Determination of the B_s Lifetime Using Hadronic Decays

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for the CDF Collaboration

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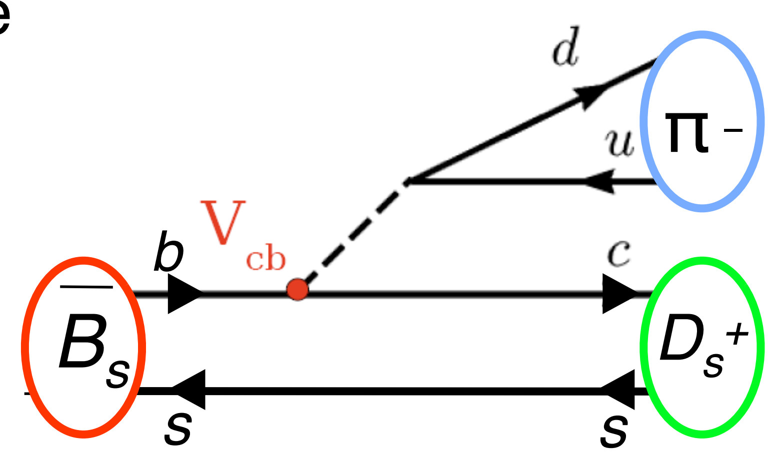
Motivation

Spectator model: *b* mesons and baryons have same lifetime

Pauli interference, weak annihilation, weak exchange induce **lifetime hierarchy**

$\tau(B_c) < \tau(\Lambda_b) < \tau(B_s) \cong \tau(B^0) < \tau(B^+)$



Experimental status:

	$\frac{\tau(B^+)}{\tau(B^0)}$	$\frac{\tau(B_s)}{\tau(B^0)}$	$\frac{\tau(\Lambda_b)}{\tau(B^0)}$
Theory	1.06±0.02	**1.00±0.01**	0.86±0.05
Exp.	1.071±0.009	**0.939±0.021**	0.921±0.036

Tevatron experiments in great position to provide feedback to theorists on $\tau(B_s)$!

$\tau(B_s)$

PDG (2007): 1.437 + 0.031 - 0.030 ps

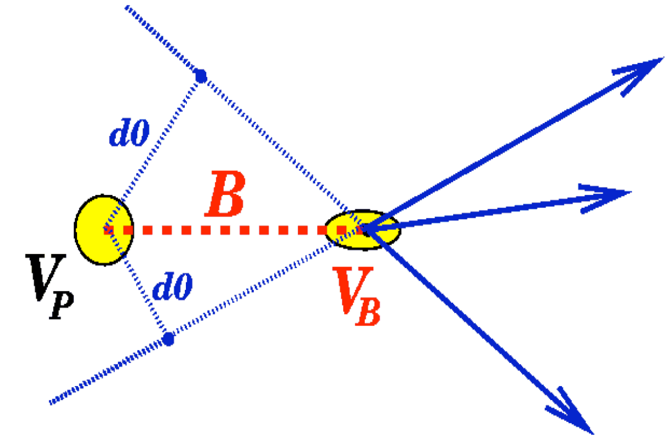
D∅ (2006): 1.398 ± 0.044 + 0.028 - 0.025 ps ← Included in PDG 2007

CDF II $J/\psi\phi$ (1.7 fb^{-1} - **Aug 2007**): 1.52 ± 0.04 ± 0.02 ps ← **New!**

Today: Update of CDF hadronic measurement

CDF II Hadronic (360 pb^{-1}): 1.60 ± **0.10** ± 0.02 ps

Hadronic Trigger Strategy

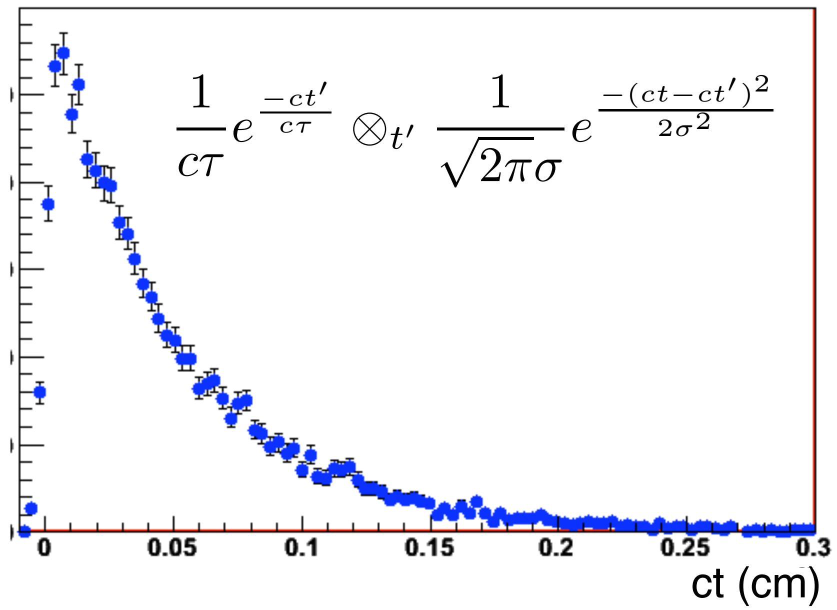


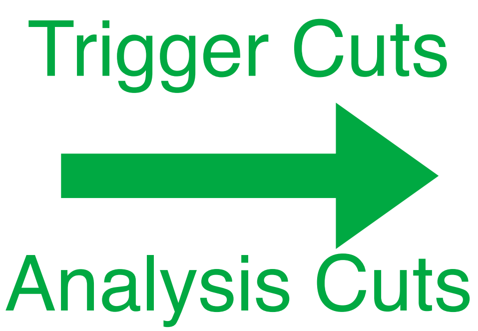
Decay mode of interest: $\boldsymbol{B_s \to D_s^- (\phi\pi^-)\pi^+}$

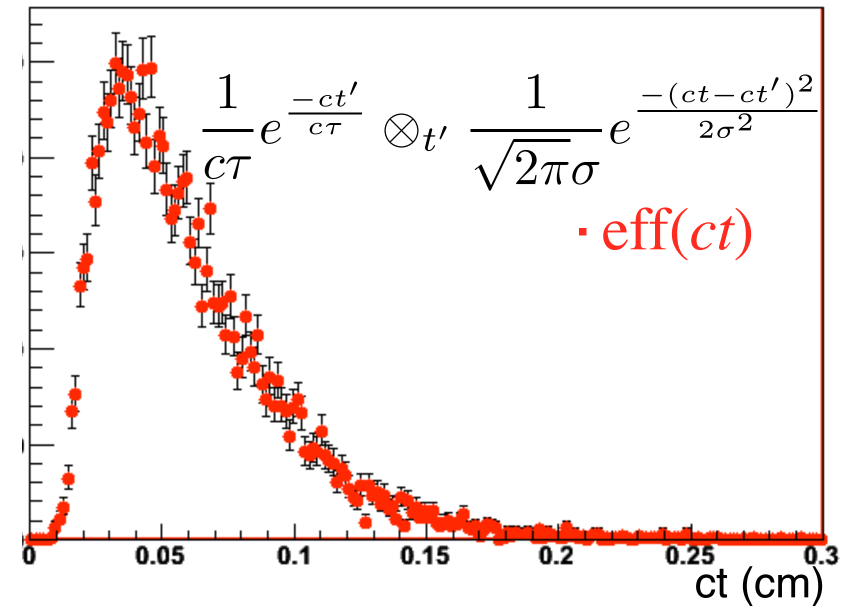
Separating heavy *B* mesons from prompt backgrounds

- ✦Take advantage of long lifetime
- ✦Trigger on displaced vertex (> 200 µm)

Trigger and analysis selections modify the proper time distribution







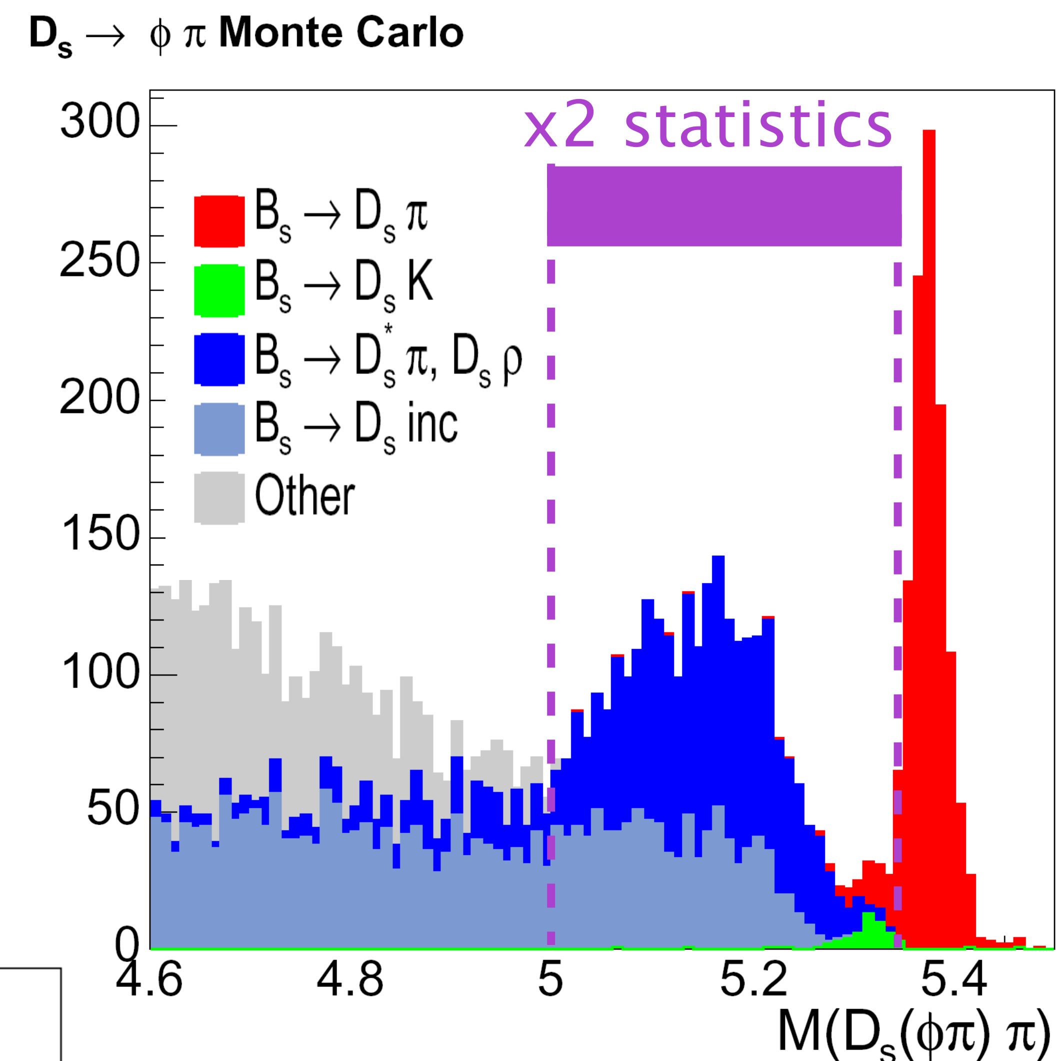
Use Monte Carlo to derive "efficiency curve" parameters → fixed in final fit to data

$$\mathrm{eff}(ct) = \sum_{i=1}^{3} N_i \cdot (ct - \beta_i)^2 \cdot e^{\frac{-ct}{c\tau_i}} \quad \text{if} \quad ct > \beta_i$$

Partially Reconstructed Decays

Goal: Decrease statistical error (increase statistics)

1. Include more luminosity (360 pb^{-1} → 1.3 fb^{-1})
2. Use partially reconstructed decays

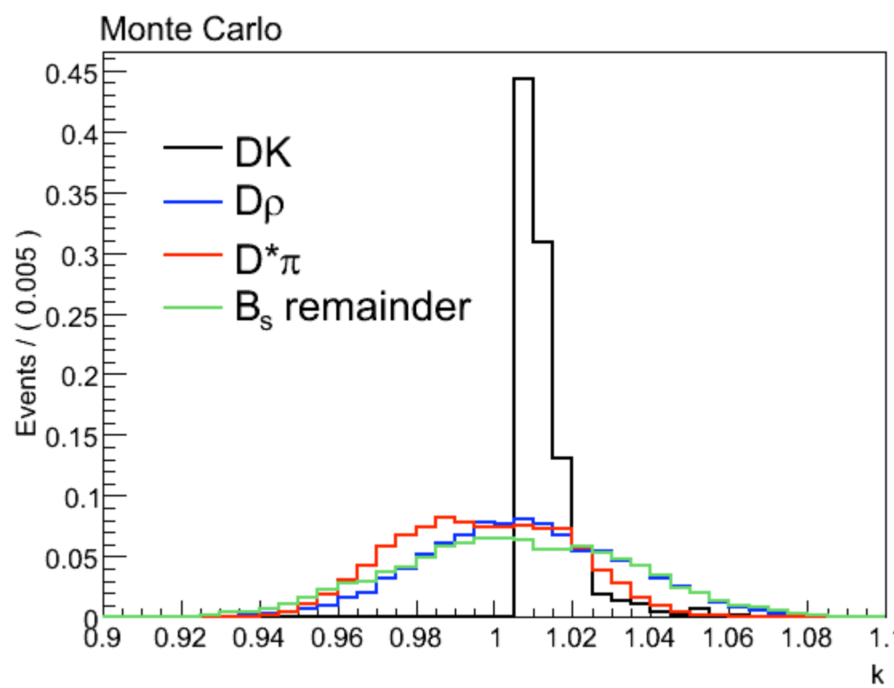


$B_s \to D_s^- (\phi\pi^-)\pi^+$ sample includes partially reconstructed *$B_s \to D_s^- (\phi\pi^-)X$* decays

- ✦ tracks not reconstructed or wrong mass assignment
- ✦ doubles the statistics!

Corrective "K" factor accounts for missing momentum and mass

$$ct = \frac{L_{xy} \cdot m_B^{rec}}{p_T} \cdot \boxed{K}$$



- ✦ Good agreement with world averages
- ✦ Good agreement between FR and PR regions

Procedure tested extensively on B^0 and B^+ control samples

$B_s \to D_s^- (\phi\pi^-)X$ Measurement

Procedure

1. Perform mass fit to determine fractions
2. Fix fractions in lifetime fit. Fit for $c\tau(B_s)$ only

Largest systematic:

✦ background composition (% prompt)

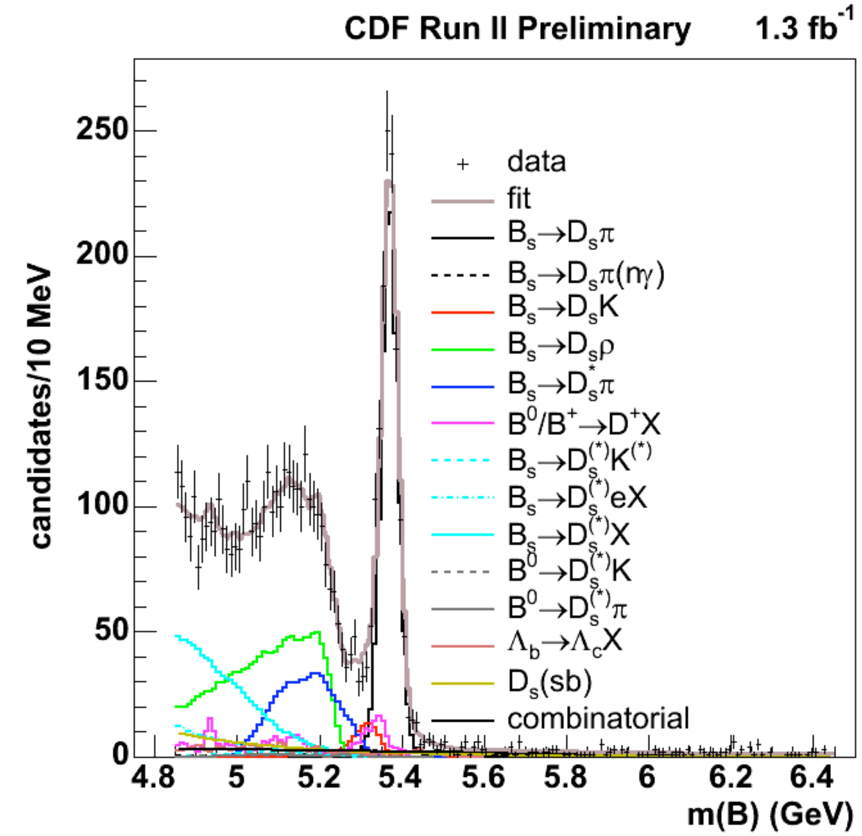
✦ background fraction

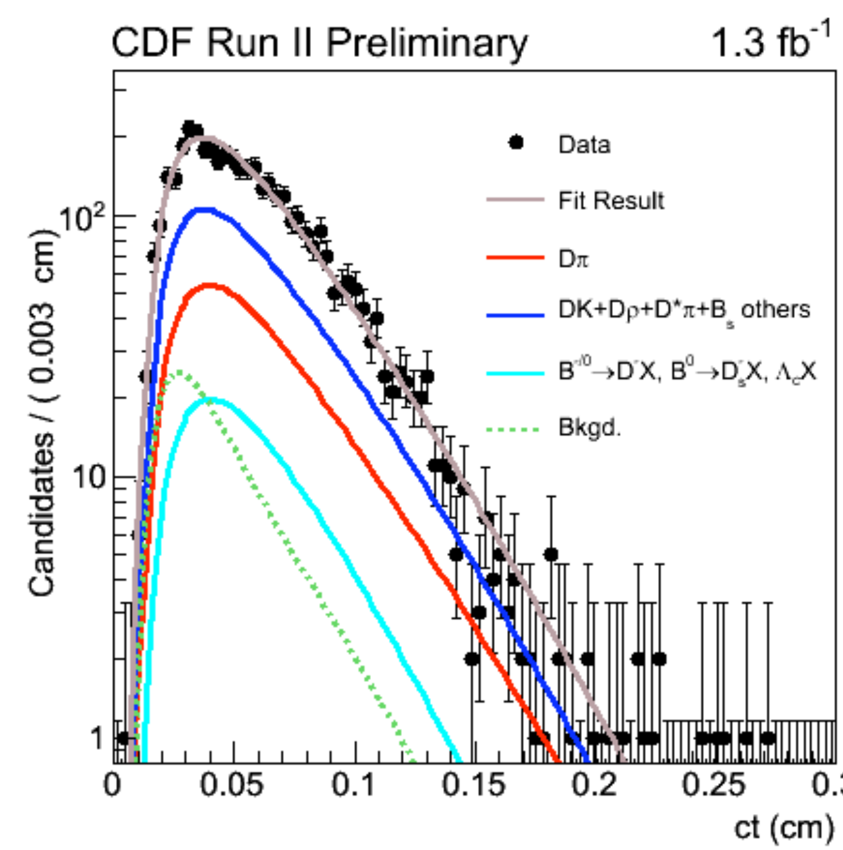
$$\tau(B_s) = 1.518 \pm 0.041 \pm 0.025 \text{ ps}$$

Most precise measurement to date!

Good agreement with recent CDF $J/\psi\phi$ result

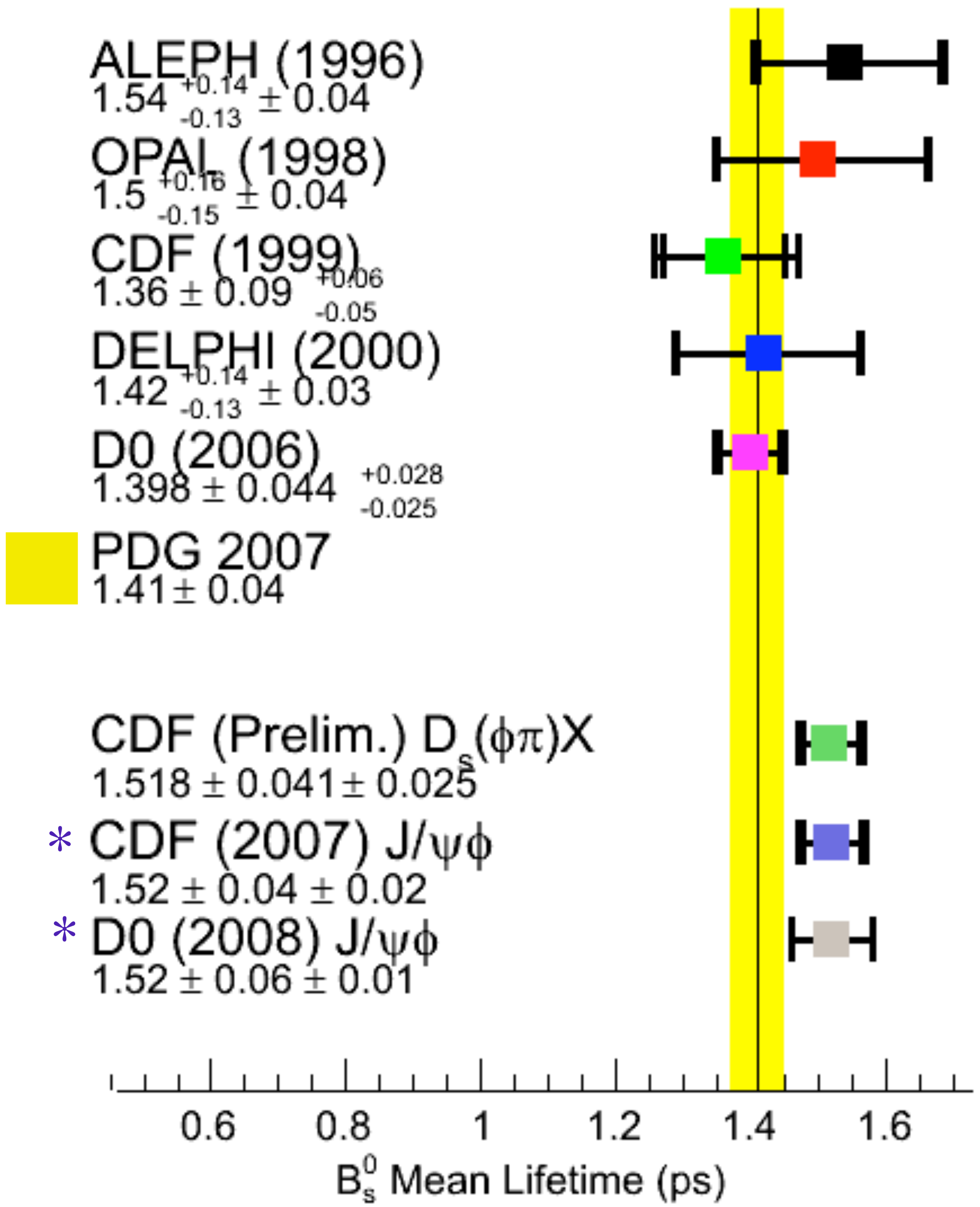
$\tau(B_s)$ $[D_s^-(\phi\pi^-)X]$ **/ $\tau(B^0)$** [PDG] = **0.99 ± 0.03**





Summary

Flavor Specific Measurements



- ✦ Theory of *B* hadron lifetimes well developed. Further experimental input needed for B_s.
- ✦ Trigger on displaced vertices
  - ➡ large B_s sample
  - ➡ can account for effect on proper time distribution
- ✦ Increase statistics using partially reconstructed B_s decays
- ✦ Hadronic lifetime results:
  - Improved exp. uncertainties
  - Good agreement with theory
- ✦ **Three new high precision B_s results!**

* Not actually a flavor specific mode