

Underlying Events in p+p Collisions at LHC Energies

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 - LHC: new challenge
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Motivation

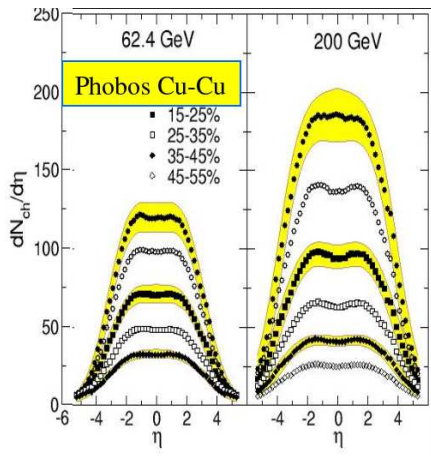
New effects at RHIC

The highest energy heavy ion collider today is RHIC (until winter 2010).

- Surprising effects in heavy ion physics.
- The collective flow ($v_2 \neq 0$).
- Jet quenching, jet tomography.



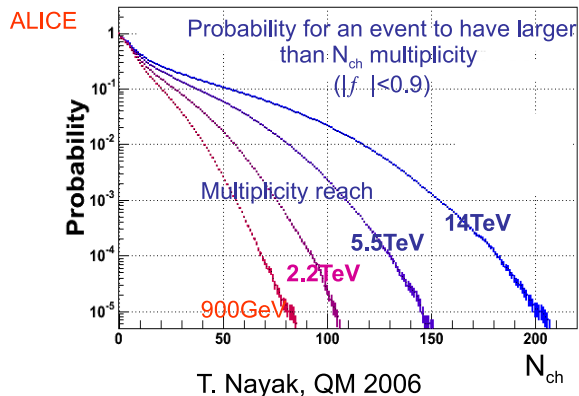
Very high multiplicity events



Multiplicity distributions in **Cu+Cu** collisions at different energies.



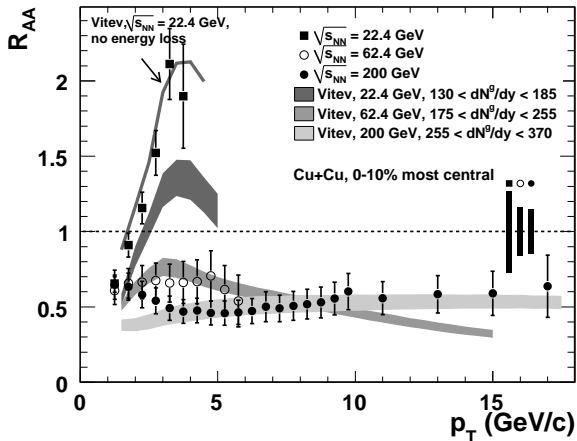
Very high multiplicity events



Expected multiplicities at various energies in **p+p** collisions at ALICE. 14 TeV p+p is comparable to mid-central 62.4 GeV Cu+Cu.



Pion suppression at RHIC



The pion production is suppressed already in 62.4 GeV Cu+Cu collisions.



The RHIC has showed many unique properties of heavy ion collisions.

The investigations have been conducted up to a certain energy.

Are we able to find similar phenomena in $p+p$ collisions at LHC energies?

We need a very good understanding of the underlying event.



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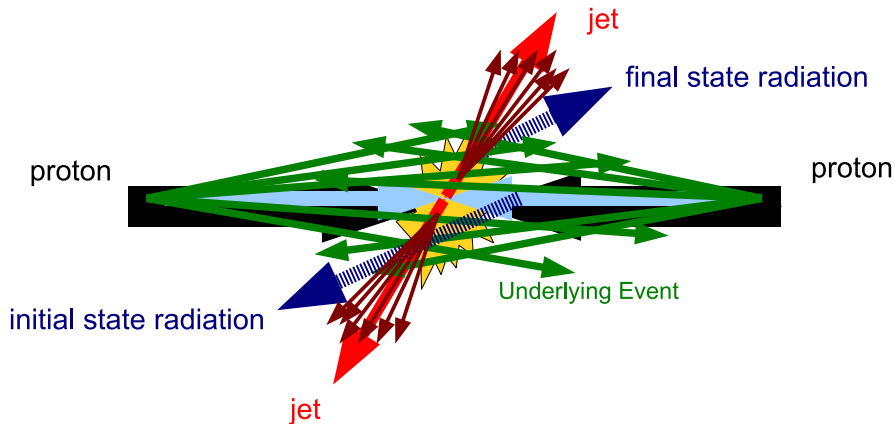
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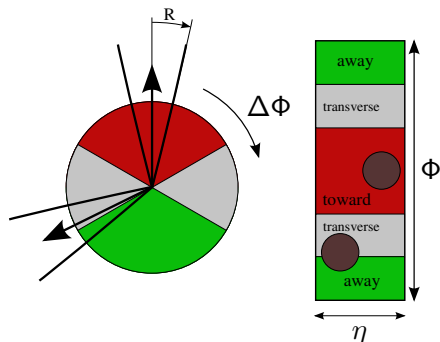
Overview of concepts

Schematic $p+p$ event



Analysis by CDF

The “standard” way



The geometry used by the CDF collaboration. The transverse region is fixed $60^\circ < |\Delta\Phi| < 120^\circ$.

Developed to subtract the UE as a background.

“The transverse region is perpendicular to the plane of the hard 2-to-2 scattering and is very sensitive to the underlying event component of the QCD Monte Carlo models.” (Phys. Rev. D65 092002, CDF collab.)

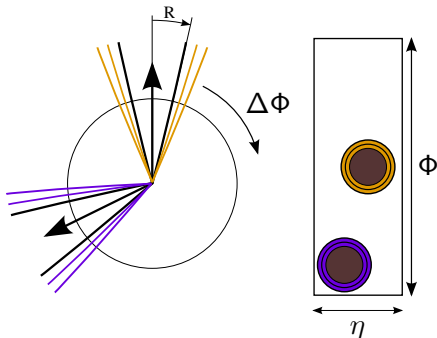


- The transverse region is fixed $60^\circ < |\Delta\Phi| < 120^\circ$.
- No dependence on the pseudo-rapidity.
- Does not use the jet finder information to its full extent.



New method

Surrounding cones



UE is defined as **everything outside** the jet cones. The geometry is more “liquid”, in both Φ and η .

The surrounding cones are ring-shaped **subregions of the UE**. They grasp the border region between the UE and the jets. Inner is #1 and the outer #2, both for the **away-side cone**, and the **leading cone**.

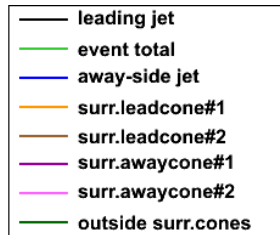
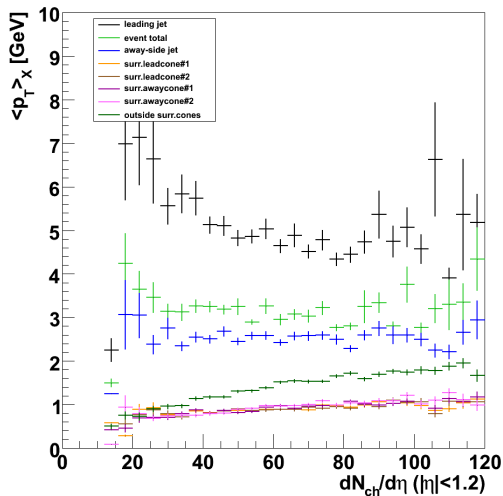
- Built on standard ALICE software framework.
- 100k events sample generated by PYTHIA 6:
 - ▶ $Q^2 > 100 \text{ GeV}^2$ pre-selection of events
 - ▶ GEANT3 used to transport through ALICE
- Cone-type jet finder with radius 0.7.



$\langle p_T \rangle$ distribution in the regions

As a function of N_{ch}

$\langle p_T \rangle$ in the various regions



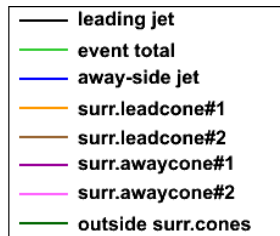
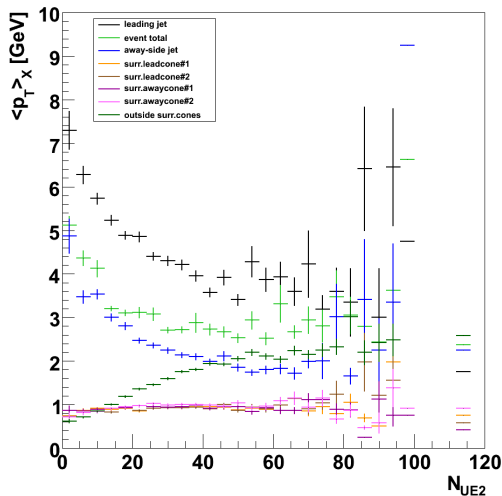
The $\langle p_T \rangle$ as a function of total event multiplicity.



$\langle p_T \rangle$ distribution in the regions

As a function of N_{UE2}

$\langle p_T \rangle$ in the various regions



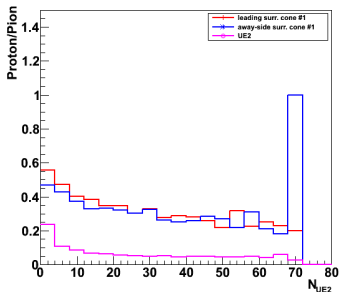
The $\langle p_T \rangle$ as a function of multiplicity in the UE without the surr. cones.



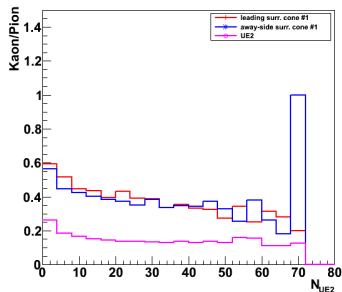
P/π and K/π ratios

Very preliminary

Proton to Pion



Kaon to Pion



Preliminary proton/pion and kaon/pion ratios, using only MC information, no detector simulation.



More signs of entropy production

Very preliminary

Comparing two methods of mean calculation:

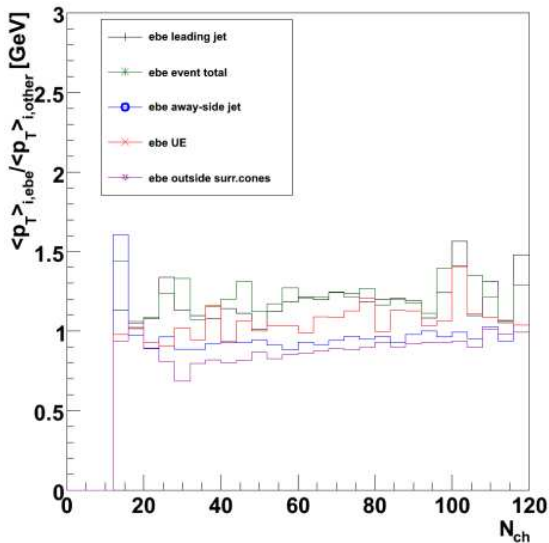
- overall: calculate means using the total event information,
- event-by-event: calculate event-wide means first then calculate their mean; **more sensitive to ebe fluctuations.**

If more entropy is produced in the events then the ratio must be closer to 1.



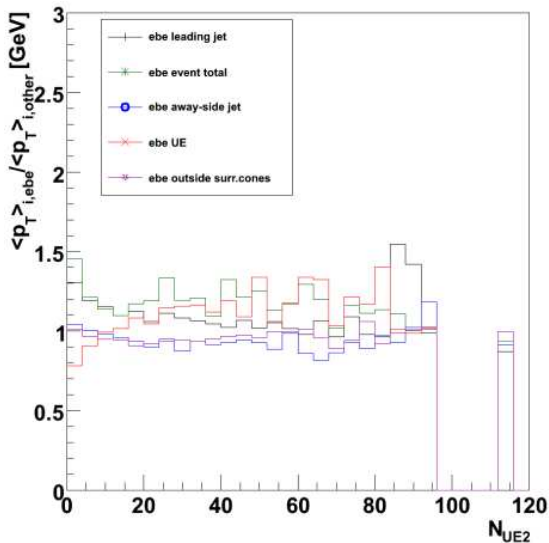
More signs of entropy production

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More signs of entropy production

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- A **new method** to separate the UE and the jets.
- **Structure of the UE** is examined.
- Ready to look for new effects.

- Outlook
 - ▶ Further studying the PID information in the regions (baryon/meson ratio etc.).
 - ▶ Looking forward for more and more physical $p+p$ collisions at LHC.

