Status of PSD simulation

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The basic settings of the simulation

- 2m x 2m x 2m ZnWO4 crystal (avoid the energy leakage)
- Inject particle: pi+
  - Kinetic energy: 9.86 GeV (energy: 10 GeV)
  - Inject direction: z-axis
- Optical process
  - Only the scintillation process is activated.
  - Birks Constant: 0.0118 mm/MeV (arXiv:0911.3041)
  - Scintillation light yield: 10000./MeV (Grainita poster)

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total energy:              7.62057GeV
total energy(e+):          0.970092GeV (12.7299%)
total energy(e-):          3.13547GeV (41.1449%)
total energy(gamma):       0.0428891GeV (0.562807%)
total energy(pi+):         0.476016GeV (6.24647%)
total energy(pi-):         0.260913GeV (3.42379%)
total energy(p):           2.43053GeV (31.8943%)
total energy(n):           0.0437727GeV (0.574402%)
total energy(a):           0.0507948GeV (0.666549%)
total energy(t):           0.00641878GeV (0.0842297%)
total energy(d):           0.015242GeV (0.200011%)
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Scintillation time settings (arXiv:nucl-ex/0409014)

- Time constants and fraction of 3 components
  - Only consider two kinds of decay time shapes: gamma-like and alpha-like

Type of irradiation	Decay constants, μs		
	τ_1 (A_1)	τ_2 (A_2)	τ_3 (A_3)
γ ray	0.7 (2%)	7.5 (9%)	25.9 (89%)
α particles	0.7 (4%)	5.6 (16%)	24.8 (80%)

  - When dE/dx <= 5, scintillation photons are always gamma-like
    - The shape chosed in different cases ⬇

	e+/e-	**p**	**pi**	**n**	**alpha**
dE/dx<=5	γ-like	γ-like	γ-like	γ-like	γ-like
dE/dx>5	γ-like	α-like	α-like	α-like	α-like

Scintillation time in simulation

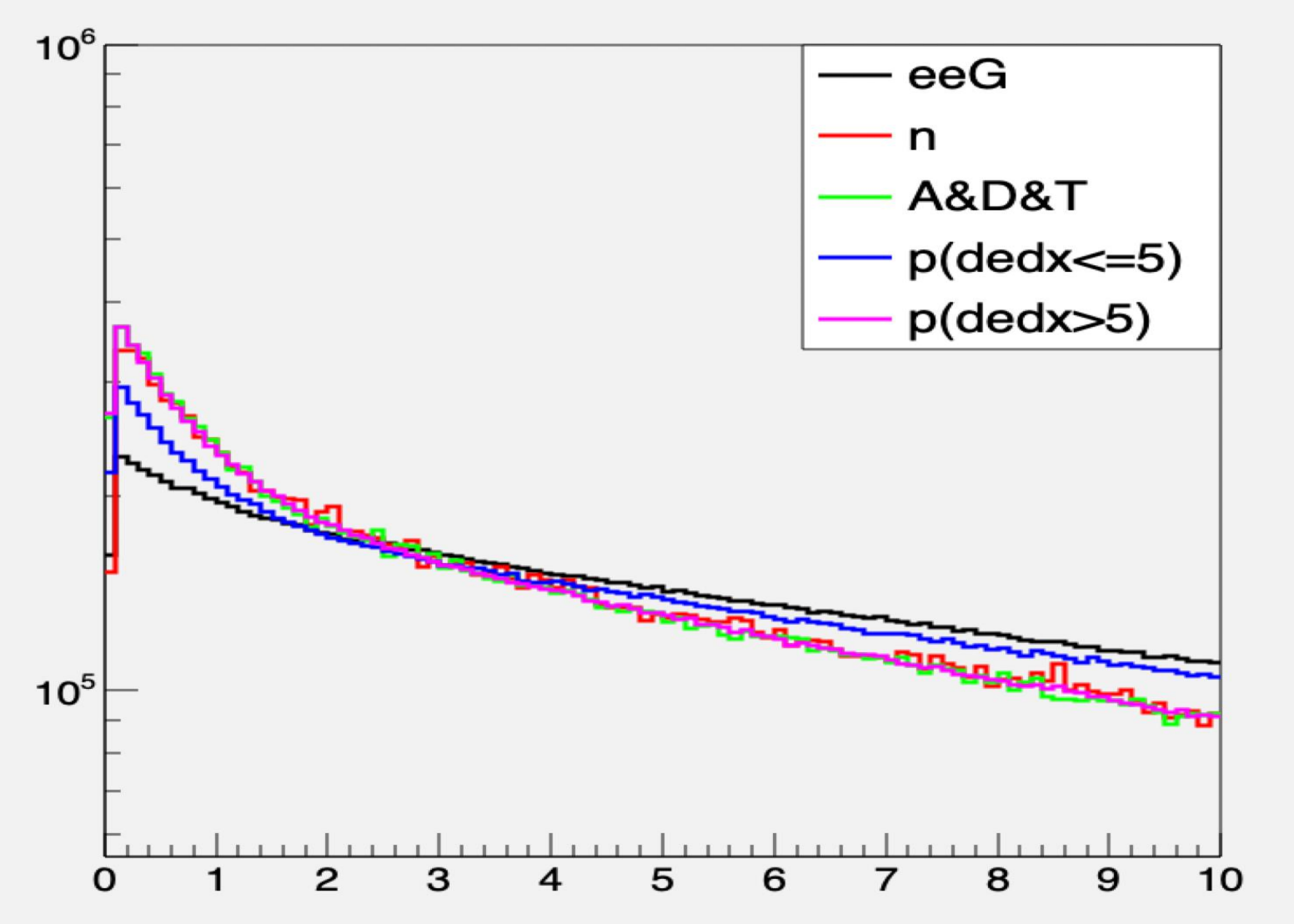
- In a step:
  1. Check the dE/dx first. If <=5, change the time constant parameters to γ-like ones to all kinds of particles, otherwise setting them to α-like ones for hadrons
  2. Generate the scintillation photons, based on the light yield, Birk's constant. A Poisson-distributed number of photons is generated based on Birk's law

$$n = LY \times \frac{E_{dep}}{1 + kB \cdot \frac{dE}{dx}}$$

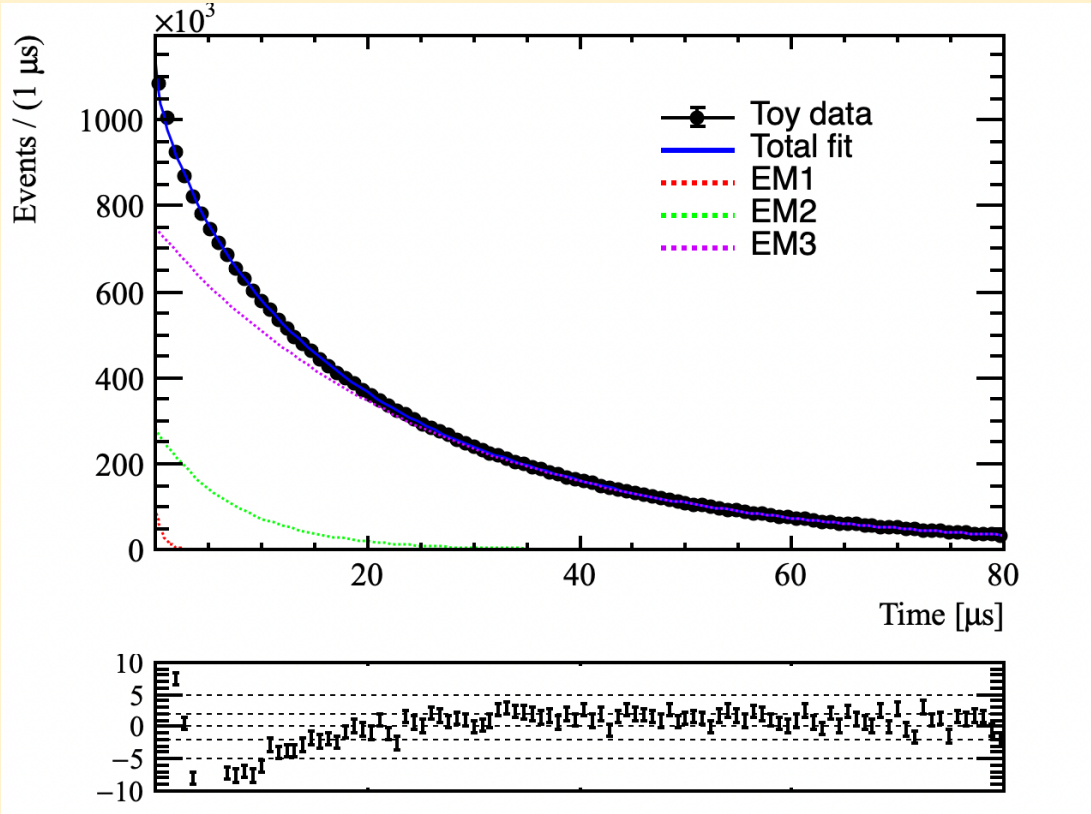
  3. The time of scintillation photons are generated based on the time PDF:

$f(t) = \sum_i^3 \frac{A_i}{\tau_i - \tau_0}\left(e^{-\frac{t}{\tau_i}} - e^{-\frac{t}{\tau_0}}\right)$ or $f(t) = \sum_i^3 \frac{A_i}{\tau_i}\left(e^{-\frac{t}{\tau_i}}\right)$ (rise time=0)

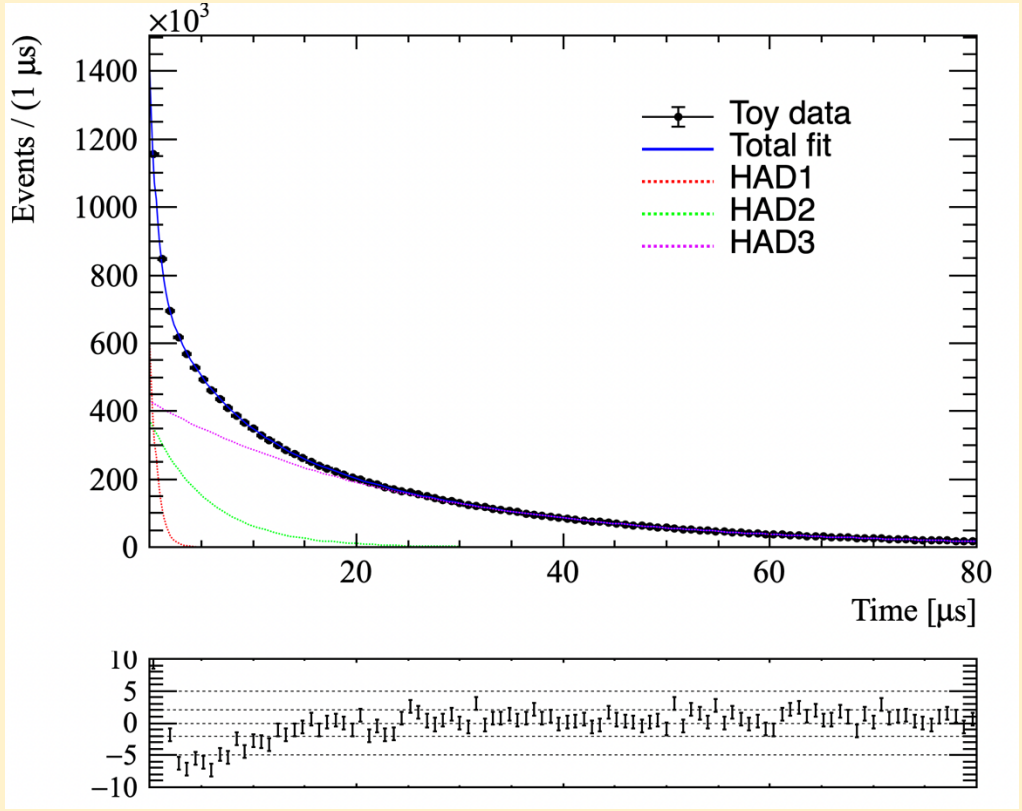
Time distribution from particles



Try fitting the time



fem1 = 0.0129273 +/- 3.7135e-05
fem2 = 0.0931813 +/- 0.000132883
fem3 = 0.893901 +/- 0.000153476



fhad1 = 0.0337322 +/- 0.000106875
fhad2 = 0.160623 +/- 0.000275289
fhad3 = 0.805646 +/- 0.00030364

A last-second-fix

⇒Changing material table is only valid for the steps after

⇒Fix: Re-initializing and Re-generating the scintillation photons

Next step

- Transfer N_photon to N_photon_electrons
  - Implement photon detector in the simulation
    - Code existed, built by Herve, need to be merged in the current simulation code
    - Can be done in ~1 week

- Generate more events.
  - Only 1 event is generated currently.
  - More events to check the distribution of fractions