

# Background Subtraction And Jet Quenching - Theory Perspective

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arXiv:1211.1161

Jet quenching: the interface between theory and experiment  
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CERN, Switzerland

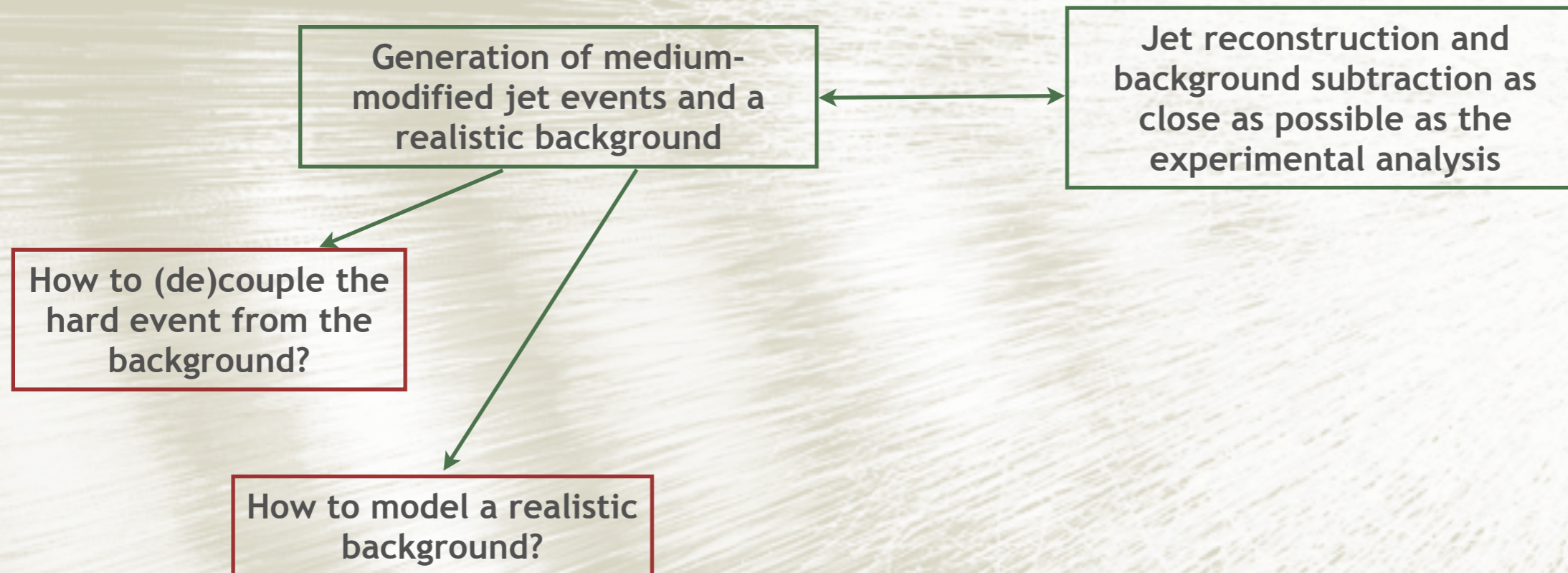
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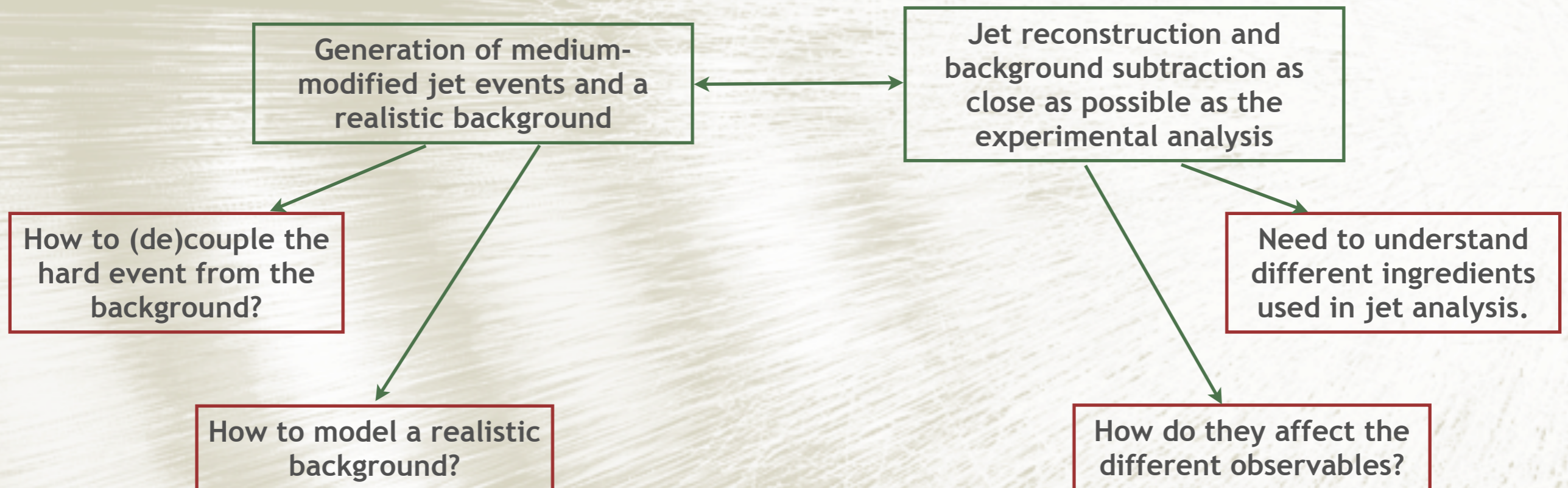
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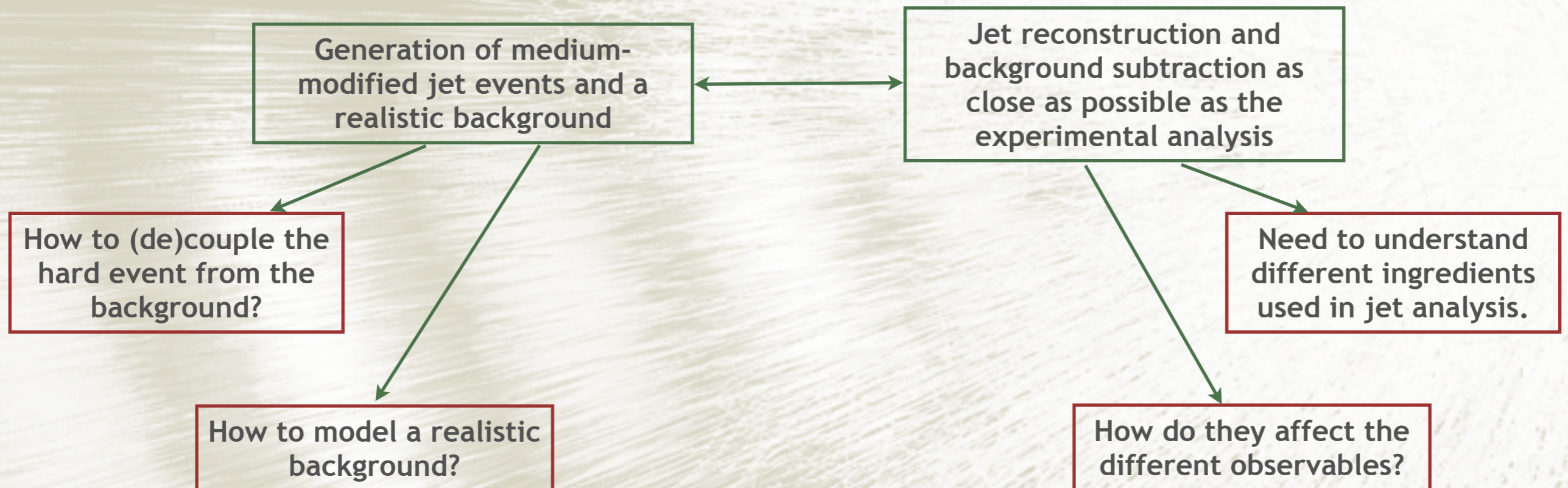
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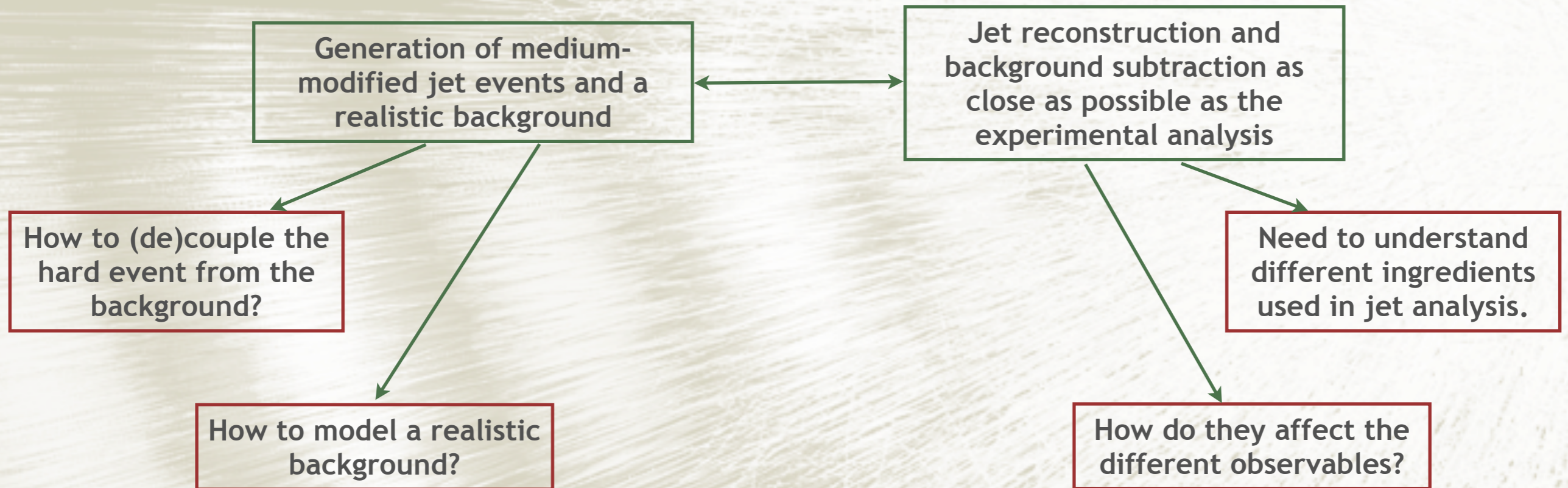
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**Necessary for a more precise extraction of medium properties!!!**

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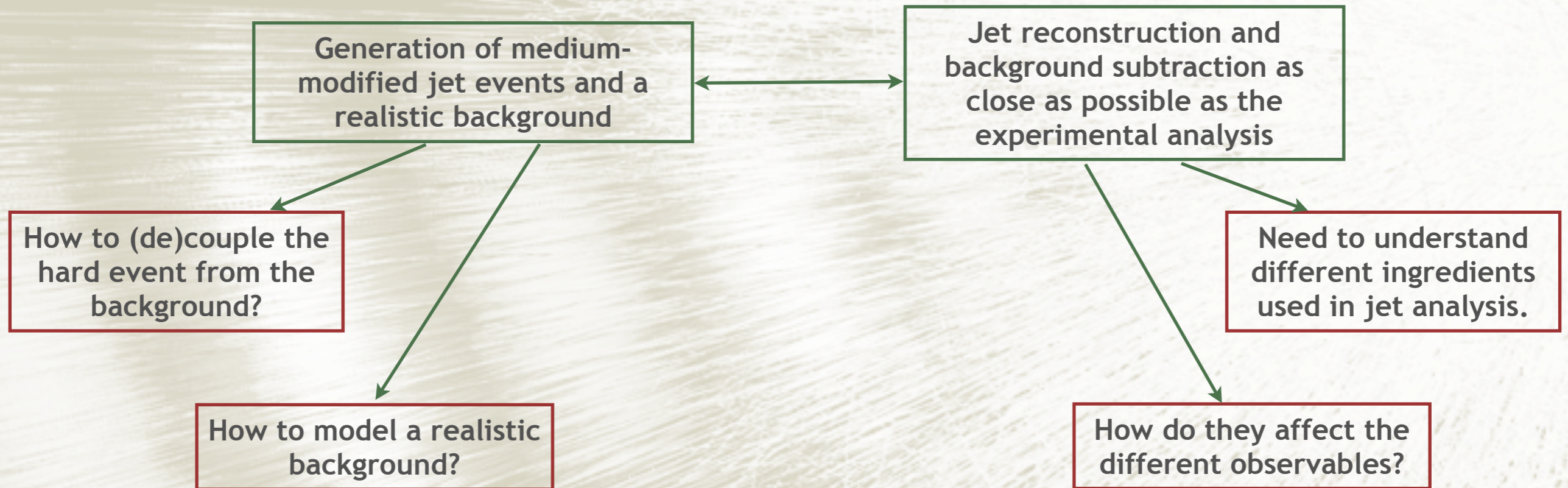
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## ◆ Ingredients:

- ◆ Hard Event: quenched or unquenched (e.g: Q-PYTHIA,...)
- ◆ Background: different modelings (e.g: PSM, Thermal,...)
- ◆ Background subtraction: different techniques (e.g: FastJet, Pedestal,...)

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Play with them and check the influence on different observables.  
Centrality class: [0-10]%

# Background Models

◆ Two different background models:

◆ Parton-String-Model (PSM): (arXiv:hep-ph/0103060)

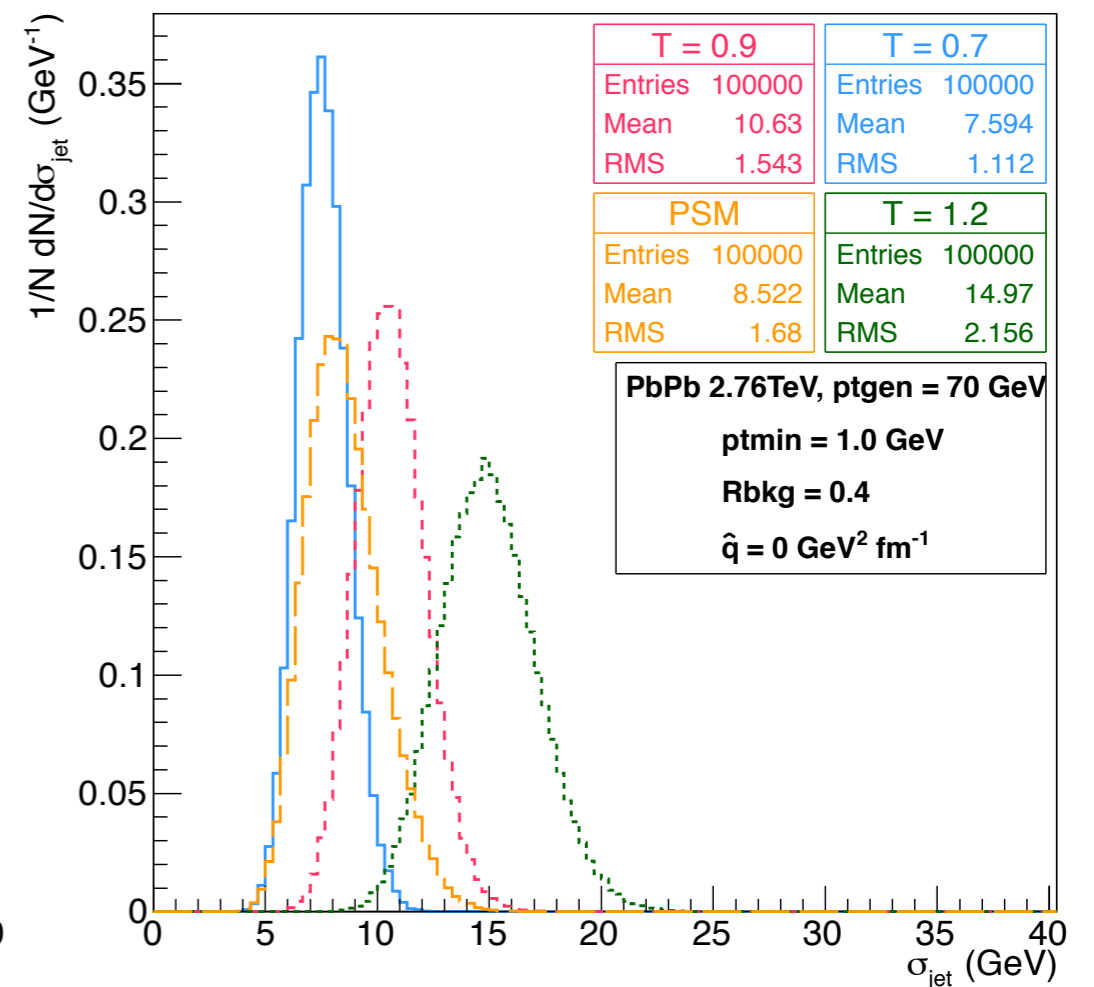
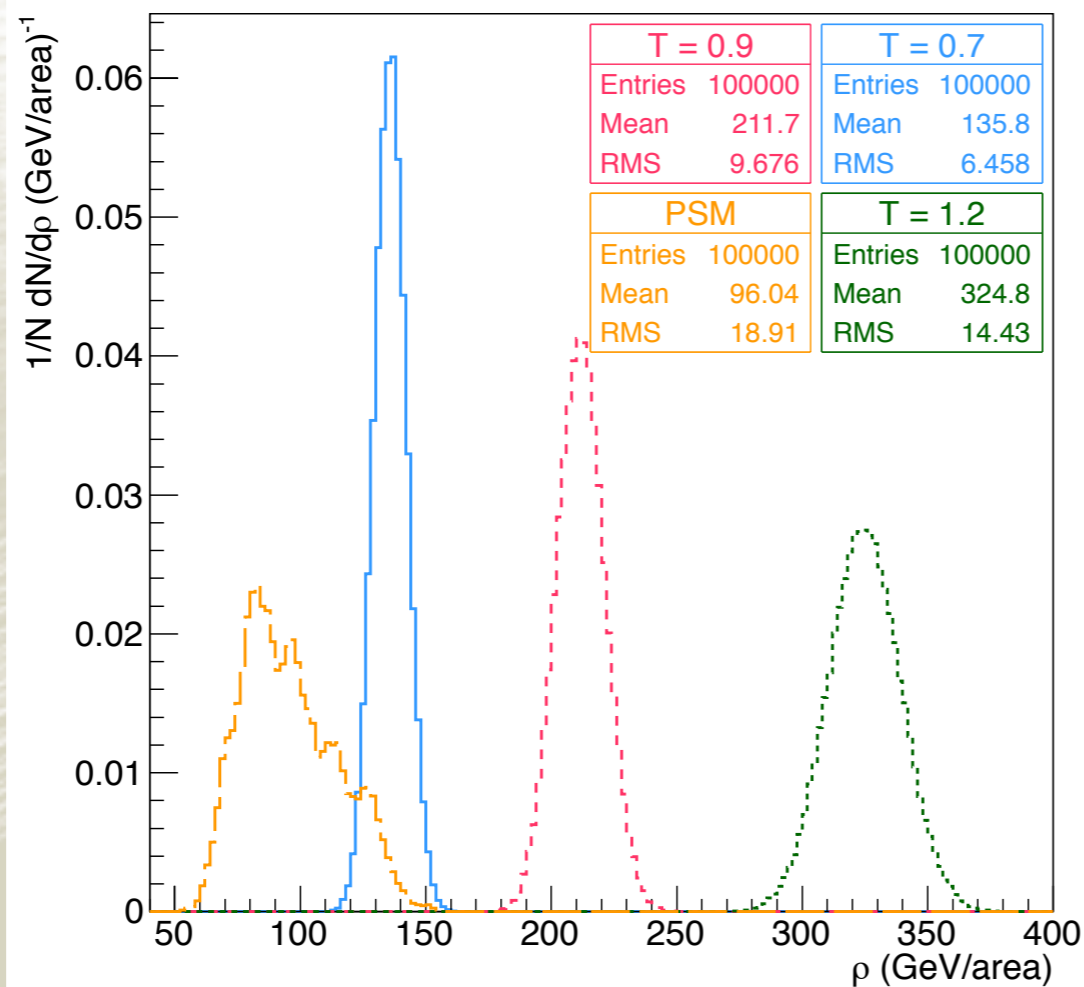
◆ Toy model based on a ‘thermal’ spectrum:  $f(p_T) = \begin{cases} e^{-p_T/T} & p_T \leq \alpha T \\ e^{-\alpha} \left(\frac{\alpha T}{p_T}\right)^\alpha & p_T > \alpha T \end{cases}$

◆  $\alpha = 6$

◆  $T \in [0.7; 1.2]$

ALICE  
(1201.2423):  
 $\sigma_{\text{jet}} \approx 10.8 \text{ GeV}$   
(scaled to account  
for neutral  
particles)

ATLAS:  
(1208.1967)  
 $\sigma_{\text{jet}} \approx 12.5 \text{ GeV}$   
( $p_{T\text{min}}^{\text{part}} = 0.5 \text{ GeV}$ )





# Background Subtraction

- ◆ Two different background subtraction techniques ( $p_{T\min}^{\text{part}} = 1\text{GeV}$ ):
  - ◆ FastJet
    - ◆  $k_T$ -jets with  $R = 0.4$ ;
    - ◆ Subtraction with active areas on the jet level.

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## ◆ Pedestal

- ◆ 1) Define a grid resembling the calorimeter segmentation of CMS;
- ◆ 2) Background estimation in each cell:

$$\langle E_T^{\text{tower}}(\eta) \rangle = \frac{\sum_i E_{Ti}^{\text{tower}}}{\#\phi \text{ bins}} \quad \langle \sigma_T^{\text{tower}}(\eta) \rangle = \sqrt{\langle E_T^{\text{tower}}(\eta)^2 \rangle - \langle E_T^{\text{tower}}(\eta) \rangle^2}$$

- ◆ 3) Correct each cell by:

$$E_T^{\text{tower}*} = \max [E_T^{\text{tower}} - \langle E_T^{\text{tower}}(\eta) \rangle - \kappa \langle \sigma_T^{\text{tower}}(\eta) \rangle, 0]$$

- ◆ 4) Using only non-zero  $E_T^{\text{tower}*}$  reconstruct jets with  $E_T > E_{T,jets}$  and  $R = 0.3$ ;
- ◆ 5) Removing the particles contained inside the previous list of jets, repeat 2);
- ◆ 6) Do 3) with the new background parameters but initial values of  $E_T^{\text{tower}}$ .

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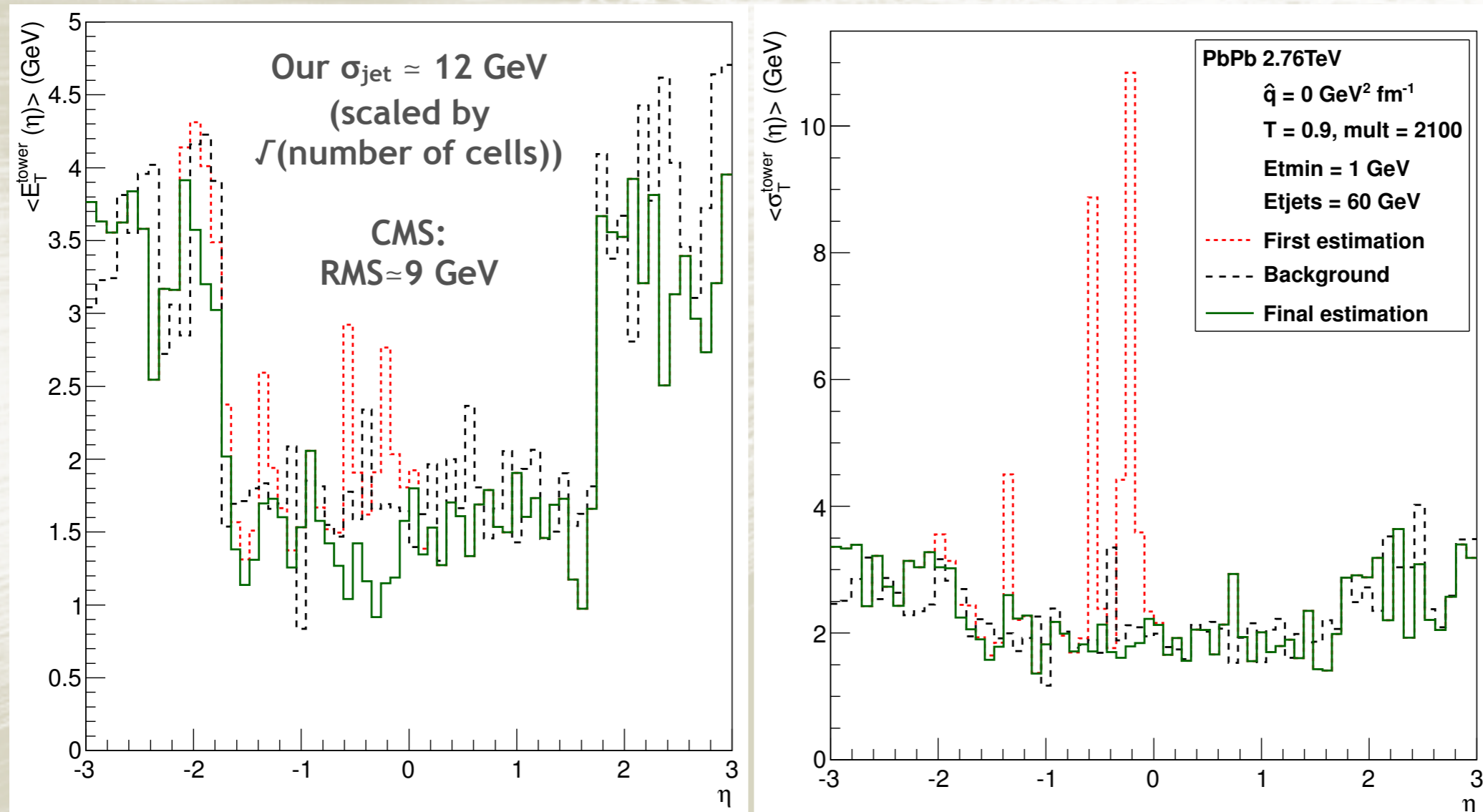
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Two parameters in the method:  $\kappa$  and  $E_{T,jets}$   
We need to fix them  
(CMS:  $\kappa = 1.0$ ,  $E_{T,jets} \in [10, 15]$  GeV)

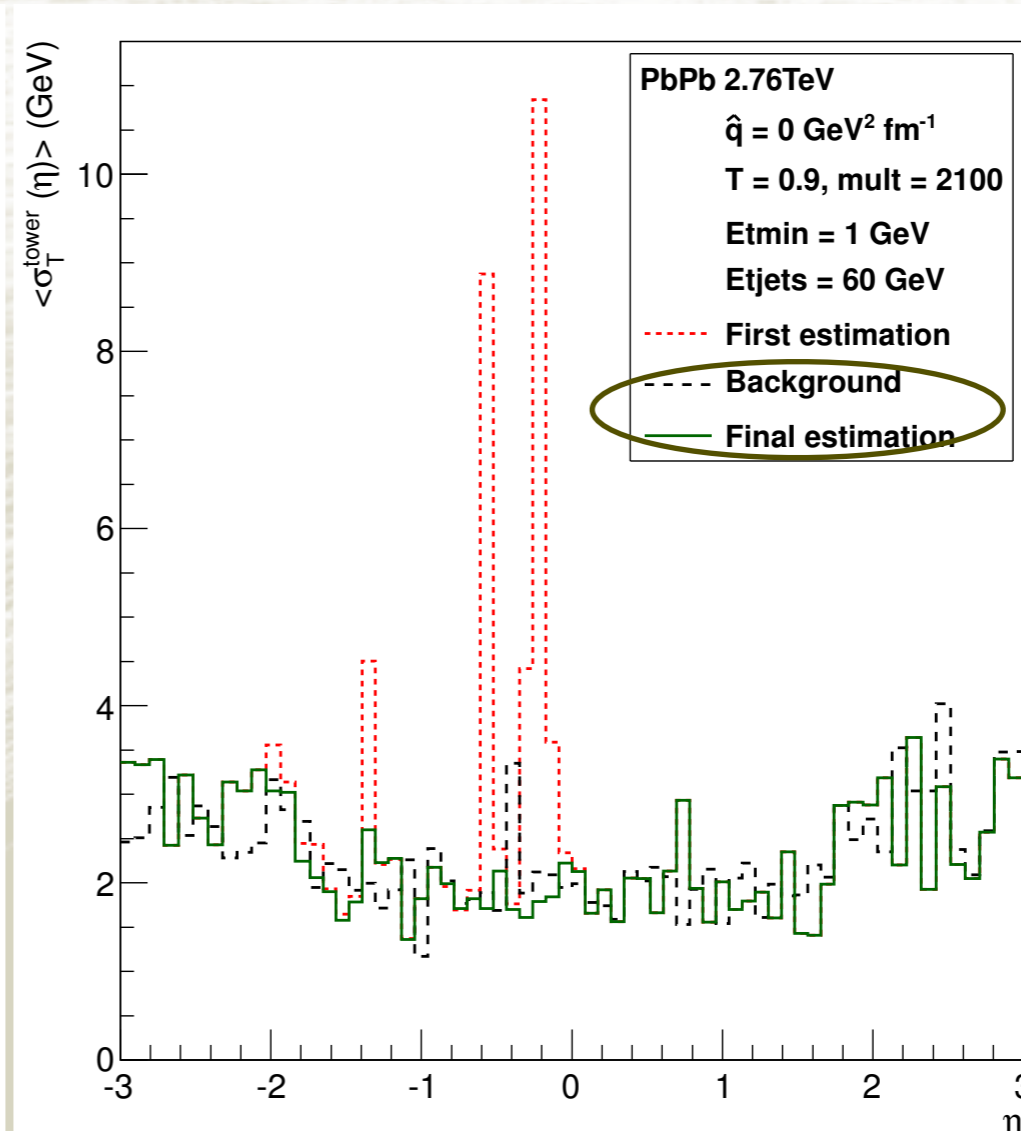
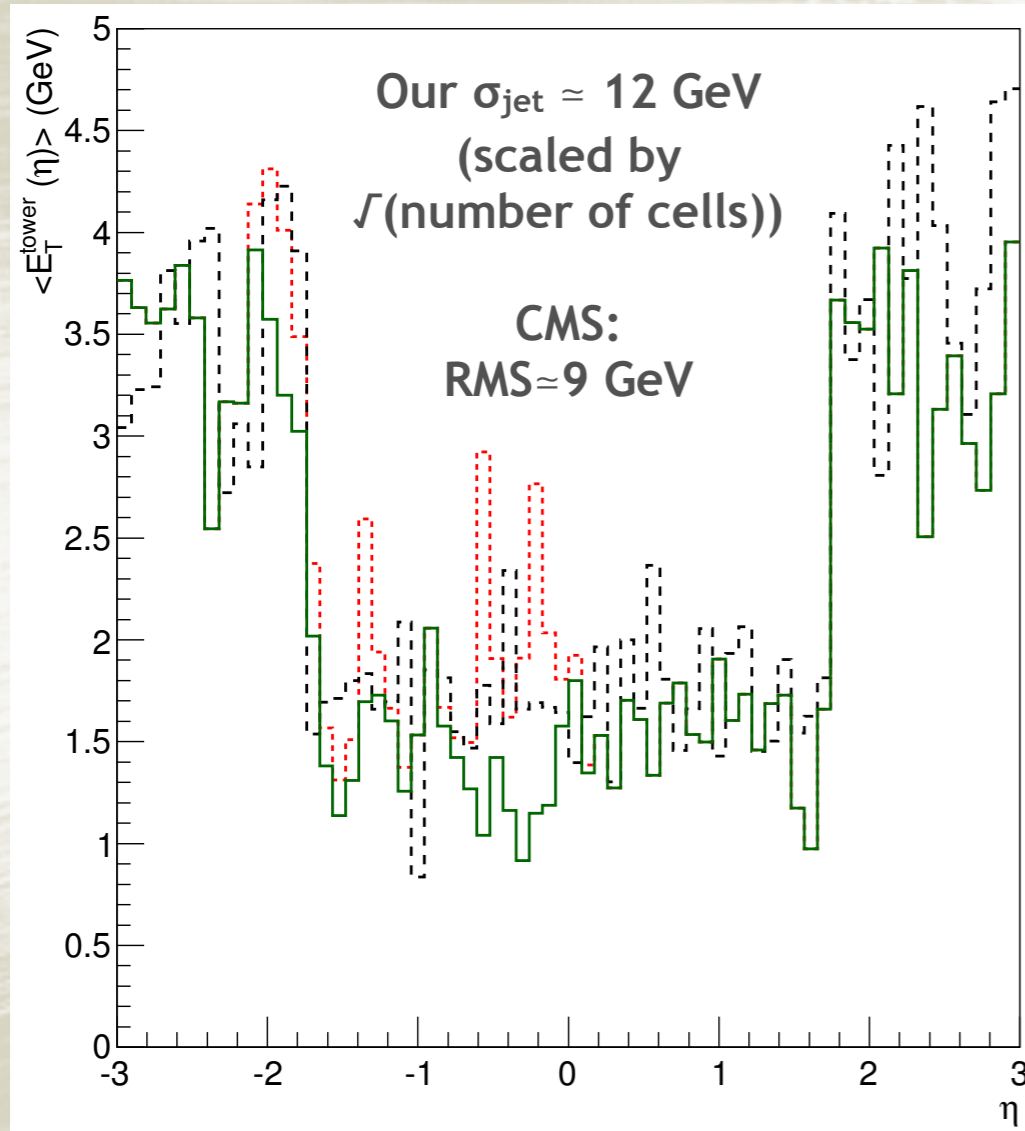
# Background Subtraction

- ◆ Fixing the parameters of the background subtraction technique:
  - ◆ Fixing  $\kappa = 1$  and find the best  $E_{T,jets}$  by estimating the background density and fluctuations:



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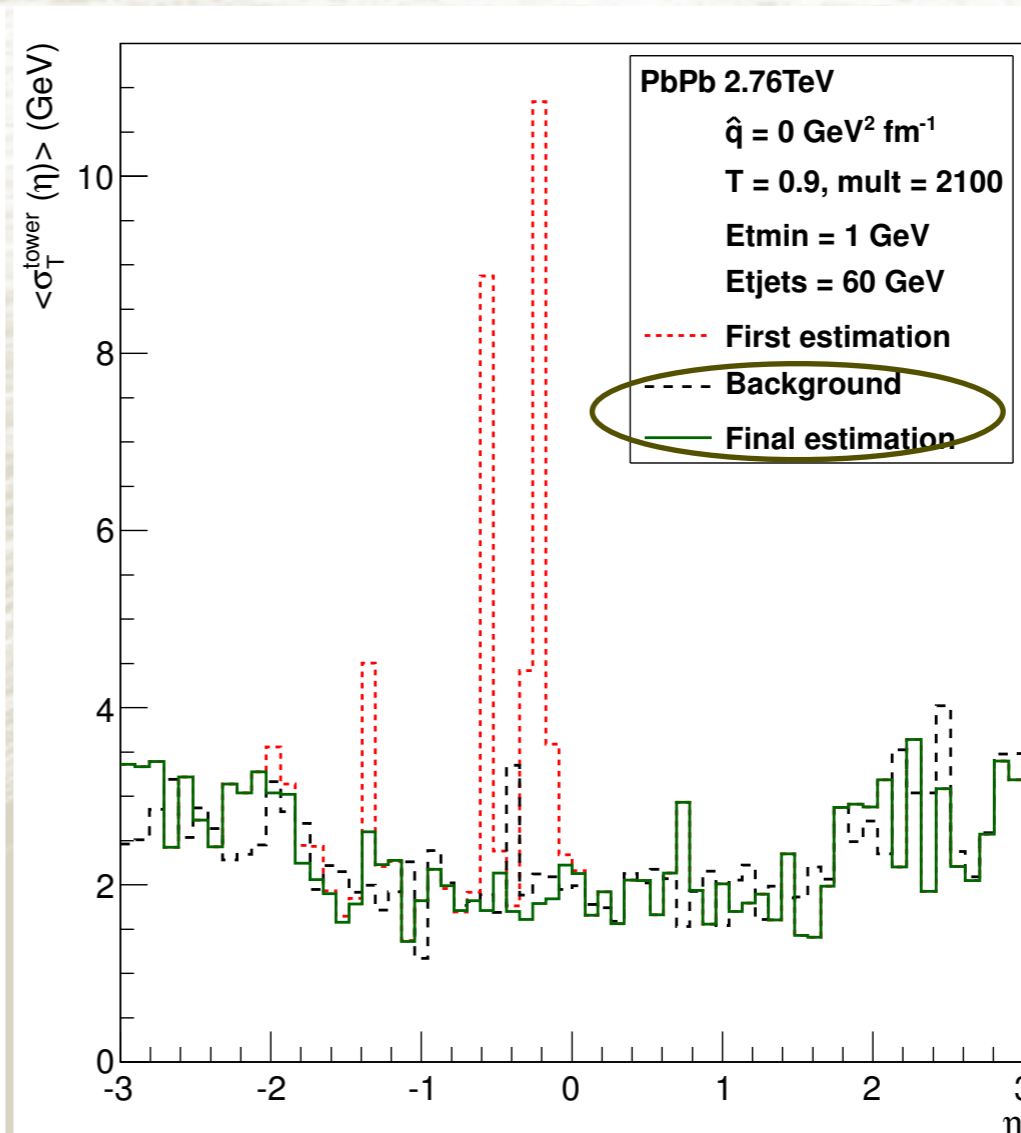
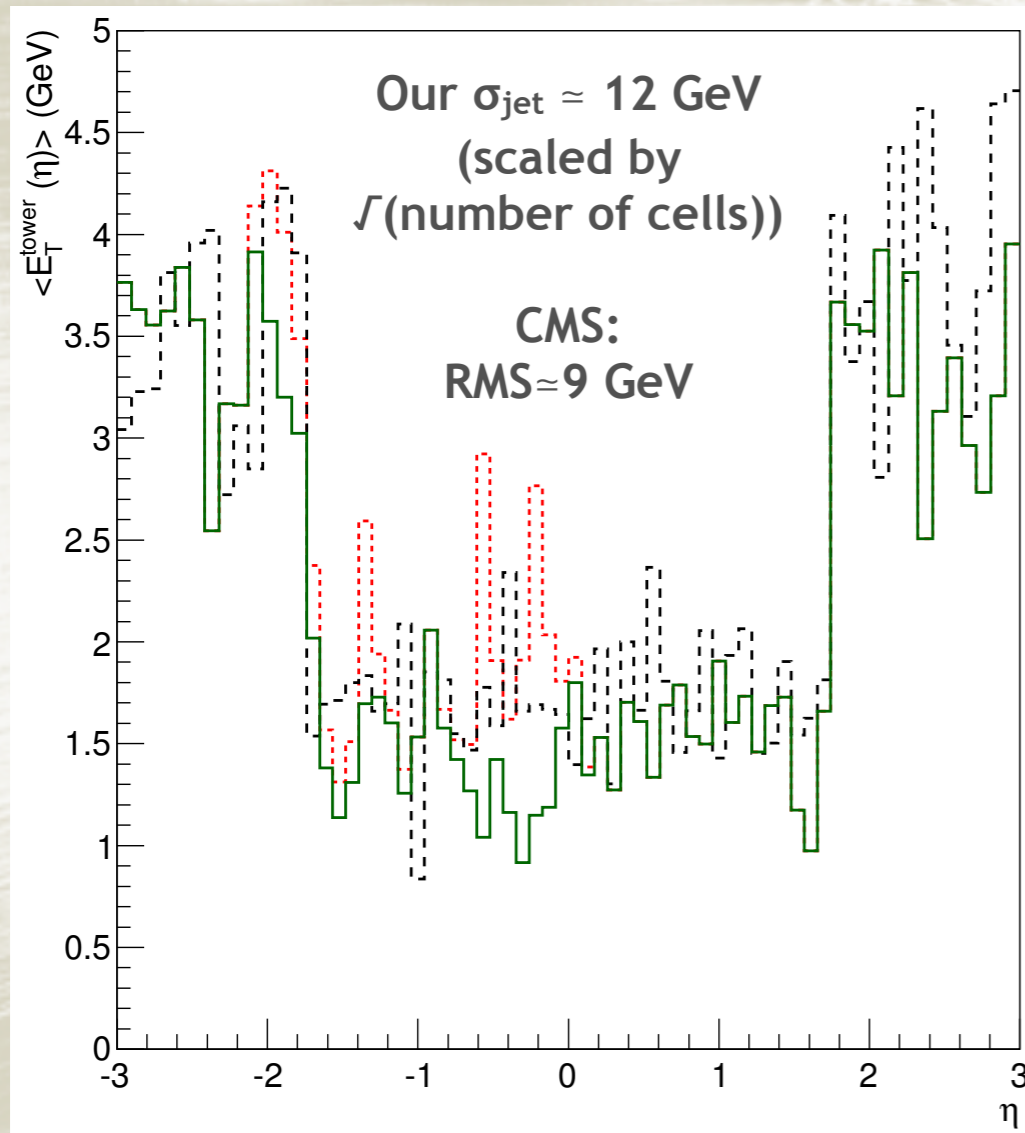
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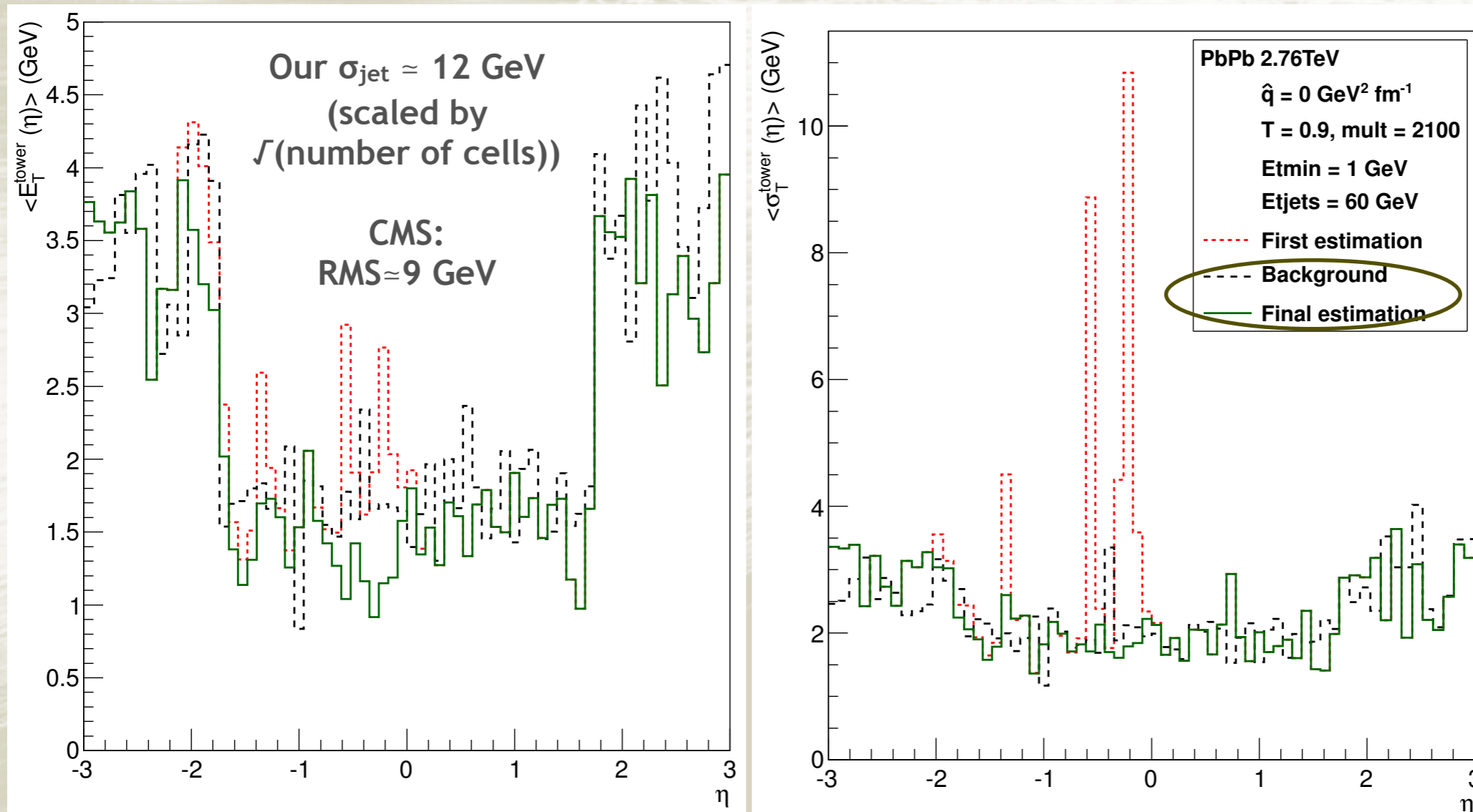


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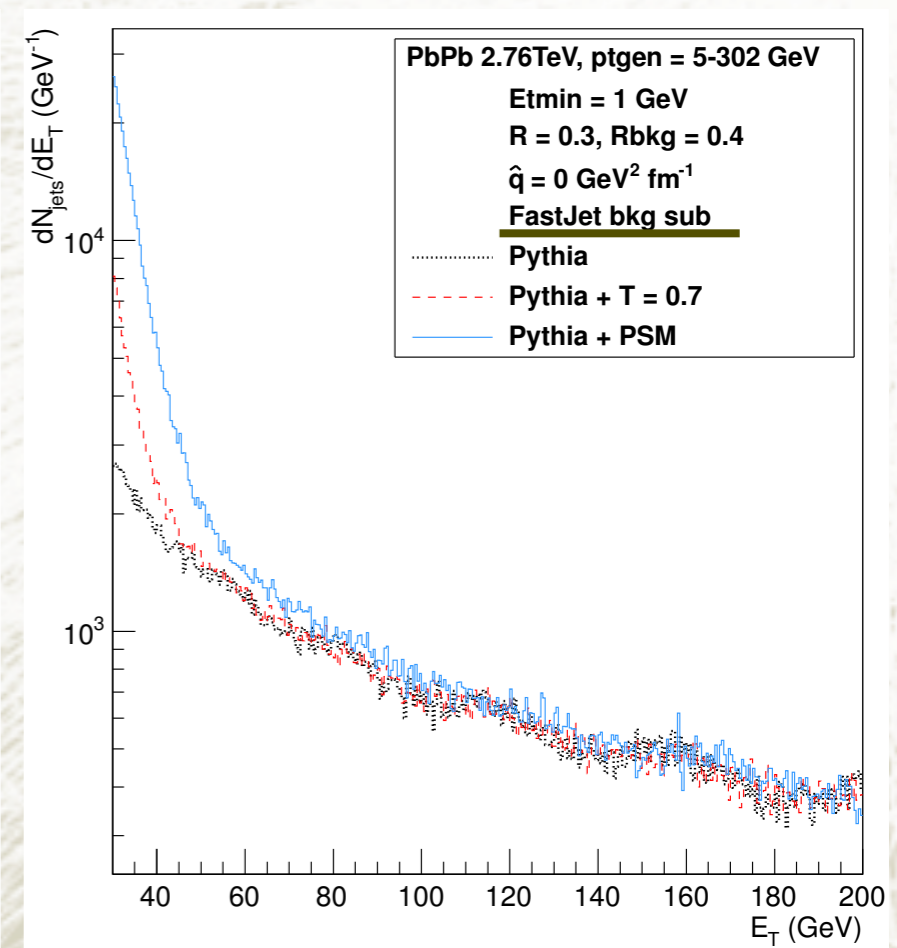
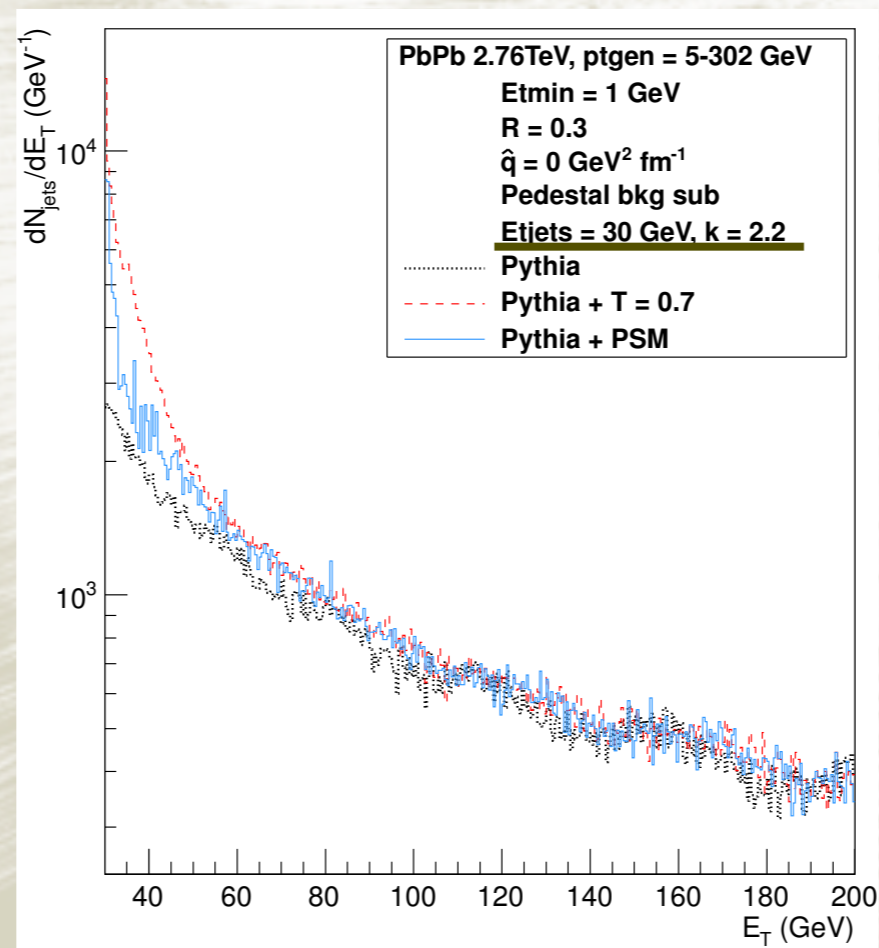
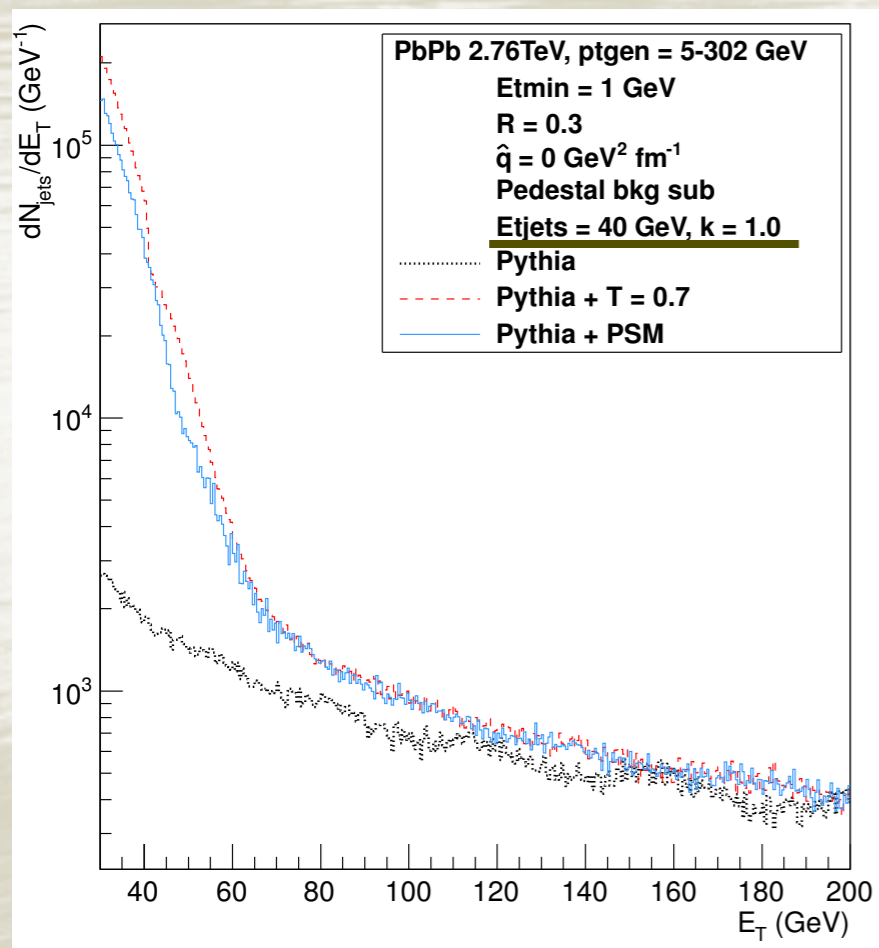
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- ◆ Problem: Bad reconstruction of the single-jet inclusive spectra...

# Background Subtraction

- ◆ Fixing the parameters of the background subtraction technique:
  - ◆ Fix  $E_{T,jets} = 30$  GeV (closer from CMS value), and find the best  $\kappa$  by constraining the single-jet inclusive spectra:

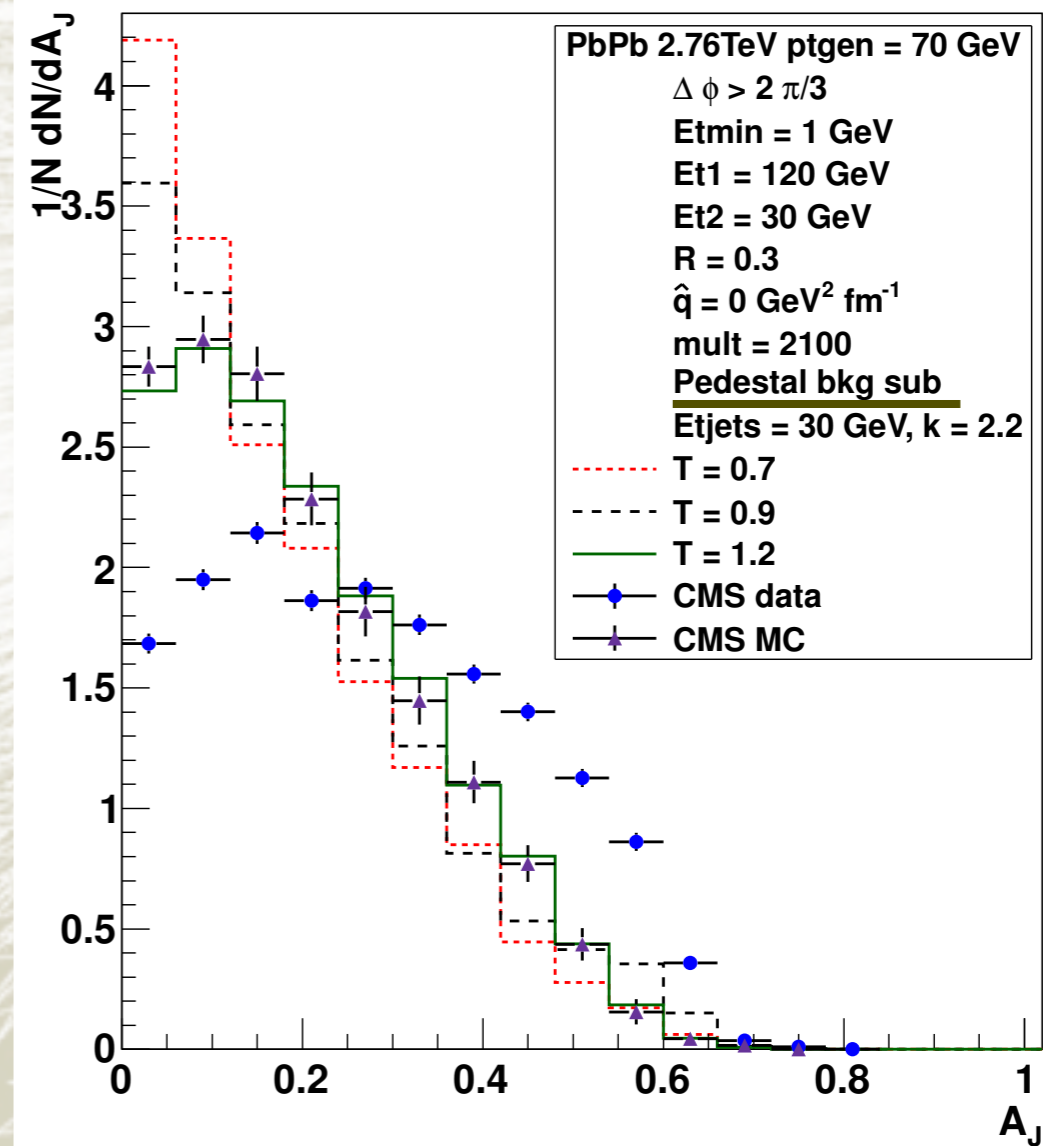
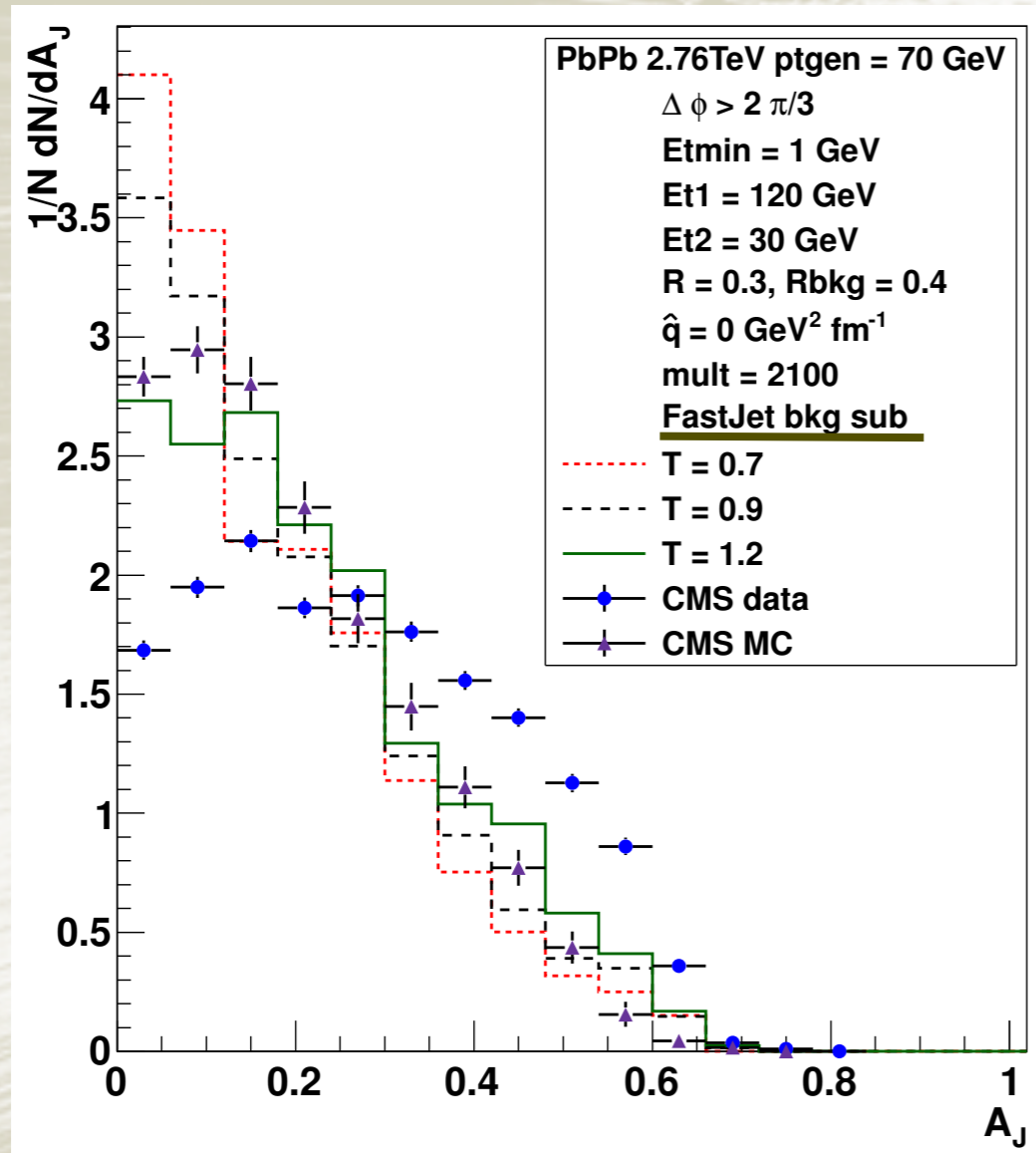


Pedestal and FastJet subtraction with similar results, depending on the parameters...  
 PSM vs. T = 0.7 GeV: Identical  $\sigma$  but different  $\rho$  → Differences in the soft part of the jet spectra.



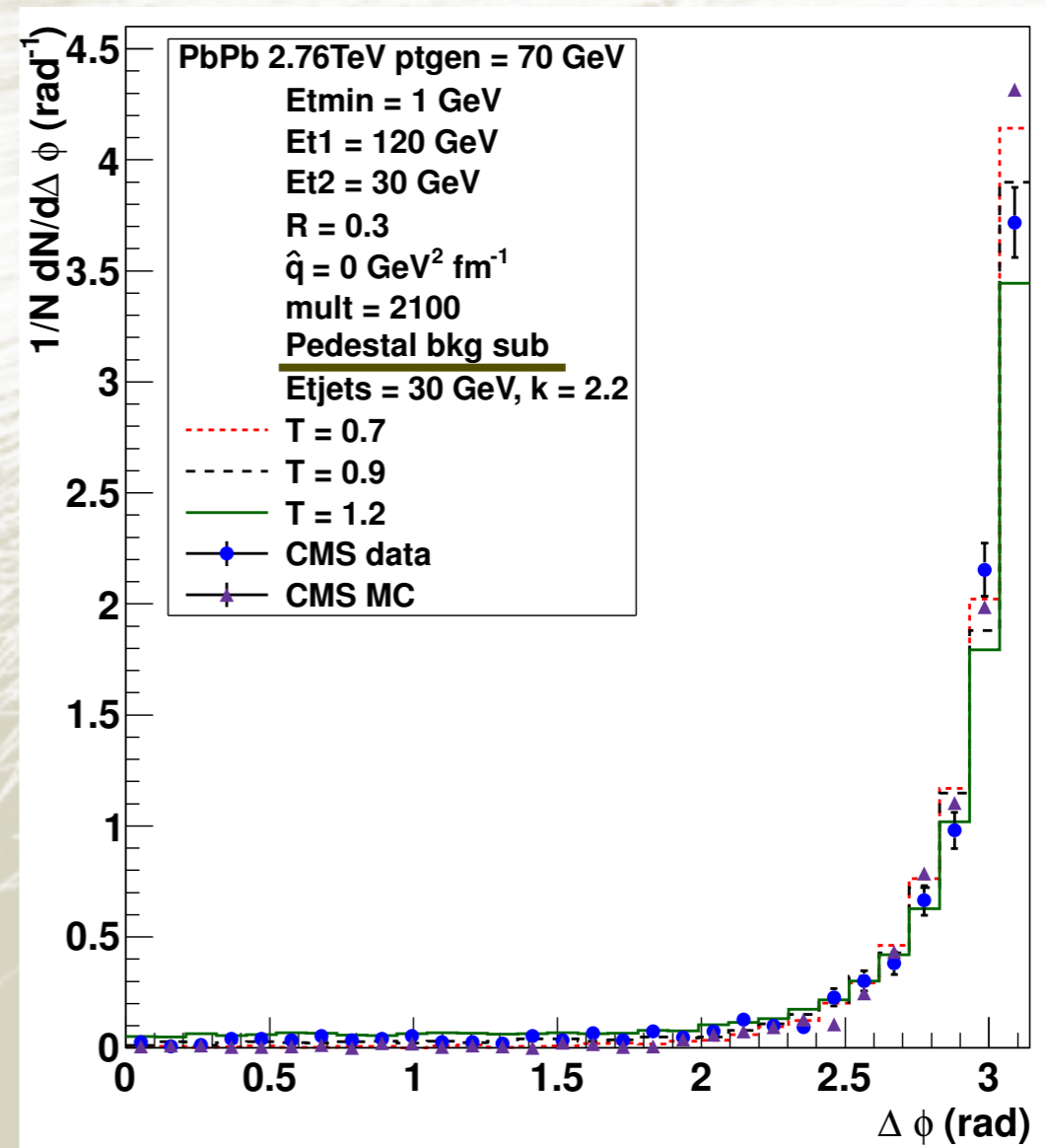
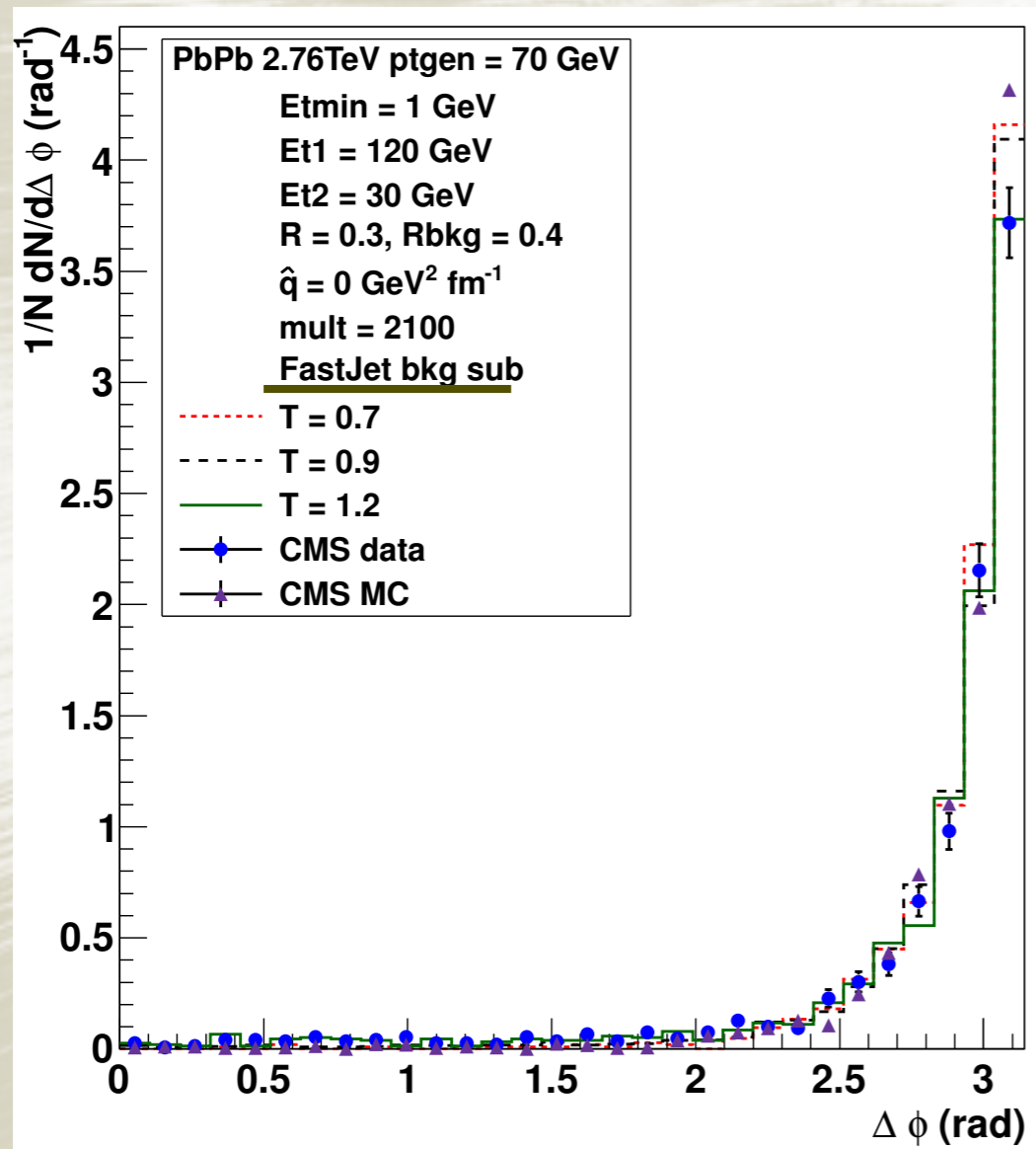
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# Bkg & Bkg Subtraction

- ◆ Similar results on the dijet asymmetry...
- ◆ ...but some differences in the dijet azimuthal correlation with increasing fluctuations:



## ◆ Thermal model:

◆ Azimuth particle distribution modulation:  $\frac{dN}{d\phi} \propto 1 + \sum_n v_n(p_T) \cos(n\phi)$

◆ Integrated  $p_T$  values (peripheral collisions):  $v_2(p_T) = \langle v_2 \rangle = 0.1$  and  $v_3(p_T) = \langle v_3 \rangle = 0.03$

◆ Effective values of  $\sigma_{\text{jet}}$  (GeV):

Temperature (GeV)	$v_2 = 0.0, v_3 = 0.0$	$v_2 = 0.1, v_3 = 0.0$	$v_2 = 0.1, v_3 = 0.03$
$T = 0.7$	7.69	9.16	9.26
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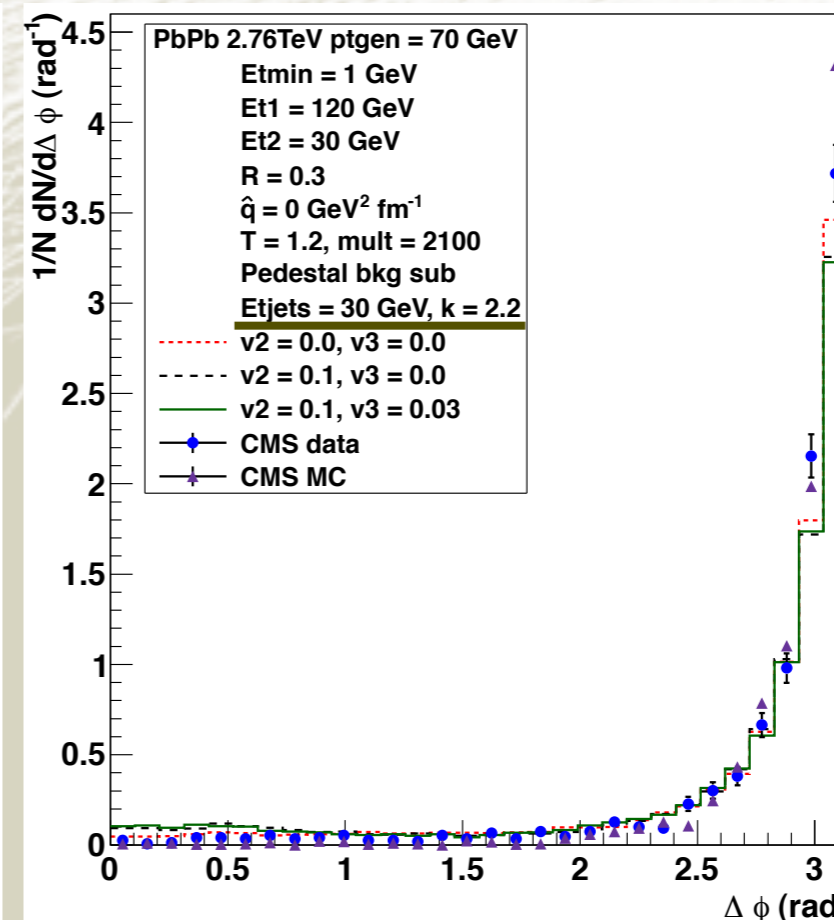
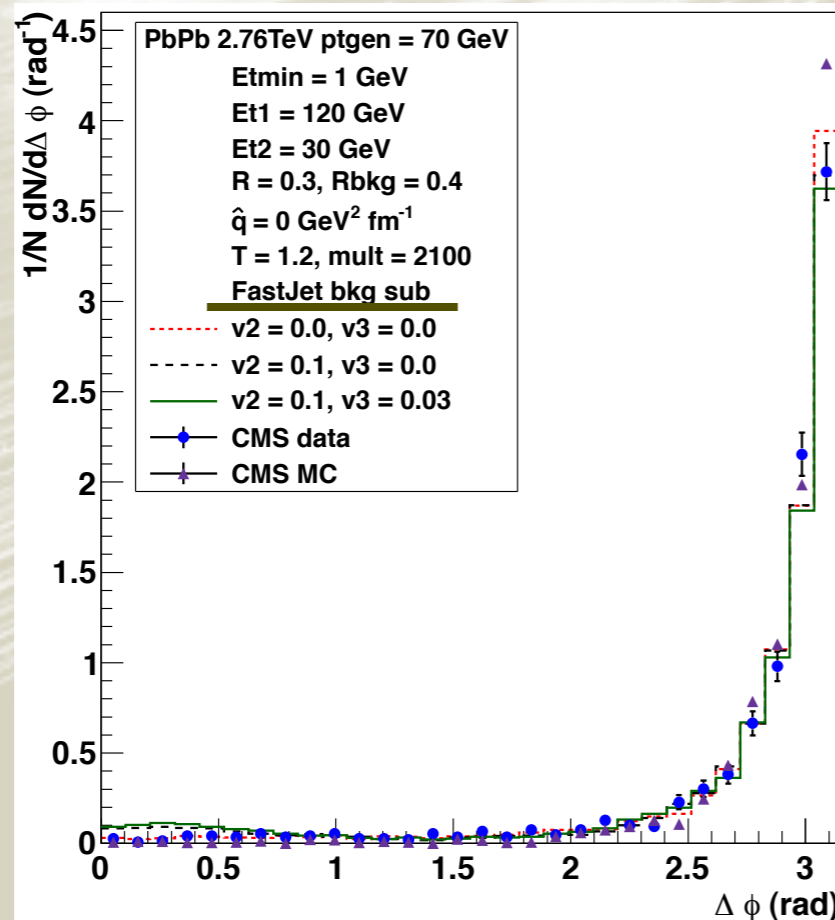
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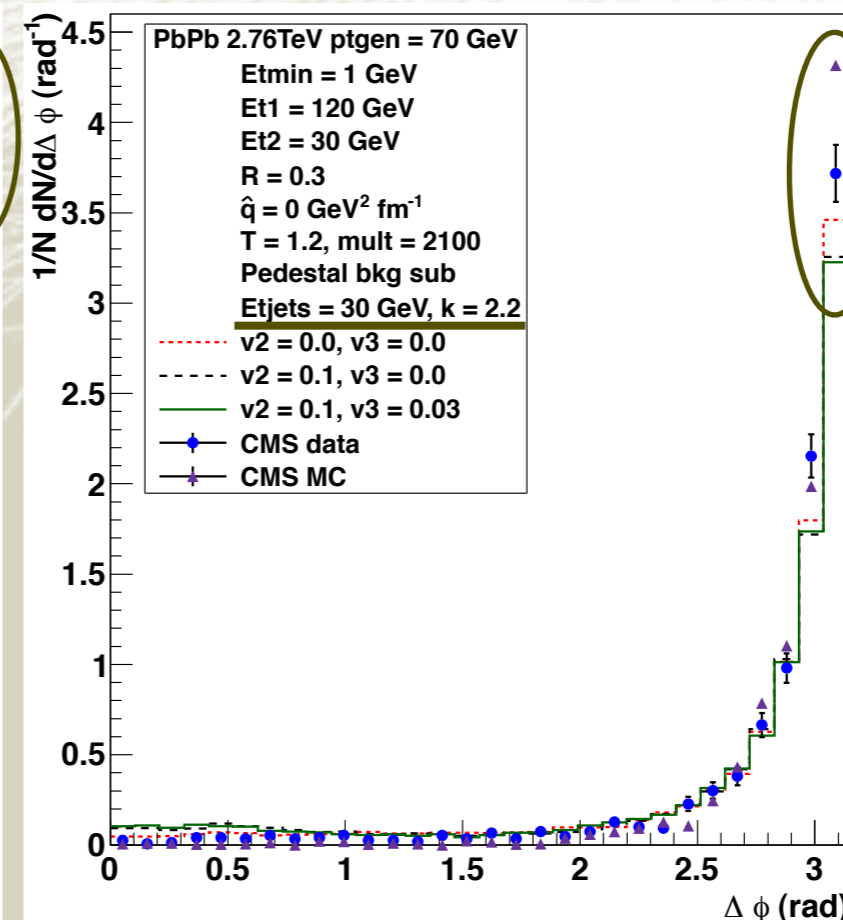
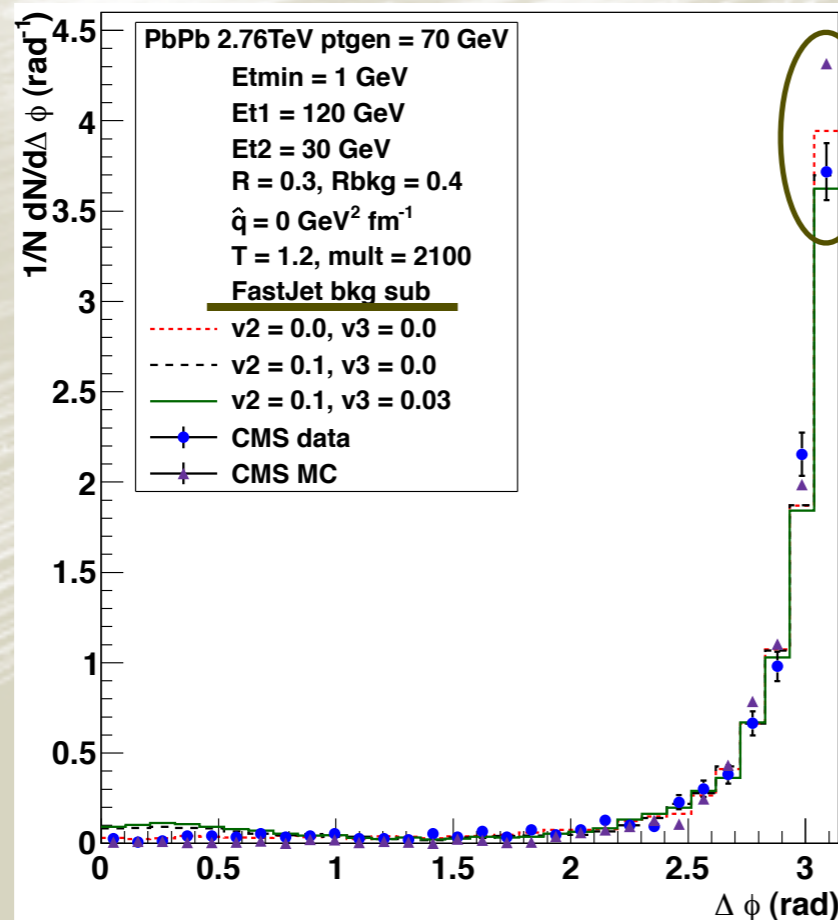
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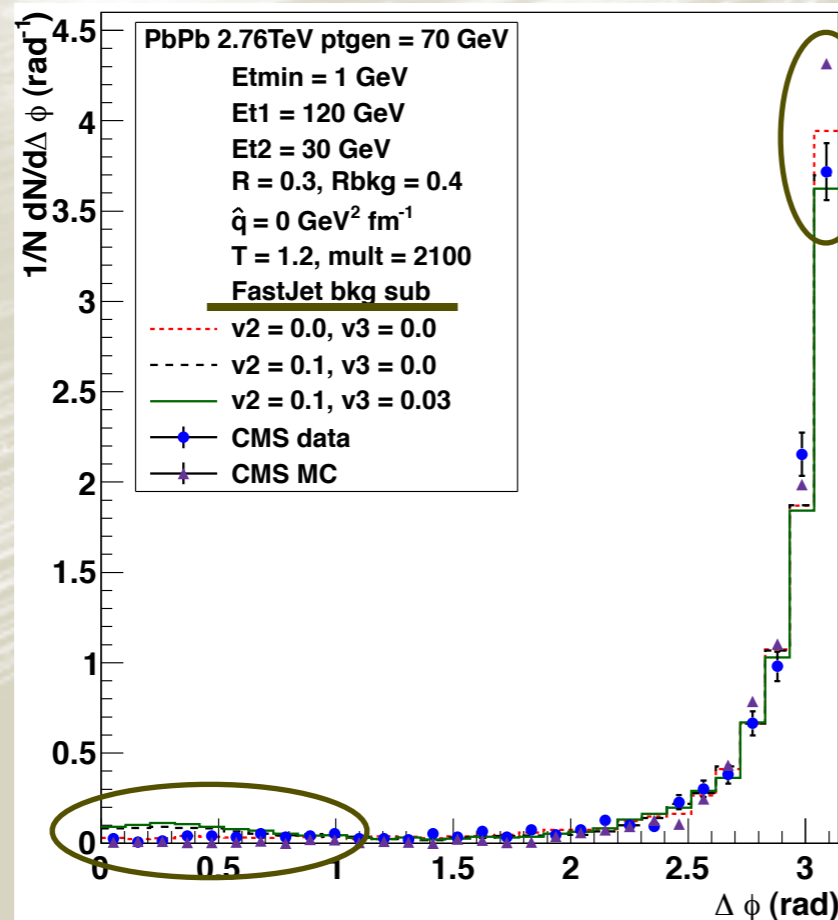
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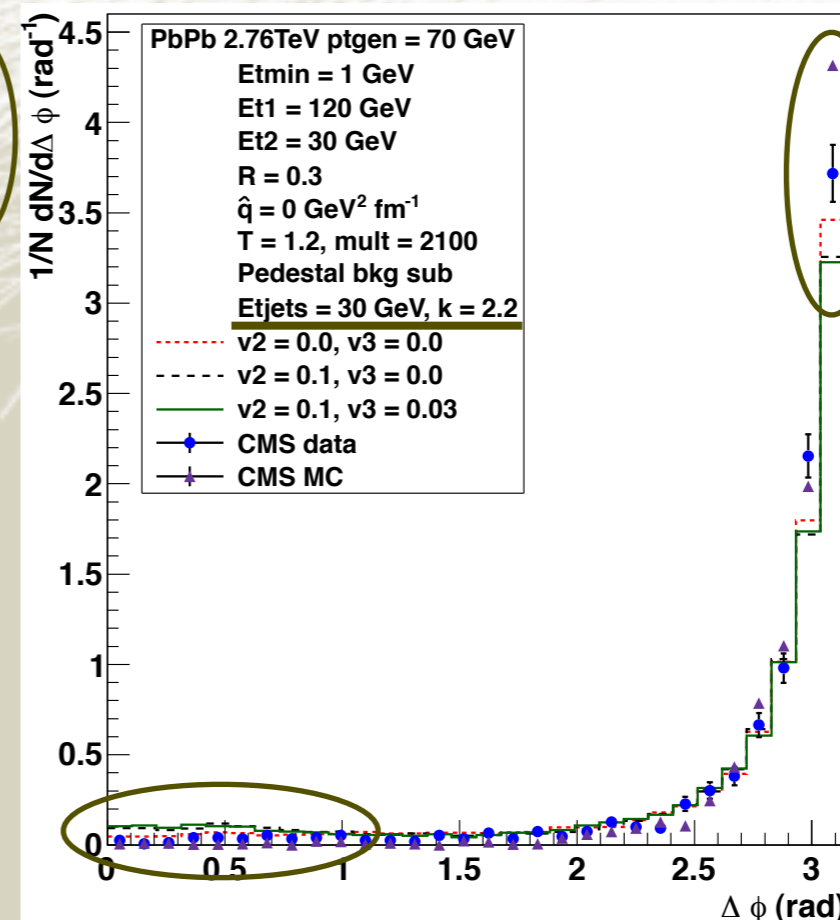
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Bump near  $\Delta\phi \sim 0$



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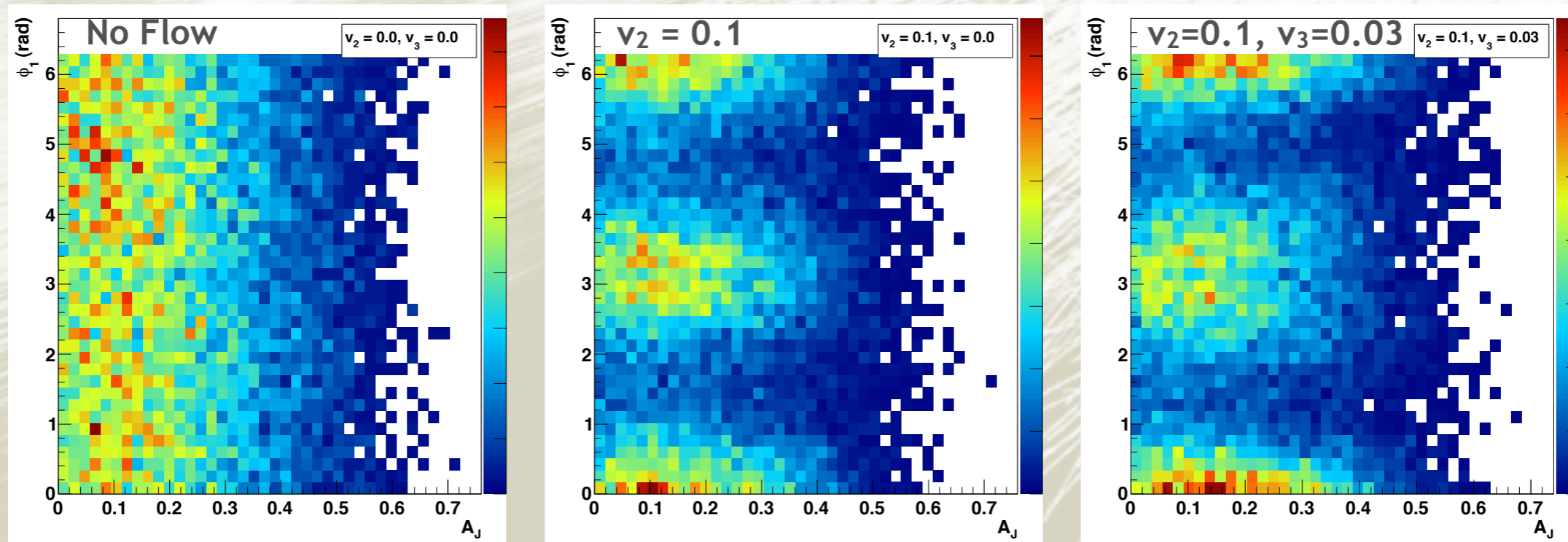
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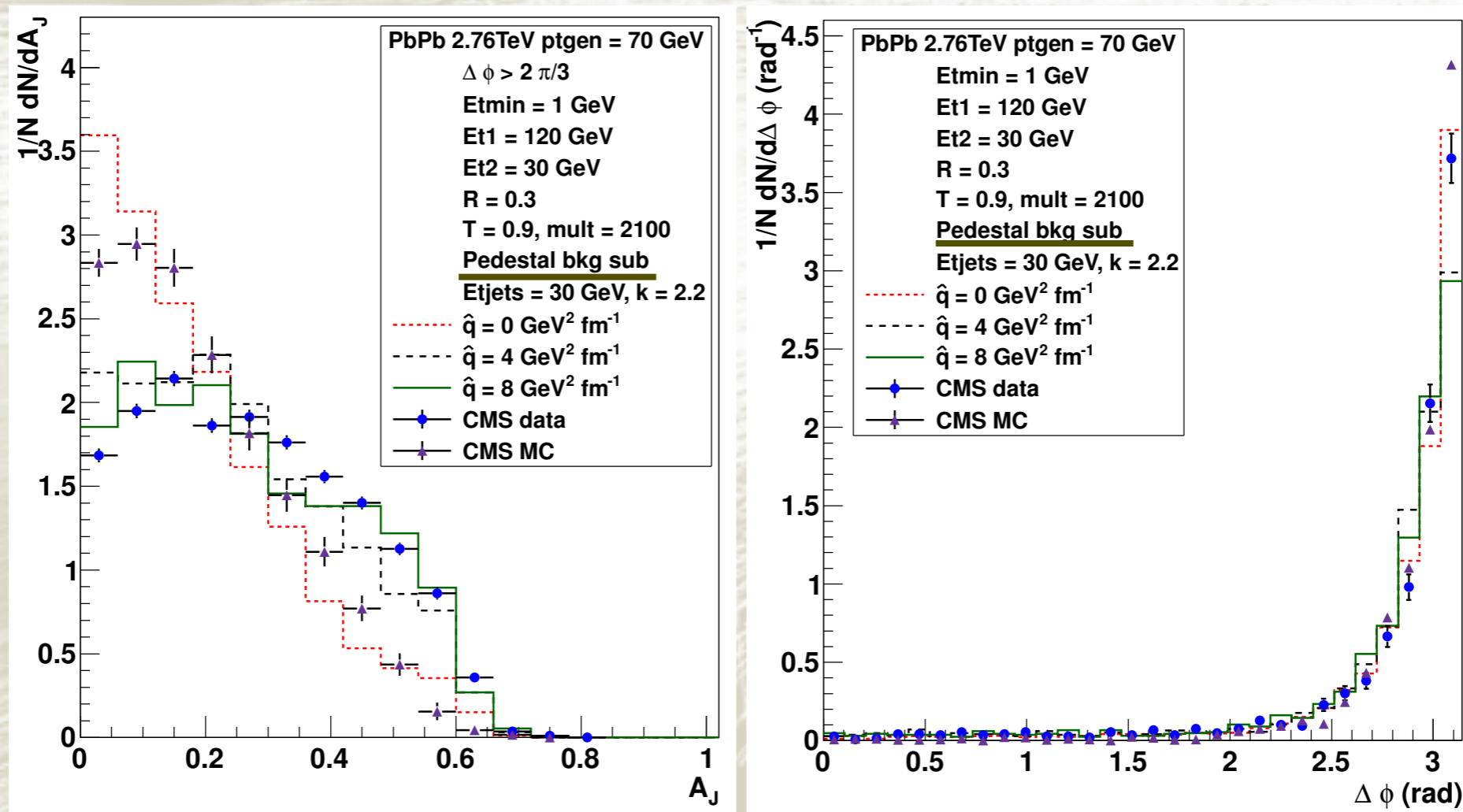


**Strong correlation between  $A_J$  and  $\Phi_{1,2}$ !**



# Jet Quenching

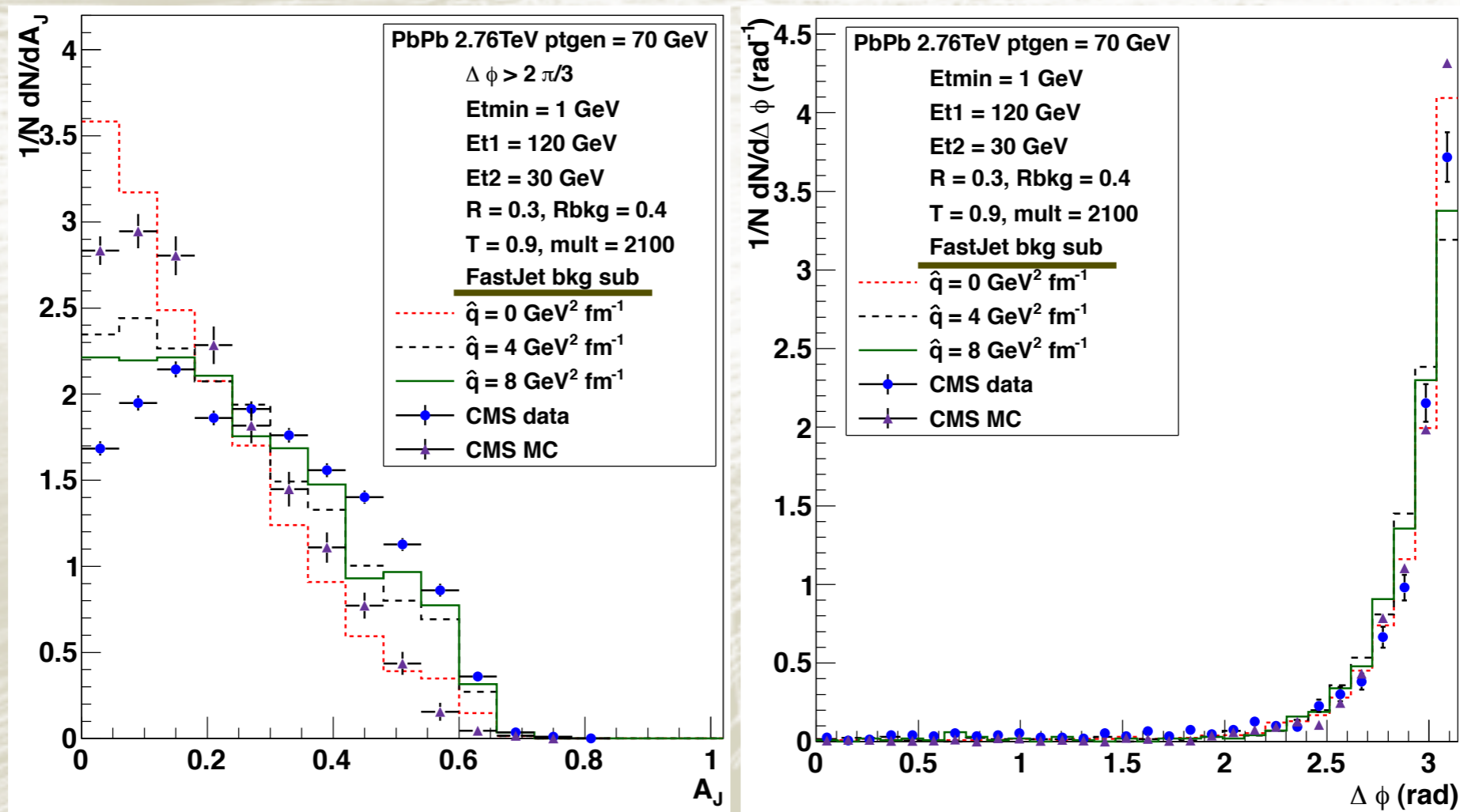
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Not a perfect description of data, but go in the same direction

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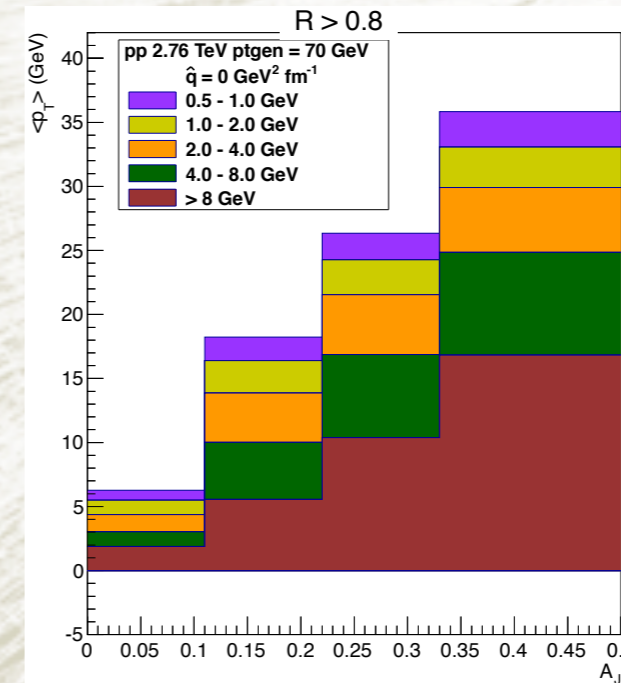
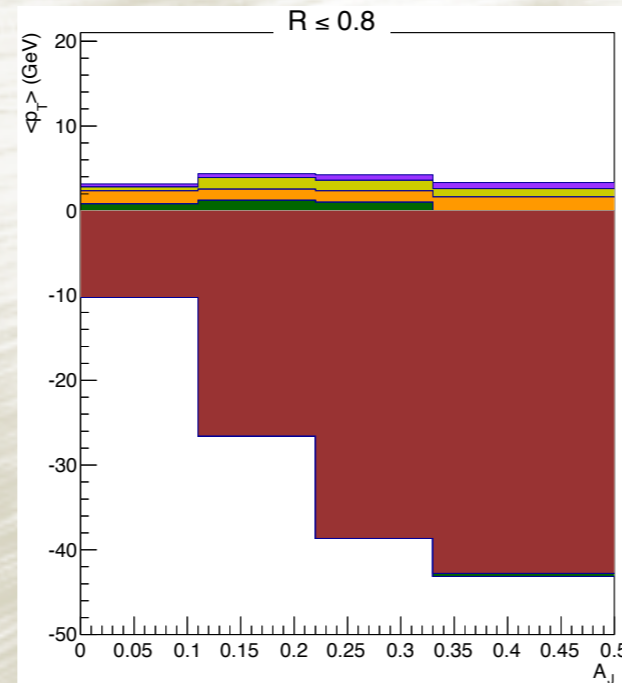
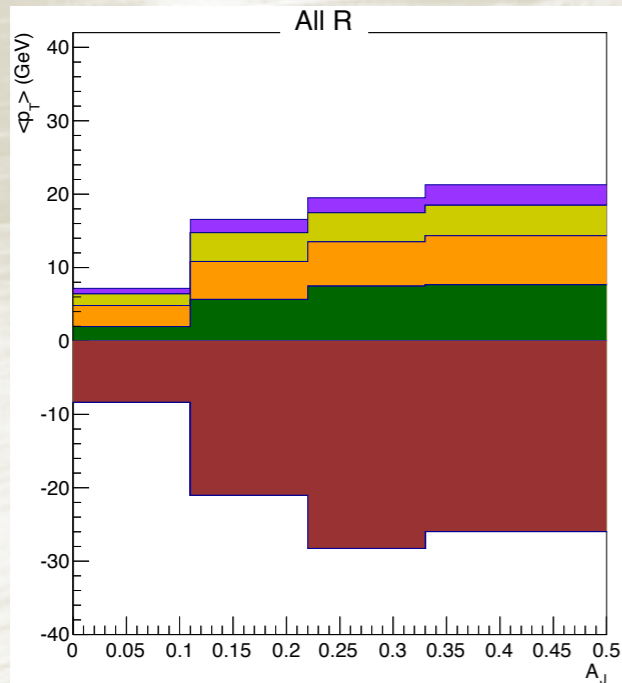
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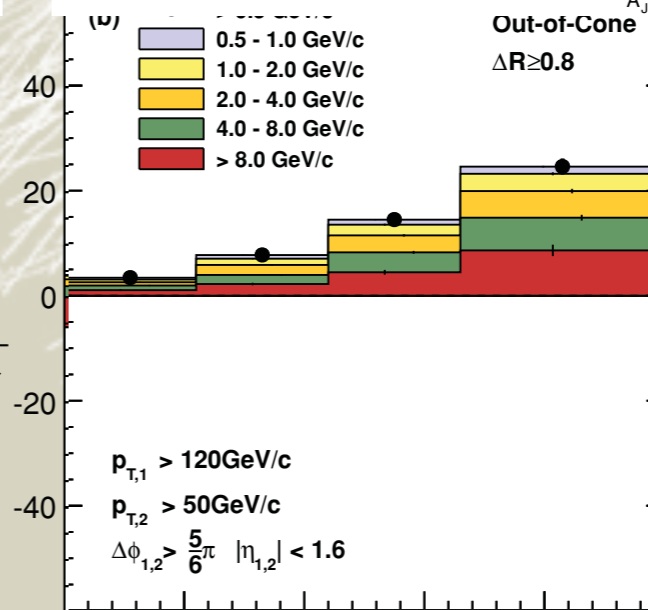
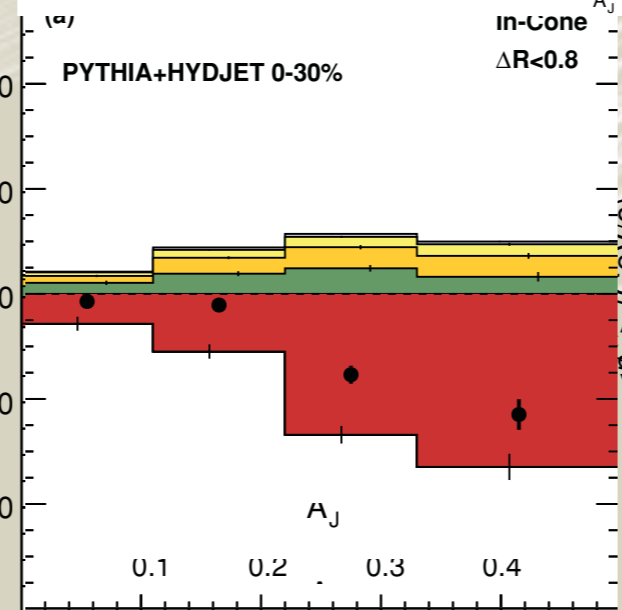
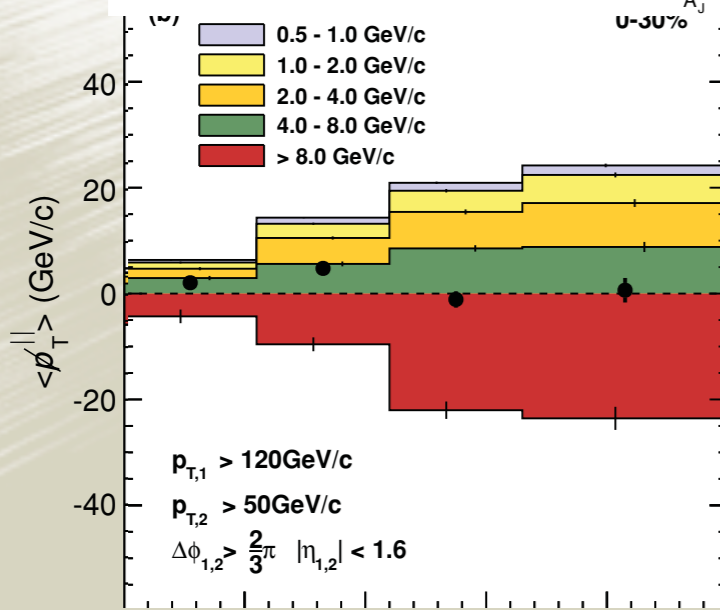
Suggestive of large angle transportation of soft particles

◆ Q-PYTHIA events without background:

qhat = 0 GeV<sup>2</sup>/fm



CMS MC



In qualitative agreement with CMS Monte Carlo!

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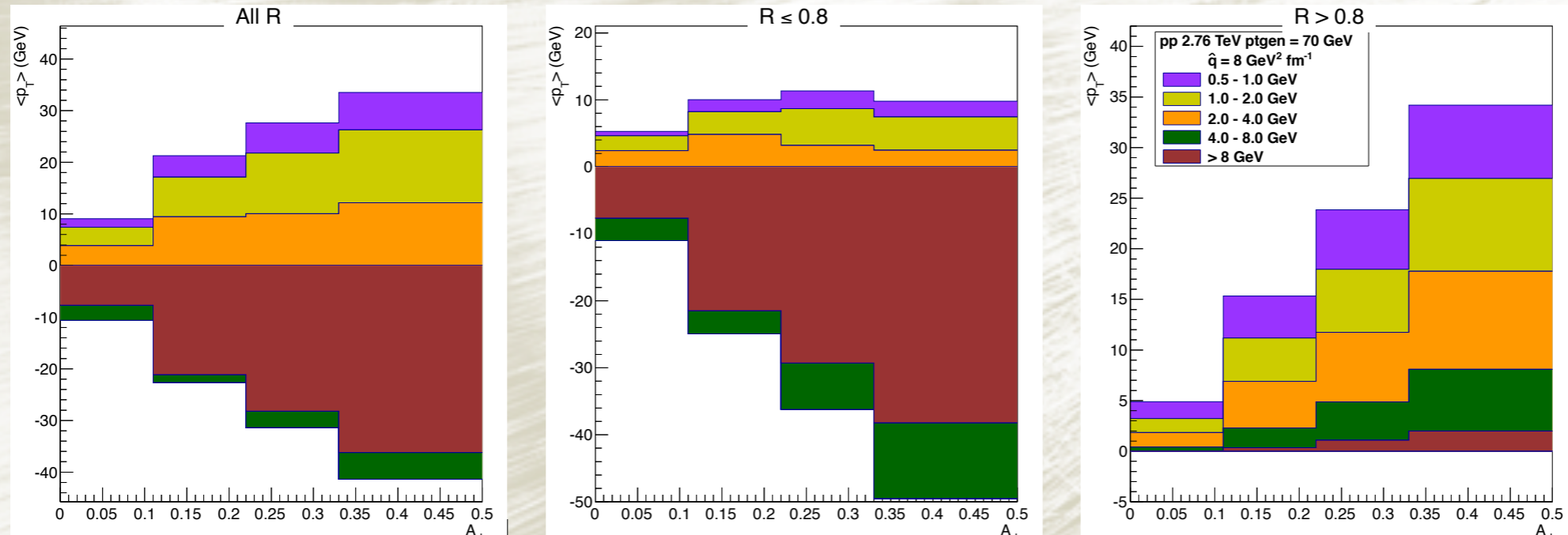
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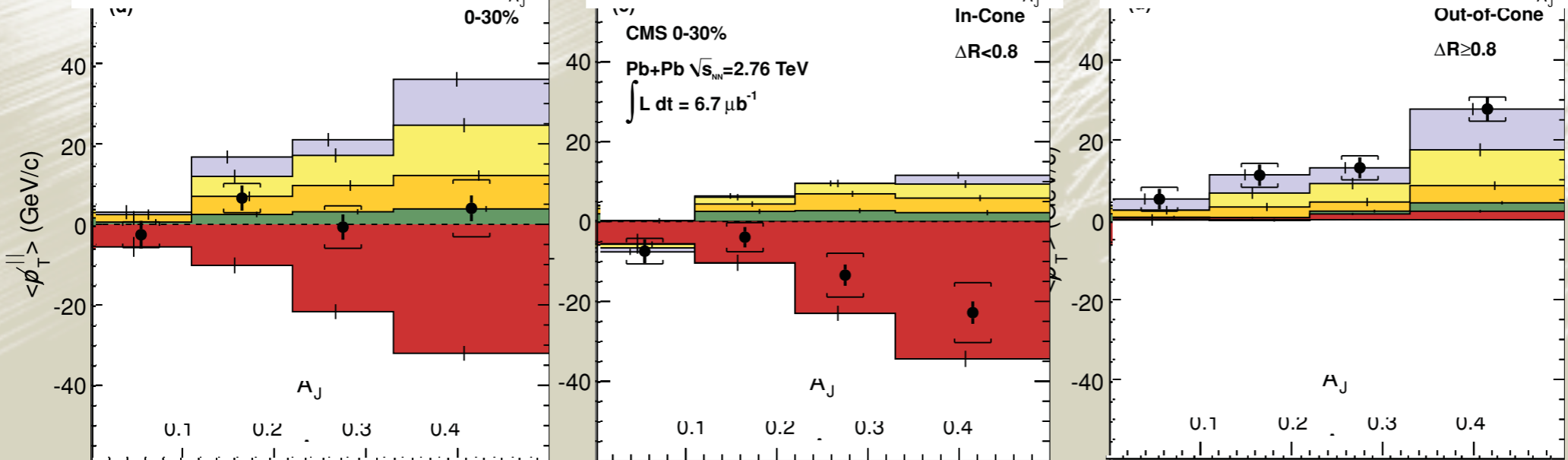
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qhat = 8 GeV<sup>2</sup>/fm



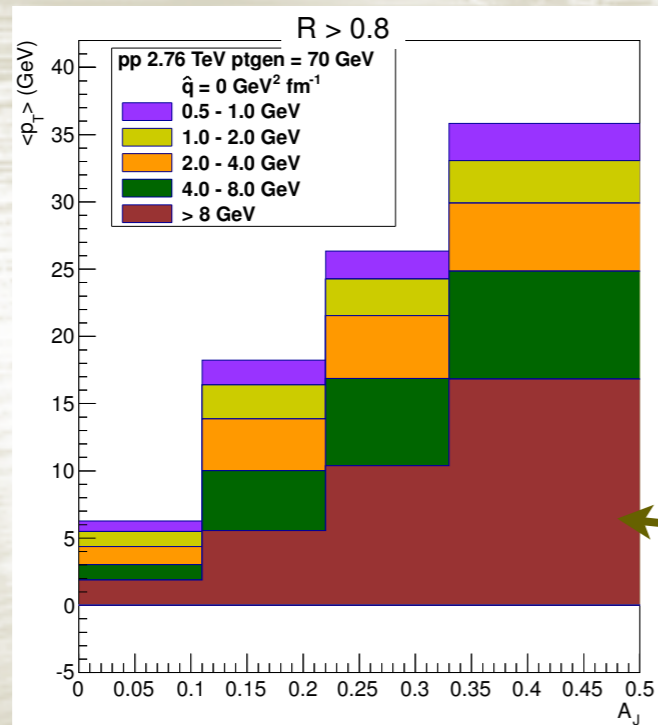
CMS Data



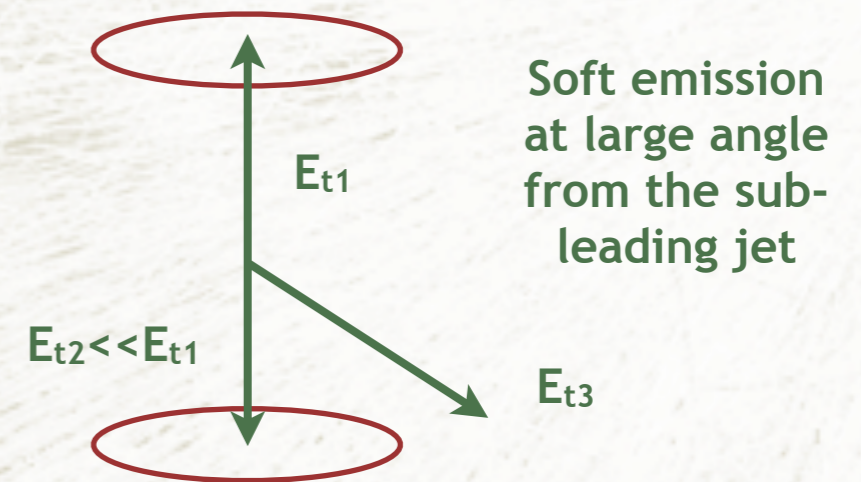
In qualitative agreement with CMS data! (considering no background)

# Jet Quenching

- ◆ Effect on average missing transverse momentum  $\langle p_T^{\parallel} \rangle$ :
- ◆ Considering events with large asymmetry ( $A_J > 0.3$ ):



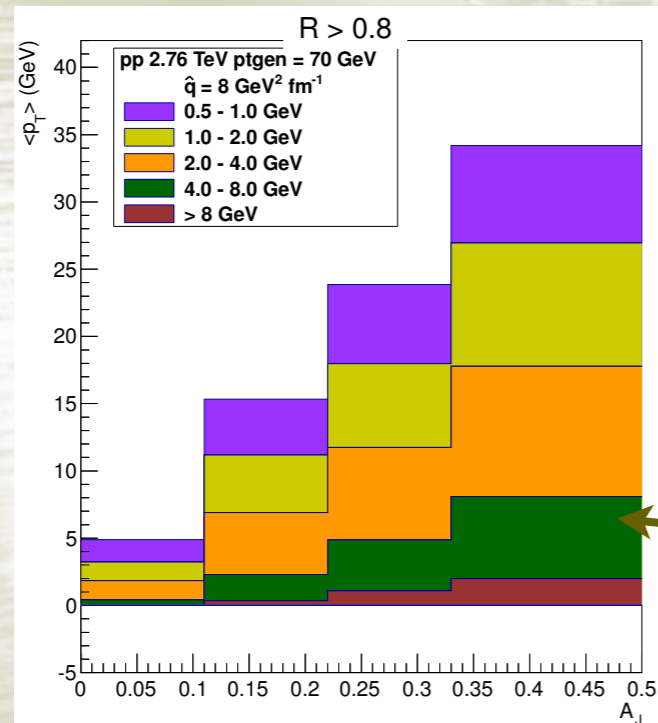
Hard structure already in pp events



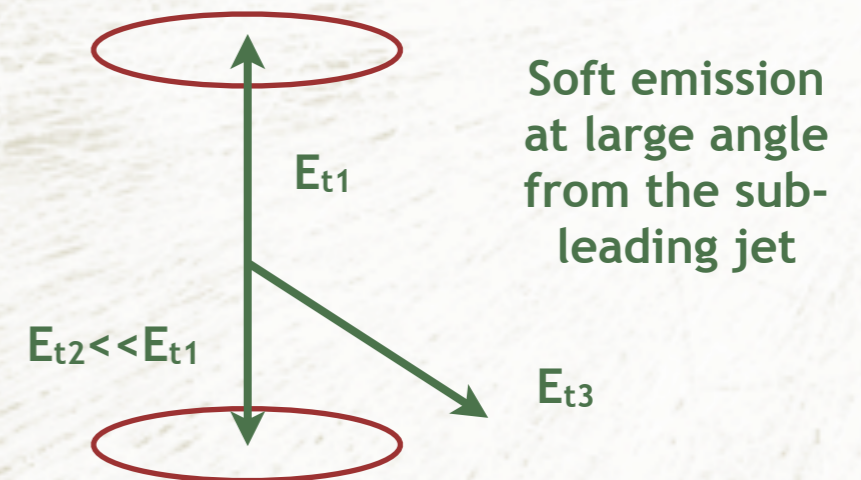


# Jet Quenching

- ◆ Effect on average missing transverse momentum  $\langle p_T^{\parallel} \rangle$ :
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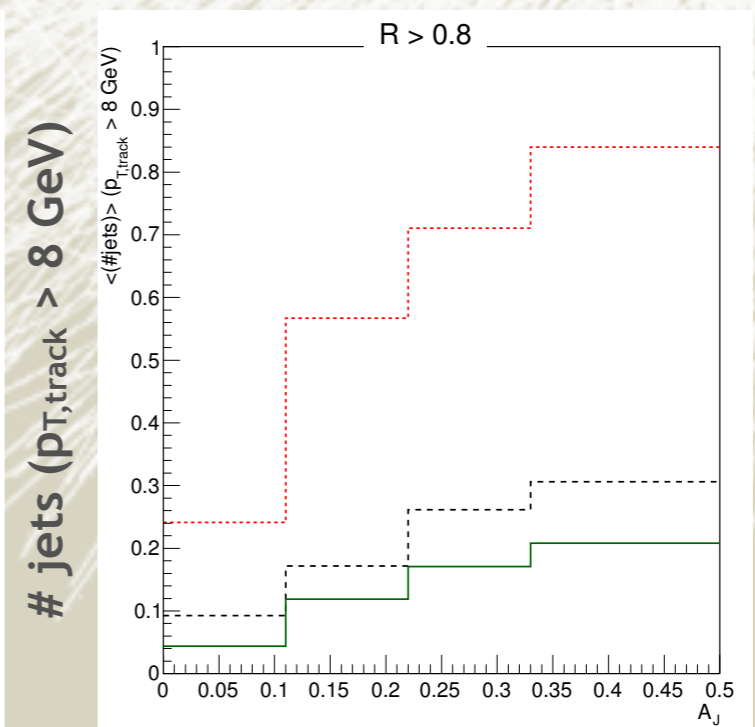
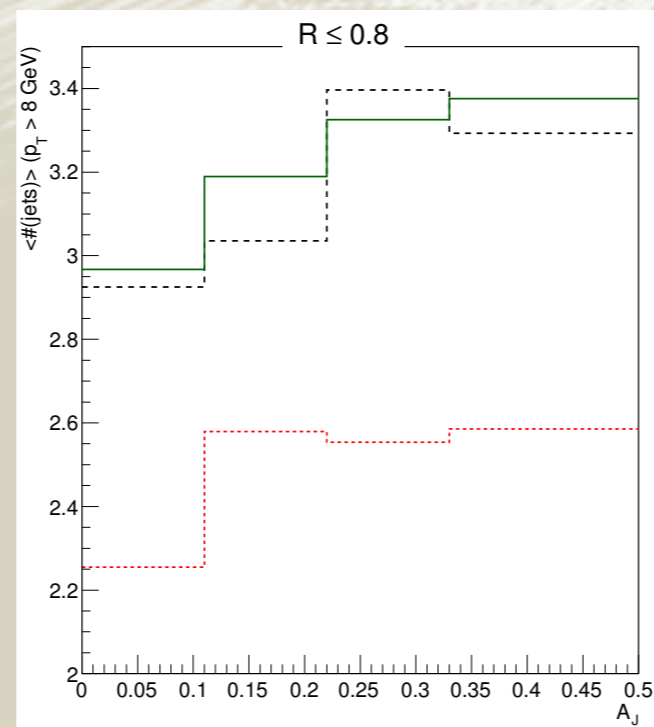
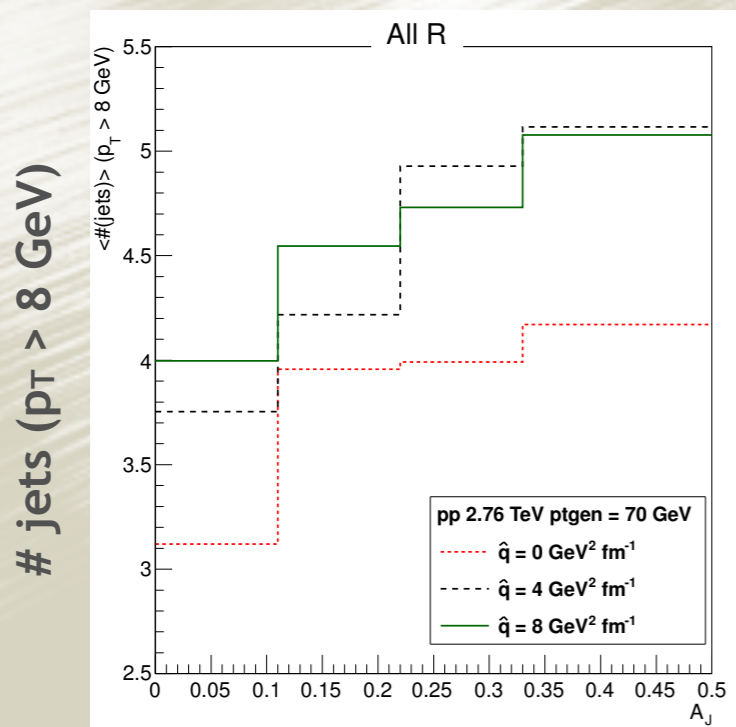
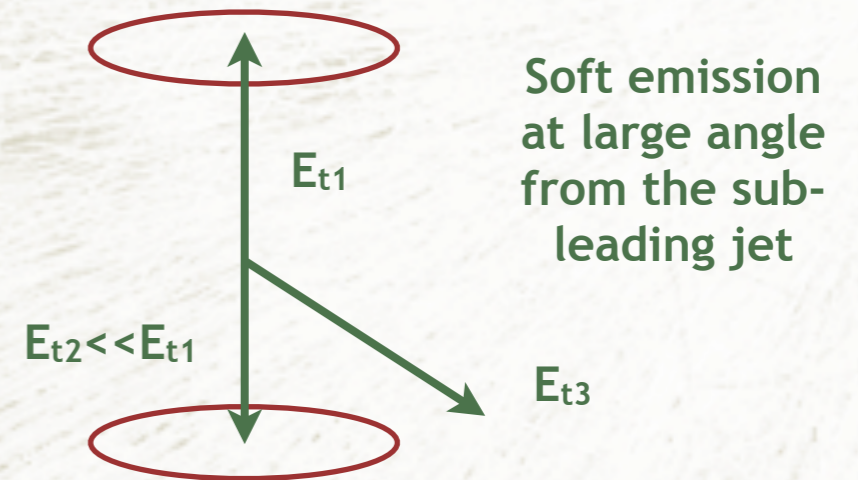
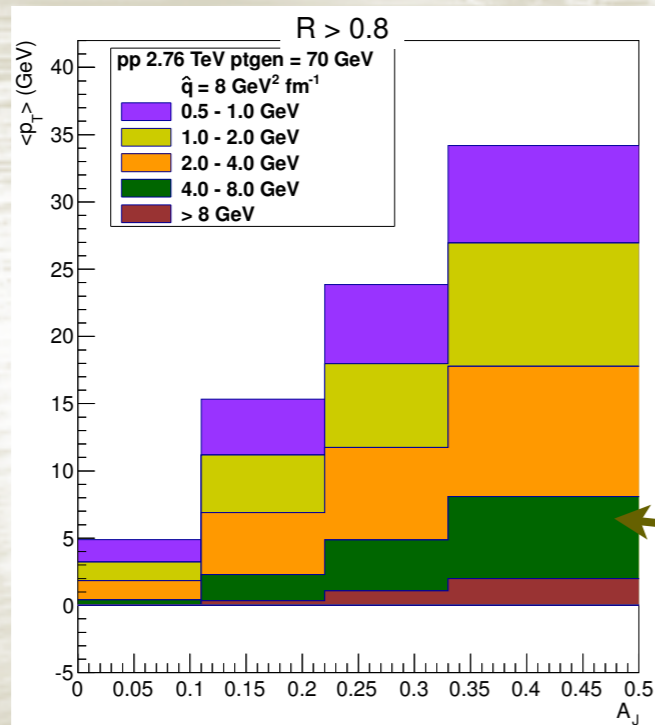


Quenching effect



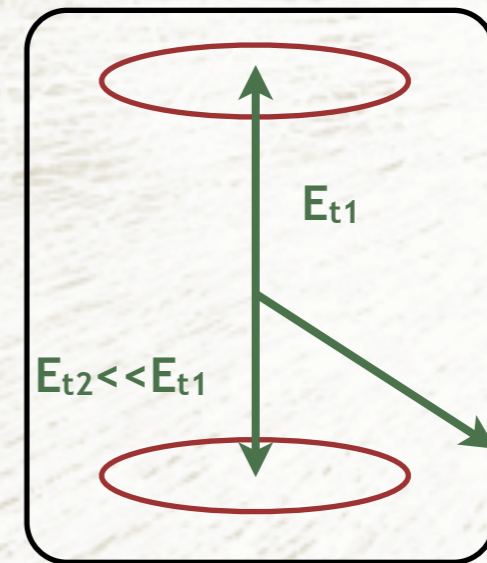
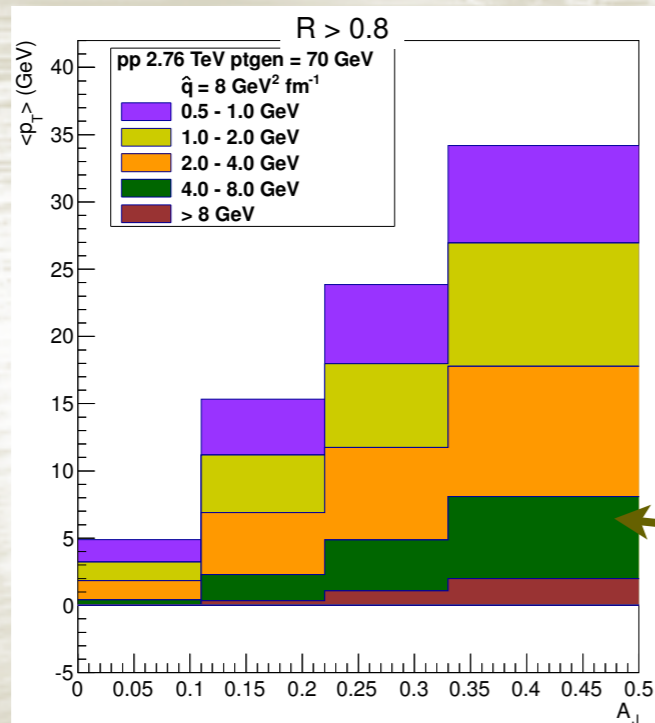
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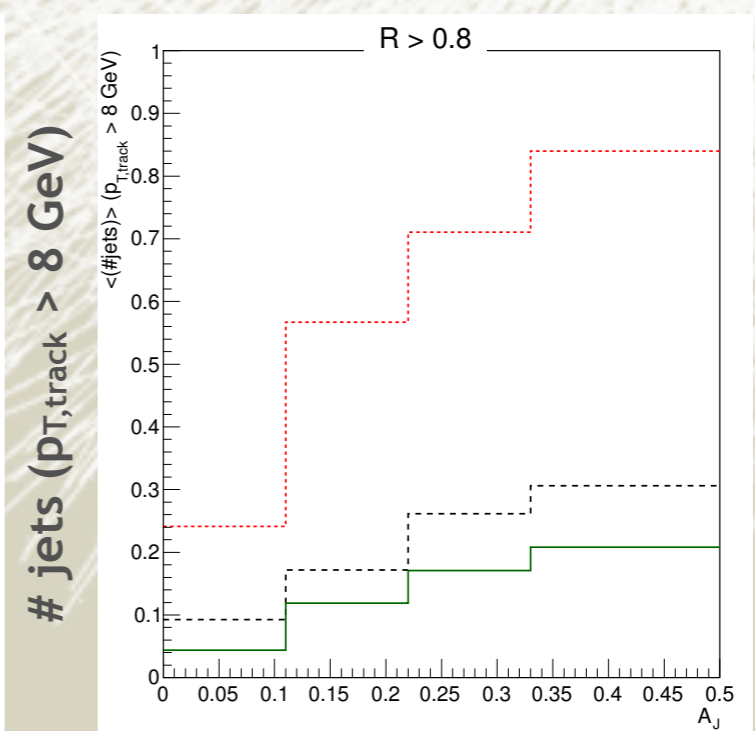
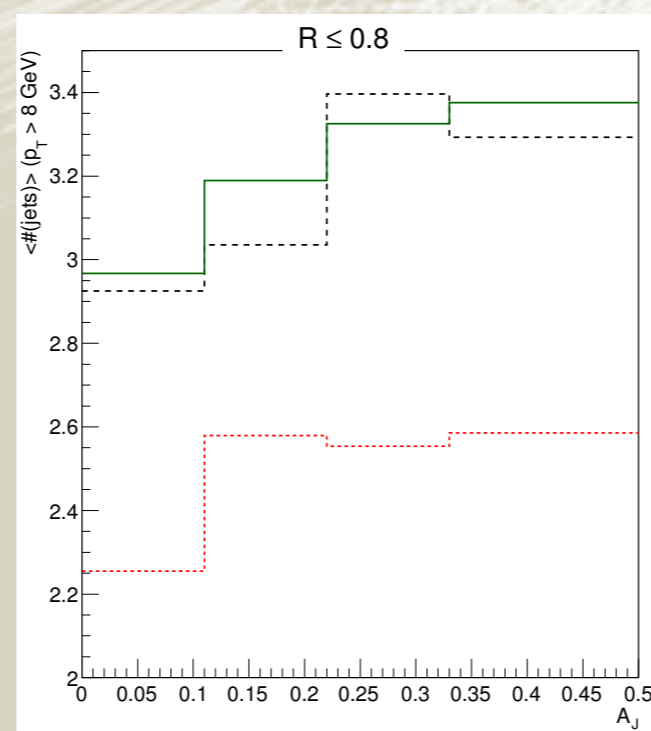
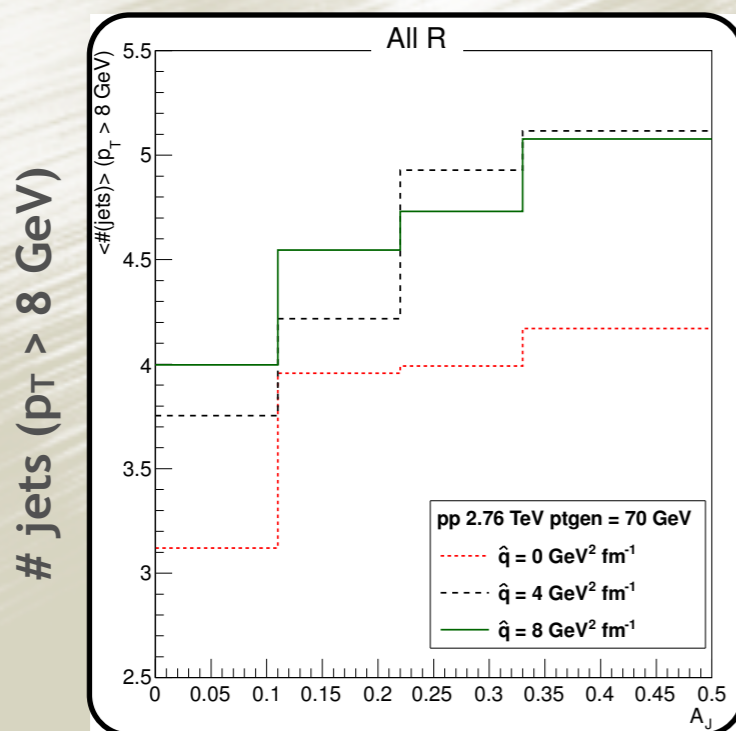
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Soft emission at large angle from the sub-leading jet

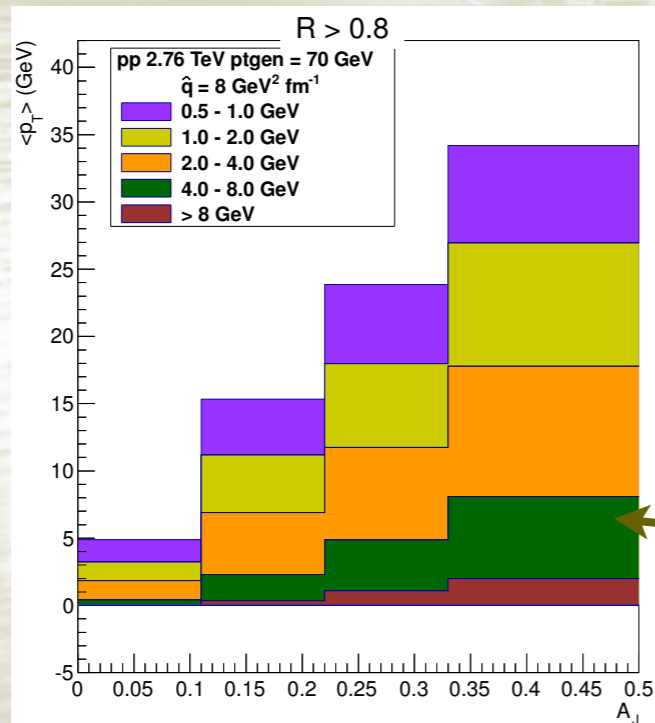
$E_{t3}$

Quenching effect

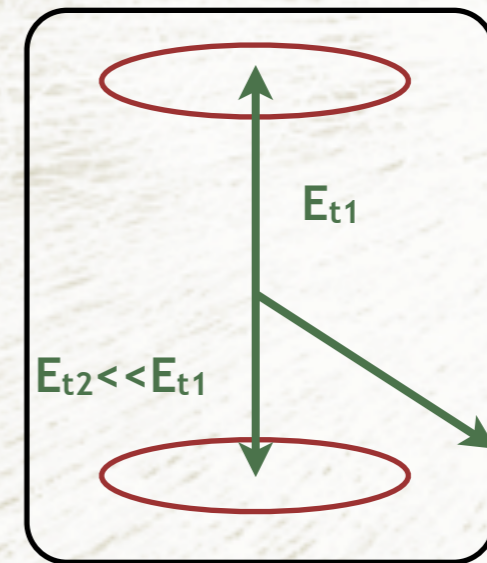


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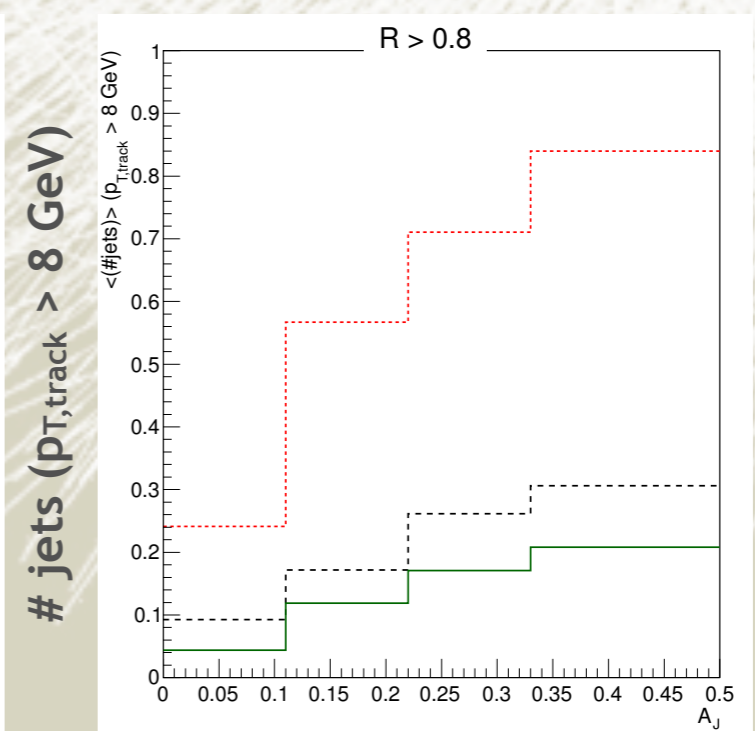
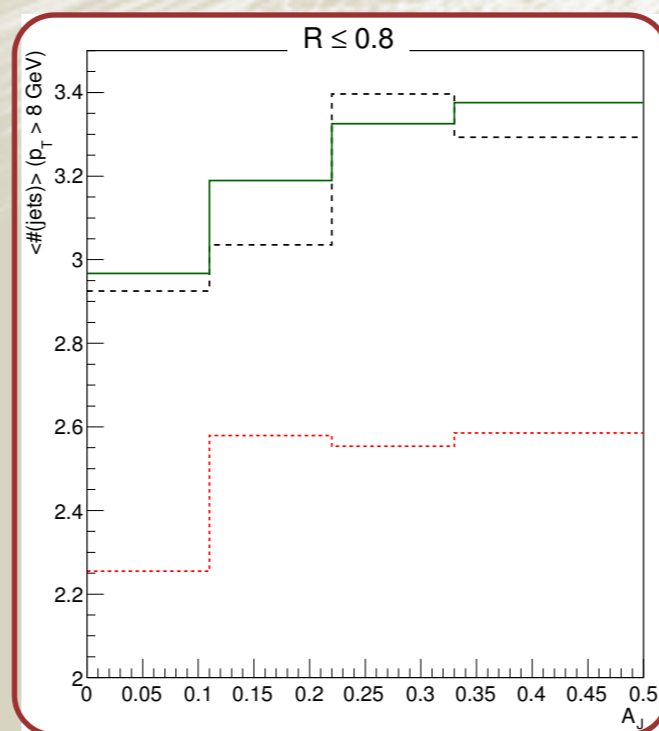
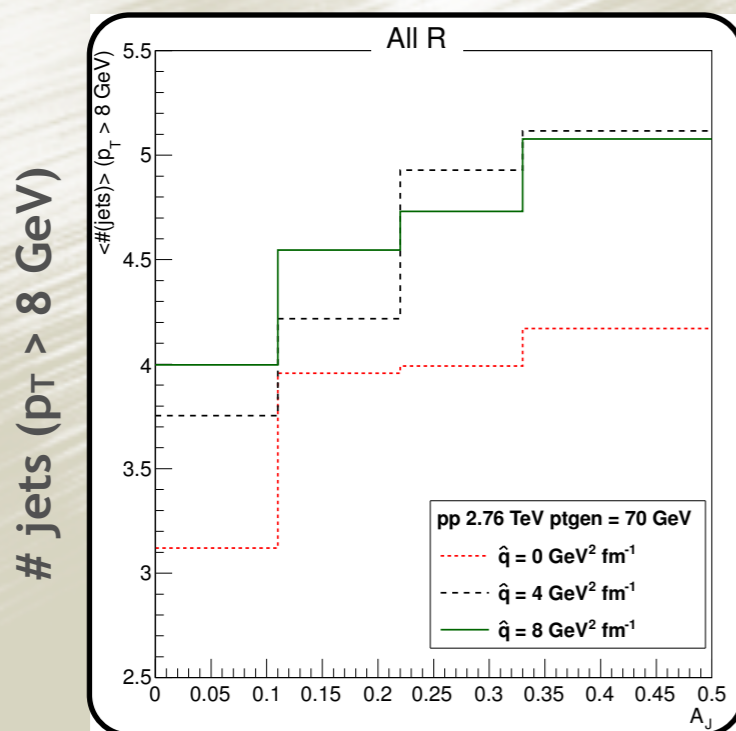


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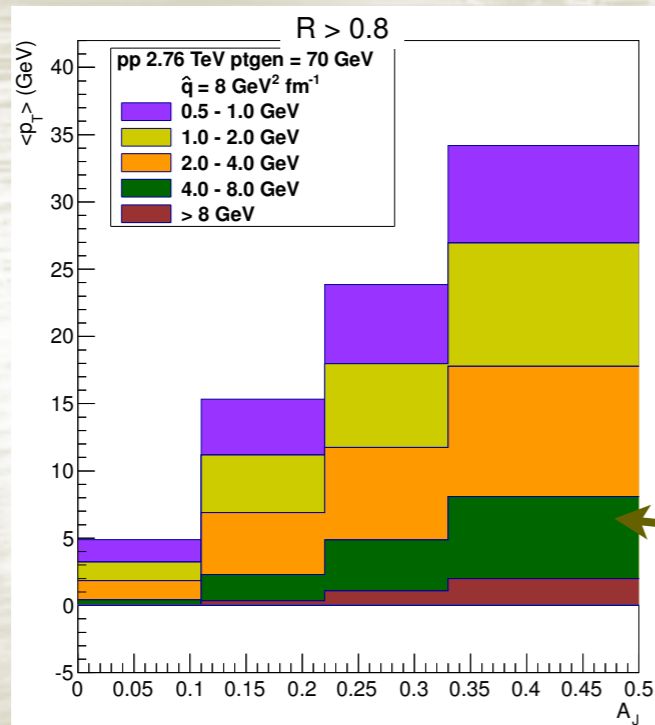
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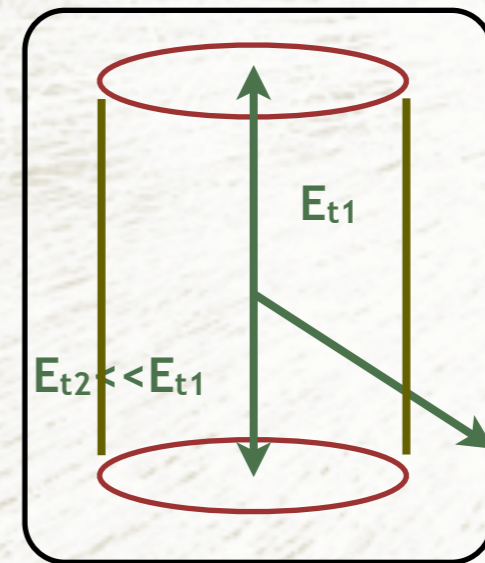


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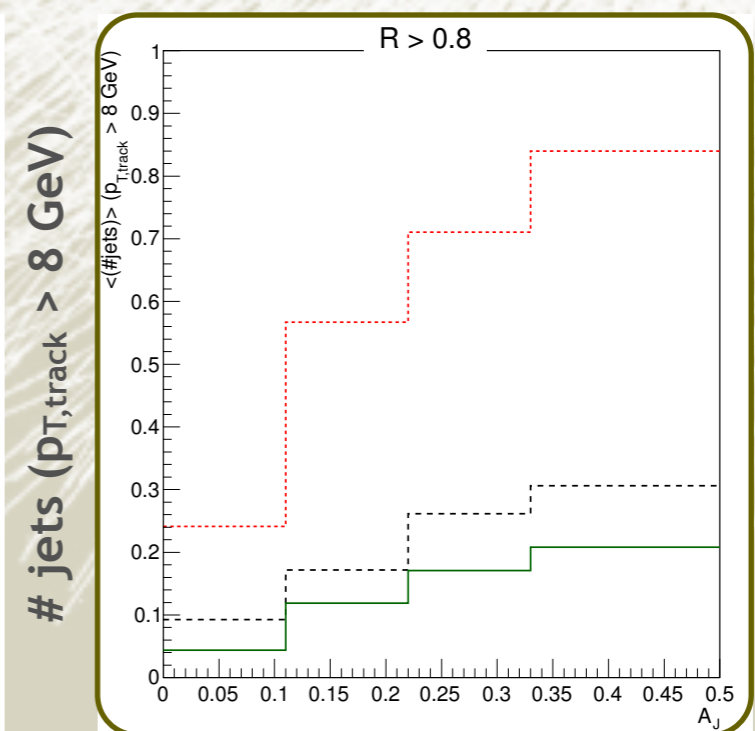
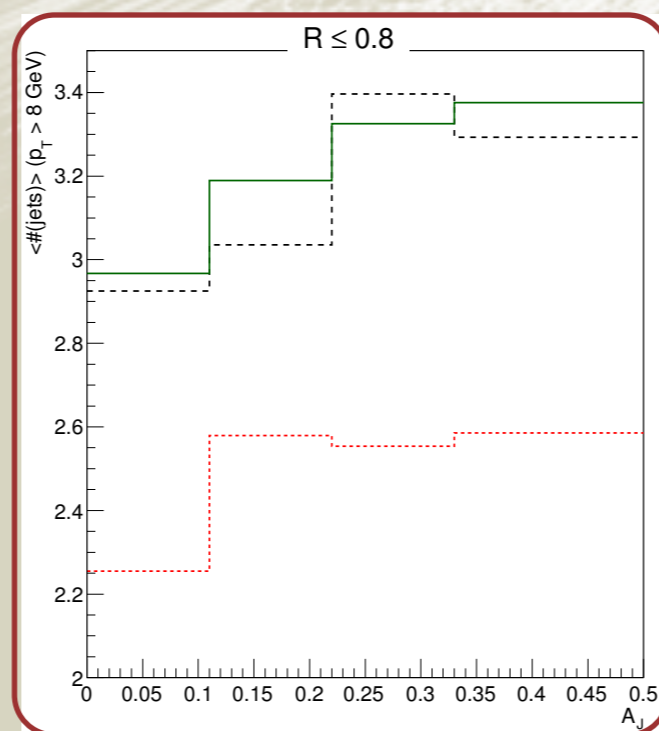
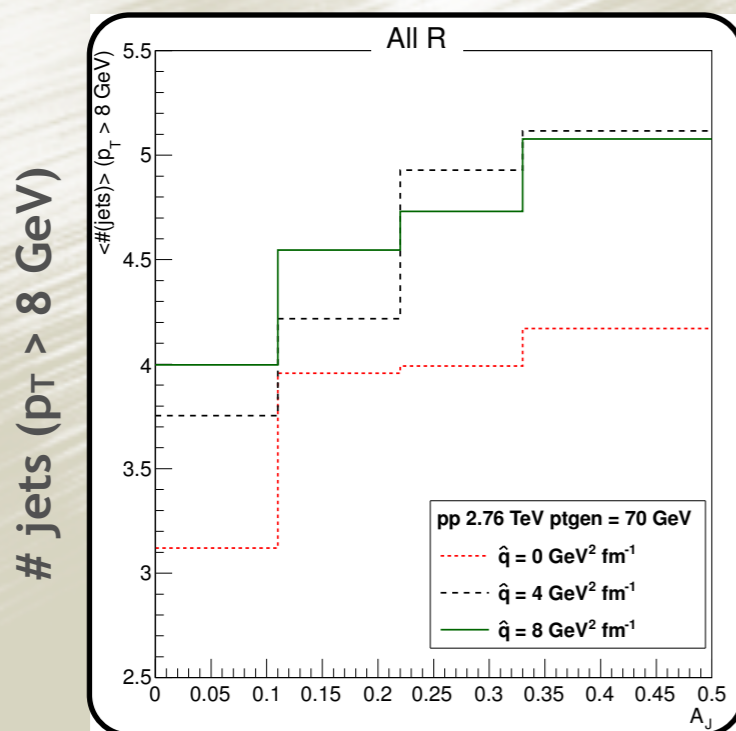


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$E_{t3}$



$A_J$

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Thanks!