

Jets and Underlying Events in p+p collisions at LHC energies

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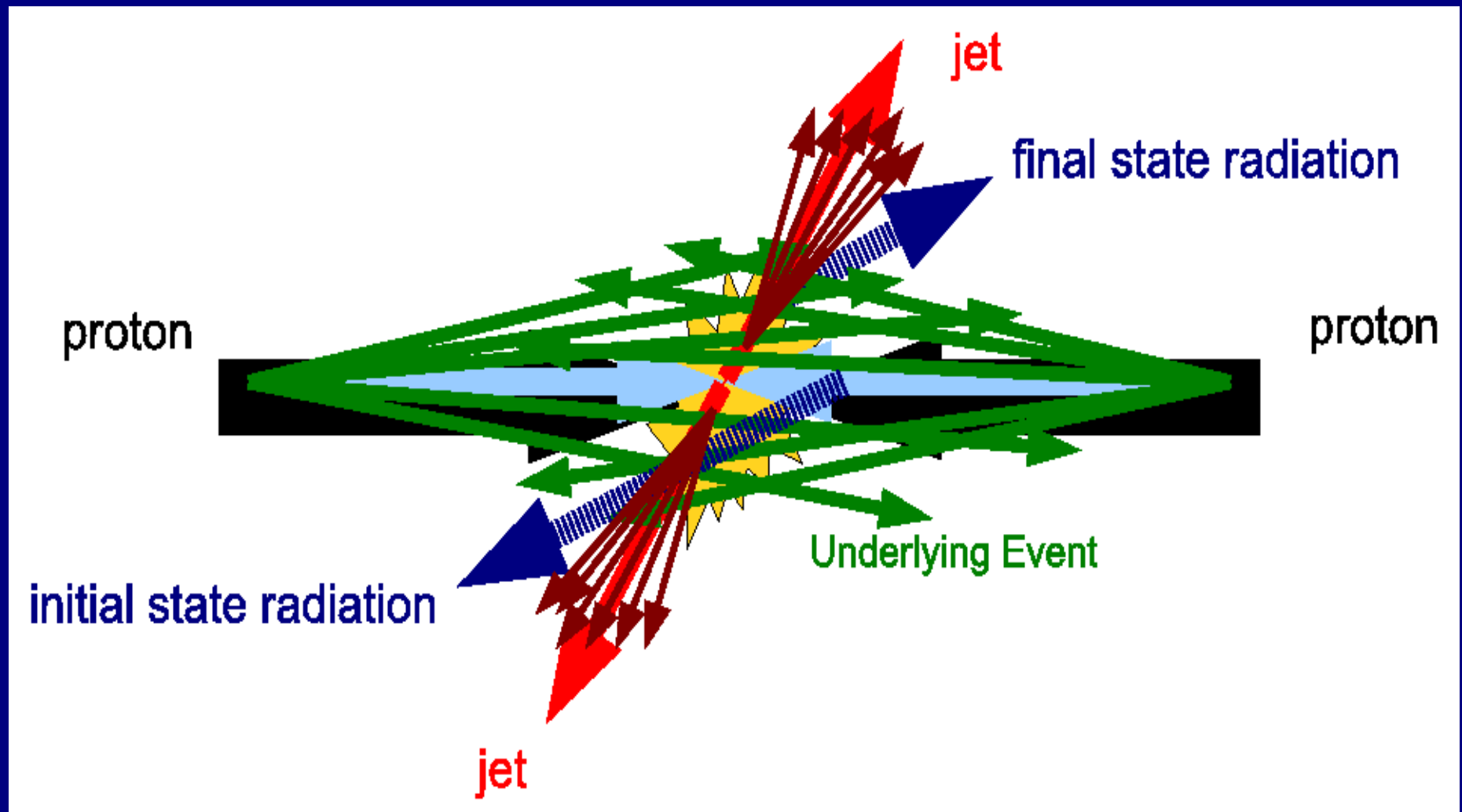
Outline

- Motivation
- The Underlying Event
 - CDF method
 - Surrounding belts
- Surrounding belts with jets and hadrons
 - correlations
 - PID

Motivation

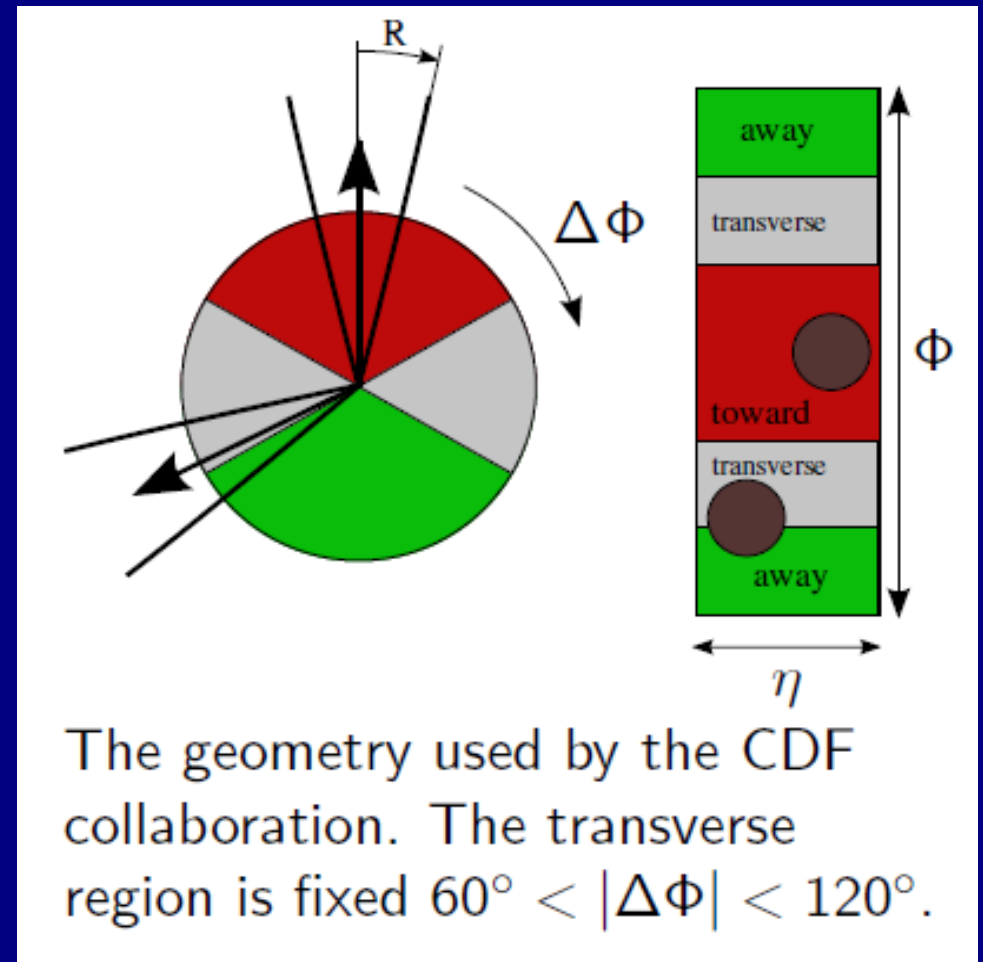
- LHC: record energy in both p+p and heavy ion (right now).
- Better understanding of the UE.

The Underlying Event



The CDF Definition

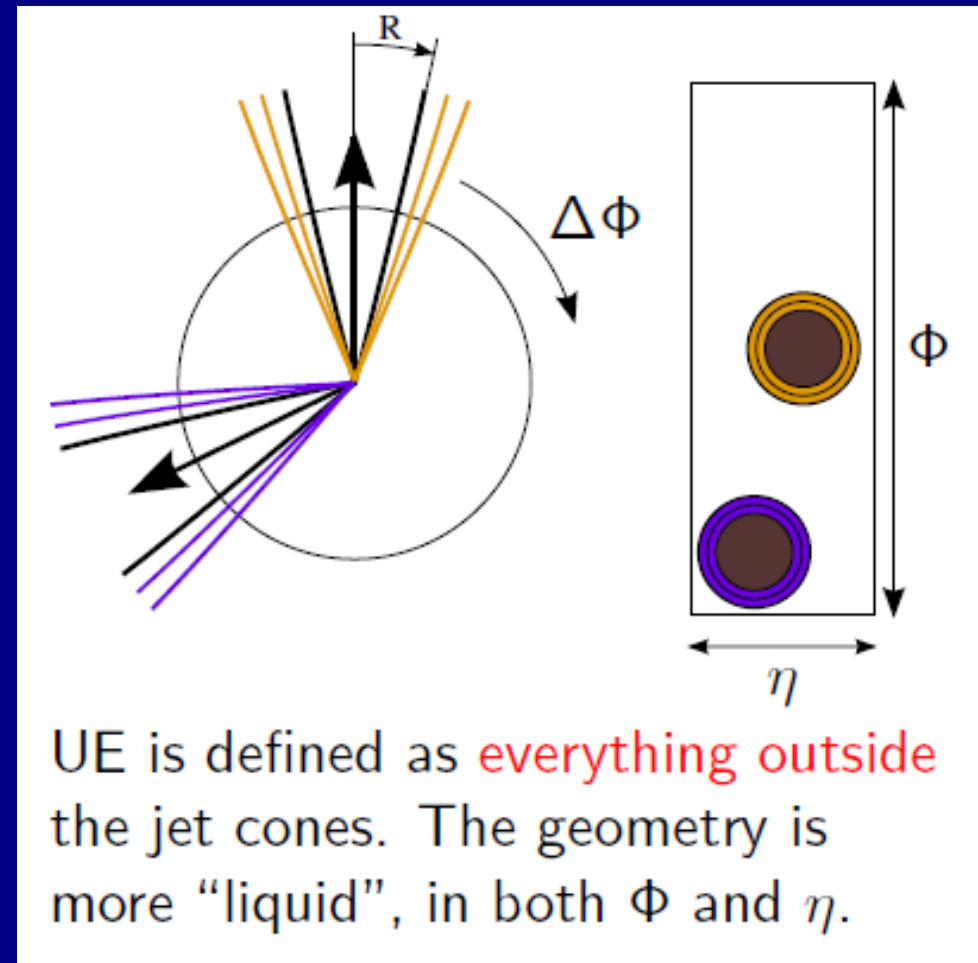
- Developed to subtract the UE as a background.
- Only depends on the azimuthal angle.
- “The transverse region is perpendicular to the plane of the hard 2->2 scattering and is very sensitive to the UE component of the QCD MC models.”



ref: PRD65 092002

Generalisation of the UE

- Around the cones the rings are the **surrounding belts** (SB): they grasp the border between the UE and the jets.
- We use 2 SBs for the near-side and away-side jets.



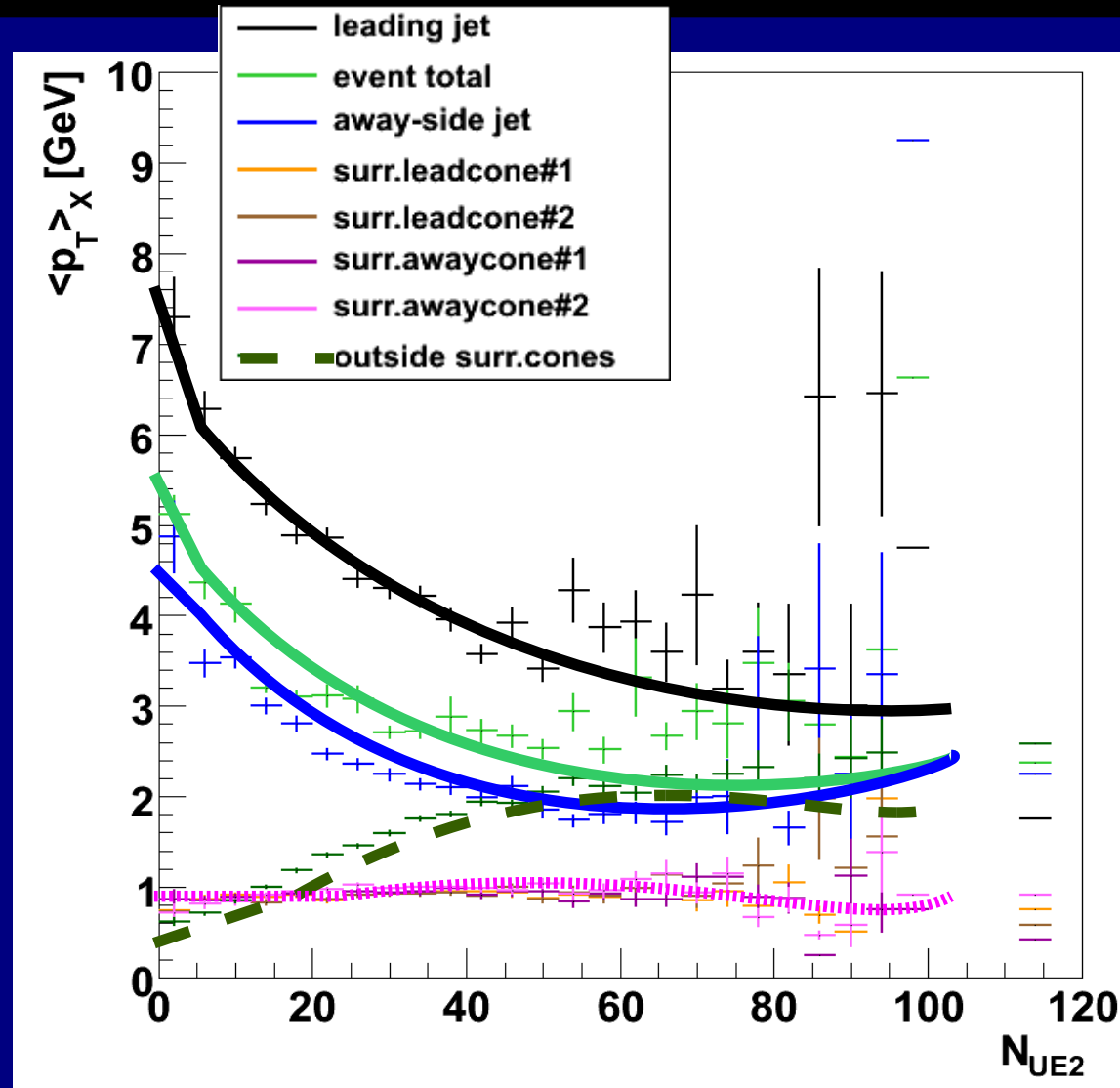
ref: PoS EPS-HEP 2009 47

Tools

- PYTHIA simulations of pp , two sets:
 - 100k events $Q > 100 \text{ GeV}/c$ @ 14 TeV
 - 100M events min-bias @ 7 TeV
- UA1 jet finder, $R=0.7$ with 14 TeV data
 - SB size: $\delta R=0.1$
- We study charged hadrons only.

$\langle p_T \rangle$ vs. N_{UE2} (pp @ 14 TeV)

- jets: high $\langle p_T \rangle$
- SB: \sim const.
1 GeV/c
- new UE: $\langle p_T \rangle$
increases with the
multiplicity
- really high
statistics needed

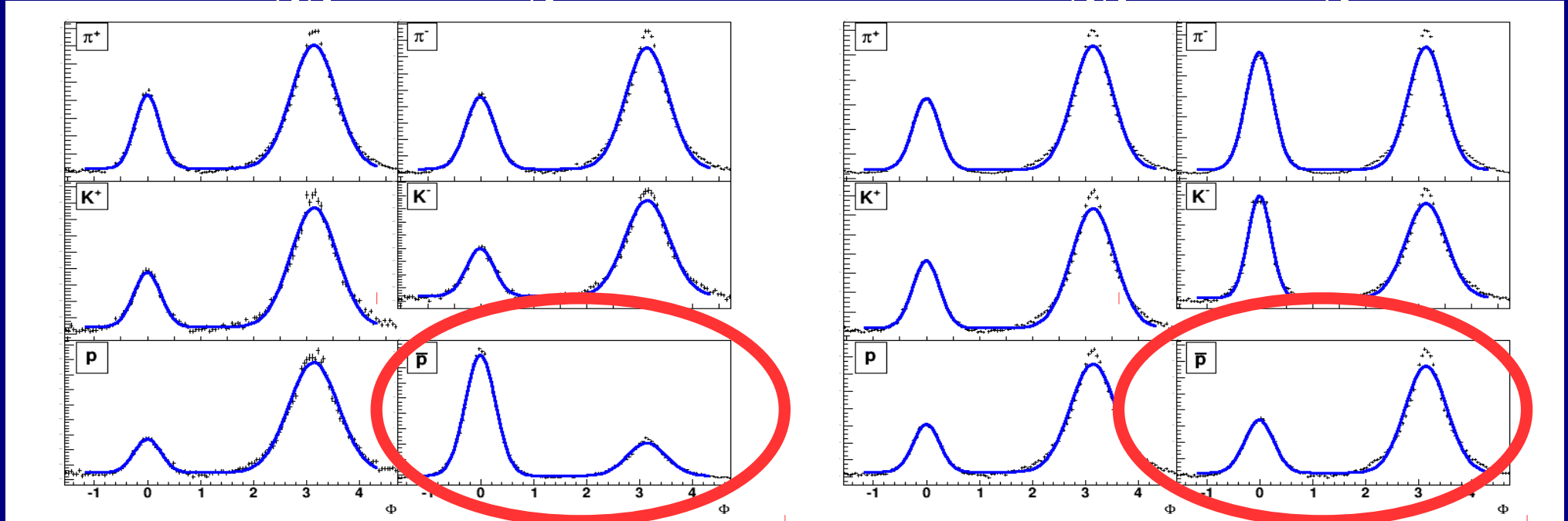


A Different Approach

- Studying **particle correlations** is more accessible with lower statistics.
- We are looking at:
 - azimuthal angle dependence,
 - p_T -dependence,
 - PID information.

Angular correlations

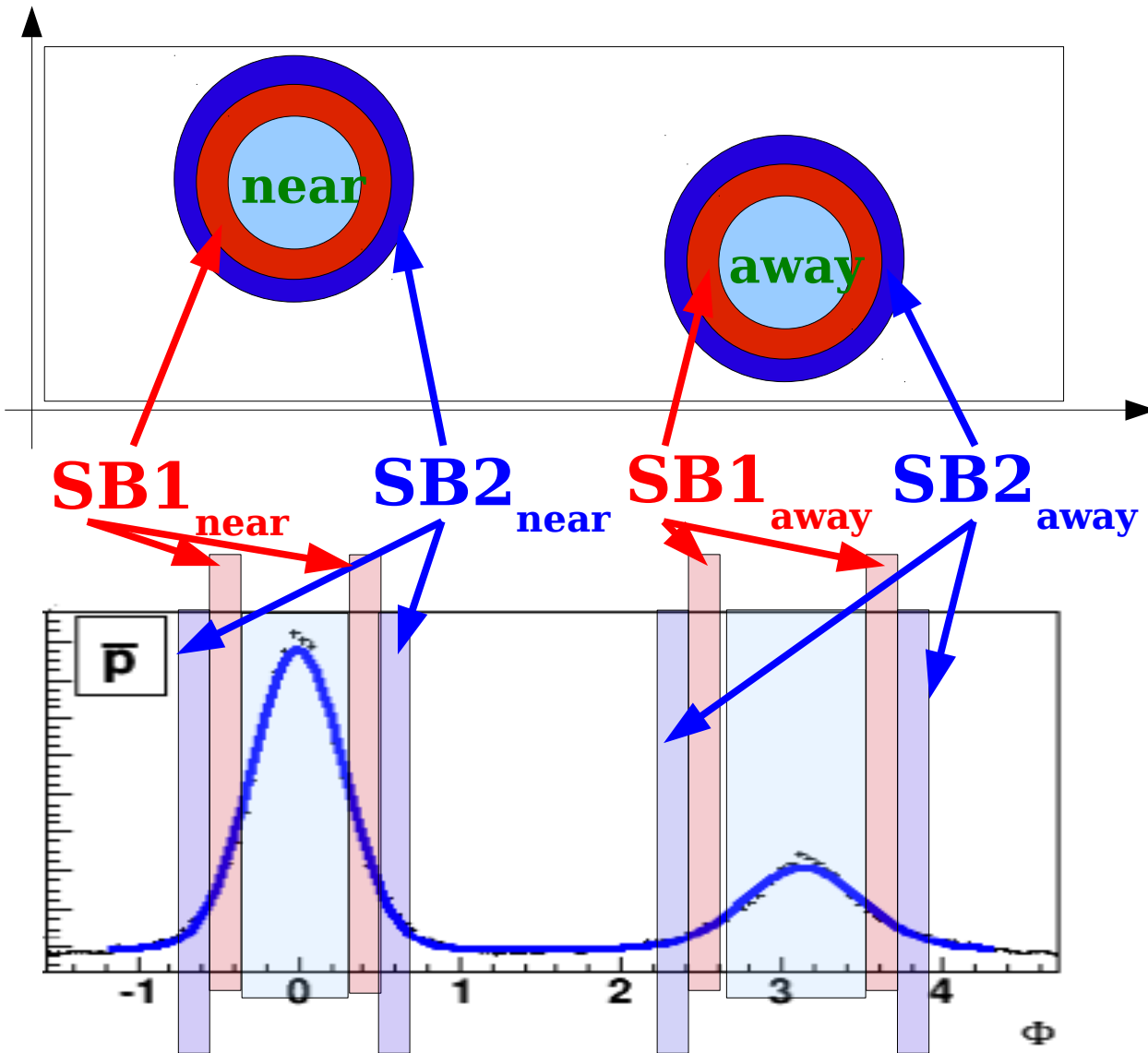
Proton triggered angular corr. Pion+ triggered angular corr.






- pp @ 7 TeV, $2 < \text{trigger } p_T [\text{GeV}/c] < 4$;
- dependence on hadron species of the trigger and the assoc. particle

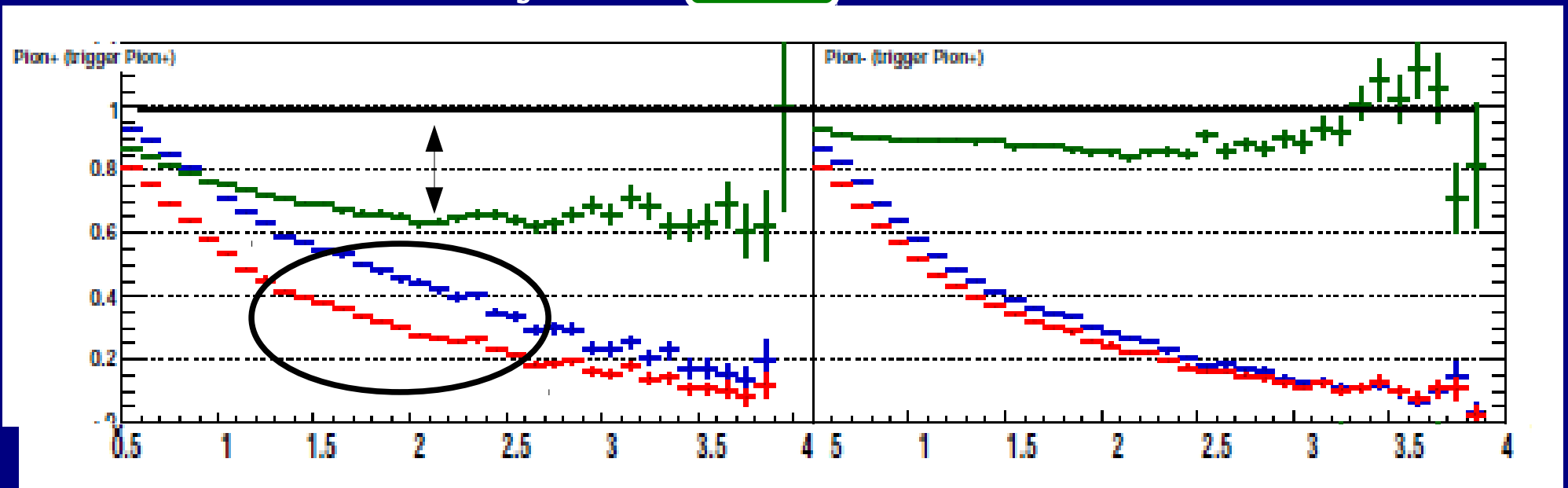
Surrounding Belts

- Compromise between the new and traditional approaches.
- We study the transitional regions in the PID-enhanced correlations (no jets) and not the original surrounding belts.
- Trade-off: the method does not need a jet finder but we have to sacrifice the η -dependence.



Spectra Ratios with π Trigger

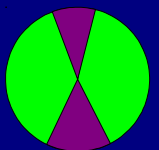
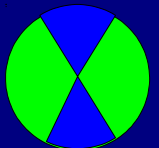
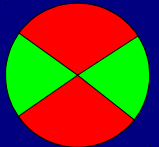
- pion-triggered pion spectra (pp @ 7 TeV)
 - Near Side / UE 
 - Away Side / UE 
 - Near / Away 



Various Belts

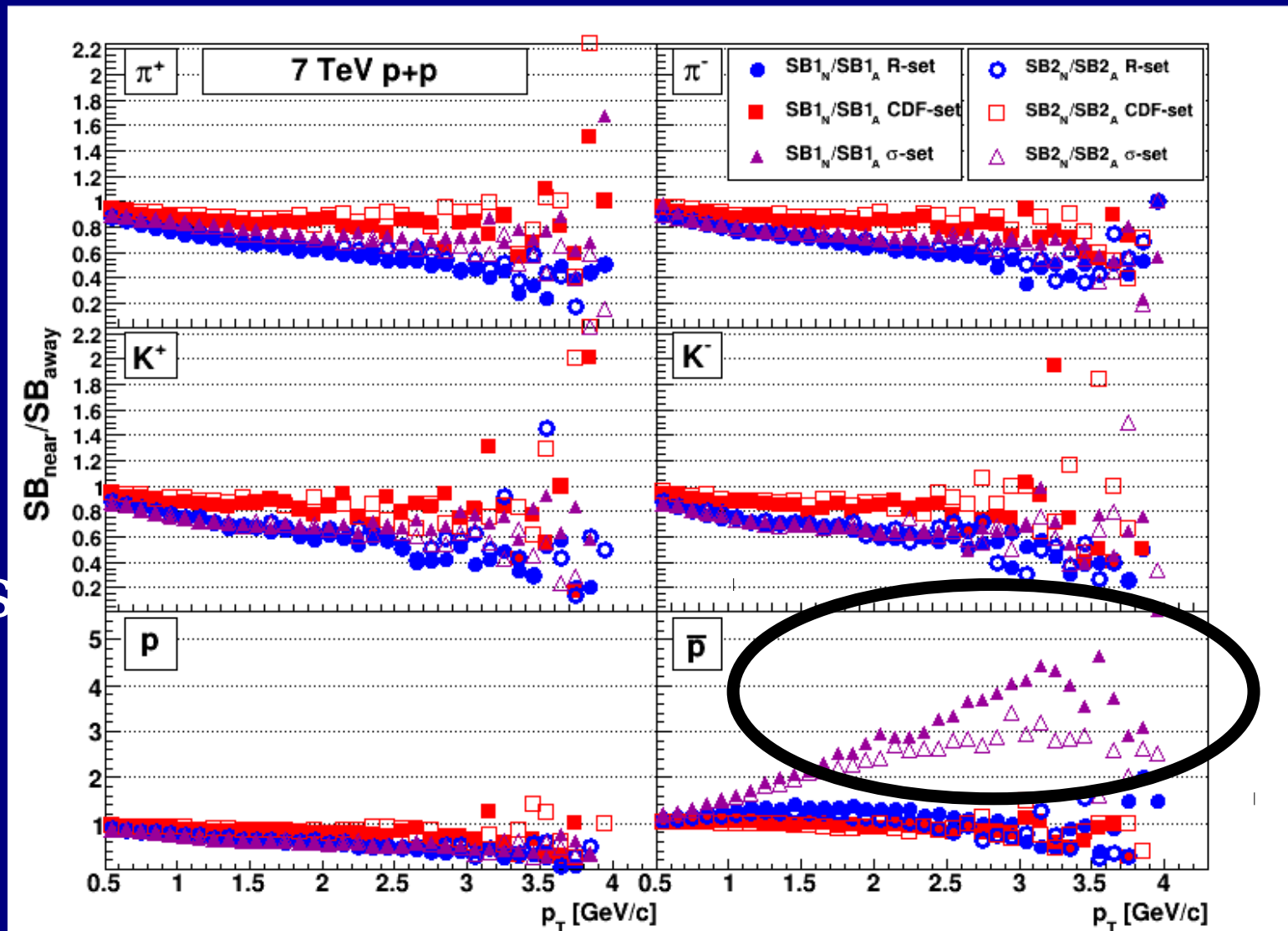
- We look at 3 different widths. The table shows corresponding cone sizes.

Selection	SB angle	$R_{\text{effective}}$ $R_{\text{effective}} = \sqrt{\Delta\Phi^2 + \Delta\eta^2}$	Belt width $\delta\Phi_{\text{SB}}$ & δR
<i>CDF-set</i>	<i>120°</i>	<i>2.3</i>	<i>6° & 0.1</i>
<i>R-set</i>	<i>60°</i>	<i>1.3</i>	<i>6° & 0.1</i>
<i>σ-set</i>	$\sigma_{\text{near}} = 16^\circ$ $\sigma_{\text{away}} = 19^\circ$	$R_{\text{near}} = 0.75$ $R_{\text{away}} = 0.77$	<i>6° & 0.1</i>



Proton trg. SB ratios

- very strong correlation with anti-protons
- PYTHIA conserves baryon number



Summary

- New UE definition and surrounding belts.
- Midway studies: correlations augmented with PID information, requires lower statistics.
- Very strong signal of baryon number conservation.
- Outlook:
 - SB studies with full jet reconstruction.
 - The VHMPID provides necessary PID capability.

Backup

An ancient red pottery story

**No, it's not
workin'!**

**...wait for
a new
tune...**

**...go to
PYTHIA
and tell
'er!**



An ancient red pottery story

No, it's not
workin'!

...wait for
a new
tune...

...go to
PYTHIA
and tell
'er!

You know
me... I'm
an
oracle!

You are not
forTUNE
teller!

