2/16/2001
KWS4YP
@KE

KAMI

($K_L \to \pi^0 \nu\bar{\nu}$)

Experiment at FNAL

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Osaka Univ.

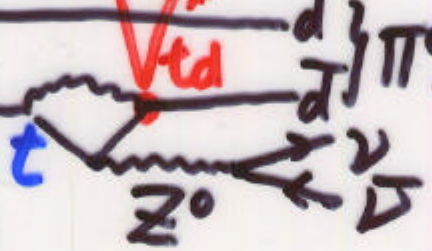
$K_L \to \pi^0 \nu \bar{\nu}$: Tool to measure the CP violation parameter, η.

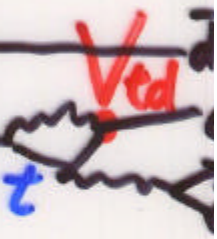
in CKM matri

$$A(K_L \to \pi^0 \nu\bar{\nu})$$

$$\propto A(K^0 \to \pi^0 \nu\bar{\nu}) - A(\bar{K}^0 \to \pi^0 \nu\bar{\nu})$$

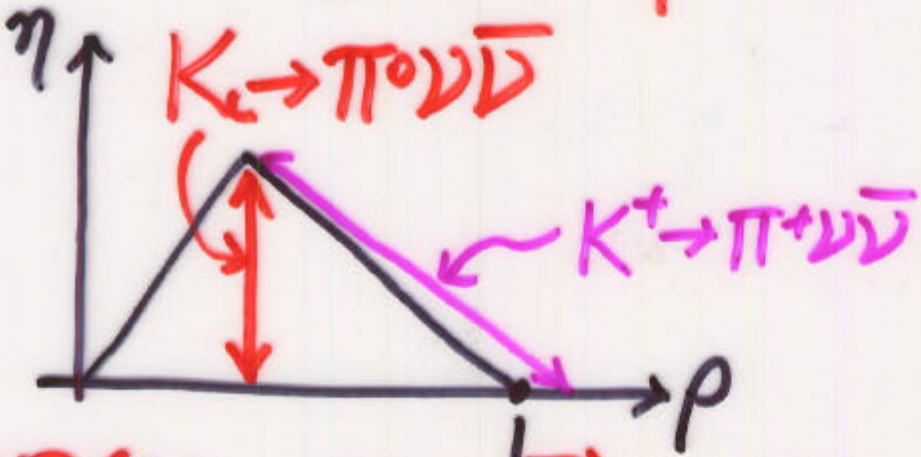
$$= K^0 \{ d, s \} \; V_{td}^* \; \{ d, \bar{d} \} \; \pi^0 - \bar{K}^0 \{ \bar{d}, s \} \; V_{td}$$





$$\propto V_{td}^* - V_{td}$$

$$\propto 2 \, \mathrm{Im}(V_{td}) \propto \eta$$



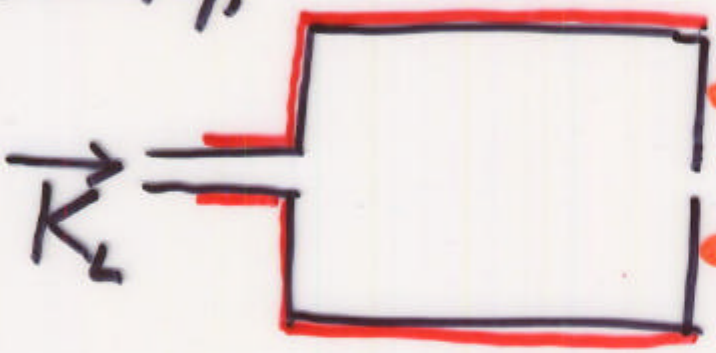
$BR(K_L \to \pi^0 \nu\bar{\nu}) \Rightarrow$ Direct and accurate measurem of η (theoretically

Experimental challenges

$BR(K_L \to \pi^0 \nu\bar{\nu}) \sim 3 \times 10^{-11}$
$\hookrightarrow \gamma\gamma$

$BR(K_L \to \pi^0\pi^0) \sim 1 \times 10^{-3}$

Usually,



E_K ?
Z ?

The largest background rejection power : veto on extra γ.

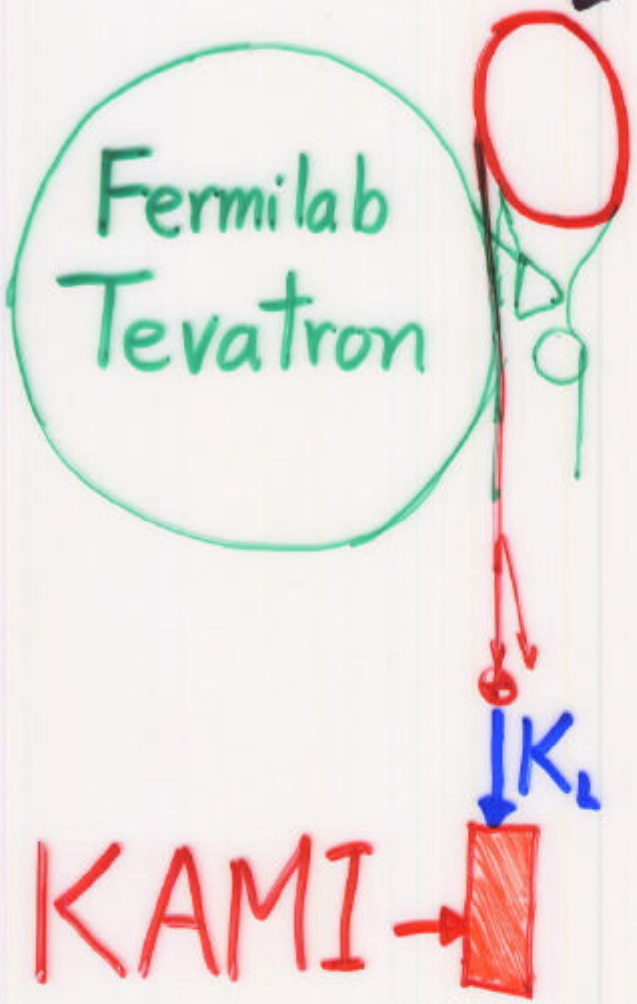
· Principle strategy of the experim

High energy K_L

⇩

- high E_γ ⇒ better γ veto efficiency
- high acceptance ⇒ less K, n
- less neutrons = clean beam

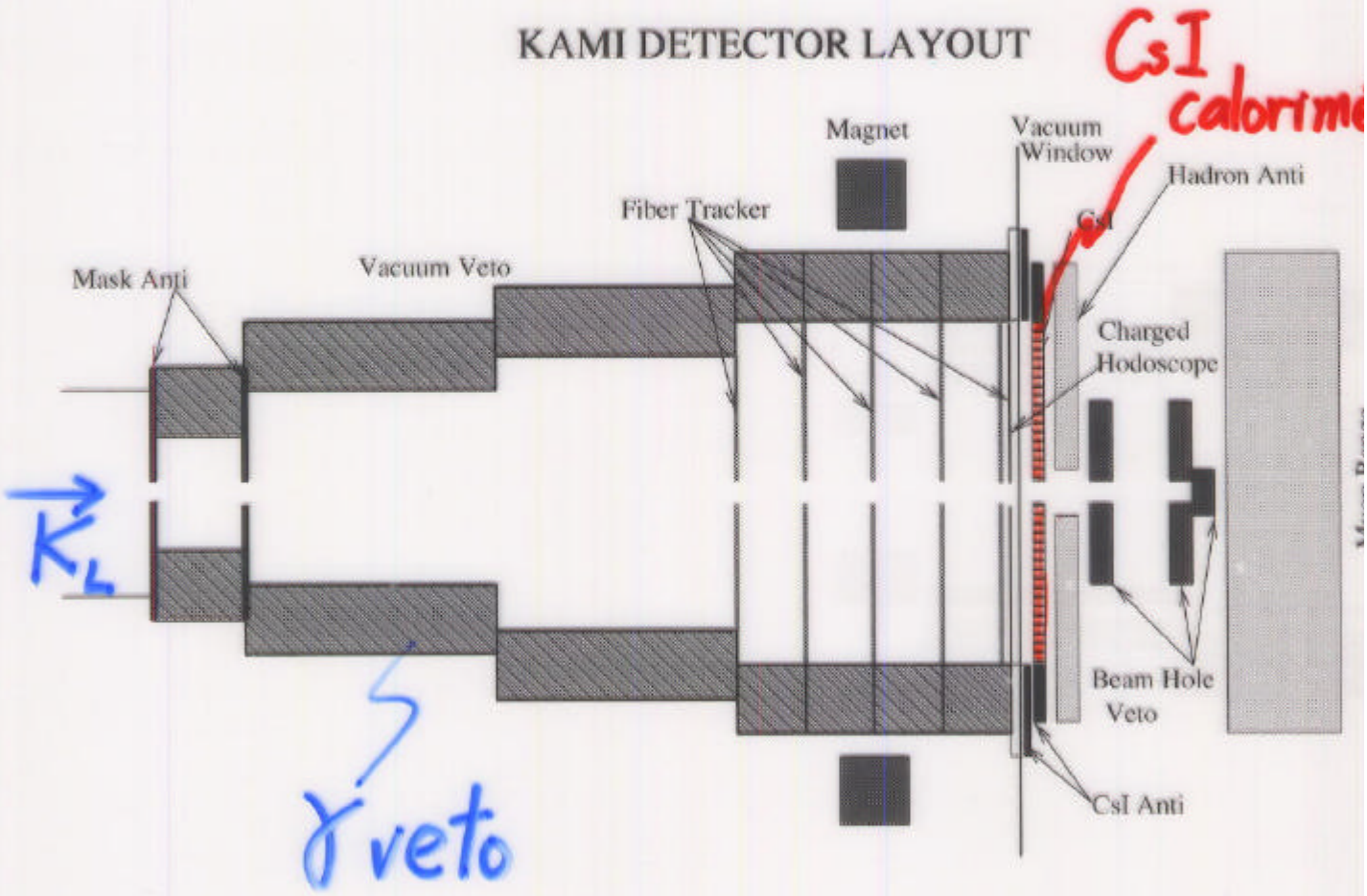
Kaon At Main Injector



- 150GeV proton mac
  as an injector
- Can deliver
  120GeV protons
  3×10^{13} / 3sec
  to fixed target area
- Collider and fixed targ
  experiments can run
  simultaneously.

- same beamline with KTeV
- existing & new target stations
- existing detector hall for KTeV+KAM
- Utilizes KTeV CsI calorimeter,
  spectrometer magnet,
  ⋮

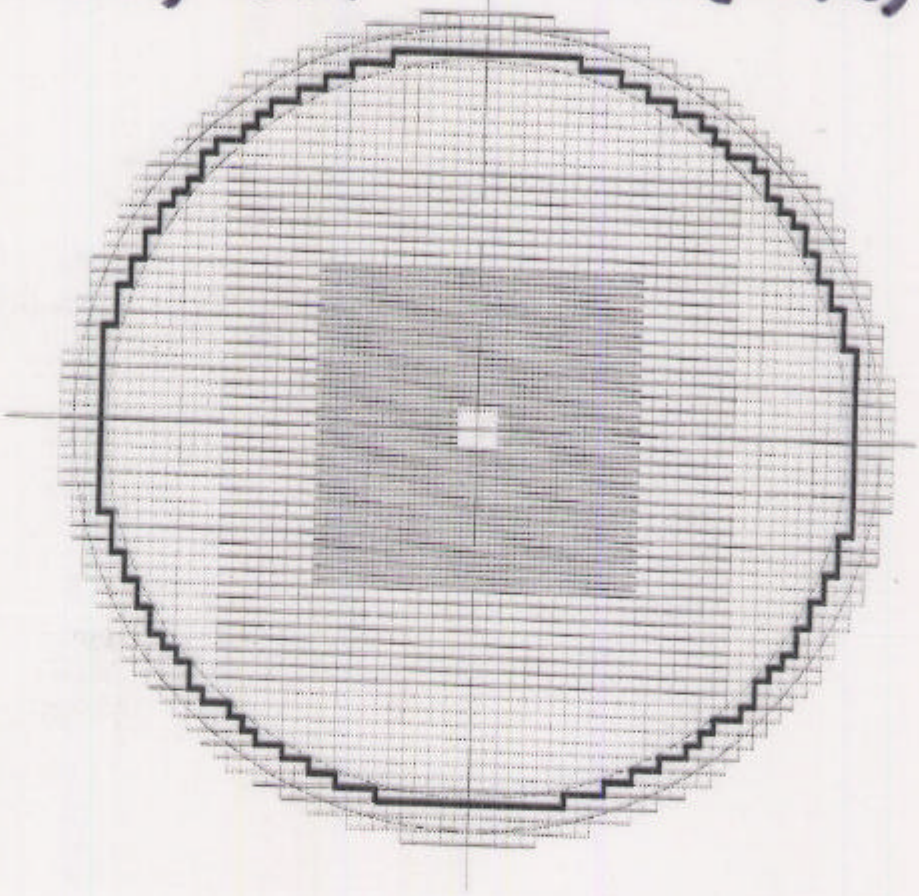
P-E8J-EP


KAMI DETECTOR LAYOUT
CsI
Magnet
Vacuum Window
Hadron Anti
Fiber Tracker
CsI
Mask Anti
Vacuum Veto
Charged Hodoscope
K_L
Beam Hole Veto
CsI Anti
γ veto

CsI calorimeter

2.75m$^{\phi}$

2.5cm$^{\square}$, 5cm$^{\square}$ × 50cm (27X_0)



Reconfigure KTeV calorimeter

+ additional crystals

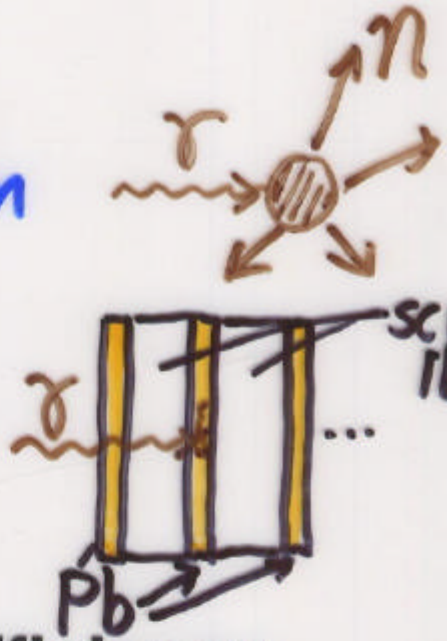
Important issues

- Better γ veto
- Clean beamline
  - High K flux
  - low n flux
- High acceptance

γ's can be missed

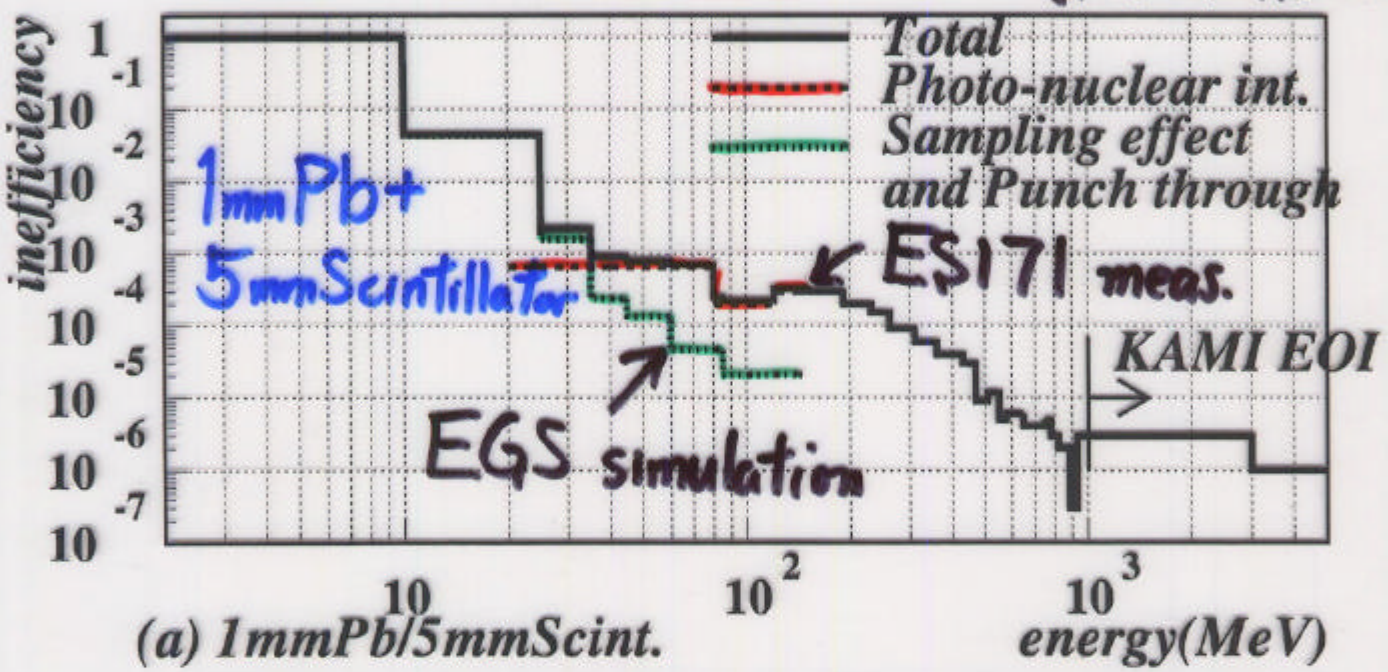
- photonuclear interaction

- absorbed in radiators
  (sampling effect)

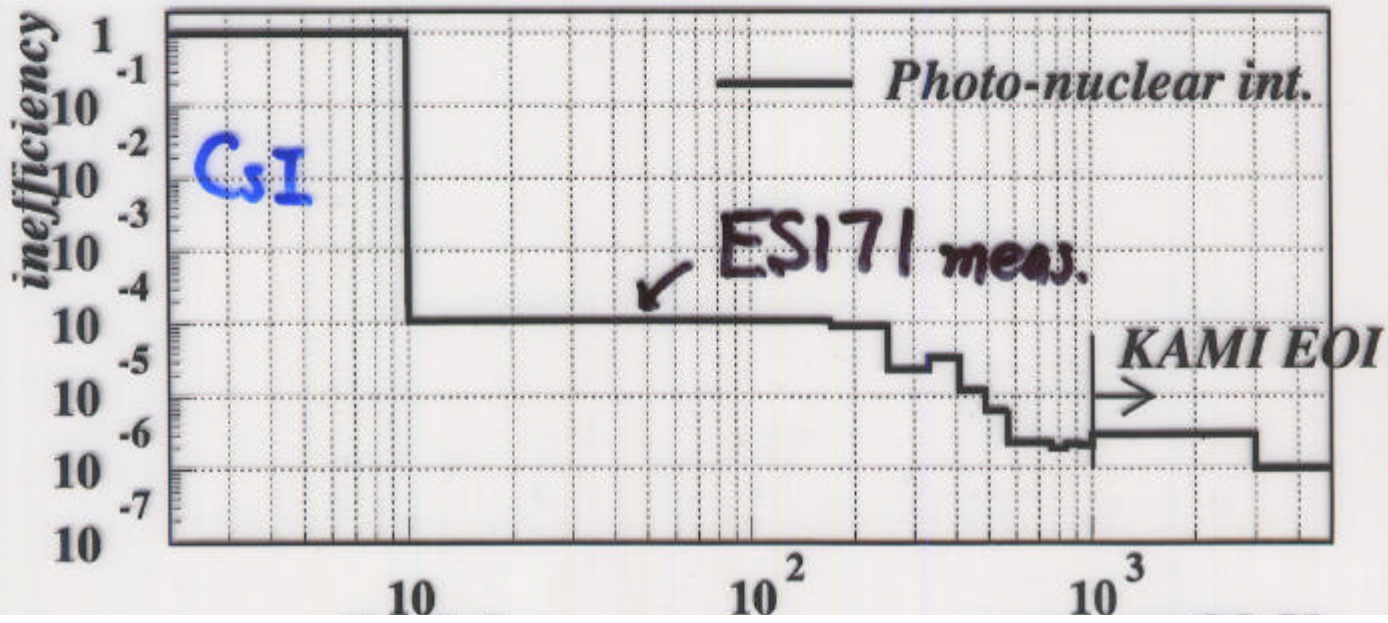


Photon Detection Inefficiency

(10MeV threshold)

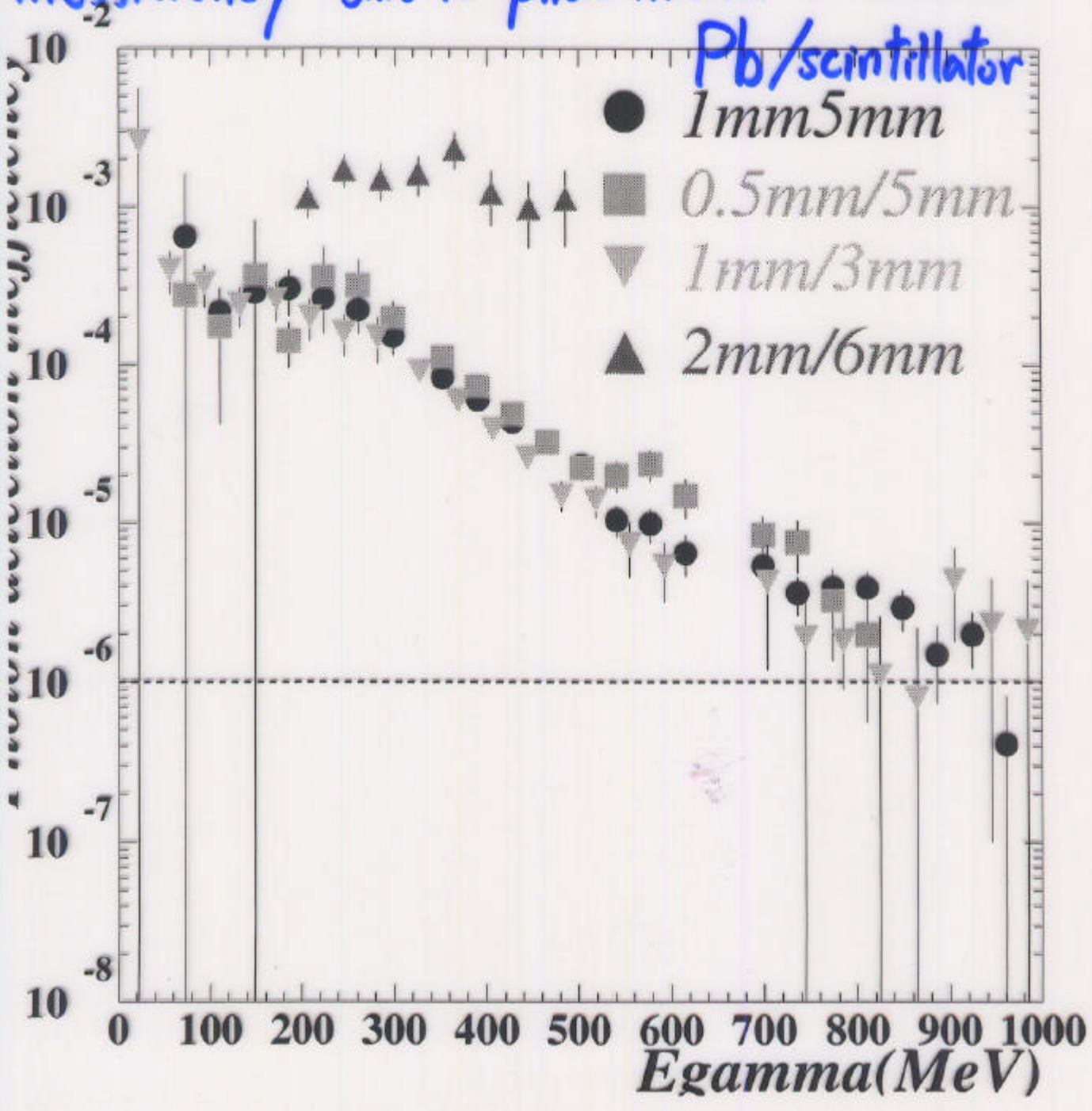


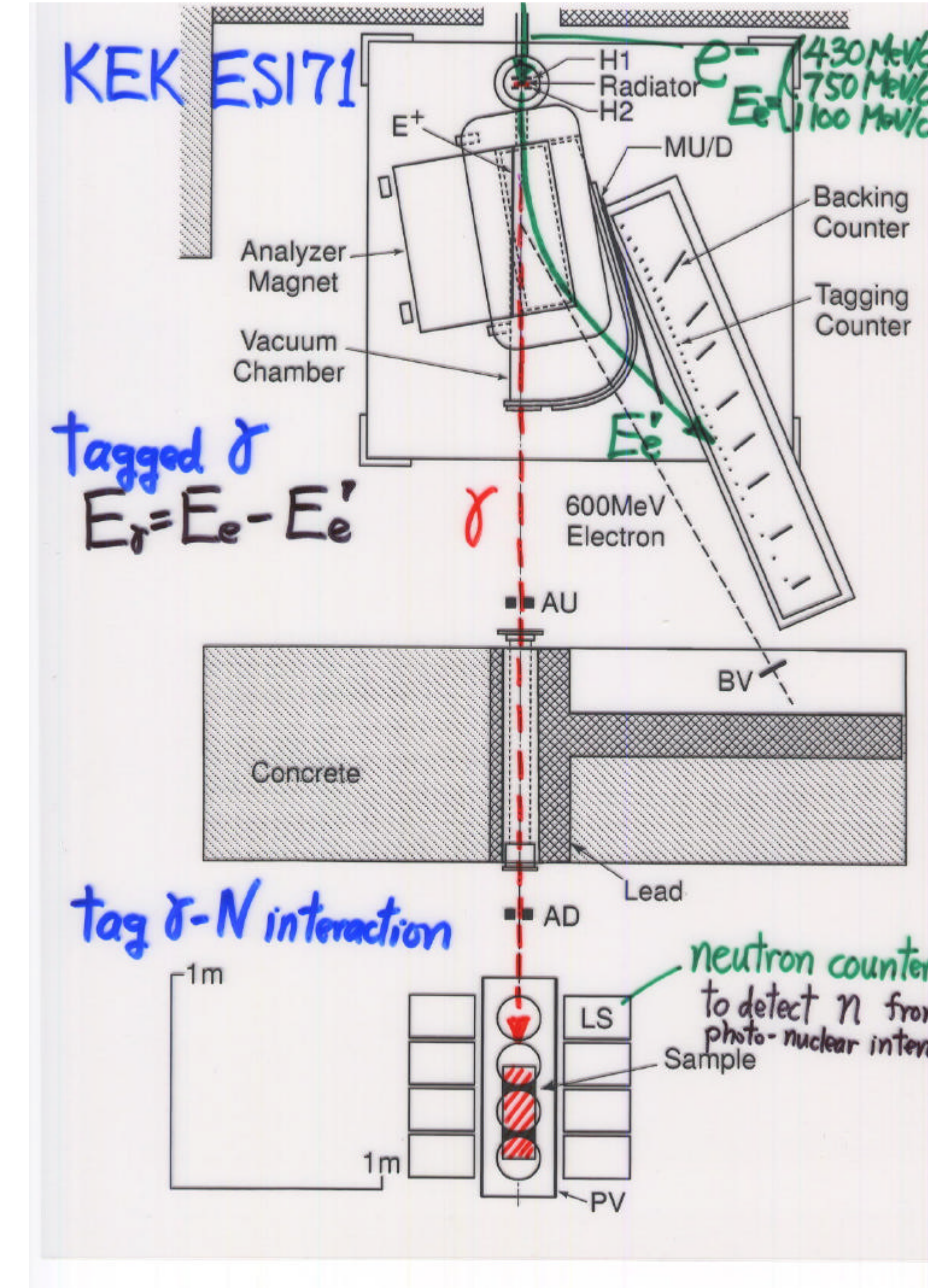
(a) 1mmPb/5mmScint.



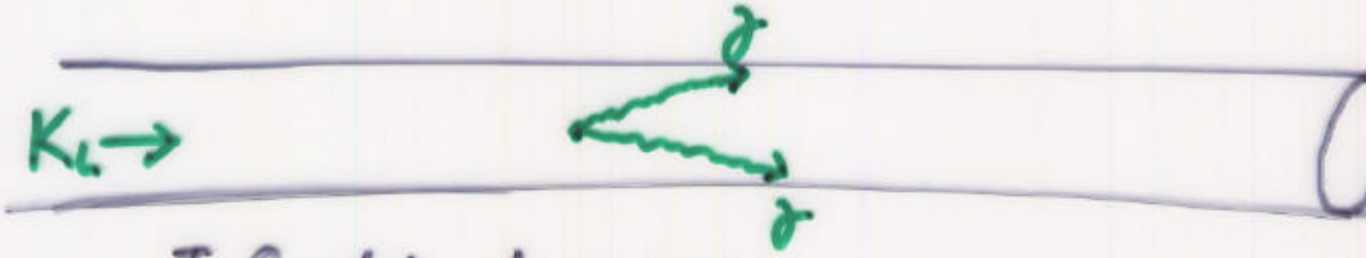
photon veto inefficiency due to photo-nuclear interaction

Pb/scintillator




KEK E5171
H1
Radiator
H2
e-
430 MeV/c
750 MeV/c
1100 MeV/c
E+
MU/D
Backing Counter
Analyzer Magnet
Tagging Counter
Vacuum Chamber
tagged γ
Eγ=Ee-Ee'
Ee'
γ
600MeV Electron
AU
BV
Concrete
Lead
tag γ-N interaction
AD
neutron counter
to detect n from
photo-nuclear inter
1m
LS
Sample
1m
PV

Very simple model



Infinitely long pipe

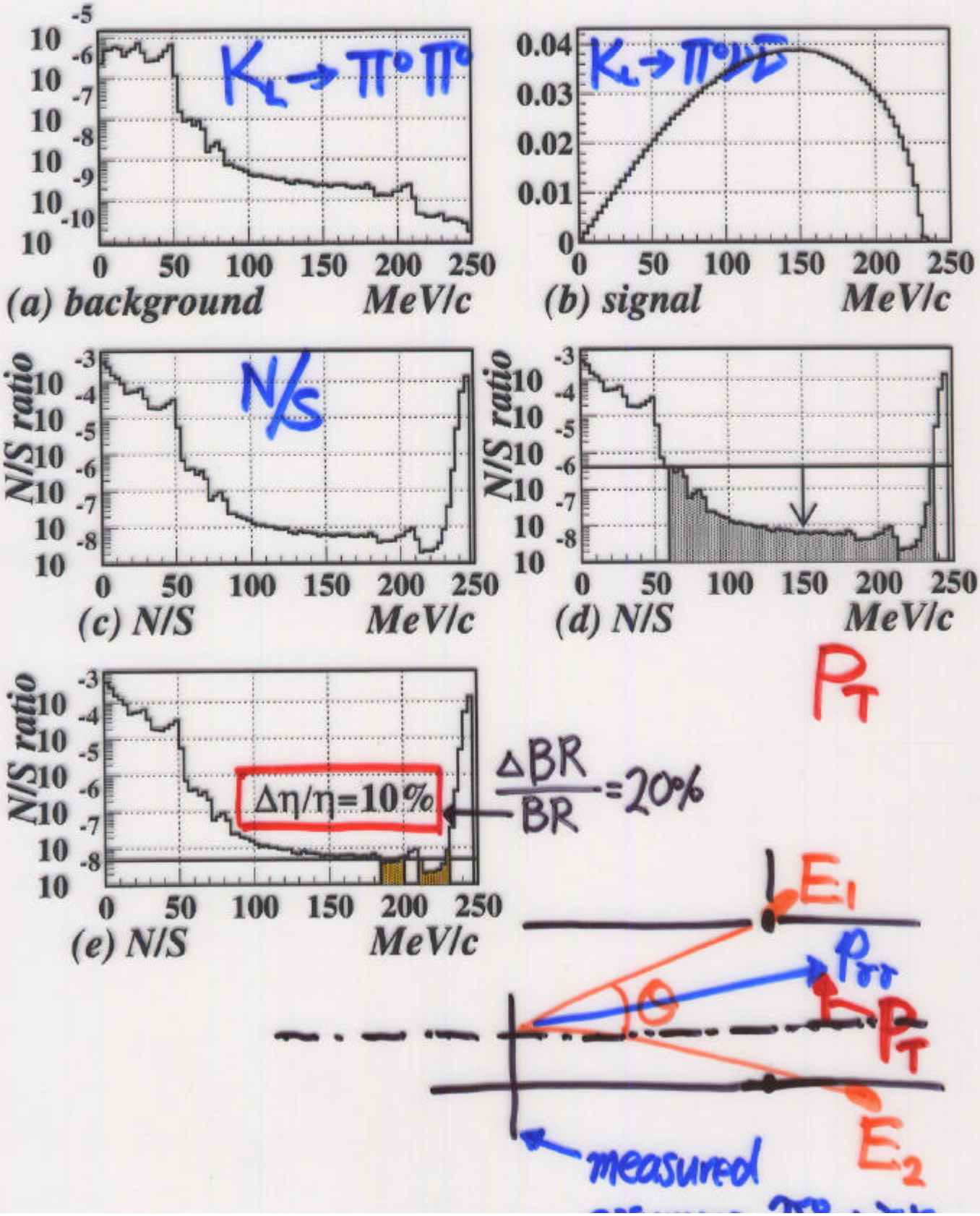
- $\Delta E/E \sim 1\%/\sqrt{E(GeV)}$ ⊕ (calorimeter
- γ veto inefficiency = 1mm Pb + 5mm sci sandwich ($18X_0$) (veto)

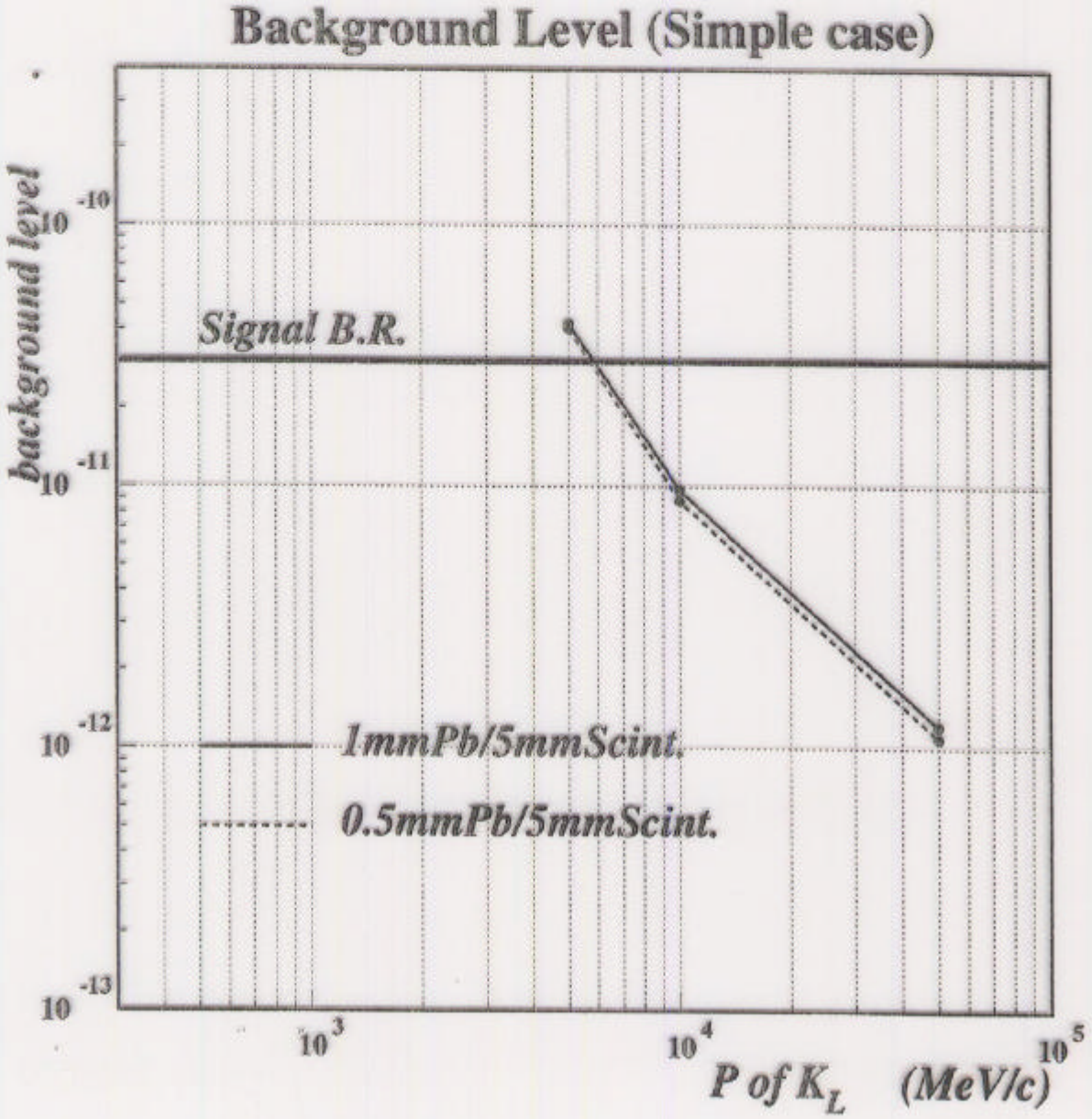
K_L decay $= 1.4 \times 10^{13}$ (FNAL KAMI EOI)

Monochromatic E_K

Background = $K_L \rightarrow \pi^0\pi^0$ with 2 missing γ

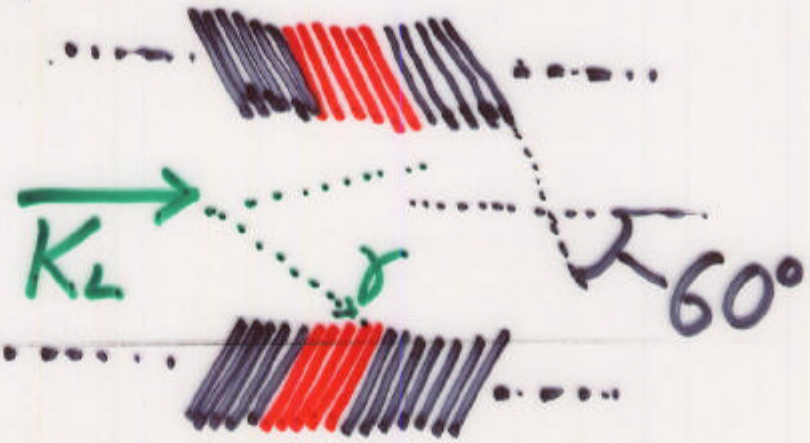
Pt(1mmPb/5mmScint.) P_K=10GeV/c

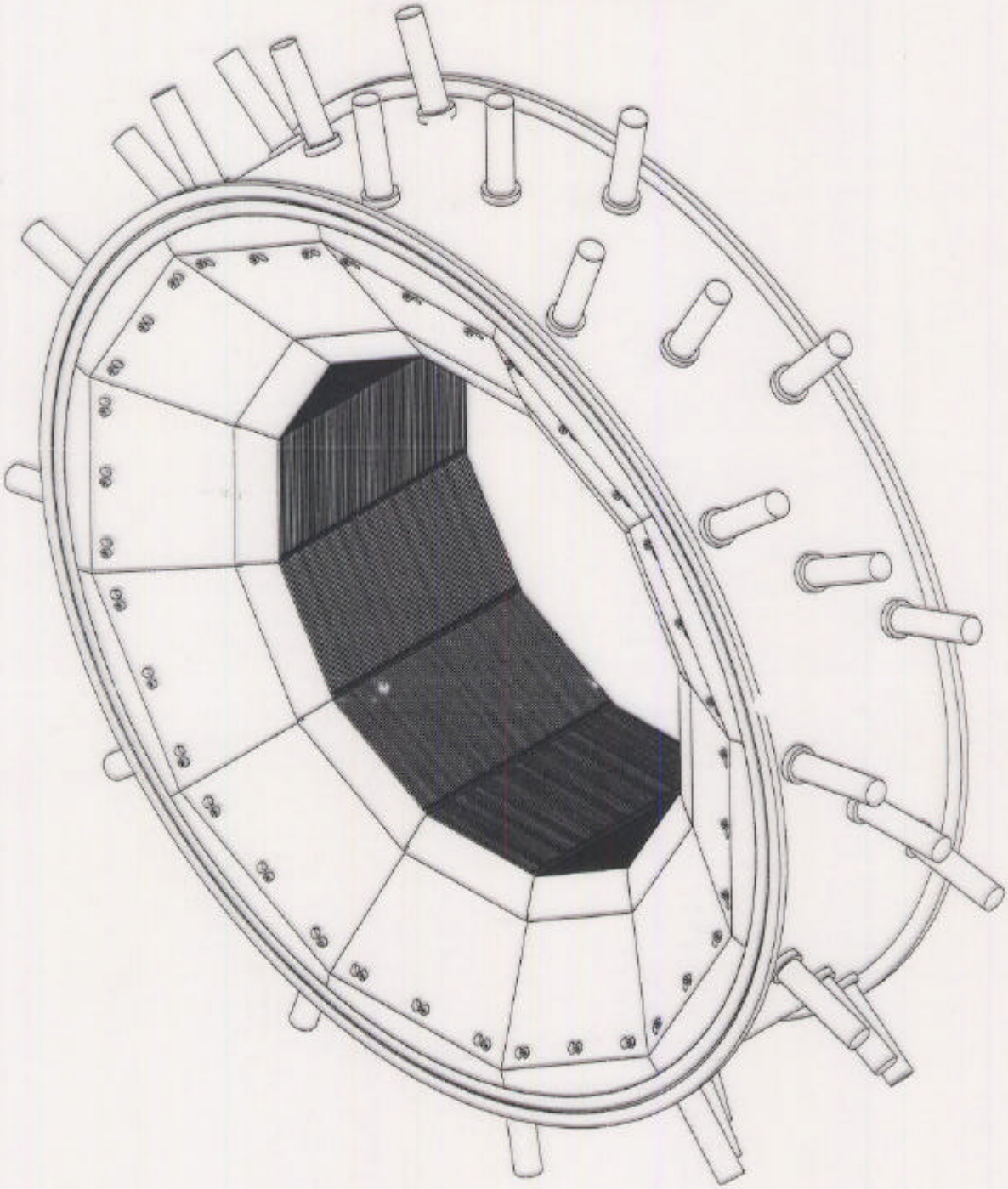



Background Level (Simple case)
background level
10^-10
10^-11
10^-12
10^-13
Signal B.R.
1mmPb/5mmScint.
0.5mmPb/5mmScint.
10^3
10^4
10^5
P of K_L (MeV/c)

γ veto design

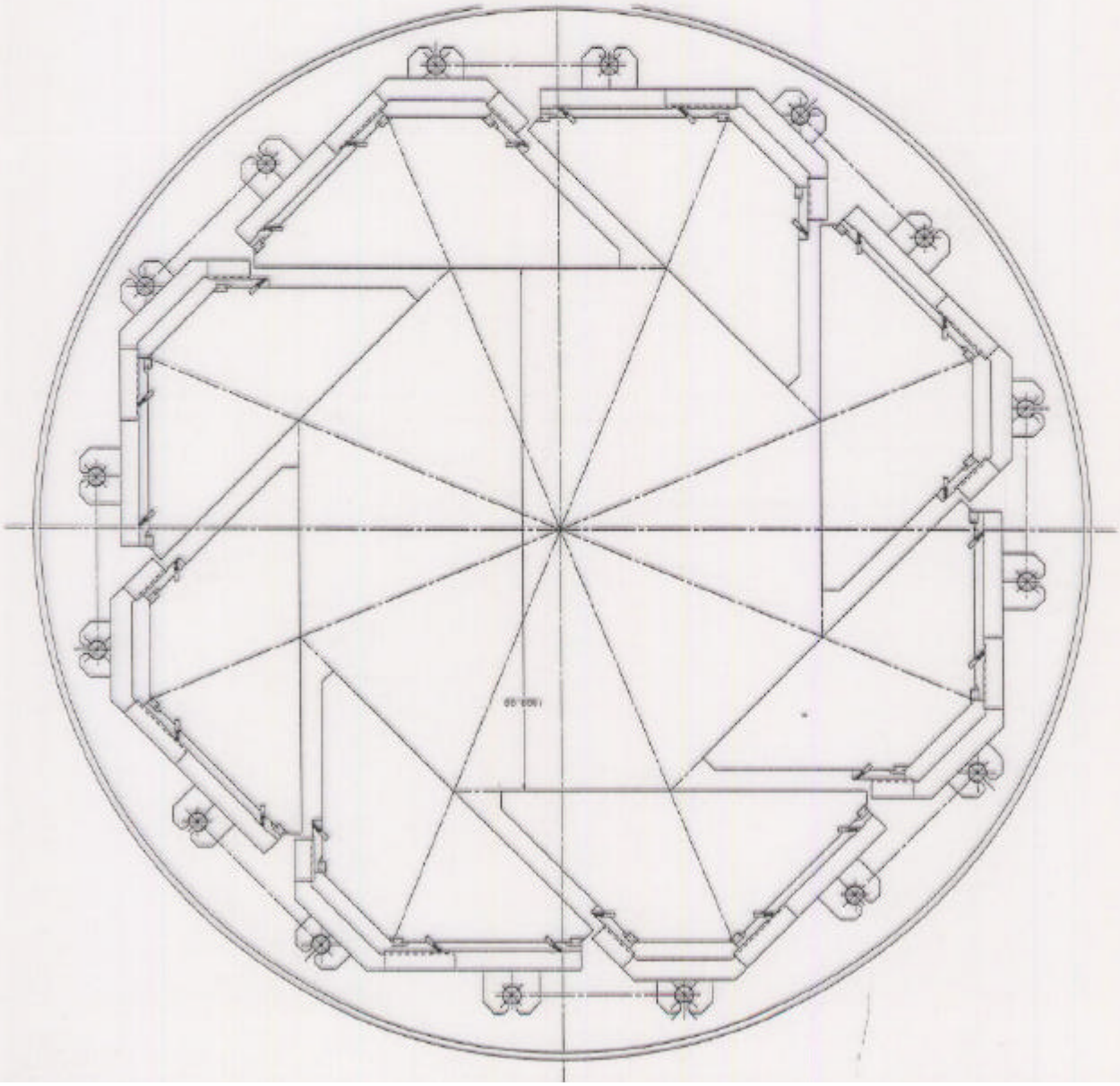
No. I.



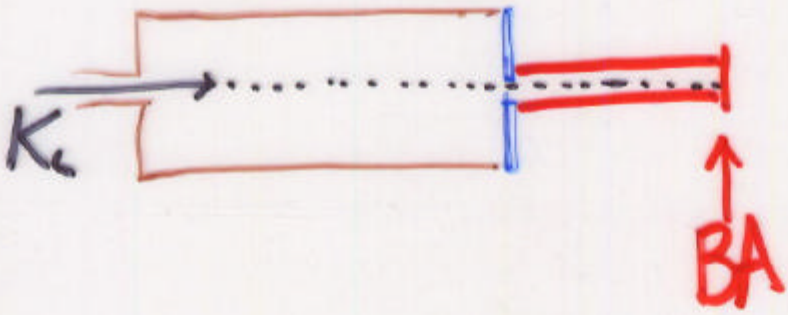


γ veto design

No. 2



γ veto at the downstream of CsI



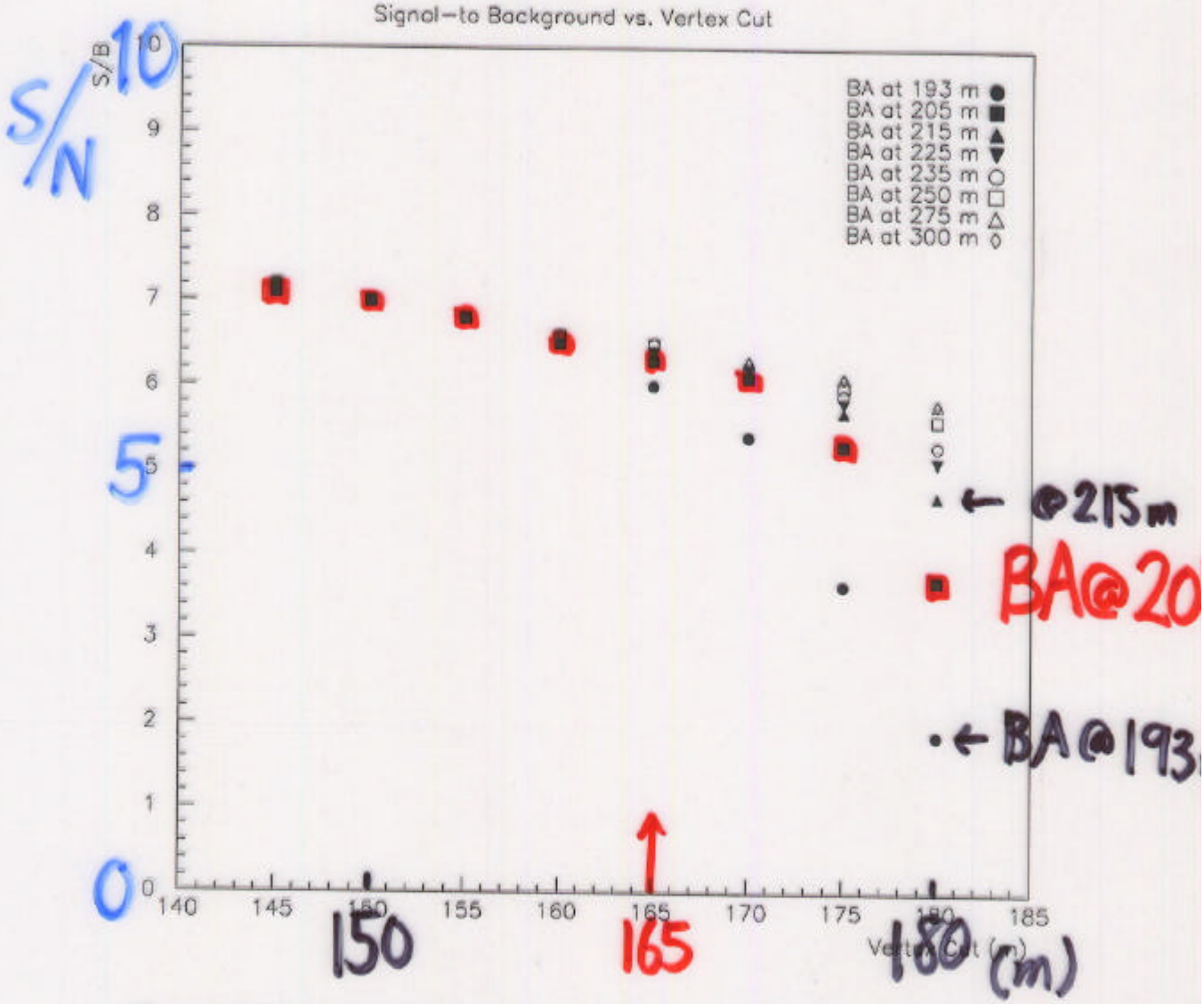


Figure 7: Signal-to-background vs. vertex cut for various BA positions.

d Z vertex cut