Jet circularity and TM correlations

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Frascati mini-jet workshop

Jet Circularity and TM correlations

-Explored interjet and intrajet broadening **: jet cores look ~vacuum like**,
 energy balance in dijets is **recovered at large angles**, **no hints for medium-induced acoplanarity**.

-Now we would like to define minimally biased observables that correlate the jet
 with the particles at large angles, differentially in particle p_T

-Observables sensitive to angular ordering

Jet circularity and TM correlations

-Find the jet
-Project the momenta of all particles at ΔR<0.4 onto the **plane perpendicular to the jet**
-Compute a 2D symmetric "Sphericity" matrix

$$\begin{pmatrix} \Sigma_i\, px^i * px^i & \Sigma_i\, px^i * py^i \\ \Sigma_i\, py^i * px^i & \Sigma_i\, py^i * py^i \end{pmatrix}$$

-Obtain eigenvalues: $\lambda_1 > \lambda_2$;
        define **Circularity C=1/2 λ_2**   ⟶   **C=1->circular jet** (in the transverse plane)
                                                           C=0->oblate jet

-Obtain eigenvectors
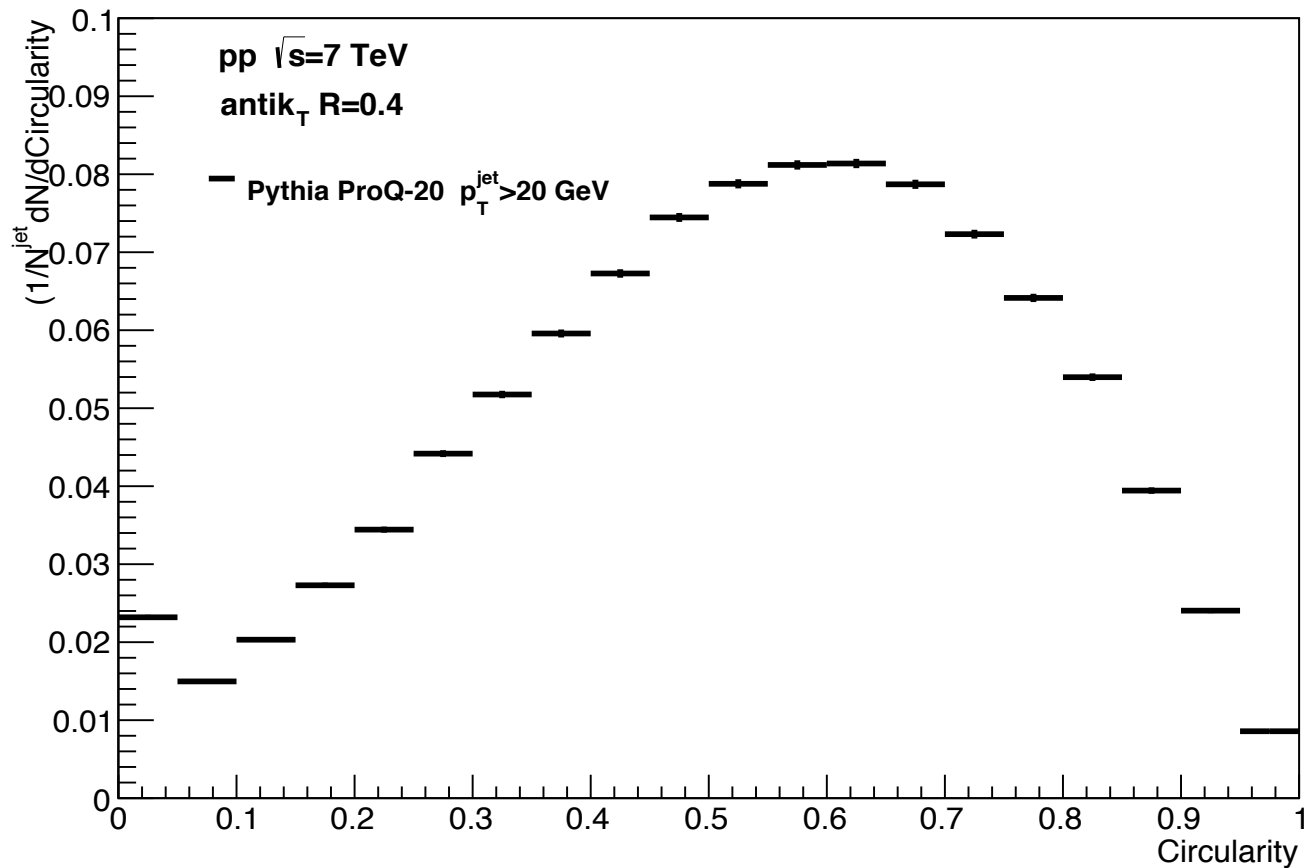   define **TM axis, eigenvector associated to the largest eigenvalue**

-Correlated TM axis with particles at 0.4<ΔR<0.8

Jet Circularity

Pythia ProQ-20
p_T^{hard}>20 GeV, |η^{jet}|<0.1
Jets with antik$_T$ R=0.4, p_T^{const}>0.15 GeV

C->0 OBLATE JETS
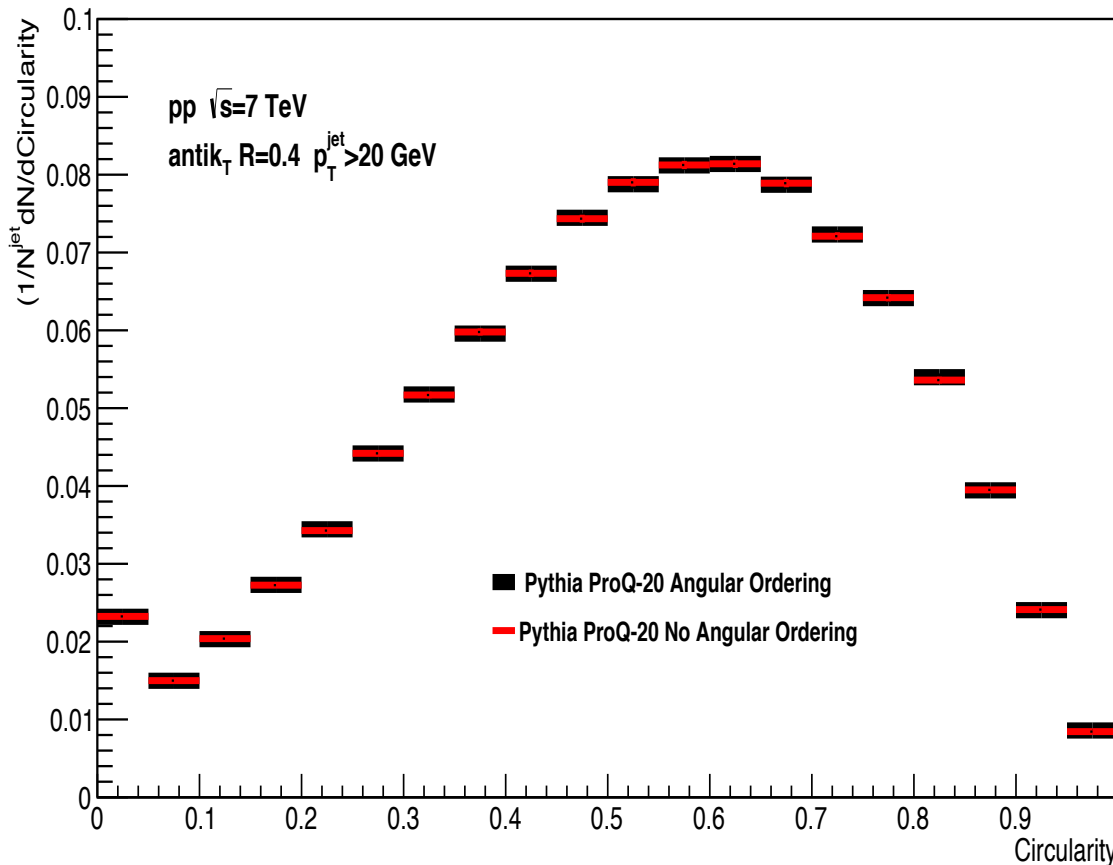
C->1 CIRCULAR JETS

Jet circularity and coherence?

Sensitive to coherence effects in the shower?

Angular ordering (via veto in Q2 ordered shower): MSTJ(42)=2
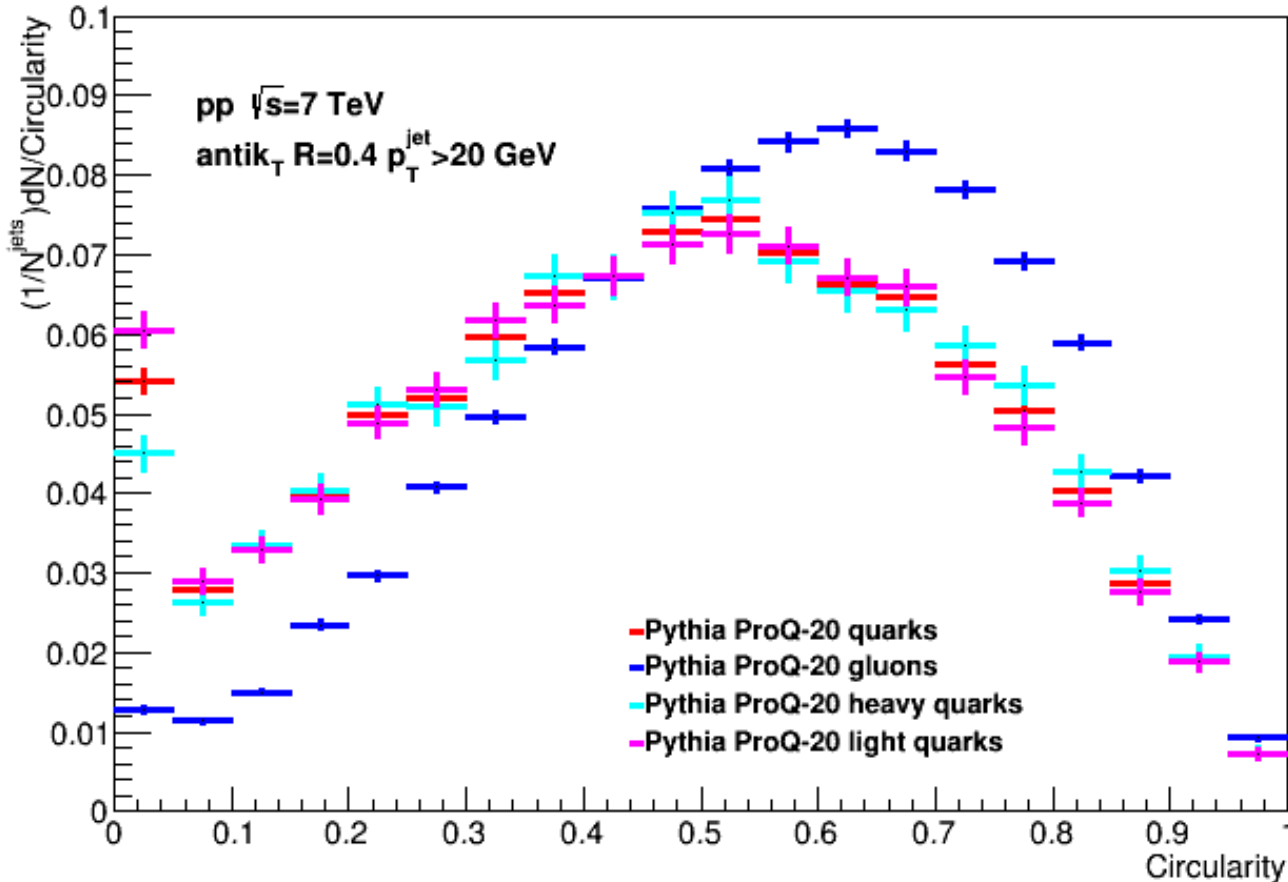No Angular ordering: MSTJ(42)=1

No significant effects are observed

What we had in mind: emissions formed by an antenna formed by 2 (semi) hard partons tend to be preferentially in the plane defined by the emitting partons→events with small C.
Then remove coherence: emissions from each leg of the antenna become decorrelated->larger C

Jet circularity and parton type?

pp √s=7 TeV

antik$_T$ R=0.4 p$_T^{jet}$ >20 GeV

- Pythia ProQ-20 quarks
- Pythia ProQ-20 gluons
- Pythia ProQ-20 heavy quarks
- Pythia ProQ-20 light quarks

Sensitive to iniciating partons but no spectacular effects here

→there are other observables like jet "girth" that can be used as more efficient taggers

Gluon jets fragment more->are more circular

Entries at Circularity=0 are due to jets with just 2 particles in the core

Correlations of the TM axis with particles in the plane perpendicular to the jet
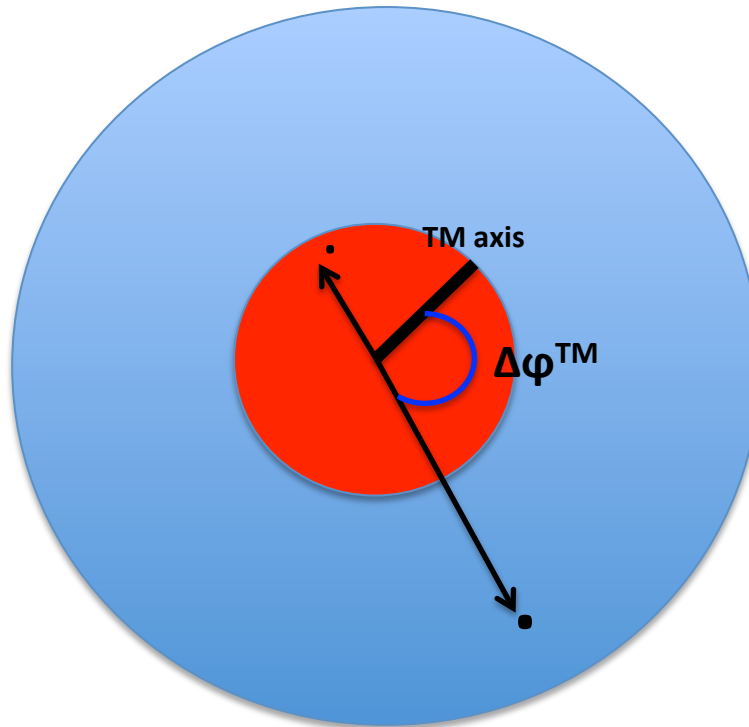
AUTOCORRELATIONS: correlate TM axis with particles in ΔR<0.4, that entered the TM axis calculation

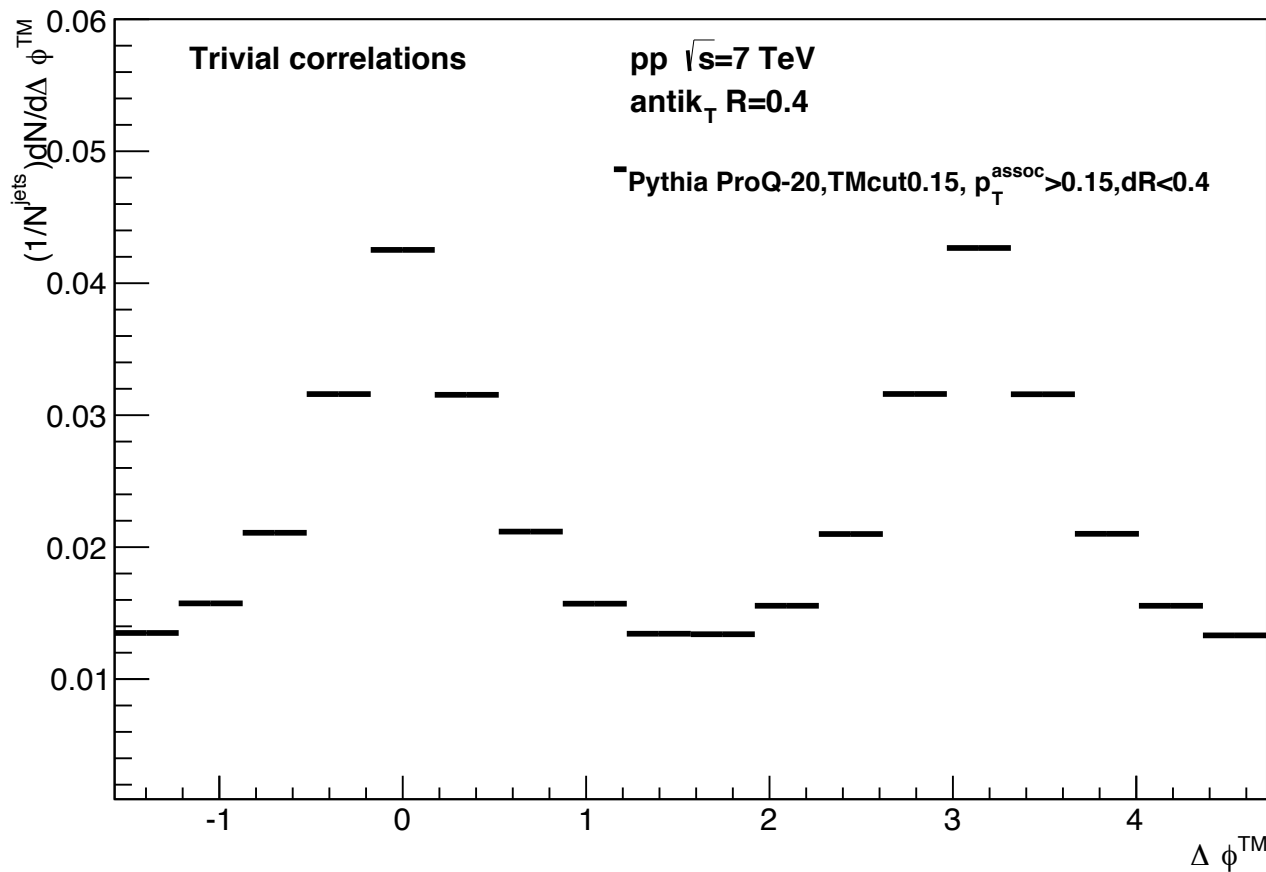**CORRELATIONS**: correlate the TM axis with particles in 0.4<ΔR<0.8 that did not enter the TM calculation

Correlations of the TM axis with particles in the plane perpendicular to the jet

$\Delta\varphi = \varphi^{TM} - \varphi T$ **AUTOCORRELATIONS**
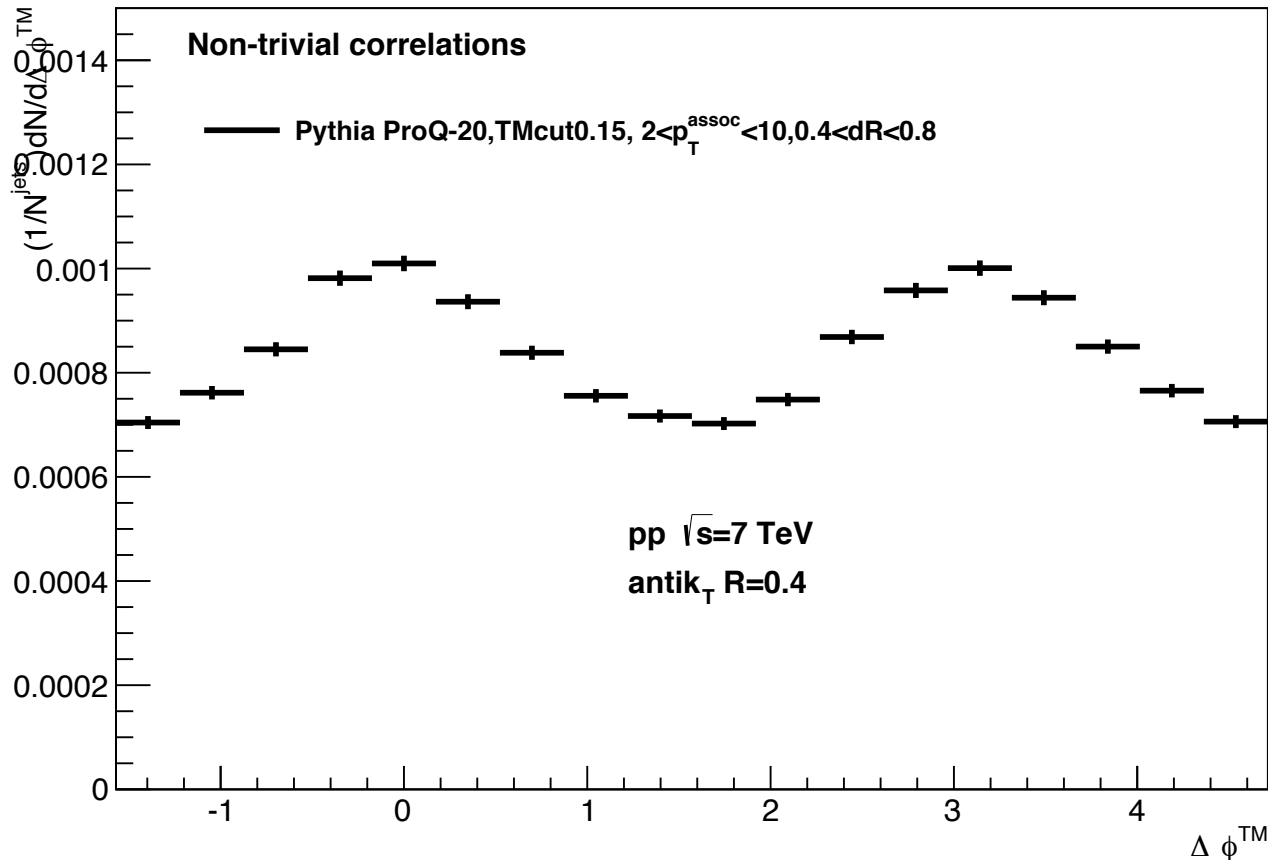
fhnJetTM projection phi

Correlations of the TM axis with particles in the plane perpendicular to the jet

NonTRIVIAL CORRELATIONS

$\Delta\varphi=\varphi^{TM}-\varphi T$

fhnJetTM projection phi

Similar behaviour pp data!

The observable in PbPb

Can we distinguish between two scenarios?:

    -Fast early energy loss decoupled from further vacuum
    shower evolution:
        we would expect**: TM uncorrelated with the radiated particles**
        found at large angles.

     -Modified shower evolution:
     we would expect: **TM correlated with radiated particles**

Does the correlation survive in the PbPb background?
Is the TM axis correlated with the background particles?

Smearing of the TM correlations in Heavy Ion Collisions

- 1. The jet axis is changed by background particles.
- 2. Background particles modify the S_{matrix}

  and the TM axis calculation.

TOY MODEL:

-**TRUE: Simulated Pythia jets (with p_T^{hard}>70 GeV)**
-**HYBRID: Simulated Pythia jets embedded into a background model**
 (PSM [Armesto et al Eur. Phys.J. C 22(2001) 149**]) (no flow in)**

-**BACKGROUND: purely background jets**
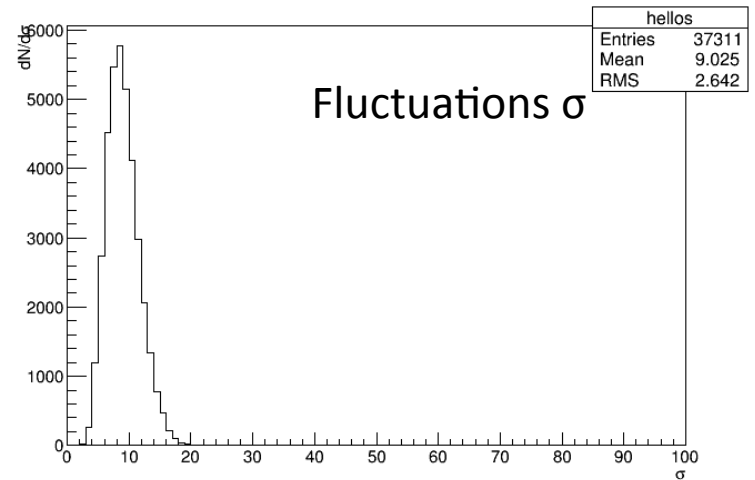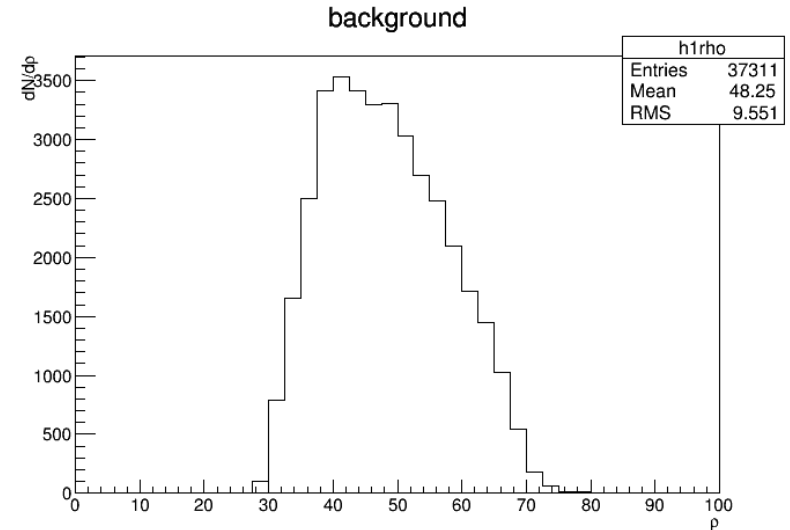-**MATCHED HYBRID: hybrid jet with at least 50% of the momentum of the true jet.**

Notation
TMcutX: the TM axis is calculated with particles with minimum p_T=X GeV

Smearing of the TM correlations in Heavy Ion Collisions

Jet spectrum smeared by bkg fluctuations
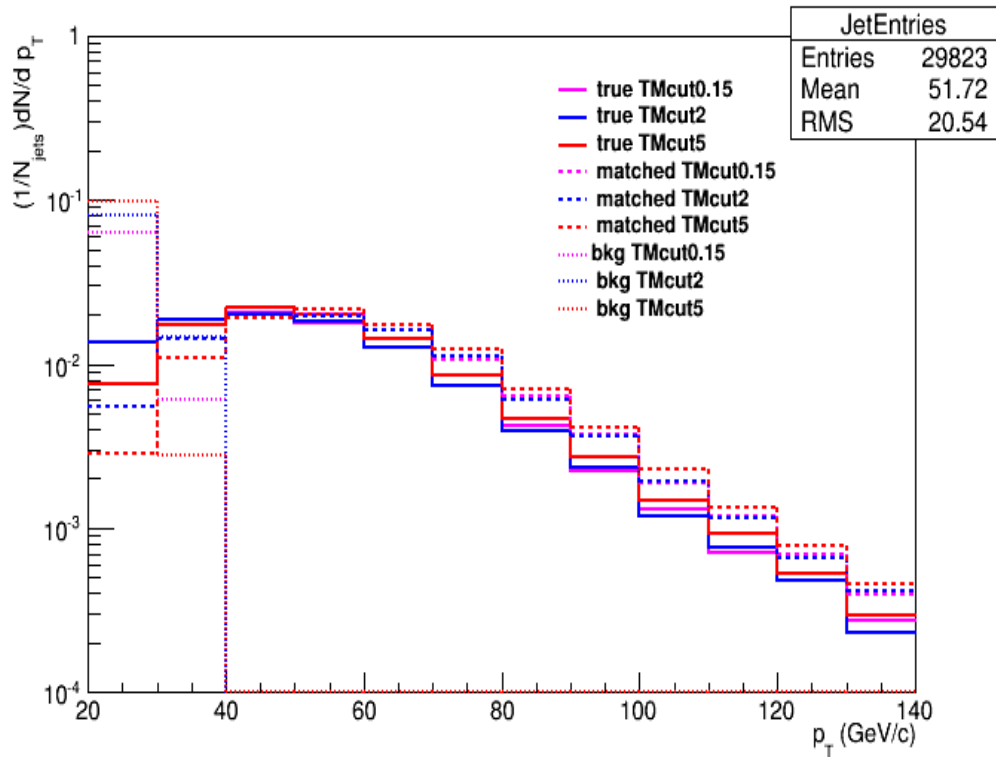
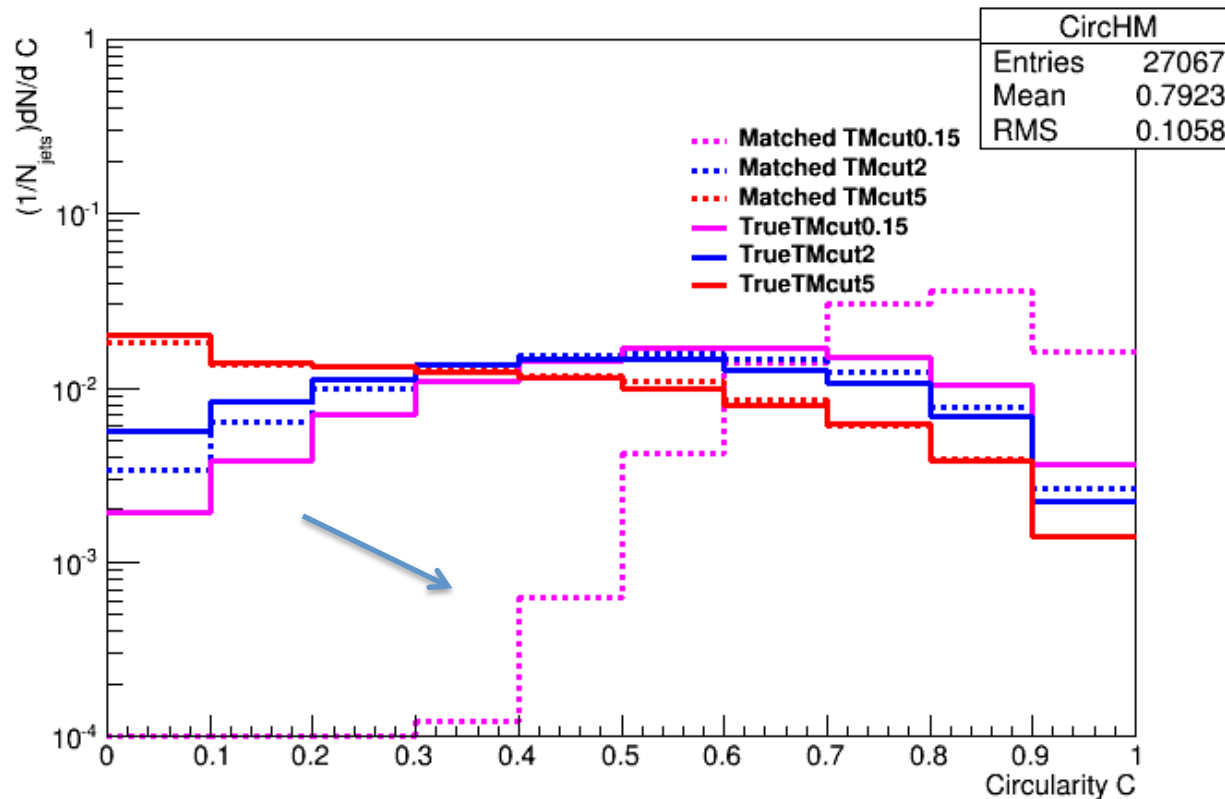σ~10 GeV (realistic)
ρ~50 GeV (not realistic)
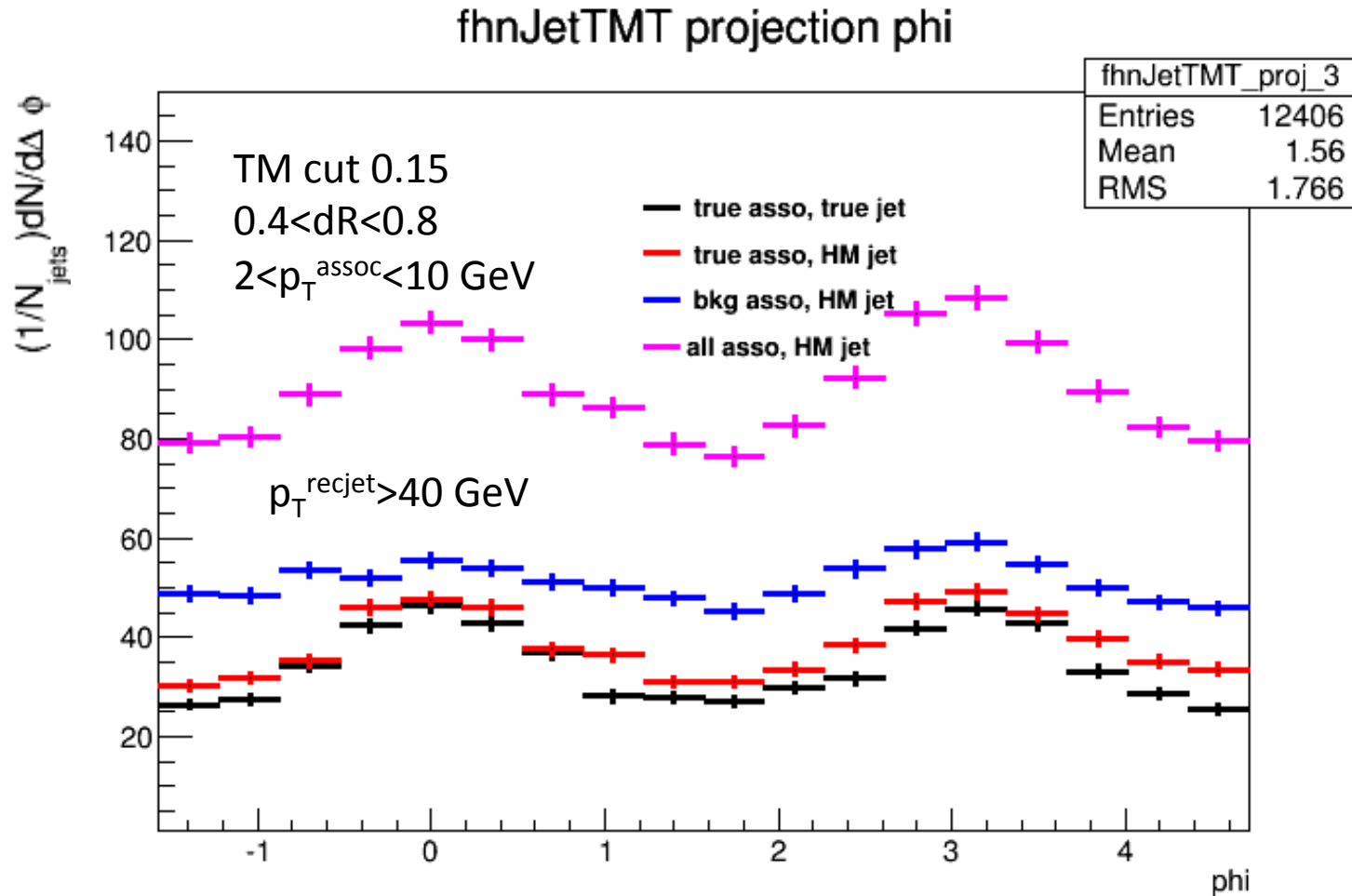
Smearing of the TM correlations in Heavy Ion Collisions

$p_T^{recjet} > 40$ GeV


Jets become circular for TMcut0.15
For TMcut2 and TMcut5 the eigenvalues of the Smatrix are not modified wrt vacuum

Smearing of the TM correlations in Heavy Ion Collisions

For TM cut 0.15, the Circularity and TM axis change with background
    →The TM axis shows non-trivial correlations with background associated particles.

Smearing of the TM correlations in Heavy Ion Collisions

fhnJetTMT projection phi

TM cut 2
0.4<dR<0.8
$2<p_T^{assoc}<10$ GeV

$p_T^{recjet}>40$ GeV
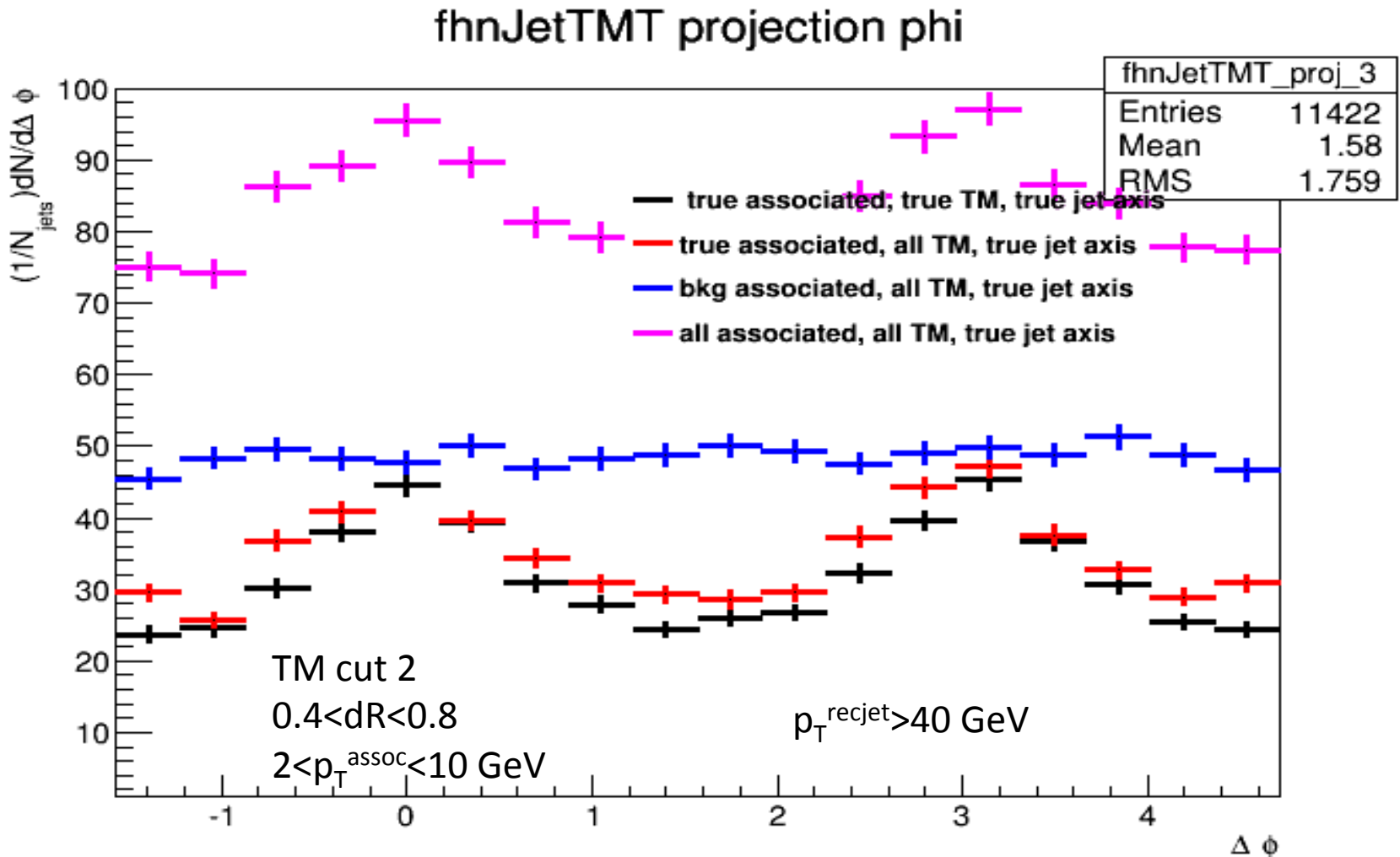
Background is uncorrelated with the TM axis ,
Non-trivial correlations with "true associated" are the only source of correlations with "all associated"! But this is background model dependent…need to embed Pythia into PbPb events

PROSPECTS

-Interesting observable in pp

-Introduce effects of quenching

-Embedding jets into real PbPb events