韓国におけるDSSDの開発

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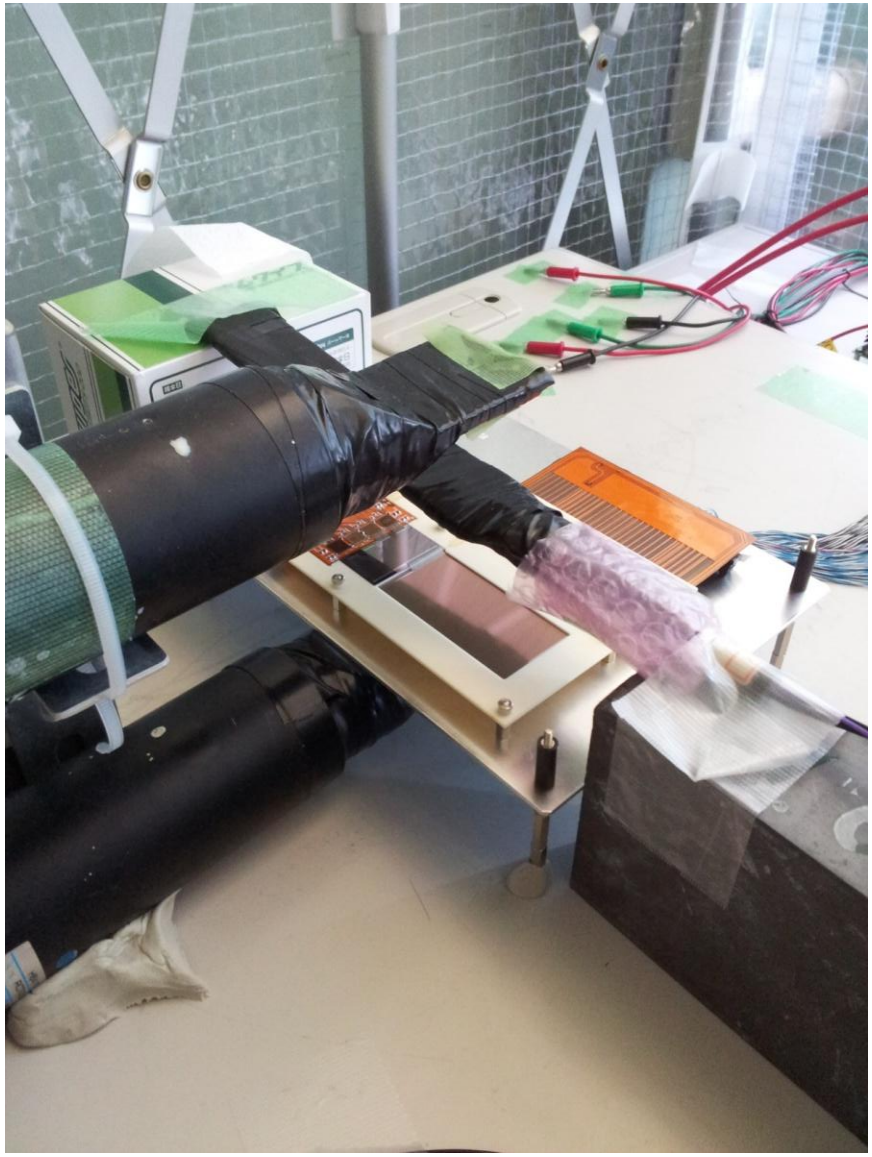


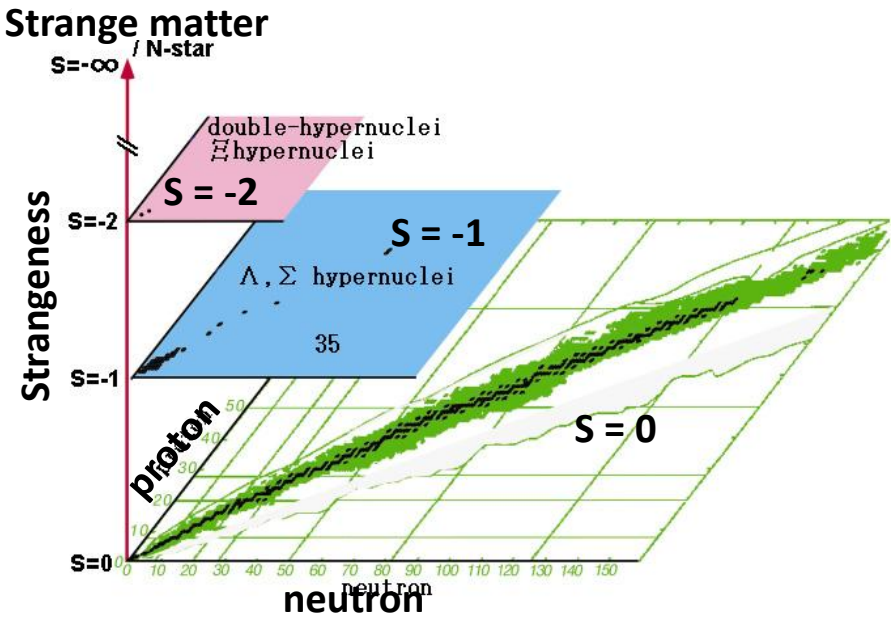
E07 experiment @ J-PARC and DSSD

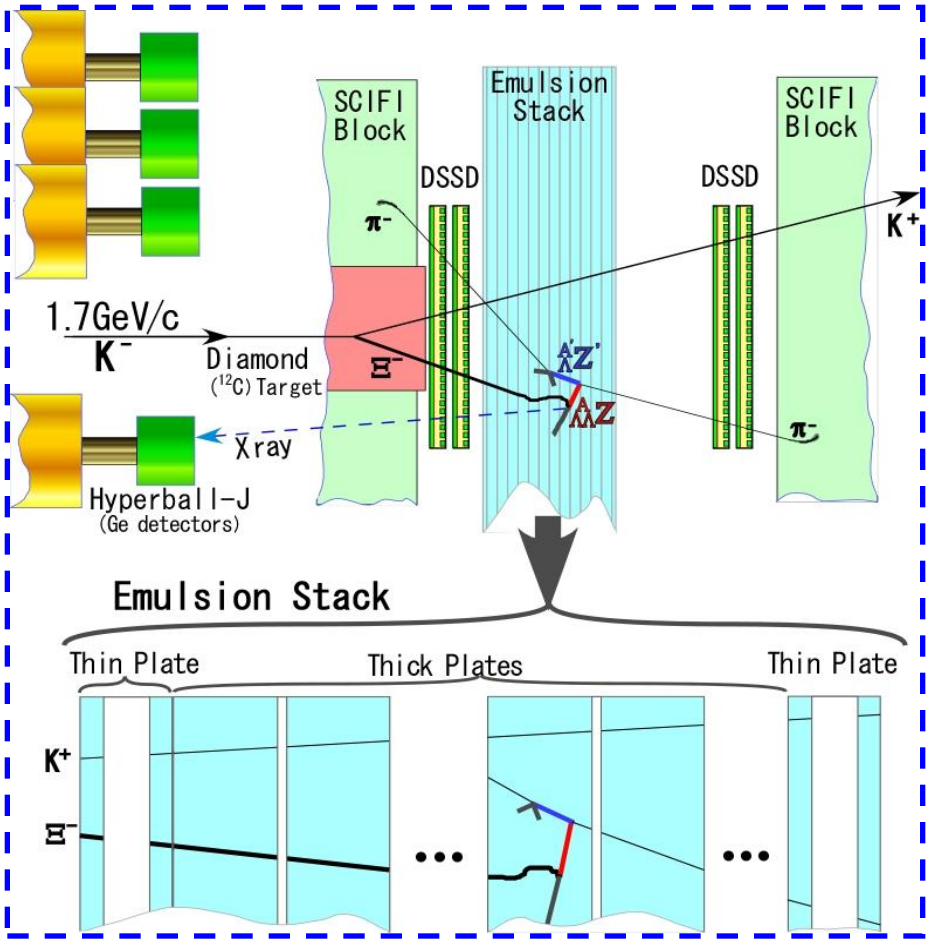
(from nakawaza-san's slide)

10^3 (E373) ==> 10^4 Ξ-stops

- Λ–Λ Interaction,
- H-dibaryon,
- Ξ-Nucleus Interaction,
- Inside Neutron Stars (Quark-star?)

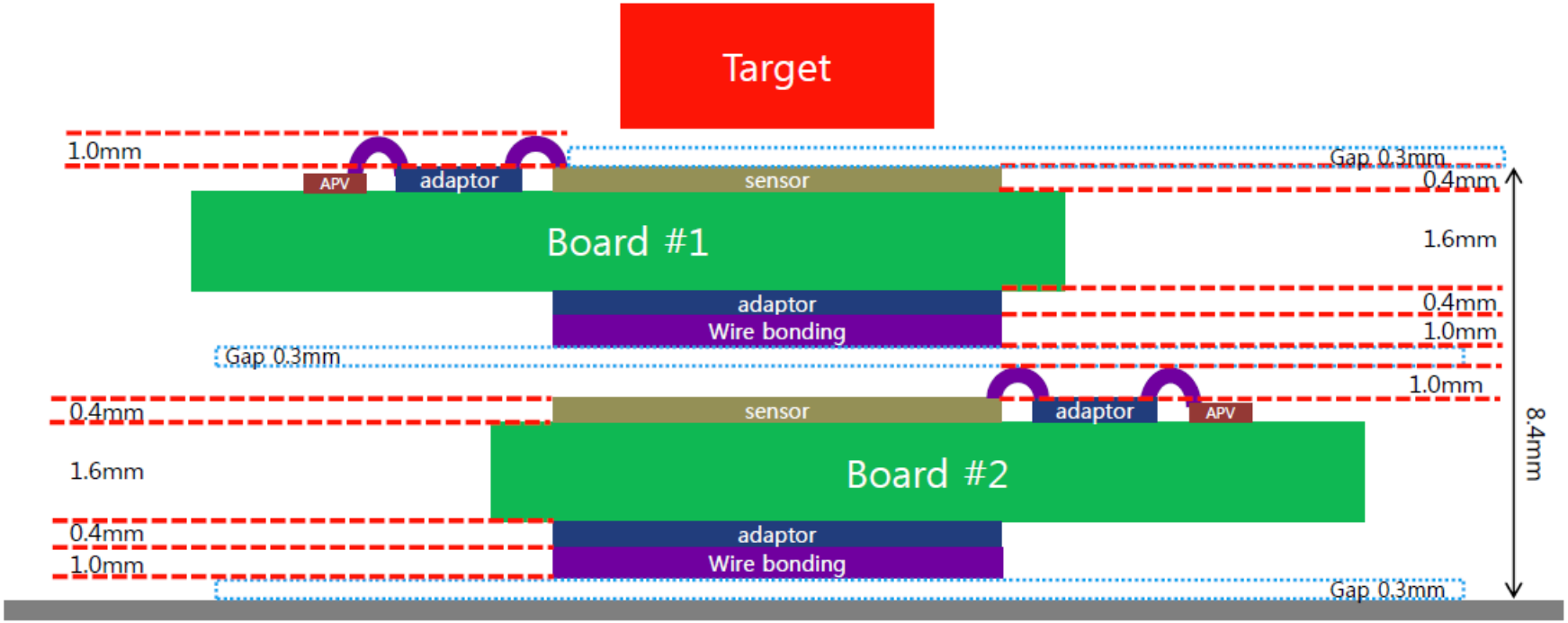
<==> **3-dimensional Nuclear chart**





Experimental Setup

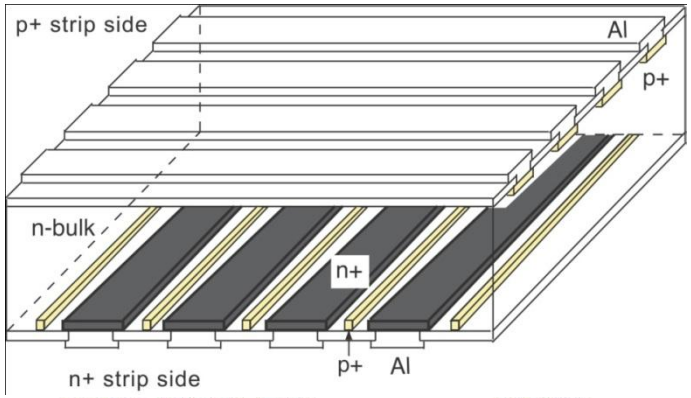
Target ～ DSSD (x2) ～ Emulsion

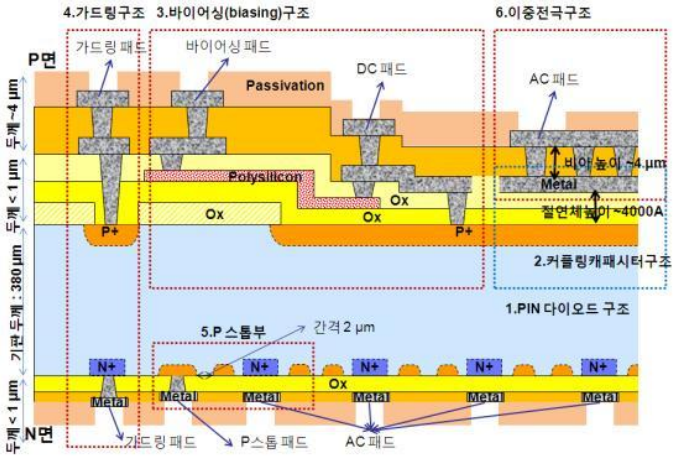


We aim to set Silicon detectors close to the emulsion plate ！

DSSD sensor

DSSD building





- By Double Silicon Strip Detector(DSSD), we can detect X-Y position with one circuit board.
- We are now collaborating with Prof.Hwanbae Park in Kyungbook university to produce DSSD

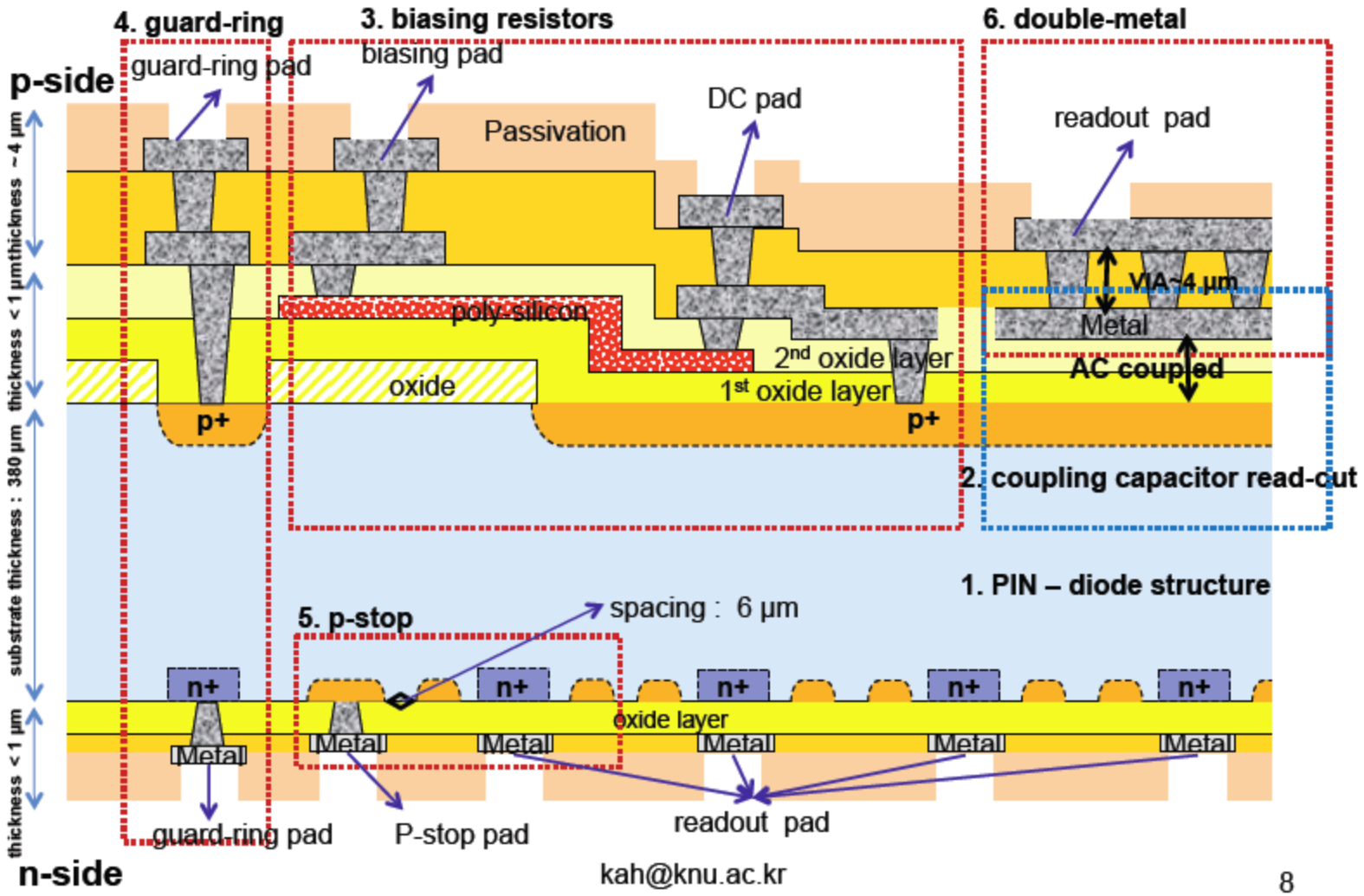
Detector

- Layout
- Sensor Cost
  - -- Masking : total ~30,000,000 won
  - -- 6’’ Wafer (x 18) : 3,000,000 won
  - -- processing cost : ~15,000,000 won

～350万円

- APV25 chip & APVDAQ VME module
- Assembly configuration by REPIC

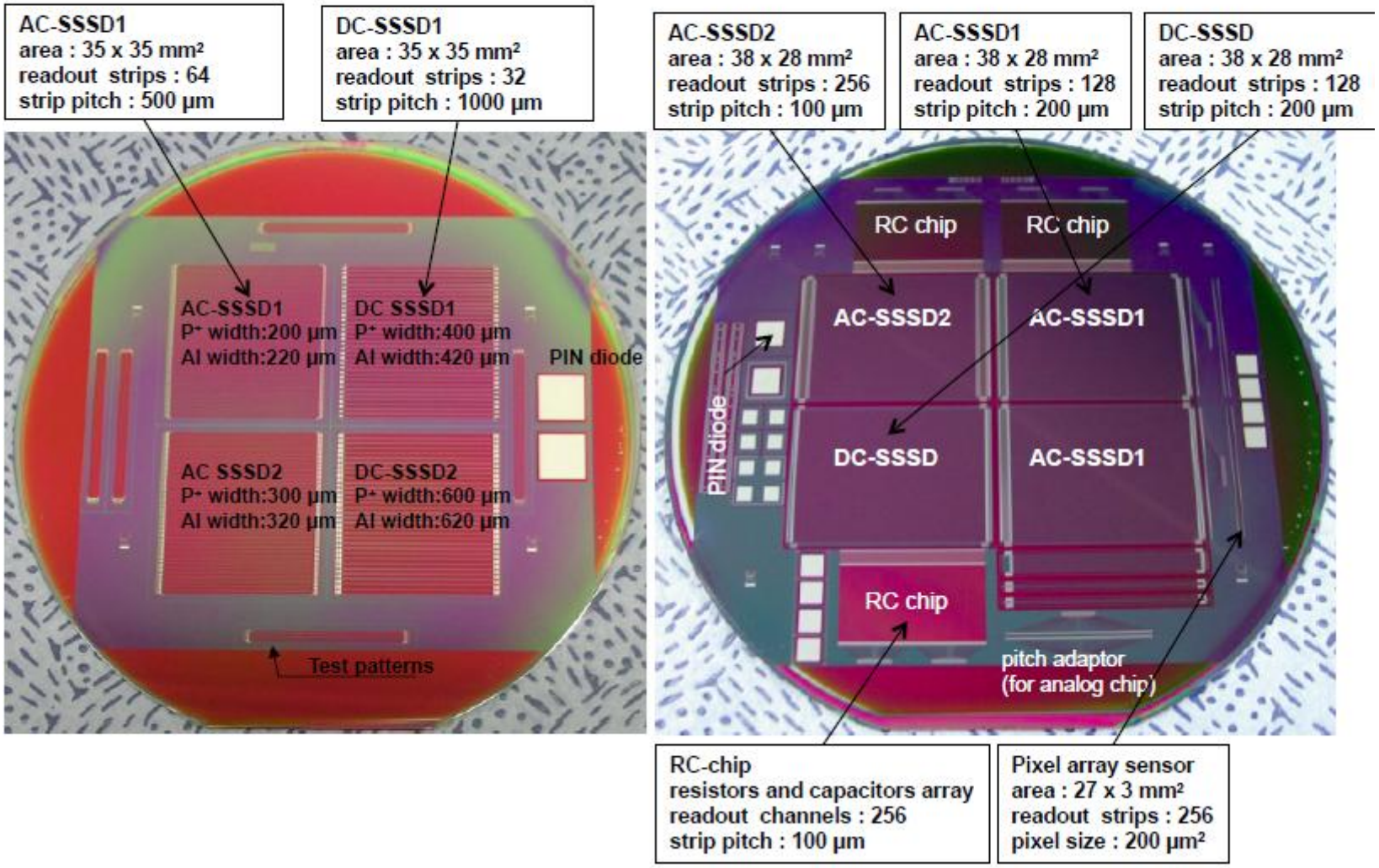
Design of AC-coupled DSSD



kah@knu.ac.kr

From Dr. Kah's slide

AC-coupled SSSD (시제품 사진들)



From Dr. Kah's slide

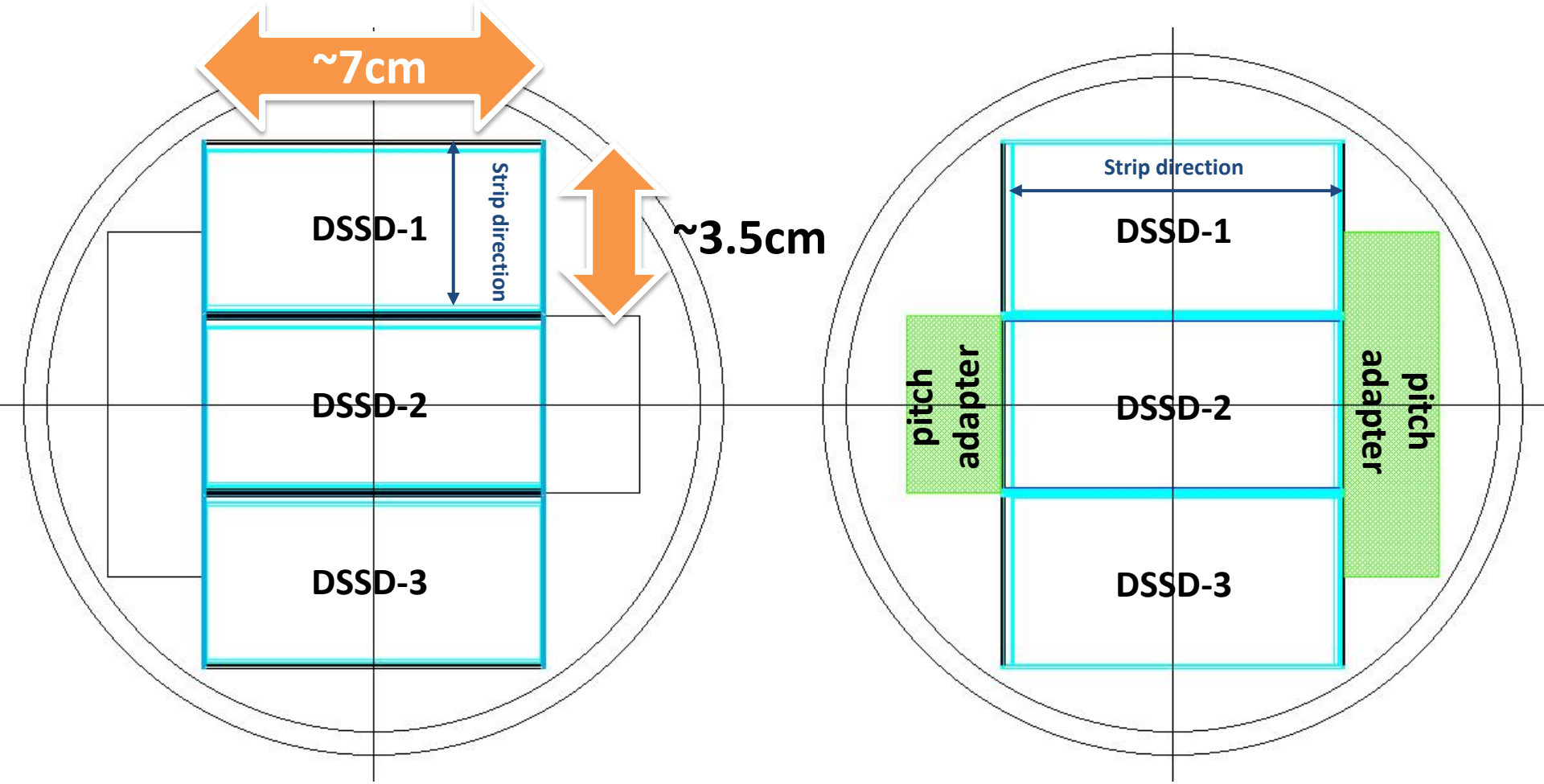
Dimensions of the AC-DSSD

Dimensions	n-side	p-side
Sensor size	73620 μm x 37760 μm	
Strip length	71630 μm	35770 μm
Strip width	20 μm	40 μm
Number of strips	512	1024
AC pad	256 μm x 72 μm	256 μm x 72 μm
DC pad	136 μm x 36 μm	98 μm x 48 μm
Biasing pad	240 μm x 100 μm	
Guard-ring pad	240 μm x 100 μm	

Designed values	n-side	p-side
Biasing resistance	8.8 MΩ	8.8 MΩ
Coupling capacitance	247 pF/strip or 123 pF/strip	247 pF/strip or 123 pF/strip

By Kha Dongha kah@knu.ac.kr

Wafer design



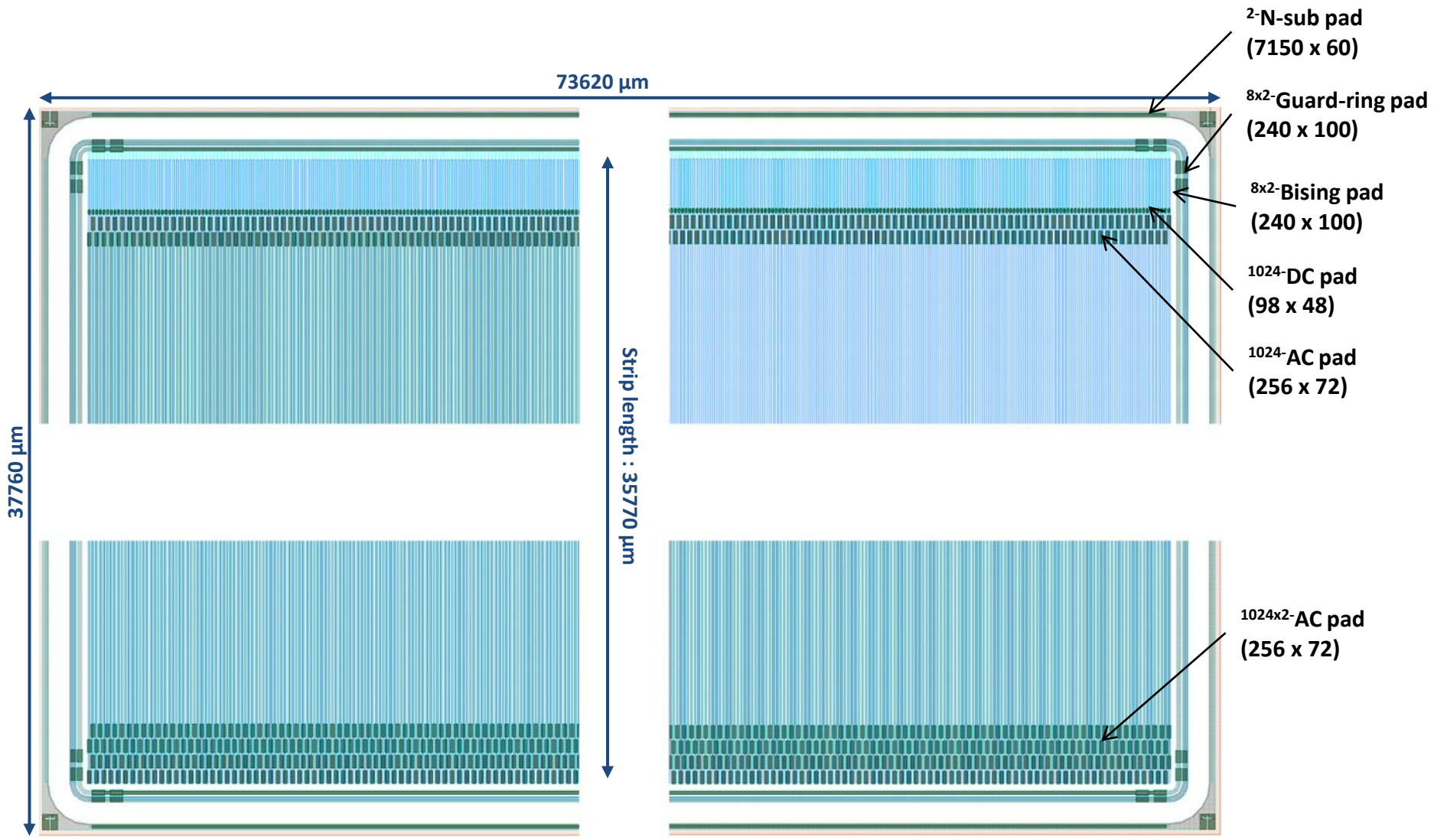
~70um pitch strip

p-side

n-side

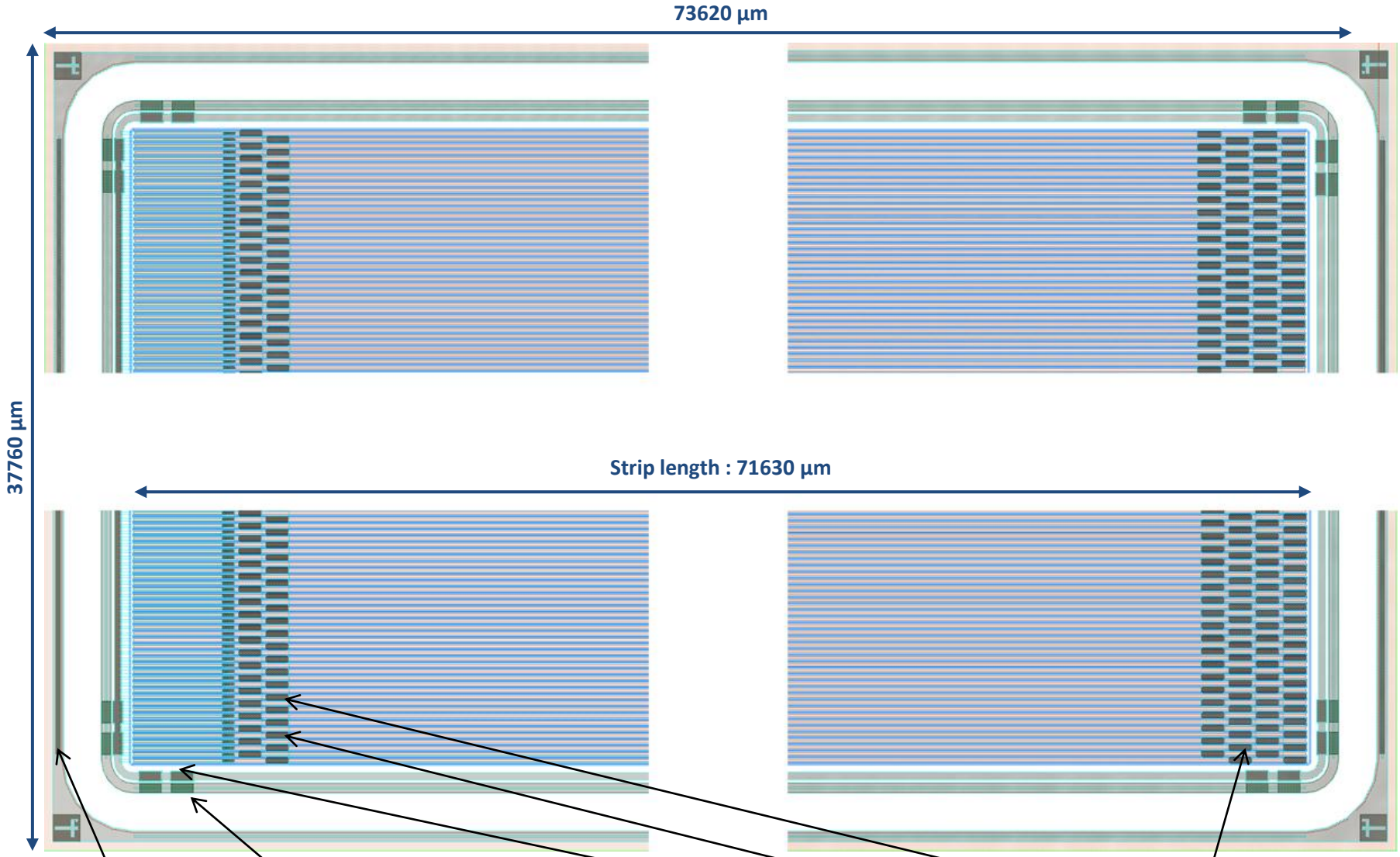
By Kha Dongha kah@knu.ac.kr

p-side



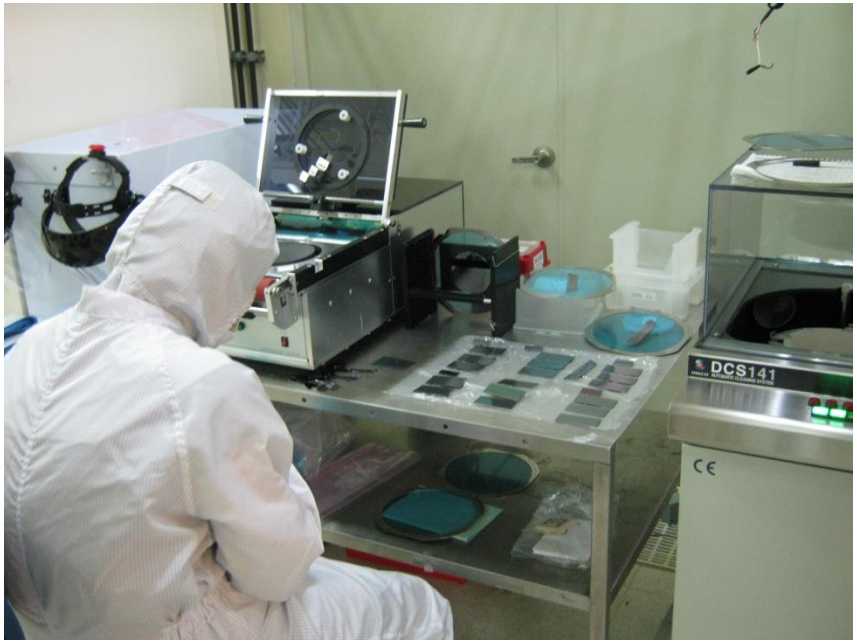
By Kha Dongha kah@knu.ac.kr

n-side

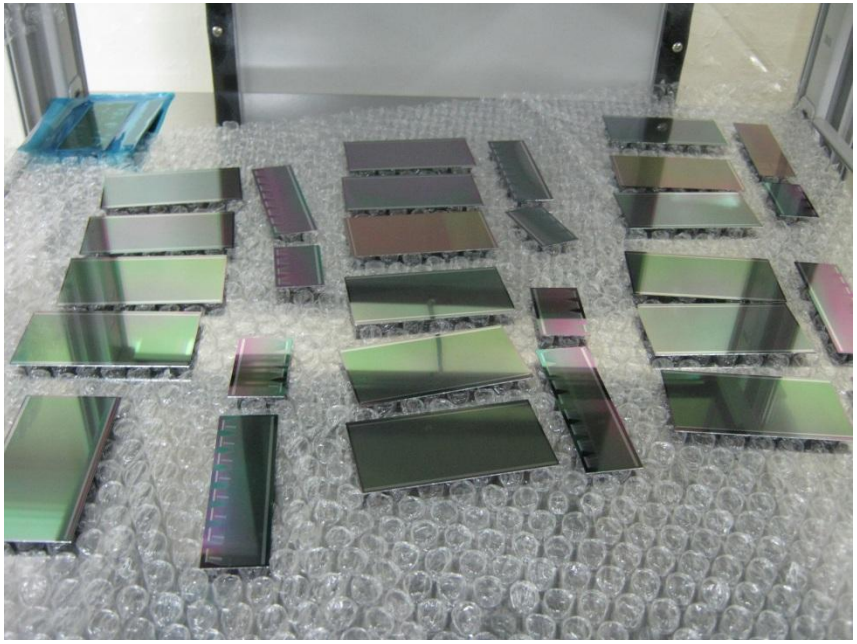


DSSD sensor produce

dicing

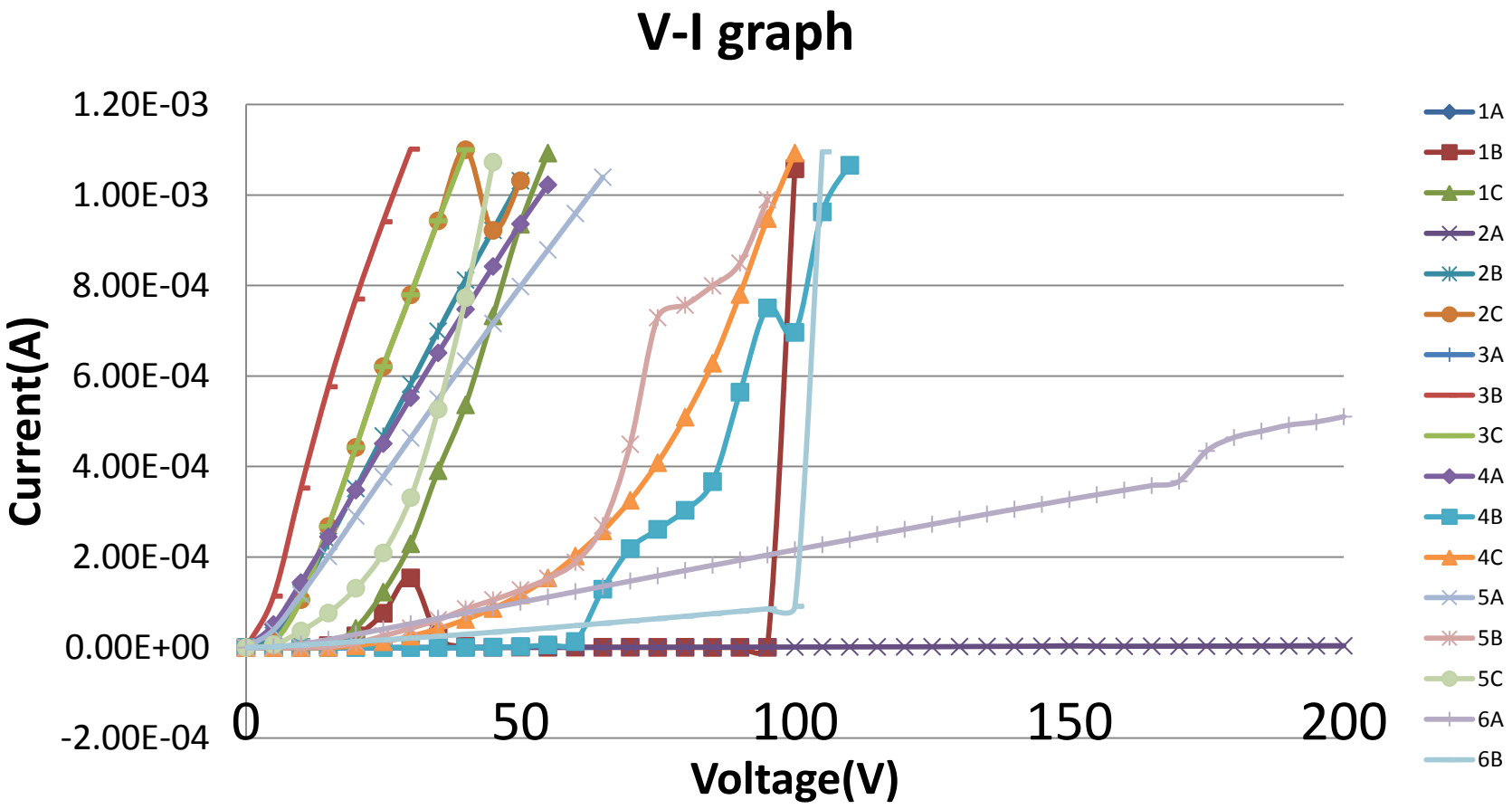


sensors



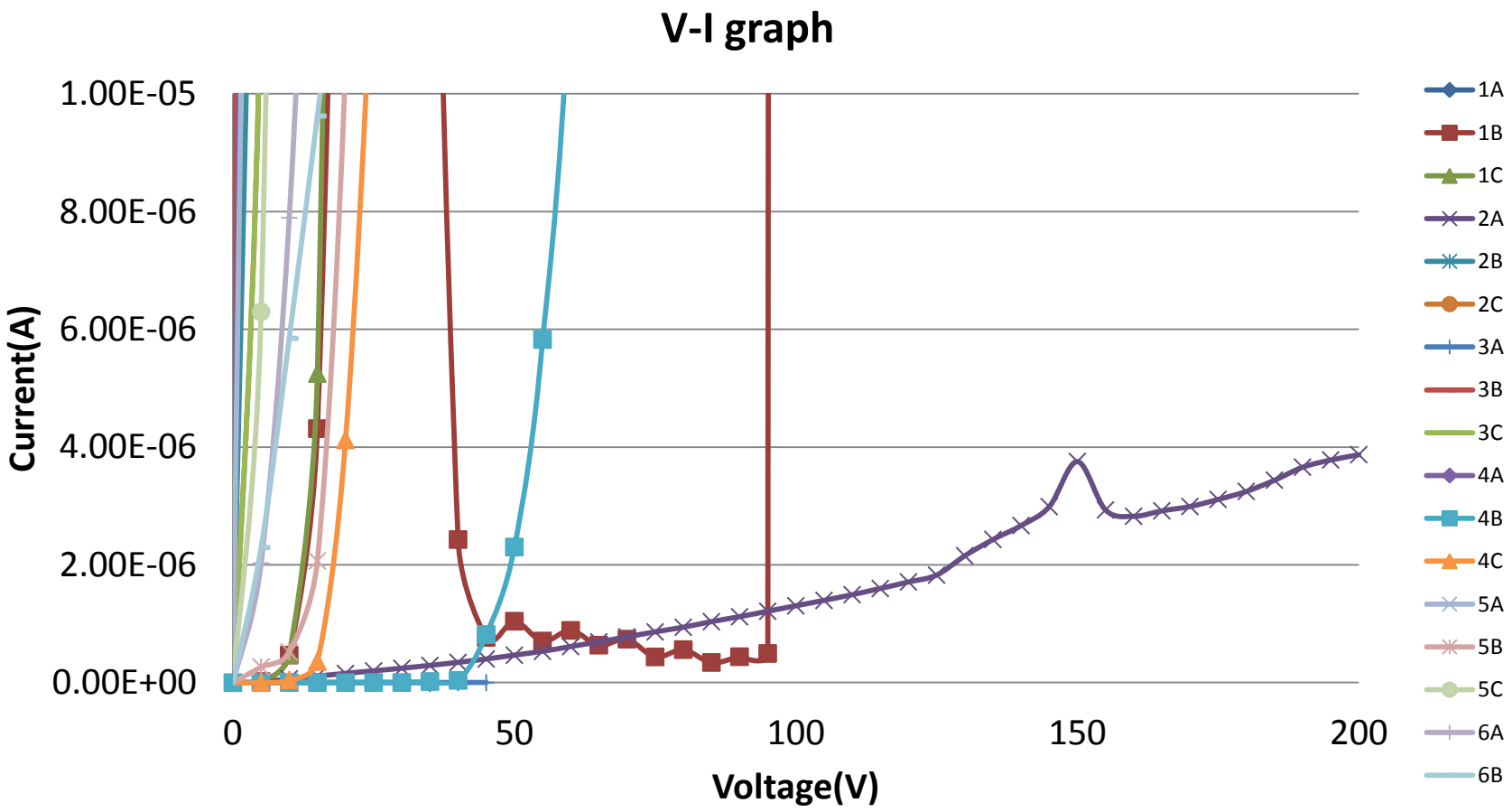
By Korean venture company (SENS)

DSSD leak current - estimate



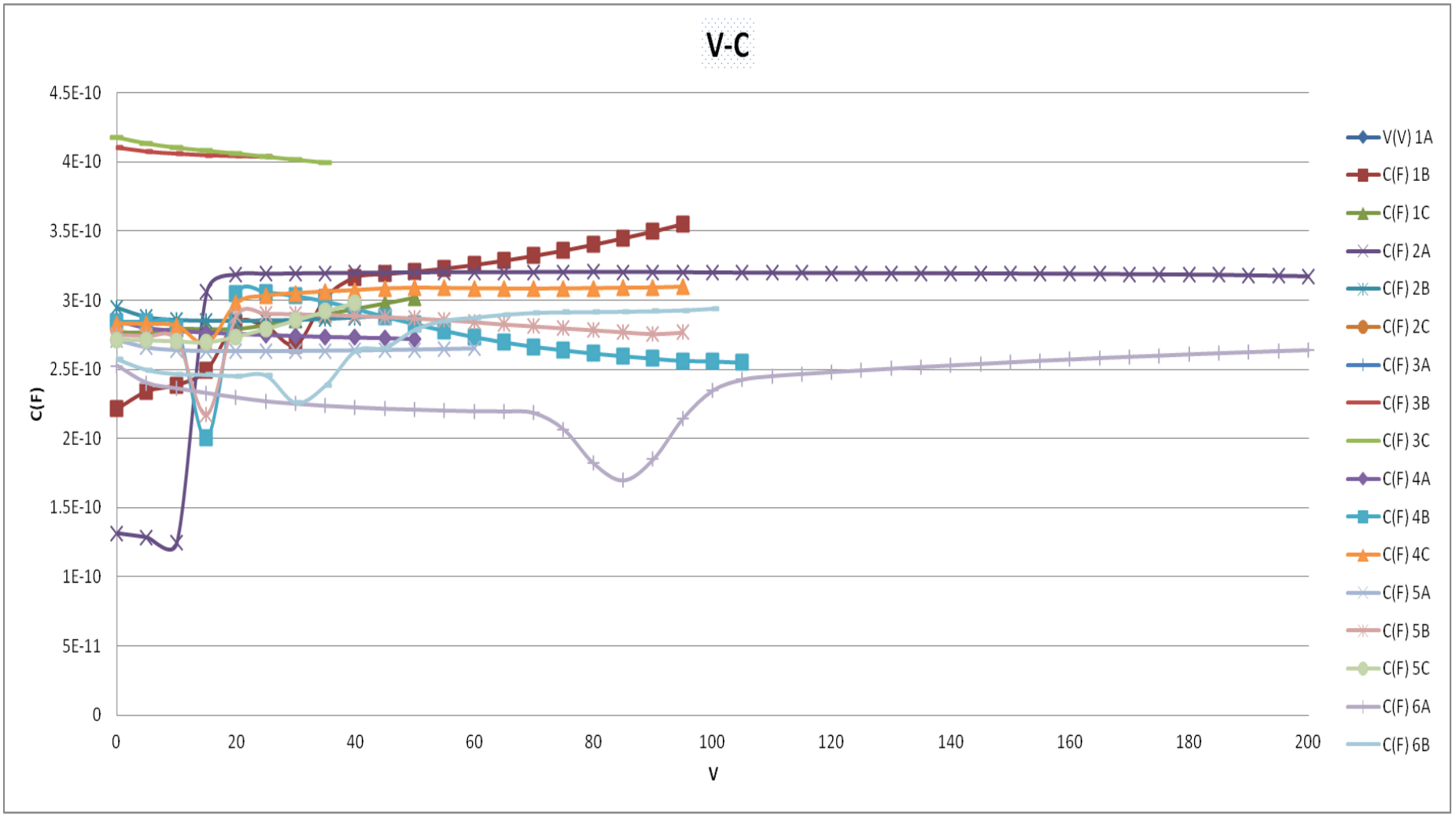
Dep. voltage ~80 V – most are useless

DSSD leak current - estimate



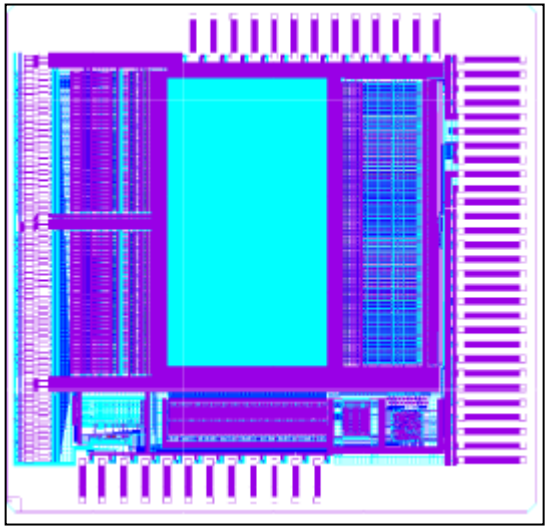
Sensors 2A (1B ,6B) may be used

Capatitance



Sensors 2A (& 1B) could be used

APV25 chip



・Analogue pipeline chip for readout of Silicon detectors developed by CMS

・Handle 128 channels

・Consists of CR-RC shaper (τ:50nsec) , amplifier, pipeline (192cells), multiplexer

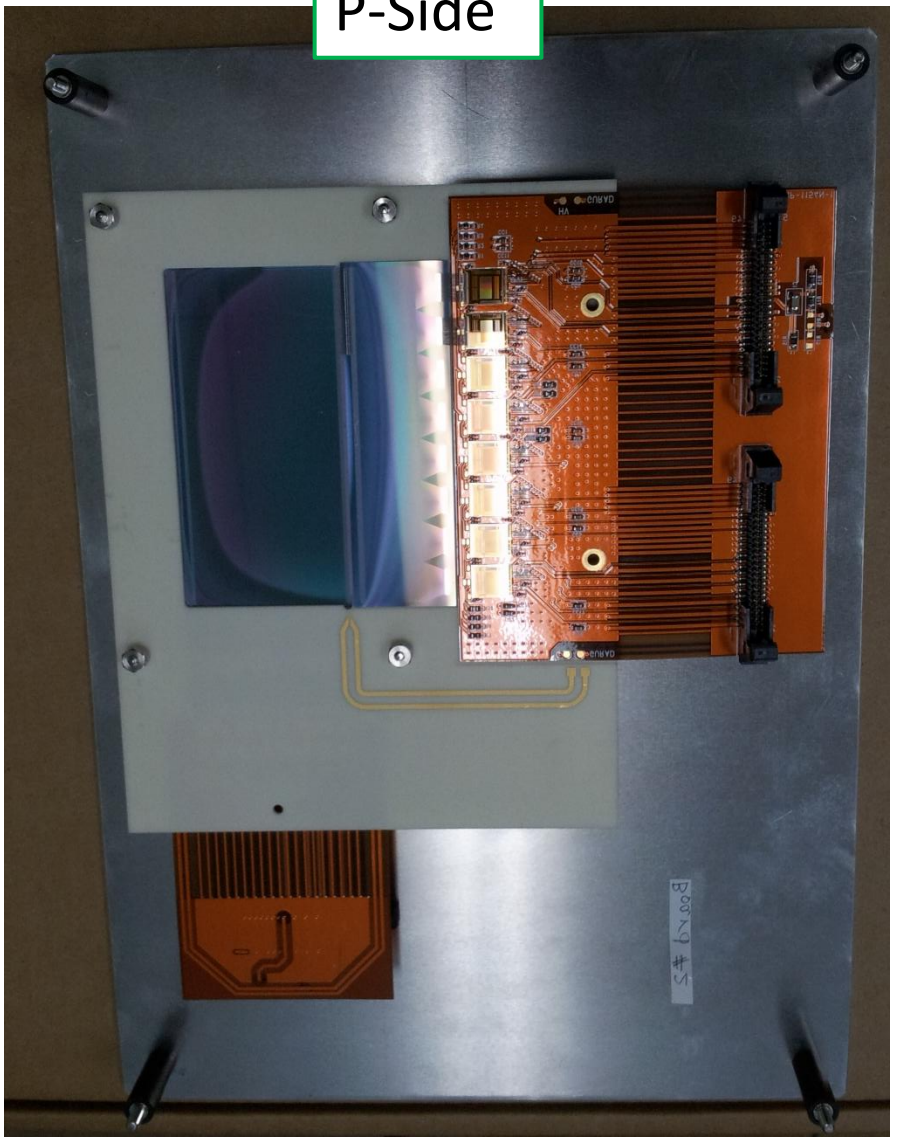
・Input : Clock, Trigger
Output : bi-directional current (multiplexed)

"The APV25 Deep Submicron Readout Chip for CMS Detectors" , L.L. Jones et.al.

DSSDの写真

N-Side

P-Side

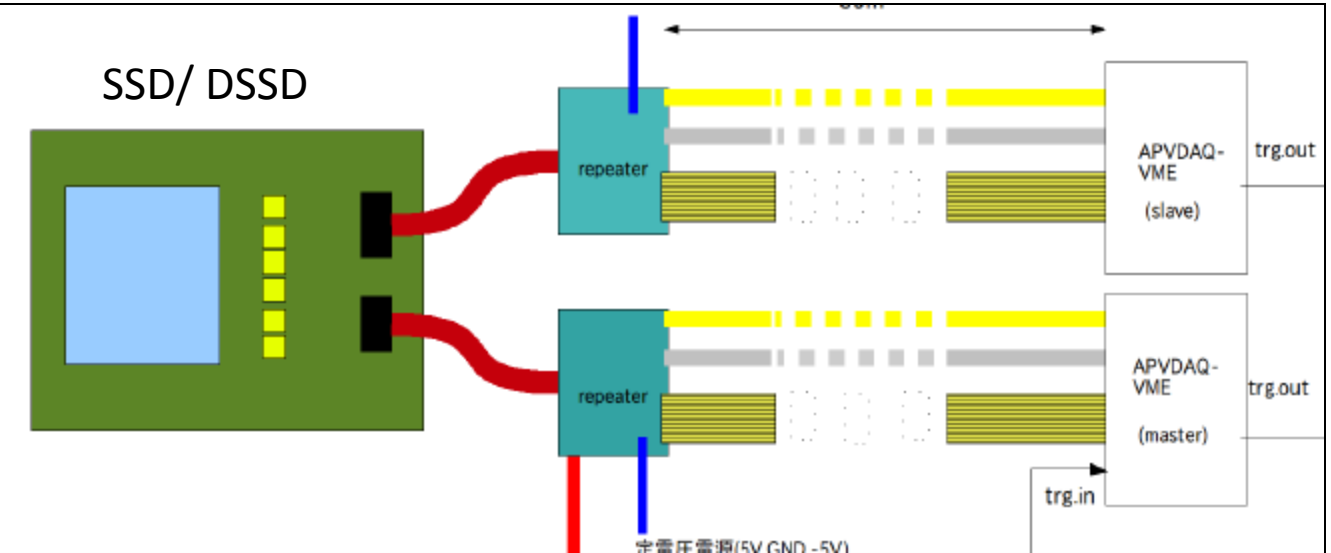


Readout Module

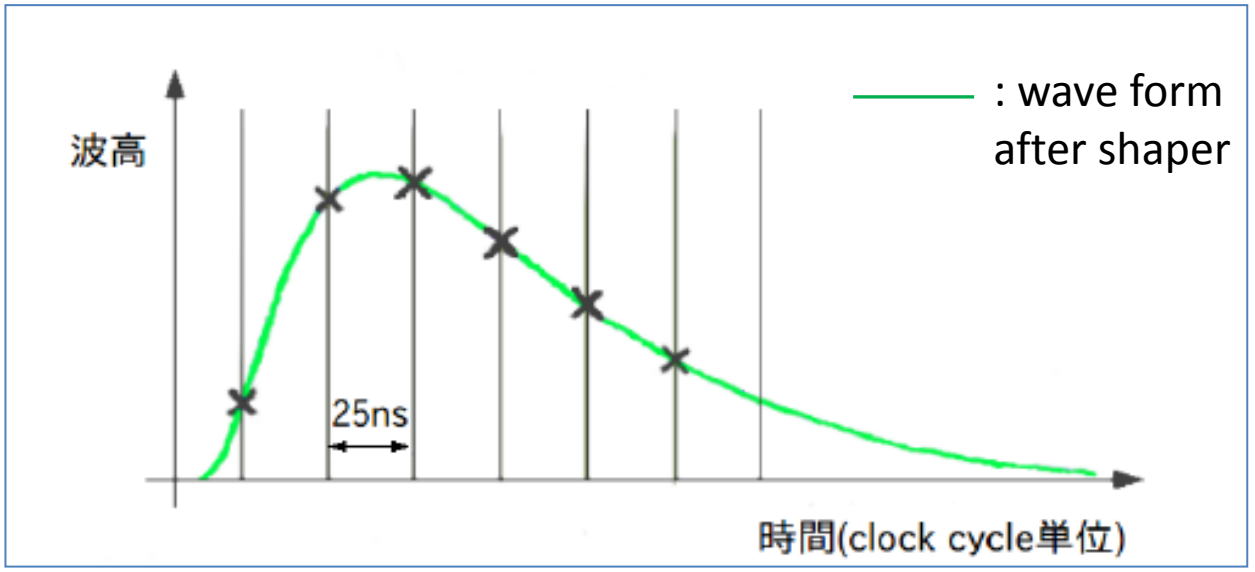
- “APVDAQ” VME module developed by Belle group
- 128 ch multiplexed signals are transferred by 30 m category 7 LAN cable

  (yellow cable in the right picture)
- Readout by FADC on the board

  (10bit, 40MHz sampling)



Data acquisition with sampling mode



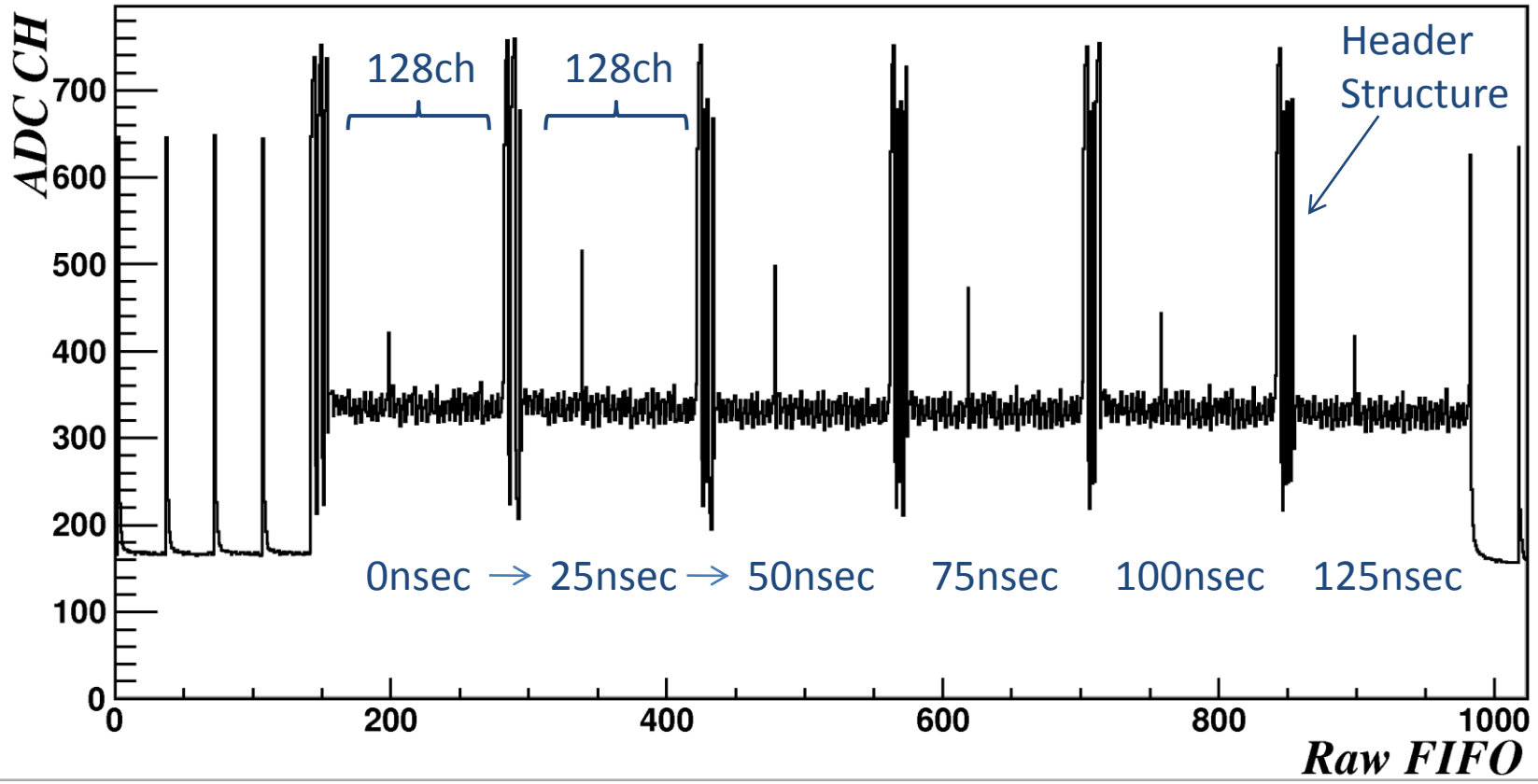
APV25 chip has a function of data sampling

By fitting the data points , we can know peaking time

We can exclude accidental hits by timing !

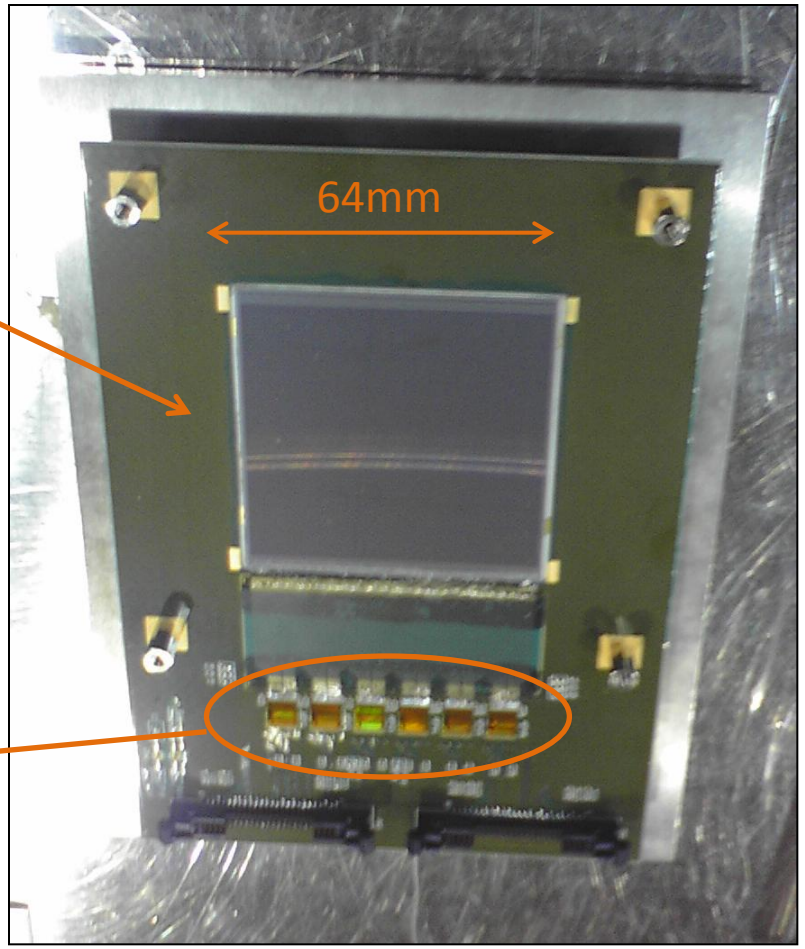
Raw Data (sample)

Raw Data from a APV25 chip which contains 128 ch's information



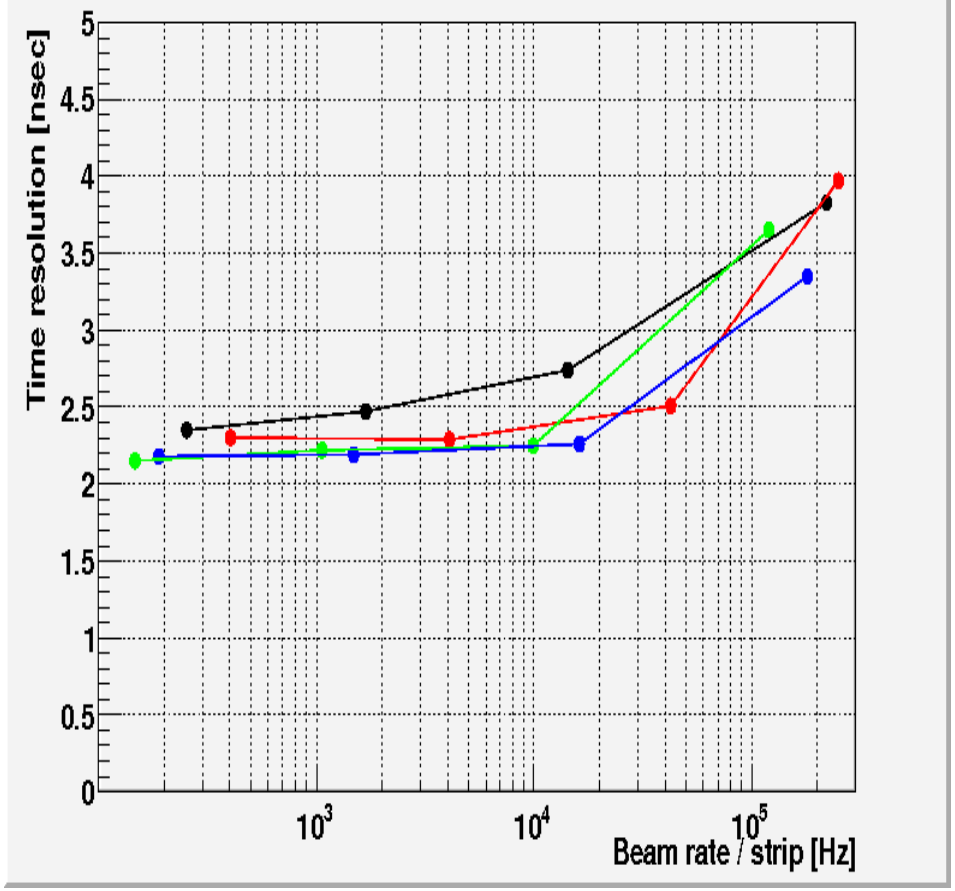
SSD

- (Single Side) Silicon Strip Detector
- Sensor
  - -- ATLAS sensor
  - -- Strip : 768ch , 80µm pitch
  - -- effective area 64mm
  - -- radiation tolerance >3*10^{14}
  - -- (typical operation voltage) ~ +70V
- Readout chip
  - -- APV25-s1 chip (developed by CMS)
  - -- Each chip has 128 ch of pre-amp and shaper and use serial transfer by multiplexer

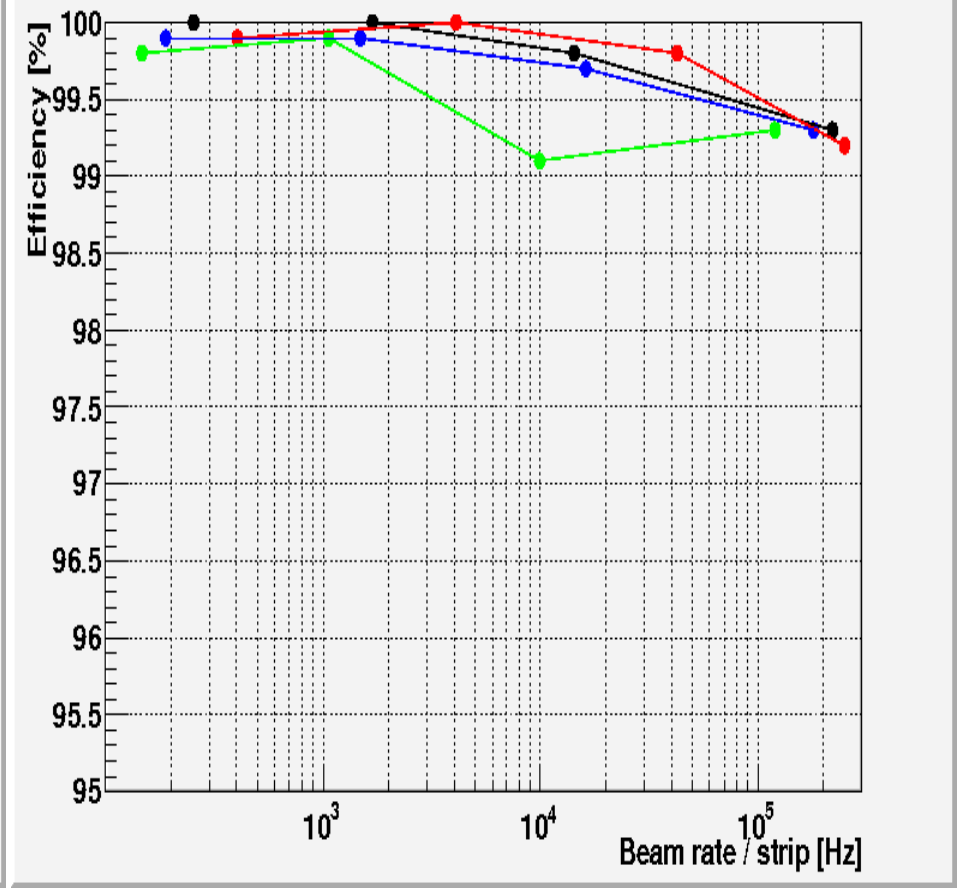


Performance of SSD
-- Beam rate dependence

Timing resolution



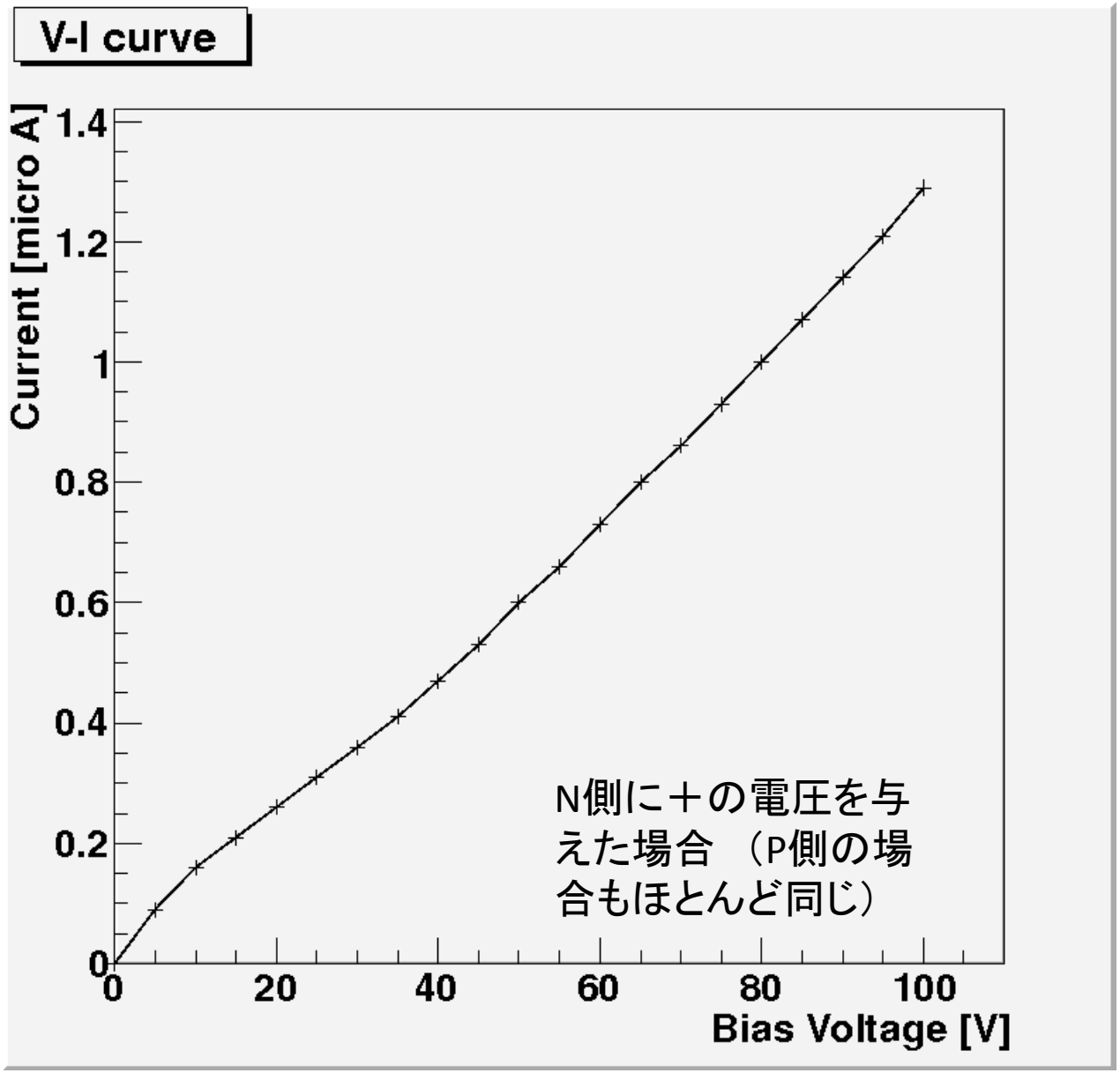
Efficiency



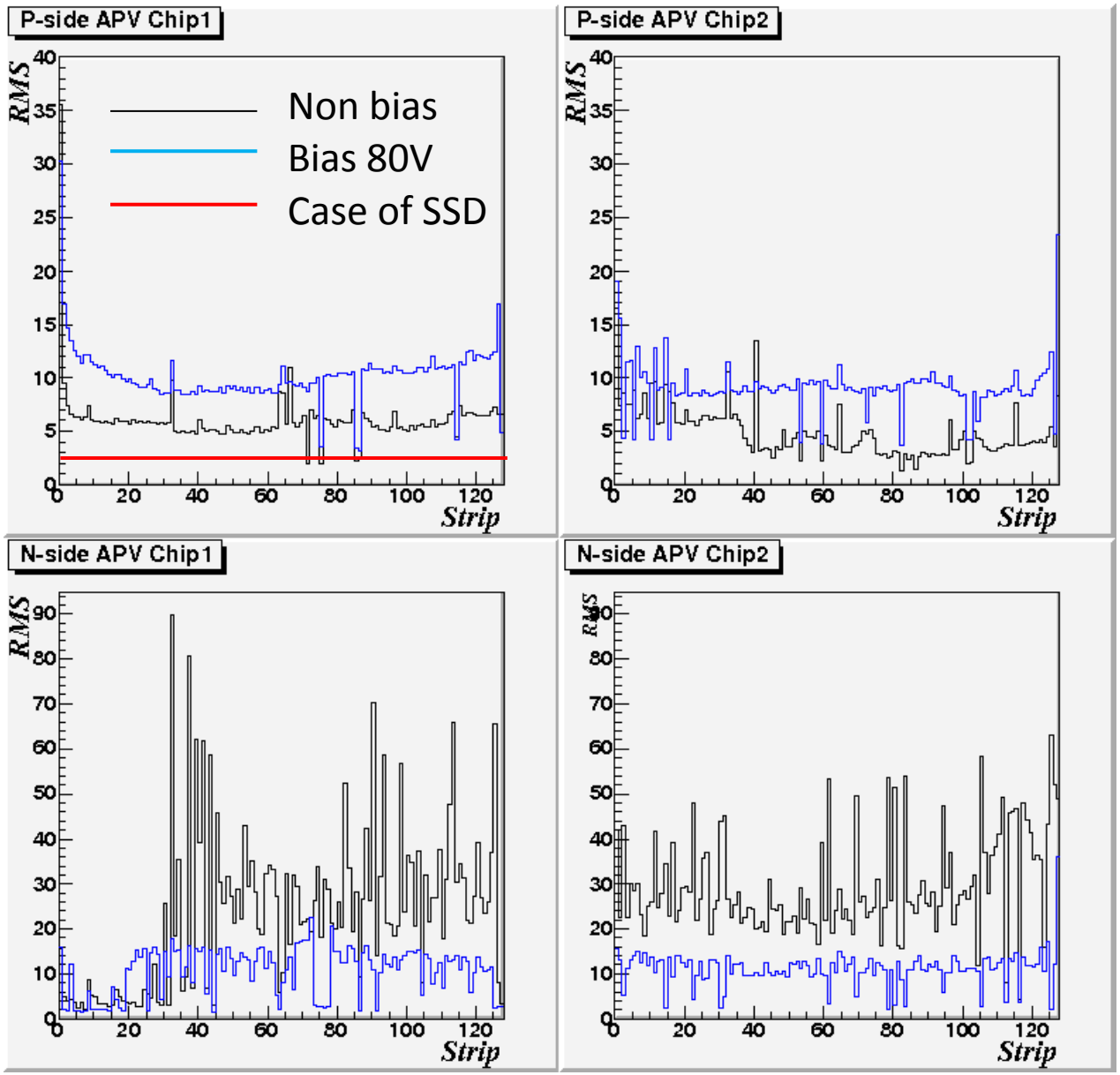
If the beam spot size is a few cm (ϕ) , SSD can work under 10 MHz .

Test of DSSD

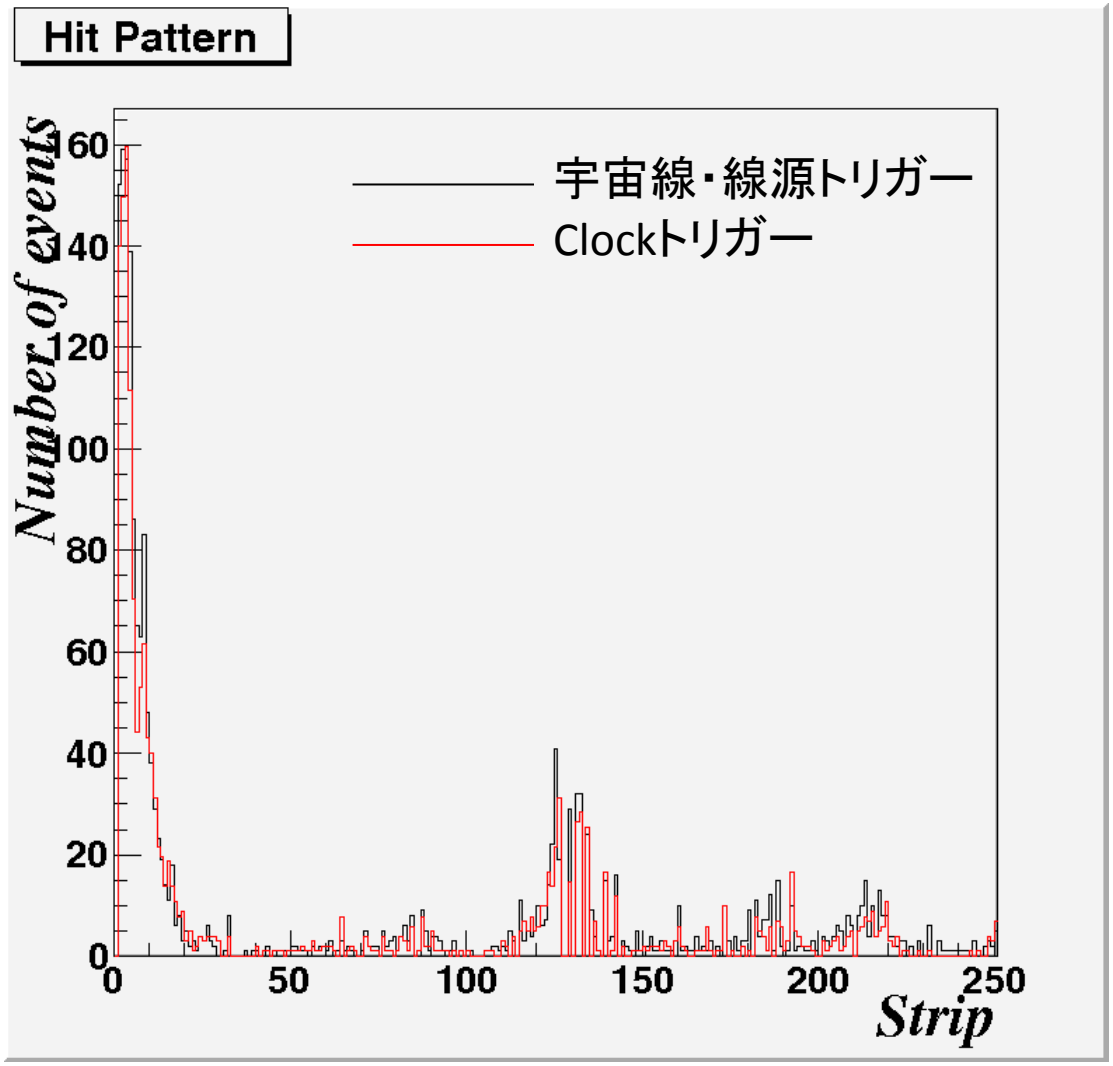
IV曲線

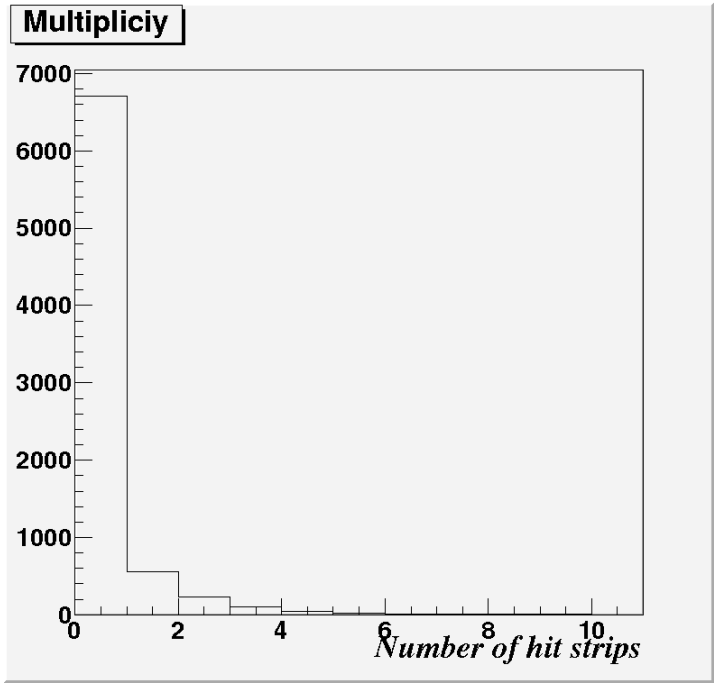

V-I curve
Current [micro A]
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
Bias Voltage [V]
N側に＋の電圧を与えた場合 （P側の場合もほとんど同じ）

Comparison of Pedestal distribution



P側読み出し時の“信号”イベント





信号と思われるイベントは現在のところ単なるfluctuation …….

まとめ

・韓国・慶北大学と共同してDSSDセンサーを開発した。

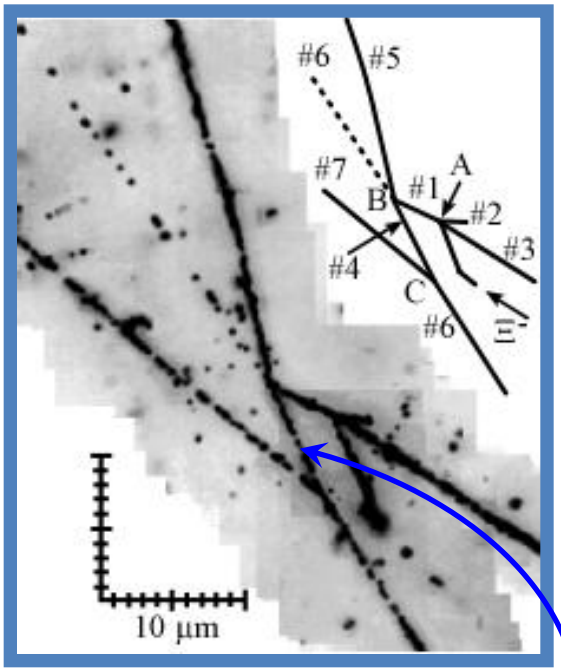
・データの読み出しその他はこれまでのところ問題ない。

・但しセンサーの評価として、ノイズが大きく(リーク電流が大きい)、また有意な信号はまだ検出できていない。

・今後については慶北大学とも連絡をとりながらどうすすめるかを検討中。

Results of KEK-E373

- **NAGARA event (1)**



H.Takahashi et al.,
PRL87 (2001) 212502

Track data (lengths, angles and PID)

point	track#	length [μm]	θ [degree]	ϕ [degree]	
A	#1	8.1 ± 0.3	44.9 ± 2.0	337.5 ± 1.8	double-hypernucleus
	#2	3.2 ± 0.4	57.7 ± 5.2	174.9 ± 2.9	
	#3	88.6 ± 0.5	156.2 ± 0.5	143.0 ± 1.0	
B	#4	9.1 ± 0.3	77.7 ± 1.6	115.9 ± 0.8	single-hypernucleus
	#5	82.1 ± 0.6	122.8 ± 1.0	284.2 ± 0.7	stopped in base
	#6	13697	81.0 ± 0.5	305.5 ± 0.2	π^-
C	#7	742.6 ± 0.6	138.5 ± 0.2	322.1 ± 0.3	stopped in D-Block
	#8	5868 ± 20	52.2 ± 1.2	123.7 ± 0.7	scattered before stopping

1. Single-Λ (TK#4)

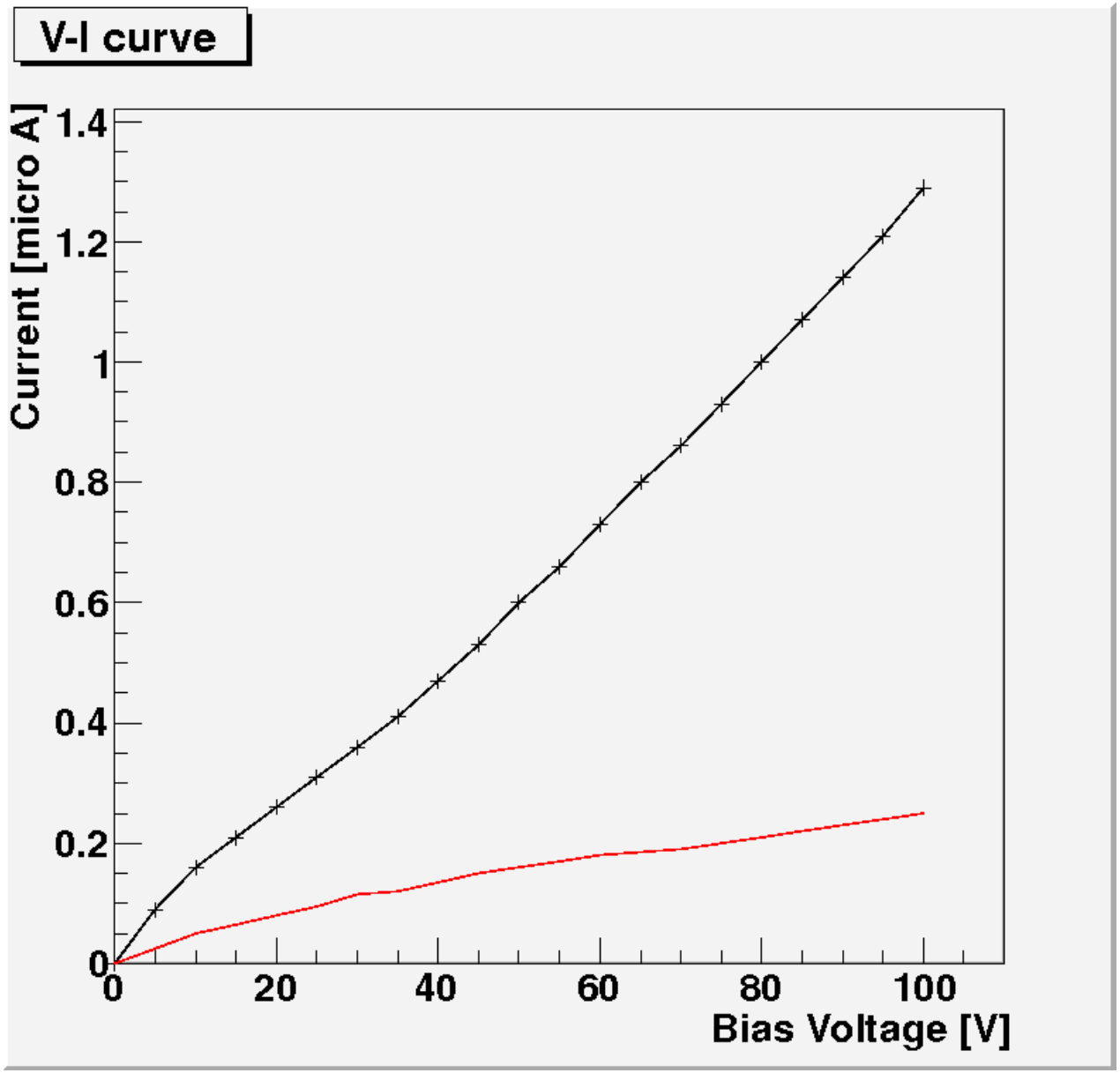
image of TK#7 in D-Block [gave **K.E.**]

=> Both of **charge** for TK#7 and #8 should be **an unit.**
(exceeding Q-value of non-mesonic decay**)**

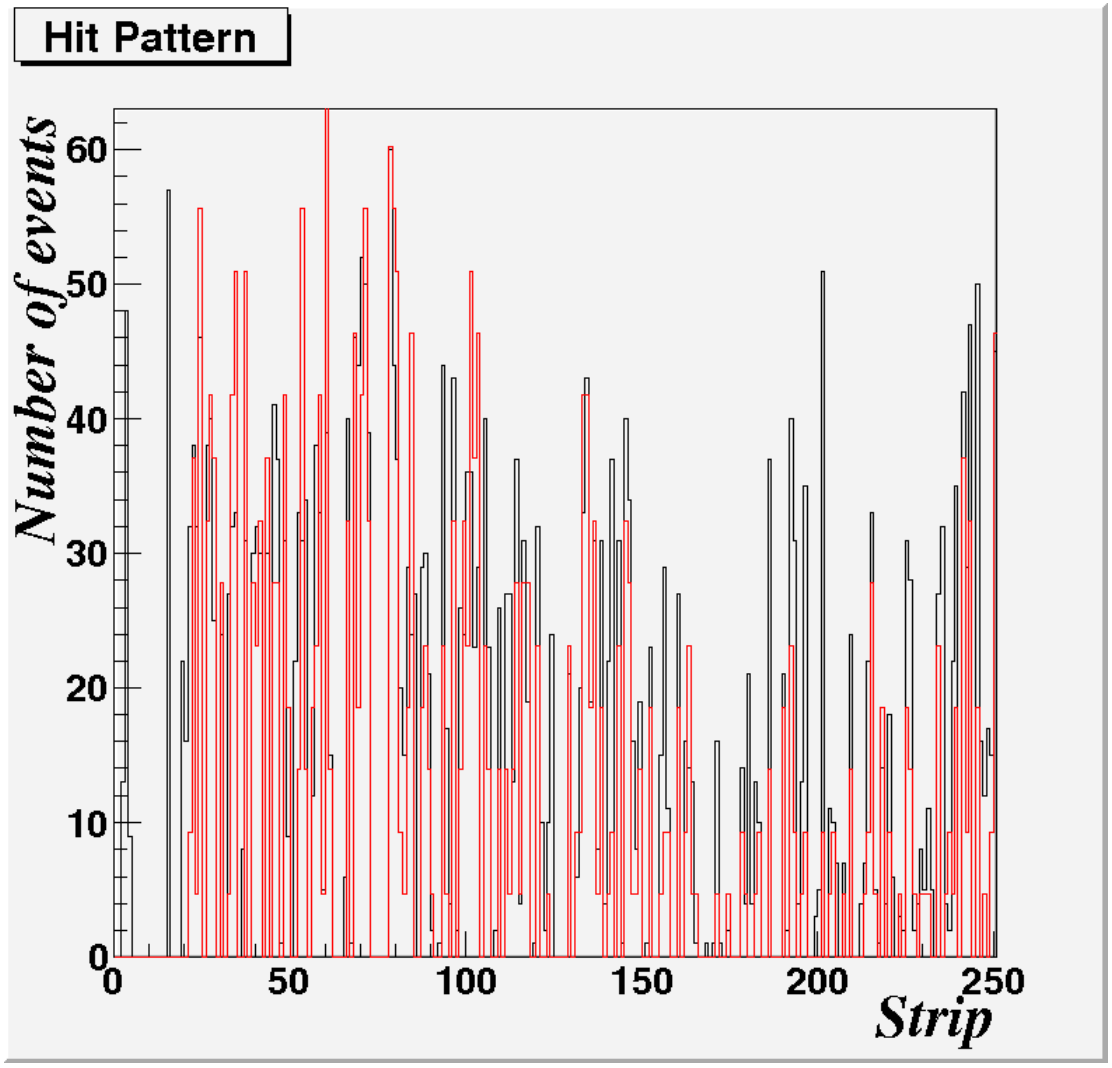
=> Single-Λ = **He** nucleus
Λ

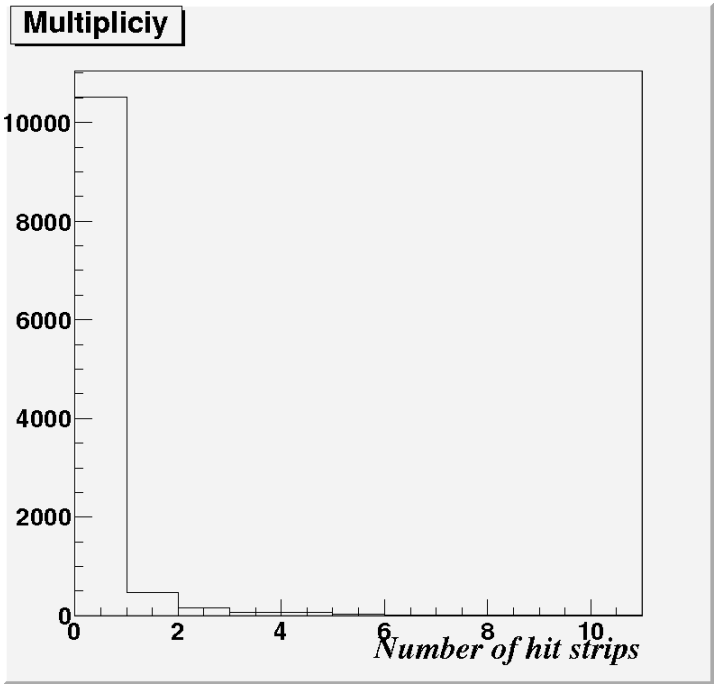
2. TK#6 was a π^- by measurement of **dE/dx** and **topology** of its end point **(**with **Auger electron).**

IV Curve


V-I curve
Current [micro A]
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
Bias Voltage [V]

N側読み出し時の“信号”イベント





Data Suppression

- DAQ trigger accept rate ~ 20 Hz (4SSDs)

⟺ ~ 1Khz @ J-PARC K1.8 beamline

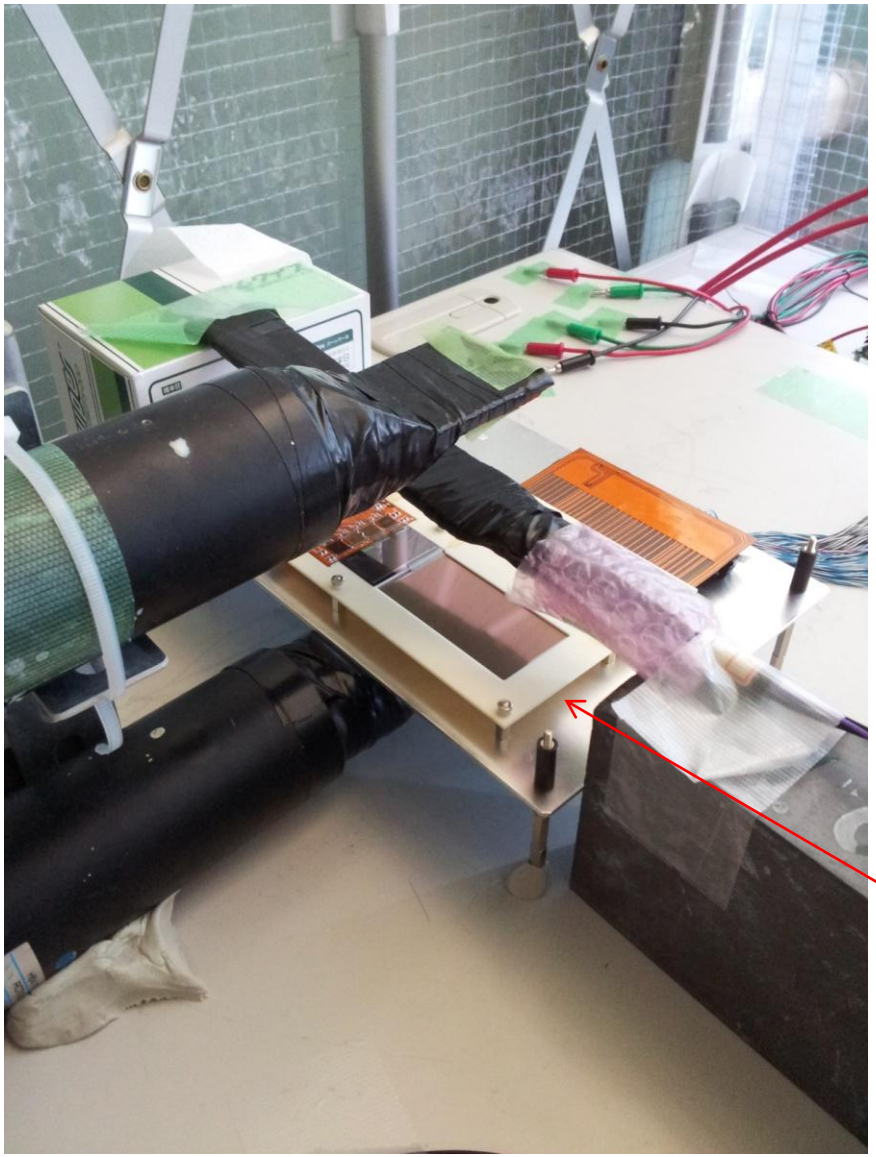
- Most of data is null : a few hits within 768 ch

↓

Discard the null data before readout

Last year, we developed this data suppression system,
And test it at RCNP experiments first time

DSSDの測定の様子



・DSSDの読み出し面に対してシンチを配置して宇宙線及び線源によるコインシデンストリガーを生成

・ただしバイアスはGNDをその他から切り離した

DSSDの下に線源(Sr90)を設置

読み出しAPVチップの領域