Study of single-muon and J/Ψ production in pp collisions at $\sqrt{s}$ = 2.76 TeV as a function of multiplicity with ALICE

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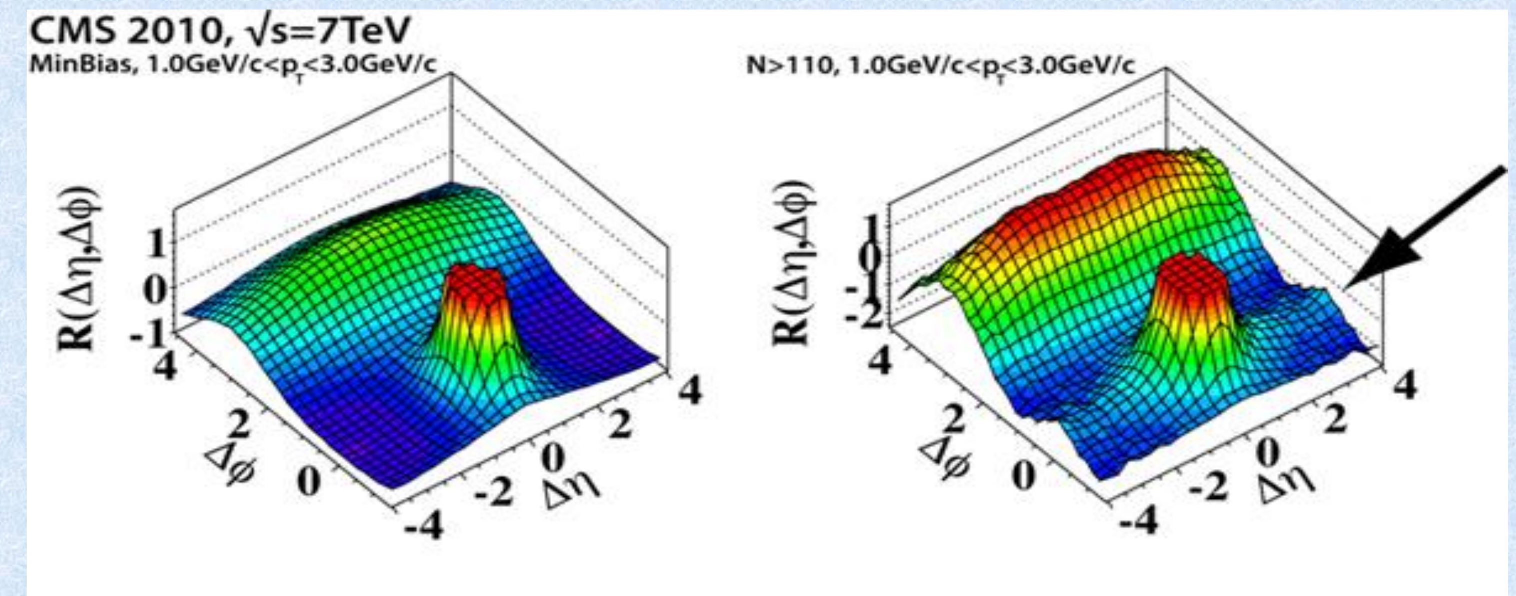
For the ALICE Collaboration

Physics Motivations

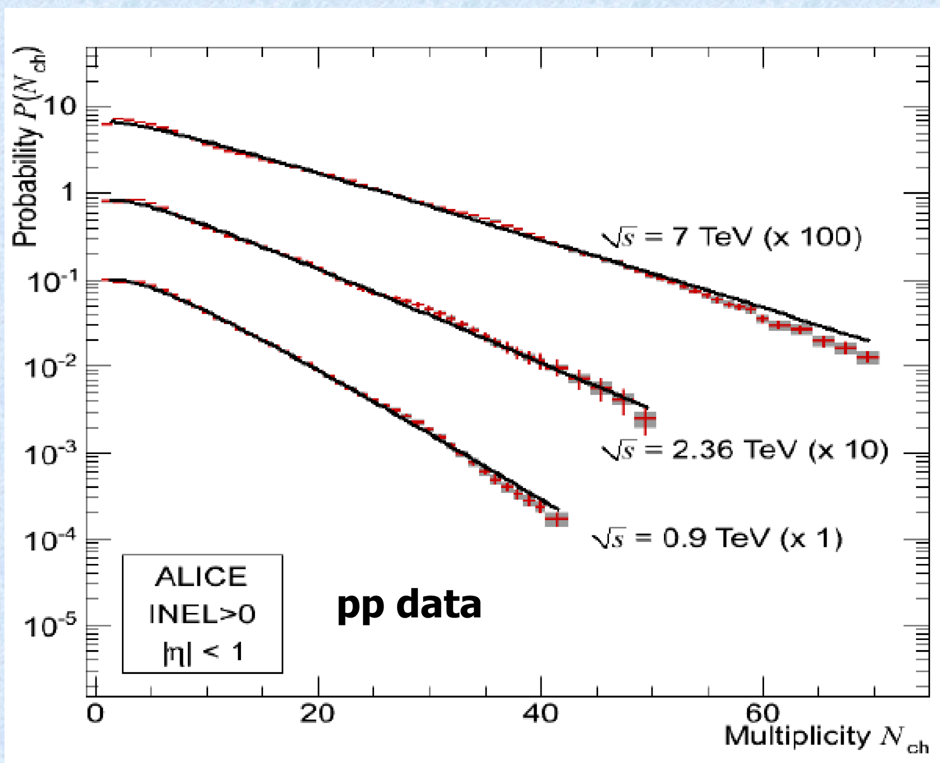
With advent of the LHC, proton-proton collision with unprecedented charged multiplicity can be studied, offering the possibility of investigating collective effects also in elementary collisions. One of the first surprises was the measurement of long range Δη-Δφ correlations by the CMS collaboration in high multiplicity pp collisions at $\sqrt{s}$ = 7 TeV [1]. The long range near side angular correlation (ridge effect) is shown on right.

It is interesting to note that charged particle densities attained in 7 TeV pp collisions approach the values characteristic for intermediate-centrality Cu-Cu collisions measured at RHIC, $dN_{ch}/d\eta$ = 30 [2]. One may speculate if such a high multiplicity may lead to the observation of collective effects. These collective effects can be studied by investigating multiplicity dependence of various observables commonly studied as probes of Quark Gluon Plasma in heavy-ion collisions.

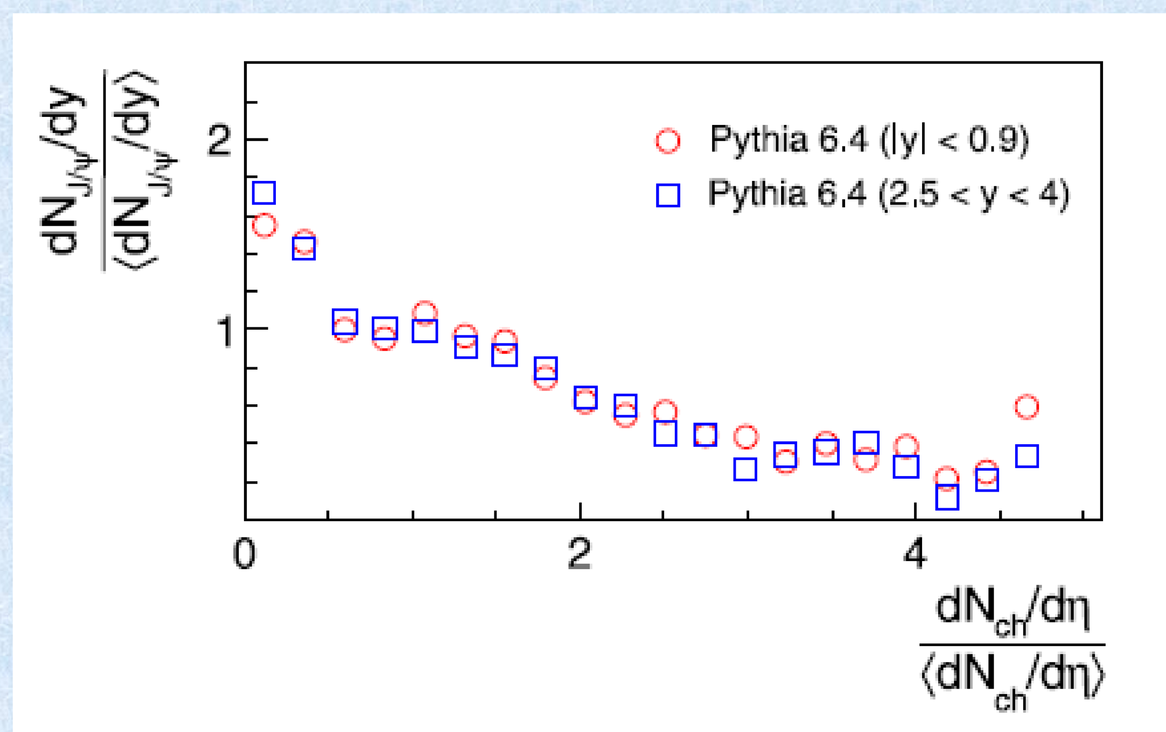
[1]CMS Collaboration, JHEP 1009, 091 (2010); [2] PHOBOS Collaboration, PRC 83, 024913 (2011); [3] ALICE Collaboration, EPJC 68, 89 (2010), EPJC 68, 345 (2010); [4] ALICE Collaboration, PLB 712,165 (2012).



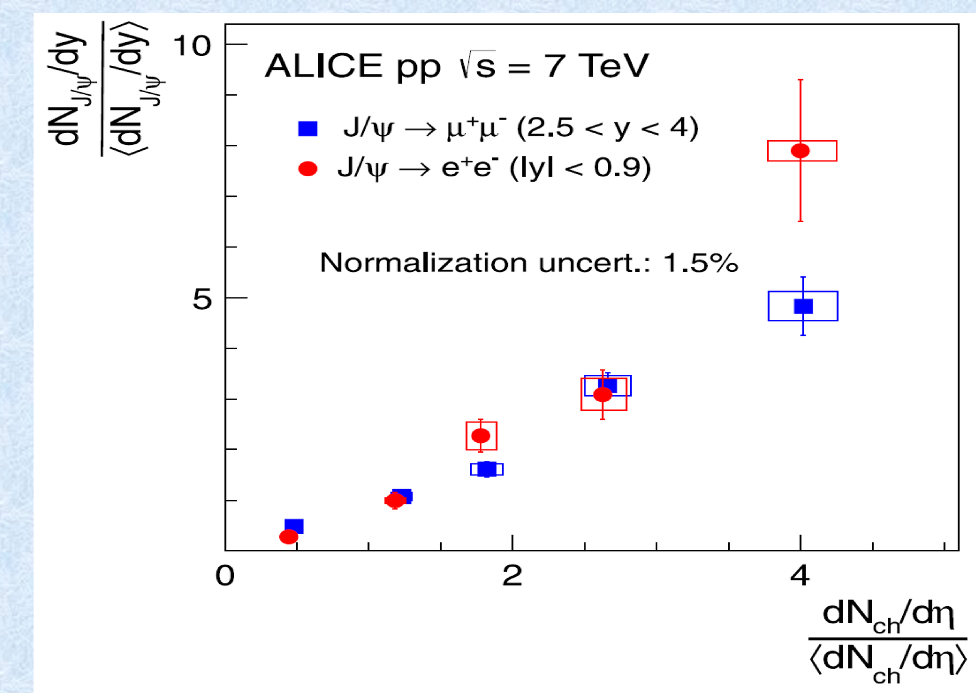
Two particle correlation function for 7 TeV pp for intermediate p_T range, minimum bias events (left) and high multiplicity events (right) [1].



Charged Particle Multiplicity in pp collisions measured in |η| < 1 with ALICE experiment [3].



The relative J/Ψ yield dN_{ch}/dy as a function of relative charged particle multiplicity densities around mid-rapidity $dN_{ch}/d\eta$ as calculated with "reference" event generator [4].



J/Ψ yield $dN_{J/\psi}/dy$ as a function of the charged particle multiplicity densities at mid-rapidity $dN_{ch}/d\eta$. Both the values are normalized by the corresponding value for minimum bias pp collisions ($dN_{J/\psi}/dy$, $dN_{ch}/d\eta$) [4].

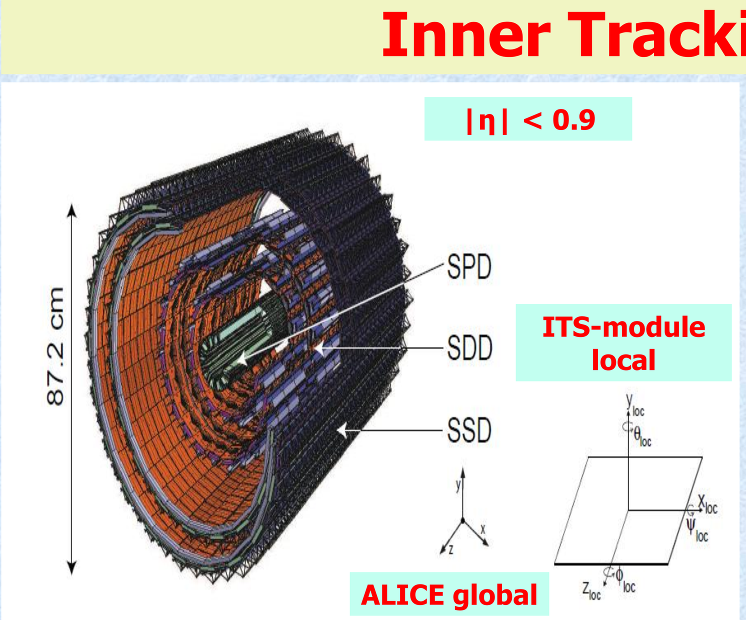
Present Work

We are investigating the production of J/Ψ and single μ at forward rapidity as a function of the charged particle density ($dN_{ch}/d\eta$) measured at mid-rapidity in pp collisions at $\sqrt{s}$ = 2.76 TeV with the ALICE detector. A similar study in pp collisions at higher energy $\sqrt{s}$ = 7 TeV was already carried out for the J/Ψ production [4]; it was shown that the J/Ψ yield significantly increases in high-multiplicity pp collisions. The "reference" event generator PYTHIA (6.4.25 in the Perugia 2011 tune) can not reproduce this behaviour.

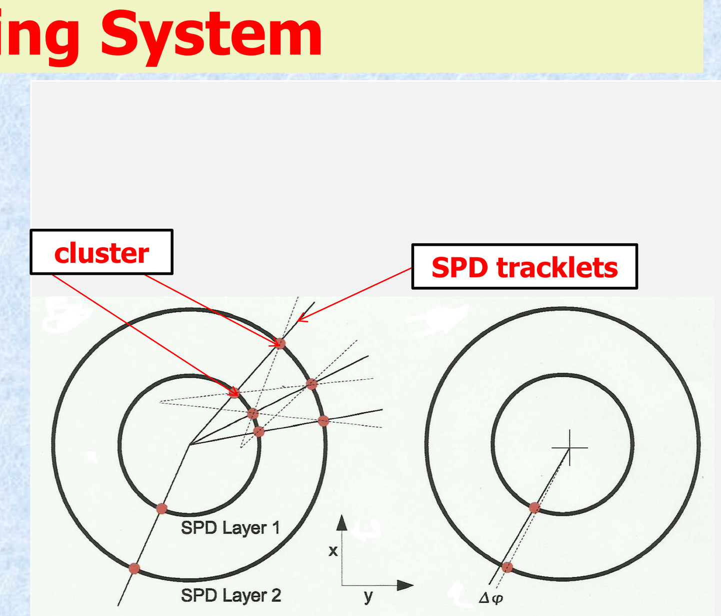
Multiplicity in ALICE

In this analysis the ALICE charged hadron multiplicity is measured through the two innermost layers (i.e. the SPD, Silicon Pixel Detector) of ITS (Inner Tracking System). The multiplicity estimator is the number of SPD tracklets reconstructed in the SPD in acceptance |η|<1.

Inner Tracking System

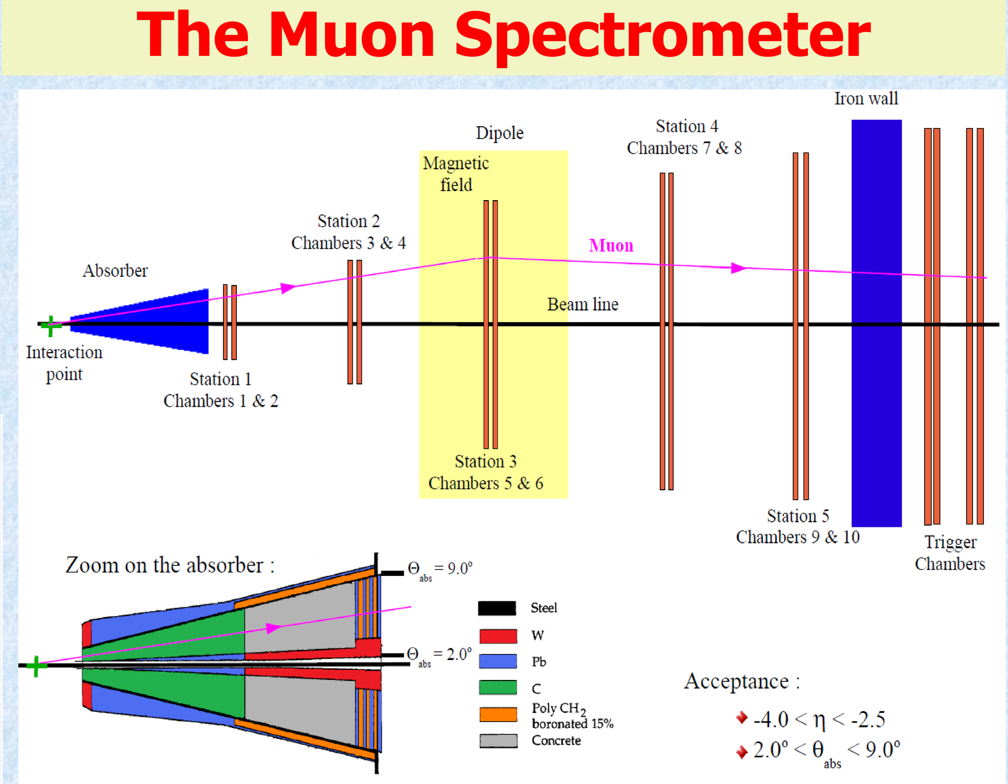


The global reference system has indeed its origin in the middle of ITS, so that the z direction coincides with the beam line [JINST 5 P03003 [2012].



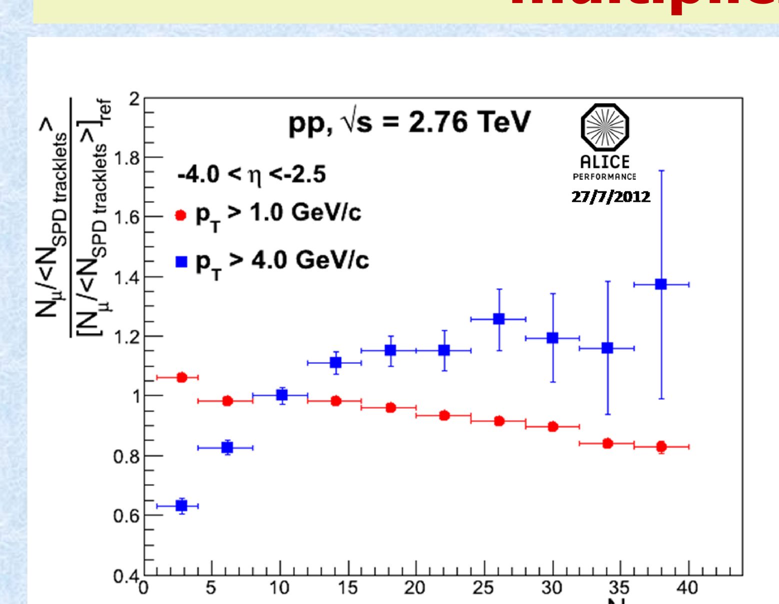
Graphical view of the definition of SPD tracklets.

The Muon Spectrometer



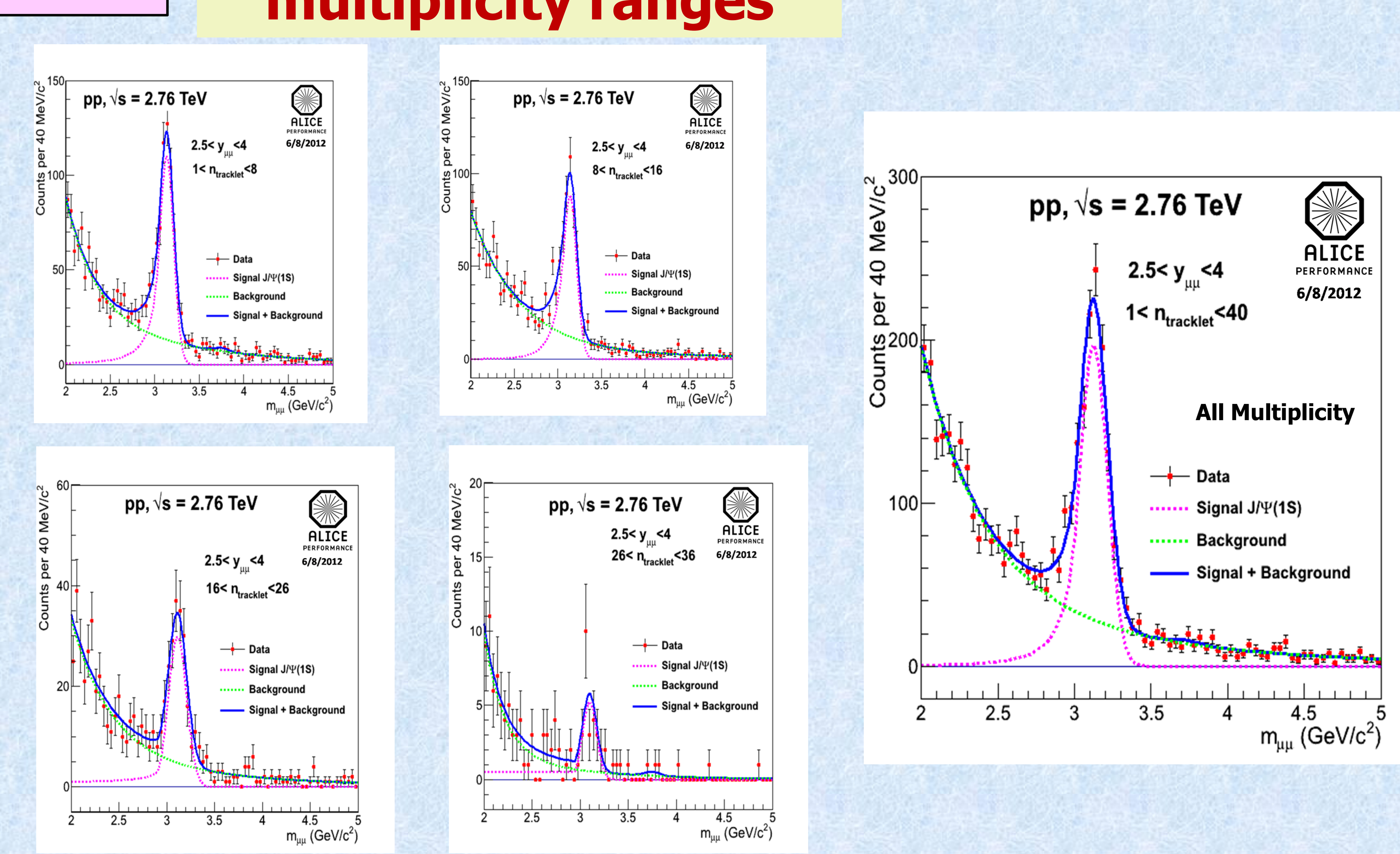
The single μ and J/ψ are detected using the muon spectrometer of ALICE.

Single μ yield per average SPD tracklet multiplicity

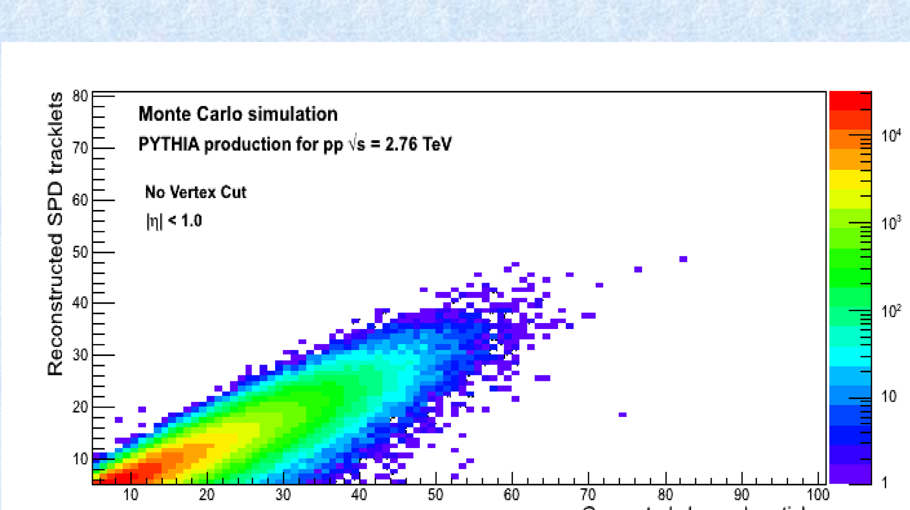


The raw single muon yield in a given multiplicity bin is divided by the average number of SPD tracklets and then normalized to a reference bin (the third in figure). The single μ yield at low p_T is close to unity for all multiplicities, while at high p_T it increases and then flattens out with the increasing number of SPD tracklets.

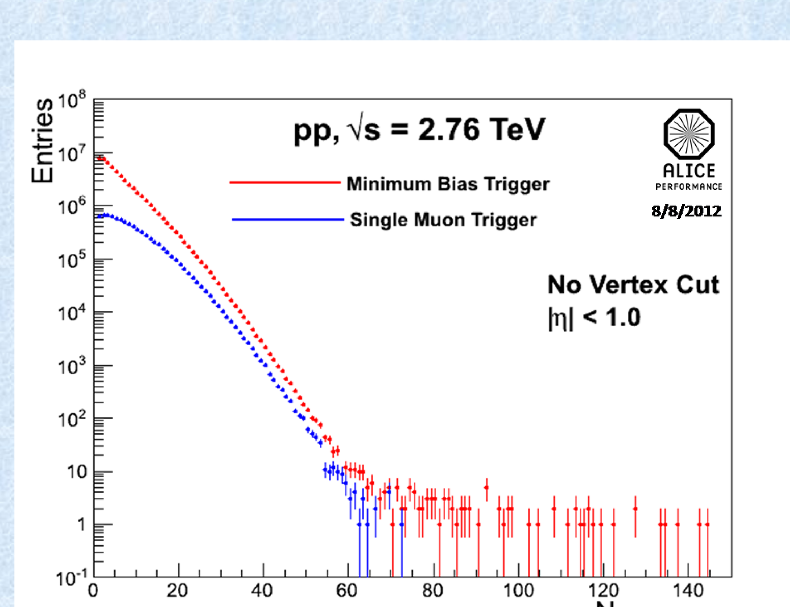
J/Ψ yield in different multiplicity ranges



The J/Ψ yield is extracted by fitting the dimuon invariant mass spectrum corresponding to several charged multiplicity ranges (see plots). The analysis is currently in progress with the evaluation of realistic efficiencies and acceptance via MC simulations, and with the estimate of the various systematic uncertainties.



The real charged particle density would be corresponding multiplicity corrected by the ratio of number of reconstructed SPD tracklets and number of generated charged particles; divided by the η range. The ratio is constant with multiplicity.



Raw multiplicity distribution for Minimum Bias and Single Muon Trigger events.