

Probing background with Method of Moments for $B^0 \rightarrow K^* \mu \mu$



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Zurich^{UZH}



- 1 Reminder
- 2 Theory introduction
- 3 Background regions
- 4 Results
- 5 Summary



Plan

Method of moments:

- 1 Last meeting showed how orthogonality of the does magic for method of moments.
- 2 Using toy MC (experimental math) checked the errors estimates.
- 3 Checked that it does not suffer from boundary conditions.
- 4 Many thanks to Tom for checking all my calculations.

For today:

- 1 How this method behaves in terms of background?

What do we start with

Let's assume for simplicity we have our pdf:

$$\begin{aligned}
 \frac{d^4\Gamma}{\Gamma dq^2 d\cos\theta_k d\cos\theta_l d\phi} = & \frac{9}{32\pi} \left(\frac{3}{4}(1-F_l) \sin^2\theta_k + F_l \cos^2\theta_k + \left(\frac{1}{4}(1-F_l) \sin^2\theta_k \right. \right. \\
 & \left. \left. - F_l \cos^2\theta_k \right) \cos 2\theta_l + S_3 \sin^2\theta_k \sin^2\theta_l \cos 2\phi + S_4 \sin 2\theta_k \sin\theta_l \cos\phi + \right. \\
 & \left. S_5 \sin 2\theta_k \sin\theta_l \cos\phi + (S_{6s} \sin^2\theta_k) \cos\theta_l + \right. \\
 & \left. S_7 \sin 2\theta_k \sin\theta_l \sin\phi + S_8 \sin 2\theta_k \sin 2\theta_l \sin\phi + S_9 \sin^2\theta_k \sin^2\theta_l \sin 2\phi \right) \quad (1)
 \end{aligned}$$

What did we assume:

- S_{1x}, J_{2x} can be parametrized by F_l .
- $S_{6c} = 0$.
- In short what was in the paper.

Obtained moments 1

Lets see how this works in practice:

$$\frac{d^3\Gamma}{\Gamma d\cos\theta_k d\cos\theta_l d\phi} \sin^2 \theta_k = \frac{2}{5}(2 - F_l) \quad (2)$$

$$\frac{d^3\Gamma}{\Gamma d\cos\theta_k d\cos\theta_l d\phi} \cos^2 \theta_k = \frac{1}{5}(1 + F_l) \quad (3)$$

$$\frac{d^3\Gamma}{\Gamma d\cos\theta_k d\cos\theta_l d\phi} \sin^2 \theta_k \cos 2\theta_l = -\frac{2}{25}(2 + F_l) \quad (4)$$

$$\frac{d^3\Gamma}{\Gamma d\cos\theta_k d\cos\theta_l d\phi} \cos^2 \theta_k \cos 2\theta_l = -\frac{1}{25}(1 + 8F_l) \quad (5)$$

$$\frac{d^3\Gamma}{\Gamma d\cos\theta_k d\cos\theta_l d\phi} \sin^2 \theta_k \cos \theta_l = \frac{2S_{6s}}{5} \quad (6)$$

Obtained moments 2

$$\frac{d^3\Gamma}{\Gamma d\cos\theta_k d\cos\theta_l d\phi} \cos^2\theta_k \cos\theta_l = \frac{S_{6s}}{10} \quad (7)$$

$$\frac{d^3\Gamma}{\Gamma d\cos\theta_k d\cos\theta_l d\phi} \sin^2\theta_k \sin^2\theta_l \cos 2\phi = \frac{8S_3}{25} \quad (8)$$

$$\frac{d^3\Gamma}{\Gamma d\cos\theta_k d\cos\theta_l d\phi} \sin 2\theta_k \sin 2\theta_l \cos\phi = \frac{8S_4}{25} \quad (9)$$

$$\frac{d^3\Gamma}{\Gamma d\cos\theta_k d\cos\theta_l d\phi} \sin 2\theta_k \sin\theta_l \cos\phi = \frac{2S_5}{5} \quad (10)$$

$$\frac{d^3\Gamma}{\Gamma d\cos\theta_k d\cos\theta_l d\phi} \sin 2\theta_k \sin\theta_l \sin\phi = \frac{2S_7}{5} \quad (11)$$

$$\frac{d^3\Gamma}{\Gamma d\cos\theta_k d\cos\theta_l d\phi} \sin 2\theta_k \sin 2\theta_l \sin\phi = \frac{8S_8}{25} \quad (12)$$

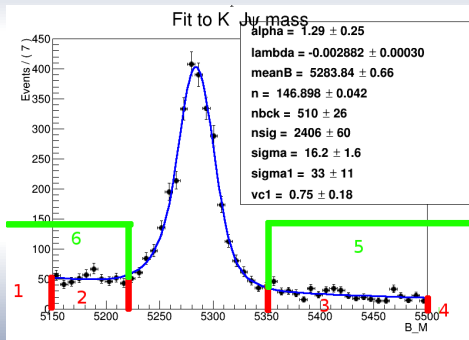
Studied background region

- Defined B^0 mass bins:
 $1 : (5, 5, 15) \cup 2 : (5.15, 5.22) \cup 3 : (5.35, 5.5) \cup 4 : (5.5, 6)$ GeV

- 1 Region 5:(5.35, 6)
- 2 Region 6:(5, 5.22)

- use the old q^2 bins:

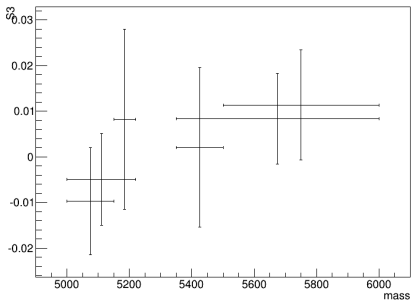
- 0:0, 2
- 1:2, 4.3
- 2:4.3, 8, 6
- 3:10.1, 12.9
- 4:14.2, 16
- 5:16, 19



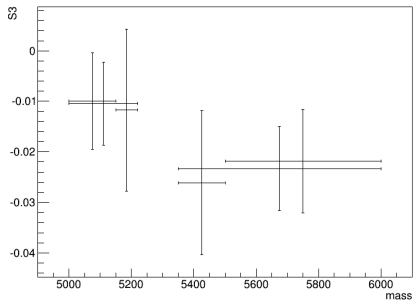
Please remember the numbers, we will need them later on.

Measurement of background moments

Q2_0_S3

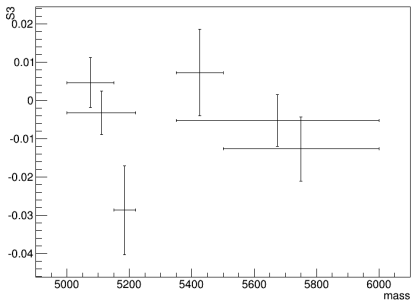


Q2_1_S3

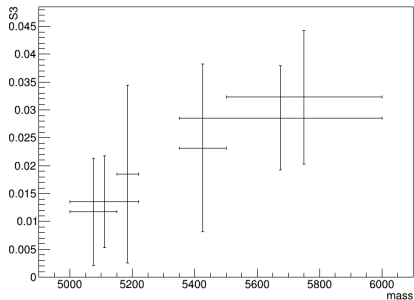


Measurement of background moments

Q2_2_S3

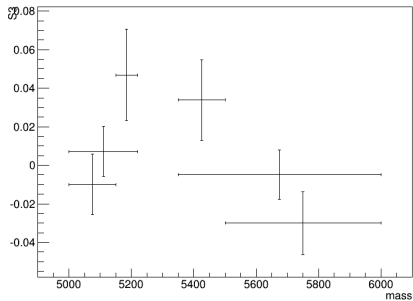


Q2_3_S3

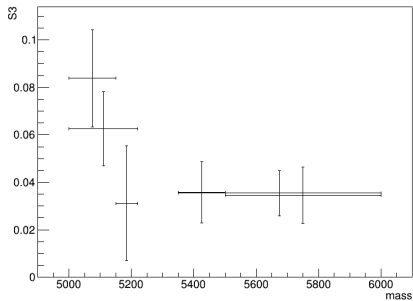


Measurement of background moments

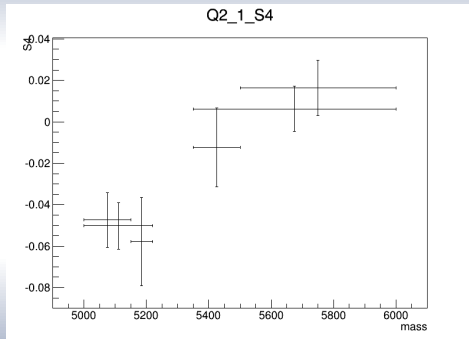
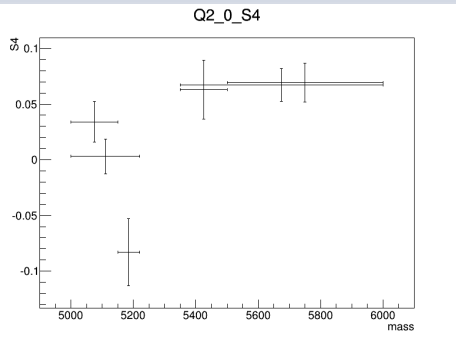
Q2_4_S3



Q2_5_S3

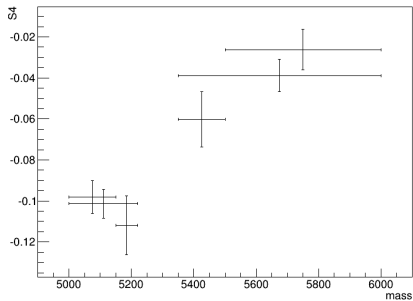


Measurement of background moments

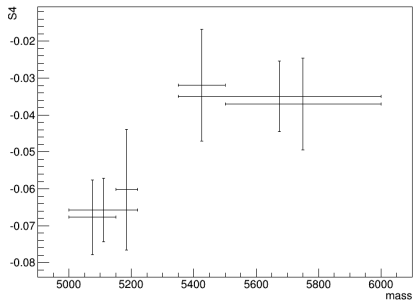


Measurement of background moments

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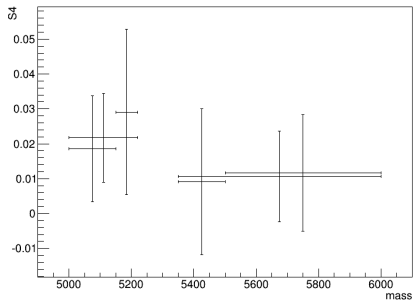


Q2_3_S4

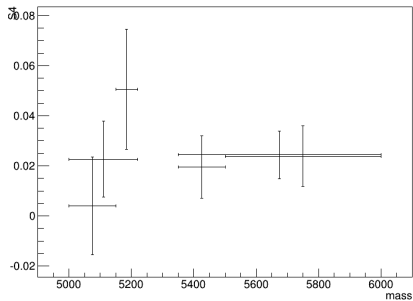


Measurement of background moments

Q2_4_S4

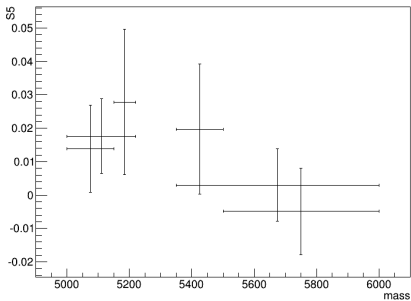


Q2_5_S4

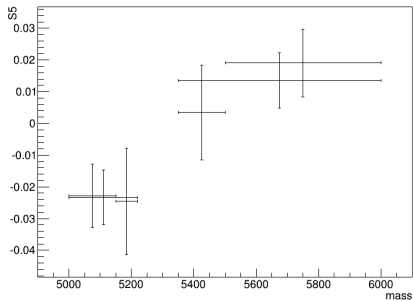


Measurement of background moments

Q2_0_S5

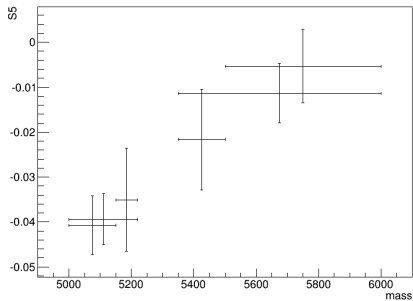


Q2_1_S5

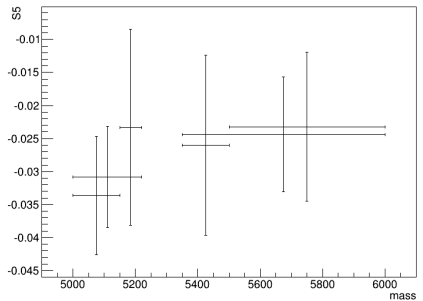


Measurement of background moments

Q2_2_S5

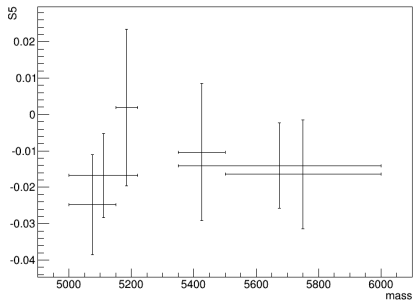


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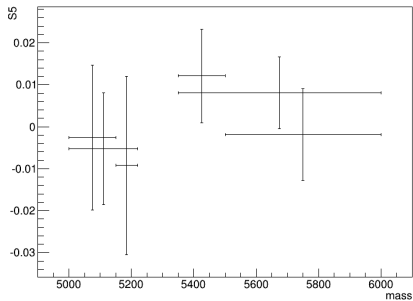


Measurement of background moments

Q2_4_S5

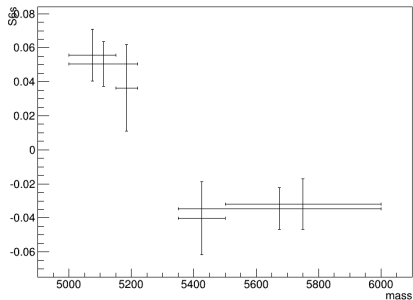


Q2_5_S5

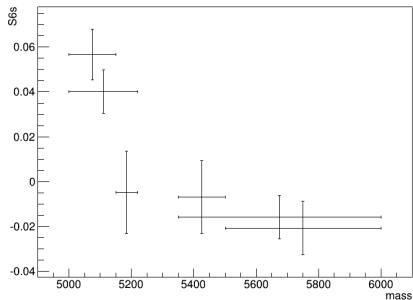


Measurement of background moments

Q2_0_S6s

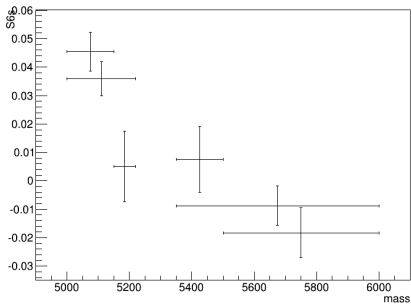


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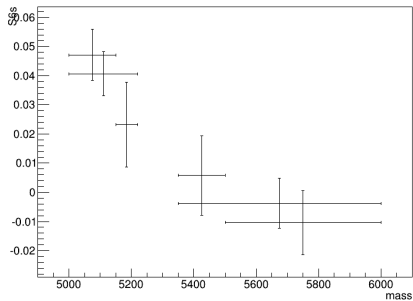


Measurement of background moments

Q2_2_S6s

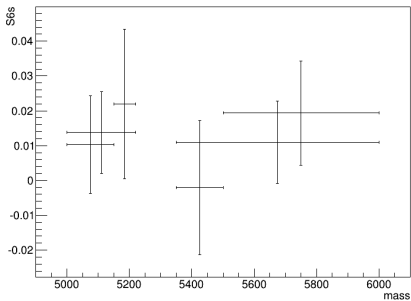


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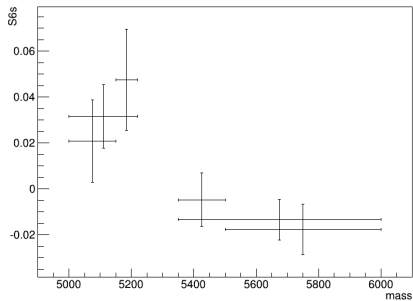


Measurement of background moments

Q2_4_S6s

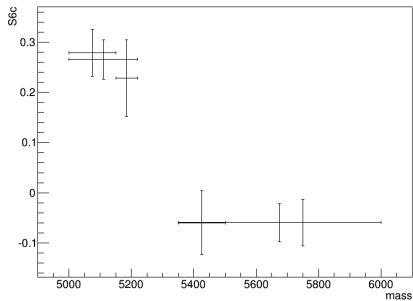


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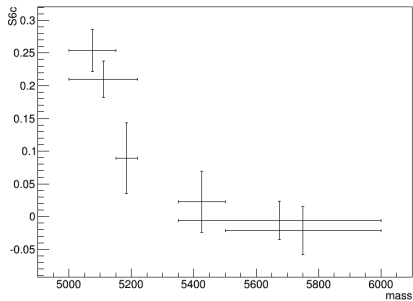


Measurement of background moments

Q2_0_S6c

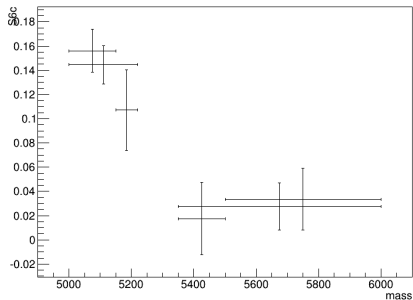


Q2_1_S6c

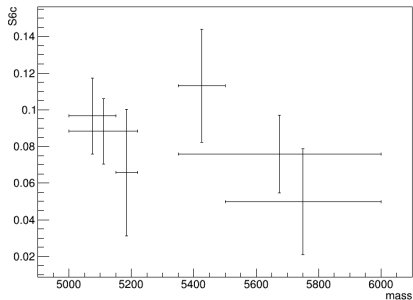


Measurement of background moments

Q2_2_S6c

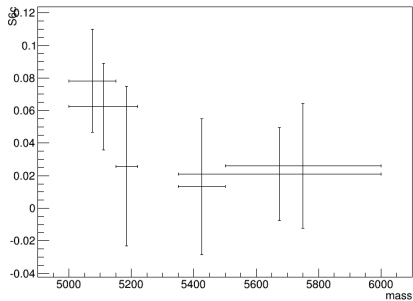


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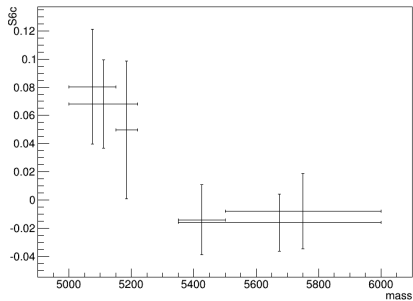


Measurement of background moments

Q2_4_S6c

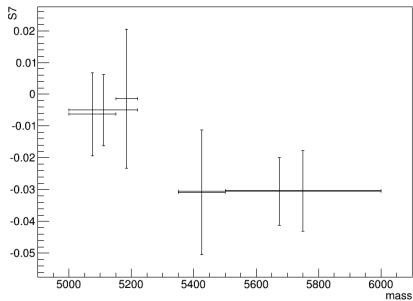


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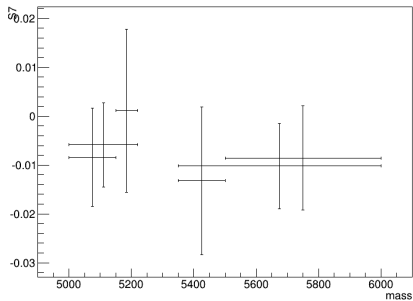


Measurement of background moments

Q2_0_S7

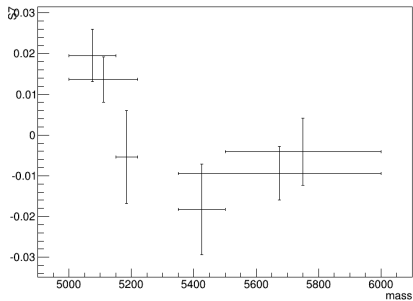


Q2_1_S7

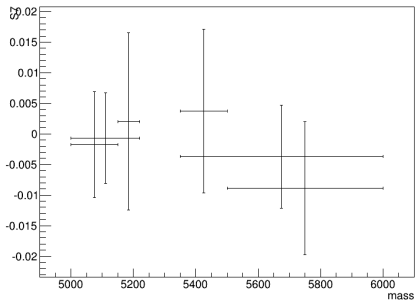


Measurement of background moments

Q2_2_S7

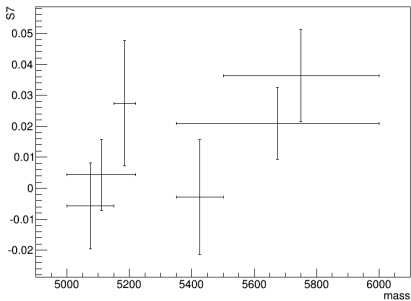


Q2_3_S7

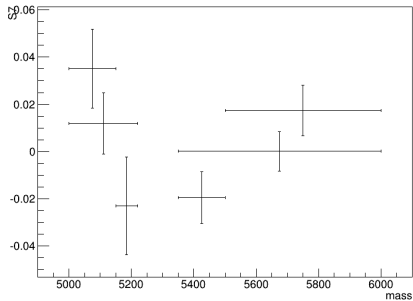


Measurement of background moments

Q2_4_S7

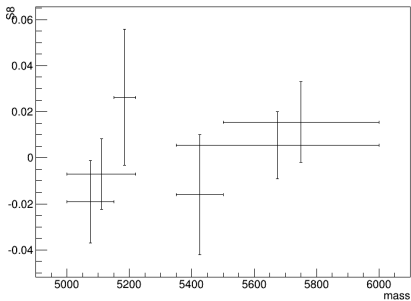


Q2_5_S7

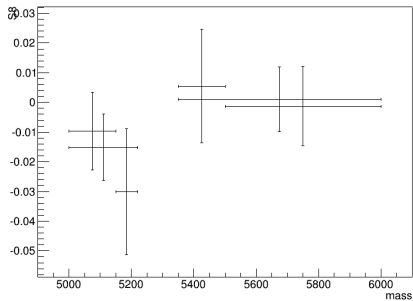


Measurement of background moments

Q2_0_S8

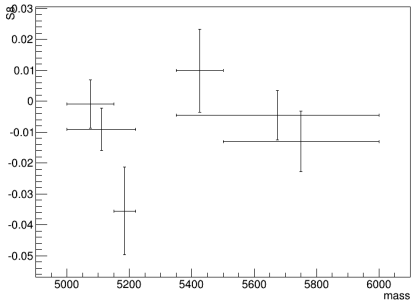


Q2_1_S8

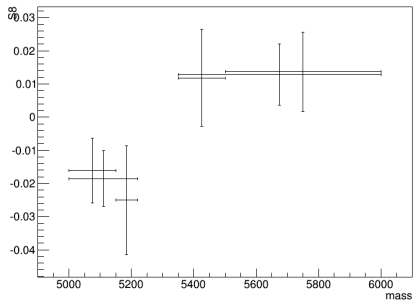


Measurement of background moments

Q2_2_S8

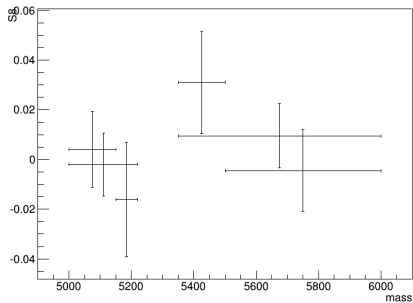


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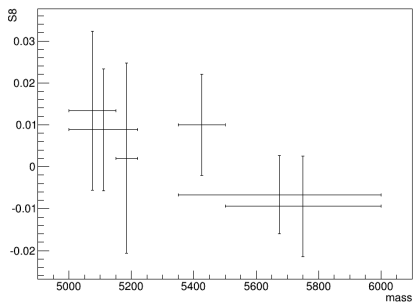


Measurement of background moments

Q2_4_S8

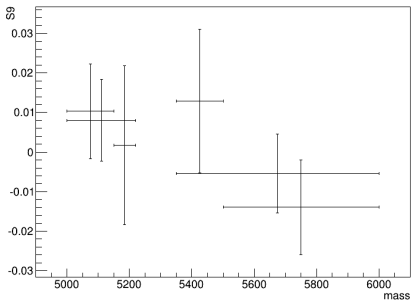


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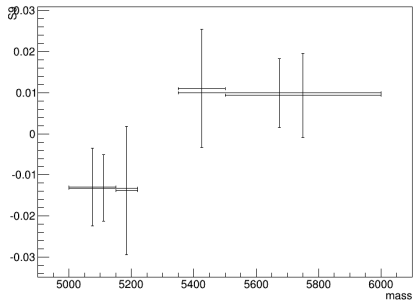


Measurement of background moments

Q2_0_S9

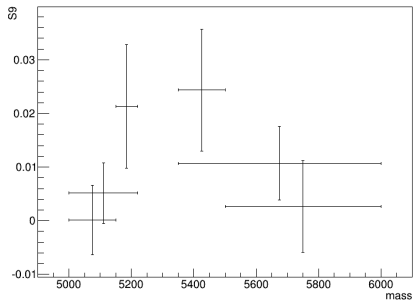


Q2_1_S9

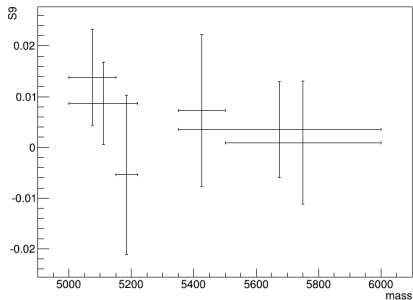


Measurement of background moments

Q2_2_S9

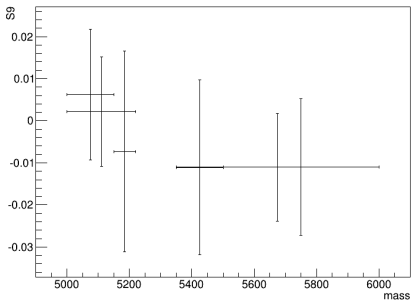


Q2_3_S9

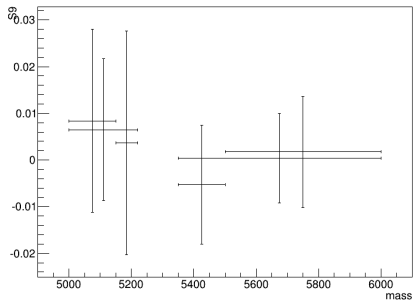


Measurement of background moments

Q2_4_S9

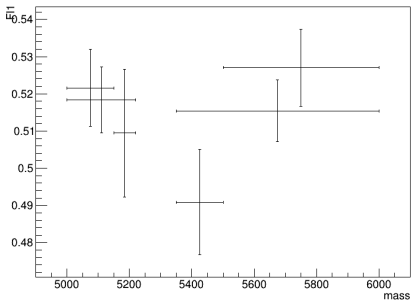


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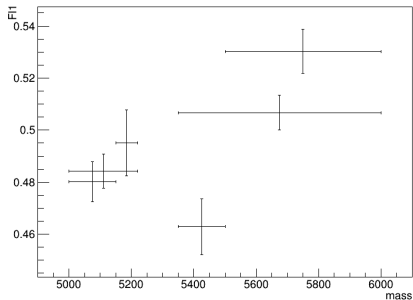


Measurement of background moments

Q2_0_Fl1

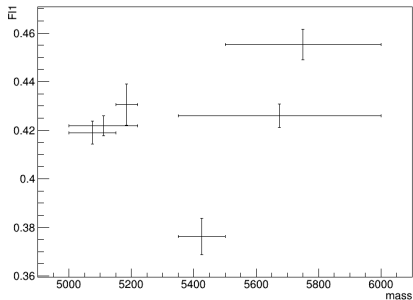


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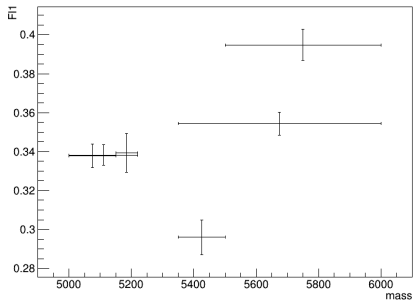


Measurement of background moments

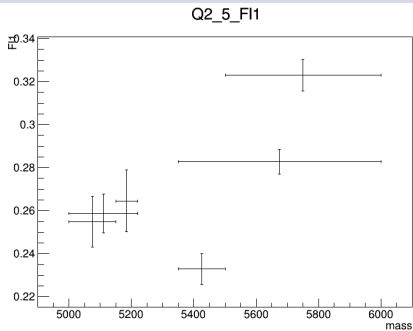
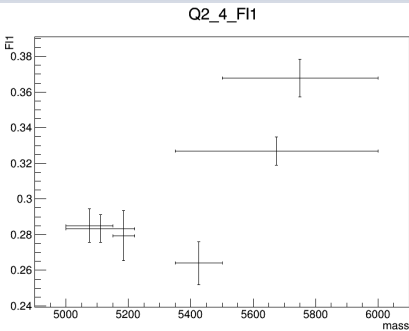
Q2_2_Fl1



Q2_3_Fl1

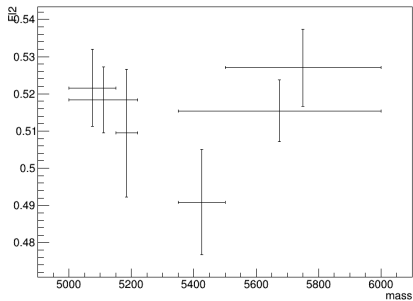


Measurement of background moments

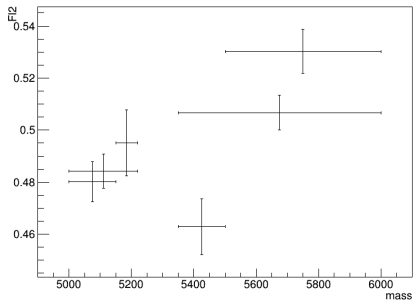


Measurement of background moments

Q2_0_FI2

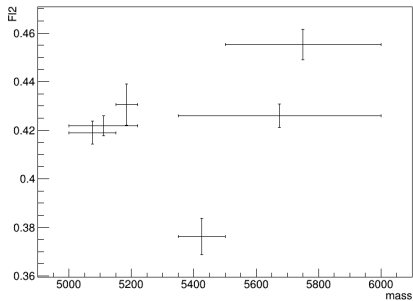


Q2_1_FI2

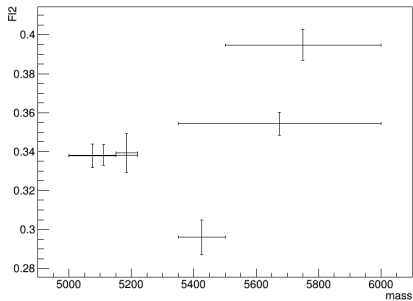


Measurement of background moments

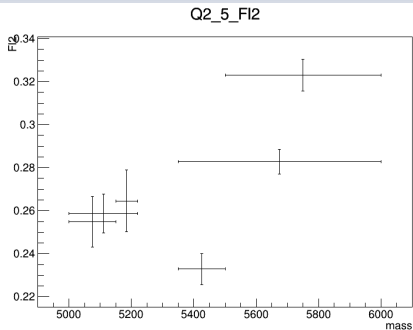
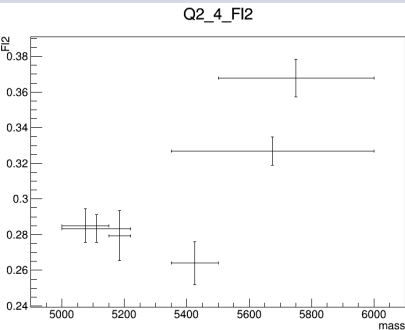
Q2_2_FI2



Q2_3_FI2

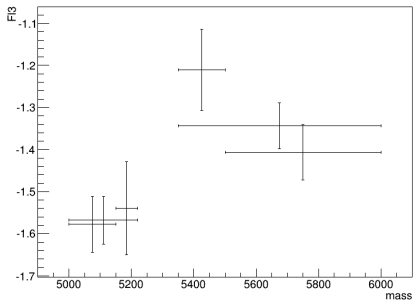


Measurement of background moments

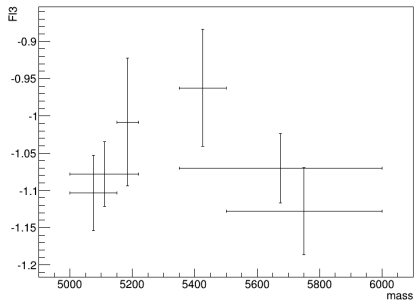


Measurement of background moments

Q2_0_F13

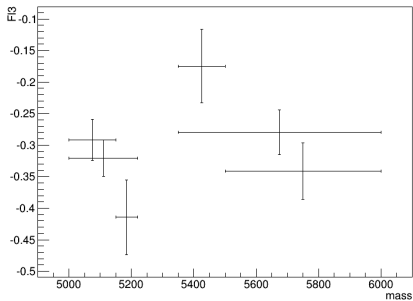


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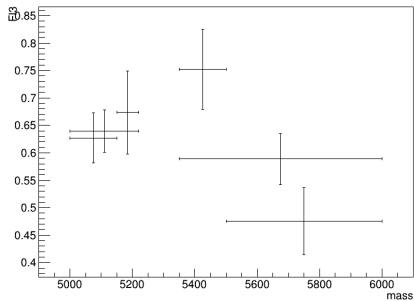


Measurement of background moments

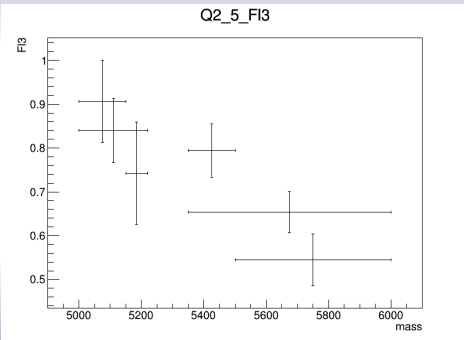
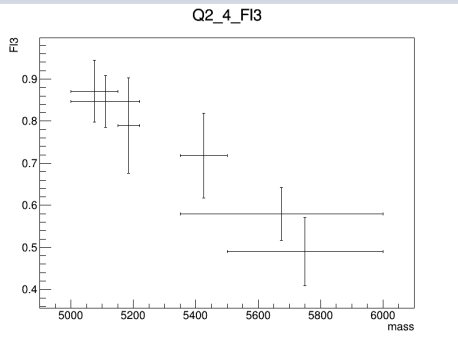
Q2_2_F13



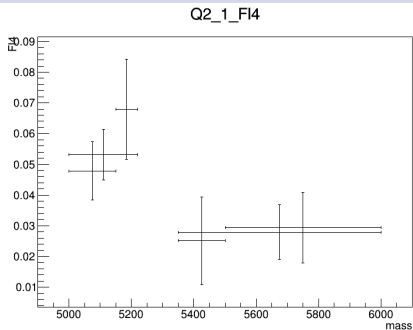
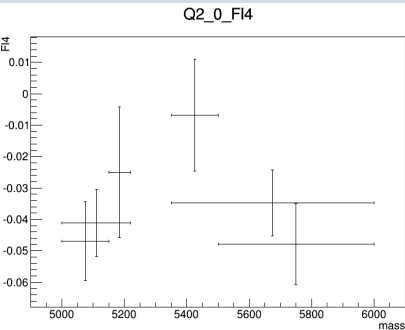
Q2_3_F13



Measurement of background moments

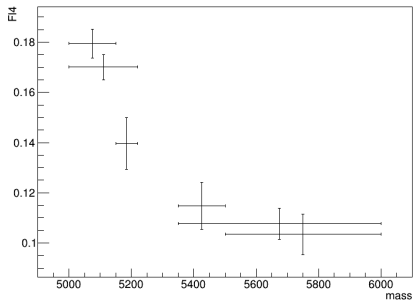


Measurement of background moments

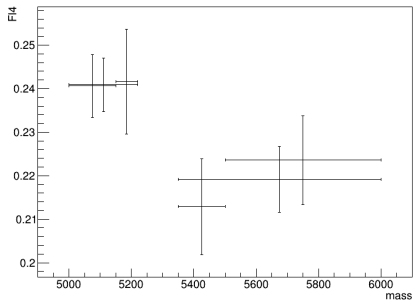


Measurement of background moments

Q2_2_FI4

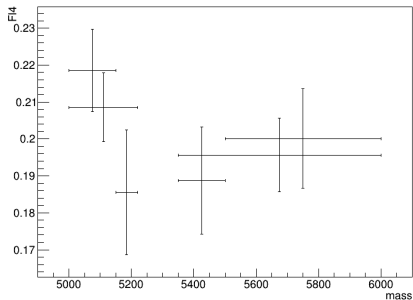


Q2_3_FI4

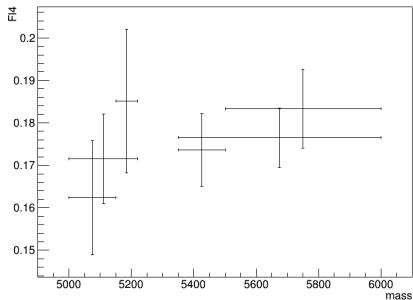


Measurement of background moments

Q2_4_FI4



Q2_5_FI4





Summary

- Background moments are effectively 0
- Apart from F_1 and S_6
- S_6 is sizeable at the left hand sideband for certain bins, evidence of partially reconstructed semileptonic decays?
- Because the moments are small, they should have small effect on the final result :)

Wish list:

- Repeat the same with smaller q^2 bins.
- Optimise the binning in q^2 taking into account background systematics and error on signal
- Do unfolding.