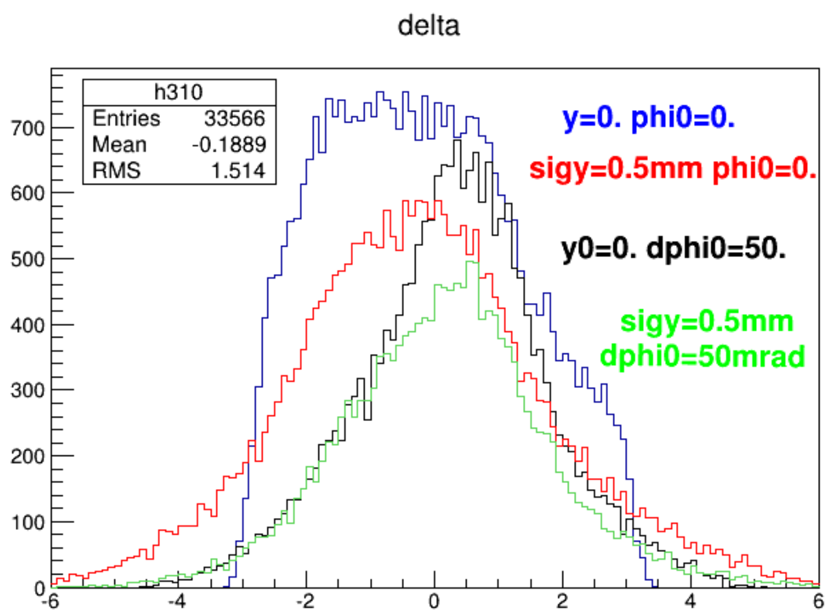
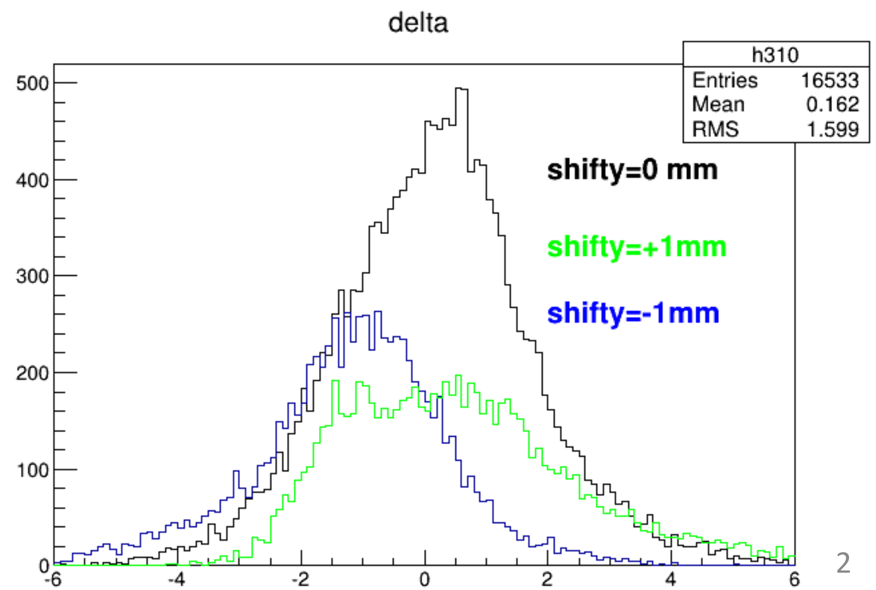
Study of Ydet2*Ydet1 correlation in simulations

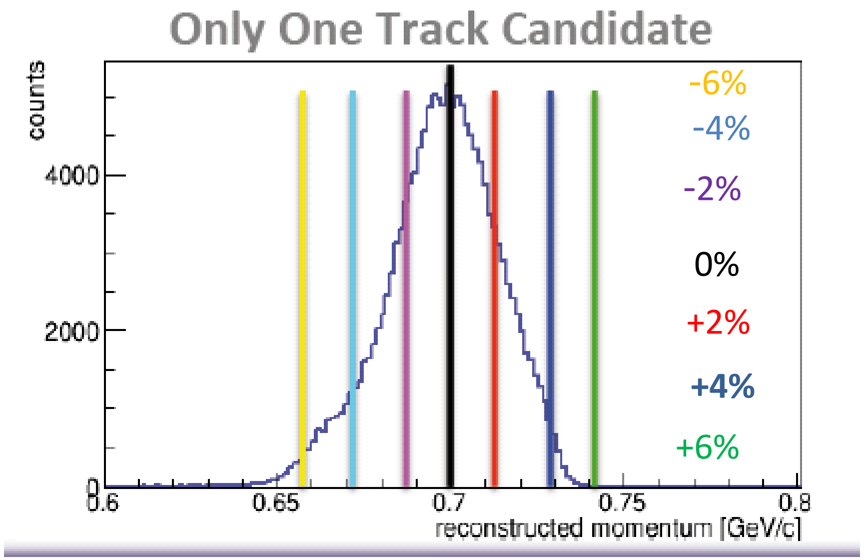
Sensitivity of acceptance to vertical effects

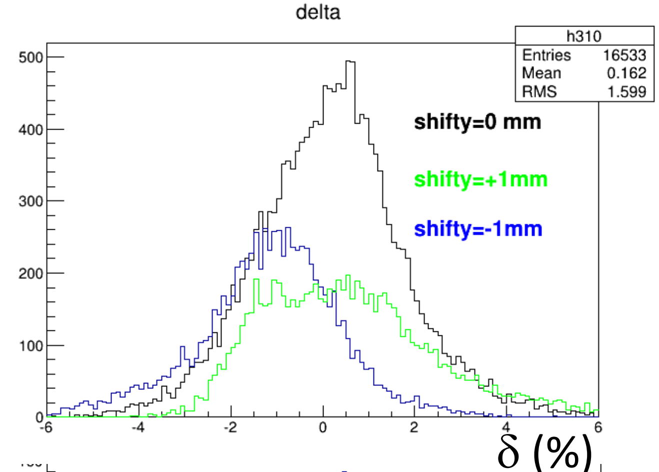


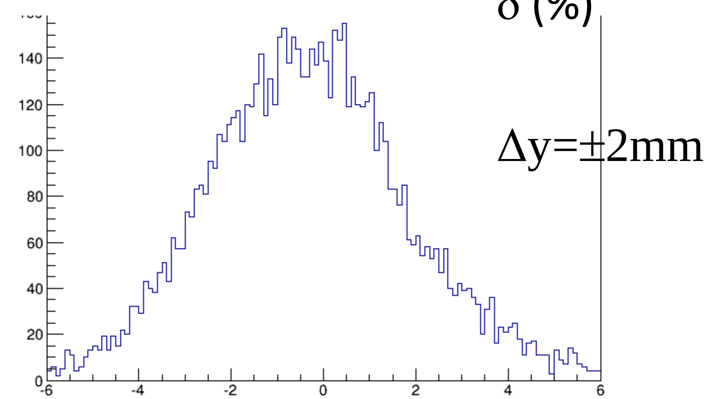
- Distribution in y gives broad acceptance tails
- Narrow distribution due to average over vertical angle distribution
- Width of the transmission and position of the maximum are sensitive to a shift in y



Comparison of experimental and theoretical transmissions







Width of experimental distribution significantly broader than calculated one:

broader y_0 distribution ? But width of about ±2mm is needed, much too large !

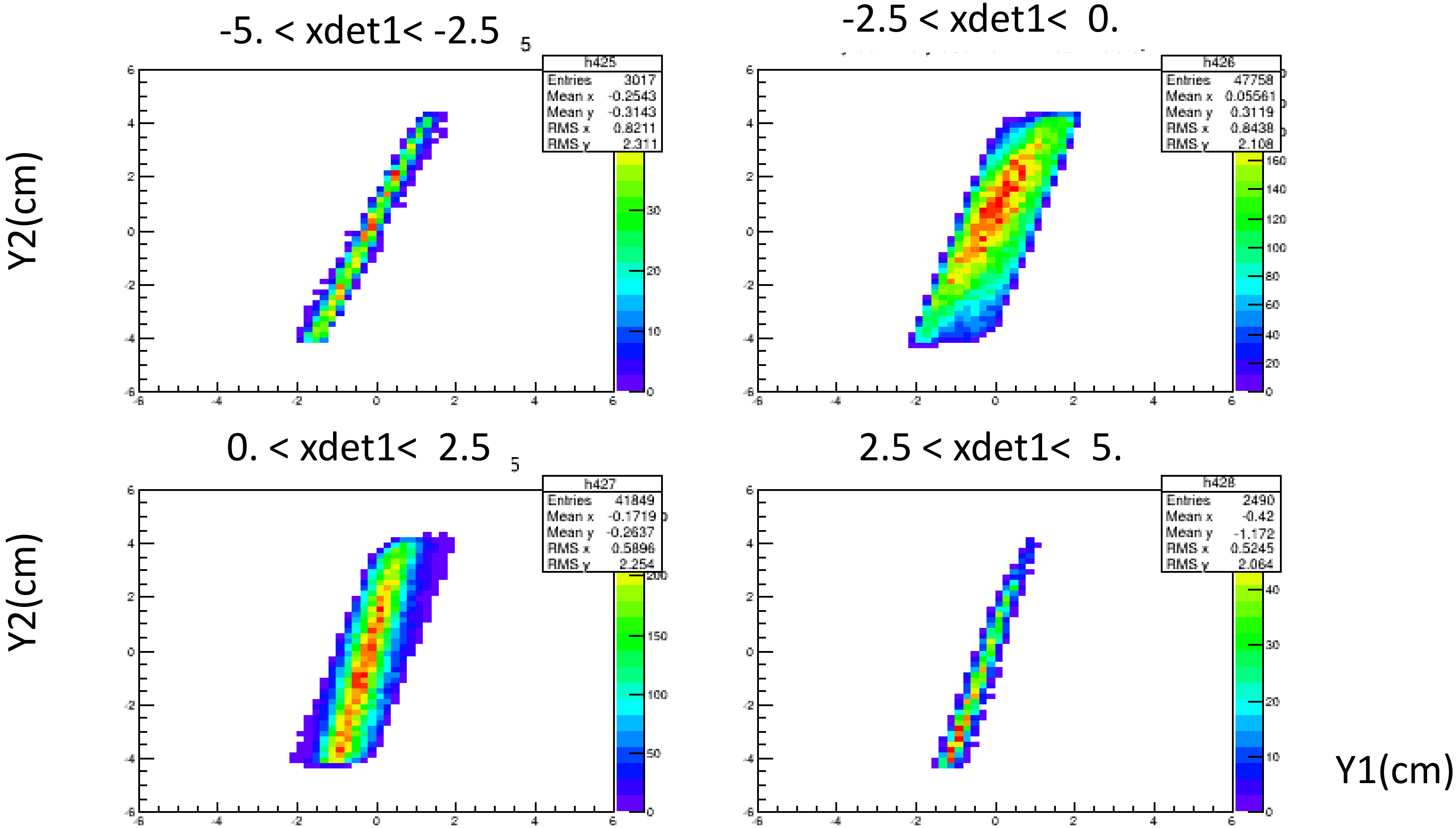
bad beam line description, acceptance underestimated ?

Can something be learned form Ydet2*Ydet1 correlations ?

standard simulation:

σ_y=0.5 mm
σ_ϕ=50 mrd

Ydet2 vs Ydet1 by bins in Xdet1



Origin of the correlation? Why is there a dependence of slope and width of the correlation with xdet1 ?

Why are Ydet2 and Ydet1 correlated ?

$$
\begin{aligned}
Y^{\mathrm{det1}} &= T_{32}^{\mathrm{det1}} \cdot \theta_0 + T_{33}^{\mathrm{det1}} \cdot y_0 + T_{34}^{\mathrm{det1}} \cdot \varphi_0 \\
&\quad + T_{36}^{\mathrm{det1}} \cdot \delta + T_{336}^{\mathrm{det1}} \cdot y_0\delta + T_{346}^{\mathrm{det1}} \cdot \varphi_0\delta \\
&+ \; T_{366} \cdot \delta^2 \\
Y^{\mathrm{det2}} &= T_{32}^{\mathrm{det2}} \cdot \theta_0 + T_{33}^{\mathrm{det2}} \cdot y_0 + T_{34}^{\mathrm{det2}} \cdot \varphi_0 \\
&+ \; T_{36}^{\mathrm{det2}} \cdot \delta + T_{336}^{\mathrm{det2}} \cdot y_0\delta + T_{346}^{\mathrm{det2}} \cdot \varphi_0\delta \\
&+ \; T_{366}^{\mathrm{det2}} \cdot \delta^2
\end{aligned}
$$

$T_{36}^{det2}/T_{36}^{det1} \approx T_{33}^{det2}/T_{33}^{det1} \approx 3.6$

Ratios for remaining coeffs stay between 2 and 4

Except $T_{34}^{det2}/T_{34}^{det1} \approx 27$!

Main transport coefficients in det1 and det2 planes are roughly proportionnal

$\rightarrow$the two equations are roughly linearly dependent

Consequences

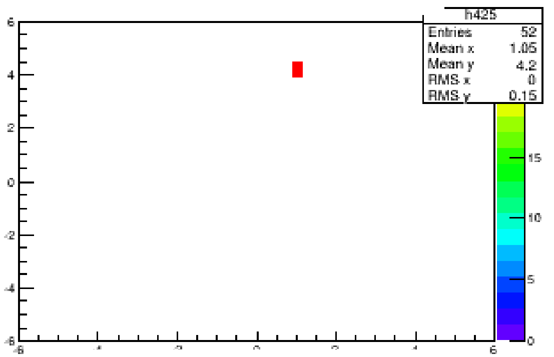
- ✓ Weak information from vertical position measurements
- ✓ Bad for pion vertical positionreconstruction
- ✓ Good for background rejection

Simulation with point-like beam in V

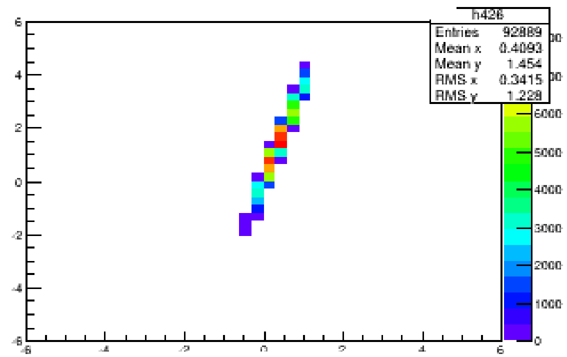
σ_y=0 mm
$\Delta\phi$ = 0 mrd

Ydet2 vs Ydet1 by bins in Xdet1

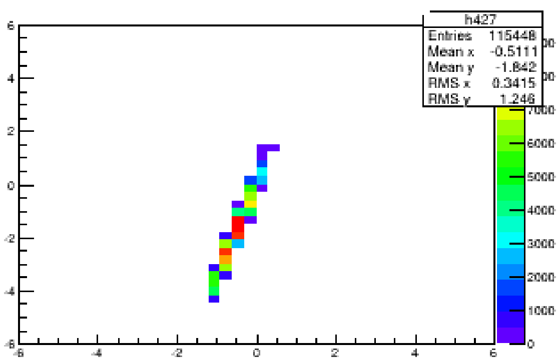
-5. < xdet1< -2.5



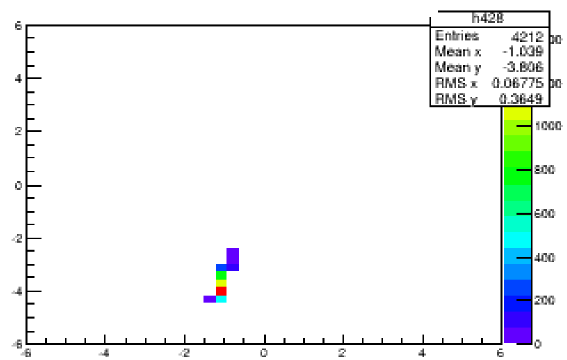
-2.5 < xdet1< 0.



0. < xdet1< 2.5



2.5 < xdet1< 5.



Y1(cm) Y1(cm)

$Y^{det1}=T_{36}^{det1}\,\delta+T_{366}^{\ det1}\,\delta^2$

$Y^{det2}=T_{36}^{det2}\,\delta+T_{366}^{\ det2}\,\delta^2$

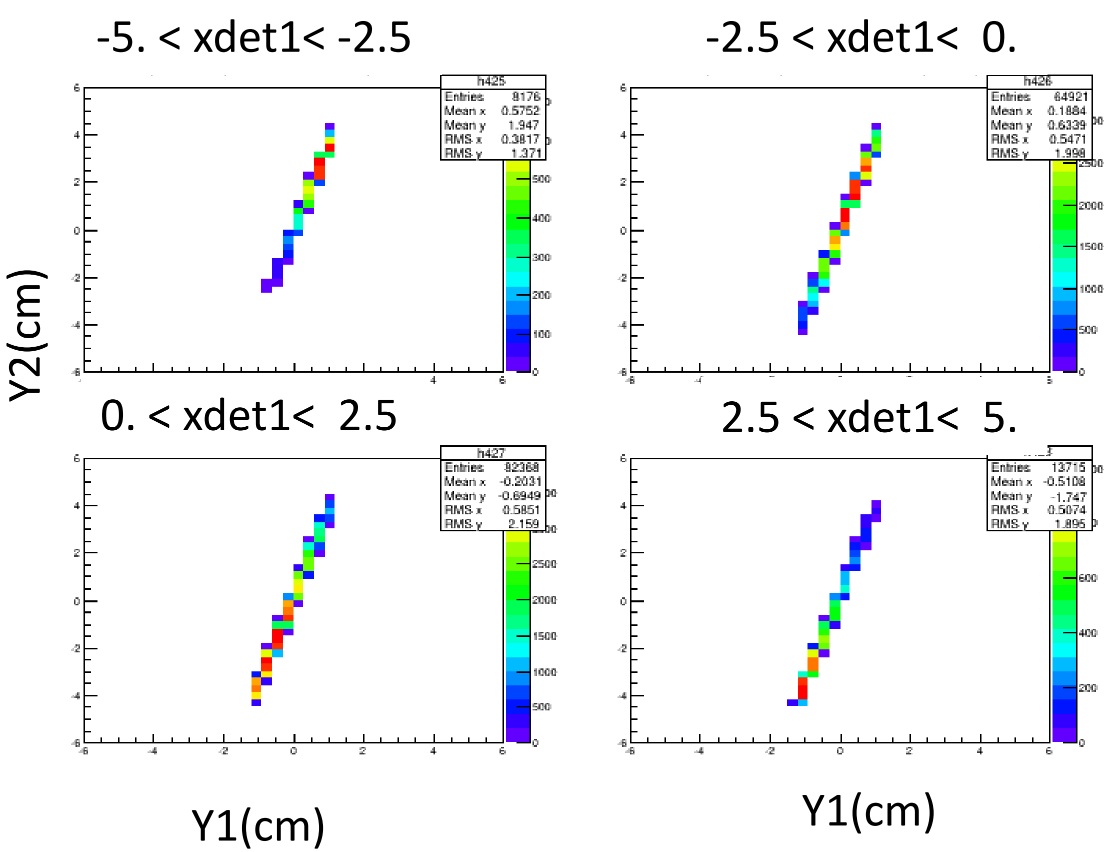
Y^{det1} and Y^{det2} ranges values determined by δ range for each X^{det1} bin

Acceptance in extreme bins is very small

correlation in Y^{det2} and Y^{det1} due to $T_{36}^{det1}/T_{36}^{det2} \approx T_{366}^{det1}/T_{366}^{det2}$
$\rightarrow$ same slope for each bin.

Simulation with only position effect in V

σ_y=0.5 mm
$\Delta\phi$ =0 mrd



$Y^{det1}=T_{36}^{det1}\,\delta+T_{366}^{det1}\,\delta^2+T_{33}^{det1}\,y_0 + T_{336}^{det1}\,y_0\delta$

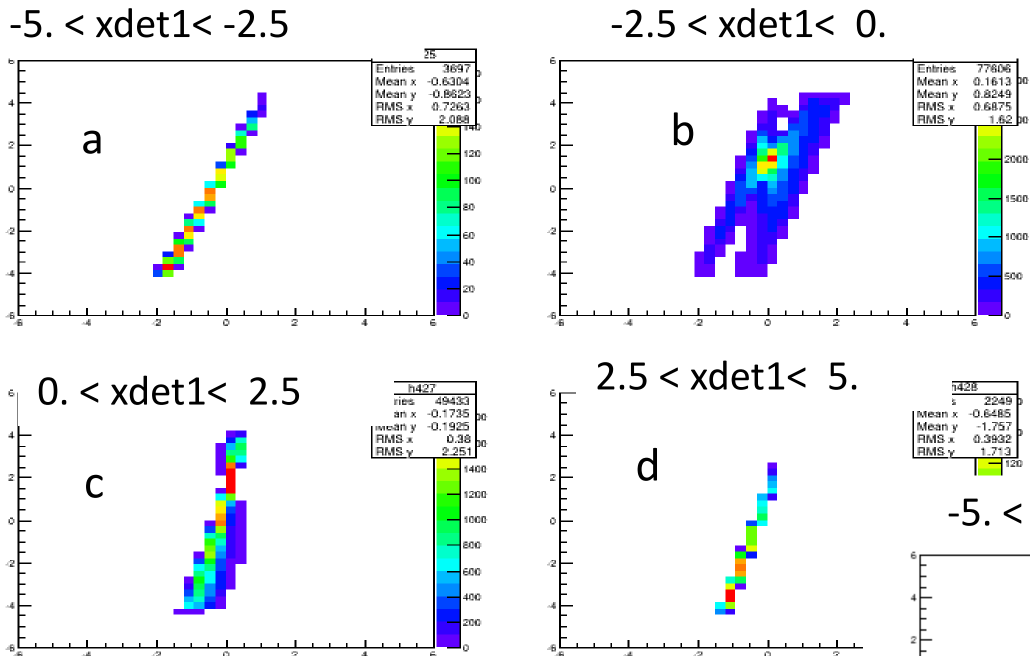
$Y^{det2}=T_{36}^{det2}\,\delta+T_{366}^{det2}\,\delta^2+T_{33}^{det2}\,y_0 + T_{336}^{det2}\,y_0\delta$

small

- Larger ranges in Y^{det1} and Y^{det2} due to y_0 effect
- correlation slope not changed $T_{36}^{det2}/T_{36}^{det1} \approx T_{33}^{det2}/T_{33}^{det1} \approx 3.6$ and $T_{366}^{det2}/T_{366}^{det1} \approx 4.1$

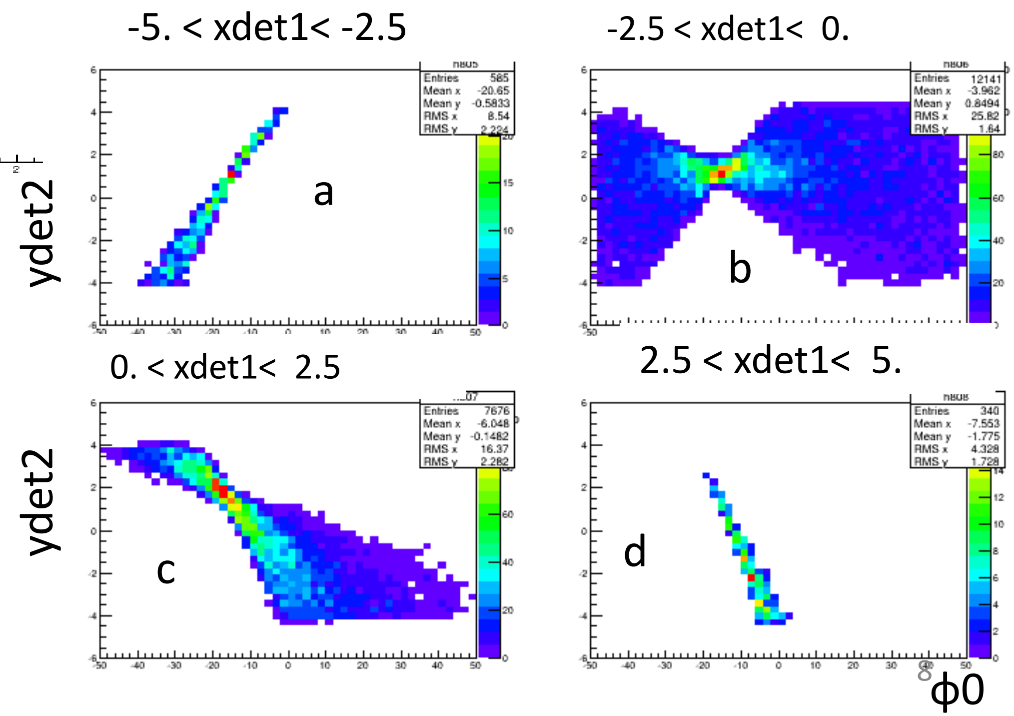
Simulation with only angular effect in V

σ_y=0. mm
$\Delta\phi$=50 mrd



$T_{36}^{det2}/T_{36}^{det1} \approx T_{346}^{det2}/T_{346}^{det1} \approx 3.6$
$T_{34}^{det2}/T_{34}^{det1} \approx 27$!
T_{34}^{det1} term negligible
$Y^{det2} \approx 3.6\, Y^{det1} - 0.08\, \phi_0$

Shift, change of slope and width of Y^{det2} vs Y^{det1} correlation due to different ϕ_0 acceptance for each slice

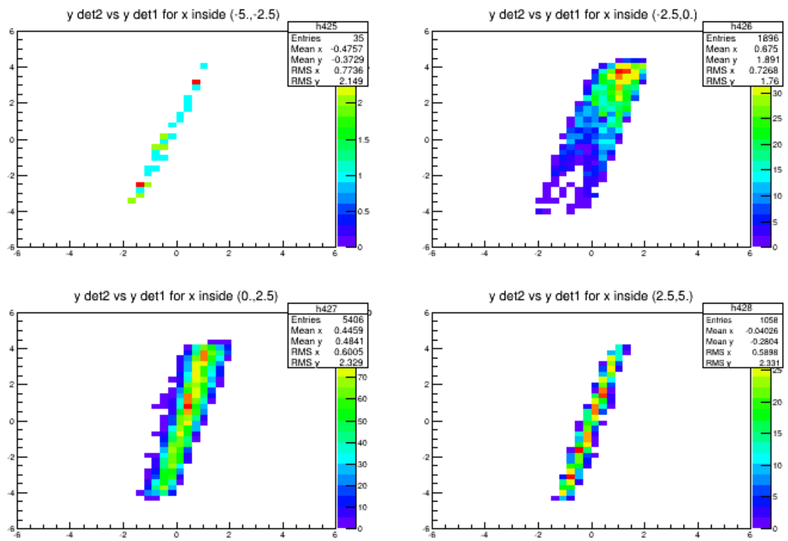


Case a: reduced slope
Case d : increased slope
Cases b and c : broad distribution

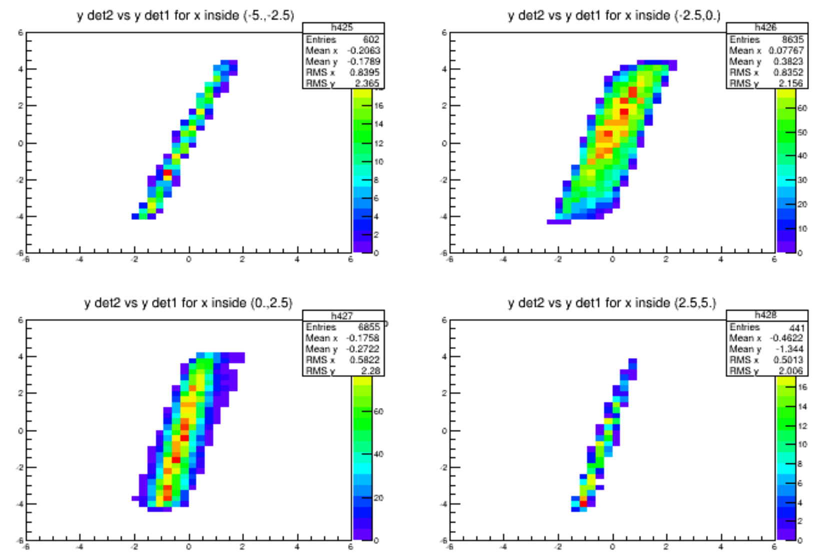
Sensitivity to shifts in y

σ_y=0.5 mm
$\Delta\phi$=50 mrd

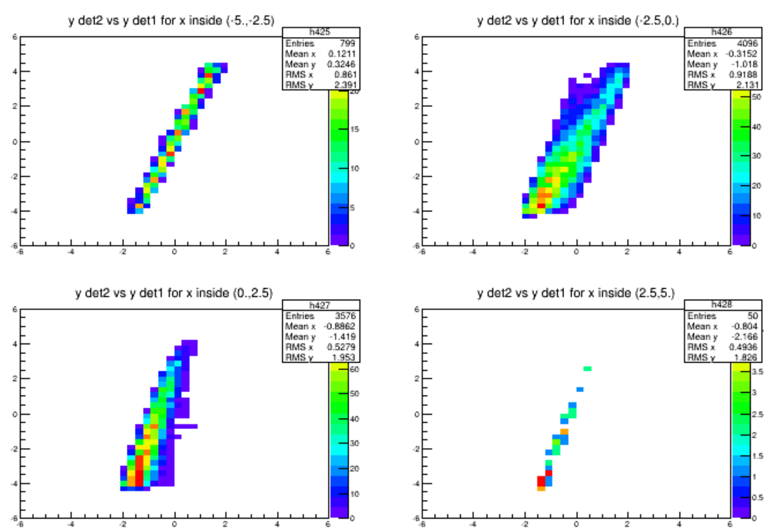
Y2(cm)%Y1(cm)Y_0=-1mm



Y2(cm)%Y1(cm) Y_0=0mm

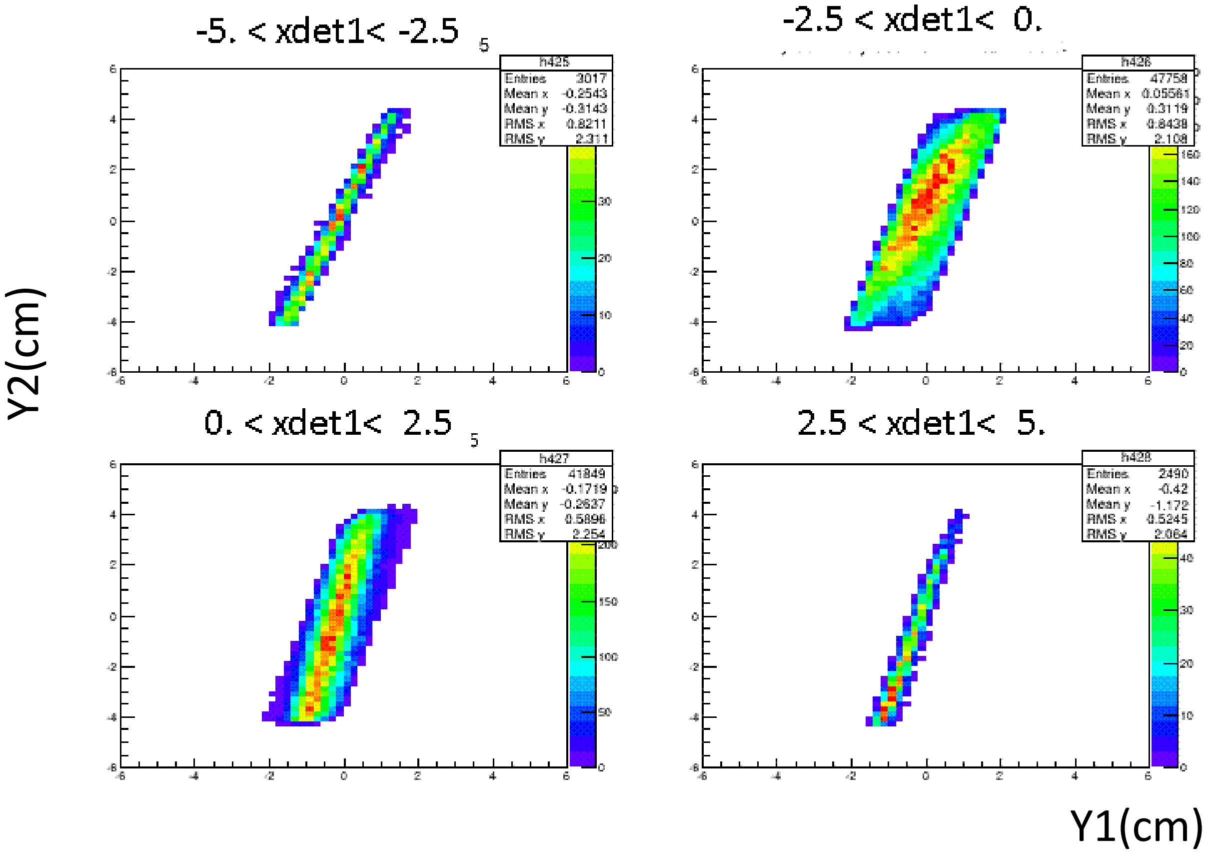


Y2(cm)%Y1(cm) Y_0=+1mm



Global trend not affected
Distribution of counts along Y2 and Y1 is very sensitive to beam shifts

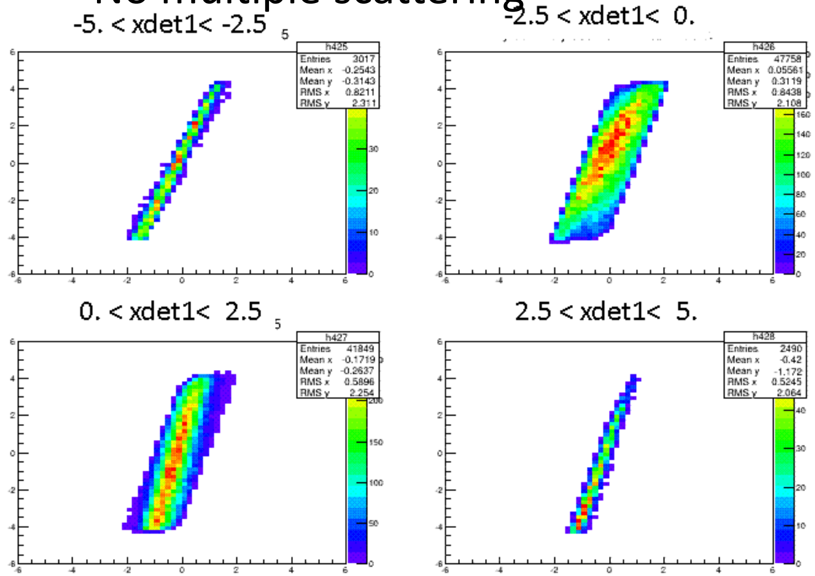
Conclusions on Ydet2*Ydet1 correlation



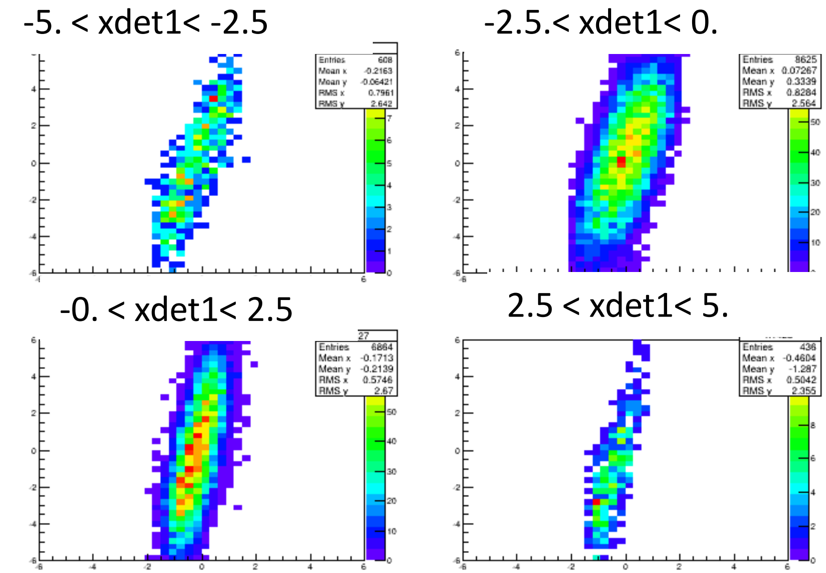
- Correlation mainly due to scaling factor (~3.6) between the main coefficients for Ydet2 and Ydet1 (except T34)
- Correlation broadened and shifted due to the $T_{34}{}^{det2}\phi_0$ term.
- Dependence of the effect on the xdet1 slice is due to the different Ydet2 * ϕ_0 correlations.
- Distribution of counts inside the correlation band is sensitive to shifts of beam in y

Multiple scattering effect

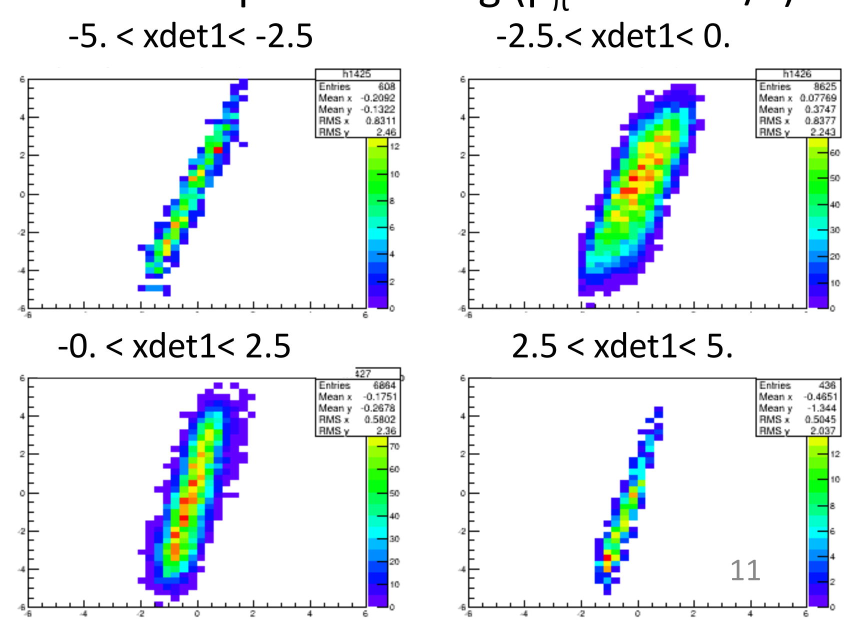
No multiple scattering



with multiple scattering (p_π=0.65 GeV/c)



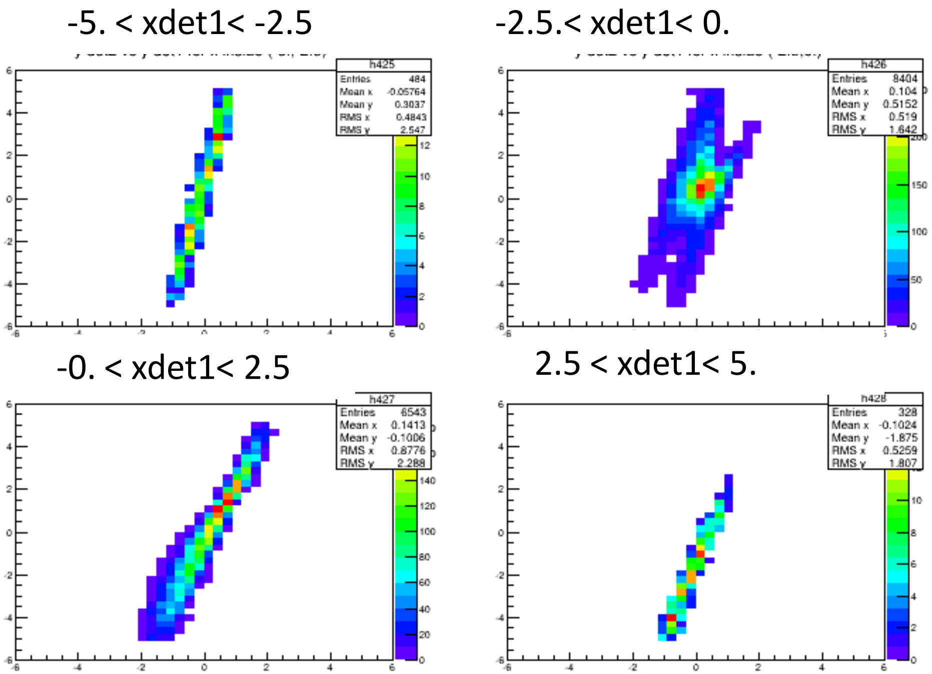
with multiple scattering (p_π=1.7 GeV/c)



- ✓ Multiple scattering broadens the correlation, but does not change the global trend
- ✓ Small effect at 1.7 GeV/c

Effects of different transport coefficients

- ✓ Calculation of positions using the « measured » coefficients
  (i.e. deduced from calibration measurements with the proton beam)
- ✓ Only indicative, since the acceptance is changed only at det1 and det2 positions



angular effect is now dominant

T_{33}^{det1} reduced by factor 2.6
T_{33}^{det2} reduced by factor 6.

T_{34}^{det1} increased by factor 12.
T_{34}^{det2} decreased by factor .75

Very different pattern for y1*y2 correlation with respect to the one with TRANSPORT coefficients ?
Does the experimental correlation bring confirmation of « measured » coefficients ?

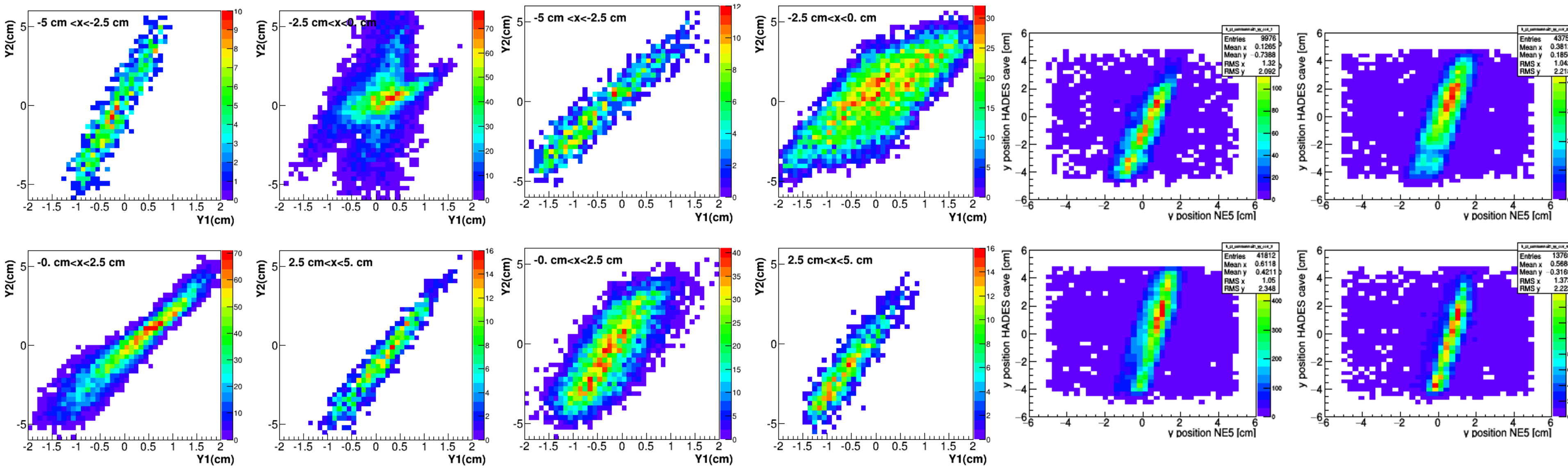
Effects of different transport coefficients and comparison with data

Simulationp=1.7 GeV/c with multiple scattering

« measured « coefficients

« Transport » coefficients

data p=1.7 GeV/c (July)

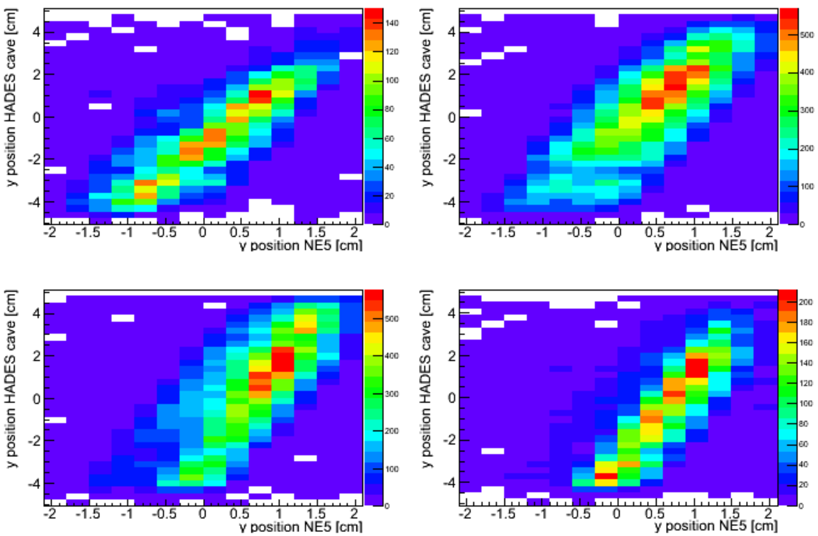


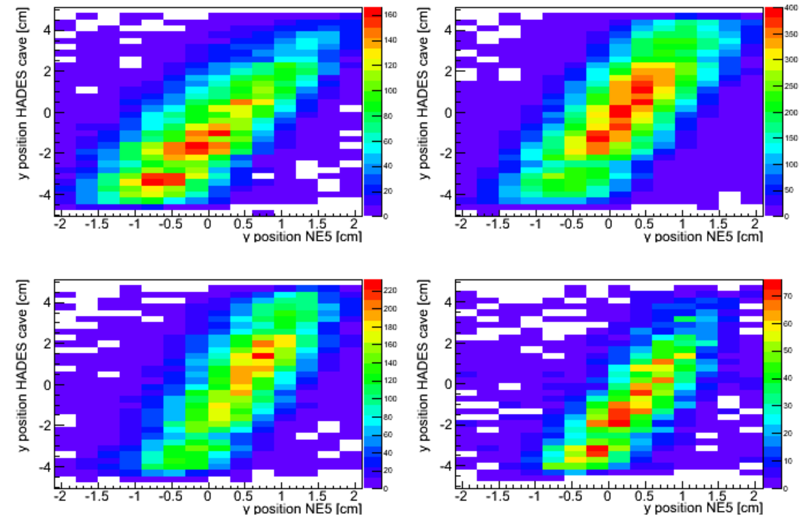
- General trend much closer to «TRANSPORT » coefficients than « measured » ones
- Seems to corroborate the fact that the vertical coeffcients were not measured accurately

Should we conclude that « measured » coefficients for vertical have not to be used ?

Stability of experimental Y1*Y2 correlation

Two different data samples p= 1.7 GeV/c (July)

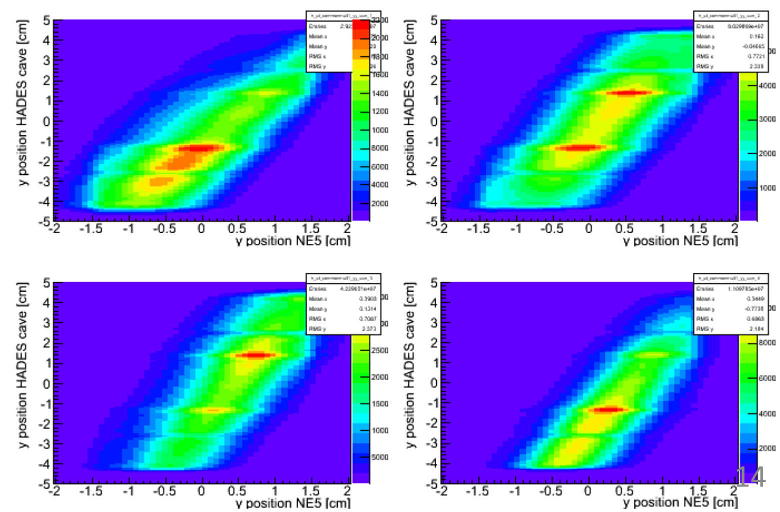




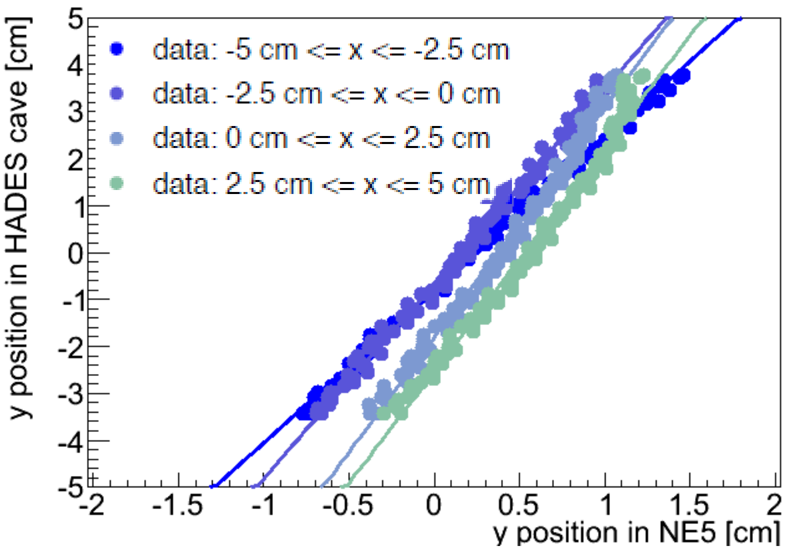
- exactly same profiles for the two sets of July data (checked by Joana), but different yields along the correlation line
- It could sign shifts in y (see slide 9)
- Same global trend for August, but slopes are

a bit different (see next slide)

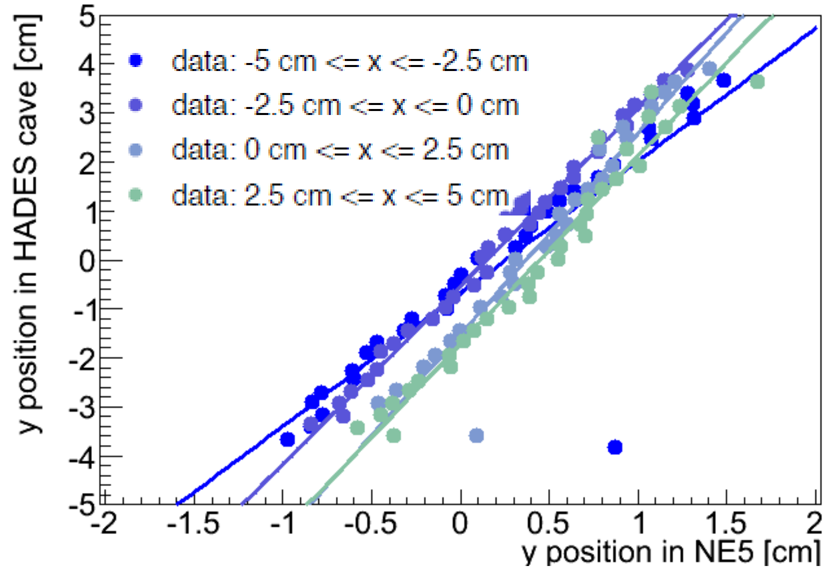
p=0.69 GeV/c (August)



Ydet2 % Ydet1 from data (p=0.69 GeV/c)



Ydet2 % Ydet1 from data (p=1.7 GeV/c)



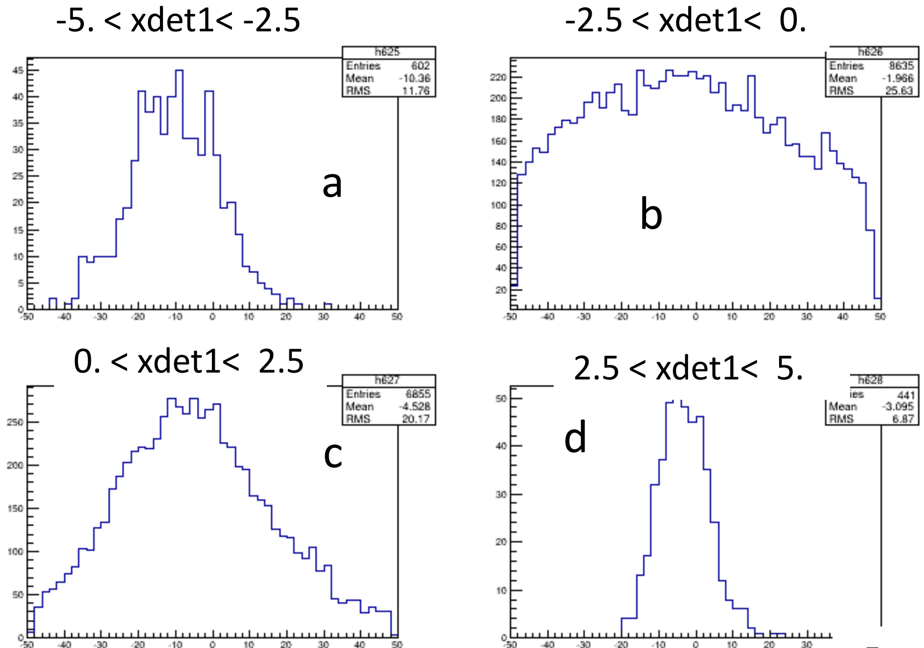
No dependence of Y1*Y2 correlation
on reference momentum in the simulation

What is the origin of the effect seen in the data ?

Next step: compare experimental and theoretical slopes

Back-up

ϕ acceptance for each slice



Φ (mrad)

N.B. No multiple scattering here

δ acceptance for each slice