Analysis of the $B_s \rightarrow \phi\phi$ Decay (ongoing!)

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Overview

- ~~CP~~ in the standard model:
  - CKM matrix
  - Unitarity triangles
- B_s mixing
- The $B_s \rightarrow \phi\phi$ Decay
  - Preliminary results from CDF
  - Current Status of my analysis ...
  - Further work

CP Violation in the Standard Model

Types of CP violation:

- CP violation in the decay

  Amplitude of decay is different to the amplitue of the CP conjugate process
- CP violation in mixing:

  If mass eigenstates are not CP eigenstates, CP violation can occur
- CP violation in interference between decays with mixing and decays without mixing

The CKM Matrix

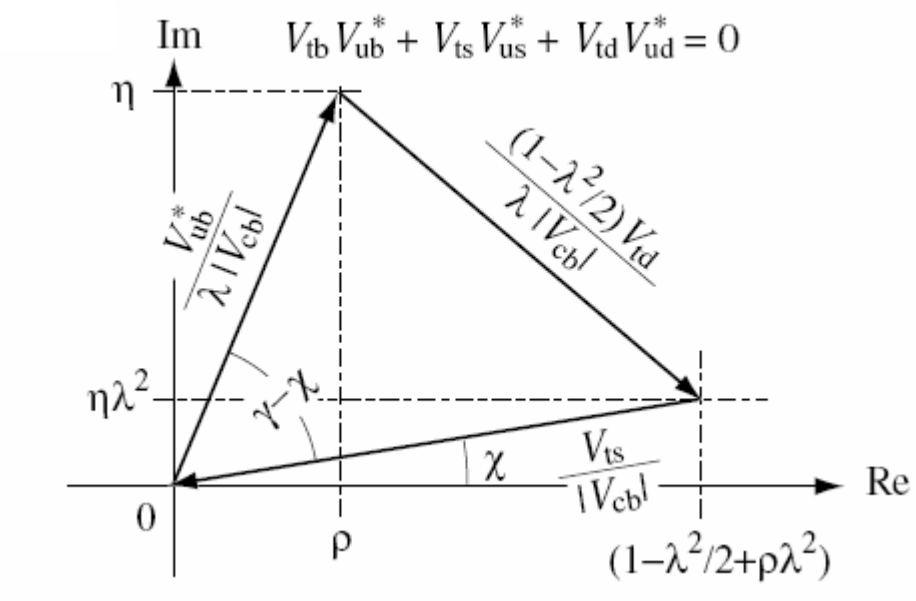
The CKM matrix which describes quark flavour mixing can be paramterised as:

$$V = \begin{pmatrix} 1 - \frac{\lambda^2}{2} & \lambda & A\lambda^3(\rho - i\eta) \\ -\lambda & 1 - \frac{\lambda^2}{2} & A\lambda^2 \\ A\lambda^3(1 - \rho - i\eta) & -A\lambda^2 & 1 \end{pmatrix} + O(\lambda^4)$$

This cointains a CP-vilating phase η

The Unitarity Triangle

This relationship can be represented by the unitarity triangle:



The phase here is χ, where $-2\chi \approx \lambda^2 \eta + \mathcal{O}(\lambda^4)$

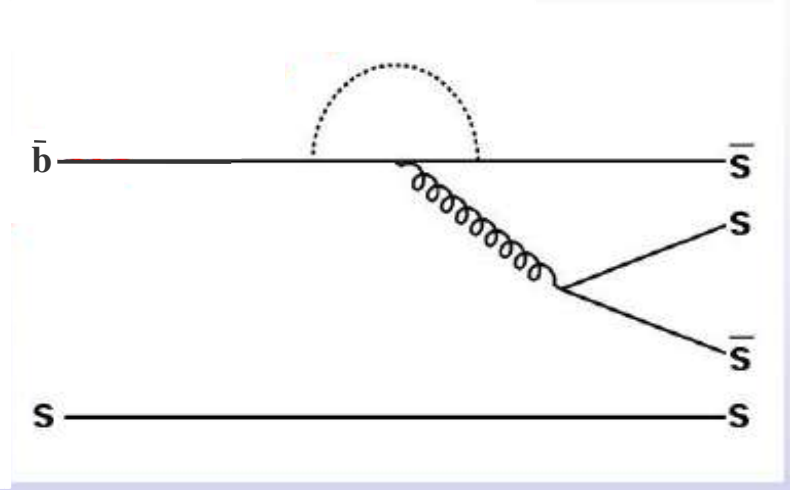
B_s Mixing

- In the Standard Model, mixing between B and Bbar mesons is described by ϕ_s, where:

$$\phi_s = -2\chi$$

- Deviaition from this result would be an indicator of new physics

The $B_s \to \phi\phi$ Decay:



- Rare penguin decay
- Very sensitive to NP
- Simiar to “Gold plated” channel

Efficiency:

Decay analyzed (MC truth) :
[B_s0 -> (phi(1020) -> ^K+ ^K-) (phi(1020) -> ^K+ ^K-)]cc

EffMcTruth:

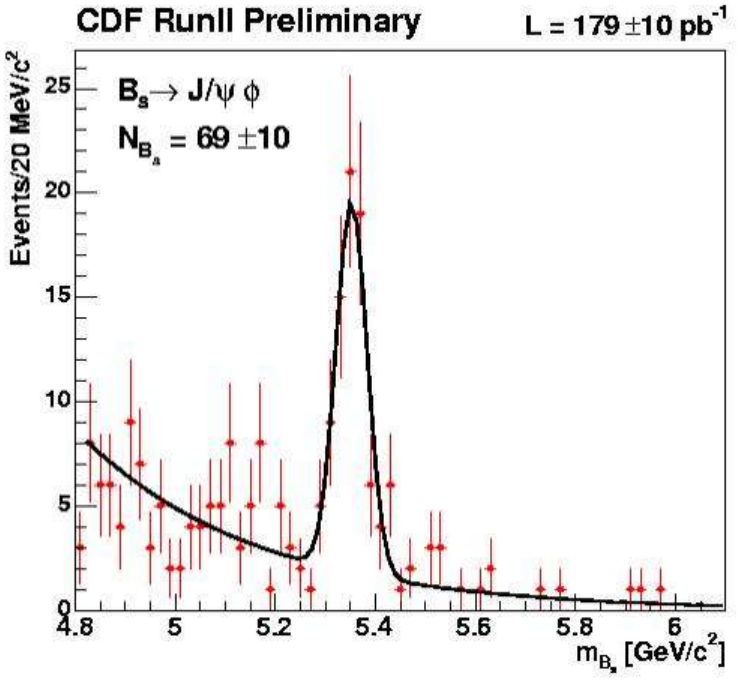
Decay Of Interest Generated	(/ Events)	4000
DoIs Gen, Reconstructible (ALL)	(/ Generated)	652
DoIs Gen, Reconstructed (ALL)	(/ Generated)	610
DoIs Gen, Rec'ble & Rec'ted (ALL)		513

Rec. efficiency:
(Rec'tible & Rec'ted)/Rec'tible (ALL): 0.78681 +- 0.0160396

Preliminary result from CDF

- CDF: preliminary observation in data taken up to August 2003
- 12 signal candidates
- Triggering on displaced vertex
- Work onging at CDF to measure poarisation amplitudes
- Not enough statistics to see CP
- Recent calculations predict

BR ~ 3.7 10^{-5}



$$BR = (1.4 \pm 0.6(stat) \pm 0.2(syst) \pm 0.5\,(BR)) \times 10^{-5}$$

LHCb Reconstrucion

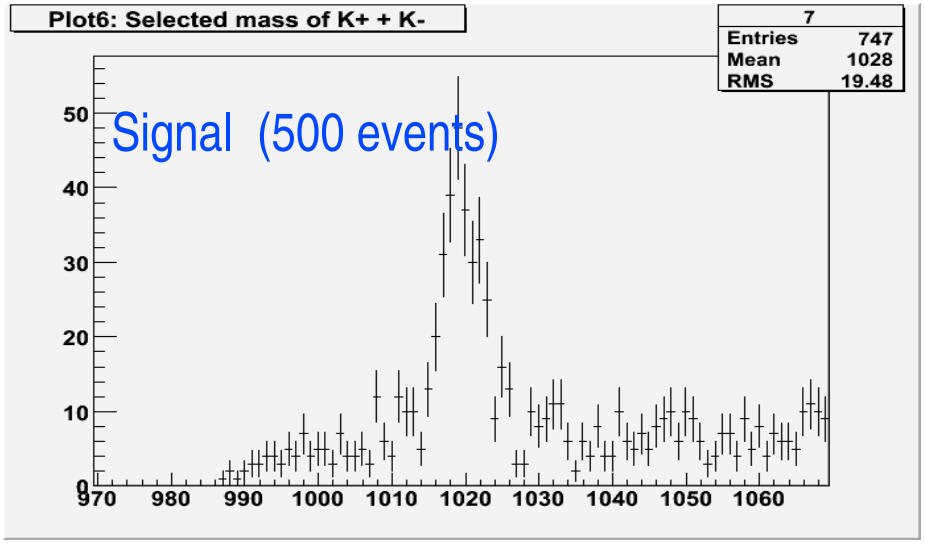
"The $B_S \rightarrow ØØ$ reconstruction at LHCb" S.Barsuk & I.Belyaev
LHCb 2003-094

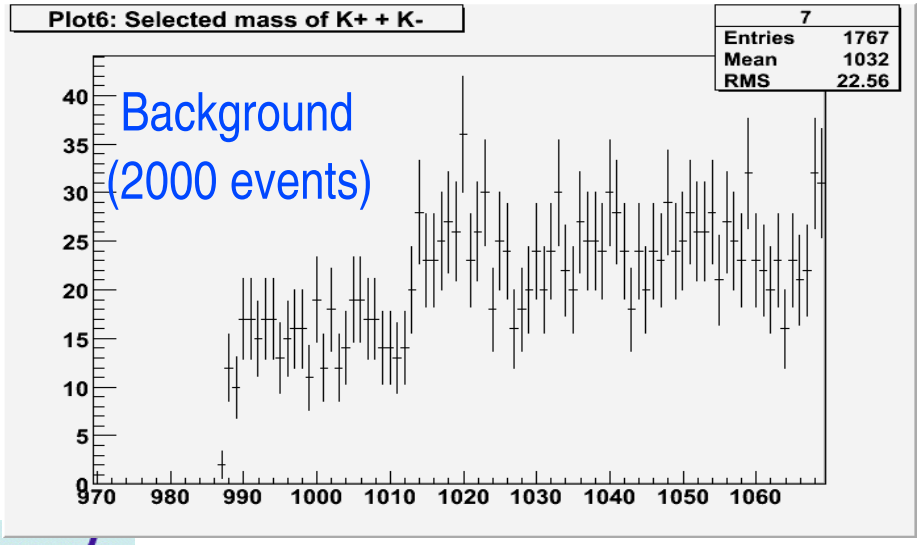
Reconstruction:

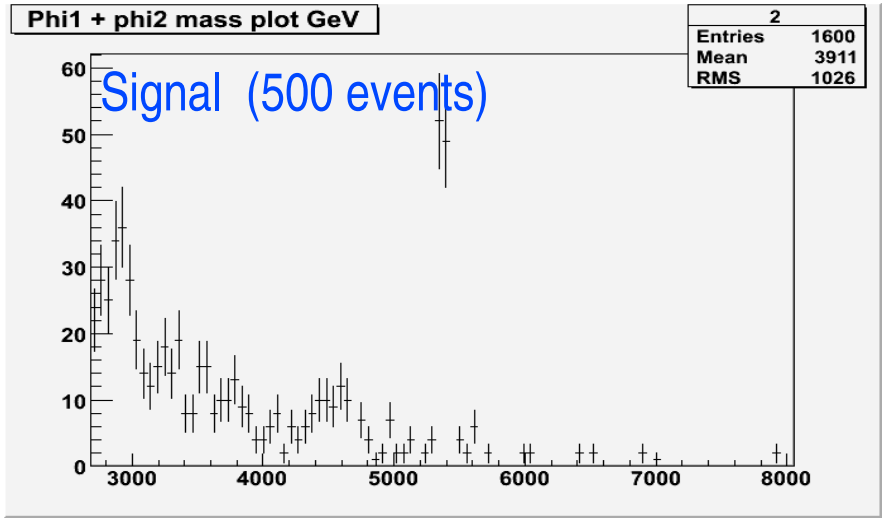
- $Ø \rightarrow K^+ / K^-$
- Background mostly inclusive bb, supressed by cuts on:
  - angle between Bs flight directions determined by different means
  - angle between rest & boost frame directions of flight
- Cut on invariant mass of K^+ / K^-
- Cut on IP for Ks wrt each primary vertex

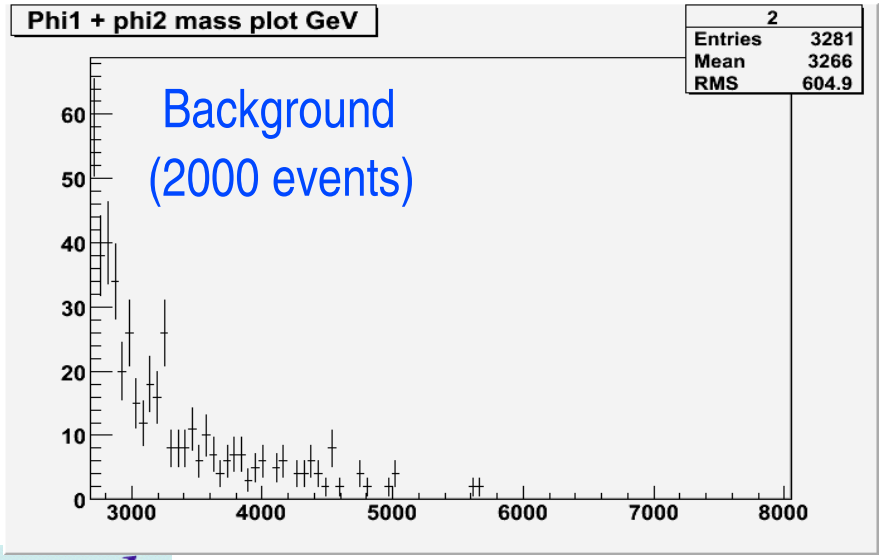
Estimate of 1200 events per year.

Combined K Masses (= ϕ mass)





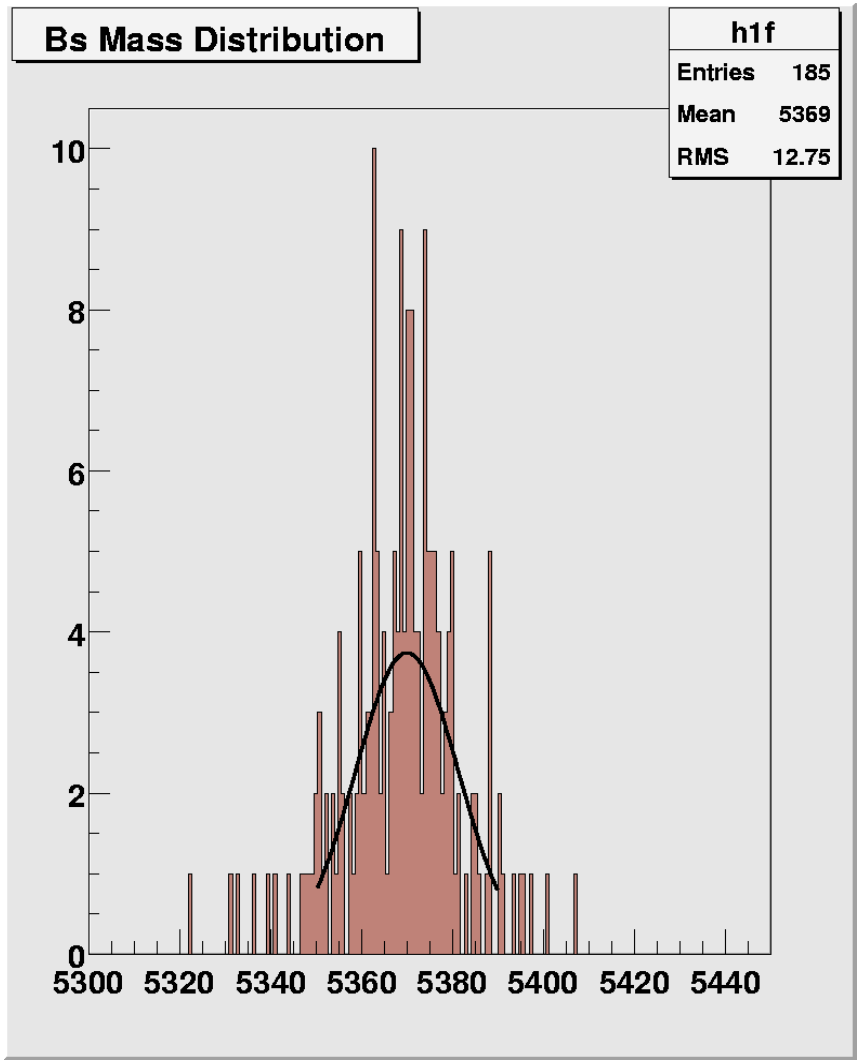




Cuts:

- Max ChiSq (20)
- Mass Window (100MeV)
- IP Significance (4.0)
- Flight Distance (3.5)

Combined ϕ Masses (=B_s)

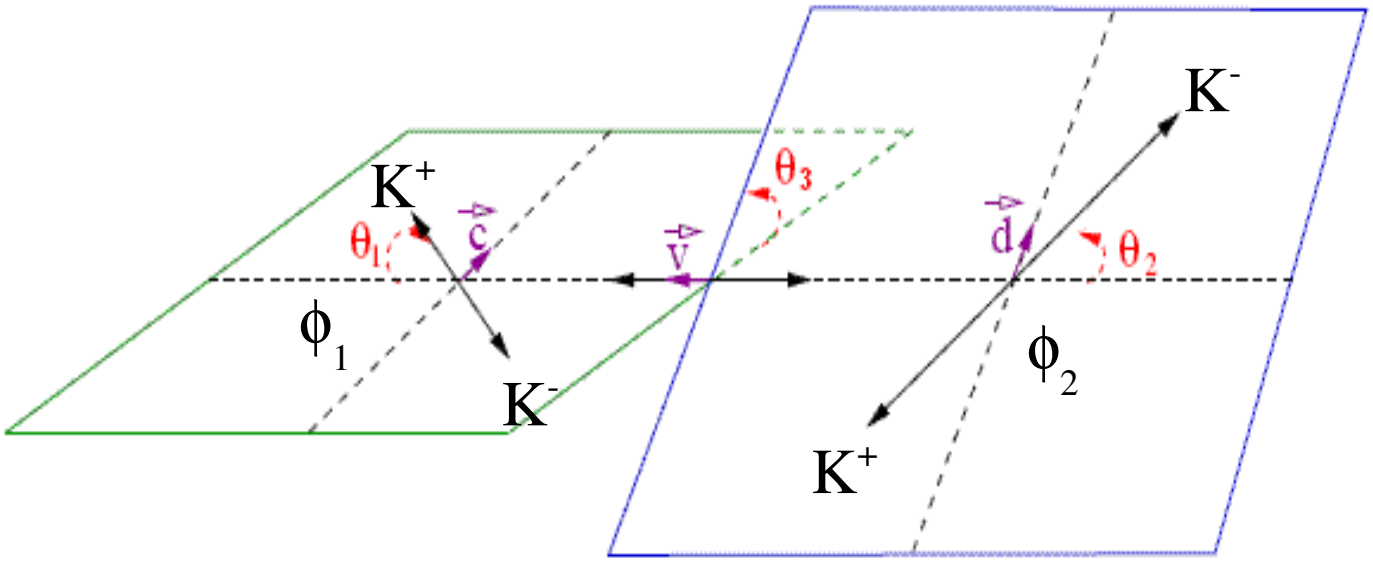


- Signal events only (4000 events)
- sigma: 11.33 +/- 1.82 (measure of resolution)

Angular Analysis

States containing two vector mesons, like , are not a CP eigenstates.
To find if CP vilation has occured, these states must be separated out using angular analysis.
This can be done because AM conservation demands that VV states take certain spin values
For , the allowed states are
L=0 (CP even)
L=1 (CP odd)
L=2 (CP even)

Angular Analysis



- Look at distribution in θ_1/θ_2
- Fit to find proportions of even/odd CP

Next Steps:

- Refine selection cuts
- Helicity angle analysis
- Toy MC generator $\rightarrow$ ~~CR~~