GATE Simulation study

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Ryo Hamanishi

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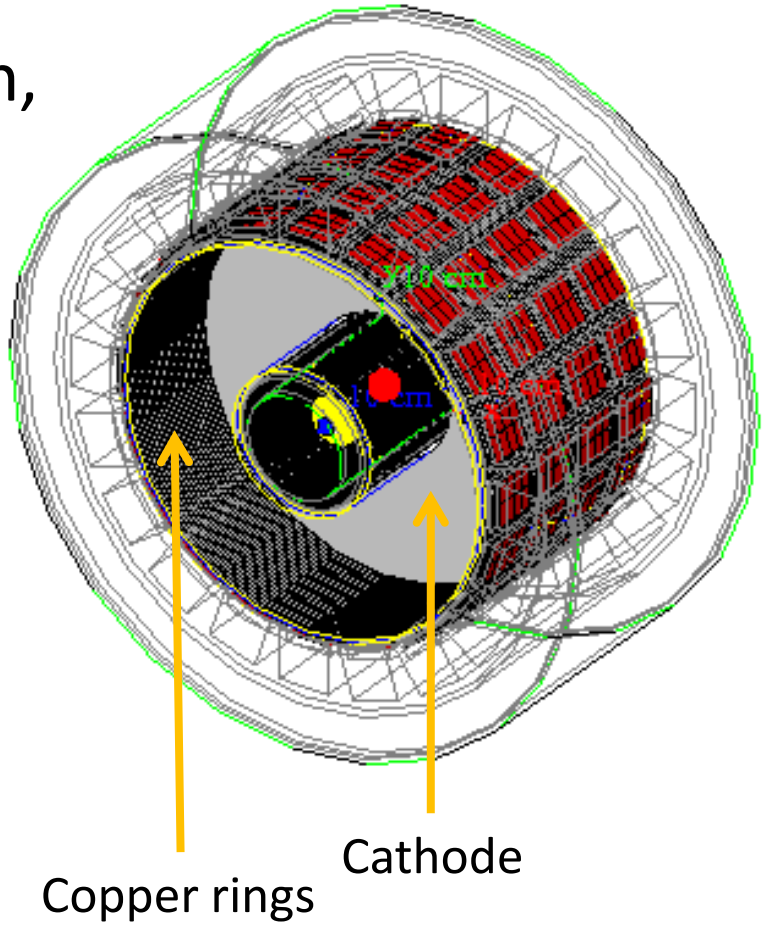
GATE simulation

Detection efficiency for photon

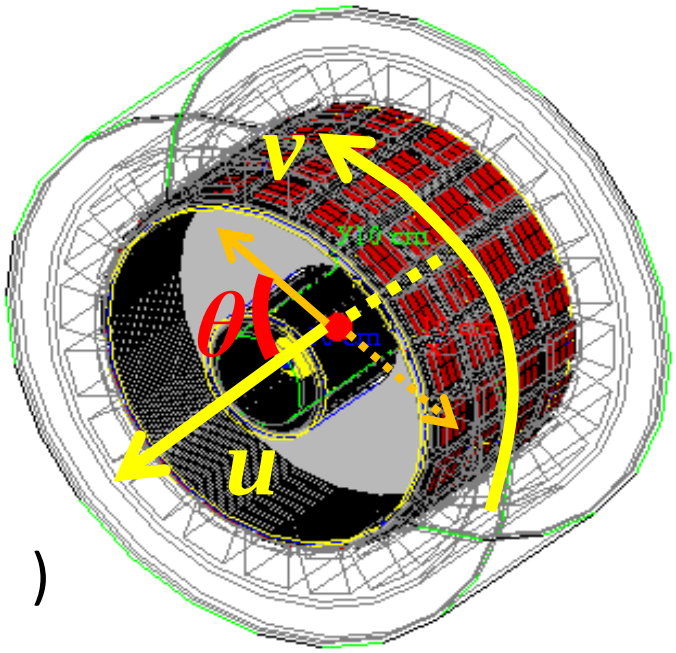
- In order to improve the detection efficiency for photon, the study focus on the optimization of geometry, especially copper rings and cathode.

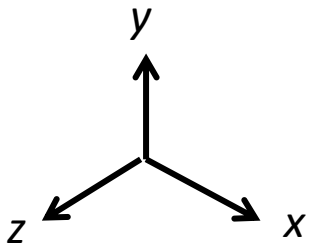
- Changed the aperture ratio of cathode and the shape of copper rings.



XEMIS2 geometry and source

- radial 7 < r < 19 cm
- axial (z) Length = 2 × 12 cm
  (divided by cathode)
- Electric Field in z direction 2 kV/cm
- Pad size : 3.175 x 3.175 mm^2
- Source
  - Positron
  - Shape : sphere (r = 1.0 cm)
  - Direction : constant (θ = 60° , ϕ = 90°)
- Drift velocity : 2.3 mm/usec
- PMTs
  - 2inch : 4 x 20
    (4.624 x 4.624 cm^2)
    (divide PhotoCathode by 2(*v*) and 4(*u*))

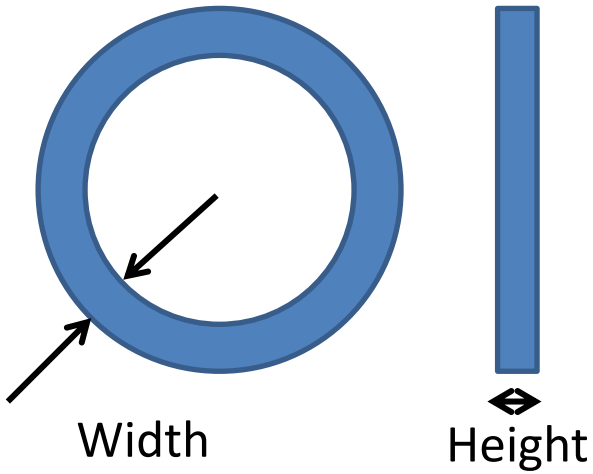




Table

- The table shows the matrix of cathode and copper rings.
  - (width, height, interval)
  - C.R. means “Copper Ring”. A.R. means “Aperture Ratio”.

C.R. / A.R.	Pattern0	Pattern1	Pattern2	Pattern3	Pattern4
1.0	(0, 0, 0)	(4, 1, 5)	(2, 1, 5)	(4, 1, 10)	(2, 1, 10)
0.5	(0, 0, 0)	(4, 1, 5)	(2, 1, 5)	(4, 1, 10)	(2, 1, 10)
0	(0, 0, 0)	(4, 1, 5)	(2, 1, 5)	(4, 1, 10)	(2, 1, 10)



Results

- These show the average number of photoelectron detected by PMTs.
  - Energy of gamma is 511[keV].
  - Data acquisition is not completed at A.R. = 0.5, because definition of geometry is complicated.

A.R. \ C.R.	Pattern0	Pattern1	Pattern2	Pattern3	Pattern4
1.0	555.00	244.26 +/- 0.40	324.05 +/- 0.52	377.51 +/- 2.07	428.47 +/- 0.90
0.5	—	—	—	—	—
0	—	214.68 +/- 0.52	259.68 +/- 1.27	291.25 +/- 1.62	310.28 +/- 3.63

These errors mean the fitting error.

Results

- Energy resolution (σ)

C.R. / A.R.	Pattern0	Pattern1	Pattern2	Pattern3	Pattern4
1.0	—	9.2 [%] (σ : 22.53 +/-0.35)	9.4 [%] (σ : 30.32 +/-0.44)	9.9 [%] (σ : 37.36 +/-1.50)	10.6 [%] (σ : 45.32 +/-0.82)
0.5	—	—	—	—	—
0	—	13.3 [%] (σ : 28.60 +/-0.43)	22.4 [%] (σ : 58.10 +/-1.38)	21.7 [%] (σ : 63.19 +/-1.99)	27.7 [%] (σ : 85.91 +/-3.23)

These errors mean the fitting error.

These don't follow the $\frac{1}{\sqrt{N}}$

Check the analysis program

- In order to improve the analysis program and eliminate its bug, I check it and summarize the code.

- The goal is that program shows the energy resolution, average number of photoelectron, sigma of u and v, and these relationship between D.

Check the analysis program

- Analysis procedure

・Define the variables
・Output data open
In each event
read the data
fill the histogram
calculate the D and center of gravity

2D histogram
(u, v), (<u>, D), (<v>, D) etc.
1D histogram
(number of photoelectron),
(D) etc.

・Draw the histograms
・Fit the histogram for number of photoelectron
get the energy resolution
・Get the Slices of <u>-D histogram and <v>-D histogram
・Get the sigma of <u> and <v> in each D

Check the analysis program

- Check list
  - formula
  - variable
  - use of ROOT function

Now modifying…….

Next

- Improve the analysis program