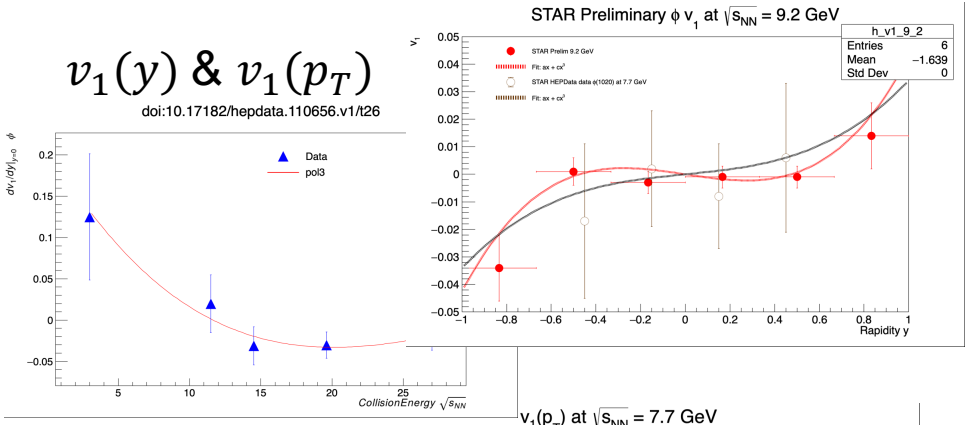
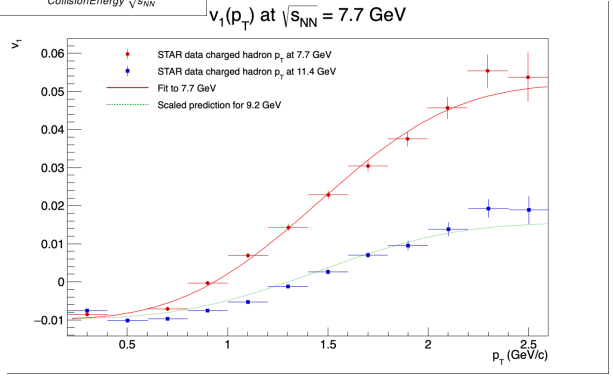
Measurement of ϕ(1020) elliptic flow in MPD with enhanced production

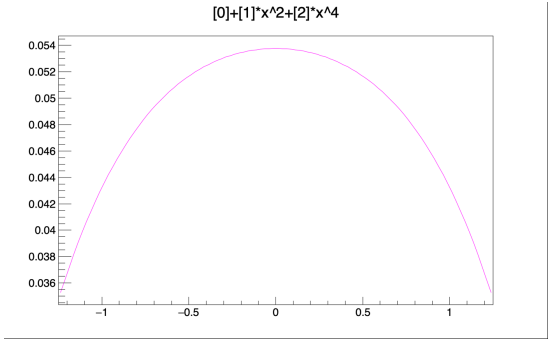
ϕ-meson v_1 and v_2 parameterization

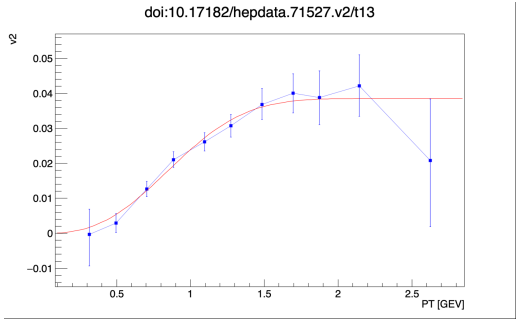
$v_1(y)$ & $v_1(p_T)$





$v_2(\eta)$ and $v_2(p_T)$ parametrized by data [3][4]





[3] arXiv:1206.5528 (Fig.8)
[4] arXiv:1509.08397v2

Dataset

- UrQMD Bi+Bi at $\sqrt{s_{NN}}$ = 9.2 GeV ~250k event
- Centrality determination: **evCentrality** wagon
- Particle identification: **evPID** wagon
- Event plane measurements: **evPlane** wagon
- ϕ meson flow measurements: **flowEpPairKK**

- 50 additional ϕ-meson within an event
- Reparametrized ϕ-meson kinematics
- For reconstruction **UniGen** generator was used
- Collider mode

Previous measurement at the prod. 25

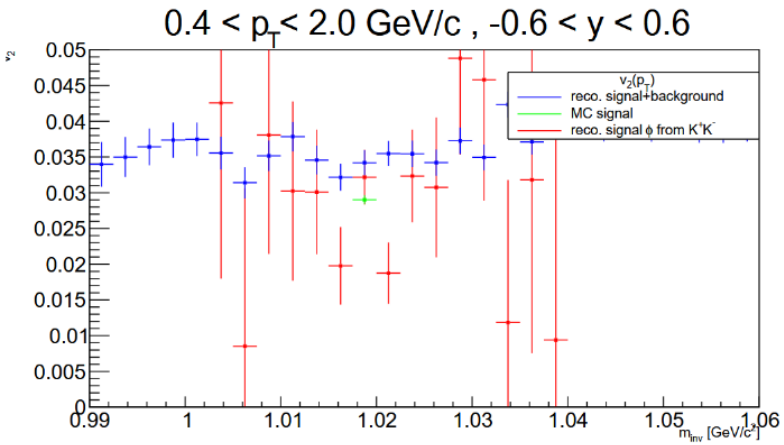
Used cuts:

Event selection: vertex z coordinate < *130*

Track selection:

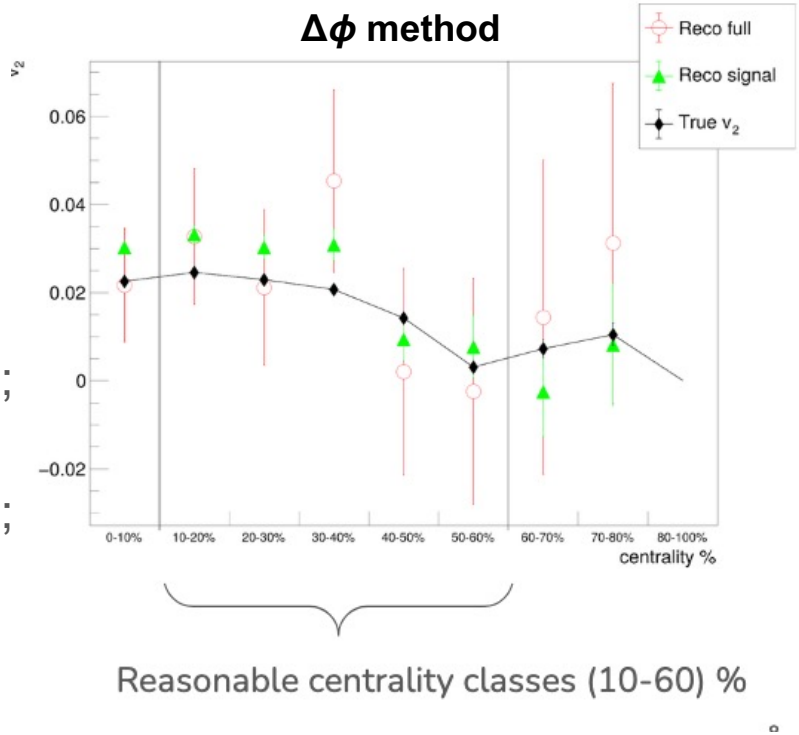
- Kaons identification within 2σ
- $N_{hits} > 24$
- $p_T > 0.1$ GeV/c
- |DCA| < 2σ
- Kaon pair $|y_{K^+K^-}| < -0.6$

Signal v_2 and background v_2 are similar – *can not distinguish between them very well*.



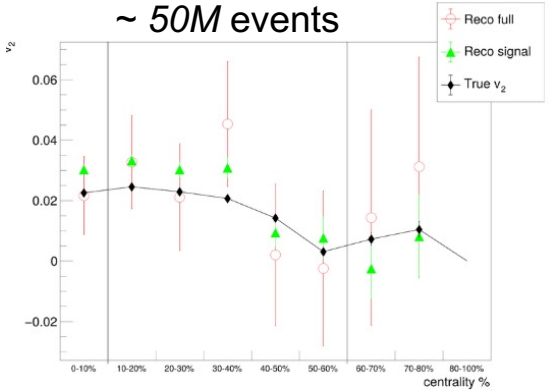
Previous measurement at the prod. 25

- (Reco full) reconstructed data (with background subtraction);
- (Reco signal)
  Δϕ method for reconstructed data:
  pdg = 321(K+) and -321(K-)
  mother particle pdg = 333 (phi meson);
- **(True)** Monte Carlo data;
  mother particle pdg = 333 (phi meson);

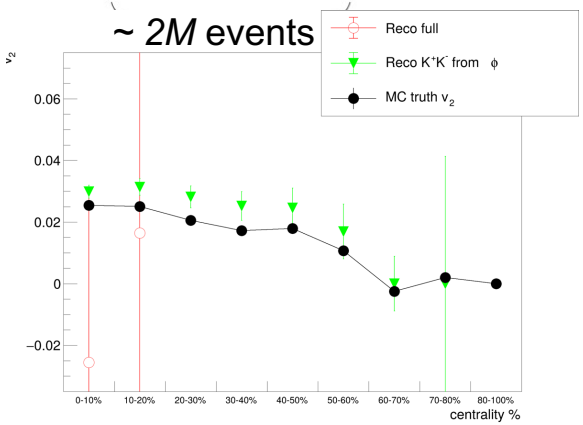


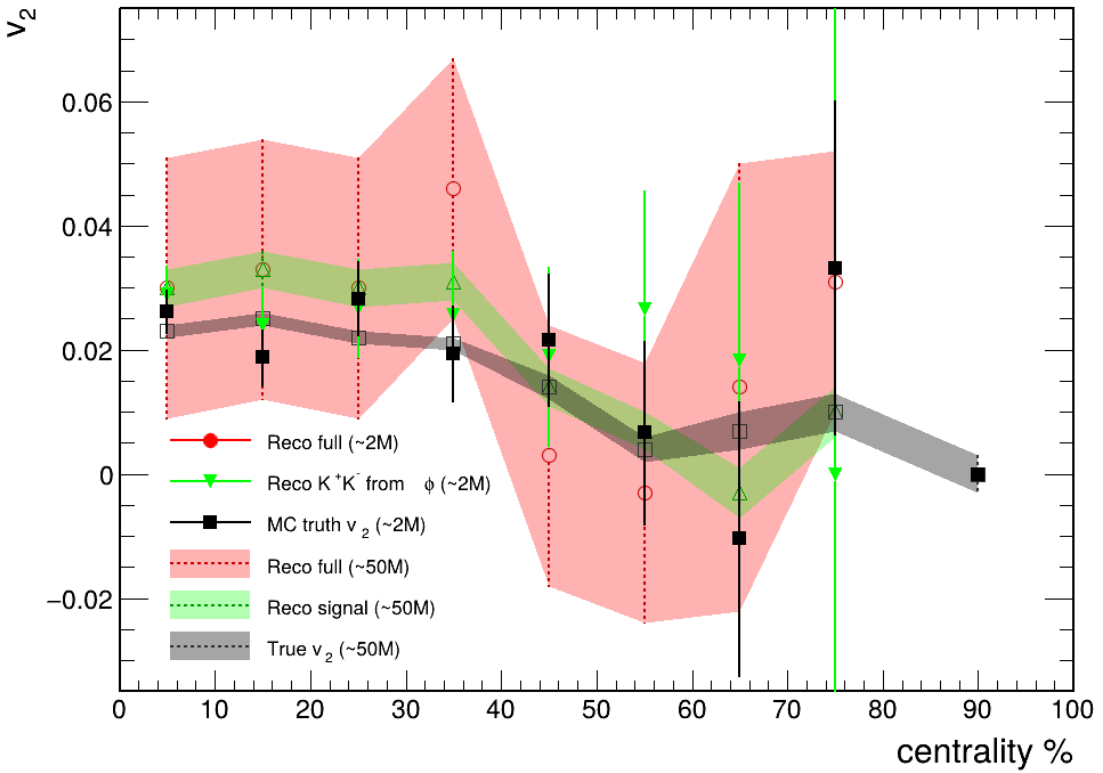
Previous measurement at the prod. 25

~ *50M* events



~ *2M* events





PID cuts

Event selection:

- cut on vertex z coordinate: *130*

PID cuts:

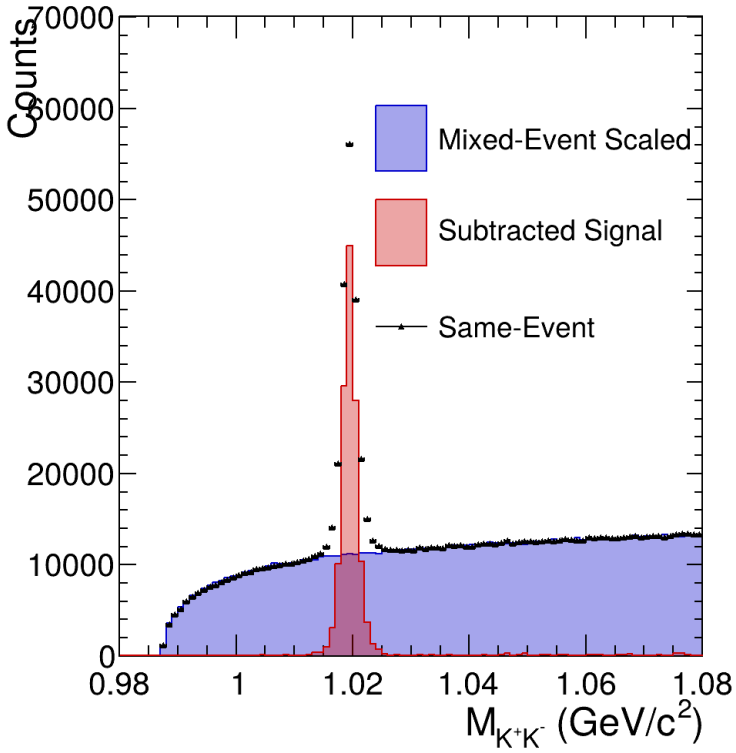
- dE/dx PID parameters: *2*
- Beta PID parameters: *2*

Track cuts:

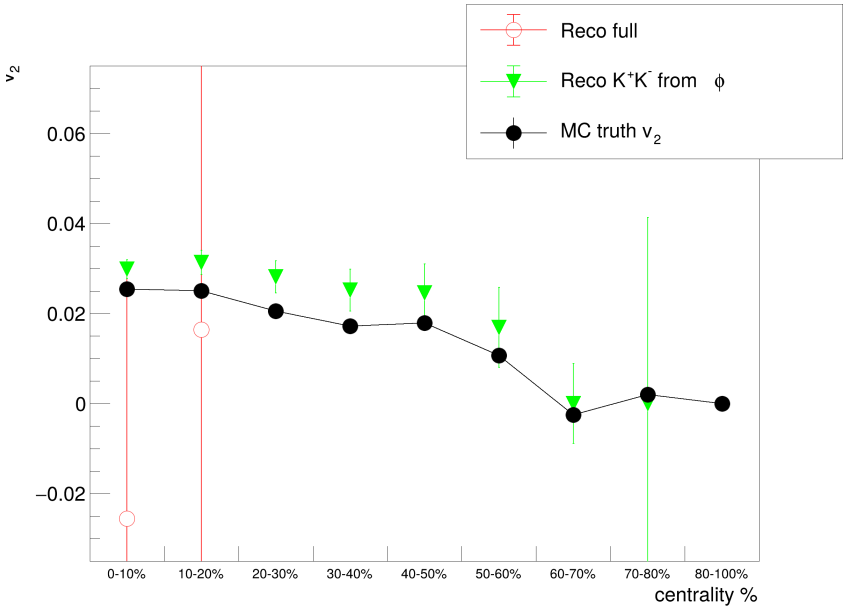
- minimal number for a track: *24*
- maximal pseudorapidity for a track: *1*
- minimal pt for a track: *0.1*
- maximum DCA for a track: *2*

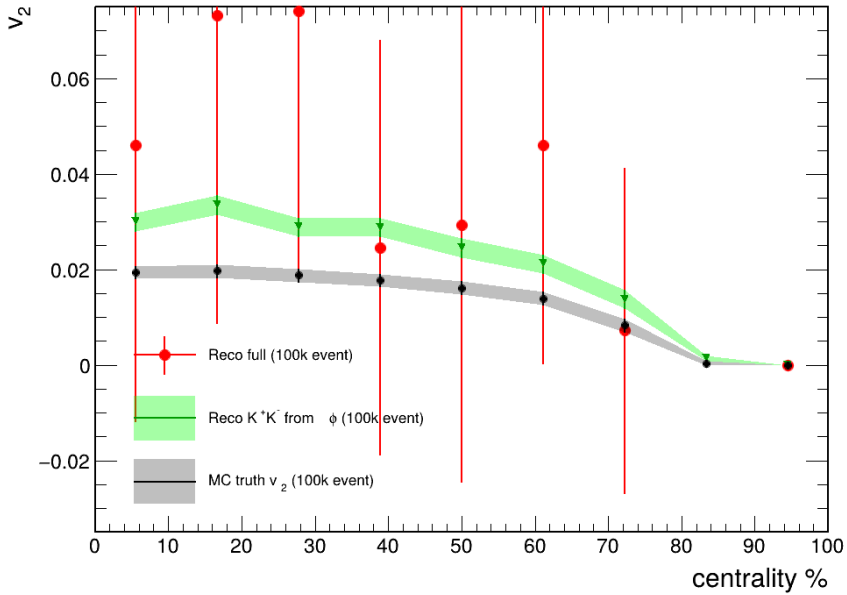
Pair cuts:

- pair cut: *1*



Centrality in enhanced and 25 prod.



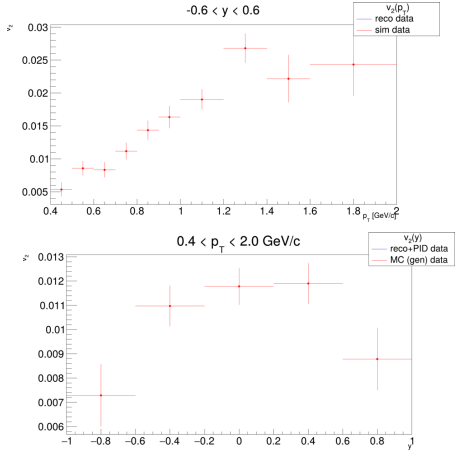


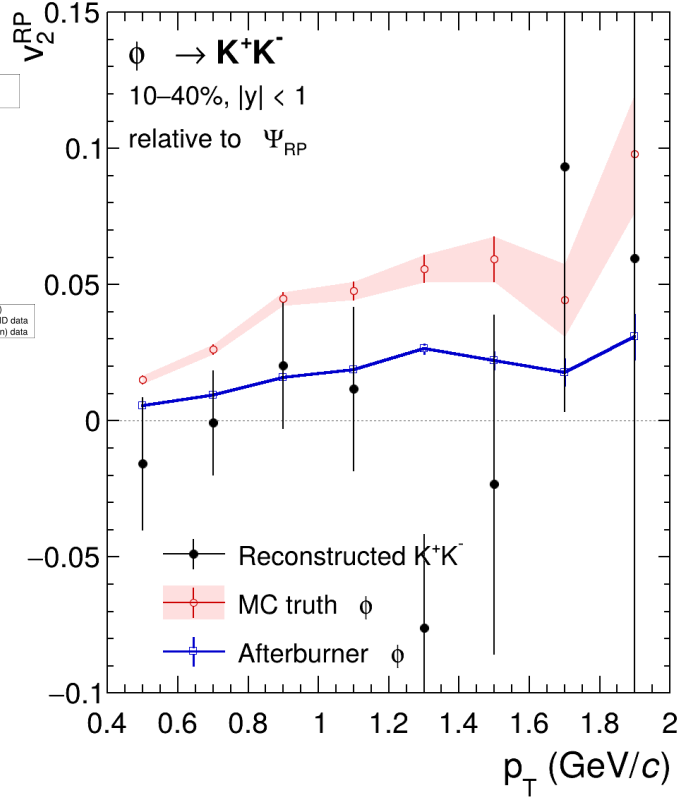
Prod. 25
~ 2M events

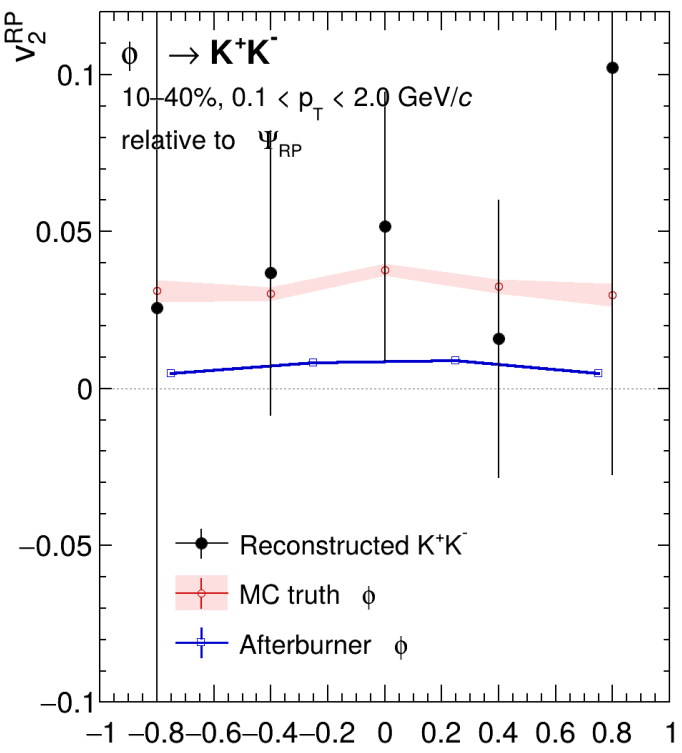
Parameterized centrality and enhanced production up to 50 additional phi-meson at event: *~ 100k events*

~100k
Δϕ – based method

Elliptic flow relative to rapidity and pT

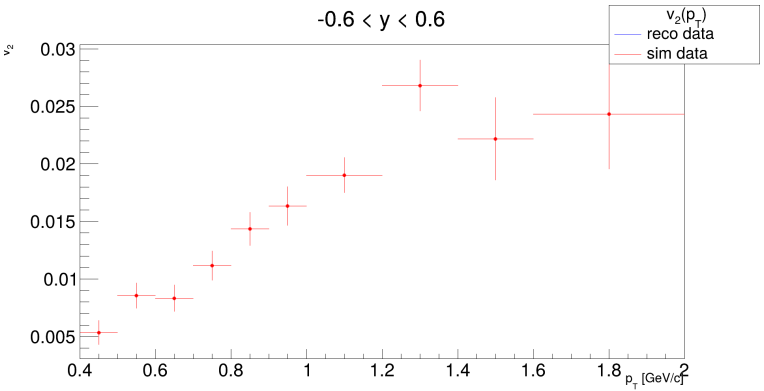


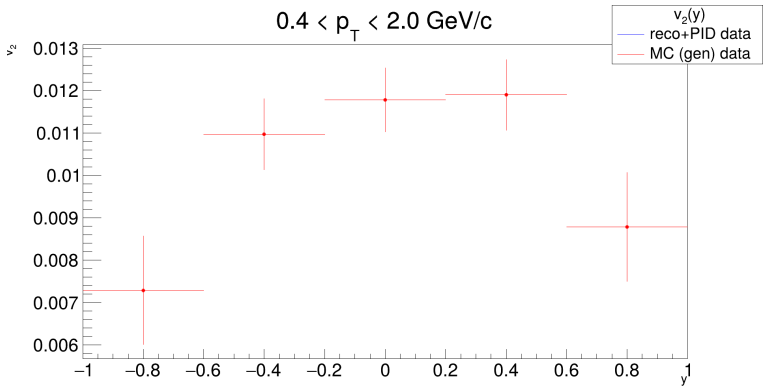




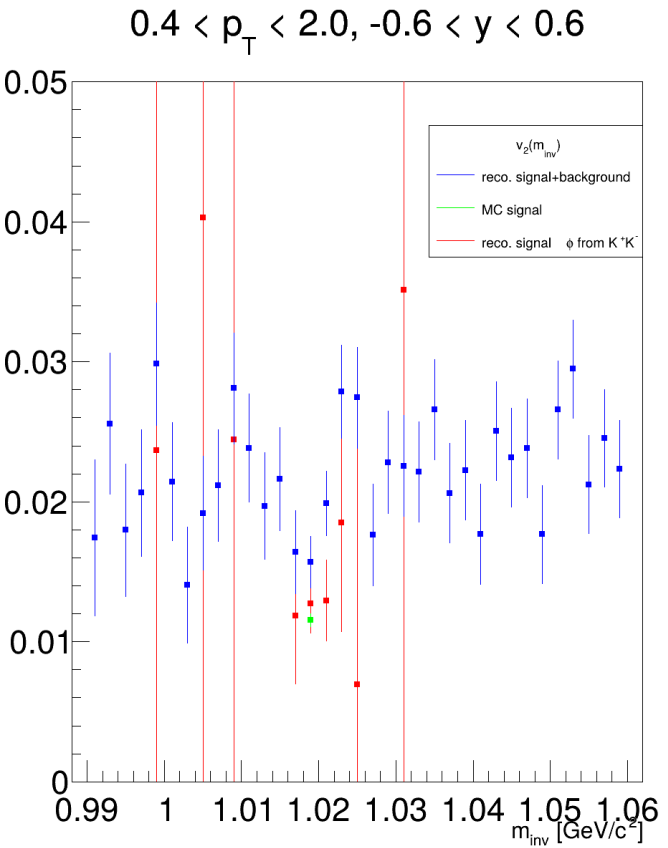
Additional

...


-0.6 < y < 0.6
$v_2(p_T)$
reco data
sim data
v_2
p_T [GeV/c]


0.4 < p_T < 2.0 GeV/c
$v_2(y)$
reco+PID data
MC (gen) data
v_2
y

...


0.4 < p_T < 2.0, -0.6 < y < 0.6
$v_2(m_{inv})$
reco. signal+background
MC signal
reco. signal ϕ from K^+K^-
m_{inv} [GeV/c^2]

OLD SLIDES

Dataset

1. UrQMD Bi+Bi at $\sqrt{s_{NN}}$ = 9.2 GeV
   50M events, prod. 25
2. Centrality determination:
   evCentrality wagon
3. Particle identification: evPID wagon
4. Event plane measurements:
   evPlane wagon
5. ϕ meson flow measurements:
   flowEpPairKK

Previous result for prod.25

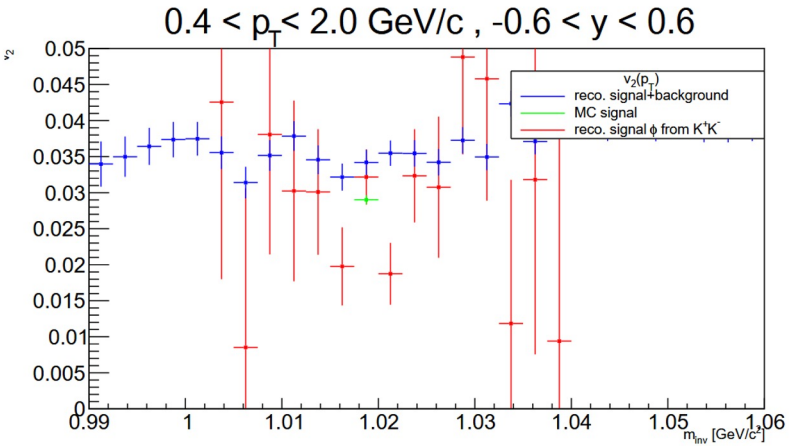
Used cuts:

Event selection: $|z_{vrtx}| < 130$ cm

Track selection:

- Kaons identification within 2σ (TPC and TOF)
- $N_{hits} > 24$
- $p_T > 0.1$ GeV/c
- $|DCA| < 2\sigma$
- Kaon pair $-0.6 < y_{K^+K^-} < 0.6$

Mixed events selection: $-0.6 < y_{K^+K^-} < 0.6$



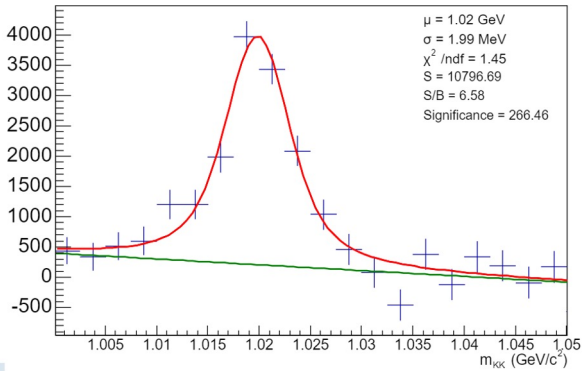
mass invariant method 10-60 %

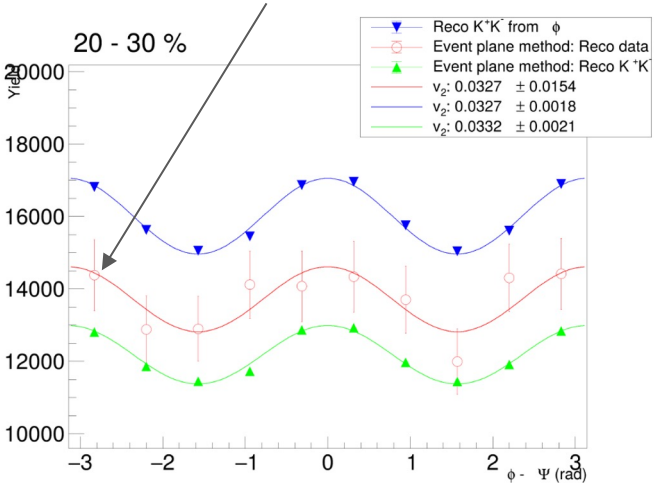
Signal v2 and background v2 are similar - can not distinguish between them very well.

Description of Δϕ method

1. m_{inv} in 10 bins $(\varphi - \Psi_{RP})$
2. Background rejection from invariant mass distribution of ϕ(1020) meson
3. Fitting the signal peak and integrating it
4. Fitting yields with Fourier series:

$$\frac{dN}{d(\phi - \Psi)} = 1 + 2 \cdot v_2 \cos(2 \cdot (\phi - \Psi))$$





Selection criteria

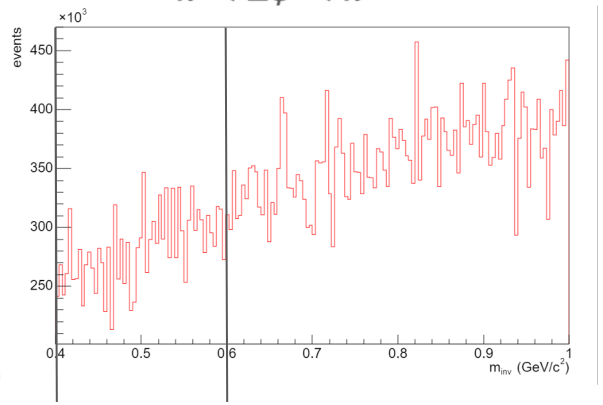
Event selection: $|z_{vrtx}| < 130\,cm$

Track selection:

- Kaons identification within 2σ (TPC and TOF)
- Nhits > 24
- pT > 0.1 GeV/c
- |DCA| < 2σ
- Kaon pair $-1 < y_{K^+K^-} < 1$
- **Pion mass cut:** $m_{\pi+\pi-} < 0.4\ GeV/c^2$ & $m_{\pi+\pi-} > 0.6\ GeV/c^2$

$0.4 < p_T < 2.0\ GeV/c$

$-\pi < \Delta\varphi < \pi$

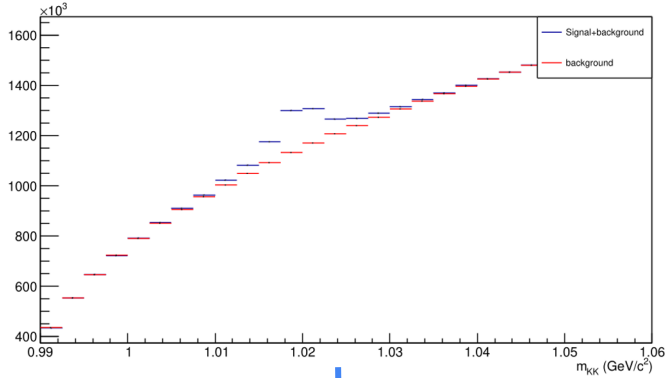


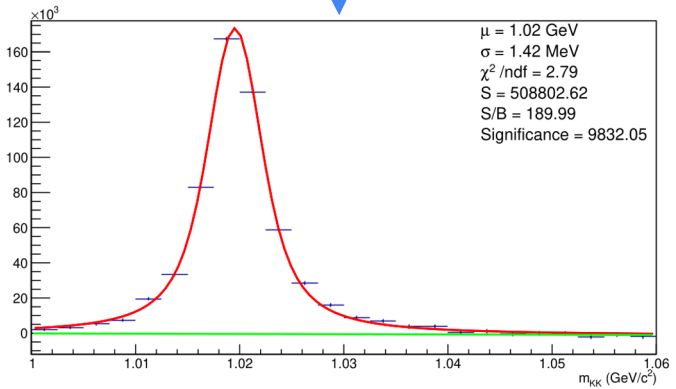
Mixed events selection: $-1 < y_{K^+K^-} < 1$

Invariant mass distribution: background rejection

1. Getting signal and mixed distribution;
2. Scaling and subtraction of signal and background
3. Calculated signal was fitted with Voigt function for peak and linear function for background

after scaling and before subtraction



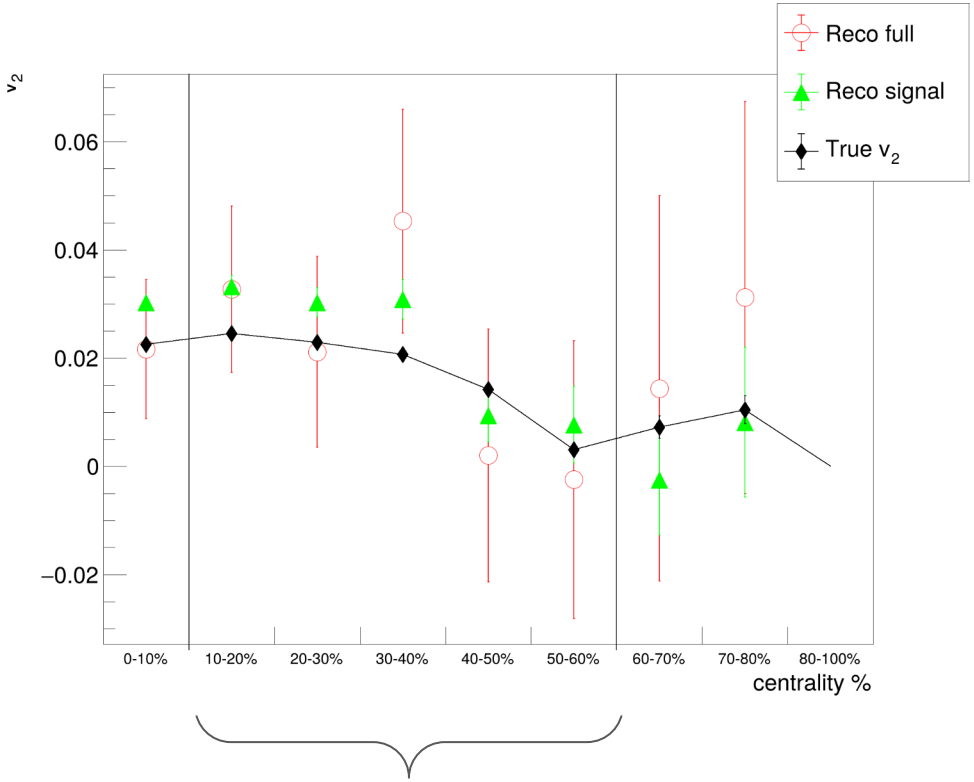


after scaling and subtraction

Results

- (Reco full) reconstructed data (with background subtraction);
- (Reco signal)
  $\Delta\phi$ method for reconstructed data:
  pdg = 321(K+) and -321(K-)
  mother particle pdg = 333 (phi meson);
- **(True)** Monte Carlo data;
  mother particle pdg = 333 (phi meson);

50M UrQMD Bi+Bi at √sNN = 9.2 GeV



Reasonable centrality classes (10-60) %

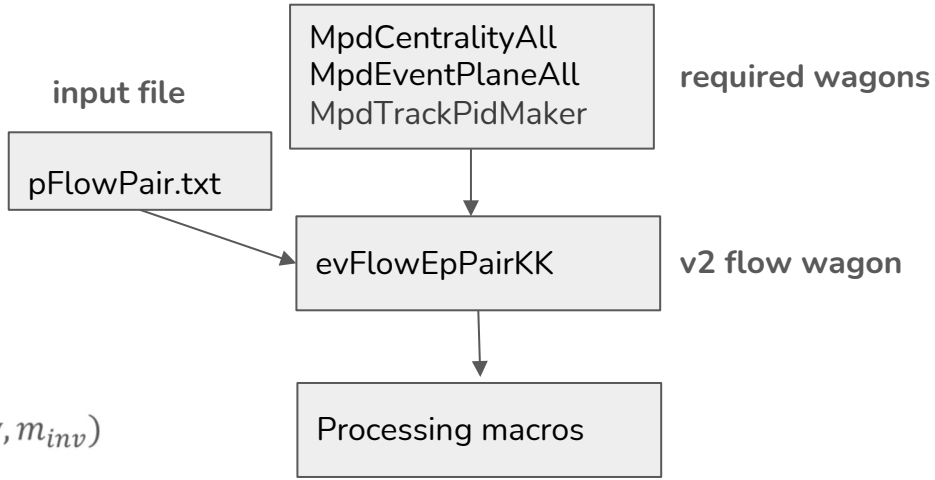
evFlowEpPairKK: analysis wagon

Required wagons

- centrality from evCentrality wagon
- reaction plane from evPlane wagon
- PID calculations evPID wagon .

Output

- 3D distributions TH3F $(p_T, \Delta\phi, m_{inv})$ and $(p_T, \mathrm{y}, m_{inv})$
- mixed event distributions for back rejection
- evFlowEpPairKK wagon will be added to mpdroot framework



Main parts:

1. **MpdSignal class**: background rejection

2. **MpdSignalFit class:** fitting and yield calculation

3. **get_mInv()**: flow calculation

evFlowEpPairKK : Input configuration file

```
#-------Parameters used for analysis------
# Event selection:
mZvtxCut     130 //  cut on vertex z coordinate
# PID cuts:
mPIDsigTPC   2  // dEdx PID parameters
mPIDsigTOF   2 // dEdx PID parameters
mNofHitsCut  24 // minimal number of hits for a track
mEtaCut      999  // maximal pseudorapidity for a track
mPtminCut    0.1  // minimal pt for a track
mDCACut      2.0  // maximum DCA for a track
# Pair cuts:
mYCut        1.0  // pair rapidity cut
```

pFlowPair.txt

Summary

- v_2 has been calculated with $\Delta\phi$ method;
- cut on $K^0_S \to \pi^+\pi^-$ was applied and results were compared with true MC data:
  - current statistics is insufficient (50M)
  - (10-60) % are reasonable centrality classes for further calculations

Outlook

- $\Delta\phi$ method with realistic EP and resolution correction
- Analysis wagon will be added to mpdroot framework