GATE Simulation study

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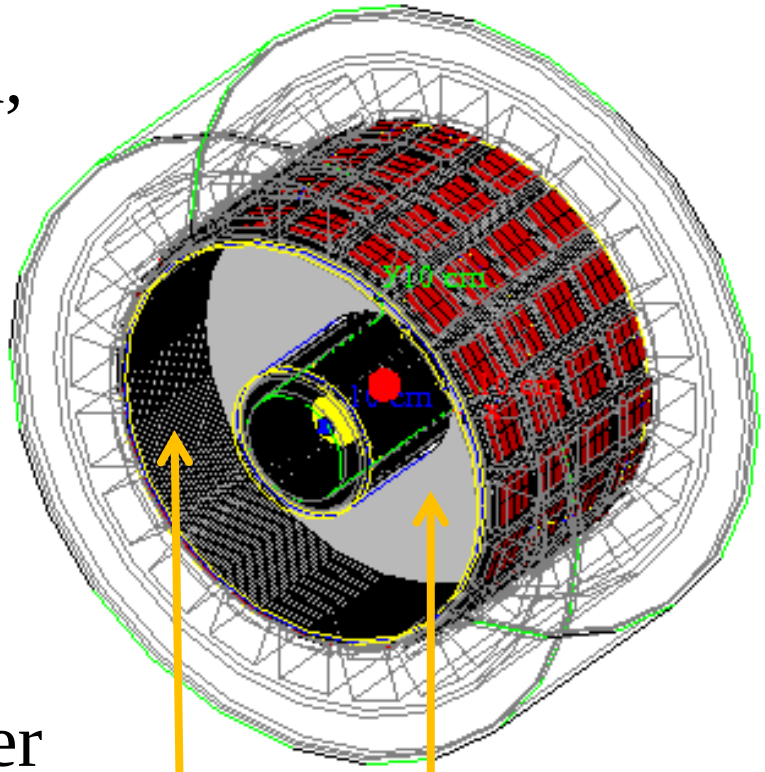
- GATE simulation
  - optimization of copper ring and Cathode for photon collection

GATE simulation

Detection efficiency for photon

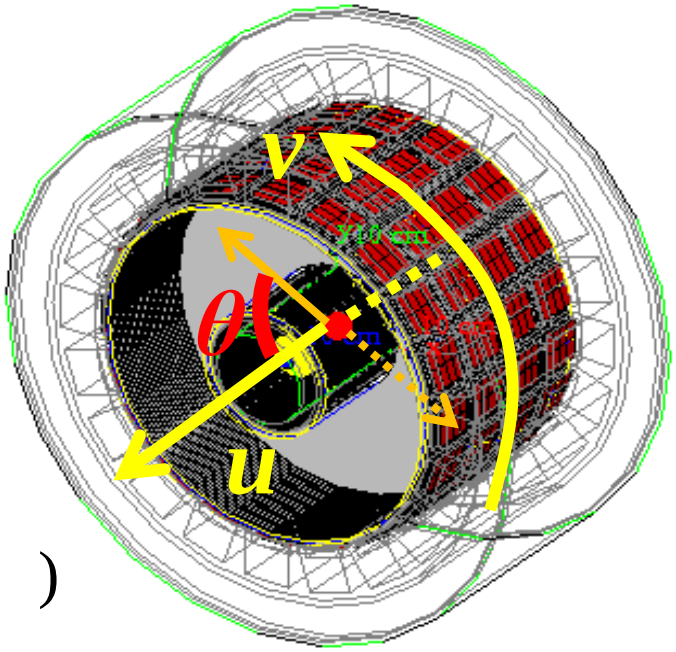
- In order to improve the detection efficiency for photon, the study focus on the optimization of geometry, especially copper rings and cathode.

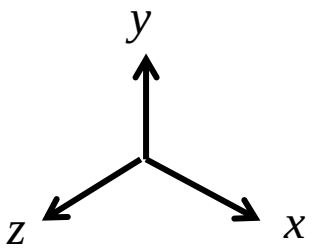
- Changed the aperture ration of cathode and the shape of copper rings.



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 ($\theta = 60^\circ$, $\varphi = 90^\circ$)
- 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*))

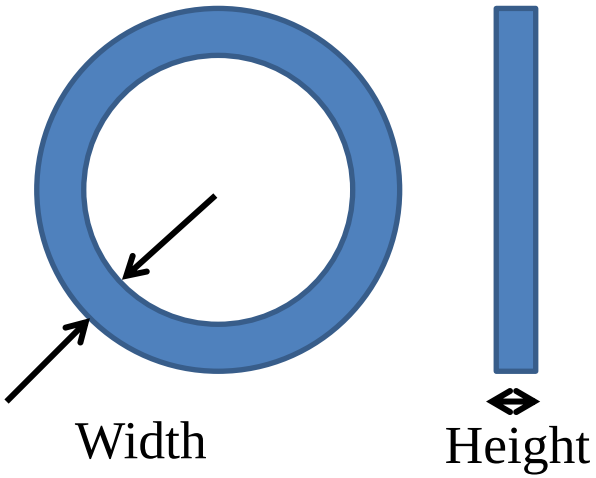




Table

- 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.	Patterm0	Patterm1	Pattern2	Pattern3
1.0	(0, 0, 0)	(4, 1, 5)	(2, 1, 5)	(4, 1, 10)
0.5	(0, 0, 0)	(4, 1, 5)	(2, 1, 5)	(4, 1, 10)
0	(0, 0, 0)	(4, 1, 5)	(2, 1, 5)	(4, 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.P. = 0.5, because definition of geometry is complicated.

A.R. \ C.R.	Patterm0	Patterm1	Pattern2	Pattern3
1.0	555.00	243.27 → 324.05 (33% up) → 377.51 (16% up)		
0.5	—	—	—	—
0	—	216.03 → 252.57 (17% up) → 285.08 (13% up)		

55% up

32% up

Conclusion

- Check the effect of copper ring and cathode.
- Interval of copper ring is more influential than width for photon collection.
- The evaluation of cathode is not completed because it is difficult to define the mesh cathode.

- To evaluate the shape of copper ring and cathode, I need to measure the energy resolution.

Next

- Change the geometry
  - For mesh cathode
- evaluate the energy resolution