

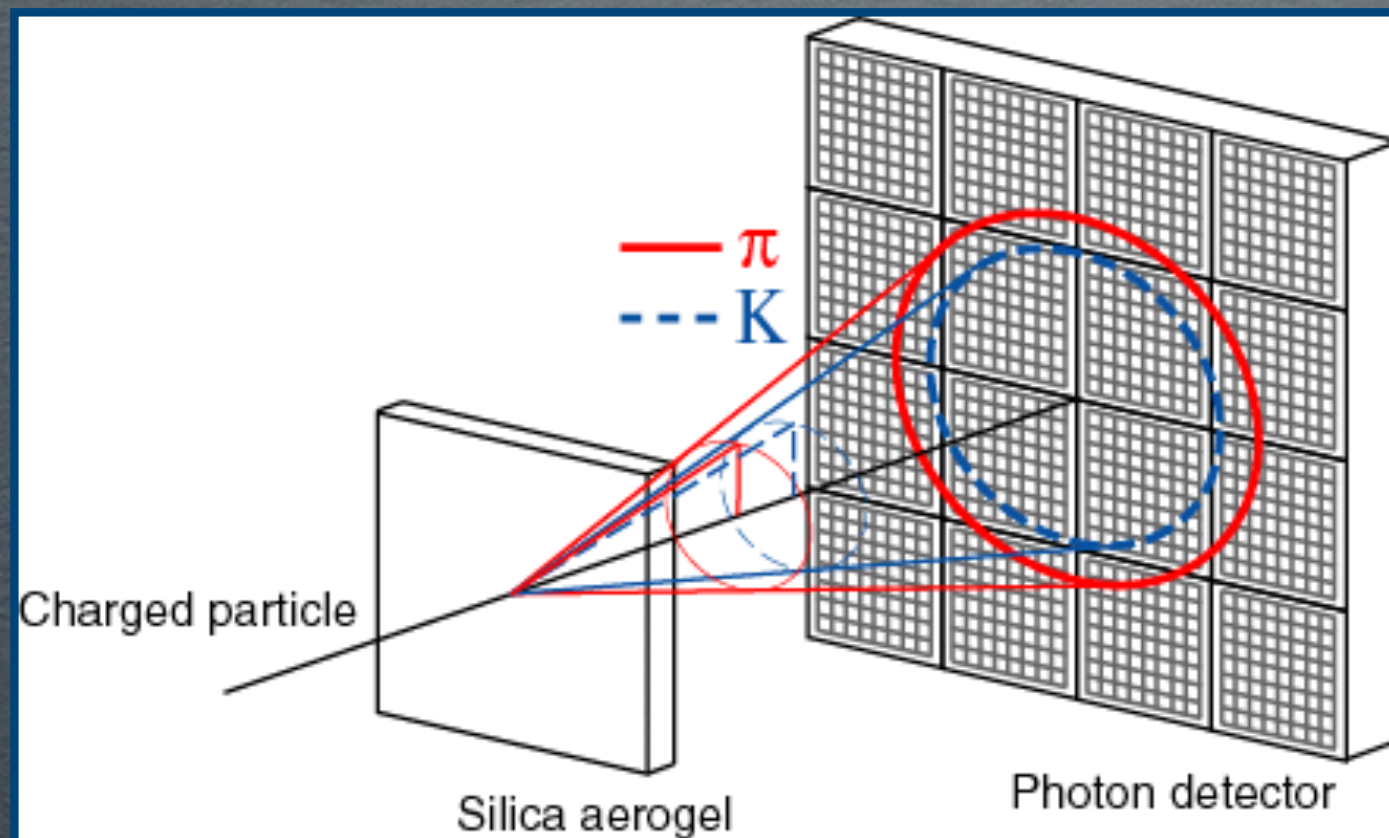
# CONTRIBUTIONS IN E-PID SESSION

I C H I R O   A D A C H I

K E K

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

B 2 G M





# E-PID SESSION

- ✻ Three summary reports of updated measurements

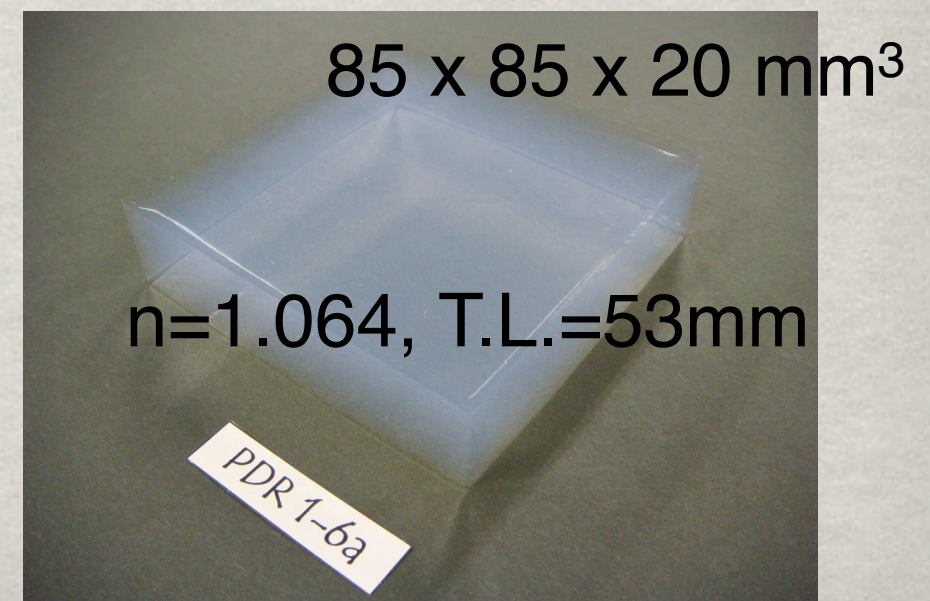
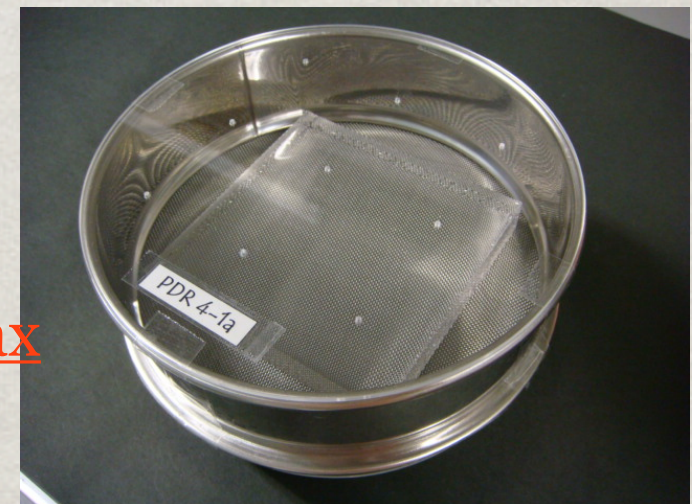
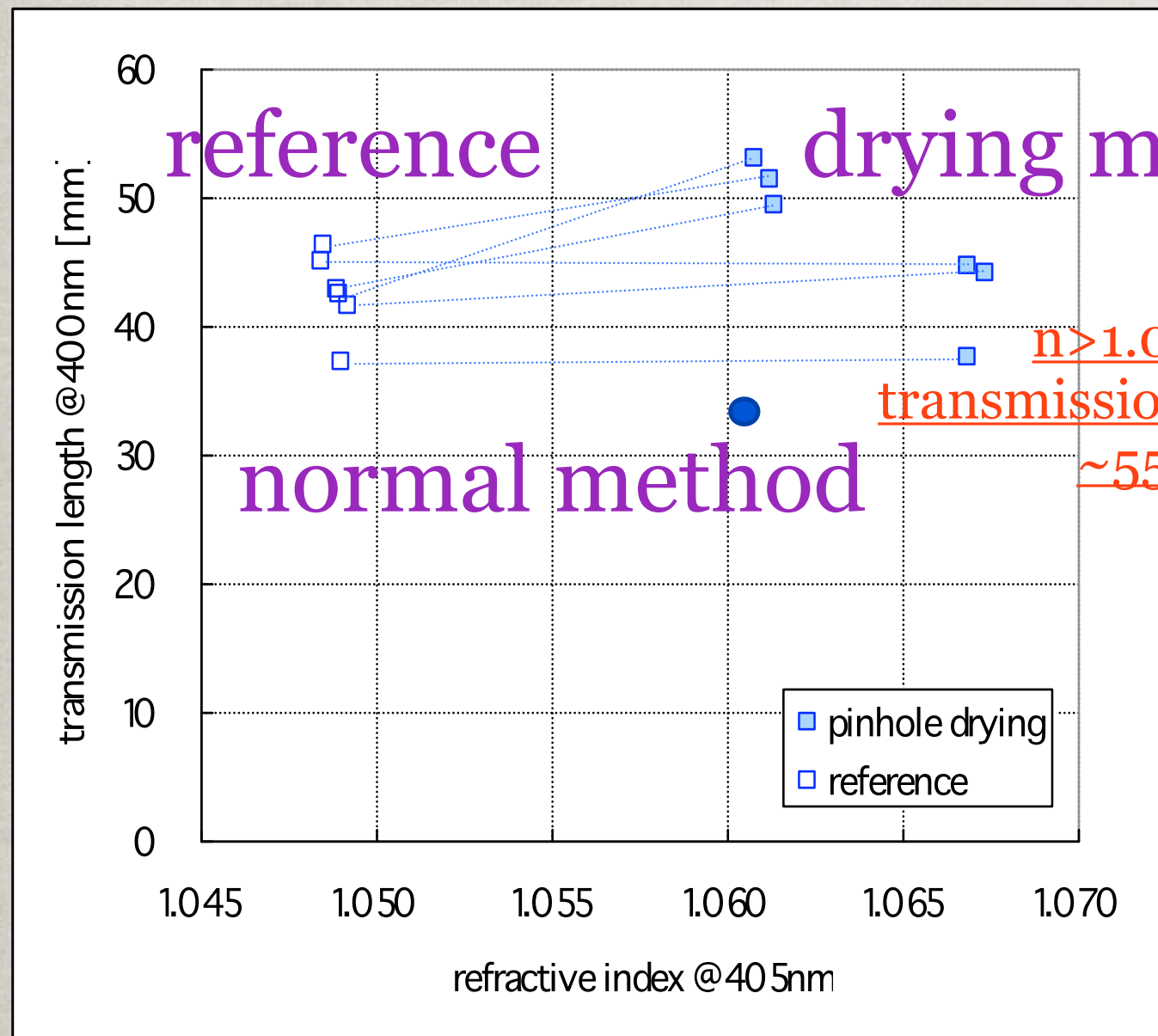
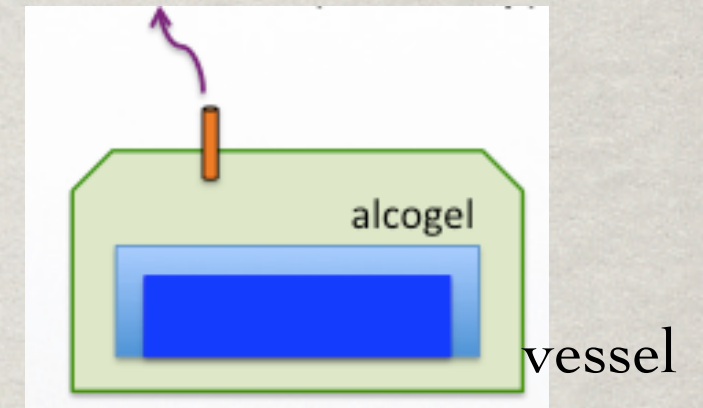
13:30->16:30	  <b>Parallel-A: E-PID</b> (3-go-kan seminar hall)	
13:30	  Aerogel status update (20')  Slides 	Ichiro Adachi (KEK)
13:50	  MCP-PMT updates (20')  Slides 	Samo Korpar (J. Stefan Institute)
14:10	  HAPD and electronics updates (20')  Slides 	Shohei Nishida (KEK)

- ✻ We will have PID-dedicated meeting at Nagoya next week.
- ✻ Leave detailed discussions there.



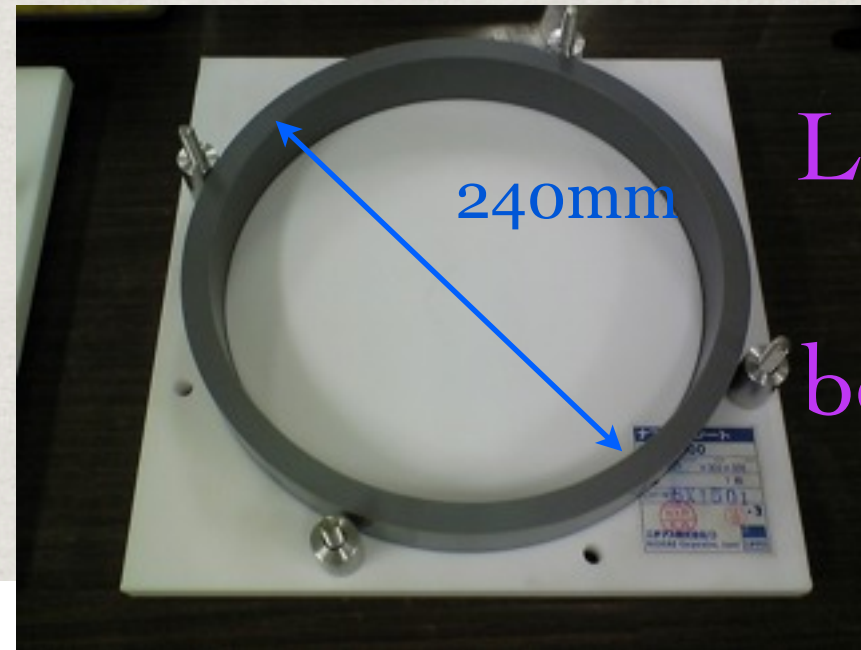
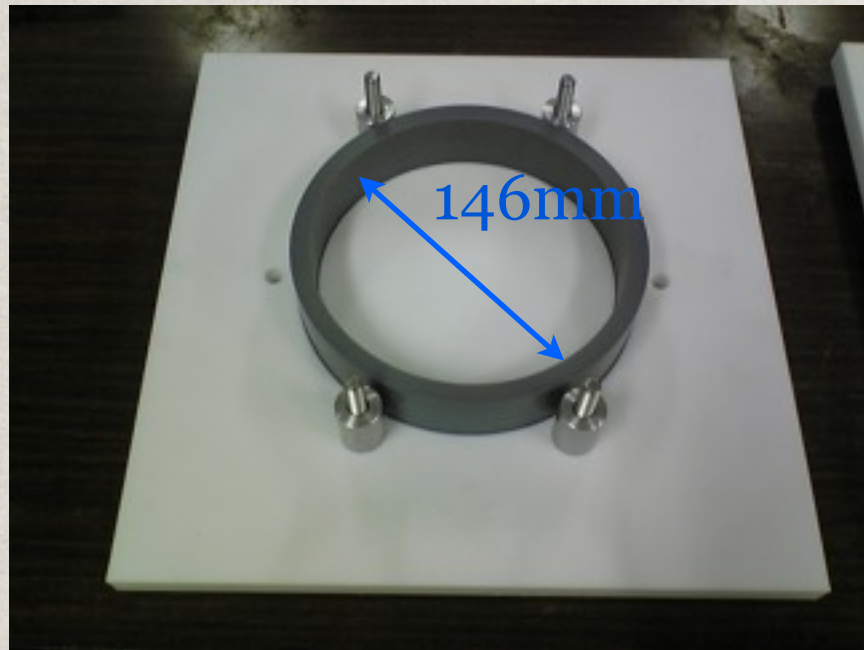
# AEROGEL RADIATOR STATUS

New production method (drying method)  
looks working OK

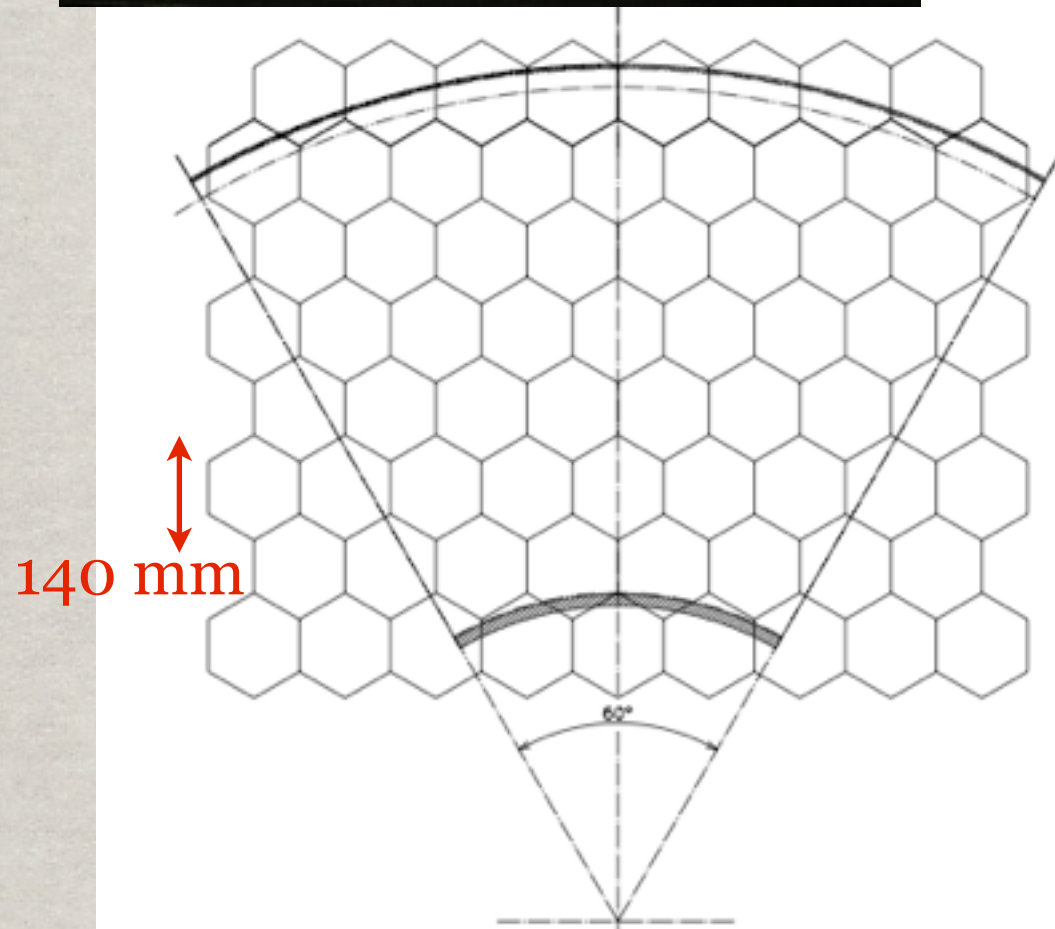




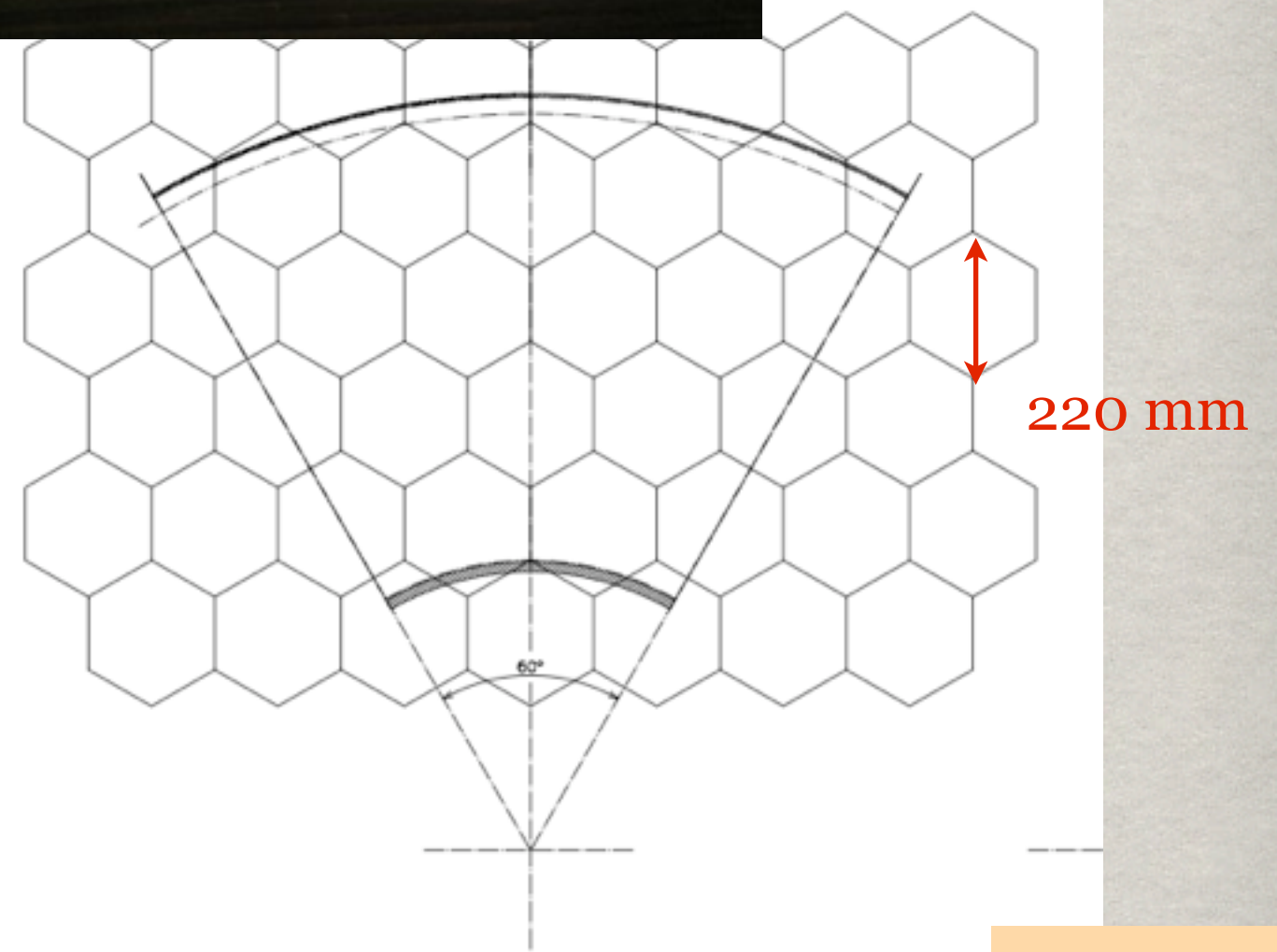
# AEROGEL RADIATOR TILE SIZE



Larger tile size  
can reduce  
boundary area



62 tiles/sector



30 tiles/sector

Yield?



# MCP-PMT BY SAMO SAN

## ✿ Information on aging from provider (Photonis)

Old information:

Current performance (no Al protection layer): → 50% drop of efficiency  
after 10-15C/tube = 350-540mC/cm<sup>2</sup>

expect ~10mC/cm<sup>2</sup>/y or more

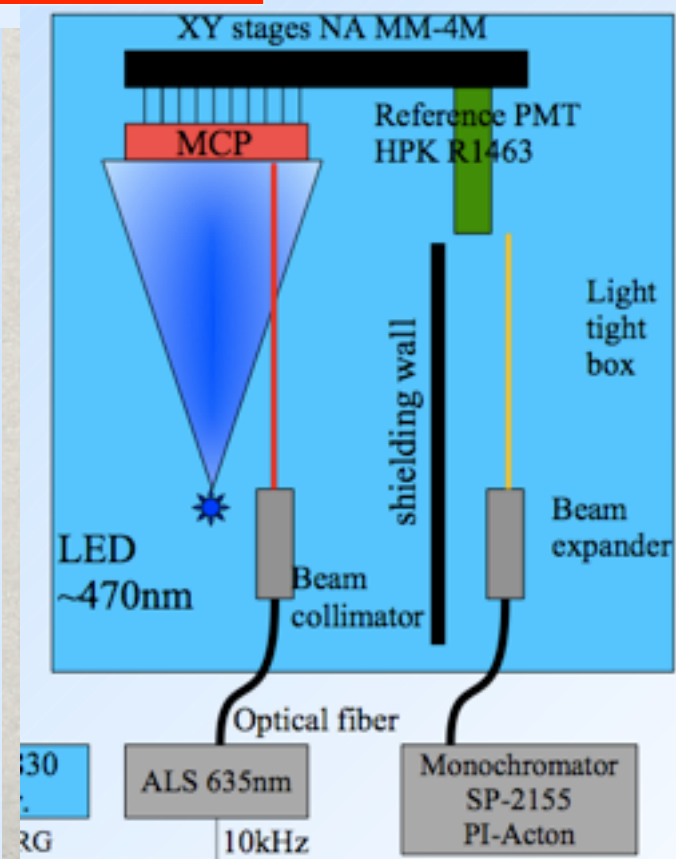
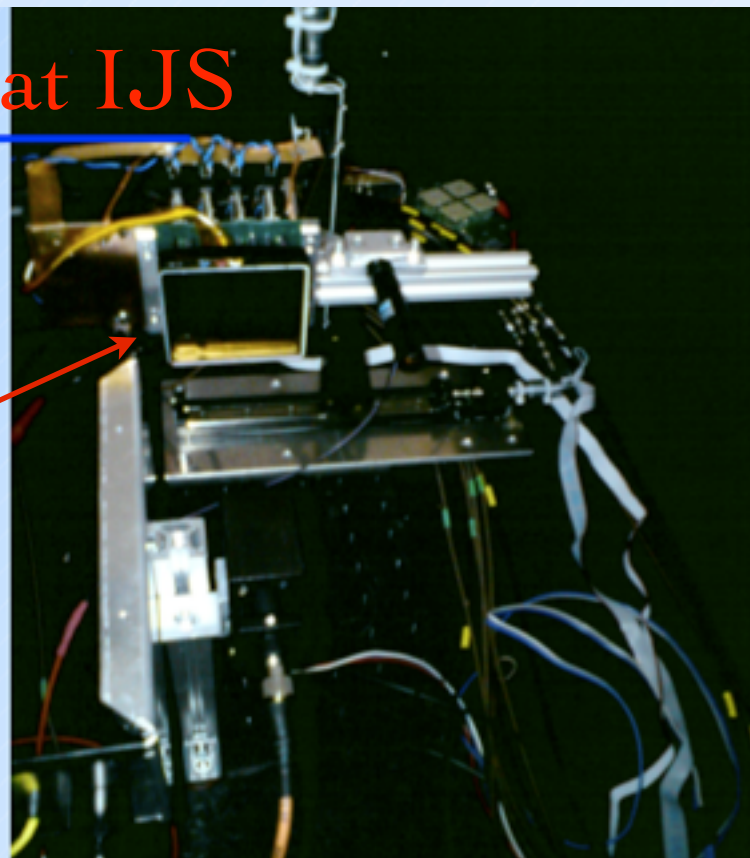
New aging test – preliminary:

- 250 mC/cm<sup>2</sup> accumulated
- drop in radiant sensitivity (blue) ~10%

Examined by  
ourselves

## ✿ Set-up at IJS

MCP-PMT  
from Photonis

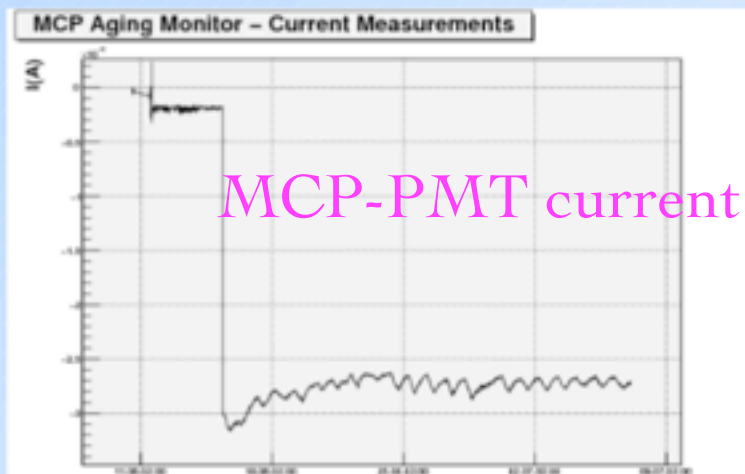
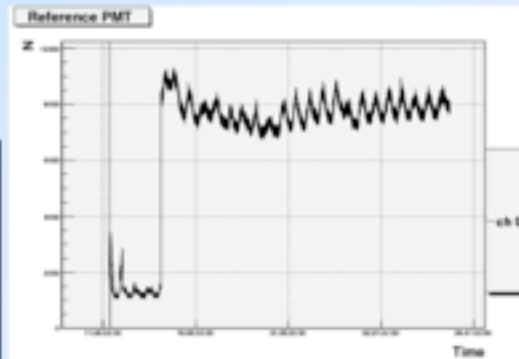
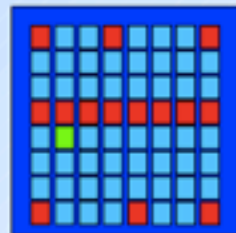




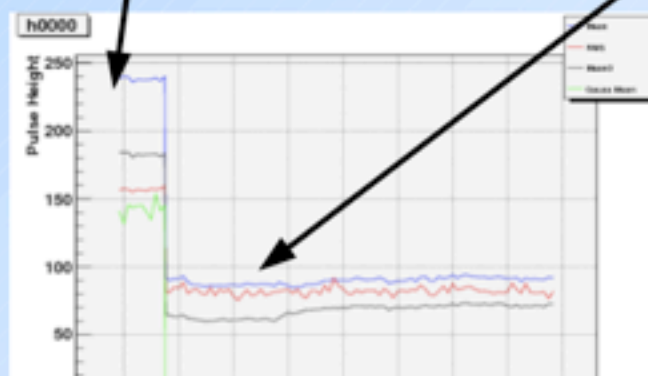
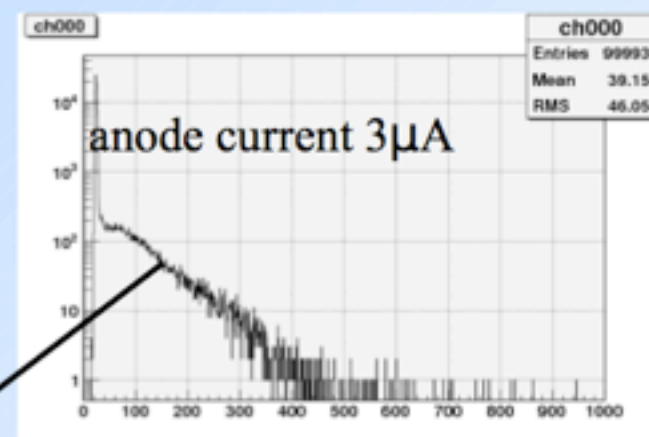
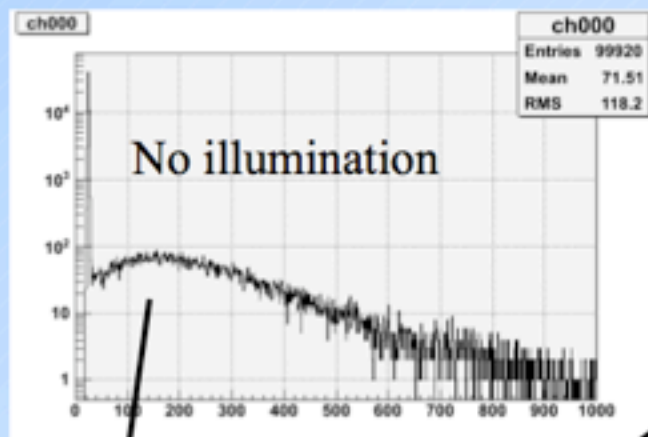
## Current and rate monitoring

Total current and rate on monitored channels measured every minute.

- daily variation with temperature
- similar variation on reference PMT

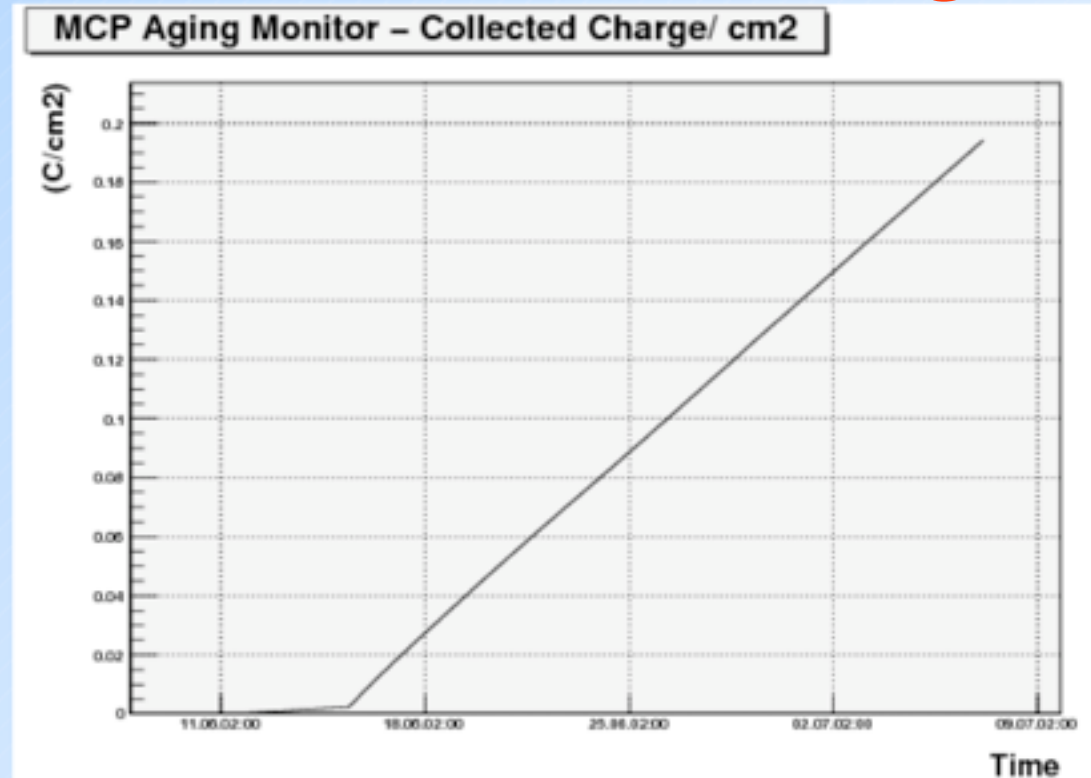


## Gain monitoring



- Initial gain at HV = -2200V  $\sim 3 \times 10^5$
- Gain drop at high rate operation
- Monitor average pulse height

## Accumulated charge



## First test at 200mC/cm2 (July/08)

### Aging:

- accumulated total anode charge  $\sim 200 \text{ mC/cm}^2$  will be reached today
- change in performance on the order of 10% - to be checked
- PDE will be measured every 200  $\text{mC/cm}^2$  (first measurement today)

will be available at  
Nagoya meeting



# TEST ON WAVEFORM READOUT

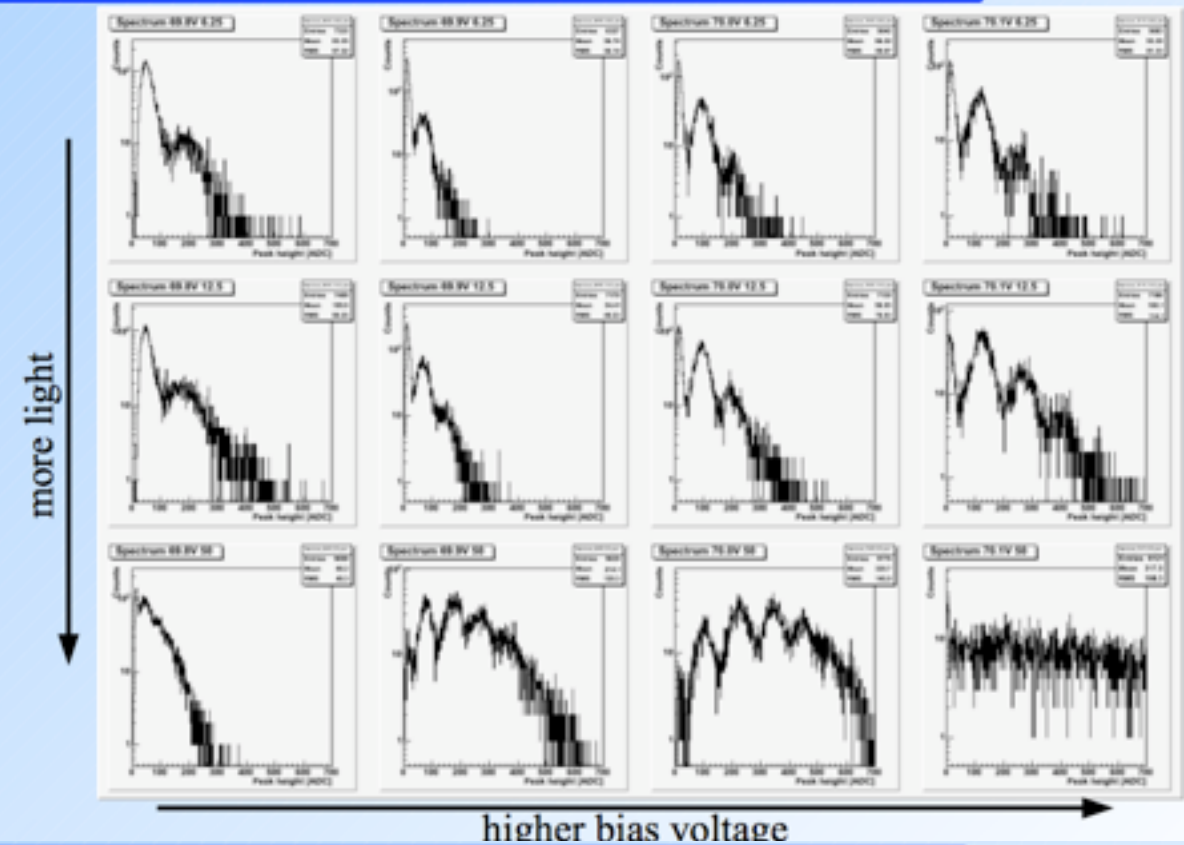
## Waveform readout - MPPC

Ruben Verheyden

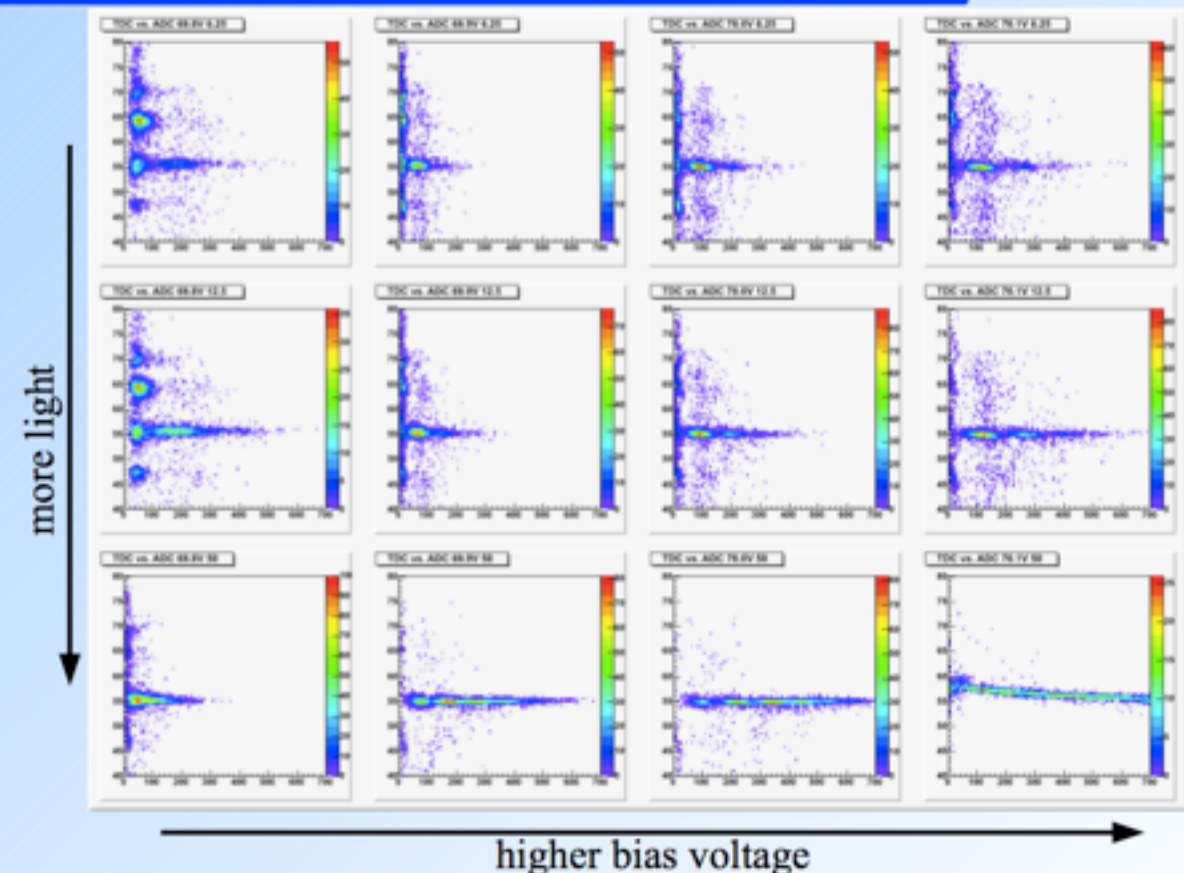
- Single photon detection and precise timing
- Compare different Hamamatsu MPPC's:
  - 3x3 mm; 100  $\mu\text{m}$  pitch; model S10931-100P(X); Serial # 19;  $V_{\text{op}} = 69.82 \text{ V}$
  - 1x1 mm; 25  $\mu\text{m}$  pitch; model S10362-11-025C; Serial # 34;  $V_{\text{op}} = 71.67 \text{ V}$
  - 1x1 mm; 100  $\mu\text{m}$  pitch; model TBD; Serial # TBD;  $V_{\text{op}} = \text{N/A}$
- Compare different operating Voltages
- Compare different light intensities (Filters  $\rightarrow$  6.25%; 12.5%; 50%)
- Setup:
  - Laser, filters, diffuser  $\rightarrow$  small # of photons hit MPPC
  - TARGET for readout
  - fast amplifier ( $\mu\text{PC2710TB}$ )
  - ( + Attenuator + Ortec fast amplifier for the 3x3 mm MPPC)

Precise timing info  
helps reducing noise?

## 3x3 mm MPPC, S10931-100P(X): Photon Spectra

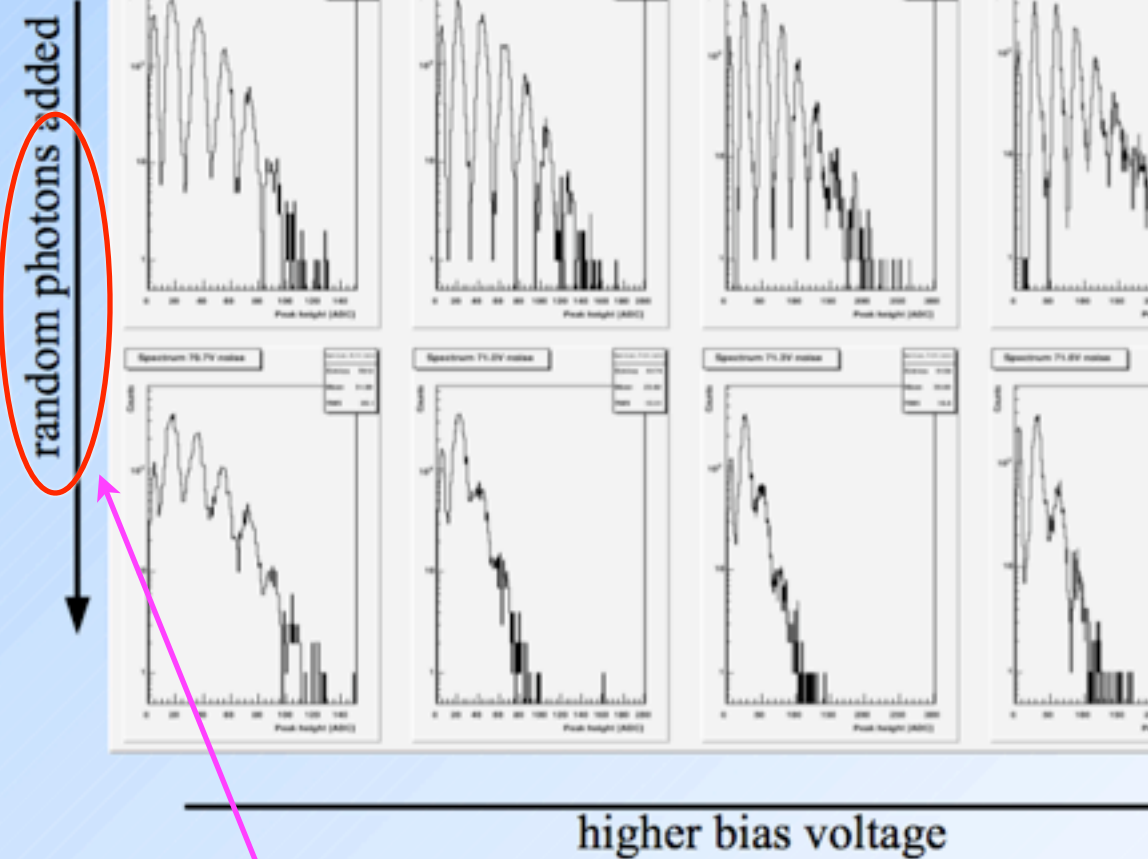


## 3x3 mm MPPC, S10931-100P(X): TDC vs. ADC





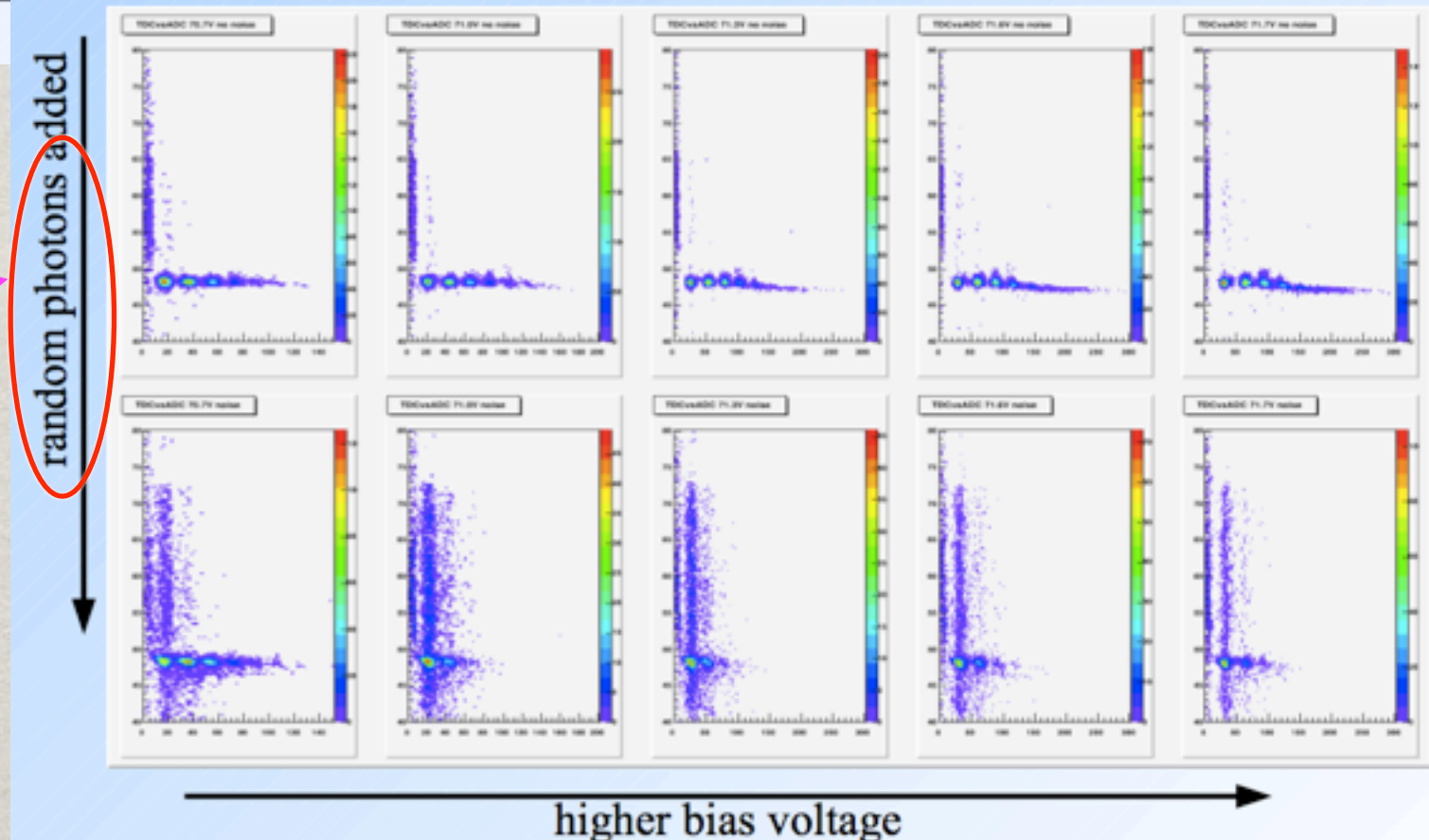
## 1x1 mm MPPC, S10362-025C: Photon Spectra



### Waveform electronics:

- currently testing with MPPCs
- timing and charge can be measured
- test with MCP-PMT after finishing MPPC tests

## 1x1 mm MPPC, S10362-025C: TDC vs. ADC



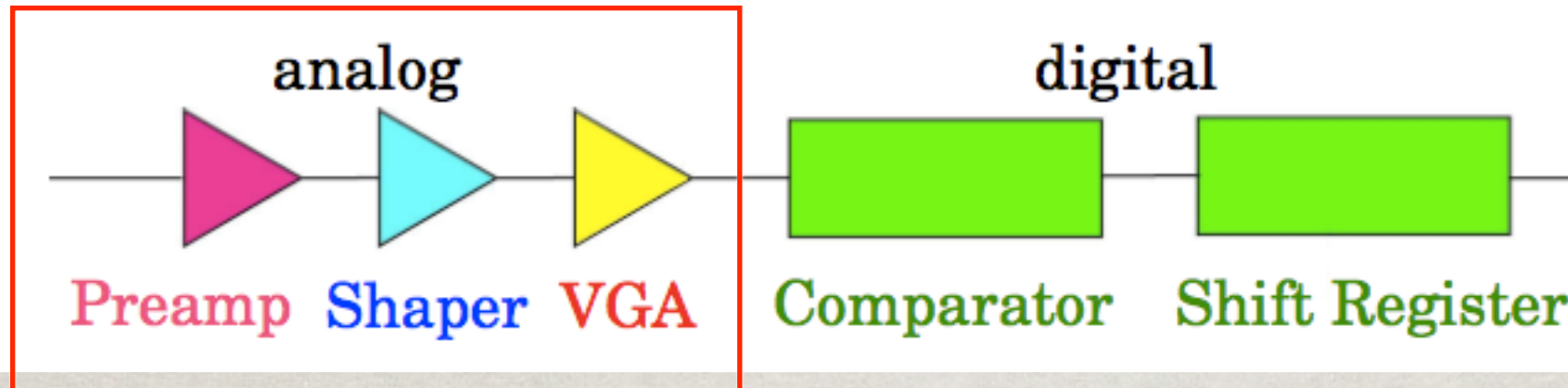
To simulate noise  
effect ( $\sim 1\text{MHz}$ )



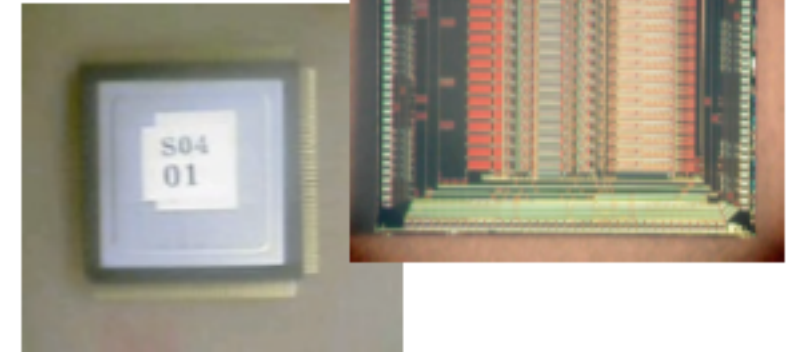
# HAPD & ELECTRONICS BY NISHIDA SAN

## ✿ ASIC for HAPD Readout Electronics

4 trial productions of prototype ASICs (S01-S04) at VDEC.



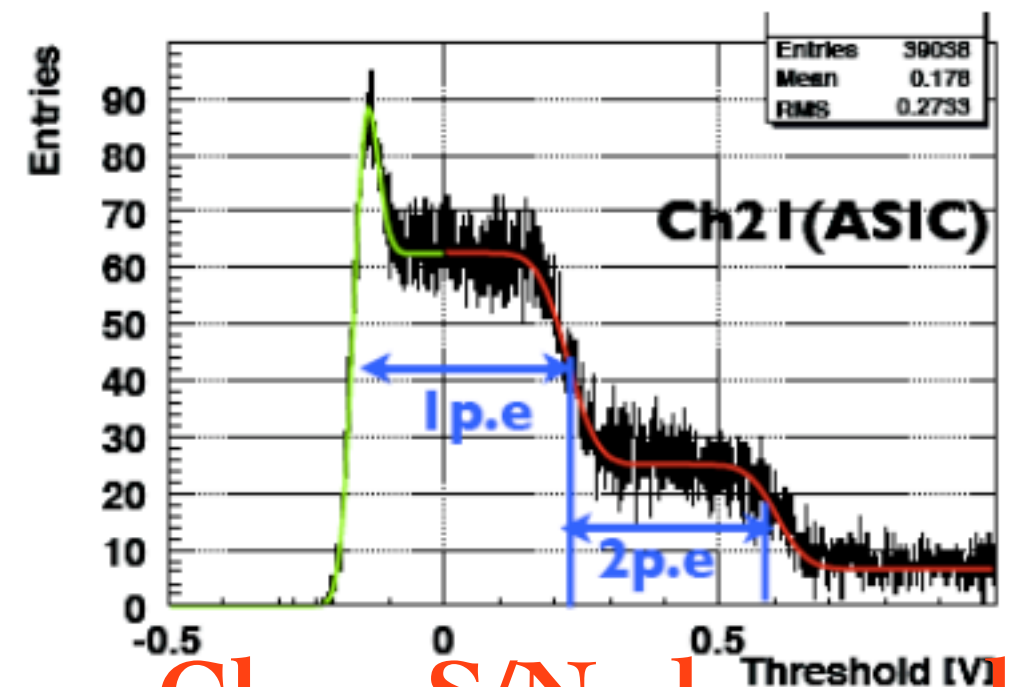
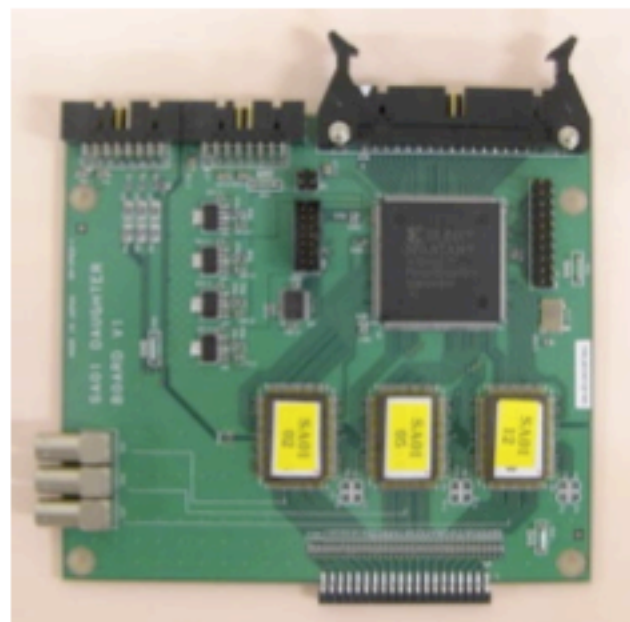
new ASIC functions



## ✿ Test ASIC+HAPD with new base-board

Updates after the previous meeting


- New board with 1 FPGA + 3 SA01 is developed.
- Now all the 36ch from 1 APD chip can be read.
- Very clean threshold scan: good S/N (the reason is not clear).

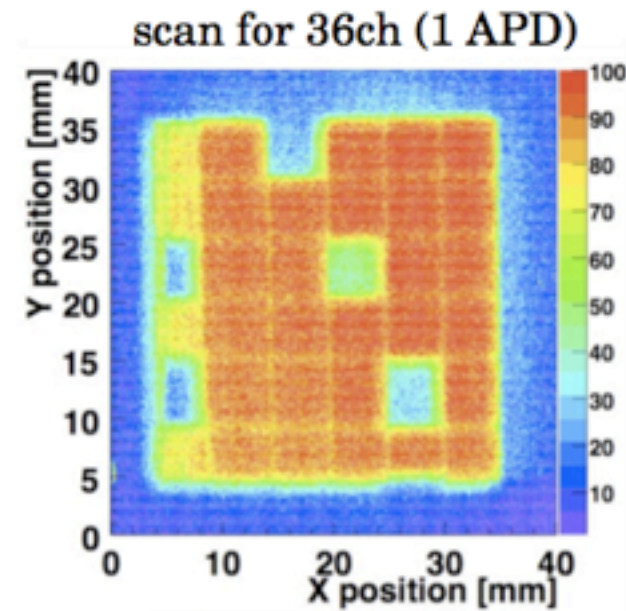


Clear S/N observed



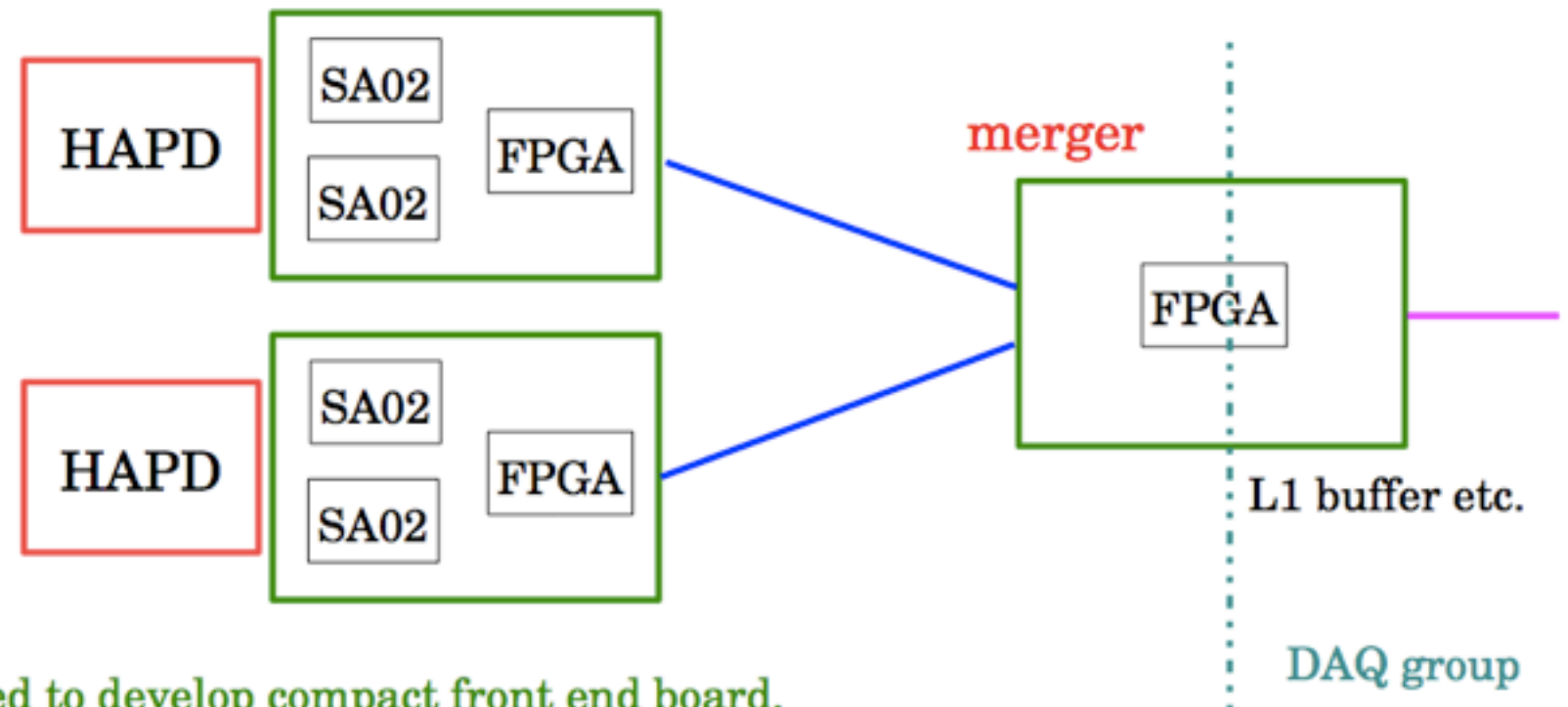
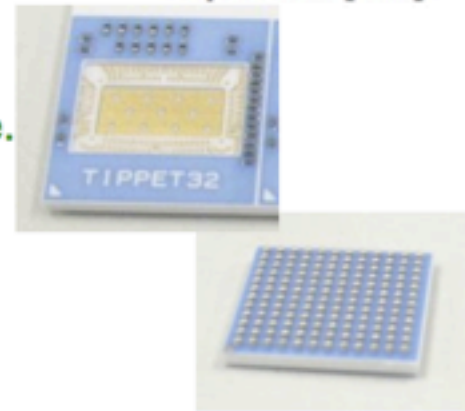
## SA01 status

- Noise problem is gone, though the reason is not clear yet.
- 2-dimensional scan successfully taken 
- Another problem is the linearity at above 1 p.e. Will be fixed by changing the gain in SA02.
- No major problem now. We will produce more boards to read full channel of HAPD.



## Next version: SA02

- 36ch per chip. Simulation O.K.
- Production of chips is just finished. Package will be done.
- Test board is also designed. We can start the test next month.
- LTCC (Low temperature co-fired ceramics) package will be tried for smaller package.

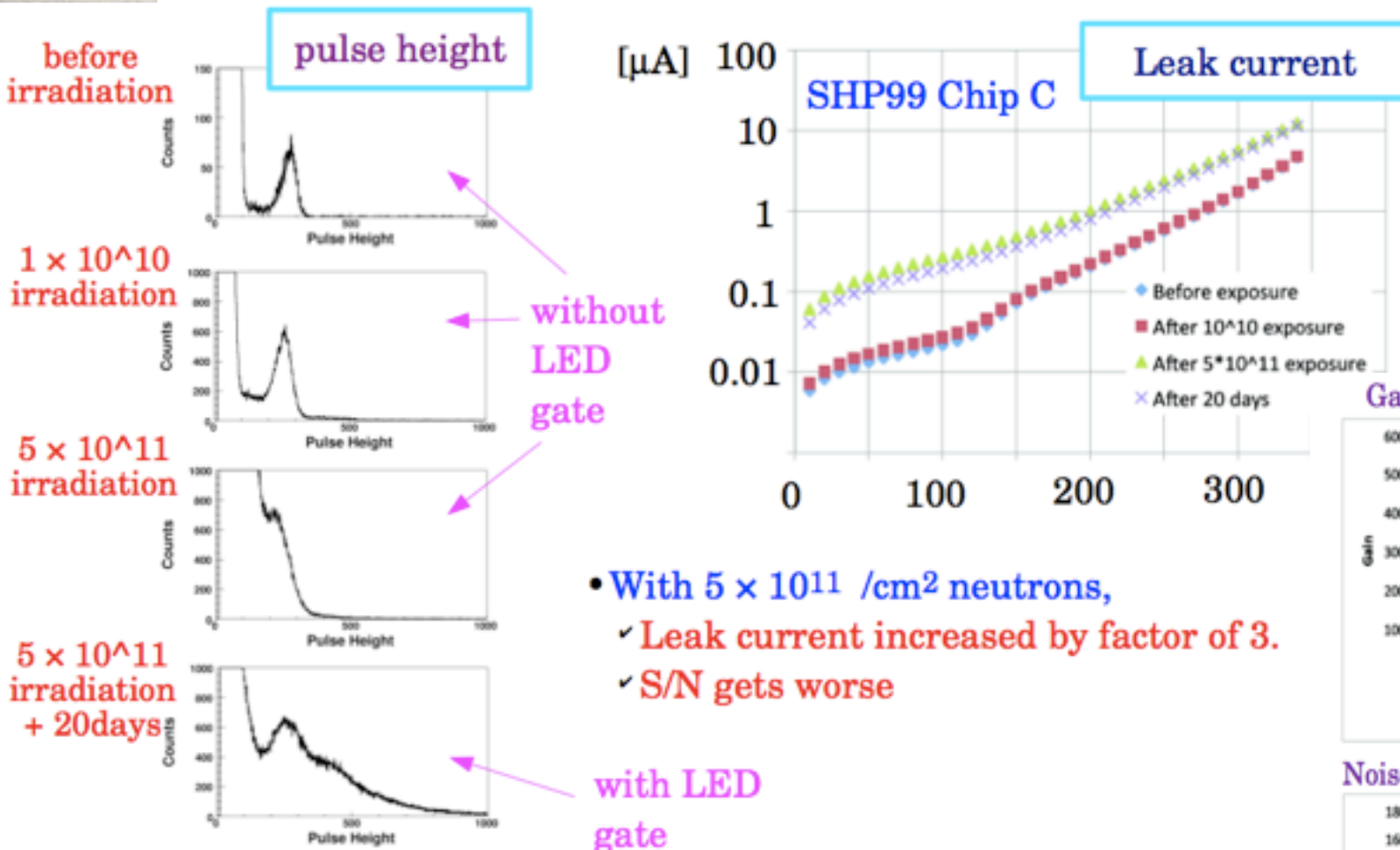


- Need to develop compact front end board.
- Data merger is also necessary.
- Link between front end board and data merger.

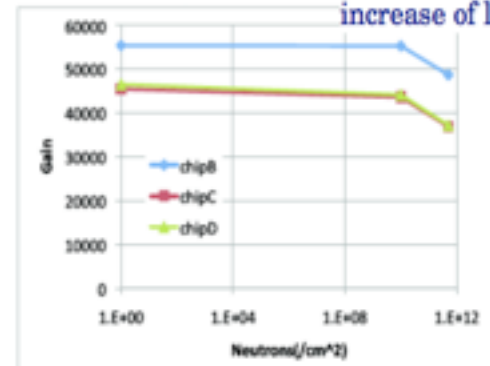


# HAPD NEUTRON IRRADIATION

- $1 \times 10^{11}$  /cm<sup>2</sup> neutrons per year are expected in Belle II.
  - ✓ Need to be tolerant to  $1 \times 10^{12}$  /cm<sup>2</sup> neutrons for 10 year's operation.
- Irradiation test is done at Yayoi (Fast neutron source reactor of the University of Tokyo; in Tokai).
  - ✓ Only one HAPD sample (SHP99: one chip dead / low QE [9%])
  - ✓  $1 \times 10^{10}$  /cm<sup>2</sup> and  $5 \times 10^{11}$  /cm<sup>2</sup>.

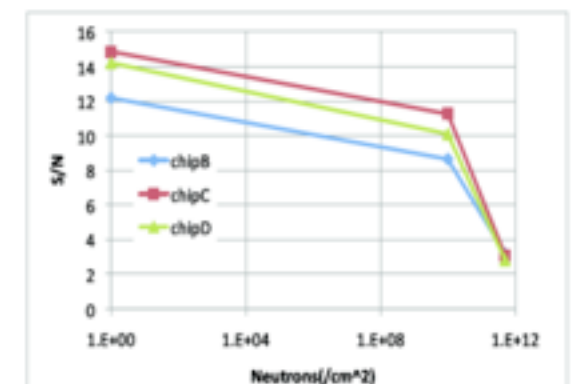


Gain: ~ 20% down maybe due to the increase of leak current

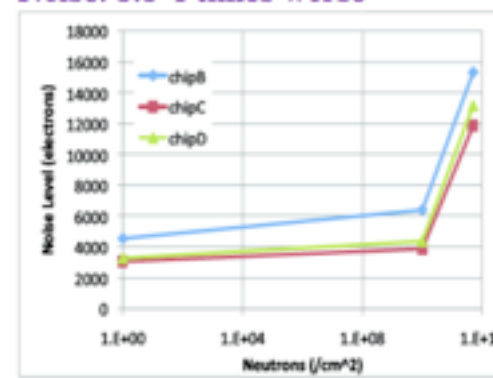


Channel dependence exists in S/N (2-5σ after irradiation)

S/N: become 1/5



Noise: 3.5-4 times worse



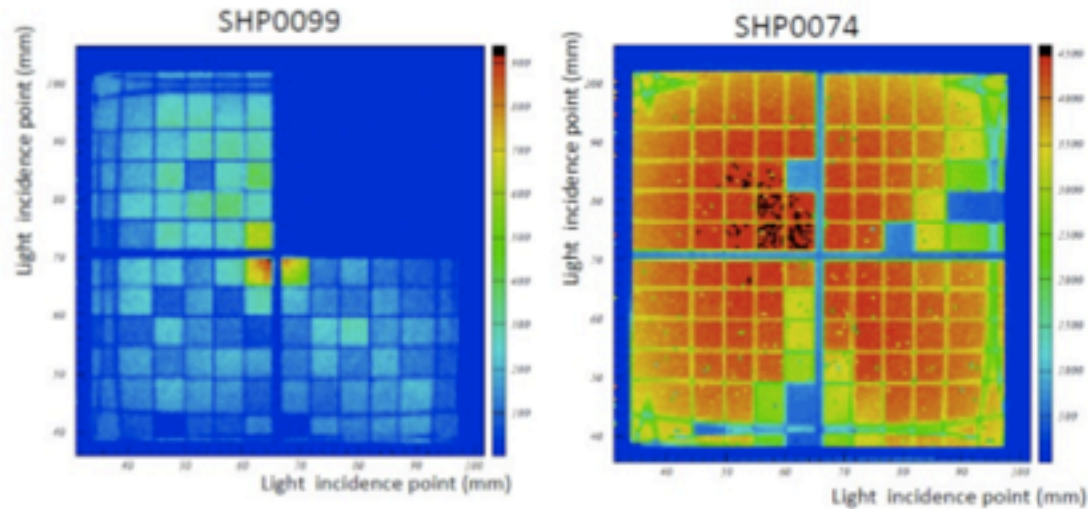
Noise level & S/N get worse

Optimization of bias voltage slightly improves S/N, but does not change the situation so much.



## Scan with ASIC (S04)

threshold =  $4\sigma$  above pedestal

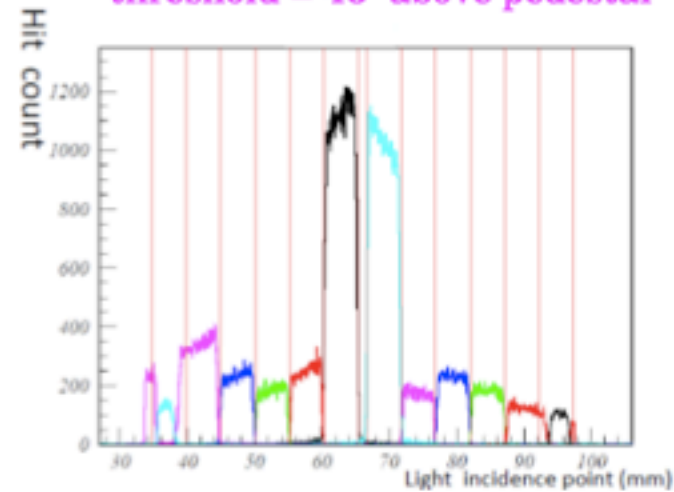


irradiated sample

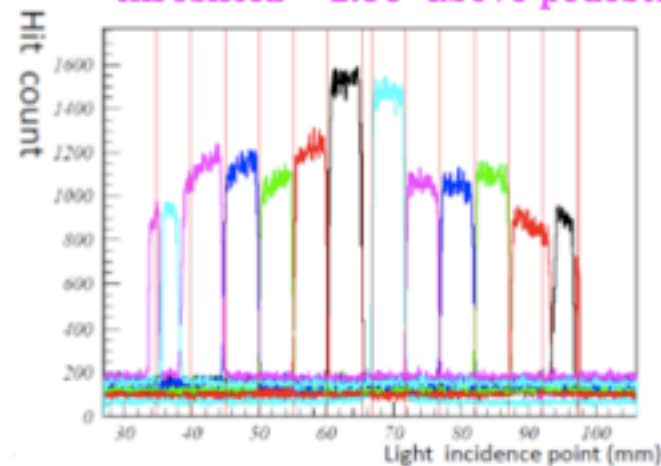
good sample

- If we set the threshold at  $4\sigma$  of noise above pedestal, efficiency is very low (even low QE of the sample is taken into account).
  - ✓ Channels near center is relatively working.
- If threshold is lowered, noise increases.
- Consistent with the previous measurement.

threshold =  $4\sigma$  above pedestal



threshold =  $1.5\sigma$  above pedestal



Large variation in channel-to-channel

## General remarks

- The increase of leak current is somehow understandable.
- But, why so noisy?

We would like to test more samples to understand what happened...



# ANOTHER TEST DONE IN JULY

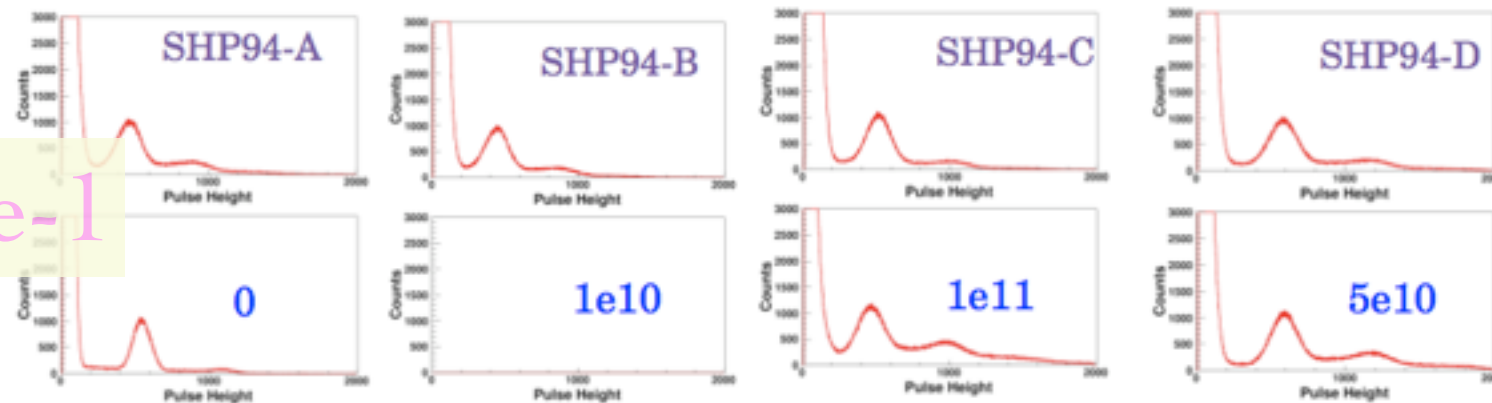
Another irradiation test was done at JAERI (Tokai) on Jul 1st-2nd.

- JRR-3 reactor. Beam line for PGA (Prompt Gamma ray Analysis).
- 2cm × 2cm spot,  $1 \times 10^8$  /cm<sup>2</sup>/s.
- Neutrons are irradiated to 9 APDs of 3 HAPDs (min  $1 \times 10^{10}$  /cm<sup>2</sup> max  $1 \times 10^{12}$  /cm<sup>2</sup>)
- We could not bring back the HAPDs, need to wait a month or so.



Need ~1 month  
for cool-down

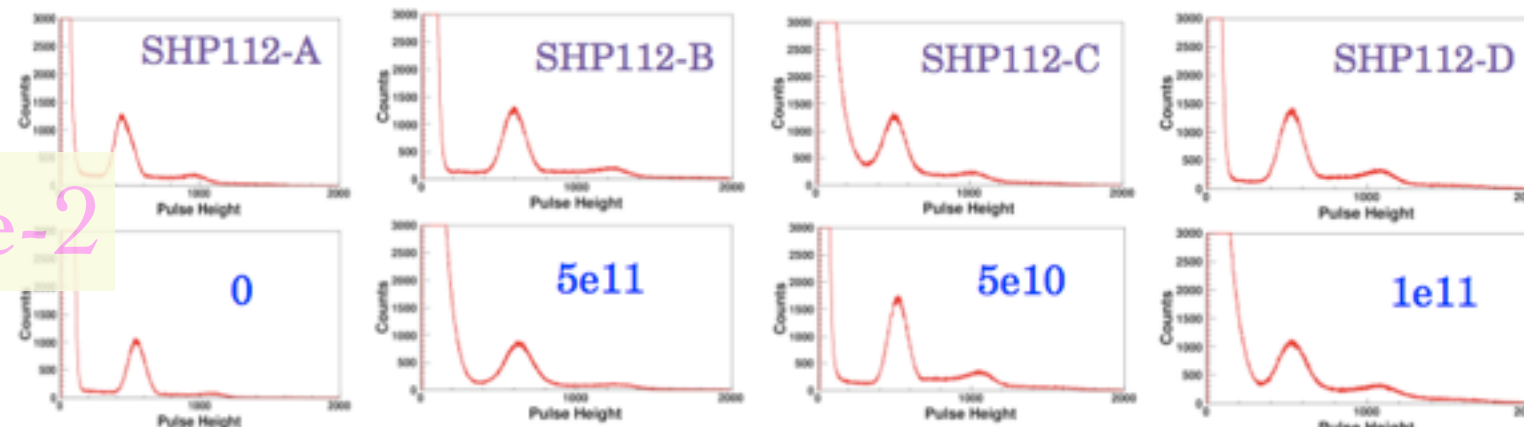
Sample-1



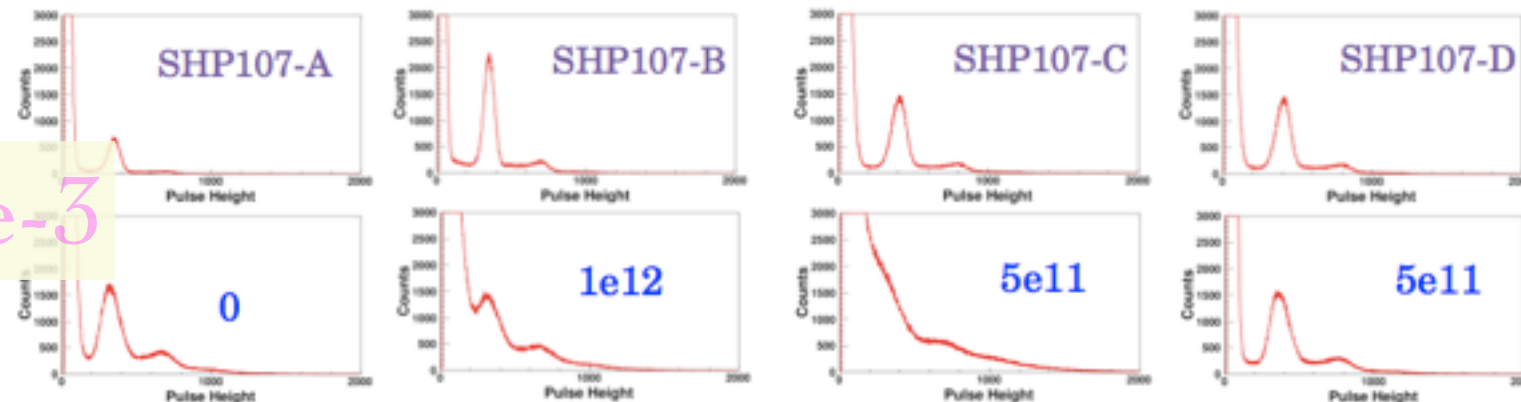
before

after

Sample-2



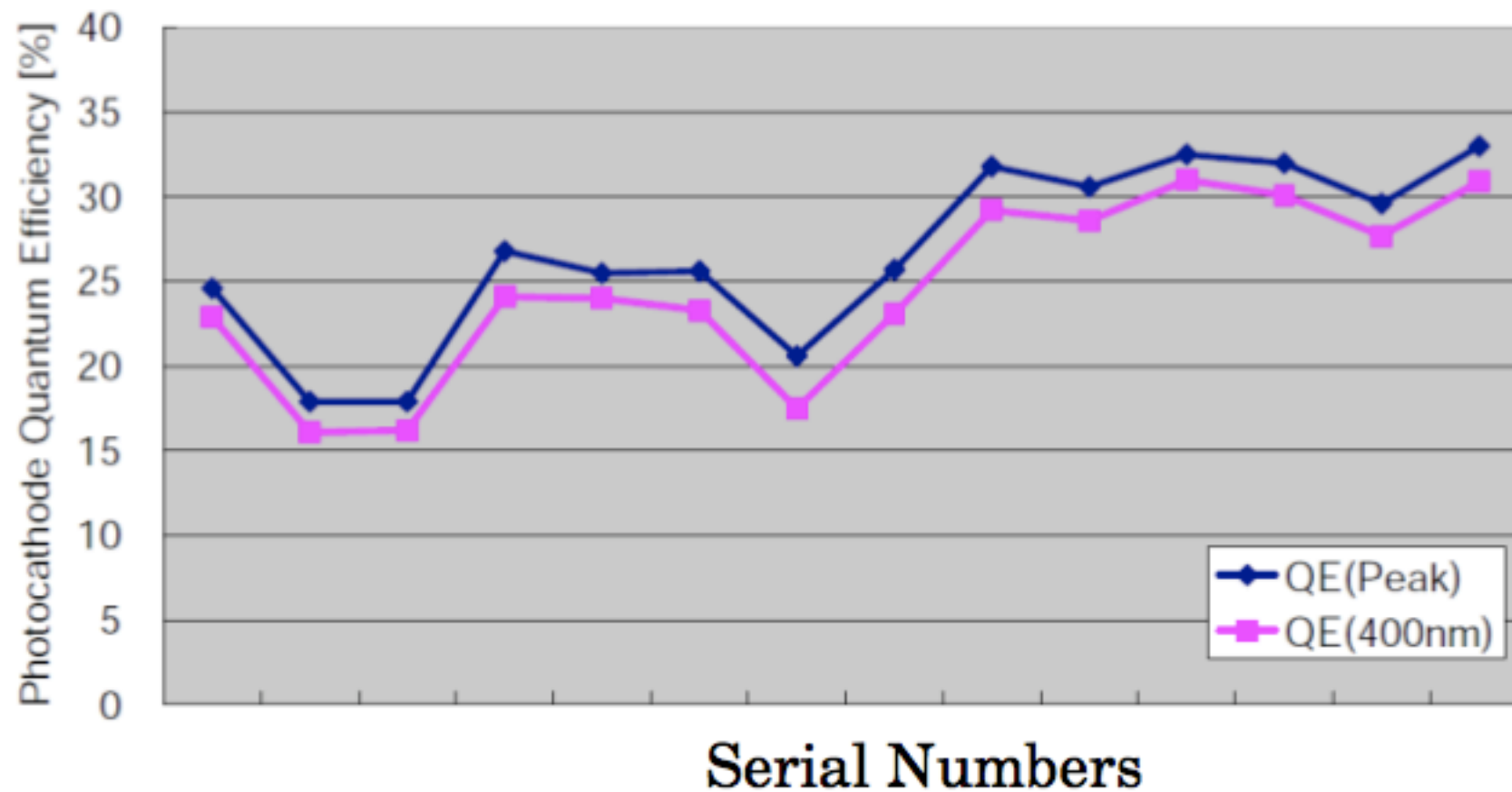
Sample-3





# NEW FROM HPK

- Newly produced HAPDs have reached Q.E. = 30% !!
  - ✓ ~20% increase (i.e. 20% more photons).



Encouraging tendency !



	HAPD	MCP-PMT	MPPC
$N_{ph}$	8(+1) (→16) <small>+1 if QE~30%</small>	10 (→15)	30
$\sigma_{\theta}$	14	15	14
B = 1.5T	OK (improved perf.)	OK (improved perf.)	OK
long term stab. (aging)	OK (HV stability?)	OK?	OK
neutron damage	More tests done leakage current? → signal / noise	1st result soon OK(?)	X
production	2.5 y	2 y	?
pieces	< 600	< 1000	< 500000
cost / piece	Need refinements & negotiations < 7000 €		< 20 €
electronics	ASIC	WFS	WFS
channels	~ 75k	~ 60k	~ 120k



# SUMMARY

- ✱ MCP-PMT lifetime test started and 1st result will come soon
- ✱ New ASIC for HAPD readout works OK
- ✱ More results from HAD neutron irradiation tests
- ✱ Further discussion at Nagoya
  - ✱ Overall schedule
  - ✱ Photon detector
  - ✱ Simulation
  - ✱ ....etc

--> November meeting