Collective phenomenon from strange particle spectra in pp, pPb and PbPb collisions

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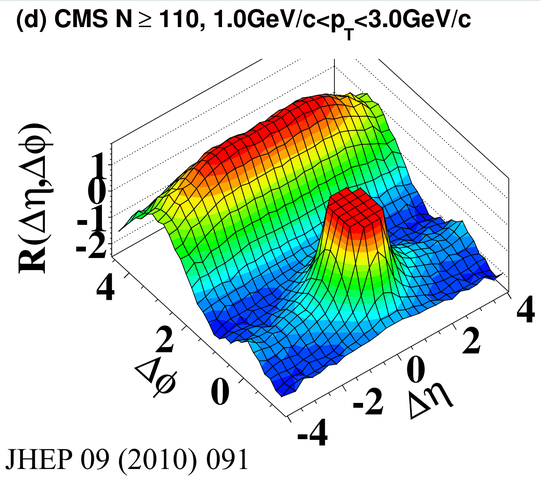
Motivation

- CMS has observed the "ridge" structure in pp collisions, indicating collective phenomenon in high multiplicity events in small systems.
- In the context of some hydrodynamic models, the radial flow effect has been proposed to be larger in smaller systems when compare at similar multiplicity.



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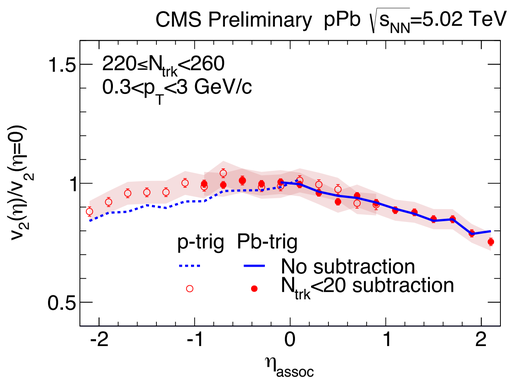
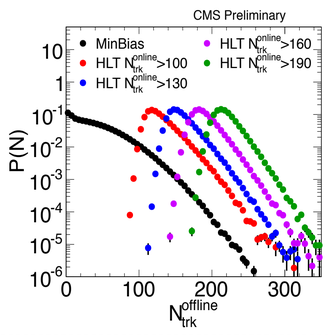


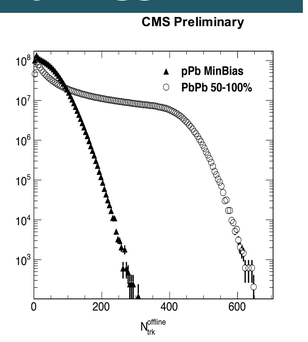
- Both hydrodynamics and models like Color Glass Condensate (CGC) propose to attribute to the long range near-side correlation in small systems.
- In pPb collisions, hydrodynamic models predict the Pb-going side has stronger radial flow effect, as opposite to CGC.

How about radial flow in pp collisions?

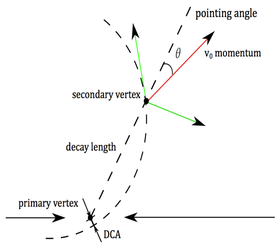
K^0_s, Λ, Ξ Reconstruction and High Multiplicity Triggers

- Unique high-level triggers enable precise studies of PID v_n in very high multiplicity pPb events

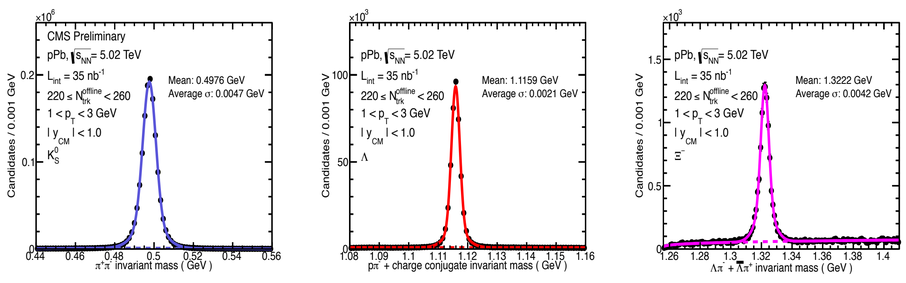




- Reconstruction via topological decays in CMS silicon tracker



K^0_s Λ Ξ



Clean reconstruction over wide range of p_T and η

Analysis Method – Blast-wave model

The Blast-wave functional form is,

$$\frac{1}{p_T}\frac{dN}{dp_T} \propto m_T \int_0^R I_0\left(\frac{p_T \sinh\rho}{T_{kin}}\right) K_1\left(\frac{m_T \cosh\rho}{T_{kin}}\right) r\,dr$$

where rho is define as the velocity profile described by,

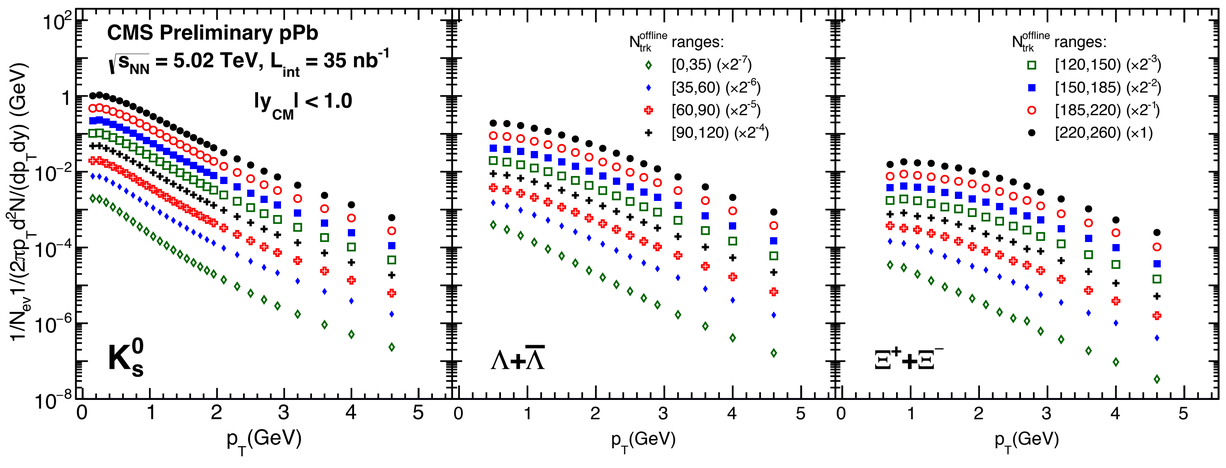
$$\rho = \tanh^{-1}(\beta_T) = \tanh^{-1}\left(\beta_S\left(\frac{r}{R}\right)^{\gamma}\right)$$

β_S is the transverse expansion velocity at the surface, R is the radius of the fireball, I and K are the Bessel functions

- Blast-wave model was motivated by hydrodynamics, and a useful tool to describe particle p_T spectra and to compare among systems

Multiplicity dependence of spectra

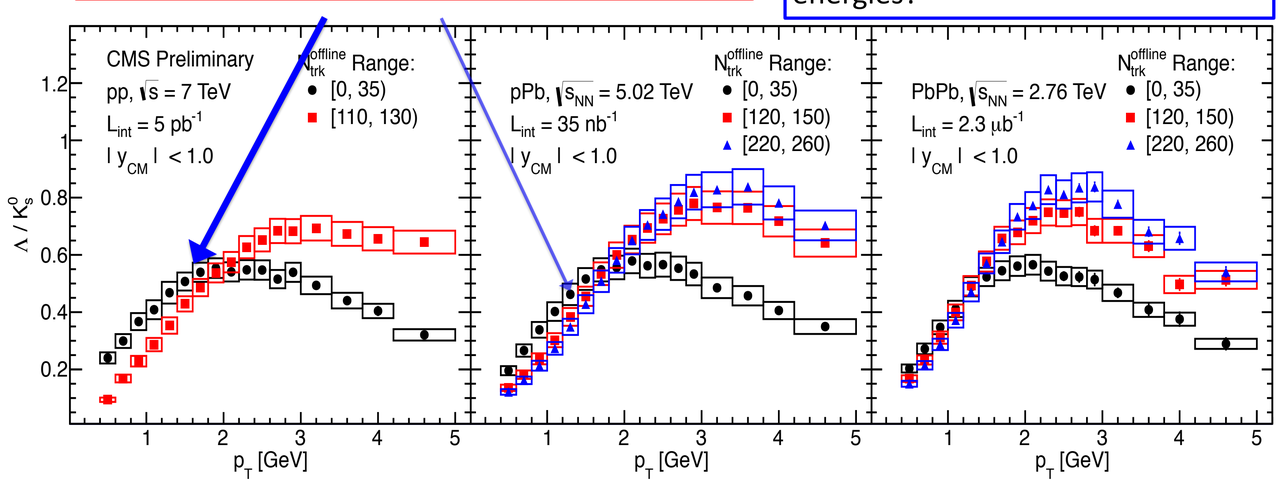
Only pPb spectra are shown



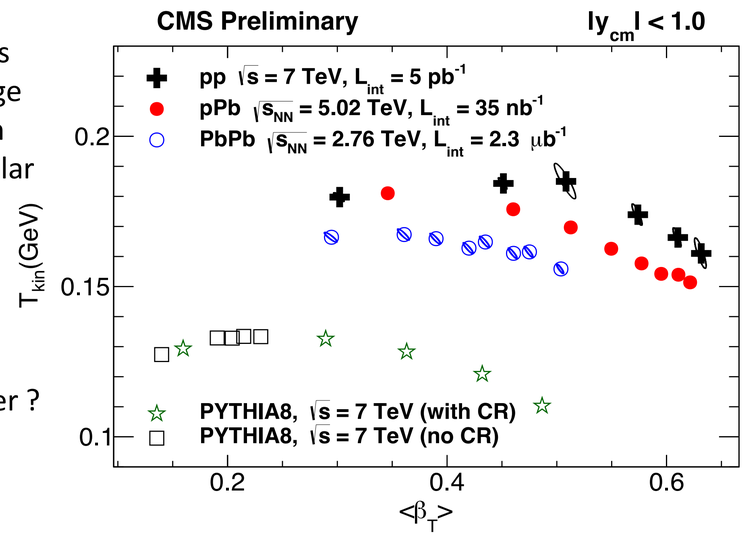
Results

In p_T < 2 GeV/c, the difference in baryon/meson ratio increases as the system becomes smaller! Stronger radial flow in small system?

Comparison with different center-of mass energy. Does the difference completely cause by the colliding energies?



- Blast-wave fits results indicate larger average radial flow velocity in small systems at similar multiplicities

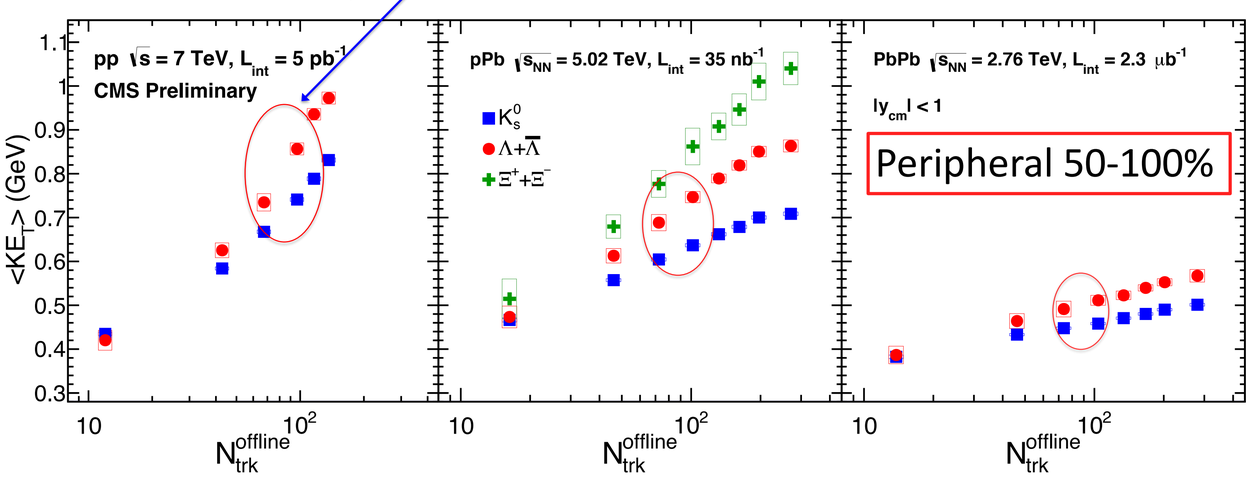


- Particle density higher ?

In hydrodynamics, the difference in kinetic energy can give us a hint of the magnitude of radial flow

~ $\Delta m \langle\beta_T\rangle^2$

- Heavier particles $\langle KE_T\rangle$ increase faster in each system
- Same particle increases faster in smaller system



Rapidity dependence of spectra

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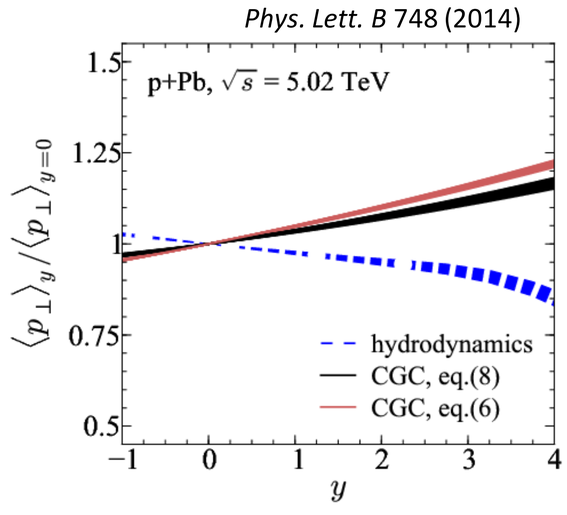
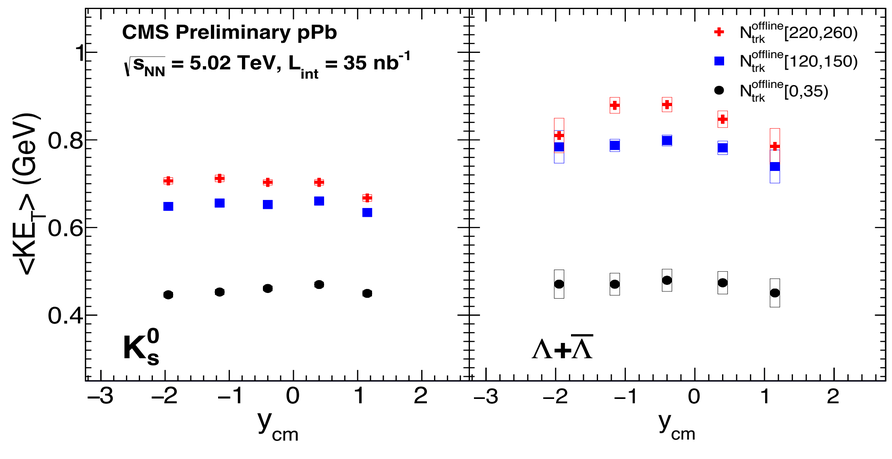


- Models like CGC predicts that the proton-going side has stronger radial flow in pA collisions, as opposed to hydrodynamics.



- Average kinetic energy increases with negative rapidity (in Pb-going side) at high multiplicity