Flow measurements in small systems with ALICE

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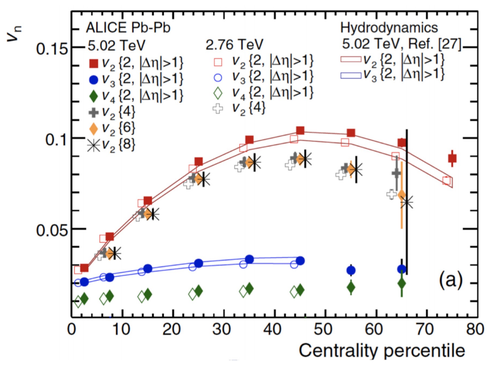
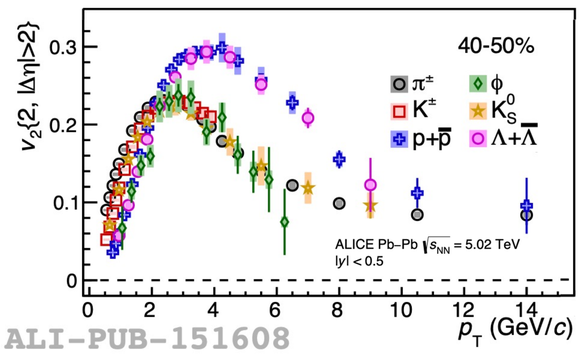
MOTIVATION :

FLOW IN HEAVY-ION COLLISIONS[1]



Anisotropic flow coefficients provide detailed information on the initial conditions and transport properties of the medium.

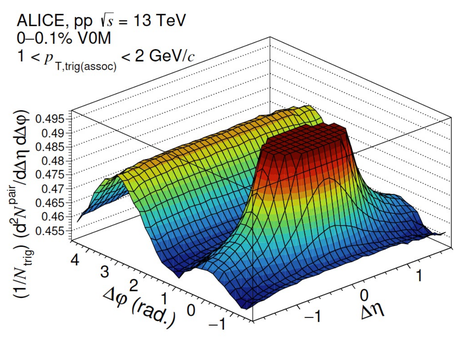
IDENTIFIED PARTICLES' FLOW[2]

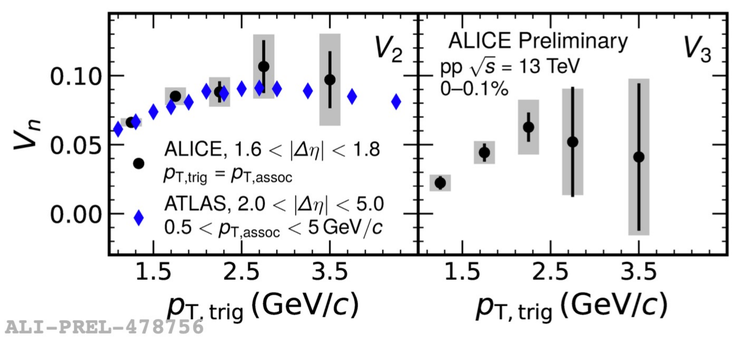


Mass ordering in low p_T :
Boost from the medium

Baryon-meson grouping in intermediate p_T :
Partonic collectivity

FLOW IN SMALL SYSTEMS[3]





Collectivity is also observed in small systems.

v_2 from ALICE show consistent value with ATLAS result even though ALICE has smaller long-range.

ALICE DETECTOR[4]

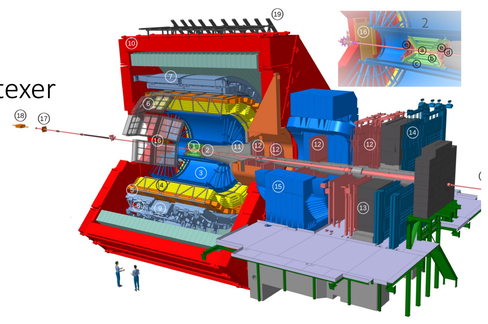
ITS – Tracker / Trigger / Vertexer

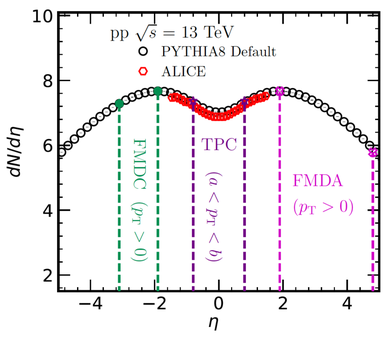
V0 – Trigger / Multiplicity

FMD – Multiplicity

TPC – Tracker / PID

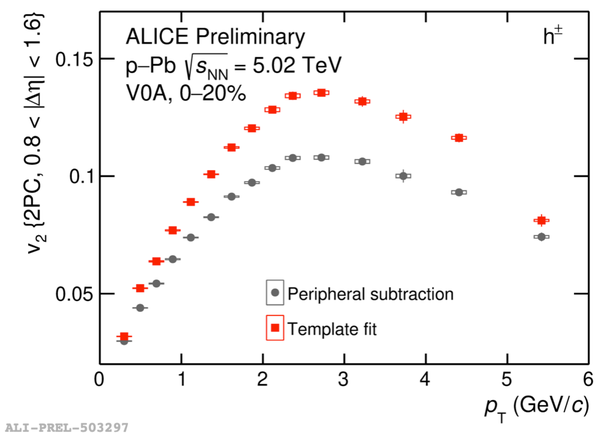
TOF – PID

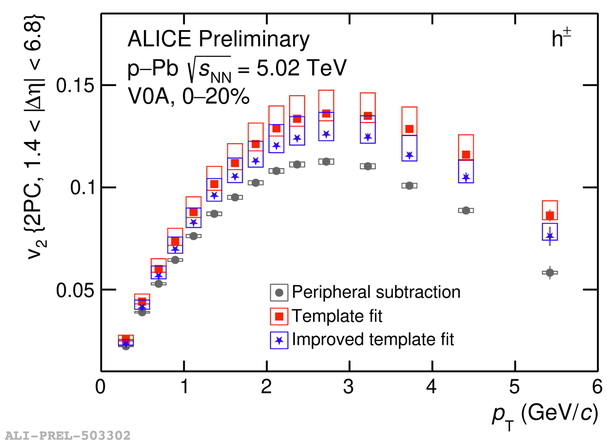


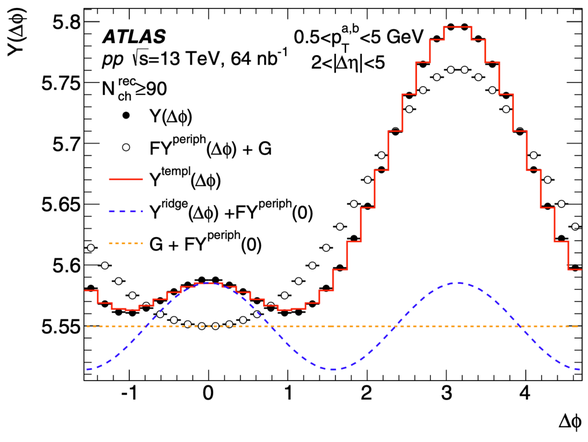


We tried correlating particles in TPC with FMD for better statistics.

NON-FLOW SUBTRACTION[5,6]





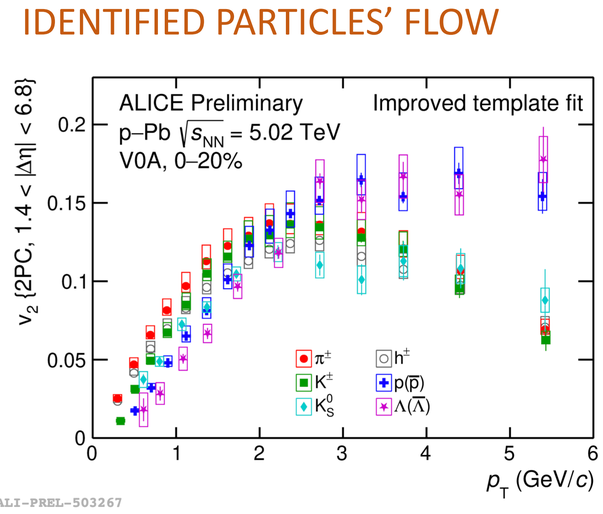


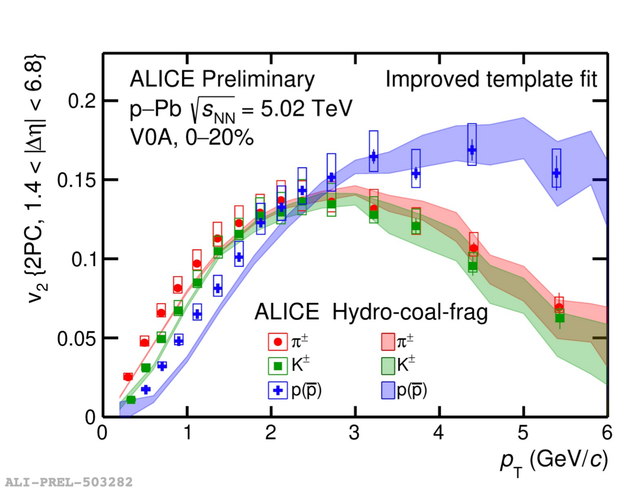
Consistent results were obtained in both detector combinations for two-particle correlations.

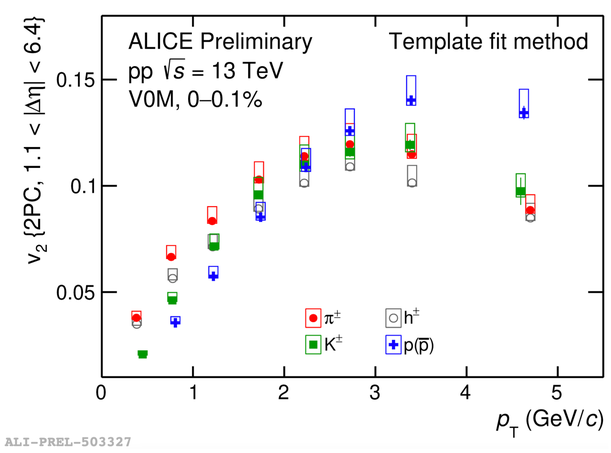
The (Improved) template fit method was used for the non-flow subtraction.

$$Y(\Delta\phi) = FY(\Delta\phi)^{LM} + G\left[1 + \sum_{n=2}^{\infty} 2v_{n,n}\cos(n\Delta\phi)\right]$$

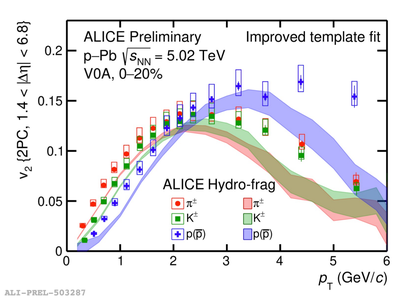
IDENTIFIED PARTICLES' FLOW





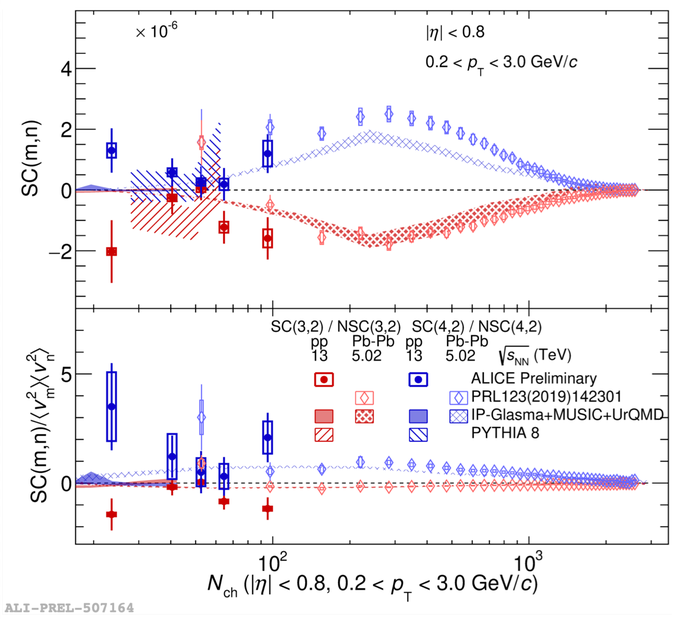


Mass ordering and baryon-meson grouping are also seen in small systems.



The quark coalescence plays a key role for the description of intermediate p_T region.

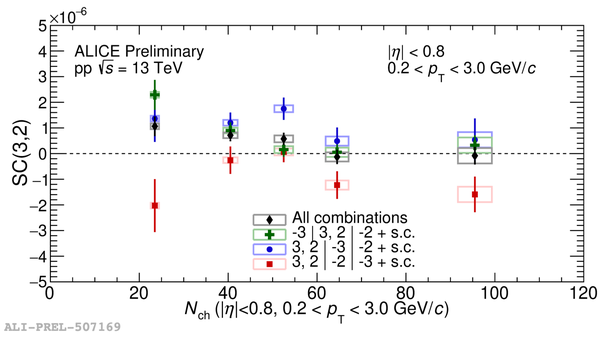
SYMMETRIC CUMULANTS



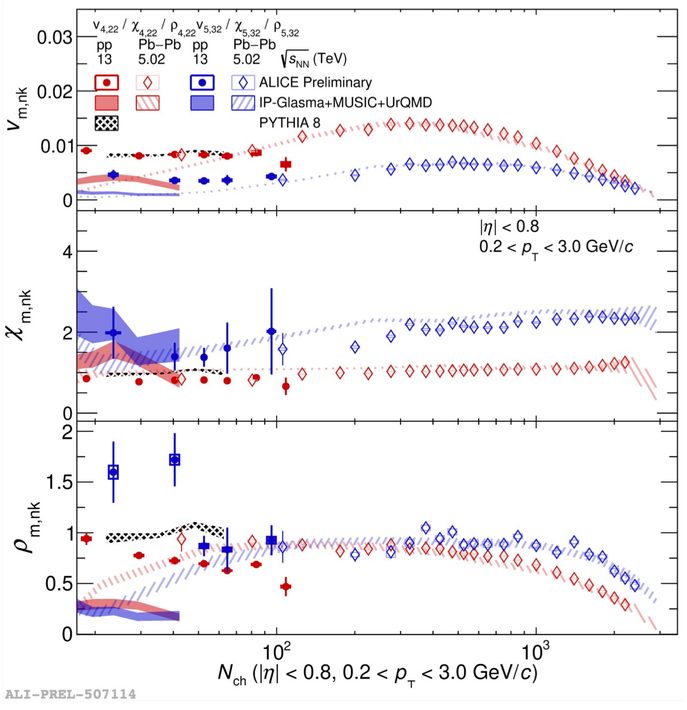
$$SC(m,n) = \langle v_m^2 v_n^2\rangle - \langle v_m^2\rangle\langle v_n^2\rangle$$

SC(m,n) represents the correlations between flow harmonics.

Same ordering of *SC(m,n)* observed in pp and Pb–Pb collisions.



NON-LINEAR FLOW



$$V_4 = V_4^L + V_4^{NL} = V_4^L + \chi_{4,22}(V_2)^2$$

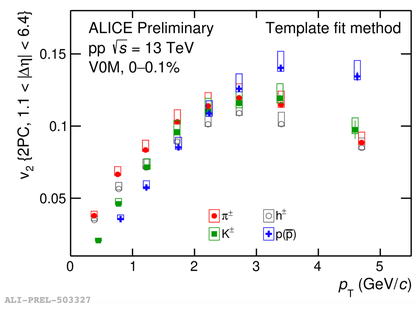
$$\rho_{4,22} = v_{4,22}/v_4\{2\} = \langle\cos(4\Psi_4 - 4\Psi_2)\rangle$$

$\chi_{m,np}$: Non-linear flow coefficient
$\rho_{m,np}$: Symmetry planes
$v_{m,np}$: Non-linear flow mode

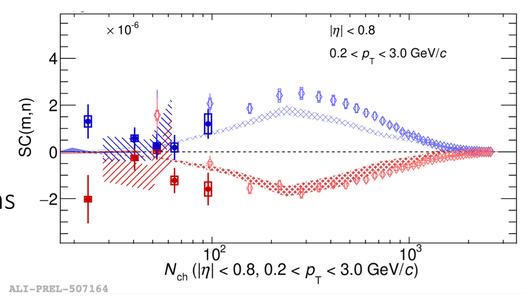
Higher order flow coefficients non-linear contribution from lower orders and sensitive to initial geometry and its fluctuations.

$\rho_{4,22}$ decreases unlike Pb–Pb collisions.
$\rho_{5,32}$ shows different trend in low and high multiplicity.

OUTLOOK



- The first observation of p_T–dependent identified particles' flow in pp collisions at $\sqrt{s} = 13$ TeV.
- Parton collectivity is also seen in small systems.
- Multiplicity dependent flow measurement is on-going.



- The first observation of same ordering of the correlations between flow harmonics in pp and Pb–Pb collisions.

REFERENCE

[1] ALICE Collaboration, Phys. Rev. Lett 116, 132302 (2016)
[2] ALICE Collaboration, JHEP 09 (2018) 006
[3] ALICE Collaboration, JHEP 05 (2021) 290
[4] S. JI, M. Virta, T. Kallio, S. LIM, D. KIM, arXiv:2303.05806
[5] ALICE Collaboration, Phys. Lett. B 726 (2013) 164–177
[6] ATLAS Collaboration, Phys. Rev. C 96, 024908 (2017)