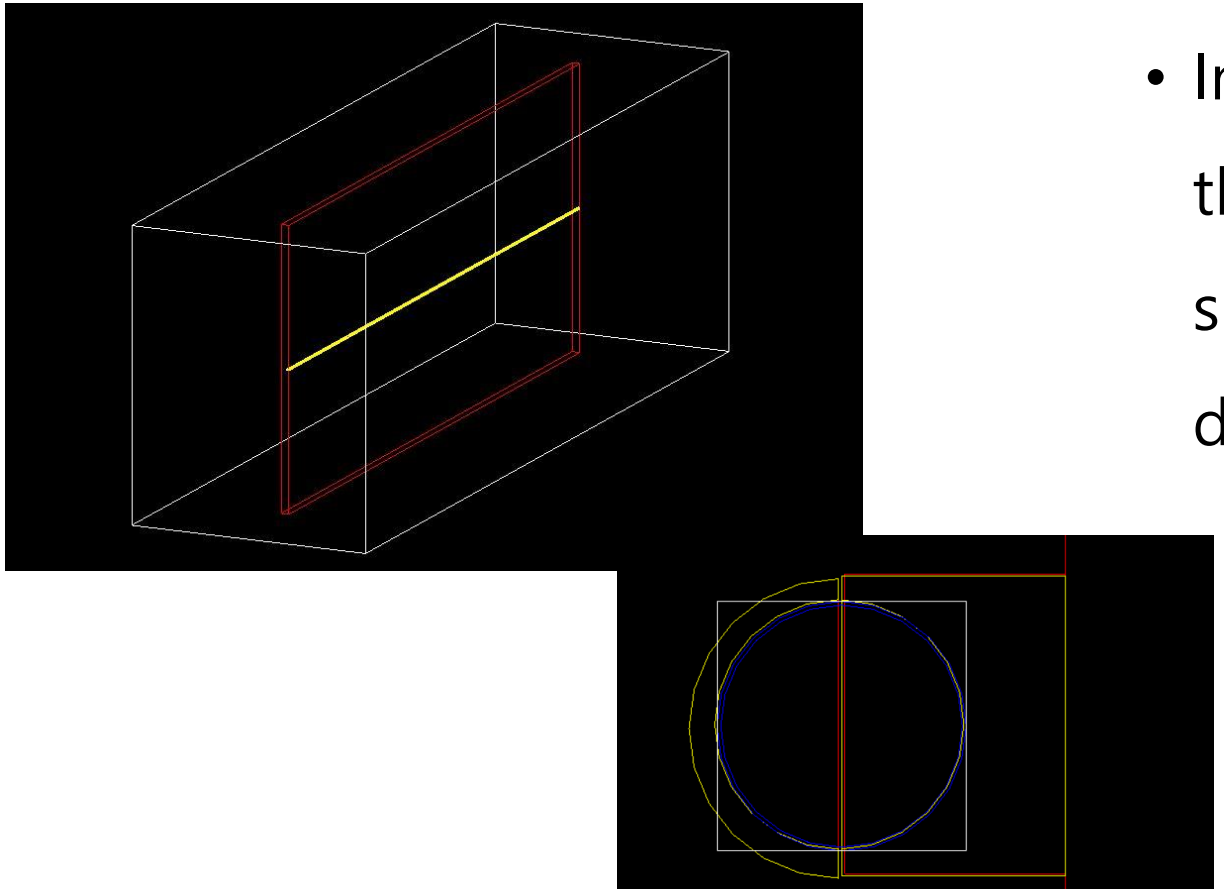
DCV Simulation

최재민

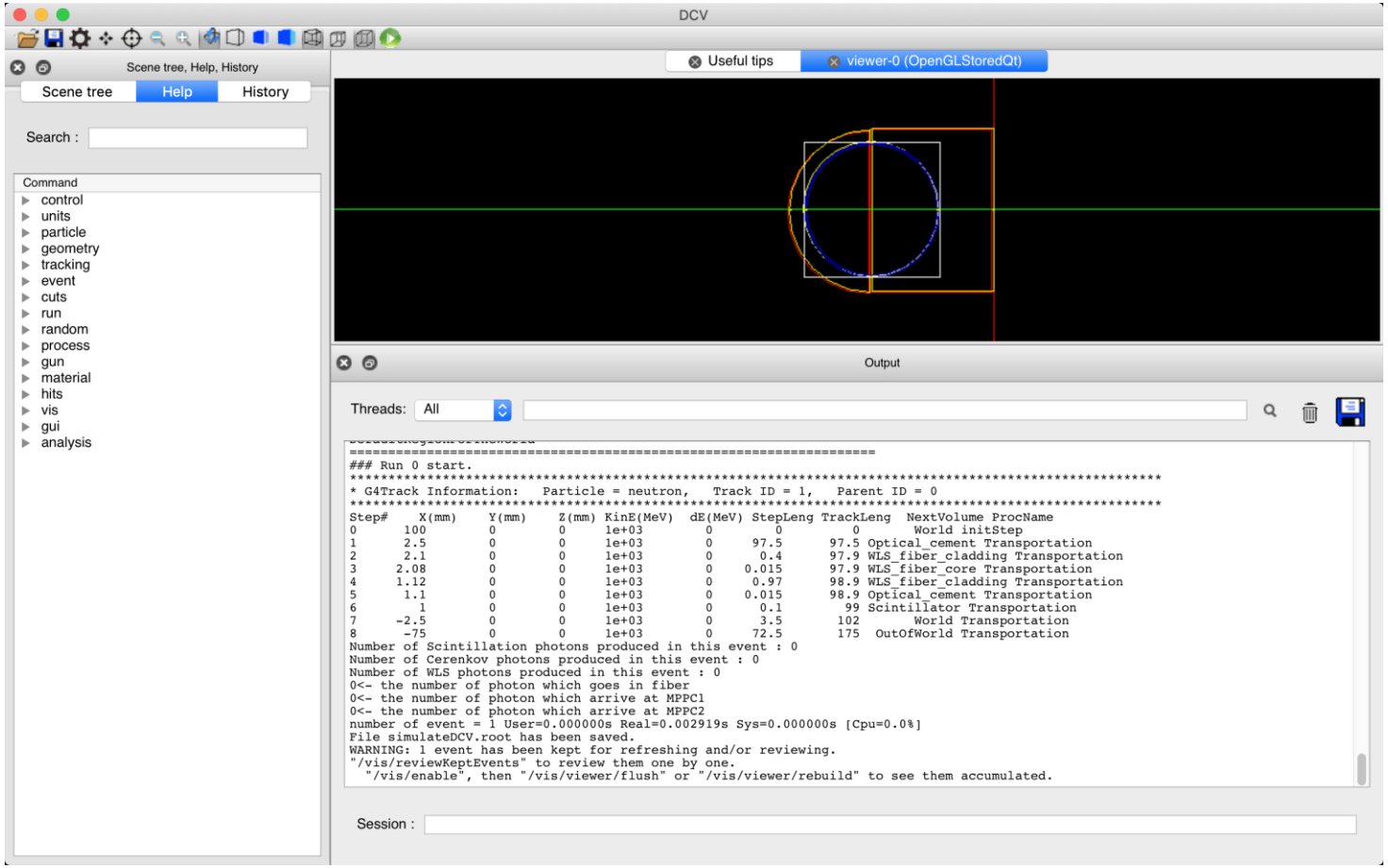
Geometry Test



- Figure of enlarged fiber section

- In visualization, it can be seen that there is a gap between two slide, tub and box which are drawn in yellow color.

Geometry Test



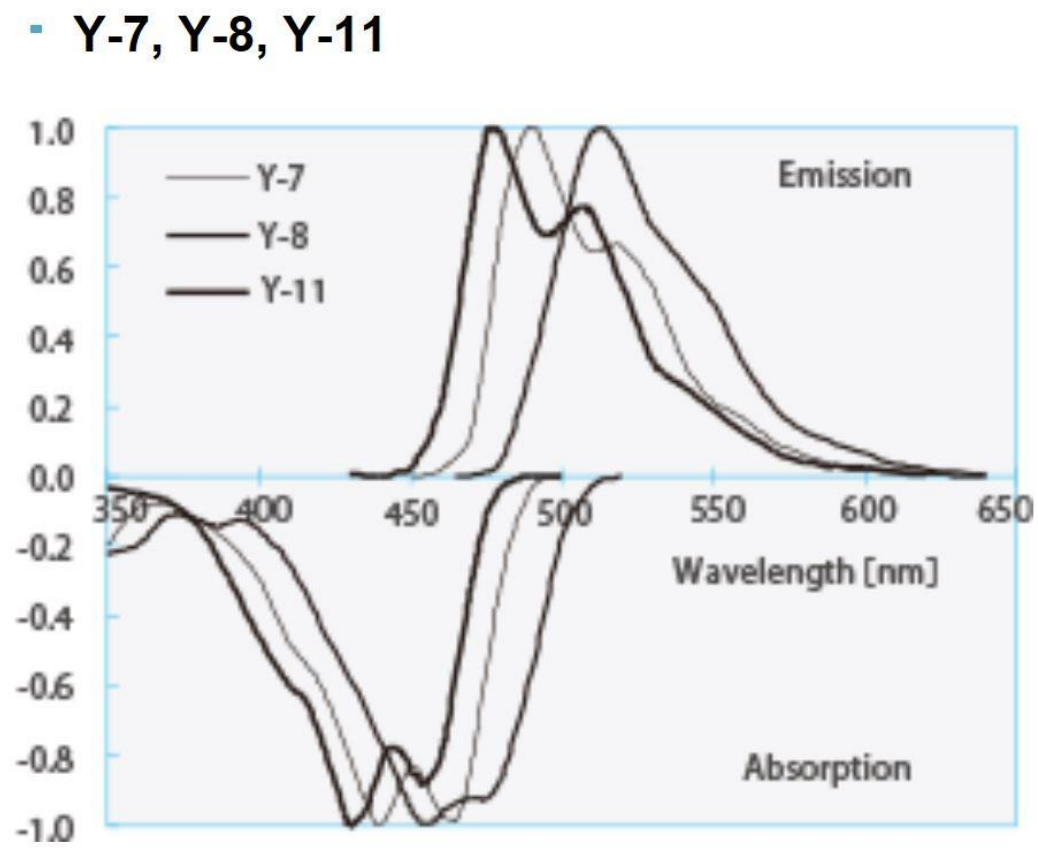
- By shooting neutron, we can see where the neutron passes.
- And we can confirm that there is no gap between the two solids.

WLS Process Test

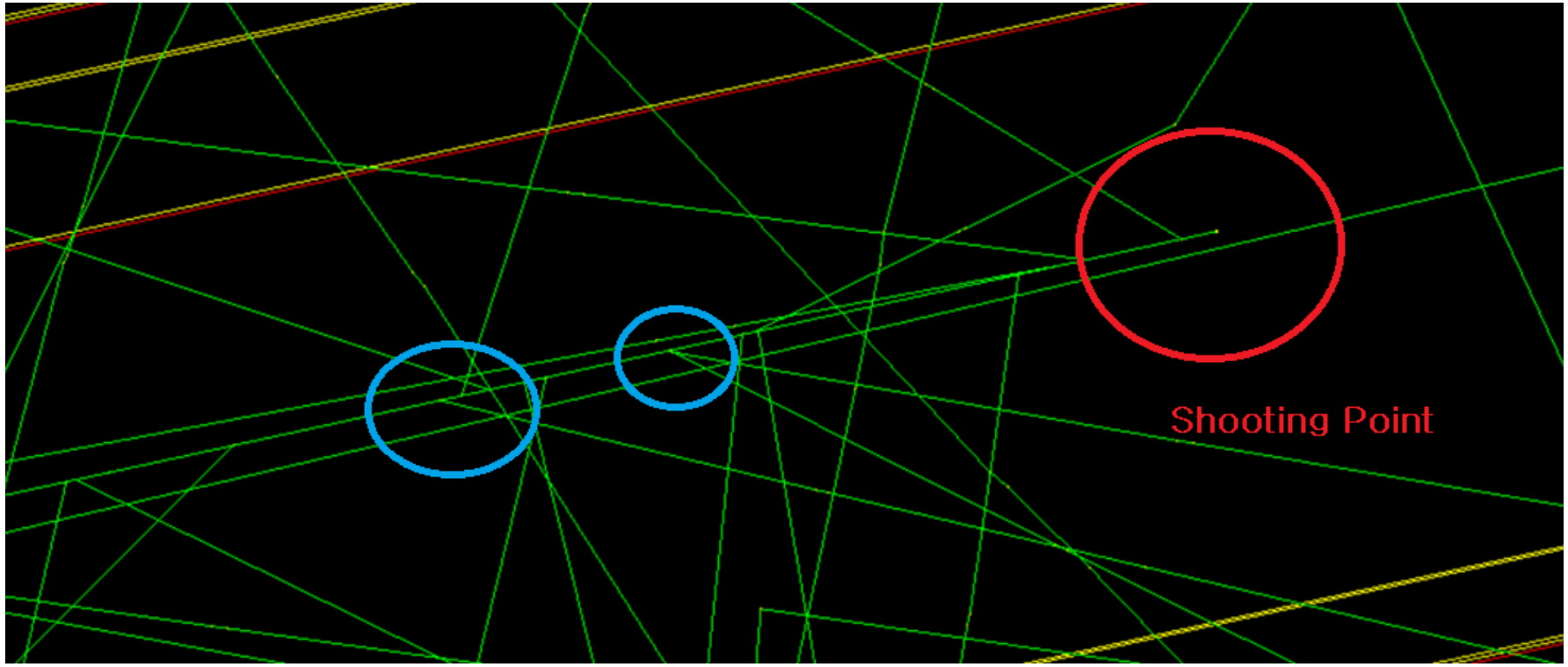
- WLS Process consists of two process. One is absorption, and the other is emission.
- Absorption process is the process by which electron absorbs light and be excited.
- Emission process is the process by which electron emits the photon and be stable.

WLS Process Test

- First of all, to check that emission process works well, we shot photons of 430nm wavelength.
- In order to see the exact emission wavelength, it is necessary to emit light that is larger than the minimum emission wavelength.
- We can get the wavelength of photon produced in WLS fiber by making use of sensitive detector of WLS fiber.



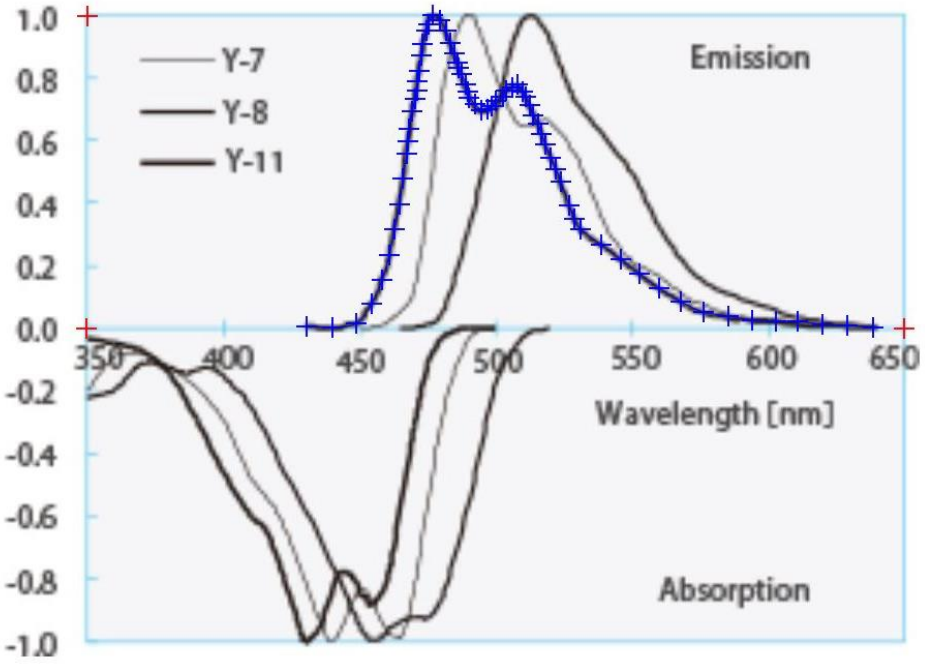
Result of Visualization - Emission



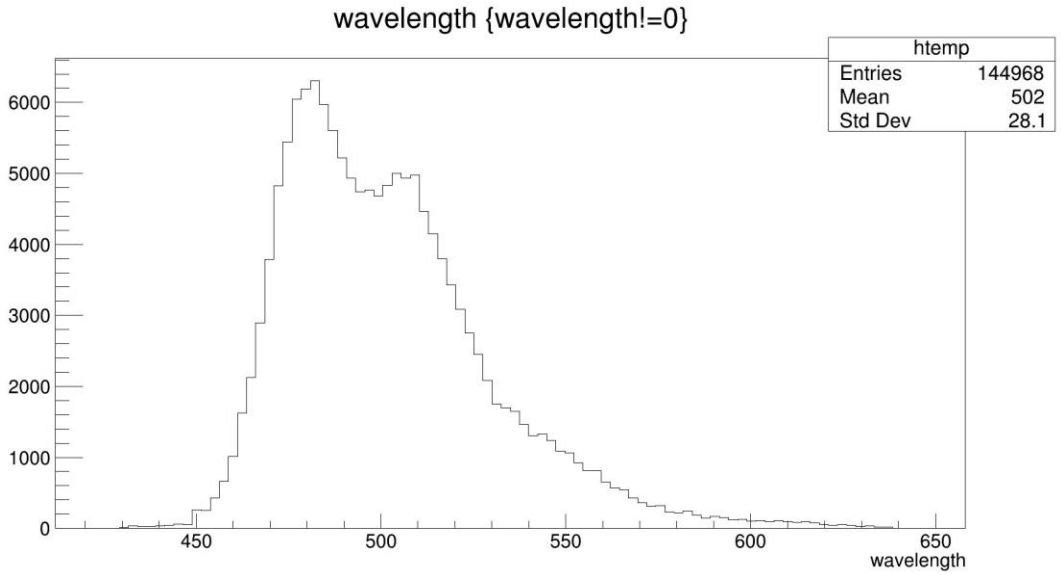
- There are photons which are traveling in the opposite direction to the shooting direction.

WLS Process Test - Emission

- **Y-7, Y-8, Y-11**



- Figure of Emission spectra of Y-11 fiber(blue line)

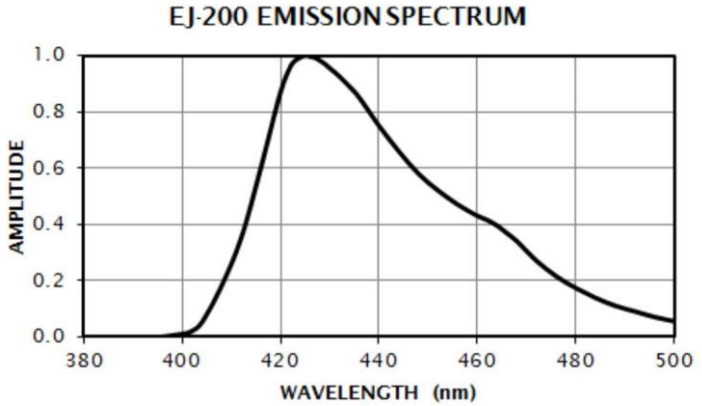


- Figure of wavelength of photons produced OpWLS Process

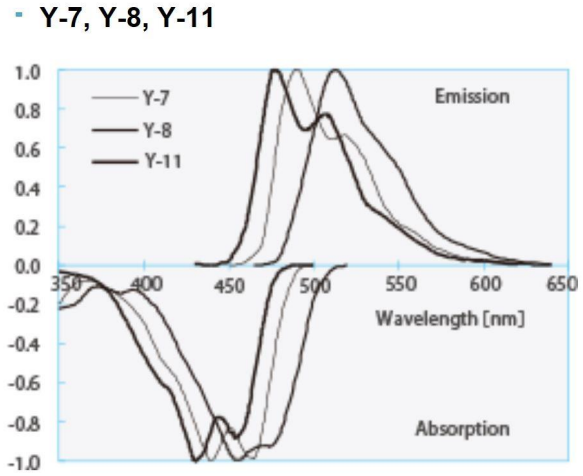
- By comparing wavelength graph with emission spectra, we can confirm that OpWLS emission process works well.

WLS Process Test - Absorption

- To test absorption process in WLS process, we shot $\pi^+$with 1 GeV to scintillator.
- Scintillator emitted photons by scintillation process with energy deposited by π^+.
- And WLS fiber absorbed photons based on absorption spectra.
- For these reasons, to understand absorption spectrum, both two factors need to be considered.
- To distinguish absorbed photons, we used 'if(aTrack -> GetTrackStatus == fStopAndKill)' Geant4 code.

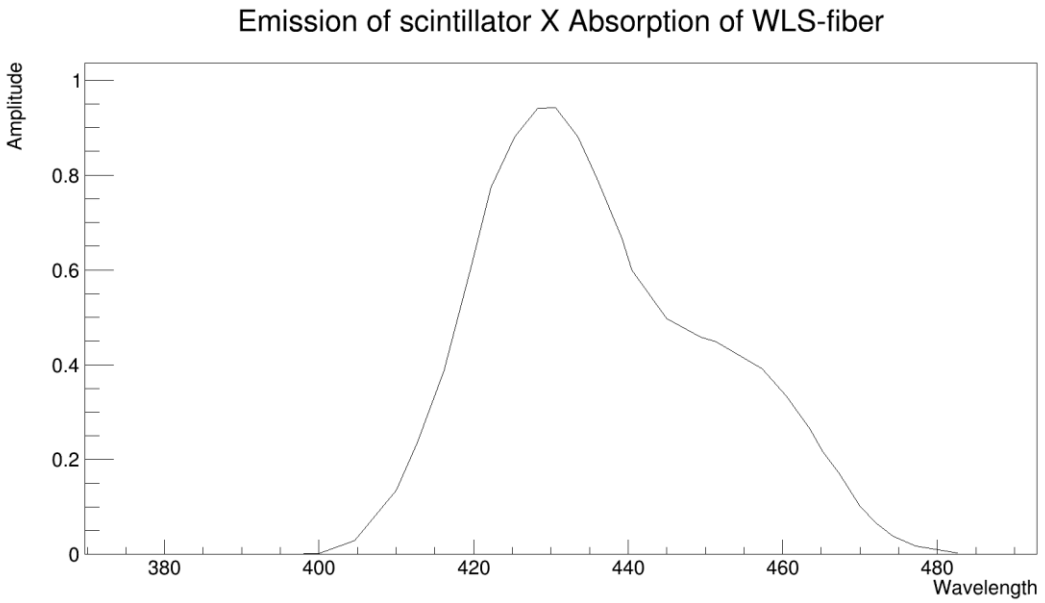


- Figure of Emission spectra of EJ-200 Scintillator

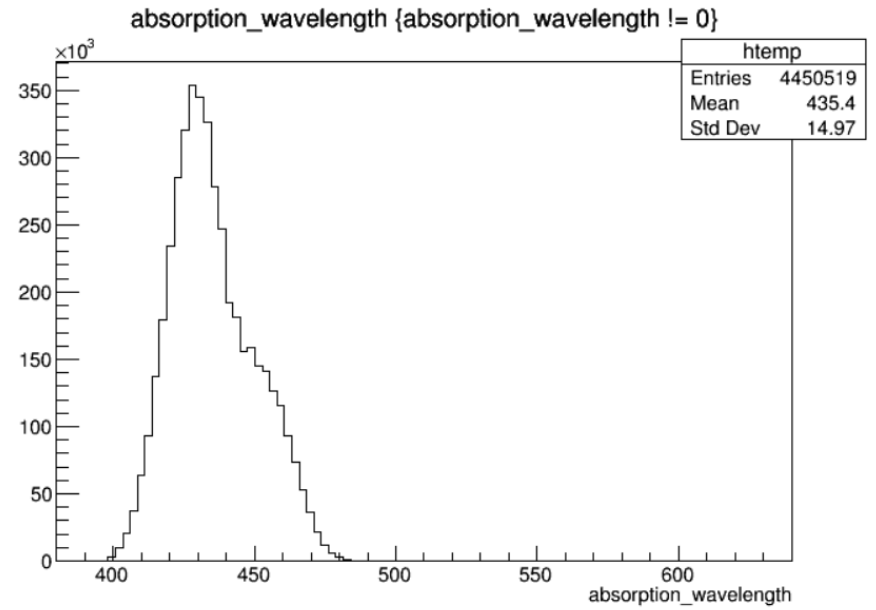


- Figure of Absorption spectra of Y-11 fiber

WLS Process Test - Absorption



- Figure of Absorption spectra considered two factors

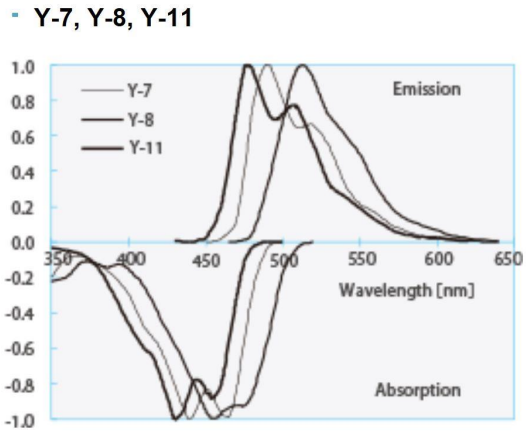


- Figure of wavelength of photons absorbed OpWLS Process

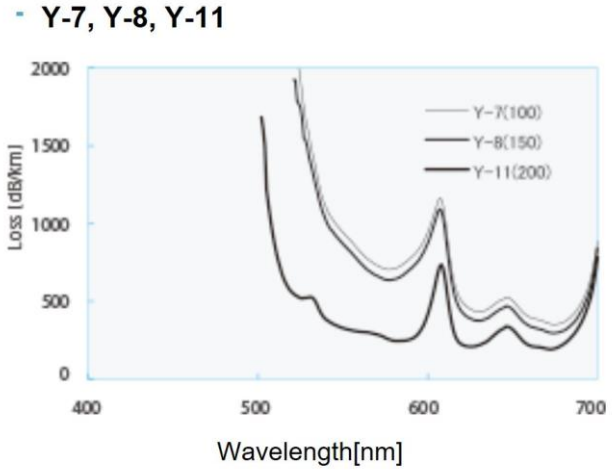
- By comparing wavelength graph with absorption spectra, we can also confirm that OpWLS absorption process works well.

WLS Process Test - Absorption

- Let's take a look at the process before checking the number of photons which are absorbed.
- In WLS process, there are two types of absorption process.
- One is the absorption leading to re-emission, called WLS absorption.
- The other is the absorption without re-emission, called absorption.
- In our code, we set range of wavelength of WLS absorption from 354nm to 500nm and range of wavelength of absorption from 500nm to 700nm.



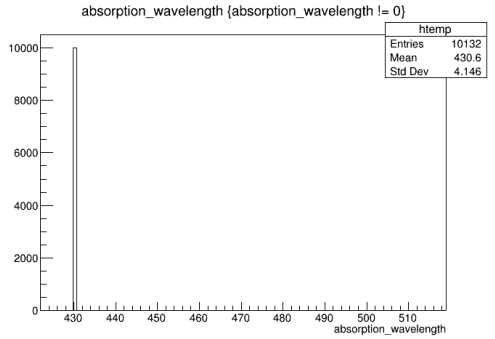
- Figure of WLS Absorption spectra of Y-11 fiber



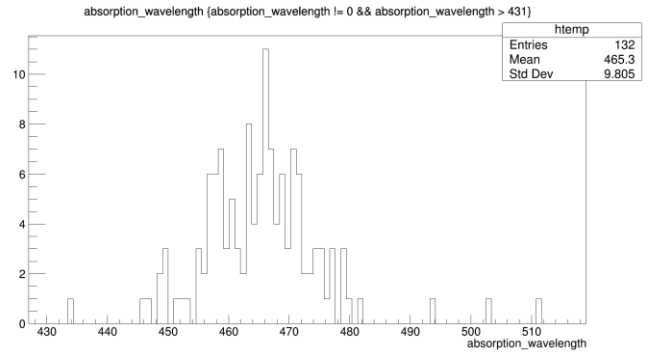
- Figure of Absorption spectra of Y-11 fiber without re-emission

WLS Process Test - Absorption

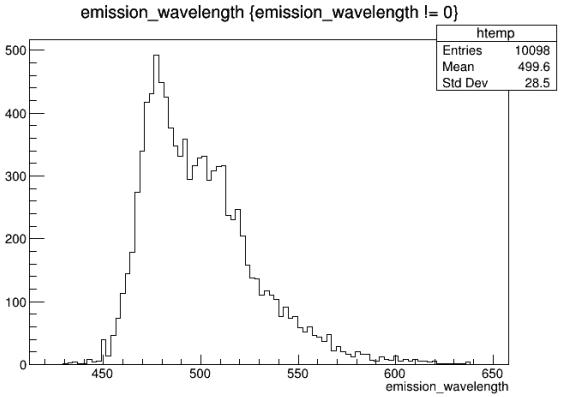
- To check efficiency of WLS Process, we shot photons of 430nm wavelength in WLS-fiber.
- We shot 10000 of photons.
- We can confirm that self absorption spectra of fiber match up with results of simulation.
- However, the number of photons which are absorbed in fiber is 10132, and the number of photons which are re-emitted by WLS emission is 10098.
- After subtracting 2, that the number of photons which is not in range for WLS absorption, there is difference between WLS absorption and emission.
- According to this simulation, we can confirm that efficiency of WLS Process is not 1.
- Efficiency of WLS Process is about 0.99684.



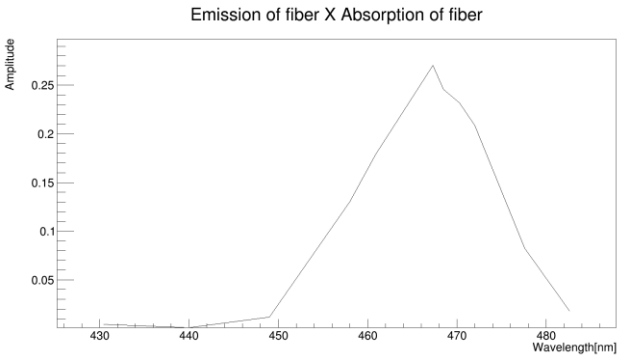
- Figure of Absorption spectra



- Figure of Absorption spectra for wavelength larger than 431nm



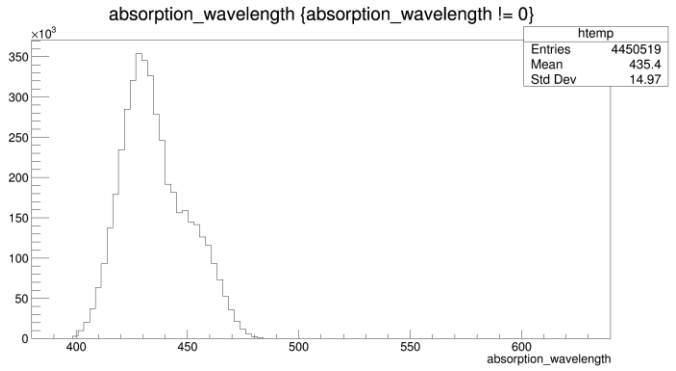
- Figure of Emission spectra



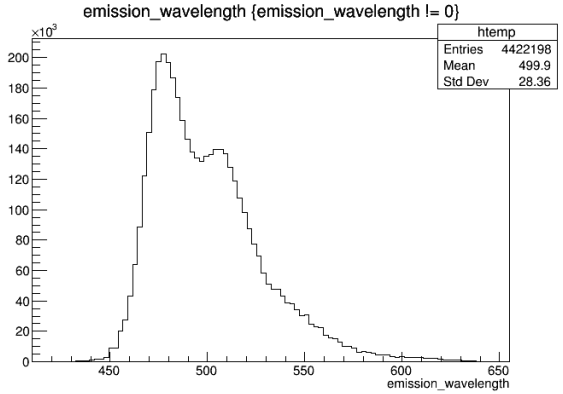
- Figure of Self absorption spectra

WLS Process - Absorption

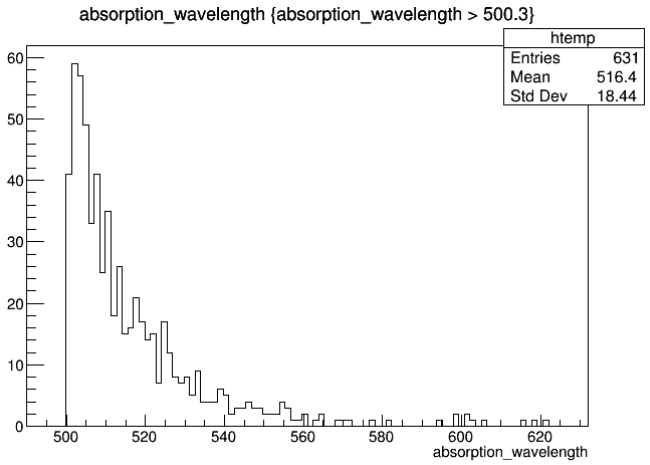
- The number of absorbed photons = 4450519
- The number of absorbed photons with wavelength larger than 500nm = 631
- The number of absorbed photons in range of WLS absorption = 4,449,888
- The number of emitted photons = 4,422,198
- Difference = 4,449,888 – 4,422,198 = 27,690
- Calculated efficiency of WLS Process = 0.99377



- Figure of Absorption spectra

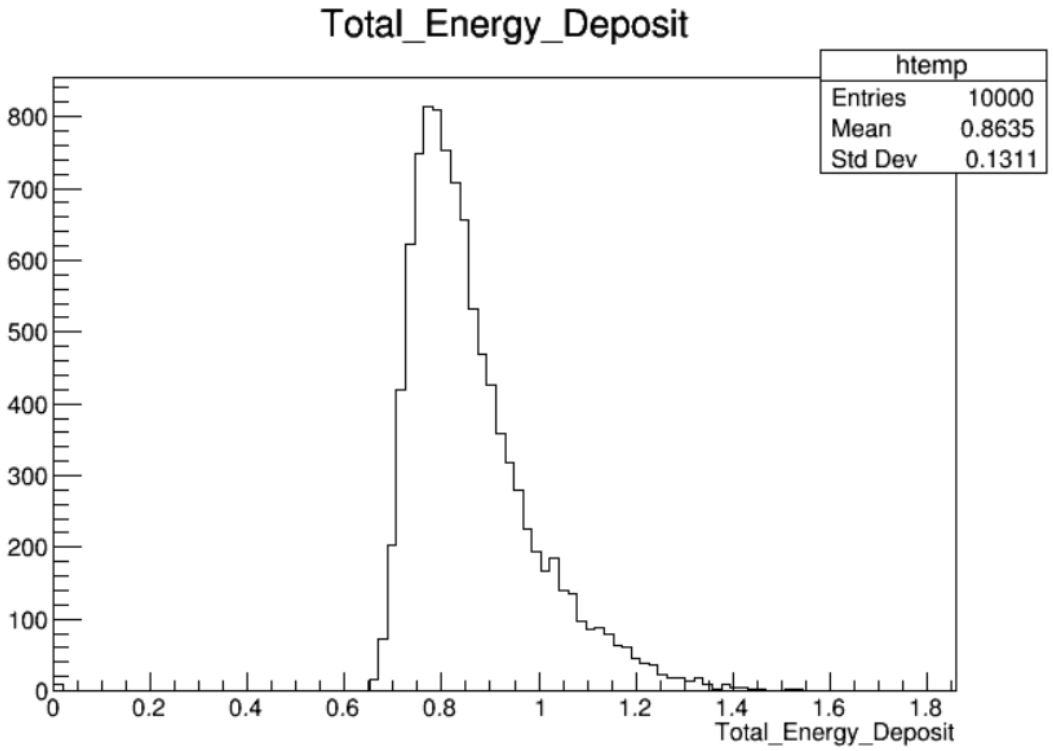


- Figure of emission spectra

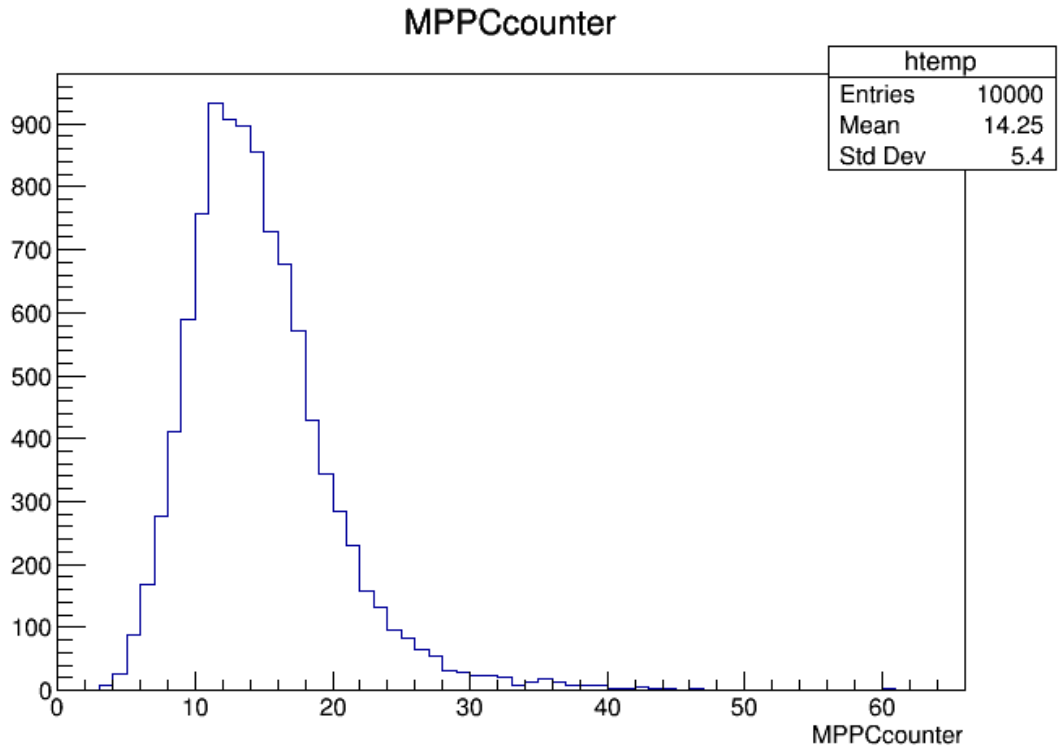


- Figure of Absorption spectra without re-emission

The number of photons arrived at MPPC



- Figure of Energy Deposit on scintillator by pi+



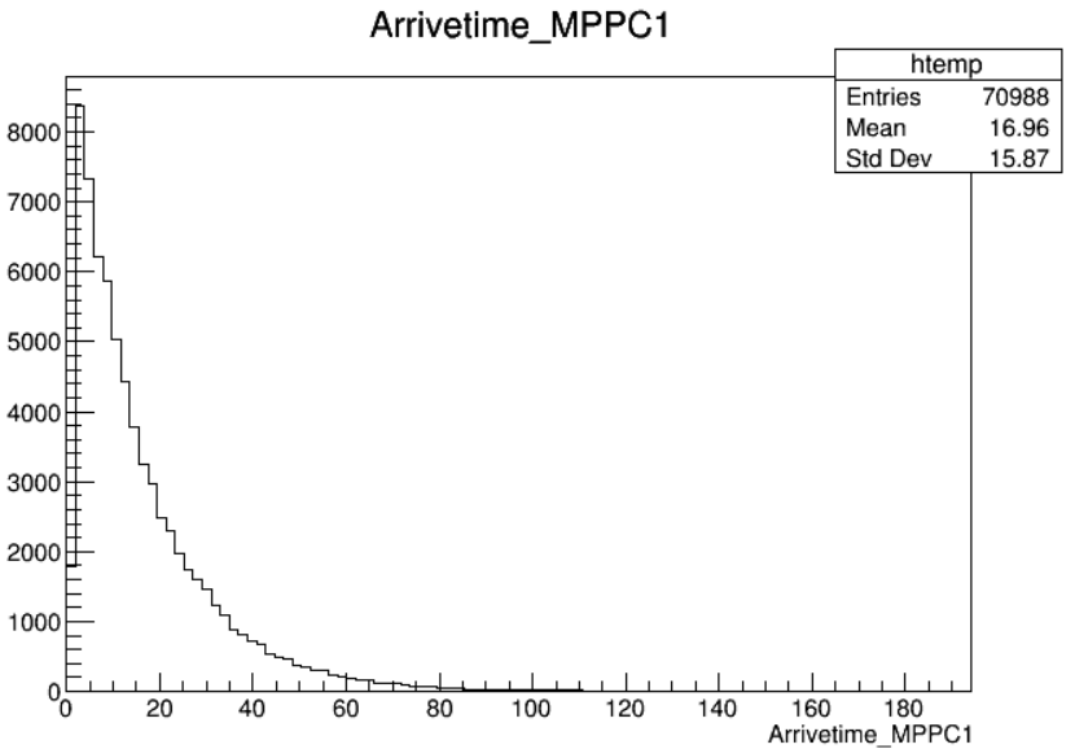
- Figure of the number of photons arrived at MPPC which are at the end of fiber

Landau Distribution in energy deposit

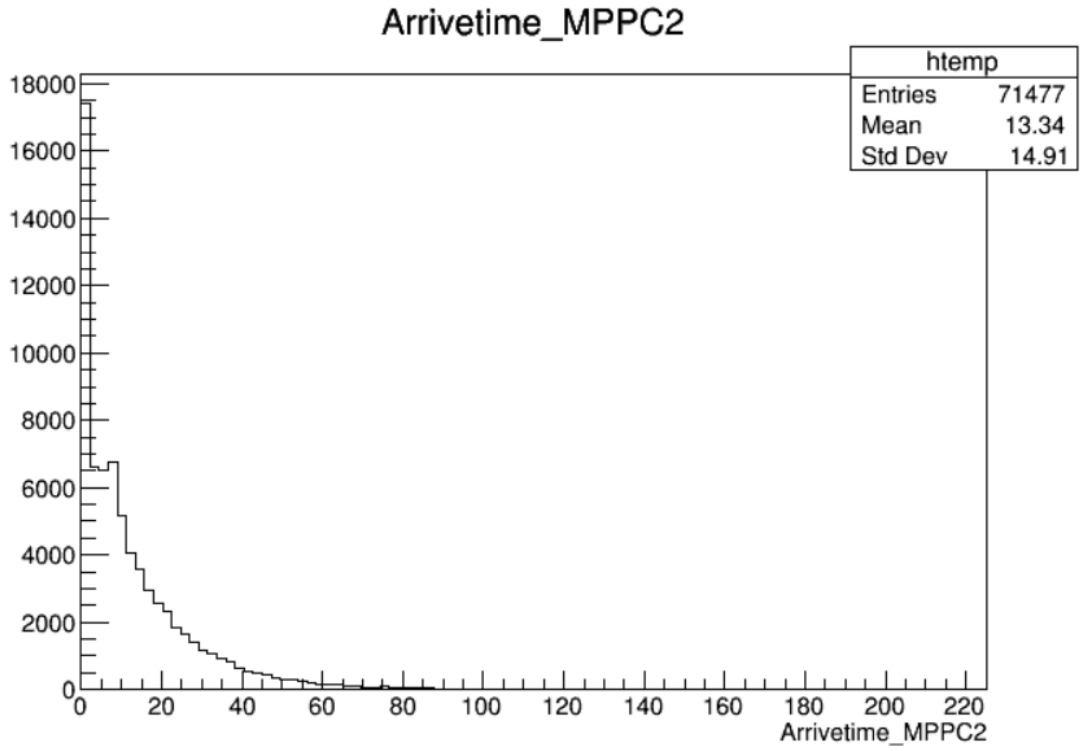
Determination of time

- In G4OpWLS, there is ‘UseTimeProfile’ which is determine the creation time of photon.
- In our code, we use ‘UseTimeProfile(delta)’ in physics lists and ‘AddConstProperty(“WLSTIMECONSTANT”, .5*ns)’ in detector construction.
- These mean that photon will be created after 0.5ns from absorption by WLS Process.

Arriving Time at MPPC



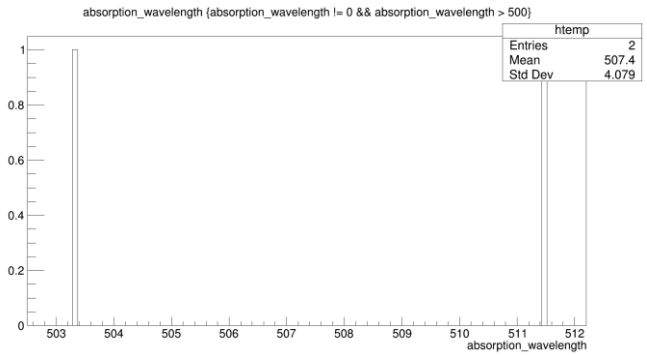
- Figure of arriving time at MPPC1



- Figure of arriving time at MPPC2

Physical meaning in distribution of arriving time

Backup



- Figure of Absorption spectra for wavelength larger than 500nm