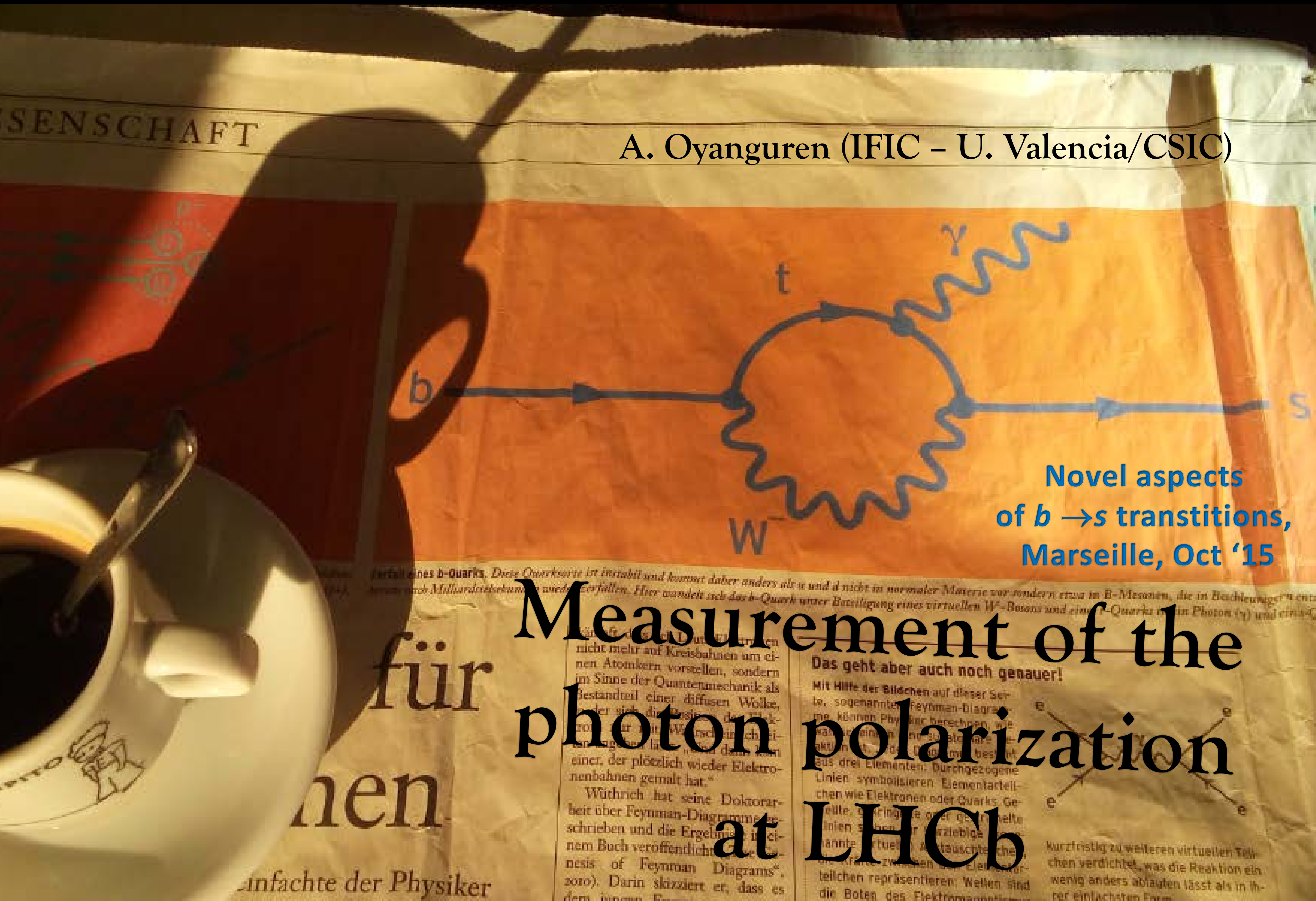


A. Oyanguren (IFIC – U. Valencia/CSIC)

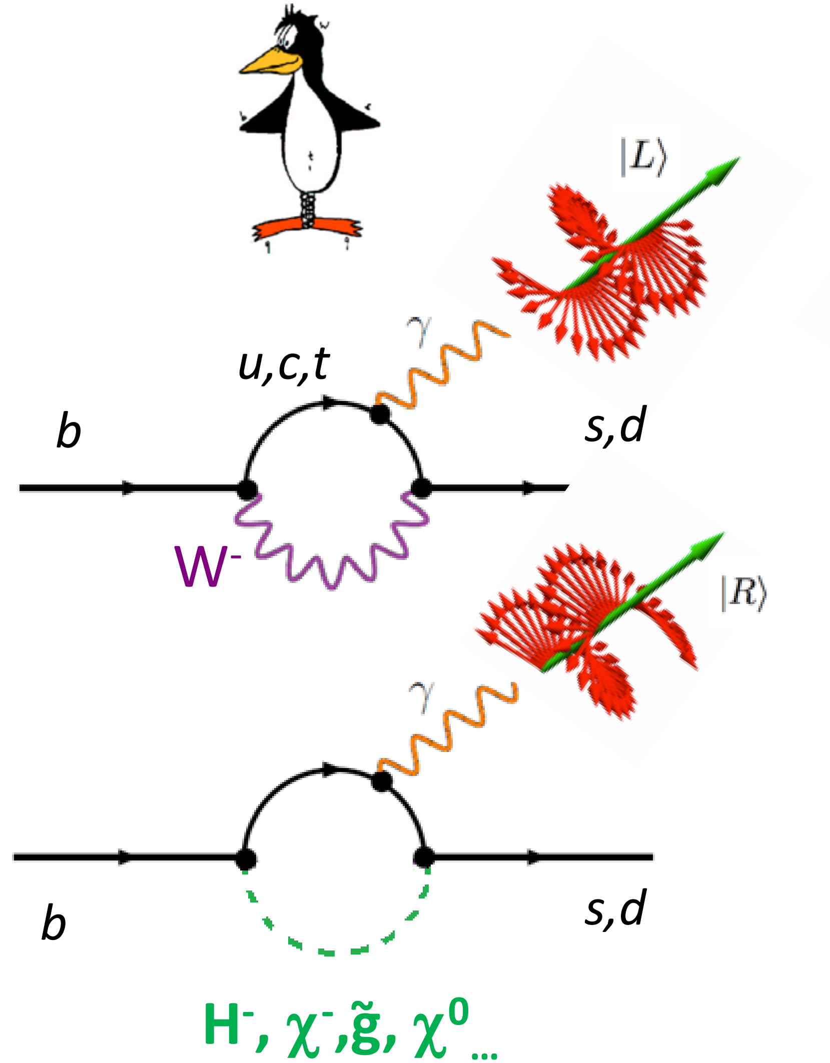
Novel aspects of *b* →*s* transtitions, Marseille, Oct '15

Measurement of the photon polarization at LHCb

Outline

- Motivation
- $B^+ \to K^+ \pi^- \pi^+ \gamma$
- $B^0 \to K^{*0} e^+ e^-$
- $B_s \to \phi \gamma$
- $\Lambda_b \to \Lambda \gamma$
- Conclusions

Motivation

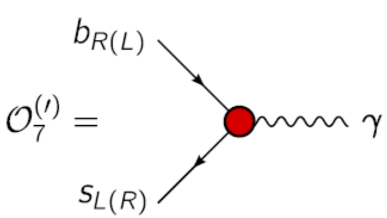


→ Photons in ***b →sγ*** are predicted to be left-handed in the SM (small corrections of order m_s/m_b ~ 2%)

→ Some new physics models, particularly **Left-Right Symmetric Models,** predict an anomalous component of polarized photons

[D. Atwood, M. Gronau and A. Soni, PRL79(97)185]
[M. Gronau, D. Pirjol, PRD66(02)054008]
[F. Yu, E. Kou, C. Lü, JHEP12(2013)102]

→ Involved Wilson coefficient: $C_7^{(')}$



$$\mathcal{O}_7^{(\prime)} = \frac{m_b}{e}(\bar{s}\sigma_{\mu\nu}P_{\mathrm{R(L)}}b)F^{\mu\nu}$$

Motivation

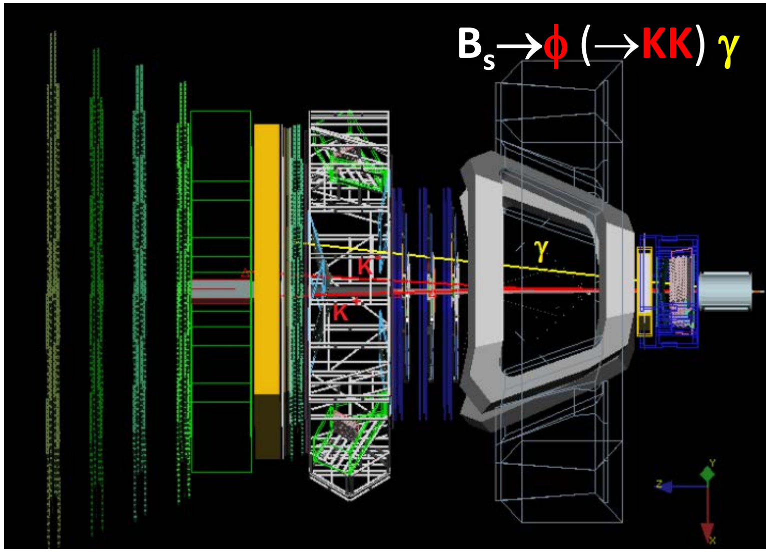
How to access **the photon polarization** in *b*-hadron decays?

- **Time dependent analyses, using B-$\bar{B}$ interference of mixing and decay:**
  - Final common state for neutral B and $\bar{B}$: $B_{(s)} \to V\gamma$, $V \to KK$, $\pi\pi$
  - B_s more profitable ($\Delta\Gamma_s >> \Delta\Gamma_d$)
  - @ LHCb: V to charged tracks, better no π^0's, no K_s 's (Ex: ~~$B_d \to K^{*0}$~~ $(K_s\pi^0)\gamma$)
  - $B_s \to \phi\gamma$, $B_d \to \rho\gamma$, $B_d \to \omega\gamma$
  - Observables: TD decay widths, TD CP asymmetries
  - Use of flavour tagging (C, S mixing param.) reduces a lot the statistics (ε_{eff}~5%)

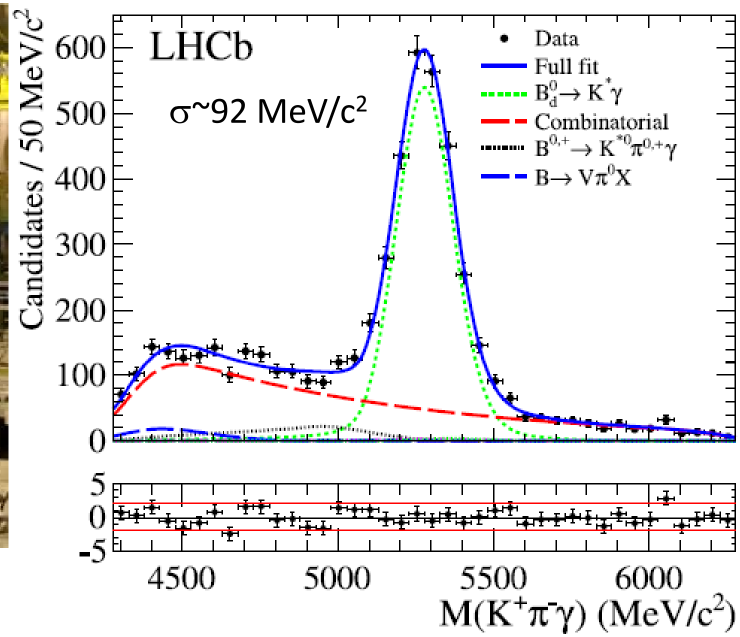
- **Angular analyses:**
  - $B_{(s)}$ to three-body + γ decays ($B^+ \to K^-\pi^+\pi^+\gamma$) **[PRL 112(2014)161801]**
  - Decays of Λ_b baryons to $\Lambda\gamma$
  - Decays with an electron pair in the final state $\gamma \to e^-e^+$
    with γ real: radiative decays with converted photons ($B_{(s)} \to V\gamma(\to e^-e^+)$)
    or virtual: $B \to K^*e^+e^-$ analyzed in the low q^2 region **[JHEP04(2015)064]**

Motivation

Radiative decays @ LHCb:



[Nuc. Phys. B 867 (2013) 1-18]



First measurements @ LHCb :

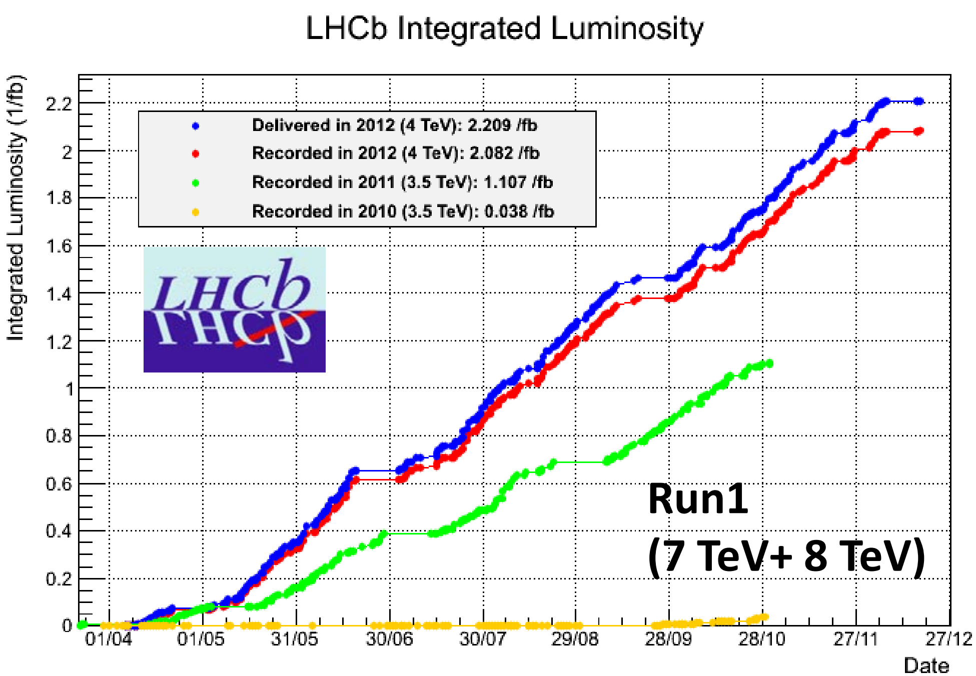
$$\frac{\mathcal{B}(B^0 \to K^{*0}\gamma)}{\mathcal{B}(B_s^0 \to \phi\gamma)} = 1.23 \pm 0.06\,(\text{stat.}) \pm 0.04\,(\text{syst.}) \pm 0.10\,(f_s/f_d)$$

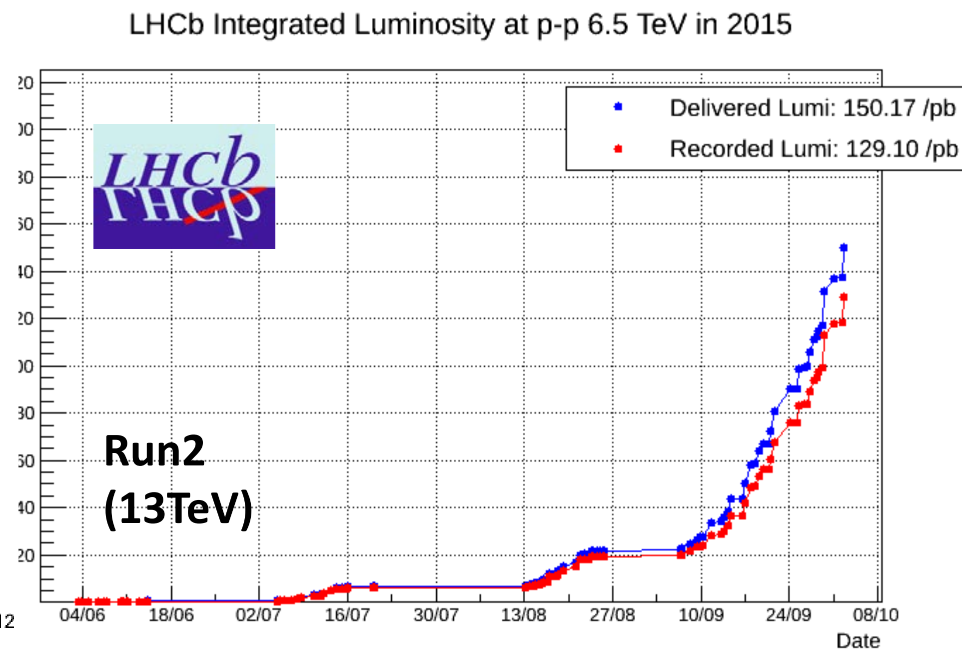
$$\mathcal{A}_{CP}(B^0 \to K^{*0}\gamma) = (0.8 \pm 1.7\,(\text{stat.}) \pm 0.9\,(\text{syst.}))\%.$$

5279 ± 93 $B_d \to K^*\gamma$
691 ± 36 $B_s \to \phi\gamma$

(this with 1fb^{-1}, update with 3fb^{-1} in progress)

Motivation





LHCb working well, expected 8 fb^{-1} at the end of Run2

(also gain from B production at higher centre-of-mass energy)

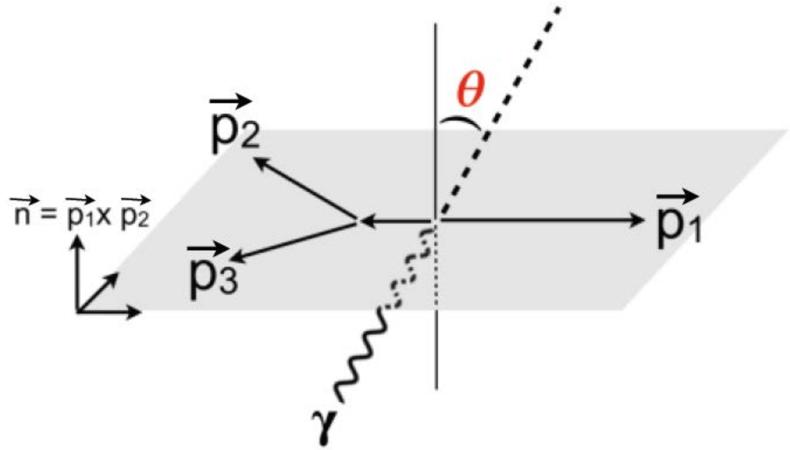
Measuring the photon polarization with:

$$B^+ \rightarrow K^+ \pi^- \pi^+ \gamma$$

$B^+ \to K^+\pi^-\pi^+\gamma$

- The photon polarization can be measured in $B_{(s)}$ to three body + γ decays
$\rightarrow$ the decay plane defines the direction of the photon

- The **photon polarization parameter λ_γ**



$$\lambda_\gamma \equiv \frac{|c_R|^2 - |c_L|^2}{|c_R|^2 + |c_L|^2}$$

expected to be -1 ($\bar{B}$) or +1 (B) with corrections of $(m_s/m_b)^2$
(C_R, C_L right and left amplitudes)

- It can be extracted by studying the three body decay of a K_J (J^P) resonant state in **$B \to K_{res}$**γ radiative decays **[Kou et al, PRD83 (2011) 094007; Gronau et al, PRL88 (2002) 051802]**

$\rightarrow$ There are two known $K_1(1^+)$ states, decaying into $K\pi\pi$ final state via $K^*\pi$ and ρK modes: the **K_1(1270)** and **K_1(1400)** resonances, from where the λ_γ can be measured.

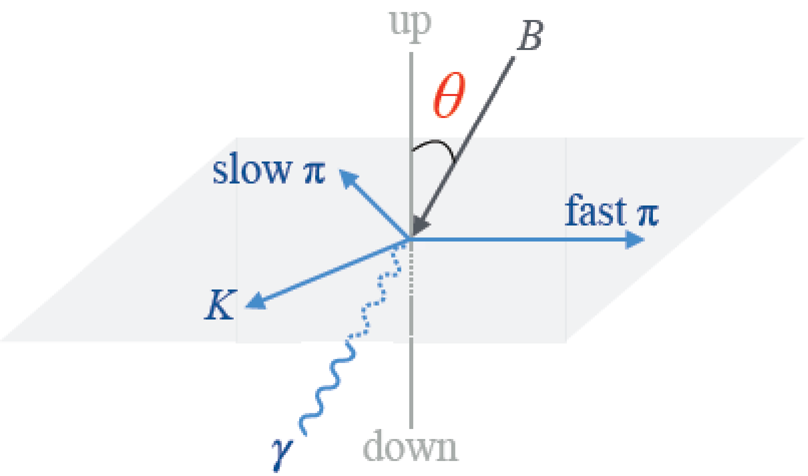
$B^+ \to K^+\pi^-\pi^+\gamma$

- For a radiative **$B \to K_{res}\gamma$**, with the K_{res} a three body decay **$K_{res} \to P_1P_2P_3$**

$$\frac{d\Gamma(\overline{B} \to \overline{K}_{\rm res}\gamma \to P_1P_2P_3\gamma)}{ds\, ds_{13}\, ds_{23}\, d\cos\theta}$$

with $s_{ij}=(p_i+p_j)^2$; $s=(p_1+p_2+p_3)^2$

is the sum of the helicity amplitudes



The **Up-down asymmetry A_{UD}**

$$\mathcal{A}_{up-down} = \frac{\int_0^1 d\cos\theta \frac{d\Gamma}{d\cos\theta} - \int_{-1}^0 d\cos\theta \frac{d\Gamma}{d\cos\theta}}{\int_{-1}^1 d\cos\theta \frac{d\Gamma}{d\cos\theta}} \propto \lambda_\gamma$$

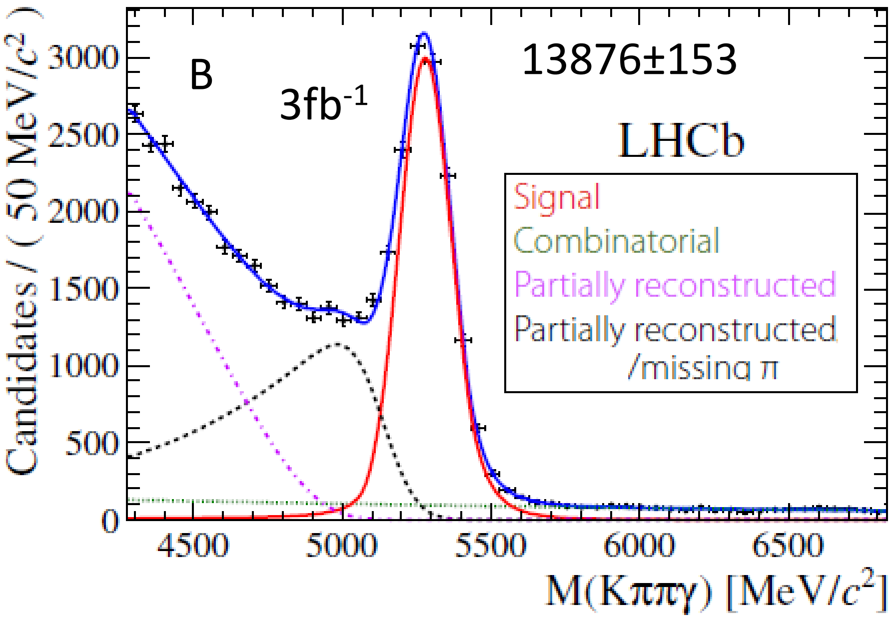
Allows to extract the photon polarization information

→ Need to count the number of events with photon emitted above/below the $\vec{p}_1\vec{p}_2$-plane and subtract them.

$B^+ \to K^+\pi^-\pi^+\gamma$

[PRL 112, 161801 (2014)] **($3fb^{-1}$)**

• Reconstruct a kaon resonance from three charged tracks: two pions of opposite sign and a kaon, plus a **high E_T photon.**



(Kππ from 1.1-1.9 GeV)

Up-down asymmetry: **A_{UD}**

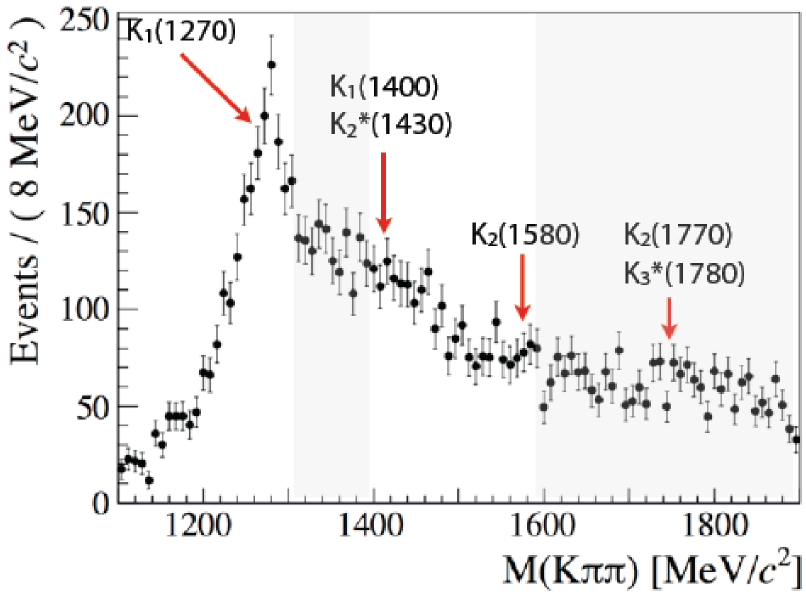
$$\mathcal{A}_{UD} = \frac{N(K\pi\pi\gamma)_{\cos\theta>0} - N(K\pi\pi\gamma)_{\cos\theta<0}}{N(K\pi\pi\gamma)_{\cos\theta>0} + N(K\pi\pi\gamma)_{\cos\theta<0}}$$

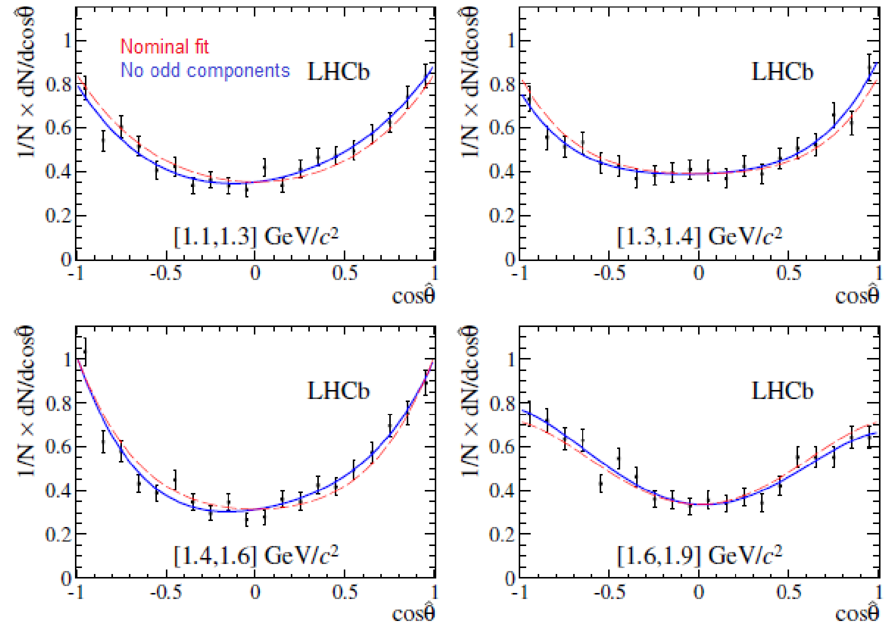
→ Many kaon resonances with different properties are expected to contribute

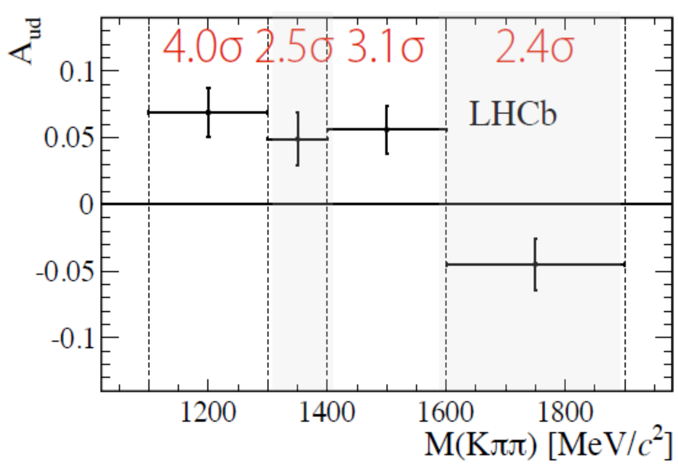
→ **A_{UD}** studied in several m(Kππ) regions , fitting m_B and the cosθ distribution.

$B^+ \to K^+\pi^-\pi^+\gamma$

Background substracted $K\pi\pi$ spectrum:







→ λ_γ differs from 0 at 5.2σ
First evidence of photon polarization in *b* →*s* transitions!

[PRL 112, 161801 (2014)]

(but this cannot be translated easily in R, L amplitudes…)

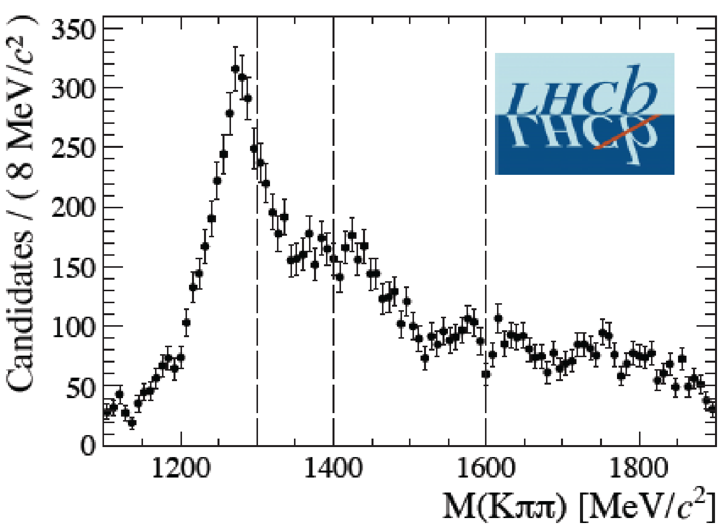
$B^+ \to K^+\pi^-\pi^+\gamma$

- At present performing an amplitude analysis on the $K\pi\pi$ system to disentangle the different resonant contributions (3-dimensions: $m^2_{K\pi\pi}$, $m^2_{K\pi}$, and $m^2_{\pi\pi}$)

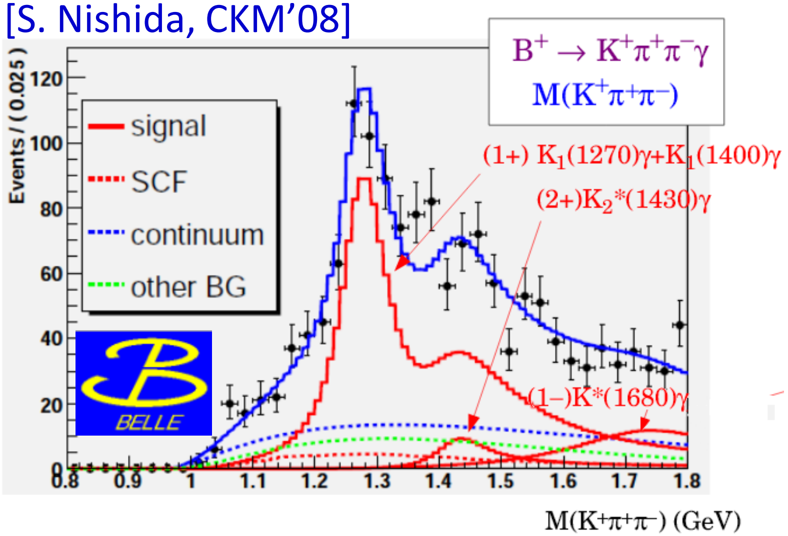
$$\mathcal{PDF}_{X\to K\pi\pi} = \underbrace{\epsilon(\vec{m})}_{\text{efficiency}} \times \underbrace{\eta(\vec{m})}_{B\to K\pi\pi\gamma \text{ phase-space}} \times \sum_{J^P}\left|\sum_k f_k\, \mathcal{A}_k^{J^P}(\vec{m})\right|^2$$

k indicates the resonance
J^P is the spin-parity
$\mathcal{A}_k^{J^P}$ is the amplitude
f_k defines a fraction and a phase

$\vec{m} = m^2_{K^+\pi^-\pi^+}, m^2_{K^+\pi^-}, m^2_{\pi^+\pi^-}$



[S. Nishida, CKM'08]



[Belle, PRL 101 (2008), 251601]

And extending the analysis to include the angular observables

Measuring the photon polarization with:

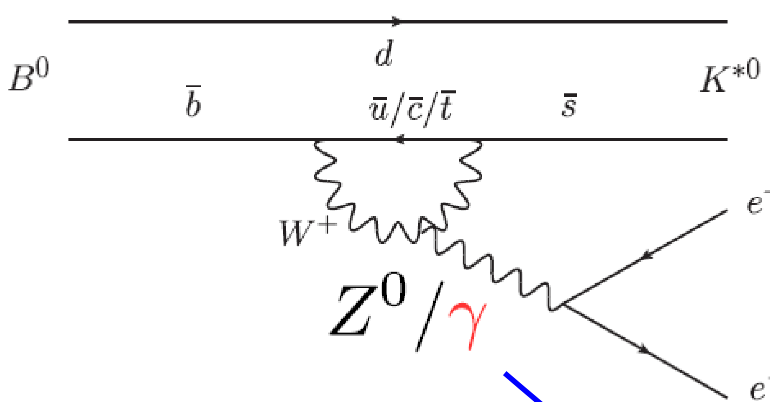
$$B^0 \rightarrow K^{*0} e^- e^+$$

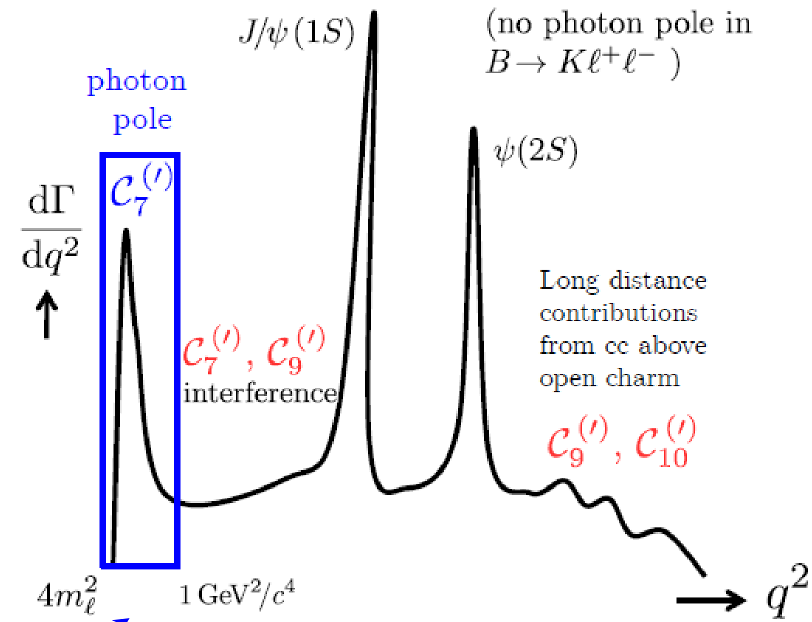
$B^0 \to K^{*0} e^- e^+$

- Measurement of angular observables of the $B^0 \to K^* e^- e^+$ in the low $q^2 <$ 1GeV^2

  [JHEP04(2015)064] (3fb^{-1})

$\to$ Virtual γ decaying in an observable $\ell^- \ell^+$ pair



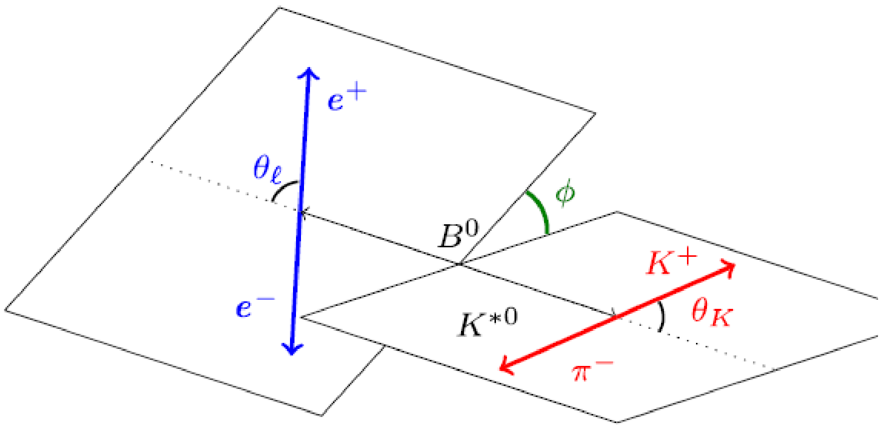


$\to$ Sensitive to the photon polarization due to the photon pole (for $B \to V e^- e^+$)

$\to$ Requires to go very low in the q^2 region $\to$ **electrons**

$B^0 \to K^{*0} e^- e^+$

- The differential decay rate depends on three angles: θ_ℓ, θ_K and ϕ



$$\frac{1}{\mathrm{d}(\Gamma+\bar{\Gamma})/\mathrm{d}q^2}\frac{\mathrm{d}^4(\Gamma+\bar{\Gamma})}{\mathrm{d}q^2\,\mathrm{dcos}\,\theta_\ell\,\mathrm{dcos}\,\theta_K\,\mathrm{d}\tilde{\phi}} =$$

$$\frac{9}{16\pi}\Big[\frac{3}{4}(1-F_{\mathrm{L}})\sin^2\theta_K + F_{\mathrm{L}}\cos^2\theta_K + \left(\frac{1}{4}(1-F_{\mathrm{L}})\sin^2\theta_K - F_{\mathrm{L}}\cos^2\theta_K\right)\cos 2\theta_\ell + \frac{1}{2}(1-F_{\mathrm{L}})A_{\mathrm{T}}^{(2)}\sin^2\theta_K\sin^2\theta_\ell\cos 2\tilde{\phi} + (1-F_{\mathrm{L}})A_{\mathrm{T}}^{\mathrm{Re}}\sin^2\theta_K\cos\theta_\ell + \frac{1}{2}(1-F_{\mathrm{L}})A_{\mathrm{T}}^{\mathrm{Im}}\sin^2\theta_K\sin^2\theta_\ell\sin 2\tilde{\phi}\Big]$$

$$\mathrm{A}_{\mathrm{T}}^{(2)}(q^2\to 0) = \frac{2\mathcal{R}e(\mathcal{C}_7\mathcal{C}_7'^*)}{|\mathcal{C}_7|^2+|\mathcal{C}_7'|^2}$$

$$\mathrm{A}_{\mathrm{T}}^{\mathrm{Im}}(q^2\to 0) = \frac{2\mathcal{I}m(\mathcal{C}_7\mathcal{C}_7'^*)}{|\mathcal{C}_7|^2+|\mathcal{C}_7'|^2}$$

access to the photon polarization information

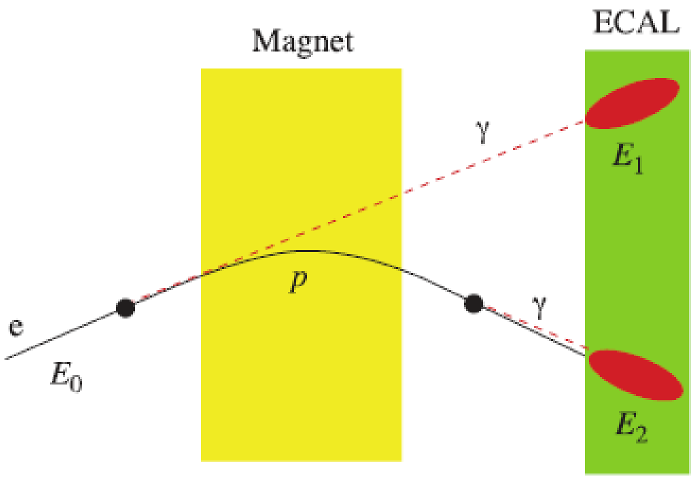
[D. Becirevic and E. Schneider Nucl. Phys. B 854 (2012) 321]

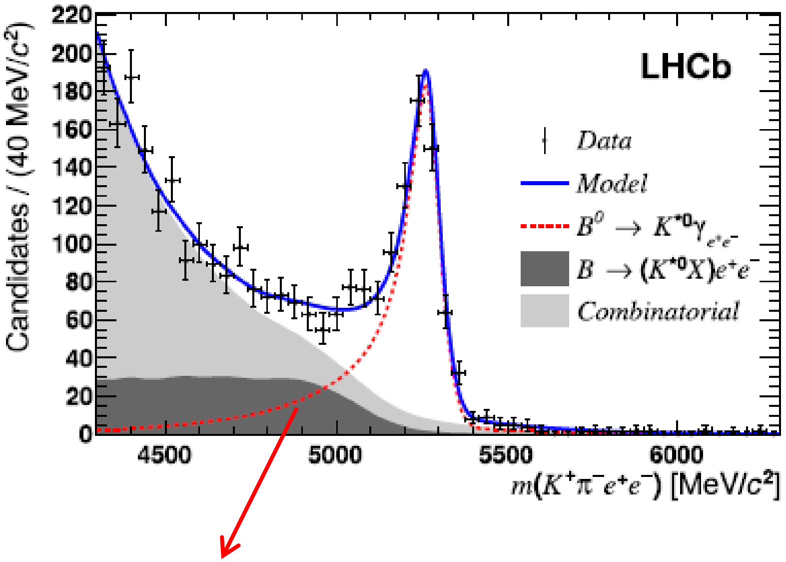
$A_{\mathrm{T}}^{\mathrm{Re}} = \frac{4}{3}A_{\mathrm{FB}}/(1-F_{\mathrm{L}})$

F_{L}: longitudinal polarization of the K*
(expected small at low q^2, $\gamma_\perp$ polarized)

$B^0 \to K^{*0} e^- e^+$

- Electrons are difficult to reconstruct since they loose energy by radiation: need **bremsstrahlung recovery**



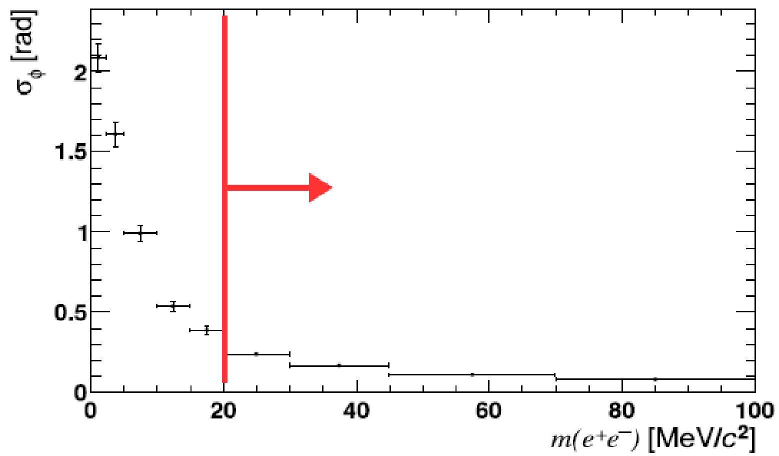


$\rightarrow$ adding neutral clusters from the ECAL , with E_T > 75MeV

Long radiative tail in the B mass distribution: controlled from $B \rightarrow K^*\gamma$ events ($\gamma \rightarrow e^-e^+$, with bremsstrahlung emission)

$B^0 \to K^{*0} e^- e^+$

- q^2 range driven by the experimental resolution in $\phi \to$ cut at $m(e^-e^+) > 20$ MeV



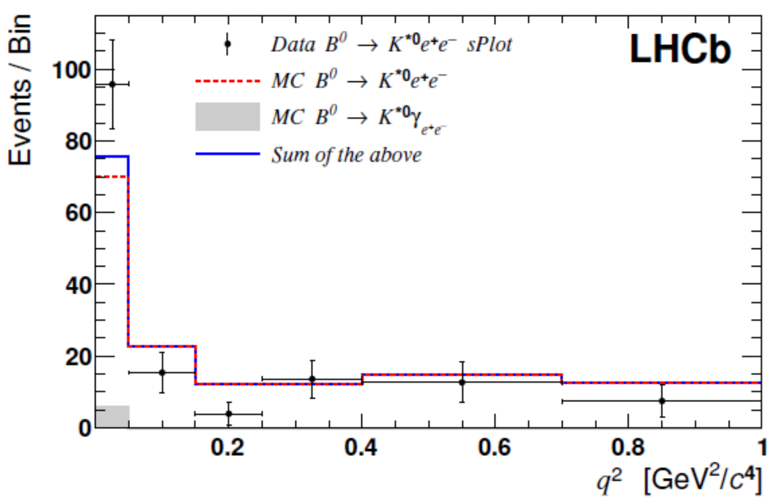
$\to$ **$q^2_{min} = 0.0004$ GeV^2**

good also to suppress the $B \to K^*\gamma(\to e^-e^+)$ background

and

$\to$ **$q^2_{max} = 1$ GeV^2**

allowing to isolate $C_7^{(\prime)}$ contributions



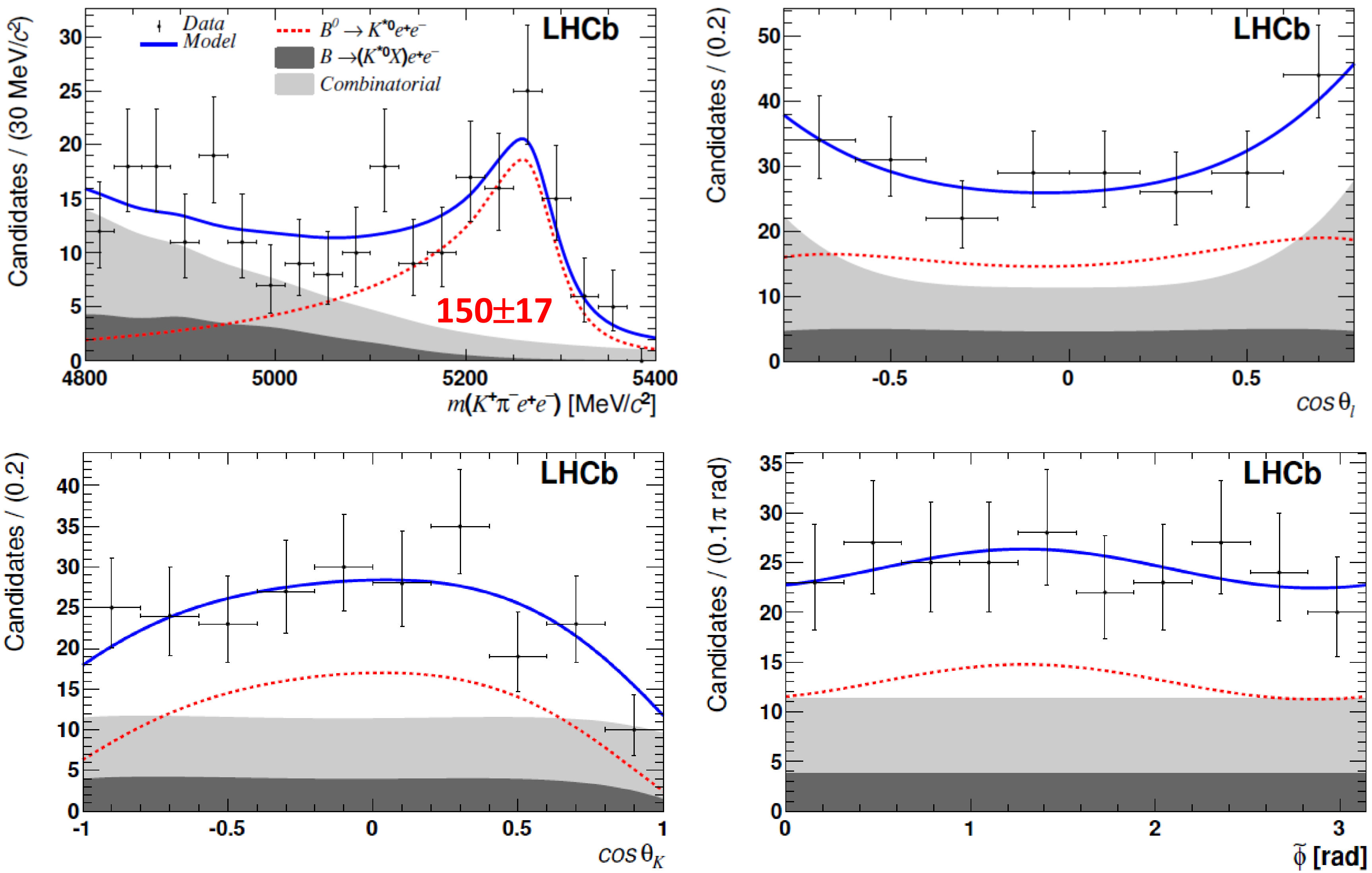
Reconstructed q^2 distribution

Unfolding reconstruction effects, the effective q^2 range is:

$q^2 \in (0.0020(8), 1.12(6))$ GeV^2

$B^0 \to K^{*0} e^- e^+$

- 4-dimensional fit to $m(K^+\pi^- e^- e^+)$ and the three angles θ_ℓ, θ_K and ϕ:



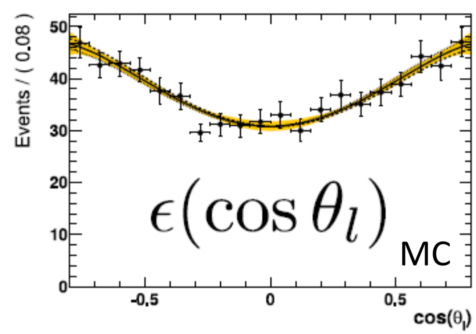
$B^0 \to K^{*0} e^- e^+$

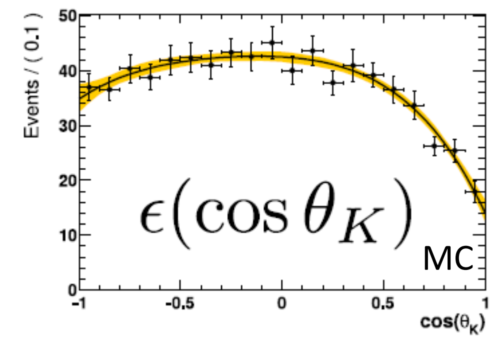
- Measurement at present limited by the statistic uncertainty
- Systematic uncertainties coming from the acceptance modelling and the background

Acceptance:

$$\epsilon(\theta_\ell, \theta_K, \phi) = \epsilon(\cos\theta_l) \times \epsilon(\cos\theta_K) \times \epsilon(\phi)$$

Flat in ϕ; symmetric in $\cos\theta_\ell$ ($e^\pm$); non symmetric in θ_K (π vs K mass)





Background:

(mainly at low mass)

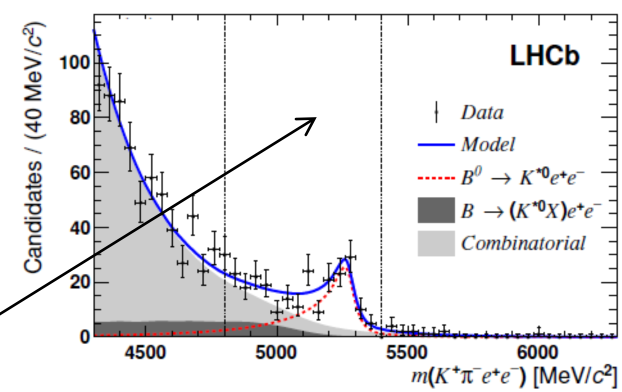
Combinatorial,

$B^0 \to D^- e^+ \nu$
$\quad \hookrightarrow K^{*0} e^- \overline{\nu}$

$B \to (K^{*0} X) e^+ e^-$

$B^0 \to K^{*0}\gamma$

Angular fit in reduced mass region



$B^0 \rightarrow K^{*0} e^- e^+$

- The results of the fitted parameters (**A_T^{im}** and **$A_T^{(2)}$** being sensible to the γ polarization):

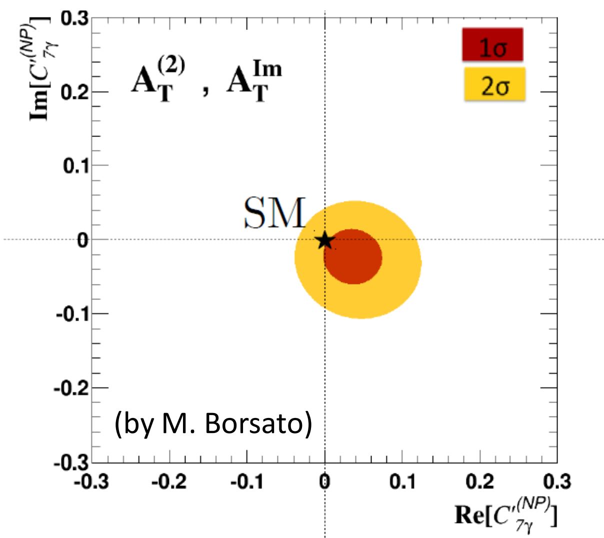
Results:

$$F_L = 0.16 \pm 0.06 \pm 0.03$$
$$A_T^{Re} = +0.10 \pm 0.18 \pm 0.05$$
$$A_T^{(2)} = -0.23 \pm 0.23 \pm 0.05$$
$$A_T^{Im} = +0.14 \pm 0.22 \pm 0.05$$

SM predictions:

$$F_L = 0.10^{+0.11}_{-0.05}$$
$$A_T^{Re} = -0.15^{+0.04}_{-0.03}$$
$$A_T^{(2)} = +0.03^{+0.05}_{-0.04}$$
$$A_T^{Im} = (-0.2^{+1.2}_{-1.2}) \times 10^{-4}$$

$\rightarrow$ **Compatible with the SM predictions:**



[Adapted from Jäger and Camalich arXiv:1412.3183]

The best sensitivity to $C^{7(\prime)}$ up to date!

[JHEP04(2015)064]

$B^0 \rightarrow K^{*0} e^- e^+$

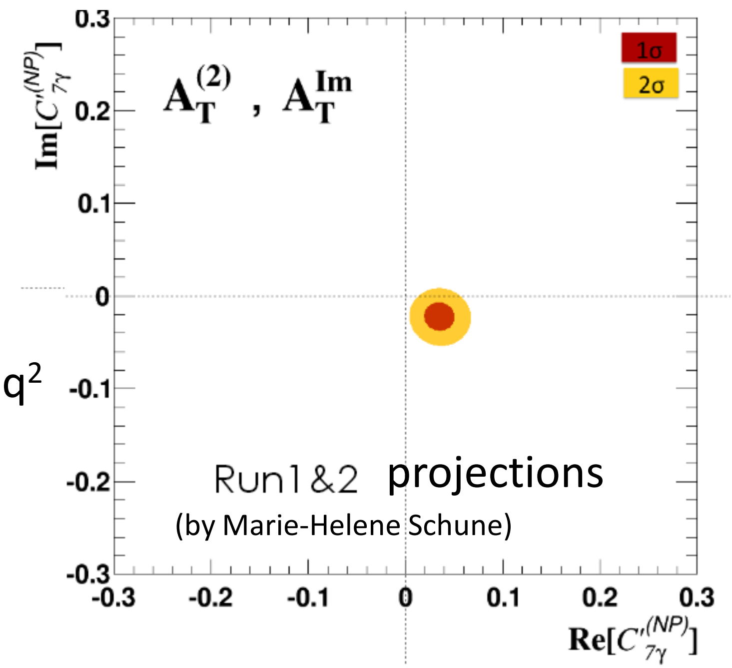
- **Run1 + Run2 projections:**

→ Statistics of Run1 x (1 + ~ 4) (with same performance):
Run1 + Run2 ~ 750 B→ $K^* e^- e^+$ events

→ Try to improve the rejection of combinatorial and partially reconstructed backgrounds at low q^2

→ Add other observables: P'_4 P'_5 P'_6 and P'_8

→ The photon polarization could be measured to about 5 to 7 % !



$B_{(s)} \to V\gamma\ (\to e^- e^+)$

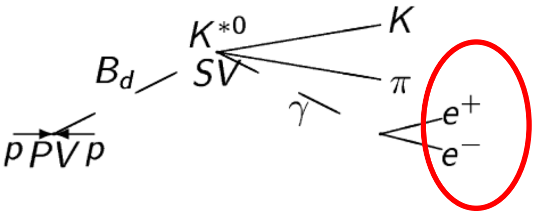
- Photon polarization from converted photons (Bethe-Heitler lepton pairs):

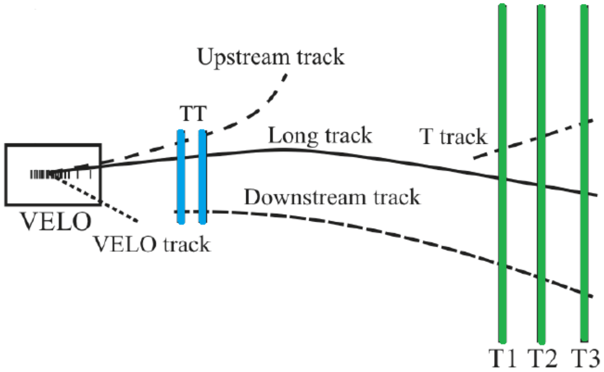
  [Y. Grossman and D. Pirjol JHEP06(2000)029]

  $\rightarrow$ Small fraction of converted photons ~ 20%

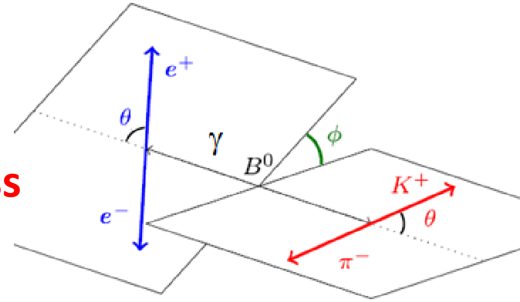
  $\rightarrow$ But better resolution:

  - For calorimeter γ's: σ~92 MeV/c²
  - For converted photons: σ~30 MeV/c², (depends a bit on where the photon materializes)





Work in progress



$\rightarrow$ The angular distribution of the positron is sensitive to the photon polarization:

$$\frac{d\sigma}{d\phi} \propto 1 + \xi R \cos(2\phi + \delta)$$

$$R \equiv \frac{|A_R(0)|\,|A_L(0)|}{|A_R(0)|^2 + |A_L(0)|^2}$$ < 5% in the SM

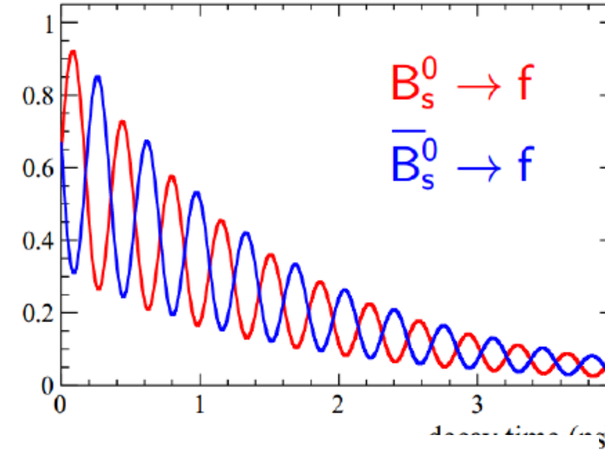
But the photon polarization information seems to be lost at LHCb…

Measuring the photon polarization with:

$$B_s \rightarrow \phi\gamma$$

$B_s \to \phi\gamma$

→ The time-dependent decay rate for $B_s \to \phi\gamma$ and $\bar{B}_s \to \phi\gamma$ decays is described by:



$$\Gamma_{\overset{(-)}{B}{}^0_s \to \phi\gamma}(t) =$$

$$= |A|^2 e^{-\Gamma_s t} \left(\cosh \frac{\Delta\Gamma_s t}{2} - \mathcal{A}^{\Delta} \sinh \frac{\Delta\Gamma_s t}{2} \pm \mathcal{C} \cos \Delta m_s t \mp \mathcal{S} \sin \Delta m_s t\right)$$

~ 0 in the SM

$$\mathcal{A}^{\Delta} \approx \sin 2\psi \cos \varphi_s$$

$$\mathcal{S} \approx \sin 2\psi \sin \varphi_s$$ **~ 0 in the SM**

φ_s= weak mixing phase (<< in the SM)

Fraction of anomalous polarized photons: $\tan\psi \equiv \left|\frac{\mathcal{A}(B_s \to \phi\gamma_L)}{\mathcal{A}(B_s \to \phi\gamma_R)}\right|$

$\Delta\Gamma_s = \Gamma_L - \Gamma_H = (0.081 \pm 0.011)\ ps^{-1}$

$\Gamma_s = 1/\tau_{Bs} = (0.6596 \pm 0.0046)\ ps^{-1}$

$B_s \to \phi\gamma$

→ Untagged measurement of the time dependent $B_s \to \phi\gamma$ width:

$$\Gamma_{B_s^0}(t) = |A|^2 e^{-\Gamma_s t} \left(\cosh\frac{\Delta\Gamma_s t}{2} - \mathcal{A}^{\Delta} \sinh\frac{\Delta\Gamma_s t}{2}\right)$$

$$\approx |A|^2 e^{-\Gamma_{B_s\to\phi\gamma} t}$$ with

It can be seen as an "Effective lifetime" depending on the A^{Δ}

$$\Gamma_{B_s\to\phi\gamma} = \Gamma_s + \frac{\mathcal{A}^{\Delta}\Delta\Gamma}{2}$$

SM value: $A^{\Delta} = 0.047 \pm 0.025 + 0.015_{(\alpha_s)}$ [Muheim, Xie, Zwicky, PLB664(08)174]

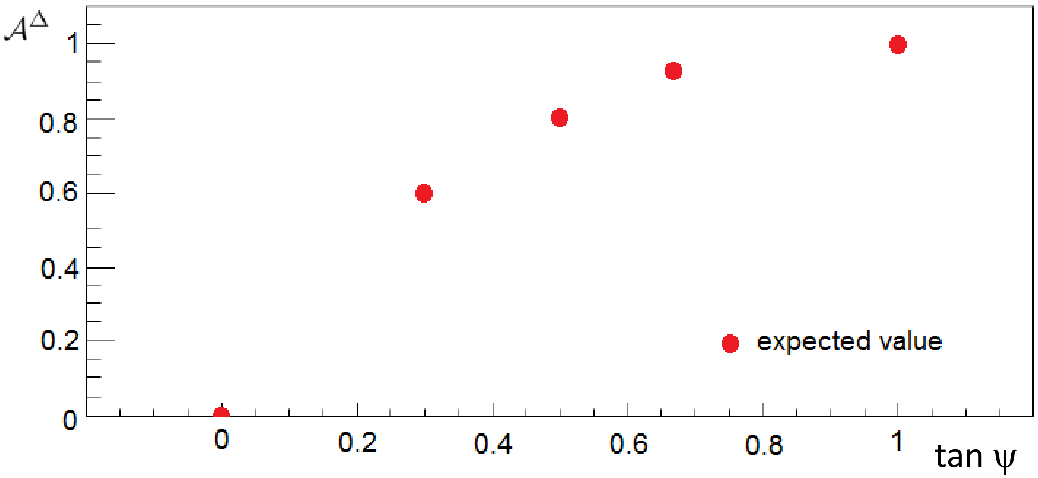
Left-Right Symmetric models: A^{Δ} up to ~ 0.7 [Atwood, Gronau and Soni, PRL79(97)185]

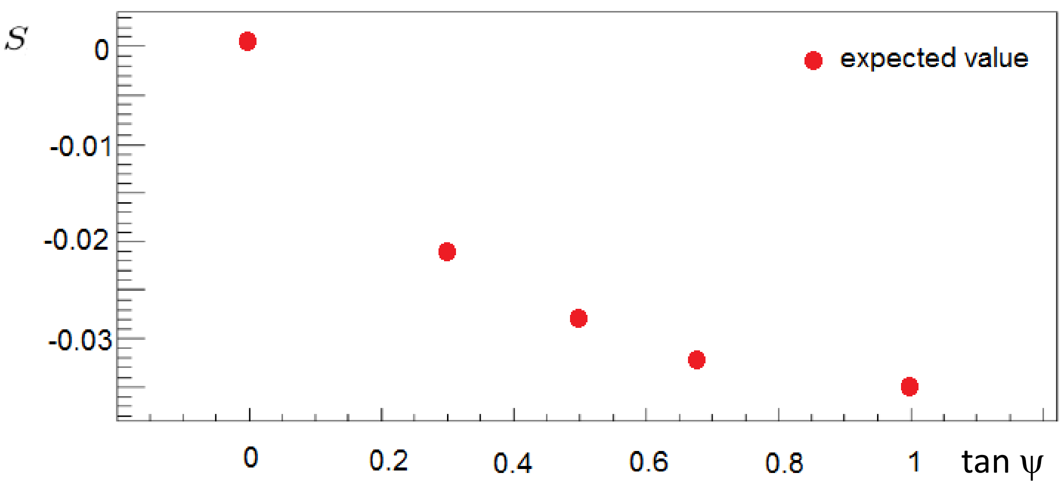
→ **Fraction of anomalous polarized photons ~ 40%**

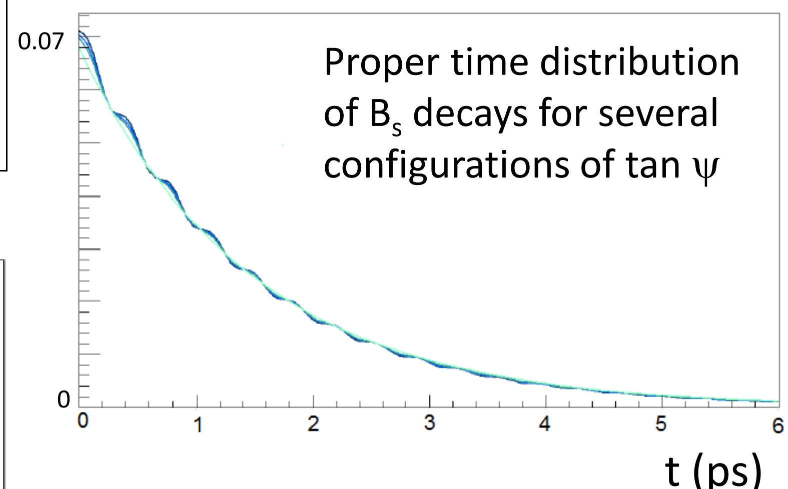
$B_s \to \phi\gamma$

- Dependence of A^{Δ} and S parameters with the fraction of anomalous polarized photons

$$\tan\psi \equiv \left| \frac{\mathcal{A}\left(B_s \to \phi\gamma_L\right)}{\mathcal{A}\left(B_s \to \phi\gamma_R\right)} \right|$$



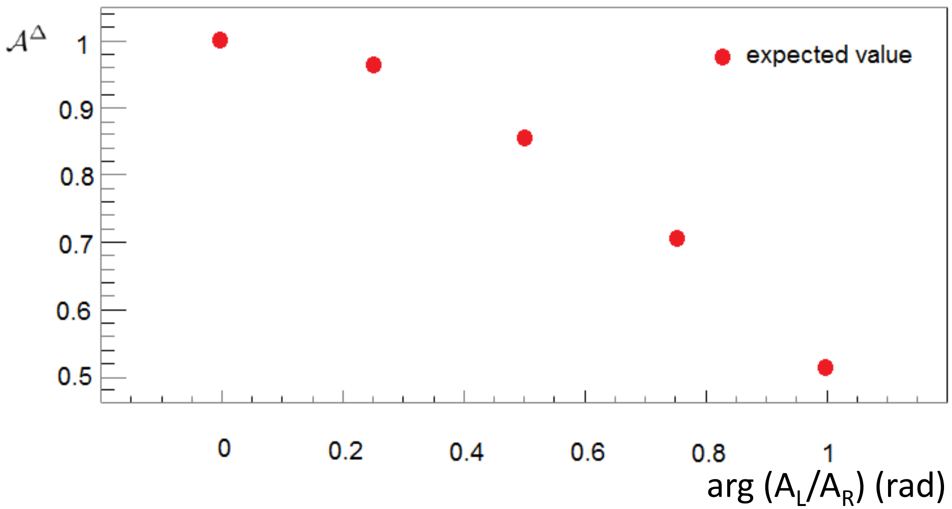


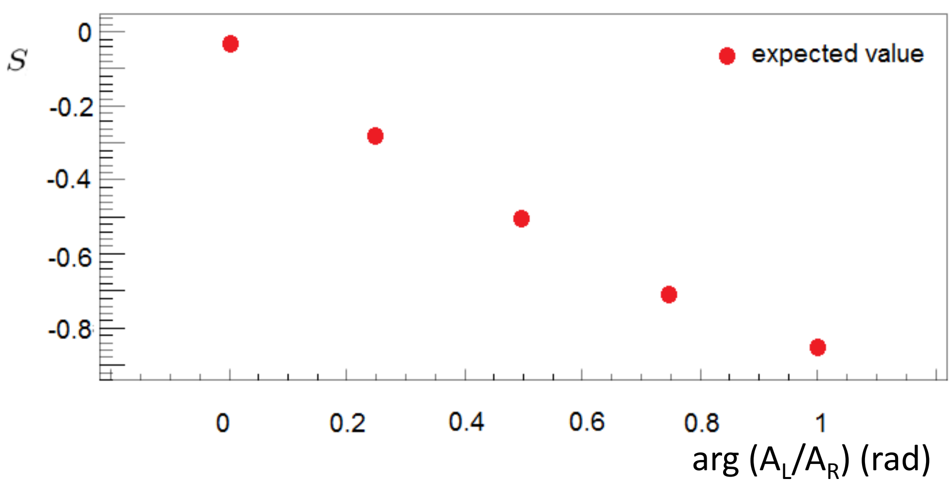


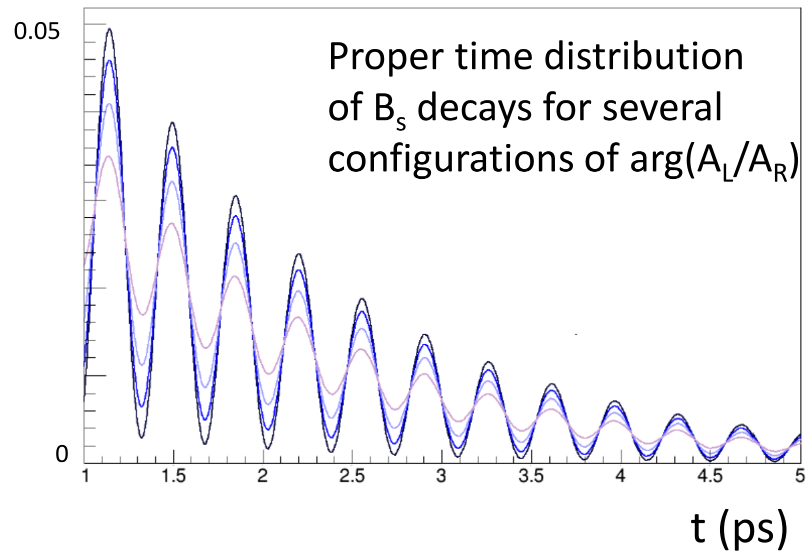
Master thesis Clara Remón (IFIC, Valencia)

$B_s \rightarrow \phi\gamma$

- Dependence of $\mathcal{A}^{\Delta}$ and S parameters with the relative phase of anomalous polarized photons (assuming 50% of A_L)





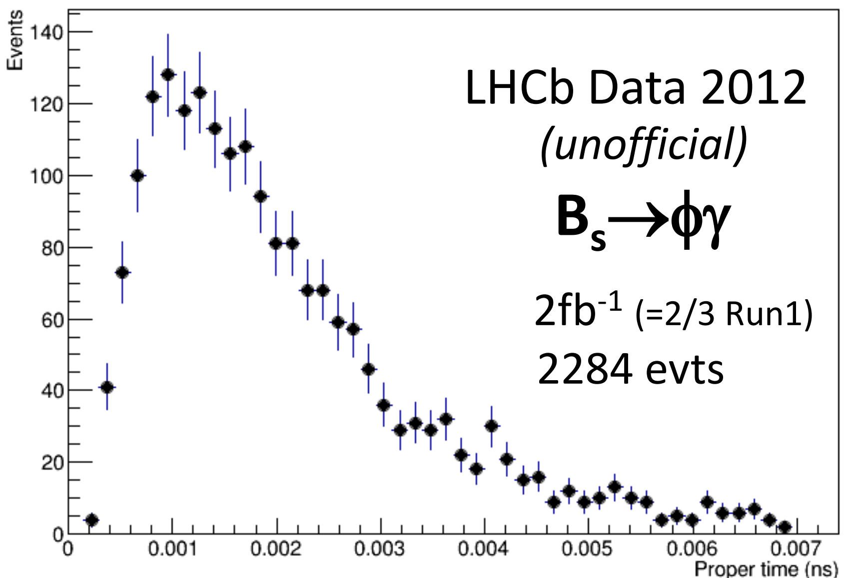


$B_s \to \phi\gamma$

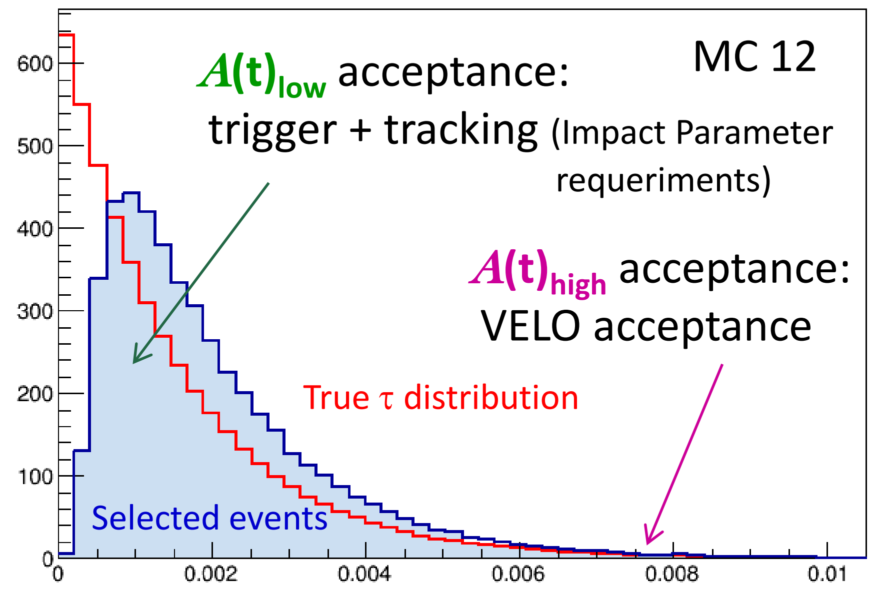
→ Untagged measurement of the time dependent decay rate:

$$\Gamma_{Bs}(t_r) \text{ measured} = \mathcal{A}(t) \cdot \Gamma_{Bs}(t;\, A^{\Delta}) \otimes R(t,t_r)$$

Untagged proper time distribution:



τ(ns)



τ_{true} (ns)

One of the main issues in this analysis concerns the determination of the acceptance:

$$\mathcal{A}(t) = \frac{at^n}{1+at^n} \times (1+\beta t)$$

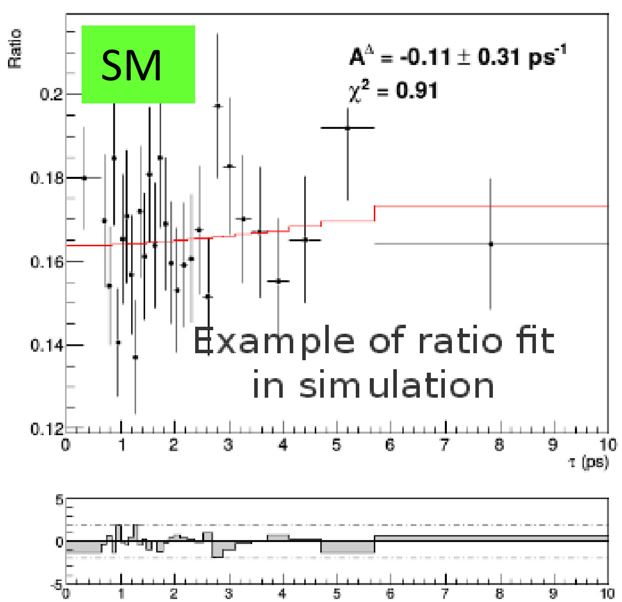
A. Oyanguren

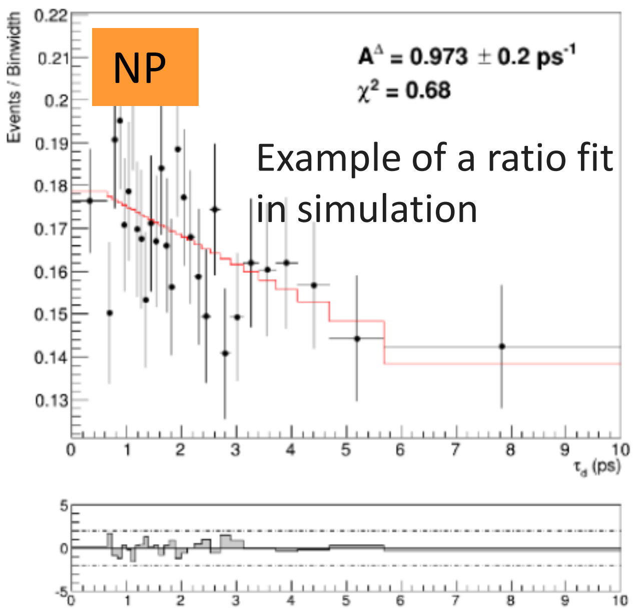
$B_s \to \phi\gamma$

$\rightarrow$ One can use the $B \rightarrow K^*\gamma$ data to constrain the acceptance

$\rightarrow$ One can extract A^{Δ} from a fit to the ratio of B_s/B_d decay widths (or from a direct fit):

The ratio gives the $(\cosh(\Delta\Gamma_s t/2) + A^{\Delta} \sinh(\Delta\Gamma_s t/2))$ piece $\rightarrow$





$\rightarrow$ One needs to include uncertainties coming from the background subtraction, the statistics of the control sample, fitting procedure and acceptance assumptions

$B_s \to \phi\gamma$

→ Flavour tagging for B_s drastically reduces our data:

$\sigma(pp \to B_s + X) = 10.5 \pm 1.3\ \mu b$ [JHEP08(2013)11]

$\mathcal{B}(B_s \to \phi\gamma) = (3.5 \pm 0.4) \times 10^{-5}$

$\varepsilon_{reconstruccion}\ (B_s \to \phi\gamma) \sim 1\%$

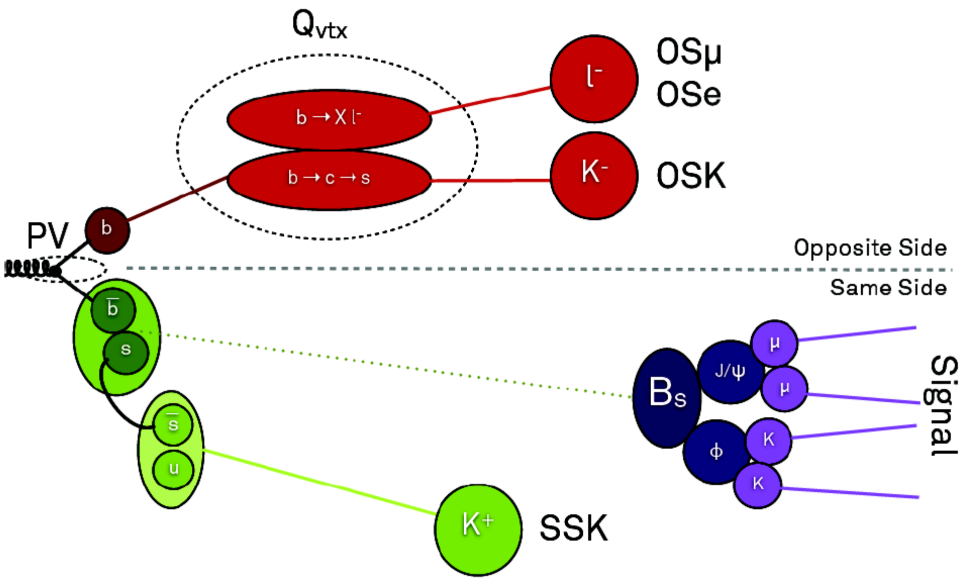
Tagging algorithms:

Same side (SS):

From fragmentation of the signal *b* (π for B, K for B_s)

Opposite side (OS):

From the opposite B:
- e, μ from semileptonic B decays,
- kaons from $b \to c \to s$,
- inclusive reconstruction of the opposite B vertex



[Eur. Phys. J. C 72(2012) 2022
LHCb-CONF-2012-026
LHCb-CONF-2012-033J
HEP11 (2014) 060]

+ ongoing improvements for Run2

→ **$N_{evts} \times \varepsilon_{tag}(1-2\omega)^2$** We found for $B_s \to \phi\gamma$:

Tagging efficiency, $\varepsilon_{tag} \sim 75\%$

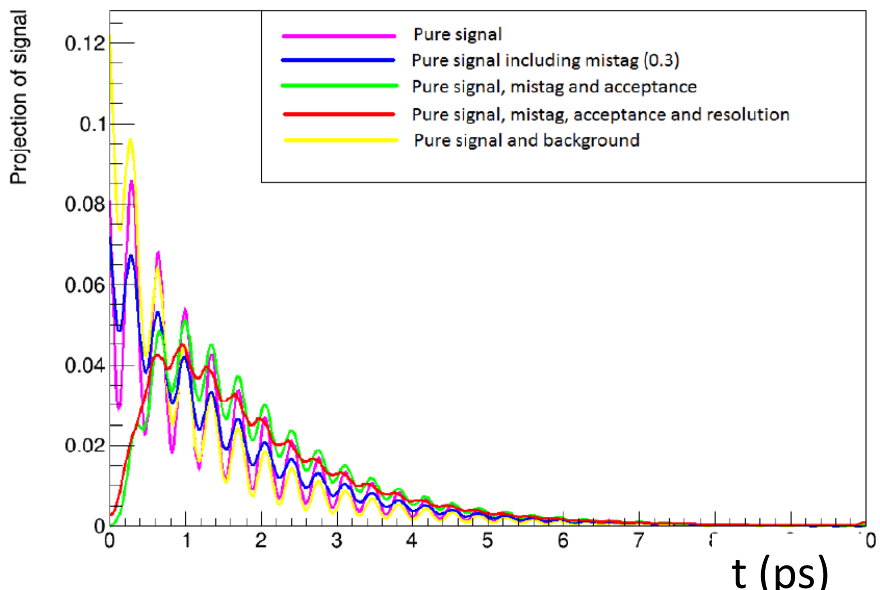
Mistag probability, $\omega \sim 36\%$

Effective efficiency: $\varepsilon_{eff} \sim$ **5.44%**

$B_s \to \phi\gamma$

→Tagged measurement of the time dependent decay rate: **expected ~ 1000** events for Run1+Run2

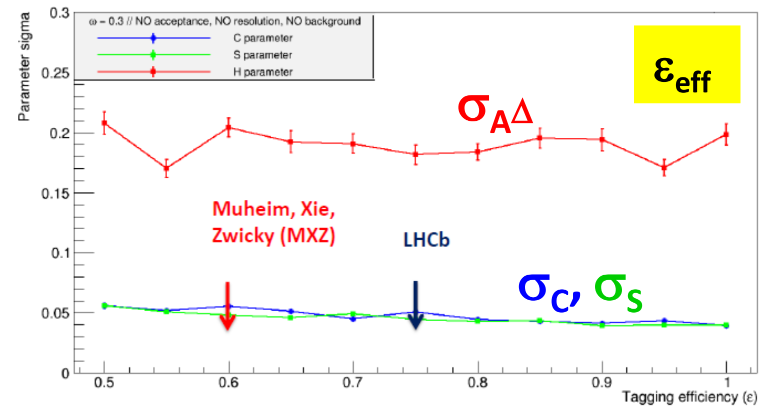
Simulation studies similar to **[Muheim, Xie, Zwicky PL B664(2008)174]**, including LHCb detector effects.

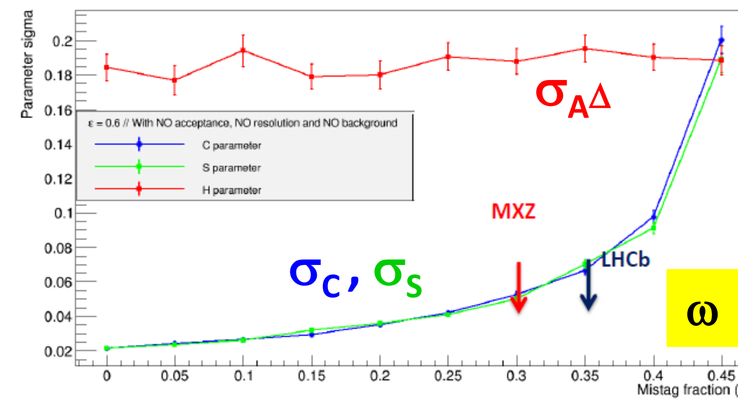


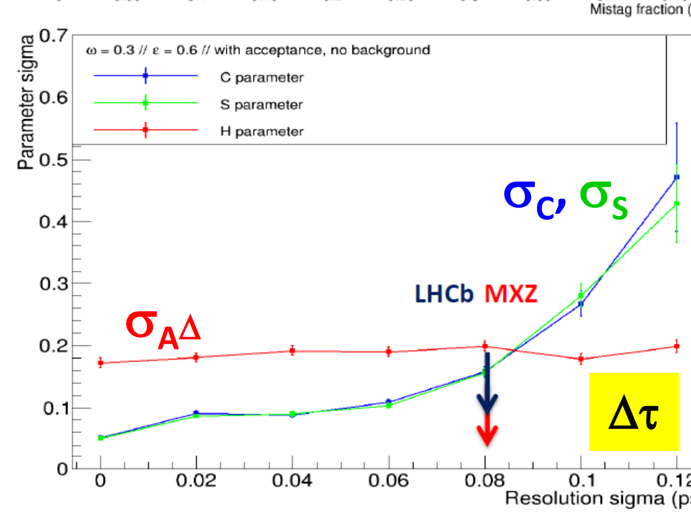
Including all the experimental effects:
(ω = 0.365 , ε_{tag} = 0.744)

σ_C ~0.17	σ_S ~0.17	$\sigma_{A\Delta}$ ~ 0.13

Master thesis Mikel Larrañaga (U. Barcelona)







Measuring the photon polarization with:

$$\Lambda_b \rightarrow \Lambda\gamma$$

$\Lambda_b \rightarrow \Lambda\gamma$

- Exploiting the angular correlations between the polarized initial state and the final state:

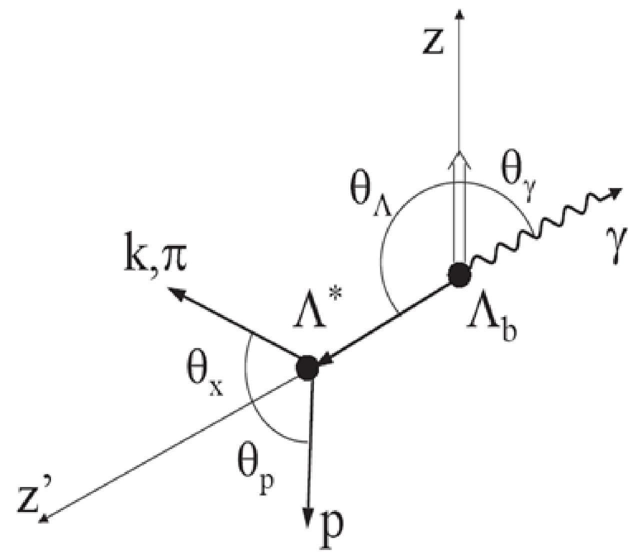
[Mannel, Recksiegel, J.Phys. G24 (1998) 979-990;
Hiller, Kagan, PRD 65, 074038 (2002)]

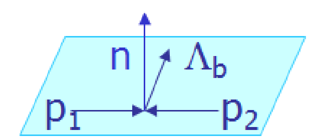
For Λ_b decaying into Λ^0(1115) with J=1/2:

$$\frac{d\Gamma}{d\cos\theta_\gamma} \propto 1 - \alpha_\gamma P_{\Lambda_b} \cos\theta_\gamma$$

$$\frac{d\Gamma}{d\cos\theta_p} \propto 1 - \alpha_\gamma \alpha_{p,1/2} \cos\theta_p$$

$$\alpha_\gamma = \frac{P(\gamma_L) - P(\gamma_R)}{P(\gamma_L) + P(\gamma_R)}$$





$P_{\Lambda b}$ is the Λ_b polarization

$\alpha_{p,1/2}$ is the weak decay parameter

α_γ is the photon polarization

$\rightarrow$ The Λ_b transverse production polarization has been found to be small:

$P_{\Lambda b} = 0.06 \pm 0.07 \pm 0.02$ [PLB724 (2013)27] $\rightarrow$ No sensitivity in $\cos\theta_\gamma$

$\rightarrow$ $\alpha_{p1/2} = 0.642 \pm 0.013$ [PDG2014] $\rightarrow$ **access to α_γ via the angular distribution of the proton**

$\Lambda_b \rightarrow \Lambda\gamma$

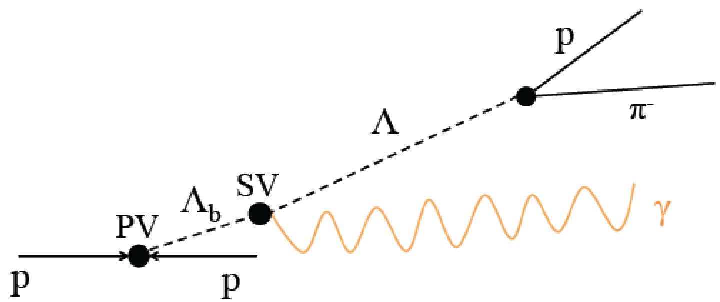
$\rightarrow$ Branching fractions for $\Lambda_b \rightarrow \Lambda^0$ (1115) γ expected to be ~ 10^{-5}

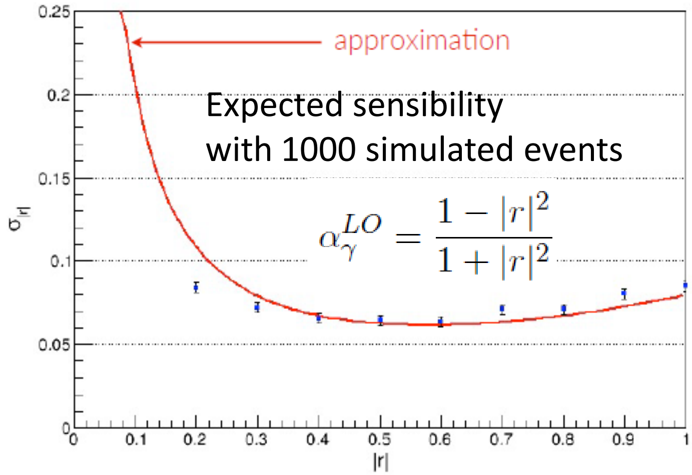
$\rightarrow$ $\sigma(pp \rightarrow b\bar{b}X)$ = 310.5 $\pm$ 57.9 μb^{-1}

and the production fraction: $f_{\Lambda b}$ = 17.1 $\pm$ 4.0%

$\sigma(\Lambda^0 \rightarrow p\pi)$ = 63.9 $\pm$5%

$\rightarrow$ **Experimental challenge:** the Λ_b decay vertex cannot be reconstructed due to the long lifetime of the Λ^0 baryon ($c\tau$ = 7.89 cm)





At present defining the selection and reconstruction procedures $\rightarrow$ An improved HLT for Run2 has been prepared

Conclusion

- The **photon polarization** is being measured **at LHCb** using several channels and different observables
- Important to constrain $\mathbf{C_7^{(\prime)}}$ in NP scenarios, it is usually set to zero in global fits
- Difficult analyses due to the γ/e reconstruction in pp collisions, but we did it $\rightarrow$ **NP constraints more precise than the ones from B-factories!**
- Working hard in **new and improved measurements**
- **Run 2** data still to come…
- **New ideas and methods,** profitable at LHCb, are quite welcome

Stay tuned, the best is yet to come… !

Thank you!