Using Event Shape Engineering to study anisotropic flow of inclusive and identified particles in Pb-Pb collisions with ALICE

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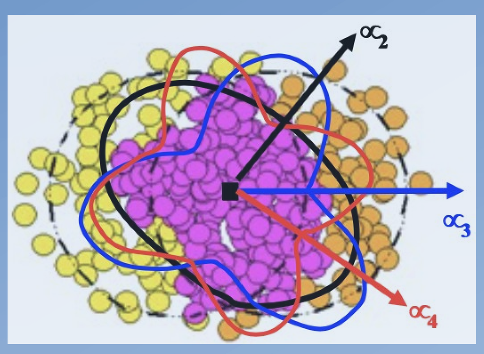
Anisotropic flow

Heavy-ion collisions: initial state anisotropy $\xrightarrow{\text{multiple interactions}}$ final state momentum anisotropy, a phenomenon called ***anisotropic flow*** [1]



$$E\frac{d^3N}{d^3p}=\frac{1}{2\pi}\frac{d^2N}{p_T dp_T dy}\left(1+\sum_{n=1}^{\infty}2v_n\cos[n(\phi-\Psi_n)]\right)$$

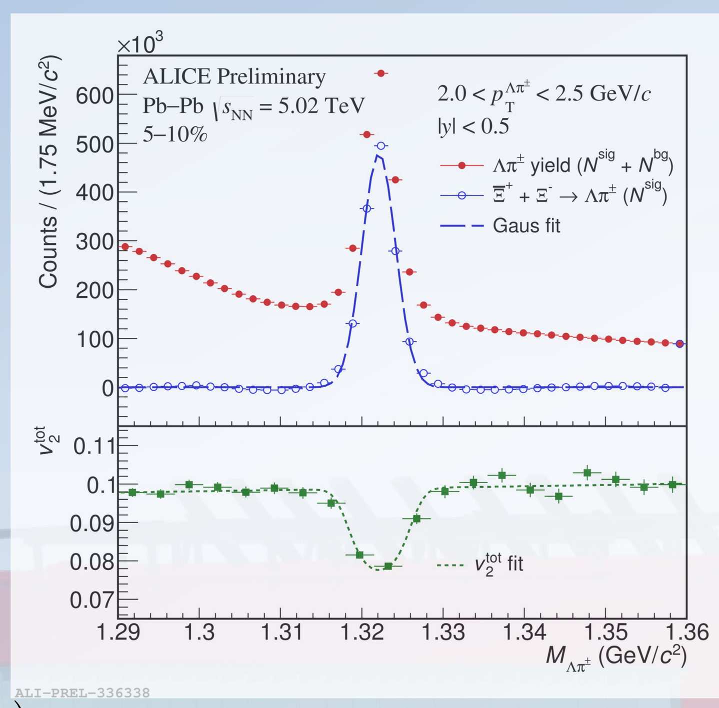
- Magnitude is quantified by the v_n coefficients in a Fourier series of the azimuthal distribution of produced particles [2]
  - v_2 elliptic flow, v_3 triangular flow, ...
- Constrains initial conditions, deconfined phase, particle production mechanisms

Methods used to measure anisotropic flow

$$v_n=\frac{\langle uQ_n^A\rangle}{\sqrt{\dfrac{\langle Q_n^A Q_n^B\rangle\langle Q_n^A Q_n^C\rangle}{\langle Q_n^B Q_n^C\rangle}}}$$

- Inclusive, π, K, p measured with scalar product method [3]
  - Particle of interest (POI) and references particles (RPs) separated by |Δη|>2, to suppress non-flow
- v_n of Λ, K^0_S, Ξ, and Ω measured using invariant mass method [4]

$$v_n^{Tot}(m_{inv})=v_n^{Sgn}\frac{N^{Sgn}}{N^{Tot}}(m_{inv})+v_n^{Bg}(m_{inv})\frac{N^{Bg}}{N^{Tot}}(m_{inv})$$

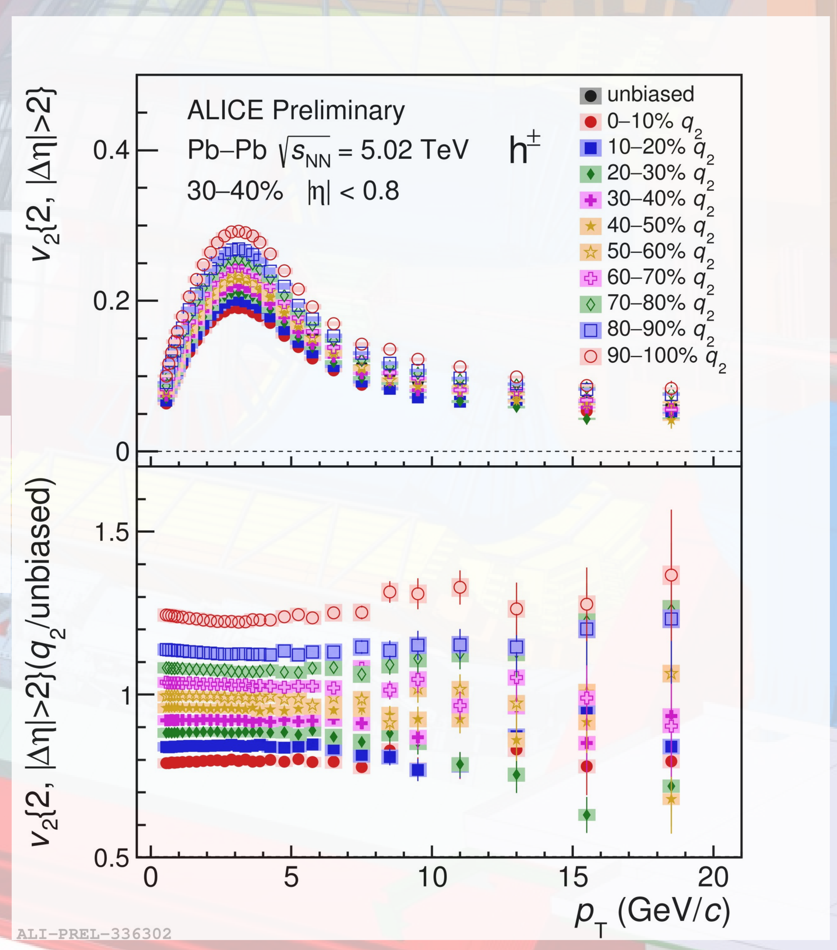


Event Shape Engineering (ESE)

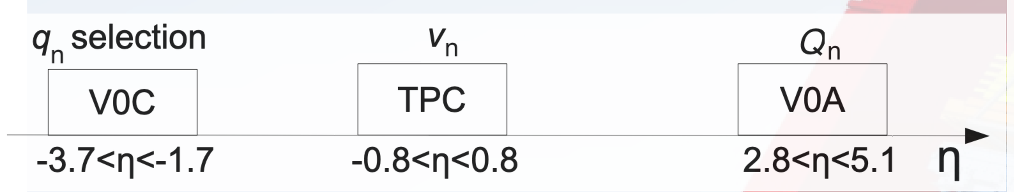
Select events with similar centralities and different shapes based on the event-by-event flow/eccentricity fluctuations [5]

Flow vector → q-distributions

$$Q_{n,x}=\sum_i\cos(n\varphi_i)\qquad Q_n=\{Q_{n,x},iQ_{n,y}\}$$
$$Q_{n,y}=\sum_i\cos(n\varphi_i)\qquad q_n=|Q_n|/\sqrt{M}$$

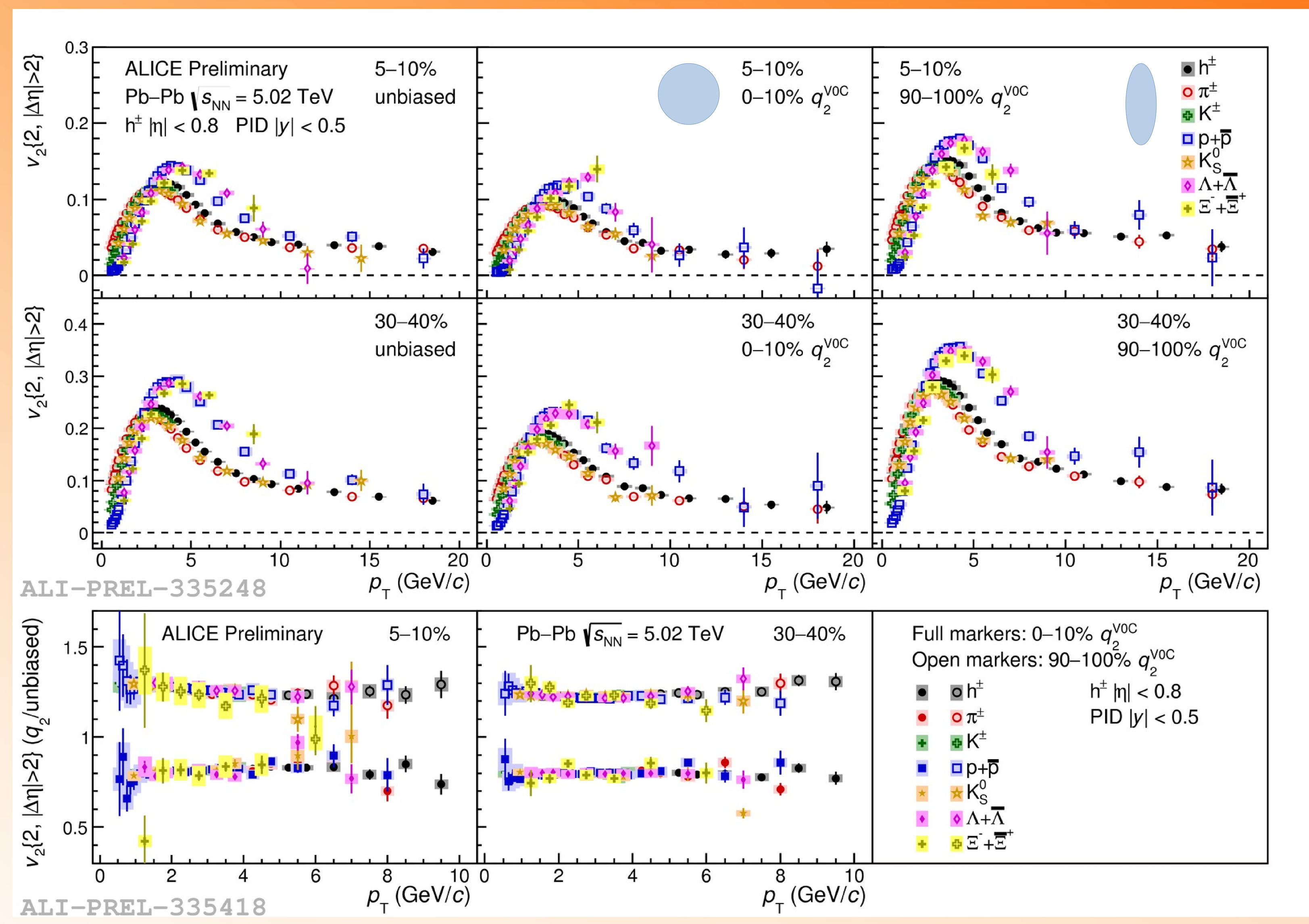


ESE in ALICE



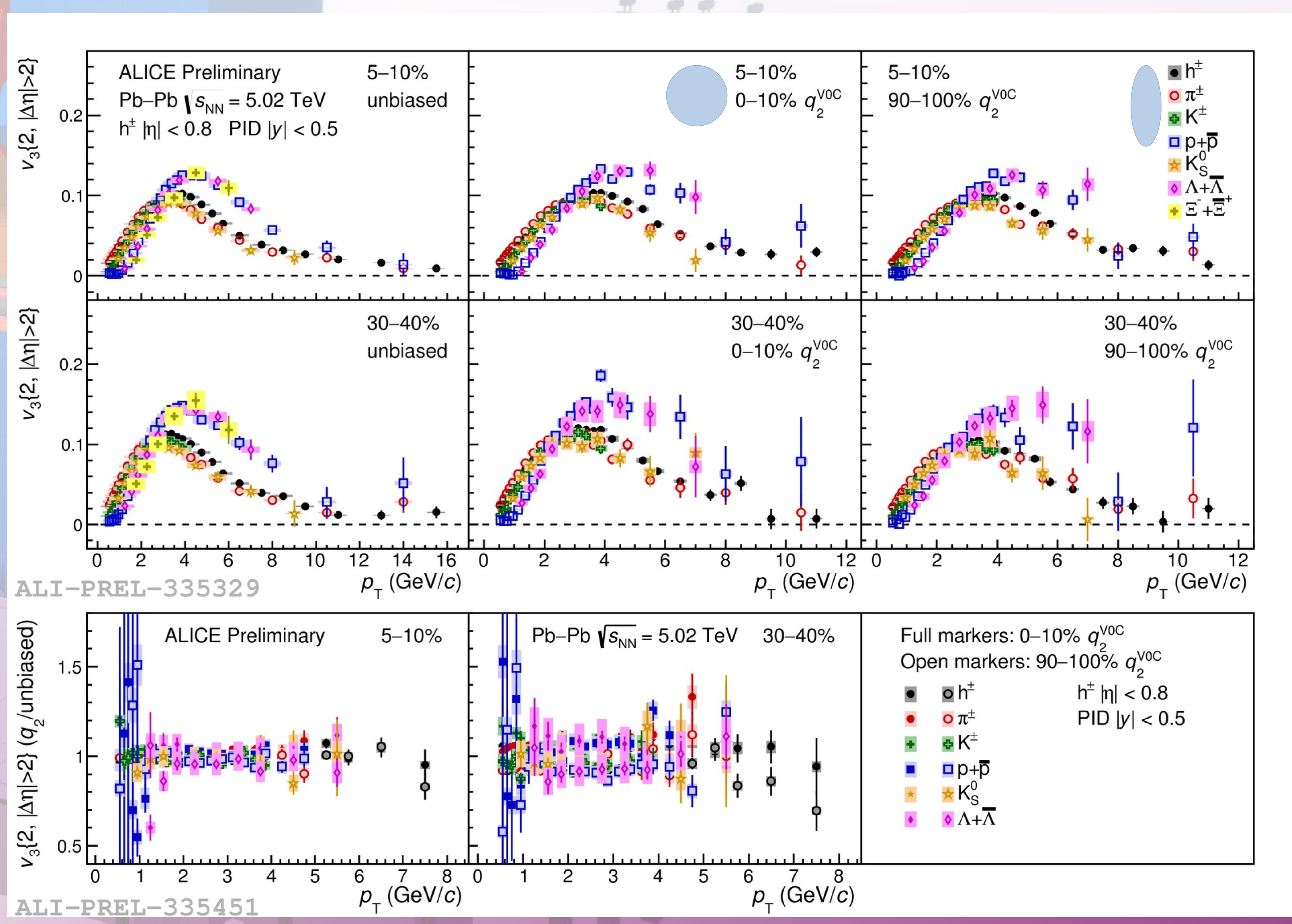
- q_2^{V0C} [6] used to select events with 30% larger or 20% smaller v_2 than the average
- ESE/unbiased: almost flat up to $p_T \sim 20$ GeV/c
  - Same source of flow fluctuations
  - Small deviations for p_T<3 GeV/c (different ellipticity)

$v_2\{2, |\Delta\eta|>2\}(p_T)$ with q_2: 5-10%, 30-40% centrality



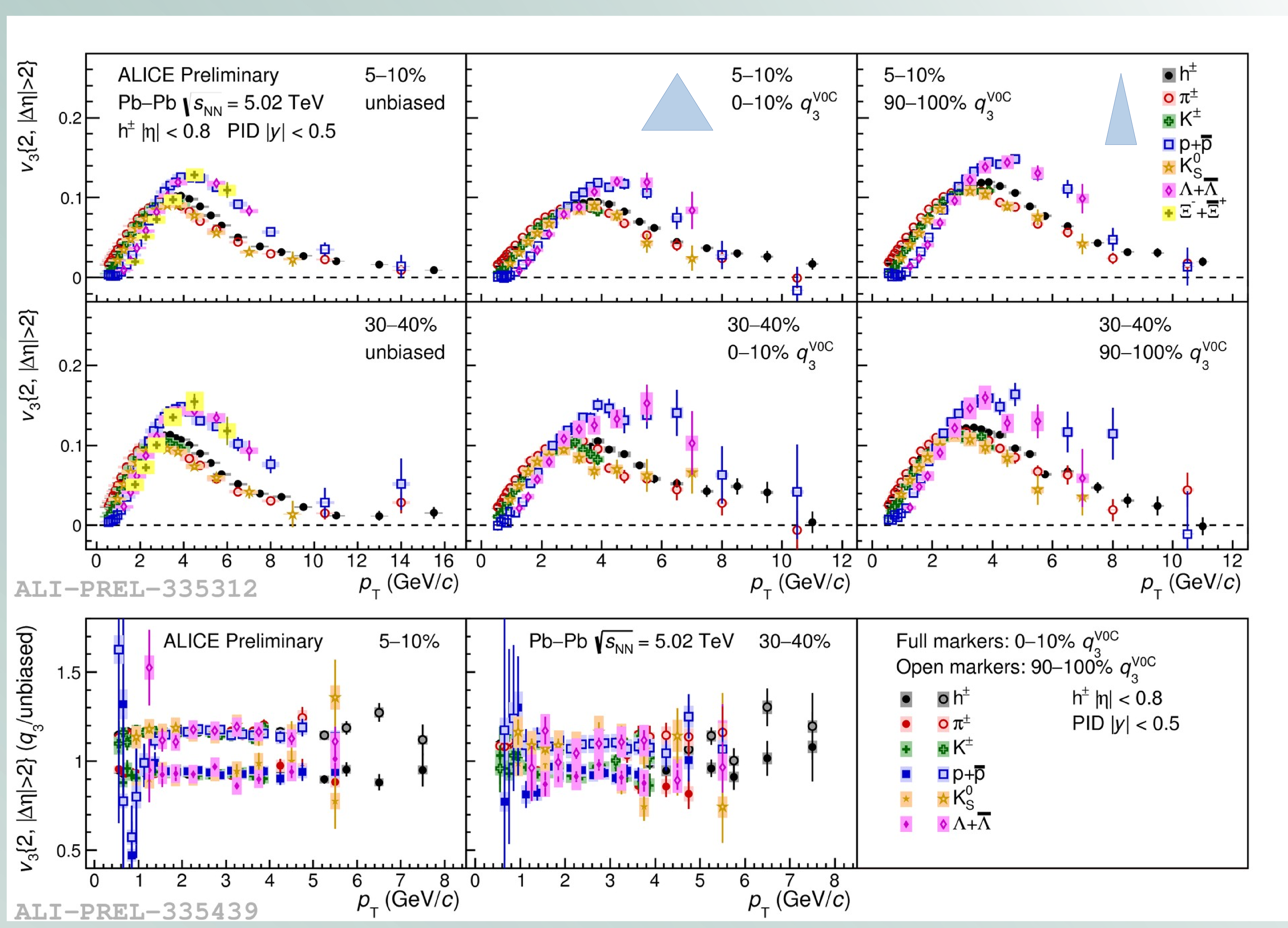
- p_T < 2 GeV/c: mass ordering → interplay between radial and elliptic flow
- p_T ~ 2-3 GeV/c: crossing between v_2 of mesons and baryons
- 3 < p_T < 10 GeV/c: v_2(baryons) > v_2(mesons)
  - Particles grouping according to their type (mesons and baryons)
- p_T > 10 GeV/c: no particle type dependence within uncertainties
- $v_2^{q_2}/v_2^{unbiased}$: same source of flow fluctuations
  - No dependence on particle species

$v_3\{2, |\Delta\eta|>2\}(p_T)$ with q_2: 5-10%, 30-40% centrality



- Mass ordering at low p_T, baryon-meson grouping at intermediate p_T
- v_3 anti-correlated with q_2
- $v_3^{q_2}/v_3^{unbiased}$: same source of flow fluctuations
  - No dependence on particle species
  - Weak sensitivity for central collisions

$v_3\{2, |\Delta\eta|>2\}(p_T)$ with q_3: 5-10%, 30-40% centrality



- Mass ordering at low p_T, baryon-meson grouping at intermediate p_T
- $v_3^{q_3}/v_3^{unbiased}$: same source of flow fluctuations
  - No dependence on particle species

CONCLUSIONS

- $v_n^{q_n}$: same trends as found in the unbiased results
  - Mass ordering at low p_T, baryon-meson grouping at intermediate p_T
- v_3 anticorrelated with q_2 (i.e., v_2)
- $v_n^{q_n}/v_n^{unbiased}$: same source of flow fluctuations
  - No dependence on particle species

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