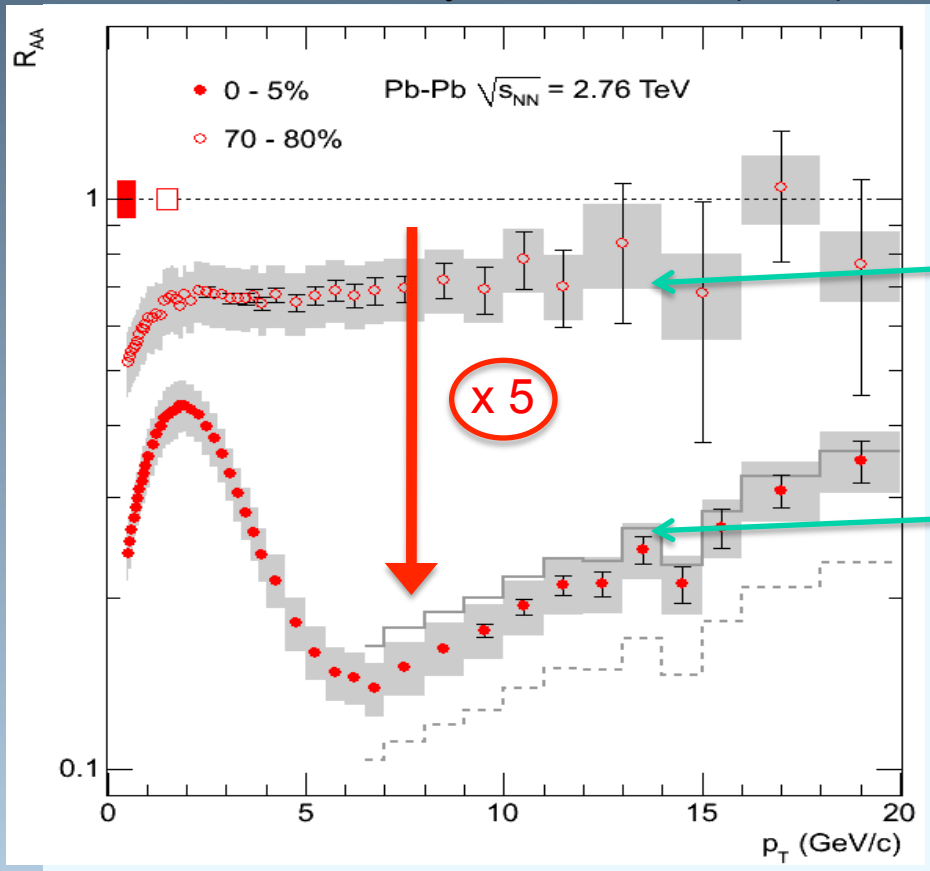
PHY397K - NUCLEAR PHYSICS - 5

PHY397K - NUCLEAR PHYSICS
Spring 2015, Unique numbers: 57115
RLM 5.116, TTH 12:30 - 2:00 pm

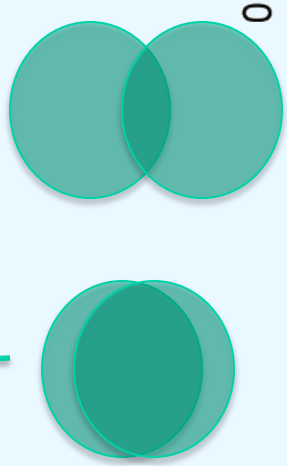
Christina Markert
Office: RLM: 10.305
Phone: 512 471 8834
Email: cmarkert@physics.utexas.edu

High transverse momentum suppression

ALICE: Phys. Lett. B 696 (2011) 30.



$$R_{AA} = \frac{d^2N/dp_T d\eta \ \text{(Pb+Pb)}}{T_{AA}\, d^2\sigma/dp_T d\eta \ \text{(p+p)}}$$



At high transverse momentum (p_T) the yield is only 1/5 of what we would expect from superposition p-p collision

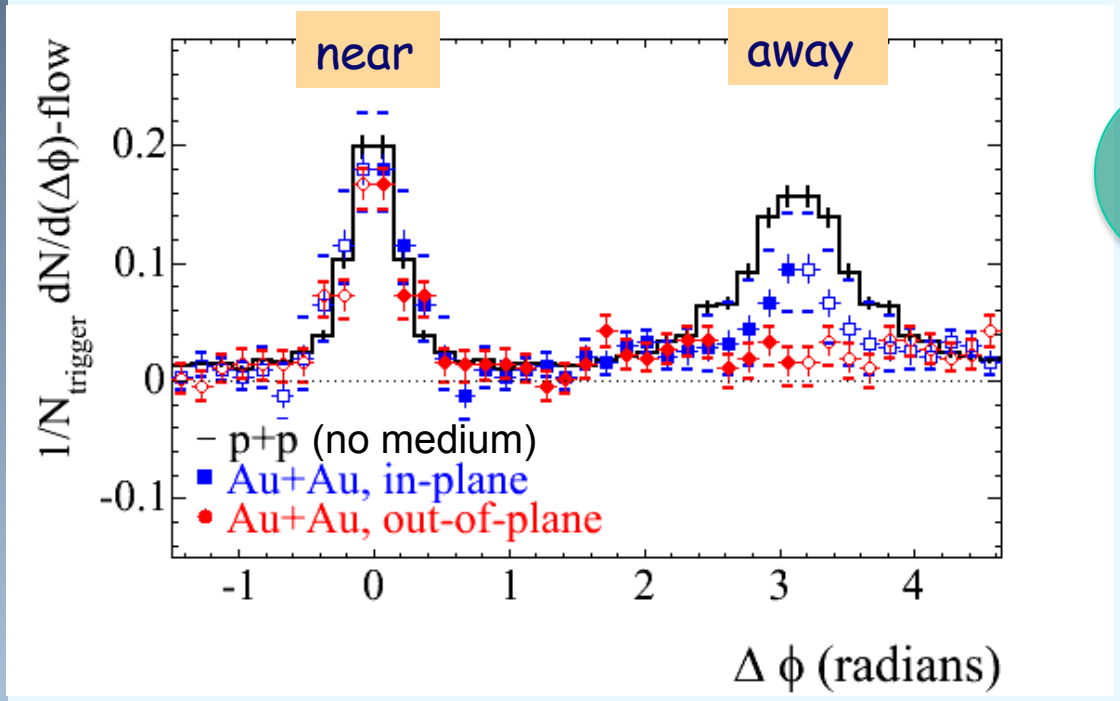
High p_T suppression → partonic medium (Jet modified by medium)

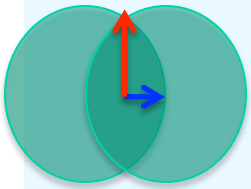
$\varepsilon \approx 15$ GeV/fm^3

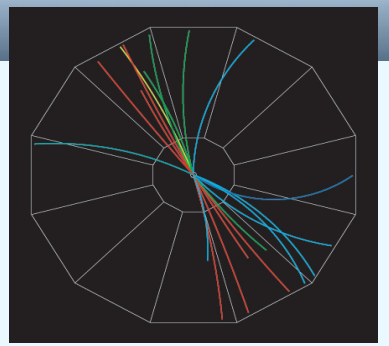
(e.g. X.N. Wang nucl-th/0307036)

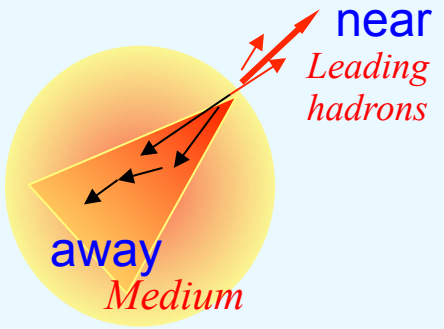
Di-jet quenching - energy loss in medium

Trigger particle p_T = 4-6 GeV
Correlated particle p_T = 2-4 GeV





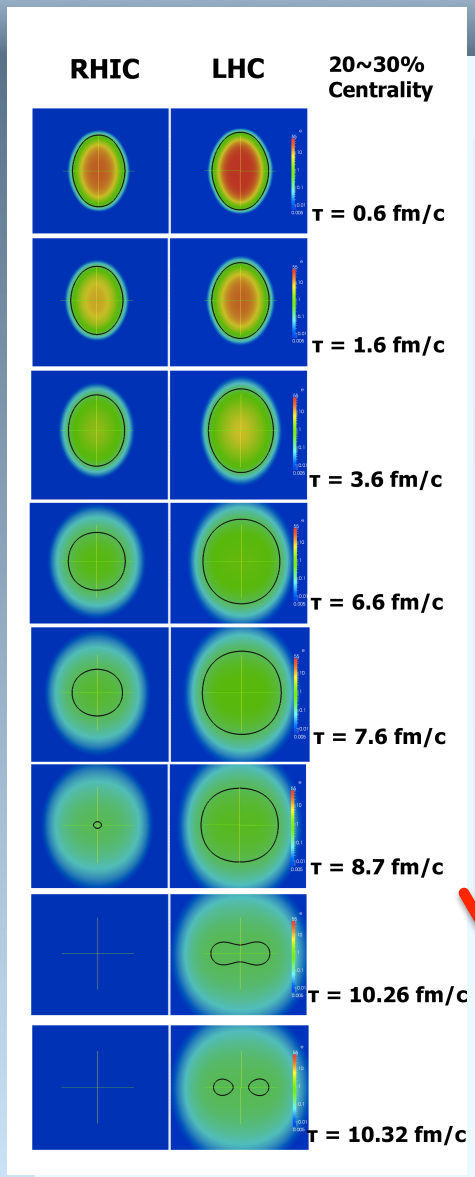




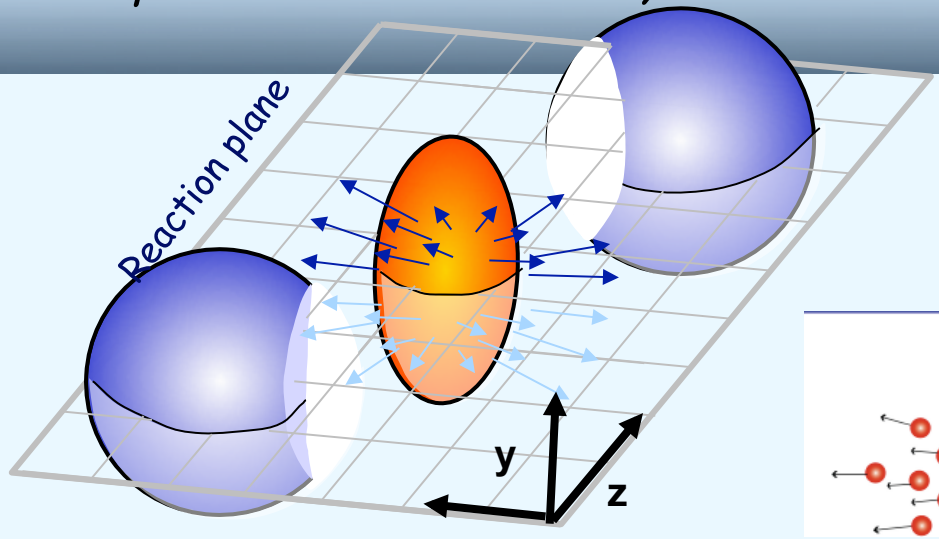
Away-side suppression: (RHIC energies)
Suppression larger in out-of-plane
→ Path length dependence of energy loss
→ Density ≈ 15 GeV/fm3

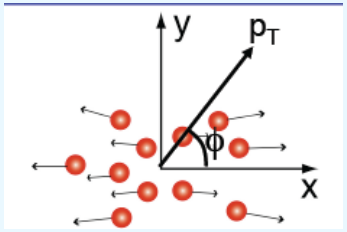
Hydrodynamic evolution of a system

elliptic flow = collectivity

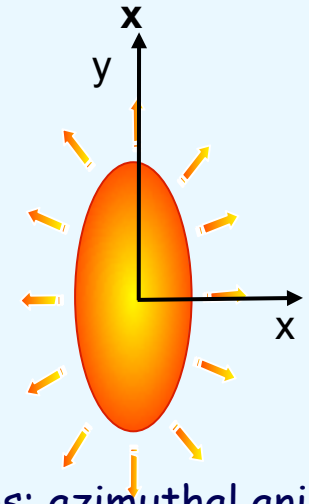


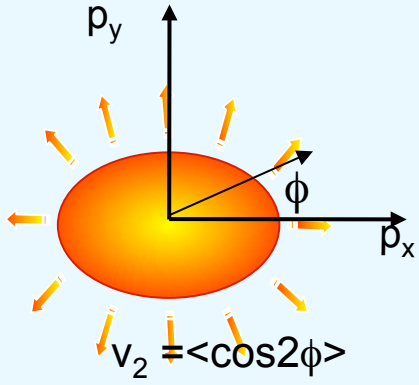
time





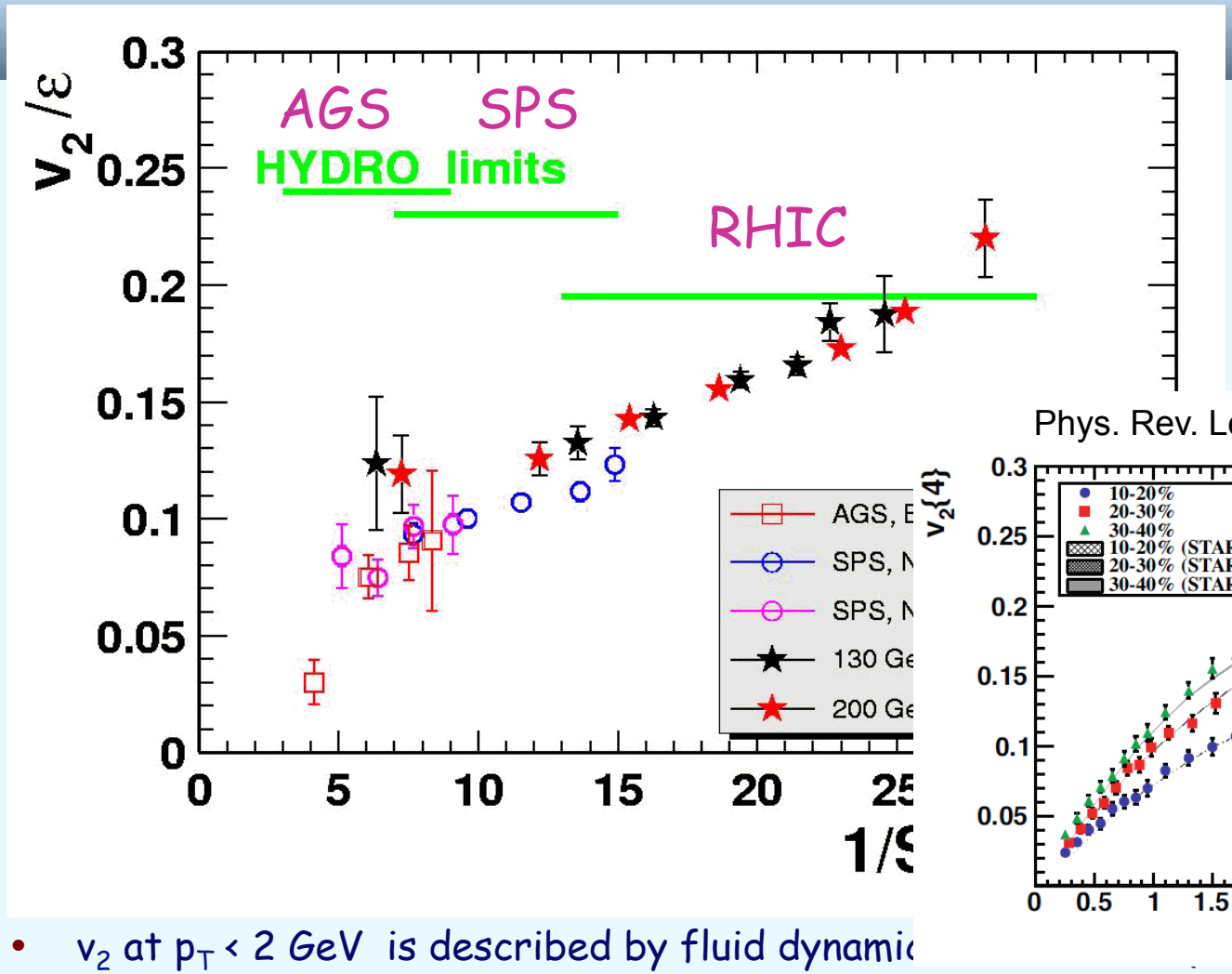
$$v_2 = \frac{\langle p_x^2 \rangle - \langle p_y^2 \rangle}{\langle p_x^2 \rangle + \langle p_y^2 \rangle}$$



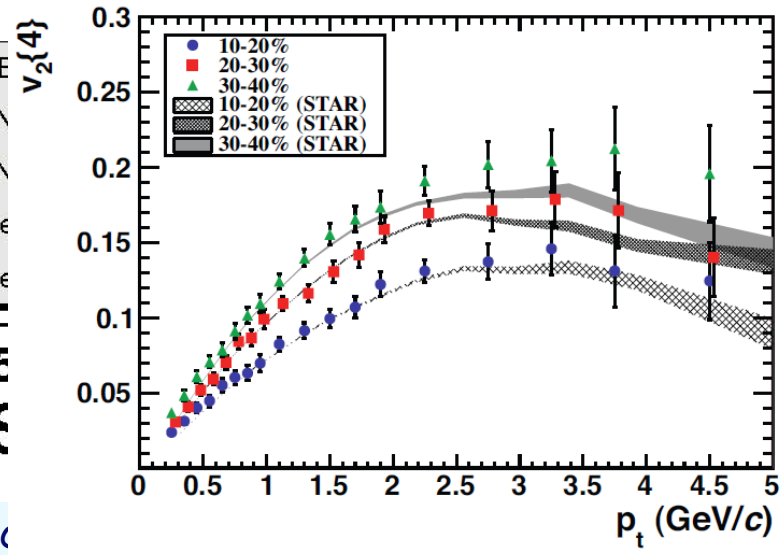


- non-central collisions: azimuthal anisotropy in coordinate-space.
- interactions ➔ asymmetry in momentum-space.
- sensitive to early time in the system's evolution.
- Large v_2 is an indication of ***early thermalization***

Hydrodynamic Behavior – did we form a fluid ?

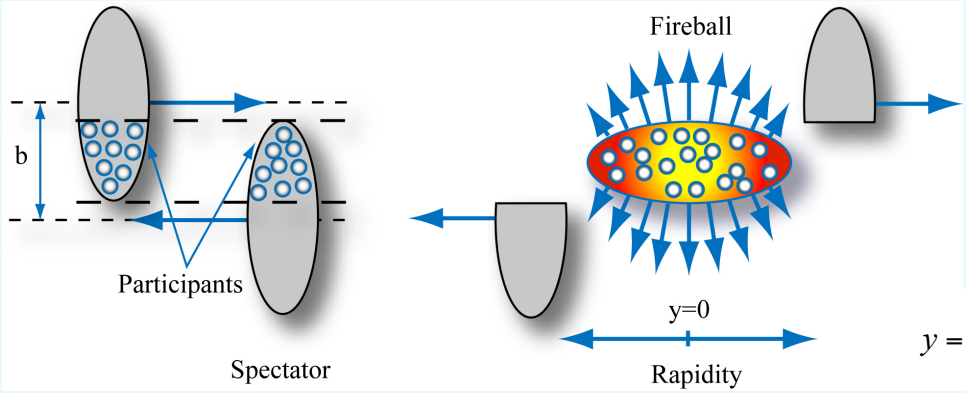


Phys. Rev. Lett .105, 252302 (2010)



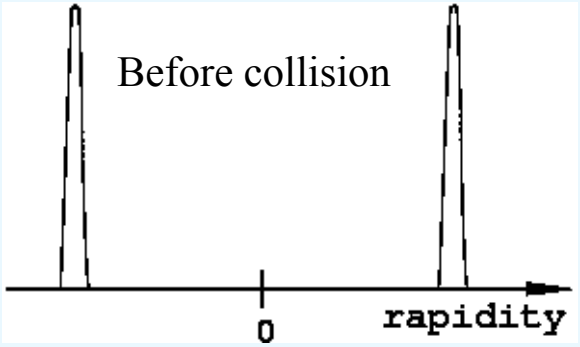
- v_2 at p_T < 2 GeV is described by fluid dynamic
  → collective interactions at early stage (assumes QGP Equation of State based on lattice QCD: Equilibration time t=0.6 fm/c and ε=20 GeV/fm^3).
- System reaches hydro limit at RHIC → liquid behavior of QGP → strong coupling

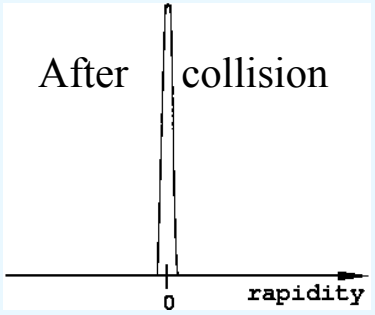
Spectators and Participants

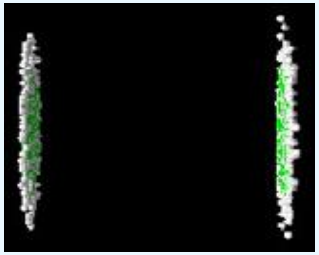


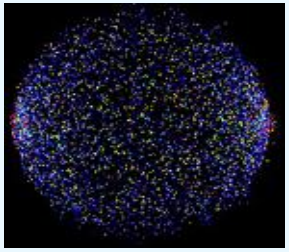
$$y = \frac{1}{2}\log\left(\frac{E + p_z}{E - p_z}\right)$$

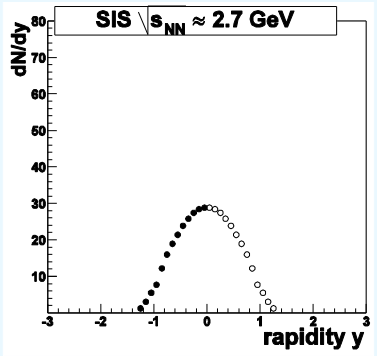
"Velocity" space

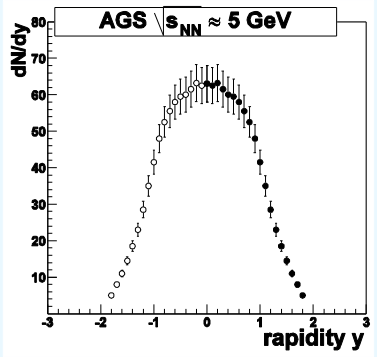


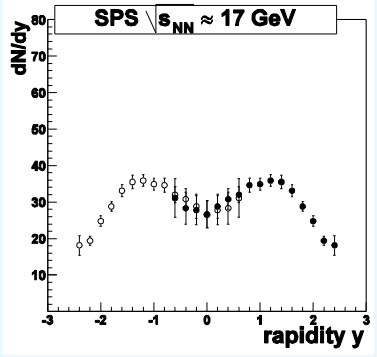








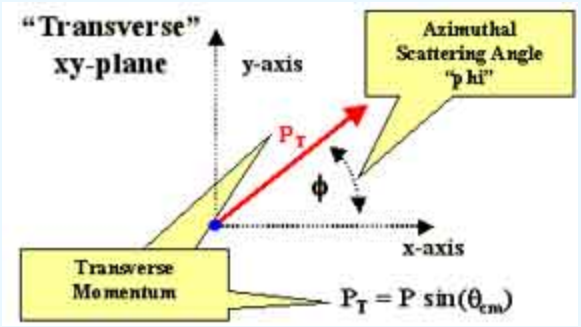


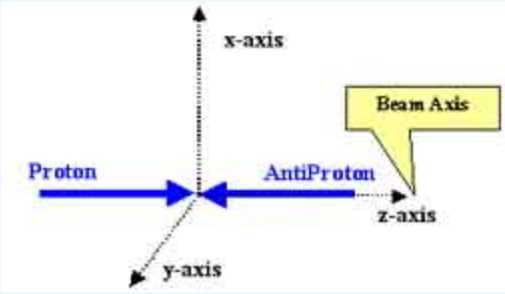


Kinematic Variables

Transverse momentum p_T:

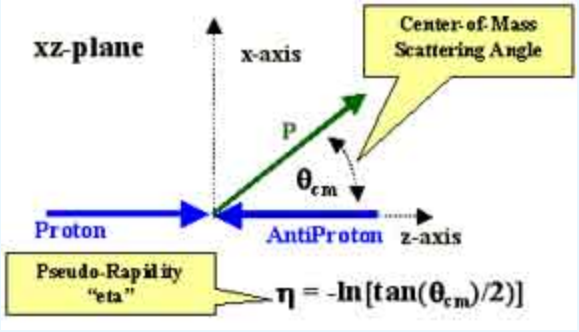
$$p_T = \sqrt{p_x^2 + p_y^2}$$





Rapidity y: (corresponds to longitudinal momentum)

$$y = \frac{1}{2}\log\left(\frac{E + p_L}{E - p_L}\right) \qquad \tanh(y) = p_L / E$$



E= energy of particle
p_L = is the longitudinal momentum along the direction of the incident particle

The shape of a rapidity distribution is a invariant under boosts in the z-direction