# Double hump structure observed in azimuthal correlations in pp collision ?

Alejandro Ayala, Eleazar Cuautle, Isabel Domínguez, Antonio Ortiz, Guy Paić

[1]*Instituto de Ciencias Nucleares, Universidad Nacional Autonóma de México, 04510 México*

## Introduction

The azimuthal correlations allow the study of important parameters in pp collisions like the $J_t$ and $k_t$ they are important for comparison with similar parameters in heavy ion collisions. Considerable attention has been focused on the so called "double hump structure" observed in the away side azimuthal correlations [3] in central Au-Au collisions, accompanied by the claim that no such structure has been observed in pp collisions. In the present work we analyze the pp case using a sample of Pythia generated minimum bias events and the Event Shape Analysis (ESA)[2] to isolate specific event topologies. The topological analysis in terms of the transverse thrust ($T$) variable reveals that indeed, as one would expect from QCD, there is a finite probability for three prong events were three jets are emitted a 120 degrees from each other.

We focus our attention on the following questions:

1.- Is it possible to identify and isolate events with topologies that resemble the double hump structure, using ESA in proton-proton collisions at 200 GeV?

2.- What is the effect of the event structure on the width of the away peak in the case of dijets?

## Event Shape Analysis Basis

The shape analysis consists in constructing a two dimensional distribution with the variables: thrust ($T$) and recoil ($R$). By definition these variables are infrared and collinear safe [4]. $T$ is defined as:

$$T_{\perp} \equiv \max_{\vec{n}_T} \frac{\sum_i |\vec{q}_{\perp,i} \cdot \vec{n}_T|}{\sum_i |\vec{q}_{\perp,i}|}, \quad (1)$$

where the sum runs over all particles in the final state within the acceptance, $\vec{q}_{\perp,i}$ is the transverse momentum of the particle $i$; $\vec{n}_T$ is the vector that maximizes the ratio. $T$ (the sphericity in the transverse plane, $1-T$, closely related to $T$) will be equal to 1 (0) for a jet detected within the acceptance. On the other hand a fully isotropic event will result in a sphericity of 0.5. $R$ is defined as:

$$R_{\perp} \equiv \frac{|\sum_i \vec{q}_{\perp i}|}{\sum_i |\vec{q}_{\perp i}|}, \quad (2)$$

where again, the sum runs over all particles in the final state within the acceptance. The necessity for this variable stems from the incomplete acceptance we are faced with in the present application. As defined above, the maximum value of the recoil will be for a jet event where only one jet is detected within the acceptance.

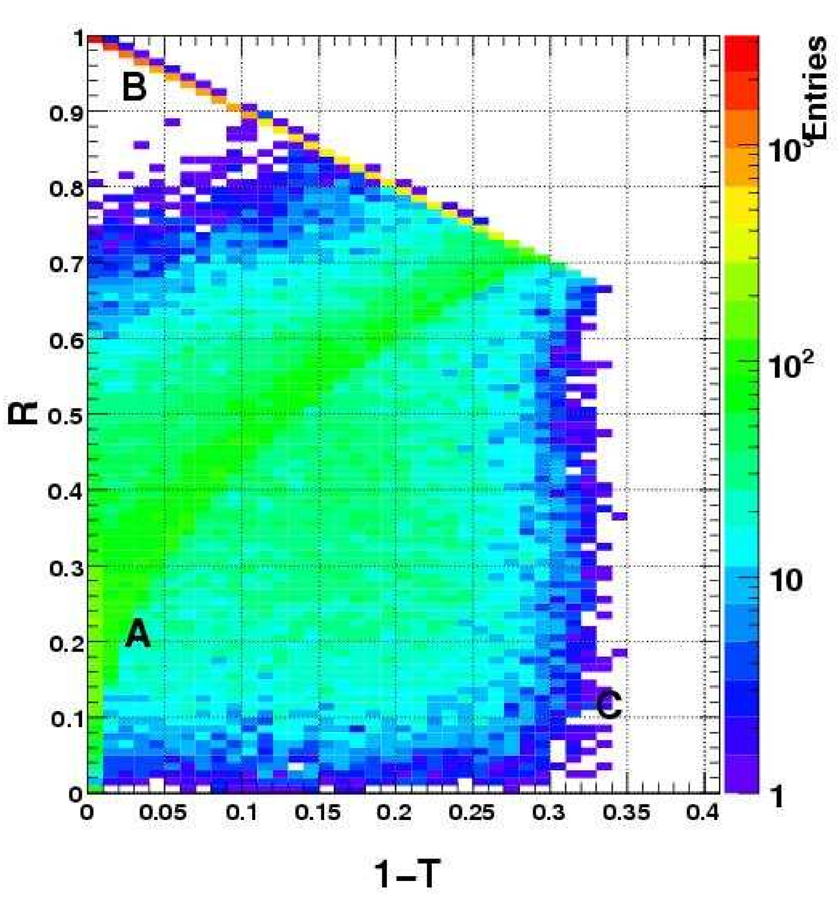
In this section, we used 500000 minimum bias events: proton-proton collisions at 200 GeV in the c. m., such events were simulated using the Pythia event generator version 6.3. We restrict our analysis to the acceptance: $|\eta| \leq 1$. In order to perform the computation we demanded at least one particle with $p_t \geq 0.8$ GeV/c. After that the participants to get the shape variables are primary charged particles with $p_t \geq 0.5$ GeV. In the figure 1 there is the so called thrust map for such sample.

We limit ourselves in the present work to the three simplest configurations labelled A, B and C:

The low $R$ and $1-T$ region which is known to correspond to dijets.

The high $R$ and low $1-T$ region which is known to correspond to single jets (with the second jet being out of the acceptance).

The high $1-T$ region which is known to correspond to the most isotropic events.




| region | topology | cuts | entries |
|---|---|---|---|
| A | di-jet | *1-T<0.06, R<0.35* | 10450 |
| B | mono-jet | *1-T<0.06, R>0.9* | 38010 |
| C | mercedes | *1-T>0.3, R<0.4* | 424 |

FIGURE 1: Thrust map

In the figure 2 is shown the correlations $\Delta\phi$ vs. $p_t$ obtained for the above topologies (we performed a rotation to place the leading particle at $\Delta\phi = \pi/2$ rad).

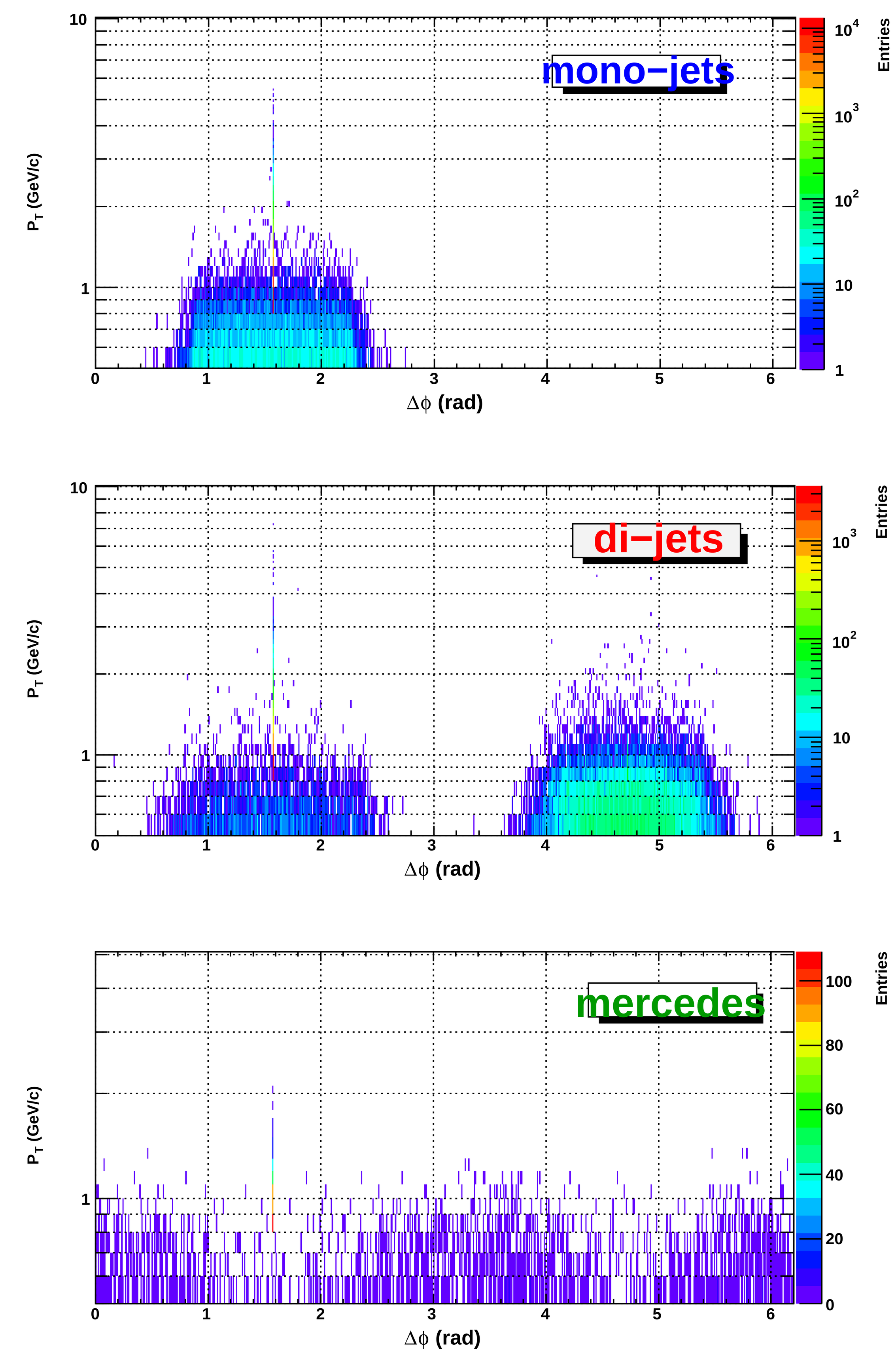
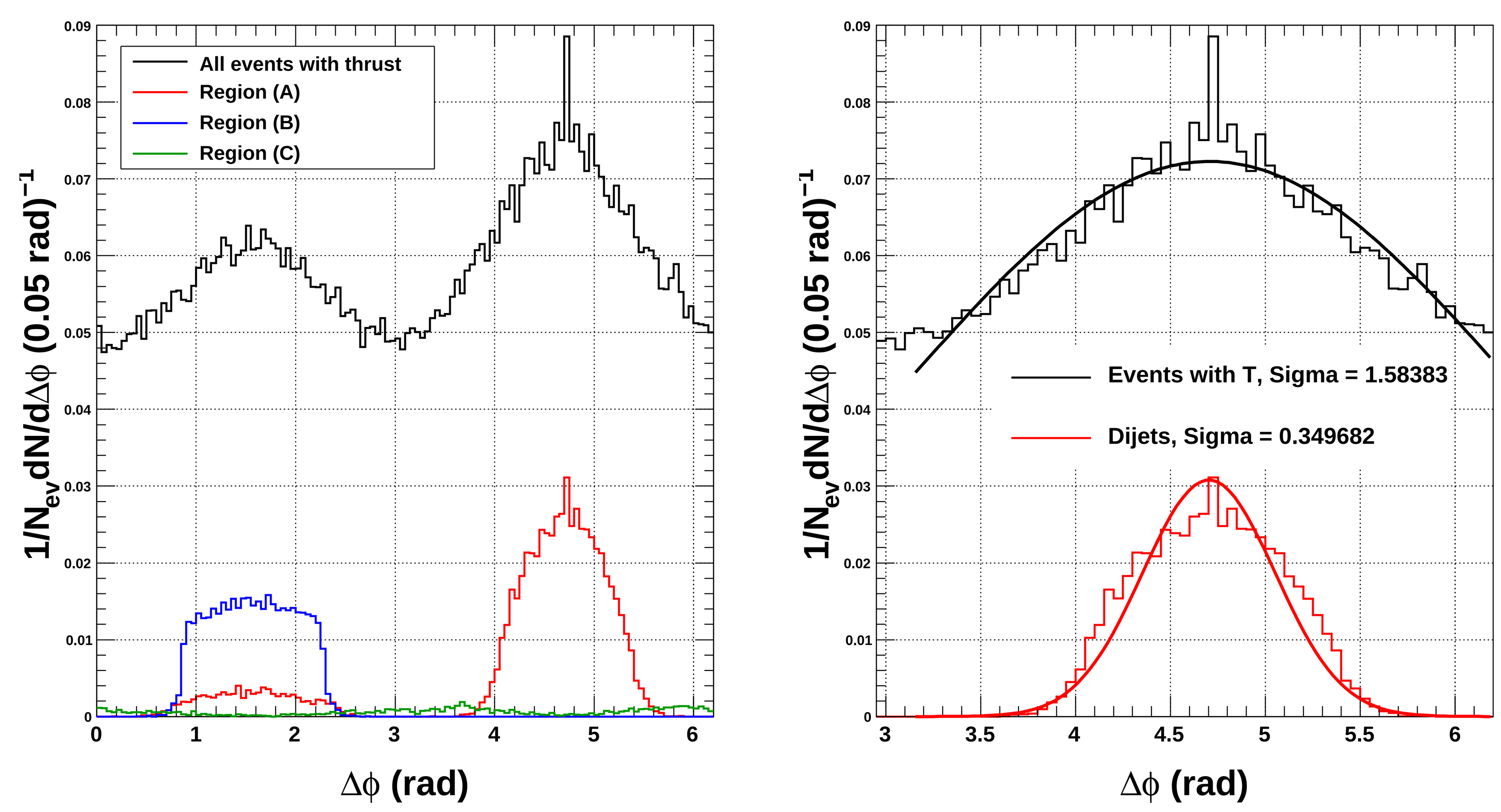



FIGURE 2: $\Delta\phi$ vs. $p_t$, for the different topologies.

In order to see the evolution of the away side peak, we plot in the figure 3 the $\Delta\phi$ distribution (left plot).

In the right plot we compare the shape of the away peak obtained from the topology when only two jets are identify with the shape obtained for the same peak in the case where the whole sample is taken. One easily sees that there are notable differences in the width of the peak. This does not seem to be surprising because we see that the contribution of the three prong events does contribute to the width of the away peak. There are also other configurations present in the Thrust map that play a similar role of broadening the away peak. Finally, we demonstrate that the event shape analysis may be applied even at low energy yielding the possibility to disentangle many specific topologies.




## Conclusions

We have presented the Event Shape Analysis and we applied it to proton-proton collisions at 200 GeV. We demonstrated that it is possible to isolate and identify events with a double hump structure in the away side of the azimuthal correlation.

## References

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