Simulation for the Monolithic Active Pixel Sensor

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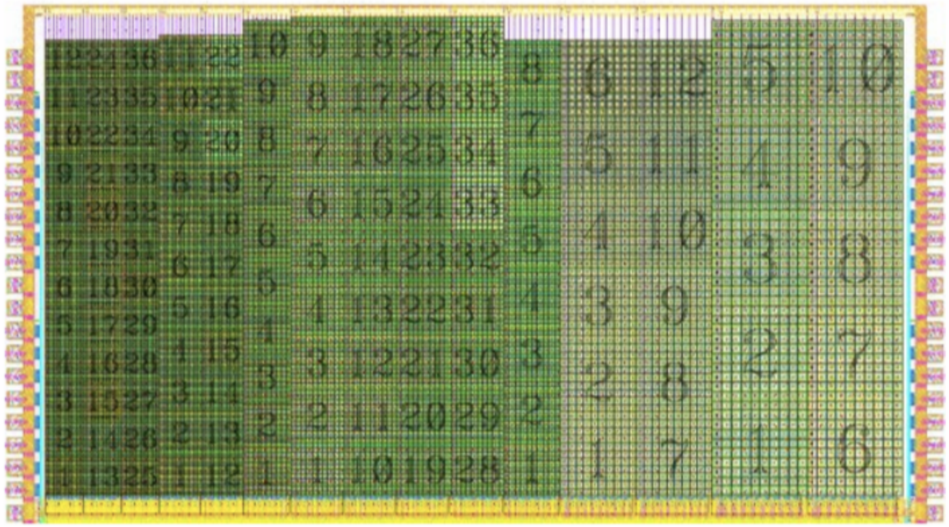
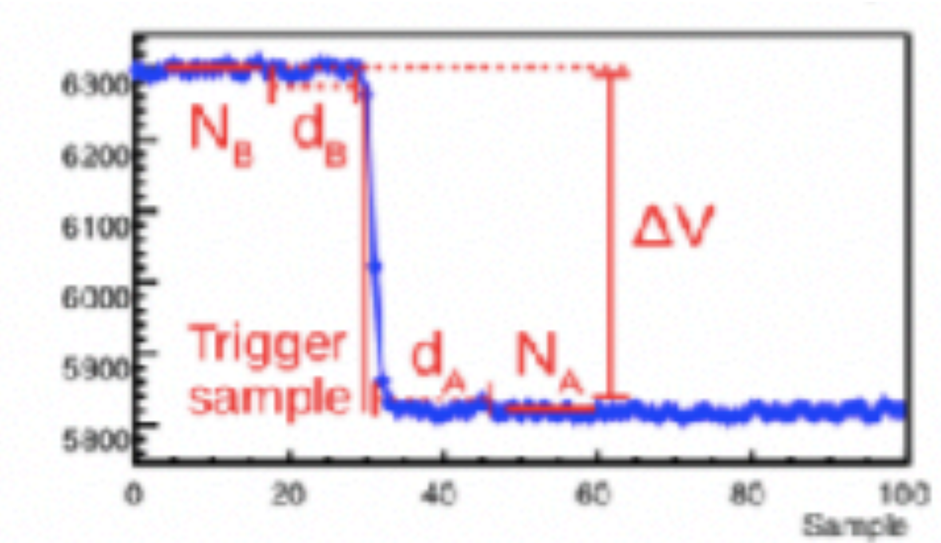
Jihye Jeong

Investigator





- The performance depends on pixel design parameters.
- The choice of the parameter values is driven by the maximisation of the Q_{coll}/C_p, i.e. signal ΔV.

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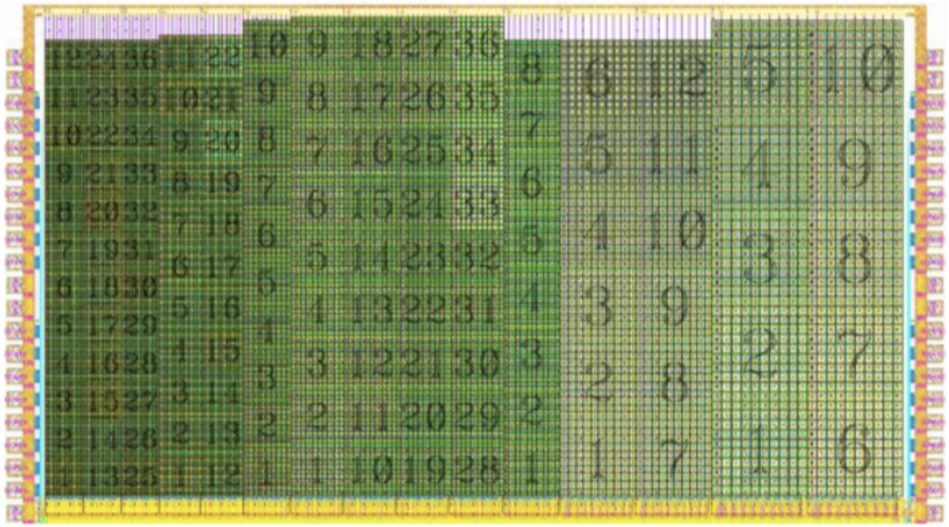
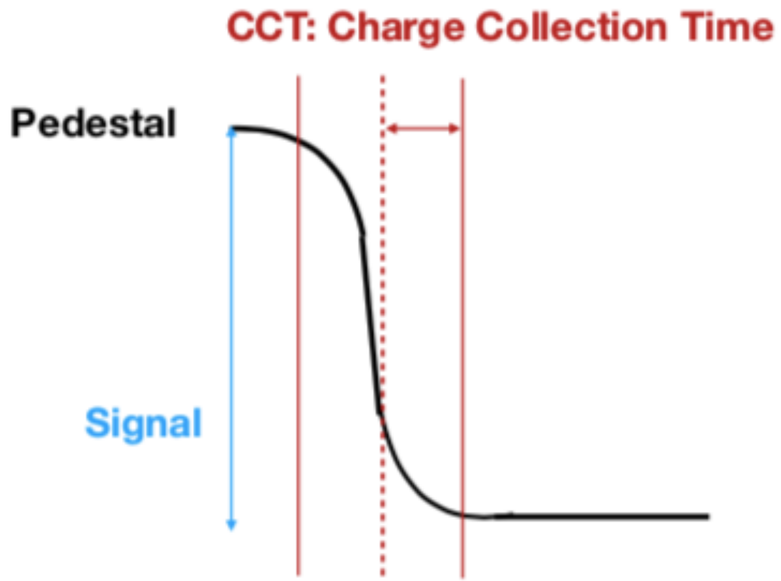


표 1

Mini-matrix ID	Pitch (um)	N-well size (um)	Spacing (um)
0	20	3	1
36	22		
58	25		
78	28	3	2
79			
80			3
81			4
82			5
83		4	1
88		5	
104	30	3	

- Will refer to 11 Mini-matrices
- And 4 different reverse voltages for each geometries: 0V, -1V, -3V, -6V

Investigator



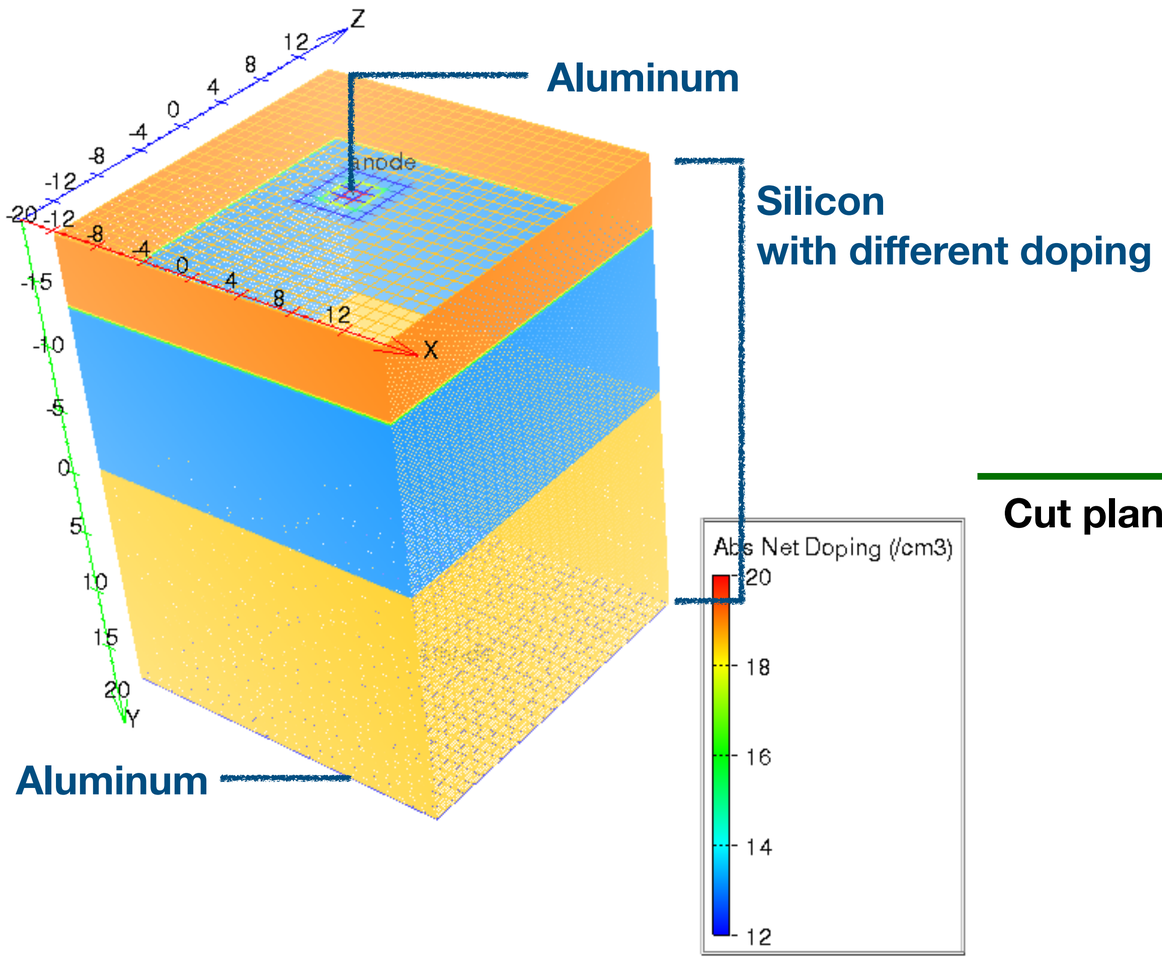
- CCT(Charge Collection Time):
  The time how fast the electrons are collected.

- Calculate the charge collection time considering $\sqrt{2}\sigma$.
  Half from 8~92% of the full amplitude of charge.

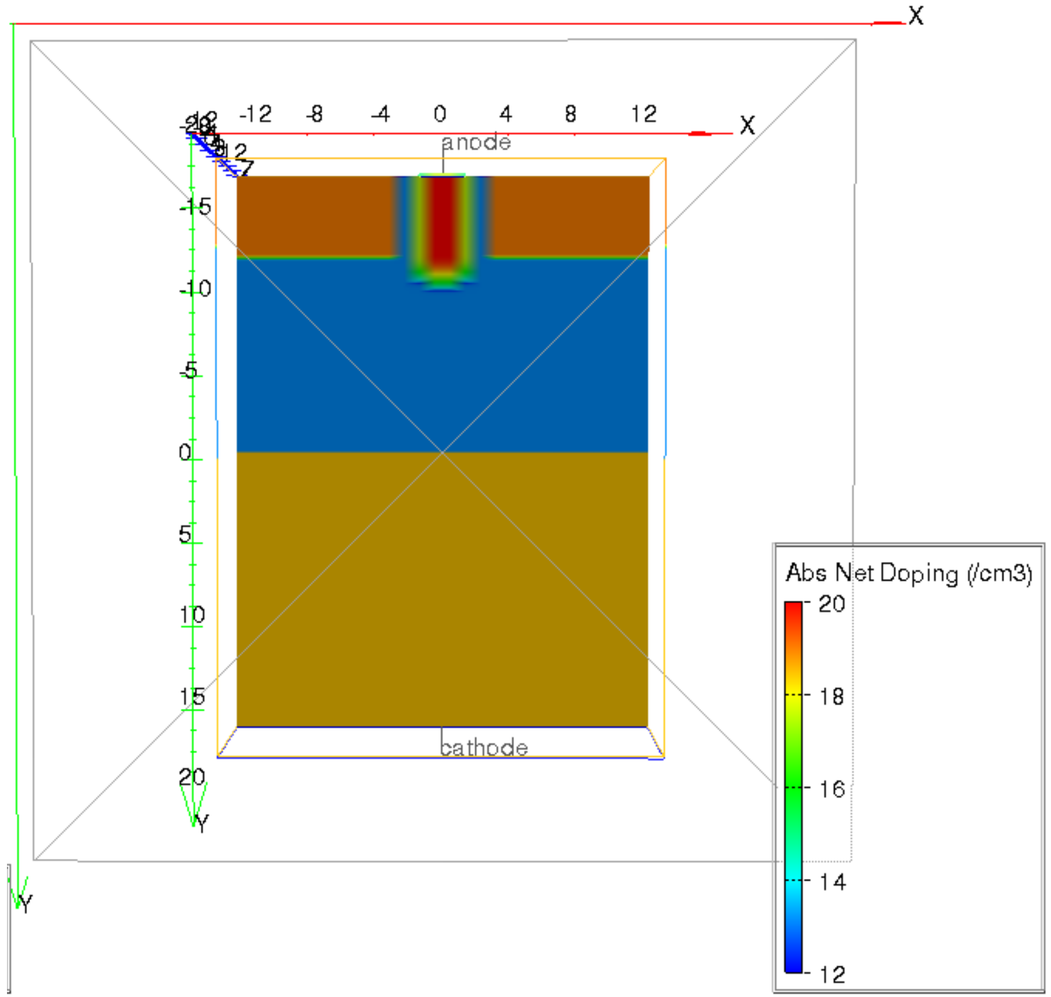
Simulation tools

- **Technology computer-aided design** (**technology CAD** or **TCAD**)
  - A branch of electronic design automation that models semiconductor fabrication and semiconductor device operation.
  - Change the device design, device operation condition, etc, and control the impact of various physics in the device.
- **Garfield++**
  - A toolkit for a detailed simulation of particle detectors that use gas and semi-conductors as sensitive medium.
  - It can up-to-date treatment of electron transport, simulate silicon sensors, and the user interface, which is based on ROOT.

TCAD simulation

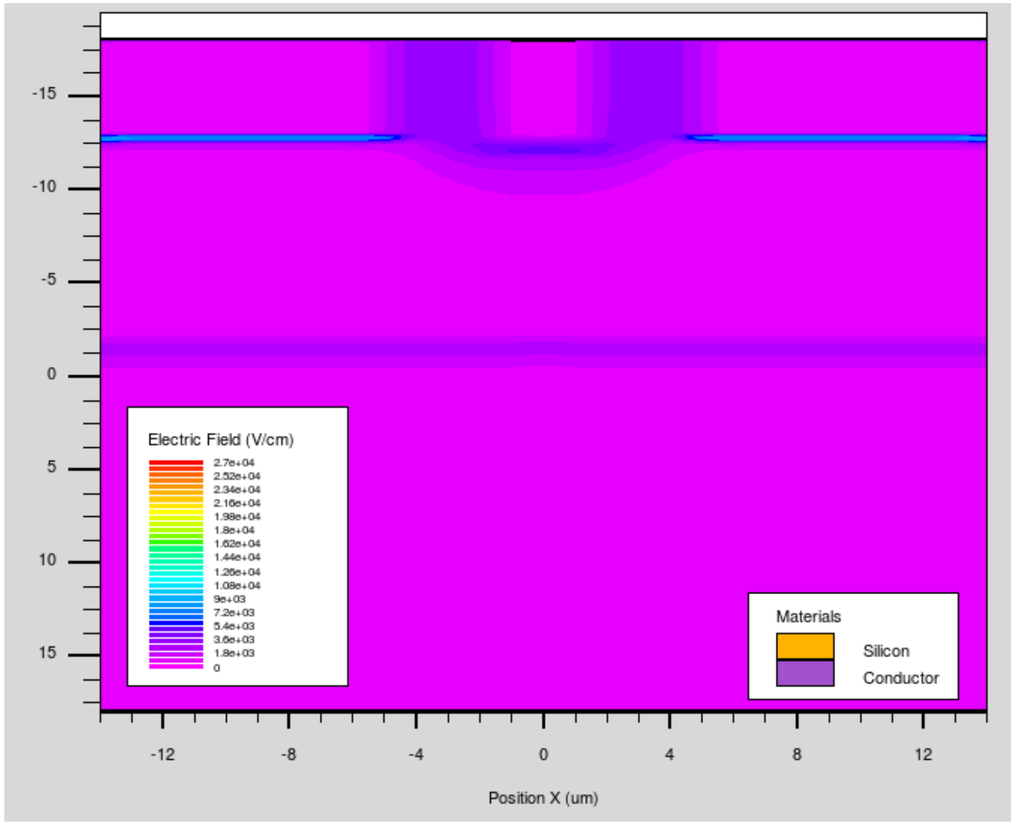


Cut plane

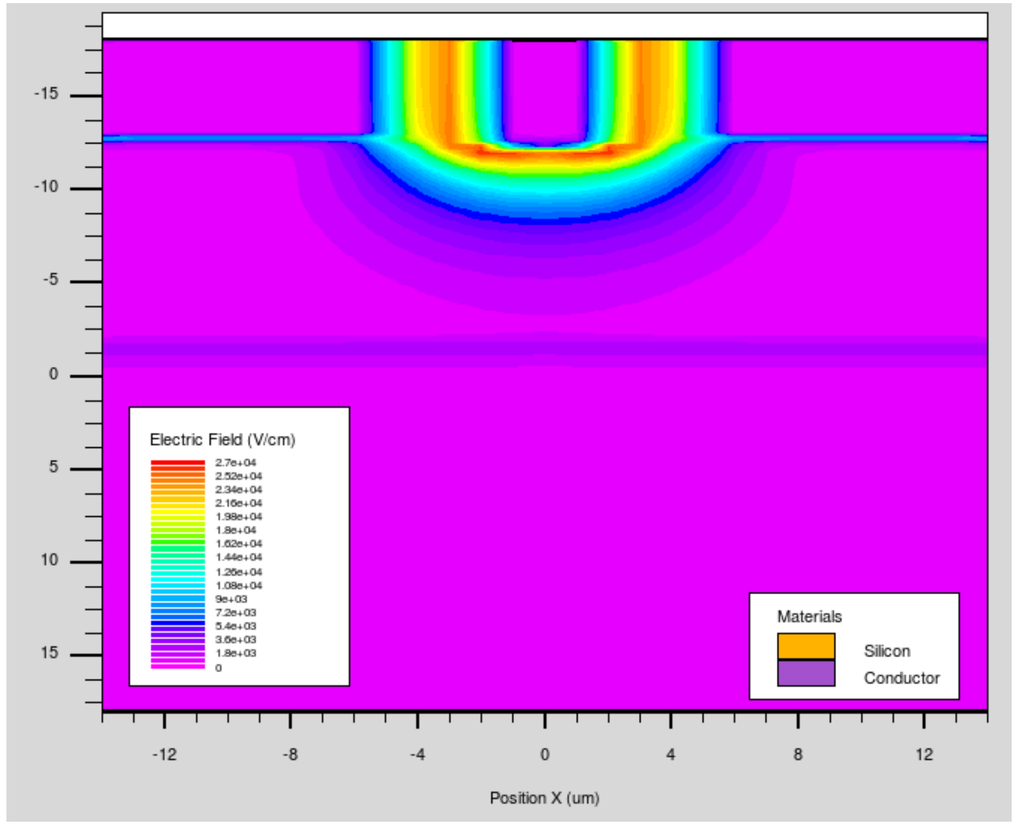


- Simulated with Mini-matrix No.58 geometry. (Pixel pitch: 25um, N-well size: 3um, Spacing: 1)

TCAD simulation



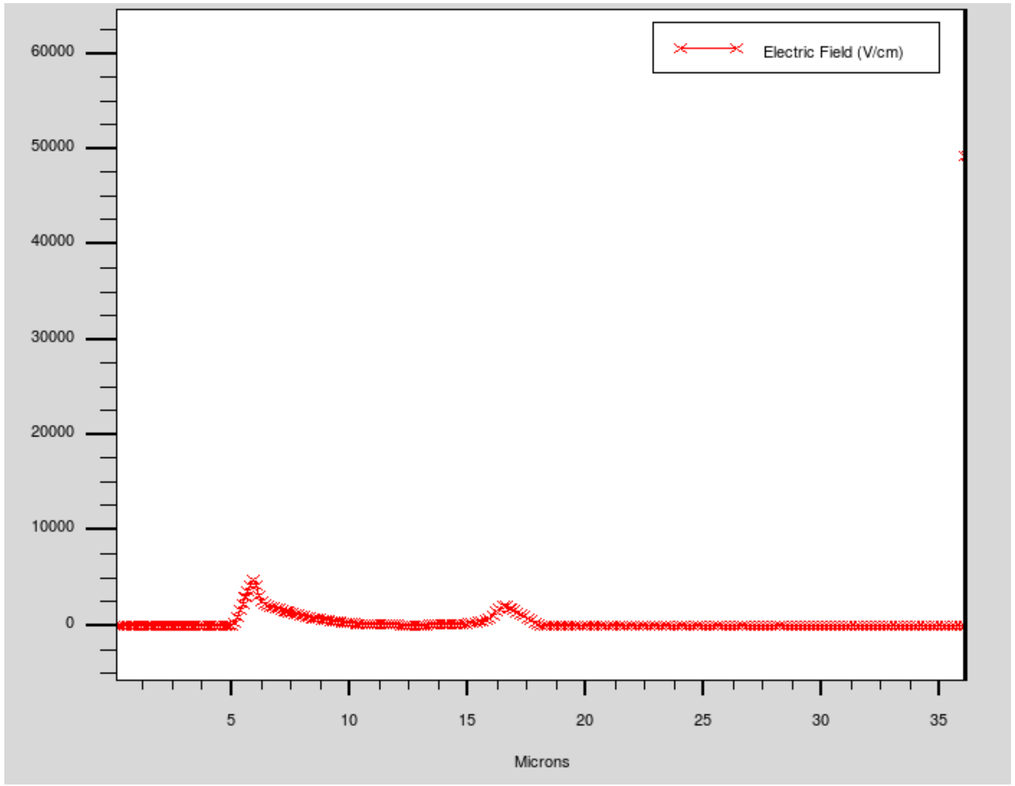
V_{BB}=0V



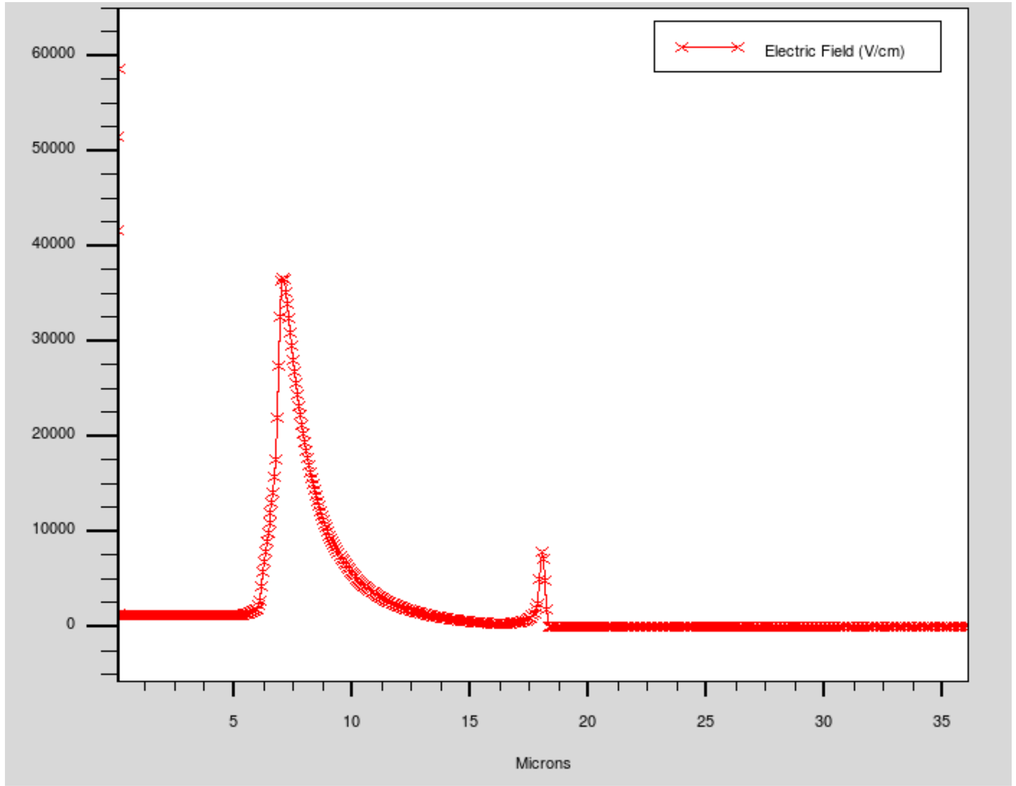
V_{BB}=6V

- Comparison of E-field by reverse voltage. (Mini-matrix 80)

TCAD simulation



V_{BB}=0V

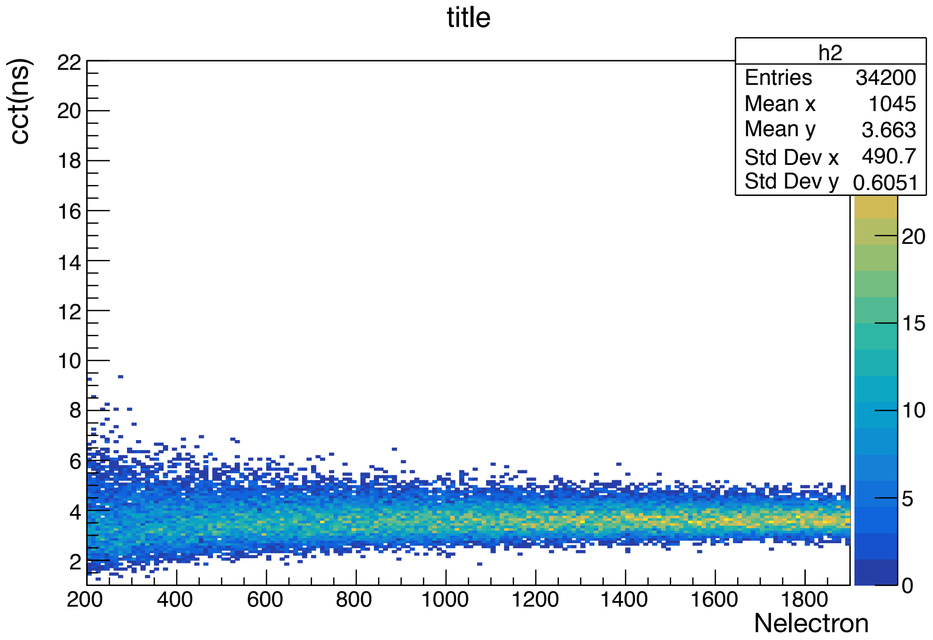


V_{BB}=6V

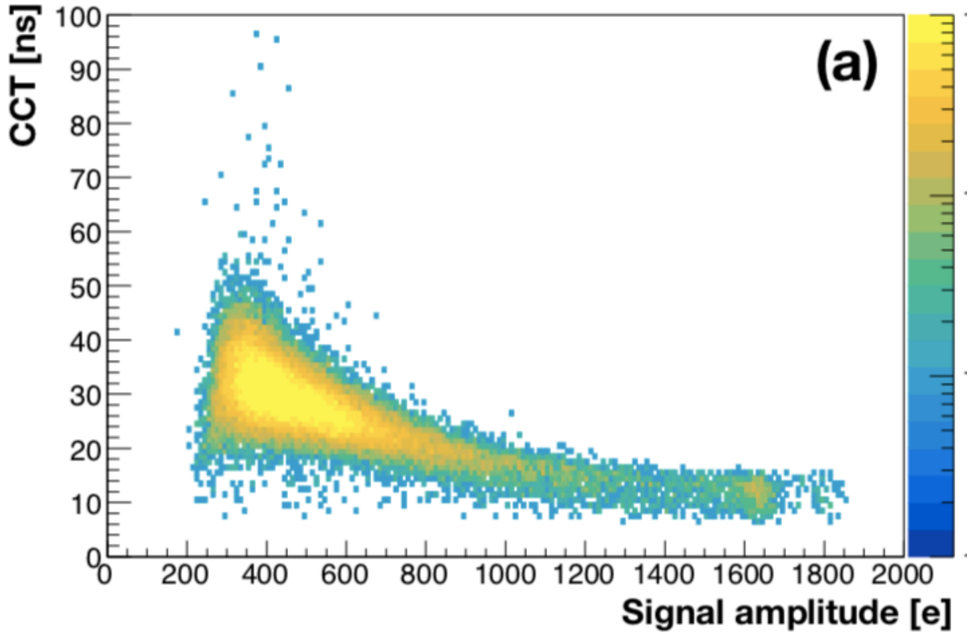
- Cut line of the E-field plane and compare precisely.
- Save E-fields for the Garfield++ simulation.

Goal of Garfield++ simulation

Simulation



Experiment



- Change the distribution of electrons and calibrate with reference to delay caused by inner circuitry.

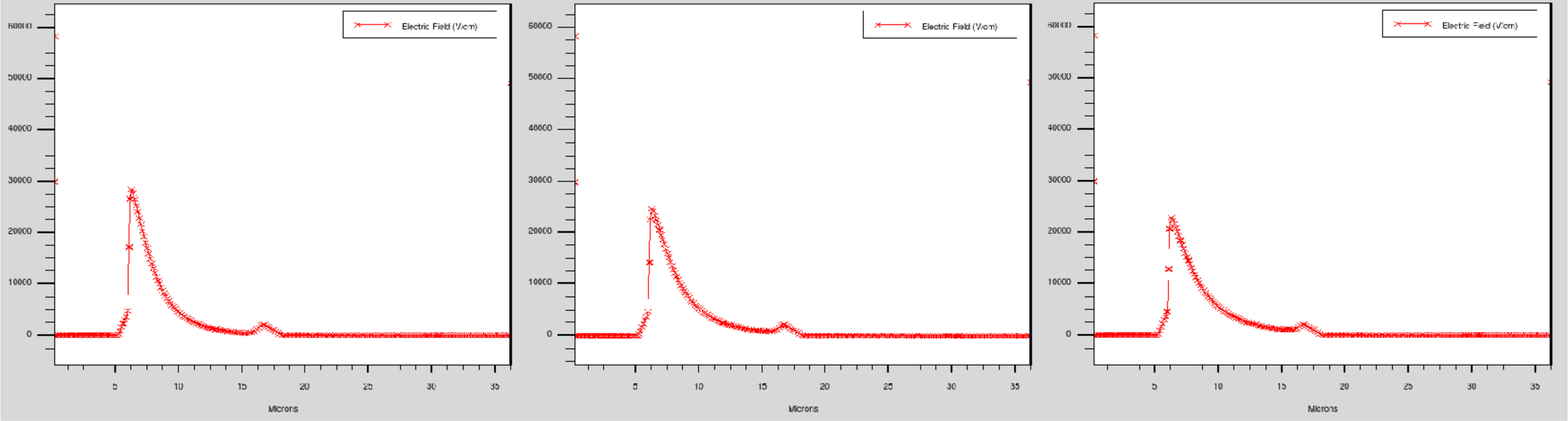
- Confirm the Experimental CCT results with simulation.

Status and Plan

- Status
  - Exporting E-field data from TCAD.
  - Trying to modify the simulation code according to Garfield++’s update.
- Plan
  - Confirm the E-field data by comparing with previous Garfield++ simulation results.
  - Modify the simulation code from random electron distribution to e-h pair generation.
  - Calibrate CCT data with reference to Miko’s calculation.

Back up

TCAD simulation



Spacing 1um (MM78) **Spacing 3um (MM80)** **Spacing 5um (MM82)**

- Comparison of E-fields according to spacing.
- (Pixel pitch: 28um, N-well size: 3um, V_{BB}: 6V)