Comparison between data and simulation for MT3/MPT

Multi Technologies Testing TPC/
Multi-Prototype TPC

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on behalf of MT3/MPT collaboration

What was our experiment
Status of our data
What should be explained by MC
Which effects are included in MC
How much can MC reproduce data
- GEM
- MWPC

What is our experiment ?

Unbiased tests of small TPC using MWPC, GEM, MicroMegas
under Magnetic Field, beam, same readout and same analysis conditions

Ron Settles initiated this program.

Collaborators

MWPC, GEM




2004/Jun.,2005/Apr., Oct.

"this talk"

MicroMegas


2005/Jun.

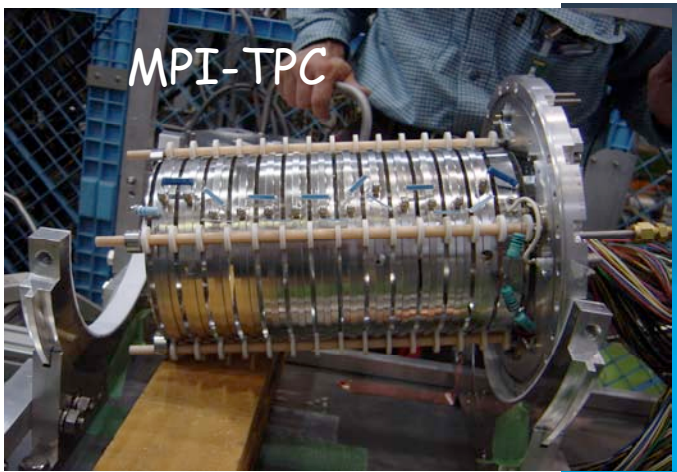
"next talk(by Rose)"

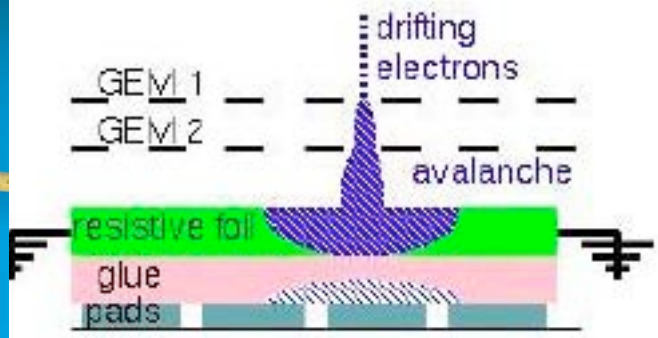
Charge Dispersion Readout

2005/Oct.

"Madhu's talk"

"theoritical understanding of MPGD-TPC" by Makoto





Beam

11GeV KEK-PS pi2 line 4GeV/c pi
terminated at March '06

Magnet

PCMAG

upto 1.2T
thin wall

Go to EUDET
this summer

Readout electronics

"Ancient" ALEPH electronics
PreAmp. + TPD system
80nsec time bucket(12.5MHz)

OS9 based DAQ
J/F-TPC for on-line event display
by French group

Analysis

Multi-Fit program developed at DESY
hit point making in each pad-row
chi2 fit using line,curve, circle

FTPC is also used by French group

We are accepting any good tools/enviroments

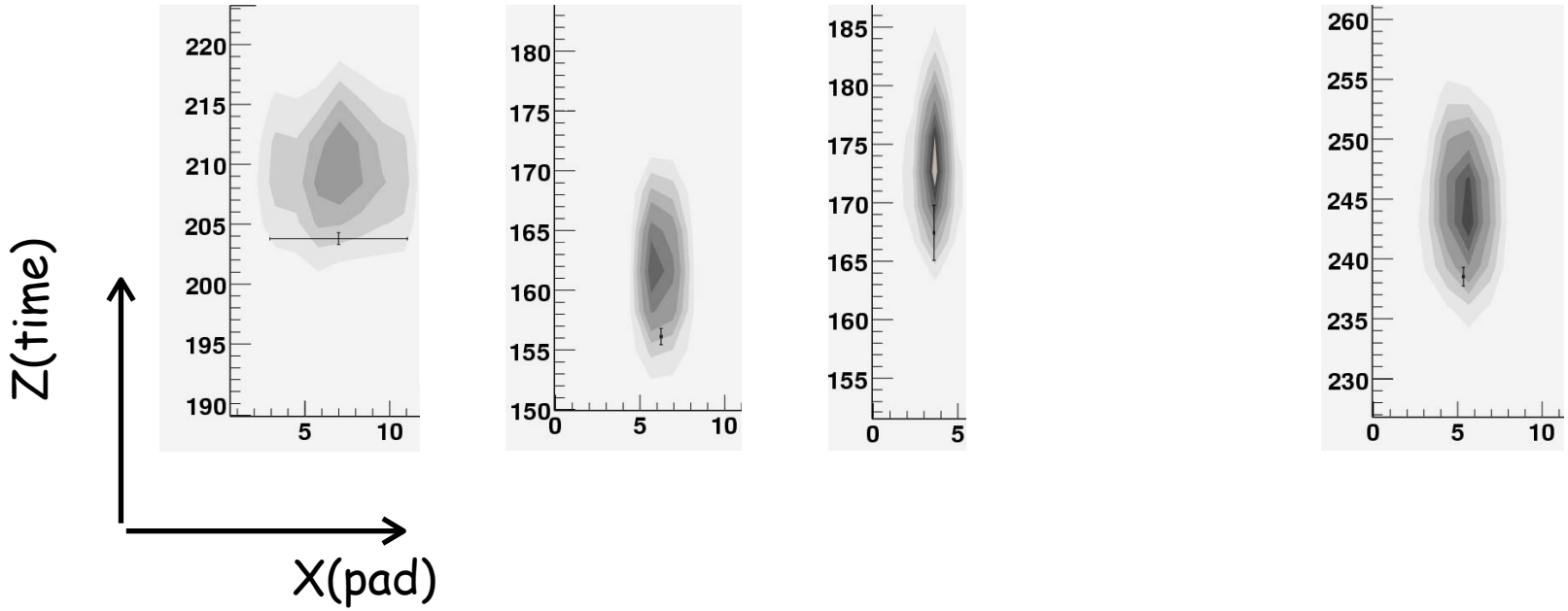
Status of Our data : which kind of data we've taken

	GAS	Edrift	B	term	pad pitch	beam
MWPC						
	TDR	236V/cm	0,1	2004/Jun.	2.3 mm	4GeV/c pi
	TDR	236V/cm	0,1,4	2004/Mar.		cosmi @DESY
GEM						
	TDR	236V/cm	0, 1	2005/Apr.	1.27mm	4GeV/c pi
	P5	100V/cm	1	2005/Apr./Oct.	stagg.	
		50V/cm	1	2005/Oct.		
Micromegas						
	Ar:iso-C4H10		0, 0.5, 1	2005/Jun.	2.3 mm	4GeV/c pi
	Ar:CF4					
Micromegas+resistive foil						
	Ar:CO2		0, 1	2005/Oct.	2.3 mm	4GeV/c pi

How does signal look like ?

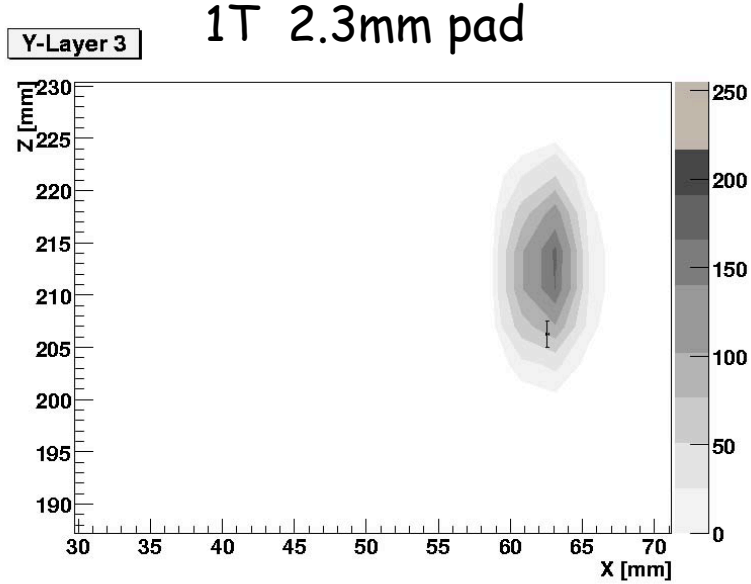
GEM P5 1.27mm pad TDR

0T 1T(100V/cm) (50V/cm) 1T

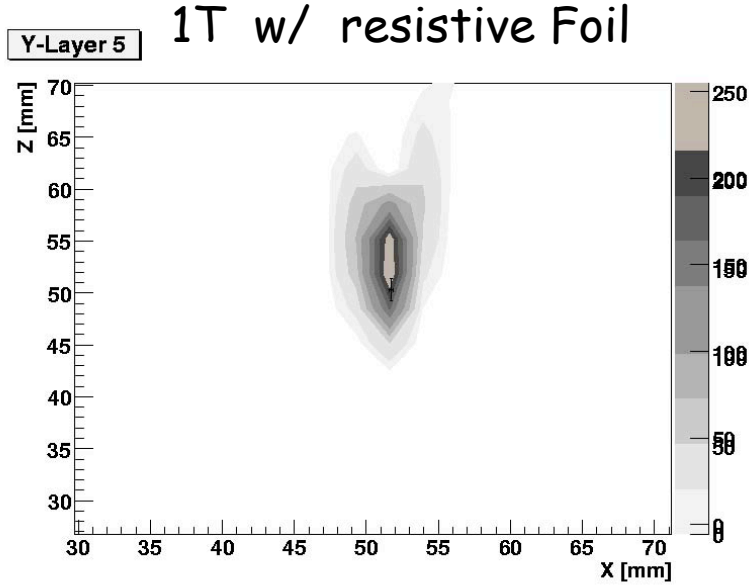


MicroMegas

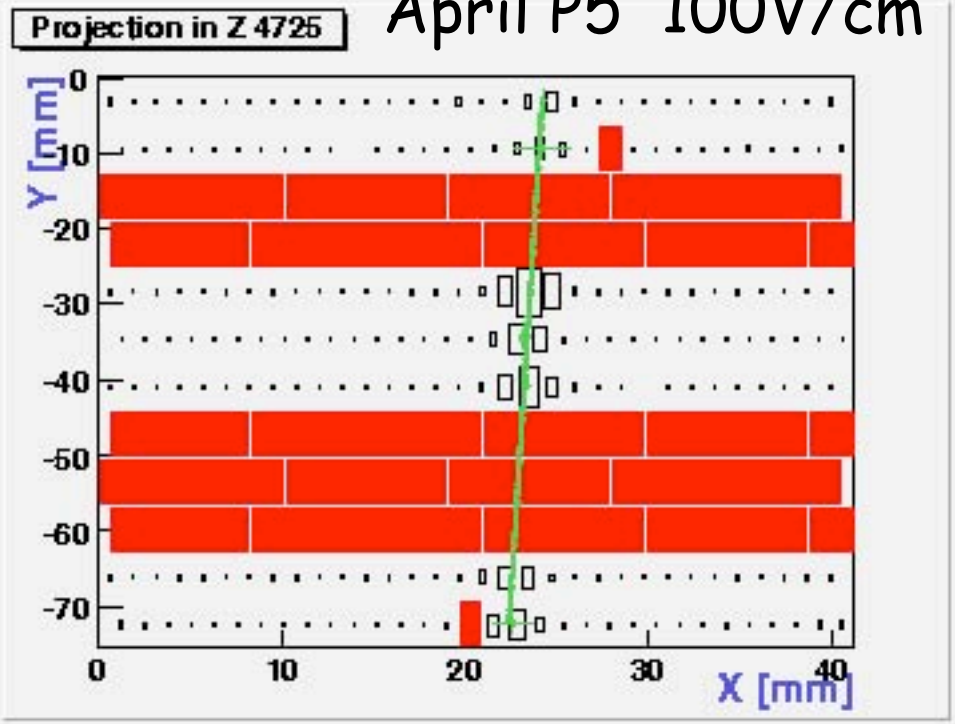
1T 2.3mm pad

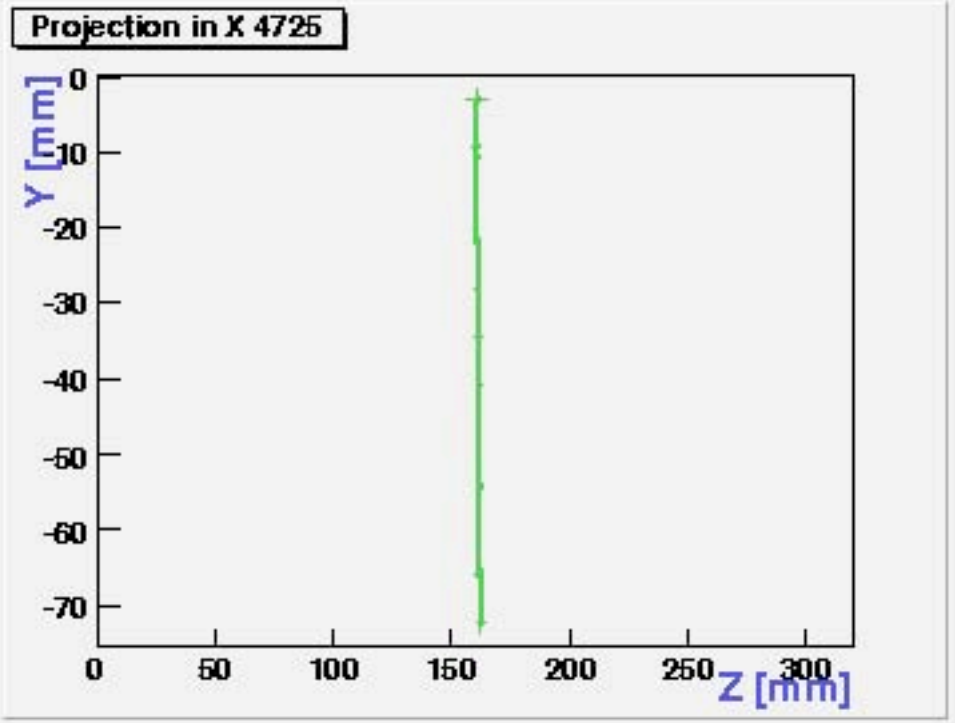


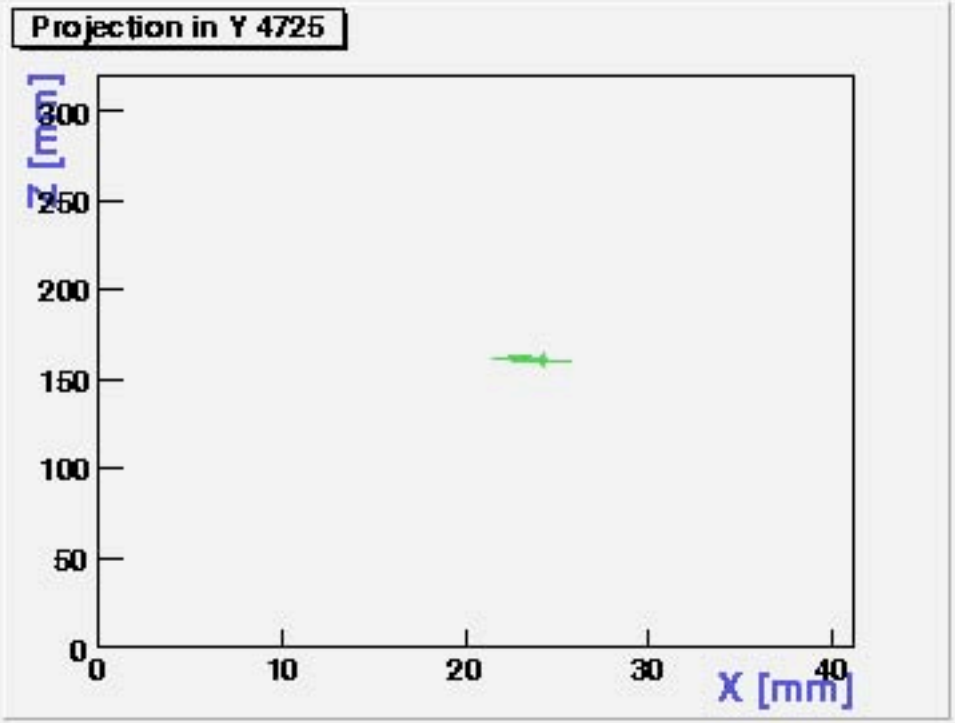
1T w/ resistive Foil

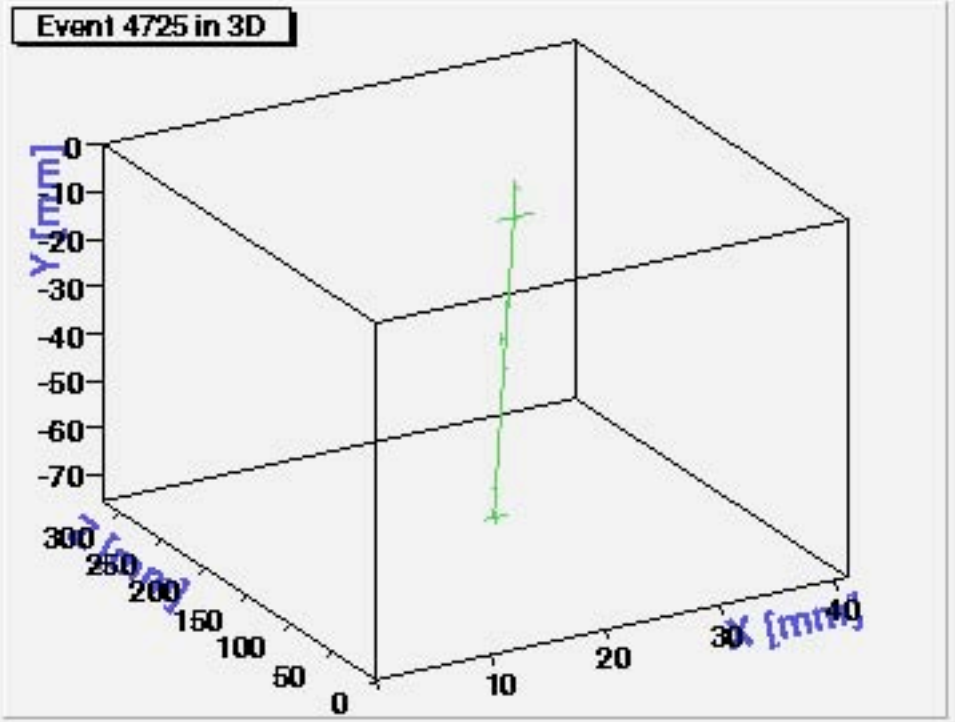


April P5 100V/cm









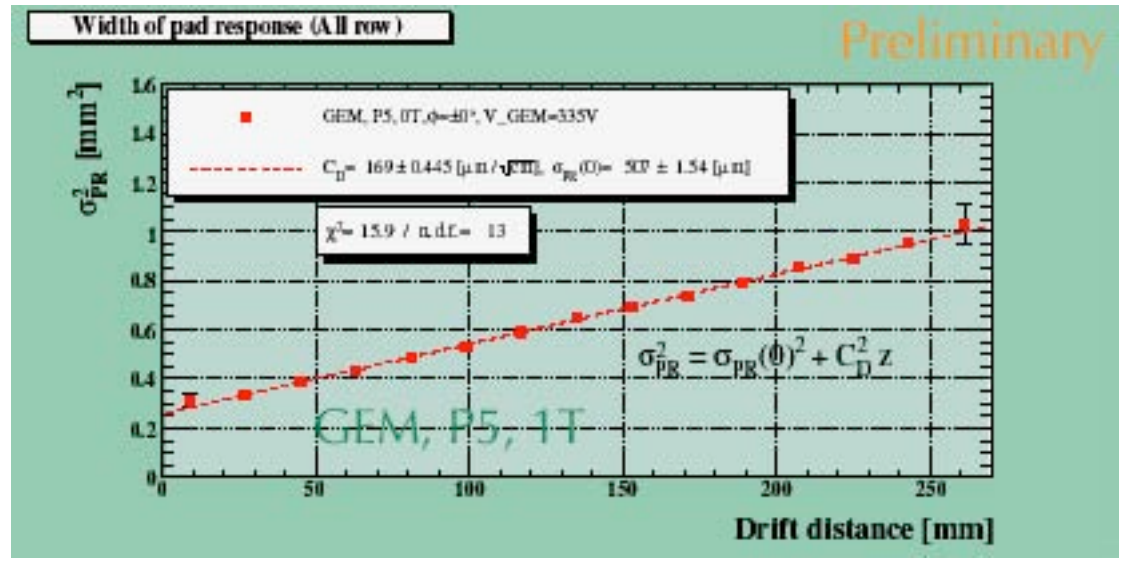
Signal Spread on pads

$$\sigma_C = \sqrt{\sigma_G^2 + C_D^2 z}$$

Diff. in GEM

Gas property

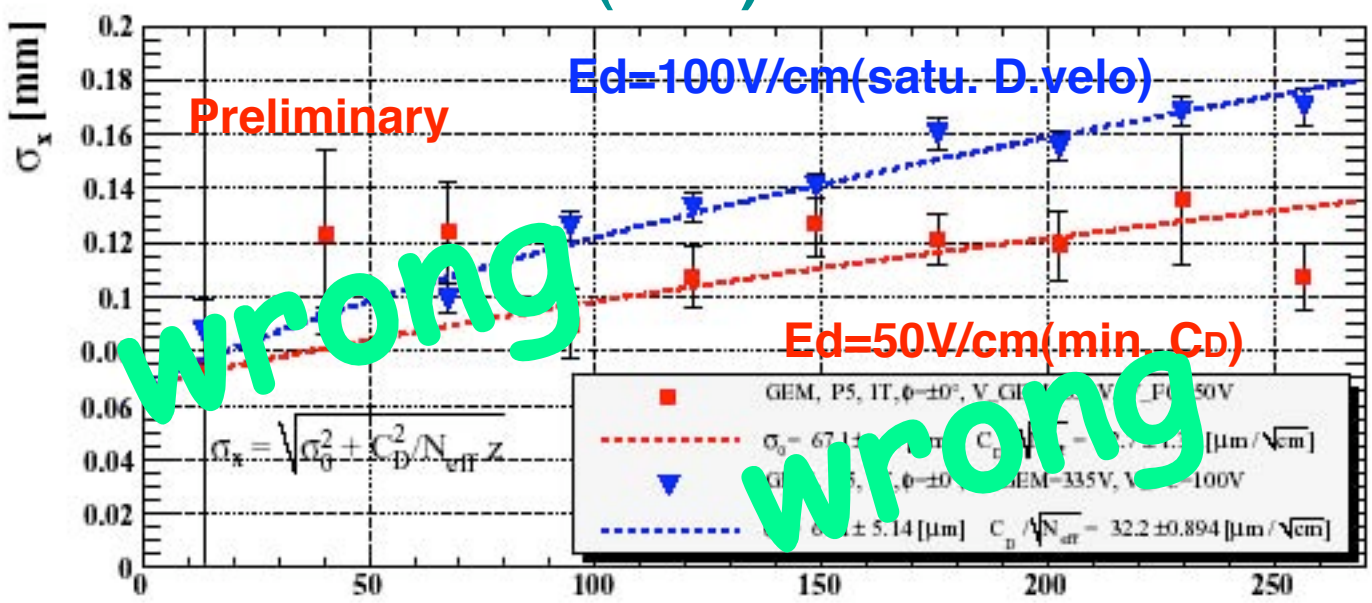
GEM P5 1T (Apr.)



x Resolution

$$\sigma_x = \sqrt{\sigma_0^2 + \frac{C_D^2}{N_{eff}} z}$$

GEM P5 1T (Oct.)

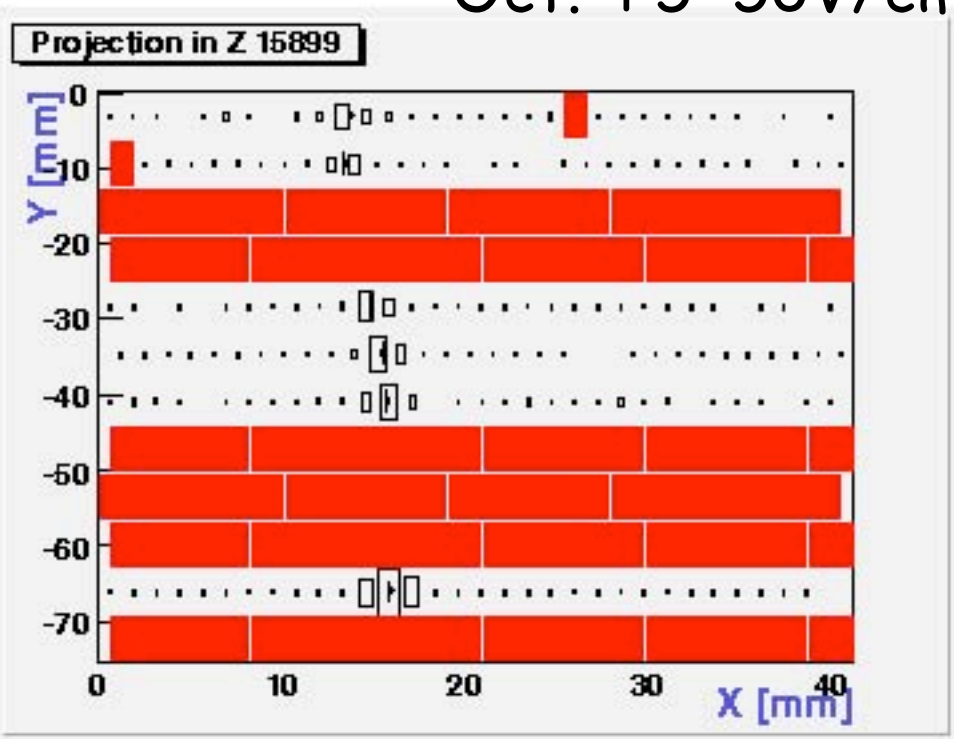


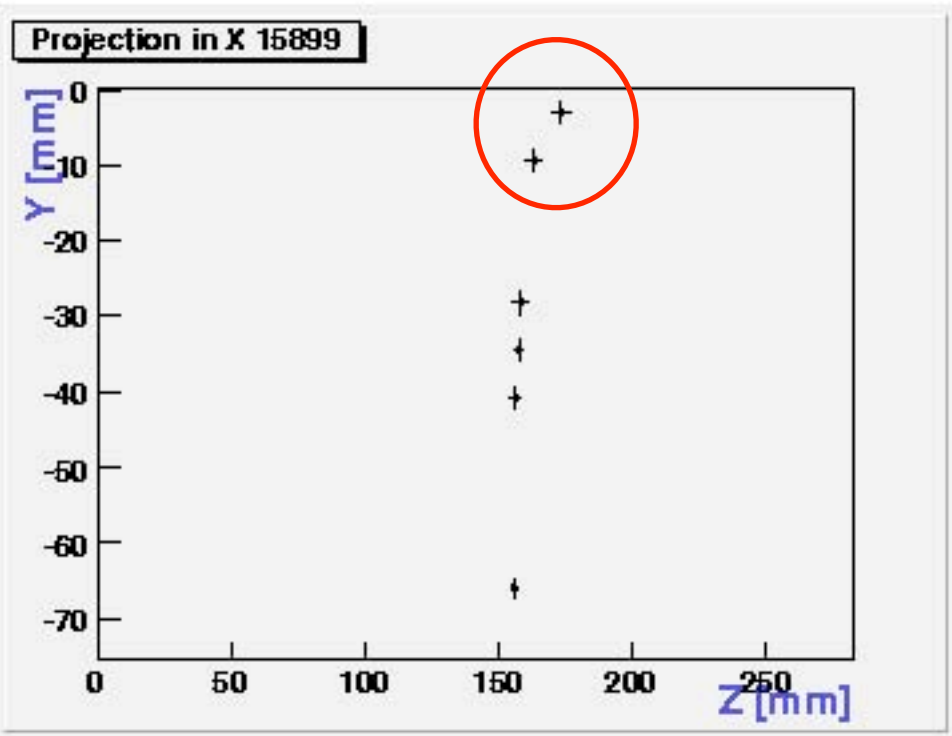
"When we borrow tools, we have to know its detail."

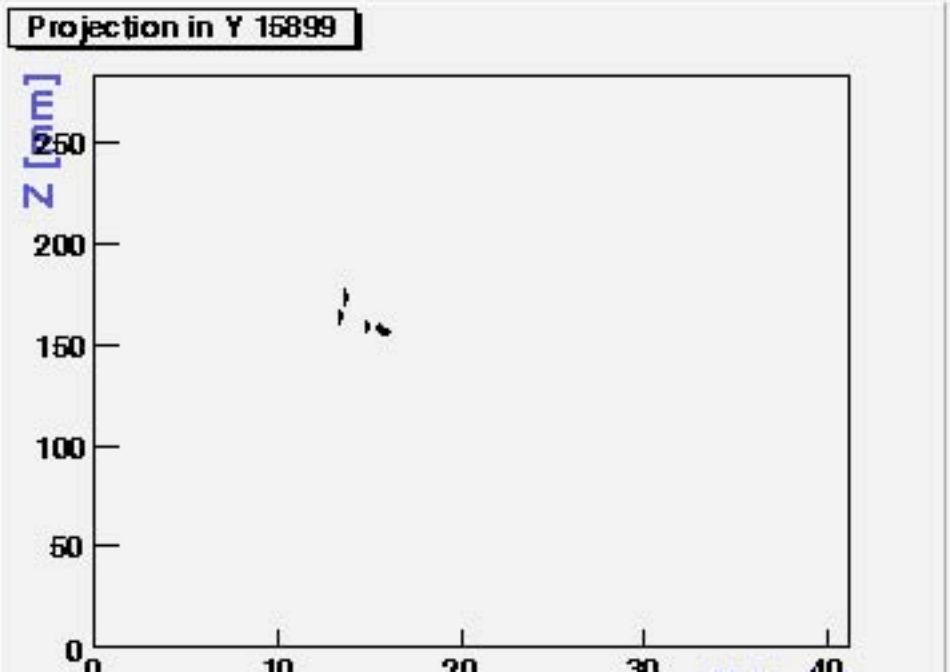
documentation is important !! otherwise it takes long to understand

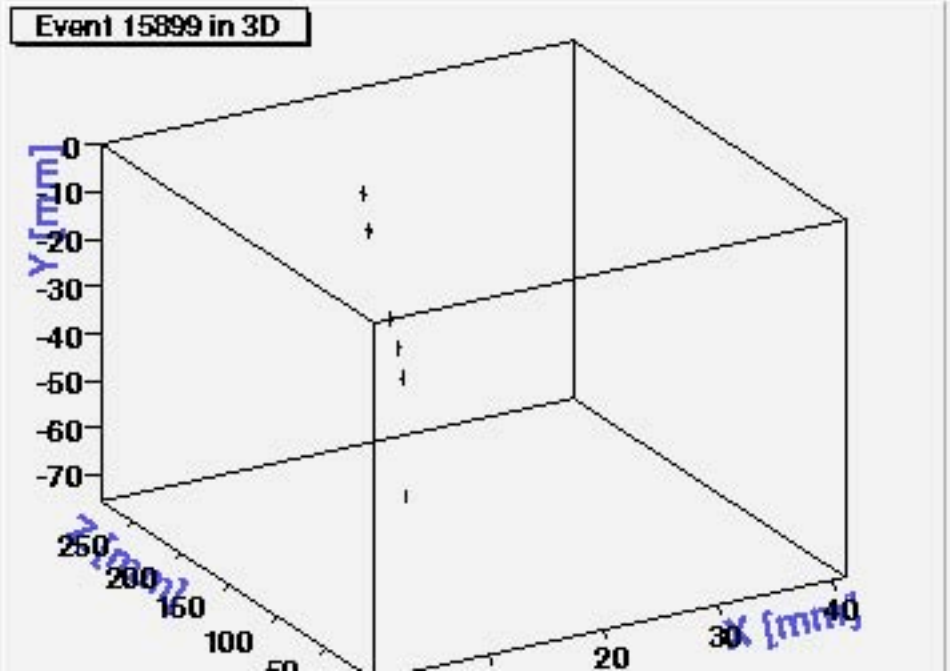
What's happen to Oct. data ??

Oct. P5 50V/cm





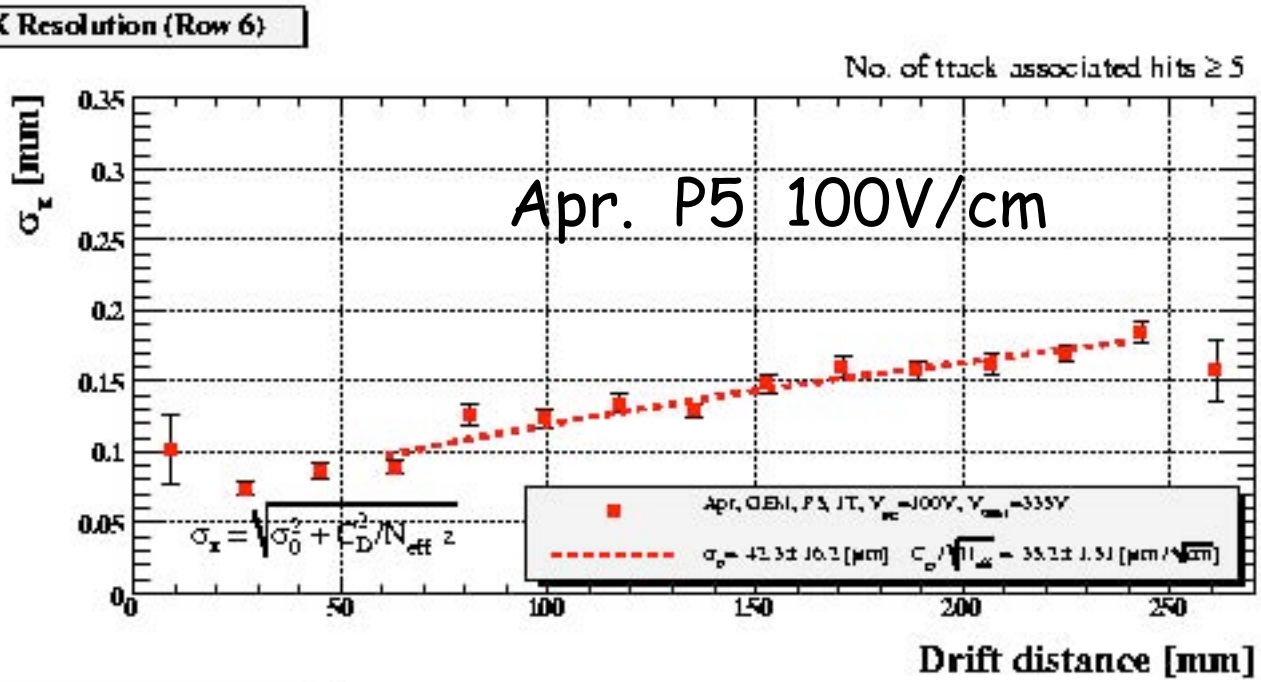




April and Oct. data is comparable ?

□0 Cd/√N

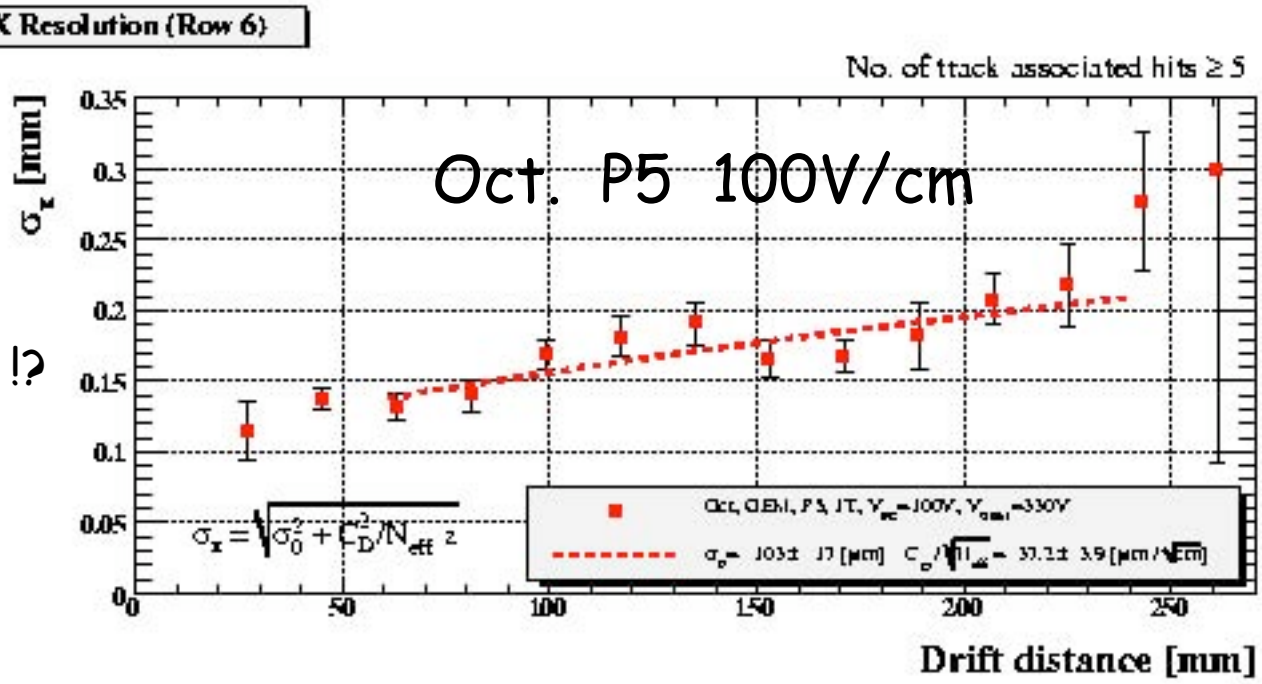
42.3 33.2
(10.2) (1.5)



FitProb
C.L. >10^{-4}

103. 37.2
(17) (3.9)

consistent !?



FitProb
C.L. >10^{-9}

angular pad effect
Apr. □ ~ 0 deg.
Oct. □ ~5 deg.

Data is not perfectly understood yet at this moment !

But this talk is for MC comparison

What should be explained by MC ?

Do we get proper Cd ?

Check the method of Cd evaluation

Do we get proper Cd/√Neff ?

Do we understand Neff

Which effects are included in GEM MC (very primitive MC)

Primary Ion Pairs :

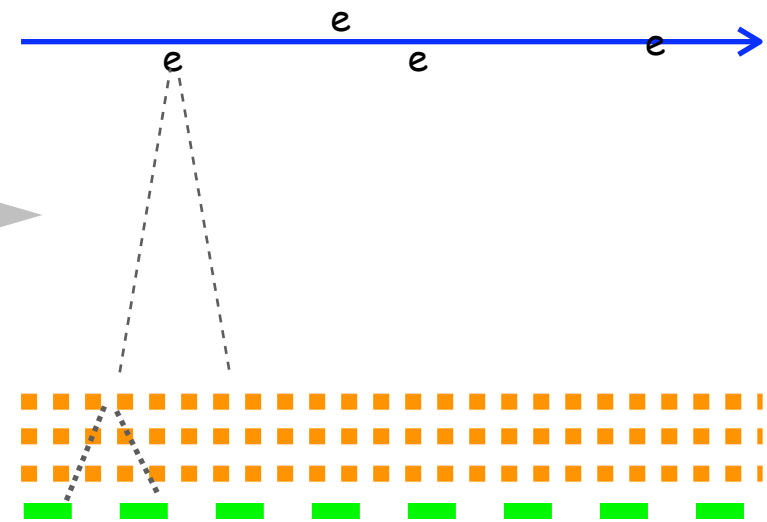
HEED w/ 4GeV/c pion

Diffusion in drift region :

params. from MagBoltz

Diffusion in gas amp. region

params. from MagBoltz



Efficiency

Gain fixed gain

important when we consider sigma_0 for GEM
(not for MM)

Collection at pad

single pad row

residual = Obs. - Gen.

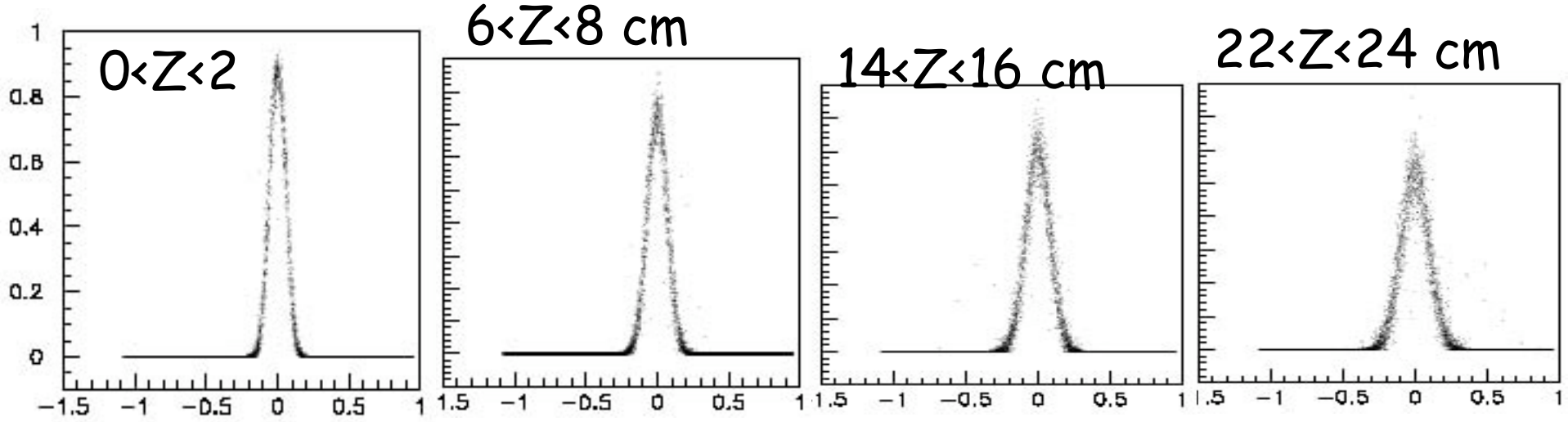
signal shaping

S/N

Signal Spread

Cd evaluation

MC



MC input

Cd = 165.89 um/√cm

we obtain

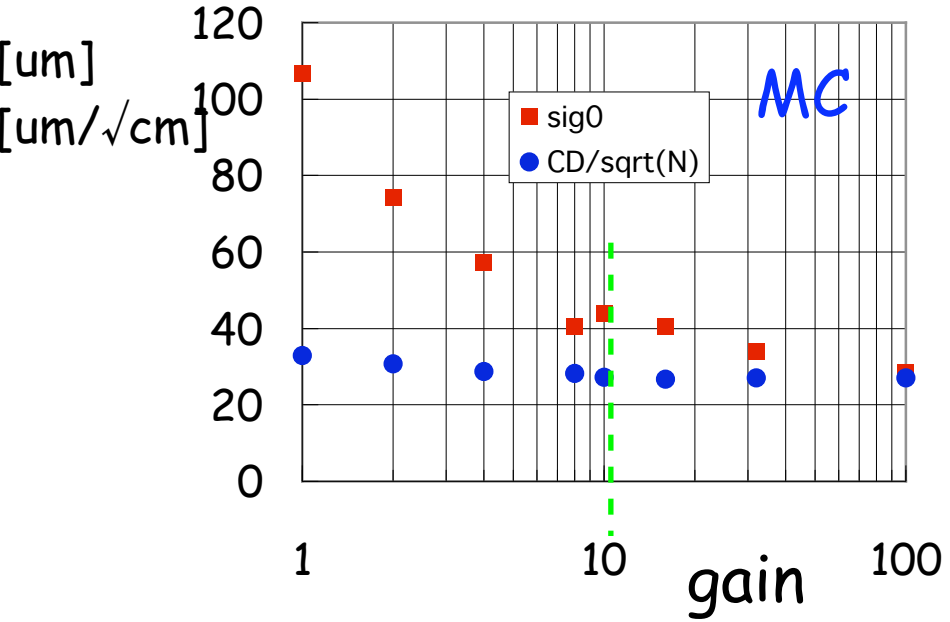
Cd = 162 um/√cm

Cd evaluation seems to be OK

as far as data can be fit w/ gaussian

Resolution

effect of gain (not gain fluctuation)



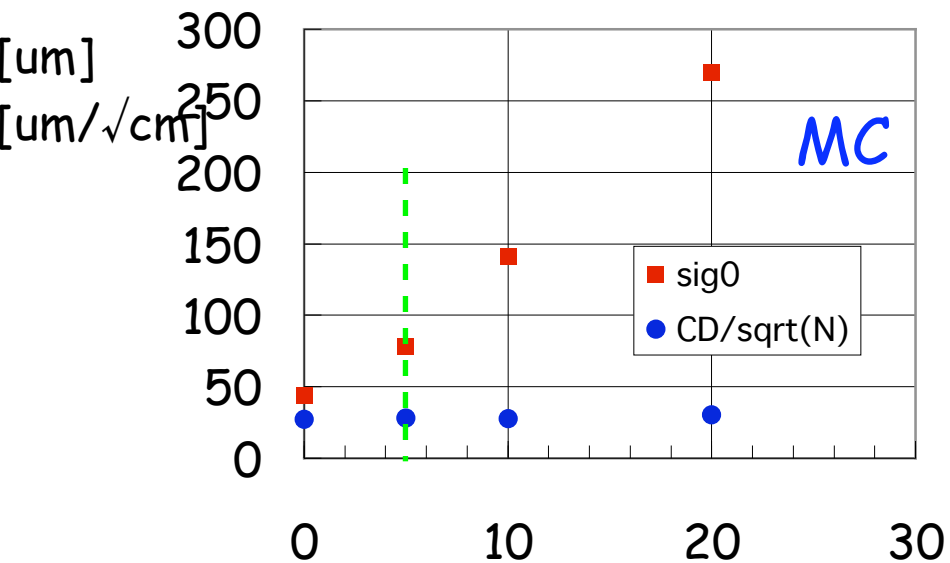
Gain reduce a fluctuation at amp. gap

minor contribution to Cd/sqrt(N)

Need to include gas gain properly

but now we use fixed gain 10
(only 1st GEM contribution)

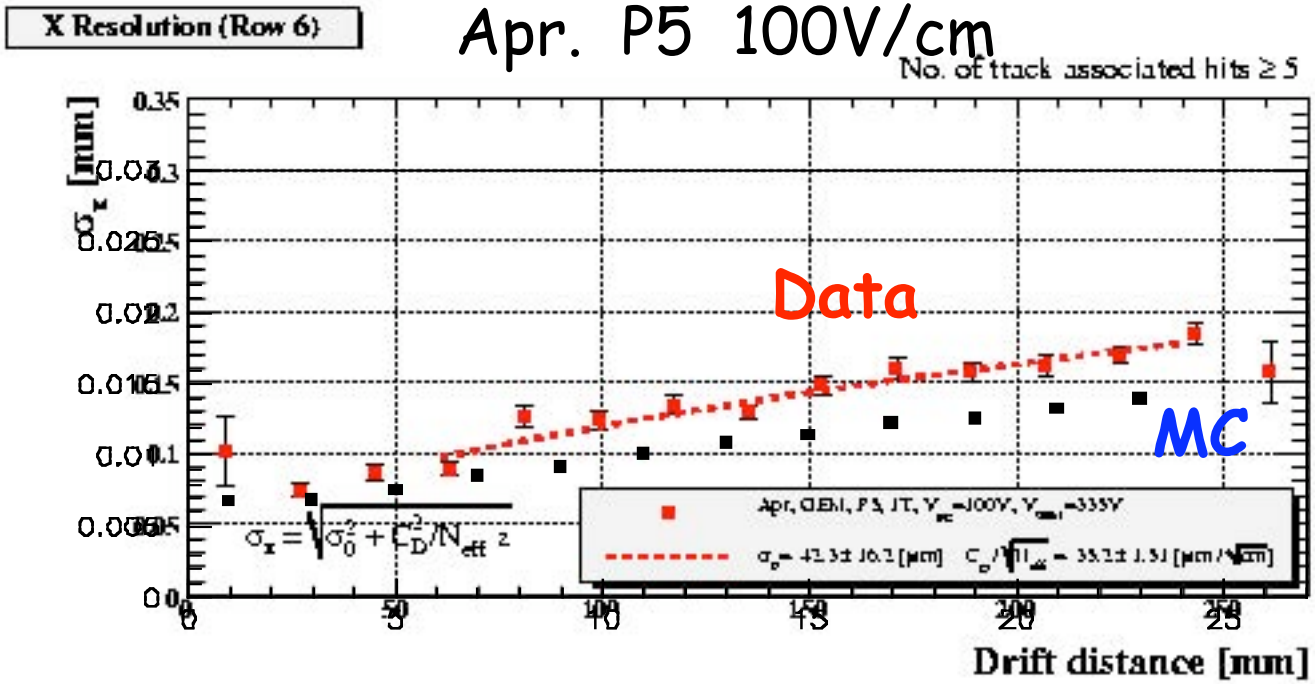
effect of angular pad



Angular pad effect increase sigma_0

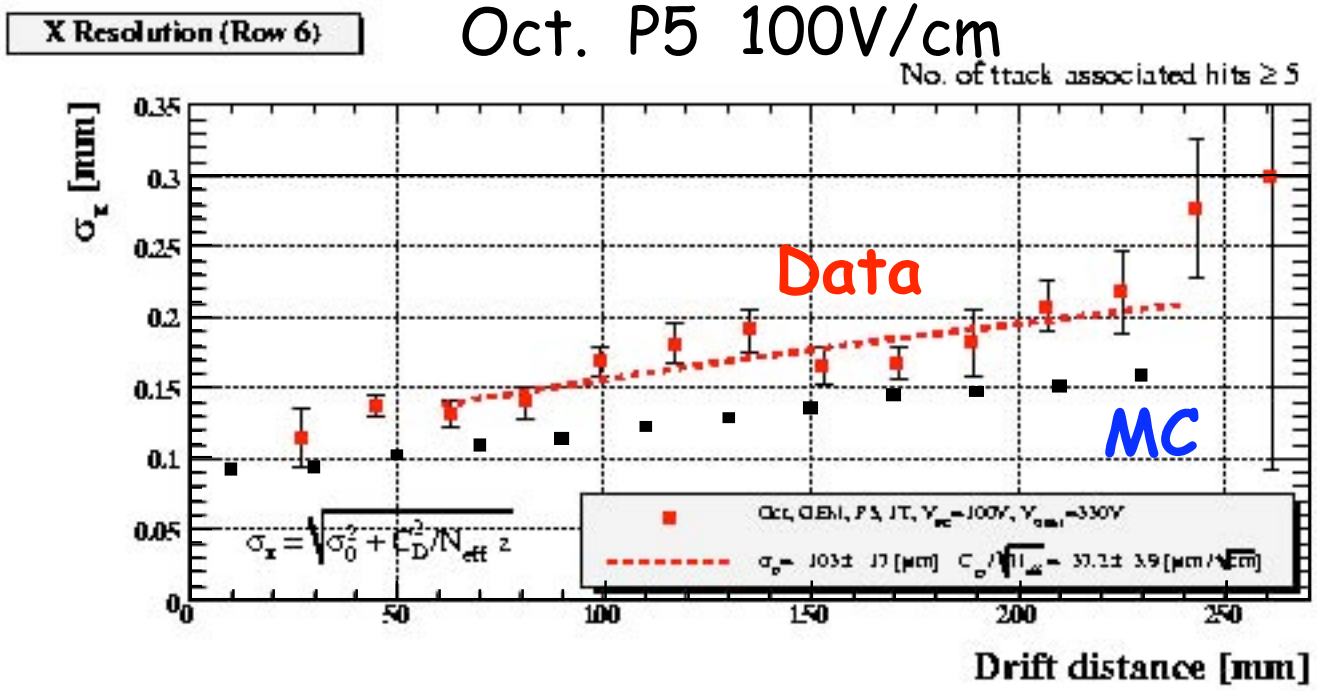
Large effect !!

Is this depend on tracking method?



σ_0	Cd/√N
42.3	33.2
(10.2)	(1.5)
43.9	27.3
(2.1)	(0.3)

67% diff in N
btw data MC

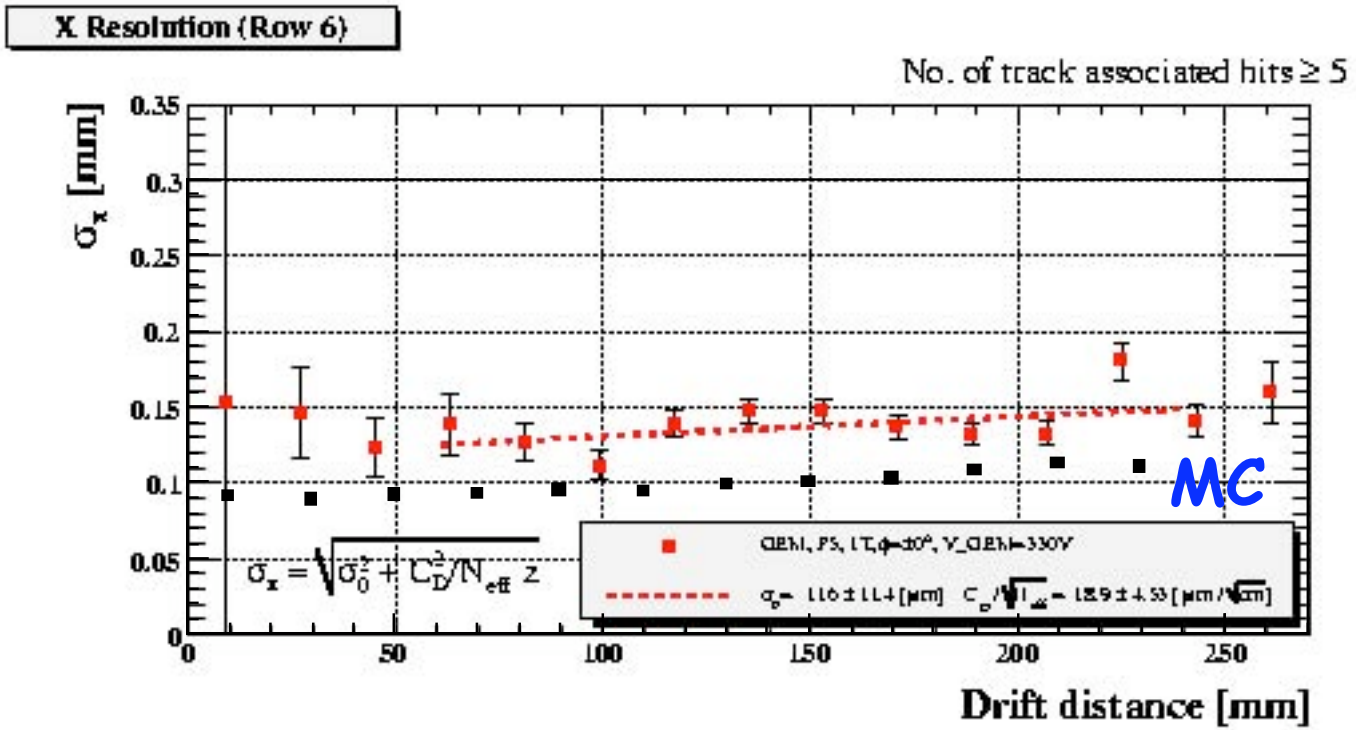


σ_0	Cd/√N
103.	37.2
(17)	(3.9)
78.4	28.3
(1.2)	(0.3)

58% diff

detail will be explained
by Makoto's talk

Oct. P5 50V/cm



σ_0	Cd/√N
116	18.9
(11.4)	(4.5)
80.6	16
(1.4)	(0.5)

72% diff in N
btw data MC

only 60~70% of 1/<1/N> is contributing to N_{eff}

gain fluctuation/efficiency at 1st stage can explain ?

σ_0 is another param. to be explained

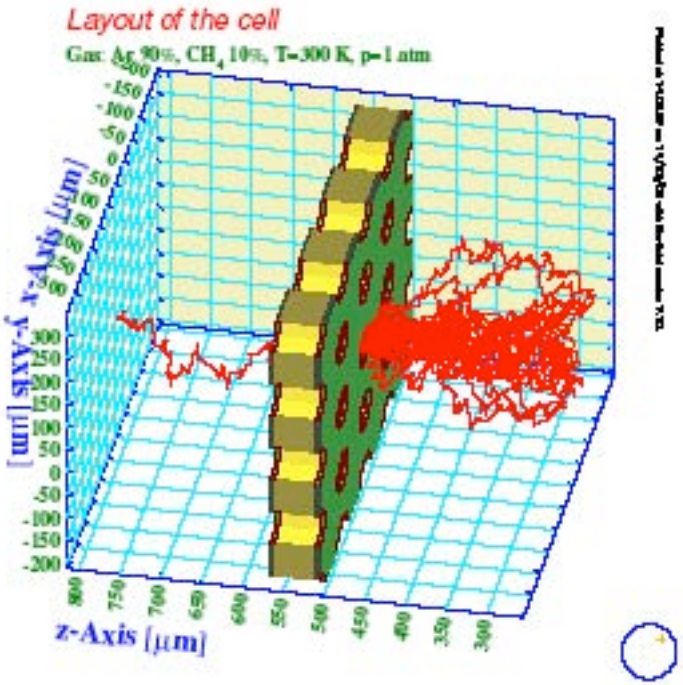
using gain/gain fluc./eff.

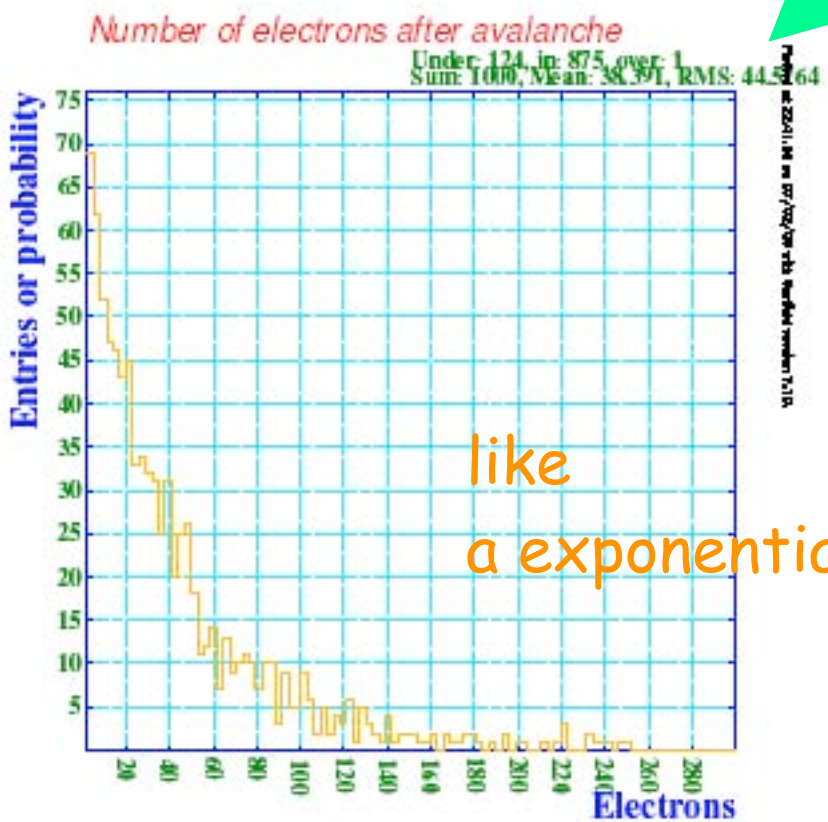
Gain estimated from Garfield

Single GEM w/ P10

input : Single Electron

count # of electrons @readout electrode





like

a exponential !!

These effects will be included later

and hope to reproduce data behavior

MWPC MC

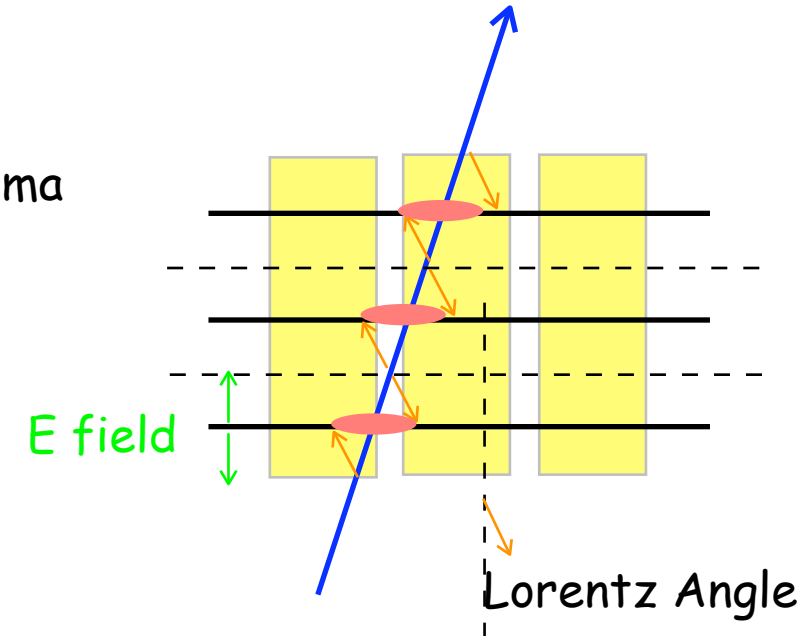
Pad Response Function : gaussian w/ 1.38 mm sigma

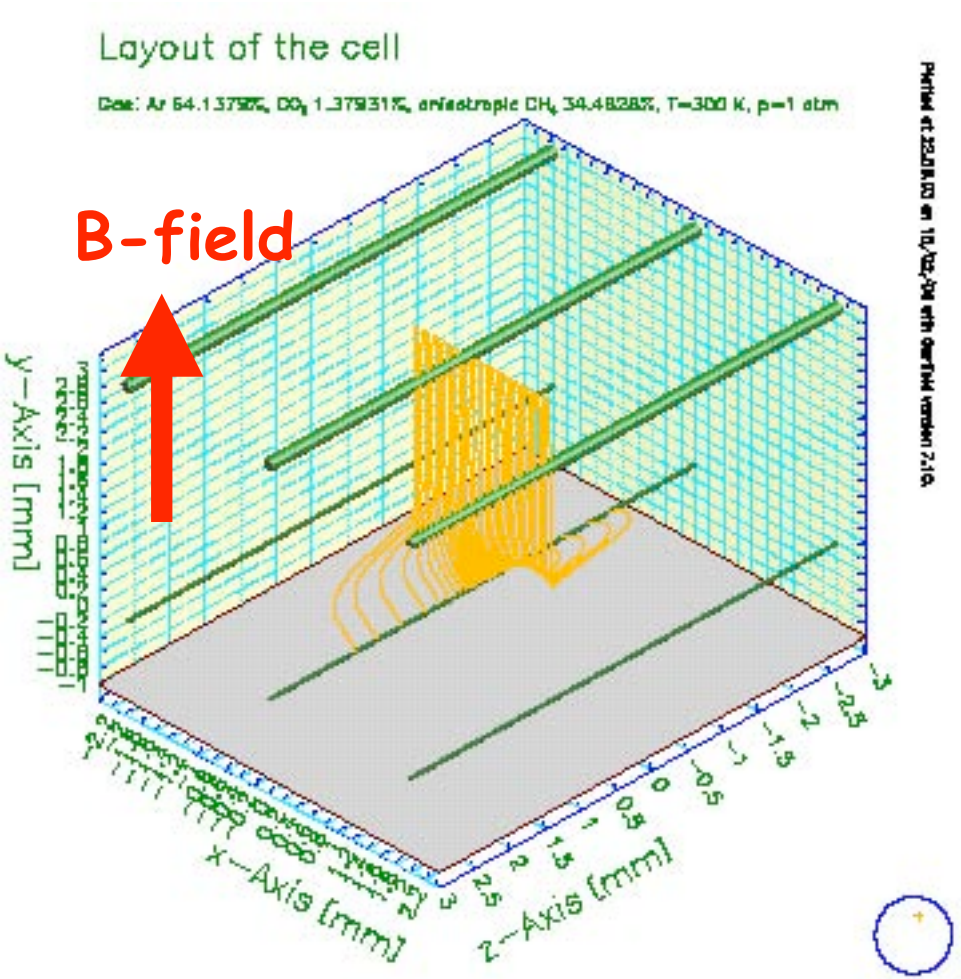
Single Pad row is facing 3 sense wires

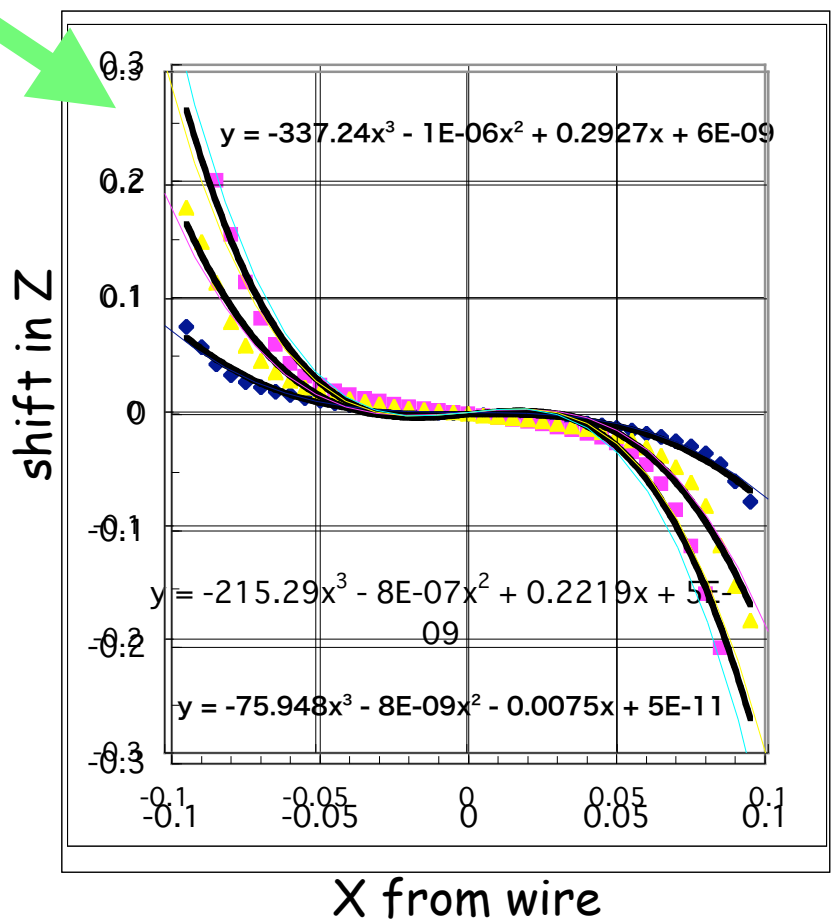
ExB effect; estimated from Garfield

param. function

shift in Z = fcn(X,B)

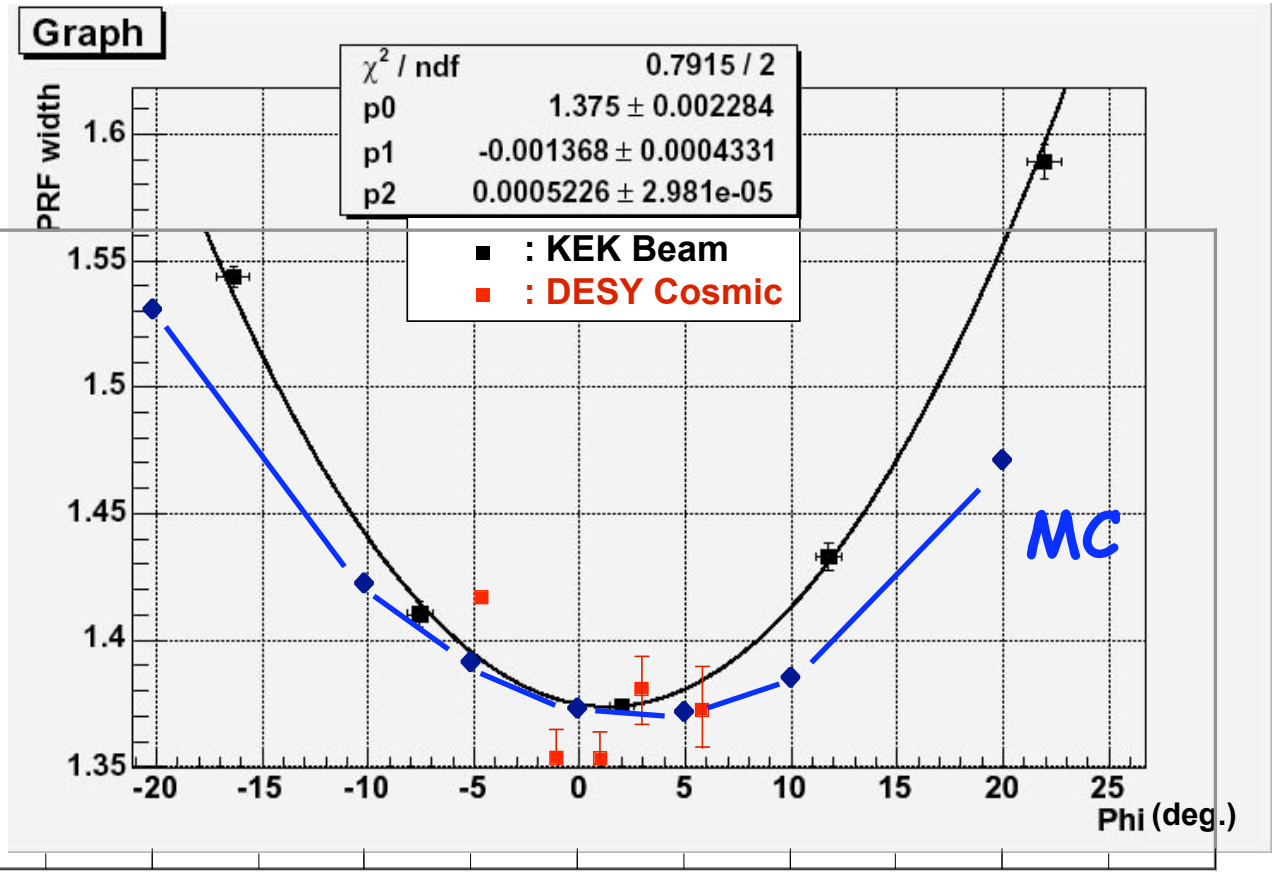


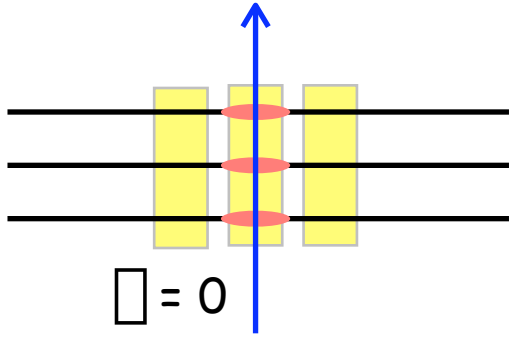


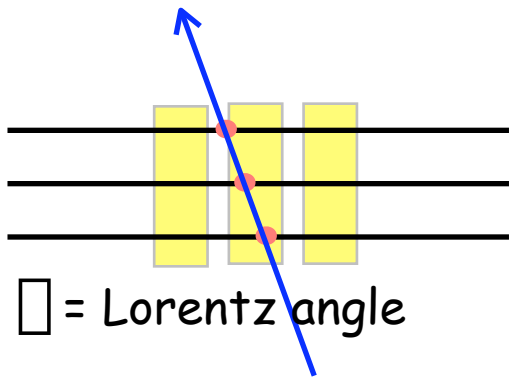


ϕ dependense(1Tesla)

pad response





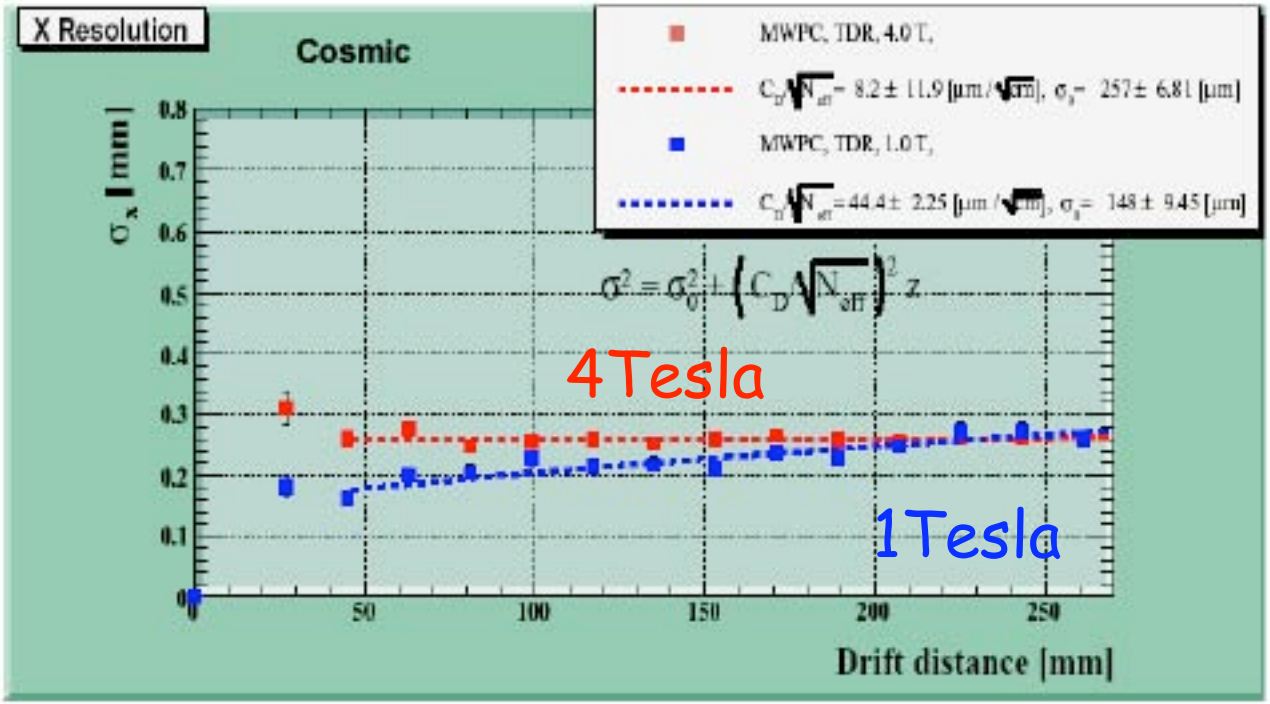


not produced well in quantitatively

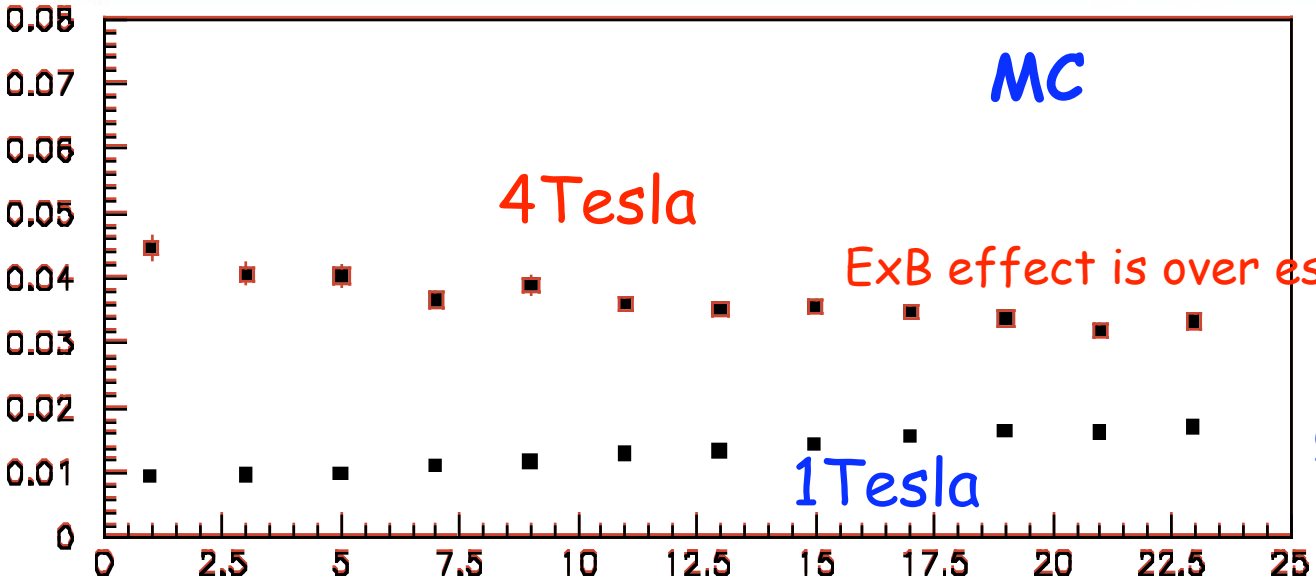
need tuning of pad response function(PRF)

and ExB shift function

Resolution



4T data provides worse resolution



Large ExB and angular-pad effects make MWPC resolution worse at high B.

ExB effect is over estimated now

gain fluctuation & S/N are necessary to explain 1T data.

Summary

Oct. data has some uncertainty
but almost comparable to Apr. data.
consistency check.

Param. MC is under construction to understand data.
Neff(data) is 60~70% of MC expected(w/o g. fluctuation..)
gain is necessary to reproduce σ_0
gain fluctuation/efficiency is important
to understand Neff

Behavior of MWPC data may be understood
with ExB, angular-pad effects .