Angular Correlations at High-p_t

- Basic idea
  - hard scattering produces two high-pt partons
  - hadrons from fragmenting parton emitted in tight cone
  - any two of these hadrons are strongly correlated in angle
    - » 2-particle angular correlation function in Au+Au
      - X.N Wang Phys. Rev. D47, 2754 (93)
    - » sensitive to energy-loss of fast parton within QGP?
    - » not sensitive to shadowing of structure functions?
    - » complementary to change in high-pt spectra
- Preliminary simulations for STAR
- Next steps

Angular Correlations Between Two Final Hadrons

$$\alpha = \cos^{-1}(\hat{p}_1 \cdot \hat{p}_2)$$

$$\Delta\phi = |\phi_1 - \phi_2|$$

$$\mathrm{C(angle, pt_1, pt_2)} = \frac{\mathrm{N_{real}(angle, pt_1, pt_2)}}{\mathrm{N_{mixed\ events}(angle, pt_1, pt_2)}}$$

1) Correlations less sensitive to <u>rate</u> of initial hard-scattering than high-pt spectra of hadrons
   => less sensitive to shadowing of structure functions in Au

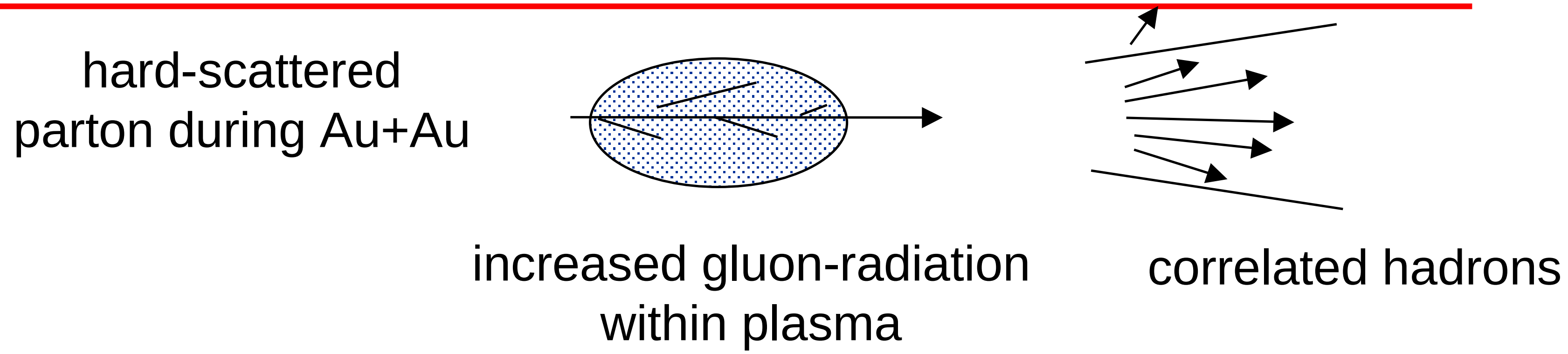
2) Use both angles, α frame dependence, φ worse combinatorics

3) Instrumental effects cancel, e.g. acceptance, track efficiency

(apply 2-track acceptance-cut)

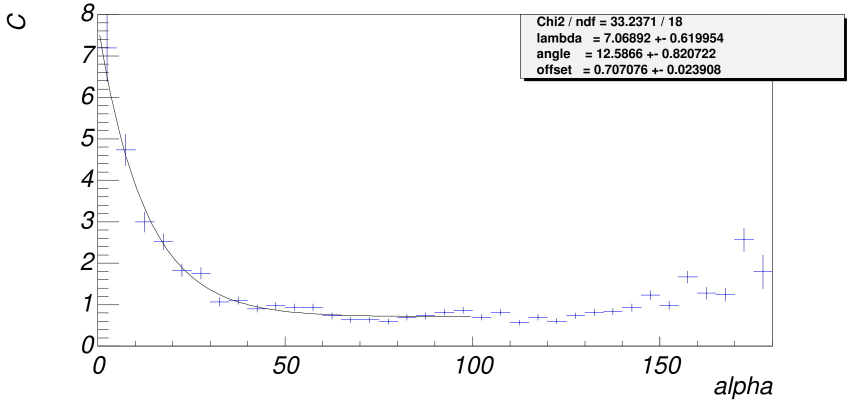
   => early, robust measurement in year 1 @ RHIC

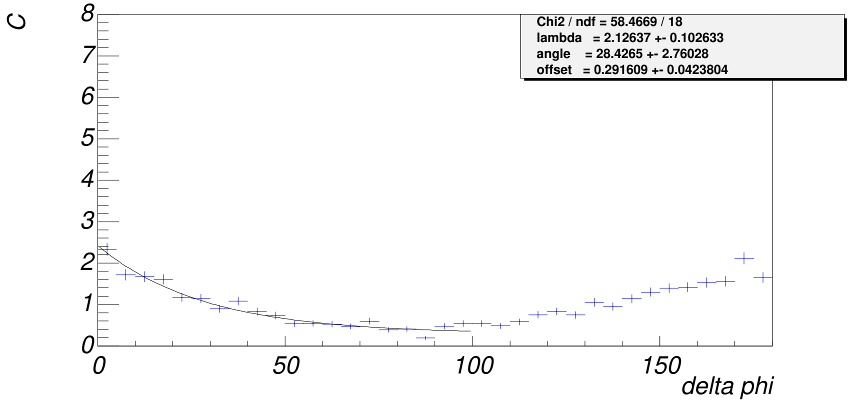
Do Correlations Probe Energy-loss ?



- How does the redistribution of energy change the correlation of hadrons?
  - nearly-collinear bremstrahlung gluons
    - » maintain but broaden angular correlation ?
  - energy given to nearby “string” (HIJING)
    - » little angular correlation between string, fast parton ?

Pythia: p+p $s^{1/2}$ 200 GeV/c in STAR's Acceptance





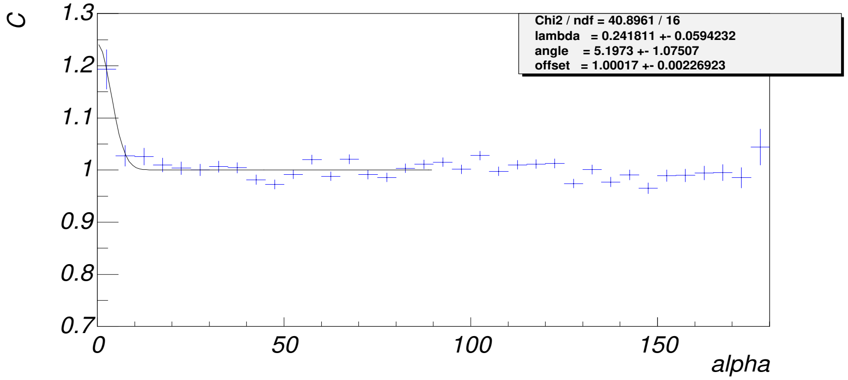
$pt_1, pt_2 > 1$ GeV $|\eta|<1.7$

$$C = \mathrm{offset} + \mathrm{lambda} \times e^{-\alpha/\mathrm{fit\_angle}}$$

$$C = \mathrm{offset} + \mathrm{lambda} \times e^{-\Delta\phi/\mathrm{fit\_angle}}$$

Correlation in α much tighter than $\Delta\phi$

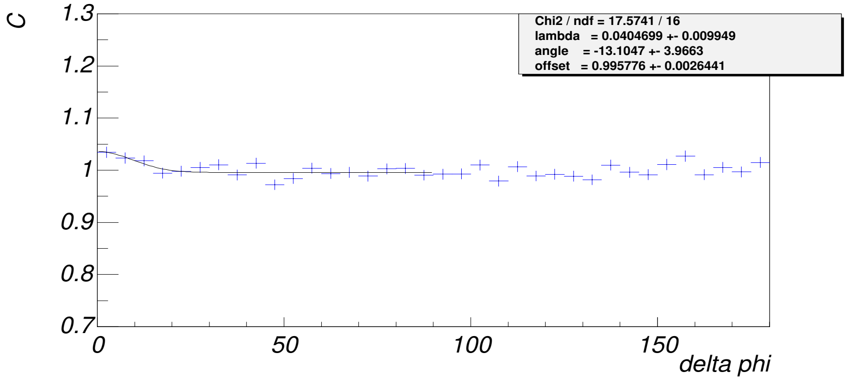
Correlations Can be Measured in Au+Au



α

HIJING : Au+Au 200 AGeV
b<10fm: Jet Quenching ON

$p_\perp^1, p_\perp^2 > 1.0\,\mathrm{GeV/c}$ |η|<1.7

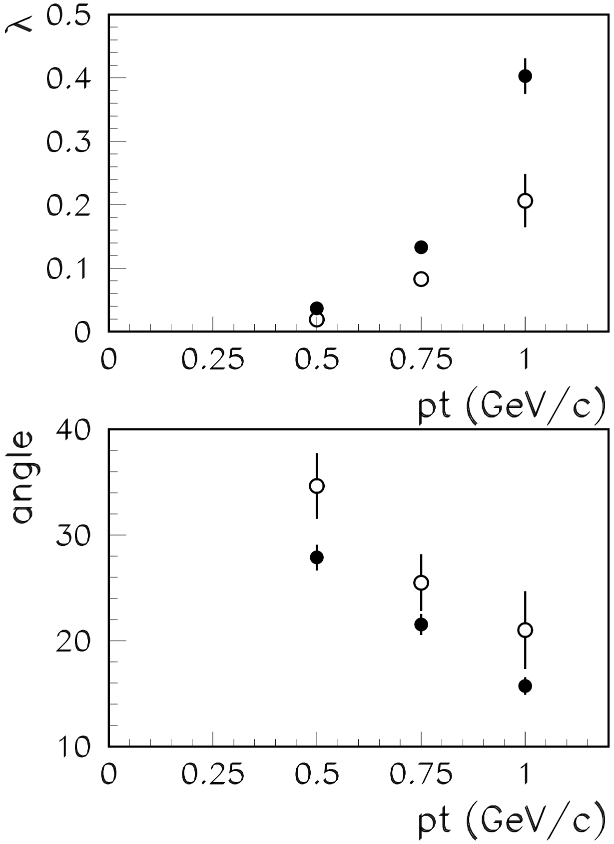


$$C = \mathrm{offset} + \mathrm{lambda} \times e^{-(\Delta\phi/\mathrm{fit\_angle})^2}$$

$\Delta\phi$

Correlation in α much tighter than $\Delta\phi$
Correlation in $\Delta\phi$ very weak in central reactions

HIJING : Au+Au $s^{1/2}$=200 AGeV, central



$$C = \mathrm{offset} + \lambda \times \mathrm{e}^{-(\alpha/\mathrm{fit\_angle})^2}$$

- ● ‘jet quenching’ off
- ○ ‘jet quenching’ on

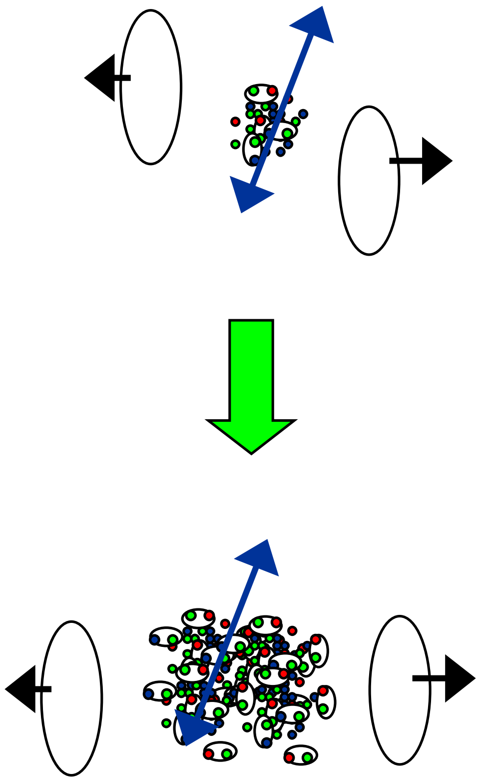
HIJING high-pt partons lose energy to nearby strings

=> broadens and weakens angular correlation

How to search for this at RHIC?

<u>study correlations vs centrality</u>

Centrality Dependence of Angular Correlations



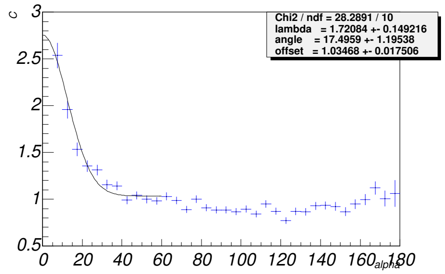
Angular correlations in peripheral reactions ~ p+p

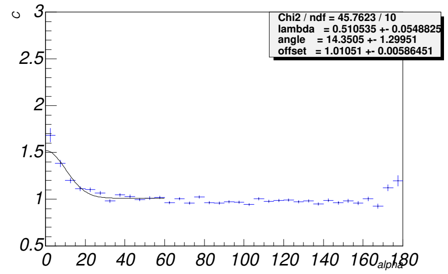
Steadily increase centrality

Steadily increase the average length hard partons travel through plasma

HIJING : Au+Au $s^{1/2}$=200 AGeV: Quenching ON

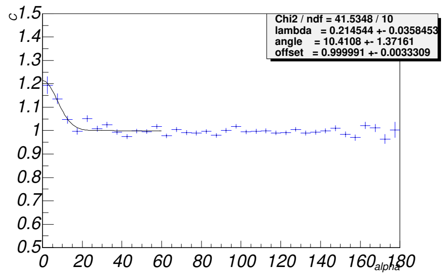
0<M<250

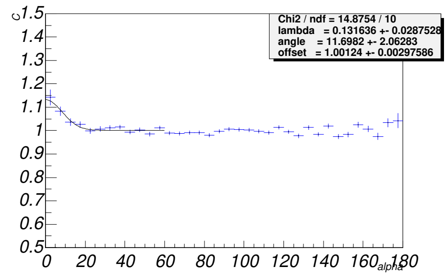




250<M<750

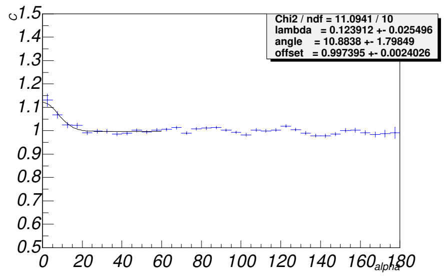
750<M<1250





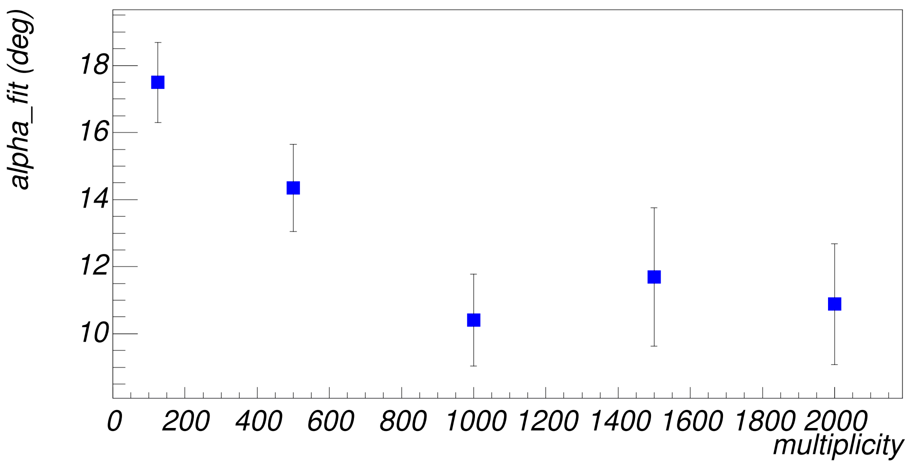
1250<M<1750

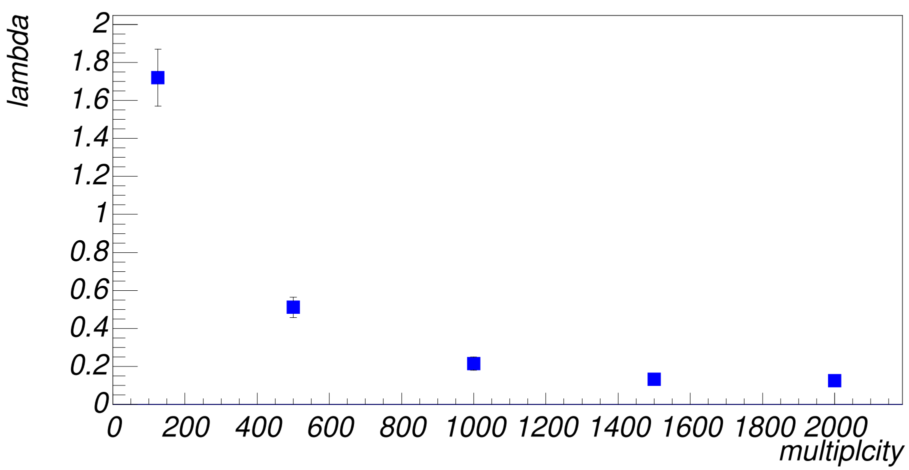
1750<M<2250



M= event multiplicity
correlation function
tracks in TPC
$pt_1, pt_2 > 1$ GeV/c, $|\eta|<1.7$

HIJING: Jet-Quenching ON





Correlation functions
tracks in TPC
$pt_1, pt_2 > 1$ GeV/c, $|\eta|<1.7$

Decrease in λ due to increasing combinatorics

but why does alpha_fit decrease with multiplicity?

Questions and Plans

- How do other treatments of energy-loss change angular correlations? e.g. medium-induced bremstrahlung
- Are correlations insensitive to initial gluon shadowing?
- Choice of relative angle α or $\Delta\phi$
- Explore
  - tighten η-cut, select on total transverse momentum of pair
- Technical : two-track acceptance cut, resolution vs pt, ghosts

Angular correlations - feasible, complementary probe of energy loss in a plasma

Early robust, observable : many instrumental effects cancel, e.g. acceptance, track efficiency