# Update: SIMBA in python

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## Contents

# 1 What I did

Chisq()

$$\chi^2(a) = (V_{meas} - V_{pred}(a)) \cdot M_{cov}^{-1} \cdot (V_{meas} - V_{pred}(a))$$

ConvertPars()

$$V_{pred}(c(a)) = \begin{pmatrix} V_{pred,1}(c(a)) \\ V_{pred,2}(c(a)) \\ \vdots \\ V_{pred,i}(c(a)) \end{pmatrix} \qquad c(a) = \begin{pmatrix} 1 \\ a_1 \\ a_2 \\ \vdots \\ a_N \end{pmatrix} \cdot \frac{1}{(1+\sum_1^N a_n^2)^{1/2}} \qquad \boxed{a_0 = n^2}$$

$i$ - Index for experiment

BsgPrediction_full()

$$V_{pred_i}(c,n) = M_{Smear} \cdot \Big( \underbrace{\sum_{\{t\}} b_t(c) \cdot P_t(n)}_{\text{Leading Terms}} + \underbrace{S(c) \cdot P_s(n)}_{\text{SubLeading Term}} \Big)$$

$t \in \{\text{"NNLLNNLO"}, \text{"NS27NNLO"}, \dots\}$

$S(c)$ is Subleading theory prediction SSF27_1 or SSF27_2

BsgPrediction()

$$b_h(c,n) = (\mathrm{expxs}_{hjk} \cdot c_j \cdot c_k) \cdot n \quad \Rightarrow b(c,n) = \begin{pmatrix} b_0 \\ b_1 \\ \vdots \\ b_{Bin} \end{pmatrix}$$

$h$ - Index for Bin

$$P_{t/s}(n) = N_0 \cdot \begin{cases} C_2 C_2 \cdot \frac{1}{n} \cdot (V_{tb} V_{ts} \cdot m_b)^2 & \text{if 22 in } t \\ C_2 C_7 \cdot \frac{1}{\sqrt{n}} \cdot V_{tb} V_{ts} \cdot m_b \cdot \lambda_2 / m_b & \text{if subleading theory} \\ C_2 C_7 \cdot \frac{1}{\sqrt{n}} \cdot V_{tb} V_{ts} \cdot m_b & \text{if 27 in } t \\ C_2 C_8 \cdot \frac{1}{n} (V_{tb} V_{ts} \cdot m_b)^2 & \text{if 28 in } t \\ C_8 C_8 \cdot \frac{1}{n} \cdot (V_{tb} V_{ts} \cdot m_b)^2 & \text{if 88 in } t \\ C_8 C_7 \frac{1}{\sqrt{n}} V_{tb} \cdot V_{ts} \cdot m_b & \text{if 78 in } t \end{cases}$$

$N_0 \approx 794$
$\lambda_2 \approx 0{,}12$
$V_{tb} V_{ts} \approx 0{,}041$

$m_B = 5{,}279$

$$m_b(c) = \frac{1}{6} \cdot (5 \cdot (m_B - M^1(c)) - \frac{P}{u} + u))$$

$$\lambda(c) = 3 \cdot \lambda_2 + 2 \cdot m_b(c) \cdot (m_B - M^1(c) - m_b(c))$$

order $\rightarrow$

$$M^\ell(c) = F_{\ell mn} \cdot c_m c_n$$

BsgSubLeadingPrediction()

$$S_h(f(c), n) = (SSF_{hj} \cdot f_j(c)) \cdot n \quad \Rightarrow S(c,n) = \begin{pmatrix} S_0 \\ S_1 \\ \vdots \\ S_{Bin} \end{pmatrix}$$

$$f(c, d_2) = \begin{pmatrix} 1 - x \\ x \cdot (1 - d_2) \\ x \cdot d_2 \end{pmatrix}, \text{ where } x = \begin{cases} (0{,}65 \cdot (m_B - m_b) - 0{,}86 \cdot \lambda + 0{,}33 \cdot \frac{\rho_2}{\lambda_2}) / (1{,}85 \cdot \lambda - d_2 \cdot \lambda) & \{SSF27\_1\} \\ (0{,}47 \cdot (m_B - m_b) - 0{,}57 \lambda + 0{,}24 \cdot \frac{\rho_2}{\lambda_2}) / (1{,}40 \cdot \lambda - d_2 \cdot \lambda) & \{SSF27\_2\} \end{cases}$$

Figure 1: Equations according to my python code

A problem could be the $d_2$. In my code it's constantly zero. I got this information from the *fit.config* file.

```
##########################################################
#  Subleading theory coefficients
##########################################################

## Default value is
SSF27_1055.d2: 0.
SSF27_2055.d2: 0.
```

Figure 2: Information in *fit.config* file

# 2 Comparisons

As you can see in the following, something is off with the subleading theory. To compare different fits, I always plotted the Fit with the subleading prediction added on the leading prediction and with just the leading prediction. For the fitting I used 4 to 7 start parameters, which gave different results for the prediction, as it is shown in the columns. Every pair of rows has more amount of measurements included in the fit (["babar_incl", *"babar_hadtag", "babar_sem", "belle"]).*

## 2.1 Results for each fit

In the tables and in the following figueres, I circled the best looking fit green. The best looking fit was the one with the lowest $\chi^2$ and the $m_b$ which was closest to the result from the paper, which is listet in the first table in the last row. The best looking fit is without the subleading theory, and looks good for the first two measurements (*"babar_incl"*, *"babar_hadtag"*) but for the third (*"babar_sem"*) it starts to differ a lot from the aimed fit.

| Number of included measurements | With or without subleading theory | Number of fitted parameters | $\chi^2$ | $m_b$ [GeV] | $a_0$ (Norm) |
|---|---|---|---|---|---|
| 2 | subleading | 4 | 174477.25 | 4.6877 | 0.9204 |
| 2 | subleading | 5 | 143976.56 | 4.6900 | 0.9514 |
| 2 | subleading | 6 | 145631.54 | 4.6843 | 0.9678 |
| 2 | subleading | 7 | 248645.38 | 4.5712 | 0.9708 |
| 2 | leading | 4 | 230.97 | 4.6932 | 0.3826 |
| 2 | leading | 5 | 323.33 | 4.8005 | 0.5210 |
| 2 | leading | 6 | 262.79 | 4.8515 | 0.5774 |
| 2 | leading | 7 | 292.88 | 4.1603 | 0.6252 |
| 3 | subleading | 4 | 91211.26 | 4.6821 | 0.9228 |
| 3 | subleading | 5 | 67852.28 | 4.6845 | 0.9519 |
| 3 | subleading | 6 | 66673.56 | 4.6711 | 0.9680 |
| 3 | subleading | 7 | 139735.90 | 4.5526 | 0.9721 |
| 3 | leading | 4 | 167.13 | 3.9984 | 0.5020 |
| 3 | leading | 5 | 258.61 | 4.7932 | 0.4933 |
| 3 | leading | 6 | 156.92 | 3.9980 | 0.8149 |
| 3 | leading | 7 | 231.09 | 4.7644 | 0.2352 |
| 4 | subleading | 4 | 45178.57 | 4.7032 | 0.9143 |
| 4 | subleading | 5 | 19.59 | 3.4633 | 0.0426 |
| 4 | subleading | 6 | 23165.42 | 4.7386 | 0.9323 |
| 4 | subleading | 7 | 22746.34 | 4.5274 | 0.9208 |
| 4 | leading | 4 | 12.36 | 4.5904 | 0.4373 |
| 4 | leading | 5 | 11.72 | 4.4835 | 0.6715 |
| 4 | leading | 6 | 10.10 | 4.7076 | 0.3762 |
| 4 | leading | 7 | 14.15 | 4.2259 | 0.0892 |
| Result from paper | | | | 4.764 | |

Table 1: Values calculated with the fit-parameters

| $n_{meas}$ | | $n_{pars}$ | $c_0$ | $c_1$ | $c_2$ | $c_3$ | $c_4$ | $c_5$ | $c_6$ |
|---|---|---|---|---|---|---|---|---|---|
| 2 | s | 4 | 0.896 | -0.394 | 0.159 | 0.126 | | | |
| 2 | s | 5 | 0.855 | -0.438 | 0.181 | 0.182 | 0.102 | | |
| 2 | s | 6 | 0.842 | -0.450 | 0.183 | 0.203 | 0.121 | 0.011 | |
| 2 | s | 7 | 0.709 | -0.101 | -0.205 | 0.625 | -0.107 | 0.184 | -0.096 |
| 2 | l | 4 | 0.890 | -0.441 | 0.009 | 0.113 | | | |
| 2 | l | 5 | 0.025 | -0.089 | 0.758 | -0.646 | -0.023 | | |
| 2 | l | 6 | 0.032 | 0.043 | 0.284 | -0.739 | 0.608 | 0.020 | |
| 2 | l | 7 | 0.000 | -0.494 | 0.524 | 0.457 | 0.496 | 0.153 | -0.058 |
| 3 | s | 4 | 0.910 | -0.378 | 0.139 | 0.095 | | | |
| 3 | s | 5 | 0.867 | -0.422 | 0.176 | 0.169 | 0.098 | | |
| 3 | s | 6 | 0.852 | -0.433 | 0.174 | 0.200 | 0.123 | 0.030 | |
| 3 | s | 7 | 0.742 | -0.153 | -0.116 | 0.599 | -0.097 | 0.178 | -0.115 |
| 3 | l | 4 | 0.000 | 0.880 | 0.473 | -0.033 | | | |
| 3 | l | 5 | 0.032 | -0.090 | 0.642 | -0.760 | -0.018 | | |
| 3 | l | 6 | 0.000 | 0.815 | 0.568 | -0.110 | 0.019 | 0.001 | |
| 3 | l | 7 | 0.000 | 0.371 | -0.061 | 0.489 | -0.775 | 0.053 | 0.126 |
| 4 | s | 4 | 0.857 | -0.433 | 0.214 | 0.178 | | | |
| 4 | s | 5 | 0.022 | 0.587 | 0.531 | 0.494 | 0.358 | | |
| 4 | s | 6 | 0.242 | -0.178 | 0.812 | -0.387 | 0.062 | 0.310 | |
| 4 | s | 7 | 0.132 | 0.431 | -0.225 | 0.589 | 0.300 | -0.438 | 0.343 |
| 4 | l | 4 | 0.231 | 0.391 | -0.891 | -0.017 | | | |
| 4 | l | 5 | 0.148 | -0.163 | 0.974 | 0.055 | -0.005 | | |
| 4 | l | 6 | 0.034 | 0.875 | -0.445 | 0.107 | -0.096 | -0.122 | |
| 4 | l | 7 | 0.019 | 0.297 | 0.117 | -0.089 | 0.062 | -0.907 | -0.251 |

Table 2: $c_n$ calculated by $a_n$ which are the fitted parameters

In the following: The **red dots** show my calculated prediction.
The **black dots** show the experimental values, which I extracted from the root files.
The **green line** shows the fit I extracted from the root files.
The **blue line** shows the difference between the green line and the red dots.

## 2.2 Babar hadronic tag

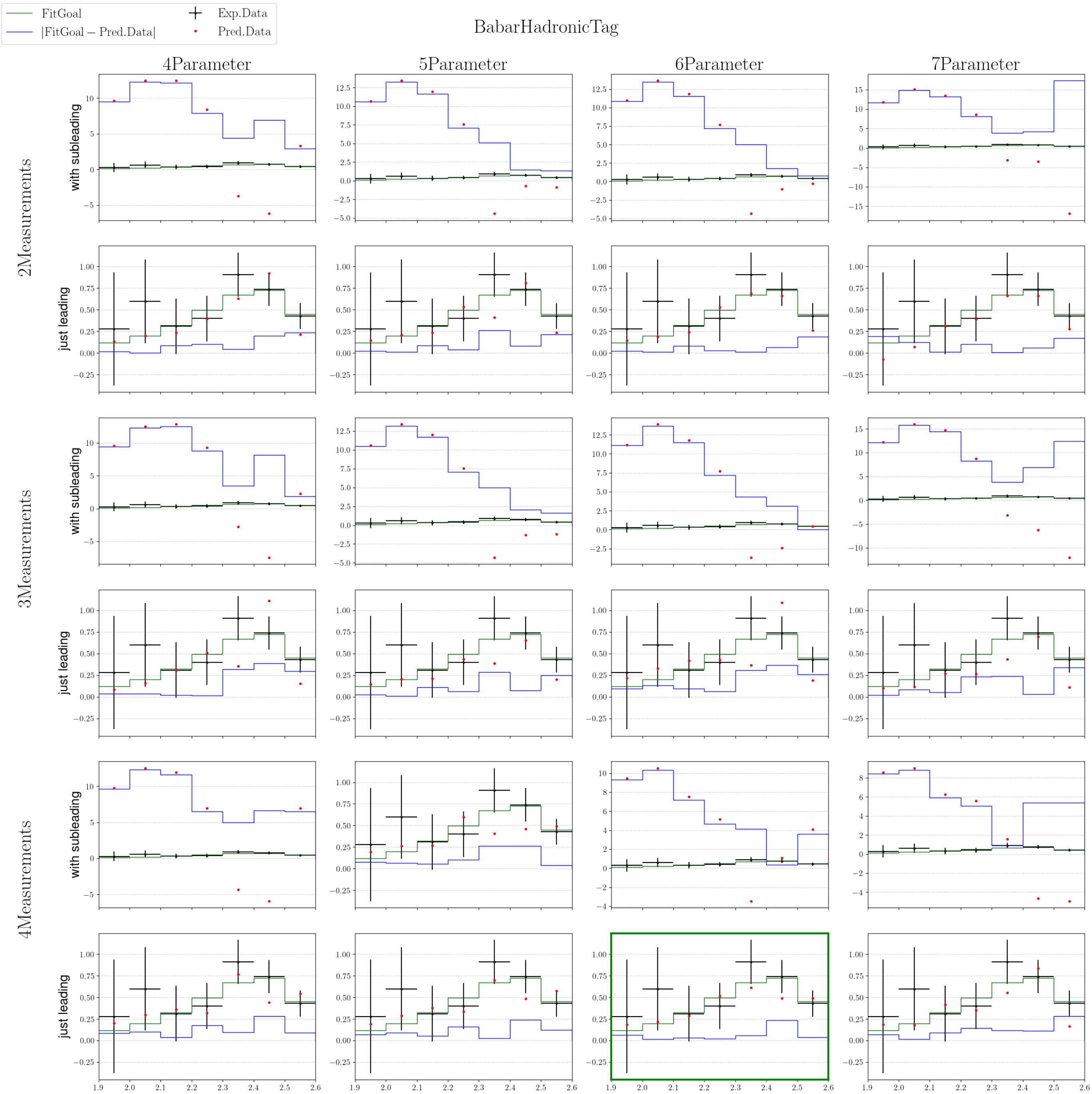


Figure 3: Fit Comparison for 'babar_hadtag'

## 2.3 Babar inclusive spectra

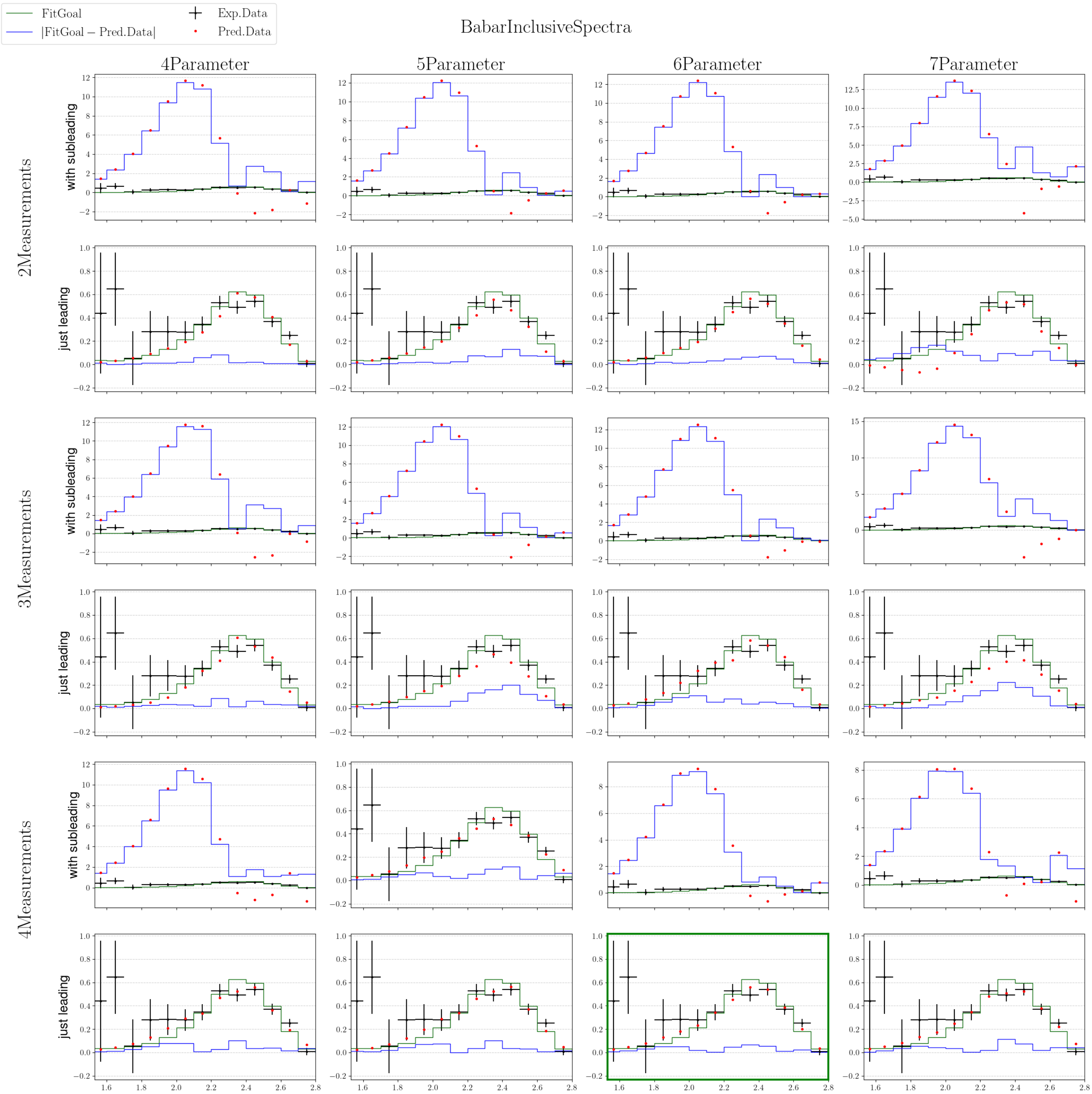


Figure 4: Fit Comparison for 'babar_incl'

## 2.4 Babar semileptonic

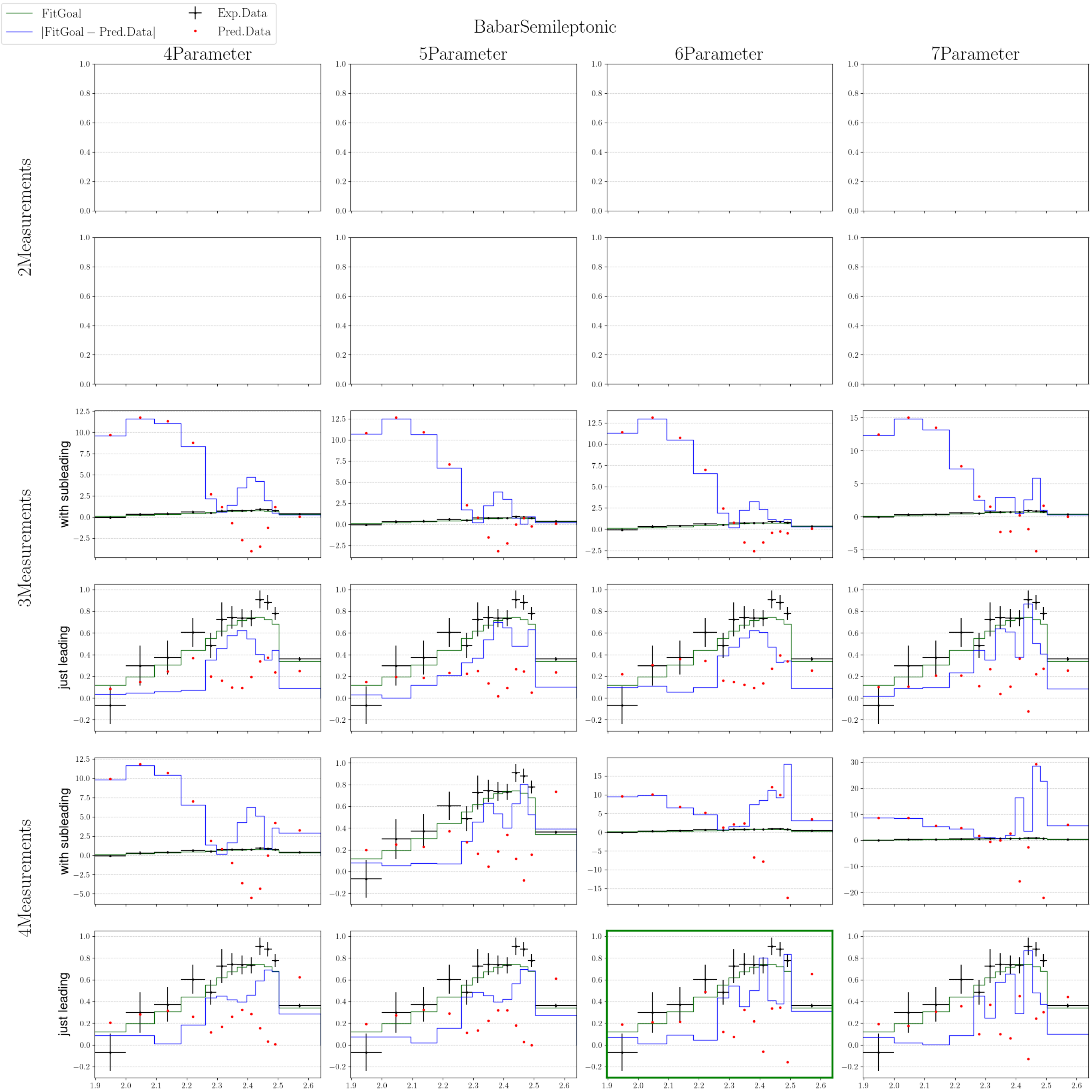


Figure 5: Fit Comparison for 'babar_sem'

## 2.5 Belle

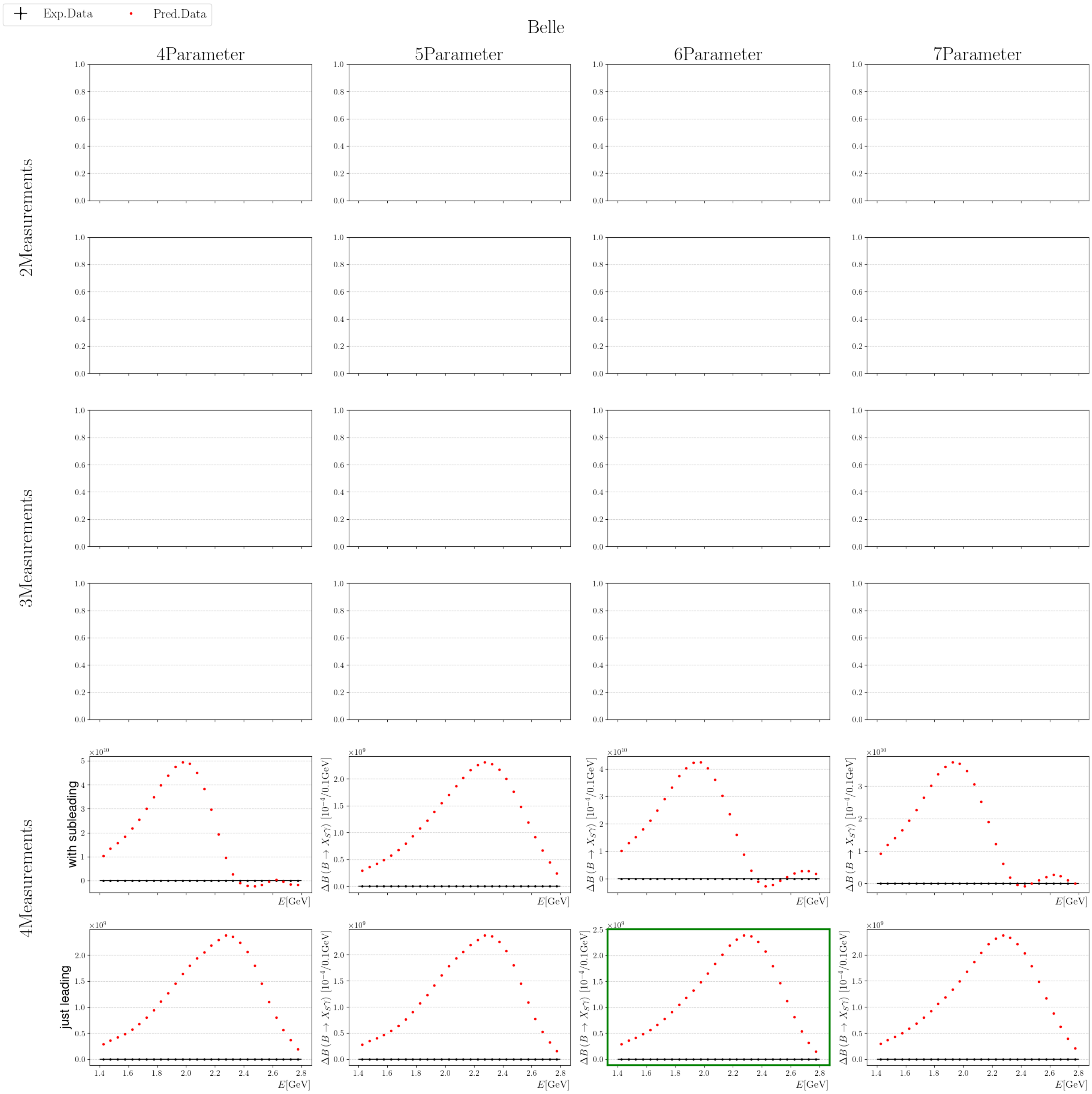


Figure 6: Fit Comparison for 'belle'