J-PARC K_L Experiment – Approach 2 –

M. Yamaga
Osaka Univ.

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Motivation

- ~300 events in 3 years

  at optimum experimental setup.

  S.E.S. = $1x10^{-13}$

  - 1-order better than KOPIO
  - 3-order better than E391a

- S.E.S. = 1 / (T x A x R)

  T : Data collection time. A : Acceptance ,   R : Decay rate

  e.g. $T=3\times10^{7}$sec(3year), A=0.01 → R~150MHz

  A=0.5 → R~3MHz

  c.f. E391a ~ 10KHz

  → High-acceptance detector is crucial.

Strategy

- Same concept as E391a $+\alpha$
  - Pencil beam, 2 γ detection.
  - (Angular measurement of γ).
- High-acceptance
  - Side-calorimeter as an active γ detector.
  - Beam intensity might not necessarily so high.

    → Less intensity-related backgrounds.
- High-energy
  - Better γ inefficiency

Sensitivity estimation

- Assumption
  - B-line
  - No limitation for the target, beamline and detector design.
  - Simplified beam and detector.

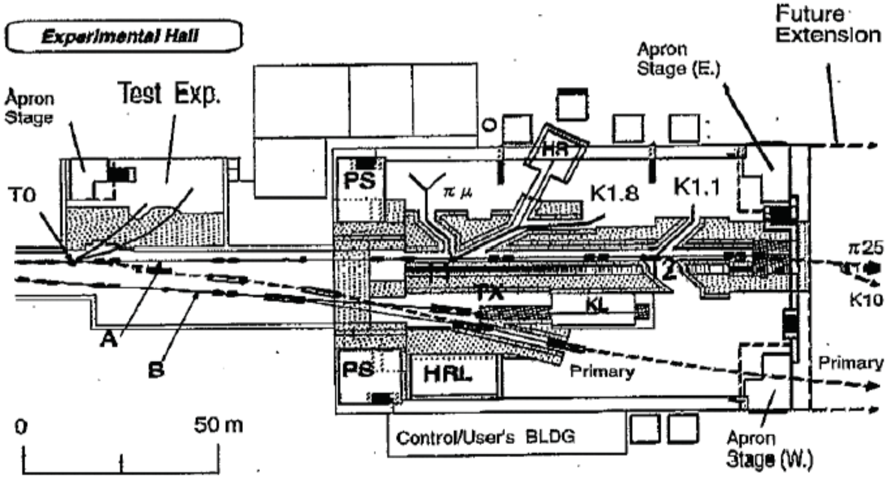
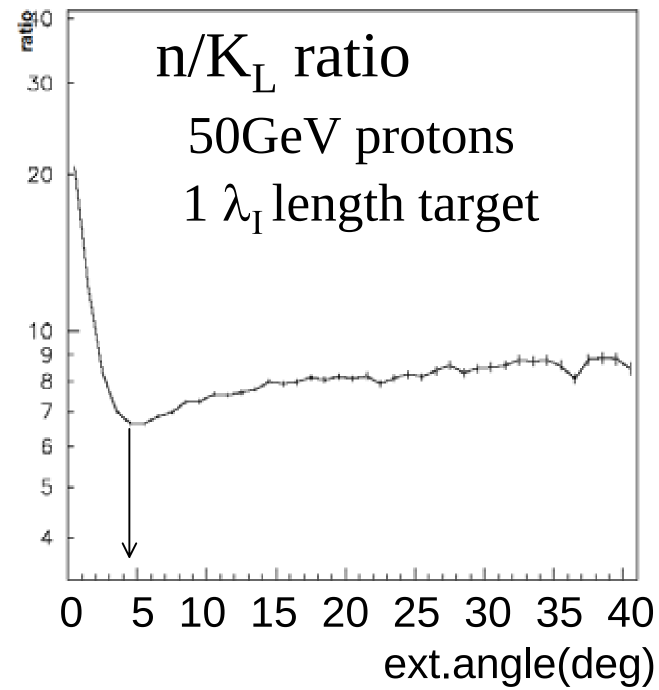


Fig. 2.1 Schematic layout of the experimental area at the 50-GeV PS.

Target, Beamline

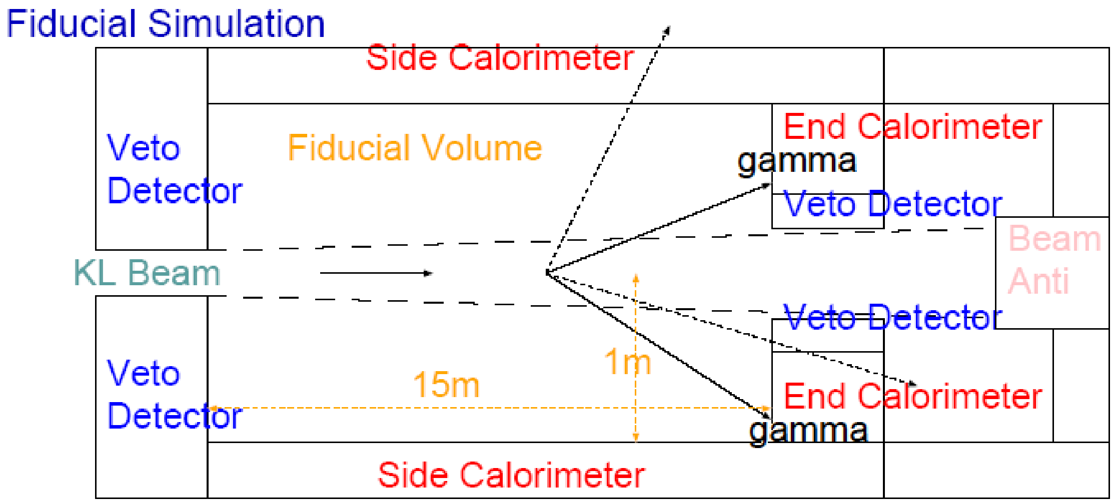
- Target
  - 50 GeV protons on 1 λ_I length of target.
  - 4° extraction to minimize n/K_L ratio.
  - $<p_{KL}>$ ~ 5 GeV/c.



- Neutral beamline
  - 1.2 μstr of solid angle.
  - 0.75 λ_I Be and 9 X_0 Pb absorber.

Detector

- 15m-long, 2m-ϕ cylinder.
- Located at z=50m to avoid Λ decays.
- Both of side- and endcap- calorimeters are the active γ detectors.
- Beam-anti completely dead.



Signal Yield

- 2×10^{14} ppp intensity
  - 1.8×10^{21} protons / 3 years
  - 1.5×10^{15} K_L / 3 years @ z=50m
  - 10 MHz of K_L decay rate @ z=52~60m
  - 1800 $\pi^0 \nu\nu$ decays / 3 years
- Signal yield = ~900 events / 3 years.
  - Endcap only = ~240 events

    → Side-calorimeter enhances by factor 3.8 .

Optimization underway…

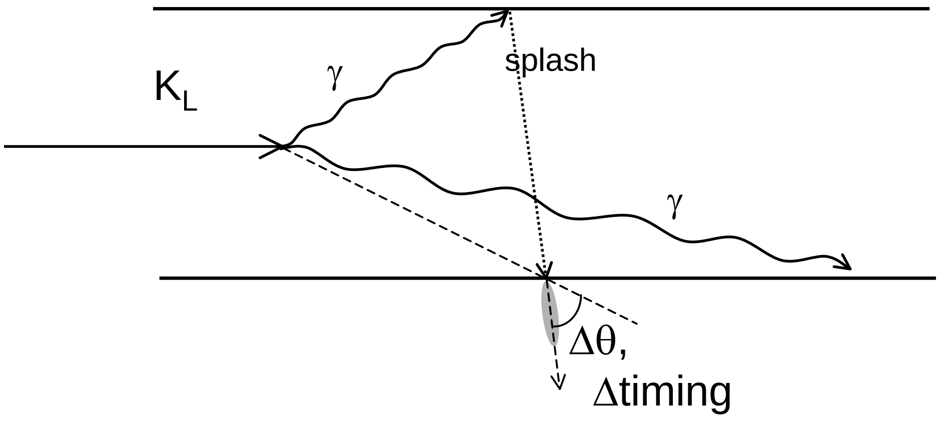
- Longer detector :
  - More decay probability.
  - More γ to side-calorimeter … S/N ?
- Larger diameter :
  - Better separation of 2 γs.
- Larger solid angle of beam :
  - More K_L.
  - Large beam size → p_T resolution ?
  - Large beam hole → BG by escaping particles.
  - Long detector … ‘effective’ beam-hole size would be small.

Problem of shower splash

- Acceptance loss by splashed γ and $e^{\pm}$.
  - E>5MeV for γ veto → ~50% of acceptance loss.

  ⇒ Timing or angular measurement might help to reduce it.
- Better BG reduction rate expected for $2\pi^0$, $3\pi^0$ due to many γs.

(Under study)



Applying to A-line

- Same detector configuration at A-line :

  30GeV protons, 16° extraction, 20m beamline.
  - # of K_L : x 0.06
  - Decay prob. : x 3 ($\langle p_{KL} \rangle \sim$ 2GeV/c)
  - Beam solid angle : x 3
  - 0.3 λ_I of T1 target : x 0.4

⇒ Signal yield ~200 events / 3 years.

BG could be large due to lower K_L energy.

Summary

- High-acceptance detector is crucial.
- 15m-long side-calorimeter increases the signal yield by factor of 3.8 .
- ~900 signals/3years with 2×10^{14} ppp at B-line.

- Further study needed for precise estimation.
  - Optimization for detector size, beam size.
  - Splashed particles.
  - BG