CF_4 Gas Test for GEM-TPC

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Ryo YONAMINE

～OUTLINE～

1. PURPOSE
2. THIS WORK
3. RESULTS
4. SUMMARY
5. PLANS

Collaboration with
KEK, TUAT, KogakuinU
KinkiU, SagaU
MPI, Saclay, TsinghuaU

1.PURPOSE

WHY NEED GAS TEST ?

The chamber gas plays important roles
in order to measure the position of tracks.

The gas decide three parameters.

1. velocity of drifting electrons (V_{drift})
2. diffusion constant of drifting electrons (C_D)
3. the effective number of seed electrons (N_{eff})

PURPOSE OF OUR STUDY

According to GARFIELD,
CF_4 gas mixtures are likely to give low C_D.
But, ...

problem

CF_4 gas mixtures are not yet fully studied as GEM-TPC gas.

Our task is to confirm
whether these gases can become GEM-TPC gas.

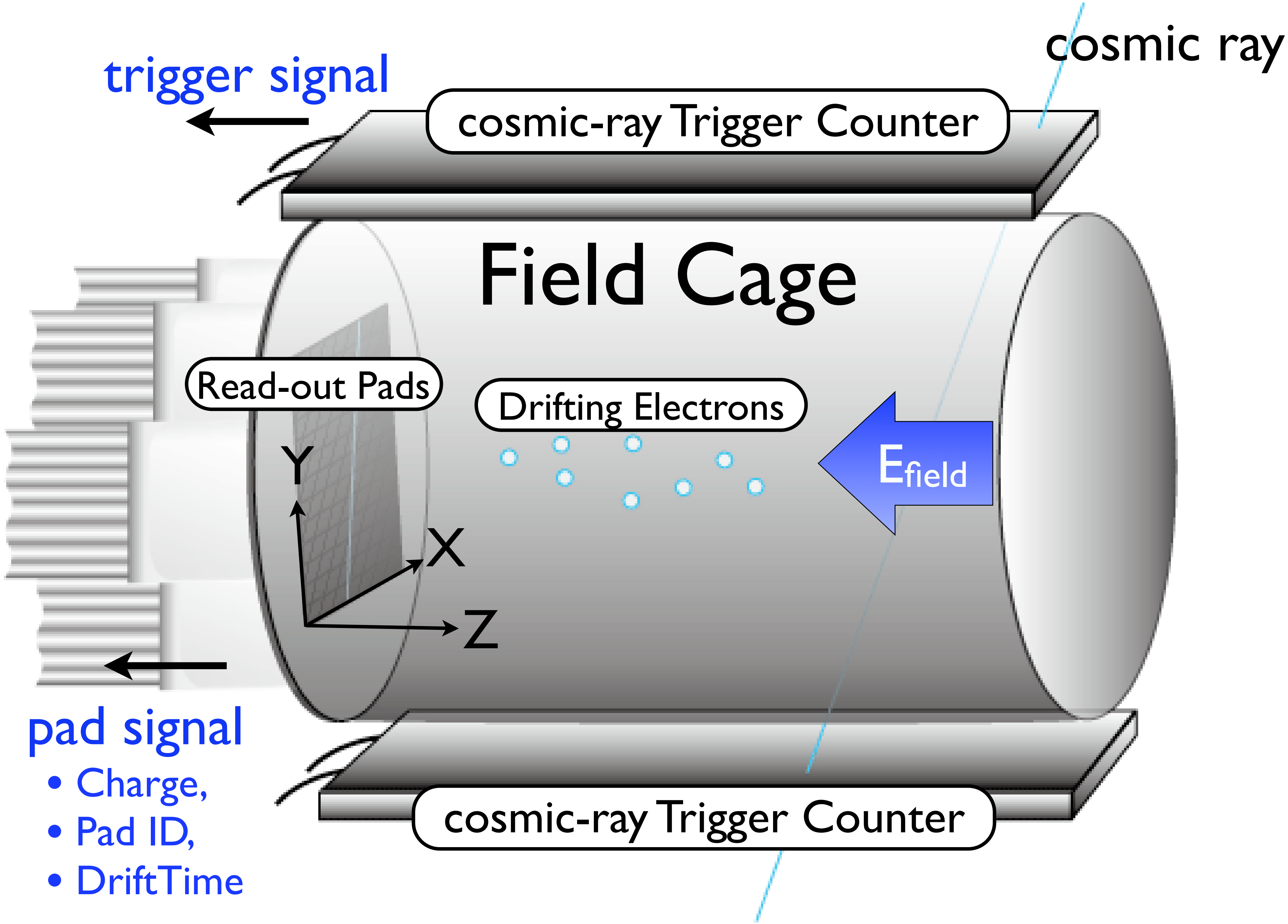
2. THIS WORK

<u>THIS WORK</u>

~cosmic ray test~

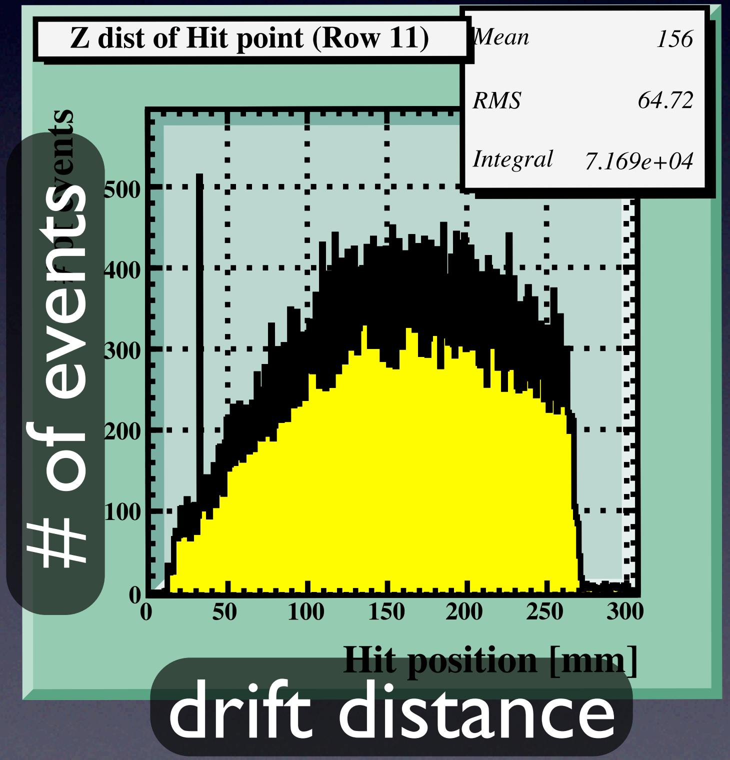
We tested $Ar\text{-}CF_4\text{-}isoC_4H_{10}$(94:3:3) with GEM-TPC
as a first step, (Source was cosmic ray)
and estimated $\mathbf{V_{drift}}$, $\mathbf{C_D}$(transverse) and $\mathbf{N_{eff}}$.

And we compared our measurement with GARFIELD
in V_{drift} and C_D.



trigger signal
cosmic ray
cosmic-ray Trigger Counter
Field Cage
Read-out Pads
Drifting Electrons
Y
X
Z
E field
cosmic-ray Trigger Counter
pad signal
• Charge,
• Pad ID,
• DriftTime

PROBLEMS IN DATA ANALYSIS



This is one of the histograms which shows Z-distribution of "seed electrons".

We estimated V_{drift} from this.

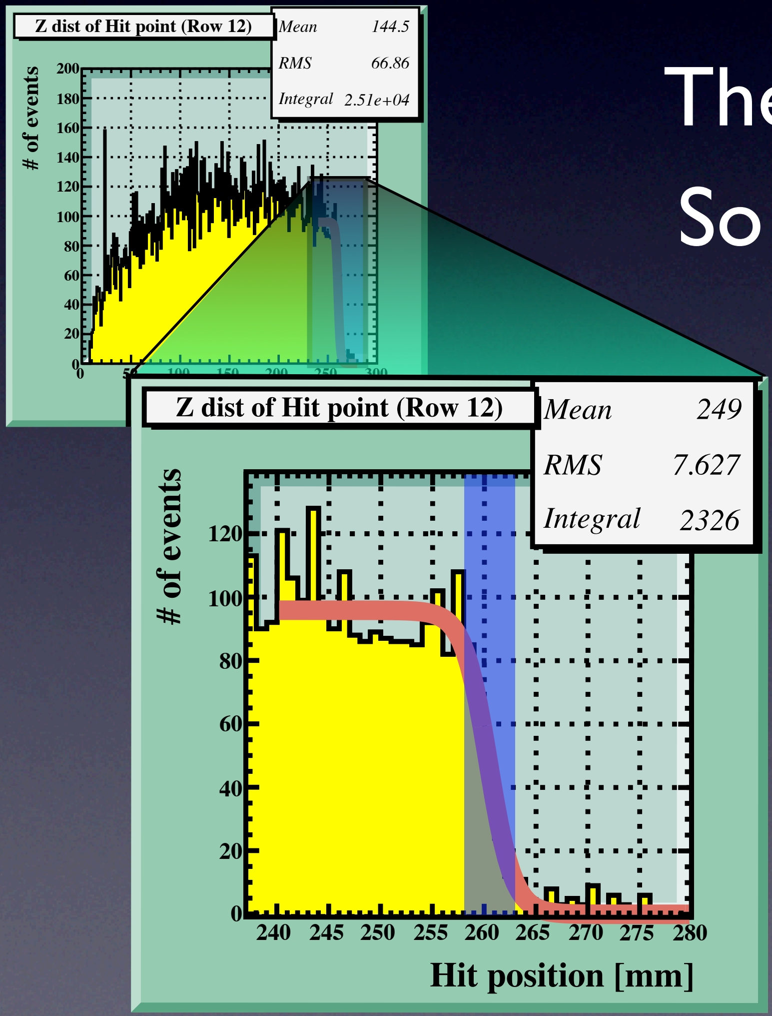
(Drift distance shoud be TPC length.)

Here, there are two problems.

1. What's the gap at left side ?
2. What's the value of the end point ? (right side)

OUR ACTION FOR THE PROBLEMS 1

- Where's the right side end ?



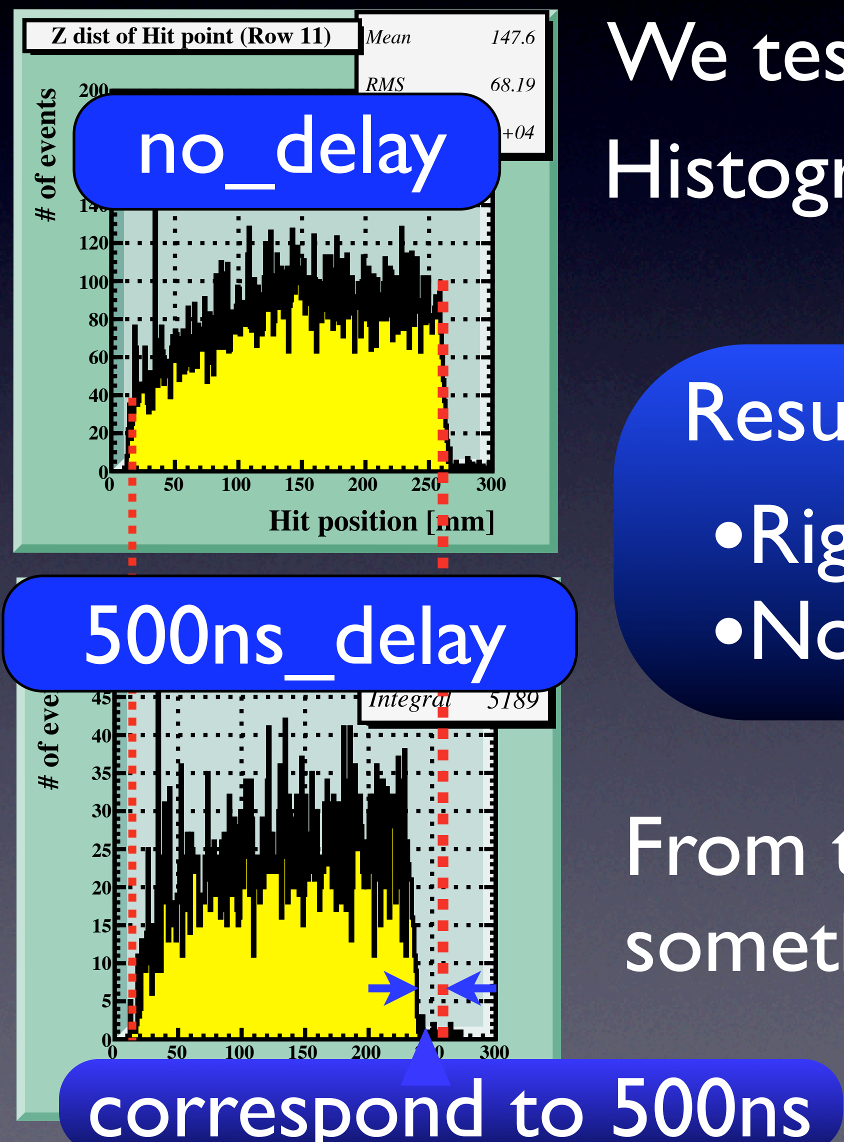
The right edge is slightly-tilted.

So we define the end point as follows.

1. fit the edge as $y = \dfrac{a_0}{exp[\frac{x-a_1}{a_2}]}$ (Red Line)
2. let the end point $= a_1 \pm 2a_2$ (Blue Region)

OUR ACTION FOR THE PROBLEMS 2

- What's the gap at left side ?



We tested with delayed trigger gate.

Histograms were expected to move to the left because of the trigger delay.

Result (left figure)

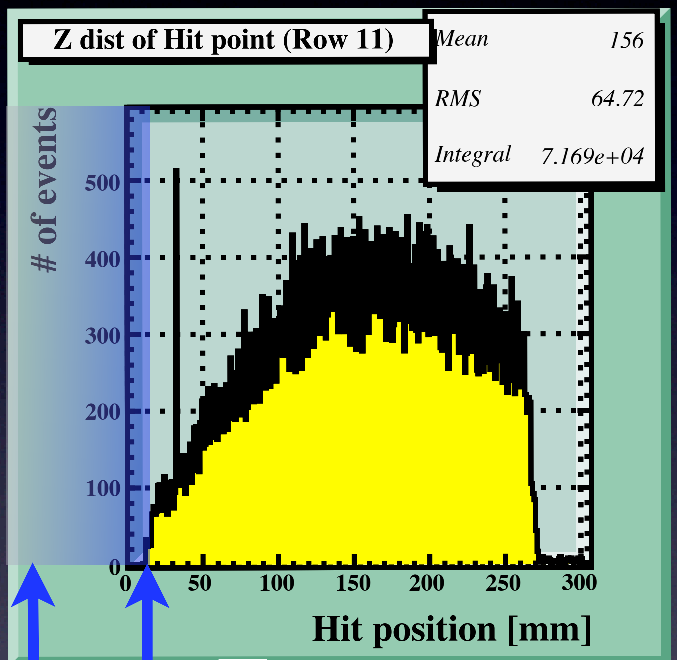
- Right edge moved reasonably.
- No change was seen with Left edge.

From this result, we take the left gap as something like "invisible region".

NEW PROBLEM

~ T_0 calibration by P10 ~

- Where is T_0 ?



not T_0

"invisible region"

We calibrated T_0 by using P10 gas.

	our measurement	Garfield
C_D	113±4.8	116.7
V_{drift}	?	5.37

ASSUMPTION

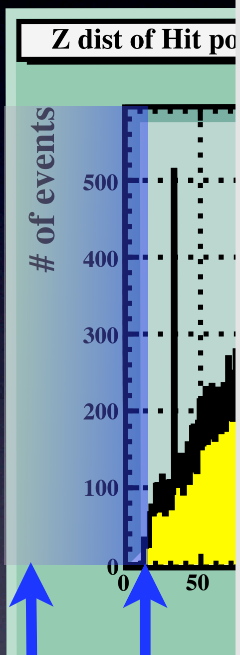
P10 gas give also some consistency in V_{drift}.

V_{drift}(P10@E=108.5[V/cm])=5.37±0.30

We estimate T_0 by analysis for P10.

NEW

- Wh



not

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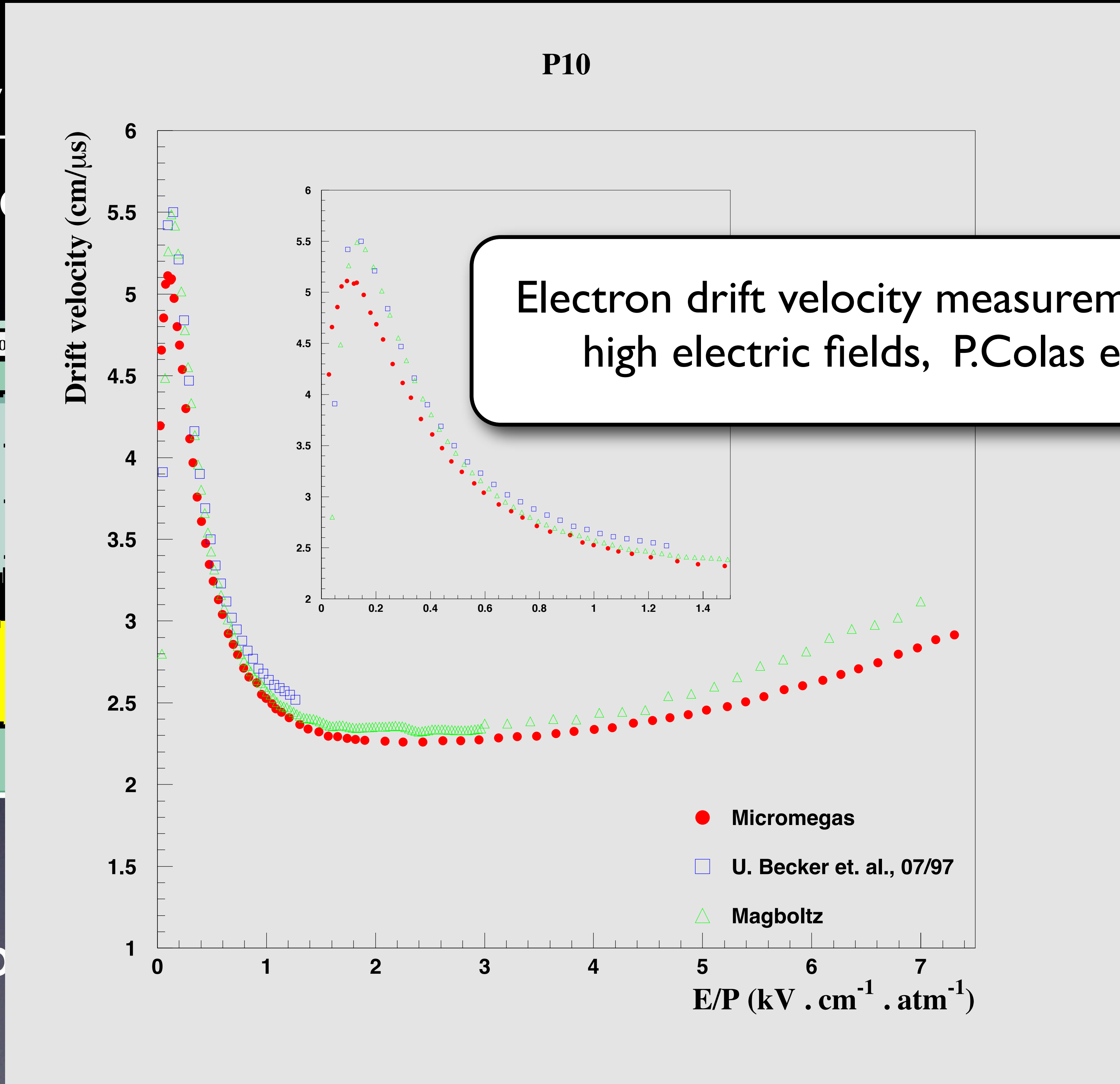


Fig. 4. Calibration in P10.

Electron drift velocity measurements at high electric fields, P.Colas et al.

tency

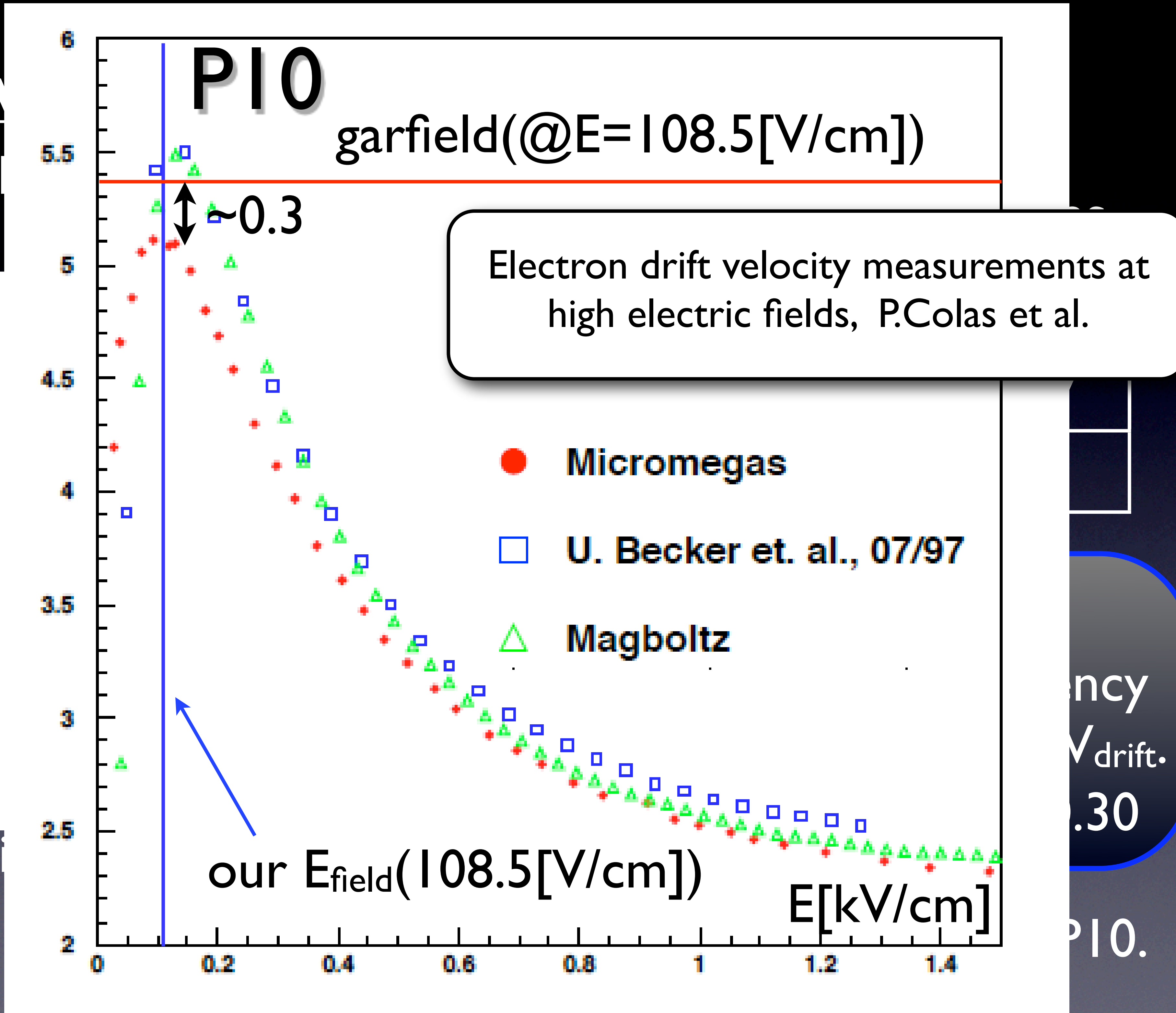
n V_{drift}.

±0.30

P10.

NEW

W



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Vdrift.

.30

P10.

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~ T_0 calibration by P10 ~

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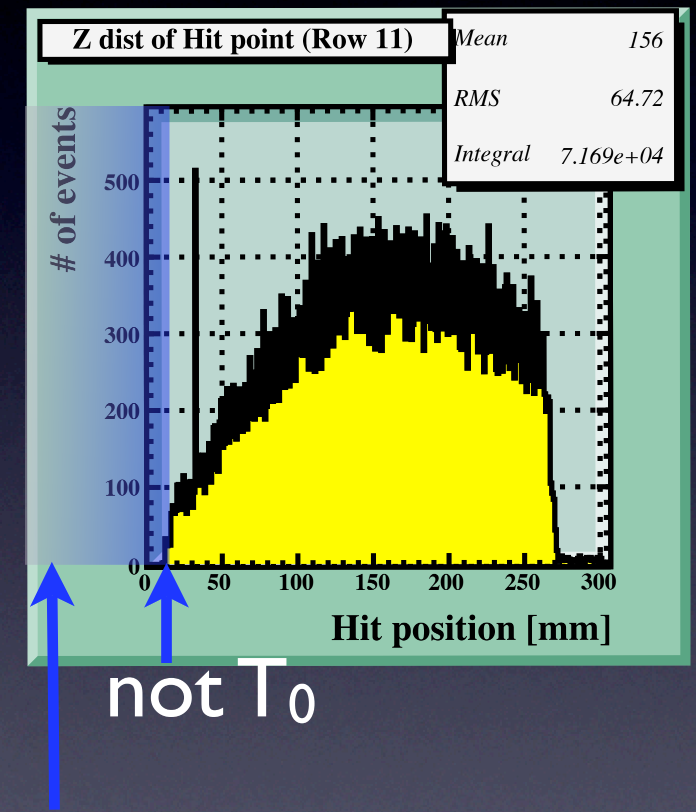

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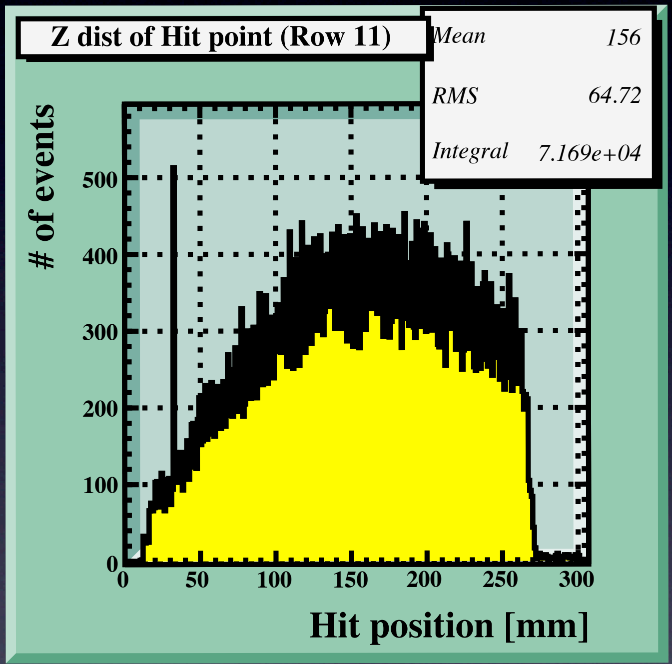
SUMMARY OF OUR ACTION FOR THE PROBLEMS ~analysis procedure~



1. Obtain the value of end point(Z_{end}) by fitting the right edge.
2. Obtain Z-offset by using T_0 from P10 test.
3. Obtain drift-length($L_{measure}$) from 1, 2.
4. Calibrate V_{drift} to make consistency in $L_{measure}$ and L_{true}. (L_{true} =254mm)

As a result, V_{drift} includes error originated from Z_{end} and V_{drift}(P10).

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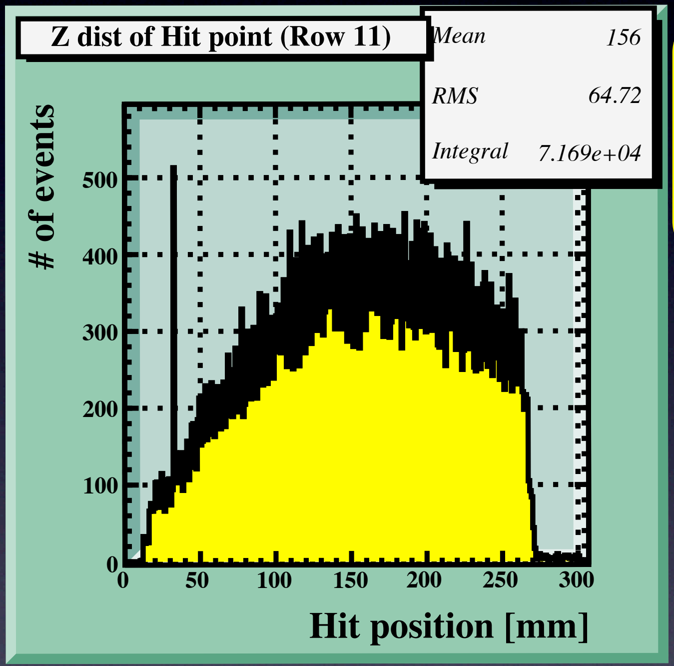

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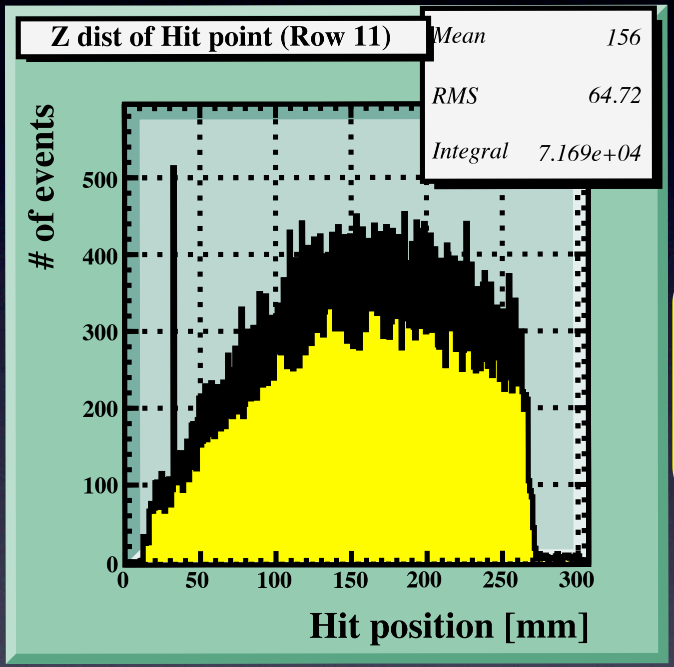

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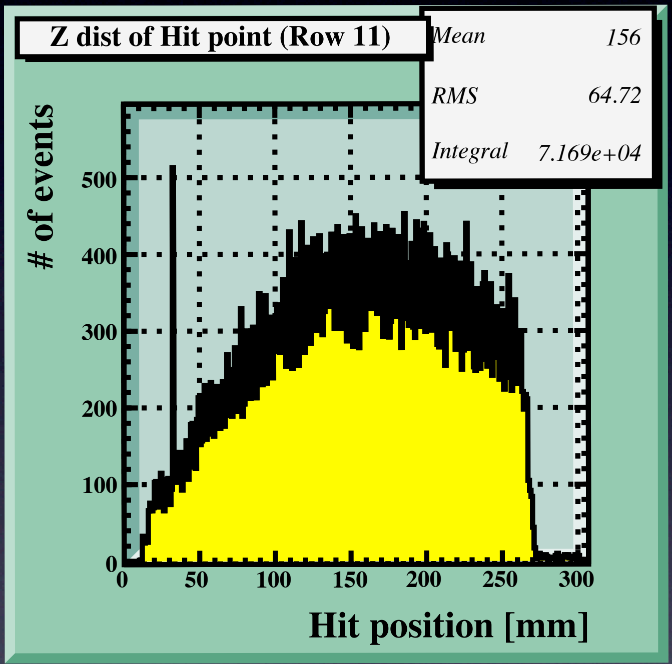

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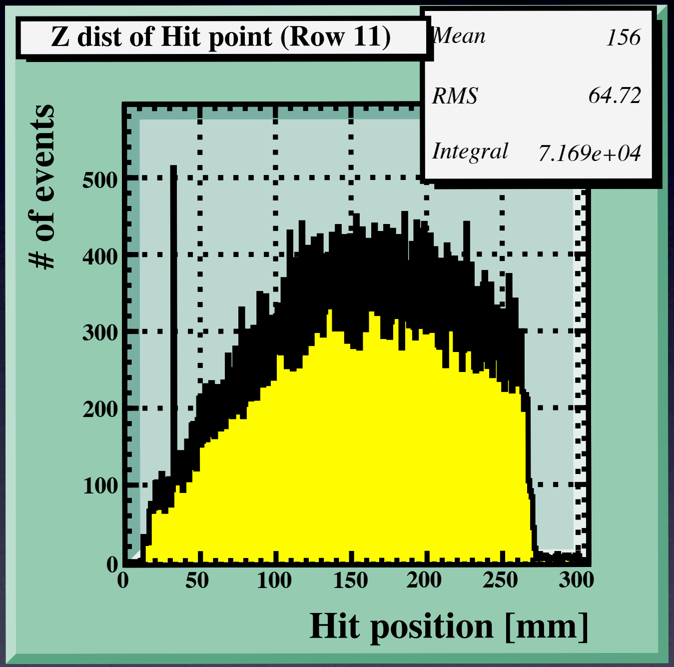

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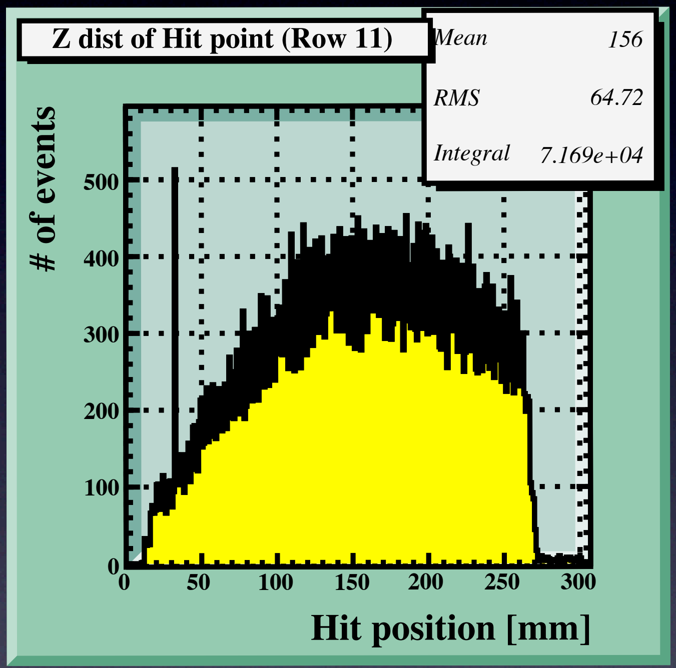

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3.RESULTS

Ar-CF4-iso C4H10(94:3:3) TEST

We tested the following condition.

E=80, 100, 120, 135,150[V/cm] B=1[T]

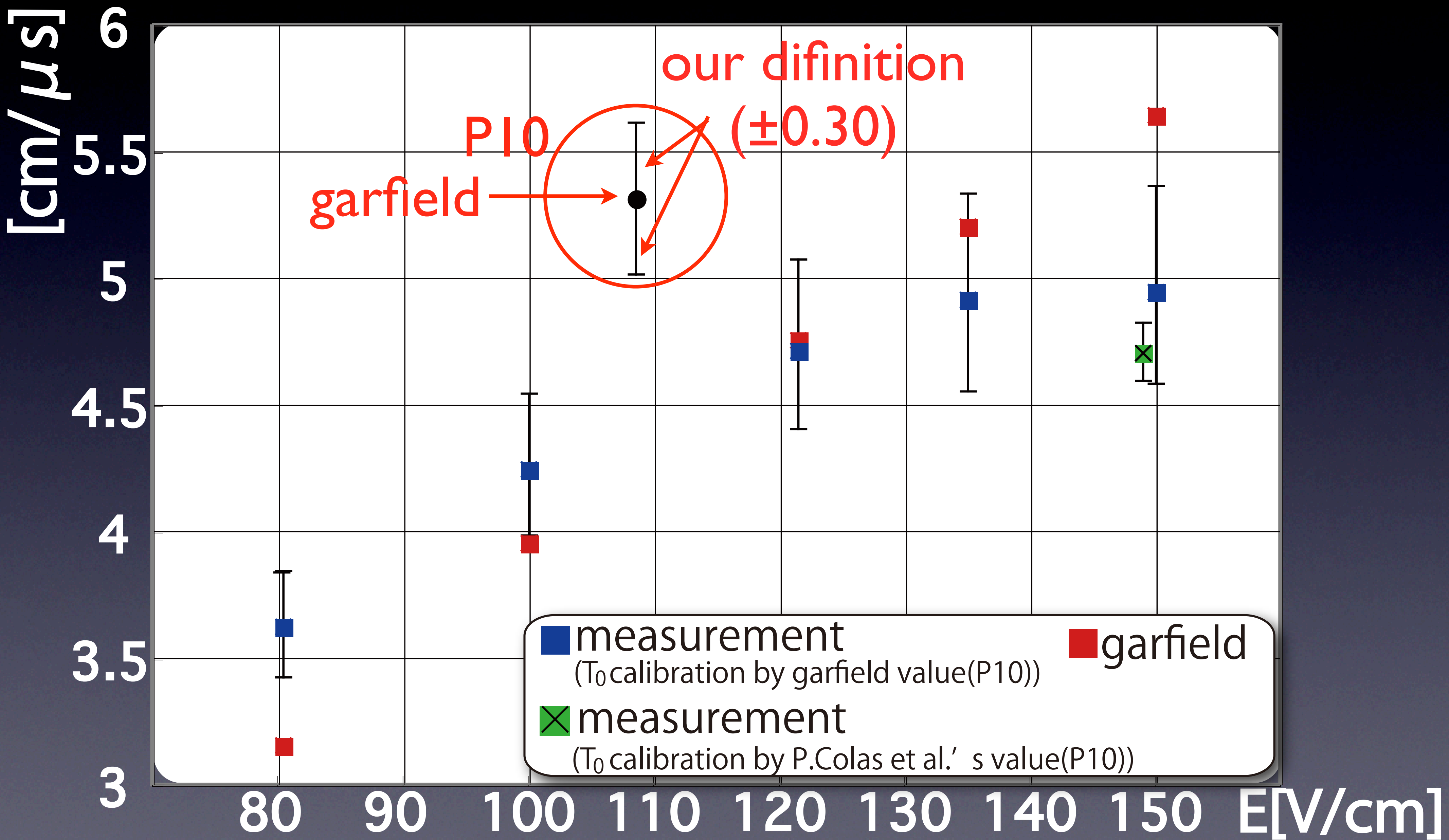
RESULTS

E[V/cm]	N_{eff}	# of tracks
80	23±6	~21,000
100	21±8	~18,000
120	25±9	~17,000
135	24±9	~16,000
150	21±2	~64,000

→ No Problem with Electron Attachment

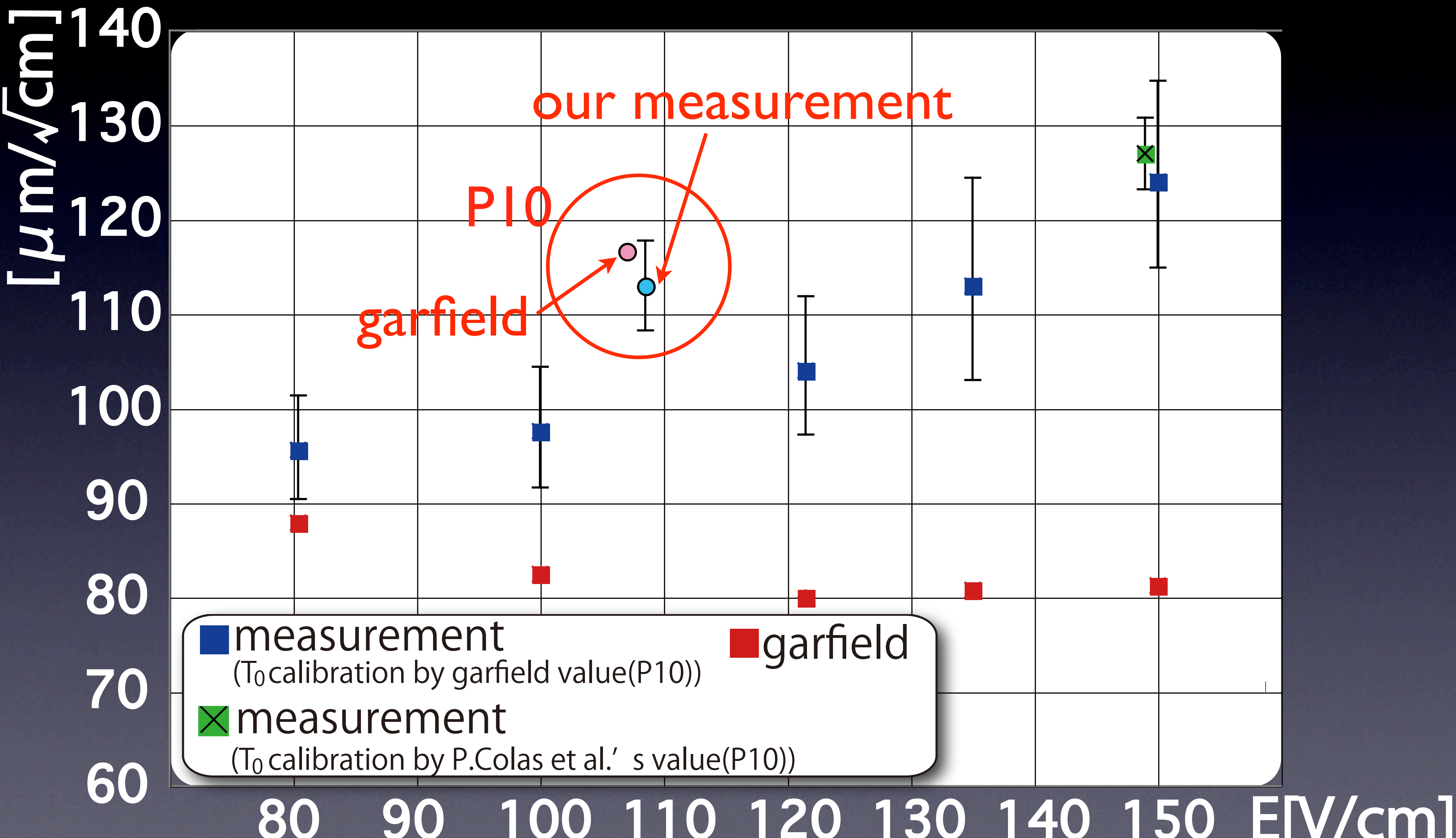
COMPARISON TO GARFIELD

~DriftVelocity~ Ar-CF_4-isoC_4H_{10}(94:3:3)



COMPARISON TO GARFIELD
~DiffusionConstant~

$Ar\text{-}CF_4\text{-}isoC_4H_{10}$(94:3:3)



4.SUMMARY

SUMMARY

We tested Ar-CF4-isoC4H10(94:3:3) as GEM-TPC gas,

(cosmic-ray test, E=80,100,120,135,150[V/cm], B=1[T])

and

compared with GARFIELD.

CONCLUSIONS

We can confirm Ar-CF_4-isoC_4H_{10} (94:3:3) work as GEM-TPC gas @E=80~150[V/cm]

(N_{eff} seems to be O.K.)

Discrepancy can be seen between our results and garfield.

(especially at high electric field)

5.PLANS

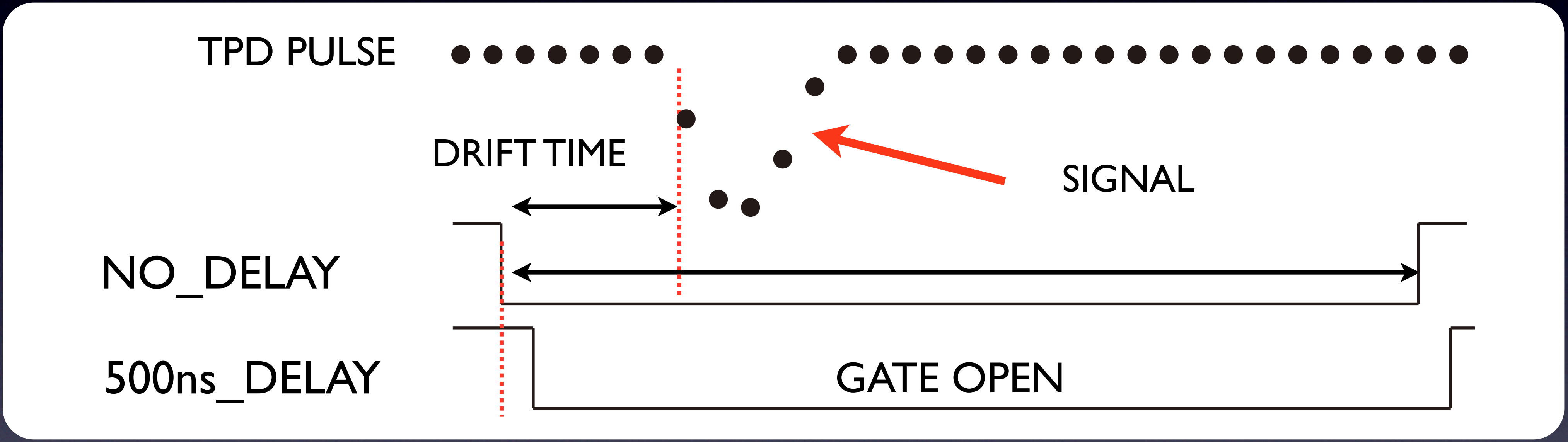
PLANS

Bito-san(TUAT) is going to measure V_{drift} in our condition independently.
So, we'd like to compare the results to ours.

- Test with other E,B field , same gas
  E=50,180,...[V/cm]
  B=0[T]

- Test with other gases
  Ar-CF4-isoC4H10(95:3:2)
  Ar-CF4-isoC4H10(96:3:1)
  ⋮

→ Study about advantage of CF4 gas mixtures

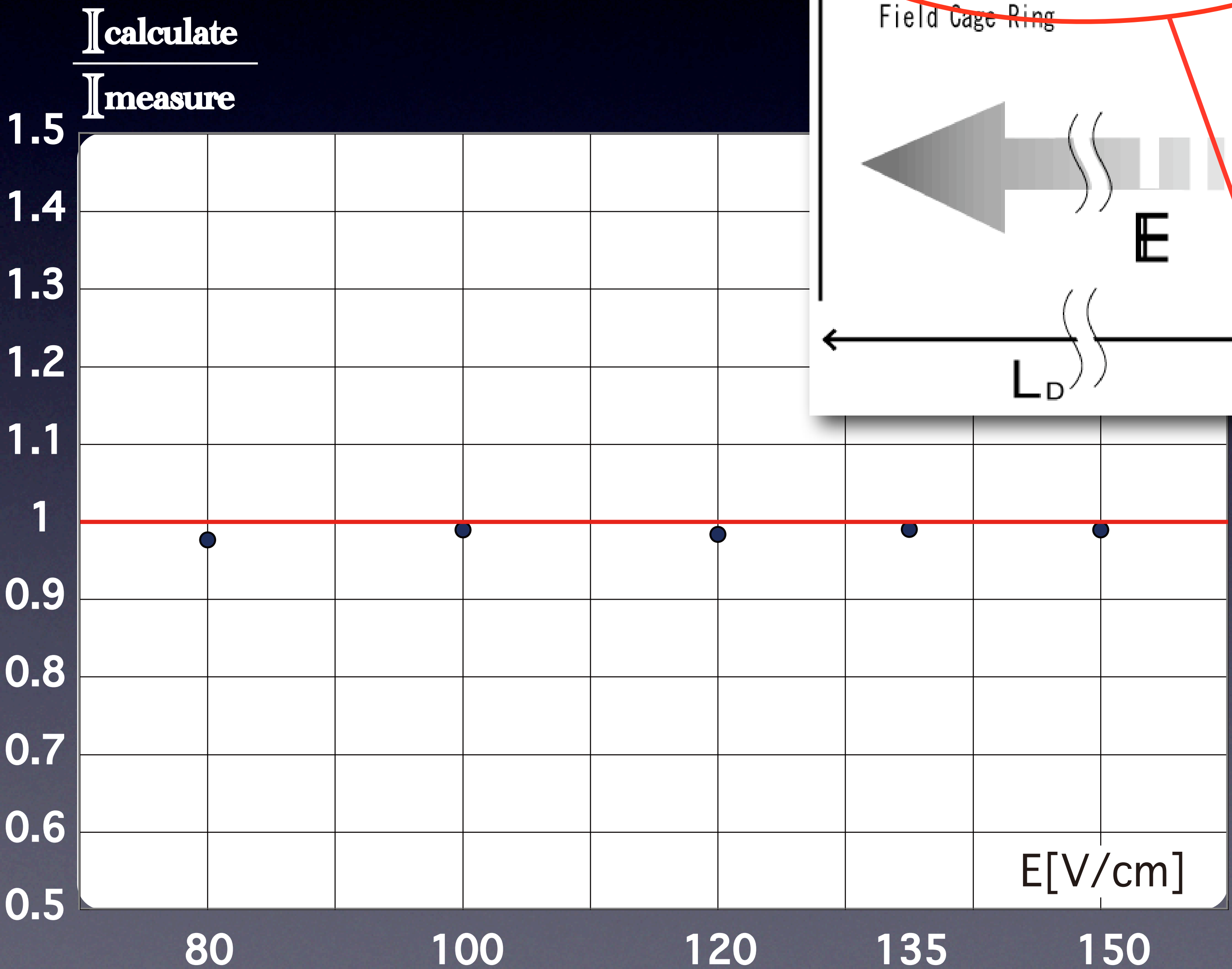

TPD PULSE
DRIFT TIME
SIGNAL
NO_DELAY
500ns_DELAY
GATE OPEN

CHECK H.V. SUPPLIER

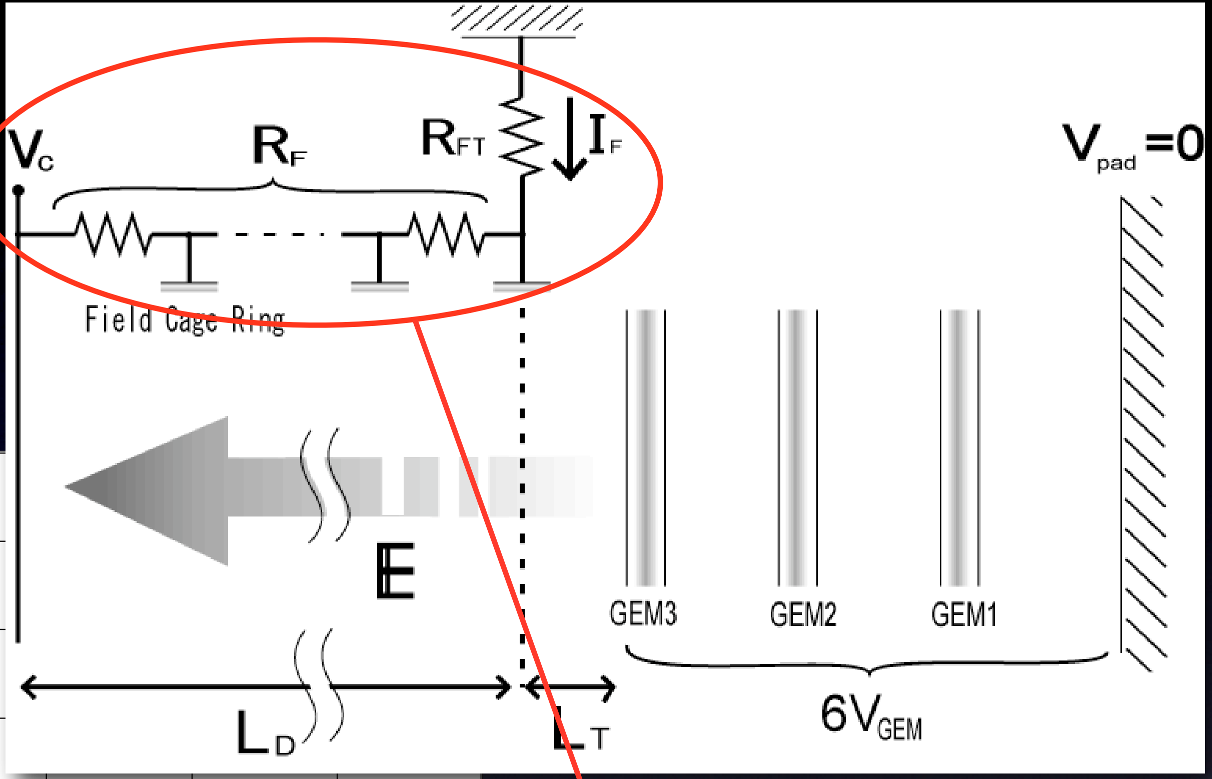
DIFINITION

$I_{measure}$: indicated current value

$I_{caluculate}$: caluculated from voltage



Chamber Sketch



$$I_{calculate} = \frac{V_c}{(R_F + R_{FT})}$$