Keeping decay times under control:

decay time resolution for CP-violation in $B_s^0 \to J/\psi\phi(1020)$

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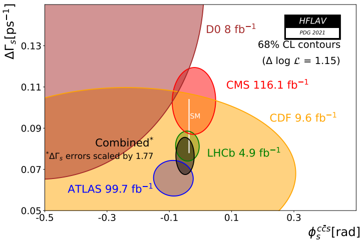
Moriond EW 17.03.2022

With our colleagues in Ukraine

Golden decay: $B_s^0 \to J/\psi_{\to\mu^+\mu^-}\phi(1020)_{\to K^+K^-}$

$$\phi_s = \phi_s^{SM,tree} + \phi_s^{SM,penguin} + \Delta\phi_s^{NP}$$



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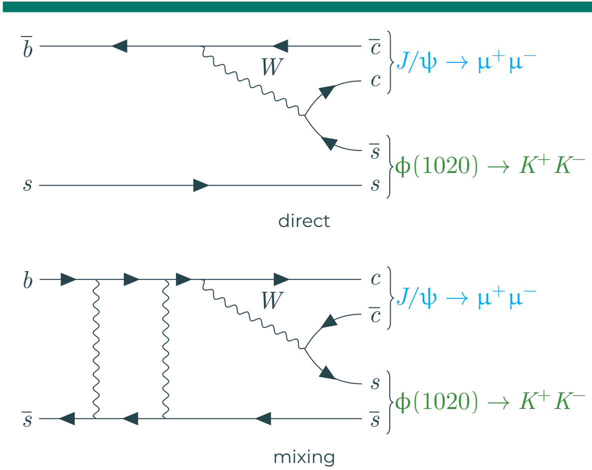
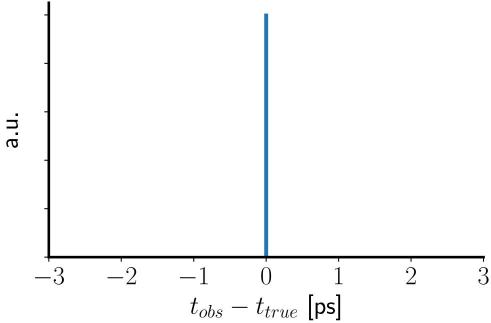


$$\frac{d^4\Gamma(B_s^0 \to J/\psi\phi)}{dt d\Omega} = \frac{1}{N}\sum_{k=1}^{10} f_k(\Omega)\varepsilon(t)(FT(B_s^0)\cdot h_k(t|B_s^0) + FT(\overline{B}_s^0)\cdot h_k(t|\overline{B}_s^0)) \otimes G(t|\sigma_t)$$

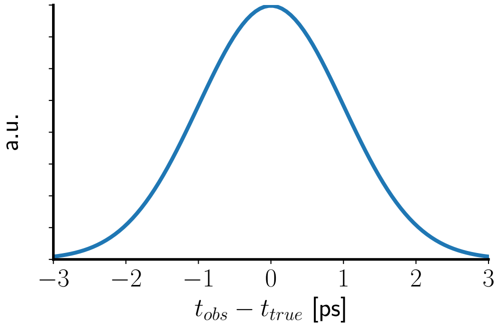
Finite decay time resolution influence on decay time distribution

1. Promptly decaying sample ($t_{true} = 0$)

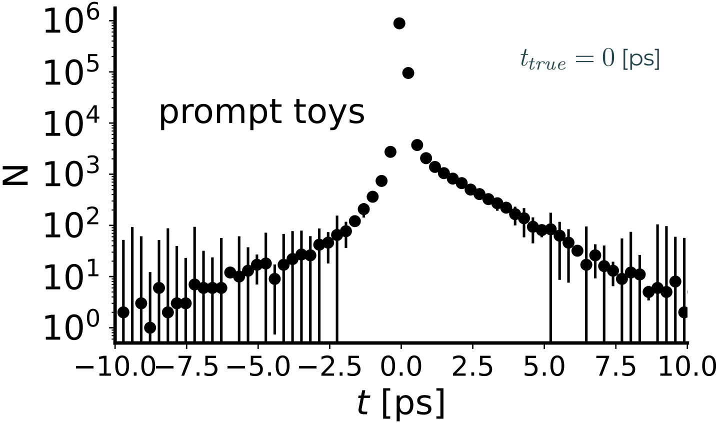


Finite decay time resolution influence on decay time distribution

1. Promptly decaying sample ($t_{true} = 0$)
2. Measured decay time error $\neq$ true decay time resolution



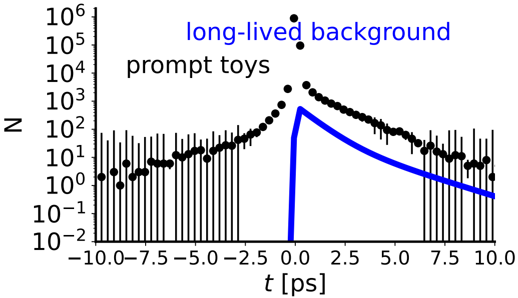
Challenges



N
10^6
10^5
10^4
10^3
10^2
10^1
10^0
prompt toys
$t_{true} = 0$ [ps]
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0
t [ps]

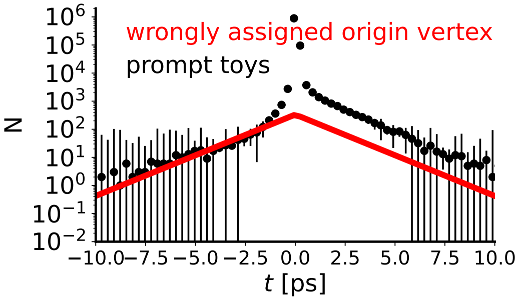
Challenges

1 | Long-lived background



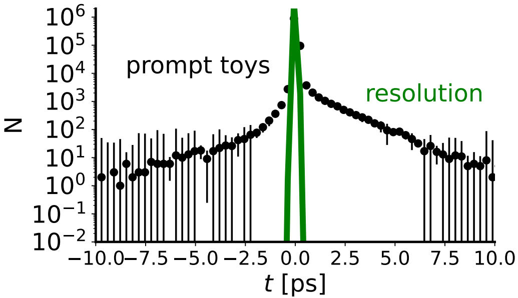
Challenges

1. Long-lived background
2. Wrongly assigned origin vertices



Challenges

1. Long-lived background
2. Wrongly assigned origin vertices
3. One Gaussian is not enough

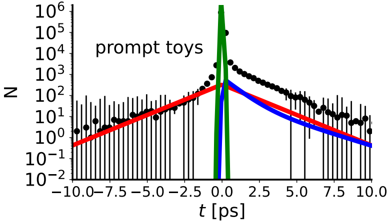


Two ways to reach the goal

Fit approach

+ Theoretically can be very precise

— Uncertainty from the model



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Fit approach

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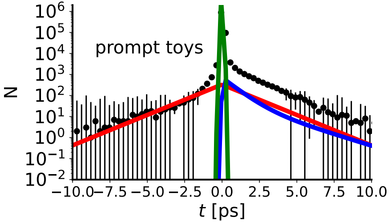
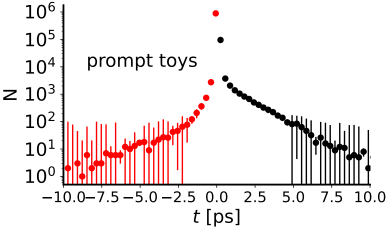


Numerical approach

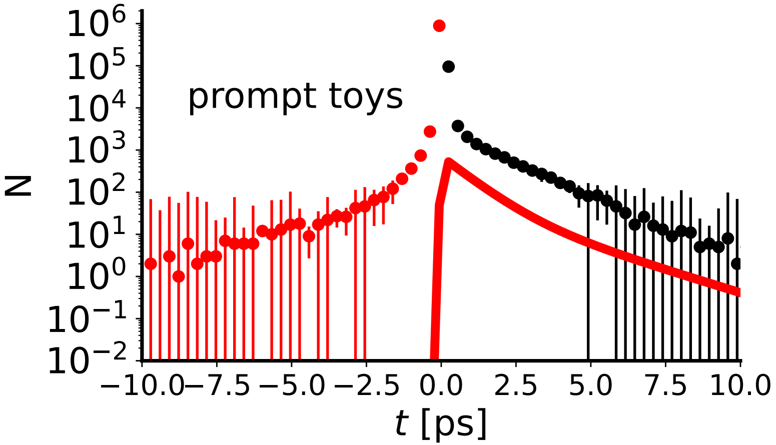
+ No model dependence
— Correction for the long-lived component



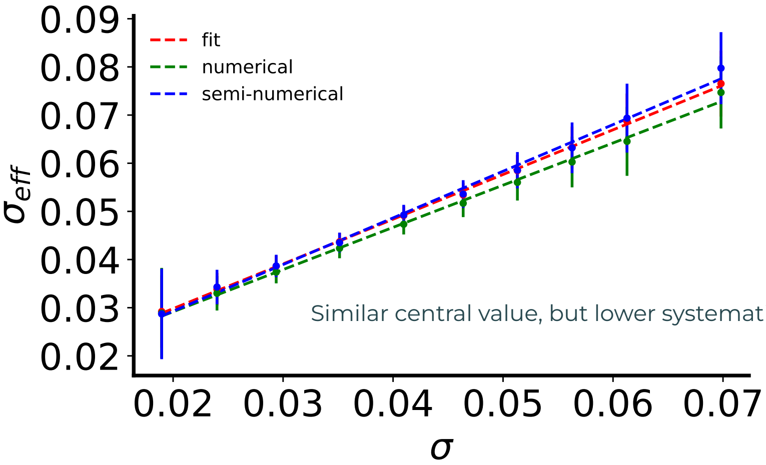
~~Two~~ Three! ways to reach the goal

Semi-numerical approach

+ The best of both worlds
— Small correction from the long-lived component is needed



In conclusion: results



Similar central value, but lower systematics!

Thank you for your attention!