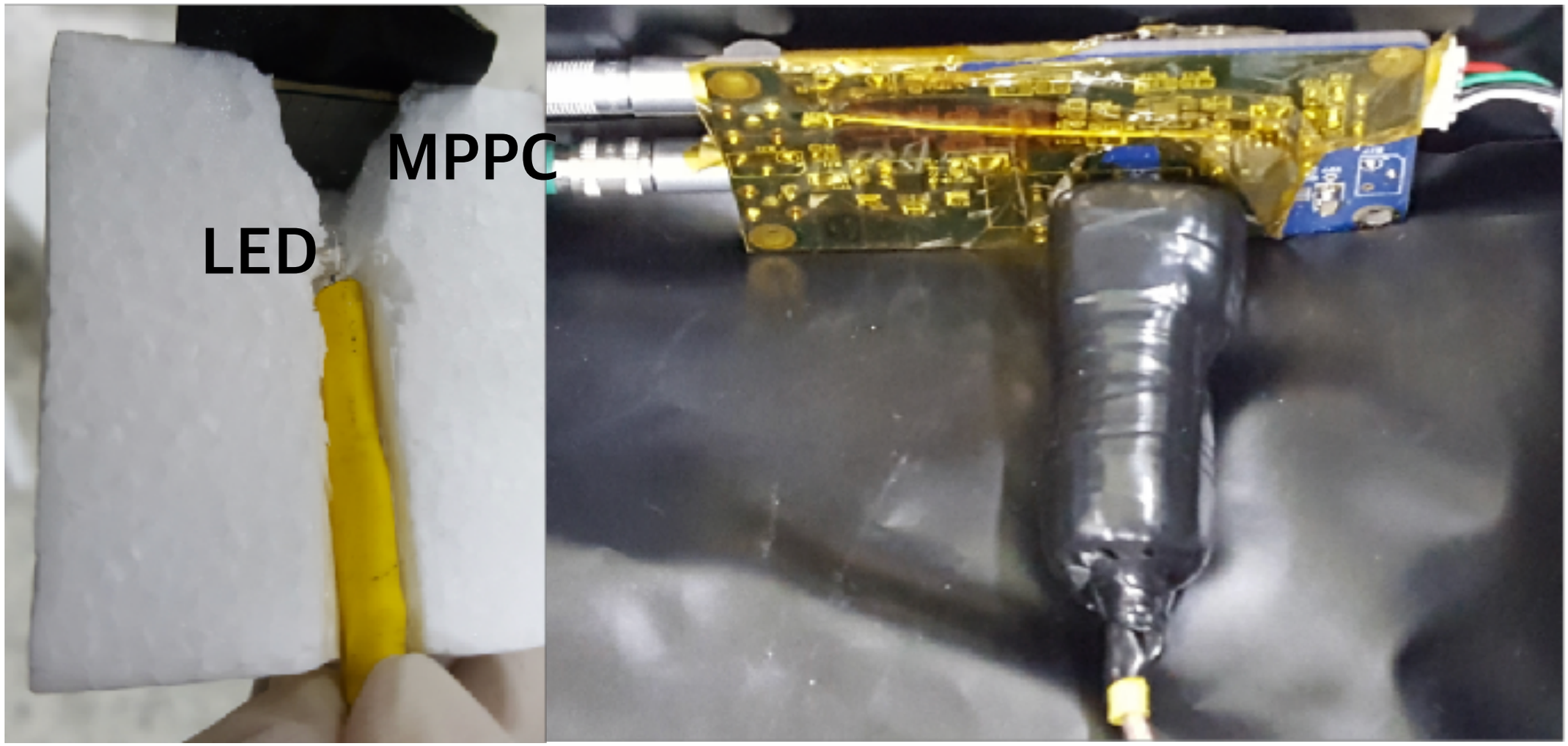
MPPC LED TEST @KRISS



CONTENTS

PURPOSE

-Comparing a timing performance of KU curcuit with tohoku group's circuit

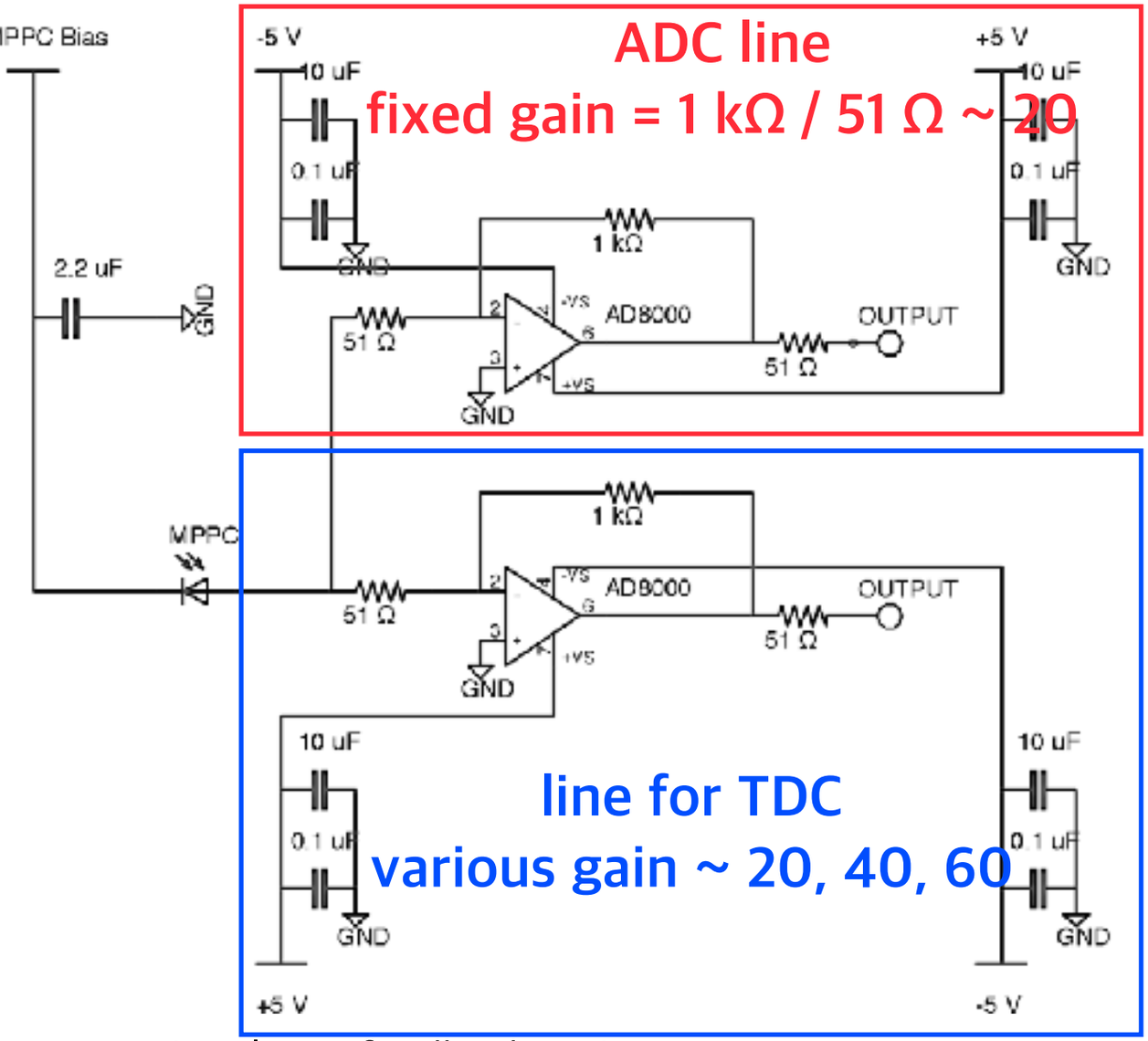
-Optimization of amplifier's gain, amplification method in the circuit

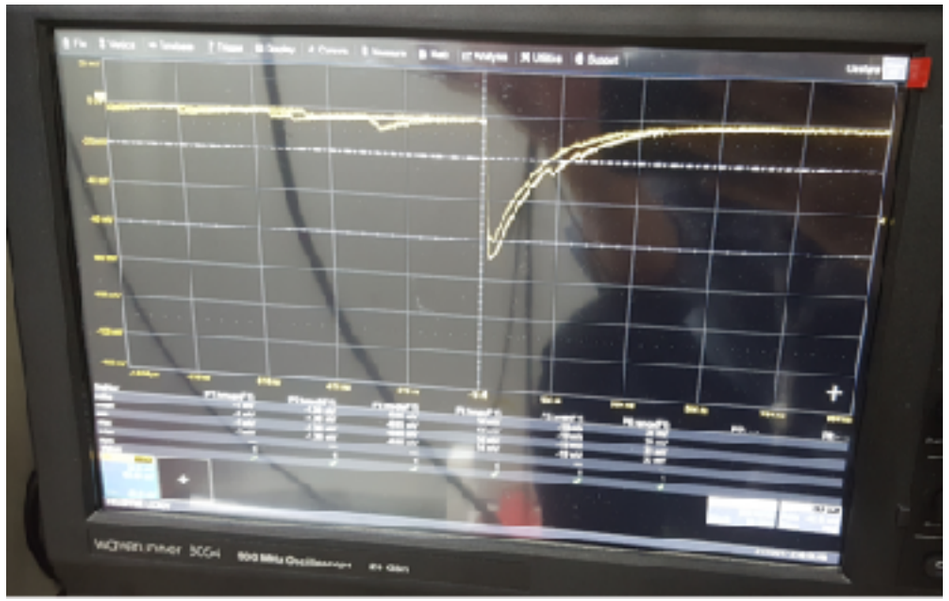
-Get relation between time resolution and # of photons

CIRCUITS

Inverting amplifier(KU circuit)

-mppc signal divided into 2 lines



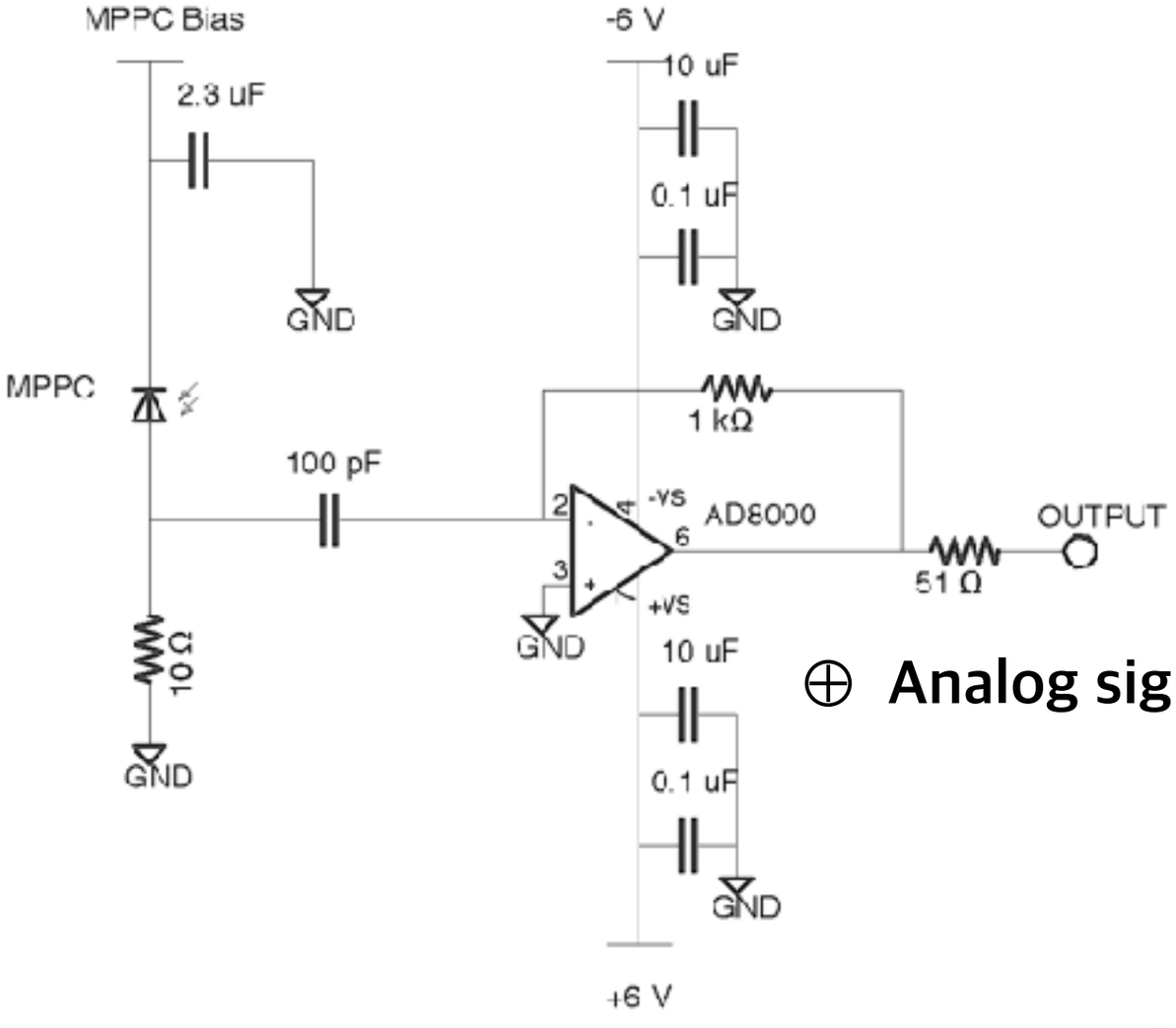


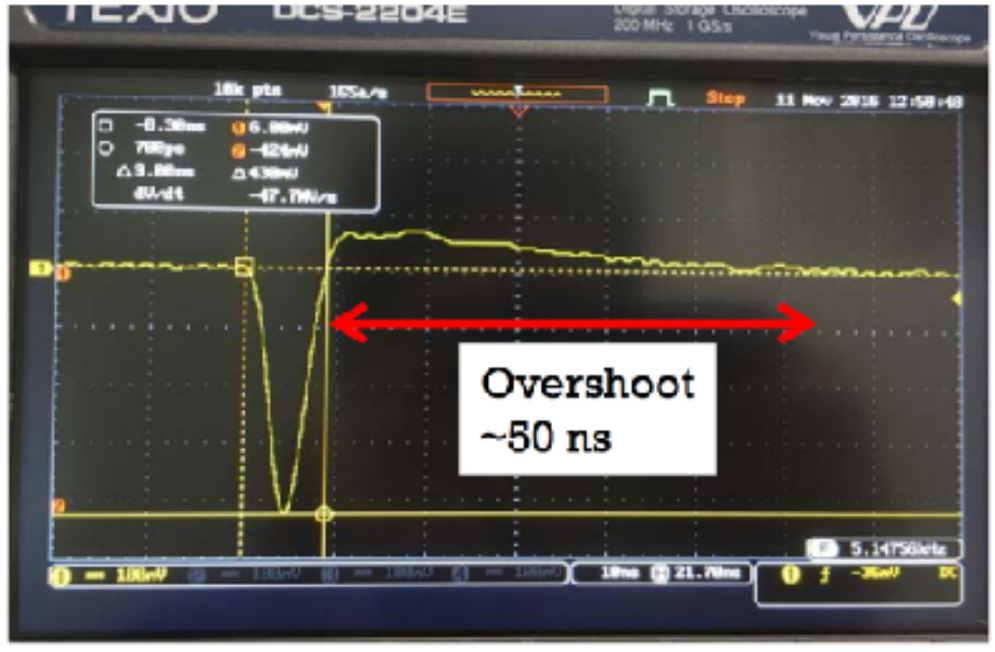
- gain is proportional to a feedback resistance
- by changing the feedback resistance from 1k to 2k,3k (gain 20 ~ 60), took TDC data (**with a leading edge discriminator**

CIRCUITS

Differentiator(Tohoku group)

-for the performance comparison with KU curcuit





⊕ **Analog signal divider**

Tohoku (and J-PARC E50) group's circuit design **T. Nishizawa, IEEE Trans. Nucl. Sci. 61 (2014) 1278**

- gain is proportional to a feedback resistance
- by changing the feedback resistance from 1k to 2k, 5k, 10k, took TDC data (with leading edge discriminator)
- to take both ADC and TDC together, used analog signal divider

TEST LIST

Inverting amplifier(KU circuit)

with feedback resistance : 1k ohm(reference) + 2k, 3k ohm

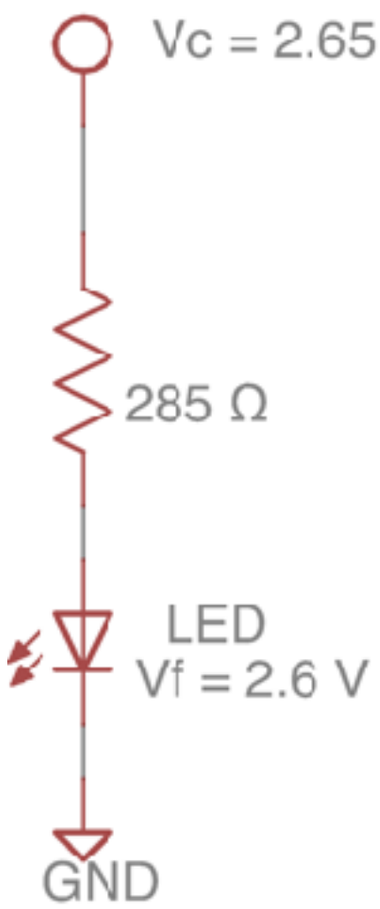
Differentiator(Tohoku group)

with feedback resistance : 1k(same value as Tohoku group) , 2k, 5k ,10k ohm

2 types of circuits ⊗ various gain ⊗ LED light yield(bias voltage)

TEST SET UP

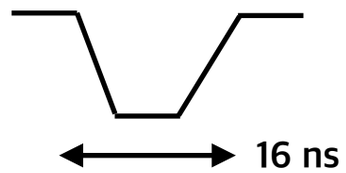
LED SOURCE



Function generator

Pulse height : 2.65 < V < 2.80 V

Pulse width : 16 ns



LED

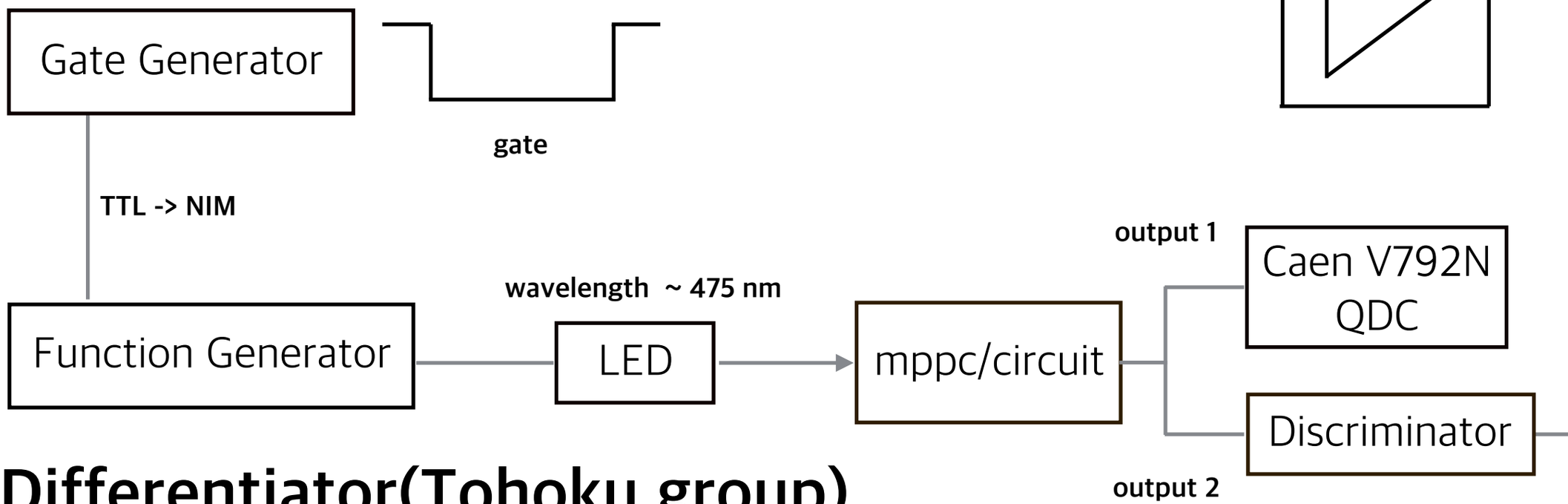
V_f = 2.6 V

V_f : LED voltage drop

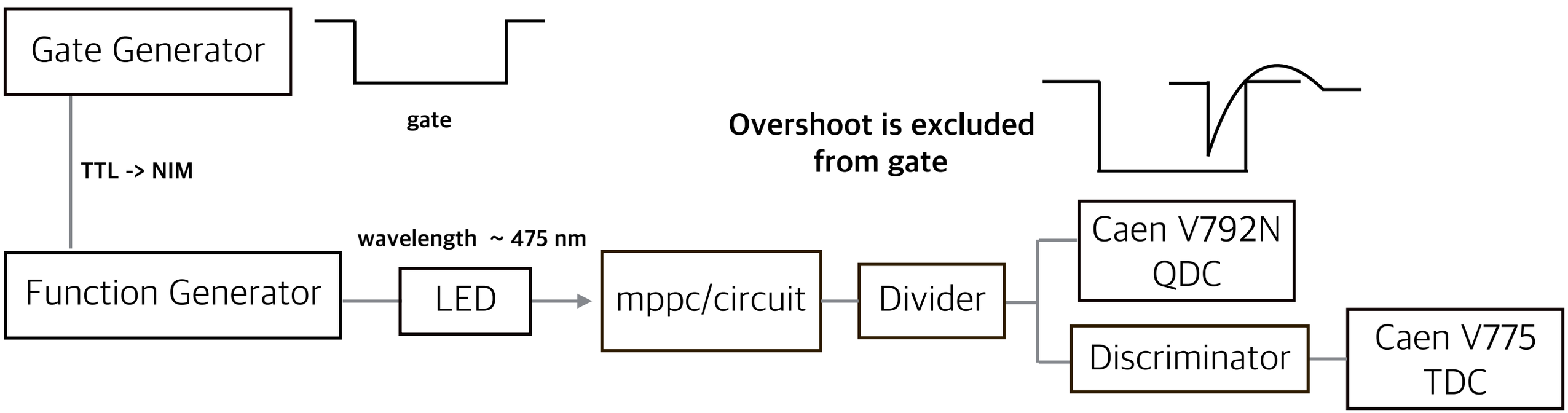
460 < λ < 490 nm (Blue LED)

SIGNAL PROCESSING

Inverting amplifier(KU circuit)

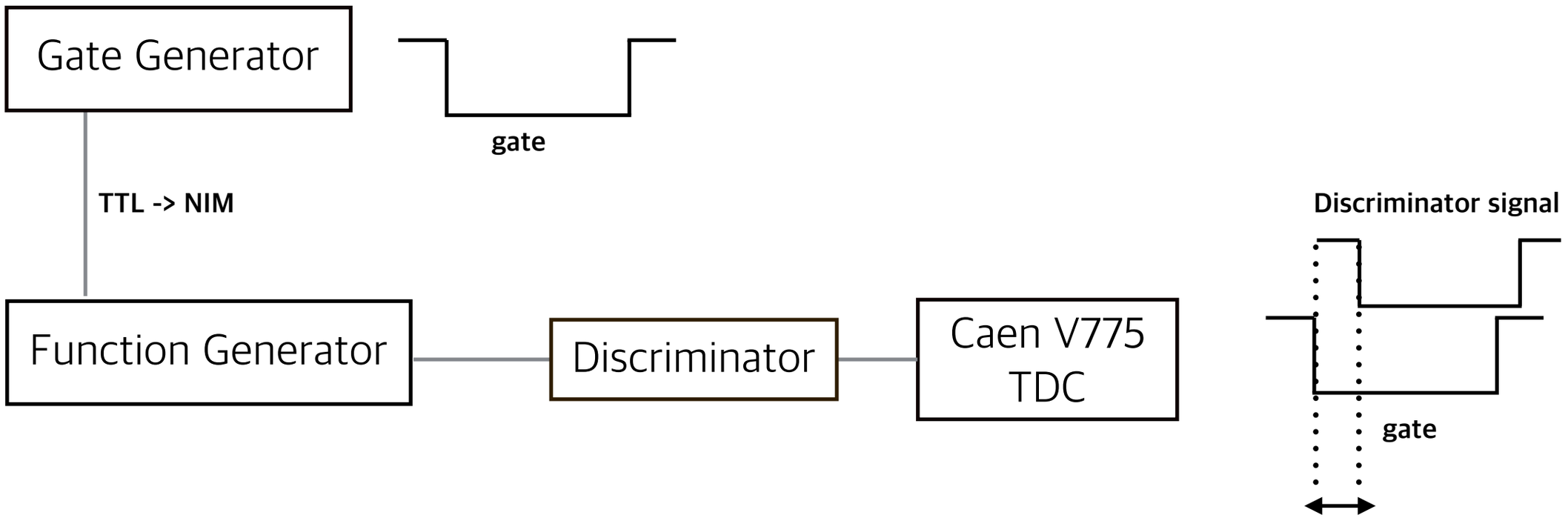


Differentiator(Tohoku group)



PRE-TEST

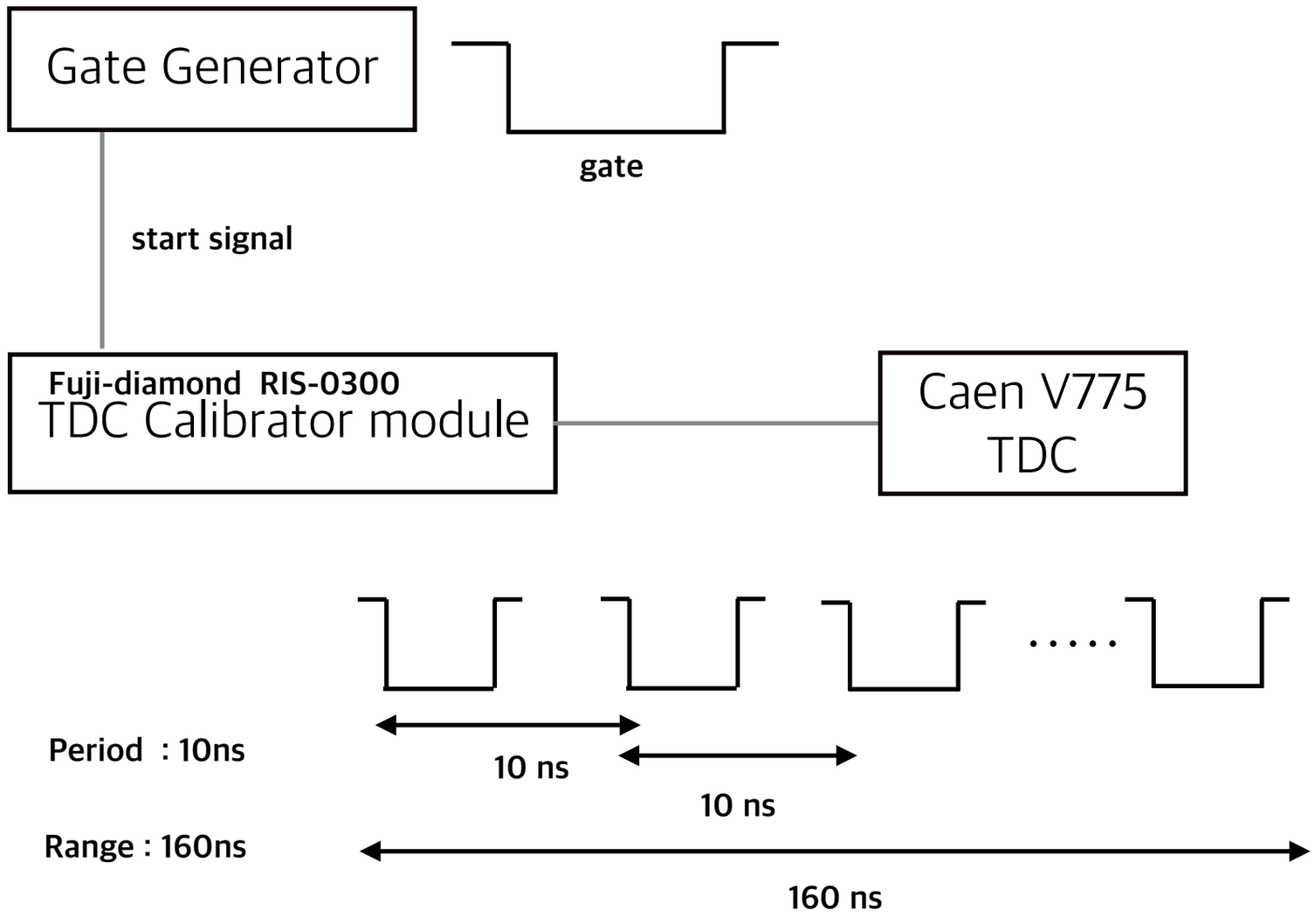
TRIGGER SWINGING CHECK



trigger swinging < 1 TDC ch (35 ps)

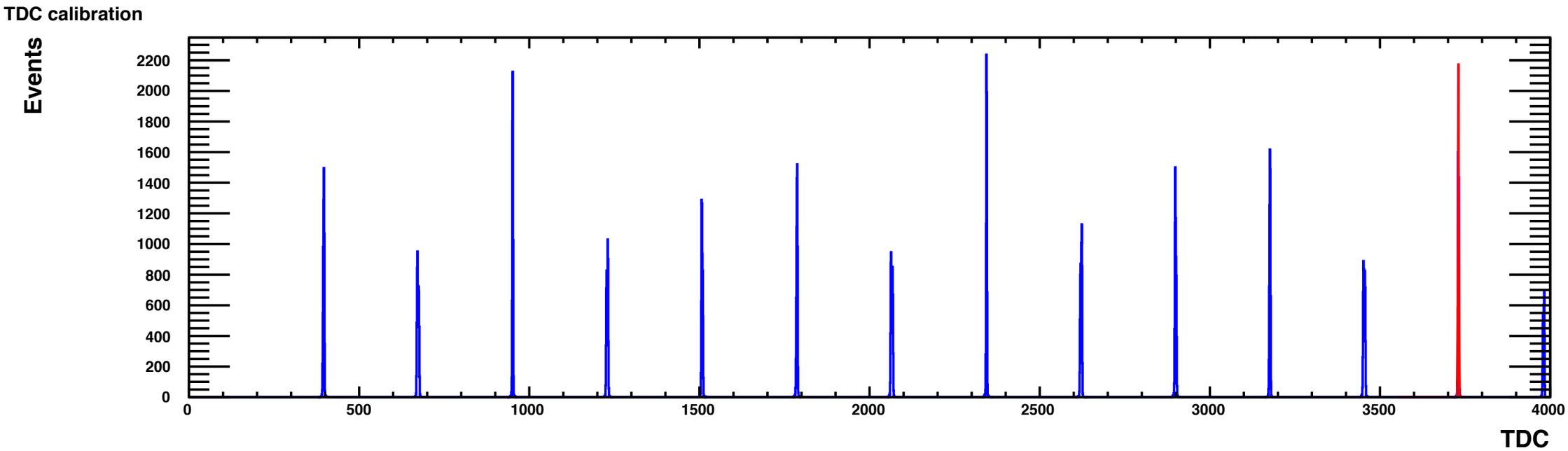
TDC CALIBRATION

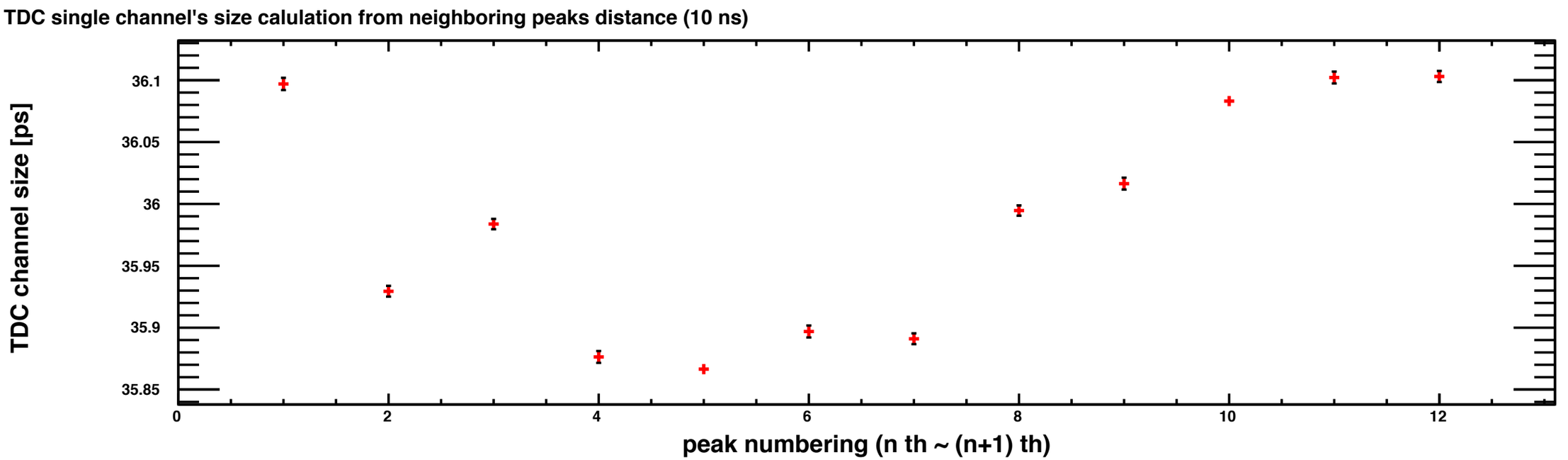
set-up



TDC CALIBRATION

A single TDC channel's data(10 ns pulse)

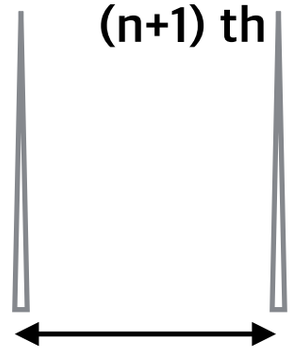




TDC CALIBRATION

summary

for the neighboring two peaks,
peak numbering : n th



peak to peak distance

#ch = mean$_n$ -mean$_{(n+1)}$

$$Error_{ch}^2 = Error_n^2 + Error_{(n+1)}^2$$

real size of single TDC channel = 10 ns / #ch

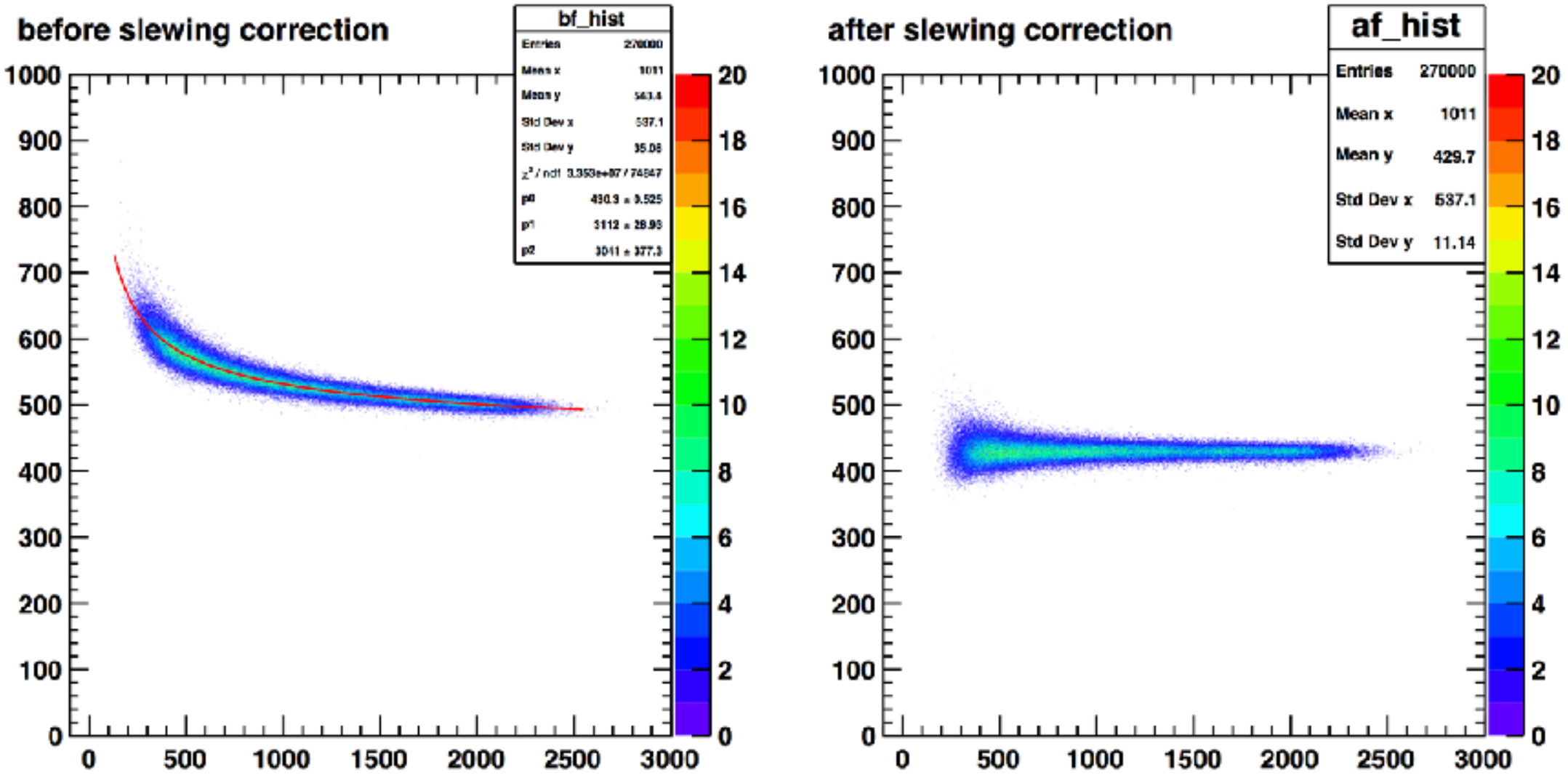
$$Error_{tdc\ channel} = (10 \times Error_{ch} / \#ch^2)\ ns$$

Average : 36.0 +/- 0.00130 [ps/channel]

LED TEST

DATA ANALYSIS

Slewing correction



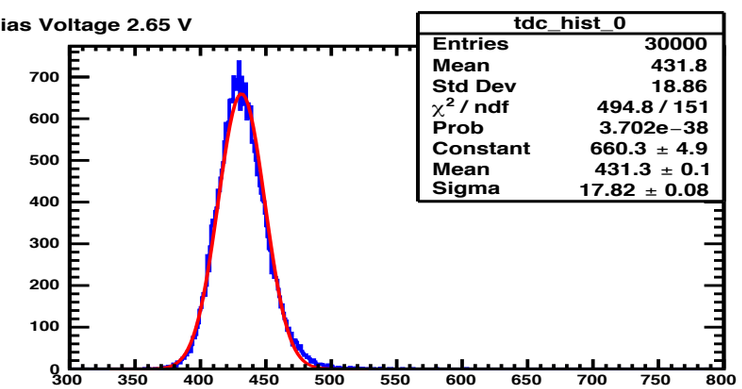
9 data points are drawn together

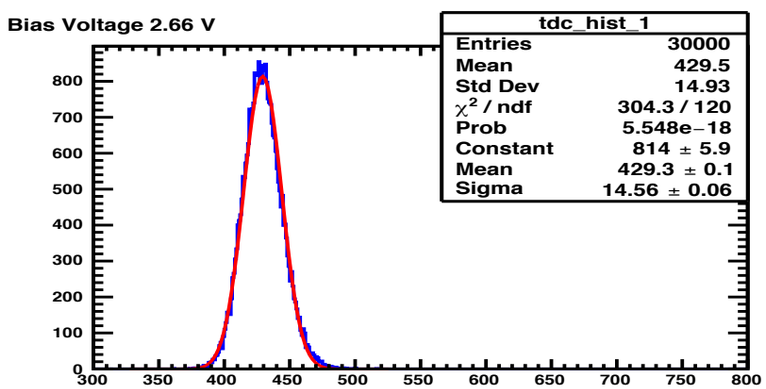
time walk function

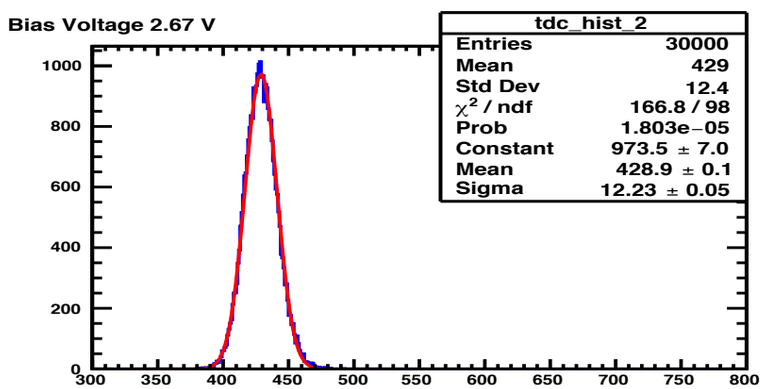
$[0]+[1]/QDC^{0.5}+[2]/QDC$ ([0], [1], [2] : paramaters)

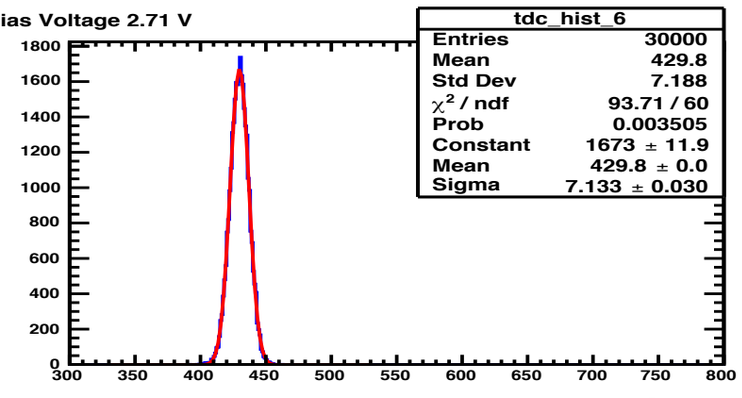
DATA ANALYSIS

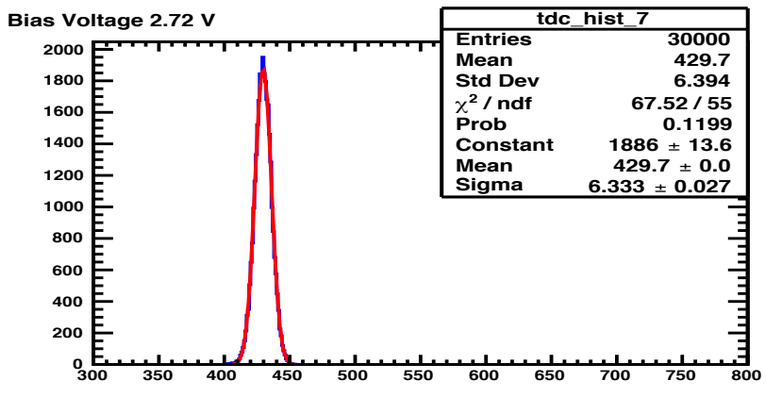
Slewing corrected TDC

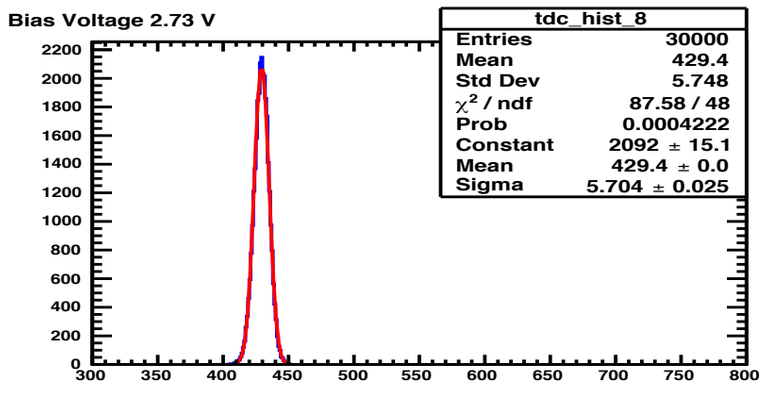








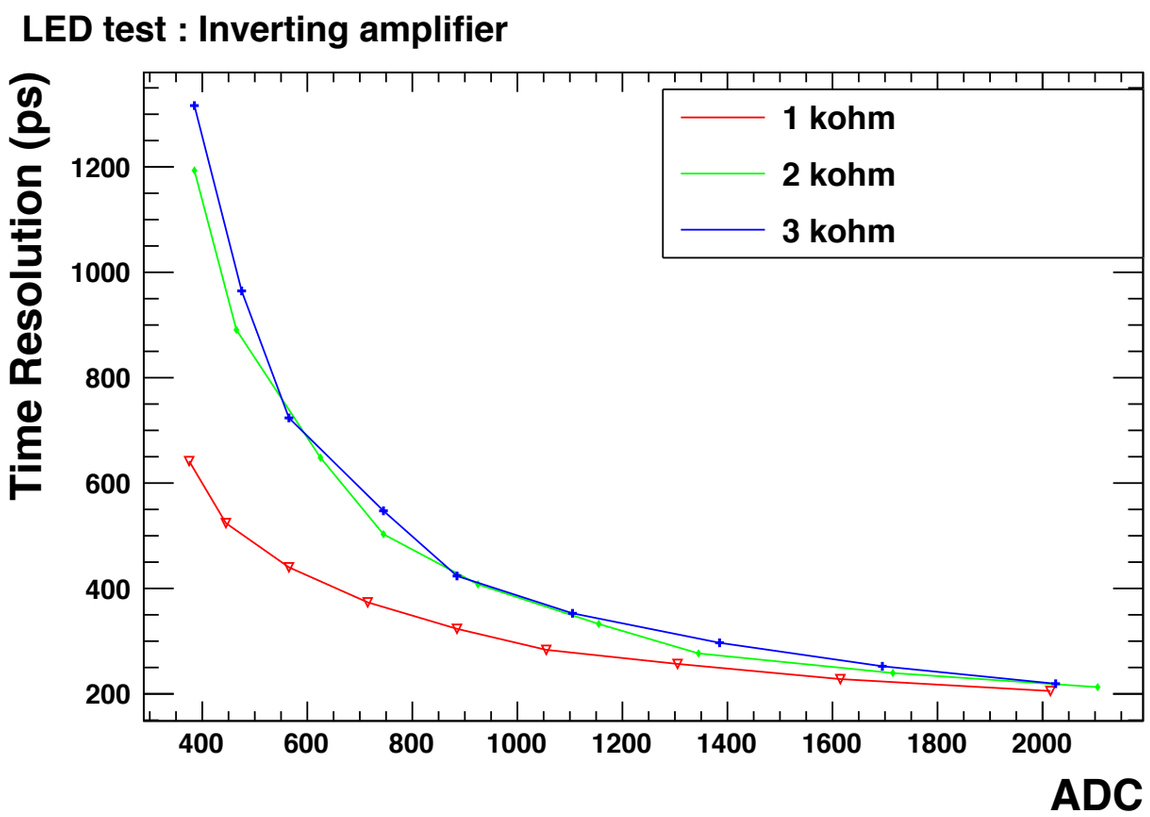


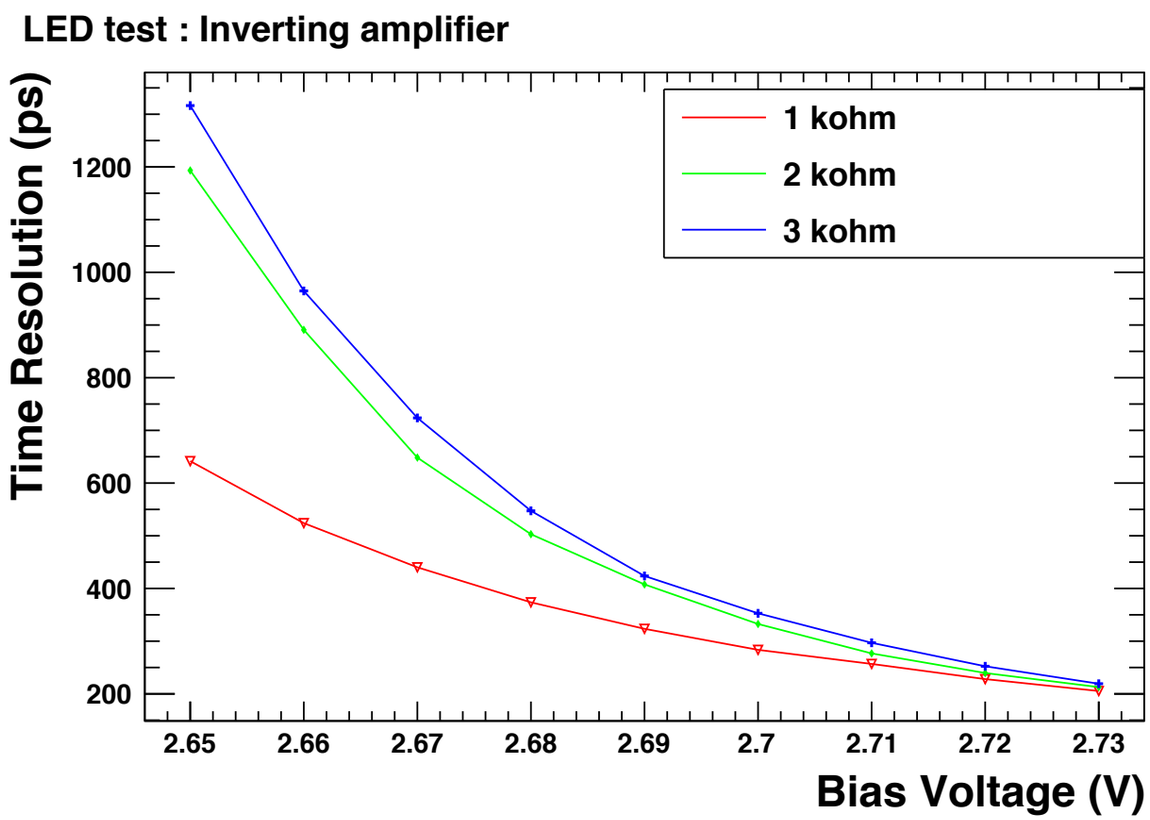


time resolution = Gaussian fitting -> GET Sigma value

RESULT

Inverting amplifier(KU circuit)

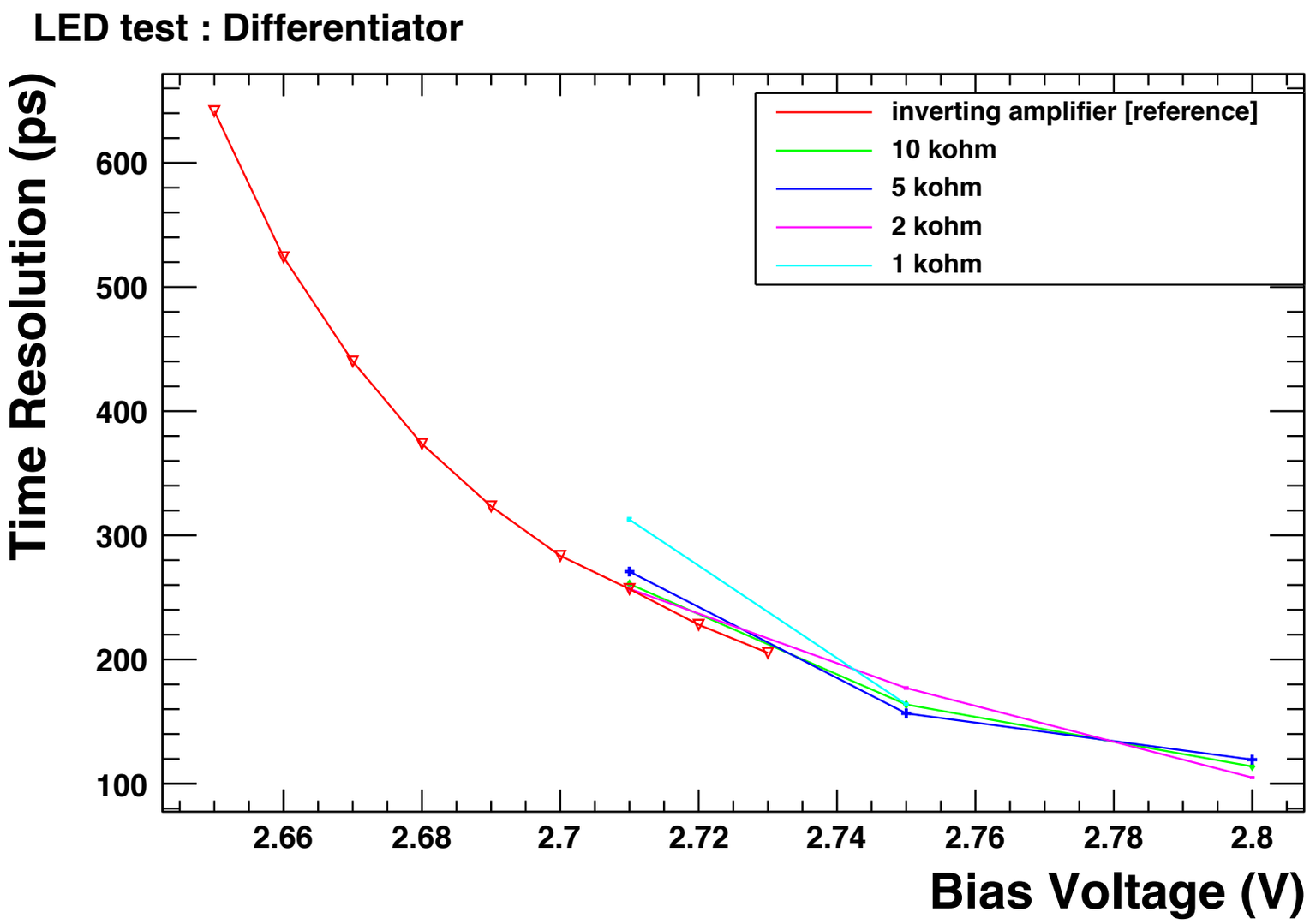




A red line is a reference (1 kΩ inverting amplifier)

RESULT

Differentiator (Tohoku Group) data with ku circuit as a reference



A red line is a reference 1 kΩ inverting amplifier

all lines have the same tendency even their gains and circuit types are different

SUMMARY

- **Circuit type and feedback resistance(gain) are not a dominant factor for the timing resolution**
- **For the low ADC region, lower gain circuit has better time resolution.**

To do

- **Test the circuits which has a smaller feedback resistance than 1k ohm**
- **Have to figure out that the MPPC's bias voltage and the time resolution (very important study but missed out in this test)**

BACK UP

P-Pi delta tof, 3sigma seperation