

GATE Simulation study

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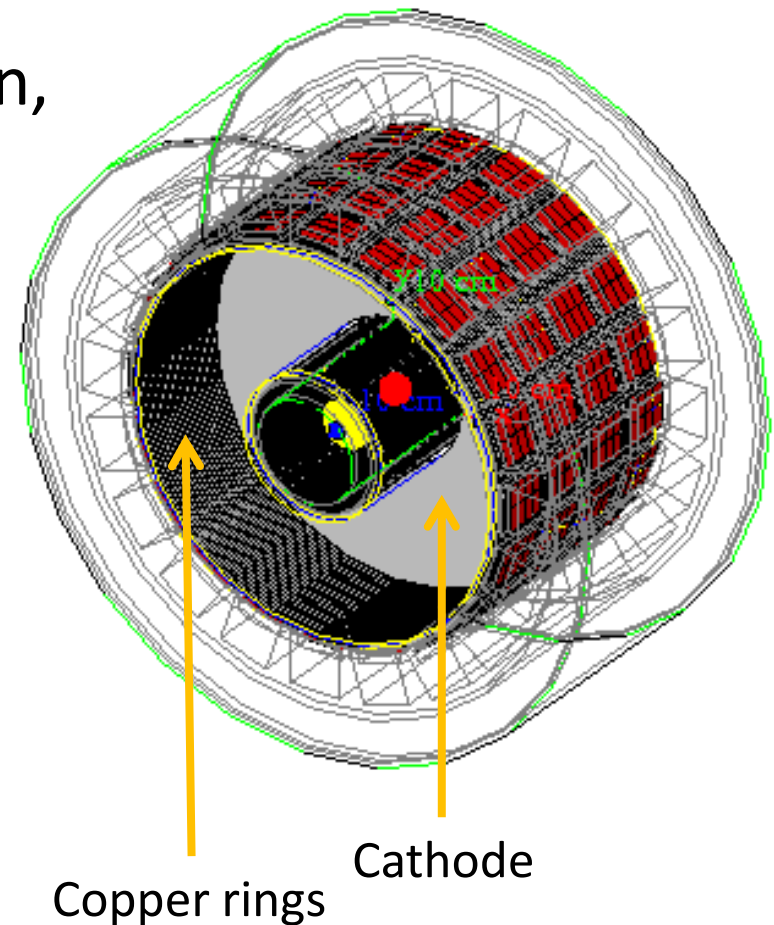
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- GATE simulation
 - define the mesh cathode
 - analyze the data for energy resolution

GATE simulation

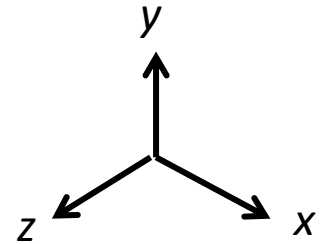
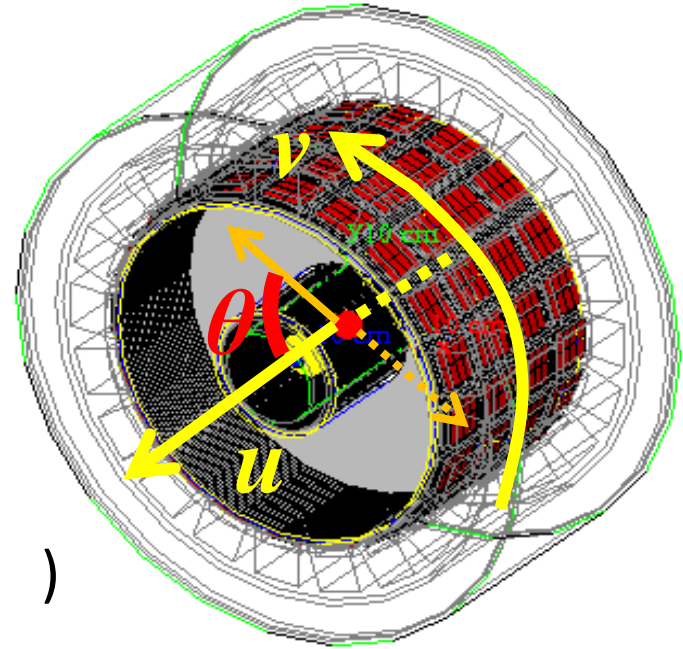
Detection efficiency for photon

- 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 : 3.175×3.175 mm²
- Source
 - Positron
 - Shape : sphere ($r = 1.0$ cm)
 - Direction : constant ($\theta = 60^\circ$, $\phi = 90^\circ$)
- Drift velocity : 2.3 mm/usec
- PMTs
 - 2inch : 4×20
(4.624×4.624 cm²)
(divide PhotoCathode by 2(v) and 4(u))

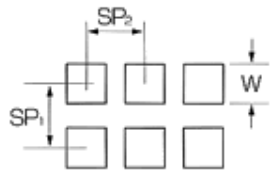


Mesh cathode

- 50 mesh
 - SUS(SUS304) wire : $2r=0.10$ [mm], $d(\text{interval})=0.41$ [mm]
 - aperture ratio : 57[%] $(S_{\text{cavity}}/S_{\text{whole}})^2$

⑦ 角穴並列型

開孔率 (%) = $\frac{W^2}{SP_1 \times SP_2} \times 100$



入力項目

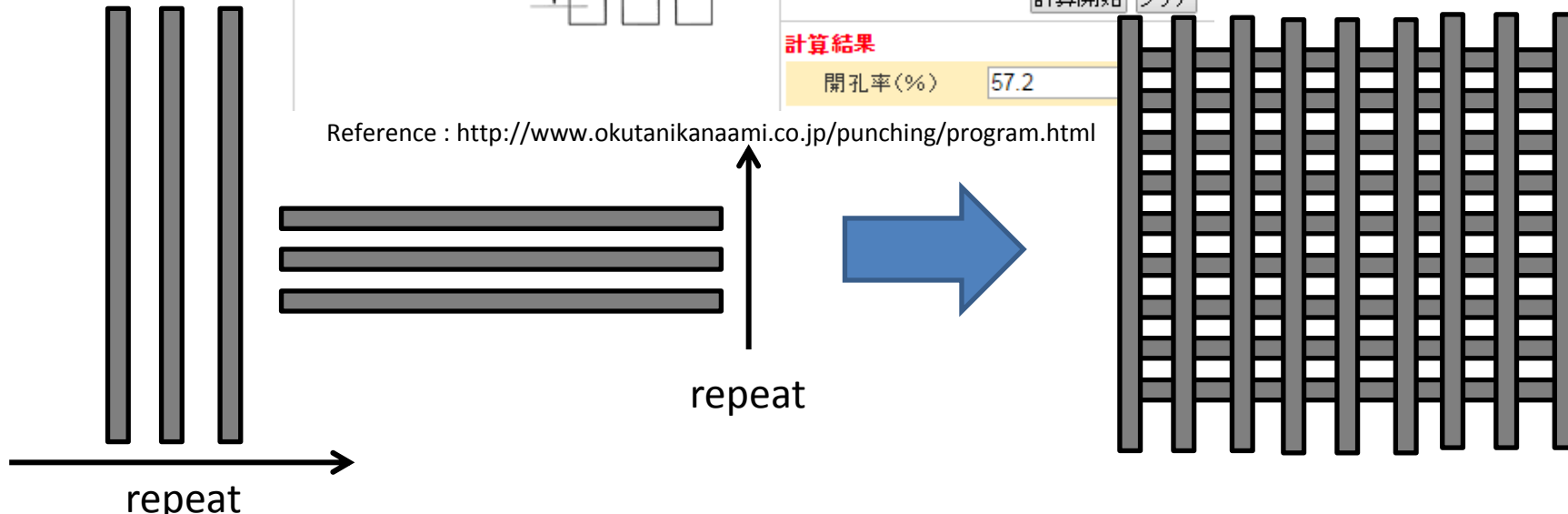
W	0.31
SP 1	0.41
SP 2	0.41

計算開始 クリア

計算結果

開孔率 (%)	57.2
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Reference : <http://www.okutanikanaami.co.jp/punching/program.html>



Mesh cathode

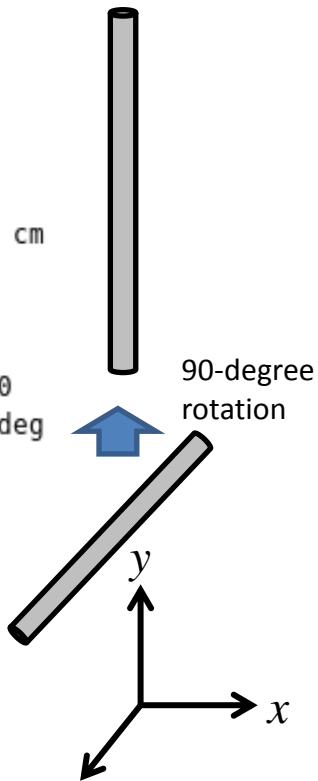
- GATE macro

```
#####
# Mesh Cathode1 #
#####

/gate/xenon/daughters/name Cathode1
/gate/xenon/daughters/insert cylinder
/gate/Cathode1/placement/setTranslation 0 0 0 cm
/gate/Cathode1/geometry/setRmax 0.10 mm
/gate/Cathode1/geometry/setRmin 0. mm
/gate/Cathode1/geometry/setHeight 400 mm
/gate/Cathode1/placement/setRotationAxis 1 0 0
/gate/Cathode1/placement/setRotationAngle 90 deg
/gate/Cathode1/setMaterial SS304
/gate/Cathode1/vis/setColor gray
/gate/Cathode1/vis/forceWireframe
#/gate/Cathode1/vis/setVisible 1

#####
# Mesh Cathode1 repeater #
#####

/gate/Cathode1/repeaters/insert linear
/gate/Cathode1/linear/setRepeatNumber 975
/gate/Cathode1/linear/setRepeatVector 0.41 0 0 mm
```



hollowing out

```
#####
# Add Air #
#####

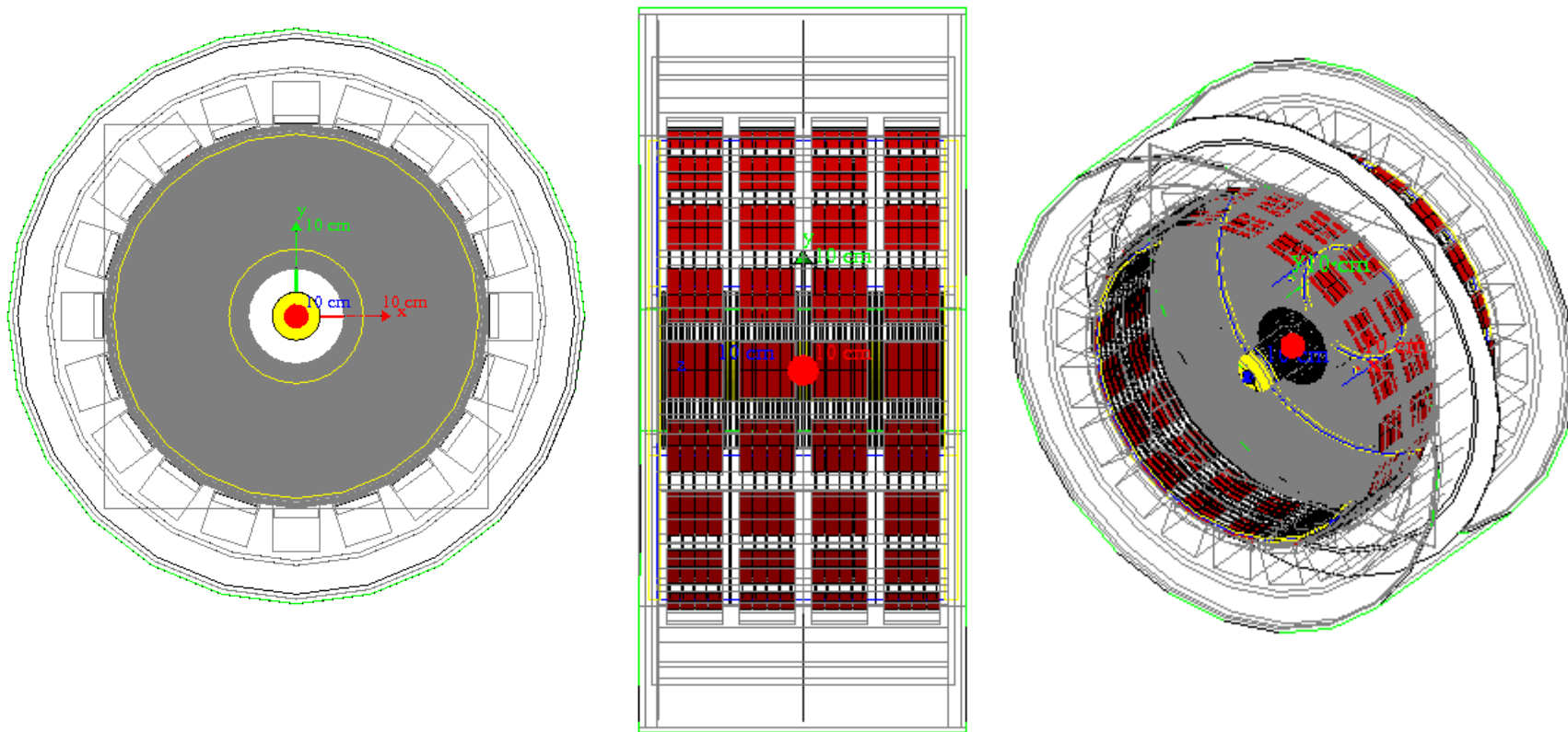
/gate/xenon/daughters/name AddAir
/gate/xenon/daughters/insert cylinder
/gate/AddAir/placement/setTranslation 0 0 0 cm
/gate/AddAir/geometry/setRmax 5. cm
/gate/AddAir/geometry/setRmin 0. cm
/gate/AddAir/geometry/setHeight 1. mm
/gate/AddAir/setMaterial Air
/gate/AddAir/vis/setColor white
#/gate/AddAir/vis/forceSolid
/gate/AddAir/vis/setVisible 1

#####
# Add Xenon #
#####

/gate/xenon/daughters/name AddXenon
/gate/xenon/daughters/insert cylinder
/gate/AddXenon/placement/setTranslation 0 0 0 cm
/gate/AddXenon/geometry/setRmax 25.5 cm
/gate/AddXenon/geometry/setRmin 20 cm
/gate/AddXenon/geometry/setHeight 1. mm
/gate/AddXenon/setMaterial LXenon
/gate/AddXenon/vis/setColor white
#/gate/AddXenon/vis/forceWireframe
#/gate/AddXenon/vis/forceSolid
/gate/AddXenon/vis/setVisible 1
```

Mesh cathode

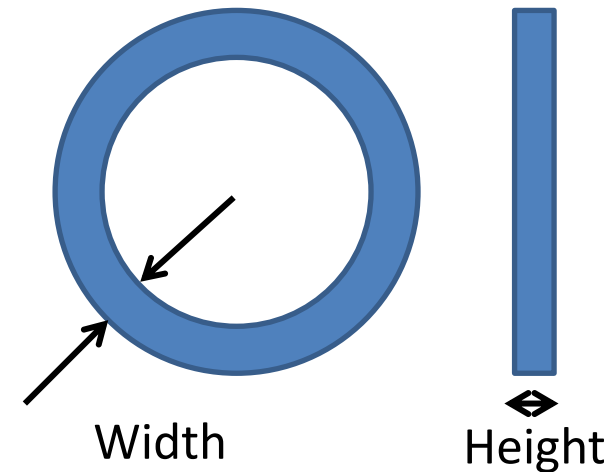
- GATE macro



Table

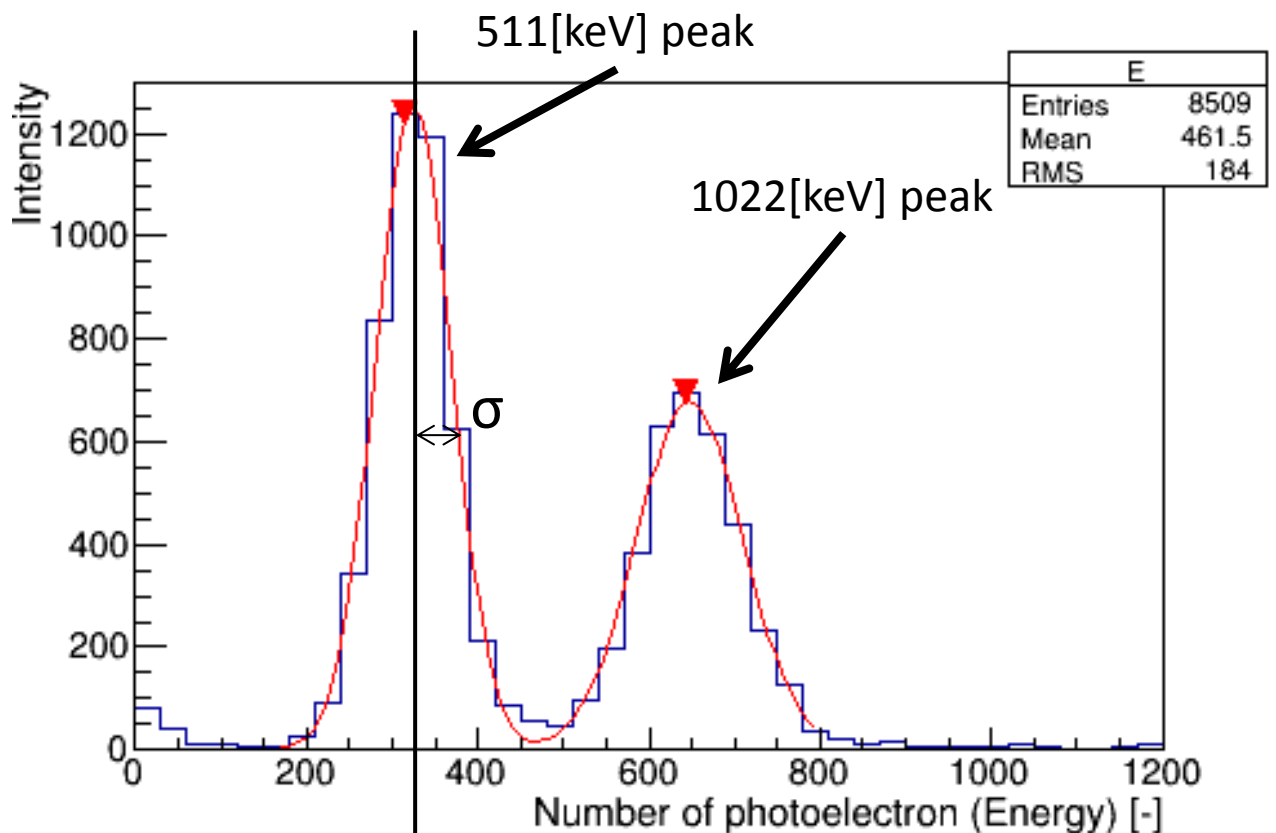
- The table shows the matrix of cathode and copper rings.
 - (width, height, interval)
 - C.R. means “Copper Ring”. A.R. means “Aperture Ratio”.

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)
0.57	(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










- Fitting Example (A.R. = 0.5, Pattern2)



Number of photoelectron
detected by PMT in one event

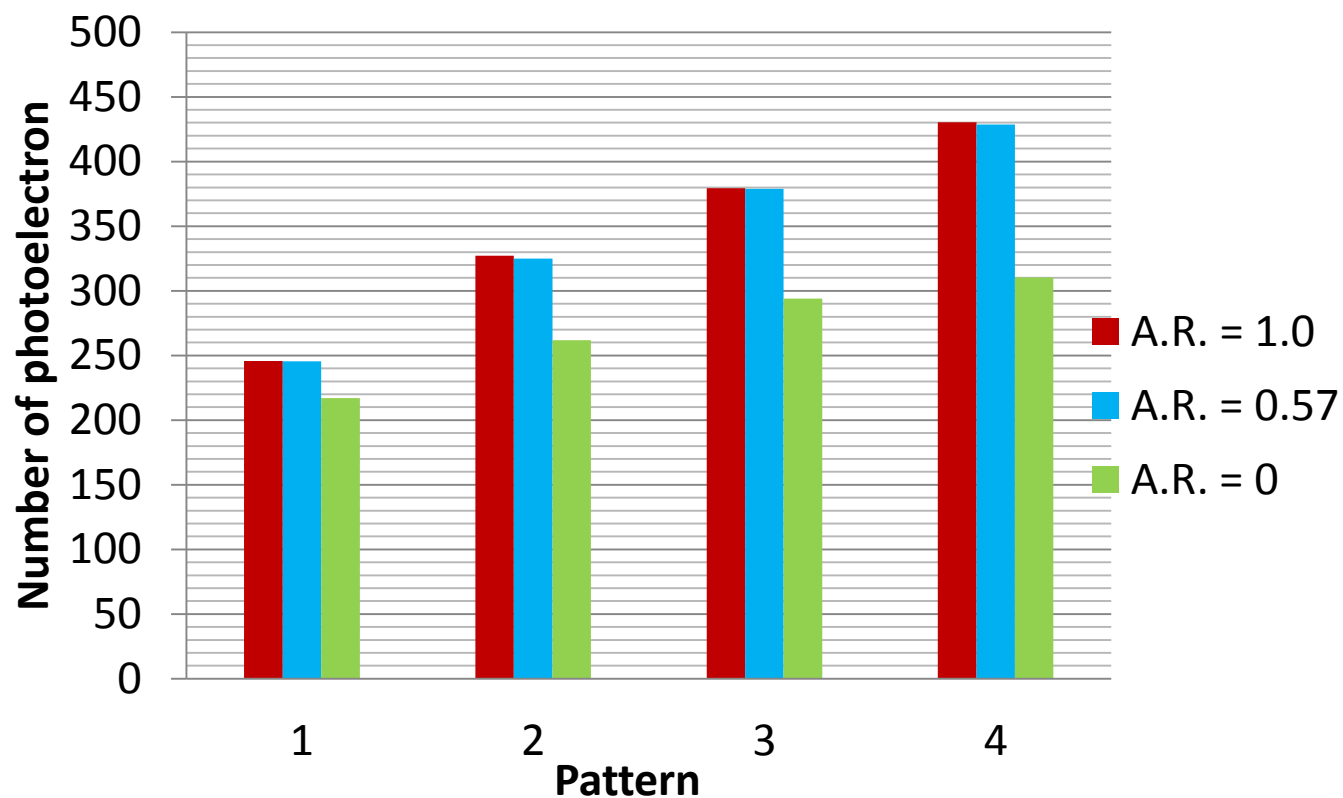
Results

- These show the average number of photoelectron detected by PMTs.
 - Energy of gamma is 511[keV].
 - These errors are the fitting error.

A.R.	C.R.	Pattern0	Pattern1	Pattern2	Pattern3	Pattern4
1.0		538.73 +/- 1.47	245.61 +/- 0.50	 327.12 +/- 0.68	 379.30 +/- 0.78	 430.41 +/- 0.98
0.57		538.34 +/- 1.41	245.41 +/- 0.51	 324.81 +/- 0.66	 378.83 +/- 0.80	 428.66 +/- 0.94
0		355.00 +/- 3.63	217.02 +/- 0.63	 261.92 +/- 1.11	 293.91 +/- 1.47	 310.44 +/- 2.50

Results

- 2D graph



Results

- σ (@511[keV])
 - These errors are the fitting error.

C.R. A.R.	Pattern0	Pattern1	Pattern2	Pattern3	Pattern4
1.0	88.50 +/- 1.44	33.98 +/- 0.41	46.42 +/- 0.56	53.00 +/- 0.68	63.93 +/- 0.84
0.57	86.30 +/- 1.36	33.95 +/- 0.41	44.37 +/- 0.56	54.30 +/- 0.69	62.29 +/- 0.82
0	80.48 +/- 3.42	40.03 +/- 0.49	54.96 +/- 0.75	61.76 +/- 0.89	72.74 +/- 1.79

Results

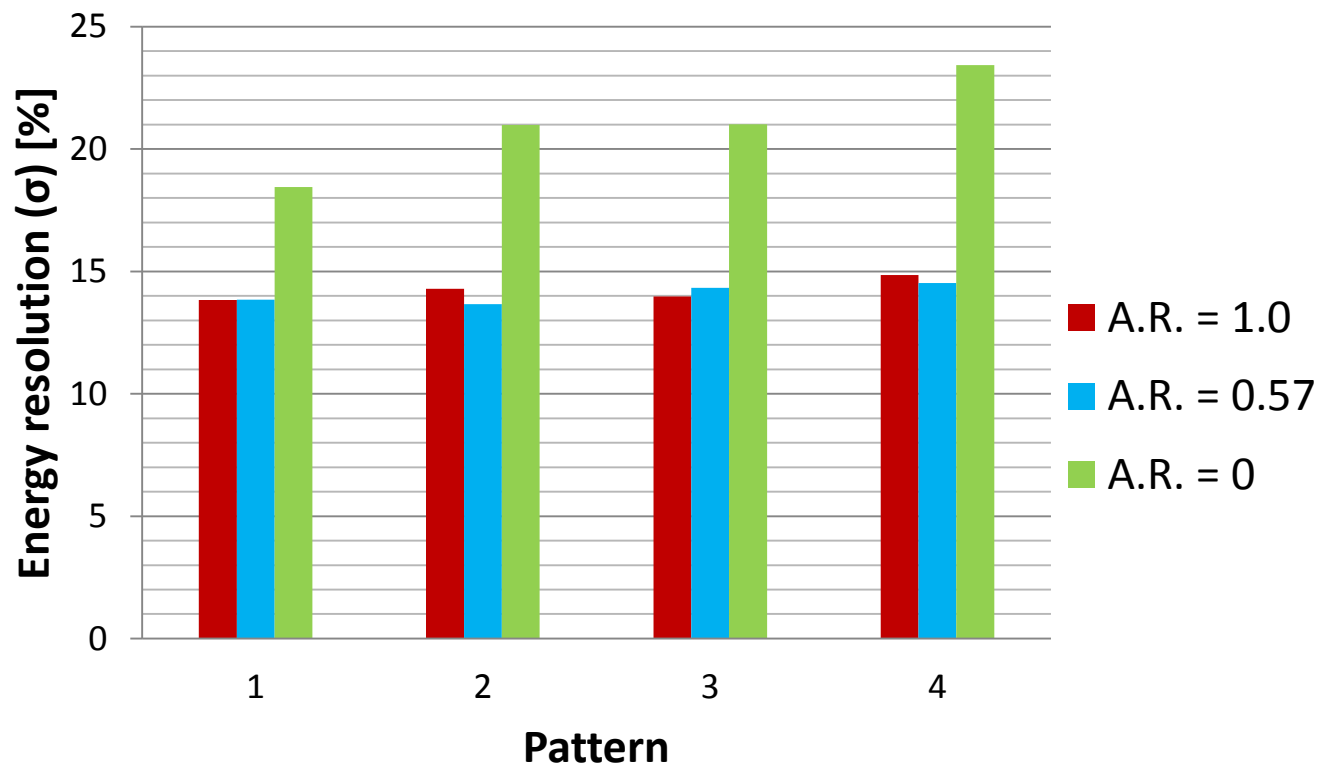
- Energy resolution (σ) (@511[keV])

A.R. \ C.R.	Pattern0	Pattern1	Pattern2	Pattern3	Pattern4
1.0	16.43 [%] +/- 1.65	13.83 [%] +/- 1.21	14.29 [%] +/- 1.22	13.97 [%] +/- 1.31	14.85 [%] +/- 1.33
0.57	16.03 [%] +/- 1.60	13.84 [%] +/- 1.23	13.66 [%] +/- 1.27	14.33 [%] +/- 1.29	14.53 [%] +/- 1.34
0	22.67 [%] +/- 4.37	18.45 [%] +/- 1.27	20.98 [%] +/- 1.42	21.01 [%] +/- 1.53	23.43 [%] +/- 2.59

The results of 0.57 show the almost same energy resolution, comparing with 1.0.

Results

- 2D graph



Conclusion

- Define the mesh cathode
- Get the energy resolution in case the aperture ration is 0, 0.57, and 1.
- In case the aperture ration is 0.57 and , these results showed the almost same energy resolution.

Next



- Make the presentation file for proposal to Subatech.

Copper mesh

銅 平織金網

2010年7月1日現在

2.5mesh～100mesh 在庫表 (稲田金網株式会社)

mesh メッシュ	線径 (φ)	頻 度	組織	開目 (mm)	開口率 (%)	m ² /kg	金網幅 910mm	
							910X30m	切売対応
2.5 mesh	1.20		平織	8.96	77.8	1.88	ask	ask
	1.10			9.06	79.5	1.58	○	○
4 mesh	1.10			5.25	68.4	2.53	ask	ask
	0.80			5.55	76.4	1.34	○	○
5 mesh	0.80			4.28	71.0	1.67	○	○
	0.70			4.38	74.3	1.28	ask	ask
8 mesh	0.55			2.63	68.4	1.26	○	○
10 mesh	0.55			1.99	61.4	1.58	○	○
	0.45			2.09	67.7	1.06	○	○
12 mesh	0.45			1.67	62.1	1.27	ask	ask
16 mesh	0.45			1.14	51.4	1.69	○	○
	0.28			1.31	67.9	0.66	ask	ask
	0.25			1.34	71.0	0.52	○	○
20 mesh	0.40			0.87	46.9	1.67	ask	ask
	0.28			0.99	60.8	0.82	ask	ask
30 mesh	0.28			0.57	45.0	1.23	○	○
40 mesh	0.22			0.42	43.1	1.01	○	○
50 mesh	0.23			0.28	30.1	1.38	ask	ask
	0.18			0.33	41.9	0.85	○	○
60 mesh	0.14			0.28	44.8	0.63	○	○
80 mesh	0.14		0.18	31.6	0.82	○	○	
100 mesh	0.11		0.14	32.1	0.64	ask	ask	