# Precise measurement of the fs /fd ratio of fragmentation fractions and of Bs0 decay branching fractions

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# Supplemental material for LHCb-PAPER-2020-046

Full results on the parameters for the default fit and the fit without external theory constraints are presented in Tables 1 and 2, respectively. The correlation matrices of the results for these fits also shown in Tables 3 and 4, respectively. This is important when considering the results at different energies, since they are correlated among each other.

The listed parameters are:

- $a$ and $b$ are the intercept and slope of the transverse-momentum-dependent functions at the three center-of-mass energies;
- $r_{\rm AF}$ and $r_{\rm E}$ are the scaling parameters with respect to the theoretical inputs;
- $S_1$ is the parameter propagating the correlated systematic uncertainty due to external parameters;
- $S_2$, $S_3$, and $S_4$ are the parameters propagating experimental systematic uncertainties.
- $\mathcal{F}_R$ is the ratio of the $B_s^0 \to J/\psi\phi$ to $B^+ \to J/\psi K^+$ branching fractions, as detailed in the text.

Table 1: Output parameters of the default fit to the data.

| | |
|---|---|
| $a(7\,\text{TeV})$ | $0.244 \pm 0.008$ |
| $b(7\,\text{TeV})$ | $(-10.3 \pm 2.7) \times 10^{-4}$ |
| $S_1$ | $1.009 \pm 0.026$ |
| $S_2$ | $1.030 \pm 0.028$ |
| $r_{\rm AF}$ | $1.082 \pm 0.032$ |
| $\mathcal{F}_R$ | $0.505 \pm 0.016$ |
| $a(8\,\text{TeV})$ | $0.240 \pm 0.008$ |
| $b(8\,\text{TeV})$ | $(-3.5 \pm 2.3) \times 10^{-4}$ |
| $a(13\,\text{TeV})$ | $0.263 \pm 0.008$ |
| $b(13\,\text{TeV})$ | $(-17.6 \pm 2.1) \times 10^{-4}$ |
| $S_3$ | $0.997 \pm 0.008$ |
| $S_4$ | $0.977 \pm 0.021$ |
| $r_{\rm E}$ | $1.071 \pm 0.030$ |

Table 2: Output parameters of the fit to the data without external theory constraints.

| | |
|---|---|
| $a(7\,\text{TeV})$ | $0.238 \pm 0.008$ |
| $b(7\,\text{TeV})$ | $(-10.3 \pm 2.7) \times 10^{-4}$ |
| $S_1$ | $1.000 \pm 0.026$ |
| $S_2$ | $1.00 \pm 0.04$ |
| $r_{\text{AF}}$ | $1.16 \pm 0.06$ |
| $\mathcal{F}_R$ | $0.517 \pm 0.017$ |
| $a(8\,\text{TeV})$ | $0.234 \pm 0.008$ |
| $b(8\,\text{TeV})$ | $(-3.3 \pm 2.3) \times 10^{-4}$ |
| $a(13\,\text{TeV})$ | $0.256 \pm 0.009$ |
| $b(13\,\text{TeV})$ | $(-16.9 \pm 2.0) \times 10^{-4}$ |
| $S_3$ | $1.000 \pm 0.009$ |
| $S_4$ | $0.998 \pm 0.023$ |
| $r_{\text{E}}$ | $1.04 \pm 0.04$ |

Table 3: Output correlation matrix of the default fit versus $p_{\text{T}}$.

| | $a(7\,\text{TeV})$ | $b(7\,\text{TeV})$ | $S_1$ | $S_2$ | $r_{\text{AF}}$ | $\mathcal{F}_R$ | $a(8\,\text{TeV})$ | $b(8\,\text{TeV})$ | $a(13\,\text{TeV})$ | $b(13\,\text{TeV})$ | $S_3$ | $S_4$ | $r_{\text{E}}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $a(7\,\text{TeV})$ | 1.000 | −0.360 | −0.589 | −0.185 | −0.318 | −0.955 | 0.925 | −0.046 | 0.933 | −0.314 | −0.223 | −0.645 | −0.198 |
| $b(7\,\text{TeV})$ | | 1.000 | 0.067 | −0.045 | −0.003 | 0.131 | −0.129 | 0.010 | −0.130 | 0.048 | 0.034 | 0.097 | 0.109 |
| $S_1$ | | | 1.000 | −0.075 | −0.128 | 0.615 | −0.596 | 0.029 | −0.601 | 0.170 | 0.022 | 0.064 | −0.079 |
| $S_2$ | | | | 1.000 | −0.542 | 0.193 | −0.184 | 0.004 | −0.186 | 0.068 | 0.083 | 0.239 | 0.841 |
| $r_{\text{AF}}$ | | | | | 1.000 | 0.328 | −0.320 | 0.019 | −0.322 | 0.129 | 0.142 | 0.410 | −0.569 |
| $\mathcal{F}_R$ | | | | | | 1.000 | −0.967 | 0.044 | −0.976 | 0.326 | 0.233 | 0.676 | 0.198 |
| $a(8\,\text{TeV})$ | | | | | | | 1.000 | −0.257 | 0.945 | −0.318 | −0.226 | −0.654 | −0.202 |
| $b(8\,\text{TeV})$ | | | | | | | | 1.000 | −0.046 | 0.021 | 0.010 | 0.030 | 0.030 |
| $a(13\,\text{TeV})$ | | | | | | | | | 1.000 | −0.492 | −0.228 | −0.660 | −0.202 |
| $b(13\,\text{TeV})$ | | | | | | | | | | 1.000 | 0.056 | 0.161 | 0.098 |
| $S_3$ | | | | | | | | | | | 1.000 | −0.059 | 0.087 |
| $S_4$ | | | | | | | | | | | | 1.000 | 0.251 |
| $r_{\text{E}}$ | | | | | | | | | | | | | 1.000 |

Table 4: Output correlation matrix of the fit versus $p_{\text{T}}$ without theory constraints.

| | $a(7\,\text{TeV})$ | $b(7\,\text{TeV})$ | $S_1$ | $S_2$ | $r_{\text{AF}}$ | $\mathcal{F}_R$ | $a(8\,\text{TeV})$ | $b(8\,\text{TeV})$ | $a(13\,\text{TeV})$ | $b(13\,\text{TeV})$ | $S_3$ | $S_4$ | $r_{\text{E}}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $a(7\,\text{TeV})$ | 1.000 | −0.343 | −0.525 | 0.001 | −0.367 | −0.958 | 0.931 | −0.049 | 0.938 | −0.333 | −0.257 | −0.672 | −0.002 |
| $b(7\,\text{TeV})$ | | 1.000 | 0.069 | 0.000 | −0.032 | 0.125 | −0.123 | 0.011 | −0.124 | 0.048 | 0.034 | 0.088 | 0.111 |
| $S_1$ | | | 1.000 | 0.000 | −0.166 | 0.548 | −0.531 | 0.027 | −0.536 | 0.150 | 0.003 | 0.007 | 0.000 |
| $S_2$ | | | | 1.000 | −0.768 | −0.001 | 0.001 | −0.000 | 0.001 | −0.000 | −0.000 | −0.001 | 0.920 |
| $r_{\text{AF}}$ | | | | | 1.000 | 0.378 | −0.367 | 0.019 | −0.370 | 0.152 | 0.178 | 0.467 | −0.787 |
| $\mathcal{F}_R$ | | | | | | 1.000 | −0.970 | 0.048 | −0.978 | 0.343 | 0.267 | 0.701 | −0.004 |
| $a(8\,\text{TeV})$ | | | | | | | 1.000 | −0.252 | 0.949 | −0.336 | −0.260 | −0.680 | −0.005 |
| $b(8\,\text{TeV})$ | | | | | | | | 1.000 | −0.049 | 0.023 | 0.013 | 0.034 | 0.018 |
| $a(13\,\text{TeV})$ | | | | | | | | | 1.000 | −0.502 | −0.262 | −0.686 | −0.004 |
| $b(13\,\text{TeV})$ | | | | | | | | | | 1.000 | 0.073 | 0.191 | 0.018 |
| $S_3$ | | | | | | | | | | | 1.000 | 0.004 | −0.000 |
| $S_4$ | | | | | | | | | | | | 1.000 | −0.001 |
| $r_{\text{E}}$ | | | | | | | | | | | | | 1.000 |