Hadronization in BAMPS

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Outline

Motivation

Reminder - previous approaches

New approach - hadronization via partonic clusters

Summary & outlook

Motivation

- **Transportalgorithm solves Boltzmann equation with Monte-Carlo-technik**

$$p^{\mu}\partial_{\mu} f(x,p) = C_{22} + C_{23} + \dots$$

Boltzmann
Approach for
Multi-
Parton
Scatterings

- **stochastic interpretation of collision rates**

$$P_{2i} = v_{rel} \frac{\sigma_{2i}}{N_{test}} \frac{\Delta t}{\Delta^3 x}$$

- **pQCD interactions with 2<->3 and 3<->2 prozesses**

Z. Xu & C. Greiner,
Phys. Rev. C 71 (2005) 064901

Motivation

-BAMPS purely gluonic – need for a ‘translation’

-describe hadronization via microscopic processes

-create Pions via (elastic) gluon fusion

Previous approaches

Describe Hadronization process via $gg \rightarrow \pi\pi$ reactions.

With constant cross sections for $\epsilon < \epsilon_{crit}$.

-conserves energy and momentum

-Problem: No confinement!

Previous approaches

Describe Hadronization via instantaneous
cell-by-cell process

In each cell with $\epsilon < \epsilon_{crit}$ every parton is clustered with other partons from the cell until $\sqrt{s} > 2M_{\mathrm{Pion}}$.

If no more partons in cell, choose geometrically nearest.

Each cluster decays into to two Pions.

-conserves energy and momentum
-fullfills confinement

-Problem: entropy drops dramatically!

Previous approaches

Modify algorithm by allowing 3 Pion decay of a cluster whenever kinematically possible.

-conserves energy and momentum
-fullfills confinement
-roughly conserves entropy

-Problem: Hadronization happens instantaneous
→ diverging cross sections
→ no rates definable

Hadronization via partonic clusters

Introduce partonic states p*

$gg \rightarrow p^*$

$gp^* \rightarrow p^*$

$p^*p^* \rightarrow p^*$

$p^* \rightarrow p^*\pi$

$p^* \rightarrow \pi\pi$

Define partonic cross sections $\sigma = x_0 / \Delta x$

Use BAMPS stochastic method for collision in cells.
Use geometric collision routines if only one particle in cell.

Define decay probabilities via half-life $\lambda(E_{cm})$

-conserves energy and momentum
-fullfills confinement
-roughly conserves entropy
-rates and cross sections well defined

Hadronization via partonic clusters

Model has three Parameters

$\sigma = x_0 / \Delta x$ $\lambda(E_{cm})$ ϵ_{crit}

What is missing?

No colour in BAMPS yet!

No Quarks/Baryons yet!

The entropy problem

Asuming massless gluon gas going to massive Pion gas

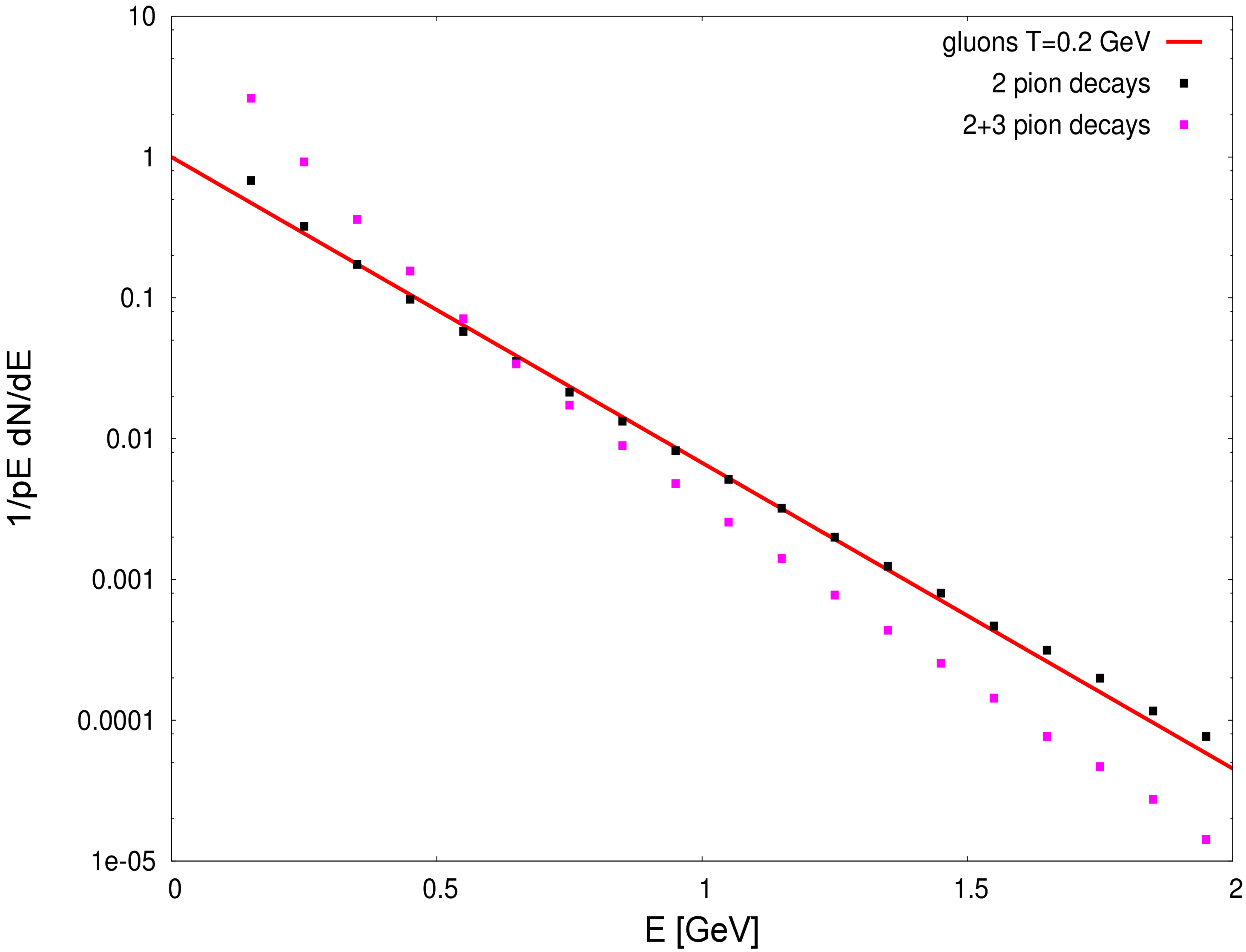
$$\mathrm{f}_{gluon} = g_{part} \exp\left(-p/T\right) \qquad \mathrm{f}_{Pion} = \lambda_{Pion}\, g_{Pion} \exp\left(-\sqrt{p^2+m^2}/T\right)$$

$$s = \int f\left(1-\ln\left(f\right)\right) d^3 p$$

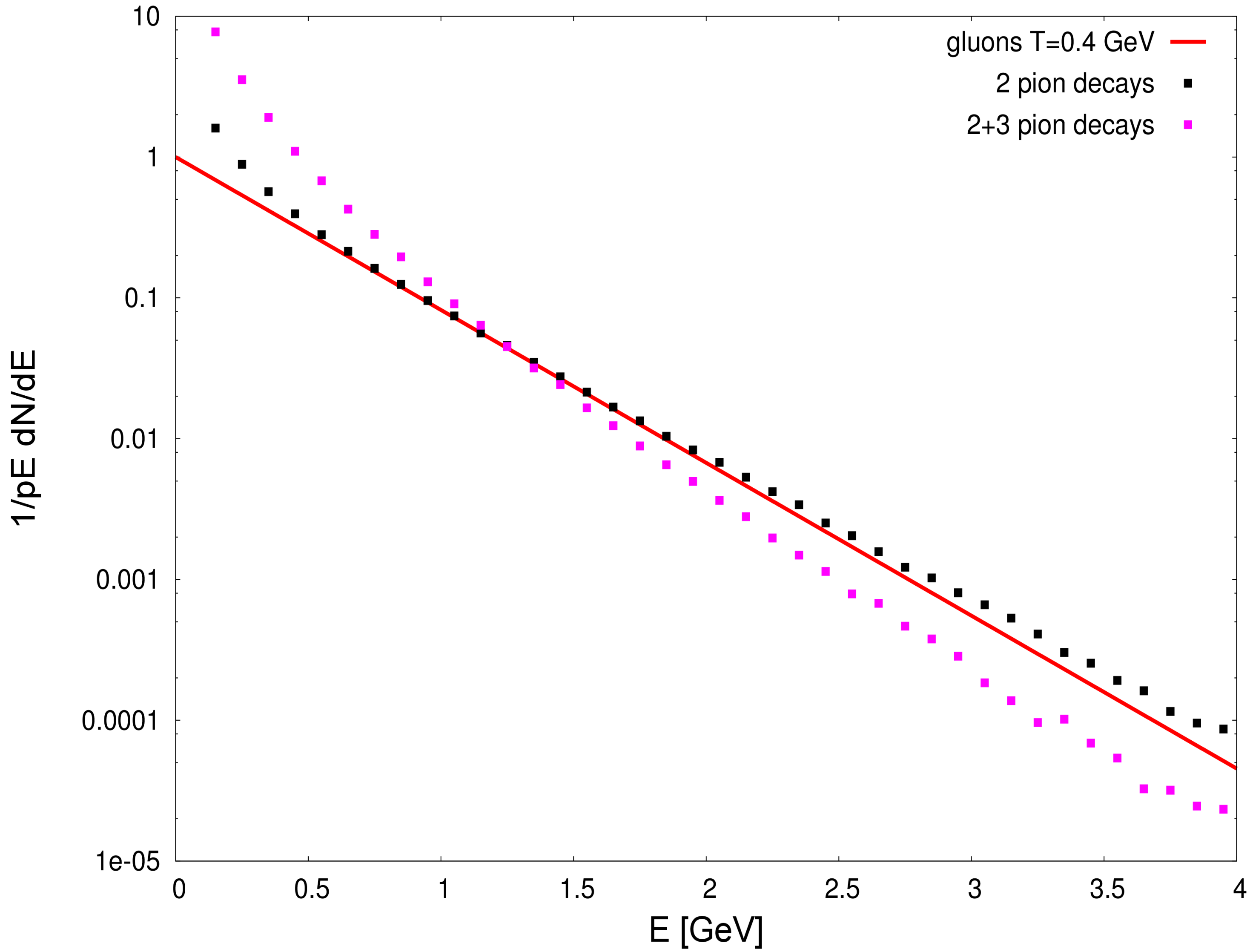
Total energy mus be conserved!
For a given partonic state only one free parameter left!

Task is to find a transition that maximises s!

The entropy problem



The entropy problem



Hadronization via partonic clusters

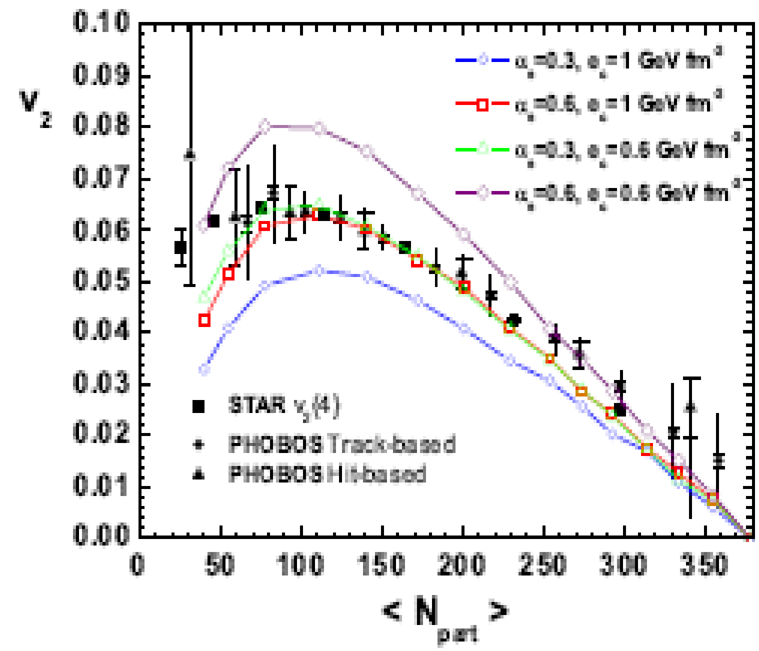
Au Au @ RHIC 200GeV b= 8.6 fm
mid-rapidity

Preliminary results on integrated v_2

BAMPS without hadronization: 6.3 %

O. Fochler, Z. Xu, C. Greiner, PRL 102 (2009)
O. Fochler et al. arXiv:0811.4133 [hep-ph]

BAMPS with hadronization 1.2%



Summary

Approach 1 – elastic scatterings
- no confinement

Approach 2 – instantaneous cell-by-cell hadronization
-confinement
-entropy conserved
-diverging cross sections

Approach 3 – partonic clusters
-confinement
-entropy conserved
-well defined cross sections

Outlook

If the world doesn’t end tomorrow

- improve statistics for results on v2 and v2(pt)
- compare to results from Fochler et al.

- switch to LHC energies

- implement Quarks / Baryons (and other Mesons)