Update of CGEM Digitization
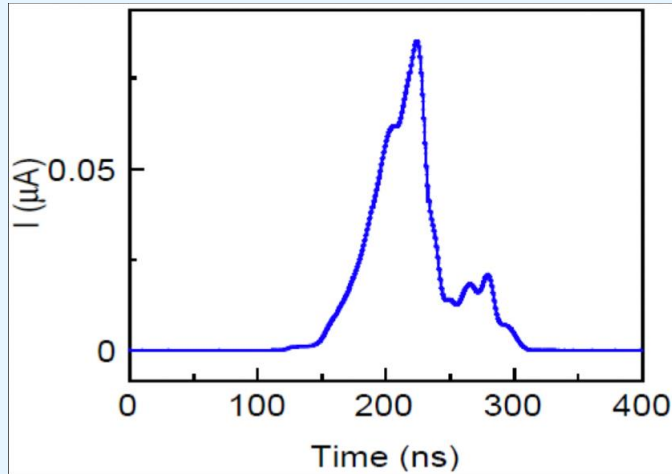
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March 4 , 2021

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Introduction

- Status of full digitization

✓ Signal production (ionization, sampling of drift & multiplication, induction) implemented but not tuned

✓ Model to simulate electronics output implemented but not complete (E-branch trigger from T-branch, sampling and hold, … missing)

- Implement more details in digitization for electronics

➢ To make digitization more complete and realistic

➢ To be able to fix the electronics part to tune the signal producing part (inputs of electronics)

E-branch trigger

A typical input current

Output of T-Branch
(10 ns delay added)

V_{th}

T_{start}

t

V_{max}

$V_{sampled}$

Output of E-Branch
(5 ns delay added)

$T_{sampling}$

T_{start}

t

- Maximum voltage exceeds threshold

- Sampling start given by T-branch discriminator

- Sampling time is integer multiples of 25ns
  (default 175 ns same as in cosmic-ray data taking,
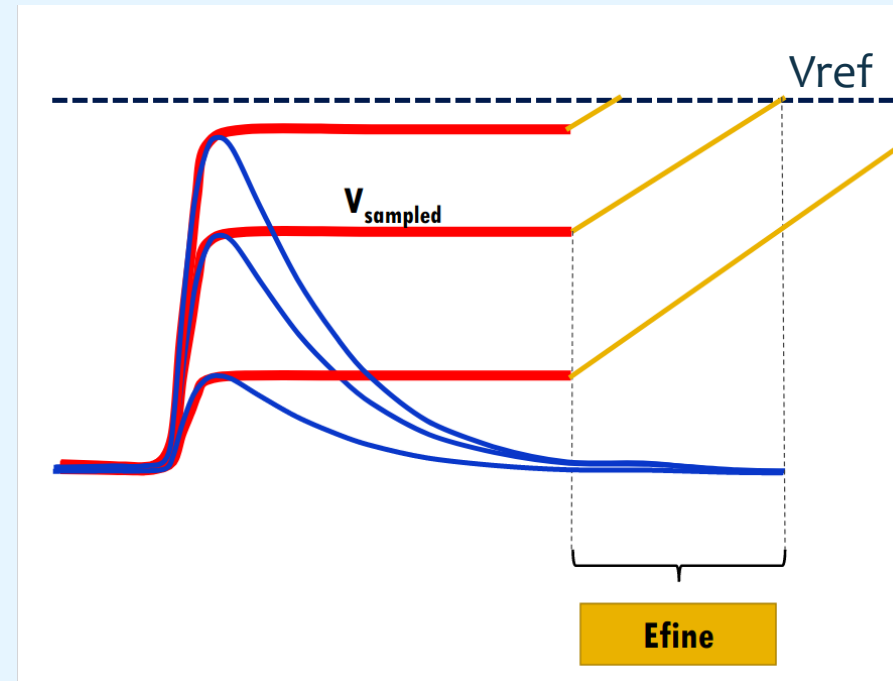 150 ns used in this talk)

- $V_{sampled}$ is close to V_{max}

3
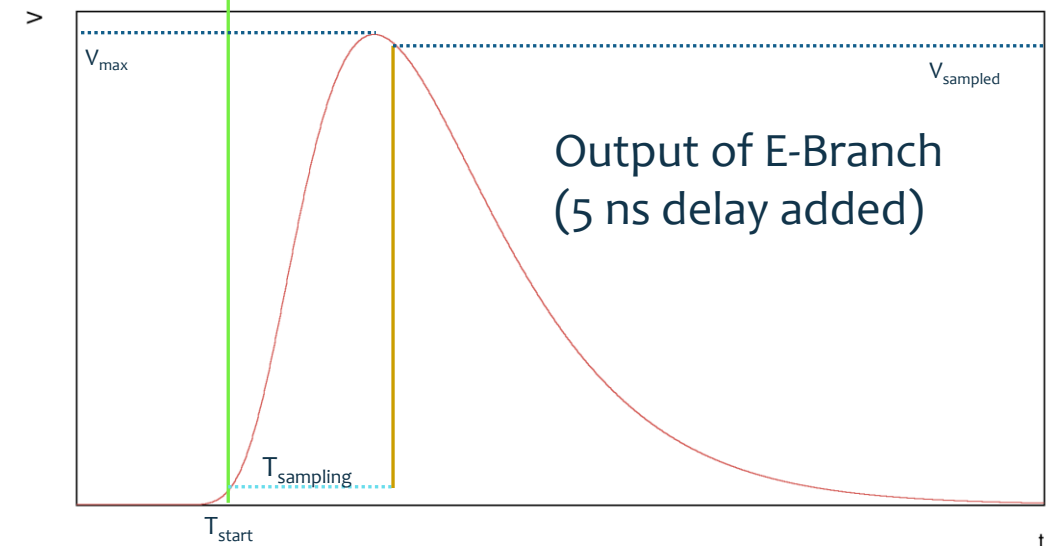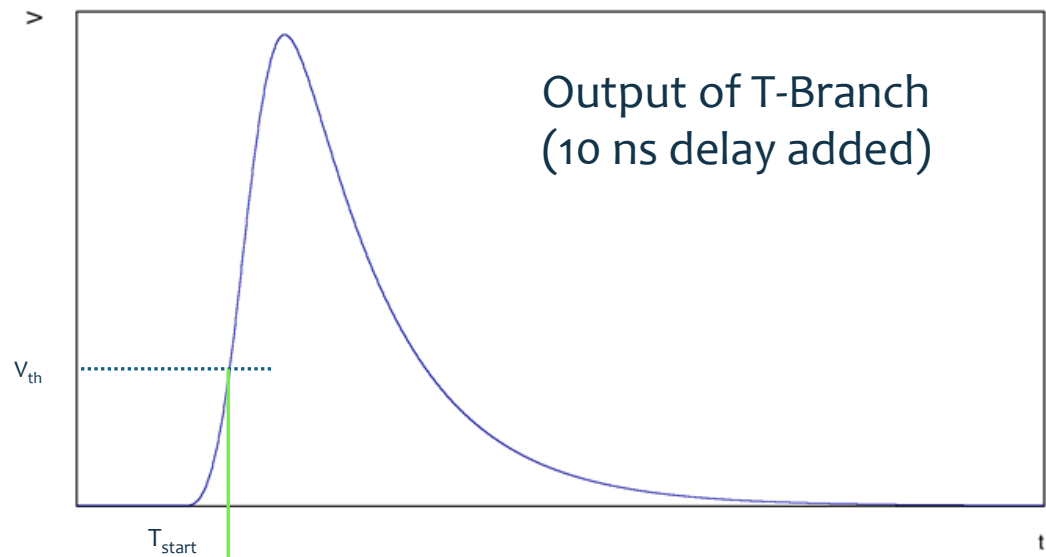
Charge calibration in practice: E_{fine}-Q_{in} curves

Efine->Q

$V_{sampled}$ $\xrightarrow[\text{constant current}]{\text{charge with a}}$ V_{ref}
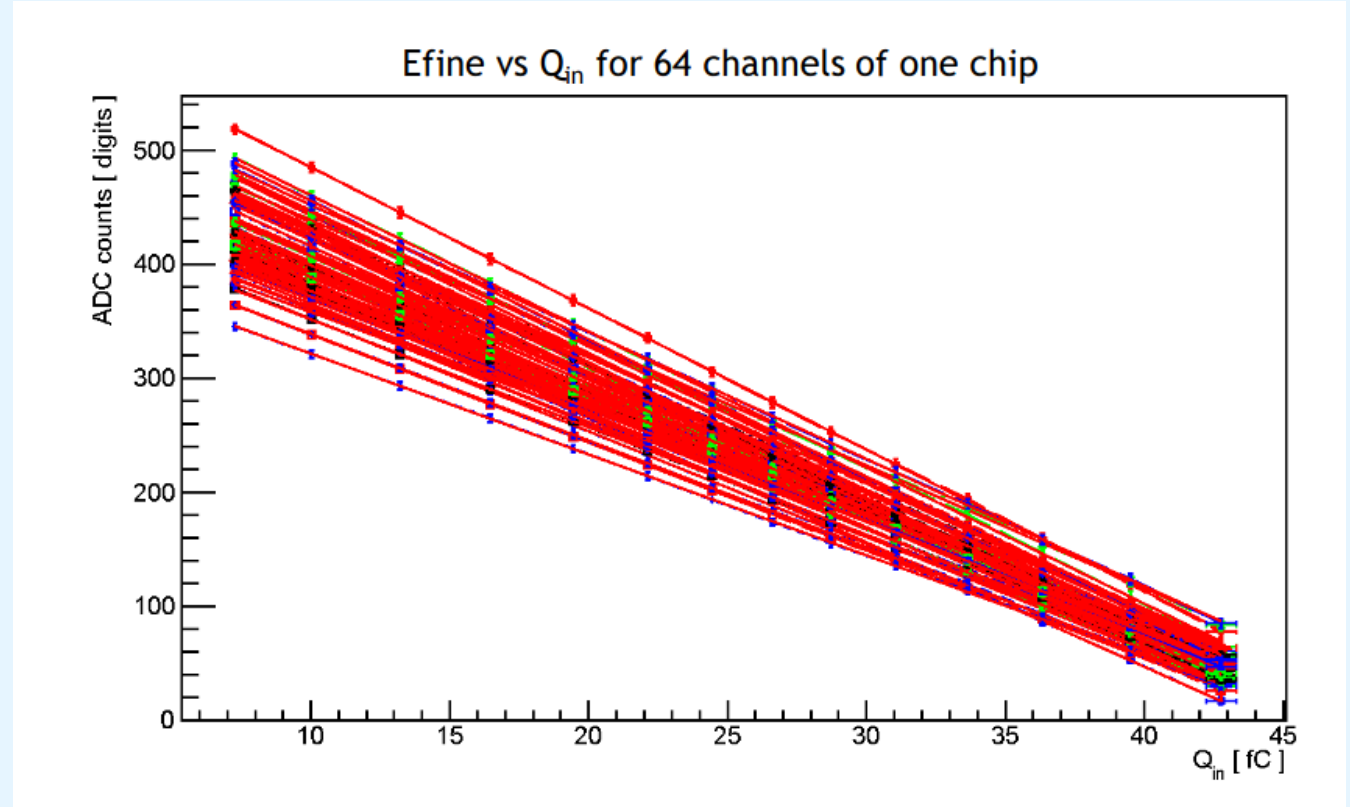
Efine vs $V_{sampled}$ relation is linear

Vref

$V_{sampled}$

Efine

- Efine depends on sampling voltage

- Efine and Qin are linear

Charge calibration in practice: E_{fine}-Q_{in} curves

Input signal: 1 ns , rectangle
threshold=3~4 fC in T-branch, $T_{sampling}$=150 ns

Because of inconsistency of electronics ,
Efine vs Qin conversion should be
calibrated channel-by-channel

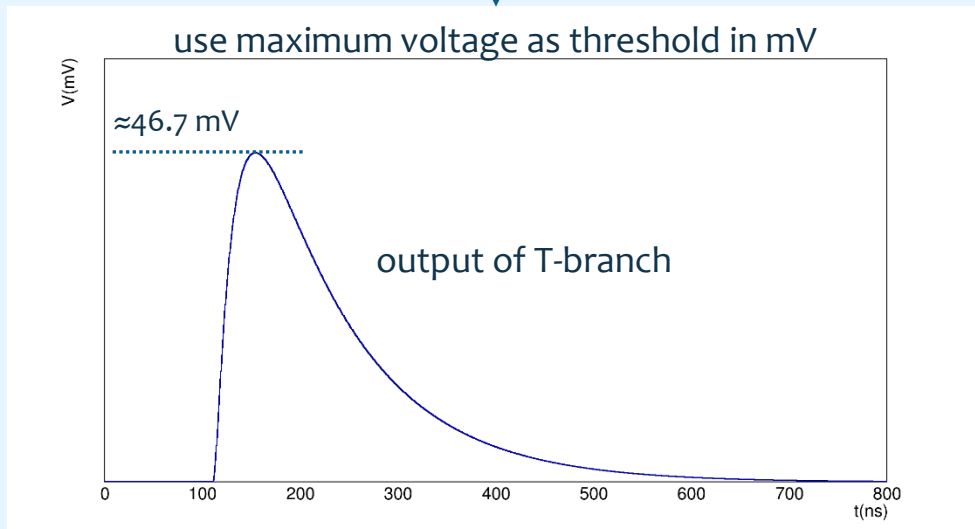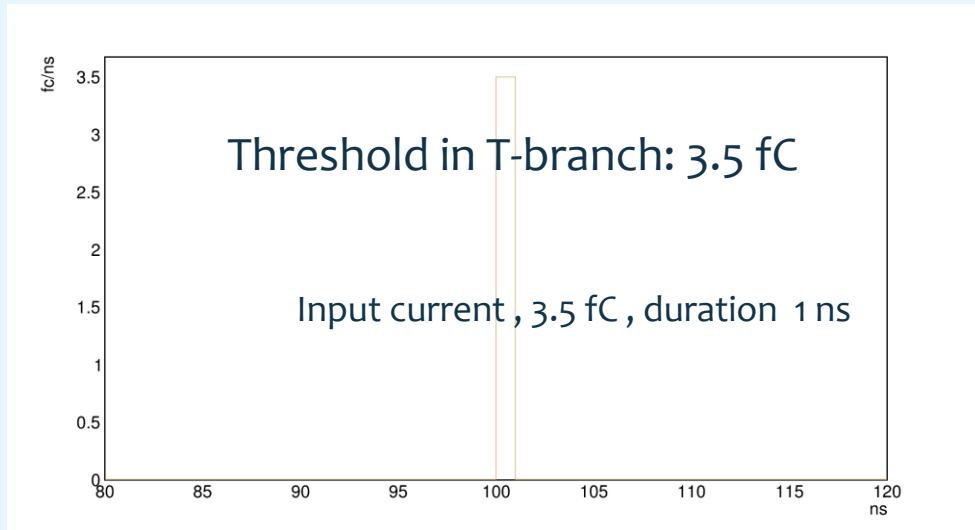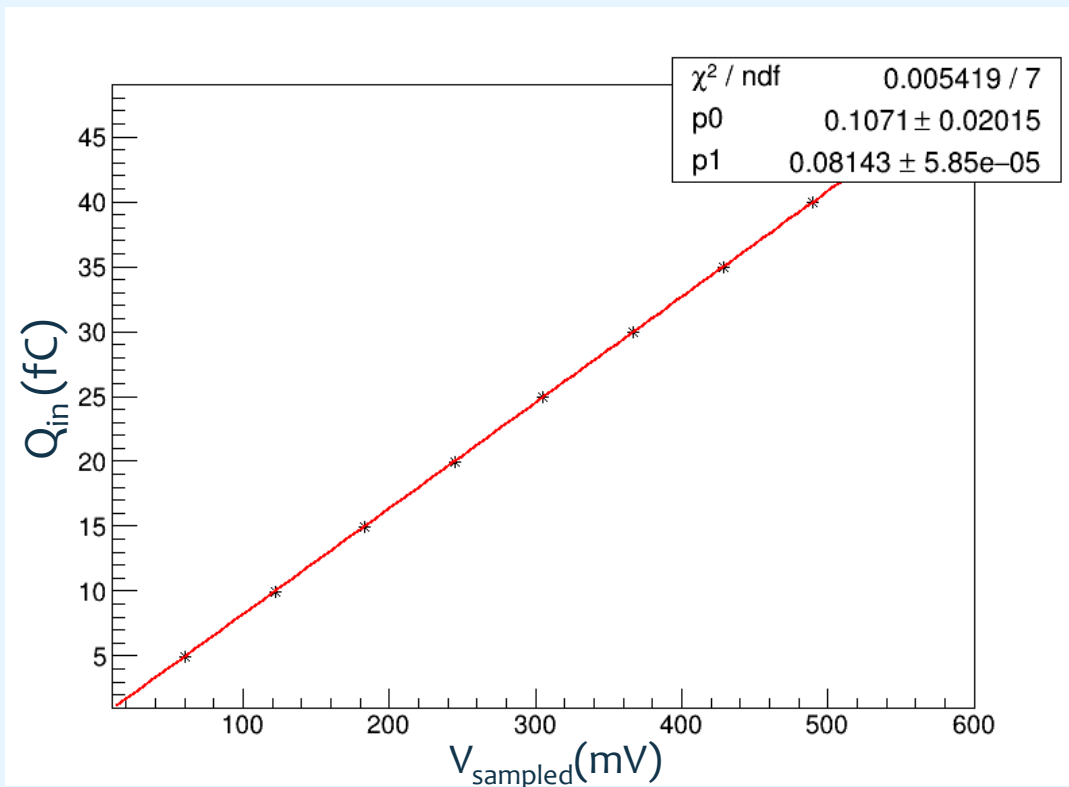# Charge calibration in simulation: $V_{sampled}-Q_{in}$ curve

- Good linearity of $V_{sampled}$ vs E_{fine}

=> $V_{sampled}-E_{fine}$ conversion is not simulated

- ✓ Use $V_{sampled}-Q_{in}$ relationship in simulation

different input charge (current shape: 1 ns , rectangle)
$T_{sampling}$=150 ns


Threshold in T-branch: 3.5 fC

Input current , 3.5 fC , duration 1 ns

χ^2 / ndf	0.005419 / 7
p0	0.1071 ± 0.02015
p1	$0.08143 \pm 5.85e{-}05$

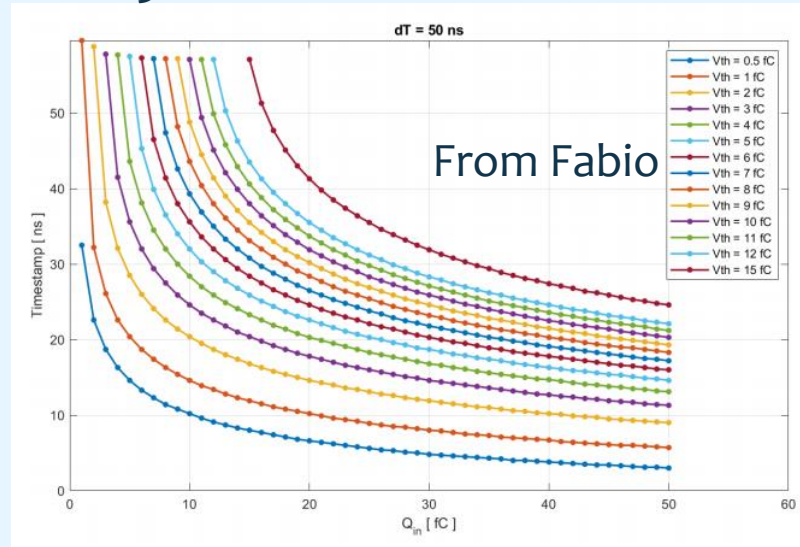use maximum voltage as threshold in mV

≈46.7 mV

output of T-branch

Update of CgemDigitizerSvc

- Improve digitization of E-Branch (input current -> voltage)

- Use thresholds from LUT file (CGEM_cosmic_look_up_table_from_10_to_17.root)

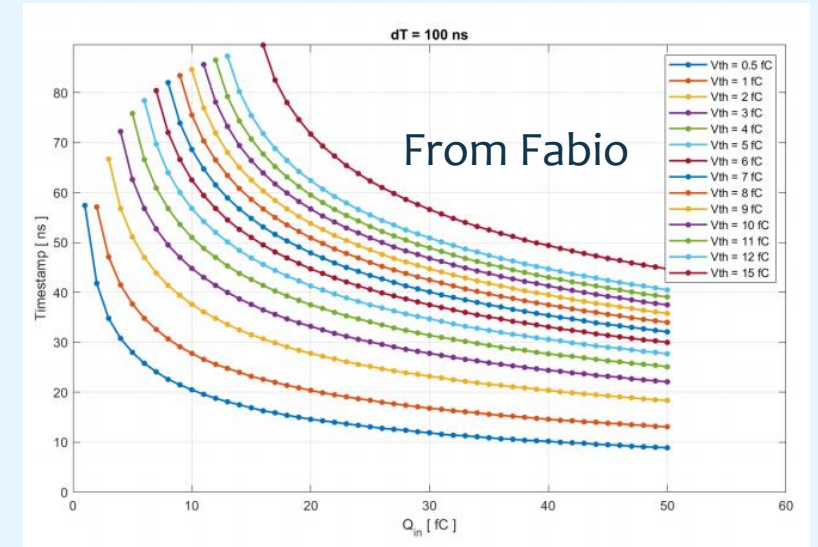- Get sampling voltage then charge obtained by the $V_{sampled}$-Q_{in} curve

Check of Digitization: time walk
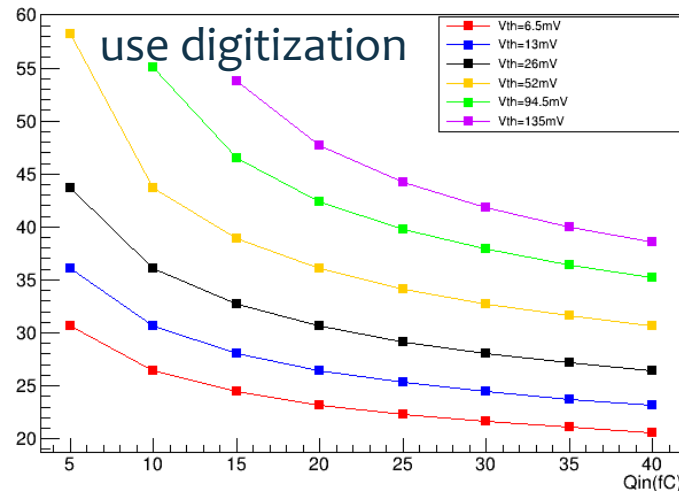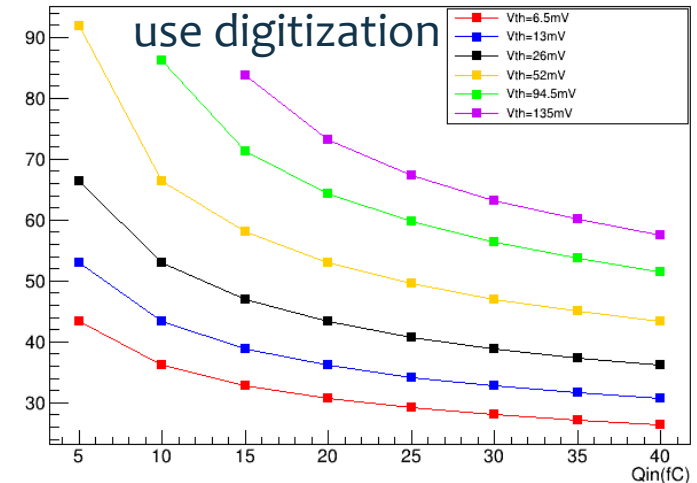
input:

50ns

From Fabio

100ns

From Fabio
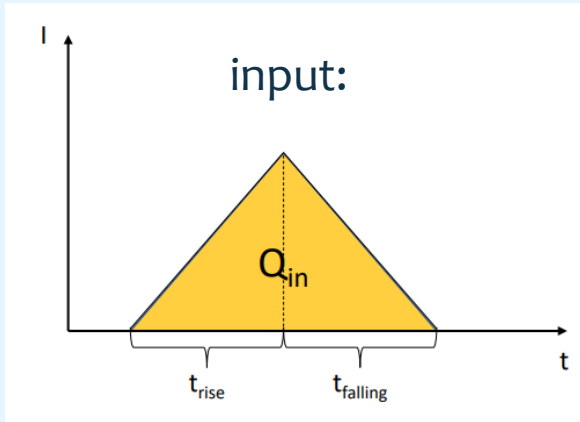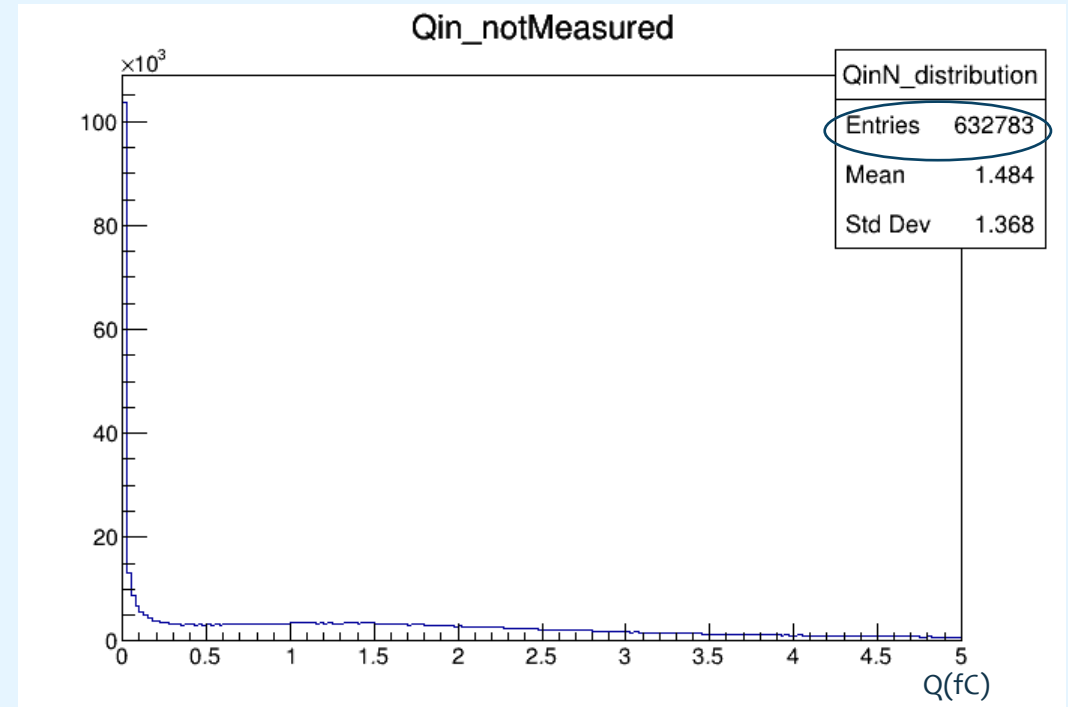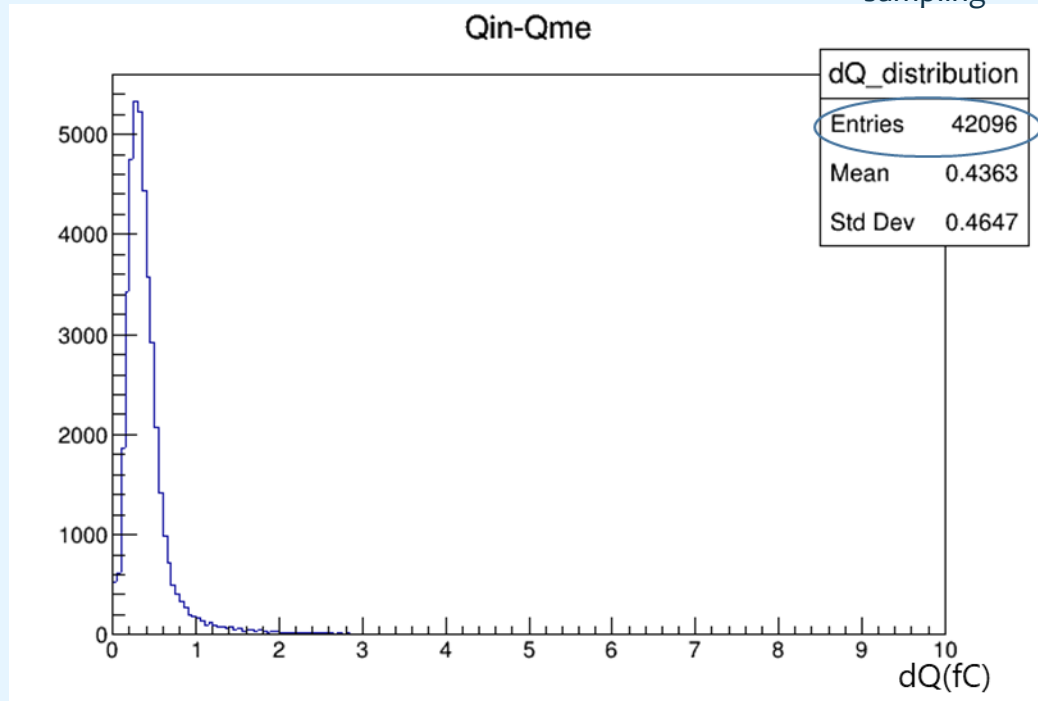
use digitization

use digitization

- Same input to get time walk in digitization
- Time walk behavior is similar
- But it seems there is a time shift between the two sets of results

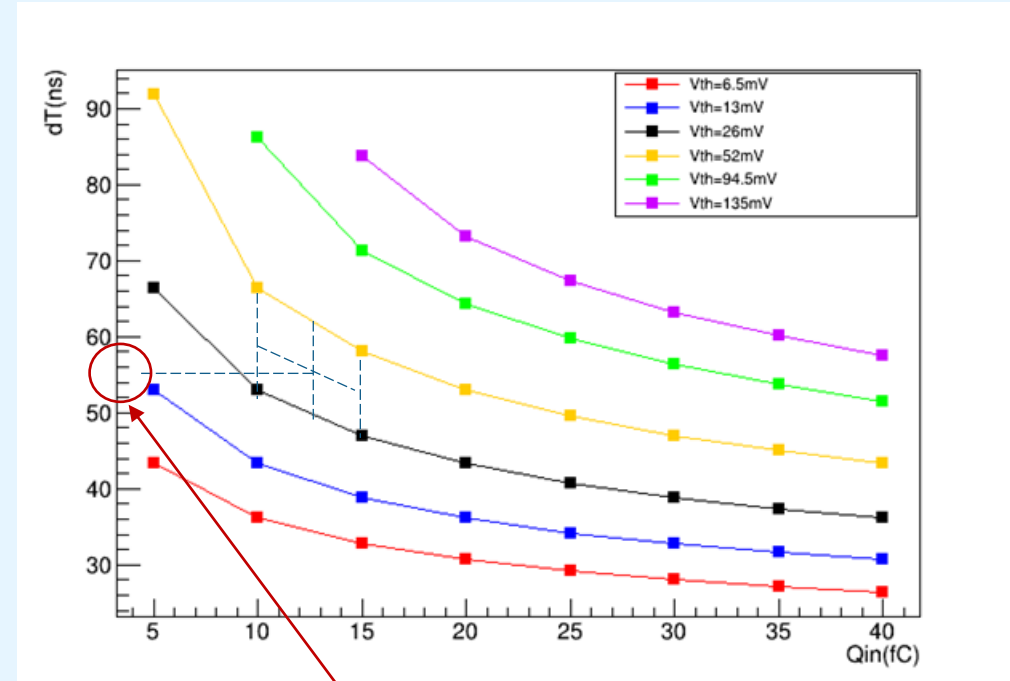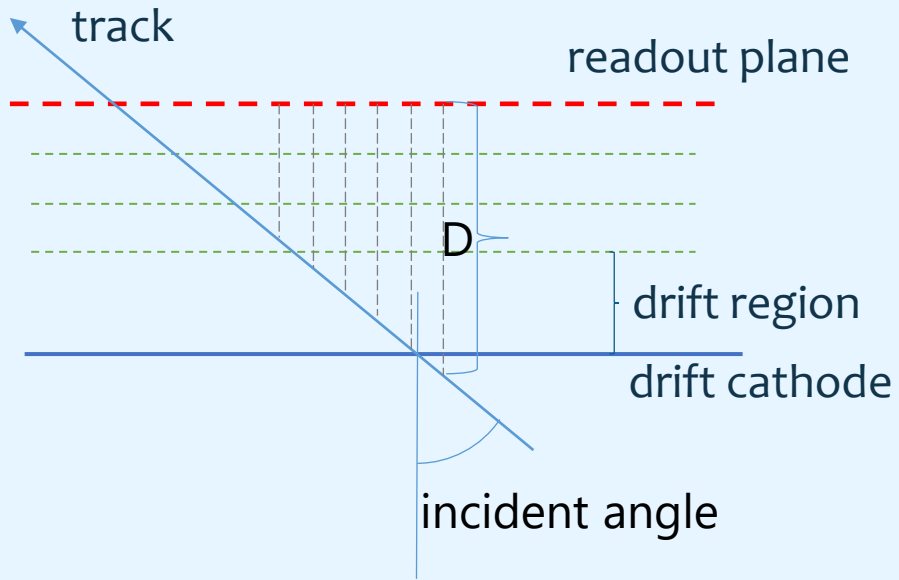threshold:13 mV ⇔1 fC

Check of Digitization: charge measurement

Innermost layer : thresholds from LUT ,$T_{sampling}$ = 150 ns

Q_{in} : input charge (simulation)
$Q_{measured}$: measured charge via $V_{samlped}$ & $V_{sampled}$-Q_{in} conversion

Check of Digitization: drift distance vs time
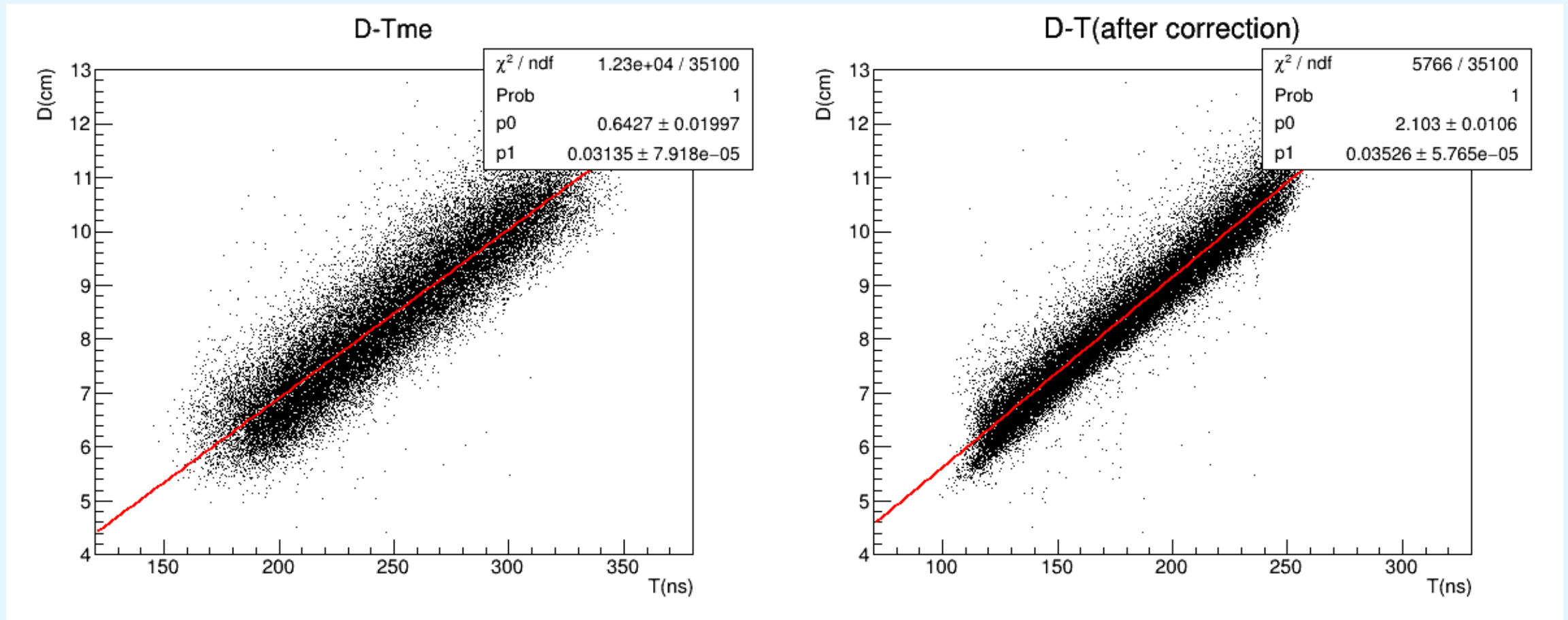
track

readout plane

D

drift region

drift cathode

incident angle

Time correction : linear interpolation of threshold and Q

Check of Digitization: drift distance vs time
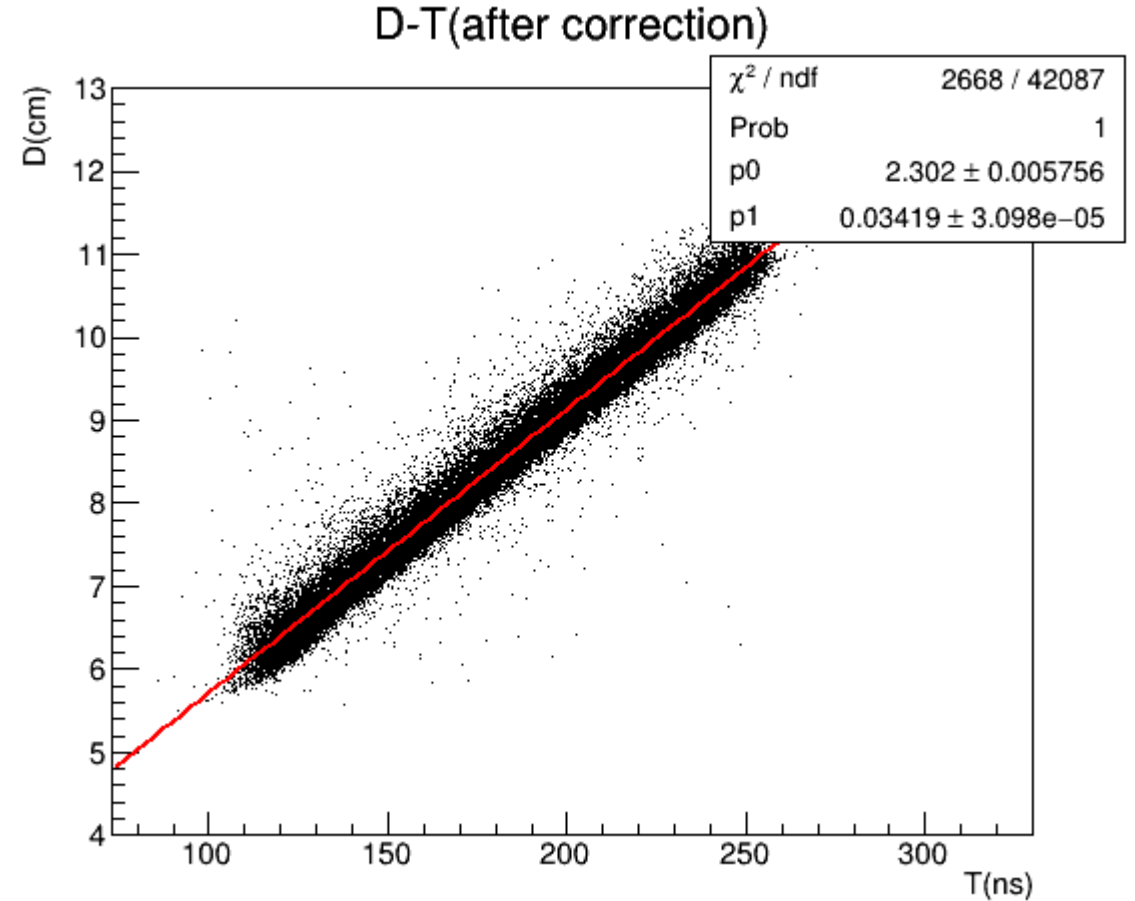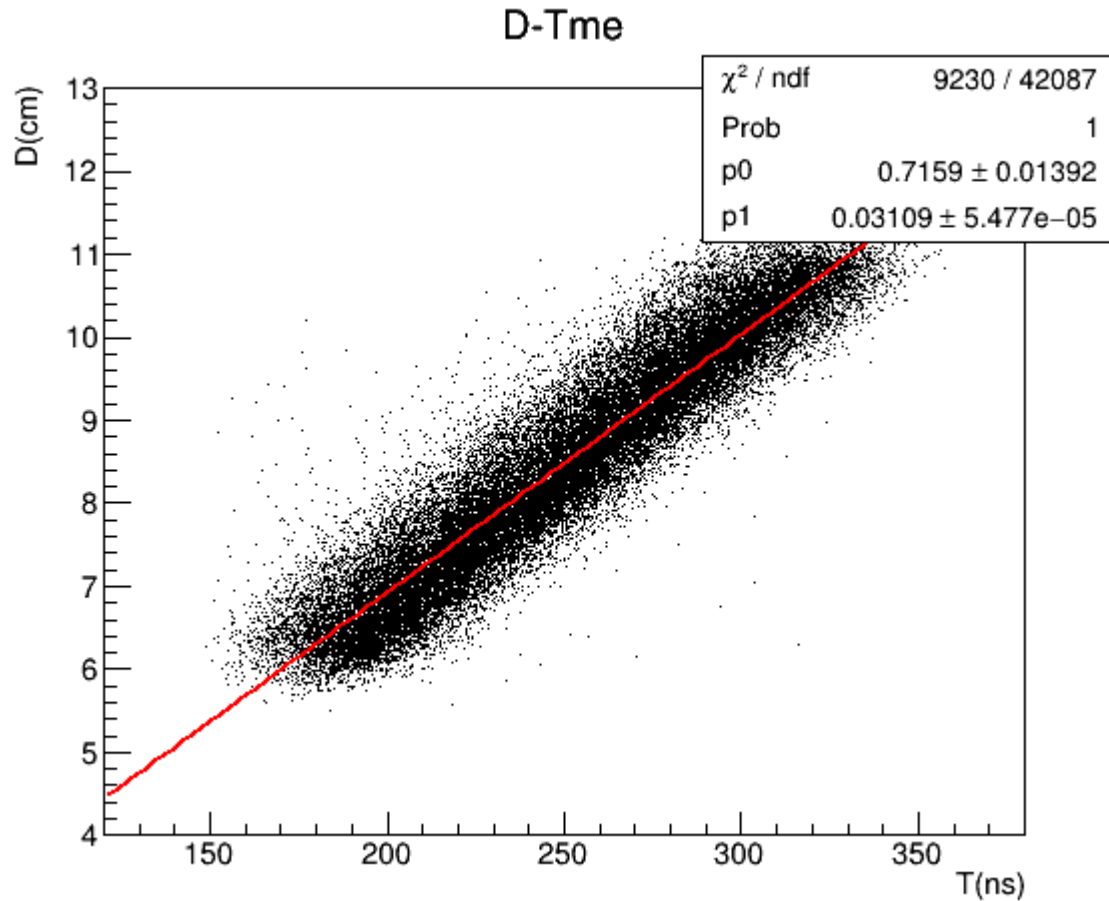
Innermost layer : thresholds from LUT , $T_{sampling}$ = 150 ns , e- ,P_t = 1 GeV

Incident angle = 0.6 rad

Check of Digitization: drift distance vs time

Innermost layer : thresholds from LUT , $T_{sampling}$ = 150ns , e- ,P_t = 1 GeV

Incident angle = 1.0 rad

Summary

- Improved digitization package.

  - ✓ E-Branch , convert input current to voltage
  - ✓ charge measurement use Vsampled – Qin relation

- check of charge measurement and D-T relation

- Results reasonable

- The new version of digitization is to be uploaded soon.