Discussion with Hamamatsu's Engineer

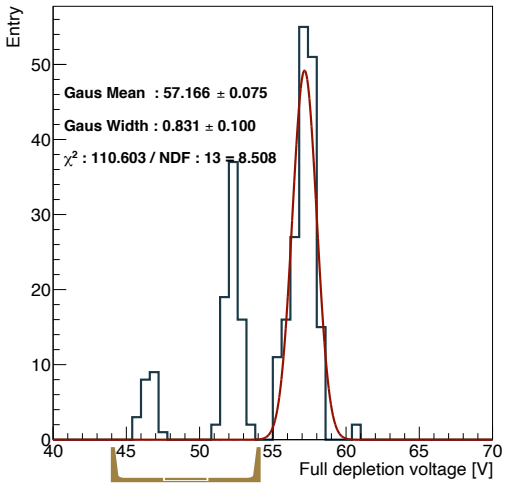
RIKEN/RBRC

Itaru Nakagawa

INTT sensor, full depletion voltage

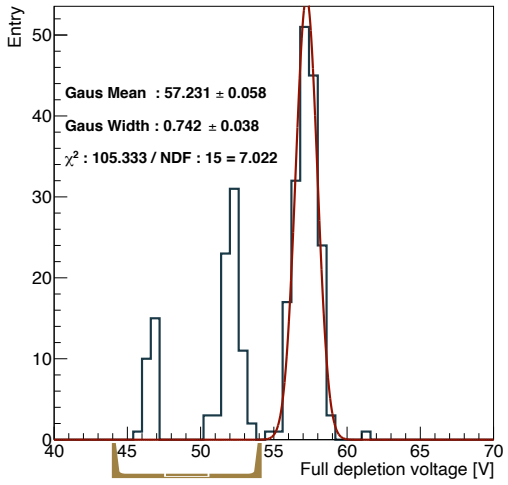
274 sets of sensors are included,
file title : 190528_S…datasheet (149 sets) + 211130_S…datasheet (25 sets) + 200519_S…datasheet (100 sets)
sensor ID (A & B) : 1011 ~ 1159 + 1161 ~ 1185
1231 ~ 1330 (A) & 1223 ~ 1322 (B)

Type-A, full depletion voltage



200519_S…datasheet

Type-B, full depletion voltage



200519_S…datasheet

These three peaks are originated from the purity of silicon within ingots for wafers. They are known to vary by this much from one batch to another.

This is usually not an issue as long as silicons are operated high enough from the full depletion voltage, not to mention.

Hamamatsu's insight

Cheng-Wei's slide June 3rd, 2022

Silicon Ingot

TELESCOPE Magazine
What does technology hold in store for societies of the future?

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MENU

small stick of seed crystal hung from the end of a wire is dipped into liquid silicon. As the stick is rotated and slowly pulled up, an ingot of monocrystalline silicon is formed that has the same atomic arrangement as the seed crystal (Figure 3, top). The cylindrical ingot is then sliced into thin circular wafers, which are polished, etched, and cleaned multiple times until their surface is as shiny as a mirror (Figure 3, bottom).

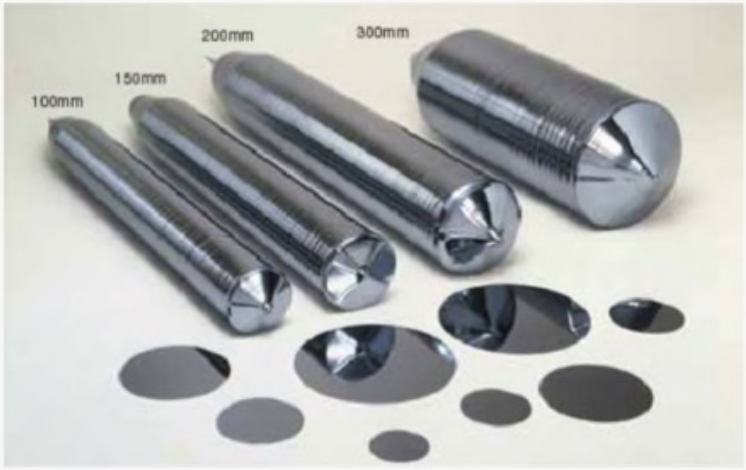

Figure 3. Silicon ingots (top) and wafers (bottom) of different diameters
Source: SUMCO

Contents

- Cross Talk
- Visiting Laboratories
- Expert Interview
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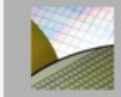


Semiconductor Technology Now

Part 1

- The Race for 14 nm Semiconductor Fabrication to Intensify This Year Question: What Exactly Does the 14 nm Dimension Correspond to?

https://www.tel.com/museum/magazine/material/150430_report04_03/02.html

INTT Performance Open Questions

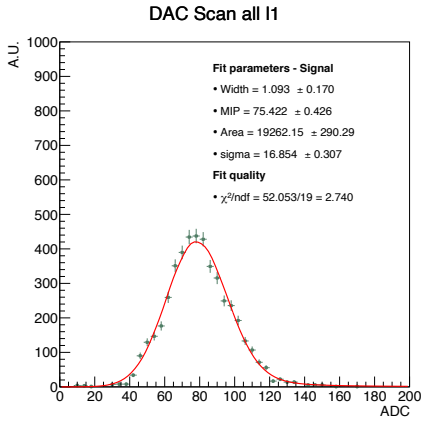
- ADC response as a function of the bias voltage
  - 100V@Fermi 2019 vs. 50V@Tohoku 2021
  - Bias scan result with source in Taiwan still doesn't explain 50V response. Sensitivity?
- Offset 200mV or 280mV is question, but this doesn't explain
  - MIP position vs single+double hit methods conflict
  - Does collimater with source helps?
  - Will be investigated by the latest NWU cosmic ray measurement with 3 ladder telescope. This study gives better angular control of trajectory compared to past single+double hit measurement.
- Thick tail of the residual distribution cannot be reproduced by MC
  - Implement accidental hit rates in MC using far side silicon area from the beam spot (Cheng-Wei)
  - Compare with low rate cosmic ray residual distribution.
  - Ultimate rate effect free efficiency evaluation with cosmic ray

Slide from the INTT meeting in May/27/2022

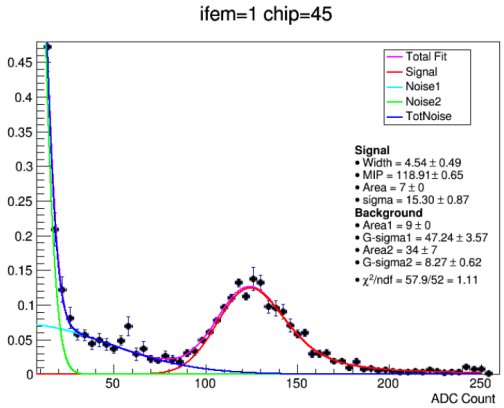
DAC scan comparison

https://indico.bnl.gov/event/15657/contributions/63079/attachments/40865/68318/INTT_energydeposit_summary.pdf

Testbeam2021, 50 V
Positron beam, 1 GeV



Testbeam2019, 100 V
Proton beam, 120 GeV



The peaks are different
Original though : because of the difference of the supplied voltage

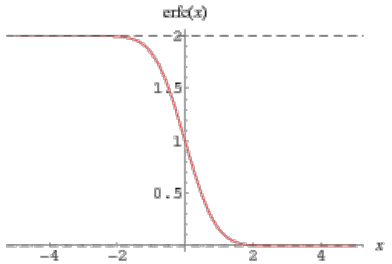
Capacitance - bias voltage

174 sets of sensors are included, file title : 190528_S…datasheet + 211130_S…datasheet
sensor ID : 1011 ~ 1159 + 1161 ~ 1185

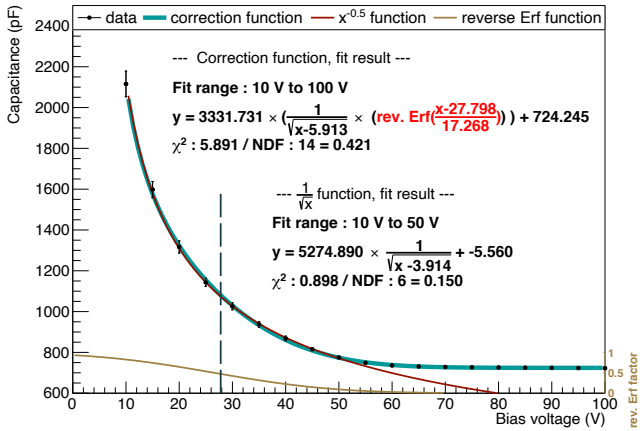
Based on the theory :

$$C \propto \frac{1}{d} \propto \frac{1}{\sqrt{V}} \propto \frac{1}{signal}$$

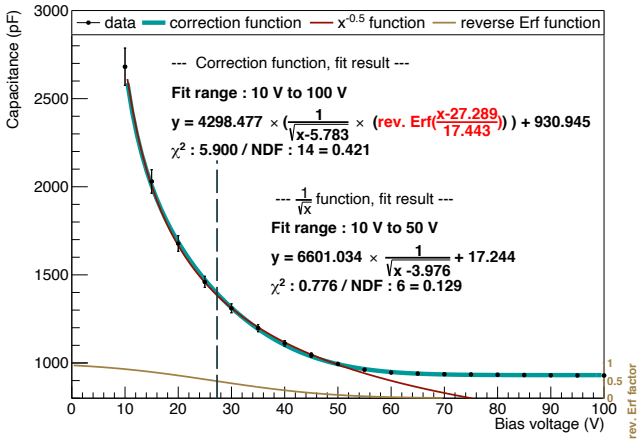
Complementary error function as a factor



Capacitance - Bias voltage (Type-B)



Capacitance - Bias voltage (Type-A)

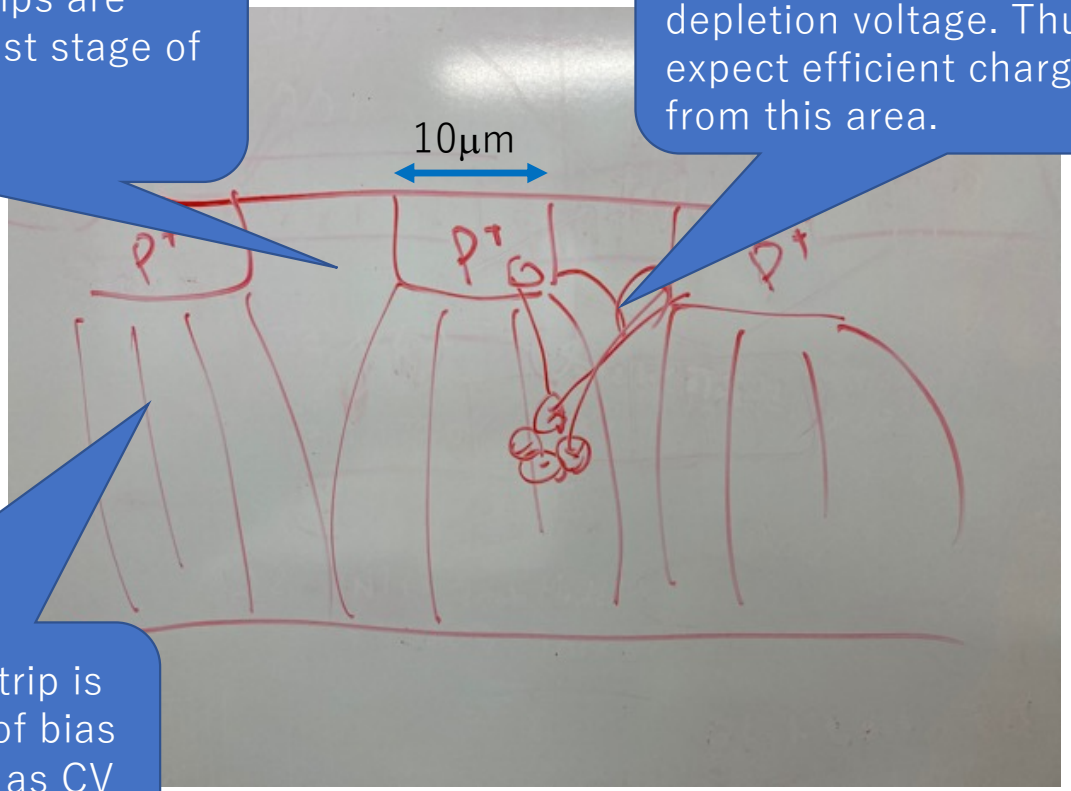


https://indico.bnl.gov/event/15909/contributions/63587/attachments/41050/68704/INTT_2022_05_20.pdf

Electric field at non-fully depleted voltage

Electric field between strips are developed towards the last stage of fully depletion voltage.

This area between strips might not be depleted even slightly below the depletion voltage. Thus we cannot expect efficient charge collection from this area.



The best way to prove this hypothesis is to see the position dependence of the resolution within the strip width.
We'll see a dip in the efficiency distribution around the edge of a strip.

Is this doable in cosmic ray?

The electric field just below strip is well developed as a function of bias voltage. This directly appears as CV response.