Experiments for properties of components of DCV

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Scintillation Yield

Purpose of Experiment

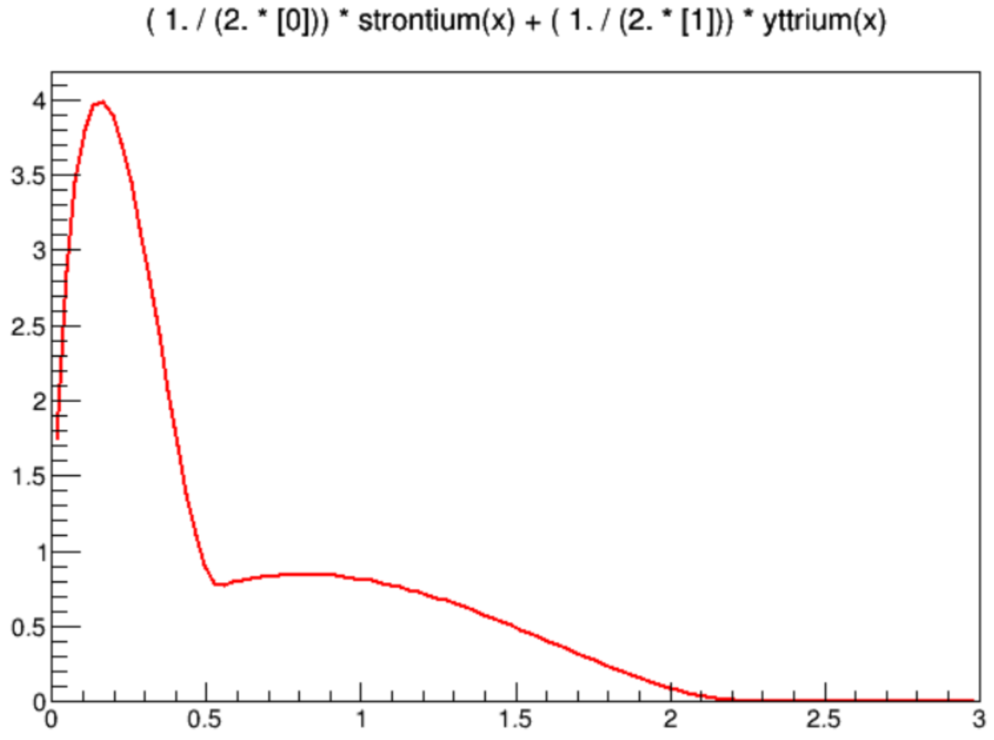
- Calcualte the Scintillation Yield

- Assumption

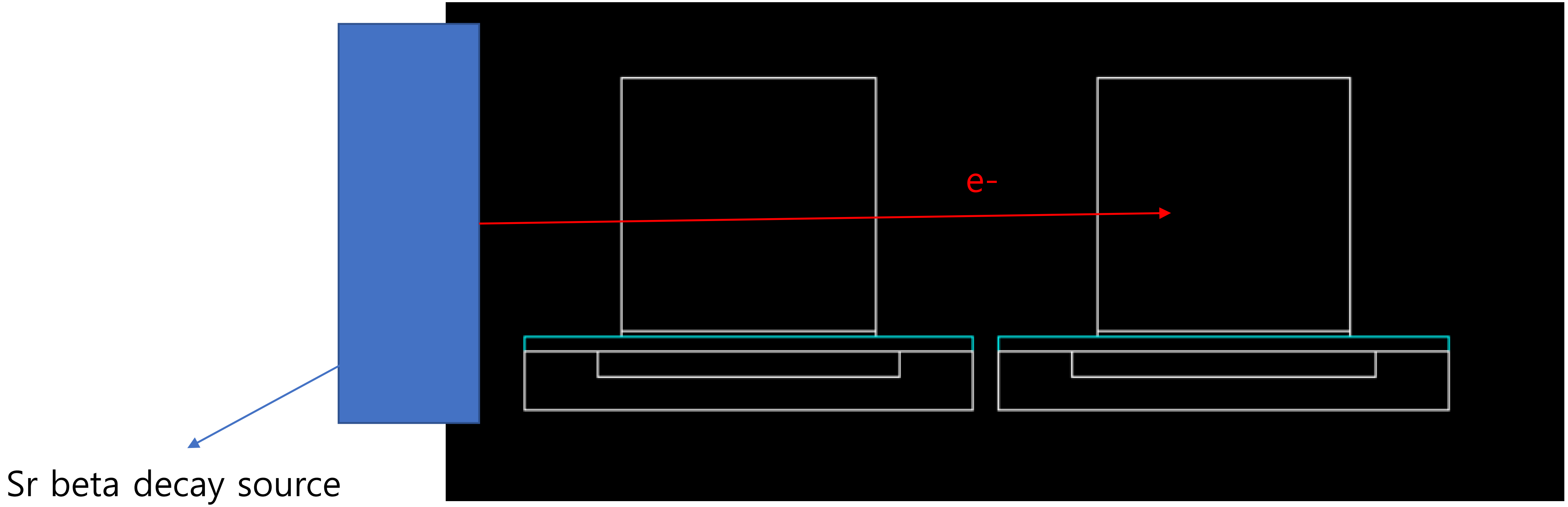
- Energy deposit in scintillator is same with simulation.

Strontium source(beta dacay)

- Since we need to minimize the attenuation in scintillator, we use the scintillator cubic that is 5 mm long.
- However, it is too small to conduct a experiment by making use of cosmic ray.
- Therefore, we use beta decay source, strontium-90.
- Energy spectrum of strontium 90 is shown on the right.

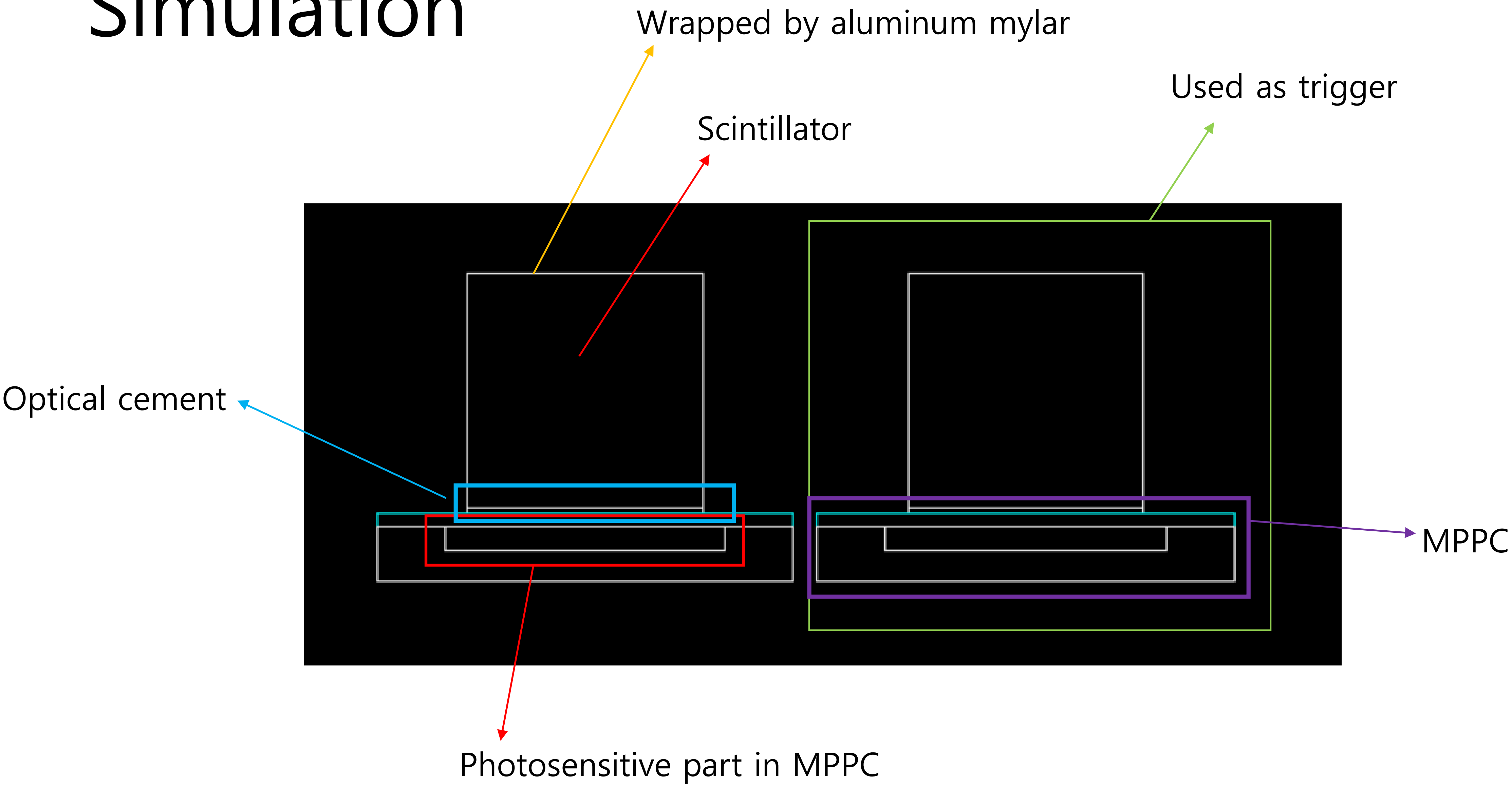


Plan for experiments



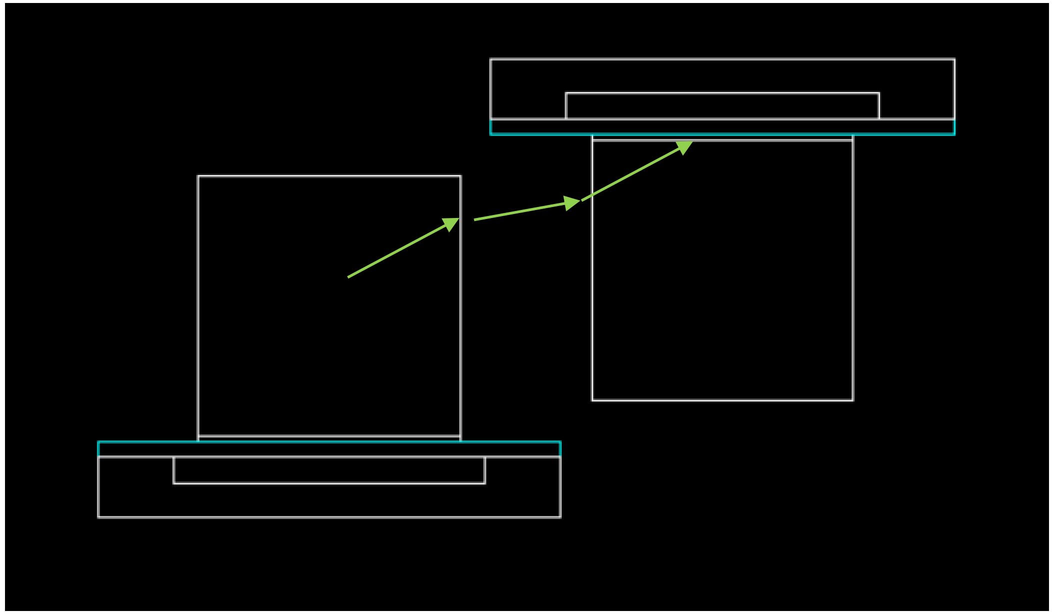
When signal of trigger over the threshold about 200 photons, get data. The peak of histogram of ADC is appeared when energy deposit is about 1 MeV.

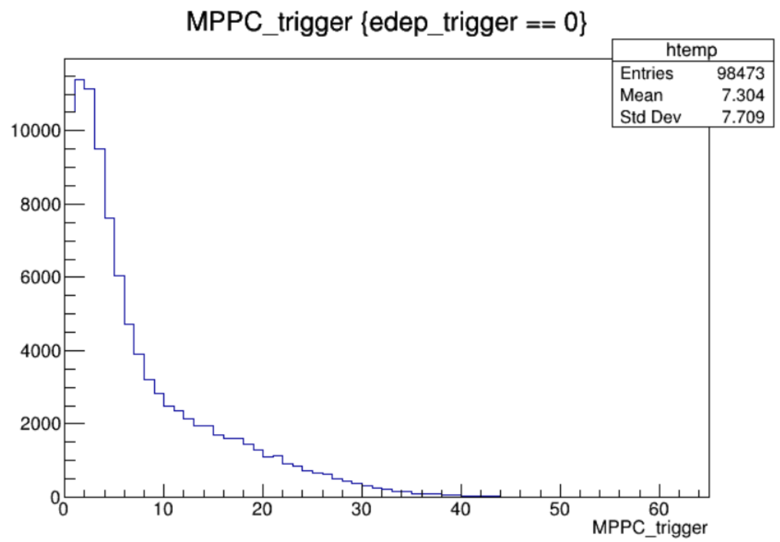
Simulation


Wrapped by aluminum mylar
Used as trigger
Scintillator
Optical cement
MPPC
Photosensitive part in MPPC

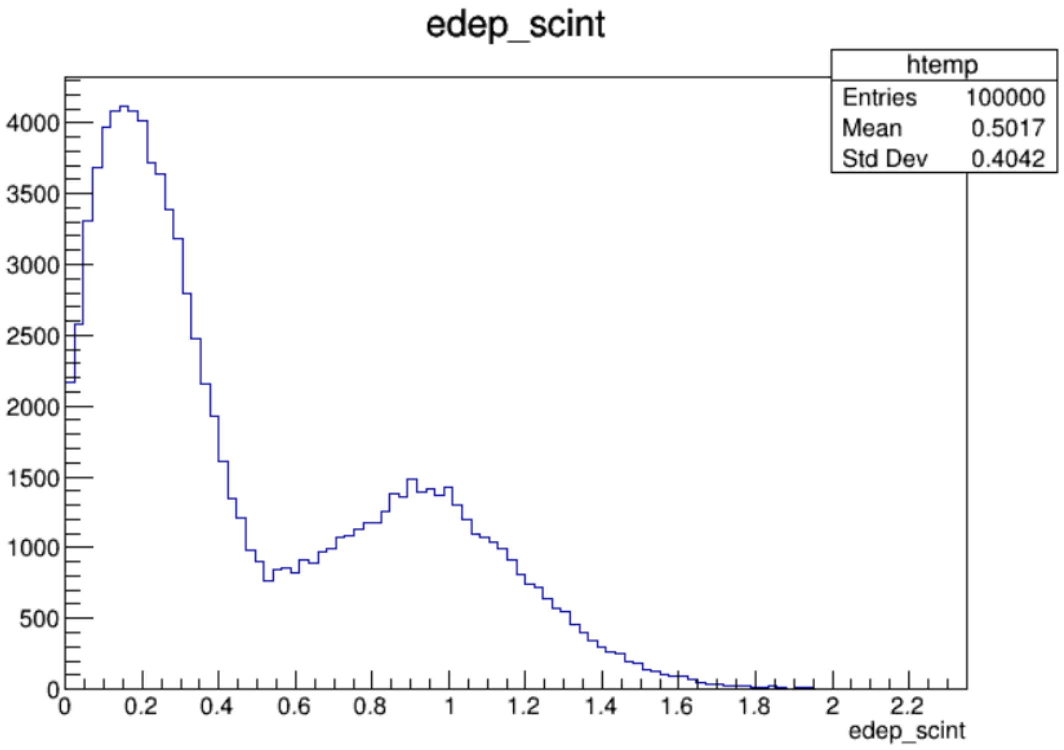
Reasons for experiments conditions

- Place triggers on the right of scintillators to eliminate the effects of cosmic ray.
- Place the MPPC of the scintillator and the trigger in the same direction to count the number of photons from each scintillator.(Of course there are photons arrived at trigger's MPPC from scintillator. However the number is very small)

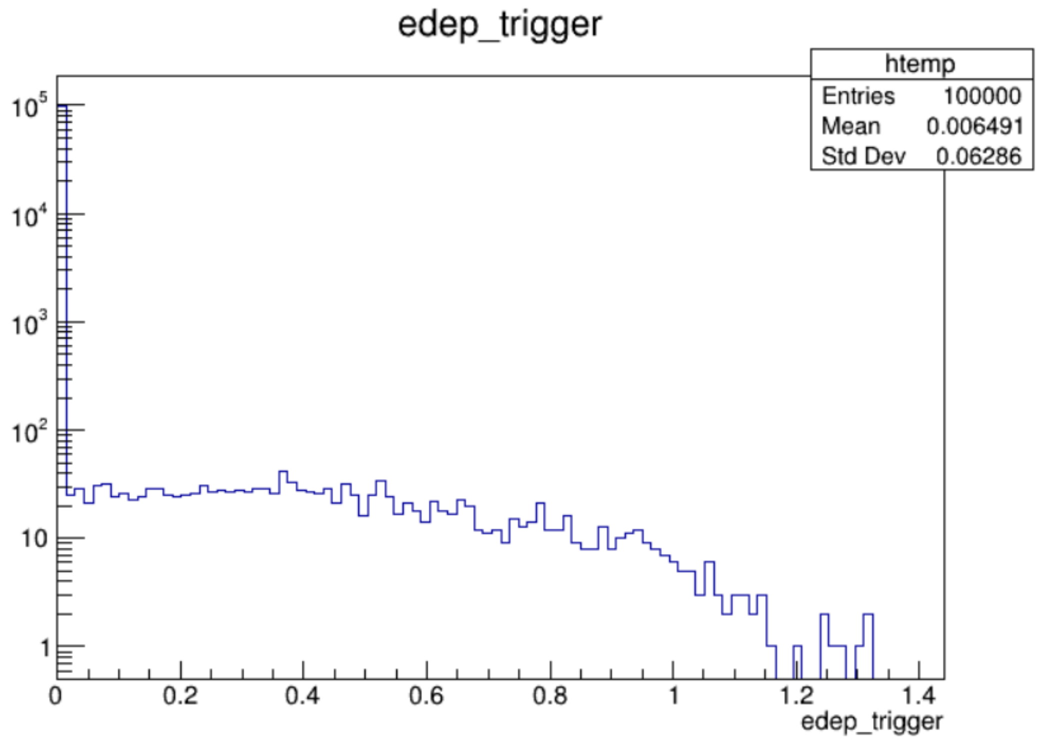




Energy deposit(simulation)

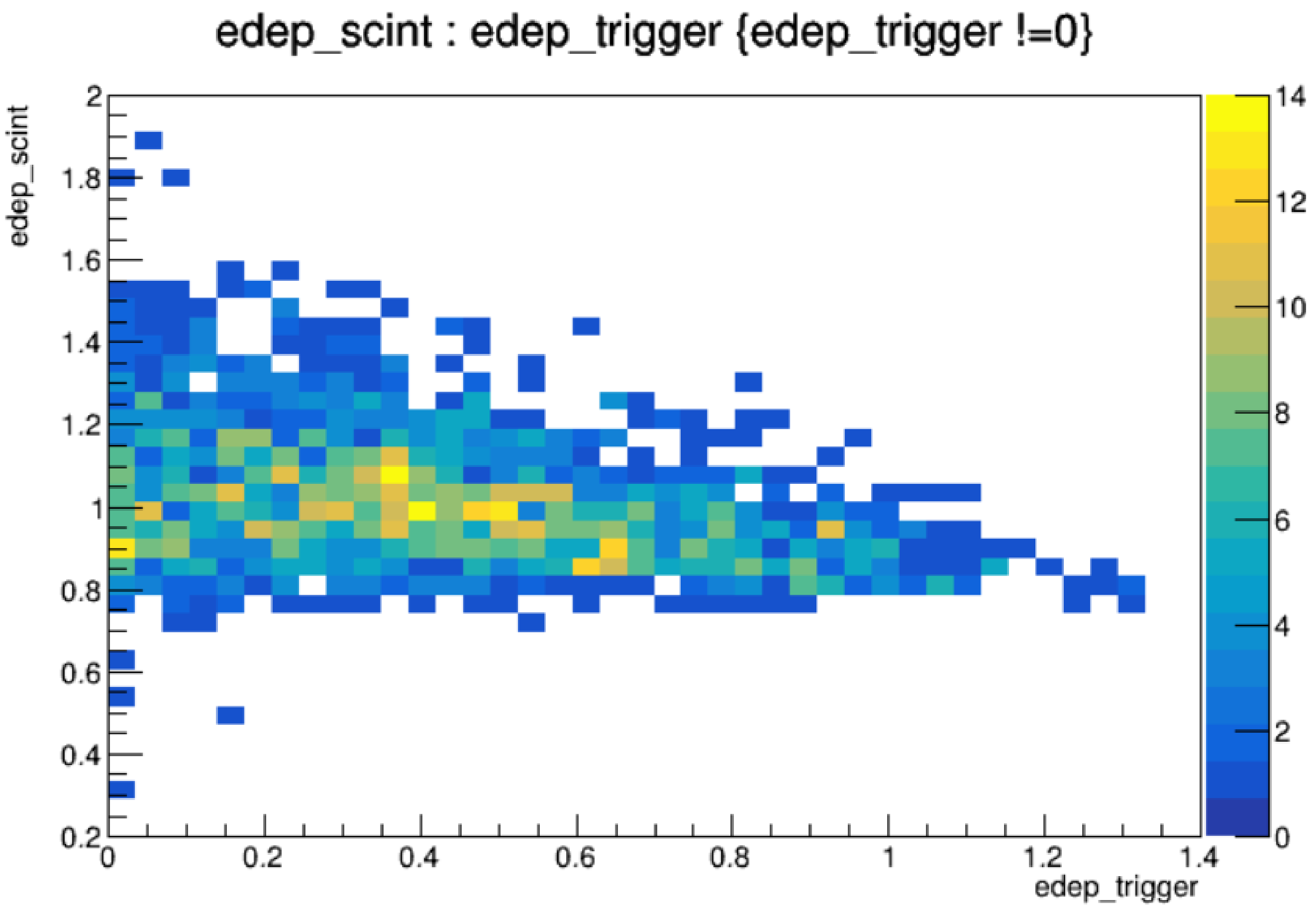


Energy deposit on scintillator

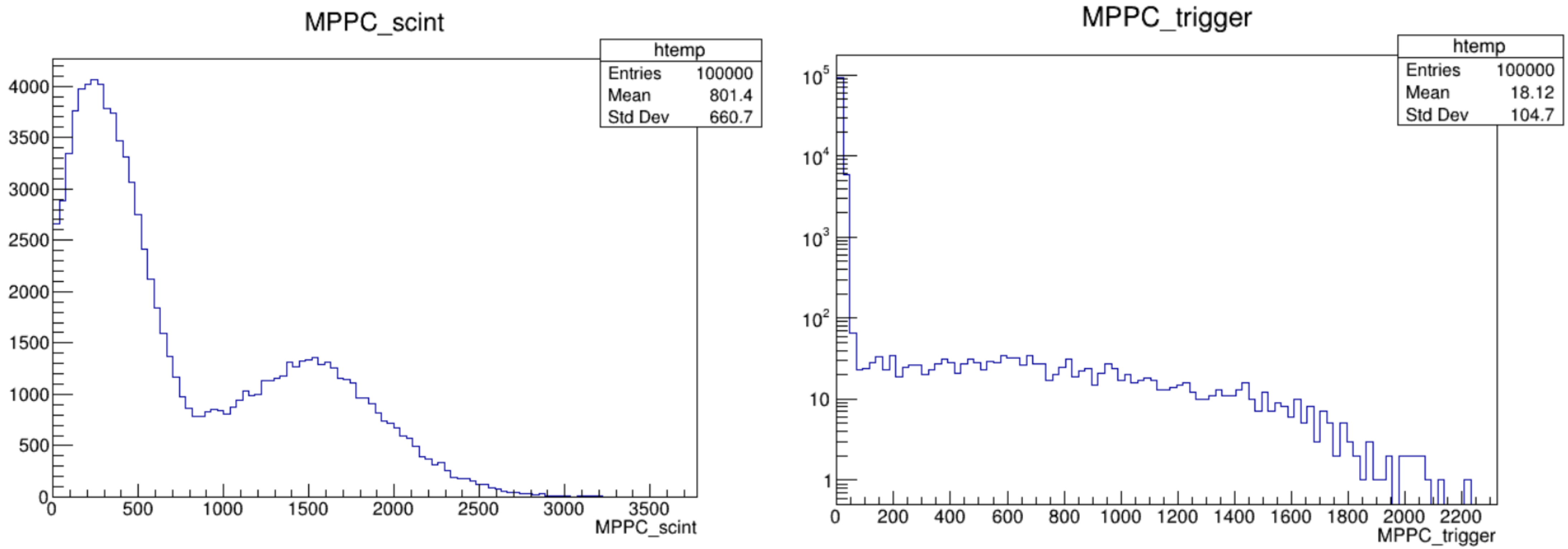


Energy deposit on trigger

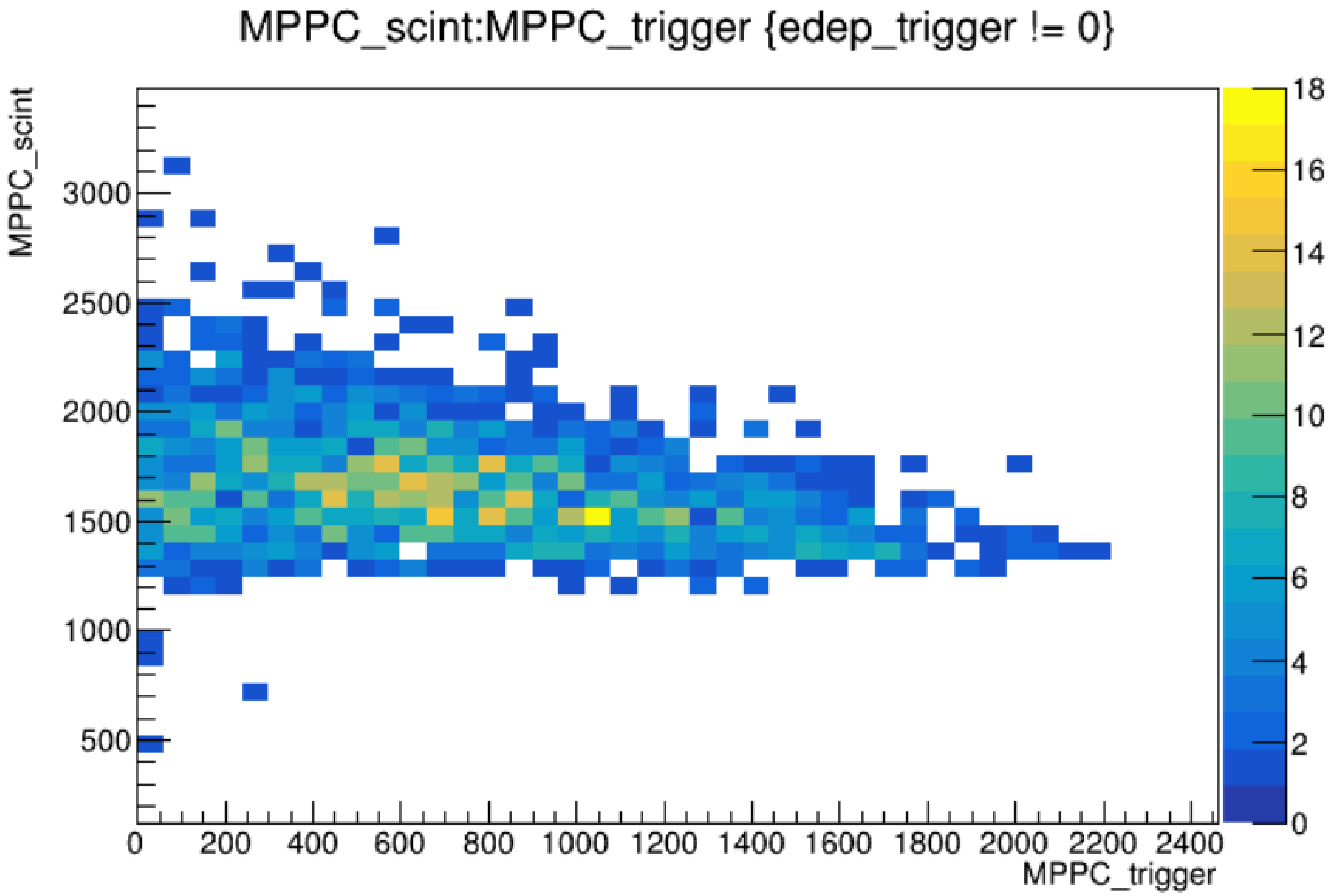
Energy deposit trigger - scintillator(simulation)



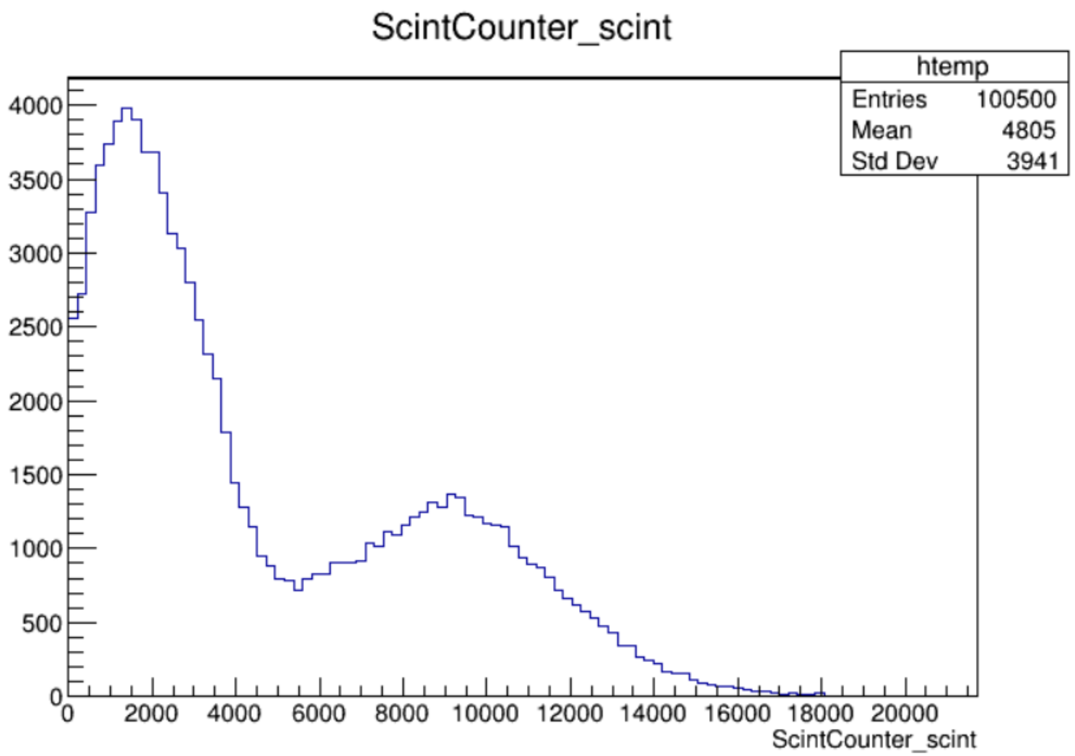
The number of photons arrived at each MPPC (simulation)

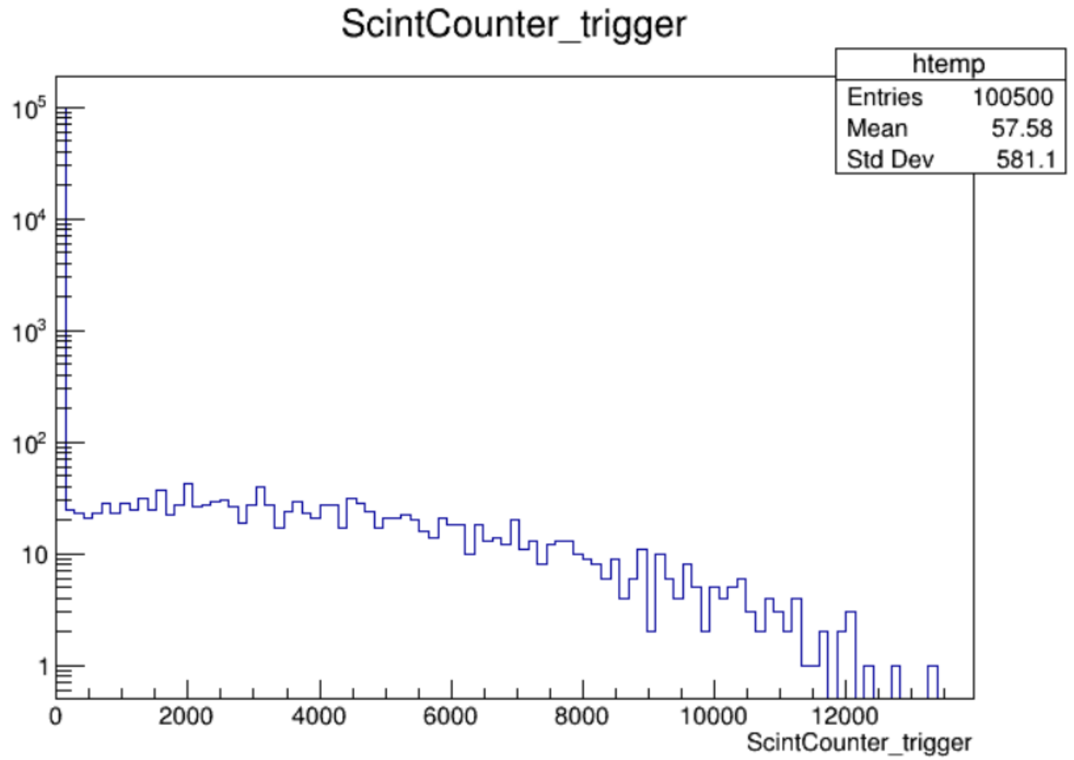


The number of photons arrived at each MPPC trigger - scintillator(simulation)

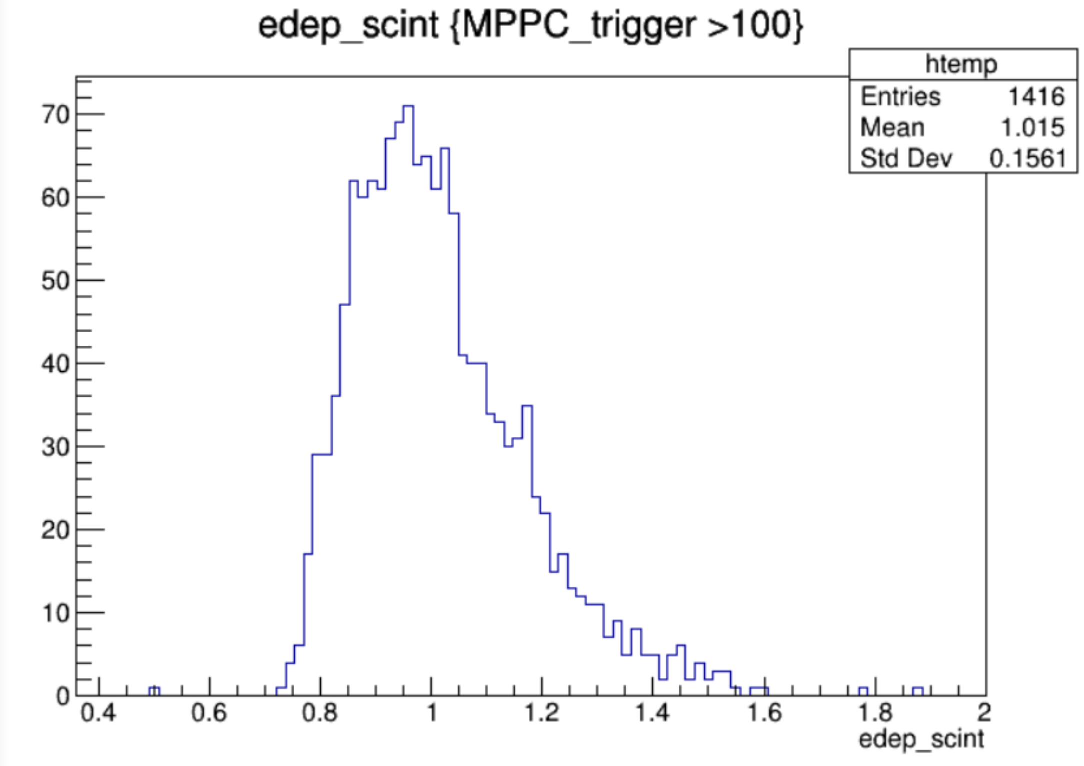


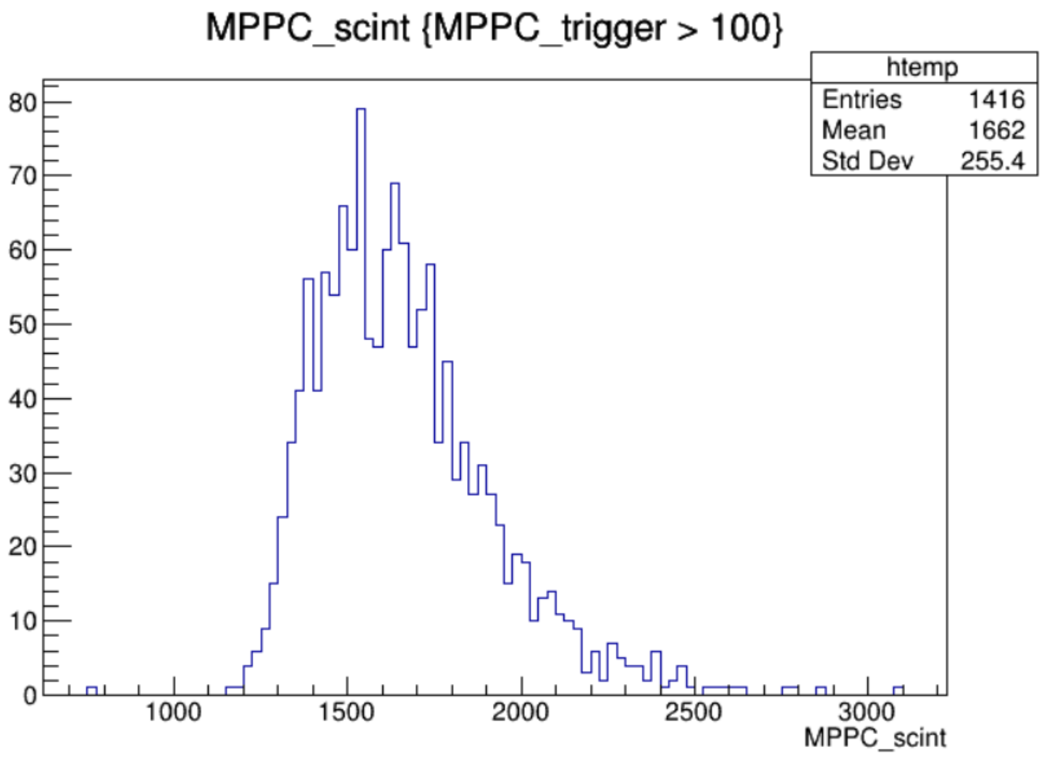
The number of scintillation photons(simulation)





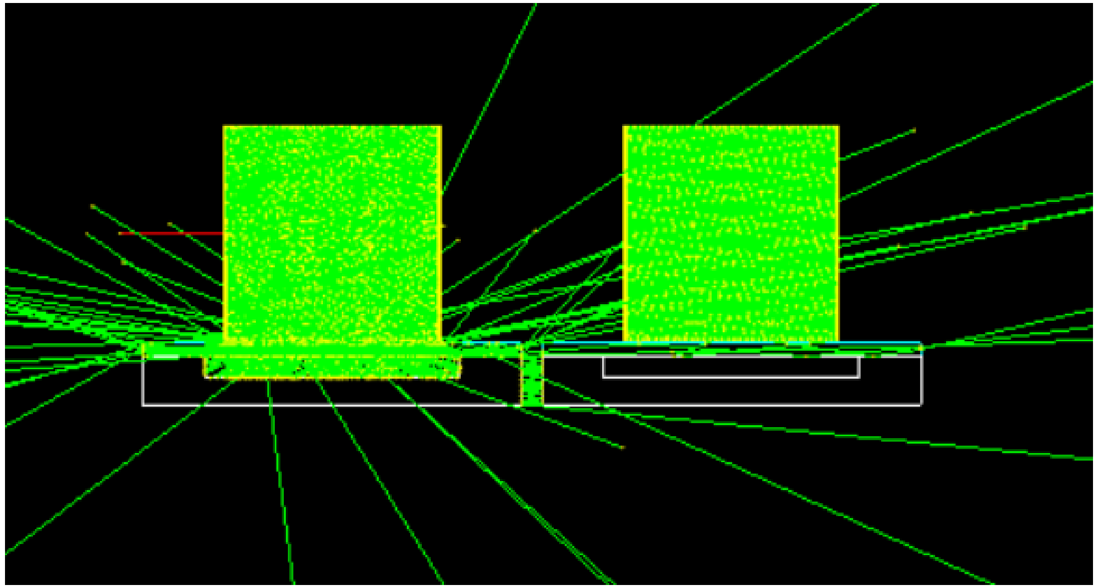
Trigger setting(simulation)





By making use of the threshold of trigger, it was possible to make a condition in which the peak appeared near 1 MeV.

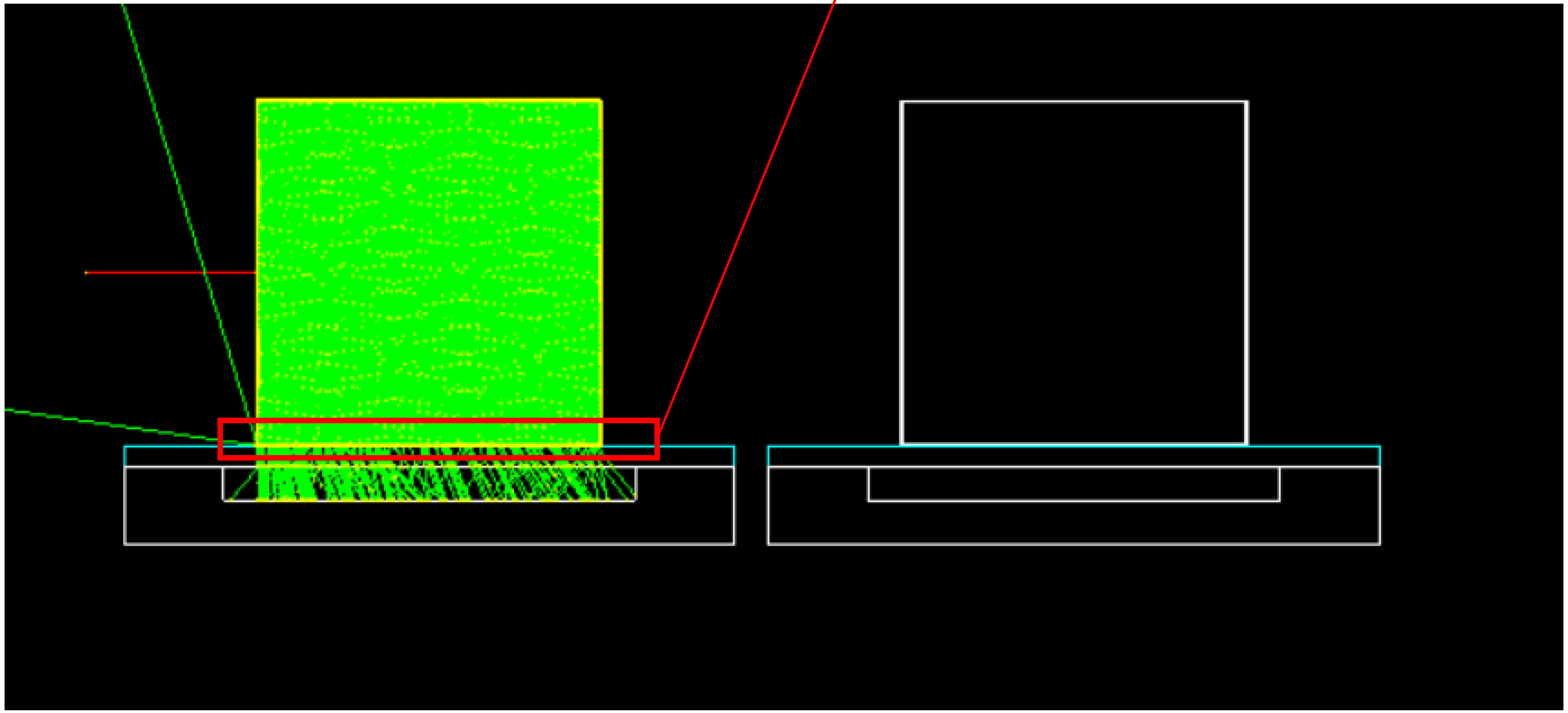
Problems



- However, we cannot calculate the scintillation yield, since we don't know exact probability that photon arrived at MPPC.
- Most of leak of photons are occurred in optical cement and window of MPPC.
- However, we cannot make the exactly same condition with simulation.
- Also we don't know the exact value of refractive index of optical cement, because optical cement is mixture.
- Therefore, we decide to do not use optical cement

Visualization

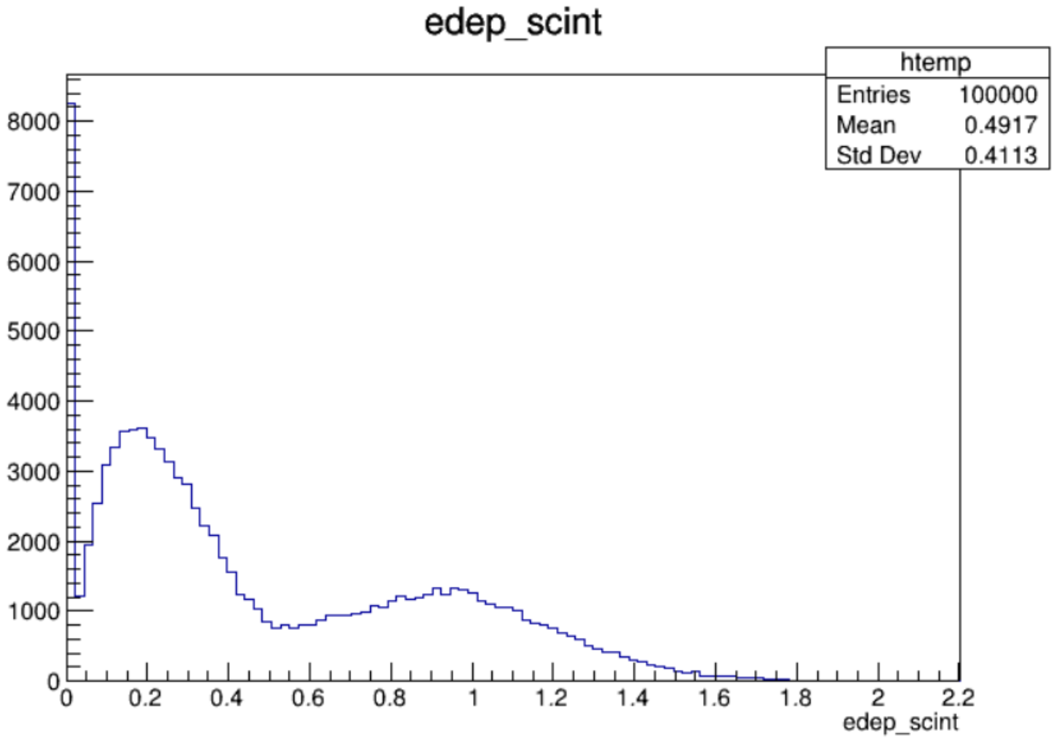
No optical cement
but air layer that is 0.01 mm long



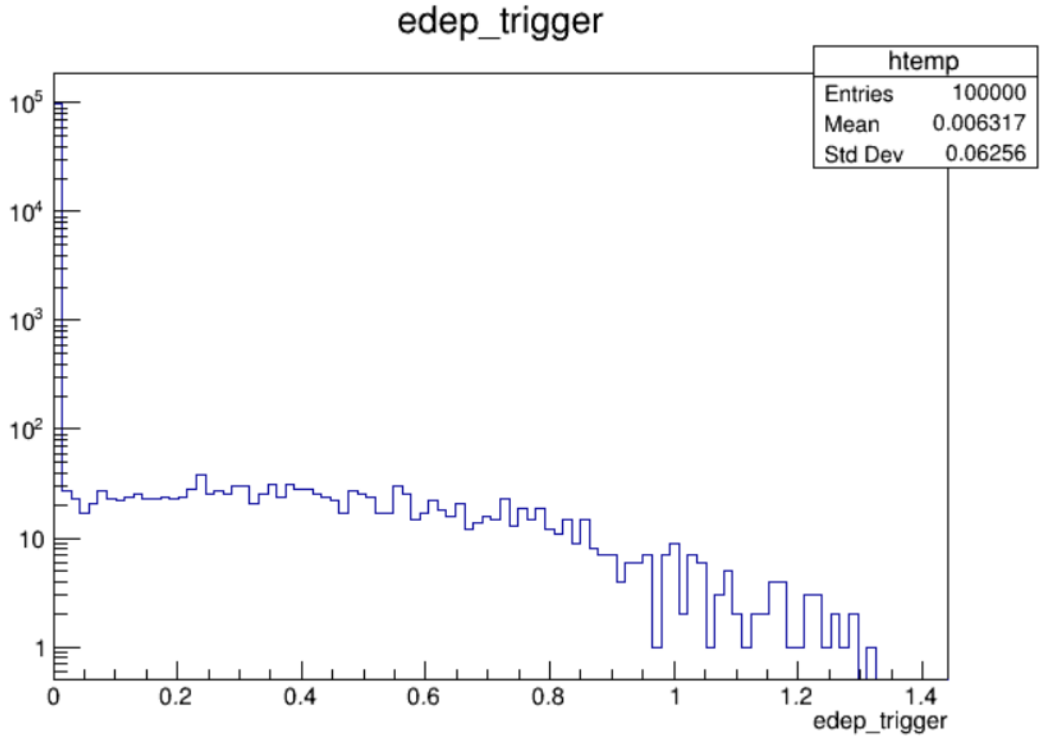
Example for electron with low energy

We can conduct the experiments because what we need is only polished scintillator and polished window of MPPC .

Energy deposit(simulation)

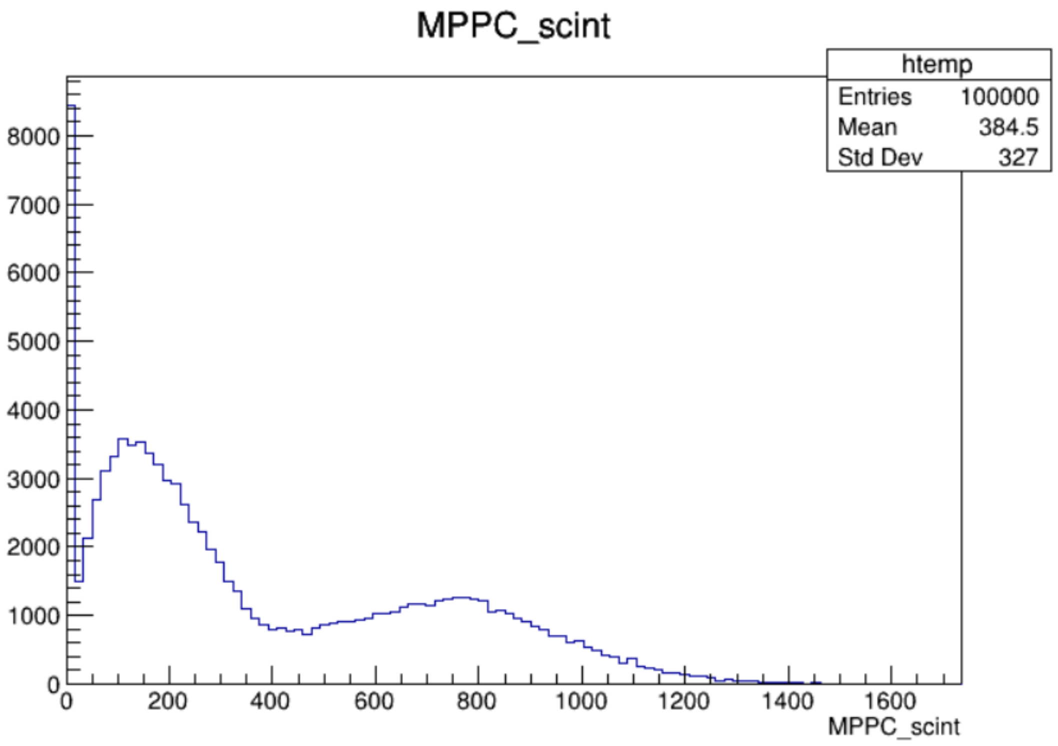


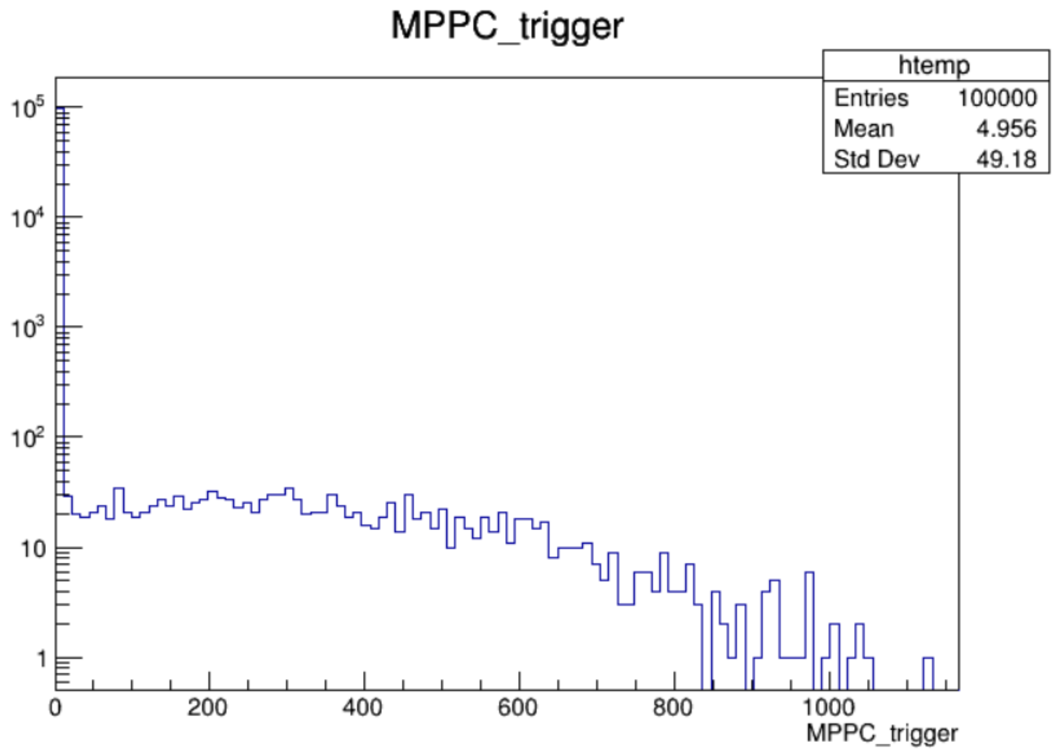
Energy deposit on scintillator



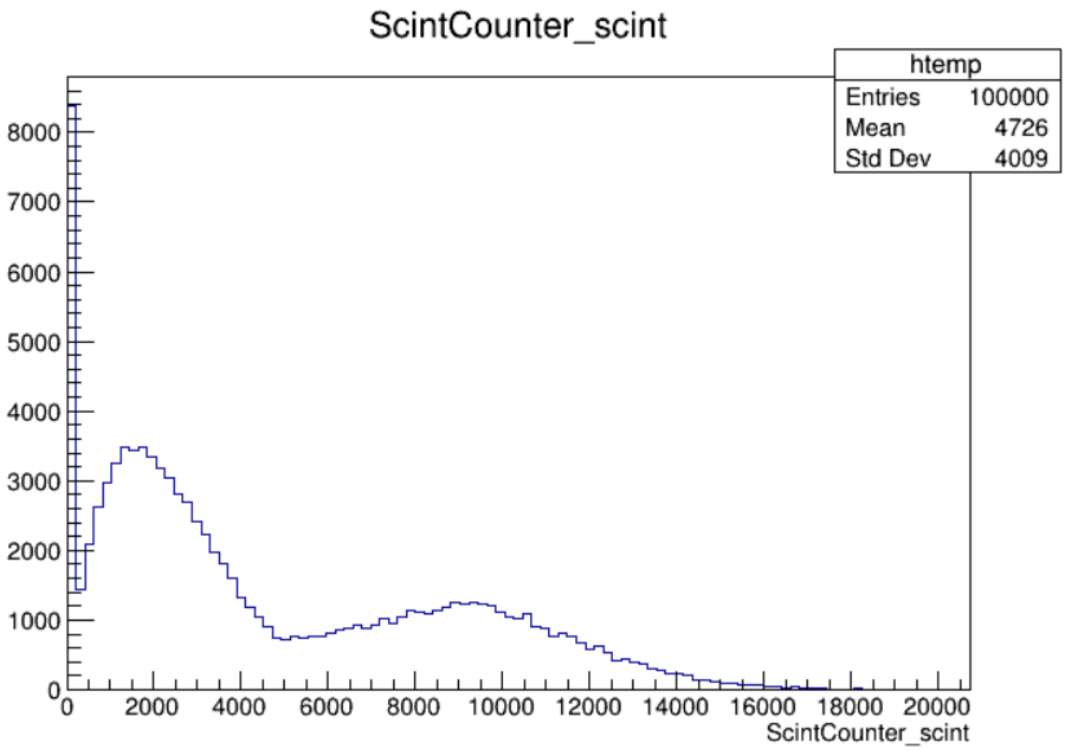
Energy deposit on trigger

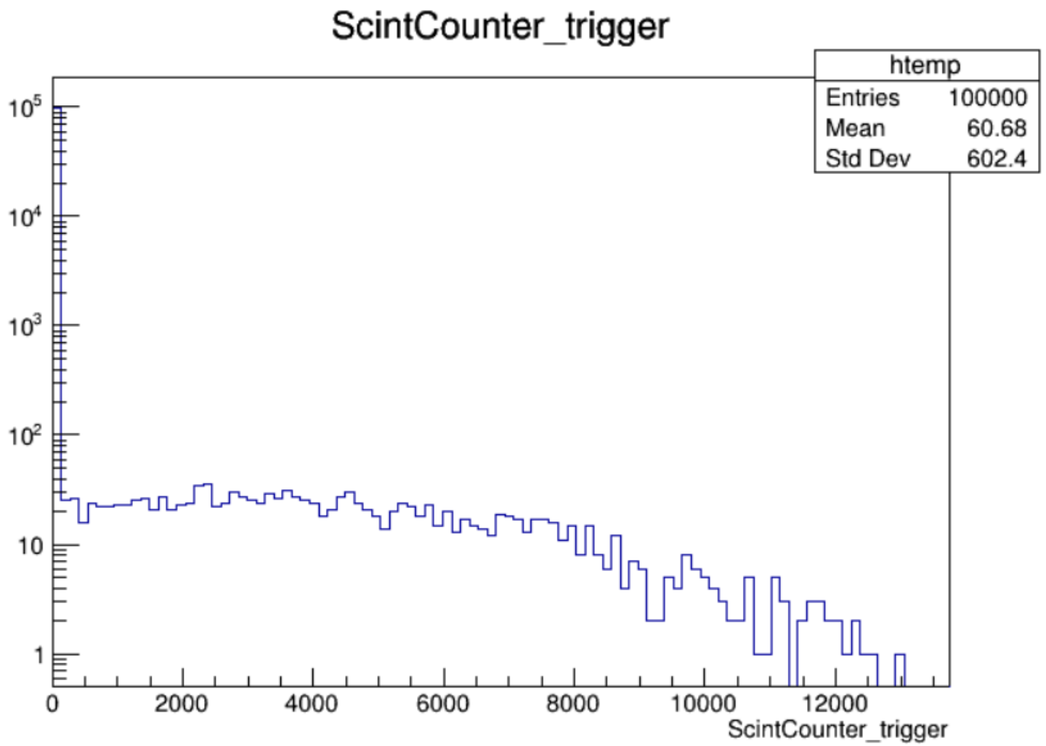
The number of photons arrived at each MPPC (simulation)



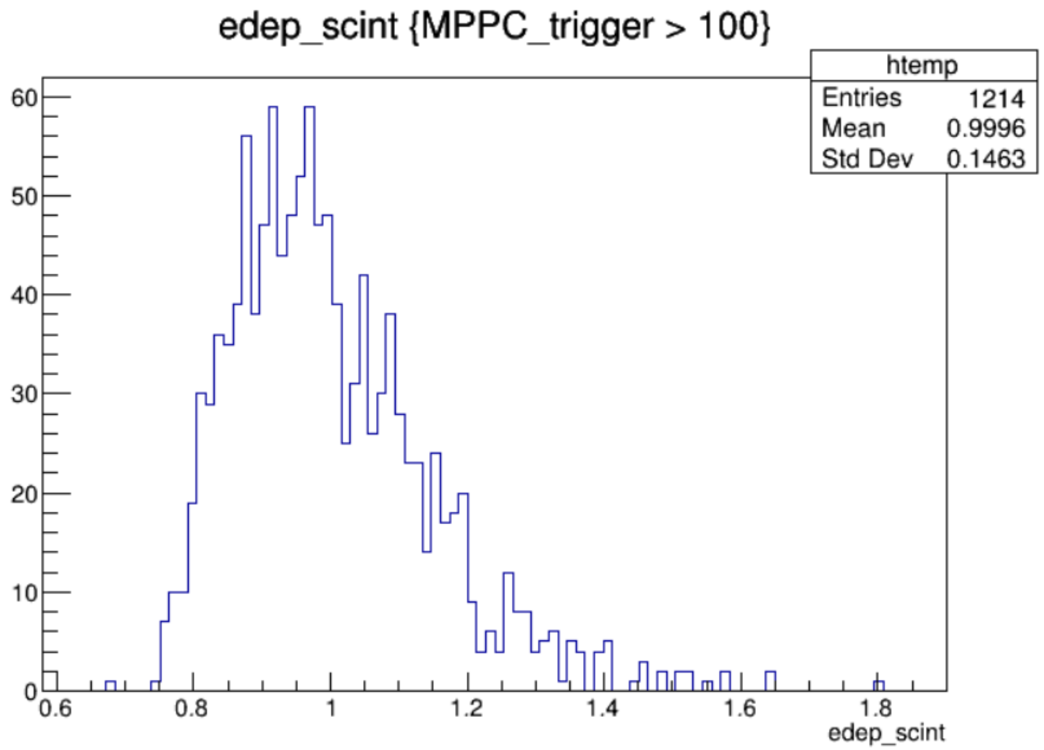


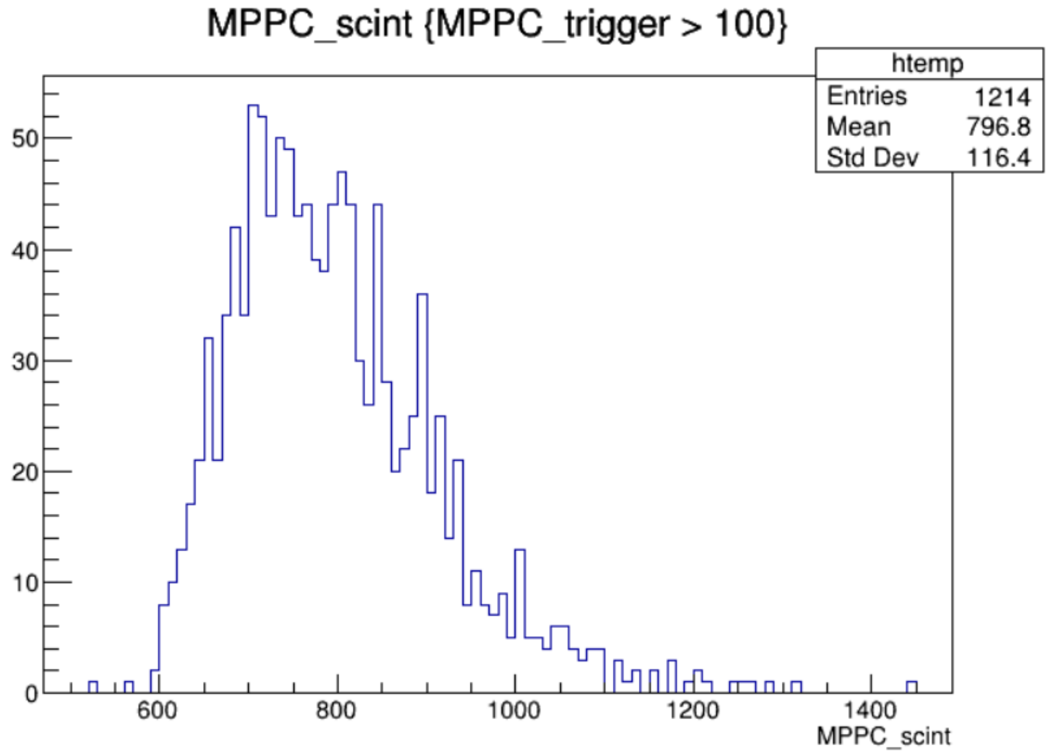
The number of scintillation photons(simulation)





Conclusion(simulation)





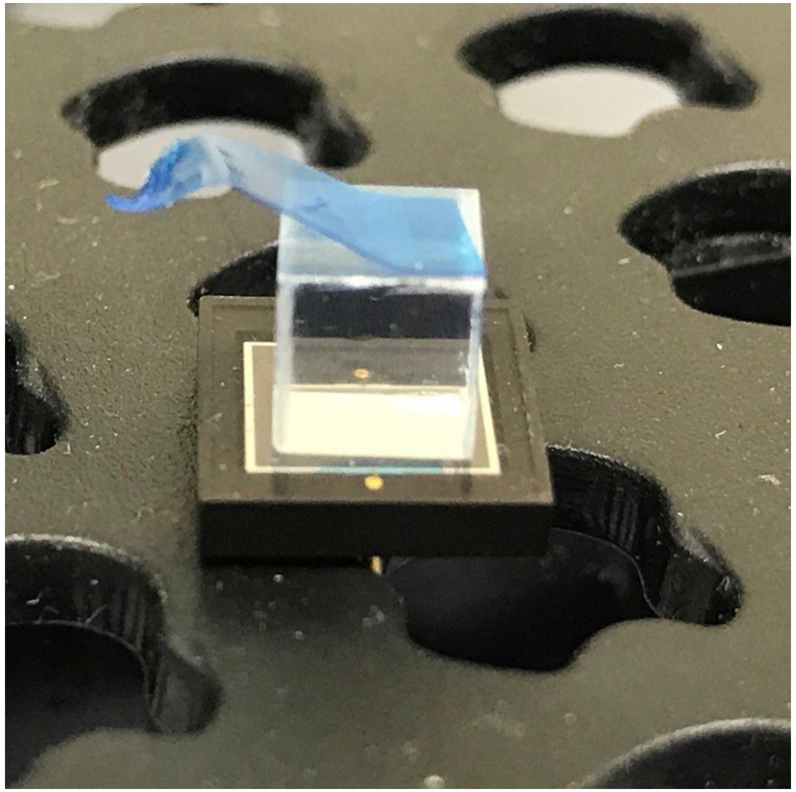
And this value is consistent with calculated value by critical angle for total reflection.

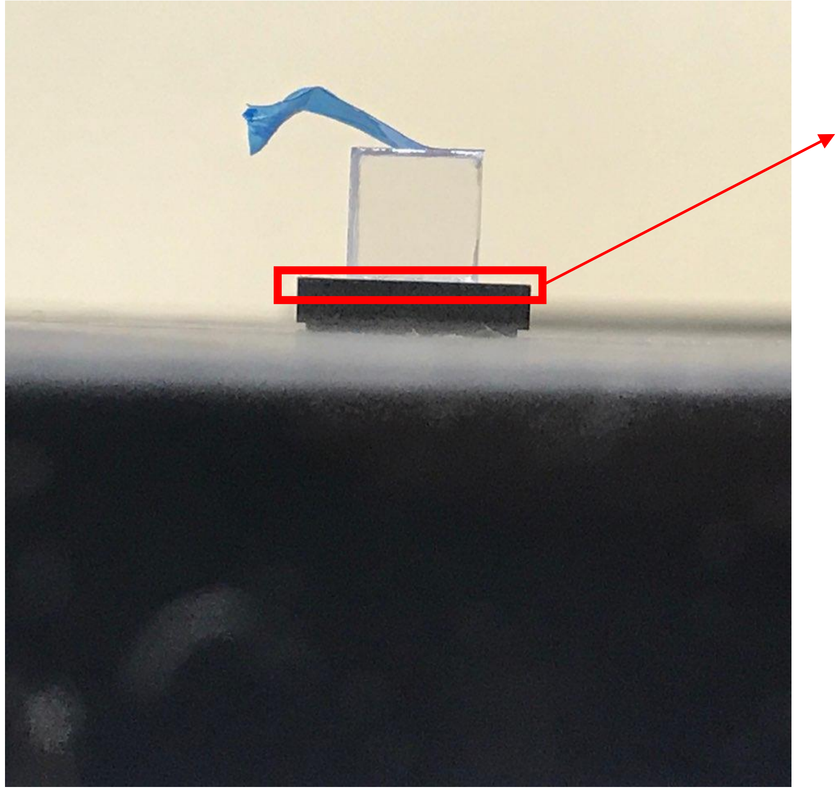
Calculation(backup)

- Critical angle for total reflection is about 39.27 deg.
- And if there is reflection with plane which is parallel to MPPC plane, incident angle change into pi – 39.27 deg.
- In last, scintillation process occur isotropically.
- Considering the above conditions, the probability is about 4 times of 39.27 deg / 4 pi .

P.S. the number of photons which are dead in scintillator because they cannot go out of scintillator, is same with our expectation.

If there is no air layer between scintillator and MPPC

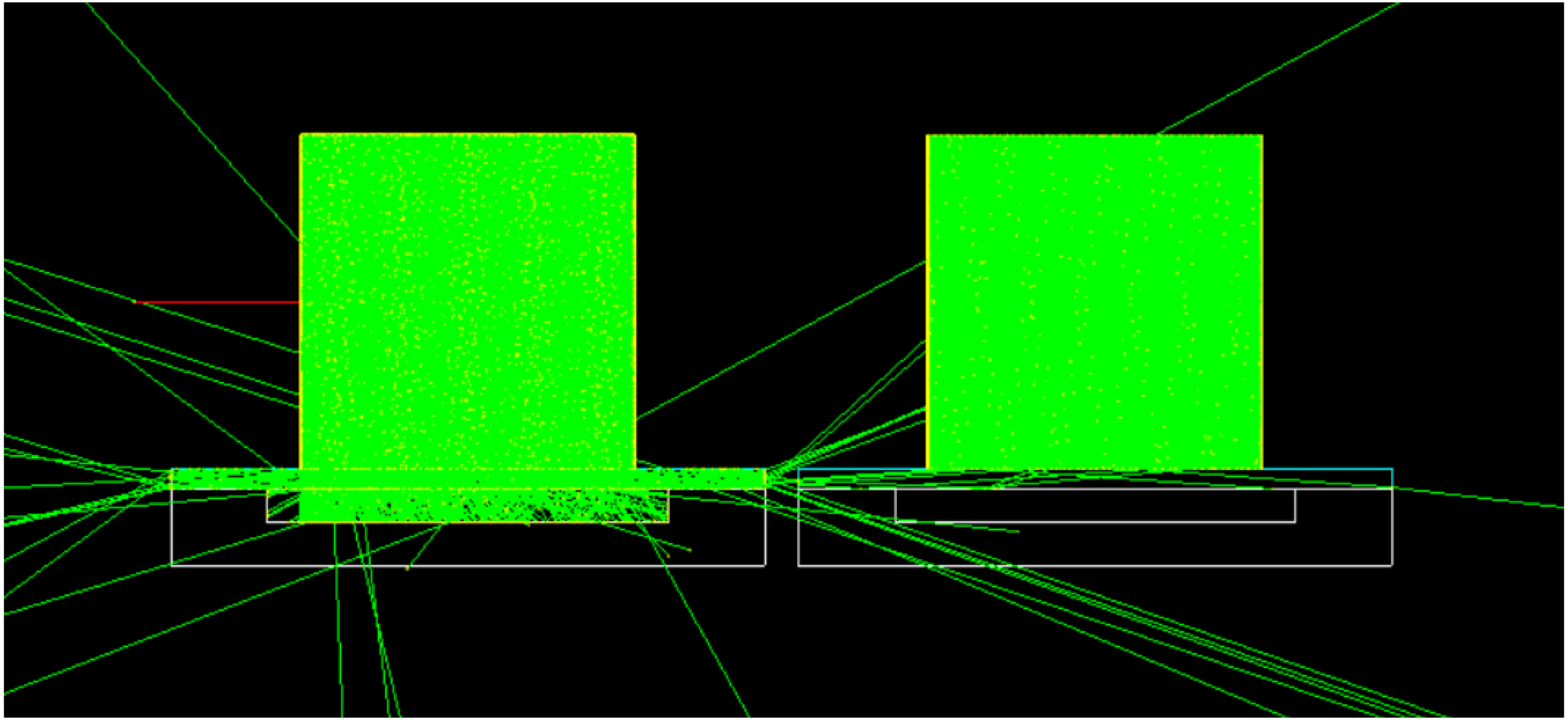




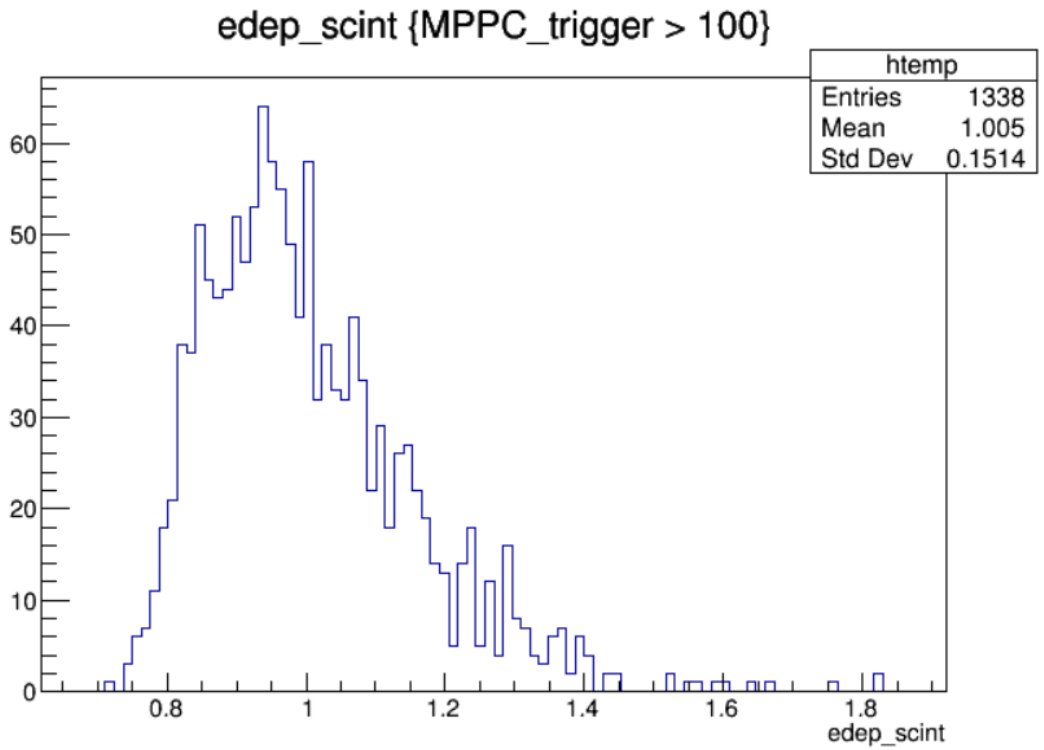
Is there air layer between them?

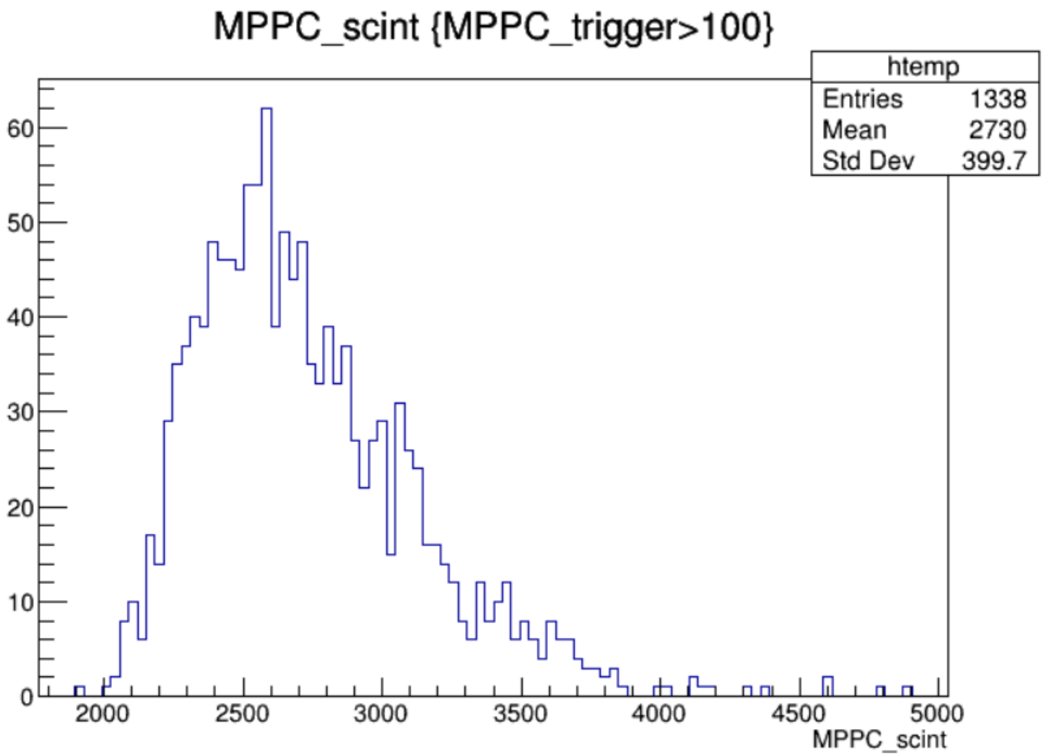
If scintillator and MPPC are well-polished enough, we can assume that there is no air-layer between scintillator and MPPC.

Visualization



Result(simulation witout air layer)





WLS efficiency

Purpose of Experiment

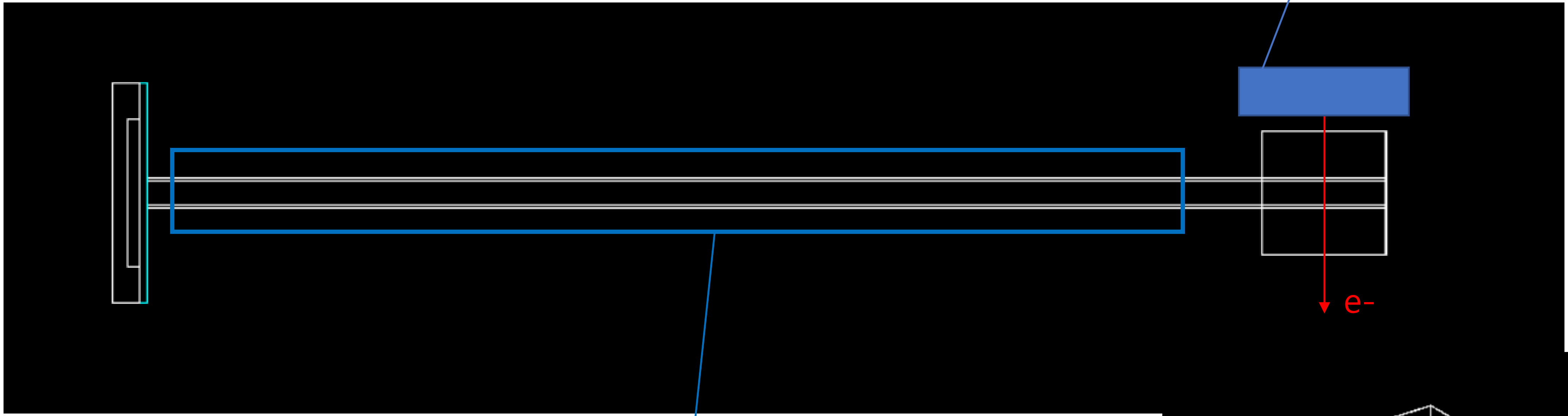
- By comparing experiments with simulation, find the efficiency of WLS process.

- Assumption

- WLS absorption length, emission spectrum, attenuation length given by Kurary company are correct.

Plan for experiments

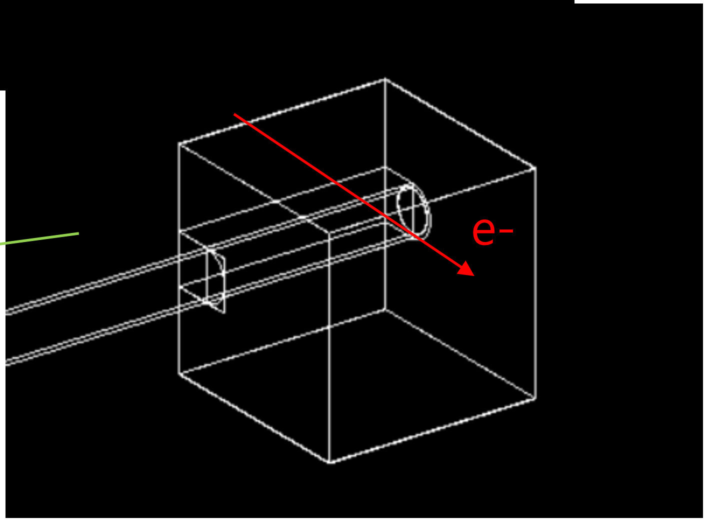
Sr beta decay source



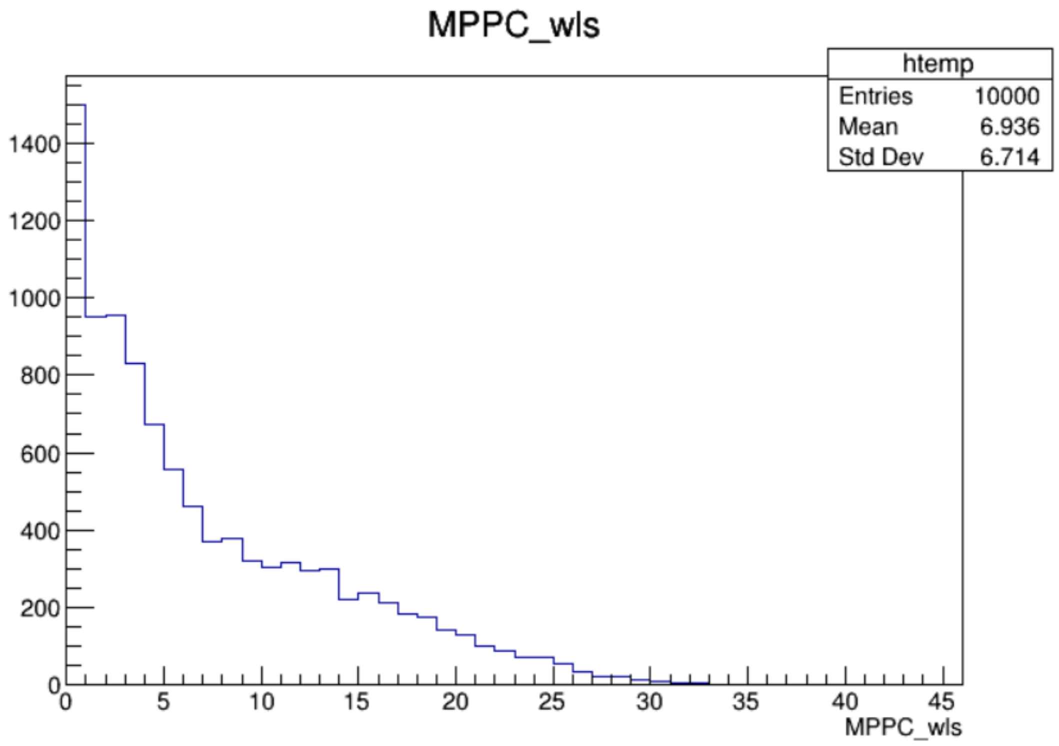
Important point is making fiber straight

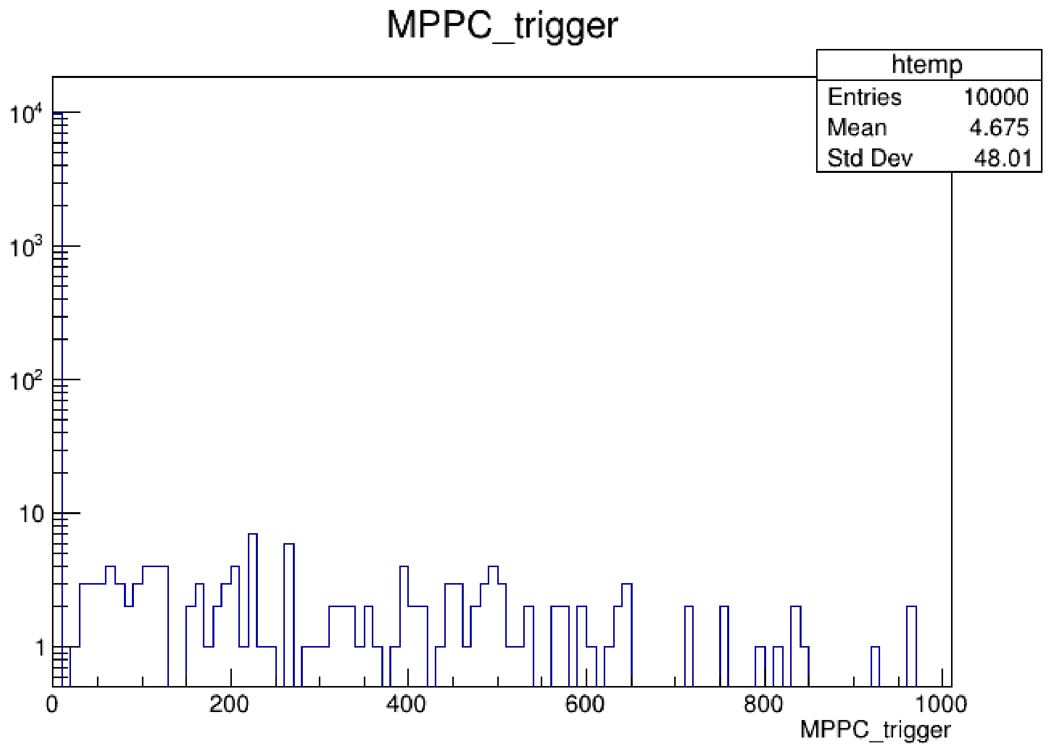
Source is placed not the center of scintillator,
since groove makes small energy deposit.

Grooved scintillator with WLS fiber

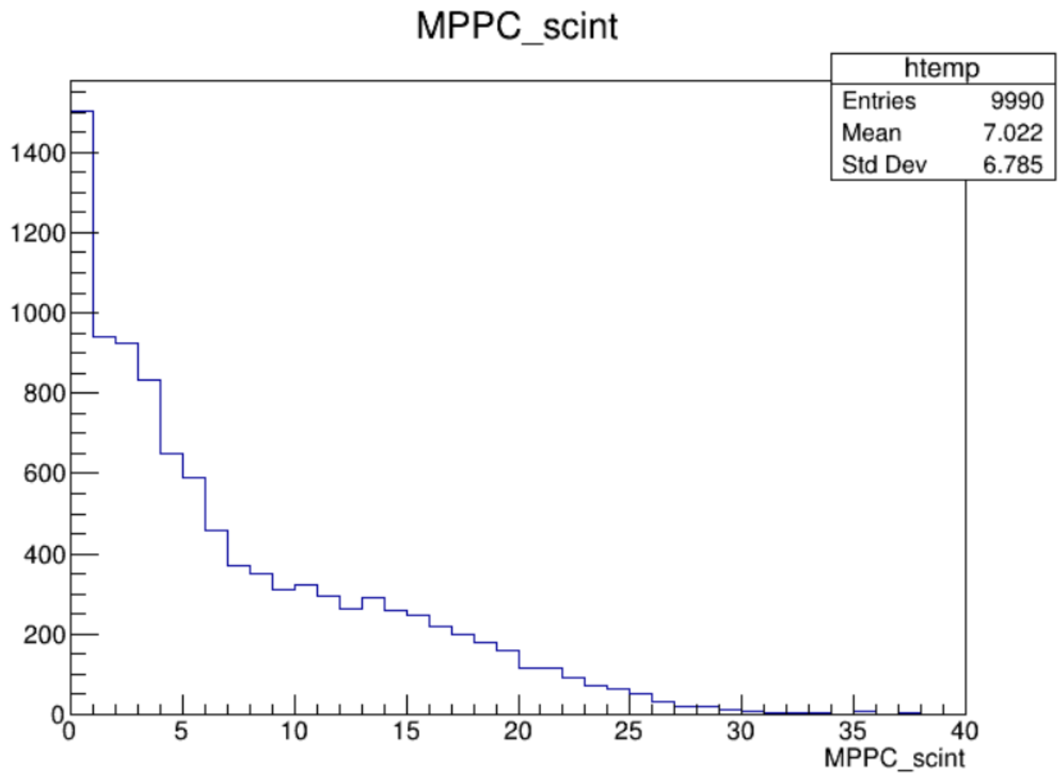


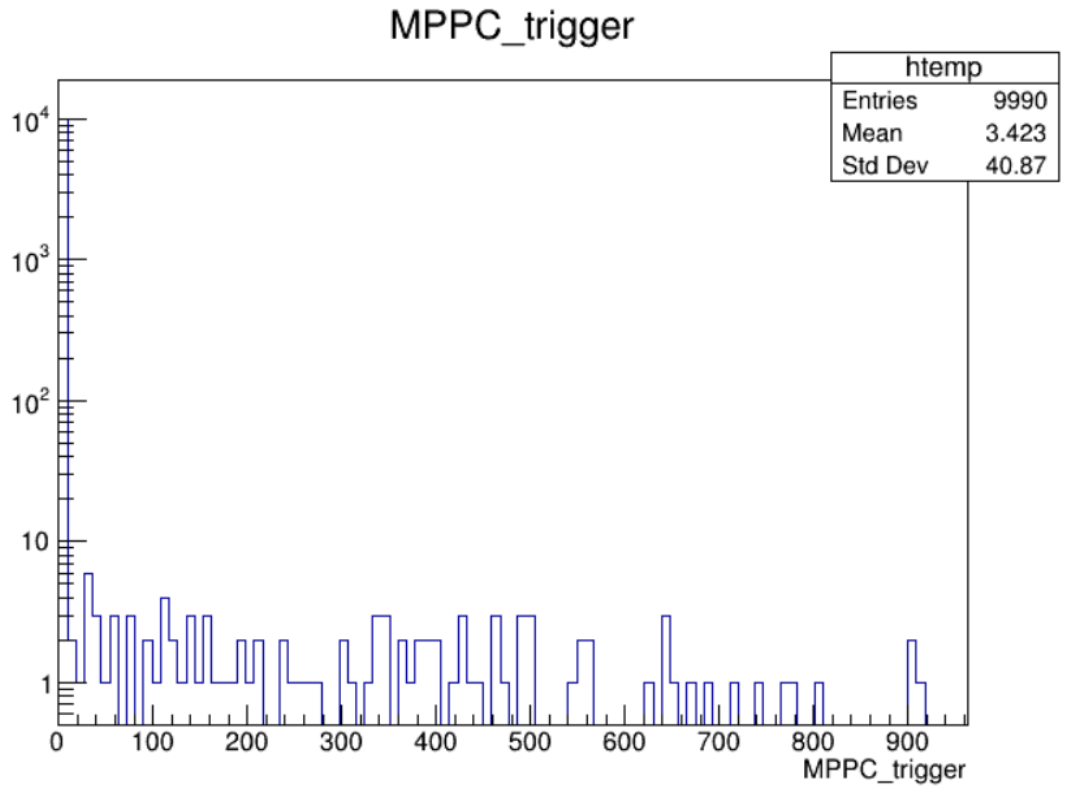
The number of photons arrived at MPPC after WLS process (efficiency = 1, simulation)



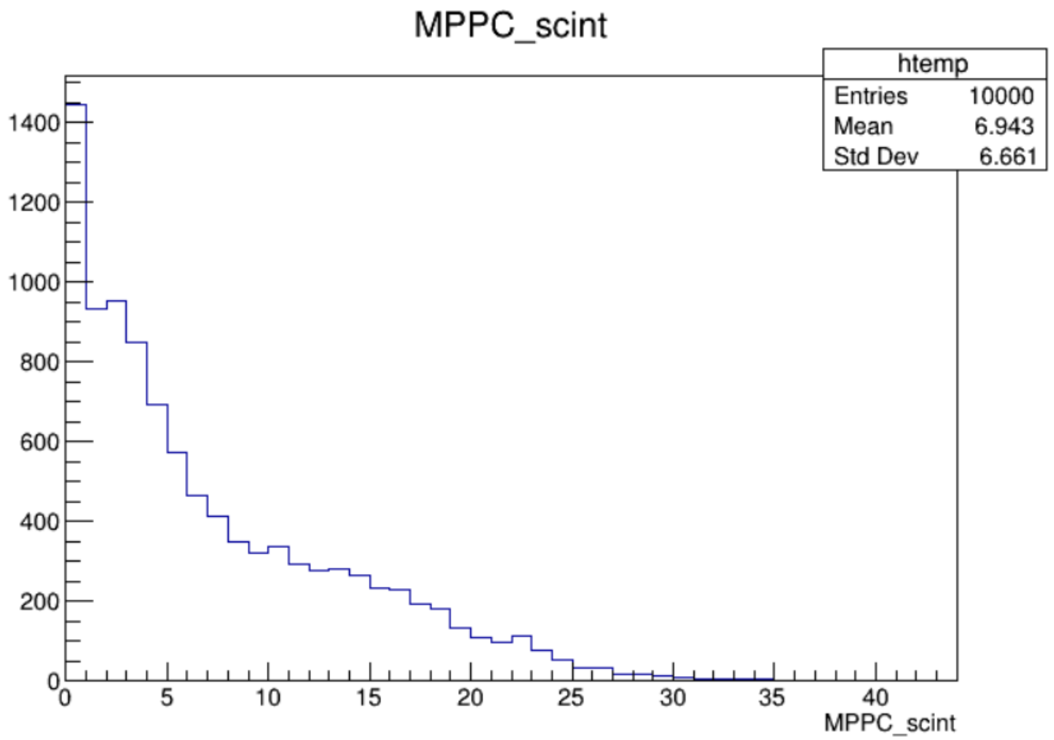


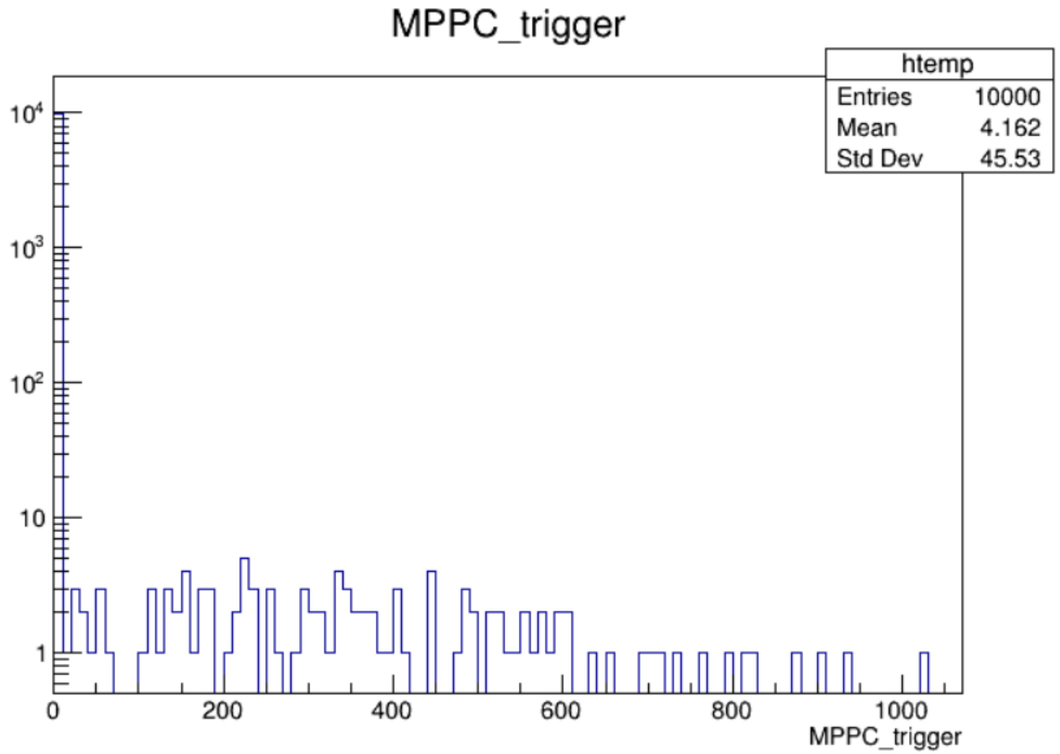
The number of photons arrived at MPPC after WLS process (efficiency = 0.9, simulation)



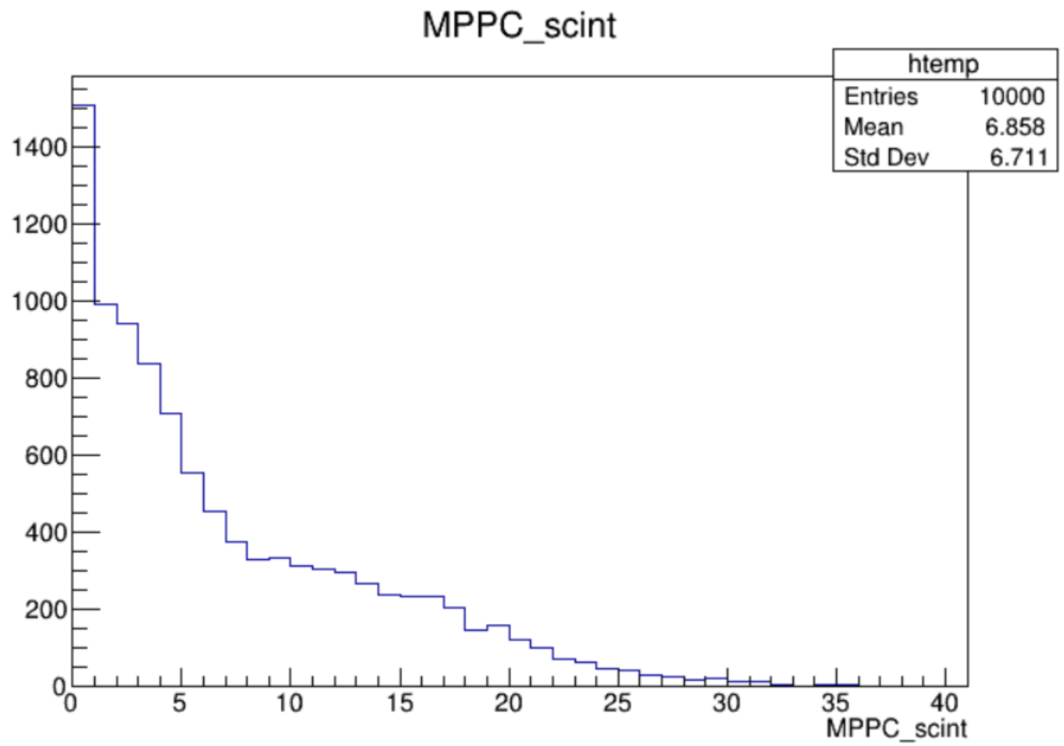


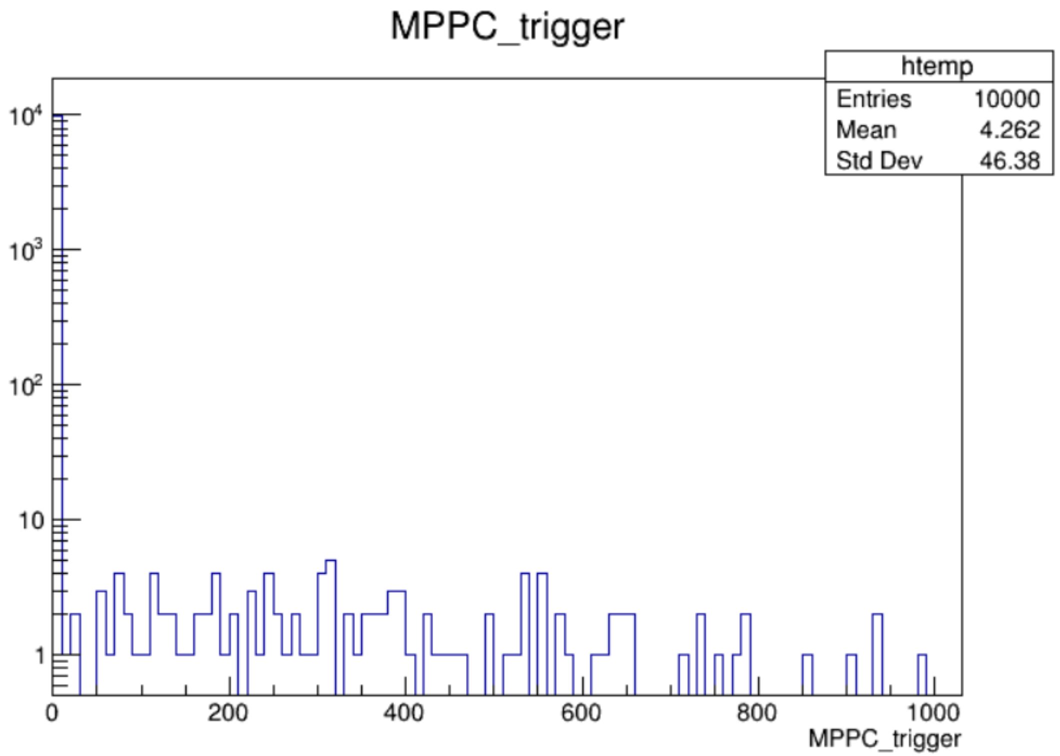
The number of photons arrived at MPPC after WLS process (efficiency = 0.8, simulation)



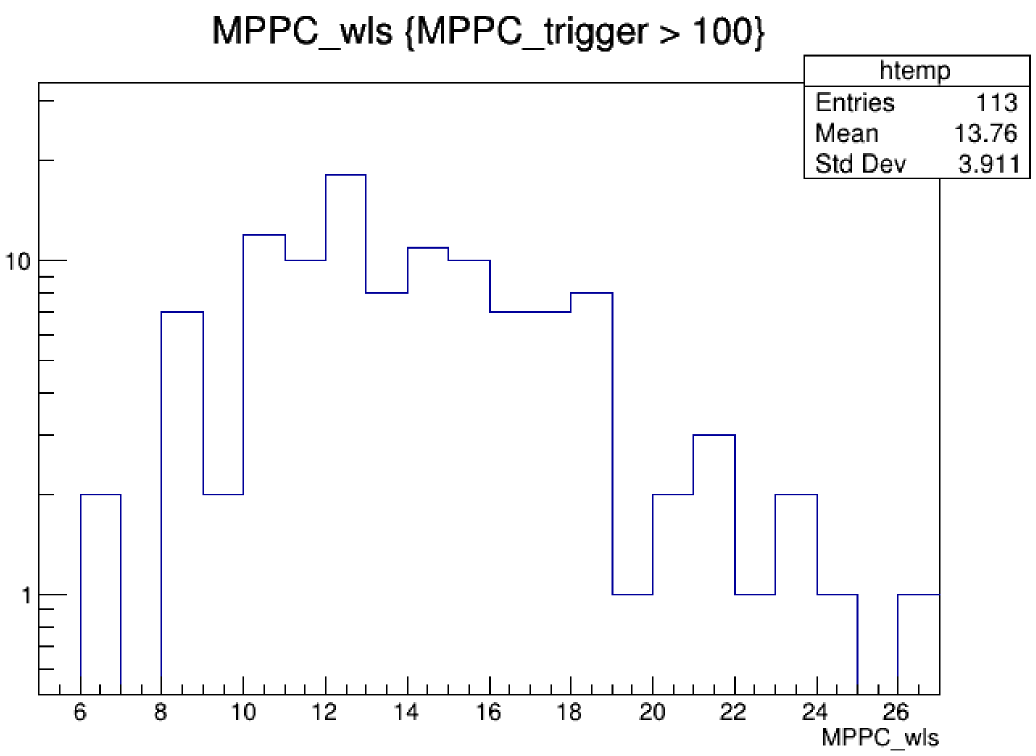


The number of photons arrived at MPPC after WLS process (efficiency = 0.7, simulation)

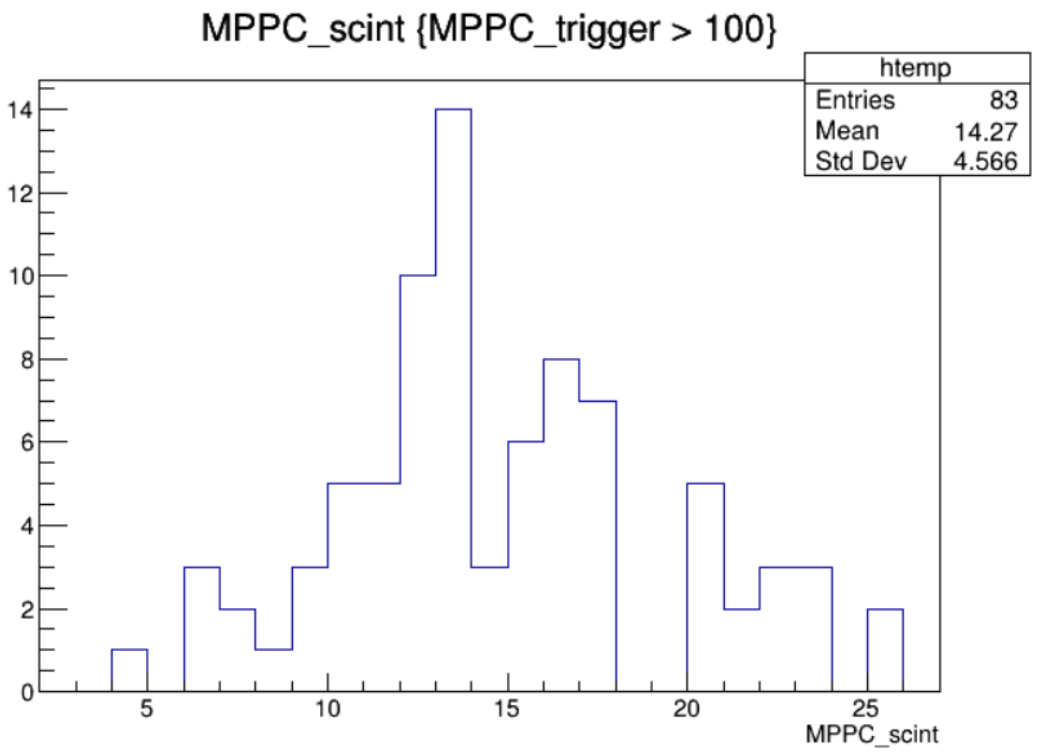




Conclusion(simulation)

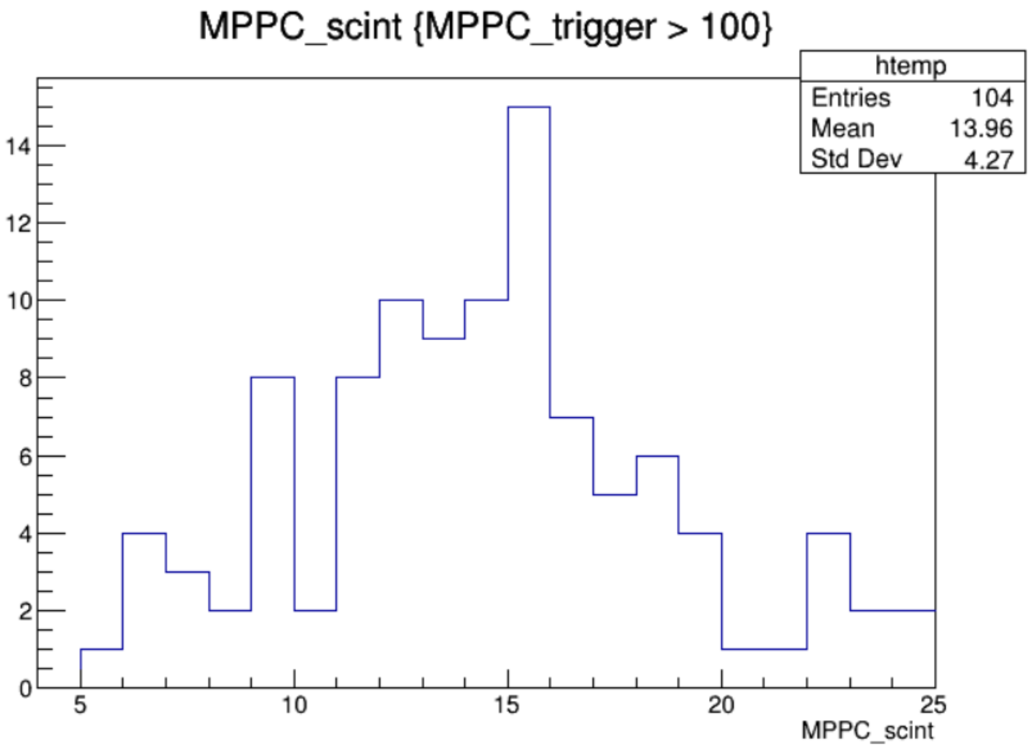


WLS efficiency = 1

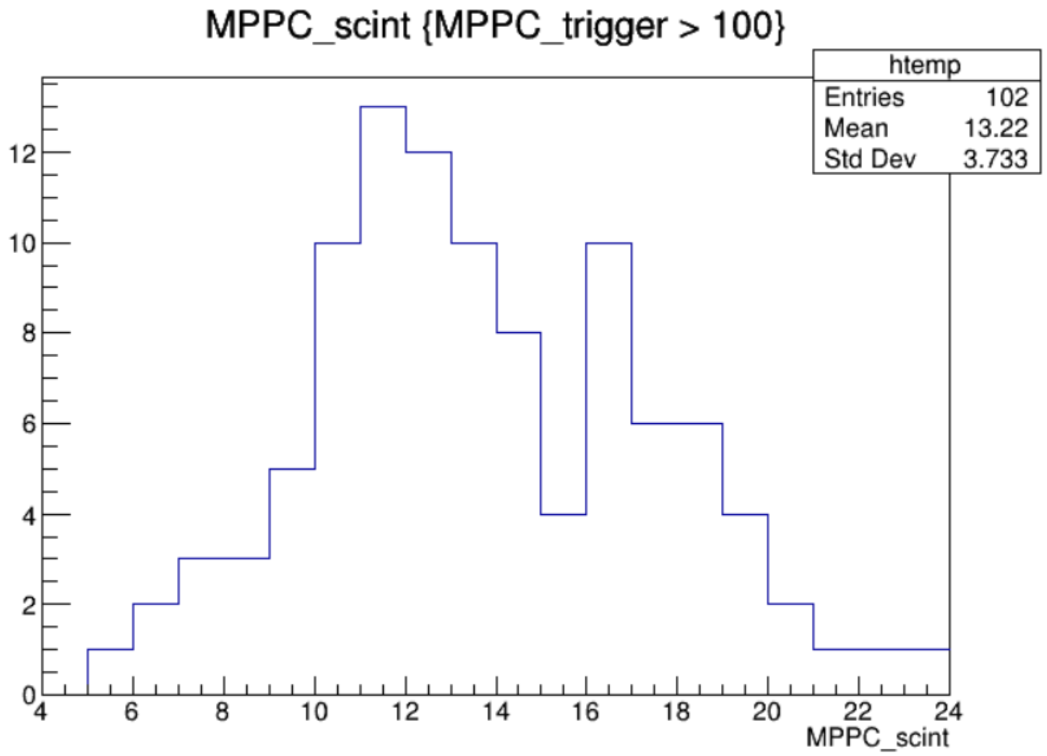


WLS efficiency =0.9

Conclusion(simulation)



WLS efficiency = 0.8



WLS efficiency = 0.7

Question

- Why the number of photons does not differ so much at different efficiency?

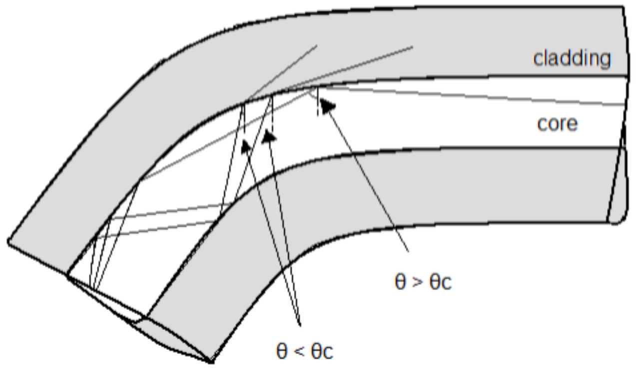
Effect of Defects in WLS fiber

Purpose of Experiment

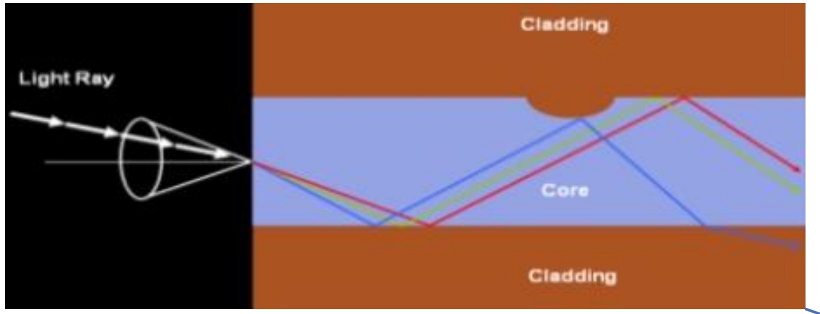
- By comparing experiments with simulation, find effect of defect(disloation) in WLS fiber

Bending Loss

Already implemented in simulation

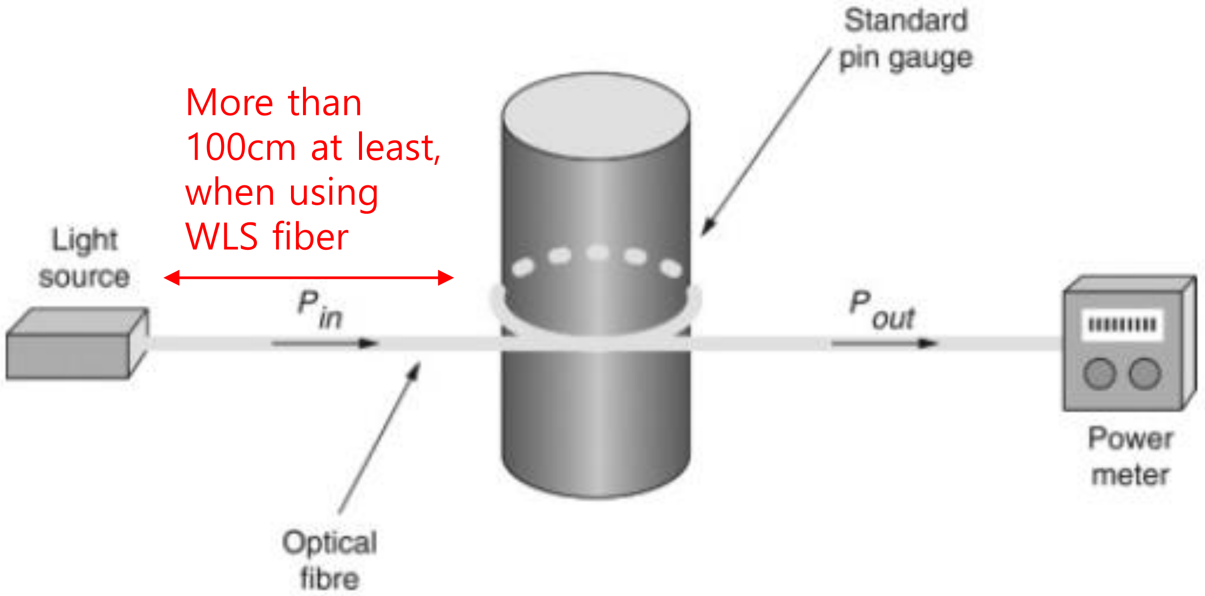


Macroscopic Bending Loss



Microscopic Bending Loss

More than 100cm at least, when using WLS fiber



Experiment Instrument

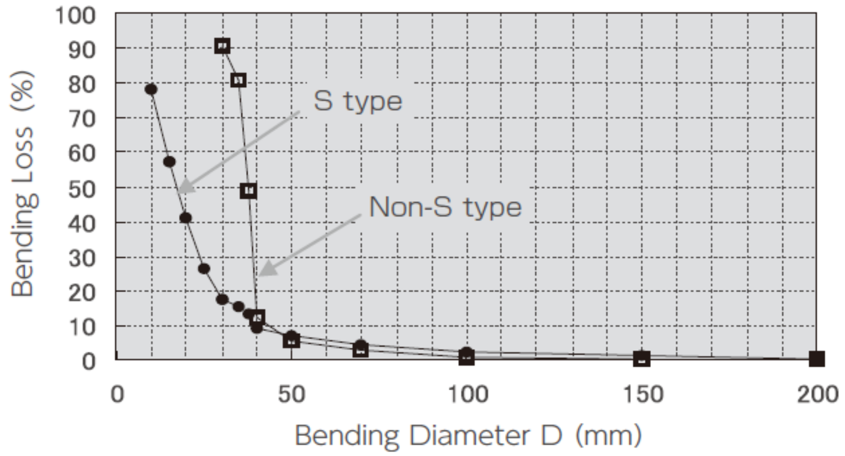
Need to be fix by surface of fiber

Manual for WLS fiber

Bending Loss and Minimum Bending Diameter

Bending Loss

The following figure shows bending loss of Clear-PSM and Clear-PSMS.
S type is better than Non-S type.
The rapid increase of bending loss of non-S type is due to cracking of core.
S type does not show such cracking.



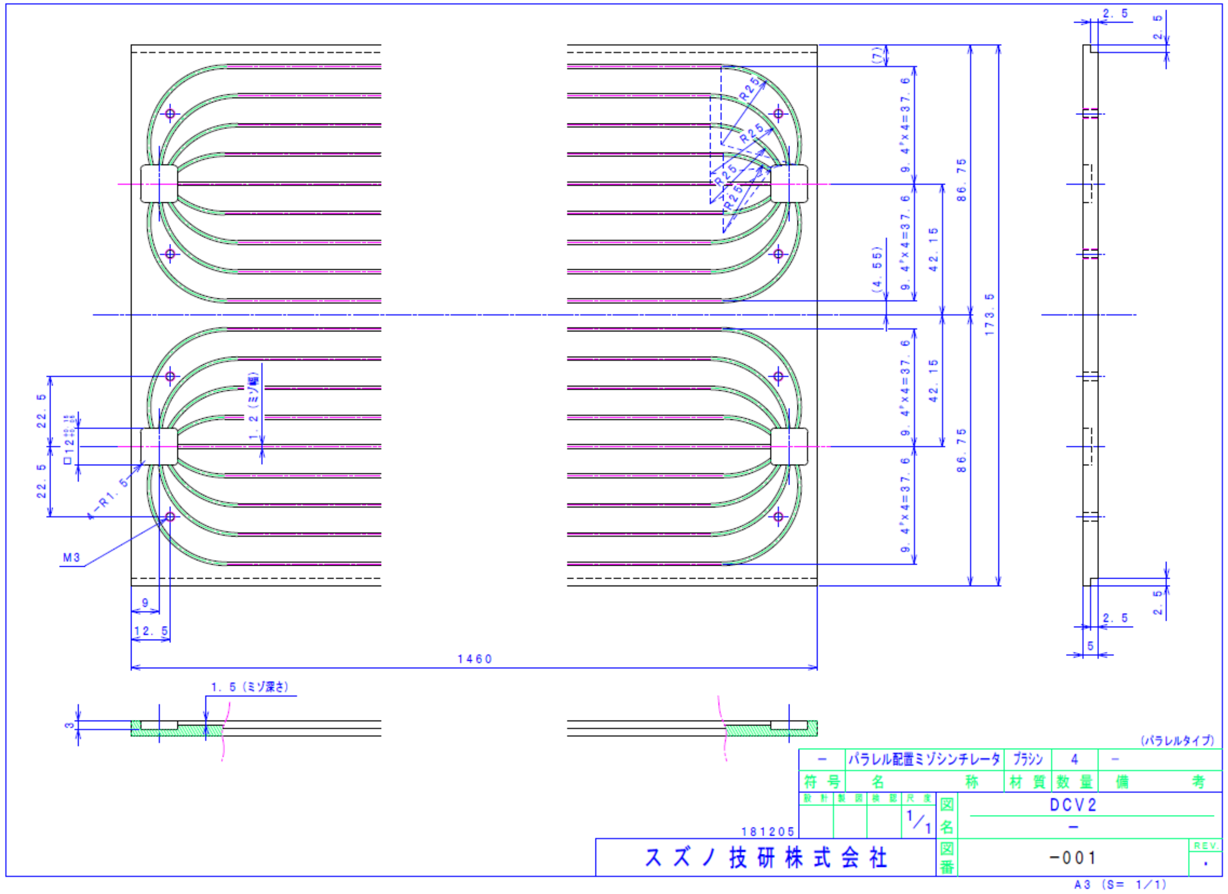
- In the end, checking the effect of defect in WLS fiber is equivalent with checking the surface of WLS fiber when fiber is bent.
- According to the manual for WLS fiber, S-type do not crack.
- Therefore, what we should do is just find the surface of WLS fiber, by comparing with data from Kuraray.

Effect of Surface of Aluminum

Purpose of Experiment

- By comparing experiments with simulation, find effect of surface of aluminum box.

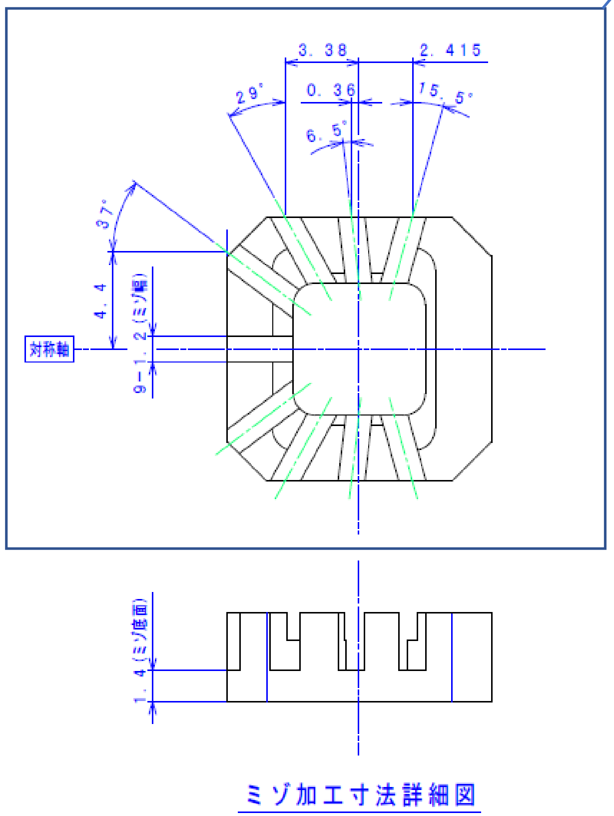
DCV2 Blueprint

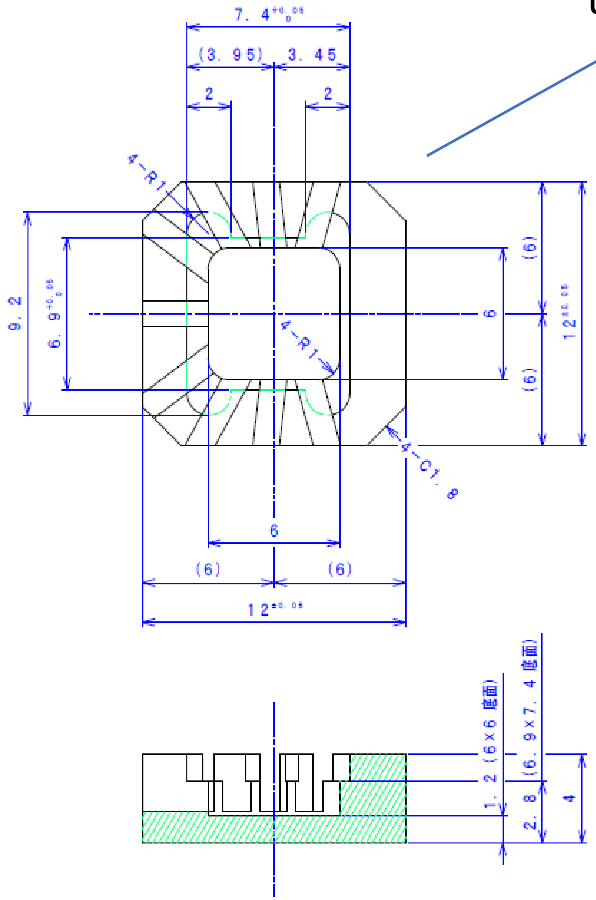


Aluminum Box

Get Slope

Get a point through the circle.



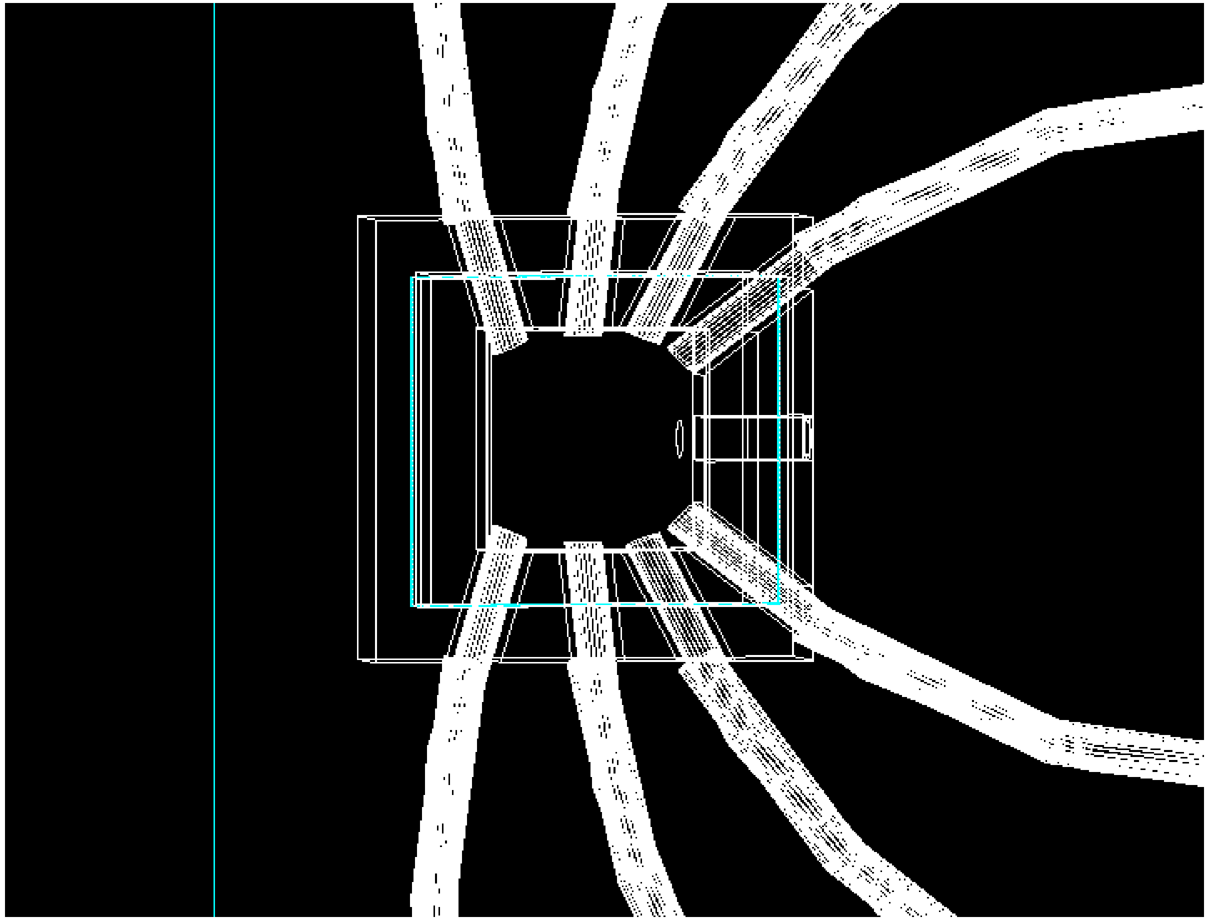


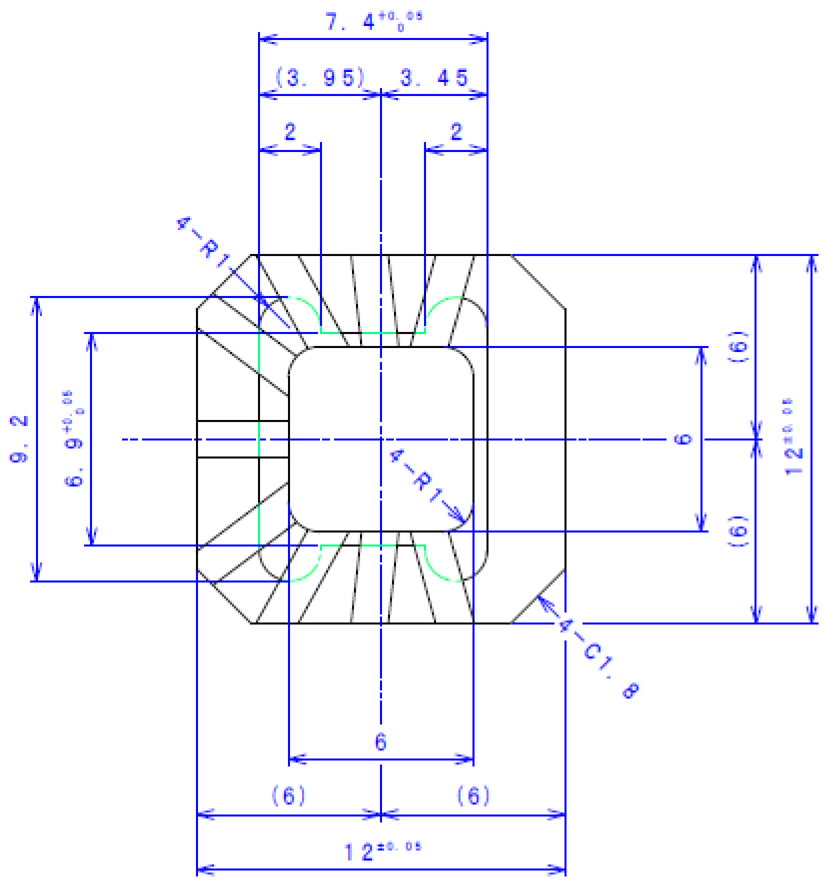
Calculation

- Curvature = 25 mm
- The center of each torus determined by one point and slope at that point in blueprint of aluminum box is not consistent with blueprint of DCV.

>> Is there any other information about that?

Visualization





Effect of Collimator

Scintillation Process

Things to do

- Make Colliminator and measure the kinetic energy of electron which pass through the colliminator.
- Make full geometry for ¼ DCV and find the difference by changing surface of aluminum box.
- Make Average Energy deposit in scintillator with 5 mm width 1 MeV.

Backup