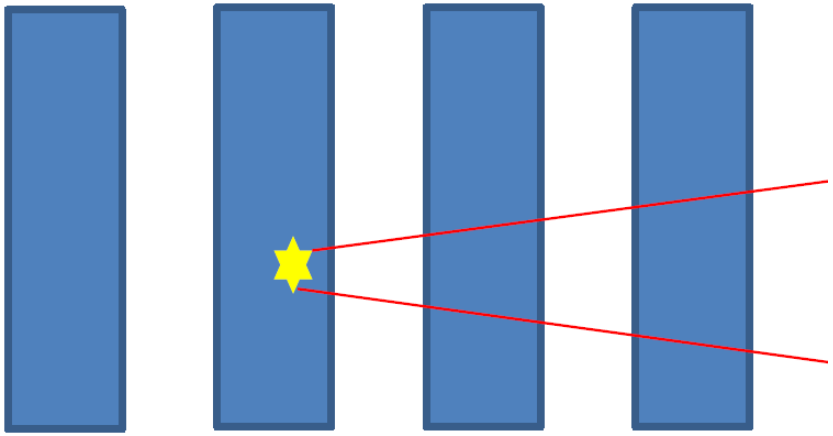
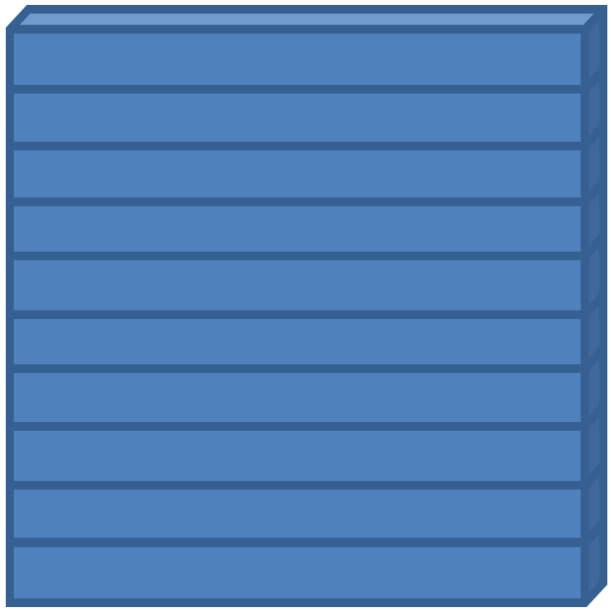
Neutron Detector Simulation
2013 / 12 / 23

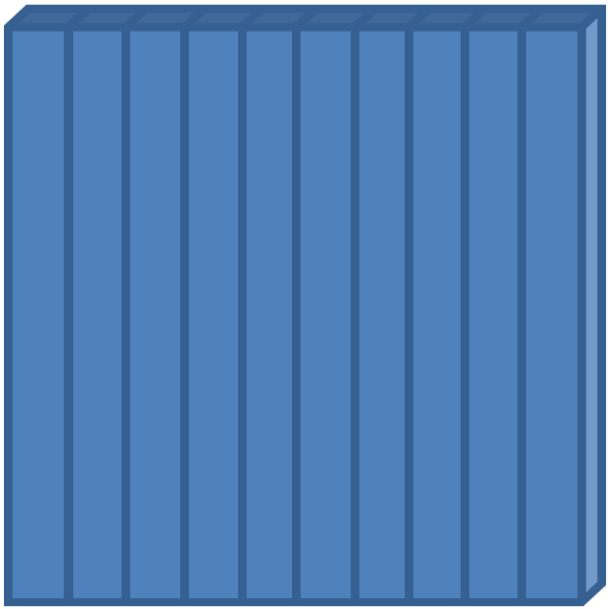


Korea University
Nuclear Physics Lab.
BumGon Kim

(Back Up)Neutron Bar Detector



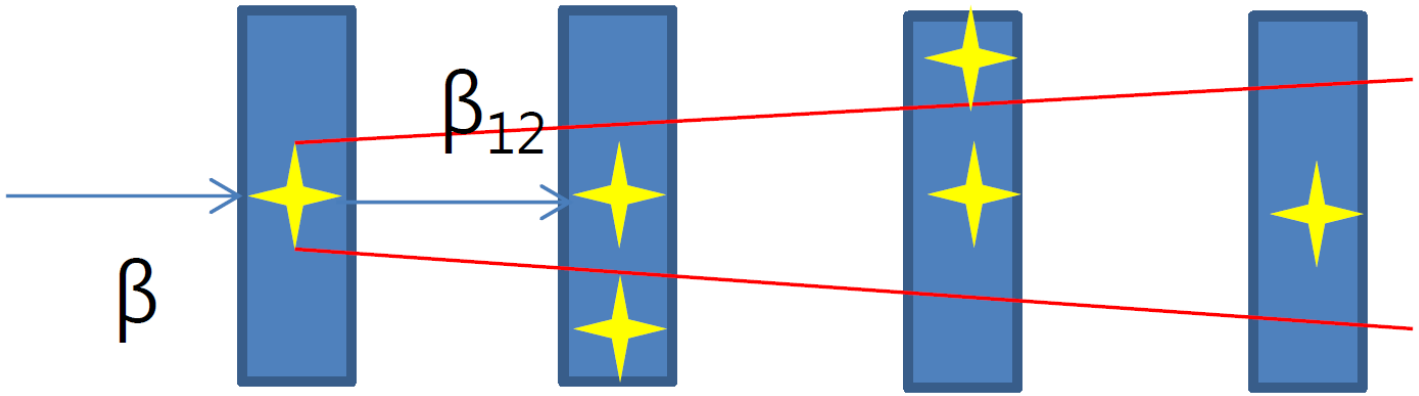
Horizontal



Vertical

- Horizontal layer + Vertical layer = 1 Stack
- Structure to know the locations where neutrons have passed.
  → To recognize the path where neutrons have traveled.

(Back Up)Multi-neutron Recognition Basic Algorithm



1. Geometric Condition

- 1st layer : within 30 cm from 1st hit.
- 2nd layer : 40 cm
- 3rd layer & 4th layer : 60 cm

2. Betha Condition

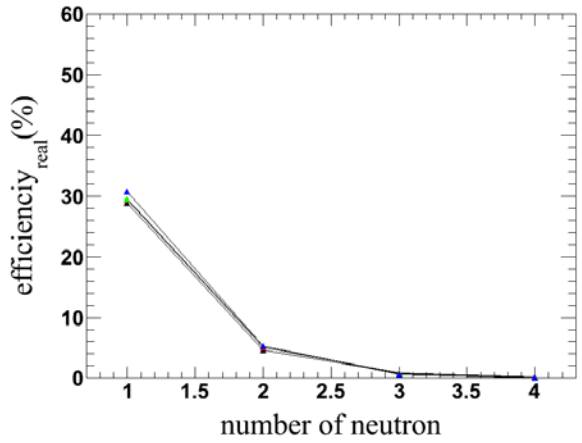
- $\beta > \beta_{12}$: earlier incoming, larger velocity(loss of energy).

(Back Up)The Number of Stacks & Real Efficiency

Real Efficiency(%) = (# of well recognized)/(# of event-Null event) * (1-fake rate) * 100

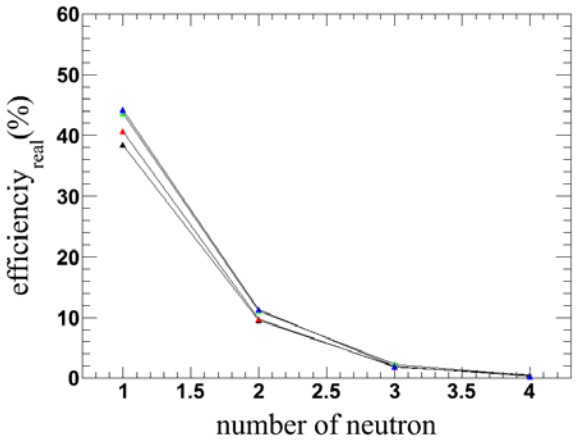
Neutron Energy : 100 ~ 300 MeV, Time Resolution : 0.3 ns

2 stack, **40 cm gap**

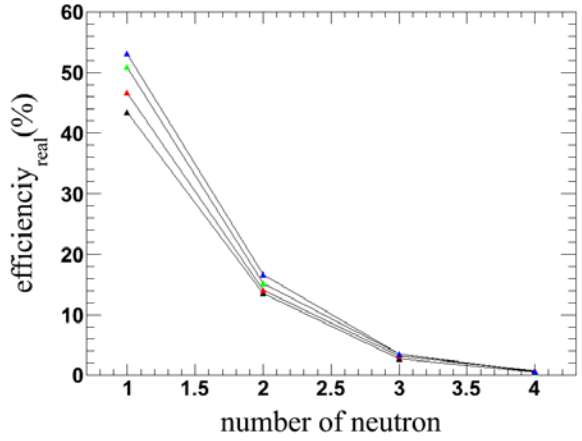


Black : 3 MeV,
Red : 5 MeV,
Green : 7 MeV,
Blue : 10 MeV

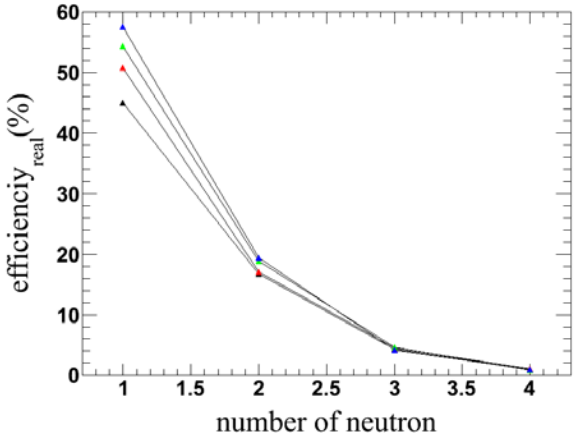
4 stack, **40 cm gap**



6 stack, **40 cm gap**



8 stack, **40 cm gap**

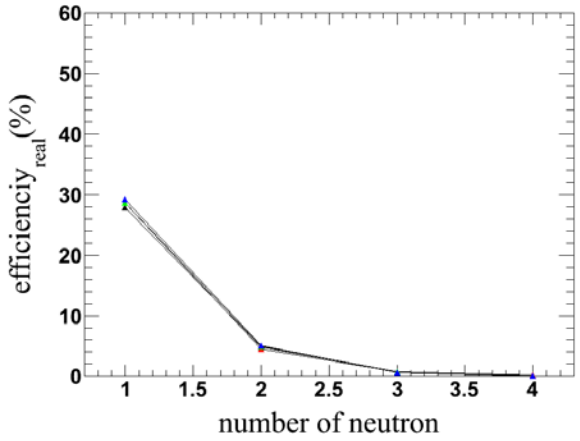


(Back Up)The Number of Stacks & Real Efficiency

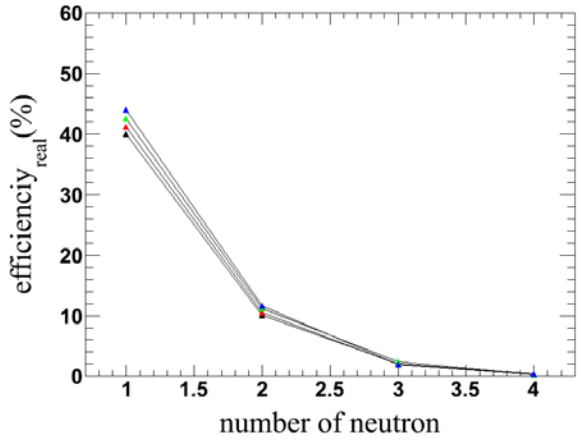
Real Efficiency(%) = (# of well recognized)/(# of event-Null event) * (1-fake rate) * 100

Neutron Energy : 100 ~ 300 MeV, Time Resolution : 0.3 ns

2 stack, **60 cm gap**

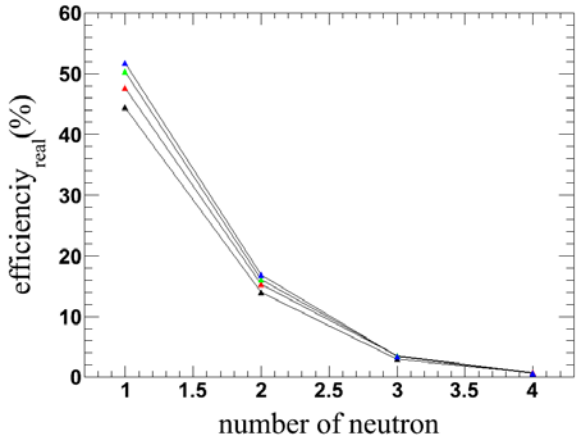


4 stack, **60 cm gap**

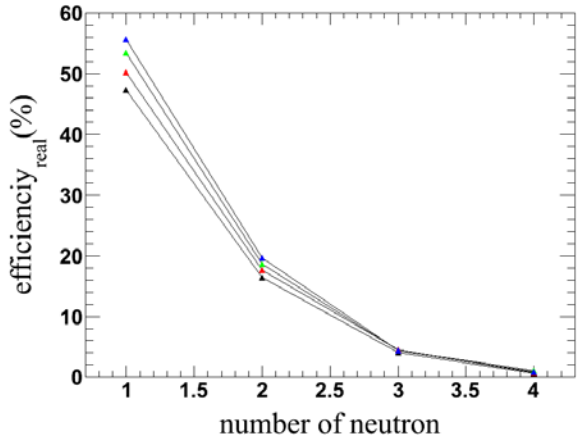


Black : 3 MeV,
Red : 5 MeV,
Green : 7 MeV,
Blue : 10 MeV

6 stack, **60 cm gap**

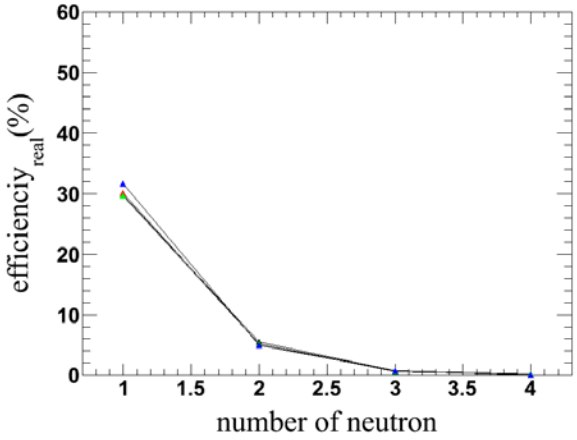


8 stack, **60 cm gap**

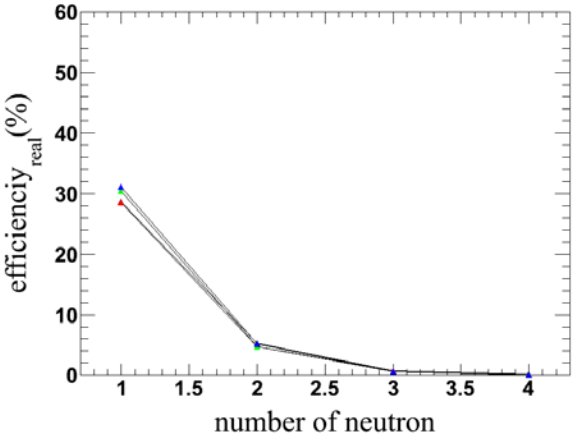


(Back Up)Two Stacks & Gap

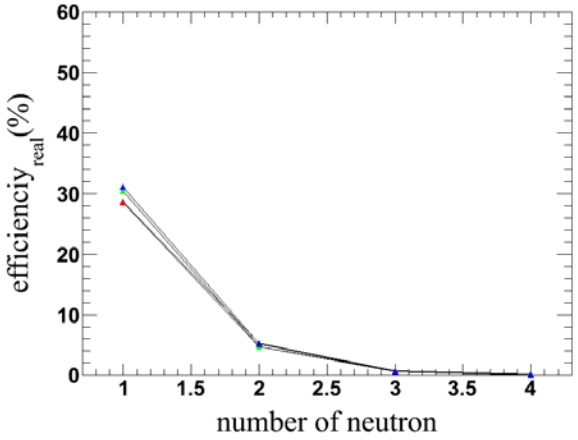
20 cm gap



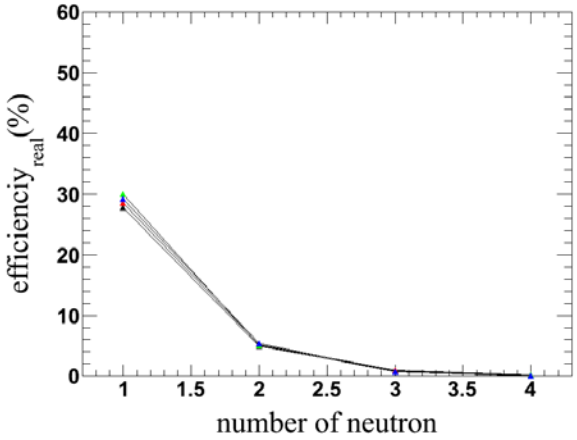
40 cm gap



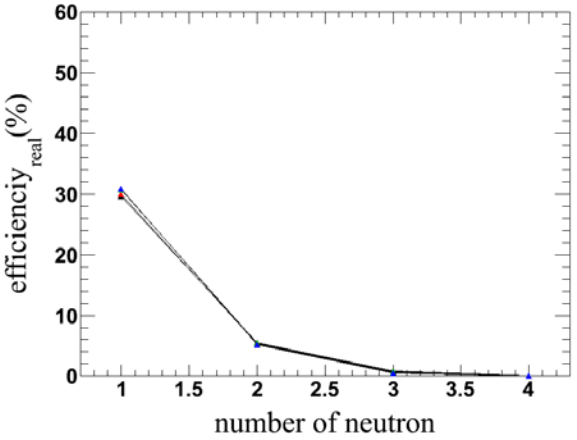
60 cm gap



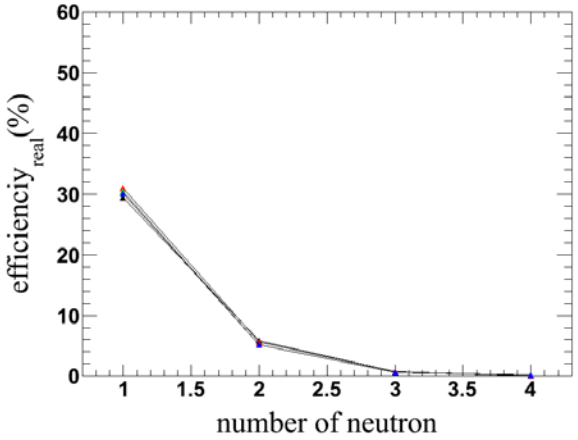
80 cm gap



100 cm gap



120 cm gap



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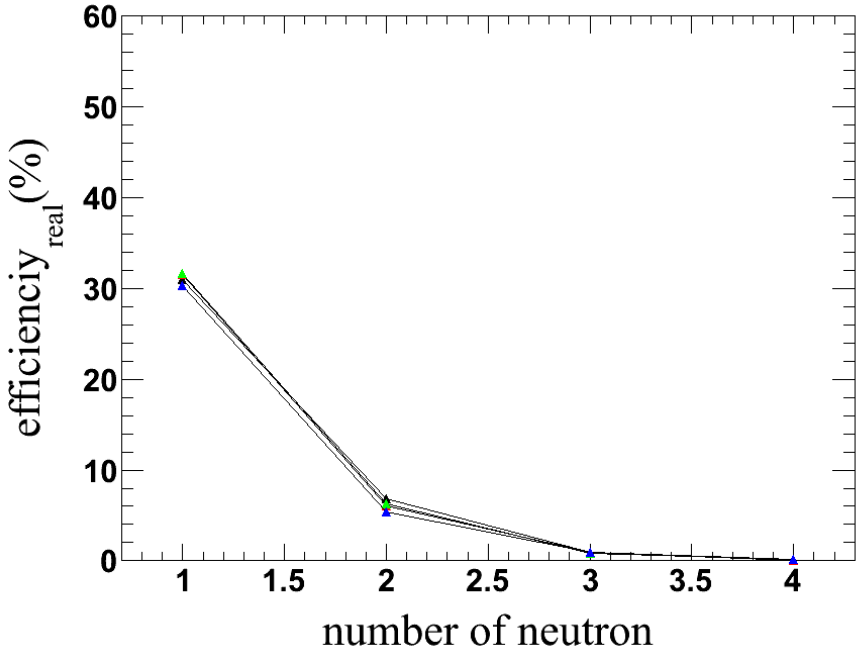
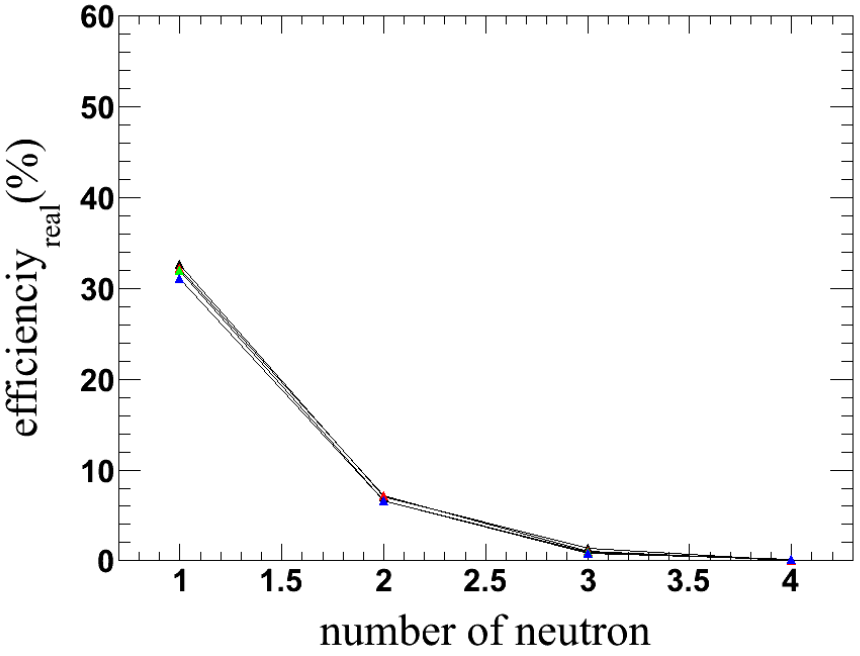
(Back Up)Two Stacks & Gap

220 cm gap



400 cm gap

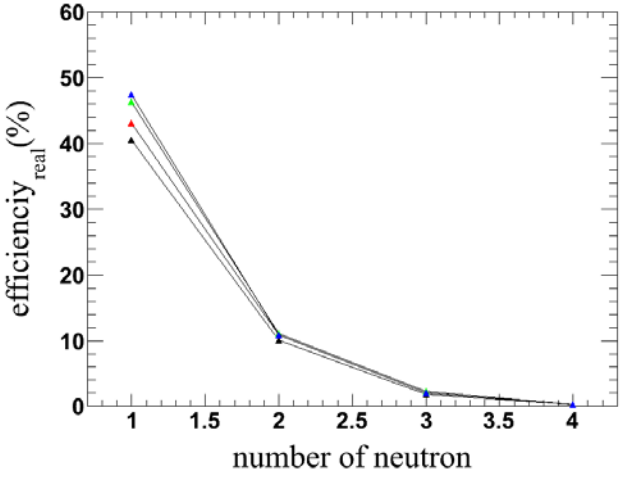


Black : 3 MeV
Red : 5 MeV
Green : 7 MeV
Blue : 10 MeV

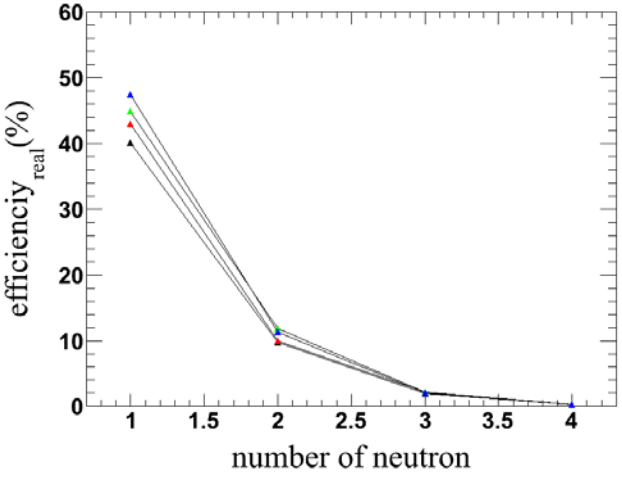
Four Stacks & Gap(time resolution : 0.30 ns)

Back scattering
+ β condn.
+ Geometric condn.

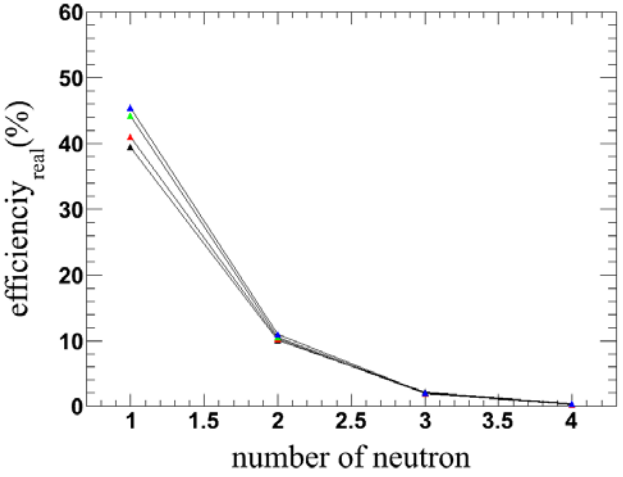
10cm gap



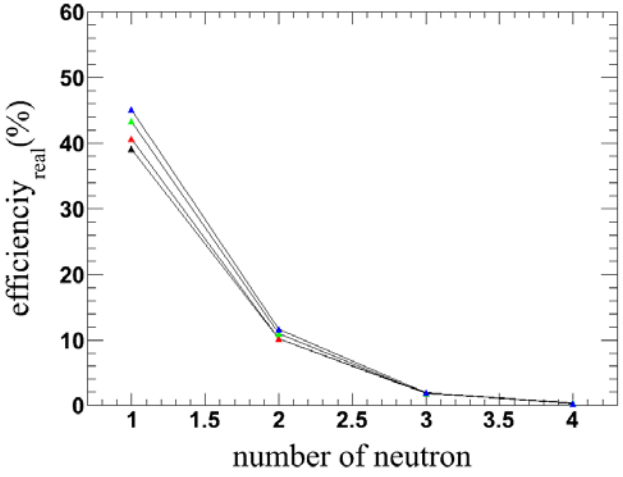
20cm gap



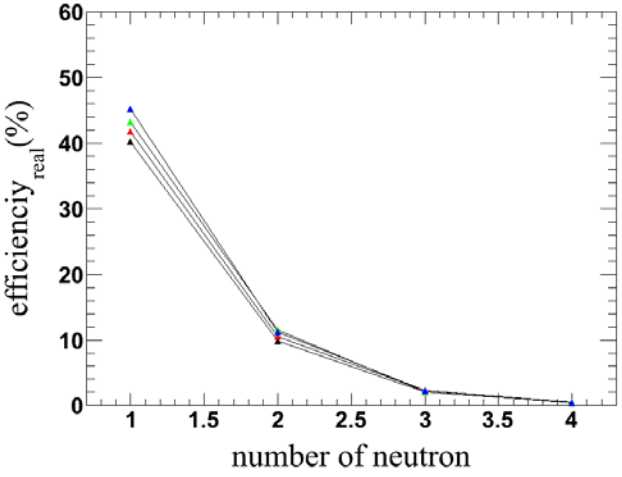
30cm gap



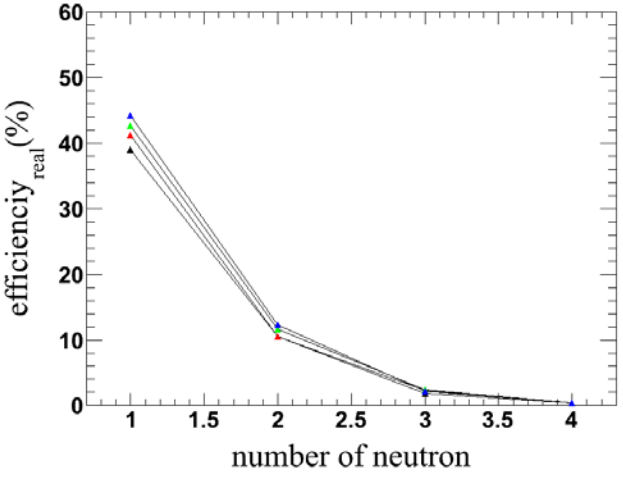
40cm gap



50cm gap



60cm gap

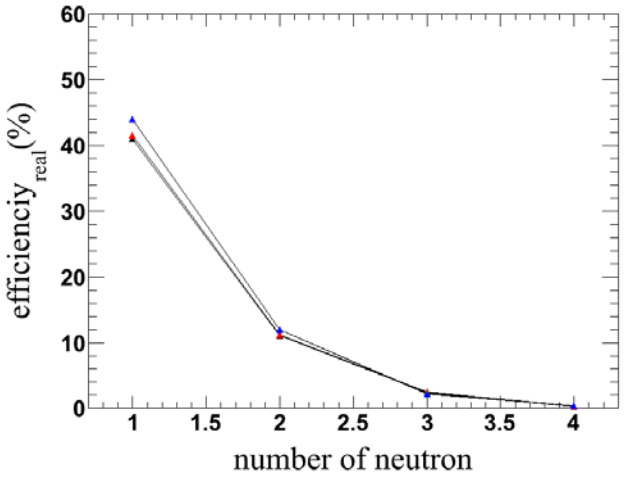


Black : 3 MeV
Red : 5 MeV
Green : 7 MeV
Blue : 10 MeV

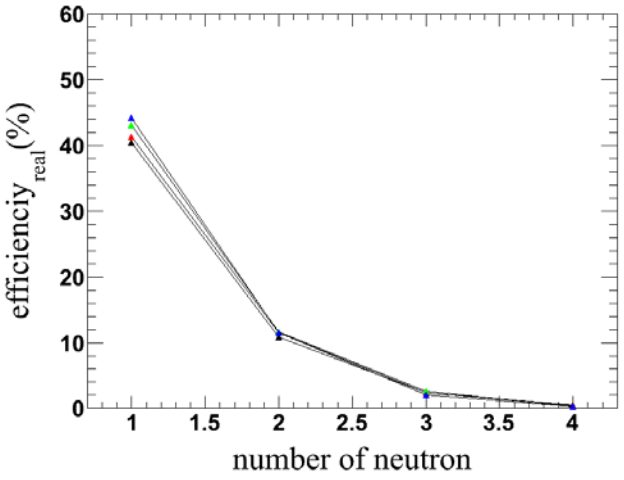
Four Stacks & Gap(time resolution : 0.30 ns)

Back scattering
+ β condn.
+ Geometric condn.

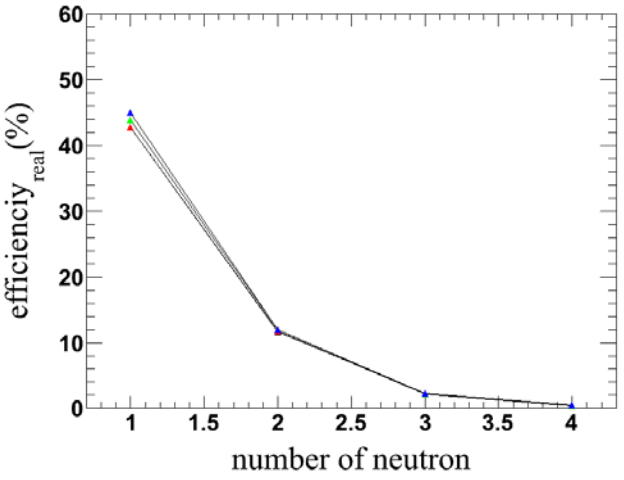
70cm gap



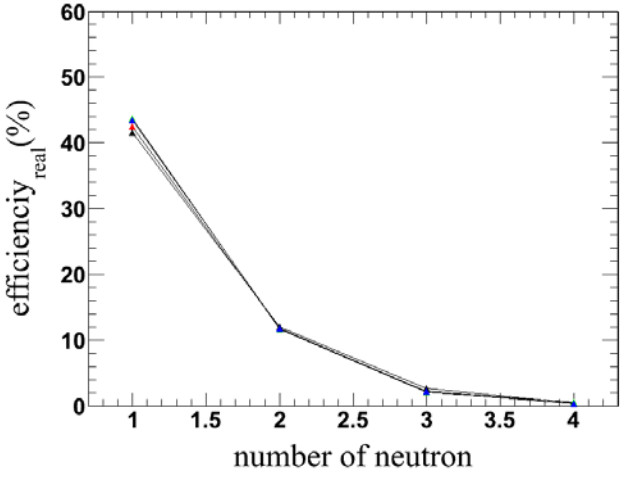
80cm gap



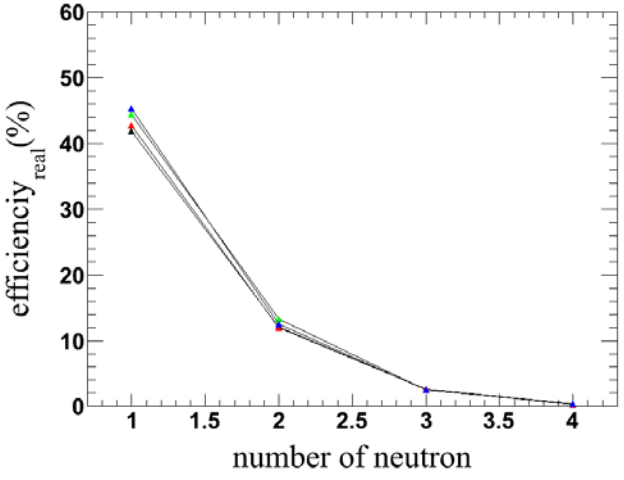
90cm gap



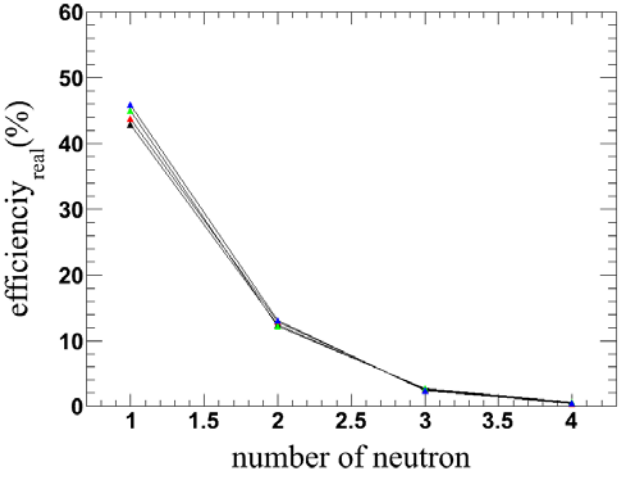
100cm gap



110cm gap



120cm gap



Black : 3 MeV
Red : 5 MeV
Green : 7 MeV
Blue : 10 MeV

Four Stacks & Gap(time resolution : 0.30 ns)

Back scattering
+ β condn.
+ Geometric condn.

- Gap이 10 ~ 120cm 의 범위인 영역에서 efficiency는 크게 변하지 않는다.

- Gap이 80cm 가 될 때까지는 gap이 증가할수록 efficiency가 줄어들다가,
  90cm 이후부터는 gap이 증가할수록 efficiency가 조금씩 증가함을 볼 수 있다.
  (back scattering의 감소에 의한 영향?)

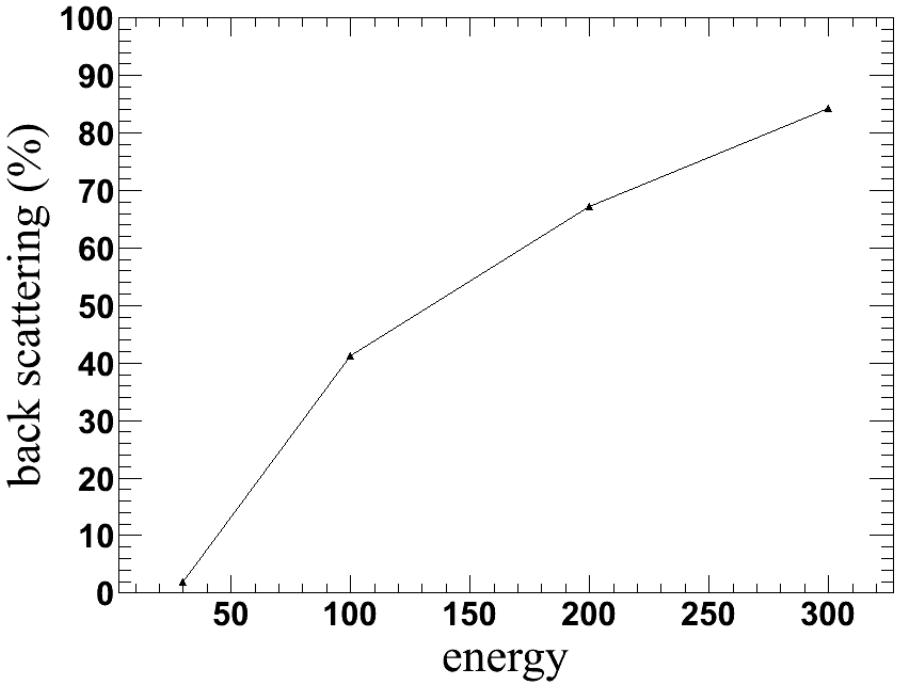
(Pure)Back Scattering(time resolution : 0.25 ns)

※ 4 Stacks, 40cm gap VS. 120cm gap, Threshold 3 MeV

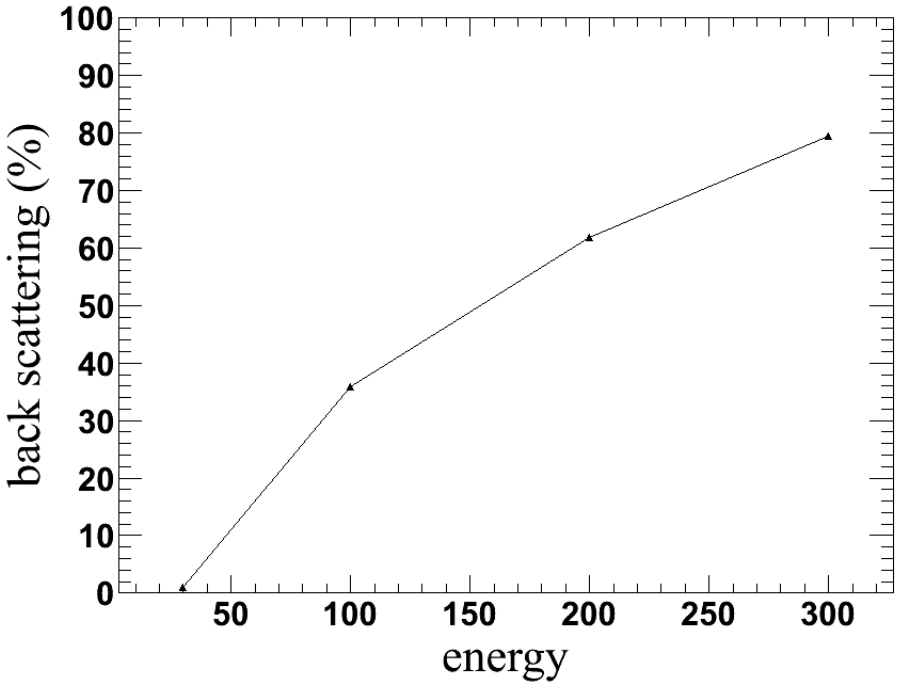
(Back Scattering(%)) = (the num. of back scattering) / (non-zero event num.)

: 각 event 당 1회 이상 hitTime 과 layer number 가 순서대로 정렬되지 않은 비율.

40cm gap



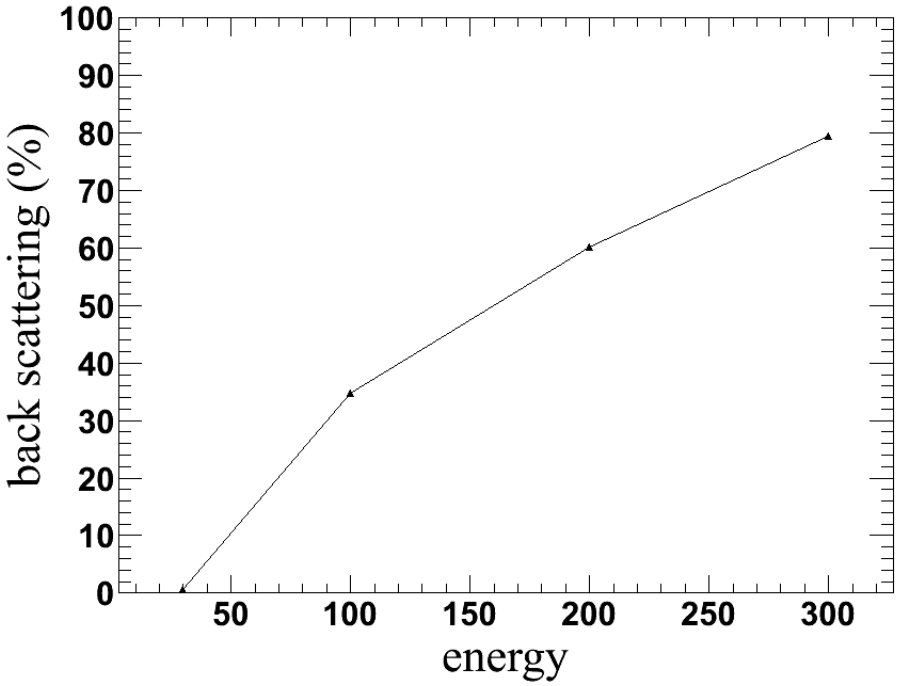
120cm gap



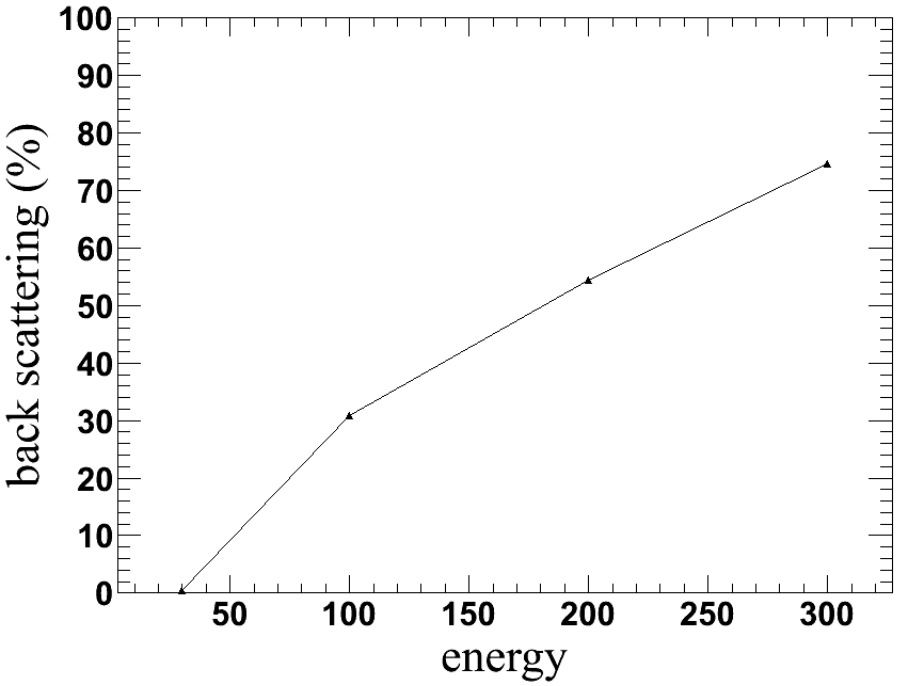
(Pure)Back Scattering(time resolution : 0.25 ns)

※ 4 Stacks, 40cm gap VS. 120cm gap, Threshold 5 MeV

40cm gap



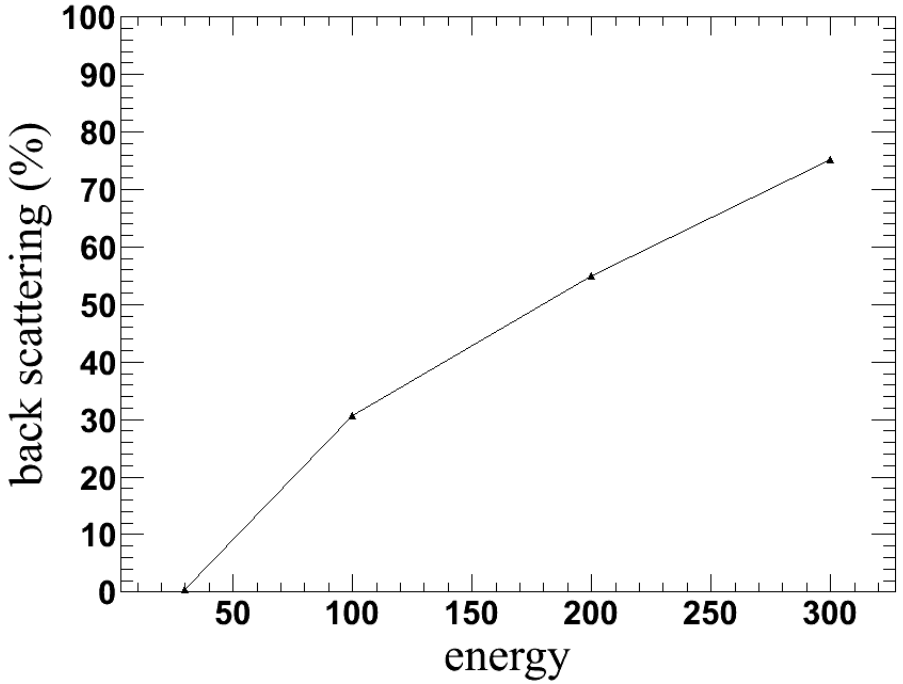
120cm gap



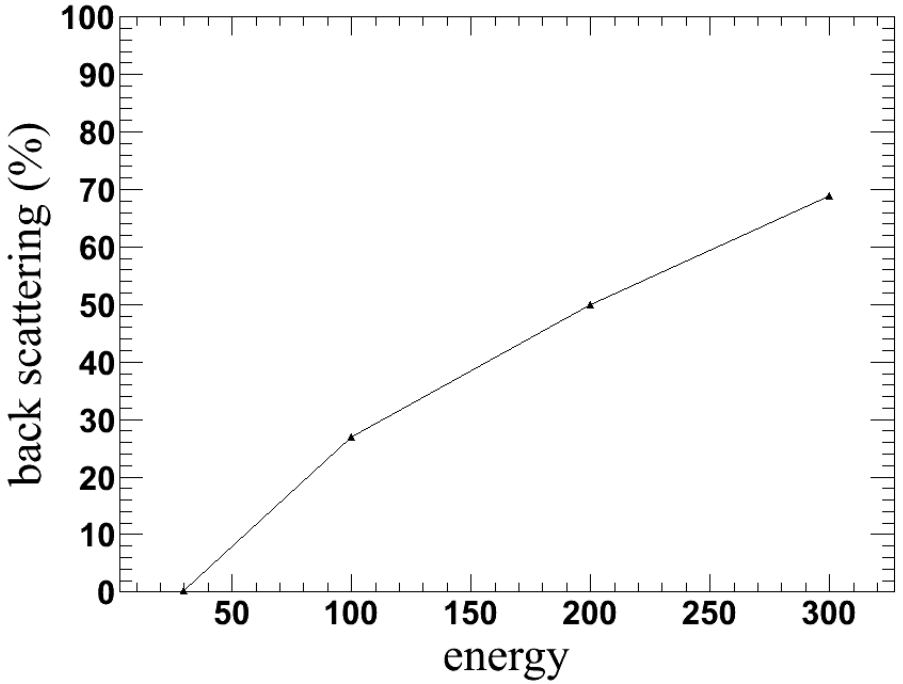
(Pure)Back Scattering(time resolution : 0.25 ns)

※ 4 Stacks, 40cm gap VS. 120cm gap, Threshold 7 MeV

40cm gap



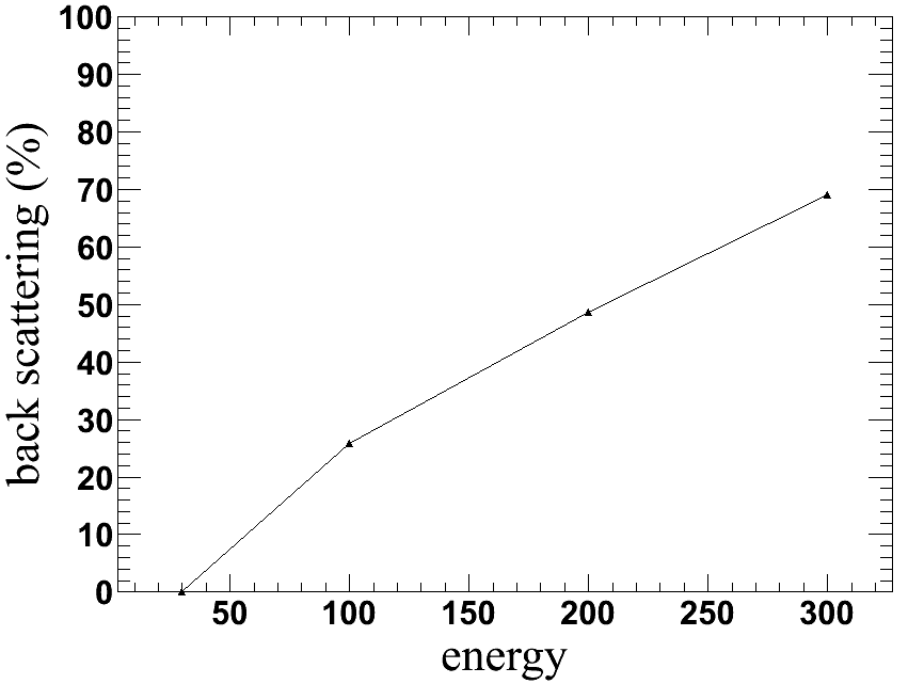
120cm gap



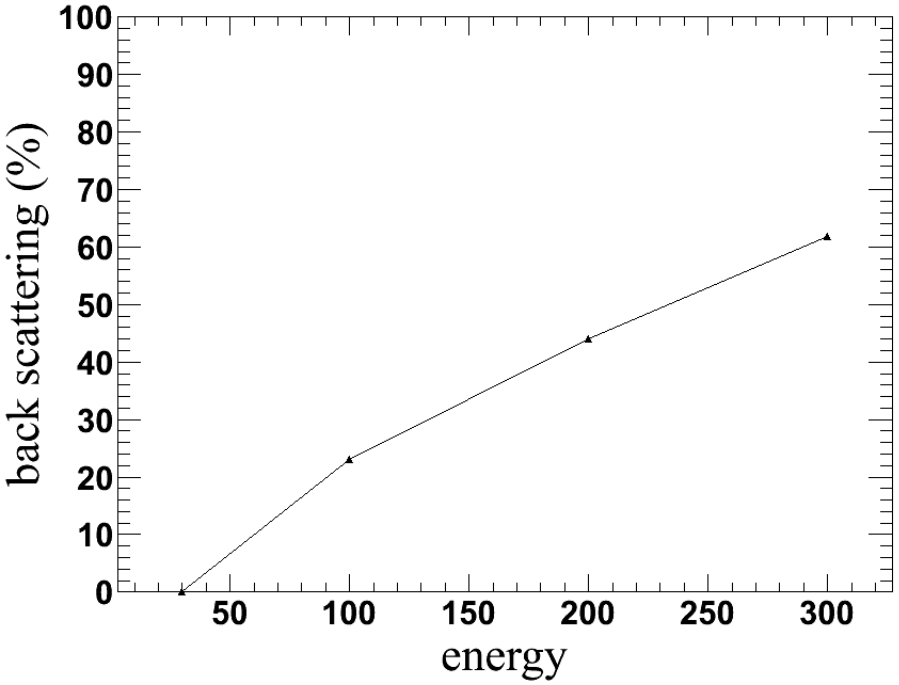
(Pure)Back Scattering(time resolution : 0.25 ns)

※ 4 Stacks, 40cm gap VS. 120cm gap, Threshold 10 MeV

40cm gap



120cm gap

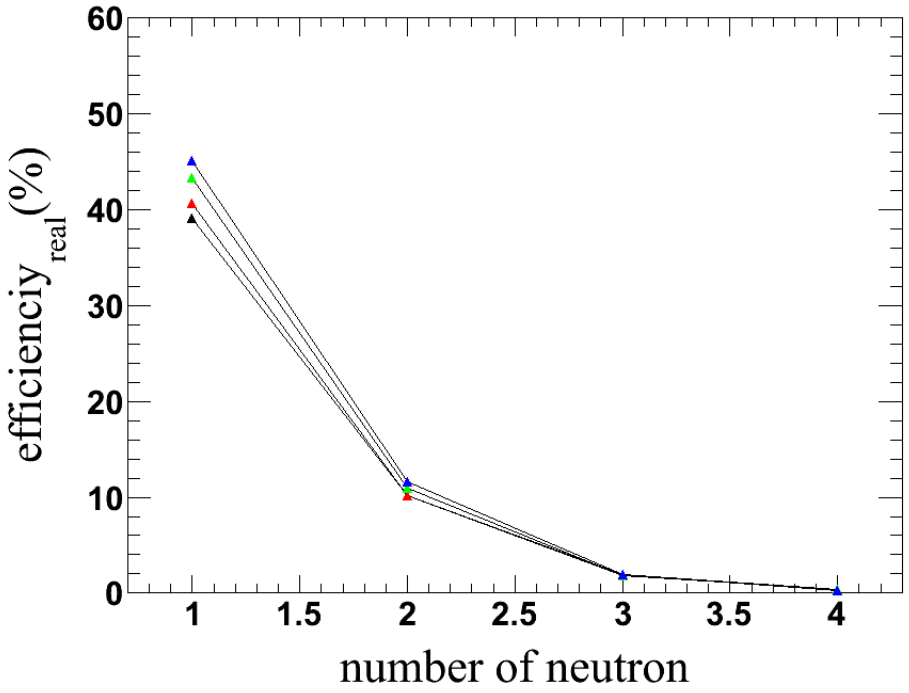


- Threshold가 커질수록, energy가 커질수록 back scattering이 gap의 영향을 많이 받는다. (Threshold가 10 MeV, energy가 300 MeV 일 때 대략 9~10 % 로, 이때 가장 큰 차이를 보임.)

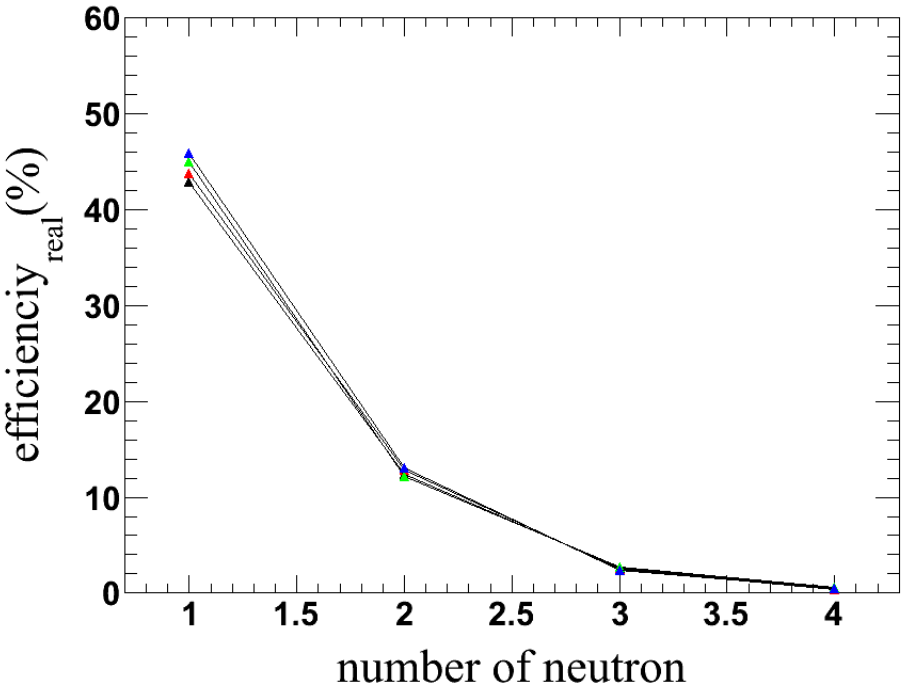
Real Efficiency(time resolution : 0.30 ns)

2) 4 Stacks, 40cm gap VS. 120cm gap, Threshold 10 MeV

40cm gap



120cm gap



- Gap이 120cm인 경우가 40cm인 경우보다 efficiency가 다소 더 높다(Back scattering이 줄어든 영향?).

- Back scattering이 줄어든 정도에 비해서 efficiency의 변화가 미미하다(back scattering 외의 다른 이유?).

Summary

- 4 stack 의 경우에서도 gap 10cm ~ 120cm 의 범위에서 efficiency의 변화는 크지 않았다.
- 2 stack 의 경우에서와 마찬가지로, gap이 90cm 이상이 되면 efficiency가 조금씩 증가한다
- Gap 의 크기에 따른 back scattering 의 감소에 비해, efficiency의 증가가 미미하다. (Algorithm, 혹은 코드의 문제? 또는 다른 변수?)