Comparison of the main distributions of the vHLLE+UrQMD and UrQMD models

Models and Statistics

UrQMD

- S. A. Bass, *et. al.* Prog. Part. Nucl. Phys. **41** (1998) 225
- M. Bleicher *et. al.* J. Phys. G **25**, (1999) 1859
- Version 3.4, cascade mode
- **Available statistics:**

10M fully reconstructed min. bias AuAu @ 11.5 GeV (local production)

vHLLE+UrQMD

- Iurii Karpenko, Comput. Phys. Commun. **185** (2014), 3016
- Parameters: from Iu. A. Karpenko, P. Huovinen, H. Petersen, M. Bleicher, Phys. Rev. C **91** (2015) no.6, 064901
- Initial conditions: UrQMD model
- QGP phase: 3D viscous hydro (vHLLE) with crossover (XPT) or 1-st phase transition (1PT) EoS
- Hadronic phase: UrQMD model
- **Available statistics:**

PWG3 official production – 15M fully reconstructed min. bias AuAu @ 11.5 GeV for each EoS [link]

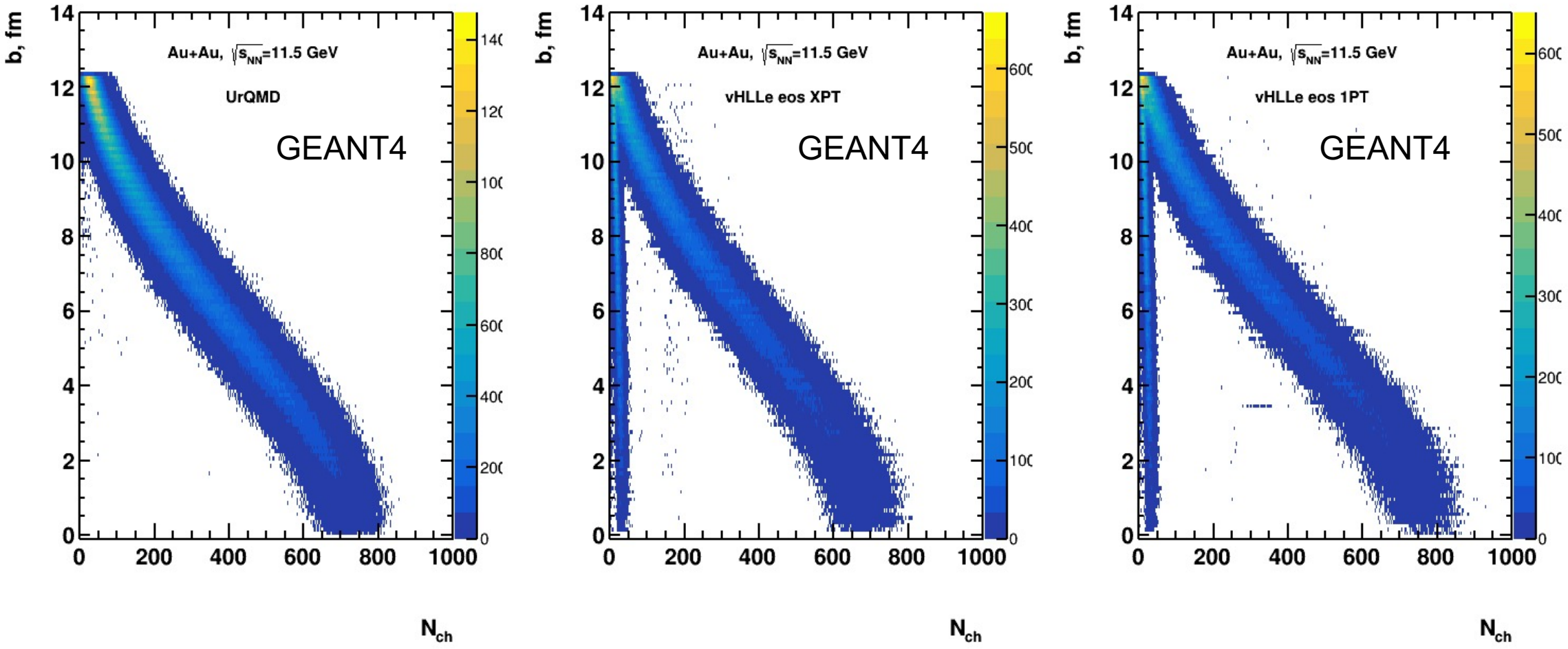
Centrality classes selection

Centrality	b_{min}, fm	b_{max}, fm
0-5%	0	2.91
5-10%	2.91	4.18
10-20%	4.18	6.01
20-30%	6.01	7.37
30-40%	7.37	8.52
40-50%	8.52	9.57
50-60%	9.57	10.55
60-70%	10.55	11.46
70-80%	11.46	12.31

Centrality was defined based on impact parameter: $b_{min} < b < b_{max}$

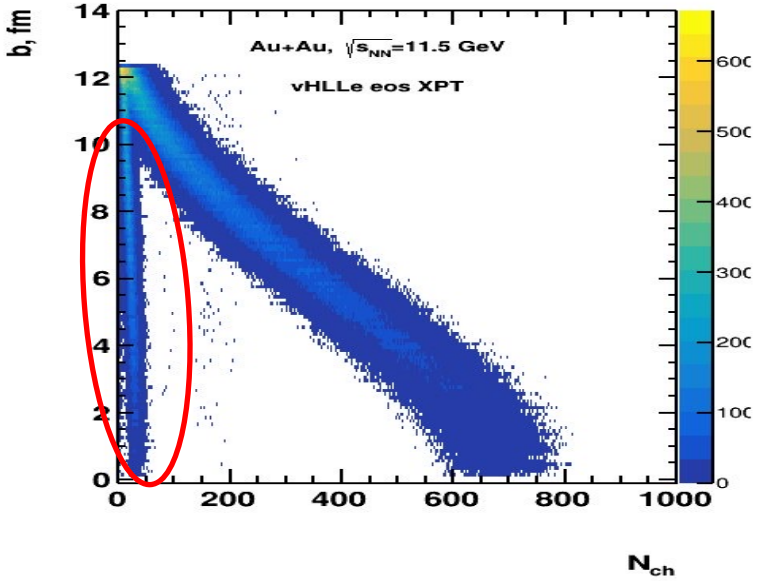
Distribution of the multiplicity vs impact parameter

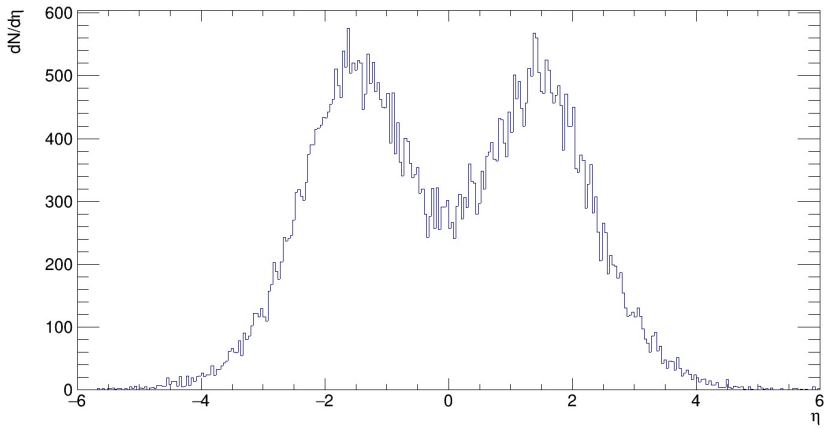
Partcle selection: $0.2<p_T<3$ GeV/c, $|\eta|<1.5$, $N_{hits}>16$

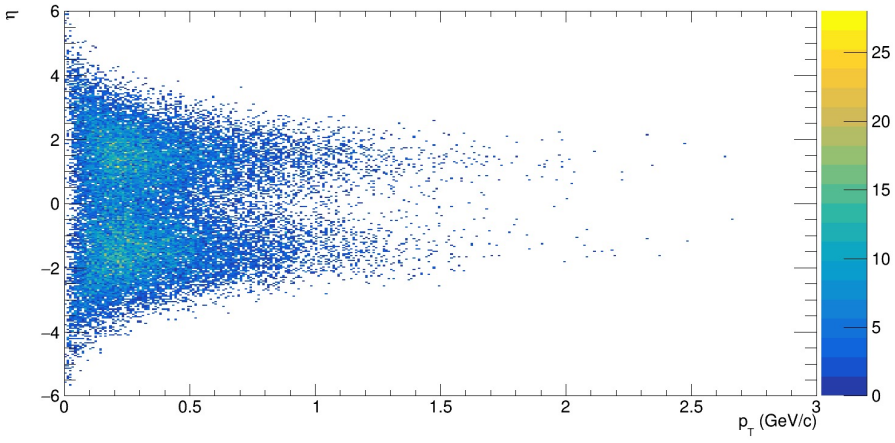


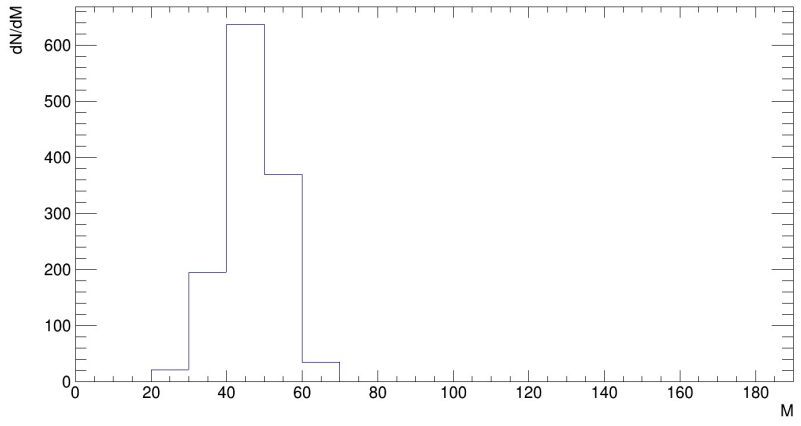
Strange ”tail” at small N_{ch} in vHLLE+UrQMD model

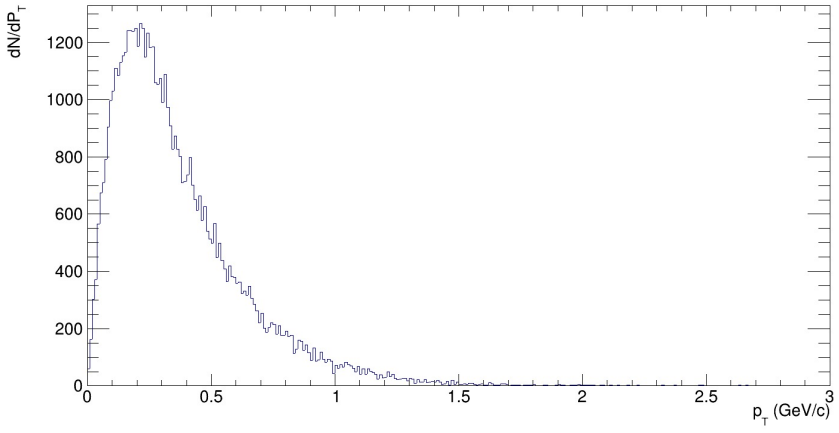
vHLLE+UrQMD XPT, Au+Au, 20-30%, $h^{\pm}$

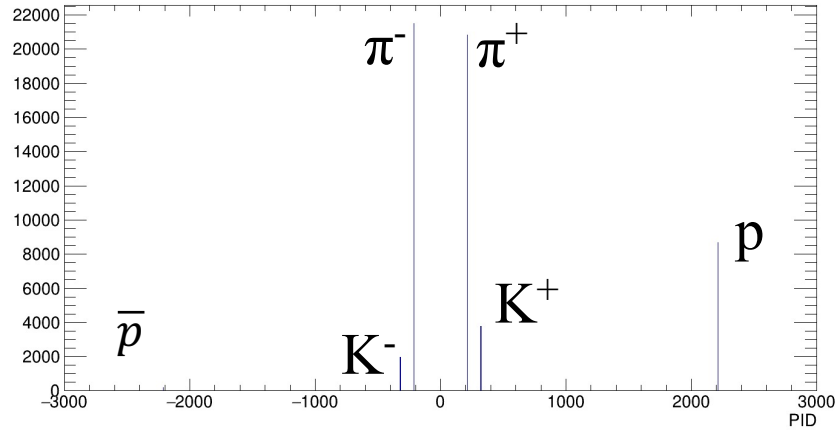






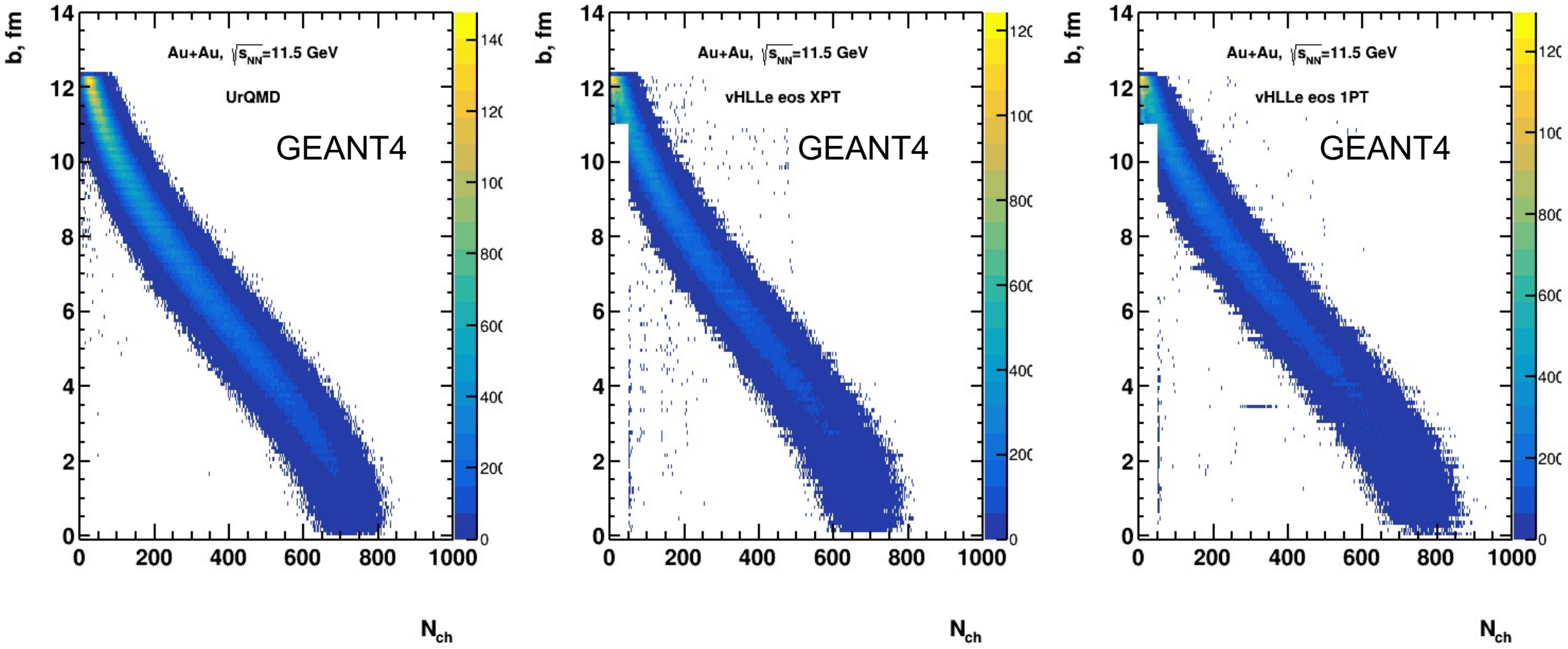






Distribution of the multiplicity vs impact parameter

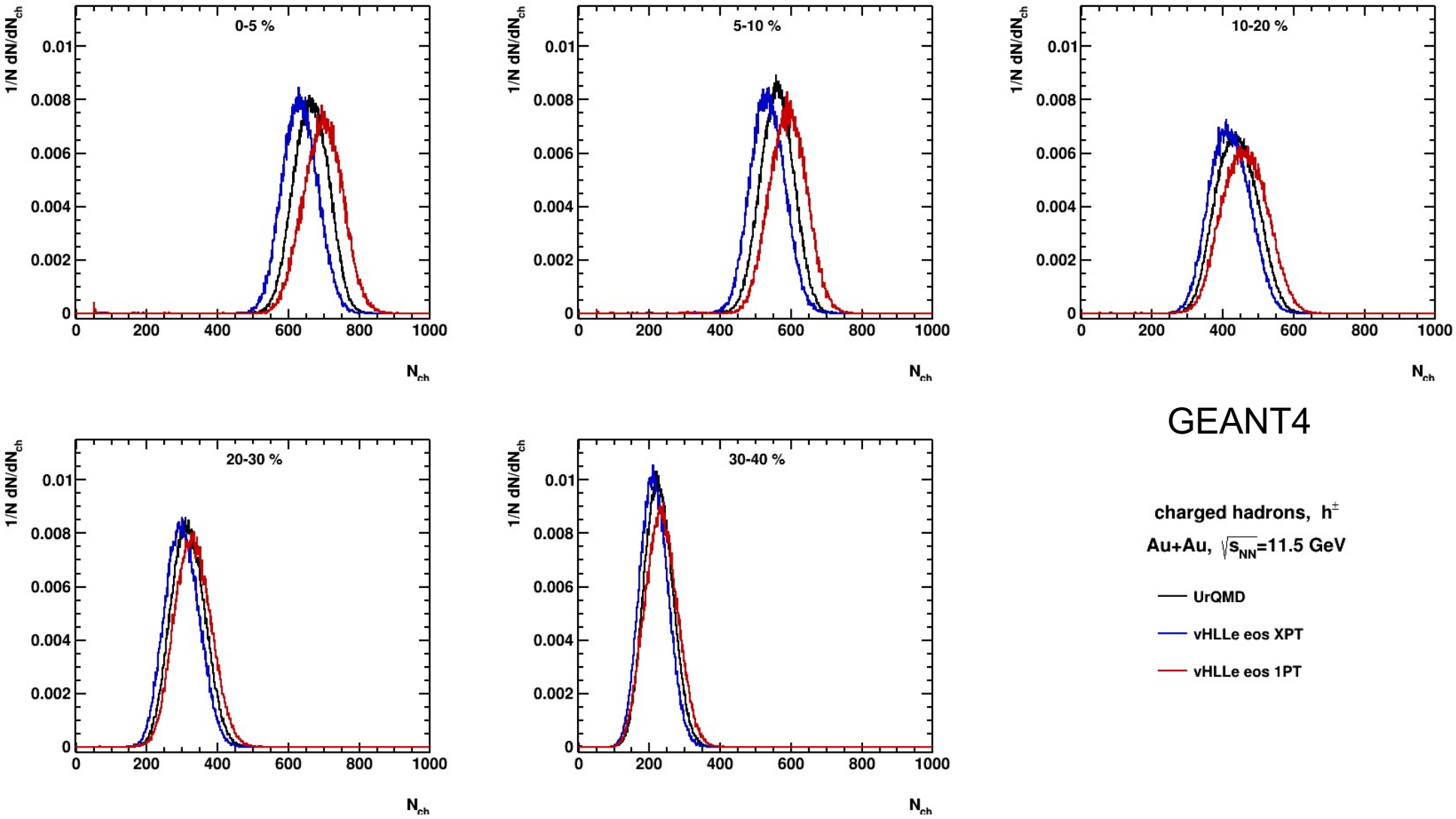
Partcle selection: $0.2<p_T<3$ GeV/c, $|\eta|<1.5$, $N_{hits}>16$



Cut ($N_{ch}>50$ || $b>11$ fm) was applied

Distribution of the multiplicity of charged particles with (Nch>50 || b>11 fm) cut

Partcle selection: $0.2<p_T<3$ GeV/c, $|\eta|<1.5$, $N_{hits}>16$



GEANT4

charged hadrons, $h^{\pm}$

Au+Au, $\sqrt{s_{NN}}$=11.5 GeV

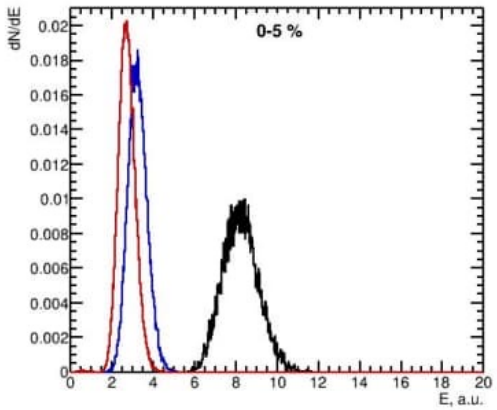
UrQMD

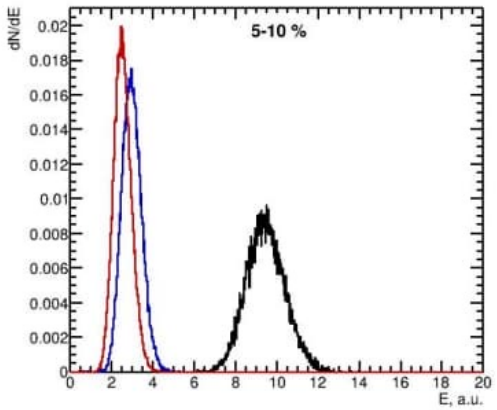
vHLLe eos XPT

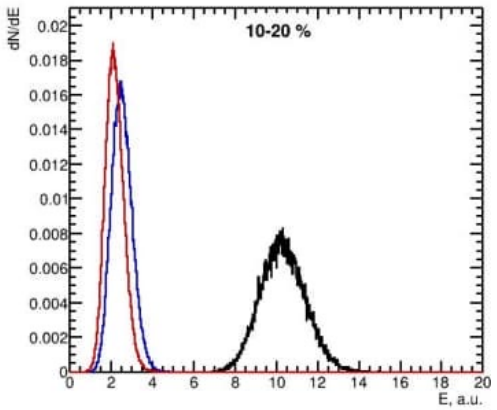
vHLLe eos 1PT

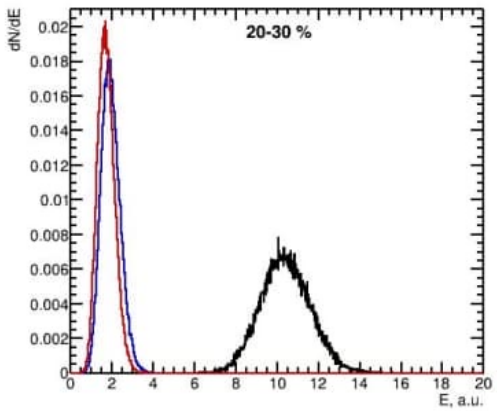
Distribution of the energy deposited in FHCal of charged particles with (Nch>50 || b>11 fm) cut

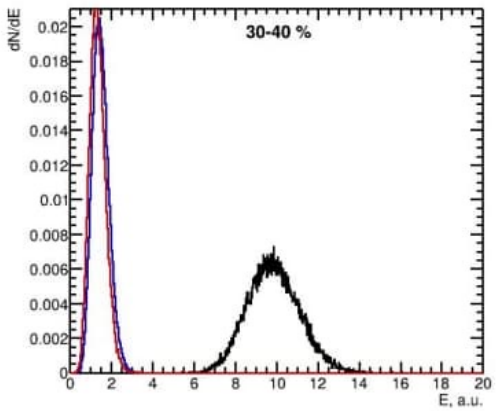
Partcle selection: $0.2<p_T<3$ GeV/c, $|\eta|<1.5$, $N_{hits}>16$



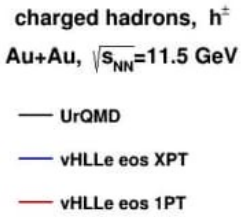


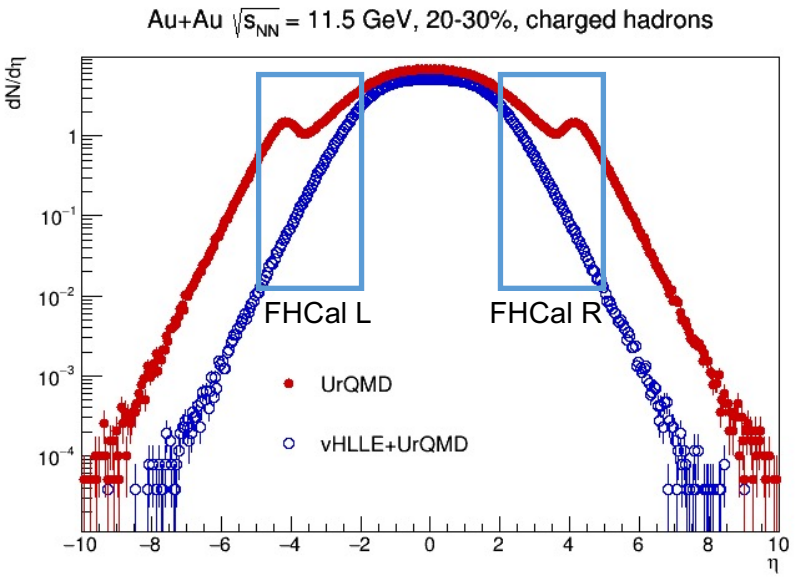






GEANT4

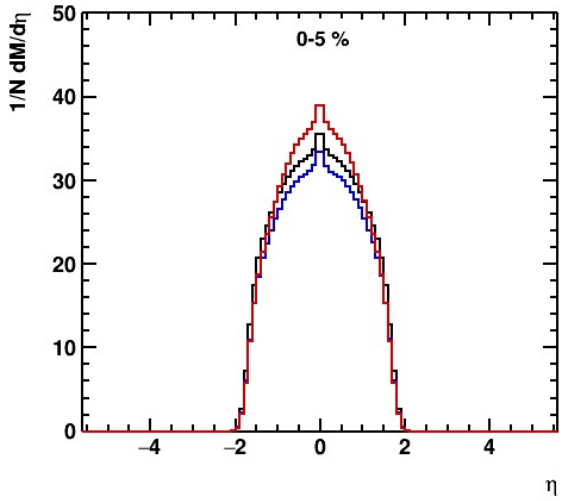


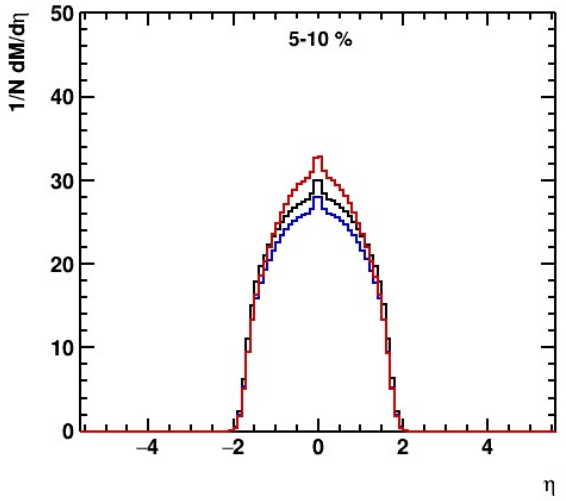


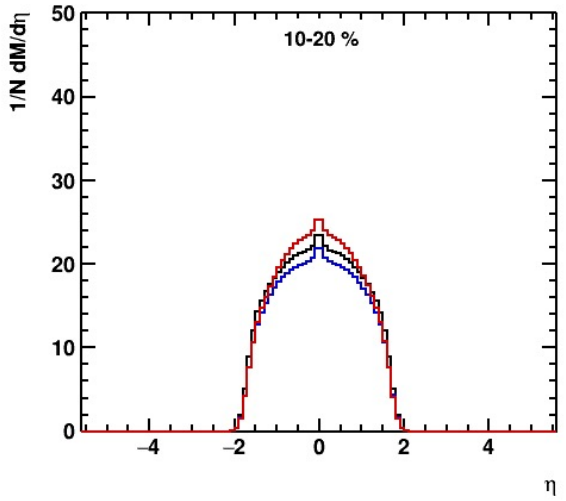
vHLLE+UrQMD cuts spectators in forward/backward pseudorapidity regions

Distribution of the pseudorapidity of of charged particles with (Nch>50 || b>11 fm) cut

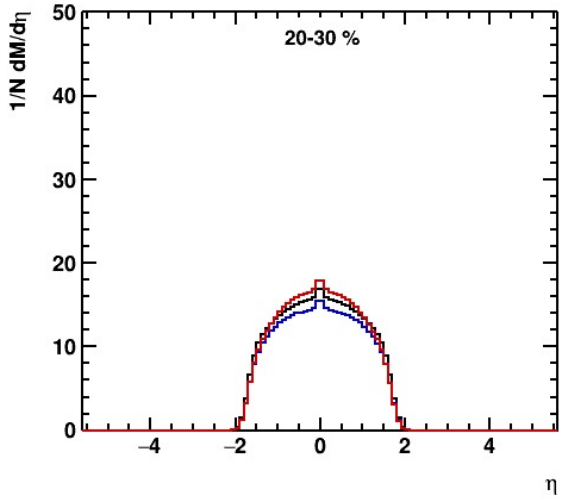
Partcle selection: $0.2<p_T<3$ GeV/c, $N_{hits}>16$

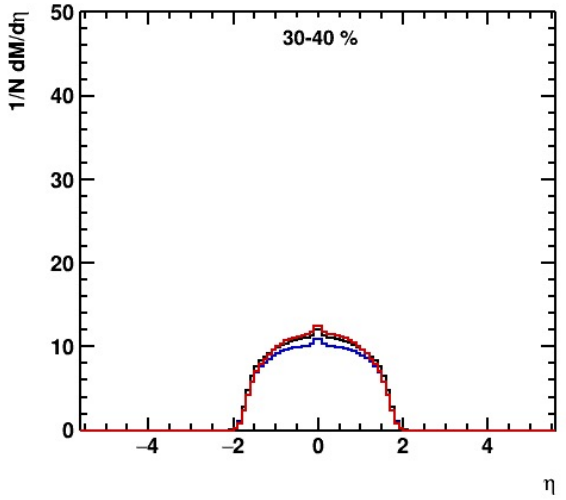


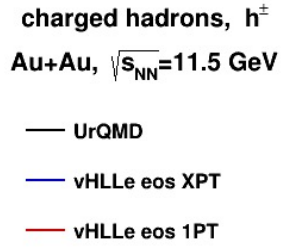




GEANT4

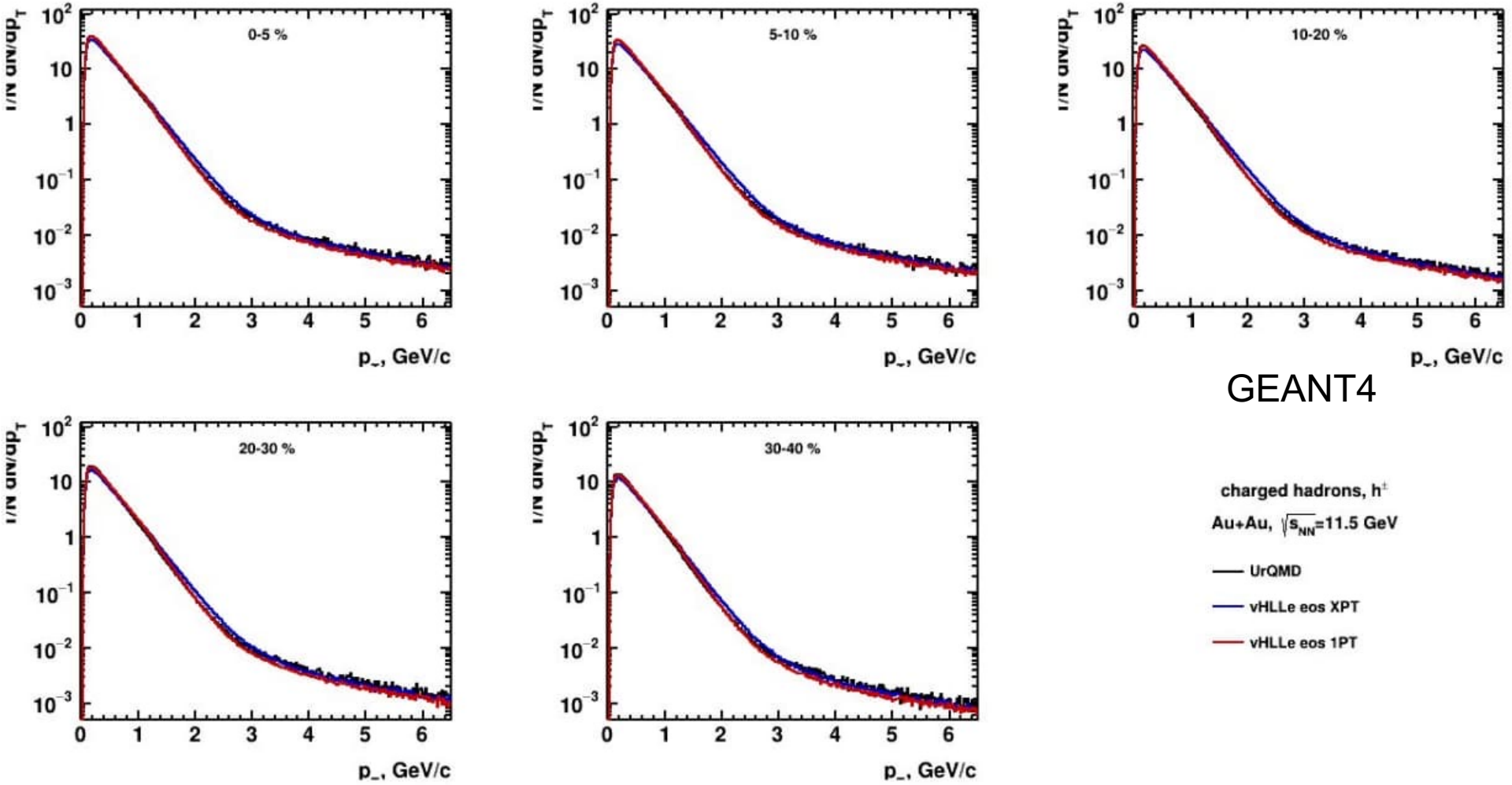






Distribution of the transverse momentum of charged particles with (Nch>50 || b>11 fm) cut

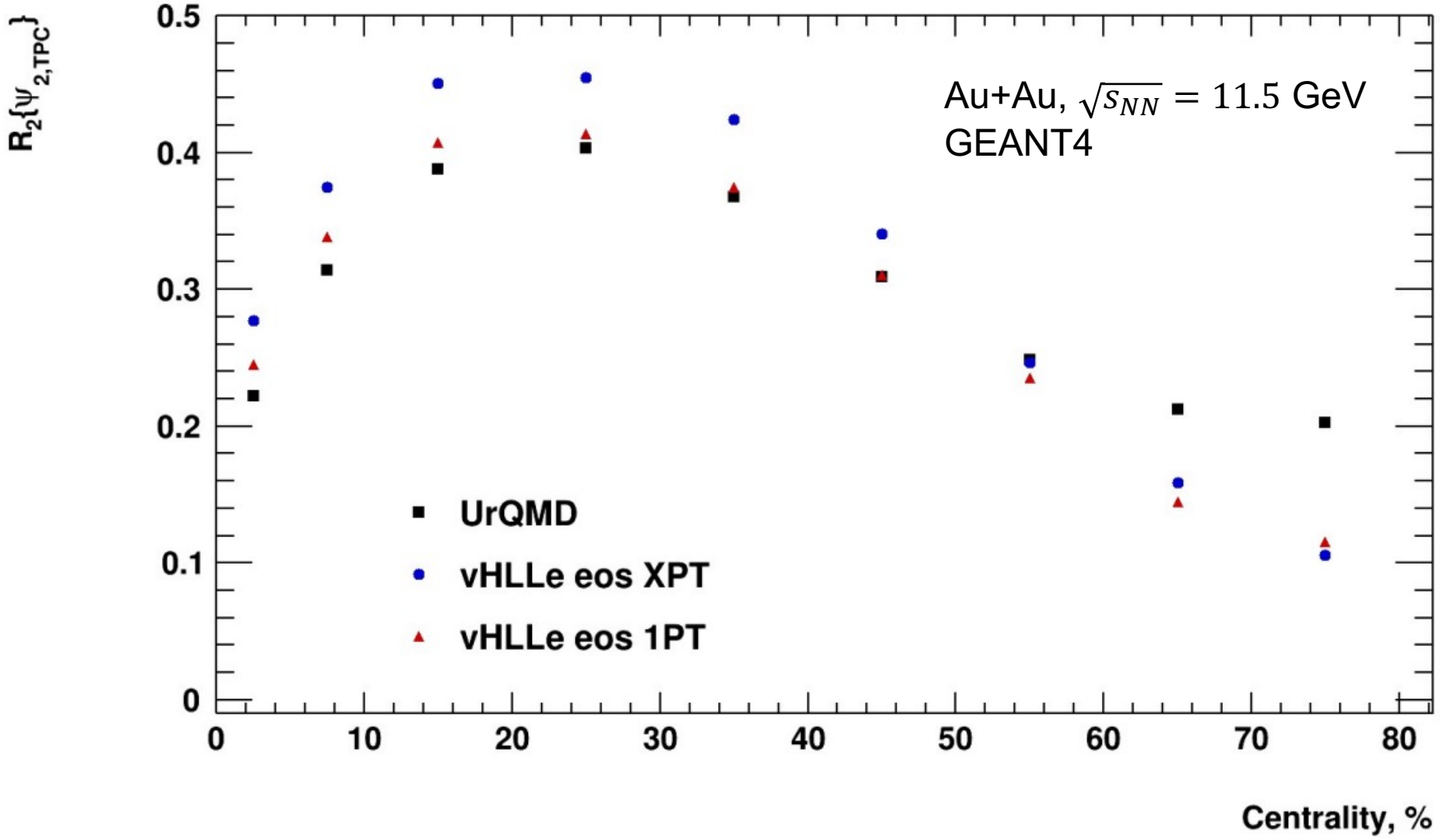
Partcle selection: $|\eta|<1.5$, $N_{hits}>16$



GEANT4

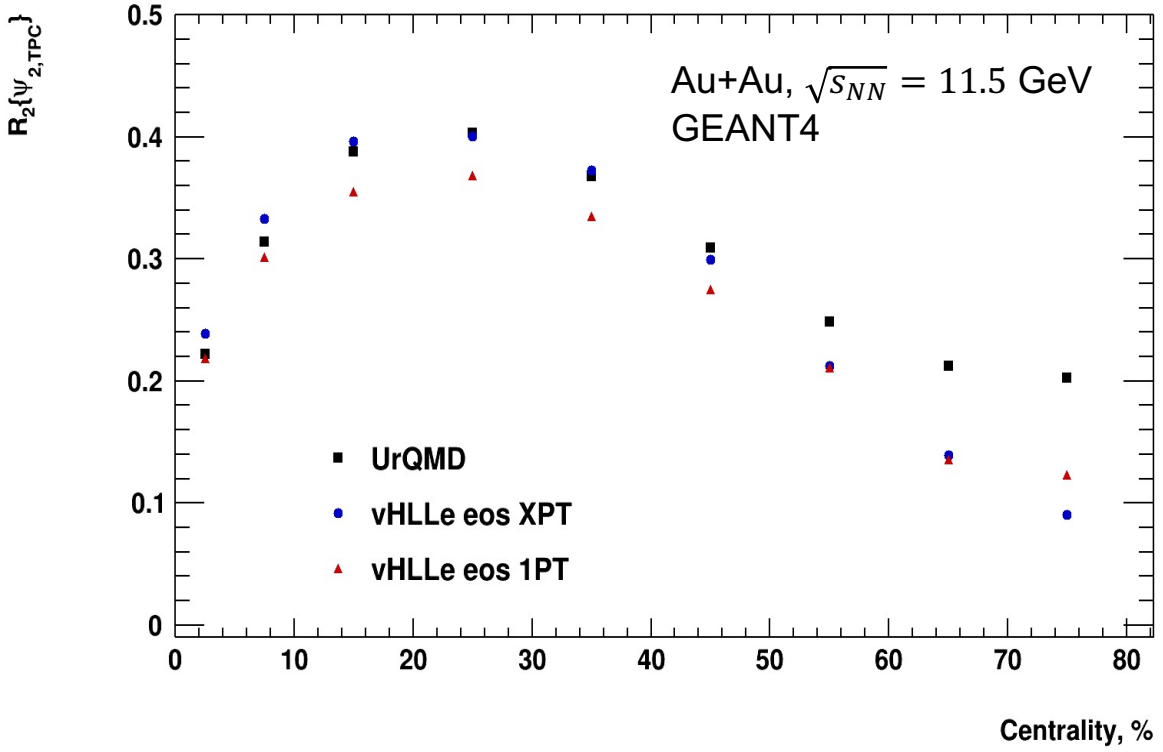
Resolution with (Nch>50 || b>11 fm) cut

Partcle selection: $0.2<p_T<3$ GeV/c, $|\eta|<1.5$, $N_{hits}>16$; $\Delta\eta$-gap=0.1

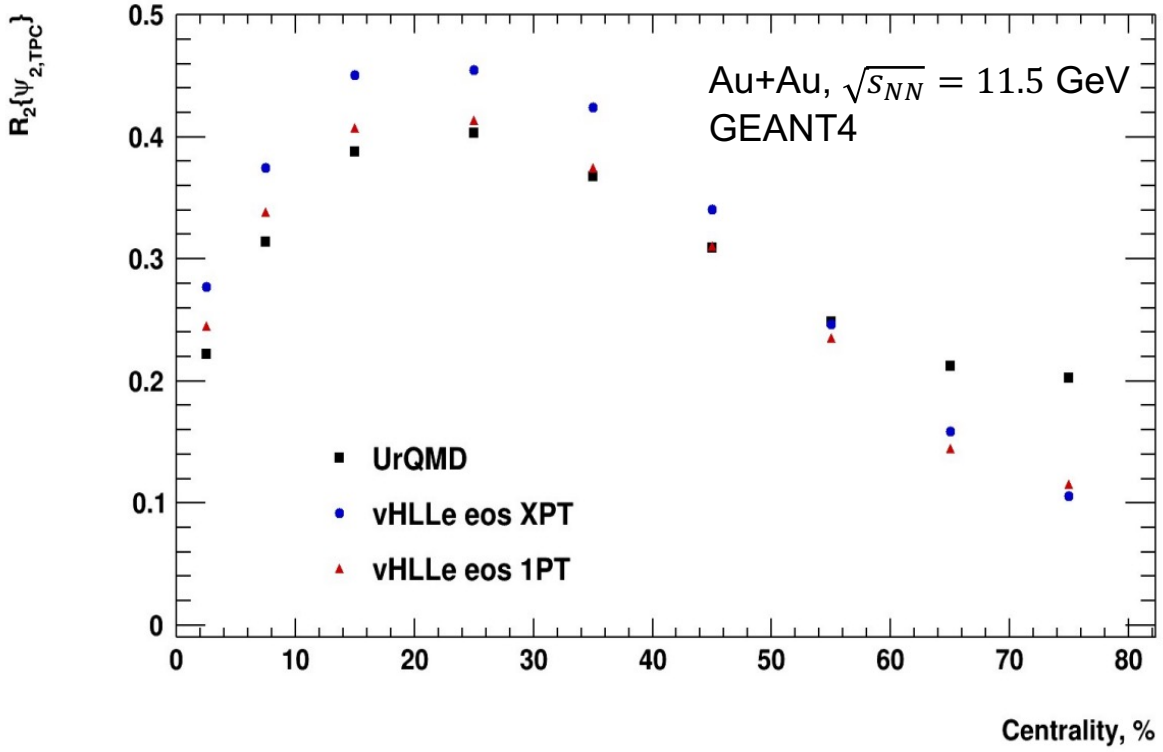


Effect of the (N_{ch}>50 || b>11 fm) cut on resolution

Without cut

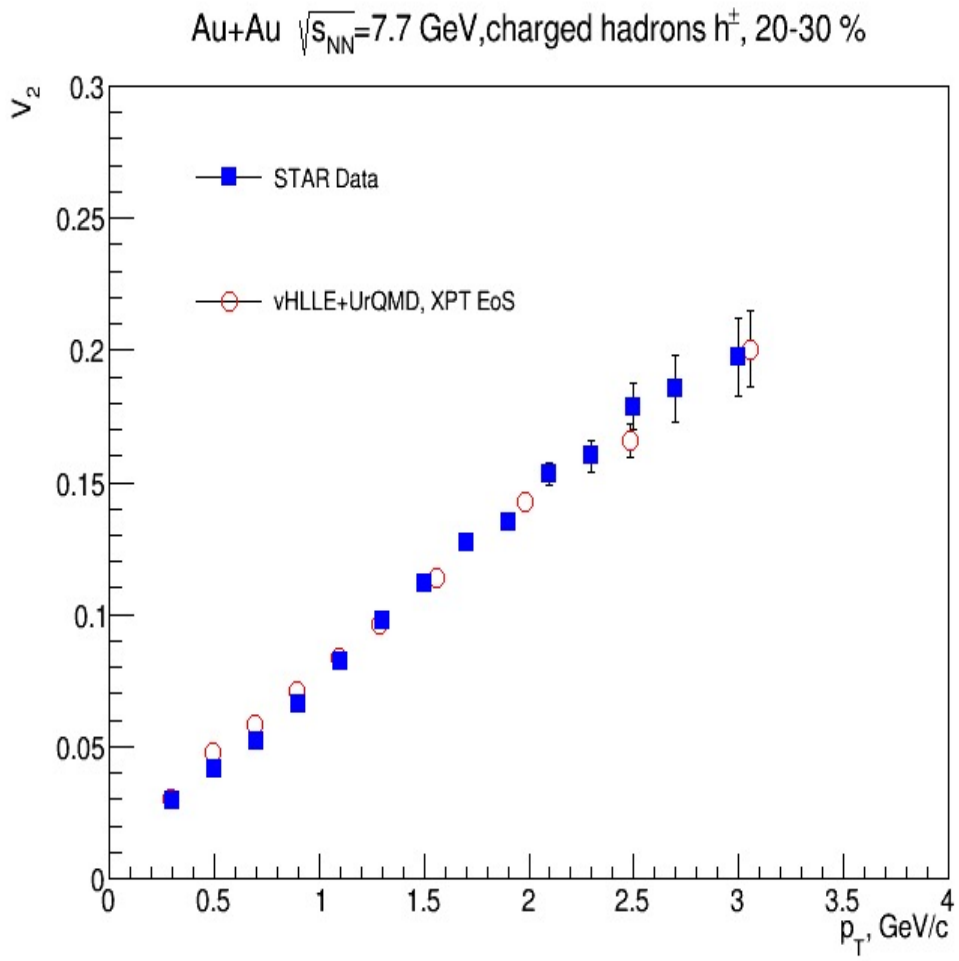


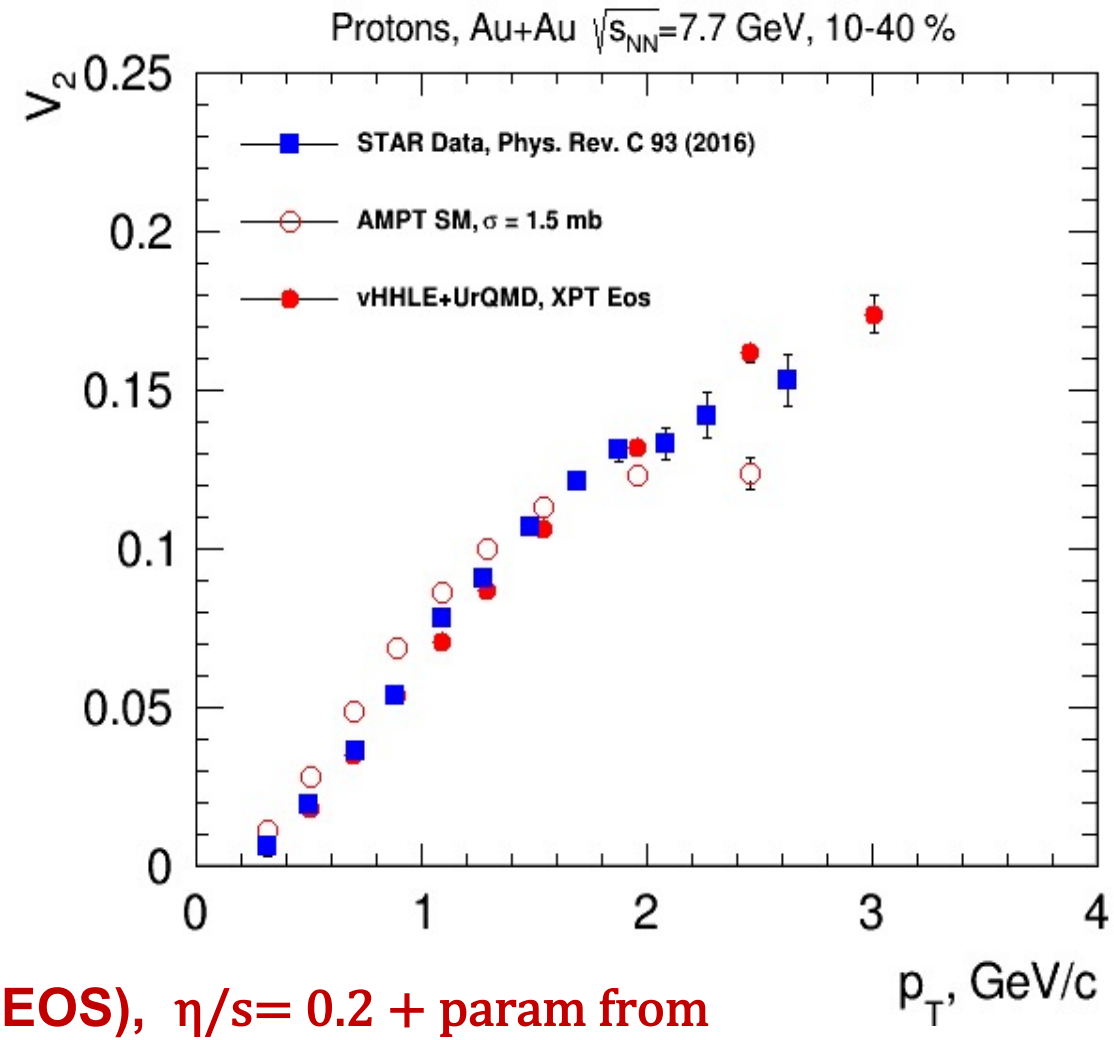
With cut



”Tail” at small N_{ch} affects resolution correction factor

Elliptic flow at NICA energies: Models vs Data comparison

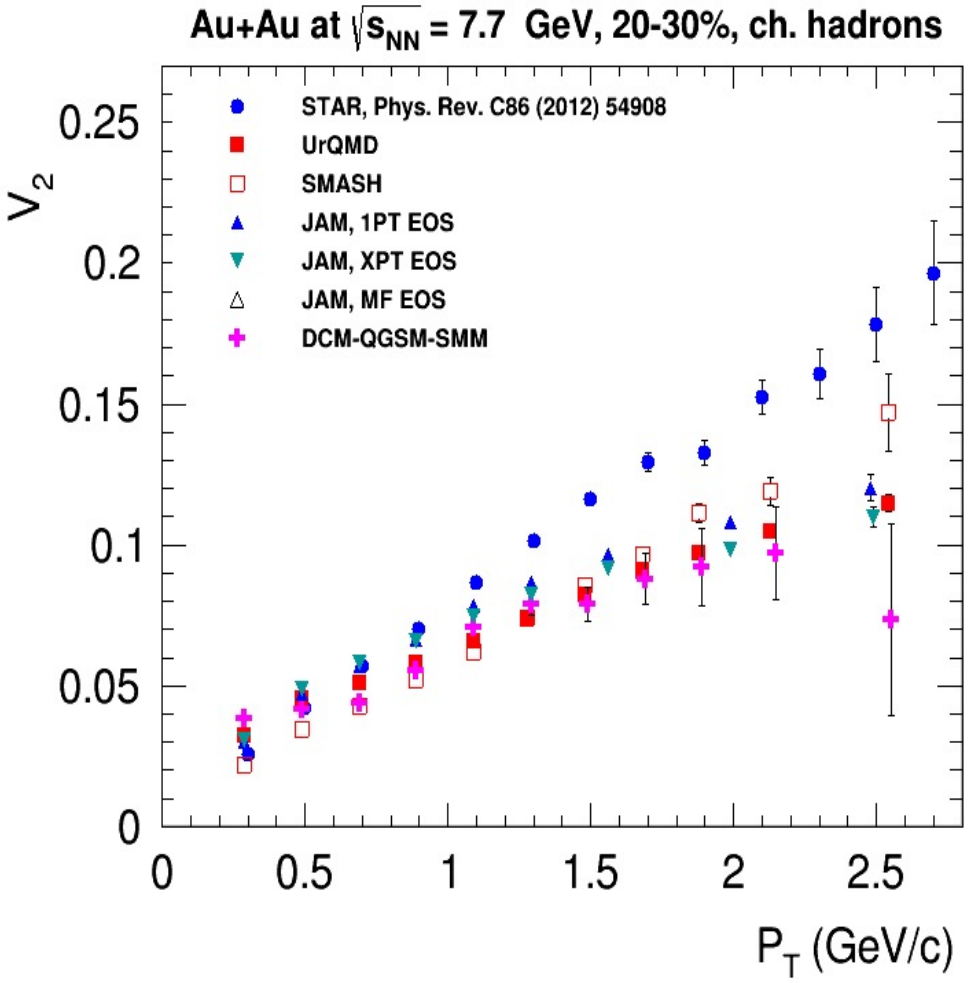


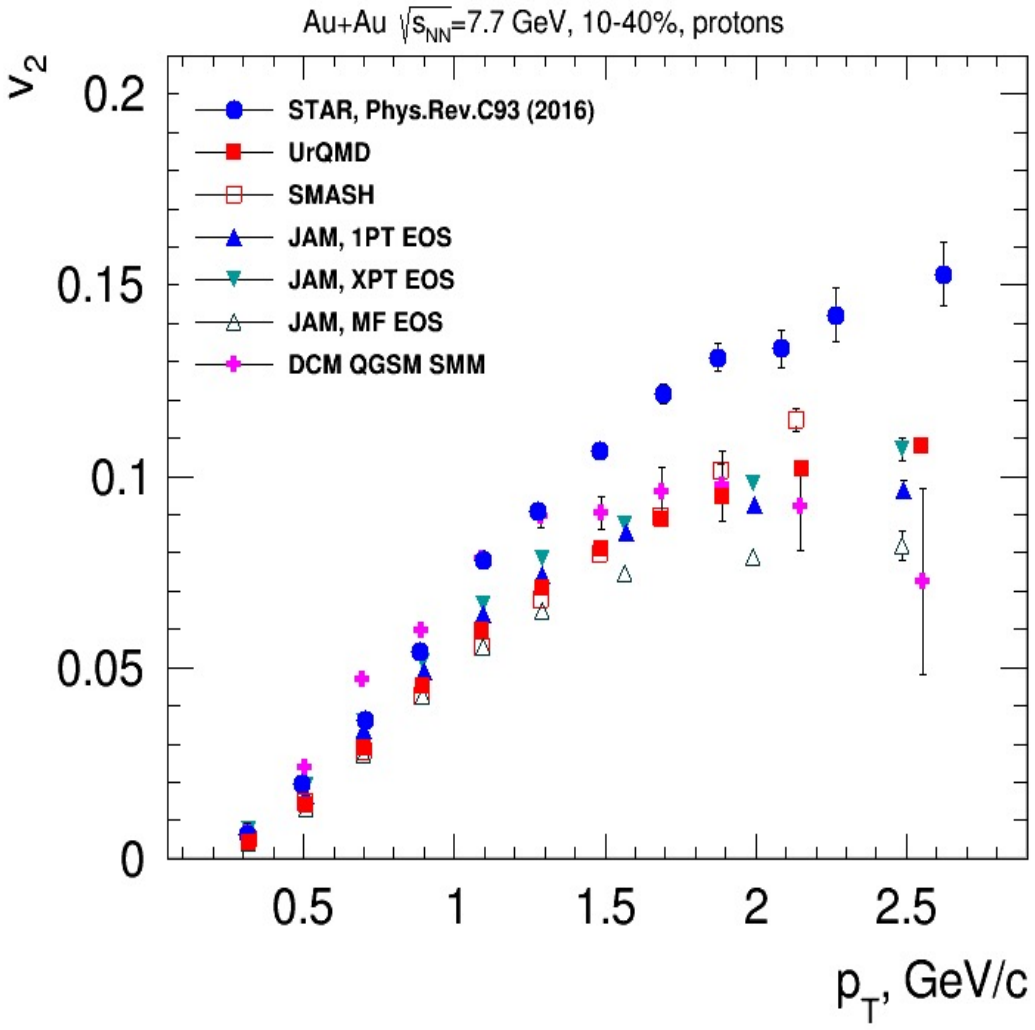


3D hydro model vHHLE + UrQMD (XPT EOS), $\eta/s = 0.2$ + param from

Iu.A. Karpenko, P. Huovinen, H. Petersen, M. Bleicher , Phys.Rev. C91 (2015) no.6, 064901

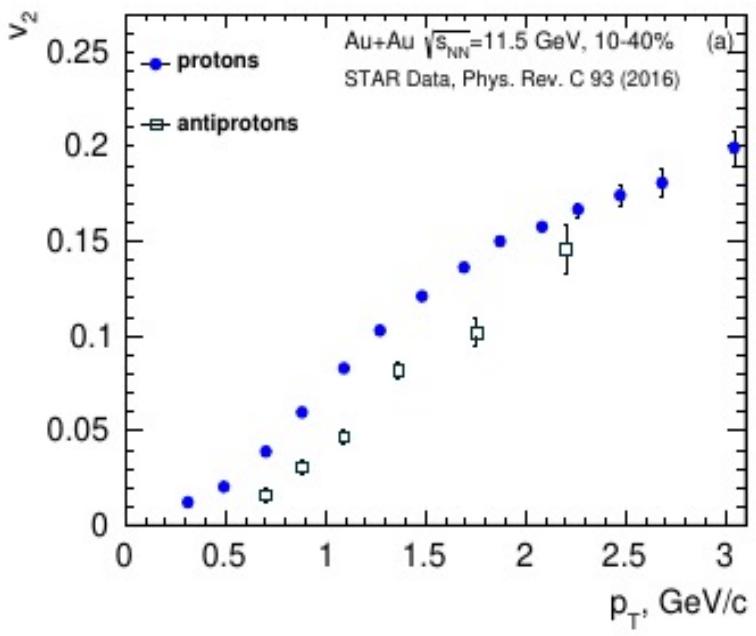
Elliptic flow at NICA energies: Models vs Data comparison

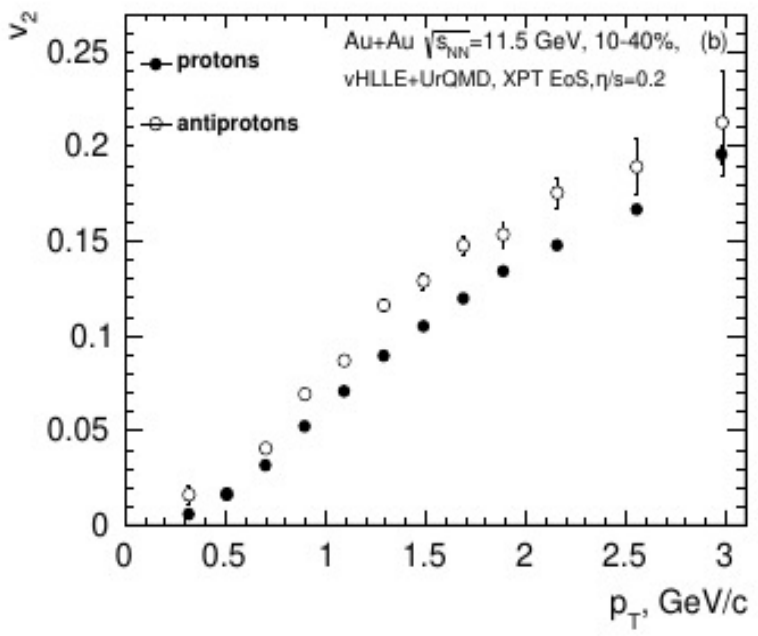


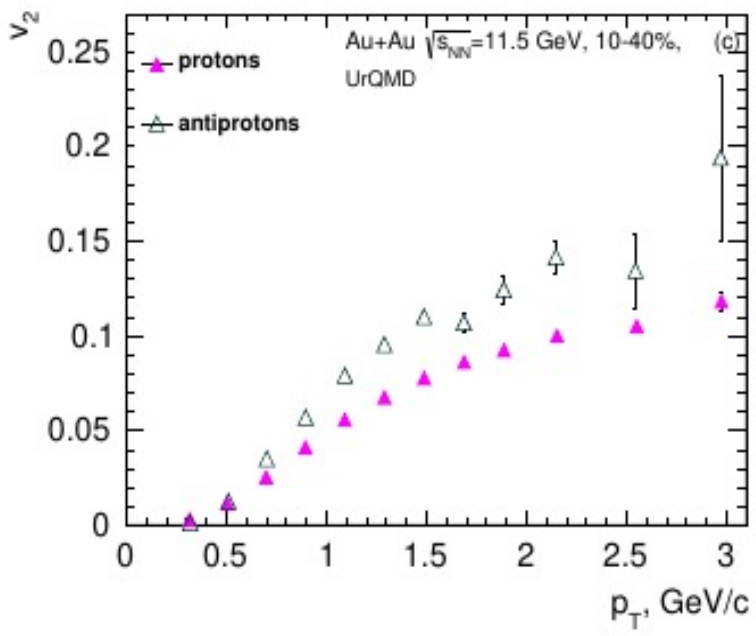


Pure String/Hadronic Cascade models give smaller v_2 signal compared to STAR data for Au+Au $\sqrt{s_{NN}}$=7.7 GeV and above

Elliptic flow: protons vs. antiprotons





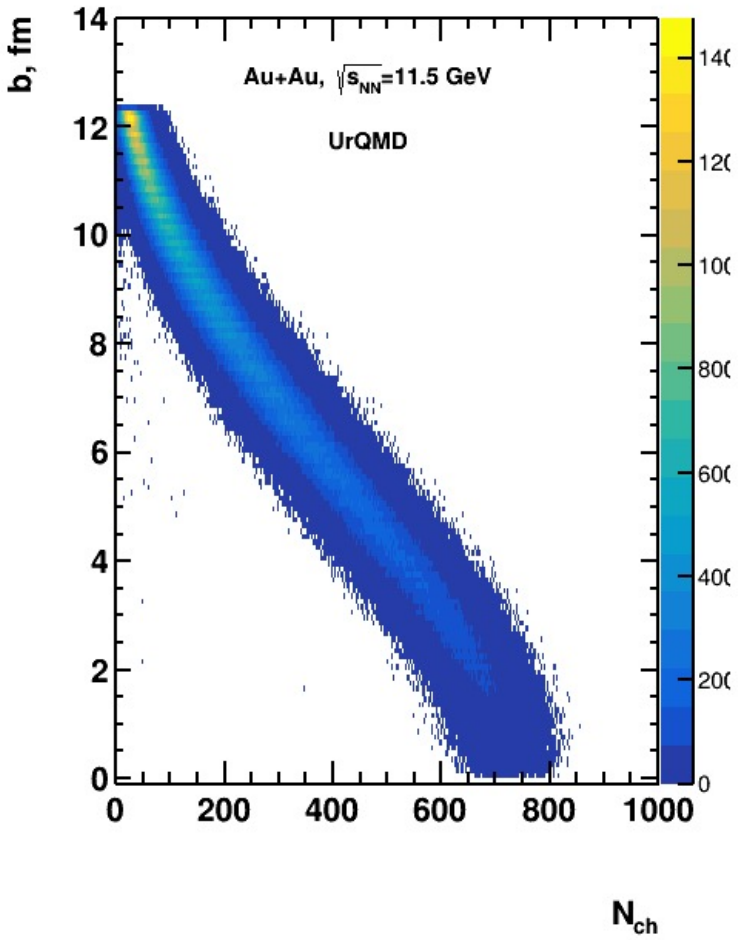


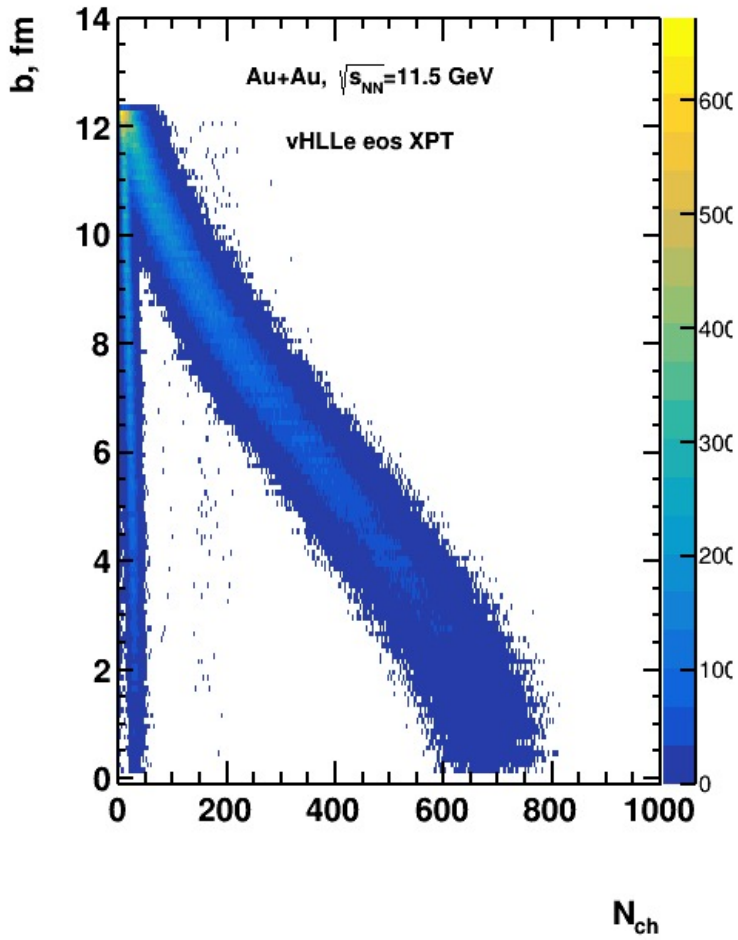
- Both vHLLE+UrQMD and UrQMD predict $v_2(p) < v_2(\bar{p})$ but experimental data shows $v_2(p) > v_2(\bar{p})$

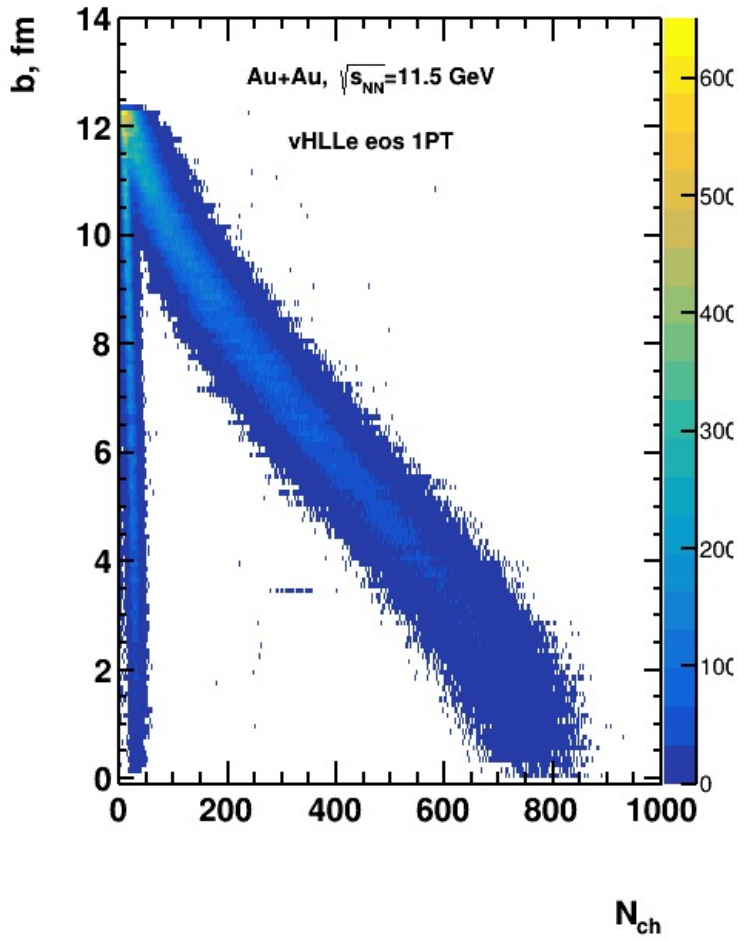
Thank you for your attention!

Backup

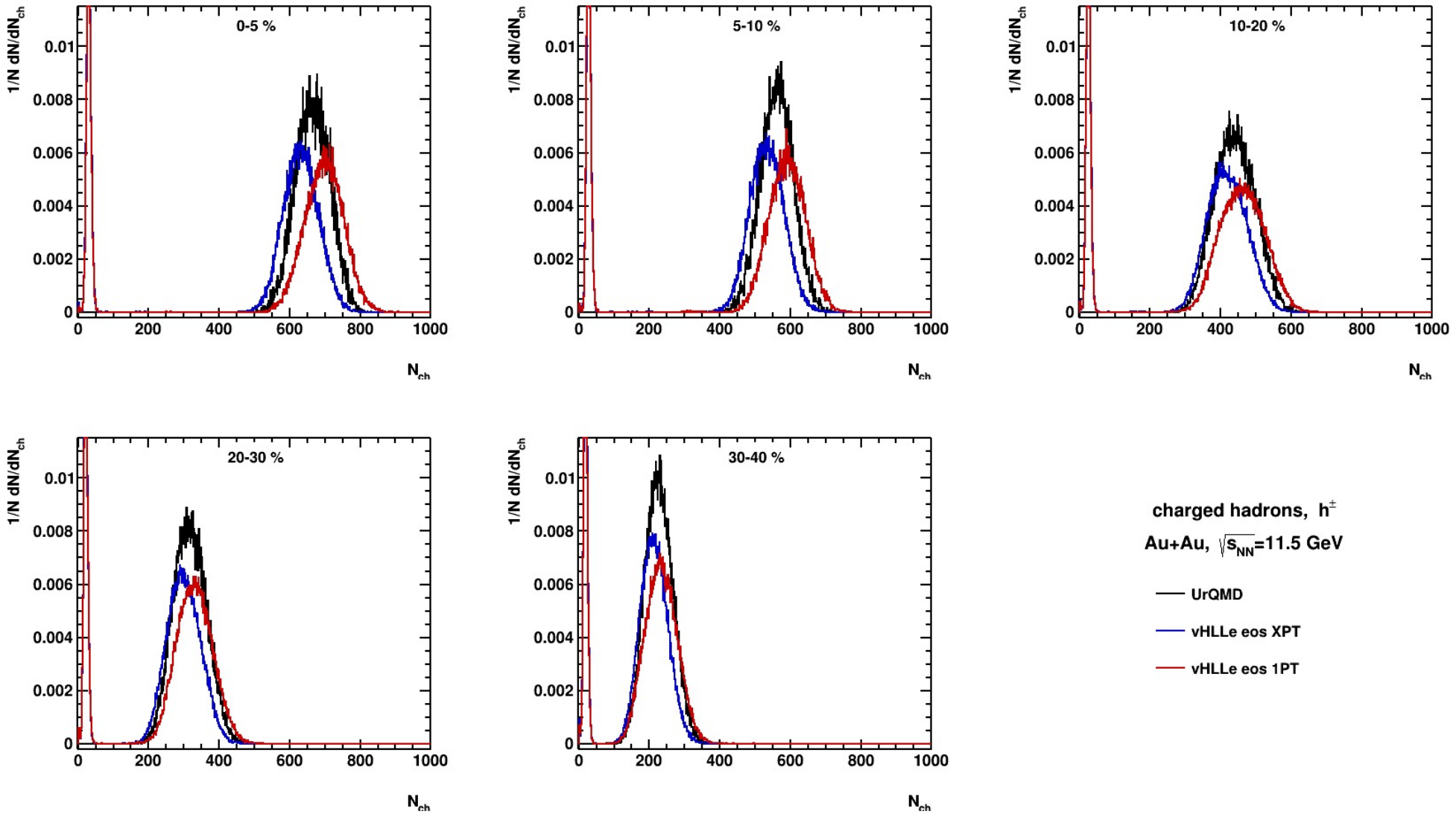
Without (N_{ch}>75 || b>11 fm) cut



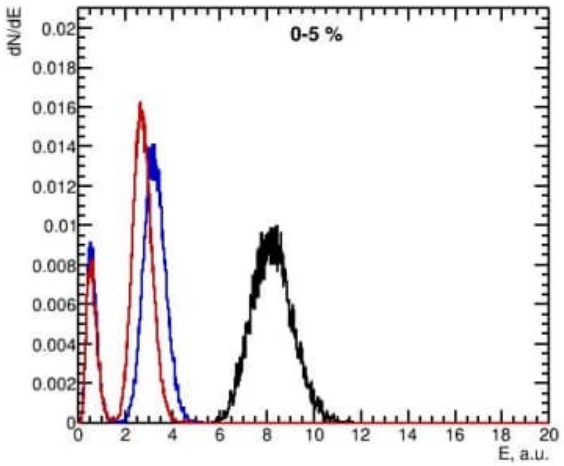


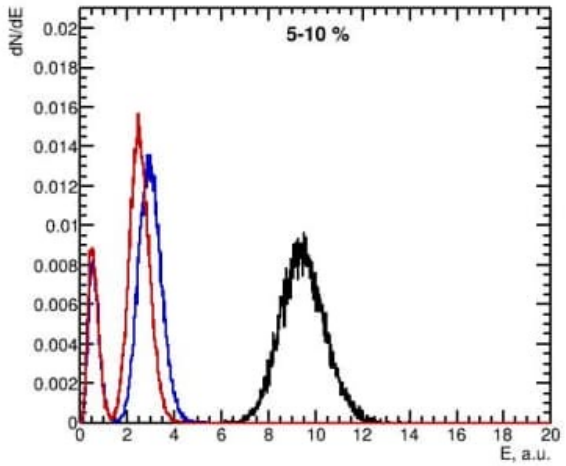


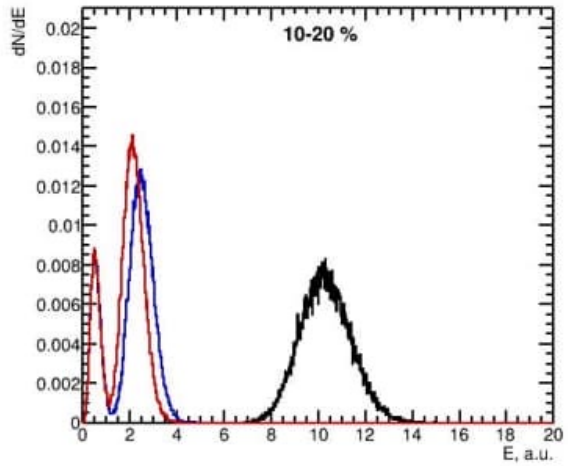
Distribution of the multiplicity of charged particles for different centrality classes

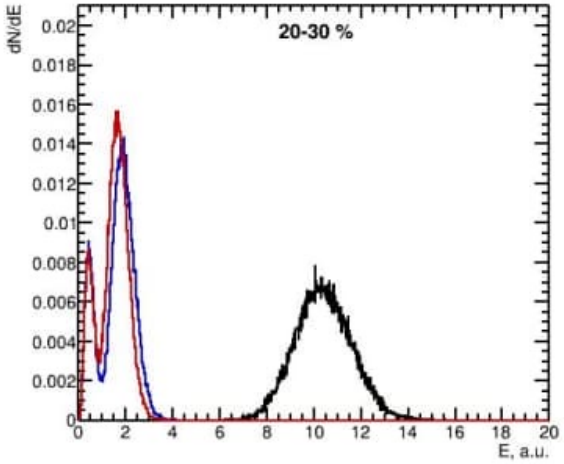


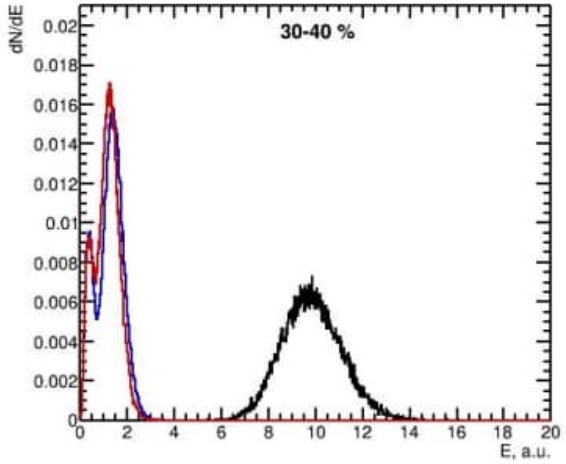
Distribution of the energy deposited in FHCal of charged particles











charged hadrons, $h^{\pm}$

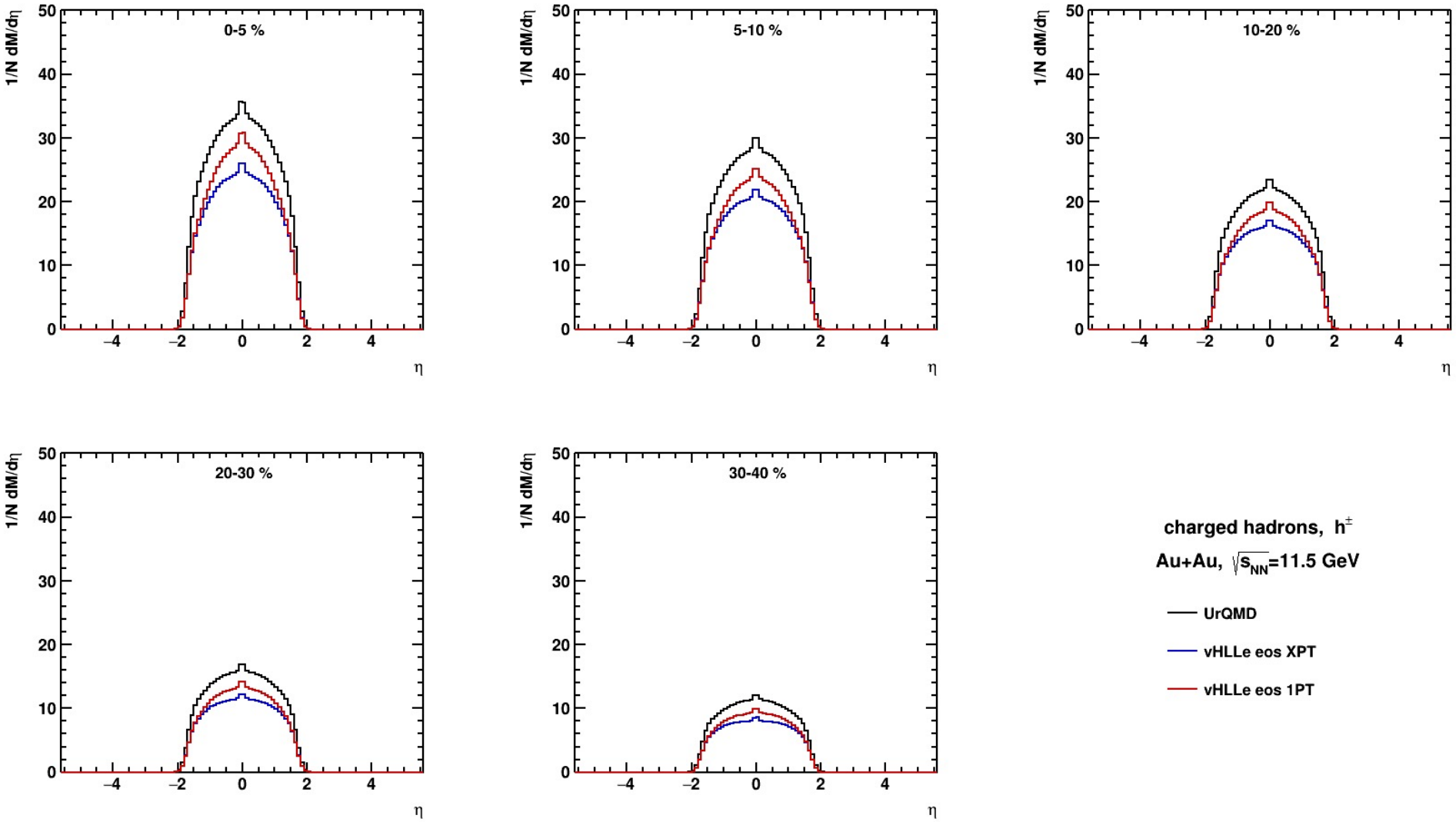
Au+Au, $\sqrt{s_{NN}}$=11.5 GeV

UrQMD

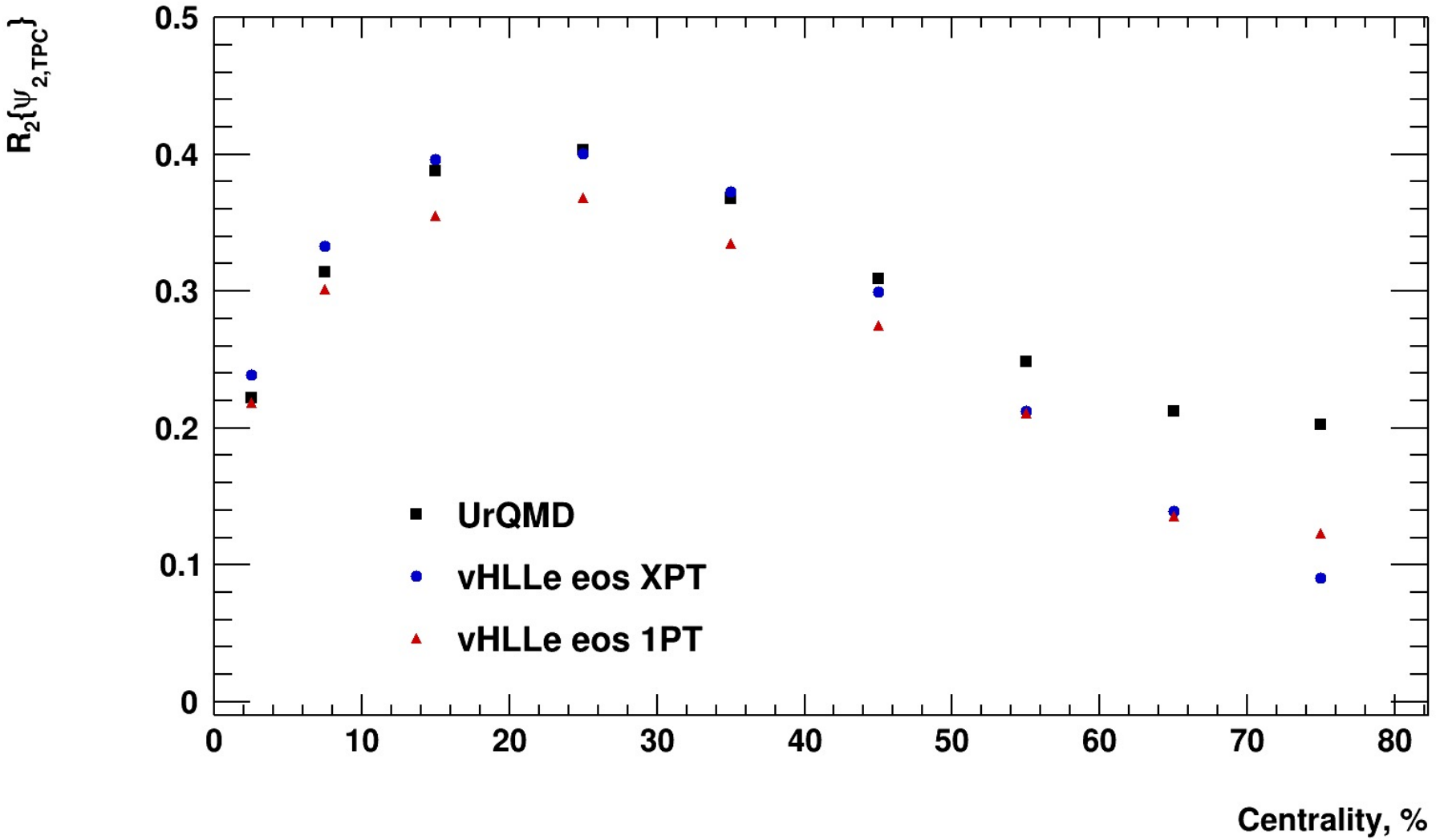
vHLLe eos XPT

vHLLe eos 1PT

Distribution of the pseudorapidity of charged particles for different centrality classes

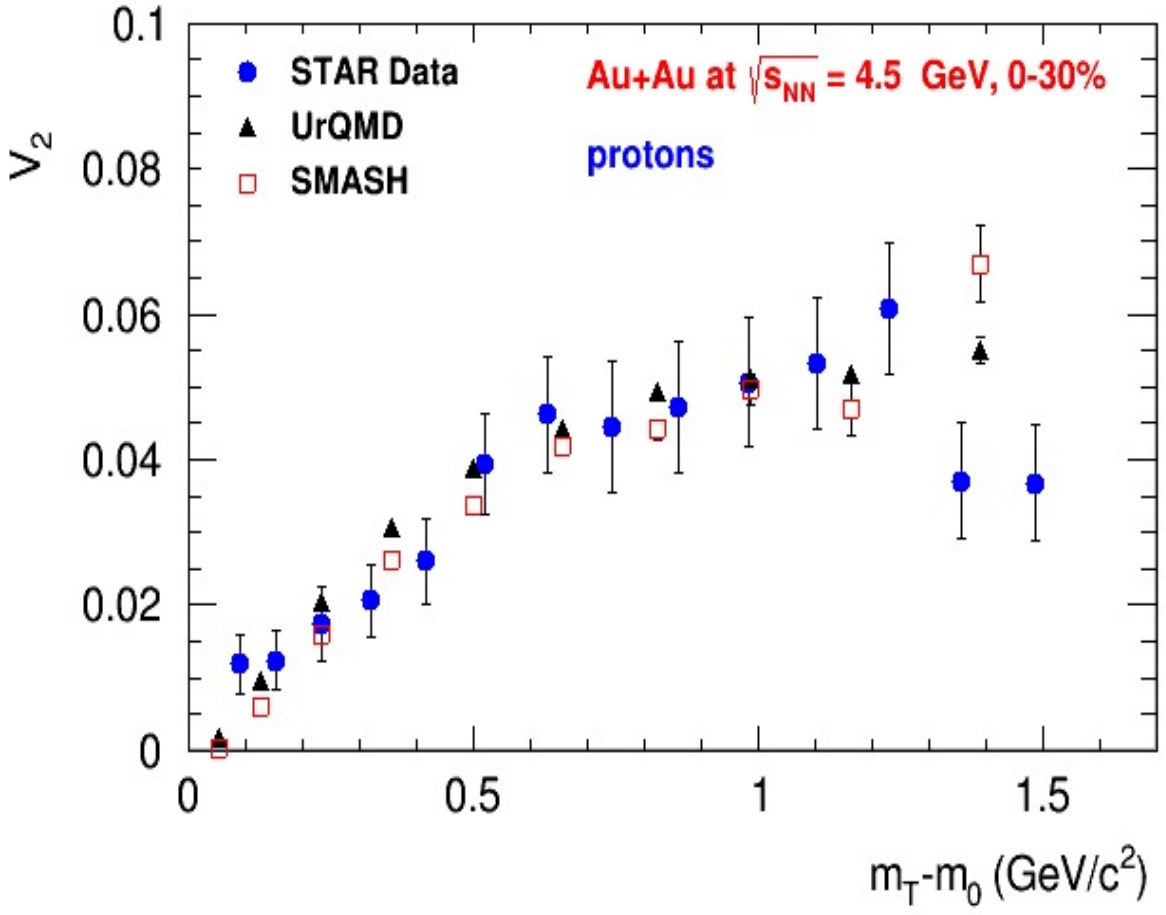


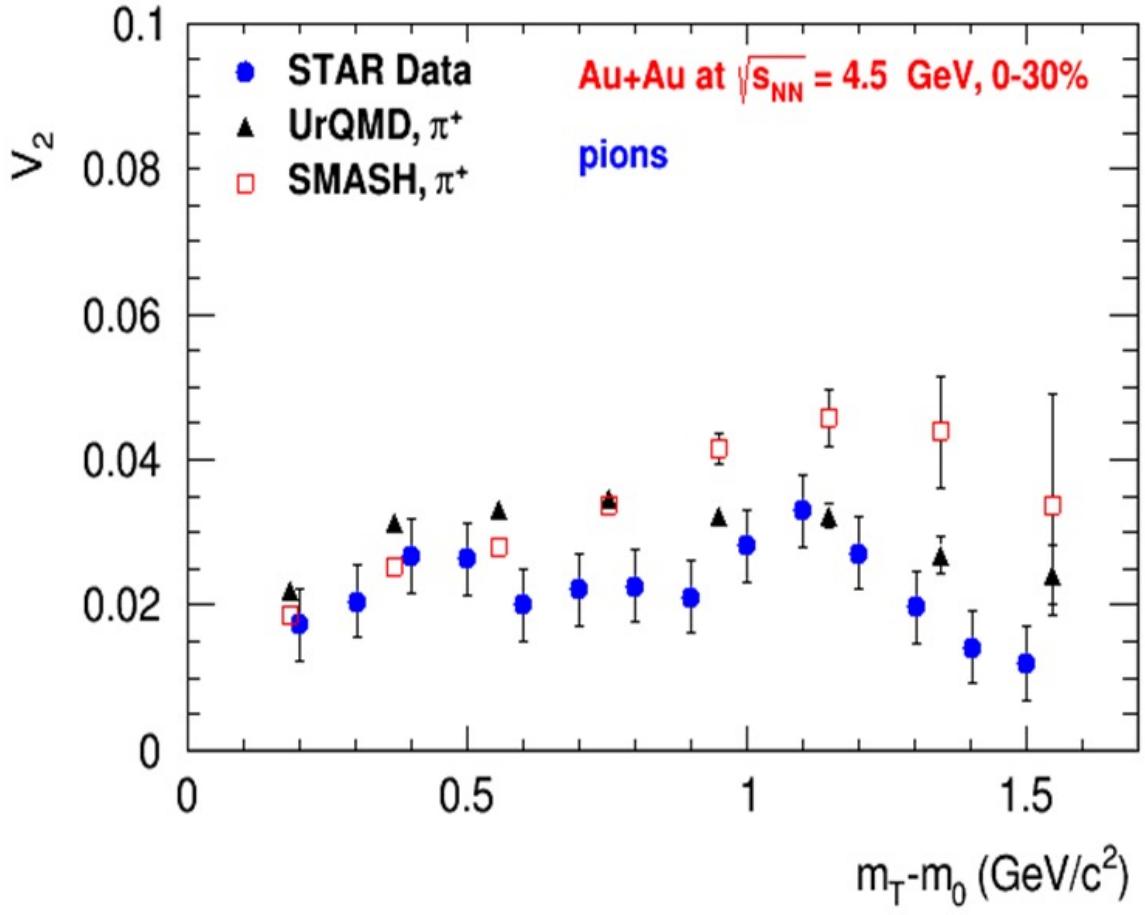
Resolution without N_{ch} cut



Elliptic flow at NICA energies: Models vs Data comparison

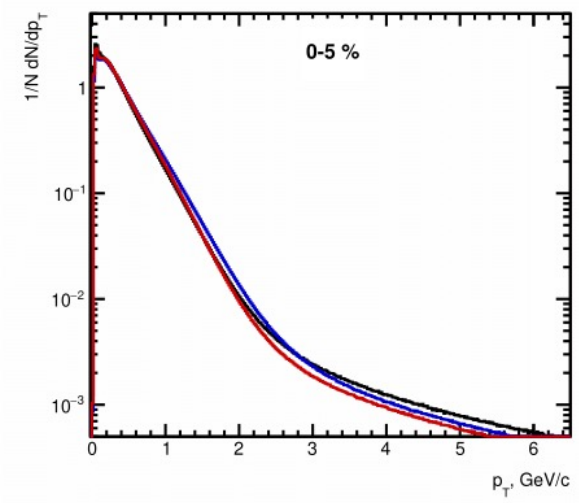
STAR Data, https://arxiv.org/abs/2007.14005

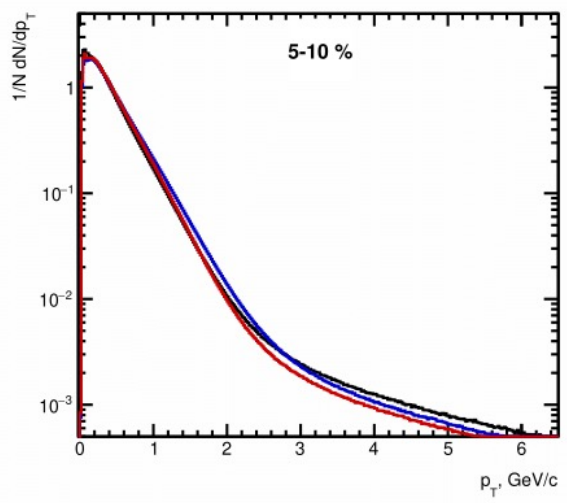


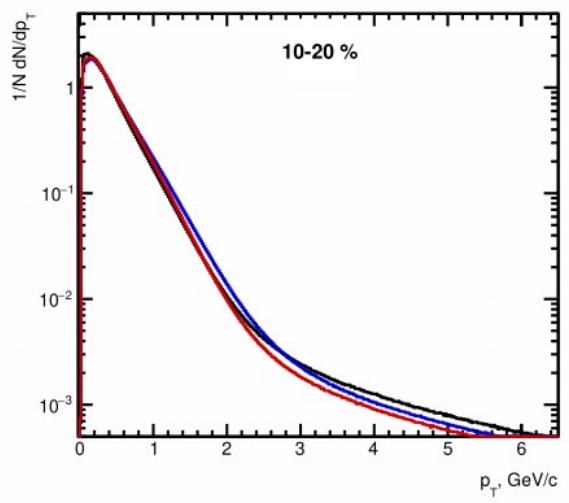


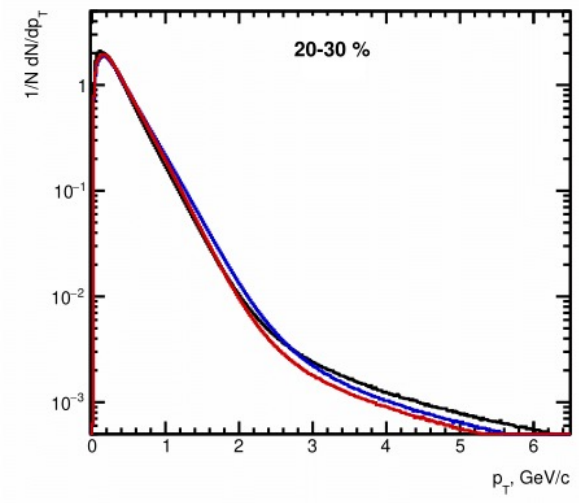
Pure String/Hadronic Cascade models give similar v_2 signal compared to STAR data for Au+Au $\sqrt{s_{NN}}$=4.5 GeV

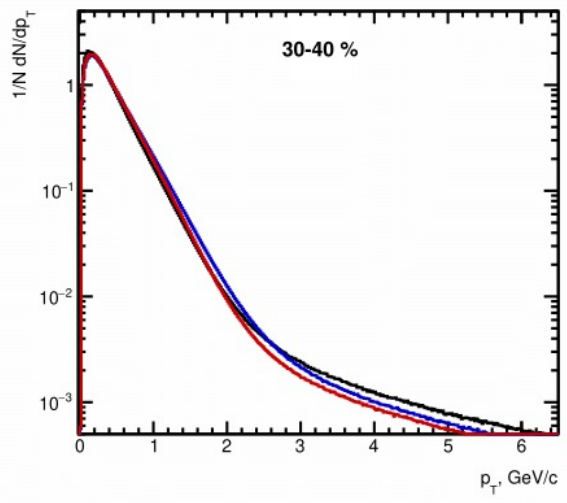
Distribution of the transverse momentum of charged particles for different centrality classes











charged hadrons, ± h

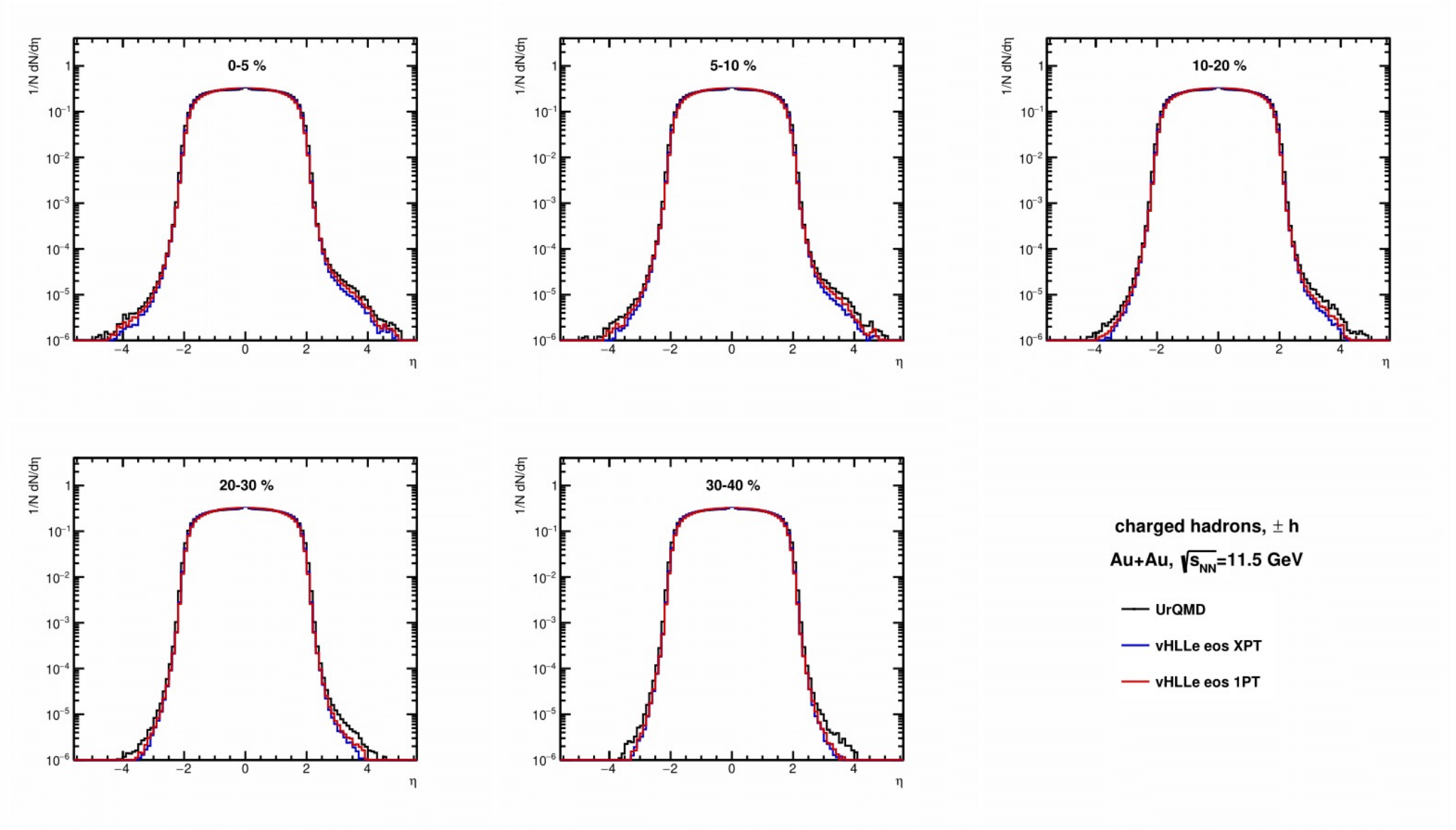
Au+Au, $\sqrt{s_{NN}}$=11.5 GeV

UrQMD

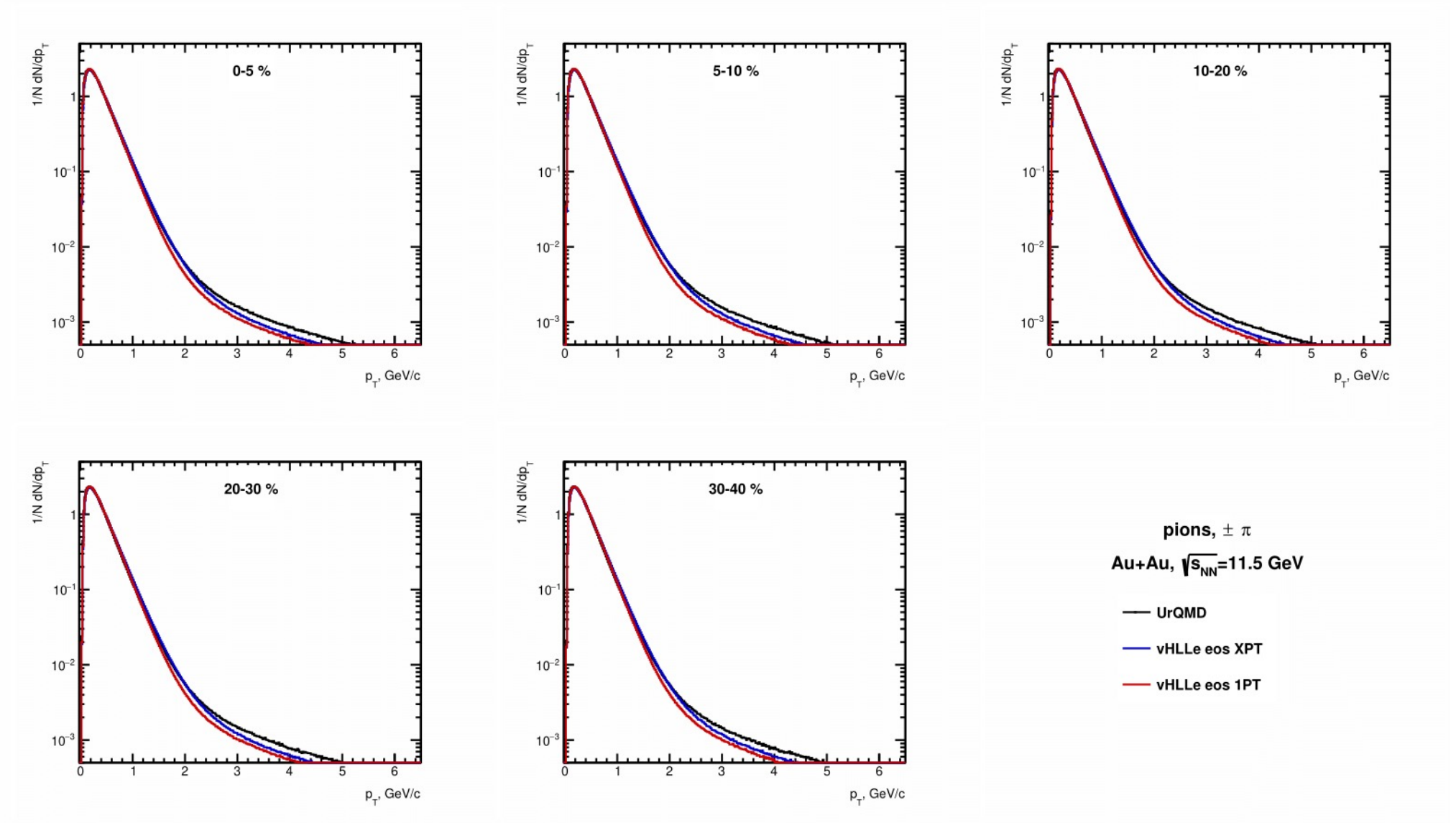
vHLLe eos XPT

vHLLe eos 1PT

Distribution of the pseudorapidity of charged particles for different centrality classes



Distribution of the transverse momentum of pions for different centrality classes



Distribution of the pseudorapidity of pions for different centrality classes