

Vector mesons spin alignment in ions collisions. Challenges for NICA

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SPD meeting 26,10,2017

Vector mesons polarization

ρ , ω , φ , K^* etc. can be transversely (helicity $\lambda=\pm 1$) or longitudinally (helicity $\lambda=0$) polarized.

Vector meson polarization can be determined by measuring decay product distribution.

- S. Gevorkyan, A. Kechechyan, O. Rogachevskiy
- B. Mohanty (for Alice collaboration)

17 International Conference on Strangeness in Quark Matter, July, 2017

K*(896) decay.

K*⁰ Vector meson

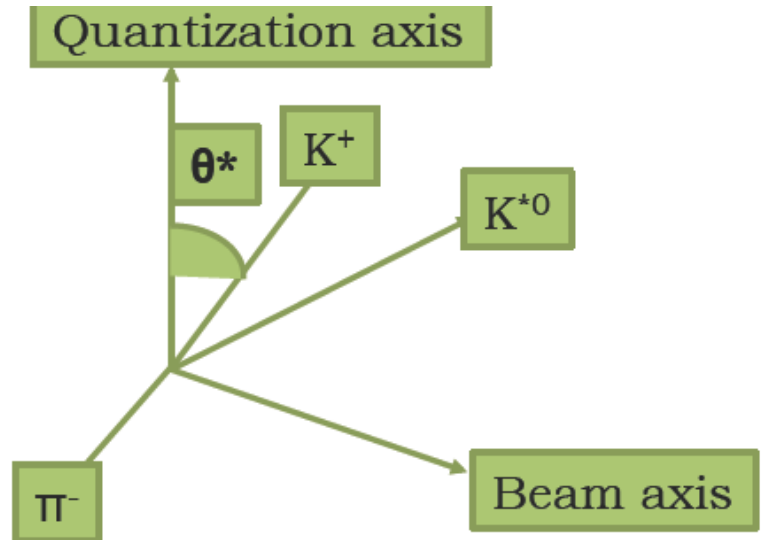
- Mass: 896 MeV/c²
- Lifetime: 1.38 × 10⁻²³ s
- Spin: 1
- Decays to K⁺ and π⁻ (B.R. ~ 66.6%)
- Quark content (d,sbar)

$$\frac{dN}{d\cos\theta^*} = N_0 [1 - \rho_{00} + \cos^2\theta^* (3\rho_{00} - 1)]$$

polarization.

K. Schilling, P. Seyboth and G. Wolf, Nucl. Phys. B 15, 397 (1970)

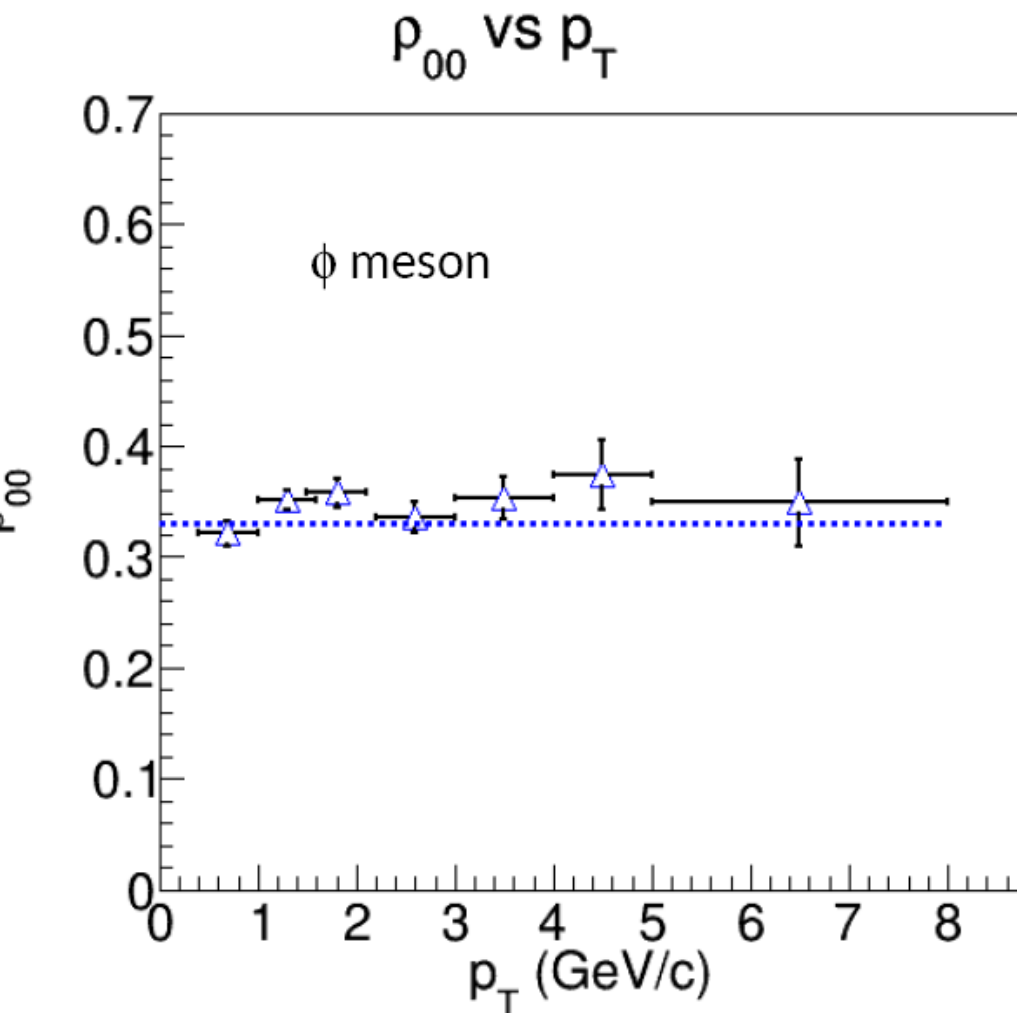
ρ_{00} = Element of spin density matrix
= 1/3 → No spin alignment



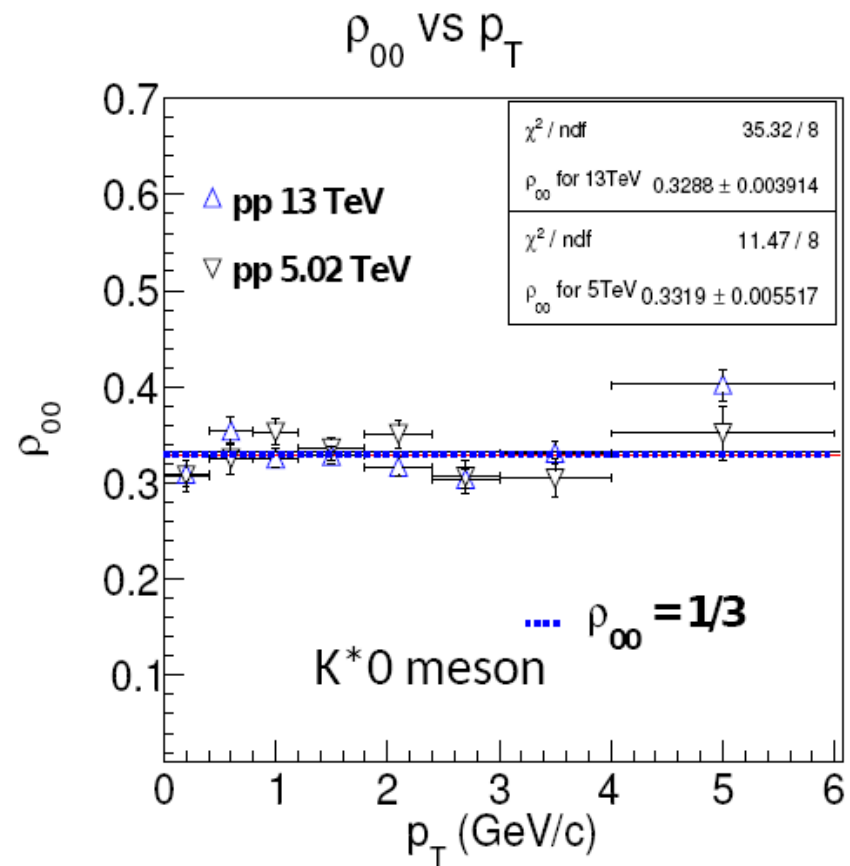
Quantization axis

- Normal to production plane
- Normal to reaction plane

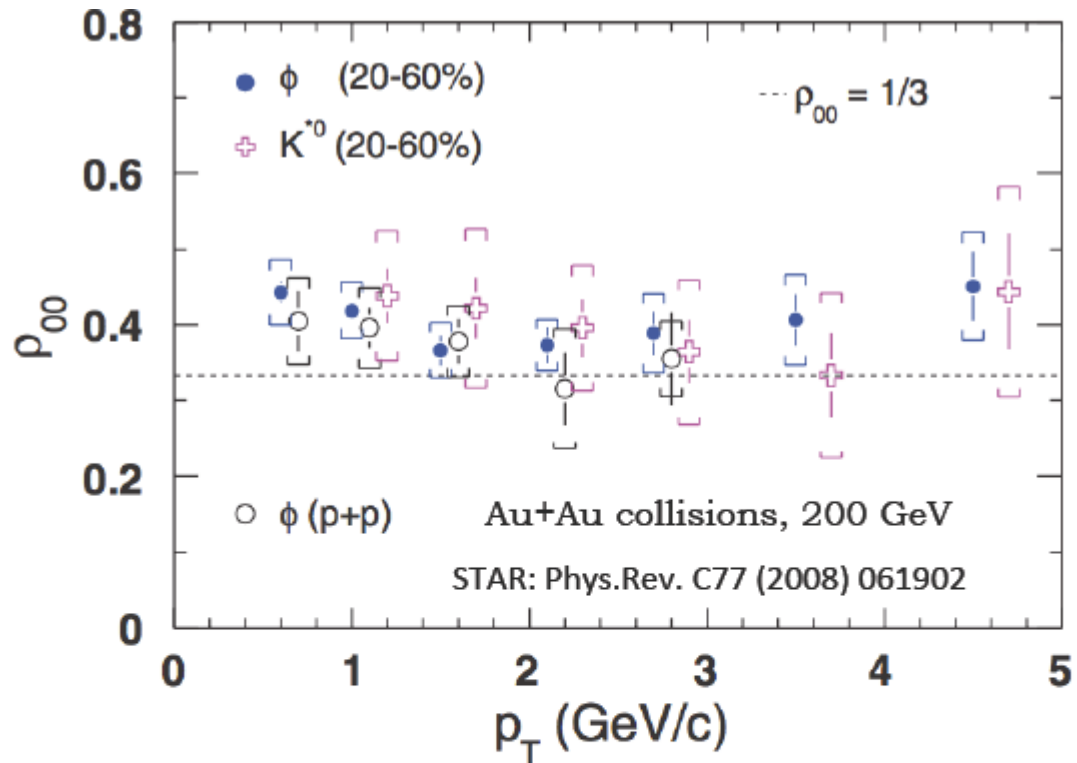
Spin Alignment in pp collisions at LHC



No spin alignment observed for ϕ in pp collisions at 13 TeV



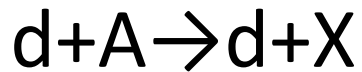
No spin alignment observed for K^{*0} in pp collisions at 5.02 and 13 TeV



Spin alignment of vector mesons
Results w.r.t production plane

Absorption of vector mesons in nuclei is polarization dependent!!!

Deuteron scattering:



- Juelich 2010, $E=10-20\text{MeV}$, $d+\text{He}^3 \rightarrow p+\text{He}^4$
- LHEP 2008, $E=5\text{GeV}$, $d+\text{Be} \rightarrow p+X$

Absorption of longitudinally polarized deuterons
in matter is lower than transversely polarized
as a result of D-wave in deuteron!!!

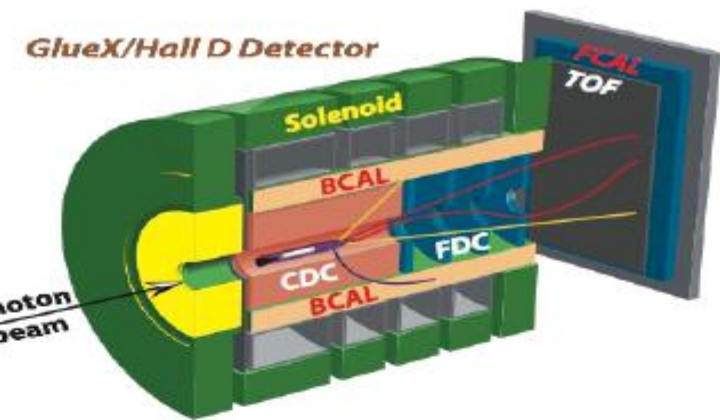
Vector mesons photoproduction on nuclei.

- E. Chudakov, S. Gevorkyan, A. Somov

“Photoproduction of ω -mesons off nuclei and impact of polarization on meson-nucleon interactions”

Phys. Rev. C93, 015203, 2016

- Lett. of Intend to Jefferson Lab, PAC43, 2015
- S. Gevorkyan: DSPIN15, BALDIN16



Jefferson Lab

Photoproduction of vector mesons off nuclei

A. Somov

Jefferson Lab

A. Gasparyan

NC A&T State University, NC

L. Gan

UNCW, NC

S. Gevorkyan,

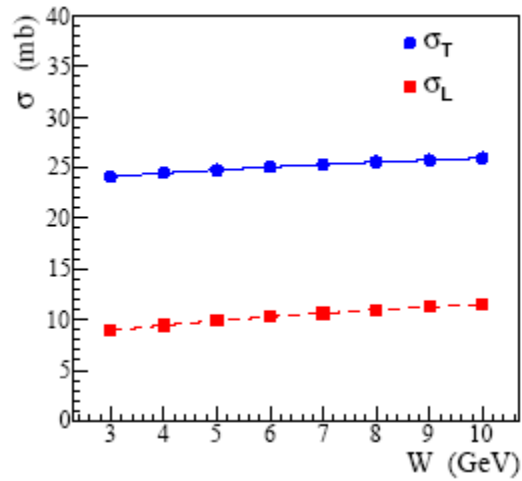
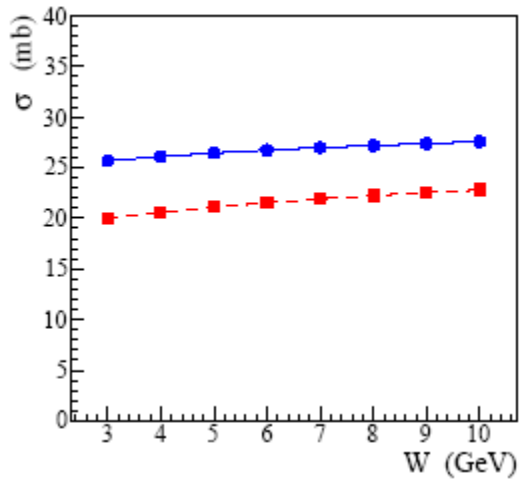
JINR

I. Larin

UMas. ITEP

and GlueX Collaboration

PAC 45, July 11, 2017



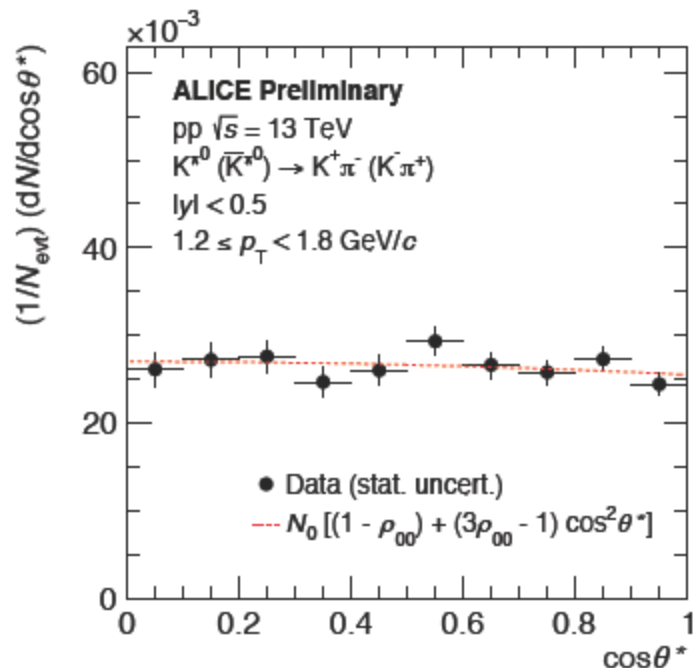
Total cross sections for longitudinal and transverse ρN interaction as a function of total energy $W=vs$

Color dipole model

Angular distribution

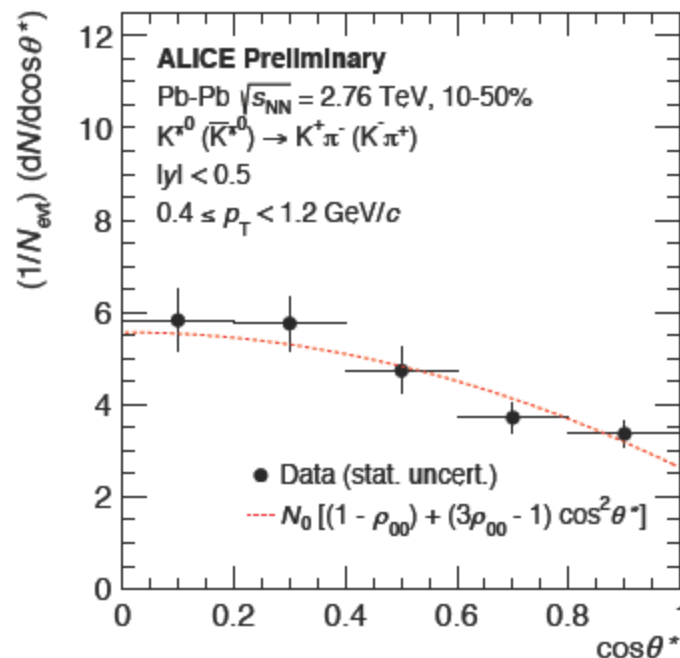


pp collisions



ALI-PRYL-130360

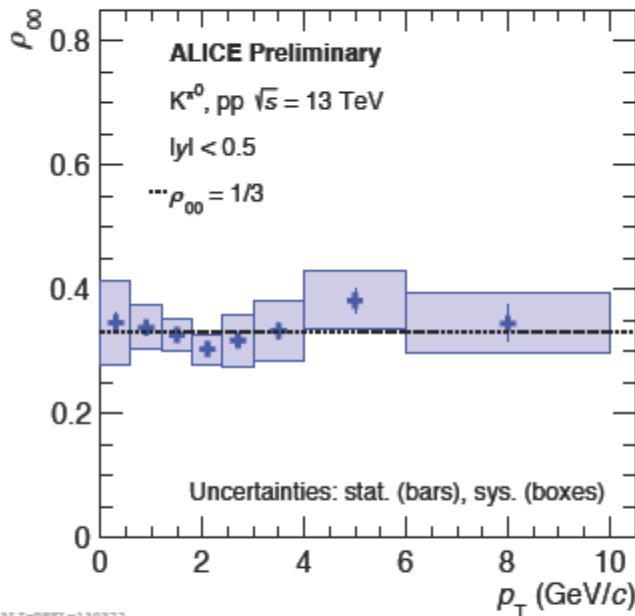
Heavy-ion collisions



ALI-PRYL-130364

Two parameters (N_0 and ρ_{00}) fit to $\cos\theta^*$ distributions measured in different p_T bins

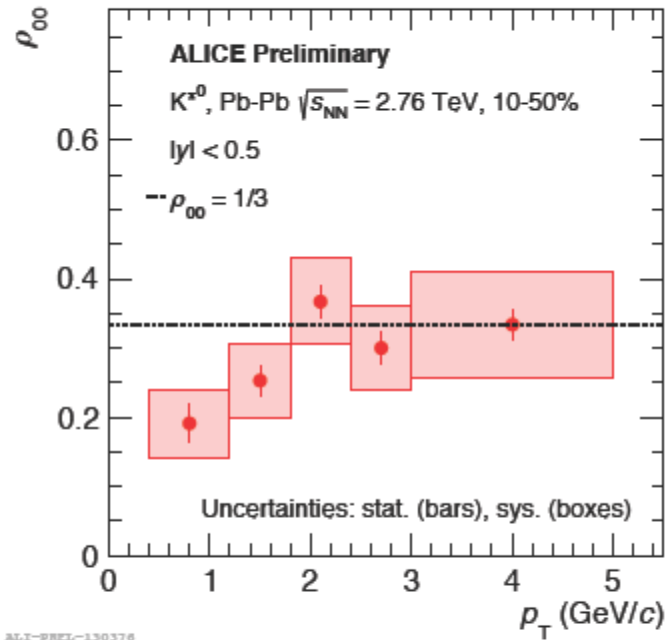
Spin density matrix element (ρ_{00}) measurements



ALI-9HEZ-130372

pp collisions: $\rho_{00} = 1/3$

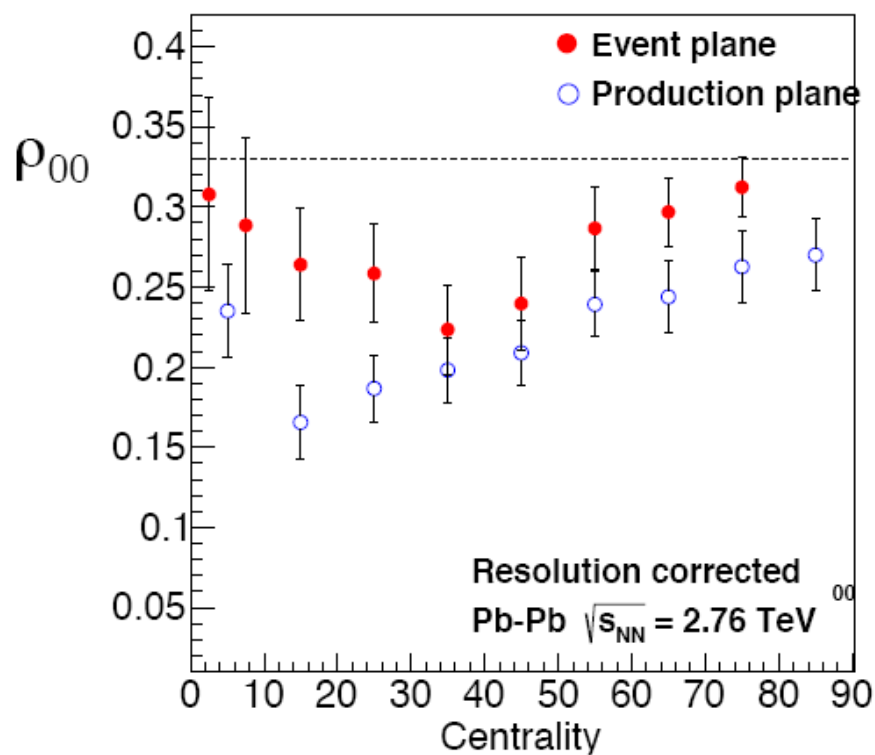
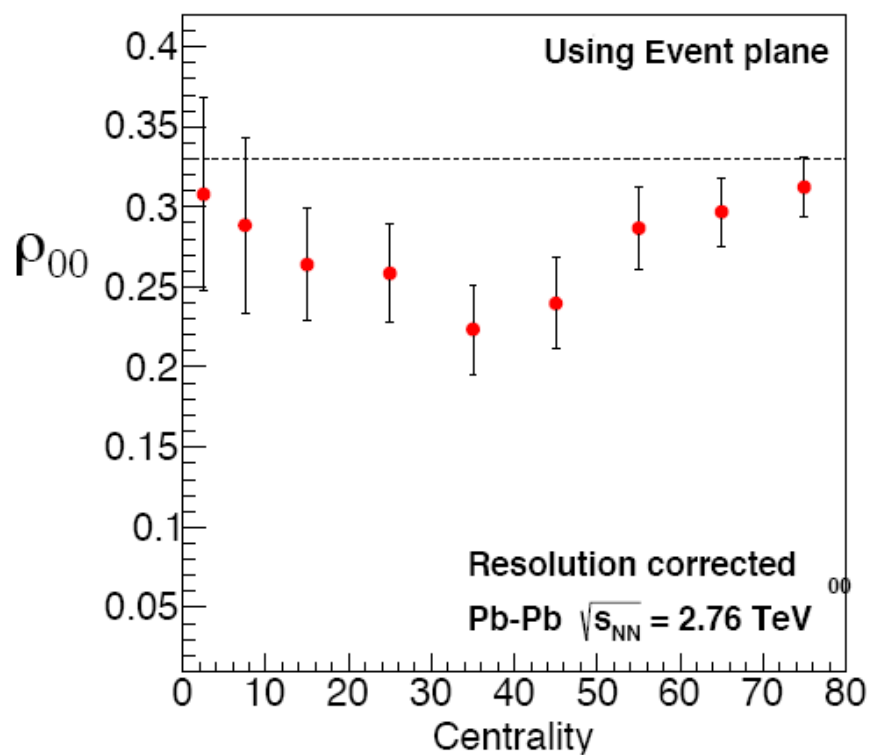
Sources of systematic errors include: Signal extraction, track reconstruction parameter variations, material budget and uncertainties associated with determination of efficiency x acceptance



ALI-9HEZ-130376

Pb-Pb collisions: ρ_{00} values about 2.5σ below $1/3$ for $0.4 \leq p_T < 1.2$ GeV/c and 1.4σ for $1.2 \leq p_T < 1.8$ GeV/c

Results: Resolution Corrected ρ_{00} From EP and Compared to that obtained from production plane.



K*0 has a centrality dependence $\rho_{00} < 1/3$ both w.r.t EP and production plane