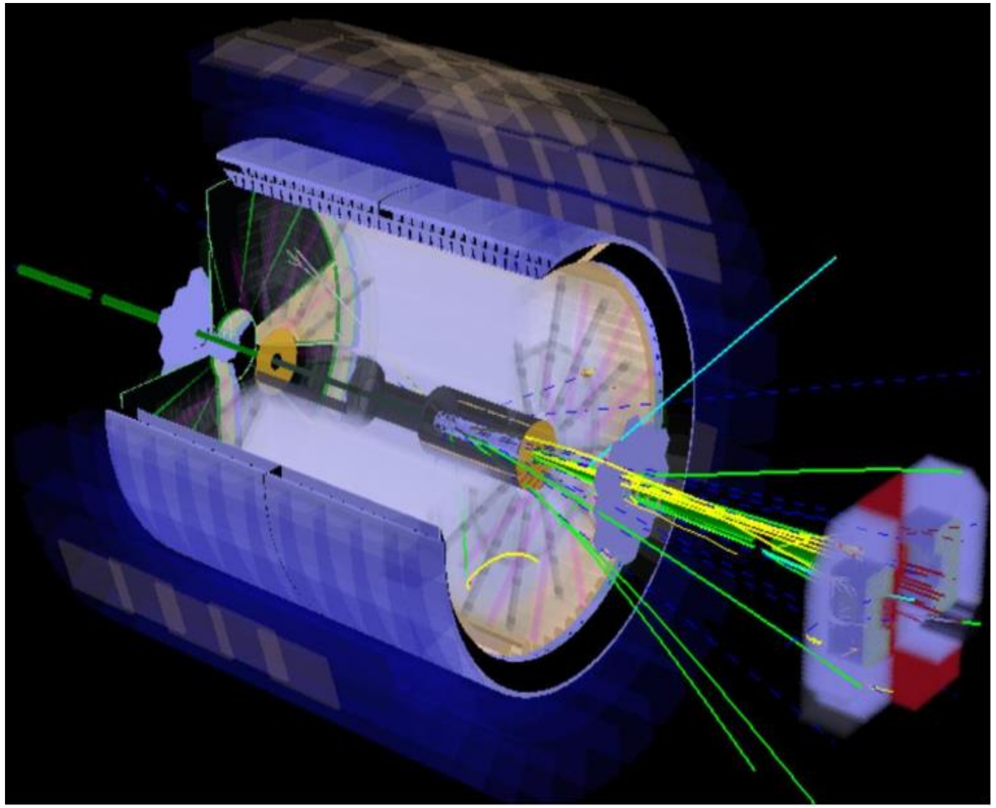
Forward-backward transverse momentum correlations for Au-Au collisions at 27 GeV

Tongzhou Guo   Shengli Huang   Chunjian Zhang   Jiangyong Jia

Dec. 23   2020

Outline

- Physics motivations for the $\boldsymbol{p_T}$ correlation calculation and important physical quantities to describe correlations.
- Analysis results on forward-backward p_T correlations and their comparison with adjacent correlation calculations (AuAu collisons at 27 GeV).
- Conclusions and Outlooks.



➢ Motivations

- The forward-backward $\boldsymbol{p_T}$ correlations are created predominantly at the early stages of the heavy ion collision, so the study of $\boldsymbol{p_T}$ correlations will lead to a better understanding of the initial conditions and early dynamics.
- $\boldsymbol{p_T}$ correlations are believed to give insight into the mechanism of energy deposition in heavy ion collisions and could serve as a probe of the properties of the medium formed.

➢ Notations

- Average of tranverse momentum in an event: $[p_T] = \frac{1}{n}\sum_{i=1}^{n} p_T^i$, where $[\ldots]$ stands for an average in a single event.
- Ensemble average of tranverse momentum: $\langle[p_T]\rangle = \frac{1}{N}\sum_{ev=1}^{N}[p_T]_{ev}$, where $\langle\ldots\rangle$ denotes an average taken over all the events.

Two important physical quantities, $\boldsymbol{b}$ vs $\boldsymbol{\rho}$

- $\mathrm{b}([p_T]_I,\ [p_T]_{II}) \coloneqq \frac{Cov([p_T]_I, [p_T]_{II})}{\sqrt{Var([p_T]_I)}\sqrt{Var([p_T]_{II})}}$, *pearson coefficient*

  -> $Cov([p_T]_I,\ [p_T]_{II}) \coloneqq \langle([p_T]_I - \langle[p_T]\rangle_I)([p_T]_{II} - \langle[p_T]\rangle_{II})\rangle$

  -> $Var([p_T]) \coloneqq \langle([p_T] - \langle[p_T]\rangle)^2\rangle$

  -> $Var([p_T]) = \left\langle(\frac{1}{n}\sum_i p_T^i - \langle[p_T]\rangle)^2\right\rangle = \left\langle\frac{1}{n^2}\sum_{i,j}(p_T^i - \langle[p_T]\rangle)(p_T^j - \langle[p_T]\rangle)\right\rangle$

- $\rho([p_T]_I,\ [p_T]_{II}) \coloneqq \frac{Cov([p_T]_I, [p_T]_{II})}{\sqrt{C([p_T]_I)}\sqrt{C([p_T]_{II})}}$, p_T *flow correlation coefficient*

  -> $\mathrm{C}([p_T]) \coloneqq \left\langle\frac{1}{n(n-1)}\sum_{i\neq j}(p_T^i - \langle[p_T]\rangle)(p_T^j - \langle[p_T]\rangle)\right\rangle$

  -> Applying the variance excluding the self-correlation; more meaningful.

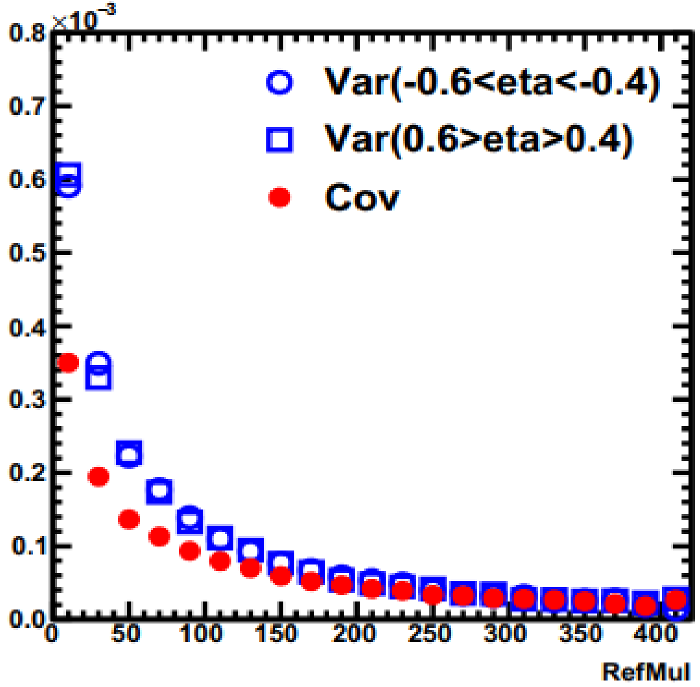
Cuts applied in my analysis

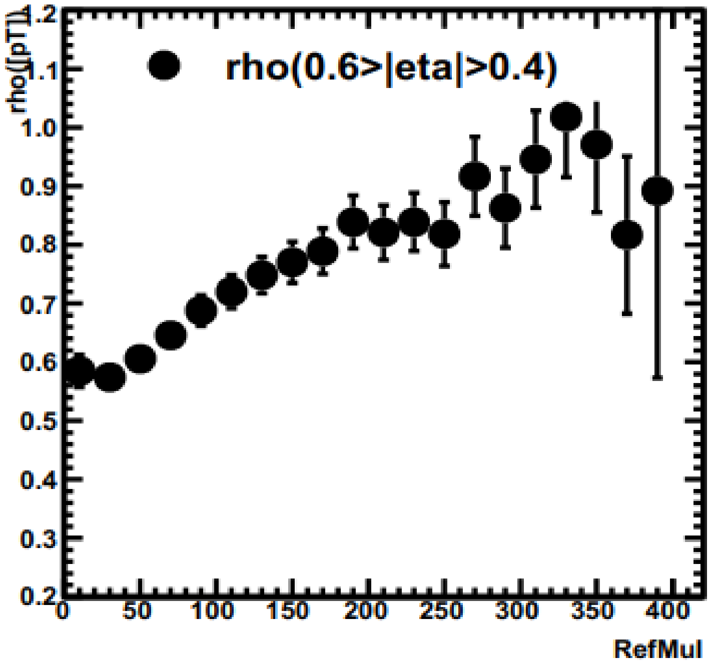
➢ Event Cuts

- Energy: 27GeV
- Trigger setup name: 27GeV_production_2018
- Centrality: official StRefMultCorr
- Trigger ID: 610011, 610016, 610021, 610026, 610031, 610046, 610051
- |Vz|<30.0 |Vr|<2.00

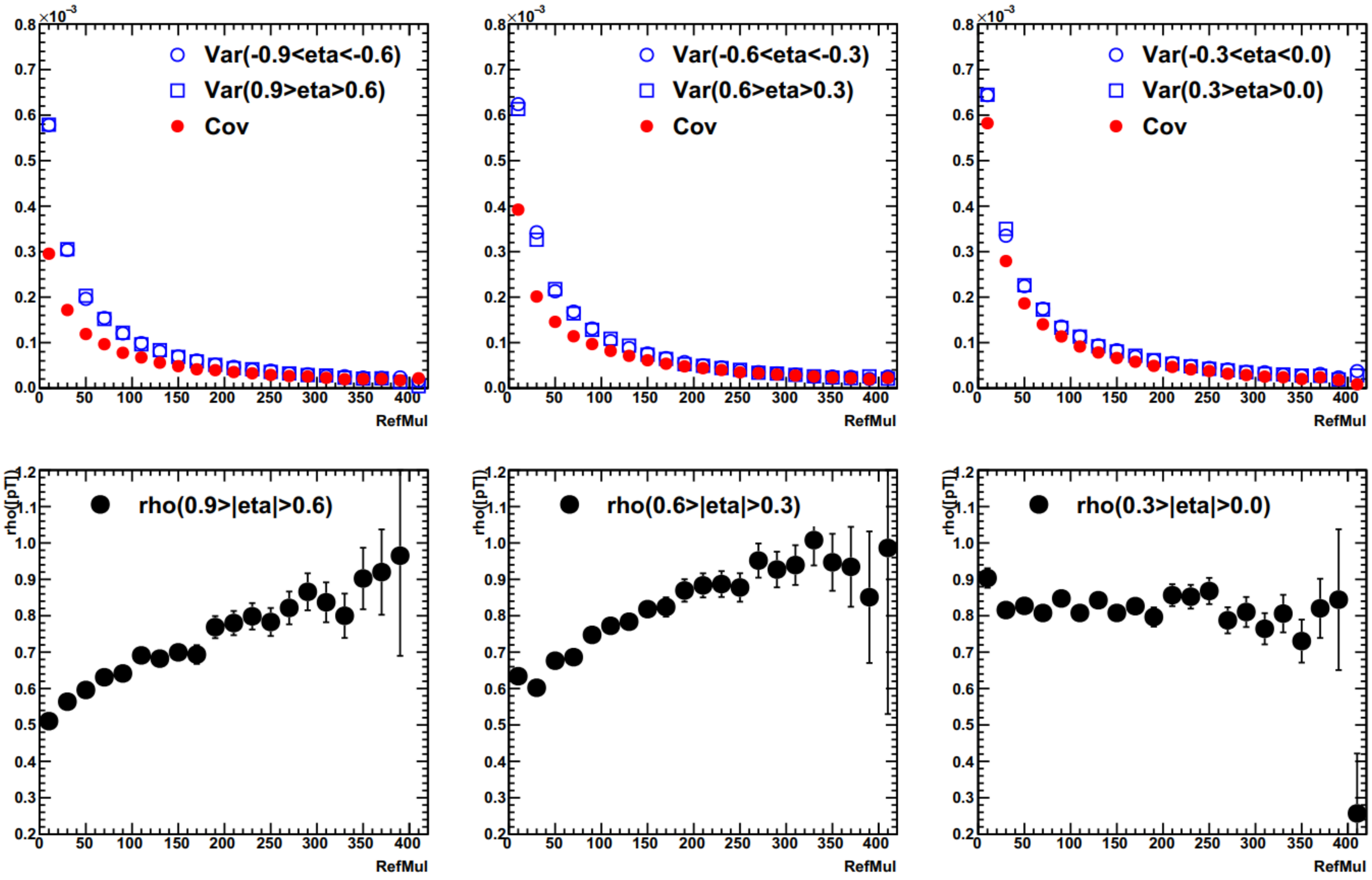
➢ Track Cuts

- nHitsFit>15   nHitsFit/nHitsMax > 0.52
- Dca < 3cm |eta|<1
- $0.2 < pt < 2.0\ GeV/c$



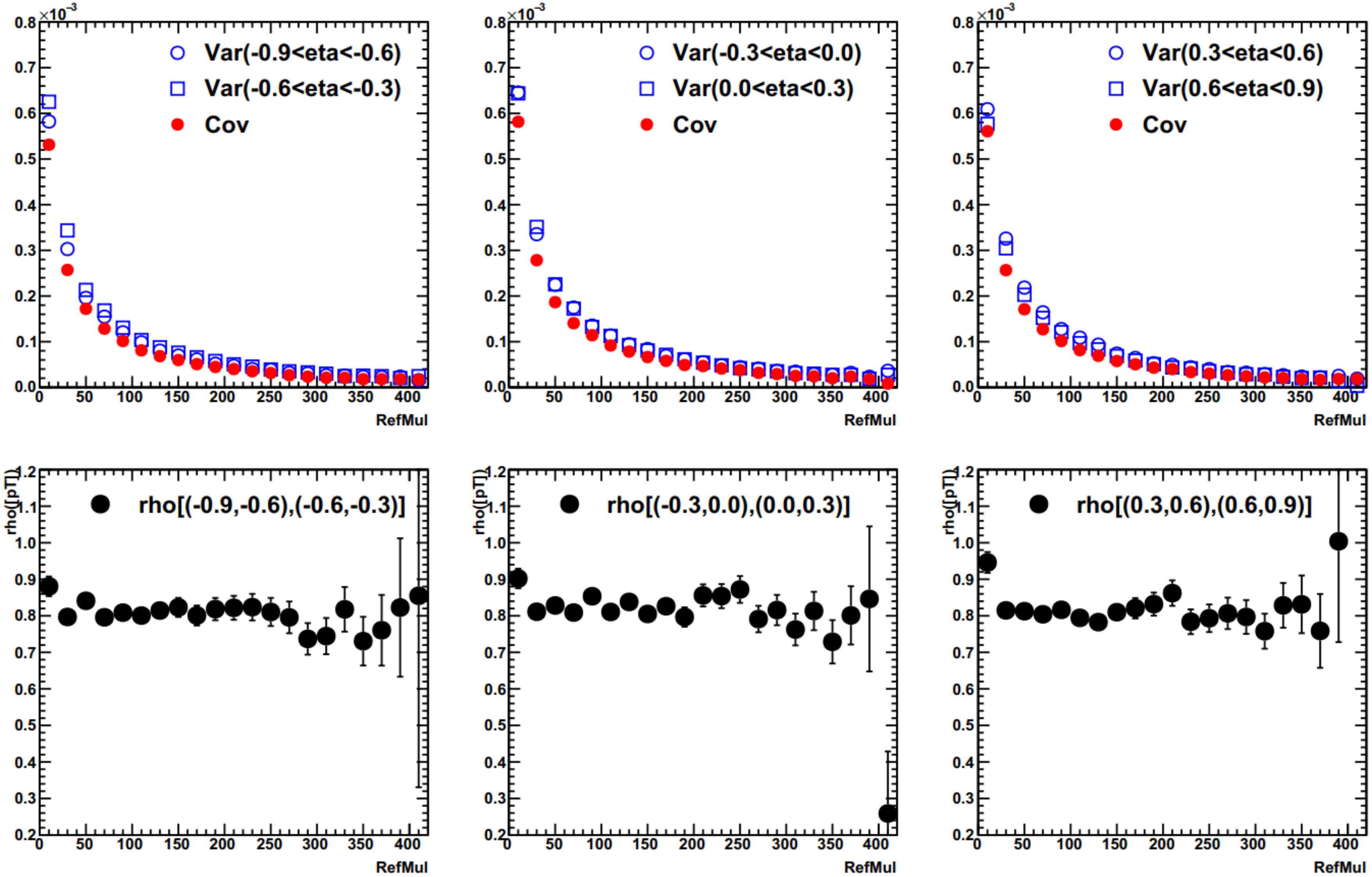


FB correlations at (-0.9, 0.9), width: 0.3



- **FB correlations**
  - There is an observable centrality dependence for forward-backward correlations.
  - The slope is slightly greater when the gap of the pseudorapidity is wider.

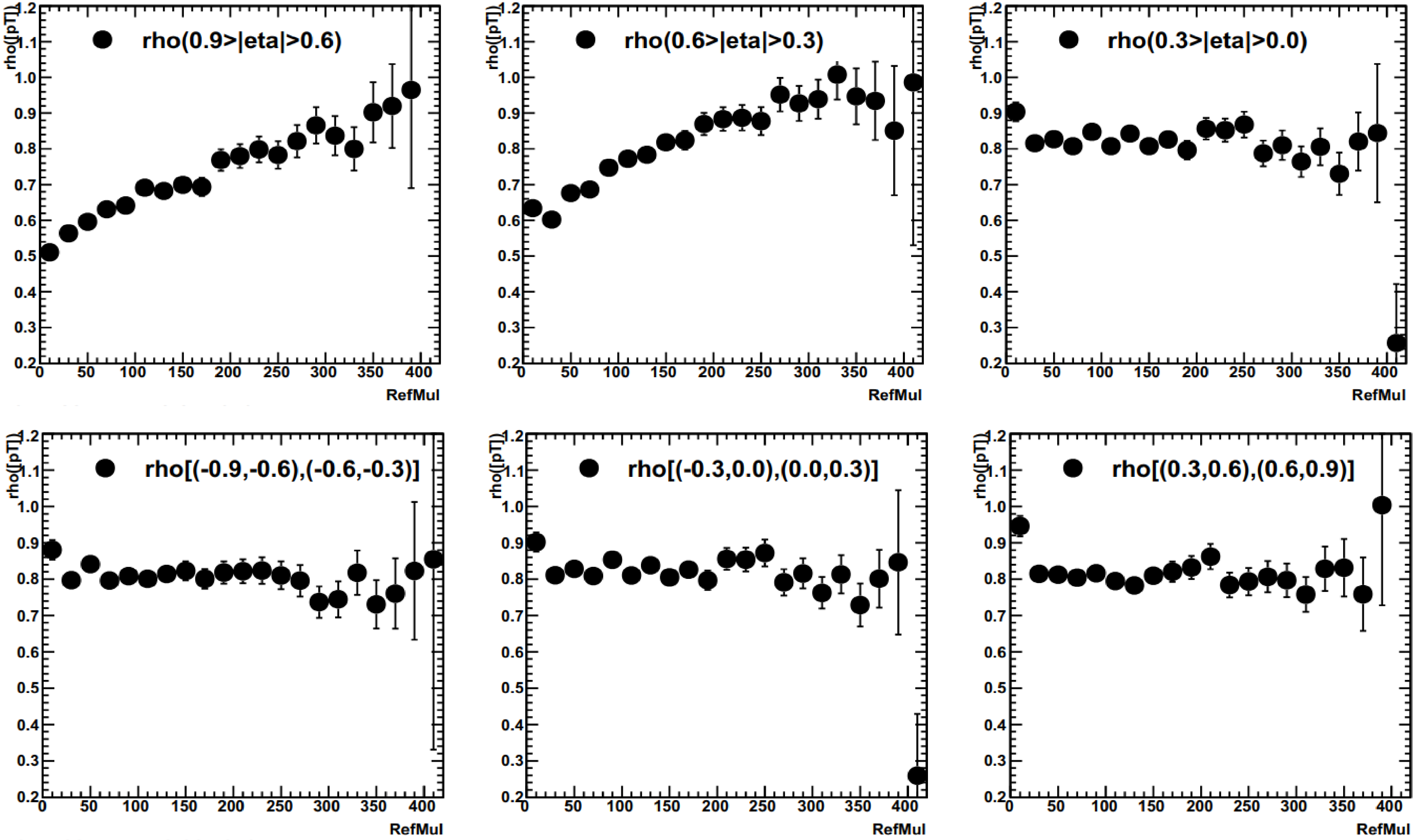
Correlations at adjacent intervals, width: 0.3



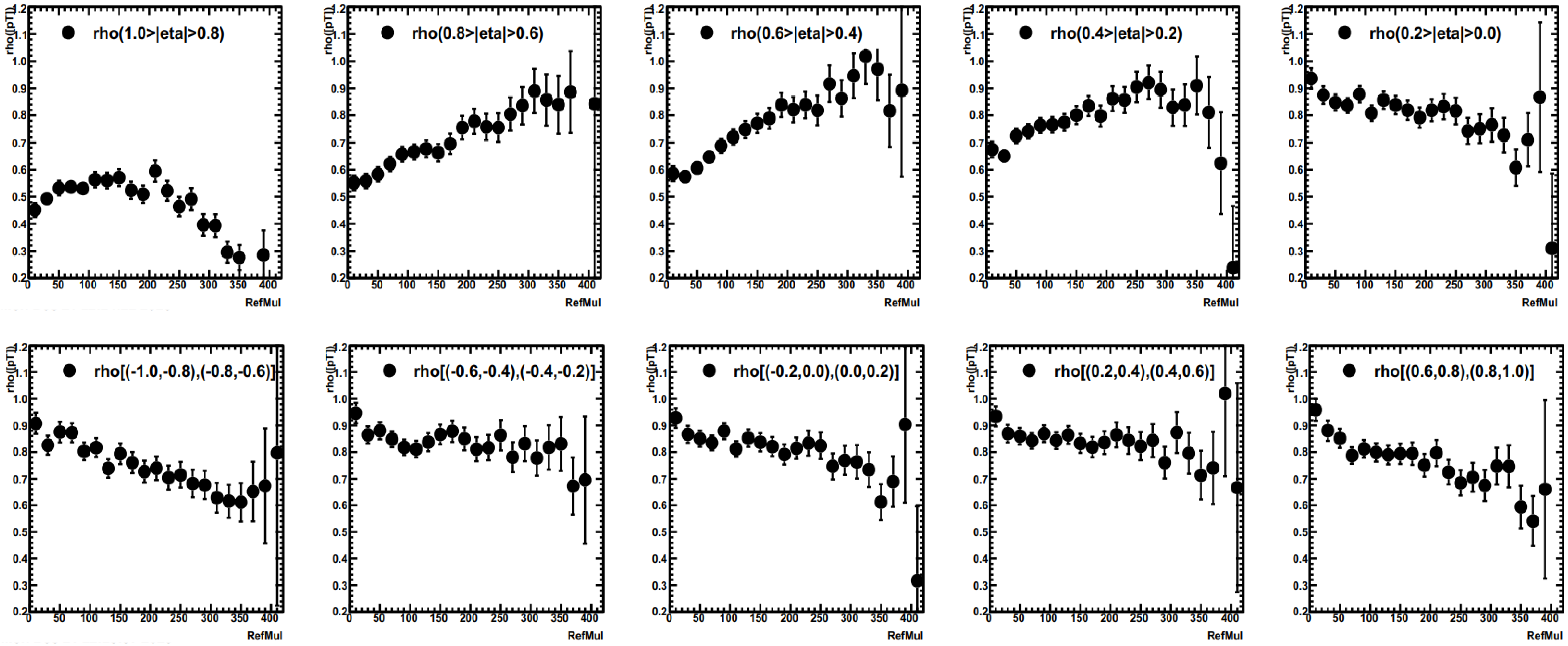
- **Correlations at adjacent intervals**

- No pseudorapidity gaps applied when calculating the correlation coefficients.
- The slopes are close to zero. No obvious centrality dependence.

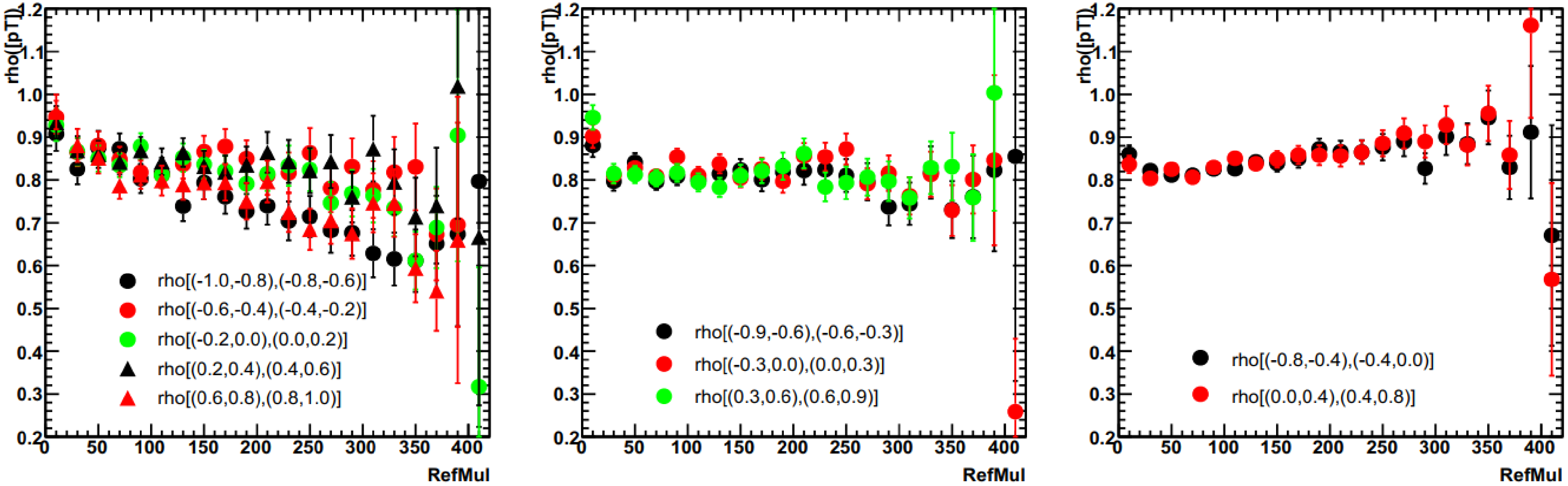
A comparison: FB correlations *vs* adjacent correlations

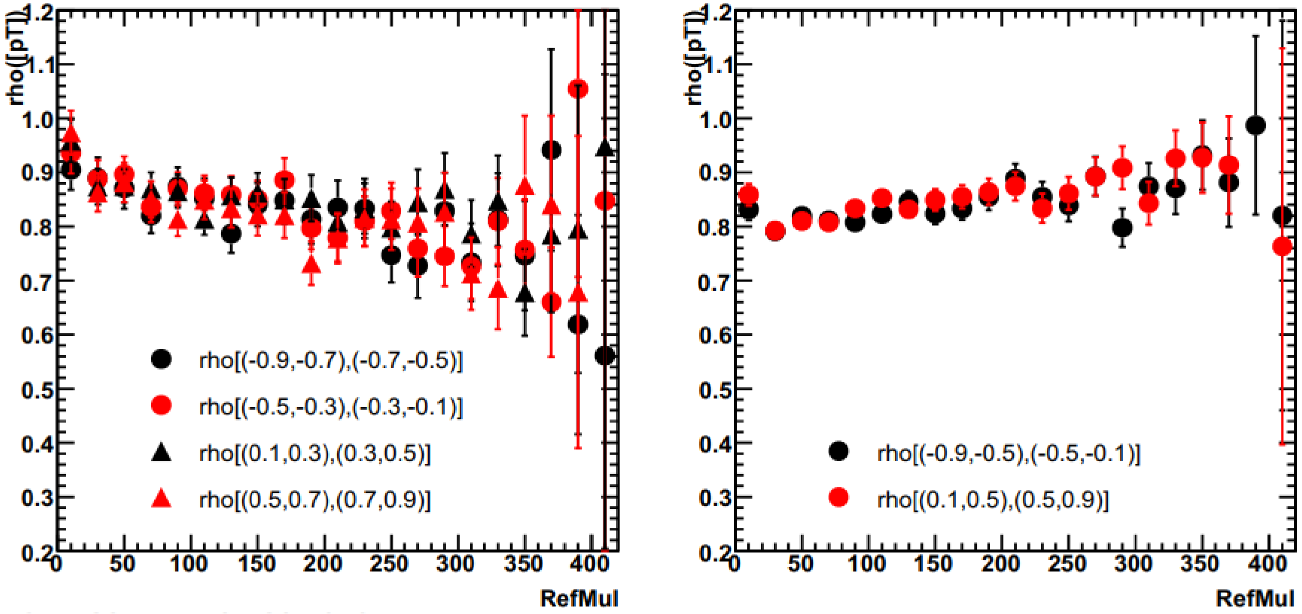


FB *vs* adjacent correlations at (-1.0, 1.0), width: 0.2



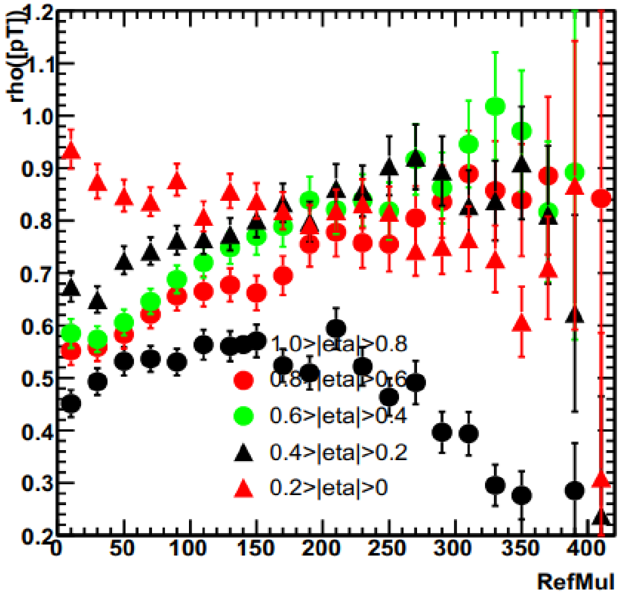
A summary: results for adjacent correlation

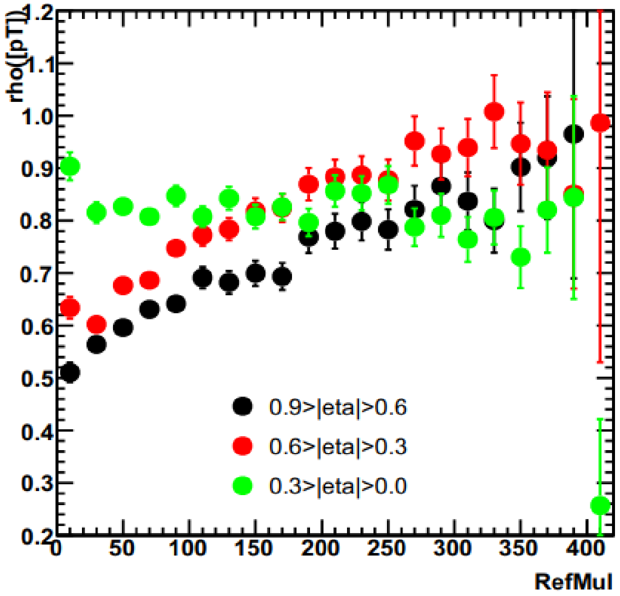


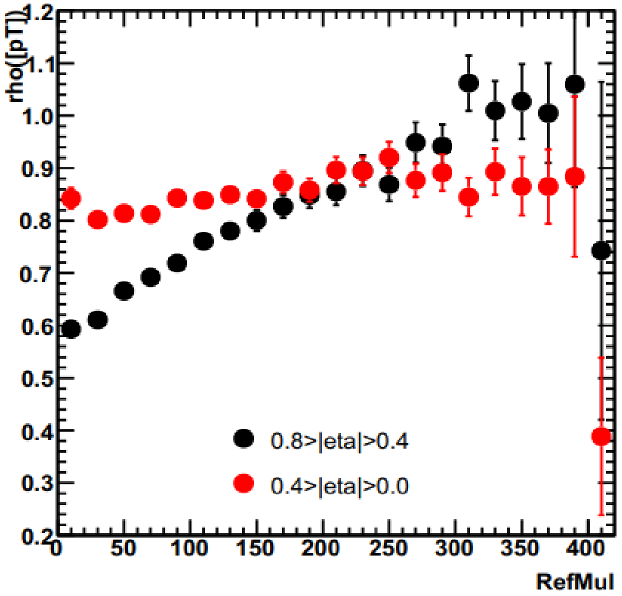


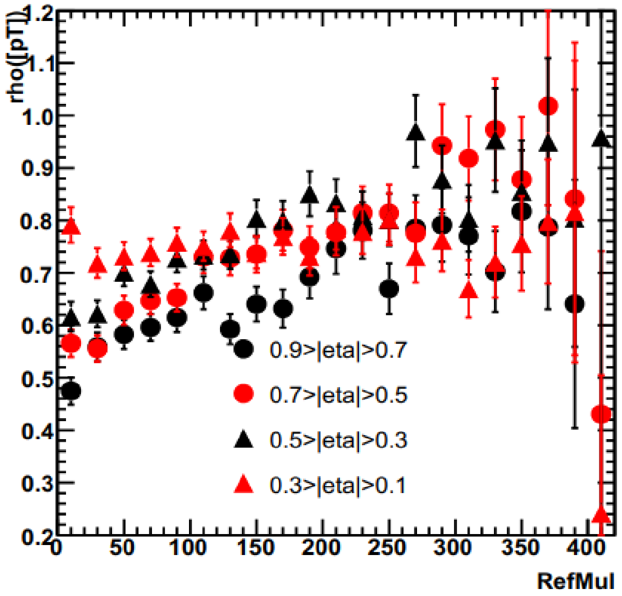
- No obvious centrality dependence can be observed in adjacent correlations.
- The curves are close to each other.

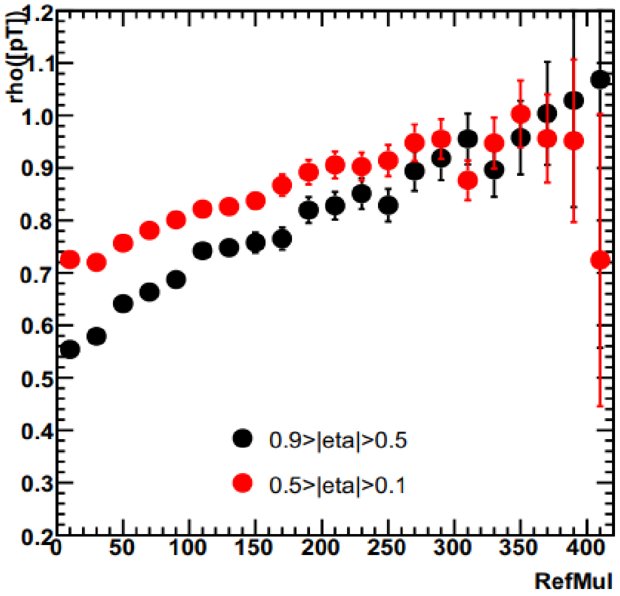
A summary: results for forward-backward correlation



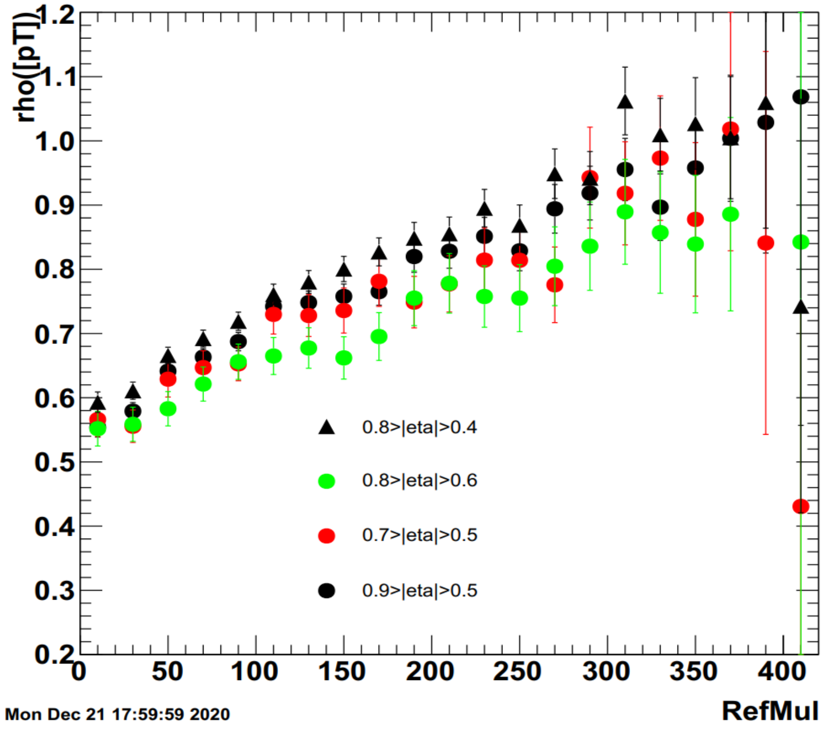








- The slope is greater with the increase of the gap width.
- Most of the curves intersect with each other.



- Comparing with adjacent correlations, there is an observable centrality dependence for ρ in FB correlations.
- No obvious eta range dependence for FB correlations can be identified.

Conclusions and Outlooks

- ➢ The centrality dependence of ρ will be studied more comprehensively by fitting and its physical meanings will be discussed.
- ➢ The relations between ρ and the pseudorapidity bins selection in a fixed centrality will be learned.
- ➢ Calculations for other statistical quantities, such as pearson coefficient b (which includes the self-correlation) are in progress.
- ➢ Calculations at different energy ranges (54 and 200 GeV) are in progress.