Constraints on the CKM angle γ and extensions with $B^{\pm}\to DK^{*\pm}$ decays at LHCb

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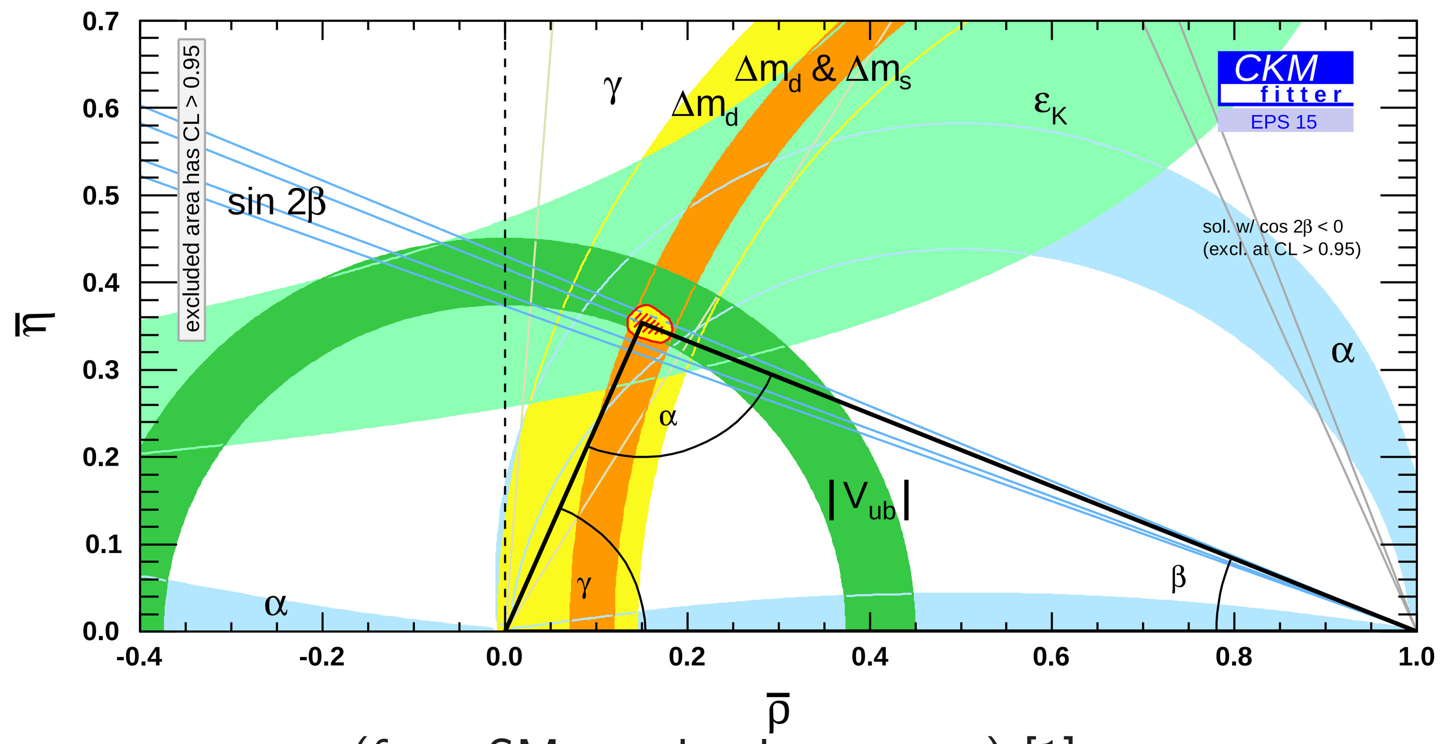
Why measure γ?

- Non-unitarity of the CKM matrix is a clear sign of physics beyond the Standard Model
- γ is the only angle that can be accessed via **entirely tree level** processes (no loops)- pure SM measurement



Direct measurements (from SM tree level processes) [1]:

$$(73.2\ {}^{+6.3}_{-7.0})^{o}$$

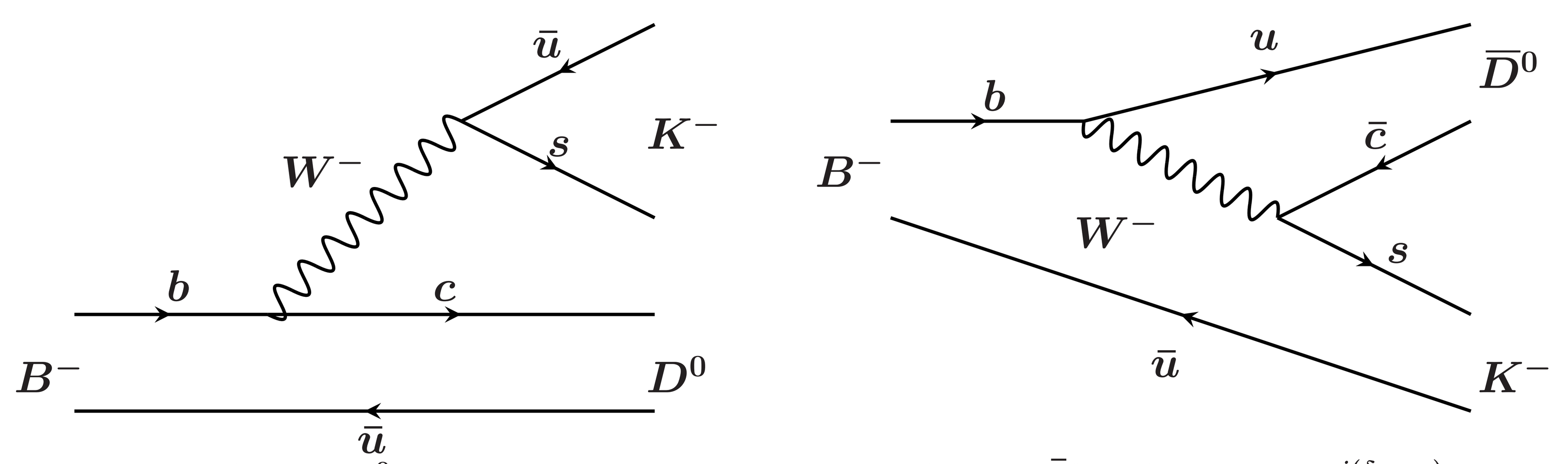
Indirect measurements (from global CKM fit, including many loop level measurements of other CKM parameters) [1]:

$$(66.9\ {}^{+0.9}_{-3.7})^{o}$$

- Difference between these measurements would be a sign of New Physics
- Look at **as many modes as possible** to improve precision

$B^{\pm}\to DK^{\pm}$ decays

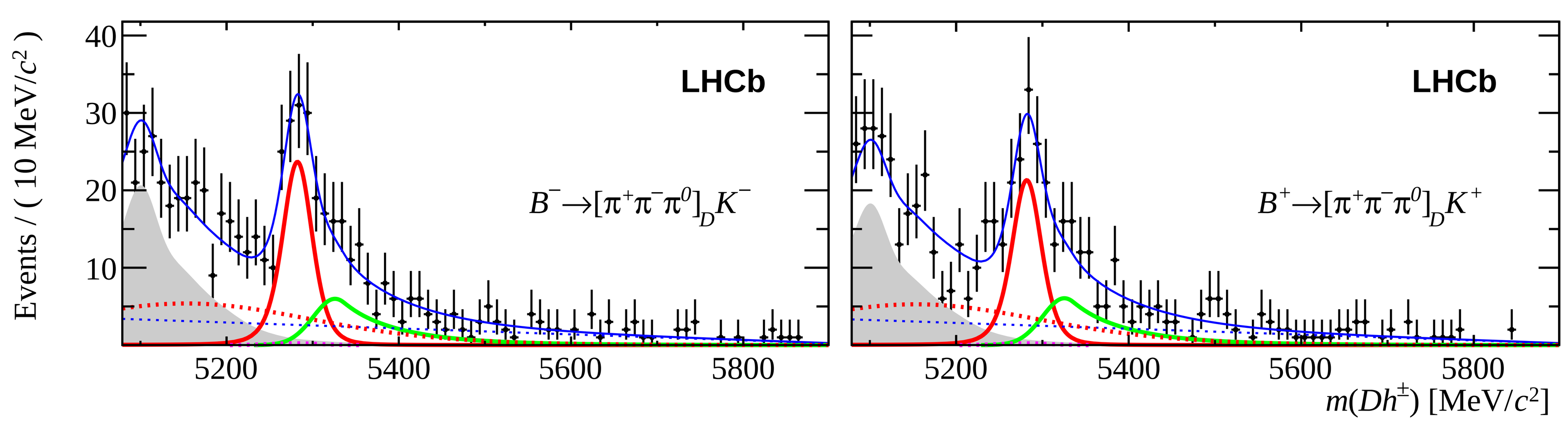
- Extensively investigated in Run 1 at LHCb
- Sensitivity to γ originates from the interference when D^0 and $\overline{D}^0$ decays to the same final state [2]



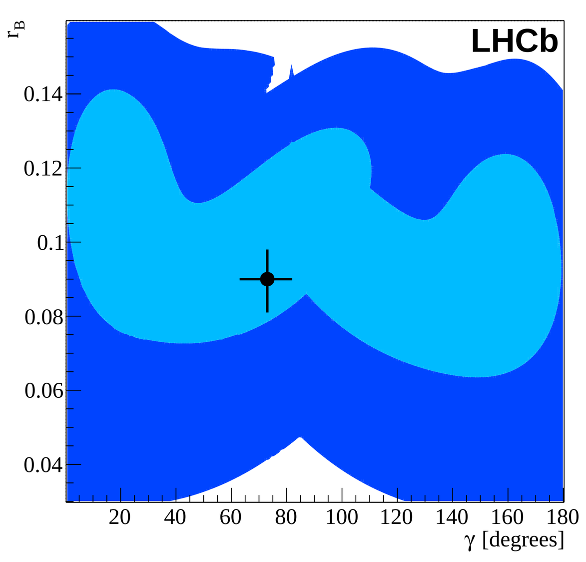
$A(B^-\to D^0K^-) = A_B$ $\quad$ $A(B^-\to \bar{D}^0K^-) = A_B r_B e^{i(\delta_B-\gamma)}$

- Many different D decay modes have been investigated:
  - $D^0\to hh$, $D^0\to h\pi\pi\pi$ and $D^0\to hh\pi^0$
  - $D^0\to K^0_s\pi\pi$, $D^0\to K^0_sKK$ and $D^0\to K^0_sK\pi$

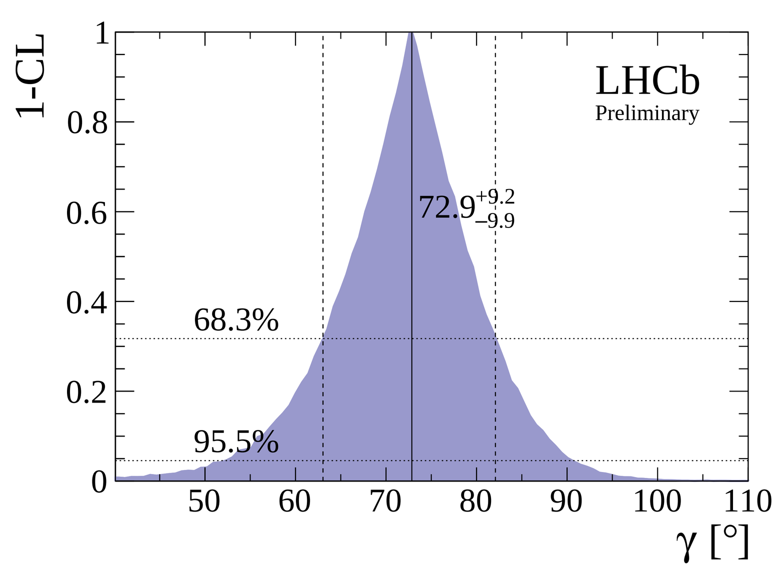
Where h refers to a pion or a kaon



$B\to D(\pi\pi\pi^0)K$ results from the 3 fb^{-1} analysis of $B\to D(hh\pi^0)K$ at LHCb [3].



Constraint the $B\to D(hh\pi^0)K$ analysis places on r_B of 0.11 ± 0.03 [3]



Combination of LHCb γ measurements from $B\to DK$ and similar modes [4]

- r_B is the ratio of amplitudes between $B^-\to\overline{D}^0K^-$ and $B^-\to D^0K^-$
- Asymmetries between yields for B^+ and B^- have sensitivity to γ
- The $hh\pi^0$ mode improves precision on r_B, which has subsequent impact on γ

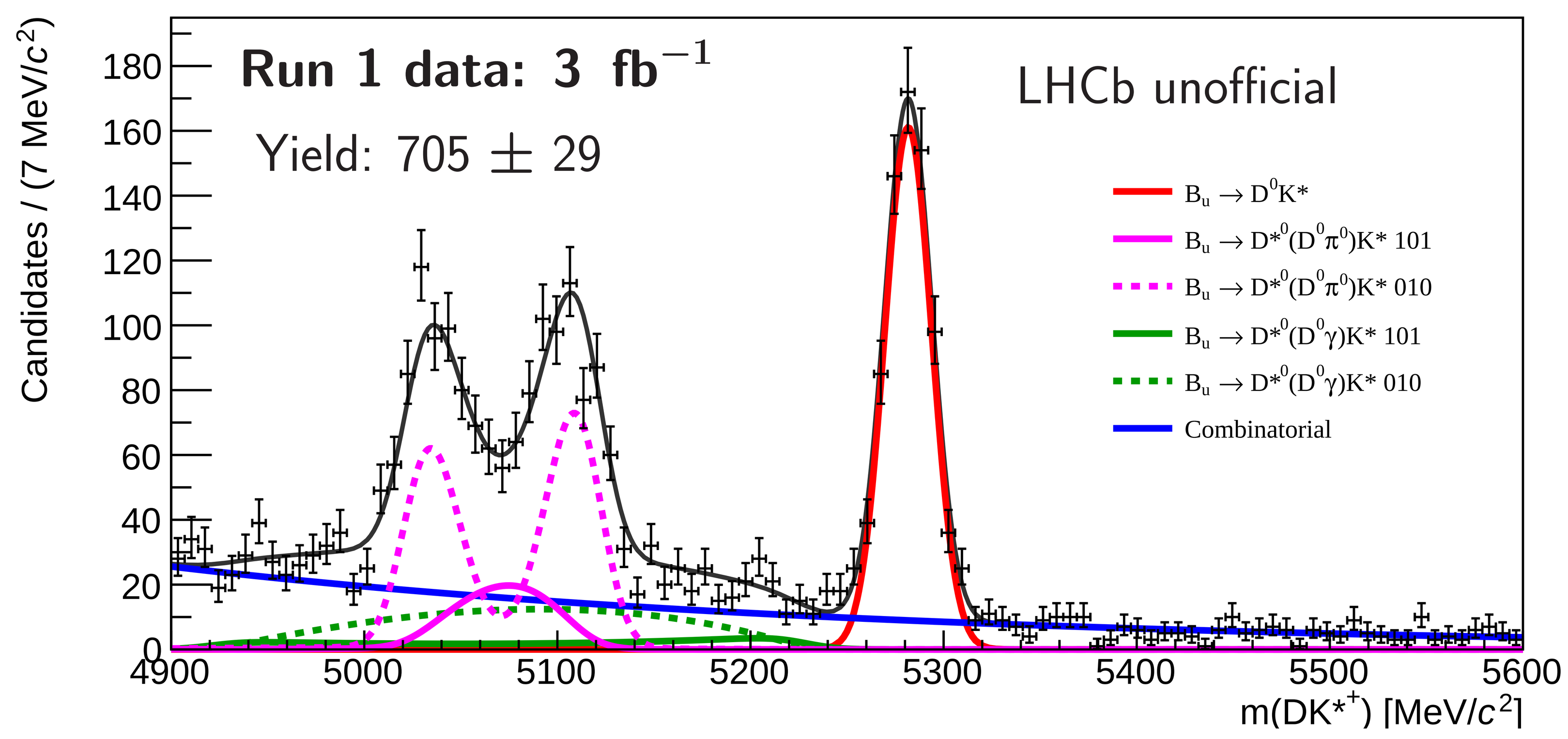
$B^{\pm}\to DK^{*\pm}$ decays

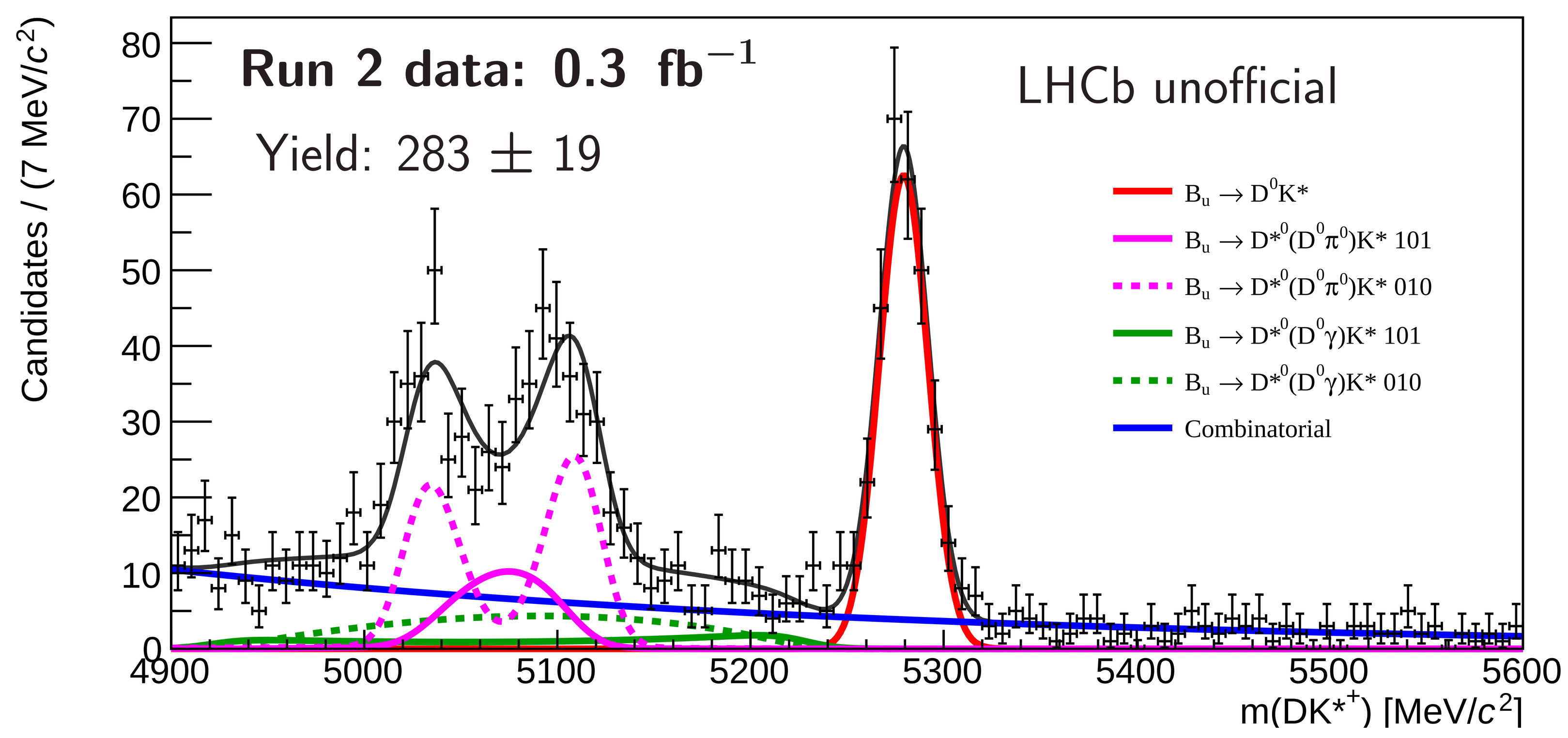
- Being studied at LHCb
- There are some advantages compared to the $B\to DK$:
  - **No background from** $B\to D\pi$ due to mis-identification of pions
  - **Well separated low mass** background ($B\to D^*K^*$)
- Drawbacks: low reconstruction efficiency of the $K^*\to K^0_s\pi$ reduces yield
- Initially looking at two body D decays;
  - **Control mode:** $D^0\to K^-\pi^+$
  - **GLW modes:** $D^0\to K^+K^-$ or $\pi^+\ \pi^-$ (CP eigenstates)
  - **ADS mode:** $D^0\to K^+\pi^-$ (Doubly Cabibbo supressed)

Selection

- Define optimal selection for control mode $D^0\to K^-\pi^+$ (not sensitive to γ)
- **Loose pre-selection** on track quality, vertex quality, masses of intermediate states, etc.
- **Multivariate analysis** to separate signal from combinatoric background training on MC and data high in B mass respectively
- **Particle identification** on final state particles
- Selection significantly reduces combinatoric background to obtain a B mass peak with a **purity of 90%**

Results





Fits to the invariant mass of the control mode

- Extend analysis to also fit the GLW and ADS modes
- Expected yields for the KK, $\pi\pi$ and ADS modes are 90, 30 and 10 respectively
- Yields are approximately 40 times smaller than for the $B\to D^0(hh)K$ channel, but with much simpler backgrounds

References

[1] CKMfitter Group (J. Charles et al.), Phys.Rev.D91:073007,2015 (2015). arXiv:1501.05013. `http://ckmfitter.in2p3.fr/www/results/plots_eps15/ckm_res_eps15.html`

[2] W. Wang. Phys. Rev. Lett. 110 (2013) 6, 061802. arXiv:1211.4539

[3] LHCb Phys. Rev. D 91 (2015) 112014. arXiv:1504.05442

[4] 8th International Workshop on the CKM Unitarity Triangle, Univ. Tech., Vienna, Austria, Sep 2014. LHCB-CONF-2014-004

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