Event-by-event mean p_T fluctuations in pp and p-Pb collisions

- Dr. Antonio Ortiz Velázquez
- Dra. Irais Bautista Guzmán
- Pablo Fierro
- Angel Sierra

Motivations

- In the study of QGP the phase transition may go along with critical fluctuations of thermodynamic quantities which could be observed in event-by-event fluctuation measurements
- The aim of the analysis is to study event-by-event fluctuations of the mean transverse momentum of final-state charged particles as a function of the average charged-particle multiplicity density
- There are many kinds of correlations among the transverse momenta that may lead to such fluctuations (jets, resonance decays)

- We present results for pp collisions at $\sqrt{s} = 13\ TeV$ and p-Pb collisions at $\sqrt{s} = 5.02\ TeV$
- Event Selection: KINT7 (Thanks to Gyula), Vertex Selection, Pile-Up rejection (Remove Pile-Up using SPD)
- Using estimator V0M multiplicity=event->cent
- Estimator CombTPCITS08 reference (trackmult08)
- Bins for pp {0,0.1,1,5,10,15,20,30,40,50,60,70,100}
- Bins for p-Pb {0,5,10,20,30,40,50,60,70,80,100}

Track Selection

- We are interested on bulk particle production, in orden to guarantee a good tracking efficency and momentum resolution we get the following conditions:
- Reference multiplicity selection:

$$|\eta| < 0.8 \qquad 0.15 < p_T < 2\frac{GeV}{c}$$

- V0M percentil selection
- The number of accepted tracks in one event within this ranges is denoted as N_{acc}

- The event-by-event (EbE) mean transverse momentum is aproximated by the mean value $M_{EbE}(p_T)_k$ of the transverse momenta $p_{T,i}$ of the N_{acc} accepted charged particles in event k

$$M_{EbE}(p_T)_k = \frac{1}{N_{acc,k}} \sum_{i=1}^{N_{acc,k}} p_{T,i} \qquad (1)$$

- The mean transverse momentum of all tracks in all events of a multiplicity class m is denoted as $M(p_T)_m$ and is given by:

$$M(p_T)_m = \frac{1}{\sum_{k=1}^{n_{ev,m}} N_{acc,k}} \sum_{k=1}^{n_{ev,m}} \sum_{i=1}^{N_{acc,k}} p_{T,i} \qquad (2)$$

$$= \frac{1}{\sum_{k=1}^{n_{ev,m}} N_{acc,k}} \sum_{k=1}^{n_{ev,m}} N_{acc,k} \cdot M_{EbE}(p_T)_k$$

Where $n_{ev,m}$ is the mumber of events in a multiplicity class m.

- A measure of the dynamical contribution to the fluctuations is the two-particle correlator $C = \langle \Delta p_{T,i}, \Delta p_{T,j} \rangle$, so we use the correlator C_m defined in multiplicity classes m

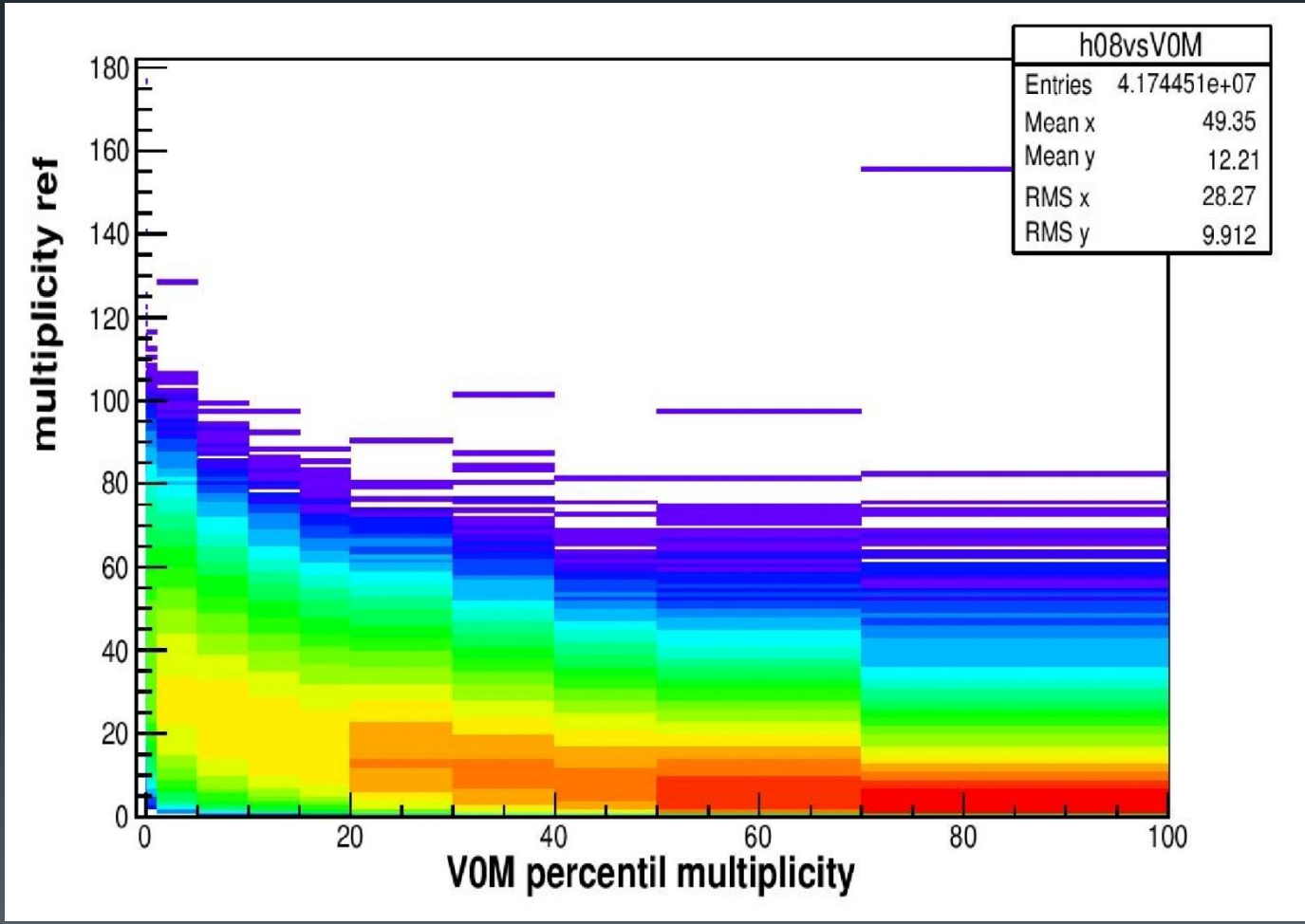
And if we note that the number of particle pairs in a event k is ${N_k}^{pairs} = \frac{1}{2} N_{acc,k}\left(N_{acc,k} - 1\right)$ we get:

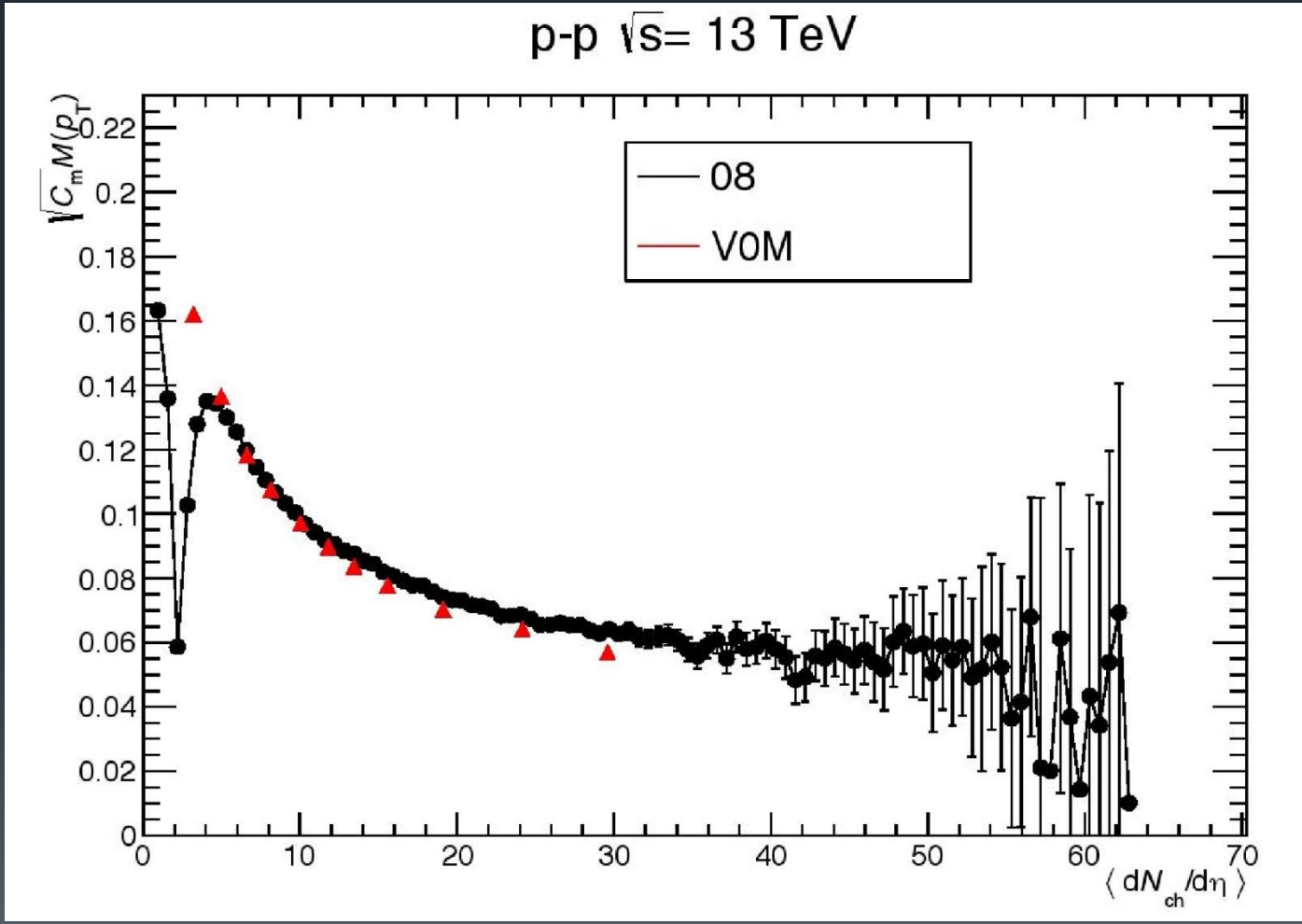
$$C_m = \frac{1}{\sum_{k=1}^{n_{ev,m}} {N_k}^{pairs}} \sum_{k=1}^{n_{ev,m}} \sum_{i=1}^{N_{acc,k}} \sum_{j=i+1}^{N_{acc,k}} \left(p_{T,i} - M(p_T)_m\right).\left(p_{T,j} - M(p_T)_m\right)$$

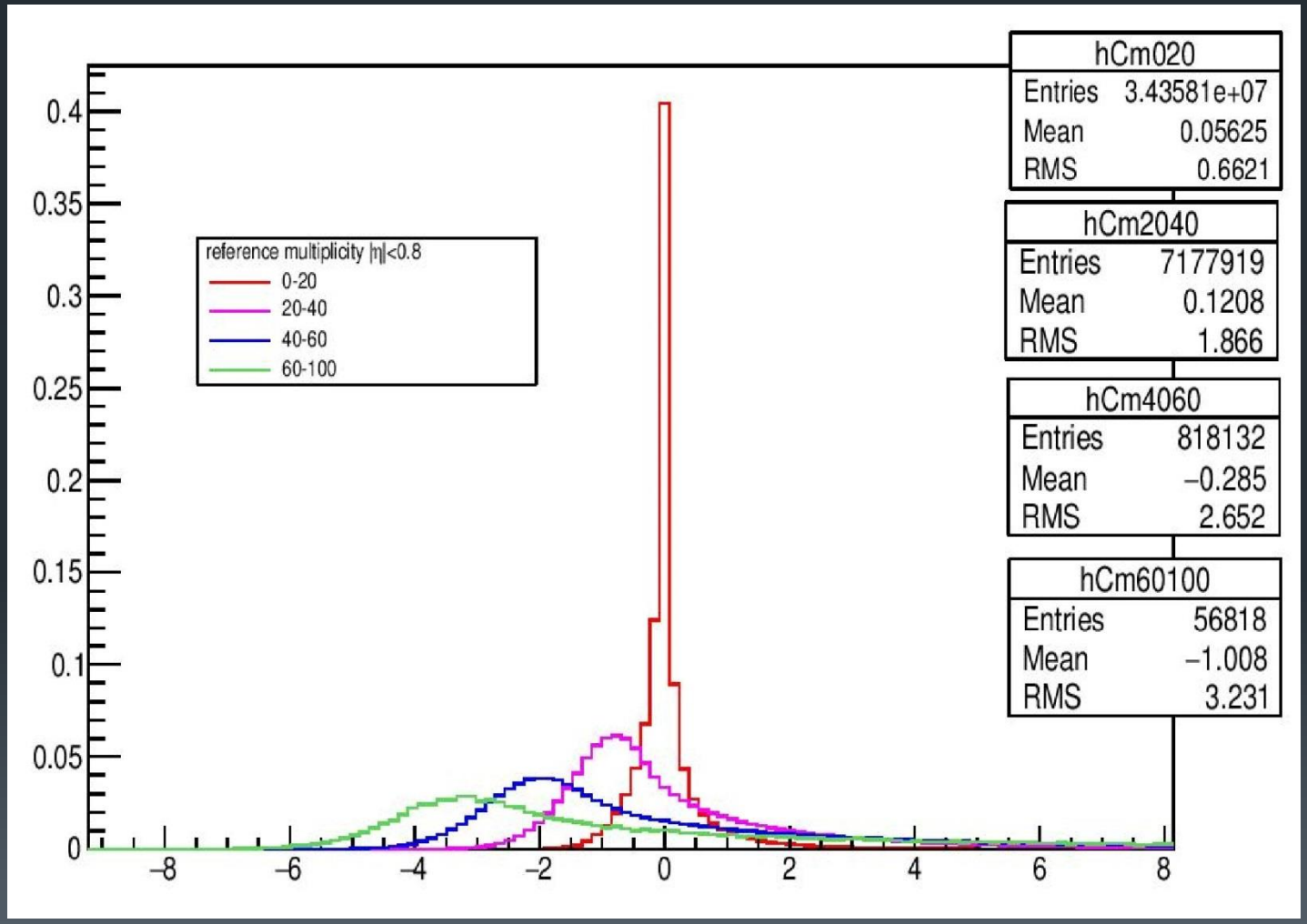
(3)

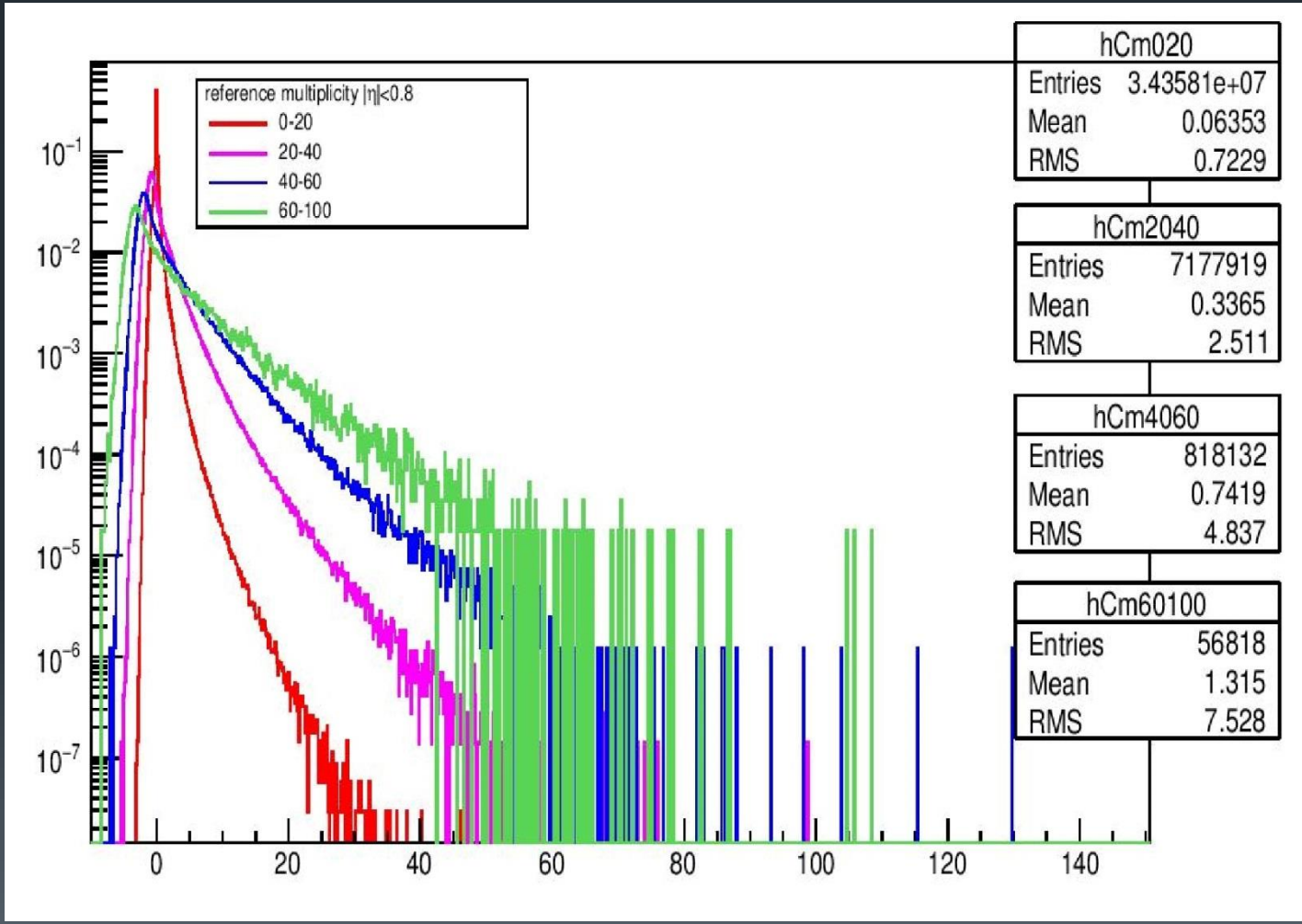
- The dimensionless ratio $\frac{\sqrt{C_m}}{M(p_T)_m}$ quantifies the strength of the dynamical fluctuations in units of the mean transverse momentum

Results in pp collisions

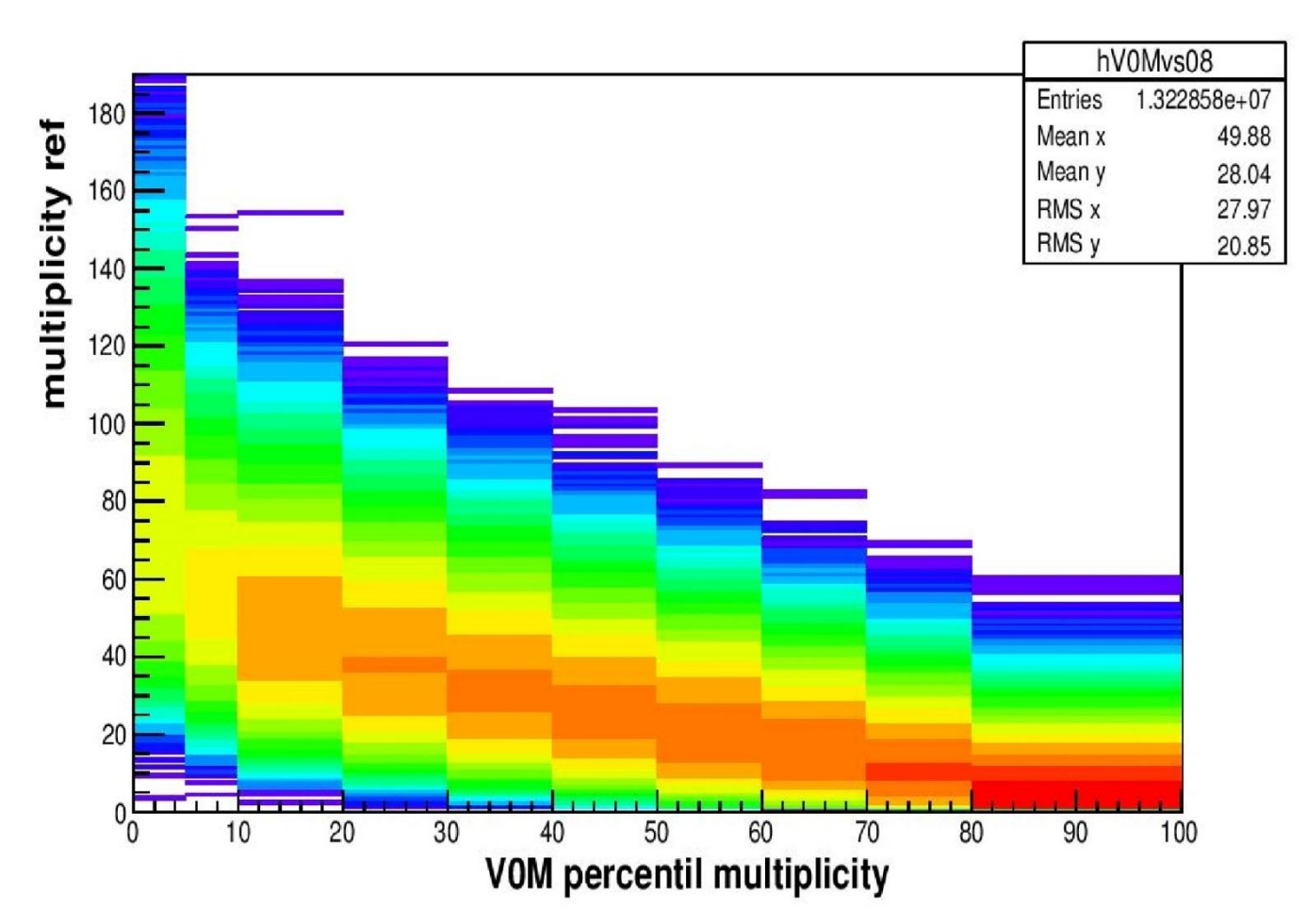


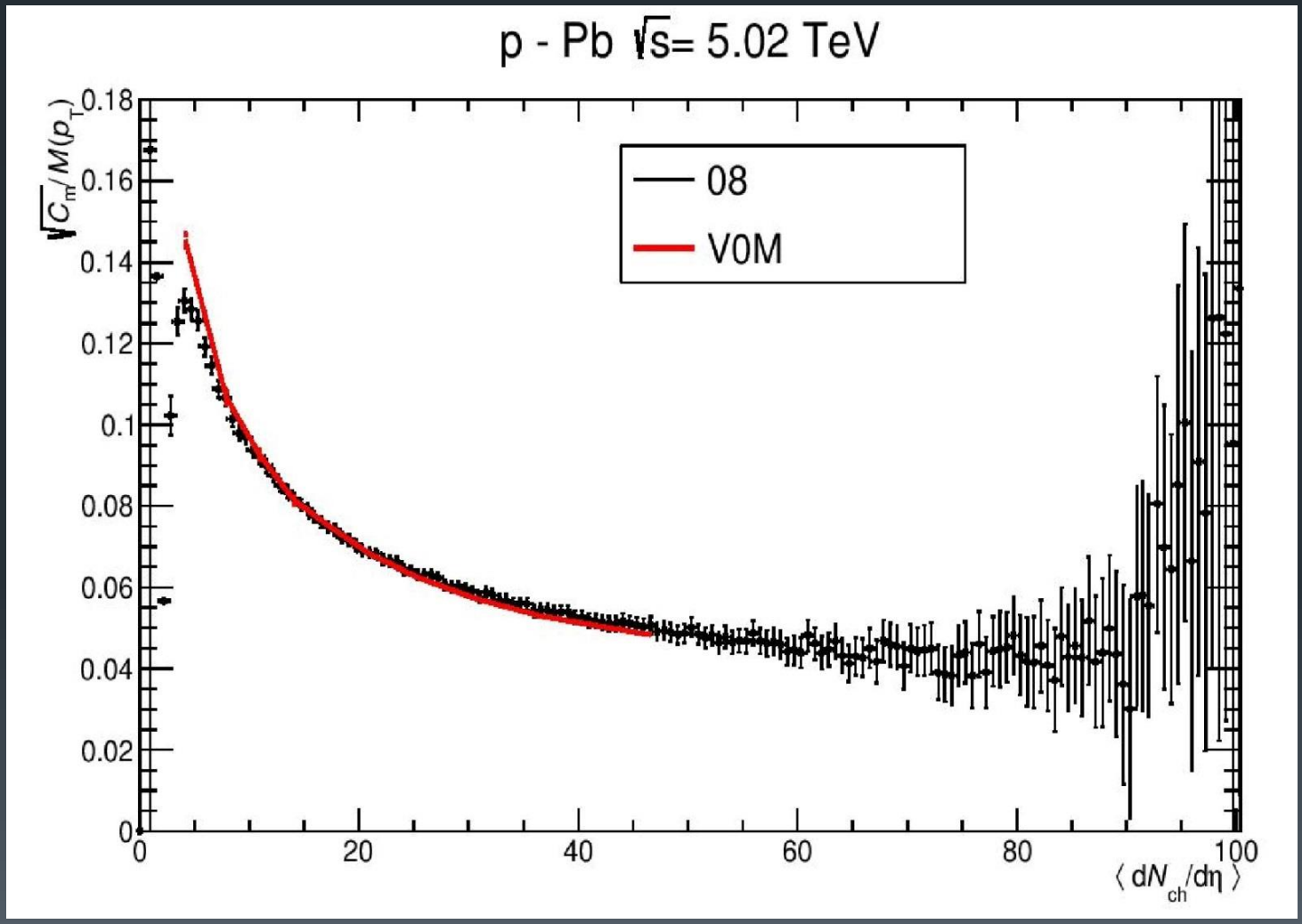

p-p √s= 13 TeV
$\sqrt{C_m M(p_T)}$
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
08
V0M
0
10
20
30
40
50
60
70
⟨ dN_ch/dη ⟩

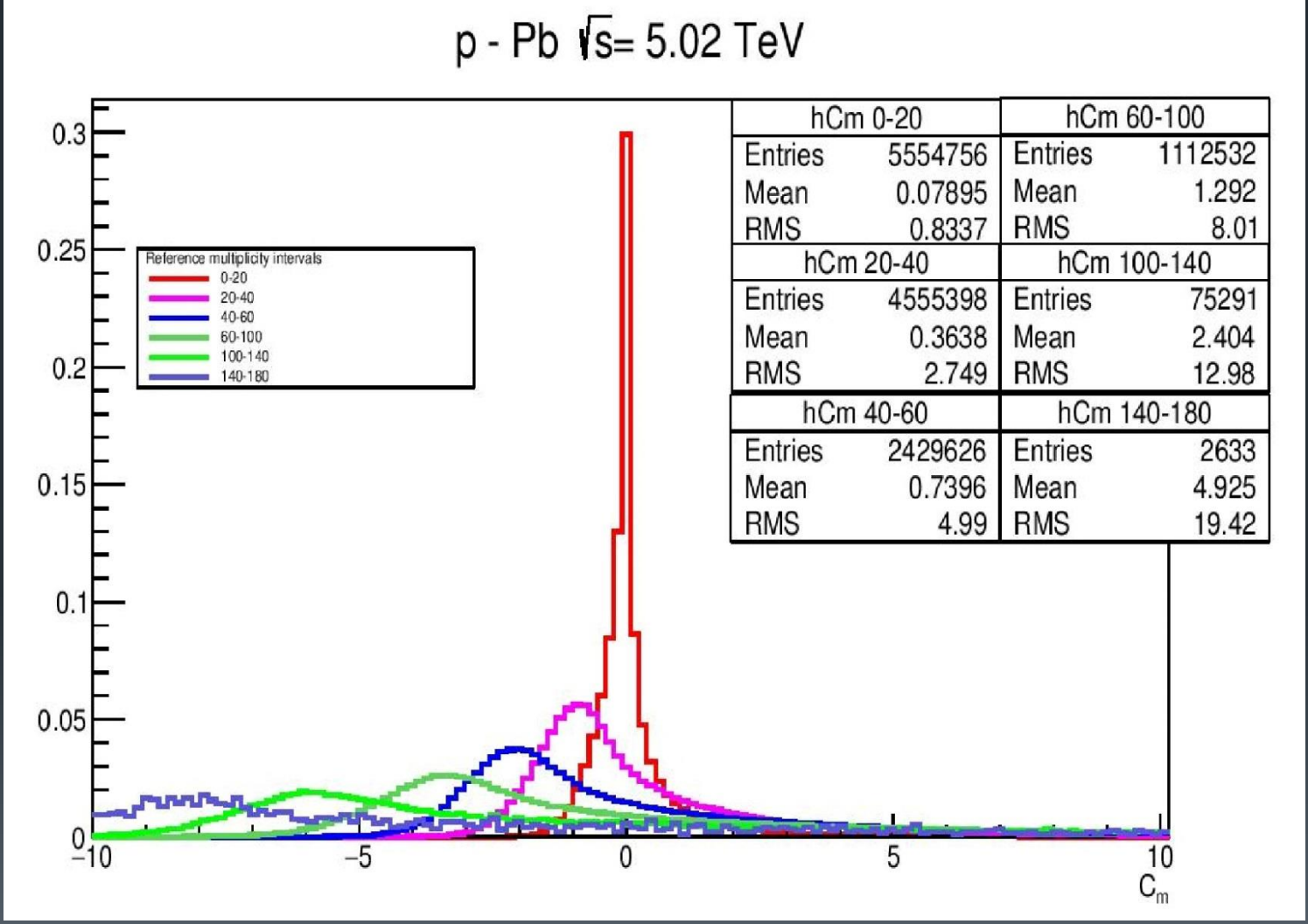

reference multiplicity |η|<0.8
0-20
20-40
40-60
60-100
hCm020
Entries 3.43581e+07
Mean 0.05625
RMS 0.6621
hCm2040
Entries 7177919
Mean 0.1208
RMS 1.866
hCm4060
Entries 818132
Mean −0.285
RMS 2.652
hCm60100
Entries 56818
Mean −1.008
RMS 3.231
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
−8
−6
−4
−2
0
2
4
6
8

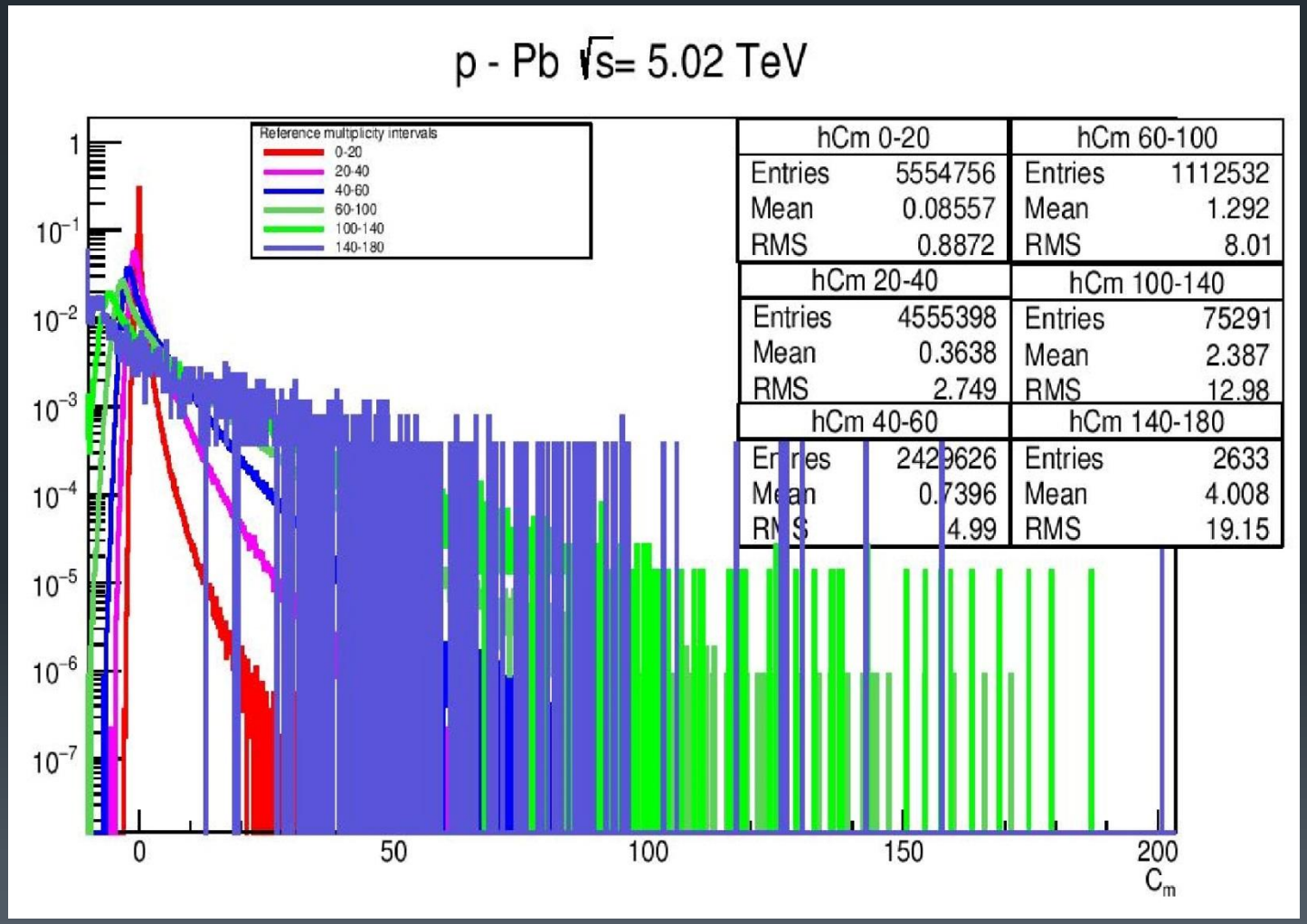

reference multiplicity |η|<0.8
0-20
20-40
40-60
60-100
hCm020
Entries 3.43581e+07
Mean 0.06353
RMS 0.7229
hCm2040
Entries 7177919
Mean 0.3365
RMS 2.511
hCm4060
Entries 818132
Mean 0.7419
RMS 4.837
hCm60100
Entries 56818
Mean 1.315
RMS 7.528
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
0
20
40
60
80
100
120
140

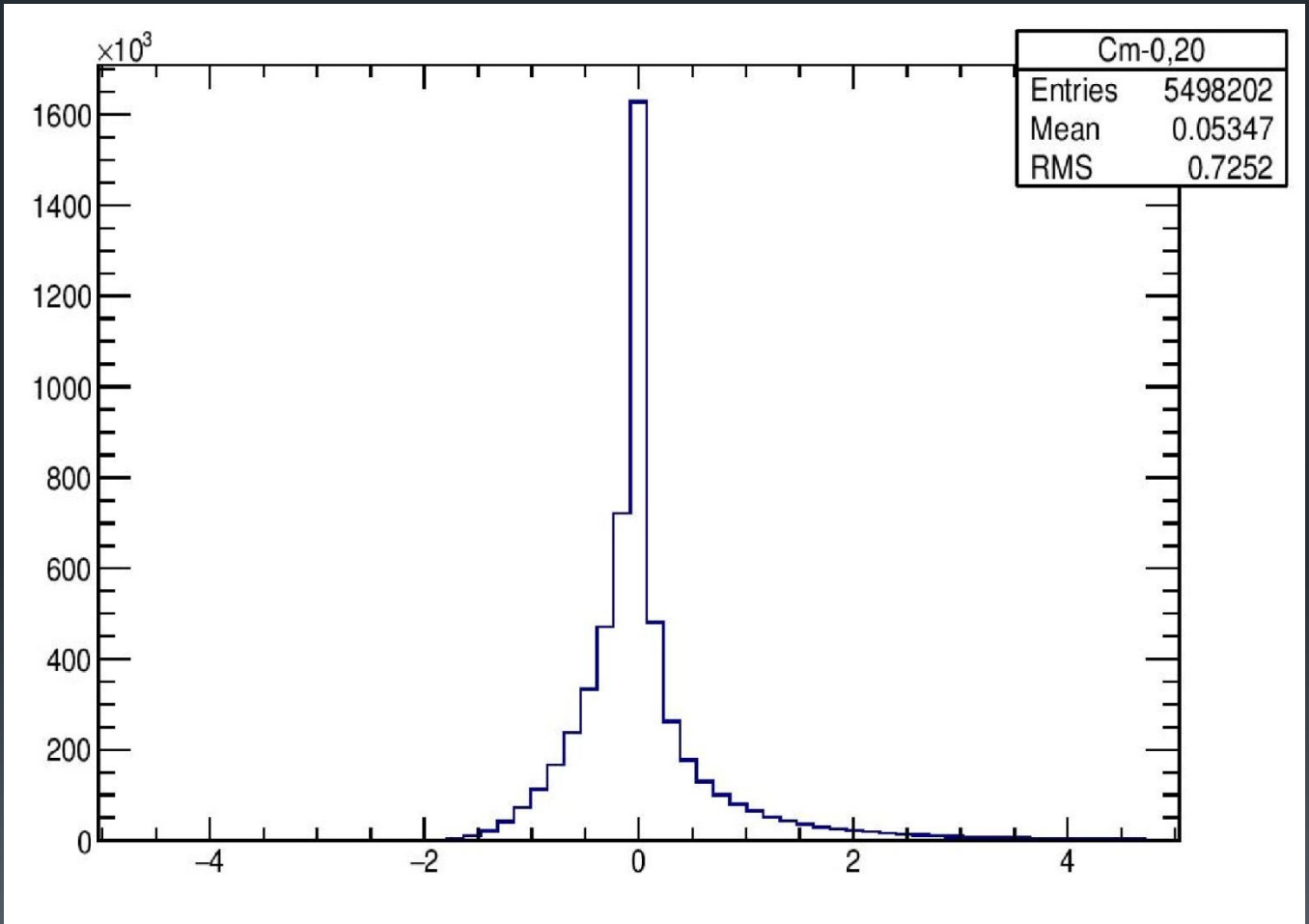
Results in p-Pb collisions

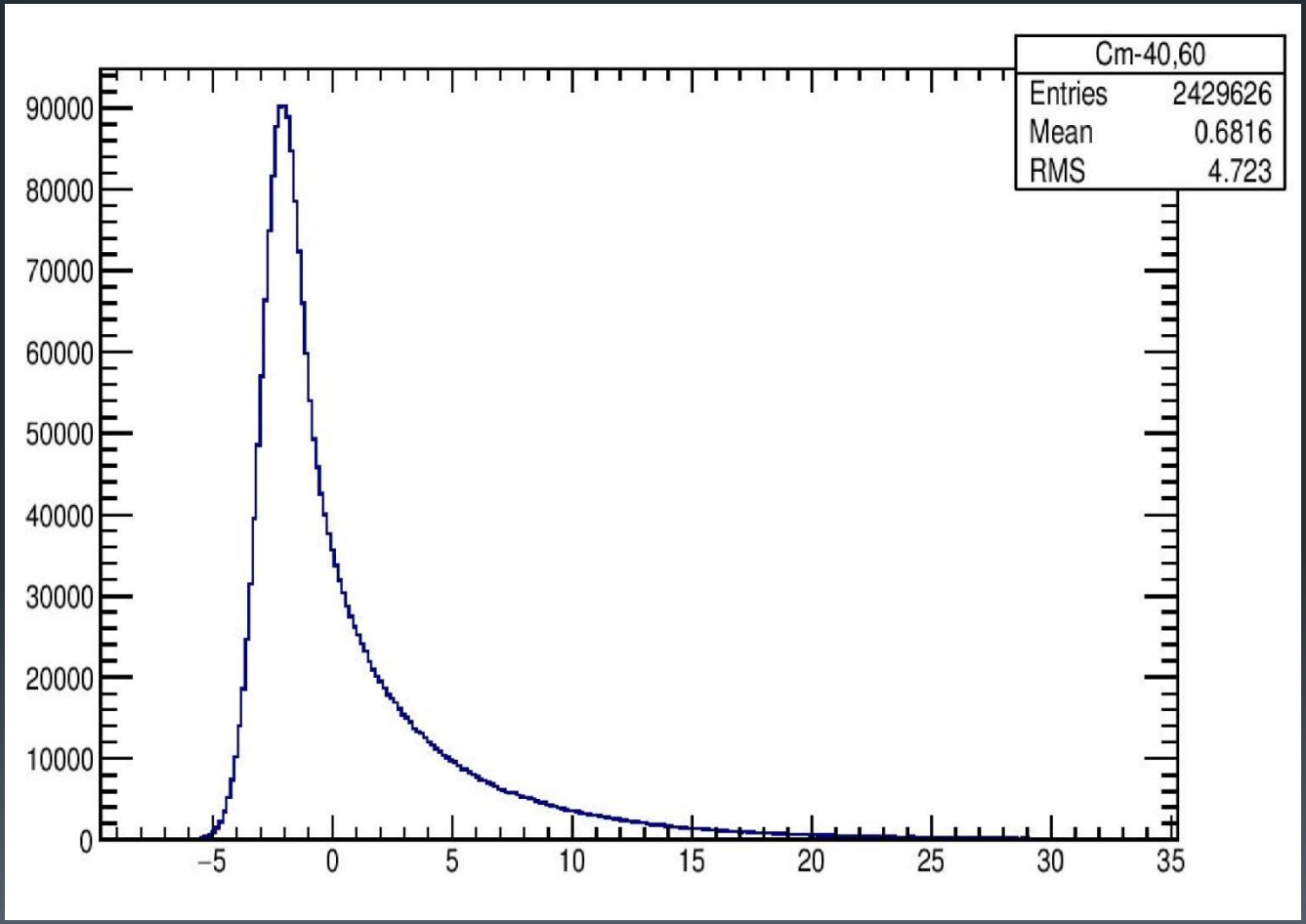


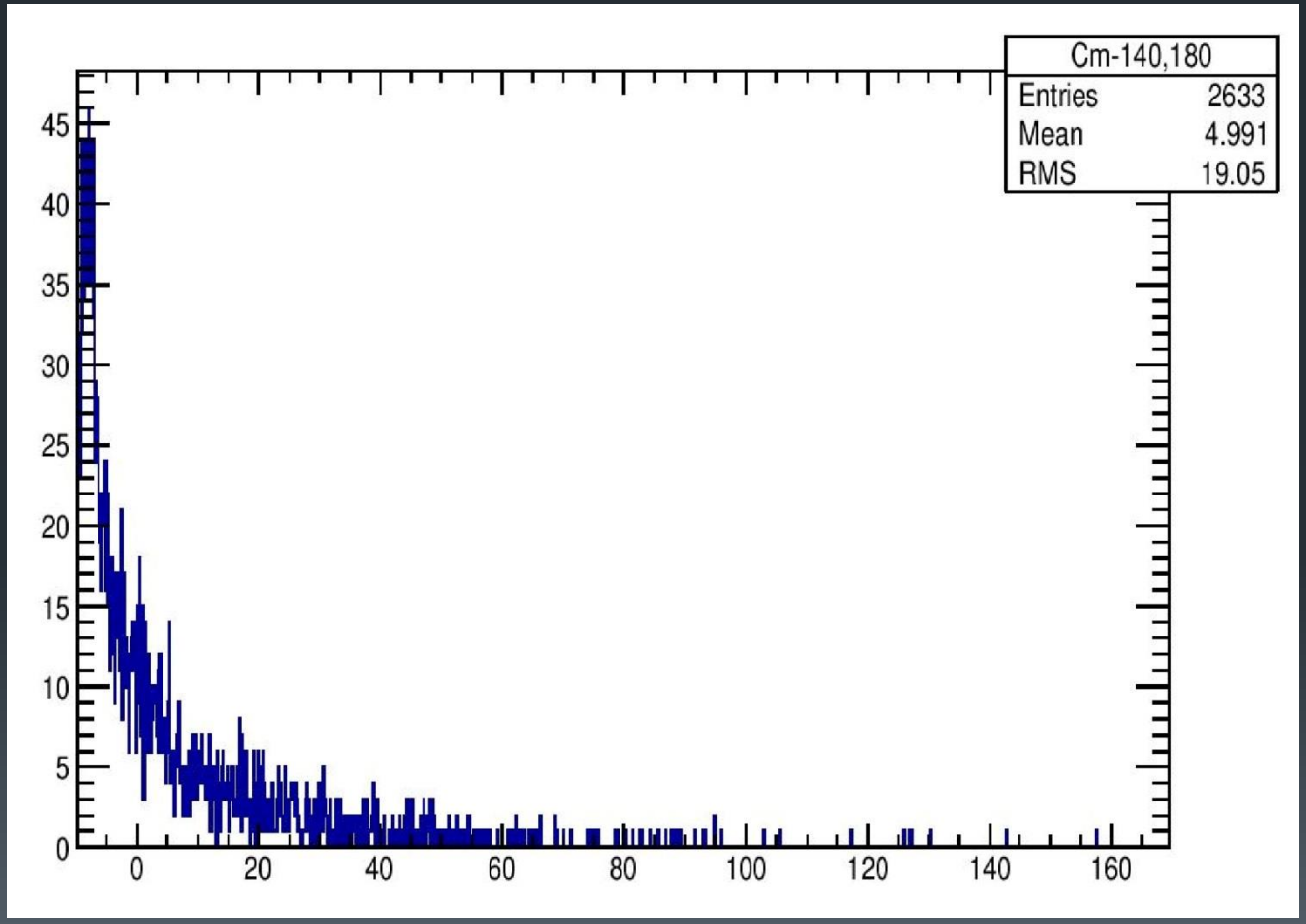

p - Pb √s= 5.02 TeV
√C_m / M(p_T)
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
20
40
60
80
100
⟨ dN_ch/dη ⟩
08
V0M


p - Pb √s= 5.02 TeV
Reference multiplicity intervals
0-20
20-40
40-60
60-100
100-140
140-180
hCm 0-20
Entries 5554756
Mean 0.07895
RMS 0.8337
hCm 20-40
Entries 4555398
Mean 0.3638
RMS 2.749
hCm 40-60
Entries 2429626
Mean 0.7396
RMS 4.99
hCm 60-100
Entries 1112532
Mean 1.292
RMS 8.01
hCm 100-140
Entries 75291
Mean 2.404
RMS 12.98
hCm 140-180
Entries 2633
Mean 4.925
RMS 19.42
0.3
0.25
0.2
0.15
0.1
0.05
0
−10
−5
0
5
10
C_m


p - Pb √s= 5.02 TeV
Reference multiplicity intervals
0-20
20-40
40-60
60-100
100-140
140-180
hCm 0-20
Entries 5554756
Mean 0.08557
RMS 0.8872
hCm 20-40
Entries 4555398
Mean 0.3638
RMS 2.749
hCm 40-60
Entries 2429626
Mean 0.7396
RMS 4.99
hCm 60-100
Entries 1112532
Mean 1.292
RMS 8.01
hCm 100-140
Entries 75291
Mean 2.387
RMS 12.98
hCm 140-180
Entries 2633
Mean 4.008
RMS 19.15
1
10⁻¹
10⁻²
10⁻³
10⁻⁴
10⁻⁵
10⁻⁶
10⁻⁷
0
50
100
150
200
Cm


×10^3
1600
1400
1200
1000
800
600
400
200
0
−4
−2
0
2
4
Cm-0,20
Entries 5498202
Mean 0.05347
RMS 0.7252


Cm-40,60
Entries 2429626
Mean 0.6816
RMS 4.723
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
−5
0
5
10
15
20
25
30
35


Cm-140,180
Entries 2633
Mean 4.991
RMS 19.05
45
40
35
30
25
20
15
10
5
0
0
20
40
60
80
100
120
140
160

- # of events for pp 49,084,813 run 2 LHC
- # of events for p-Pb 15,534,829 run 1 LHC

To do

- Implement Event-mixing method
- Compare both p-p and p-Pb results