Field Map + Mass Studies

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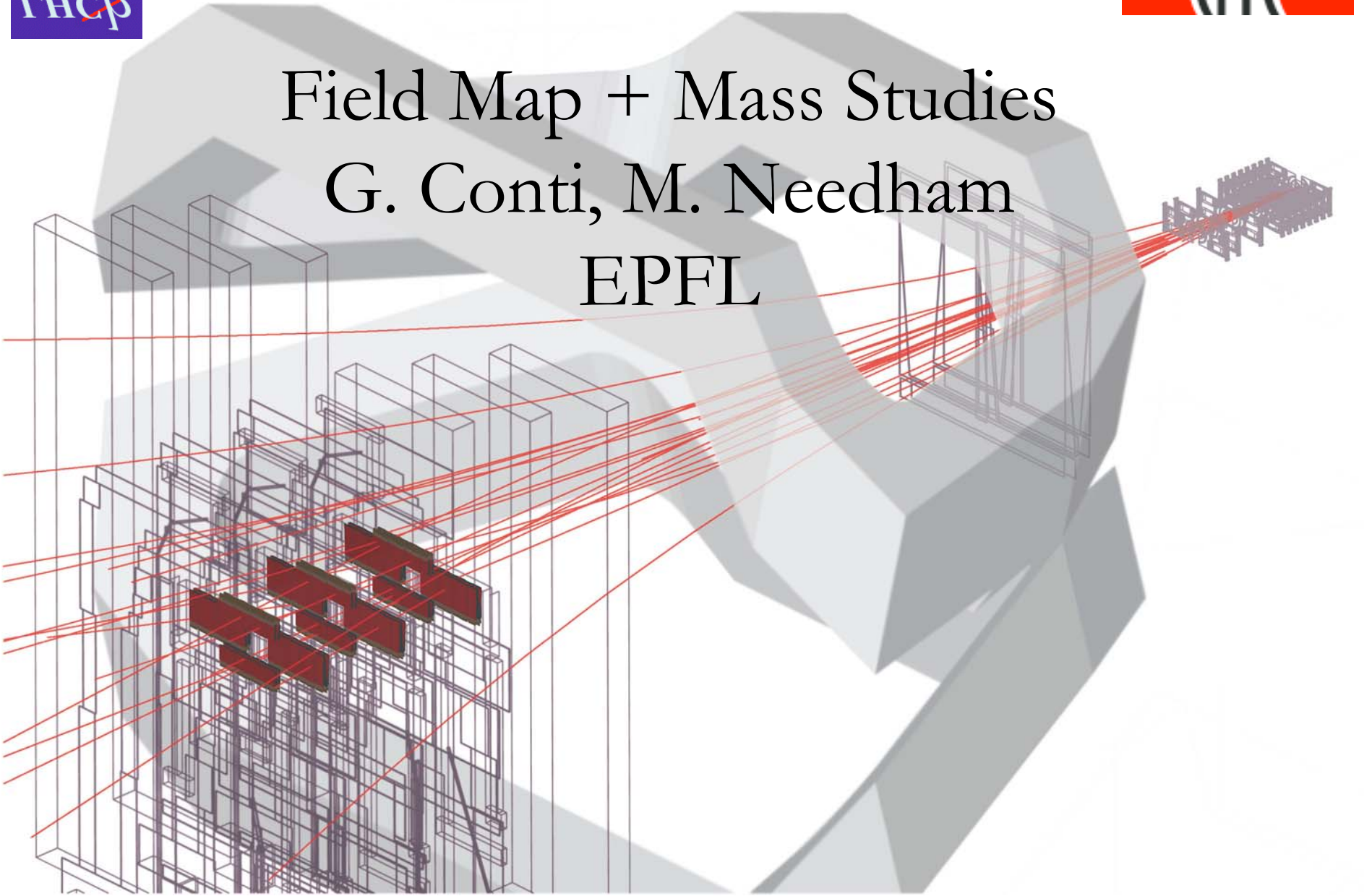
EPFL



Outline

Remind where we are with charged momentum scale calibration, try to give overview of what has been found, therefore many of the slides have been shown before…

- Why we think the measured field is better than Tosca
- B-field and alignment
- J/ψ : first look
- Summary of plots
- Outlook + what remains to be done

Maps

The Tosca versus measured maps:

- Tosca map has a $\int$ Bdl 7×10^{-4} larger than the meaurements.
attributed to the known expansion of the coils by ~ 8 mm when field powered

- Measured map has a large asymmetry between up and down quadrants

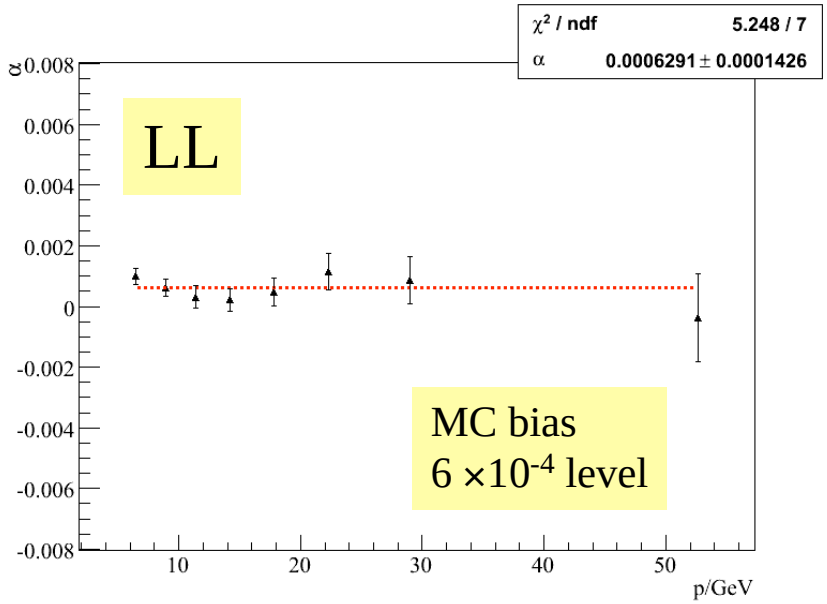
- Left/right symmetry is not forced for the measured map

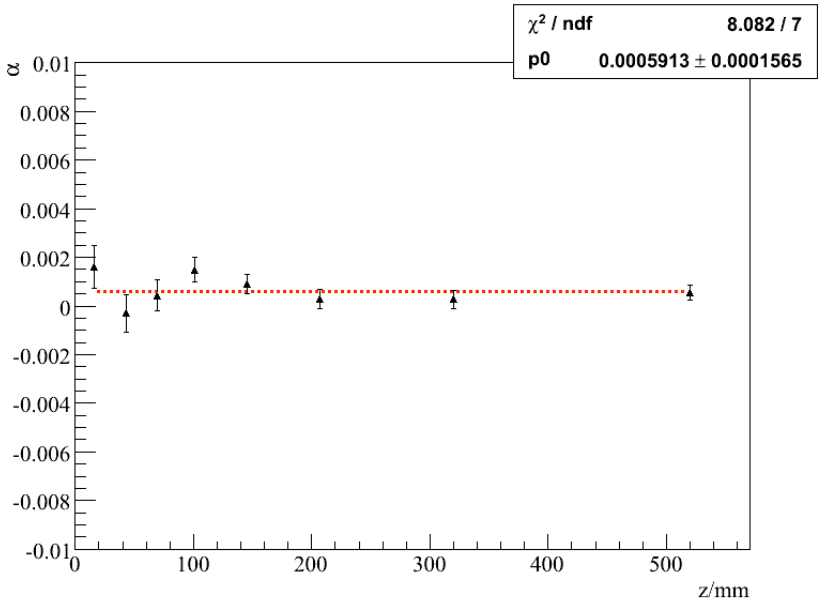
- Currently we use an early version Modified positive map for up data and the original negative map for down data

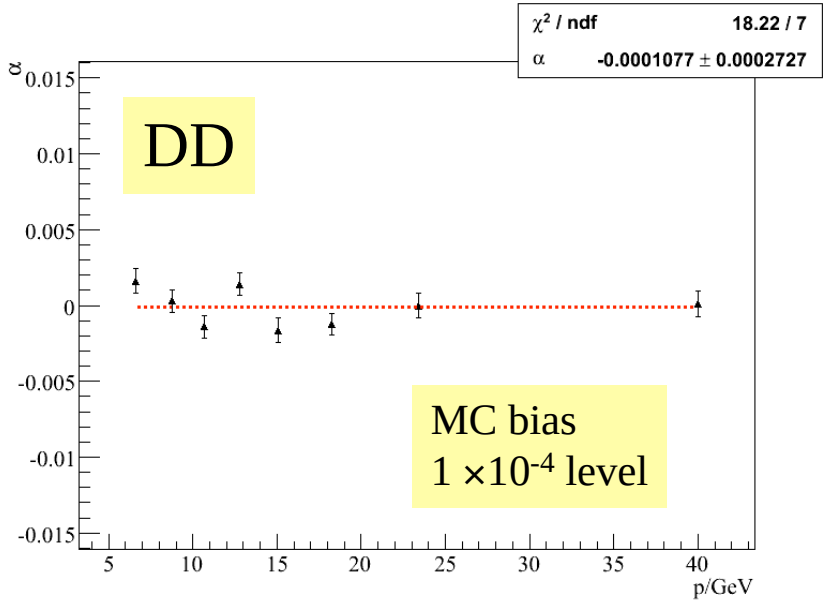
- First indications: differences between different measured maps is small, the big choice is between TOSCA and measured

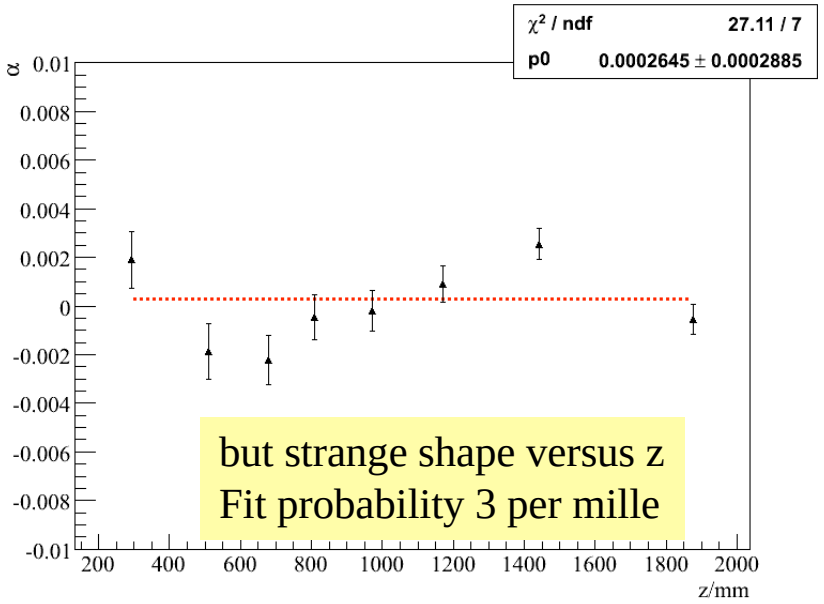
- Once we have decided TOSCA versus measured, rather rapid to converge on one map…

MC Validation

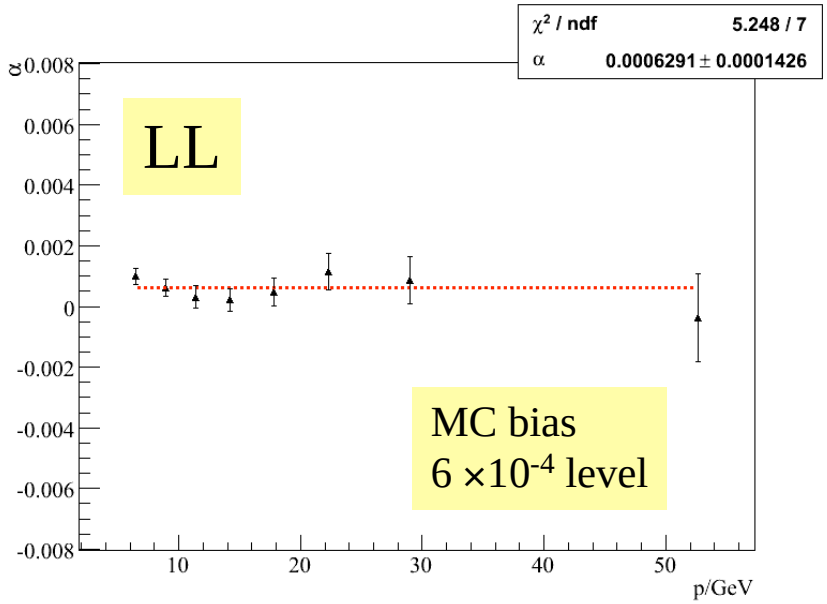


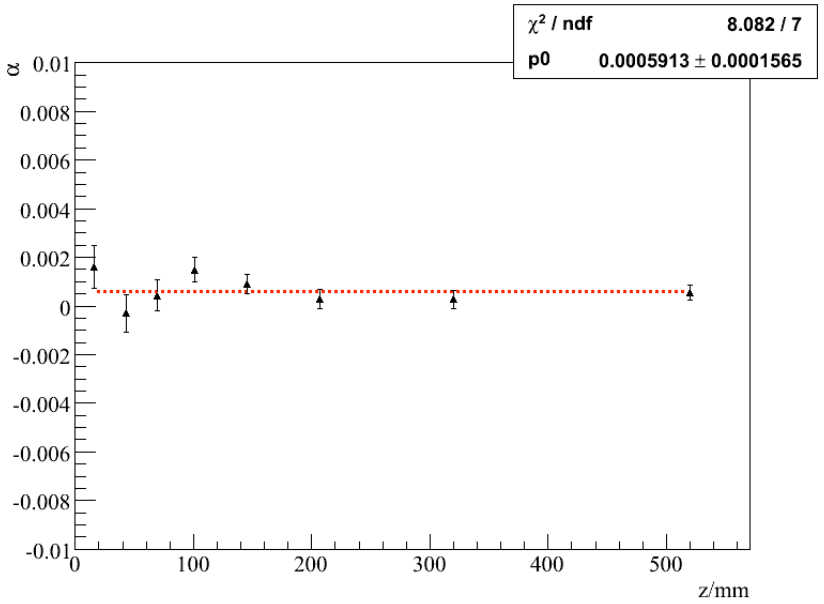


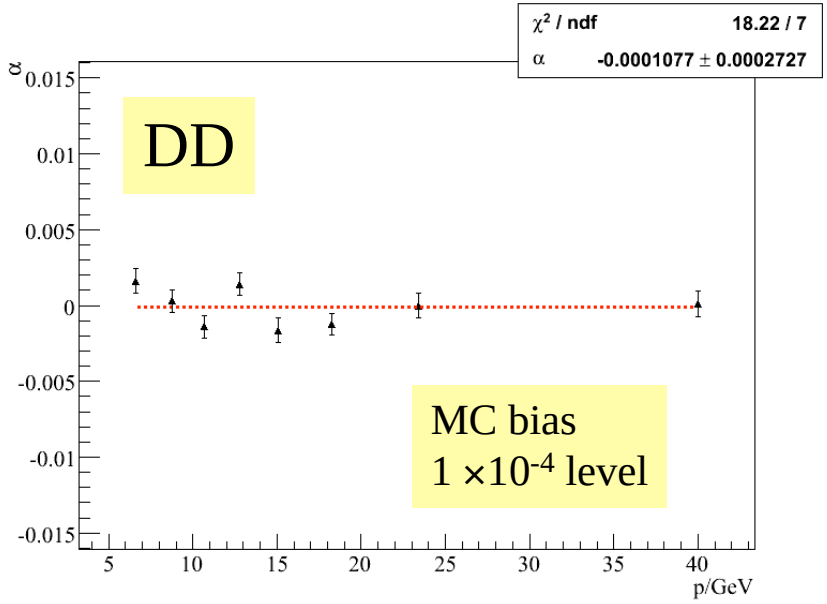


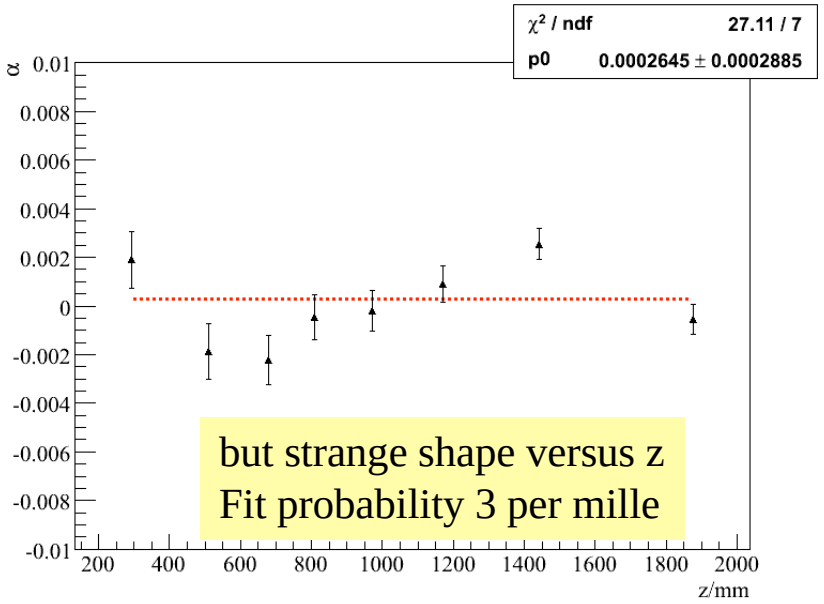


MC Validation



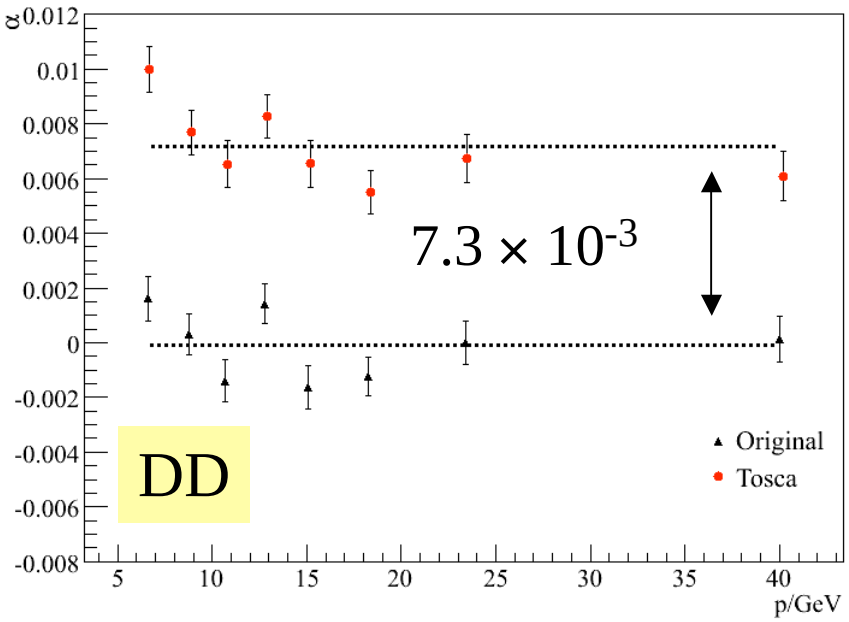


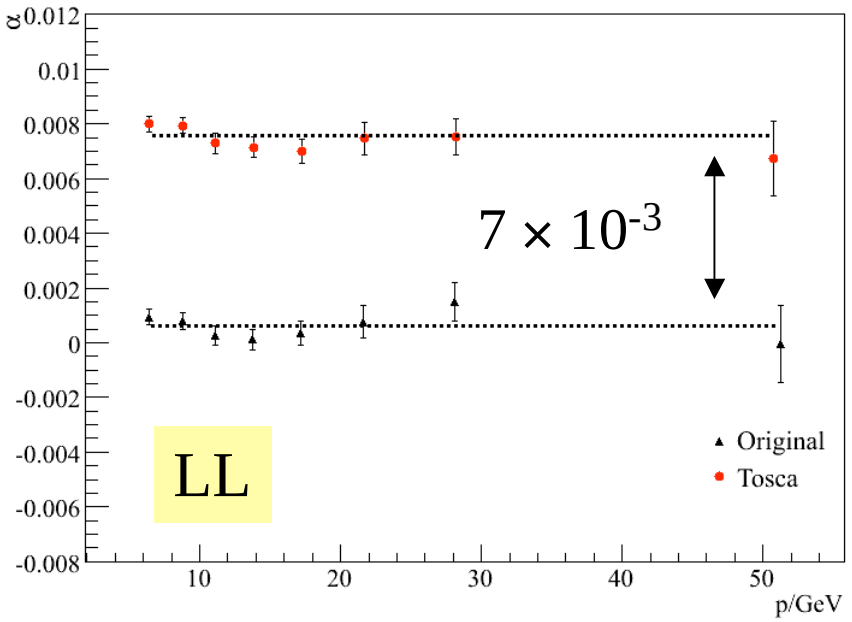




Comparing field maps

Refit the MC which was simulated with the Original with the Tosca map





Binning in p the difference between Tosca map is to first order and the original map is a simple scaling of 7.3×10^{-4}

Comparing field maps

The measured map has a large up-down asymmetry

- The field is stronger for $y > 0$

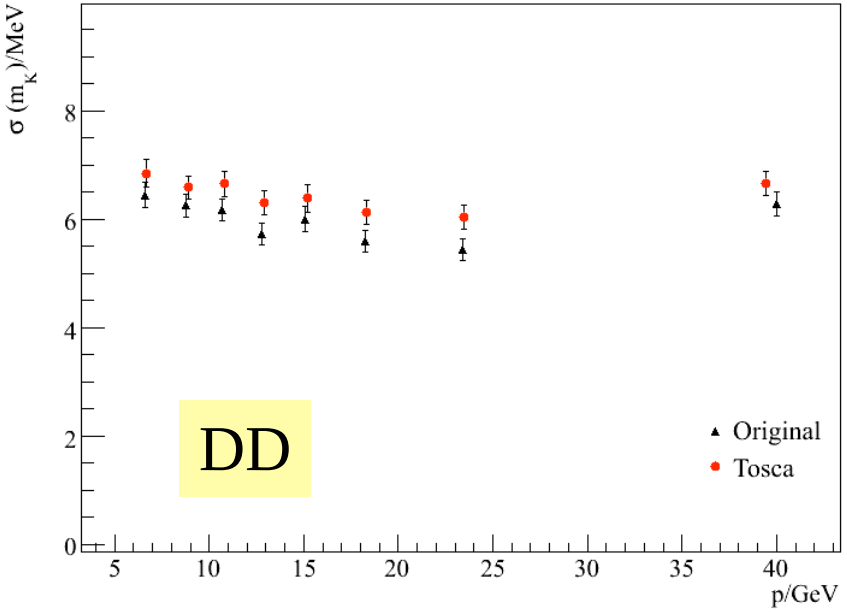
- Refitting J/ψ MC generated with the original map with Tosca a 3 MeV difference is seen between decays where both daughters are above or below $y = 0$

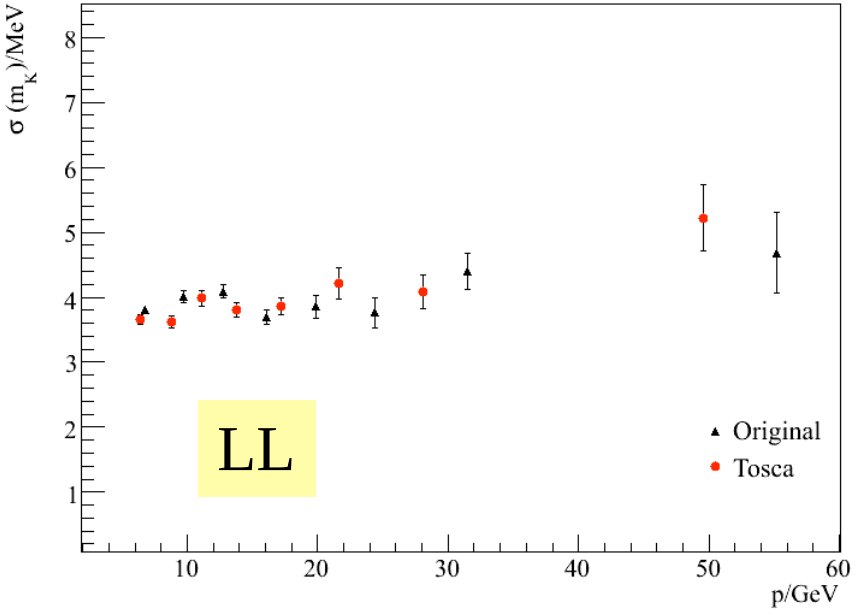
- That translates to ~ 0.3 MeV effect on the Ks mass

- If we see no difference between up and down in the data with the original map but a difference refitting with Tosca this will support that measured map + the y asymmetry

Comparing field maps

Refit the MC which was simulated with the Original with the Tosca map

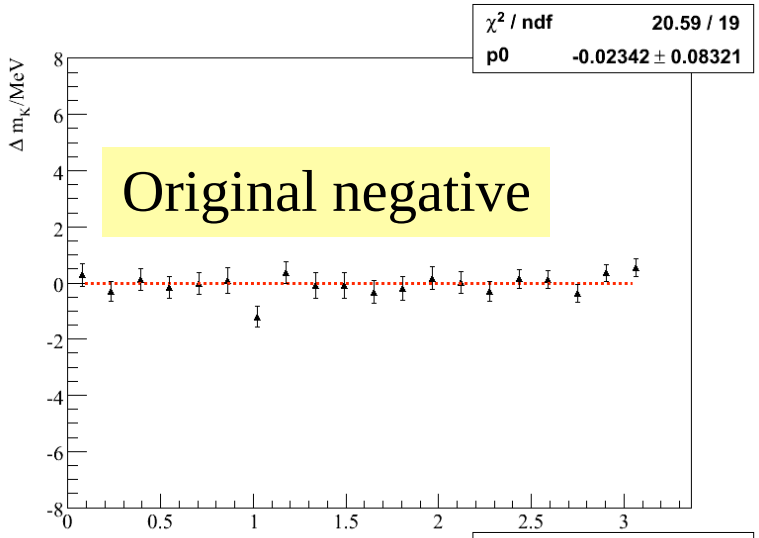




Down-down mass resolution is ~5 % worse refitting with the Tosca map
Lose ~ 1 % of candidates

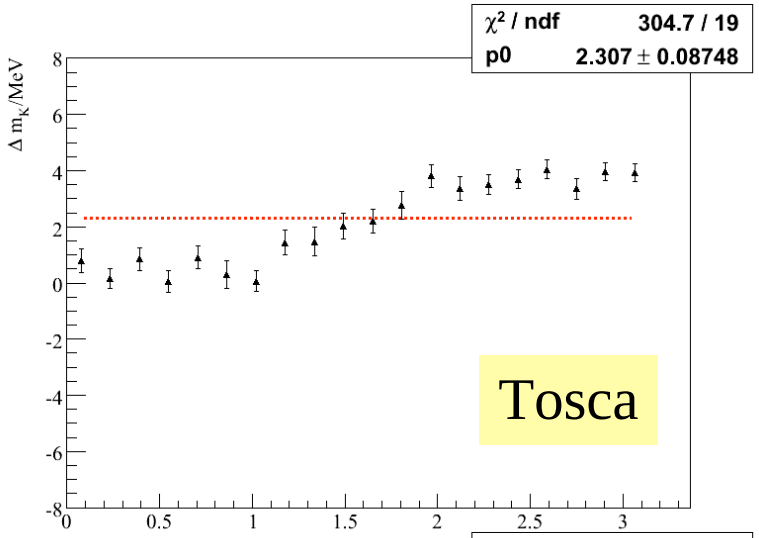
Comparing field maps

Good discrimination between Tosca + original negative map using the angle between the normal to the decay plane and the y-axis (ie 'field') direction

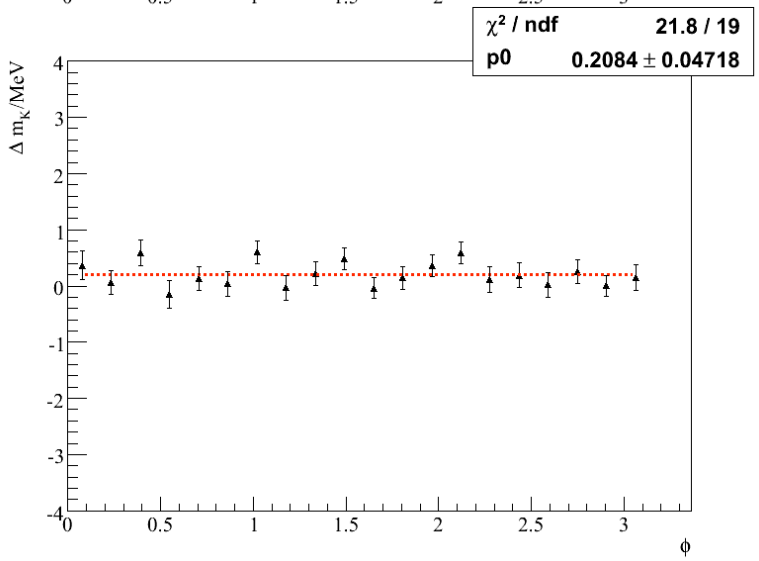


Original negative

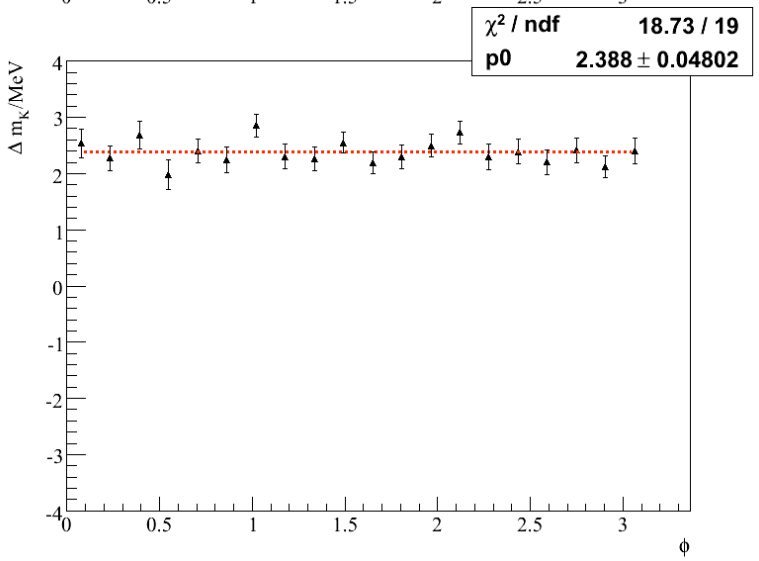
DD



Tosca



LL



Comparing field maps

To summarize the tests we have:

- Quadrant test: Is there a difference between Ks decays where above and below y = 0 ?

- Study of the DD mass bias as a function of the angle between the decay plane and the y-axis

- Study of the DD mass resolution with different maps

Note:

The DD are more sensitive to the field: decay in the field, opening angle measurement depends on the field components

LL opening angle measured by the VELO independent of the field, only sensitive to the field scale

Tosca Map + Data

Quadrant Study for LL

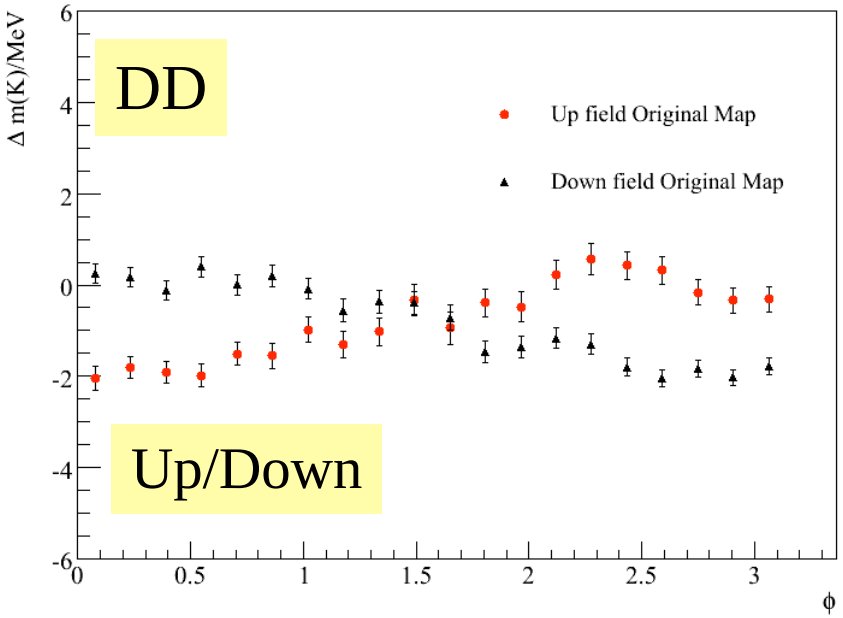
Q1	Q2
Q3	Q4

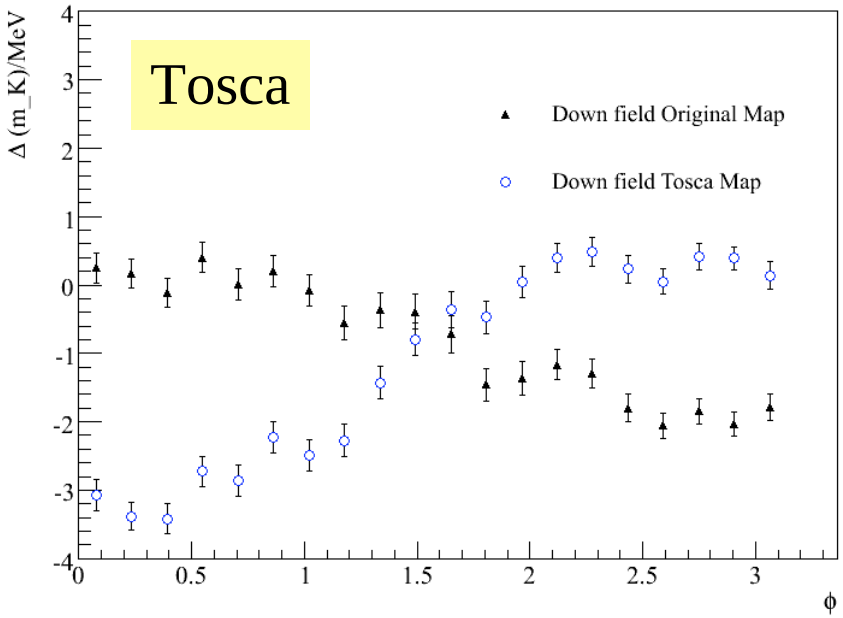
Map	Mass Q12/MeV	Mass Q34/MeV
Negative down	497.2 +/- 0.1	497.2 +/ 0.1
Tosca	499.6 +/- 0.1	499.0 +/- 0.1

No difference in upper/lower quadrants in data using measured map, Difference between upper/lower using Tosca is consistent with MC expectation if measured field map data is refitted with Tosca

Tosca Map + Data

Refit the down data reconstructed with the negative map with a scaled Tosca field (to get same average bias) + positive field

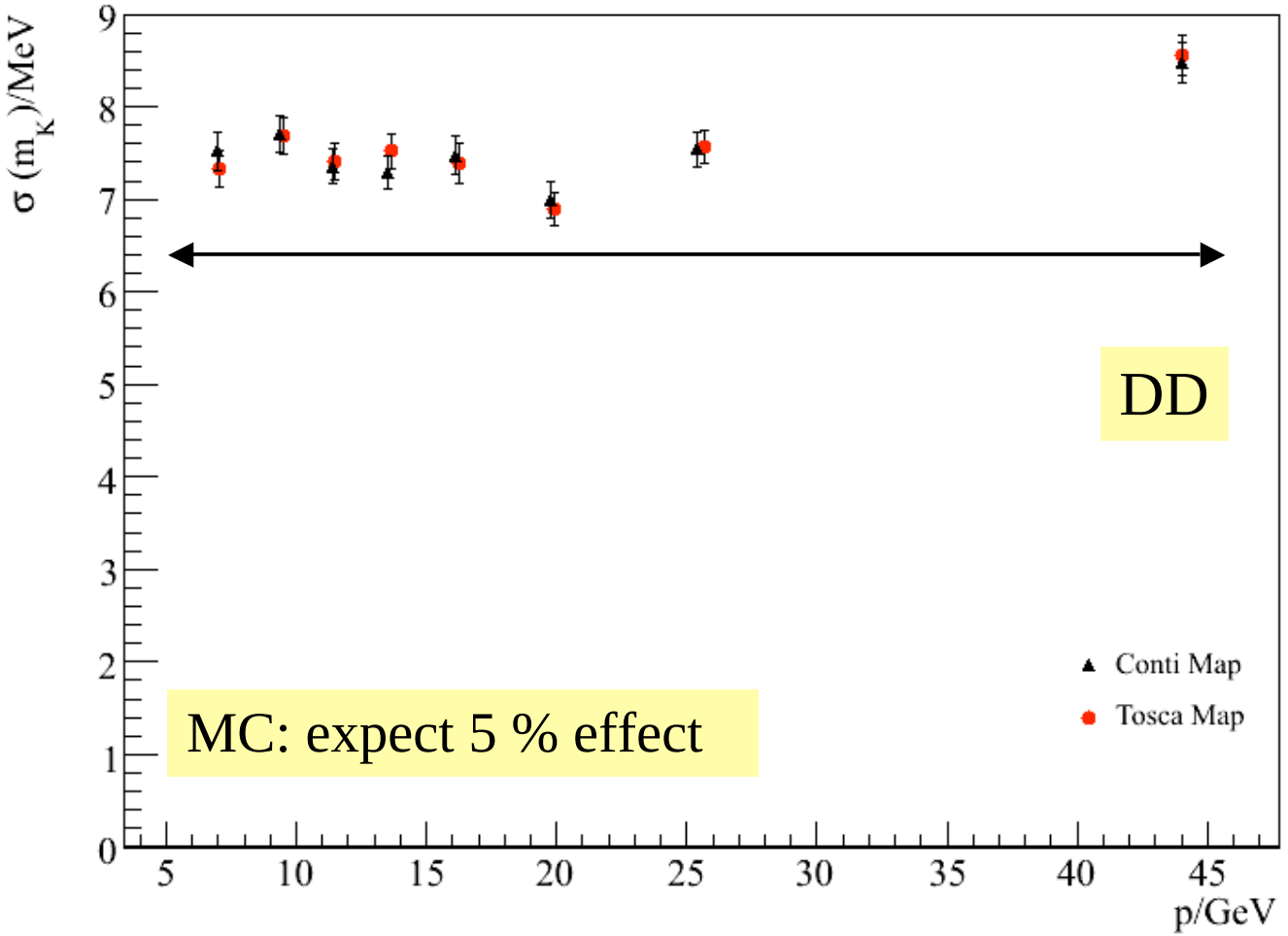




- Shape in data that flips with the field polarity
- Shape not a simple scaling, shape same in both maps
- Using Tosca shows same shape as MC: Tosca disfavoured
- Measured map overcorrecting Tosca ? would be nice to have TOSCA MC

Tosca Map + Data

Refit the data reconstructed with the original field with the Tosca field



No clear effect seen: washed out by worse resolution in the data ?

Alignment and K_s mass

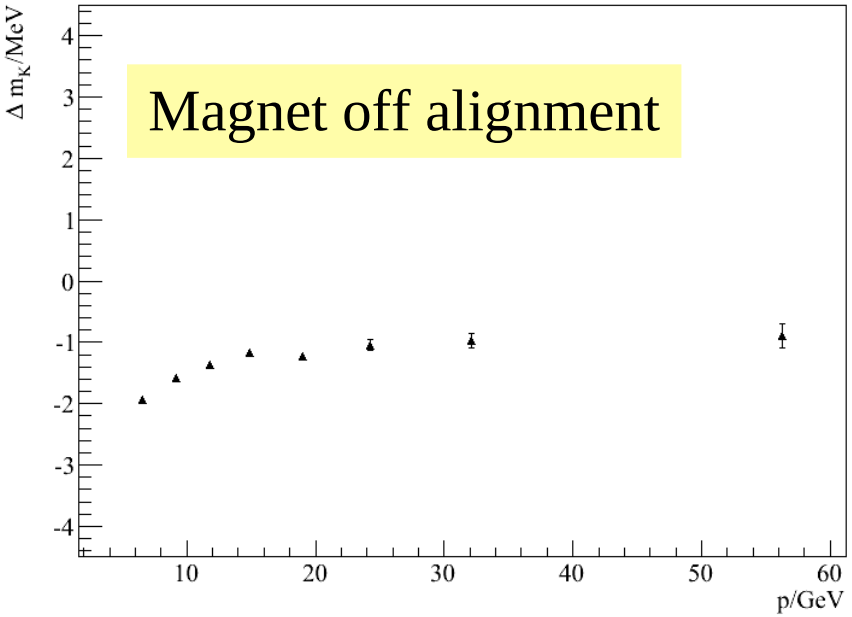
How do the magnet off and on alignment, compare in terms of Ks mass ?

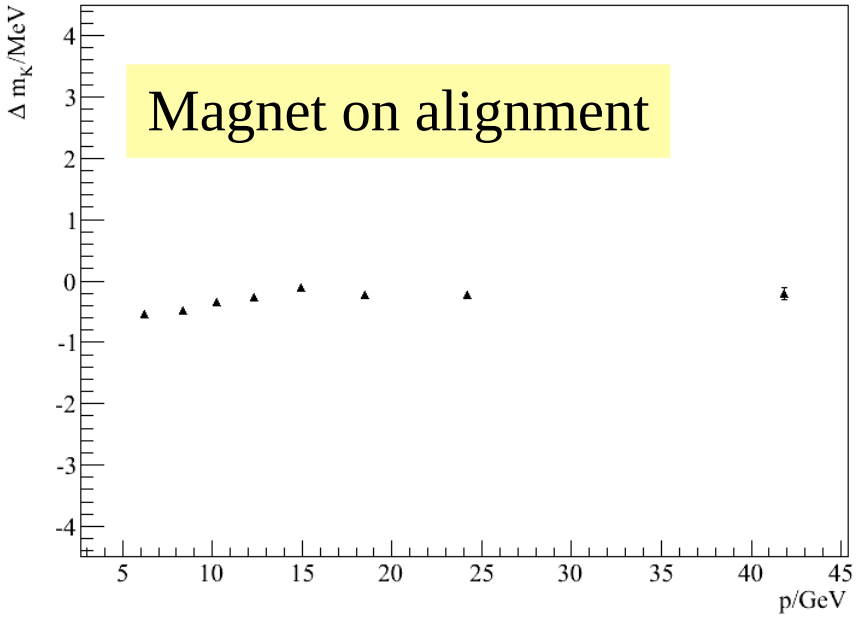
The magnet off alignment is biased for low momentum Ks

Going to the magnet on alignment this bias is reduced (or even removed)

Consistant with a ‘z’ related problem (low p tracks, high angle, sensitive to z)

Clear from these plots that extracting dE/dx effects from data not possible



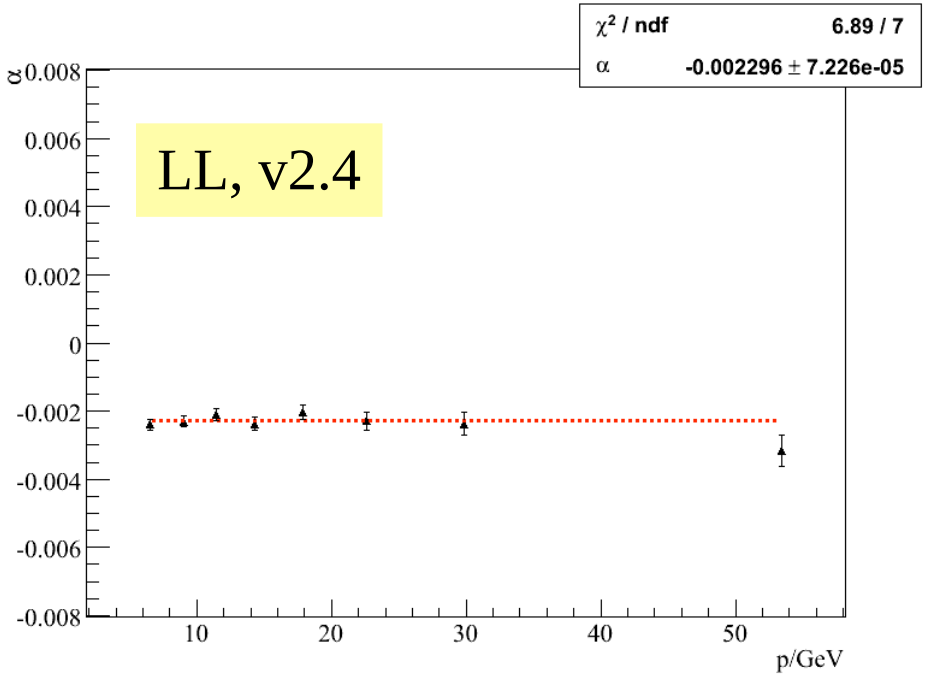


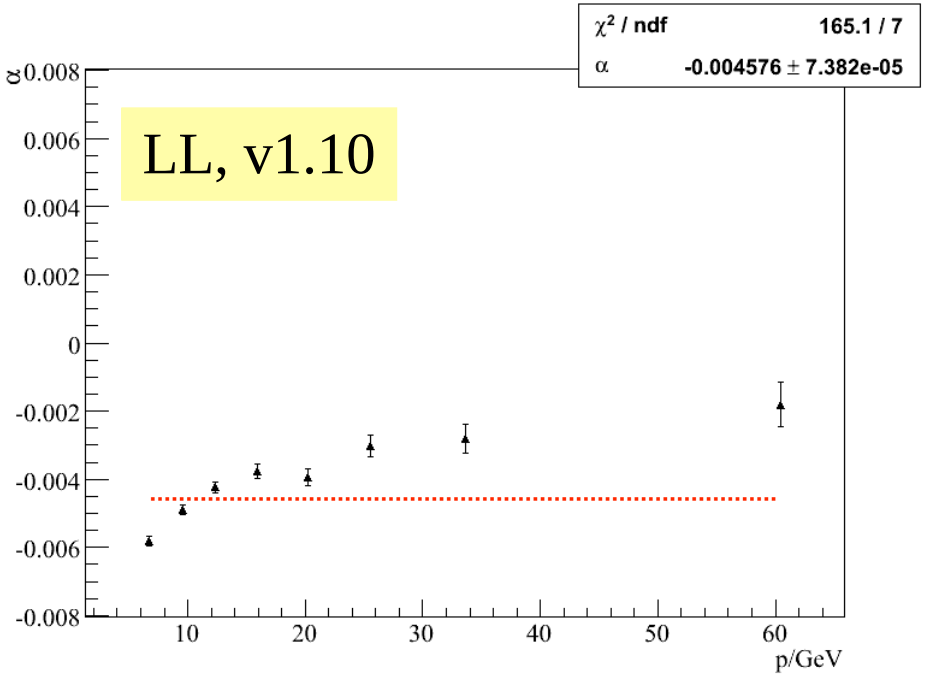
v2.4 versus v1.10

Set	LL bias per mille	DD bias per mille
v2.4	-2.3 +/ 0.1	-2.7 +/- 0.2
v1.1	-4.6 +/- 0.1	-3.9 +/ 0.2

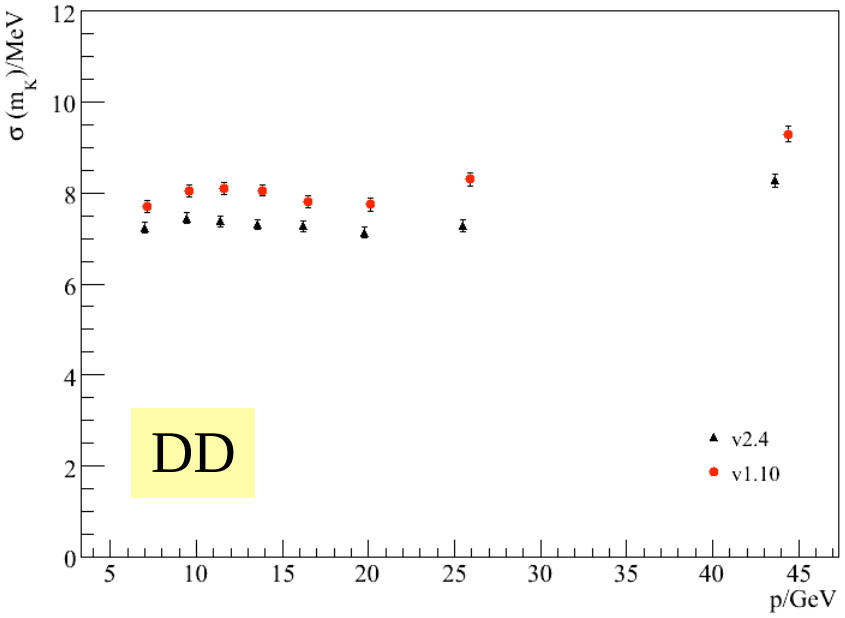
In fact most of correction for DD and LL from v1.10 to v2.4 is at low p

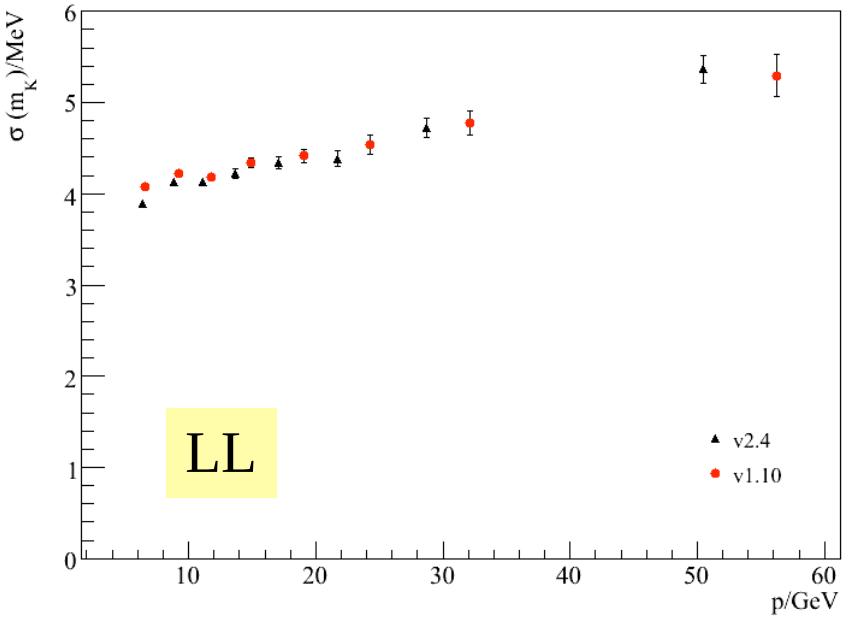
Was the same in 2009 ! What does it mean ? Field wrong ? Movements





v2.4 versus v1.10

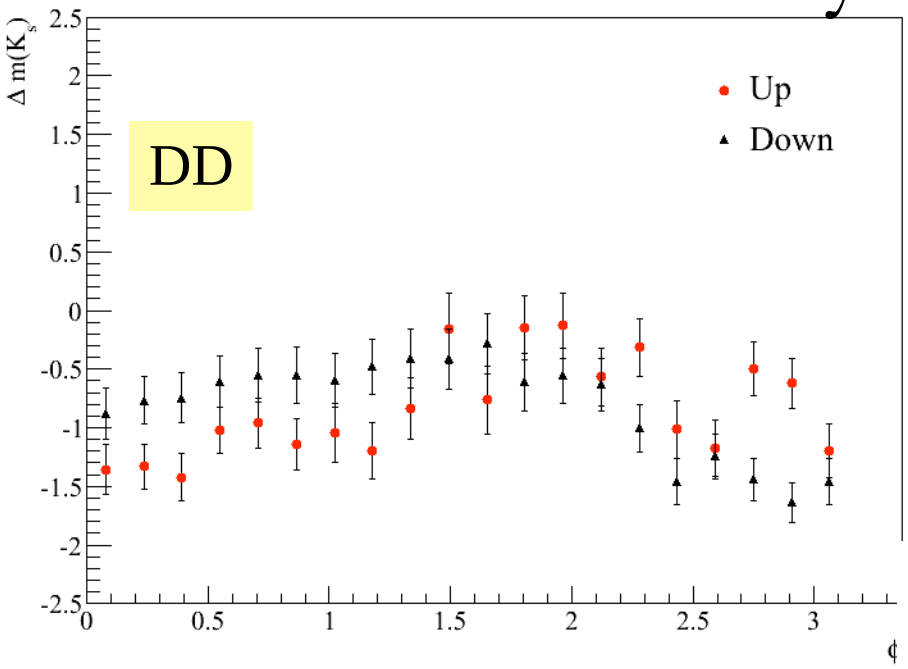


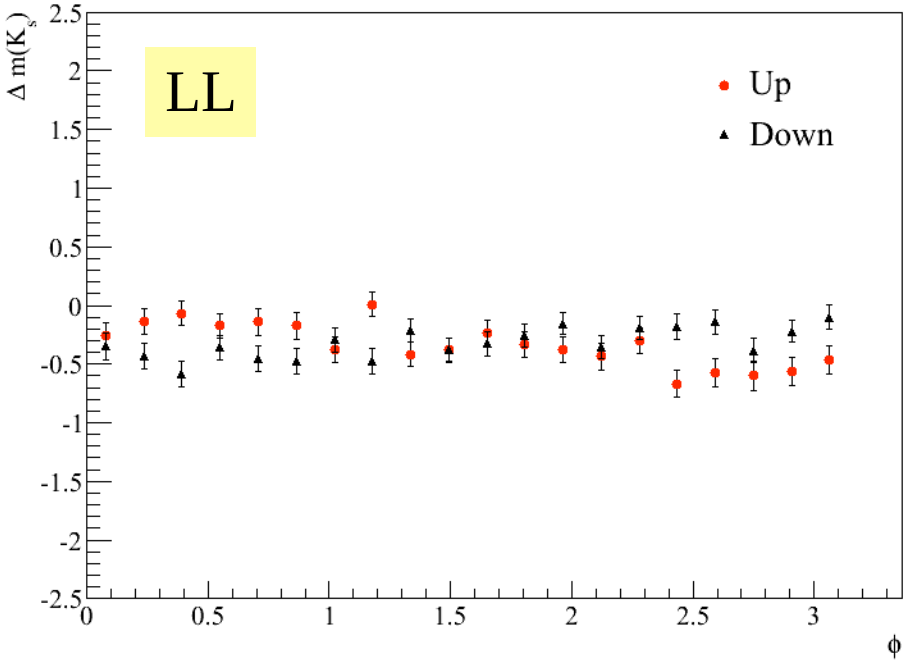


Why does the resolution improve if the magnet on alignment is used ?

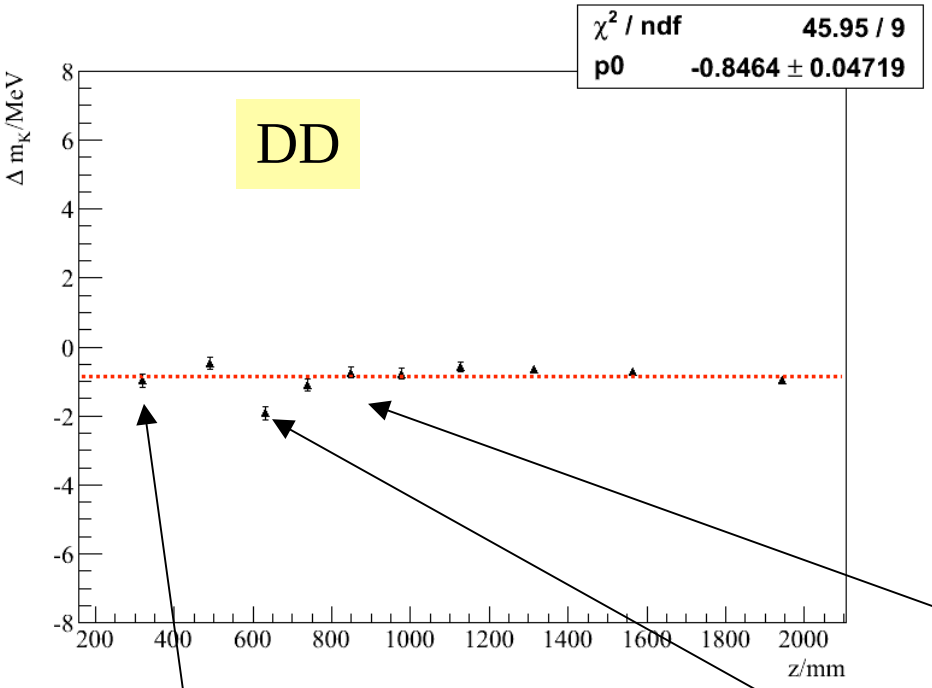
- A Weak mode ? What mode ?
- Field is wrong
- Detector Moves

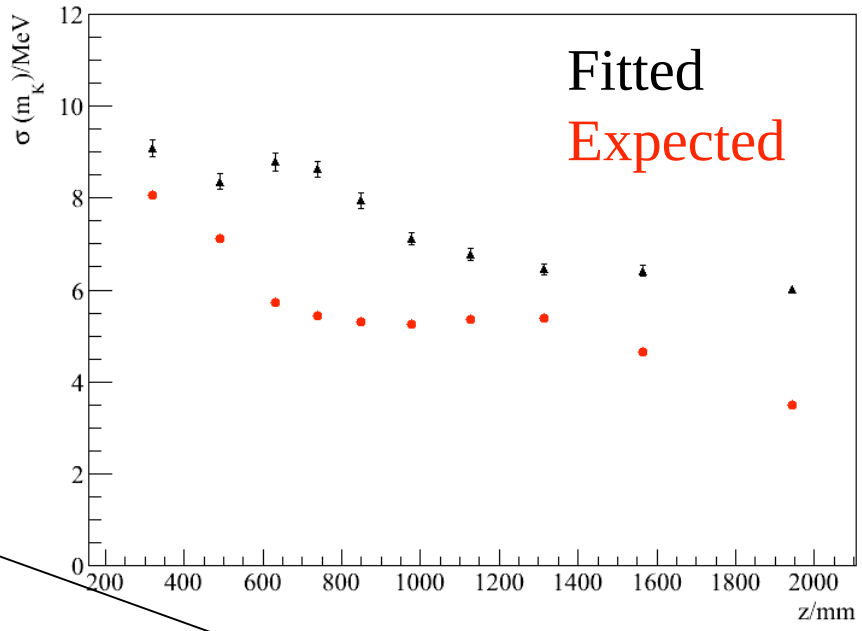
Decay Plane Ks

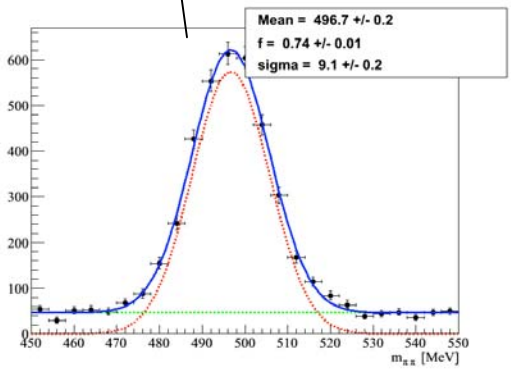


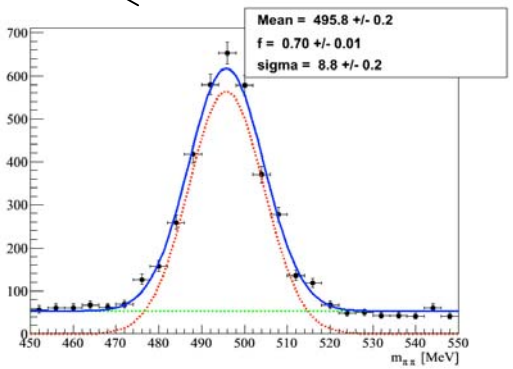


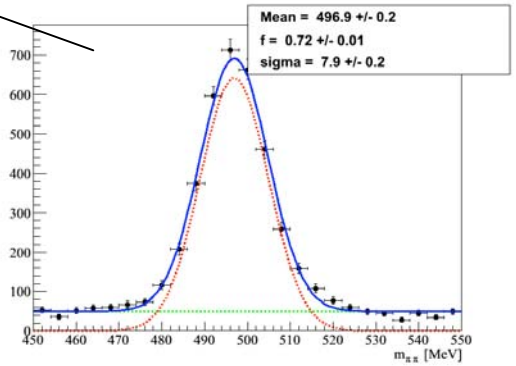
Ks and z





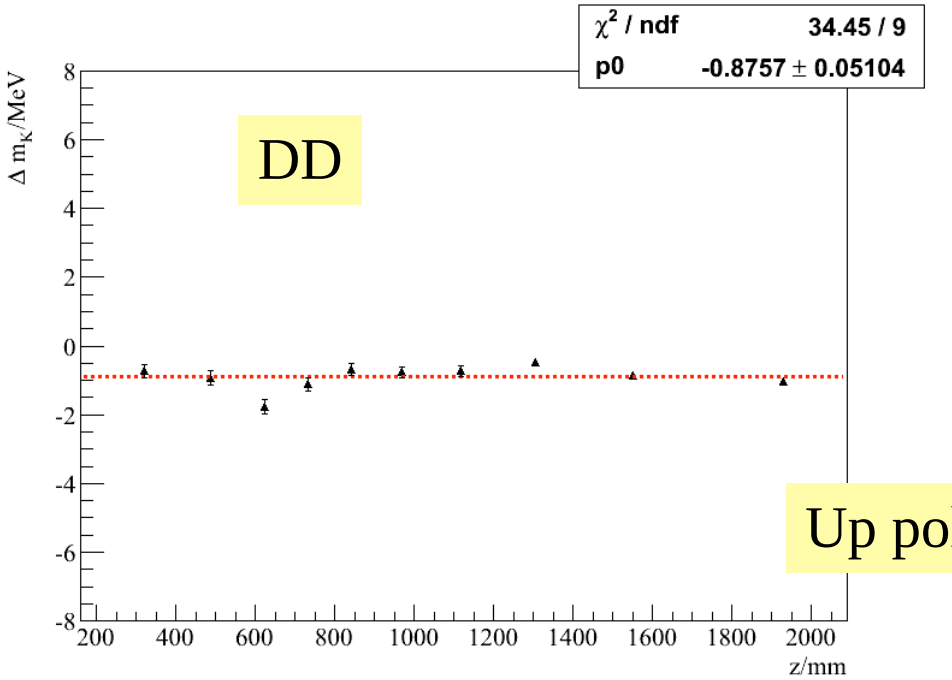


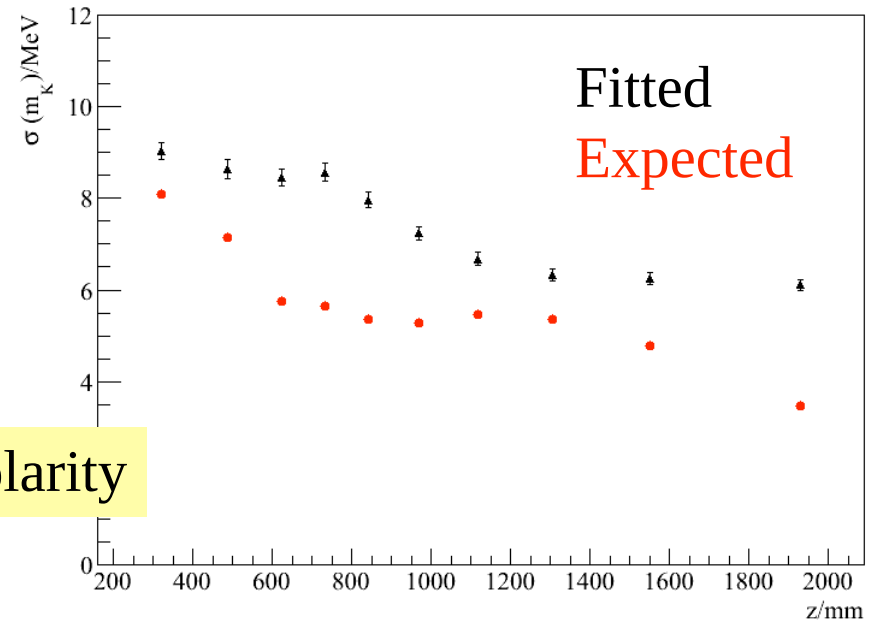




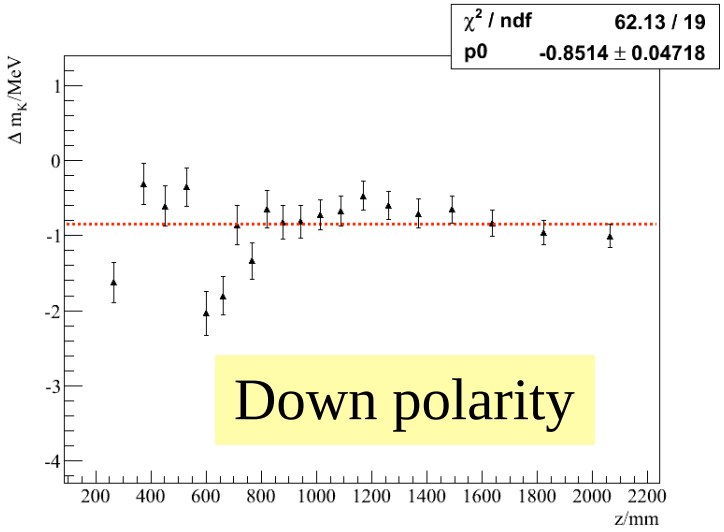
Down polarity

Ks and z





Up polarity



Down polarity

Structure in mass for z just before exit window for both Up and Down

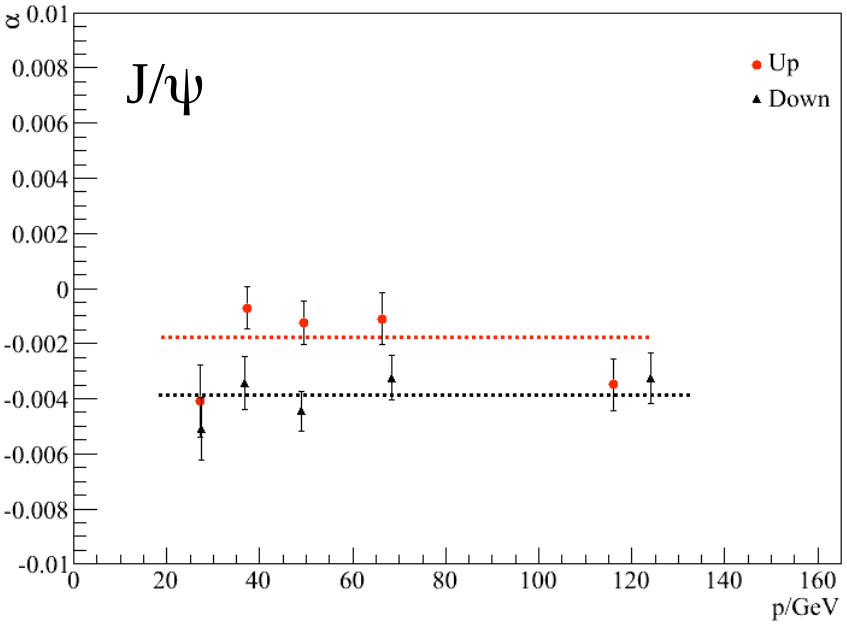
J/ψ Cuts

- Standard Loose dimuon preselection
- $8 < p < 500$ GeV
- $pt > 800$ MeV
- isMuon

Track quality cuts

- $tx < 300$ mrad
- $ty < 250$ mrad
- $\eta < 4.9$
- χ^2/dof track < 4

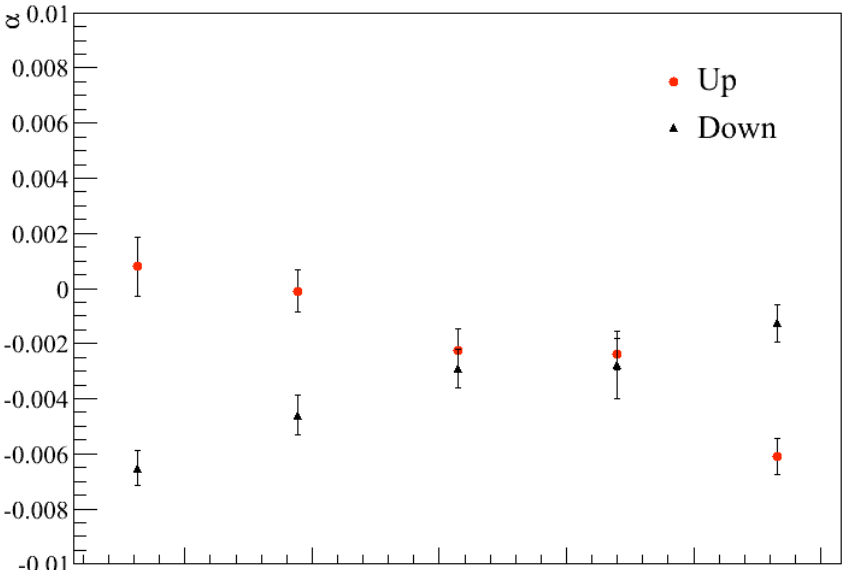
Up and Down

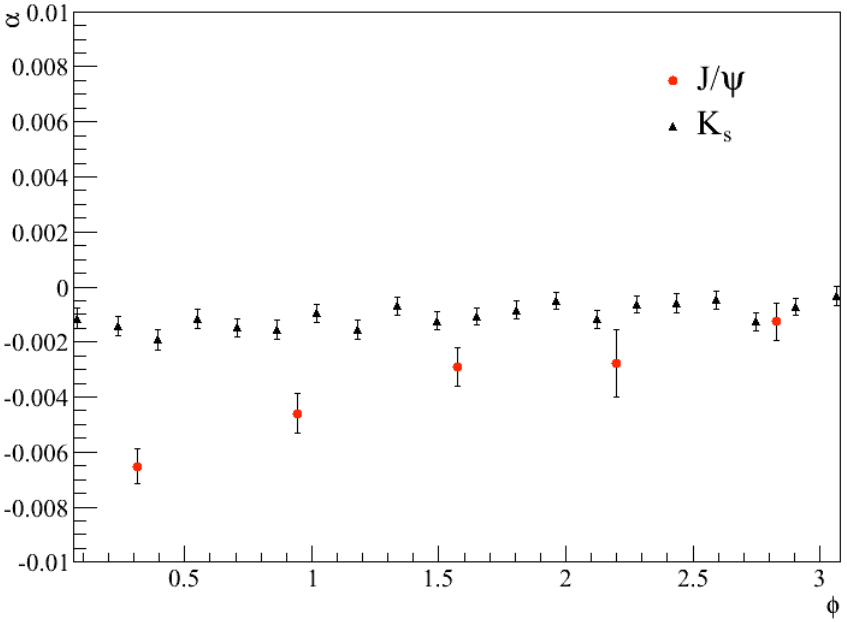


Up: (-1.8 +/- 0.4) × 10^{-3}
Down: (-3.9 +/- 0.4) × 10^{-3}

[0.5 per mille difference, same sign was seen for Ks, due to differences in the field maps]

Decay plane dependence





Bin in terms of the angle between the normal to decay plane and y-axis

A big effect is seen that flips sign with different field polarities !

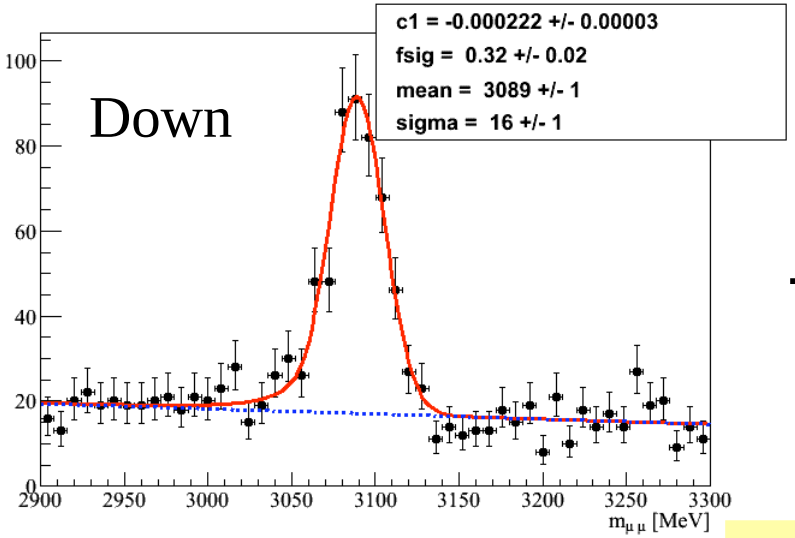
Factor 6 larger than expected from the LL Ks

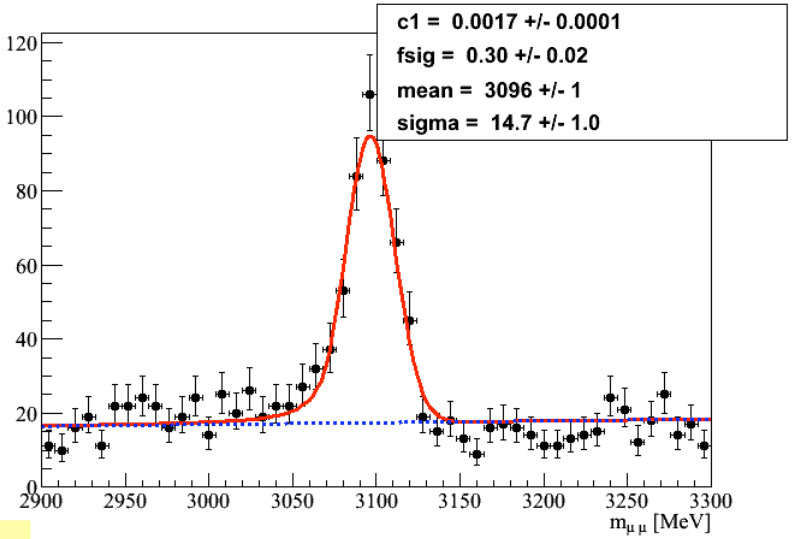
)pposite shape to the DD Ks

Ve don't understand anything at all but oints to way to improve the J/ψ mass. esolution. Assume linear variation with ıe angle that flips sign with the field

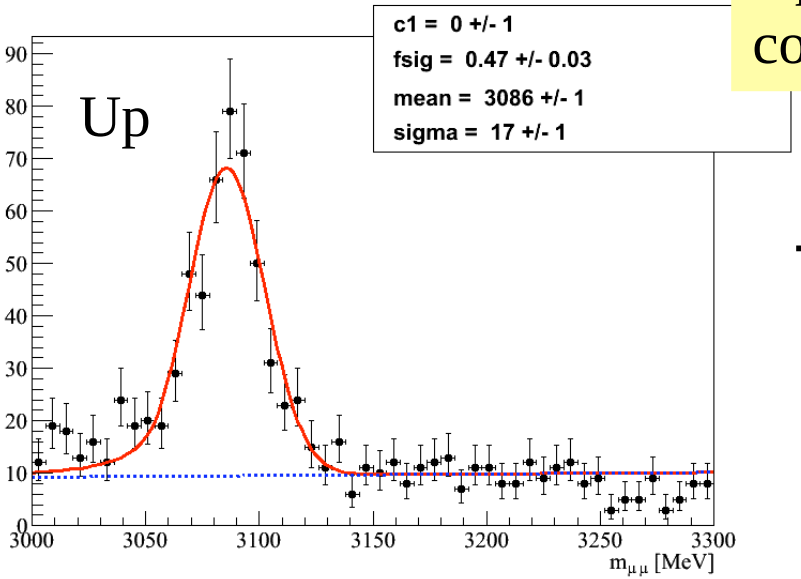
nproves somethings, but not the hole story

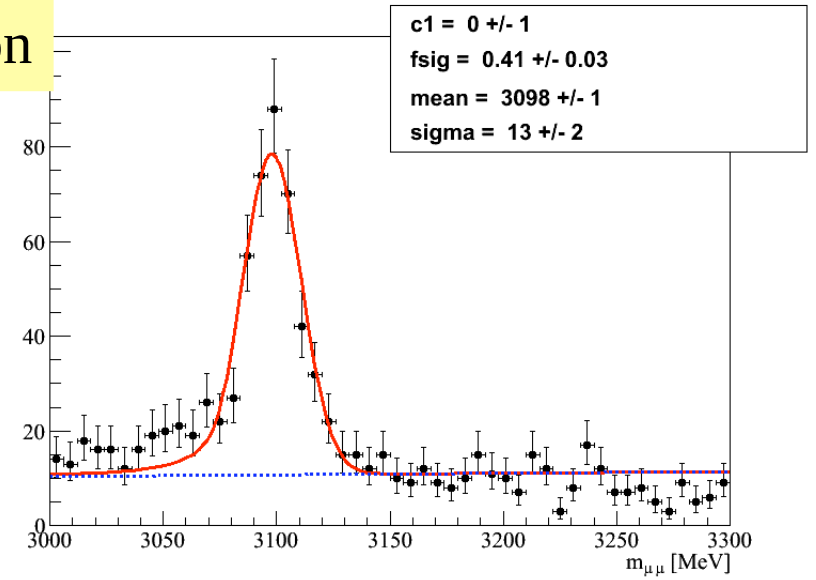
Decay plane dependence



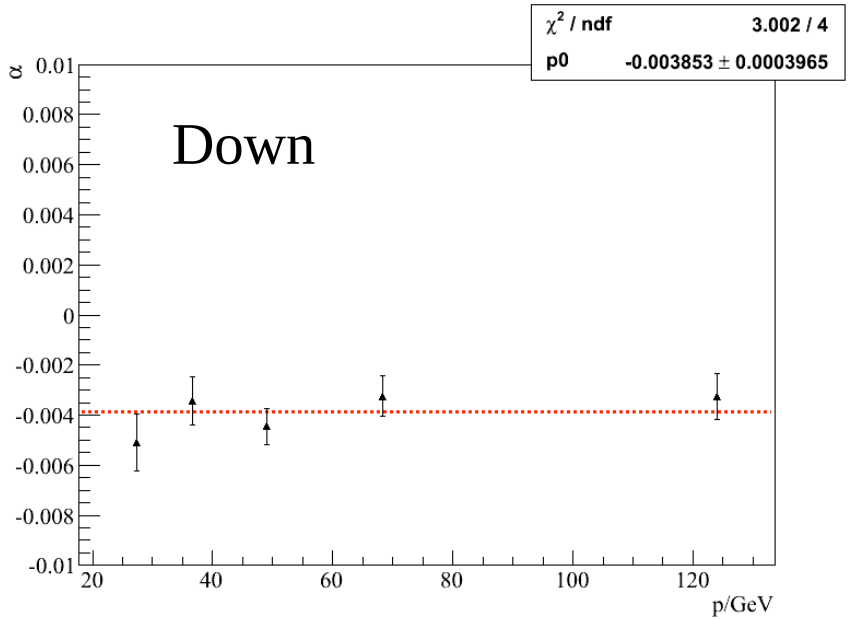


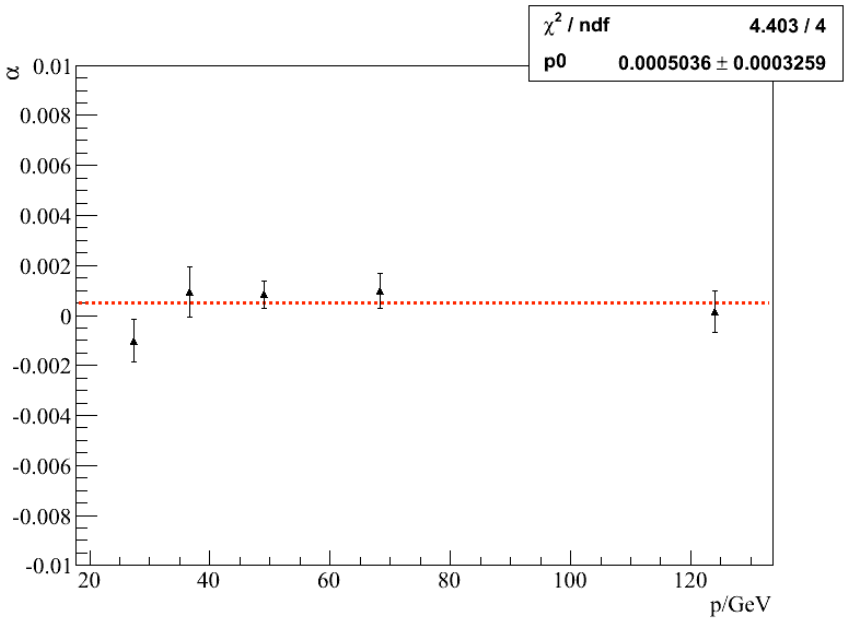
Apply correction

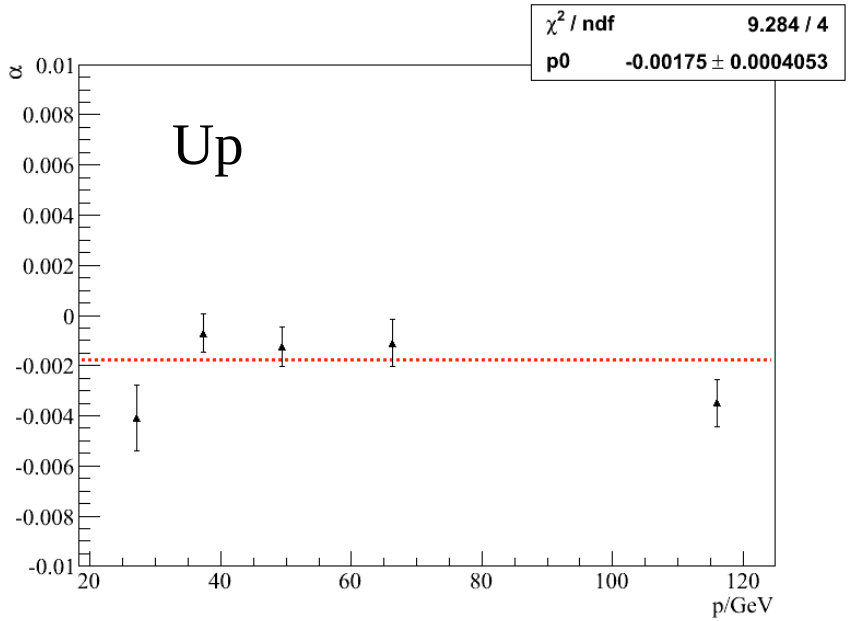


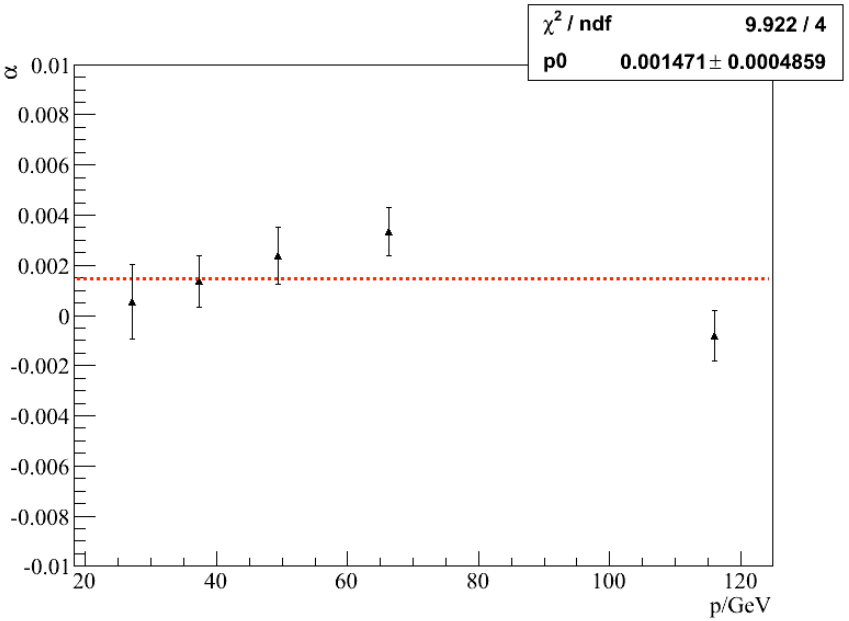


Decay plane dependence

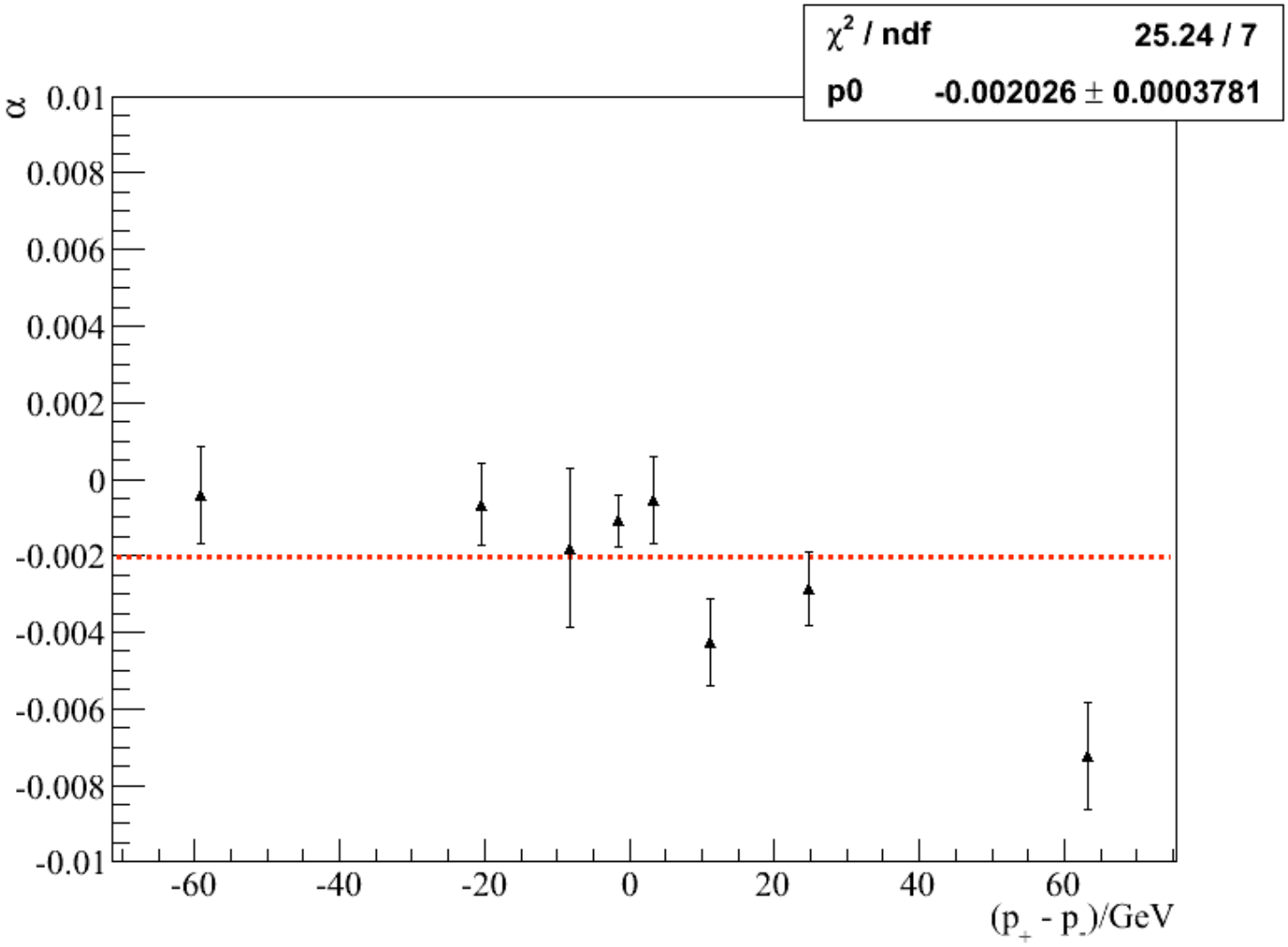




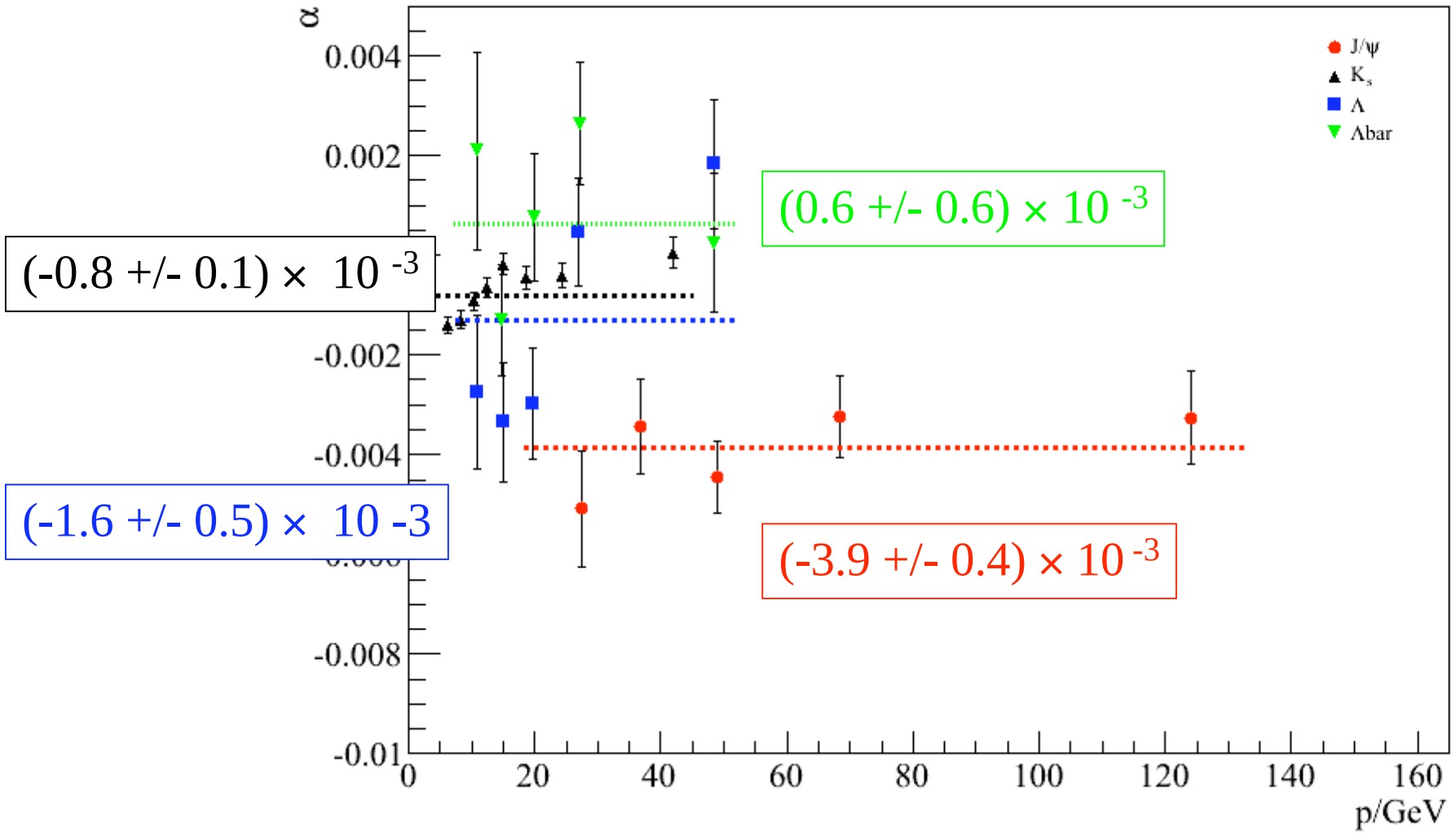




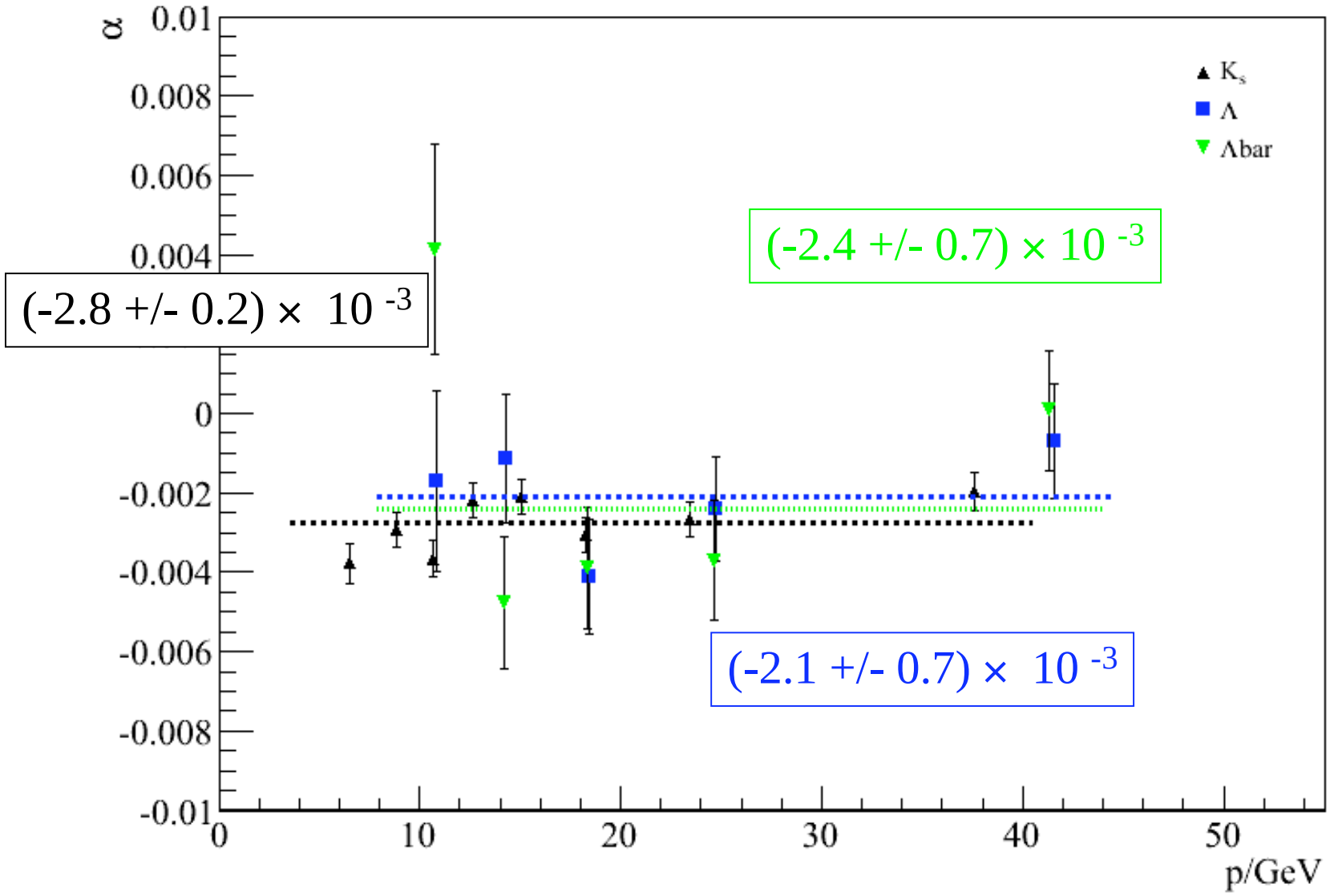
Dependence on the p+ - p-



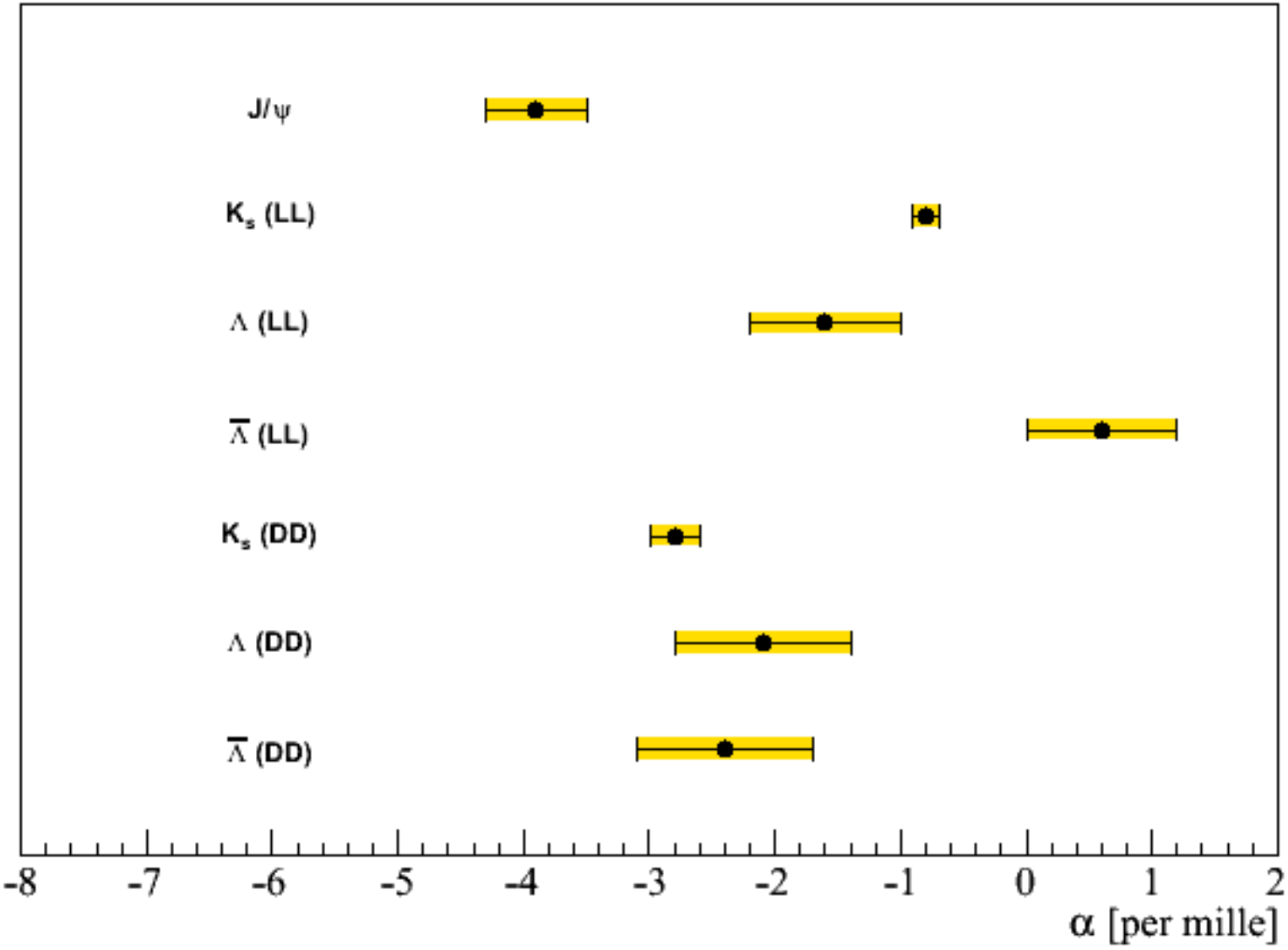
Momentum Scale LL



Momentum Scale DD

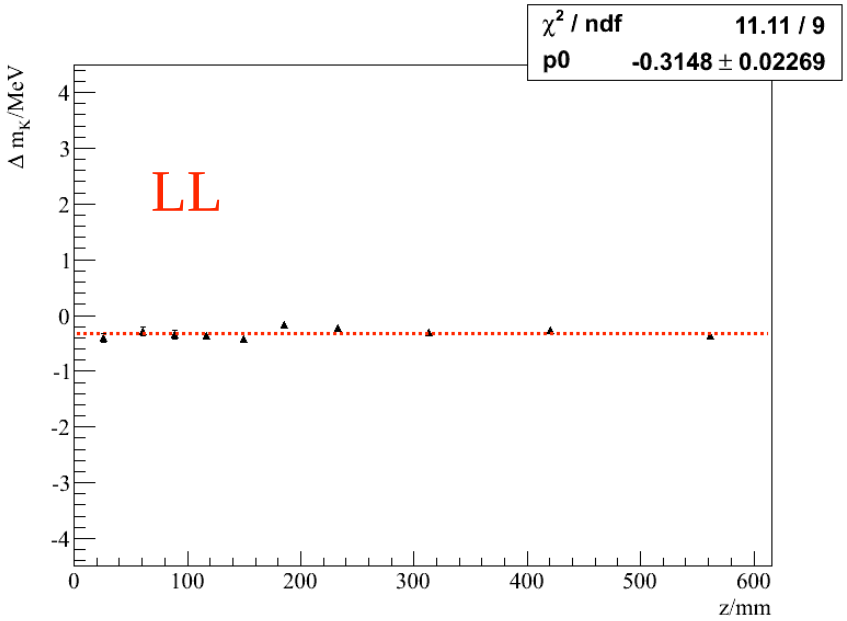


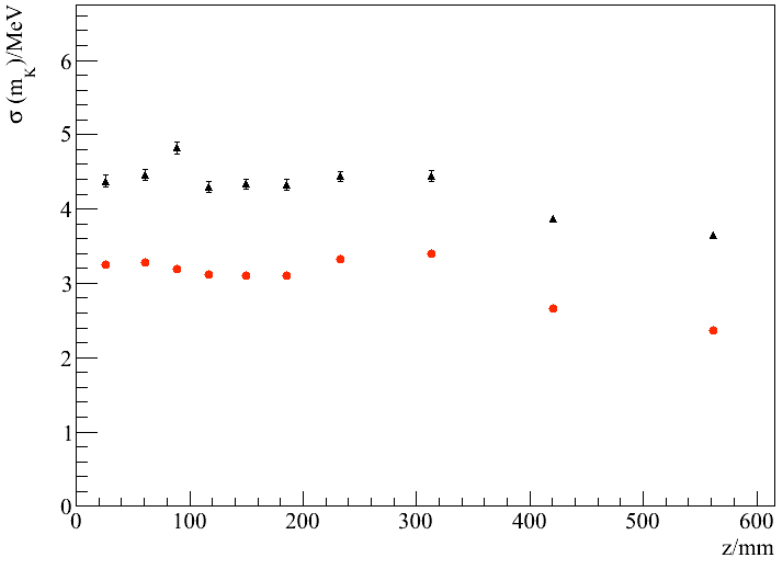
Momentum Scale



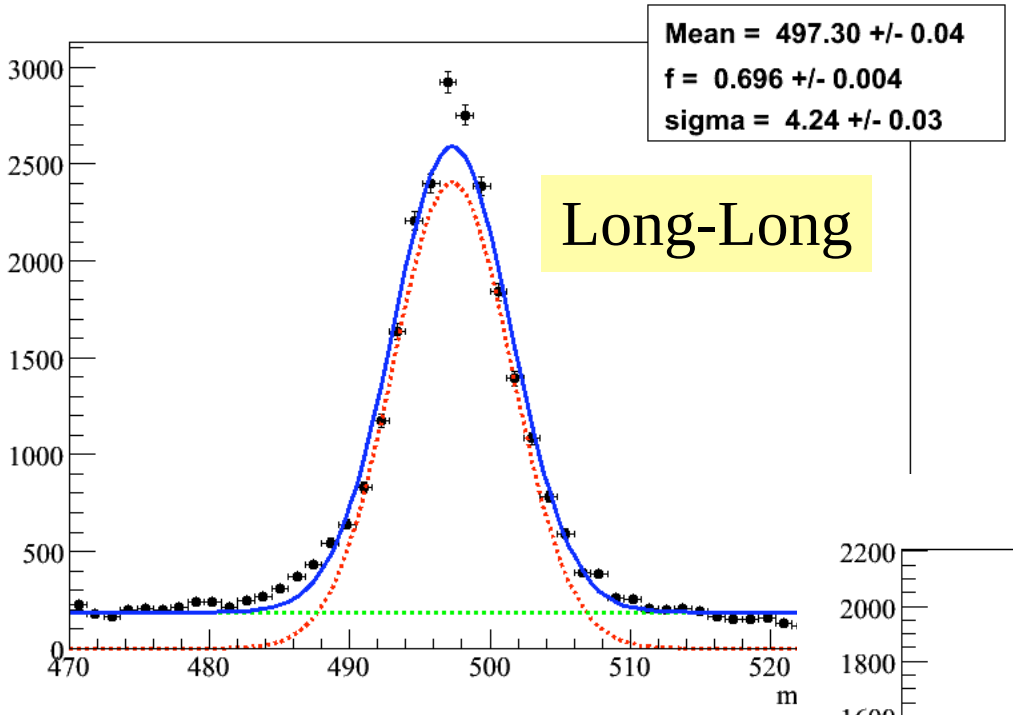
Backup

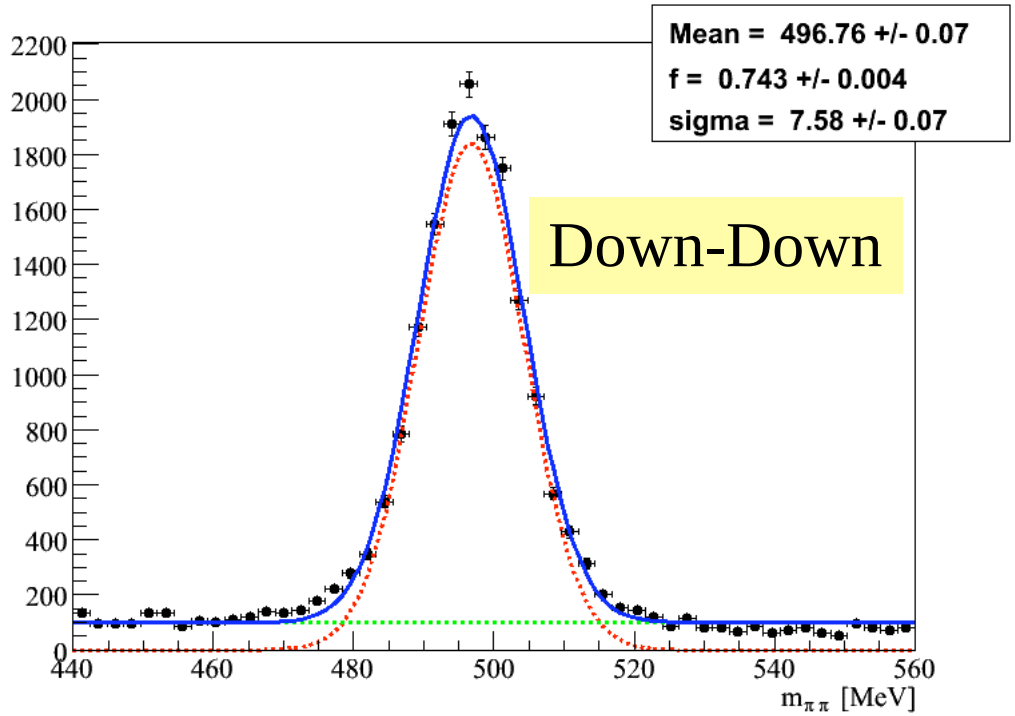
Ks and z


χ^2 / ndf 11.11 / 9
p0 -0.3148 ± 0.02269
LL
Δm_K/MeV
z/mm

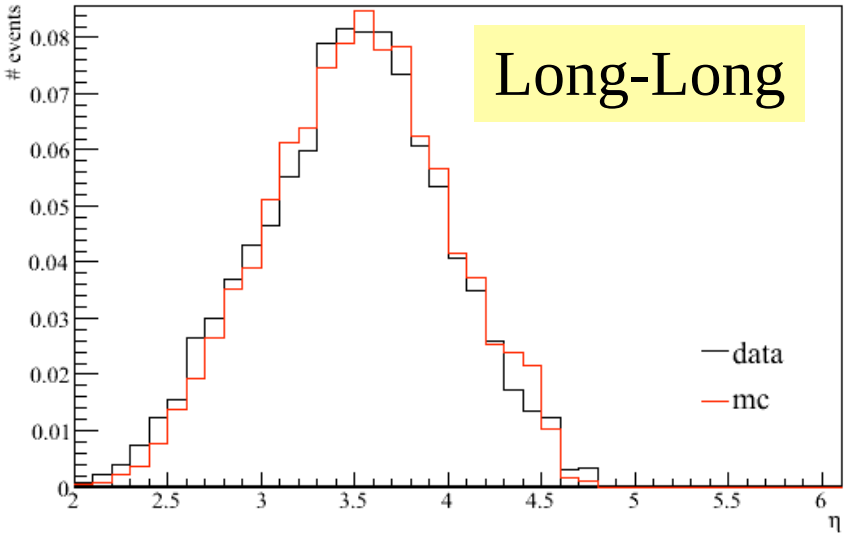

$\sigma(m_K)$/MeV
z/mm

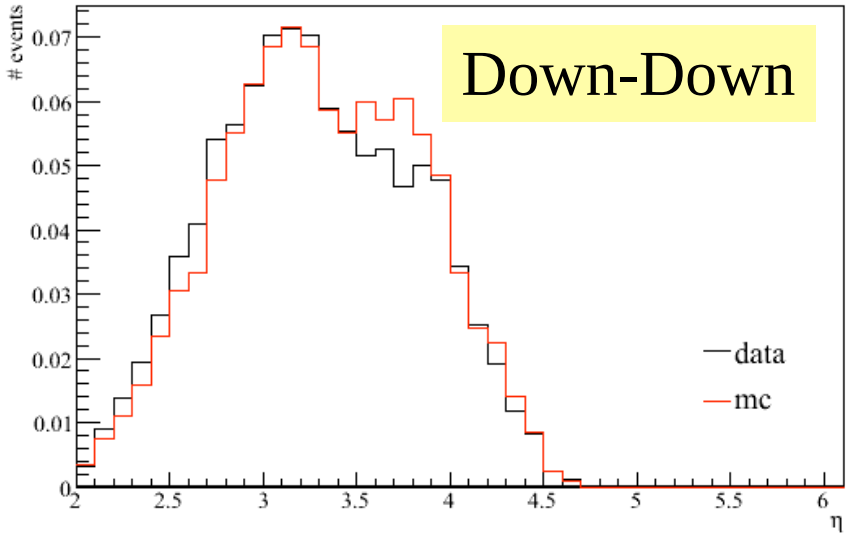
Selected Events

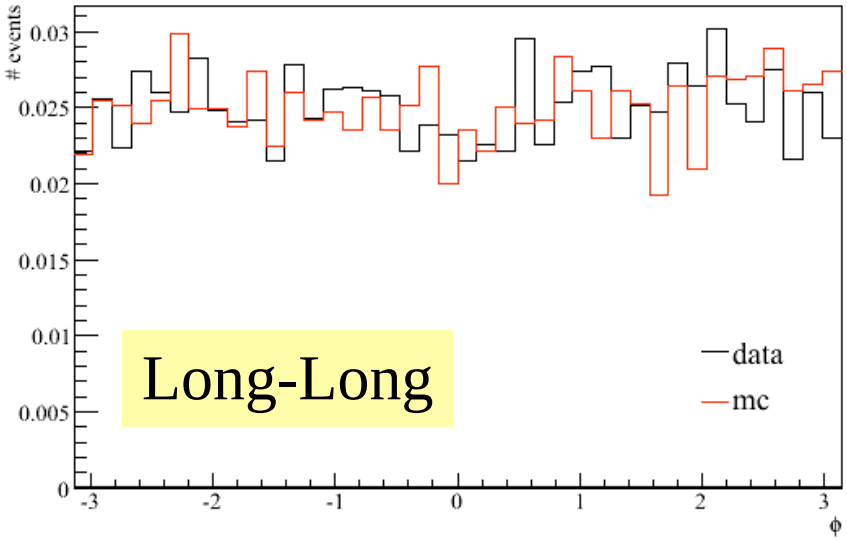


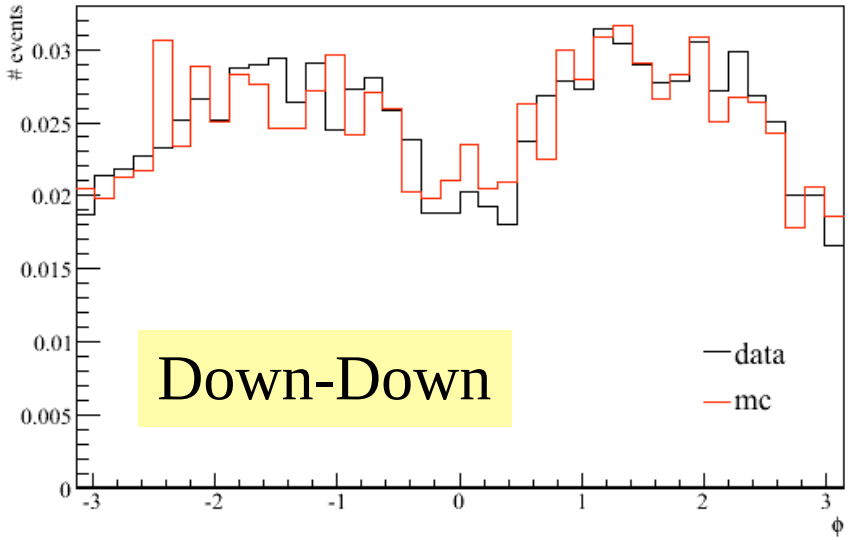


Selected Events







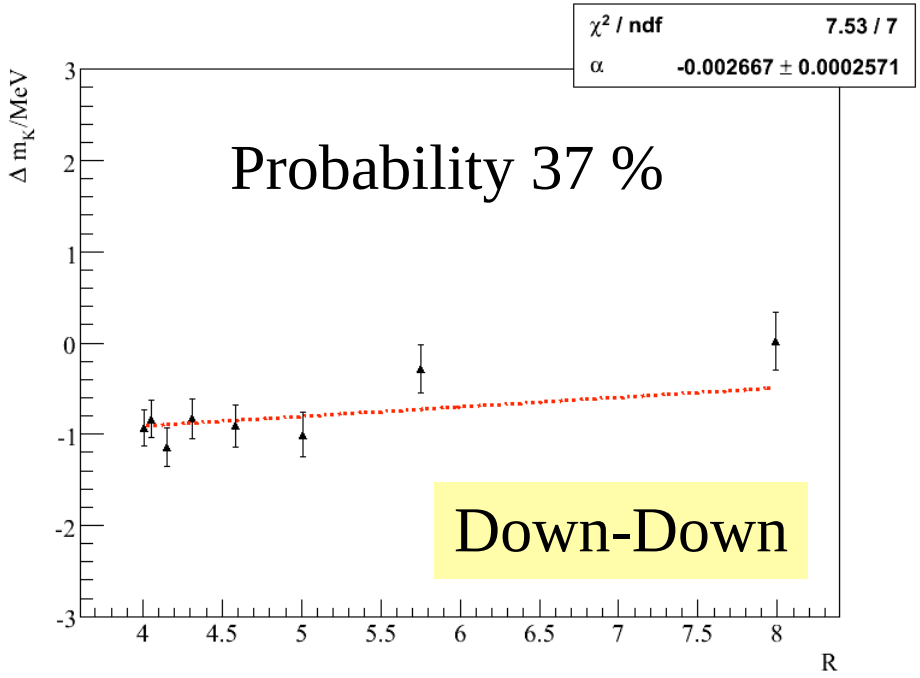


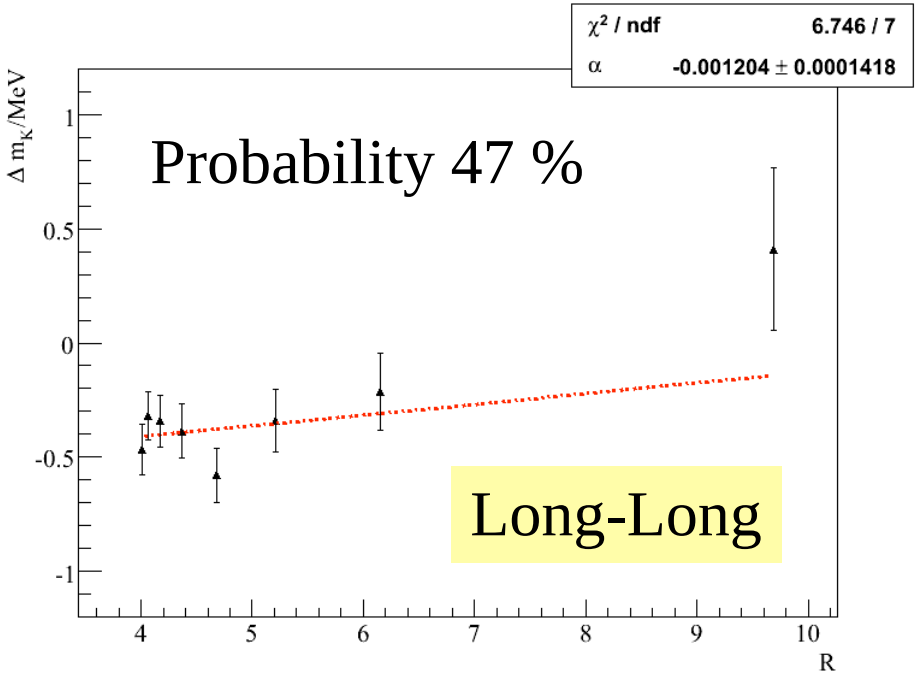
Δm versus R

Expect linear depedence on R in case of uniform B-field scaling

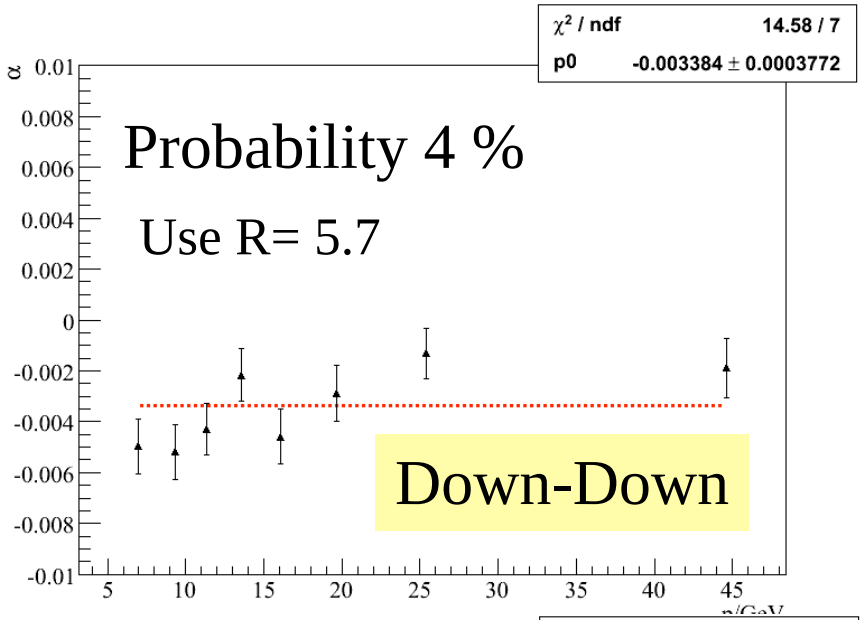
$$\Delta m = \alpha \cdot \frac{m_d^2 R - m_P^2}{m_P}$$

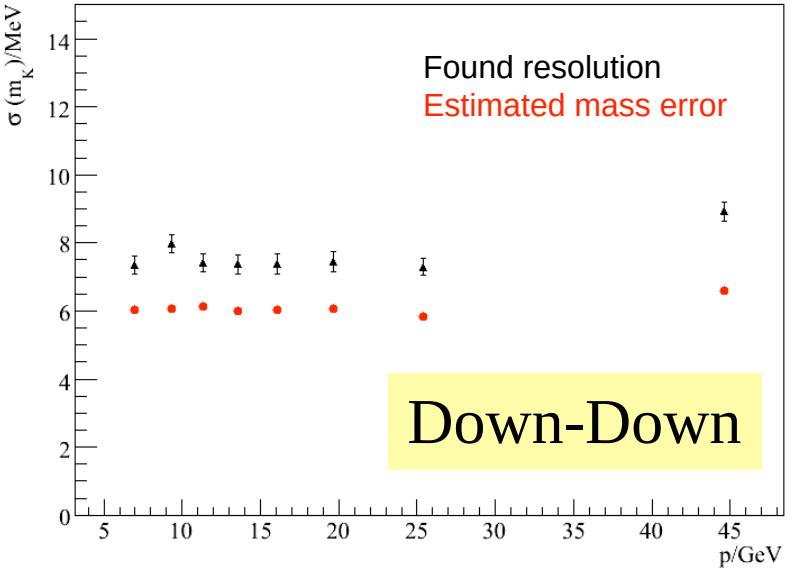
Scale factor

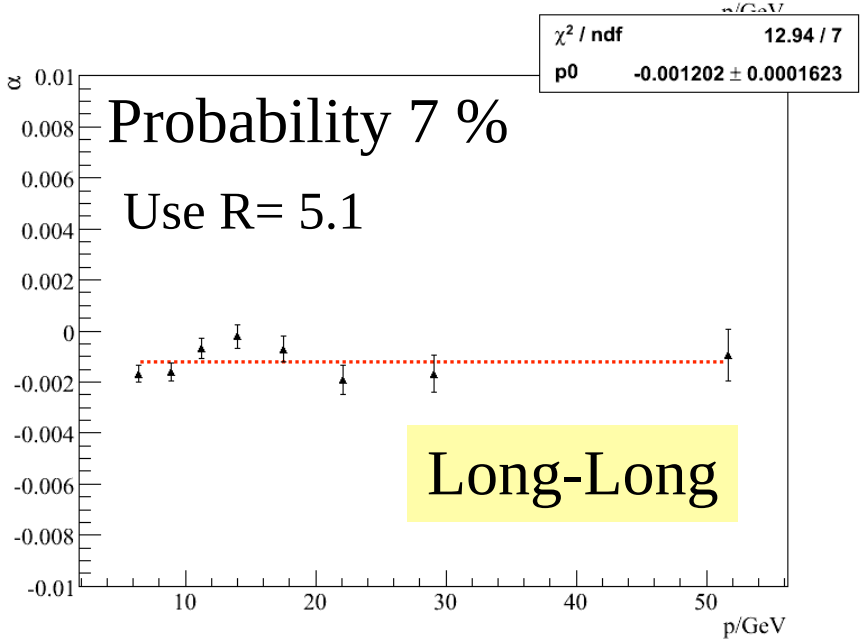


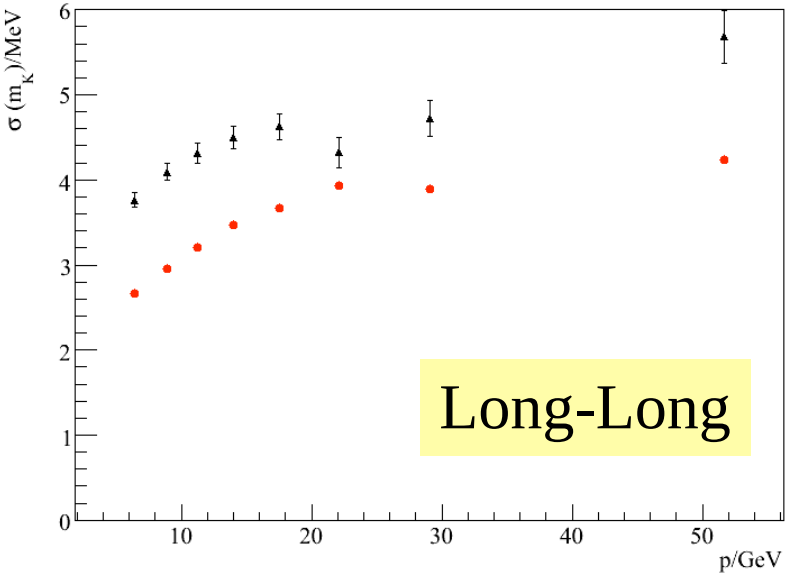


α +Resolution versus p

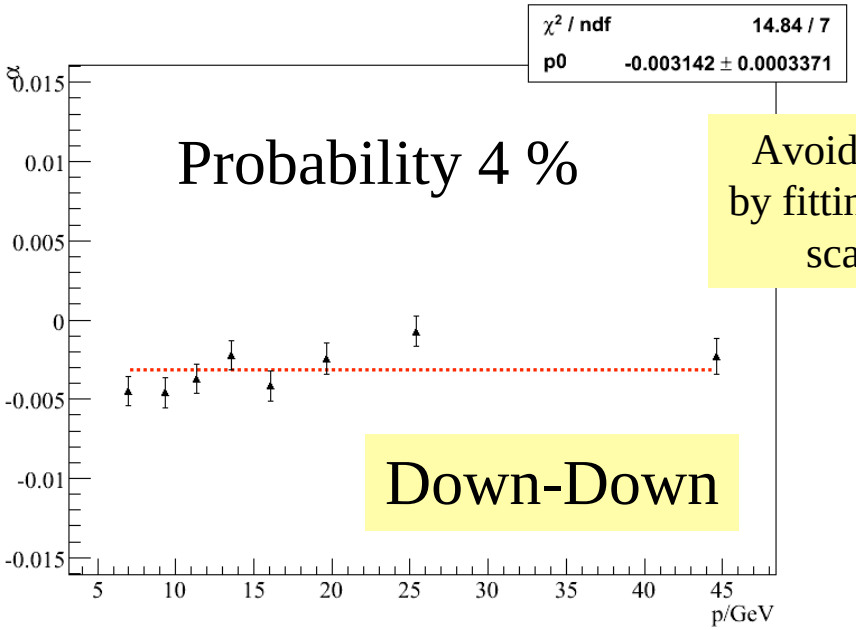








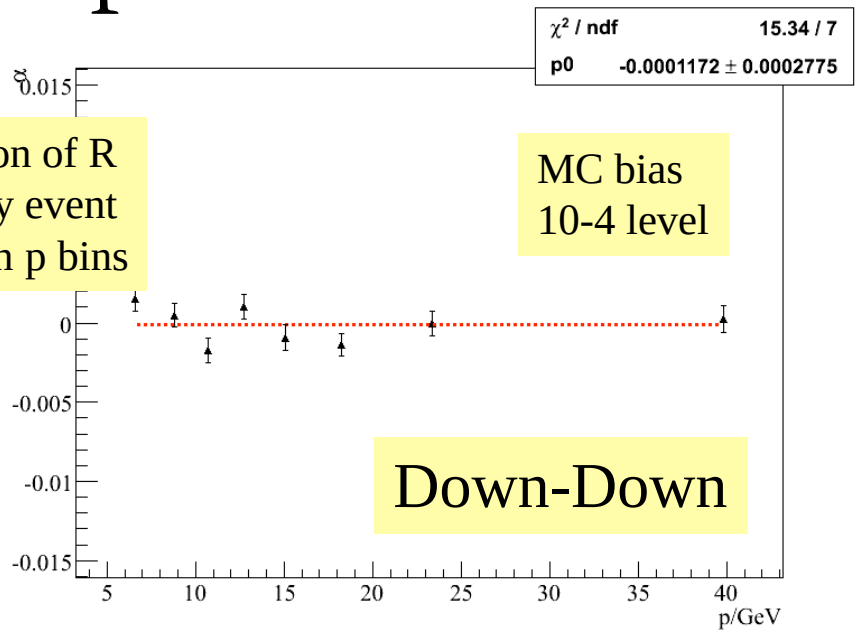
α versus p



Probability 4 %

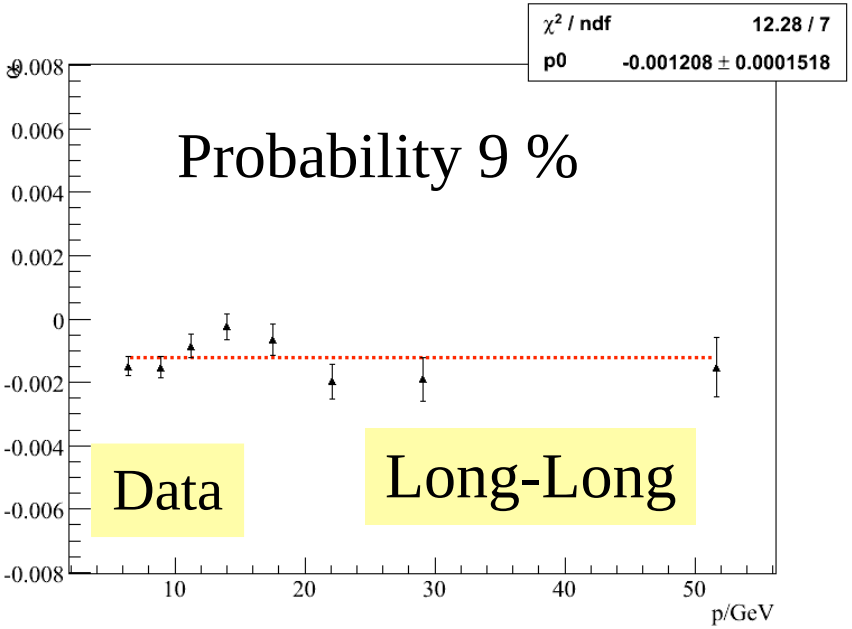
Down-Down

Avoid assumption of R by fitting event-by event scale factor in p bins



MC bias 10-4 level

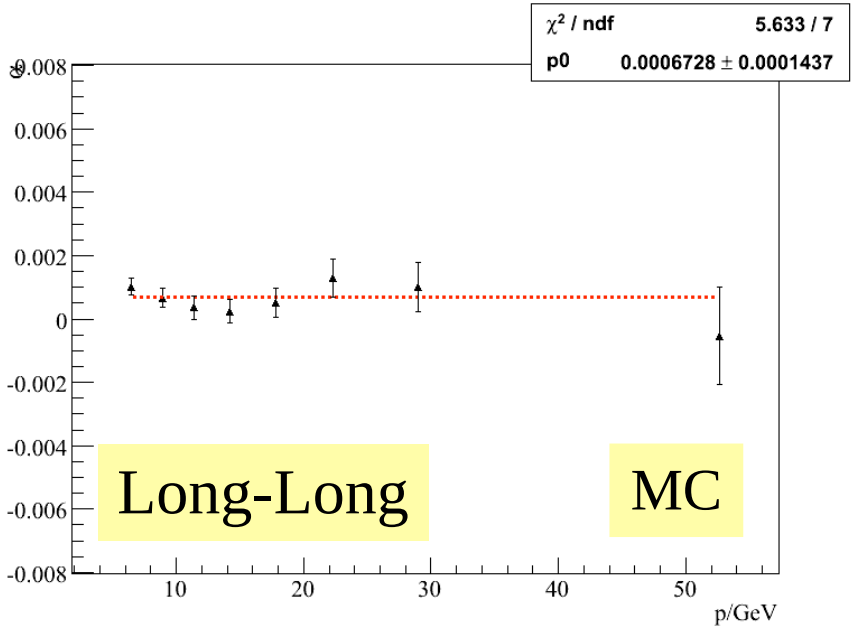
Down-Down



Probability 9 %

Data

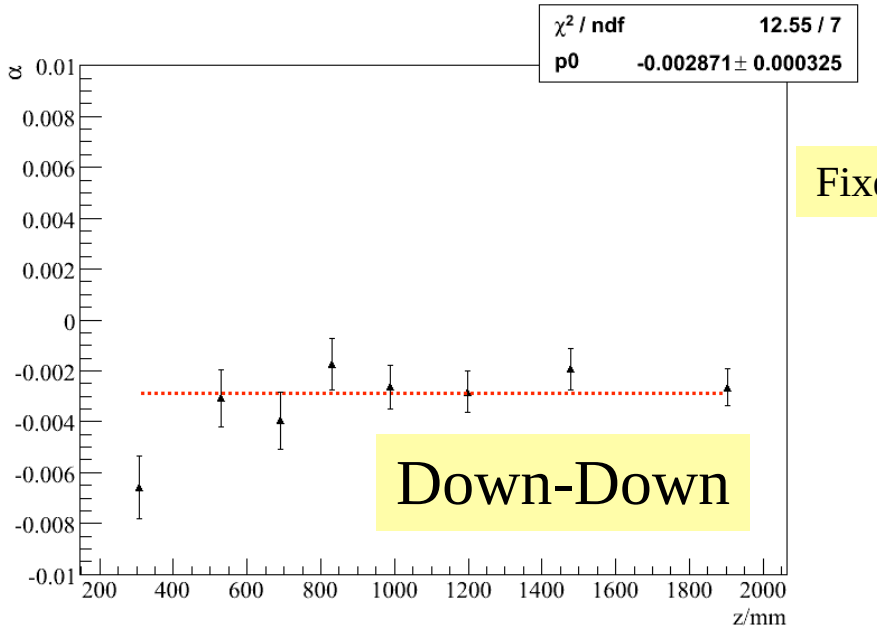
Long-Long



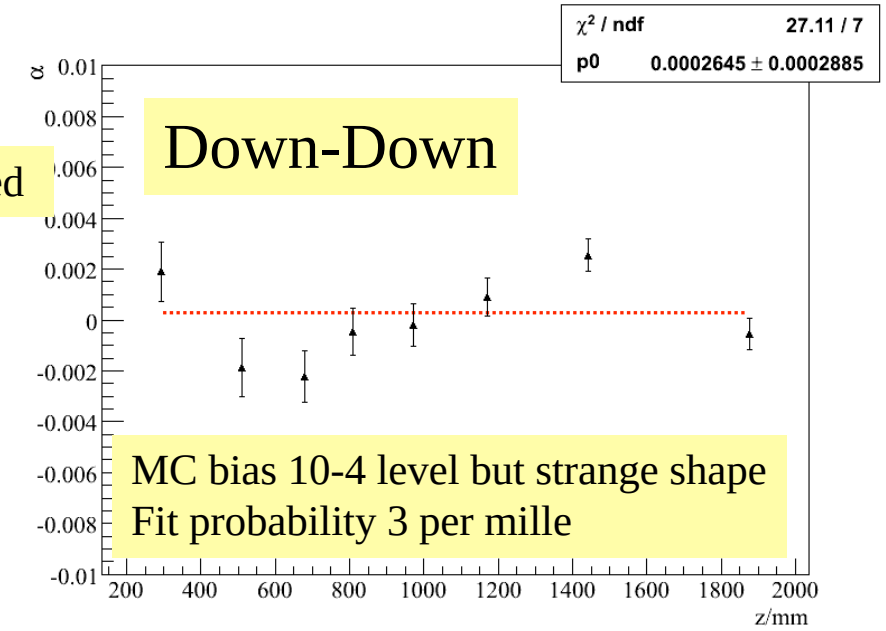
Long-Long

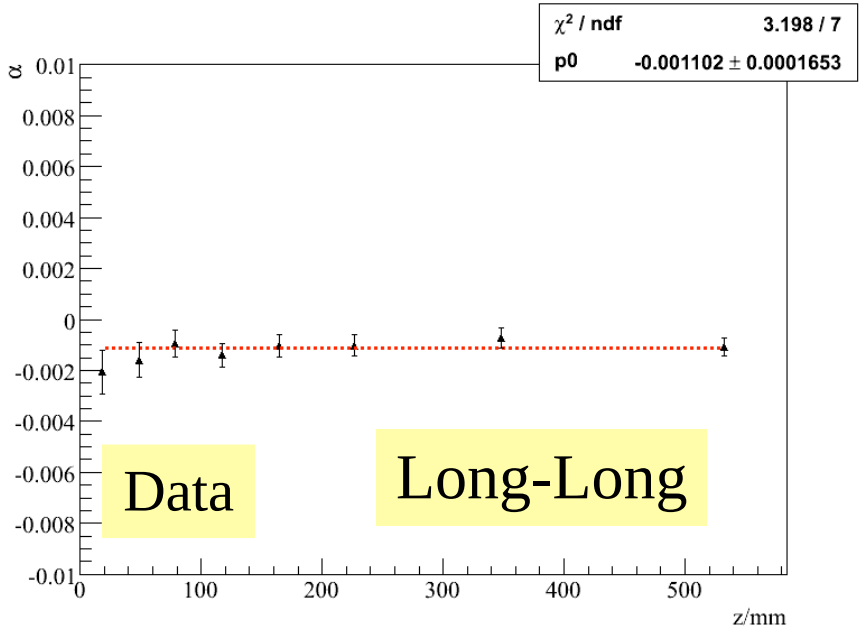
MC

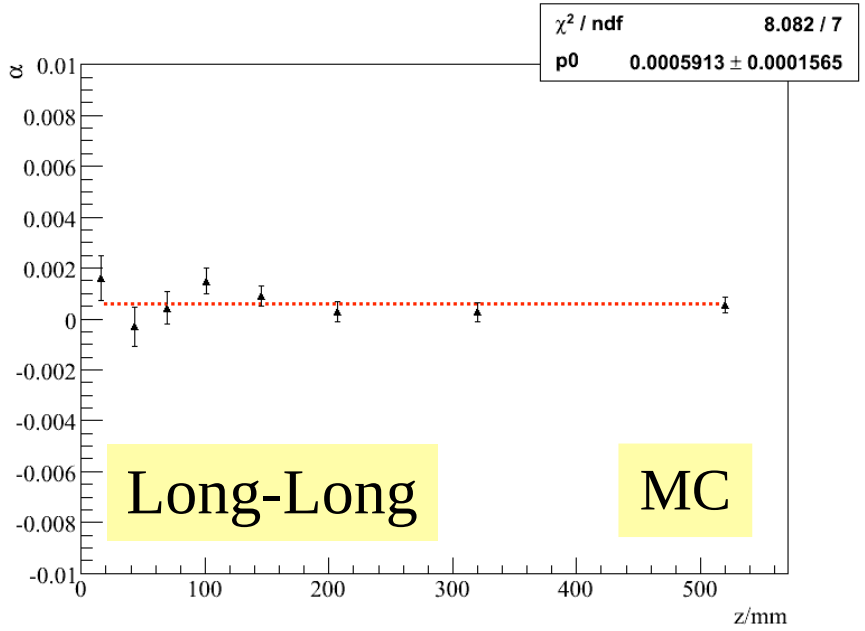
α versus z



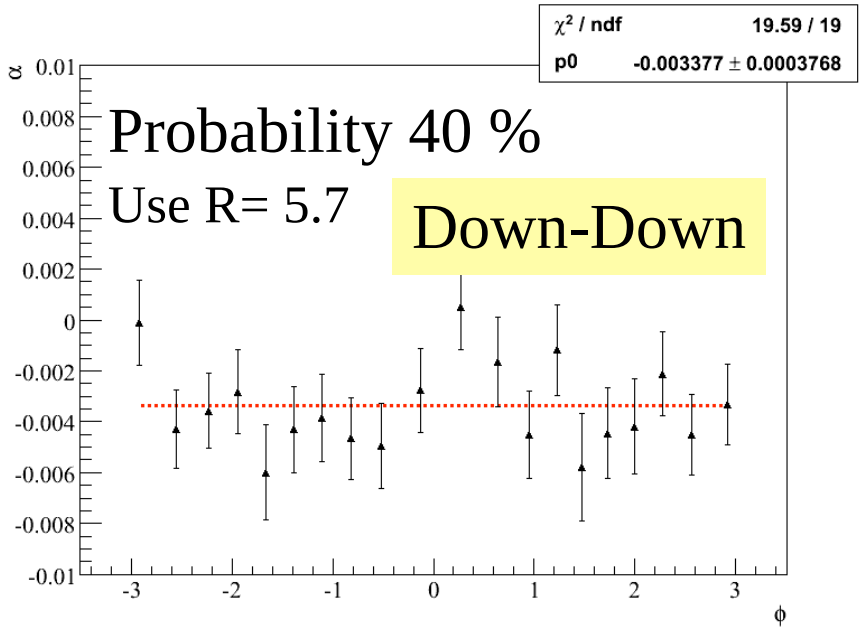
Fixed R used







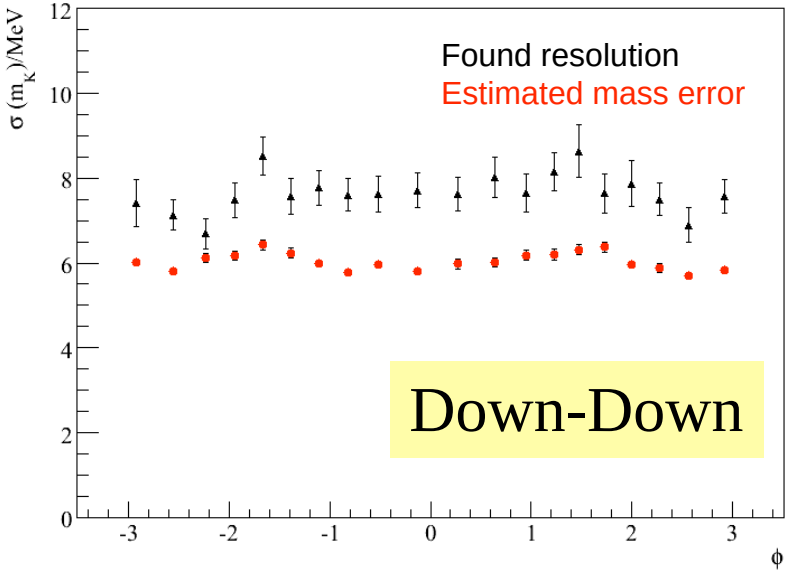
α +Resolution versus ϕ



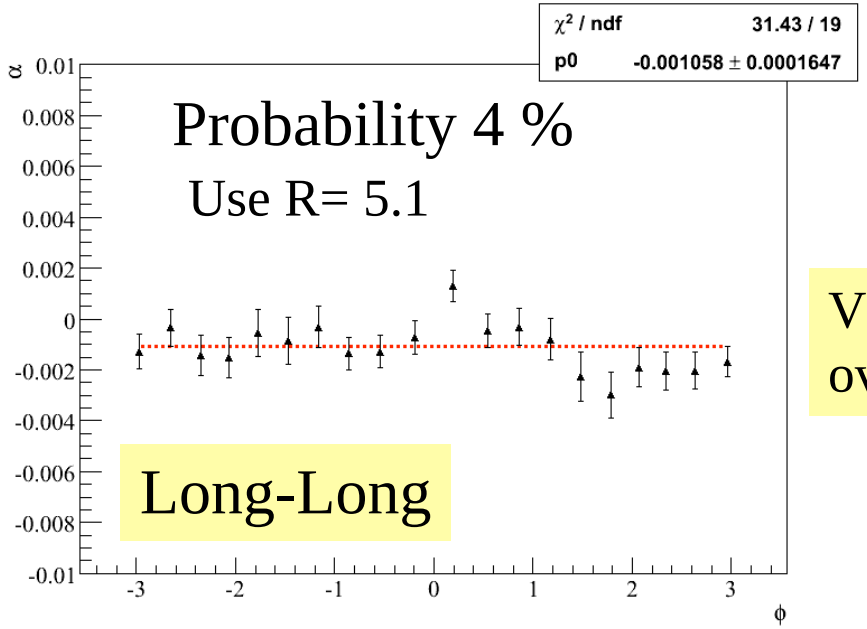
Probability 40 %

Use R= 5.7

Down-Down



Down-Down

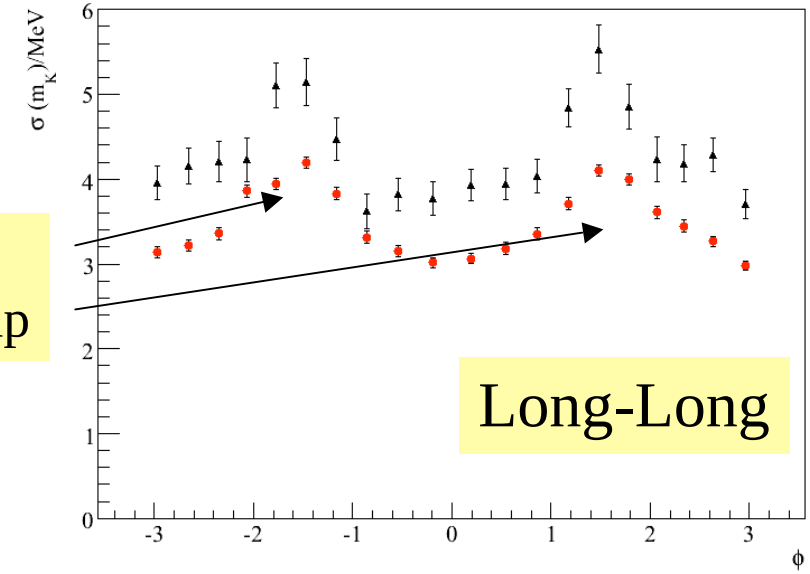


Probability 4 %

Use R= 5.1

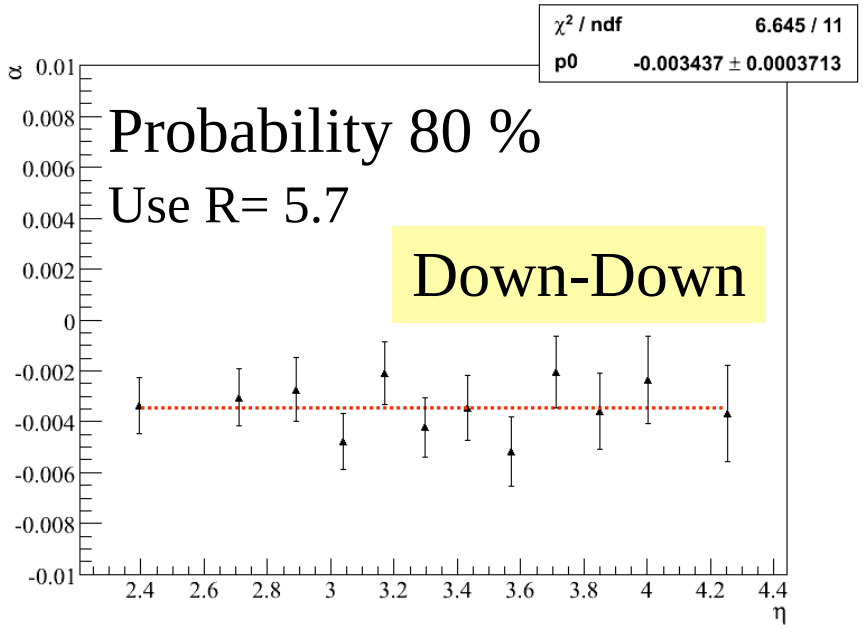
Long-Long

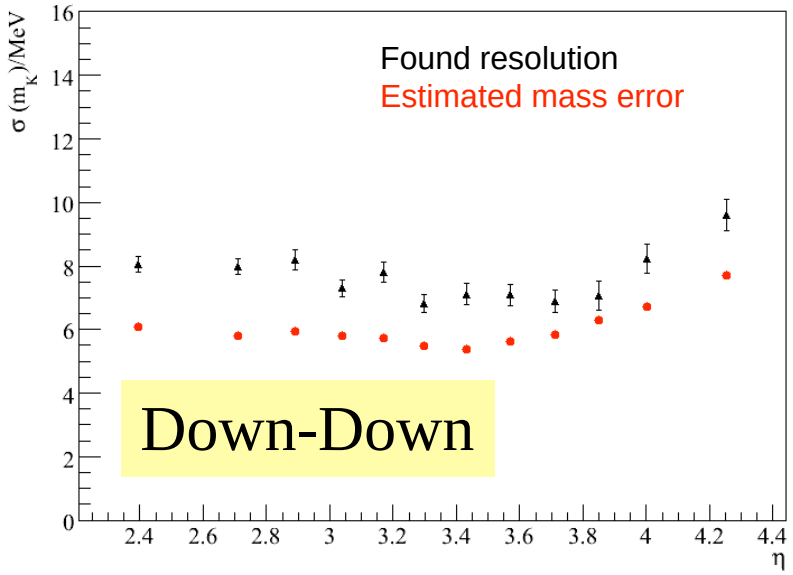
Velo overlap

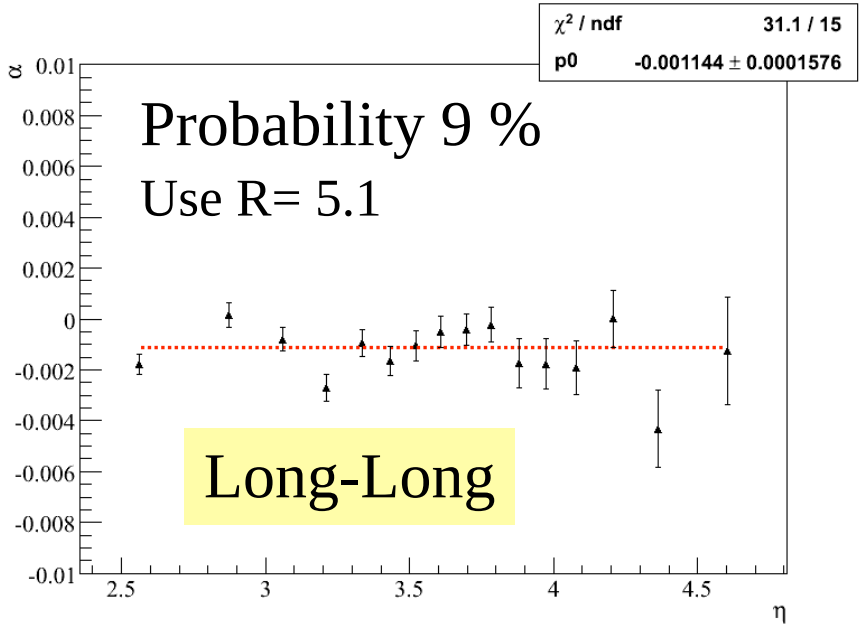


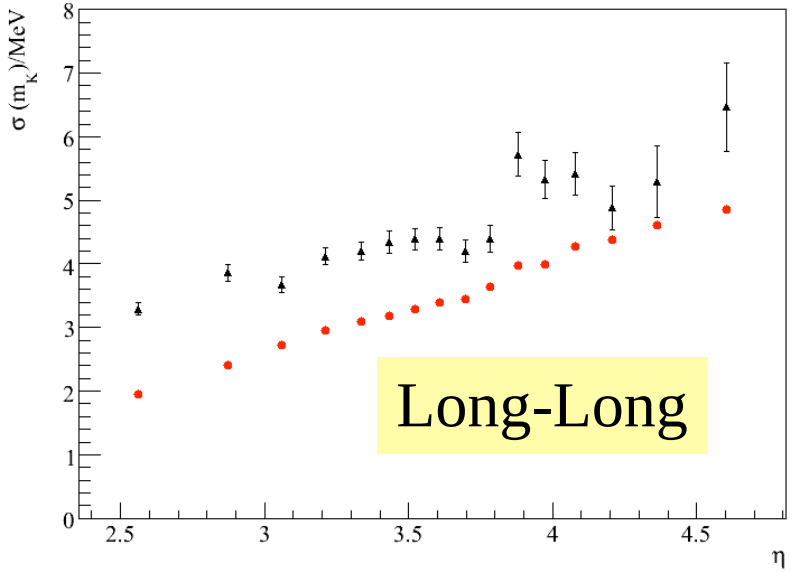
Long-Long

α +Resolution versus η

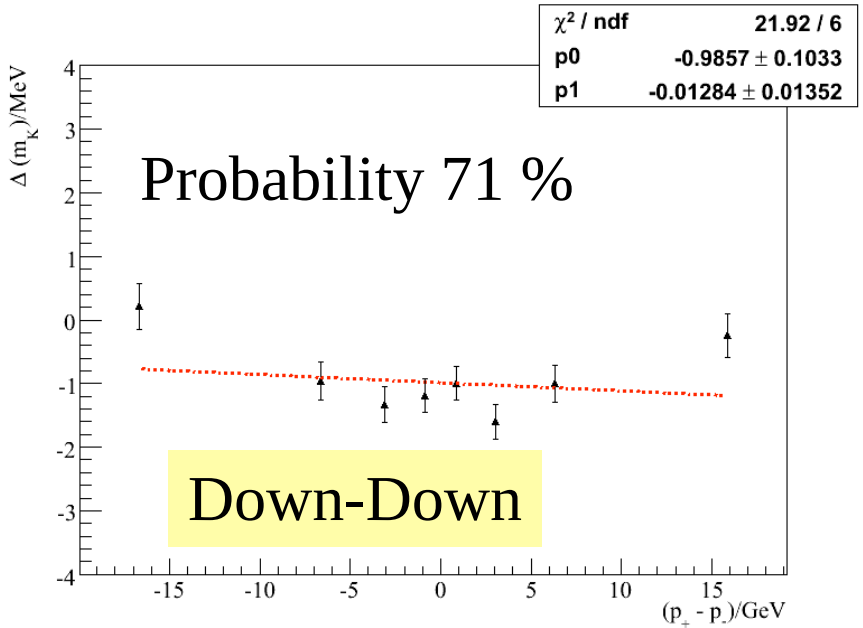






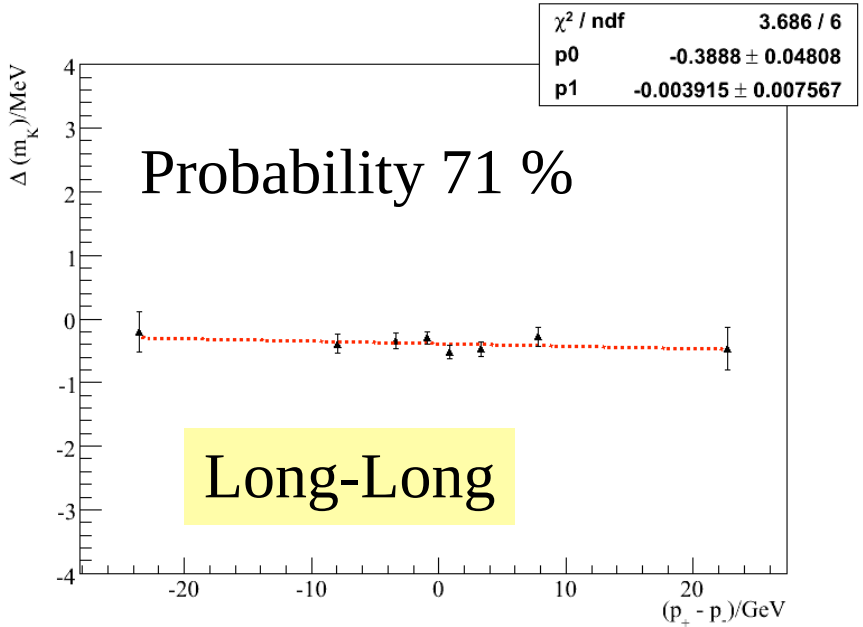


Δm versus $p_+ - p_-$



Probability 71 %

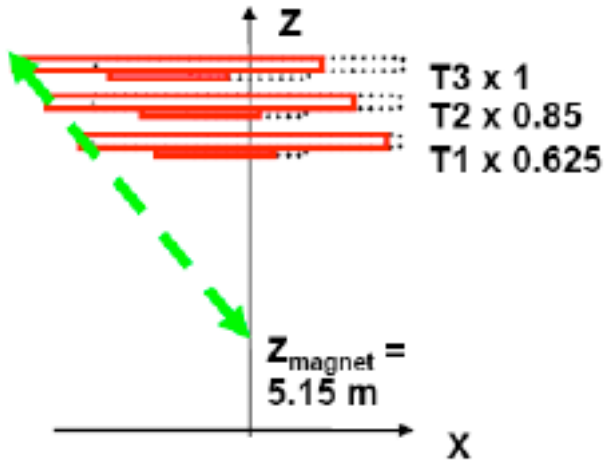
Down-Down



Probability 71 %

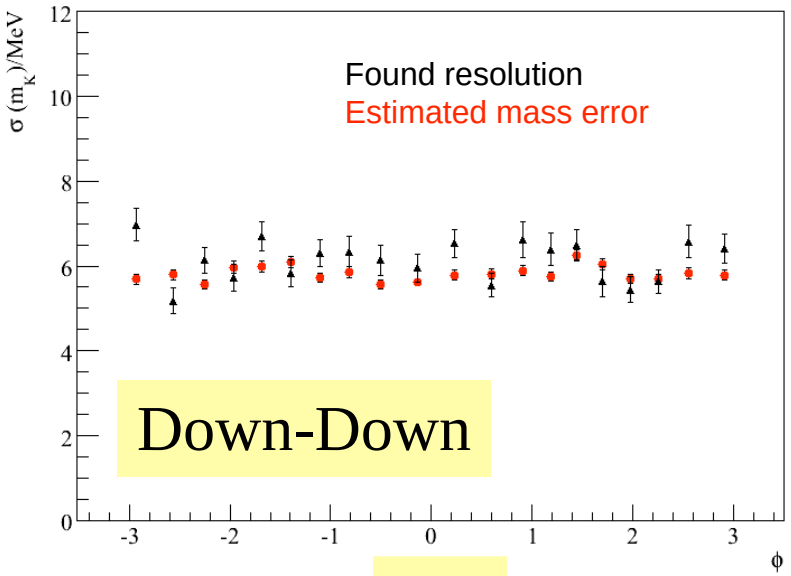
Long-Long

Weak mode depending on the p difference



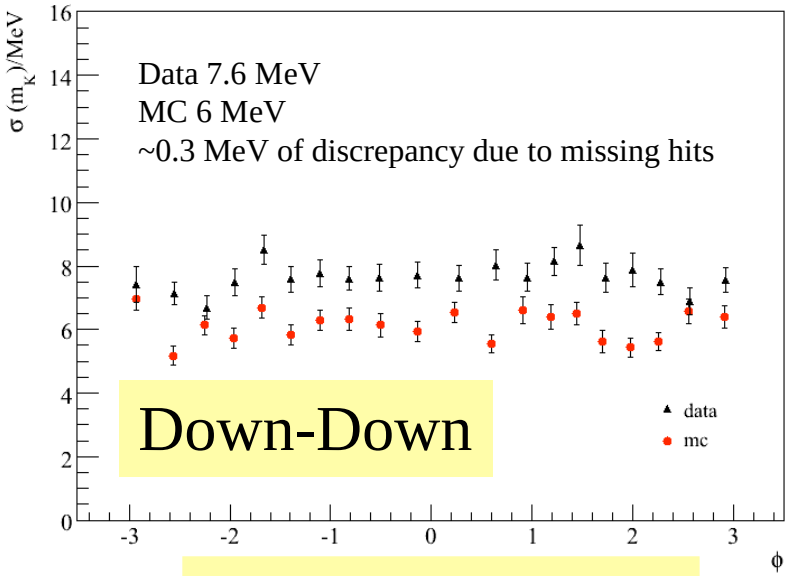
Common X-translation with a scale factor of IT and OT

MC resolution ϕ



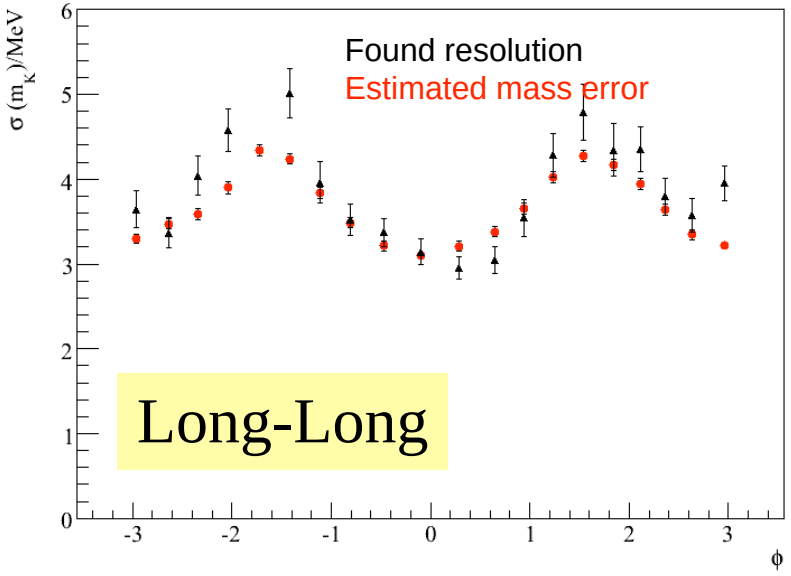
Down-Down

MC

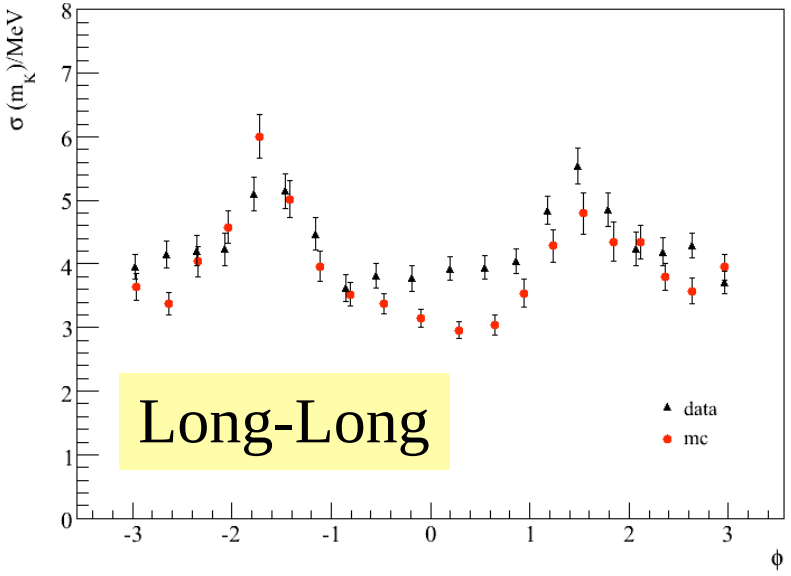


Down-Down

Resolution data/MC

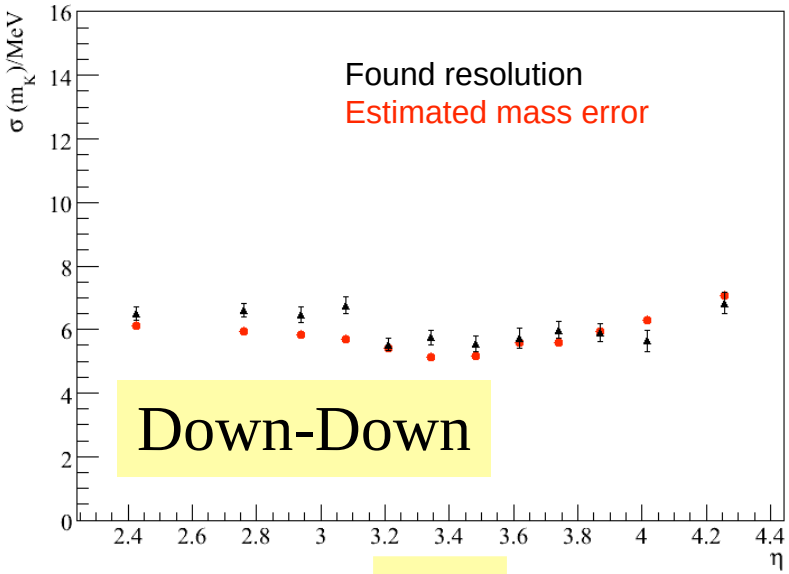


Long-Long

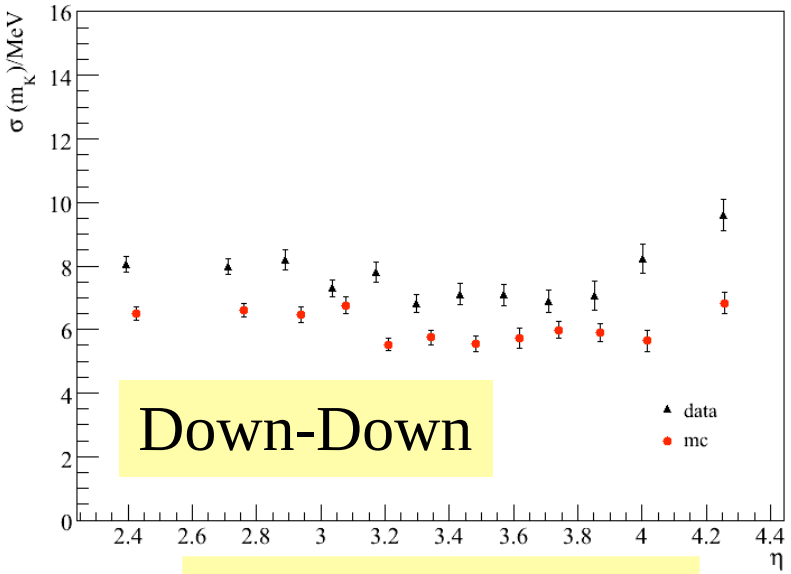


Long-Long

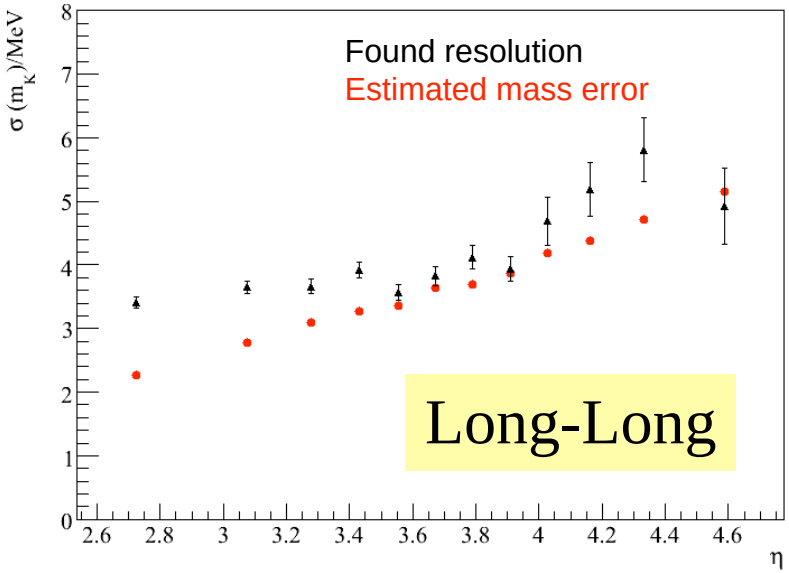
MC resolution η

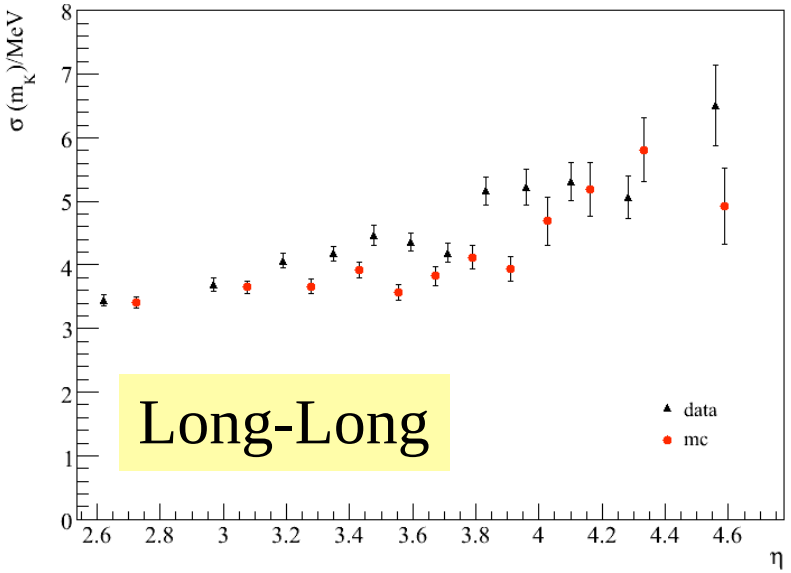


MC

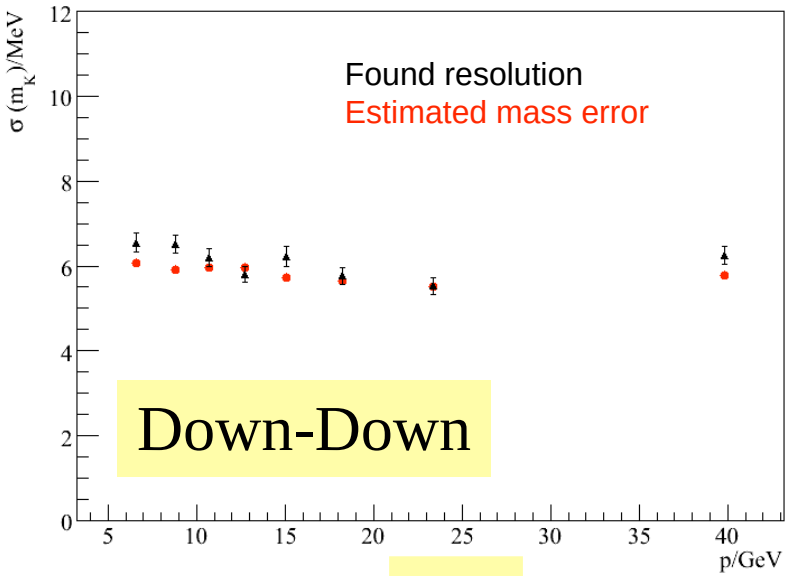


Resolution data/MC



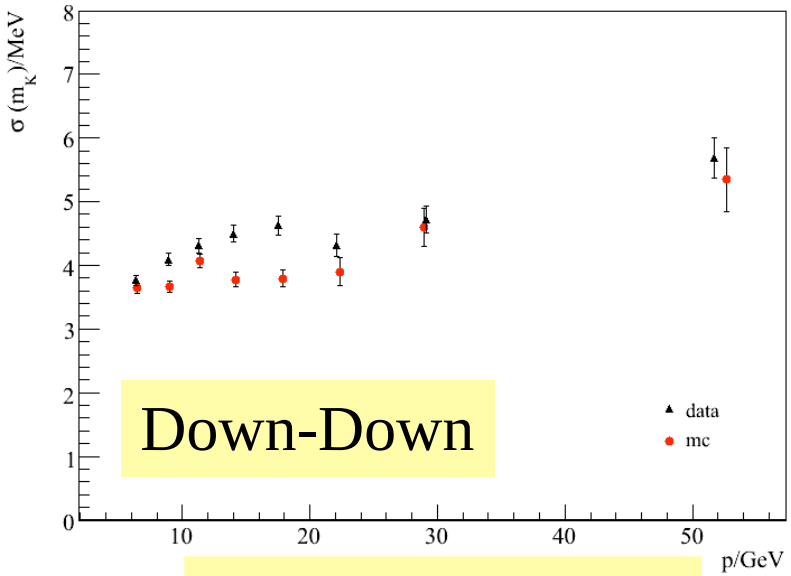


MC resolution p



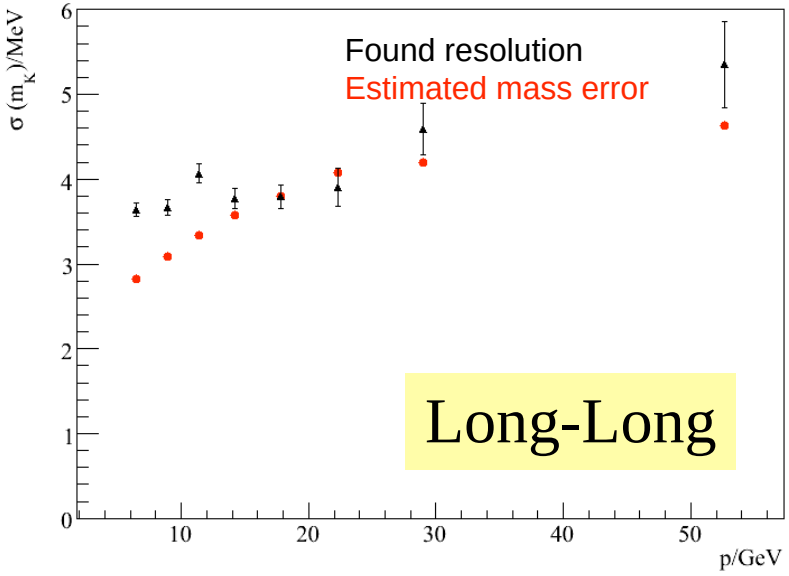
Down-Down

MC

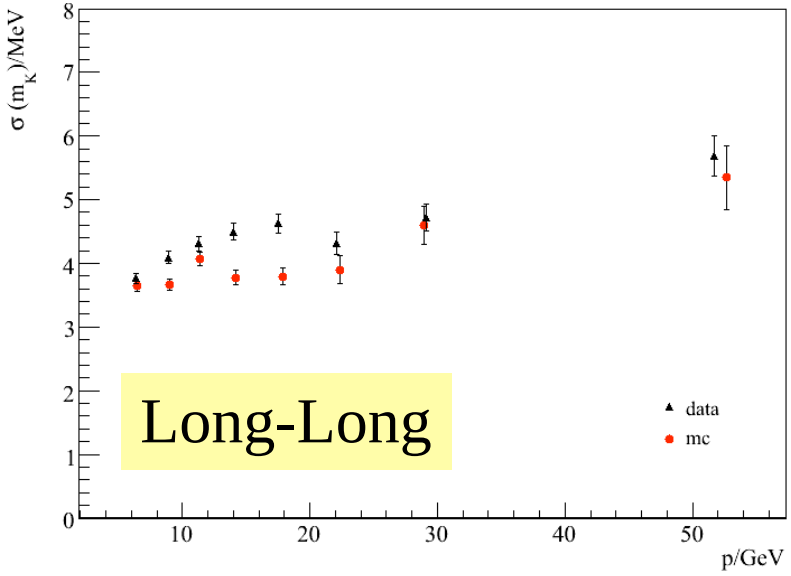


Down-Down

Resolution data/MC



Long-Long



Long-Long