Angular Analysis of the $B_s^0 \to \phi(K^+K^-)e^+e^-$ decay in the low dielectron mass region at LHCb

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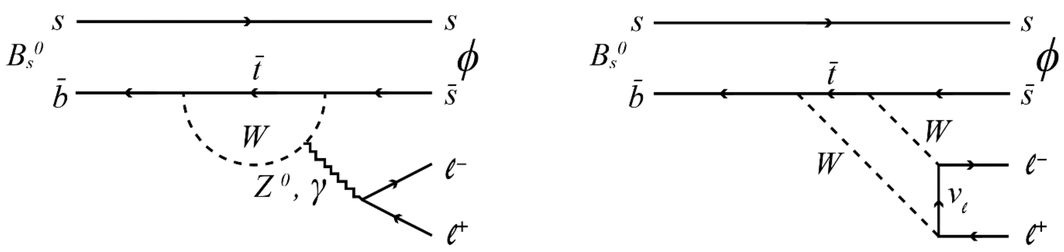
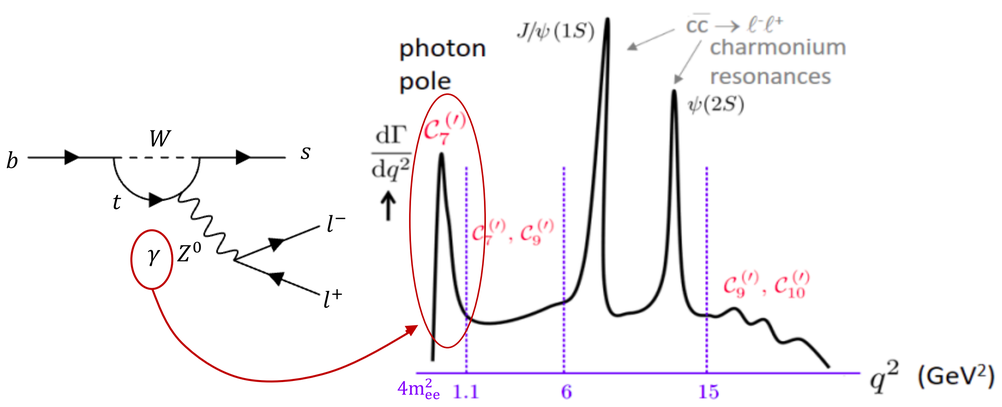
$B_s^0 \to \phi e^+e^-$ decay

- Flavor changing neutral currents (FCNC)
  → Occur via loops within the Standard Model (SM)
  → Highly suppressed
- Very sensitive to New Physics (NP).



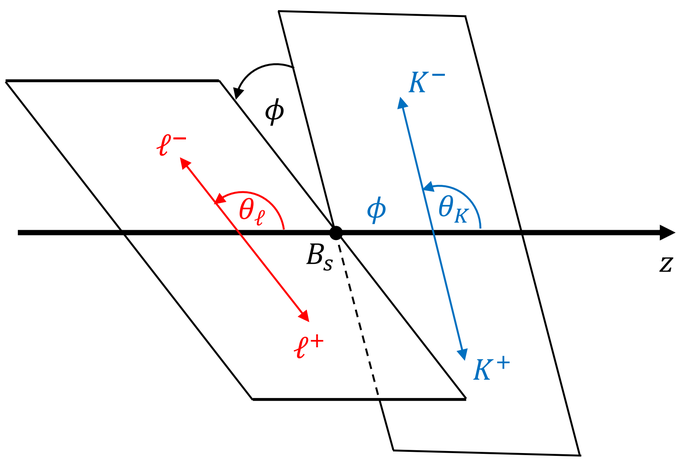
At low q^2 (dilepton mass squared):

- Virtual photon coupling to lepton pair dominates.
- Can study the photon polarization through an angular analysis.



Angular basis

Three angles to describe the dynamics of $B_s^0 \to \phi(\to K^+K^-)e^+e^-$.



The differential decay width (PDF) in the low dielectron mass region defined as $m_{ee} \in [10, 500]$ MeV reads

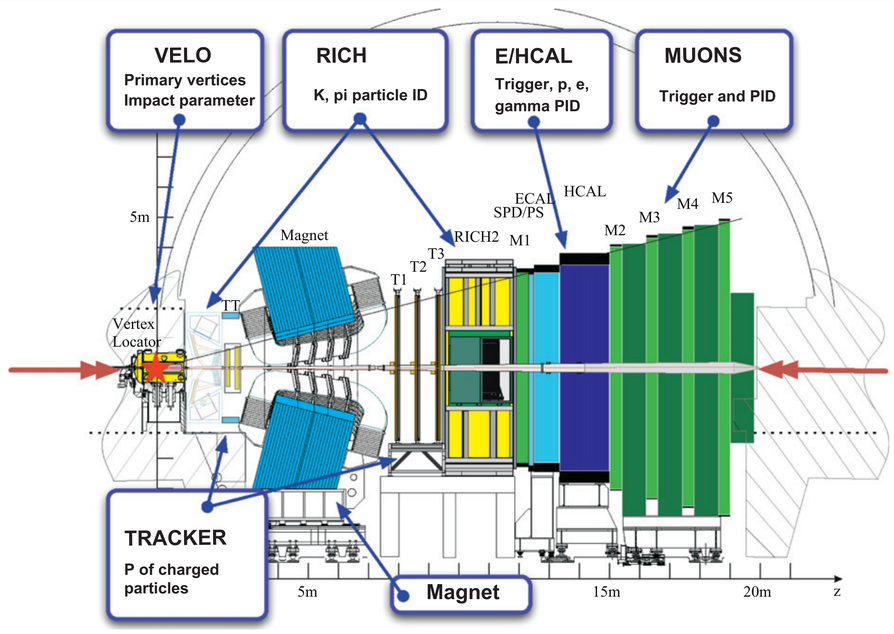
$$\langle \frac{d^3\Gamma}{d\cos\theta_l d\cos\theta_k d\phi} \rangle = \frac{9}{16\pi} \left\{ \frac{3}{4}(1-F_L)\sin^2\theta_k + F_L\cos^2\theta_k + \left[\frac{1}{4}(1-F_L)\sin^2\theta_k - F_L\cos^2\theta_k\right]\cos 2\theta_l + \frac{1}{2}(1-F_L)A_T^{(2)}\sin^2\theta_k\sin^2\theta_l\cos 2\phi + (1-F_L)A_T^{ReCP}\sin^2\theta_k\cos\theta_l + \frac{1}{2}(1-F_L)A_T^{ImCP}\sin^2\theta_k\sin^2\theta_l\sin 2\phi \right\}$$

A_T^{ImCP} and $A_T^{(2)}$ key observables → sensitive to the photon polarization [1].

References

[1] On the impact of meson mixing on $B_s \to \phi e^+e^-$ angular observables at low q^2
S. Descotes-Genon, I. Plakias, O. Sumensar
arXiv:2210.11995

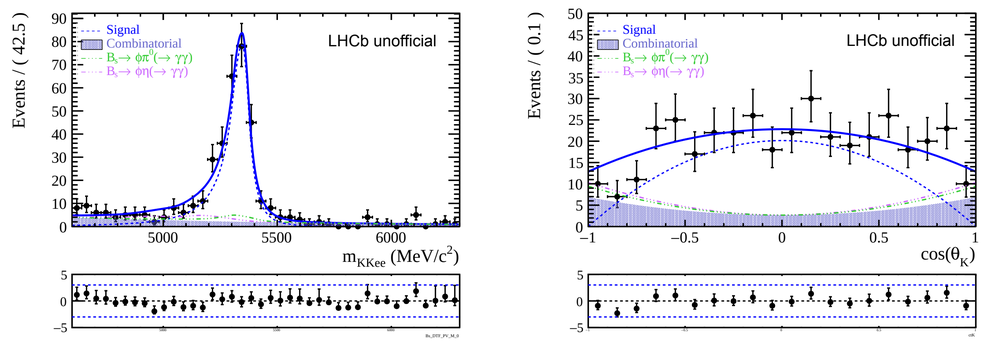
LHCb



- Single arm forward spectrometer.
- Designed for heavy hadrons physics (b/c).

Control channel

- $B_s^0 \to \phi\gamma$ decay serves as a control sample very similar to the signal (with ~ 500 signal events).
- Used to validate the angular fit.
- Electrons come from material conversion of photons in detector → PDF only sensitive to F_L (the longitudinal polarization).



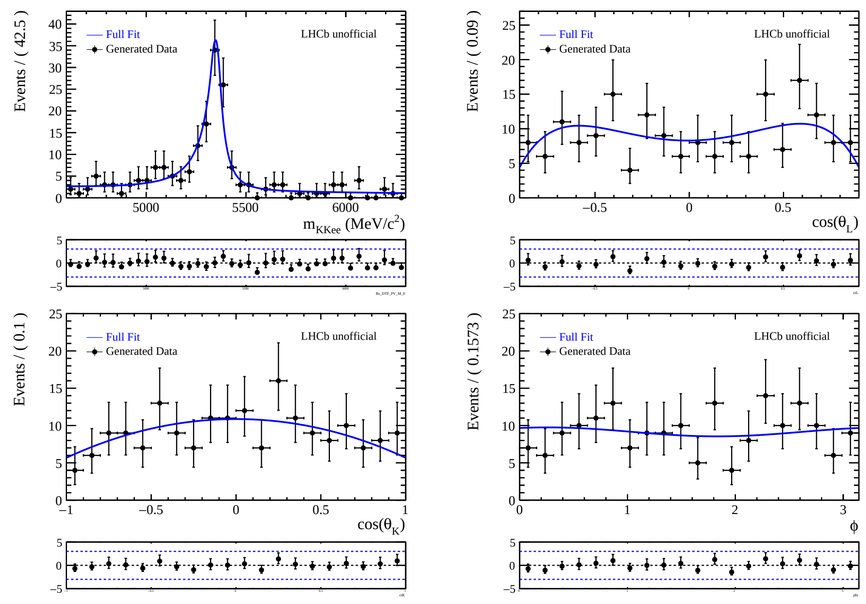
$F_L^\gamma = 0.02 \pm 0.02(\text{stat})$ as expected for a real γ

Work in progress

- ~ 100 signal events.
- 4D fit (mass and 3 angles) to extract the observables of interest:

$$F_L,\ A_T^{(2)},\ A_T^{ImCP},\ A_T^{ReCP}$$

- Pseudo experiments (Toys) done with expected statistics and SM predictions (validate the fit, check sensitivity).



Projections of the 4D fit to a random toy

Expected statistical sensitivity[a]

$\sigma(F_L)$	0.050
$\sigma(A_T^{(2)})$	0.240
$\sigma(A_T^{ImCP})$	0.240
$\sigma(A_T^{ReCP})$	0.160

[a] dominant over systematics

$\sigma(A_T^{(2)}) \sim 0.24$
→ Precision of $\sim 12\%$ on the photon polarization in $B_s^0 \to \phi\gamma$