

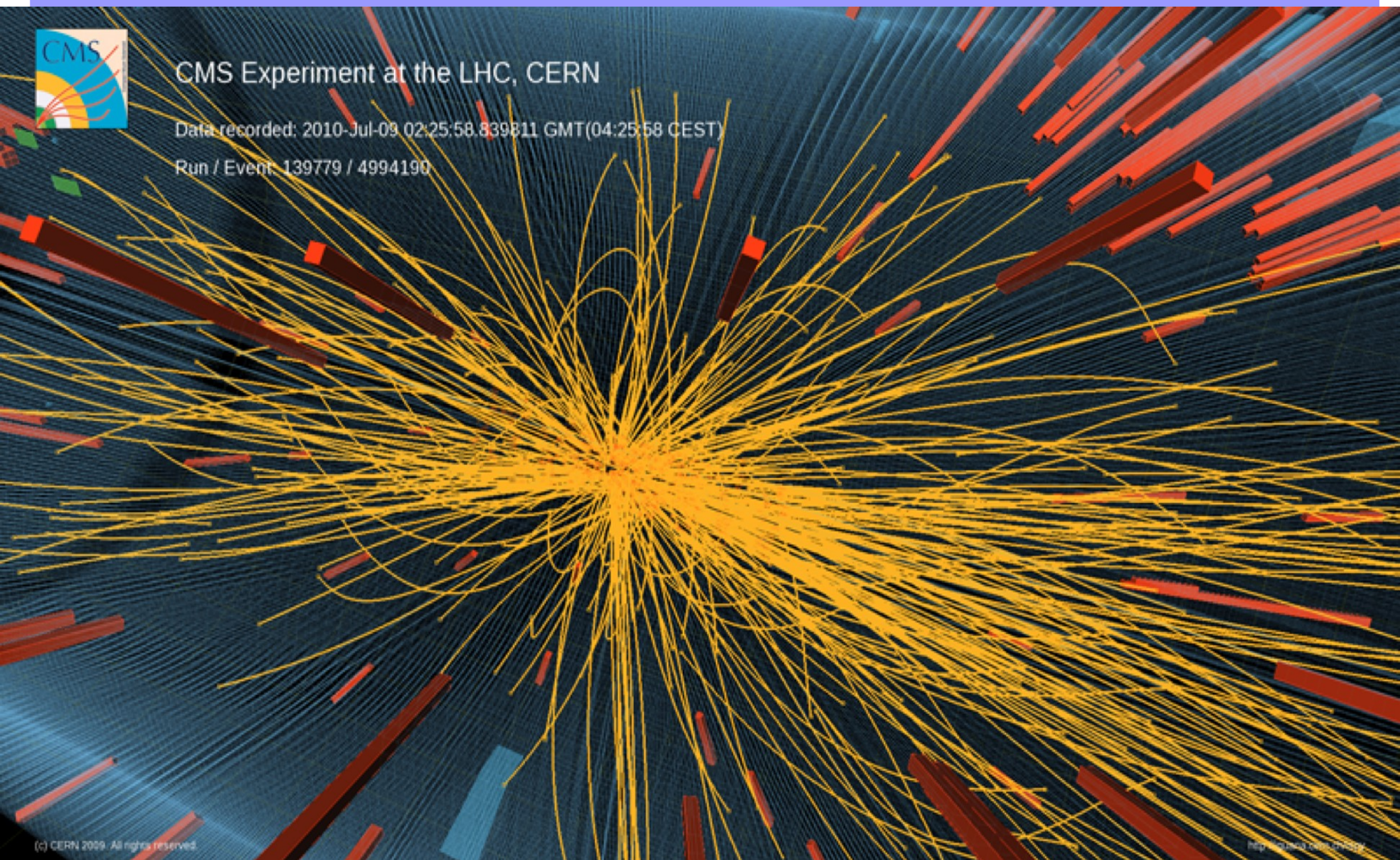
Some thoughts about the CMS ridge



CMS Experiment at the LHC, CERN

Data recorded: 2010-Jul-09 02:25:58.839811 GMT(04:25:58 CEST)

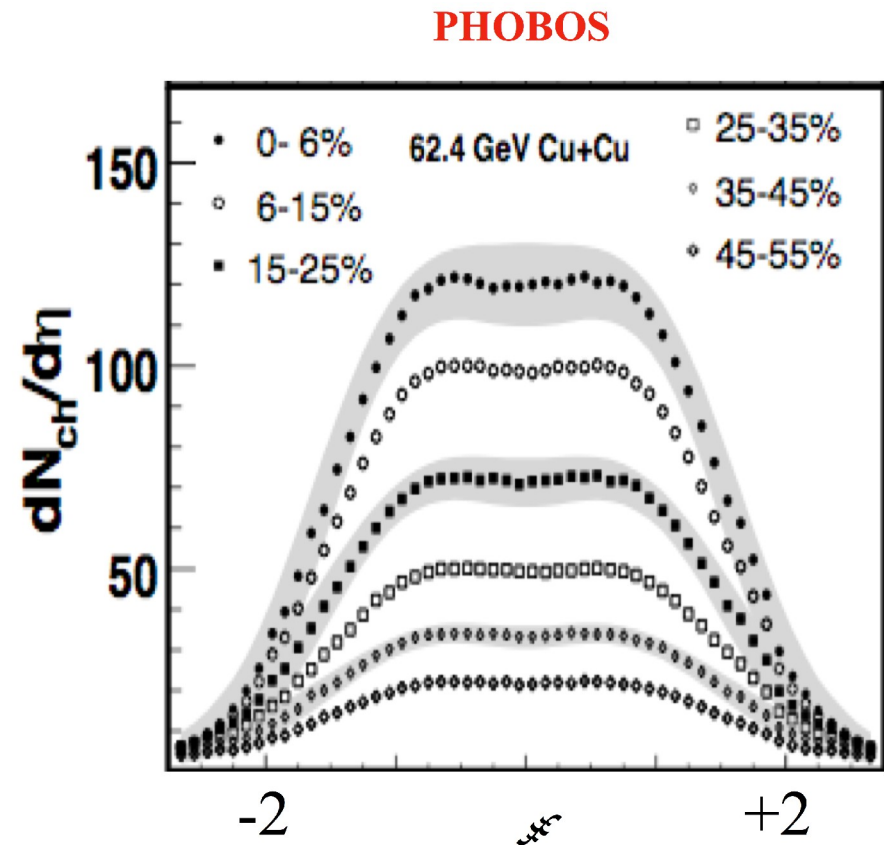
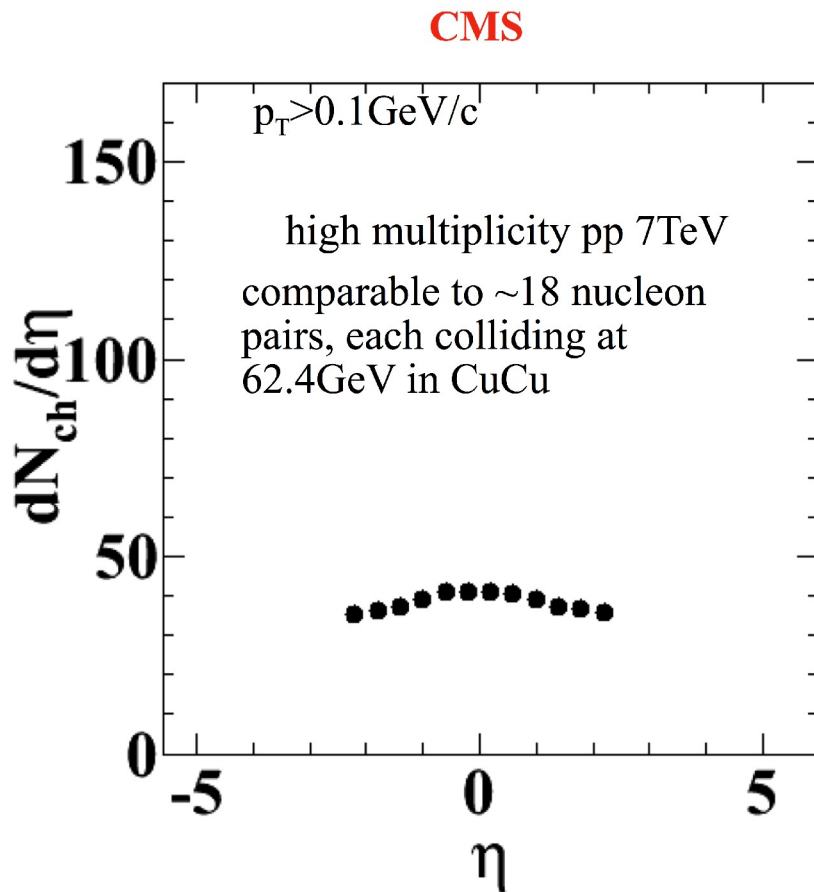
Run / Event: 139779 / 4994190



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<http://cms.cern.ch/>

Additional motivation for high multiplicity studies



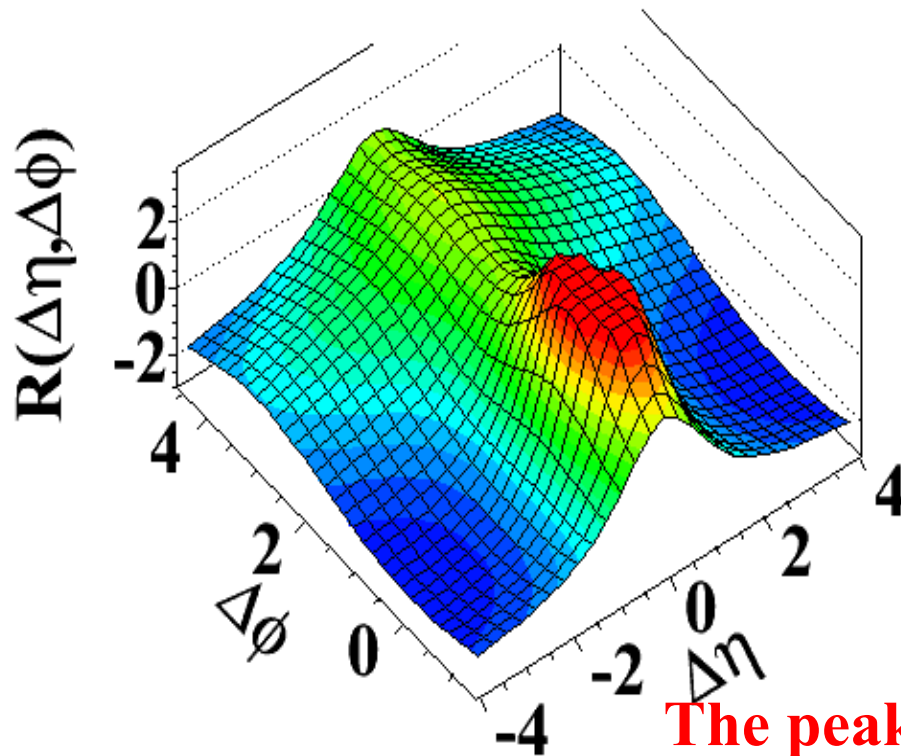
The particle densities in the high multiplicity events of proton-proton collisions at 7TeV begin to approach those in high-energy collisions of nuclei such as Copper.

It was considered natural to study the two particle angular correlations in LHC and compare the results with the ones obtained in relativistic heavy ion colliders like RHIC.

Results for inclusive p_T

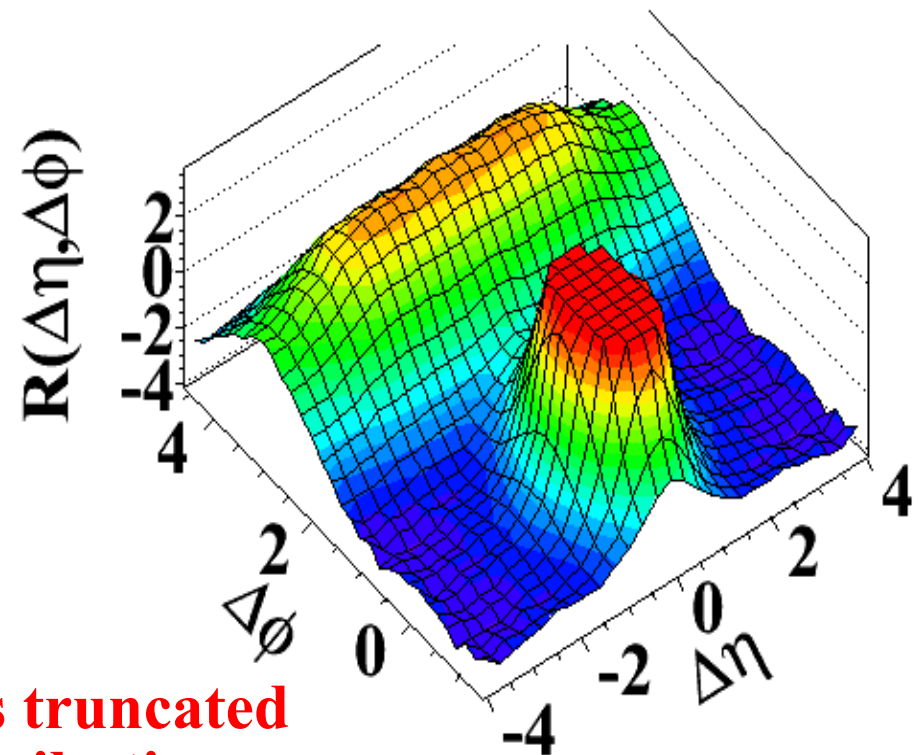
Minimum Bias
no cut on multiplicity

(a) MinBias, $p_T > 0.1 \text{ GeV/c}$



High multiplicity data set
and $N > 110$

(c) $N > 110$, $p_T > 0.1 \text{ GeV/c}$



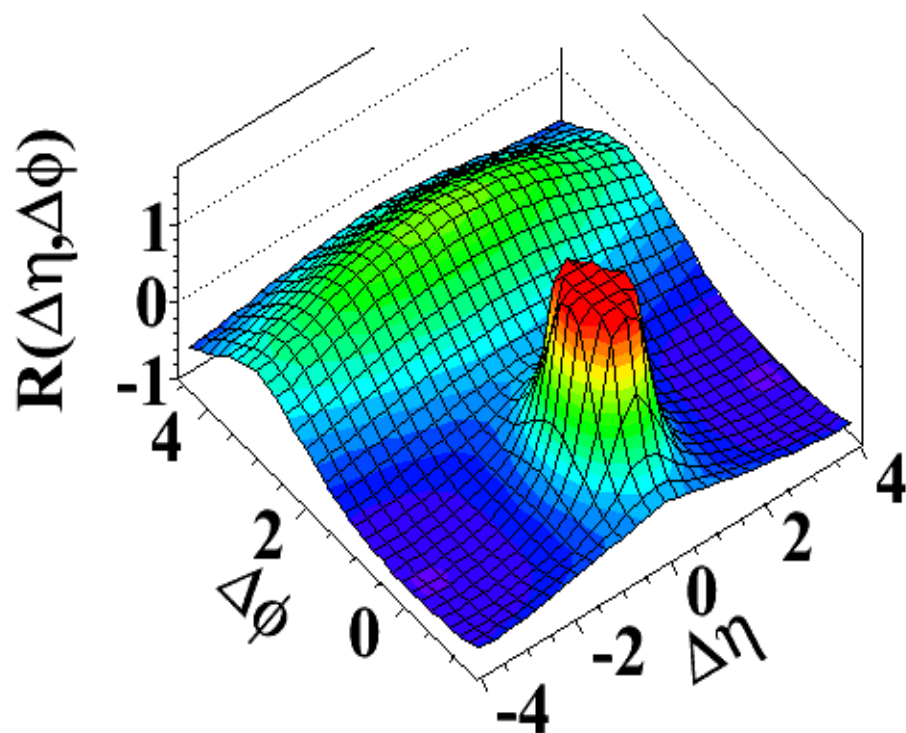
The peak is truncated
in both distributions

Back-to-back jet correlations enhanced in high multiplicity sample.

Results for intermediate p_T : 1-3 GeV/c

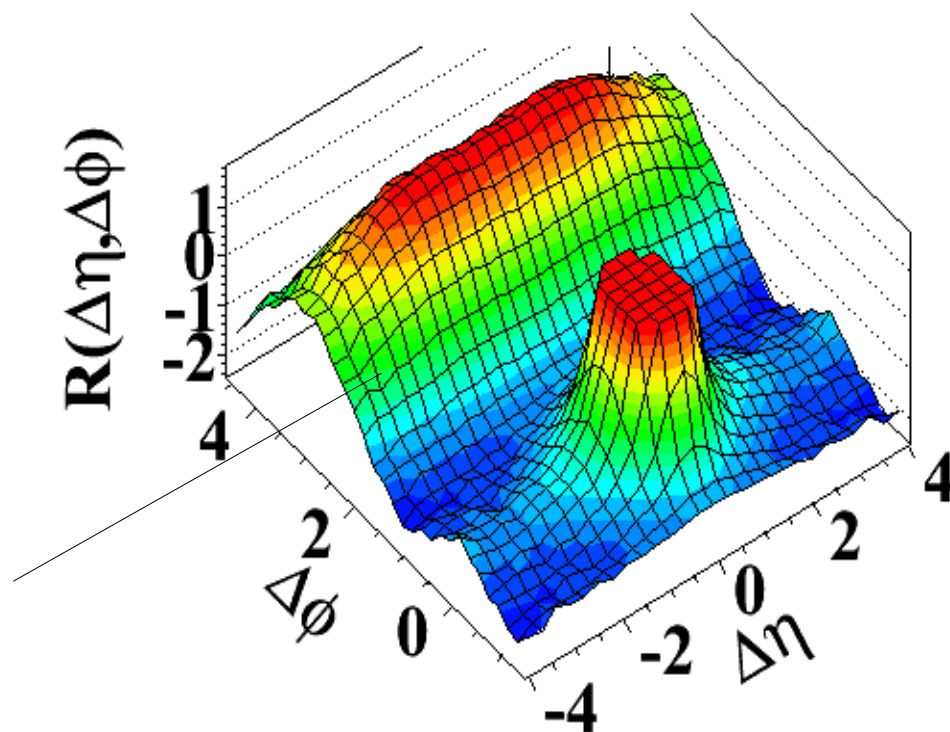
Minimum Bias
no cut on multiplicity

(b) MinBias, $1.0 \text{ GeV}/c < p_T < 3.0 \text{ GeV}/c$



High multiplicity data set
and $N > 110$

(d) $N > 110$, $1.0 \text{ GeV}/c < p_T < 3.0 \text{ GeV}/c$



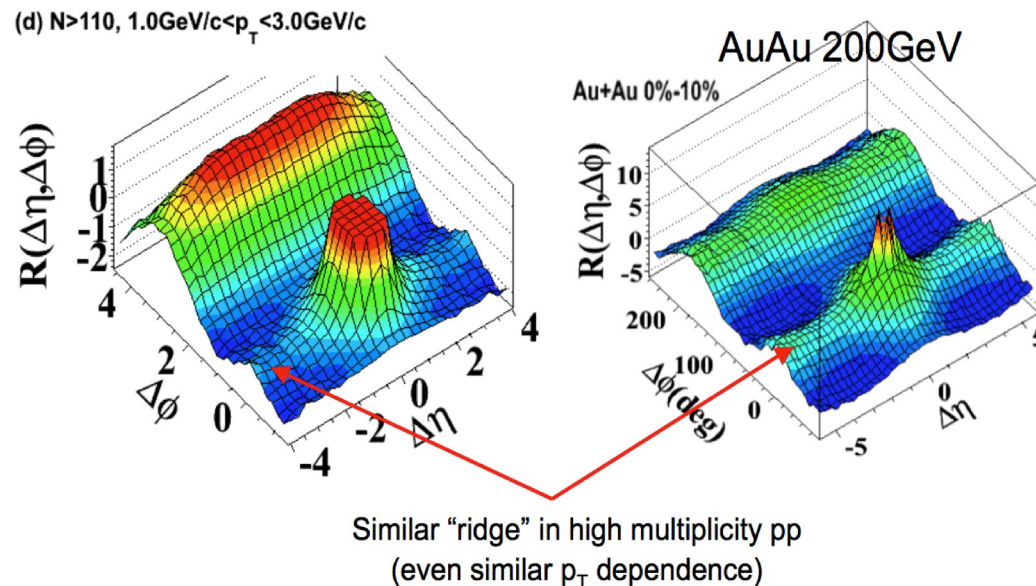
New “ridge-like” structure extending to large $\Delta\eta$ at $\Delta\phi \sim 0$

First observation of a ridge-like structure in pp collisions

The new feature is clearly seen for large rapidity differences $2 < |\Delta\eta| < 4.8$ in events with $N \sim 90$ or higher. The enhancement is most evident in the intermediate p_T range $1 < p_T < 3$ GeV/c.

This is the first observation of such a long-range, near-side feature in two-particle correlation functions in pp or p-pbar collisions.

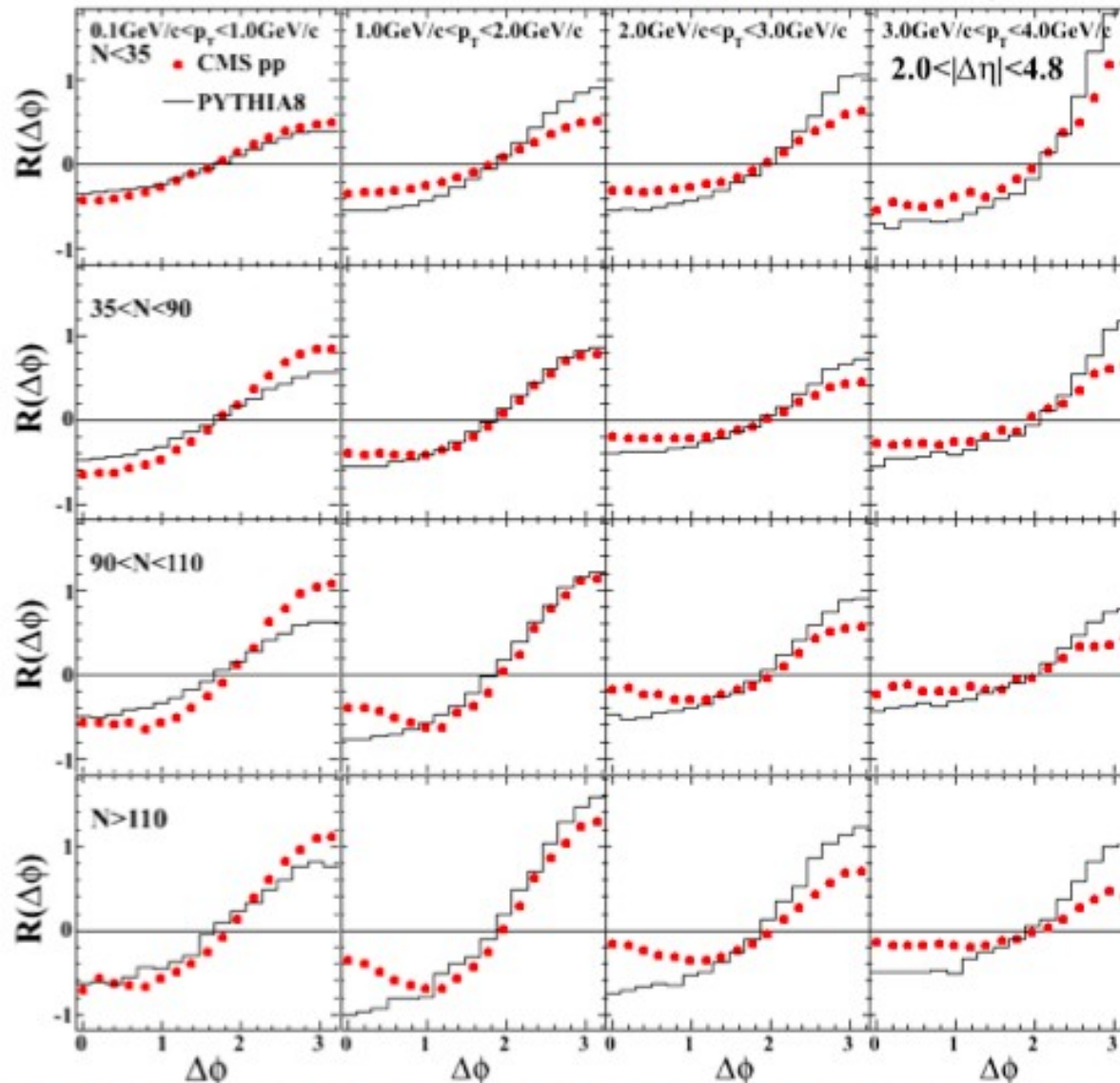
It is a small effect, however, very interesting. Although there are also differences, it resembles a similar feature observed at RHIC that was interpreted as being due to the hot and dense matter formed in relativistic heavy ion collisions.



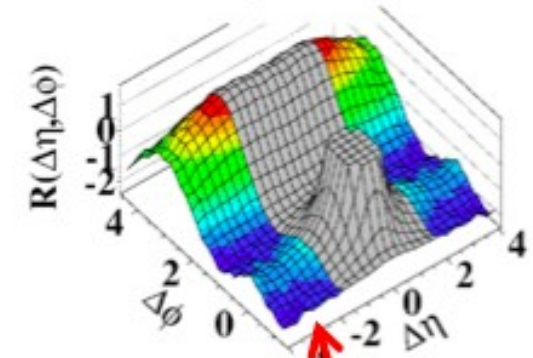
Multiplicity- and p_T -Dependence

Increasing p_T →

Increasing multiplicity ↓



(d) $N > 110$, $1.0 \text{ GeV}/c < p_T < 3.0 \text{ GeV}/c$



Project $|\Delta\eta| > 2$
onto $\Delta\phi$

“Ridge” maximal for highest multiplicity and $1 < p_T < 3 \text{ GeV}/c$

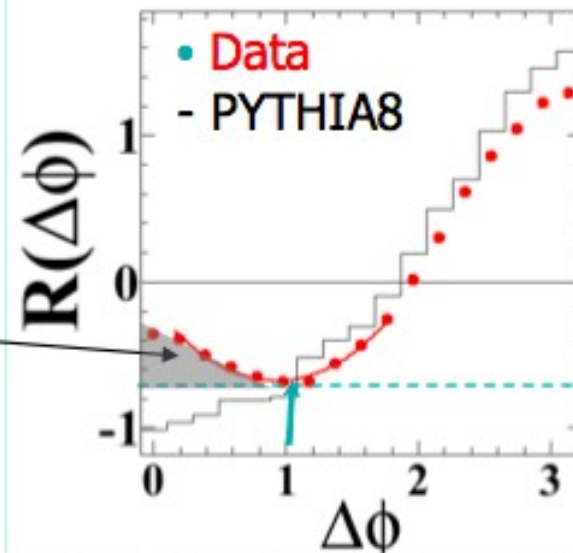


Multiplicity- and p_T -Dependence



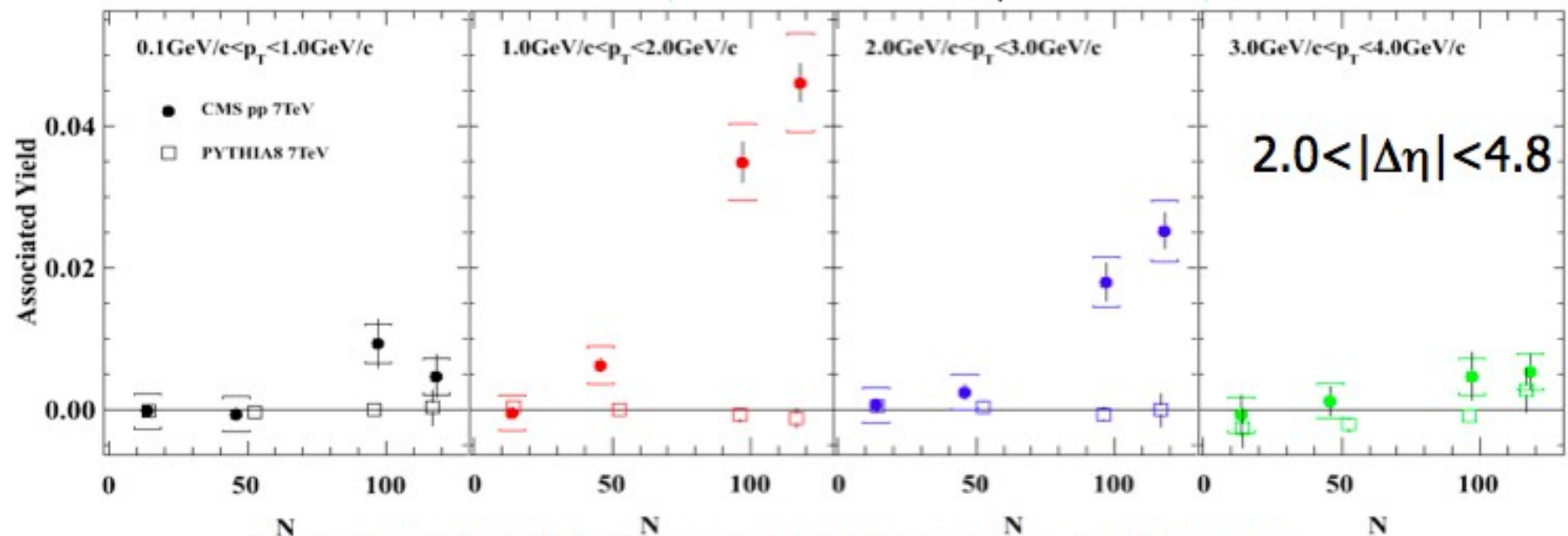
Zero Yield At Minimum (ZYAM)

Associated yield:
correlated multiplicity per particle



$N > 110$
 $2.0 < |\Delta\eta| < 4.8$
 $1\text{ GeV}/c < p_T < 2\text{ GeV}/c$

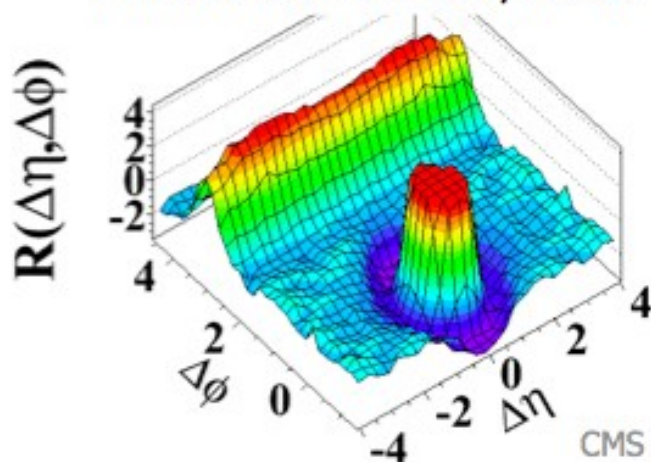
Minimum of R



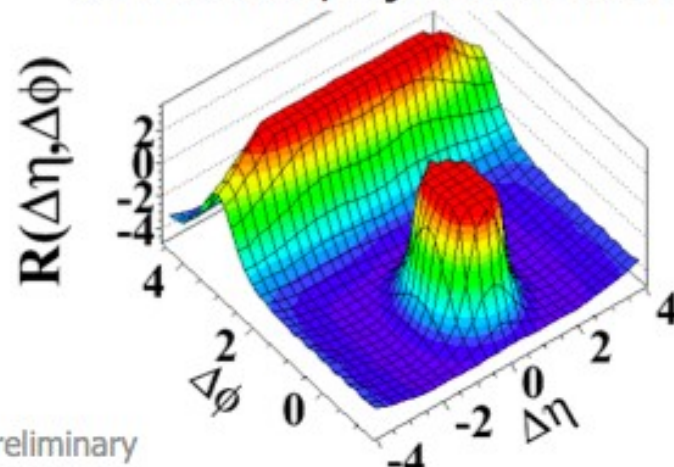
Associated yield grows with increasing multiplicity

Other pp Event Generators

PYTHIA D6T MinBias, $N > 70$



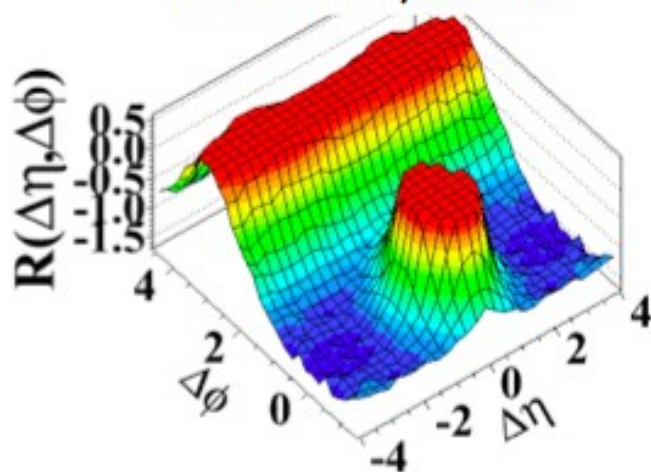
PYTHIA D6T, Dijet 80-120GeV



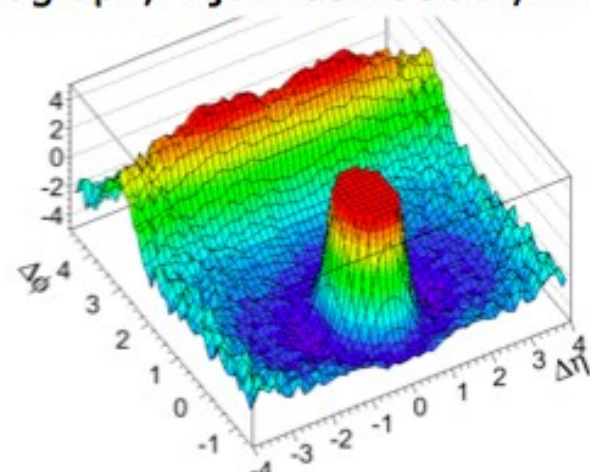
CMS preliminary

$1 < p_T < 3 \text{ GeV}/c$

HERWIG++, $N > 110$



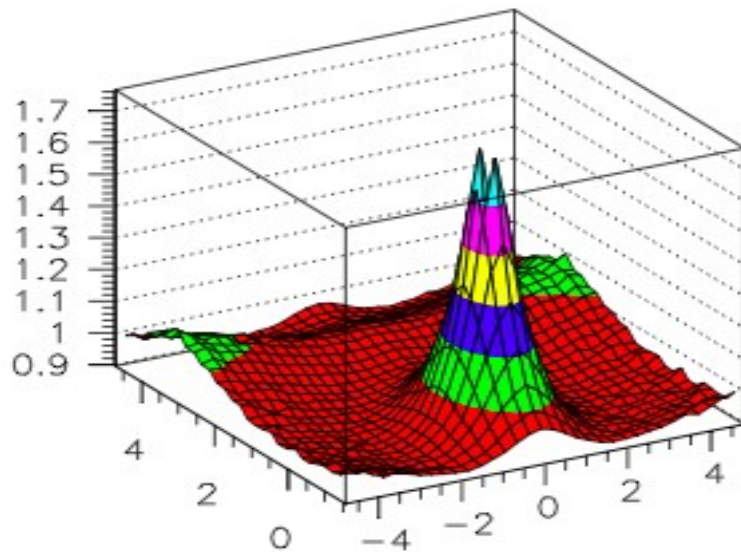
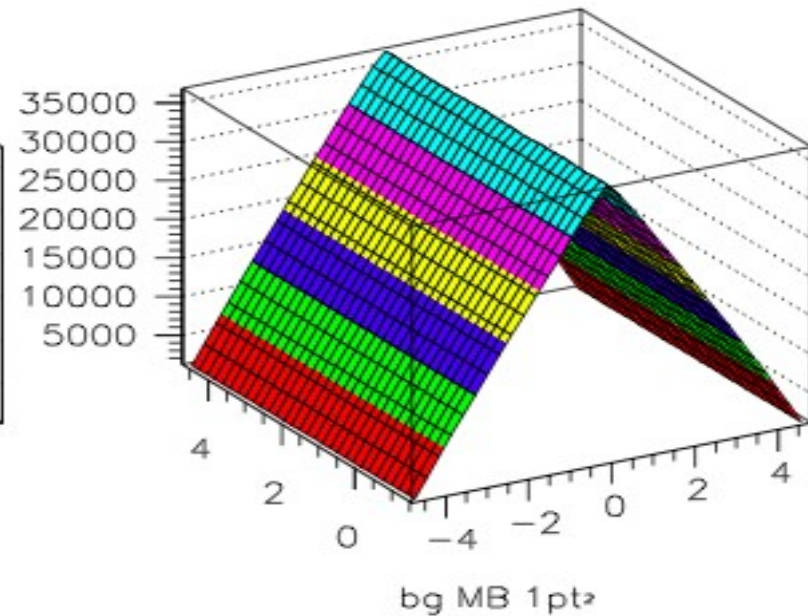
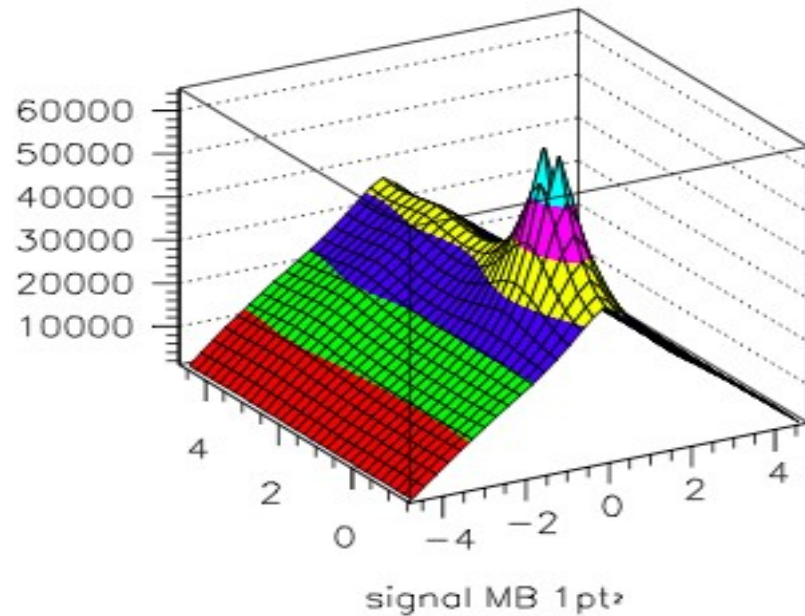
Madgraph, Dijet 100-250GeV, $N > 90$



No ridge effect in these models (with the tunes used)

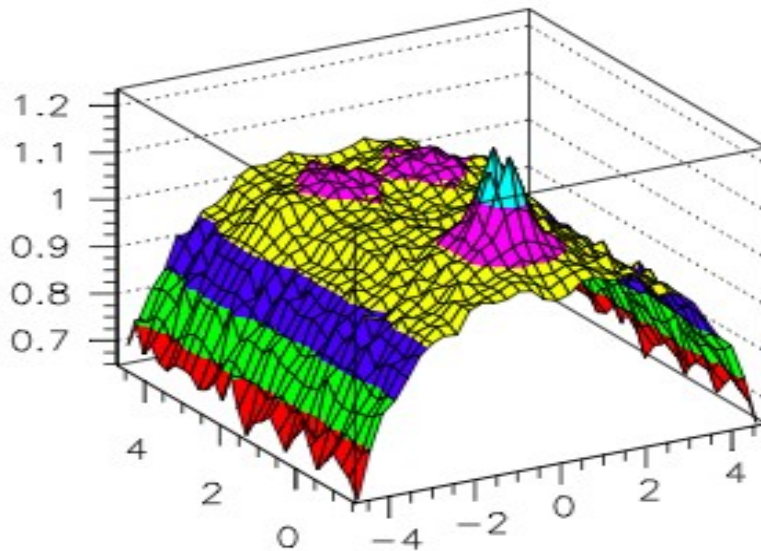
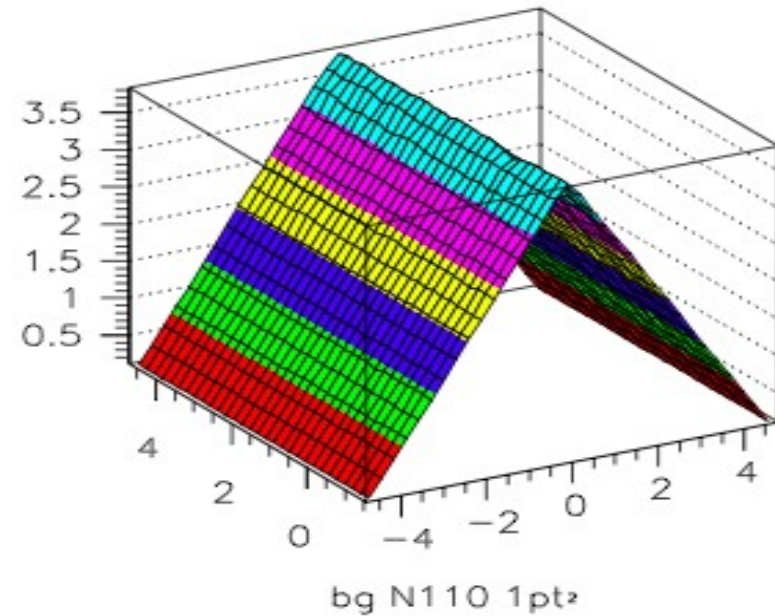
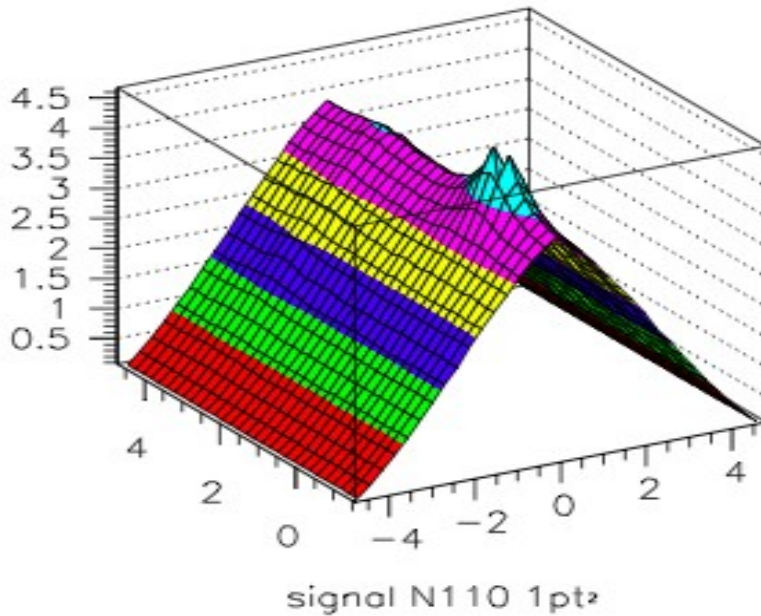
Predictions from PYTHIA

Predictions from PYTHIA (Nastjas params)



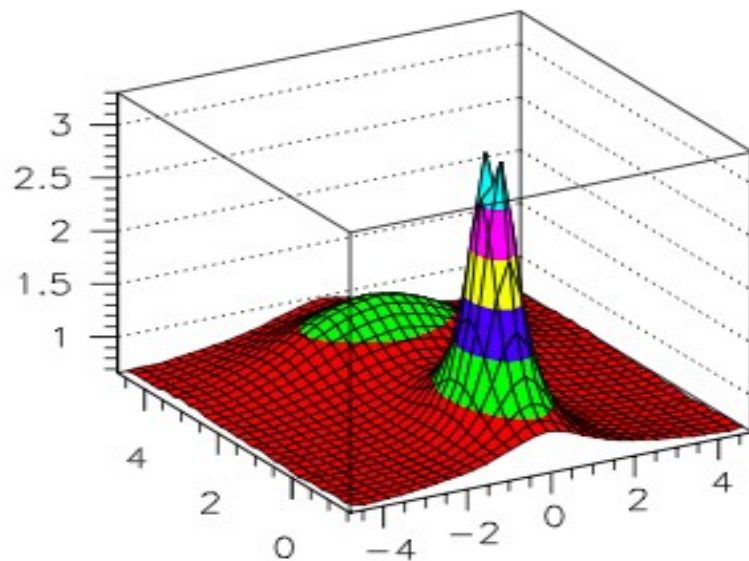
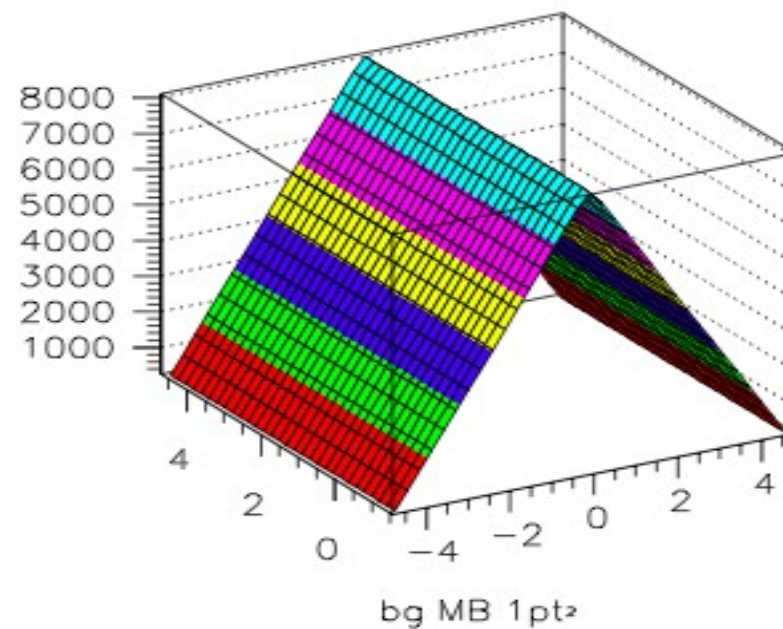
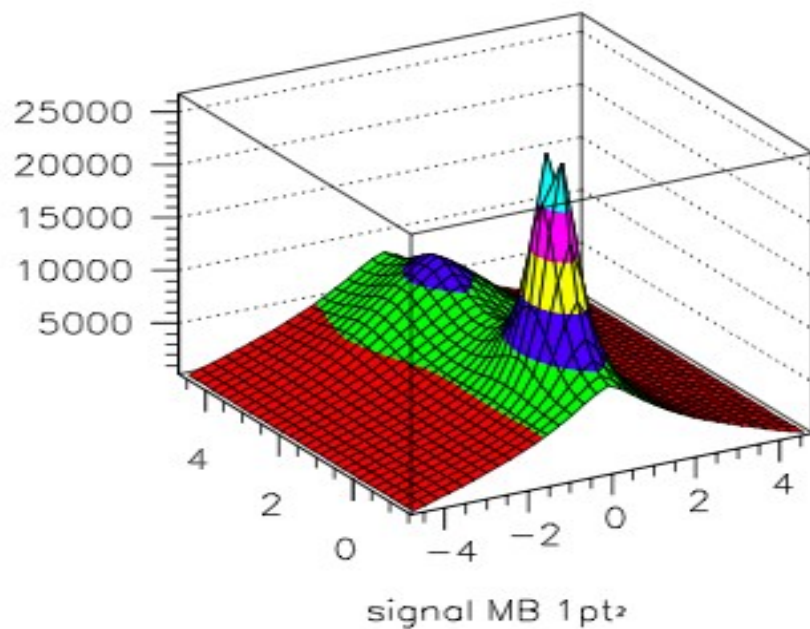
Min Bias

Predictions from PYTHIA (Nastjas params)



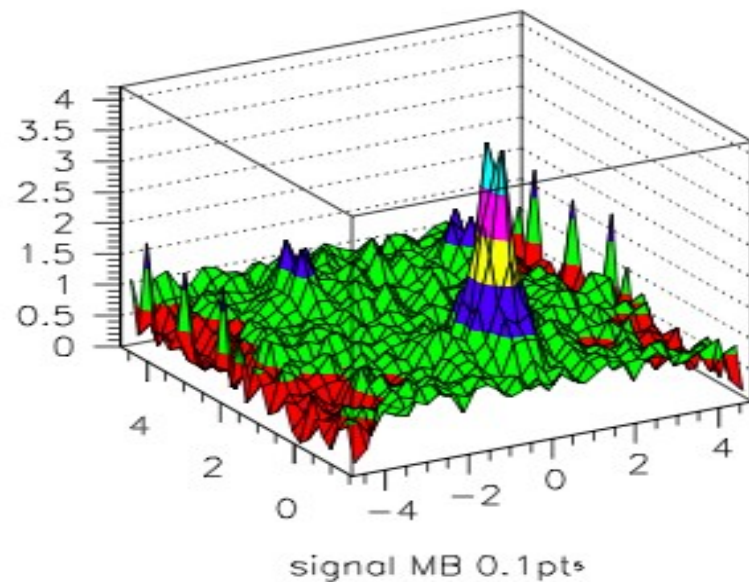
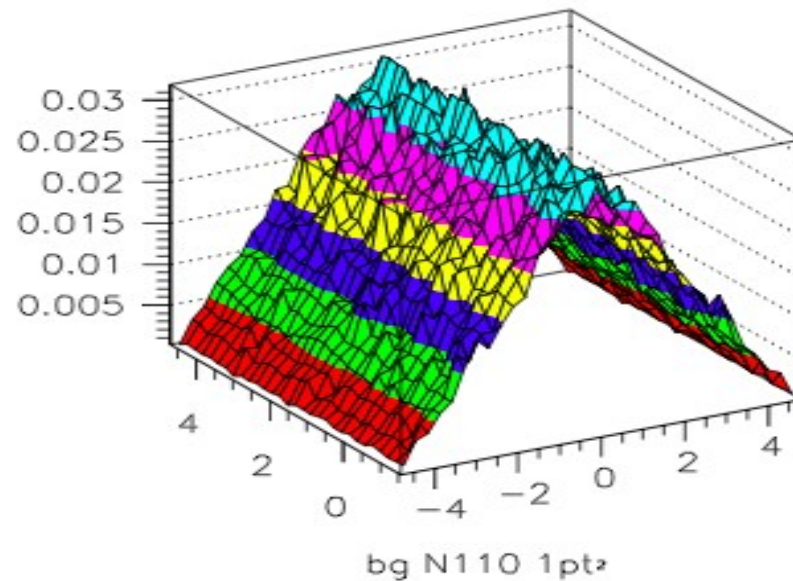
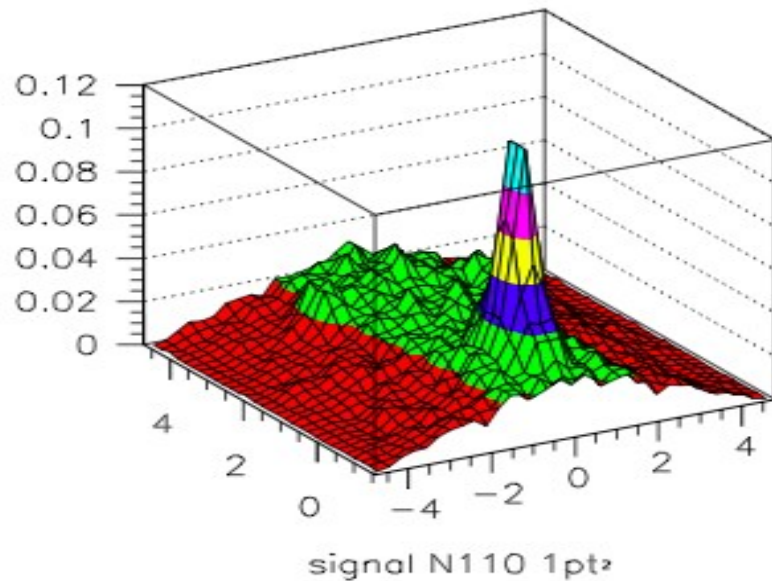
High Multiplicity

Predictions from CASCADE



Min Bias

Predictions from CASCADE



High Multiplicity

What can it be ?

- Just tuning of MC parameters is not enough
- even updfs with CCFM and CASCADE does not help
 - Need for multiparton interactions
 - Also need correlations

A proposal from CGC

A. Dumitru et al. The ridge in proton-proton collisions at the LHC
arXiv 1009.5295

