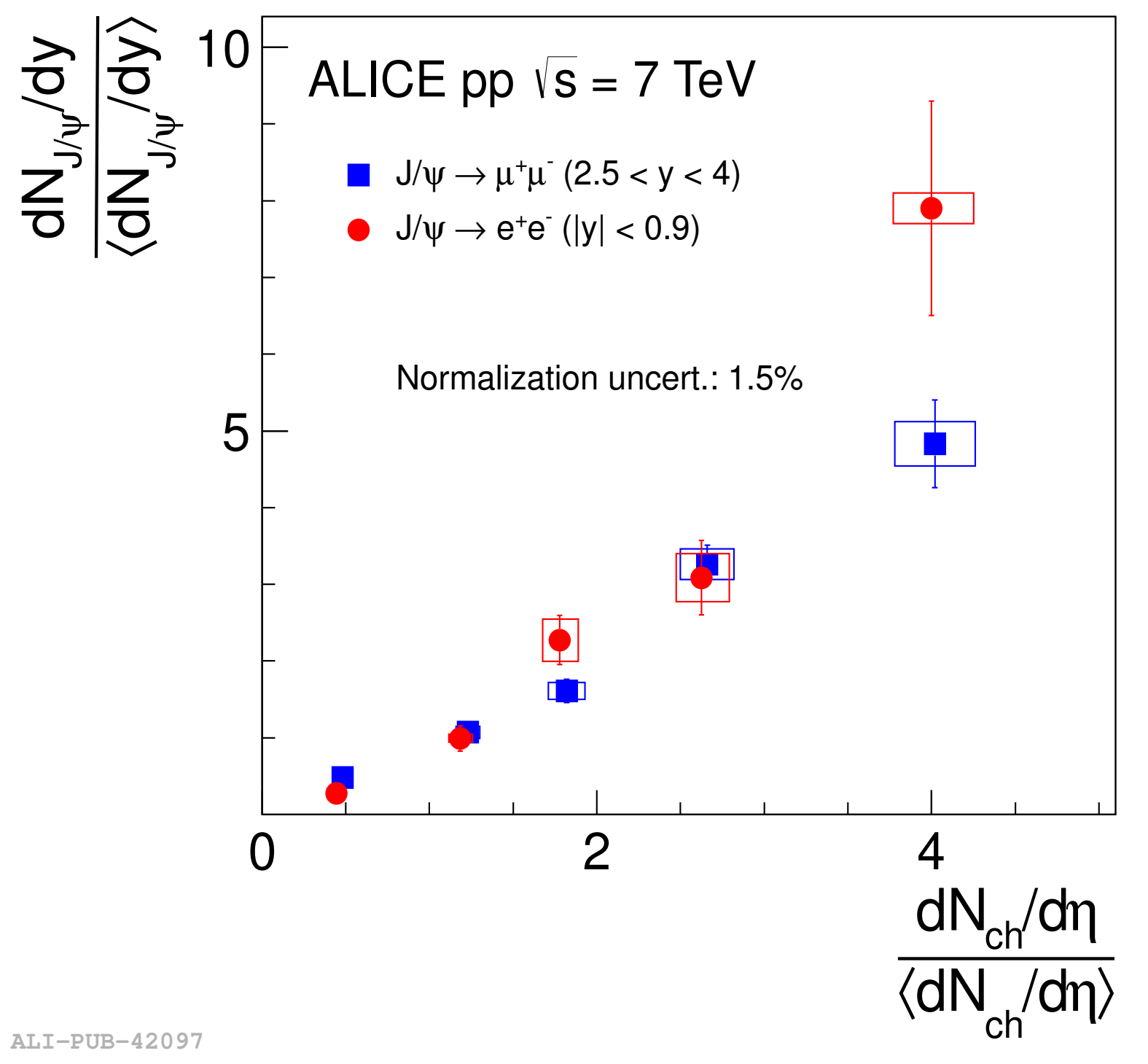
CHARGED PARTICLE MULTIPLICITY DEPENDENCE OF J/ψ PRODUCTION IN p-Pb COLLISIONS

Javier Martin Blanco* for the ALICE Collaboration
* SUBATECH Laboratory, Nantes, France

MOTIVATION

Study the correlation of the J/ψ yield and its <p_T> with the density of charged particles produced in the collision.

Particle production as a function of multiplicity is a useful tool to study the presence of **collective-like effects** in small size systems compared to Pb-Pb, such as pp and p-Pb collisions.



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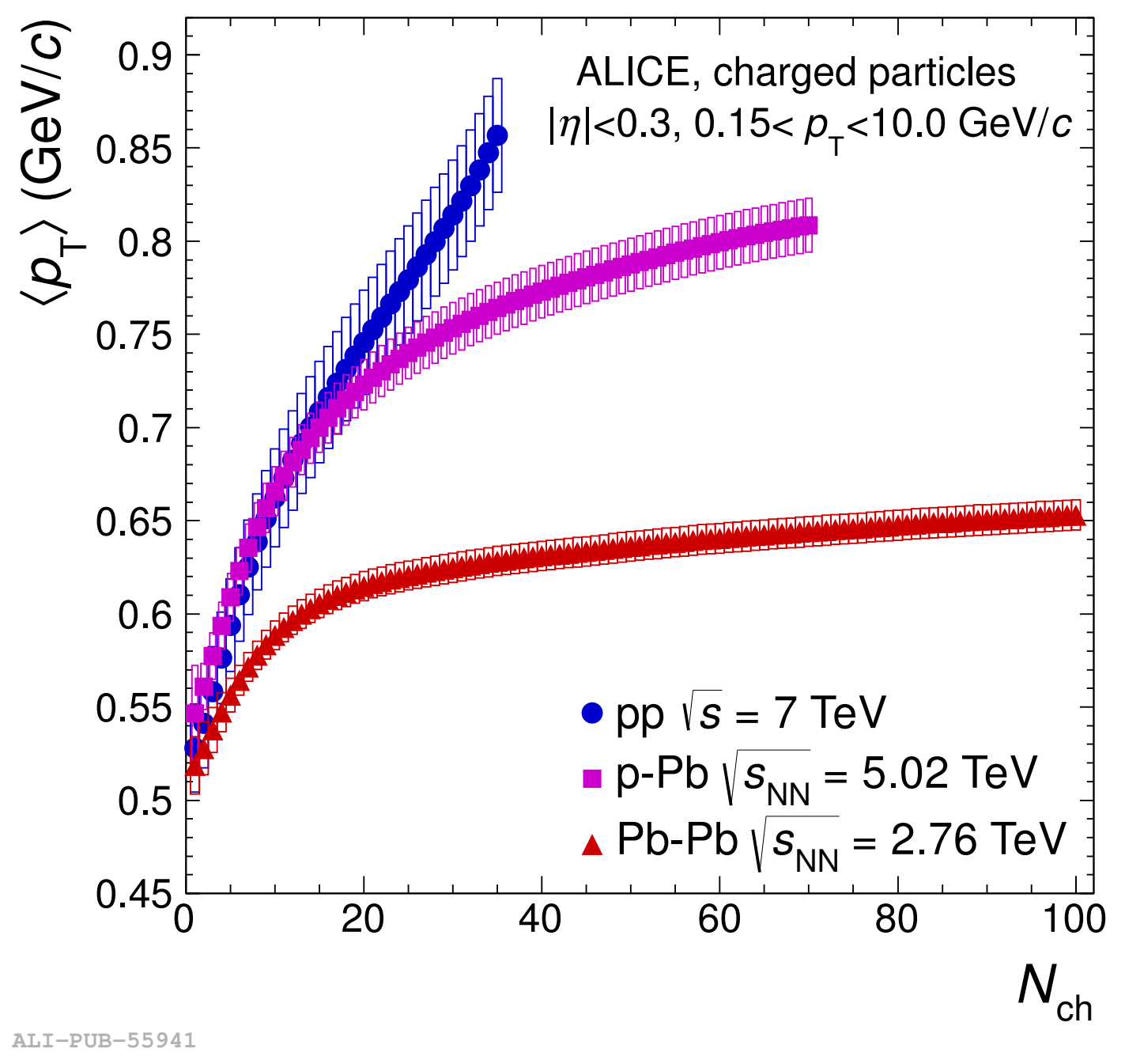

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- Strong increase of J/ψ yields with multiplicity in pp. Can be reproduced by multi-parton interactions and initial state effects (parton saturation or string interactions) [1,2].
- Strong increase of charged particle <p_T> in pp. Can be reproduced by multi-parton interactions and final state effects (Color reconnections) [3].
- The charged particle <p_T> saturation in Pb-Pb collisions is ascribed to particle thermalisation in the medium. Collective hydrodynamic-type behaviour.
- Charged particle <p_T> in p-Pb has pp features at low multiplicity and Pb-Pb ones at high multiplicity.

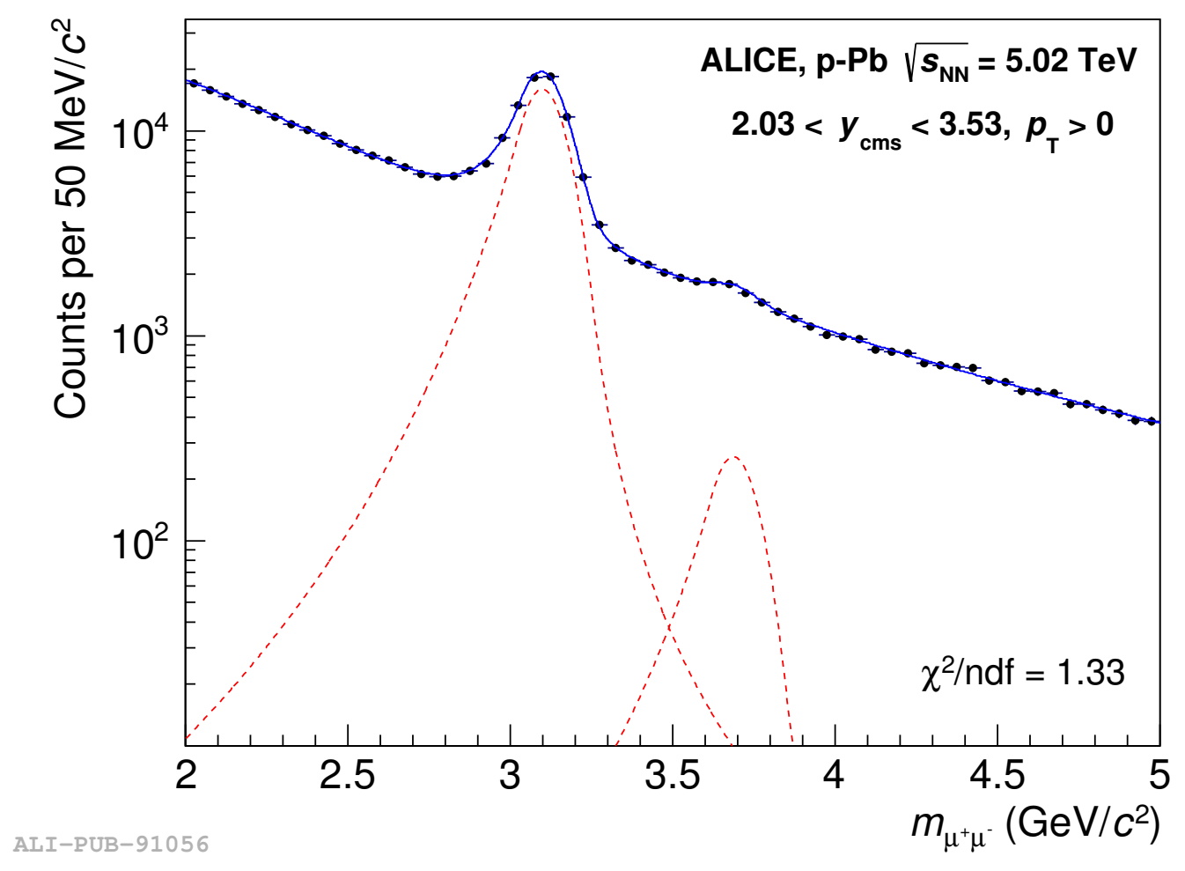
J/ψ yield and <p_T> results as a function of multiplicity in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV may help to constrain models to improve the understanding on particle production and the role of initial and final state effects.

J/ψ YIELD MEASUREMENT

In 'standard' analysis, the J/ψ signal is extracted by fitting the **raw opposite-sign dimuon** invariant mass spectra [4,5] :

- **Fitting function for signal** : Crystal ball extended or pseudo-Gaussian
  - ✶**Tails parameters** : Fixed from the pure J/ψ signal simulation
- **Fitting function for background** : variable width gaussian or POL2×EXP
- **Fitting range** : 2 - 5 or 2.2- 4.7 GeV/c^2

The number of J/ψ is obtained by integrating the signal function and then correcting for the muon spectrometer Acc×ε.



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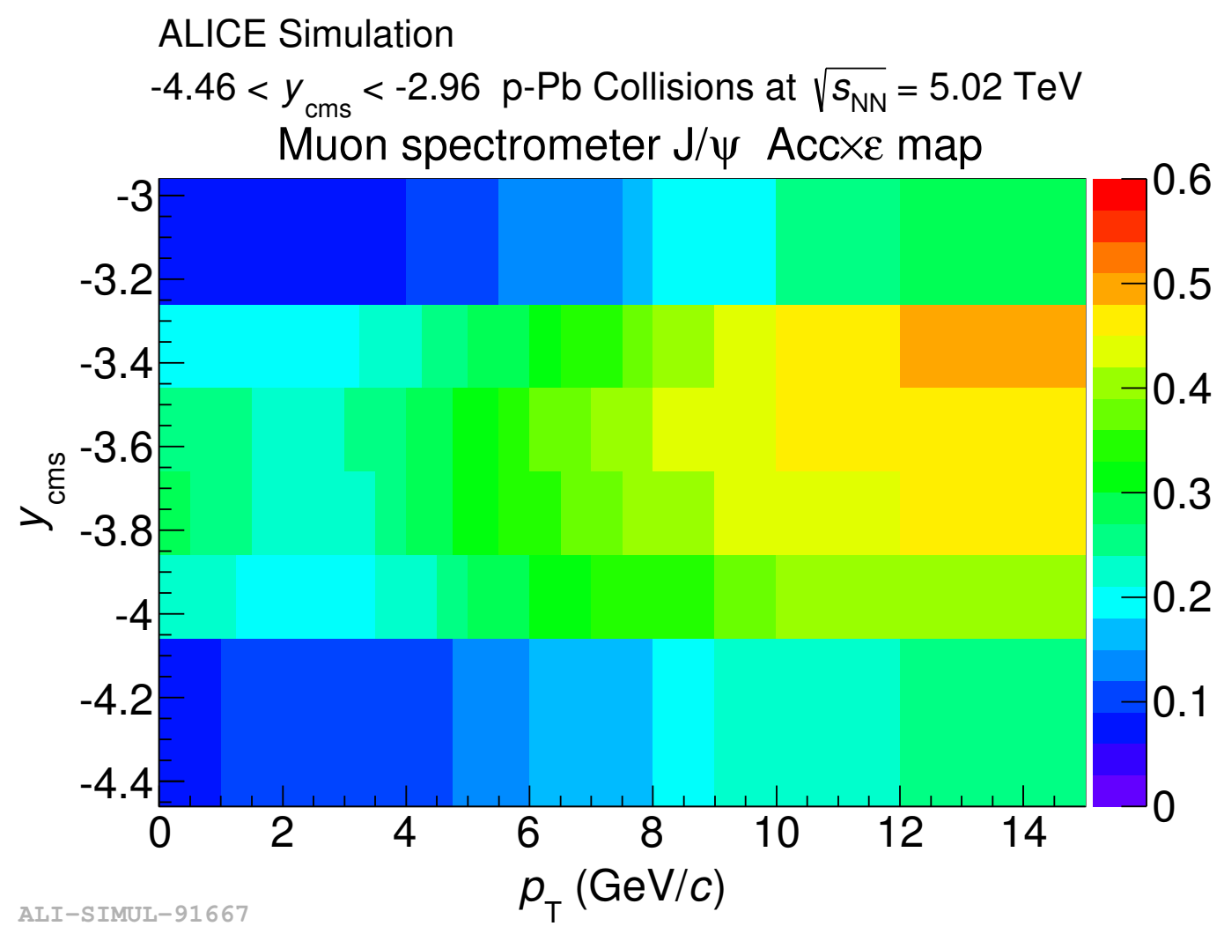
In the analysis procedure used to extract the J/ψ <p_T>, we need to **correct the dimuons for the Acc×ε prior to fit the mass spectra**. This is done by **weighting each dimuon by the two-dimensional (p_T,y) Acc×ε.**



- The corrected J/ψ signal can be obtained by following the same procedure as above with one difference:
  - ✶**Tails parameters**: Fixed from the pure J/ψ signal simulation corrected by J/ψ Acc×ε(p_T,y) as in data.

The number of J/ψ is obtained by integrating the signal shape already corrected by Acc×ε . Procedure less sensitive to variation of input kinematic distributions in the simulation.

Comparison of integrated J/ψ yield with published values [4] validates the method.

J/ψ <p_T> MEASUREMENT

The 'standard' method is to measure the J/ψ yield in p_T bins and fit the obtained p_T distribution to extract the <p_T>.

In this analysis we aim to **study effects that may arise at high multiplicities**, where the statistics is too low to use the 'standard' method.

The following approach allows to extract the J/ψ <p_T> **without slicing the dimuon sample in p_T bins**:

- Each dimuon is weighted by J/ψ Acc×ε.
- The invariant mass distribution of Acc×ε corrected dimuon <p_T> is fitted with the following formula:

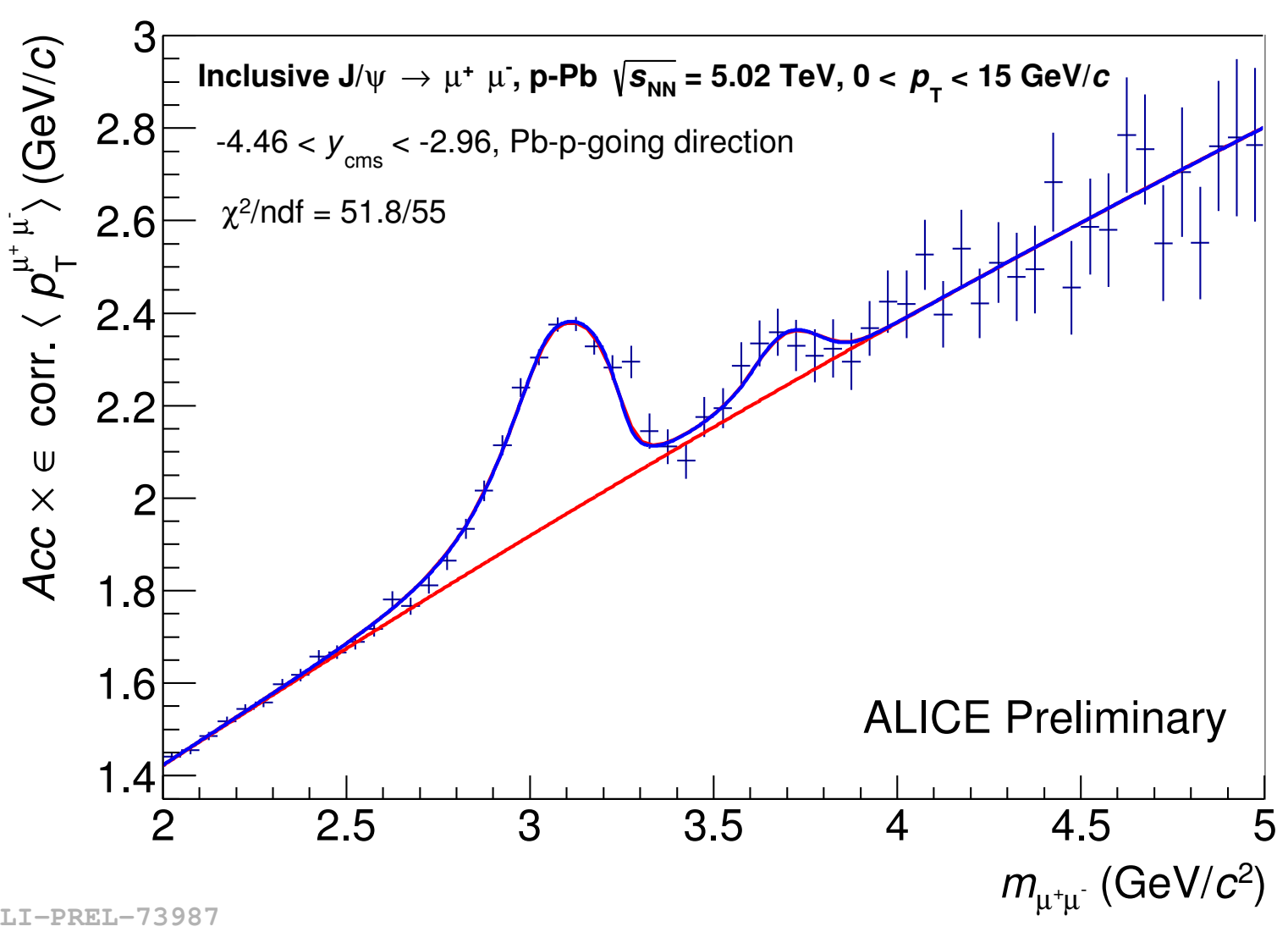
$$\boxed{\begin{gathered}\langle p_{\rm T}\rangle^{\mu^+\mu^-}(m_{\mu^+\mu^-}) = \alpha^{J/\psi}(m_{\mu^+\mu^-})\times\langle p_{\rm T}\rangle^{J/\psi} + \alpha^{\psi'}(m_{\mu^+\mu^-})\times\langle p_{\rm T}\rangle^{\psi'} + \\ (1-\alpha^{J/\psi}(m_{\mu^+\mu^-}) - \alpha^{\psi'}(m_{\mu^+\mu^-}))\times\langle p_{\rm T}\rangle^{bkg}\end{gathered}}$$

with:

$$\alpha(m_{\mu^+\mu^-}) = \frac{S(m_{\mu^+\mu^-})}{S(m_{\mu^+\mu^-}) + B(m_{\mu^+\mu^-})}$$

$$< p_T >^{J/\psi} \rightarrow constant$$
$$< p_T >^{\psi'} \rightarrow constant$$
$$< p_T >^{bkg} = pol2$$

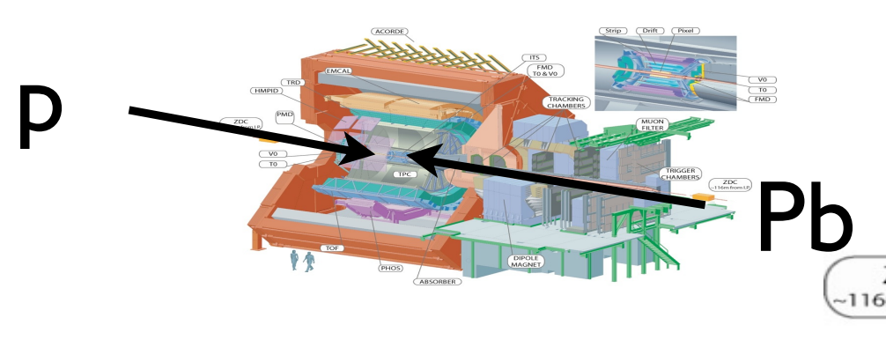
$S(m_{\mu\mu})$ and $B(m_{\mu\mu})$ are the signal and background contributions extracted from the fit to the Acc×ε corrected invariant mass spectra.



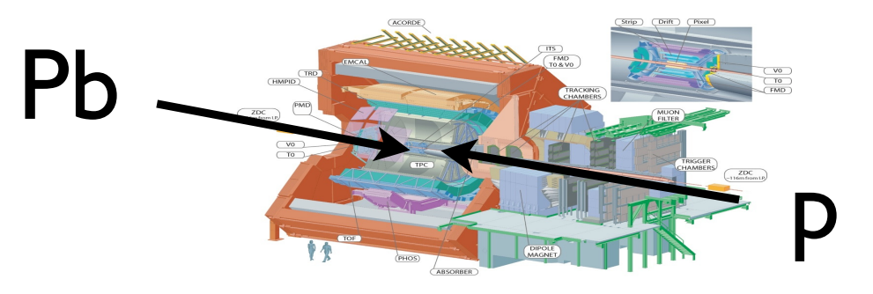
Comparison of multiplicity integrated J/ψ <p_T> with standard analysis validates the method.

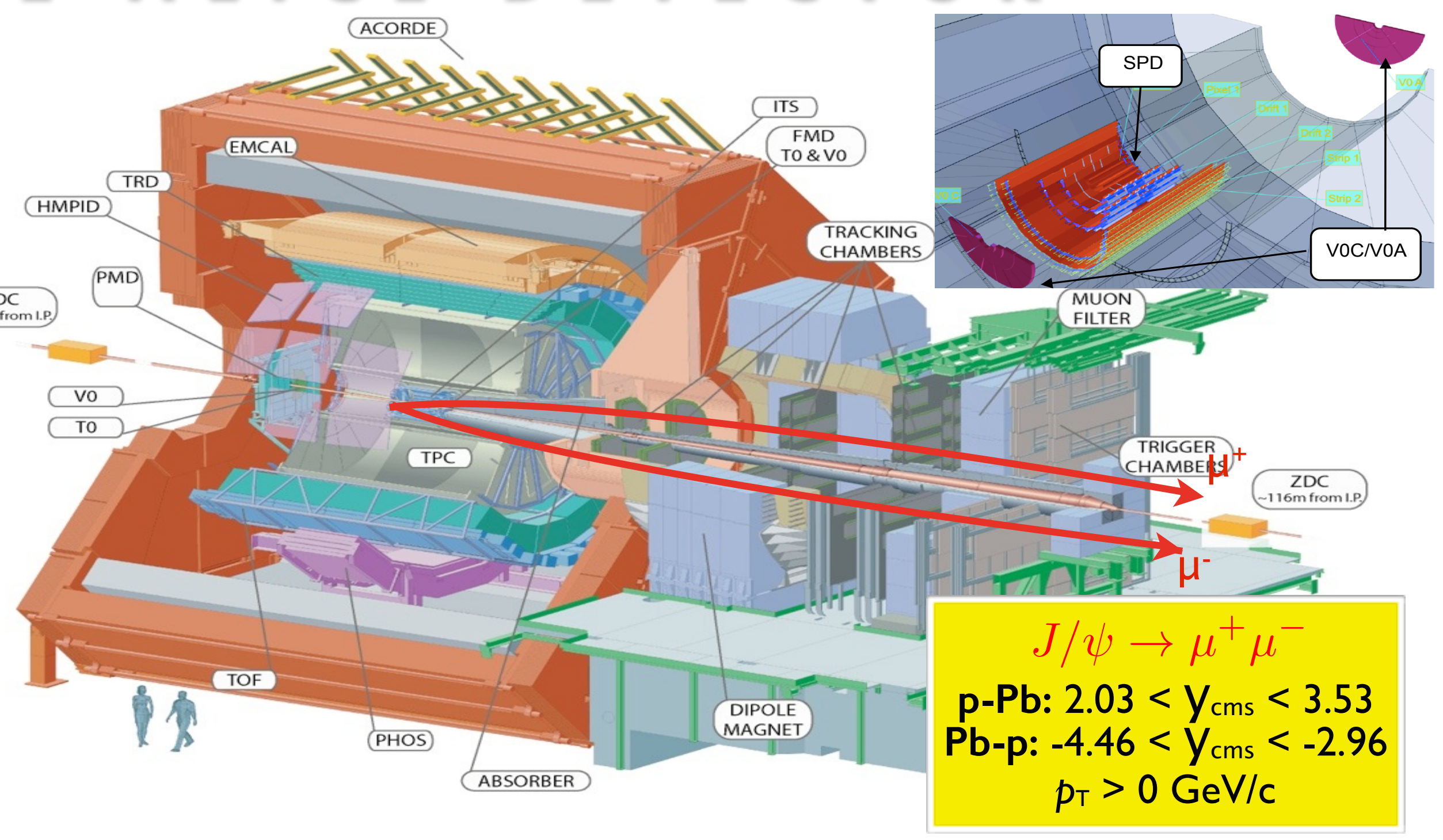
THE ALICE DETECTOR

p-Pb beam configuration:



Pb-p beam configuration:





$J/\psi \rightarrow \mu^+\mu^-$
p-Pb: 2.03 < y_{cms} < 3.53
Pb-p: -4.46 < y_{cms} < -2.96
p_T > 0 GeV/c

MULTIPLICITY DETERMINATION

The dN_{ch}/dη measurement is based on a **SPD tracklets analysis (|η|<1)**. The variation of the SPD efficiency with the z position of the primary vertex (z_{vtx}) is corrected using a **data-driven method** (Fig.1).

Fig. 1

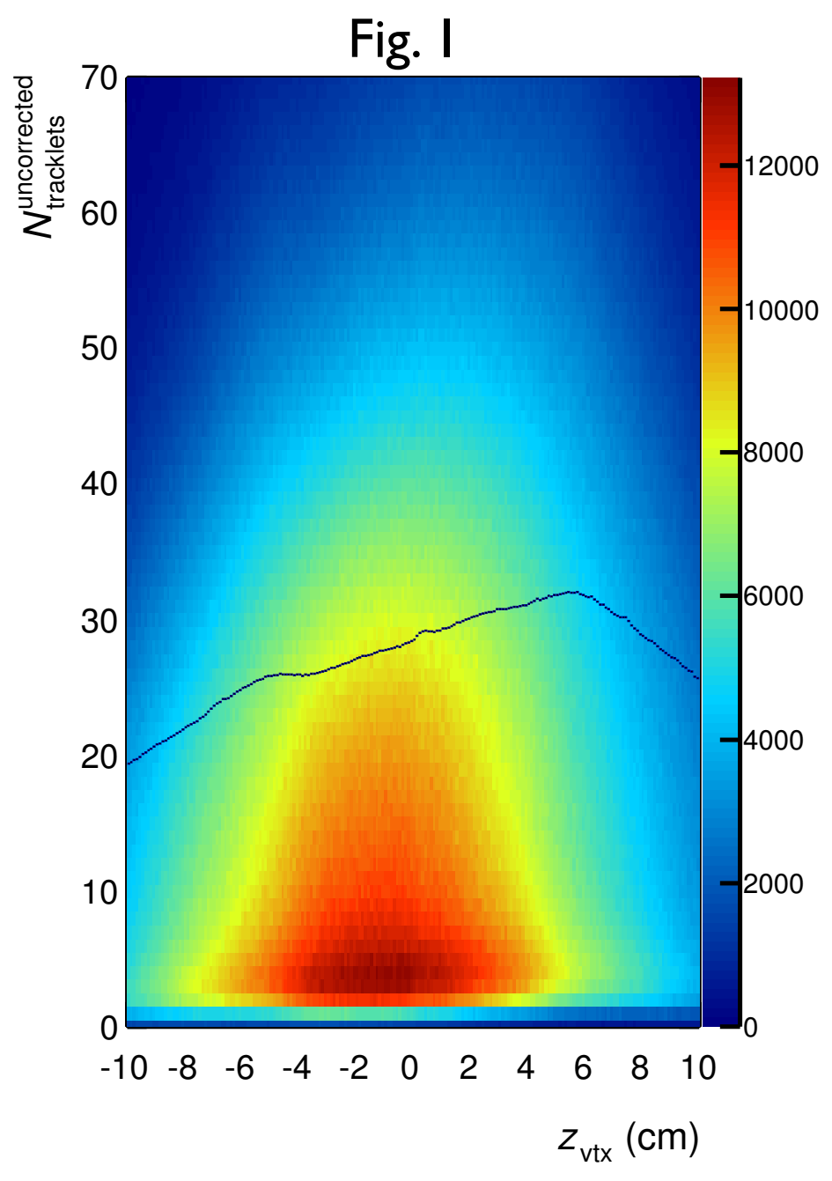
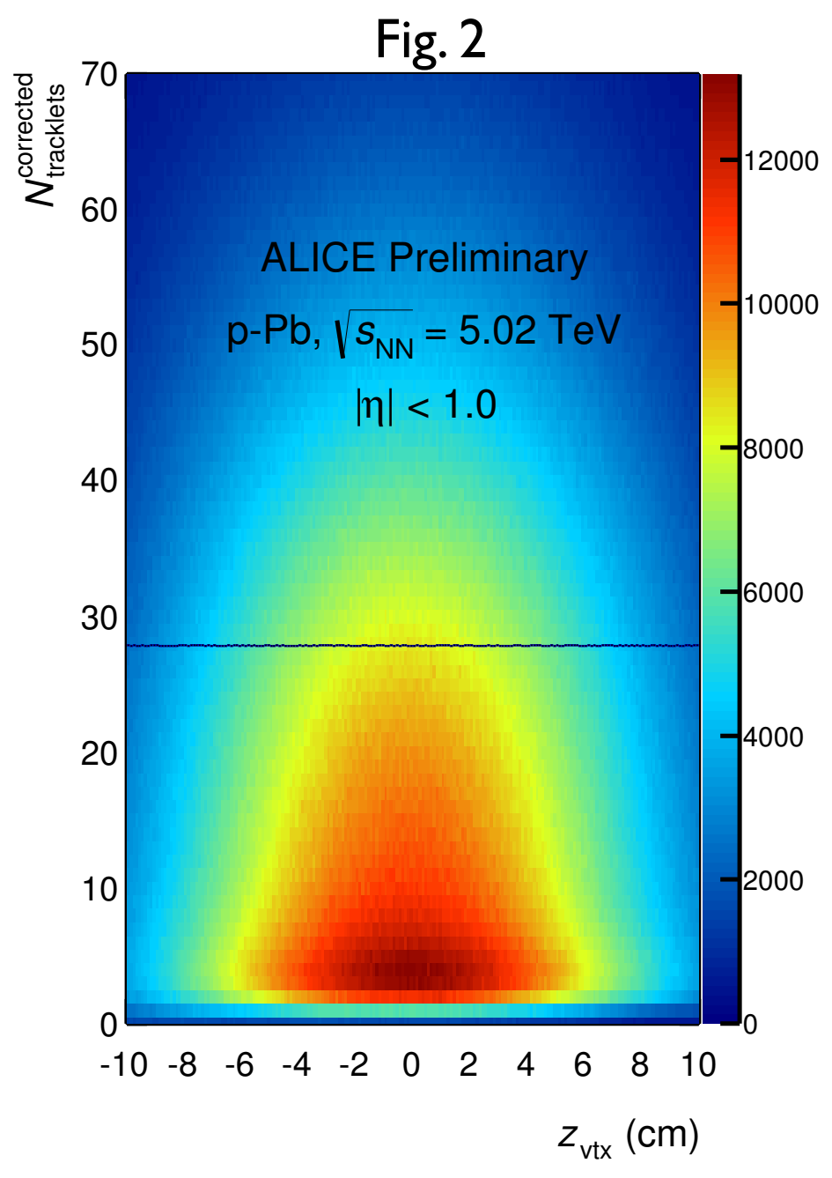


Fig. 2



The measured number of tracklets N_{tr} for an event in a given z_{vtx} is corrected with the following formula:

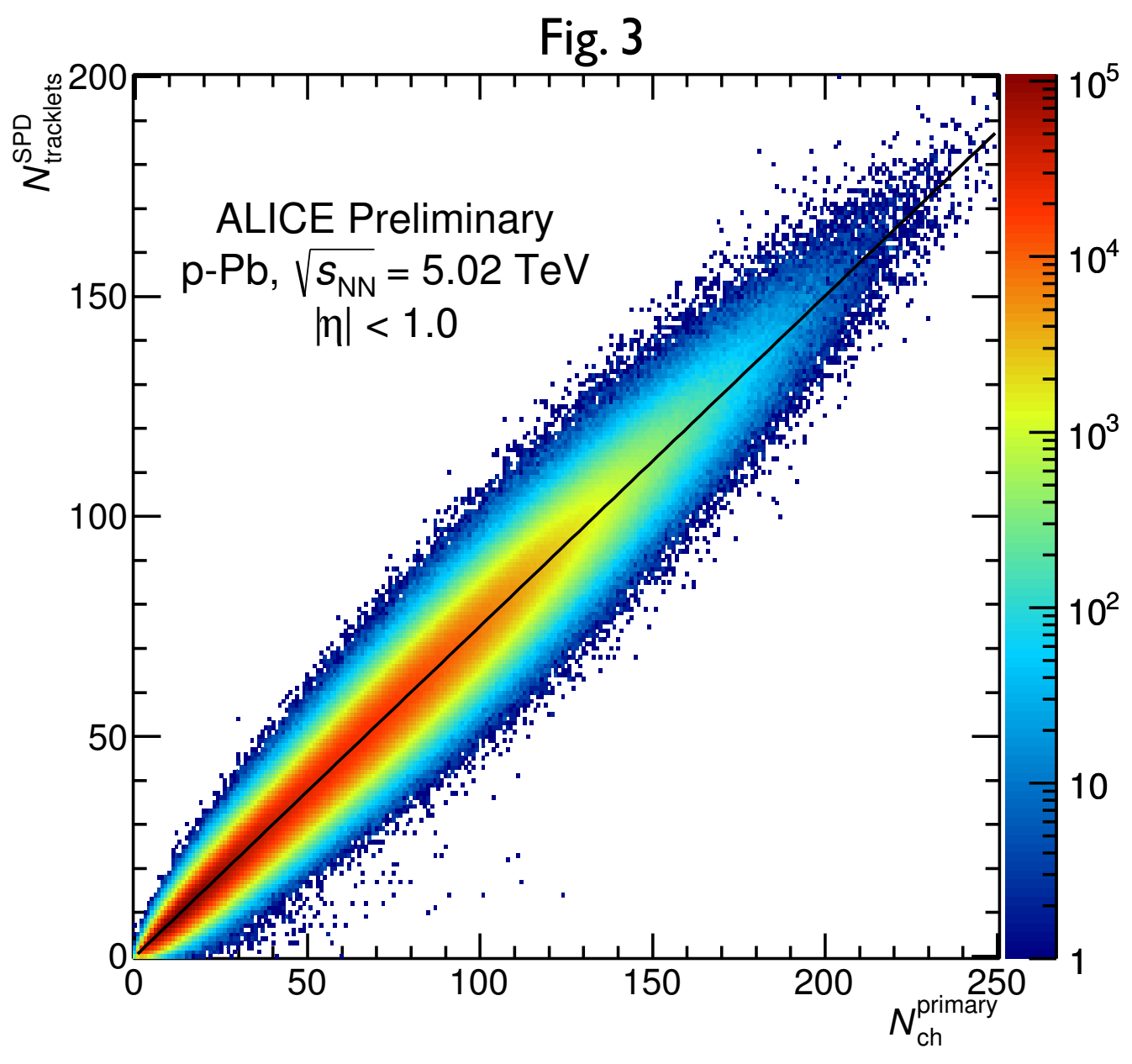
$$\boxed{\begin{gathered}N_{tr}^{corr} = N_{tr} + \Delta N_{rand} \\ \Delta N = N_{tr}(z)\frac{< N_{tr}(z_0) > - < N_{tr}(z) >}{< N_{tr}(z) >}\end{gathered}}$$

where ΔN_{rand} is supposed to follow a poissonian distribution with mean value ΔN, and z_0 is the position corresponding to the minimum in Fig. 1.

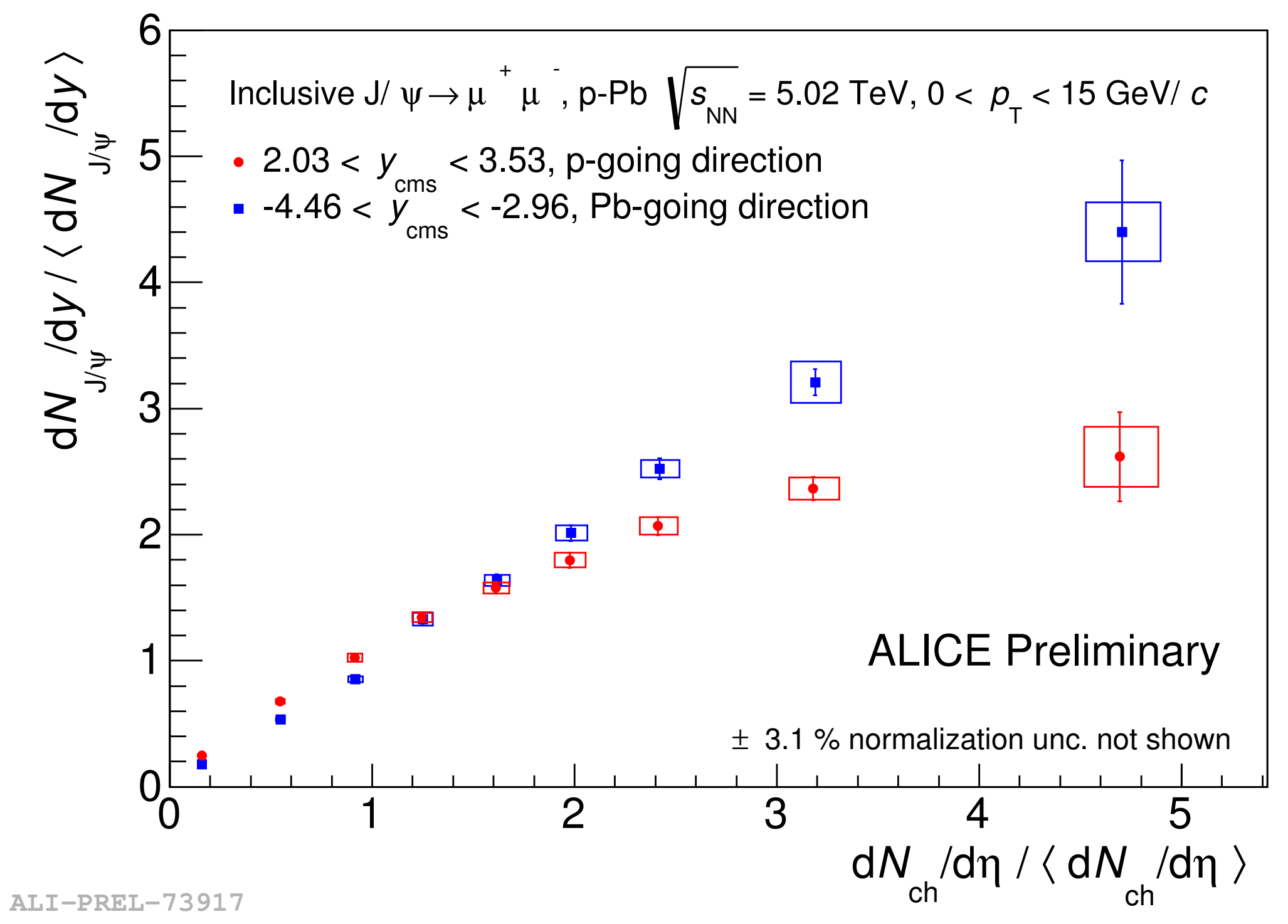
- This correction provides the event multiplicity, N_{tr}^{corr}, **as if the SPD efficiency was constant with z_{vtx} and it had the value of the SPD efficiency at the chosen reference z_0** (Fig.2).
- Then to get the particle multiplicity (N_{ch}) measurement we need to **correct for the efficiency loss at z_0, which slightly depends on the multiplicity.** The correction factors α_i are obtained from simulation in each multiplicity bin under study (Fig. 3).

$$\frac{\langle dN_{ch}/d\eta\rangle_i}{\langle dN_{ch}/d\eta\rangle} = \frac{\alpha_i \cdot \langle dN_{tr}^{corr}/d\eta\rangle_i}{\langle dN_{ch}/d\eta\rangle}$$

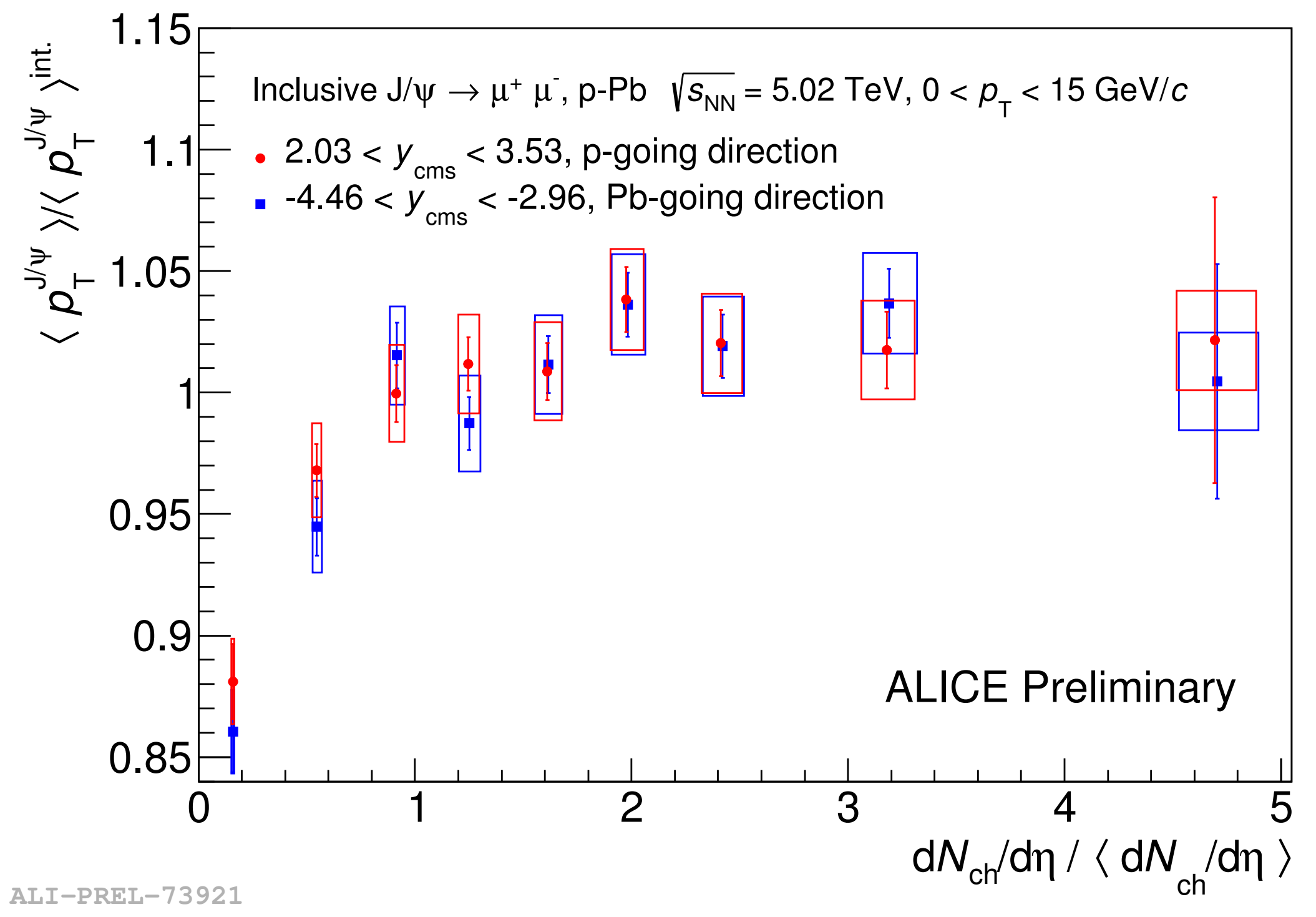
Fig. 3



RESULTS



- **Strong increase** of relative J/ψ yield with multiplicity. Similar behaviour at backward rapidity in p-Pb and in pp. **Deviation at forward rapidity.**



- Relative J/ψ <p_T> **increases** with multiplicity and it **saturates** beyond dN_{ch}/dη/<dN_{ch}/dη> ~1.5.

- **Observed J/ψ yield behaviour at forward rapidity only due to cold nuclear matter effects? But why <p_T> behave the same at forward and backward rapidities?**
- **Observed J/ψ <p_T> behaviour similar to that observed in Pb-Pb for charged particles, possible hint of collective effects in p-Pb?**

References

[1] Phys. Rev. C 86, (2012) 034903
[2] Phys.Lett. B712 (2012) 165-175
[3] Phys.Lett. B727 (2013) 371-380
[4] JHEP 1402, (2014) 073
[5] JHEP 1412 (2014) 073

Contact: javier.martin-blanco@subatech.in2p3.fr