Quark Matter 2009

Nu's One day summary:

Focus on issues related to QCD phase diagram

Lattice : QCD Critical Point

Expectation value of an observable

$$\langle \Theta(m_v) \rangle = \frac{\int DU \exp(-S_G)\Theta(m_v)\ \mathrm{Det}\ M(m_s)}{\int DU \exp(-S_G)\ \mathrm{Det}\ M(m_s)}$$

M : Dirac Matrix
S_G : Gluonic action

For $\mu > 0$ the quark determinant becomes complex

Issue for non Zero μ, Det M is not positive definite
-- Sign problem

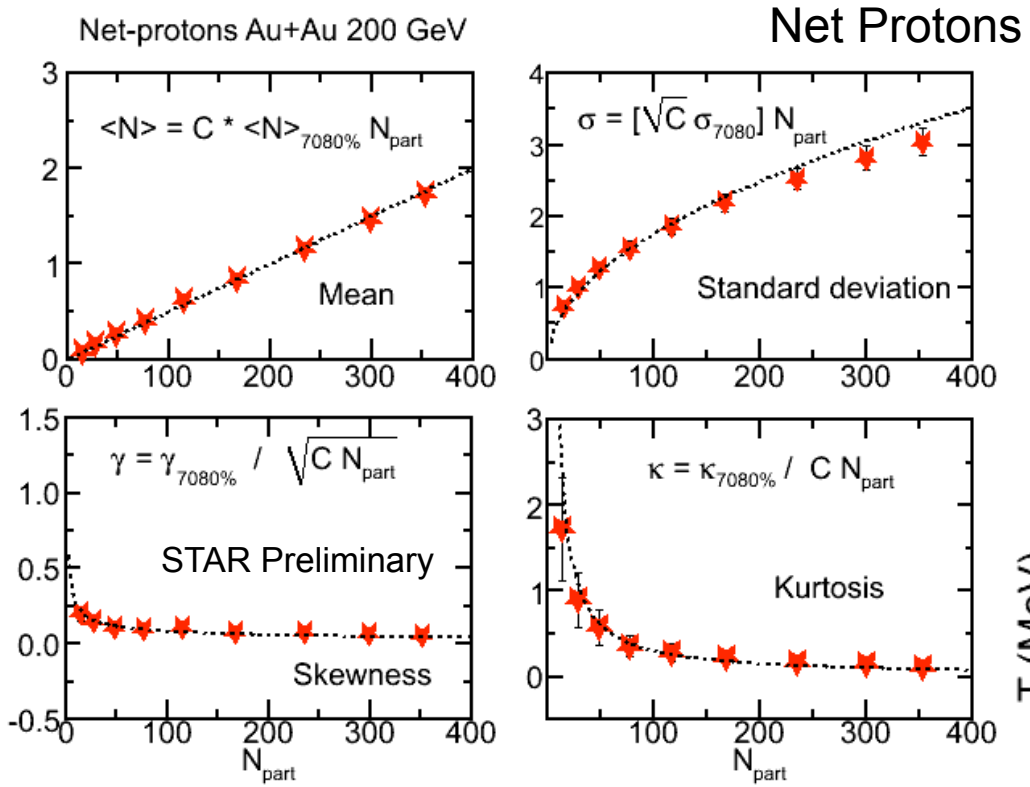
Four approaches

✓Reweighting : $Z = \langle\ e^{-S(\beta)} \det D(\mu)\ /\ e^{-S(\beta_0)} \det D(0) \rangle_{\mu=0,\beta_0}$
✓Taylor expansion of thermodynamic observables in μ/T about $\mu = 0$
✓ Imaginary chemical potential : μ imaginary, fermion determinant positive
✓ ***Canonical ensemble - predicts existence of QCD critical point***

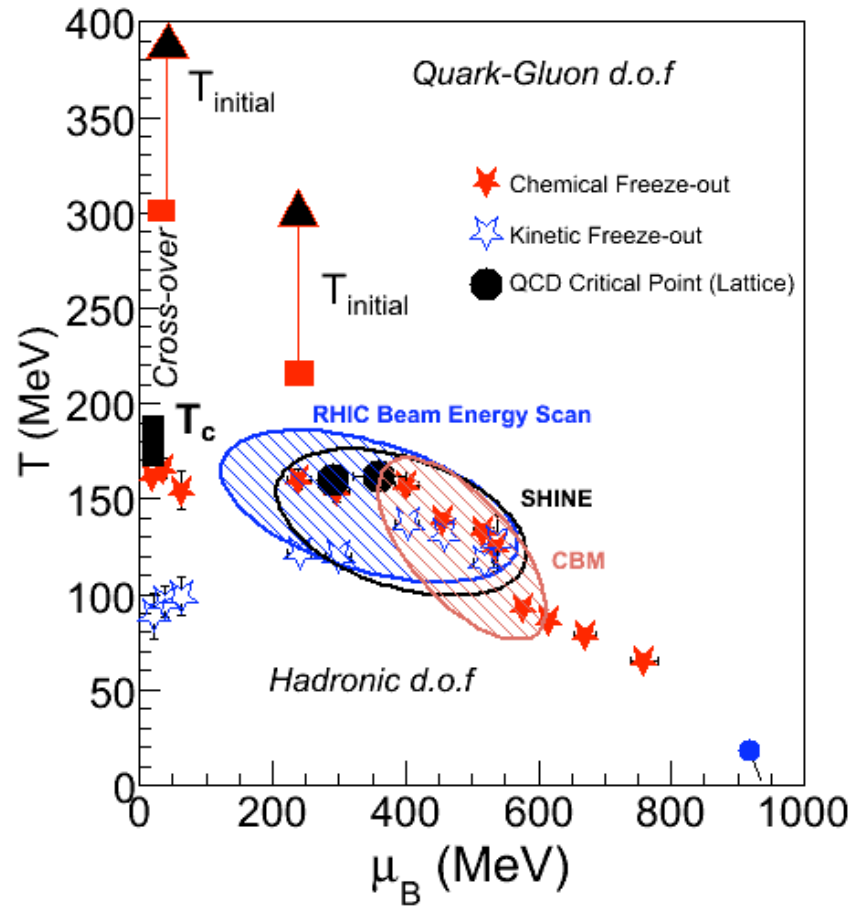
(T_E ~ 160 MeV and μ_E ~ 600 MeV, **m_π ~ 700 MeV)**

QM09 poster : A. Li

Results on Higher Moments

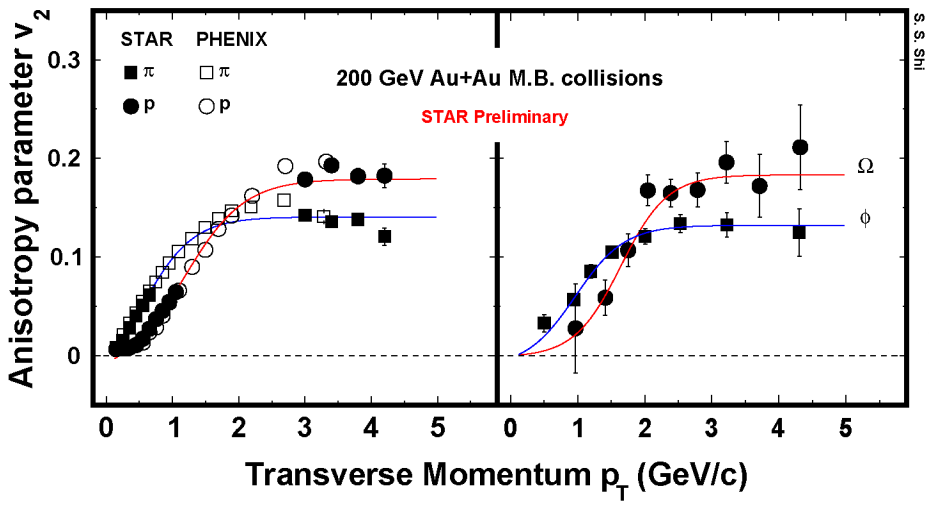


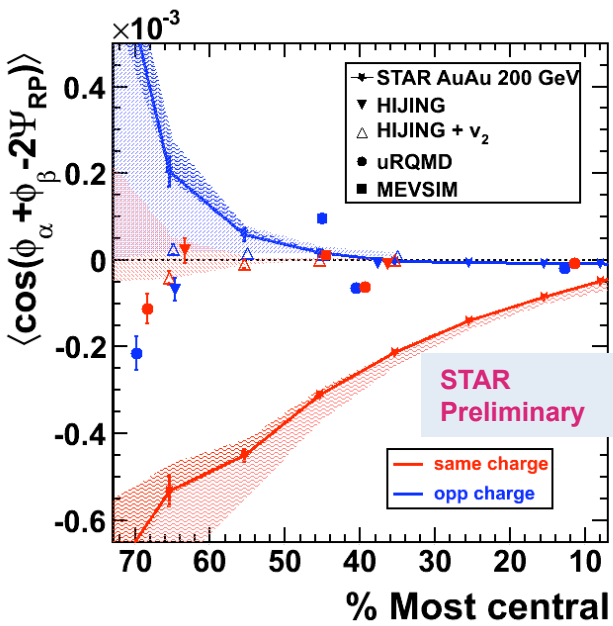
First look at net-protons
First look at higher moments



Setting the baseline for the future
QCD critical point search program

Future Programs





Partonic Collectivity!

De-confinement!

Higher moments!

- Conserved quantities:
  - ***baryons (~ net protons)***
  - ***charge***
  - ***strangeness***
- long range fluctuations
  - higher sensitivity
  - critical point search