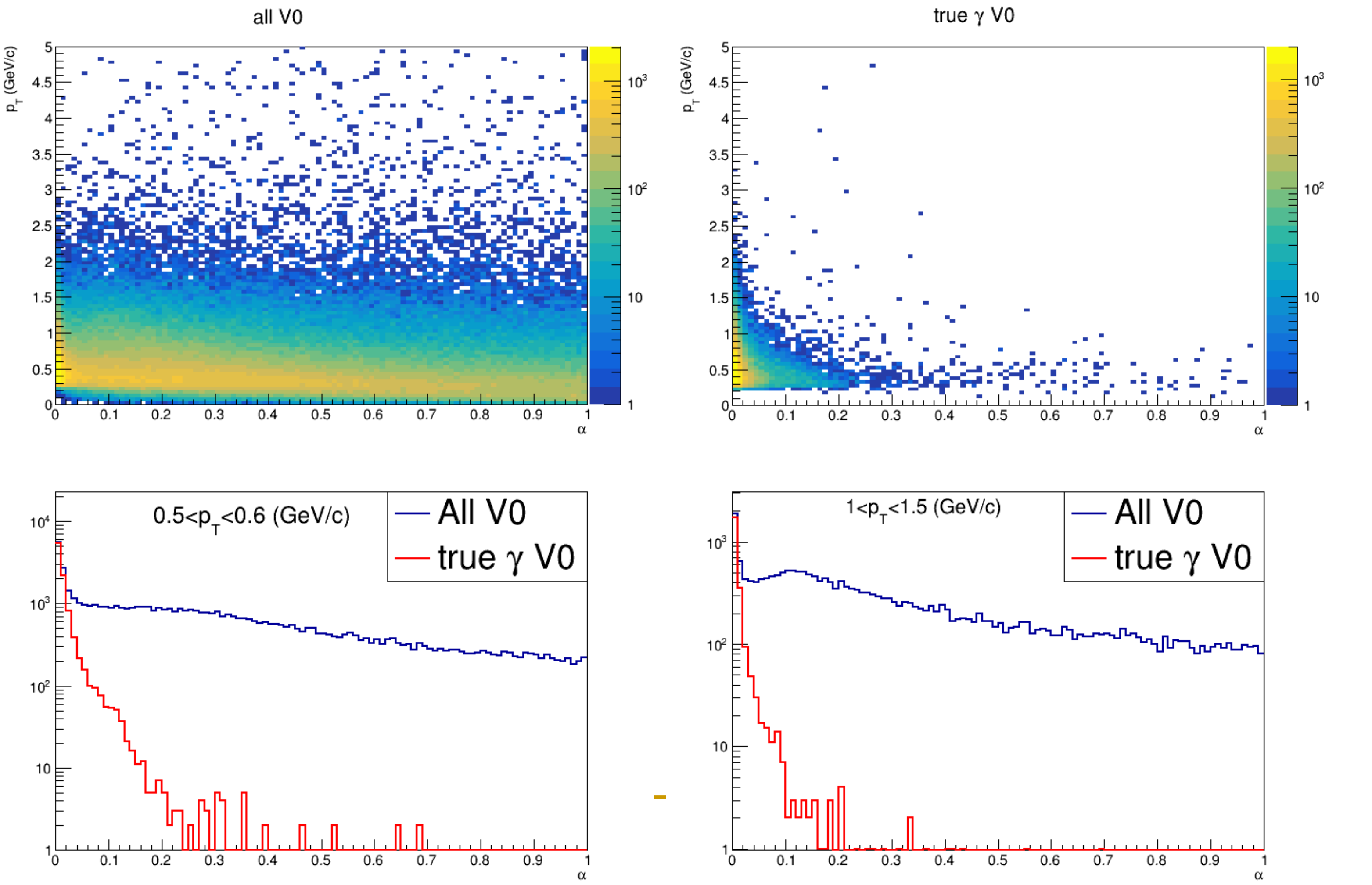
e+e- invariant mass

- One of the most effective cuts, use m<cut



Alpha angle

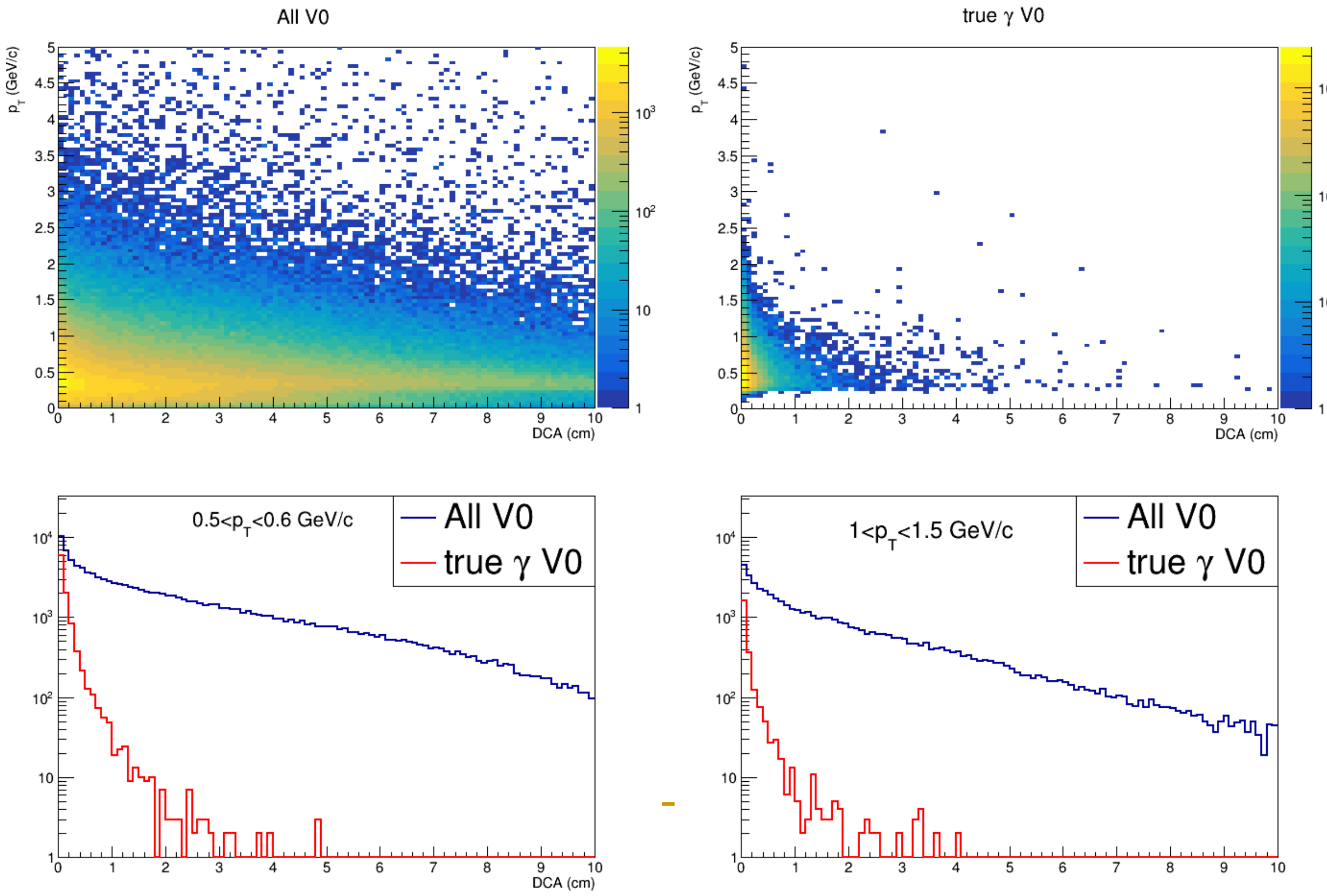
- The most effective cut, use α<cut



Daughter DCA

- Reduce combinatorial background, use (p_T-independent)

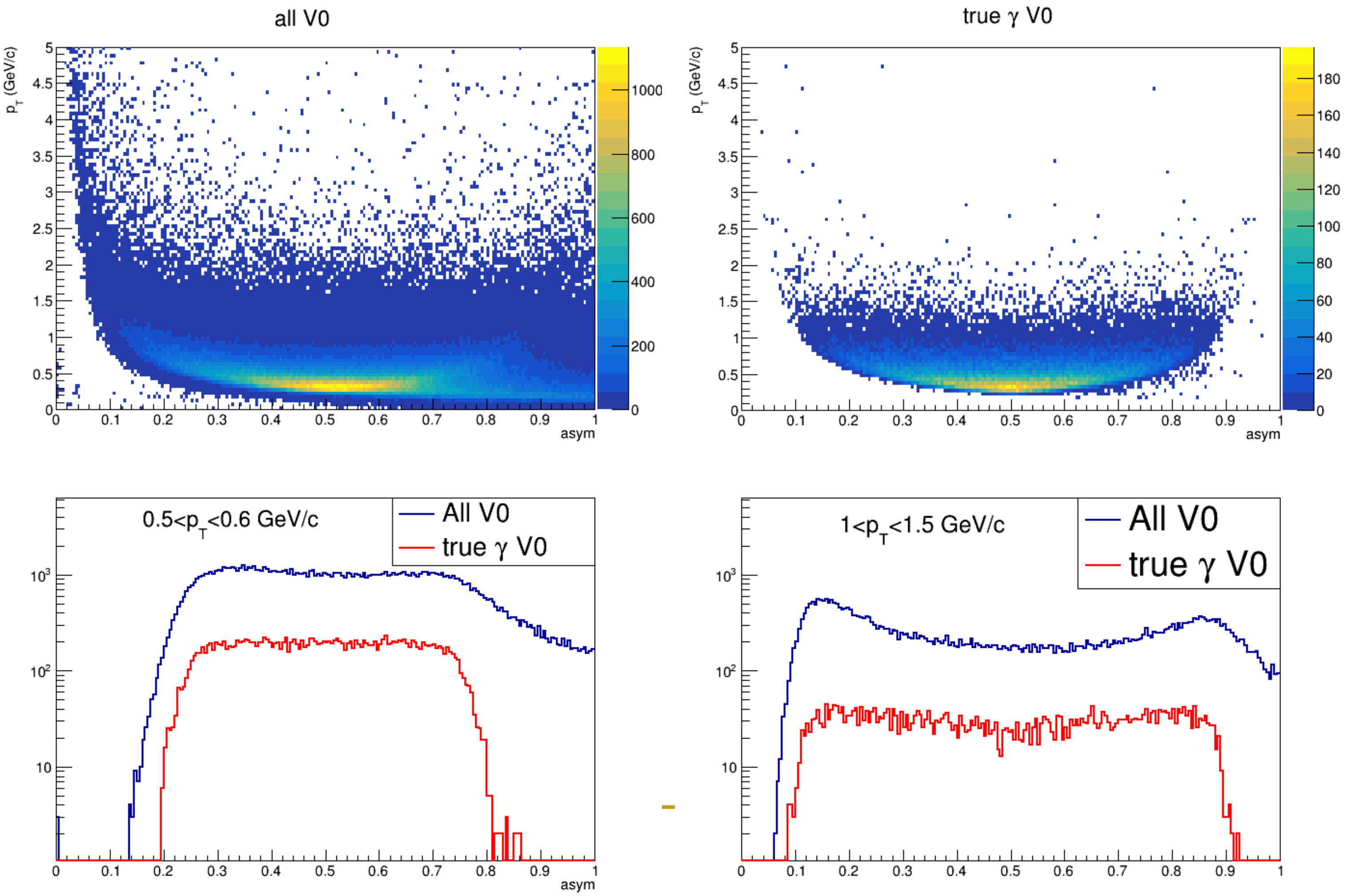
  dca <cut



Asymmetry cut

- Almost useless cut, use

  cut<asym<1-cut



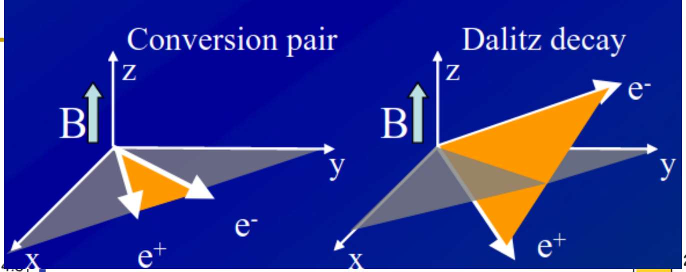
ψ cut

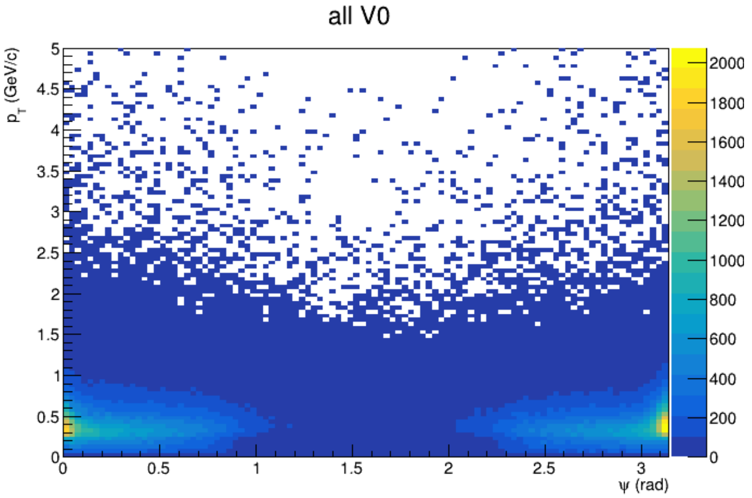
- Pair orientation wrt B-field,

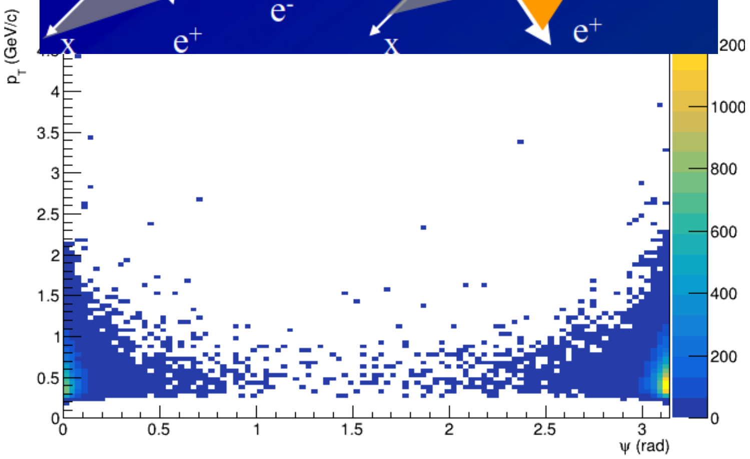
  use

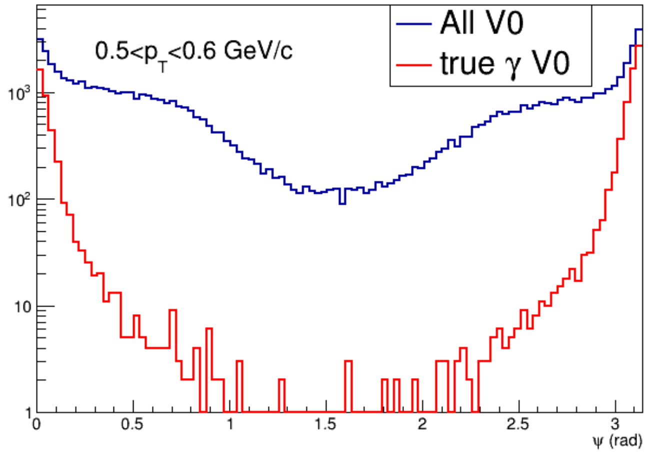
  ψ<cut ||

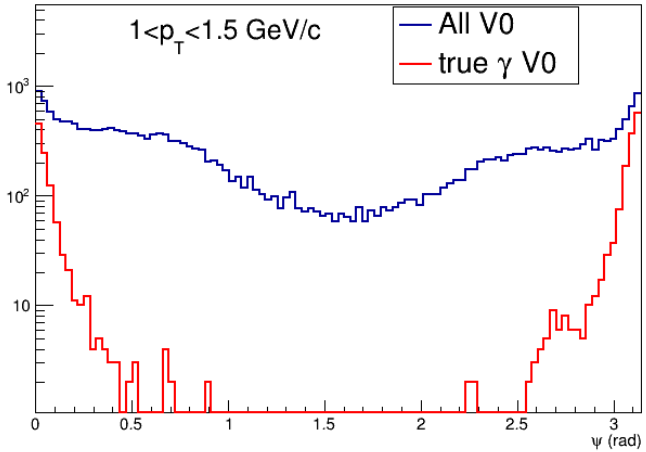
  π-cut <ψ



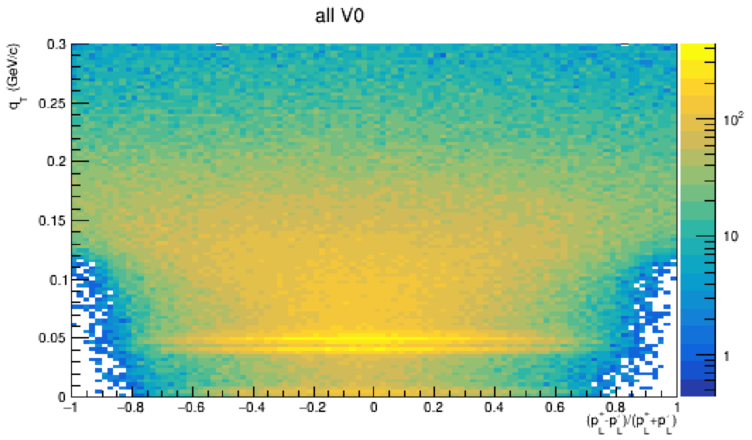


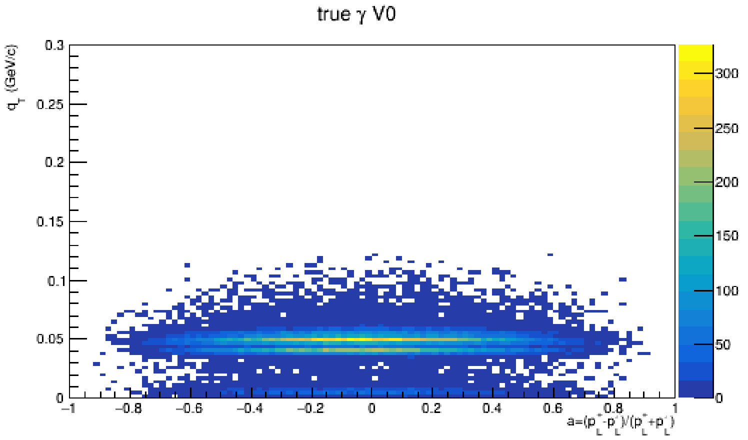


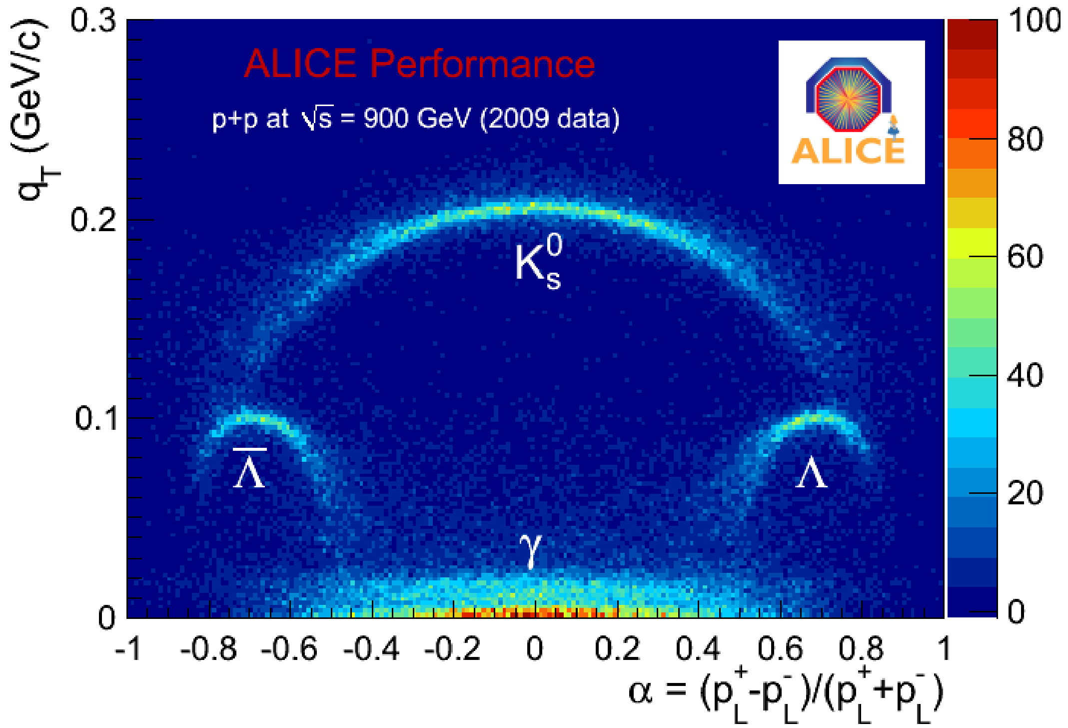




Armenteros-Podolanski plot





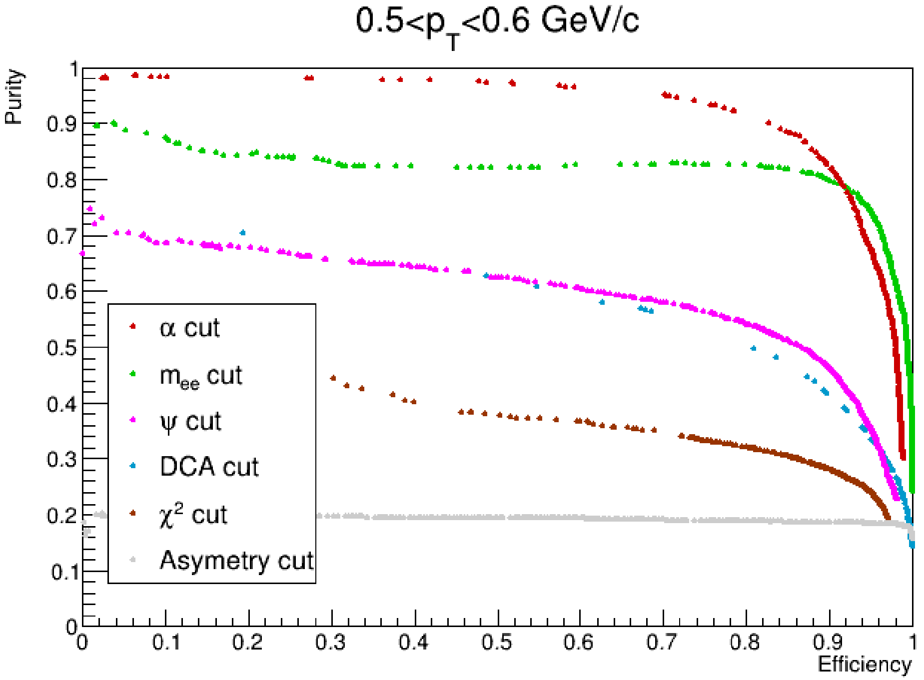


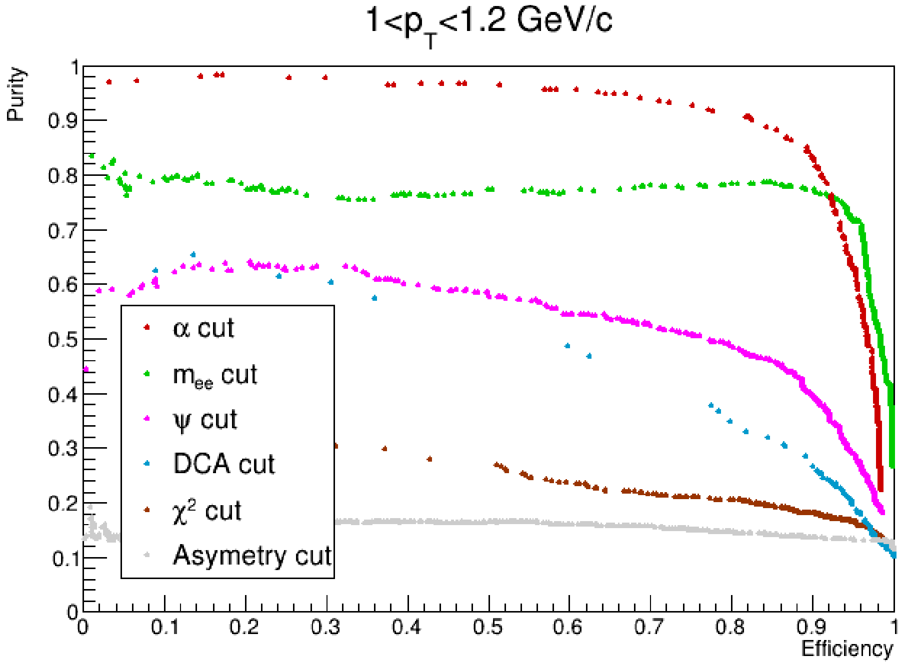
A-P plot looks different from expected. To be clarified with tracking experts

Cut optimization

- 7-8 cuts to be optimized
- Cuts are strongly correlated: optimization of one cut will influence another, e.g. one cut may contradict another and reduce efficiency without improving purity
- Simultaneous optimization
  - For each cut define possible variation range and scale to have $cut_i=f(x)$, $x=0..1$
  - Scan MC data fill tree with V0 parameters
  - Generate random sets $(x_1,...x_n)$ and for each set calculate pair (Efficiency,Purity)

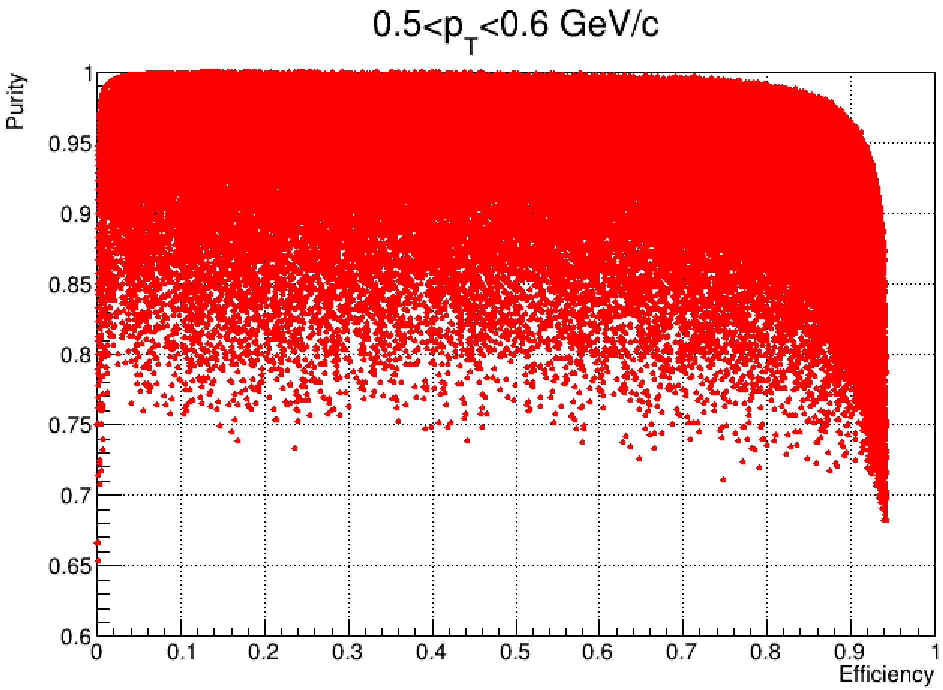
ROC for individual cuts

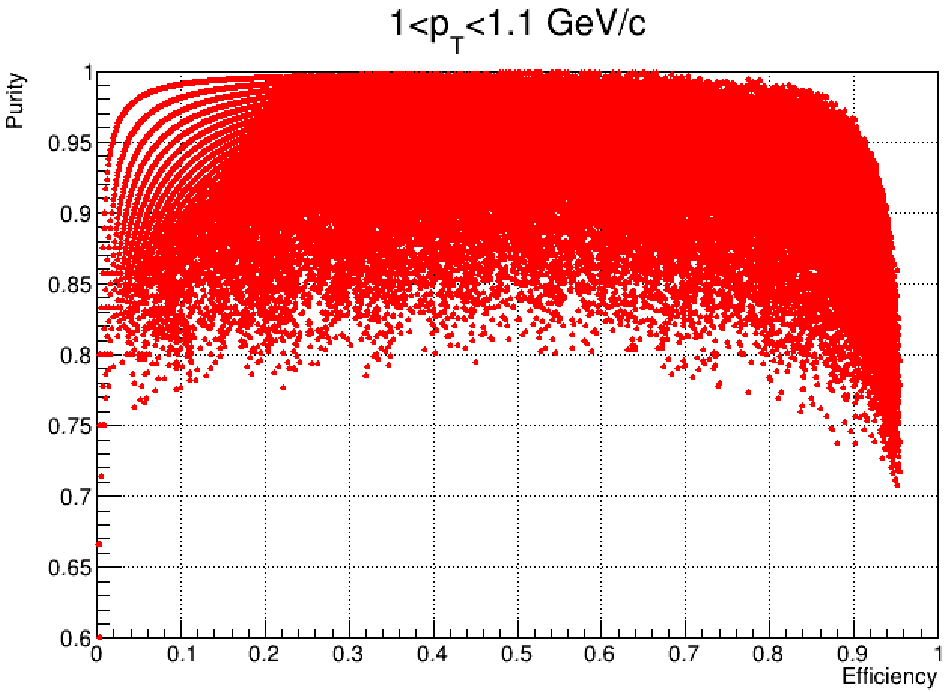




Most effective is a-cut, and cut on m_{ee}. Asymmetry cut has no resolving power

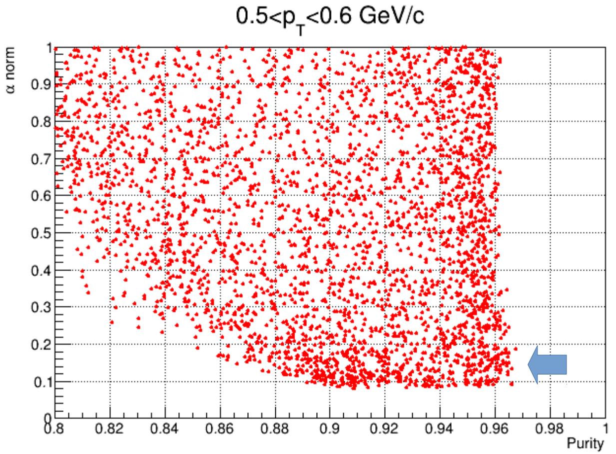
ROC: combined cuts

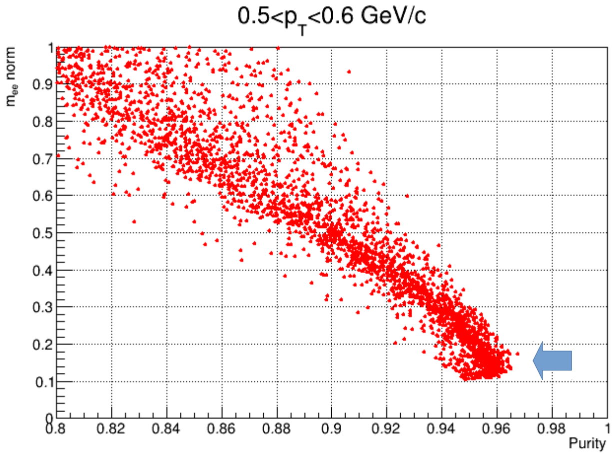


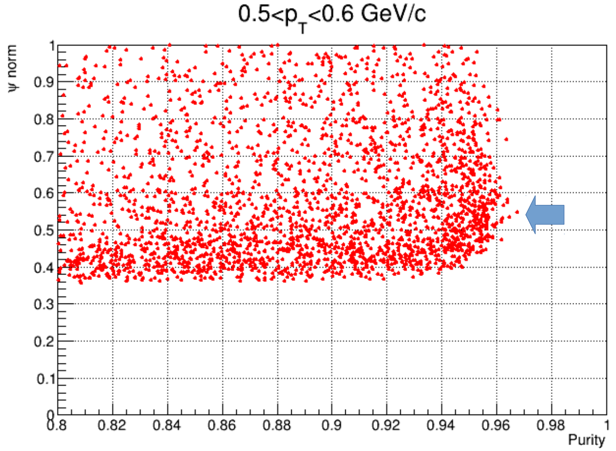


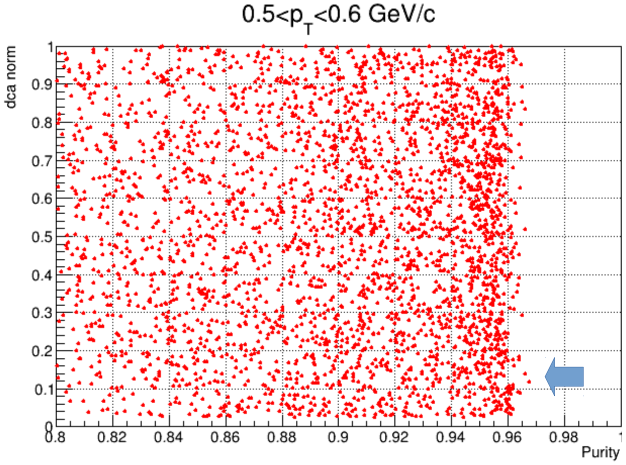
Not optimal combination of cuts can reduce purity for a fixed eff by ~20%.
Find combinations, providing maximal purity for a fixed efficiency

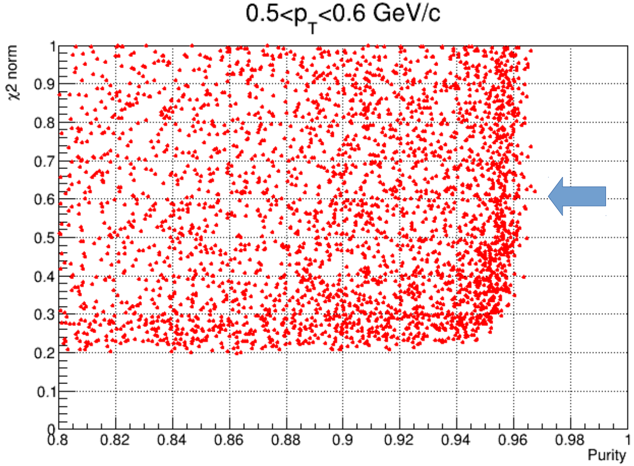
Cut optimization for efficiency=0.9

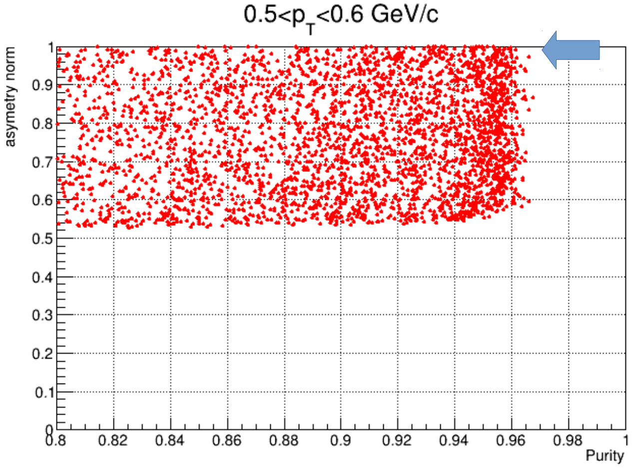








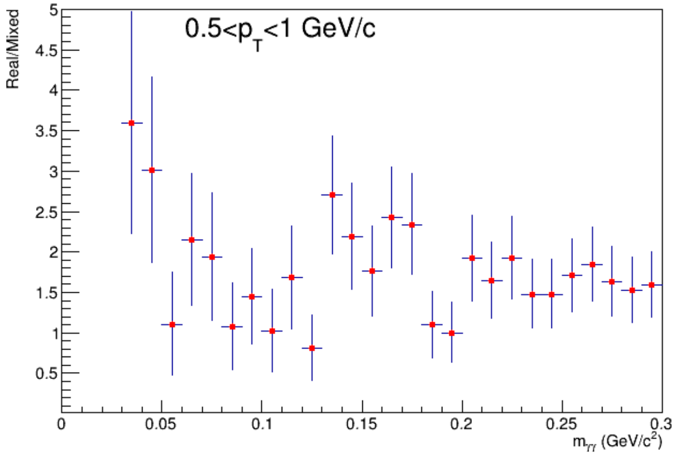




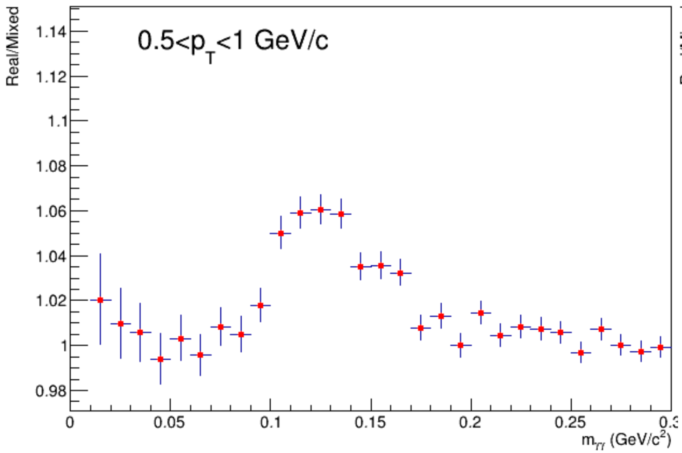
Pion peaks

160 kEvents, BiBi-09.2GeV-mb*

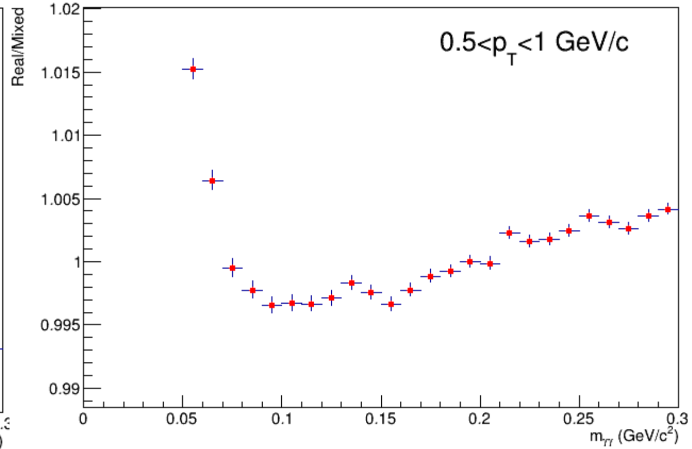
Conv.+conv.



Conv+Calo



Calo+Calo



Conversion + conversion: expected to have the best resolution but tiny efficiency
Conversion + calorimeter: good resolution at small energies & good purity
Calorimeter + calorimeter: high efficiency but large contamination

Code implementation

- Cluster and V0 selection implemented in class
  - MpdConvPi0
- Set of cuts for photon selection in calorimeter and V0 is in the class
  - MpdPhotonAnalysisParams
- To be added to repository
- Scan large data sample and estimate purity and efficiency for single photons and neutral mesons