Study of Geant4 based Simulation for Super-Kamiokande Experiment

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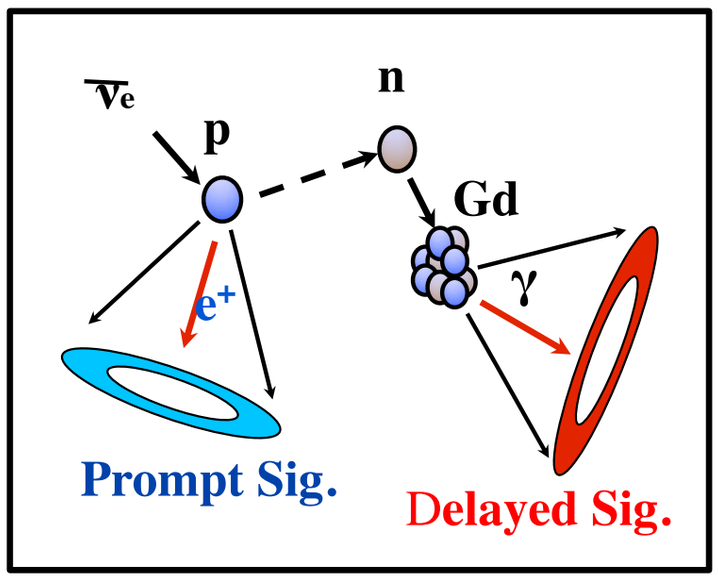
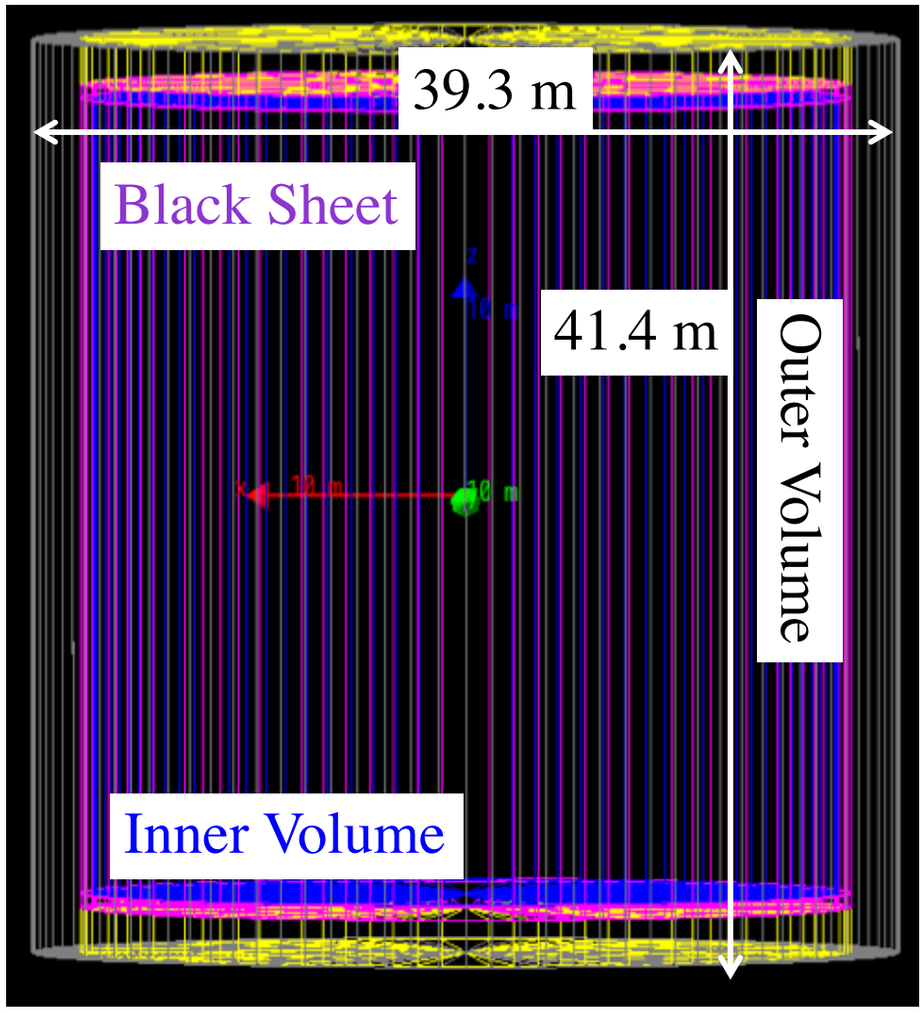
Introduction

- Super-Kamiokande Experiment(SK) is simulated by Geant3 (SKDetSim), This is written by FORTRAN and physics model will never upgrade anymore.
- SK-Gd project will start within this year, so SK simulation needs the latest physics model.
- In order to use the latest physics model and C++, we are developing Geant4 based simulation(SKG4).



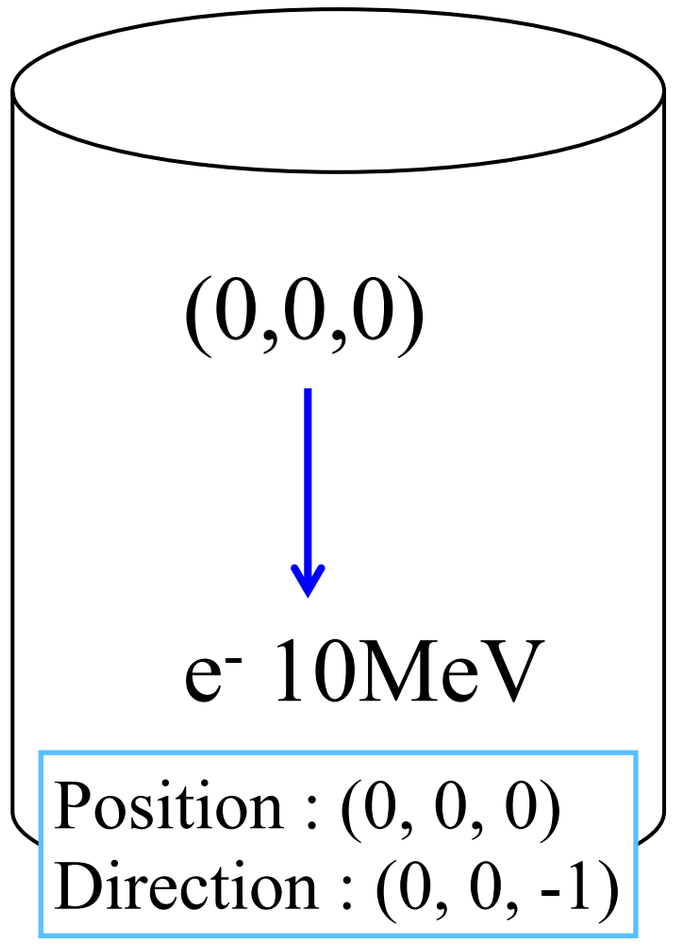
Current status

- Geometry of SK inner tank has already constructed. This is based on the SKDetSim(SK-IV version).
- Outer detector has not constructed.
- The latest physics model has already installed. The model of Neutron capture for Gd is based on the latest experiment.
- and we always welcome anyone who join the SKG4 development!



EM physics check

- SKG4 has different EM physics model from SKDetSim, so we have to check it.
- 10 MeV electron is generated from center of tank.
- We checked 4 behavior.
  - Number of total generated photon
  - Number of PMT hit of photon
  - Photon angle from (0,0,-1)
  - Wave length of generated photon



Comparison of number of photon

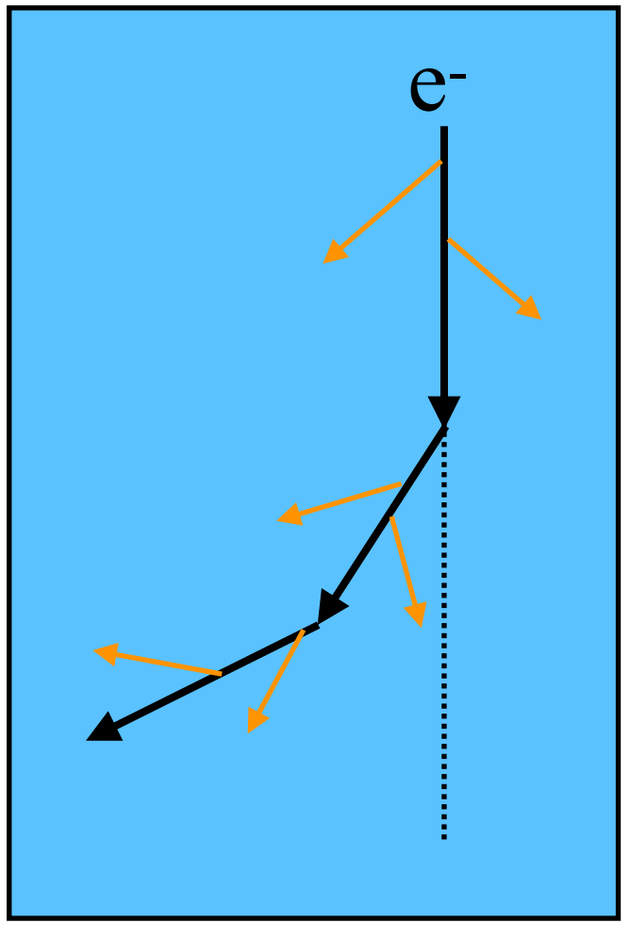
- The number of generated photon and PMT hit of photon was compared.
- In both comparisons, SKG4 is about 2.6% less than SKDetSim.

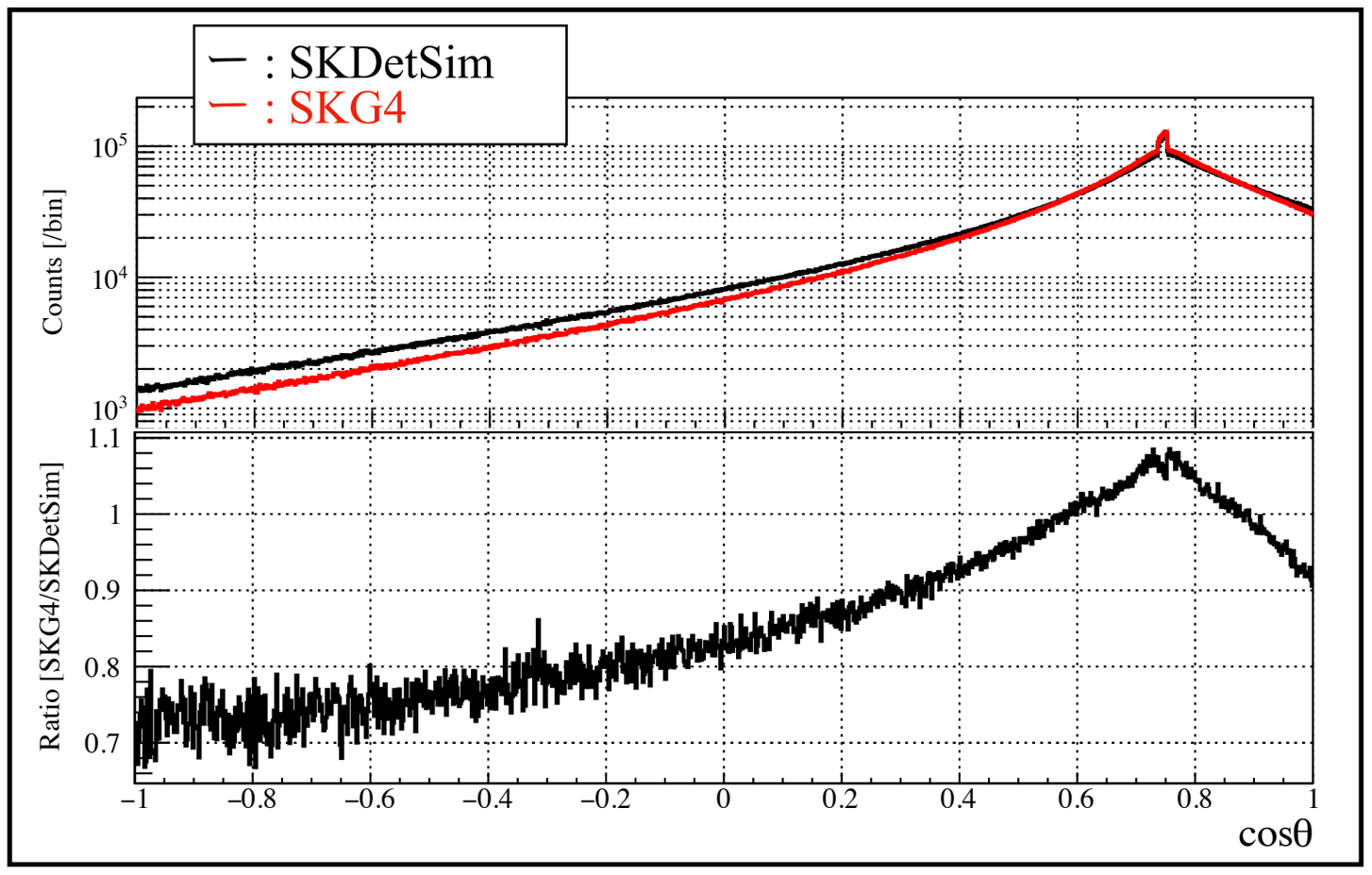
# of generated photon	Mean	Sigma
SKG4	1900	165.6
DETSIM	1950	162.3

# of PMT hit	Mean	Sigma
SKG4	740	66.9
DETSIM	760	68.1

Photon angle comparison

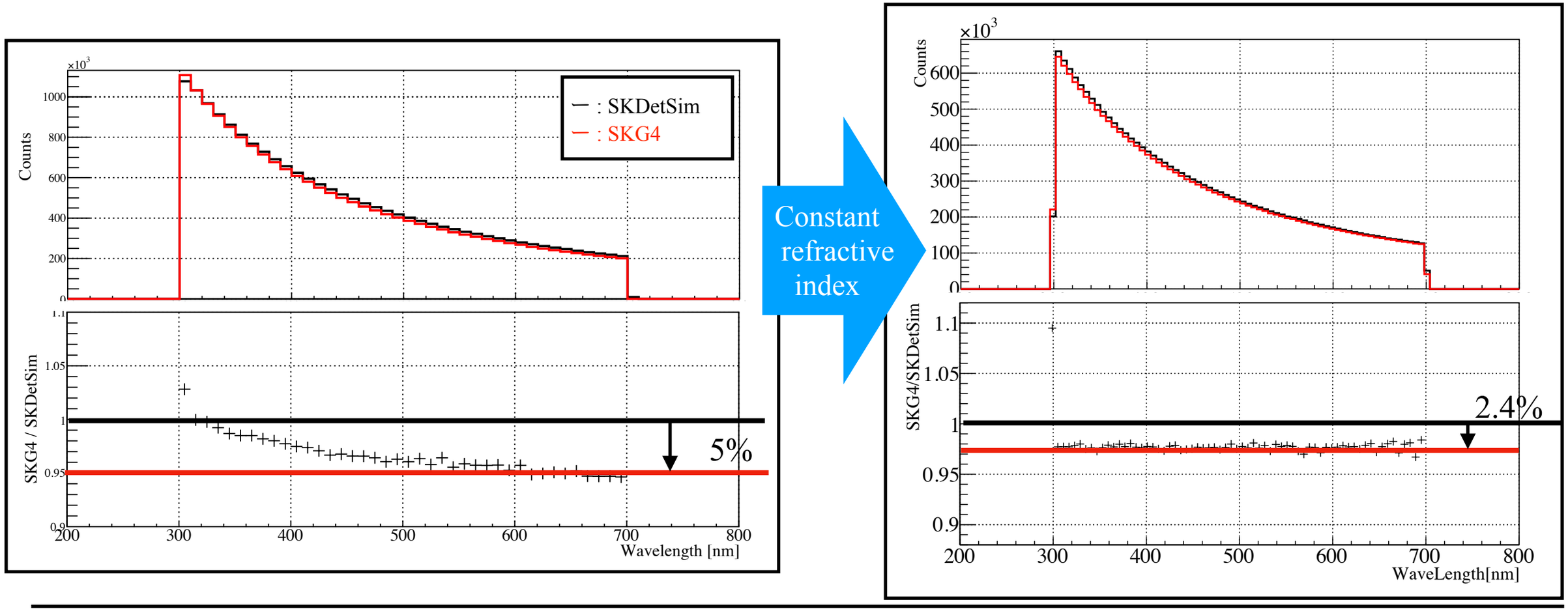
- The photon angle of generated photon from (0,0,-1) direction was compared.
- The tail part is different from SKDetSim, this is due to multiple scattering model.





Wave length dependence

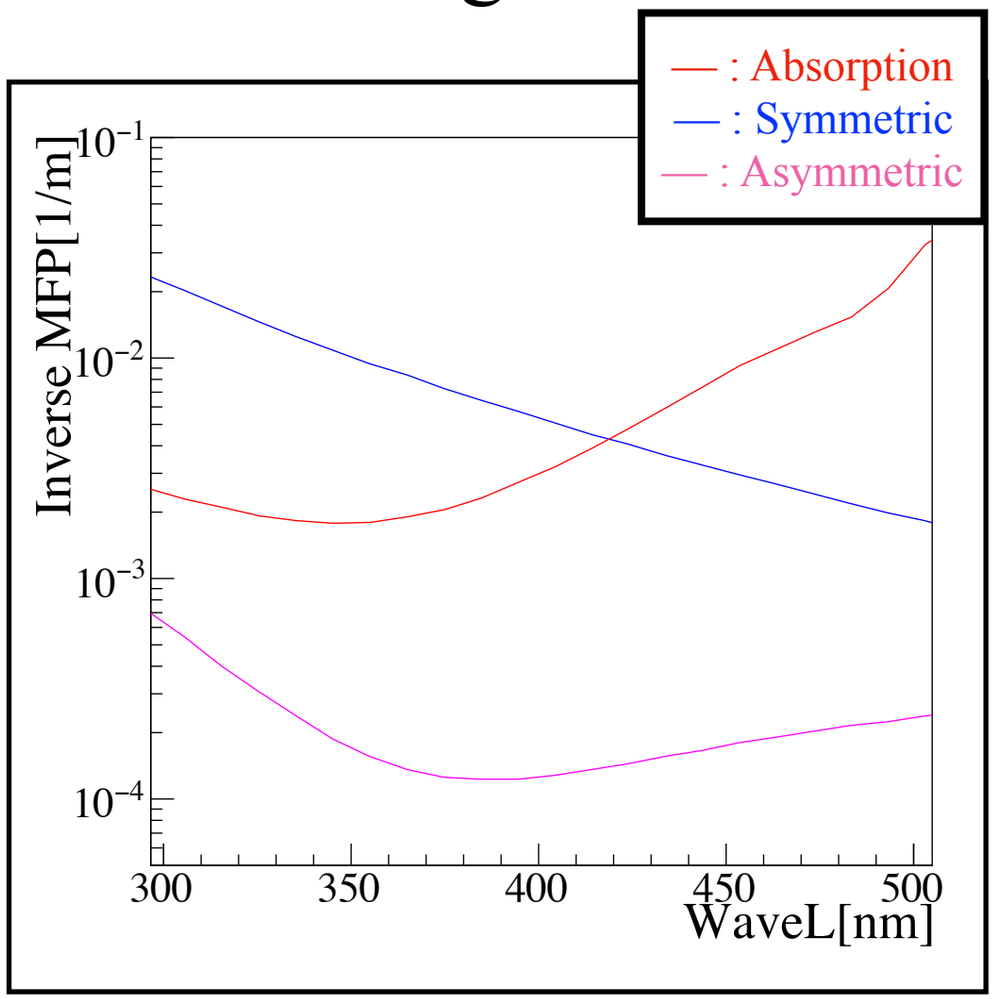
- The number of generated photons has dependence on the wave length.
- This problem is due to the method of deciding the wave length of Cerenkov photon → Geant4 is more realistic.



Photon tracking

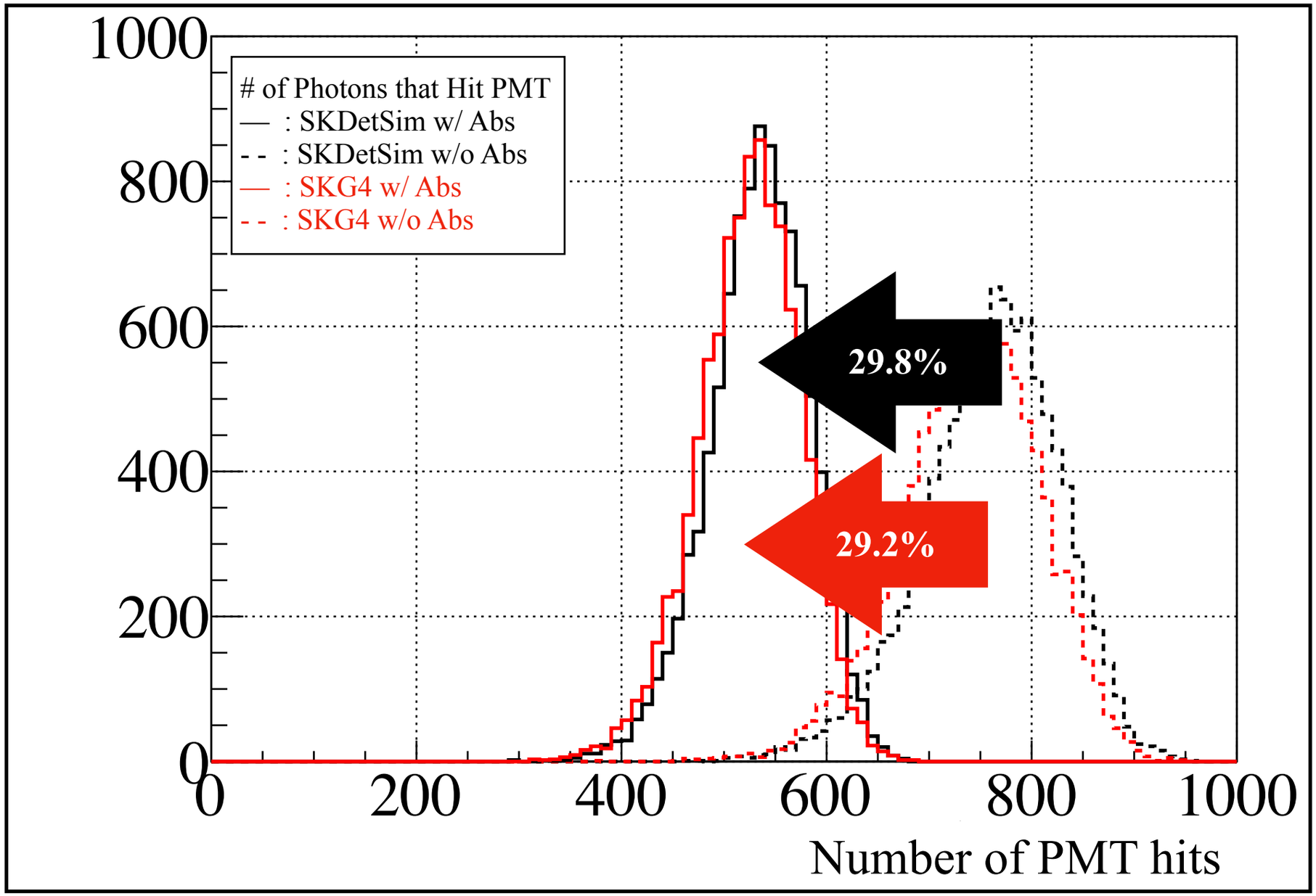
- The photon has some scattering process and absorption process.
- Both of them input the interaction length, or its inverse number.
- SKDetSim has different definition for scattering.

	SKG4	DetSim
Absorption	Absorption	Absorption
Rayleigh Scattering	Rayleigh Scattering	**Symmetric Scattering**
Mie Scattering	Mie Scattering	**Asymmetric Scattering**



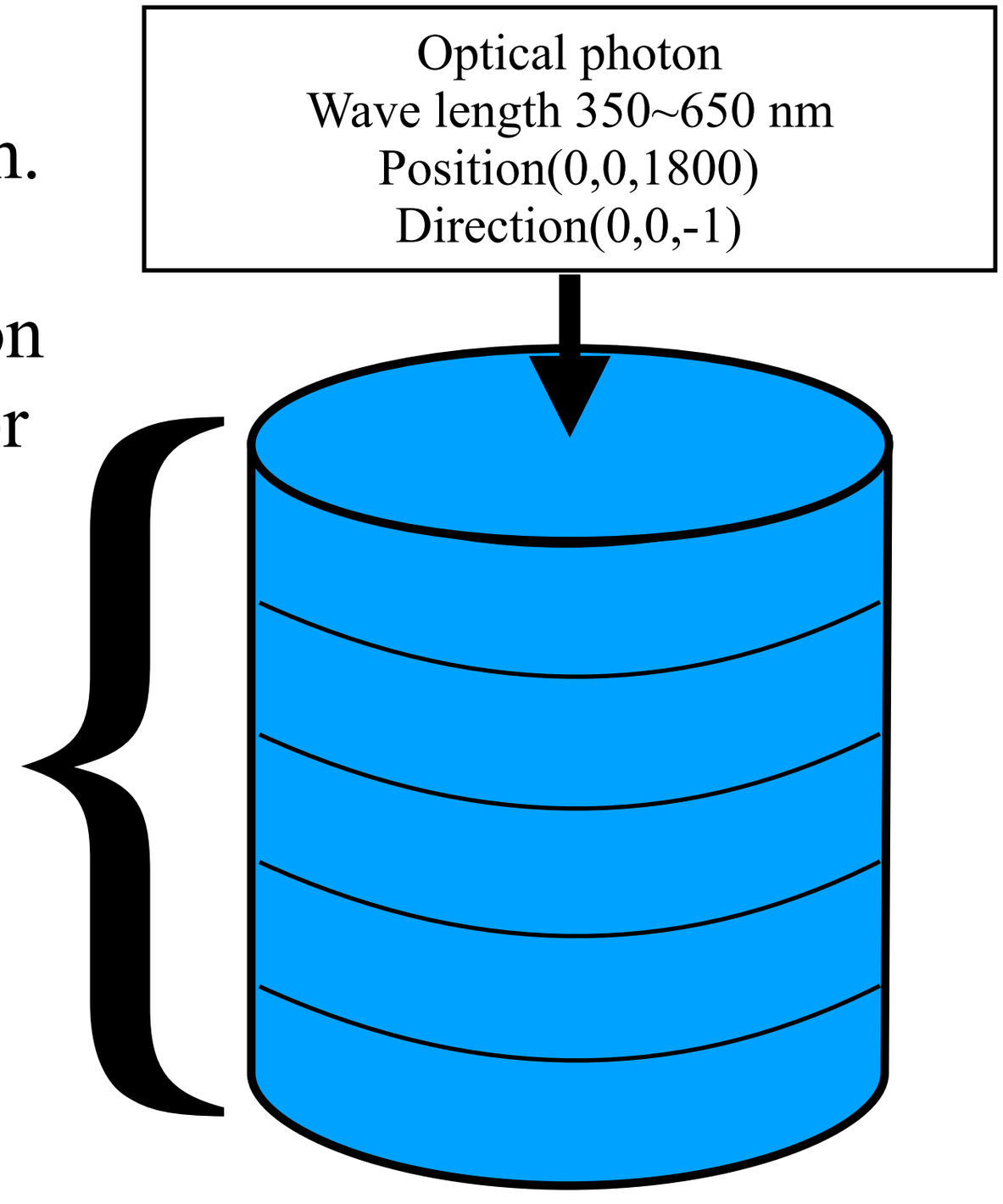
Photon absorption in the water

- The Absorption in the water was compared→consistent.



Photon scattering in the water

- Photon scattering in the water was compared with SKDetSim.
- PMT hit timing and z direction spatial distribution are used for comparison.

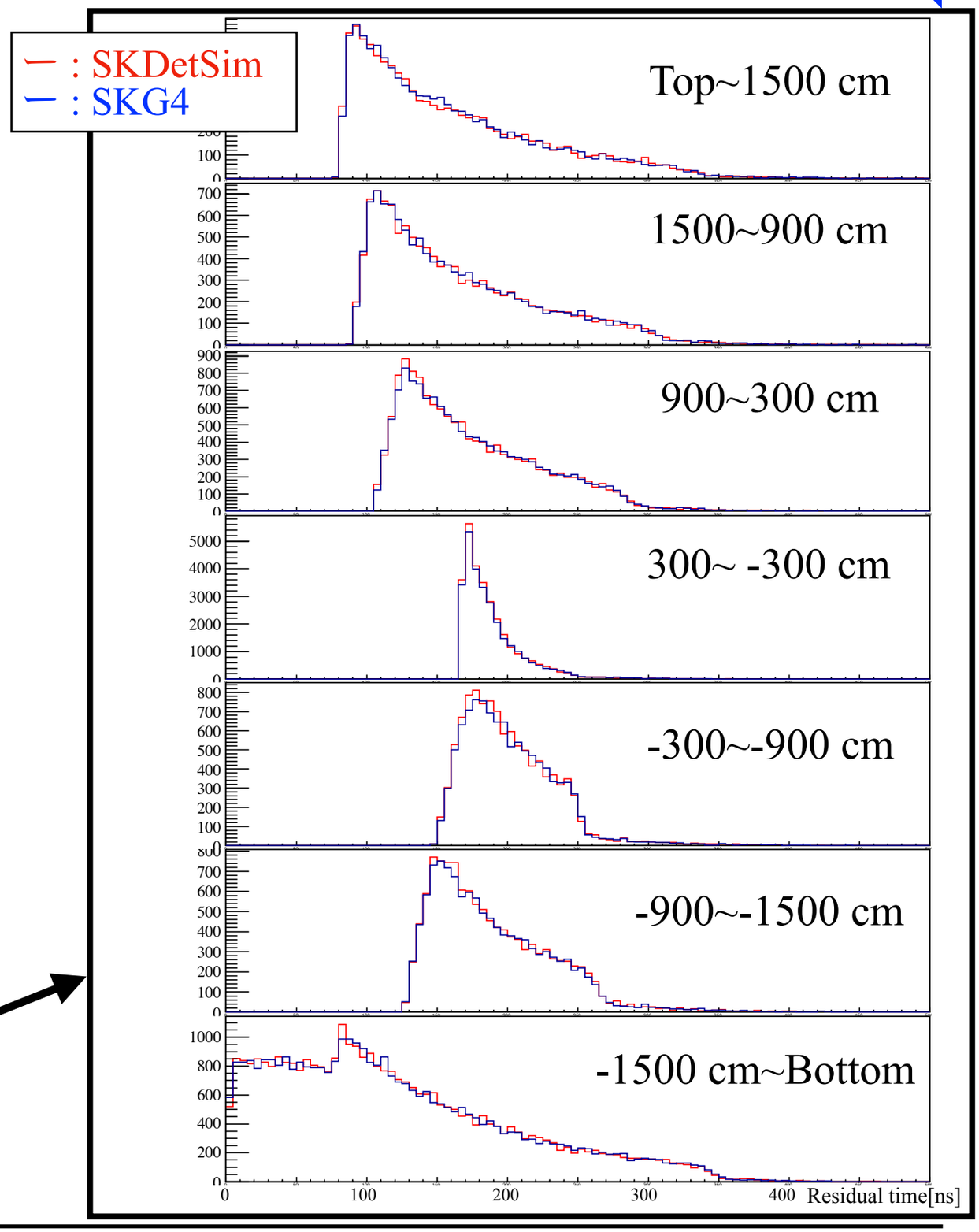


Result

- There was no significant difference in each wave length.
  →Timing distribution is consistent.

✓Scattering and Absorption was correctly introduced.

e.g. Timing distribution using 350 nm wave length photon



Conclusion

- Geant4 based SK simulation project(SKG4) was started.
- Some comparison with SKDetSim was done and some difference was found.
- Photon scattering and absorption process was constructed and checked.

Remind work

- PMT response construction (QE and detail tune…)
- Detail tuning of geometry.