Fit stability studies

QCD model

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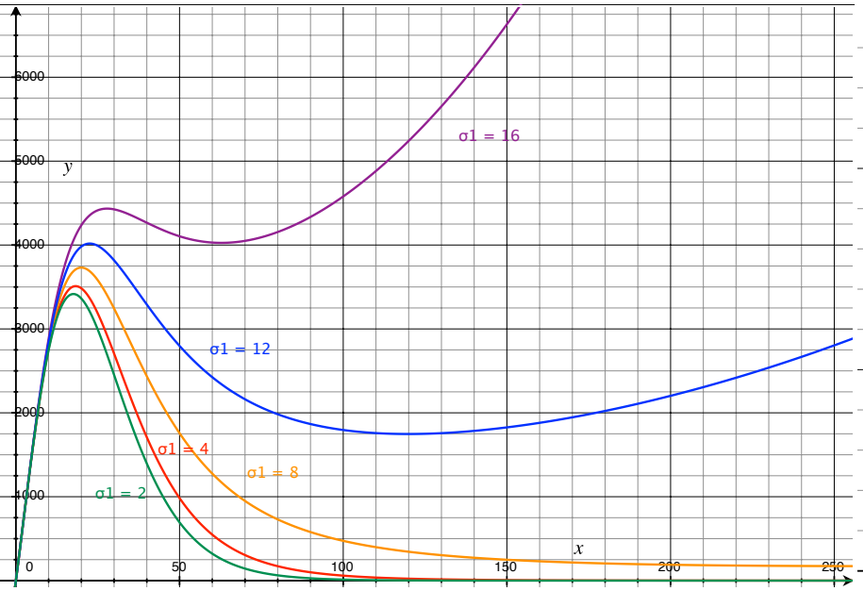
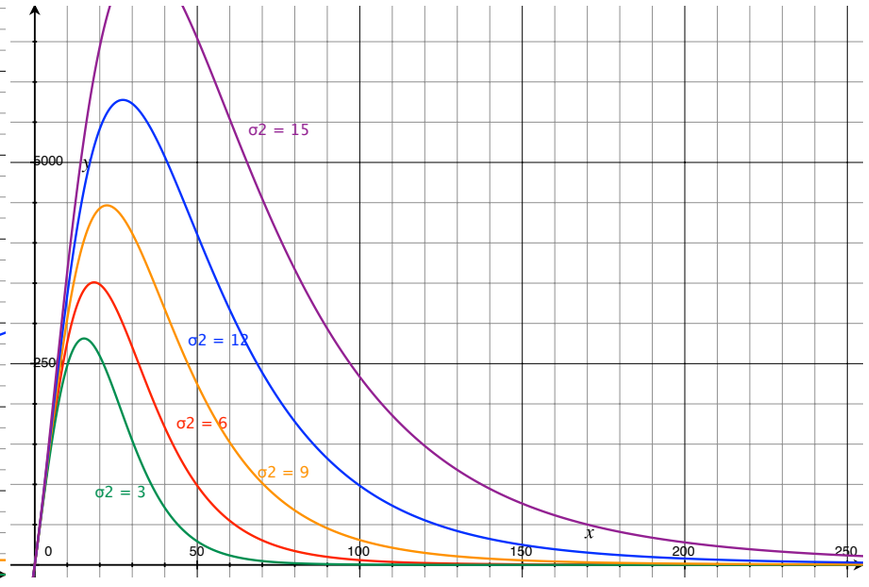
QCD model in W-asymmetries fit

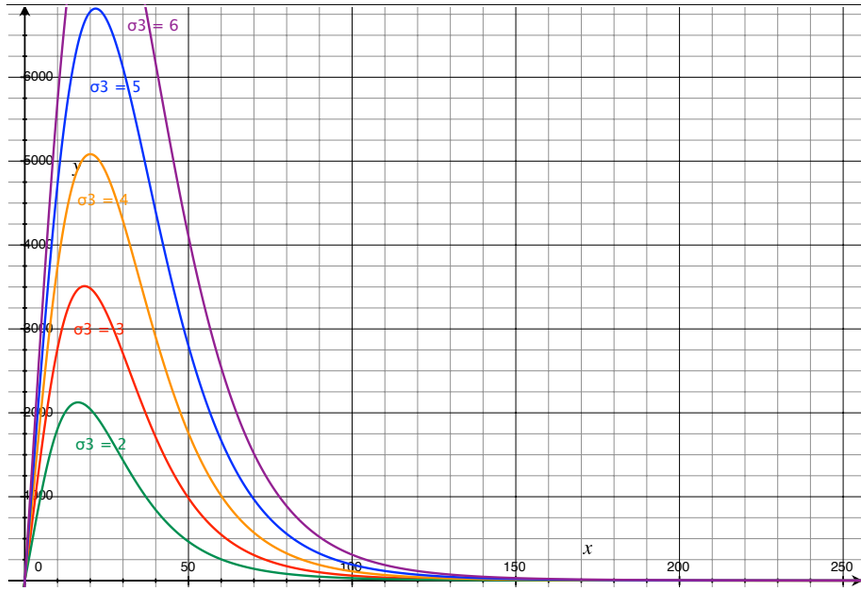
No reliable QCD MC with sufficient statistics exists.

The fraction of QCD in the selected events is modelled with an *analytical function*:

$$QCD = x(0.01\ a_1\ x^2 + a_2\ x + 100\ a_3) * e^{\frac{-x^2}{0.01\ a_1\ x^2 + a_2\ x + 100\ a_3}}$$







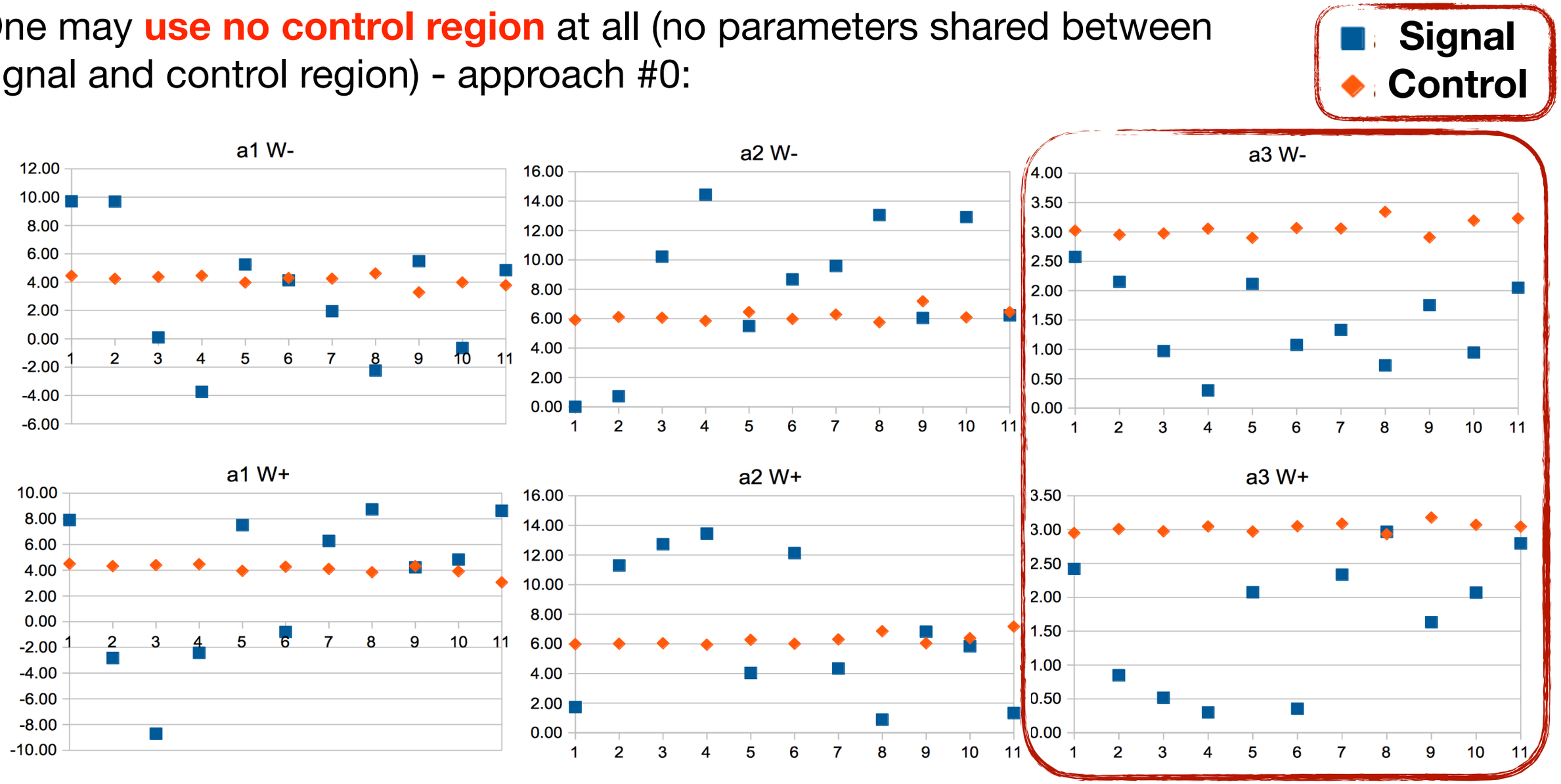
Each of the parameters modifies the *function* in its own way. (experiment with on at a time!)

To get a handle on the QCD background shapes one may use a so-called **control region**.

Control region - large muon cones —> **almost 100% QCD content**.

QCD model: approach #0

One may **use no control region** at all (no parameters shared between signal and control region) - approach #0:



Control region consists almost exceptionally of QCD bkg

- Shows remarkable stability of parameters over full eta range (unlike signal here)
- Demonstrates only small fluctuations (unlike signal here)

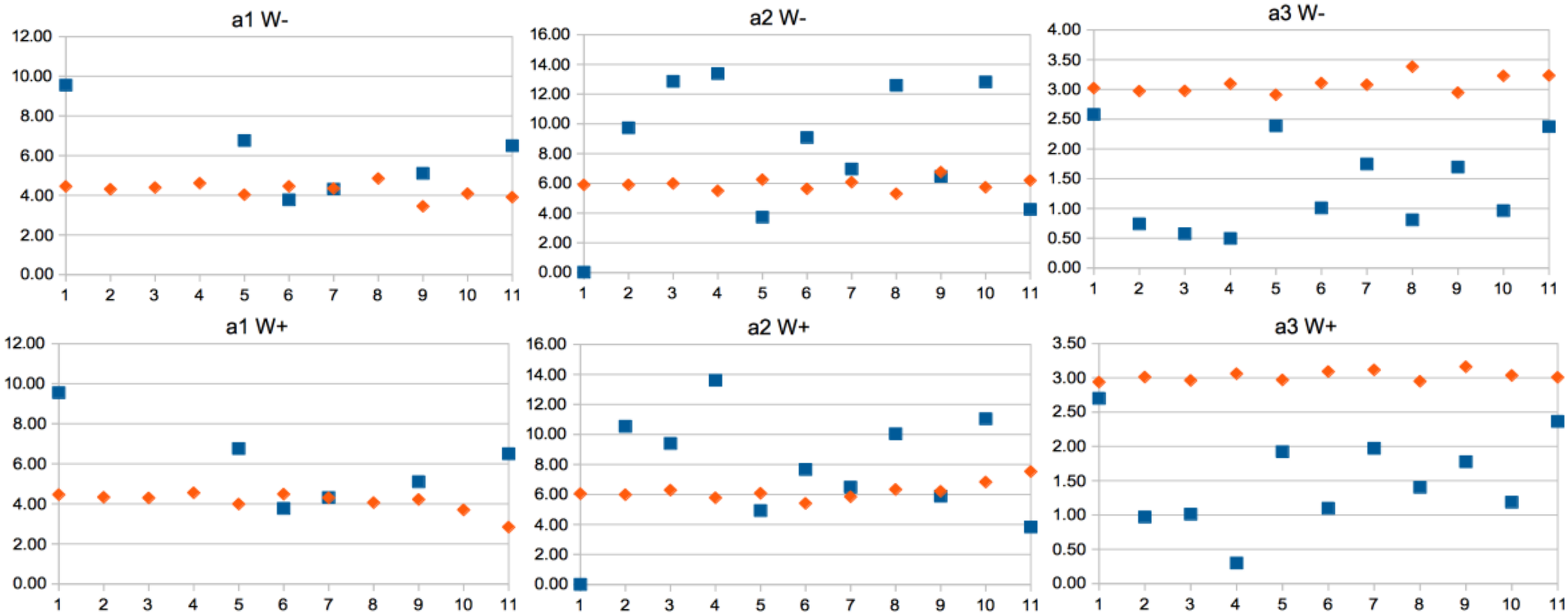
No reasons not to expect something similar in signal region!

QCD model: approach #1.1

Try to tie only one parameter between the processes:
a1W-_sig ←→ a1W+_sig

Signal
Control

Do not use control region



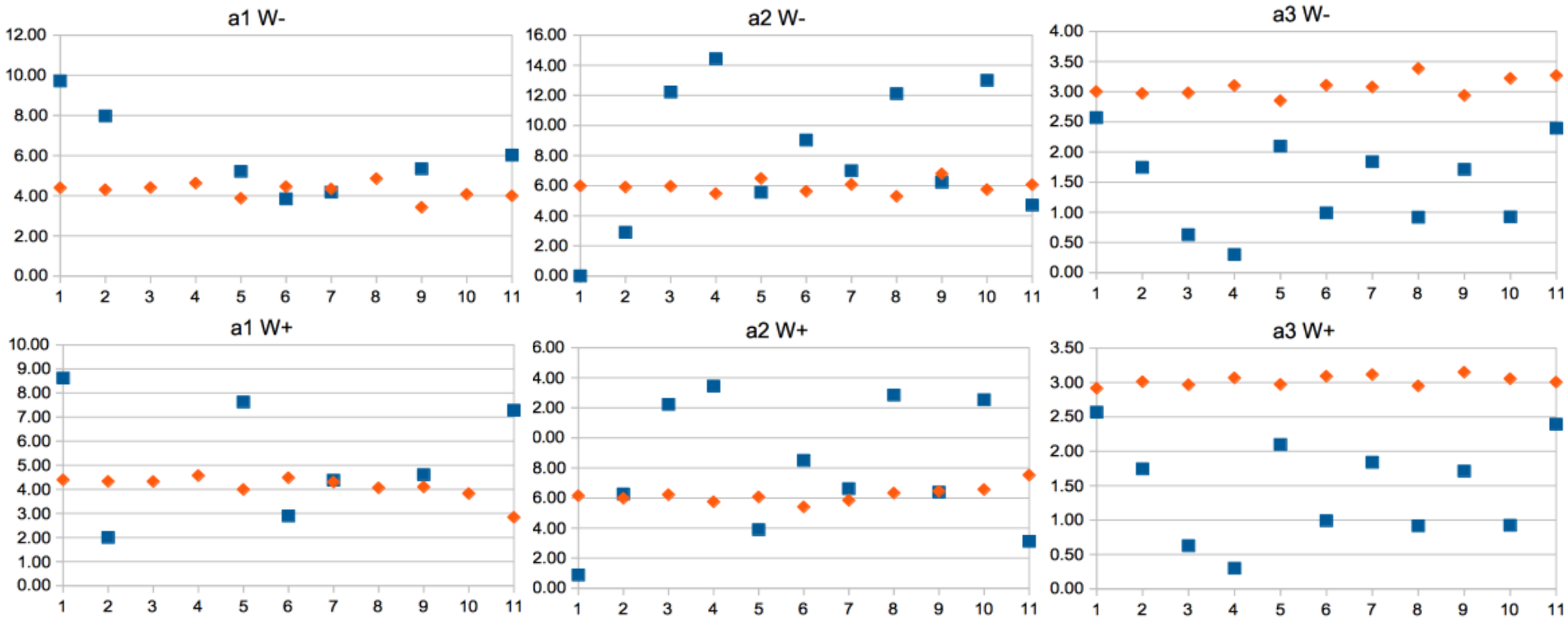
Fluctuations are barely decreased.
a1 fluctuations are even larger (note negative values - missing on the plots)

QCD model: approach #1.3

Try to tie only one parameter between the processes:
a3W-_sig ←→ a3W+_sig

Signal
Control

Do not use control region



Bit smaller fluctuations but in principle the same unsuccessful case

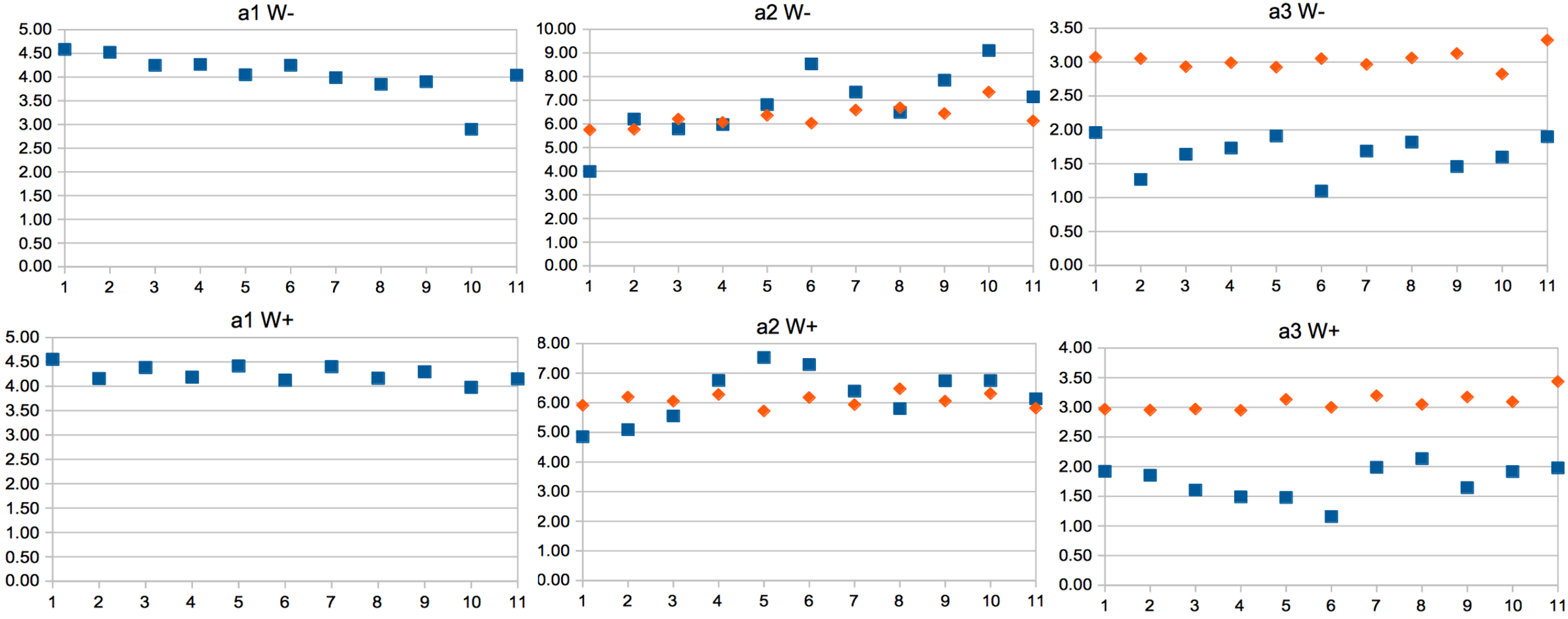
Conclusion: we need the control region as a lever.

QCD model: approach #2.1

Try to tie only one parameter between the regions:
a1W-_sig ←→ a1W−_control, a1W+_sig ←→ a1W+_control

Signal
Control

W+ and W- are kept independent



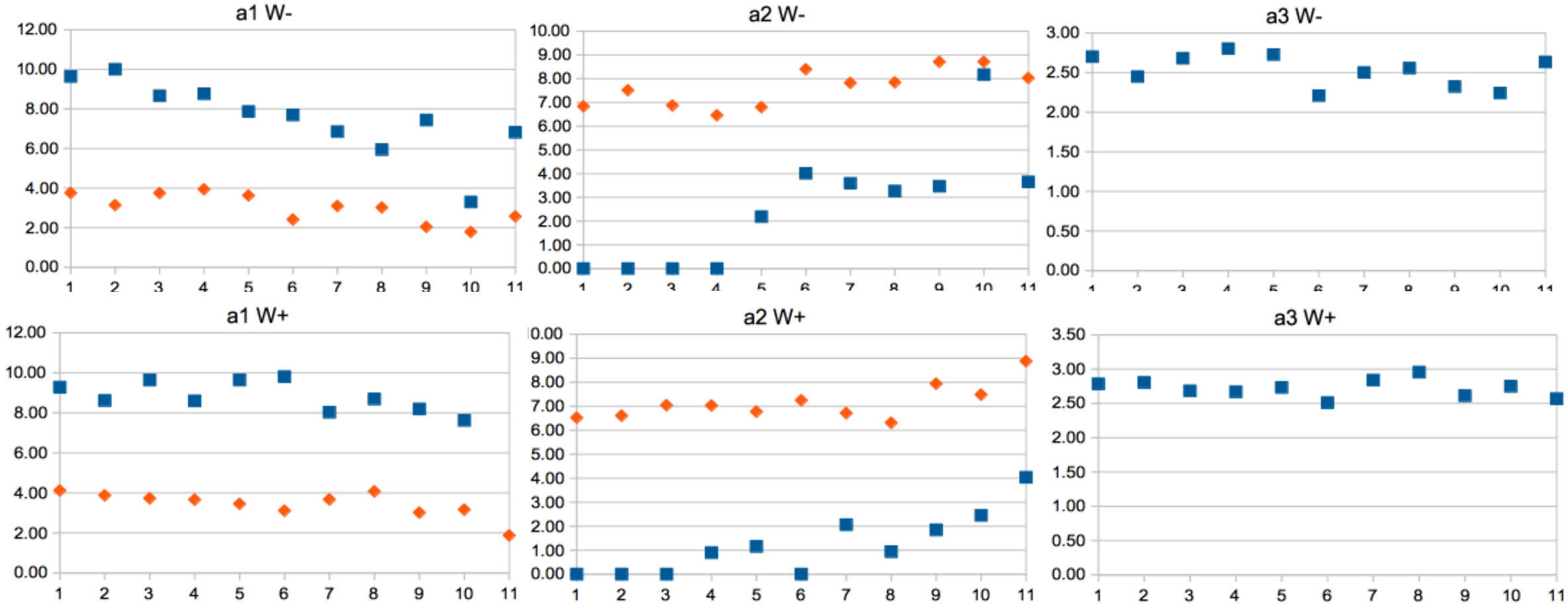
Only one parameter is tied to control region -> signal dispersion reduced, trend established.
- a3 is still systematically off (most likely the effect of muon isolation..?)

QCD model: approach #2.3

Try to tie only one parameter between the regions:
a3W-_sig ←→ a3W−_control, a3W+_sig ←→ a3W+_control

Signal
Control

W+ and W- are kept independent

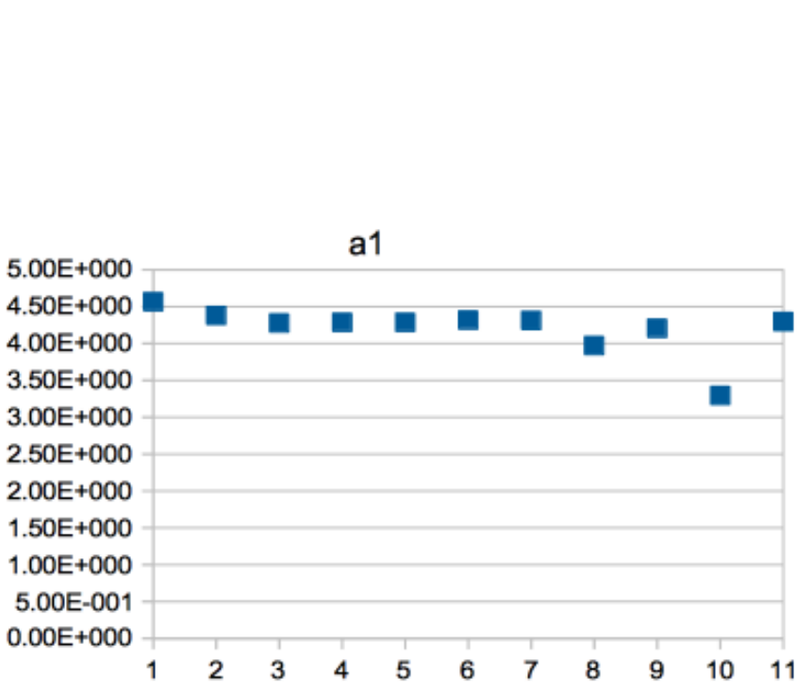


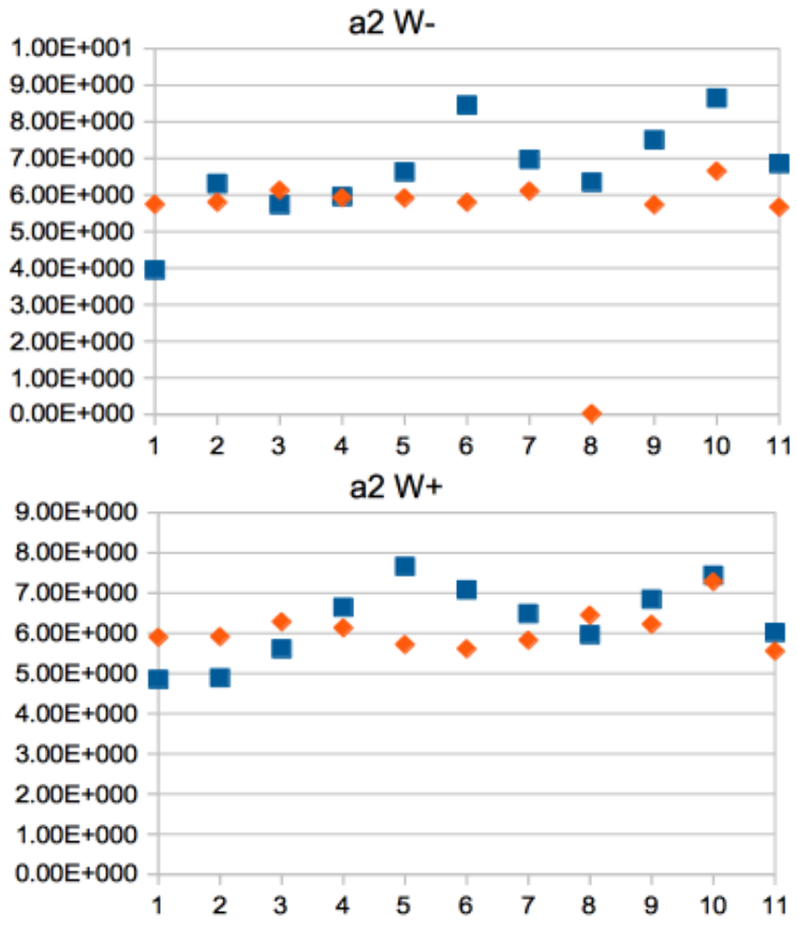
- former a3 offset is compensated bu new offsets in a1 and a2
- Dispersion is higher then in 2.1 case.

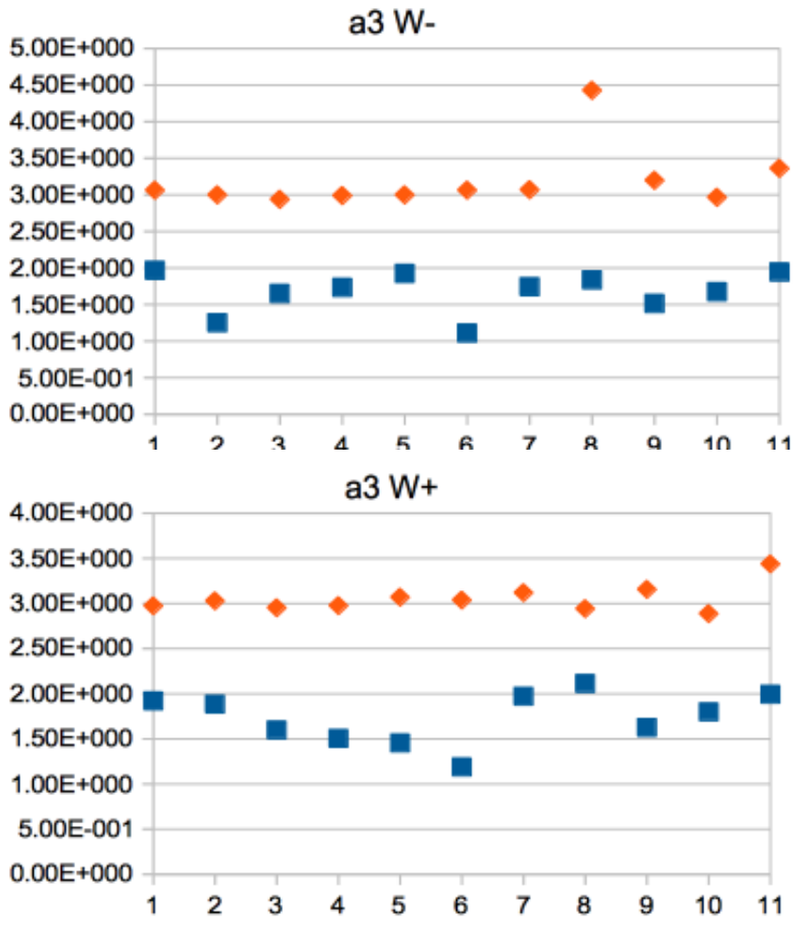
QCD model: approach #3.1

Try to tie only one parameter between the processes:
a1W-_sig,control ←→ a1W+_sig,control

Signal
Control



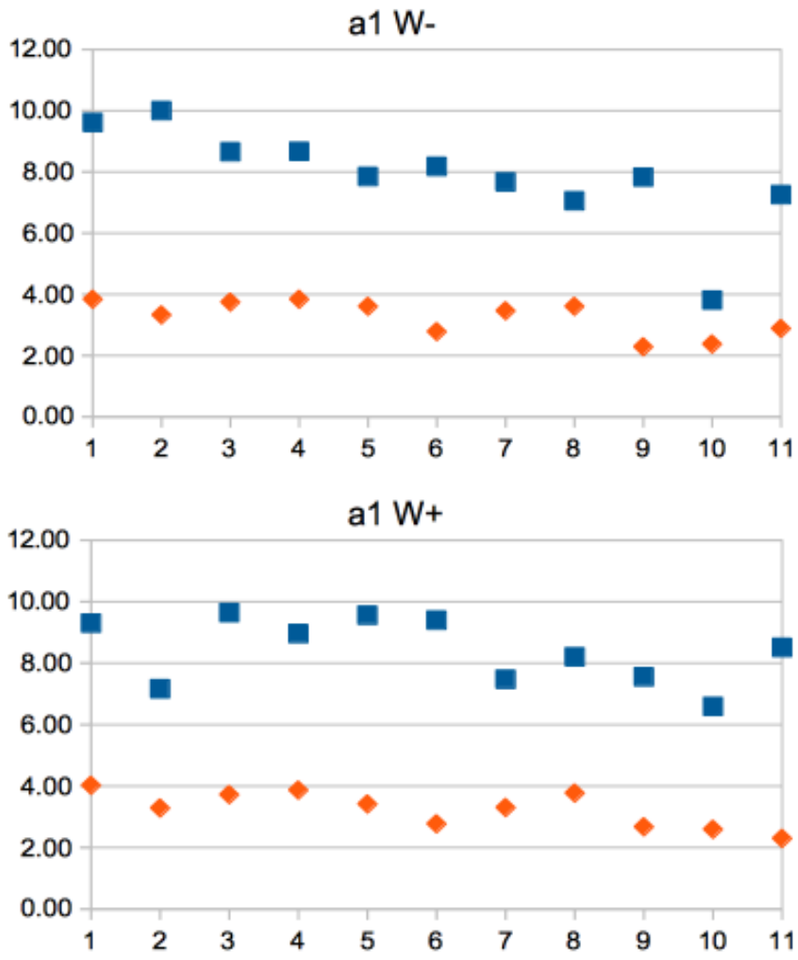


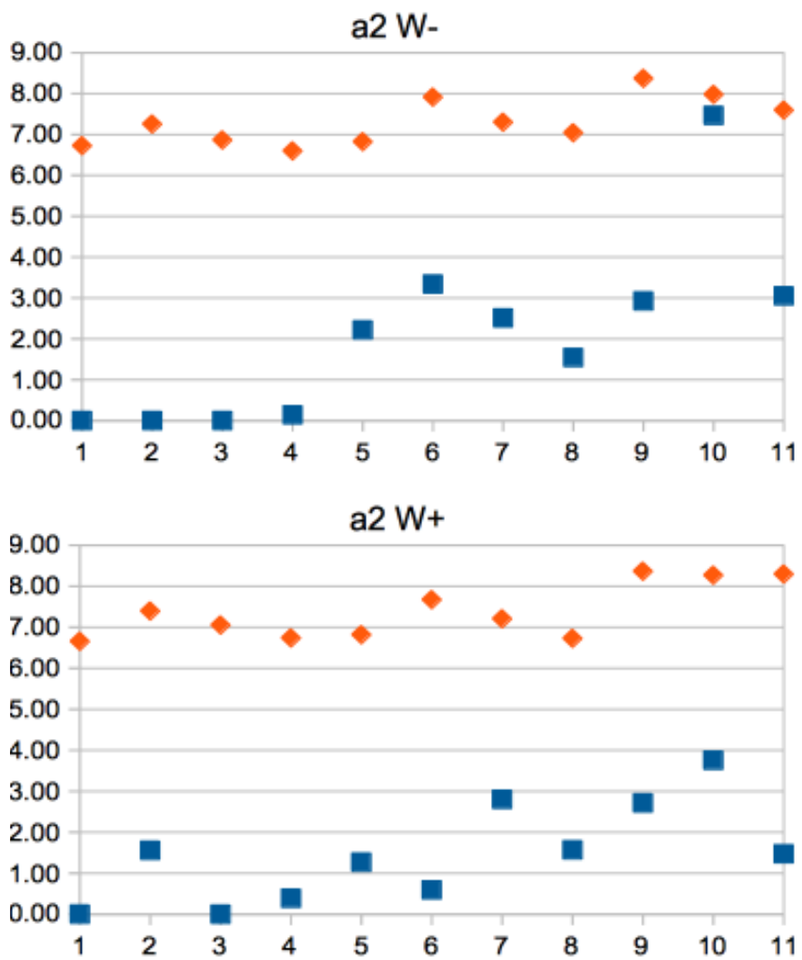


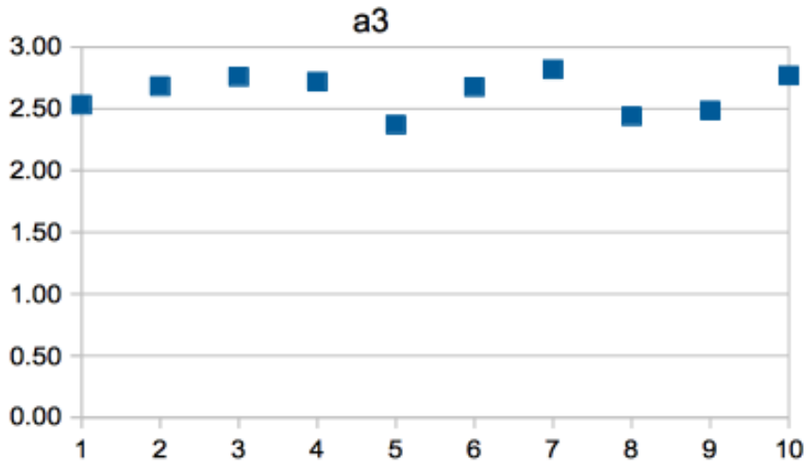
Only **a1** parameter is shared between all sets -> very similar to #1.1
One parameter less to constrain!
Note bin 8 at a2/a3 W- in control region popping down/up.

QCD model: approach #3.3

Try to tie only one parameter between the processes:
a1W-_sig,control ←→ a1W+_sig,control



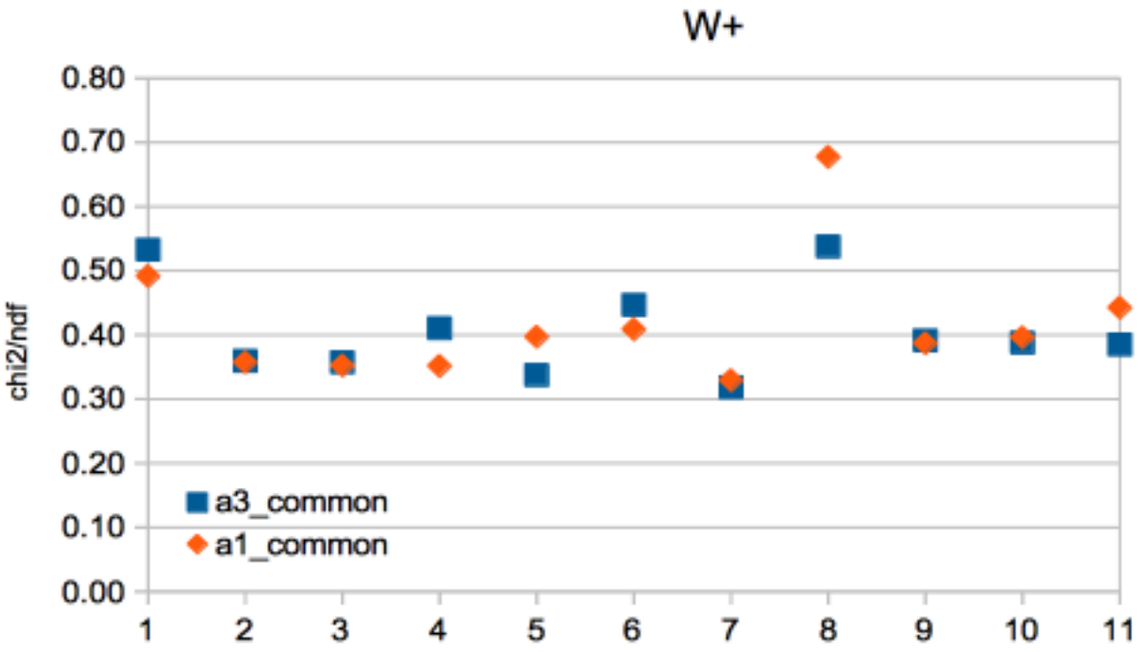


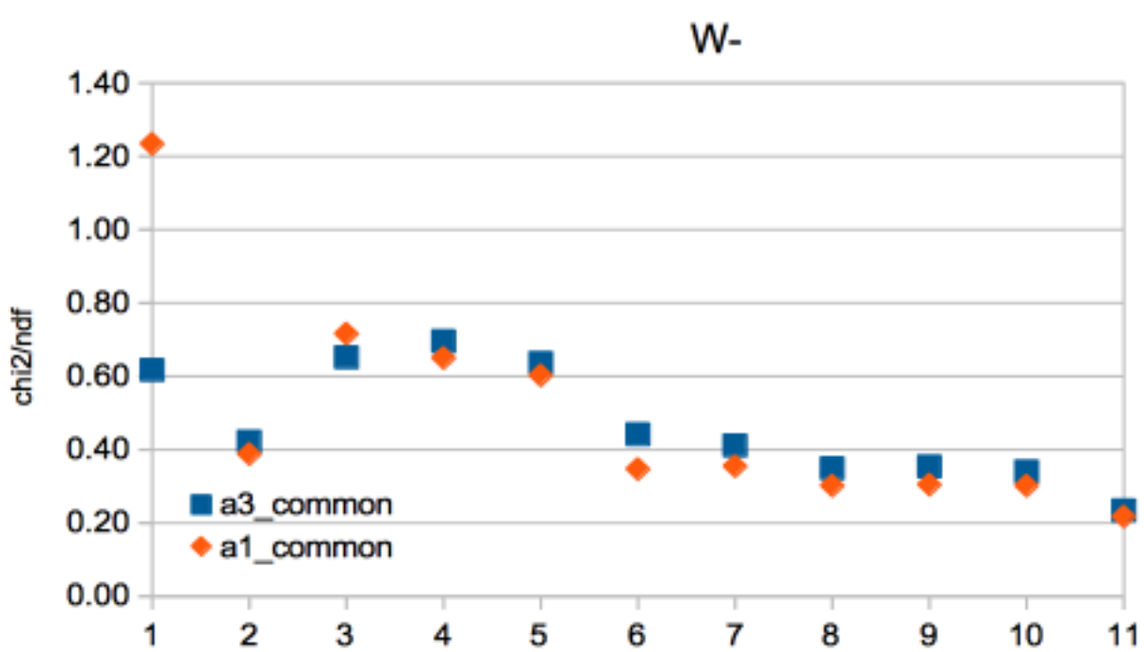


Signal
Control

Only **a3** parameter is shared between all sets -> previous a3 offset is compensated by a1 and a2.

QCD model: approach #3





Chi2/ndf values are not conclusive:

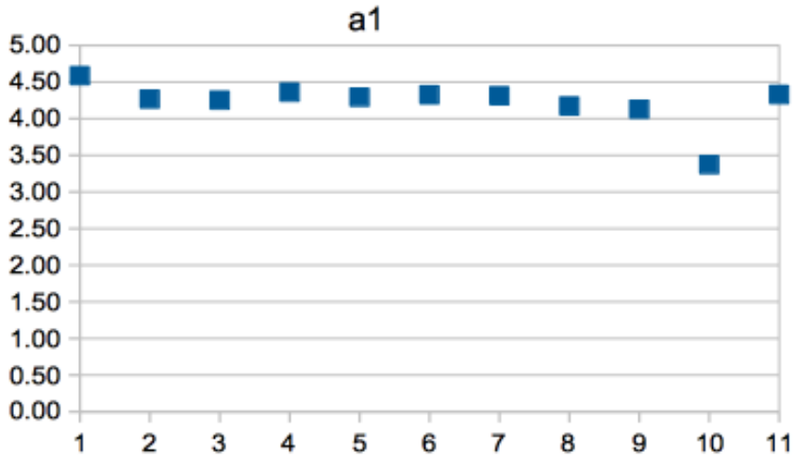
- **a1_common - tiny bit better overall**
- a1_common shows few unattractive jumps here and there.

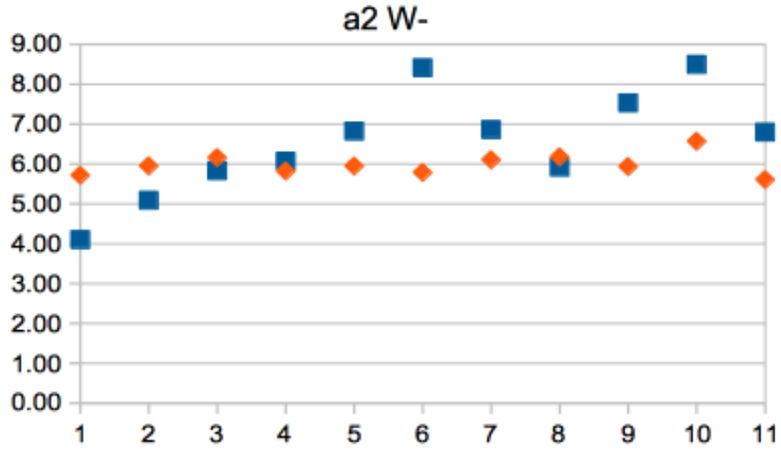
I favour trying to keep a1 common and share other pars between signal_W+ and signal_W-.

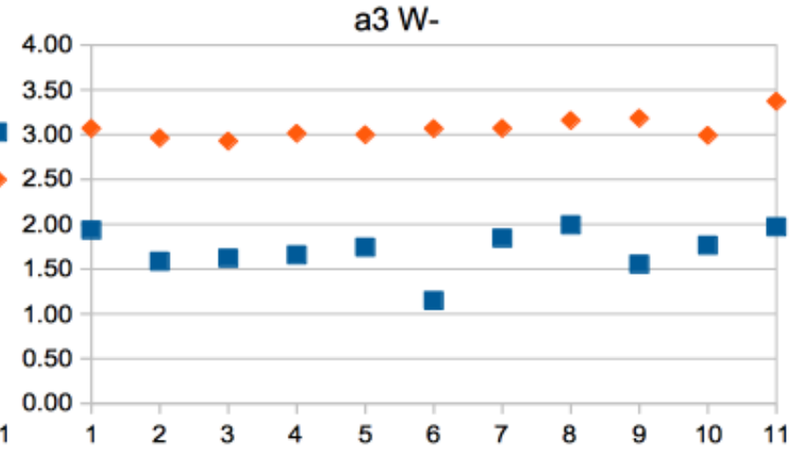
a1 common, a3 from signal

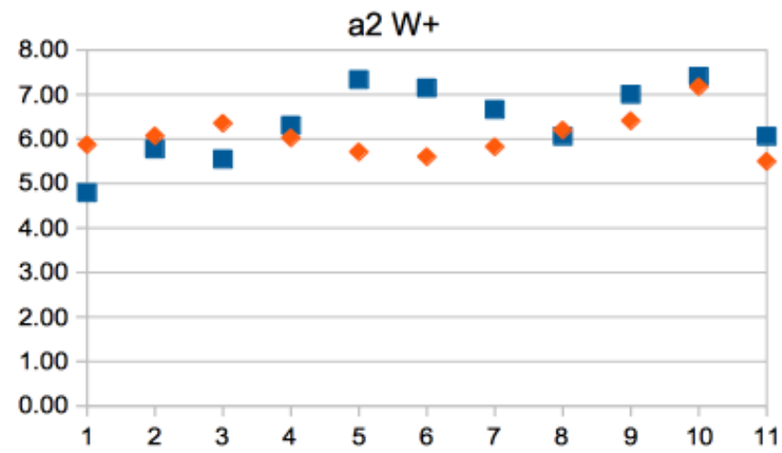
Signal
Control

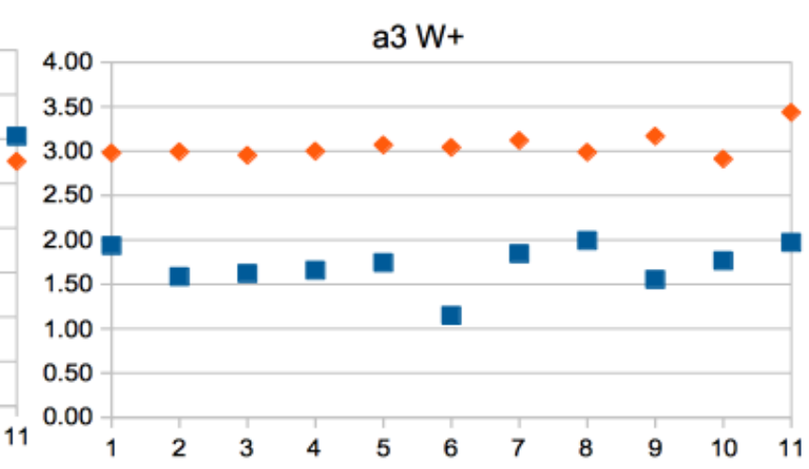
Try to tie only one parameter between the regions and another between the processes:
a1W-_sig,control ←→ a1W+_sig,control
a3W- sig ←→ a3W+ sig











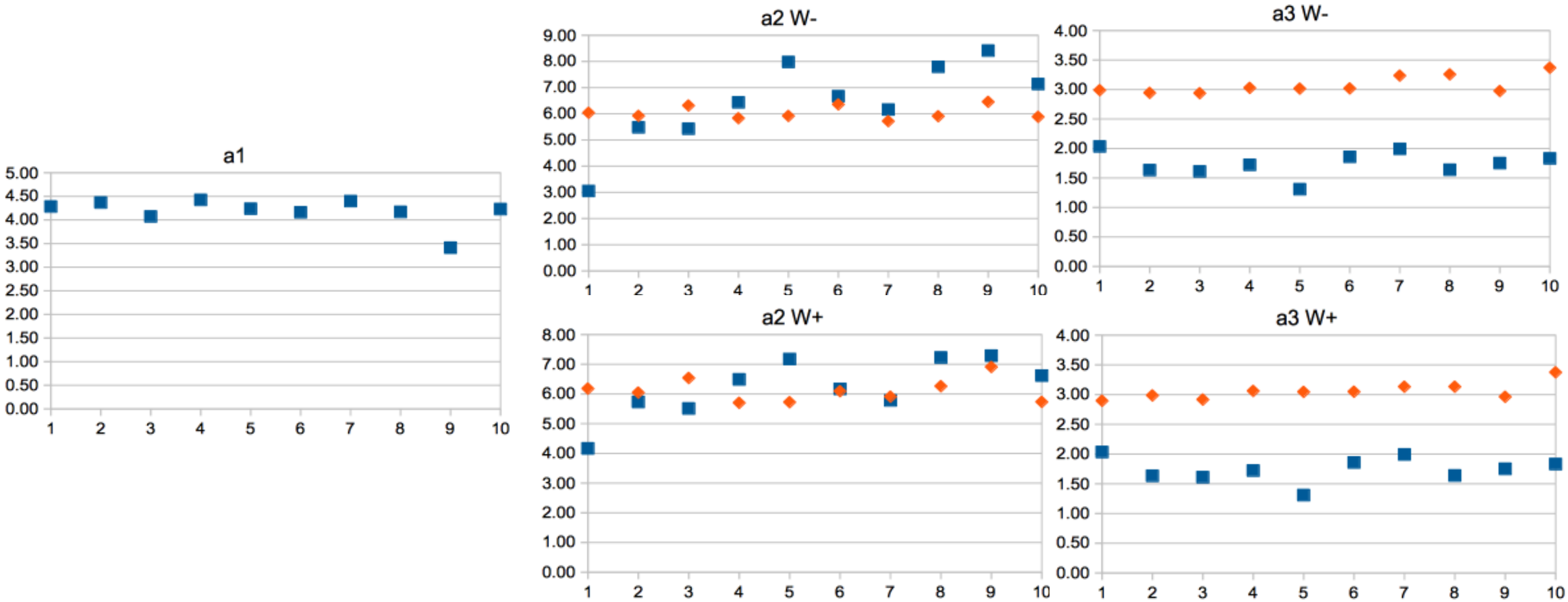
- Fluctuations are reasonable
- All parameters establish their trends (more or less)
- The fit is the most robust of all (8 parameters instead of 12)
- Identical chi2 to #3.1

a1 common, a3 from signal

a1W-_sig,control ←→ a1W+_sig,control
a3W- sig ←→ a3W+ sig

Signal
Control

Same but using 10 eta bins



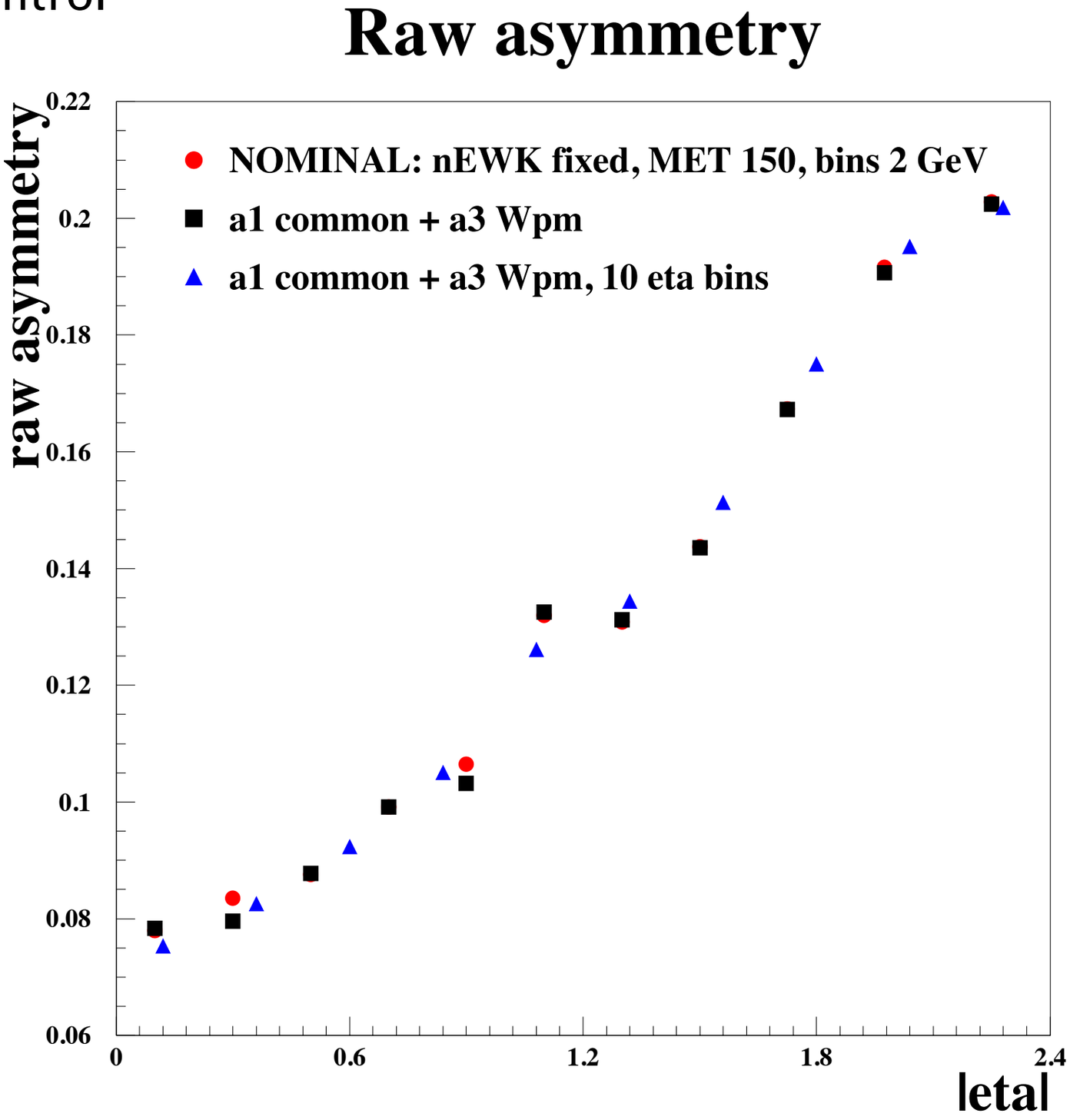
- No significant changes.

a1 common, a3 from signal

a1W-_sig,control ←→ a1W+_sig,control
a3W- sig ←→ a3W+ sig

Same but using 10 eta bins

- Some fluctuations look better but not entirely cured.



Conclusions

- Control region IS essential for the QCD background determination
- Fit with a common a1 parameter and a3 shared between signal W+ and W- seems to be the best
- New strategy of fitting is more robust.
- Fit modifications do not cure the "6th bin problem”
- Rebinning in 10 bins somewhat smoothens the "6th bin problem”
- In the process of trying various styles of eta binning…

Acceptance

- The acceptance problem was cured (KK and VD)
- The cross sections and asymmetries look reasonable and agree well with NLO MCFM.