Performance of anisotropic flow studies at MPD (NICA)

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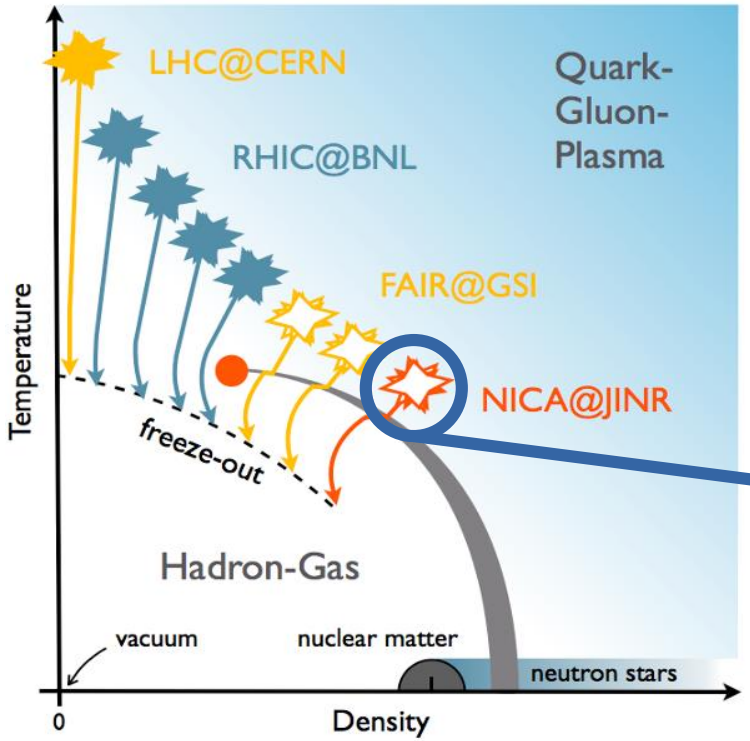
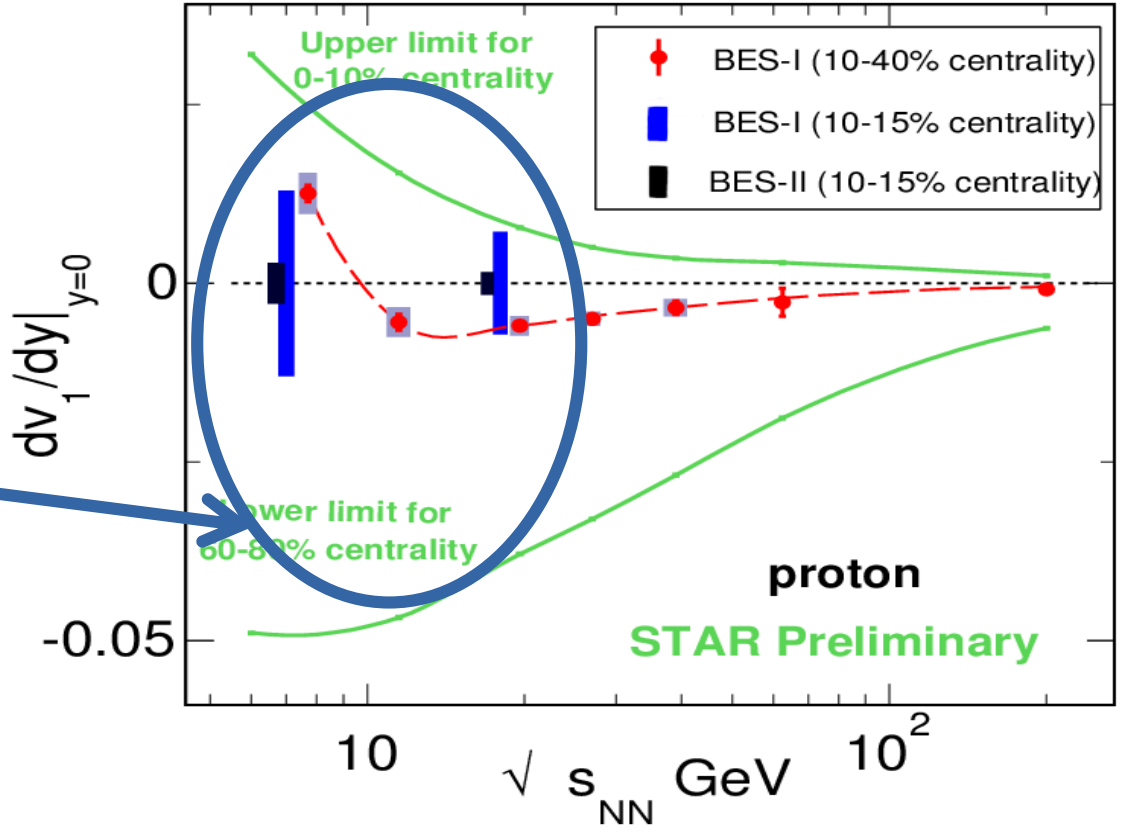
Peter Parfenov, Ilya Selyuzhenkov, Arkadiy Taranenko, Anton Trutse

Round table "Physics at NICA: status & needs", VBLHEP, JINR
15.04.2019

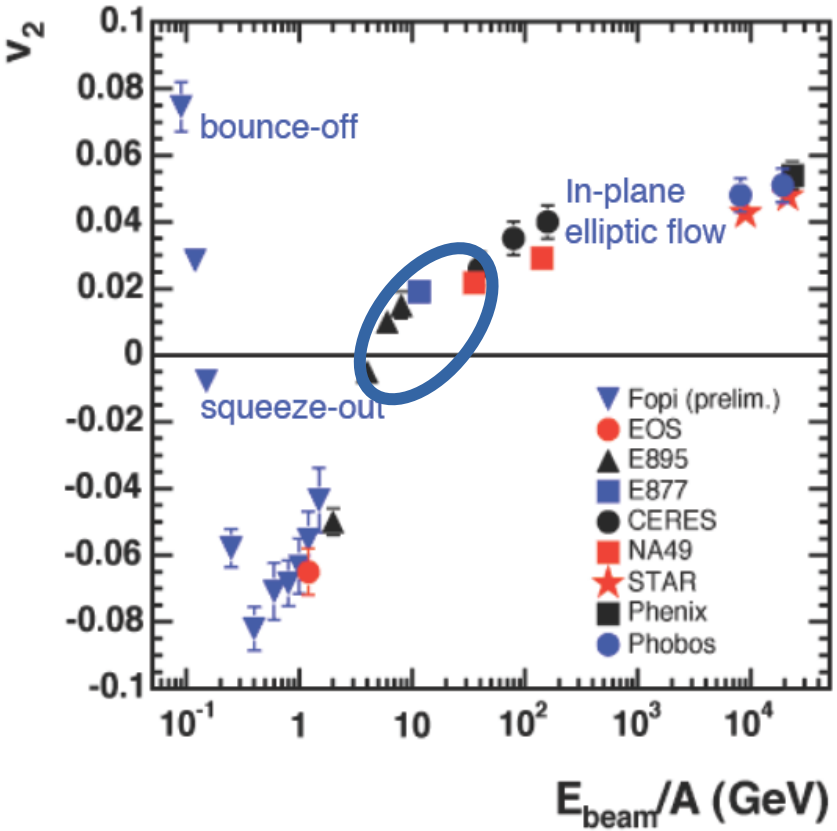
Directed flow at NICA energies

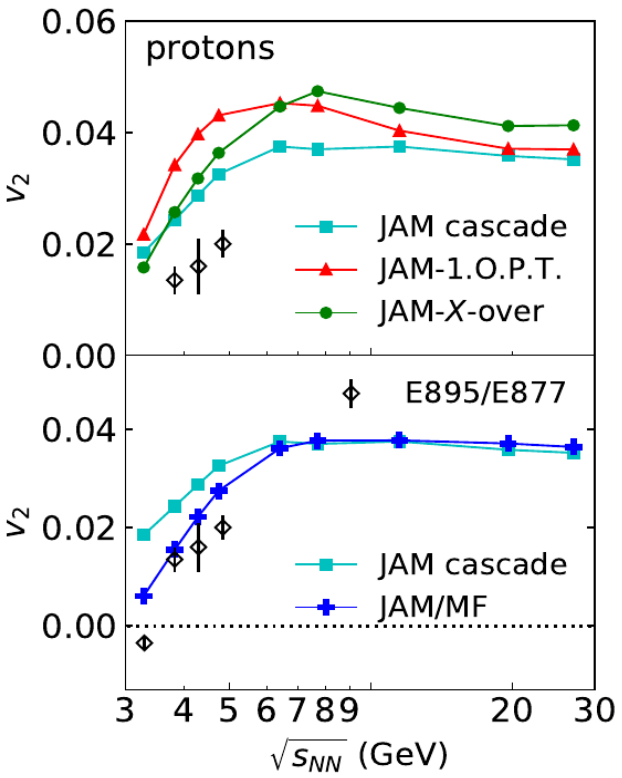




Non-monotonic dv_1/dy behavior can signal the phase transition

Elliptic flow at NICA energies

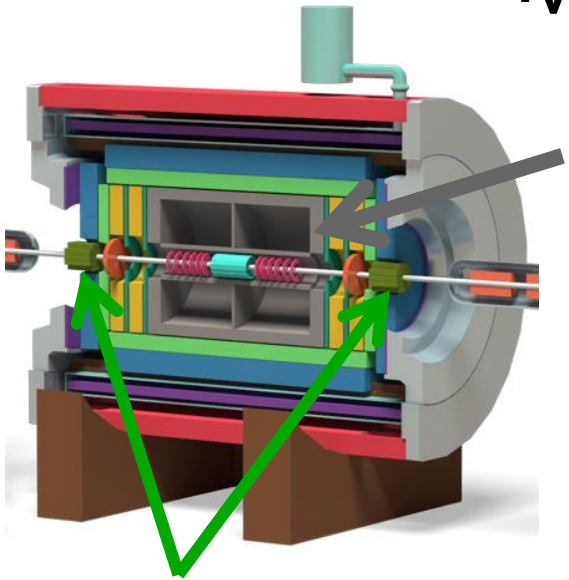




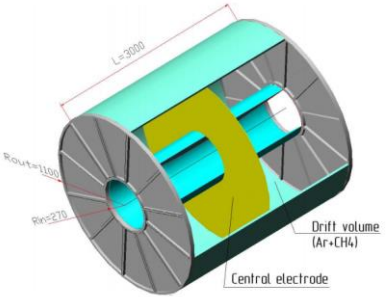
Nara, Yasushi et al. Eur.Phys.J. A54 (2018)

At Nuclotron-NICA energy range elliptic flow as a function of energy changes sign
Both directed and elliptic flow can signal a first order phase transition

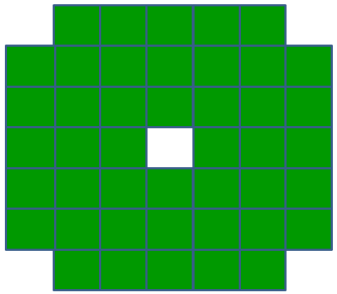
MPD experiment at NICA



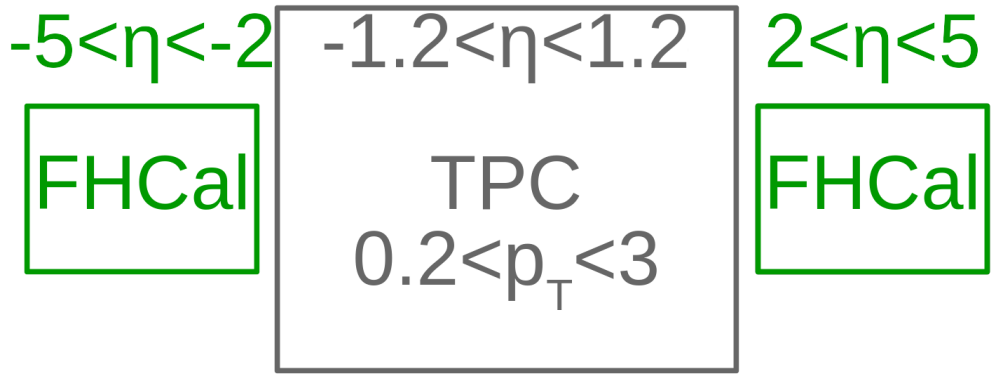
Time projection chamber (TPC)



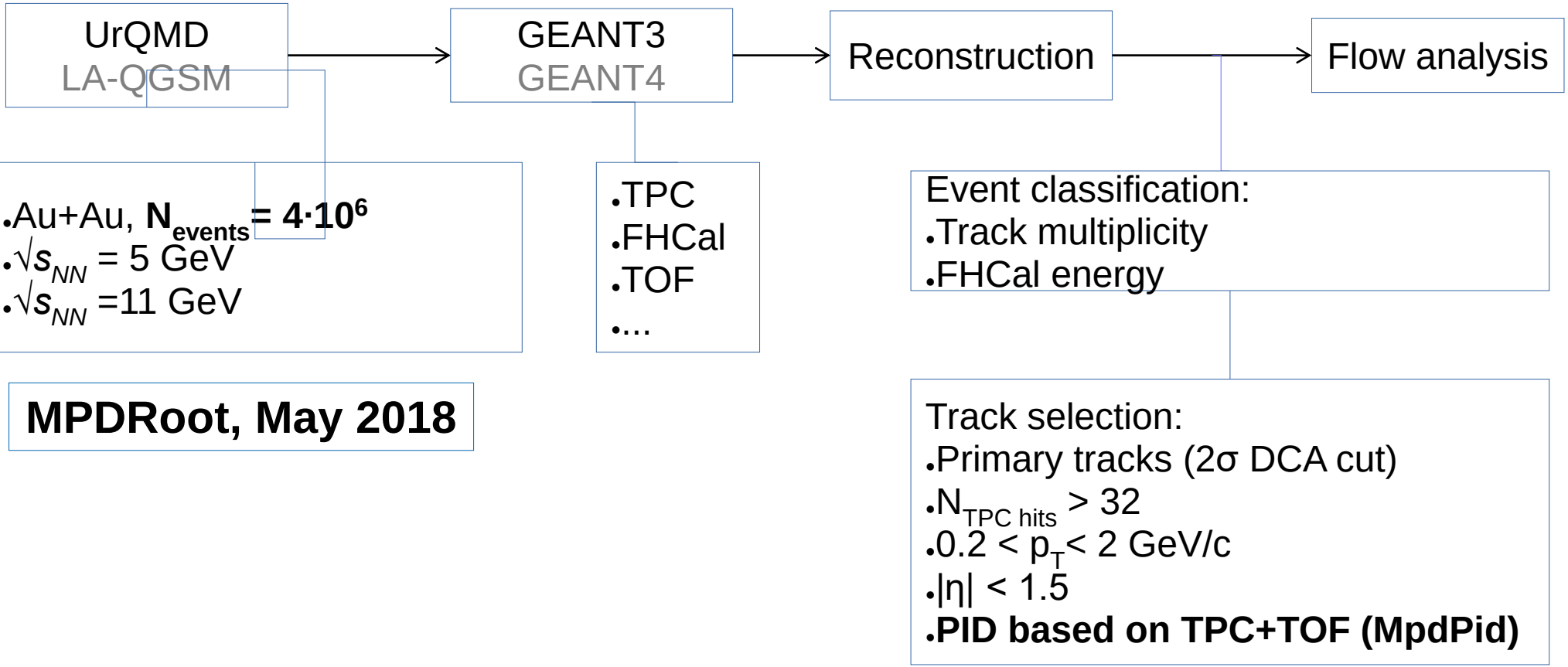
Forward Hadron Calorimeter (FHCal)



- **TPC** (l = 340 cm, r_{in} = 54 cm):
- Charged particles at midrapidity
- **FHCal** (44 15×15 cm modules):
- Hadrons at forward rapidity



Setup, event and track selection



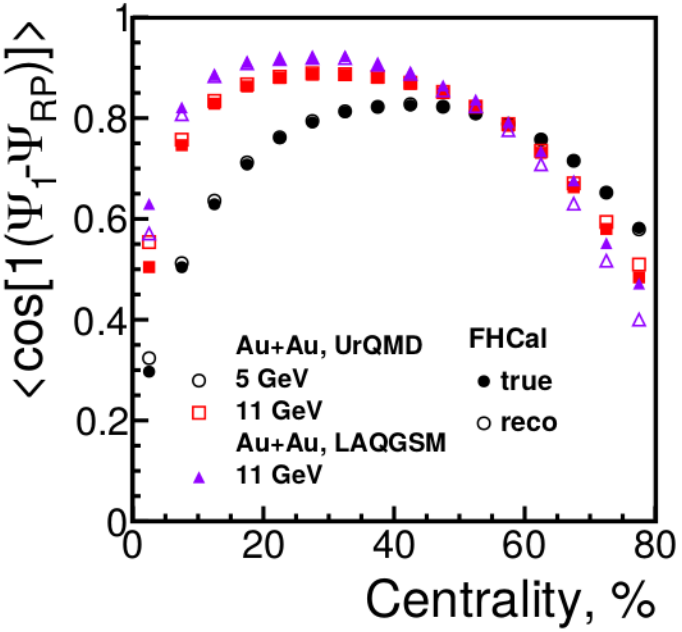
http://mpd.jinr.ru/wp-content/uploads/2018/05/MPD_TDR_FHCal_28_05_2018.pdf

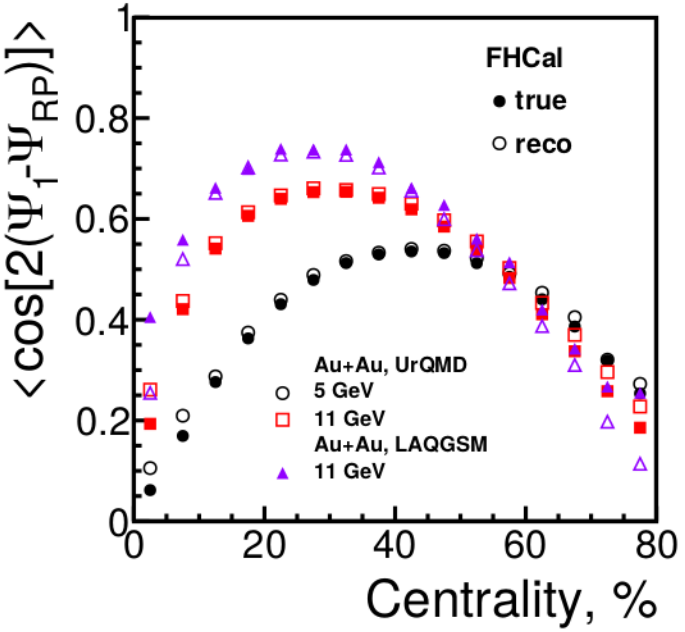
Resolution correction factor

$$v_n = \frac{\left\langle \cos\left(n(\varphi - \Psi_{n,EP})\right)\right\rangle}{R_{n,EP}}$$

$$R_{n,EP} = \left\langle \cos\left(n(\Psi_{n,EP} - \Psi_{RP})\right)\right\rangle$$

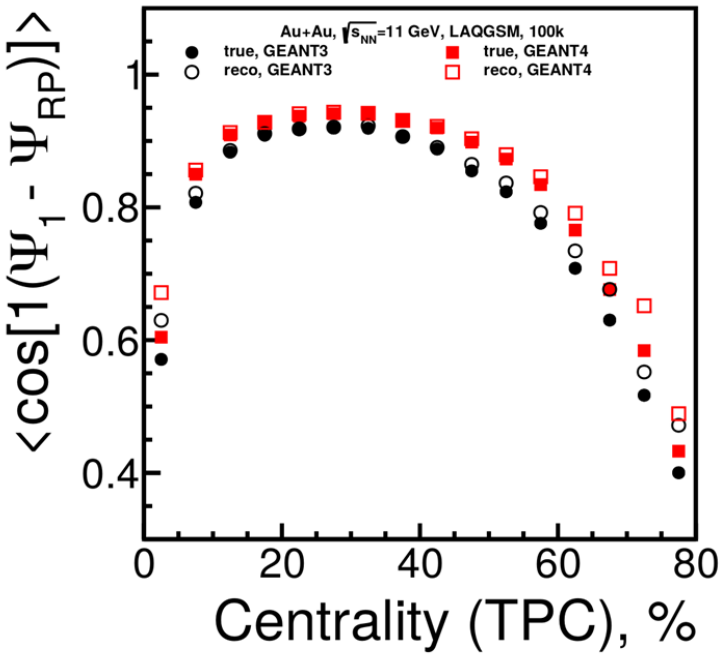
$R_{n,EP}$ – Resolutioncorrectionfactor

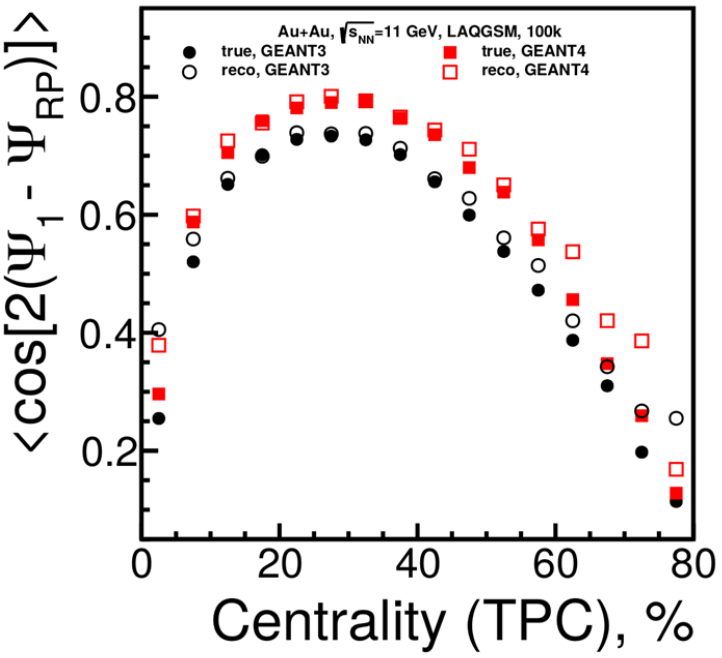




Good performance in the centrality range 0-80% for NICA collision energy range

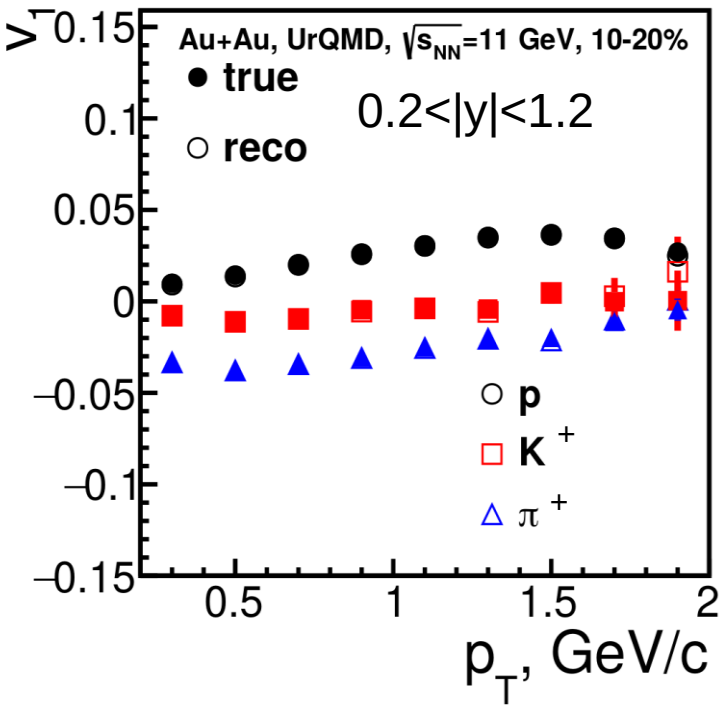
Resolution correction factor: GEANT3 vs GEANT4 comparison

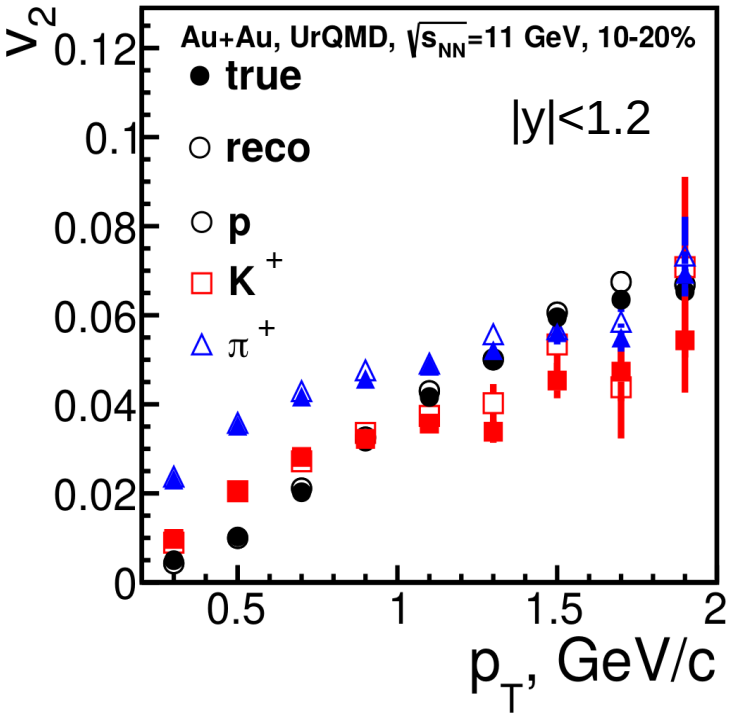




GEANT4 has more realistic hadronic shower simulation

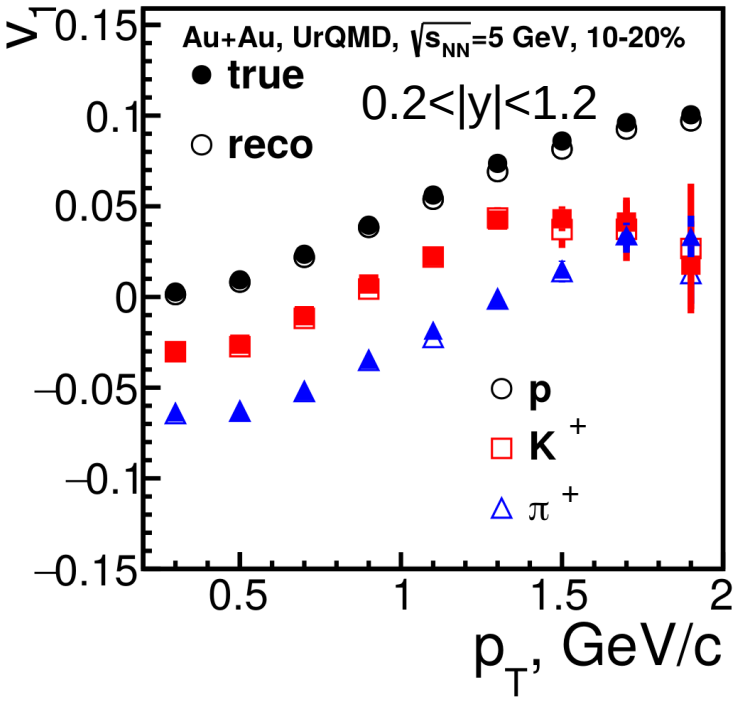
p_T dependence of directed and elliptic flow
Au+Au, $\sqrt{s_{NN}}$ = 11 GeV

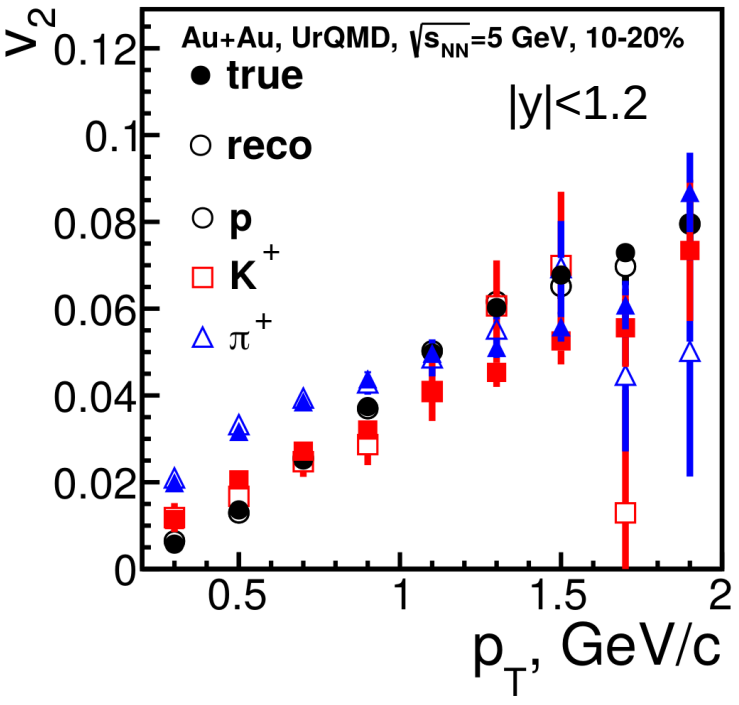




Both directed and elliptic flow results after reconstruction and resolution correction are consistent to that of MC simulation

p_T dependence of directed and elliptic flow
Au+Au, $\sqrt{s_{NN}}$ = 5 GeV





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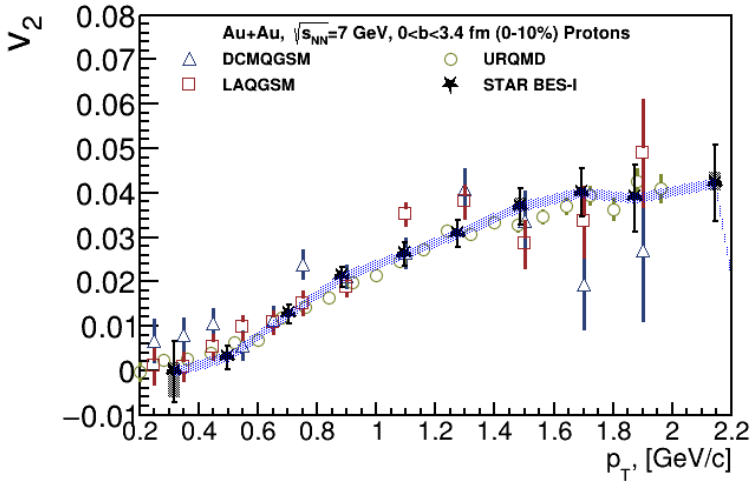
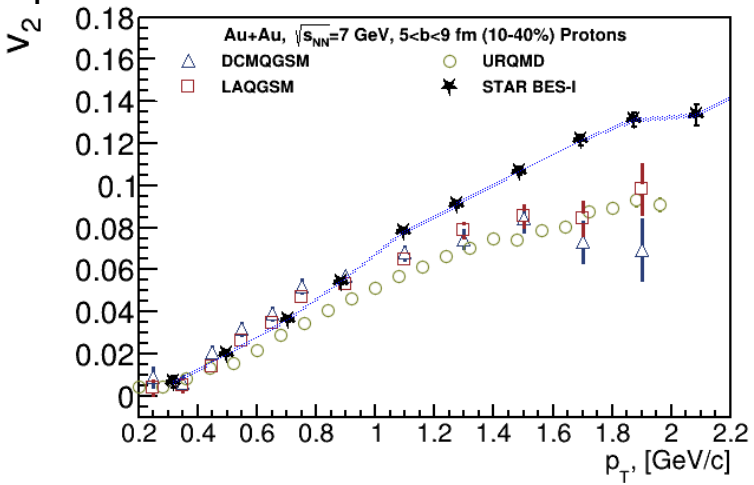
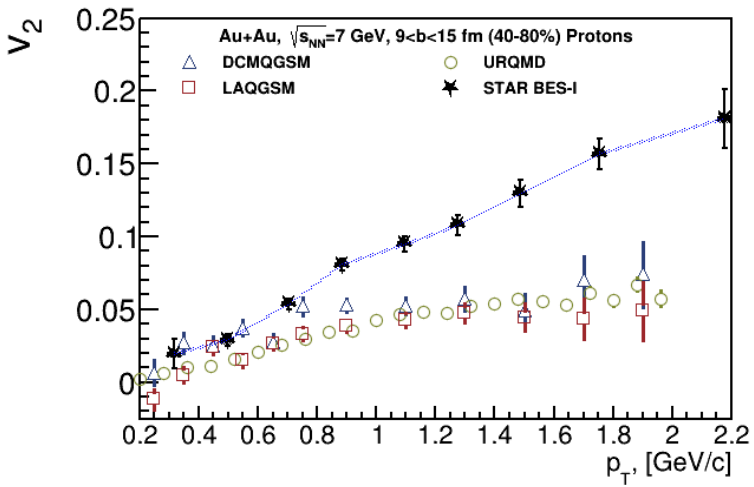
Elliptic flow $v_2(p_T)$ for protons



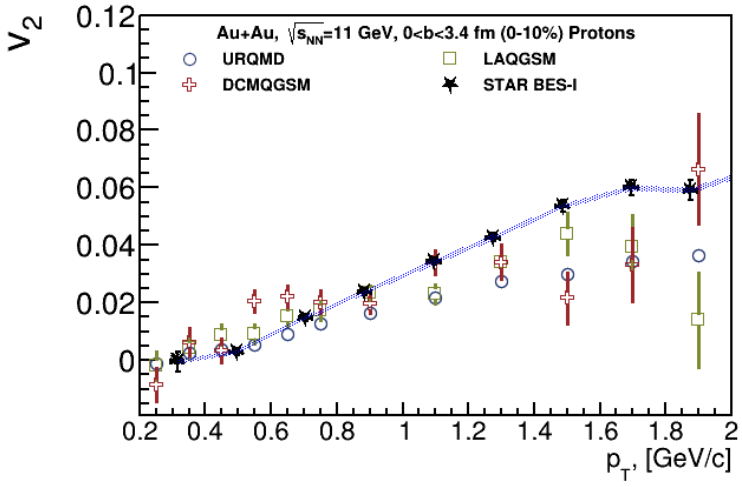


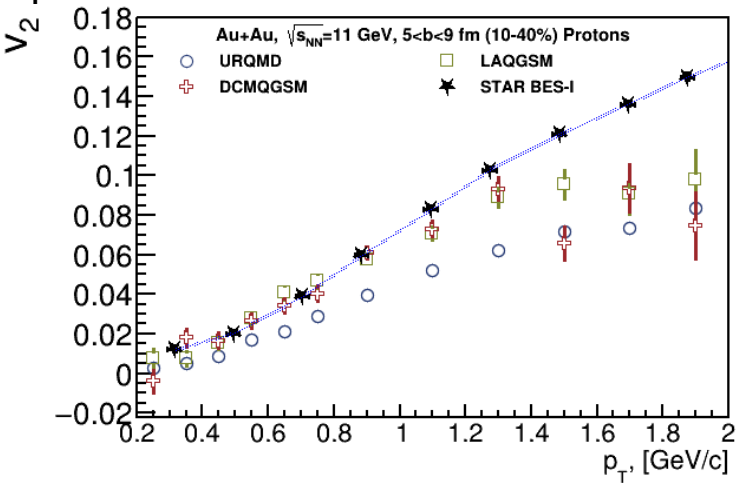


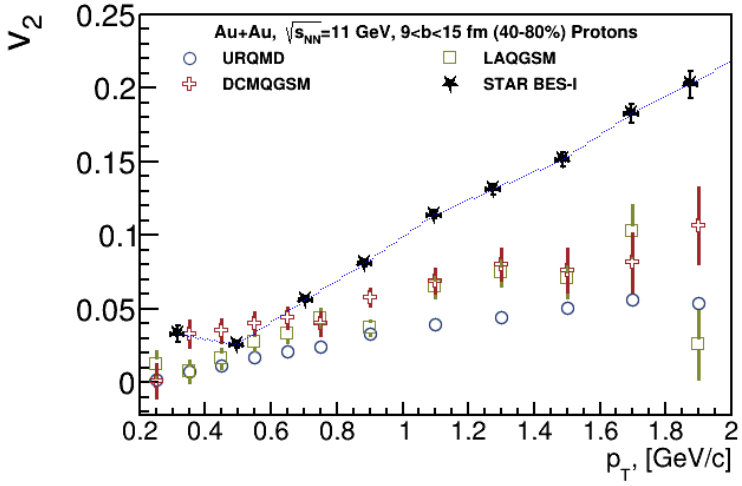
Experimental data: [STAR BES-I]

- statistical error
- systematic error
- global error

Elliptic flow $v_2(p_T)$ for protons







Experimental data: STAR BES-I

- statistical error
- systematic error
- global error

Summary

- **Anisotropic flow performance:**
- Full reconstruction chain was implemented:
  - Combined particle identification based on TPC and TOF
  - Full tracking: latest version of cluster finder
  - Realistic hadronic simulation (GEANT4)
- Reconstructed v_1,v_2 are in agreement with MC simulated values

http://mpd.jinr.ru/wp-content/uploads/2018/05/MPD_TDR_FHCal_28_05_2018.pdf

https://git.jinr.ru/nica/mpdroot/tree/dev/macro/physical_analysis/Flow

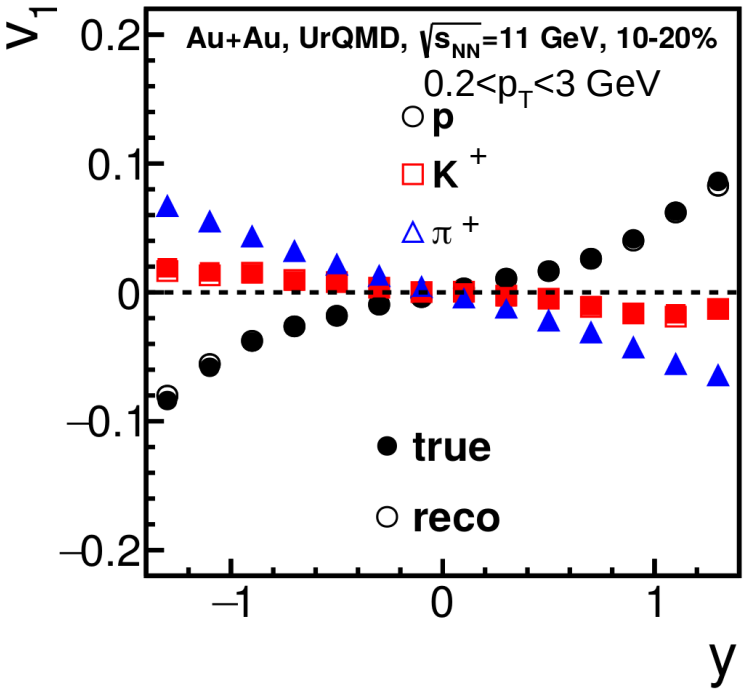
Plans for 2019

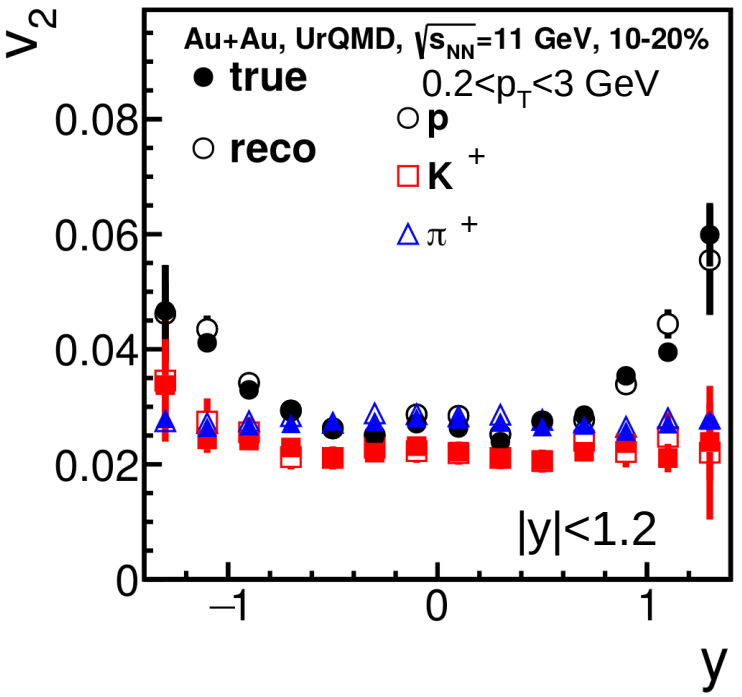
- **Anisotropic flow performance:**
- Unified data format for all HI generators (UrQMD,PHSD,SMASH,HydroModels
- Detailed comparison of model calculations and HI results (E895,STAR,NA61)
- Unified data format for picoDST for reconstructed data
- Detailed systematic studies for anisotropic flow of identified charged hadrons (different methods for centrality determination, event planes using different detector systems, different methods of flow measurements (EP, SP, cumulants)

Thank you for your attention!

Backup

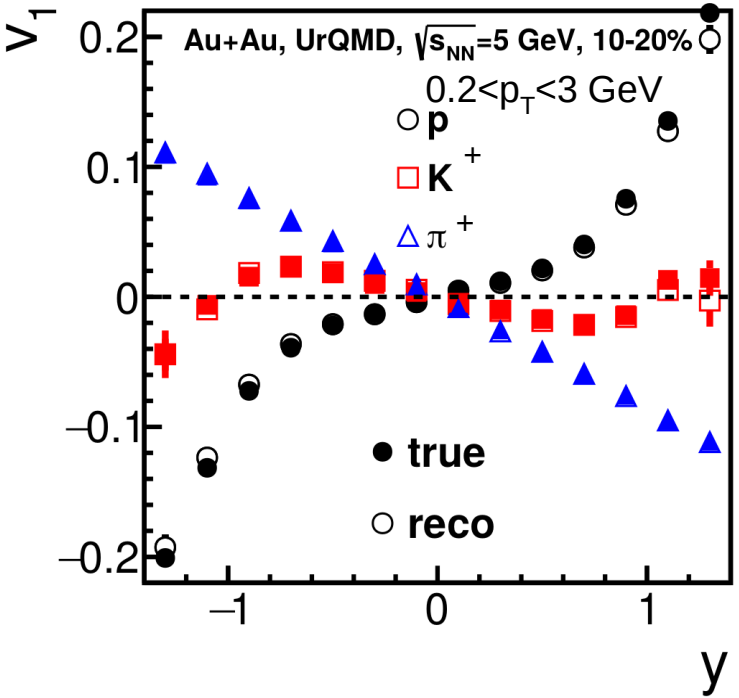
y dependence of directed and elliptic flow Au+Au, $\sqrt{s_{NN}}$ = 11 GeV

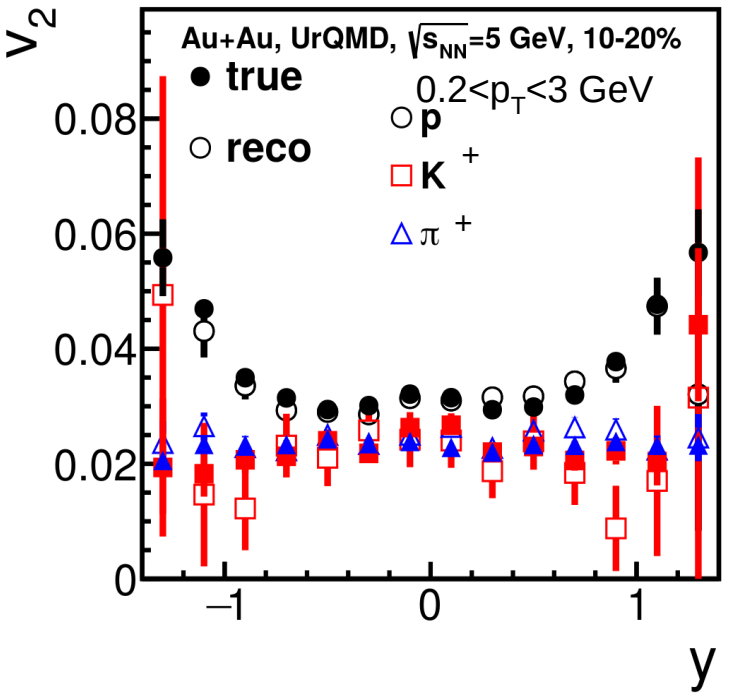




Both directed and elliptic flow results after reconstruction and resolution correction are consistent to that of MC simulation

y dependence of directed and elliptic flow Au+Au, $\sqrt{s_{NN}}$ = 5 GeV

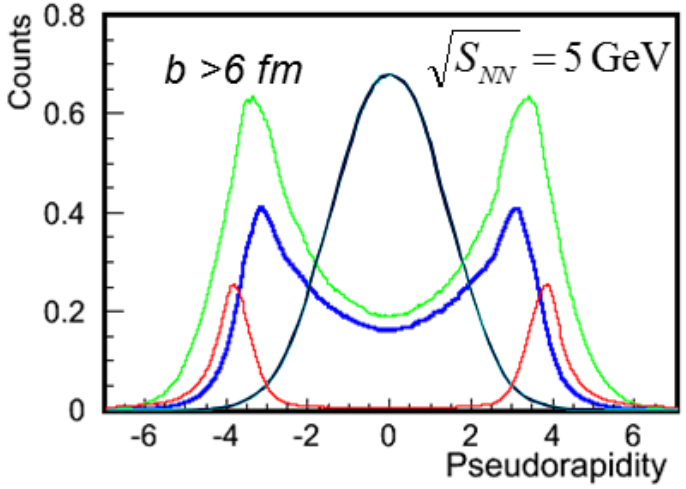


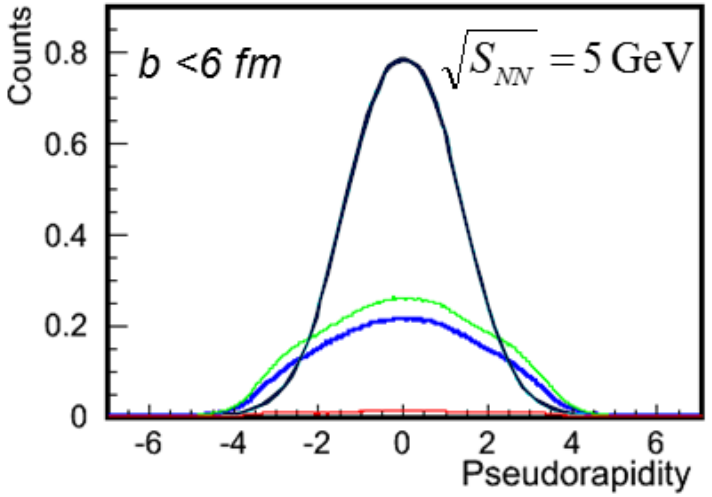


Both directed and elliptic flow results after reconstruction and resolution correction are consistent to that of MC simulation

Results for 40-50% centrality range are stored in the backup slides

FHCal and TPC acceptance





Pions

Neutrons

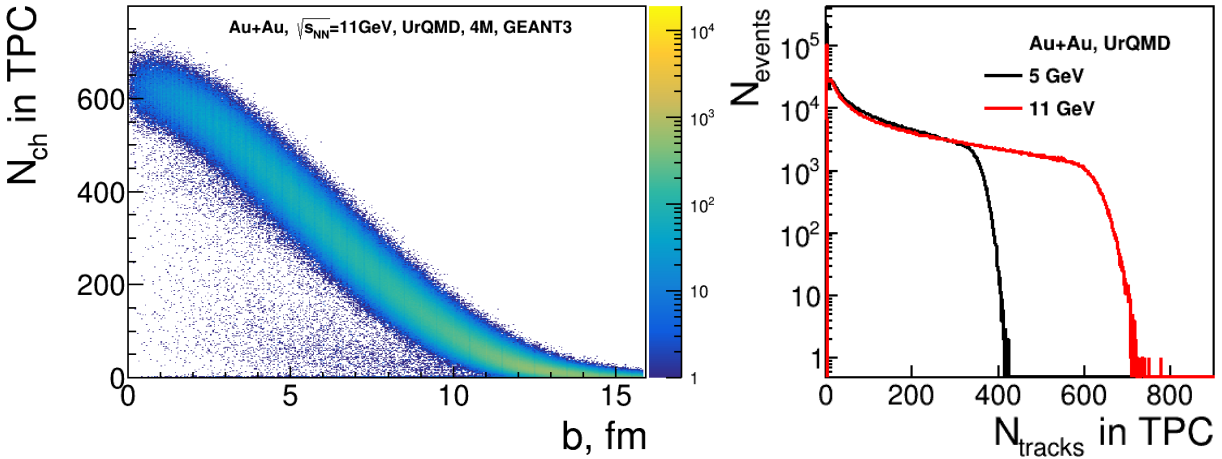
Protons

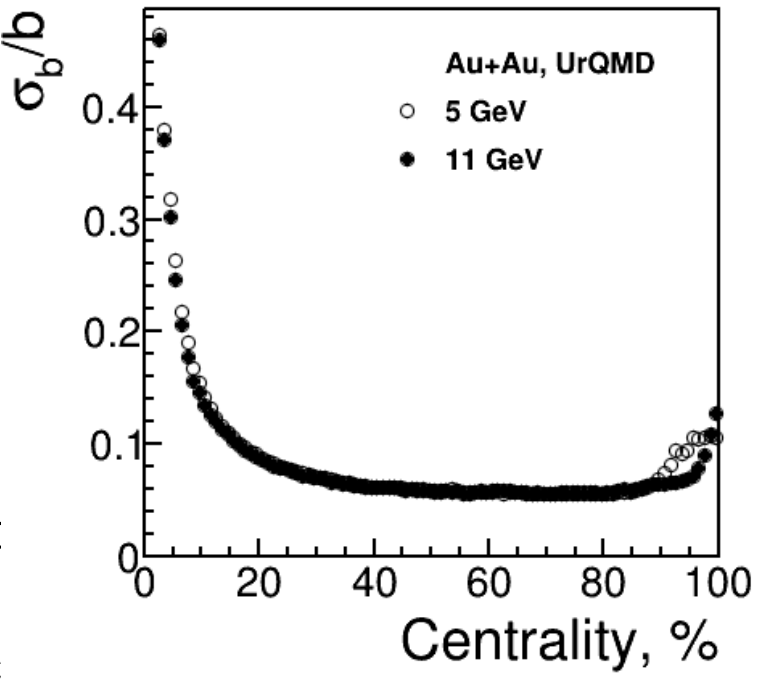
Fragments

- **TPC** - charged particles at midrapidity (participants)
- **FHCal** - hadrons at forward rapidity (spectators + participants)

-5<η<-2	-1.2<η<1.2	2<η<5
FHCal	TPC 0.2<p_T<2 GeV/c	FHCal

Centrality estimation using multiplicity distribution in TPC

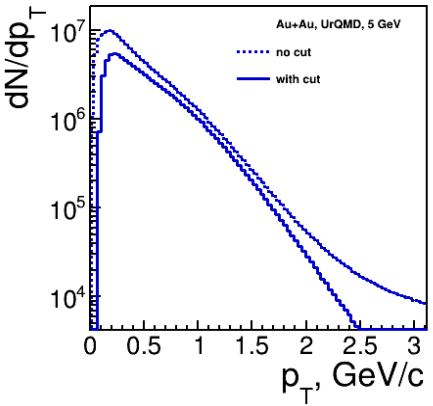


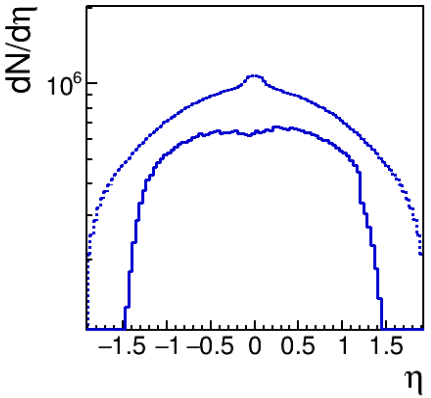


- Good correlation between *b* and TPC Multiplicity
- Events were grouped in centrality classes based on multip

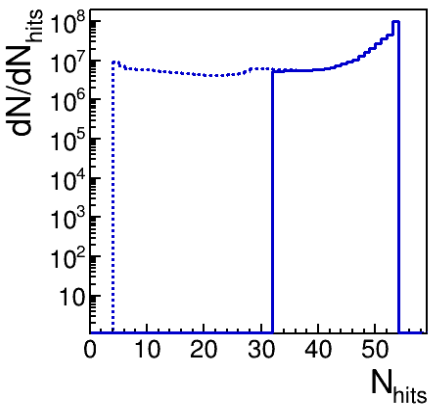
Impact parameter resolution is 5-10% for ~10-80% c

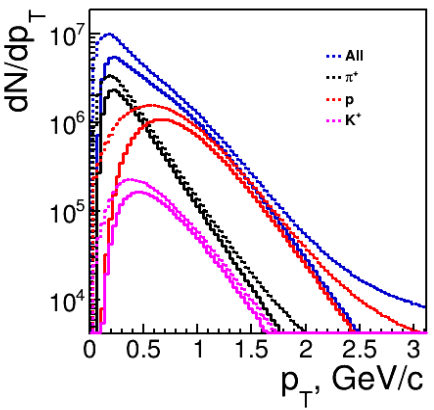
Track selection

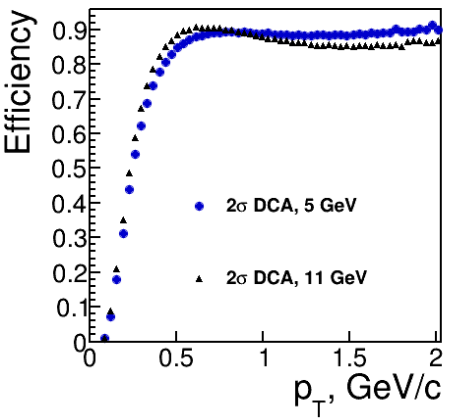




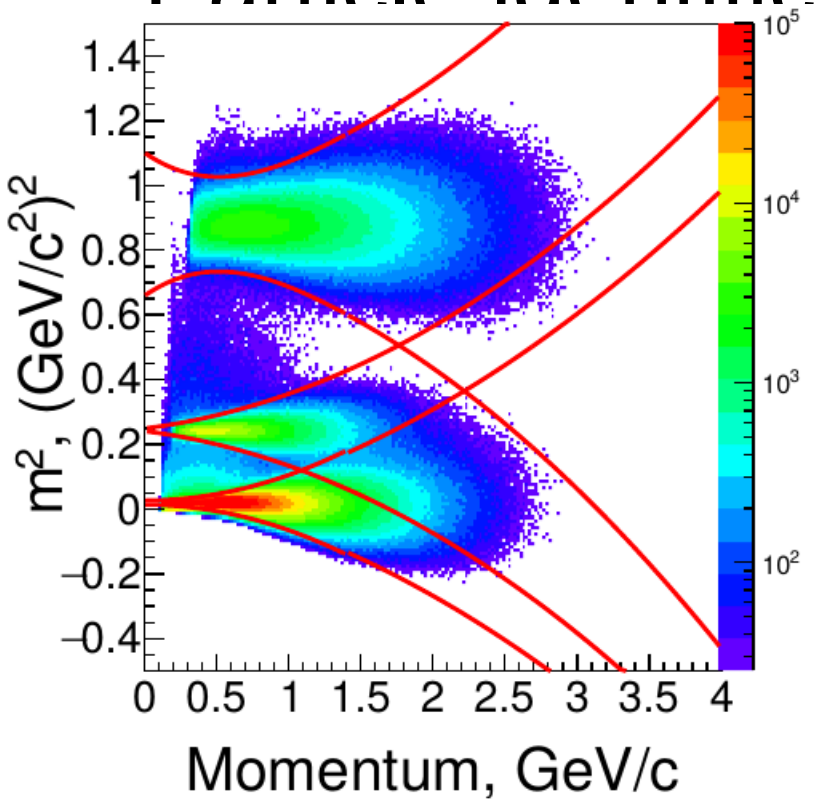
- $N_{TPC\ hits}$ >32
- $|p_T|$<3
- |η|<1.5
- PID based on TPC+TOF (MpdPid)

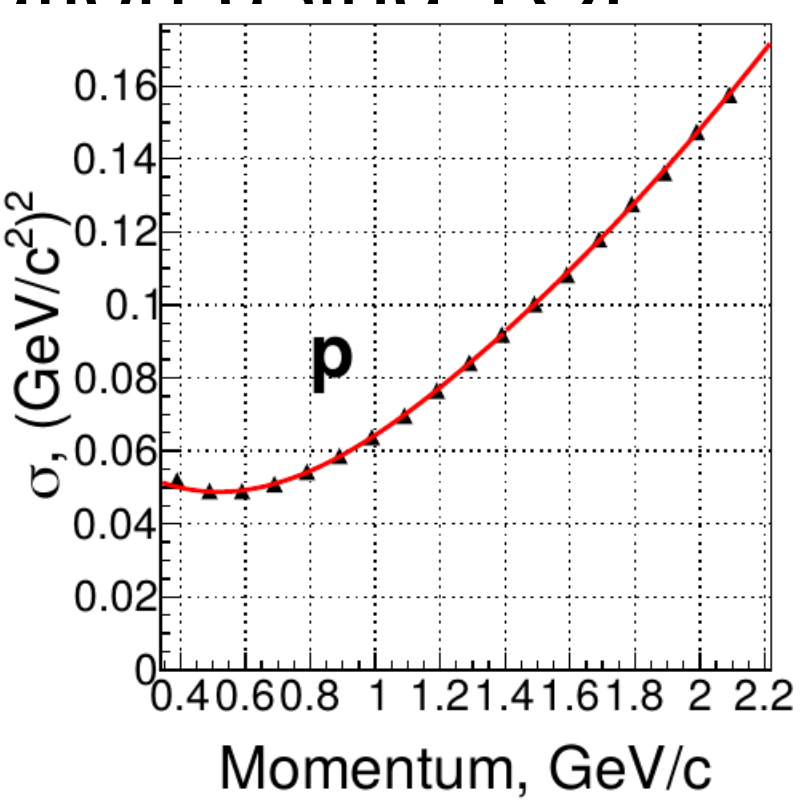






Particle identification using TOF





TOF identification significantly improves PID results in the high momenta region (p>1 GeV/c).

It is based on the separation by the m^2 values.

Red lines on this figure show 3σ bands for pions, kaons and protons.