Study of the decay $K_S^0 \to \pi^0 \mu\mu$

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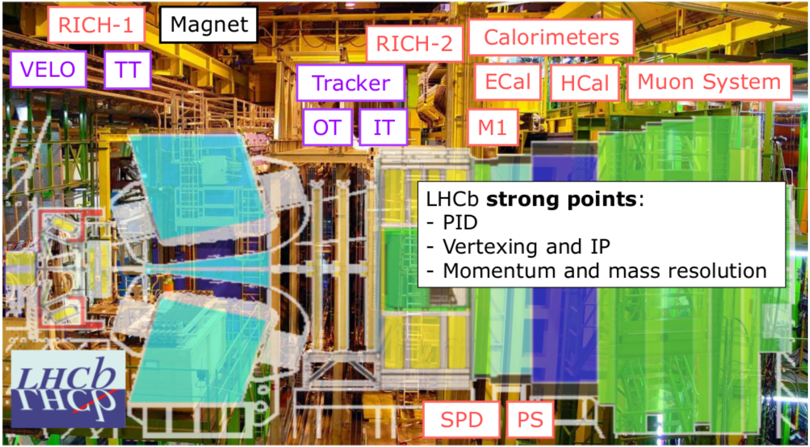
RICH-1
Magnet
VELO
TT
RICH-2
Calorimeters
Tracker
ECal
HCal
Muon System
OT
IT
M1
LHCb strong points:
- PID
- Vertexing and IP
- Momentum and mass resolution
SPD
PS

Introduction

- $BF(K_L^0 \to \pi^0\mu\mu)$ could be sensitive to New Physics
- $BF(K_S^0 \to \pi^0\mu\mu)$ can constrain the CP violating amplitude of $K_L^0 \to \pi^0\mu\mu$ and let us access the New Physics contribution.
- Now $BF(K_S^0) = (2.9^{+1.5}_{-1.2}) \times 10^{-9}$

$\to$ *Is it possible to measure this BF and improve accuracy ?*

Origin of Background

Several sources of Background (a priori):

- $K_S^0 \to \pi\pi$
- $\Lambda, \overline{\Lambda} \to p\pi$
- $K_S^0 \to \pi^{\pm}\mu^{\mp}\nu_{\mu}$
- Interaction with the detector
- combinatorial Background

$\to$ We need to find cuts to separate the signal to this background
We will compare MC truth matched and Data after Stripping Selections.

$K_S^0 \to \pi\pi$

$BF(K_S^0 \to \pi\pi) \approx 0.69$
$p(\pi \to \mu) \approx 0.01$
$\to$
$BF(K_S^0 \to \pi\pi_{doubleMisID}) \approx 0.69 \times 0.01^2 \approx 6.9\ 10^{-5} >> 10^{-9}$
Idea for a cut : reconstruct the $\pi\pi$ mass, it should produce a peak with all the events $K_S^0 \to \pi\pi$

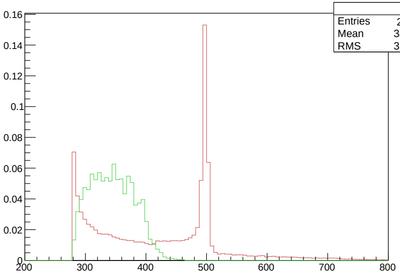

Figure : Distribution of $\pi\pi$ mass. Data and MC signal.

fake K_S^0 from particles interacting with the detector.

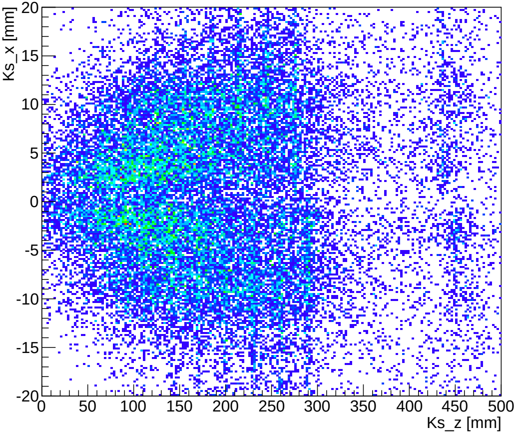

Figure : Plot of the x and z components of the reconstructed K_S^0 vertex.

Position of the π^0

- Reconstructing π^0 is very difficult.
- π^0 in each event is randomly chosen.
- each π^0 decays in two photons.

$\rightarrow$ *Can we determine the direction of the π^0 and compare its expected position with the positions of the two photons ?*

Position of the π^0

We reconstruct the expected position of the π^0 with :

- The direction of the K_S^0 (via the primary[1] and second[2] vertices).
- The momenta, energies and masses of both muons.
- π^0 and K_S^0 masses.

The most efficient strategy is to reject the candidates in which we can't compute the solution.

[1] where the pp collision happens
[2] where the K_S^0 decays

Conclusion

Name	Efficiency on Data (%)	Efficiency on MC signal (%)
$\pi\pi$ mass	75.8	99.7
reconstruction of the pi^0 position	27.7	76.7
$\pi\mu$ mass	49.8	90.1
$p\pi$ mass	91.6	93.3
PID cuts for both muons	3.2	53.0
All cuts	0.31	34.1

Data refers to a small sample of data which is mostly composed by background.

- We will explore all the variables.
- We will develop a MVA.

Thank you for your attention !