B hadron lifetimes in CMS data

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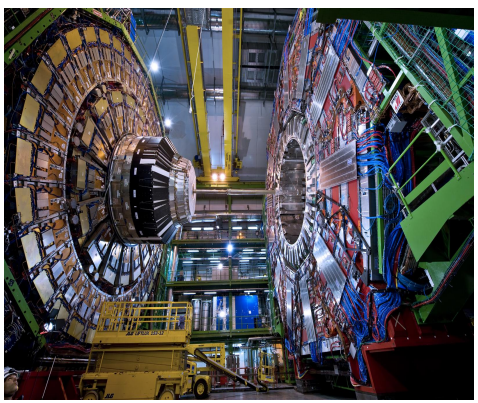
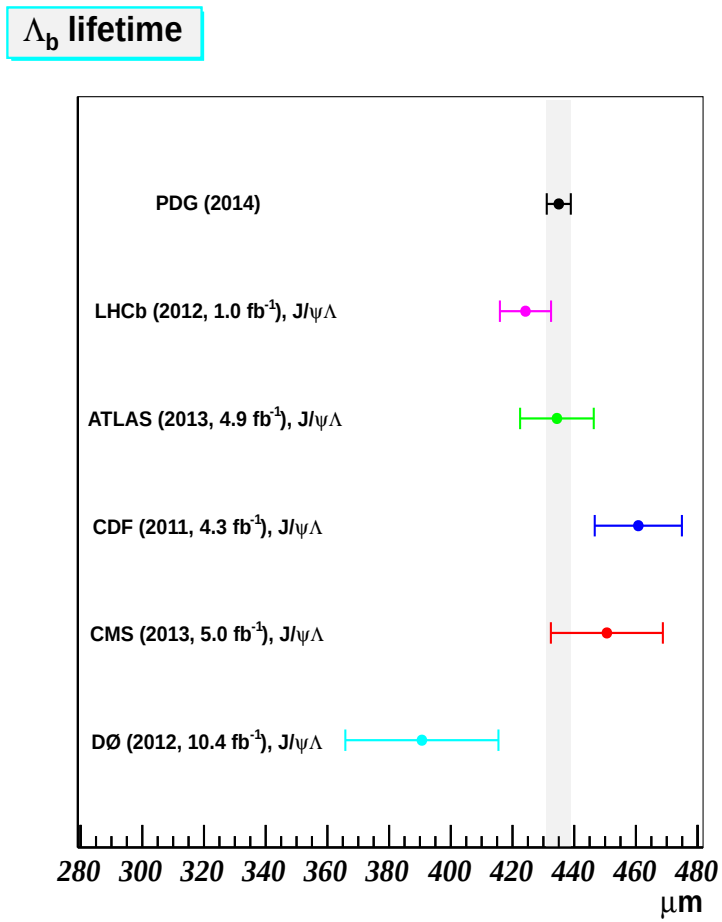


Introduction

- All work presented here is in progress
- We make the lifetime measurement of differents hadrons: $B_s \to J/\Psi f_0$, $B_d \to J/\Psi K^*$, $B_d \to J/\Psi K_s^0$, $B_u^+ \to J/\Psi K^+$, $\Lambda_b \to J/\Psi \Lambda_0$ and $\Xi_b \to J/\Psi \Xi^-$
- We can make contributions in different topics of particle physics like heavy quark expansion (HQE) and cp violation.
- We will show CMS is competitive in several of the lifetime measurements.

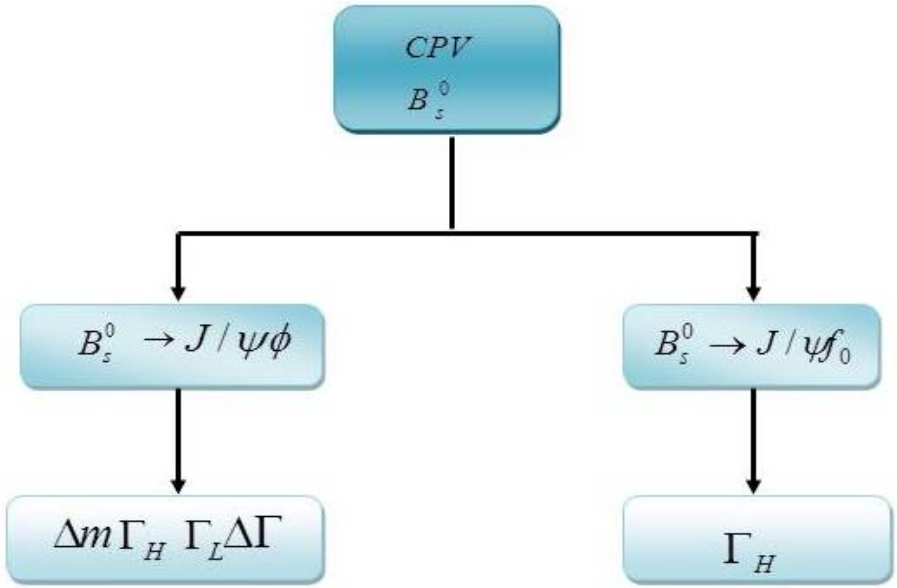
$\Lambda_b \to J/\Psi\Lambda_0$ puzzle

$$\tau(B^+) \geq \tau(B_d^0) \simeq \tau(B_s^0) > \tau(\Lambda_b^0) \gg \tau(B_C^-)$$



The issue of the Λ_b lifetime is not yet solved.

Why the lifetime in $B_s^0 \to J/\psi f_0(980)$?



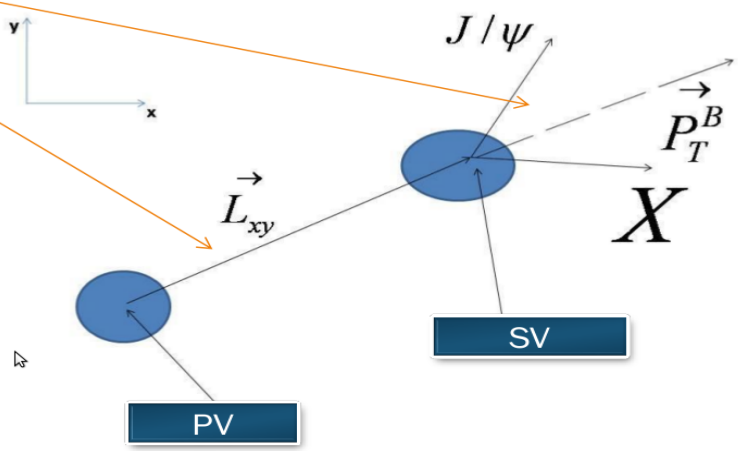
$$\triangle\Gamma = \Gamma_s^L - \Gamma_s^H = 2|\Gamma_{12}^s|cos\phi_s$$

$$\phi = \phi_s + \phi_?$$

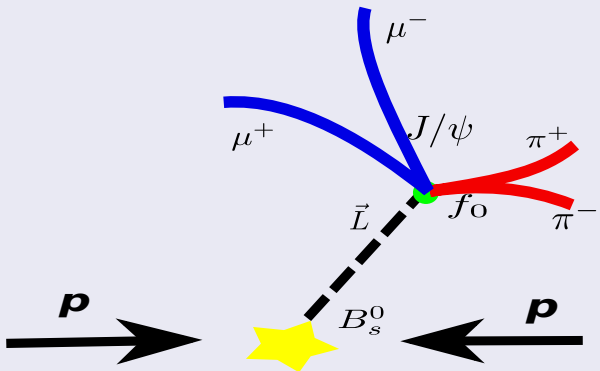
Main difficulties with lifetime

Lifetime bias due to triggers (displaced vertex triggers)

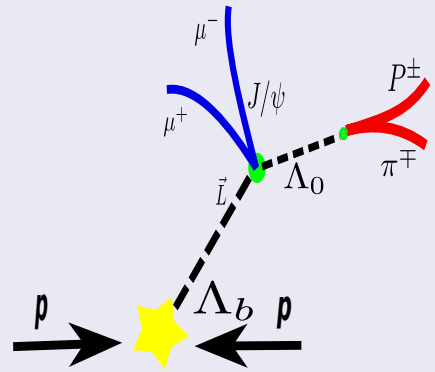
- cos(α)>0.9
- Lxy/σxy > 3



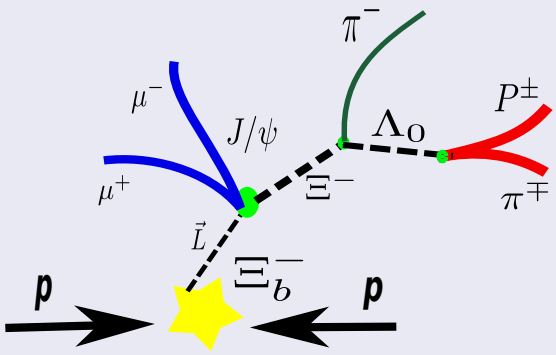
$B_s^0 \to J/\psi f_0(980)$



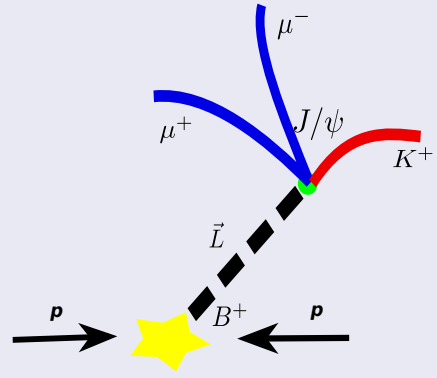
$\Lambda_b \to J/\psi \Lambda_0$



$\Xi_b \to J/\psi \Xi^-$

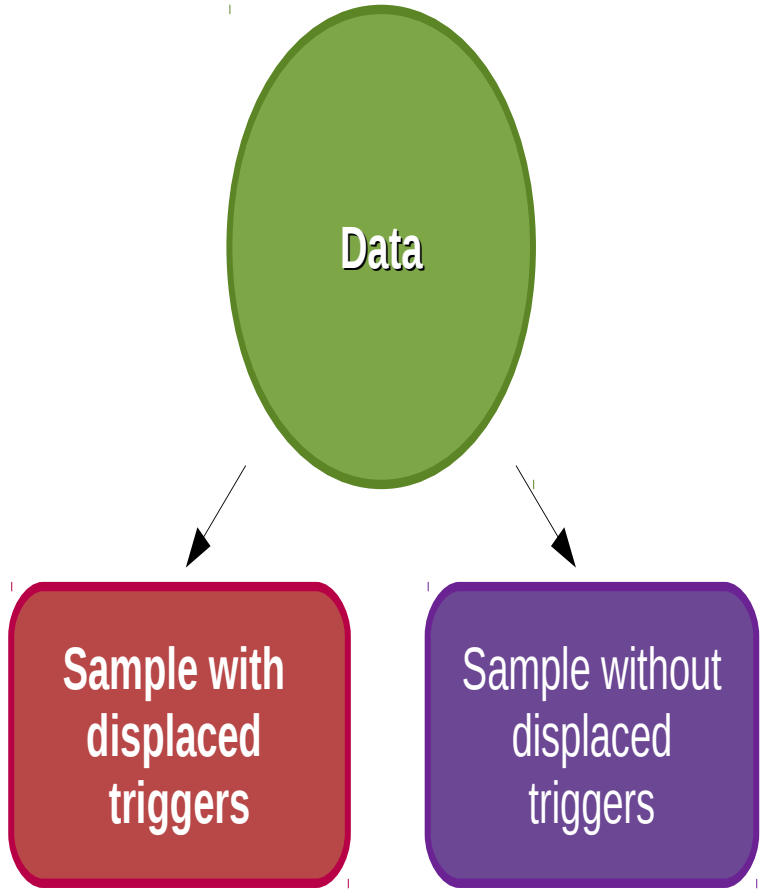


$B_u^+ \to J/\psi K^+$

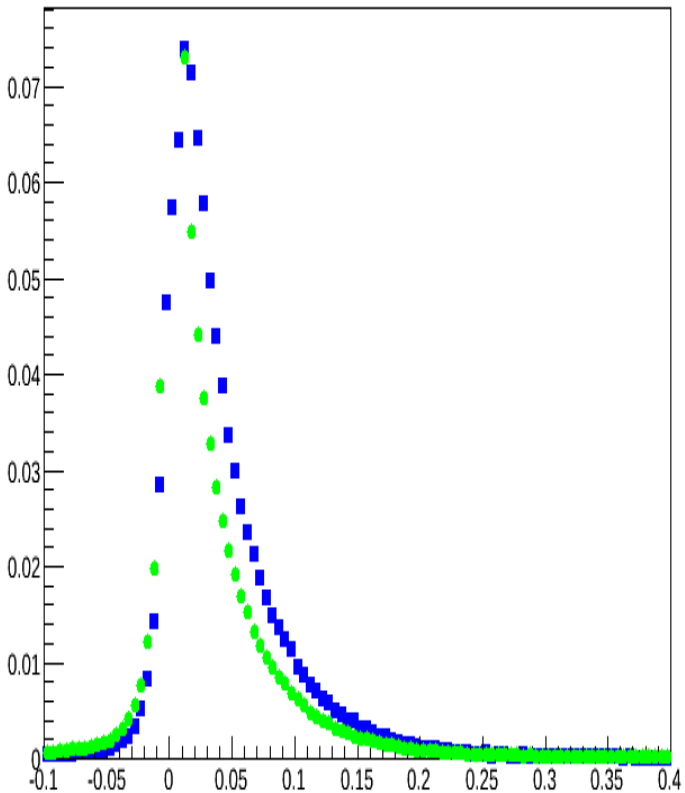


Estimate of lifetime correction

- We searched full simulated MC for $B_d \rightarrow J/\Psi + K^*$ decays and divided them in two samples: with displaced vertex trigger and without displace vertex trigger



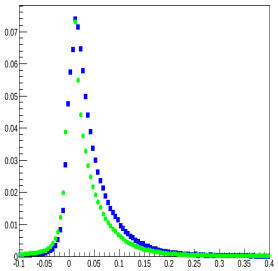
Displaced vertex triggers effects



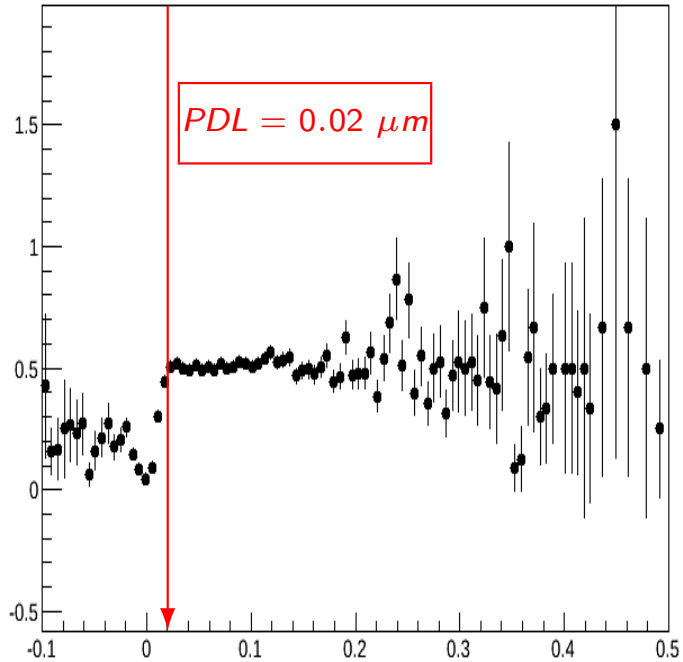
- Effects due to triggers with displaced vertex affects more negative and low proper decay length of the B hadron.
- Green no displaced vertex sample and Blue displaced vertex sample

$$\lambda = M_B \frac{L_{XY} \cdot P_T}{P_T \cdot P_T}$$

Triggers correction



Ratio of displaced vertex to no displaced vertex samples distributions.



Efficiency

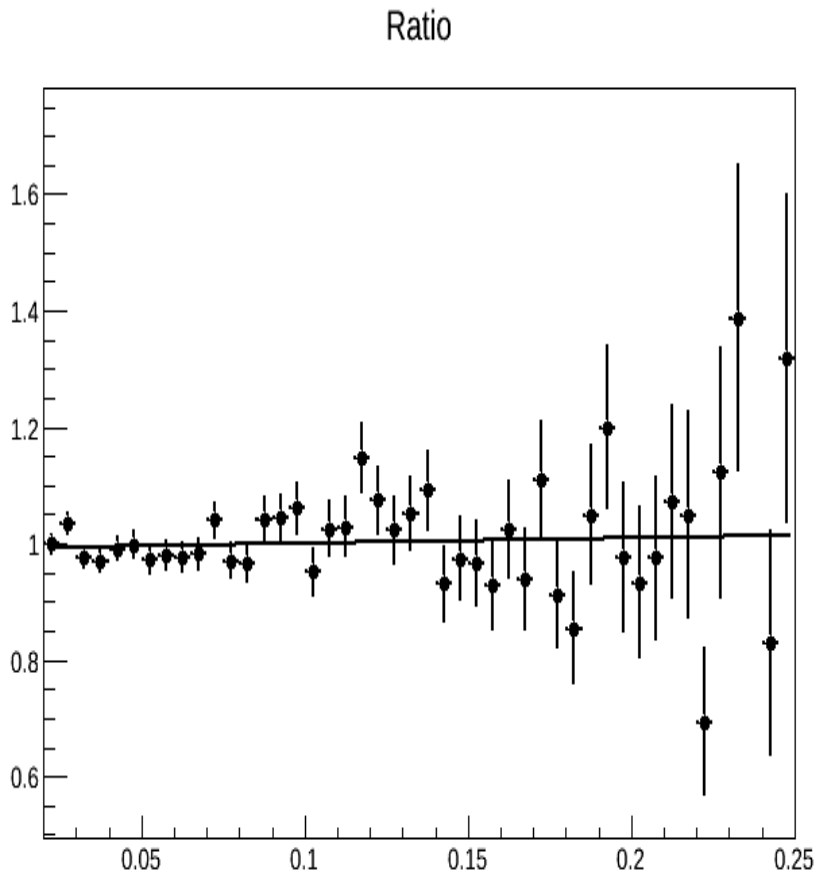
Due to high variations, we selected values greater than 0.02 cm.

$$T = a + b * \lambda$$

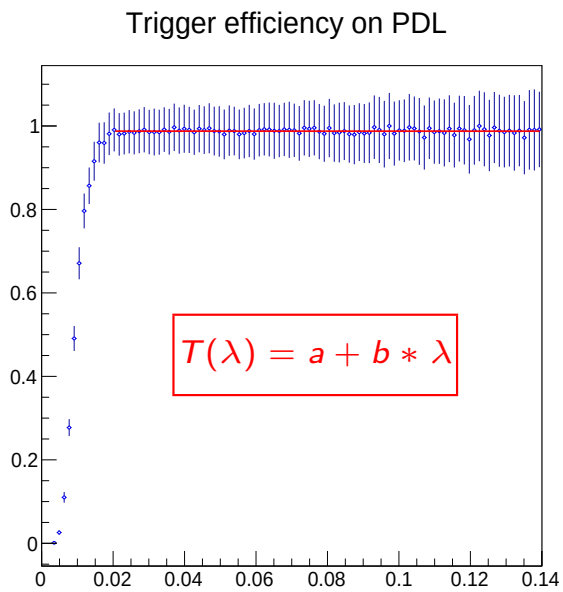
$a = 0.991559 \pm 0.01108$

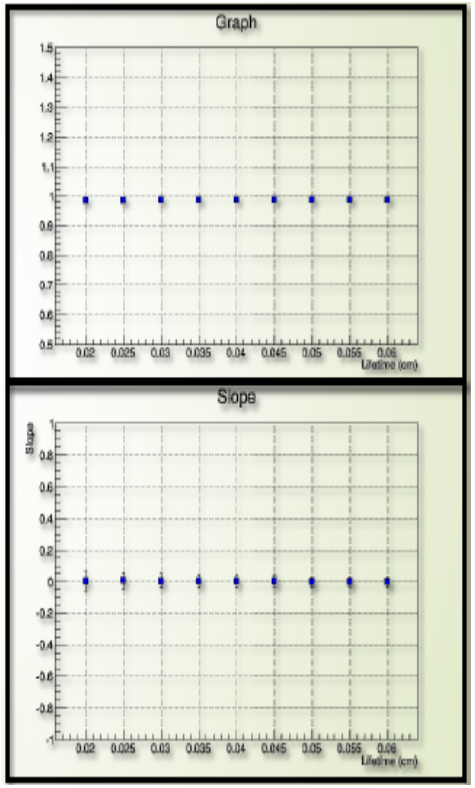
$b = 0.0917707 \pm 0.147202$

$chi2 = 1.20528$



How the flatness depends on the lifetime?





Flatness for $PDL > 200\ \mu m$ does not depends on the lifetime of the B hadron.

Probability Density Functions (Models)

$$PDF = f_s * S_M * S_\lambda * S_\sigma * +(1 - f_s) * B_M * B_\lambda * B_\sigma$$

- f_s: sfraction of signal events
- S_M: Mass signal pdf
- S_λ : Signal proper decay length pdf (One exponential decay convoluted with Gaussian Resolution with event per event error)
- S_σ: Pdf for signal in PDL error distribution (Gaussian convoluted with exponentials)
- B_M :Background mass pdf (1 order polynomial)
- B_λ: Pdf for background in PDL (Several exponential decays convoluted with Gaussian Resolution with event per event error)
- B_σ:Pdf for background in PDL error distribution (Gaussian convoluted with exponentials)

Results $\Lambda_b \to J/\Psi\Lambda_0$, simultaneous fit

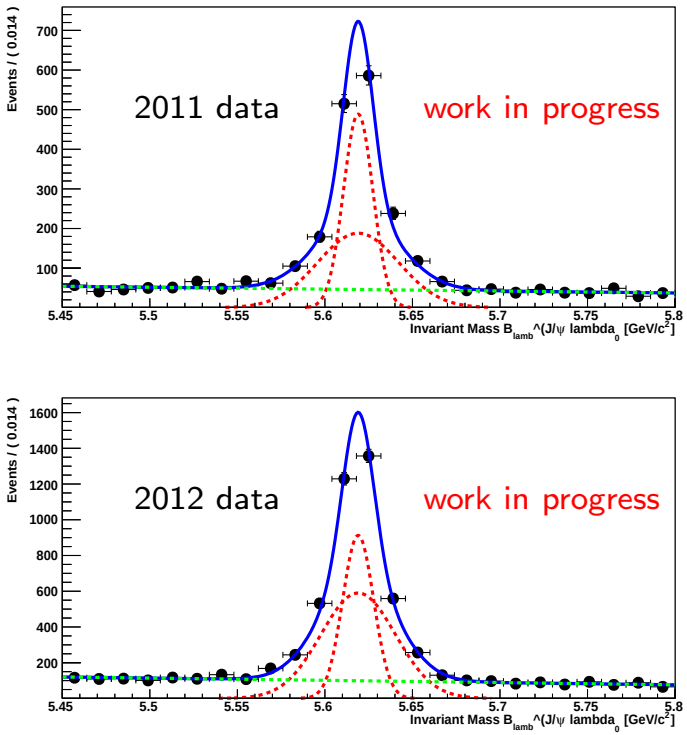


Figure: mass Simultaneous fit

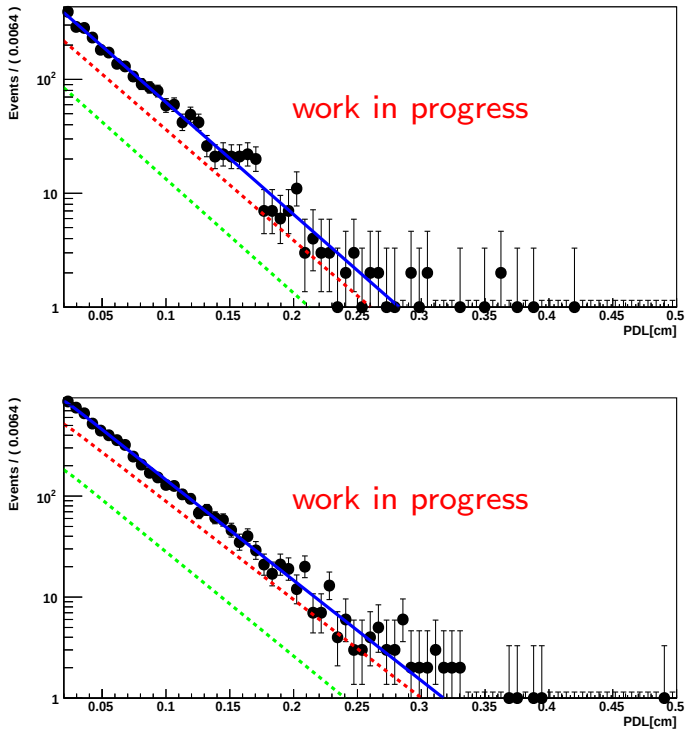


Figure: lifetime Simultaneous fit

Results $B_s \to J/\Psi f_0$, simultaneous fit

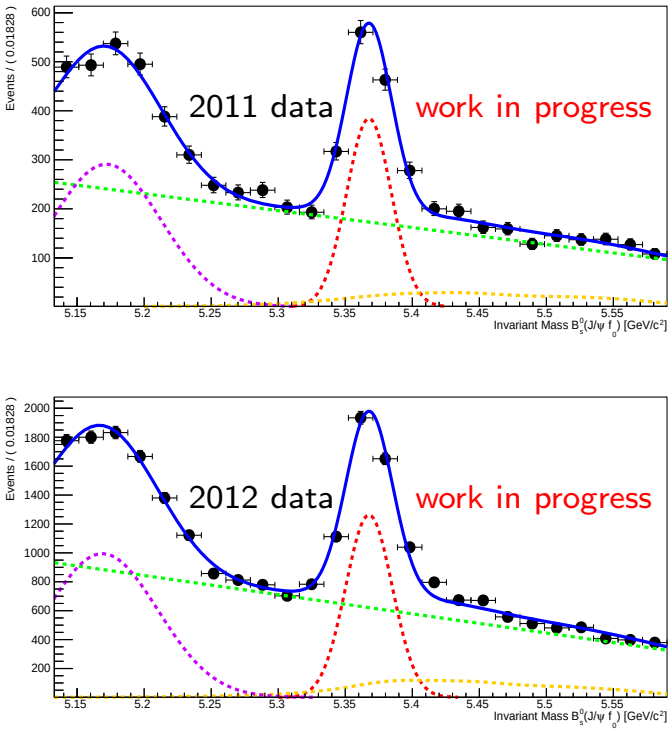


Figure: mass Simultaneous fit

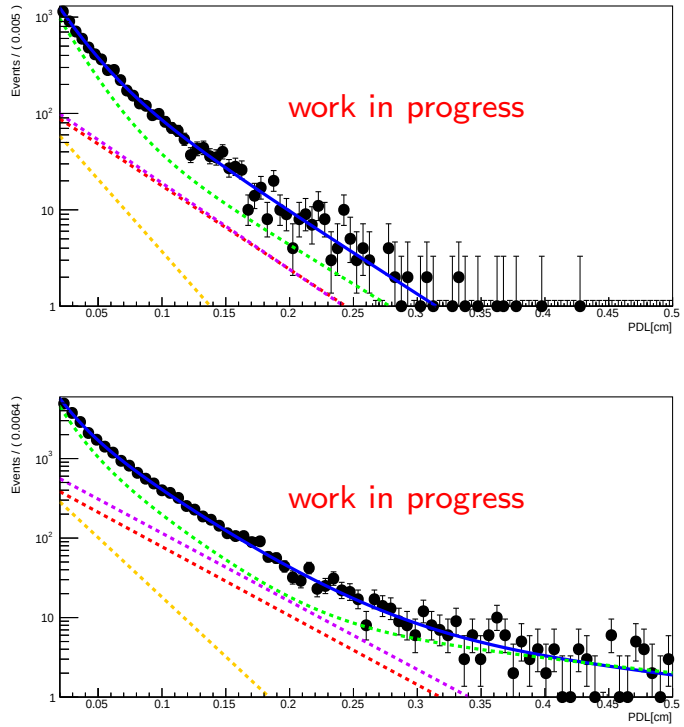


Figure: lifetime Simultaneous fit

Summary

Decay channel	CMS (μm)	LHCb (μm)	PDG (μm)
$B_s \to J/\Psi f_0$	501.0 ± 11.0	510.0 ± 12.0	509.0 ± 12.0
$\Lambda_b \to J/\Psi \Lambda_0$	446.4 ± 6.9	424.2 ± 8.1	434.9 ± 3.8
$\Xi_b \to J/\psi \Xi^-$	457.0 ± 44.0	464.5 ± 30.0	467.6 ± 81.0
$B_u^+ \to J/\Psi K^+$	491.1 ± 0.8	490.8 ± 1.2	491.1 ± 1.2
$B_d \to J/\Psi K^*$	452.6 ± 1.8	456.9 ± 1.8	455.4 ± 1.5
$B_d \to J/\Psi K_s^0$	452.8 ± 2.7	449.4 ± 3.9	455.4 ± 1.5

Decay channel	Particle (μm)	Antiparticle (μm)	Ratio (μm)	LHCb (μm)
$\Lambda_b \to J/\Psi \Lambda_0$	452.8 ± 9.7	439.6 ± 9.8	1.030 ± 0.032	0.940 ± 0.035
$B_u^+ \to J/\Psi K^+$	491.1 ± 1.2	491.0 ± 1.2	1.001 ± 0.006	1.002 ± 0.004
$B_d \to J/\Psi K^*$	449.7 ± 2.6	455.8 ± 2.6	0.987 ± 0.008	1.000 ± 0.008

Work in progress

!GRACIAS!