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Run, track selection, efficiency correction for jet transverse momentum spectra analysis in p–p$\sqrt{s}$=2.76 , 7 TeV and $p+Pb$ $\sqrt{s}$=5.02 TeV collisions

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Abstract

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1 Introduction

All the analysis presented here are analyzed via the ALICE legotrain framework, where the location of the code is PWGCF/Correlation/JCORRAN in Aliroot and the details of the real data and MC data sets can be found the legotrain system.

2 List of Data sets

Here I list all the data sets and the corresponding legotrain ID for each analysis.

Table 1: List of Data sets used in the analysis.

legotrain	Data set	legotrain ID
CF_pp	2760GeV_LHC11a_p4_AOD113_noSDD	511_201410311000
CF_pp	2760GeV_LHC11a_p4_AOD113_withSDD	521_201410311051
CF_pp	Full_pp_data_set_7TeV_pass3_LHC10b	519_201410311008
CF_pp	Full_pp_data_set_7TeV_pass3_LHC10c	520_201410311009
CF_pp	Full_pp_data_set_7TeV_pass2_LHC10d	517_201410311006
CF_pp	7TeV_LHC10c_p2_AOD147	514_201410311003
CF_pp	7TeV_LHC10e_p2_AOD147	516_201410311005
CF_pPb	LHC13b_pass3	573_201410241505
CF_pPb	LHC13c_pass2	574_201410241505
CF_pPb	LHC13d_pass2	575_201410241505
CF_pPb	LHC13e_pass2	576_201410241505

3 Track selection cuts

We have used the following charged particle track selection cuts based on the ALICE AOD track filter bit selection. The naming and fiter bit for each track selection are shown in table 2. The details on AOD track filter bit can be found at the twiki page[1].

Table 2: Track selections

cut name	AOD filter bit
TPCOnly	7
Raa	10
Hybrid	8 or 9
GlobalTightDCA	5
GlobalDCA	4
GlobalSDD	5 or 6

[1] https://twiki.cern.ch/twiki/bin/viewauth/ALICE/PWGPPAODTrackCuts

4 Efficiency corrections

Monte Carlo production cycles which were analyzed in order to study reconstruction efficiency are listed in Tab. 3. Estimate of track reconstruction efficiency and event selection efficiency follows the approach discussed in Section 6.2 of [1].

Table 3: Monte Carlo simulations

Period	Tune	lego train
p–p 2.76 TeV	LHC12f1a_Pythia_2760GeV	CF_pp_MC212_20141015
	LHC12f1b_Phojet_2760GeV	CF_pp_MC213_20141015
p–p 7 TeV	Pythia_Full_pp_data_set_7_TeV_LHC10d1	CF_pp_MC229_20141024
	Pythia:_Full_pp_data_set_7.0_TeV_LHC10d4	CF_pp_MC227_20141024
	Pythia6:_Full_pp_data_set_7.0_TeV_LHC10f6a	CF_pp_MC226_20141024
	Pythia:_Full_pp_data_set_7.0_TeV_LHC10e20	CF_pp_MC228_20141024
$p+Pb$5.02 TeV	LHC13b2_efix_p1,2,3,4	CF_pPb_MC193(5,6,7)_20141010

Based on simulated inelastic events we studied reconstruction efficiency of charged physical primaries selected with cuts listed in Tab. 2. Charged physical primaries are particles produced in a collision including the products of strong and electromagnetic decay and excluding the feed-down from weak decays of strange particles. The simulation tunes listed in Tab. 3 were used to get the relation between the number of charged physical primaries and the number of charged reconstructed tracks. Charged physical primaries were identified using the AliRoot function IsPhysicalPrimary. Only those charged particles that were emitted to the range $|\eta| < 0.8$ were considered. In case of p–p and $p+Pb$ collisions event vertex z coordinate was constrained to $|z_{vertex}| < 10$ cm.

Single track *overall reconstruction correction* takes into account

– contamination of the reconstructed track sample with fake primary tracks,

– track reconstruction efficiency,

In following equations G_{trigvtx} stands for the number of true charged physical primaries emitted to $|\eta| < 0.8$ in triggered events where an event vertex was reconstructed. Similarly to [1], we define the track-to-particle *overall reconstruction correction* $C(p_{\mathrm{T}})$,

$$C^{-1}(p_{\mathrm{T}}) = \frac{M_{\mathrm{trigvtx}}(p_{\mathrm{T}}) + B(p_{\mathrm{T}})}{G_{\mathrm{trigvtx}}(p_{\mathrm{T}})}, \tag{1}$$

Here M_{trigvtx} denotes the number of properly reconstructed primary tracks[2] and B gives the number of fake and secondary tracks. Let us point out that G_{trigvtx} and M_{trigvtx} are functions of the original MC generator p_{T} while B is a function of the reconstructed p_{T}. We assume that reconstruction correction of the trigger and associated particle are independent. Furthermore, we plot also the true track reconstruction efficiency and contamination which are defined as

$$\text{true efficiency} = M_{\mathrm{trigvtx}}(p_{\mathrm{T}}) / G_{\mathrm{trigvtx}}(p_{\mathrm{T}}), \tag{2}$$
$$\text{contamination} = B(p_{\mathrm{T}}) / \left[M_{\mathrm{trigvtx}}(p_{\mathrm{T}}) + B(p_{\mathrm{T}})\right]. \tag{3}$$

[2]Reconstructed track that passed the selection cut had to have an absolute value of assigned label equal to a label of some MC particle from the input MC sample of physical primaries, i.e., charged primary particles emitted to $|\eta| < 0.8$.

These ratios tell us what is the probability that an input MC charged primary track is reconstructed and passes the selection cuts and what is the fraction of fake primary tracks among all reconstructed tracks, respectively. Overall reconstruction corrections, the true track reconstruction efficiency and contamination are shown in Fig. 1 for $p+Pb$, Fig. 2 for p–p$\sqrt{s}$=2.76 TeV and Fig. 3 for p–p$\sqrt{s}$=7 TeV, respectively.

4.1 Trigger Efficiency

In order to cross-check the efficiency correction we will compare charged track p_{T} spectra obtained from this analysis with the results of the GSI group. For this purpose we have to normalize the p_{T} spectrum per one inelastic event.

The total number of inelastic events equals

$$N_{\mathrm{inel}} = \sum_{n=0}^{\infty} \int dz I\,(z,\,n) \tag{4}$$

where $I\,(z,\,n)$ gives the number of inelastic events having the number of contributors to a reconstructed vertex equal to n and the true MC vertex position in some range $(z, z+dz)$. The events where an interaction vertex was not reconstructed have $n=0$ by definition.

The number of inelastic events with a reconstructed vertex ($n>0$) can be estimated as

$$I\,(z,\,n) = E^{*}_{\mathrm{trigvtx}}\,(z,\,n)\,\tilde{C}_{\mathrm{vtx}}\,(z,\,n)\,\tilde{C}_{\mathrm{trig}}\,(z,\,n) \tag{5}$$

where $E^{*}_{\mathrm{trigvtx}}\,(z,\,n)$ stands for the measured number of triggered events with a reconstructed vertex and $\tilde{C}_{\mathrm{vtx}}\,(z,\,n)$ and $\tilde{C}_{\mathrm{trig}}\,(z,\,n)$ denote corrections on vertex reconstruction efficiency and trigger efficiency, respectively. Both correction factors are assessed based on simulation

$$\tilde{C}_{\mathrm{vtx}}\,(z,\,n) = \frac{E_{\mathrm{trig}}\,(z,\,n)}{E_{\mathrm{trigvtx}}\,(z,\,n)}, \tag{6}$$

$$\tilde{C}_{\mathrm{trig}}\,(z,\,n) = \frac{E_{\mathrm{all}}\,(z,\,n)}{E_{\mathrm{trig}}\,(z,\,n)} \tag{7}$$

where $E_{\mathrm{class}}\,(z,\,n)$ represents the number of inelastic events obtained from MC generator corresponding to one of the event classes quoted in Tab. **??**.

In case that vertex was not reconstructed ($n=0$), we have

$$I\,(z,\,0) = E^{*}_{\mathrm{trig}}\,(0)\,\alpha^{*}\,(z)\,F\,(z)\,\tilde{C}_{\mathrm{trig}}\,(z,\,0)\;. \tag{8}$$

Here $E^{*}_{\mathrm{trig}}\,(0)$ gives the measured number of events which triggered but where an interaction vertex was not reconstructed. These events are then distributed in the vertex diamond according to the measured distribution of vertex positions

$$\alpha^{*}\,(z) = \frac{\sum_{n=1}^{\infty} E^{*}_{\mathrm{trigvtx}}\,(z,\,n)}{\sum_{n=1}^{\infty} \int dz E^{*}_{\mathrm{trigvtx}}\,(z,\,n)}\;. \tag{9}$$

The function $F\,(z)$ is a MC based correction which relates the shape of vertex distribution in events where a vertex was not reconstructed and the vertex distribution from reconstructed vertices

$$F\,(z) = \frac{E_{\mathrm{trig}}(z,\,0)/\int dz E_{\mathrm{trig}}(z,\,0)}{\sum_{n=1}^{\infty} E_{\mathrm{trigvtx}}(z,\,n)/\sum_{n=1}^{\infty}\int dz E_{\mathrm{trigvtx}}(z,\,n)}\;. \tag{10}$$

Simulated and real events were divided into 6 multiplicity bins ($n=0$, 1, 2, 3, 4, 5 to ∞) and 8 bins in z vertex position (bin borders -10, -6, -3, -1.5, 0, 1.5, 3, 6, 10 cm).

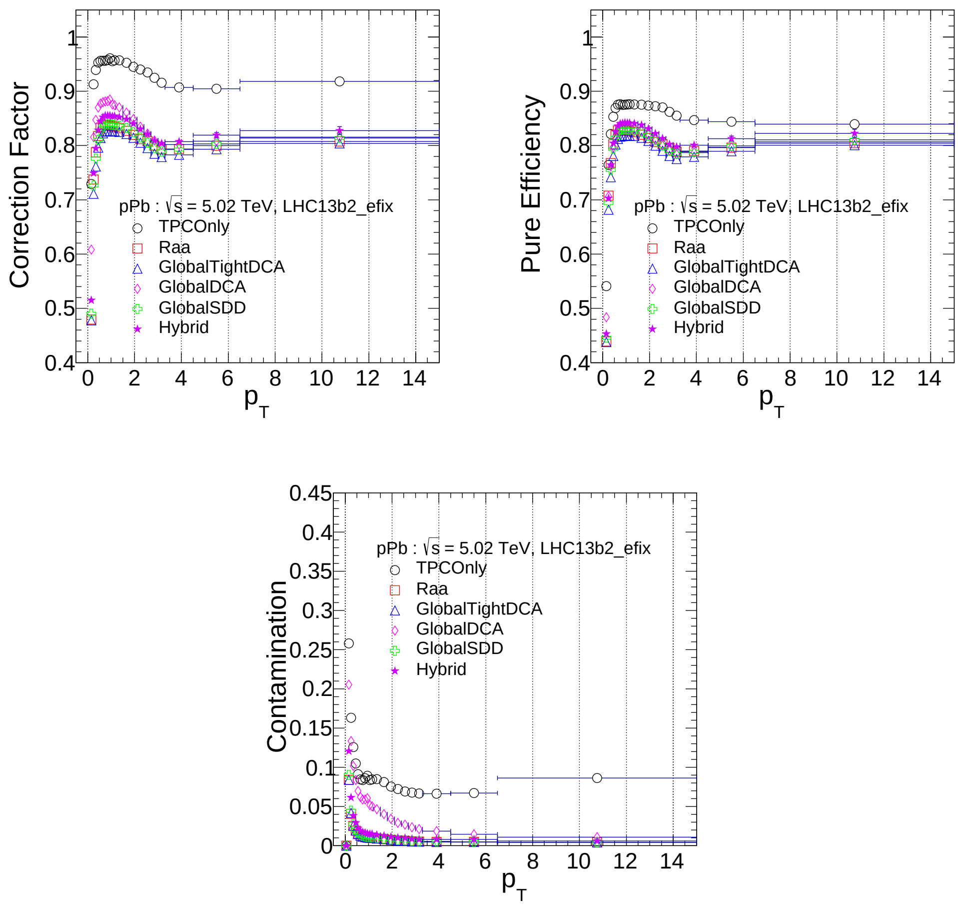


Fig. 1: Top: Inverse of the overall reconstruction correction of reconstructed charged tracks selected with various cuts. Middle: Corresponding true efficiency. Bottom: Corresponding contamination. Data are from the MC tune.

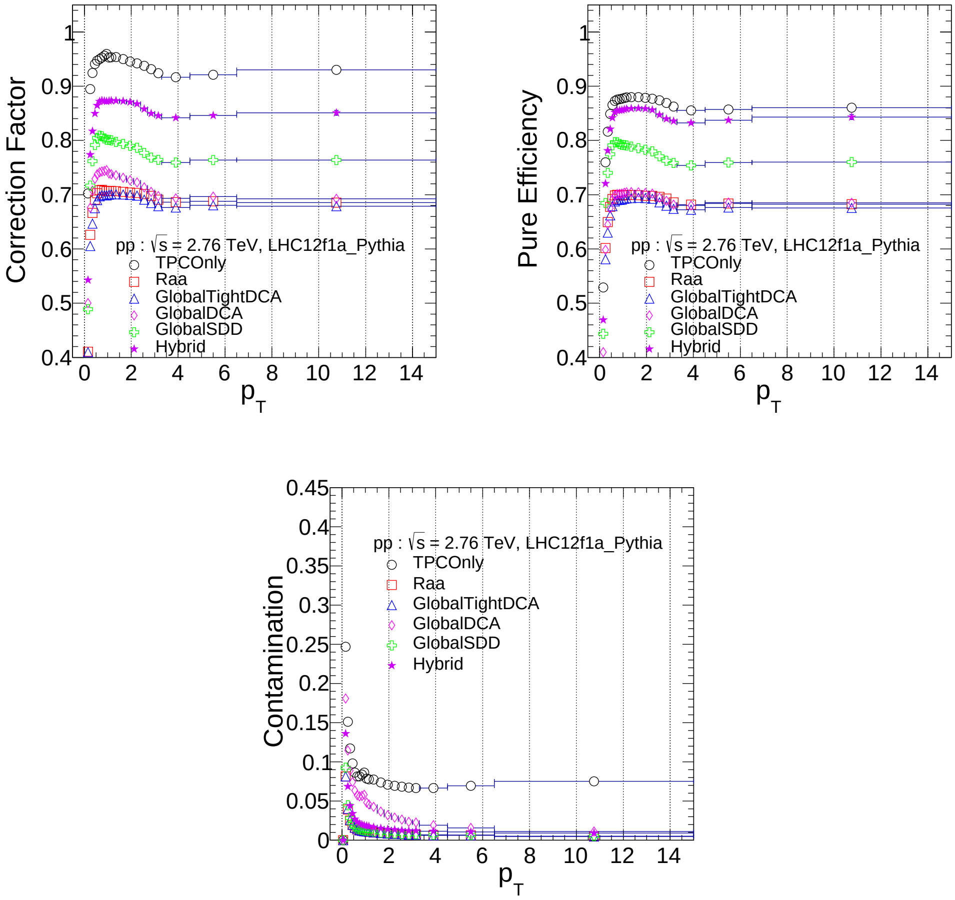
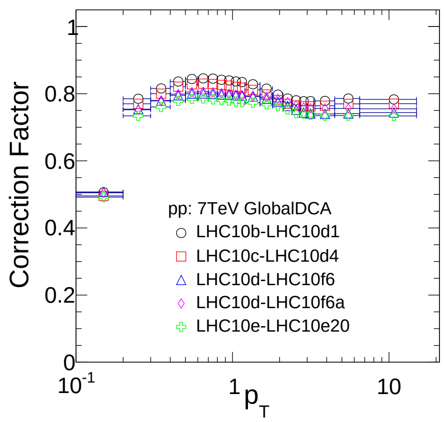
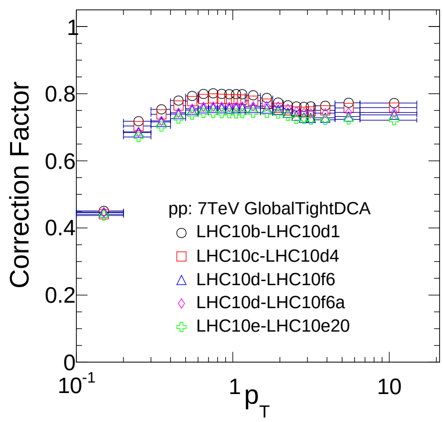


Fig. 2: Top: Inverse of the overall reconstruction correction of reconstructed charged tracks selected with various cuts. Middle: Corresponding true efficiency. Bottom: Corresponding contamination. Data are from the MC tune.





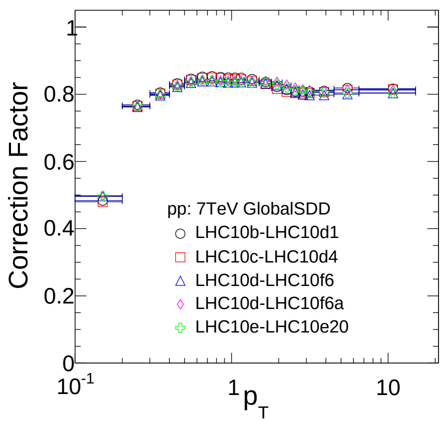


Fig. 3: Top: Inverse of the overall reconstruction correction of reconstructed charged tracks selected with various cuts. Middle: Corresponding true efficiency. Bottom: Corresponding contamination. Data are from the MC tune.

4.2 Comparison of charged track p_{T} spectra with the published result

We compare our inclusive spectra to the published ALICE results for each data sets. $p+Pb$ charged particle spectra from our analysis is compared with the published data [4] in different bins of η windows and good agreement is shown in Fig 4. p–p$\sqrt{s}$=2.76 and 7 TeVspectra from our analysis is compared with the published data [5] and good agreement for 7 TeV and 5% difference in 2.76 TeV is observed and shown in Fig 5 and 6. Since there is no Raa or Hybrid cut for MC tuned AOD for 7 TeV, we have used 3 different sets of cuts available and difference among the cut variations are below few % level.

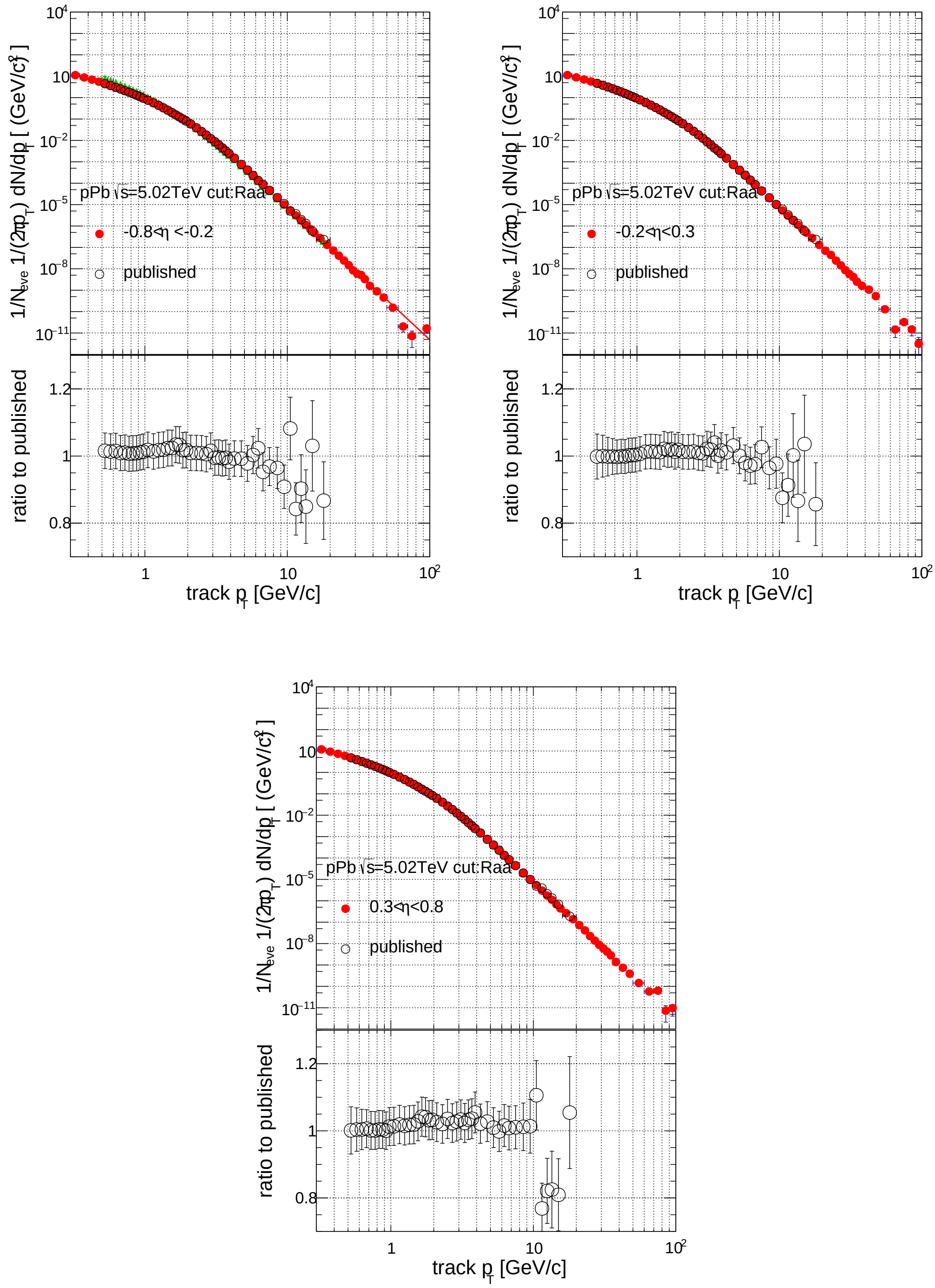


Fig. 4: The spectra from this analysis in $p+Pb\sqrt{s}$= 5.02 TeV is compared with the published ALICE data [4].

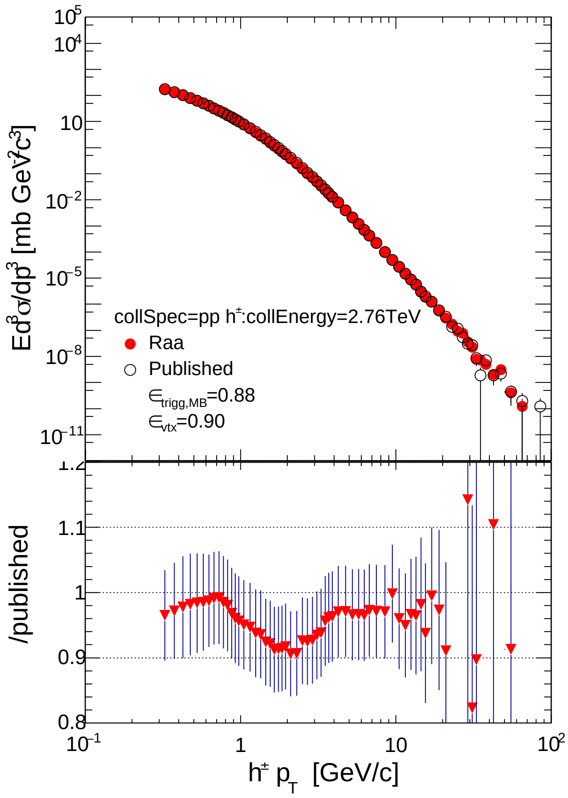


Fig. 5: The spectra from this analysis in p–p $\sqrt{s}$= 2.76 TeVis compared with the published ALICE data [5].

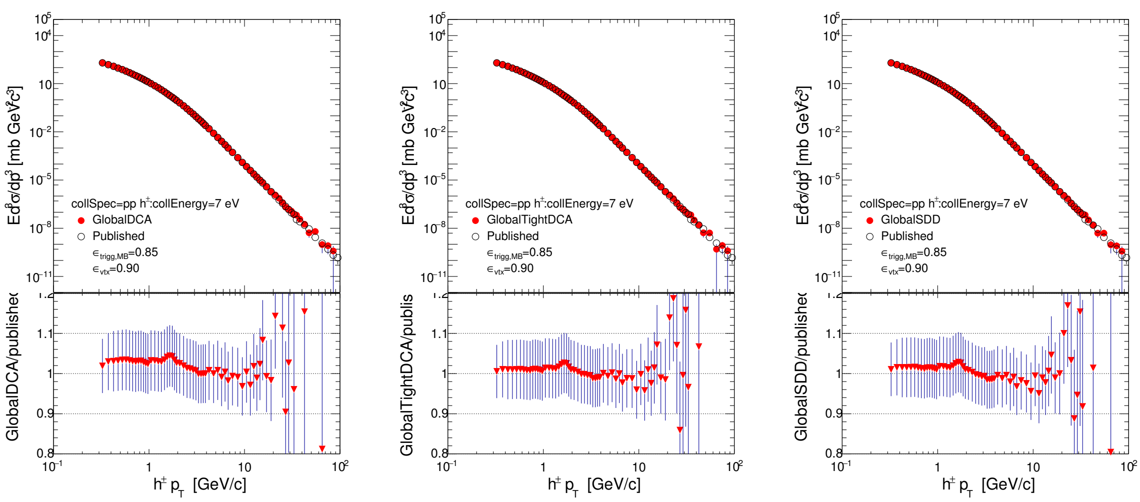


Fig. 6: The spectra from this analysis in p–p $\sqrt{s}$= 7 TeV is compared with the published ALICE data [5].

References

[1] J.F. Grosse-Oetringhaus, *Measurement of the Charged-Particle Multiplicity in Proton+Proton Collisions with the ALICE Detector*, CERN-THESIS-2009-033.

[2] A.Adare. , J.F. Grosse-Oetringhaus, A. Morsch, *Azimuthal Correlations in Pb+Pb Collisions*, AN version 5, 5 Sep. 2011.

[3] Phys. Rev. Lett. 108, 092301 (2012).

[4] Eur. Phys. J. C 74 (2014) 3054, *Transverse momentum dependence of inclusive primary charged-particle production in p-Pb collisions at* $\sqrt{s_{\rm NN}} = 5.02$ *TeV*

[5] B. B. Abelev *et al.* [ALICE Collaboration], Eur. Phys. J. C **73**, 2662 (2013) [arXiv:1307.1093 [nucl-ex]].