Composition of RHICf-II detector

18 Aug 2021
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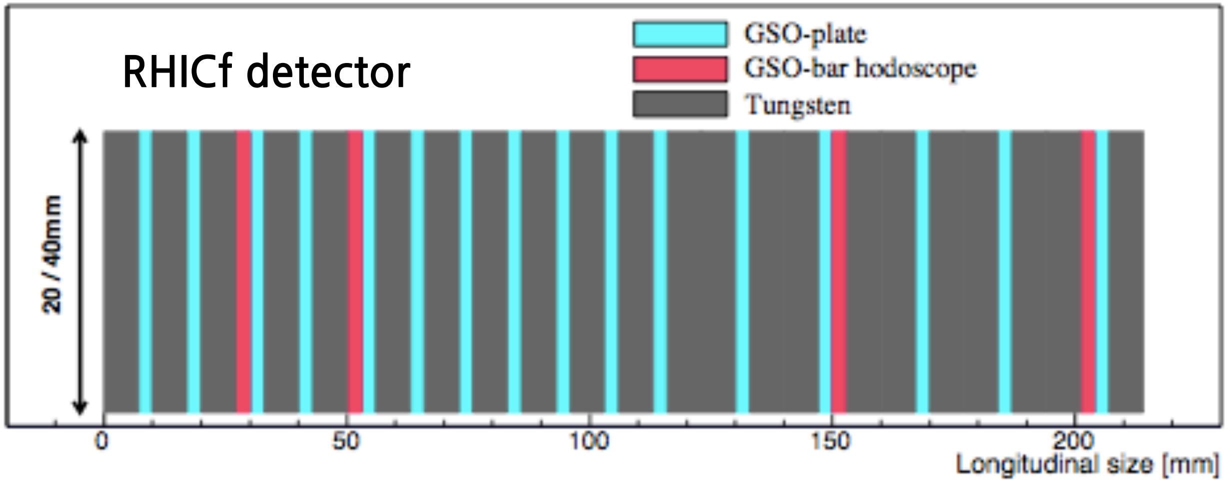
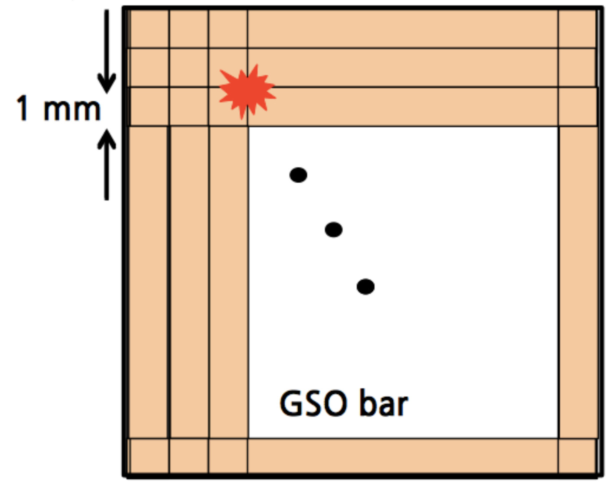
RHICf detector geometry

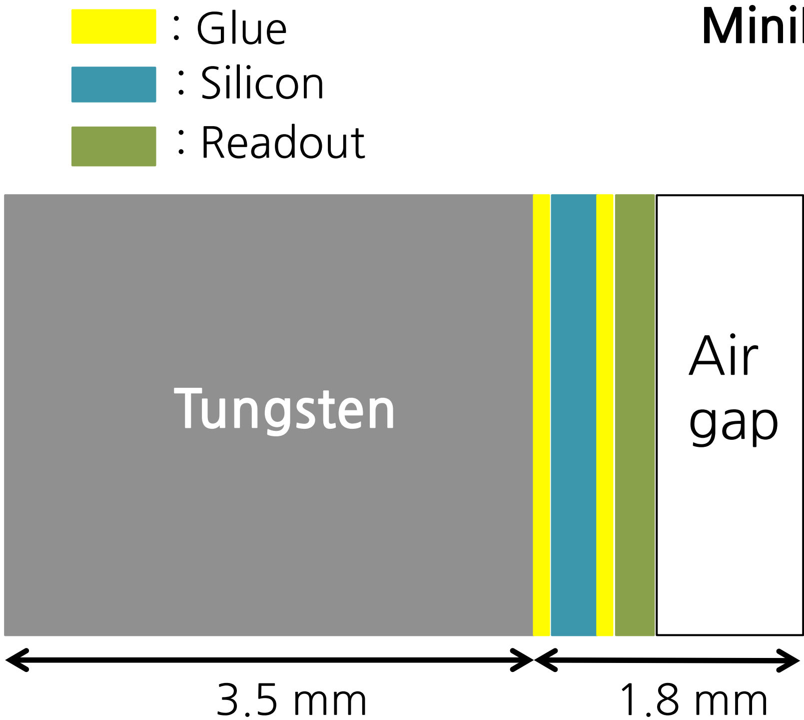
$44\ X_0$, $1.6\ \lambda_{int}$



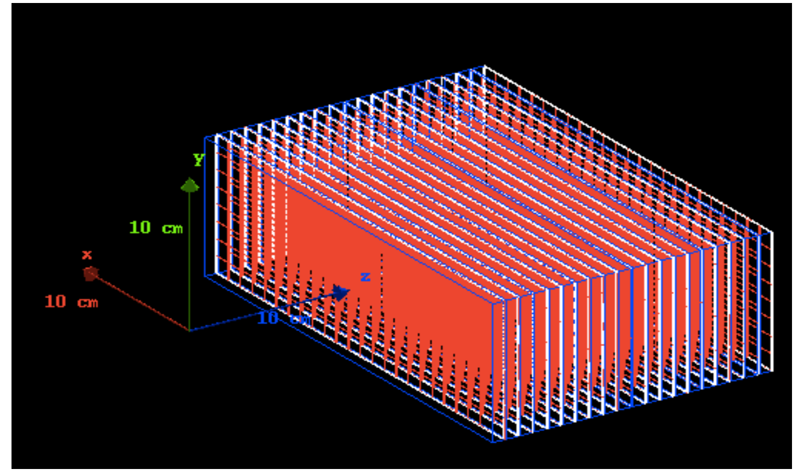


- RHICf detector consists of 17 (16) layers of tungsten, 16 layers of GSO-plate for energy measurement, and 4 layers of GSO-bars.
- Thickness of thinner forward tungsten is 7 mm and thicker backward one is 14 mm.
- It has enough radiation length for photon but poor nuclear length length for neutron.

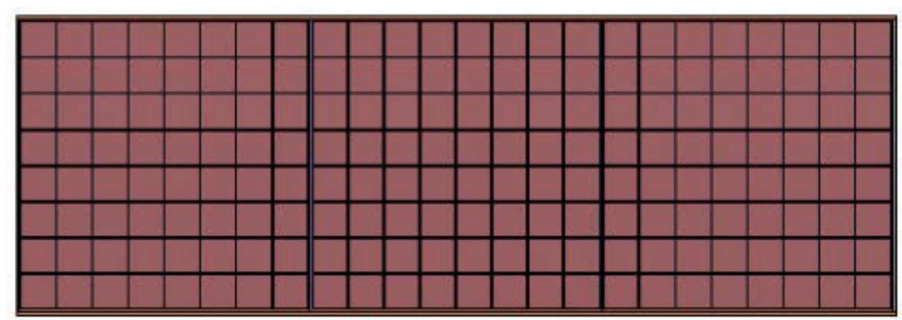
MiniFoCal geometry by Norbert



MiniFoCal

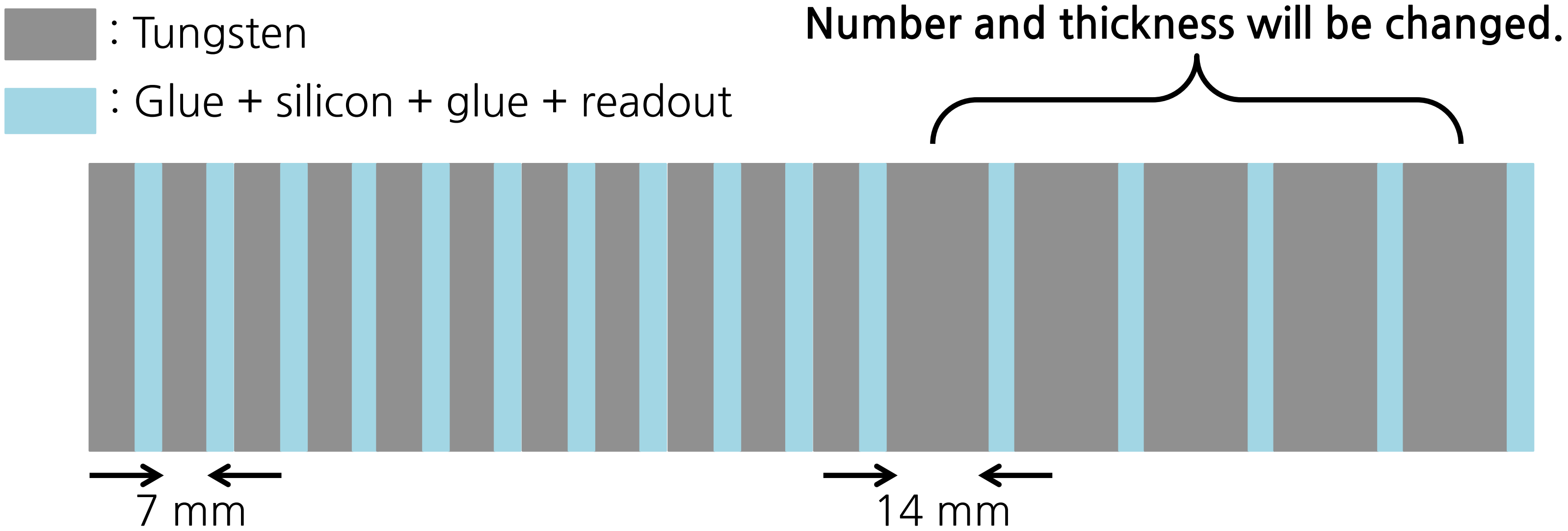


Silicon area (HG or LG)



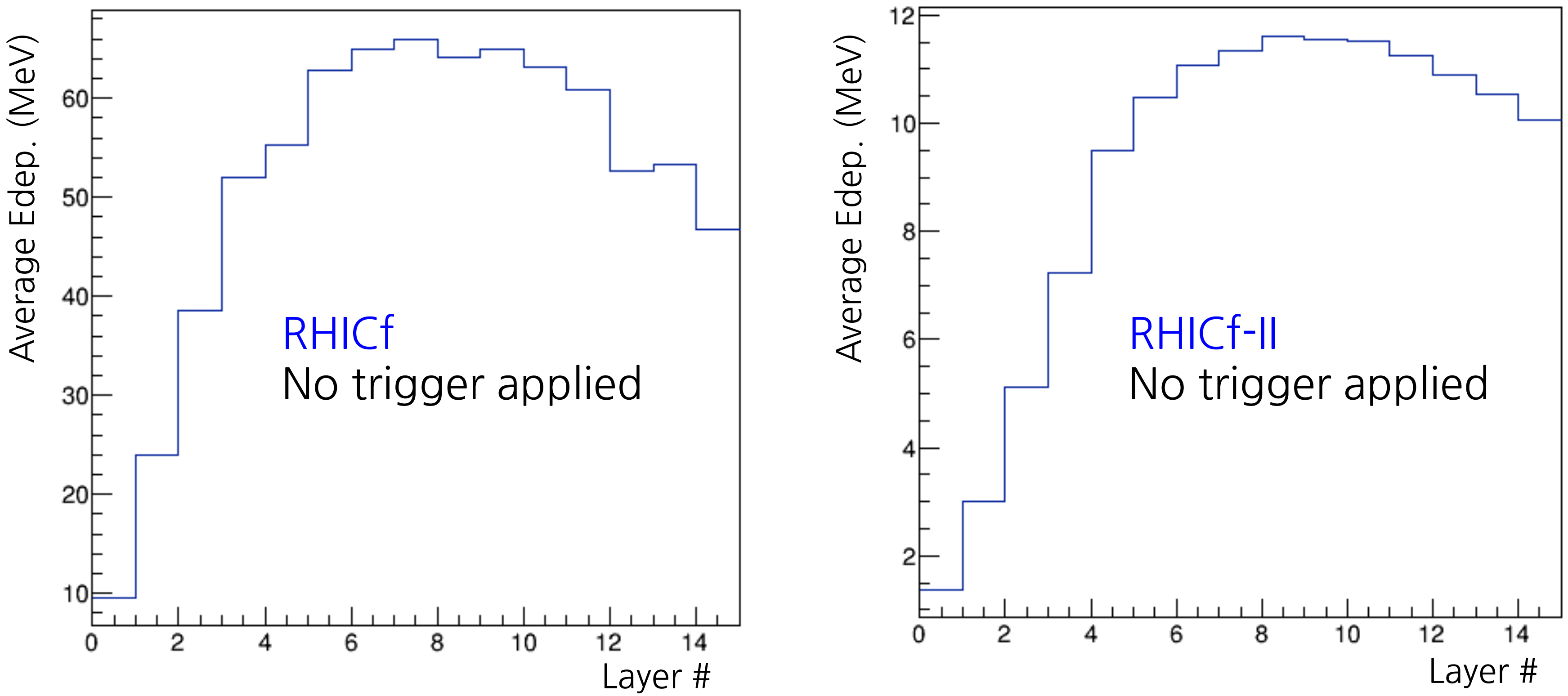
- RHICf-II detector follows MiniFoCal geometry which is composed of Si pads.
- HG: 0.3 mm x 0.3 mm, LG: 10 mm x 10 mm
- In the simulation, thickness of tungsten get thicker and the detector dimension is also modified to the RHICf-II one, 8 cm x 18 cm.

Simulation setup



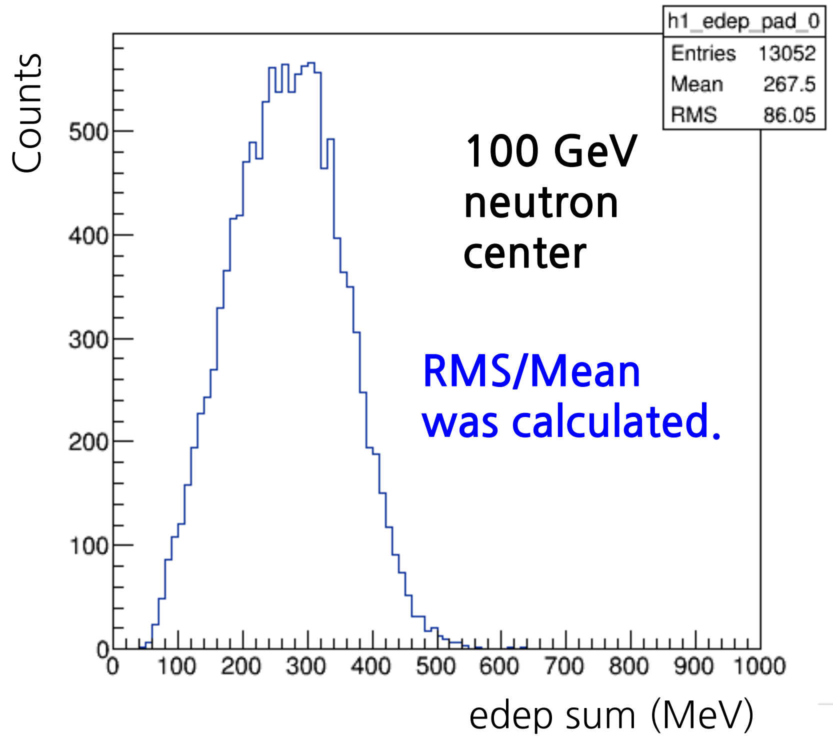
- The longitudinal tungsten dimension started from the RHICf detector one: forward 11 layers: 7 mm + backward 5 layers 14 mm.
- Photon energy resolution is enough.
- Neutron energy resolution depending on the number of thicker tungsten and their thickness was studied.
- Neutron and photon position resolution depending on the position of the HG layer was studied.

RHICf vs RHICf-II: 100 GeV neutron



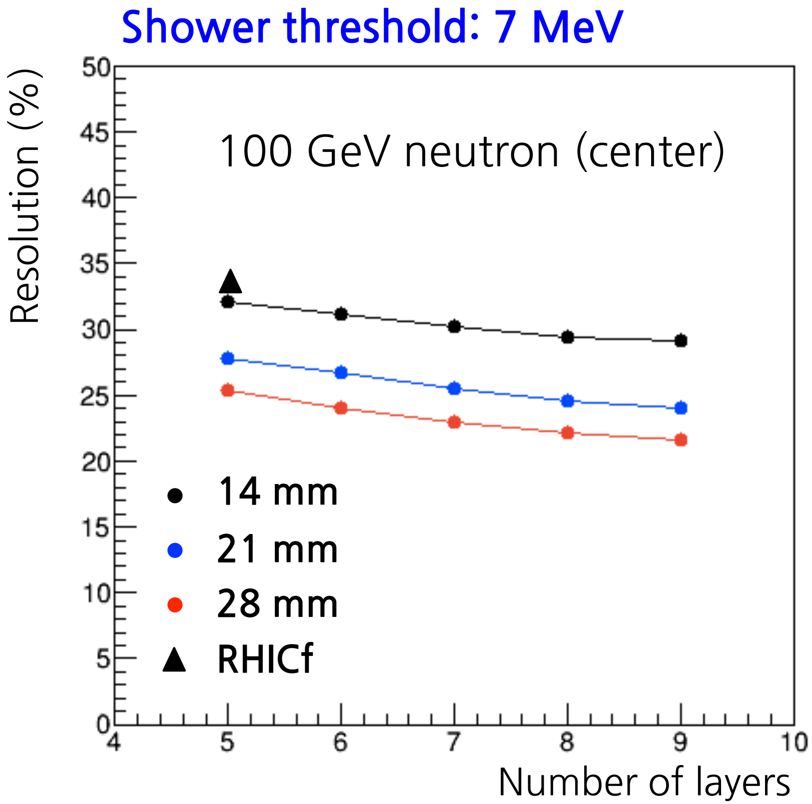
- Since the thickness of layer of the RHICf-II detector is thinner than RHICf one, the average Edep. is smaller.
- For a practical comparison, 7 MeV was applied for a shower trigger (Edep. of any three successive layer is larger than 7 MeV).

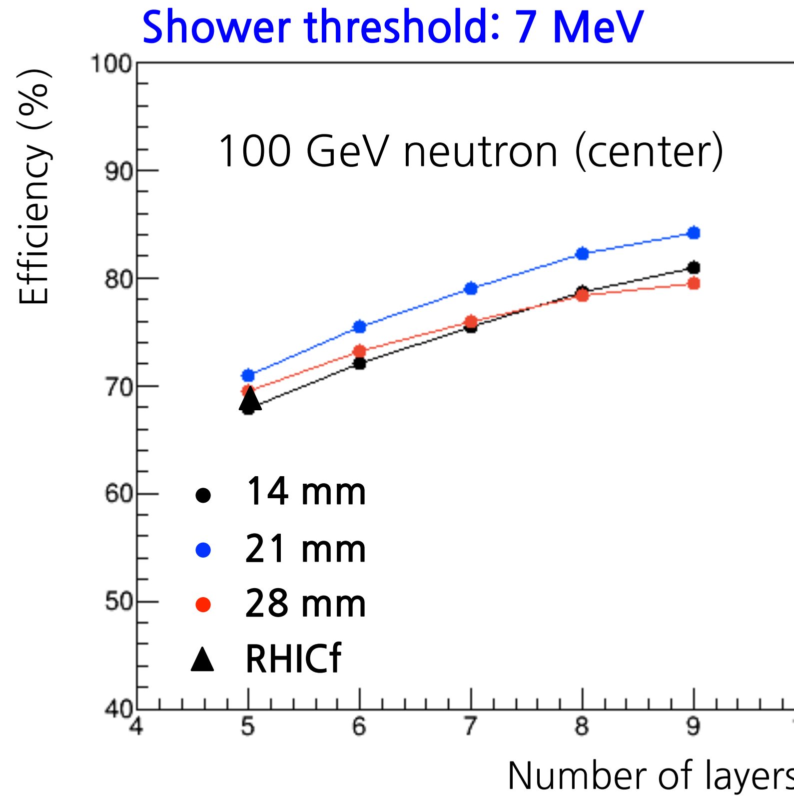
Energy reconstruction



- Only shower triggered events were used.
- The energy is reconstructed using the total energy deposits in the LG layers.
- When the energy is summed, Edeps of thicker tungsten were weighted following the tungsten thickness.

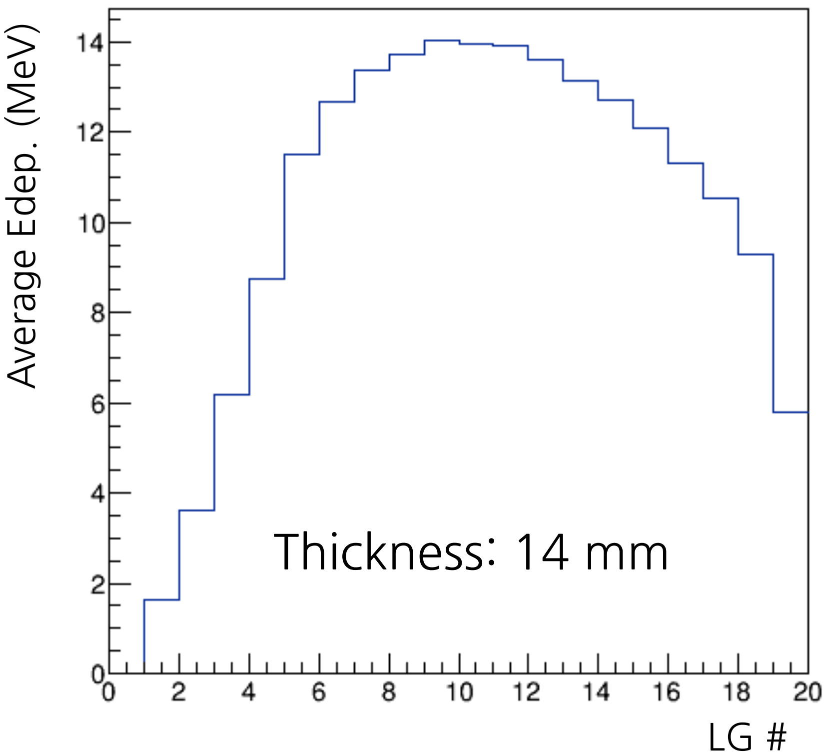
Energy resolution

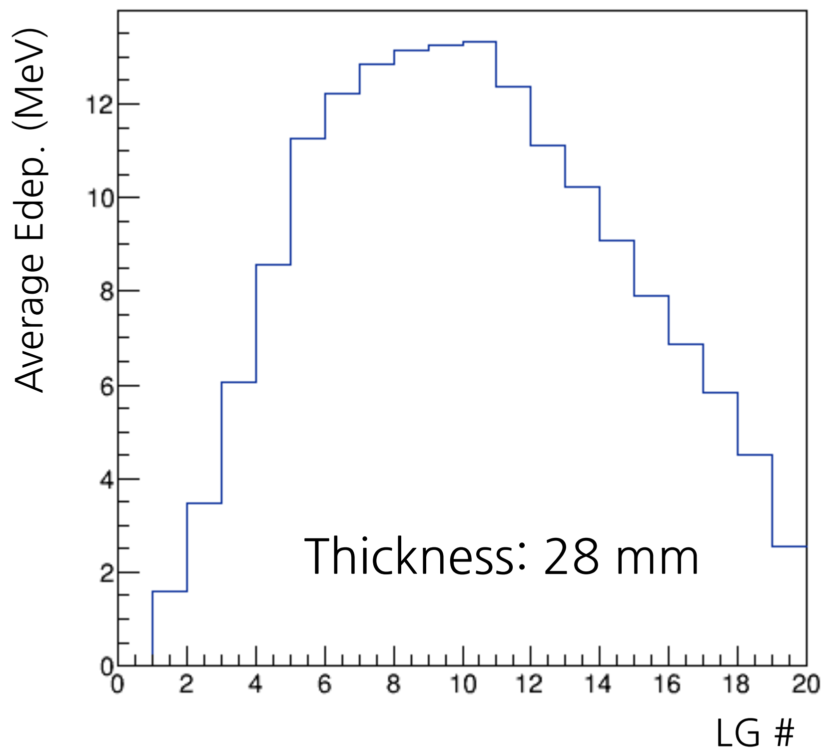




- Energy resolution decreases as the tungsten thickness and the number of its thicker layers increase.
- If the thickness get thicker than a level (shower particles are too much absorbed in the tungsten), the efficiency starts getting down.

Lower efficiency at thicker tungsten

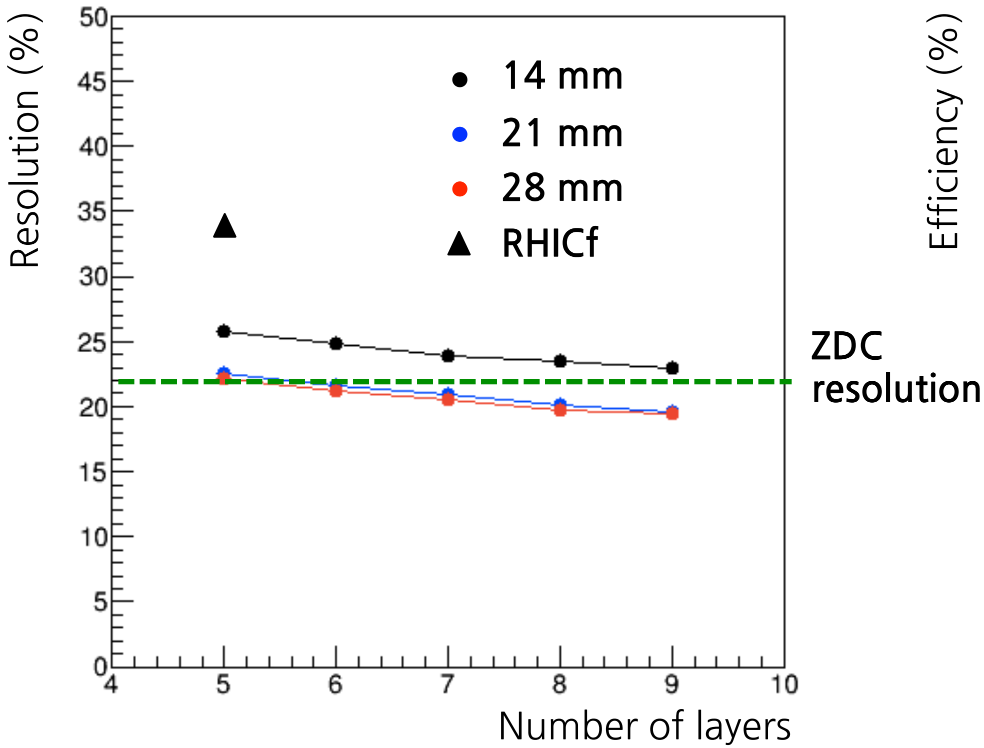


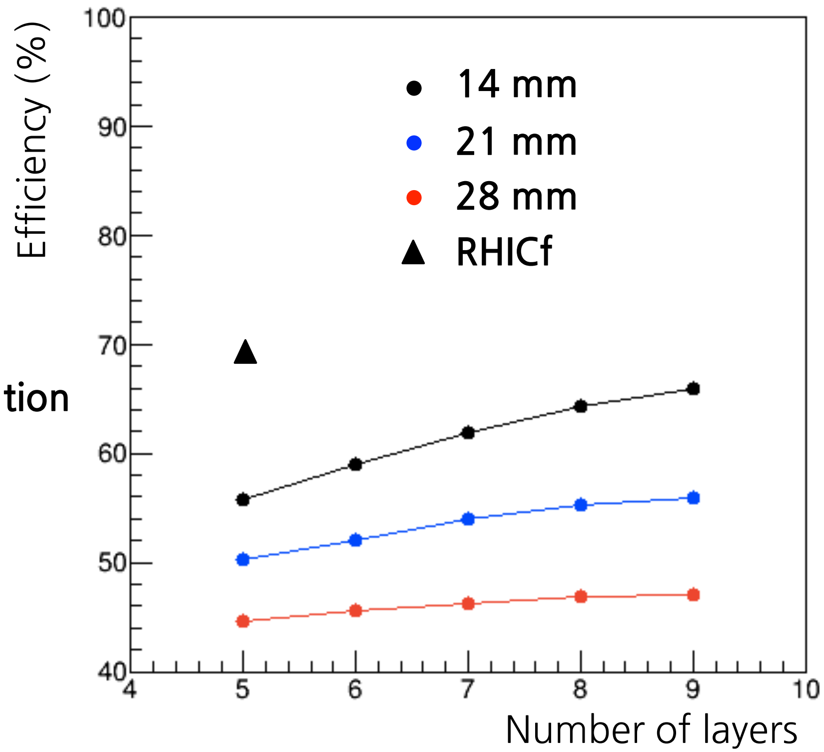


- If the tungsten is too thick, more particles are absorbed in the tungsten, thereby relatively smaller energy deposit behind.

Energy resolution: 100 GeV neutron

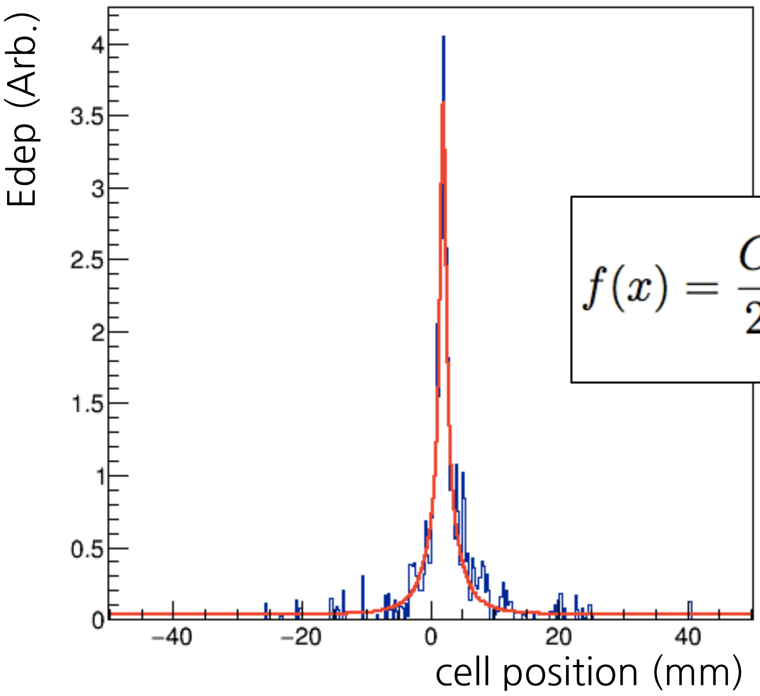
Shower threshold: 15 MeV





- With 21~28 mm tungsten thickness and higher trigger threshold, we can approach the ZDC resolution.
- Lower efficiency ~50% would be OK due to abundant neutron statistics in the very forward region.

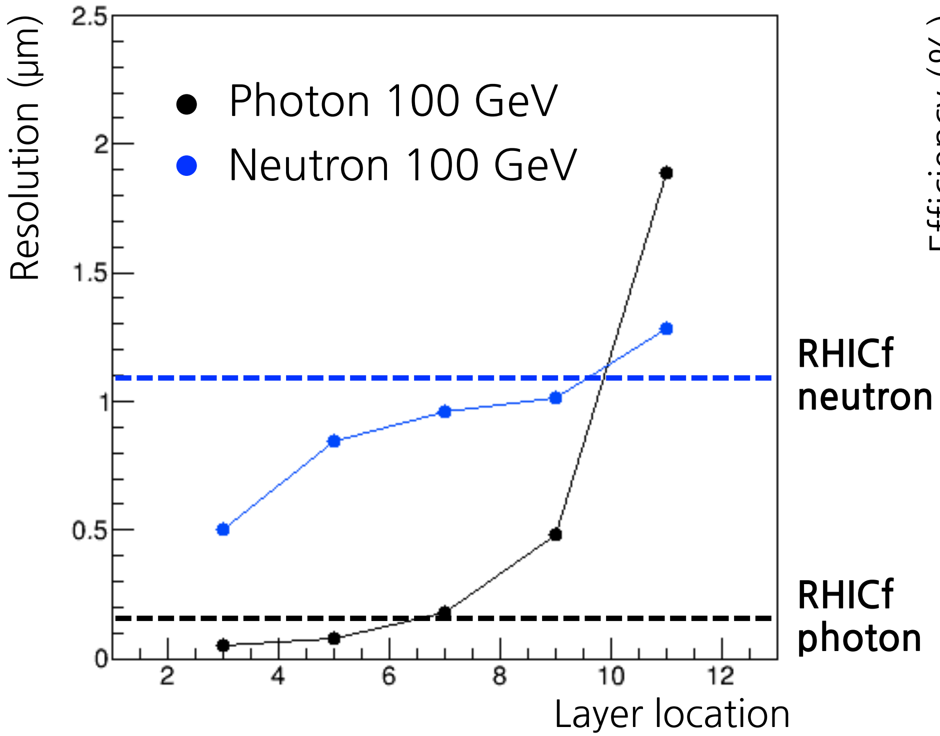
Position reconstruction

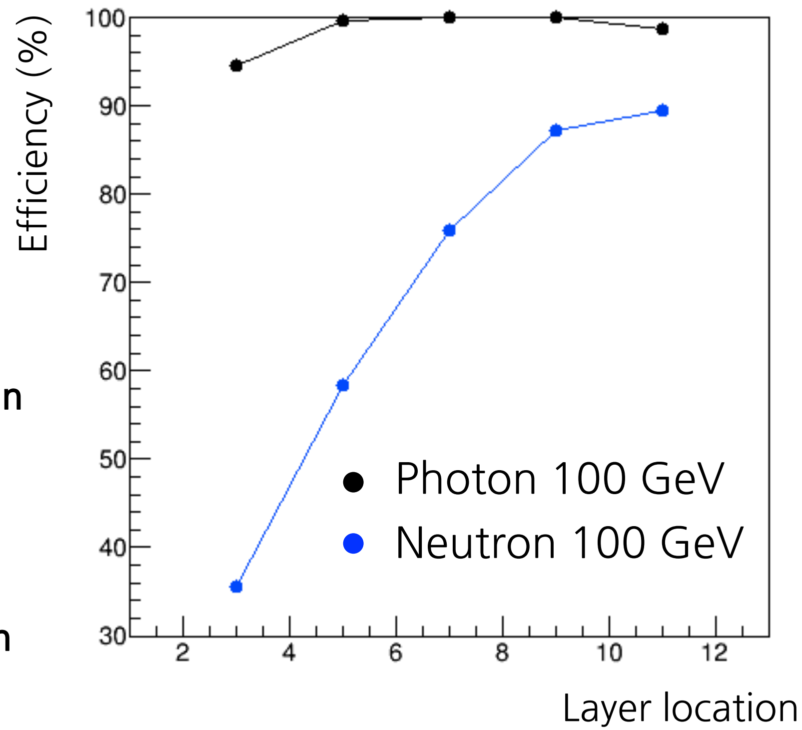


$$f(x) = \frac{C}{2}\left[\frac{\sigma_S a}{((x-x_0)^2+\sigma_S)^{3/2}} + \frac{\sigma_W(1-a)}{((x-x_0)^2+\sigma_W)^{3/2}}\right] + C_0$$

- Middle positions of each cell were assumed as the cell position.
- 2D Edep map was projected to x and y-axis.
- The projected Edep distribution over cell position was fitted by Lorentzian-based function which was used at RHICf analysis.

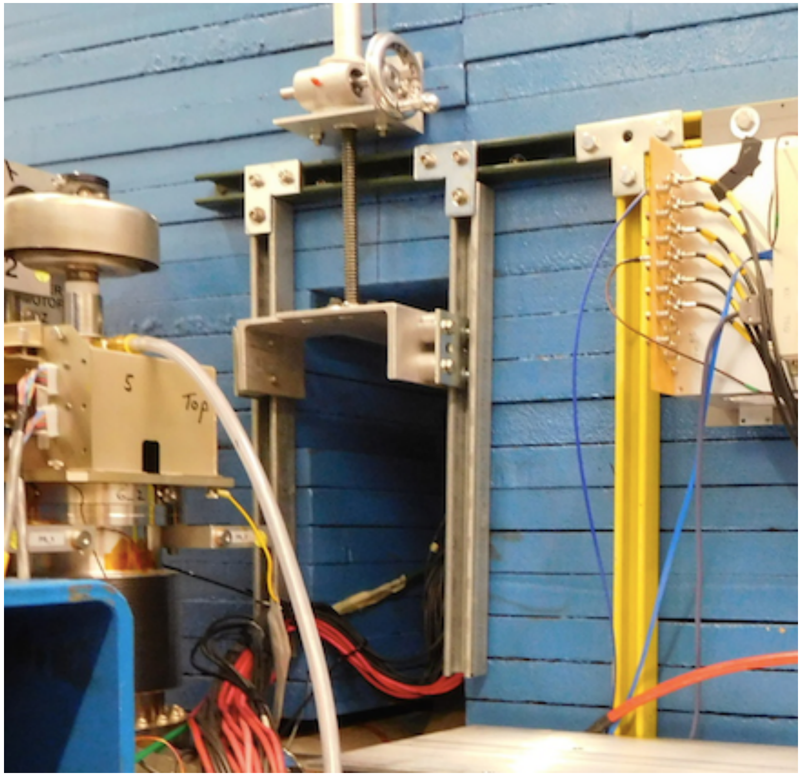
Position resolution





- FWHM was estimated at x_true - x_rec distribution.
- If the layer location is more forward than 7th, better position resolution than RHICf is expected for photon.
- If we use only one HG layer, layer location of ~5th would be the best.

Feasibility of the detector size



- Limit of the detector size is related with the Pb (blue) whole and how far the ZDC (in the Pb hole) can be moved backward.