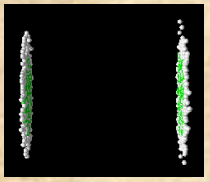
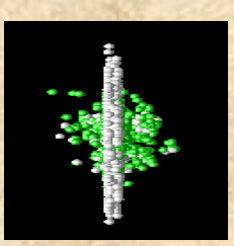
Centrality dependence of high pT hadron suppression in Au+Au collisions at $\sqrt{S_{NN}}$=130GeV

CNR Paper Talk – II

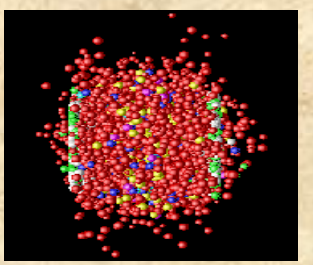
Jaiby Joseph
09/17/2010

RHIC Collisions

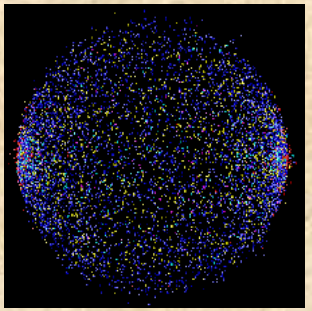




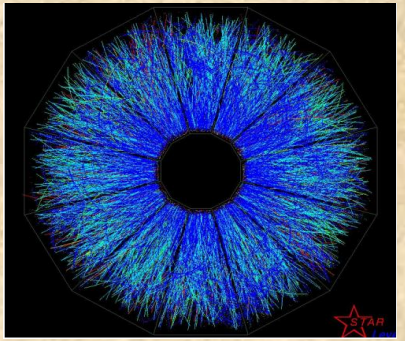
Au+Au collisions



dense medium



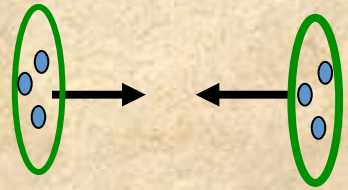
hadrons

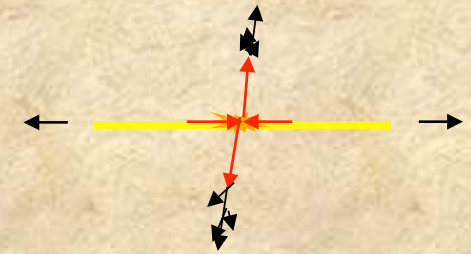


STAR Detector view of the event

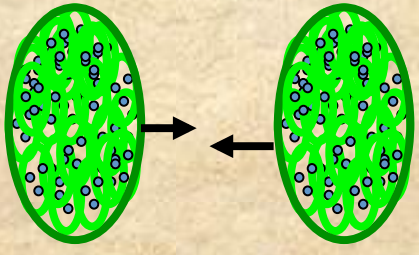
Collision systems used at RHIC are: Au+Au, Cu+Cu, p+p, d+Au at different energies.

p+p, baseline system





Au+Au collisions

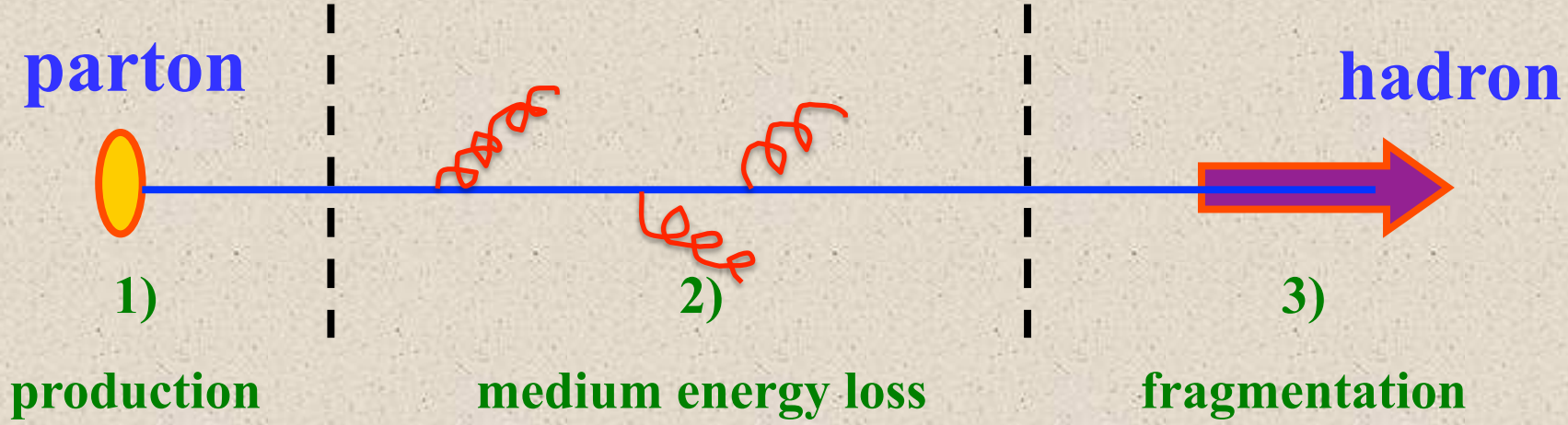


Leading jet

??

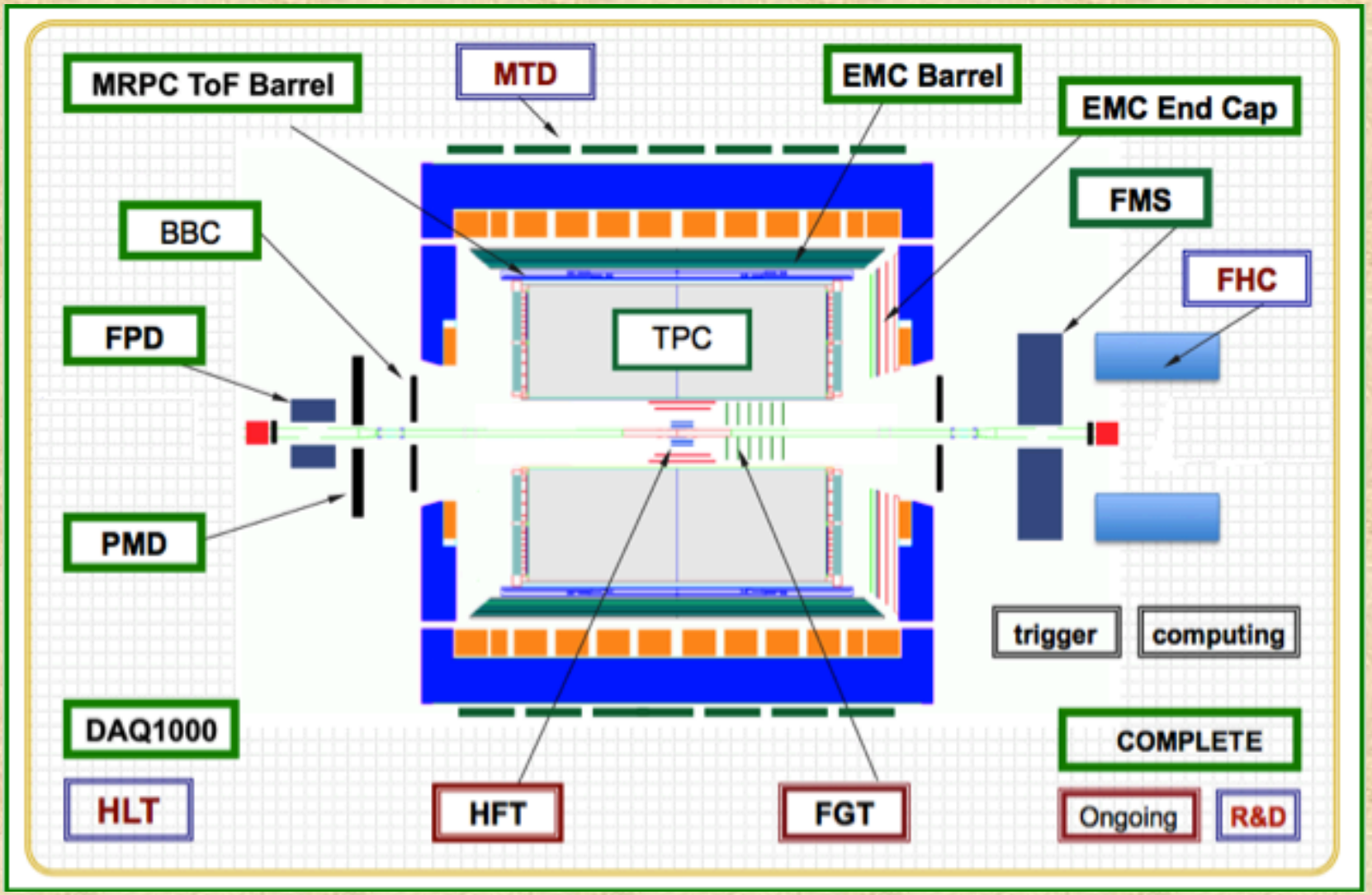
Motivation

◆ It was predicted that partons propagating through the QGP lose energy via gluon radiation with a magnitude depending strongly on the gluon density of the medium (E_{loss} ~ dN_g/dy)



◆ Hard scattering of partons occurs early in the evolution of the system, so a measurement of energy loss of high pT hadrons provides a unique tool to probe the highest density of the medium.

◆ The disappearance of the back-to-back partner of the dijet, which goes into the medium was an another motivation for looking at the high pT spectra of the hadrons.



Cross-Section View of STAR Detector with Sub-detectors

Measurement

✓A Measurement of the energy loss is done through the inclusive hadron yield, $\frac{(h^+ + h^-)}{2}$ for different centralities for 0.2 < pT <6.0 GeV/c .

✓ For comparison of spectra from Nuclear Collisions to nucleon-nucleon (NN) reference, the nuclear modification factor, R_{AA} is defined,

$$R_{AA}(pT) = \frac{d^2N^{AA}/dp_T d\eta}{T_{AA} d^2\sigma^{NN}/dp_T d\eta} \quad \text{.....(1)} \qquad \text{Where, } T_{AA} = \frac{\langle N_{bin} \rangle}{\sigma^{NN}_{inel}}$$

T_{AA} accounts for the collision geometry.

Effects of the medium can be measured at high pT by looking at deviation of $R_{AA}(p_T)$ from unity.

- **In the absence of medium effects, the yield for hard processes scales as $\langle N_{bin} \rangle$, and $R_{AA}(p_T)$ =1 for all pT.**
- **If, R_{AA} < 1, it indicates suppression.**

Event Selection & Cuts

Event Level:

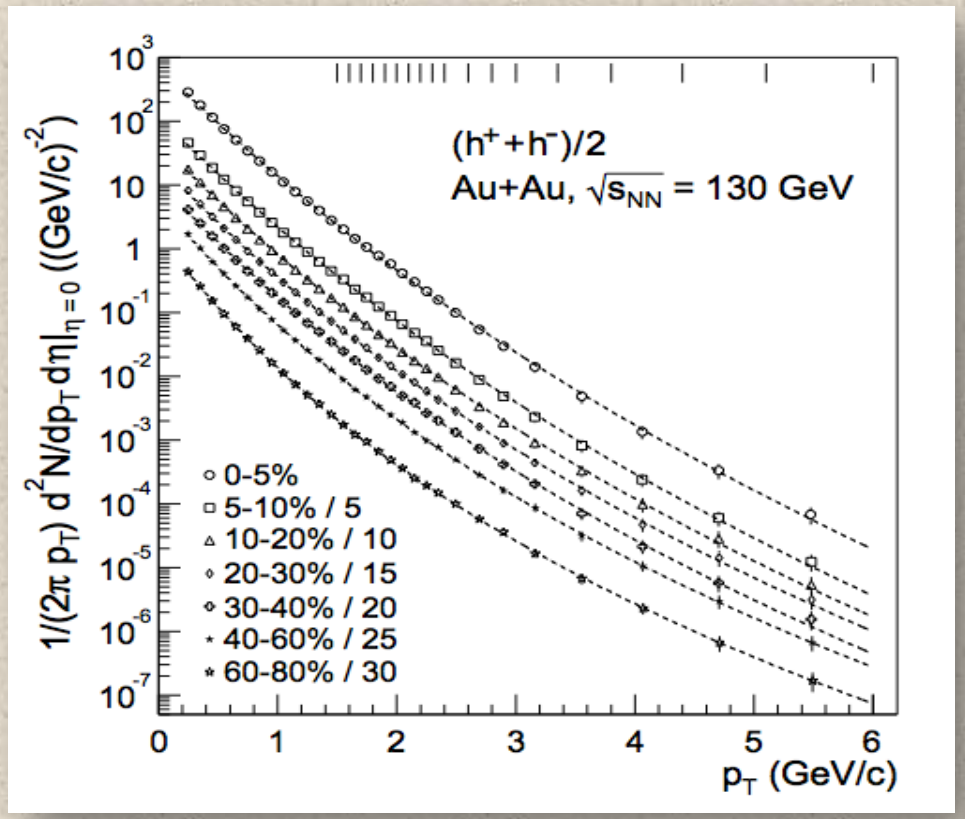
Trigger: minimum bias trigger and a trigger selecting the 10% most central events.
Centrality selection: Based on the primary charged particle multiplicity, N_{ch}.
Most Central bin ➔ 0-5%, Most Peripheral bin ➔ 60-80%

Track Level

Track Selection: pT>2GeV/c
$|\eta|<0.5$
DCA_{PV} < 1 cm.

Inclusive pT distribution of $(h^+ + h^-)/2$

Au+Au Collisions at $\sqrt{S_{NN}}$=130GeV

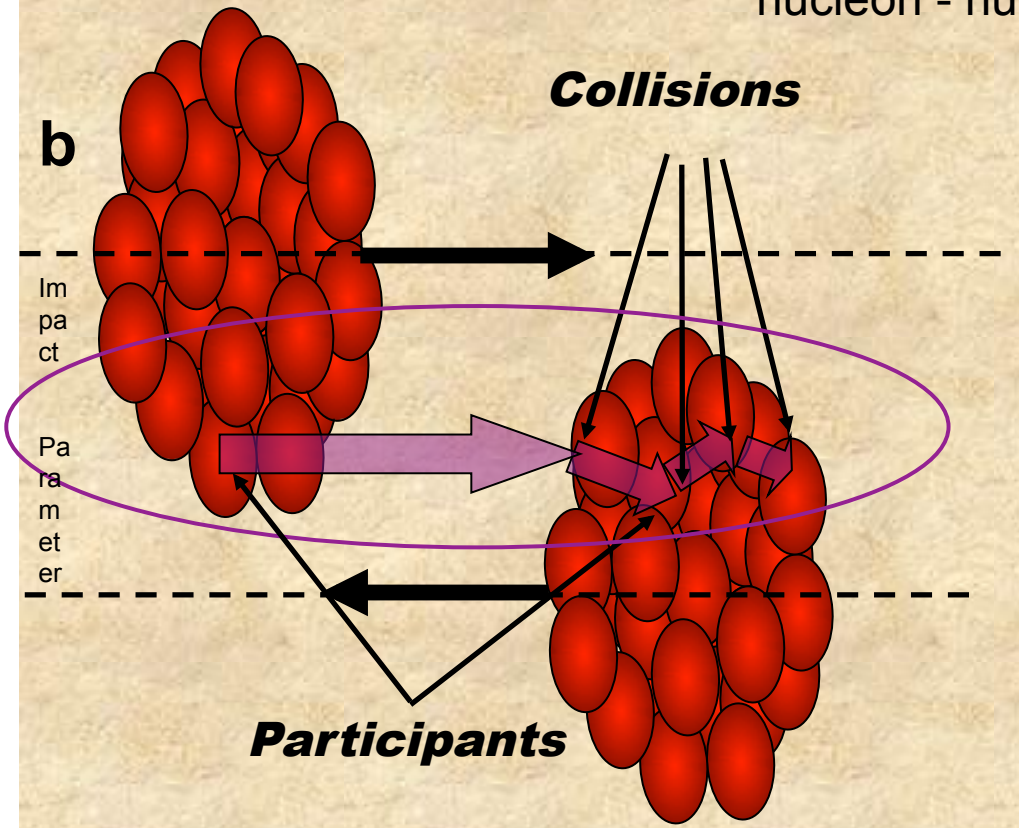


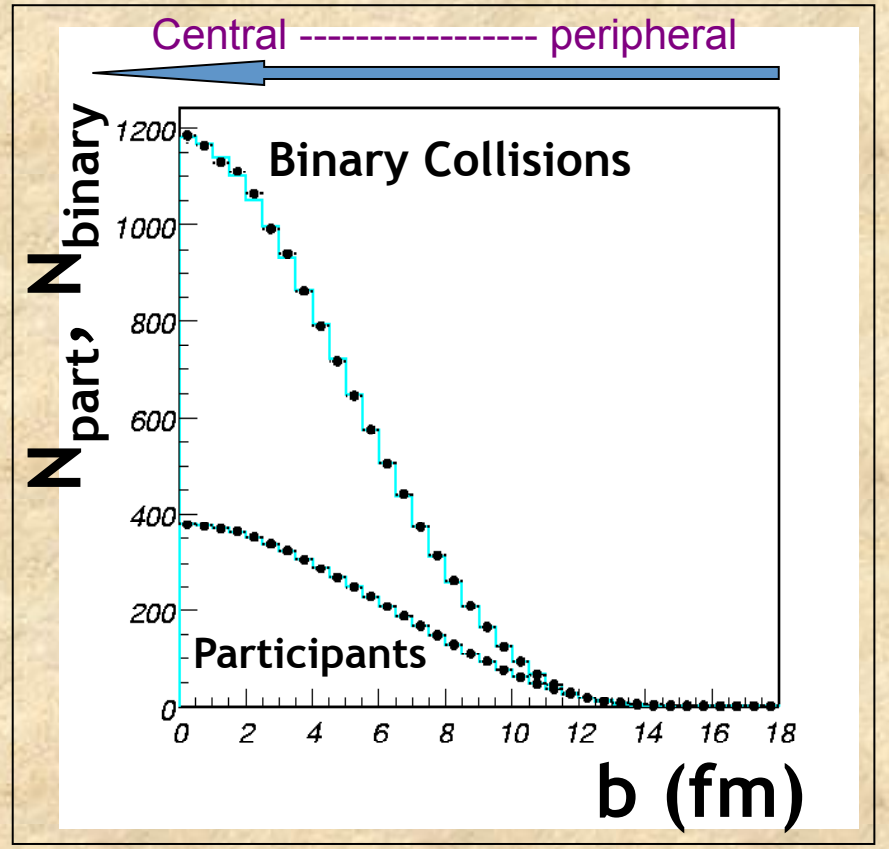
The spectra is fitted with power-law function: $\frac{1}{2\pi p_T}\frac{dN}{dp_T} = C\left(1 + p_T/p_0\right)^{-n}$ →(2)

The systematic changes in shape of the spectra with centrality are revealed by the fit parameters C, n and <pT>= $2p_0/(n-3)$

Geometry of the collision

$N_{bin}(N_{coll})$: number of inelastic nucleon - nucleon collisions (# binary collisions)





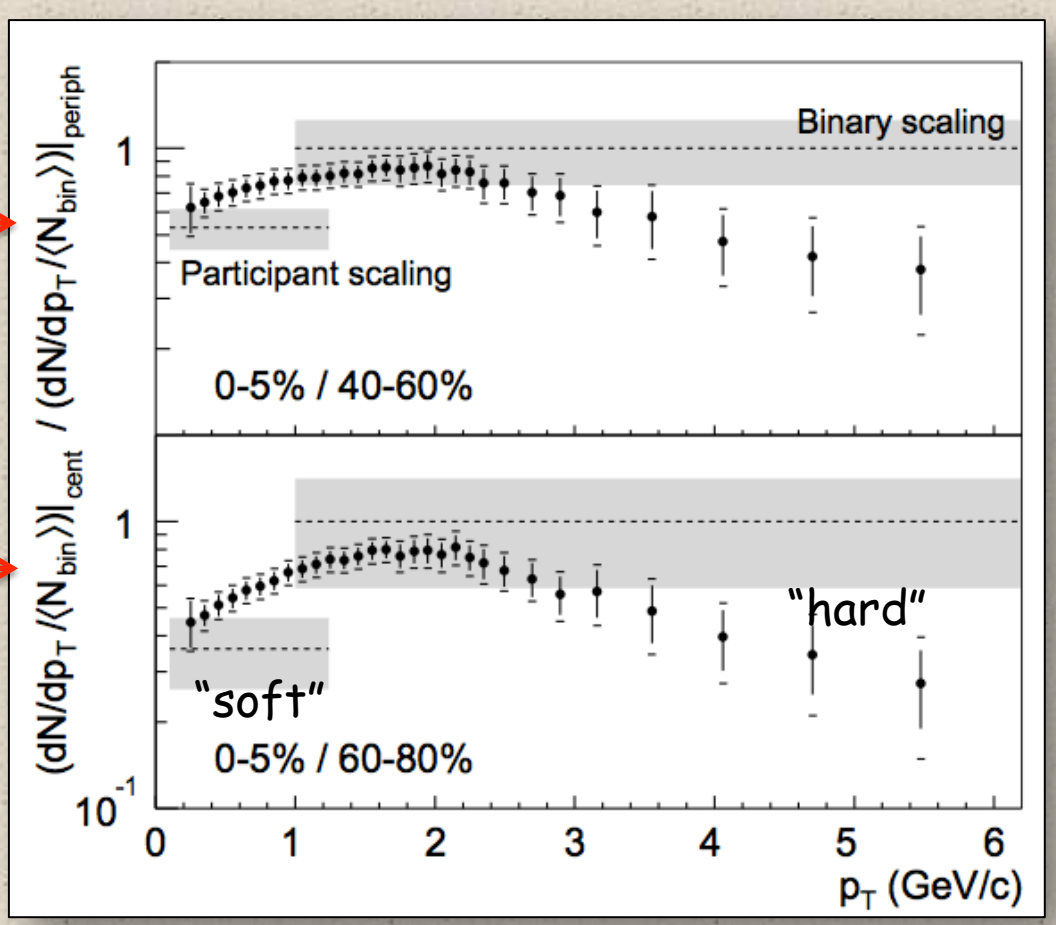
N_{part} number of nucleons in the overlap region

Ratio of charged hadron yields –Central to Peripheral

"R_{CP}"

Central (0-5%) to peripheral (40-60%)

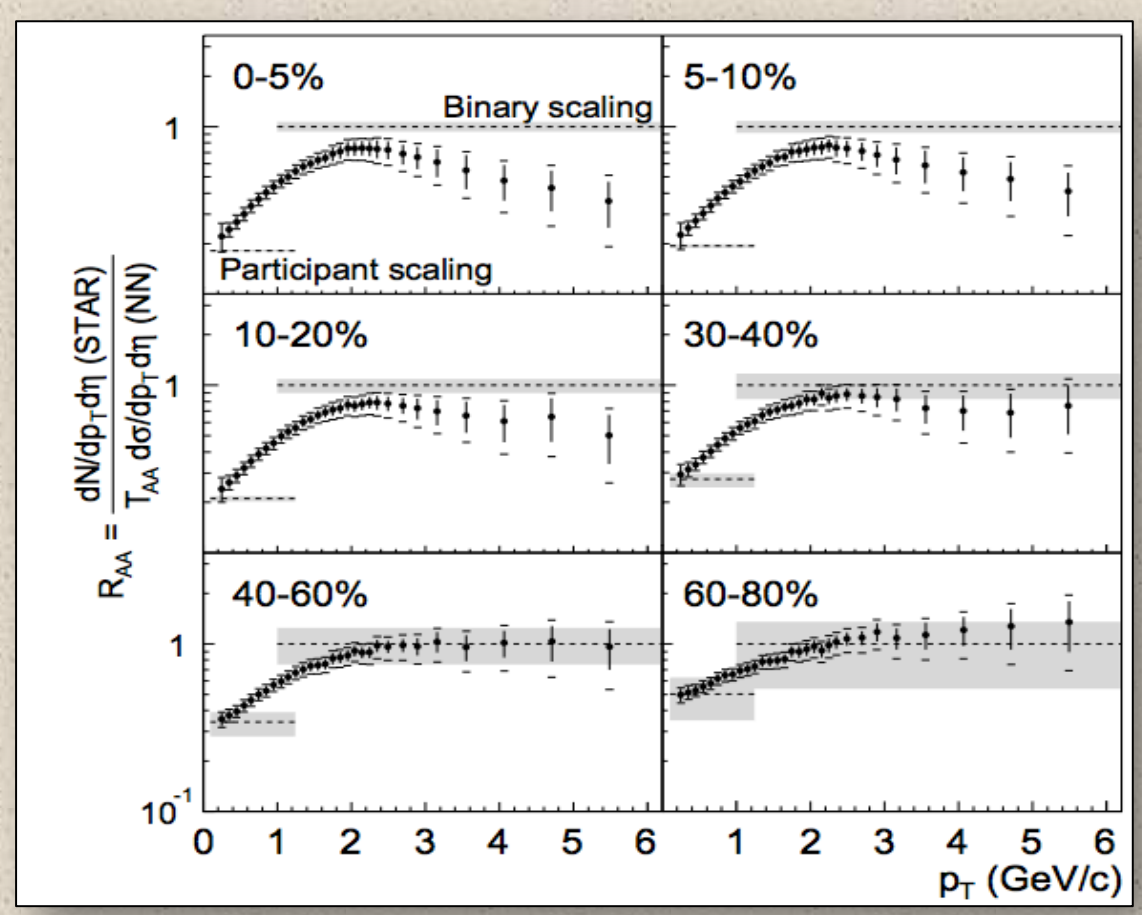
Central (0-5%) to peripheral (60-80%)



The ratio shows significant suppression of charged hadron production at high p_T (> ~ 2GeV/c) in central AuAu collision compared to peripheral collisions.

Ratio of charged hadron yields – "R_{AA}" for various centralities

RAA(pT) relative to NN reference spectrum. (Parameterized with power-law function)



✧ For pT < 2GeV/c, RAA increases monotonically for all centralities

✧ For pT> 2GeV/c, RAA saturates near unity for peripheral bins → "No Suppression"
RAA shows strong decrease for central bins → Suppression

Summary

- At high pT, significant suppression of hadron production is seen for central collisions while hadron yields scale with the number of binary collisions for peripheral events.
- Indication of substantial energy loss of the final state partons in the medium (QGP).
- Energy loss of partons softens the hadronization of jets, leading to the suppression of high pT hadron yield in the final state.