Production Asymmetry and a_{fs} Fits in B_s->$D_s\mu\nu$ at LHCb.

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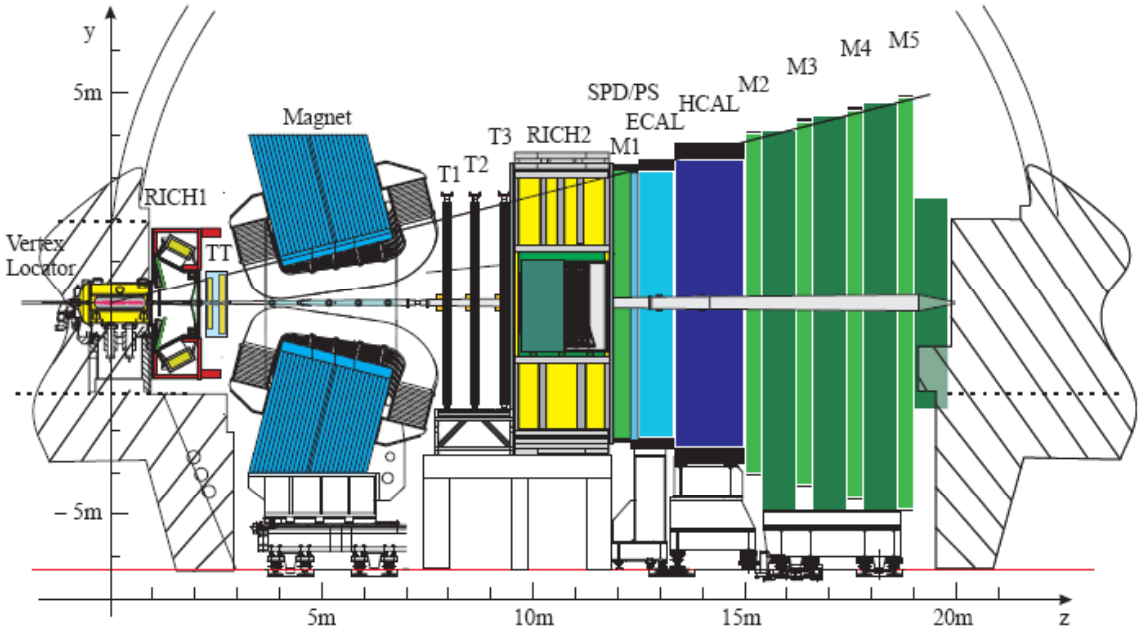
The LHCb Detector.

- Single arm forward spectrometer dedicated to B physics.



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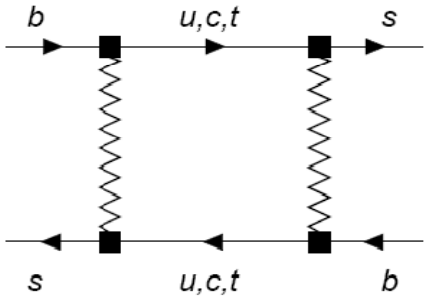
CP violation in mixing.

- The parameter a_{fs} describes the CP violation in mixing.
- It is very small in the standard model.
  - ~2×10^{-5} for the B_s system.
- Main contributions to mixing are from the loop below.



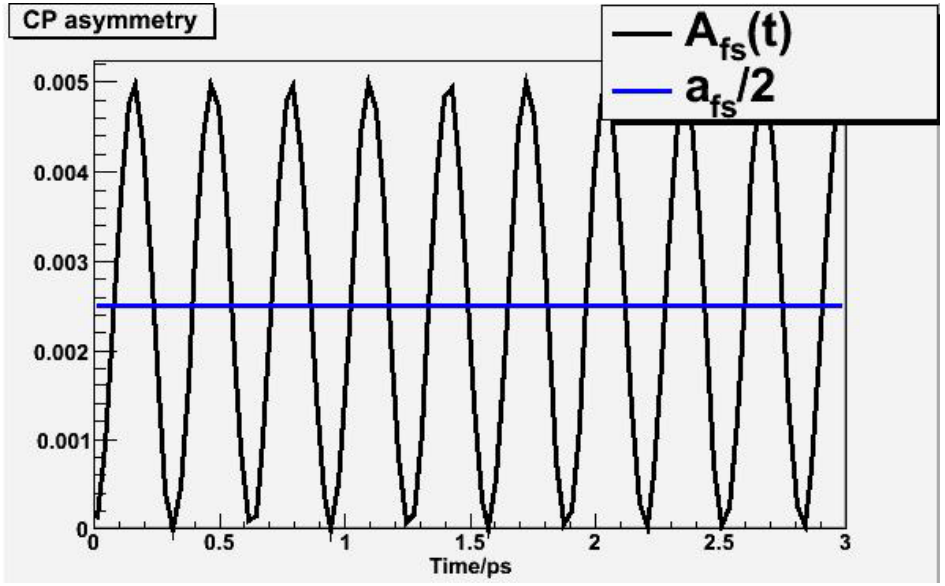
- Can be significantly enhanced by CP violating phases in new physics models.
  - An increase of two orders of magnitude in some models.

CP violation in mixing

- CP violation in mixing can be accessed through the measurement of time dependant, un-tagged, charge asymmetry for flavour specific decays:

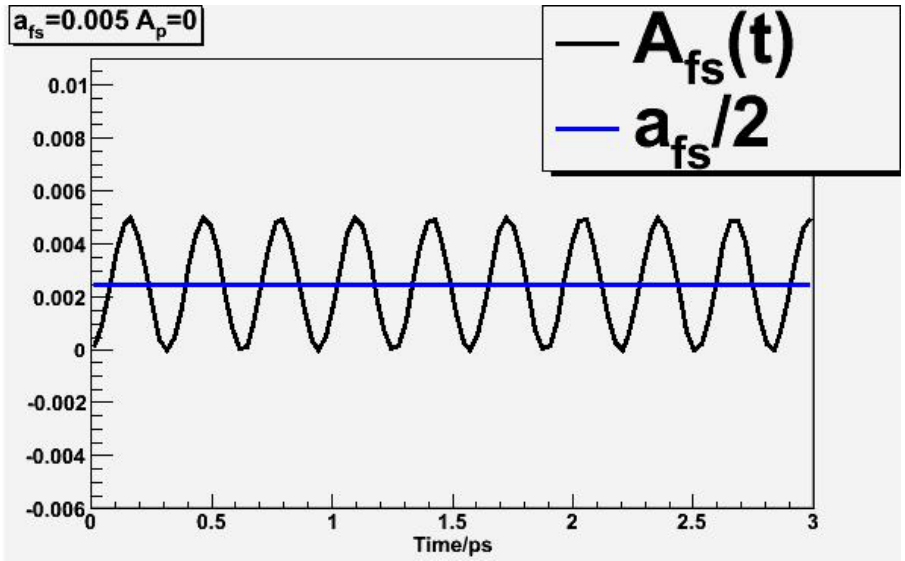
$$A_{fs}(t) = \frac{\Gamma\left(B \text{ or } \overline{B} \to f\right) - \Gamma\left(B \text{ or } \overline{B} \to \overline{f}\right)}{\Gamma\left(B \text{ or } \overline{B} \to f\right) + \Gamma\left(B \text{ or } \overline{B} \to \overline{f}\right)}$$

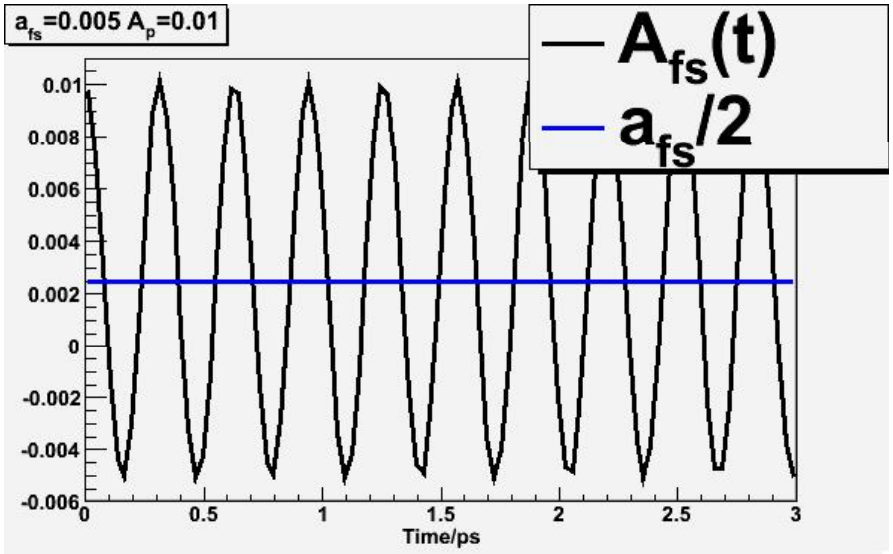
- State f can be $D_s\pi$ or $D_s\mu\nu$ for example.



Production asymmetry

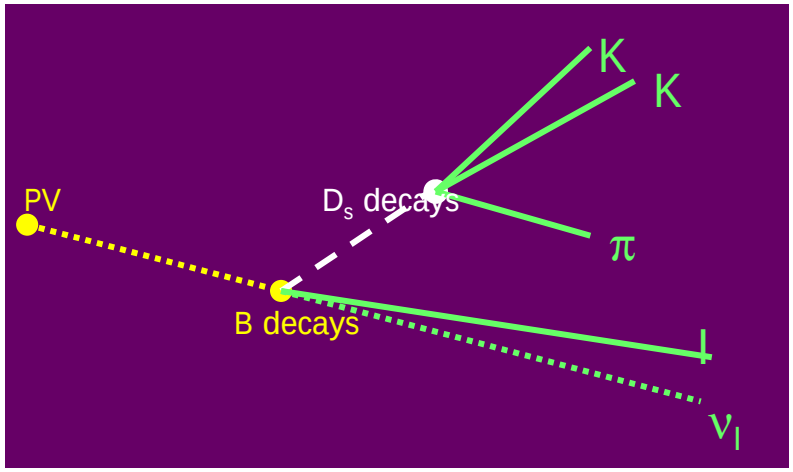
- Production asymmetry, A_p, also contributes to $A_{fs}(t)$.
- It must be measured and understood for many different studies.
- Modifying expression for $A_{fs}(t)$ allows fitting of production and CP asymmetries.
- Production asymmetry measurement more strongly dependant on lifetime resolution.
- Detection asymmetry also affects $A_{fs}(t)$. Measured elsewhere.





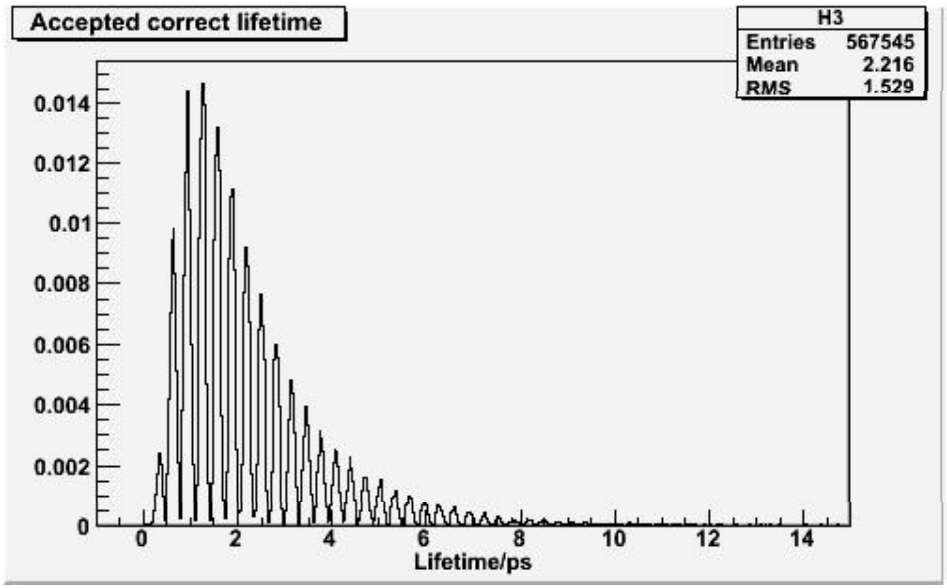
Two Lifetimes per Event

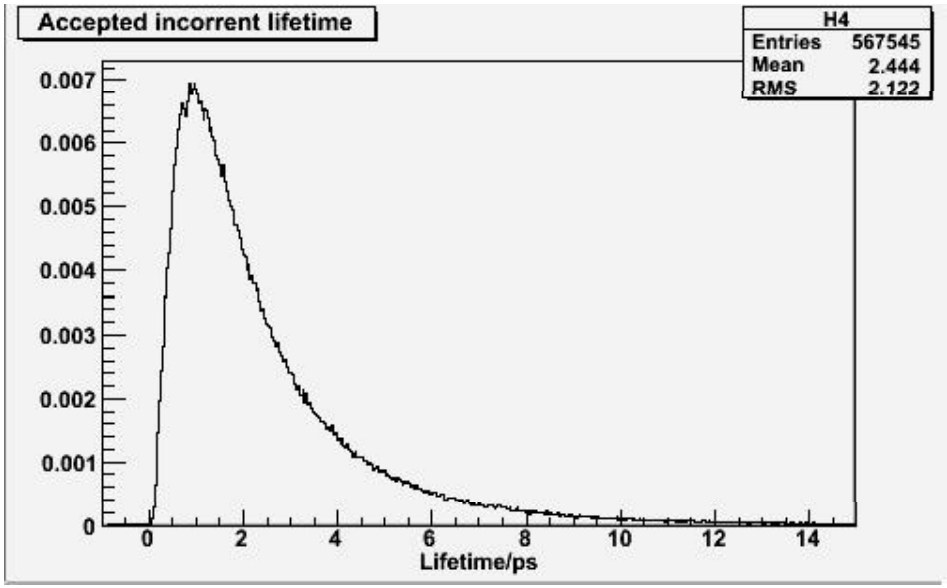
- Lifetime requires decay length and momentum.
  - Decay length comes from vertex positions.
- The neutrino is undetected making the decay time difficult to find.
- Vertex information and decay kinematics constrain neutrino momentum.
- Equation is quadratic.
  - **Two solutions**.
  - No way of distinguishing correct time.
- I have written a Monte Carlo that gives me the B direction and daughter momentum.



B->f decays from Toy Monte Carlo

- The false momentum solution smears out the lifetime distribution.
- LHCb is biased towards accepting long lived decays.





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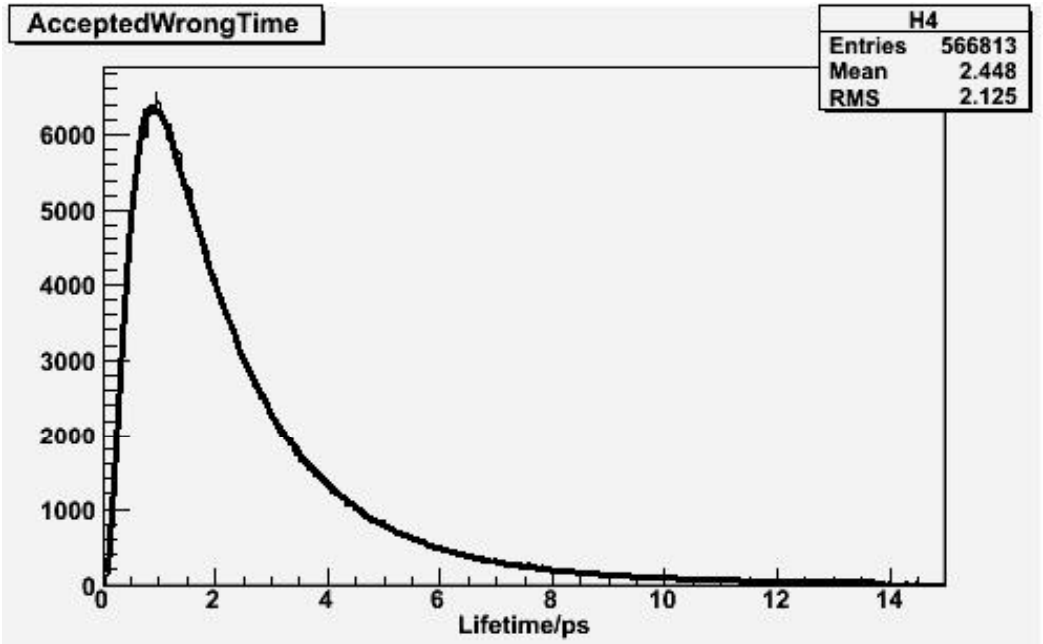
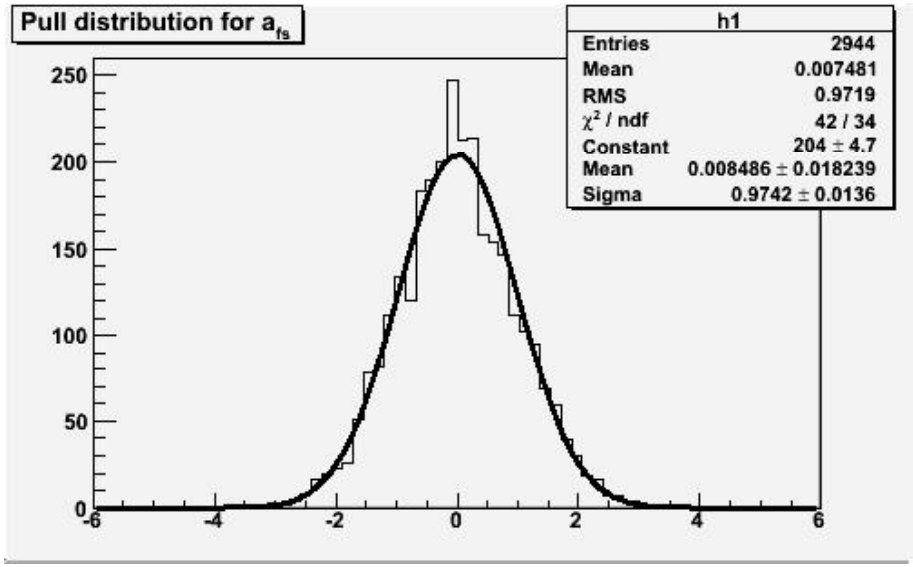
Fitting strategy.

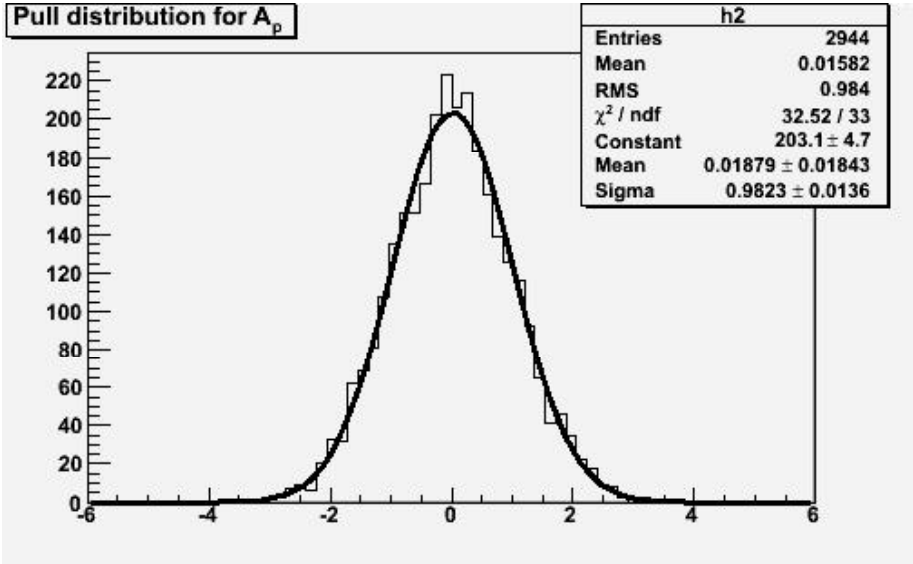
- It is not known which of the two times is correct.
  - One chosen at random, the other discarded.
- A model is needed for the wrong lifetime distribution.
- This model is included in a modified $A_{fs}(t)$.
- The data is then fitted to $A_{fs}(t)$ and the CP and production asymmetries are extracted.



Fitting the data

- Data generated with toy Monte Carlo. One time thrown away at random.
- Then fit the modified $A_{fs}(t)$ to find a_{fs} and A_p.
- 250000 events in each sample. 1 Year of data taking.
- Input values of $A_p = 0.01$ and $a_{fs} = 0.005$.
- Extracted values are:
  - $A_p = 1.009 \times 10^{-2} +/- 6.0 \times 10^{-3}$
  - $a_{fs} = 5.030 \times 10^{-3} +/- 4.0 \times 10^{-3}$





Comparison with lifetime estimation

- Calculating the lifetimes, and discarding one solution leads to errors of:
  - $\sigma_{Ap} = 6.0 \times 10^{-3}$
  - $\sigma_{afs} = 4.0 \times 10^{-3}$
- For the same number of events, estimating the time with a resolution of 0.120ps:
  - $\sigma_{Ap} = 5.1 \times 10^{-2}$
  - $\sigma_{afs} = 4.0 \times 10^{-3}$

Summary

- Study of B_s->$D_s\mu\nu$ decays yields values for:
  - a_{fs}: Susceptible to new physics.
  - A_p: Essential for many physics analyses.
- Calculation of the B_s momentum from kinematic constraints leads to a precise measurement of the production asymmetry.