Feasibility study of $\mathrm{B_d^0} \rightarrow \mathrm{J}/\psi\mathrm{K_0^s}$ with DELPHI

Motivation

Study

Conclusions

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with thanks to Tim Adye

Motivation

Not many $\mathrm{B_d^0} \rightarrow \mathrm{J}/\psi \mathrm{K_0^s}$ events expected in full LEP 1 dataset:

$\sim$ 25 $\mu^+\mu^-$ and e^+e^- events

prior to reconstruction (assuming visible B.R. 1.8×10^{-5})

Would require maybe half this number at least, to say something meaningful about CP violation. Looks demanding.

However, other experiments seem to have been very lucky:

- OPAL see 14 signal events, expect 5 (efficiency 17%)
- ALEPH see 16 signal events, expect 9 (efficiency 28%)

These + CDF result 'prove' CP violation at *almost* 99% C.L.

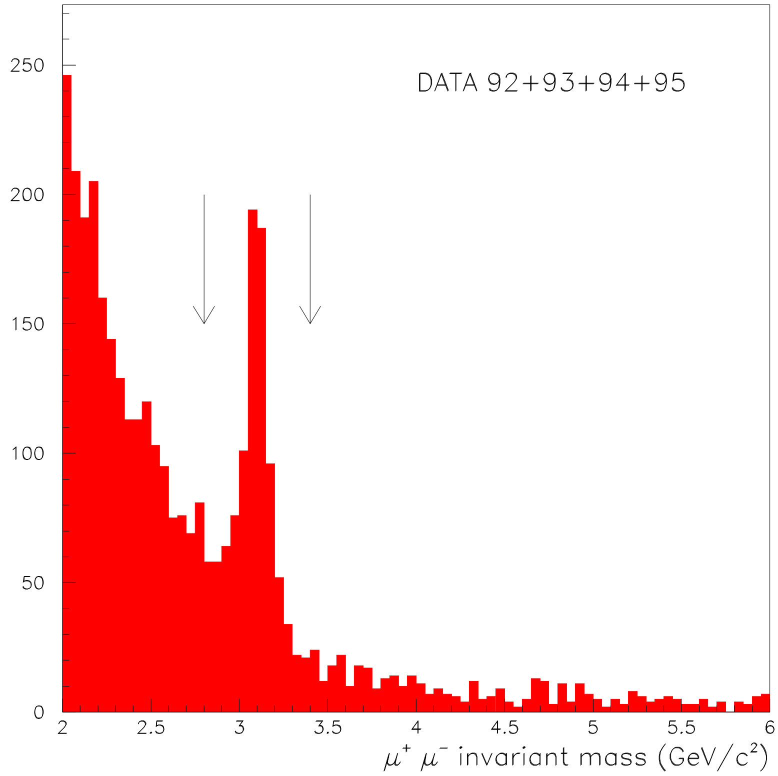
Maybe DELPHI also has a chance of being lucky?

Perform *quick* feasibility study to see whether we too have hint of a significant upwards fluctuation. (This work initiated unaware of the Gopal/Kubinec/Mitaroff study.)

$\mathrm{J}/\psi \to \mu^+\mu^-$

Take as starting point exisiting J/ψ ntuples of Tim Adye prepared for his PhD. Restricted to muon info and excludes '91. If we see anything promising will extend analysis!

Use combination of MUC L and HCAL tags to select candidates which are then vertex fitted (efficiency $\sim 45\%$):



Consider 963 events in wide mass window $2.8 \to 3.4\,\mathrm{GeV}/\mathrm{c}^2$

Eyeball fit to background gives estimated purity of $\sim 45\%$

Make accompanying ntuple of V^0 information for these events

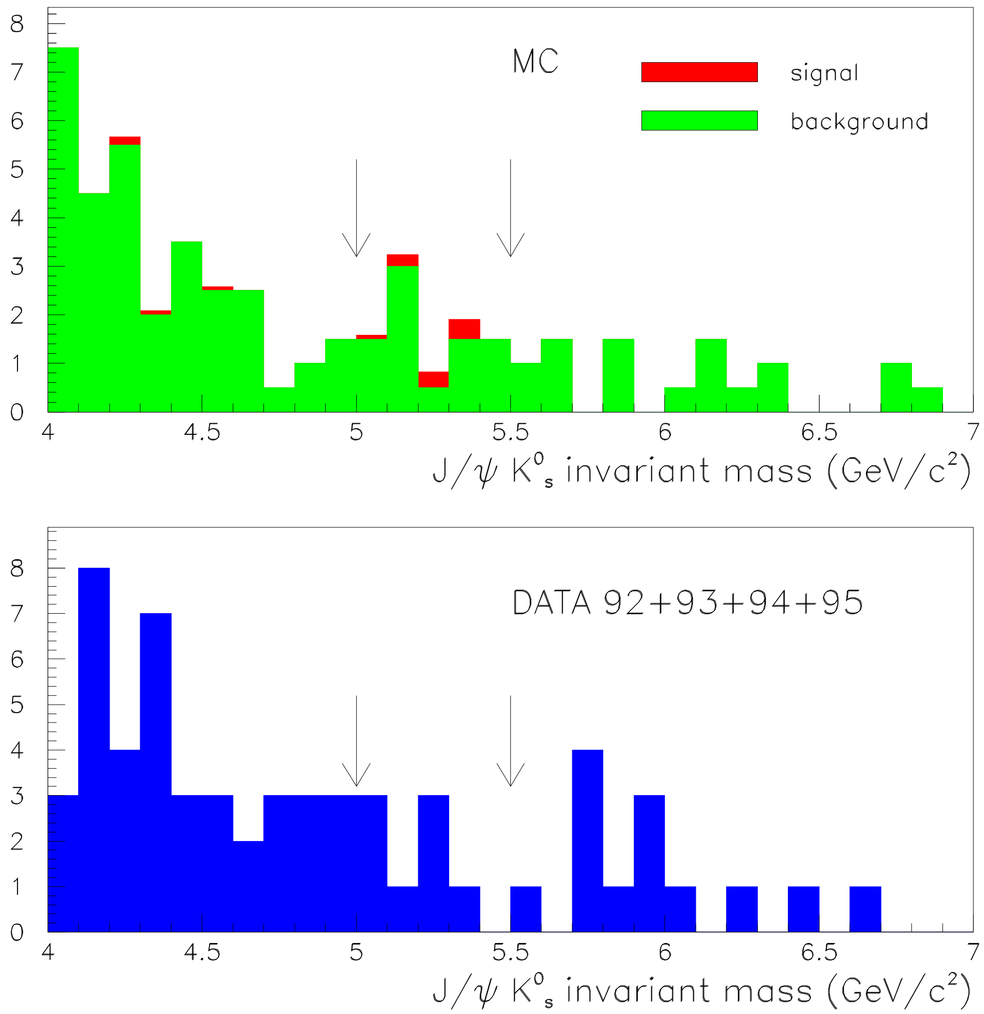
Corresponding study in MC using large $q\overline{q}$ and $b\overline{b}$ samples, in which we have $\sim 60\ \mathrm{B}^0_\mathrm{d} \to \mathrm{J}/\psi\mathrm{K}^\mathrm{s}_0$ events after ψ rec.

J/ψ and K_s^0

Combine J/ψ and K_s^0, where available. This sadly has efficiency of $\sim 25\%$ w.r.t. events where J/ψ already found...

Signal events in MC have mass resolution of ~ 200 MeV – here no kinmeatic fit. For now just look in $5.0 \rightarrow 5.5\,\mathrm{GeV/c^2}$

From Monte Carlo expect 7.9 events, including 2.1 signal



In data see 8 events

Background cuts

Now apply further cuts to suppress background:

- IP of K_s^0 w.r.t. ψ vertex < 0.4 cm
- Closest approach of K_s^0 w.r.t. ψ vertex < 1 cm
- Flight distance > -1 mm
- Cosine of opening angle between ψ and $K_s^0 > 0.85$
- Momentum of ψ candidate $> 10\,\mathrm{GeV/c}$, $K_s^0 > 2\,\mathrm{GeV/c}$
- Momentum of B candidate $> 20\,\mathrm{GeV/c}$

Has efficiency on signal of $\sim 60\%$

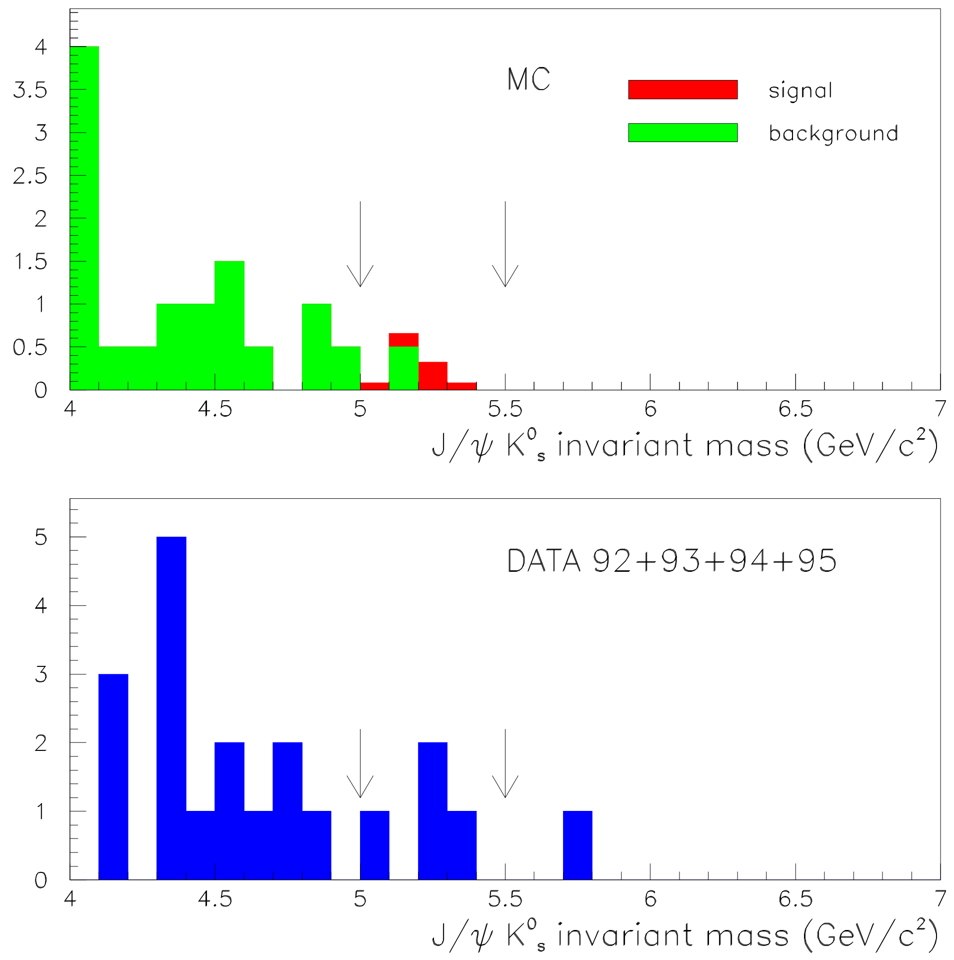
Total signal efficiency now only $\sim 7\%$ (with large error)

After background cuts

Combine J/ψ and K^0_s, where available. This sadly has efficiency of $\sim 25\%$ w.r.t. events where J/ψ already found...

Signal events in MC have mass resolution of ~ 200 MeV – here no kinmeatic fit. For now just look in $5.0 \rightarrow 5.5\,\mathrm{GeV}/\mathrm{c}^2$

Now from Monte Carlo expect 1.8 events, including 1.3 signal



In data see 4 events, with a cute looking distribution

These clearly consistent – nothing very remarkable happening

Conclusions

First the good news

It could be that we have observed the first few $\mathrm{B_d^0} \rightarrow \mathrm{J}/\psi\mathrm{K_0^s}$ events in pit 8!

(We have seen ≤ 4 in 1992-1995. 2005 should see $\sim 100k$!)

And now the bad news

Little sign of us sharing the miracle of ALEPH and OPAL

Our modest K_s^0 finding efficiency puts us at a disadvanatge...

To them that have, shall more be given!

We will optimise our cuts on dedicated signal MC, and if we feel energetic include the electrons and '91.