Measuring the CKM angle γ

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Physikalisches Institut, Universitaet Heidelberg

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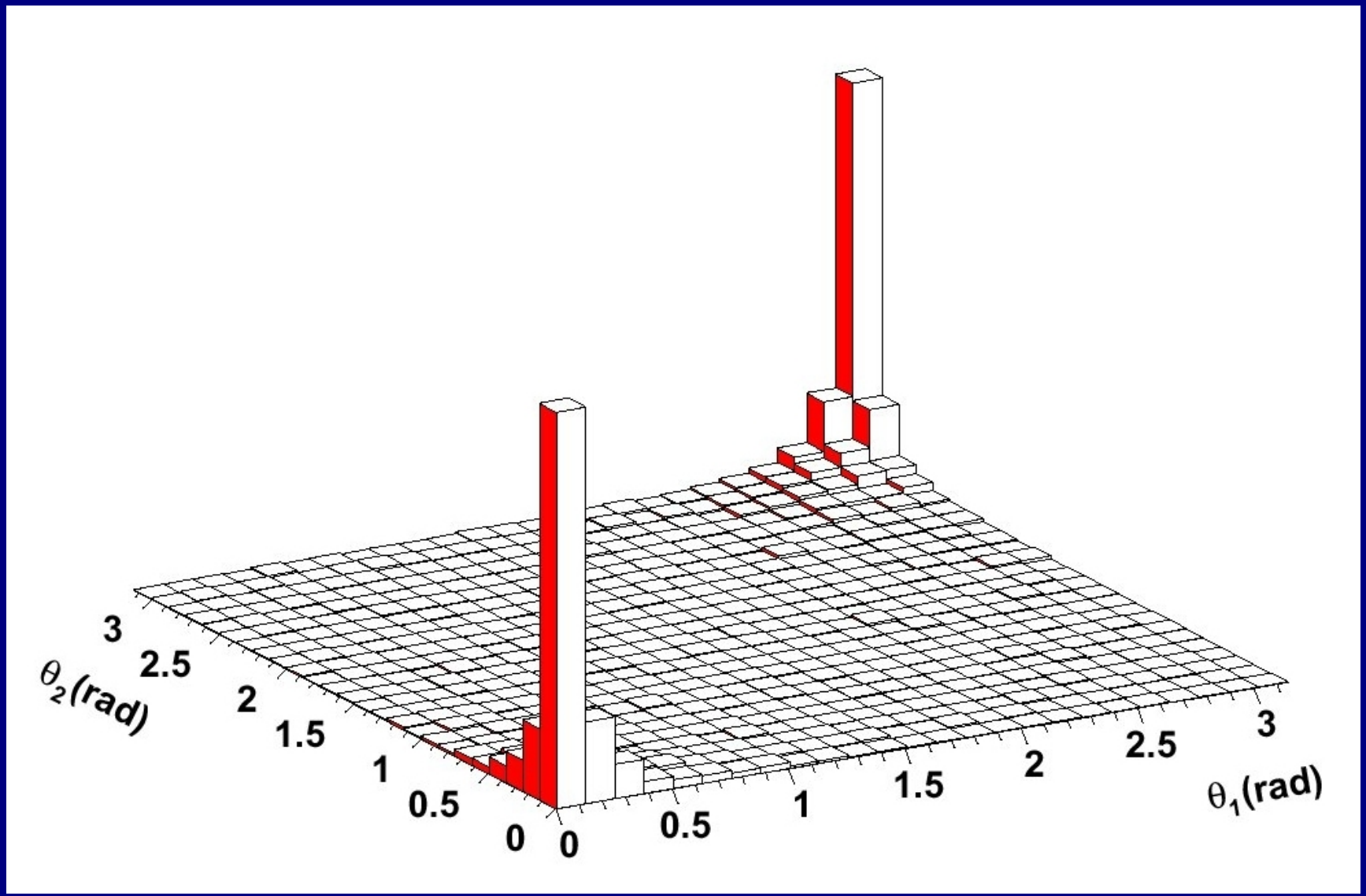
The LHCb Spectrometer



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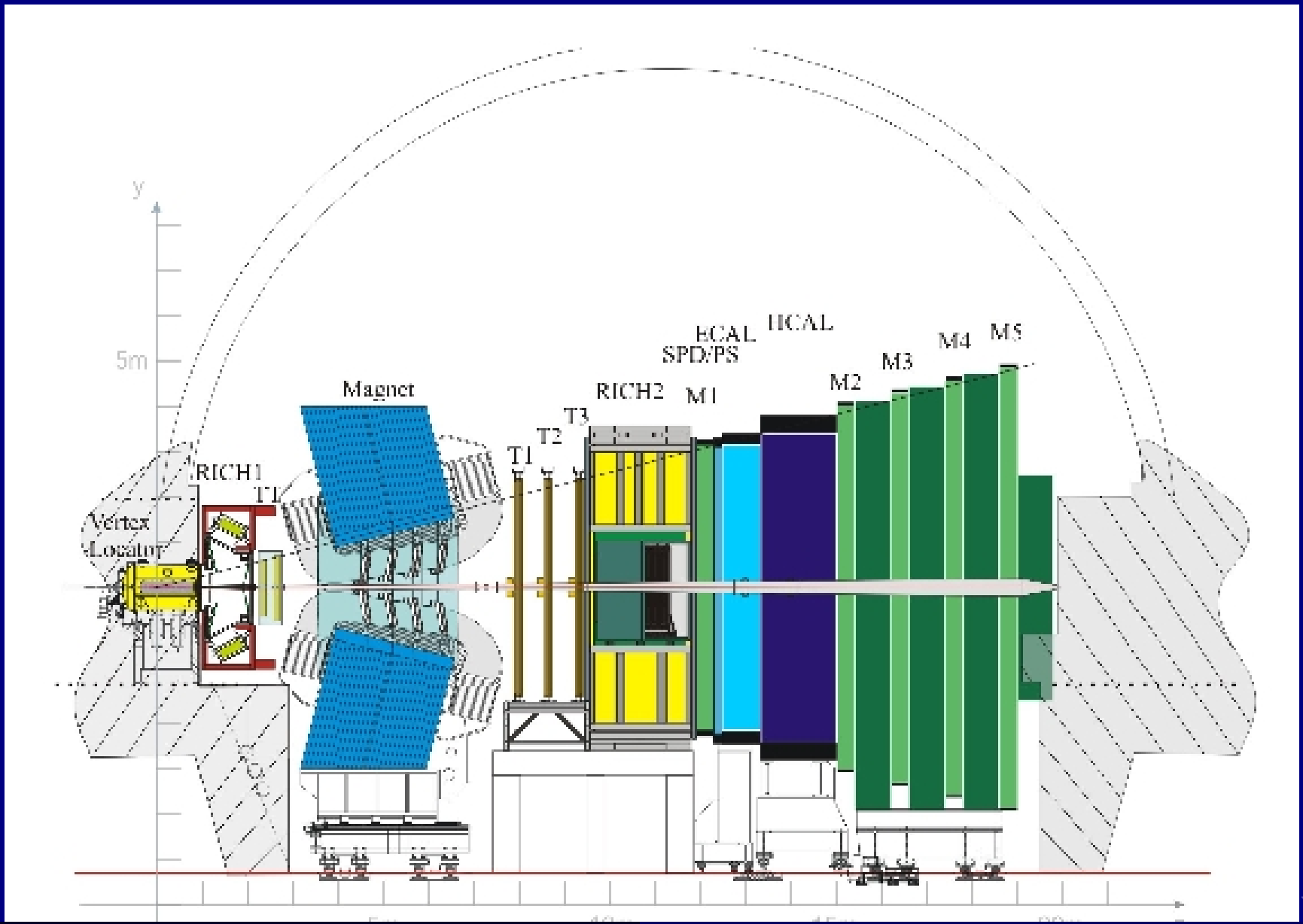
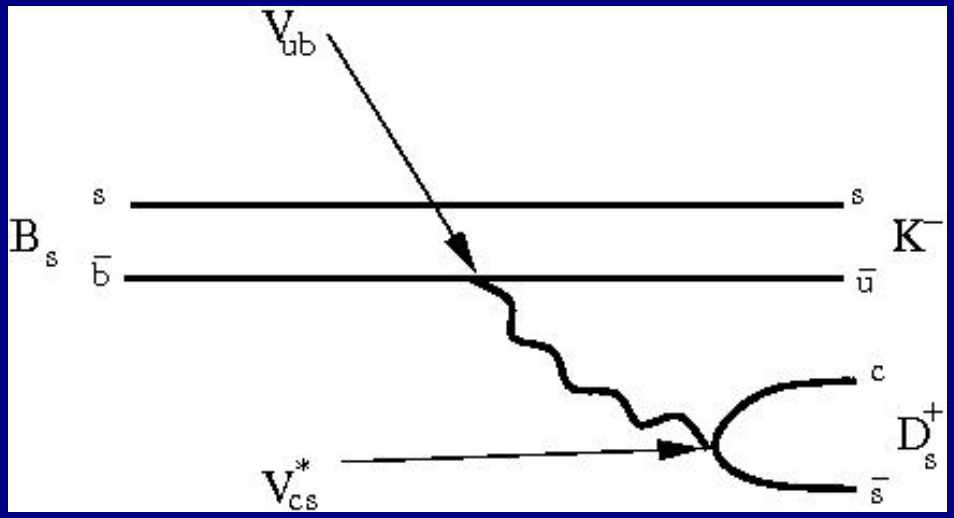


Feynmann diagram for $B_s \to D_s^{\pm} K^{-}$



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4. But: very small interference effects for $B_d \to D^{*\pm}\pi^{\mp}$, and$B_d \to D^{\pm}\pi^{\mp}$
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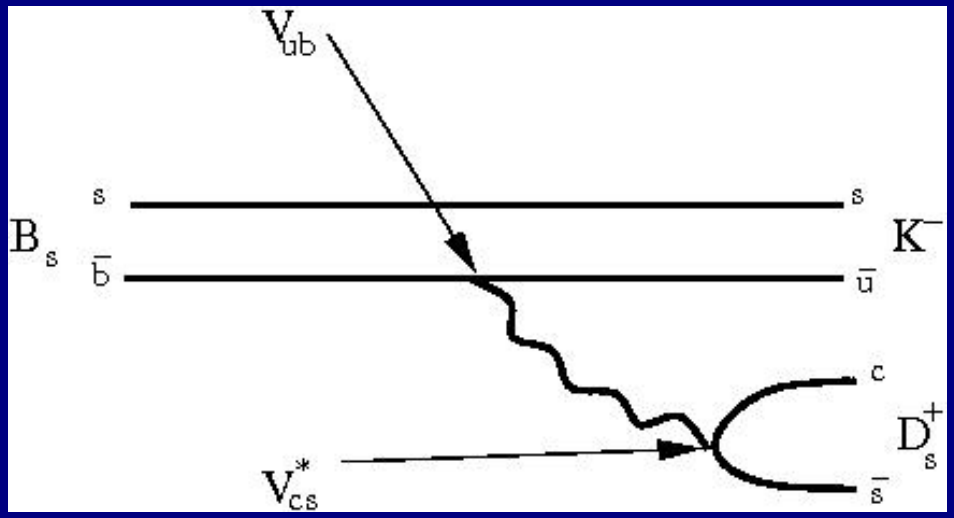

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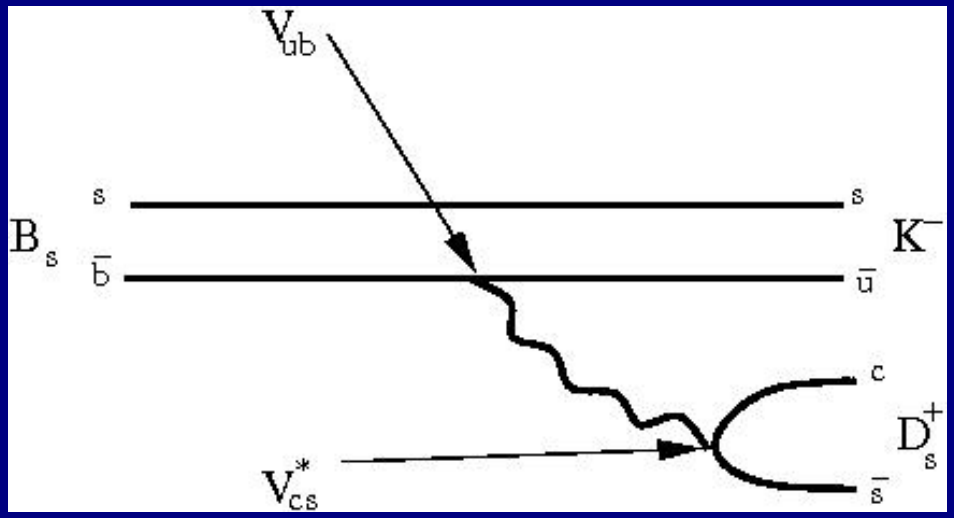

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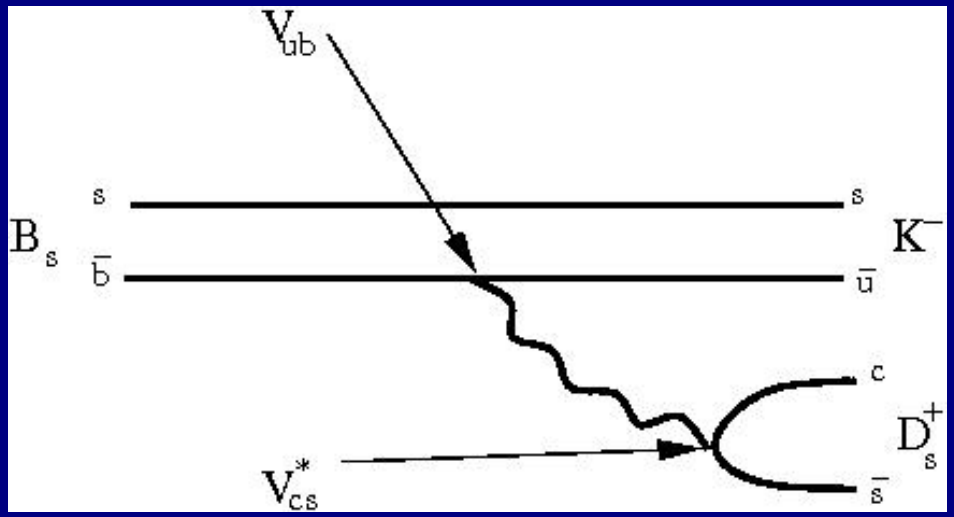

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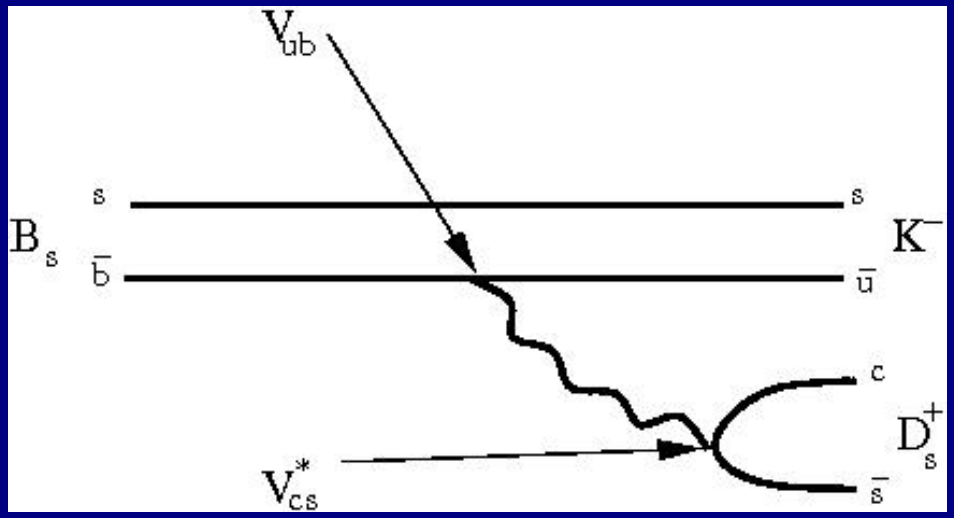

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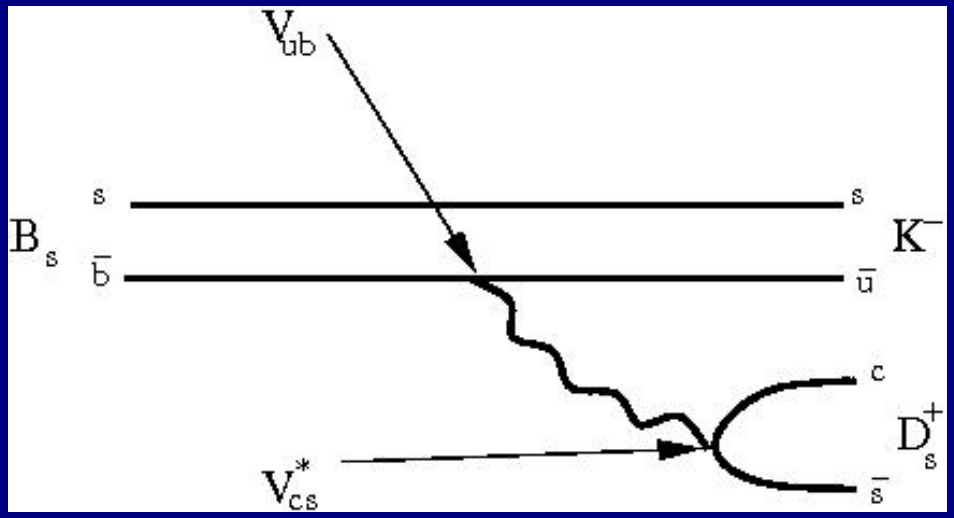

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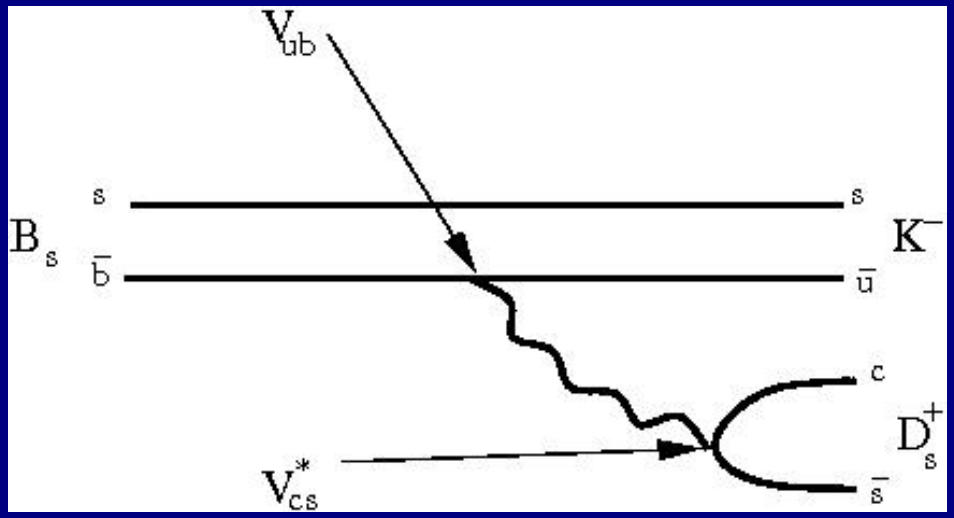

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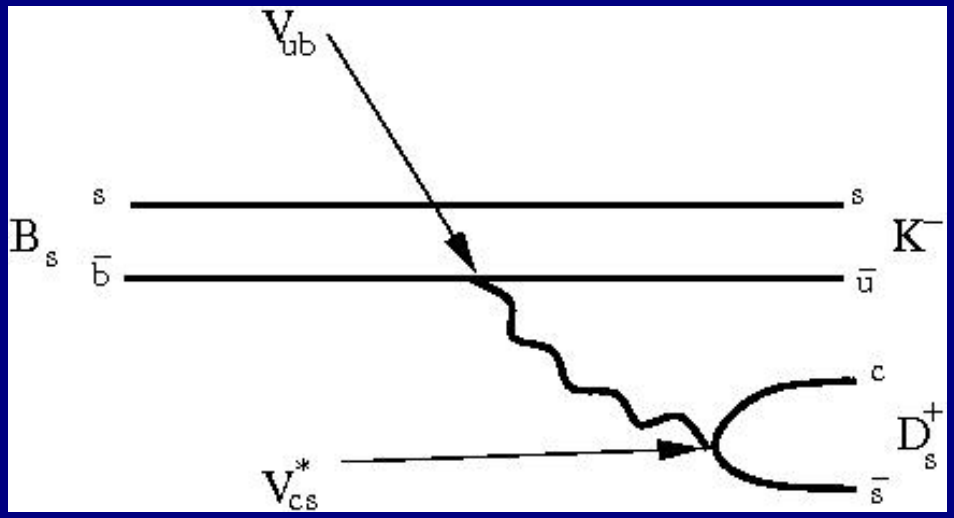

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- Sensitivity to γ through
- matrix element $V_{ub}V_{cs}^{*}$
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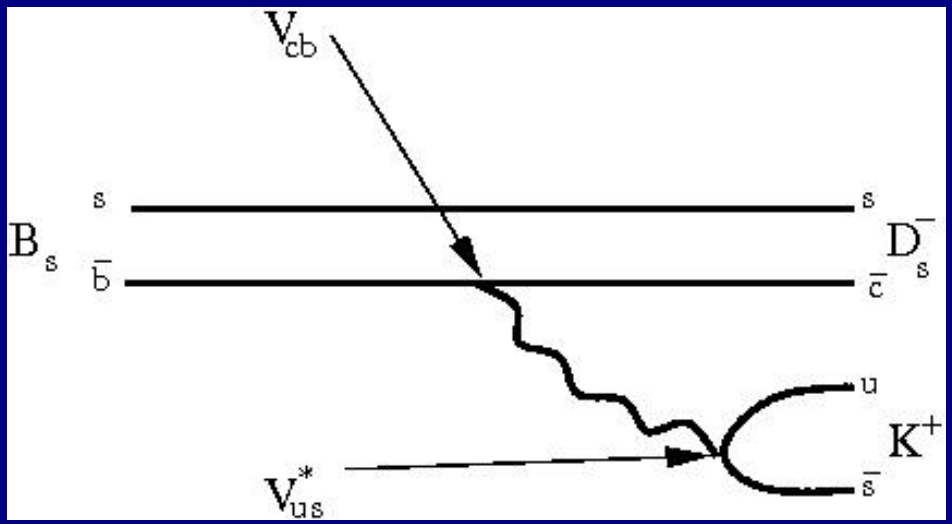

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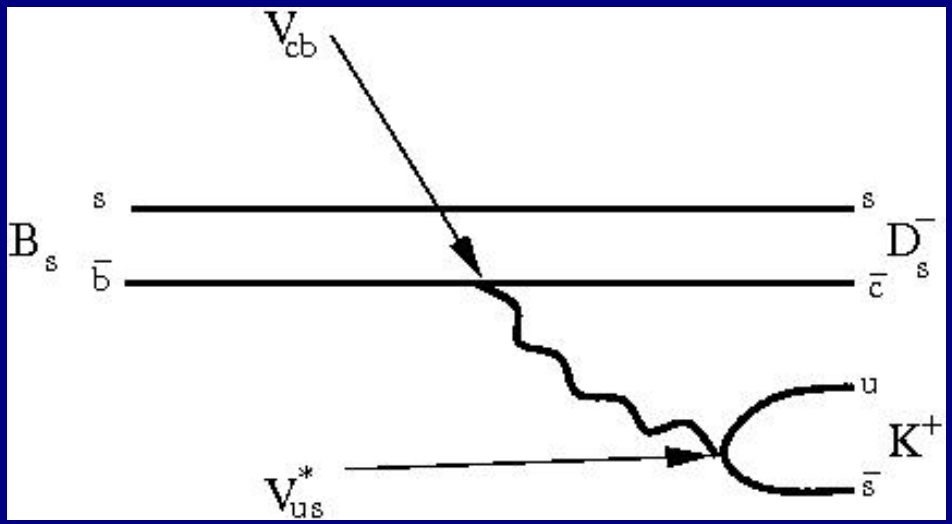

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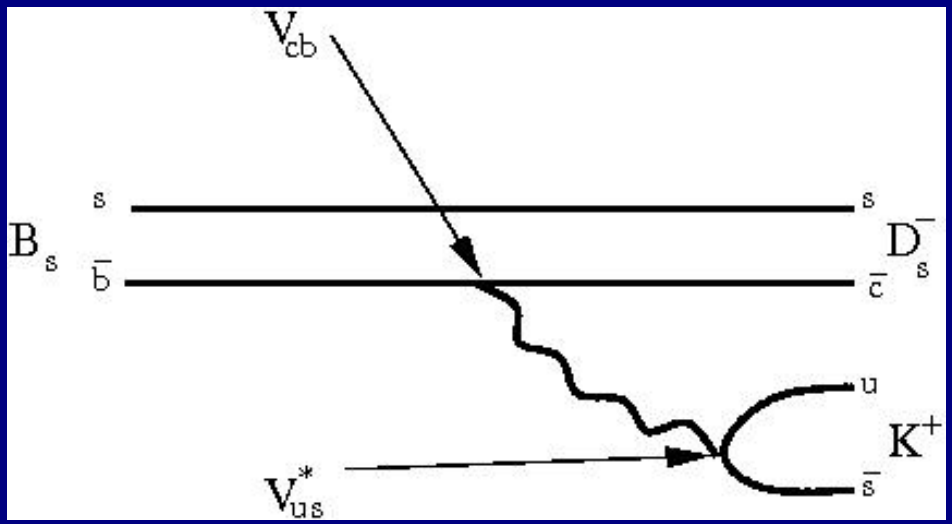

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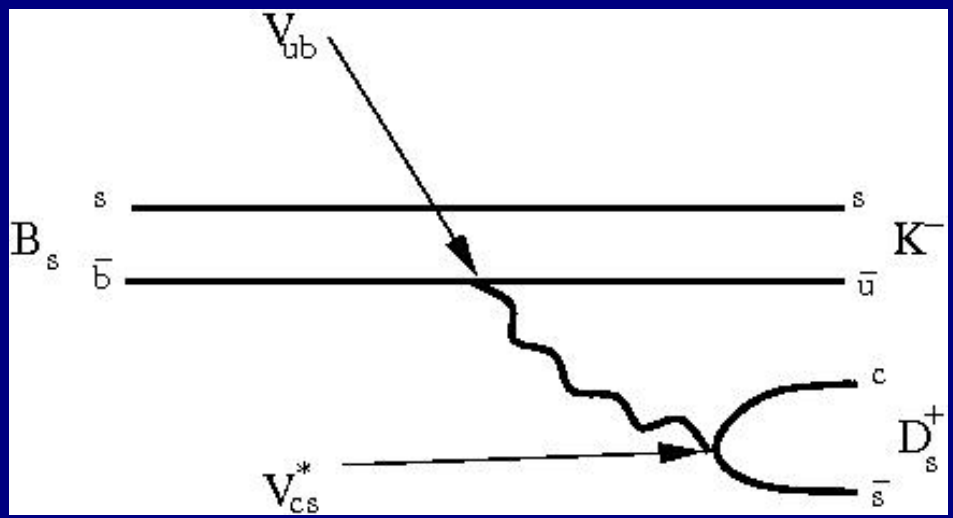
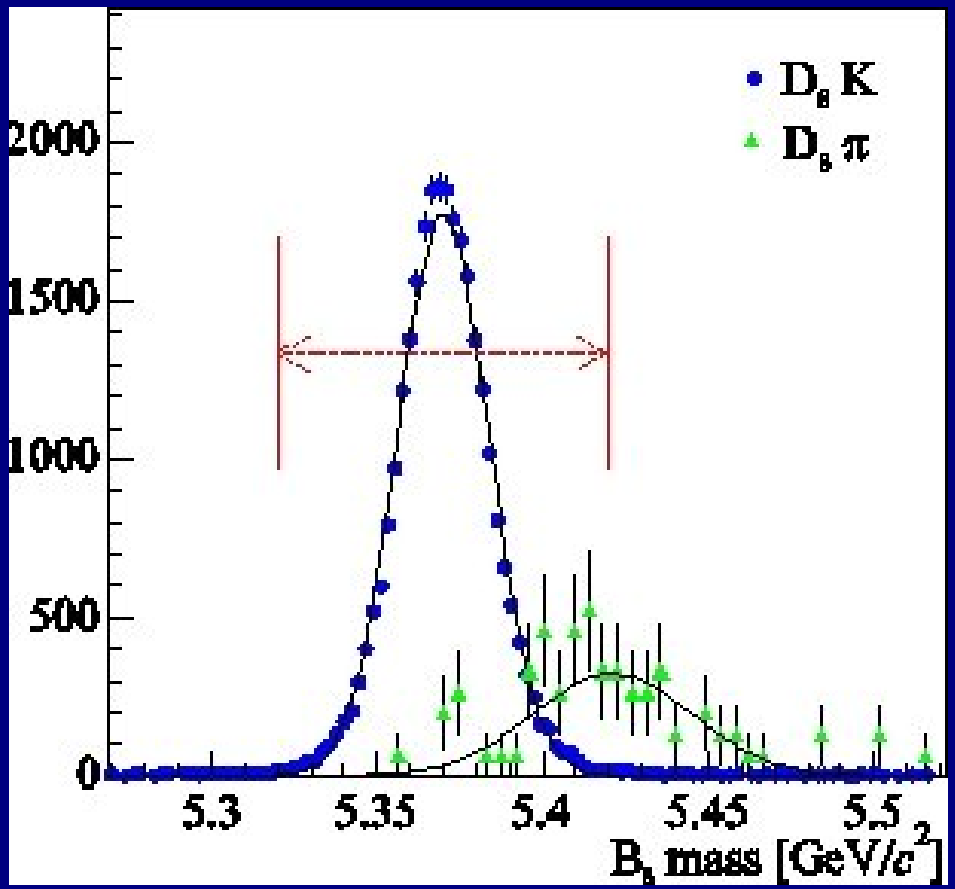


A Combined $B_s \to D_s^{\pm} K^{\mp}$ and $B_d \to D^{\pm} \pi^{\mp}$ Analysis



- Interference through mixing
- CP assymetries measure $\gamma + \phi_s$
- Tree diagrams only: NO sensitivity to New Physics
- 5400 $B_s \to D_s K$ events/year at LHCb
- 82000 $B_s \to D_s \pi$ events/year

Time-dependent Asymmetries

$$\mathcal{A}_{CP}(D_s^+ K^-) = \frac{B_s \to D_s K^-(t) - \bar{B}_s \to D_s K^-(t)}{B_s \to D_s K^-(t) + \bar{B}_s \to D_s K^-(t)}$$

dependence:

$$\mathcal{A}_{CP}(D_s^+ K^-) = \frac{C_s \cos \Delta m_s t + S_s \sin \Delta m_s t}{\cosh(\Delta\Gamma_s t/2) - A_{\Delta\Gamma_s} \sinh(\Delta\Gamma_s t/2)}$$

1. Δm_s: mass difference between heavy & light B-meson
2. $\Delta\Gamma_s$: lifetime difference between heavy & light B-meson
3. C_s depends on ratio of amplitudes of Feynmann diagrams
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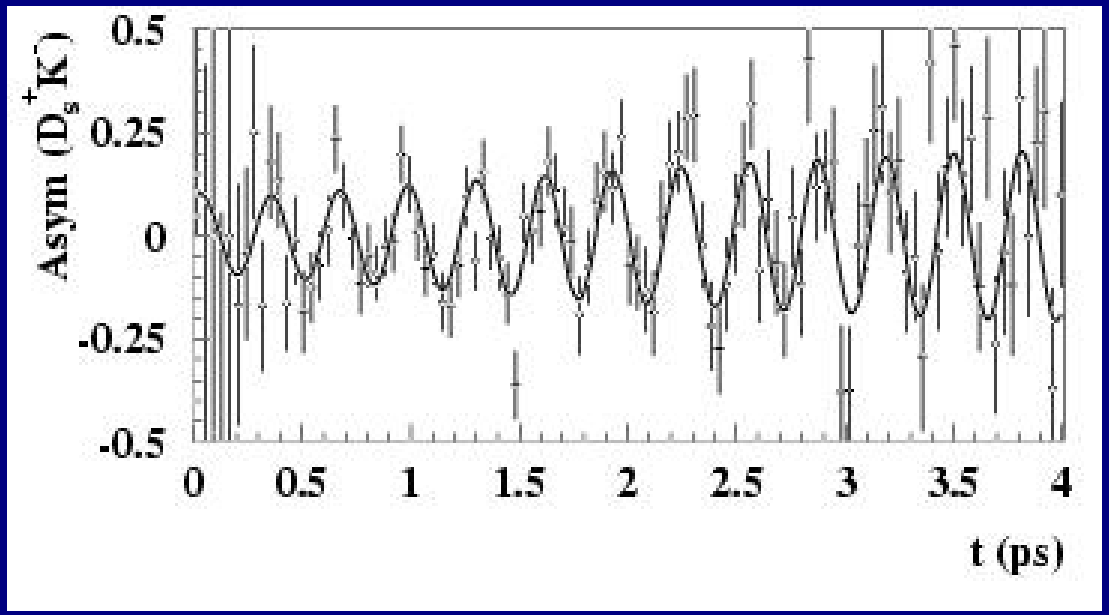
LHCb Simulated Results

From $\sim$ 5 years of LHCb data:



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4. $\Delta m_s \sim 20\ \mathrm{ps}^{-1}$: $\sigma_\gamma \approx 14°$
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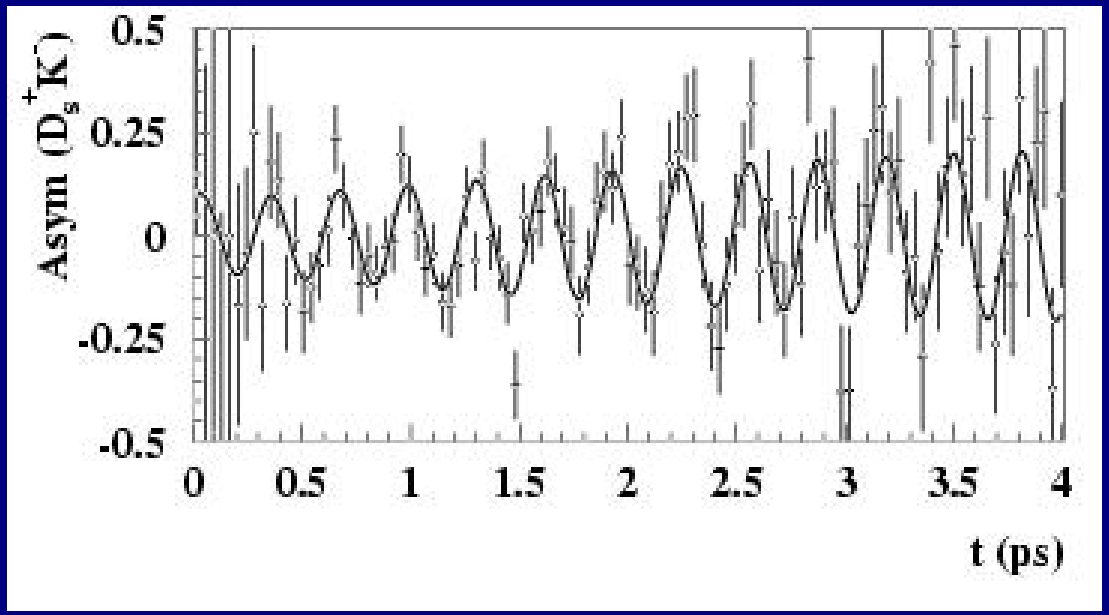

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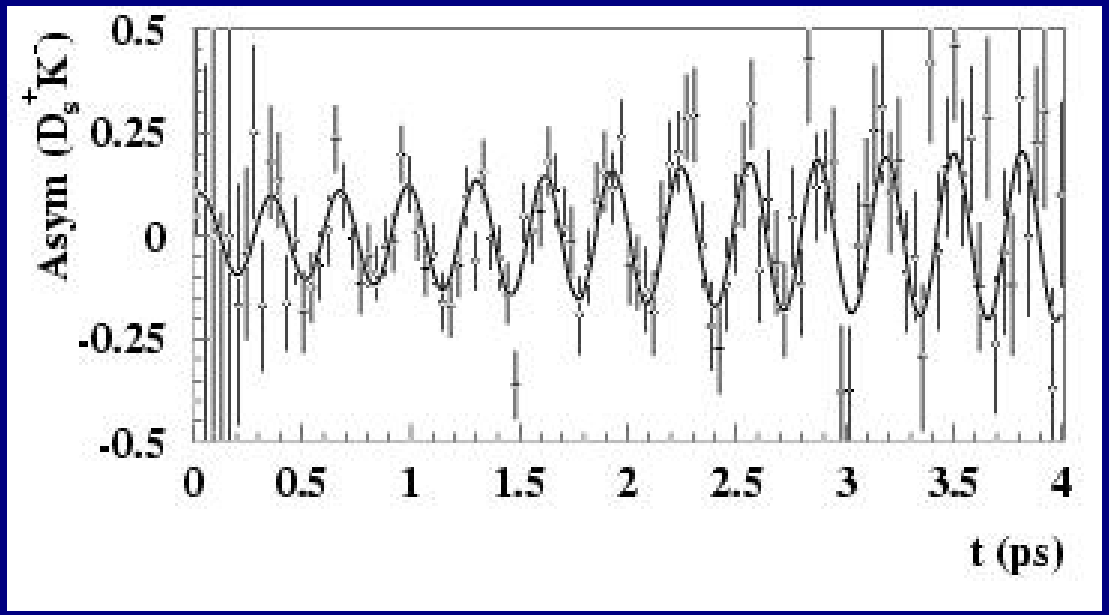

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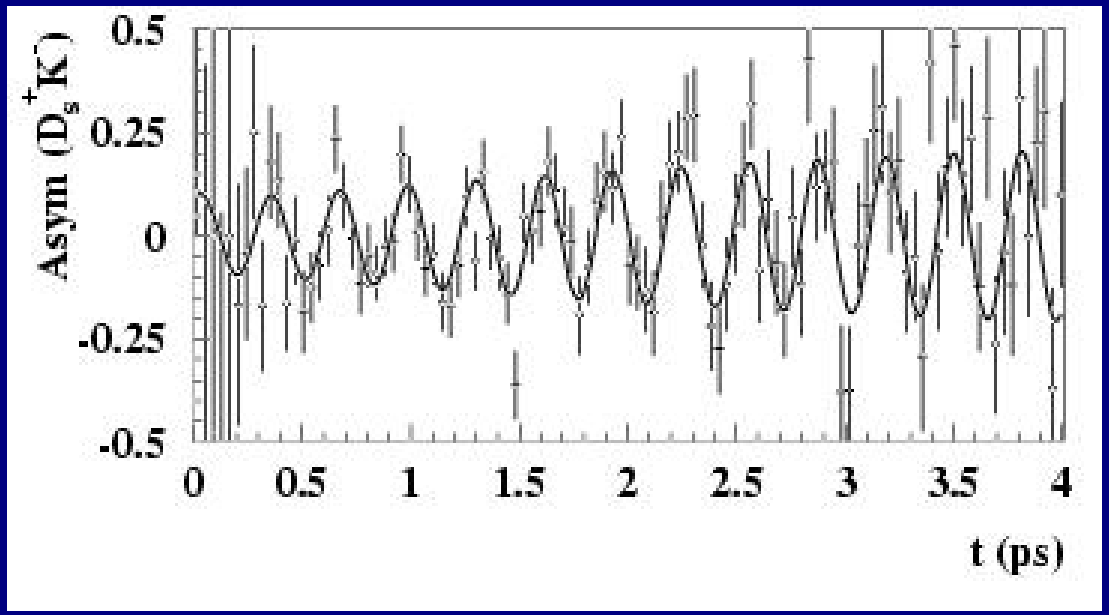

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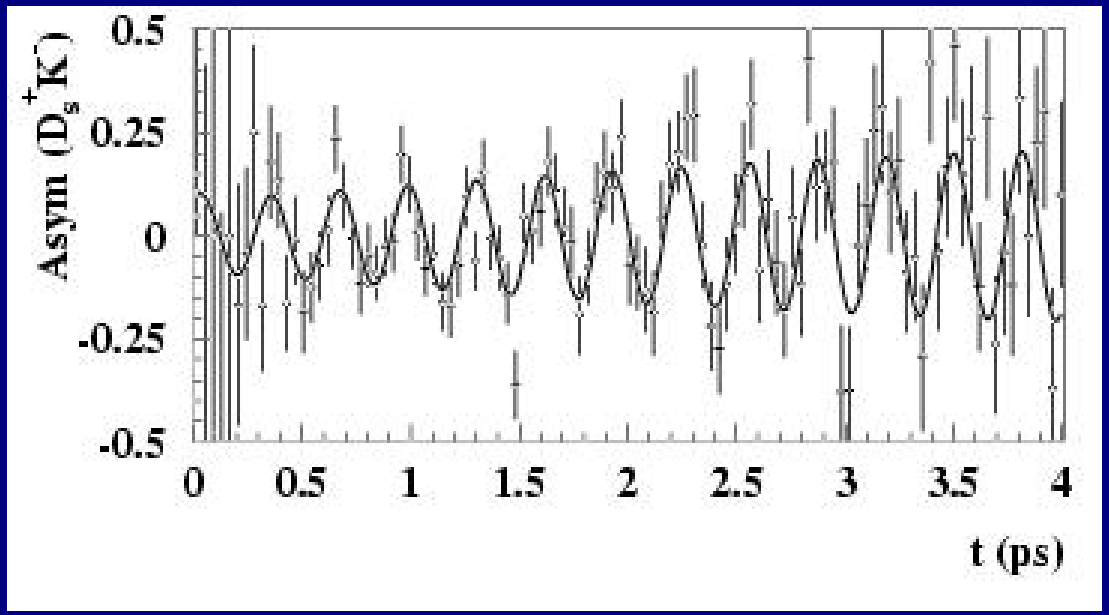

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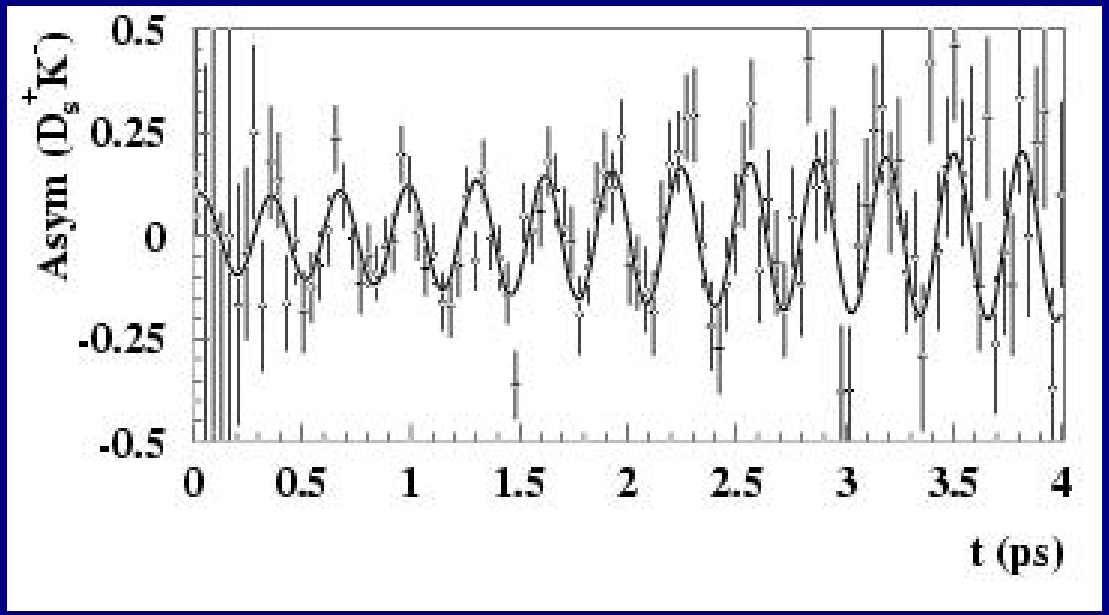

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1. time-dependent CP-asymmetries for $B^0_d \to \pi^+\pi^-$
2. and $B_s \to K^+K^-$
3. But: penguin diagram contributes!
4. A_{dir}, A_{mix} depend on ϕ_s, ϕ_d & γ
5. and on ratio of penguin to tree amplitudes: $de^{i\theta}$
6. with U-spin symmetry: $d_{\pi\pi} = d_{KK}$, $\theta_{\pi\pi} = \theta_{KK}$
7. ϕ_s from $B_s \to J/\psi\phi$ and ϕ_d from $B_d \to J/\psi K_s$
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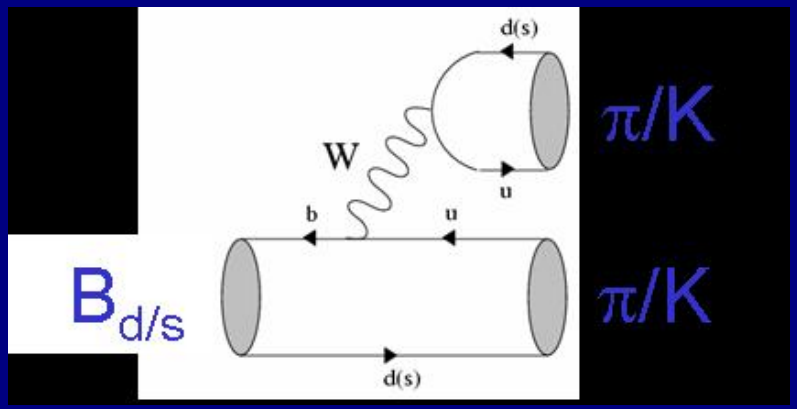

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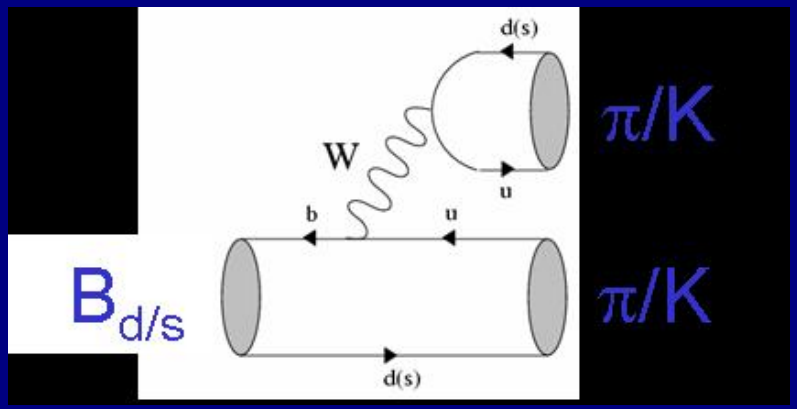

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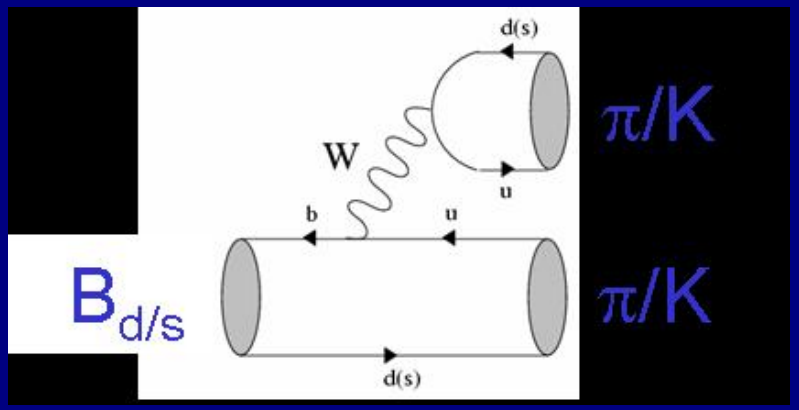

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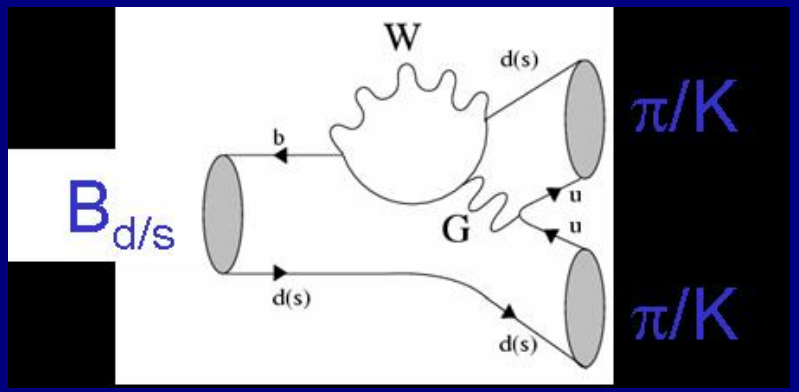

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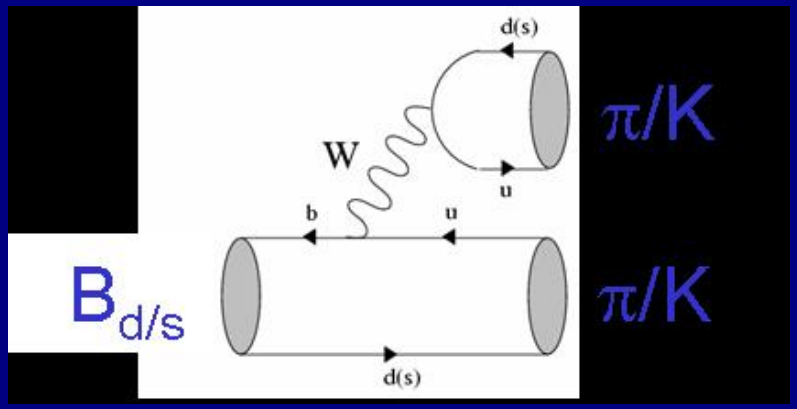

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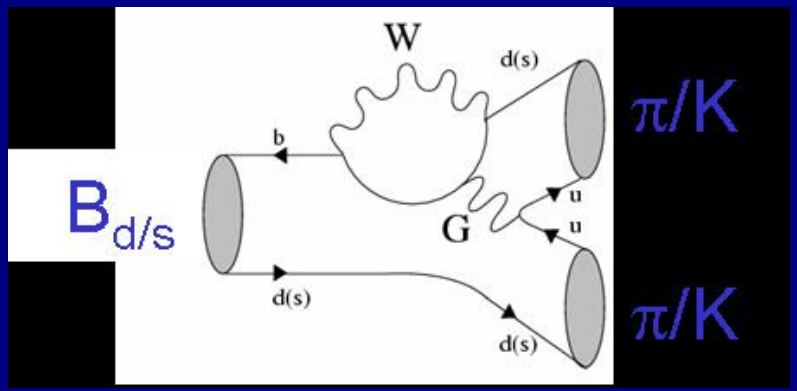

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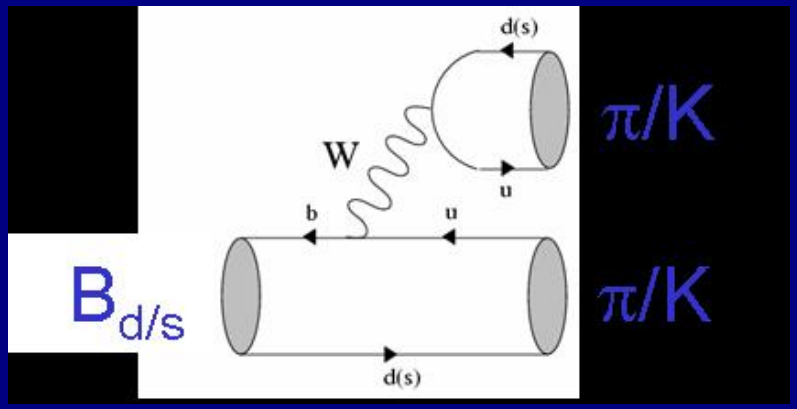

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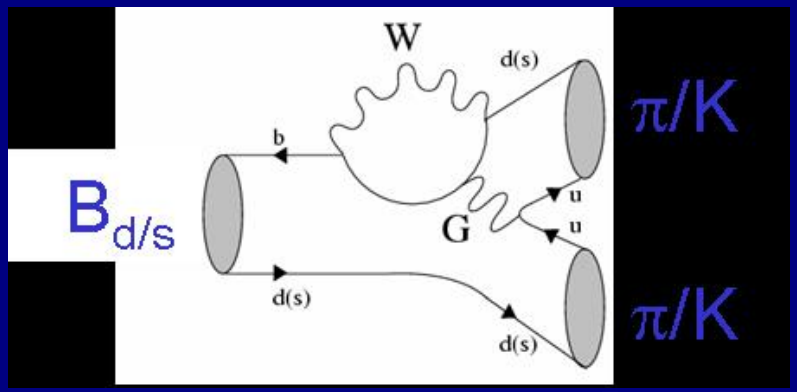

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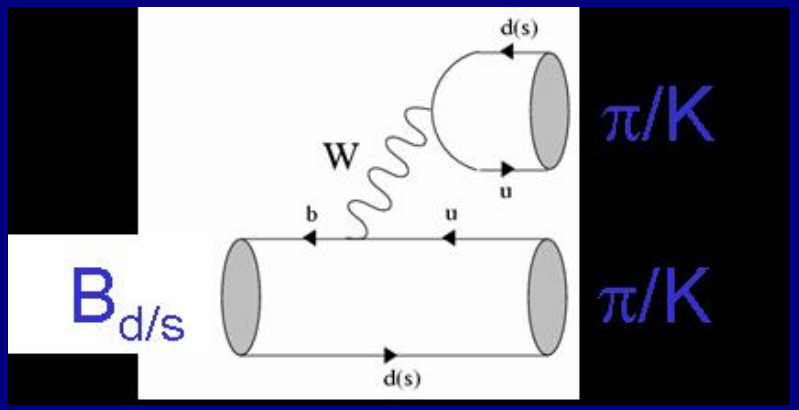

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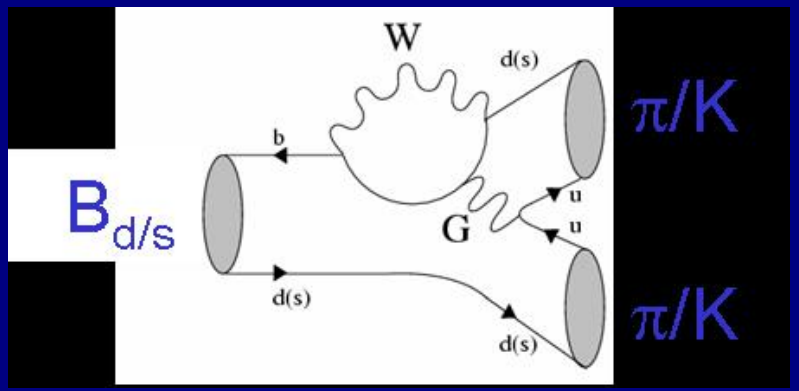

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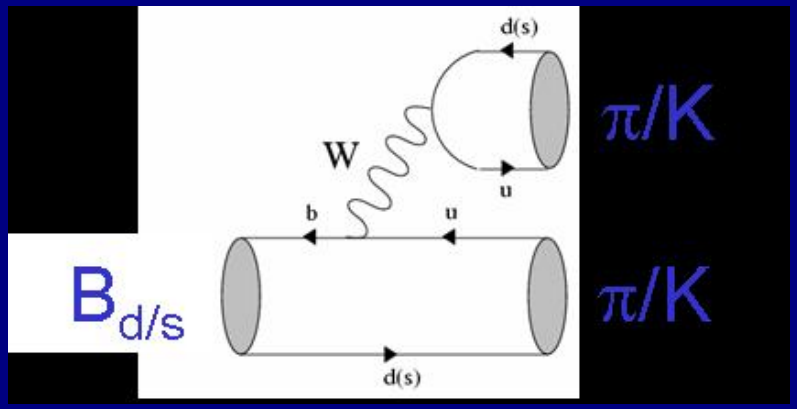

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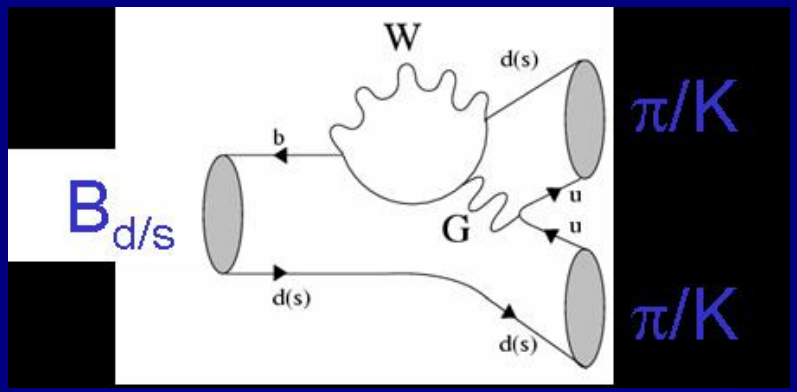

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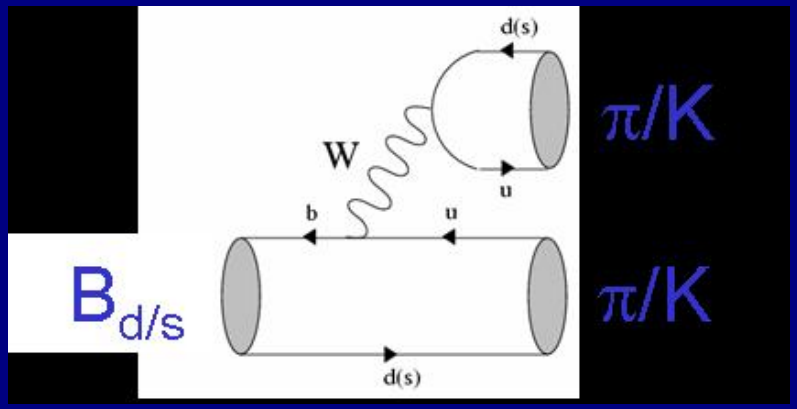

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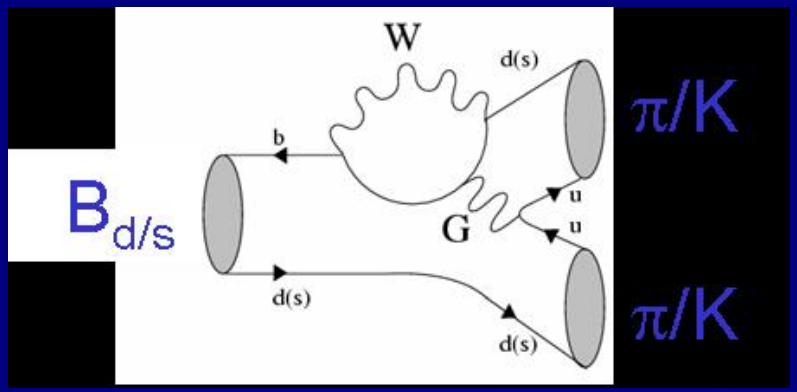

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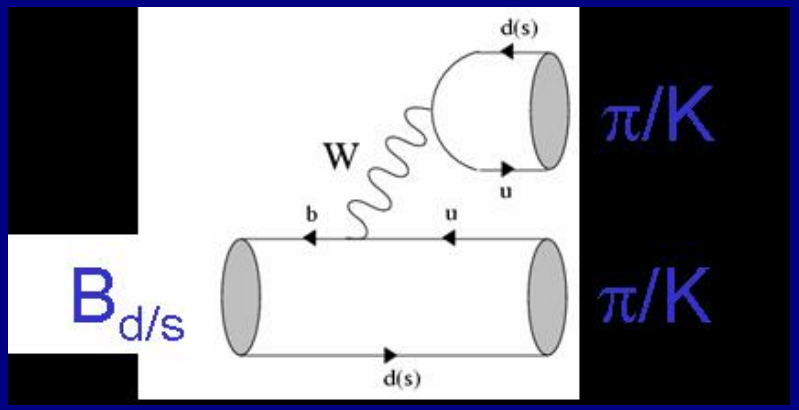

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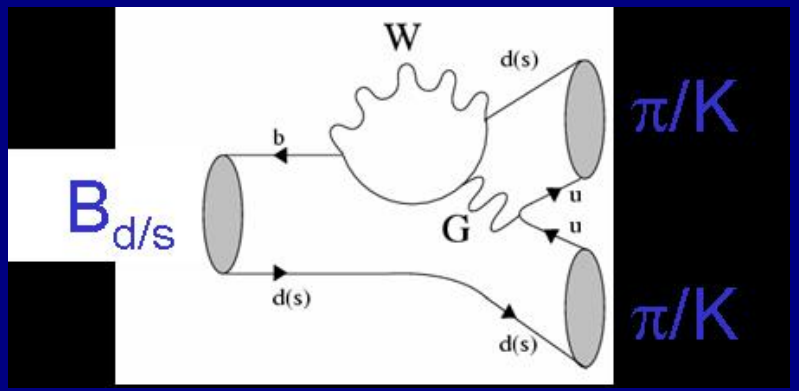

Conclusions

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   1. Use U-spin symmetry to resolve discrete ambiguities
   2. Measure time-dependent CP-asymmetry
   3. ϕ_s measured with $B_s \to J/\psi\phi$ analysis
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   1. Measure 2 time-dependent CP asymmetries
   2. Problem: penguin diagram contributes
   3. Need angles ϕ_s and ϕ_d from $B_s \to J/\psi\phi$ and $B^0 \to J/\psi K_s$
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