Multiplicity dependence of charged jet properties in pp collisions at √s = 13 TeV with ALICE

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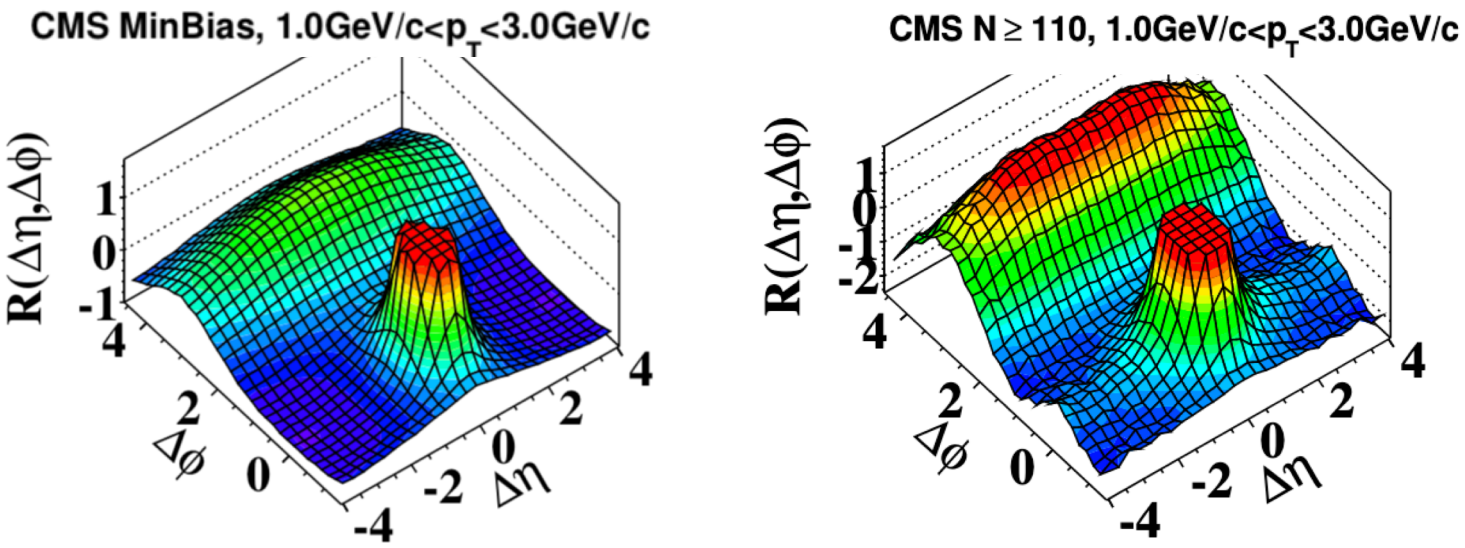
10-15 January 2021

Motivation

Hint of collective effects in small systems



CMS, JHEP 09 (2010) 091

- Indication of collective effects in small collision systems in high multiplicity events.
- Interesting to compare low and high multiplicity pp events by studying typical HI observables e.g. long range azimuthal correlations, jet property modifications.

Why Jet?

- Indirect observation of partons.
- Calculable from pQCD.
- In-medium modification of QCD shower.
- Probe of the QGP medium.

Jet Observables

- Jet shapes distributions are related to the details of parton shower process.
- Fragmentation functions represent the distribution of final state particles resulting from a jet.

Jet observables

Charged particle multiplicity in the jet:

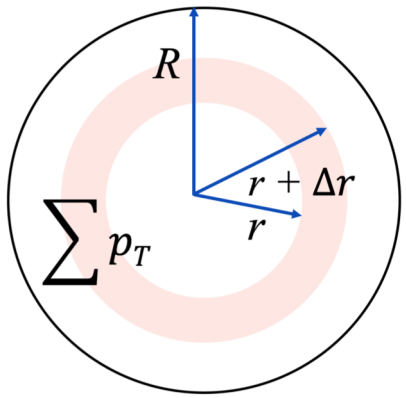
$$\langle N_{\mathrm{ch}} \rangle = \frac{1}{N_{\mathrm{jets}}} \sum_{i=1}^{N_{\mathrm{jets}}} N_{\mathrm{ch,i}}$$

where N_{jets} = number of jets and $N_{\mathrm{ch,i}}$ = number of particles within jet

Transverse momentum density within jet:

$$\left\langle \frac{\mathrm{d}p_{\mathrm{T}}^{\mathrm{sum}}}{\mathrm{d}r} \right\rangle (r) = \frac{1}{\Delta r} \frac{1}{N_{\mathrm{jets}}} \sum_{i=1}^{N_{\mathrm{jets}}} p_{\mathrm{T},i}^{\mathrm{sum}} (r - \Delta r/2, r + \Delta r/2)$$

Where, $r = \sqrt{(\Delta\eta)^2 + (\Delta\phi)^2}$

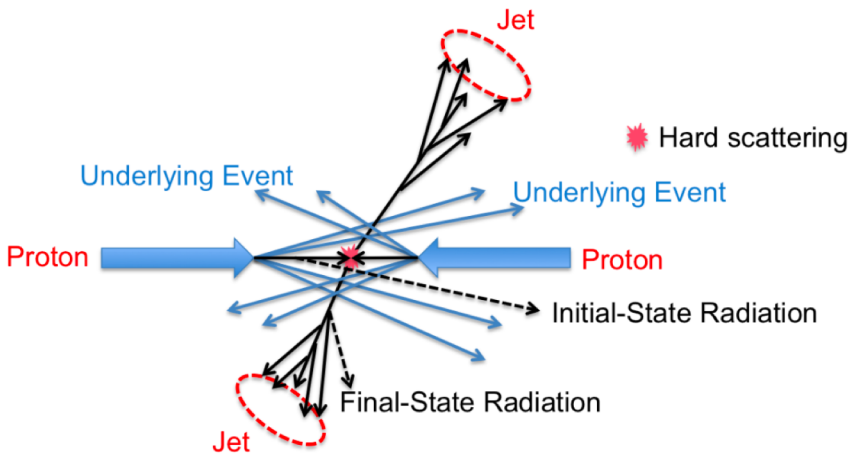


Fragmentation function (FF) :

$$F^{z} = \frac{1}{N_{\mathrm{jets}}} \frac{\mathrm{d}N}{\mathrm{d}z^{\mathrm{ch}}}$$

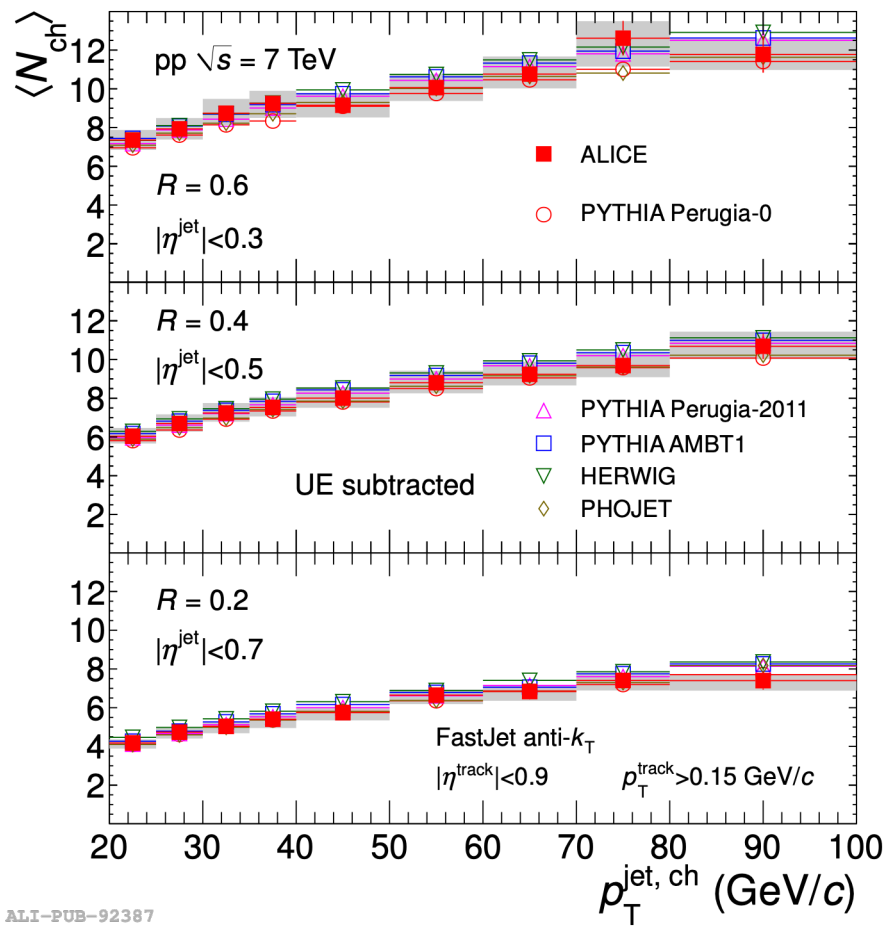
Where, $z^{\mathrm{ch}} = p_{\mathrm{T}}^{\mathrm{particle}} / p_{\mathrm{T}}^{\mathrm{jet,ch}}$

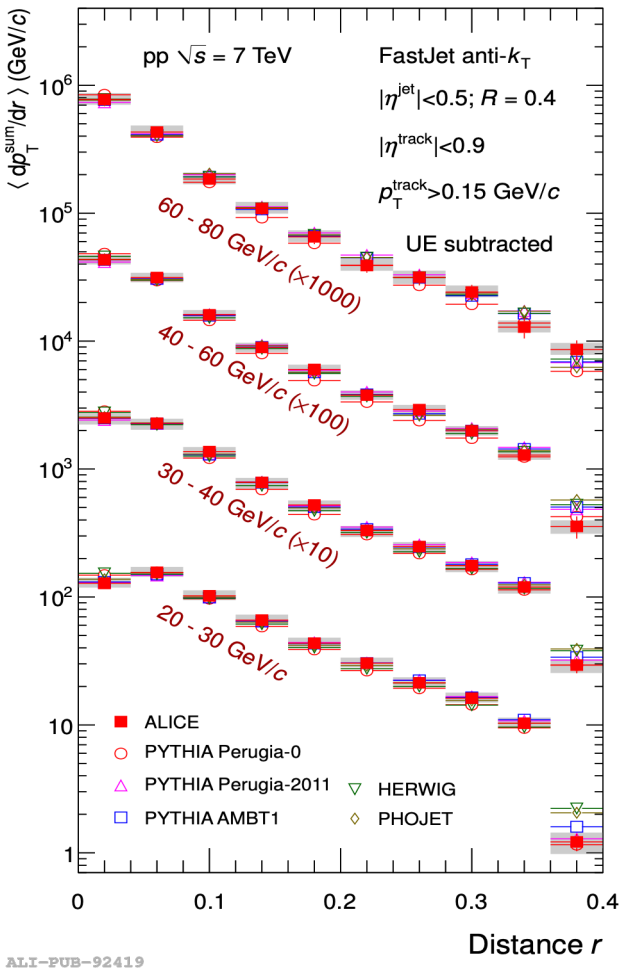
Underlying events (UE)

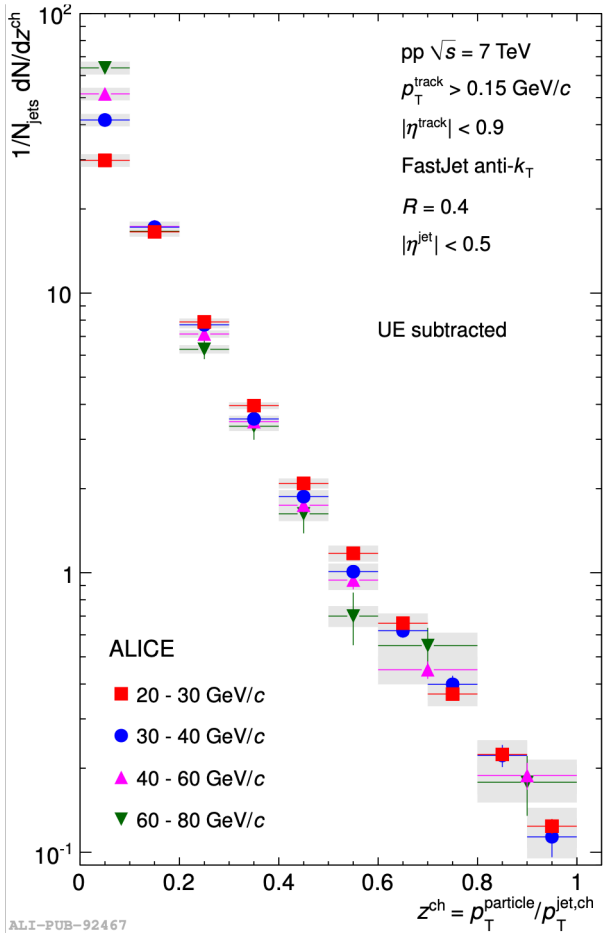


- **UE:** Contributions from initial and final state radiations, beam remnants, MPI
- **UE estimation:** Perpendicular cone method
- **UE correction:** Contributions of UE are corrected using bin by bin technique

Results: Jet properties in pp collisions at 7 TeV (Minimum Bias)







- $\langle N_{ch} \rangle$ increases with jet p_T and R

- p_T density largest near jet axis
- High p_T jets more collimated

- Indication of a scaling of charged jet fragmentation with jet p_T for $z^{ch} > 0.1$

ALICE, *Phys.Rev. D91 (2015) no.11, 112012*

Charged particle jet properties in pp collisions at 13 TeV

MC event generator: PYTHIA 8 Monash

Event selection:

- ❑ Minimum Bias (MB): 800 M
V0A ($2.8 < \eta < 5.1$) and V0C ($-3.7 < \eta < -1.7$) coincidence

- ❑ High-multiplicity: 3250 M
V0M = V0A+V0C
$\langle$V0M$\rangle$ = mean of MB distribution

Scaled multiplicity = V0M/ $\langle$V0M$\rangle$

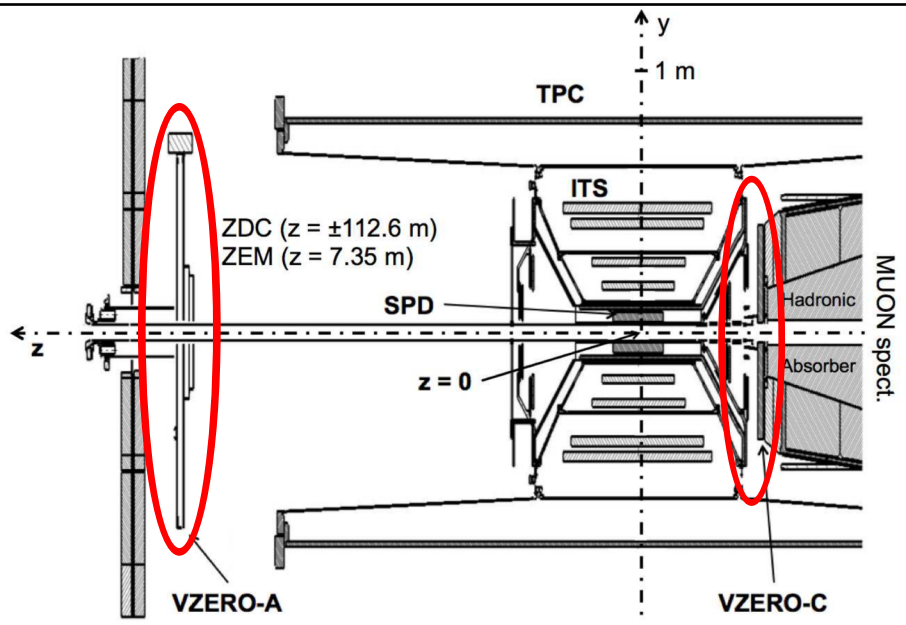
We choose HM: $4 <$ V0M/ $\langle$V0M$\rangle$ < 9 = 0.3% of MB cross-section

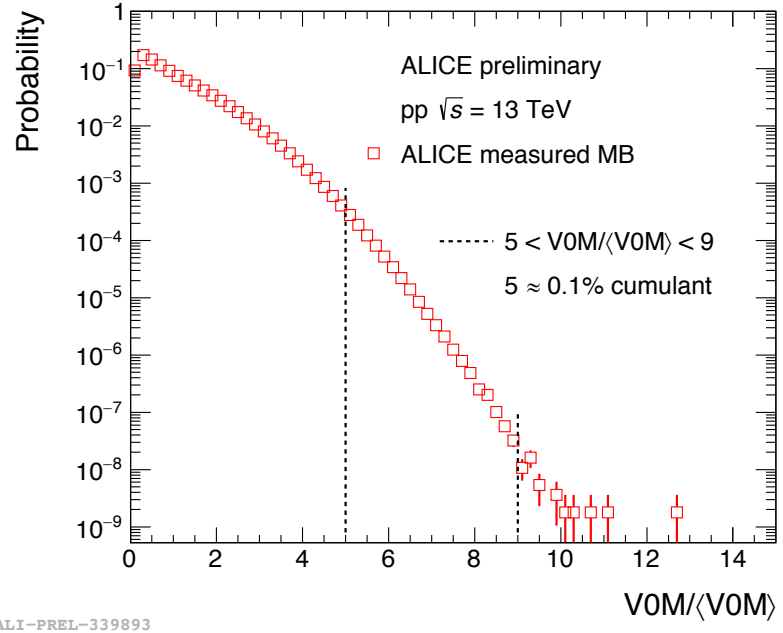
Particle selection:

- ❑ Final state charged particle
- ❑ $p_T > 150$ MeV/c
- ❑ $|\eta_{\text{particle}}| < 0.9$

Jet reconstruction:

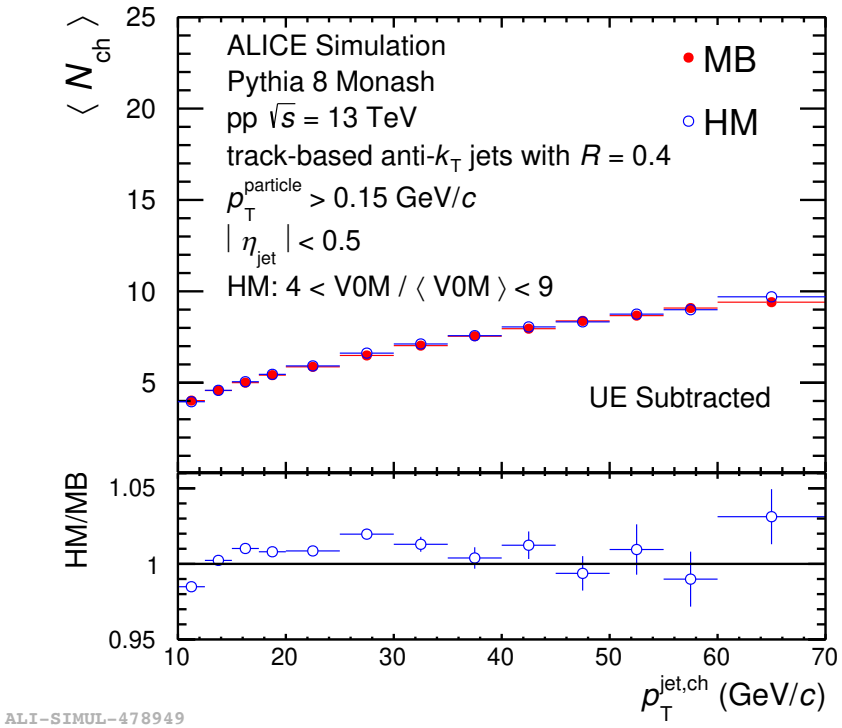
- ❑ anti-k_T jets from FastJet
- ❑ Jet radius = 0.4
- ❑ $|\eta_{\text{jet}}| < 0.5$



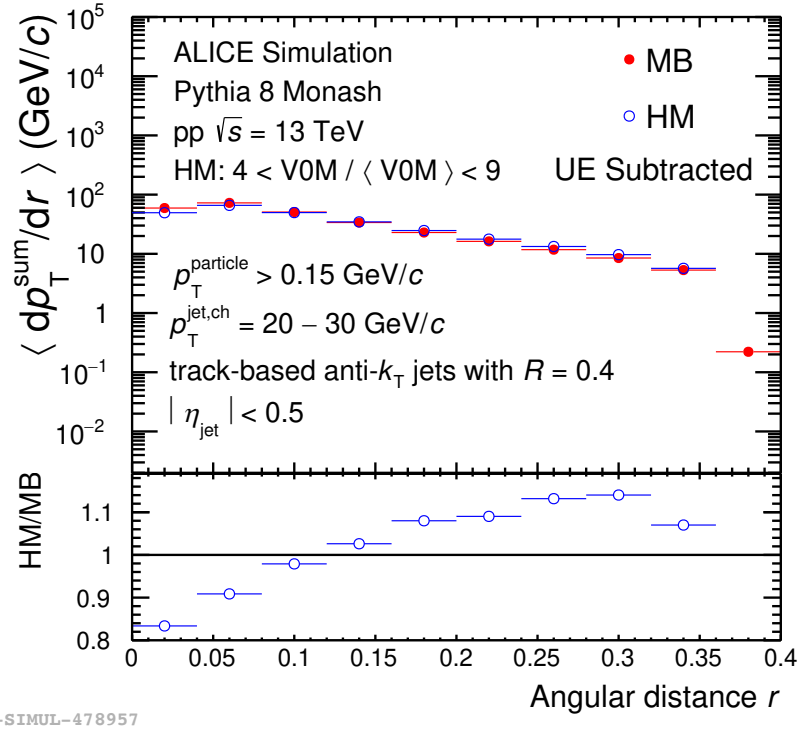


Results: Jet properties depend on event multiplicity

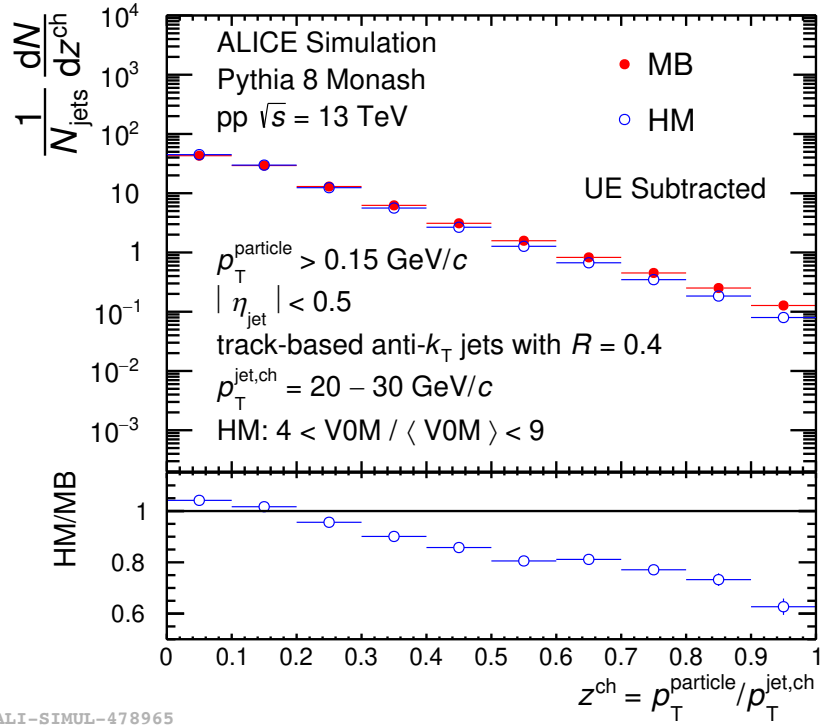
Mean charged particle multiplicity



Radial transverse momentum density



Fragmentation Function



- Jet multiplicity is slightly greater for jets in HM events
- Jets in HM events are less collimated
- Jet fragmentation is softer in HM events

Summary and Outlook

Jet properties in pp collisions at 7 TeV:

- ❑ Minimum bias ALICE data were analyzed.
- ❑ Multiplicity increases with jet p_T as well as with jet radius.
- ❑ High p_T jets are more collimated.
- ❑ Scaling of charged jet fragmentation with jet p_T.

Jet properties in pp collisions at 13 TeV:

- ❑ Minimum bias and high-multiplicity events are analyzed using PYTHIA8 Monash MC event generator.
- ❑ Dependence of jet properties on event multiplicity is observed.
- ❑ Jets in high-multiplicity pp events are softer and less collimated compared to MB events.

Outlook:

- ❑ Measurement of charged jet properties as a function of event multiplicity in pp at 13 TeV with ALICE data.

Thank You