# Measurement of the time-integrated CP asymmetry in $D^0 \to K_S^0 K_S^0$ decays

## BEAUTY, 7-11 May 2018

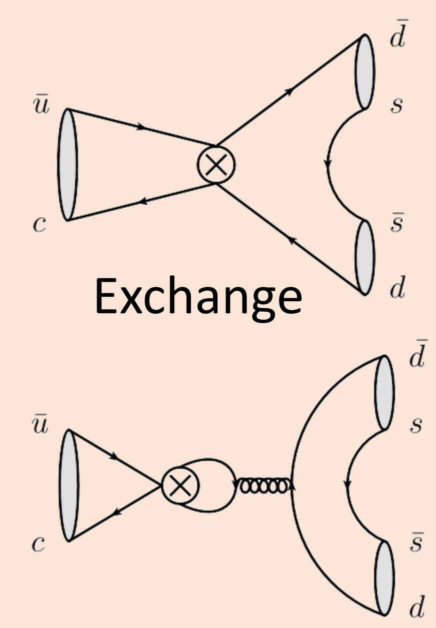
**Giulia Tuci, on behalf of the LHCb collaboration** *(giulia.tuci@cern.ch)*

## Motivations

CP violation has not yet been observed in charm sector

$D^0 \to K_S^0 K_S^0$ is a promising discovery channel:

- ➢ Amplitudes are suppressed
- ➢ $A^{CP}$ could be enhanced at level of 1.1% [1]

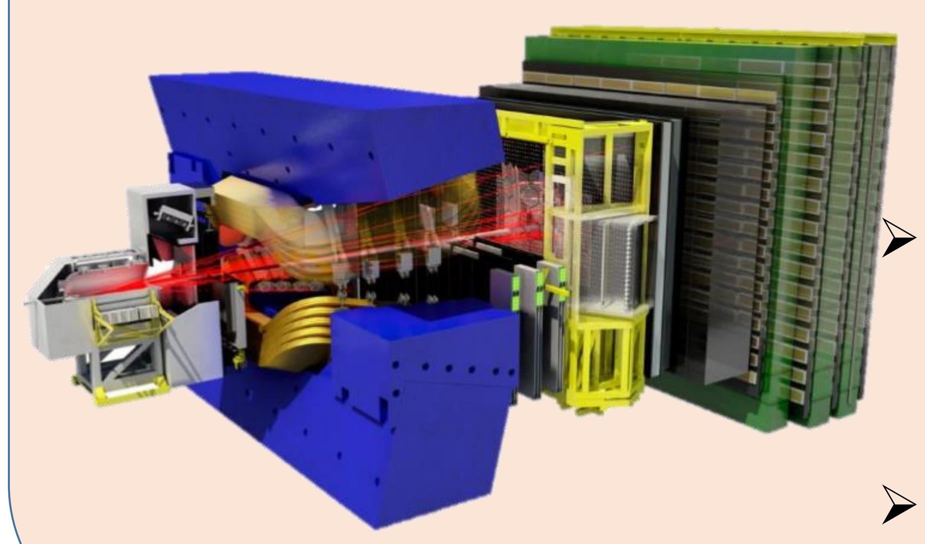



$$\mathcal{A}^{CP}(D^0 \to K_S^0 K_S^0) \equiv \frac{\Gamma(D^0 \to K_S^0 K_S^0) - \Gamma(\overline{D}^0 \to K_S^0 K_S^0)}{\Gamma(D^0 \to K_S^0 K_S^0) + \Gamma(\overline{D}^0 \to K_S^0 K_S^0)}$$

Status: no evidence of CP violation from CLEO[2], LHCb (Run 1)[3] and Belle [4]

## Detector

Single arm forward spectrometer [5].



- ➢ High resolution of the vertex detector (VELO): possible to select b and c-hadron decays
- ➢ Precise measurement of momentum ($\sigma_p/p$ ~ 0.5%-1.0%) thanks to tracking stations (TT and T) and magnet.
- ➢ Magnet polarity reversed periodically. Two configurations: MagUp and MagDown

## Analysis strategy

Quantity measured: $\mathcal{A}^{\mathrm{raw}} \equiv \frac{N_{D^0} - N_{\overline{D}^0}}{N_{D^0} + N_{\overline{D}^0}}$

The charge of the pion in $D^{*\pm} \to D^0\pi^\pm$ decays is used to determine the flavour of the $D^0$ meson at production.

$K_S^0$ are reconstructed in the final state $\pi^+\pi^-$.

$\sigma_{prod}(D^{*+}) \neq \sigma_{prod}(D^{*-})$

$$\mathcal{A}^{\mathrm{raw}} \approx \mathcal{A}^{CP} + \mathcal{A}^{\mathrm{prod}} + \mathcal{A}^{\mathrm{det}}$$

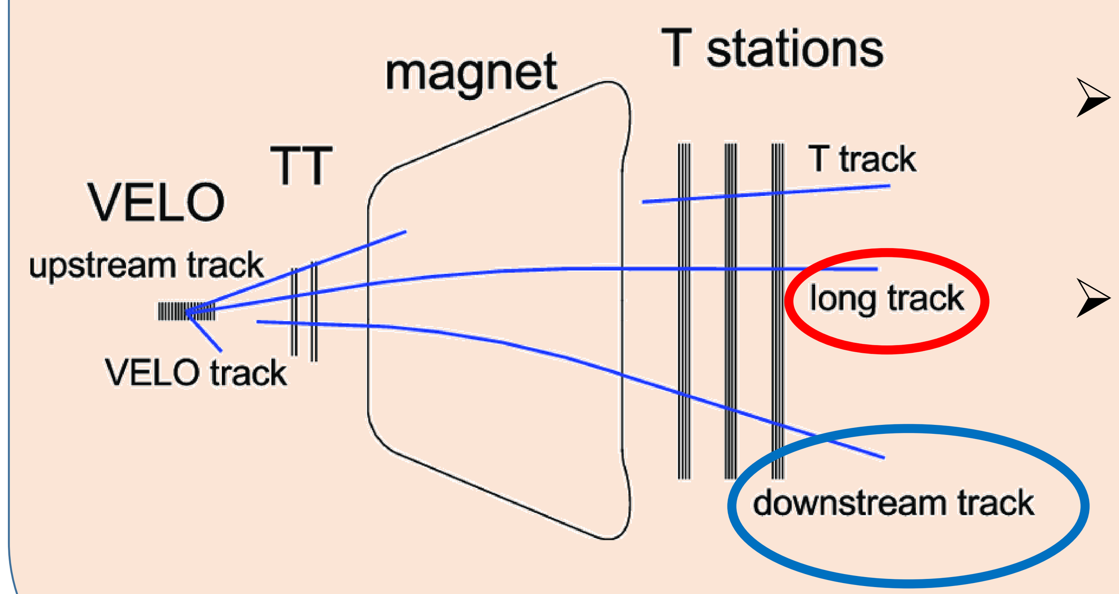
Asymmetric detector acceptance

To cancel $A^{prod}$ and $A^{det}$ the calibration channel $D^0 \to K^+ K^-$ is used

- $A^{CP}(K^+ K^-)$=( 0.04 ± 0.12 (stat) ± 0.10 (syst) )% [6]
- $A^{CP}(K_S^0 K_S^0)$= $A^{raw}(K_S^0 K_S^0)$ – $A^{raw}(K^+ K^-)$+ $A^{CP}(K^+ K^-)$

## Signal samples

Data samples collected in 2015-2016 at $\sqrt{s}$=13 TeV, ~ 2$fb^{-1}$ of integrated luminosity

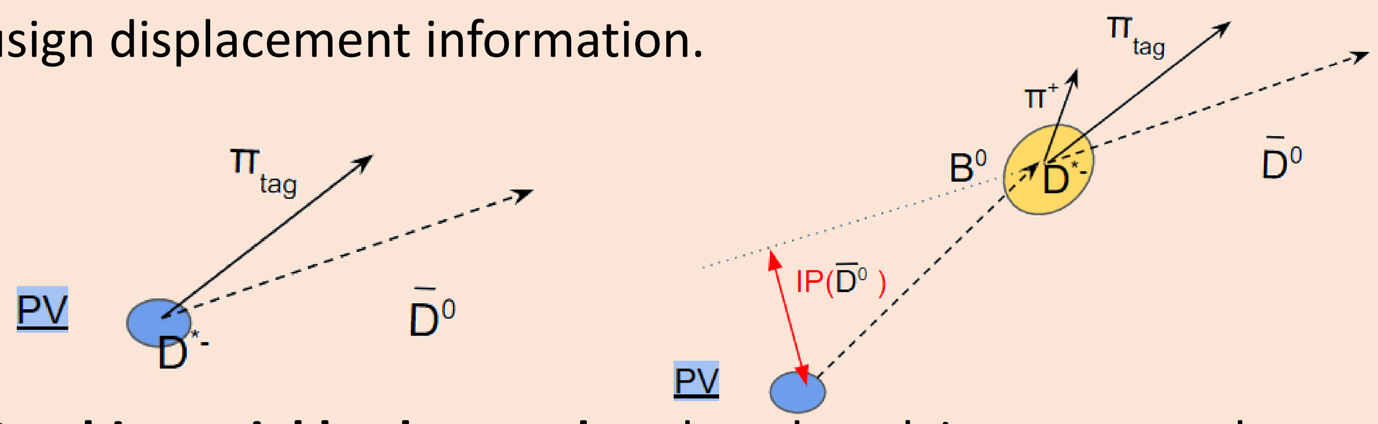



- ➢ **LL** sample: both $K_S^0$ are reconstructed from **Long** tracks
- ➢ **LD** sample: one $K_S^0$ is **Long** and the other one is **Downstream**

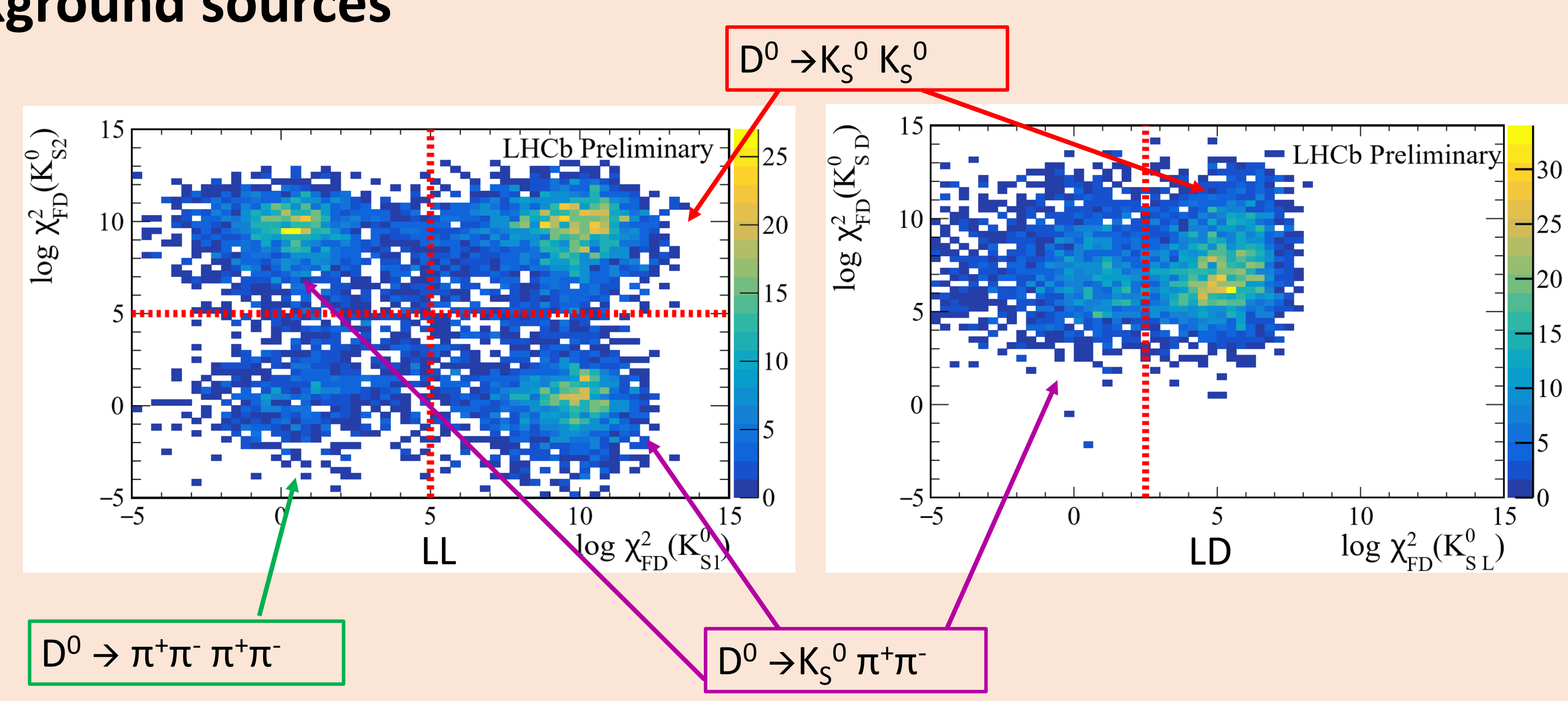
## Main background sources

Contamination from $\mathbf{D^0 \to K_S^0\pi^+\pi^-}$ : reduced using information on $K_S^0$ flight distance.

Contamination from **secondary decays**, i.e. decays in which the D* is coming from a b-hadron decay and not from the primary vertex PV (same $A^{CP}$, but different $A^{prod}$): reduced usign displacement information.

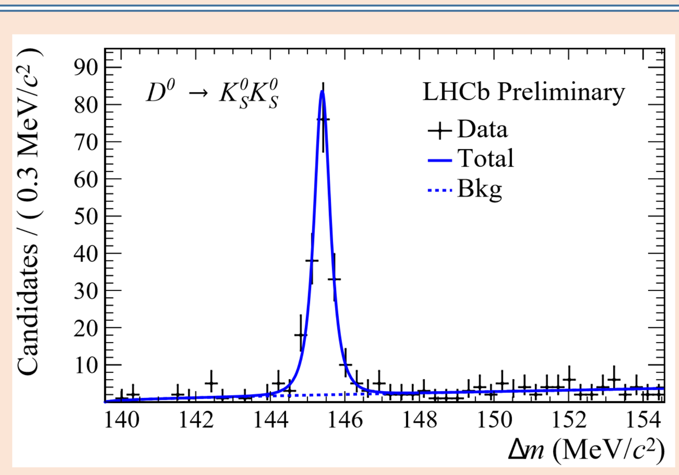
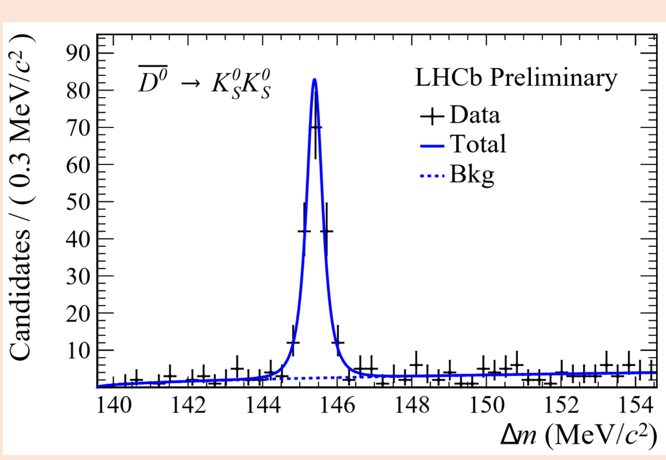



**Combinatorial background**: reduced applying a cut on the output of kNN classifier.




## Results

$A^{raw}$ extracted with a fit to Δm=m(D*)-m($D^0$) distribution

LL MagUp

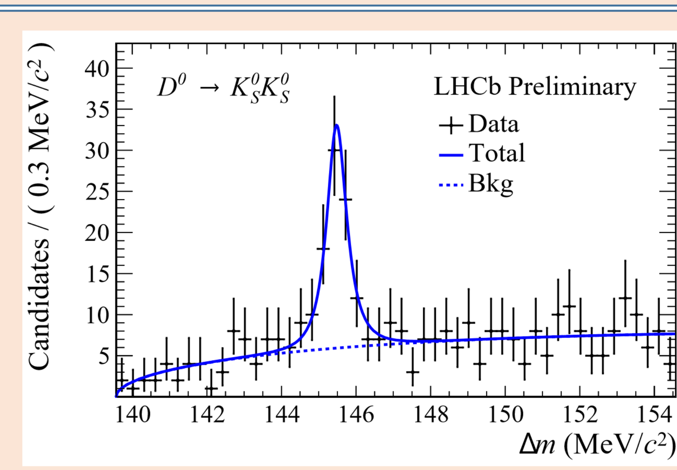
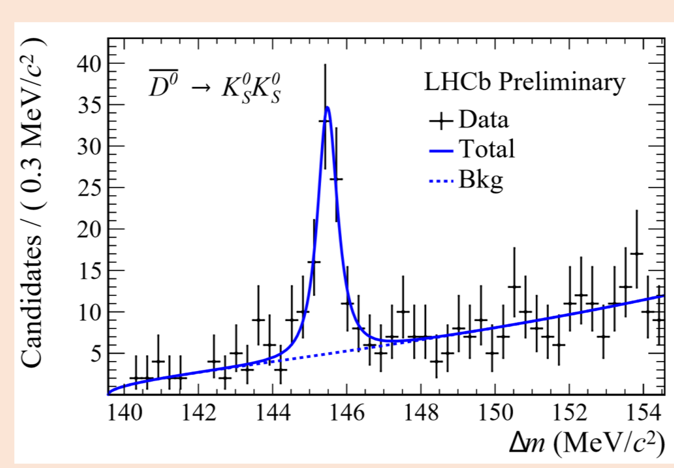
Results on LL and LD samples and on the two separate magnet polarities compatible within 2σ

$\mathbf{A^{CP}(K_S^0 K_S^0) = (0.042 \pm 0.034 \pm 0.010)}$

Combining LHCb Run 1 and Run2 measurements

$\mathbf{A^{CP}(K_S^0 K_S^0) = (0.020 \pm 0.029 \pm 0.010)}$

No evidence of CP violation and agreement with previous measurements

LD MagUp


**References:**

**[1]** U. Nierste and S. Schacht, Phys. Rev. D92 (2015) 054036, arXiv:1508.00074

**[2]** CLEO collaboration, G. Bonvicini et al., Phys. Rev. D63 (2001) 071101, arXiv:hep-ex/0012054

**[3]** LHCb collaboration, R. Aaij et al., JHEP 10 (2015) 055, arXiv:1508.06087

**[4]** Belle collaboration, N. Dash et al., Phys. Rev. Lett. 119 (2017) 171801, arXiv:1705.05966

**[5]** LHCb collaboration, A. A. Alves Jr. et al., JINST 3 (2008) S08005

**[6]** LHCb collaboration, R. Aaij et al., Phys. Lett. B767 (2017) 177, arXiv:1610.09476