Silicon Sensor Study for ILD ECAL

CALICE Collaboration Meeting @ LAPP
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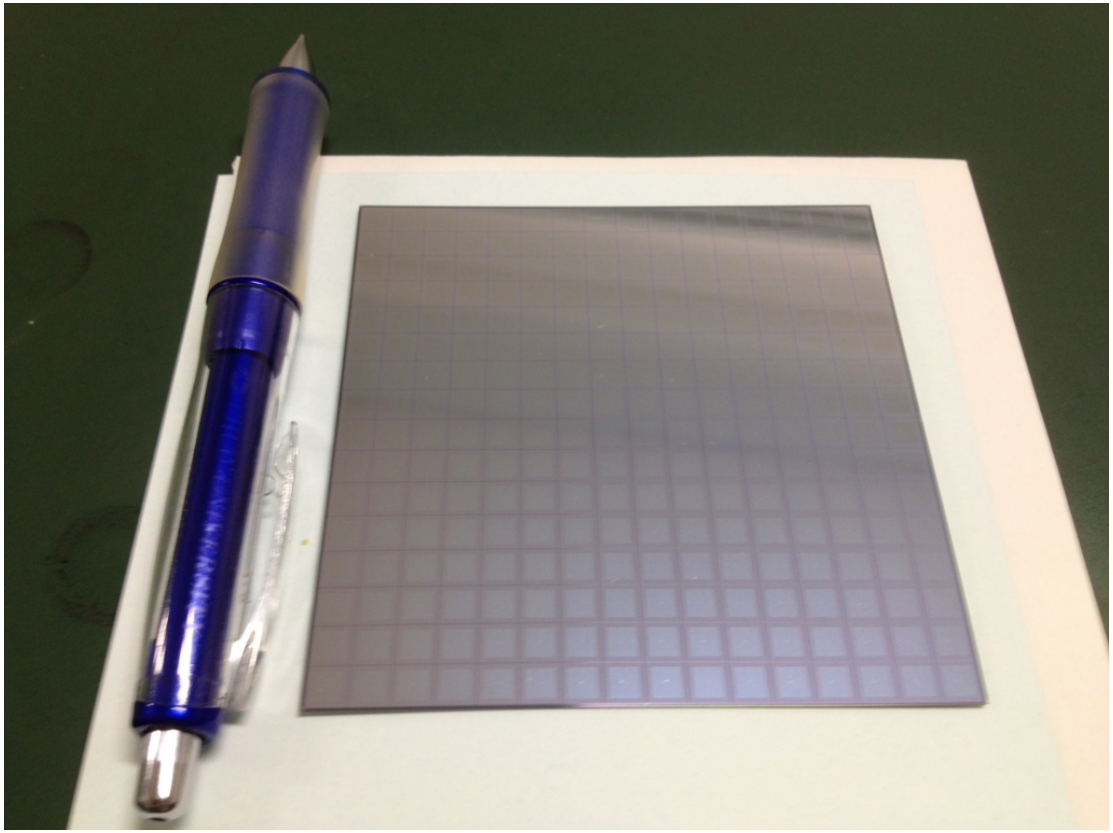
Tamaki Yoshioka
Kyushu University

Contents

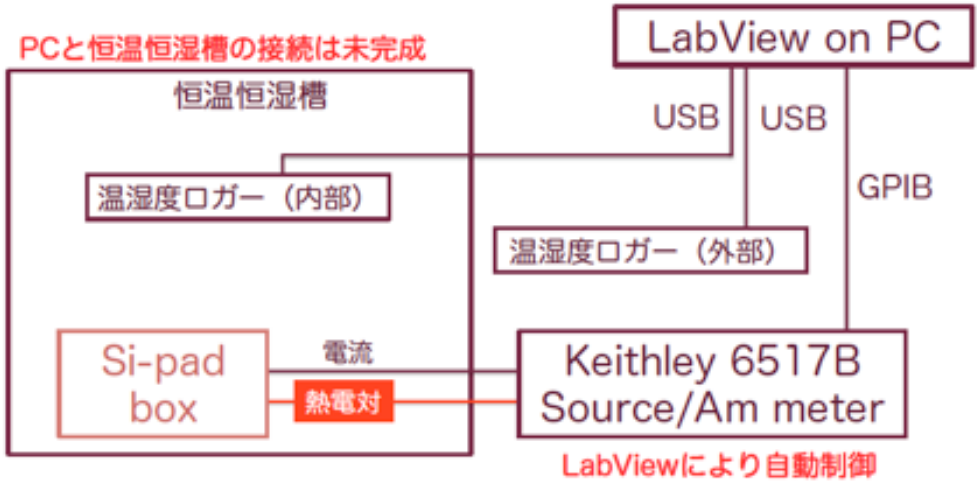
- Measurement of basic properties
  - I-V measurement
  - C-V measurement
- Activities at Kyushu University
- Activities at University of Tokyo
- Summary

Silicon Sensor for ECAL

- Produced by Hamamatus Photonics K.K.
- 16 x 16 = 256 pixels in total
- Pixel size : 5 x 5 mm^2
- Thickness : 300μm

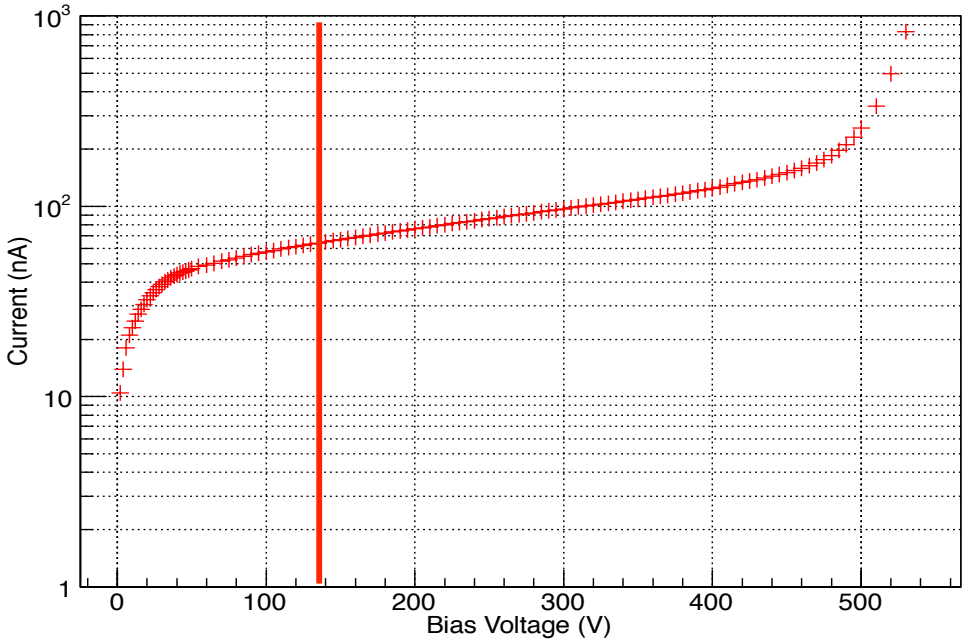


I-V Measurement

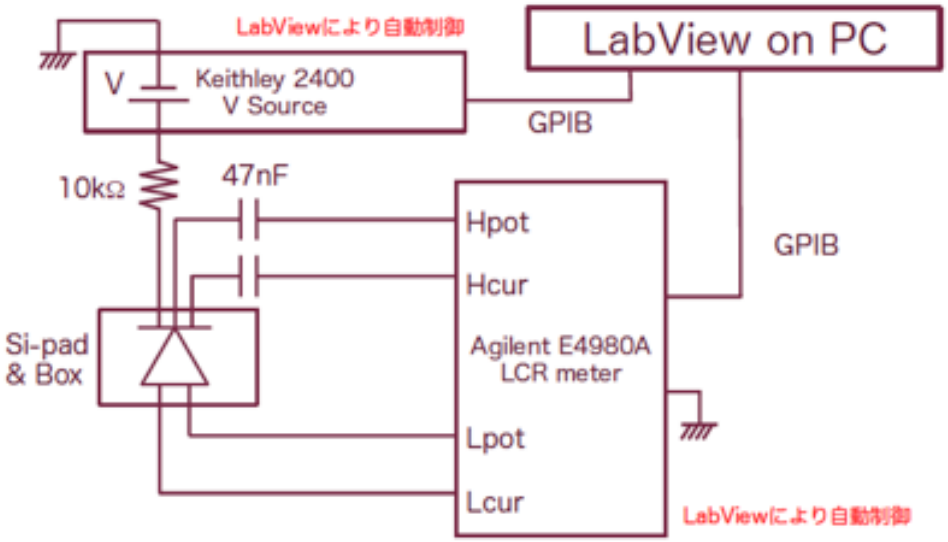


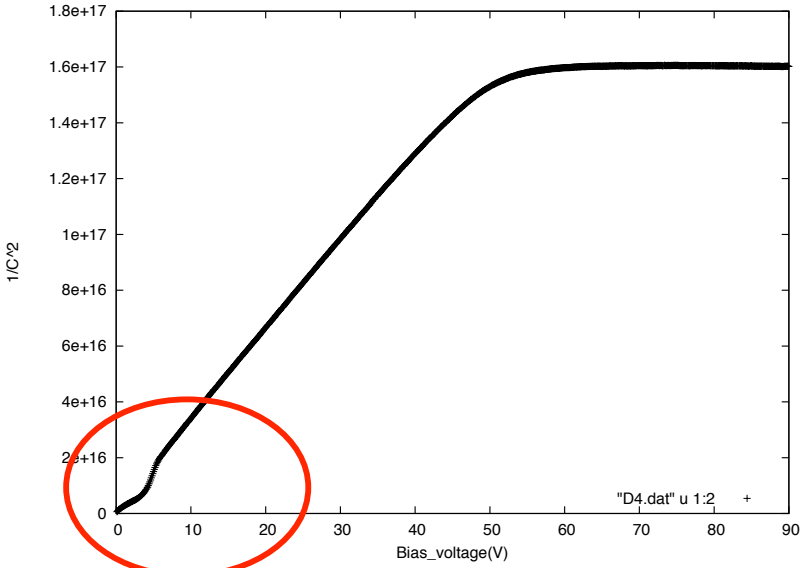
- Temperature/Humidity is controlled.
- Data taking is controlled by Labview (PC).

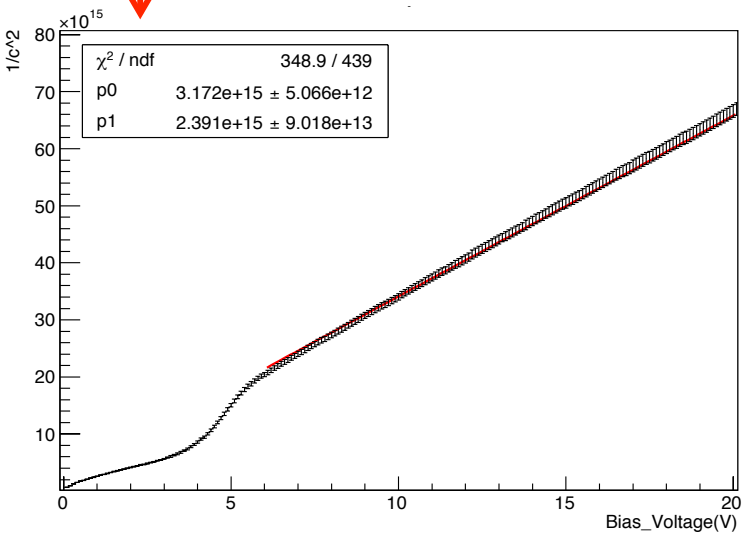
- Leakage current at the operation voltage (120V) is < 100 nA



C-V Measurement



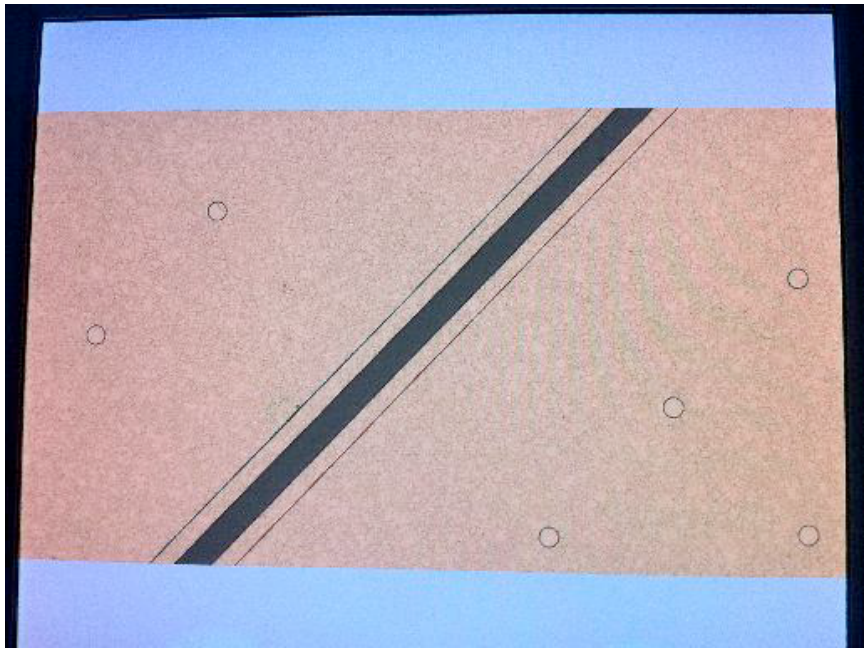




- 6 – 45 V : linear
- > 45 V : saturated (full depletion)
- < 6V : due to the MOS structure

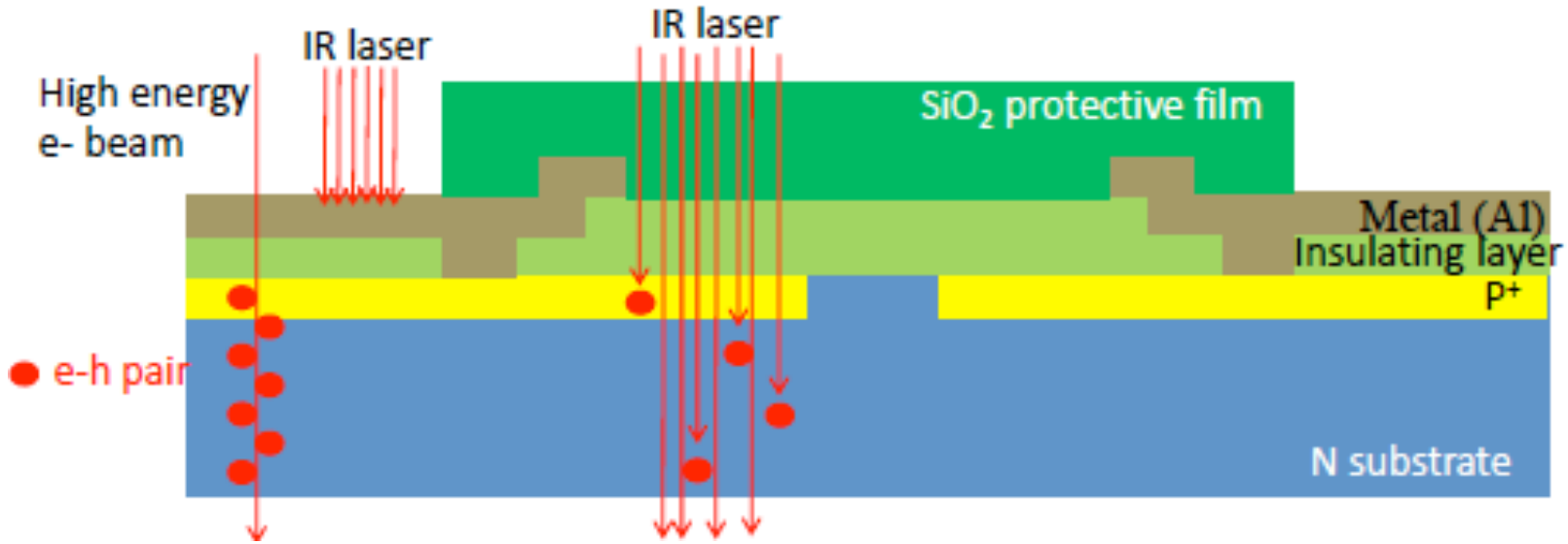
Activities at Kyushu Univ.

- We are going to study the cross talk and signal behavior systematically.
- We are setting up the infrared laser system for this purpose.



Infrared Laser

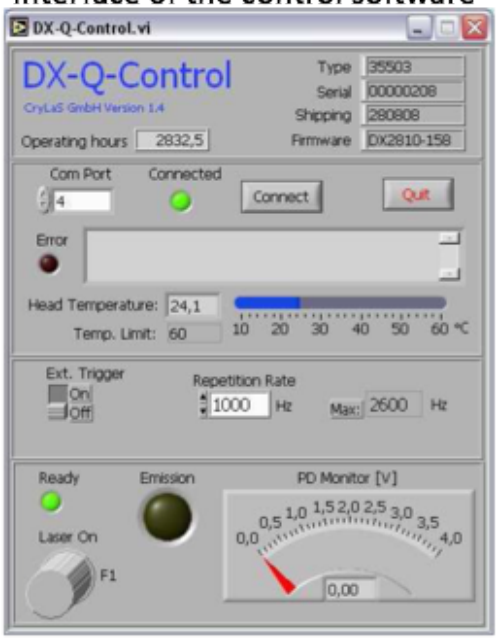
- Wave length → 1064 nm = 1.16 eV
- Energy gap of Si = 1.12 eV
- Average production energy of e-h pair = 3.6 eV
- Almost all laser light go through a Si sensor,
  but they can make e-h pair a certain probability.
  → We can make e-h pair uniformly in a sensitive area.

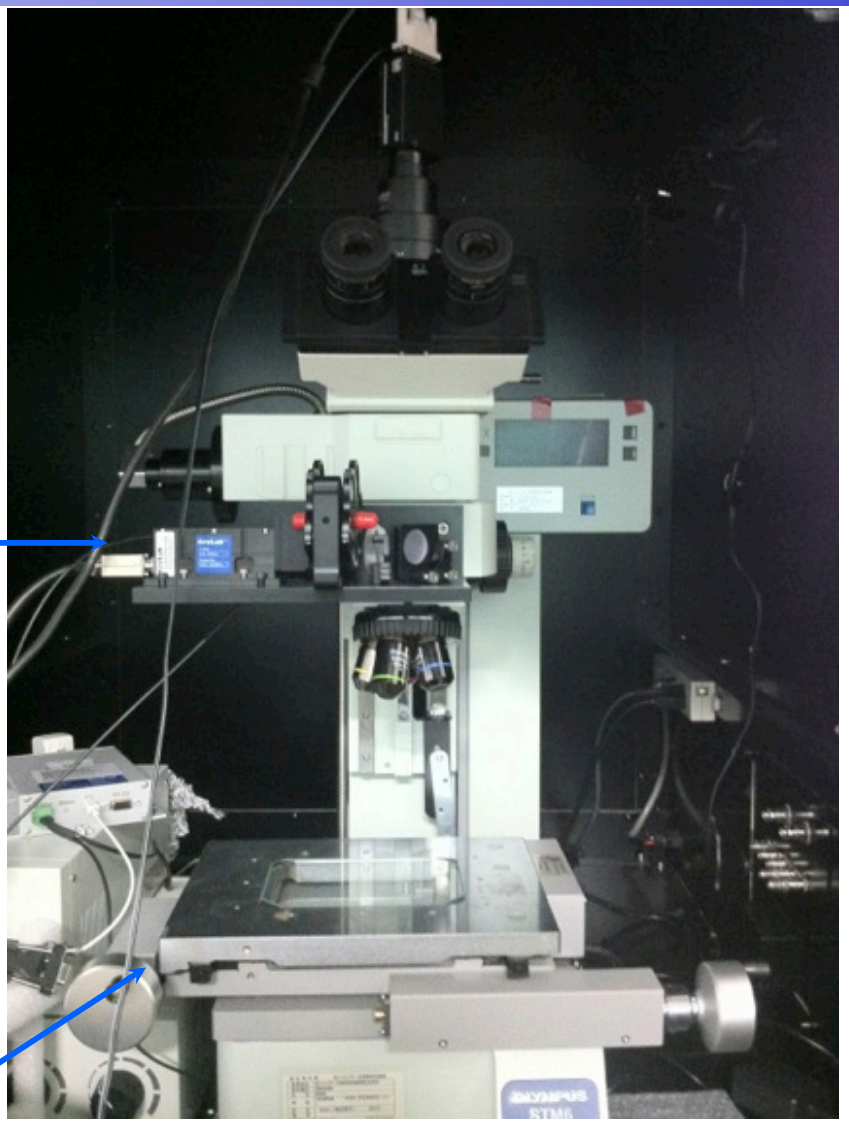


Infrared Laser System

CRYLAS GmbH
DSS1064-Q2 (Class 3B)
Wave length : 1064 nm
Pulse width : ~ 1.5 ns
Pulse energy : > 20 μJ/pulse
~ 10^{14} photons/pulse
Peak power : > 13kW
Reputation rate : 1 ~ 10kHz

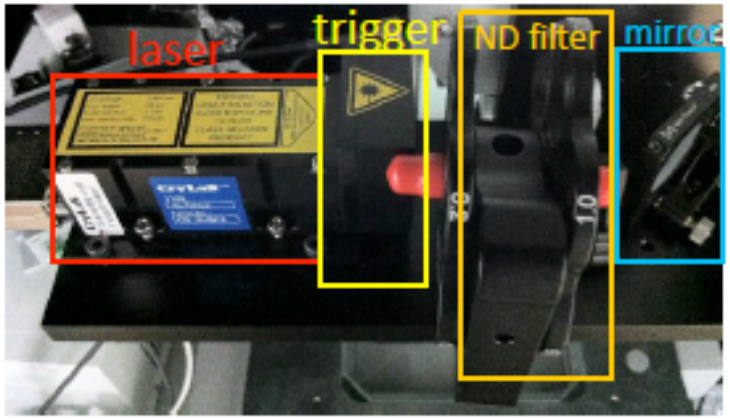
Interface of the control software

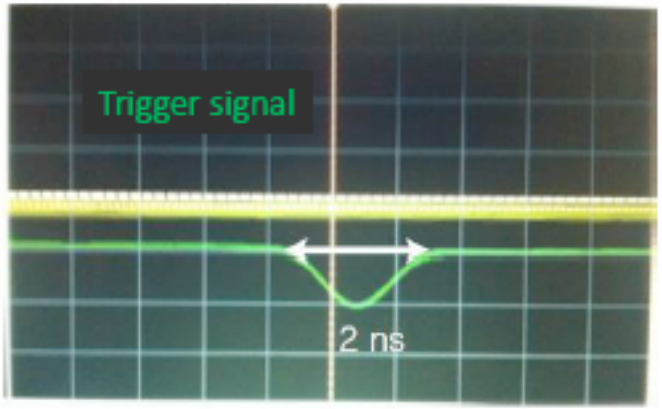




Infrared Laser System

- Trigger module attached just after laser module.
- We can reduced and control laser power with ND-filters.

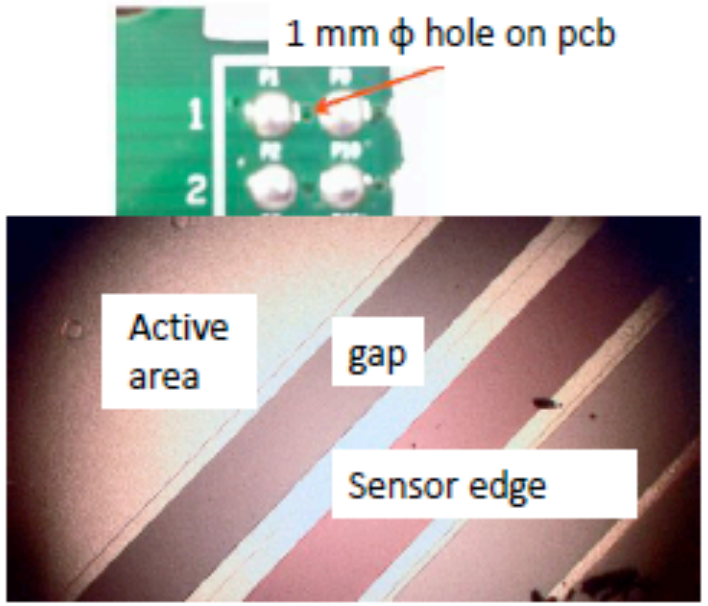


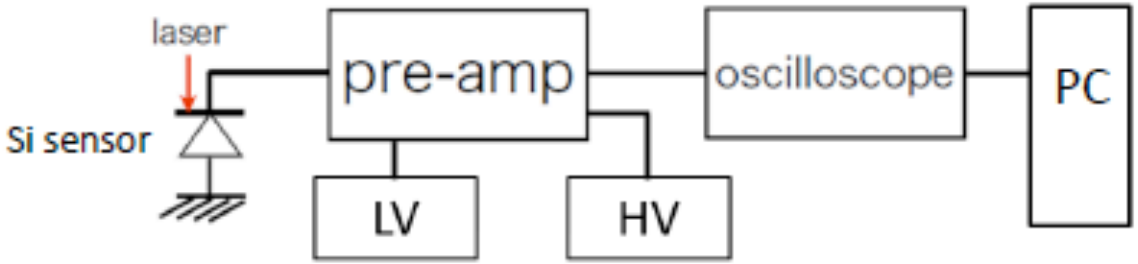


- Trigger signal is made in front of laser injection.

Setup

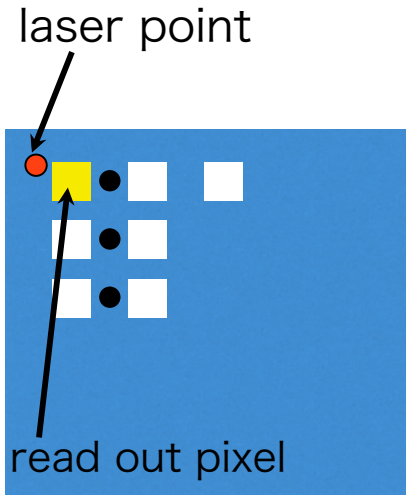
- Laser light is focused on gap between cell edge and sensor gap
- Laser diameter : < 23μm (gap is 32μm)
- Only one channel can be read out for now (one of the corner edge)

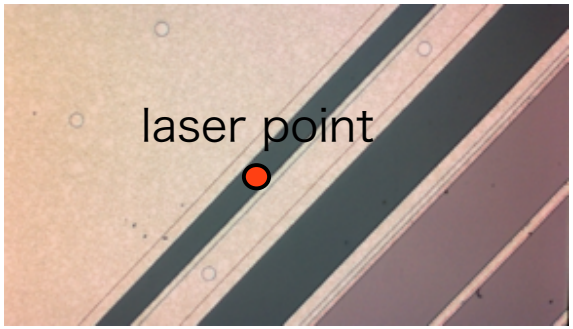


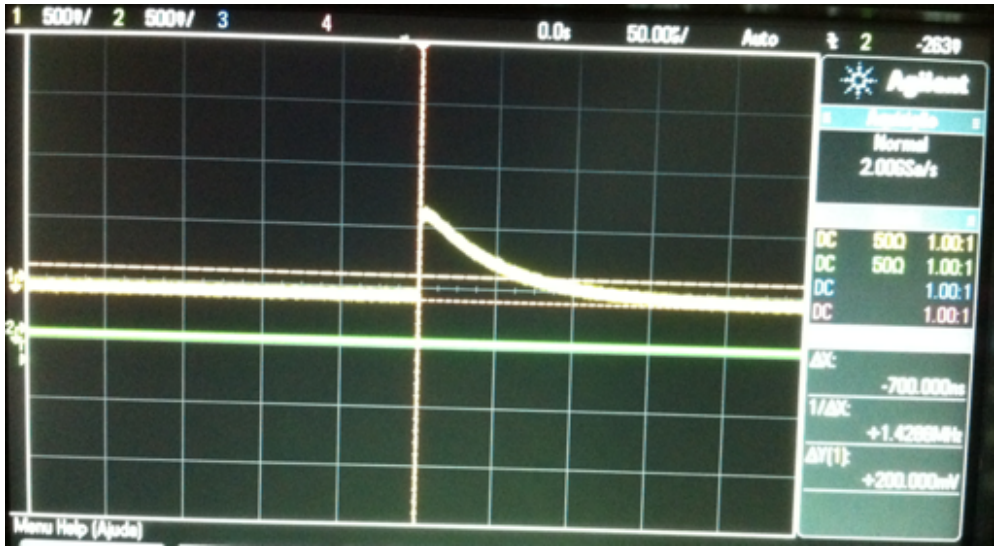


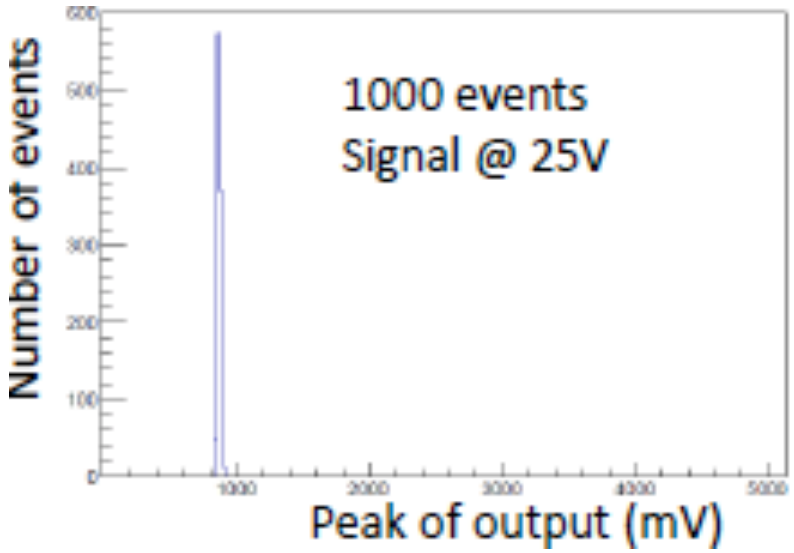
Setup (Cont'd)

- We measured the laser signal with oscilloscope
- Get peak value from each event
- Fit with gaussian function
  →fluctuation of peak value ~1%



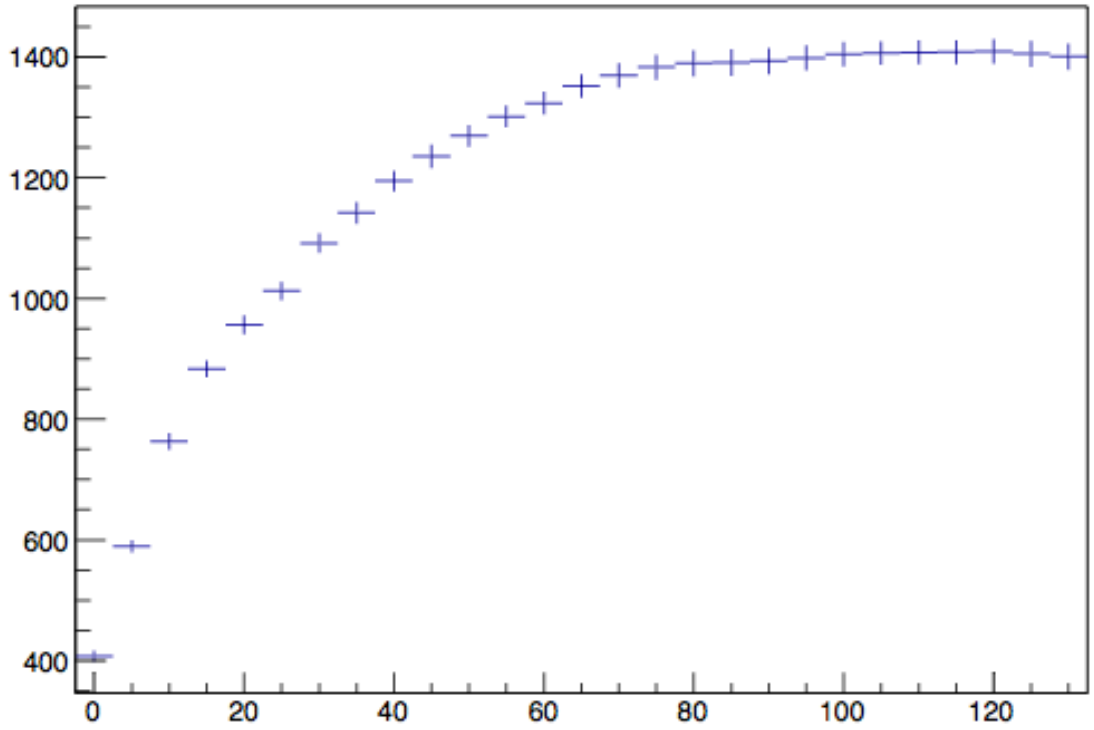






Result

- Bias Voltage scan ranging from 0 to 130 V
- the saturation occurs because of full depletion



Activities at Univ. of Tokyo

Daniel Jeans, Yoshio Kamiya, Sachio Komamiya
Chihiro Kozakai, Shion Chen

Aim:

- Develop silicon sensor testing station for quality control

Along the way:

- measure and understand sensor properties
  -> define suitable QC tests

- measure effects of radiation damage
  -> confirm expected absence of adverse effects @ ILC doses

Activities at Univ. of Tokyo

We have developed computer-controlled system to measure
I-V and C-V characteristics of sensors

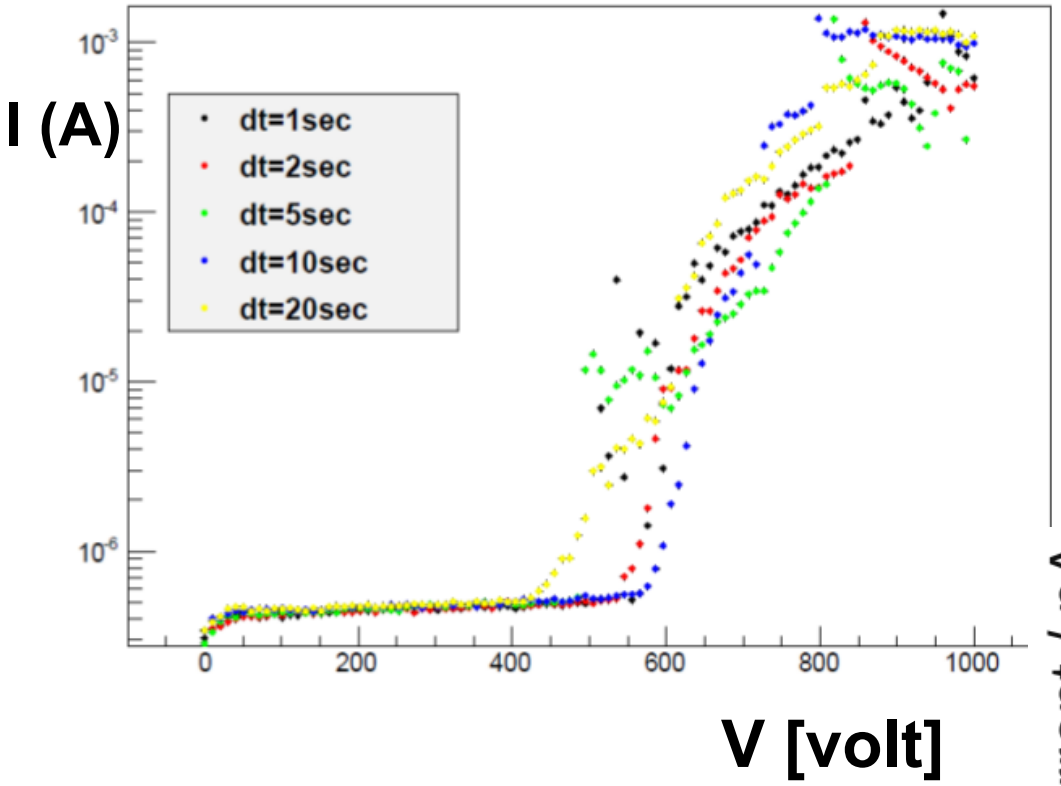
based on Keithley pico-ammeter, Agilent LCR meter, custom GUI

We have started using the system to measure properties of a few sensors

e.g. V-I curves, determination of breakdown voltage
Transient effects after HV turn-on
Temperature dependence
Capacitance vs. Voltage
contribution of si bulk and of MOS structure at pixel

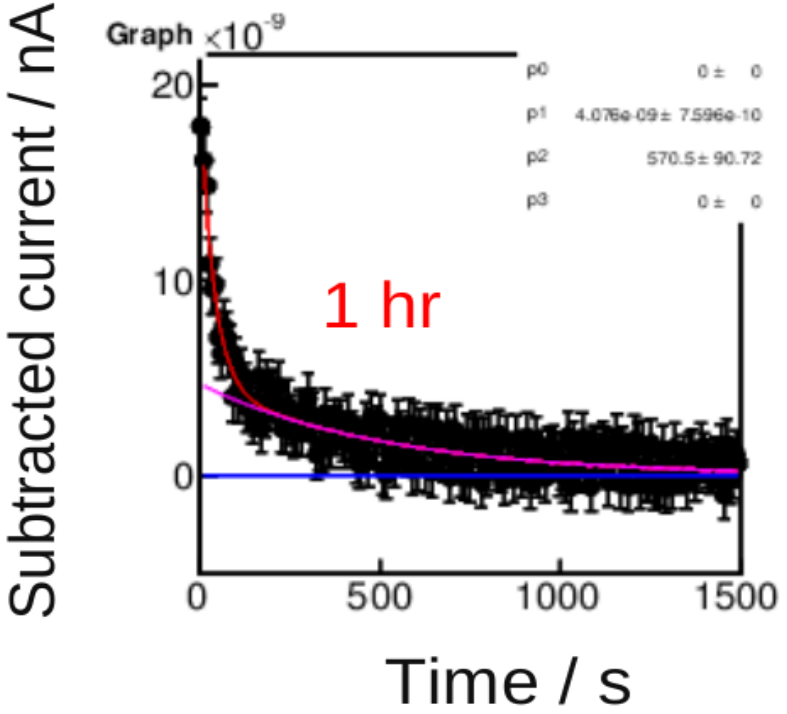
Compare measurements to expectations
to gain confidence in measurement procedure

V-I characteristics seem to depend on
time between measurements in unusual way...

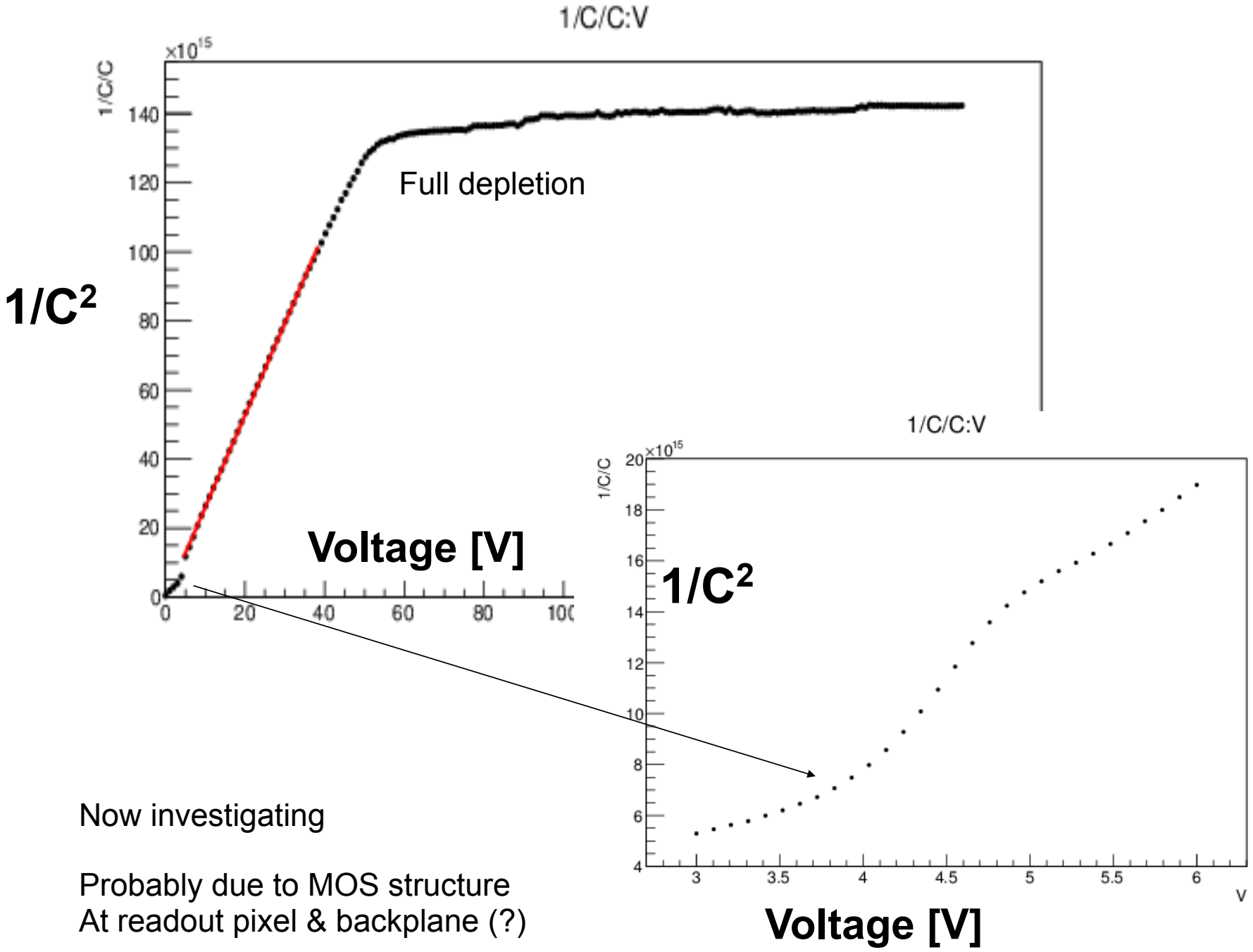


Some examples of first measurements

Transient currents after turn-on of HV



Example of C-V measurements



Now investigating

Probably due to MOS structure
At readout pixel & backplane (?)

Summary

- Both Kyushu/Tokyo group developed computer-controlled silicon sensor test bench in order to measure its properties (I-V, C-V etc).
- We will continue the measurements of several sensors with different designs.
- Kyushu group will continue the study with IR laser system.
- Tokyo group will study the radiation damage of the sensor with neutrons.

International Workshop on Future Linear Colliders

LCWS13

11-15 November 2013, The University of Tokyo

The workshop will be devoted to the study of the physics case for a high energy linear electron-positron collider, taking into account the recent results from LHC, and to review the progress in the detector and accelerator designs for both ILC and CLIC projects.

Website: http://www.icepp.s.u-tokyo.ac.jp/lcws13/

Contact: lcws13@icepp.s.u-tokyo.ac.jp

LCWS13 will be held at The University of Tokyo
11-15 November 2013 (registration is ongoing)
http://www.icepp.s.u-tokyo.ac.jp/lcws13/