Interplay of correlations & fluctuations at RHIC — What do we learn?

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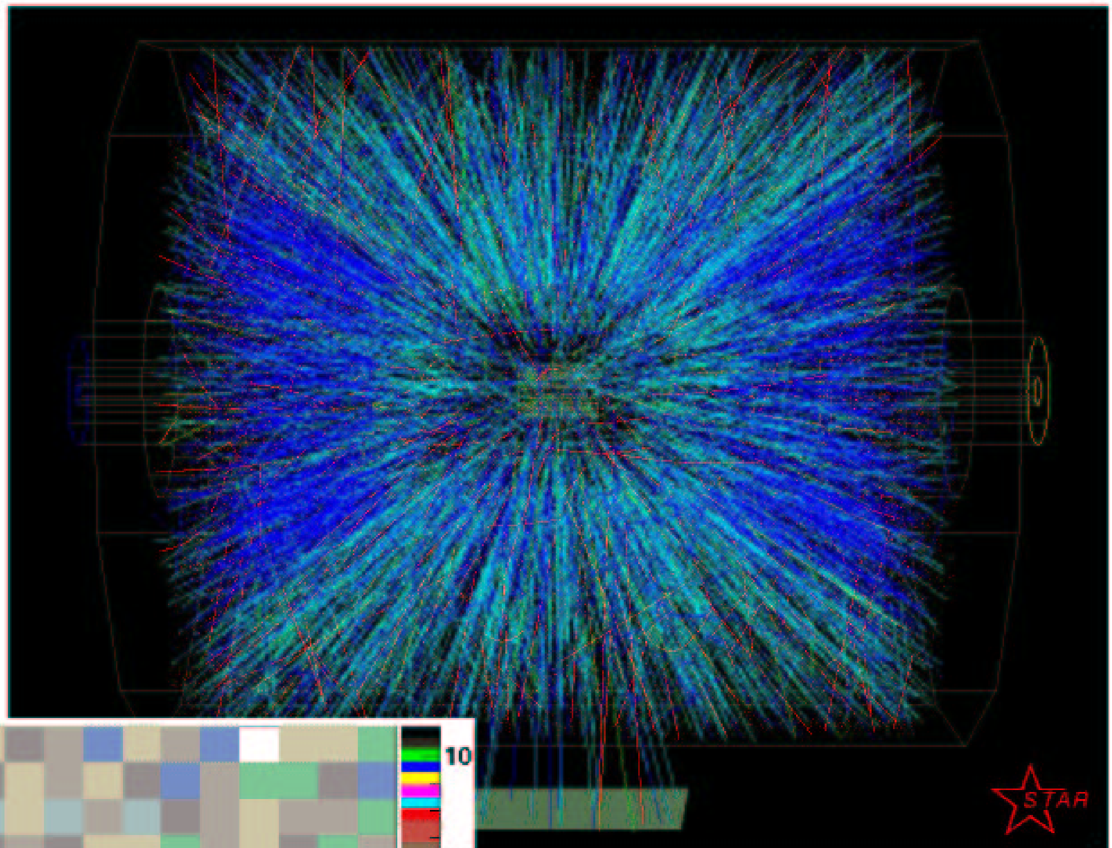
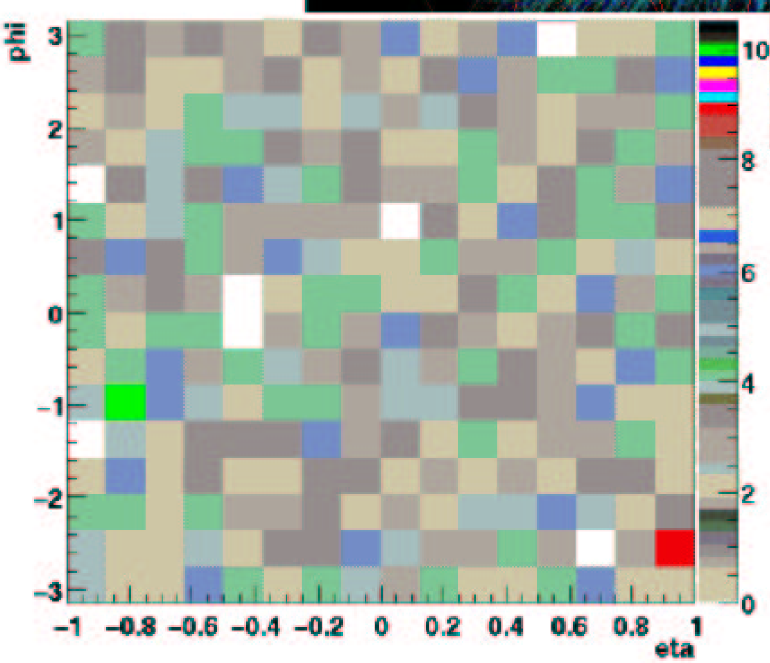
Correlations & fluctuations... how to learn anything?

- Discrete Wavelet Transform $\Rightarrow$ power spectra of local track density fluctuations

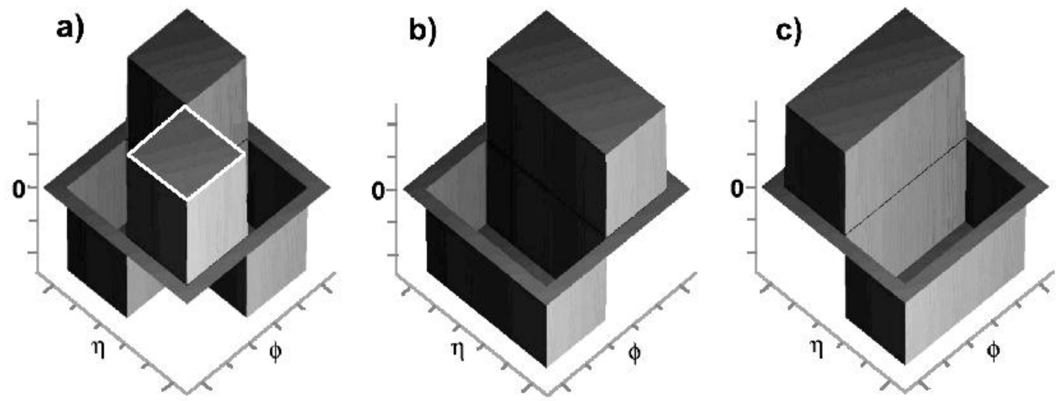
- 'thermal' reference = mixed events

- How does the medium change with initial conditions ? In this language:
  - thermalization: reality $\rightarrow$ reference
  - correlation: reality $<$ reference
  - fluctuation: reality $>$ reference (e.g. jets)


STAR


phi
3
2
1
0
−1
−2
−3
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
eta
10
8
6
4
2
0

$F^{\lambda}_{m,i,j}(\phi,\eta)$–Haar wavelet basis in 2D:



scale fineness (m), directional modes of sensitivity (λ), track density $\rho(\eta,\phi,p_T)$.

Basic observables:

Power of local fluctuations, mode λ:

$$P^{\lambda}(m) = \frac{1}{2^{2m}} \sum_{i,j} \langle \rho, F^{\lambda}_{m,i,j} \rangle^2, \tag{1}$$

Dynamic texture:

$$P^{\lambda}(m)_{true} - P^{\lambda}(m)_{mix} \tag{2}$$

"incoherently" normalized :

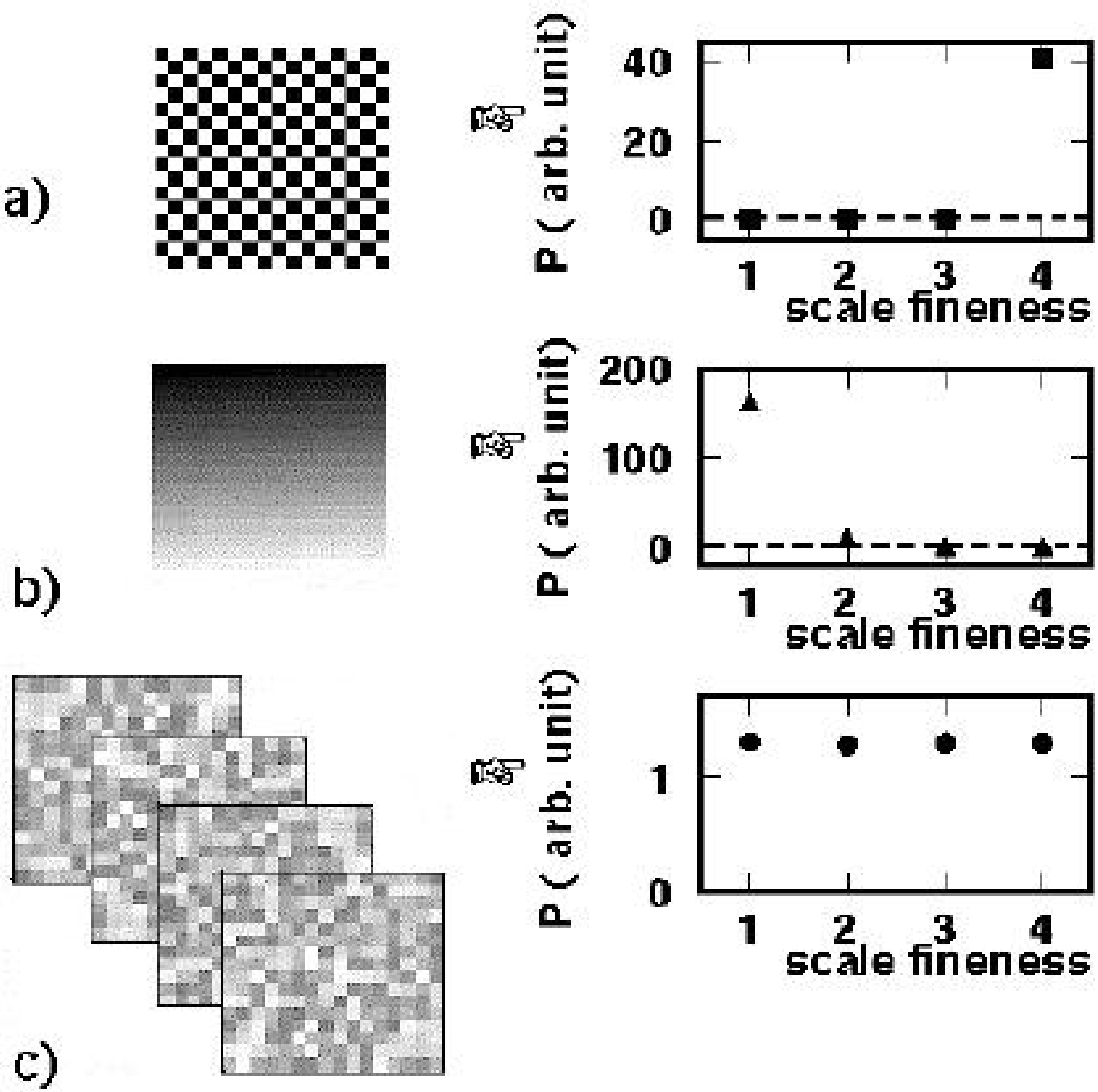
$$(P^{\lambda}(m)_{true} - P^{\lambda}(m)_{mix})/P^{\lambda}(m)_{mix} \tag{3}$$

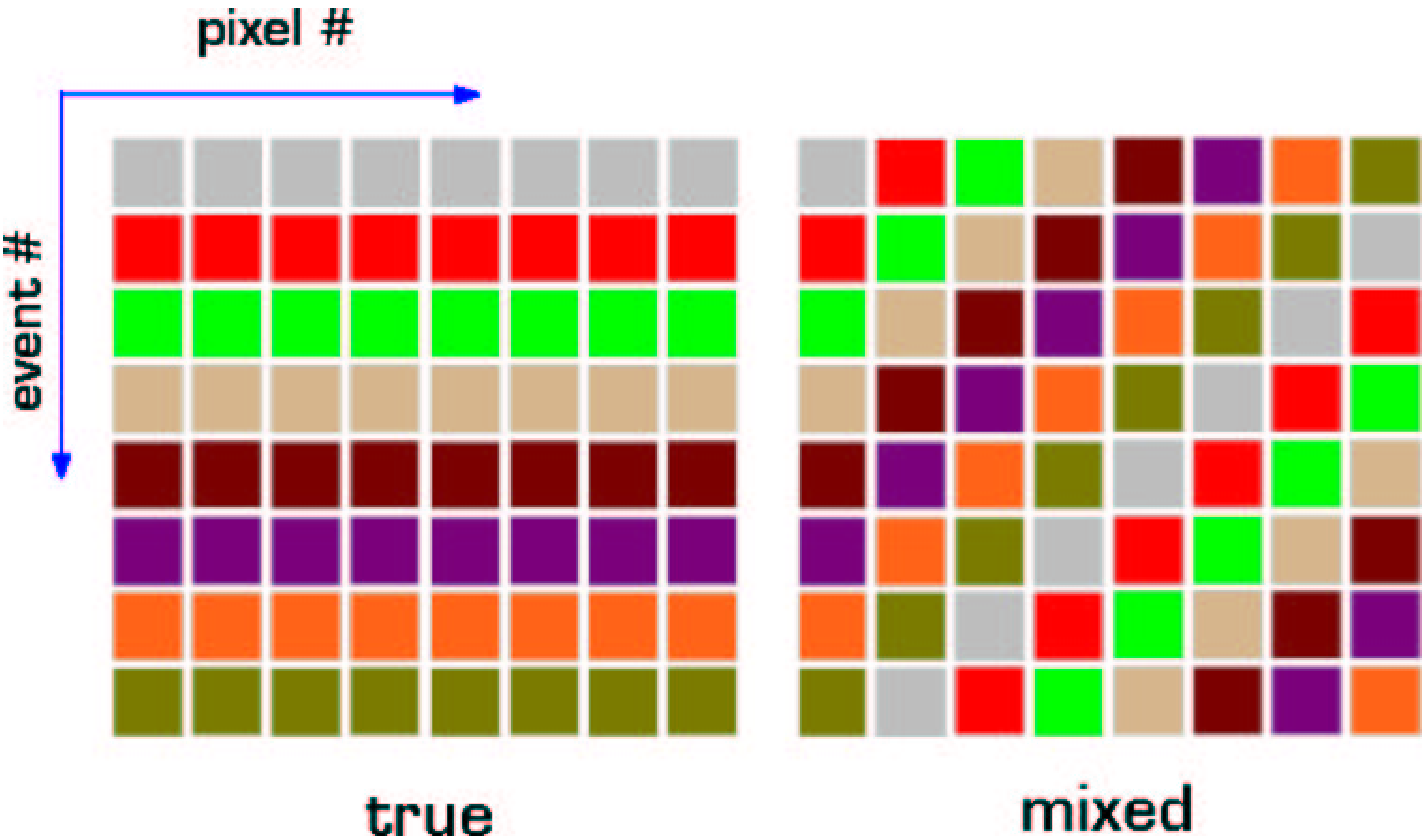
"coherently" normalized :

$$(P^{\lambda}(m)_{true} - P^{\lambda}(m)_{mix})/P^{\lambda}(m)_{mix}/N, \tag{4}$$

where N is (sub)event (p_T bin) multiplicity

Scale is localized:





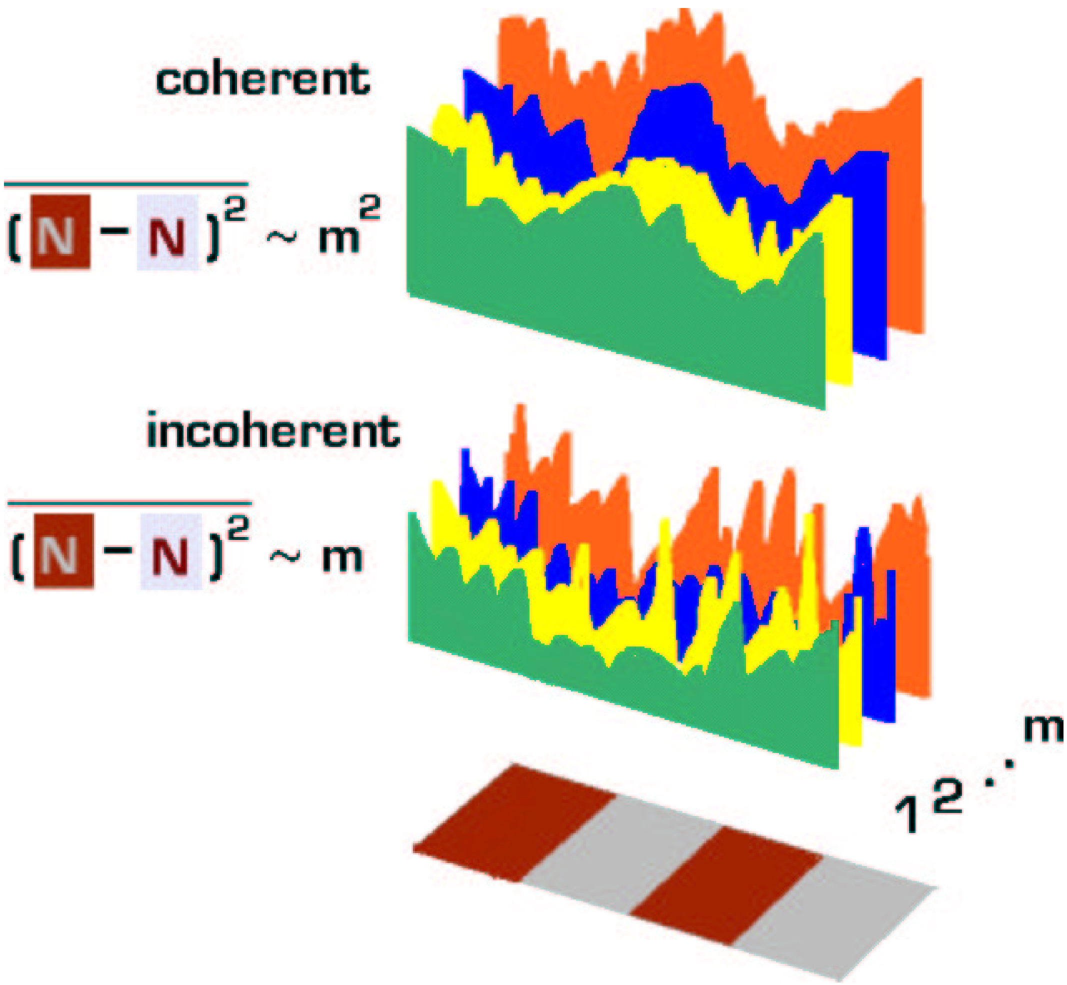
Event mixing scheme:

– no pixel is used twice

– not more than one pixel from any given true event per mixed event

– no mixing of “different” events: multiplicity, vertex

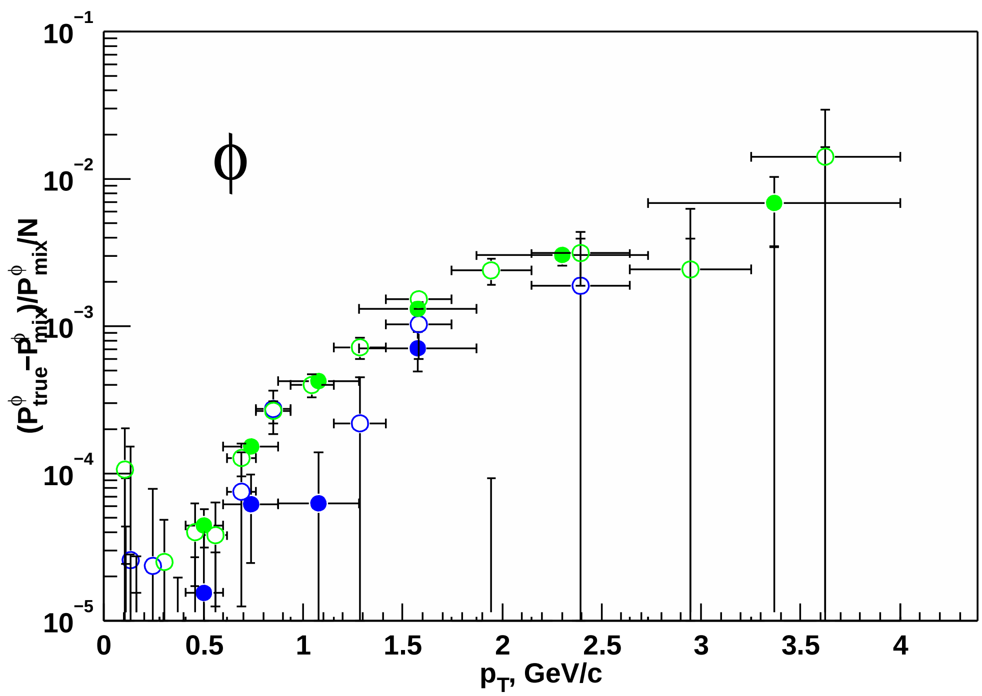
With n pixels, need $\geq n^2$ events per event class.



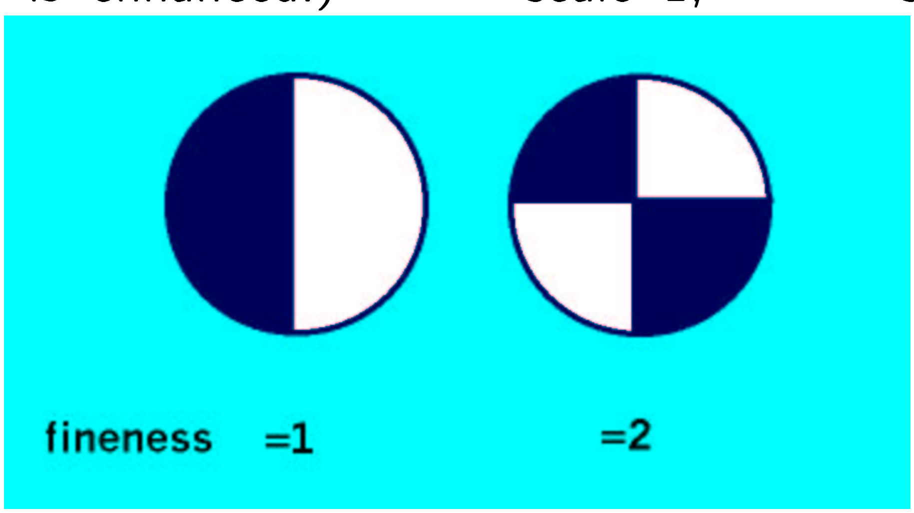
Proper **normalization** ⇒ results independent of bin size or subevent multiplicity.

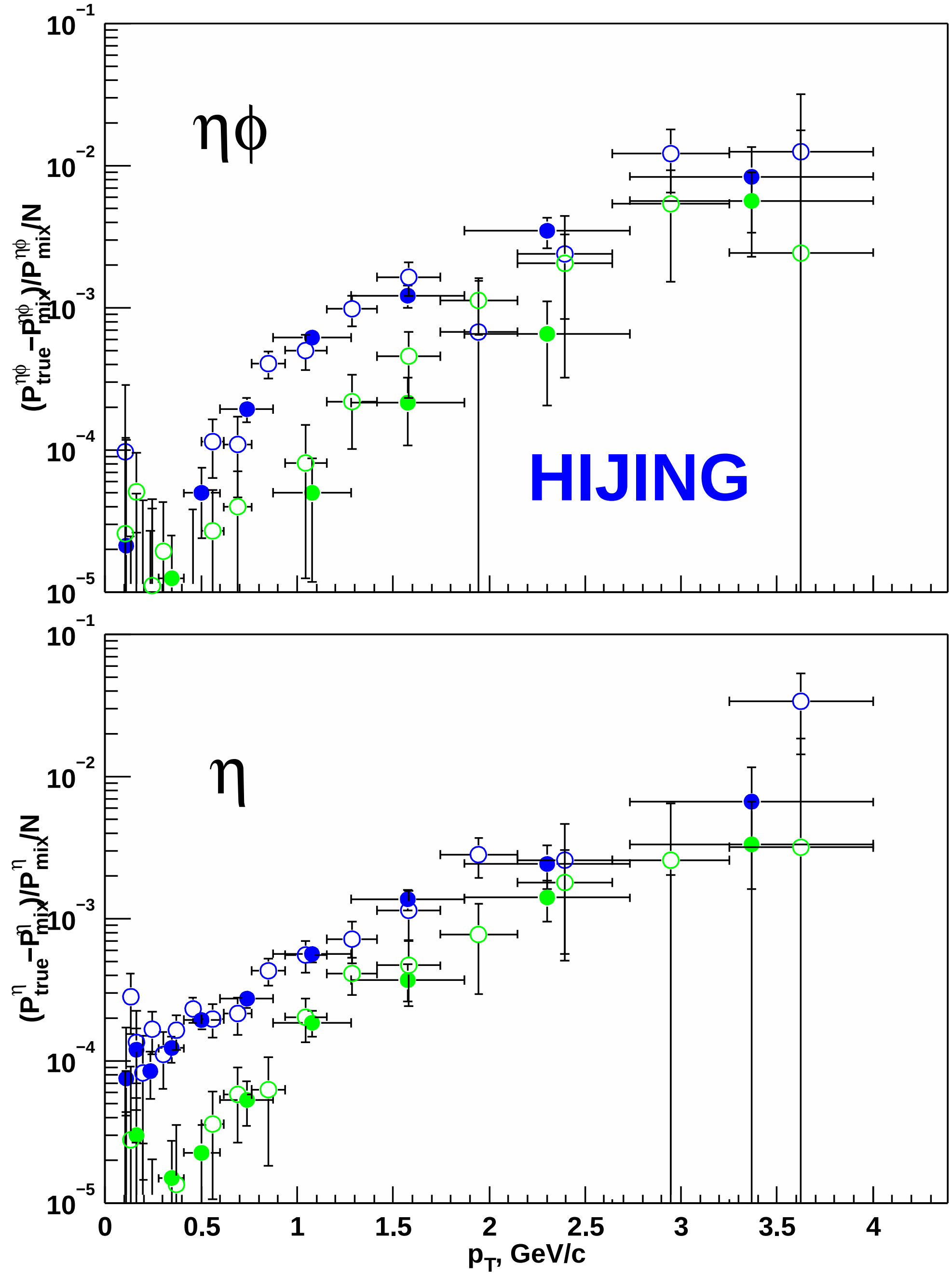
Coherent: $(P^{\lambda}(m)_{true} - P^{\lambda}(m)_{mix})/P^{\lambda}(m)_{mix}/N$,

Incoherent: $(P^{\lambda}(m)_{true} - P^{\lambda}(m)_{mix})/P^{\lambda}(m)_{mix}$

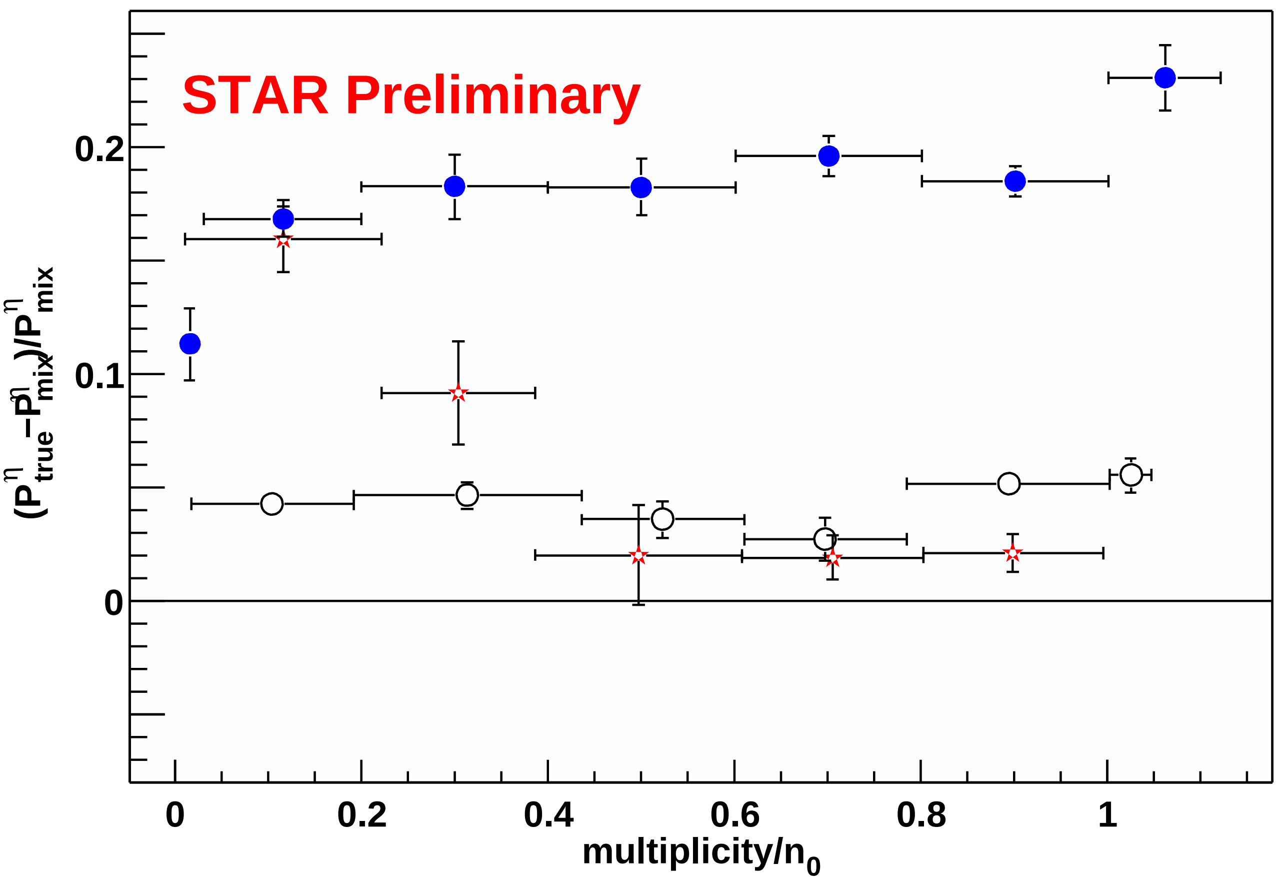


HIJING – azimuthal back to back correlations (fineness=2 is enhanced!) ● ○– scale 1; ● ○ – scale 2.

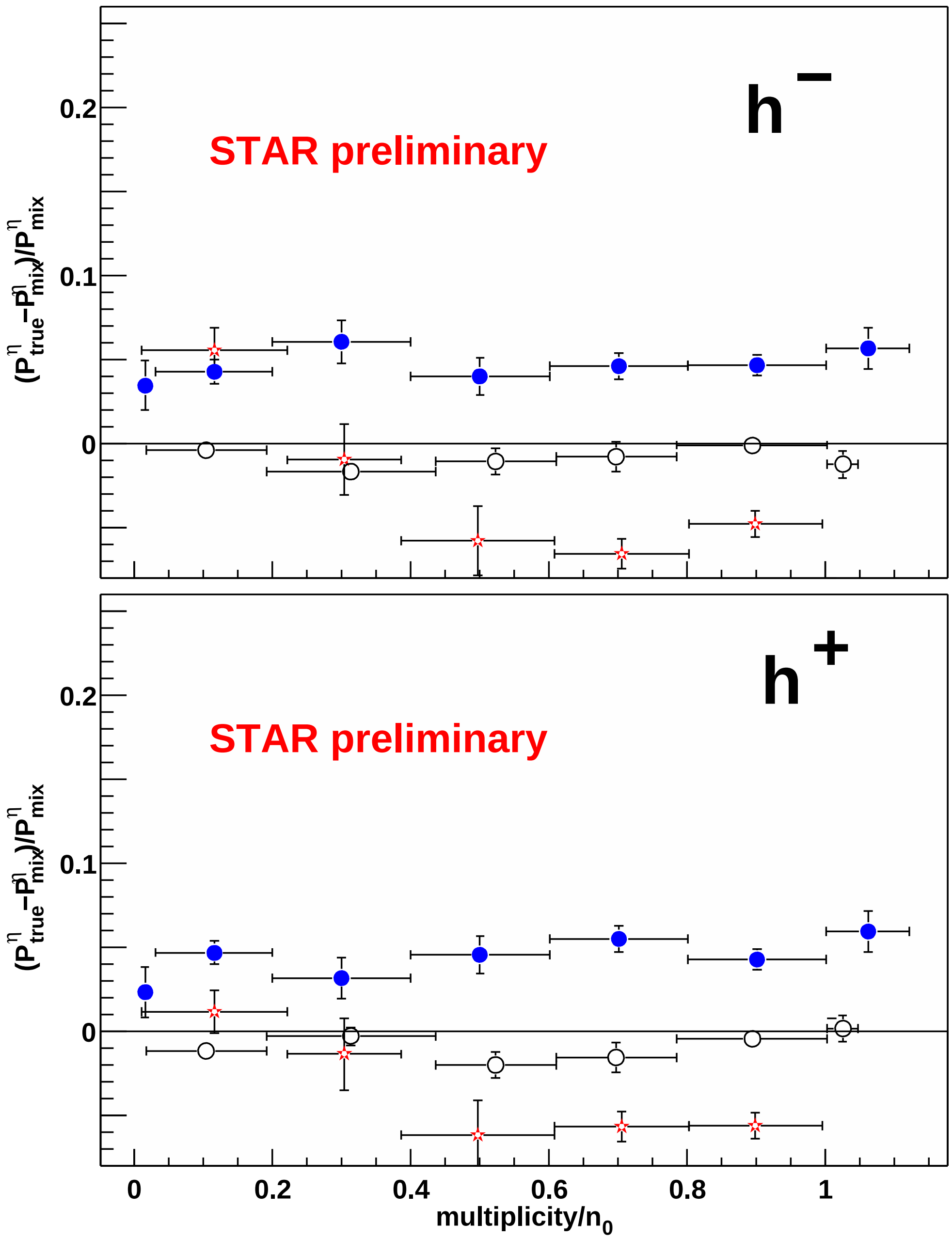




● ○ – scale 1; ● ○ – scale 2. HIJING shows coherent scaling with p_T bin width

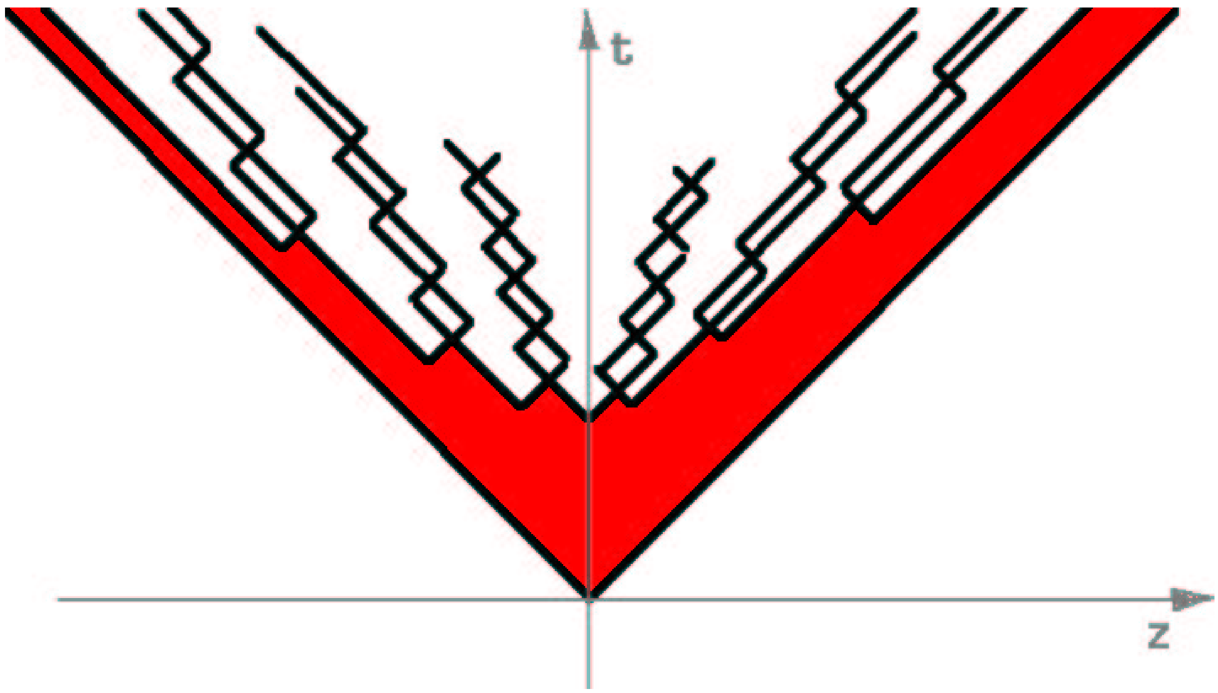


$\sqrt{S_{NN}} = 130$ GeV. Fineness scale=1 ($\delta\eta = 1$); **Charged hadrons:** $\star$ – STAR; $\bullet$ – regular HIJING; $\circ$ – HIJING without jets. The HIJING texture is mostly jets. STAR data: a change of regime with centrality.

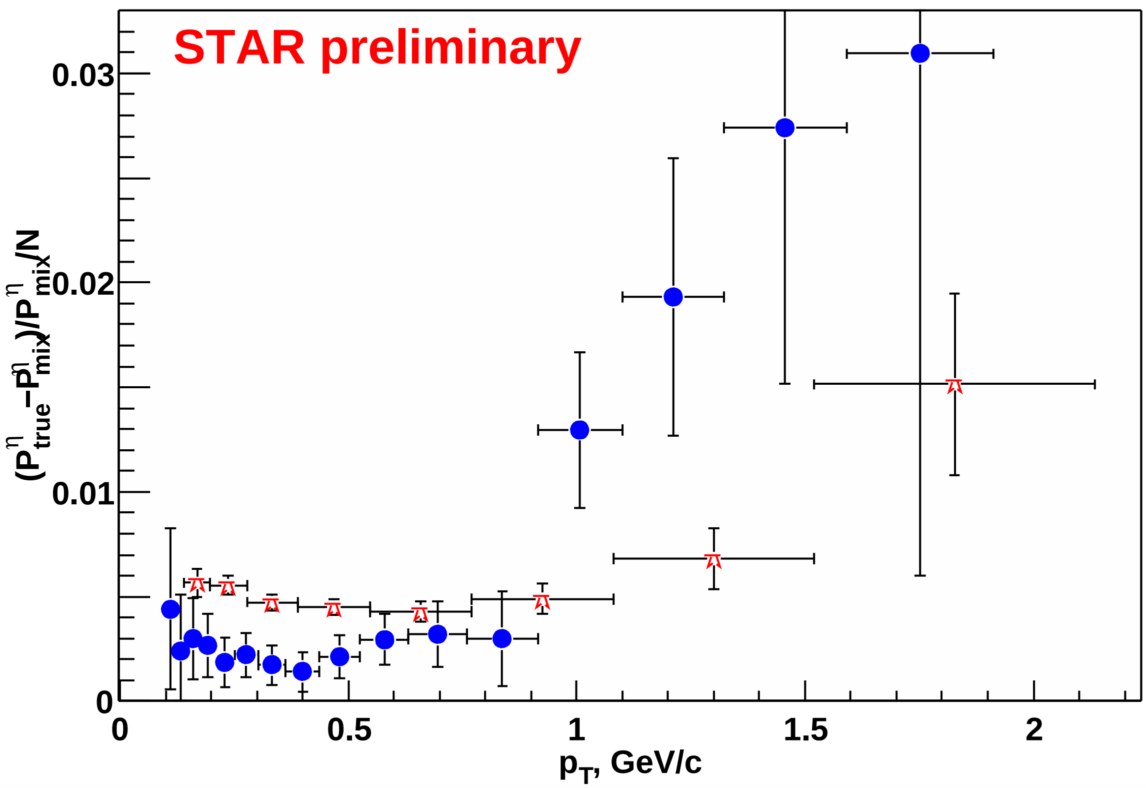


$\sqrt{S_{NN}} = 130$ GeV. Fineness scale=1 ($\delta\eta = 1$);

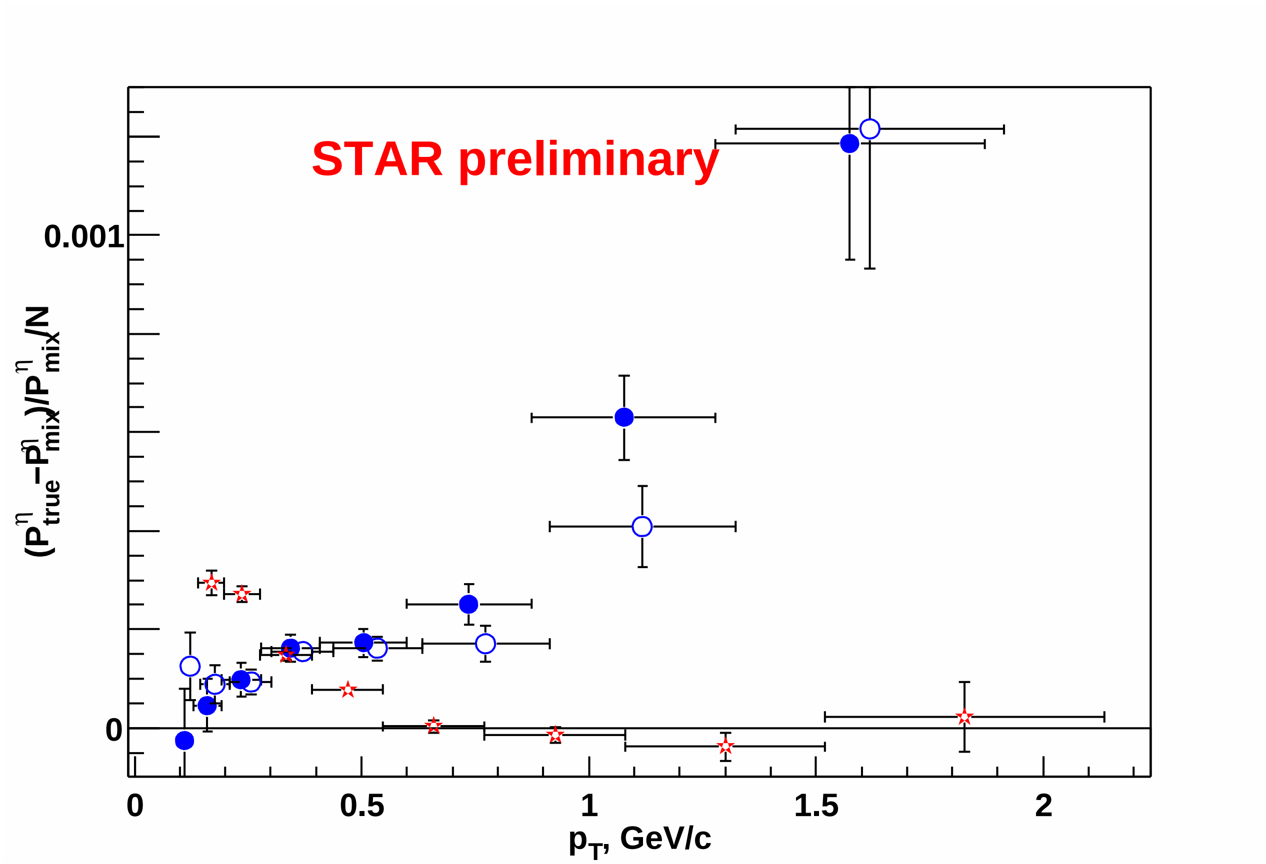
$P_{true} < P_{mix} \Rightarrow$ long range correlation



What is the origin of the long range η correlation = suppressed fluctuation ? Need common memory/communication over $\delta\eta \approx 1$. Different break-up points **causally disjoint.** Hadron rescattering can not increase order.



Fineness scale=1 ($\delta\eta = 1$). Peripheral ($mult/n_0 < 0.1$) events: $\star$ – STAR data for $\sqrt{S_{NN}} = 200$ GeV. $\bullet$ – HIJING @ same energy.



Fineness scale=1 ($\delta\eta = 1$). $\star$ – STAR $\sqrt{S_{NN}} =$ 200 GeV; $\bullet$ – regular HIJING; $\circ$ – HIJING+jet quenching (both 130 GeV). Central ($0.65 < mult/n_0 < 1$) events: Data more 'thermal' at $p_T > 0.6 GeV \rightarrow$ dissipation?

Bose-Einstein/Coulomb contribution at low p_T needs to be quantified.

Conclusions:

– peripheral ($mult/n_0 < 0.1$) data qualitatively agree with HIJING except for elliptic flow; details of p_T behaviour differ

– long range correlation (suppressed fluctuation) in η becomes visible in central events.

– p_T-dependence of η-texture: at soft $0.6 < p_T < 2$ GeV, jet texture is suppressed. At low p_T, need to understand the "HBT" contribution.

– more info: **nucl-ex/0211015, nucl-ex/0211019**