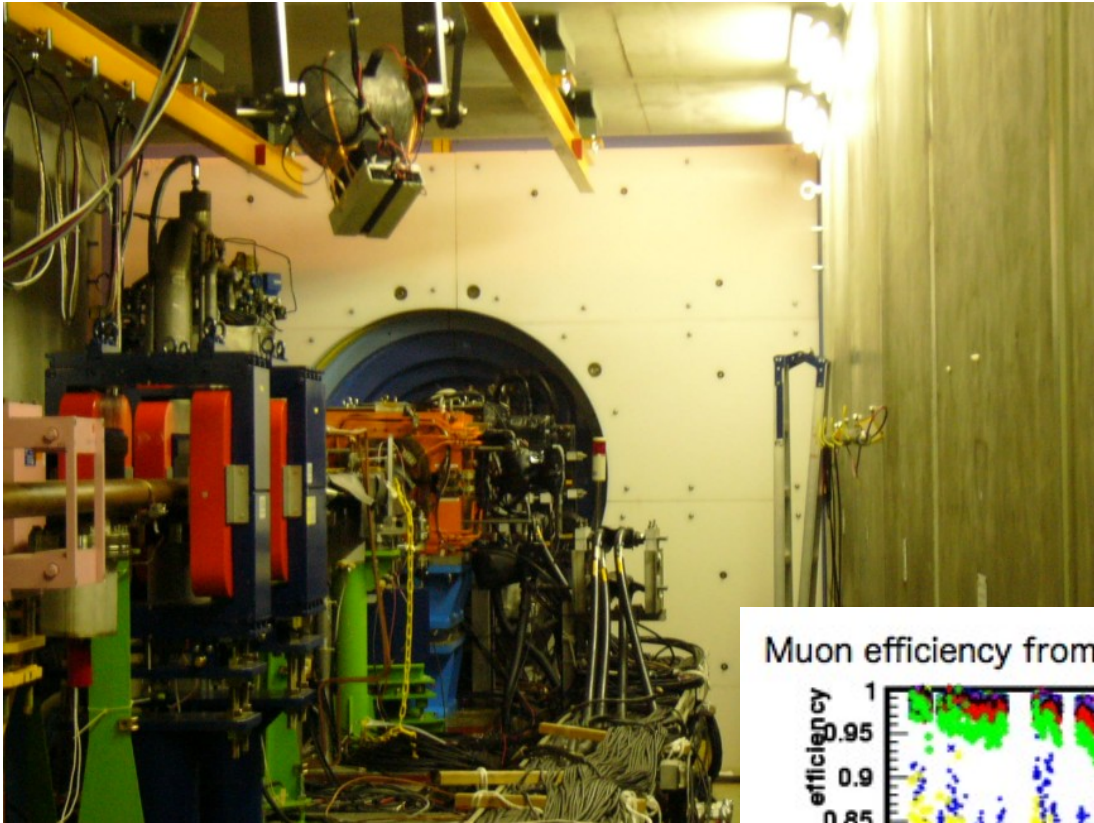


# KLM

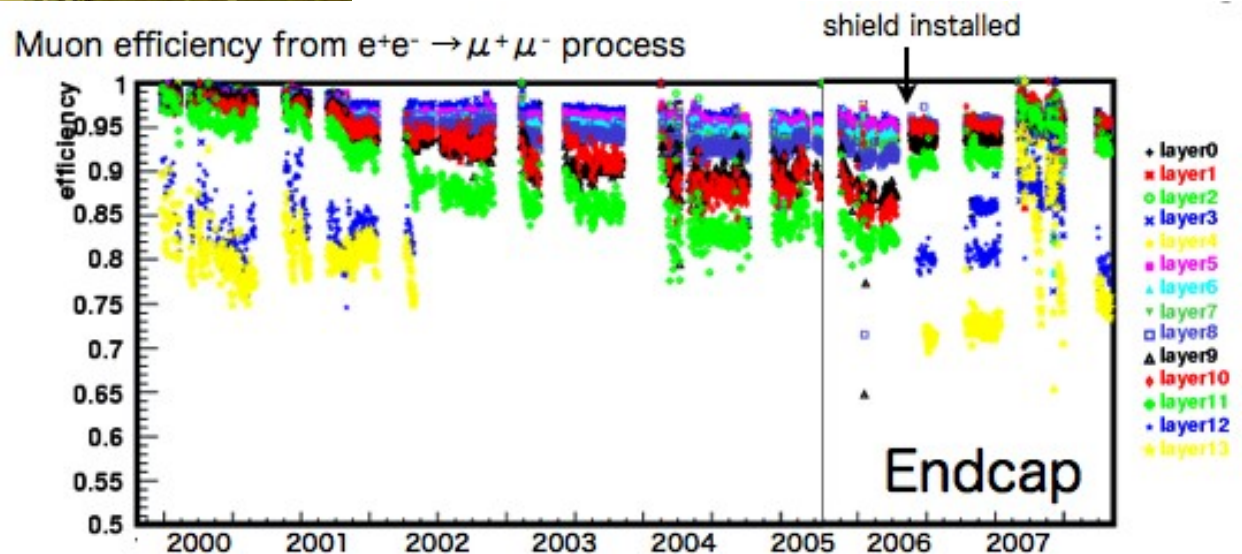
Yosuke Yusa  
Virginia Tech

Effect of new Polyethylene shield  
E.Nakano (OCU)

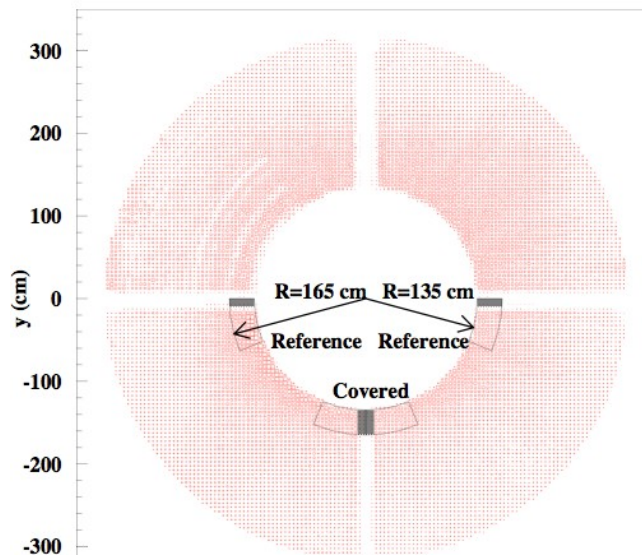
# Shield for neutron background from outside of detector



10cm-thick polyethylene shield has installed but efficiency in outer layers is still low due to high hit rate of neutron.

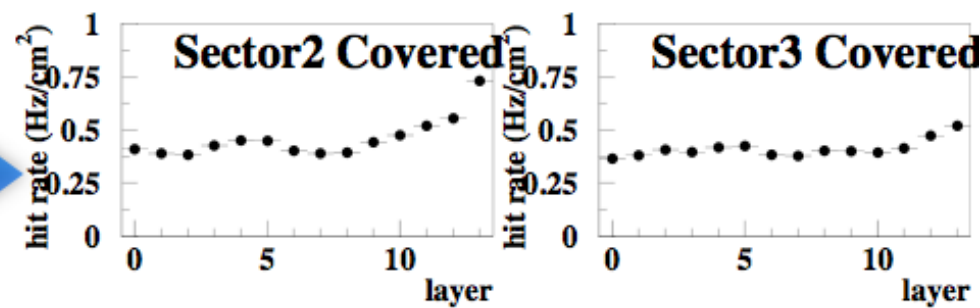
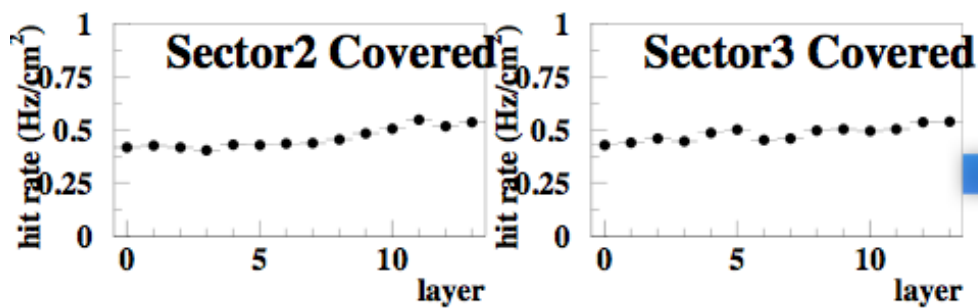
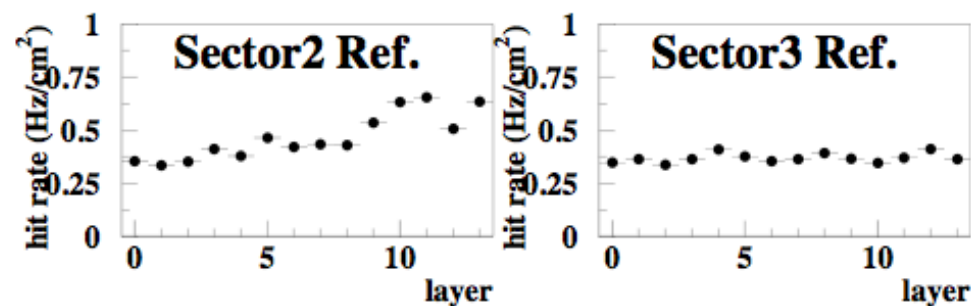
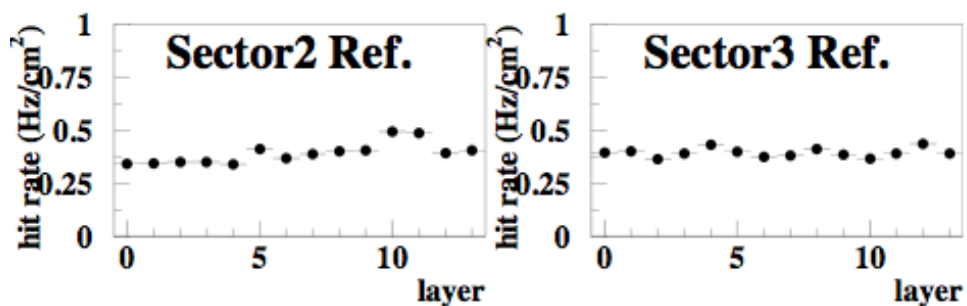


# 1<sup>st</sup> step: Cd doped blocks



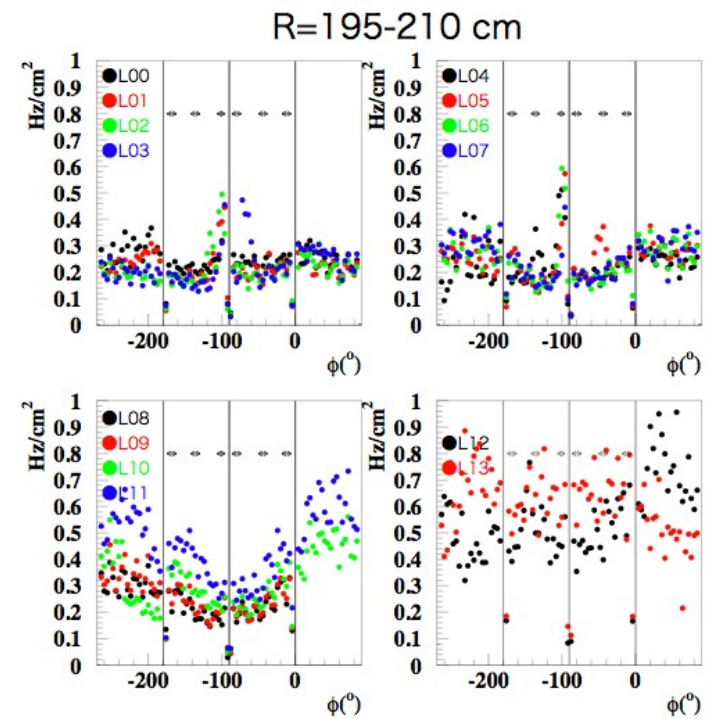
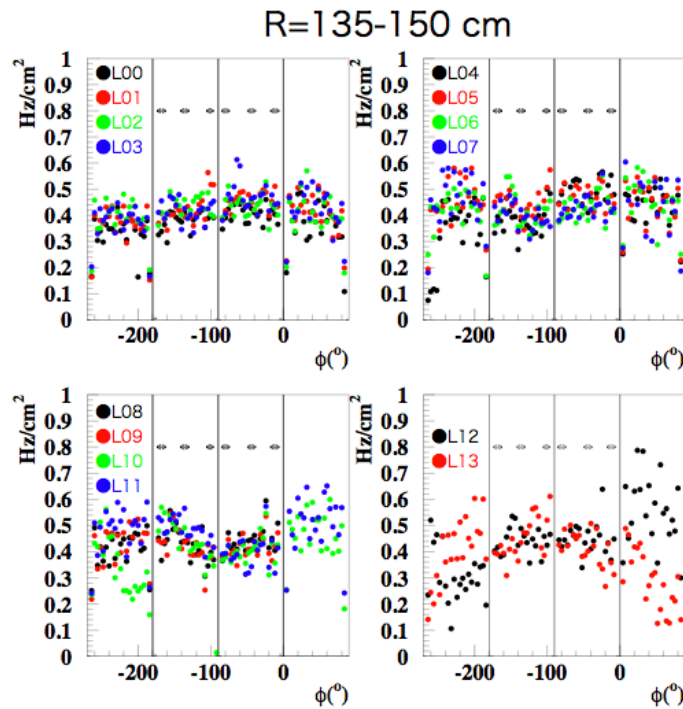
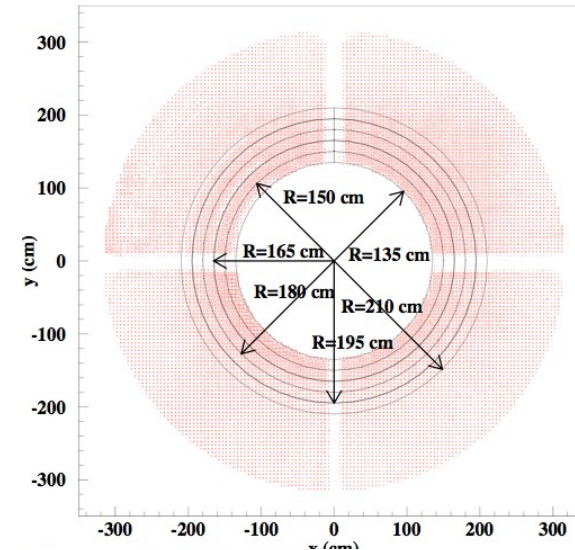
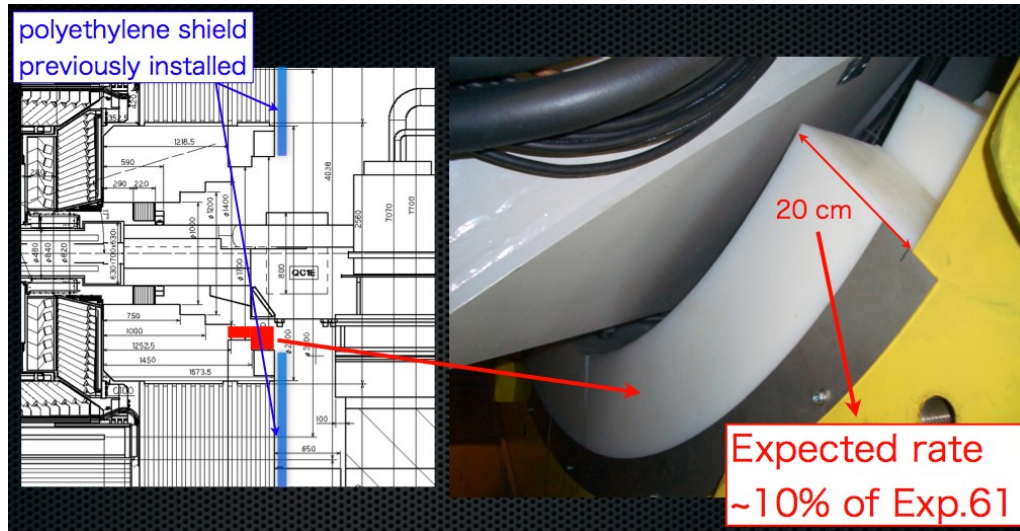
Exp.61

Exp.63





# 2<sup>nd</sup> step: Fabricated shield

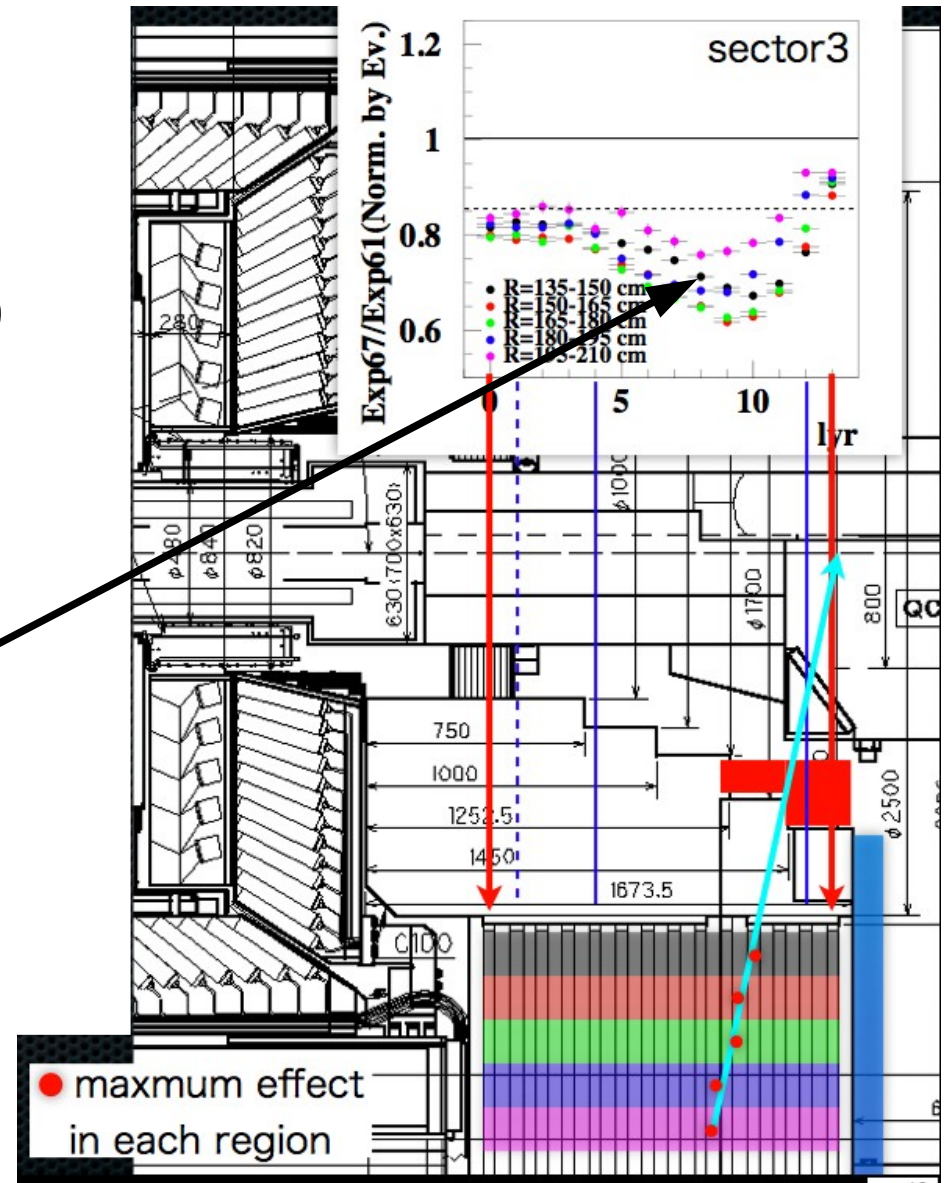


## 2<sup>nd</sup> step: Fabricated shield

By extrapolating maximum effect layers in each R region, background source is (roughly) considered to be close to Belle.

~30% of hit rate can be reduced by shield.

We may need same kind of shield in endcap region for sBelle.



# Status of scintillator KLM study

## P. Pakholv (ITEP)

# Scintillator KLM end cap detector

Scintillator detector with WLS fiber readout is a well established technique for particle detection: stable; fast; radiation hard; cheap

Drawback: it is more sensitive to neutrons due to hydrogen.

Tests in the KEKB tunnel demonstrated that neutron bg rate at scintillator is 5-7 times larger than at RPC. Independent x-y operation and good time resolution

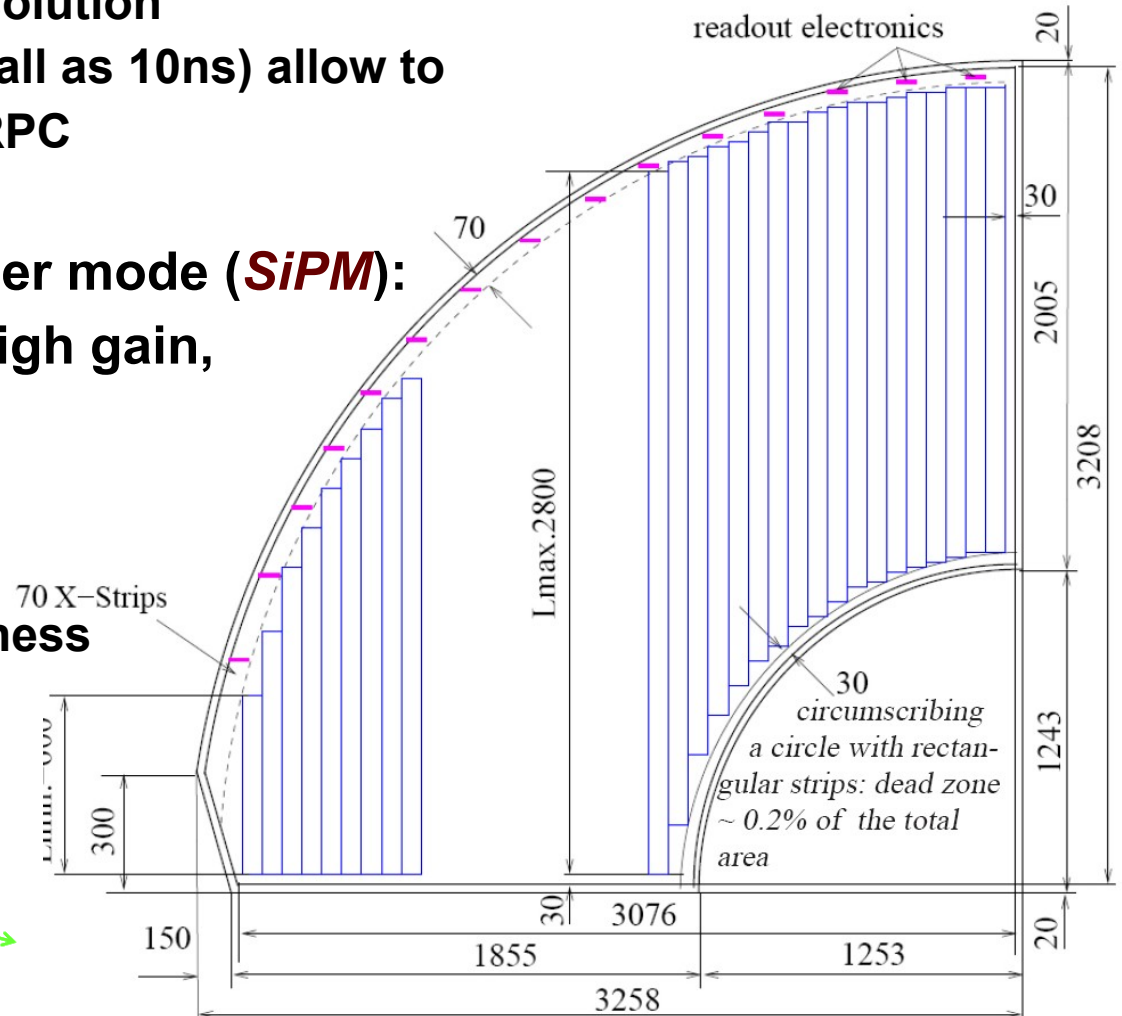
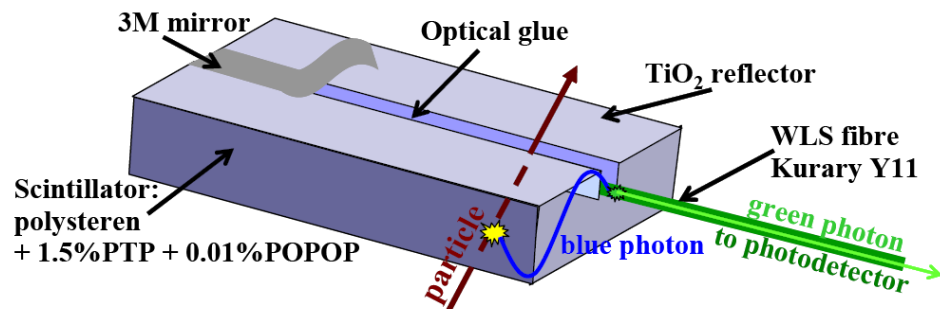
(coincidence gate can be as small as 10ns) allow to suppress bg even higher than RPC

Photosensor (one per strip) =

Si photo diode in Geiger mode (**SiPM**):

fast, efficient to green light, high gain, compact, operable in B-fields, relatively cheap

Key issues: reliability, radiation hardness



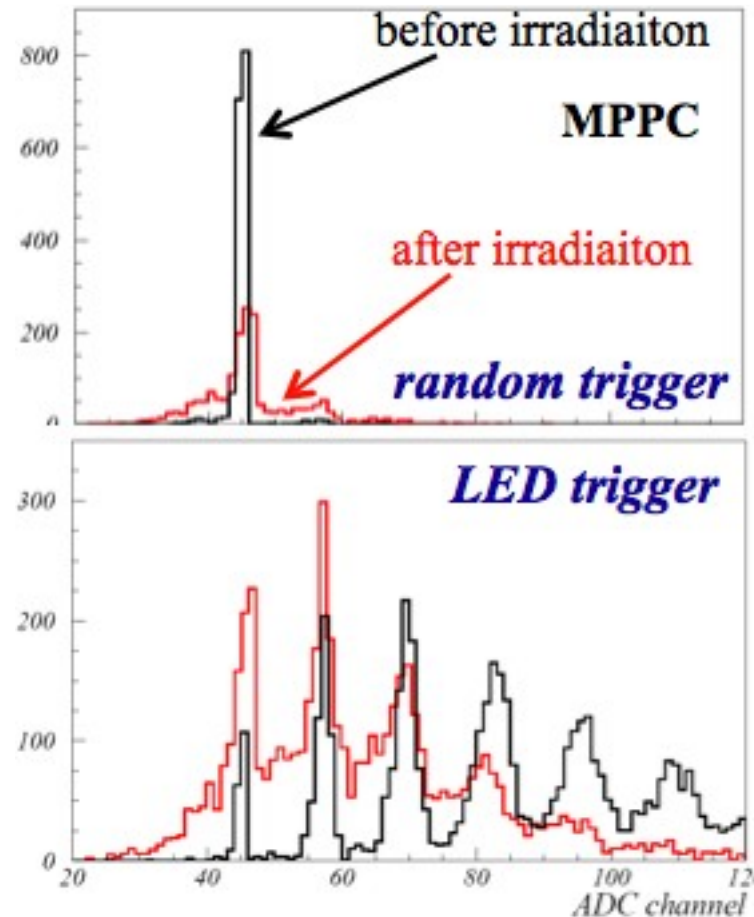


# SiPM radiation hardness tests in the KEKB tunnel

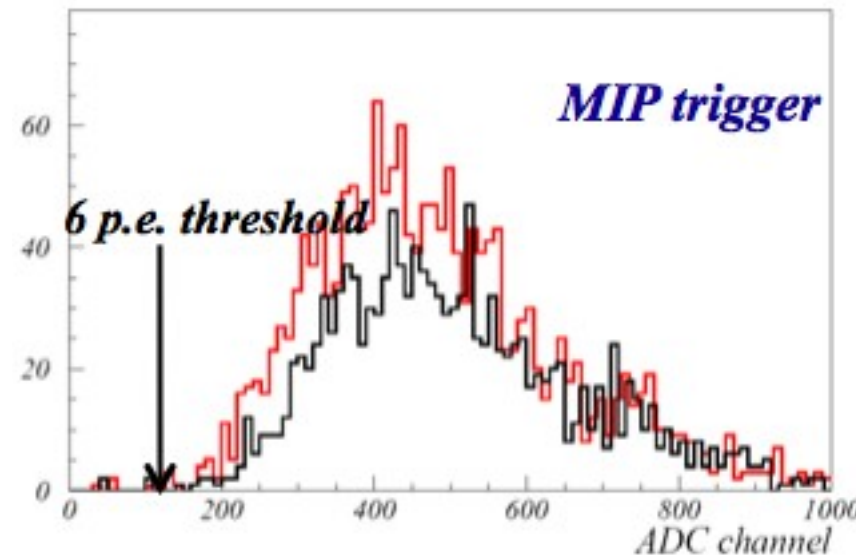
The measured neutron dose at the proposed SiPM position now ( $L=1.4 \times 10^{34}$ ) ~  
1mSv/week → 15mSv/week at SuperB ( $L=2 \times 10^{35}$ ) → 3Sv/5 years

Both Russian MRSAPD and Hamamtsu MPPC have been exposed in KEKB tunnel near beam during 50 days ( $> 1\text{Sv} = \frac{1}{3}$  of the 5 year SuperB dose):

- one photoelectron noise increased – seen in the random trigger data.
- Pedestal and p.e. peaks are smeared – seen in the LED data.
- But the signal from MIP ( $\sim 25\text{p.e.}$ ) is not changed.



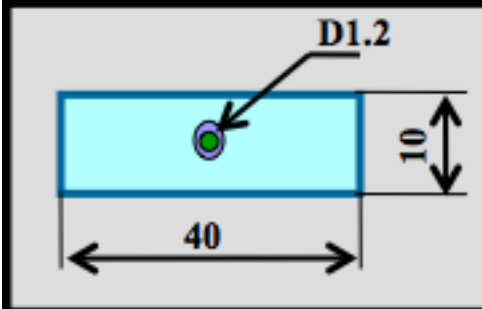
The similar MIP efficiency immunity to neutron damage is seen with MRSAPD (CPTA), however the pe peaks are poorly resolved (due to longer recovery time)



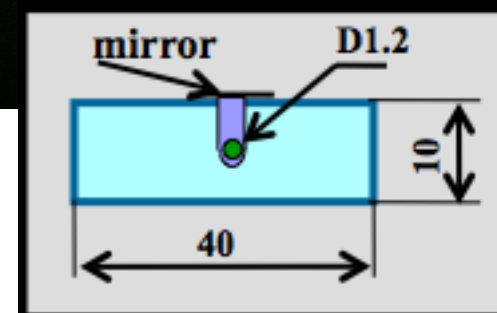
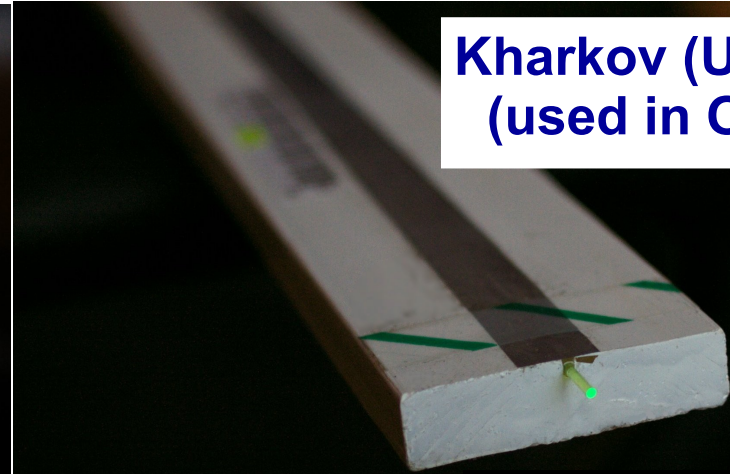
Both MRSAPD and MPPC are ok for SuperB

# Strips from two producers are tested and compared in ITEP

**Fermilab (USA)**  
**(used in T2K near detector)**



**Kharkov (Ukraine)**  
**(used in OPERA)**



The same outer strip geometry,  
but different geometry of groove

We are now not able to provide comparison of the scintillator plastic quality for Kharkov – Fermilab strips. This should be done by TDR (September 09).

*(in any case, both are ok for SuperB: sufficient light collection from the 3-meter far end)*

## TEST of the groove geometry:

The central groove (Fermilab) is slightly more preferable (~10% better light collection); glueing is easier

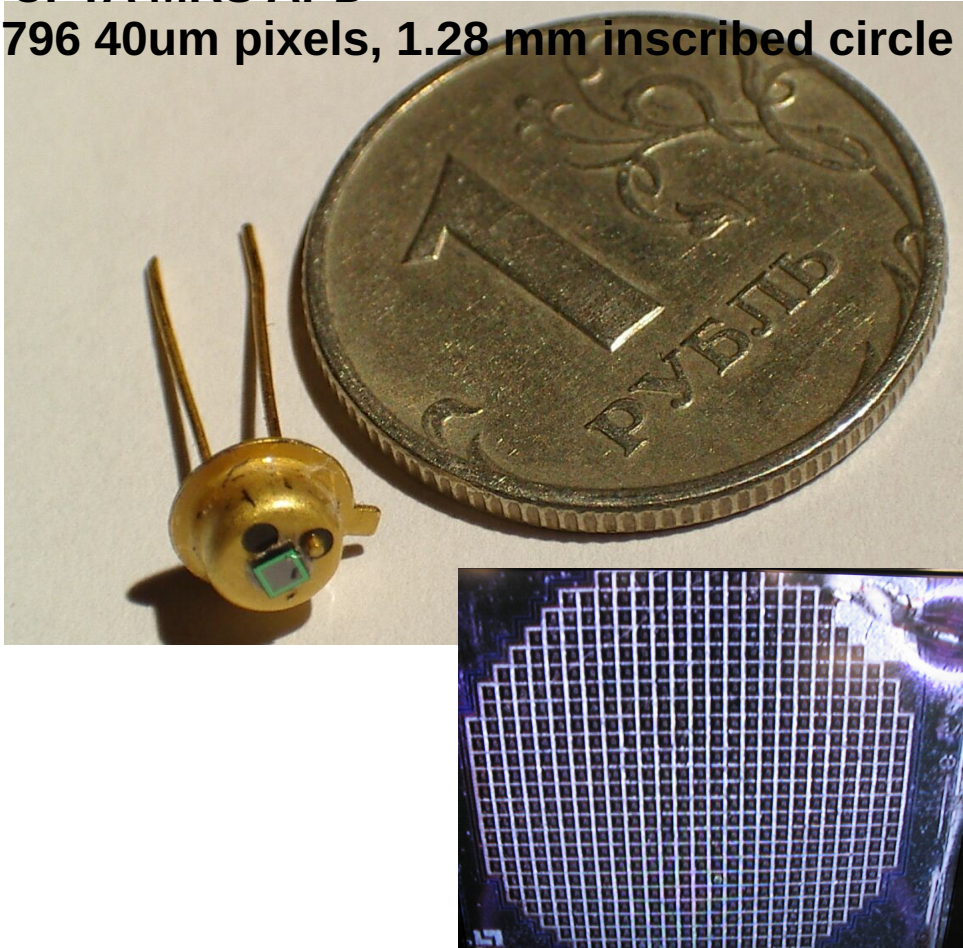
Kharkov can not produce central groove. However, if the fiber glueing is done in ITEP, transportation/tax is too costly from Fermilab.

# Comparison of CPTA and Hamamatsu SiPMs M. Danilov (ITEP)

# We consider two types of SiPMs as photodetectors for the scintillator KLM

## CPTA MRS APD

796 40um pixels, 1.28 mm inscribed circle



556 pixel version of CPTA SiPM

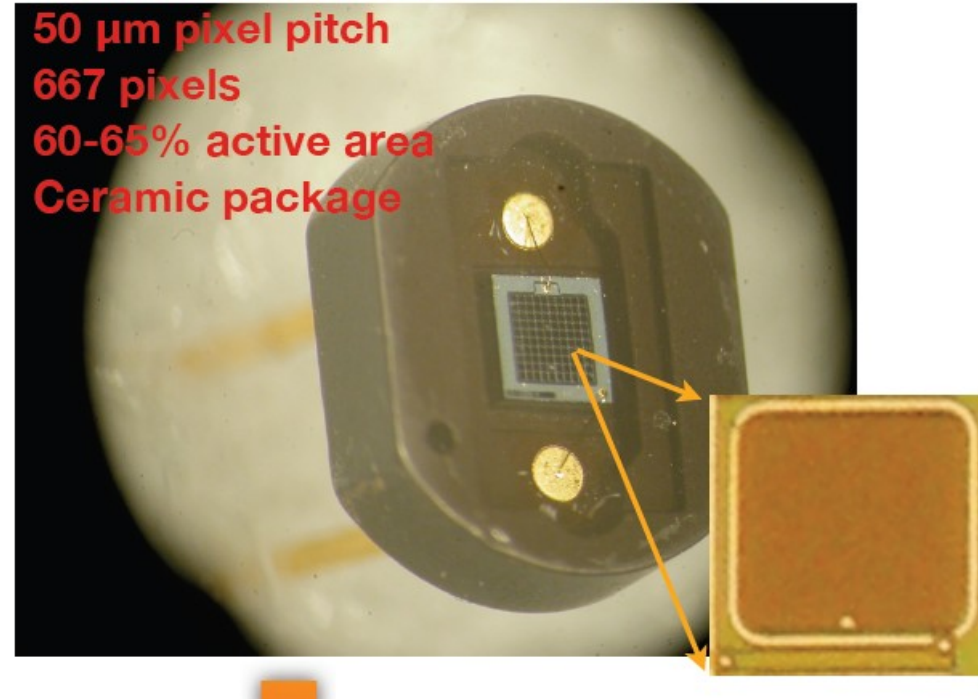
## T2K custom device 1.3 mm x 1.3 mm

50  $\mu\text{m}$  pixel pitch

667 pixels

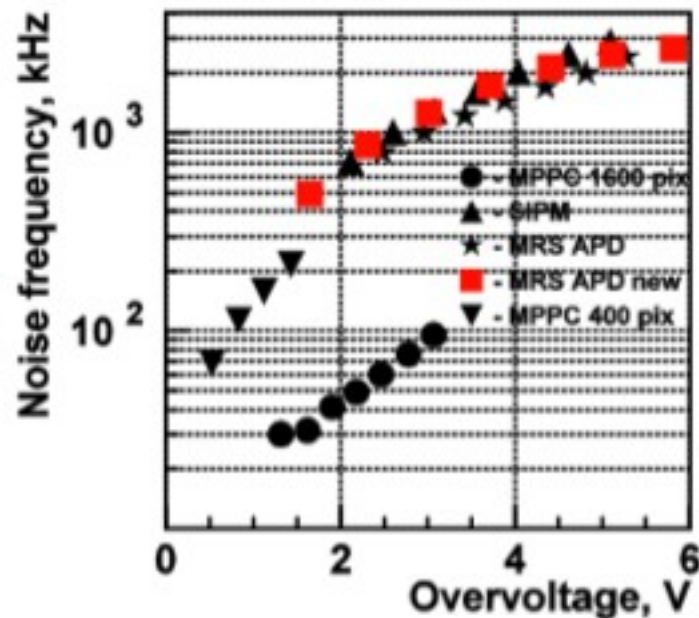
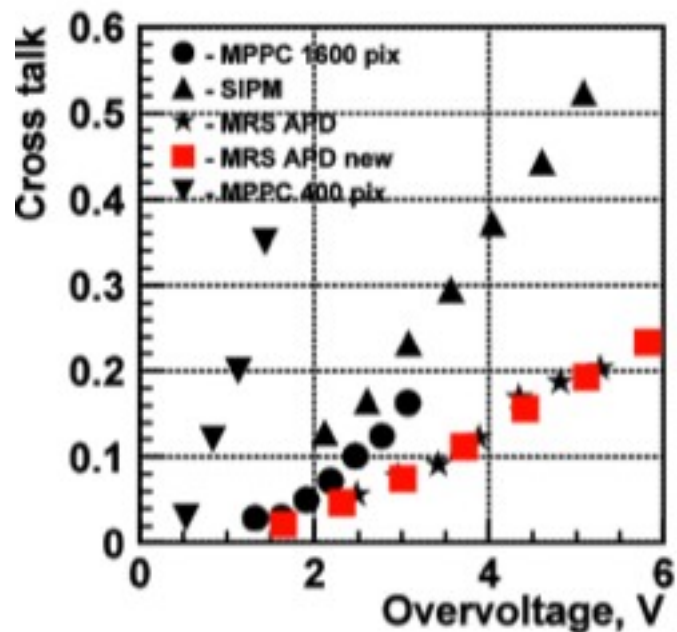
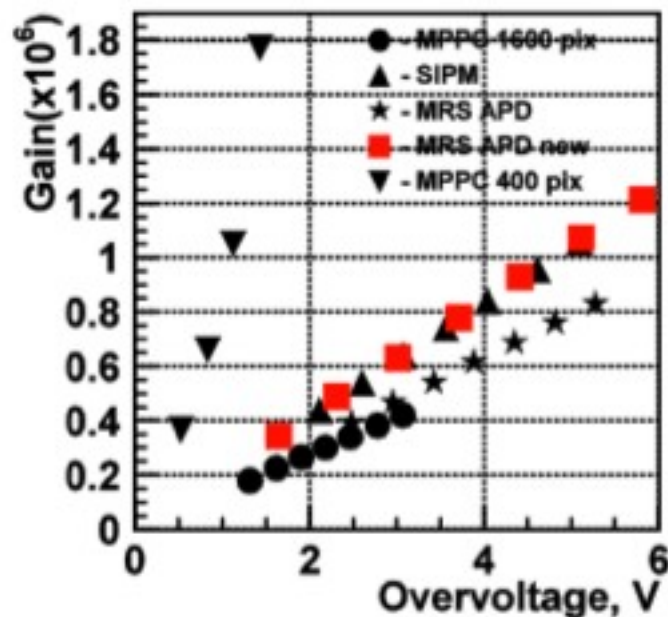
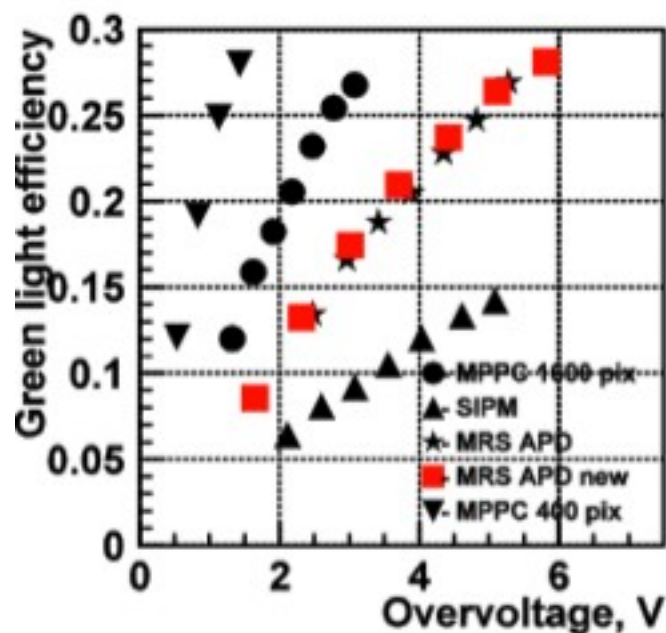
60-65% active area

Ceramic package

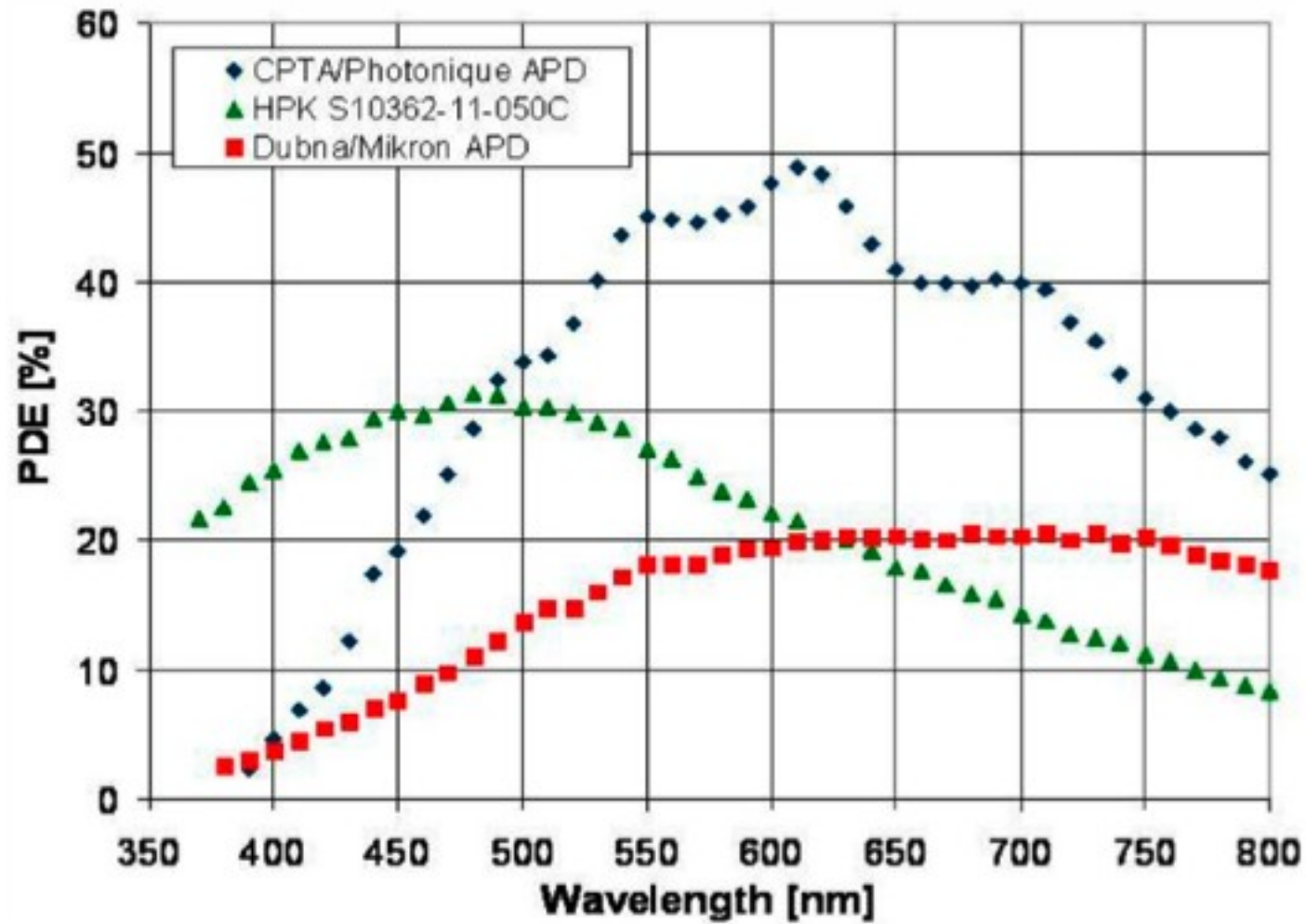




# MGPD PROPERTIES



PDE spectral dependence at maximum bias voltage  
(Yu.Musienko)

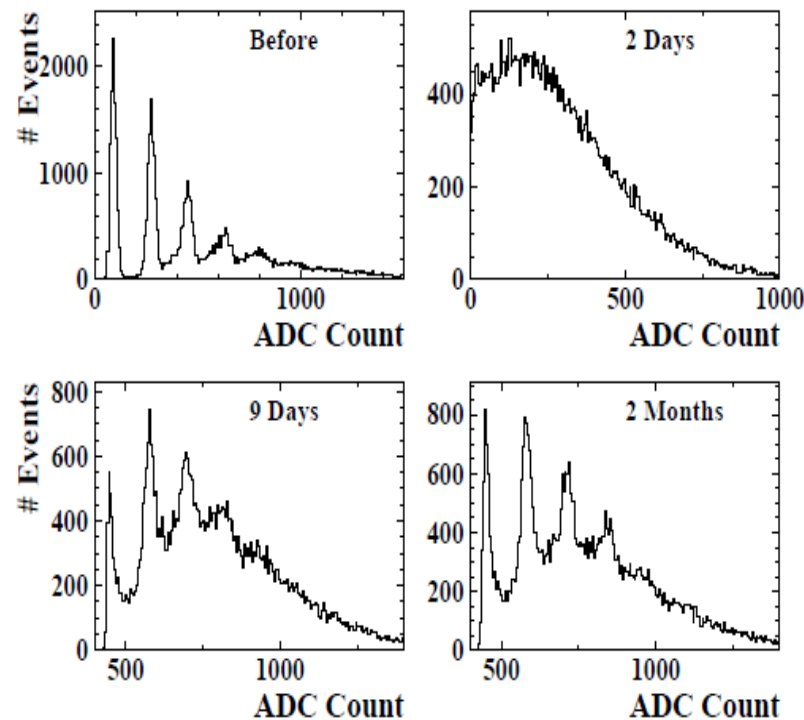


Irradiation leads to similar dark current increase in MPPC and MRSAPD.

Individual p.e. peak are smeared after  $\sim 10^{10}$  p/cm<sup>2</sup>.

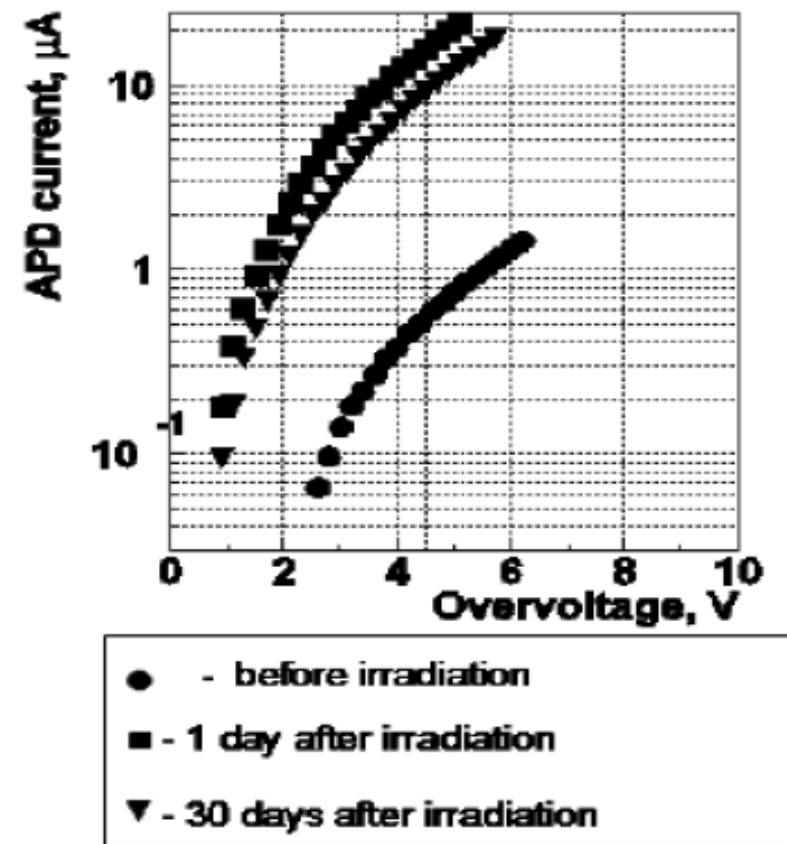
However MPPC show fast annealing after irradiation with neutrons

### ADC Distribution



ADC distribution before and after  $2 \times 10^{10}$ /cm<sup>2</sup> irradiation

Annealing of CPTA SiPM irradiated with  $3 \times 10^9$  cm<sup>-2</sup> protons



Annealing of MRSAPD is slower than of MPPC? More studies required.

# Summary of two types of Photo devices for Sci. KLM

MRSAPD and MPPC are practically identical in size and in number of pixels

MRSAPD has slightly higher PDE

MRSAPD has somewhat smaller X-talk and after-pulses

MPPC has shorter pulses and no signal tail

MPPC has 4 times smaller dark counting rate

MPPC has better uniformity of parameters but PDE varies a lot for fixed gain

MRSAPD has ~8 times smaller sensitivity to temperature variations

MRSAPD has ~3 times smaller sensitivity to voltage variations

MRSAPD is slightly cheaper (subject to negotiations)

MPPC will have high statistics data on long term stability soon (from T2K)

(SiPMs from MEPhI demonstrated excellent long term stability in

ILC calorimeter prototype- only 5 dead photo-detectors out of 8000 in 3 years)

MRSAPD and MPPC show similar increase of dark current after irradiation

but MPPC has faster annealing (to be checked)

Both photo-detectors are adequate for the SuperKEKB KLM

However there is very little safety margin in radiation hardness



Other topics

# TDC upgrade

- FASTBUS TDC has been replaced to COPPER+AMT-3.

Test pulse/cosmic test has done, start operation from spring run.

→ For sBelle, Q-to-T conversion will be obsolete.  
New pipe-line readout system will be introduced.

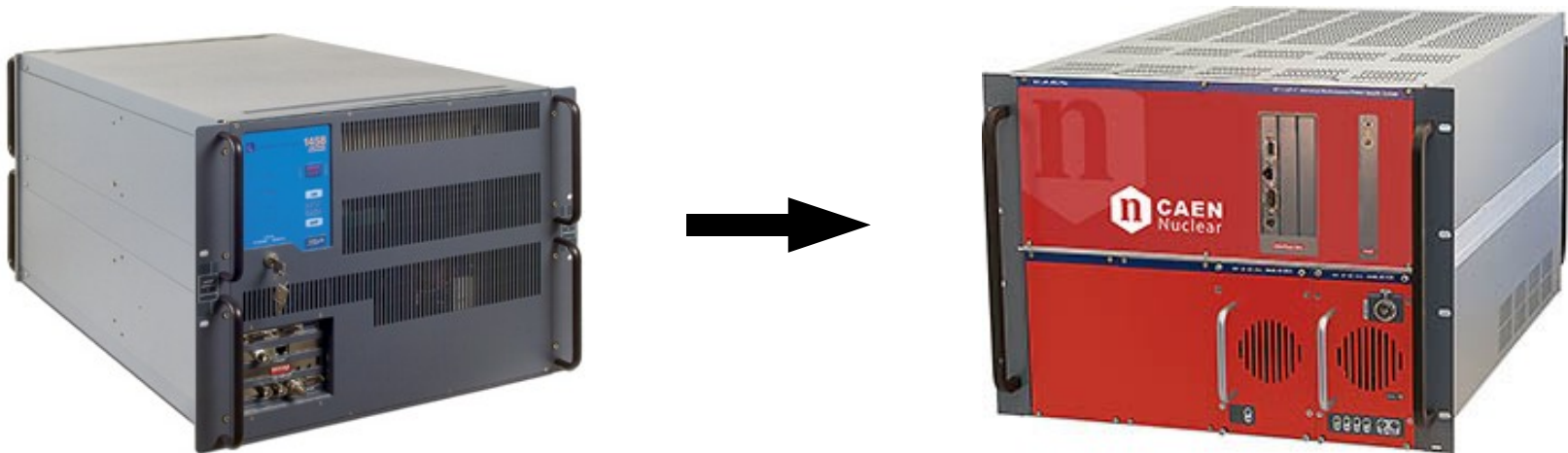


# High Voltage modules

- High voltage module will be replaced.  
LeCroy (→ Universal Voltronics) → CAEN
  - × Current modules has been working <10 yrs and aged deterioration is getting to be highly visible.
  - × Universal Voltronics has no branch in Japan and support service for us is MISERABLE. (ex. ACC group sent 1 crate for maintenance a few years ago, but not returned...)

We have ordered 2 crates (SY1527LC), 5 12ch positive boards (A1832P) and 13 24ch negative boards (A1535N) and start test soon.

Helpful also for CDC/PID?



# **Summary = to do list for TDR (P.Pakholv)**

- **Comparison of design with MRSAPD (CPTA) & MPPC (Hamamtsu)**
  - Both are ok, however application of either requires to solve some technical problems.
  - Elaborate details of using for both: mounting, HV supply, control and calibration, maintenance, cost.
  - Compare and find optimal solution.
- **Comparison of design with Kharkov and Fermilab scintillator strips**
  - Both are ok.
  - Need to compare scintillator quality first and elaborate the manufacturing (fiber glueing) procedure.
  - Compare resulting quality and cost to find optimal solution.
- **Full Geant MC study (standalone MC for KLM encap is done already) to confirm/study physics performance.**
- **Electronics:**
  - Gary's electronics seems to be optimal for our purposes. The features that seemed to be excessive are very welcomed now.
  - Need to check that it is possible to work without preamplifier
  - Adjustable HV supply still needs to be elaborated