HGCROCv2 for ALICE FoCal

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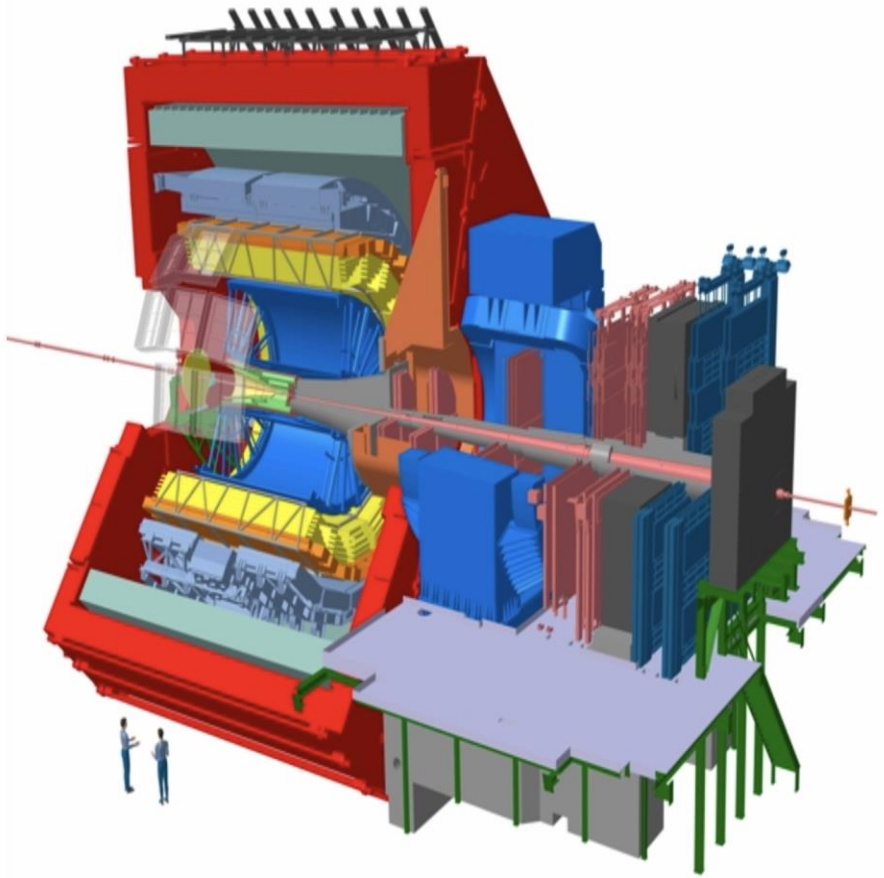
ALICE(A Large Ion Collider Experiment)

- The heavy-ion collision experiment using the Large Hadron Collider (LHC) at the European Organization for Nuclear Research (CERN).

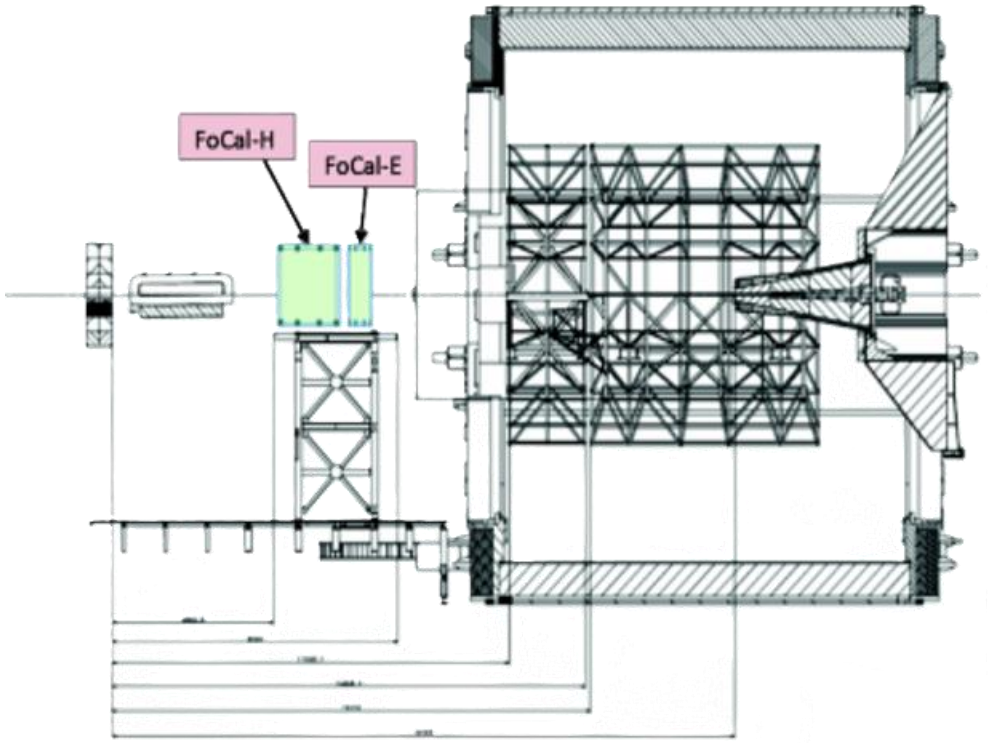
- Purpose

  To recreate and understand the properties of quark-gluon plasma (QGP), a state of matter believed to have existed in the early universe.



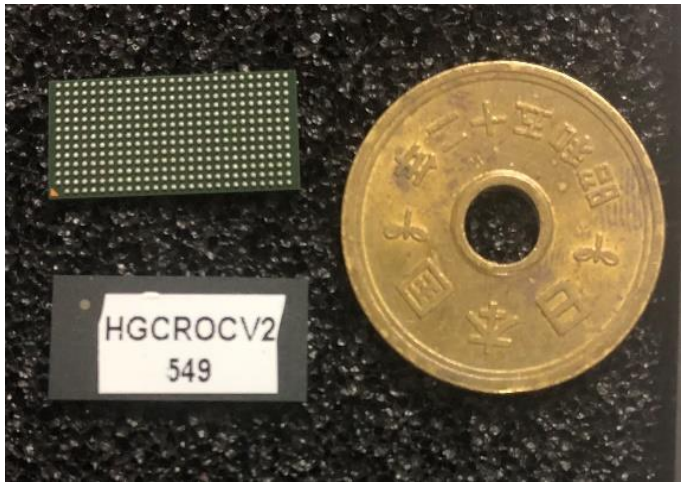
ALICE FoCal

- Upgrade plans for the ALICE experiment.
- Focal = Forward Calorimeter
- It will be installed in the forward region of the heavy-ion collision point to measure areas that have not been accessible before.



HGCROCv2

High Granularity Calorimeter Read Out Chip version2



- The integrated circuit chip used

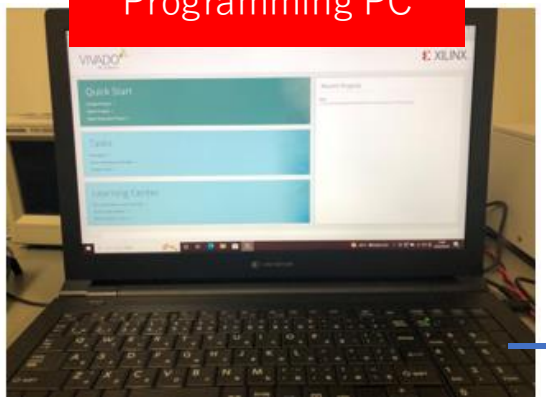
for data acquisition in the ALICE experiment.

- High radiation tolerance

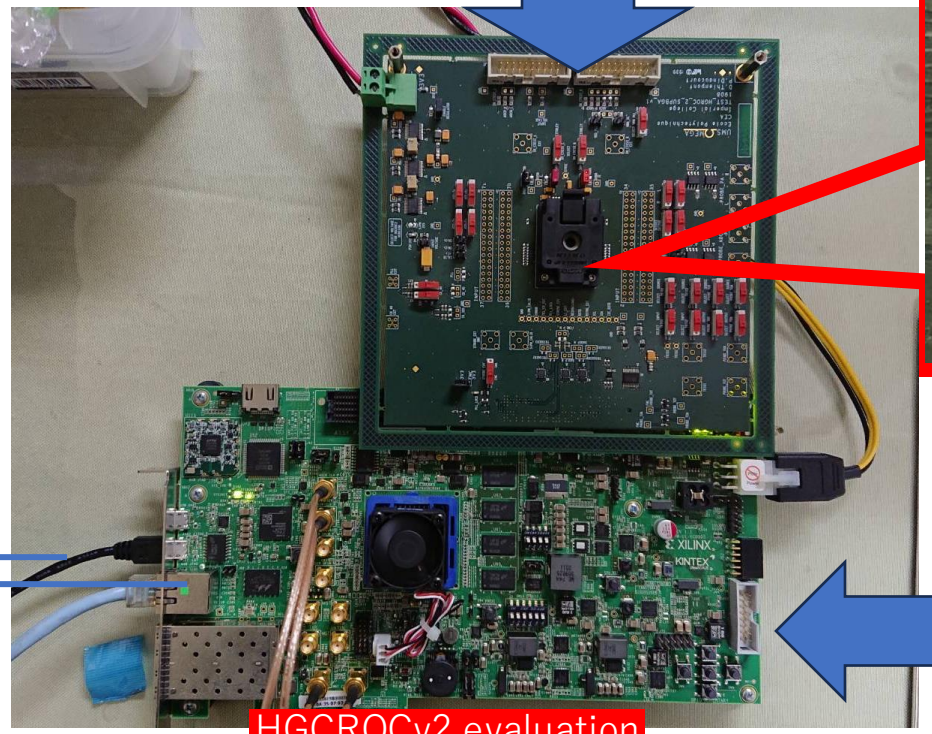
- HGCROCv1 : Prototype
- HGCROCv2 : Channel count increased to 72ch
  - 36 standard ADC channels
  - + 36 experimental ADC channels
- HGCROCv3 : Final version

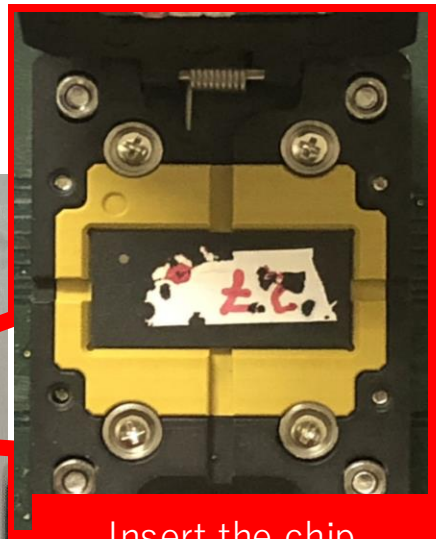
Measurement device

Programming PC

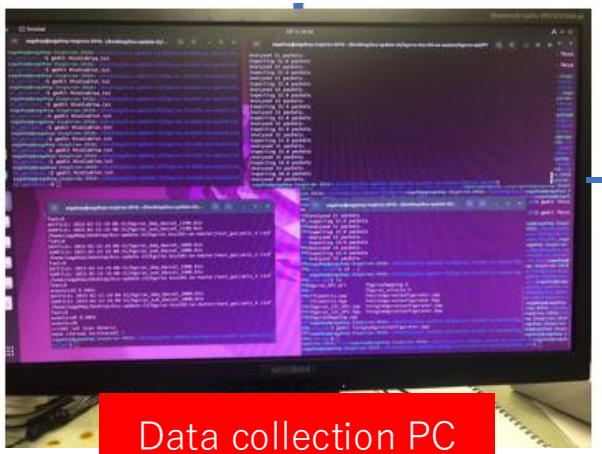


HGCROC
test board





Insert the chip



Data collection PC

HGCROCv2 evaluation
devices

XILINX FPGA KCU105

HGCROCv2

- ADC The signal pulse height obtained in the low-energy range.

- ToA(Time to Arrival)

  The time information at which the set threshold was reached.

- ToT(Time over Threshold)

  Indicates the difference between the time when the preset threshold was reached and the Time of Arrival (ToA).

Performance Evaluation of HGCROCv2

- The performance is evaluated by assessing whether linearity is maintained with respect to the magnitude of the acquired energy in the processing of ADC and ToT.

- Eventually, we will evaluate the properties of several hundred HGCROCv2 chips and make adjustments to various parameters with the aim of completing the HGCROC.

ADC and ToT Measurement Range

ADC →Measures charge range from 0 to 160 fC.
ToT →Measures charge range from 160fC to 10pC

The ADC enters a saturated state at a certain input charge level, and instead, the ToT is used for measurement.

Is the linearity maintained between the ADC and ToT?

Is measurement proportional to the amount of input charge possible?

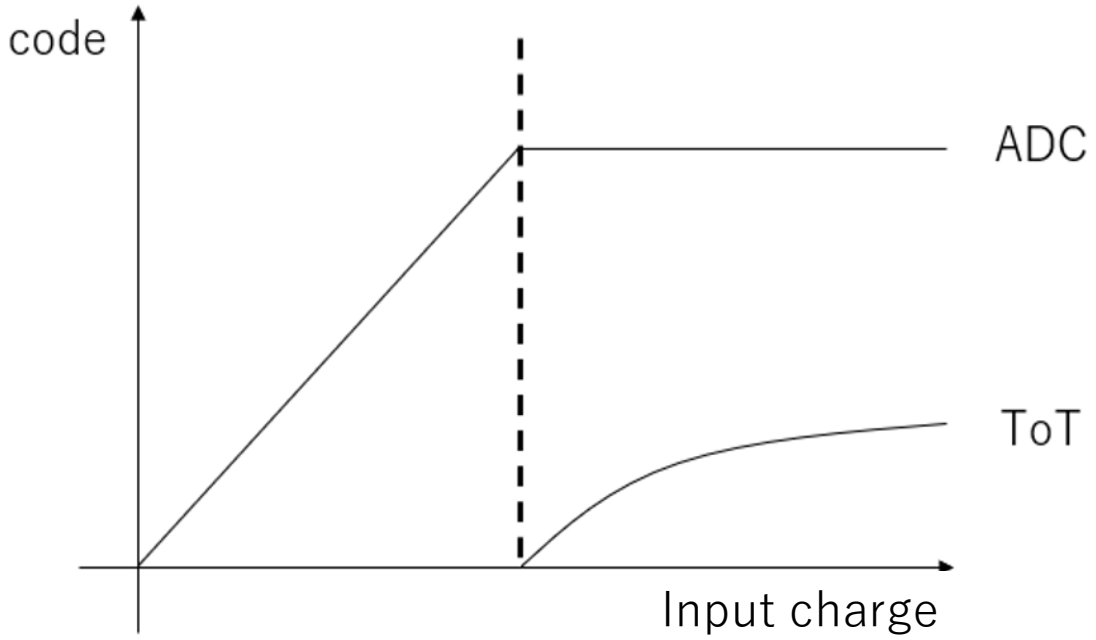


Image Diagram

Actual measurement

- 12 chips measurements
- 10 chips do not move

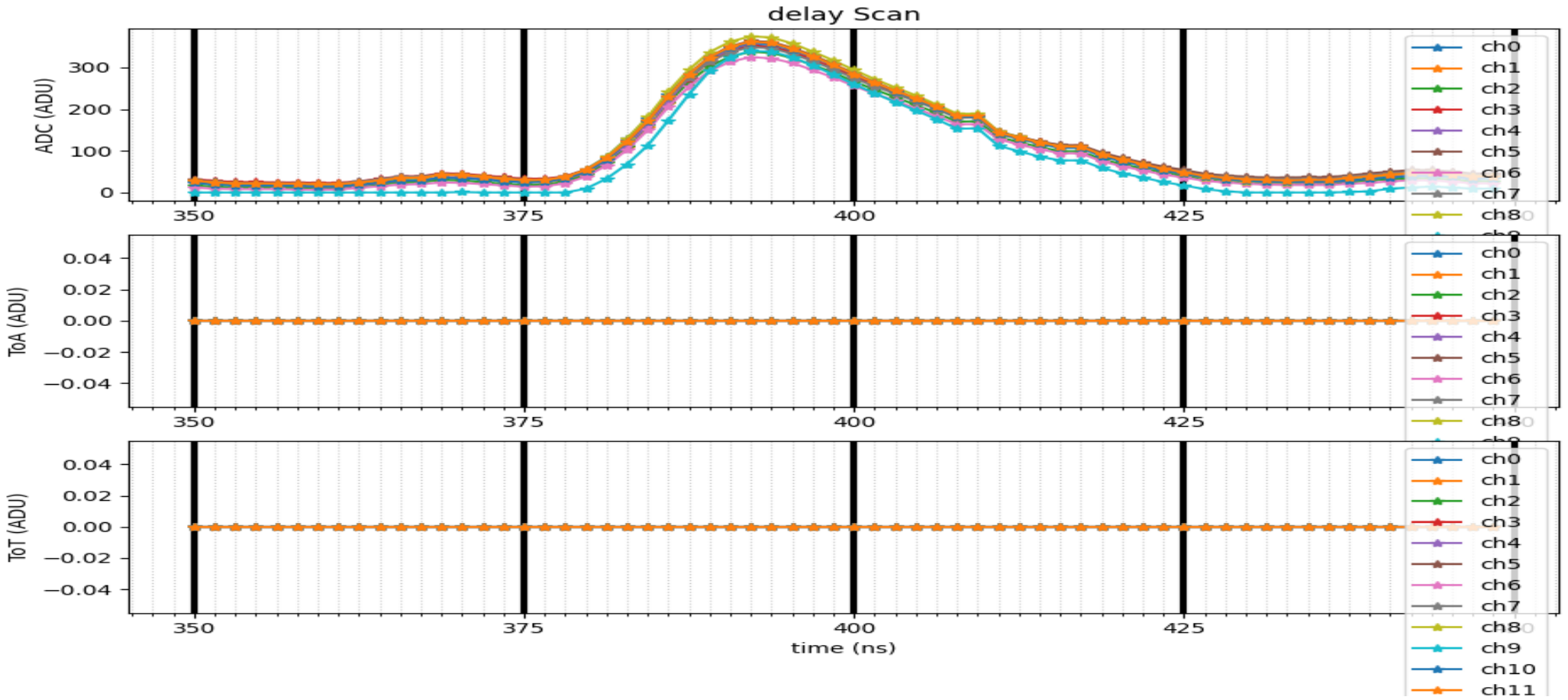
  No delay, error, etc

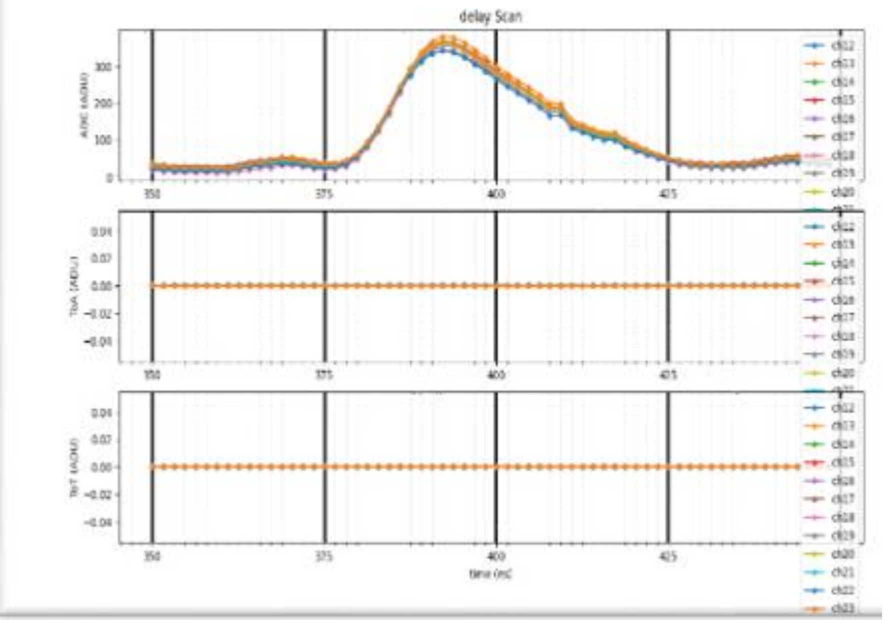
Cause: Is the chip faulty?

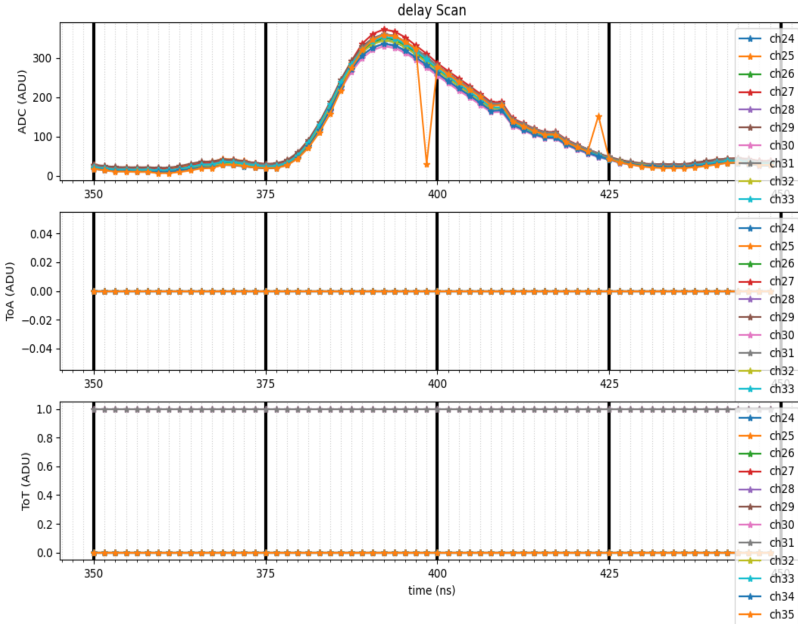
Will it work with a different firmware?

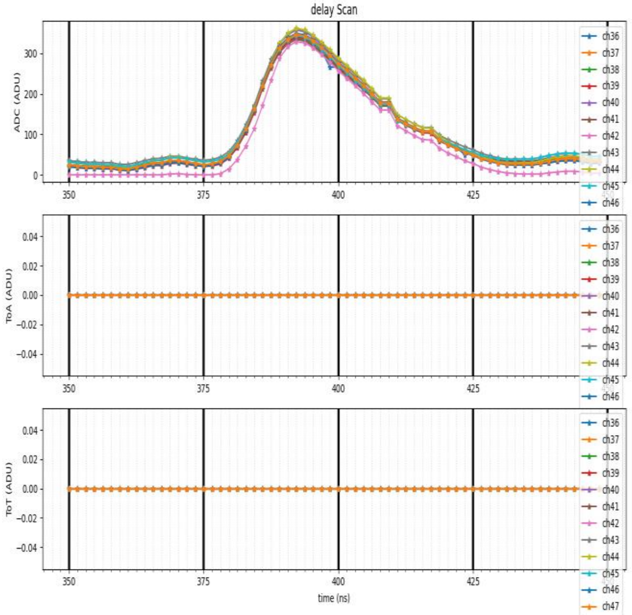
I don't fully understand it right now

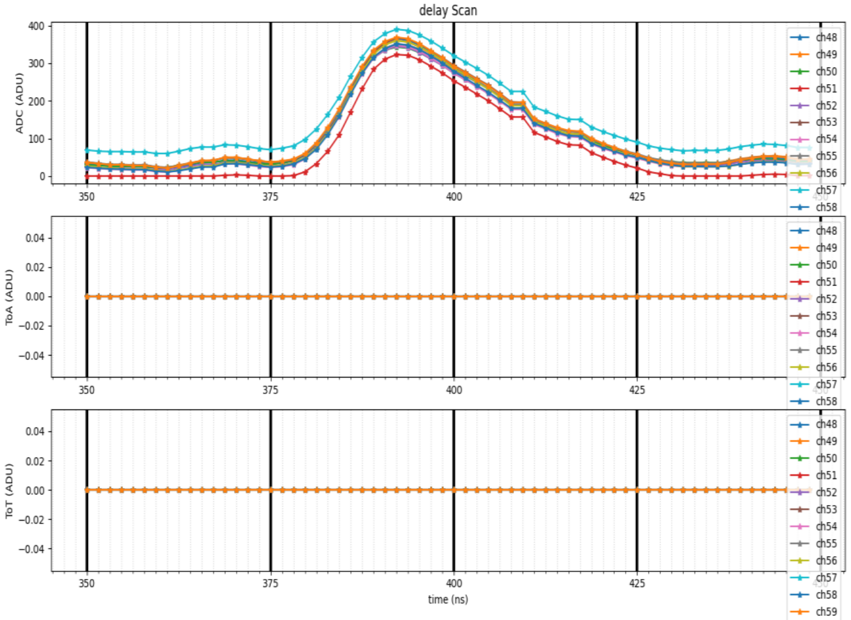
Example of measurement data(DelayScan)

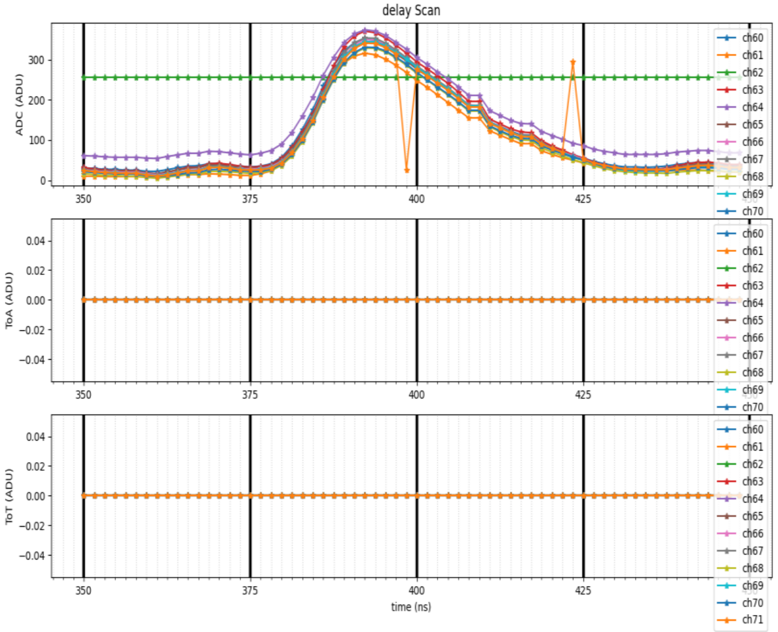



delay Scan
ADC (ADU)
ToA (ADU)
ToT (ADU)
time (ns)

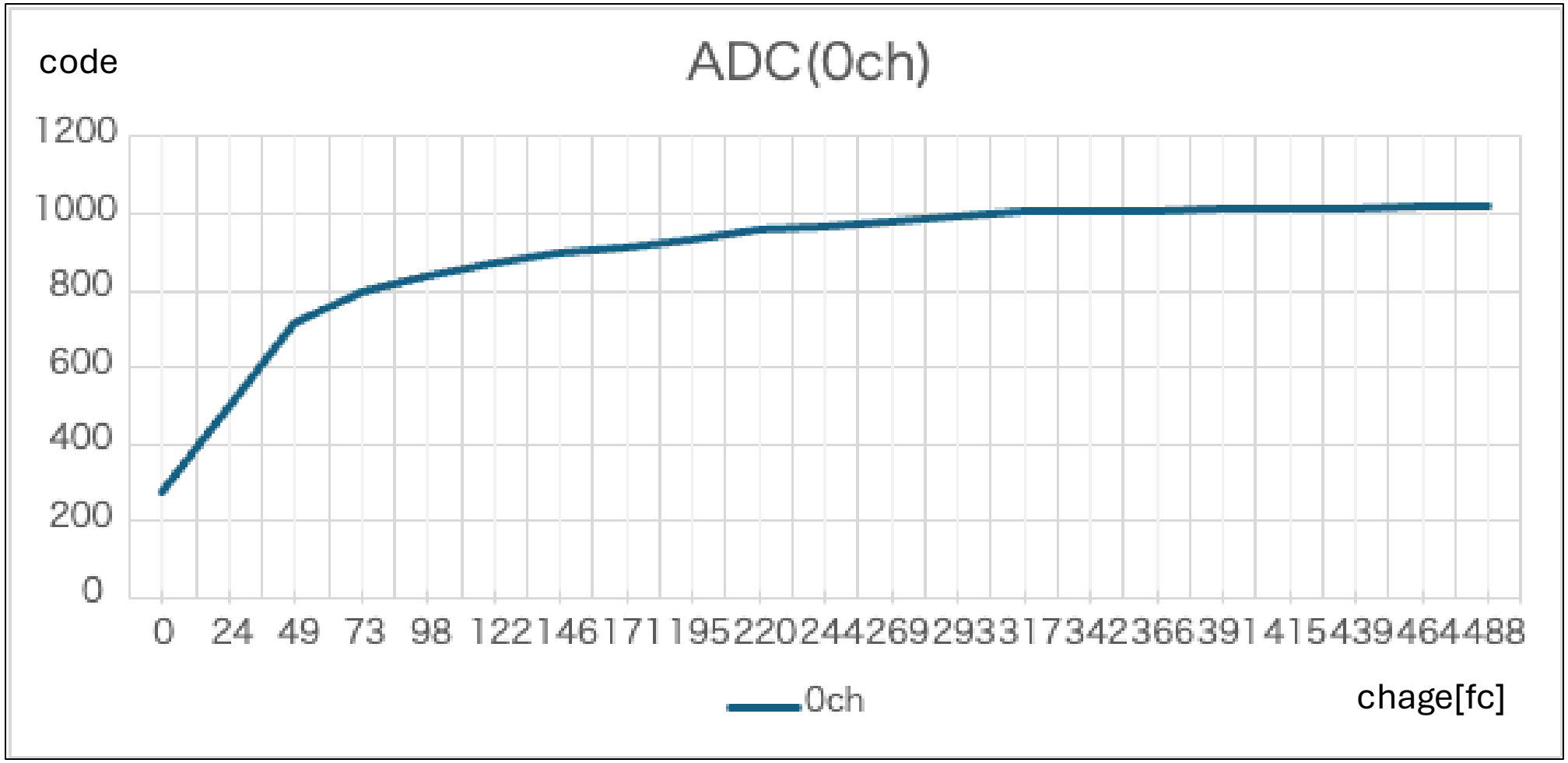

delay Scan
ADC (ADU)
ToA (ADU)
ToT (ADU)
time (ns)
ch24
ch25
ch26
ch27
ch28
ch29
ch30
ch31
ch32
ch33
ch34
ch35


delay Scan
ADC (ADU)
ToA (ADU)
ToT (ADU)
time (ns)

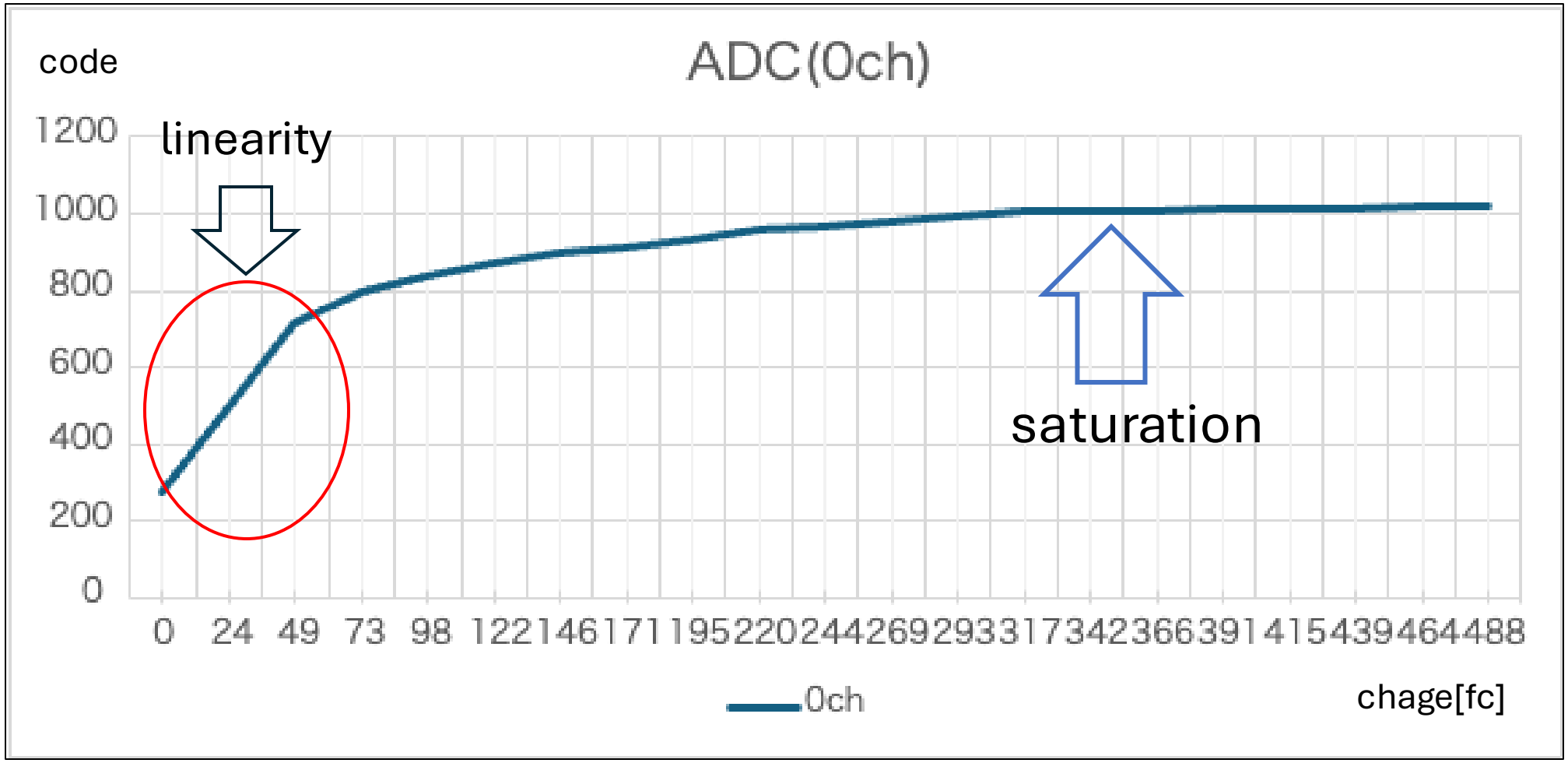

delay Scan
ADC (ADU)
ToA (ADU)
ToT (ADU)
time (ns)
ch48
ch49
ch50
ch51
ch52
ch53
ch54
ch55
ch56
ch57
ch58
ch59


delay Scan
ADC (ADU)
ToA (ADU)
ToT (ADU)
time (ns)
ch60
ch61
ch62
ch63
ch64
ch65
ch66
ch67
ch68
ch69
ch70
ch71

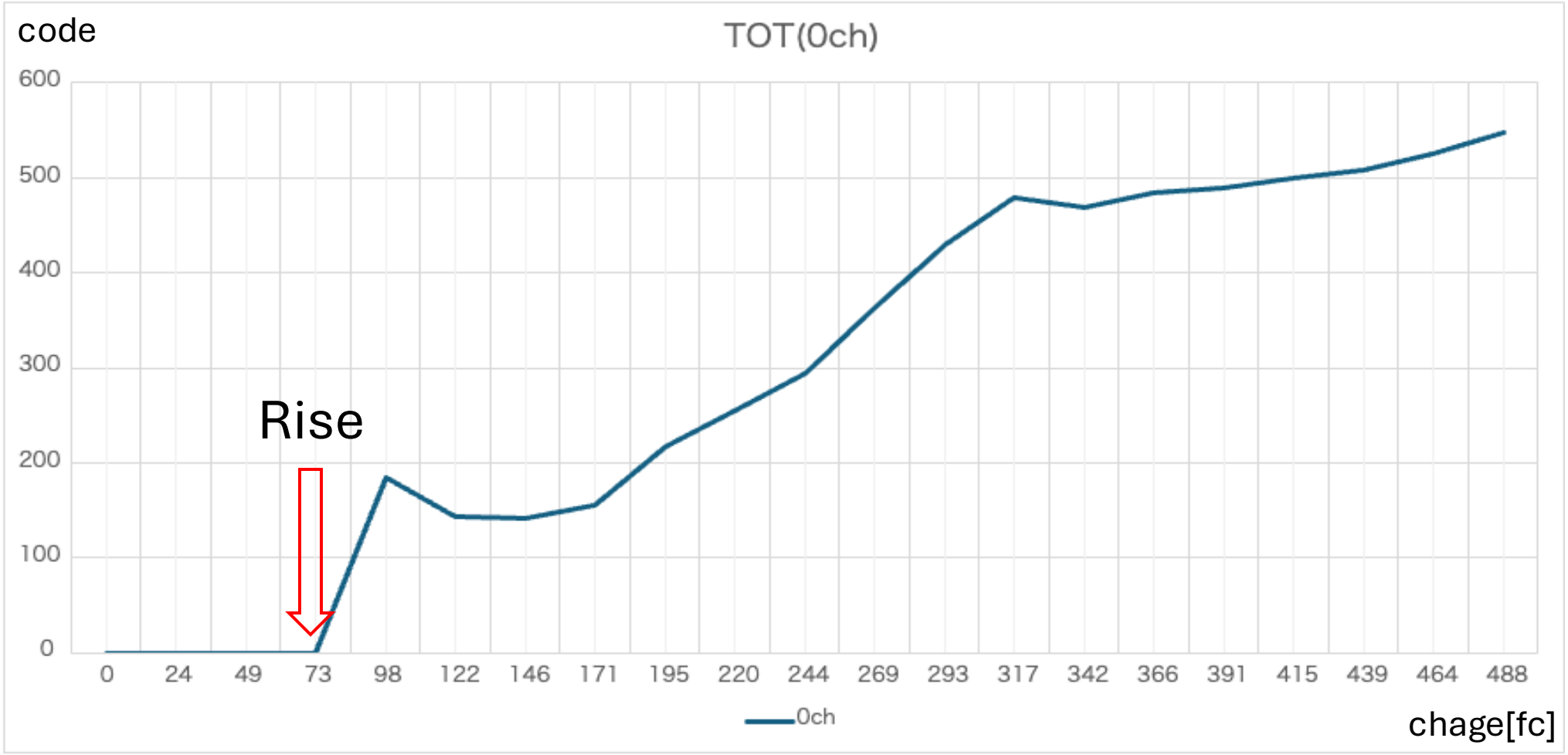
ADC(0ch)


code
ADC(0ch)
1200
1000
800
600
400
200
0
0 24 49 73 98 122146171195220244269293317342366391415439464488
0ch
chage[fc]

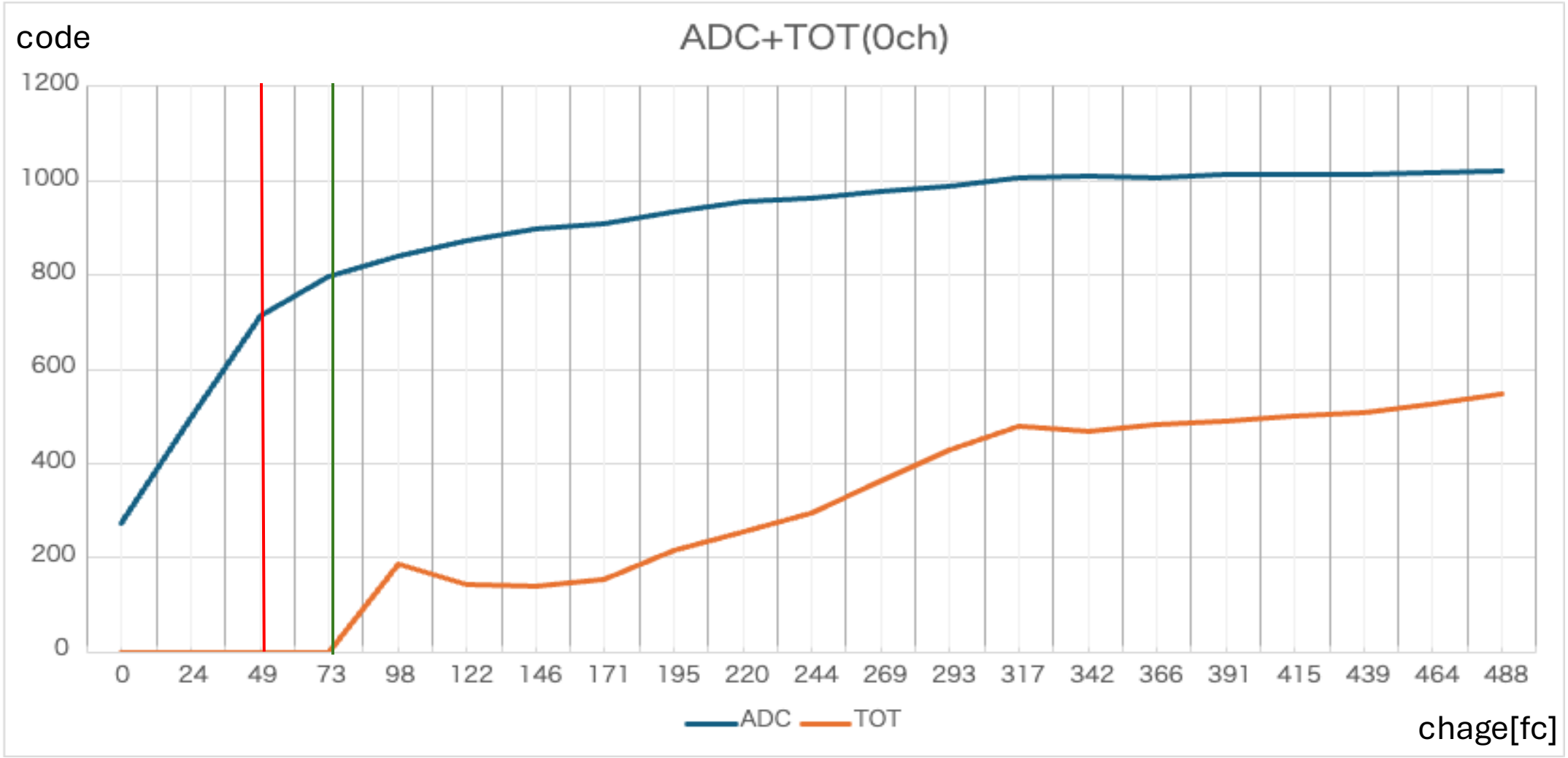
ADC(0ch)


code
ADC(0ch)
linearity
saturation
1200
1000
800
600
400
200
0
0 24 49 73 98 122146171195220244269293317342366391415439464488
0ch
chage[fc]

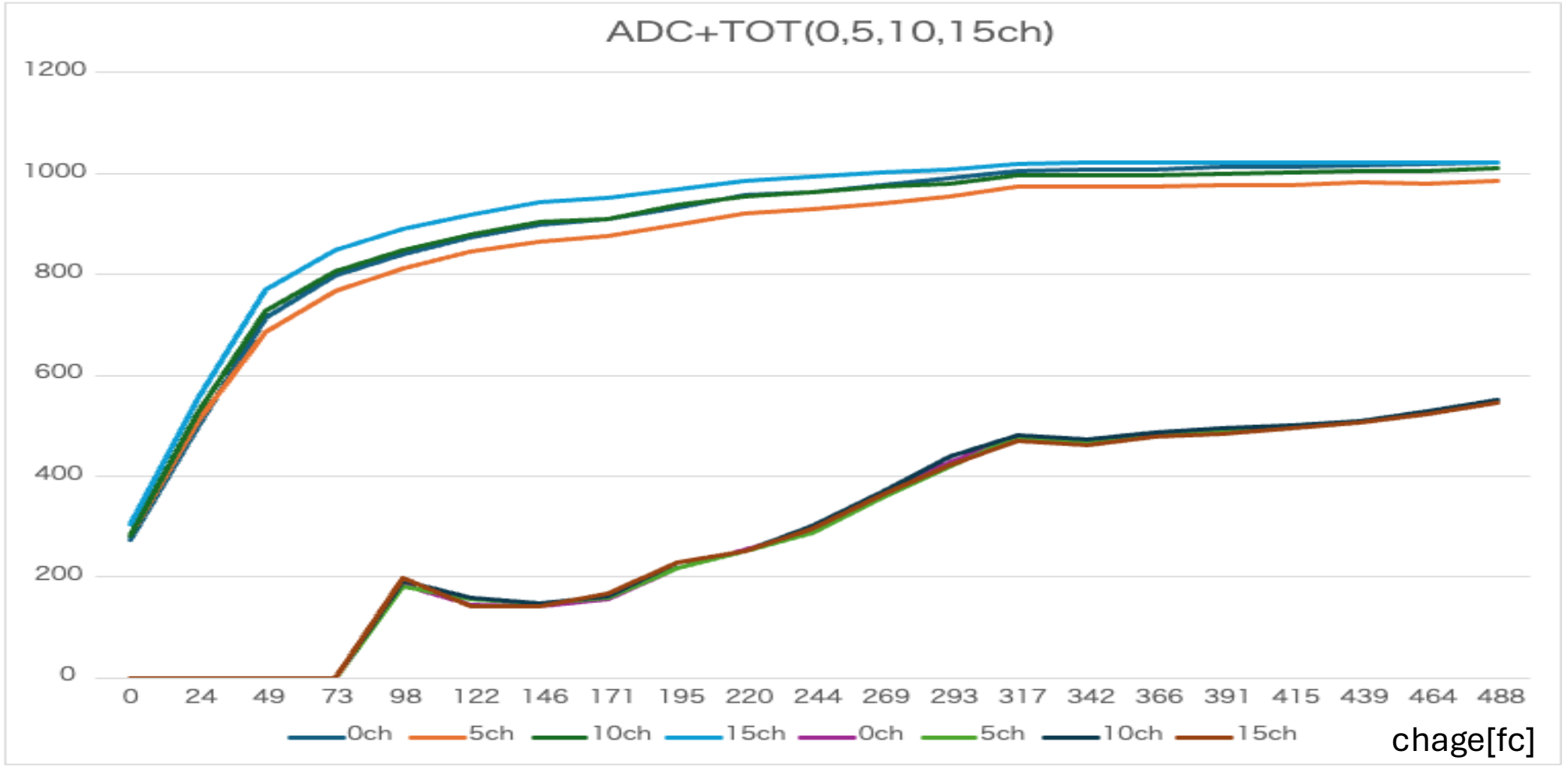
TOT(0ch)


code
TOT(0ch)
600
500
400
300
200
100
0
Rise
0
24
49
73
98
122
146
171
195
220
244
269
293
317
342
366
391
415
439
464
488
0ch
chage[fc]

ADC+TOT(0ch)


code
ADC+TOT(0ch)
1200
1000
800
600
400
200
0
0
24
49
73
98
122
146
171
195
220
244
269
293
317
342
366
391
415
439
464
488
ADC
TOT
chage[fc]

0,5,10,15ch


ADC+TOT(0,5,10,15ch)
1200
1000
800
600
400
200
0
0
24
49
73
98
122
146
171
195
220
244
269
293
317
342
366
391
415
439
464
488
0ch
5ch
10ch
15ch
0ch
5ch
10ch
15ch
chage[fc]

Summary

- The timing when the ADC loses linearity and the timing when ToT starts are both early.

- The thresholds for ToA and ToT may be inappropriate.

Plan

- I would like to deepen my understanding of parameter settings during measurements and other related aspects.

- There are about 300 v2 chips, so measurements will be conducted on them.

- Preparation for measuring the v3 chips

Thank you for your attention

TOT (Time Over Threshold)

Threshold A＝TOA (Time of Arrive)

Indicates the time when the rising edge of the signal reaches threshold A.

Threshold B＝TOT

Indicates the difference between the time when the falling edge of the signal reaches threshold B and the TOA