

Measurement of direct CP asymmetry in the $B^0 \rightarrow K^{*0}\gamma$ channel in LHCb

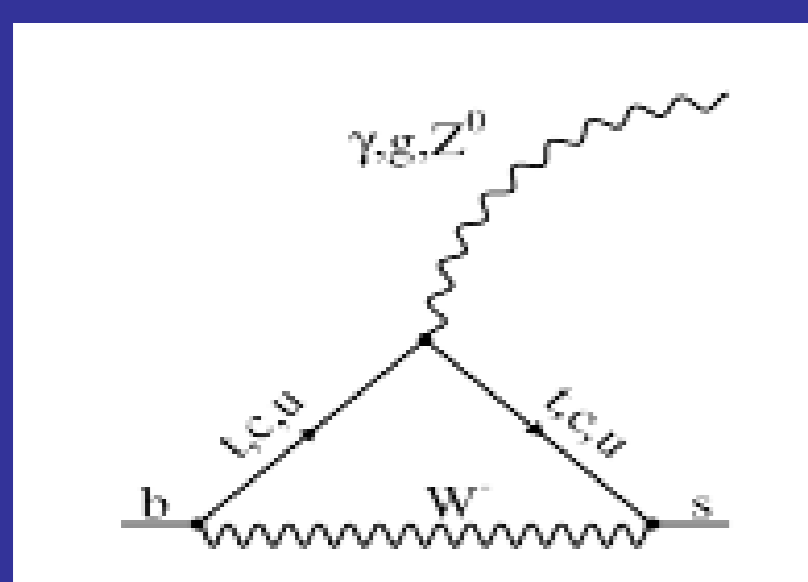
LHCb-CONF-2012-004

Ricardo Vázquez Gómez¹ on behalf of the LHCb collaboration

[1] rvazquez@cern.ch Universitat de Barcelona-ICC

Theoretical and experimental status

In the Standard Model (SM), the radiative decays of B mesons proceed at leading order through $b \rightarrow s\gamma$ one-loop electromagnetic penguin transitions, dominated by a virtual intermediate top quark coupling to a W boson. Extensions of the SM predict additional one-loop contributions that can enhance observables such as direct CP asymmetries in $b \rightarrow s\gamma$ transitions.



$$A_{CP} = \frac{N(\bar{B}^0 \rightarrow \bar{K}^{*0}\gamma) - N(B^0 \rightarrow K^{*0}\gamma)}{N(\bar{B}^0 \rightarrow \bar{K}^{*0}\gamma) + N(B^0 \rightarrow K^{*0}\gamma)}$$

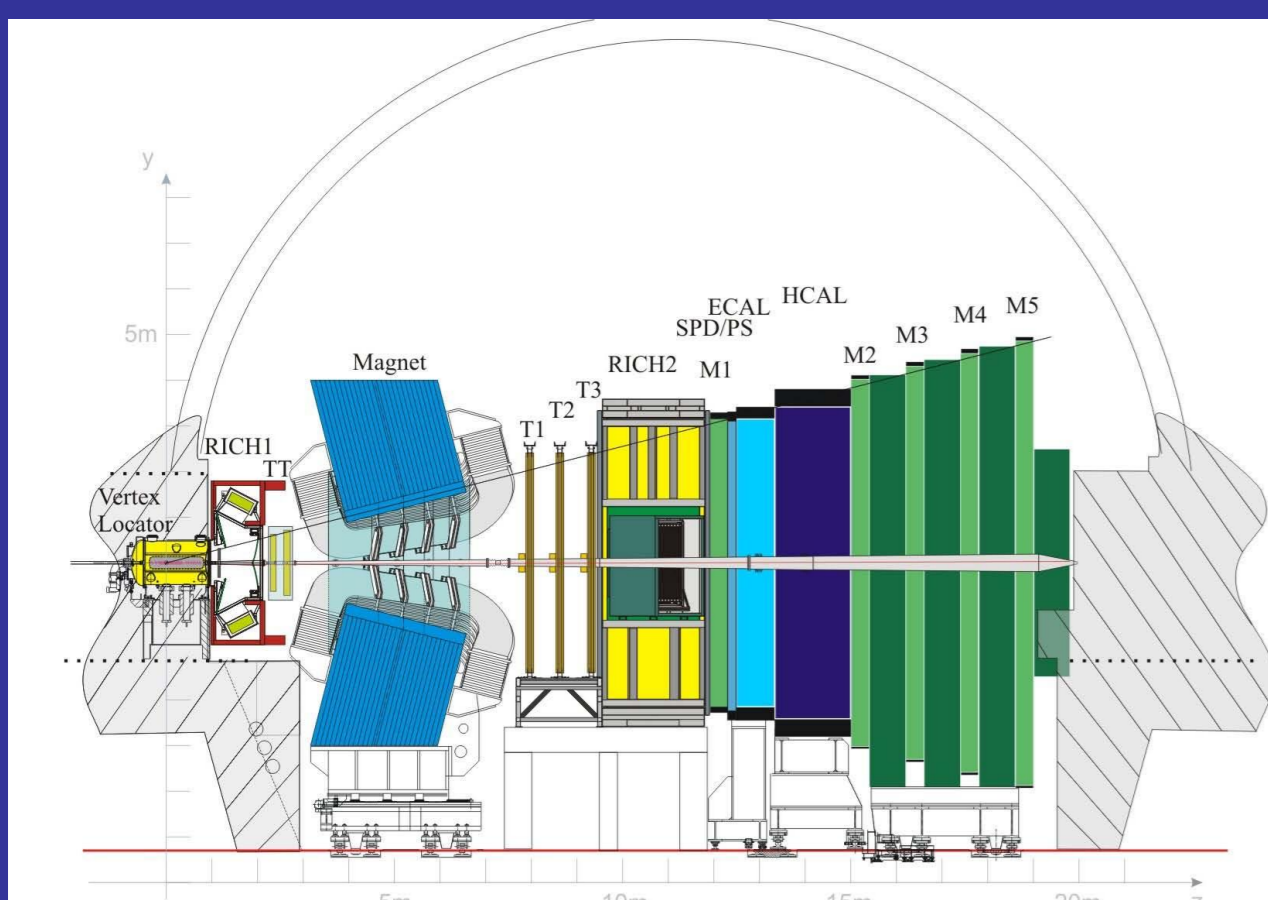
The SM prediction of the direct CP asymmetry in the $B^0 \rightarrow K^{*0}\gamma$ decay is

$$A_{CP}(\text{SM}) = (-0.61 \pm 0.43)\% \text{ [1]}$$

The most precise measurement has been performed by the *BaBar* experiment yielding

$$A_{CP}(\text{BaBar}) = (-1.6 \pm 2.2 \pm 0.7)\% \text{ [2]}$$

The LHCb detector [3]



Excellent tracking capabilities and impact parameter resolution.

Charged hadrons identification using two ring-imaging Cherenkov detectors.

Electromagnetic calorimeter resolution

$$\frac{\sigma(E)}{E} = \frac{10\%}{\sqrt{E}} \oplus 1.5\%$$

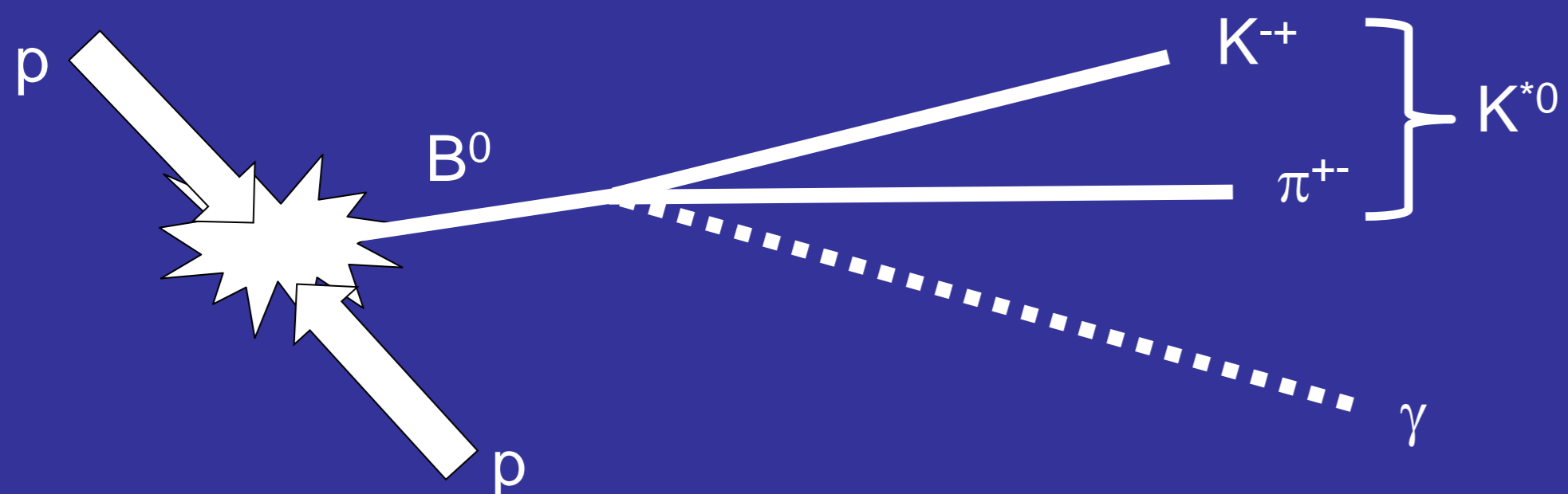
Event filtering is done by the two-level LHCb trigger system. The first level (L0) fully implemented on hardware and the second trigger level (High Level Trigger, HLT) which is a software trigger running on a computer farm.

Offline selection

Combination of K^{*0} candidates with high energetic photon candidates. The K^{*0} are built from oppositely charged $K\pi$ pairs and the photon is reconstructed from large deposits in the electromagnetic calorimeter.

The helicity structure of the decay is exploited to veto contamination from $B^0 \rightarrow K^{*0}\pi^0$ decay.

An algorithm to separate γ from π^0 based on the cluster shape is used.

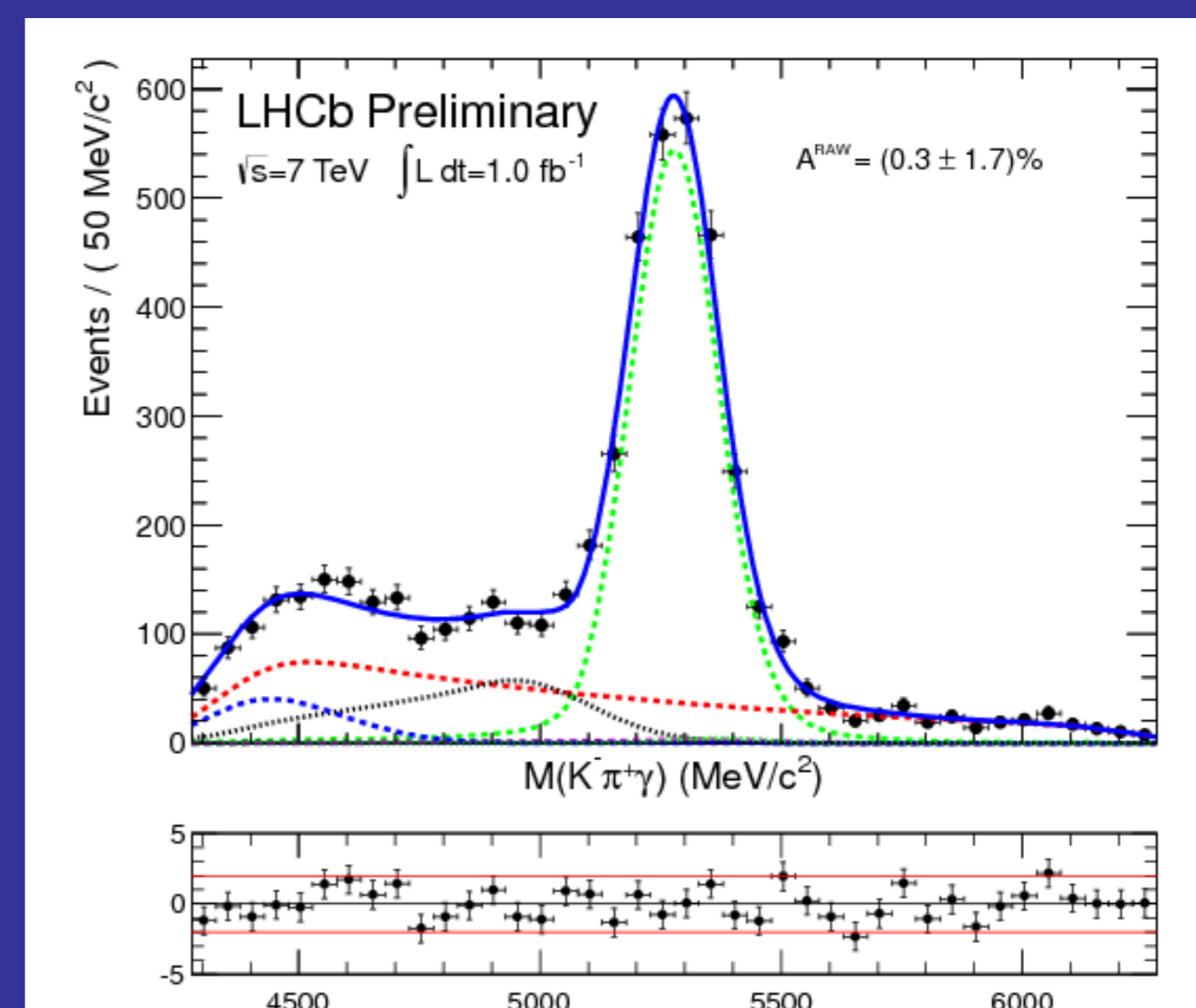
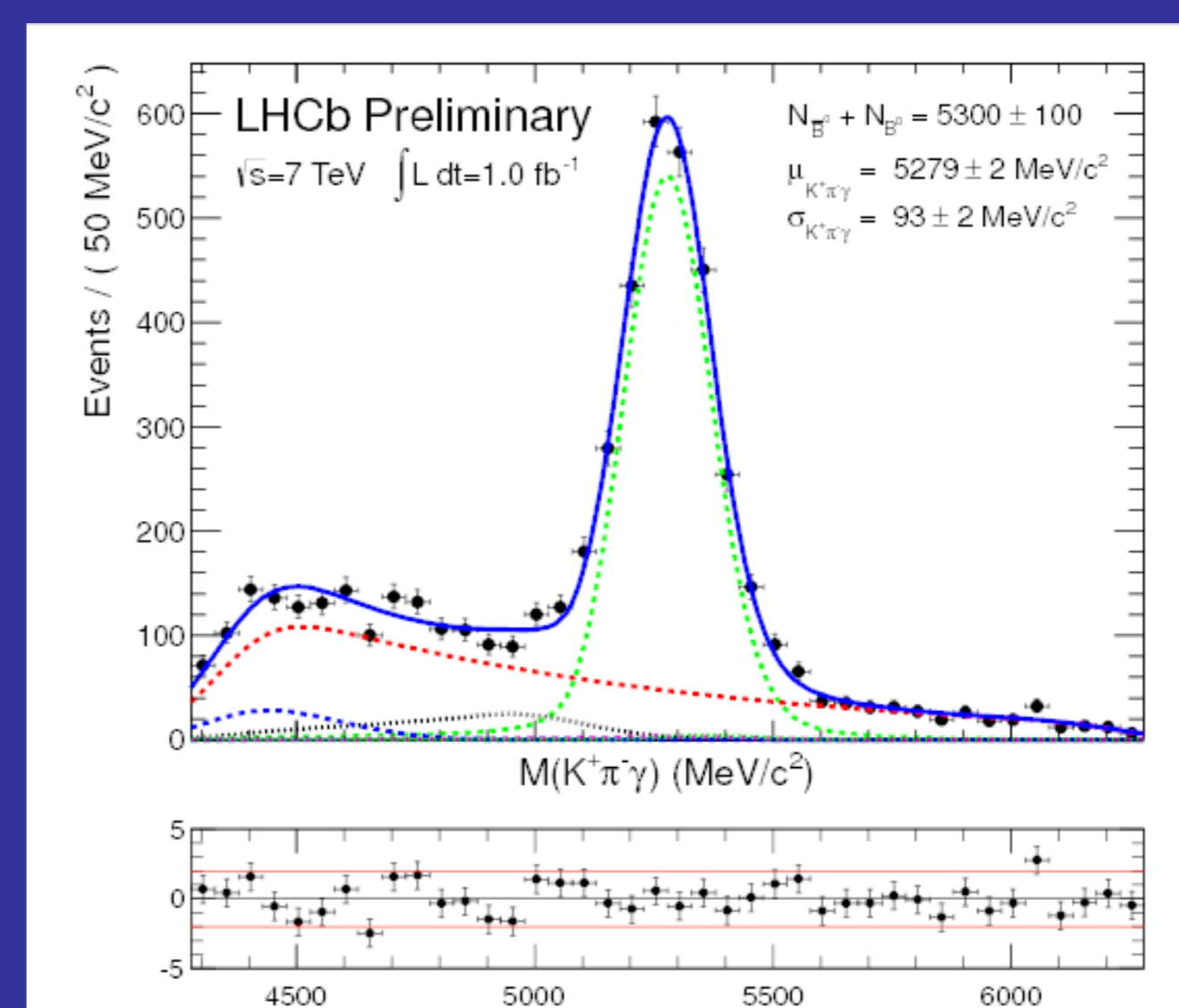


Background studies and fit

Different sources of background contamination:

- Combinatorial
- Irreducible from $B_s \rightarrow K^{*0}\gamma$
- Mis-identified b -baryon radiative decays
- Charmless decays $B \rightarrow hhX\pi^0$
- Partially reconstructed $B \rightarrow hhX\gamma$ or $B \rightarrow hhX\pi^0$

Their shape has been modelled using MC samples. Their contamination level has been left free in the fit in the cases where it peaked outside the signal mass peak, otherwise it has been estimated from MC.



The asymmetry between the two flavour species is extracted from an unbinned maximum likelihood fit applied simultaneously to the two invariant mass distributions, yielding a raw value of:

$$A_{\text{raw}} = (0.3 \pm 1.7(\text{stat}))\%$$

Corrections and uncertainties

The uncertainty in the background contributions on the raw asymmetry is estimated to be $(-0.2 \pm 0.7)\%$.

The physical CP asymmetry is related to the measured raw asymmetry by

$$A_{CP} = A_{\text{raw}} - A_d - \kappa A_p$$

where A_d and A_p are the detection and production asymmetry, respectively. The κ factor is a dilution due to the neutral B meson oscillation.

It has been found in other LHCb analysis (LHCb-CONF-2011-042) [4] that

$$A_d = (-1.0 \pm 0.2)\%, A_p = (1.0 \pm 1.3)\%.$$

The κ factor has been calculated through the B meson proper time acceptance function yielding

$$\kappa = 0.41 \pm 0.04.$$

Possible bias induced by a non perfect cancellation using both magnet polarities is estimated to be $(0.1 \pm 0.2)\%$.

Preliminary results with 1 fb⁻¹ of data

In 1 fb⁻¹ of pp collisions taken with the LHCb detector at a centre of mass energy of $\sqrt{s} = 7$ TeV, the direct CP asymmetry in the $B^0 \rightarrow K^{*0}\gamma$ channel has been measured to be

$$A_{CP} = (0.8 \pm 1.7(\text{stat}) \pm 0.9(\text{syst}))\%$$

in agreement with previous measurements and the SM expectations. This is the most precise measurement of the direct CP asymmetry in the decay $B^0 \rightarrow K^{*0}\gamma$ to date.

References

- [1] Y. Y. Keum, M. Matsumori, and A. I. Sanda, *CP asymmetry, Branching ratios and isospin breaking effects of $B^0 \rightarrow K^{*0}\gamma$ with perturbative QCD approach*. Phys. Rev. D72 (2005) 014013.
- [2] BaBar collaboration, B. Aubert *et al.*, *Measurement of Branching Fractions and CP and Isospin Asymmetries in $B^0 \rightarrow K^{*0}\gamma$ Decays*, Phys. Rev. Lett. 103 (2009) 211802.
- [3] LHCb collaboration, A. Augusto Alves Jr *et al.*, *The LHCb detector at the LHC*, JINST 3 (2008), no. S08005.
- [4] LHCb collaboration, *Measurement of direct CP violation in charmless charged two-body B decays at LHCb using 2010 data*, LHCb-CONF-2011-042.