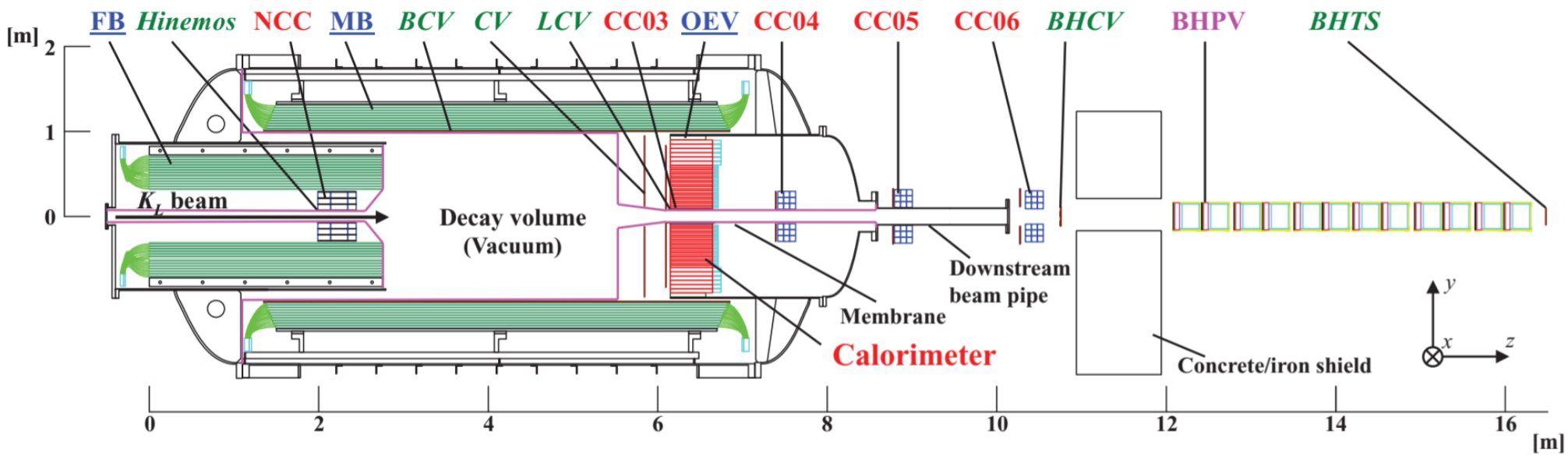
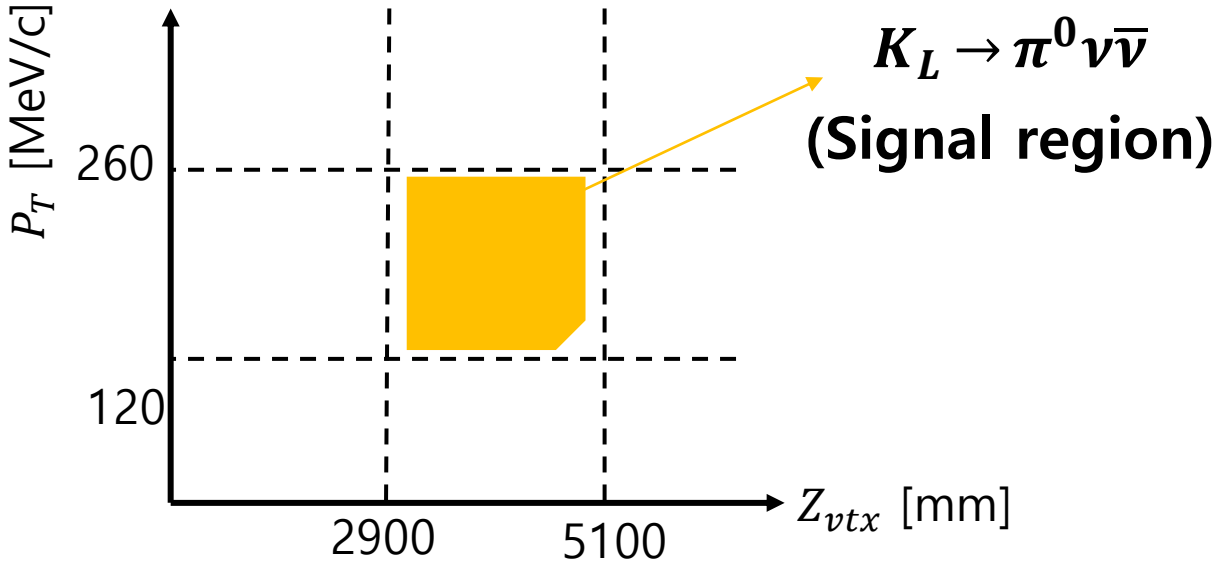
CHARACTERIZATION OF A CHARGE VETO DETECTOR WITH WAVELENGTH-SHIFTING FIBERS AND MPPC READOUT FOR THE KOTO EXPERIMENT

고려대학교 최재민

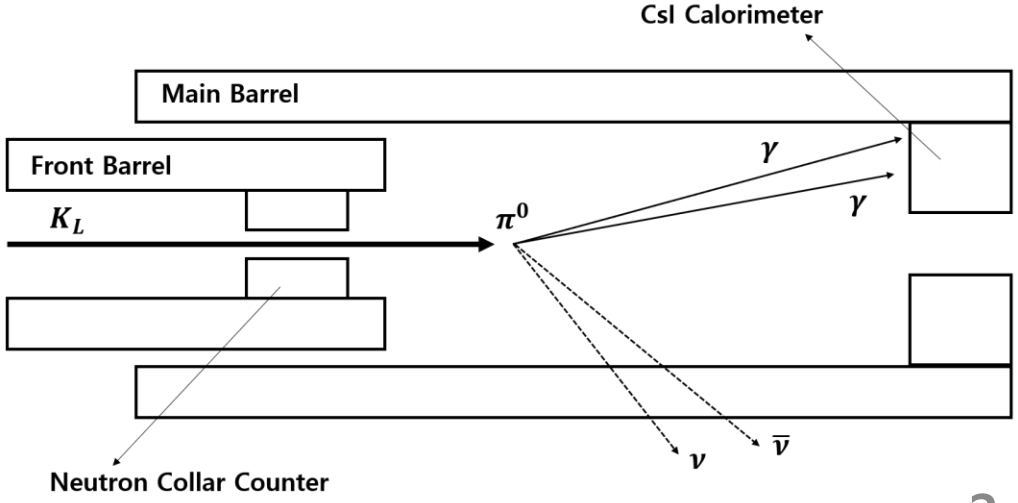
KOTO experiment



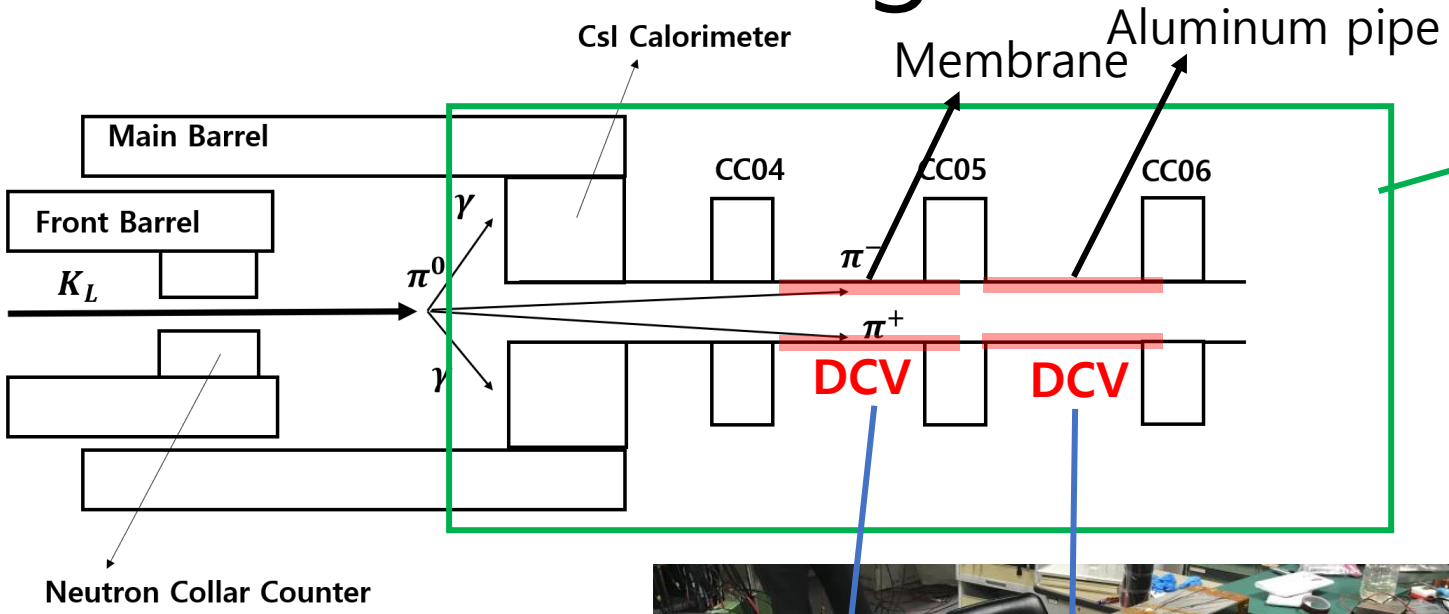


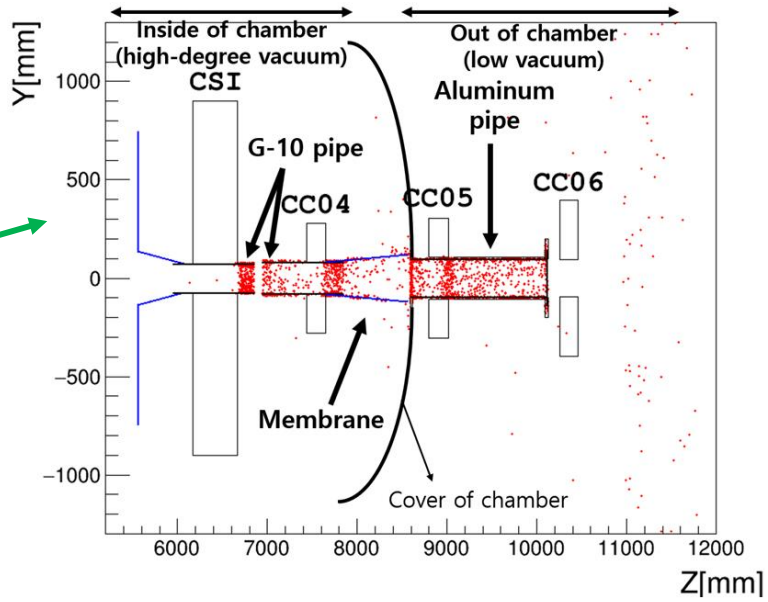
$K_L \to \pi^0 \nu\bar{\nu}$

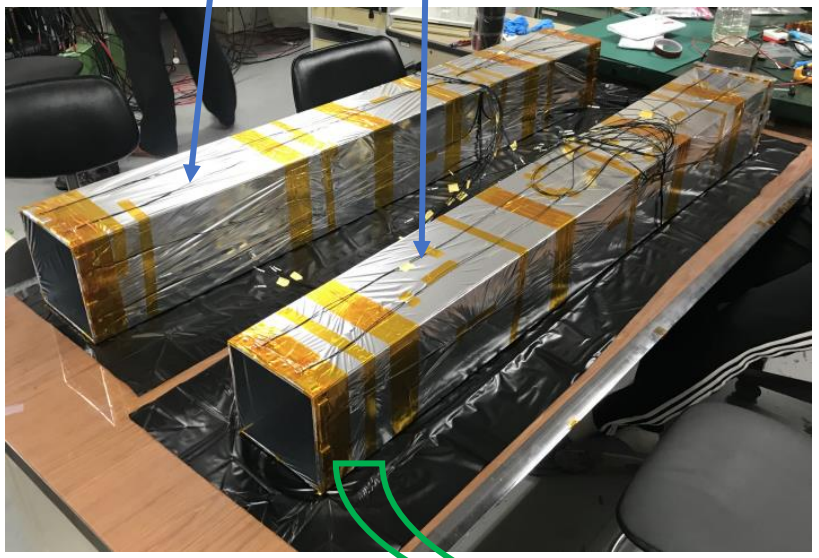
(Signal region)

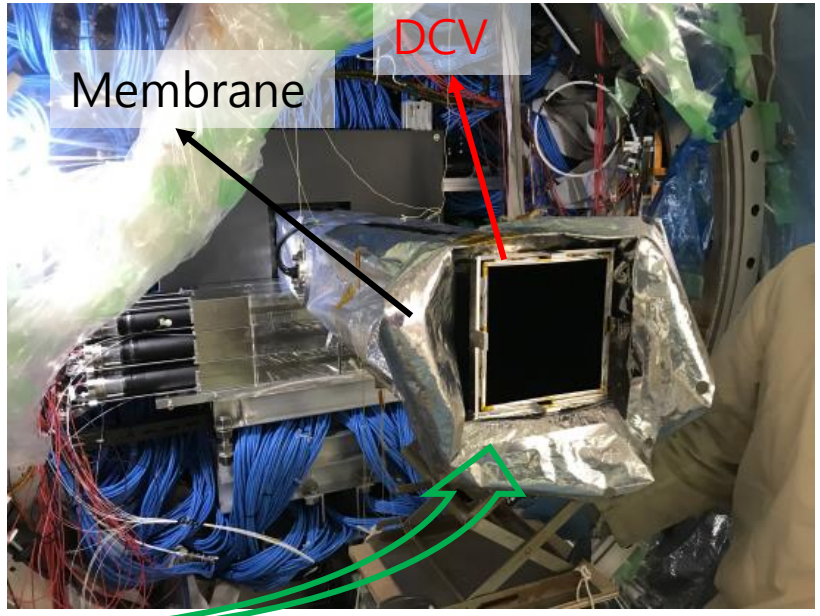


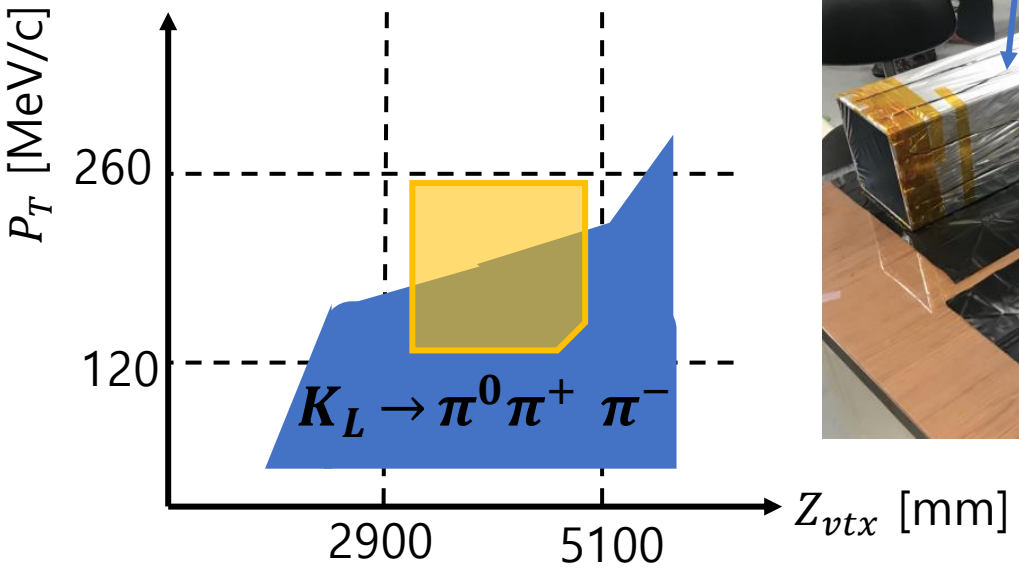
Downstream Charge Veto



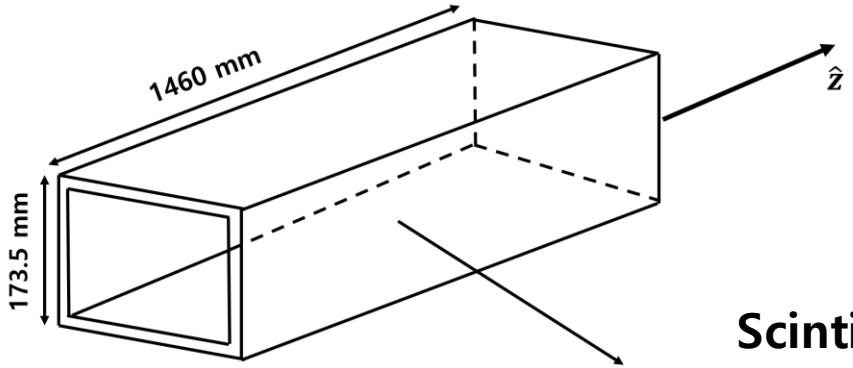


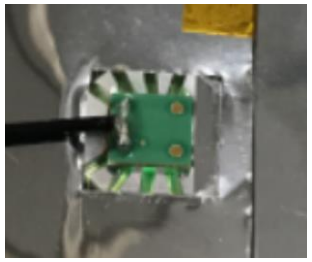


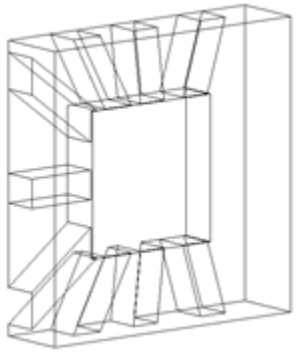


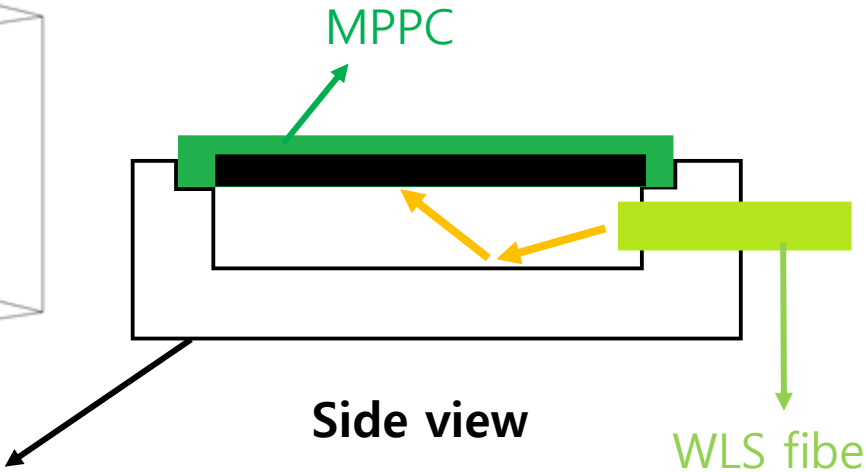


Structure of DCV



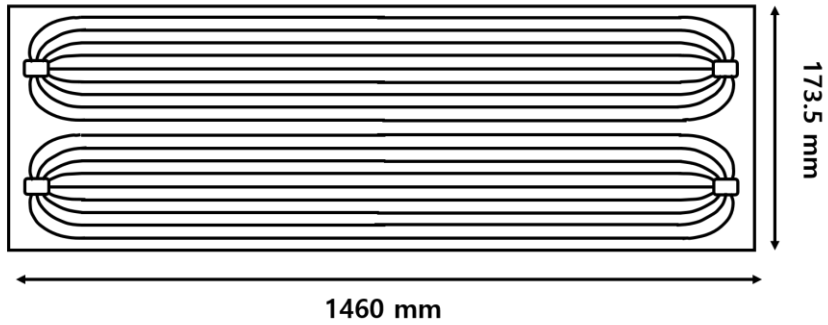


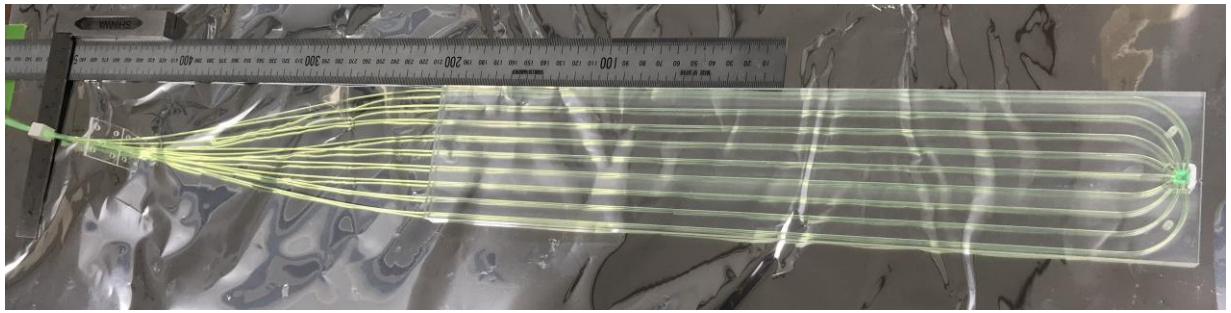


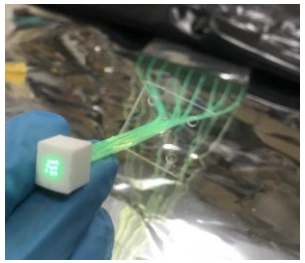


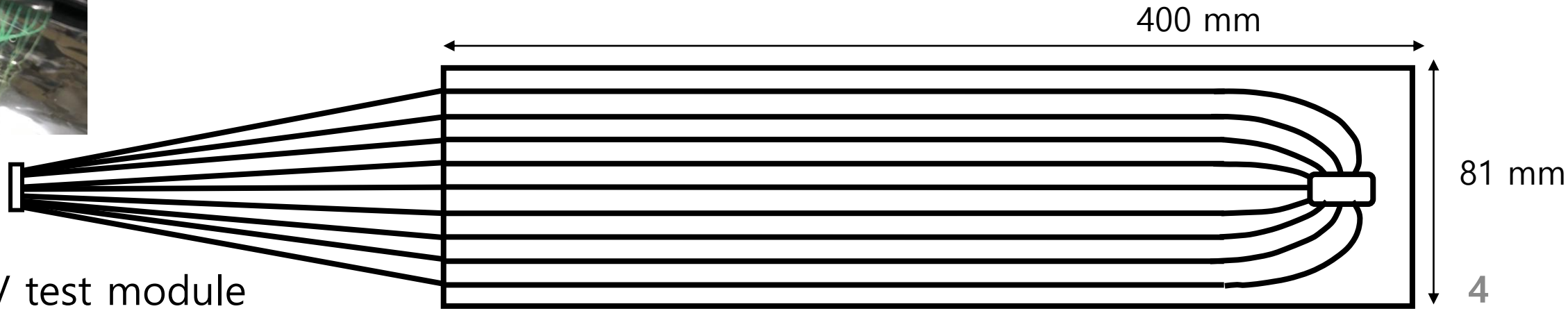
Al light collecting box

Scintillator



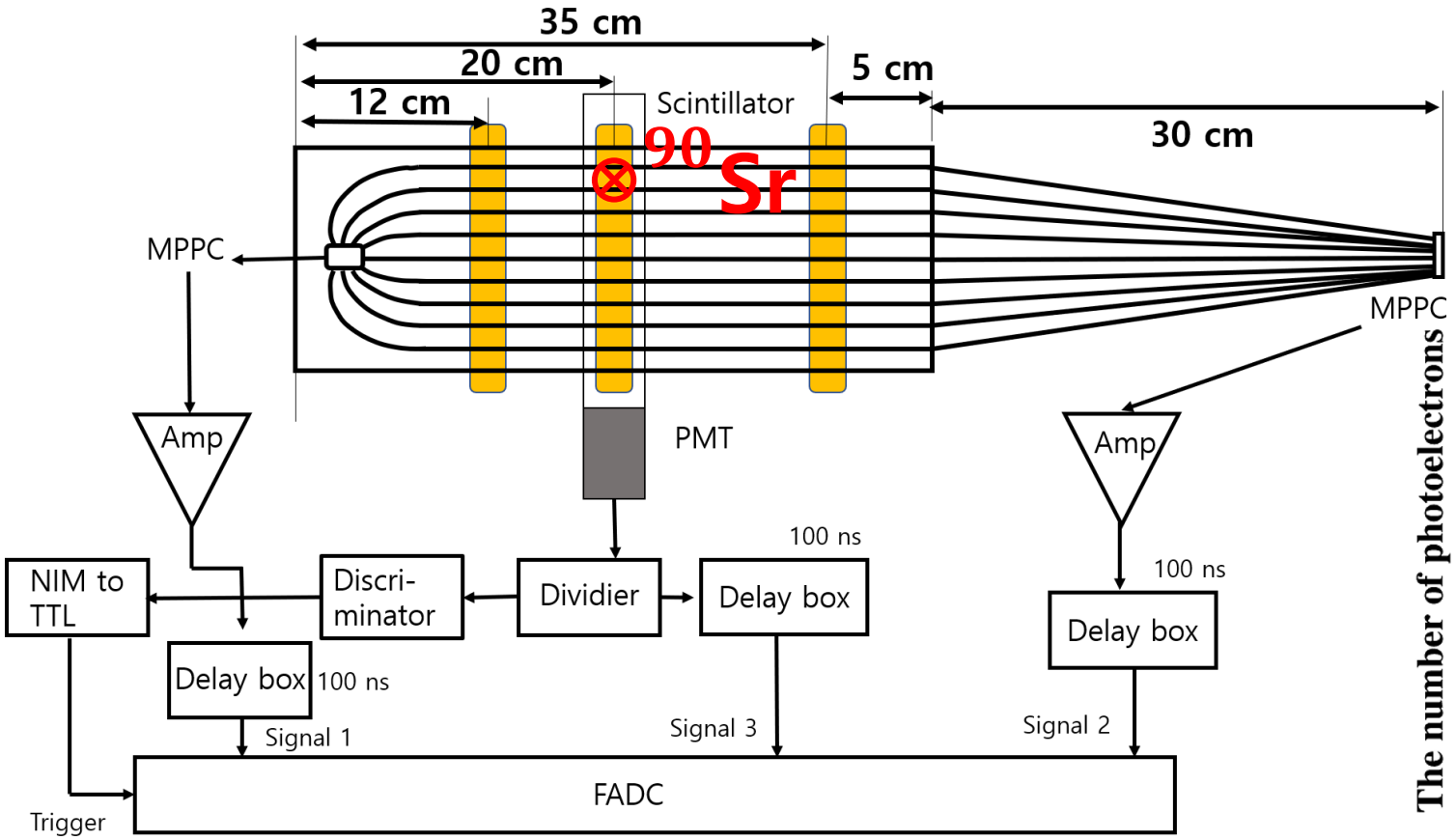


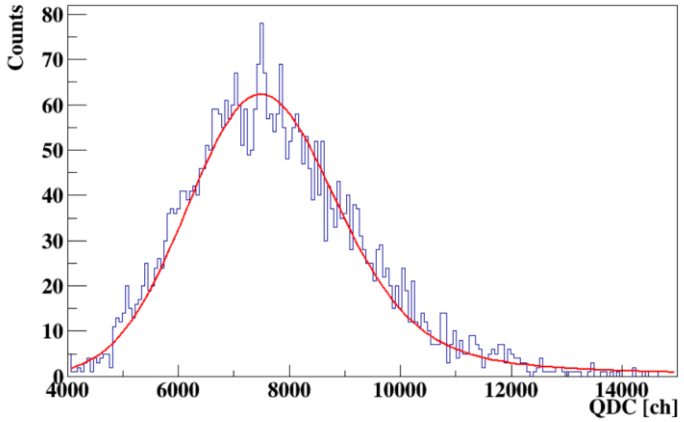




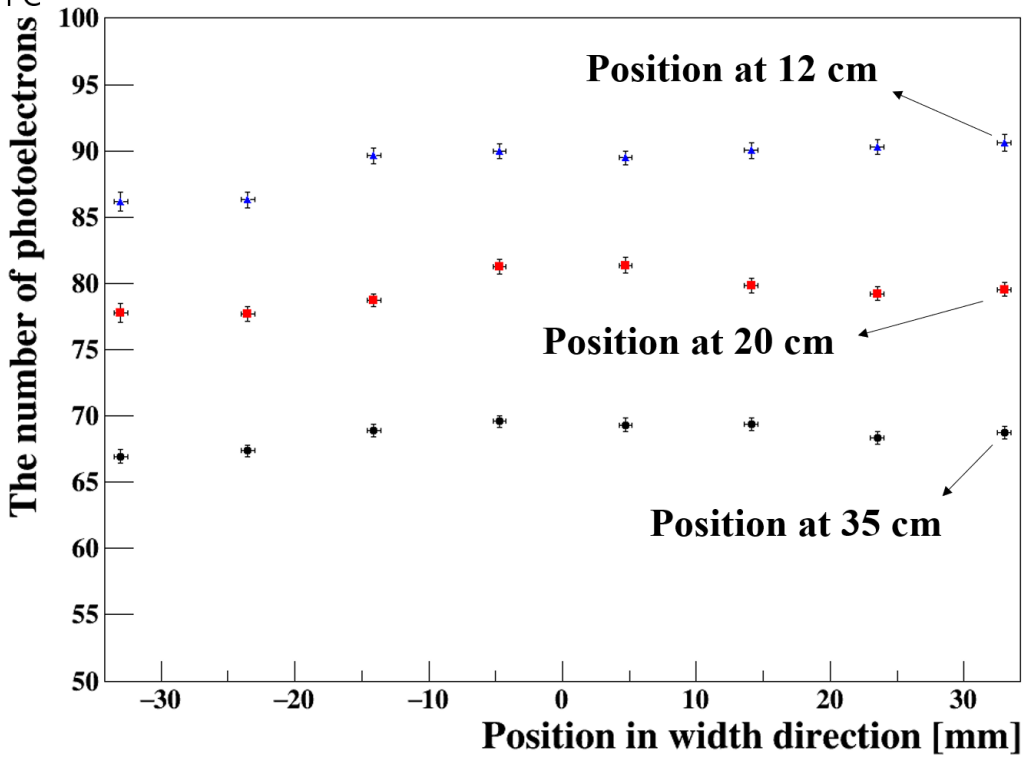
- DCV test module

Measurement setup





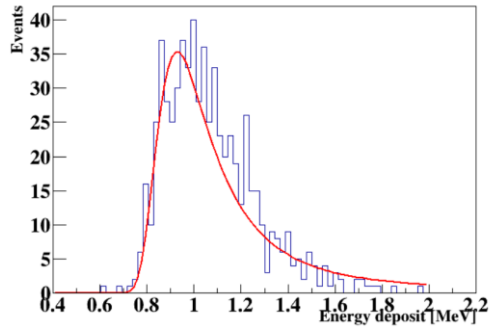
Fitting function : Landau Gaussian

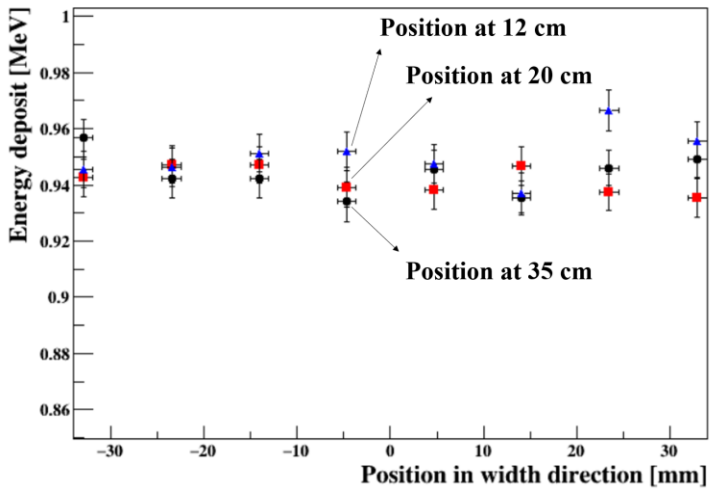


Modelization

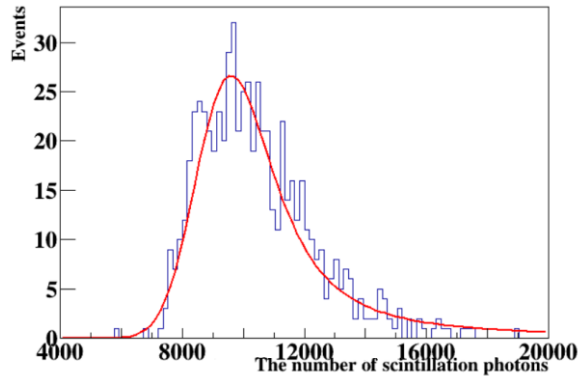
$$N_{PE} = \Delta E \frac{dL}{dE} \epsilon_A \epsilon_P \epsilon_C PDE$$

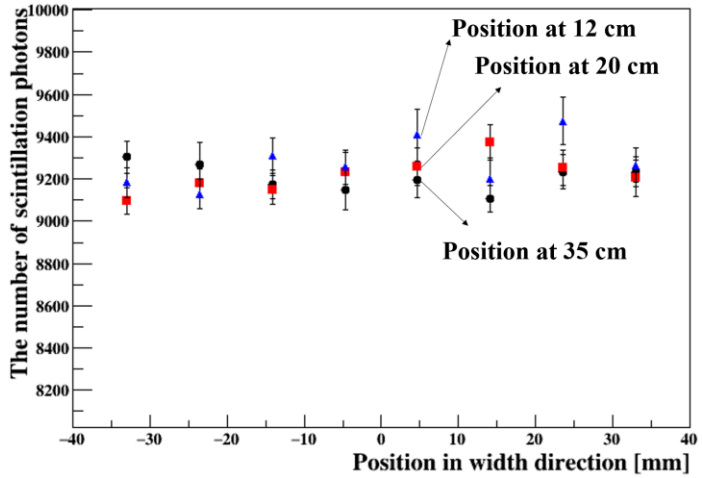
Energy deposit on plastic scintillator



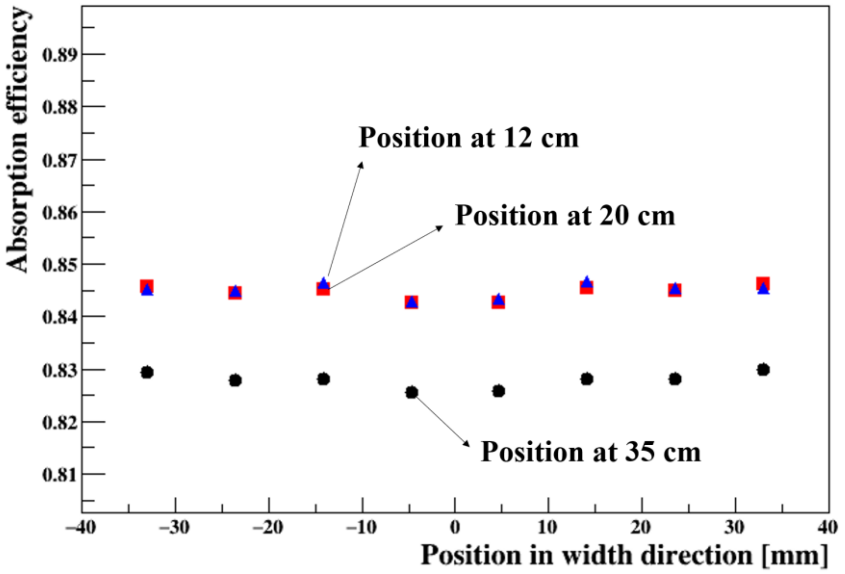


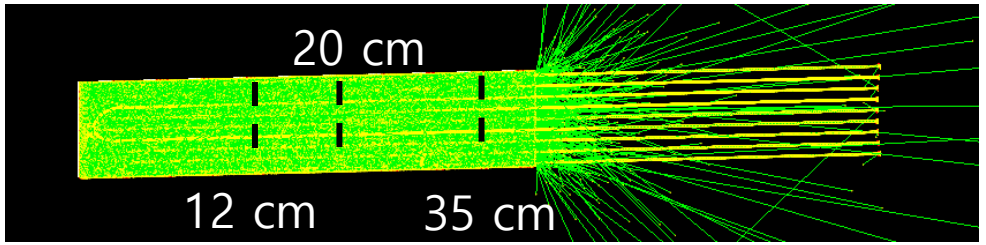
Light yield of EJ-200





Absorption efficiency in WLS fiber

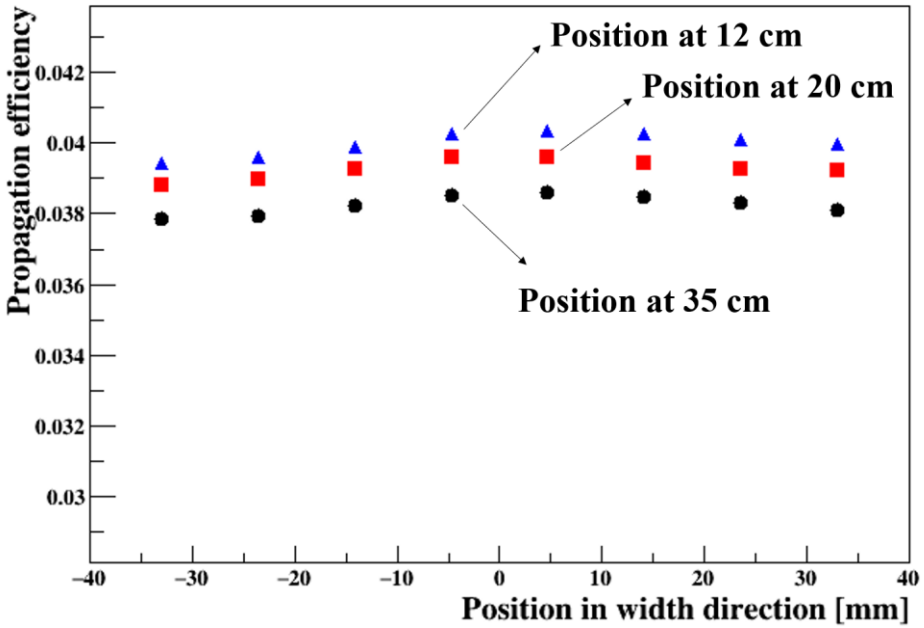


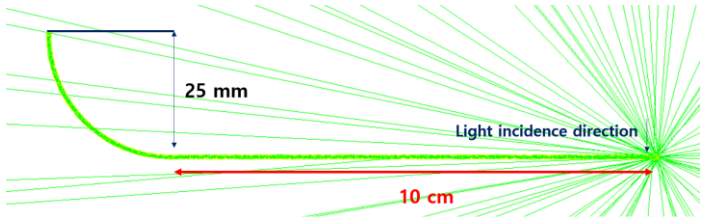


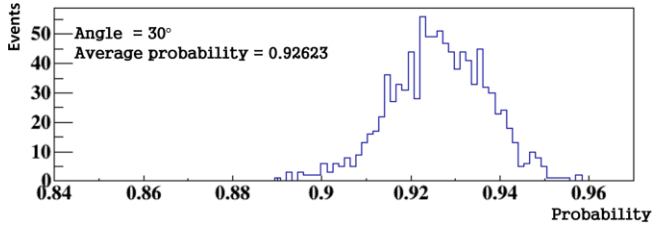
Modelization

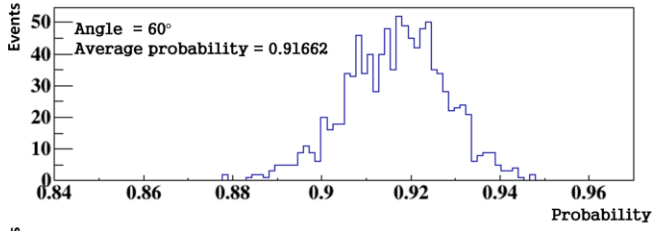
$$N_{PE} = \Delta E \frac{dL}{dE} \epsilon_A \epsilon_P \epsilon_C PDE$$

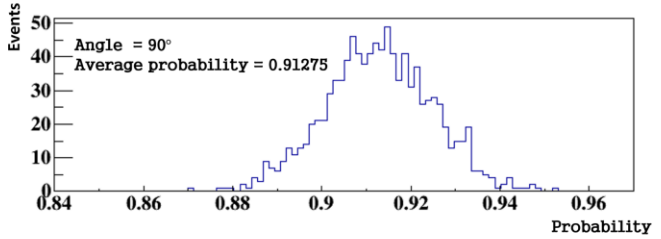
Propagation efficiency in WLS fiber

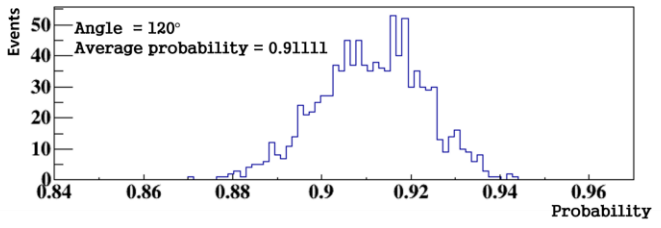


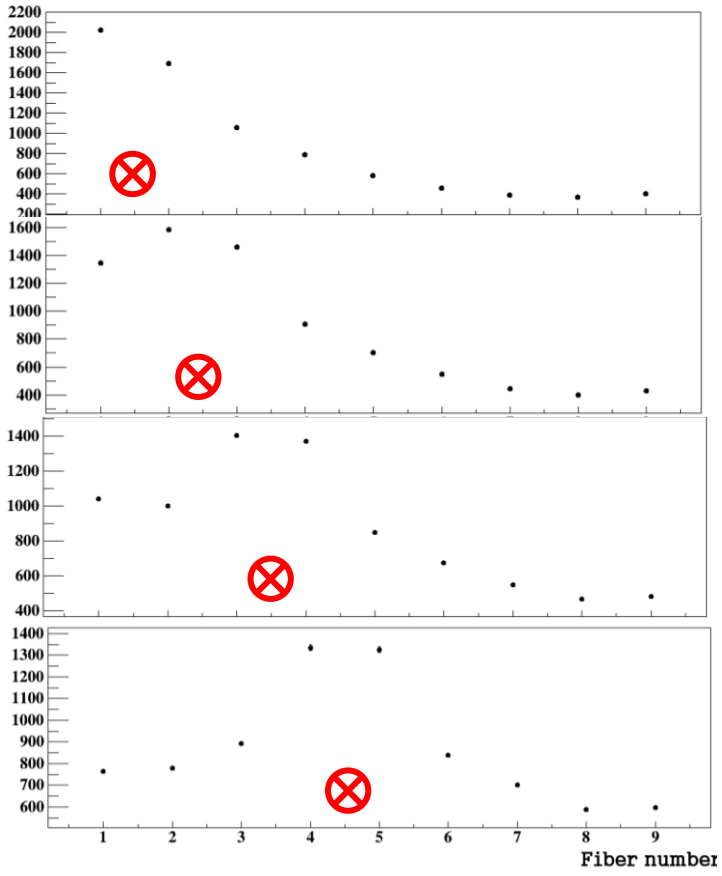








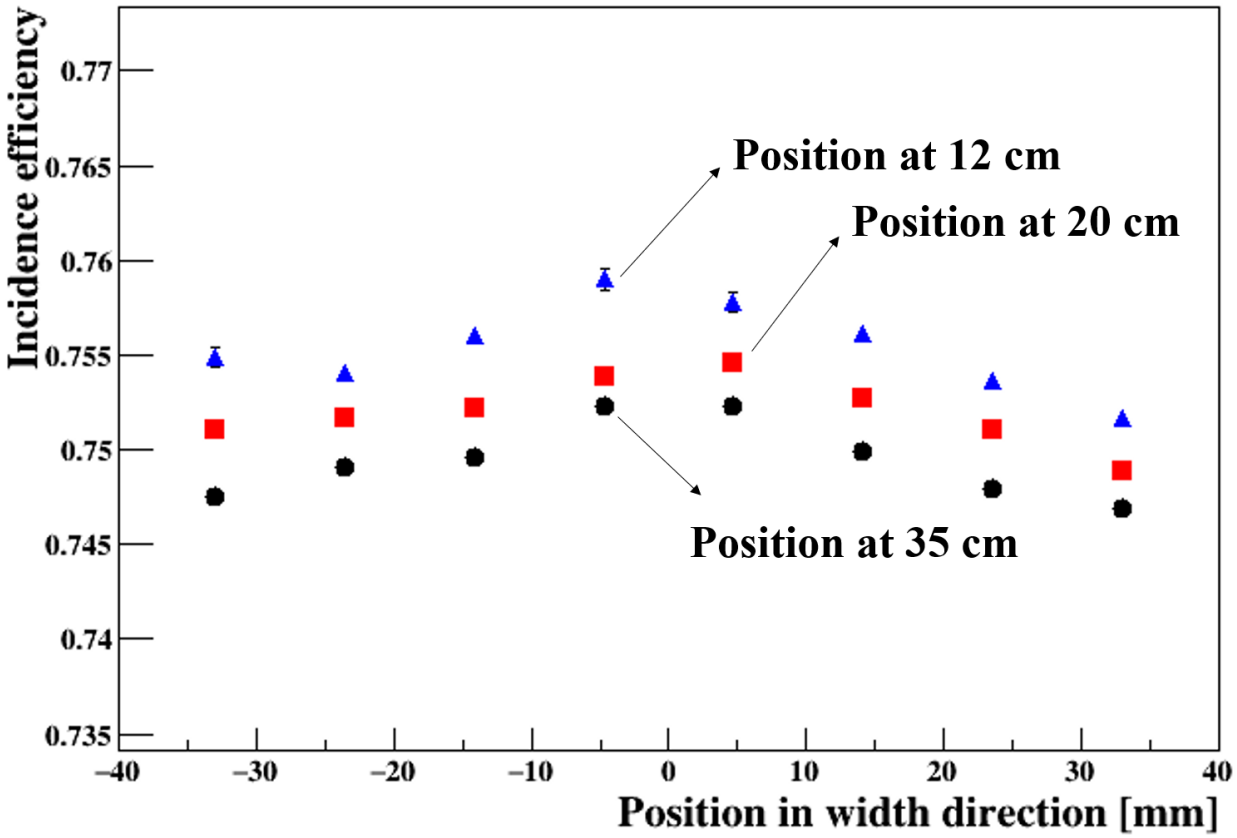


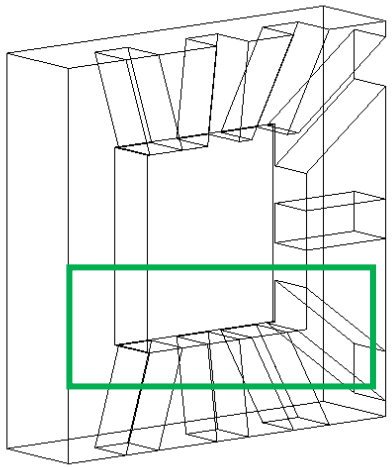


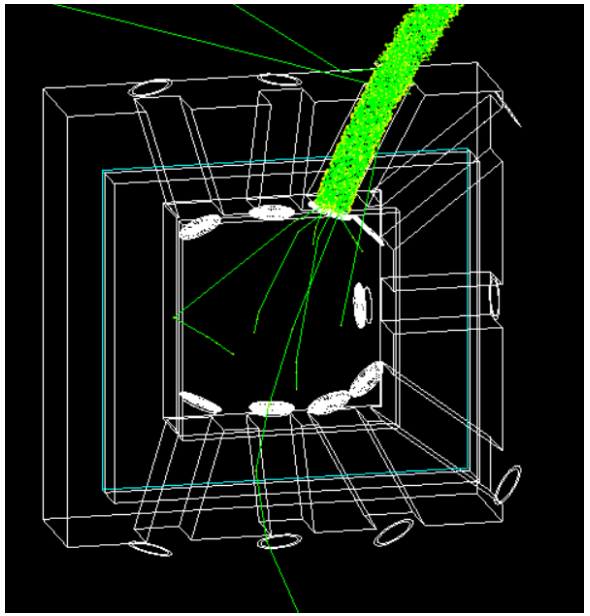
Modelization

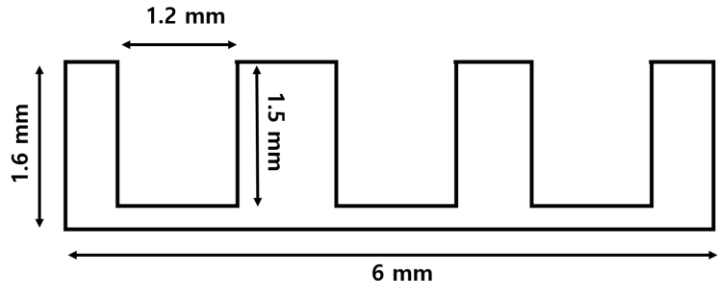
$$N_{PE} = \Delta E \frac{dL}{dE} \epsilon_A \epsilon_P \epsilon_C PDE$$

Incidence efficiency into MPPC

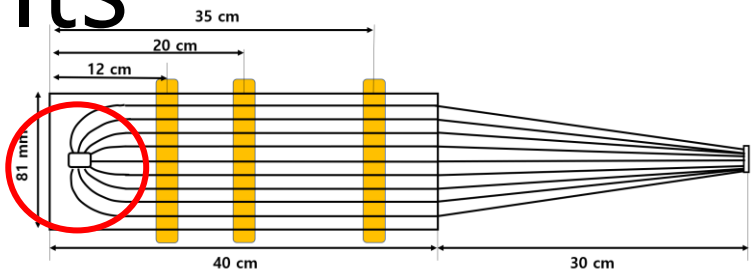




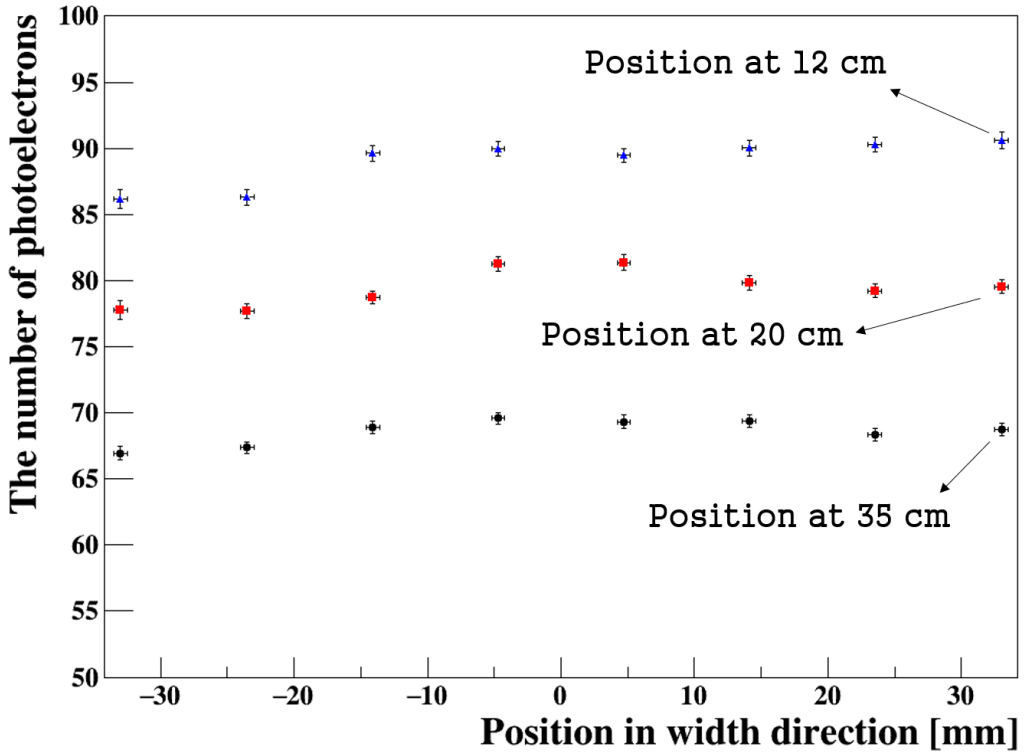




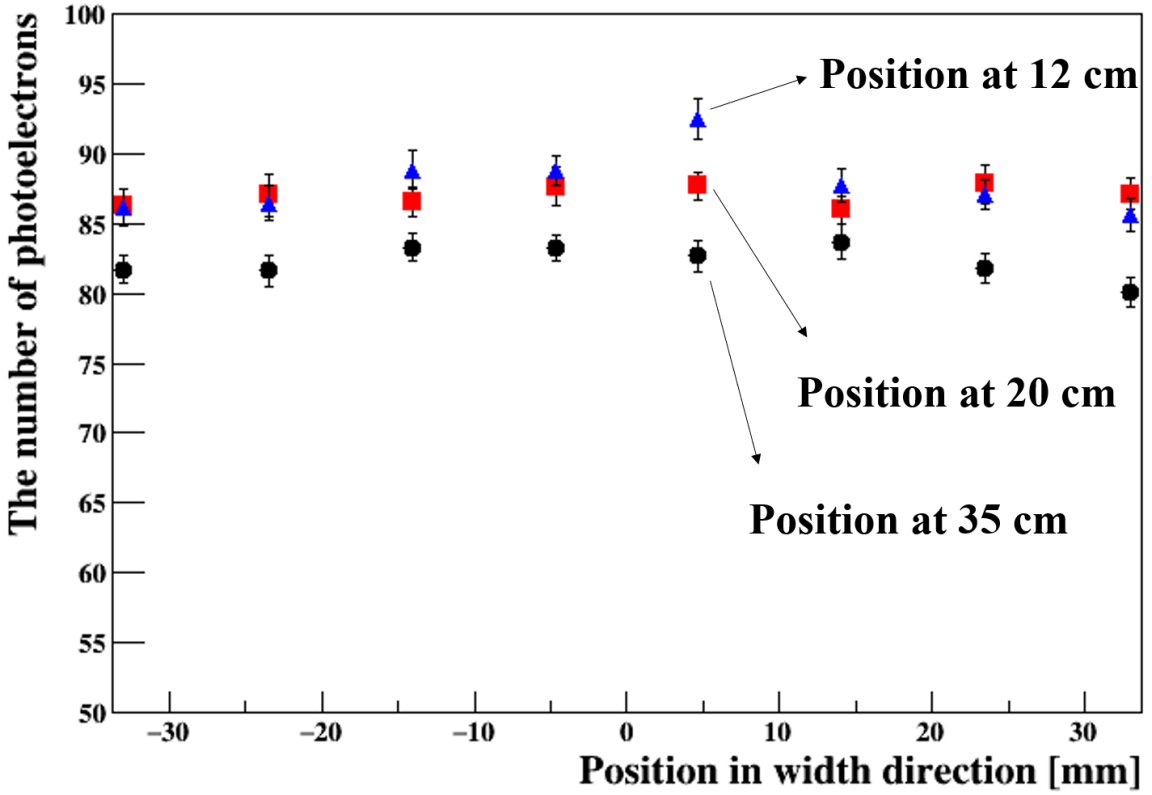
Simulation and Experiment results



Experiment results

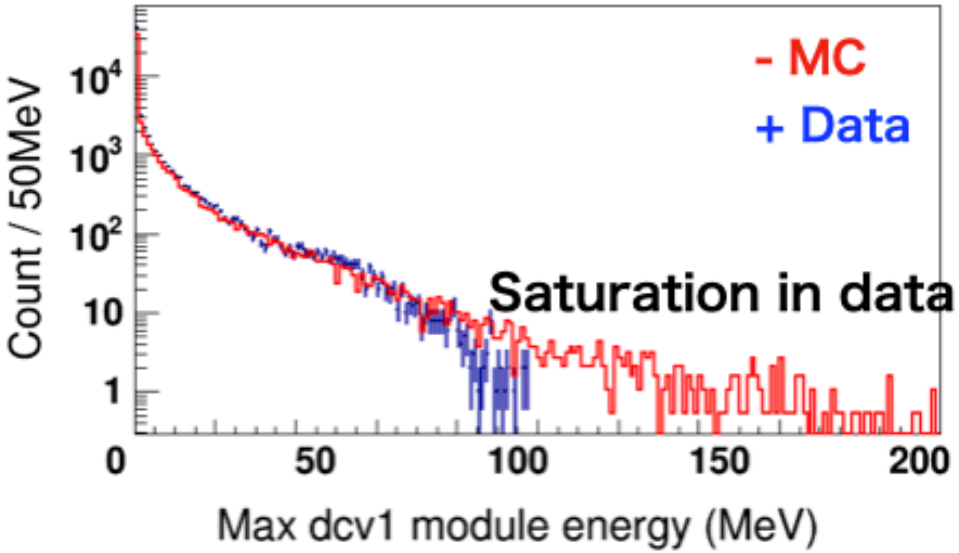


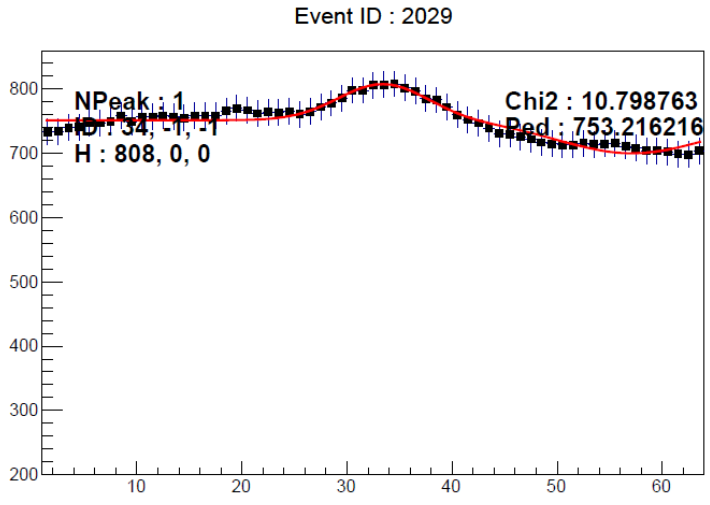
Simulation results

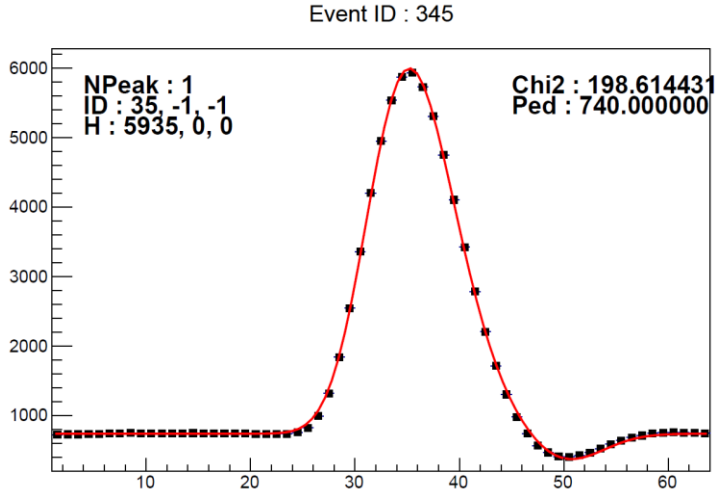


Conclusion

- Characteristics of the KOTO DCV plastic scintillator with embedded WLS fibers and MPPC readouts have been studied using a quarter-size DCV test module and Geant4 simulation.
- A full Geant4 optical simulation could reproduce the ^{90}Sr source measurement results within 1% difference(assuming dL/dE = 10^4/MeV, Quantum efficiency of WLS fiber = 85% and ground surface of aluminum light collecting box).
- KOTO DCV data analysis is now underway. The DCV can detect charged particles leaving energy deposit larger than 0.3 MeV.

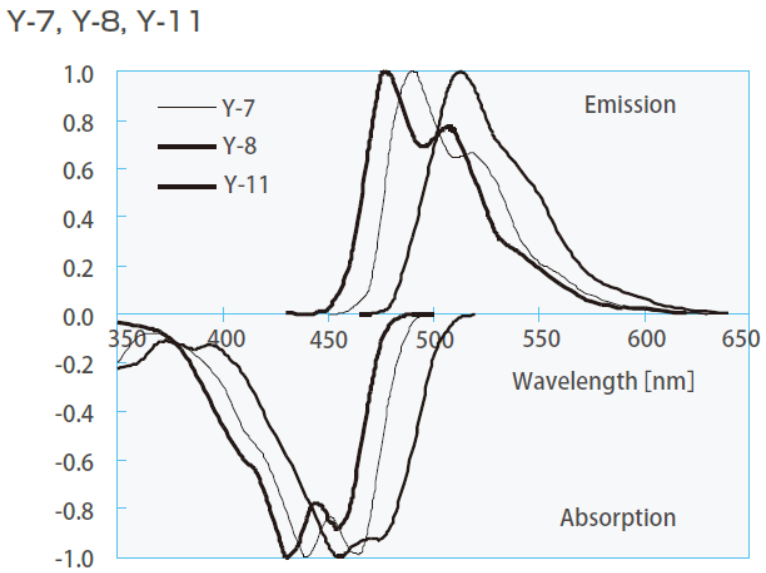






backup

Absorbance



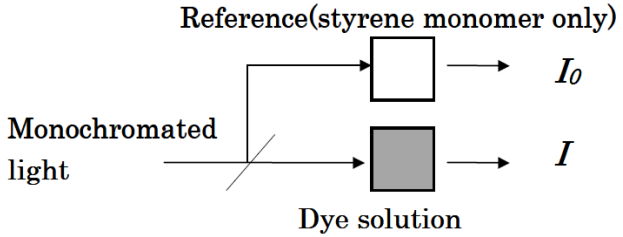


Fig.1 Absorbance measurement by d=10mm path cell

- Mathematically, probability of finding a particle at depth x into the material in calculated by Beer-Lambert Law

$$P(x) = e^{-x/l_0}$$

- And $l_0$is attenuation(absorption) length, and it depend on material and energy.
- Definition of absorbance is as follow.

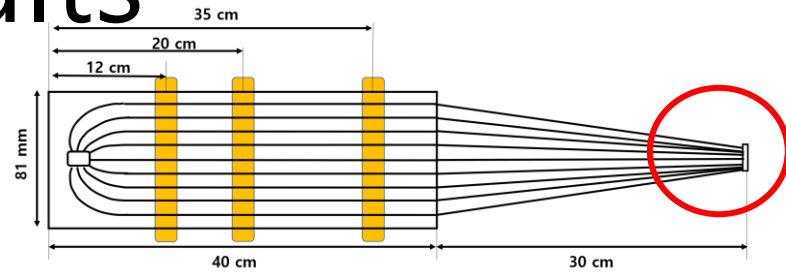
$$\text{ABS} = k(\lambda)Cd = log_{10}\{\frac{I_0(\lambda)}{I(\lambda)}\} \qquad \text{when d = 10 mm}$$

- For reference, C is equal to 200 ppm and k_p(k at peak of abosorption) is equal to 0.00638 in Y-11 of Kurarary
- Absorption(attenuation) length of Y-11 is as follow.

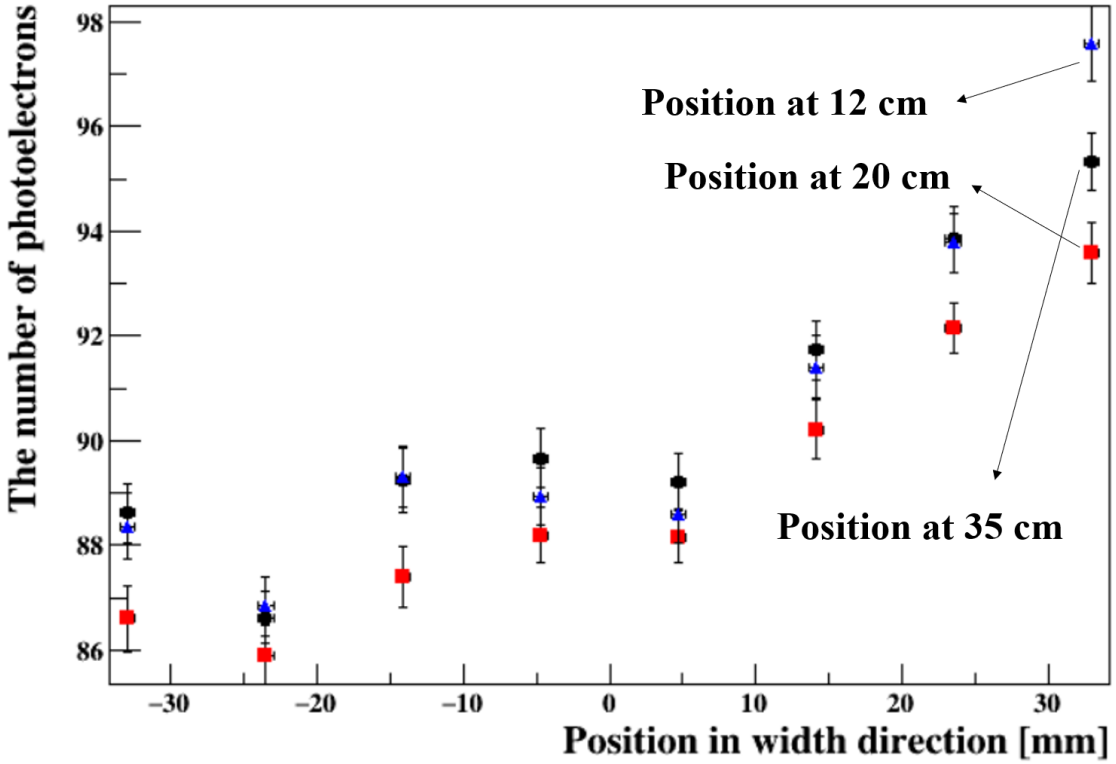
$$l_0 = \frac{1}{kC * ln10}$$

- C is concentration of dyne used in Y-11 and k is constant which is function of wavelength.

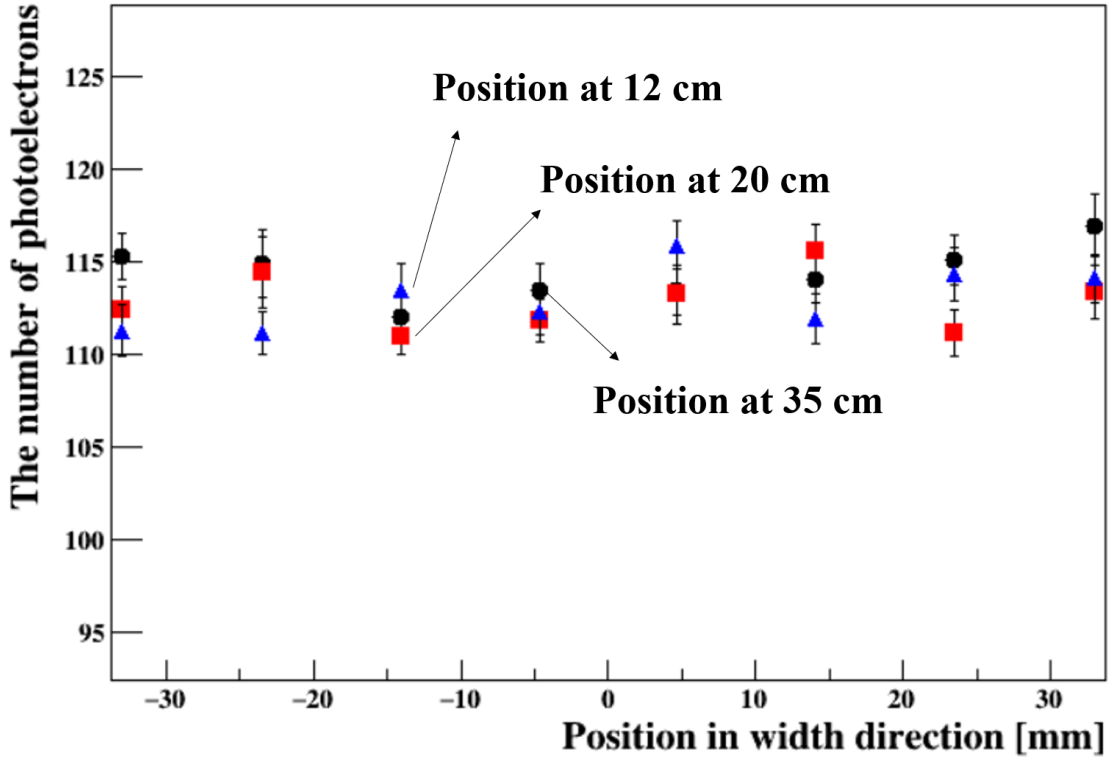
Simulation and Experiment results



Experiment results



Simulation results



MPPC Connection Problem