Anisotropic flow of $\phi$ meson in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV with the ALICE detector

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Motivation
- The main goal of the heavy-ion program at the LHC is the creation of the Quark Gluon Plasma (QGP) and the study of its properties.
- Anisotropic flow, especially elliptic flow ($v_2$), is an observable which is sensitive to the properties of this matter.
- $\phi$ meson flow is an important experimental probe:
  - assuming a smaller hadronic cross section,
  - reflects the partonic collectivity
  - has a large mass,
  - test the mass splitting picture of differential flow
  - study the hydrodynamic behavior
  - carries two strange quarks,
  - check/confirm the NQ scaling picture built at RHIC energies

$\phi$ reconstruction
- The combinatorial background is subtracted using the distribution of like-sign kaon pairs.
- A polynomial fit used to remove the residual background,
  - the 2nd and 3rd polynomial functions has been tested.
- Both Breit-Wigner and Voigtian functions are applied to fit the spectrum. The differences between extracted $v_2$ is used to estimate the systematic errors.

$v_2$ versus invariant mass method
- We extract the $\phi$ meson $v_2$, fitting the $v_2$ of kaon pairs $v_2^T(m_{inv})$ with invariant mass method:

$$v_2^T(m_{inv}) = v_2^S \frac{N^S}{N^T}(m_{inv}) + v_2^B \frac{N^B}{N^T}(m_{inv}) \quad (1)$$

- the yields $N^S$, $N^B$ are obtained from the fits to the $\phi$ meson invariant mass distribution.
- the $v_2^T(m_{inv})$ are measured by Q-Cumulant, $v_2(2)$, Scalar Product and Event Plane methods.
- $v_2$ of background is parameterized with the polynomial function.

Centrality dependence of $\phi$ meson $v_2$
- A good agreement is observed among $v_2(2)$, $v_2(EP)$ and $v_2(SP)$ measurements.
- There is a clear centrality dependence of $\phi$ meson $v_2$.
- $\phi$ meson $v_2$ is compared with viscous hydrodynamic model calculations. The theoretical predictions slightly overestimate the $\phi$ meson $v_2$ measurements.
- Adding the phase of hadronic rescattering into the hydrodynamic model calculations may improve the agreement with measured $\phi$ meson $v_2$.

Comparisons with $\phi$ meson $v_2$ at RHIC
- $\phi$ meson $v_2$ at the LHC is pushed toward higher $p_T$.
- This might indicate a stronger radial flow produced at the LHC energy.

Mass splitting and number of quark scaling
- $\phi$ meson reveals a behavior similar to antiprotons at low $p_T$ (mass splitting) but similar to pion at high $p_T$ (number of quark).
- We don’t observe a clear number of quark scaling picture.

Conclusions
- Elliptic flow of $\phi$ meson is measured in $\sqrt{s_{NN}} = 2.76$ TeV Pb-Pb collisions with the ALICE detector.
  - hydrodynamic calculations slightly overestimate the $\phi$ meson $v_2$
  - comparison with STAR measurements indicate a stronger radial flow produced at LHC energy.
  - $\phi$ meson flow follows the mass splitting at low $p_T$ and follows meson’s flow at intermediate $p_T$, but there is no clear scaling with the number of quarks observed at intermediate $p_T$ region.