LASPD simulation

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SPD Simulation

- LASPD scintillation and photon transport
- Two options:
  - G4Scintillation
  - post-GEMC simulation: Make use of the current GEMC simulation output.

post-GEMC simulation

- Using the hit information of the GEMC output
- Photons generated uniformly along the particle path and isotropic emission
- Number of generated photoelectrons is reduced by a couple factors:

  - Collection factor: assume the effective area of PMT to the scintillator end area as 0.6 (can be optimized later with a comparison to the data or simulation)

  - Assumed QE of 0.15

  - Attenuation: Simulated according to the probability of $1 - \exp(-l_{pro}/\lambda_{pro})$

post-GEMC simulation

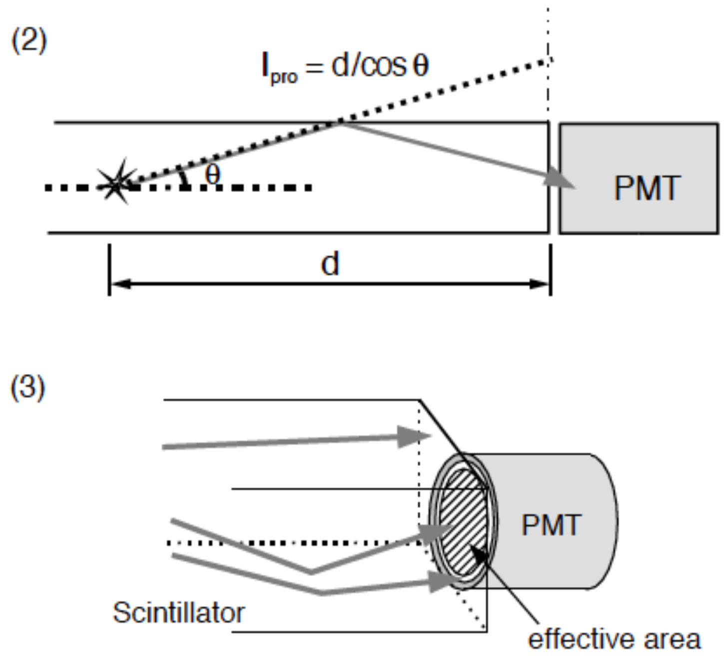


Fig. 7. Light propagation in a scintillator counter.

A detailed Monte Carlo simulation for the Belle TOF system
(NIM(A) 491 (2002) 54-58)

- We assume perfect internal reflection on the surfaces except for two PMT end sides.
- Light with its emission angle < critical angle can reach to the PMT.
- For the scintillator used in this study has the refractive index of 1.58, and therefore we get the critical angle of ~39.2 degree.

post-GEMC simulation

- Time information:
  - time = $t_{traj} + t_{emit} + t_{pro} + t_{TT}$

t_{traj} : time for the particle trajectory (currently using the average time information of the particle in the SPD)

t_{emit}: light emission time. Simulated using the emission time probability function

$$E(t_{emit}) = \frac{1}{1+R}\left(\frac{e^{-t_{emit}/\tau_2} - e^{-t_{emit}/\tau_1}}{\tau_2 - \tau_1} + \frac{R}{\tau_3} e^{-t_{emit}/\tau_3}\right)$$

t_{pro} : light propagation time in the scintillator. tpro = $n_{scin} * l_{pro} / c$

t_{TT} : transit time of a single pe in the PMT (Gaussian smearing with a mean of PMT transit time (TT) and rms transit time spread (TTS). For R9779, TT is 20 ns and TTS is 0.25.)

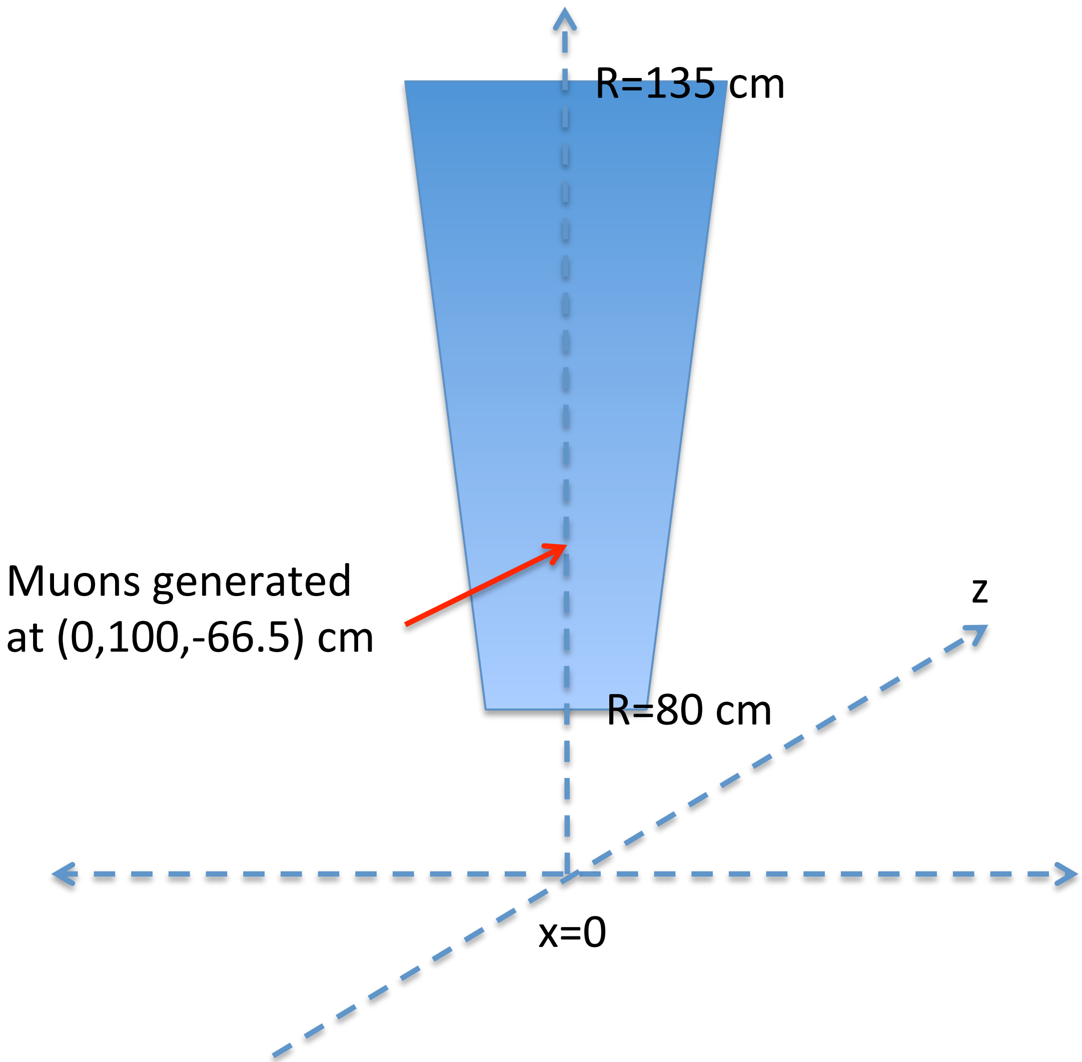
Scintillator specification (EJ-200)

- Dimension: 20x83 to 20x140x570 mm

PMT: Hamamatsu PMT R9779 on both sides

Parameters	
Density (g cm-3)	1.302
Refractive index	1.58
Light output (64% anthracene)	0.64 * (17400 / MeV)
Rise time of fast components (ns)	0.9
Decay time of fast components (ns)	2.1
Decay time of slow components (ns)	14.2
Slow to fast Ratio R	0.27
Light attenuation length (cm)	380

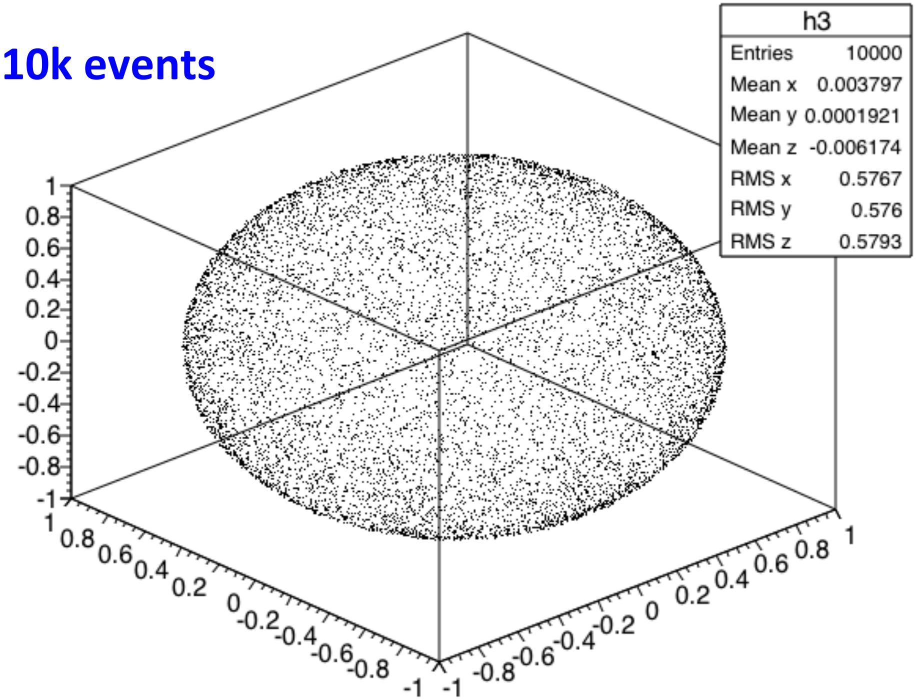
Single muon generation

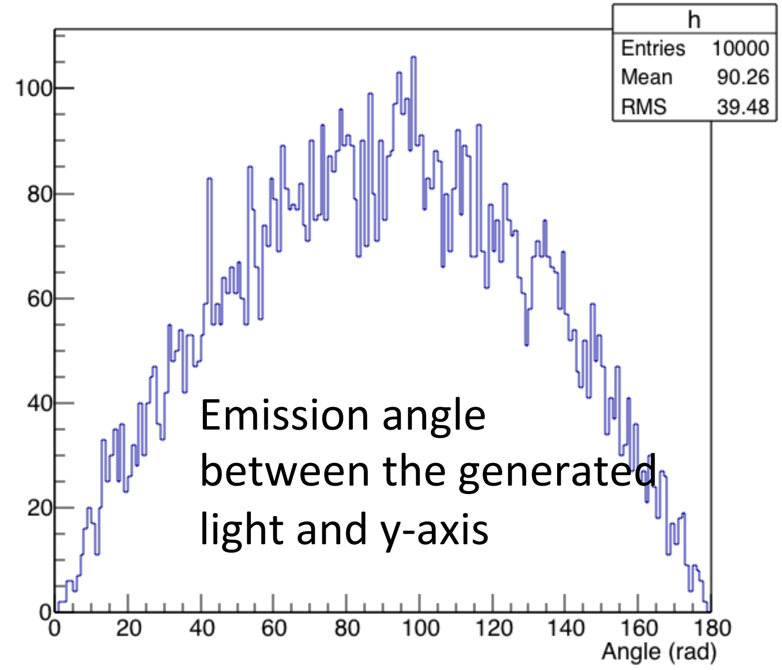


Generate photons

- Uniformly distributed along the particle path
- Isotropic emission

10k events

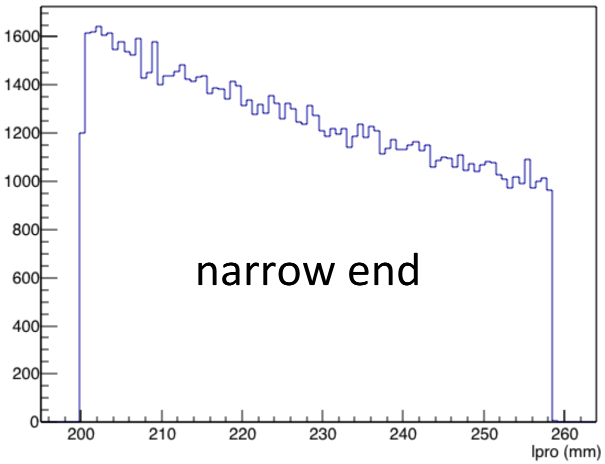


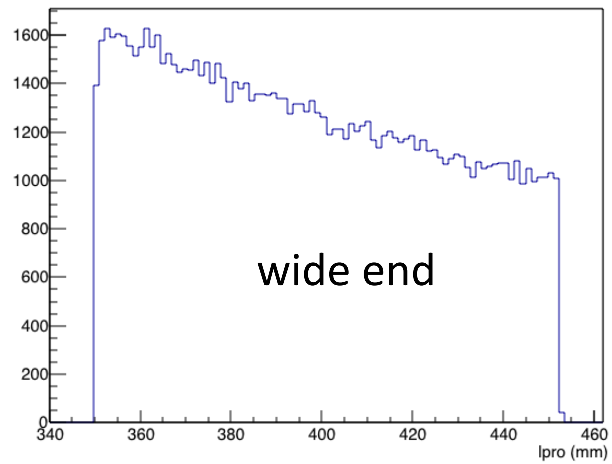


Emission angle between the generated light and y-axis

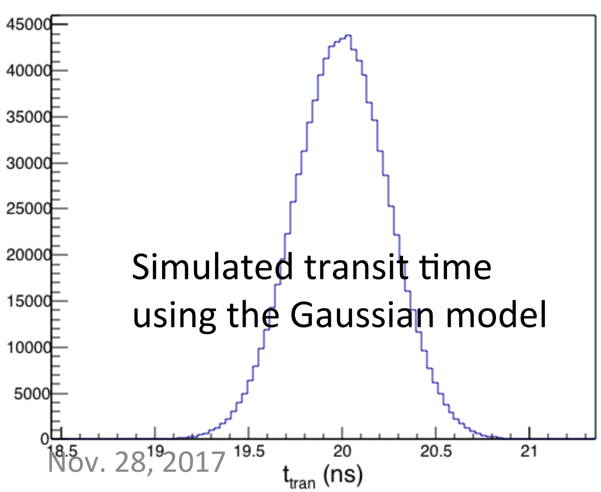
Simulation output

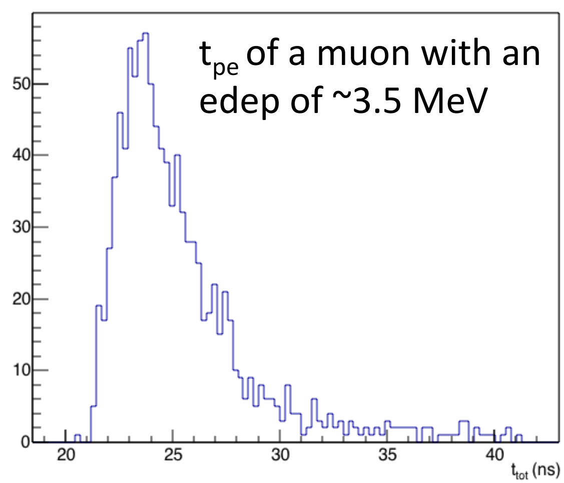
- Propagation length:

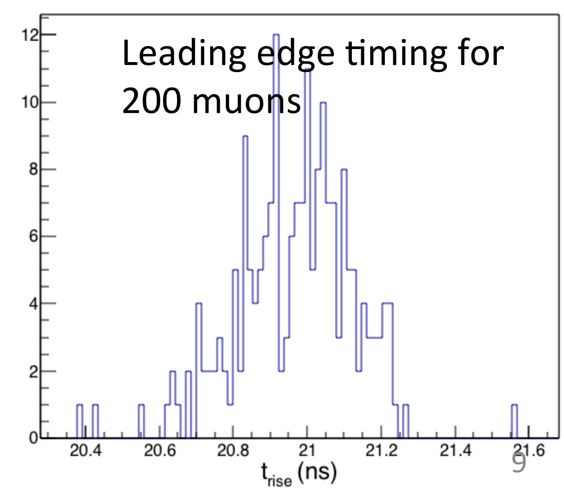




- Time information:







Summary

- A simple post-GEMC LASPD simulation is under its test.
- A few more things to implement (ADC, TDC)
- Further reducing the computing time is necessary. Need to think about some simplified model/parameterization of simulated quantities
- Comparison with a simple Geant4 simulation using G4Scintillation might be useful.