

# GATE Simulation study

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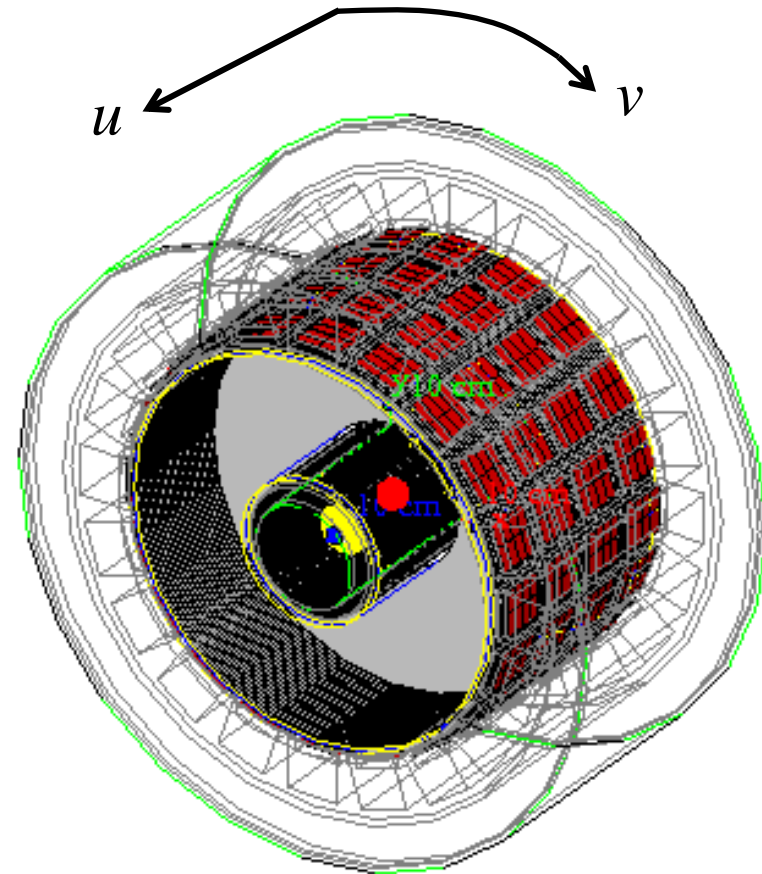
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- GATE simulation
  - compare the center of photoelectron distribution with one of interaction position
  - calculate the solid angle

# GATE simulation

# XEMIS2 Geometry

- radial  $7 < r < 19$  cm
- axial (z) Length =  $2 \times 12$  cm  
(divided by cathode)
- Electric Field in z direction 2 kV/cm
- Pad size :  $3.175 \times 3.175$  mm<sup>2</sup>
- Source <sup>44</sup>Sc ( $\beta^+$ ,  $\gamma$  : 1.157 MeV)
- Source position  
(sphere :  $r = 1.0$  cm)
- Drift velocity : 3 mm/usec
- PMTs
  - 2inch :  $4 \times 20$   
( $4.624 \times 4.624$  cm<sup>2</sup>)  
(divide PhotoCathode by  $2(v)$  and  $4(u)$ )



# Compared the center of photoelectron distribution with one of interaction position

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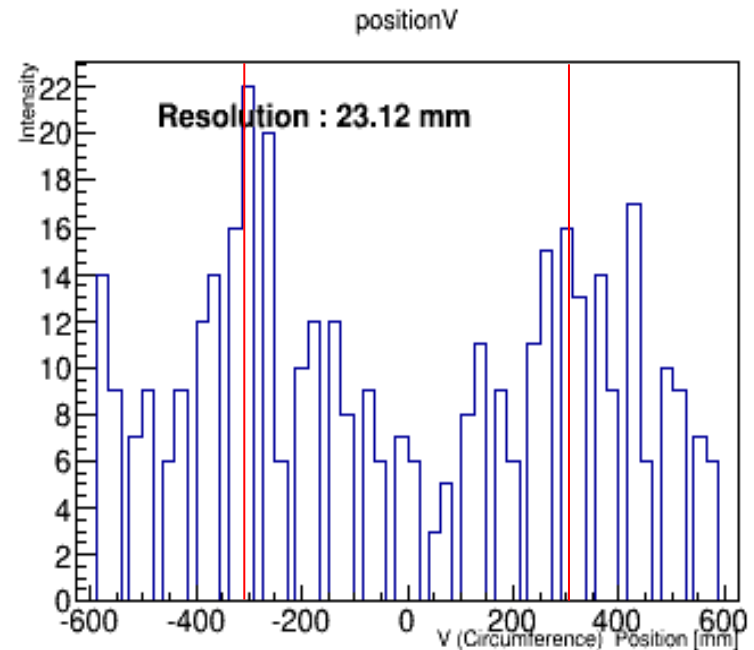
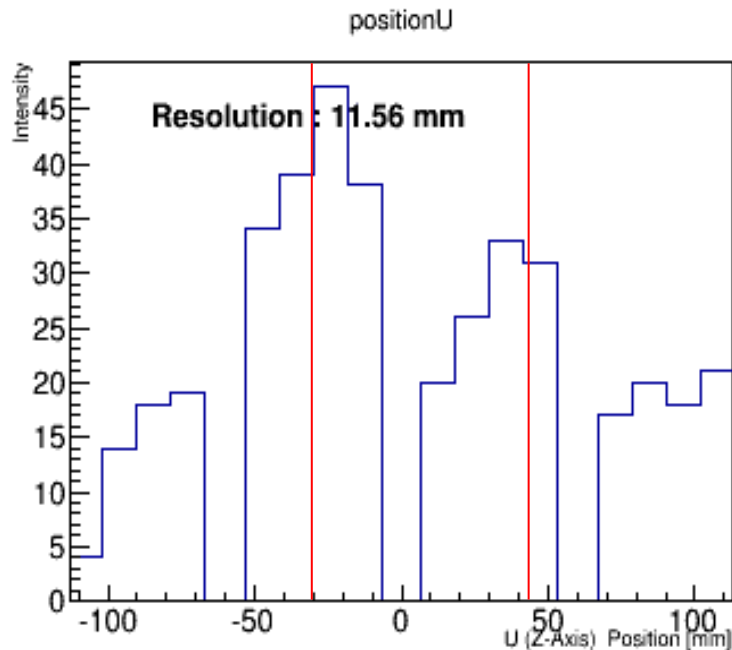
- In order to check the accuracy of simulation, I confirmed the center position of interaction and compare it with peak position of photon distribution
- If correct, these shows almost same positions in  $v$ -plane and  $u$ -plane.

# Compared the center of photoelectron distribution with one of interaction position

- Interaction position (unit : mm)
  - $(u, v, w) = (43, 316.53, 106.49)$  positron1 compton
  - $(u, v, w) = (42.7, 316.47, 103.89)$  positron1 photoelectric
  - $(u, v, w) = (-30.3, -316.21, 91.9)$  positron2 photoelectric
- Concerning to positron1, compton scattering and photoelectric are occurred in this case, but these positions are almost same in resolution of reconstruction.

# Compared the center of photoelectron distribution with one of interaction position

- Compared the simulation results (unit : mm)



These shows good match.

# Calculate the solid angle

- In order to confirm the accuracy of simulation, I calculated the number of photoelectron in each photocathode by solid angle
- In this case, depth of interaction position from photocathode is much longer than  $u$  and  $v$  length of photocathode.



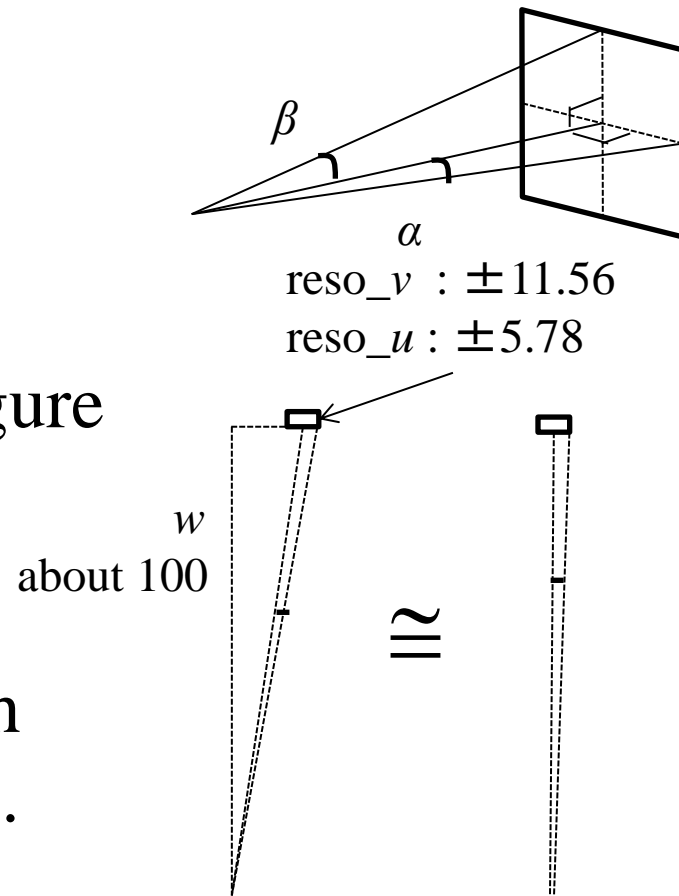
# Calculate the solid angle

- Equation :

$$\Omega = 4 \arcsin(\sin \alpha \sin \beta)$$

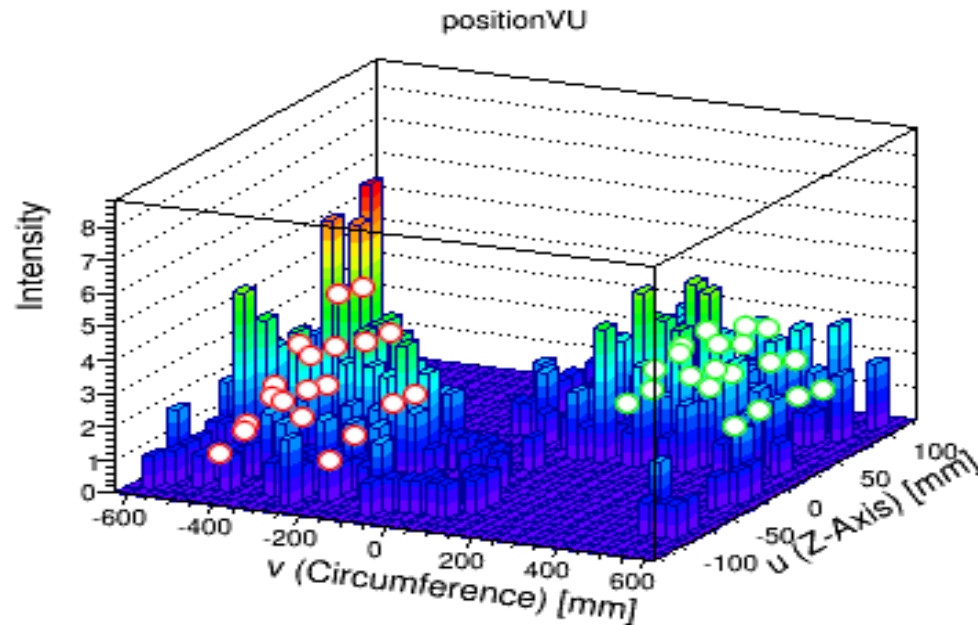
- In this time, solid angle is approximated like right figure because  $w \gg \Delta v$  ( $\Delta u$ ).

- Calculated 20 points which surround the peak position.



# Calculate the solid angle

- Results
  - red and green markers are the calculated results
  - generated 2068 photoelectron



It is difficult to judge the match or not by only this graph

# Calculate the solid angle

- Results (based on positron2 data, calculated by Excel)
  - generated 2068 photoelectron

U-ID	V-ID	$\angle U$	$\angle V$	$\alpha$	$\beta$	solid angle( $\Omega/4\pi$ )	number of photoelectron	simulation results	match or not
1	5	65.480	135.168	0.040	0.038	0.00048	1.000	1	○
1	7	65.480	72.336	0.040	0.073	0.00094	1.944	1	○
1	9	65.480	9.505	0.040	0.122	0.00157	3.246	2	○
1	11	65.480	53.327	0.040	0.089	0.00114	2.366	1	×
1	13	65.480	116.159	0.040	0.046	0.00059	1.215	2	○
3	5	42.360	135.168	0.051	0.038	0.00060	1.250	2	○
3	7	42.360	72.336	0.051	0.073	0.00117	2.429	2	○
3	9	42.360	9.505	0.051	0.122	0.00196	4.056	2	×
3	11	42.360	53.327	0.051	0.089	0.00143	2.957	2	○
3	13	42.360	116.159	0.051	0.046	0.00073	1.518	1	○
5	5	5.480	135.168	0.062	0.038	0.00074	1.539	2	○
5	7	5.480	72.336	0.062	0.073	0.00145	2.991	5	○
5	9	5.480	9.505	0.062	0.122	0.00241	4.993	4	○
5	11	5.480	53.327	0.062	0.089	0.00176	3.641	3	○
5	13	5.480	116.159	0.062	0.046	0.00090	1.869	2	○
7	5	17.640	135.168	0.060	0.038	0.00071	1.478	2	○
7	7	17.640	72.336	0.060	0.073	0.00139	2.873	3	○
7	9	17.640	9.505	0.060	0.122	0.00232	4.796	6	○
7	11	17.640	53.327	0.060	0.089	0.00169	3.497	4	○
7	13	17.640	116.159	0.060	0.046	0.00087	1.795	2	○

nearest

# Summary

- Confirmed the interaction position ( $u$  and  $v$ ) and compared it with the peak of photoelectron distribution.
  - It shows good match
- Calculated the solid angle from interaction position to photocathode and got the number of photoelectron detected by each PMTs.
  - Almost the simulation results and calculation results matches.

# Next

- Arrange the peak search program of TSpectrum2 (ROOT function) and test it.
  - generate the Gaussian peak with defined sigma
  - show the smoothed spectrum