

# CP violation in $B_s^0$ mixing at LHCb

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On behalf of the LHCb collaboration

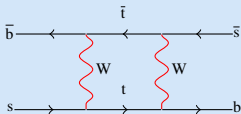
August 30, 2011



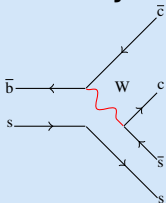


# CP violation in $B_s^0$ mixing

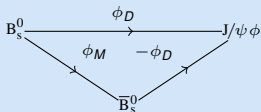
## Mixing



## Decay



## Interference



- CP violation in the SM described by CKM matrix
- In  $B_s^0$ , interference between mixing and decay  $\rightarrow$  CP violating phase  
 $\phi_s = \phi_M - 2\phi_D$
- Precise SM calculation for  $B_s^0 \rightarrow J/\psi\phi$  possible  $\rightarrow$  small Penguin contribution

$$\phi_s^{SM} = 0.0363 \pm 0.0016 \text{ rad}$$

CKMfitter, hep-ph/0406184

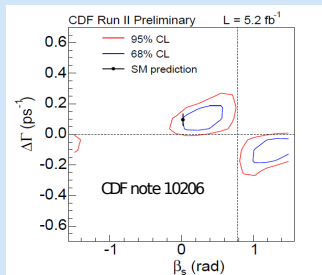
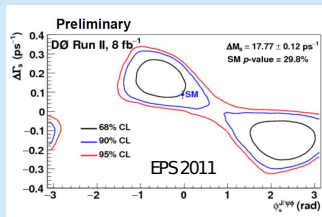
- Additional contributions from New Physics possible

$$\phi_s = \phi_s^{SM} + \phi_s^{NP}$$

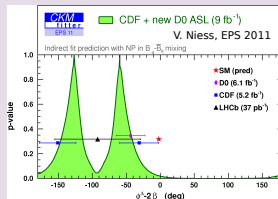


# Current experimental status - Tevatron

- First measurements in  $B_s^0 \rightarrow J/\psi \phi$  at Tevatron - both  $1\sigma$  deviation
- Hints for additional CPV seen in combination of measurements with  $A_{SL}$

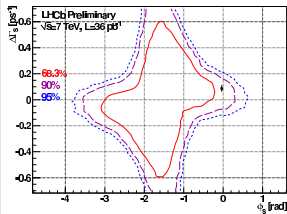
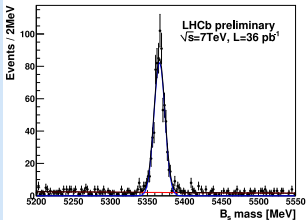


## New physics?





# Current experimental status - LHCb 2010 data



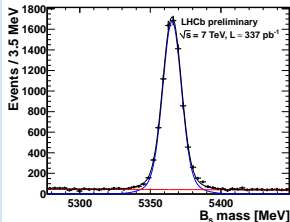
- Many ingredients necessary:
  - Angular acceptances,
  - Proper time resolution,
  - Flavour tagging,
  - ...
- Used about 760 signal candidates
- Fully statistically limited

see LHCb-CONF-2011-002

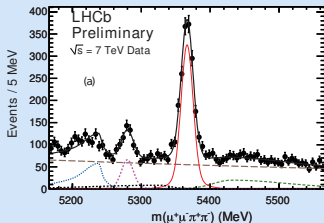


# $\phi_s$ with 2011 data at LHCb

$$B_s^0 \rightarrow J/\psi \phi$$

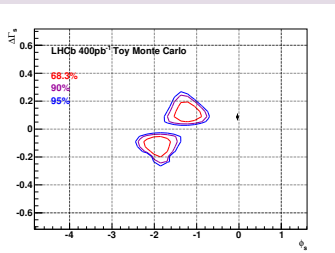


$$B_s^0 \rightarrow J/\psi f_0$$



- 10 times more statistics
- First measurement in additional mode  $B_s^0 \rightarrow J/\psi f_0$

## Disagreement with SM?



see LHCb-CONF-2011-049, LHCb-CONF-2011-050,  
LHCb-CONF-2011-56



Georg Krocker, on behalf of the LHCb collaboration



For a measurement of the mixing frequency a knowledge of the production and decay flavour is necessary. The flavour at production time is determined by flavour tagging algorithms. For the measurement of the mixing, we use the decay

$$\bar{B}_d^0 \rightarrow \bar{B}_d^0 \pi^0$$

The flavour at decay time is given by the charge of the  $D_{CP}$  meson.

$$x_{\text{max}} = \begin{pmatrix} \beta_d & \gamma_d & \eta_d \\ \beta_c & \gamma_c & \eta_c \\ \beta_u & \gamma_u & \eta_u \end{pmatrix}$$

$$\phi_\pm \text{ in } B_\pm^0 \rightarrow J/\psi \phi$$


- Thermally clean channel with a high branching ratio.
- Interference between mixing and decay gives rise to CP violating phase  $\phi_1$ .

- Measurement uses about 8100 signal candidates

■ Amplitude of oscillation is directly depending on proper time resolution and favour logging performance which can be determined in this section.

■ Efficiency of opposite-side tagged:  $\epsilon^{\text{opp}} = 3.7\% \pm 8.4\%$

- Efficiency of the same side larynx lappet = not yet optimised:  $\pm 12\%$  to  $0.4\%$

- Excellent program time resolution of 100fs.

■ Dominating systematic effects on the  $\alpha$ -scale and momentum scale caused by alignment and B field

#### ■ Result on the missing hypothesis

$$\Delta m_{\nu} = 17.725 \pm 0.041 \text{ (stat.)} \pm 0.026 \text{ (syst.) ps}^{-1}$$

CP violation in  $B_s^0$ 

- CP violation in the  $\bar{K}_S^0$  system arises from an interference of mixing and decay.

- This interference gives rise to a  $\pi$  rotating phase

$$\phi_6^{1/24} = \phi_M - 2/3$$

- This can be translated in terms of Feynman diagrams

6002

- The CP violating phase can be probed  
contributions from Perseus alignments.

measured, it is a valuable point of reference.

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**Contact:**

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Georg K

For full LHCb results, please come and visit my poster!

See also talk by Patrick on  
Wednesday.