Instead of picking the best fit window by eye, **use all** of them. Calculate your observables as a **weighted average** over all time regions.

Using weighted averaging methods in measurements of $SU(3)_f$ symmetry breaking in B meson decay constants

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Overview

- Measuring B-physics anomalies rely on minimising systematic errors in experiment and theory.
- Tuning heavy b-quark action requires the calculation of a large number of distinct correlators**[1]**.
- Correlator measurements typically require optimising the choice of fitting windows. Analyst choice is not feasible for the ≈ 1600 unique correlators required for our model.
- We propose fitting correlators via a weighted average**[2]** over all possible windows. Poorly performing fits are algorithmically surpressed without additional analyst input.

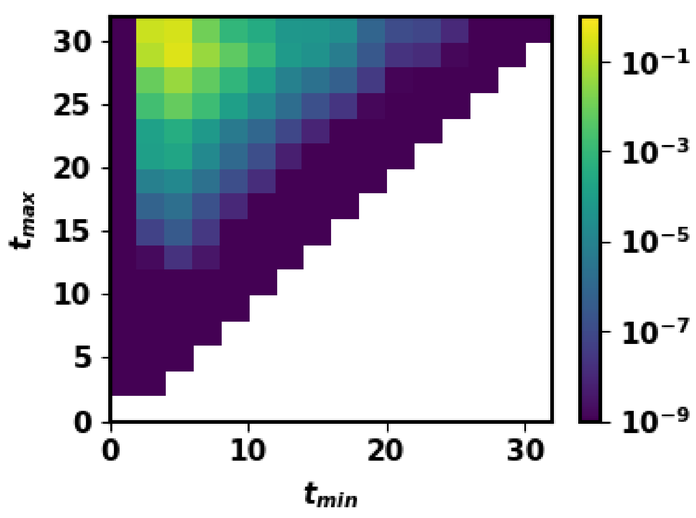

Fig 1: Fit ensemble weights against t_{min} and t_{max}. The highest weight window is $t \in [4, 31] \cup [32, 59]$ with $w_i = 0.16$

[1] arXiv:1206.2554
[2] arXiv:2008.01069

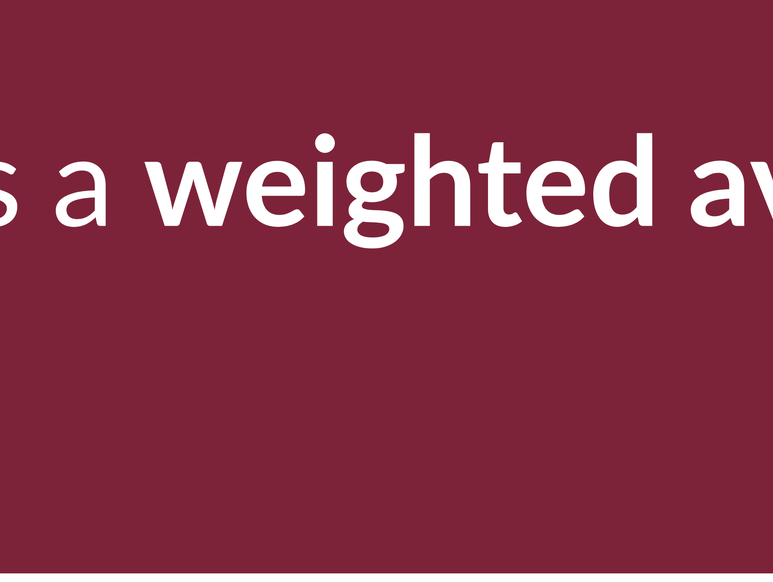

Fig 2: Effective mass of $B^* - B$ ratio, with analyst choice: $t \in [5, 20] \cup [43, 58]$: $\chi^2_{\nu,red} = 0.89$, $w_i = 6.0 \times 10^{-6}$, $\Delta m = 0.134a$

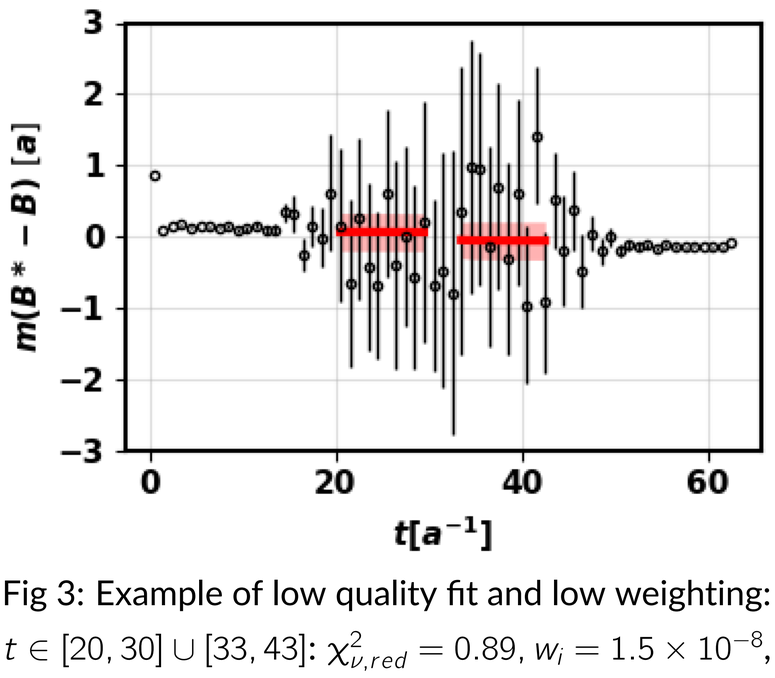

Fig 3: Example of low quality fit and low weighting: $t \in [20, 30] \cup [33, 43]$: $\chi^2_{\nu,red} = 0.89$, $w_i = 1.5 \times 10^{-8}$, $\Delta m = 1.17a$

Table: Gauge ensemble parameters

volume	$32^3 \times 64$
β	5.4
a (fm)	0.082
m_π (MeV)	413

Method

As a proof of principle, we perform weighted average fitting to measure the splitting of $B^* - B$, on a single QCDSF $SU(3)_f$-symmetric ensemble. The ratio of correlators is fit as:

$$R(t) = A[\exp(-\Delta m t) + \exp(-\Delta m(64 - t))] \quad (1)$$

The parameter is fit for all 496 time combinations, with each assigned a weighting determined by:

$$w_i = \exp(-\frac{1}{2}\chi^2_{\nu,i} + N_{DOF,i}) \quad (2)$$

The weight of each window is normalised, multiplied to the corresponding fit and summed to evaluate final, weight-averaged result. Systematic error is treated as the summed square residuals of the weights applied to each bootstrap measurement and to the ensemble average.

Results

The weighted average over all 496 windows of the $B^* - B$ mass splitting was found to be $0.140a \pm 0.070(\text{sys}) \pm 0.020(\text{stat})$. This value is consistent with the traditional single-window fit results in Fig 2 (analyst choice of window) and Fig 3 (example of poorer choice).

For more information on deriving B-physics parameters from these results, see companion talk $SU(3)_f$ symmetry breaking in f_B and f_{B_s}, July 29, 2021, 1:30 PM EST, Standard Model Parameters stream.

Scan QR code to see links to previous work and the companion talk

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