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

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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:

$$\frac{d^4\Gamma}{\Gamma dq^2 dcos\theta_k dcos\theta_l d\phi} = \frac{9}{32\pi}(\frac{3}{4}(1-F_l)\sin^2\theta_k + F_l\cos^2\theta_k + (\frac{1}{4}(1-Fl)\sin^2\theta_k$$
$$-F_l\cos^2)cos2\theta_l + S_3\sin^2\theta_k\sin^2\theta_l\cos 2\phi + S_4\sin 2\theta_k\sin\theta_l\cos\phi +$$
$$S_5\sin 2\theta_k\sin\theta_l\cos\phi + (S_{6s}\sin^2\theta_k)\cos\theta_l +$$
$$S_7\sin 2\theta_k\sin\theta_l\sin\phi + S_8\sin 2\theta_k\sin 2\theta_l\sin phi + S_9 sin^2\theta_k\sin^2\theta_l\sin 2\phi) \tag{1}$$

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:

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

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

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

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

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

Obtained moments 2

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

$$\frac{d^3\Gamma}{\Gamma dcos\theta_k dcos\theta_l d\phi} sin^2\theta_k sin^2\theta_l cos2\phi = \frac{8S_3}{25} \tag{8}$$

$$\frac{d^3\Gamma}{\Gamma dcos\theta_k dcos\theta_l d\phi} sin2\theta_k sin2\theta_k cos\phi = \frac{8S_4}{25} \tag{9}$$

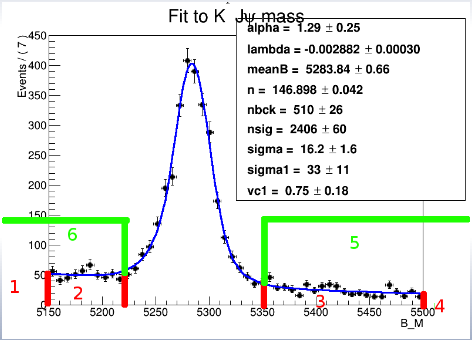
$$\frac{d^3\Gamma}{\Gamma dcos\theta_k dcos\theta_l d\phi} sin2\theta_k sin\theta_l cos\phi = \frac{2S_5}{5} \tag{10}$$

$$\frac{d^3\Gamma}{\Gamma dcos\theta_k dcos\theta_l d\phi} sin2\theta_k sin\theta_l sin\phi = \frac{2S_7}{5} \tag{11}$$

$$\frac{d^3\Gamma}{\Gamma dcos\theta_k dcos\theta_l d\phi} sin2\theta_k sin2\theta_l sin\phi = \frac{8S_8}{25} \tag{12}$$

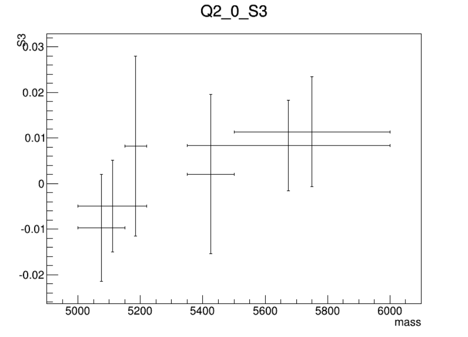
Studied background region

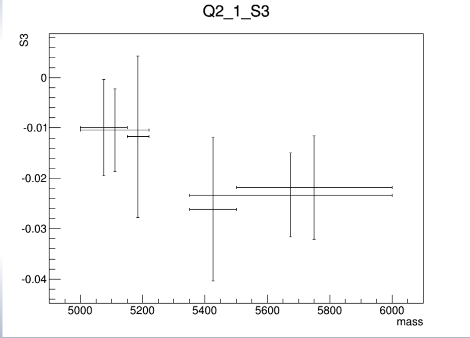
- Defined B^0 mass bins:
  $1 : (5, 5, 15) \cup 2 : (5.15, 5.22) \cup 3 : (5.35, 5.5) \cup 4 : (5.5, 6)$ *GeV*
  1. Region 5:$(5.35, 6)$
  2. Region 6:$(5, 5.22)$
- use the old q^2 bins:
  - 0:0, 2
  - 1:2, 4.3
  - 2:4.3, 8, 6
  - 3:10.1, 12.9
  - 4:14.2, 16
  - 5:16, 19



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

Measurement of background moments





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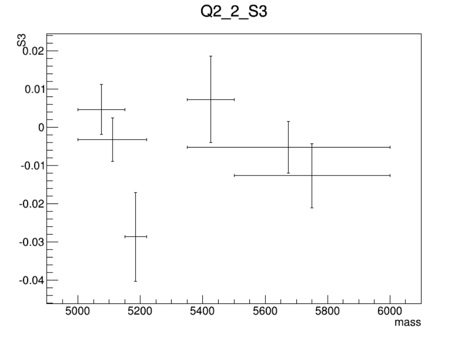

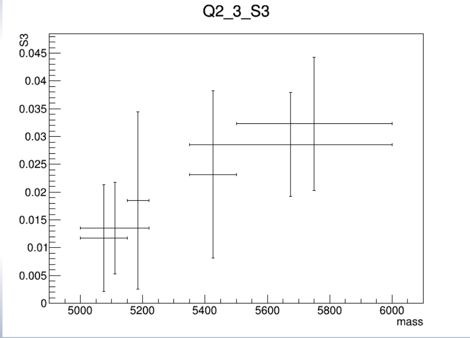

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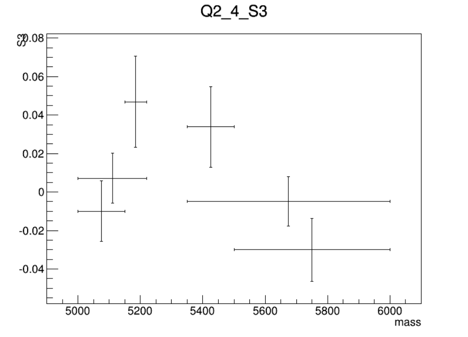

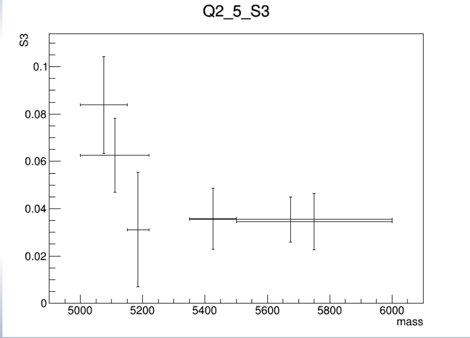

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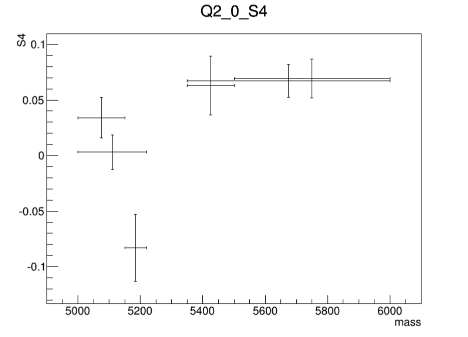

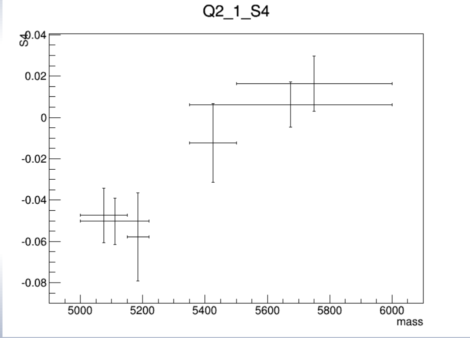

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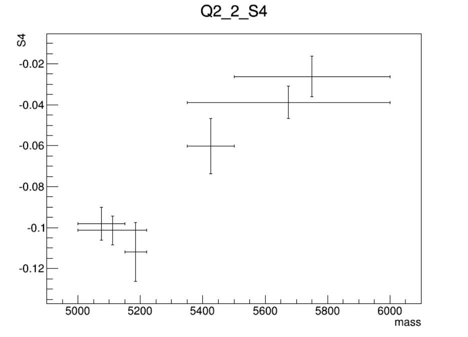

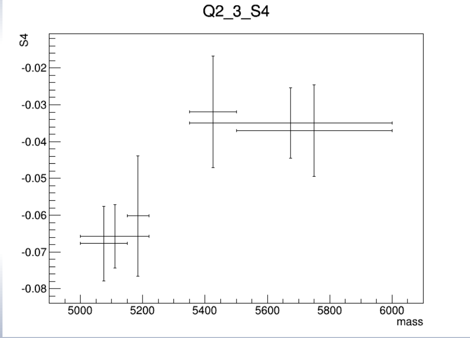

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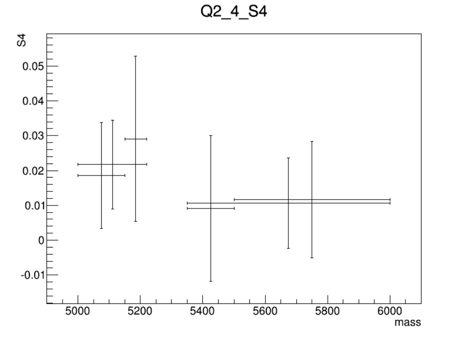

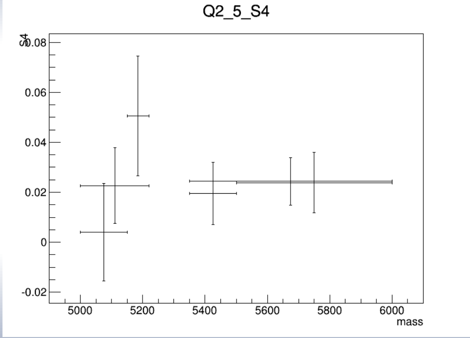

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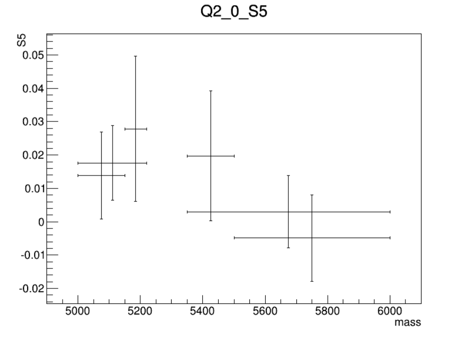

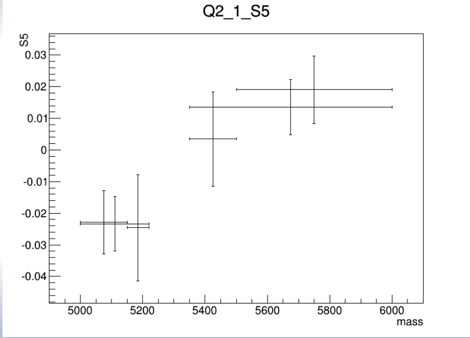

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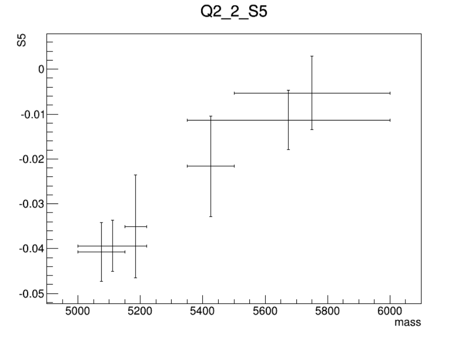

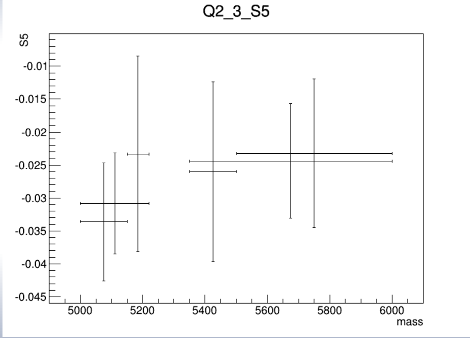

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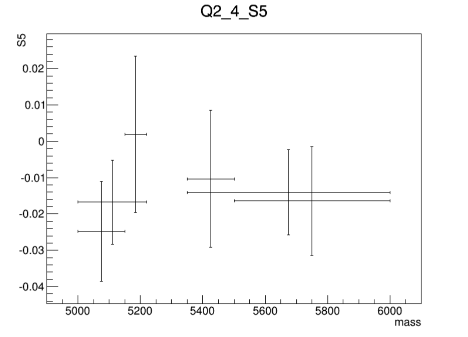

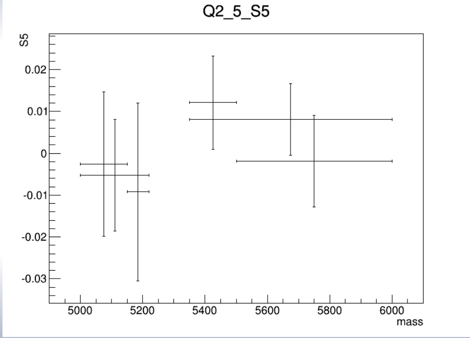

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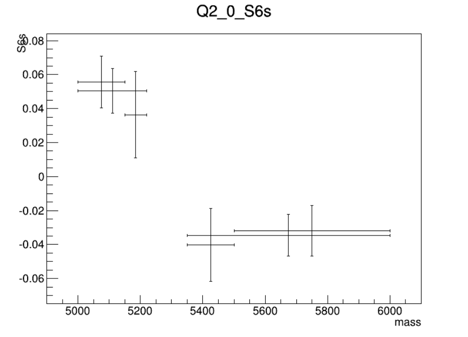

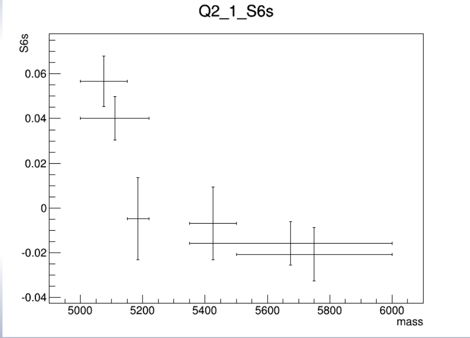

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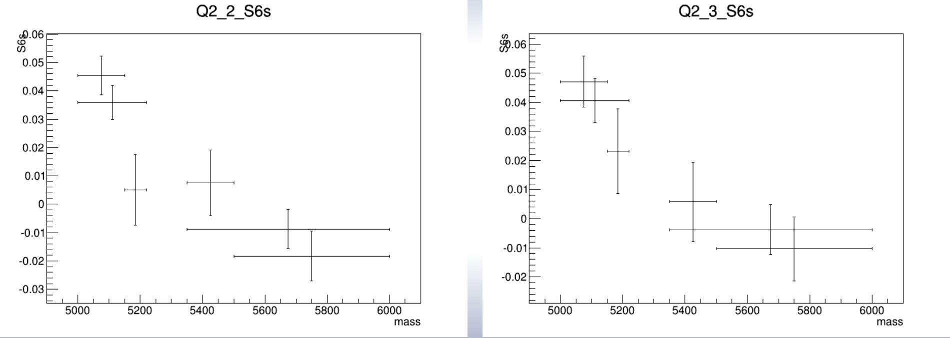

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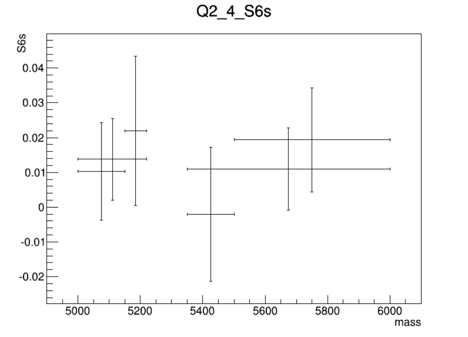

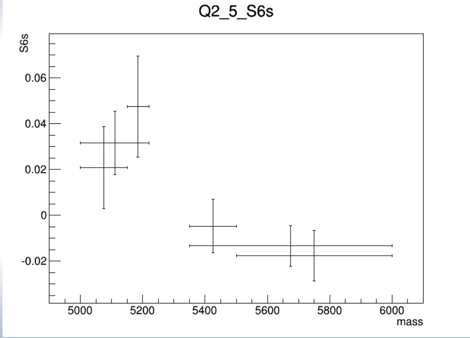

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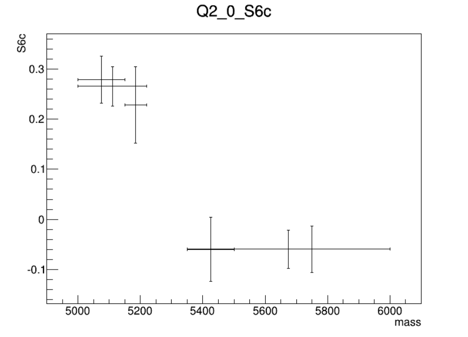

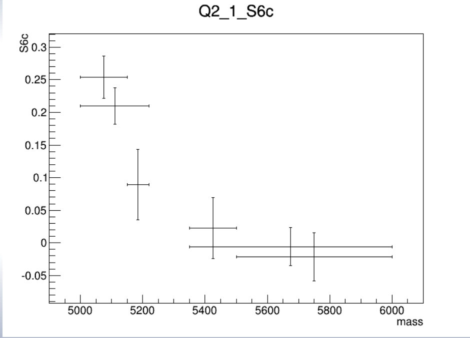

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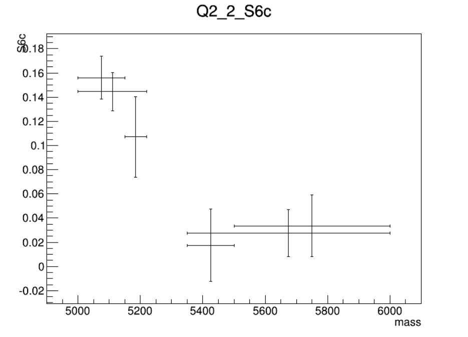

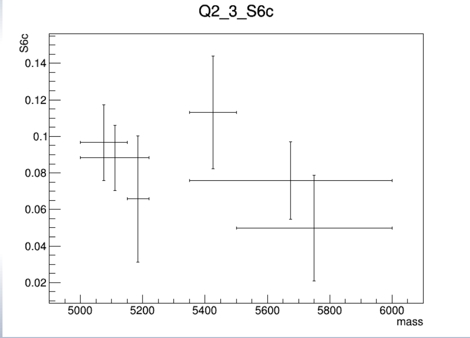

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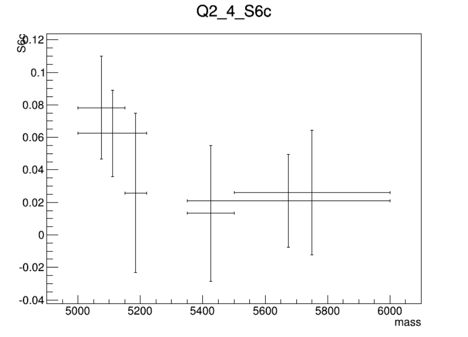

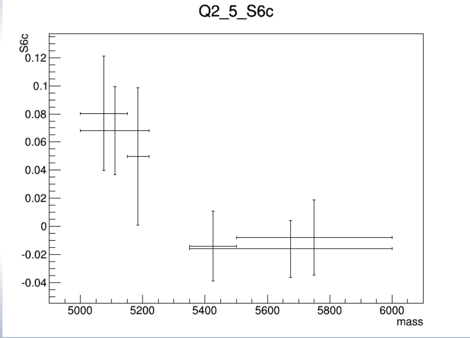

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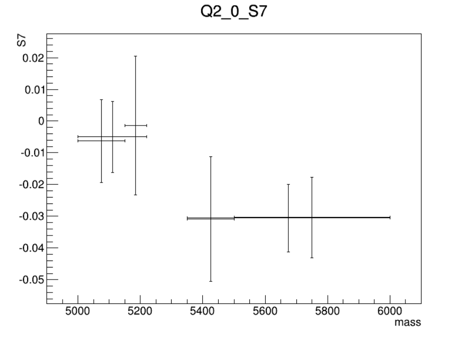

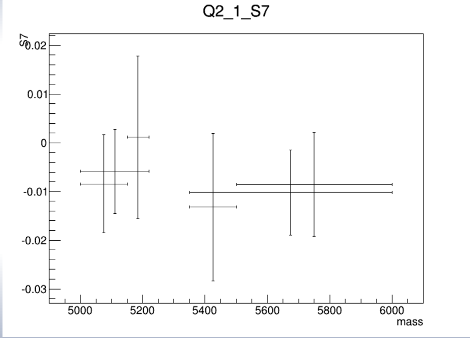

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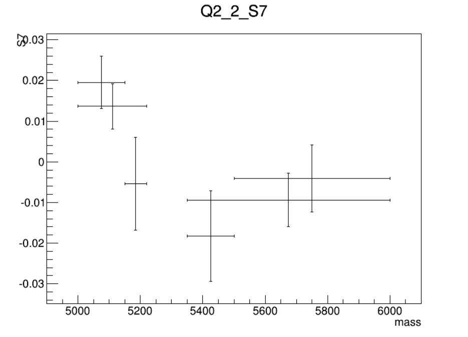

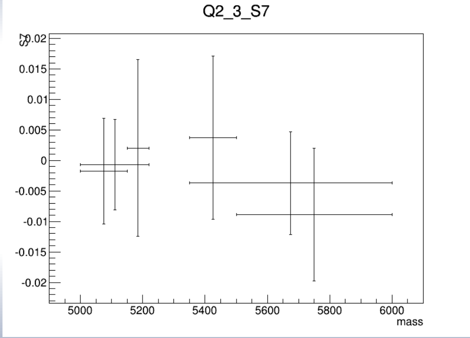

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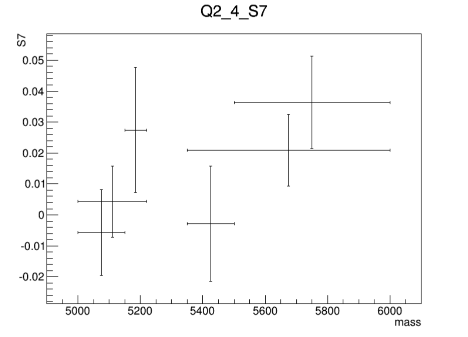

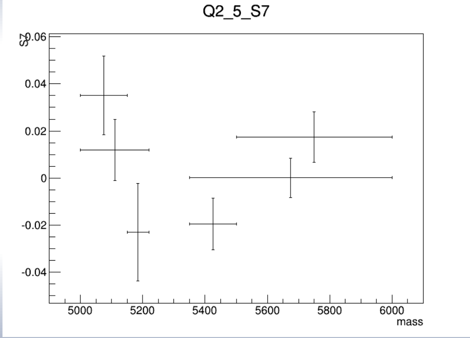

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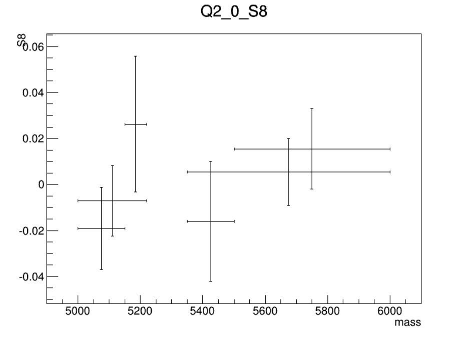

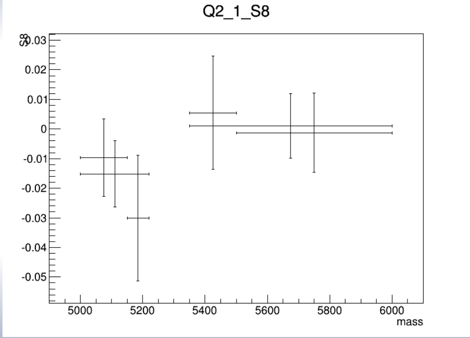

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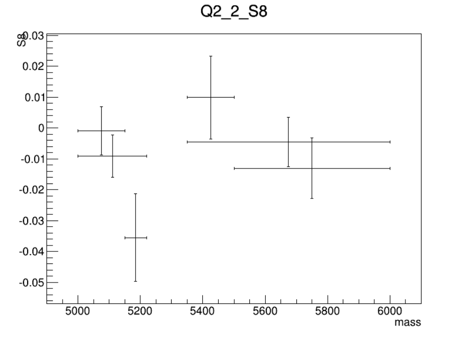

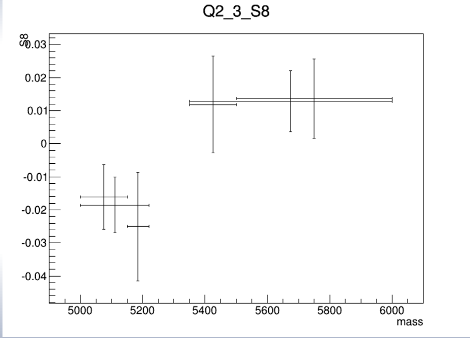

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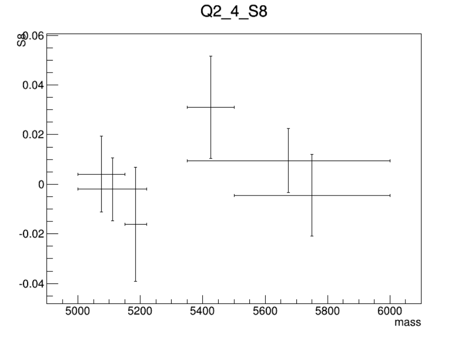

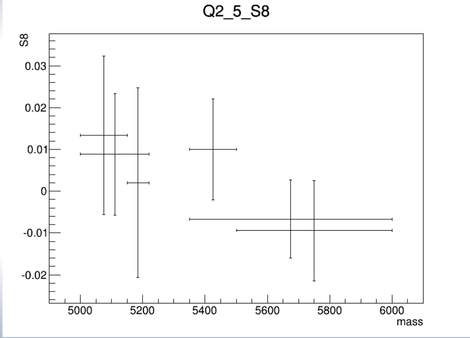

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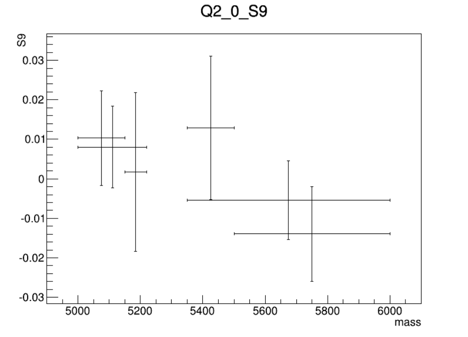

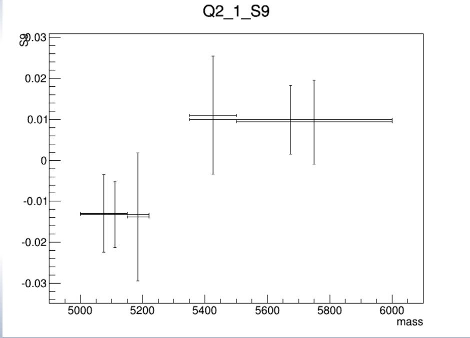

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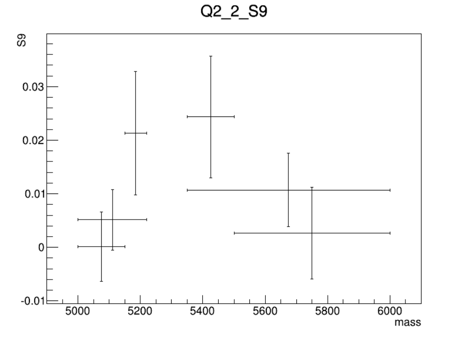

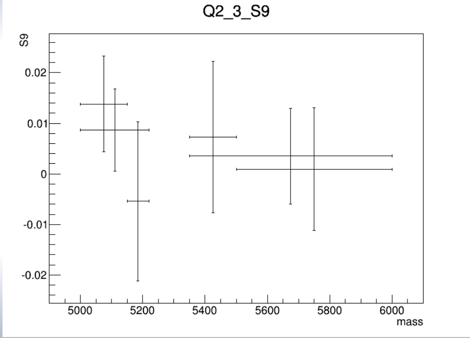

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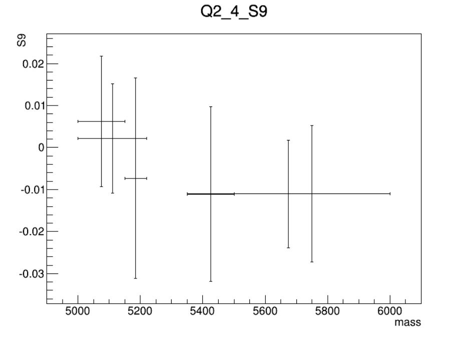

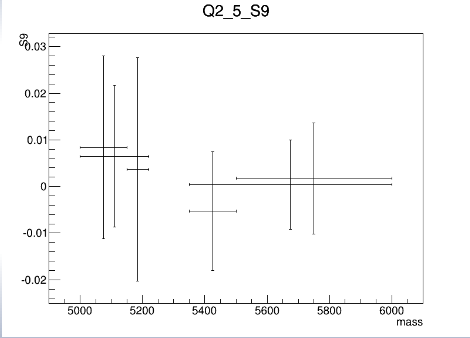

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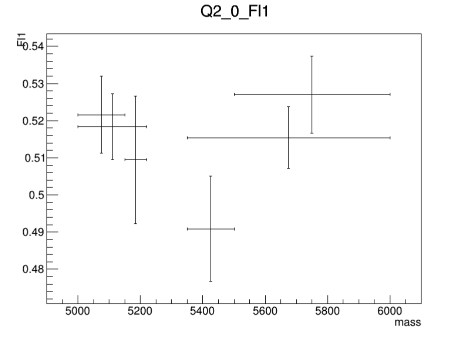

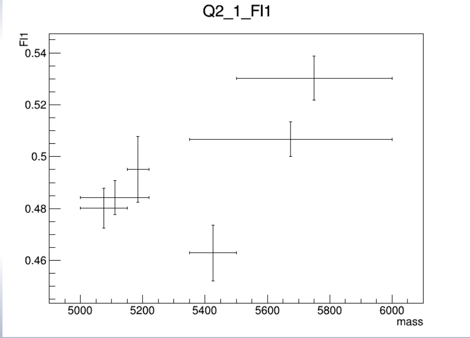

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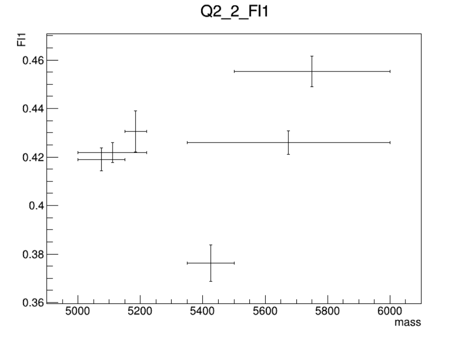

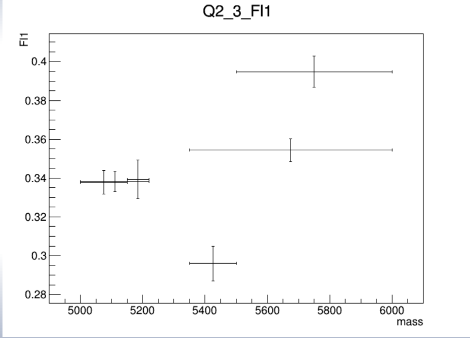

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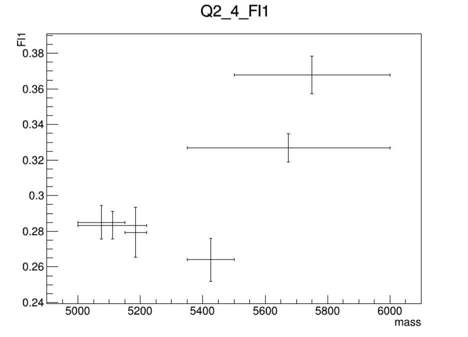

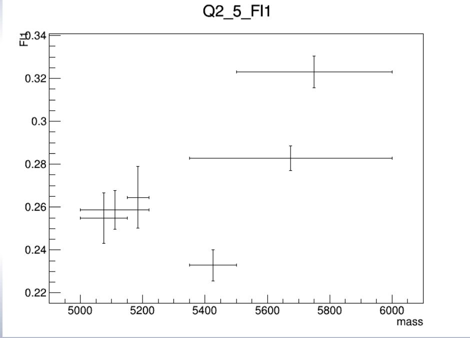

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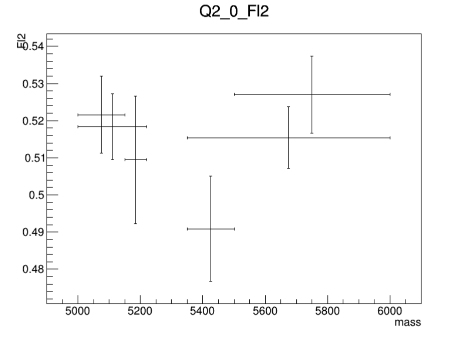

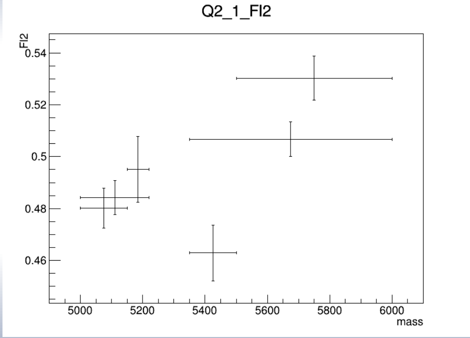

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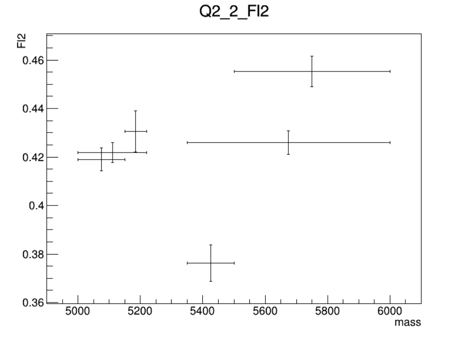

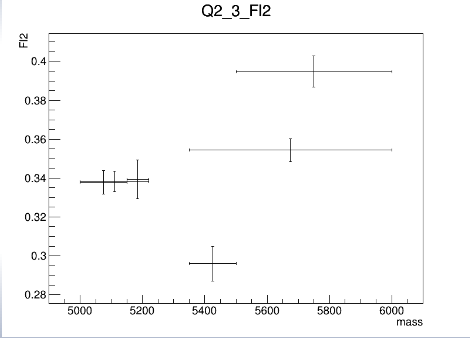

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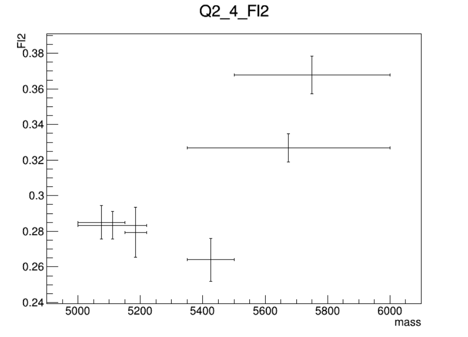

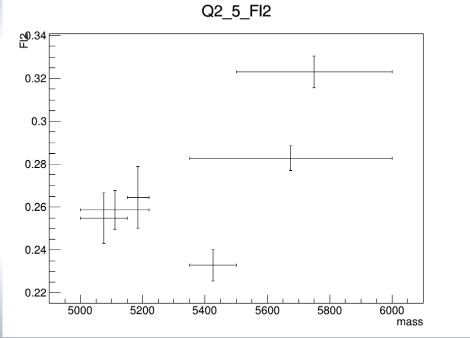

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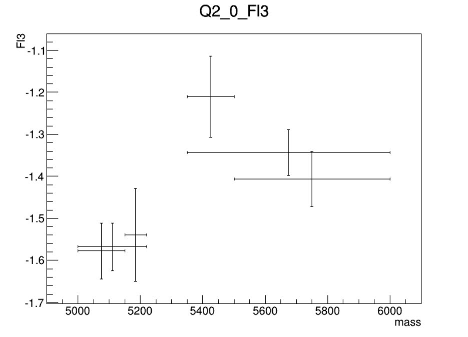

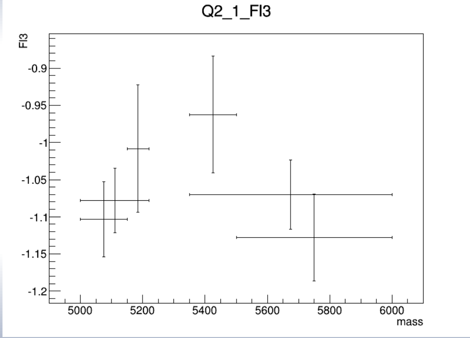

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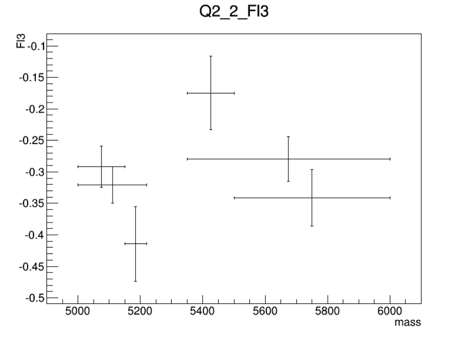
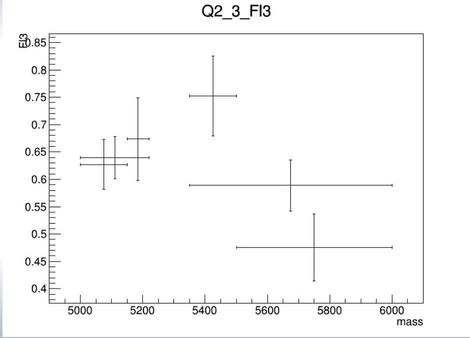
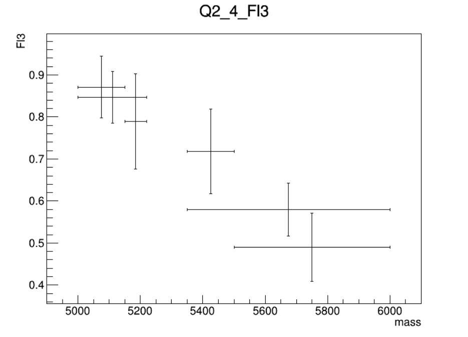
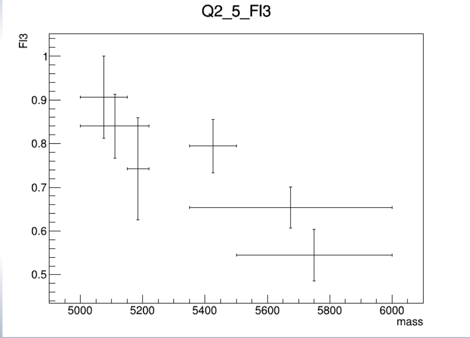


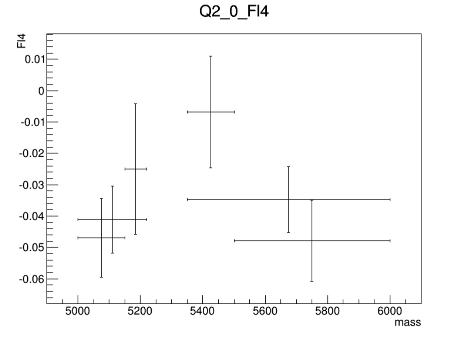


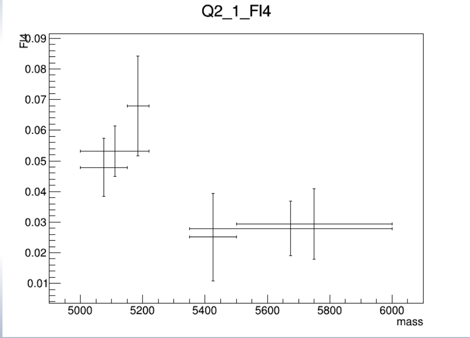
Measurement of background moments



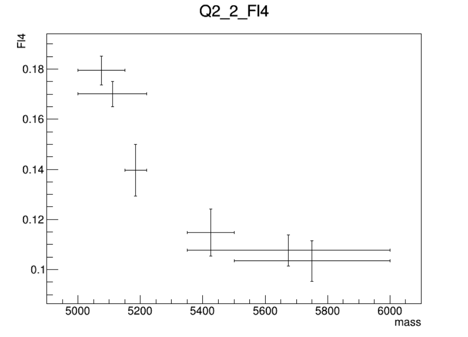


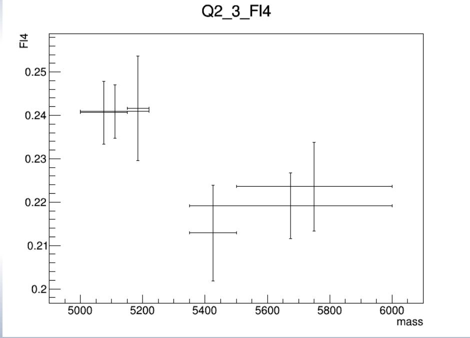
Measurement of background moments



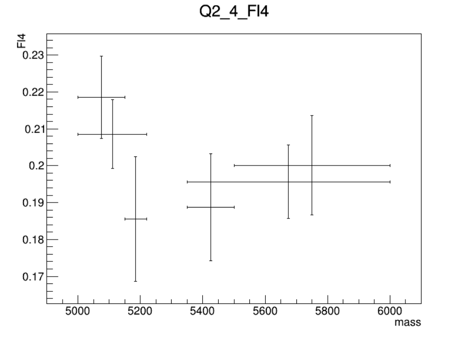


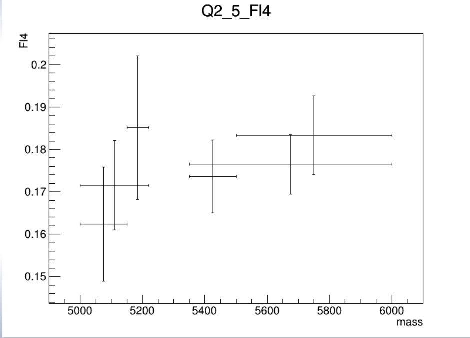
Measurement of background moments





Measurement of background moments





Summary

- Background moments are effectivelly 0
- Apart from F_l 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.