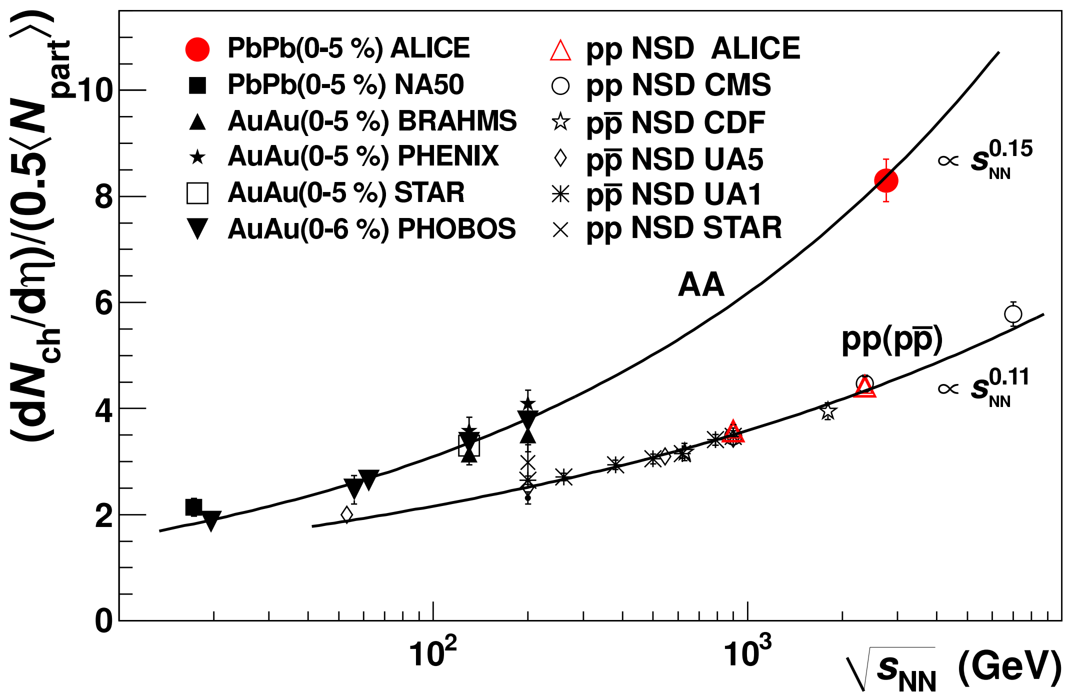


FIG. 1: Charged-particle multiplicity normalized to $N_{\text{part}}/2$ in pp and central A+A (Au+Au and Pb+Pb) collisions as a function of $\sqrt{s_{NN}}$. The increase in central A+A collisions with $\sqrt{s_{NN}}$ is stronger than in pp collisions. [Fig. from 1208.1626]

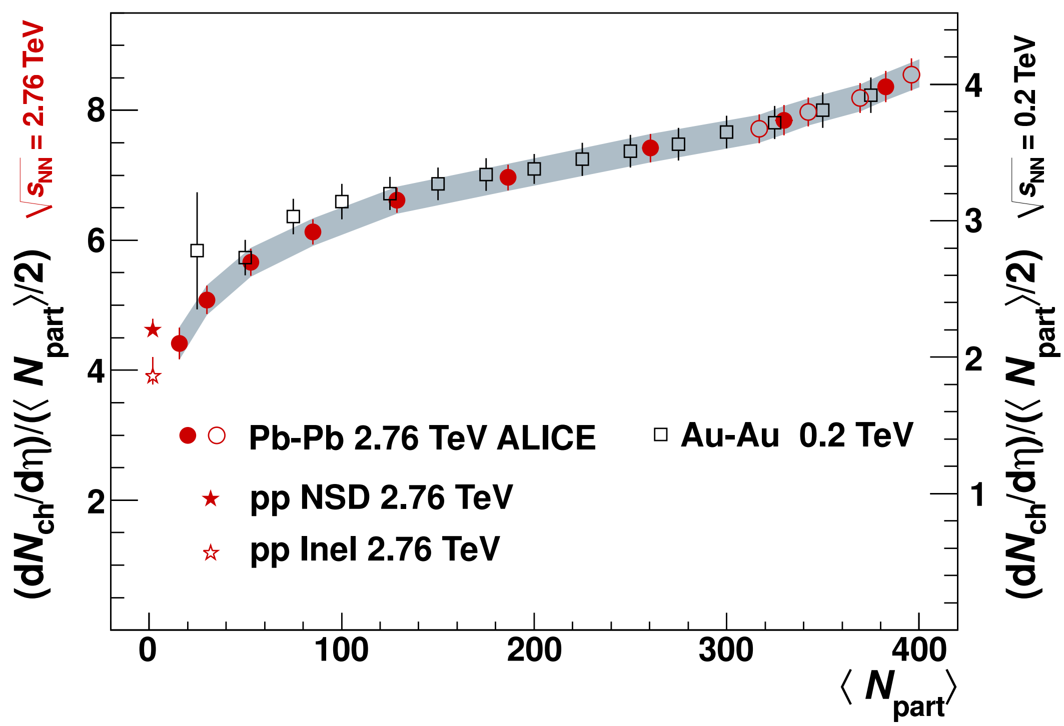


FIG. 2: The increase of the charged-particle multiplicity per participant pair with N_{part} at RHIC and LHC exhibits a very similar shape. [Fig. from 1208.1626]

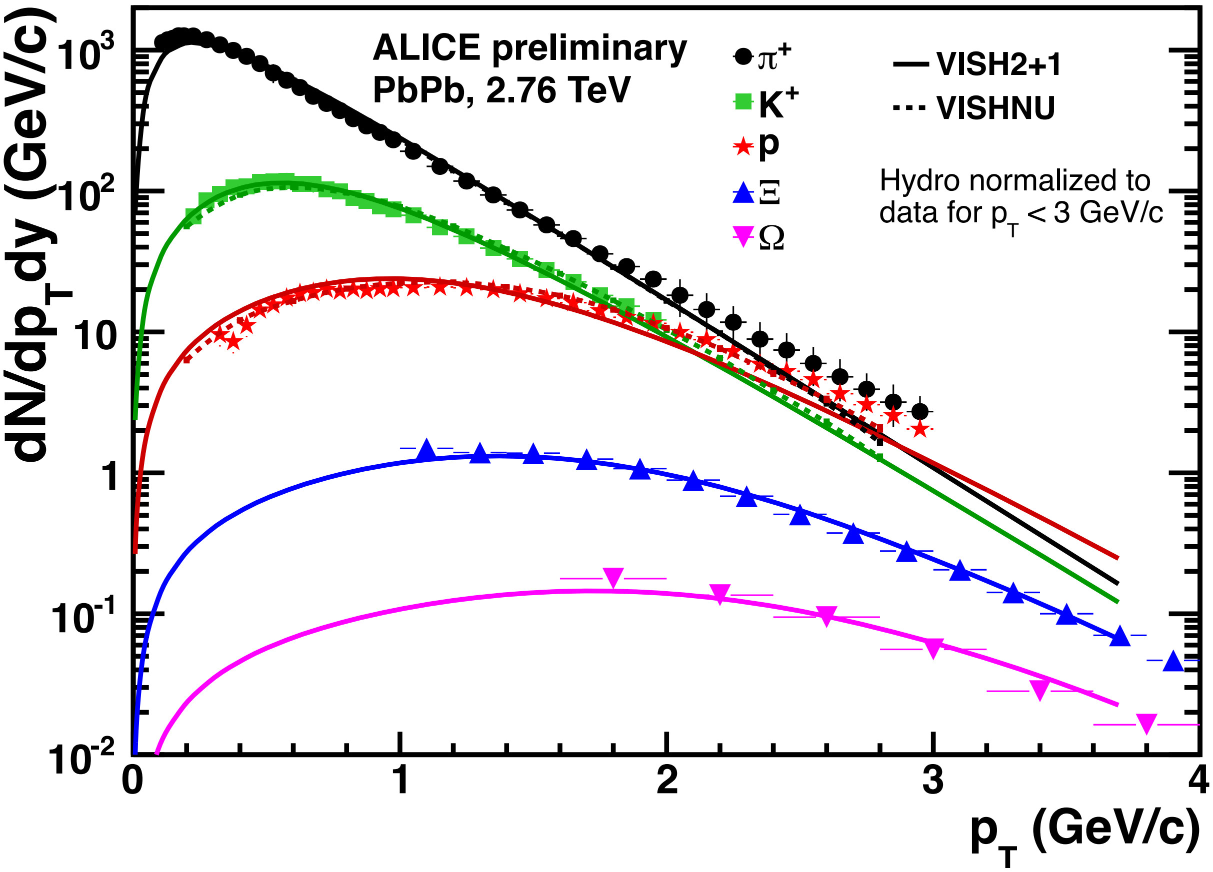


FIG. 3: p_T spectra of identified particles measured by ALICE. The data are rather well described by hydro models which model the expansion of the fireball. [Fig. from 1208.1626]

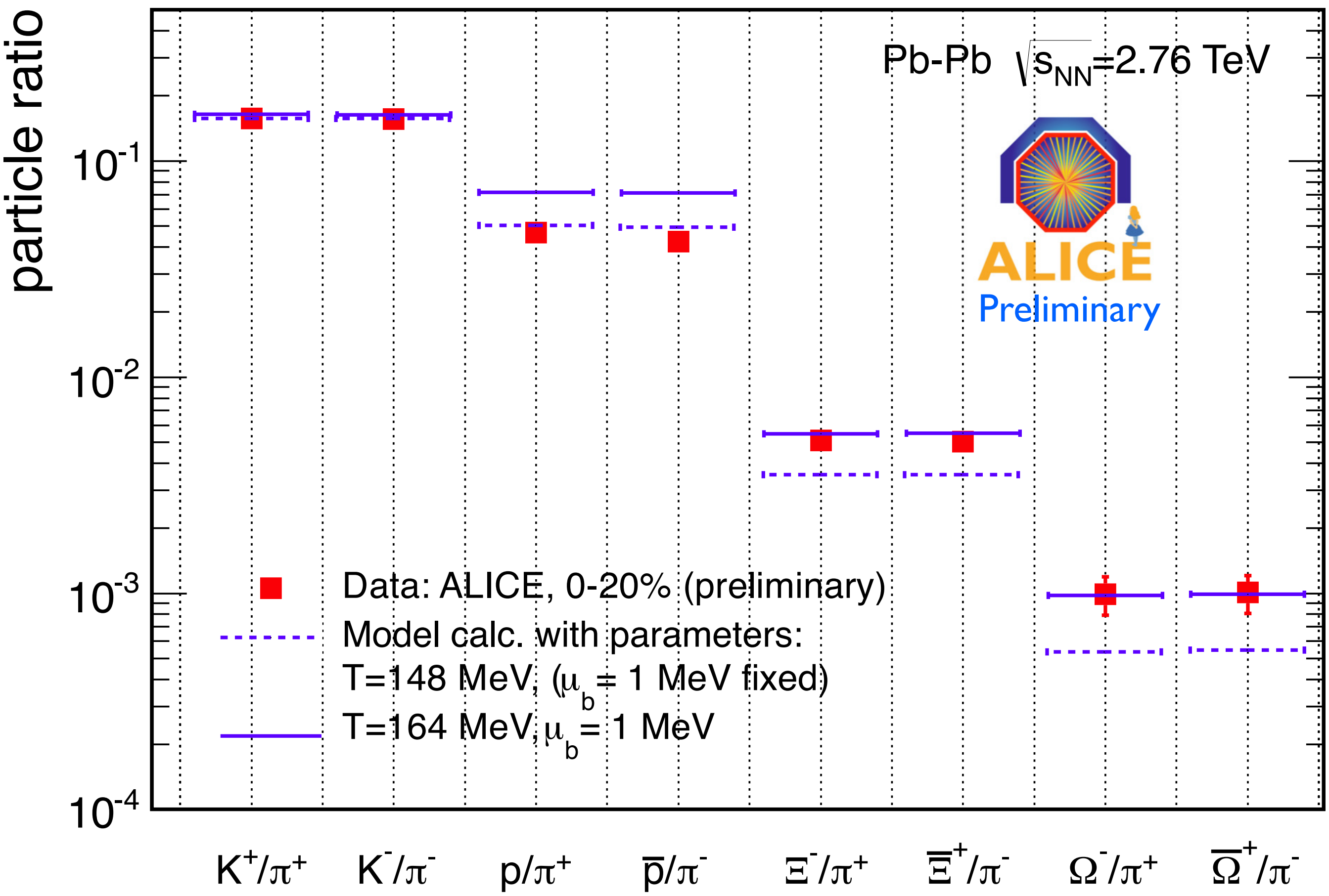


FIG. 4: Ratios of the yields of different particle species measured by ALICE in comparison with predictions from a statistical model. Except for the p/π ratios the data are well described with a chemical freeze-out temperature of 164 MeV and a small chemical potential of $\mu_B = 1$ MeV. [Fig. from 1208.1626]

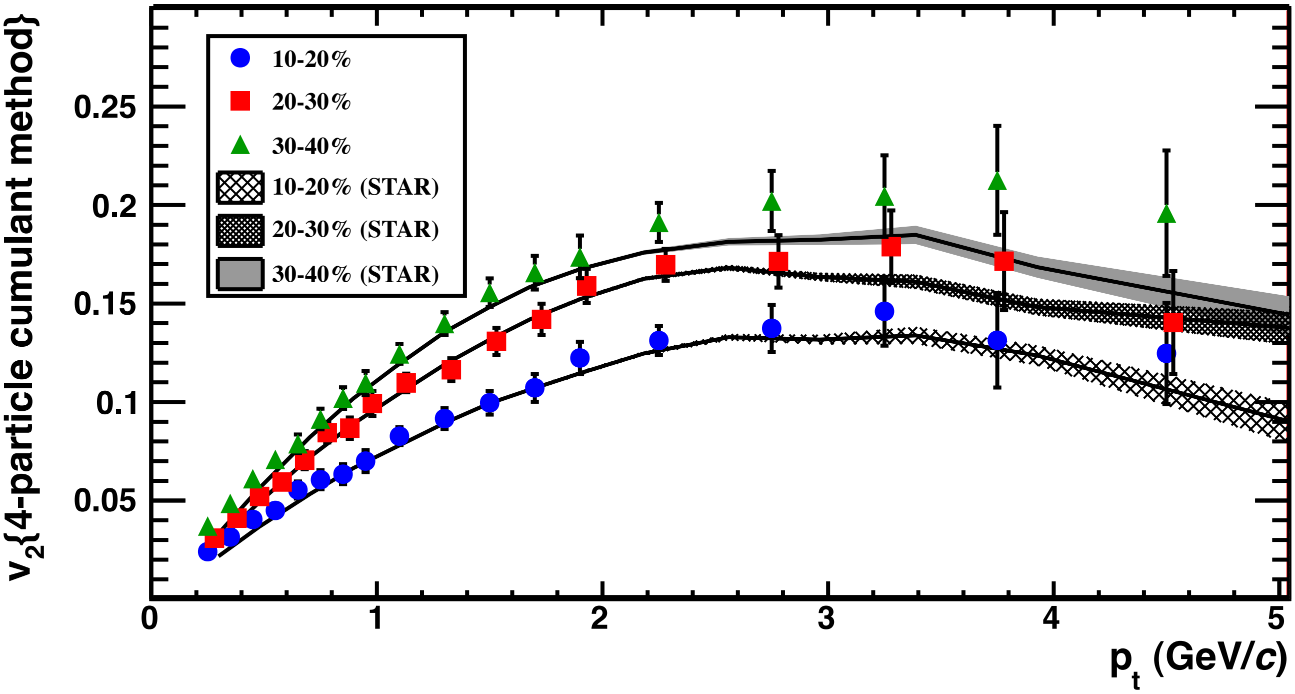


FIG. 5: Elliptic flow coefficient v_2 for charged particles as a function of p_T for three centrality classes measured by ALICE. For the shown classes v_2 decreases with increasing centrality. The p_T and centrality dependence at LHC and RHIC is remarkably similar. [Fig. from 1208.1626]

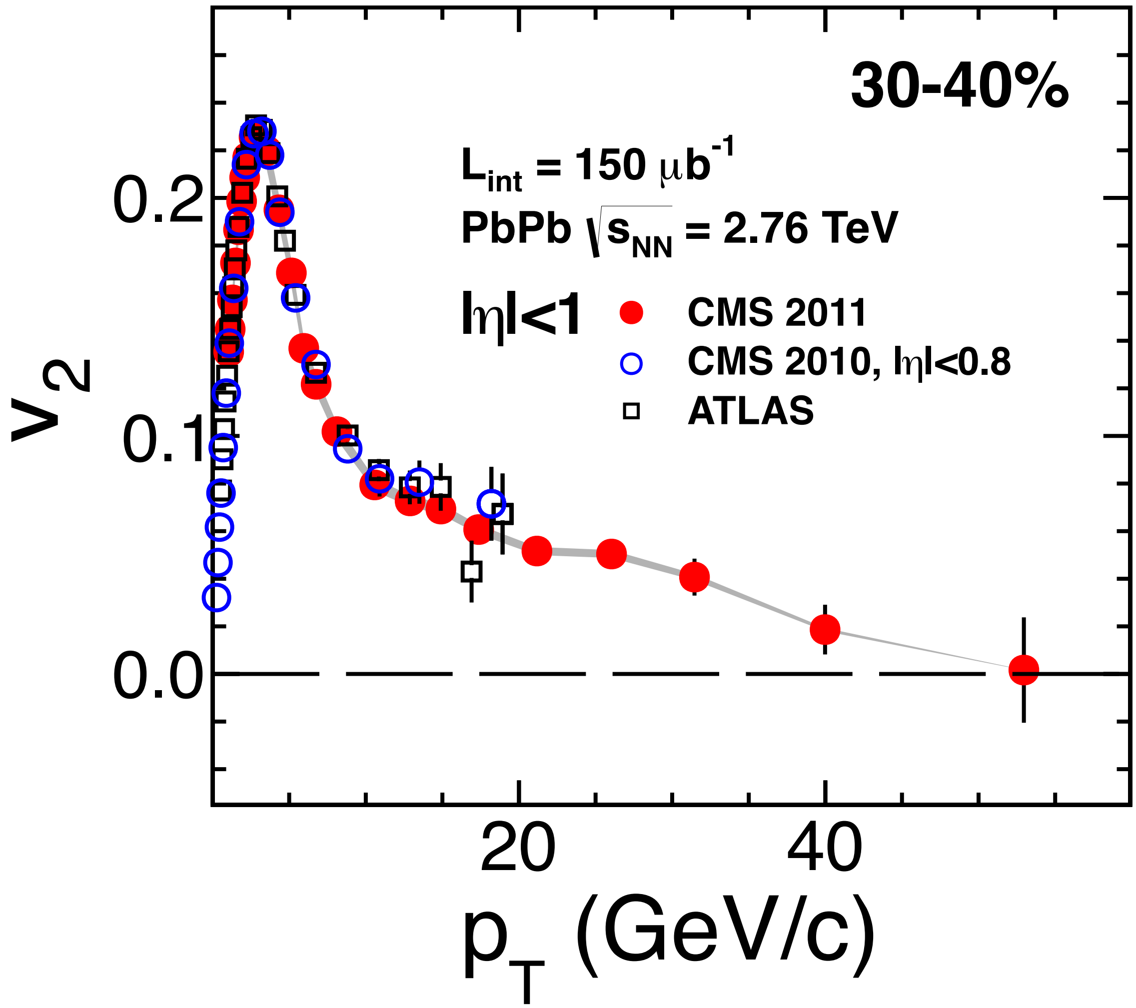


FIG. 6: v_2 for charged particles up to $p_T \approx 50$ GeV/c from CMS. [Fig. from 1208.1626]

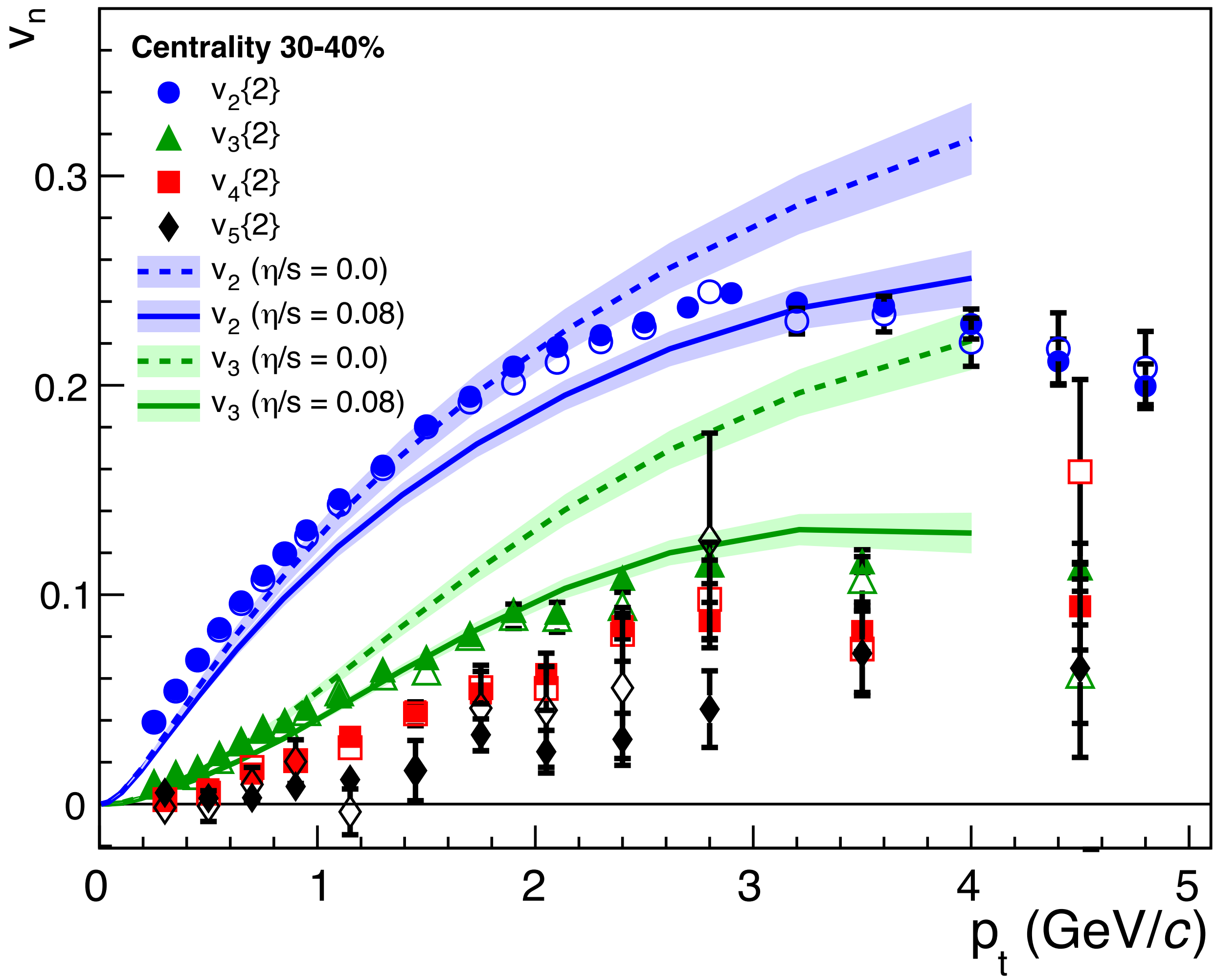


FIG. 7: Fourier coefficients v_2, v_3, v_4, and v_5 of charged particles as a function of p_T in Pb+Pb collisions ($30-40\,\%$ most central class) from ALICE. The p_T dependence of v_2 and v_3 is described with hydro calculations with small η/s. [Fig. from 1208.1626]

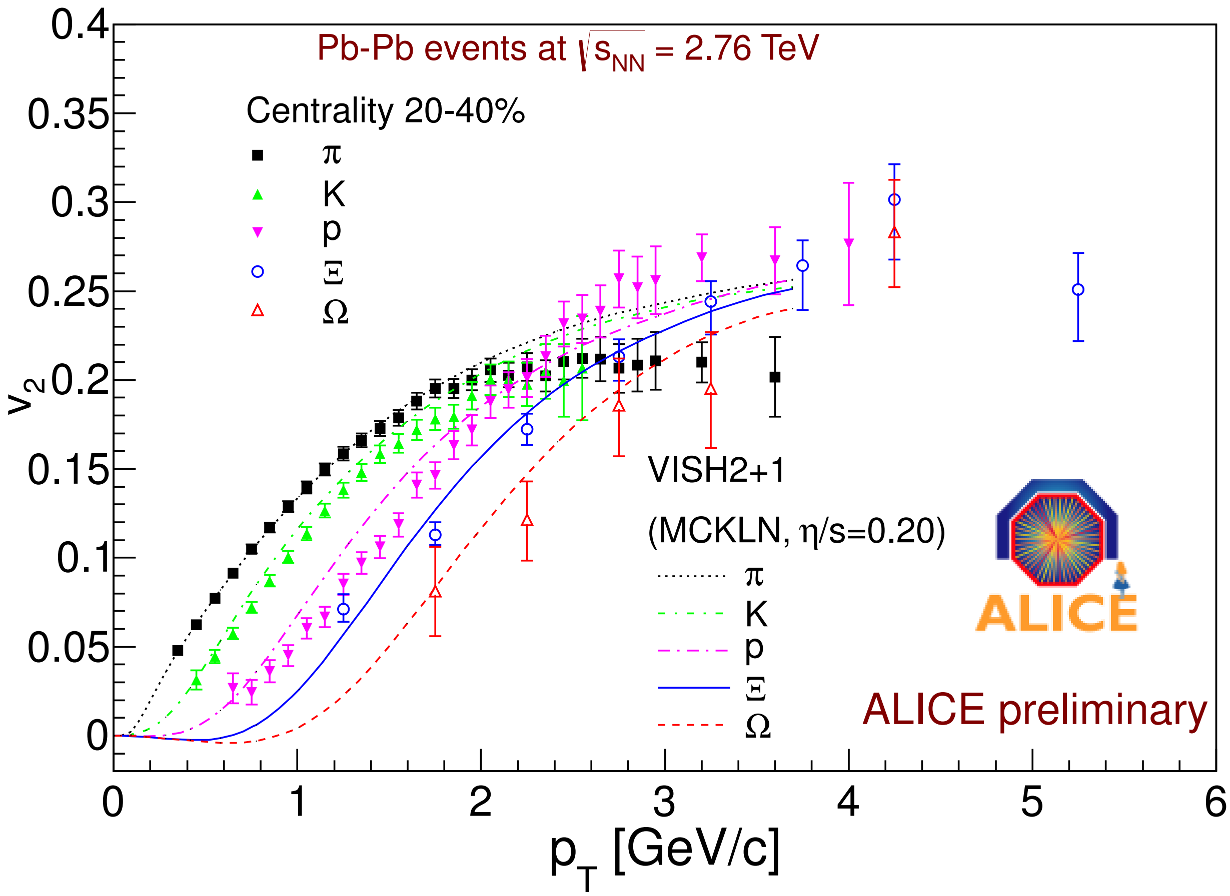


FIG. 8: v_2 as a function of p_T for different particle species from ALICE. The v_2 shows the mass ordering expected from hydro calculations. [Fig. from 1208.1626]

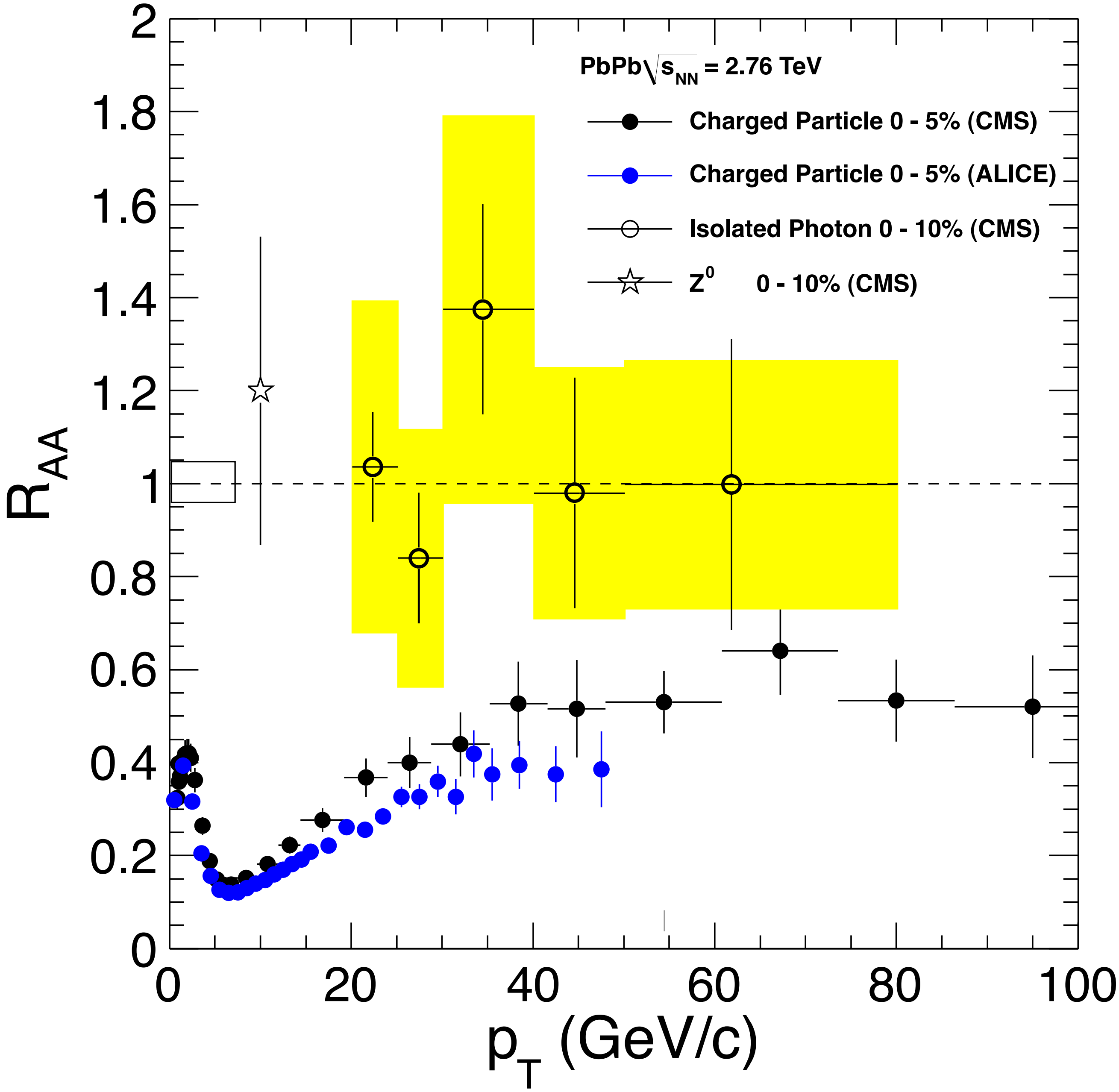


FIG. 9: $R_{AA}(p_T)$ for charged particles and isolated photons in central Pb+Pb collisions at the LHC. Charged particles are suppressed whereas isolated photons are not. This is expected in the parton energy loss picture because photons essentially do not interact with the medium as indicated by the sketch in Fig. 10. [Fig. from 1208.1626]

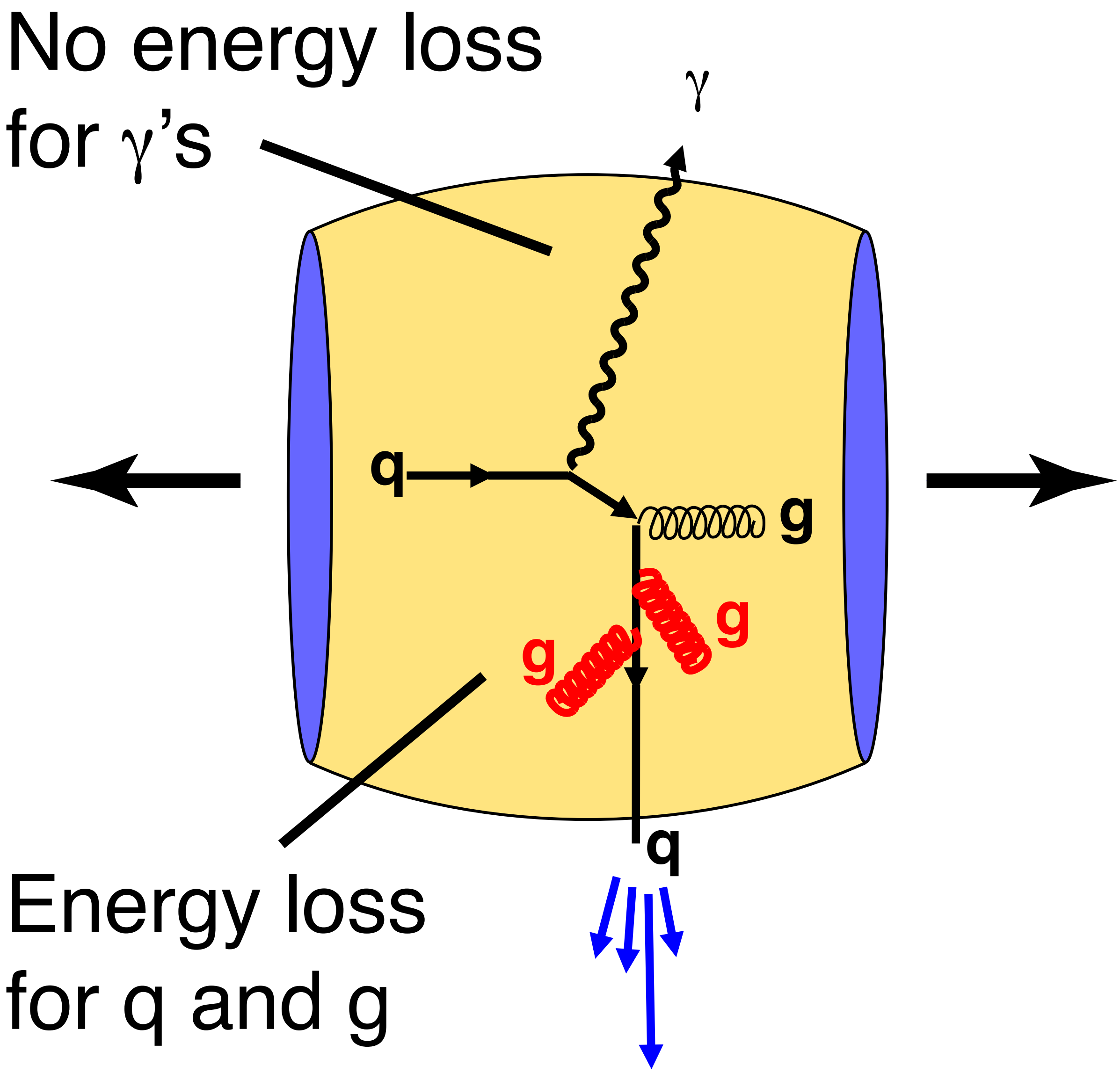


FIG. 10: Photons essentially do not interact with the medium as indicated by the sketch. [Fig. from 1208.1626]

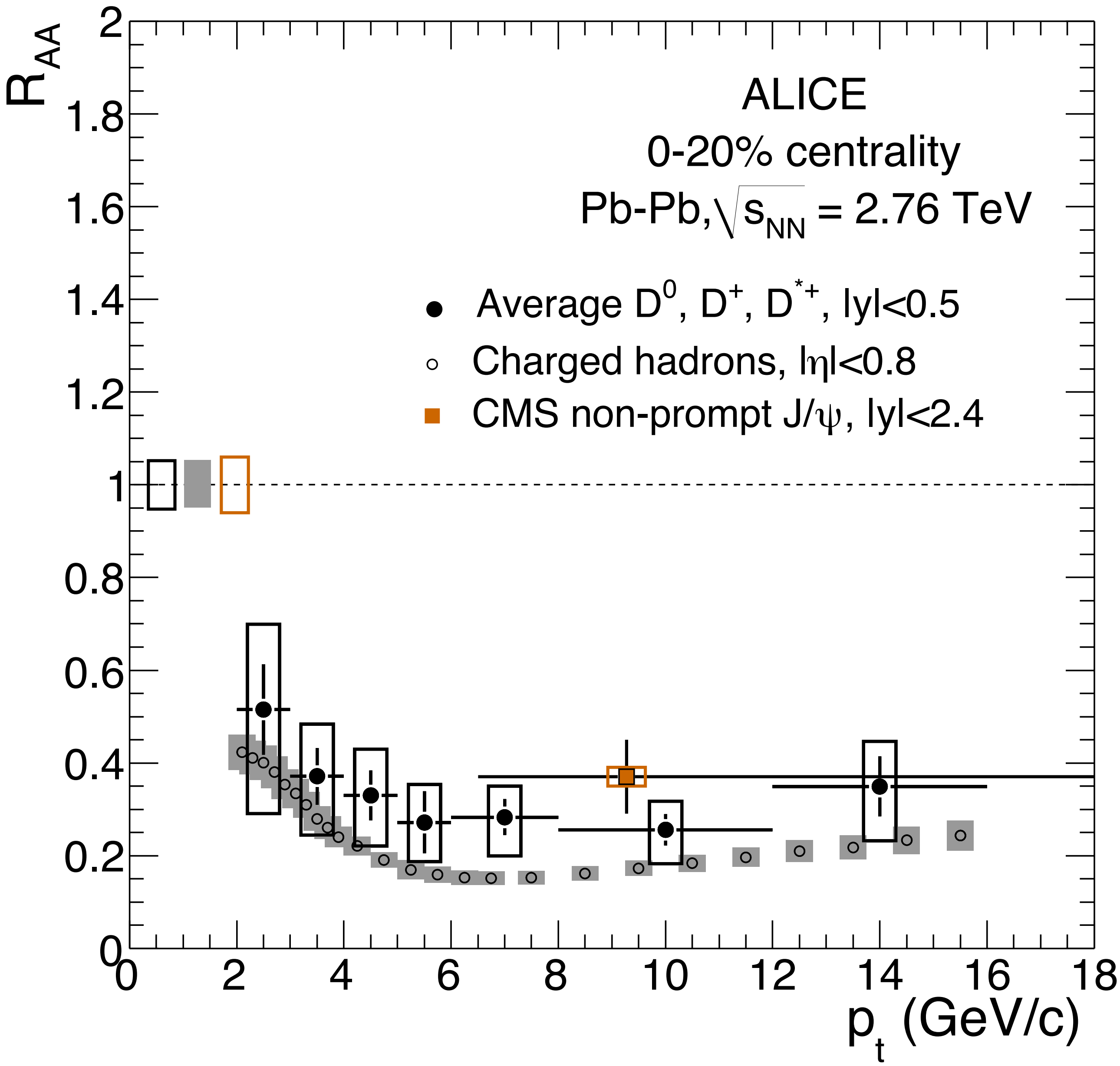


FIG. 11: The comparison of the R_{AA} for charged hadron, D mesons, and J/ψ's from B meson decays ("non-prompt J/ψ's") tests the expected hierarchy $\Delta E_g > \Delta E_{u,d,s} > \Delta E_c > \Delta E_b$. [Fig. from 1208.1626]

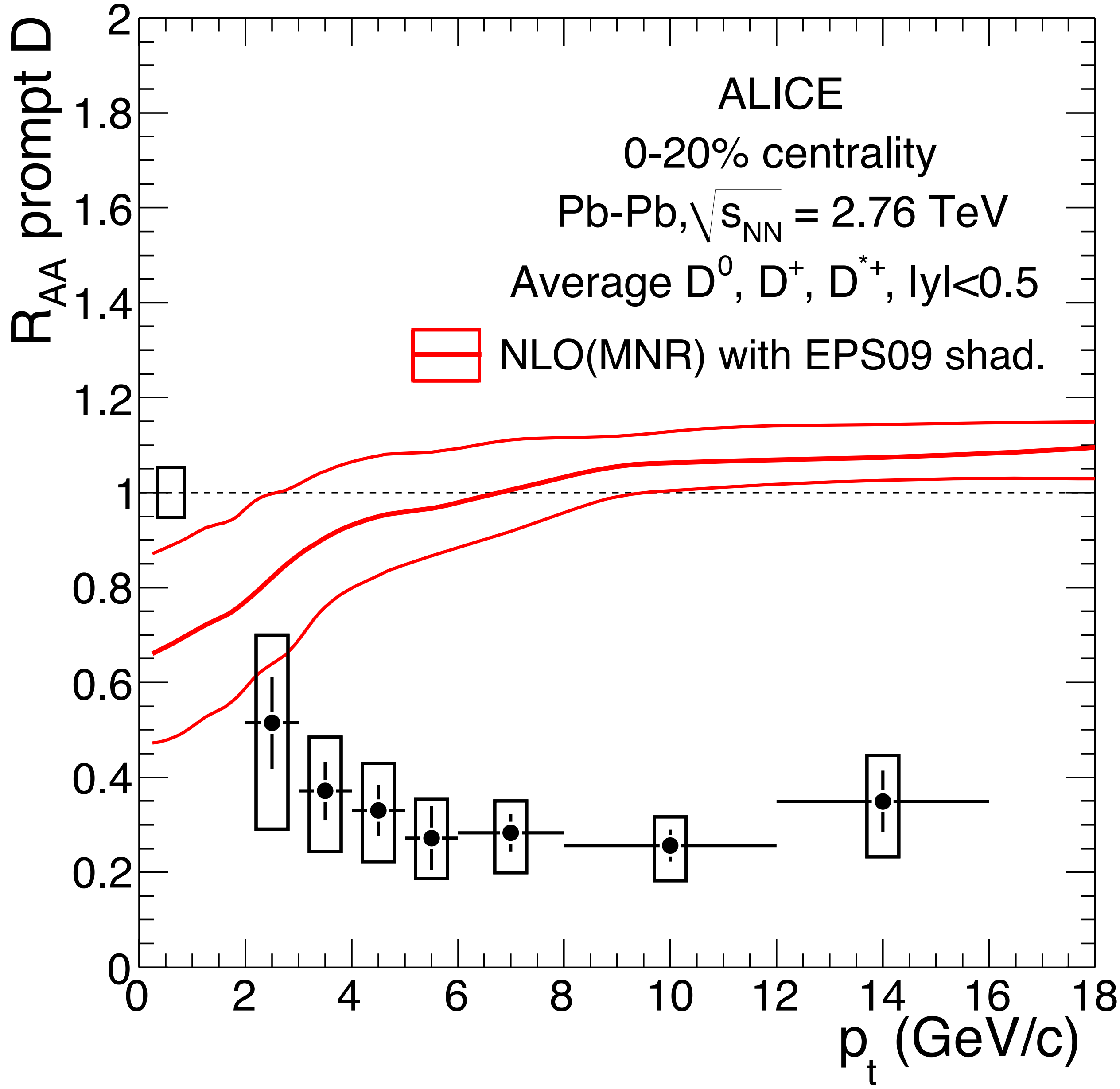


FIG. 12: Initial state effects related to modification of the gluon distribution function in the Pb nucleus (shadowing) appear to be negligible for $p_T \gtrsim 5$ GeV/c as indicated by the NLO perturbative QCD calculation. [Fig. from 1208.1626]

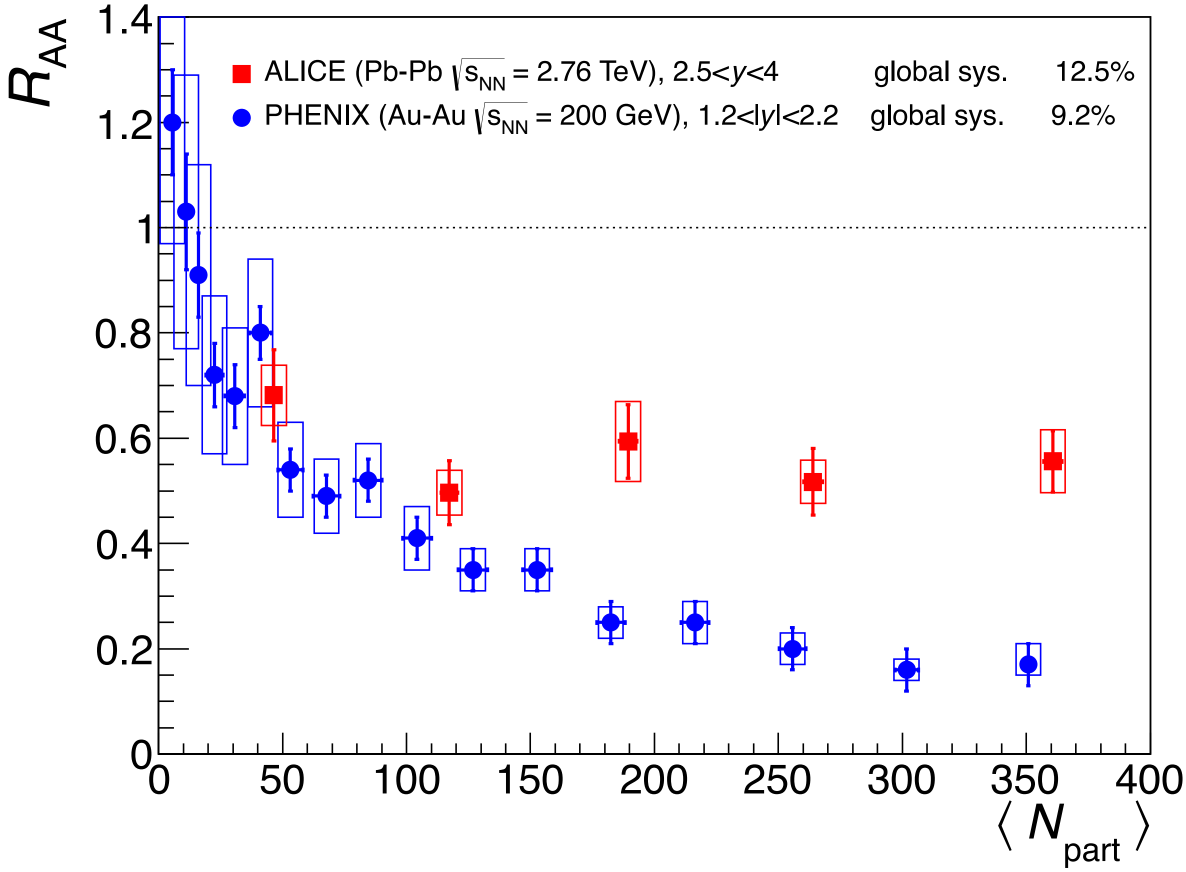


FIG. 13: R_{AA} of inclusive J/ψ's measured by ALICE over the full p_T range ($p_T > 0$) and in $2.5 < y < 4$ as a function of centrality. In central collisions the suppression ($R_{AA} \approx 0.5 - 0.6$) is smaller than at RHIC. [Fig. from 1208.1626]

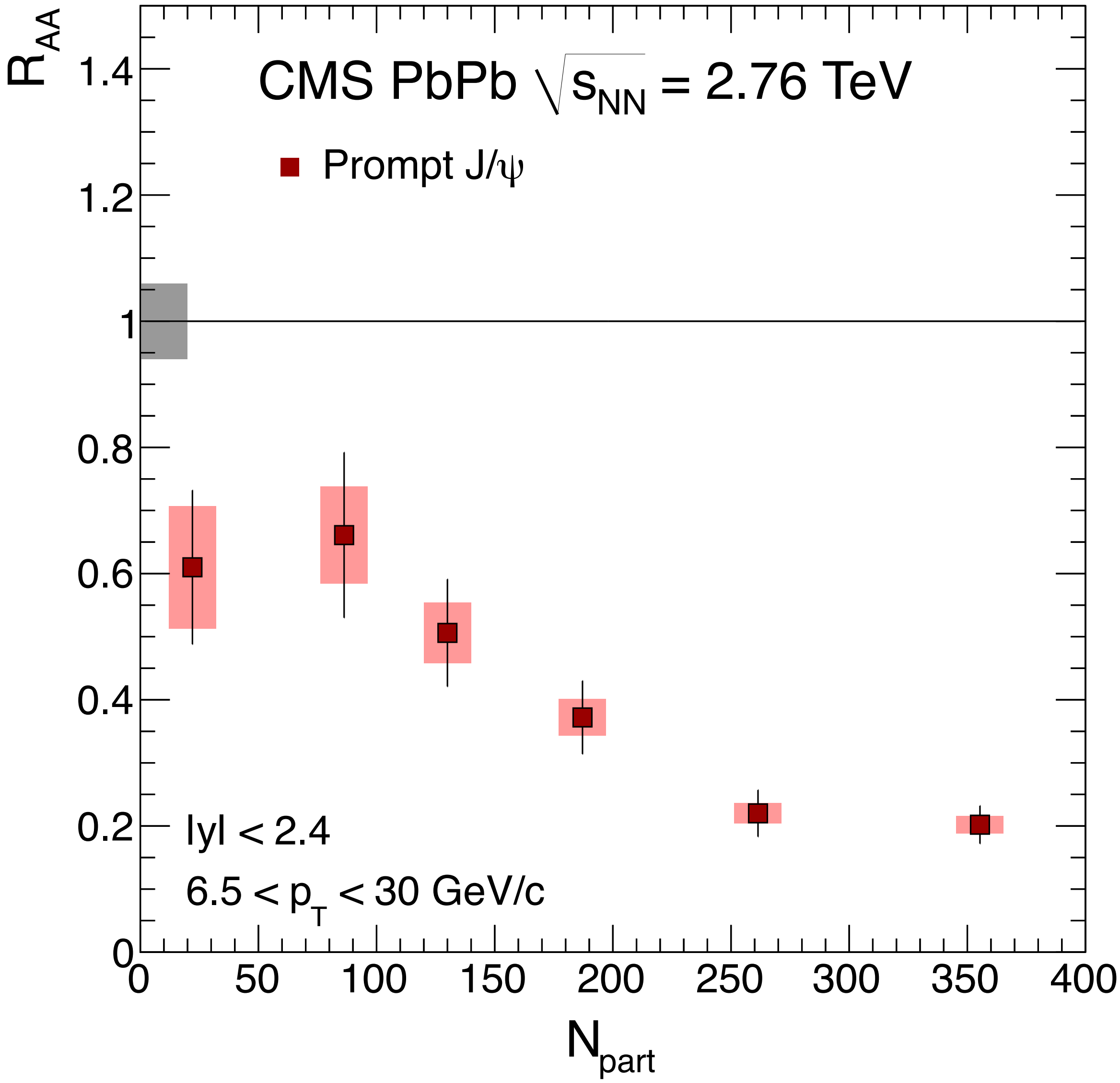
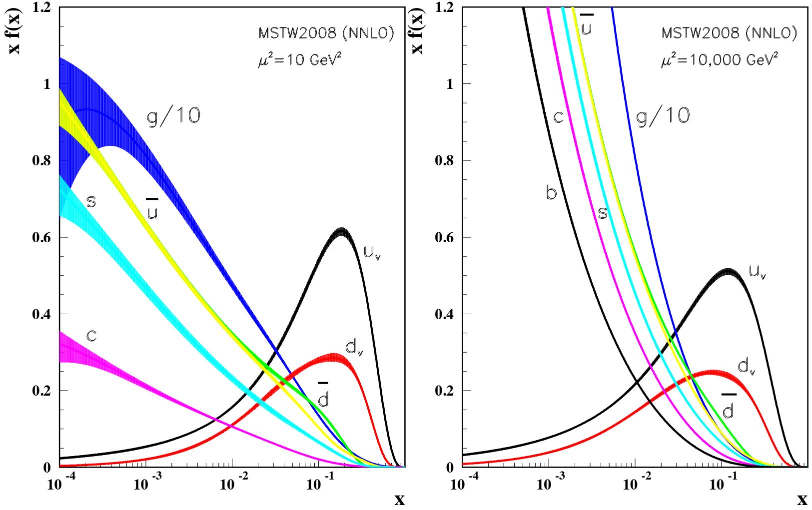


FIG. 14: At larger p_T ($p_T > 6.5$ GeV/c) prompt J/ψ measured by CMS exhibit a stronger suppression in central collisions ($R_{AA} \approx 0.2$). [Fig. from 1208.1626]

Some surprises at LHC

- pp collisions: MC event generators & NLO pQCD calculations were not able to predict correctly hadron production at LHC energies.
- p/π^+ and $\bar{p}/\pi^-$ abundance ratios too low (by a factor 1.5) compared with the prediction of the statistical/thermal model.
- R_{AA} for J/ψ (at forward rapidity) ~ 0.545 almost independent of centrality at ALICE. Was ~ 0.2 at PHENIX at comparable forward rapidity.

Colour Glass Condensate - 1



Unpolarized parton distribution functions in proton (PDG 2010)

Colour Glass Condensate - 2

- As x decreases, $xg(x, Q^2)$ increases. Transverse phase space density of gluons rises. It is expected to saturate. CGC: this dense but weakly coupled system.
- CGC is a form of QCD matter associated with the wee partons.
- CGC is coherent unlike QGP which is incoherent.
- Source of QGP: Collision of 2 sheets of CGC $\rightarrow$ Glasma $\rightarrow$ QGP.
- Colour: Gluons carry colour.
- Glass: Natural time scales of small- and large-x gluons are fast and slow, resp. But small-x gluons arise from larger-x gluons.
- Condensate: Like Bose condensate. Quantum states are multiply occupied. Coherence.

Take-Home Message

- Quark-Gluon Plasma has been discovered, and we are in the midst of trying to determine its properties accurately.
- Collective flow at RHIC/LHC has put an upper limit on the η/s of the QGP fluid as $\sim 2.5/(4\pi)$. This is the average value in the relevant temperature region. Uncertainties associated with (mainly) the initial conditions prevent a more precise determination.
- QCD Phase Diagram still remains largely unknown.
- RHIC remains operational. LHC results have just started coming. FAIR & NICA are several years in the future. So this exciting field is going to remain very active for a decade at least.