design of KL beam-line for E14

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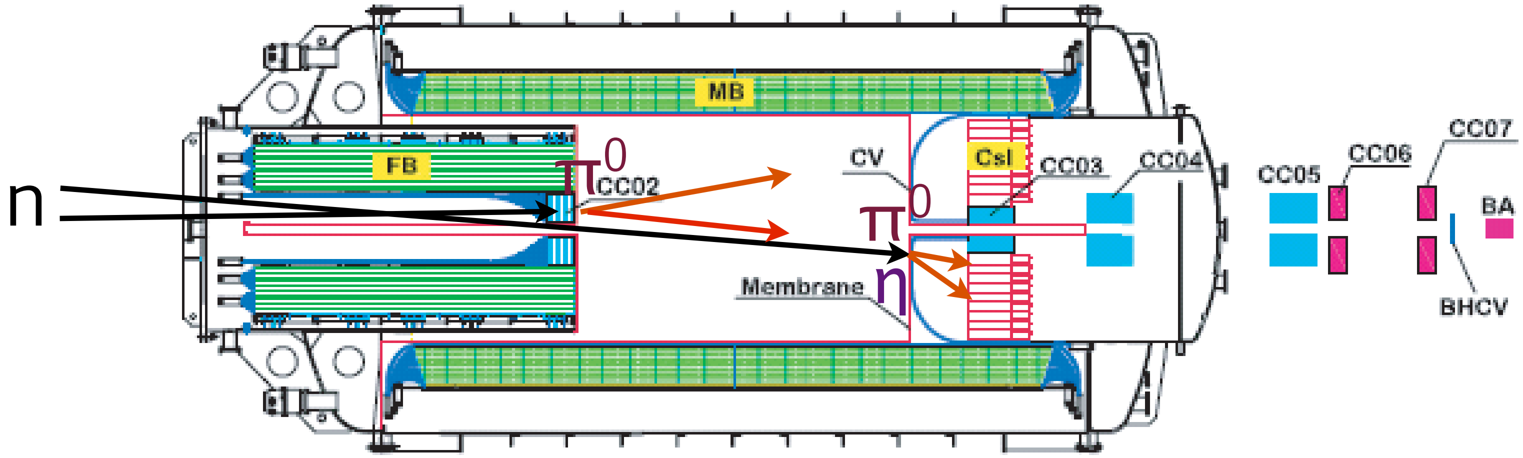
motivation

- From E391a, We understand halo neutron can be serious B.G. source.
- For halo neutron B.G., need to design "clean" neutral beam-line.
  - "clean"
    - High K^0_L & low halo neutron intensity.

halo neutron B.G.

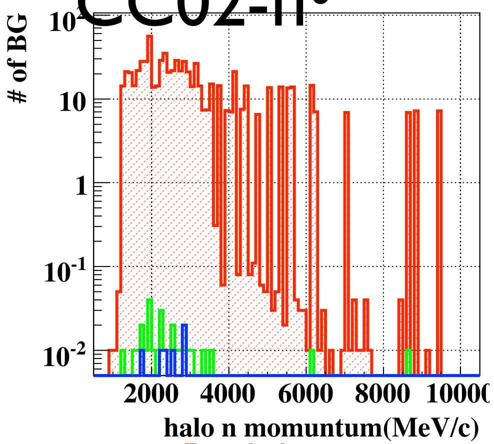
- In E391a, halo neutron is one of main B.G. source.
  - hit CC02 : product $\pi^0(\rightarrow 2\gamma)$.
  - hit CV :
    product $\pi^0(\rightarrow 2\gamma)$+X(w/extra energy)&$\eta(\rightarrow 2\gamma)$.



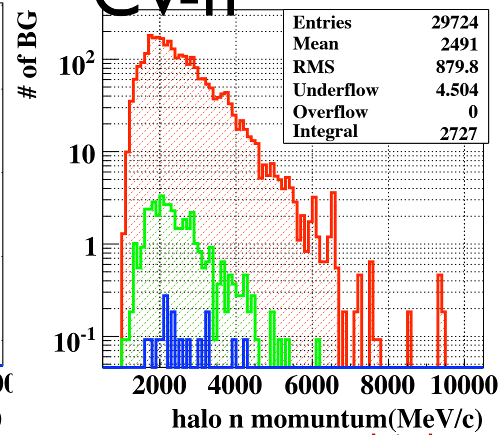
definition of halo neutron.

- halo neutron : hit detectors.
  - Inner size of detector
    - R_{in} @CC02 = 8.cm
    - $X_{in}(Y_{in})$ @CV = ±11.25cm
  - Momentum dependency
    - π0 production : P_n > 1.0GeV/c
    - η production : P_n > 2.0GeV/c

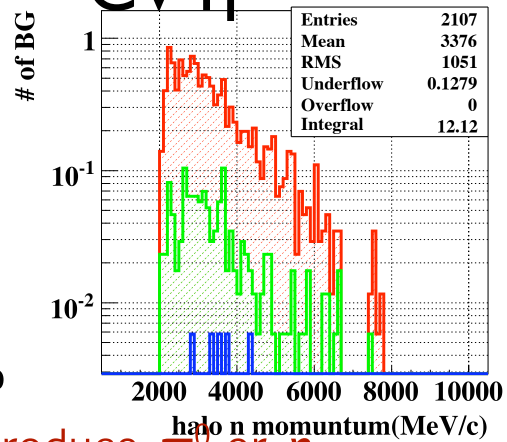
CC02-π^0



CV-π^0

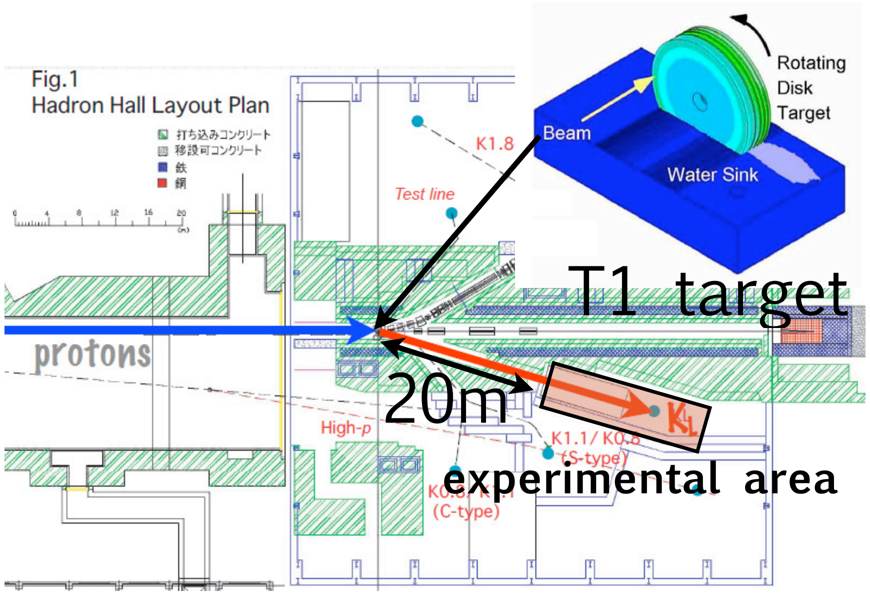


CV-η



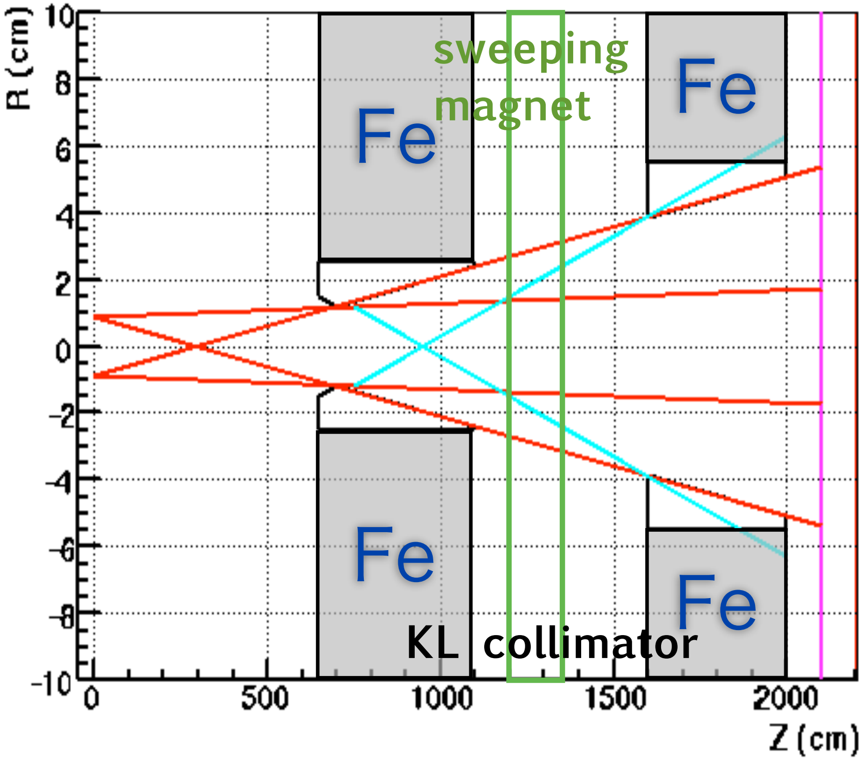
Red line : neutron momentum which produce π^0 or η.

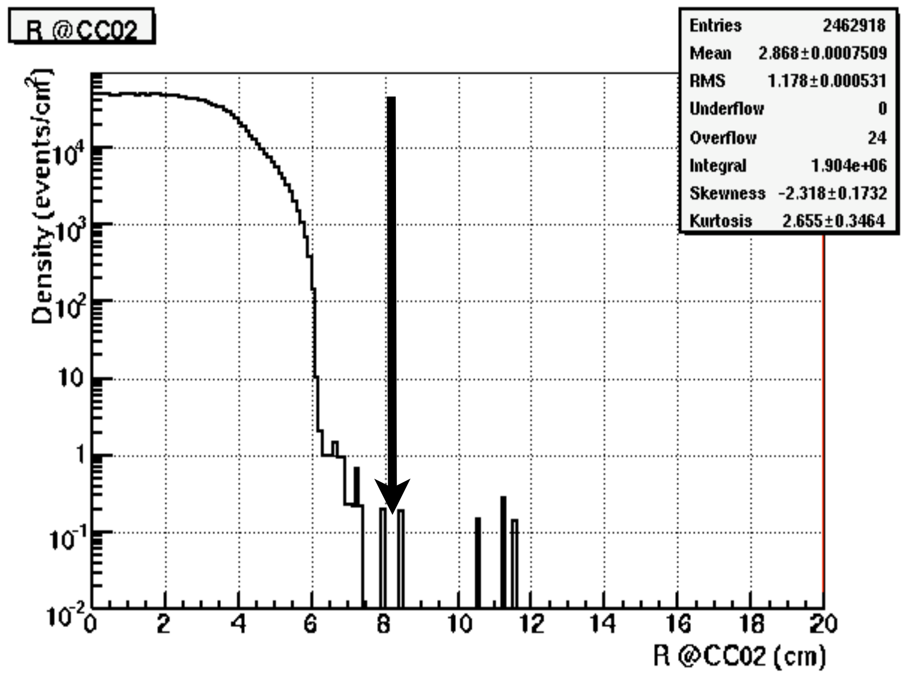
characteristic of beam-line



- common T1 target
  - target image has finite size.
- beam-line
  - 20m long beam-line
  - smaller solid angle
  - Large extraction angle :
    larger KL/neutron ratio & soft momentum neutron.

basic configuration

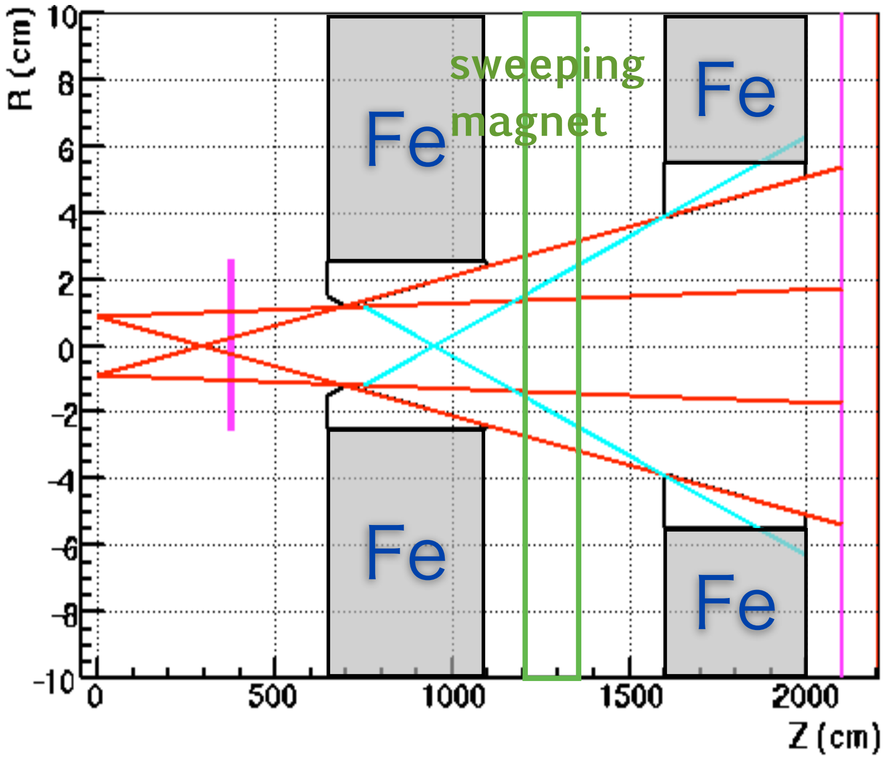


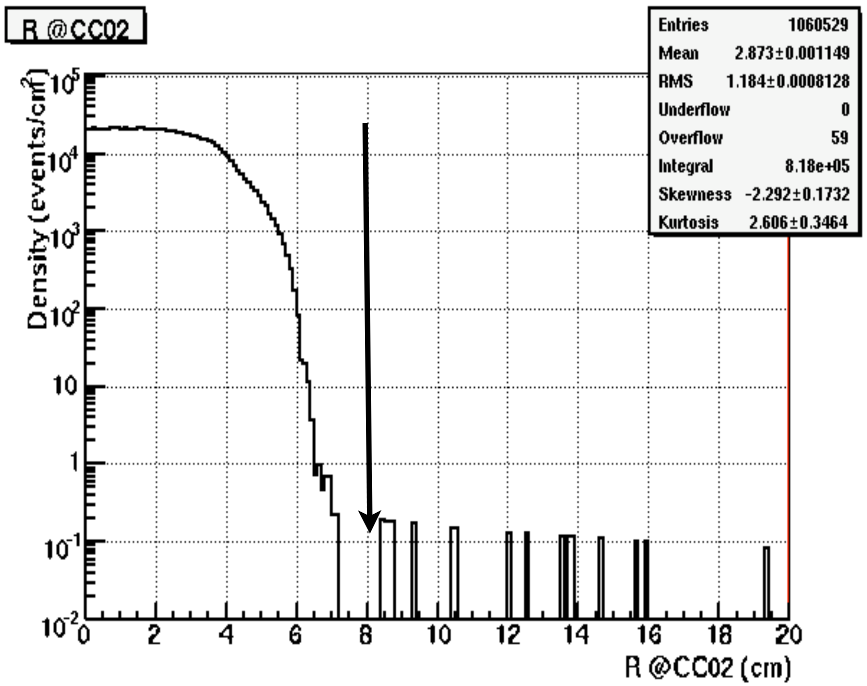


$N_{halo}/N_{core} \sim 10^{-5}$

- collimator line
  - To avoid multiple scattering, Inner wall of KL collimator can't be faced from target.

γ absorber



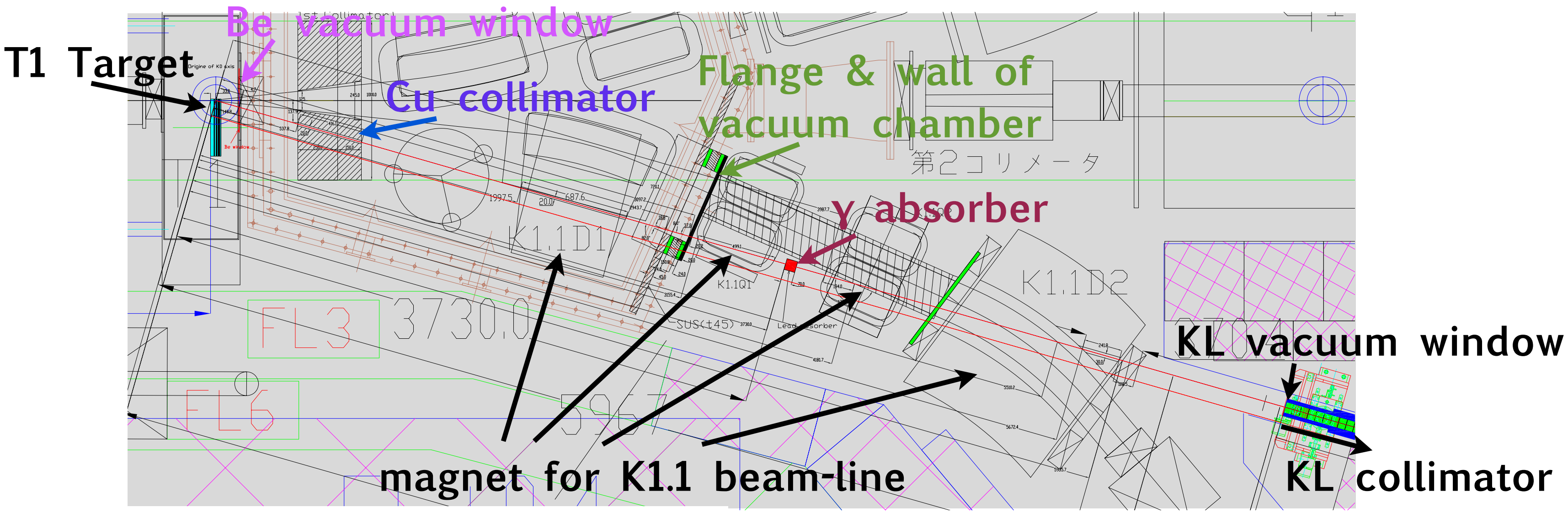


$N_{halo}/N_{core} \sim 10^{-4}$

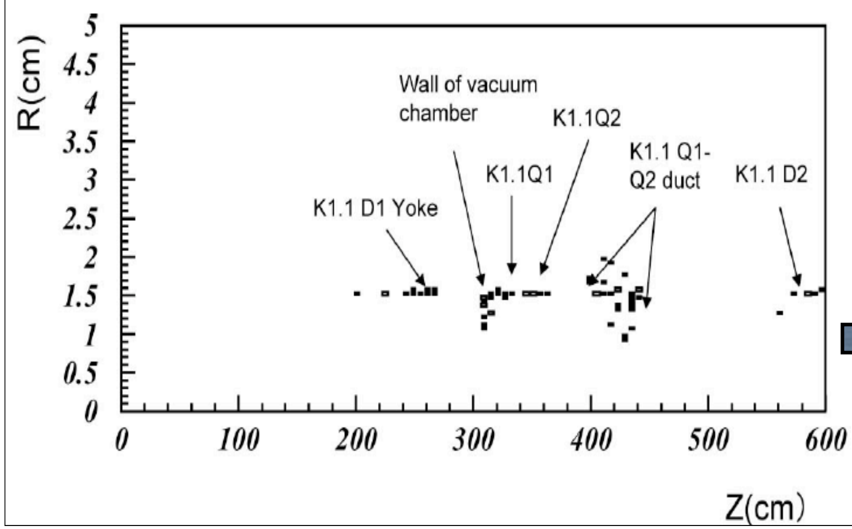
- 7cm-thick lead ($12.5\chi^0$) for γ.
- N_{halo} is increase, N_{core} is decrease.

➡ Lead absorber is scattering source.

upstream material



Scattering points to produce halo neutron

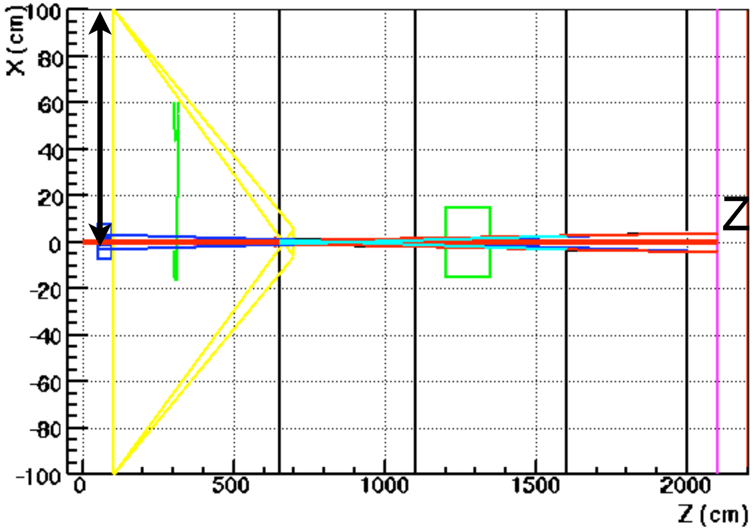


- K1.1 material are scattering sources for halo neutron.

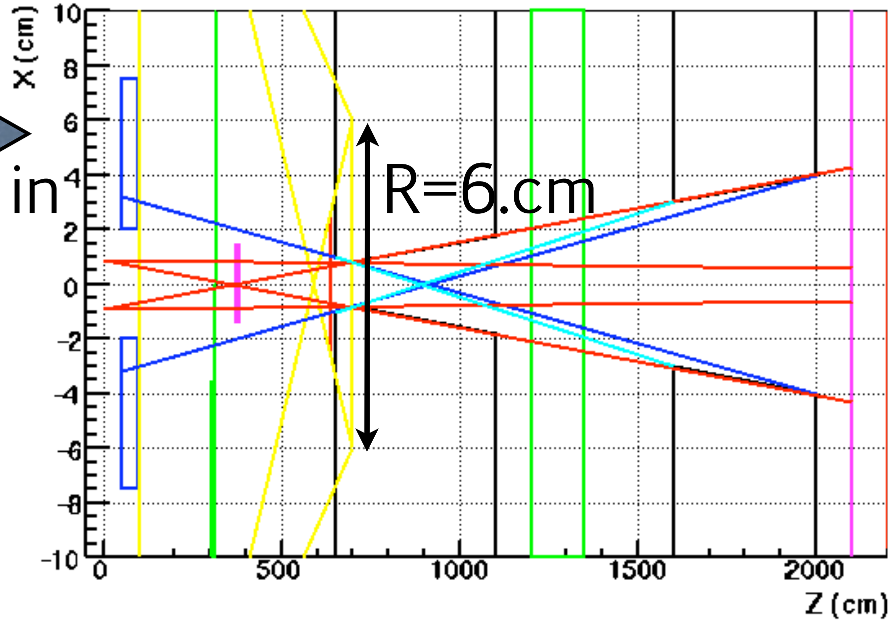
Material between target & KL beam-line is source of halo neutron.

effect of neutron which is not target origin

R=100cm

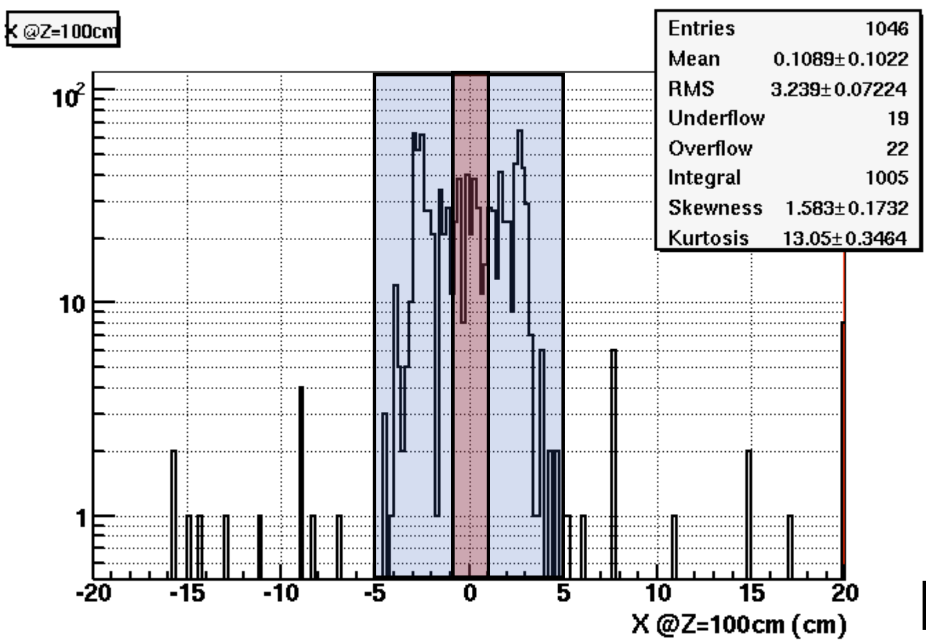


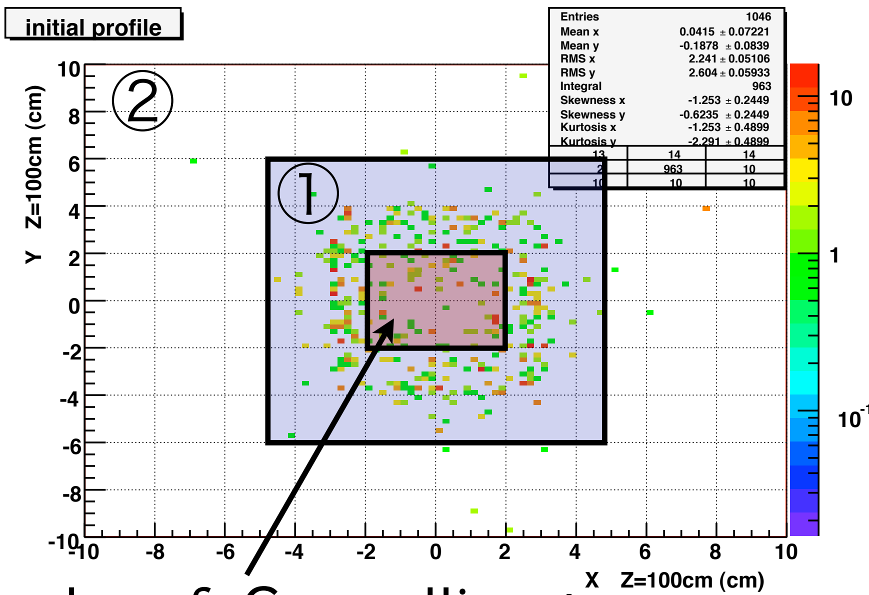
zoom in



- Generate position: 200cmφ@end of Cu collimator.
- Generate region: 12cmφ@700cm
- Momentum distribution : flat(0.~20.GeV/c)

R dependency



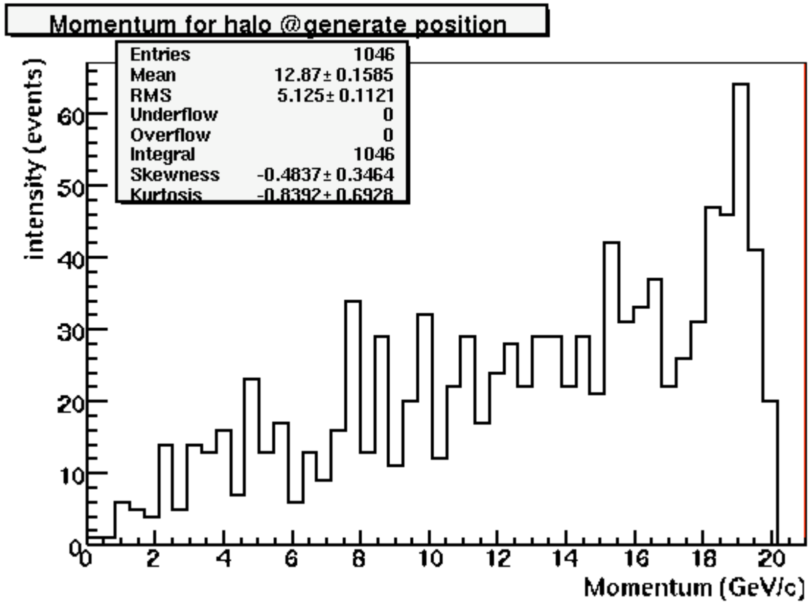


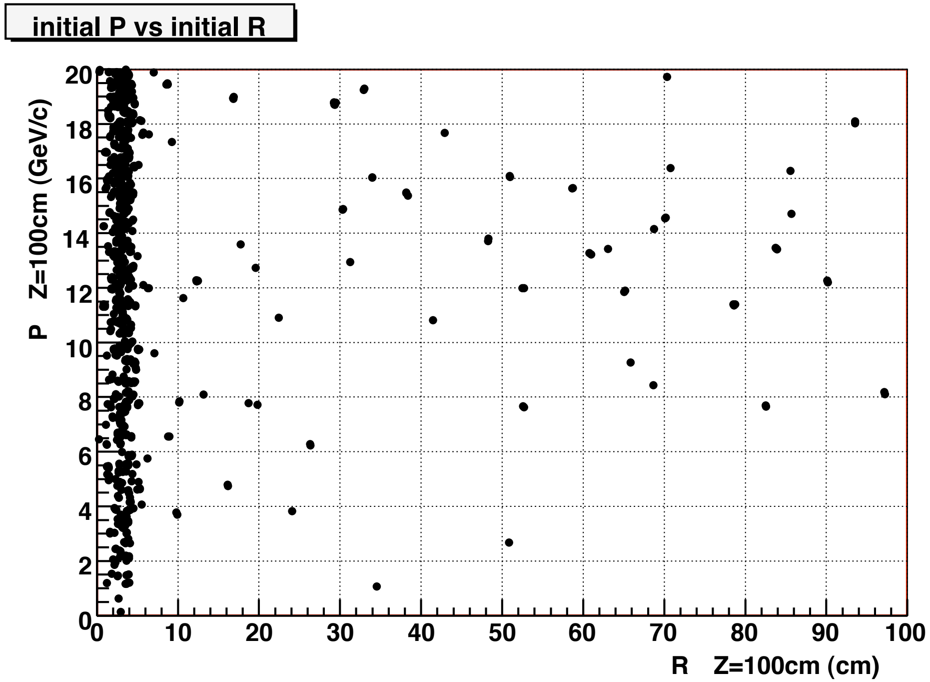
hole of Cu collimator

- Separate 2 areas.
  1. faced inner face of KL collimator.
  2. enter beam-hole indirectly.

To study way of rejection in each area.

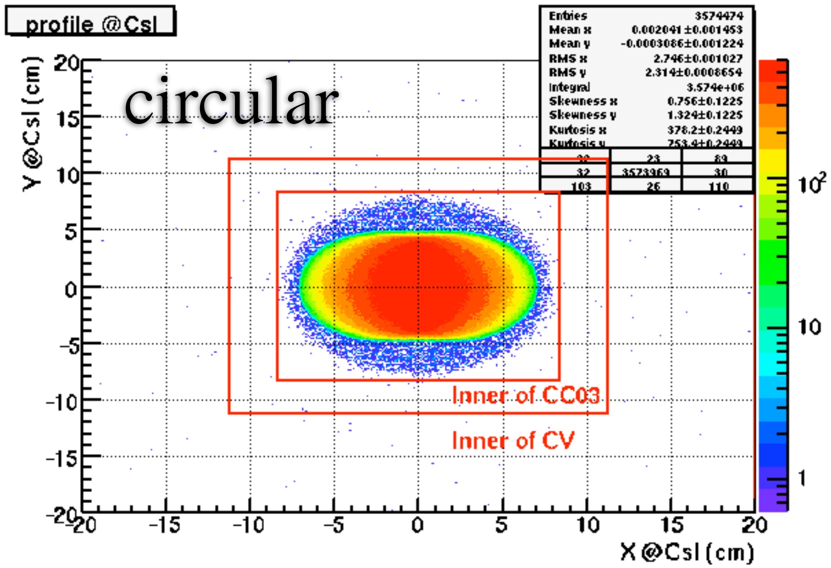
momentum dependency

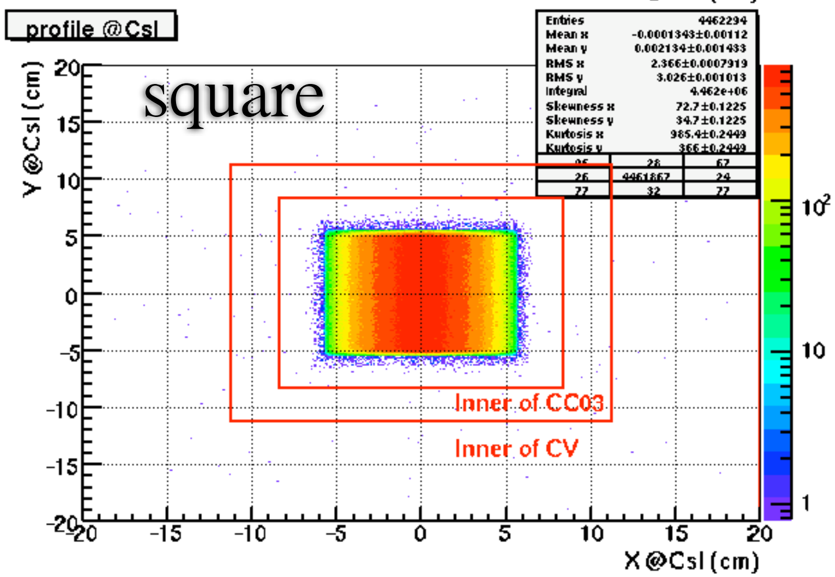




- In R > 6.cm(②), High momentum neutron is easy to be halo events.
- need to obtain momentum distribution @Z=100cm from target simulation.

beam-hole shape





- Comparison 2 designs.
  - circular ⇒ square

  N_{core} : 30% increase.
  N_{halo} : 15% decrease.

- Square beam-hole : Shadow of collimator is small.
  (adapt shape of target image.)
- Square beam-hole is better !!

Summary

- Neutron which is not origin target.
  - Now studying....
  - We obtain R, P distribution with target simulation @end of Cu collimator. → estimate B.G. level
  - We have to suppress with trimming or masking.
- Square beam-hole collimator.
  - To adapt target image is important for N_{halo}/N_{core}.
- Need more optimize !!
  - Study of trimming line for upstream material.