FLATENICITY

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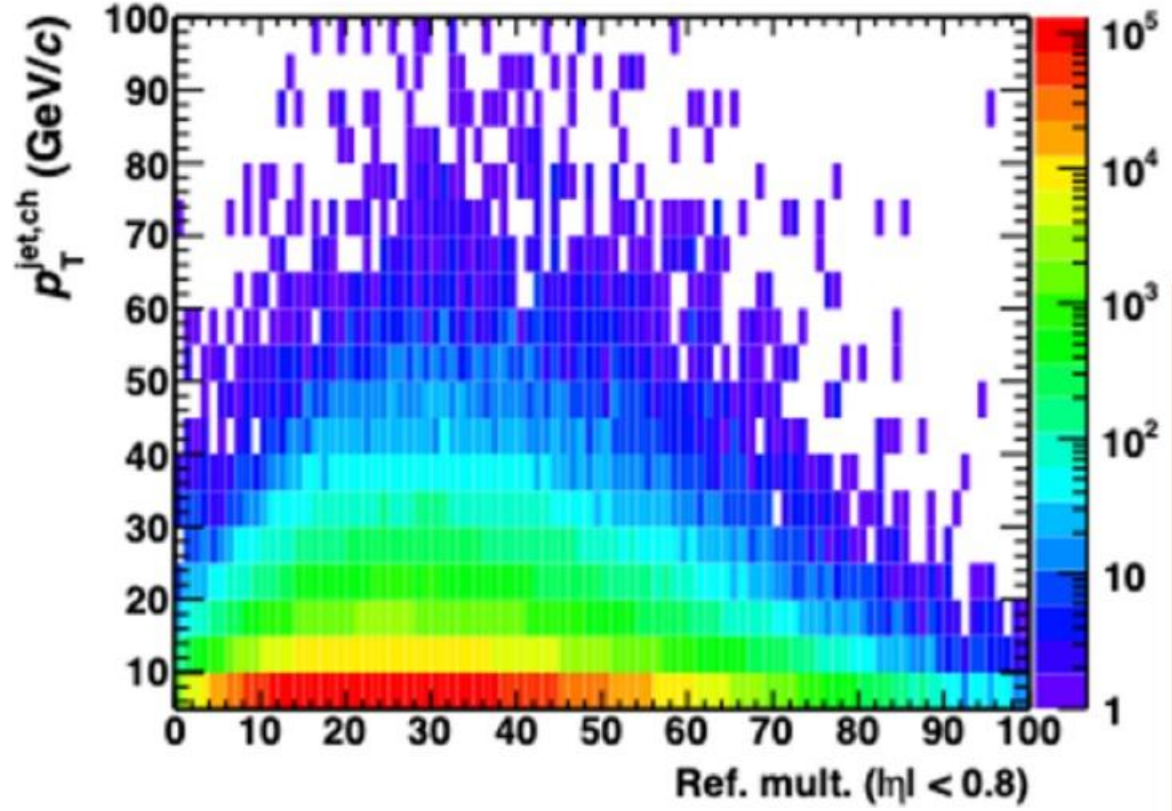
A. Ortiz&G.P A look into the “hedgehog” events in pp collisions using a new event shape - flatenicity



- The highest multiplicities do not yield the maximum leading-pT reach

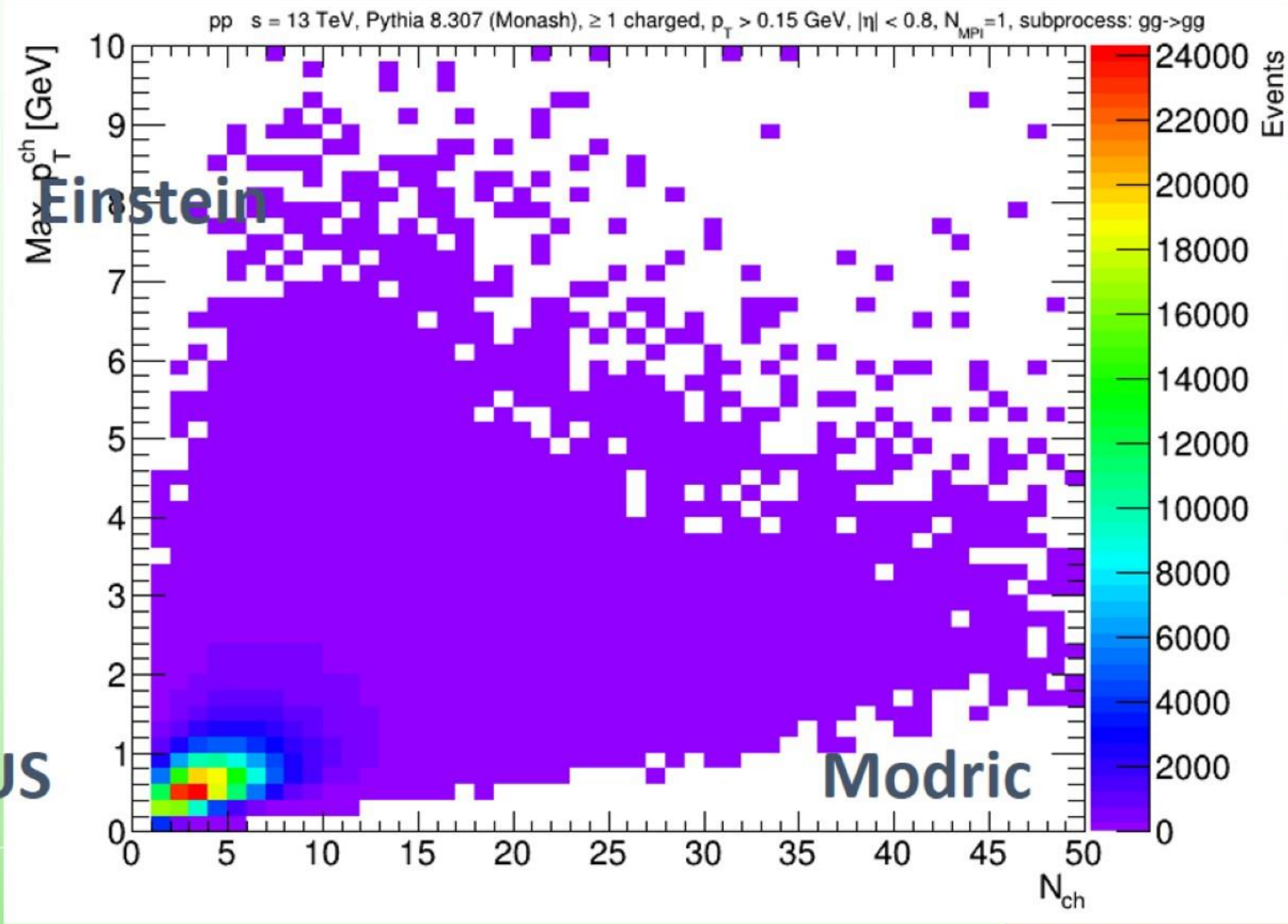
THE FORGOTTEN FEATURES

ALICE data Figure from B. Hess PhD thesis: https://cds.cern.ch/record/2058633/

Are the "means" the end of the story?

Much of the results on quark gluon plasma rely on "means" the distributions around it are not studied with the exception of some analises in the frame work of evento structure variables.

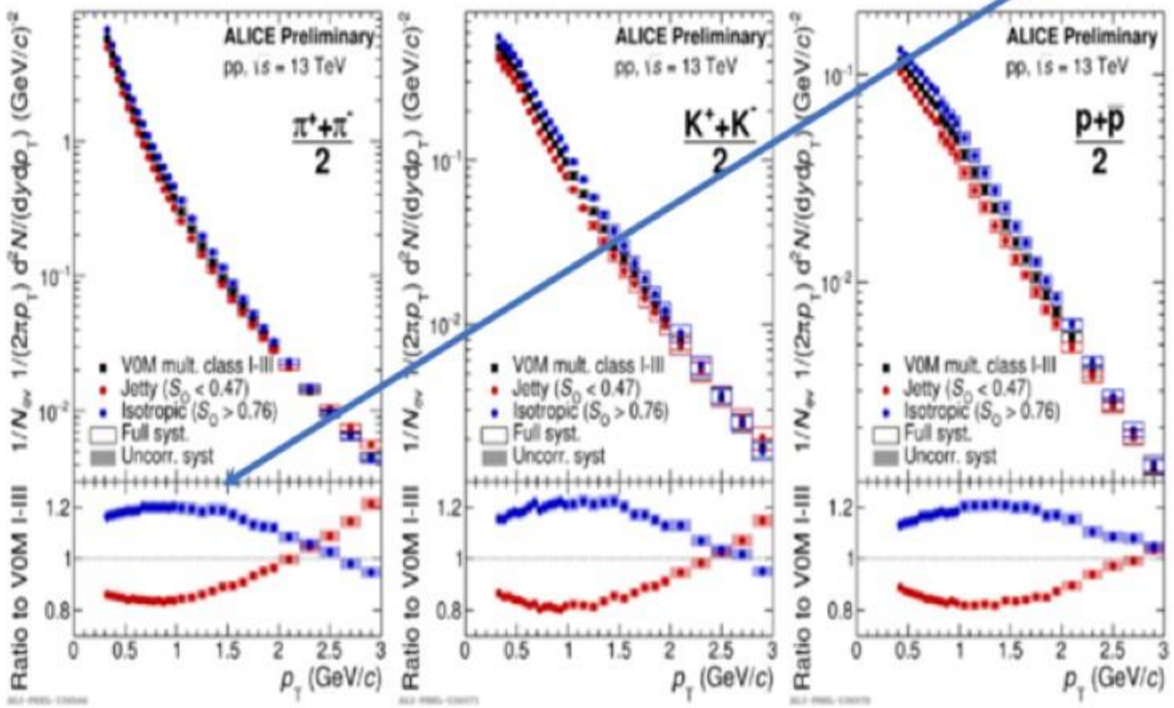
In the normal life we are interested exclusively by "outliers" champions, scientists, events on the world scene - that are outside the means…



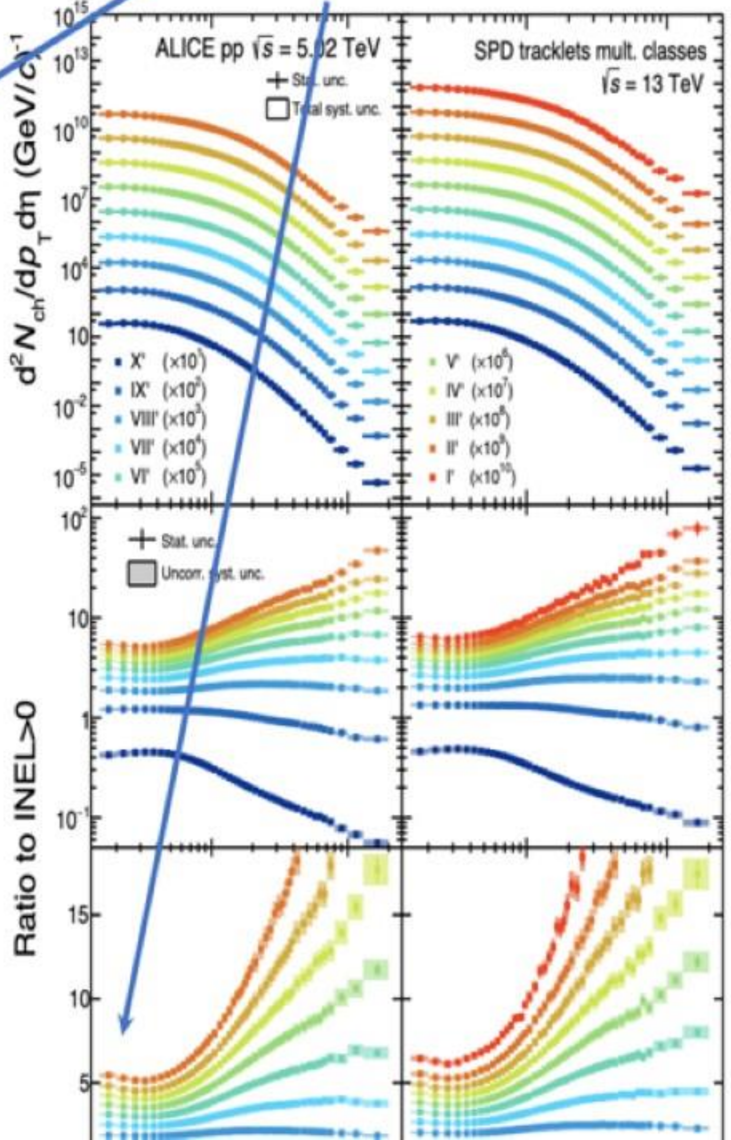
pp √s = 13 TeV, Pythia 8.307 (Monash), ≥ 1 charged, p_T > 0.15 GeV, |η| < 0.8, N_{MPI}=1, subprocess: gg->gg
Max p_T^{ch} [GeV]
N_{ch}
Events
Einstein
US
Modric

Strong increase in the high-p_T yields with multiplicity

But observed increase at low momenta – small but real

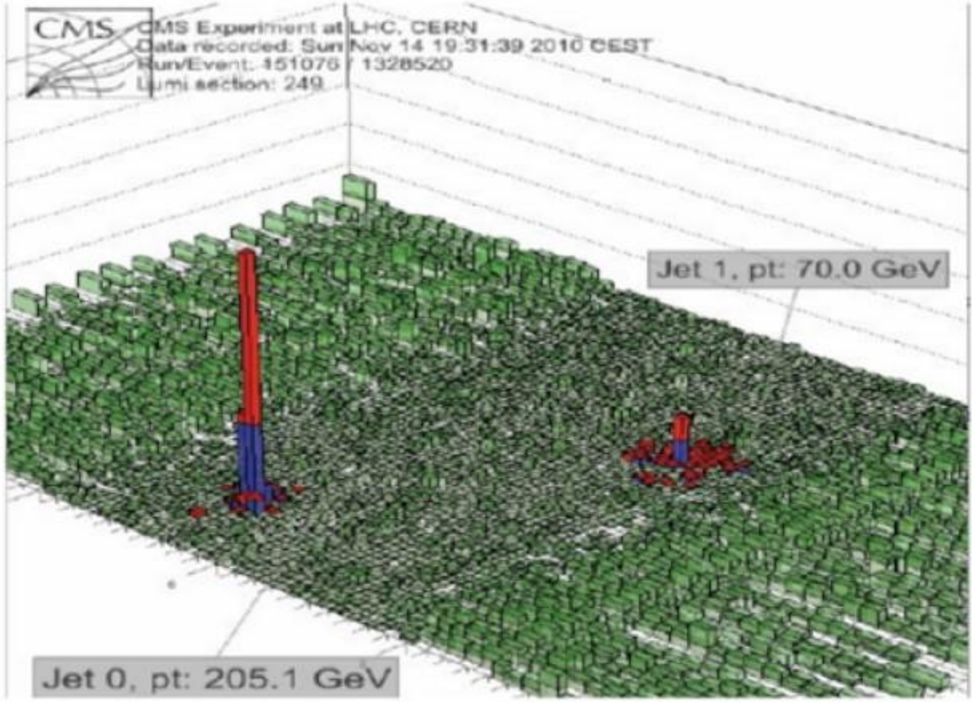


g. 2. Top panels: transverse momentum spectra of $\pi^{\pm}$, $K^{\pm}$, and p($\bar{p}$) in V0M multiplicity class I–III events, jetty events (20% lowest)) and isotropic events (20% highest S_O). Bottom panels: ratio of spectra in jetty (isotropic) events to the V0M class I–III.



ALICE, Eur. Phys. J. C80 (2020) 8, 693

In heavy ion emegy loss is well estabilshed but this is for the time the only signature that was not observed in pp collisions



But, if I can have question: if I have a quenched jet should I allow for the possibility to see both primary jets absorbed?

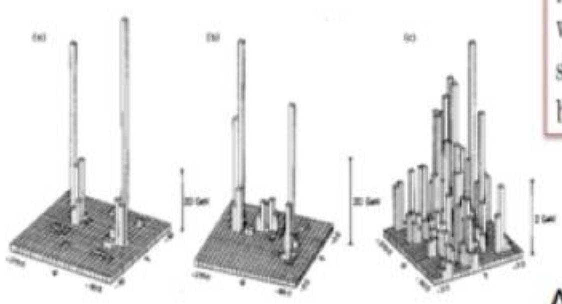
In that sense let's go back to **prehistory**!

CDF

hriss Quigg: arXiv:1004.0975v1 [hep-ph]

An interesting example—an *atypical* event observed in $\bar{p}p$ interactions at $\sqrt{s}$ = 1.8 TeV by CDF's Run 1 detector, is shown in Figure 3.([3]) This event was accepted by a $\sum E_{\perp}$ trigger, without any topological requirement. The LEGO® plot shows many bursts of energy: More than a hundred active towers pass the display threshold of 0.5 GeV. The total transverse energy in the event is 321 GeV, but it is not concentrated in a few sprays, it is everywhere. The central tracking chamber records about sixty charged particles.

I am assured that this "hedgehog" event is authentic: it is not merely coherent noise in the counters. The colleague who selected this specimen estimated similar events to be about as common in the online event stream as Z^0 production and decay into lepton pairs: about one in ten thousand triggers. I include this outlier as a reminder that when we think about the strong interactions outside the realm of a single hard scattering, we should think not only about the large diffractive and "multiperipheral" cross sections, but also about less common phenomena.

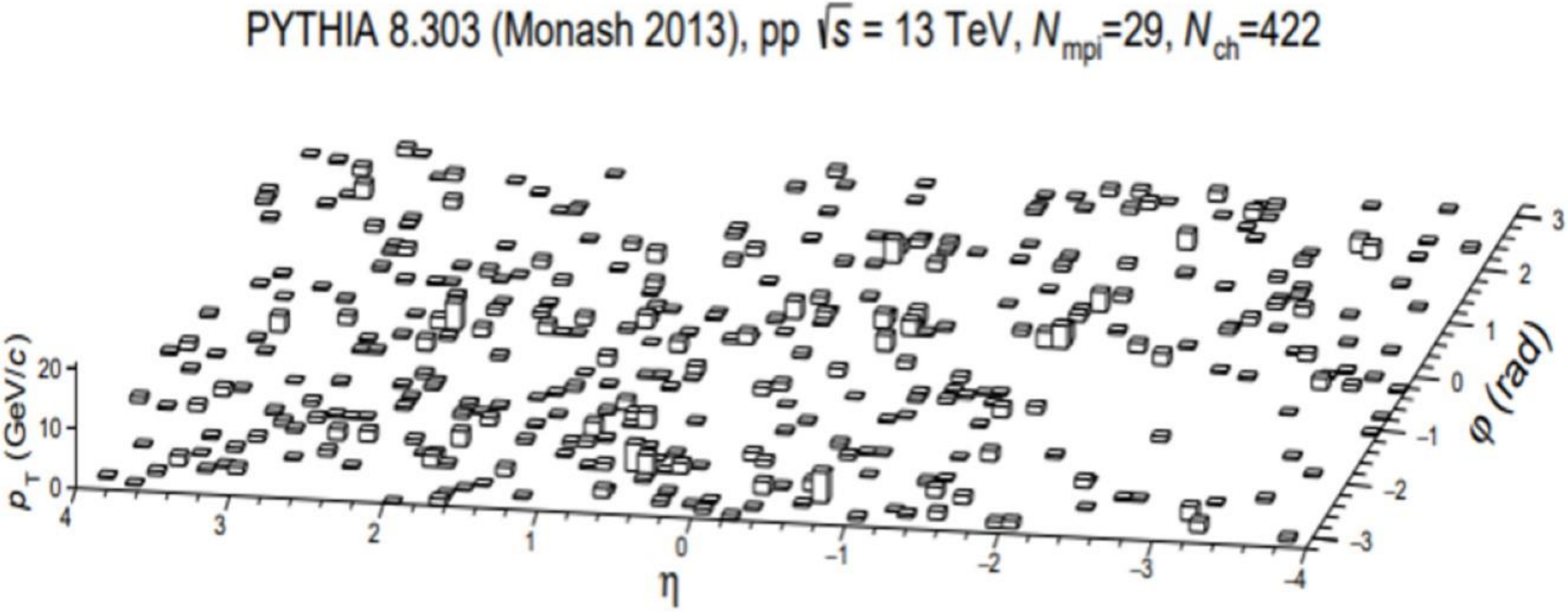


UA1

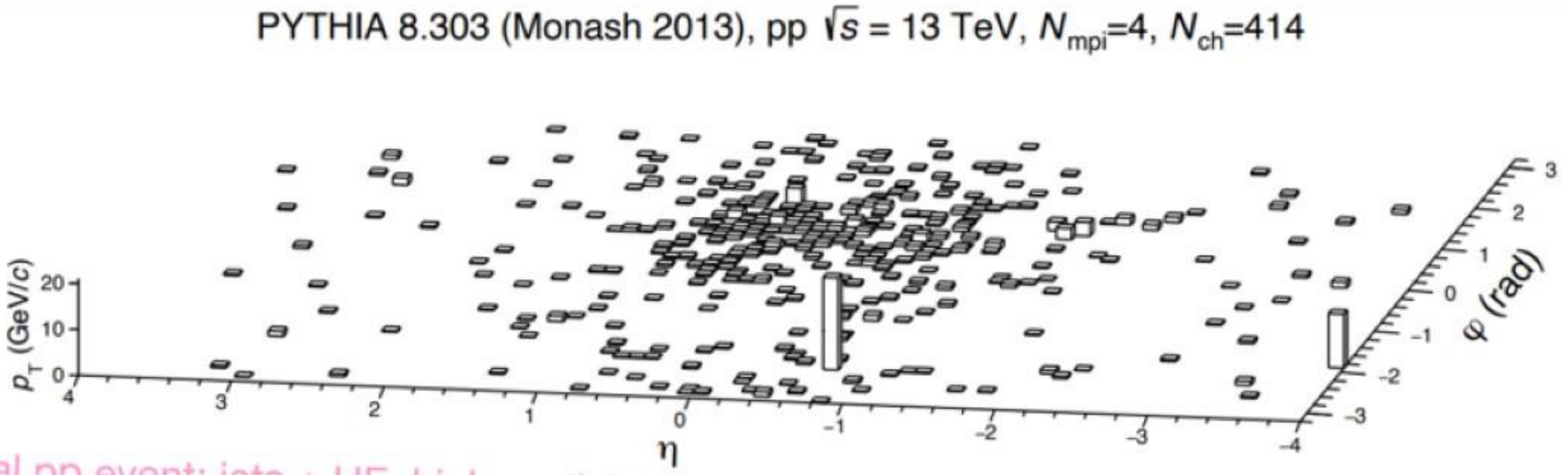
Albajar, C., et al. (UA1 Collaboration). Analysis of the Highest Transverse Energy Events Seen in the UA1 Detector at the SppS Collider. Z. Phys. C36 (1987),

- **Conclusion: there are "rare" events in pp collisions that have never been seriously studied**

Rare events seen also in Generators!



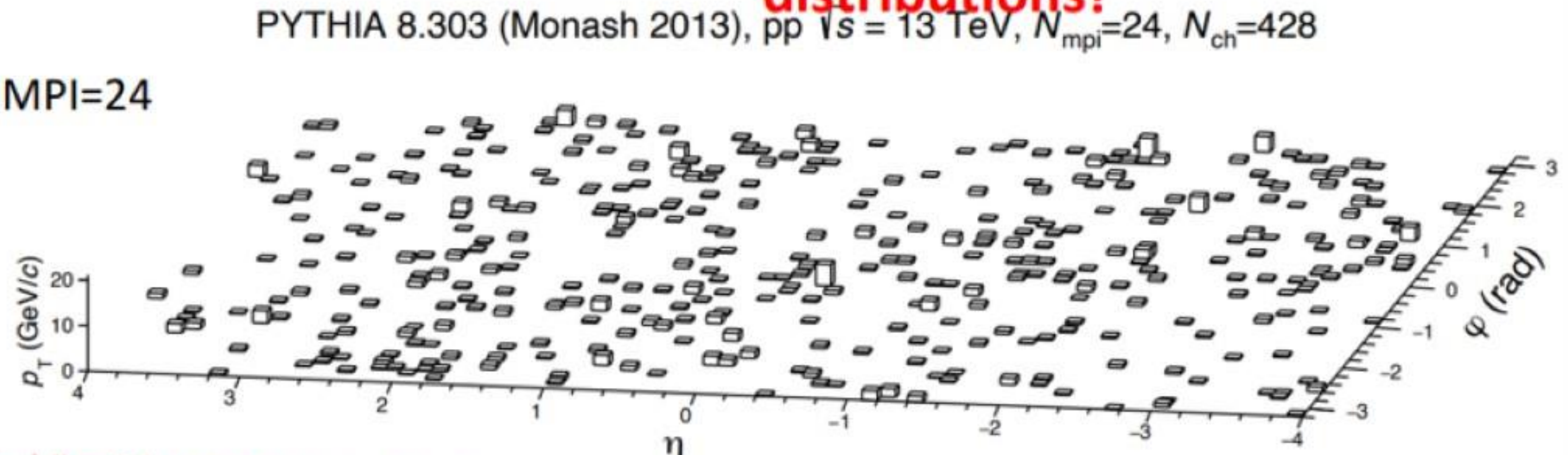
Absence of high pts



Typical pp event: jets + UE, high particle density at mid-pseudorapidity

Same multiplicity – completely different distributions!

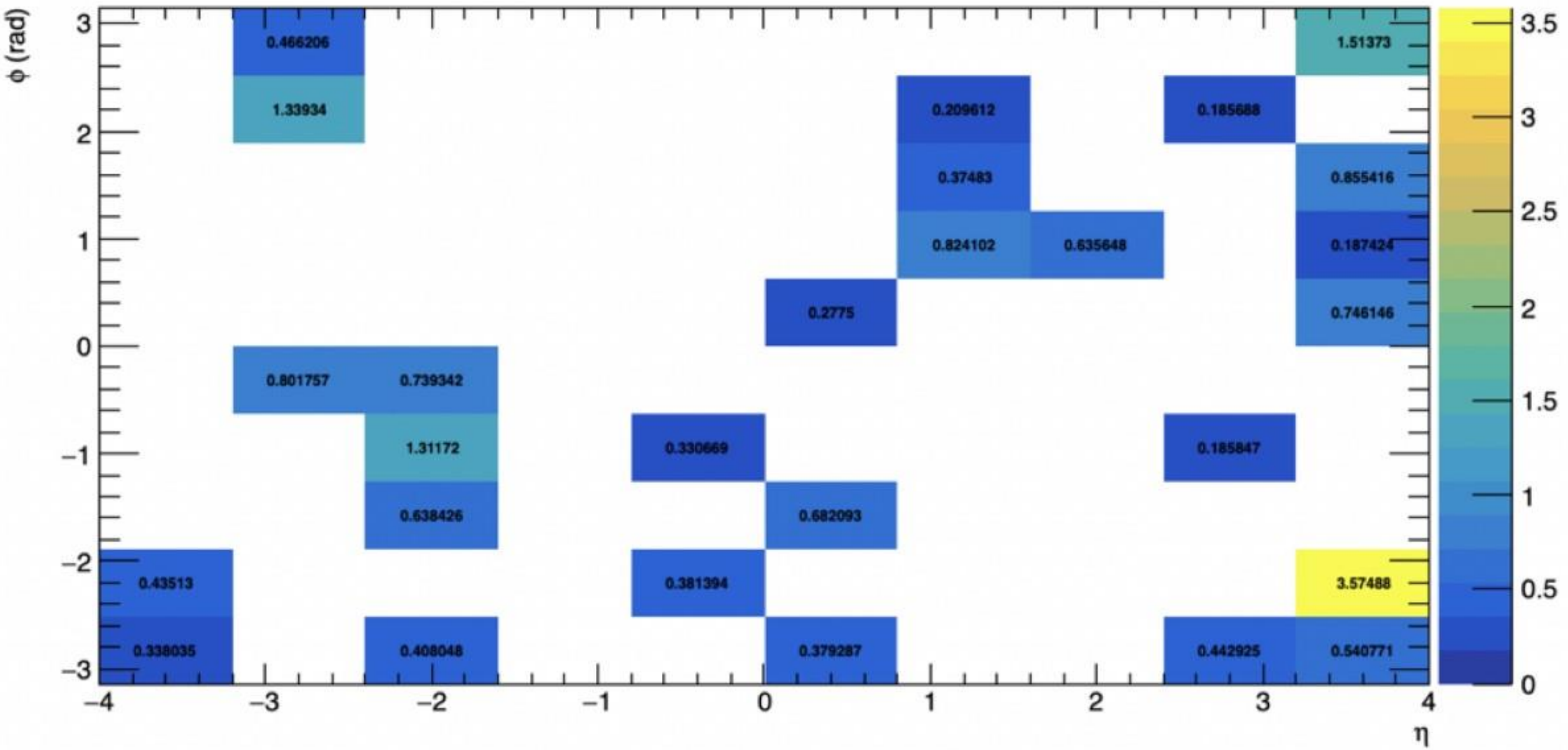
NMPI=24



Several “soft” partonic

How to trigger on such events?

YES!



A grid in eta-phi is built (10x10)

The average p_T is determined in each cell ($0.15<p_T<20$ GeV/c): $\langle p_T \rangle = \sum \langle p_T \rangle^{cell}/100$

The relative sigma is determined as follows: $\rho=\sigma_{\langle pT \rangle}/\langle p_T \rangle$

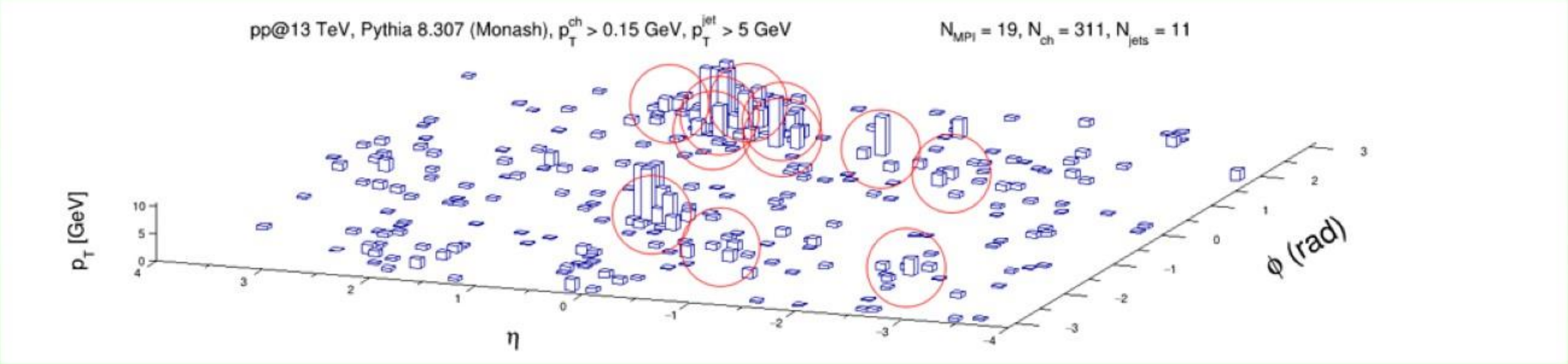
The difference between known evento structure parameters and rho

.

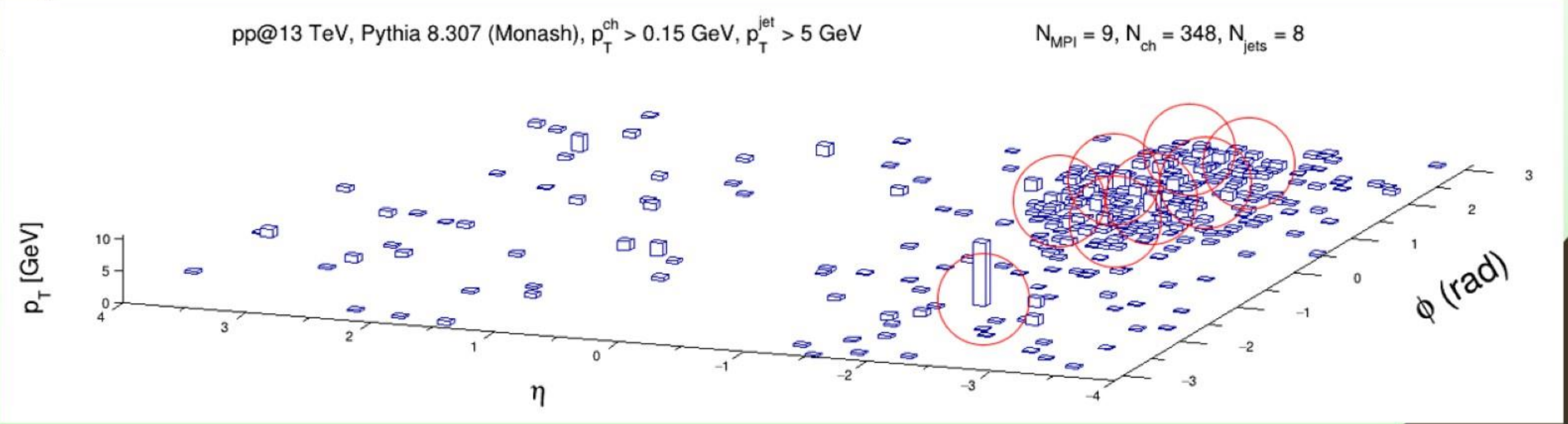
It is more detailed than the sphericicy/spherocity/RT parameters

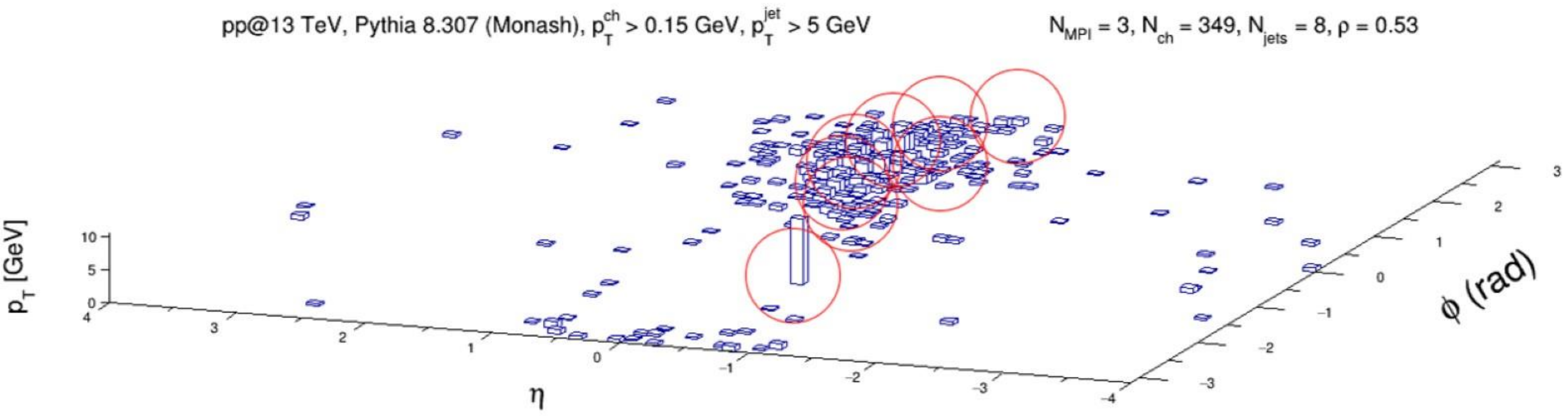
By selecting the events using the two parameters: sigma and rho One can perfectly well observe the evolution of the events from a jetty form to the hedgehog type

Many low energy jets that look originating from initial jets?!

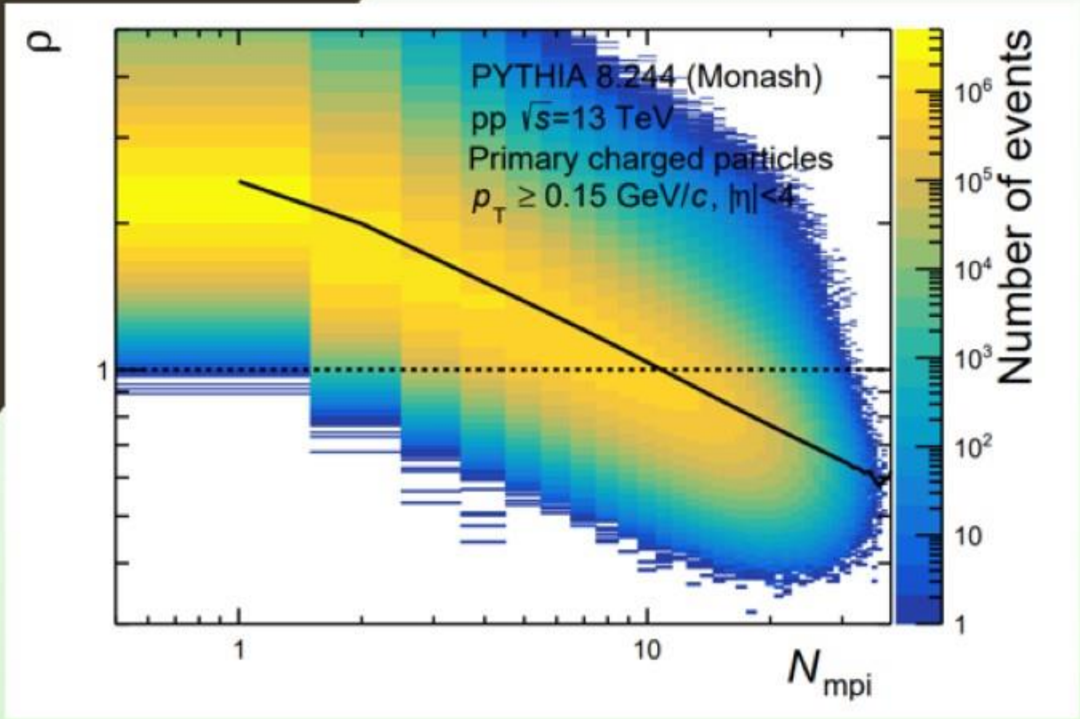


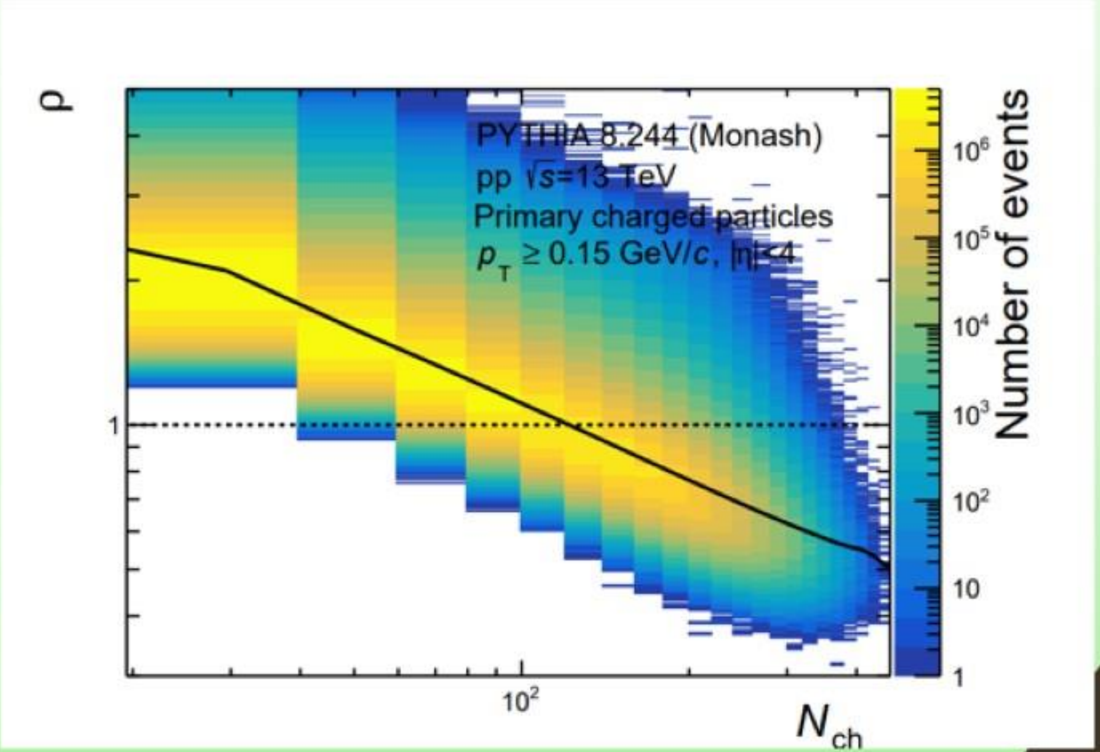
FastJet, anti-kt, R=0.4, min jet pT of 5 GeV





pp@13 TeV, Pythia 8.307 (Monash), p_T^{ch} > 0.15 GeV, p_T^{jet} > 5 GeV
N_{MPI} = 3, N_{ch} = 349, N_{jets} = 8, ρ = 0.53
p_T [GeV]
η
ϕ (rad)


PYTHIA 8.244 (Monash)
pp √s=13 TeV
Primary charged particles
$p_T \geq 0.15$ GeV/c, |η|<4
ρ
N_{mpi}
Number of events
1
10
1
10
10^2
10^3
10^4
10^5
10^6


PYTHIA 8.244 (Monash)
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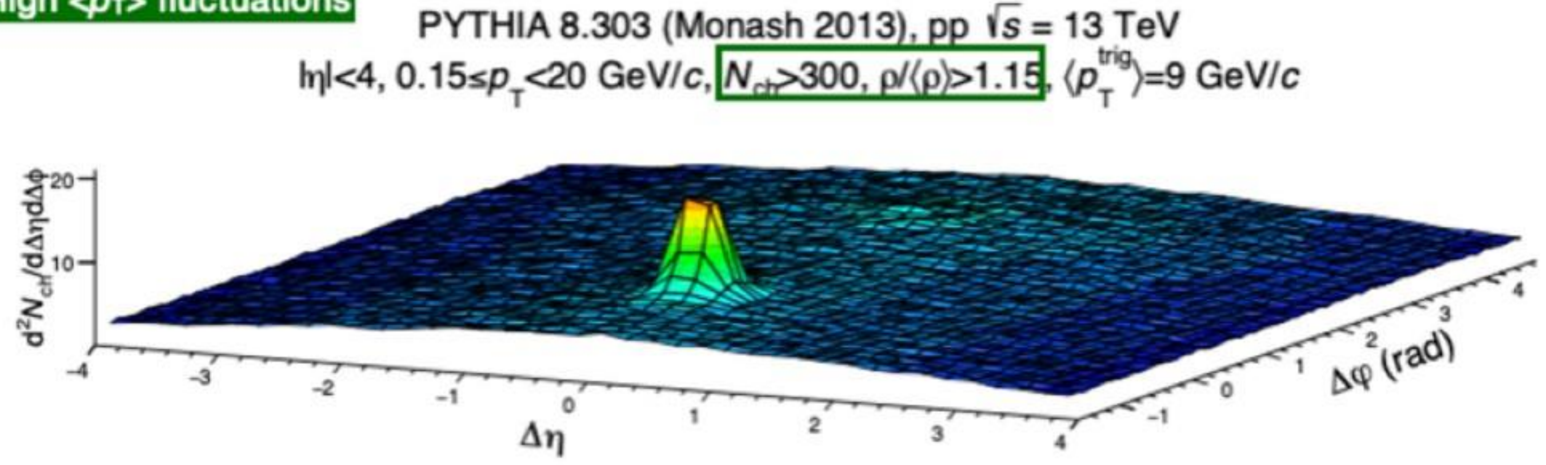
ρ
N_{ch}
Number of events
1
10^2
1
10
10^2
10^3
10^4
10^5
10^6

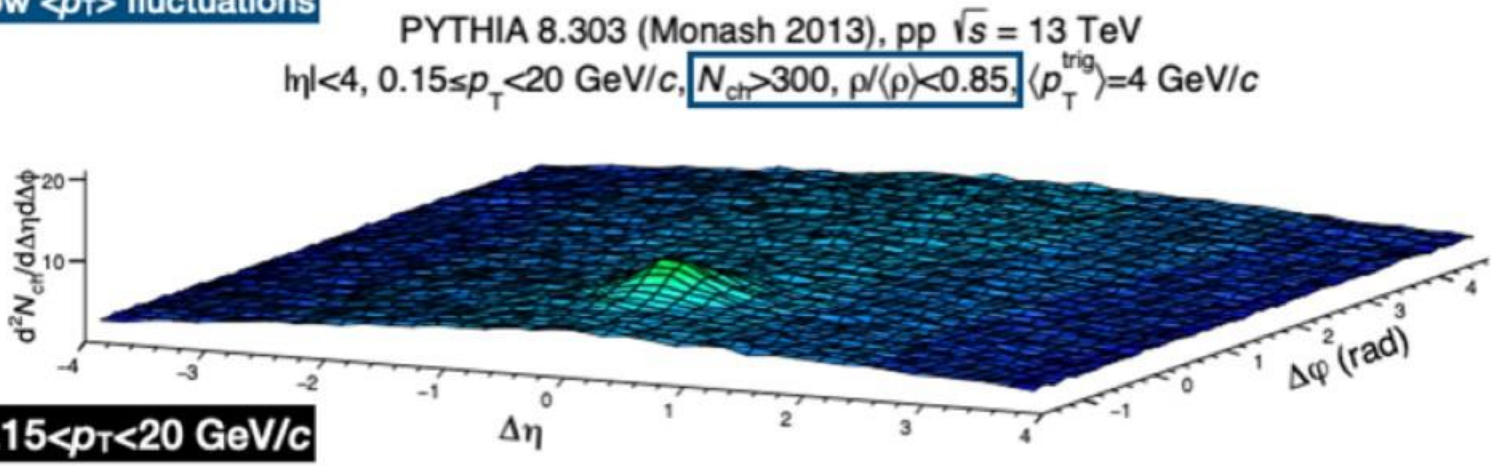
Dial your favorite event!

- **By choosing the trigger we can identify very rare events for study**

High <p_T> fluctuations



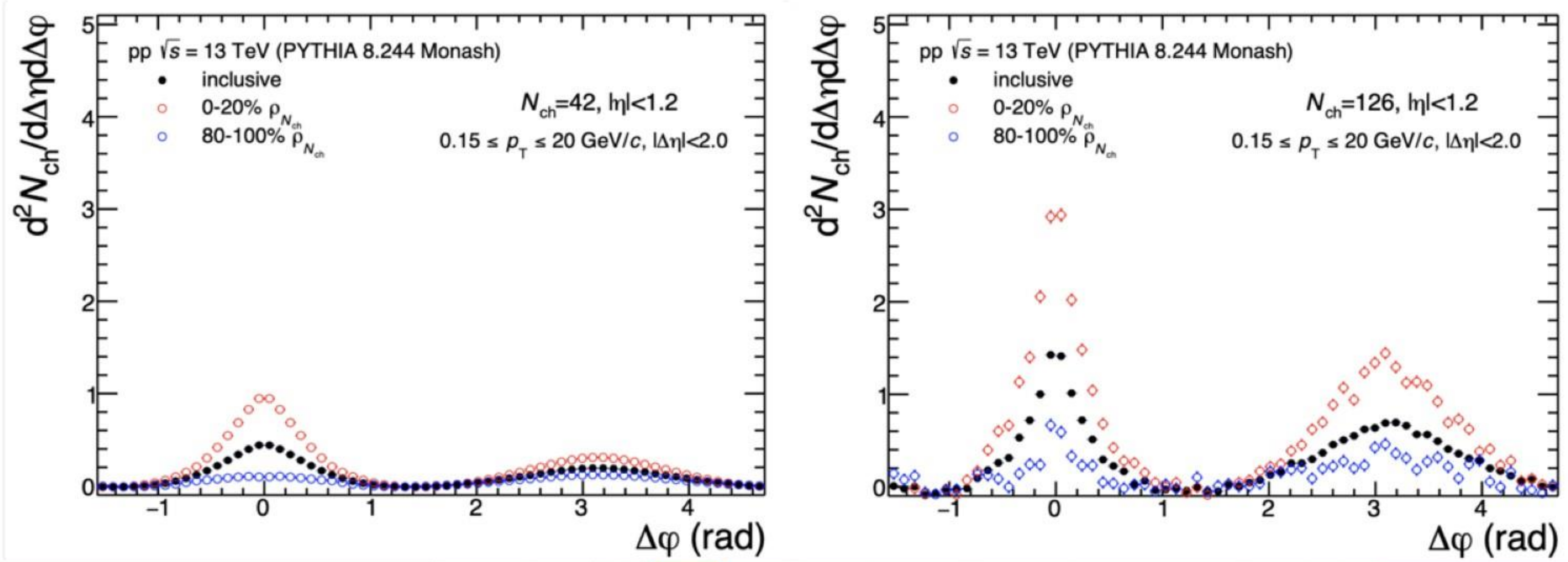
Low <p_T> fluctuations



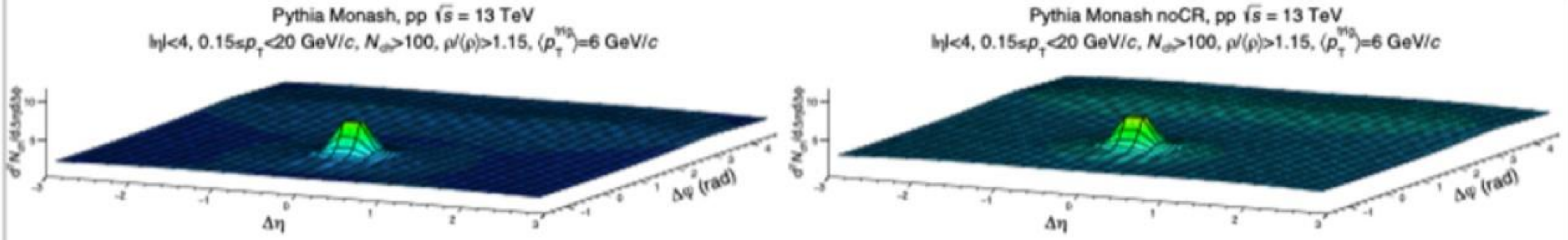
$0.15<p_T<20$ GeV/c

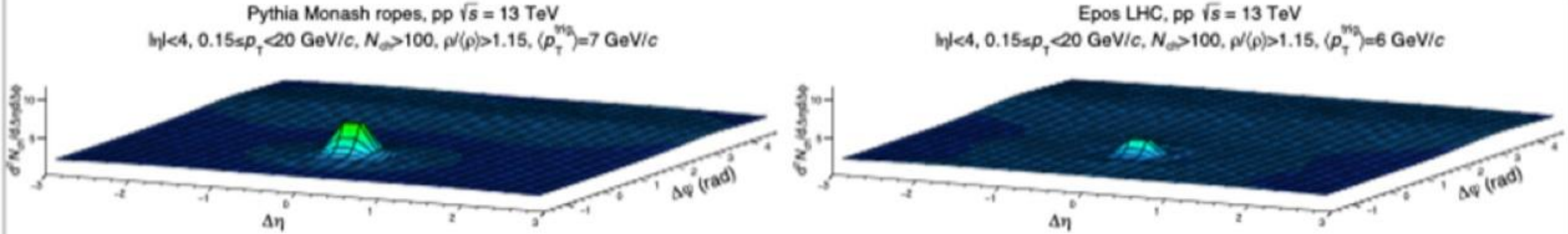
High multiplicity pp collisions

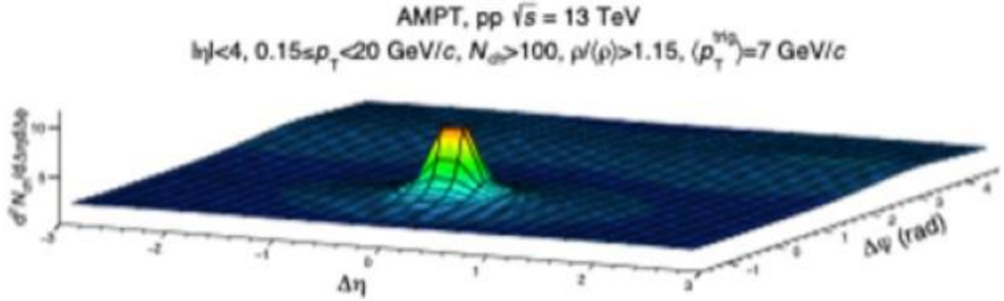
Hedgehog events can be tagged even at low multiplicities!



Di-hadron correlations (jetty): several MC generators



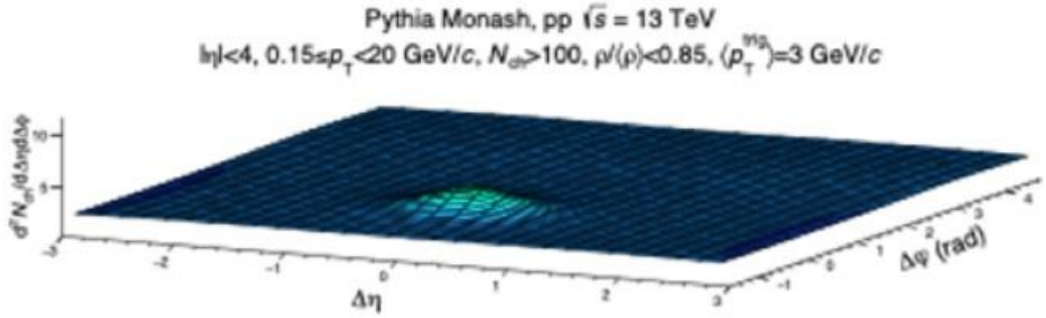


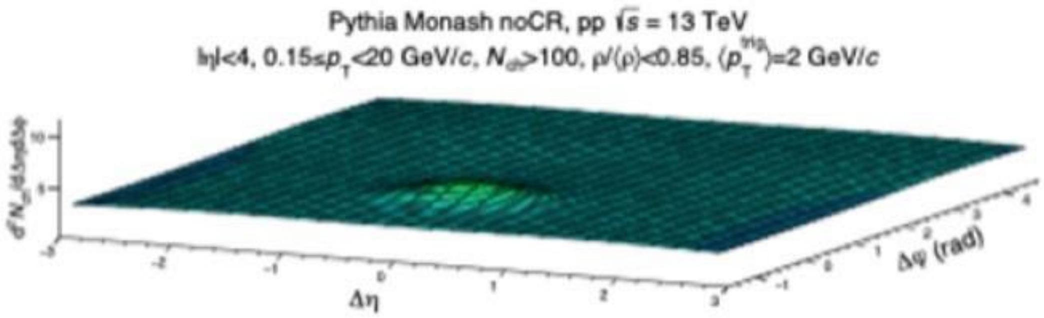


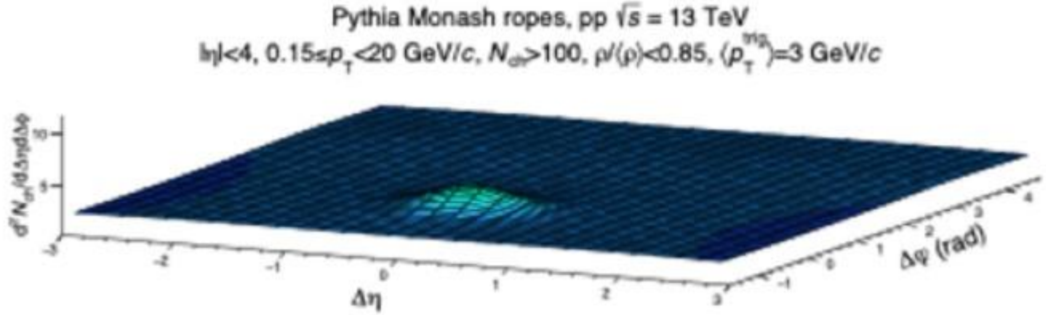
Leading jet peak is model dependent, in particular EPOS LHC gives a "suppression effect"

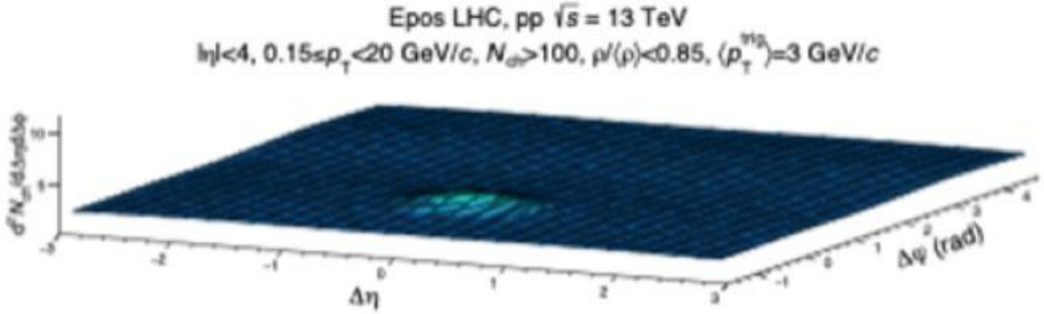
High multiplicity $N_{ch} \geq 100$ ($|\eta| < 4$), jet-like structure ($\rho/\langle\rho\rangle > 1.15$)

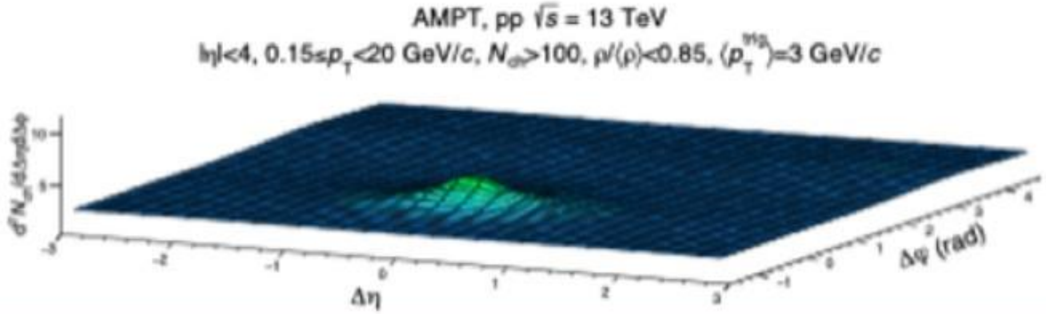
Di-hadron correlations (hedgehog): several MC generators low









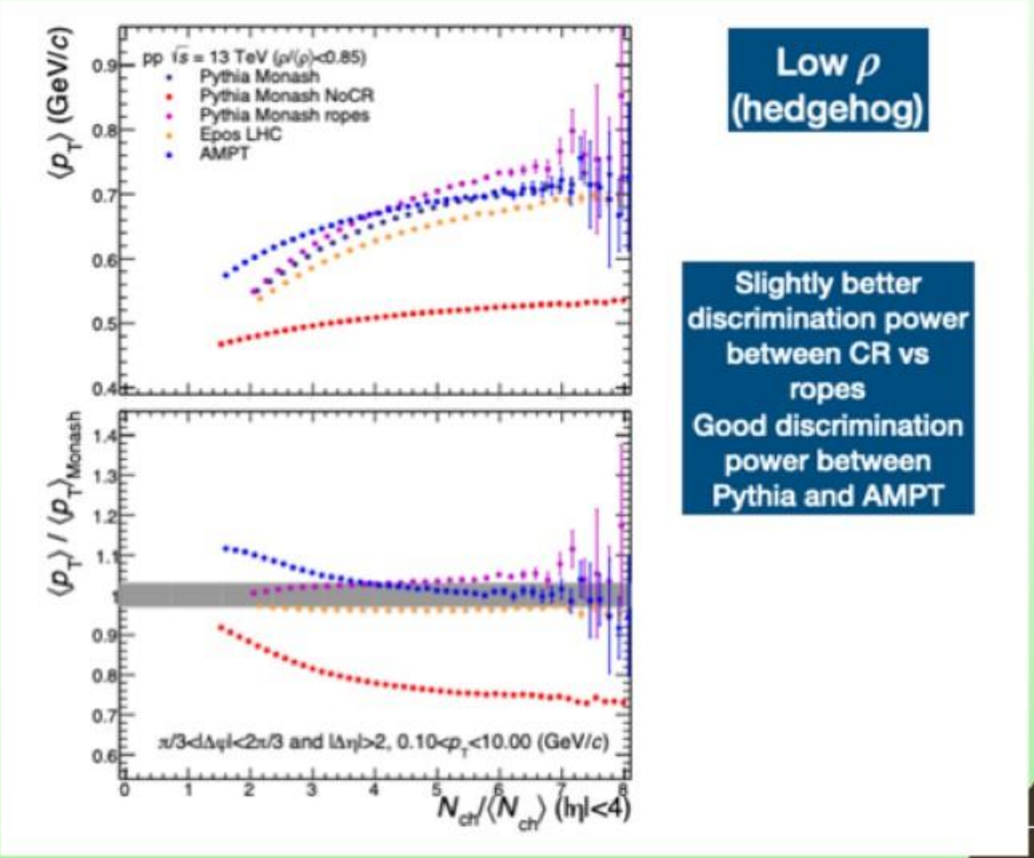


We can find hedgehogs like events in all event generators

High multiplicity $N_{\mathrm{ch}} \geq 100\,(|\eta| < 4)$, isotropic distribution of p_{T} $(\rho/\langle\rho\rangle < 0.85)$

All MC generators predict the existence of hedgehog events!!!

- The details of the predictions varies from one generator to another so that experimental comparison with MCs offers the possibility to tune the generators



Summary

- **We define a new event structure - flattenicity- to isolate hedgehog events.**
- **The quantity rho, which measures how isotopic the event is, has been defined and tested using different MC generators**
- **MC generators predict different features of hedgehog-like events (di-hadron correlations and average pT)**
- **We propose to measure di-hadron correlations, and average transverse momentum, for hedgehog and jetty like events.**
- **The hedgehog events may shed light to the long search for "energy loss" like effects in pp and open a new way to study pp collisions**

Stay tuned as we analyze the data!