Status Report

12/09/2025

The simulation setting for proton

- The settings that not same as the previous version (γ-, α-, p-like)
  - γ-like: 0.070 us (6%) + 0.360 us (94%)
  - α-like: 0.046 us (12%) + 0.360 us (88%)
  - p-like: 0.046 us (9%) + 0.360 us (91%)

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

Simulation side

- Re-write the physics process =>"DynamicScintillation"
  - Keep the same logic on photon generation as offical library (G4Scintillation)
  - Set time constant and yield based on particle type and dEdx in the step
    - => Not update the material table (old method)
    - => Set parameter directly to the scintillation process (checked step-by-step)
    - => No multi-thread issue anymore since not need to share updating material table among different thread
    - => No memory usage issue since no need to re-generate the scintillation process after update material table

```
[SCINT-DBG] evt 0 trk 5962434 pdg 11 mat BGO dedx 13.193659 | tau(ns)=(70.000000,360.000000,0.000000) yield(%)=(600.000000,9400.000000,0.000000)
[SCINT-DBG] evt 0 trk 5962434 pdg 11 mat BGO dedx 29.913581 | tau(ns)=(70.000000,360.000000,0.000000) yield(%)=(600.000000,9400.000000,0.000000)
[SCINT-DBG] evt 0 trk 5962434 pdg 11 mat BGO dedx 0.000000 | tau(ns)=(70.000000,360.000000,0.000000) yield(%)=(600.000000,9400.000000,0.000000)
[SCINT-DBG] evt 0 trk 5375858 pdg 2212 mat BGO dedx 11.091879 | tau(ns)=(46.000000,360.000000,0.000000) yield(%)=(900.000000,9100.000000,0.000000)
[SCINT-DBG] evt 0 trk 5375858 pdg 2212 mat BGO dedx 11.894536 | tau(ns)=(46.000000,360.000000,0.000000) yield(%)=(900.000000,9100.000000,0.000000)
[SCINT-DBG] evt 0 trk 5375858 pdg 2212 mat BGO dedx 13.825347 | tau(ns)=(46.000000,360.000000,0.000000) yield(%)=(900.000000,9100.000000,0.000000)
```

```
├── include
│   ├── ActionInitialization.hh
│   ├── DetectorConstruction.hh
│   ├── DetectorMessenger.hh
│   ├── DynamicScintillation.hh
│   ├── HistoManager.hh
│   ├── PrimaryGeneratorAction.hh
│   ├── PrimaryGeneratorMessenger.hh
│   ├── RunAction.hh
│   ├── Run.hh
│   ├── SteppingAction.hh
│   ├── SteppingMessenger.hh
│   ├── SteppingVerbose.hh
│   ├── TrackInformation.hh
│   ├── TrackingAction.hh
│   ├── UseDynamicScintillation.hh
│   └── Utils.hh
├── src
│   ├── ActionInitialization.cc
│   ├── DetectorConstruction.cc
│   ├── DetectorMessenger.cc
│   ├── DynamicScintillation.cc
│   ├── HistoManager.cc
│   ├── PrimaryGeneratorAction.cc
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│   ├── TrackingAction.cc
│   ├── UseDynamicScintillation.cc
│   └── Utils.cc
```
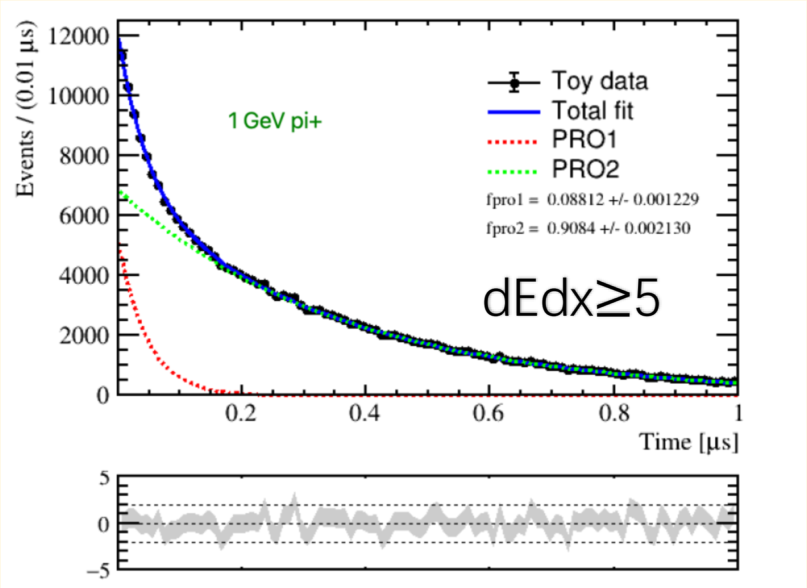
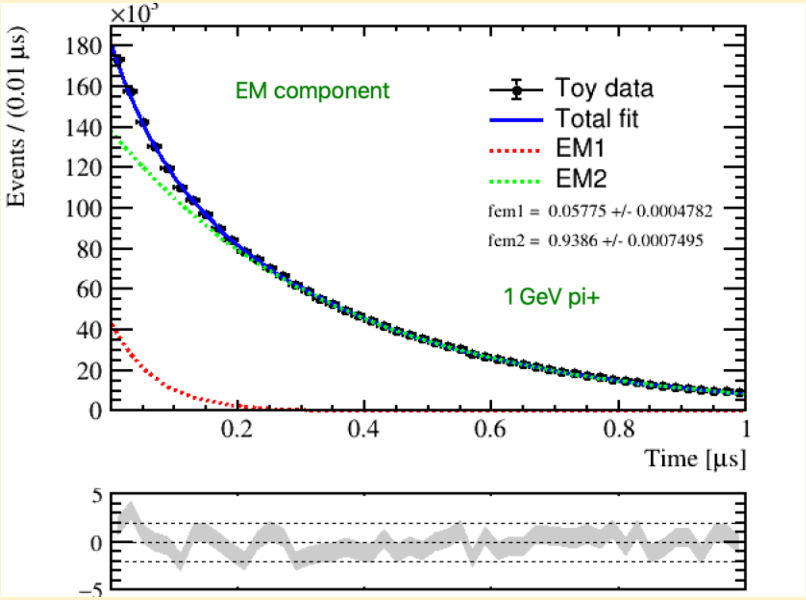
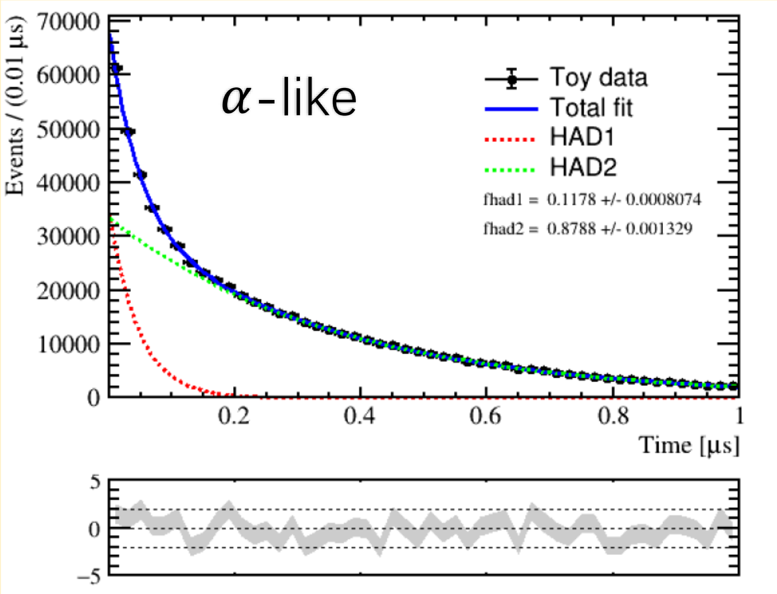

Validation on the simulation

- τs are fixed, fractions are float
  - γ-like: 0.070 us (6%) + 0.360 us (94%)
  - α-like: 0.046 us (12%) + 0.360 us (88%)
  - p-like: 0.046 us (9%) + 0.360 us (91%)



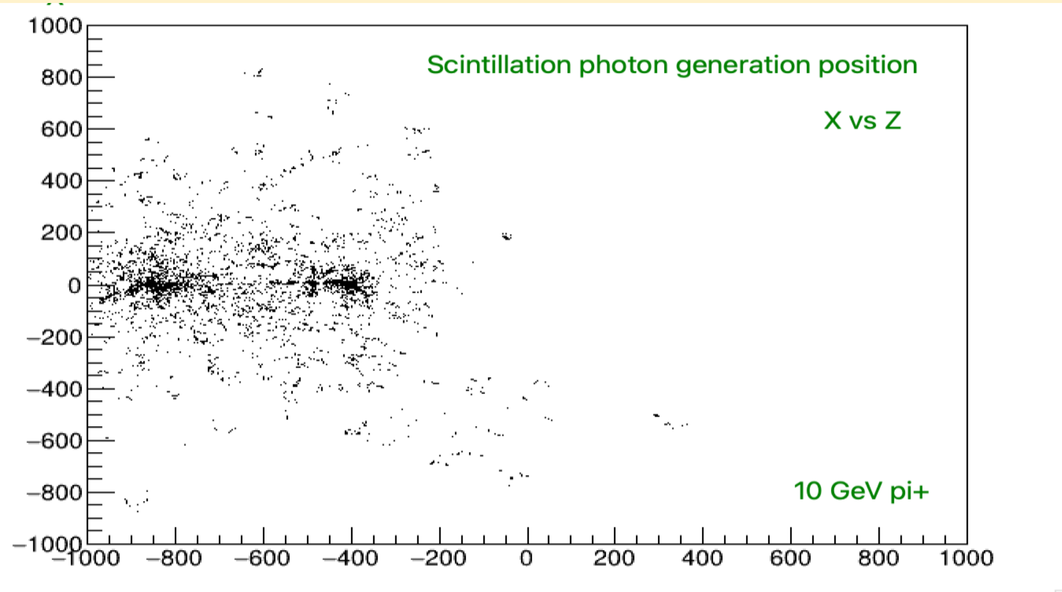




The start position of Scintillation

- $n_{PE} = n_{PE}^{h} \cdot a + n_{init}$
- $n_{init} = n_{PE}[1 - a(1 - f_{em})]$

- Gun position (0,0,-1.001m)
- Gun direction (0,0,1)
- For the resolution vs size
  1. Take a size cut: $z \leq z_0$
  2. Extract correlation a by $f_{EM}^{z \leq z_0}$ and $n_{ph}^{z \leq z_0} + n_{ph}^{z > z_0}$(set with an uncertainty from resolution)
  3. Extract energy resolution from multiple samples
- Time consuming part: time fit with different z_0



	High granularity Si/W ECAL and scintillator based HCAL	Fiber-based dual-readout calorimeter	Hybrid crystal and dual-readout calorimeter
N. of longitudinal layers	> 40	1	3-5
ECAL cell cross-section HCAL cell cross-section	25–100 mm² 100–900 mm²	2–144 mm²	100 mm² 400–2500 mm²
EM energy resolution HAD energy resolution	$15 - 25\%/\sqrt{E}$ $45 - 55\%/\sqrt{E}$	$10 - 15\%/\sqrt{E}$ $25 - 30\%/\sqrt{E}$	$\approx 3\%/\sqrt{E}$ $\approx 25 - 30\%/\sqrt{E}$

Baseline resolution of IDEA

Doing and to-do

- Scaning the energy resolution vs z_0 with samples (pi+, 1-20 GeV)
  - Scanning step on z_0 is set to be 0.02 m from -0.8 m to 0m (z size: [0.2, 1] m)
  - Fitting (to get f_{EM}) is ongoing, expected to be finished in ~1 week.
  - Code for extracting energy resolution is ready (~0.5 day)
- Will check the resolution vs x_0, y_0
  - $\pm x_0(y_0)$ in [0.1, 0.6], with step 0.05 m