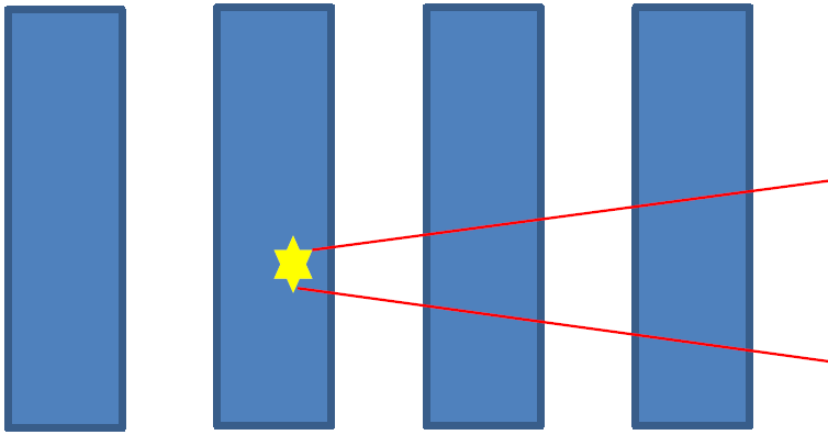
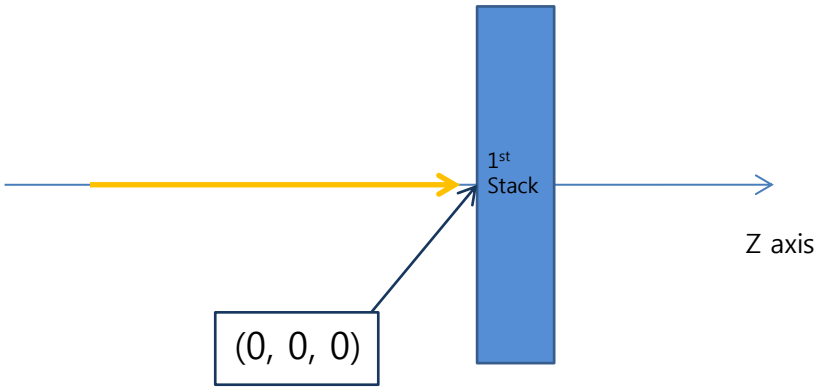
Neutron Detector Simulation
2014 / 02 / 28

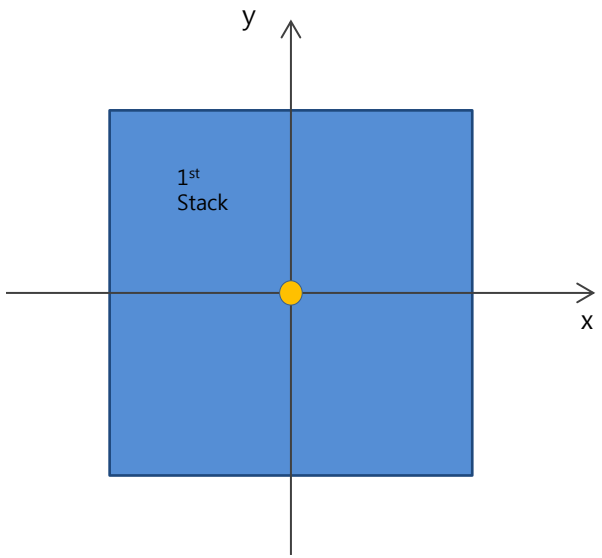


Korea University
Nuclear Physics Lab.
BumGon Kim

Beam Conditions

➢ Pinpoint Neutron Beam





- Neutron Energy : 100 MeV or 300 MeV
- GunPosition : (0, 0, -15000 mm)
- Momentum direction : (0, 0, 1)
- Threshold ~ 0 MeV

Algorithm

I. Generate events(10000 events)

II. Randomly select (1, 2, 3, 4) event(s) among the events, and collect hits of that(those) event(s).
   - **Real incident neutrons**

III. Using 3 conditions(Beta condn., Geometric condn., Back Scattering), classify the hits into groups that is expected to be the hits by same neutron.

IV. Count the number of groups.
   - **Reconstructed incident neutrons**

V. Real Efficiency (%) = {(Real_good) / (event_number)} × 100
   - **Real_good : the case satisfying both Beta condn & Geometric condn, and also satisfying (Real incident neutrons) = (Reconstructed incident neutrons)**
   - **Event_number : 10000 (constant)**

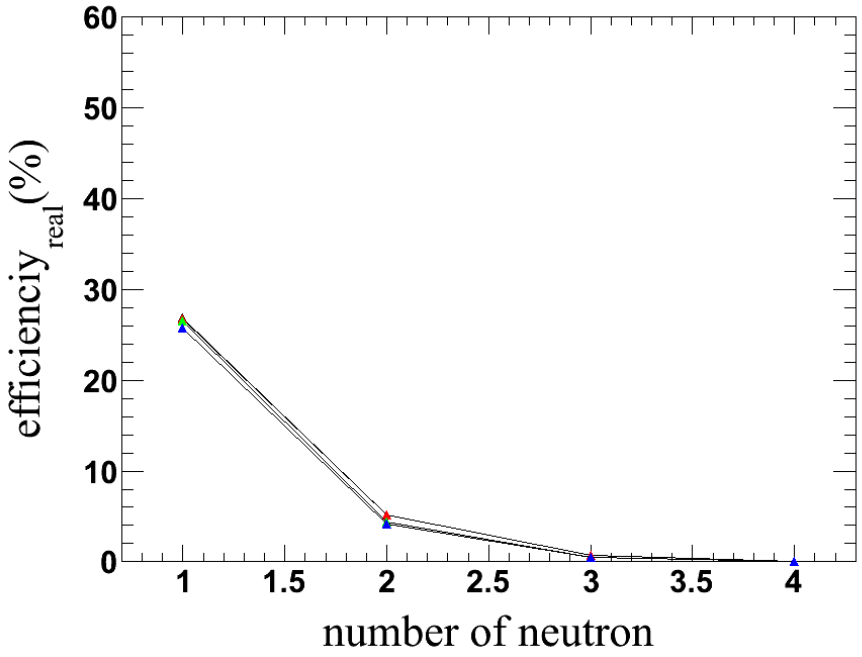
Pinpoint beam + Only Beta Condition

- GunPosition : (0, 0, -15000 mm)
- Momentum direction : (0, 0, 1)
- Event : 10000

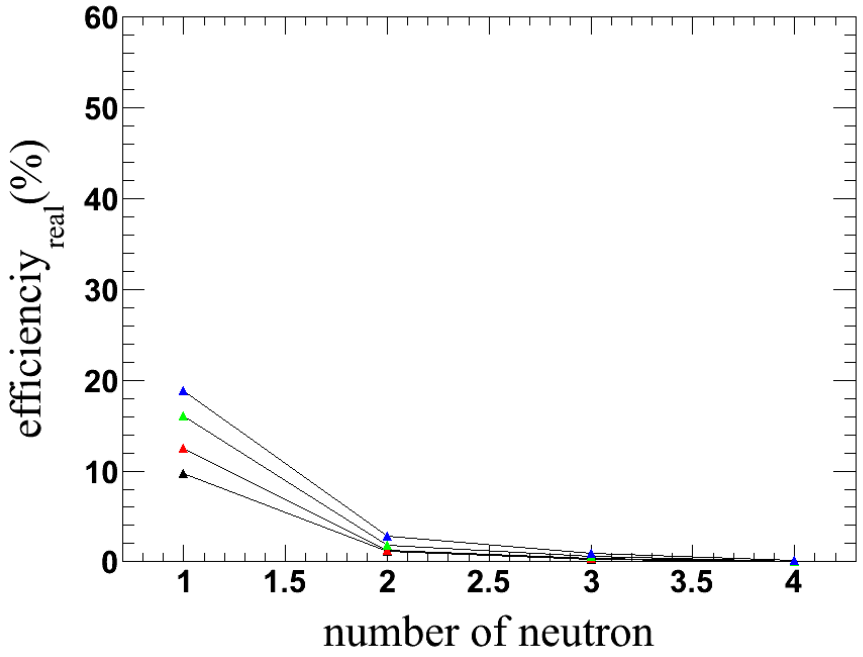
Black : 3 MeV
Red : 5 MeV
Green : 7 MeV
Blue : 10 MeV

❖ Threshold : If deposited energy is higher than threshold, it considered as hit.

Energy : 100 MeV



300 MeV

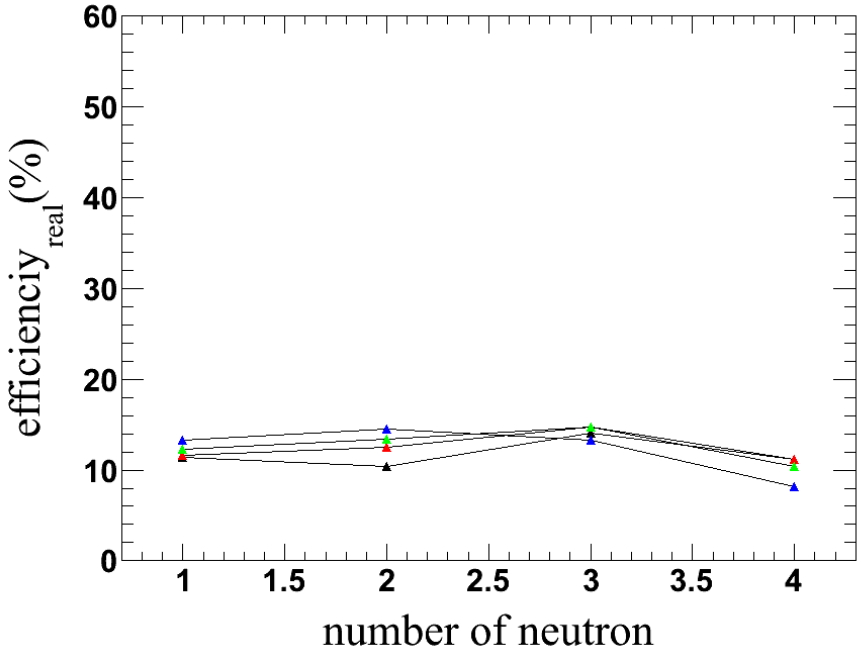


Pinpoint beam + Only Back Scattering Condition

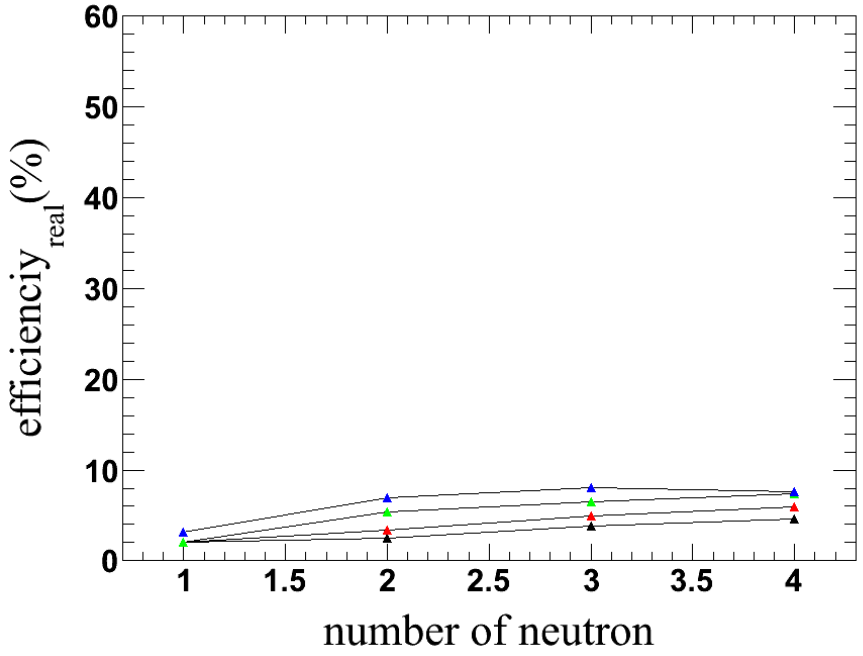
- GunPosition : (0, 0, -15000 mm)
- Momentum direction : (0, 0, 1)
- Event : 10000

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

Energy : 100 MeV



300 MeV

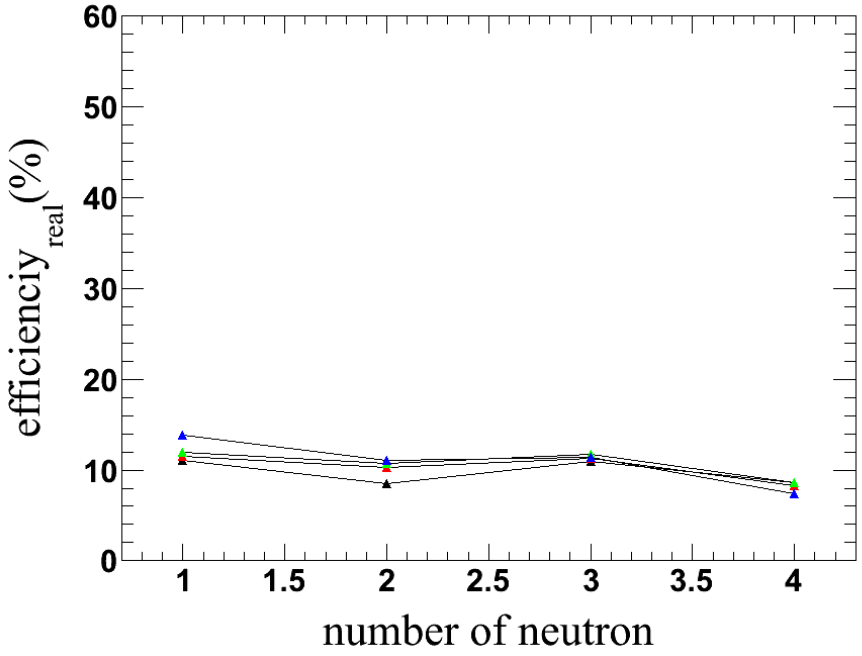


Pinpoint beam + Only Geometric Condition

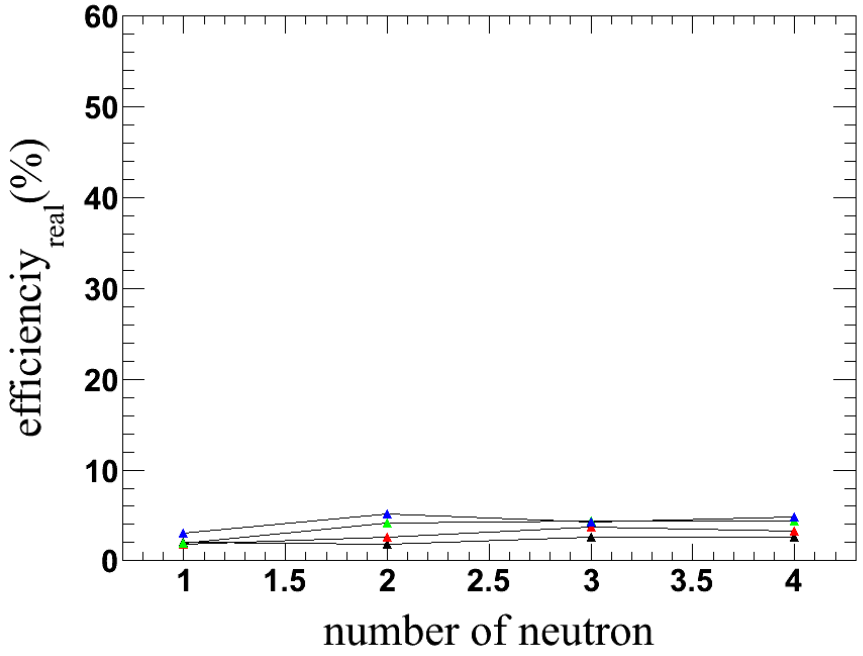
- GunPosition : (0, 0, -15000 mm)
- Momentum direction : (0, 0, 1)
- Event : 10000

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

Energy : 100 MeV



300 MeV

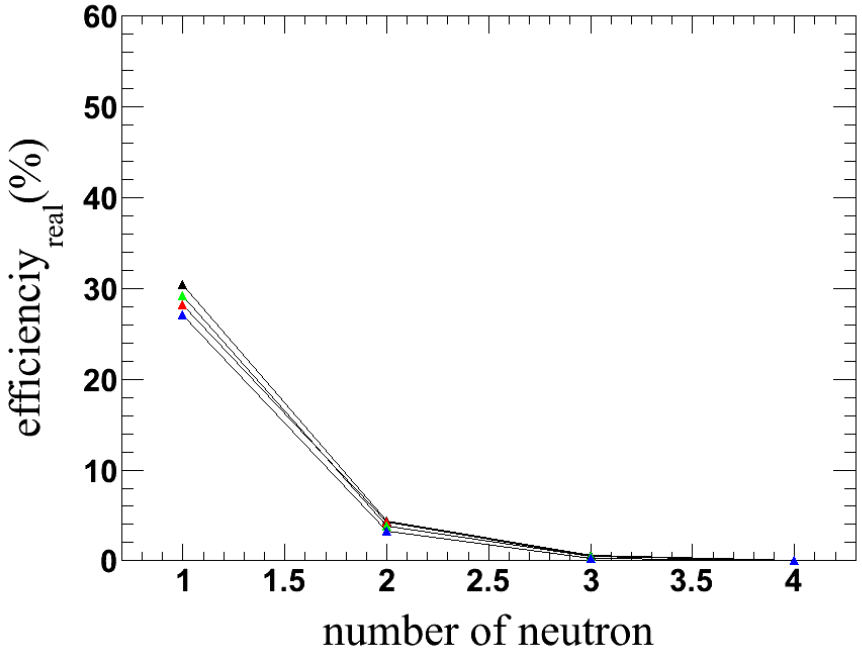


Pinpoint beam + Beta + Back Scattering

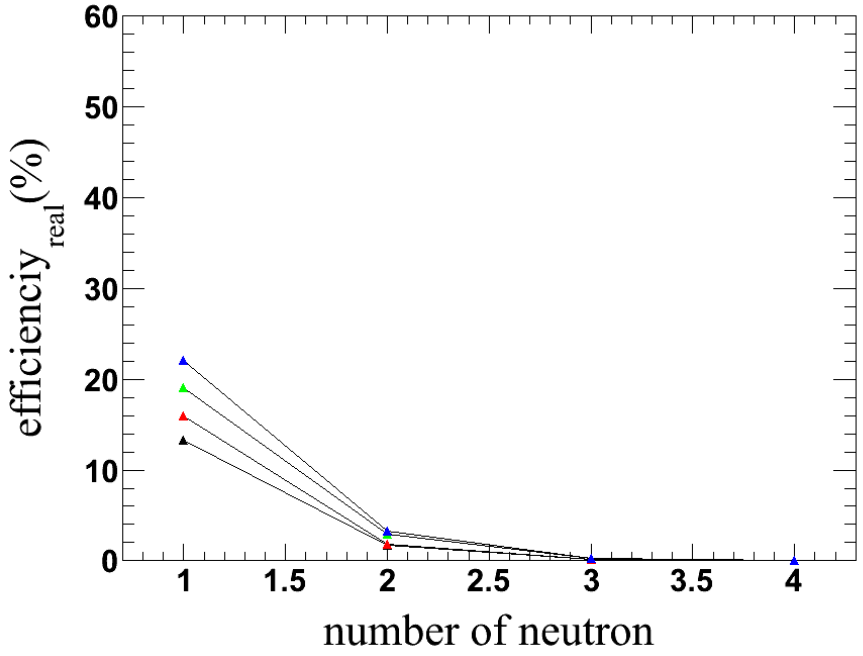
- GunPosition : (0, 0, -15000 mm)
- Momentum direction : (0, 0, 1)
- Event : 10000

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

Energy : 100 MeV



300 MeV

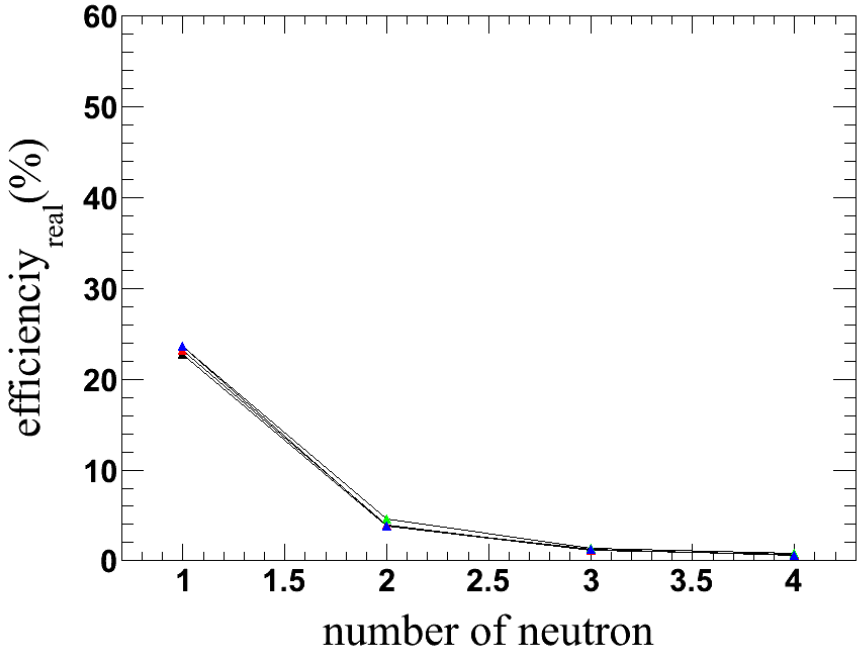


Pinpoint beam + Beta + Geometric Condn.

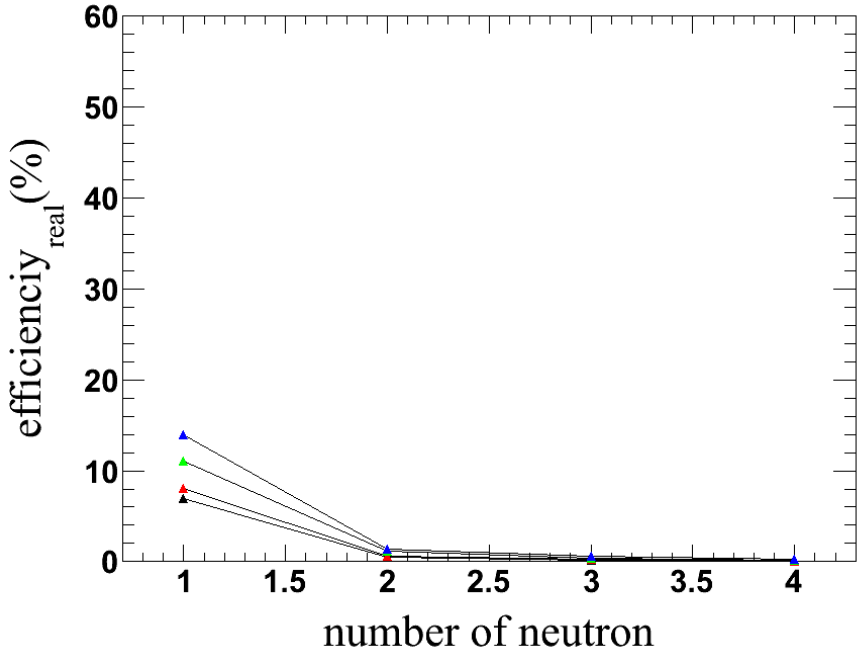
- GunPosition : (0, 0, -15000 mm)
- Momentum direction : (0, 0, 1)
- Event : 10000

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

Energy : 100 MeV



300 MeV

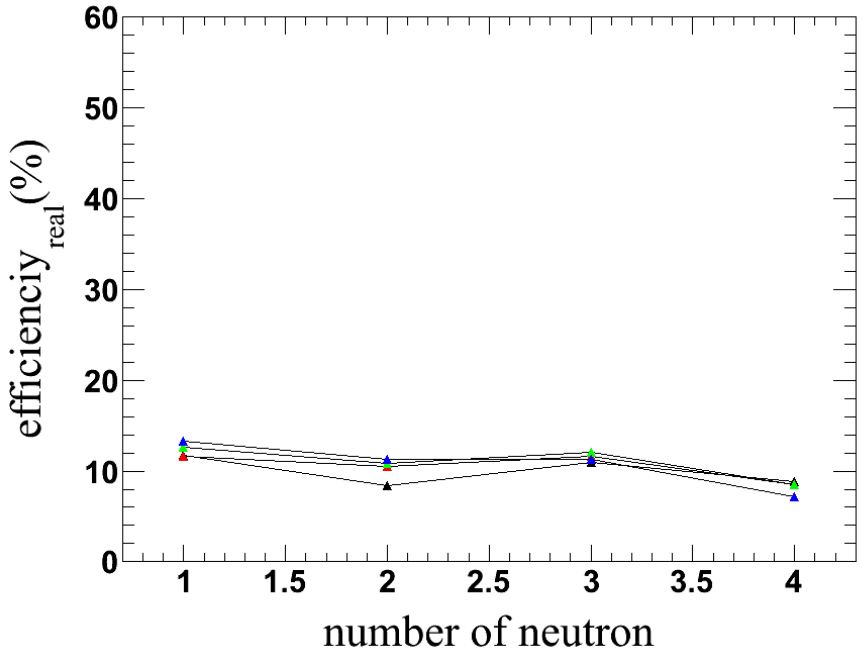


Pinpoint beam + Back Scattering + Geometric Condn.

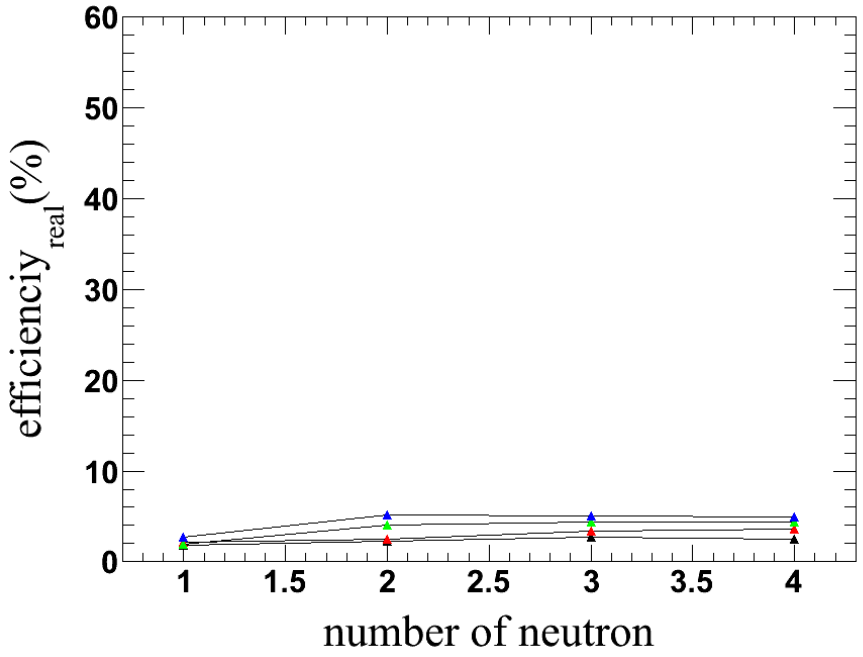
- GunPosition : (0, 0, -15000 mm)
- Momentum direction : (0, 0, 1)
- Event : 10000

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

Energy : 100 MeV



300 MeV

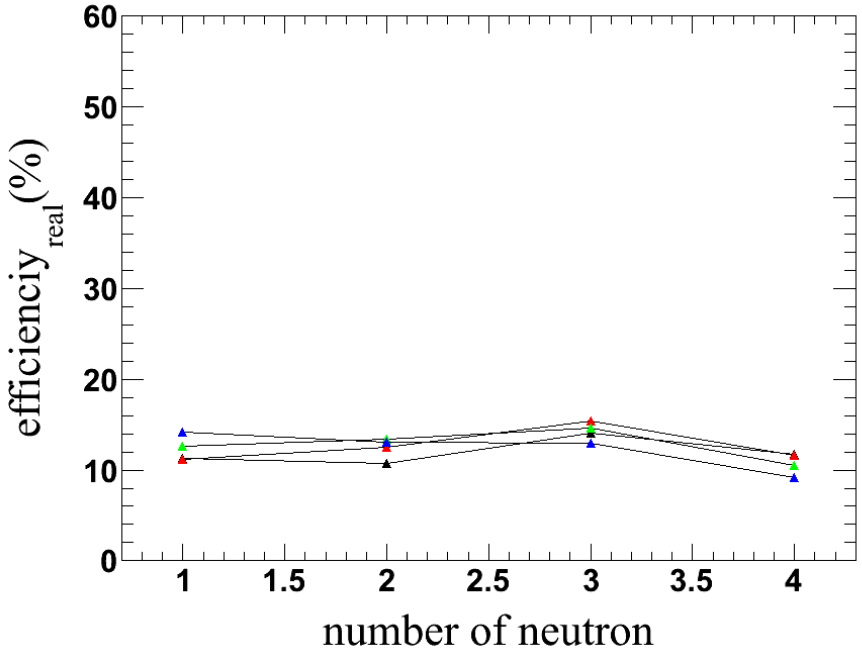


Pinpoint beam + No Conditions

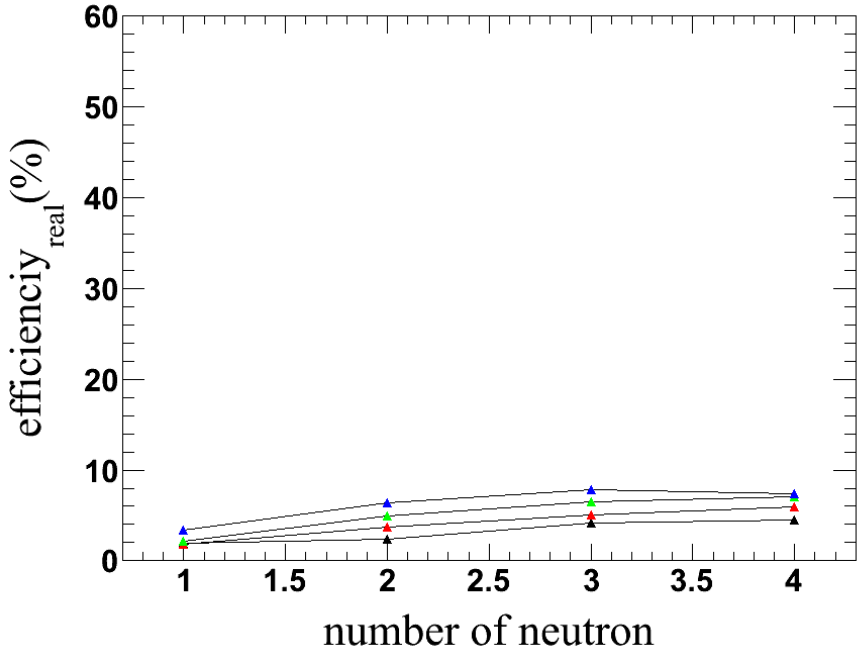
- GunPosition : (0, 0, -15000 mm)
- Momentum direction : (0, 0, 1)
- Event : 10000

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

Energy : 100 MeV



300 MeV

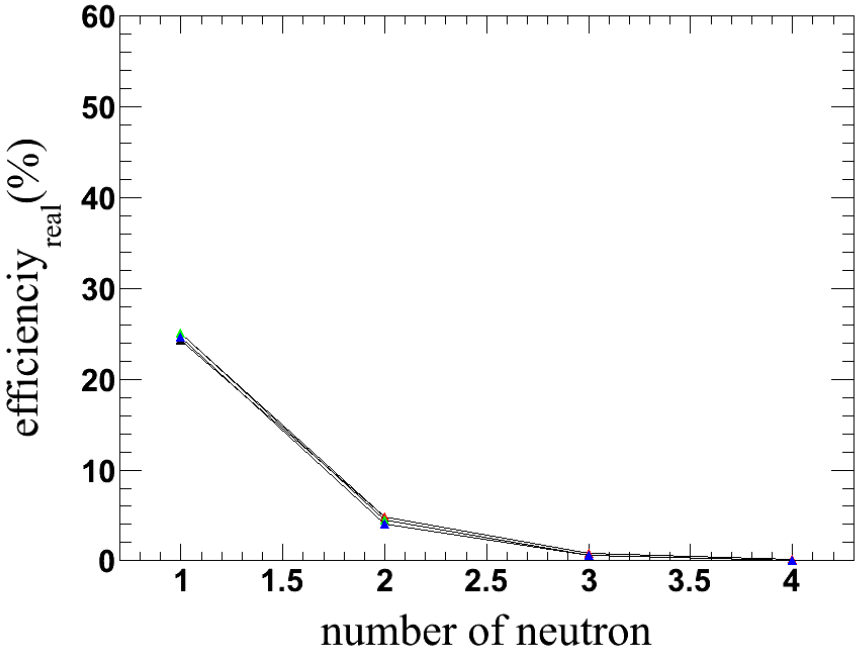


Pinpoint beam + All Conditions

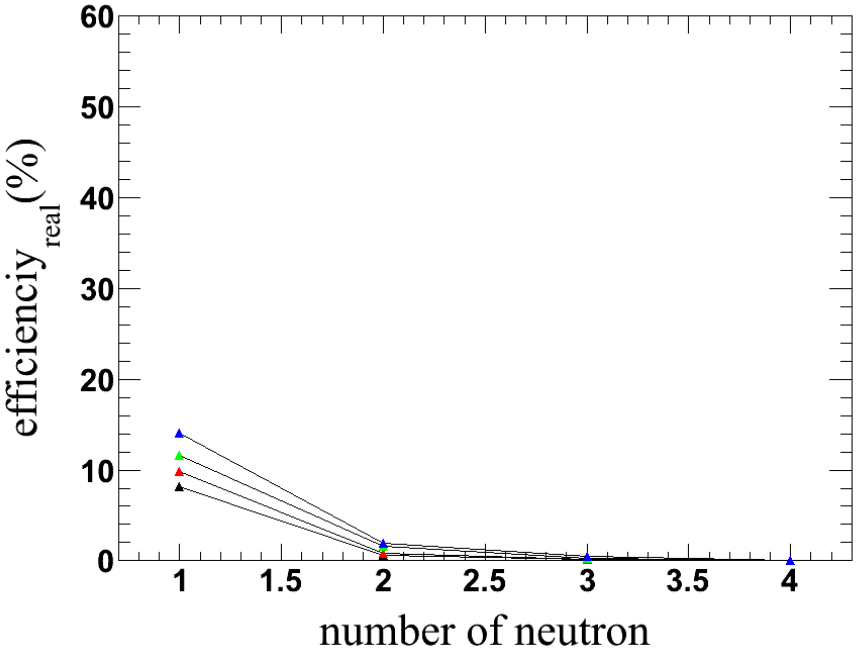
- GunPosition : (0, 0, -15000 mm)
- Momentum direction : (0, 0, 1)
- Event : 10000

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

Energy : 100 MeV



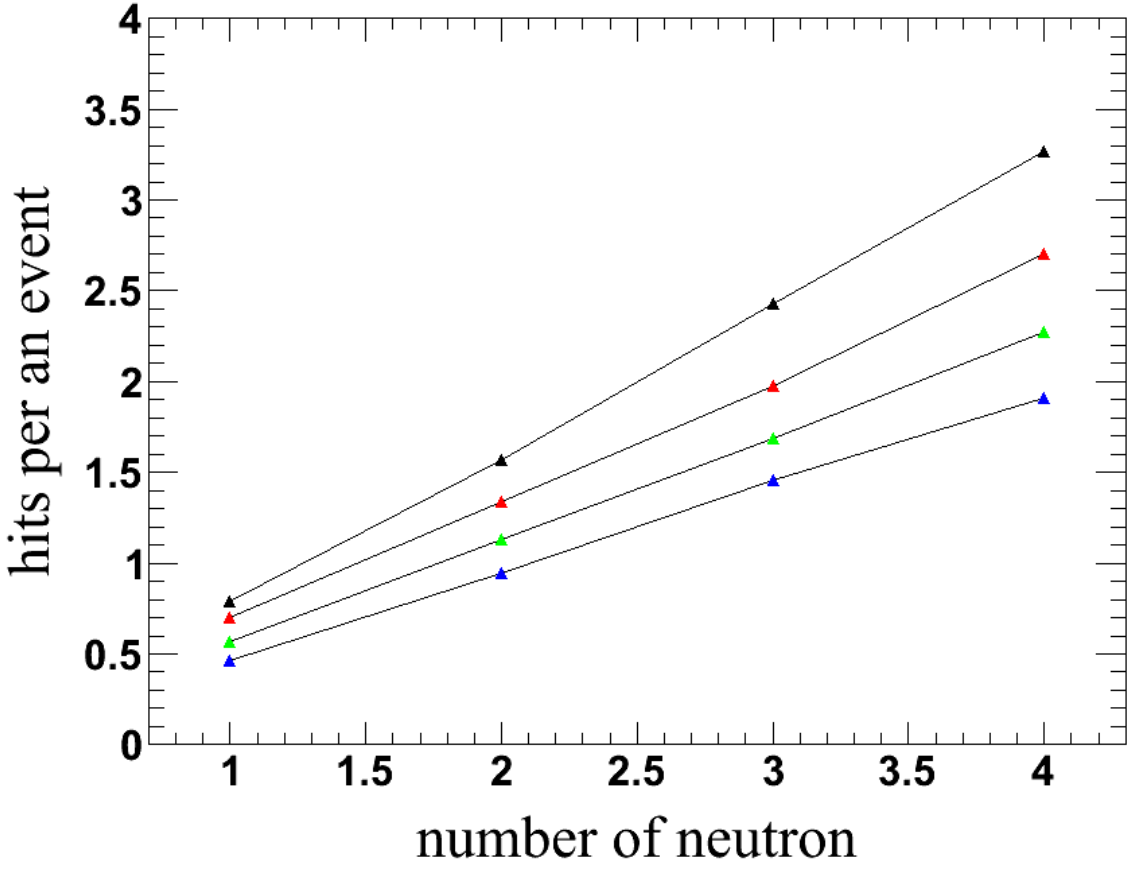
300 MeV



Hits per Event

- GunPosition : (0, 0, -15000 mm)
- Momentum direction : (0, 0, 1)
- Event : 10000

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



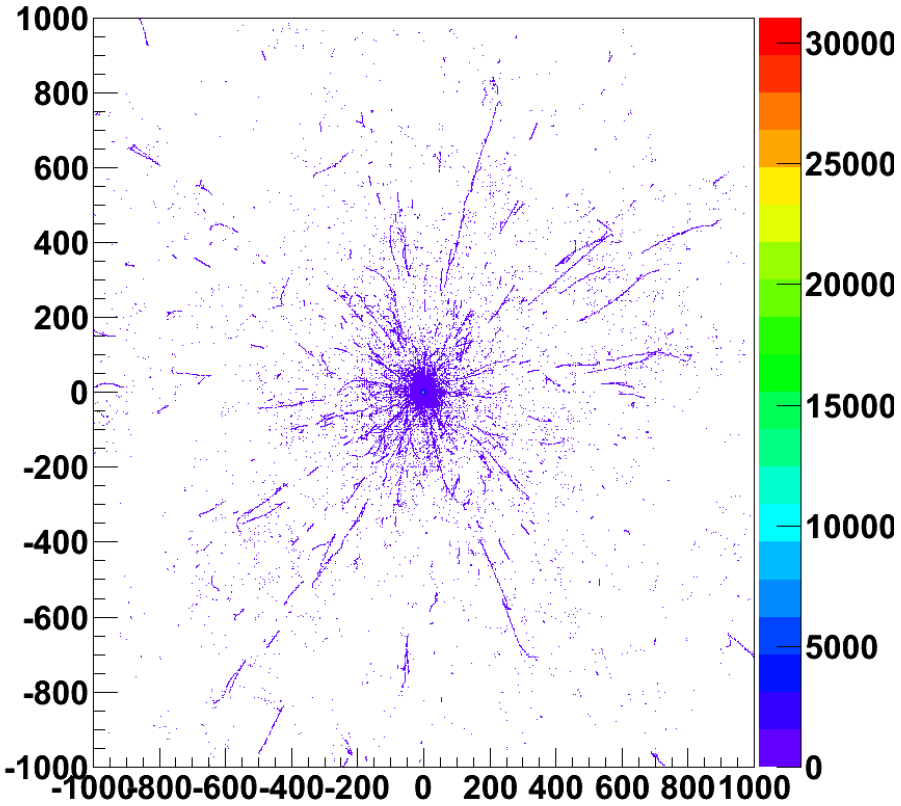
Discussion

I. Why higher threshold cases have higher efficiency in many circumstances?
   - ➢ By threshold, many hits are removed.
   - ➢ "Real hits" per an event for higher threshold is fewer than those for lower threshold.
   - ❖ "Threshold" :
     If energy deposit of an hit is larger than threshold, it considered as "real hit".

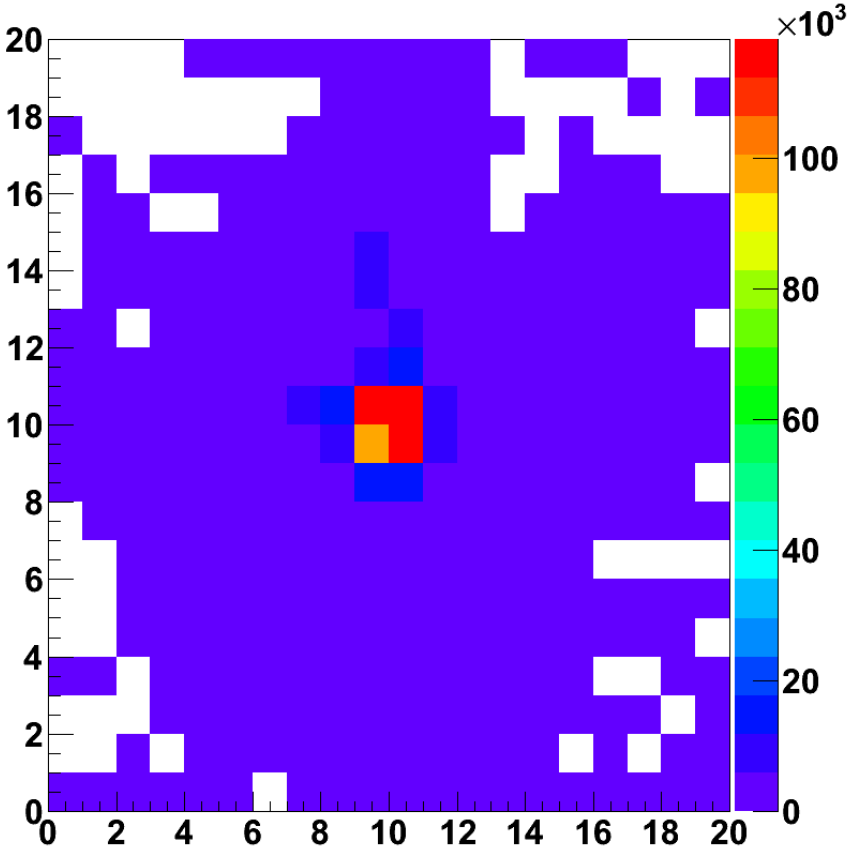
II. For many neutrons cases(≥2), why "no beta condition cases" have higher efficiency?
   - ➢ Accidental cases

Hits in 1st Stack (10000 Events)

XY – Position & Hits (Real Hit Positions)
($2000\ mm \times 2000\ mm$, $1000 \times 1000\ bins$)

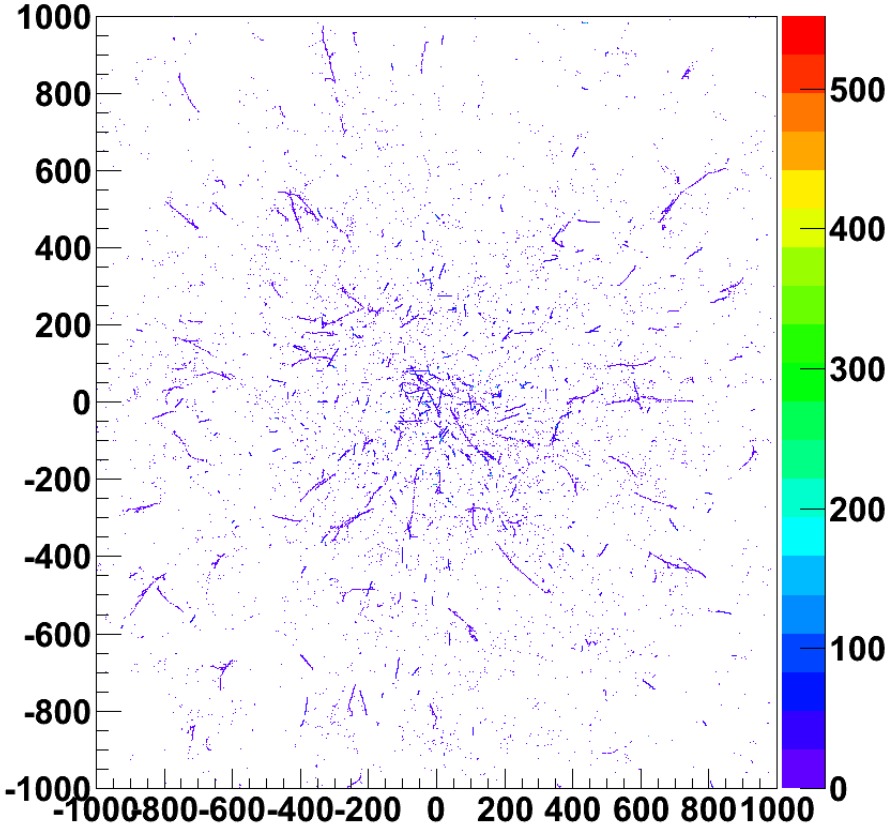


XY – BarNum & Hits (Detected Hit Positions)
($20\ bars \times 20\ bars$)

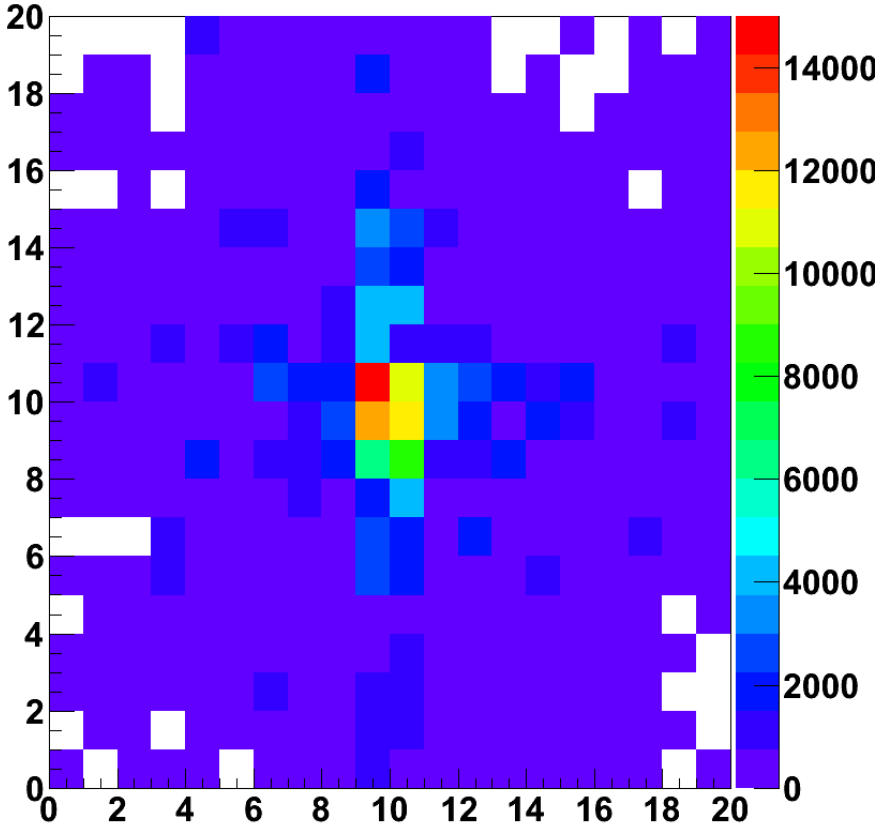


Hits in 2nd Stack (10000 Events)

XY – Position & Hits (Real Hit Positions)
($2000\ mm\ \times 2000\ mm$, $1000\ \times 1000\ bins$)

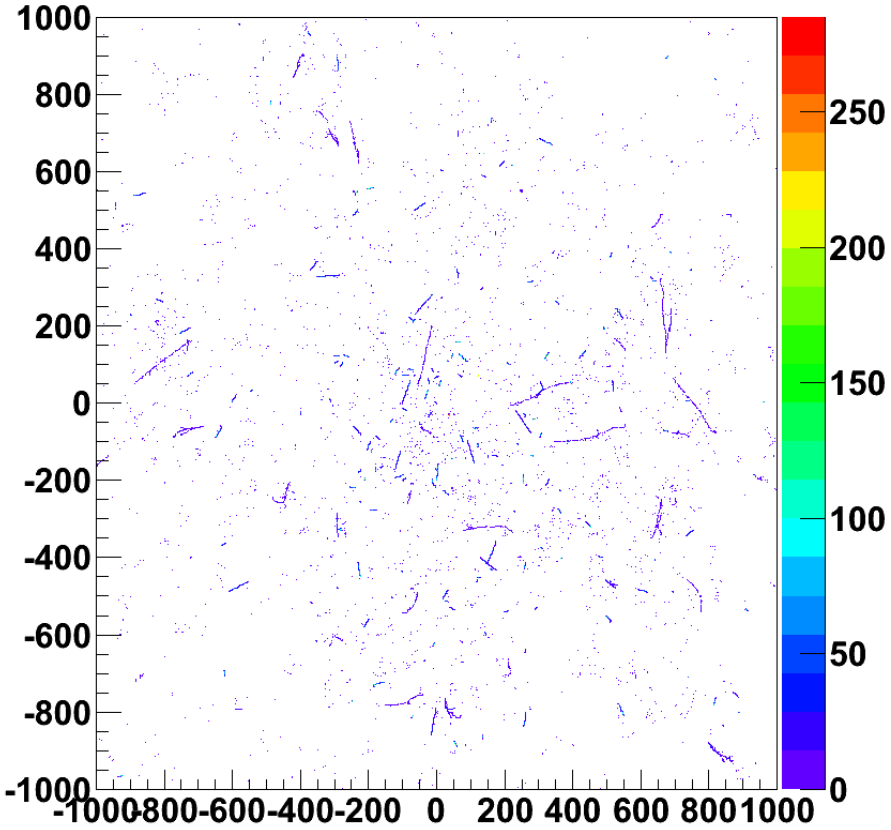


XY – BarNum & Hits (Detected Hit Positions)
($20\ bars\ \times 20\ bars$)

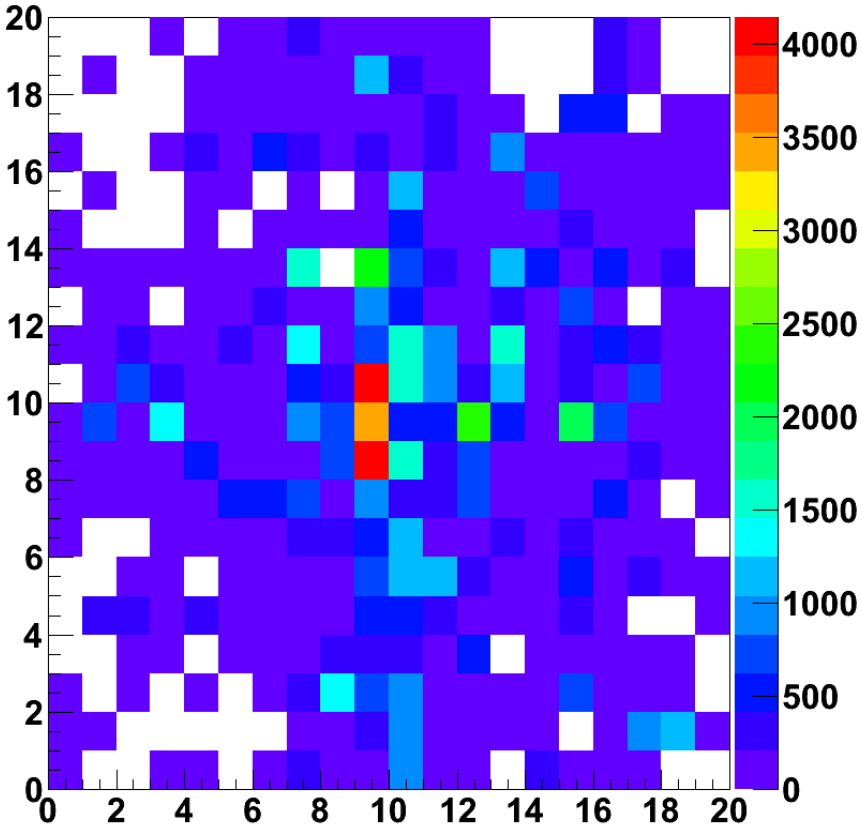


Hits in 3rd Stack (10000 Events)

XY – Position & Hits (Real Hit Positions)
($2000\ mm \times 2000\ mm$, $1000 \times 1000\ bins$)

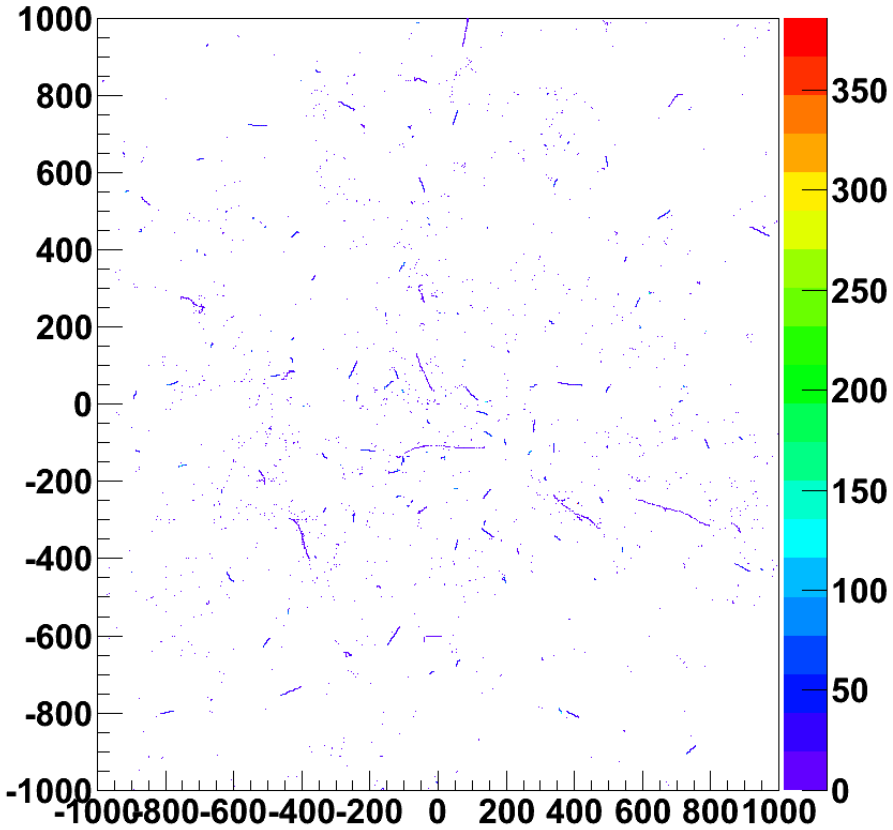


XY – BarNum & Hits (Detected Hit Positions)
(20×20)

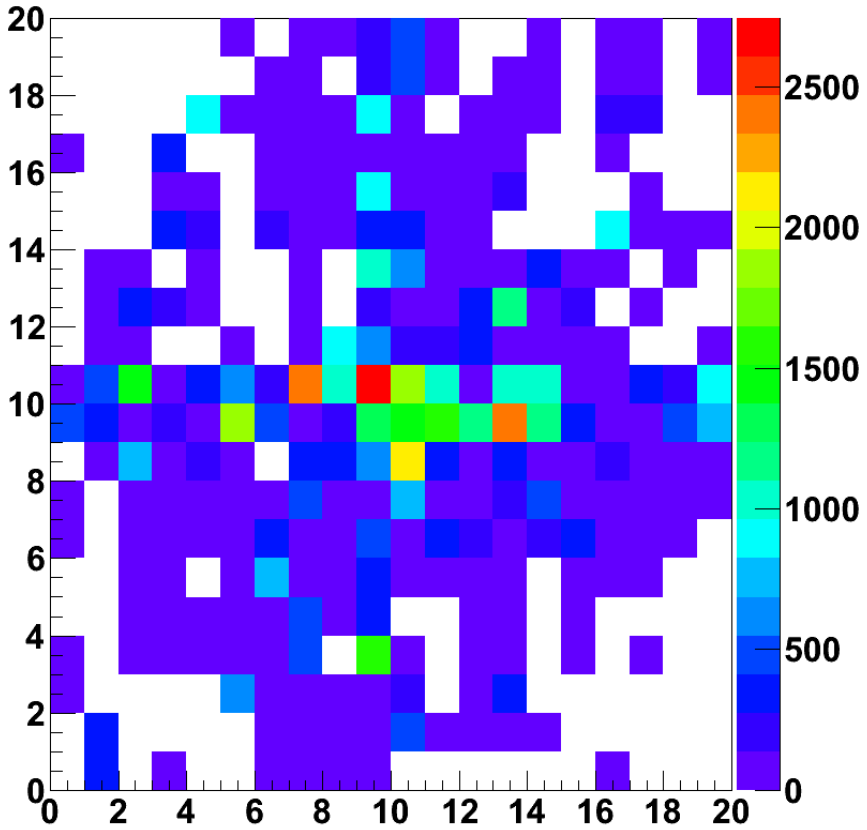


Hits in 4th Stack (10000 Events)

XY – Position & Hits (Real Hit Positions)
$(2000\ mm \times 2000\ mm,\ 1000 \times 1000\ bins)$

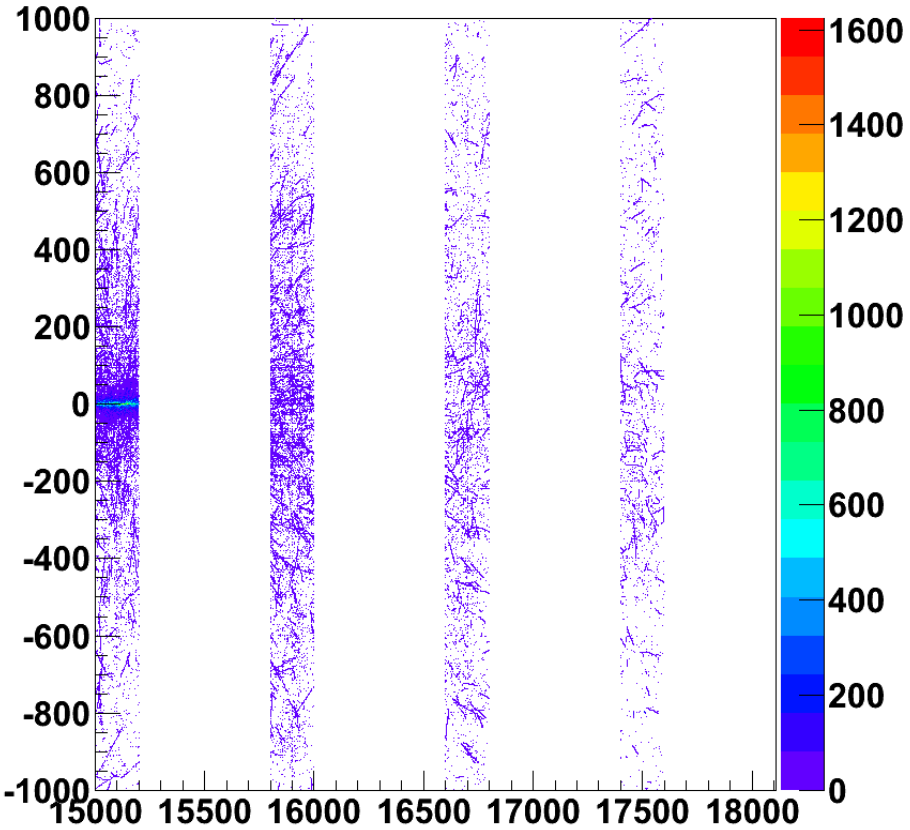


XY – BarNum & Hits (Detected Hit Positions)
(20×20)

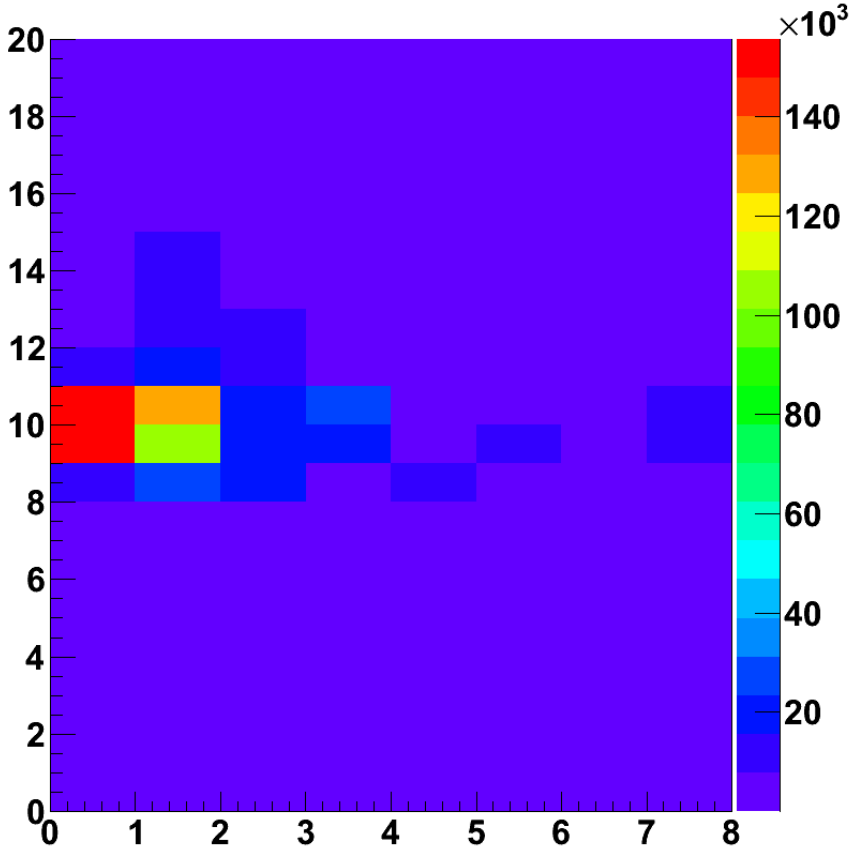


Hits in 1st ~ 4th Stack (10000 Events)

ZY – Position & Hits (Real Hit Positions)
($3110\ mm \times 2000\ mm$, $1600 \times 1000\ bins$)

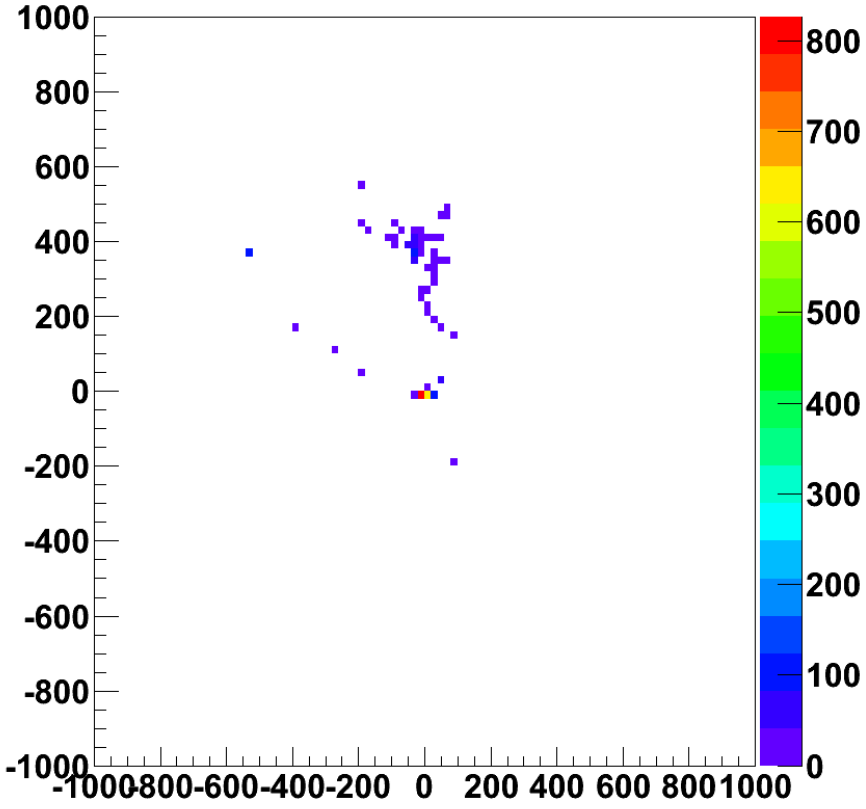


LayerNum - Bar & Hits (Detected Hit Positions)
($8\ layerNum \times 20\ barNum$)

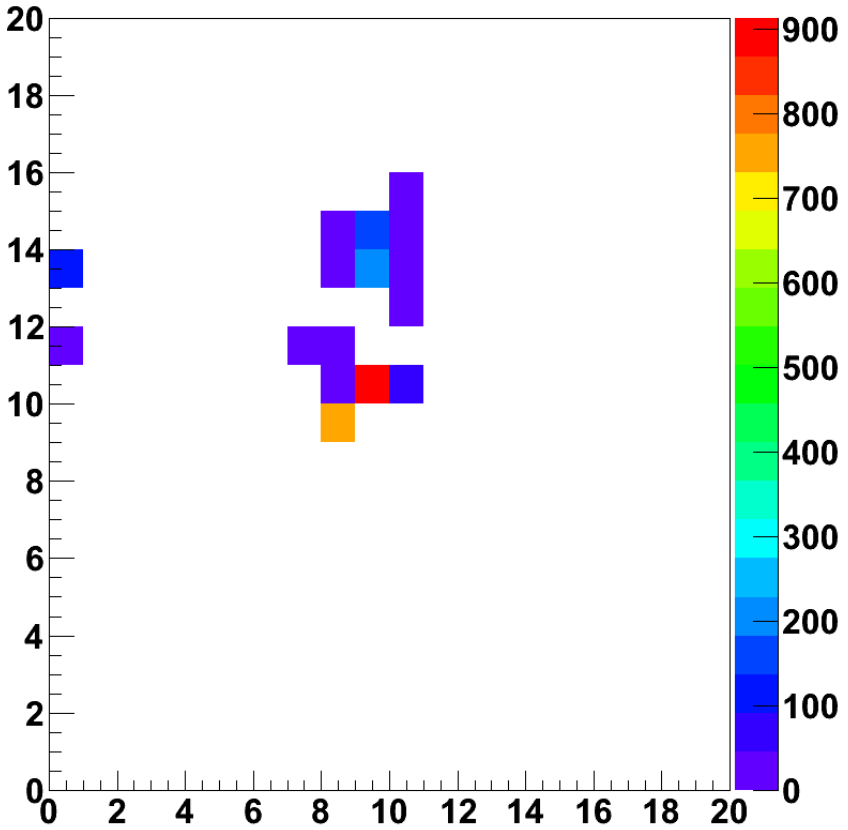


Hits in 1st Stack (10 Events)

XY – Position & Hits (Real Hit Positions)
($2000\ mm \times 2000\ mm$, $100 \times 100\ bins$)

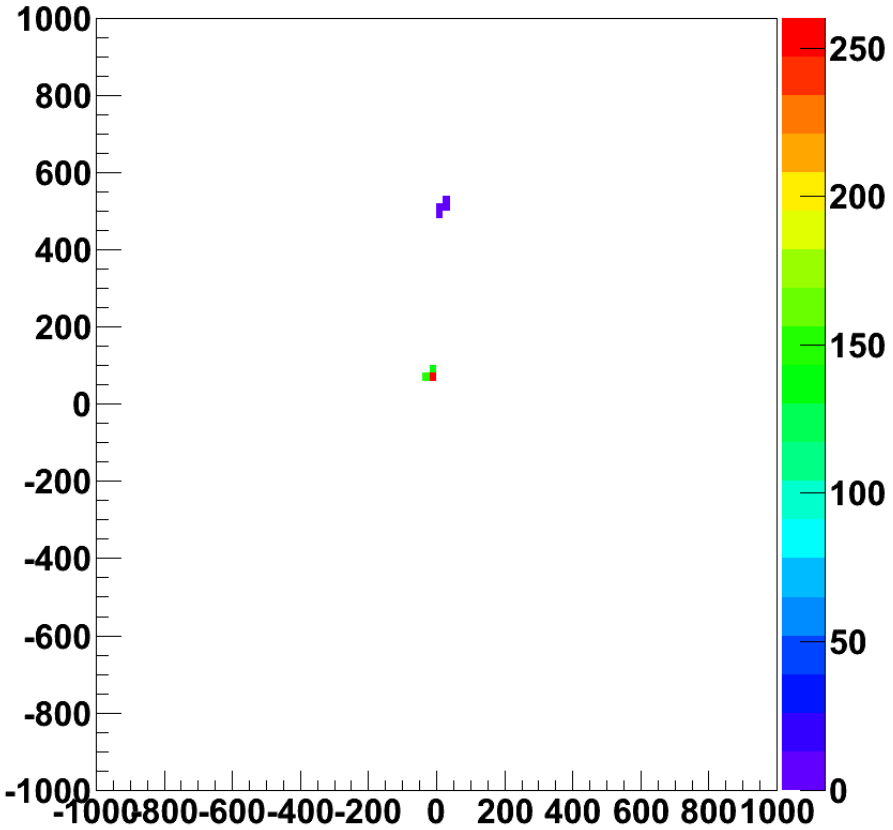


XY – BarNum & Hits (Detected Hit Positions)
(20×20)

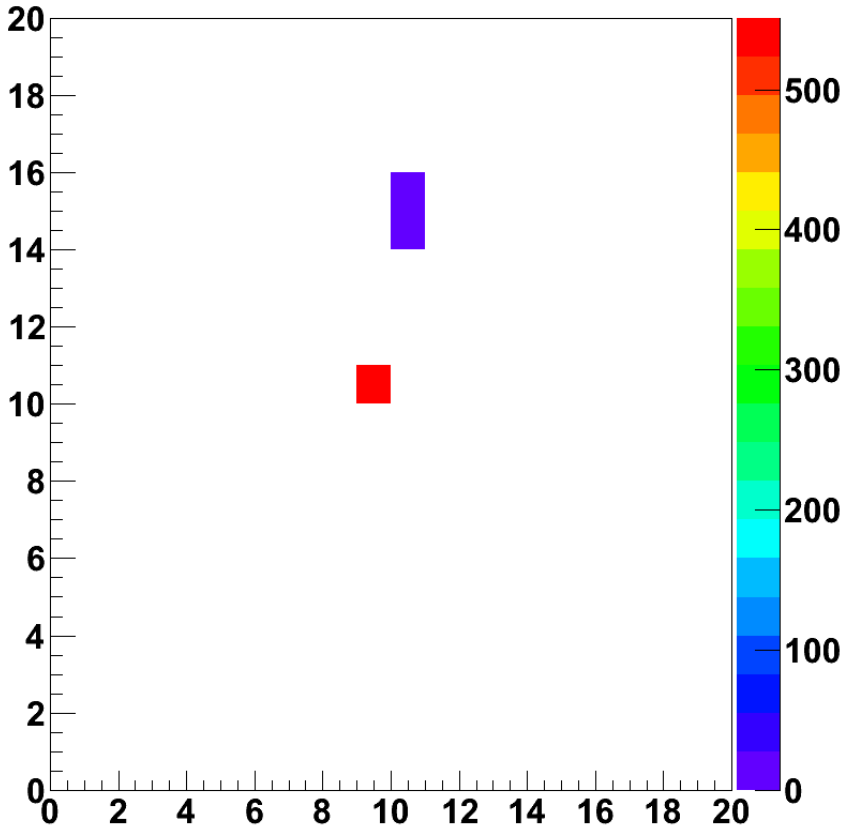


Hits in 2nd Stack (10 Events)

XY – Position & Hits (Real Hit Positions)
($2000\ mm\ \times 2000\ mm$, $100\ \times 100\ bins$)

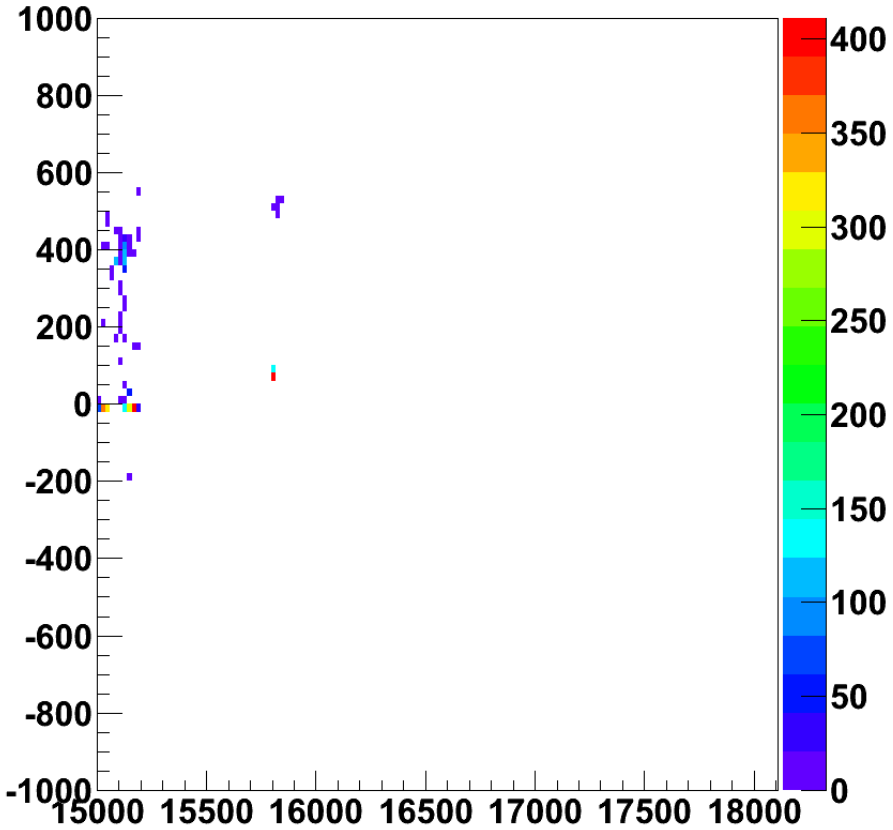


XY – BarNum & Hits (Detected Hit Positions)
($20\ \times 20$)

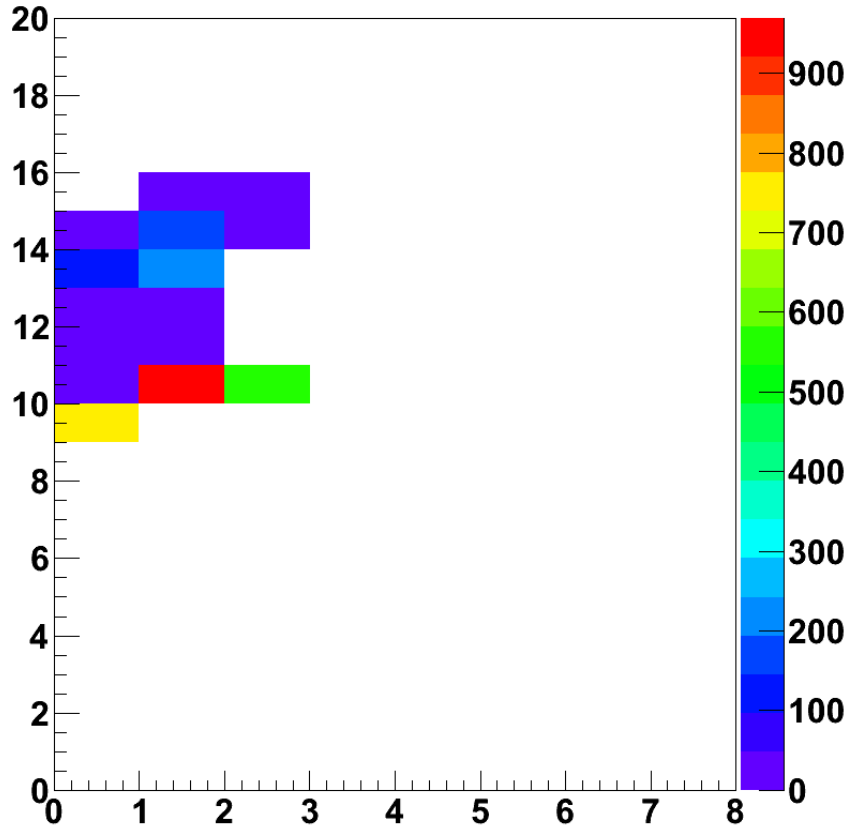


Hits in 1st ~ 4th Stack (10 Events)

ZY – Position & Hits (Real Hit Positions)
($3110\ mm \times 2000\ mm$, $156 \times 100\ bins$)



LayerNum - yBar & Hits (Detected Hit Positions)
(8×20)



Next Step

I. **Position resolution & time resolution of bar detector**

II. **Slowly change the beam diameter or shape.**
   - **Finally, change the beam shape into realistically randomized beam.**