DSSD R&D Progress at KNU

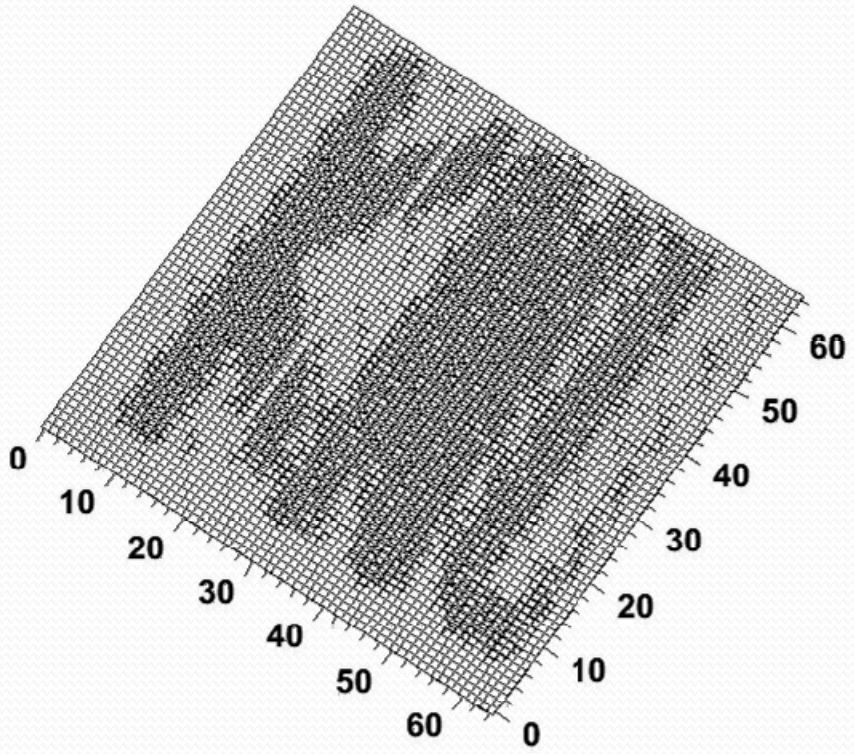
HyoJung Hyun, DongHa Kah, Youngim Kim,
Hyunok Kim, Hongjoo Kim, and Hwanbae Park

Kyungpook National University

2nd proto-collaboration Meeting, KEK, Japan July 3rd and 4th 2008

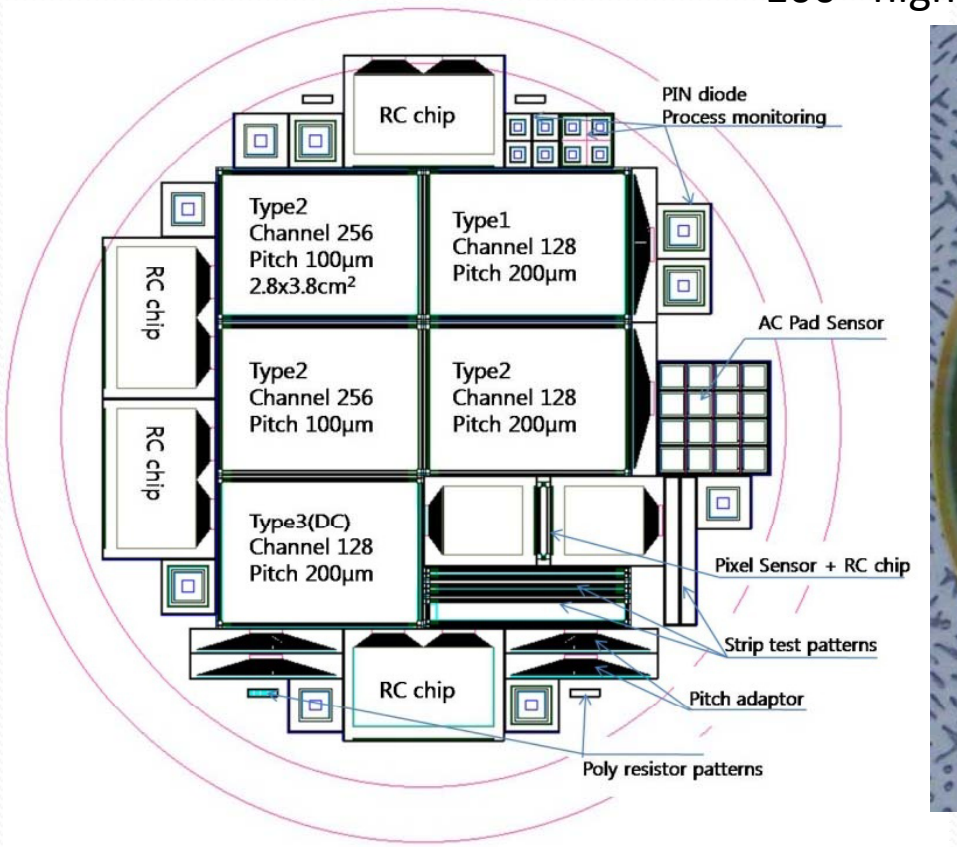
Contents

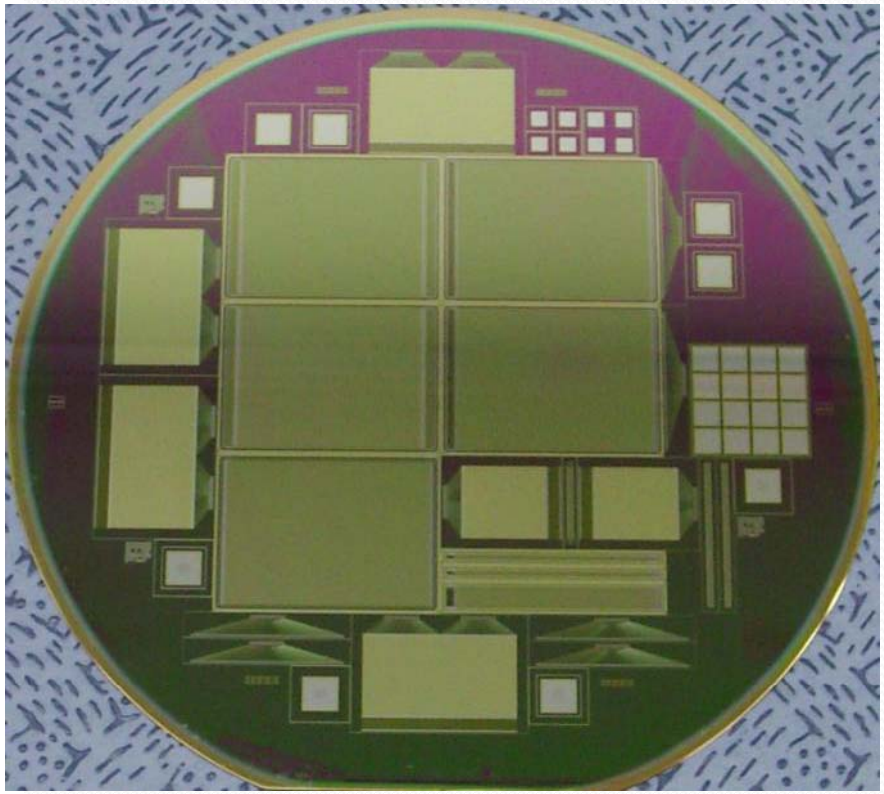
- Brief reports
  - AC-SSSD and DC-DSSD ：
    Prototype and Specification
- AC-DSSD
  - Target
  - Design and Fabrication
- Readout electronics
- Summary and Plan



Prototype 1 of AC-SSD

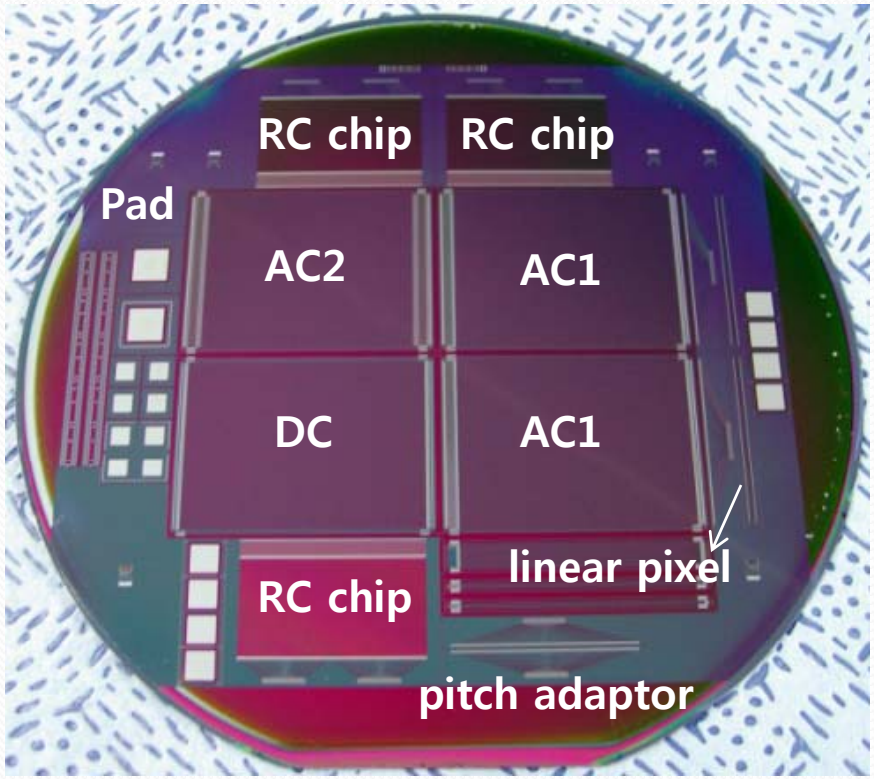
<100> high resistivity n-type 6 in. 400 μm thick wafer

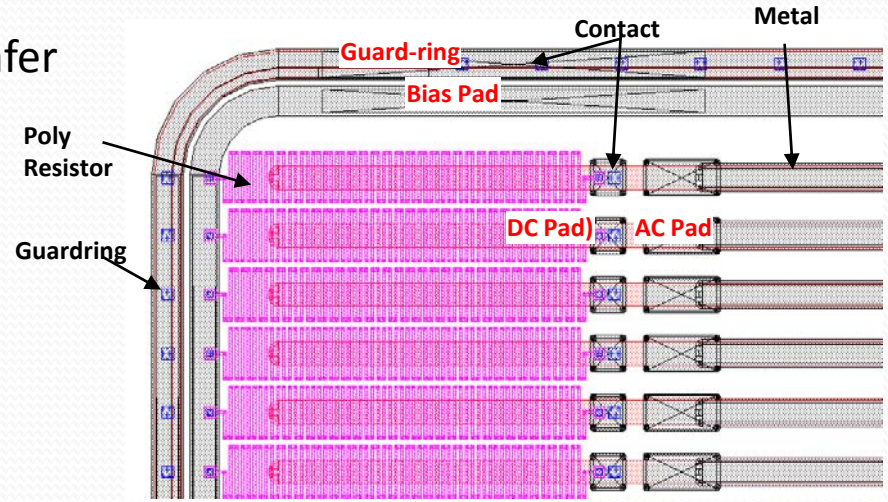


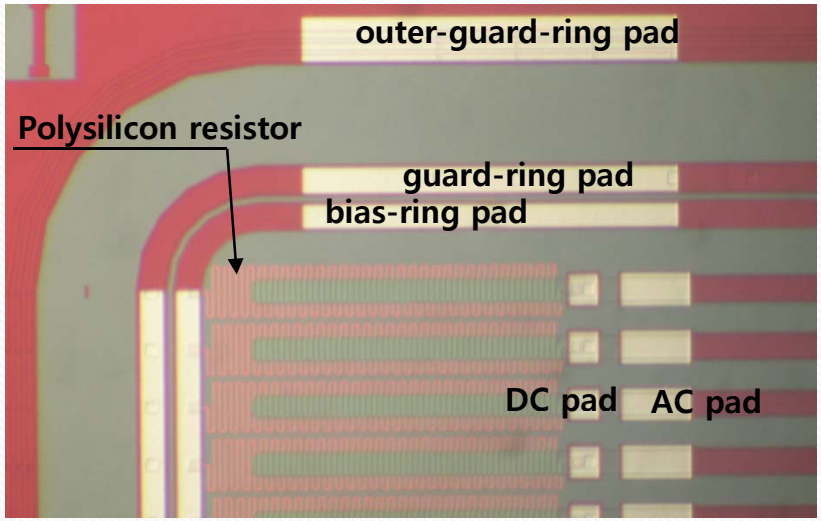


Prototype 2 of AC-SSD

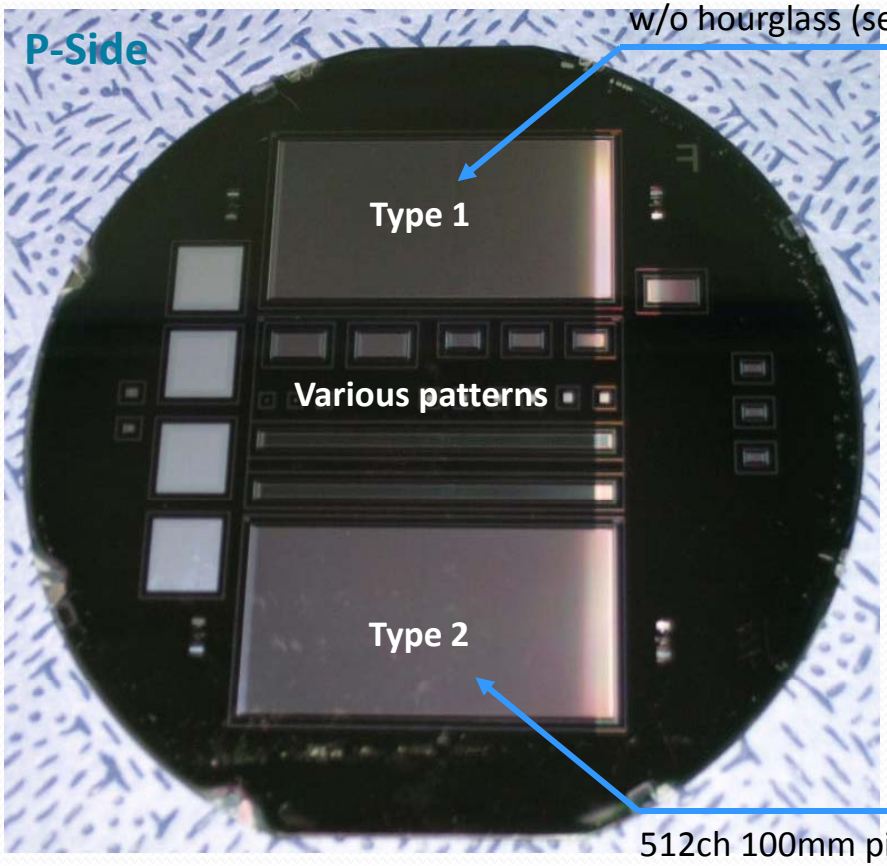
<100> high resistivity n-type 5 in. 380 μm wafer

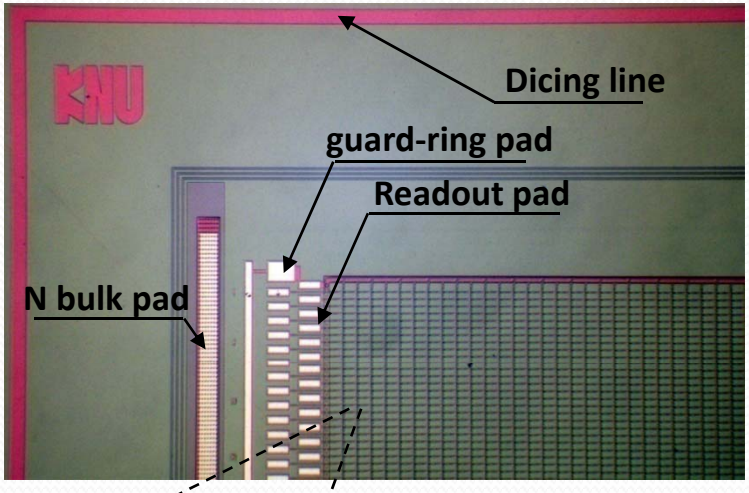






Prototype of DC-DSSD





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

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				

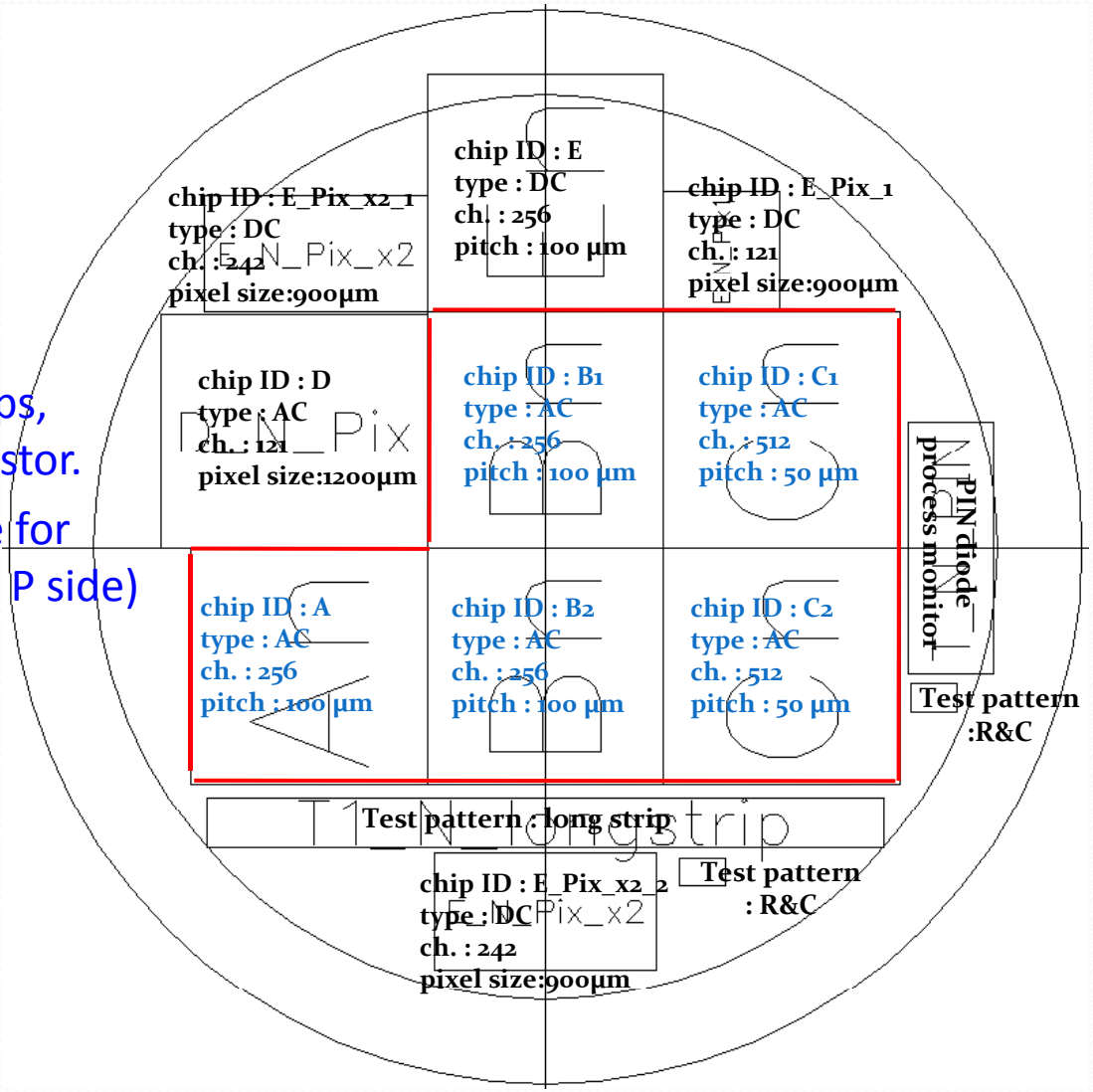
AC- DSSD

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.
- D.H. Kah finished drawing of sensor and photo-masks have been completed.
- At now, wafers are be processing.

AC-DSSD : wafer view

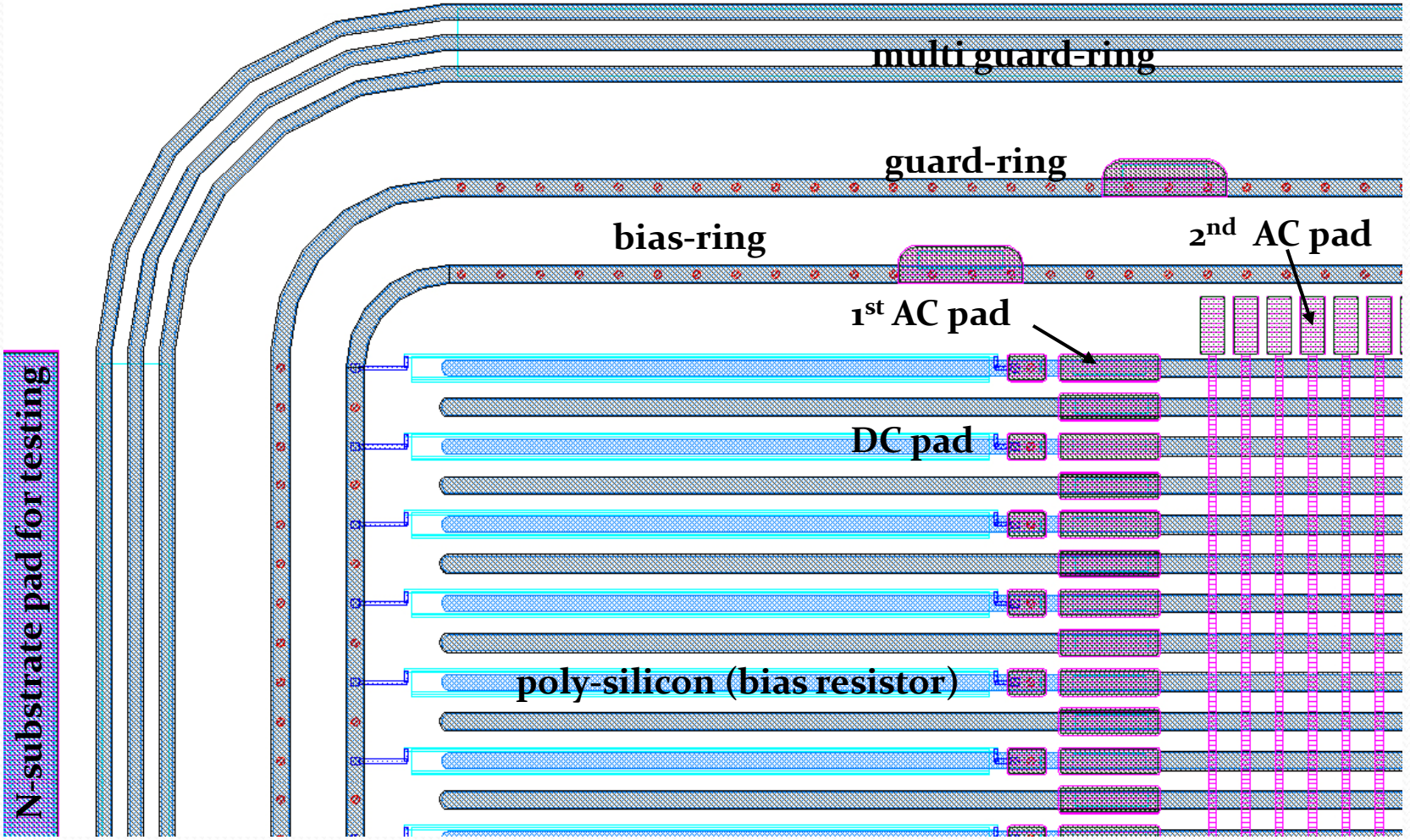
- 5inch wafer
  - <100> 5kΩ•cm N type
  - thickness : 380μm
- 3 type strip sensors
  - size : 2.8cm X 2.8cm
  - A,B,C type has the 256/512 strips, coupling capacitor and bias resistor.
  - B and C type have VIA structure for same read-out direction (N and P side)
  - E type is DC sensor
- 3 type Pixel sensors
  - AC Pixel array
    - 11X11 array – D type
  - DC pixel array
    - 11X11 array – E_Pix type
    - 11X22 array – E_Pix_x2 type



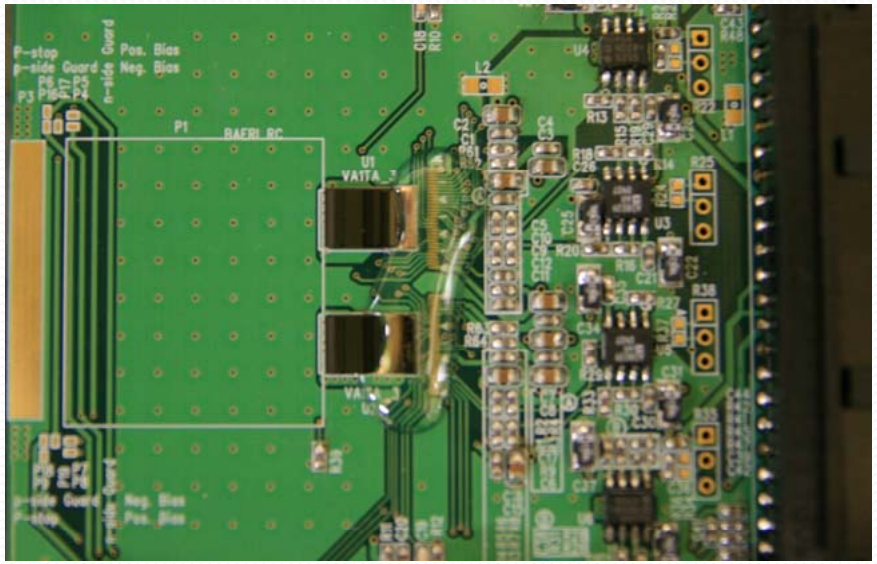
AC-DSSD : Specification

type	AC			DC
	A	B	C	E
size	2.8 cm × 2.8 cm			
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 : left corner view of B-type



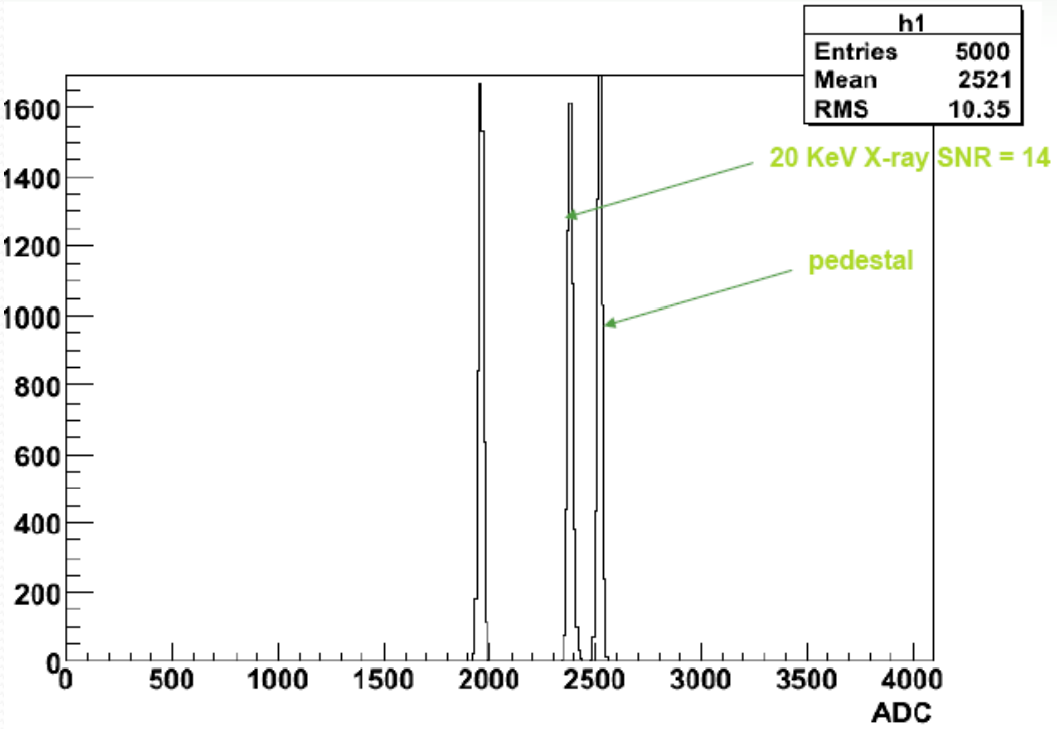
Readout Electronics



- VA1TA
  - 128 channels
  - low-noise/low-power charge sensitive preamplifier-shaper circuits, with simultaneous sample and hold, multiplexed analogue readout
  - common wire-or'ed trigger output
  - Noise : 180 + 7.5/pF e^-rms for 1 µs peaking time
- Flash ADC module using VME

Readout Electronics

- Calibration test result with VATA Hybrid at KNU
  - A input pulse corresponding 20 keV X-ray was provided
  - SNR is obtained about 14



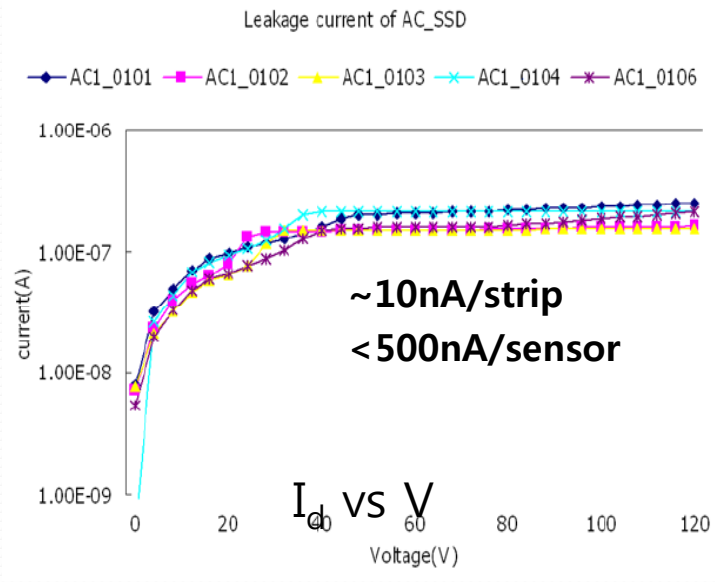
Summary and Plan

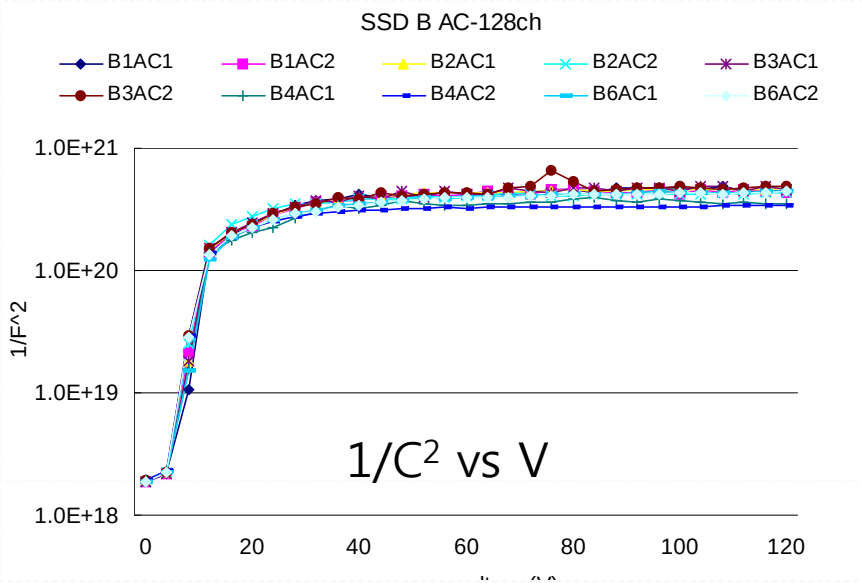
- We've got experience of development of various sensors.
  - Strip sensor with DSSD and Integrated capacitive readout coupling, AC-SSSD
  - also we designed and fabricated pixel array sensors
- We have a ability to fabrication of good quality sensors.

- **AC-DSSD** is being fabricated. If first batch will be fab-out in this summer, electrical characteristics measurement and source test will be processed.
- Readout electronics with VA1TA is testing at KNU and KEK.

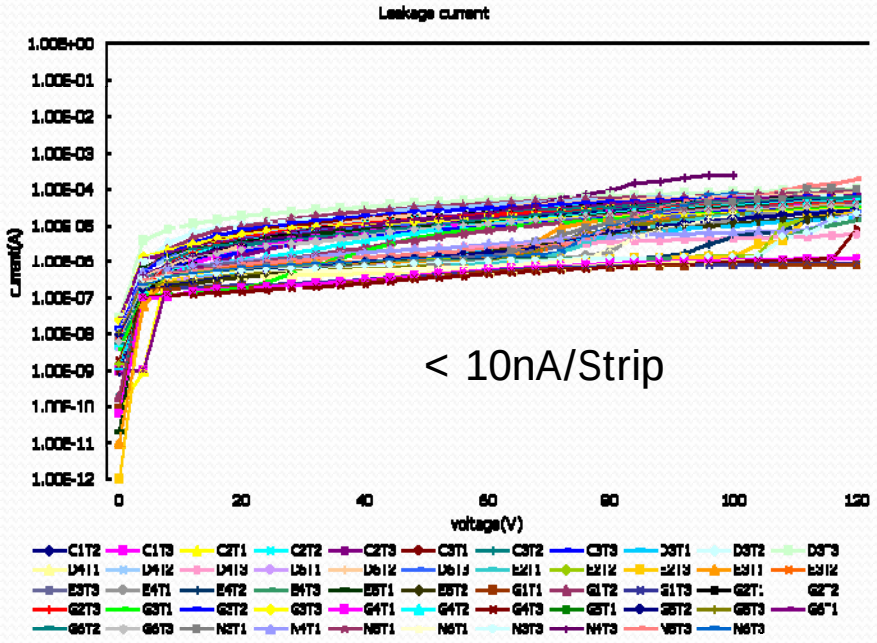
Extra page

AC-SSSD : Electrical Characteristics

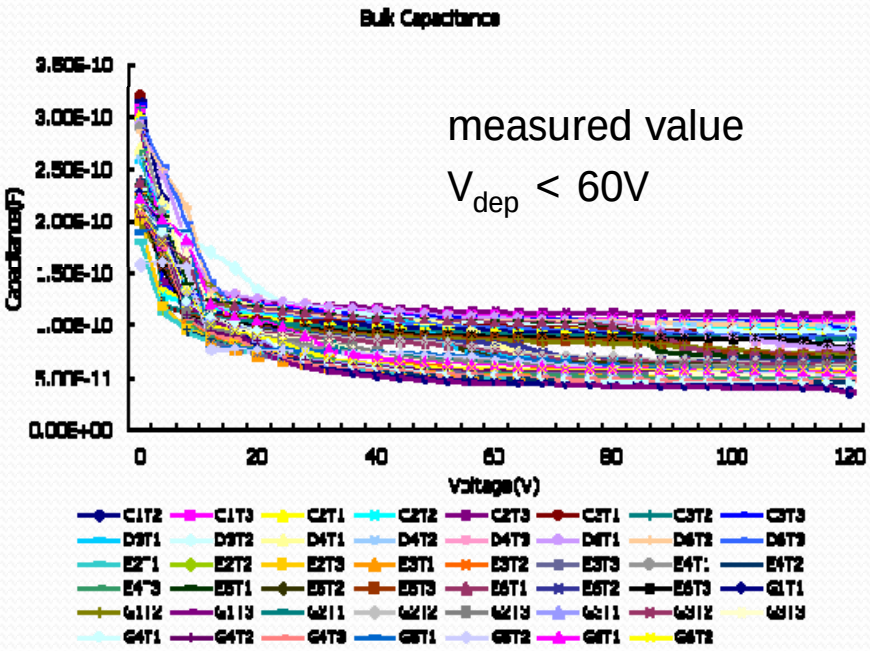




DC-DSSD : Electrical Characteristics



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