

The influence of hard partons on the bulk elliptic flow

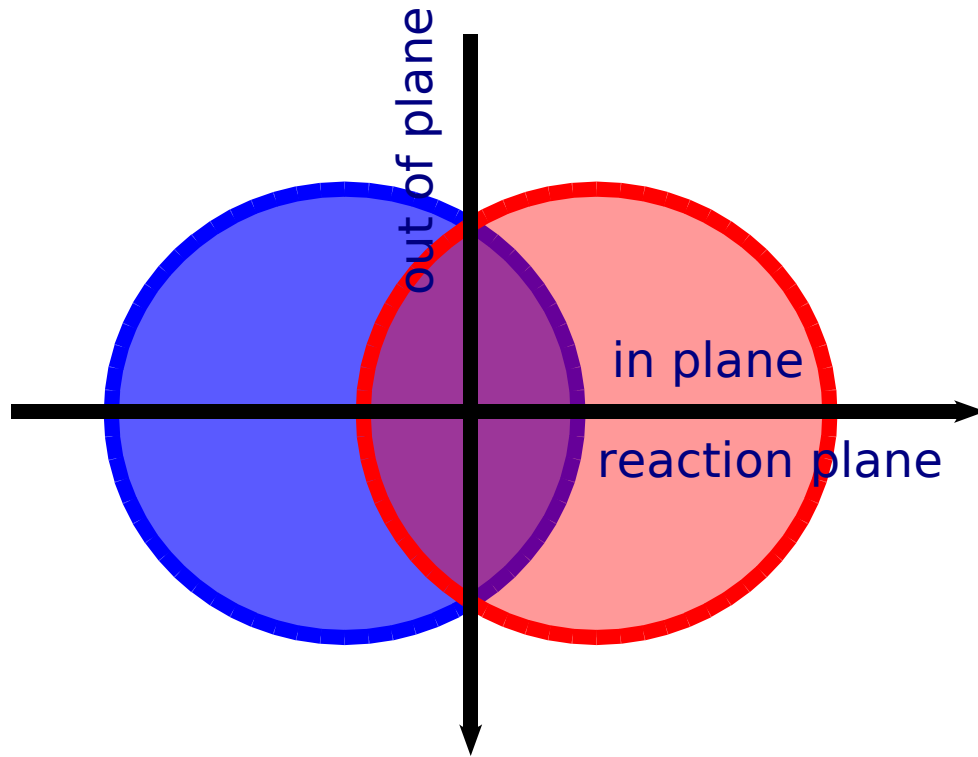
Boris Tomášik

*Univerzita Mateja Bela, Banská Bystrica, Slovakia
and
Czech Technical University, Prague, Czech Republic*

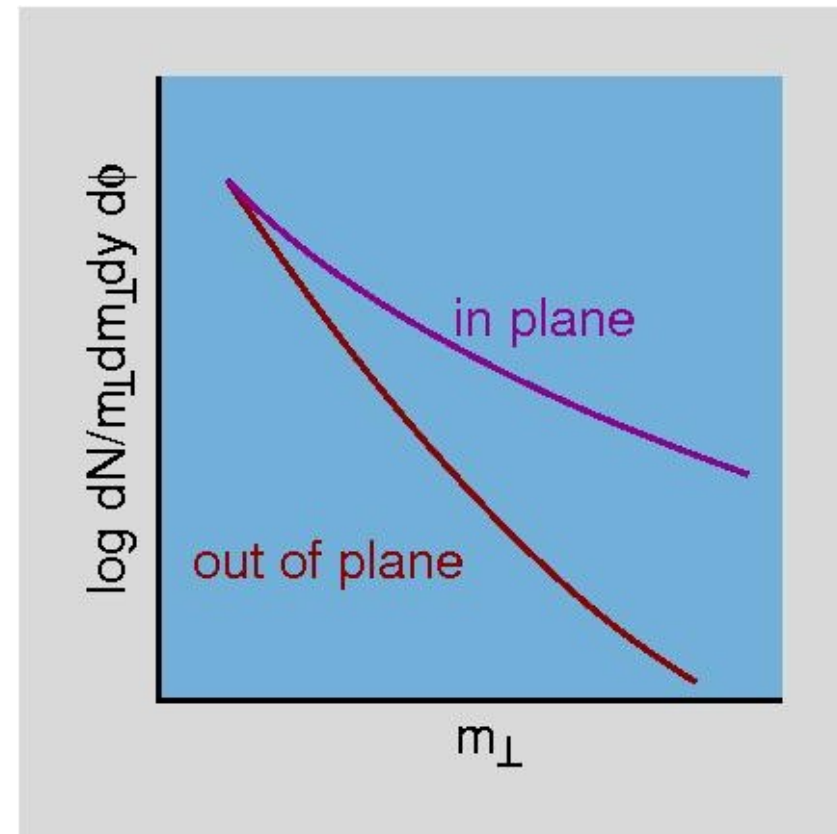
Zimányi Winter School
Budapest, Hungary
December 1, 2008

Elliptic flow: what is it?

- Asymmetry in particle production in non-central collisions



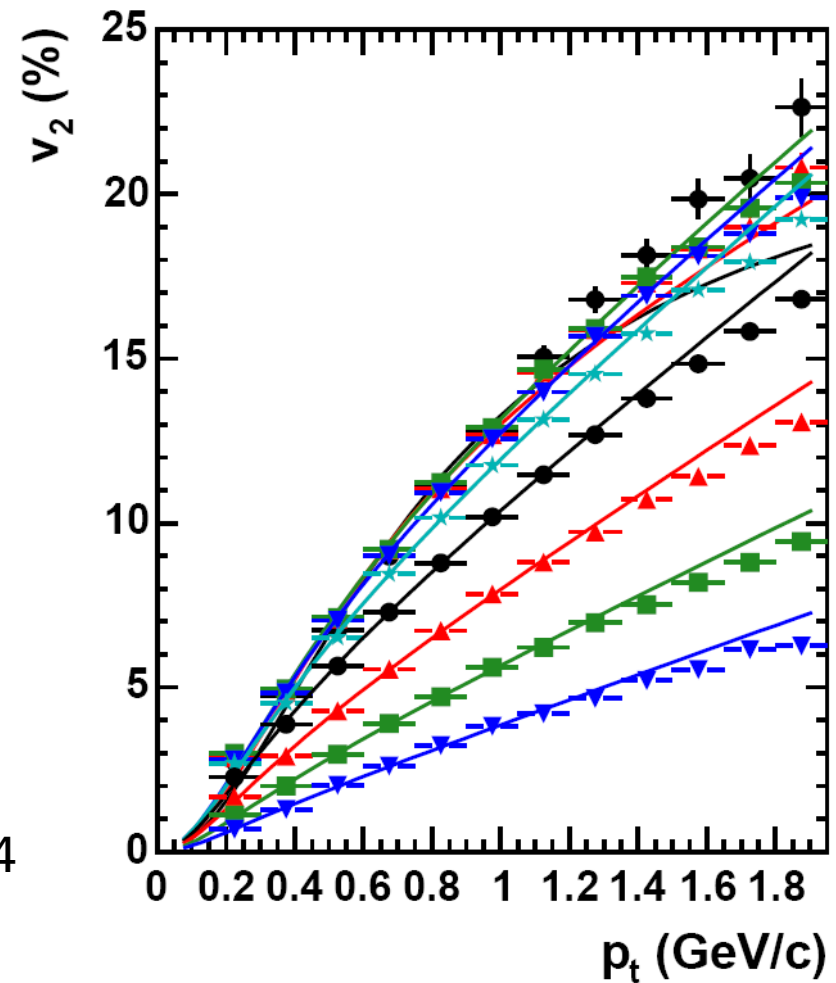
- Transverse mass spectra are steeper in the reaction plane



Coefficient v_2

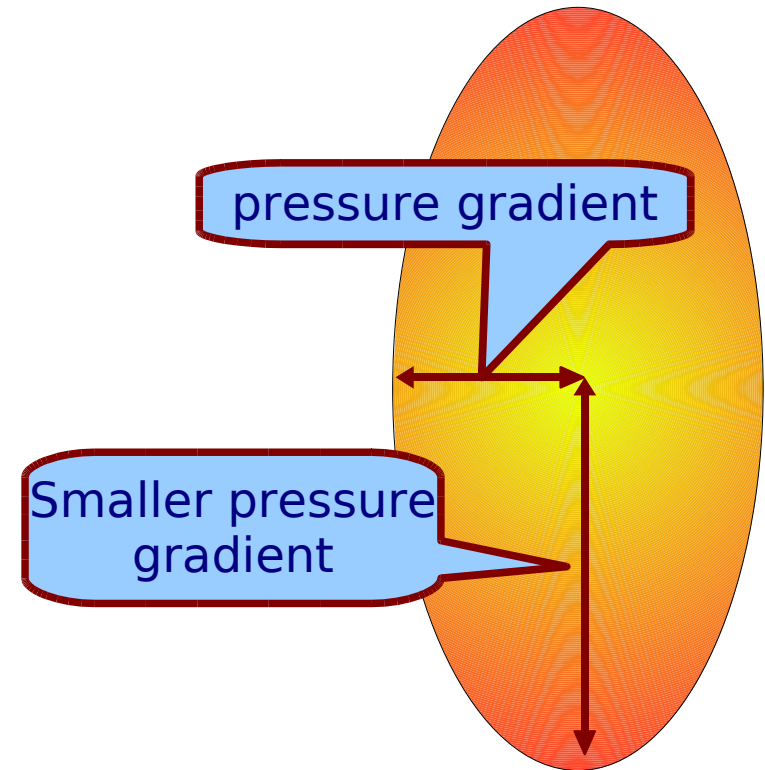
$$\frac{d^3 N}{d\phi p_T dp_T dy} = \frac{1}{2\pi} \frac{d^3 N}{p_T dp_T dy} (1 + 2v_2 \cos(2\phi) + \dots)$$

Data: STAR collaboration,
Phys. Rev. C **72** (2005) 014904



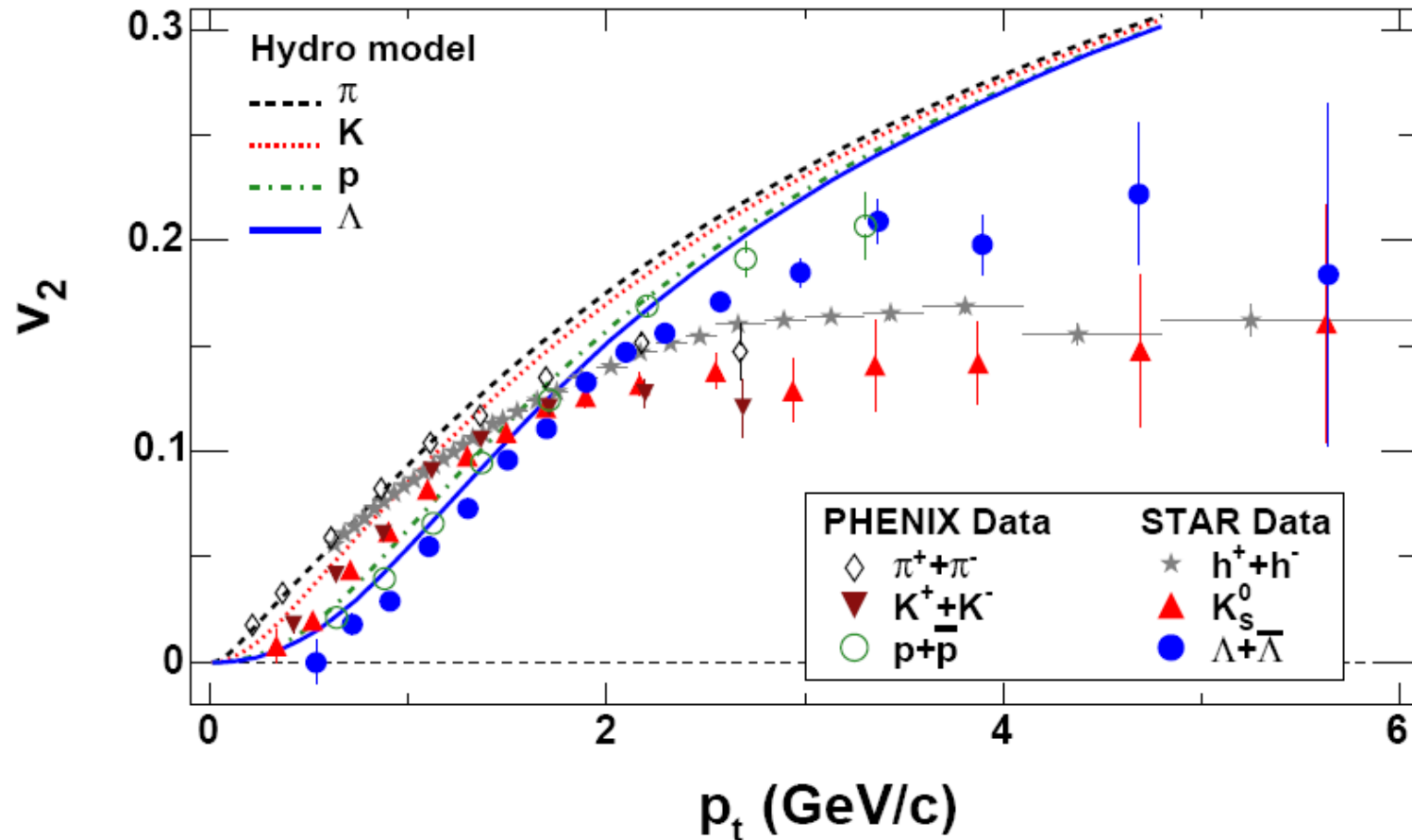
The interpretation of v_2

- flattening of spectra is due to **transverse expansion**
- Expansion results from **pressure gradients**



=> stronger expansion in the reaction plane

Elliptic flow in hydrodynamics

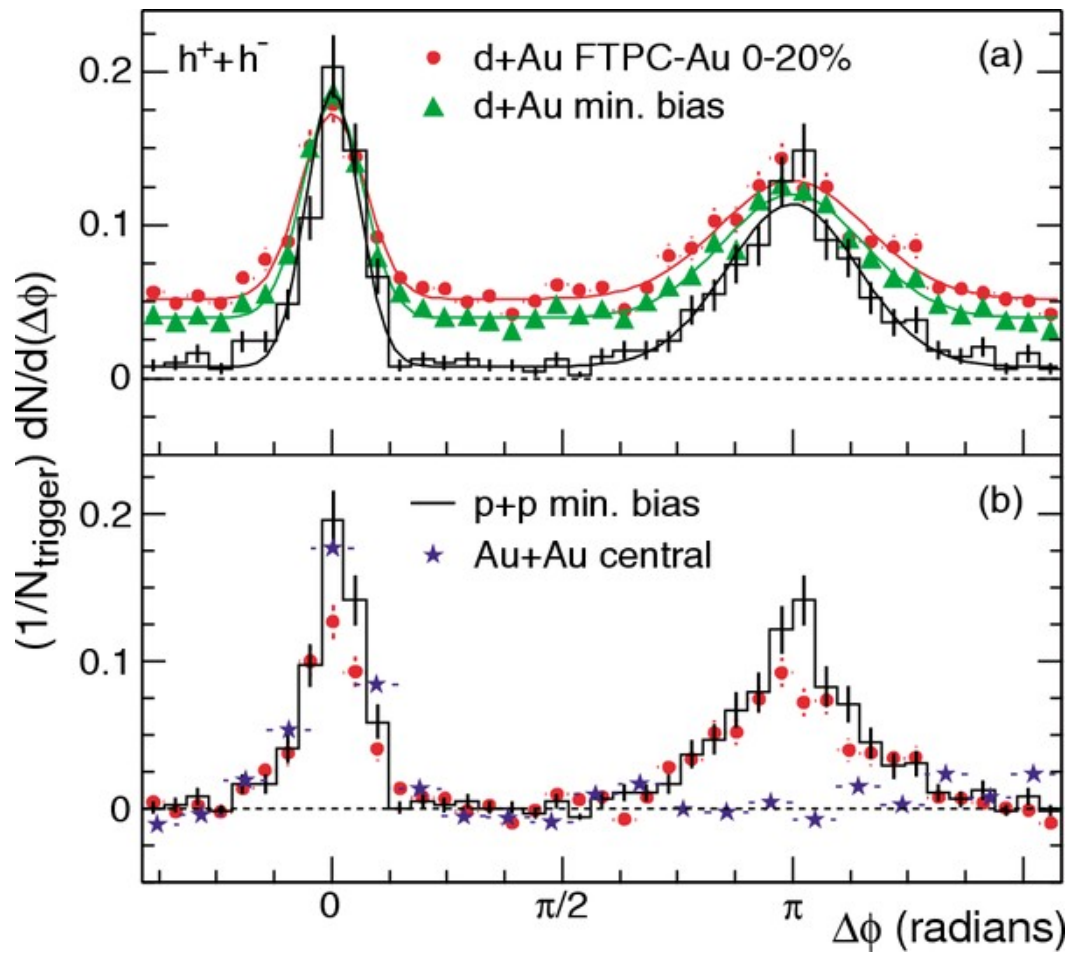


indication of **early thermalisation and low viscosity**

important to understand elliptic flow quantitatively well



Jets in nuclear collisions: QGP suppression



[STAR Collaboration, PRL **91** (2003) 072304]



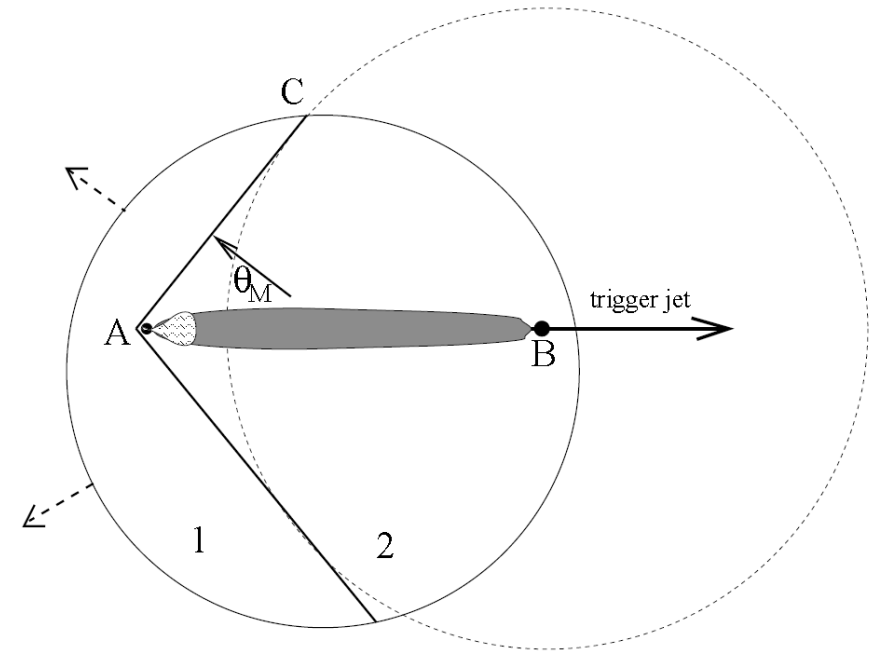
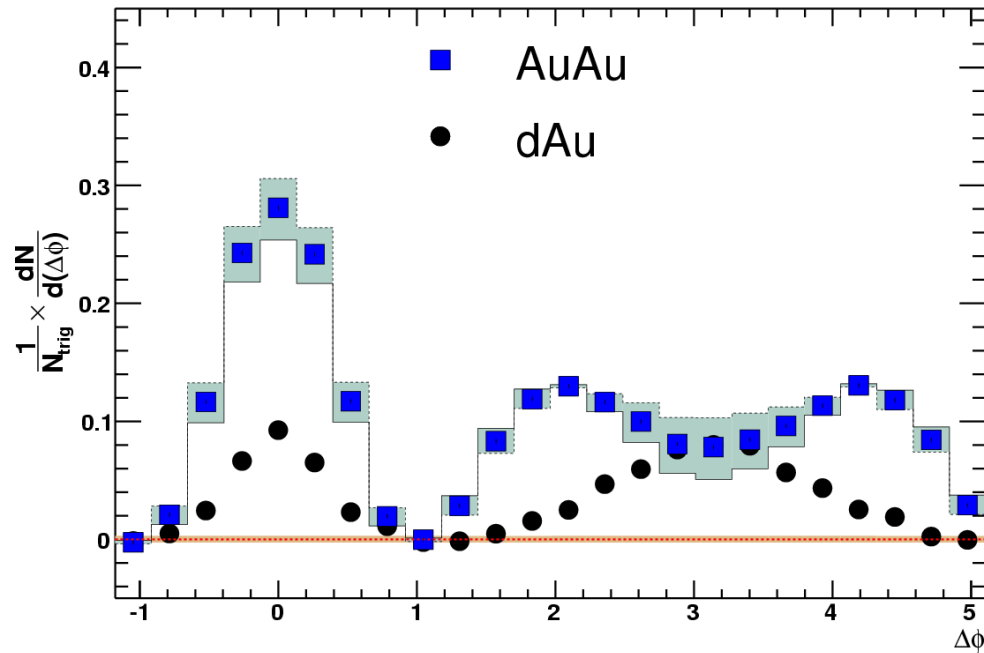
Second jet eaten up by the medium

=> Quark-Gluon Plasma

One jet in medium

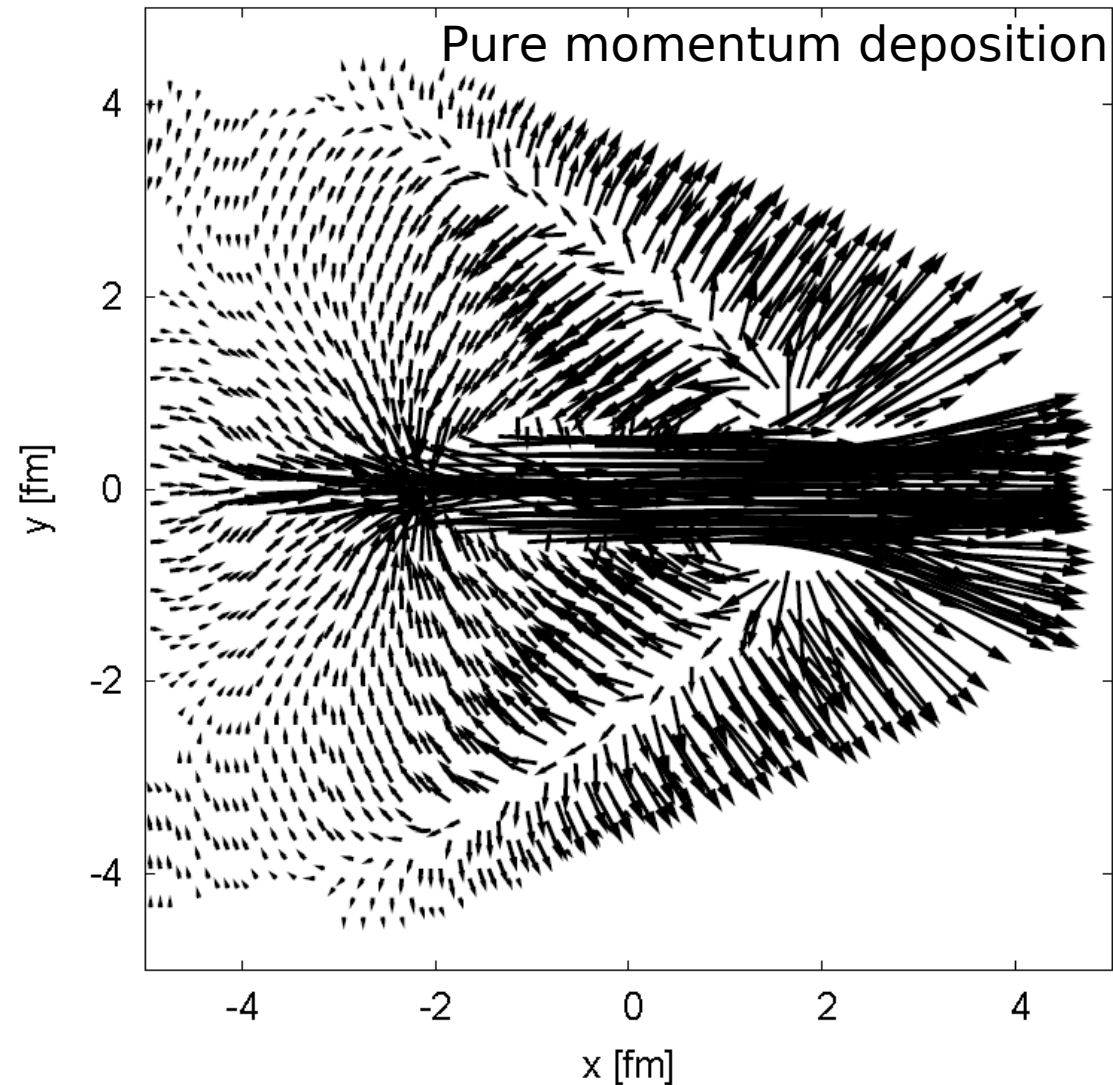
- Momentum is being transferred to the bulk
=> expect collective response of the bulk
- Proposed Mach cones
 - > possible signals seen in correlation data
 - > cones correlated to leading particle
(not *primarily* correlated to elliptic flow)

Angular correlations: Mach cones?



Simulation of medium response

B. Betz, M. Gyulassy, D. Rischke, H. Stocker, G. Torrieri, J.Phys.G35:104106,2008



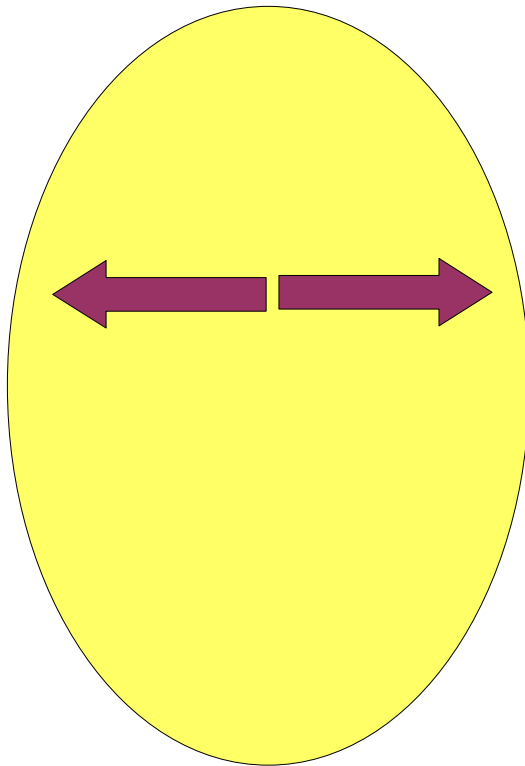
More jets in medium

- LHC (and maybe RHIC):
more than one (mini)jet in single event

What is the influence of two or more (pairs of) jets which transfer momentum on the bulk?

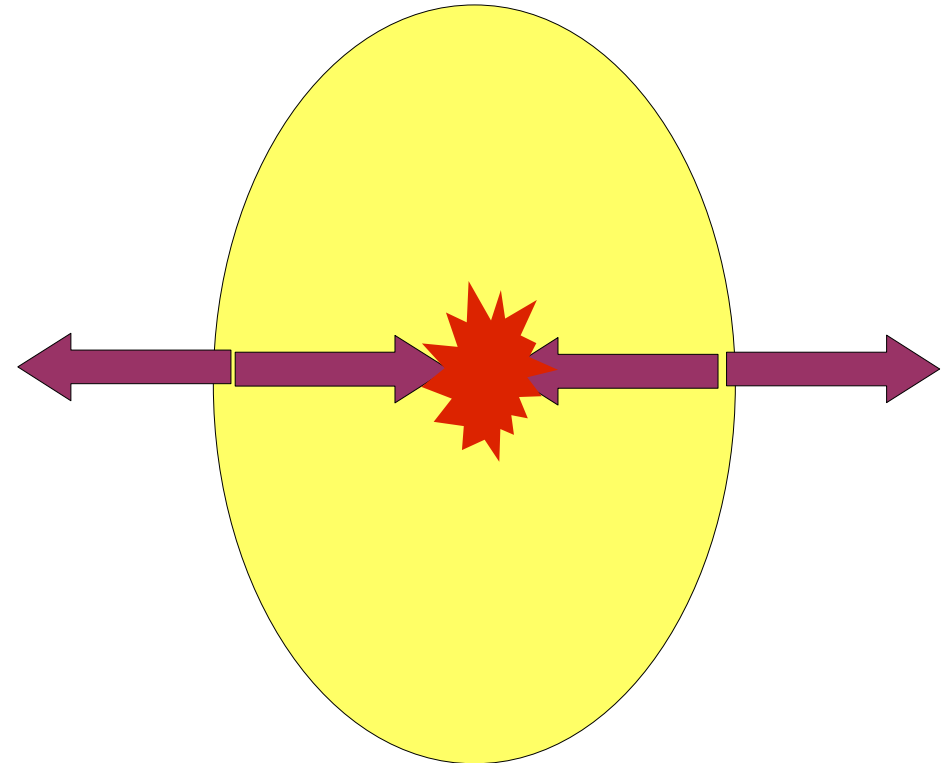
Jets in medium

One pair of jets



Contribution to v_2

Two pairs of jets



Momenta cancel out
- energy deposition
=> less v_2 generation
=> decrease of flow in $\langle\!\!\langle$ direction

More jets in medium

Question:

If

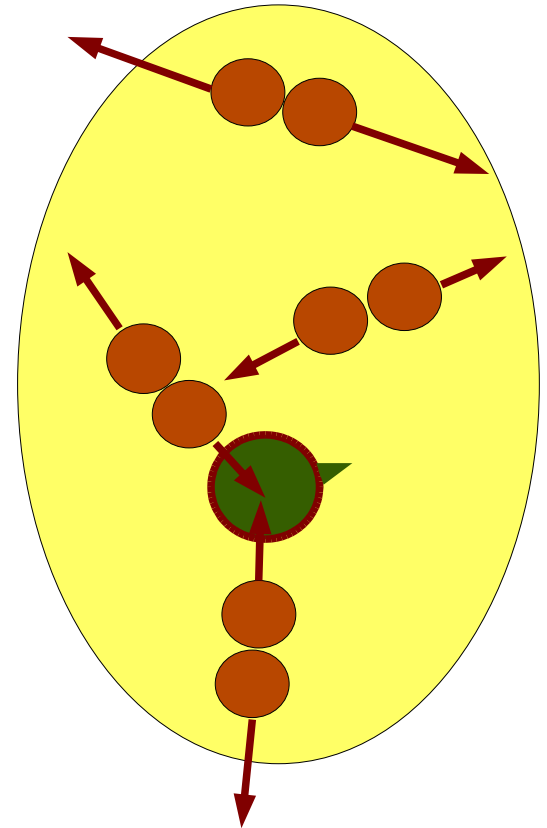
- we have ellipsoidal fireball,
 - jets are produced isotropically,
- in which direction will most of the collisions happen?

In that direction we shall have less flow.

This will give contribution to v_2 .

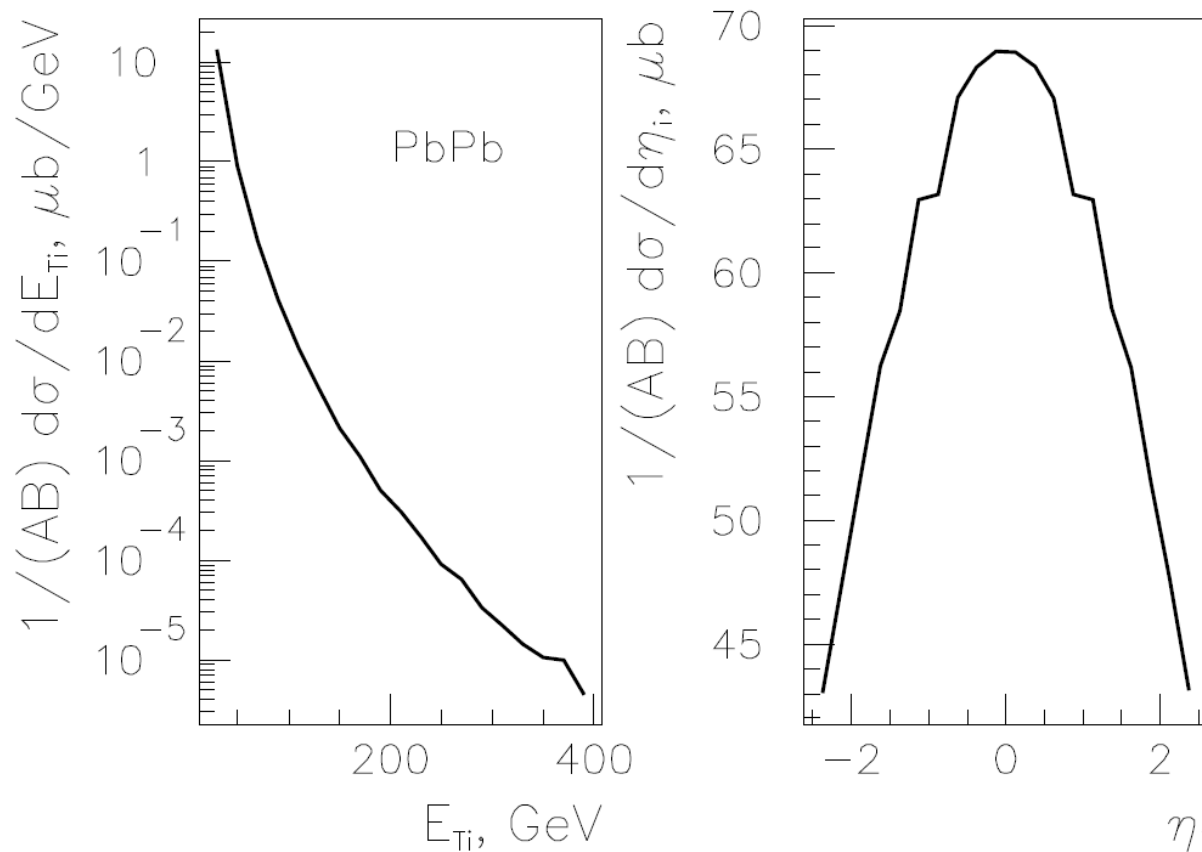
A toy model

- “Streams” are represented by droplets of matter, they are
- Produced back-to-back
- When droplets collide, they merge into a heavier droplet
- Droplet size represents stream diameter (used is radius 3.5 fm, tests also with 1.5 fm)
- Droplets evaporate pions



(Mini)jet distribution: momenta

From: A. Accardi et al., CERN Yellow Report, 2004-009



Fit by a power law down to a threshold E_T of 5-6 GeV

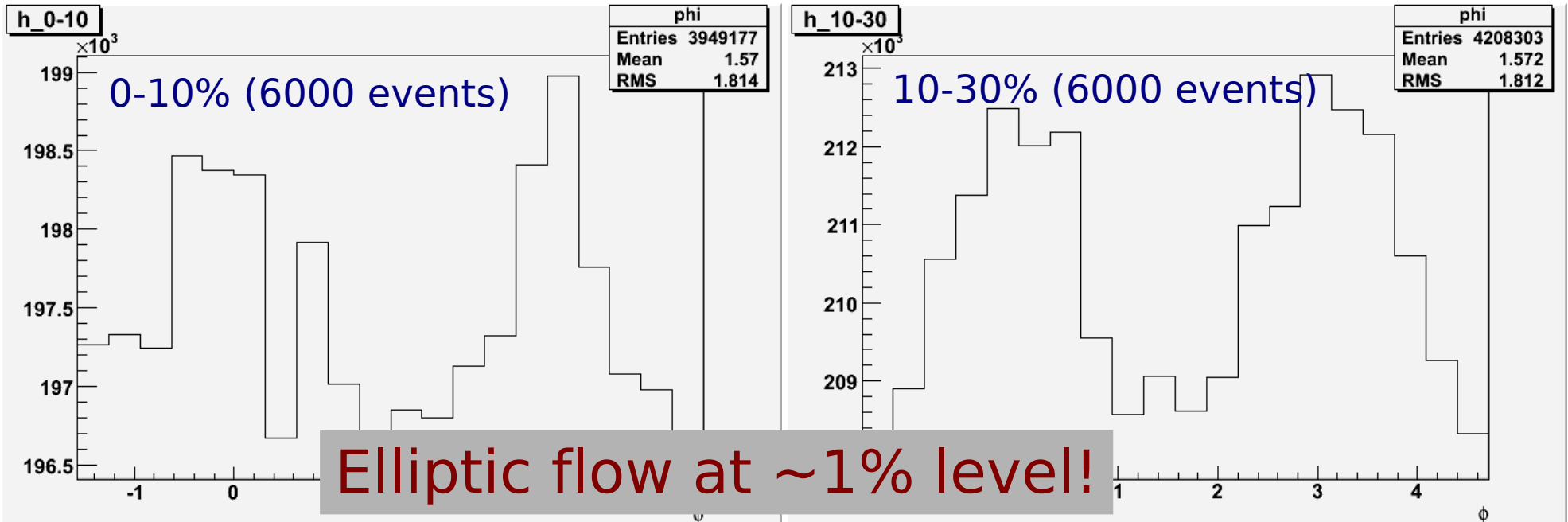
(Mini)jet distribution: position

Glauber model calculation of the distribution

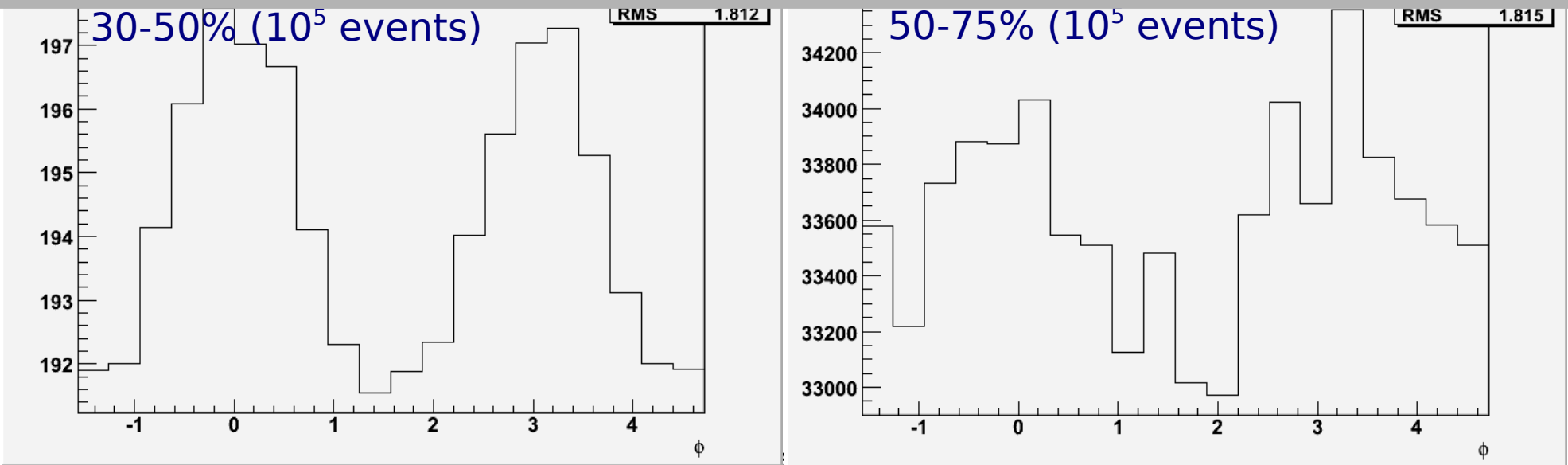
$$U_{AA}(\vec{b}, \vec{x}) = T_{AA}(b, \vec{x})T_{AA}(b, \vec{x} - \vec{b})$$



A toy model: results



What would be the result of hydrodynamic simulation?



Summary... ..outlook

- At LHC, it may be interesting to look at contributions to elliptic flow from the action of more jets.
- Expect effect on per cent level – needs to be understood for the extraction of bulk properties.
- How to recognise this contribution?
(v_2 fluctuations?)
- Do hydro + jets!