CLAS Collaboration Meeting, JLAB

07/10 – 07/13/2018

Kinematic monitoring and corrections for CLAS12 – status and perspectives

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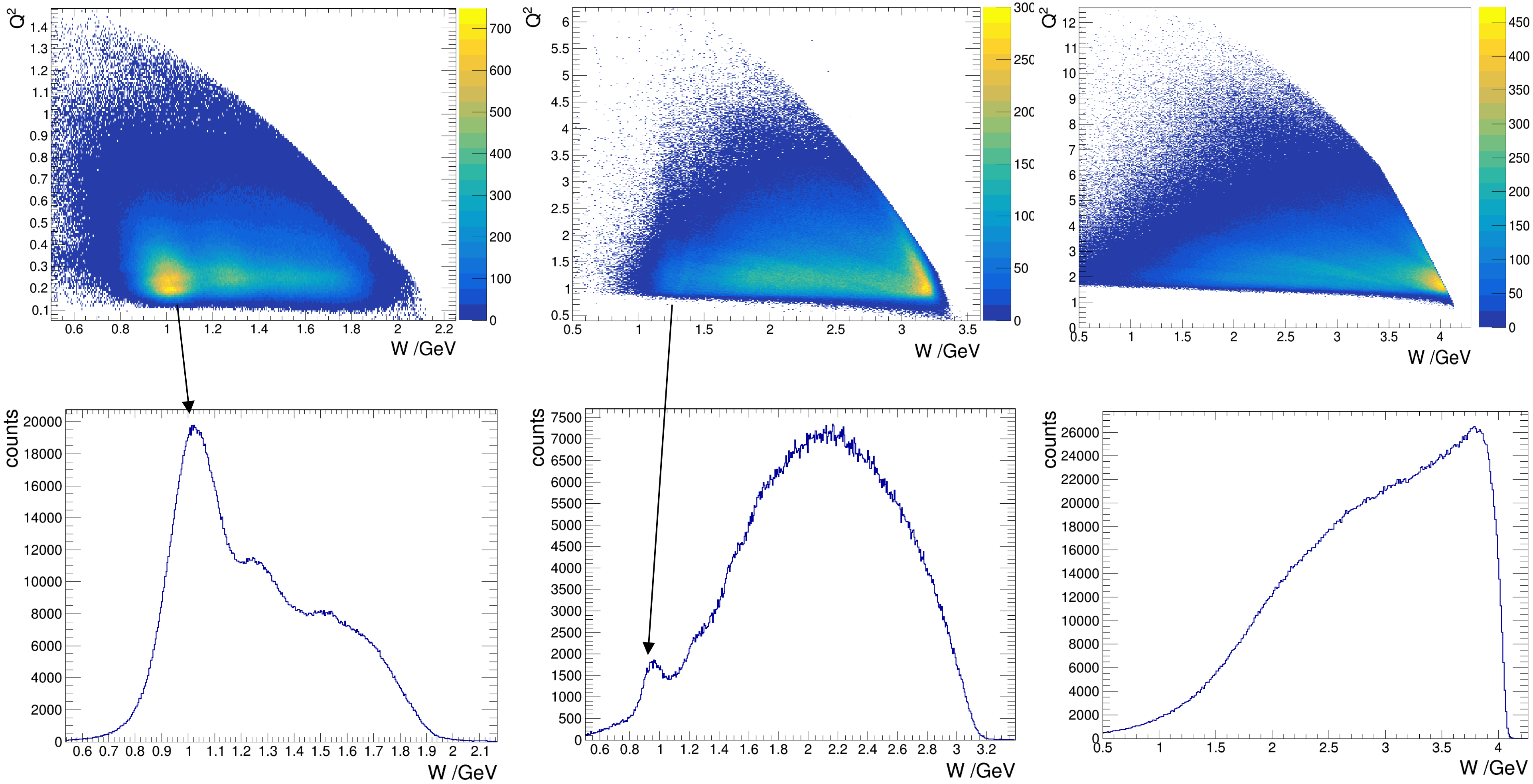
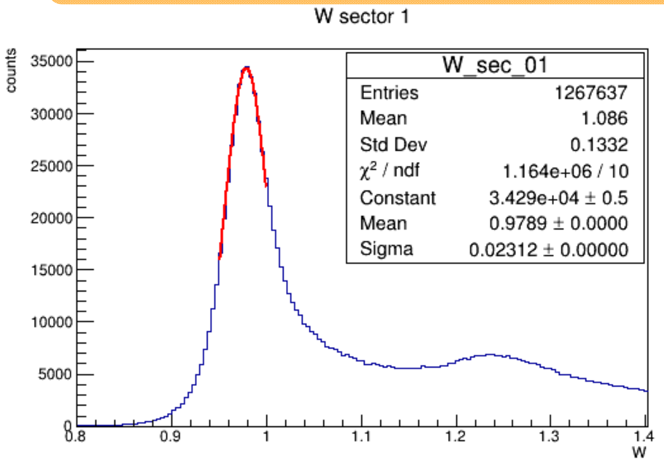
Introduction

2.2 GeV **6.4 GeV** **10.6 GeV**



Introduction



- Elastic peak at 2.2 GeV is at a wrong position and wider than expected
- Missing energy and missing momentum for fully exclusive reactions at 10.6 GeV are shifted

➔ Electron momentum is shifted and shows a θ and Φ dependence

<u>Up to now:</u>

Several improvments have been applied to the torus field and to the geometry

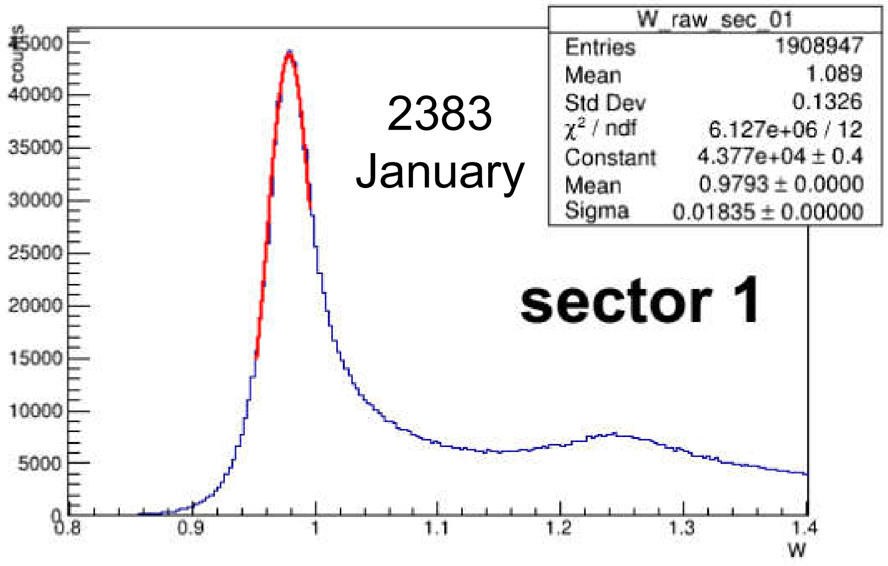
January: Theoretical map with individual coils shifted to fit the field measuremnts

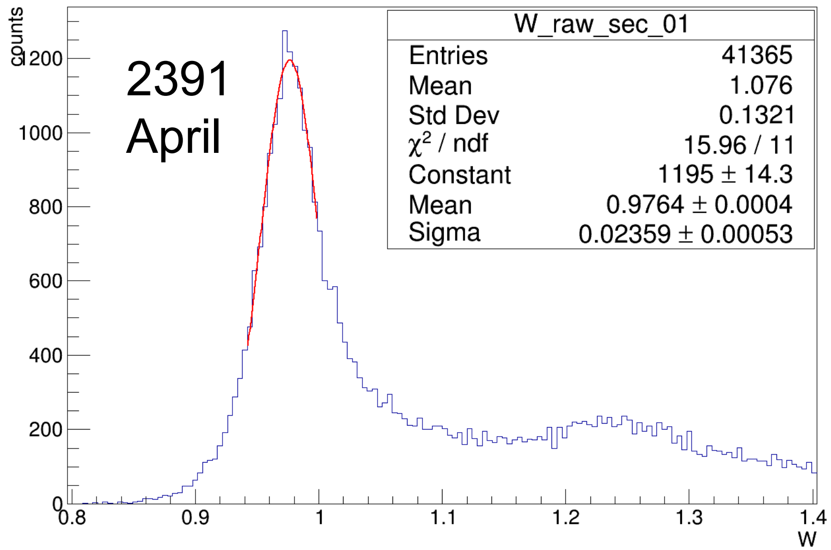
April: Symmetric field map based on coil shape/ current flux calculations

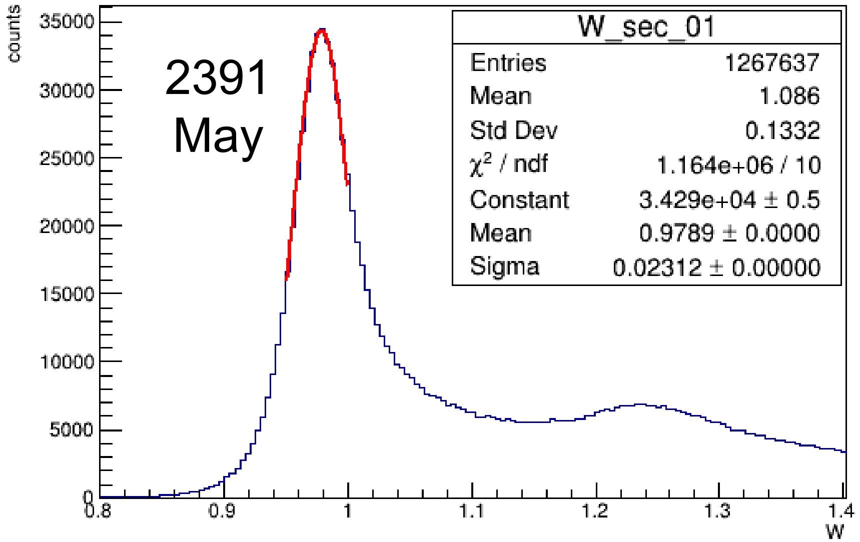
May: April map with individual coils shifted to fit the field measuremnts

July: May map with a shift of the detector geometry

Comparison of sector 1 (solenoid: -1 torus: + 1 (outbending))







January: 979.3 MeV / 18.4 MeV

April: 976.4 MeV / 23.6 MeV

May: 978.9 MeV / 23.1 MeV

July: 1026 MeV / 27.9 MeV

Monitoring and correction approach

- CLAS 12 has two idenpendent magnetic fields and two spectrometer parts with different resolutions

➡ Momentum corrections for electrons (detected in the FD) can not be based on protons, mainly detected in the CD

Correction approach: Use well known correlation between the θ scattering angle of elastically scattered electrons and their momentum

$$ep \rightarrow e'p'$$

➡ At **2.2 GeV** most electrons are scattered elastically

→ Correction can be done with the statistics of a single run

➡ At **6.4 GeV** a clear elastic peak is visible, but the cross section is significantly reduced

→ Several runs have to be combined to obtain a sufficient statistics

Basic concept of the momentum correction

For eleastic scattering:
(W < 1.05 GeV for the 2.2 GeV data)

$$P_e^{corr} = \frac{E_{beam}}{1 + \frac{2 \cdot E_{beam} \cdot \sin^2(\theta_e / 2)}{M_p}}$$

Define: $x = \frac{P_{corr}}{P_{meas}}$ ⇒ $P_{corr} = x \cdot P_{meas}$

Interpreatation of the x value under ideal conditions:

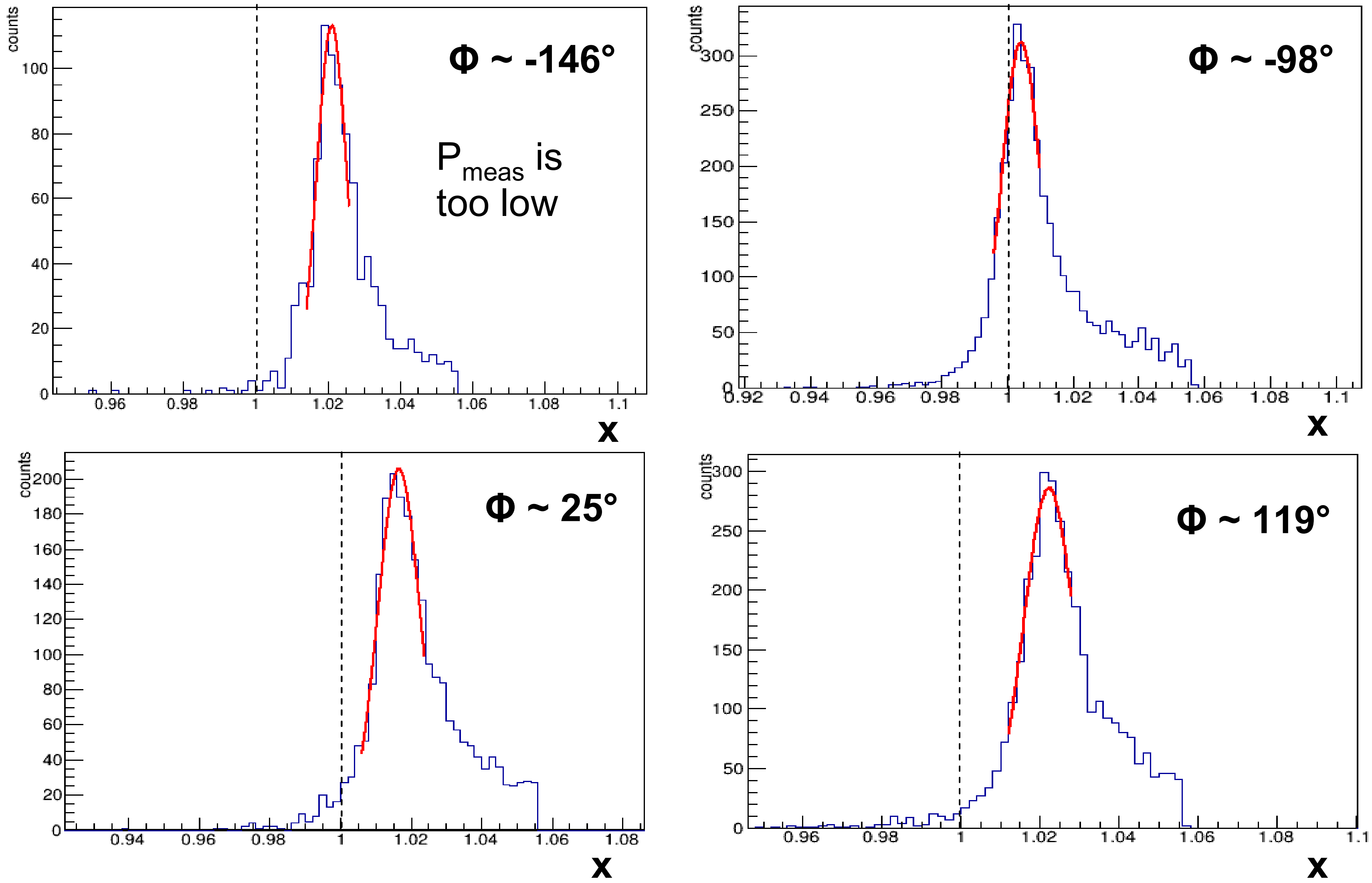
Momentum calculation from track radius: $p \approx 0.3 \cdot B \cdot R$

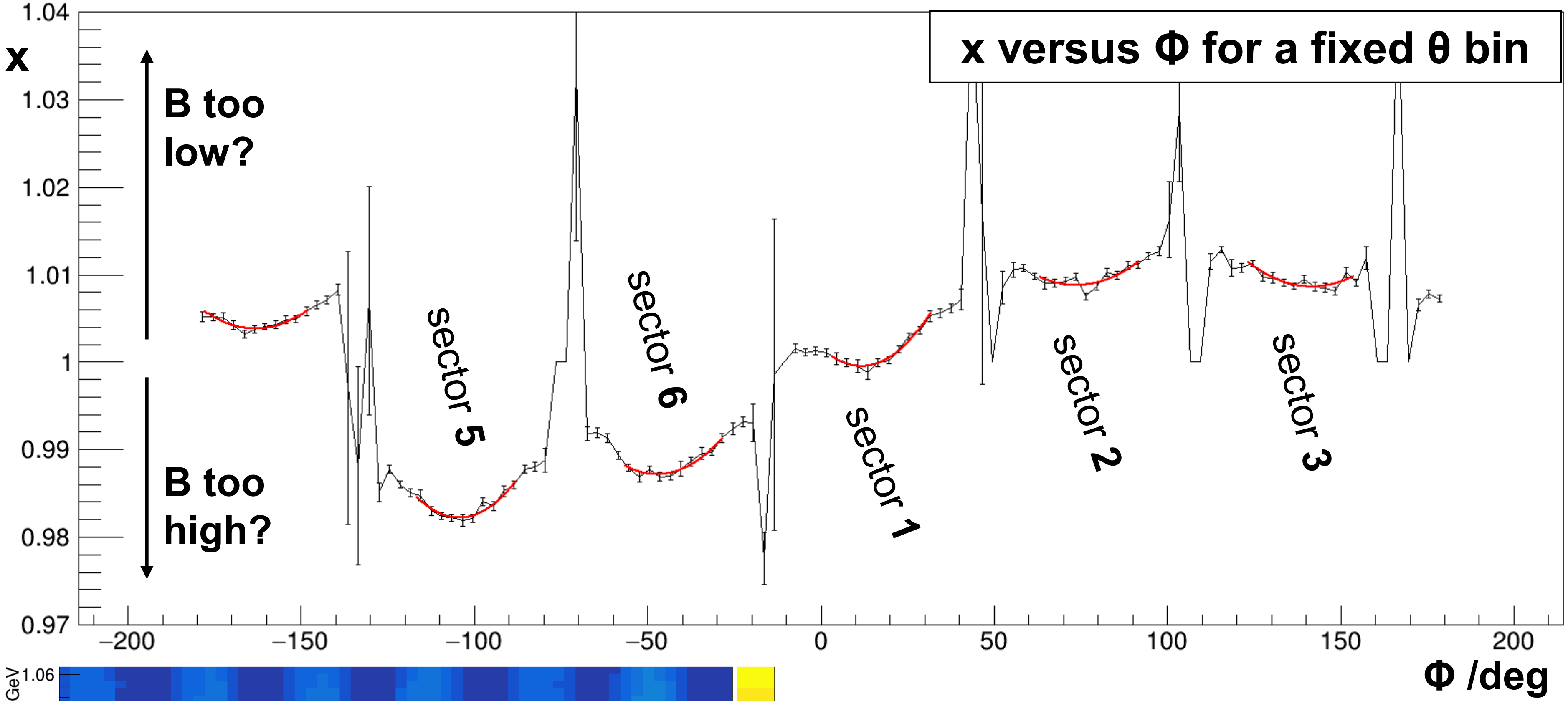
$$x = \frac{P_{corr}}{P_{meas}} = \frac{0.3 \cdot B_{corr} \cdot R}{0.3 \cdot B_{map} \cdot R} = \frac{B_{corr}}{B_{map}}$$ ⇒ $B_{corr} = x \cdot B_{map}$

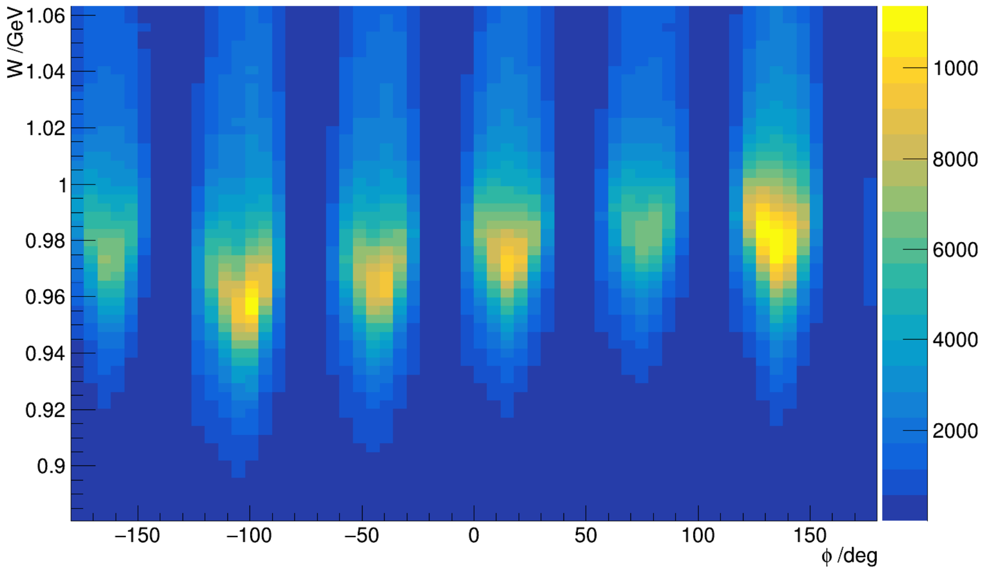
In reality x also contains:

- Misalignment of Driftchambers, beam position and position of torus coils, ….

$x = P_{corr} / P_{meas}$ for different Φ bins of θ = 11° - 12°



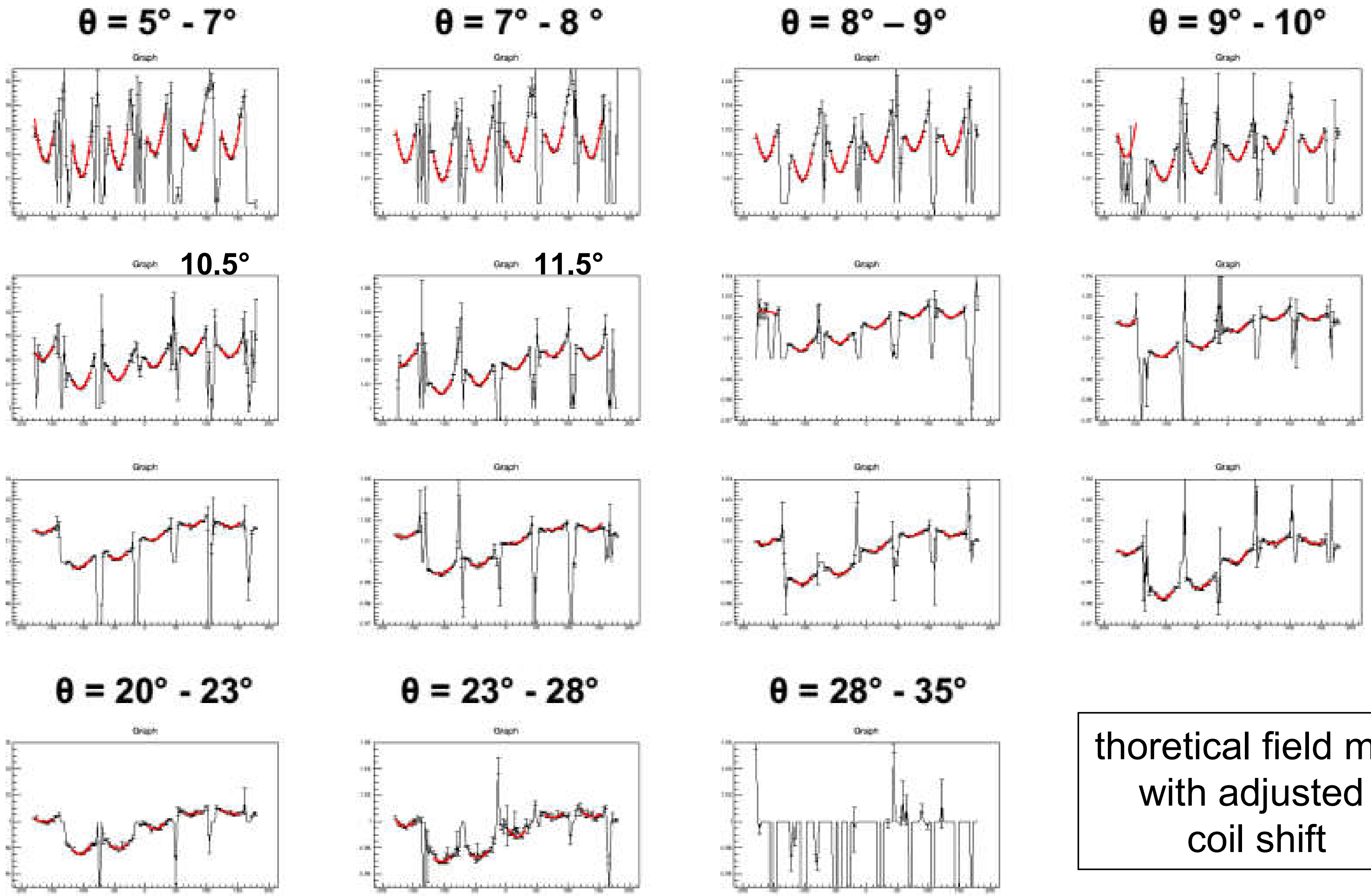




$$x = A + B \cdot \varphi + C \cdot \varphi^2$$

→ 1 fit for each sector

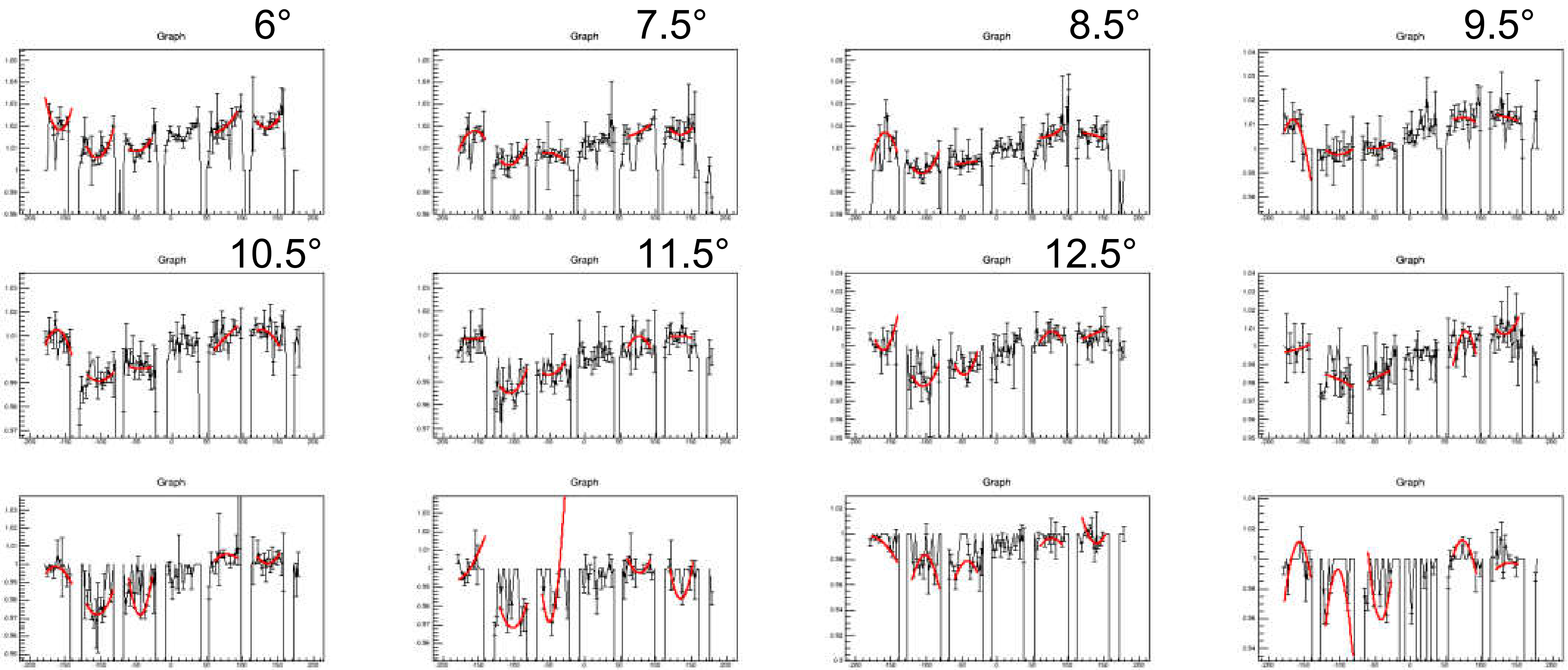
Φ dependence - run 2383 (January)



thoretical field map with adjusted coil shift

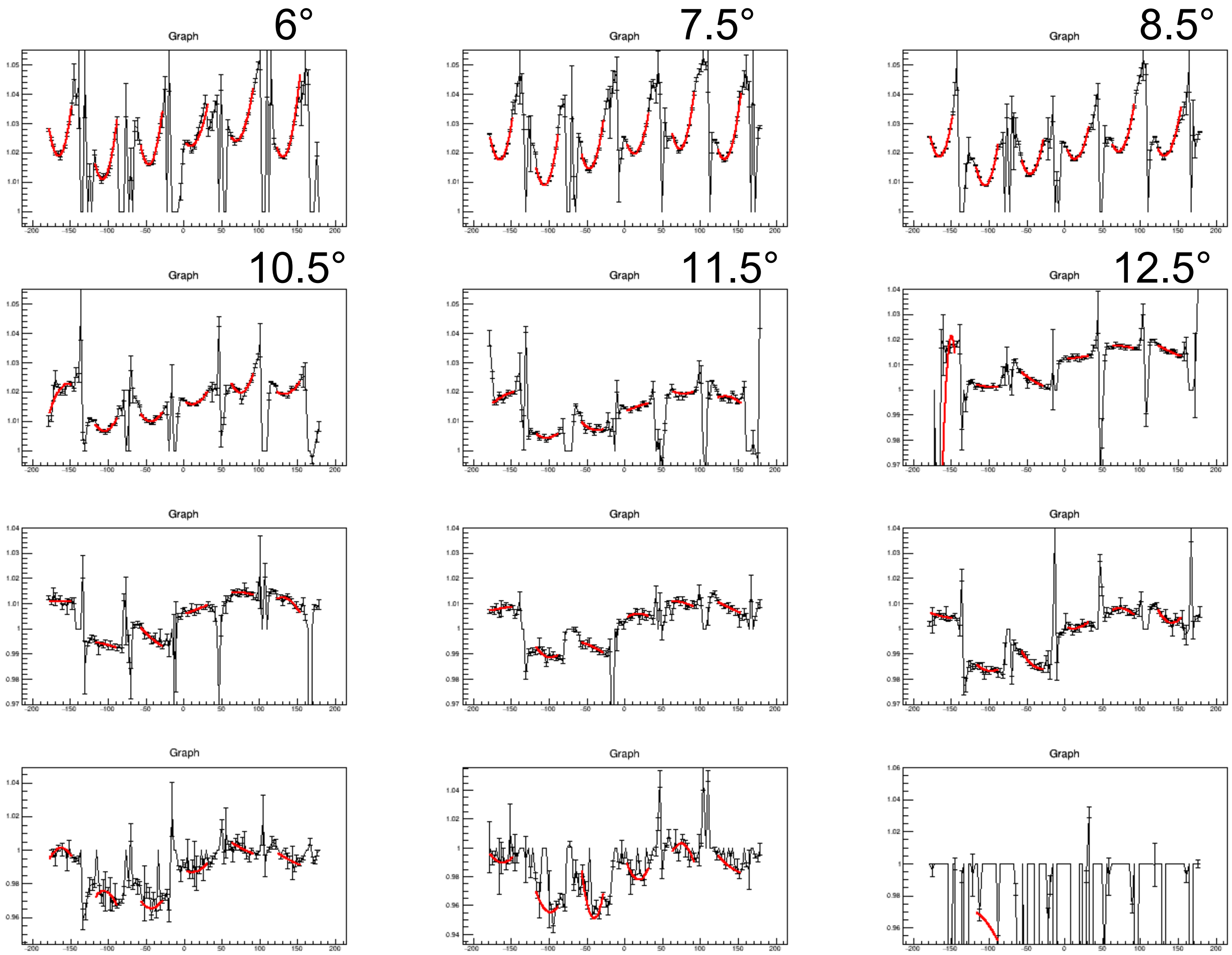
Φ dependence - run 2391 (April)

Symmetric field map, but field based on coil shape/current flux calculations



➔ **+ 0 - 2 % offset in x**

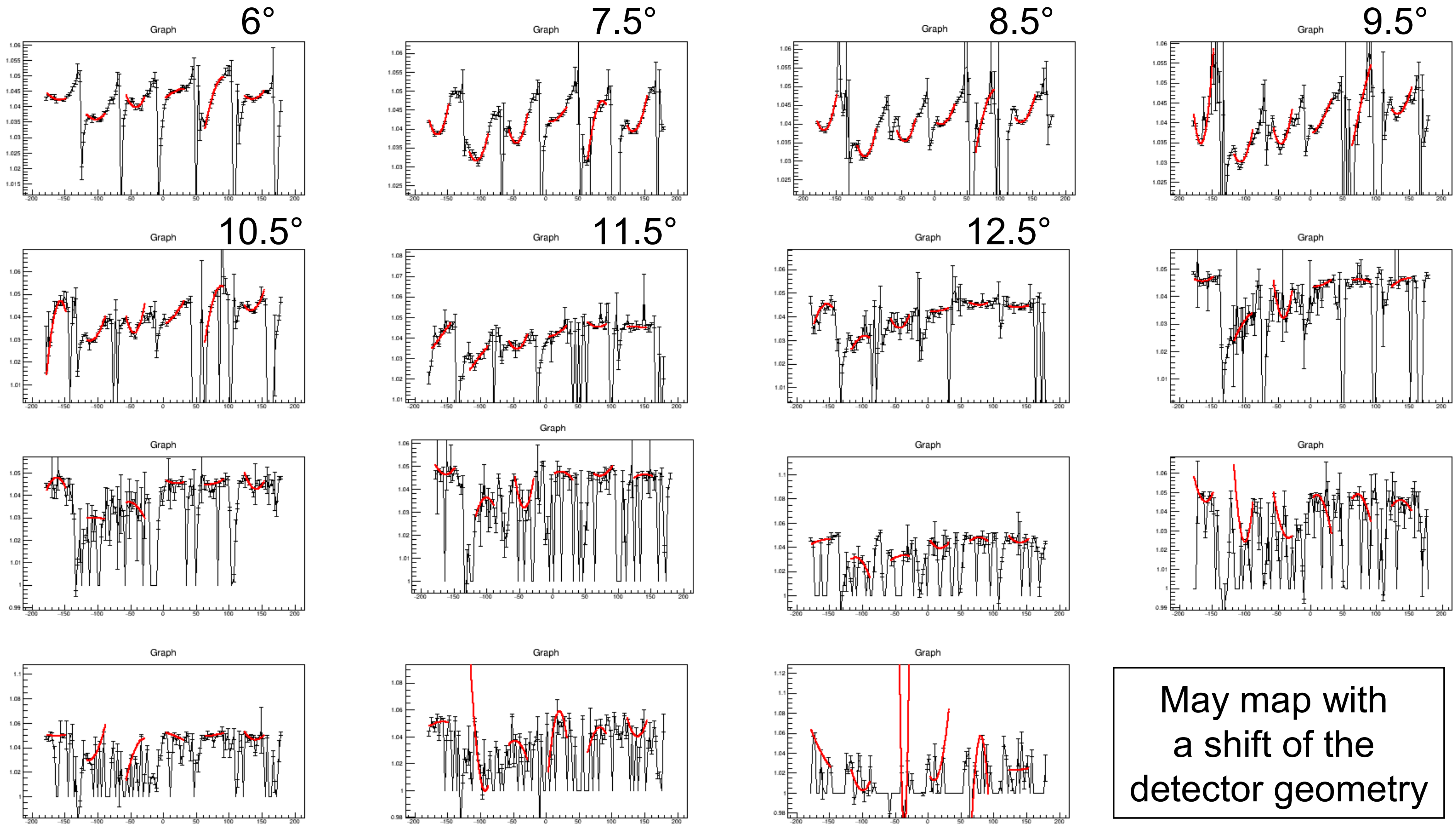
Φ dependence - run 2391 (May)



April map with individual coils shifted to fit the field measuremnts

➔ + 0-3 % offset in x

Φ dependence - run 2391 (July)

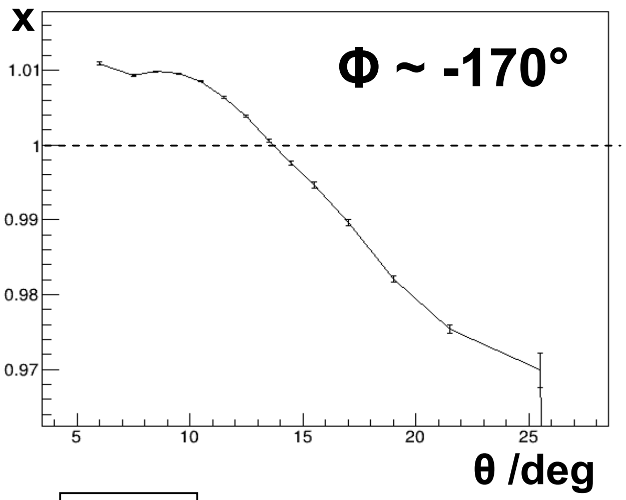


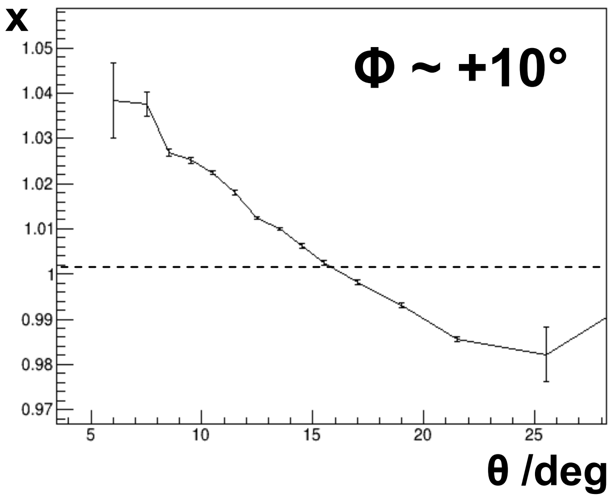
May map with a shift of the detector geometry

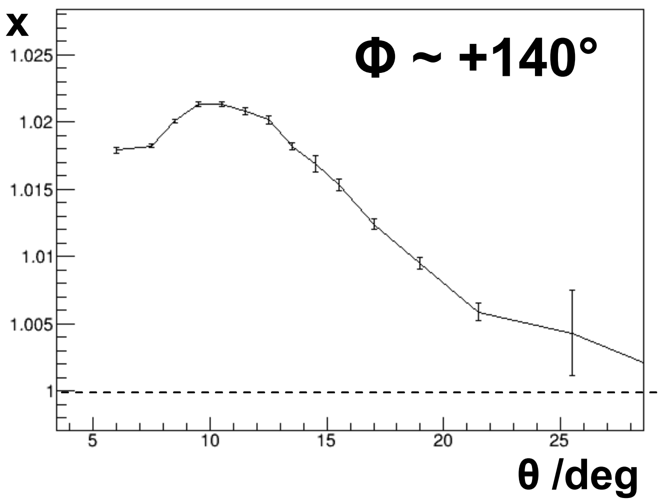
➔ + 4 % offset in x

x versus θ for selected Φ bins

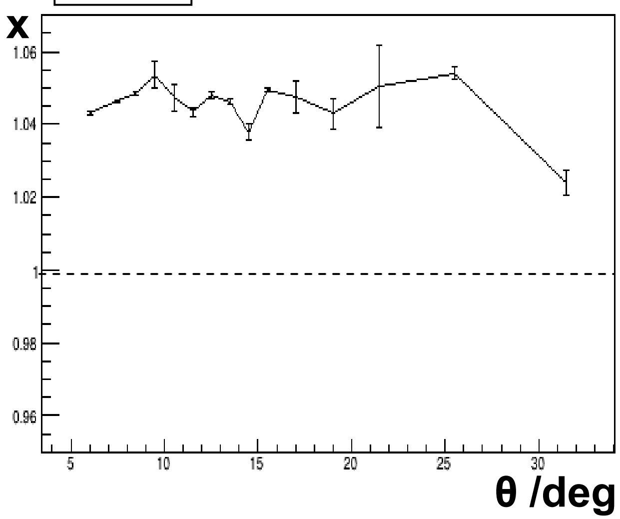
January

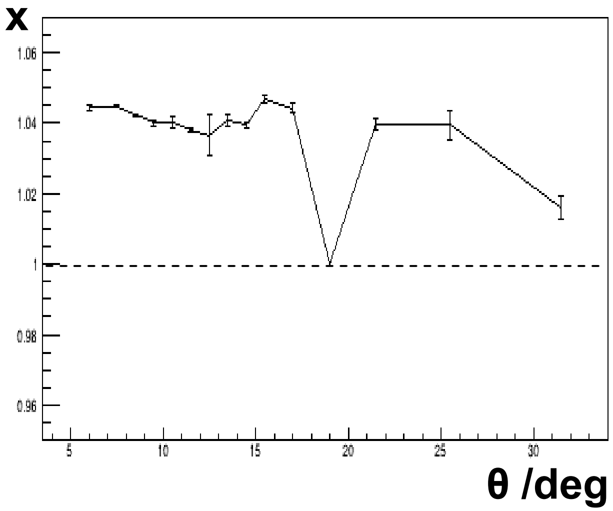


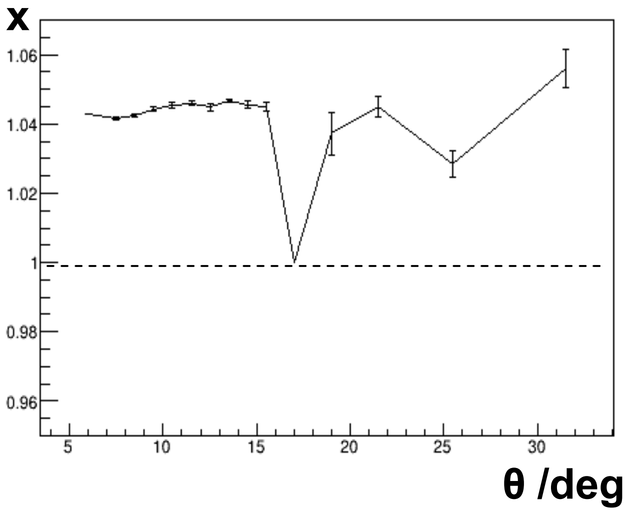


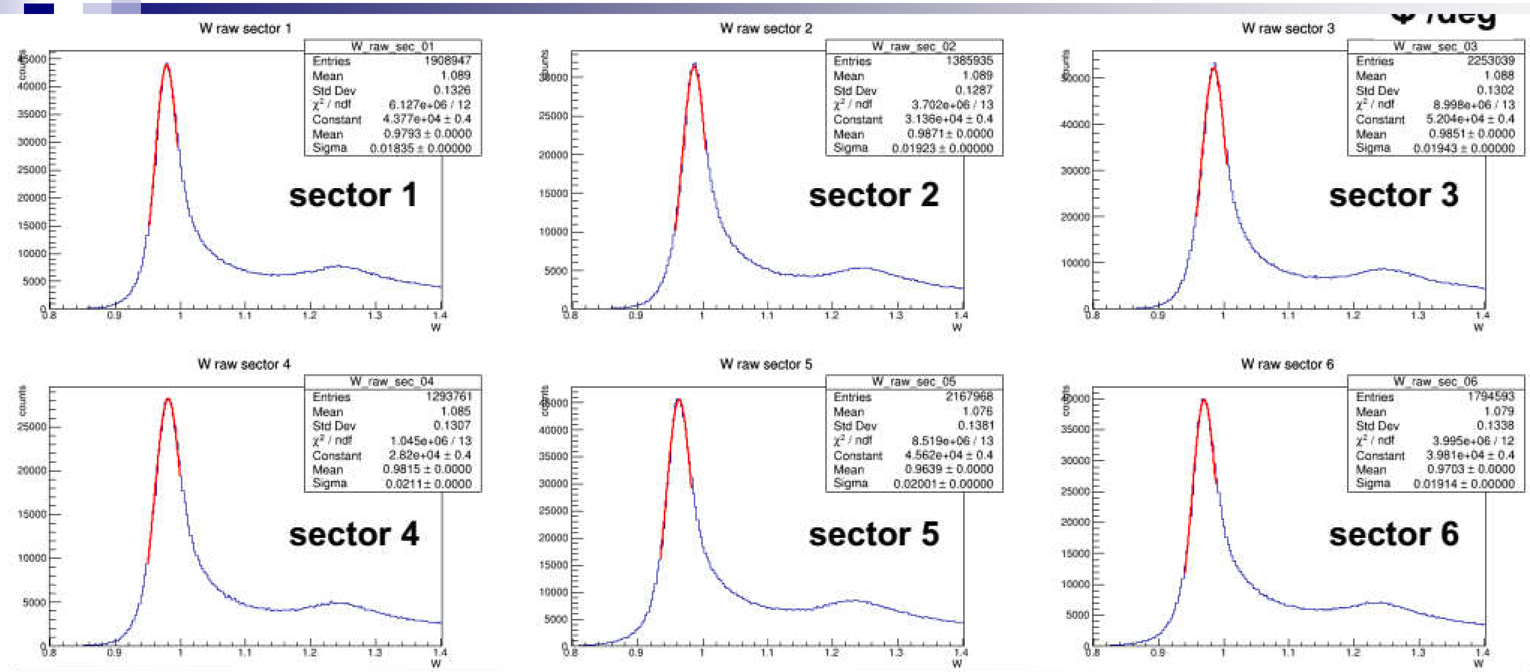


July



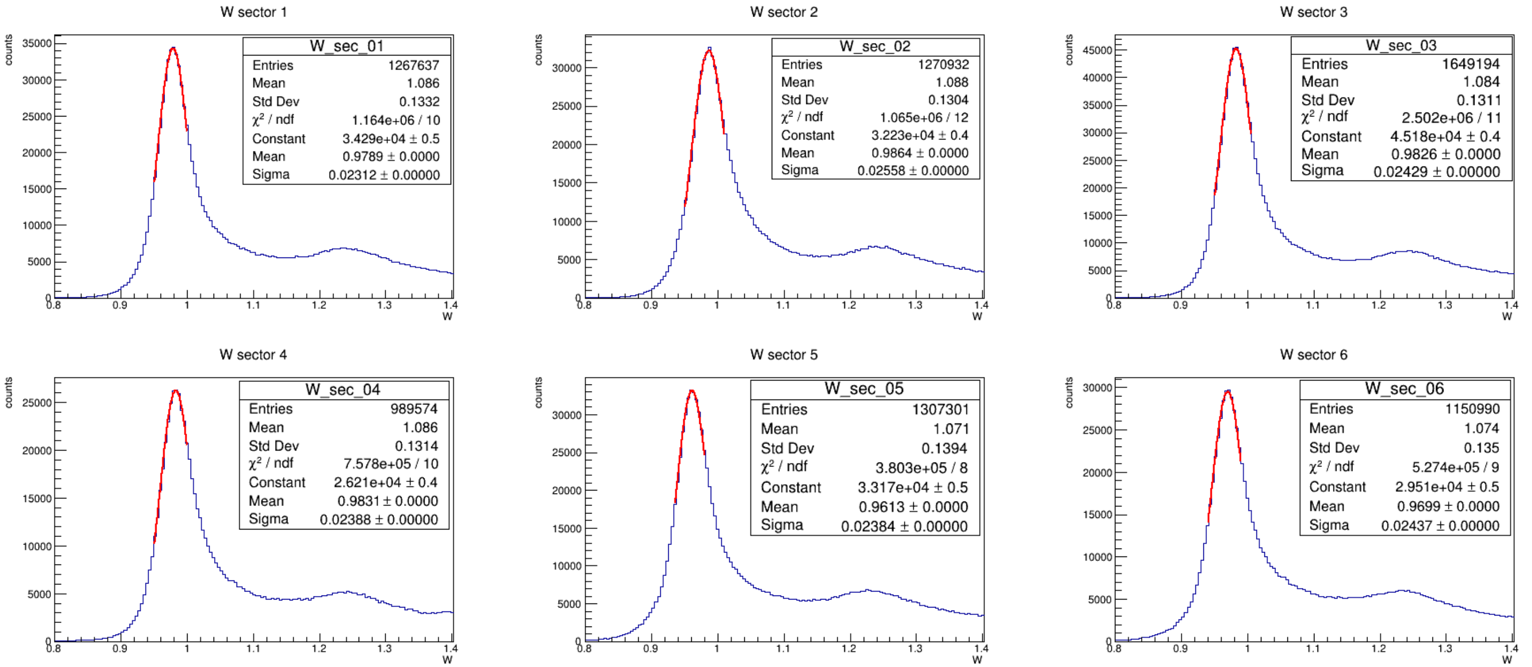






January map

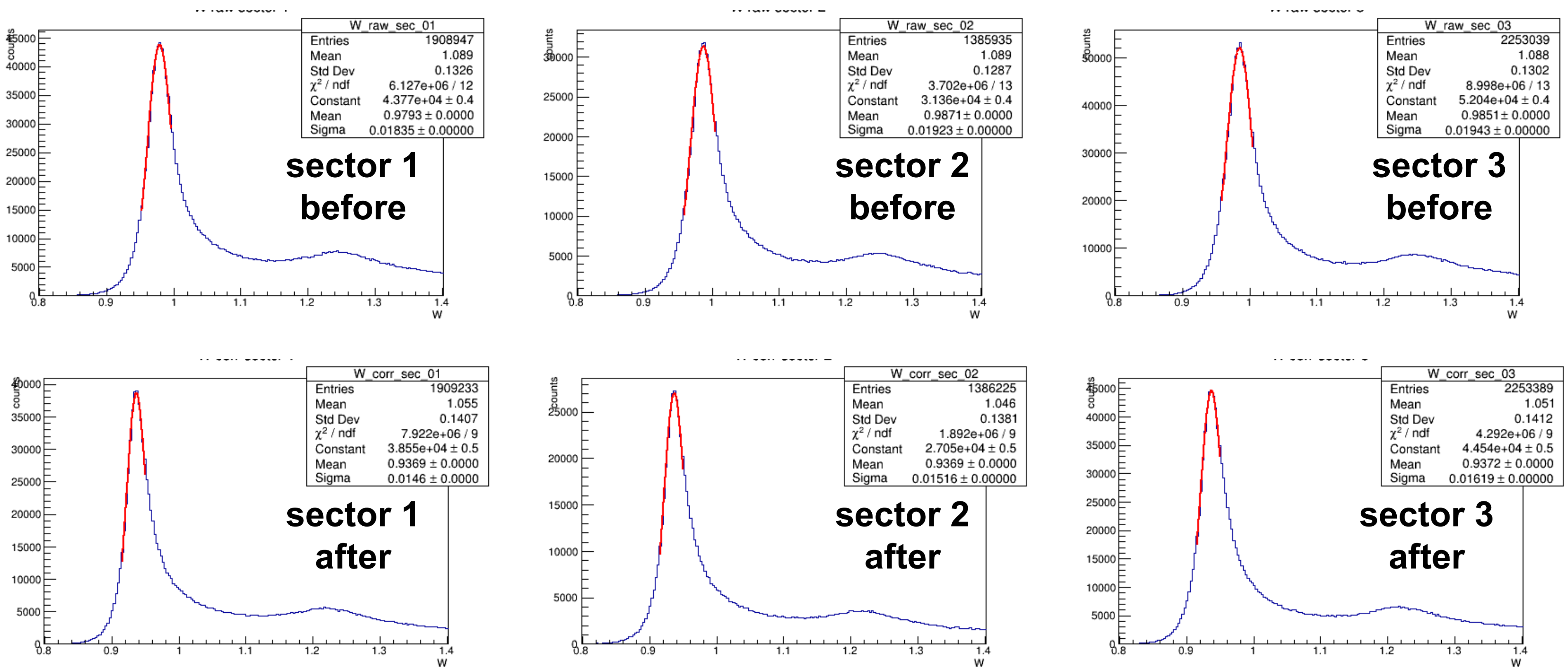
sigma =
18.4 – 21 MeV



May map

sigma =
23 – 26 MeV

Results of a momentum correction (see March meeting)



Before the correction:

mean value = 963 MeV and 987 MeV

σ ~ 19 – 21 MeV

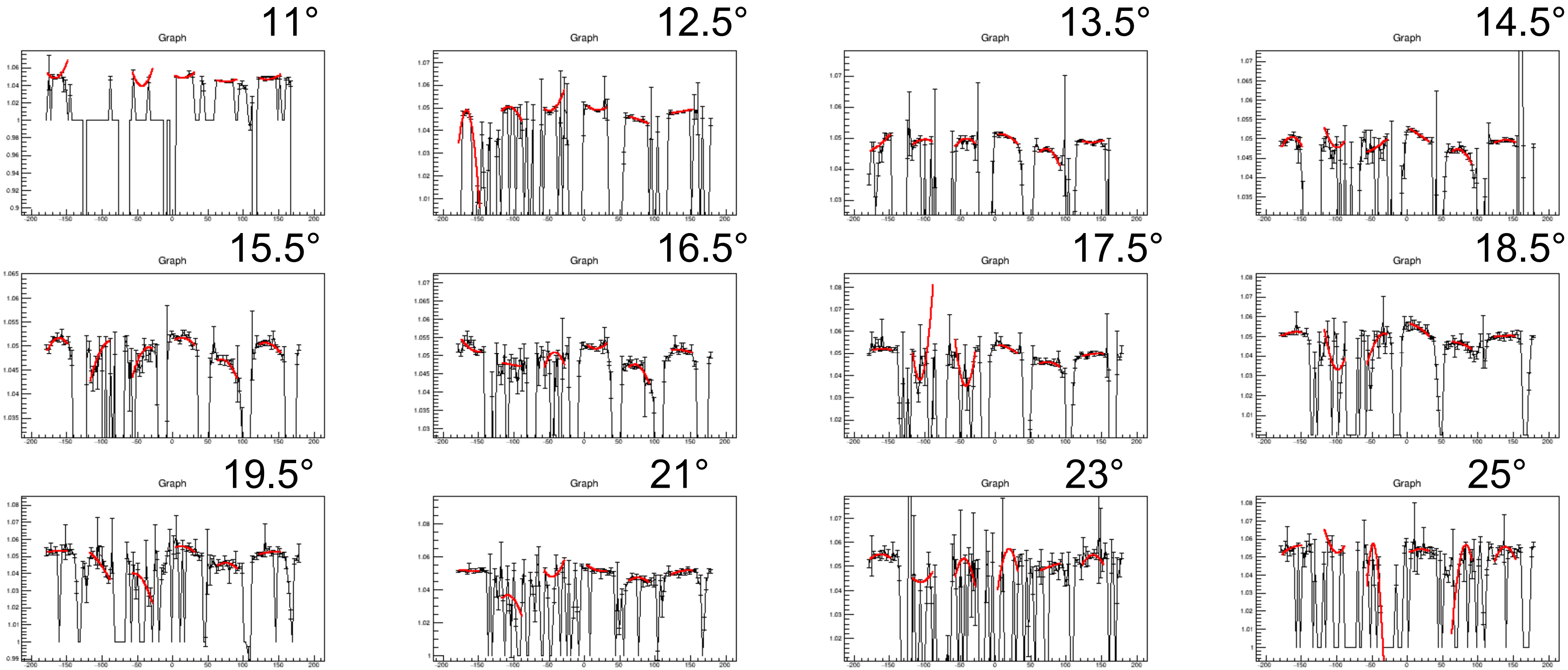
Ater the correction:

mean value = 936.9 – 937.3 MeV

σ = 14.1 – 16.2 MeV

run 2587 (t = -0.6 % → inbending, opposite polarity)

➔ electrons are only detected with vertex angles above 10°



➔ nearly constant 5% offset in x for all sectors

➔ offset reduced in newest reconstruction version

Conclusion and Outlook

- The parameter x has been used to monitor the progress of the improvements in the electron momentum

- Different changes of the field map and geometry have been applied according to survey data and calculations

- Especially for low θ angles, where the B field shows the highest gradients, a significant Φ dependence within the sectors is still present

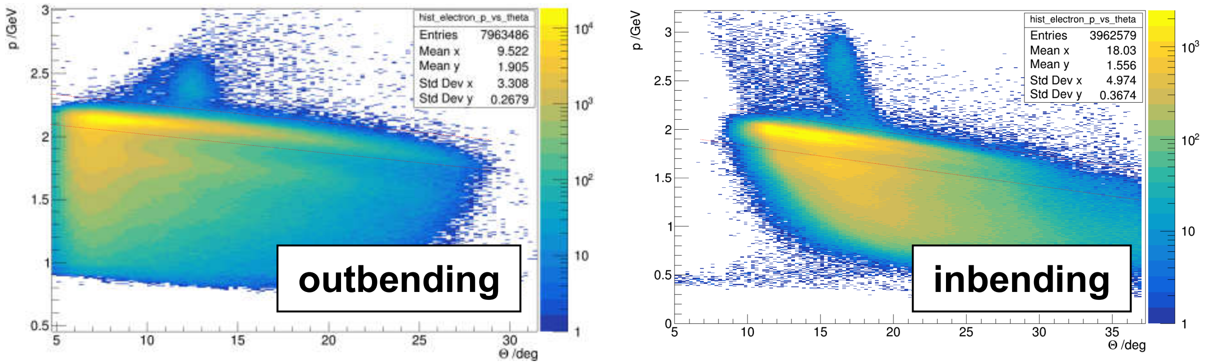
  → Less relevant for an inbending field polarity due to a minimum vertex angle > 10°

- The two field polarities show an opposit shift bahaviour for geometrical shifts.

Conclusion and Outlook

- A kinematic correction can move the elastic peak in W to the correct position and make the resolution σ significantly narrower
- Correction parameters extracted from 2.2 GeV data are not directly applicable to higher energies

p vs θ for e⁻ @ 2.2 GeV:



- A kinematic correction will be the last step, first all other uncertainties leading to the observed effects should be minimized.

Possible reason: - small errors in the magnetic field map
- misalignment of detectors, especially in DC
- calibration errors / beam energy uncertainties
- shift of the beam and or target or DC position, ….