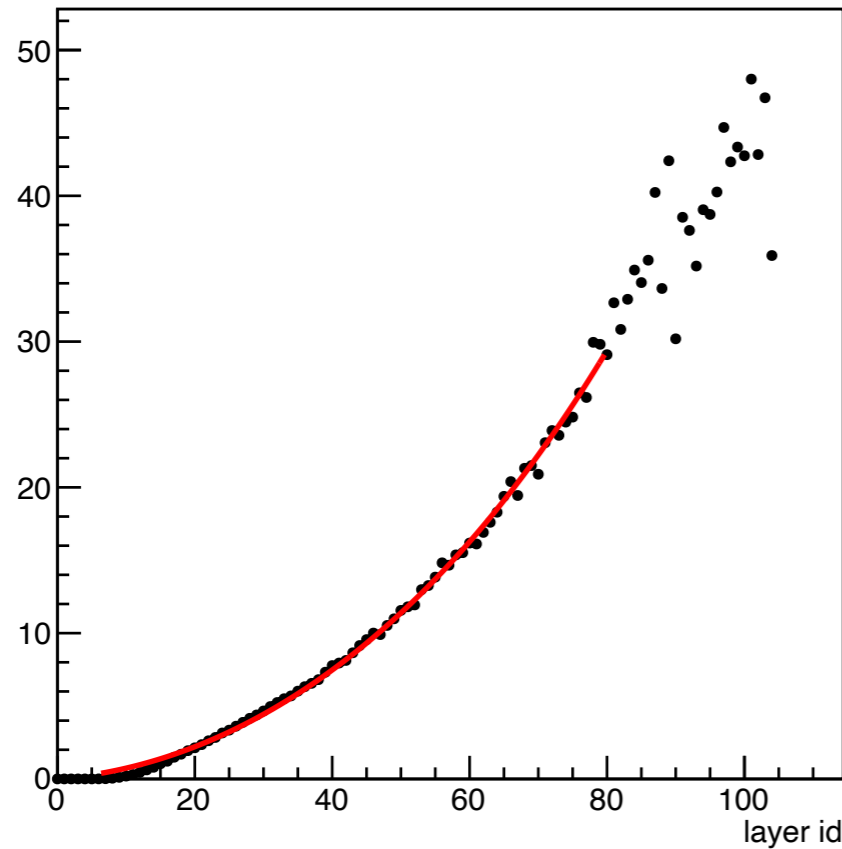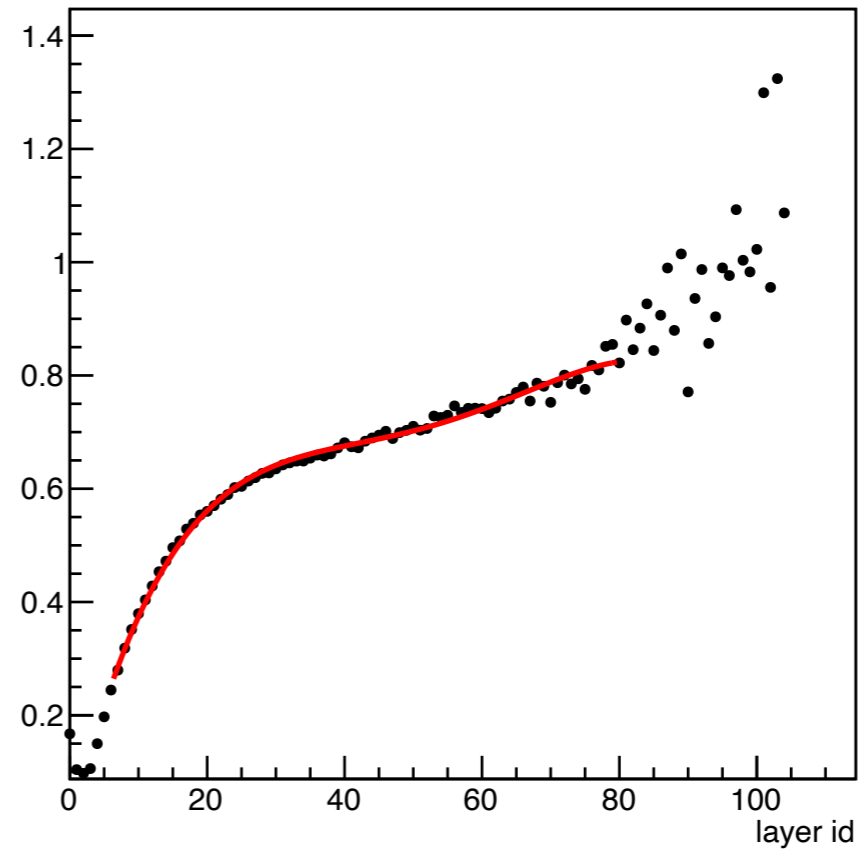# K-Koto Meeting

2020/06/03

YoungJun Kim

Parameter Fix

Alpha

Beta

$$\alpha(t) = a_0 t + a_1 t^2 + a_2 t^3 + a_3 t^4 \qquad \beta(t) = b_0 t + b_1 t^2 + b_2 t^3 + b_3 t^4$$

Look up table, linear interpolation.

```
double alpha[105] = {
  4.1362e-08,
  3.45538e-12, 1.14273e-12, 5.08733e-11, 9.50504e-07, 0.000169351,
  0.00318972, 0.0145551, 0.0479294, 0.107964, 0.193025,
  0.301253, 0.443859, 0.619487, 0.79829, 1.03986,
  1.21347, 1.48802, 1.6934, 1.93872, 2.13334,
  2.35357, 2.619, 2.84479, 3.15172, 3.34634,
  3.61689, 3.88052, 4.15773, 4.38801, 4.66043,
  4.96429, 5.24201, 5.50174, 5.69493, 6.02147,
  6.32714, 6.55582, 6.81088, 7.32093, 7.77527,
  7.94982, 8.1274, 8.65232, 9.15094, 9.55764,
  10.0045, 9.90205, 10.5284, 10.9826, 11.5612,
  11.8072, 11.9365, 12.9862, 13.2668, 13.8433,
  14.8236, 14.6603, 15.3683, 15.5208, 16.179,
  16.1162, 16.9115, 17.6035, 18.2957, 19.3847,
  20.3944, 19.4432, 21.308, 21.4954, 20.9005,
  23.0648, 23.8987, 23.5709, 24.4766, 24.8188,
  26.4844, 26.1671, 29.9504, 29.8139, 29.1021,
  32.6627, 30.8351, 32.9022, 34.9087, 34.0489,
  35.5839, 40.2324, 33.6434, 42.4064, 30.1905,
  38.5273, 37.6266, 35.1821, 39.0471, 38.7228,
  40.2614, 44.6897, 42.3323, 43.3462, 42.7472,
  48.006, 42.8315, 46.7252, 35.9035
};
```

```
double beta[105] = {
  0.167291,
  0.104044, 0.0973468, 0.105899, 0.14985, 0.197228,
  0.244514, 0.279706, 0.318466, 0.351538, 0.379444,
  0.403708, 0.428265, 0.453505, 0.472163, 0.495988,
  0.508005, 0.528847, 0.539003, 0.553753, 0.560054,
  0.570091, 0.581462, 0.589692, 0.602071, 0.604181,
  0.613552, 0.619516, 0.627084, 0.627886, 0.635069,
  0.642053, 0.645637, 0.648728, 0.648871, 0.653972,
  0.659439, 0.657741, 0.661556, 0.672026, 0.681222,
  0.674076, 0.672261, 0.683953, 0.689643, 0.694638,
  0.701469, 0.688614, 0.699131, 0.703082, 0.710249,
  0.703395, 0.706368, 0.728384, 0.725826, 0.729733,
  0.746255, 0.734614, 0.742026, 0.74224, 0.741541,
  0.734281, 0.74221, 0.754854, 0.758227, 0.77001,
  0.779566, 0.75486, 0.786414, 0.780911, 0.752547,
  0.787226, 0.800683, 0.785097, 0.794112, 0.775544,
  0.817754, 0.809772, 0.851449, 0.854837, 0.822137,
  0.897794, 0.845523, 0.883566, 0.926417, 0.844062,
  0.906378, 0.989768, 0.8796, 1.0146, 0.77099,
  0.935962, 0.987053, 0.85663, 0.903588, 0.989966,
  0.976427, 1.09277, 1.0034, 0.982892, 1.02264,
  1.29922, 0.955516, 1.32416, 1.08702
};
```
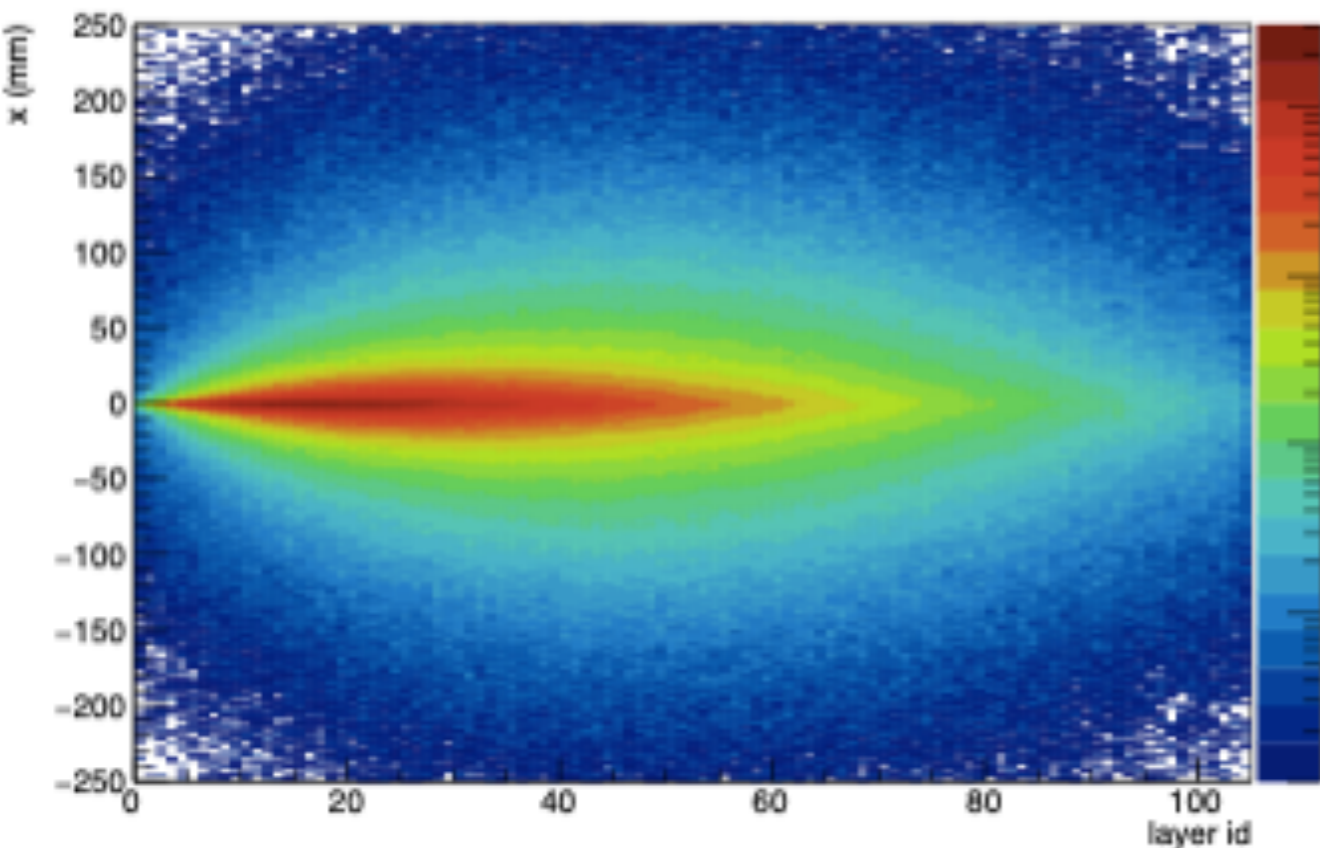
2

2D Fit

. Longitudinal shower shape : $f(t) = E_{tot} b \dfrac{(bt)^{a-1} e^{-bt}}{\Gamma(a)}, \; (t = z/X_0)$

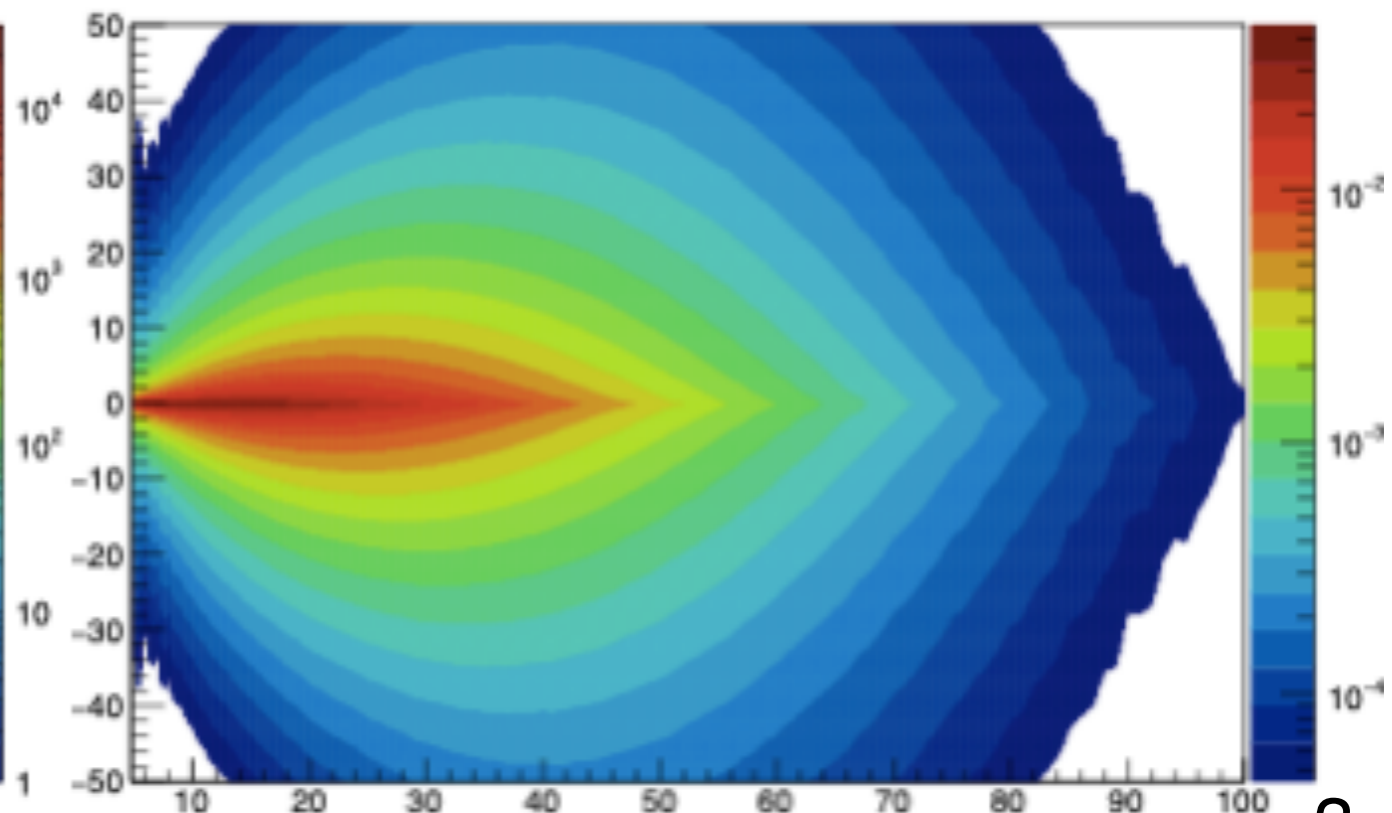Transverse shower shape : $f(x) = E_0 \dfrac{\beta}{2\alpha\Gamma(1/\beta)} e^{-(|x-m|/\alpha)^{\beta}}$

$PDF(x, t) = f_x(x) f_t(t)$

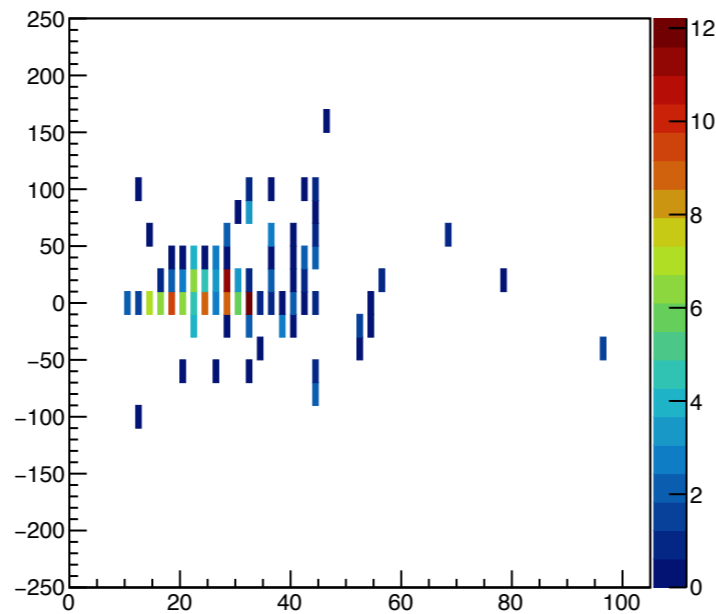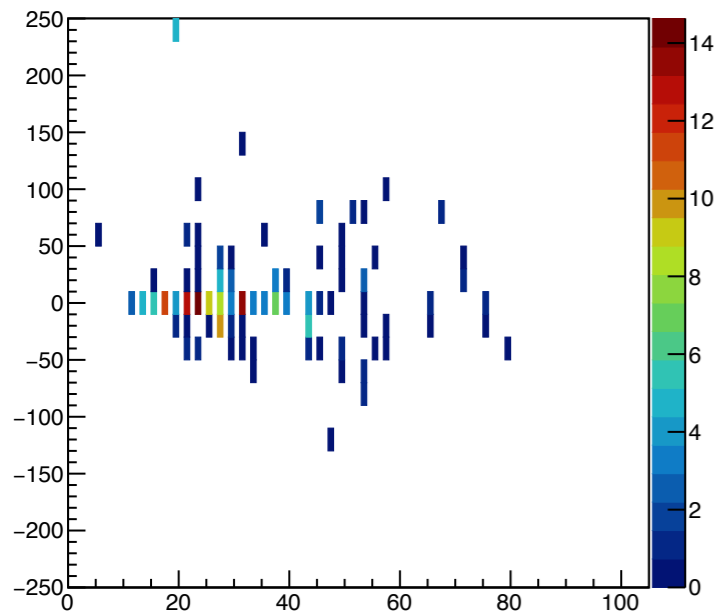- **Fix parameters : $\alpha(t), \beta(t), a, b$**
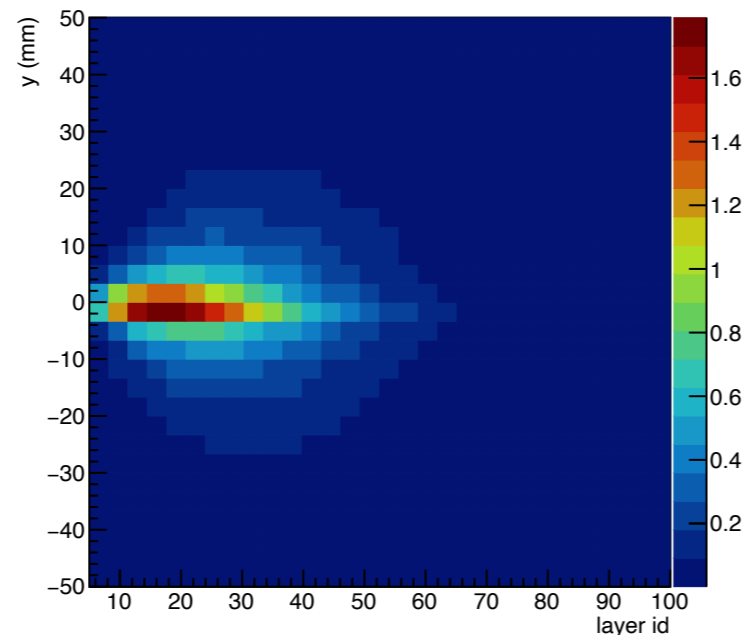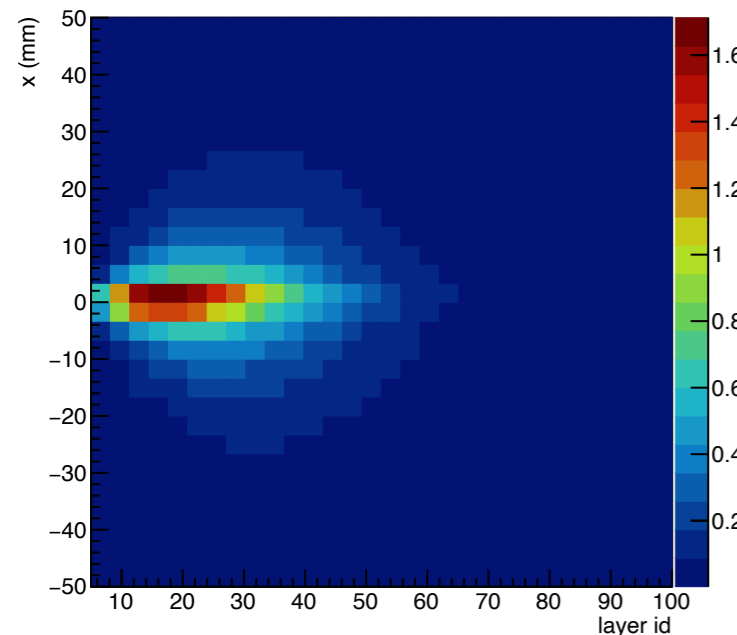

Simulation Edep

2D Shower PDF
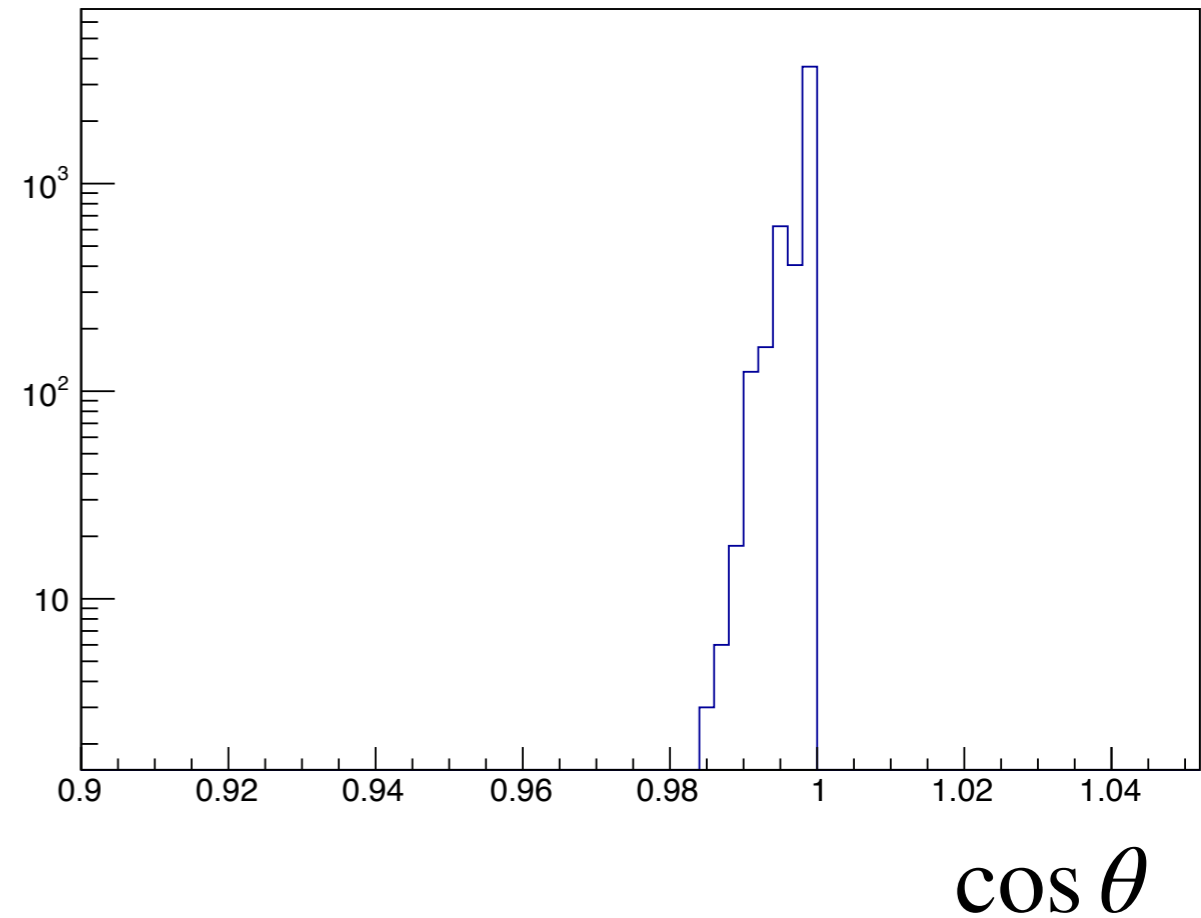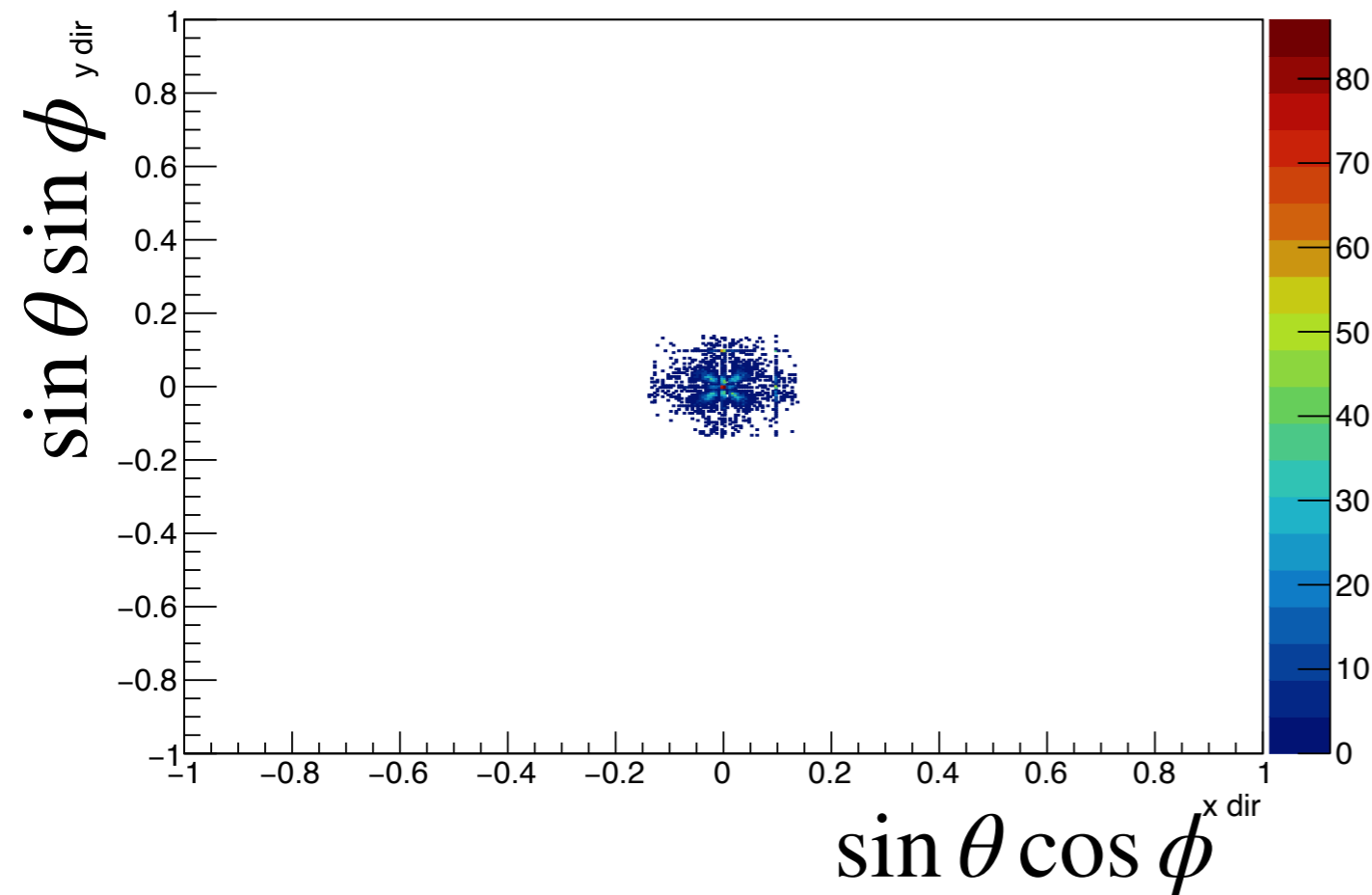
3

2D Fit

ML Fit

xz plane Fit Result

yz plane Fit Result

- $PDF(x, t; \alpha(t), \beta(t), a, b)$

- **Fit parameters :**

  - $\alpha(t), \beta(t), a, b \rightarrow$ Fixed

  - θ, height $\rightarrow$ Free parameters

- **Rotate coordinate (x-z or y-z)**

  - $z = z_0 \cos(\theta) - x_0 \sin(\theta)$

  - $x = z_0 \sin(\theta) + x_0 \cos(\theta)$

- **Maximum Likelihood Fit**

4

Angular distribution

Plan

- Additional free parameter : x_0 (or y_0) position at z = 0 (layer id = 0)

- Test under different incident angles / positions

- Improve algorithm

back up

Incident angle estimation

- $x = a_0 + a_1 z, \; a_1 = \tan \theta_{xz}$
- $y = b_0 + b_1 z, \; b_1 = \tan \theta_{yz}$

- $\cos \theta = 1/\sqrt{1 + a_1^2 + b_1^2}, \quad \sin \phi = 1/\sqrt{1 + (a_1/b_1)^2}$