1st Open Meeting of the SuperKEKB Collaboration

DSSD R&D Progress at KNU

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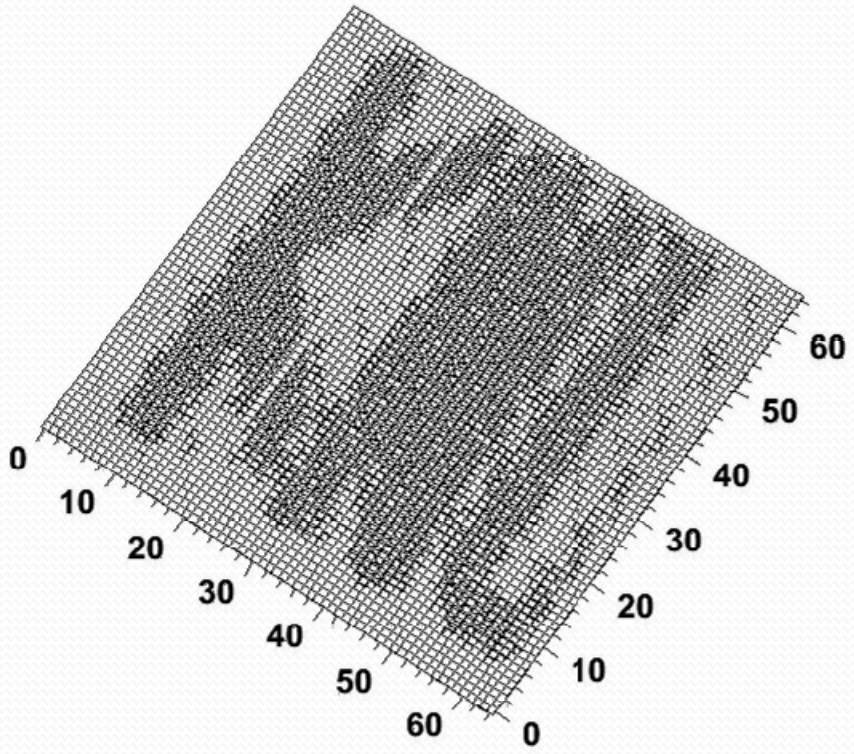
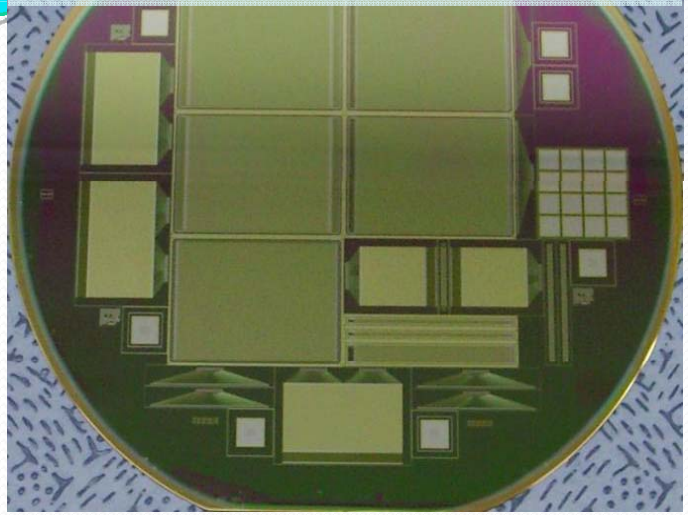
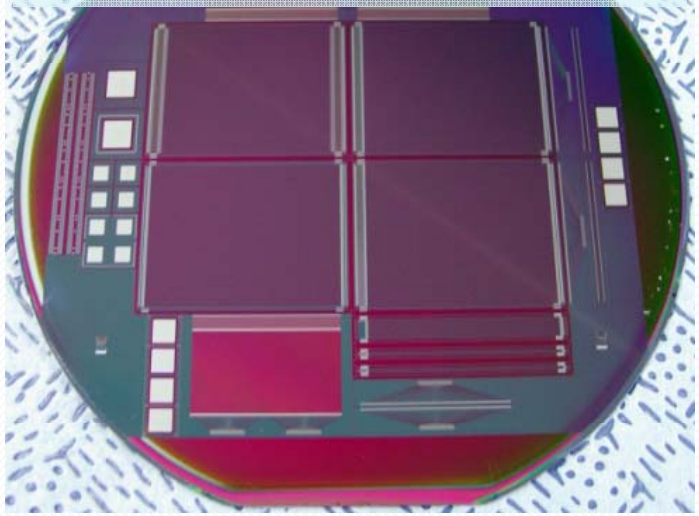


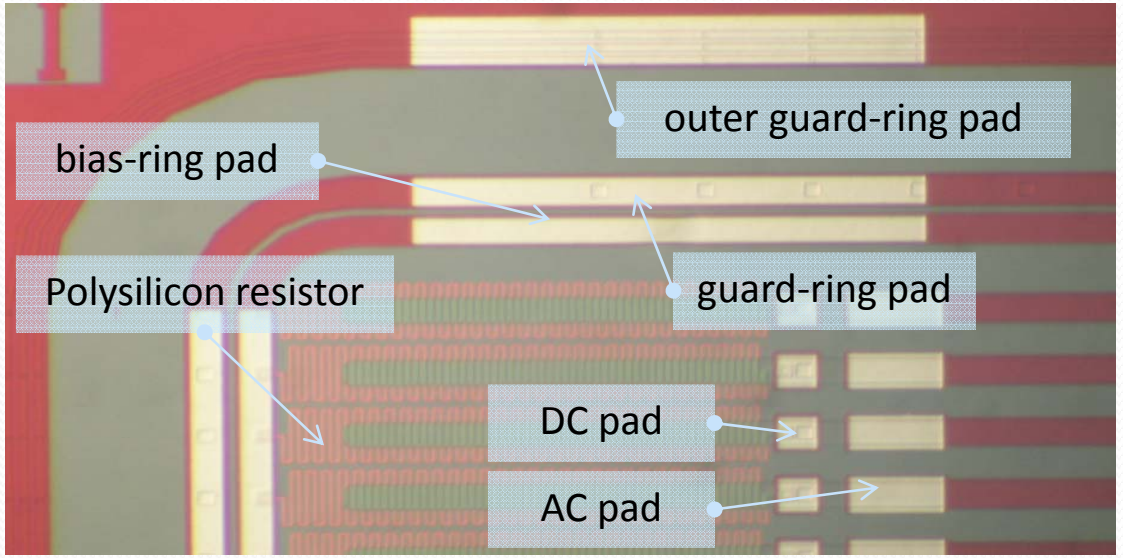
AC-SSSD : Prototypes

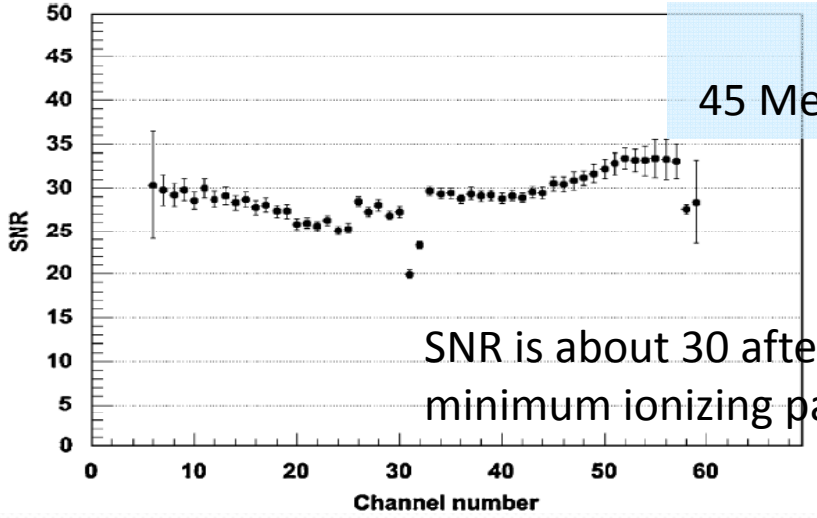
<100> high resistivity ,n-type,
6 in. 400 μm thick wafer



<100> high resistivity ,n-type,
5 in. 380 μm thick wafer



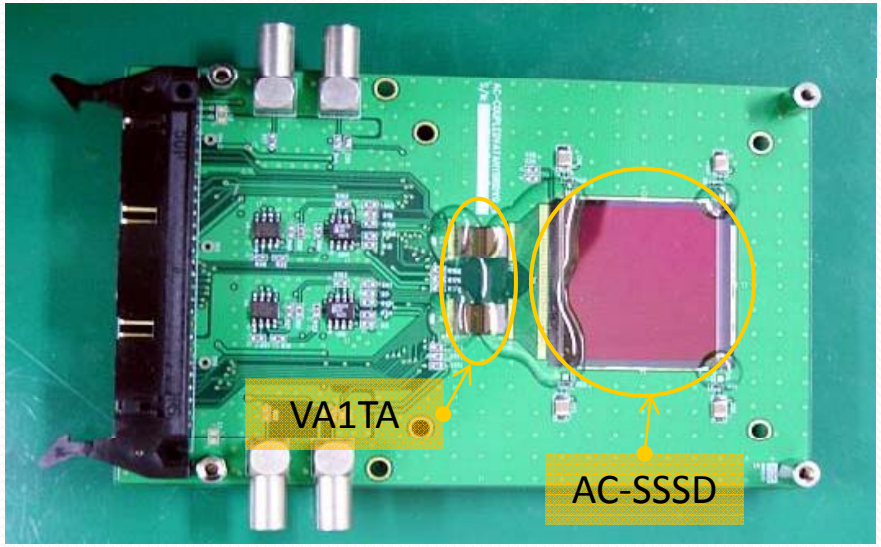


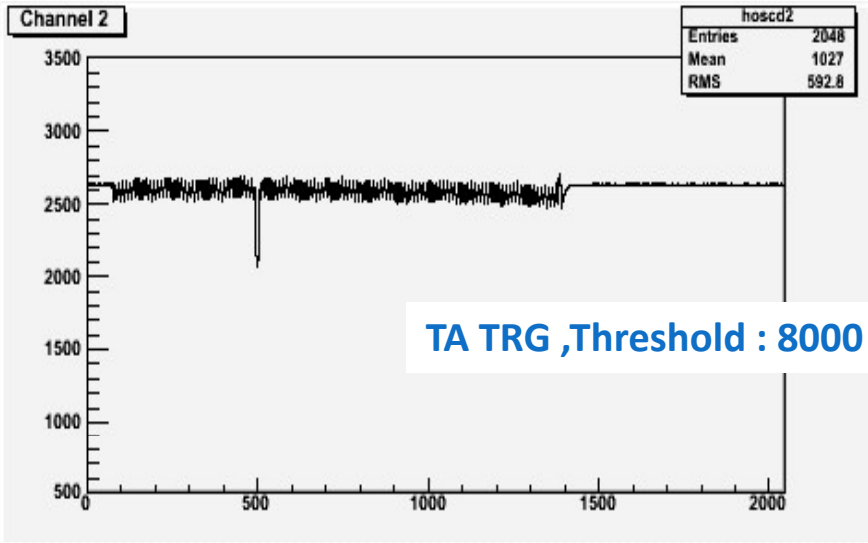


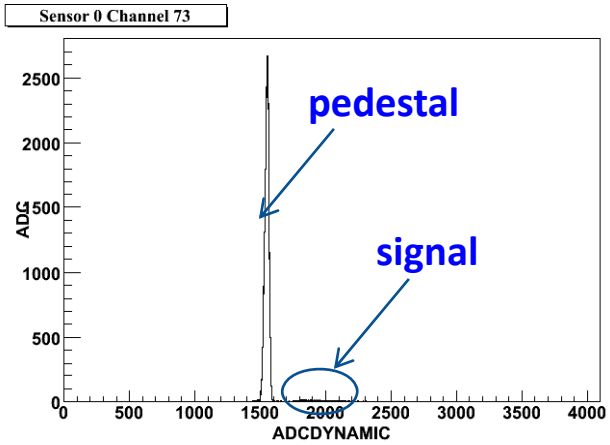
SNR test using
45 MeV proton beam

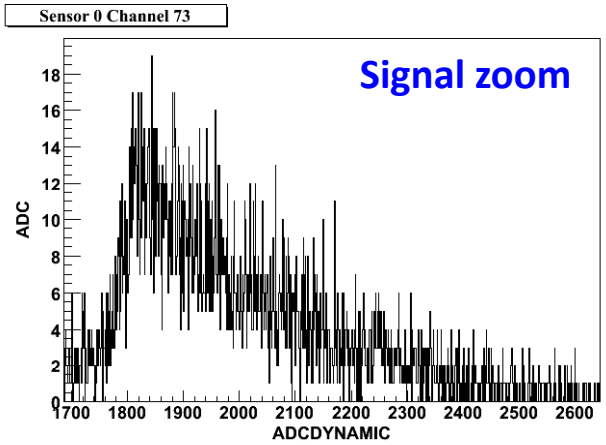
SNR is about 30 after correcting for minimum ionizing particles

AC-SSSD : Source test with ^{90}Sr









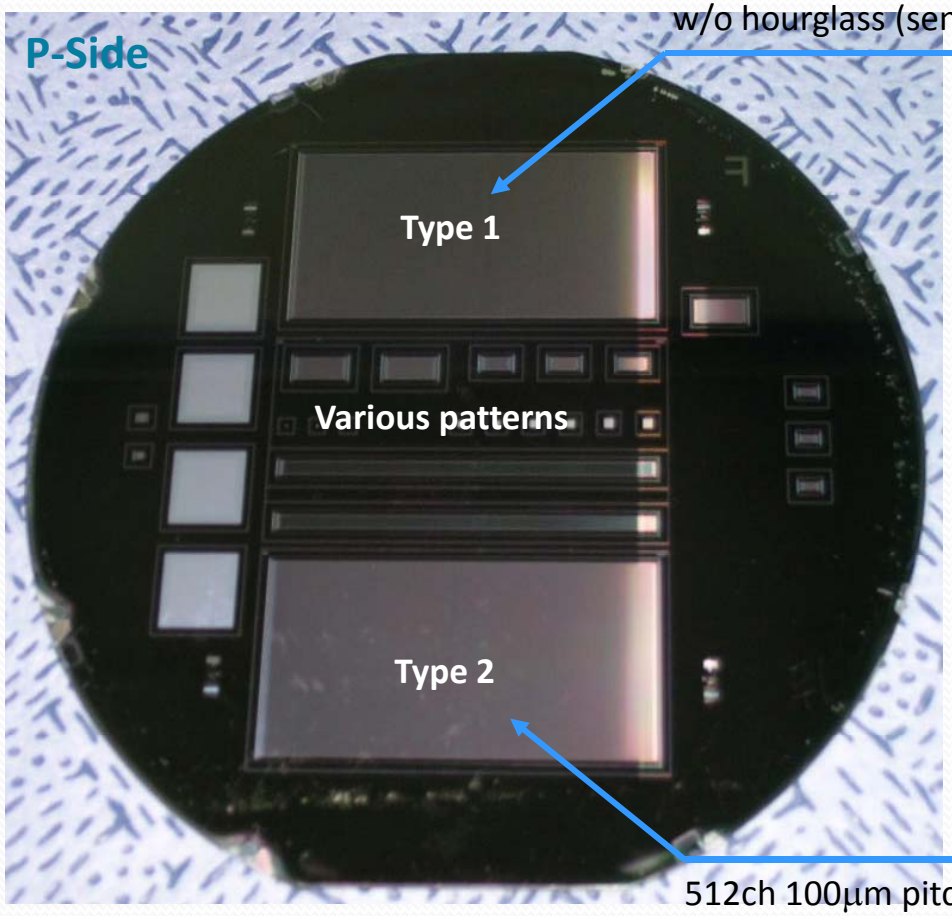
Pedestal : 1549.73 ± 15.17

Signal (MPV) : 1882.67

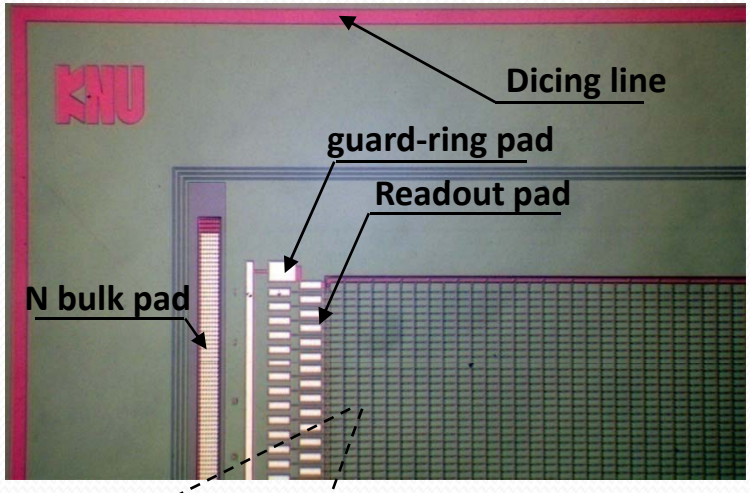
→ SNR = 21.94

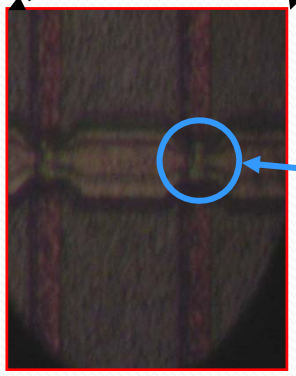
DC-DSSD : Prototype

512ch 100μm pitch
w/o hourglass (sensor-1)



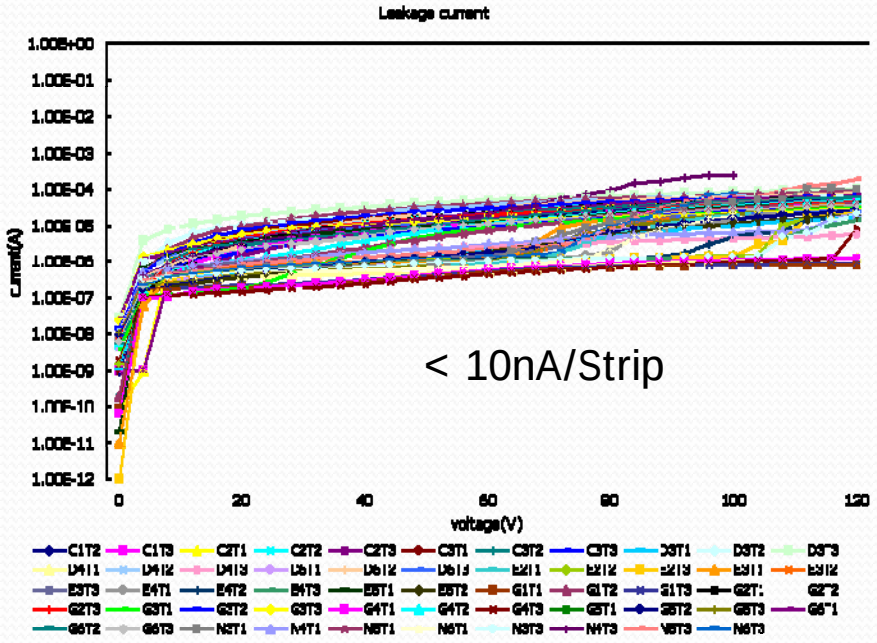
512ch 100μm pitch
w/ hourglass (sensor-1)



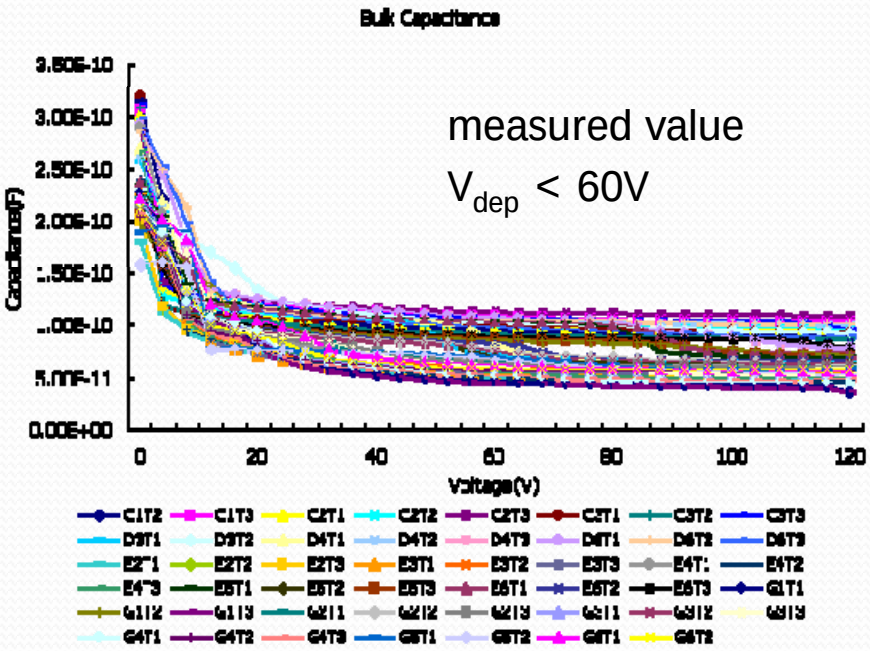


Hour-glass pattern
on the p-side
to reduce the
capacitance
in the double metal
structure

DC-DSSD : Electrical characteristics



I_d vs. V



C vs. V

$$c = \frac{\varepsilon\varepsilon_0}{d} = \sqrt{\frac{\varepsilon\varepsilon_0 q N_D}{2V}}$$

c : capacitance, V : depletion voltage,
d : depletion layer depth,
N_D : doping concentration,
q = elementary charge,
ε : dielectric constant,
ε_o : permittivity in a vacuum

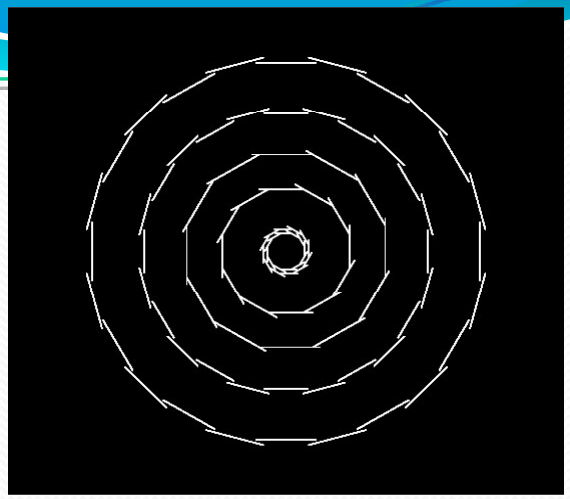
→ expected V_{dep} ~ 55 V

Specification

AC-SSSD			DC-DSSD	
380		Thickness (μm)	380	
35000 × 28000		Area (μm^2)	55610 × 29460	
type 1	type2	Number of strips	p+ side	n+ side
128	256		512	512
200	100	Strip pitch (μm)	100	50
200	100	Readout pitch (μm)	50	50
80	40	Strip width (μm)	9	9
500		SiO_2 layer thickness (nm)		
~ 25		target biasing resistance (MΩ)		
~ 150		target coupling capacitance (pF)		
Good quality				

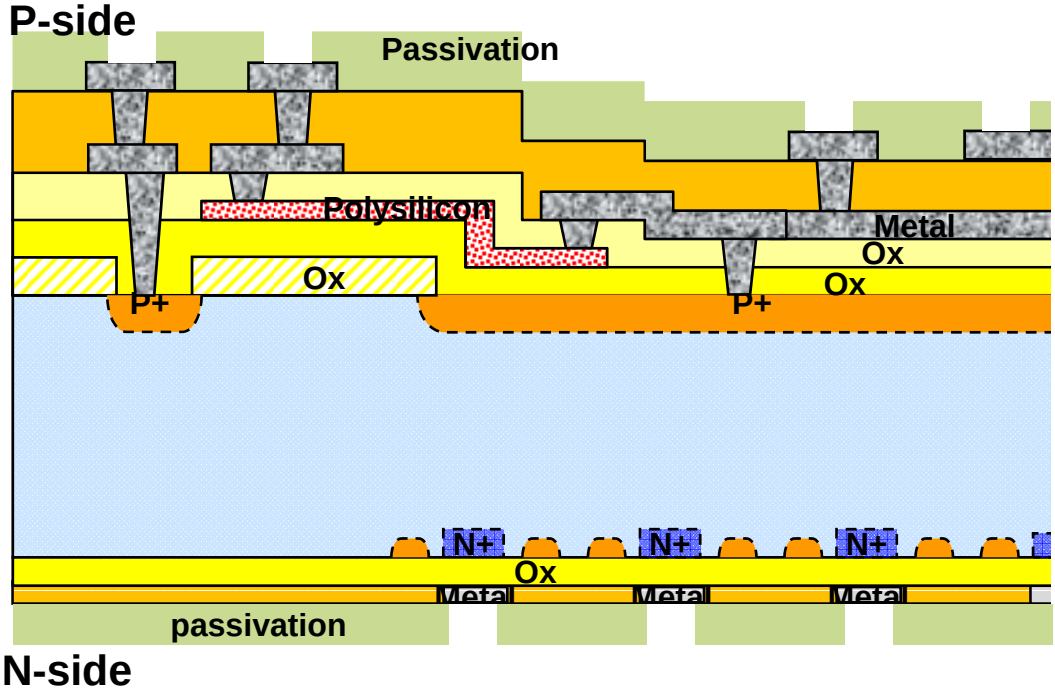
AC- DSSD

AC-DSSD



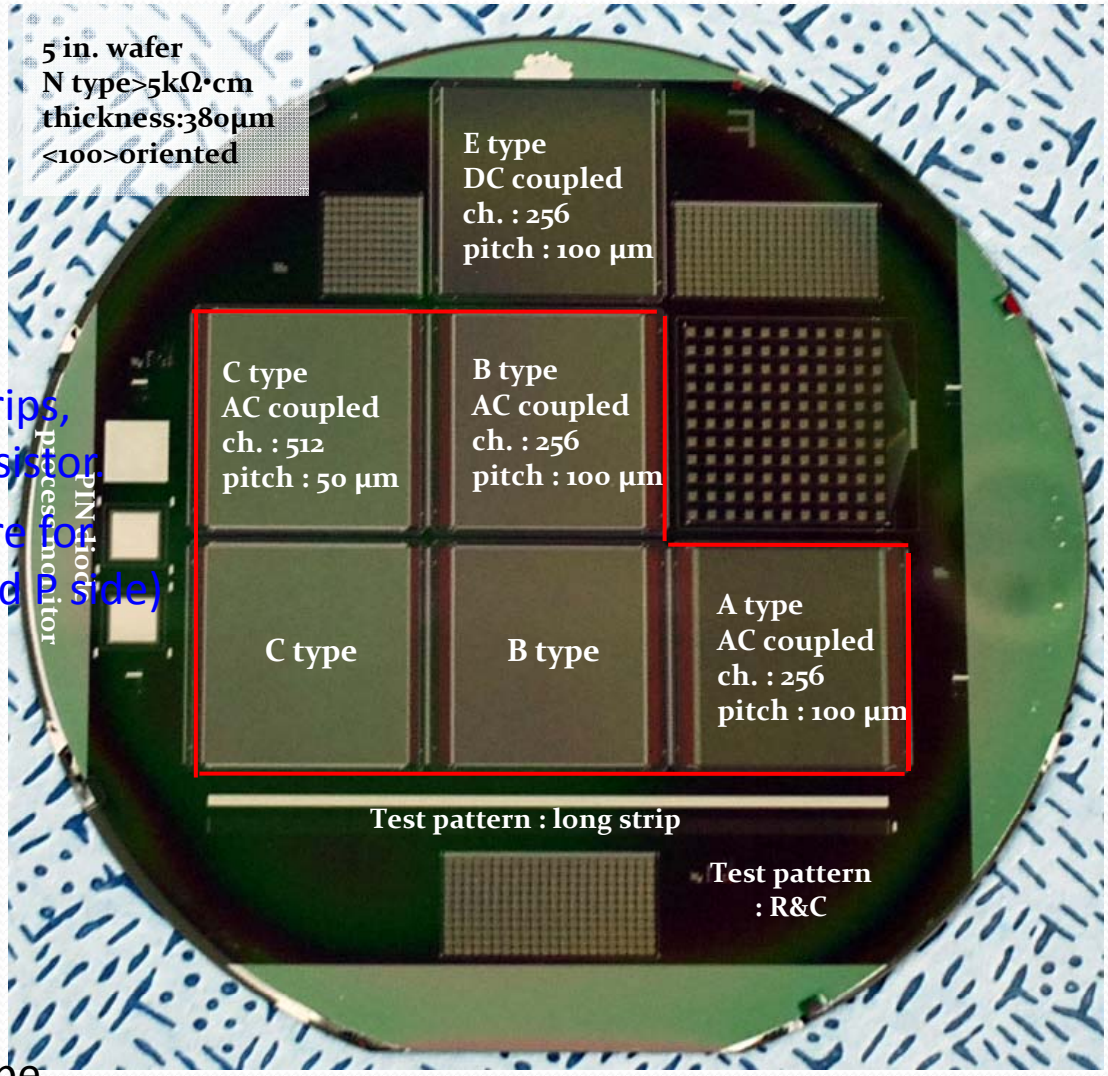
- SuperB Silicon Vertex Detector (LOI' 04)
  - Inner 2-layer PXD / Outer 4-layer DSSD

- Total 14 photo-masks are needed to fabricate the sensor.



AC-DSSD : Prototype

- 5inch wafer
  - <100> 5kΩ•cm N type
  - thickness : 380μm
- 3 type strip sensors
  - size : 2.8cm × 2.8cm
  - A,B,C type has the 256/512 strips, coupling capacitor and bias resistor
  - B and C type have VIA structure for same read-out direction (N and P side)
  - E type is DC sensor
- 3 type Pixel sensors
  - AC Pixel array
    - 11 × 11 array – D type
  - DC pixel array
    - 11 × 11 array – E_Pix type
    - 11 × 22 array – E_Pix_x2 type

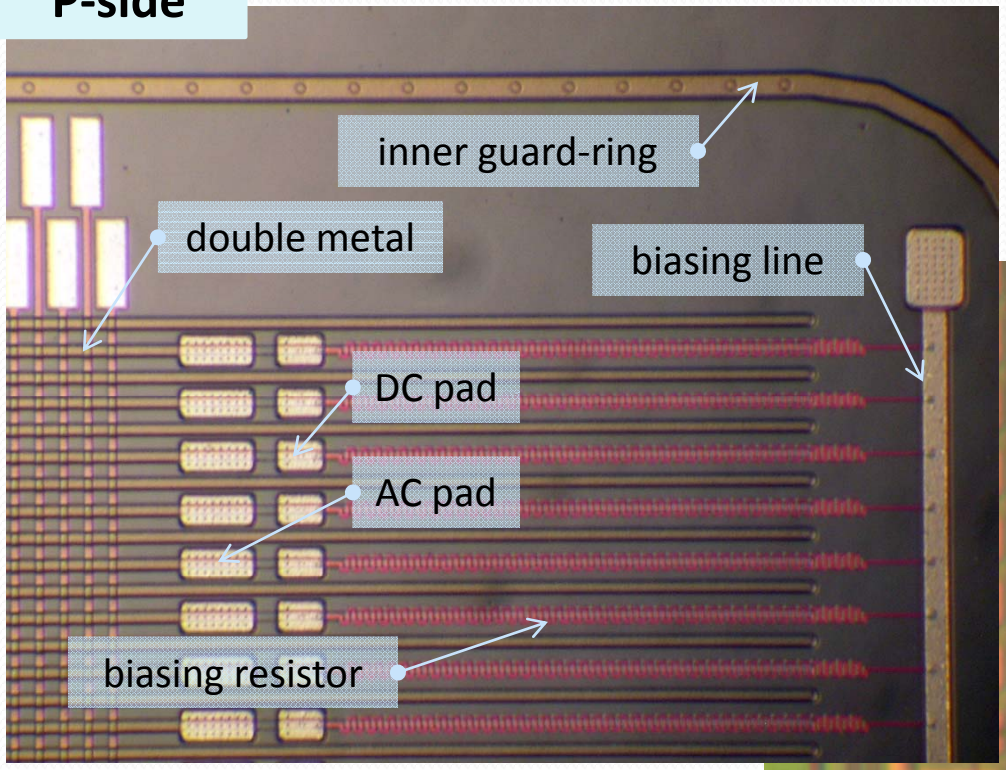


AC-DSSD : Specification

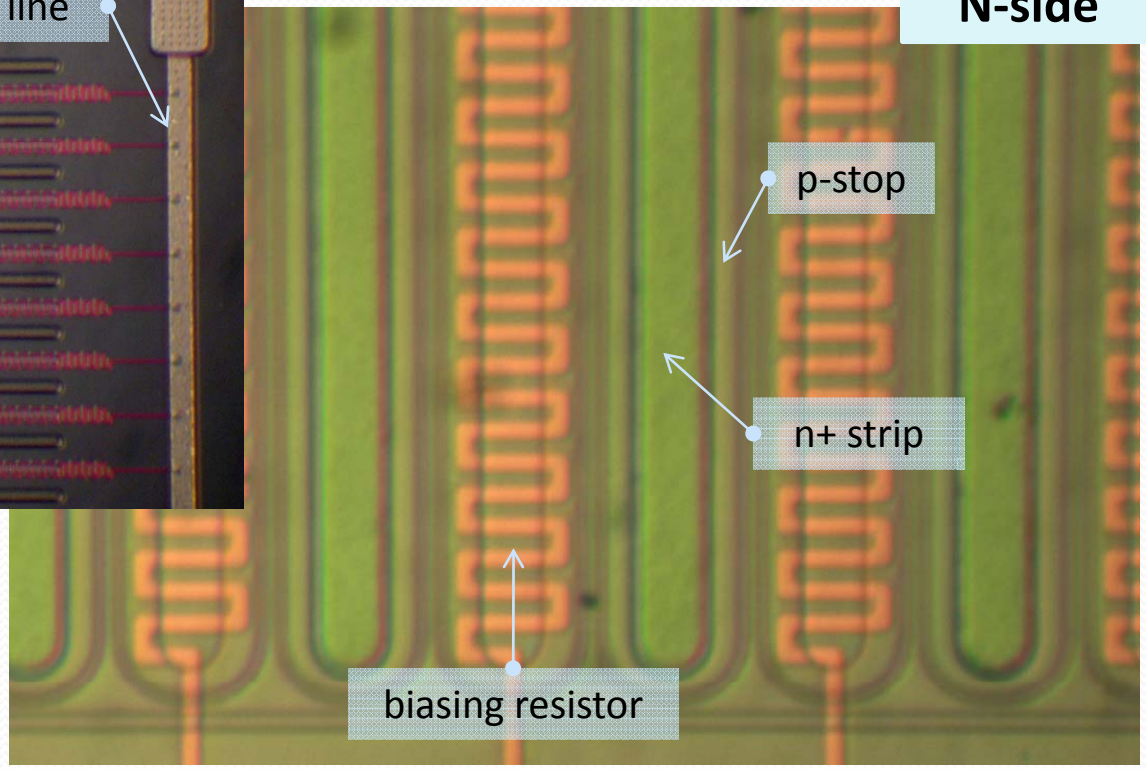
type	AC			DC
	A	B	C	E
size	2.8 cm × 2.8 cm			
number of channels	256	256	512	256
strip pitch (μm)	100	100	50	100
strip width (μm)	40	40	10	40
P-stop punch-through space (μm)	6	6	6	6
Biasing resistance expected value (MΩ)	11.88	11.88	12.88	-
coupling capacitance expected value (pF)	212.06	212.06	61.85	-
VIA structure for same readout direction	w/o	w/	w/	w/o

AC-DSSD : detailed view of C-type

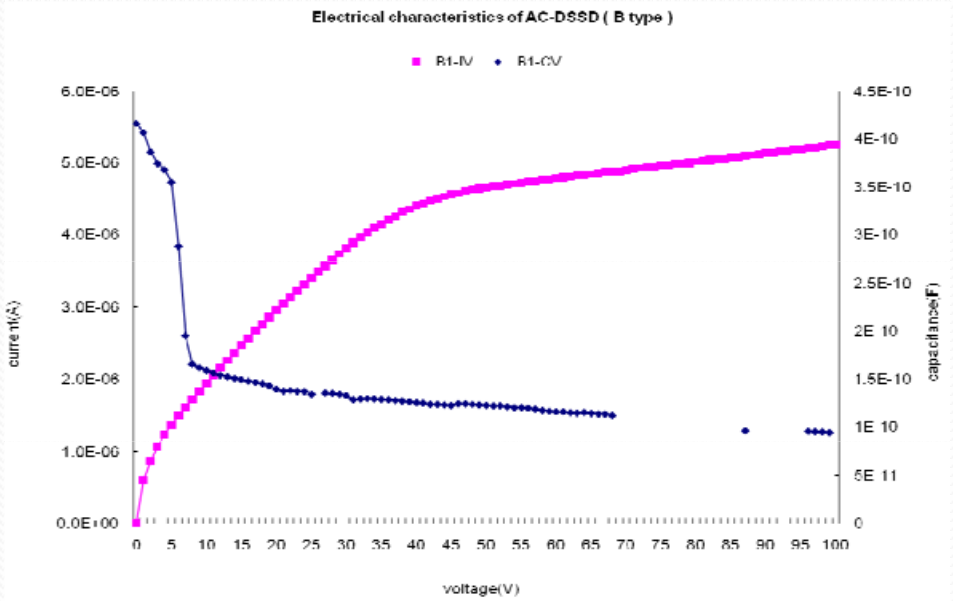
P-side



N-side

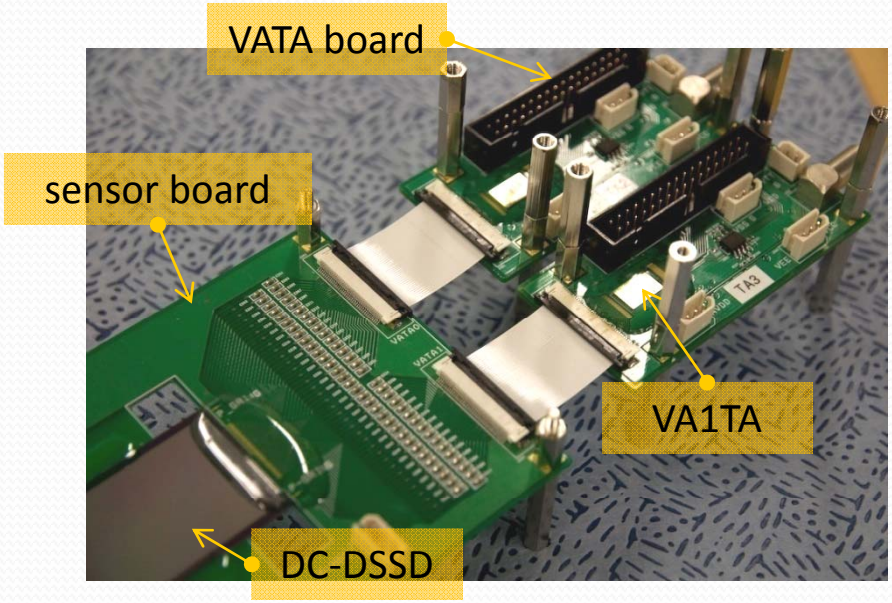


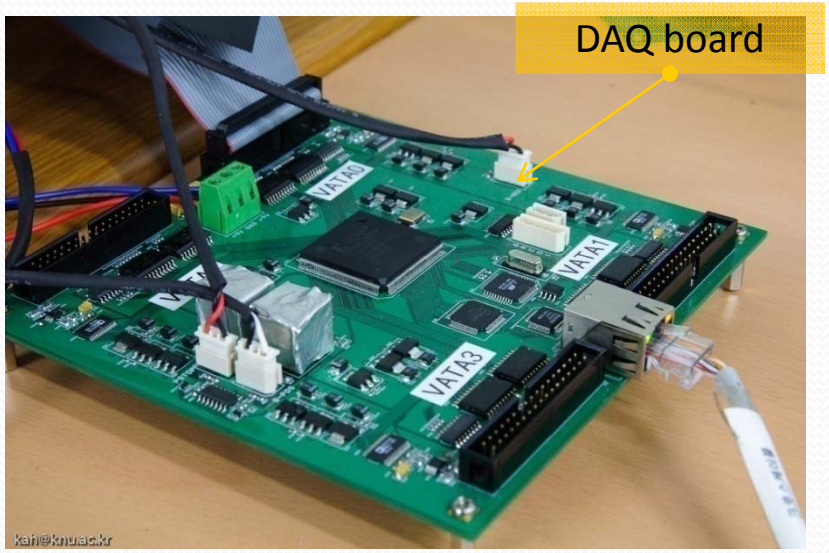
AC-DSSD : Electrical characteristics



- Leakage current and bulk capacitance of AC-DSSD is about 5 μA and 95 pF at around 70 V, respectively.
- Bias resistor : target value is 12 MΩ , and measured values are about 11 MΩ (5 MΩ) for p-side (n-side).
- Coupling capacitance : target value is 200 pF, measured value is about 140 pF for both sides.

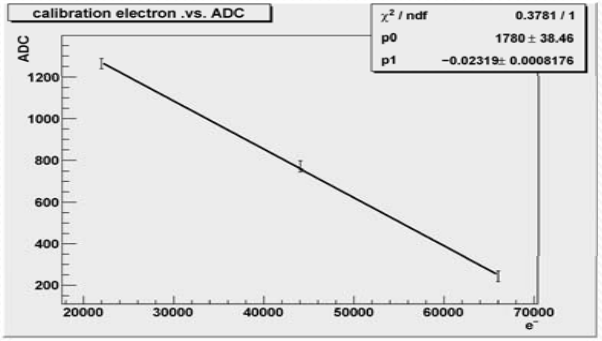
Readout Electronics

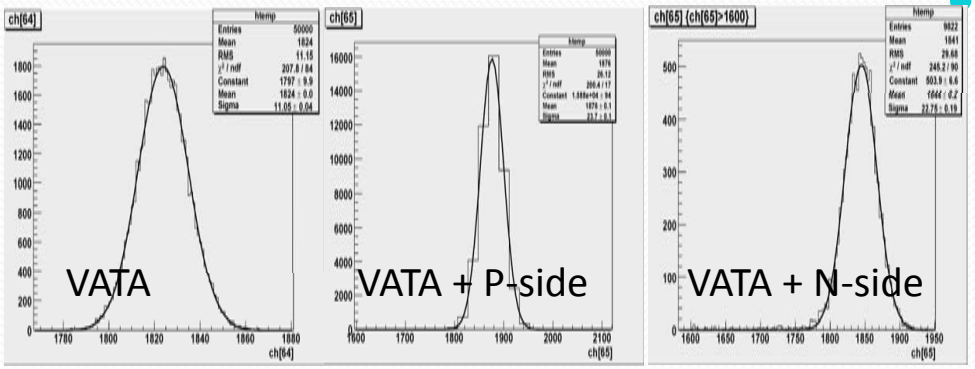


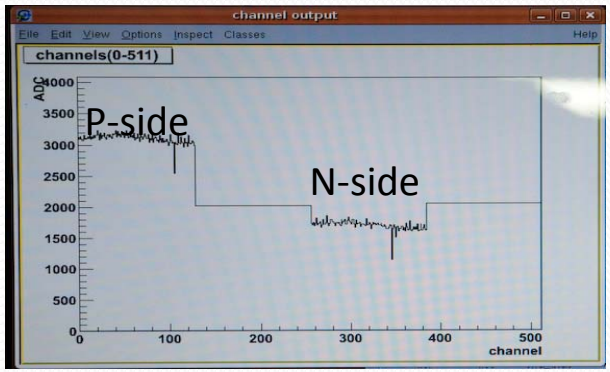


- Sensor board
  - DC - DSSD
  - Discrete RCs
- VATA board
  - multiplexed analogue readout
  - common wire-or'ed trigger output
- DAQ board
  - FADC chip
  - Xilinx chip
  - Ethernet Interface

Readout Electronics(preliminary test result)







- VATA Calibration
  - 1 ADC count = 43 electrons
- Pedestal
  - ENC(VATA) ~ 480 e- rms
  - ENC(p-side+VATA) ~ 1000 e- rms
  - ENC(n-side+VATA) ~ 1000 e- rms
- Coincidence between p and n sides works well

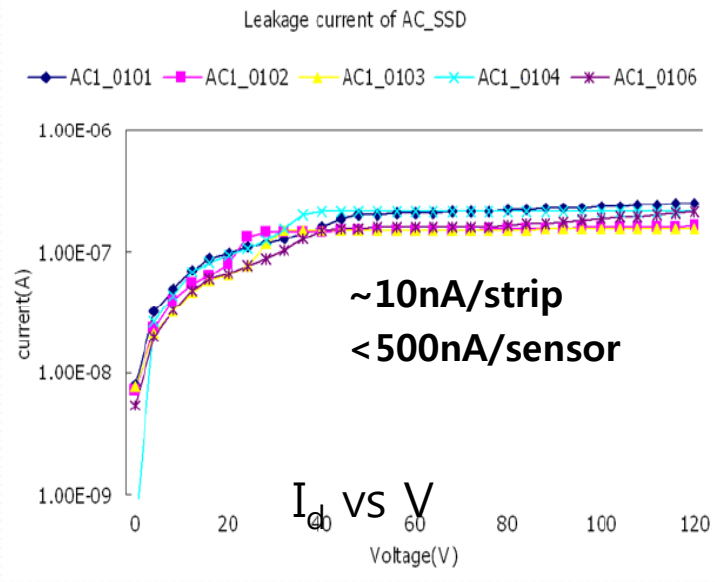
Summary and Plan

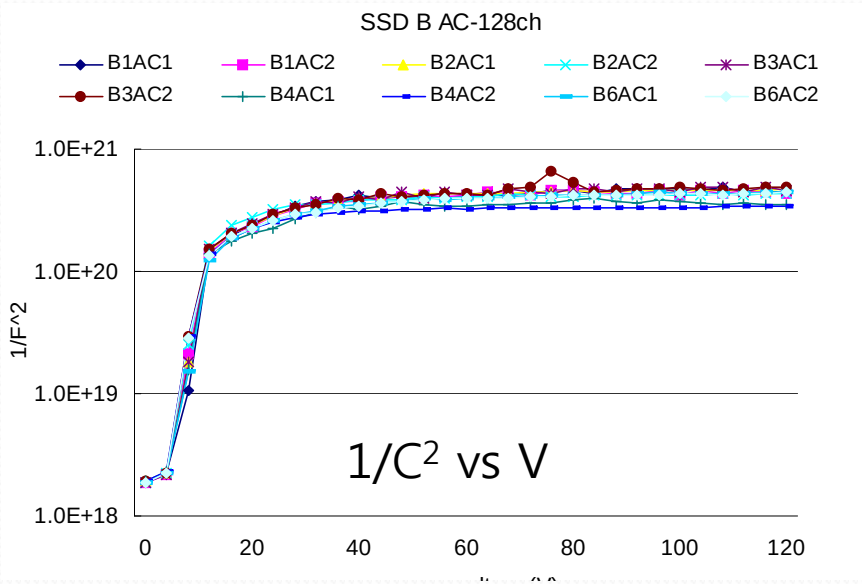
- We've got experience of development of various sensors.
  - Strip sensor with DSSD and Integrated capacitive readout coupling, AC-SSSD
  - also we designed and fabricated pixel array sensors
- We have a ability to fabrication of good quality sensors.

- **AC-DSSD**s are being fabricated. Electrical characteristics were measured and the second batch is being processed based on the measurement results.
- A radioactive source test is planned.

Extra page

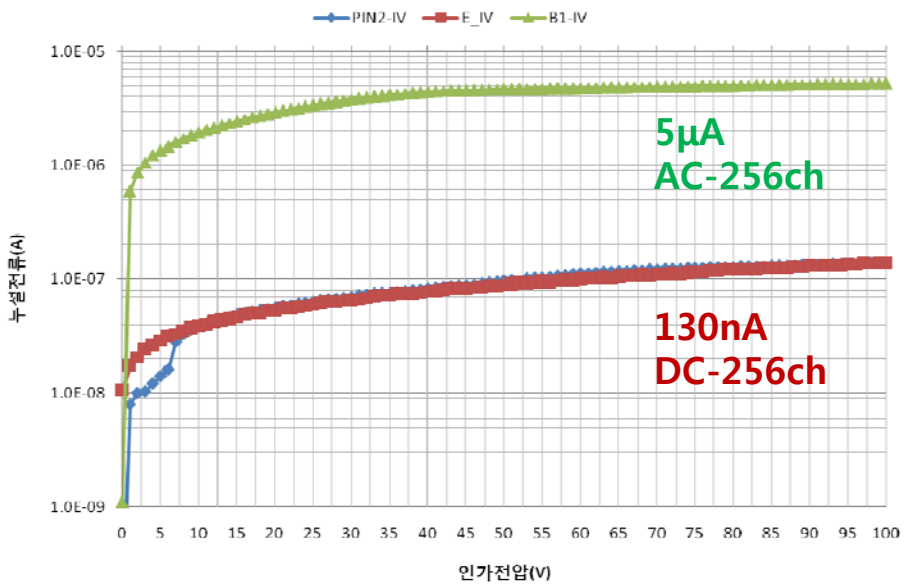
AC-SSSD : Electrical characteristics



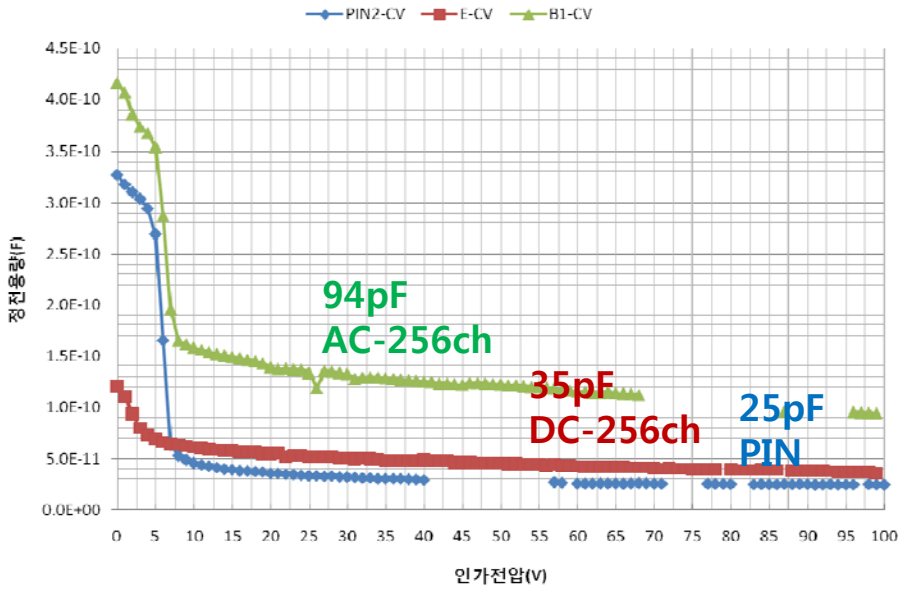


AC-DSSD : Electrical characteristics

Leakage current



Bulk capacitance



- Leakage current :
  ~ 5 μA for AC-DSSD and ~ 130 μA for DC-DSSD at around 70 V
- Bulk capacitance :
  256 pF for AC-DSSD, 35 pF for DC-DSSD, and 25 pF for PIN at around 70 V

Readout Electronics