# Summary of Sieve Slit Simulation

Daisuke Kawama

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Here I summarize Sieve Slit simulation using Geant4.

## 1 HES side

### 1.1 SS Thickness

For $e'$ side, most of electrons hit SS lose its energy with bremsstrahlung. In the case of heavymet (W:90%, Ni:6%, Cu:4%), ladiation length is 0.35 [cm]. Therefore, if we use 1" heavymet for SS, mean energy loss of 844MeV/c electron is $844/0.35 * 2.54 = 6.13$[MeV]. From this calculation and Geant simulation result, we conclude that the 1" SS is enough to stop scatter in or punch through.

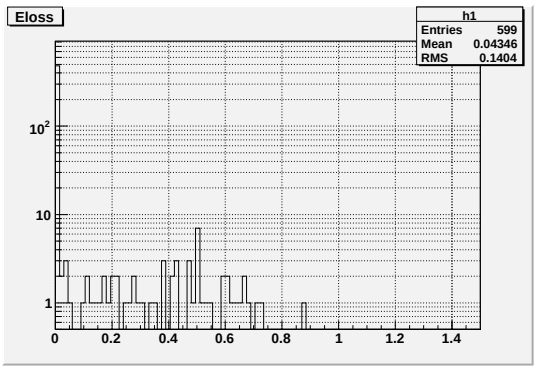


Figure 1: Energy loss at Sieve Slit

Table 1: Ratio of lost energy requiring FP hit

| | |
|---|---|
| Eloss = 0 | 90% |
| 0 < Eloss < 100keV | 0.6% |
| Eloss > 100keV | 10% |

### 1.2 Hole angle

In HKS side, SS holes have each angle corresponding to kaon angle at SS in order to reduce energy loss events which are background of SS analysis. But in HES side, almost all events which hit SS stop in SS with bremsstrahlung.

Geant4 simulation results show that the difference between "non-angled hole" and "angled hole" is less than 1%. Then, we do not need to make "angled hole SS".

## 1.3 Hole size, pattern

I created SS model in Geant according to following criteria:

1. Thickness is 1”.
2. Horizontal hole angle.
3. At least three holes in a row or column.
4. Wider spacing between holes for y. Because vertical resolution is worse than horizontal one.
5. Contain missing hole to be able to identify up/down and left/right.
6. No hole outside the acceptance.

Table2 shows the used parameter for Geant simulation according to the criteria. And hole pattern is also like figure2.

Table 2: Sieve Slit Parameters

| | |
|---|---|
| Distance from Virtual target | 178.53 cm |
| SS hole dimeter (center) | 1/16” = 1.5875 mm |
| SS hole dimeter (smaller) | 3/16” = 4.7625 mm |
| SS hole dimeter (Bigger) | 1/4” = 6.35 mm |
| SS hole angle | 0deg |
| SS thickness | 1” |
| Spacing between two holes in horizontal | 3/4” = 19.05 mm |
| Spacing between two holes in vertical | 1” = 25.4 mm |

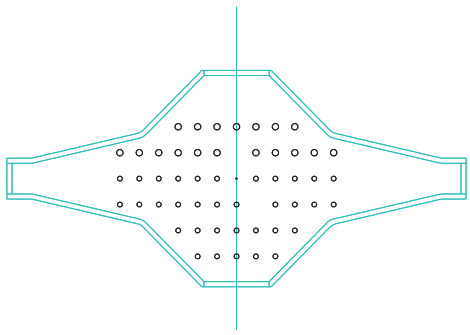

Figure 2: SS hole pattern

And the simulation results is shown in figure3, 4. Figure3 shows how do the SS events distribute in FP and the correspondence to target SS hole (not reconstructed one). And figure4 shows the correspondence between FP cut and target angular distribution (not reconstructed one). There are almost no background due to SS, then we can distinguish SS hole using FP distribution.

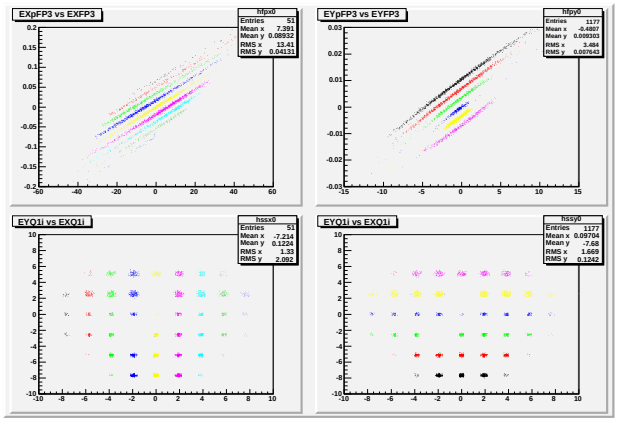


Figure 3: The correspondence between FP cut and SS hole

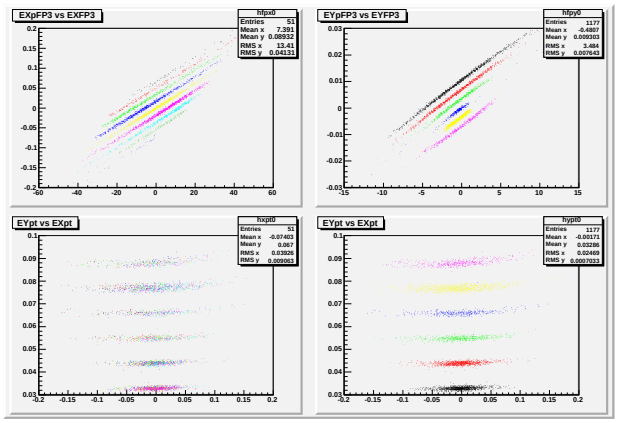


Figure 4: The correspondence between FP cut and target angle

# 2 HKS side

## 2.1 Scatter in, punch through

For HKS side, there are existing one used in the last experiment. Differences from last experiment are following two point:

1. Beam energy is 2.344 GeV/c which is higher than the last experimental energy 1.856 GeV/c. Then in this experimnet, there is almost no doubt that the number of punch through event, which create background events get to be larger.

2. New splitter magnet. The splitter used in this experiment is much bigger than last experiment's one.

Taking these two points into account, there are some possibility to recreate new-angled hole SS. Figure5 shows the design of HKS SS, and one can know that holes of HKS SS has angle corresponded to the particle angle. The reason is to reduce background due to punch through. And this angle is calculated using last experiment parameter, then this angle does not correspond to next experiment. The distance from virtual target from SS was 85cm, but this time the distance is about 170cm. Then, the particle angles become half in this time.

I checked how much does the S/N raio become better if we used new SS. Table2.1 shows the result. First I apply FP cut to the SS event, then reconstructed these events using matrix. Then I checked whether the events return to the "correct" hole corresponding to the FP cut. As a result, th S/N ratio of new SS will be better than old one by 2-3%. This is not so much, then we decided to use old SS for next experiment.

| | Num. of recon event | Num. of total event | ratio |
|---|---|---|---|
| d=170cm (x) | 6381 | 14558 | 43.4% |
| d=85cm (x) | 5882 | 14261 | 41.2% |
| d=170cm (y) | 3030 | 14558 | 20.8% |
| d=85cm (y) | 2526 | 14261 | 17.7% |

Table 3: The comparation of S/N ratio between new and old SS. Here "recon event" mean the number of reconstructed event which return to the SS hale.

## 2.2 Hole pattern

From Simulation result, we conclude same hole pattern as last experiment's one is suitable for next experiment.

As a result, we use same SS for HKS side in next time.

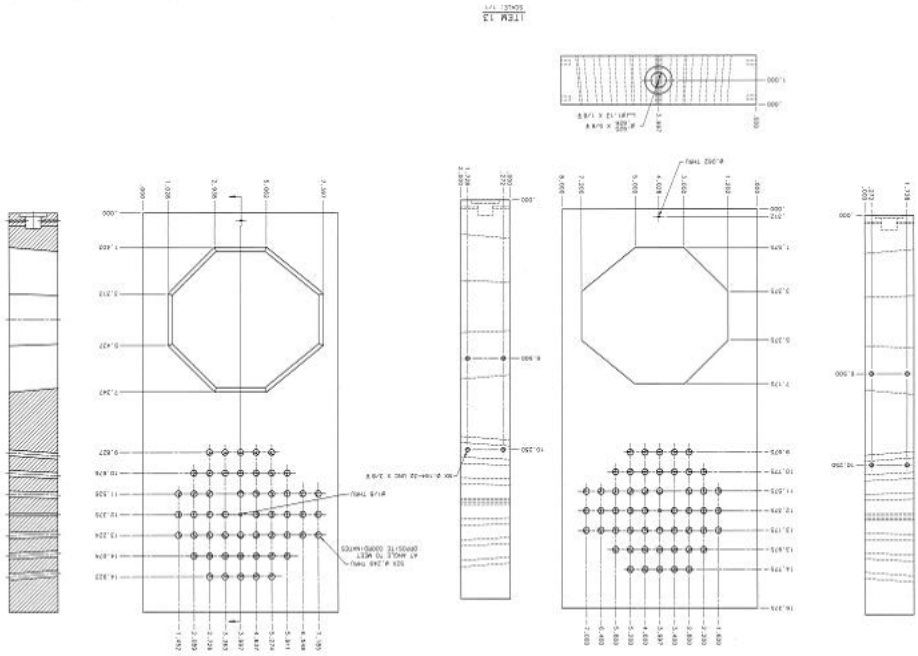

Figure 5: Design of HKS Sieve Slit